Semiconductor Data Handbook

Third Edition

HOW TO USE THIS BOOK

IF THE DEVICE TYPE NUMBER IS KNOWN

Look up the number in the *Index.* Either the exact General Electric type or a suggested replacement type will be shown. The page number of the referenced *Specification Sheet* is also indicated, and going to that page will provide you detailed information. Listings are numeric-alpha, by column.

IF THE GENERAL APPLICATION IS KNOWN

Refer to the *Selector Guide* for an overview of devices available and select one or more types to fit your application. Then refer back to the *Index* to obtain the page number of the detailed *Specification Sheets.*

USE INDEX FOR EXACT PAGE NUMBER

GENERAL ELECTRIC

The information in this catalog has been carefully checked and is believed to be reliable. However, no responsibility is assumed for inaccuracies. The suggested replacements in this catalog represent what we believe to be the nearest GE equivalents for the products listed and in most instances are exact replacements. However, GE assumes no responsibility and does not guarantee that the replacements are exact, but only that the replacements will meet the terms of its applicable published written product warranties. The pertinent GE product specification sheets should be used as the key tool for actual replacements.

Semiconductor Products Department

Electronics Park

Syracuse, N.Y. 13201

U.S.A.

Semiconductor Data Handbook

Third Edition

PRINTED IN U.S.A.

CONTENTS

MANUFACTURER'S CODES

AME – Amelco Semiconductors
AM – American Micro Semiconductors
AMD – Advanced Micro Devices
APX – Amperex Electronic Corp.
ATL – Atlantic Semiconductor, Inc.
CL – Centra Lab
CLA – Clarix
CMI – CMI, Inc.
DI – Diodes, Inc.
ECC – Electronics Component Corp.
ECD – Unisem Corp.
EDL – Edal Industries
ED – Electronic Devices, Inc.
ELN – Electro-Nuclear Labs
ESM – Societe European De Semiconducteurs, France
FER – Ferranti Ltd., England
FSC – Fairchild Semiconductor
GI – General Instruments
GSI – General Semiconductors, Inc.
HEI – Hei, Inc.
HP – Hewlett-Packard Co.
HUN – Hunt Semiconductors
HUT – Hutson Semiconductors
IR – International Rectifier
INT – Intel
ITC – Industro Transistor Corp.
KMC – KMC Semiconductor Corp.
LIT – Litronix
LUC – Lucas, England
MAT – Matsushita, Japan
MEH – Micro Electronics, Hong Kong
MIC – Microsemiconductor Corp.
MS – Micro State
MIT – Mitsubishi, Japan
MON – Monsanto Co.
MOS – Mosek
MOT – Motorola Semiconductor Products, Inc.
MS – Micro Systems, Int.
MST – MS Transistor Corp.
NAT – National Electronics
NEC – Nippon Electronic, Japan
NSC – National Semiconductor Corp.
OPC – Opcoa, Inc.
OPT – Optron, Inc.
PHF – Philco-Ford Corp.
PIR – Pirgo Electronics, Inc.
PLY – Plessy, Ltd.
PPC – Power Physics
PSI – Power Semiconductor, Inc.
RAD – La Radiotechnique, France
RAY – Raytheon Co.
RCA – RCA/Electronics Components
RC – Rectifier Components
ST – Sarkes-Tarzian
SK – Semicon, Inc.
SM – Semteck Corp.
SER – Servex Semiconductor Division, Australia
SGS – Societa Generale Semiconductors, Italy
SHW – Siemens, W. Germany
SIG – Signetics
SG – Silicon General
SIL – Silicon Transistor Corp.
SOD – Solitron Devices, Inc.
SPE – Spectronics, Inc.
SPR – Sperry Gyroscope Co.
SPG – Sprague
SSI – Solid State Products, Inc.
STC – Silicon Transistor Corp.
SYL – Sylvania Electric Products, Inc.
SYN – Syntron
TAG – Transistor AG, Switzerland
TEC – Transitron Electronic Corp.
TI – Texas Instruments, Inc.
TOS – Toshiba, Japan
TRW – TRW Semiconductor Division
TSC – Teledyne Semiconductors
UNI – Unitrode Corp.
UNS – Unisem, Inc.
UPI – United Page, Inc.
VAR – Varo, Inc.
VAD – Varadyne
WES – Westinghouse Electric Corp.

The suggested replacements represent what we believe to be equivalents for the products listed. GE assumes no responsibility and does not guarantee that the replacements are exact, but only that the replacements will meet the terms of its applicable published written product warranties. The pertinent GE product specification sheets should be used as the key tool for actual replacements.

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
1000PK**	IR	SCR		C450/C451	CF
101KL**	IR	RECTIFIER		A177	577
101RA**	IR	SCR		C180	842
101RC**	IR	SCR		C180	842
10RC100A	IR	SCR		C137PX27	CF
10RC10A	IR	SCR		C230AX243	CF
10RC10AS24	IR	SCR		C37AX127	CF
10RC120A	IR	SCR		C137PBX27	CF
10RC20A	IR	SCR		C230BX243	CF
10RC20AS24	IR	SCR		C37BX127	CF
10RC30A	IR	SCR		C230CX243	CF
10RC30AS24	IR	SCR		C37CX127	CF
10RC40A	IR	SCR		C230DX243	CF
10RC40AS24	IR	SCR		C37DX127	CF
10RC50A	IR	SCR		C230EX243	CF
10RC50AS24	IR	SCR		C37EX127	CF
10RC60A	IR	SCR		C230MX243	CF
10RC60AS24	IR	SCR		C37MX127	CF
10RC80A	IR	SCR		C137NX27	CF
115PA**	IR	SCR		C350	886
125PALB**	IR	SCR		C365	906
125PAM**	IR	SCR		C365	906
140PAM**	IR	SCR		C364	906
150K**	IR	RECTIFIER		A180	581
151RB**	IR	SCR		C180	842
151RC**	IR	SCR		C180	842
16C025C	SYN	SCR		2N681	306
16C050C	SYN	SCR		2N682	306
16C10C	SYN	SCR		2N683	306
16C15C	SYN	SCR		2N684	306
16C20C	SYN	SCR		2N685	306
16C25C	SYN	SCR		2N686	306
16C30C	SYN	SCR		2N687	306
16C40C	SYN	SCR		2N688	306
16C50C	SYN	SCR		2N689	306
16C60C	SYN	SCR		2N690	306
16C70C	SYN	SCR		2N691	306
16C80C	SYN	SCR		2N692	306
16RC100A	IR	SCR		2N5206	463
16RC10A	IR	SCR		C230AX244	CF
16RC10AS24	IR	SCR		C140A	783
16RC120A	IR	SCR		2N5207	463
16RC20A	IR	SCR		C230BX244	CF
16RC20AS24	IR	SCR		C140B	783
16RC30A	IR	SCR		C230CX244	CF
16RC30AS24	IR	SCR		C140C	783
16RC40A	IR	SCR		C230DX244	CF
16RC40AS24	IR	SCR		C140D	783
16RC50A	IR	SCR		C230EX244	CF
16RC50AS24	IR	SCR		C139E20E	775
16RC60A	IR	SCR		C230MX244	CF
16RC60AS24	IR	SCR		C139M20M	775
16RC80A	IR	SCR		2N5205	463
1714-0402		PWR TRAN		D44C6	1147
1714-0405		PWR TRAN		D44C6	1147
1714-0602		PWR TRAN		D44C8	1147
1714-0605		PWR TRAN		D44C8	1147
175PA**	IR	SCR		C380	912
18RC10	IR	SCR		C137AX149	CF
18RC15	IR	SCR		C137GX149	CF
18RC20	IR	SCR		C137BX149	CF
18RC25	IR	SCR		C137HX149	CF
18RC2	IR	SCR		C137UX149	CF
18RC30	IR	SCR		C137CX149	CF
18RC40	IR	SCR		C137DX149	CF
18RC50	IR	SCR		C137EX149	CF
18RC5	IR	SCR		C137FX149	CF
18RC60	IR	SCR		C137MX149	CF
18RC70	IR	SCR		C137SX149	CF
18RC80	IR	SCR		C137NX149	CF
18RC90	IR	SCR		C137TX149	CF
18RC100	IR	SCR		C137PX149	CF
1N914	GE	SIG DIODE	205		
1N914A	GE	SIG DIODE	205		
1N914B	GE	SIG DIODE	205		
1N916	GE	SIG DIODE	205		
1N916A	GE	SIG DIODE	205		
1N916B	GE	SIG DIODE	205		
1N248A, RA	GE	RECTIFIER	201		
1N248B, RB	GE	RECTIFIER	201		
1N248C, RC	GE	RECTIFIER	201		
1N248, R	GE	RECTIFIER	201		
1N249A, RA	GE	RECTIFIER	201		
1N249B, RB	GE	RECTIFIER	201		
1N249C, RC	GE	RECTIFIER	201		
1N249, R	GE	RECTIFIER	201		
1N250A, RA	GE	RECTIFIER	201		
1N250B, RB	GE	RECTIFIER	201		
1N250C, RC	GE	RECTIFIER	201		
1N250, R	GE	RECTIFIER	201		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
1N1183A, RA	GE	RECTIFIER	209		
1N1183, R	GE	RECTIFIER	209		
1N1184A, RA	GE	RECTIFIER	209		
1N1184, R	GE	RECTIFIER	209		
1N1185A, RA	GE	RECTIFIER	209		
1N1185, R	GE	RECTIFIER	209		
1N1186A, RA	GE	RECTIFIER	209		
1N1186, R	GE	RECTIFIER	209		
1N1187A, RA	GE	RECTIFIER	209		
1N1187, R	GE	RECTIFIER	209		
1N1188A, RA	GE	RECTIFIER	209		
1N1188, R	GE	RECTIFIER	209		
1N1189A, RA	GE	RECTIFIER	209		
1N1189, R	GE	RECTIFIER	209		
1N1190A, RA	GE	RECTIFIER	209		
1N1190, R	GE	RECTIFIER	209		
1N1191,R,A,RA	GE	RECTIFIER	CF		
1N1192,R,A,RA	GE	RECTIFIER	CF		
1N1193,R,A,RA	GE	RECTIFIER	CF		
1N1194,R,A,RA	GE	RECTIFIER	CF		
1N1195,R,A,RA	GE	RECTIFIER	CF		
1N1196,R,A,RA	GE	RECTIFIER	CF		
1N1197,R,A,RA	GE	RECTIFIER	CF		
1N1198,R,A,RA	GE	RECTIFIER	CF		
1N1199,R,A,RA	GE	RECTIFIER	213		
1N1200,R,A,RA	GE	RECTIFIER	213		
1N1201,R,A,RA	GE	RECTIFIER	213		
1N1202,R,A,RA	GE	RECTIFIER	213		
1N1203,R,A,RA	GE	RECTIFIER	213		
1N1204,R,A,RA	GE	RECTIFIER	213		
1N1205,R,A,RA	GE	RECTIFIER	213		
1N1206,R,A,RA	GE	RECTIFIER	213		
1N1341,R,A,RA	GE	RECTIFIER	217		
1N1342,R,A,RA	GE	RECTIFIER	217		
1N1343,R,A,RA	GE	RECTIFIER	217		
1N1344,R,A,RA	GE	RECTIFIER	217		
1N1345,R,A,RA	GE	RECTIFIER	217		
1N1346,R,A,RA	GE	RECTIFIER	217		
1N1347,R,A,RA	GE	RECTIFIER	217		
1N1348,R,A,RA	GE	RECTIFIER	217		
1N1581, R	GE	RECTIFIER	CF		
1N1582, R	GE	RECTIFIER	CF		
1N1583, R	GE	RECTIFIER	CF		
1N1584, R	GE	RECTIFIER	CF		
1N1585, R	GE	RECTIFIER	CF		
1N1586, R	GE	RECTIFIER	CF		
1N1587, R	GE	RECTIFIER	CF		
1N1612 R	GE	RECTIFIER	221		
1N1613 R	GE	RECTIFIER	221		
1N1614 R	GE	RECTIFIER	221		
1N1615, R	GE	RECTIFIER	221		
1N1616 R	GE	RECTIFIER	221		
1N2154, R	GE	RECTIFIER	225		
1N2155, R	GE	RECTIFIER	225		
1N2156, R	GE	RECTIFIER	225		
1N2157, R	GE	RECTIFIER	225		
1N2158, R	GE	RECTIFIER	225		
1N2159, R	GE	RECTIFIER	225		
1N2160, R	GE	RECTIFIER	225		
1N3208, R	GE	RECTIFIER	230		
1N3209, R	GE	RECTIFIER	230		
1N3210, R	GE	RECTIFIER	230		
1N3211, R	GE	RECTIFIER	230		
1N3212, R	GE	RECTIFIER	230		
1N3213, R	GE	RECTIFIER	230		
1N3214, R	GE	RECTIFIER	230		
1N3260,R	GE	RECTIFIER	232		
1N3261,R	GE	RECTIFIER	232		
1N3262,R	GE	RECTIFIER	232		
1N3263,R	GE	RECTIFIER	232		
1N3264,R	GE	RECTIFIER	232		
1N3265,R	GE	RECTIFIER	232		
1N3266, R	GE	RECTIFIER	232		
1N3267, R	GE	RECTIFIER	232		
1N3268, R	GE	RECTIFIER	232		
1N3269, R	GE	RECTIFIER	232		
1N3270, R	GE	RECTIFIER	232		
1N3271, R	GE	RECTIFIER	232		
1N3272, R	GE	RECTIFIER	232		
1N3273, R	GE	RECTIFIER	232		
1N3288,R	GE	RECTIFIER	234		
1N3289,R	GE	RECTIFIER	234		
1N3290, R	GE	RECTIFIER	234		
1N3291, R	GE	RECTIFIER	234		
1N3292,R	GE	RECTIFIER	234		
1N3293, R	GE	RECTIFIER	234		
1N3294,R	GE	RECTIFIER	234		
1N3295, R	GE	RECTIFIER	234		
1N3296, R	GE	RECTIFIER	234		
1N3670,A, R	GE	RECTIFIER	213		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
1N3671,A R	GE	RECTIFIER	213		
1N3672,A, R	GE	RECTIFIER	213		
1N3673,A, R	GE	RECTIFIER	213		
1N3712	GE	TUNNEL DIO	237		
1N3713	GE	TUNNEL DIO	237		
1N3714	GE	TUNNEL DIO	237		
1N3715	GE	TUNNEL DIO	237		
1N3716	GE	TUNNEL DIO	237		
1N3717	GE	TUNNEL DIO	237		
1N3718	GE	TUNNEL DIO	237		
1N3719	GE	TUNNEL DIO	237		
1N3720	GE	TUNNEL DIO	237		
1N3721	GE	TUNNEL DIO	237		
1N3735,R	GE	RECTIFIER	241		
1N3736,R	GE	RECTIFIER	241		
1N3738, R	GE	RECTIFIER	241		
1N3739, R	GE	RECTIFIER	241		
1N3740, R	GE	RECTIFIER	241		
1N3741, R	GE	RECTIFIER	241		
1N3742, R	GE	RECTIFIER	241		
1N3743, R	GE	RECTIFIER	241		
1N3765, R	GE	RECTIFIER	209		
1N3766, R	GE	RECTIFIER	209		
1N3767, R	GE	RECTIFIER	209		
1N3768, R	GE	RECTIFIER	209		
1N3879,R	GE	RECTIFIER	247		
1N3880,R	GE	RECTIFIER	247		
1N3881,R	GE	RECTIFIER	247		
1N3882,R	GE	RECTIFIER	247		
1N3883,R	GE	RECTIFIER	247		
1N3889,R	GE	RECTIFIER	249		
1N3890,R	GE	RECTIFIER	249		
1N3891,R	GE	RECTIFIER	249		
1N3892,R	GE	RECTIFIER	249		
1N3893,R	GE	RECTIFIER	249		
1N3899,R	GE	RECTIFIER	251		
1N3900,R	GE	RECTIFIER	251		
1N3901,R	GE	RECTIFIER	251		
1N3902,R	GE	RECTIFIER	251		
1N3903,R	GE	RECTIFIER	251		
1N3909,R	GE	RECTIFIER	253		
1N3910,R	GE	RECTIFIER	253		
1N3911,R	GE	RECTIFIER	253		
1N3912	GE	RECTIFIER	253		
1N3913,R	GE	RECTIFIER	253		
1N3987, R	GE	RECTIFIER	CF		
1N3988, R	GE	RECTIFIER	CF		
1N3989, R	GE	RECTIFIER	CF		
1N3990, R	GE	RECTIFIER	CF		
1N4044,R	GE	RECTIFIER	255		
1N4045,R	GE	RECTIFIER	255		
1N4046,R	GE	RECTIFIER	255		
1N4047,R	GE	RECTIFIER	255		
1N4048,R	GE	RECTIFIER	255		
1N4049,R	GE	RECTIFIER	255		
1N4050,R	GE	RECTIFIER	255		
1N4051,R	GE	RECTIFIER	255		
1N4052,R	GE	RECTIFIER	255		
1N4053,R	GE	RECTIFIER	255		
1N4054,R	GE	RECTIFIER	255		
1N4055,R	GE	RECTIFIER	255		
1N4056,R	GE	RECTIFIER	255		
1N4090		TUNNEL DIO	257		
1N4148	GE	SIG DIODE	205		
1N4149	GE	SIG DIODE	205		
1N4150	GE	SIG DIODE	258		
1N4151	GE	SIG DIODE	262		
1N4152	GE	SIG DIODE	262		
1N4153	GE	SIG DIODE	262		
1N4154	GE	SIG DIODE	205		
1N4156	GE	SIG DIODE	266		
1N4157	GE	SIG DIODE	266		
1N4245	GE	RECTIFIER	270		
1N4247	GE	RECTIFIER	270		
1N4248	GE	RECTIFIER	270		
1N4249	GE	RECTIFIER	270		
1N4305	GE	SIG DIODE	229		
1N4444	GE	SIG DIODE	272		
1N4446	GE	SIG DIODE	205		
1N4447	GE	SIG DIODE	205		
1N4448	GE	SIG DIODE	205		
1N4449	GE	SIG DIODE	205		
1N4450	GE	SIG DIODE	258		
1N4451	GE	SIG DIODE	274		
1N4453	GE	SIG DIODE	266		
1N4454	GE	SIG DIODE	262		
1N4510,R	GE	RECTIFIER	278		
1N4511,R	GE	RECTIFIER	278		
1N4529,R	GE	RECTIFIER	282		
1N4530,R	GE	RECTIFIER	282		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
1N4531	GE	SIG DIODE	205		
1N4532	GE	SIG DIODE	262		
1N4533	GE	SIG DIODE	262		
1N4534	GE	SIG DIODE	262		
1N4536	GE	SIG DIODE	205		
1N4606	GE	SIG DIODE	258		
1N4607	GE	SIG DIODE	274		
1N4608	GE	SIG DIODE	274		
1N4727	GE	SIG DIODE	286		
1N4828	GE	RECTIFIER	CF		
1N4829	GE	SIG DIODE	266		
1N4830	GE	SIG DIODE	266		
1N4863	GE	SIG DIODE	288		
1N4864	GE	SIG DIODE	288		
1N5059	GE	RECTIFIER	290		
1N5060	GE	RECTIFIER	290		
1N5061	GE	RECTIFIER	290		
1N5062	GE	RECTIFIER	290		
1N5179	GE	SIG DIODE	266		
1N5331, R	GE	RECTIFIER	213		
1N5332, R	GE	RECTIFIER	209		
1N5624	GE	RECTIFIER	294		
1N5625	GE	RECTIFIER	294		
1N5626	GE	RECTIFIER	294		
1N5627	GE	RECTIFIER	294		
201A	WESY	SCR		2N682	306
201B	WESY	SCR		2N683	306
201C	WESY	SCR		2N684	306
201D	WESY	SCR		2N685	306
201E	WESY	SCR		2N686	306
201F	WESY	SCR		2N687	306
201H	WESY	SCR		2N688	306
201K	WESY	SCR		2N689	306
201M	WESY	SCR		2N690	306
201P	WESY	SCR		2N691	306
201S	WESY	SCR		2N692	306
201U	WESY	SCR		2N681	306
201V	WESY	SCR		C137TX27	CF
201Z	WESY	SCR		C137PX27	CF
201ZB	WESY	SCR		C137PAX27	CF
201ZD	WESY	SCR		C137PBX27	CF
202A	WESY	SCR		2N1843	328
202B	WESY	SCR		2N1844	328
202C	WESY	SCR		2N1845	328
202D	WESY	SCR		2N1846	328
202E	WESY	SCR		2N1847	328
202F	WESY	SCR		2N1848	328
202H	WESY	SCR		2N1849	328
202K	WESY	SCR		2N1850	328
202M	WESY	SCR		C36M	328
202P	WESY	SCR		C36S	328
202S	WESY	SCR		C36N	328
202U	WESY	SCR		2N1842	328
202V	WESY	SCR		C137TX31	CF
202Z	WESY	SCR		C137PX31	CF
202ZB	WESY	SCR		C137PAX31	CF
202ZD	WESY	SCR		C137PBX31	CF
203A	WESY	SCR		2N1843A	328
203B	WESY	SCR		2N1844A	328
203C	WESY	SCR		2N1845A	328
203D	WESY	SCR		2N1846A	328
203E	WESY	SCR		2N1847A	328
203F	WESY	SCR		2N1848A	328
203H	WESY	SCR		2N1849A	328
203K	WESY	SCR		2N1850A	328
203M	WESY	SCR		C35M	675
203P	WESY	SCR		C35S	675
203S	WESY	SCR		C35N	675
203U	WESY	SCR		2N1842A	328
203V	WESY	SCR		C137TX31	CF
203Z	WESY	SCR		C137PX31	CF
22RC10	IR	SCR		C38A	683
22RC20	IR	SCR		C38B	683
22RC30	IR	SCR		C38C	683
22RC40	IR	SCR		C38D	683
22RC50	IR	SCR		C38E	683
22RC60	IR	SCR		C137MX63	CF
23C100B	SYN	SCR		C137P	771
23C110B	SYN	SCR		C137PA	771
23C120B	SYN	SCR		C137PB	771
23C50B	SYN	SCR		C137E	771
23C60B	SYN	SCR		C137M	771
23C70B	SYN	SCR		C137S	771
23C80B	SYN	SCR		C137N	771
23C90B	SYN	SCR		C137T	771
240PAM**	IR	SCR		C385	921
250PAC**	IR	SCR		C380X500	917
250PAM**	IR	SCR		C438	CF
250PA**	IR	SCR		C430	CF
251UL**	IR	RECTIFIER		A197	588

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement	
				Type	Page
2853		PWR TRAN		D42C6	1135
2853-2		PWR TRAN		D44C6	1147
2853-3		PWR TRAN		D42C6	1135
2854-1		PWR TRAN		D42C6	1135
2854-2		PWR TRAN		D44C6	1147
2854-3		PWR TRAN		D42C6	1135
2855-1		PWR TRAN		D42C6	1135
2855-2		PWR TRAN		D44C6	1147
2855-3		PWR TRAN		D42C6	1135
2856-1		PWR TRAN		D42C6	1135
2856-2		PWR TRAN		D44C6	1147
2856-3		PWR TRAN		D42C6	1135
2N489	GE	UJT TRAN	298		
2N489A	GE	UJT TRAN	298		
2N489B	GE	UJT TRAN	298		
2N490	GE	UJT TRAN	298		
2N490A	GE	UJT TRAN	298		
2N490B	GE	UJT TRAN	298		
2N490C	GE	UJT TRAN	304		
2N490C	GE	UJT TRAN	304		
2N681	GE	SCR	306		
2N681	GE	SCR	306		
2N682	GE	SCR	306		
2N682	GE	SCR	306		
2N683	GE	SCR	306		
2N683	GE	SCR	306		
2N684	GE	SCR	306		
2N684	GE	SCR	306		
2N685	GE	SCR	306		
2N685	GE	SCR	306		
2N686	GE	SCR	306		
2N686	GE	SCR	306		
2N687	GE	SCR	306		
2N687	GE	SCR	306		
2N688	GE	SCR	306		
2N688	GE	SCR	306		
2N689	GE	SCR	306		
2N689	GE	SCR	306		
2N690	GE	SCR	306		
2N690	GE	SCR	306		
2N690A	GE	SCR	306		
2N691	GE	SCR	306		
2N691	GE	SCR	306		
2N692	GE	SCR	306		
2N692	GE	SCR	306		
2N696A		PWR TRAN		D40E5	1109
2N697		PWR TRAN		D40E5	1109
2N697A		PWR TRAN		D40E5	1109
2N877	GE	SCR	310		
2N878	GE	SCR	310		
2N879	GE	SCR	310		
2N880	GE	SCR	310		
2N881	GE	SCR	310		
2N885	GE	SCR	310		
2N886	GE	SCR	310		
2N887	GE	SCR	310		
2N888	GE	SCR	310		
2N889	GE	SCR	310		
2N929		SIG TRAN		GES929	1191
2N930		SIG TRAN		GES930	1191
2N1047		PWR TRAN		D44C7	1147
2N1049		PWR TRAN		D44C8	1147
2N1050		PWR TRAN		D44R1	1159
2N1067		PWR TRAN		D40E1	1109
2N1068		PWR TRAN		D40E1	1109
2N1069		PWR TRAN		D44C6	1147
2N1070		PWR TRAN		D44C8	1147
2N1084		PWR TRAN		D43C5	1143
2N1092		PWR TRAN		D42C1	1135
2N1206		PWR TRAN		D40E5	1109
2N122		PWR TRAN		D40P1	1121
2N1335		PWR TRAN		D44R1	1159
2N1336		PWR TRAN		D44R1	1159
2N1337		PWR TRAN		D44R1	1159
2N1338		PWR TRAN		D44R1	1159
2N1339		PWR TRAN		D44R1	1159
2N1340		PWR TRAN		D44R1	1159
2N1341		PWR TRAN		D44R1	1159
2N1342		PWR TRAN		D44R1	1159
2N1409		PWR TRAN		D40E1	1109
2N1410A		PWR TRAN		D40E1	1109
2N1445		PWR TRAN		D44R1	1159
2N1470		PWR TRAN		D44C8	1147
2N1479		PWR TRAN		D40E5	1109
2N1480		PWR TRAN		D40E7	1109
2N1481		PWR TRAN		D40E5	1109
2N1482		PWR TRAN		D40E7	1109
2N1483		PWR TRAN		D44C5	1147
2N1484		PWR TRAN		D44C8	1147
2N1485		PWR TRAN		D44C5	1147

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement	
				Type	Page
2N1486		PWR TRAN		D44C8	1147
2N1505		PWR TRAN		D40E5	1109
2N1506		PWR TRAN		D40E5	1109
2N1506A		PWR TRAN		D40E7	1109
2N1595	GE	SCR	314		
2N1595A	GE	SCR	314		
2N1596	GE	SCR	314		
2N1596A	GE	SCR	314		
2N1597	GE	SCR	314		
2N1597A	GE	SCR	314		
2N1598	GE	SCR	314		
2N1598A	GE	SCR	314		
2N1599	GE	SCR	314		
2N1599A	GE	SCR	314		
2N1600	GE	SCR	322		
2N1601	GE	SCR	322		
2N1602	GE	SCR	322		
2N1603	GE	SCR	322		
2N1604	GE	SCR	322		
2N1613A		PWR TRAN		D40E5	1109
2N1613B		PWR TRAN		D40E7	1109
2N1671	GE	UJT TRAN	318		
2N1671A	GE	UJT TRAN	318		
2N1671B	GE	UJT TRAN	318		
2N1671C	GE	UJT TRAN	318		
2N1691		PWR TRAN		D40P1	1121
2N1700		PWR TRAN		D40E5	1109
2N1701		PWR TRAN		D44C4	1147
2N1709		PWR TRAN		D42C7	1135
2N1710		PWR TRAN		D42C4	1135
2N1714		PWR TRAN		D40E5	1109
2N1715		PWR TRAN		D44R1	1159
2N1716		PWR TRAN		D40E5	1109
2N1717		PWR TRAN		D44R1	1159
2N1718		PWR TRAN		D40E5	1109
2N1719		PWR TRAN		D42R1	1139
2N1720		PWR TRAN		D44C8	1147
2N1721		PWR TRAN		D42R1	1139
2N1722		PWR TRAN		D44H10	1155
2N1723		PWR TRAN		D44H11	1155
2N1725		PWR TRAN		D44H11	1155
2N1768		PWR TRAN		D44C6	1147
2N1769		PWR TRAN		D44C8	1147
2N1770	GE	SCR	322		
2N1770A	GE	SCR	663		
2N1771	GE	SCR	322		
2N1771A	GE	SCR	663		
2N1772	GE	SCR	322		
2N1772A	GE	SCR	663		
2N1773	GE	SCR	322		
2N1773A	GE	SCR	663		
2N1774	GE	SCR	322		
2N1774A	GE	SCR	663		
2N1775	GE	SCR	322		
2N1775A	GE	SCR	663		
2N1776	GE	SCR	322		
2N1776A	GE	SCR	663		
2N1777	GE	SCR	322		
2N1777A	GE	SCR	663		
2N1778	GE	SCR	322		
2N1792	GE	SCR	707		
2N1793	GE	SCR	707		
2N1794	GE	SCR	707		
2N1795	GE	SCR	707		
2N1796	GE	SCR	707		
2N1797	GE	SCR	707		
2N1798	GE	SCR	707		
2N1837		PWR TRAN		D40E5	1109
2N1838		PWR TRAN		D40E5	1109
2N1839		PRW TRAN		D40E5	1109
2N1840		PRW TRAN		D40E1	1109
2N1842	GE	SCR	328		
2N1842A	GE	SCR	328		
2N1842B	GE	SCR	675		
2N1843	GE	SCR	328		
2N1843A	GE	SCR	328		
2N1843B	GE	SCR	675		
2N1844	GE	SCR	328		
2N1844A	GE	SCR	328		
2N1844B	GE	SCR	675		
2N1845	GE	SCR	328		
2N1845A	GE	SCR	328		
2N1845B	GE	SCR	675		
2N1846	GE	SCR	328		
2N1846A	GE	SCR	328		
2N1846B	GE	SCR	675		
2N1847	GE	SCR	328		
2N1847A	GE	SCR	328		
2N1847B	GE	SCR	675		
2N1848	GE	SCR	328		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
2N1848A	GE	SCR	328		
2N1848B	GE	SCR	675		
2N1849	GE	SCR	328		
2N1849A	GE	SCR	328		
2N1849B	GE	SCR	675		
2N1850	GE	SCR	328		
2N1850A	GE	SCR	328		
2N1850B	GE	SCR	675		
2N1886		PWR TRAN		D44C8	1147
2N1889		PWR TRAN		D40E7	1109
2N1890		PWR TRAN		D40E7	1109
2N1909	GE	SCR	707		
2N1910	GE	SCR	707		
2N1911	GE	SCR	707		
2N1912	GE	SCR	707		
2N1913	GE	SCR	707		
2N1914	GE	SCR	707		
2N1915	GE	SCR	707		
2N1916	GE	SCR	701		
2N1943		PWR TRAN		D40E5	1109
2N1958		PWR TRAN		D40E5	1109
2N1958A		PWR TRAN		D40E5	1109
2N1959		PWR TRAN		D40E5	1109
2N1959A		PWR TRAN		D40E5	1109
2N1972		PWR TRAN		D40E5	1109
2N1973		PWR TRAN		D40E7	1109
2N1974		PWR TRAN		D40E7	1109
2N1975		PWR TRAN		D40N1	1117
2N1986		PWR TRAN		D40E1	1109
2N1987		PWR TRAN		D40E1	1109
2N1990		PWR TRAN		D40E7	1109
2N2008		PWR TRAN		D40N1	1117
2N2017		PWR TRAN		D40E5	1109
2N2018		PWR TRAN		D44Q1	1157
2N2019		PWR TRAN		D44Q3	1157
2N2020		PWR TRAN		D44Q1	1157
2N2021		PWR TRAN		D44Q3	1157
2N2023	GE	SCR	712		
2N2024	GE	SCR	712		
2N2025	GE	SCR	712		
2N2026	GE	SCR	712		
2N2027	GE	SCR	712		
2N2028	GE	SCR	712		
2N2029	GE	SCR	712		
2N2030	GE	SCR	712		
2N2033		PWR TRAN		D42C8	1135
2N2034		PWR TRAN		D42C8	1135
2N2035		PWR TRAN		D44C7	1147
2N2036		PWR TRAN		D44C8	1147
2N2038		PWR TRAN		D40E5	1109
2N2039		PWR TRAN		D40E7	1109
2N2040		PWR TRAN		D40E5	1109
2N2041		PWR TRAN		D40E7	1109
2N2049		PWR TRAN		D40E7	1109
2N2060		PWR TRAN		D40E7	1109
2N2060A		PWR TRAN		D40E7	1109
2N2102		PWR TRAN		D42R3	1139
2N2102A		PWR TRAN		D42R3	1139
2N2108		PWR TRAN		D40E5	1109
2N2150		PWR TRAN		D44Q1	1157
2N2151		PWR TRAN		D44Q1	1157
2N2160	GE	SCR	332		
2N2162		PWR TRAN		D40E1	1109
2N2163		PWR TRAN		D40E1	1109
2N2185		PWR TRAN		D41E1	1129
2N2186		PWR TRAN		D41E1	1129
2N2187		PWR TRAN		D41E1	1129
2N2192		PWR TRAN		D40E5	1109
2N2192A		PWR TRAN		D40E5	1109
2N2192B		PWR TRAN		D40E5	1109
2N2193		PWR TRAN		D40E7	1109
2N2193A		PWR TRAN		D40E7	1109
2N2193B		PWR TRAN		D40E7	1109
2N2194		PWR TRAN		D40E7	1109
2N2194A		PWR TRAN		D40E7	1109
2N2194B		PWR TRAN		D40E7	1109
2N2197		PWR TRAN		D44C7	1147
2N2198		PWR TRAN		D40E5	1109
2N2217		PWR TRAN		D40E5	1109
2N2218		PWR TRAN		D40E5	1109
2N2218A		PWR TRAN		D40E7	1109
2N2219		PWR TRAN		D40E5	1109
2N2220		PWR TRAN		D40E5	1109
2N2221		SIG TRAN		GES2221	1195
2N2221		PWR TRAN		D40E5	1109
2N2221A		SIG TRAN		GES2221A	1197
2N2222		SIG TRAN		GES2222	1195
2N2222		PWR TRAN		D40E5	1109
2N2222A		SIG TRAN		GES2222A	1197
2N2239		PWR TRAN		D40E5	1109

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
2N2270		PWR TRAN		D40E5	1109
2N2297		PWR TRAN		D40E5	1109
2N2322	GE	SCR	653		
2N2322A	GE	SCR	653		
2N2323	GE	SCR	653		
2N2323A	GE	SCR	653		
2N2324	GE	SCR	653		
2N2324A	GE	SCR	653		
2N2325	GE	SCR	653		
2N2325A	GE	SCR	653		
2N2326	GE	SCR	653		
2N2326A	GE	SCR	653		
2N2327	GE	SCR	653		
2N2327A	GE	SCR	653		
2N2328	GE	SCR	653		
2N2328A	GE	SCR	653		
2N2329	GE	SCR	653		
2N2330		PWR TRAN		D40E1	1109
2N2339		PWR TRAN		D44C4	1147
2N2344	GE	SCR	333		
2N2345	GE	SCR	333		
2N2346	GE	SCR	333		
2N2347	GE	SCR	333		
2N2348	GE	SCR	333		
2N2410		PWR TRAN		D40E1	1109
2N2443		PWR TRAN		D44R1	1159
2N2483		SIG TRAN		GES2483	1199
2N2537		PWR TRAN		D40E1	1109
2N2538		PWR TRAN		D40E1	1109
2N2573	GE	SCR	874		
2N2574	GE	SCR	874		
2N2575	GE	SCR	874		
2N2576	GE	SCR	874		
2N2577	GE	SCR	874		
2N2578	GE	SCR	874		
2N2579	GE	SCR	874		
2N2594		PWR TRAN		D40E1	1109
2N2619	GE	SCR	322		
2N2632		PWR TRAN		D44C8	1147
2N2646	GE	UJT TRAN	337		
2N2647	GE	UJT TRAN	337		
2N2653	GE	SCR	671		CF
2N2657		PWR TRAN		D42C7	1135
2N2699		PWR TRAN		D42C8	1135
2N2711	GE	SIG TRAN	341		
2N2712	GE	SIG TRAN	341		
2N2713	GE	SIG TRAN	343		
2N2714	GE	SIG TRAN	343		
2N2723		PWR TRAN		D40C7	1101
2N2724		PWR TRAN		D40C7	1101
2N2787		PWR TRAN		D40E7	1109
2N2788		PWR TRAN		D40E7	1109
2N2828		PWR TRAN		D44C5	1147
2N2829		PWR TRAN		D44C8	1147
2N2840	GE	UJT TRAN	348		
2N2846		PWR TRAN		D40E5	1109
2N2848		PWR TRAN		D40E5	1109
2N2853-1		PWR TRAN		D42C5	1135
2N2854-1		PWR TRAN		D42C3	1135
2N2855-1		PWR TRAN		D42C5	1135
2N2856-1		PWR TRAN		D42C5	1135
2N2863		PWR TRAN		D40E5	1109
2N2864		PWR TRAN		D40E5	1109
2N2868		PWR TRAN		D40D	1105
2N2875		PWR TRAN		D45C8	1163
2N2876		PWR TRAN		D42C7	1135
2N2877		PWR TRAN		D44C8	1147
2N2878		PWR TRAN		D44C6	1147
2N2883		PWR TRAN		D40E5	1109
2N2884		PWR TRAN		D40E5	1109
2N2888	GE	SCR	CF		
2N2889	GE	SCR	CF		
2N2906		SIG TRAN		GES2906	1201
2N2907		SIG TRAN		GES2907	1203
2N2923	GE	SIG TRAN	350		
2N2924	GE	SIG TRAN	350		
2N2925	GE	SIG TRAN	350		
2N2926	GE	SIG TRAN	351		
2N2927		PWR TRAN		D41E5	1129
2N2941		PWR TRAN		D44R1	1159
2N2947		PWR TRAN		D44C7	1147
2N2948		PWR TRAN		D44C4	1147
2N2949		PWR TRAN		D40E5	1109
2N2950		PWR TRAN		D40E5	1109
2N3015		PWR TRAN		D40E5	1109
2N3016		PWR TRAN		D40D7	1105
2N3017		PWR TRAN		D40D7	1105
2N3021		PWR TRAN		D45C5	1163
2N3022		PWR TRAN		D45C2	1163
2N3023		PWR TRAN		D45C6	1163

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
2N3024		PWR TRAN		D45C8	1163
2N3025		PWR TRAN		D45C6	1163
2N3026		PWR TRAN		D45C8	1163
2N3053		PWR TRAN		D40E5	1109
2N3053		SIG TRAN		GES3053	CF
2N3054		PWR TRAN		D44C8	1147
2N3072		PWR TRAN			CF
2N3091-96	IR	SCR		C50	707
2N3107		PWR TRAN			CF
2N3108		PWR TRAN			CF
2N3109		PWR TRAN			CF
2N3110		PWR TRAN			CF
2N3114		PWR TRAN		D44R1	1159
2N3118		PWR TRAN		D40E7	1109
2N3119		PWR TRAN		D40E7	1109
2N3120		PWR TRAN		D41E5	1129
2N3121		PWR TRAN		D41E5	1129
2N3122		PWR TRAN		D40E1	1109
2N3138		PWR TRAN		D44C7	1147
2N3140		PWR TRAN		D44C7	1147
2N3142		PWR TRAN		D44C7	1147
2N3144		PWR TRAN		D44C7	1147
2N3199		PWR TRAN		D45C5	1163
2N3200		PWR TRAN		D45C8	1163
2N3205		PWR TRAN		D45C4	1163
2N3206		PWR TRAN		D45C7	1163
2N3226		PWR TRAN		D44C5	1147
2N3228	GE	SCR	747		
2N3229		PWR TRAN		D42C7	1135
2N3244		PWR TRAN		D41E1	1129
2N3245		PWR TRAN		D41E5	1129
2N3252		PWR TRAN		D40E5	1109
2N3253		PWR TRAN		D40E5	1109
2N3269	GE	SCR	CF		
2N3270	GE	SCR	CF		
2N3271	GE	SCR	CF		
2N3272	GE	SCR	CF		
2N3295		PWR TRAN		D40E5	1109
2N3296		PWR TRAN			
2N3297		PWR TRAN		D44C4	
2N3298		PWR TRAN		D40E1	1109
2N3299		PWR TRAN		D40E1	1109
2N3300		PWR TRAN		D40E1	1109
2N3309		PWR TRAN		D40E7	1109
2N3326		PWR TRAN		D40E5	1109
2N3375		PWR TRAN		D40E5	1109
2N3390	GE	SIG TRAN	353		
2N3391	GE	SIG TRAN	354		
2N3391A	GE	SIG TRAN	354		
2N3392	GE	SIG TRAN	356		
2N3393	GE	SIG TRAN	356		
2N3394	GE	SIG TRAN	356		
2N3395	GE	SIG TRAN	359		
2N3396	GE	SIG TRAN	359		
2N3397	GE	SIG TRAN	359		
2N3398	GE	SIG TRAN	359		
2N3402	GE	SIG TRAN	361		
2N3403	GE	SIG TRAN	361		
2N3404	GE	SIG TRAN	361		
2N3405	GE	SIG TRAN	361		
2N3414	GE	SIG TRAN	361		
2N3415	GE	SIG TRAN	361		
2N3416	GE	SIG TRAN	361		
2N3417	GE	SIG TRAN	361		
2N3418		PWR TRAN		D42C8	1135
2N3420		PWR TRAN		D42C8	1135
2N343A		PWR TRAN		D40E5	1109
2N3440		PWR TRAN		D44R2	1159
2N3444		PWR TRAN		D40E7	1109
2N3464		PWR TRAN		D42C4	1135
2N3467		PWR TRAN		D41E5	1129
2N3468		PWR TRAN		D41E7	1129
2N3469		PWR TRAN		D42C3	1135
2N3485		PWR TRAN		D41E5	1129
2N3486		PWR TRAN		D41E5	1129
2N3500		PWR TRAN		D44R2	1159
2N3506		PWR TRAN		D42C6	1135
2N3507		PWR TRAN		D42C6	1135
2N3512		PWR TRAN		D40E5	1109
2N3525	GE	SCR	747		
2N3526		PWR TRAN		D42R1	1139
2N3528	GE	SCR	747		
2N3529	GE	SCR	747		
2N3553		PWR TRAN		D42C7	1135
2N3554		PWR TRAN		D42C7	1135
2N3565		SIG TRAN		GES3565	
2N3566		SIG TRAN		GES3566	
2N3567		SIG TRAN		GES3567	
2N3568		SIG TRAN		GES3568	
2N3569		SIG TRAN		GES3569	

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
2N3569		PWR TRAN		D40E5	1109
2N3583		PWR TRAN		D44R2	1159
2N3584		PWR TRAN		D44R2	1159
2N3585		PWR TRAN		D44R4	1159
2N3590		PWR TRAN		D44R2	1159
2N3591		PWR TRAN		D44R1	1159
2N3592		PWR TRAN		D44R2	1159
2N3593		PWR TRAN		D44R1	1159
2N3594		PWR TRAN		D44R2	1159
2N3619		PWR TRAN		D42C6	1135
2N3620		PWR TRAN		D42C2	1135
2N3621		PWR TRAN		D44C6	1147
2N3622		PWR TRAN		D44C6	1147
2N3623		PWR TRAN		D42C6	1135
2N3624		PWR TRAN		D42C6	1135
2N3625		PWR TRAN		D44C6	1147
2N3626		PWR TRAN		D44C6	1147
2N3627		PWR TRAN		D42C8	1135
2N3628		PWR TRAN		D42C8	1135
2N3629		PWR TRAN		D44C8	1147
2N3630		PWR TRAN		D44C8	1147
2N3632		PWR TRAN		D44C5	1147
2N3633		PWR TRAN		D44C5	1147
2N3638		SIG TRAN		MPS3638	CF
2N3638A		SIG TRAN		MPS3638A	CF
2N3649	GE	SCR	783		
2N3649	GE	SCR	783		
2N3650	GE	SCR	783		
2N3650	GE	SCR	783		
2N3651	GE	SCR	783		
2N3651	GE	SCR	783		
2N3652	GE	SCR	783		
2N3652	GE	SCR	783		
2N3653	GE	SCR	783		
2N3653	GE	SCR	783		
2N3654	GE	SCR	783		
2N3654	GE	SCR	783		
2N3655	GE	SCR	783		
2N3655	GE	SCR	783		
2N3656	GE	SCR	783		
2N3656	GE	SCR	783		
2N3657	GE	SCR	783		
2N3657	GE	SCR	783		
2N3658	GE	SCR	783		
2N3658	GE	SCR	783		
2N3659		PWR TRAN		D44R1	1159
2N3660		PWR TRAN		D43C3	1143
2N3661		PWR TRAN		D43C8	1143
2N3662	GE	SIG TRAN	365		
2N3663	GE	SIG TRAN	365		
2N3668	GE	SCR	874		
2N3669	GE	SCR	874		
2N3670	GE	SCR	874		
2N3675		PWR TRAN		D42C7	1135
2N3678		PWR TRAN		D41E7	1129
2N3702		SIG TRAN		MPS3702	1360
2N3703		SIG TRAN		MPS3703	1360
2N3704		SIG TRAN		MPS3704	1363
2N3705		SIG TRAN		MPS3705	1363
2N3706		SIG TRAN		MPS3706	1363
2N3712		PWR TRAN		D44R1	1159
2N3719		PWR TRAN		D43C6	1143
2N3720		PWR TRAN		D43C8	1143
2N3721	GE	SIG TRAN	369		
2N3722		PWR TRAN		D41E7	1129
2N3724		PWR TRAN		D41E1	1129
2N3724A		PWR TRAN		D41E1	1129
2N3725		PWR TRAN		D40E7	1109
2N3725A		PWR TRAN		D40E7	1109
2N3734		PWR TRAN		D40E5	1109
2N3735		PWR TRAN		D40E7	1109
2N3738		PWR TRAN		D42R1	1139
2N3739		PWR TRAN		D42R2	1139
2N3740		PWR TRAN		D45C7	1163
2N3740A		PWR TRAN		D45C7	1163
2N3742		PWR TRAN		D40N3	1117
2N3744		PWR TRAN		D44C5	1147
2N3745		PWR TRAN		D44C8	1147
2N3747		PWR TRAN		D44C6	1147
2N3748		PWR TRAN		D44C8	1147
2N3753	GE	SCR	CF		
2N3754	GE	SCR	CF		
2N3755	GE	SCR	CF		
2N3756	GE	SCR	CF		
2N3757	GE	SCR	CF		
2N3758	GE	SCR	CF		
2N3759	GE	SCR	CF		
2N3760	GE	SCR	CF		
2N3761	GE	SCR	CF		
2N3762		PWR TRAN		D43C6	1143

				Suggested GE Replacement	
Type	Mfg.	Prod. Line	Page	Type	Page
2N3763		PWR TRAN		D43C8	1143
2N3766		PWR TRAN		D44C8	1147
2N3818		PWR TRAN		D44C7	1147
2N3829		PWR TRAN		D41E1	1129
2N3830		PWR TRAN		D40E7	1109
2N3831		PWR TRAN		D40E5	1109
2N3843	GE	SIG TRAN	370		
2N3843A	GE	SIG TRAN	370		
2N3844	GE	SIG TRAN	370		
2N3844A	GE	SIG TRAN	370		
2N3845	GE	SIG TRAN	370		
2N3845A	GE	SIG TRAN	370		
2N3852		PWR TRAN		D42C6	1135
2N3853		PWR TRAN		D42C5	1135
2N3854	GE	SIG TRAN	374		
2N3854A	GE	SIG TRAN	374		
2N3855	GE	SIG TRAN	374		
2N3855A	GE	SIG TRAN	374		
2N3856	GE	SIG TRAN	374		
2N3856A	GE	SIG TRAN	374		
2N3858	GE	SIG TRAN	382		
2N3858A	GE	SIG TRAN	387		
2N3859	GE	SIG TRAN	382		
2N3859A	GE	SIG TRAN	387		
2N3860	GE	SIG TRAN	382		
2N3867		PWR TRAN		D43C6	1143
2N3868		PWR TRAN		D43C8	1143
2N3870	GE	SCR	874		
2N3871	GE	SCR	874		
2N3872	GE	SCR	874		
2N3873	GE	SCR	874		
2N3877	GE	SIG TRAN	391		
2N3877A	GE	SIG TRAN	391		
2N3878		PWR TRAN		D44C8	1147
2N3896	GE	SCR	874		
2N3897	GE	SCR	874		
2N3898	GE	SCR	874		
2N3899	GE	SCR	874		
2N3900	GE	SIG TRAN	393		
2N3900A	GE	SIG TRAN	393		
2N3901	GE	SIG TRAN	395		
2N3903	GE	SIG TRAN	397		
2N3904	GE	SIG TRAN	397		
2N3905	GE	SIG TRAN	401		
2N3906	GE	SIG TRAN	401		
2N3916		PWR TRAN		D44R2	1159
2N3917		PWR TRAN		D44C8	1147
2N3918		PWR TRAN		D44C8	1147
2N3919		PWR TRAN		D42C8	1135
2N3923		PWR TRAN		D44R1	1159
2N3924		PWR TRAN		D40E1	1109
2N3925		PWR TRAN		D42C1	1135
2N3926		PWR TRAN		D40E1	1109
2N3927		PWR TRAN		D44C1	1147
2N3936	GE	SCR	CF		
2N3937	GE	SCR	CF		
2N3938	GE	SCR	CF		
2N3939	GE	SCR	CF		
2N3940	GE	SCR	CF		
2N3945		PWR TRAN		D40E5	1109
2N3948		PWR TRAN		D40E1	1109
2N3961		PWR TRAN		D42C4	1135
2N4012		PWR TRAN		D40E5	1109
2N4026		PWR TRAN		D41E5	1129
2N4027		PWR TRAN		D41E7	1129
2N4028		PWR TRAN		D41E5	1129
2N4029		PWR TRAN		D41E7	1129
2N4030		PWR TRAN		D41E5	1129
2N4032		PWR TRAN		D41E5	1129
2N4036		PWR TRAN		D41E7	1129
2N4037		PWR TRAN		D41E5	1129
2N4040		PWR TRAN		D42C4	1135
2N4041		PWR TRAN		D42C4	1135
2N4046		PWR TRAN		D40E5	1109
2N4047		PWR TRAN		D40E7	1109
2N4047		PWR TRAN		D40E7	1109
2N4054		PWR TRAN		D40N3	1117
2N4055		PWR TRAN		D40N1	1117
2N4056		PWR TRAN		D40N1	1117
2N4057		PWR TRAN		D40N1	1117
2N4064		PWR TRAN		D44R2	1159
2N4069		PWR TRAN		D44R2	1159
2N4073		PWR TRAN		D40E7	1109
2N4101	GE	SCR	747		CF
2N4103	GE	SCR	CF		
2N4111		PWR TRAN		D44C8	1147
2N4123	GE	SIG TRAN	405		
2N4124	GE	SIG TRAN	405		
2N4125	GE	SIG TRAN	409		
2N4126	GE	SIG TRAN	409		
2N4127		PWR TRAN		D44C5	1147
2N4128		PWR TRAN		D44C4	1147
2N4152	GE	SCR	862		
2N4153	GE	SCR	862		
2N4154	GE	SCR	862		
2N4155	GE	SCR	862		
2N4156	GE	SCR	862		
2N4157	GE	SCR	862		
2N4158	GE	SCR	862		
2N4159	GE	SCR	862		
2N4160	GE	SCR	862		
2N4161	GE	SCR	862		
2N4162	GE	SCR	862		
2N4163	GE	SCR	862		
2N4164	GE	SCR	862		
2N4165	GE	SCR	862		
2N4166	GE	SCR	862		
2N4167	GE	SCR	CF		
2N4168	GE	SCR	CF		
2N4169	GE	SCR	CF		
2N4170	GE	SCR	CF		
2N4171	GE	SCR	CF		
2N4172	GE	SCR	CF		
2N4173	GE	SCR	CF		
2N4174	GE	SCR	CF		
2N4175	GE	SCR	862		
2N4176	GE	SCR	862		
2N4177	GE	SCR	862		
2N4178	GE	SCR	862		
2N4179	GE	SCR	862		
2N4180	GE	SCR	862		
2N4181	GE	SCR	862		
2N4182	GE	SCR	862		
2N4183	GE	SCR	CF		
2N4184	GE	SCR	CF		
2N4185	GE	SCR	CF		
2N4186	GE	SCR	CF		
2N4187	GE	SCR	CF		
2N4188	GE	SCR	CF		
2N4189	GE	SCR	CF		
2N4190	GE	SCR	CF		
2N4191	GE	SCR	CF		
2N4192	GE	SCR	CF		
2N4193	GE	SCR	CF		
2N4194	GE	SCR	CF		
2N4195	GE	SCR	CF		
2N4196	GE	SCR	CF		
2N4197	GE	SCR	CF		
2N4198	GE	SCR	CF		
2N4225		PWR TRAN		D42C6	1135
2N4226		PWR TRAN		D42C8	1135
2N4231		PWR TRAN		D44C6	1147
2N4232		PWR TRAN		D44C8	1147
2N4234		PWR TRAN		D41E1	1129
2N4235		PWR TRAN		D41E5	1129
2N4236		PWR TRAN		D41E7	1129
2N4237		PWR TRAN		D40D	1105
2N4238		PWR TRAN		D40E7	1109
2N4240		PWR TRAN		D44R4	1159
2N4248		SIG TRAN		GES4248	CF
2N4256	GE	SIG TRAN	413		
2N4271		PWR TRAN		D44R1	1159
2N4296		PWR TRAN		D44R2	1159
2N4297		PWR TRAN		D44R2	1159
2N4307		PWR TRAN		D42C8	1135
2N4308		PWR TRAN		D42C8	1135
2N4311		PWR TRAN		D42C8	1135
2N4312		PWR TRAN		D42C8	1135
2N4314		PWR TRAN		D41E7	1129
2N4316	GE	SCR	CF		
2N4317	GE	SCR	CF		
2N4318	GE	SCR	CF		
2N4349		PWR TRAN		D40E1	1109
2N4350		PWR TRAN		D40E5	1109
2N4387		PWR TRAN		D45C5	1163
2N4388		PWR TRAN		D45C8	1163
2N4400	GE	SIG TRAN	415		
2N4401	GE	SIG TRAN	415		
2N4402	GE	SIG TRAN	418		
2N4403	GE	SIG TRAN	418		
2N4409	GE	SIG TRAN	421		
2N4410	GE	SIG TRAN	421		
2N4424	GE	SIG TRAN	423		
2N4425	GE	SIG TRAN	423		
2N4428		PWR TRAN		D42C2	1135
2N4429		PWR TRAN		D40E5	1109
2N4430		PWR TRAN		D40E5	1109
2N4440		PWR TRAN		D40E5	1109
2N4441	GE	SCR	747		
2N4442	GE	SCR	747		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
2N4443	GE	SCR	747		
2N4444	GE	SCR	862		
2N4877		PWR TRAN		D42C7	1135
2N4890		PWR TRAN		D41E5	1129
2N4898		PWR TRAN		D45C5	1163
2N4899		PWR TRAN		D45C8	1163
2N4910		PWR TRAN		D44C5	1147
2N4911		PWR TRAN		D44C8	1147
2N4918		PWR TRAN		D45C5	1163
2N4919		PWR TRAN		D45C8	1163
2N491	GE	UJT TRAN	298		
2N491A	GE	UJT TRAN	298		
2N491B	GE	UJT TRAN	298		
2N4920		PWR TRAN		D45C11	1163
2N4921		PWR TRAN		D44C4	1147
2N4922		PWR TRAN		D44C7	1147
2N4923		PWR TRAN		D44C10	1147
2N4924		PWR TRAN		D40N1	1117
2N4925		PWR TRAN		D44R2	1159
2N4926		PWR TRAN		D40N1	1117
2N4927		PWR TRAN		D40N1	1117
2N492	GE	UJT TRAN	298		
2N492A	GE	UJT TRAN	298		
2N492B	GE	UJT TRAN	298		
2N492C	GE	UJT TRAN	304		
2N492C	GE	UJT TRAN	304		
2N493	GE	UJT TRAN	298		
2N493A	GE	UJT TRAN	298		
2N493B	GE	UJT TRAN	298		
2N494	GE	UJT TRAN	298		
2N494A	GE	UJT TRAN	298		
2N494B	GE	UJT TRAN	298		
2N494C	GE	UJT TRAN	304		
2N494C	GE	UJT TRAN	304		
2N4976		PWR TRAN		D40E1	1109
2N4983	GE	SWITCH	427		
2N4984	GE	SWITCH	431		
2N4985	GE	SWITCH	431		
2N4986	GE	SWITCH	427		
2N4987	GE	SWITCH	435		
2N4988	GE	SWITCH	439		
2N4989	GE	SWITCH	439		
2N4990	GE	SWITCH	435		
2N4991	GE	SWITCH	443		
2N4992	GE	SWITCH	447		
2N4993	GE	SWITCH	451		
2N5022		PWR TRAN		D41E7	1129
2N5023		PWR TRAN		D41E1	1129
2N5034		PWR TRAN		D44H4	1155
2N5035		PWR TRAN		D44H4	1155
2N5036		PWR TRAN		D44H8	1155
2N5037		PWR TRAN		D44H8	1155
2N5058		PWR TRAN		D44R2	1159
2N5059		PWR TRAN		D44R4	1159
2N5060	GE	SCR	455		
2N5061	GE	SCR	455		
2N5062	GE	SCR	455		
2N5063	GE	SCR	455		
2N5064	GE	SCR	455		
2N5079		PWR TRAN		D40E5	1109
2N5080		PWR TRAN		D40E5	1109
2N5088	GE	SIG TRAN	457		
2N5089	GE	SIG TRAN	457		
2N5112		PWR TRAN		D45C4	1163
2N5160		PWR TRAN		D41E5	1129
2N5161		PWR TRAN		D45C5	1163
2N5164	GE	SCR	CF		
2N5165	GE	SCR	CF		
2N5166	GE	SCR	CF		
2N5167	GE	SCR	CF		
2N5168	GE	SCR	CF		
2N5169	GE	SCR	CF		
2N5170	GE	SCR	CF		
2N5171	GE	SCR	CF		
2N5172	GE	SIG TRAN	461		
2N5174	GE	SIG TRAN	462		
2N5175	GE	SIG TRAN	462		
2N5176	GE	SIG TRAN	462		
2N5189		PWR TRAN		D42C6	1135
2N5190		PWR TRAN		D44C6	1147
2N5191		PWR TRAN		D44C8	1147
2N5192		PWR TRAN		D44C11	1147
2N5193		PWR TRAN		D44C6	1147
2N5194		PWR TRAN		D44C8	1147
2N5195		PWR TRAN		D45C11	1163
2N5204	GE	SCR	463		
2N5205	GE	SCR	463		
2N5206	GE	SCR	463		
2N5207	GE	SCR	463		
2N5213		PWR TRAN		D40E7	1109

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
2N5219	GE	SIG TRAN	467		
2N5220	GE	SIG TRAN	468		
2N5221	GE	SIG TRAN	469		
2N5223	GE	SIG TRAN	470		
2N5225	GE	SIG TRAN	471		
2N5226	GE	SIG TRAN	472		
2N5227	GE	SIG TRAN	473		
2N5232	GE	SIG TRAN	474		
2N5232A	GE	SIG TRAN	474		
2N5249	GE	SIG TRAN	476		
2N5249A	GE	SIG TRAN	476		
2N5252		PWR TRAN		D44R3	1159
2N5253		PWR TRAN		D44R4	1159
2N5262		PWR TRAN		D42C7	1135
2N5279		PWR TRAN		D44R4	1159
2N5293		PWR TRAN		D44C10	1147
2N5294		PWR TRAN		D44C10	1147
2N5295		PWR TRAN		D44C8	1147
2N5296		PWR TRAN		D44C8	1147
2N5297		PWR TRAN		D44C12	1147
2N5298		PWR TRAN		D44C12	1147
2N5305	GE	SIG TRAN	476		
2N5306	GE	SIG TRAN	476		
2N5306A	GE	SIG TRAN	476		
2N5307	GE	SIG TRAN	482		
2N5308	GE	SIG TRAN	482		
2N5308A	GE	SIG TRAN	482		
2N5309	GE	SIG TRAN	486		
2N5310	GE	SIG TRAN	486		
2N5321		PWR TRAN		D42C7	1135
2N5322		PWR TRAN		D42C8	1135
2N5323		PWR TRAN		D43C7	1143
2N5334		PWR TRAN		D42C7	1135
2N5344		PWR TRAN		D44R1	1159
2N5345		PWR TRAN		D44R3	1159
2N5354	GE	SIG TRAN	490		
2N5355	GE	SIG TRAN	490		
2N5356	GE	SIG TRAN	490		
2N5365	GE	SIG TRAN	498		
2N5366	GE	SIG TRAN	498		
2N5367	GE	SIG TRAN	498		
2N5368	GE	SIG TRAN		GES5368	1209
2N5369	GE	SIG TRAN		GES5369	1209
2N5370	GE	SIG TRAN		GES5370	1209
2N5371	GE	SIG TRAN		GES5371	1209
2N5372	GE	SIG TRAN		GES5372	1211
2N5373	GE	SIG TRAN		GES5373	1211
2N5374	GE	SIG TRAN		GES5374	1211
2N5375	GE	SIG TRAN		GES5375	1211
2N5380	GE	SIG TRAN	CF	GES5380	
2N5381	GE	SIG TRAN	CF	GES5381	
2N5382	GE	SIG TRAN	CF	GES5382	
2N5383	GE	SIG TRAN	CF	GES5383	
2N5418	GE	SIG TRAN	506		
2N5419	GE	SIG TRAN	506		
2N5420	GE	SIG TRAN	506		
2N5421		PWR TRAN		D40E1	1109
2N5422		PWR TRAN		D40E1	1109
2N5423		PWR TRAN		D42C1	1135
2N5424		PWR TRAN		D44C1	1147
2N5427		PWR TRAN		D44H10	1155
2N5428		PWR TRAN		D44H11	1155
2N5441	GE	TRIAC	1393		
2N5442	GE	TRIAC	1393		
2N5443	GE	TRIAC	1393		
2N5444	GE	TRIAC	1393		
2N5445	GE	TRIAC	1393		
2N5446	GE	TRIAC	1393		
2N5447		SIG TRAN		GES5447	1213
2N5448		SIG TRAN		GES5448	1213
2N5449		SIG TRAN		GES5449	1215
2N5450		SIG TRAN		GES5450	1215
2N5451		SIG TRAN		GES5451	1215
2N5470		PWR TRAN		D40E7	1109
2N5471		PWR TRAN		D40E1	1109
2N5483		PWR TRAN		D44C1	1147
2N5489		PWR TRAN		D42C2	1135
2N5490		PWR TRAN		D44H4	1155
2N5491		PWR TRAN		D44H4	1155
2N5492		PWR TRAN		D44H10	1155
2N5493		PWR TRAN		D44H10	1155
2N5494		PWR TRAN		D44H4	1155
2N5495		PWR TRAN		D44H4	1155
2N5496		PWR TRAN		D44H10	1155
2N5497		PWR TRAN		D44H10	1155
2N5567	GE	TRIAC	1393		
2N5568	GE	TRIAC	1393		
2N5569	GE	TRIAC	1393		
2N5570	GE	TRIAC	1393		
2N5571	GE	TRIAC	1393		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
2N5572	GE	TRIAC	1393		
2N5573	GE	TRIAC	1393		
2N5590		PWR TRAN		D44C2	1147
2N5597		PWR TRAN		D45C8	1163
2N5598		PWR TRAN		D44C8	1147
2N5606		PWR TRAN		D44C8	1147
2N5614		PWR TRAN		D44C9	1147
2N5637		PWR TRAN		D44C5	1147
2N5642		PWR TRAN		D44C4	1147
2N5644		PWR TRAN		D40E1	1109
2N5645		PWR TRAN		D42C1	1135
2N5646		PWR TRAN		D44C1	1147
2N5655		PWR TRAN		D42R1	1139
2N5656		PWR TRAN		D42R2	1139
2N5660		PWR TRAN		D44R2	1159
2N5661		PWR TRAN		D44R4	1159
2N5662		PWR TRAN		D44R1	1159
2N5663		PWR TRAN		D44R3	1159
2N5682		PWR TRAN		D44R2	1159
2N5687		PWR TRAN		D40E1	1109
2N5688		PWR TRAN		D42C1	1135
2N5689		PWR TRAN		D44C4	1147
2N5690		PWR TRAN		D44C1	1147
2N5697		PWR TRAN		D40E1	1109
2N5698		PWR TRAN		D40E1	1109
2N5699		PWR TRAN		D40E1	1109
2N5700		PWR TRAN		D44C1	1147
2N5701		PWR TRAN		D44C1	1147
2N5703		PWR TRAN		D40E1	1109
2N5704		PWR TRAN		D44C1	1147
2N5705		PWR TRAN		D44C1	1147
2N5710		PWR TRAN		D40E1	1109
2N5711		PWR TRAN		D40E1	1109
2N5712		PWR TRAN		D44C4	1147
2N5713		PWR TRAN		D44C1	1147
2N5754	GE	TRIAC	1377		
2N5755	GE	TRIAC	1377		
2N5756	GE	TRIAC	1377		
2N5764		PWR TRAN		D40E5	1109
2N5765		PWR TRAN		D44C1	1147
2N5766		PWR TRAN		D40E5	1109
2N5767		PWR TRAN		D40E1	1109
2N5768		PWR TRAN		D44C1	1147
2N5777	GE	SIG TRAN	508		
2N5778	GE	SIG TRAN	508		
2N5779	GE	SIG TRAN	508		
2N5780	GE	SIG TRAN	508		
2N5782		PWR TRAN		D43C5	1143
2N5783		PWR TRAN		D42C7	1135
2N5785		PWR TRAN		D42C6	1135
2N5786		PWR TRAN		D42C5	1135
2N5810		SIG TRAN		GES5810	1217
2N5811		SIG TRAN		GES5811	1217
2N5812		SIG TRAN		GES5812	1217
2N5813		SIG TRAN		GES5813	1217
2N5814		SIG TRAN		GES5814	1219
2N5815		SIG TRAN		GES5815	1219
2N5816		SIG TRAN		GES5816	1219
2N5817		SIG TRAN		GES5817	1219
2N5818		SIG TRAN		GES5818	1219
2N5819		SIG TRAN		GES5819	1219
2N5820		SIG TRAN		GES5820	1223
2N5821		SIG TRAN		GES5821	1223
2N5822		SIG TRAN		GES5822	1223
2N5823		SIG TRAN		GES5823	1223
2N5824		SIG TRAN		GES5824	1227
2N5825		SIG TRAN		GES5825	1227
2N5826		SIG TRAN		GES5826	1227
2N5827		SIG TRAN		GES5827	1232
2N5828		SIG TRAN		GES5828	1234
2N6000		SIG TRAN		GES6000	1236
2N6001		SIG TRAN		GES6001	1240
2N6002		SIG TRAN		GES6002	1236
2N6003		SIG TRAN		GES6003	1240
2N6004		SIG TRAN		GES6004	1244
2N6005		SIG TRAN		GES6005	1248
2N6006		SIG TRAN		GES6006	1244
2N6007		SIG TRAN		GES6007	1248
2N6010		SIG TRAN		GES6010	1252
2N6011		SIG TRAN		GES6011	1256
2N6012		SIG TRAN		GES6012	1252
2N6013		SIG TRAN		GES6013	1256
2N6014		SIG TRAN		GES6014	1264
2N6015		SIG TRAN		GES6015	1260
2N6016		SIG TRAN		GES6016	1264
2N6017		SIG TRAN		GES6017	1260
2N6021		PWR TRAN		D45C11	1163
2N6022		PWR TRAN		D45C11	1163
2N6023		PWR TRAN		D45C5	1163
2N6024		PWR TRAN		D45C5	1163

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
2N6025		PWR TRAN		D45C8	1163
2N6026		PWR TRAN		D45C8	1163
2N6027	GE	SIG TRAN	510		
2N6028	GE	SIG TRAN	510		
2N6034		PWR TRAN		D45E1	1167
2N6035		PWR TRAN		D45E2	1167
2N6036		PWR TRAN		D45E3	1167
2N6037		PWR TRAN		D44E1	1151
2N6038		PWR TRAN		D44E2	1151
2N6039		PWR TRAN		D44E3	1151
2N6068	GE	TRIAC	CF		
2N6069	GE	TRIAC	CF		
2N6070	GE	TRIAC	CF		
2N6071	GE	TRIAC	CF		
2N6072	GE	TRIAC	CF		
2N6073	GE	TRIAC	CF		
2N6074	GE	TRIAC	CF		
2N6075	GE	TRIAC	CF		
2N6076	GE	SIG TRAN	461		
2N6076		SIG TRAN		2N6076	461
2N6098		PWR TRAN		D44H7	1155
2N6099		PWR TRAN		D44H7	1155
2N6100		PWR TRAN		D44H10	1155
2N6101		PWR TRAN		D44H10	1155
2N6102		PWR TRAN		D44H4	1155
2N6103		PWR TRAN		D44H4	1155
2N6106		PWR TRAN		D45H10	1171
2N6107		PWR TRAN		D45H10	1171
2N6108		PWR TRAN		D45H4	1171
2N6109		PWR TRAN		D45H4	1171
2N6110		PWR TRAN		D45H1	1171
2N6111		PWR TRAN		D45H1	1171
2N6114	GE	SIG TRAN	514		
2N6115	GE	SIG TRAN	514		
2N6121		PWR TRAN		D45H4	1171
2N6122		PWR TRAN		D45H7	1171
2N6123		PWR TRAN		D45H10	1171
2N6124		PWR TRAN		D44H4	1155
2N6125		PWR TRAN		D45H7	1171
2N6126		PWR TRAN		D45H10	1171
2N6129		PWR TRAN		D44H4	1155
2N6130		PWR TRAN		D44H7	1155
2N6131		PWR TRAN		D44H10	1155
2N6132		PWR TRAN		D45H4	1171
2N6133		PWR TRAN		D45H7	1171
2N6134		PWR TRAN		D45H10	1171
2N6139	GE	TRIAC	1393		
2N6140	GE	TRIAC	1393		
2N6141	GE	TRIAC	1393		
2N6142	GE	TRIAC	1393		
2N6143	GE	TRIAC	1393		
2N6144	GE	TRIAC	1393		
2N6145	GE	TRIAC	1393		
2N6146	GE	TRIAC	1393		
2N6147	GE	TRIAC	1393		
2N6151	GE	TRIAC	1381		
2N6152	GE	TRIAC	1381		
2N6153	GE	TRIAC	1381		
2N6154	GE	TRIAC	1381		
2N6155	GE	TRIAC	1381		
2N6156	GE	TRIAC	1381		
2N6157	GE	TRIAC	1393		
2N6158	GE	TRIAC	1393		
2N6159	GE	TRIAC	1393		
2N6160	GE	TRIAC	1393		
2N6161	GE	TRIAC	1393		
2N6162	GE	TRIAC	1393		
2N6163	GE	TRIAC	1393		
2N6164	GE	TRIAC	1393		
2N6165	GE	TRIAC	1393		
2N6167	GE	SCR	874		
2N6168	GE	SCR	874		
2N6169	GE	SCR	874		
2N6170	GE	SCR	874		
2N6171	GE	SCR	868		
2N6172	GE	SCR	868		
2N6173	GE	SCR	868		
2N6174	GE	SCR	868		
2N6175		PWR TRAN		D40N1	1117
2N6176		PWR TRAN		D40N5	1117
2N6177		PWR TRAN		D40N3	1117
2N6178		PWR TRAN		D44C10	1147
2N6179		PWR TRAN		D44C5	1147
2N6180		PWR TRAN		D45C10	1163
2N6181		PWR TRAN		D45C5	1163
2N6218		SIG TRAN		GES6218	1268
2N6219		SIG TRAN		GES6219	1268
2N6220		SIG TRAN		GES6220	1268
2N6221		SIG TRAN		GES6221	1268
2N6222		SIG TRAN		GES6222	1271

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
2N6224		SIG TRAN		GES6224	1271
2N6288		PWR TRAN		D44H1	1155
2N6289		PWR TRAN		D44H1	1155
2N6290		PWR TRAN		D44H4	1155
2N6291		PWR TRAN		D44H4	1155
2N6292		PWR TRAN		D44H10	1155
2N6293		PWR TRAN		D44H10	1155
2N6294		PWR TRAN		D44E2	1151
2N6295		PWR TRAN		D44E3	1151
2N6296		PWR TRAN		D45E2	1167
2N6297		PWR TRAN		D45E3	1167
2N6342	GE	TRIAC	1381		
2N6342A	GE	TRIAC	1381		
2N6343	GE	TRIAC	1381		
2N6343A	GE	TRIAC	1381		
2N6344	GE	TRIAC	1381		
2N6344A	GE	TRIAC	1381		
2N6346	GE	TRIAC	1381		
2N6346A	GE	TRIAC	1381		
2N6347	GE	TRIAC	1381		
2N6347A	GE	TRIAC	1381		
2N6348	GE	TRIAC	1381		
2N6348A	GE	TRIAC	1381		
2N6386		PWR TRAN		D44E1	1151
2N6387		PWR TRAN		D44E2	1151
2N6388		PWR TRAN		D44E3	1151
2N6394	GE	SCR	763		
2N6395	GE	SCR	763		
2N6396	GE	SCR	763		
2N6397	GE	SCR	763		
2N6398	GE	SCR	763		
2N6400	GE	SCR	CF		
2N6401	GE	SCR	CF		
2N6402	GE	SCR	CF		
2N6403	GE	SCR	CF		
2N6404	GE	SCR	CF		
2SA257		PWR TRAN		D43C5	1143
2SA258		PWR TRAN		D43C5	1143
2SA527		PWR TRAN		D43C5	1143
2SA528		PWR TRAN		D43C5	1143
2SA547		PWR TRAN		D43C8	1143
2SA565		PWR TRAN		D41E5	1129
2SA571		PWR TRAN		D41E5	1129
2SA597		PWR TRAN		D41E5	1129
2SA613		PWR TRAN		D45C6	1163
2SA671		PWR TRAN		D45C9	1163
2SA715		PWR TRAN		D43C3	1143
2SA738		PWR TRAN		D43C3	1143
2SA743		PWR TRAN		D43C5	1143
2SA743A		PWR TRAN		D43C11	1143
2SA755		PWR TRAN		D43C6	1143
2SA779		PWR TRAN		D43C3	1143
2SA780A		PWR TRAN		D43C11	1143
2SC1012A		PWR TRAN		D40N1	1117
2SC101A		PWR TRAN		D44C8	1147
2SC1024		PWR TRAN		D44C8	1147
2SC1061		PWR TRAN		D44C9	1147
2SC106		PWR TRAN		D42C7	1135
2SC107		PWR TRAN		D42C7	1135
2SC108A		PWR TRAN		D40E7	1109
2SC109A		PWR TRAN		D40E7	1109
2SC1104		PWR TRAN		D44R4	1159
2SC1105		PWR TRAN		D40N4	1117
2SC1162		PWR TRAN		D42C3	1135
2SC1212		PWR TRAN		D42C5	1135
2SC1212A		PWR TRAN		D42C11	1135
2SC130		PWR TRAN		D40E7	1109
2SC1368		PWR TRAN		D42C3	1135
2SC1419		PWR TRAN		D42C6	1135
2SC1514		PWR TRAN		D40N3	1117
2SC1516		PWR TRAN		D42C3	1135
2SC1517A		PWR TRAN		D42C11	1135
2SC213		PWR TRAN		D40E1	1109
2SC214		PWR TRAN		D40E1	1109
2SC215		PWR TRAN		D40E1	1109
2SC223		PWR TRAN		D40E1	1109
2SC224		PWR TRAN		D40E1	1109
2SC225		PWR TRAN		D40E1	1109
2SC23		PWR TRAN		D42C8	1135
2SC24		PWR TRAN		D42C8	1135
2SC291		PWR TRAN		D42C5	1135
2SC292		PWR TRAN		D42C7	1135
2SC297		PWR TRAN		D42C7	1135
2SC298		PWR TRAN		D42C8	1135
2SC306		PWR TRAN		D40E5	1109
2SC307		PWR TRAN		D40E5	1109
2SC310		PWR TRAN		D44R	1159
2SC354		PWR TRAN		D42C5	1135
2SC490		PWR TRAN		D44C5	1147
2SC491		PWR TRAN		D44C1	1147

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
2SC5120		PWR TRAN		D42C8	1135
2SC512R		PWR TRAN		D42C7	1135
2SC5130		PWR TRAN		D42C5	1135
2SC513R		PWR TRAN		D42C4	1135
2SC515		PWR TRAN		D44R4	1159
2SC516		PWR TRAN		D40E7	1109
2SC516A		PWR TRAN		D44R1	1159
2SC517		PWR TRAN		D42C7	1135
2SC51		PWR TRAN		D40E1	1109
2SC524		PWR TRAN		D40C7	1101
2SC525		PWR TRAN		D40E5	1109
2SC541		PWR TRAN		D40E1	1109
2SC543		PWR TRAN		D44C5	1147
2SC547		PWR TRAN		D40E5	1109
2SC548		PWR TRAN		D40E1	1109
2SC549		PWR TRAN		D40E5	1109
2SC550		PWR TRAN		D44C7	1147
2SC551		PWR TRAN		D44C1	1147
2SC552		PWR TRAN		D44C5	1147
2SC553		PWR TRAN		D40E1	1109
2SC554		PWR TRAN		D40E1	1109
2SC571		PWR TRAN		D40E1	1109
2SC572		PWR TRAN		D42C1	1135
2SC573		PWR TRAN		D44C3	1147
2SC582		PWR TRAN		D40N3	1117
2SC585		PWR TRAN		D44C5	1147
2SC591		PWR TRAN		D44C7	1147
2SC592		PWR TRAN		D42C8	1135
2SC597		PWR TRAN		D40E5	1109
2SC598		PWR TRAN		D40E5	1109
2SC599		PWR TRAN		D44C5	1147
2SC59		PWR TRAN		D40E7	1109
2SC600		PWR TRAN		D44C5	1147
2SC608T		PWR TRAN		D40E5	1109
2SC609T		PWR TRAN		D40E5	1109
2SC61		PWR TRAN		D40E1	1109
2SC635		PWR TRAN		D42C7	1135
2SC636		PWR TRAN		D44C5	1147
2SC637		PWR TRAN		D40E1	1109
2SC638		PWR TRAN		D44C1	1147
2SC646		PWR TRAN		D44C8	1147
2SC685		PWR TRAN		D40N3	1117
2SC685A		PWR TRAN		D40N3	1117
2SC686		PWR TRAN		D40N2	1117
2SC688		PWR TRAN		D44C5	1147
2SC690		PWR TRAN		D44C4	1147
2SC691		PWR TRAN		D42C4	1135
2SC692		PWR TRAN		D42C5	1135
2SC697		PWR TRAN		D40E1	1109
2SC700		PWR TRAN		D40E5	1109
2SC702		PWR TRAN		D42C1	1135
2SC703		PWR TRAN		D44C1	1147
2SC704		PWR TRAN		D44C1	1147
2SC730		PWR TRAN		D40E5	1109
2SC737		PWR TRAN		D44C5	1147
2SC756		PWR TRAN		D42C6	1135
2SC774		PWR TRAN		D40E5	1109
2SC777		PWR TRAN		D40E7	1109
2SC781		PWR TRAN		D40E5	1109
2SC788		PWR TRAN		D44R1	1159
2SC795		PWR TRAN		D40N1	1117
2SC799		PWR TRAN		D42C6	1135
2SC802		PWR TRAN		D40E5	1109
2SC803		PWR TRAN		D40E5	1109
2SC816		PWR TRAN		D40E1	1109
2SC821		PWR TRAN		D40E1	1109
2SC822		PWR TRAN		D40E1	1109
2SC830		PWR TRAN		D44C6	1147
2SC831		PWR TRAN		D45C2	1163
2SC840		PWR TRAN		D44C8	1147
2SC867		PWR TRAN		D44R2	1159
2SC890		PWR TRAN		D40E1	1109
2SC891		PWR TRAN		D42C1	1135
2SC892		PWR TRAN		D44C1	1147
2SC893		PWR TRAN		D42C8	1135
2SC909		PWR TRAN		D40E5	1109
2SC911		PWR TRAN		D42C4	1135
2SC916		PWR TRAN		D42C8	1135
2SC92		PWR TRAN		D44C8	1147
2SC931		PWR TRAN		D42C6	1135
2SC932		PWR TRAN		D42C3	1135
2SC93		PWR TRAN		D44C8	1147
2SC94		PWR TRAN		D44C7	1147
2SC97		PWR TRAN		D40E5	1109
2SC990		PWR TRAN		D42C2	1135
2SC996		PWR TRAN		D40N3	1117
2SD120		PWR TRAN		D40E7	1109
2SD121		PWR TRAN		D44C7	1147
2SD130		PWR TRAN		D40N1	1117
2SD136		PWR TRAN		D40N3	1117

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
2SD137		PWR TRAN		D42C2	1135
2SD141		PWR TRAN		D42C2	1135
2SD142		PWR TRAN		D44C2	1147
2SD146		PWR TRAN		D44C8	1147
2SD150		PWR TRAN		D44C5	1147
2SD152		PWR TRAN		D42C8	1135
2SD154		PWR TRAN		D44C8	1147
2SD155		PWR TRAN		D44C8	1147
2SD156		PWR TRAN		D40N1	1117
2SD157		PWR TRAN		D40N8	1117
2SD158		PWR TRAN		D44R1	1159
2SD159		PWR TRAN		D44R3	1159
2SD174		PWR TRAN		D44C6	1147
2SD175		PWR TRAN		D44C8	1147
2SD182		PWR TRAN		D40E5	1109
2SD183		PWR TRAN		D40D7	1105
2SD184		PWR TRAN		D44C5	1147
2SD185		PWR TRAN		D44C8	1147
2SD226		PWR TRAN		D44C5	1147
2SD226A		PWR TRAN		D44C7	1147
2SD2340		PWR TRAN		D44C8	1147
2SD234R		PWR TRAN		D44C8	1147
2SD2350		PWR TRAN		D44C6	1147
2SD235R		PWR TRAN		D44C5	1147
2SD24		PWR TRAN		D40N3	1117
2SD28		PWR TRAN		D44C6	1147
2SD29		PWR TRAN		D44C8	1147
2SD48		PWR TRAN		D44C8	1147
2SD49		PWR TRAN		D44C8	1147
2SD50		PWR TRAN		D44C8	1147
2SD57		PWR TRAN		D44C3	1147
2SD58		PWR TRAN		D44C5	1147
2SD78		PWR TRAN		D42C8	1135
2SD79		PWR TRAN		D44C8	1147
2SD90		PWR TRAN		D44C5	1147
2SD91		PWR TRAN		D44C8	1147
2SD92		PWR TRAN		D40E5	1109
2SF11	NECJ	SCR		C220F	862
2SF12	NECJ	SCR		C220A	862
2SF131	TSAJ	SCR		2N681	306
2SF132	TSAJ	SCR		2N682	306
2SF133	TSAJ	SCR		2N683	306
2SF134	TSAJ	SCR		2N684	306
2SF135	TSAJ	SCR		2N685	306
2SF136	TSAJ	SCR		2N687	306
2SF137	TSAJ	SCR		2N688	306
2SF138	TSAJ	SCR		2N689	306
2SF139	TSAJ	SCR		2N689	306
2SF14	NECJ	SCR		C220B	862
2SF16	NECJ	SCR		C220C	862
2SF18	NECJ	SCR		C220D	862
2SF200	NECJ	SCR		C220E	862
2SF201	NECJ	SCR		C220M	862
2SF221	TSAJ	SCR		C220U	862
2SF222	TSAJ	SCR		C220F	862
2SF223	TSAJ	SCR		C220A	862
2SF224	TSAJ	SCR		C220B	862
2SF225	TSAJ	SCR		C220B	862
2SF226	TSAJ	SCR		C220C	862
2SF227	TSAJ	SCR		C220D	862
2SF228	TSAJ	SCR		C220E	862
2SF22	NECJ	SCR		C230A	874
2SF248	MATJ	SCR		C220B	862
2SF24	NECJ	SCR		C230B	874
2SF261	MITJ	SCR		C220F	862
2SF262	MITJ	SCR		C220A	862
2SF263	MITJ	SCR		C220B	862
2SF264	MITJ	SCR		C220B	862
2SF265	MITJ	SCR		C220C	862
2SF266	MITJ	SCR		C220C	862
2SF267	MITJ	SCR		C220D	862
2SF268	MITJ	SCR		C220D	862
2SF269	MITJ	SCR		C220E	862
2SF26	NECJ	SCR		C230C	874
2SF271	MITJ	SCR		C220F	862
2SF272	MITJ	SCR		C220A	862
2SF273	MITJ	SCR		C220B	862
2SF274	MITJ	SCR		C220B	862
2SF275	MITJ	SCR		C220C	862
2SF276	MITJ	SCR		C220C	862
2SF277	MITJ	SCR		C220D	862
2SF278	MITJ	SCR		C220D	862
2SF279	MITJ	SCR		C220E	862
2SF286	MITJ	SCR		C230C	874
2SF288	MITJ	SCR		C230D	874
2SF289	MITJ	SCR		C230E	874
2SF28	NECJ	SCR		C230D	874
2SF291	MITJ	SCR		C230F	874
2SF292	MITJ	SCR		C230A	874
2SF293	MITJ	SCR		C230B	874

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
2SF294	MITJ	SCR		C230B	874
2SF295	MITJ	SCR		C230C	874
2SF296	MITJ	SCR		C230C	874
2SF297	MITJ	SCR		C230D	874
2SF298	MITJ	SCR		C230D	874
2SF299	MITJ	SCR		C230E	874
2SF32A	NECJ	SCR		C38A	683
2SF34A	NECJ	SCR		C38B	683
2SF36A	NECJ	SCR		C38C	683
2SF38A	NECJ	SCR		C38D	683
2SF448	MITJ	SCR		C220M	862
2SF451	MITJ	SCR		C220M	862
2SF454	MITJ	SCR		C37M	679
2SF455	MITJ	SCR		C37N	679
2SF457	MITJ	SCR		C137M	771
2SF458	MITJ	SCR		C137S	771
2SF459	MITJ	SCR		C137N	771
2SF71	SHEJ	SCR		C230U	874
2SF72	SHEJ	SCR		C230F	874
2SF73	SHEJ	SCR		C230A	874
2SF74	SHEJ	SCR		C230B	874
2SF75	SHEJ	SCR		C230B	874
2SF76	SHEJ	SCR		C230C	874
2SF77	SHEJ	SCR		C230D	874
300PAC**	IR	SCR		C380X500	917
300PA**	IR	SCR		C380X500	917
35C025	SYN	SCR		C46U	689
35C025B	SYN	SCR		C46U	689
35C025BF	SYN	SCR		C45U	689
35C025F	SYN	SCR		C45U	689
35C050	SYN	SCR		C46F	689
35C050B	SYN	SCR		C46F	689
35C050BF	SYN	SCR		C45U	689
35C050F	SYN	SCR		C45F	689
35C100	SYN	SCR		C46P	689
35C100B	SYN	SCR		C46P	689
35C100BF	SYN	SCR		C45P	689
35C100F	SYN	SCR		C45P	689
35C10	SYN	SCR		C46A	689
35C10B	SYN	SCR		C46A	689
35C10BF	SYN	SCR		C45A	689
35C10F	SYN	SCR		C45A	689
35C110	SYN	SCR		C46PA	689
35C110B	SYN	SCR		C46PA	689
35C110BF	SYN	SCR		C45PA	689
35C110F	SYN	SCR		C45PA	689
35C120	SYN	SCR		C46PB	689
35C120B	SYN	SCR		C46PB	689
35C120BF	SYN	SCR		C45PB	689
35C120F	SYN	SCR		C45PB	689
35C15	SYN	SCR		C46G	689
35C15B	SYN	SCR		C46G	689
35C15BF	SYN	SCR		C45G	689
35C15F	SYN	SCR		C45G	689
35C20	SYN	SCR		C46B	689
35C20B	SYN	SCR		C46B	689
35C20BF	SYN	SCR		C45B	689
35C20F	SYN	SCR		C45B	689
35C25	SYN	SCR		C46H	689
35C25B	SYN	SCR		C46H	689
35C25BF	SYN	SCR		C45H	689
35C25F	SYN	SCR		C45H	689
35C30	SYN	SCR		C46C	689
35C30B	SYN	SCR		C46C	689
35C30BF	SYN	SCR		C45C	689
35C30F	SYN	SCR		C45C	689
35C40	SYN	SCR		C46D	689
35C40B	SYN	SCR		C46D	689
35C40BF	SYN	SCR		C45D	689
35C40F	SYN	SCR		C45D	689
35C50	SYN	SCR		C46E	689
35C50B	SYN	SCR		C46E	689
35C50BF	SYN	SCR		C45E	689
35C50F	SYN	SCR		C45E	689
35C60	SYN	SCR		C46M	689
35C60B	SYN	SCR		C46M	689
35C60BF	SYN	SCR		C45M	689
35C60F	SYN	SCR		C45M	689
35C70	SYN	SCR		C46S	689
35C70B	SYN	SCR		C46S	689
35C70BF	SYN	SCR		C45S	689
35C70F	SYN	SCR		C45S	689
35C80	SYN	SCR		C46N	689
35C80B	SYN	SCR		C46N	689
35C80BF	SYN	SCR		C45N	689
35C80F	SYN	SCR		C45N	689
35C90	SYN	SCR		C46T	689
35C90B	SYN	SCR		C46T	689
35C90BF	SYN	SCR		C45T	689
35C90F	SYN	SCR		C45T	689

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
36RA**	IR	SCR		C150	818
36RC**	IR	SCR		C45	689
36REH**	IR	SCR		C50	818
3N81	GE	SWITCH	516		
3N82	GE	SWITCH	516		
3N83	GE	SWITCH	521		
3N84	GE	SWITCH	525		
3N85	GE	SWITCH	525		
3N86	GE	SWITCH	529		
3RC10A	IR	SCR		C11A	322
3RC20A	IR	SCR		C11B	322
3RC30A	IR	SCR		C11C	322
3RC40A	IR	SCR		C11D	322
3RC50A	IR	SCR		C11E	322
3RC60A	IR	SCR		C11M	322
40081		PWR TRAN		D40E1	1109
40082		PWR TRAN		D40E1	1109
401PDA**	IR	RECTIFIER		A397	596
40216	RCA	SCR		C144M30M	791
40250		PWR TRAN		D44C6	1147
40250V1		PWR TRAN		D42C5	1135
40279		PWR TRAN		D42C5	1135
40280		PWR TRAN		D40E1	1109
40281		PWR TRAN		D40E1	1109
40282		PWR TRAN		D44C1	1147
40290		PWR TRAN		D40E7	1109
40291		PWR TRAN		D40E7	1109
40292		PWR TRAN		D44C4	1147
40305		PWR TRAN		D40E5	1109
40306		PWR TRAN		D40E5	1109
40307		PWR TRAN		D44C4	1147
40309		PWR TRAN		D40E5	1109
40310		PWR TRAN		D44C5	1147
40311		PWR TRAN		D40E1	1109
40312		PWR TRAN		D44C8	1147
40314		PWR TRAN		D40E5	1109
40315		PWR TRAN		D40E5	1109
40316		PWR TRAN		D44C5	1147
40317		PWR TRAN		D40E5	1109
40319		PWR TRAN		D41E5	1129
40320		PWR TRAN		D40E5	1109
40321		PWR TRAN		D44R3	1159
40323		PWR TRAN		D40E5	1109
40324		PWR TRAN		D44C5	1147
40327		PWR TRAN		D40E1	1109
40346		PWR TRAN		D44R1	1159
40346V1		PWR TRAN		D44R1	1159
40346V2		PWR TRAN		D44R1	1159
40347		PWR TRAN		D40E5	1109
40347V1		PWR TRAN		D40E5	1109
40347V2		PWR TRAN		D40E7	1109
40348		PWR TRAN		D40E7	1109
40348V1		PWR TRAN		D40E7	1109
40348V2		PWR TRAN		D40E7	1109
40355		PWR TRAN		D40N1	1117
40360		PWR TRAN		D40E7	1109
40361		PWR TRAN		D40E7	1109
40362		PWR TRAN		D41E7	1129
40366		PWR TRAN		D41E7	1129
40367		PWR TRAN		D41E7	1129
40368		PWR TRAN		D44C6	1147
40372		PWR TRAN		D42C8	1135
40378	RCA	SCR		C122B	747
40379	RCA	SCR		C122D	747
40389		PWR TRAN		D40E1	1109
40390		PWR TRAN		D44R2	1159
40391		PWR TRAN		D41E5	1129
40392		PWR TRAN		D40E5	1109
40394		PWR TRAN		D43C5	1143
40406		PWR TRAN		D41E7	1129
40407		PWR TRAN		D40E7	1109
40412		PWR TRAN		D44R2	1159
40412V1		PWR TRAN		D44R2	1159
40412V2		PWR TRAN		D44R2	1159
40422		PWR TRAN		D44R4	1159
40424		PWR TRAN		D44R4	1159
40426		PWR TRAN		D44R3	1159
40450		PWR TRAN		D40E5	1109
40451		PWR TRAN		D40E5	1109
40452		PWR TRAN		D40E5	1109
40453		PWR TRAN		D40E5	1109
40454		PWR TRAN		D40E1	1109
40455		PWR TRAN		D40E5	1109
40456		PWR TRAN		D40E1	1109
40459		PWR TRAN		D40E5	1109
40491		PWR TRAN		D44R4	1159
40537		PWR TRAN		D41E5	1129
40538		PWR TRAN		D41E5	1129
40544		PWR TRAN		D40E5	1109
40578		PWR TRAN		D40E1	1109

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
40581		PWR TRAN		D40E1	1109
40582		PWR TRAN		D40E1	1109
40594		PWR TRAN		D42C7	1135
40595		PWR TRAN		D43C7	1143
40605		PWR TRAN		D40E5	1109
40608		PWR TRAN		D40E5	1109
40611		PWR TRAN		D40E5	1109
40613		PWR TRAN		D44C2	1147
40616		PWR TRAN		D40E5	1109
40618		PWR TRAN		D44C2	1147
40621		PWR TRAN		D44C2	1147
40622		PWR TRAN		D44C6	1147
40624		PWR TRAN		D44H8	1155
40627		PWR TRAN		D44H7	1155
40629		PWR TRAN		D44C6	1147
40630		PWR TRAN		D44C6	1147
40631		PWR TRAN		D44C6	1147
40632		PWR TRAN		D44H7	1155
40634		PWR TRAN		D41E1	1129
40635		PWR TRAN		D40E7	1109
40654	RCA	SCR		C122B	747
40655	RCA	SCR		C122D	747
40665		PWR TRAN		D44C4	1147
40666		PWR TRAN		D40E5	1109
40680	RCA	SCR		C228A2	868
40681	RCA	SCR		C228B2	868
40682	RCA	SCR		C228D2	868
40683	RCA	SCR		C228M2	868
40735	RCA	SCR		C144M15M	791
40737	RCA	SCR		C222A	862
40738	RCA	SCR		C222B	862
40739	RCA	SCR		C222D	862
40740	RCA	SCR		C222M	862
40741	RCA	SCR		C220A	862
40742	RCA	SCR		C220B	862
40743	RCA	SCR		C220D	862
40744	RCA	SCR		C220M	862
40745	RCA	SCR		C220A2	862
40746	RCA	SCR		C220B2	862
40747	RCA	SCR		C220D2	862
40748	RCA	SCR		C220M2	862
40749	RCA	SCR		C232A	874
40750	RCA	SCR		C232B	874
40751	RCA	SCR		C232D	874
40752	RCA	SCR		C232M	874
40753	RCA	SCR		C230A	874
40754	RCA	SCR		C230B	874
40755	RCA	SCR		C230D	874
40756	RCA	SCR		C230M	874
40757	RCA	SCR		C230A2	874
40758	RCA	SCR		C230B	874
40759	RCA	SCR		C230D	874
40760	RCA	SCR		C230M	874
40816		PWR TRAN		D44H8	1155
40833	RCA	SCR		C122M	747
40867	RCA	SCR		C122A	747
40868	RCA	SCR		C122B	747
40869	RCA	SCR		C122D	747
40873		PWR TRAN		D44H10	1155
40874		PWR TRAN		D45H10	1171
40875		PWR TRAN		D44H7	1155
40876		PWR TRAN		D45H7	1171
40877		PWR TRAN		D44H10	1155
40878		PWR TRAN		D45H10	1171
40881		PWR TRAN		D44H4	1155
40882		PWR TRAN		D45H7	1171
40884		PWR TRAN		D44H10	1155
40885		PWR TRAN		D40P3	1121
40886		PWR TRAN		D40P5	1121
40938	RCA	SCR		C137N	771
40C025	SYN	SCR		C147U	799
40C025B	SYN	SCR		C147U	799
40C050	SYN	SCR		C147F	799
40C050B	SYN	SCR		C147F	799
40C100	SYN	SCR		C147P	799
40C100B	SYN	SCR		C147P	799
40C10	SYN	SCR		C147A	799
40C10B	SYN	SCR		C147A	799
40C110	SYN	SCR		C147PA	799
40C110	SYN	SCR		C147PA	799
40C120	SYN	SCR		C147PB	799
40C120B	SYN	SCR		C147PB	799
40C15	SYN	SCR		C147G	799
40C15B	SYN	SCR		C147G	799
40C20	SYN	SCR		C147B	799
40C20B	SYN	SCR		C147B	799
40C25	SYN	SCR		C147H	799
40C25B	SYN	SCR		C147H	799
40C30	SYN	SCR		C147C	799
40C30B	SYN	SCR		C147C	799

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
40C40	SYN	SCR		C147D	799
40C40B	SYN	SCR		C147D	799
40C50	SYN	SCR		C147E	799
40C50B	SYN	SCR		C147E	799
40C60	SYN	SCR		C147M	799
40C60B	SYN	SCR		C147M	799
40C70	SYN	SCR		C147S	799
40C70B	SYN	SCR		C147S	799
40C80	SYN	SCR		C147N	799
40C80B	SYN	SCR		C147N	799
40C90	SYN	SCR		C147T	799
40C90B	SYN	SCR		C147T	799
40RCS100	IR	SCR		C147P	799
40RCS10	IR	SCR		C147A	799
40RCS110	IR	SCR		C147PA	799
40RCS120	IR	SCR		C147PB	799
40RCS20	IR	SCR		C147B	799
40RCS30	IR	SCR		C147C	799
40RCS40	IR	SCR		C147D	799
40RCS50	IR	SCR		C147E	799
40RCS5	IR	SCR		C147F	799
40RCS60	IR	SCR		C147M	799
40RCS70	IR	SCR		C147S	799
40RCS80	IR	SCR		C147N	799
40RCS90	IR	SCR		C147T	799
40RCS**	IR	SCR		C45	689
420PBM**	IR	SCR		C447	982
420PB**	IR	SCR		C390/C391	936
45190		PWR TRAN		D44H4	1155
45191		PWR TRAN		D44H7	1155
45192		PWR TRAN		D44H10	1155
45193		PWR TRAN		D45H4	1171
45194		PWR TRAN		D45H7	1171
45195		PWR TRAN		D45H10	1171
470PB**	IR	SCR		C390/C391	93
4N25	GE	OPTO COUPL	531		
4N25A	GE	OPTO COUPL	531		
4N26	GE	OPTO COUPL	531		
4N27	GE	OPTO COUPL	531		
4N28	GE	OPTO COUPL	531		
4N29	GE	OPTO COUPL	533		
4N29A	GE	OPTO COUPL	533		
4N30	GE	OPTO COUPL	533		
4N31	GE	OPTO COUPL	533		
4N32	GE	OPTO COUPL	533		
4N32A	GE	OPTO COUPL	533		
4N33	GE	OPTO COUPL	533		
4N35	GE	OPTO COUPL	535		
4N36	GE	OPTO COUPL	535		
4N37	GE	OPTO COUPL	535		
4N38	GE	OPTO COUPL	539		
4N38A	GE	OPTO COUPL	539		
4N39	GE	OPTO COUPL	541		
4N40	GE	OPTO COUPL	541		
500PBQ**	IR	SCR		C397	958
501PBQ**	IR	SCR		C398	958
50RCS**	IR	SCR		C150	818
550PBQ**	IR	SCR		C444	976
550PB**	IR	SCR		C390/C391	936
5RC10A	IR	SCR		C11A	322
5RC20A	IR	SCR		C11B	322
5RC30A	IR	SCR		C11C	322
5RC40A	IR	SCR		C11D	322
5RC50A	IR	SCR		C11E	322
5RC60A	IR	SCR		C11M	322
600PB**	IR	SCR		C602	1005
651PDB**L	IR	RECTIFIER		A437	603
700PK**	IR	SCR		C450/C451	CF
71RA**	IR	SCR		C150	818
71RB**	IR	SCR		C150	818
71RC**	IR	SCR		C150	818
71REH**	IR	SCR		C50	818
72T2		PWR TRAN		D40E7	1109
73T2		PWR TRAN		D40E7	1109
74T2		PWR TRAN		D40E7	1109
750PB**	IR	SCR		C440/C441	966
801PDB**	IR	RECTIFIER		A540/A696	610
801PDB**B	IR	RECTIFIER		A430	600
81RLB**	IR	SCR		C158	830
81RM**	IR	SCR		C165	838
82T2		PWR TRAN		D40E7	1109
850PK**	IR	SCR		C450/C451	CF
900PB**	IR	SCR		C440	966
91RM**	IR	SCR		C164	838
A14A	GE	RECTIFIER	547		
A14C	GE	RECTIFIER	547		
A14E	GE	RECTIFIER	547		
A14F	GE	RECTIFIER	547		
A14P	GE	RECTIFIER	290		
A14U	GE	RECTIFIER	547		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
A15A	GE	RECTIFIER	549		
A15F	GE	RECTIFIER	549		
A15U	GE	RECTIFIER	549		
A114A	GE	RECTIFIER	557		
A114B	GE	RECTIFIER	559		
A114C	GE	RECTIFIER	559		
A114D	GE	RECTIFIER	559		
A114E	GE	RECTIFIER	559		
A114F	GE	RECTIFIER	557		
A114M	GE	RECTIFIER	559		
A115A	GE	RECTIFIER	563		
A115B	GE	RECTIFIER	565		
A115C	GE	RECTIFIER	565		
A115D	GE	RECTIFIER	565		
A115E	GE	RECTIFIER	565		
A115F	GE	RECTIFIER	563		
A115M	GE	RECTIFIER	565		
A139	GE	RECTIFIER	569		
A139E, R	GE	RECTIFIER	569		
A139M, R	GE	RECTIFIER	569		
A139N, R	GE	RECTIFIER	569		
A139P, R	GE	RECTIFIER	569		
A170,170RE	GE	RECTIFIER	571		
A170,170RA	GE	RECTIFIER	571		
A170,170RS	GE	RECTIFIER	571		
A170,170RT	GE	RECTIFIER	571		
A170,170RPA	GE	RECTIFIER	571		
A170,170RPB	GE	RECTIFIER	571		
A170,170RPC	GE	RECTIFIER	571		
A170,170RPD	GE	RECTIFIER	571		
A170,170RPE	GE	RECTIFIER	571		
A170,170RB	GE	RECTIFIER	571		
A170,170RC	GE	RECTIFIER	571		
A170,170RD	GE	RECTIFIER	571		
A170,170RM	GE	RECTIFIER	571		
A170,170RN	GE	RECTIFIER	571		
A170,170RP	GE	RECTIFIER	571		
A177,177RA	GE	RECTIFIER	577		
A177,177RPC	GE	RECTIFIER	577		
A177,177RB	GE	RECTIFIER	577		
A177,177RC	GE	RECTIFIER	577		
A177,177RPE	GE	RECTIFIER	577		
A177,177RS	GE	RECTIFIER	577		
A177,177RM	GE	RECTIFIER	577		
A177,177RN	GE	RECTIFIER	577		
A177,177RE	GE	RECTIFIER	577		
A177,177RP	GE	RECTIFIER	577		
A177,177RD	GE	RECTIFIER	577		
A177,177RPA	GE	RECTIFIER	577		
A177,177RPB	GE	RECTIFIER	577		
A177,177RPD	GE	RECTIFIER	577		
A177,177RT	GE	RECTIFIER	577		
A180,180RA	GE	RECTIFIER	581		
A180,180RN	GE	RECTIFIER	581		
A180,180RP	GE	RECTIFIER	581		
A180,180RD	GE	RECTIFIER	581		
A180,180RB	GE	RECTIFIER	581		
A180,180RC	GE	RECTIFIER	581		
A180,180RPD	GE	RECTIFIER	581		
A180,180RPE	GE	RECTIFIER	581		
A180,180RS	GE	RECTIFIER	581		
A180,180RPA	GE	RECTIFIER	581		
A180,180RT	GE	RECTIFIER	581		
A180,180RPB	GE	RECTIFIER	581		
A180,180RM	GE	RECTIFIER	581		
A180,180RE	GE	RECTIFIER	581		
A180,180RPC	GE	RECTIFIER	581		
A187,187RN	GE	RECTIFIER	584		
A187,187RM	GE	RECTIFIER	584		
A187,187RE	GE	RECTIFIER	584		
A187,187RD	GE	RECTIFIER	584		
A187,187RC	GE	RECTIFIER	584		
A187,187RS	GE	RECTIFIER	584		
A187,187RT	GE	RECTIFIER	584		
A187,187RA	GE	RECTIFIER	584		
A187,187RB	GE	RECTIFIER	584		
A187,187RP	GE	RECTIFIER	584		
A187,187RPA	GE	RECTIFIER	584		
A187,187RPC	GE	RECTIFIER	584		
A187,187RPB	GE	RECTIFIER	584		
A187,187RPD	GE	RECTIFIER	584		
A187,187RPE	GE	RECTIFIER	584		
A19013	GE	RECTIFIER	643		
A19015	GE	RECTIFIER	643		
A190,190RPE	GE	RECTIFIER	241		
A190,190RT	GE	RECTIFIER	241		
A190,190RN	GE	RECTIFIER	241		
A190,190RP	GE	RECTIFIER	241		
A190,190RPA	GE	RECTIFIER	241		
A190,190RPD	GE	RECTIFIER	241		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
A190,190RS	GE	RECTIFIER	241		
A190,190RA	GE	RECTIFIER	241		
A190,190RB	GE	RECTIFIER	241		
A190,190RC	GE	RECTIFIER	241		
A190,190RPB	GE	RECTIFIER	241		
A190,190RPC	GE	RECTIFIER	241		
A190,190RE	GE	RECTIFIER	241		
A190,190RM	GE	RECTIFIER	241		
A190,190RD	GE	RECTIFIER	241		
A197,197RB	GE	RECTIFIER	588		
A197,197RT	GE	RECTIFIER	588		
A197,197RA	GE	RECTIFIER	588		
A197,197RPD	GE	RECTIFIER	588		
A197,197RP	GE	RECTIFIER	588		
A197,197RPE	GE	RECTIFIER	588		
A197,197RS	GE	RECTIFIER	588		
A197,197RC	GE	RECTIFIER	588		
A197,197RD	GE	RECTIFIER	588		
A197,197RE	GE	RECTIFIER	588		
A197,197RM	GE	RECTIFIER	588		
A197,197RN	GE	RECTIFIER	588		
A197,197RPA	GE	RECTIFIER	588		
A197,197RPB	GE	RECTIFIER	588		
A197,197RPC	GE	RECTIFIER	588		
A2011	GE	RECTIFIER	625		
A202		PWR TRAN		D44C1	1147
A203		PWR TRAN		D40E1	1109
A208		PWR TRAN		D44C2	1147
A210		PWR TRAN		D40E1	1109
A211		PWR TRAN		D40E1	1109
A245		PWR TRAN		D40E1	1109
A246		PWR TRAN		D40E1	1109
A247		PWR TRAN		D40E1	1109
A2511	GE	RECTIFIER	631		
A253		PWR TRAN		D42C2	1135
A27BR1200	GE	HI-REL REC	CF		
A27DR1200	GE	HI-REL REC	CF		
A27DR521A	GE	HI-REL REC	CF		
A27DR521A	GE	HI-REL REC	CF		
A27DR521B	GE	HI-REL REC	CF		
A27DR521B	GE	HI-REL REC	CF		
A27DR521M	GE	HI-REL REC	CF		
A27DR521M	GE	HI-REL REC	CF		
A27MR1200	GE	HI-REL REC	CF		
A270		PWR TRAN		D40E5	1109
A271		PWR TRAN		D42C5	1135
A272		PWR TRAN		D44C4	1147
A273		PWR TRAN		D44C1	1147
A275		PWR TRAN		D42C2	1135
A276		PWR TRAN		D44C3	1147
A277		PWR TRAN		D44C1	1147
A278		PWR TRAN		D40N1	1117
A279		PWR TRAN		D40N1	1117
A28A, A29A	GE	RECTIFIER	551		
A28BR1200	GE	HI-REL REC	CF		
A28BR1201	GE	HI-REL REC	CF		
A28B, A29B	GE	RECTIFIER	551		
A28C, A29C	GE	RECTIFIER	551		
A28DR1200	GE	HI-REL REC	CF		
A28DR1201	GE	HI-REL REC	CF		
A28D, A29D	GE	RECTIFIER	551		
A28F, A29F	GE	RECTIFIER	551		
A3512	GE	RECTIFIER	637		
A38BR1200	GE	HI-REL REC	CF		
A38BR1202	GE	HI-REL REC	CF		
A38DR019A	GE	HI-REL REC	CF		
A38DR019A	GE	HI-REL REC	CF		
A38DR019B	GE	HI-REL REC	CF		
A38DR019B	GE	HI-REL REC	CF		
A38DR019M	GE	HI-REL REC	CF		
A38DR019M	GE	HI-REL REC	CF		
A38DR1200	GE	HI-REL REC	CF		
A38DR1202	GE	HI-REL REC	CF		
A38MR1200	GE	HI-REL REC	CF		
A390M	GE	RECTIFIER	592		
A390N	GE	RECTIFIER	592		
A390P	GE	RECTIFIER	592		
A390PA	GE	RECTIFIER	592		
A390PB	GE	RECTIFIER	592		
A390PC	GE	RECTIFIER	592		
A390PD	GE	RECTIFIER	592		
A390PE	GE	RECTIFIER	592		
A390S	GE	RECTIFIER	592		
A390T	GE	RECTIFIER	592		
A397A	GE	RECTIFIER	596		
A397B	GE	RECTIFIER	596		
A397C	GE	RECTIFIER	596		
A397D	GE	RECTIFIER	596		
A397E	GE	RECTIFIER	596		
A397M	GE	RECTIFIER	596		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
A397N	GE	RECTIFIER	596		
A397P	GE	RECTIFIER	596		
A397PA	GE	RECTIFIER	596		
A397PB	GE	RECTIFIER	596		
A397PC	GE	RECTIFIER	596		
A397PD	GE	RECTIFIER	596		
A397PE	GE	RECTIFIER	596		
A397S	GE	RECTIFIER	596		
A397T	GE	RECTIFIER	596		
A40A, A41A	GE	RECTIFIER	230		
A40B, A41B	GE	RECTIFIER	230		
A40C, A41C	GE	RECTIFIER	230		
A40D, A41D	GE	RECTIFIER	230		
A40E, A41E	GE	RECTIFIER	230		
A40F, A41F	GE	RECTIFIER	230		
A40M, A41M	GE	RECTIFIER	230		
A430E	GE	RECTIFIER	600		
A430M	GE	RECTIFIER	600		
A430N	GE	RECTIFIER	600		
A430P	GE	RECTIFIER	600		
A430PA	GE	RECTIFIER	600		
A430PB	GE	RECTIFIER	600		
A430PC	GE	RECTIFIER	600		
A430PD	GE	RECTIFIER	600		
A430PE	GE	RECTIFIER	600		
A430PM	GE	RECTIFIER	600		
A430PS	GE	RECTIFIER	600		
A430S	GE	RECTIFIER	600		
A430T	GE	RECTIFIER	600		
A437E	GE	RECTIFIER	603		
A437M	GE	RECTIFIER	603		
A437N	GE	RECTIFIER	603		
A437P	GE	RECTIFIER	603		
A437PA	GE	RECTIFIER	603		
A437PB	GE	RECTIFIER	603		
A437PC	GE	RECTIFIER	603		
A437PD	GE	RECTIFIER	603		
A437PE	GE	RECTIFIER	603		
A437S	GE	RECTIFIER	603		
A437T	GE	RECTIFIER	603		
A44A, A45A	GE	RECTIFIER	555		
A44B, A45B	GE	RECTIFIER	555		
A44C, A45C	GE	RECTIFIER	555		
A44D, A45D	GE	RECTIFIER	555		
A44E, A45E	GE	RECTIFIER	555		
A44F, A45F	GE	RECTIFIER	555		
A44M, A45M	GE	RECTIFIER	555		
A500L	GE	RECTIFIER	607		
A500LA	GE	RECTIFIER	607		
A500LB	GE	RECTIFIER	607		
A500LC	GE	RECTIFIER	607		
A500LD	GE	RECTIFIER	607		
A500LE	GE	RECTIFIER	607		
A500LM	GE	RECTIFIER	607		
A500LN	GE	RECTIFIER	607		
A500LP	GE	RECTIFIER	607		
A500LS	GE	RECTIFIER	607		
A500LT	GE	RECTIFIER	607		
A500PE	GE	RECTIFIER	607		
A500PM	GE	RECTIFIER	607		
A500PN	GE	RECTIFIER	607		
A500PS	GE	RECTIFIER	607		
A500PT	GE	RECTIFIER	607		
A540D	GE	RECTIFIER	610		
A540E	GE	RECTIFIER	610		
A540L	GE	RECTIFIER	610		
A540LA	GE	RECTIFIER	610		
A540LB	GE	RECTIFIER	610		
A540LC	GE	RECTIFIER	610		
A540LD	GE	RECTIFIER	610		
A540M	GE	RECTIFIER	610		
A540N	GE	RECTIFIER	610		
A540P	GE	RECTIFIER	610		
A540PA	GE	RECTIFIER	610		
A540PB	GE	RECTIFIER	610		
A540PC	GE	RECTIFIER	610		
A540PD	GE	RECTIFIER	610		
A540PE	GE	RECTIFIER	610		
A540PM	GE	RECTIFIER	610		
A540PN	GE	RECTIFIER	610		
A540PS	GE	RECTIFIER	610		
A540PT	GE	RECTIFIER	610		
A540S	GE	RECTIFIER	610		
A540T	GE	RECTIFIER	610		
A570A	GE	RECTIFIER	613		
A570B	GE	RECTIFIER	613		
A570C	GE	RECTIFIER	613		
A570D	GE	RECTIFIER	613		
A570E	GE	RECTIFIER	613		
A570M	GE	RECTIFIER	613		

				Suggested GE Replacement	
Type	Mfg.	Prod. Line	Page	Type	Page
A596M	GE	RECTIFIER	616		
A596N	GE	RECTIFIER	616		
A596P	GE	RECTIFIER	616		
A596PA	GE	RECTIFIER	616		
A596PB	GE	RECTIFIER	616		
A596PC	GE	RECTIFIER	616		
A596PD	GE	RECTIFIER	616		
A596S	GE	RECTIFIER	616		
A596T	GE	RECTIFIER	616		
A640L	GE	RECTIFIER	619		
A640P	GE	RECTIFIER	619		
A640PA	GE	RECTIFIER	619		
A640PB	GE	RECTIFIER	619		
A640PC	GE	RECTIFIER	619		
A640PD	GE	RECTIFIER	619		
A640PE	GE	RECTIFIER	619		
A640PM	GE	RECTIFIER	619		
A640PN	GE	RECTIFIER	619		
A640PS	GE	RECTIFIER	619		
A640PT	GE	RECTIFIER	619		
A640T	GE	RECTIFIER	619		
A696	GE	RECTIFIER	623		
A7011	GE	RECTIFIER	643		
A7012	GE	RECTIFIER	643		
A7013	GE	RECTIFIER	643		
A7014	GE	RECTIFIER	643		
A70,A71S	GE	RECTIFIER	234		
A70,A71T	GE	RECTIFIER	234		
A72,A73A	GE	SCR	CF		
A72,A73B	GE	SCR	CF		
A72,A73C	GE	SCR	CF		
A72,A73D	GE	SCR	CF		
A72,A73E	GE	SCR	CF		
A72,A73M	GE	SCR	CF		
A72,A73N	GE	SCR	CF		
A72,A73P	GE	SCR	CF		
A72,A73PA	GE	SCR	CF		
A72,A73PB	GE	SCR	CF		
A72,A73S	GE	SCR	CF		
A72,A73T	GE	SCR	CF		
A7811055	GE	GE-MOV HDW	CF		
AC130V	GE	GE MOV	545		
AC14V	GE	GE MOV	545		
AC250V	GE	GE MOV	545		
AC28V	GE	GE MOV	545		
AC42V	GE	GE MOV	545		
AC56V	GE	GE MOV	545		
AT470		PWR TRAN		D40E5	1109
AT471		PWR TRAN		D40E7	1109
AT473		PWR TRAN		D40E5	1109
AT476		PWR TRAN		D40E5	1109
AT477		PWR TRAN		D40E7	1109
B143000		PWR TRAN		D42C5	1135
B143001		PWR TRAN		D42C5	1135
B143003		PWR TRAN		D42C3	1135
B143004		PWR TRAN		D42C7	1135
B143009		PWR TRAN		D42C4	1135
B143010		PWR TRAN		D42C4	1135
B143011		PWR TRAN		D42C7	1135
B143012		PWR TRAN		D42C7	1135
B143015		PWR TRAN		D42C5	1135
B143016		PWR TRAN		D42C5	1135
B143018		PWR TRAN		D42C8	1135
B143019		PWR TRAN		D42C8	1135
B143024		PWR TRAN		D42C4	1135
B143025		PWR TRAN		D42C4	1135
B143026		PWR TRAN		D42C7	1135
B143027		PWR TRAN		D42C7	1135
B3465		PWR TRAN		D40E7	1109
B3466		PWR TRAN		D40E7	1109
B3531		PWR TRAN		D40E5	1109
B3533		PWR TRAN		D40E5	1109
B3537		PWR TRAN		D42C5	1135
B3538		PWR TRAN		D40E5	1109
B3539		PWR TRAN		D40E7	1109
B3540		PWR TRAN		D40E5	1109
B3541		PWR TRAN		D40E5	1109
B3542		PWR TRAN		D40E5	1109
B3543		PWR TRAN		D40E7	1109
B3544		PWR TRAN		D40E7	1109
B3547		PWR TRAN		D44C8	1147
B3548		PWR TRAN		D44C8	1147
B3550		PWR TRAN		D44C6	1147
B3551		PWR TRAN		D44C8	1147
B3570		PWR TRAN		D42C5	1135
B3576		PWR TRAN		D42C5	1135
B3577		PWR TRAN		D44C7	1147
B3578		PWR TRAN		D44C6	1147
B3580		PWR TRAN		D44C6	1147
B3584		PWR TRAN		D44C8	1147

CF = CONTACT FACTORY

				Suggested GE Replacement	
Type	Mfg.	Prod. Line	Page	Type	Page
B3585		PWR TRAN		D44C5	1147
B3586		PWR TRAN		D44C8	1147
B3588		PWR TRAN		D44C6	1147
B3589		PWR TRAN		D44C8	1147
B3606		PWR TRAN		D42C3	1135
B3607		PWR TRAN		D42C6	1135
B3608		PWR TRAN		D42C8	1135
B3609		PWR TRAN		D42C3	1135
B3610		PWR TRAN		D42C6	1135
B3611		PWR TRAN		D42C8	1135
B3612		PWR TRAN		D42C3	1135
B3613		PWR TRAN		D42C6	1135
B3614		PWR TRAN		D42C8	1135
B3747		PWR TRAN		D40E1	1109
B3748		PWR TRAN		D40E1	1109
B3750		PWR TRAN		D42C6	1135
B5001		PWR TRAN		D44C5	1147
B5002		PWR TRAN		D44C8	1147
B5021		PWR TRAN		D44C5	1147
B5022		PWR TRAN		D44C8	1147
B5031		PWR TRAN		D44C6	1147
B5032		PWR TRAN		D44C8	1147
BC119		PWR TRAN		D40E5	1109
BC120		PWR TRAN		D40E5	1109
BC140		PWR TRAN		D40E5	1109
BC140C		PWR TRAN		D40E5	1109
BC140D		PWR TRAN		D40E7	1109
BC141		PWR TRAN		D40E7	1109
BC142		PWR TRAN		D40E7	1109
BC160		PWR TRAN		D40E7	1109
BC161		PWR TRAN		D41E7	1129
BC286		PWR TRAN		D40E7	1109
BC287		PWR TRAN		D41E7	1129
BC301		PWR TRAN		D40E7	1109
BC312		PWR TRAN		D44R1	1159
BC313		PWR TRAN		D40E5	1109
BD106		PWR TRAN		D42C4	1135
BD107		PWR TRAN		D42C1	1135
BD109		PWR TRAN		D44C5	1147
BD112		PWR TRAN		D44C6	1147
BD115		PWR TRAN		D44R1	1159
BD124		PWR TRAN		D44C5	1147
BD127		PWR TRAN		D44R4	1159
BD131		PWR TRAN		D44C5	1147
BD135		PWR TRAN		D42C5	1135
BD136		PWR TRAN		D43C5	1143
BD137		PWR TRAN		D42C7	1135
BD138		PWR TRAN		D43C7	1143
BD145		PWR TRAN		D44C8	1147
BD162		PWR TRAN		D44C7	1147
BD163		PWR TRAN		D44C6	1147
BD1,2,4	GE	TUNNEL DIO	651		
BD220		PWR TRAN		D44C11	1147
BD221		PWR TRAN		D44C6	1147
BD222		PWR TRAN		D44C9	1147
BD223		PWR TRAN		D45C11	1163
BD224		PWR TRAN		D45C6	1163
BD225		PWR TRAN		D45C9	1163
BD3	GE	TUNNEL DIO	651		
BD402,3,4,5,6,7	GE	TUN DIODE	CF		
BD5,6,7	GE	TUNNEL DIO	451		
BDY12		PWR TRAN		D44C6	1147
BDY13		PWR TRAN		D44C8	1147
BDY15A		PWR TRAN		D42C8	1135
BDY16A		PWR TRAN		D42C8	1135
BDY34		PWR TRAN		D42C5	1135
BDY60		PWR TRAN		D44C8	1147
BDY61		PWR TRAN		D44C8	1147
BDY62		PWR TRAN		D44C6	1147
BF108		PWR TRAN		D44R1	1159
BF109		PWR TRAN		D40N1	1117
BF118		PWR TRAN		D40N1	1117
BF156		PWR TRAN		D44R1	1159
BF157		PWR TRAN		D44R1	1159
BF174		PWR TRAN		D40N1	1117
BF179A		PWR TRAN		D40N1	1117
BF179B		PWR TRAN		D40N1	1117
BF179C		PWR TRAN		D40N1	1117
BF257		PWR TRAN		D40N1	1117
BF258		PWR TRAN		D40N1	1117
BF259		PWR TRAN		D40N3	1117
BF292A		PWR TRAN		D40N1	1117
BF292B		PWR TRAN		D40N1	1117
BF292C		PWR TRAN		D40N1	1117
BF294		PWR TRAN		D40N2	1117
BFS23		PWR TRAN		D42C1	1135
BFS50		PWR TRAN		D40E1	1109
BFS51		PWR TRAN		D40E1	1109
BFX38		PWR TRAN		D41E5	1129
BFX39		PWR TRAN		D41E5	1129

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
BFX69		PWR TRAN		D40E5	1109
BFX69A		PWR TRAN		D40E5	1109
BFX84		PWR TRAN		D40E7	1109
BFX85		PWR TRAN		D40E7	1109
BFX86		PWR TRAN		D40E5	1109
BFX96		PWR TRAN		D40E1	1109
BFX96A		PWR TRAN		D40E1	1109
BFX97		PWR TRAN		D40E5	1109
BFX98		PWR TRAN		D44R2	1159
BFY40		PWR TRAN		D40E1	1109
BFY41		PWR TRAN		D44R1	1159
BFY43		PWR TRAN		D40N1	1117
BFY44		PWR TRAN		D40E7	1109
BFY51		PWR TRAN		D40E5	1109
BFY53		PWR TRAN		D40E1	1109
BFY56		PWR TRAN		D40E5	1109
BFY57		PWR TRAN		D40N1	1117
BFY70		PWR TRAN		D40E5	1109
BFY72		PWR TRAN		D40E5	1109
BLY12		PWR TRAN		D44C3	1147
BLY15A		PWR TRAN		D42C8	1135
BLY20		PWR TRAN		D42C1	1135
BLY21		PWR TRAN		D42C8	1135
BLY33		PWR TRAN		D40E1	1109
BLY34		PWR TRAN		D40E1	1109
BLY35		PWR TRAN		D44C1	1147
BLY36		PWR TRAN		D44C1	1147
BLY37		PWR TRAN		D42C5	1135
BLY38		PWR TRAN		D40E1	1109
BLY53		PWR TRAN		D42C2	1135
BLY61		PWR TRAN		D40E1	1109
BLY62		PWR TRAN		D42C1	1135
BLY63		PWR TRAN		D44C1	1147
BLY78		PWR TRAN		D40E1	1109
BLY79		PWR TRAN		D44C1	1147
BLY88		PWR TRAN		D44C3	1147
BLY89		PWR TRAN		D44C1	1147
BLY91		PWR TRAN		D42C5	1135
BLY92		PWR TRAN		D44C6	1147
BLY93		PWR TRAN		D44C4	1147
BPW38	GE	OPTO DET	CF		
BR-100B		PWR TRAN		D42C5	1135
BR-101B		PWR TRAN		D42C8	1135
BS10-01A	BBC	TRIAC		SC245B	1393
BS10-02A	BBC	TRIAC		SC245B	1393
BS10-03A	BBC	TRIAC		SC245D	1393
BS10-04A	BBC	TRIAC		SC245D	1393
BS10-05A	BBC	TRIAC		SC245E	1393
BS10-06A	BBC	TRIAC		SC245M	1393
BS6-01A	BBC	TRIAC		SC240B	1393
BS6-01E	BBC	TRIAC		SC241B	1393
BS6-02A	BBC	TRIAC		SC240B	1393
BS6-02E	BBC	TRIAC		SC241B	1393
BS6-03A	BBC	TRIAC		SC240D	1393
BS6-03E	BBC	TRIAC		SC241D	1393
BS6-04A	BBC	TRIAC		SC240D	1393
BS6-04E	BBC	TRIAC		SC241D	1393
BS6-05A	BBC	TRIAC		SC240E	1393
BS6-05E	BBC	TRIAC		SC241E	1393
BS6-06A	BBC	TRIAC		SC240M	1393
BS6-06E	BBC	TRIAC		SC241M	1393
BS7-02A	BBC	TRIAC		SC141B	1381
BS7-04A	BBC	TRIAC		SC141D	1381
BS7-05A	BBC	TRIAC		SC141E	1381
BS8-01A	BBC	TRIAC		SC245B	1393
BS8-02A	BBC	TRIAC		SC245B	1393
BS8-03A	BBC	TRIAC		SC245B	1393
BS8-04A	BBC	TRIAC		SC245D	1393
BS8-05A	BBC	TRIAC		SC245E	1393
BS8-06A	BBC	TRIAC		SC245M	1393
BS9-02A	BBC	TRIAC		SC143B	1381
BS9-04A	BBC	TRIAC		SC143D	1381
BS9-05A	BBC	TRIAC		SC143E	1381
BSV16		PWR TRAN		D40E7	1109
BSV60		PWR TRAN		D42C6	1135
BSW28		PWR TRAN		D40E5	1109
BSW29		PWR TRAN		D40E1	1109
BSW66		PWR TRAN		D44R1	1159
BSW67		PWR TRAN		D44R1	1159
BSW68		PWR TRAN		D44R1	1159
BSX22		PWR TRAN		D42C1	1135
BSX30		PWR TRAN		D40E1	1109
BSX32		PWR TRAN		D40E5	1109
BSX46		PWR TRAN		D40E5	1109
BSX48		PWR TRAN		D40E1	1109
BSX49		PWR TRAN		D40E1	1109
BSX58		PWR TRAN		D40E1	1109
BSX59		PWR TRAN		D40E5	1109
BSX60		PWR TRAN		D40E1	1109
BSX61		PWR TRAN		D40E5	1109

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
BSX62		PWR TRAN		D40E5	1109
BSX63		PWR TRAN		D40E7	1109
BSX91		PWR TRAN		D40E5	1109
BSX92		PWR TRAN		D40E7	1109
BT101-300R	PHIN	SCR		C231CX211	CF
BT101-500R	PHIN	SCR		C231EX211	CF
BT102-300R	PHIN	SCR		C230CX211	CF
BT102-500R	PHIN	SCR		C230EX211	CF
BT106A	PHIM	SCR		C106A1	720
BT106B	PHIN	SCR		C106B1	720
BT106C	PHIN	SCR		C106C1	720
BT106D	PHIN	SCR		C106D1	720
BTD0105	TEC	TRIAC		SC136A	1377
BTD0110	TEC	TRIAC		SC136A	1377
BTD0120	TEC	TRIAC		SC136B	1377
BTD0140	TEC	TRIAC		SC136D	1377
BTD0305	TEC	TRIAC		SC136A	1377
BTD0310	TEC	TRIAC		SC136A	1377
BTD0320	TEC	TRIAC		SC136B	1377
BTD0340	TEC	TRIAC		SC136D	1377
BTL0810	TEC	TRIAC		SC143B	1381
BTR0605	TEC	TRIAC		SC141B2	1381
BTR0610	TEC	TRIAC		SC141B2	1381
BTR0620	TEC	TRIAC		SC141B2	1381
BTR0640	TEC	TRIAC		SC141D2	1381
BTR0660	TEC	TRIAC		S141M2	1381
BTR1005	TEC	TRIAC		SC146B2	1381
BTR1010	TEC	TRIAC		SC146B2	1381
BTR1020	TEC	TRIAC		SC146B2	1381
BTR1040	TEC	TRIAC		SC146D2	1381
BTR1060	TEC	TRIAC		SC146M2	1381
BTS0605	TEC	TRIAC		SC241B	1393
BTS0610	TEC	TRIAC		SC241B	1393
BTS0620	TEC	TRIAC		SC241B	1393
BTS0640	TEC	TRIAC		SC241D	1393
BTS0660	TEC	TRIAC		SC241M	1393
BTS1005	TEC	TRIAC		SC246B	1393
BTS1010	TEC	TRIAC		SC246B	1393
BTS1020	TEC	TRIAC		SC246B	1393
BTS1040	TEC	TRIAC		SC246D	1393
BTS1060	TEC	TRIAC		SC246M	1393
BTS1605	TEC	TRIAC		SC251B	1393
BTS1610	TEC	TRIAC		SC251B	1393
BTS1620	TEC	TRIAC		SC251B	1393
BTS1640	TEC	TRIAC		SC251D	1393
BTS1660	TEC	TRIAC		SC51M	1393
BTS2505	TEC	TRIAC		SC261B	1393
BTS2510	TEC	TRIAC		SC261B	1393
BTS2520	TEC	TRIAC		SC261B	1393
BTS2540	TEC	TRIAC		SC261D	1393
BTS2560	TEC	TRIAC		SC261M	1393
BTU0505	TEC	TRIAC		SC250B	1393
BTU0510	TEC	TRIAC		SC250B	1393
BTU0520	TEC	TRIAC		SC250B	1393
BTU0530	TEC	TRIAC		SC250D	1393
BTU0540	TEC	TRIAC		SC250D	1393
BTU0550	TEC	TRIAC		SC250E	1393
BTU0560	TEC	TRIAC		SC250M	1393
BTU0605	TEC	TRIAC		SC240B	1393
BTU0610	TEC	TRIAC		SC240B	1393
BTU0620	TEC	TRIAC		SC240B	1393
BTU0640	TEC	TRIAC		SC240D	1393
BTU0660	TEC	TRIAC		SC240M	1393
BTU1005	TEC	TRIAC		SC245B	1393
BTU1010	TEC	TRIAC		SC245B	1393
BTU1020	TEC	TRIAC		SC245B	1393
BTU1040	TEC	TRIAC		SC245D	1393
BTU1060	TEC	TRIAC		SC245M	1393
BTU1605	TEC	TRIAC		SC250B	1393
BTU1610	TEC	TRIAC		SC250B	1393
BTU1620	TEC	TRIAC		SC250B	1393
BTU1640	TEC	TRIAC		SC250D	1393
BTU1660	TEC	TRIAC		SC250M	1393
BTU2505	TEC	TRIAC		SC260B	1393
BTU2510	TEC	TRIAC		SC260B	1393
BTU2520	TEC	TRIAC		SC260B	1393
BTU2540	TEC	TRIAC		SC260D	1393
BTU2560	TEC	TRIAC		SC260M	1393
BTW30-300RM	PHIN	SCR		C141C	783
BTW30-400RM	PHIN	SCR		C141D	783
BTW30-500RM	PHIN	SCR		C139E10E	775
BTW30-600RM	PHIN	SCR		C139M10M	775
BTW30-800RM	PHIN	SCR		C139N10M	775
BTW31-300RM	PHIN	SCR		C140C	783
BTW31-400RM	PHIN	SCR		C140D	783
BTW31-500RM	PHIN	SCR		C139E15E	775
BTW31-600RM	PHIN	SCR		C139M15M	775
BTW31-800RM	PHIN	SCR		C139N15M	775
BTX0605	TEC	TRIAC		SC240B2	1393
BTX0610	TEC	TRIAC		SC240B2	1393

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
BTX0620	TEC	TRIAC		SC240B2	1393
BTX0640	TEC	TRIAC		SC240D2	1393
BTX0660	TEC	TRIAC		SC240M2	1393
BTX1005	TEC	TRIAC		SC245B2	1393
BTX1010	TEC	TRIAC		SC245B2	1393
BTX1020	TEC	TRIAC		SC245B2	1393
BTX1040	TEC	TRIAC		SC245D2	1393
BTX1060	TEC	TRIAC		SC245M2	1393
BTX1605	TEC	TRIAC		SC250B2	1393
BTX1610	TEC	TRIAC		SC250B2	1393
BTX1620	TEC	TRIAC		SC250B2	1393
BTX1640	TEC	TRIAC		SC250D2	1393
BTX1660	TEC	TRIAC		SC250M2	1393
BTX2505	TEC	TRIAC		SC260B2	1393
BTX2510	TEC	TRIAC		SC260B2	1393
BTX2520	TEC	TRIAC		SC260B2	1393
BTX2540	TEC	TRIAC		SC260D2	1393
BTX2560	TEC	TRIAC		SC260M2	1393
BTX94-100	PHIN	TRIAC		SC260B	1393
BTX94-200	PHIN	TRIAC		SC260B	1393
BTX94-300	PHIN	TRIAC		SC260D	1393
BTX94-400	PHIN	TRIAC		SC260D	1393
BTX94-500	PHIN	TRIAC		SC260E	1393
BTX94-600	PHIN	TRIAC		SC260M	1393
BUY10		PWR TRAN		D44C1	1147
BUY11		PWR TRAN		D44C2	1147
BUY24		PWR TRAN		D44C8	1147
BUY43		PWR TRAN		D44C6	1147
BUY46		PWR TRAN		D44C8	1147
C1012	GE	SCR	1046		
C103A	GE	SCR	716		
C103B	GE	SCR	716		
C103Q	GE	SCR	716		
C103Y	GE	SCR	716		
C103YY	GE	SCR	716		
C106A	GE	SCR	720		
C106B	GE	SCR	720		
C106C	GE	SCR	720		
C106D	GE	SCR	720		
C106E	GE	SCR	720		
C106F	GE	SCR	720		
C106M	GE	SCR	720		
C106Q	GE	SCR	720		
C106Y	GE	SCR	720		
C107A	GE	SCR	728		
C107B	GE	SCR	728		
C107C	GE	SCR	728		
C107D	GE	SCR	728		
C107E	GE	SCR	728		
C107F	GE	SCR	728		
C107M	GE	SCR	728		
C107Q	GE	SCR	728		
C107Y	GE	SCR	728		
C108A	GE	SCR	733		
C108B	GE	SCR	733		
C108C	GE	SCR	733		
C108D	GE	SCR	733		
C108E	GE	SCR	733		
C108F	GE	SCR	733		
C108M	GE	SCR	733		
C108Q	GE	SCR	733		
C108Y	GE	SCR	733		
C10	GE	SCR	663		
C10AR1200	GE	HI-REL SCR	CF		
C10BR1200	GE	HI-REL SCR	CF		
C10DR1200	GE	HI-REL SCR	CF		
C1112	GE	SCR	1046		
C116A1	GE	SCR	741		
C116B1	GE	SCR	741		
C116D1	GE	SCR	741		
C116E1	GE	SCR	741		
C116F1	GE	SCR	741		
C116M1	GE	SCR	741		
C11	GE	SCR	322		
C11AR1200	GE	HI-REL SCR	CF		
C11BR1200	GE	HI-REL SCR	CF		
C11DR1200	GE	HI-REL SCR	CF		
C1212	GE	SCR	1046		
C122A1	GE	SCR	747		
C122B1	GE	SCR	747		
C122C1	GE	SCR	747		
C122D1	GE	SCR	747		
C122E1	GE	SCR	747		
C122F1	GE	SCR	741		
C122M1	GE	SCR	747		
C123A	GE	SCR	755		
C123B	GE	SCR	755		
C123C	GE	SCR	755		
C123D	GE	SCR	755		
C123E	GE	SCR	755		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
C123F	GE	SCR	755		
C123M	GE	SCR	755		
C126A	GE	SCR	763		
C126B	GE	SCR	763		
C126C	GE	SCR	763		
C126D	GE	SCR	763		
C126E	GE	SCR	763		
C126F	GE	SCR	763		
C126M	GE	SCR	763		
C12A	GE	SCR	CF		
C12B	GE	SCR	CF		
C12C	GE	SCR	CF		
C12F	GE	SCR	CF		
C12G	GE	SCR	CF		
C12H	GE	SCR	CF		
C12U	GE	SCR	CF		
C136D	GE	SCR			
C136E	GE	SCR			
C136M	GE	SCR			
C137E	GE	SCR	771		
C137ER1200	GE	HI-REL SCR	CF		
C137M	GE	SCR	771		
C137MR1200	GE	HI-REL SCR	CF		
C137N	GE	SCR	771		
C137NR1200	GE	HI-REL SCR	CF		
C137P	GE	SCR	771		
C137PA	GE	SCR	771		
C137PB	GE	SCR	771		
C137PBR1200	GE	HI-REL SCR	CF		
C137PR1200	GE	HI-REL SCR	CF		
C137S	GE	SCR	771		
C137T	GE	SCR	771		
C138E10E	GE	SCR	775		
C138E20E	GE	SCR	775		
C138M10M	GE	SCR	775		
C138M20M	GE	SCR	775		
C138N10M	GE	SCR	775		
C138N20M	GE	SCR	775		
C138S10M	GE	SCR	775		
C138S20M	GE	SCR	775		
C139E10E	GE	SCR	775		
C139E20E	GE	SCR	775		
C139M10M	GE	SCR	775		
C139M20M	GE	SCR	775		
C139N10M	GE	SCR	775		
C139N10MR1200	GE	HI-REL SCR	CF		
C139N20M	GE	SCR	775		
C139S10M	GE	SCR	775		
C139S20M	GE	SCR	775		
C13F	GE	SCR	667		
C13Y	GE	SCR	667		
C140	GE	SCR	783		
C141	GE	SCR	783		
C144E15E	GE	SCR	791		
C144E30E	GE	SCR	791		
C144M15M	GE	SCR	791		
C144M30M	GE	SCR	791		
C144N15M	GE	SCR	791		
C144N30M	GE	SCR	791		
C144S15M	GE	SCR	791		
C144S30M	GE	SCR	791		
C147A	GE	SCR	799		
C147B	GE	SCR	799		
C147C	GE	SCR	799		
C147D	GE	SCR	799		
C147E	GE	SCR	799		
C147M	GE	SCR	799		
C147N	GE	SCR	799		
C147P	GE	SCR	799		
C147PA	GE	SCR	799		
C147PB	GE	SCR	799		
C147S	GE	SCR	799		
C147T	GE	SCR	799		
C148M30	GE	SCR	803		
C148M40	GE	SCR	803		
C148N30	GE	SCR	803		
C148N40	GE	SCR	803		
C148P30	GE	SCR	803		
C148P40	GE	SCR	803		
C148PA30	GE	SCR	803		
C148PA40	GE	SCR	803		
C148PB30	GE	SCR	803		
C148PB40	GE	SCR	803		
C148S30	GE	SCR	803		
C148S40	GE	SCR	803		
C148T30	GE	SCR	803		
C148T40	GE	SCR	803		
C149A10	GE	SCR	811		
C149A20	GE	SCR	811		
C149B10	GE	SCR	811		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
C149B20	GE	SCR	811		
C149C10	GE	SCR	811		
C149C20	GE	SCR	811		
C149D10	GE	SCR	811		
C149D20	GE	SCR	811		
C149E10	GE	SCR	811		
C149E20	GE	SCR	811		
C149M10	GE	SCR	811		
C149M20	GE	SCR	811		
C150, C152P	GE	SCR	818		
C150, C152M	GE	SCR	818		
C150, C152N	GE	SCR	818		
C150, C152PA	GE	SCR	818		
C150, C152PB	GE	SCR	818		
C150, C152PC	GE	SCR	818		
C150, C152S	GE	SCR	818		
C150, C152T	GE	SCR	818		
C150, C152E	GE	SCR	818		
C154, C156A	GE	SCR	823		
C154, C156C	GE	SCR	823		
C154, C156B	GE	SCR	823		
C154, C156D	GE	SCR	823		
C154, C156E	GE	SCR	823		
C155, C157B	GE	SCR	823		
C155, C157C	GE	SCR	823		
C155, C157D	GE	SCR	823		
C155, C157M	GE	SCR	823		
C155, C157A	GE	SCR	823		
C155, C157E	GE	SCR	823		
C158,159E	GE	SCR	830		
C158,159M	GE	SCR	830		
C158,159N	GE	SCR	830		
C158,159PA	GE	SCR	830		
C158,159PB	GE	SCR	830		
C158,159P	GE	SCR	830		
C158,159S	GE	SCR	830		
C158,159T	GE	SCR	830		
C15A	GE	SCR	671		
C15B	GE	SCR	671		
C15C	GE	SCR	671		
C15D	GE	SCR	671		
C15E	GE	SCR	671		
C15F	GE	SCR	671		
C15G	GE	SCR	671		
C15M	GE	SCR	671		
C15U	GE	SCR	671		
C164A	GE	SCR	838		
C164B	GE	SCR	838		
C164C	GE	SCR	838		
C164D	GE	SCR	838		
C164E	GE	SCR	838		
C164M	GE	SCR	838		
C165A	GE	SCR	838		
C165B	GE	SCR	838		
C165C	GE	SCR	838		
C165D	GE	SCR	838		
C165E	GE	SCR	838		
C165M	GE	SCR	838		
C165N	GE	SCR	838		
C165S	GE	SCR	838		
C180A	GE	SCR	842		
C180B	GE	SCR	842		
C180C	GE	SCR	842		
C180D	GE	SCR	842		
C180E	GE	SCR	842		
C180M	GE	SCR	842		
C180N	GE	SCR	842		
C180P	GE	SCR	842		
C180PA	GE	SCR	842		
C180PB	GE	SCR	842		
C180PC	GE	SCR	842		
C180S	GE	SCR	842		
C180T	GE	SCR	842		
C180X500	GE	SCR	847		
C184A	GE	SCR	851		
C184B	GE	SCR	851		
C184C	GE	SCR	851		
C184D	GE	SCR	851		
C184E	GE	SCR	851		
C184M	GE	SCR	851		
C185A	GE	SCR	851		
C185B	GE	SCR	851		
C185C	GE	SCR	851		
C185D	GE	SCR	851		
C185E	GE	SCR	851		
C185M	GE	SCR	851		
C185N	GE	SCR	851		
C185S	GE	SCR	851		
C186N	GE	SCR	CF		
C186P	GE	SCR	CF		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
C186PA	GE	SCR	CF		
C186PB	GE	SCR	CF		
C186S	GE	SCR	CF		
C186T	GE	SCR	CF		
C203A	GE	SCR	858		
C203B	GE	SCR	858		
C203Q	GE	SCR	858		
C203Y	GE	SCR	858		
C203YY	GE	SCR	858		
C20A	GE	SCR	862		
C20B	GE	SCR	862		
C20C	GE	SCR	862		
C20D	GE	SCR	862		
C20E	GE	SCR	862		
C20F	GE	SCR	862		
C20U	GE	SCR	862		
C220A	GE	SCR	862		
C220B	GE	SCR	862		
C220C	GE	SCR	862		
C220D	GE	SCR	862		
C220E	GE	SCR	862		
C220F	GE	SCR	862		
C220M	GE	SCR	862		
C220U	GE	SCR	862		
C222A	GE	SCR	862		
C222B	GE	SCR	862		
C222C	GE	SCR	862		
C222D	GE	SCR	862		
C222E	GE	SCR	862		
C222F	GE	SCR	862		
C222M	GE	SCR	862		
C222U	GE	SCR	862		
C228A	GE	SCR	868		
C228B	GE	SCR	868		
C228C	GE	SCR	868		
C228D	GE	SCR	868		
C228E	GE	SCR	868		
C228F	GE	SCR	868		
C228M	GE	SCR	868		
C229A	GE	SCR	868		
C229B	GE	SCR	868		
C229C	GE	SCR	868		
C229D	GE	SCR	868		
C229E	GE	SCR	868		
C229F	GE	SCR	868		
C229M	GE	SCR	868		
C22A	GE	SCR	862		
C22B	GE	SCR	862		
C22C	GE	SCR	862		
C22D	GE	SCR	862		
C22E	GE	SCR	862		
C22F	GE	SCR	862		
C22U	GE	SCR	862		
C230A	GE	SCR	874		
C230B	GE	SCR	874		
C230C	GE	SCR	874		
C230D	GE	SCR	874		
C230E	GE	SCR	874		
C230F	GE	SCR	874		
C230M	GE	SCR	874		
C230U	GE	SCR	874		
C231A	GE	SCR	874		
C231B	GE	SCR	874		
C231C	GE	SCR	874		
C231D	GE	SCR	874		
C231E	GE	SCR	874		
C231F	GE	SCR	874		
C231M	GE	SCR	874		
C231U	GE	SCR	874		
C232A	GE	SCR	874		
C232B	GE	SCR	874		
C232C	GE	SCR	874		
C232D	GE	SCR	874		
C232E	GE	SCR	874		
C232F	GE	SCR	874		
C232M	GE	SCR	874		
C232U	GE	SCR	874		
C233A	GE	SCR	874		
C233B	GE	SCR	874		
C233C	GE	SCR	874		
C233D	GE	SCR	874		
C233E	GE	SCR	874		
C233F	GE	SCR	874		
C233M	GE	SCR	874		
C233U	GE	SCR	874		
C234A	GE	SCR	880		
C234B	GE	SCR	880		
C234C	GE	SCR	880		
C234D	GE	SCR	880		
C234E	GE	SCR	880		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
C234F	GE	SCR	880		
C234M	GE	SCR	880		
C235A	GE	SCR	880		
C235B	GE	SCR	880		
C235C	GE	SCR	880		
C235D	GE	SCR	880		
C235E	GE	SCR	880		
C235F	GE	SCR	880		
C235M	GE	SCR	880		
C30A	GE	SCR	874		
C30B	GE	SCR	874		
C30C	GE	SCR	874		
C30D	GE	SCR	874		
C30E	GE	SCR	874		
C30F	GE	SCR	874		
C30U	GE	SCR	874		
C31A	GE	SCR	874		
C31B	GE	SCR	874		
C31C	GE	SCR	874		
C31D	GE	SCR	874		
C31E	GE	SCR	874		
C31F	GE	SCR	874		
C31U	GE	SCR	874		
C32A	GE	SCR	874		
C32B	GE	SCR	874		
C32C	GE	SCR	874		
C32D	GE	SCR	874		
C32E	GE	SCR	874		
C32F	GE	SCR	874		
C32U	GE	SCR	874		
C33A	GE	SCR	874		
C33B	GE	SCR	874		
C33C	GE	SCR	874		
C33D	GE	SCR	874		
C33E	GE	SCR	874		
C33F	GE	SCR	874		
C33U	GE	SCR	874		
C34A1	GE	SCR	880		
C34A2	GE	SCR	880		
C34B1	GE	SCR	880		
C34B2	GE	SCR	880		
C34C1	GE	SCR	880		
C34C2	GE	SCR	880		
C34D1	GE	SCR	880		
C34D2	GE	SCR	880		
C34E1	GE	SCR	880		
C34E2	GE	SCR	880		
C34F1	GE	SCR	880		
C34F2	GE	SCR	880		
C350C	GE	SCR	886		
C350D	GE	SCR	886		
C350E	GE	SCR	886		
C350M	GE	SCR	886		
C350N	GE	SCR	886		
C350P	GE	SCR	886		
C350PA	GE	SCR	886		
C350PB	GE	SCR	886		
C350PC	GE	SCR	886		
C350S	GE	SCR	886		
C350T	GE	SCR	886		
C3512	GE	SCR	1046		
C354A	GE	SCR	891		
C354B	GE	SCR	891		
C354C	GE	SCR	891		
C354D	GE	SCR	891		
C354E	GE	SCR	891		
C354M	GE	SCR	891		
C355A	GE	SCR	891		
C355B	GE	SCR	891		
C355C	GE	SCR	891		
C355D	GE	SCR	891		
C355E	GE	SCR	891		
C355M	GE	SCR	891		
C358E	GE	SCR	898		
C358M	GE	SCR	898		
C358N	GE	SCR	898		
C358P	GE	SCR	898		
C358PA	GE	SCR	898		
C358PB	GE	SCR	898		
C358S	GE	SCR	898		
C358T	GE	SCR	898		
C35A	GE	SCR	675		
C35AR1200	GE	HI-REL SCR	CF		
C35B	GE	SCR	675		
C35BR1200	GE	HI-REL SCR	CF		
C35C	GE	SCR	675		
C35D	GE	SCR	675		
C35DR1200	GE	HI-REL SCR	CF		
C35E	GE	SCR	675		
C35ER1200	GE	HI-REL SCR	CF		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
C35F	GE	SCR	675		
C35G	GE	SCR	675		
C35H	GE	SCR	675		
C35M	GE	SCR	675		
C35MR1200	GE	HI-REL SCR	CF		
C35S	GE	SCR	675		
C35U	GE	SCR	675		
C364A	GE	SCR	906		
C364B	GE	SCR	906		
C364C	GE	SCR	906		
C364D	GE	SCR	906		
C364E	GE	SCR	906		
C364M	GE	SCR	906		
C365A	GE	SCR	906		
C365B	GE	SCR	906		
C365C	GE	SCR	906		
C365D	GE	SCR	906		
C365E	GE	SCR	906		
C365M	GE	SCR	906		
C36M	GE	SCR	328		
C36S	GE	SCR	328		
C37A	GE	SCR	679		
C37B	GE	SCR	679		
C37C	GE	SCR	679		
C37D	GE	SCR	679		
C37E	GE	SCR	679		
C37F	GE	SCR	679		
C37M	GE	SCR	679		
C37S	GE	SCR	679		
C37U	GE	SCR	679		
C380A	GE	SCR	912		
C380B	GE	SCR	912		
C380C	GE	SCR	912		
C380D	GE	SCR	912		
C380E	GE	SCR	912		
C380M	GE	SCR	912		
C380N	GE	SCR	912		
C380P	GE	SCR	912		
C380PA	GE	SCR	912		
C380PB	GE	SCR	912		
C380PC	GE	SCR	912		
C380S	GE	SCR	912		
C380T	GE	SCR	912		
C380X500	GE	SCR	917		
C384A	GE	SCR	921		
C384B	GE	SCR	921		
C384C	GE	SCR	921		
C384D	GE	SCR	921		
C384E	GE	SCR	921		
C384M	GE	SCR	921		
C385A	GE	SCR	921		
C385B	GE	SCR	921		
C385C	GE	SCR	921		
C385D	GE	SCR	921		
C385E	GE	SCR	921		
C385M	GE	SCR	921		
C385N	GE	SCR	921		
C385S	GE	SCR	921		
C386N	GE	SCR	CF		
C386P	GE	SCR	CF		
C386PA	GE	SCR	CF		
C386PB	GE	SCR	CF		
C386S	GE	SCR	CF		
C386T	GE	SCR	CF		
C387E	GE	SCR	928		
C387M	GE	SCR	928		
C387N	GE	SCR	928		
C387P	GE	SCR	928		
C387PA	GE	SCR	928		
C387PB	GE	SCR	928		
C387S	GE	SCR	928		
C387T	GE	SCR	928		
C388E	GE	SCR	928		
C388M	GE	SCR	928		
C388N	GE	SCR	928		
C388P	GE	SCR	928		
C388PA	GE	SCR	928		
C388PB	GE	SCR	928		
C388S	GE	SCR	928		
C388T	GE	SCR	928		
C38A	GE	SCR	683		
C38B	GE	SCR	683		
C38BR1200	GE	HI-REL SCR	CF		
C38C	GE	SCR	683		
C38D	GE	SCR	683		
C38DR1200	GE	HI-REL SCR	CF		
C38E	GE	SCR	683		
C38F	GE	SCR	683		
C38G	GE	SCR	683		
C38H	GE	SCR	683		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
C38HR1200	GE	HI-REL SCR	CF		
C38U	GE	SCR	683		
C390M	GE	SCR	936		
C390N	GE	SCR	936		
C390P	GE	SCR	936		
C390PA	GE	SCR	936		
C390PB	GE	SCR	936		
C390PC	GE	SCR	936		
C390S	GE	SCR	936		
C390T	GE	SCR	936		
C391PC	GE	SCR	941		
C391PD	GE	SCR	941		
C391PE	GE	SCR	941		
C391PM	GE	SCR	941		
C391PN	GE	SCR	941		
C391PS	GE	SCR	941		
C392A	GE	SCR	947		
C392B	GE	SCR	947		
C392C	GE	SCR	947		
C392D	GE	SCR	947		
C392E	GE	SCR	947		
C392M	GE	SCR	947		
C393A	GE	SCR	947		
C393B	GE	SCR	947		
C393C	GE	SCR	947		
C393D	GE	SCR	947		
C393E	GE	SCR	947		
C393M	GE	SCR	947		
C394A	GE	SCR	947		
C394B	GE	SCR	947		
C394C	GE	SCR	947		
C394D	GE	SCR	947		
C394E	GE	SCR	947		
C394M	GE	SCR	947		
C395A	GE	SCR	947		
C395B	GE	SCR	947		
C395C	GE	SCR	947		
C395D	GE	SCR	947		
C395E	GE	SCR	947		
C395M	GE	SCR	947		
C397E	GE	SCR	958		
C397M	GE	SCR	958		
C397N	GE	SCR	958		
C397P	GE	SCR	958		
C397PA	GE	SCR	958		
C397PB	GE	SCR	958		
C397S	GE	SCR	958		
C397T	GE	SCR	958		
C398E	GE	SCR	958		
C398M	GE	SCR	958		
C398N	GE	SCR	958		
C398P	GE	SCR	958		
C398PA	GE	SCR	958		
C398PB	GE	SCR	958		
C398S	GE	SCR	958		
C398T	GE	SCR	958		
C40A	GE	SCR	783		
C40B	GE	SCR	783		
C40C	GE	SCR	783		
C40D	GE	SCR	783		
C40F	GE	SCR	783		
C40G	GE	SCR	783		
C40H	GE	SCR	783		
C40U	GE	SCR	783		
C420		PWR TRAN		D40E5	1109
C425		PWR TRAN		D40E7	1109
C426		PWR TRAN		D40E5	1109
C440M	GE	SCR	966		
C440N	GE	SCR	966		
C440P	GE	SCR	966		
C440PA	GE	SCR	966		
C440PB	GE	SCR	966		
C440S	GE	SCR	966		
C440T	GE	SCR	966		
C441PB	GE	SCR	971		
C441PC	GE	SCR	971		
C441PD	GE	SCR	971		
C441PE	GE	SCR	971		
C441PM	GE	SCR	971		
C441PN	GE	SCR	971		
C441PS	GE	SCR	971		
C444A	GE	SCR	976		
C444B	GE	SCR	976		
C444C	GE	SCR	976		
C444D	GE	SCR	976		
C444E	GE	SCR	976		
C444M	GE	SCR	976		
C445A	GE	SCR	976		
C445B	GE	SCR	976		
C445C	GE	SCR	976		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
C445D	GE	SCR	976		
C445E	GE	SCR	976		
C445M	GE	SCR	976		
C445S	GE	SCR	976		
C447N	GE	SCR	982		
C447P	GE	SCR	982		
C447PA	GE	SCR	982		
C447PB	GE	SCR	982		
C447S	GE	SCR	982		
C447T	GE	SCR	982		
C448N	GE	SCR	982		
C448P	GE	SCR	982		
C448PA	GE	SCR	982		
C448PB	GE	SCR	982		
C448S	GE	SCR	982		
C448T	GE	SCR	982		
C449	GE	SCR	990		
C450	GE	SCR	CF		
C45,46B	GE	SCR	689		
C45,46C	GE	SCR	689		
C45,46D	GE	SCR	689		
C45,46E	GE	SCR	689		
C45,46F	GE	SCR	689		
C45,46G	GE	SCR	689		
C45,46H	GE	SCR	689		
C45,46M	GE	SCR	689		
C45,46N	GE	SCR	689		
C45,46P	GE	SCR	689		
C45,46PA	GE	SCR	689		
C45,46PB	GE	SCR	689		
C45,46S	GE	SCR	689		
C45,46T	GE	SCR	689		
C45,46U	GE	SCR	689		
C48	GE	SCR	694		
C49	GE	SCR	701		
C501L	GE	SCR	993		
C501PC	GE	SCR	993		
C501PD	GE	SCR	993		
C501PE	GE	SCR	993		
C501PM	GE	SCR	993		
C501PN	GE	SCR	993		
C501PS	GE	SCR	993		
C501PT	GE	SCR	993		
C502L	GE	SCR	999		
C502LA	GE	SCR	999		
C502PT	GE	SCR	999		
C50,52E	GE	SCR	707		
C50,52M	GE	SCR	707		
C50,52N	GE	SCR	707		
C50,52P	GE	SCR	707		
C50,52PA	GE	SCR	707		
C50,52PB	GE	SCR	707		
C50,52S	GE	SCR	707		
C50,52T	GE	SCR	707		
C511A	GE	SCR	653		
C511B	GE	SCR	653		
C511C	GE	SCR	653		
C511D	GE	SCR	653		
C511F	GE	SCR	653		
C511G	GE	SCR	653		
C511H	GE	SCR	653		
C511U	GE	SCR	653		
C5	GE	SCR	653		
C5AR1200	GE	HI-REL SCR	CF		
C5BR1200	GE	HI-REL SCR	CF		
C5DR1200	GE	HI-REL SCR	CF		
C600N	GE	SCR	CF		
C600P	GE	SCR	CF		
C600PA	GE	SCR	CF		
C600PB	GE	SCR	CF		
C600PC	GE	SCR	CF		
C600S	GE	SCR	CF		
C600T	GE	SCR	CF		
C601L	GE	SCR	CF		
C601PB	GE	SCR	CF		
C601PC	GE	SCR	CF		
C601PD	GE	SCR	CF		
C601PE	GE	SCR	CF		
C601PM	GE	SCR	CF		
C601PN	GE	SCR	CF		
C601PS	GE	SCR	CF		
C601PT	GE	SCR	CF		
C602L	GE	SCR	1005		
C602LA	GE	SCR	1005		
C602LB	GE	SCR	1005		
C602LC	GE	SCR	1005		
C602LD	GE	SCR	1005		
C602LE	GE	SCR	1005		
C602LM	GE	SCR	1005		
C602LN	GE	SCR	1005		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
C602LS	GE	SCR	1005		
C602PT	GE	SCR	1005		
C609P	GE	SCR	CF		
C609PA	GE	SCR	CF		
C609PB	GE	SCR	CF		
C609T	GE	SCR	CF		
C60 SERIES	GE	SCR	712		
C611A	GE	SCR	659		
C611B	GE	SCR	659		
C611F	GE	SCR	659		
C611G	GE	SCR	659		
C611U	GE	SCR	659		
C612PC	GE	SCR	1010		
C612PD	GE	SCR	1010		
C612PE	GE	SCR	1010		
C612PM	GE	SCR	1010		
C612PN	GE	SCR	1010		
C612PS	GE	SCR	1010		
C613	GE	SCR	1016		
C62A	GE	SCR	712		
C62B	GE	SCR	712		
C62C	GE	SCR	712		
C62D	GE	SCR	712		
C62E	GE	SCR	712		
C62F	GE	SCR	712		
C62G	GE	SCR	712		
C62H	GE	SCR	712		
C62U	GE	SCR	712		
C648	GE	SCR	1022		
C6A	GE	SCR	659		
C6B	GE	SCR	659		
C6C	GE	SCR	659		
C6D	GE	SCR	659		
C6F	GE	SCR	659		
C6G	GE	SCR	659		
C6U	GE	SCR	659		
C701L	GE	SCR	1029		
C701PB	GE	SCR	1029		
C701PC	GE	SCR	1029		
C701PD	GE	SCR	1029		
C701PE	GE	SCR	1029		
C701PM	GE	SCR	1029		
C701PN	GE	SCR	1029		
C701PS	GE	SCR	1029		
C701PT	GE	SCR	1029		
C702L	GE	SCR	1035		
C702LA	GE	SCR	1035		
C702LB	GE	SCR	1035		
C702LC	GE	SCR	1035		
C702LD	GE	SCR	1035		
C712L	GE	SCR	1041		
C712PC	GE	SCR	1041		
C712PD	GE	SCR	1041		
C712PE	GE	SCR	1041		
C712PM	GE	SCR	1041		
C712PN	GE	SCR	1041		
C712PS	GE	SCR	1041		
C712PT	GE	SCR	1041		
C764		PWR TRAN		D40N1	1117
C7	GE	SCR	333		
CL100	CLA	IRLED		LED56	1347
CL12	CLA	OPTO COUPL		H11A5	1279
CL13	CLA	OPTO COUPL		4N37	531
CL15	CLA	OPTO COUPL		H11A2	1275
CLI10	CLA	OPTO COUPL		H11B1	1293
CLI20	CLA	OPTO COUPL		H11A2	1275
CLI506	CLA	OPTO COUPL		H11A4	1277
CLI510	CLA	OPTO COUPL		4N37	531
CLI511	CLA	OPTO COUPL		4N37	531
CNY17-3C	GE	OPTO COUPL	CF		
CP409		PWR TRAN		D40E7	1109
CQX14-17	GE	IRLED	CF		
CR0121A	RTN	SCR		C123A	755
CR0121B	RTN	SCR		C123B	755
CR0121D	RTN	SCR		C123D	755
CR0121M	RTN	SCR		C123M	755
CR0122A	RTN	SCR		C122A	747
CR0122B	RTN	SCR		C122B	747
CR0122D	RTN	SCR		C122D	747
CR0122M	RTN	SCR		C122M	747
CR1040	RTN	SCR		C137PB	747
CR10B-10	MITJ	SCR		C220E	862
CR10B-12	MITJ	SCR		C220M	862
CR10B- 1	MITJ	SCR		C220F	862
CR10B- 2	MITJ	SCR		C220A	862
CR10B- 4	MITJ	SCR		C220B	862
CR10B- 6	MITJ	SCR		C220C	862
CR10B- 8	MITJ	SCR		C220D	862
CR12A-10	MITJ	SCR		C230E	874
CR12A-12	MITJ	SCR		C37M	679

CF= CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
CR12A-14	MITJ	SCR		C37S	679
CR12A-16	MITJ	SCR		C37N	679
CR12A- 6	MITJ	SCR		C230C	874
CR12A- 8	MITJ	SCR		C230D	874
CR1-051C	AEIL	SCR		C6F	659
CR1-051CA	AEIL	SCR		C6F	659
CR1-051CB	AEIL	SCR		C5F	653
CR1-101C	AEIL	SCR		C6A	659
CR1-101CA	AEIL	SCR		C6A	659
CR1-101CB	AEIL	SCR		C5A	653
CR1-201C	AEIL	SCR		C6B	659
CR1-201CA	AEIL	SCR		C6B	659
CR1-201CB	AEIL	SCR		C5B	653
CR1-301C	AEIL	SCR		C6C	659
CR1-301CA	AEIL	SCR		C6C	659
CR1-301CB	AEIL	SCR		C5C	653
CR1-401C	AEIL	SCR		C6D	659
CR1-401CA	AEIL	SCR		C6D	659
CR1-401CB	AEIL	SCR		C5D	653
CR20A-10	MITJ	SCR		C230E	874
CR20A-12	MITJ	SCR		C137M	771
CR20A-14	MITJ	SCR		C137S	771
CR20A-16	MITJ	SCR		C137N	771
CR20A- 1	MITJ	SCR		C230F	874
CR20A- 2	MITJ	SCR		C230A	874
CR20A- 4	MITJ	SCR		C230B	874
CR20A- 6	MITJ	SCR		C230C	874
CR20A- 8	MITJ	SCR		C230D	874
CR20AY-10	MITJ	SCR		C144E15E	791
CR20AY-12	MITJ	SCR		C144M15M	791
CR20AY- 2	MITJ	SCR		C140A	783
CR20AY- 4	MITJ	SCR		C140B	783
CR20AY- 6	MITJ	SCR		C140C	783
CR20AY- 8	MITJ	SCR		C140D	783
CR2AM1	MITJ	SCR		C106F12	720
CR2AM2	MITJ	SCR		C106A12	720
CR2AM4	MITJ	SCR		C106B12	720
CR2AM6	MITJ	SCR		C106C12	720
CR2AM8	MITJ	SCR		C106D12	720
CR3AM1	MITJ	SCR		C106F12	720
CR3AM2	MITJ	SCR		C106A12	720
CR3AM4	MITJ	SCR		C106B12	720
CR3AM6	MITJ	SCR		C106C12	720
CR3AM8	MITJ	SCR		C106D12	720
CR5B-10	MITJ	SCR		C220E	862
CR5B-12	MITJ	SCR		C220M	862
CR5B-8	MITJ	SCR		C220D	862
CR 1157	RTN	SCR		C137M	747
CR 5B- 6	MITJ	SCR		C220C	862
CS10-02M	CRL	SCR		C222U	862
CS10-02N	CRL	SCR		C220U	862
CS10-05M	CRL	SCR		C222F	862
CS10-05N	CRL	SCR		C220F	862
CS10-1M	CRL	SCR		C222A	862
CS10-1N	CRL	SCR		C220A	862
CS10-2M	CRL	SCR		C222B	862
CS10-2N	CRL	SCR		C220B	862
CS10-3M	CRL	SCR		C222C	862
CS10-3N	CRL	SCR		C220C	862
CS10-4M	CRL	SCR		C222D	862
CS10-4N	CRL	SCR		C220D	862
CS10-6M	CRL	SCR		C222M	862
CS10-6N	CRL	SCR		C220M	862
CS11B	WESY	SCR		C6U	659
CS11C	WESY	SCR		C6F	659
CS11D	WESB	SCR		C6A	659
CS11E	WESB	SCR		C6G	659
CS11G	WESB	SCR		C6B	659
CS11H	WESB	SCR		C6B	659
CS11K	WESB	SCR		C6C	659
CS11M	WESB	SCR		C6D	659
CS13-02	BBC	SCR		C228B	868
CS13-04	BBC	SCR		C228D	868
CS13-06	BBC	SCR		C228M	868
CS15.906	BBC	SCR		C144M15M	791
CS15.9-04	BBC	SCR		C234D	880
CS16-02	BBC	SCR		C228BX12	CF
CS16-04	BBC	SCR		C228DX12	CF
CS16-06	BBC	SCR		C137M	675
CS16-08	BBC	SCR		C137N	675
CS16-10	BBC	SCR		C137P	675
CS16-12	BBC	SCR		C137PB	675
CS20-02R	CRL	SCR		C230UX315	CF
CS20-05M	CRL	SCR		C232F	874
CS20-05N	CRL	SCR		C230F	874
CS20-05R	CRL	SCR		C230FX315	CF
CS20-1.5R	CRL	SCR		C230BX315	CF
CS20-1M	CRL	SCR		C232A	874
CS20-1N	CRL	SCR		C230A	874
CS20-1R	CRL	SCR		C230AX315	CF

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
CS20-2.5R	CRL	SCR		C230CX315	CF
CS20-2M	CRL	SCR		C232B	874
CS20-2N	CRL	SCR		C230B	874
CS20-2R	CRL	SCR		C230BX315	CF
CS20-3R	CRL	SCR		C230CX315	CF
CS20-4M	CRL	SCR		C232D	874
CS20-4N	CRL	SCR		C230D	874
CS20-4R	CRL	SCR		C230DX315	CF
CS20-5R	CRL	SCR		C230EX315	CF
CS20-6M	CRL	SCR		C232M	874
CS20-6N	CRL	SCR		C230M	874
CS20-6R	CRL	SCR		C230MX315	CF
CS25-02M	CRL	SCR		C232U	874
CS25-02N	CRL	SCR		C230U	874
CS25-02R	CRL	SCR		C230UX201	CF
CS25-05M	CRL	SCR		C232F	874
CS25-05N	CRL	SCR		C230F	874
CS25-05R	CRL	SCR		C230FX201	CF
CS25-1M	CRL	SCR		C232A	874
CS25-1N	CRL	SCR		C230A	874
CS25-1R	CRL	SCR		C230AX201	CF
CS25-2M	CRL	SCR		C232B	874
CS25-2N	CRL	SCR		C230B	874
CS25-2R	CRL	SCR		C230BX201	CF
CS25-3R	CRL	SCR		C230CX201	CF
CS25-4M	CRL	SCR		C232D	874
CS25-4N	CRL	SCR		C230D	874
CS25-4R	CRL	SCR		C230DX201	CF
CS25-6M	CRL	SCR		C232M	874
CS25-6N	CRL	SCR		C230M	874
CS35-02M	CRL	SCR		C229U	868
CS35-02N	CRL	SCR		C228U	868
CS35-02R	CRL	SCR		C228U	868
CS35-05M	CRL	SCR		C229F	868
CS35-05N	CRL	SCR		C228F	868
CS35-05R	CRL	SCR		C228F	868
CS35-1.5R	CRL	SCR		C228B	868
CS35-1M	CRL	SCR		C229A	868
CS35-1N	CRL	SCR		C228A	868
CS35-1R	CRL	SCR		C228A	868
CS35-2.5R	CRL	SCR		C228C	868
CS35-2M	CRL	SCR		C229B	868
CS35-2N	CRL	SCR		C228B	868
CS35-4M	CRL	SCR		C229D	868
CS35-4N	CRL	SCR		C228D	868
CS35-4R	CRL	SCR		C228D	868
CS35-6M	CRL	SCR		C229M	868
CS35-6N	CRL	SCR		C228M	868
CS35-6R	CRL	SCR		C228M	868
CS8-10	BBC	SCR		C136PX85	CF
CS 1-02	BBC	SCR		C116B	741
CS 1-04	BBC	SCR		C116D	741
CS 1-06	BBC	SCR		C116M	741
CS 1-08	BBC	SCR		C116N	741
CS 3-02	BBC	SCR		C122B	747
CS 3-04	BBC	SCR		C122D	747
CS 3-06	BBC	SCR		C122M	747
CS 4.9-04	BBC	SCR		C234D	880
CS 4.9-06	BBC	SCR		C144M15M	791
CS 5-02	BBC	SCR		C230BX211	CF
CS 5-04	BBC	SCR		C230DX211	CF
CS 5-06	BBC	SCR		C230MX211	CF
CS 8-02	BBC	SCR		C230B	874
CS 8-02M	CRL	SCR		C222UX304	CF
CS 8-02N	CRL	SCR		C220UX304	CF
CS 8-04	BBC	SCR		C230D	874
CS 8-05M	CRL	SCR		C222FX304	CF
CS 8-05N	CRL	SCR		C220FX304	CF
CS 8-06	BBC	SCR		C230M	874
CS 8-08	BBC	SCR		C136NX85	CF
CS 8-12	BBC	SCR		C136PBX85	CF
CS 8- 1M	CRL	SCR		C222AX304	CF
CS 8- 1N	CRL	SCR		C222FX304	CF
CS 8- 2M	CRL	SCR		C222BX304	CF
CS 8- 2N	CRL	SCR		C222BX304	CF
CS 8- 3M	CRL	SCR		C222CX304	CF
CS 8- 3N	CRL	SCR		C222CX304	CF
CS 8- 4M	CRL	SCR		C222DX304	CF
CS 8- 4N	CRL	SCR		C222DX304	CF
CS 8- 6M	CRL	SCR		C222MX304	CF
CS 8- 6N	CRL	SCR		C220MX304	CF
D13T1	GE	UJT TRAN	510		
D13T2	GE	UJT TRAN	510		
D13T3	GE	UJT TRAN	1069		
D13T4	GE	UJT TRAN	1069		
D16G6	GE	SIG TRAN	1071		
D16P1	GE	SIG TRAN	1072		
D29E10	GE	SIG TRAN	1080		
D29E10-J1	GE	SIG TRAN	1080		
D29E1	GE	SIG TRAN	1074		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
D29E1-J1	GE	SIG TRAN	1074		
D29E2	GE	SIG TRAN	1074		
D29E2-J1	GE	SIG TRAN	1074		
D29E4	GE	SIG TRAN	1076		
D29E4-J1	GE	SIG TRAN	1076		
D29E5	GE	SIG TRAN	1076		
D29E5-J1	GE	SIG TRAN	1076		
D29E6	GE	SIG TRAN	1076		
D29E6-J1	GE	SIG TRAN	1076		
D29E7	GE	SIG TRAN	1076		
D29E7-J1	GE	SIG TRAN	1076		
D29E9	GE	SIG TRAN	1080		
D29E9-J1	GE	SIG TRAN	1080		
D32H1	GE	SIG TRAN	CF		
D32H2	GE	SIG TRAN	CF		
D32H3	GE	SIG TRAN	CF		
D32H4	GE	SIG TRAN	CF		
D32H5	GE	SIG TRAN	CF		
D32H6	GE	SIG TRAN	CF		
D32H7	GE	SIG TRAN	CF		
D32H8	GE	SIG TRAN	CF		
D32H9	GE	SIG TRAN	CF		
D32L1	GE	SIG TRAN	CF		
D32L2	GE	SIG TRAN	CF		
D32L3	GE	SIG TRAN	CF		
D32L4	GE	SIG TRAN	CF		
D32L5	GE	SIG TRAN	CF		
D32L6	GE	SIG TRAN	CF		
D32S10	GE	SIG TRAN	CF		
D32S1	GE	SIG TRAN	CF		
D32S2	GE	SIG TRAN	CF		
D32S3	GE	SIG TRAN	CF		
D32S4	GE	SIG TRAN	CF		
D32S5	GE	SIG TRAN	CF		
D32S6	GE	SIG TRAN	CF		
D32S7	GE	SIG TRAN	CF		
D32S8	GE	SIG TRAN	CF		
D32S9	GE	SIG TRAN	CF		
D32V1	GE	SIG TRAN	CF		
D32V2	GE	SIG TRAN	CF		
D32V3	GE	SIG TRAN	CF		
D32W10	GE	SIG TRAN	CF		
D32W12	GE	SIG TRAN	CF		
D32W13	GE	SIG TRAN	CF		
D32W14	GE	SIG TRAN	CF		
D32W7	GE	SIG TRAN	CF		
D32W8	GE	SIG TRAN	CF		
D32W9	GE	SIG TRAN	CF		
D33D21	GE	SIG TRAN	1074		
D33D21-J1	GE	SIG TRAN	1074		
D33D22	GE	SIG TRAN	1074		
D33D22-J1	GE	SIG TRAN	1074		
D33D24	GE	SIG TRAN	1076		
D33D24-J1	GE	SIG TRAN	1076		
D33D25	GE	SIG TRAN	1076		
D33D25-J1	GE	SIG TRAN	1076		
D33D26	GE	SIG TRAN	1076		
D33D26-J1	GE	SIG TRAN	1076		
D33D27	GE	SIG TRAN	1076		
D33D27-J1	GE	SIG TRAN	1076		
D33D29	GE	SIG TRAN	1080		
D33D29-J1	GE	SIG TRAN	1080		
D33D30	GE	SIG TRAN	1080		
D33D30-J1	GE	SIG TRAN	1080		
D34C1	GE	SIG TRAN	CF		
D34C2	GE	SIG TRAN	CF		
D34C3	GE	SIG TRAN	CF		
D34C4	GE	SIG TRAN	CF		
D34C5	GE	SIG TRAN	CF		
D34C6	GE	SIG TRAN	CF		
D34J1	GE	SIG TRAN	CF		
D34J2	GE	SIG TRAN	CF		
D34J3	GE	SIG TRAN	CF		
D34J4	GE	SIG TRAN	CF		
D34J5	GE	SIG TRAN	CF		
D34J6	GE	SIG TRAN	CF		
D34J7	GE	SIG TRAN	CF		
D34J8	GE	SIG TRAN	CF		
D34J9	GE	SIG TRAN	CF		
D3814	GE	SIG TRAN	1094		
D38H1	GE	SIG TRAN	1082		
D38H2	GE	SIG TRAN	1082		
D38H3	GE	SIG TRAN	1082		
D38H4	GE	SIG TRAN	1082		
D38H5	GE	SIG TRAN	1082		
D38H6	GE	SIG TRAN	1082		
D38H7	GE	SIG TRAN	1082		
D38H8	GE	SIG TRAN	1082		
D38H9	GE	SIG TRAN	1082		
D38L1	GE	SIG TRAN	1084		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
D38L2	GE	SIG TRAN	1084		
D38L3	GE	SIG TRAN	1084		
D38L4	GE	SIG TRAN	1084		
D38L5	GE	SIG TRAN	1084		
D38L6	GE	SIG TRAN	1084		
D38S10	GE	SIG TRAN	1088		
D38S1	GE	SIG TRAN	1088		
D38S2	GE	SIG TRAN	1088		
D38S3	GE	SIG TRAN	1088		
D38S4	GE	SIG TRAN	1088		
D38S5	GE	SIG TRAN	1088		
D38S6	GE	SIG TRAN	1088		
D38S7	GE	SIG TRAN	1088		
D38S8	GE	SIG TRAN	1088		
D38S9	GE	SIG TRAN	1088		
D38V1	GE	SIG TRAN	1092		
D38V2	GE	SIG TRAN	1092		
D38V3	GE	SIG TRAN	1093		
D38W10	GE	SIG TRAN	1094		
D38W11	GE	SIG TRAN	1094		
D38W12	GE	SIG TRAN	1094		
D38W13	GE	SIG TRAN	1094		
D38W7	GE	SIG TRAN	1094		
D38W8	GE	SIG TRAN	1094		
D38W9	GE	SIG TRAN	1094		
D39C1	GE	SIG TRAN	1084		
D39C2	GE	SIG TRAN	1084		
D39C3	GE	SIG TRAN	1084		
D39C4	GE	SIG TRAN	1084		
D39C5	GE	SIG TRAN	1084		
D39C6	GE	SIG TRAN	1084		
D39J1	GE	SIG TRAN	1098		
D39J2	GE	SIG TRAN	1098		
D39J3	GE	SIG TRAN	1098		
D39J4	GE	SIG TRAN	1098		
D39J5	GE	SIG TRAN	1098		
D39J6	GE	SIG TRAN	1098		
D39J7	GE	SIG TRAN	1098		
D39J8	GE	SIG TRAN	1098		
D39J9	GE	SIG TRAN	1098		
D40C1	GE	PWR TRAN	1101		
D40C2	GE	PWR TRAN	1101		
D40C3	GE	PWR TRAN	1101		
D40C4	GE	PWR TRAN	1101		
D40C5	GE	PWR TRAN	1101		
D40C7	GE	PWR TRAN	1101		
D40D10	GE	PWR TRAN	1105		
D40D11	GE	PWR TRAN	1105		
D40D13	GE	PWR TRAN	1105		
D40D14	GE	PWR TRAN	1105		
D40D1	GE	PWR TRAN	1105		
D40D2	GE	PWR TRAN	1105		
D40D3	GE	PWR TRAN	1105		
D40D4	GE	PWR TRAN	1105		
D40D5	GE	PWR TRAN	1105		
D40D7	GE	PWR TRAN	1105		
D40D8	GE	PWR TRAN	1105		
D40E1	GE	PWR TRAN	1109		
D40E5	GE	PWR TRAN	1109		
D40E7	GE	PWR TRAN	1109		
D40K1	GE	PWR TRAN	1113		
D40K2	GE	PWR TRAN	1113		
D40K3	GE	PWR TRAN	1113		
D40K4	GE	PWR TRAN	1113		
D40N1	GE	PWR TRAN	1117		
D40N2	GE	PWR TRAN	1117		
D40N3	GE	PWR TRAN	1117		
D40N4	GE	PWR TRAN	1117		
D40N5	GE	PWR TRAN	1117		
D40P1	GE	PWR TRAN	1121		
D40P3	GE	PWR TRAN	1121		
D40P5	GE	PWR TRAN	1121		
D41D10	GE	PWR TRAN	1123		
D41D11	GE	PWR TRAN	1123		
D41D13	GE	PWR TRAN	1123		
D41D14	GE	PWR TRAN	1123		
D41D1	GE	PWR TRAN	1123		
D41D2	GE	PWR TRAN	1123		
D41D4	GE	PWR TRAN	1123		
D41D5	GE	PWR TRAN	1123		
D41D7	GE	PWR TRAN	1123		
D41D8	GE	PWR TRAN	1123		
D41E1	GE	PWR TRAN	1129		
D41E5	GE	PWR TRAN	1129		
D41E7	GE	PWR TRAN	1129		
D41K1	GE	PWR TRAN	1133		
D41K2	GE	PWR TRAN	1133		
D41K3	GE	PWR TRAN	1133		
D41K4	GE	PWR TRAN	1133		
D42C10	GE	PWR TRAN	1135		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
D42C11	GE	PWR TRAN	1135		
D42C12	GE	PWR TRAN	1135		
D42C1	GE	PWR TRAN	1135		
D42C2	GE	PWR TRAN	1135		
D42C3	GE	PWR TRAN	1135		
D42C4	GE	PWR TRAN	1135		
D42C5	GE	PWR TRAN	1135		
D42C6	GE	PWR TRAN	1135		
D42C7	GE	PWR TRAN	1135		
D42C8	GE	PWR TRAN	1135		
D42C9	GE	PWR TRAN	1135		
D42R1	GE	PWR TRAN	1139		
D42R2	GE	PWR TRAN	1139		
D42R3	GE	PWR TRAN	1139		
D42R4	GE	PWR TRAN	1139		
D43C10	GE	PWR TRAN	1143		
D43C11	GE	PWR TRAN	1143		
D43C12	GE	PWR TRAN	1143		
D43C1	GE	PWR TRAN	1143		
D43C2	GE	PWR TRAN	1143		
D43C3	GE	PWR TRAN	1143		
D43C4	GE	PWR TRAN	1143		
D43C5	GE	PWR TRAN	1143		
D43C6	GE	PWR TRAN	1143		
D43C7	GE	PWR TRAN	1143		
D43C8	GE	PWR TRAN	1143		
D43C9	GE	PWR TRAN	1143		
D44C10	GE	PWR TRAN	1147		
D44C11	GE	PWR TRAN	1147		
D44C12	GE	PWR TRAN	1147		
D44C1	GE	PWR TRAN	1147		
D44C2	GE	PWR TRAN	1147		
D44C3	GE	PWR TRAN	1147		
D44C4	GE	PWR TRAN	1147		
D44C5	GE	PWR TRAN	1147		
D44C6	GE	PWR TRAN	1147		
D44C7	GE	PWR TRAN	1147		
D44C8	GE	PWR TRAN	1147		
D44C9	GE	PWR TRAN	1147		
D44E1	GE	PWR TRAN	1151		
D44E2	GE	PWR TRAN	1151		
D44E3	GE	PWR TRAN	1151		
D44H10	GE	PWR TRAN	1155		
D44H11	GE	PWR TRAN	1155		
D44H1	GE	PWR TRAN	1155		
D44H2	GE	PWR TRAN	1155		
D44H4	GE	PWR TRAN	1155		
D44H5	GE	PWR TRAN	1155		
D44H7	GE	PWR TRAN	1155		
D44H8	GE	PWR TRAN	1155		
D44Q1	GE	PWR TRAN	1157		
D44Q3	GE	PWR TRAN	1157		
D44Q5	GE	PWR TRAN	1157		
D44R1	GE	PWR TRAN	1159		
D44R2	GE	PWR TRAN	1159		
D44R3	GE	PWR TRAN	1159		
D44R4	GE	PWR TRAN	1159		
D44R5	GE	PWR TRAN	1159		
D44R6	GE	PWR TRAN	1159		
D44R7	GE	PWR TRAN	1159		
D44R8	GE	PWR TRAN	1159		
D45C10	GE	PWR TRAN	1163		
D45C11	GE	PWR TRAN	1163		
D45C12	GE	PWR TRAN	1163		
D45C1	GE	PWR TRAN	1163		
D45C2	GE	PWR TRAN	1163		
D45C3	GE	PWR TRAN	1163		
D45C4	GE	PWR TRAN	1163		
D45C5	GE	PWR TRAN	1163		
D45C6	GE	PWR TRAN	1163		
D45C7	GE	PWR TRAN	1163		
D45C8	GE	PWR TRAN	1163		
D45C9	GE	PWR TRAN	1163		
D45E1	GE	PWR TRAN	1167		
D45E2	GE	PWR TRAN	1167		
D45E3	GE	PWR TRAN	1167		
D45H10	GE	PWR TRAN	1171		
D45H11	GE	PWR TRAN	1171		
D45H12	GE	PWR TRAN	1171		
D45H3	GE	PWR TRAN	1171		
D45H6	GE	PWR TRAN	1171		
D45H7	GE	PWR TRAN	1171		
D45H8	GE	PWR TRAN	1171		
D45H9	GE	PWR TRAN	1171		
D5J37	GE	UJT TRAN	1057		
D5J43	GE	UJT TRAN	1058		
D5J44	GE	UJT TRAN	1059		
D5J45	GE	UJT TRAN	1060		
D5K1	GE	UJT TRAN	1061		
D5K2	GE	UJT TRAN	1065		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
DA1701	GE	SIG DIODE	1173		
DA1702	GE	SIG DIODE	1173		
DA1703	GE	SIG DIODE	1173		
DA1704	GE	SIG DIODE	1173		
DC14V	GE	GE MOV	545		
DC28V	GE	GE MOV	545		
DC42V	GE	GE MOV	545		
DC56V	GE	GE MOV	545		
DE104	GE	SIG DIODE	1175		
DE110	GE	SIG DIODE	1176		
DE111	GE	SIG DIODE	1176		
DE112	GE	SIG DIODE	1176		
DE113	GE	SIG DIODE	1176		
DE114	GE	SIG DIODE	1176		
DE115	GE	SIG DIODE	1176		
DE125	GE	SIG DIODE	CF		
DT1110		PWR TRAN		D40E1	1109
DT1111		PWR TRAN		D40E7	1109
DT1112		PWR TRAN		D40N1	1117
DT1120		PWR TRAN		D40E1	1109
DT1121		PWR TRAN		D40E7	1109
DT1122		PWR TRAN		D40N1	1117
DT1311		PWR TRAN		D40E7	1109
DT1321		PWR TRAN		D40E7	1109
DT1510		PWR TRAN		D40E1	1109
DT1511		PWR TRAN		D40E5	1109
DT1512		PWR TRAN		D40E7	1109
DT1520		PWR TRAN		D40E1	1109
DT1521		PWR TRAN		D40E7	1109
DT1522		PWR TRAN		D40E7	1109
DT230A	GE	RECTIFIER	1177		
DT230B	GE	RECTIFIER	1177		
DT230F	GE	RECTIFIER	1177		
DT230G	GE	RECTIFIER	1177		
DT230H1	GE	RECTIFIER	1177		
DT230H	GE	RECTIFIER	1177		
DZ800	GE	SIG DIODE	1179		
DZ805	GE	SIG DIODE	1179		
DZ806	GE	SIG DIODE	1179		
EC103A	TCE	SCR		C103A	716
EC103B	TCE	SCR		C103B	716
EC103D	TCE	SCR		C203D	858
EC103Y	TCE	SCR		C103Y	715
FCD810	FSC	OPTO COUPL		H11A5	1279
FCD810C	FSC	OPTO COUPL		H11A520	1285
FCD810D	FSC	OPTO COUPL		H11A520	1285
FCD811	FSC	OPTO COUPL		H11A3	1277
FCD820	FSC	OPTO COUPL		H11A2	1275
FCD820C	FSC	OPTO COUPL		H11A520	1285
FCD820D	FSC	OPTO COUPL		H11A520	1285
FCD825C	FSC	OPTO COUPL		H11A550	1285
FCD825D	FSC	OPTO COUPL		H11A550	1285
FCD830C	FSC	OPTO COUPL		H11A520	1285
FCD830D	FSC	OPTO COUPL		H11A520	1285
FCD831C	FSC	OPTO COUPL		H11A520	1285
FCD831D	FSC	OPTO COUPL		H11A520	1285
FCD836C	FSC	OPTO COUPL		H11A520	1285
FCD836D	FSC	OPTO COUPL		H11A520	1285
FT340		PWR TRAN		D42C8	1135
GEMR-6		PWR TRAN		D42C5	1135
GER4001	GE	RECTIFIER	1190		
GER4002	GE	RECTIFIER	1190		
GER4003	GE	RECTIFIER	1190		
GER4004	GE	RECTIFIER	1190		
GER4005	GE	RECTIFIER	1190		
GER4006	GE	RECTIFIER	1190		
GER4007	GE	RECTIFIER	1190		
GE-18		PWR TRAN		D44R1	1159
GE-23		PWR TRAN		D44C8	1147
GE-26		PWR TRAN		D44C8	1147
GE-27		PWR TRAN		D40N8	1117
GE-28		PWR TRAN		D42C8	1135
GE-29		PWR TRAN		D43C8	1143
GES2221	GE	SIG TRAN	1195		
GES2221A	GE	SIG TRAN	1197		
GES2222	GE	SIG TRAN	1195		
GES2222A	GE	SIG TRAN	1197		
GES2483	GE	SIG TRAN	1199		
GES2906	GE	SIG TRAN	1201		
GES2907	GE	SIG TRAN	1203		
GES5305	GE	SIG TRAN	1205		
GES5306	GE	SIG TRAN	1205		
GES5306A	GE	SIG TRAN	1205		
GES5307	GE	SIG TRAN	1205		
GES5308	GE	SIG TRAN	1205		
GES5308A	GE	SIG TRAN	1205		
GES5368	GE	SIG TRAN	1209		
GES5369	GE	SIG TRAN	1209		
GES5372	GE	SIG TRAN	1211		
GES5373	GE	SIG TRAN	1211		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
GES5374	GE	SIG TRAN	1211		
GES5375	GE	SIG TRAN	1211		
GES5447	GE	SIG TRAN	1213		
GES5448	GE	SIG TRAN	1213		
GES5449	GE	SIG TRAN	1215		
GES5450	GE	SIG TRAN	1215		
GES5451	GE	SIG TRAN	1215		
GES5810	GE	SIG TRAN	1217		
GES5811	GE	SIG TRAN	1217		
GES5812	GE	SIG TRAN	1217		
GES5813	GE	SIG TRAN	1217		
GES5814	GE	SIG TRAN	1219		
GES5815	GE	SIG TRAN	1219		
GES5816	GE	SIG TRAN	1219		
GES5817	GE	SIG TRAN	1219		
GES5818	GE	SIG TRAN	1219		
GES5820	GE	SIG TRAN	1223		
GES5821	GE	SIG TRAN	1223		
GES5822	GE	SIG TRAN	1223		
GES5823	GE	SIG TRAN	1223		
GES5824	GE	SIG TRAN	1227		
GES5825	GE	SIG TRAN	1227		
GES5826	GE	SIG TRAN	1227		
GES5827	GE	SIG TRAN	1232		
GES5828	GE	SIG TRAN	1234		
GES6000	GE	SIG TRAN	1236		
GES6001	GE	SIG TRAN	1240		
GES6002	GE	SIG TRAN	1236		
GES6003	GE	SIG TRAN	1240		
GES6004	GE	SIG TRAN	1244		
GES6005	GE	SIG TRAN	1248		
GES6006	GE	SIG TRAN	1244		
GES6007	GE	SIG TRAN	1248		
GES6010	GE	SIG TRAN	1252		
GES6011	GE	SIG TRAN	1256		
GES6012	GE	SIG TRAN	1252		
GES6013	GE	SIG TRAN	1256		
GES6014	GE	SIG TRAN	1264		
GES6015	GE	SIG TRAN	1260		
GES6016	GE	SIG TRAN	1264		
GES6017	GE	SIG TRAN	1260		
GES6218	GE	SIG TRAN	1268		
GES6219	GE	SIG TRAN	1268		
GES6220	GE	SIG TRAN	1268		
GES6221	GE	SIG TRAN	1268		
GES6222	GE	SIG TRAN	1271		
GES6223	GE	SIG TRAN	1271		
GES6224	GE	SIG TRAN	1271		
GES929	GE	SIG TRAN	1191		
GES930	GE	SIG TRAN	1191		
GET2221	GE	SIG TRAN		GES2221	1195
GET2221A	GE	SIG TRAN		GES2221A	1197
GET2222	GE	SIG TRAN		GES2222	1195
GET2222A	GE	SIG TRAN		GES2222A	1197
GET2483	GE	SIG TRAN		GES2483	1199
GET2904	GE	SIG TRAN		GES2904	CF
GET2905	GE	SIG TRAN		GES2905	CF
GET2906	GE	SIG TRAN		GES2906	1201
GET2907	GE	SIG TRAN		GES2907	1203
GET3013	GE	SIG TRAN		GES3013	CF
GET3014	GE	SIG TRAN		GES3014	CF
GET3563	GE	SIG TRAN		GES3563	CF
GET3638	GE	SIG TRAN		GES3638	CF
GET3638A	GE	SIG TRAN		GES3638A	CF
GET3646	GE	SIG TRAN		GES3646	CF
GET3905	GE	SIG TRAN		GES3905	CF
GET3906	GE	SIG TRAN		GES3906	CF
GET5305	GE	SIG TRAN		GES5305	1205
GET5306	GE	SIG TRAN		GES5306	1205
GET5306A	GE	SIG TRAN		GES5306A	1205
GET5307	GE	SIG TRAN		GES5307	1205
GET5308	GE	SIG TRAN		GES5308	1205
GET5308A	GE	SIG TRAN		GES5308A	1205
GET5457	GE	SIG TRAN		GES5457	
GET5458	GE	SIG TRAN		GES5458	
GET5459	GE	SIG TRAN		GES5459	
GET929	GE	SIG TRAN		GES929	1191
GET930	GE	SIG TRAN		GES930	1191
GT015	HUT	TRIAC		SC151B2	1381
GT06	HUT	TRIAC		SC142B2	1381
GT08	HUT	TRIAC		SC143B2	1381
GT115	HUT	TRIAC		SC151B2	1381
GT16	HUT	TRIAC		SC141B2	1381
GT18	HUT	TRIAC		SC143B2	1381
GT215	HUT	TRIAC		SC151B2	1381
GT26	HUT	TRIAC		SC141B2	1381
GT28	HUT	TRIAC		SC143B2	1381
GT315	HUT	TRIAC		SC151D2	1381
GT36	HUT	TRIAC		SC141D2	1381
GT38	HUT	TRIAC		SC143D2	1381

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
GT415	HUT	TRIAC		SC151D2	1381
GT46	HUT	TRIAC		SC141D2	1381
GT48	HUT	TRIAC		SC143D2	1381
GT515	HUT	TRIAC		SC151E2	1381
GT56	HUT	TRIAC		SC141E2	1381
GT58	HUT	TRIAC		SC143E2	1381
GT66	HUT	TRIAC		SC141M2	1381
GT68	HUT	TRIAC		SC143M2	1381
H103SH	HUT	TRIAC		SC136A	1377
H113SH	HUT	TRIAC		SC136A	1377
H11A10	GE	OPTO COUPL	1281		
H11A1	GE	OPTO COUPL	1275		
H11A2	GE	OPTO COUPL	1275		
H11A3	GE	OPTO COUPL	1277		
H11A4	GE	OPTO COUPL	1277		
H11A5100	GE	OPTO COUPL	1285		
H11A5100	GE	OPTO COUPL	1285		
H11A520	GE	OPTO COUPL	1285		
H11A550	GE	OPTO COUPL	1285		
H11A550	GE	OPTO COUPL	1285		
H11A5	GE	OPTO COUPL	1279		
H11AA1	GE	OPTO COUPL	1289		
H11AA2	GE	OPTO COUPL	1289		
H11B1	GE	OPTO COUPL	1293		
H11B255	GE	OPTO COUPL	1295		
H11B2	GE	OPTO COUPL	1293		
H11B3	GE	OPTO COUPL	1293		
H11BX522	GE	OPTO COUPL	1297		
H11C1	GE	OPTO COUPL	1299		
H11C2	GE	OPTO COUPL	1299		
H11C3	GE	OPTO COUPL	1299		
H11C4	GE	OPTO COUPL	1303		
H11C5	GE	OPTO COUPL	1303		
H11C6	GE	OPTO COUPL	1303		
H11D1	GE	OPTO COUPL	1307		
H11D2	GE	OPTO COUPL	1307		
H11D3	GE	OPTO COUPL	1307		
H11D4	GE	OPTO COUPL	1307		
H123SH	HUT	TRIAC		SC136B	1377
H133SH	HUT	TRIAC		SC136D	1377
H13A1	GE	OPTO COUPL	1309		
H13A2	GE	OPTO COUPL	1309		
H13B1	GE	OPTO COUPL	1311		
H13B2	GE	OPTO COUPL	1311		
H143SH	HUT	TRIAC		SC136D	1377
H15A1	GE	OPTO COUPL	1313		
H15A2	GE	OPTO COUPL	1313		
H15B1	GE	OPTO COUPL	1315		
H15B2	GE	OPTO COUPL	1315		
H17A1	GE	OPTO DET	1317		
H17B1	GE	OPTO DET	1319		
H19A1	GE	OPTO DET	1321		
H19B1	GE	OPTO DET	1325		
H74A1	GE	OPTO COUPL	1327		
H74C1	GE	OPTO COUPL	1327		
H74C2	GE	OPTO COUPL	1327		
HEP706		PWR TRAN		D44R3	1159
HEP-714		PWR TRAN		D44R1	1159
HS07	HUT	SCR		C116F21	741
HS08	HUT	SCR		C123F	755
HS17	HUT	SCR		C116A21	741
HS18	HUT	SCR		C123A	755
HS27	HUT	SCR		C116B21	741
HS28	HUT	SCR		C123B	755
HS37	HUT	SCR		C116C21	741
HS38	HUT	SCR		C123C	755
HS47	HUT	SCR		C116D21	741
HS48	HUT	SCR		C123D	755
HS57	HUT	SCR		C116E21	741
HS58	HUT	SCR		C123E	755
HS67	HUT	SCR		C116M21	741
HS68	HUT	SCR		C123M	755
HW SERIES	GE	HEAT SINK	CF		
I3PT030	HUT	TRIAC		SC265B4	1393
I3PT040	HUT	TRIAC		SC265B4	1393
I3PT130	HUT	TRIAC		SC265B4	1393
I3PT140	HUT	TRIAC		SC265B4	1393
I3PT230	HUT	TRIAC		SC265B4	1393
I3PT240	HUT	TRIAC		SC265B4	1393
I3PT330	HUT	TRIAC		SC265D4	1393
I3PT340	HUT	TRIAC		SC265D4	1393
I3PT430	HUT	TRIAC		SC265D4	1393
I3PT440	HUT	TRIAC		SC265D4	1393
I3PT530	HUT	TRIAC		SC265E4	1393
I3PT540	HUT	TRIAC		SC265E4	1393
I3PT630	HUT	TRIAC		SC265M4	1393
I3PT640	HUT	TRIAC		SC265M4	1393
ID100	UNI	SCR		C103Y	716
ID101	UNI	SCR		C103YY	716
ID102	UNI	SCR		C103A	716

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
ID103	UNI	SCR		C103B	716
ID104	UNI	SCR		C103B	716
ID105	UNI	SCR		C203C	858
ID106	UNI	SCR		C203D	858
ID200	UNI	SCR		C5F	653
ID201	UNI	SCR		C5A	653
ID202	UNI	SCR		C5G	653
ID203	UNI	SCR		C5B	653
ID300	UNI	SCR		C5C	653
ID301	UNI	SCR		C5D	653
IL12	LIX	OPTO COUPL		H11A5	1279
IL15	LIX	OPTO COUPL		H11A5	1279
IL16	LIX	OPTO COUPL		H11A5	1279
IL1	LIX	OPTO COUPL		H11A3	1277
IL5	LIX	OPTO COUPL		H11A1	1275
IL74	LIX	OPTO COUPL		H11A5	1279
ILA30	LIX	OPTO COUPL		H11B3	1293
ILA55	LIX	OPTO COUPL		H11B255	1295
ILCA2-30	LIX	OPTO COUPL		H11B3	1293
ILCA2-55	LIX	OPTO COUPL		H13B1	1311
IN2054-68	IR	RECTIFIER		A190	643
IN2054-68	WEST	RECT		A190	643
IN3161-74	WEST	RECT		A190	643
IN4587-96	WEST	RECT		A180	581
IP100	UNI	SCR		C203Y	858
IP101	UNI	SCR		C203YY	858
IP102	UNI	SCR		C203A	858
IP103	UNI	SCR		C203G	858
IP104	UNI	SCR		C203B	858
IP105	UNI	SCR		C203C	858
IP106	UNI	SCR		C203D	858
IR106A1	IR	SCR		C106A1	720
IR106A2	IR	SCR		C106A2	720
IR106A3	IR	SCR		C106A3	720
IR106A41	IR	SCR		C106A41	720
IR106A4	IR	SCR		C106A4	720
IR106B1	IR	SCR		C106B1	720
IR106B2	IR	SCR		C106B2	720
IR106B3	IR	SCR		C106B3	720
IR106B41	IR	SCR		C106B41	720
IR106B4	IR	SCR		C106B4	720
IR106C1	IR	SCR		C106C1	720
IR106C2	IR	SCR		C106C2	720
IR106C3	IR	SCR		C106C3	720
IR106C41	IR	SCR		C106C41	720
IR106C4	IR	SCR		C106C4	720
IR106D1	IR	SCR		C106D1	720
IR106D2	IR	SCR		C106D2	720
IR106D3	IR	SCR		C106D3	720
IR106D41	IR	SCR		C106D41	720
IR106D4	IR	SCR		C106D4	720
IR106F1	IR	SCR		C106F1	720
IR106F2	IR	SCR		C106F2	720
IR106F3	IR	SCR		C106F3	720
IR106F41	IR	SCR		C106F41	720
IR106F4	IR	SCR		C106F4	720
IR106Q1	IR	SCR		C106Q1	720
IR106Q2	IR	SCR		C106Q2	720
IR106Q3	IR	SCR		C106Q3	720
IR106Q41	IR	SCR		C106Q41	720
IR106Q4	IR	SCR		C106Q4	720
IR106Y1	IR	SCR		C106Y1	720
IR106Y2	IR	SCR		C106Y2	720
IR106Y3	IR	SCR		C106Y3	720
IR106Y41	IR	SCR		C106Y41	720
IR106Y4	IR	SCR		C106Y4	720
IR122A	IR	SCR		C122A	747
IR122B	IR	SCR		C122B	747
IR122C	IR	SCR		C122C	747
IR122D	IR	SCR		C122D	747
IR122F	IR	SCR		C122F	747
IR140A	IR	SCR		2N3650	783
IR140B	IR	SCR		2N3651	783
IR140C	IR	SCR		2N3652	783
IR140D	IR	SCR		2N3653	783
IR140F	IR	SCR		2N3649	783
IR141A	IR	SCR		2N3655	783
IR141B	IR	SCR		2N3656	783
IR141C	IR	SCR		2N3657	783
IR141D	IR	SCR		2N3658	783
IR141F	IR	SCR		2N3654	783
IR30A	IR	SCR		C230A	874
IR30B	IR	SCR		C230B	874
IR30C	IR	SCR		C230C	874
IR30D	IR	SCR		C230D	874
IR30E	IR	SCR		C230E	874
IR30F	IR	SCR		C230F	874
IR30U	IR	SCR		C230U	874
IR31A	IR	SCR		C231A	874
IR31B	IR	SCR		C231B	874

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
IR31C	IR	SCR		C231C	874
IR31D	IR	SCR		C231D	874
IR31E	IR	SCR		C231E	874
IR31F	IR	SCR		C231F	874
IR31U	IR	SCR		C231U	874
IR32A	IR	SCR		C232A	874
IR32B	IR	SCR		C232B	874
IR32C	IR	SCR		C232C	874
IR32D	IR	SCR		C232D	874
IR32E	IR	SCR		C232E	874
IR32F	IR	SCR		C232F	874
IR32U	IR	SCR		C232U	874
IR33A	IR	SCR		C233A	874
IR33B	IR	SCR		C233B	874
IR33C	IR	SCR		C233C	874
IR33D	IR	SCR		C233D	874
IR33E	IR	SCR		C233E	874
IR33F	IR	SCR		C233F	874
IR33U	IR	SCR		C233U	874
IR5A	IR	SCR		C5A	653
IR5B	IR	SCR		C5B	653
IR5C	IR	SCR		C5C	653
IR5D	IR	SCR		C5D	653
IR5F	IR	SCR		C5F	653
IR5G	IR	SCR		C5G	653
IR5H	IR	SCR		C5H	653
IR5U	IR	SCR		C5U	653
IR6A	IR	SCR		C6A	659
IR6B	IR	SCR		C6B	659
IR6C	IR	SCR		C6C	659
IR6D	IR	SCR		C6D	659
IR6F	IR	SCR		C6F	659
IR6G	IR	SCR		C6G	659
IR6H	IR	SCR		C6H	659
IR6U	IR	SCR		C6U	659
IS010	HUT	SCR		C126F	763
IS015	HUT	SCR		ZJ436F	CF
IS020	HUT	SCR		ZJ436F	CF
IS110	HUT	SCR		C126A	763
IS115	HUT	SCR		ZJ436A	CF
IS120	HUT	SCR		ZJ436A	CF
IS210	HUT	SCR		C126B	763
IS215	HUT	SCR		ZJ436B	CF
IS220	HUT	SCR		ZJ436B	CF
IS310	HUT	SCR		C126C	763
IS315	HUT	SCR		ZJ436C	CF
IS320	HUT	SCR		ZJ436C	CF
IS410	HUT	SCR		C126D	763
IS415	HUT	SCR		ZJ436D	CF
IS420	HUT	SCR		ZJ436D	CF
IS510	HUT	SCR		C126E	763
IS515	HUT	SCR		ZJ436E	CF
IS520	HUT	SCR		ZJ436E	CF
IS610	HUT	SCR		C126M	763
IS615	HUT	SCR		ZJ436M	CF
IS620	HUT	SCR		ZJ436M	CF
IS 08	HUT	SCR		C123F	755
IS 18	HUT	SCR		C123A	755
IS 28	HUT	SCR		C123B	755
IS 38	HUT	SCR		C123C	755
IS 48	HUT	SCR		C123D	755
IS 58	HUT	SCR		C123E	755
IS 68	HUT	SCR		C123M	755
ISPT030	HUT	TRIAC		SC265B2	1393
ISPT040	HUT	TRIAC		SC265B2	1393
ISPT130	HUT	TRIAC		SC265B2	1393
ISPT140	HUT	TRIAC		SC265B2	1393
ISPT230	HUT	TRIAC		SC265B2	1393
ISPT240	HUT	TRIAC		SC265B2	1393
ISPT330	HUT	TRIAC		SC265D2	1393
ISPT340	HUT	TRIAC		SC265D2	1393
ISPT430	HUT	TRIAC		SC265D2	1393
ISPT440	HUT	TRIAC		SC265D2	1393
ISPT530	HUT	TRIAC		SC265E2	1393
ISPT540	HUT	TRIAC		SC265E2	1393
ISPT630	HUT	TRIAC		SC265M2	1393
ISPT640	HUT	TRIAC		SC265M2	1393
IT010	HUT	TRIAC		SC147B	1381
IT06	HUT	TRIAC		SC140B	1381
IT08	HUT	TRIAC		SC142B	1381
IT110	HUT	TRIAC		SC147B	1381
IT16	HUT	TRIAC		SC140B	1381
IT18	HUT	TRIAC		SC142B	1381
IT210	HUT	TRIAC		SC147B	1381
IT26	HUT	TRIAC		SC140B	1381
IT28	HUT	TRIAC		SC142B	1381
IT310	HUT	TRIAC		SC147D	1381
IT36	HUT	TRIAC		SC142B	1381
IT38	HUT	TRIAC		SC142D	1381
IT410	HUT	TRIAC		SC147D	1381

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
IT46	HUT	TRIAC		SC140D	1381
IT48	HUT	TRIAC		SC142D	1381
IT510	HUT	TRIAC		SC147E	1381
IT56	HUT	TRIAC		SC140E	1381
IT58	HUT	TRIAC		SC142E	1381
IT610	HUT	TRIAC		SC147M	1381
IT66	HUT	TRIAC		SC140M	1381
IT68	HUT	TRIAC		SC142M	1381
ITC103-1	ITT	SCR		C103Y	716
ITC103-2	ITT	SCR		C103YY	716
ITC103-3	ITT	SCR		C103A	716
ITC103-4	ITT	SCR		C103B	716
ITC103-5	ITT	SCR		C203C	858
ITC103-6	ITT	SCR		C203D	858
JAN1N1184,R	GE	RECTIFIER	209		
JAN1N1186,R	GE	RECTIFIER	209		
JAN1N1188,R	GE	RECTIFIER	209		
JAN1N1190,R	GE	RECTIFIER	209		
JAN1N1202A,RA	GE	RECTIFIER	213		
JAN1N1204A,RA	GE	RECTIFIER	213		
JAN1N1206A,RA	GE	RECTIFIER	213		
JAN1N1614	GE	RECTIFIER	221		
JAN1N1615	GE	RECTIFIER	221		
JAN1N1616	GE	RECTIFIER	221		
JAN1N3289	GE	RECTIFIER	234		
JAN1N3291	GE	RECTIFIER	234		
JAN1N3293	GE	RECTIFIER	234		
JAN1N3294	GE	RECTIFIER	234		
JAN1N3295	GE	RECTIFIER	234		
JAN1N3671A,RA	GE	RECTIFIER	213		
JAN1N3673A,RA	GE	RECTIFIER	213		
JAN1N3713	GE	TUNNEL DIO	237		
JAN1N3715	GE	TUNNEL DIO	237		
JAN1N3717	GE	TUNNEL DIO	237		
JAN1N3719	GE	TUNNEL DIO	237		
JAN1N3721	GE	TUNNEL DIO	237		
JAN1N3766,R	GE	RECTIFIER	209		
JAN1N3768,R	GE	RECTIFIER	209		
JAN1N3890,R	GE	RECTIFIER	249		
JAN1N3891, R	GE	RECTIFIER	249		
JAN1N3893,R	GE	RECTIFIER	249		
JAN1N3909,R	GE	RECTIFIER	253		
JAN1N3910,R	GE	RECTIFIER	253		
JAN1N3911,R	GE	RECTIFIER	253		
JAN1N3912,R	GE	RECTIFIER	253		
JAN1N3913,R	GE	RECTIFIER	253		
JAN1N4148-1	GE	SIG DIODE	205		
JAN1N4150	GE	SIG DIODE	258		
JAN1N4153	GE	SIG DIODE	262		
JAN1N4454	GE	SIG DIODE	262		
JAN1N4531	GE	SIG DIODE	205		
JAN1N4532	GE	SIG DIODE	262		
JAN2N2031	GE	SCR	712	C60	
JAN2N2323A	GE	SCR	653		
JAN2N2323A	GE	SCR	653		
JAN2N2323	GE	SCR	653		
JAN2N2323	GE	SCR	653		
JAN2N2324	GE	SCR	653		
JAN2N2324A	GE	SCR	653		
JAN2N2324A	GE	SCR	653		
JAN2N2324	GE	SCR	653		
JAN2N2326	GE	SCR	653		
JAN2N2326	GE	SCR	653		
JAN2N2326A	GE	SCR	653		
JAN2N2326A	GE	SCR	653		
JAN2N2328	GE	SCR	653		
JAN2N2328	GE	SCR	653		
JAN2N2329	GE	SCR	653		
JAN2N2329	GE	SCR	653		
JAN2N489A	GE	UJT TRAN	298		
JAN2N490A	GE	UJT TRAN	298		
JAN2N491A	GE	UJT TRAN	298		
JAN2N492A	GE	UJT TRAN	298		
JAN2N493A	GE	UJT TRAN	298		
JAN2N494A	GE	UJT TRAN	298		
JAN2N682	GE	SCR	306		
JAN2N683	GE	SCR	306		
JAN2N685	GE	SCR	306		
JAN2N686	GE	SCR	306		
JAN2N687	GE	SCR	306		
JAN2N688	GE	SCR	306		
JAN2N689	GE	SCR	306		
JANTX1184,R	GE	RECTIFIER	209		
JANTX1204A,RA	GE	RECTIFIER	213		
JANTX1N1190,R	GE	RECTIFIER	209		
JANTX1N1188,R	GE	RECTIFIER	209		
JANTX1N1186,R	GE	RECTIFIER	209		
JANTX1N1206A,RA	GE	RECTIFIER	213		
JANTX1N1202A,RA	GE	RECTIFIER	213		
JANTX1N3673A,RA	GE	RECTIFIER	213		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
JANTX1N3671A,RA	GE	RECTIFIER	213		
JANTX1N3766,R	GE	RECTIFIER	209		
JANTX1N3768,R	GE	RECTIFIER	209		
JANTX1N3893 R	GE	RECTIFIER	249		
JANTX1N3890, R	GE	RECTIFIER	249		
JANTX1N3891 R	GE	RECTIFIER	249		
JANTX1N3910,R	GE	RECTIFIER	253		
JANTX1N3909,R	GE	RECTIFIER	253		
JANTX1N3911,R	GE	RECTIFIER	253		
JANTX1N3912,R	GE	RECTIFIER	253		
JANTX1N3913,R	GE	RECTIFIER	253		
JANTX1N4148-1	GE	SIG DIODE	205		
JANTX1N4153	GE	SIG DIODE	262		
JANTX1N4150	GE	SIG DIODE	258		
JANTX1N4454	GE	SIG DIODE	262		
JANTX1N4532	GE	SIG DIODE	262		
JANTX2N2329	GE	SCR	653		
JANTX2N2326A	GE	SCR	653		
JANTX2N2328	GE	SCR	653		
JANTX2N2323	GE	SCR	653		
JANTX2N2324	GE	SCR	653		
JANTX2N2323A	GE	SCR	653		
JANTX2N2326	GE	SCR	653		
JANTX2N2324A	GE	SCR	653		
JANTX2N2326A	GE	SCR	653		
JANTX2N2328	GE	SCR	653		
JANTX2N2324A	GE	SCR	653		
JANTX2N2324	GE	SCR	653		
JANTX2N2323	GE	SCR	653		
JANTX2N2329	GE	SCR	653		
JANTX2N2326	GE	SCR	653		
JANTX2N2323A	GE	SCR	653		
JANTX2N489A	GE	UJT TRAN	298		
JANTX2N494A	GE	UJT TRAN	298		
JANTX2N492A	GE	UJT TRAN	298		
JANTX2N490A	GE	UJT TRAN	298		
JANTX2N493A	GE	UJT TRAN	298		
JANTX2N491A	GE	UJT TRAN	298		
JANTX2N688	GE	SCR	306		
JANTX2N682	GE	SCR	306		
JANTX2N685	GE	SCR	306		
JANTX2N683	GE	SCR	306		
JANTX2N689	GE	SCR	306		
JANTX2N687	GE	SCR	306		
JANTX2N686	GE	SCR	306		
JANTXV1N4531	GE	SIG DIODE	205		
JANTXV1N4148-1	GE	SIG DIODE	205		
JANTXV1N4532	GE	SIG DIODE	262		
L14F1	GE	OPTO DET	1335		
L14F2	GE	OPTO DET	1335		
L14G1	GE	OPTO DET	1337		
L14G2	GE	OPTO DET	1337		
L14G3	GE	OPTO DET	1337		
L14H1	GE	OPTO DET	1339		
L14H2	GE	OPTO DET	1339		
L14H3	GE	OPTO DET	1339		
L14H4	GE	OPTO DET	1339		
L811A	GE	OPTO SCR	1329		
L811B	GE	OPTO SCR	1329		
L811F	GE	OPTO SCR	1329		
L811G	GE	OPTO SCR	1329		
L811U	GE	OPTO SCR	1329		
L8A	GE	OPTO SCR	1329		
L8B	GE	OPTO SCR	1329		
L8F	GE	OPTO SCR	1329		
L8G	GE	OPTO SCR	1329		
L8U	GE	OPTO SCR	1329		
L911A	GE	OPTO SCR	1329		
L911B	GE	OPTO SCR	1329		
L911F	GE	OPTO SCR	1329		
L911G	GE	OPTO SCR	1329		
L911U	GE	OPTO SCR	1329		
L9A	GE	OPTO SCR	1329		
L9B	GE	OPTO SCR	1329		
L9F	GE	OPTO SCR	1329		
L9G	GE	OPTO SCR	1329		
L9U	GE	OPTO SCR	1329		
L SERIES	GE	GE-MOV	1418		
LED55B	GE	IR LED	1341		
LED55BF	GE	IR LED	1341		
LED55C	GE	IR LED	1341		
LED55CF	GE	IR LED	1341		
LED56	GE	IR LED	1341		
LED56F	GE	IR LED	1341		
M21C	MATJ	SCR		C203B	858
M21CA	MATJ	SCR		C203D	858
M23C	MATJ	SCR		C107B1	728
M23CA	MATJ	SCR		C107B1	728
M46-73 SERIES	GE	PELLETS	CF		
MA1701	GE	SIG DIODE	1343		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
MA1702	GE	SIG DIODE	1343		
MA1703	GE	SIG DIODE	1343		
MA1704	GE	SIG DIODE	1343		
MA8001		PWR TRAN		D40E5	1109
MA8003		PWR TRAN		D40E7	1109
MA SERIES	GE	GE-MOV	1426		
MAC10-1	MOT	TRIAC		SC146B	1381
MAC10-2	MOT	TRIAC		SC146B	1381
MAC10-3	MOT	TRIAC		SC146B	1381
MAC10-4	MOT	TRIAC		SC146B	1381
MAC10-5	MOT	TRIAC		SC146D	1381
MAC10-6	MOT	TRIAC		SC146D	1381
MAC10-7	MOT	TRIAC		SC146E	1381
MAC10-8	MOT	TRIAC		SC146M	1381
MAC11-1	MOT	TRIAC		SC146B	1381
MAC11-2	MOT	TRIAC		SC146B	1381
MAC11-3	MOT	TRIAC		SC146B	1381
MAC11-4	MOT	TRIAC		SC146B	1381
MAC11-5	MOT	TRIAC		SC146D	1381
MAC11-6	MOT	TRIAC		SC146D	1381
MAC11-7	MOT	TRIAC		SC146E	1381
MAC11-8	MOT	TRIAC		SC146M	1381
MAC36-1	MOT	TRIAC		SC260B	1393
MAC36-2	MOT	TRIAC		SC260B	1393
MAC36-3	MOT	TRIAC		SC260B	1393
MAC36-4	MOT	TRIAC		SC260B	1393
MAC36-5	MOT	TRIAC		SC260D	1393
MAC36-7	MOT	TRIAC		SC260E	1393
MAC36-8	MOT	TRIAC		SC260M	1393
MAC37-1	MOT	TRIAC		SC261B	1393
MAC37-2	MOT	TRIAC		SC261B	1393
MAC37-3	MOT	TRIAC		SC261B	1393
MAC37-4	MOT	TRIAC		SC261B	1393
MAC37-5	MOT	TRIAC		SC261D	1393
MAC37-6	MOT	TRIAC		SC261D	1393
MAC37-7	MOT	TRIAC		SC261E	1393
MAC38-2	MOT	TRIAC		SC260B	1393
MAC38-3	MOT	TRIAC		SC260B	1393
MAC38-4	MOT	TRIAC		SC260B	1393
MAC38-5	MOT	TRIAC		SC260D	1393
MAC38-6	MOT	TRIAC		SC260D	1393
MAC38-7	MOT	TRIAC		SC260E	1393
MAC40688	MOT	TRIAC		SC265B2	1393
MAC40689	MOT	TRIAC		SC265D2	1393
MAC40690	MOT	TRIAC		SC265M2	1393
MAC40795	MOT	TRIAC		SC246M	1393
MAC40796	MOT	TRIAC		SC245M	1393
MAC40797	MOT	TRIAC		SC246M	1393
MAC40798	MOT	TRIAC		SC245M	1393
MAC40799	MOT	TRIAC		SC245B2	1393
MAC40800	MOT	TRIAC		SC245D2	1393
MAC40801	MOT	TRIAC		SC245M2	1393
MAC4688	MOT	TRIAC		SC265B2	1393
MAC4689	MOT	TRIAC		SC265D2	1393
MAC4690	MOT	TRIAC		SC265M2	1393
MAC5441	MOT	TRIAC		SC266B	1393
MAC5442	MOT	TRIAC		SC266D	1393
MAC5443	MOT	TRIAC		SC266M	1393
MAC5444	MOT	TRIAC		SC265B	1393
MAC5445	MOT	TRIAC		SC265D	1393
MAC5446	MOT	TRIAC		SC265M	1393
MCA230	MTO	OPTO COUPL		H11B3	1293
MCA231	MTO	OPTO COUPL		H11B2	1293
MCA255	MTO	OPTO COUPL		H11B255	1295
MCA81	MTO	OPTO COUPL		H13B2	1311
MCA8	MTO	OPTO COUPL		H13B1	1311
MCH2005F		PWR TRAN		D40C1	1101
MCR101	MOT	SCR		C203Q	858
MCR102	MOT	SCR		C203Y	858
MCR103	MOT	SCR		C203YY	858
MCR104	MOT	SCR		C203A	858
MCR106-1	MOT	SCR		C106Y1	720
MCR106-2	MOT	SCR		C106A1	720
MCR106-3	MOT	SCR		C106A1	720
MCR106-4	MOT	SCR		C106B1	720
MCR106-6	MOT	SCR		C106D1	720
MCR106-8	MOT	SCR		C106M1	720
MCR107-1	MOT	SCR		C107Y1	728
MCR107-2	MOT	SCR		C107A1	728
MCR107-3	MOT	SCR		C107A1	728
MCR107-4	MOT	SCR		C107B1	728
MCR107-6	MOT	SCR		C107D1	728
MCR107-8	MOT	SCR		C107M1	728
MCR115	MOTA	SCR		C203G	858
MCR120	MOTA	SCR		C203B	858
MCR1718-5	MOT	SCR		2N3652	783
MCR1718-6	MOT	SCR		2N3653	783
MCR1718-7	MOT	SCR		C144E15E	791
MCR1718-8	MOT	SCR		C144M15M	791
MCR1907-1	MOT	SCR		C140F	783

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
MCR1907-2	MOT	SCR		C140F	783
MCR1907-3	MOT	SCR		C140A	783
MCR1907-4	MOT	SCR		C140B	783
MCR1907-5	MOT	SCR		C140C	783
MCR1907-6	MOT	SCR		C140D	783
MCR220-5	MOT	SCR		C126C	763
MCR220-7	MOT	SCR		C126E	763
MCR220-9	MOT	SCR		C126S	763
MCR221-5	MOT	SCR		ZJ436C	CF
MCR221-7	MOT	SCR		ZJ436E	CF
MCR221-9	MOT	SCR		ZJ436S	CF
MCR2315-1	MOT	SCR		C220UX300	CF
MCR2315-2	MOT	SCR		C220FX300	CF
MCR2315-3	MOT	SCR		C220AX300	CF
MCR2315-4	MOT	SCR		C220BX300	CF
MCR2315-5	MOT	SCR		C220CX300	CF
MCR2315-6	MOT	SCR		C220DX300	CF
MCR2604-1	MOT	SCR		C222UX203	CF
MCR2604-2	MOT	SCR		C222FX203	CF
MCR2604-3	MOT	SCR		C222AX203	CF
MCR2604-4	MOT	SCR		C222BX203	CF
MCR2604-5	MOT	SCR		C222CX203	CF
MCR2604-6	MOT	SCR		C222DX203	CF
MCR2604-7	MOT	SCR		C222EX203	CF
MCR2604-8	MOT	SCR		C222MX203	CF
MCR2605-1	MOT	SCR		C222UX203	CF
MCR2605-2	MOT	SCR		C222FX203	CF
MCR2605-3	MOT	SCR		C222AX203	CF
MCR2605-4	MOT	SCR		C222BX203	CF
MCR2605-5	MOT	SCR		C222CX203	CF
MCR2605-6	MOT	SCR		C222DX203	CF
MCR2605-7	MOT	SCR		C222EX243	CF
MCR2605-8	MOT	SCR		C222MX203	CF
MCR2614L-3	MOT	SCR		C222AX203	CF
MCR2614L-2	MOT	SCR		C222FX203	CF
MCR2614L-4	MOT	SCR		C222BX203	CF
MCR2614L-1	MOT	SCR		C222UX203	CF
MCR2614L-6	MOT	SCR		C222DX203	CF
MCR2614L-5	MOT	SCR		C222CX203	CF
MCR3000-1	MOT	SCR		C122F	747
MCR3000-2	MOT	SCR		C122F	747
MCR3000-3	MOT	SCR		C122A	747
MCR3000-4	MOT	SCR		C122B	747
MCR3000-5	MOT	SCR		C122C	747
MCR3000-6	MOT	SCR		C122D	747
MCR3000-7	MOT	SCR		C122E	747
MCR3000-8	MOT	SCR		C122M	747
MCR3000-9	MOT	SCR		C122S	747
MCR3818-1	MOT	SCR		C232UX240	CF
MCR3818-2	MOT	SCR		C232FX240	CF
MCR3818-3	MOT	SCR		C232AX240	CF
MCR3818-4	MOT	SCR		C232BX240	CF
MCR3818-5	MOT	SCR		C232CX240	CF
MCR3818-6	MOT	SCR		C232DX240	CF
MCR3818-7	MOT	SCR		C232EX240	CF
MCR3818-8	MOT	SCR		C232MX240	CF
MCR3835-1	MOT	SCR		C229UX10	CF
MCR3835-2	MOT	SCR		C229FX10	CF
MCR3835-3	MOT	SCR		C229AX10	CF
MCR3835-4	MOT	SCR		C229BX10	CF
MCR3835-5	MOT	SCR		C229CX10	CF
MCR3835-6	MOT	SCR		C229DX10	CF
MCR3835-7	MOT	SCR		C229EX10	CF
MCR3835-8	MOT	SCR		C229MX10	CF
MCR3918-1	MOT	SCR		C230UX240	CF
MCR3918-2	MOT	SCR		C230FX240	CF
MCR3918-3	MOT	SCR		C230AX240	CF
MCR3918-4	MOT	SCR		C230BX240	CF
MCR3918-5	MOT	SCR		C230CX240	CF
MCR3918-6	MOT	SCR		C230DX240	CF
MCR3918-7	MOT	SCR		C230EX240	CF
MCR3918-8	MOT	SCR		C230MX240	CF
MCR3935-1	MOT	SCR		C228UX10	CF
MCR3935-2	MOT	SCR		C228FX10	CF
MCR3935-3	MOT	SCR		C228AX10	CF
MCR3935-4	MOT	SCR		C228BX10	CF
MCR3935-5	MOT	SCR		C228CX10	CF
MCR3935-6	MOT	SCR		C228DX10	CF
MCR3935-8	MOT	SCR		C228MX10	CF
MCR406-1	MOT	SCR		C108Y1	733
MCR406-2	MOT	SCR		C108A1	733
MCR406-3	MOT	SCR		C108A1	733
MCR406-4	MOT	SCR		C108B1	733
MCR407-1	MOT	SCR		C108Y1	733
MCR407-2	MOT	SCR		C108A1	733
MCR407-3	MOT	SCR		C108A1	733
MCR407-4	MOT	SCR		C108B1	733
MCR649-1	MOT	SCR		C232U	874
MCR649-2	MOT	SCR		C232F	874
MCR649-3	MOT	SCR		C232A	874

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
MCR649-4	MOT	SCR		C232B	874
MCR649-5	MOT	SCR		C232C	874
MCR649-6	MOT	SCR		C232D	874
MCR649-7	MOT	SCR		C232E	874
MCS2400	MTO	OPTO COUPL		H11C6	1303
MCS2	MTO	OPTO COUPL		H11C3	1299
MCT26	MTO	OPTO COUPL		H11A5	1279
MCT2	MTO	OPTO COUPL		H11A2	1275
MCT2E	MTO	OPTO COUPL		H11A3	1277
MCT81	MTO	OPTO COUPL		H13A2	1307
MCT8	MTO	OPTO COUPL		H13A1	1309
MJ2249		PWR TRAN		D44C7	1147
MJ2250		PWR TRAN		D44C10	1147
MJ2251		PWR TRAN		D42R1	1139
MJ2252		PWR TRAN		D42R2	1139
MJ2253		PWR TRAN		D45C7	1163
MJ2254		PWR TRAN		D45C10	1163
MJ3101		PWR TRAN		D44C4	1147
MJ3201		PWR TRAN		D44R1	1159
MJ3202		PWR TRAN		D44R3	1159
MJ3701		PWR TRAN		D45C4	1163
MJ400		PWR TRAN		D42R2	1139
MJ4101		PWR TRAN		D44C5	1147
MJ420		PWR TRAN		D40N1	1117
MJ421		PWR TRAN		D40N4	1117
MJ8100		PWR TRAN		D43C8	1143
MJE101		PWR TRAN		D45C6	1163
MJE102		PWR TRAN		D45C8	1163
MJE103		PWR TRAN		D45C8	1163
MJE105		PWR TRAN		D45H7	1171
MJE105K		PWR TRAN		D45H7	1171
MJE170		PWR TRAN		D43C5	1143
MJE171		PWR TRAN		D43C8	1143
MJE172		PWR TRAN		D43C11	1143
MJE180		PWR TRAN		D42C5	1135
MJE181		PWR TRAN		D42C8	1135
MJE182		PWR TRAN		D42C11	1135
MJE200		PWR TRAN		D44C3	1147
MJE201		PWR TRAN		D44C6	1147
MJE2020		PWR TRAN		D44H4	1155
MJE2021		PWR TRAN		D44H7	1155
MJE202		PWR TRAN		D44C8	1147
MJE203		PWR TRAN		D44C8	1147
MJE2050		PWR TRAN		D44C6	1147
MJE205		PWR TRAN		D44C8	1147
MJE205K		PWR TRAN		D44H7	1155
MJE210		PWR TRAN		D45C3	1163
MJE2150		PWR TRAN		D45C3	1163
MJE220		PWR TRAN		D44C6	1147
MJE221		PWR TRAN		D44C5	1147
MJE222		PWR TRAN		D44C4	1147
MJE223		PWR TRAN		D44C9	1147
MJE224		PWR TRAN		D44C8	1147
MJE225		PWR TRAN		D44C7	1147
MJE230		PWR TRAN		D45C6	1163
MJE231		PWR TRAN		D45C5	1163
MJE232		PWR TRAN		D45C4	1163
MJE233		PWR TRAN		D45C9	1163
MJE234		PWR TRAN		D45C8	1163
MJE235		PWR TRAN		D45C7	1163
MJE2370		PWR TRAN		D45C5	1163
MJE2371		PWR TRAN		D45C8	1163
MJE240		PWR TRAN		D44C12	1147
MJE241		PWR TRAN		D44C11	1147
MJE242		PWR TRAN		D44C10	1147
MJE2480		PWR TRAN		D44C5	1147
MJE2481		PWR TRAN		D44C8	1147
MJE2482		PWR TRAN		D44C5	1147
MJE2483		PWR TRAN		D44C8	1147
MJE250		PWR TRAN		D45C12	1163
MJE251		PWR TRAN		D45C11	1163
MJE2520		PWR TRAN		D44C5	1147
MJE2521		PWR TRAN		D44C8	1147
MJE2522		PWR TRAN		D44C5	1147
MJE2523		PWR TRAN		D44C8	1147
MJE252		PWR TRAN		D45C10	1163
MJE2801		PWR TRAN		D44H7	1155
MJE2901		PWR TRAN		D45H7	1171
MJE2955		PWR TRAN		D45H7	1171
MJE3054		PWR TRAN		D44C7	1147
MJE3055		PWR TRAN		D44H7	1155
MJE3370		PWR TRAN		D45C2	1163
MJE3371		PWR TRAN		D45C5	1163
MJE340		PWR TRAN		D44R6	1159
MJE340K		PWR TRAN		D44R6	1159
MJE341		PWR TRAN		D42R1	1139
MJE341K		PWR TRAN		D44R5	1159
MJE3440		PWR TRAN		D44R3	1159
MJE344		PWR TRAN		D42R1	1139
MJE344K		PWR TRAN		D44R5	1159

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
MJE3520		PWR TRAN		D44C2	1147
MJE3521		PWR TRAN		D44C5	1147
MJE370		PWR TRAN		D45C2	1163
MJE370K		PWR TRAN		D45C2	1163
MJE371		PWR TRAN		D45C6	1163
MJE371K		PWR TRAN		D45H4	1163
MJE488		PWR TRAN		D44C8	1147
MJE520		PWR TRAN		D44C2	1147
MJE520K		PWR TRAN		D44C2	1147
MJE521		PWR TRAN		D44C6	1147
MJE521K		PWR TRAN		D44H4	1155
MJE700		PWR TRAN		D45E2	1167
MJE701		PWR TRAN		D45E2	1167
MJE702		PWR TRAN		D45E3	1167
MJE703		PWR TRAN		D45E3	1167
MJE800		PWR TRAN		D44E2	1151
MJE801		PWR TRAN		D44E2	1151
MJE802		PWR TRAN		D44E3	1151
MJE803		PWR TRAN		D44E3	1151
MM1619		PWR TRAN		D44C1	1147
MM1803		PWR TRAN		D40E1	1109
MM1812		PWR TRAN		D40N1	1117
MM2258		PWR TRAN		D44R2	1159
MM2259		PWR TRAN		D44R2	1159
MM2260		PWR TRAN		D44R2	1159
MM2261		PWR TRAN		D40E7	1109
MM2263		PWR TRAN		D44R2	1159
MM3001		PWR TRAN		D44R1	1159
MM3002		PWR TRAN		D40N1	1117
MM3003		PWR TRAN		D40N3	1117
MM3004		PWR TRAN		D40E1	1109
MM3008		PWR TRAN		D44R2	1159
MM3009		PWR TRAN		D44R2	1159
MM3724		PWR TRAN		D40E1	1109
MM3725		PWR TRAN		D40E7	1109
MM3726		PWR TRAN		D43C8	1143
MM4019		PWR TRAN		D41E5	1129
MM4020		PWR TRAN		D45C3	1163
MM4429		PWR TRAN		D40E5	1109
MM4430		PWR TRAN		D40E5	1109
MOC1000	MOTA	OPTO COUPL		4N26	531
MOC1001	MOTA	OPTO COUPL		4N25	531
MOC1002	MOTA	OPTO COUPL		4N27	531
MOC1003	MOTA	OPTO COUPL		4N28	531
MOC1005	MOTA	OPTO COUPL		H11A520	1285
MOC1006	MOTA	OPTO COUPL		H11A520	1285
MOC1200	MOTA	OPTO COUPL		4N30	533
MP8111		PWR TRAN		D44C8	1147
MP8112		PWR TRAN		D44C8	1147
MP8211		PWR TRAN		D44C5	1147
MP8212		PWR TRAN		D44C6	1147
MP8221		PWR TRAN		D44C5	1147
MP8222		PWR TRAN		D44C6	1147
MPA SERIES	GE	PELLETS	CF		
MPS3638	GE	SIG TRAN	1358		
MPS3702	GE	SIG TRAN	1360		
MPS3703	GE	SIG TRAN	1360		
MPS3704	GE	SIG TRAN	1363		
MPS3705	GE	SIG TRAN	1363		
MPS3706	GE	SIG TRAN	1363		
MPS3838	GE	SIG TRAN	1358		
MPS3838A	GE	SIG TRAN	1358		
MPS4354		SIG TRAN		GES4354	
MPS4355		SIG TRAN		GES4355	
MPS4356		SIG TRAN		GES4356	
MPS5172	GE	SIG TRAN	1364		
MPS6076	GE	SIG TRAN	1364		
MPS6512	GE	SIG TRAN	1365		
MPS6513	GE	SIG TRAN	1365		
MPS6514	GE	SIG TRAN	1365		
MPS6515	GE	SIG TRAN	1365		
MPS6516	GE	SIG TRAN	1365		
MPS6517	GE	SIG TRAN	1365		
MPS6518	GE	SIG TRAN	1365		
MPS6519	GE	SIG TRAN	1365		
MPS6530	GE	SIG TRAN	1368		
MPS6531	GE	SIG TRAN	1368		
MPS6532	GE	SIG TRAN	1368		
MPS6533	GE	SIG TRAN	1370		
MPS6534	GE	SIG TRAN	1370		
MPS6535	GE	SIG TRAN	1370		
MPS6560		SIG TRAN		GES6560	CF
MPS6561		SIG TRAN		GES6561	CF
MPS6562		SIG TRAN		GES6562	CF
MPS6563		SIG TRAN		GES6563	CF
MPS6565		SIG TRAN		MPS6565	1372
MPS6565	GE	SIG TRAN	1372		
MPS6566	GE	SIG TRAN	1372		
MPS6566		SIG TRAN		MPS6566	1372
MPS6571		SIG TRAN	CF		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
MPS6573		SIG TRAN	CF		
MPS6574		SIG TRAN	CF		
MPS6575		SIG TRAN	CF		
MPS6576		SIG TRAN	CF		
MPS8097		SIG TRAN	CF		
MPS A70	GE	SIG TRAN	1357		
MPS D05		SIG TRAN	CF		
MPS D06		SIG TRAN	CF		
MPS D55		SIG TRAN	CF		
MPS D56		SIG TRAN	CF		
MPS L01		SIG TRAN	CF		
MPSA05	GE	SIG TRAN	1345		
MPSA06	GE	SIG TRAN	1345		
MPSA12	GE	SIG TRAN	1347		
MPSA13	GE	SIG TRAN	1349		
MPSA14	GE	SIG TRAN	1349		
MPSA20	GE	SIG TRAN	1351		
MPSA55	GE	SIG TRAN	1353		
MPSA56	GE	SIG TRAN	1353		
MPSA65	GE	SIG TRAN	1355		
MPSA66	GE	SIG TRAN	1355		
MPSA70	GE	SIG TRAN	1357		
MPS-A09		SIG TRAN		MPS-A09	CF
MPSU01		PWR TRAN		D40E1	1109
MPSU01A		PWR TRAN		D40E5	1109
MPSU02		PWR TRAN		D40E5	1109
MPSU03		PWR TRAN		D40P1	1121
MPSU04		PWR TRAN		D40P3	1121
MPSU05		PWR TRAN		D40E5	1109
MPSU06		PWR TRAN		D40E7	1109
MPSU10		PWR TRAN		D40N3	1117
MPSU31		PWR TRAN		D40E7	1109
MPSU45		PWR TRAN		D40K2	1113
MPSU51		PWR TRAN		D41E1	1129
MPSU51A		PWR TRAN		D41E5	1129
MPSU52		PWR TRAN		D41E5	1129
MPSU55		PWR TRAN		D41E5	1129
MPSU56		PWR TRAN		D41E7	1129
MPSU95		PWR TRAN		D41K2	1129
MRD300	MOTA	OPTO DET		L14G1	1337
MRD3050	MOTA	OPTO DET		L14G2	1337
MRD3051	MOTA	OPTO DET		L14G2	1337
MRD3052	MOTA	OPTO DET		L14G2	1337
MRD3053	MOTA	OPTO DET		L14G2	1337
MRD3054	MOTA	OPTO DET		L14G2	1337
MRD3055	MOTA	OPTO DET		L14G2	1337
MRD3056	MOTA	OPTO DET		L14G1	1337
MRD310	MOTA	OPTO DET		L14G2	1337
MSA7505		PWR TRAN		D44C1	1147
MSA8505		PWR TRAN		D44C1	1147
MSA8506		PWR TRAN		D42C1	1135
MSA8508		PWR TRAN		D42C1	1135
MSP15		PWR TRAN		D44R1	1159
MSP20		PWR TRAN		D44R1	1159
MSP25		PWR TRAN		D44R1	1159
MSP30		PWR TRAN		D44R3	1159
MST105		PWR TRAN		D44R2	1159
MST15		PWR TRAN		D44R1	1159
MST20		PWR TRAN		D44R1	1159
MST20B		PWR TRAN		D44R1	1159
MST20S		PWR TRAN		D44R2	1159
MST25		PWR TRAN		D44R1	1159
MST30		PWR TRAN		D44R3	1159
MST30B		PWR TRAN		D44R3	1159
MST30S		PWR TRAN		D44R4	1159
MT1070		PWR TRAN		D40E1	1109
NCT200	NSC	OPTO COUPL		H11A5	1279
NCT260	NSC	OPTO COUPL		H11A5	1279
NL511-3	NAT	SCR		C137NX74	CF
NL511-4	NAT	SCR		C137PX74	CF
NL511-6	NAT	SCR		C137PBX74	CF
NL570A	NAT	SCR		C234A	880
NL570B	NAT	SCR		C234B	880
NL570C	NAT	SCR		C234C	880
NL570D	NAT	SCR		C234D	880
NL570E	NAT	SCR		C234E	880
NL570M	NAT	SCR		C234M	880
NL576B	NAT	SCR		C147B	799
NL576C	NAT	SCR		C147C	799
NL576D	NAT	SCR		C147D	799
NL576E	NAT	SCR		C147E	799
NL576M	NAT	SCR		C147M	799
NL576N	NAT	SCR		C147N	799
NL576P	NAT	SCR		C147P	799
NL576PA	NAT	SCR		C147PA	799
NL576PB	NAT	SCR		C147PB	799
NL576S	NAT	SCR		C147S	799
NL576T	NAT	SCR		C147T	799
NL577B	NAT	SCR		C147B	799
NL577C	NAT	SCR		C147C	799

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
NL577D	NAT	SCR		C147D	799
NL577E	NAT	SCR		C147E	799
NL577M	NAT	SCR		C147M	799
NL577N	NAT	SCR		C147N	799
NL577P	NAT	SCR		C147P	799
NL577PA	NAT	SCR		C147PA	799
NL577PB	NAT	SCR		C147PB	799
NL577S	NAT	SCR		C147S	799
NL577T	NAT	SCR		C147T	799
NL578B	NAT	SCR		C147B	799
NL578D	NAT	SCR		C147D	799
NL578E	NAT	SCR		C147E	799
NL578M	NAT	SCR		C147M	799
NL578N	NAT	SCR		C147N	799
NL578P	NAT	SCR		C147P	799
NL578PA	NAT	SCR		C147PA	799
NL578PB	NAT	SCR		C147PB	799
NL578S	NAT	SCR		C147S	799
NL578T	NAT	SCR		C147T	799
NL579B	NAT	SCR		C147B	799
NL579C	NAT	SCR		C147C	799
NL579D	NAT	SCR		C147D	799
NL579E	NAT	SCR		C147E	799
NL579M	NAT	SCR		C147M	799
NL579N	NAT	SCR		C147N	799
NL579P	NAT	SCR		C147P	799
NL579PA	NAT	SCR		C147PA	799
NL579PB	NAT	SCR		C147PB	799
NL579S	NAT	SCR		C147S	799
NL579T	NAT	SCR		C147T	799
NLC135A	NAT	SCR		C137AX49	CF
NLC135B	NAT	SCR		C137BX49	CF
NLC135C	NAT	SCR		C137CX49	CF
NLC135D	NAT	SCR		C137DX49	CF
NLC135E	NAT	SCR		C137EX49	CF
NLC135M	NAT	SCR		C137MX49	CF
NLC135N	NAT	SCR		C137NX49	CF
NLC135S	NAT	SCR		C137SX49	CF
NLC35A	NAT	SCR		C35A	675
NLC35B	NAT	SCR		C35B	675
NLC35C	NAT	SCR		C35C	675
NLC35D	NAT	SCR		C35D	675
NLC35E	NAT	SCR		C35E	675
NLC35G	NAT	SCR		C35G	675
NLC35H	NAT	SCR		C35H	675
NLC35M	NAT	SCR		C35M	675
NLC35N	NAT	SCR		C35N	675
NLC35S	NAT	SCR		C35S	675
NLC36A	NAT	SCR		C36A	328
NLC36B	NAT	SCR		C36B	328
NLC36C	NAT	SCR		C36C	328
NLC36D	NAT	SCR		C36D	328
NLC36E	NAT	SCR		C36E	328
NLC36G	NAT	SCR		C36G	328
NLC36H	NAT	SCR		C36H	328
NLC36M	NAT	SCR		C36M	328
NLC36N	NAT	SCR		C36N	328
NLC36S	NAT	SCR		C36S	328
NLC37A	NAT	SCR		C37A	679
NLC37B	NAT	SCR		C37B	679
NLC37C	NAT	SCR		C37C	679
NLC37D	NAT	SCR		C37D	679
NLC37E	NAT	SCR		C37E	679
NLC37M	NAT	SCR		C37M	679
NLC38A	NAT	SCR		C38A	683
NLC38B	NAT	SCR		C38B	683
NLC38C	NAT	SCR		C38C	683
NLC38D	NAT	SCR		C38D	683
NLC38E	NAT	SCR		C38E	683
NLC38G	NAT	SCR		C38G	683
NLC38H	NAT	SCR		C38H	683
NLC40A	NAT	SCR		C140AX158	CF
NLC40B	NAT	SCR		C140BX158	CF
NLC40C	NAT	SCR		C140CX158	CF
NLC40D	NAT	SCR		C140DX158	CF
NLC40E	NAT	SCR		C139E10E	775
NLC40G	NAT	SCR		C140BX158	CF
NLC40H	NAT	SCR		C140CX158	CF
NLC45A	NAT	SCR		C45A	689
NLC45B	NAT	SCR		C45B	689
NLC45C	NAT	SCR		C45C	689
NLC45D	NAT	SCR		C45D	689
NLC45E	NAT	SCR		C45E	689
NLC45G	NAT	SCR		C45G	689
NLC45H	NAT	SCR		C45H	689
NLC45M	NAT	SCR		C45M	689
NLC45N	NAT	SCR		C45N	689
NLC45P	NAT	SCR		C45P	689
NLC45PA	NAT	SCR		C45PA	689
NLC45PB	NAT	SCR		C45PB	689

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
NLC45S	NAT	SCR		C45S	689
NLC45T	NAT	SCR		C45T	689
NLC46A	NAT	SCR		C46A	689
NLC46B	NAT	SCR		C46B	689
NLC46C	NAT	SCR		C46C	689
NLC46D	NAT	SCR		C46D	689
NLC46E	NAT	SCR		C46E	689
NLC46G	NAT	SCR		C46G	689
NLC46H	NAT	SCR		C46H	689
NLC46M	NAT	SCR		C46M	689
NLC46N	NAT	SCR		C46N	689
NLC46P	NAT	SCR		C46P	689
NLC46PA	NAT	SCR		C46PA	689
NLC46PB	NAT	SCR		C46PB	689
NLC46S	NAT	SCR		C46S	689
NLC46T	NAT	SCR		C46T	689
NL-1580	NAT	SCR		C390/C391	936
NL-578	NAT	SCR		C147	799
NL-579	NAT	SCR		C147	799
NL-C150	NAT	SCR		C150	818
NL-C151	NAT	SCR		C155	823
NL-C152	NAT	SCR		C152	818
NL-C153	NAT	SCR		C157	823
NL-C154	NAT	SCR		C154	823
NL-C155	NAT	SCR		C155	823
NL-C156	NAT	SCR		C156	823
NL-C157	NAT	SCR		C157	823
NL-C178	NAT	SCR		C180	842
NL-C180	NAT	SCR		C180	842
NL-C181	NAT	SCR		C180	842
NL-C185	NAT	SCR		C185	851
NL-C350	NAT	SCR		C350	886
NL-C354	NAT	SCR		C354	891
NL-C355	NAT	SCR		C355	891
NL-C380	NAT	SCR		C380	912
NL-C385	NAT	SCR		C385	921
NL-C45	NAT	SCR		C45	689
NL-C46	NAT	SCR		C46	689
NL-C501	NAT	SCR		C390/C391	936
NL-C50	NAT	SCR		C50	707
NL-C52	NAT	SCR		C52	818
NL-C55	NAT	SCR		C154	823
NL-C56	NAT	SCR		C156	823
NL-C601	NAT	SCR		C440/C441	966
NL-C60	NAT	SCR		C60	712
NL-C62	NAT	SCR		C62	712
NL-F150	NAT	SCR		C150	818
NL-F151	NAT	SCR		C155	823
NL-F152	NAT	SCR		C152	823
NL-F153	NAT	SCR		C157	823
NL-F154	NAT	SCR		C154	823
NL-F155	NAT	SCR		C155	823
NL-F156	NAT	SCR		C156	823
NL-F157	NAT	SCR		C157	823
NL-F158	NAT	SCR		C158	830
NL-F159	NAT	SCR		C159	830
NL-F180	NAT	SCR		C180	842
NL-F185	NAT	SCR		C185	851
NL-F358	NAT	SCR		C358	898
NL-F380	NAT	SCR		C380	912
NL-F385	NAT	SCR		C385	921
NL-F390	NAT	SCR		C390	936
NL-F394	NAT	SCR		C394	947
NL-F395	NAT	SCR		C395	947
NL-F397	NAT	SCR		C397	958
NL-F398	NAT	SCR		C398	958
NL-F701	NAT	SCR		C701/C450	1029
OP130	OPI	IRLED		LED56	1347
OP131	OPI	IRLED		LED55B	1347
OP132	OPI	IRLED		LED55C	1347
OP133	OPI	IRLED		LED55C	1347
OPB120	OPI	OPTO COUPL		H13A1	1309
OPB242	OPI	OPTO COUPL		H13A1	1309
OPB243	OPI	OPTO COUPL		H13B1	1311
OPB800	OPI	OPTO COUPL		H13A1	1309
OPB800S	OPI	OPTO COUPL		H13A1	1309
OPB803	OPI	OPTO COUPL		H13B1	1311
OPB806	OPI	OPTO COUPL		H13A1	1309
OPB813	OPI	OPTO COUPL		H13A1	1309
OPB814	OPI	OPTO COUPL		H13B1	1311
OPI2150	OPI	OPTO COUPL		H11A4	1277
OPI2151	OPI	OPTO COUPL		H11A4	1277
OPI2152	OPI	OPTO COUPL		H11A2	1275
OPI2153	OPI	OPTO COUPL		H11A1	1275
OPI2250	OPI	OPTO COUPL		H11A3	1277
OPI2251	OPI	OPTO COUPL		H11A3	1277
OPI2252	OPI	OPTO COUPL		H11A3	1277
OPI2253	OPI	OPTO COUPL		H11A1	1275
OPI3150	OPI	OPTO COUPL		H11B2	1293
OPI3151	OPI	OPTO COUPL		H11B2	1293

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
OPI3152	OPI	OPTO COUPL		H11B3	1293
OPI3153	OPI	OPTO COUPL		H11B1	1293
OPI3251	OPI	OPTO COUPL		H11B1	1293
OPI3252	OPI	OPTO COUPL		H11B1	1293
OPI3253	OPI	OPTO COUPL		H11B1	1293
PA SERIES	GE	GE-MOV	1432		
PPR1006		PWR TRAN		D42C5	1135
PPR1008		PWR TRAN		D42C8	1135
PS020	HUT	SCR		C232F	874
PS030	HUT	SCR		C229FX11	CF
PS035	HUT	SCR		C229FX11	CF
PS08	HUT	SCR		C222F	862
PS120	HUT	SCR		C232A	874
PS130	HUT	SCR		C229AX11	CF
PS135	HUT	SCR		C229AX11	CF
PS18	HUT	SCR		C222A	862
PS220	HUT	SCR		C232B	874
PS230	HUT	SCR		C229BX11	CF
PS235	HUT	SCR		C229BX11	CF
PS28	HUT	SCR		C222B	862
PS320	HUT	SCR		C232C	874
PS330	HUT	SCR		C229CX11	CF
PS355	HUT	SCR		C229CX11	CF
PS38	HUT	SCR		C222C	862
PS420	HUT	SCR		C232D	874
PS430	HUT	SCR		C22DX11	CF
PS435	HUT	SCR		C229DX11	CF
PS48	HUT	SCR		C222D	862
PS520	HUT	SCR		C232E	874
PS530	HUT	SCR		C229EX11	CF
PS535	HUT	SCR		C229EX11	CF
PS58	HUT	SCR		C222E	862
PS620	HUT	SCR		C232M	874
PS630	HUT	SCR		C229MX11	CF
PS635	HUT	SCR		C229MX11	CF
PS68	HUT	SCR		C222M	862
PSIB110	PSI	SCR		C165	838
PSIBD125	PSI	RECTIFIER		A180	581
PSIBD150	PSI	RECTIFIER		A180	581
PSIC160	PSI	SCR		C185/C186	851
PSIC235	PSI	SCR		C185/C186	851
PSICD160	PSI	RECTIFIER		A190	643
PSICD250	PSI	RECTIFIER		A190	643
PSIF180	PSI	SCR		C390/C391	936
PSIF220	PSI	SCR		C390/C391	936
PSIF300	PSI	SCR		C390/C391	936
PSIF400	PSI	SCR		C390/C391	936
PSIF500	PSI	SCR		C390/C391	936
PSIF600	PSI	SCR		C390	936
PSIFD600	PSI	RECTIFIER		A430/A540	600
PSIFD900	PSI	RECTIFIER		A430/A540	600
PSIG300	PSI	SCR		C390/C391	936
PSIG400	PSI	SCR		C390/C391	936
PSIG500	PSI	SCR		C390/C391	936
PSIG650	PSI	SCR		C390/C391	936
PSIG850	PSI	SCR		C390/C391	936
PSIG950	PSI	SCR		C440/C441	966
PSIGD1400	PSI	RECTIFIER		A570/A640	613
PSIGD800	PSI	RECTIFIER		A430/A540	600
PSIH1000	PSI	SCR		C450/C451	CF
PSIH1200	PSI	SCR		C450/C451	CF
PSIH1400	PSI	SCR		C450/C451	CF
PSIH1600	PSI	SCR		C450	CF
PSIH1800	PSI	SCR		C450	CF
PSIH2000	PSI	SCR		C450	CF
PSIH800	PSI	SCR		C450/C451	CF
PSIHD1500	PSI	RECTIFIER		A570/A640	613
PT010	HUT	TRIAC		SC246B	1393
PT015	HUT	TRIAC		SC251B	1393
PT025	HUT	TRIAC		SC261B	1393
PT030	HUT	TRIAC		SC266B	1393
PT040	HUT	TRIAC		SC266B	1393
PT06	HUT	TRIAC		SC241B	1393
PT08	HUT	TRIAC		SC246B	1393
PT110	HUT	TRIAC		SC246B	1393
PT115	HUT	TRIAC		SC251B	1393
PT125	HUT	TRIAC		SC261B	1393
PT130	HUT	TRIAC		SC266B	1393
PT140	HUT	TRIAC		SC266B	1393
PT1544		PWR TRAN		D40E7	1109
PT1545		PWR TRAN		D40E7	1109
PT1558		PWR TRAN		D40E7	1109
PT1559		PWR TRAN		D40E7	1109
PT16	HUT	TRIAC		SC241B	1393
PT18	HUT	TRIAC		SC246B	1393
PT210	HUT	TRIAC		SC246B	1393
PT215	HUT	TRIAC		SC251B	1393
PT225	HUT	TRIAC		SC261B	1393
PT230	HUT	TRIAC		SC266B	1393
PT240	HUT	TRIAC		SC266B	1393

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
PT2525A		PWR TRAN		D44R1	1159
PT2620		PWR TRAN		D40E5	1109
PT2630		PWR TRAN		D40E7	1109
PT2635		PWR TRAN		D42C7	1135
PT2640		PWR TRAN		D40E5	1109
PT2660		PWR TRAN		D40E5	1109
PT2670		PWR TRAN		D40E7	1109
PT26	HUT	TRIAC		SC241B	1393
PT28	HUT	TRIAC		SC246B	1393
PT310	HUT	TRIAC		SC246D	1393
PT315	HUT	TRIAC		SC251D	1393
PT325	HUT	TRIAC		SC261D	1393
PT330	HUT	TRIAC		SC266D	1393
PT340	HUT	TRIAC		SC266D	1393
PT3502		PWR TRAN		D40E5	1109
PT3503		PWR TRAN		D40E1	1109
PT36	HUT	TRIAC		SC241D	1393
PT38	HUT	TRIAC		SC246D	1393
PT410	HUT	TRIAC		SC246D	1393
PT415	HUT	TRIAC		SC251D	1393
PT425	HUT	TRIAC		SC261D	1393
PT430	HUT	TRIAC		SC266D	1393
PT440	HUT	TRIAC		SC266D	1393
PT4690		PWR TRAN		D42C4	1135
PT46	HUT	TRIAC		SC241D	1393
PT4816		PWR TRAN		D40E1	1109
PT48	HUT	TRIAC		SC246D	1393
PT510	HUT	TRIAC		SC246E	1393
PT515	HUT	TRIAC		SC251E	1393
PT525	HUT	TRIAC		SC261E	1393
PT530	HUT	TRIAC		SC266E	1393
PT540	HUT	TRIAC		SC266E	1393
PT5693		PWR TRAN		D44C1	1147
PT56	HUT	TRIAC		SC241E	1393
PT58	HUT	TRIAC		SC246E	1393
PT600		PWR TRAN		D42C5	1135
PT601		PWR TRAN		D42C5	1135
PT610	HUT	TRIAC		SC246M	1393
PT612		PWR TRAN		D42C8	1135
PT615	HUT	TRIAC		SC251M	1393
PT625	HUT	TRIAC		SC261M	1393
PT630	HUT	TRIAC		SC266M	1393
PT640	HUT	TRIAC		SC266M	1393
PT6618		PWR TRAN		D40E1	1109
PT665		PWR TRAN		D44C8	1147
PT6696		PWR TRAN		D40E5	1109
PT66	HUT	TRIAC		SC241M	1393
PT68	HUT	TRIAC		SC246M	1393
PT896		PWR TRAN		D40E7	1109
Q2001L4	TCE	TRIAC		SC136B	1377
Q2001M	TCE	TRIAC		SC136B	1377
Q2001P	TCE	TRIAC		SC136B	1377
Q2003L3	TCE	TRIAC		SC140B	1381
Q2003L4	TCE	TRIAC		SC140BX125	CF
Q2003P3	TCE	TRIAC		SC136B	1377
Q2003P	TCE	TRIAC		SC136B	1377
Q2004A	TCE	TRIAC		SC240B4	1393
Q2004B	TCE	TRIAC		SC240B2	1393
Q2004L4	TCE	TRIAC		SC140BX125	CF
Q2004R4	TCE	TRIAC		SC141BX125	CF
Q2006A	TCE	TRIAC		SC240B4	1393
Q2006B	TCE	TRIAC		SC240B2	1393
Q2006G	TCE	TRIAC		SC241B	1393
Q2006H	TCE	TRIAC		SC240B	1393
Q2006L4	TCE	TRIAC		SC140BX125	CF
Q2006N	TCE	TRIAC		SC240B2	1393
Q2006R4	TCE	TRIAC		SC141BX125	CF
Q2008A	TCE	TRIAC		SC245B4	1393
Q2008B	TCE	TRIAC		SC245B2	1393
Q2008G	TCE	TRIAC		SC246B	1393
Q2008H	TCE	TRIAC		SC245B	1393
Q2008L4	TCE	TRIAC		SC142BX125	CF
Q2008N	TCE	TRIAC		SC245B2	1393
Q2008R4	TCE	TRIAC		SC143BX125	CF
Q2010A	TCE	TRIAC		SC245B4	1393
Q2010B	TCE	TRIAC		SC245B2	1393
Q2010G	TCE	TRIAC		SC246B	1393
Q2010H	TCE	TRIAC		SC245B	1393
Q2010L4	TCE	TRIAC		SC147BX125	CF
Q2010N	TCE	TRIAC		SC245B2	1393
Q2010R4	TCE	TRIAC		SC146BX125	CF
Q2015A	TCE	TRIAC		SC250B4	1393
Q2015B	TCE	TRIAC		SC250B2	1393
Q2015G	TCE	TRIAC		SC251B	1393
Q2015H	TCE	TRIAC		SC250B	1393
Q2015N	TCE	TRIAC		SC250B2	1393
Q2015R5	TCE	TRIAC		SC251B	1393
Q2025C	TCE	TRIAC		SC260B4	1393
Q2025D	TCE	TRIAC		SC260B2	1393
Q2025G	TCE	TRIAC		SC261B	1393

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement	
				Type	Page
Q2025H	TCE	TRIAC		SC260B	1393
Q2025N	TCE	TRIAC		SC260B2	1393
Q2040C	TCE	TRIAC		SC265B4	1393
Q2040D	TCE	TRIAC		SC265B2	1393
Q4001L4	TCE	TRIAC		SC136D	1377
Q4001M	TCE	TRIAC		SC136D	1377
Q4001P	TCE	TRIAC		SC136D	1377
Q4003L3	TCE	TRIAC		SC140D	1381
Q4003L4	TCE	TRIAC		SC140DX125	CF
Q4003P3	TCE	TRIAC		SC136D	1377
Q4003P	TCE	TRIAC		SC136D	1377
Q4004A	TCE	TRIAC		SC240D4	1393
Q4004B	TCE	TRIAC		SC240D2	1393
Q4004L4	TCE	TRIAC		SC140DX125	CF
Q4004R4	TCE	TRIAC		SC141DX125	CF
Q4006A	TCE	TRIAC		SC240D4	1393
Q4006B	TCE	TRIAC		SC240D2	1393
Q4006G	TCE	TRIAC		SC241D	1393
Q4006H	TCE	TRIAC		SC240D	1393
Q4006L4	TCE	TRIAC		SC140DX125	CF
Q4006N	TCE	TRIAC		SC240D2	1393
Q4006R4	TCE	TRIAC		SC141DX125	CF
Q4008A	TCE	TRIAC		SC245D4	1393
Q4008B	TCE	TRIAC		SC245D2	1393
Q4008G	TCE	TRIAC		SC246D	1393
Q4008H	TCE	TRIAC		SC245D	1393
Q4008L4	TCE	TRIAC		SC142DX125	CF
Q4008N	TCE	TRIAC		SC245D2	1393
Q4008R4	TCE	TRIAC		SC143DX125	CF
Q4010A	TCE	TRIAC		SC245D4	1393
Q4010B	TCE	TRIAC		SC245D2	1393
Q4010G	TCE	TRIAC		SC246D	1393
Q4010H	TCE	TRIAC		SC245D	1393
Q4010L4	TCE	TRIAC		SC147DX125	CF
Q4010N	TCE	TRIAC		SC245D2	1393
Q4010R4	TCE	TRIAC		SC146DX125	CF
Q4015A	TCE	TRIAC		SC250D4	1393
Q4015B	TCE	TRIAC		SC250D2	1393
Q4015G	TCE	TRIAC		SC251D	1393
Q4015H	TCE	TRIAC		SC250D	1393
Q4015N	TCE	TRIAC		SC250D2	1393
Q4015R5	TCE	TRIAC		SC151D	1381
Q4025C	TCE	TRIAC		SC260D4	1393
Q4025D	TCE	TRIAC		SC260D2	1393
Q4025G	TCE	TRIAC		SC261D	1393
Q4025H	TCE	TRIAC		SC260D	1393
Q4025N	TCE	TRIAC		SC260D2	1393
Q4040C	TCE	TRIAC		SC265D4	1393
Q4040D	TCE	TRIAC		SC265D2	1393
Q5004A	TCE	TRIAC		SC240E4	1393
Q5004B	TCE	TRIAC		SC240E2	1393
Q5004L4	TCE	TRIAC		SC140EX125	CF
Q5004R4	TCE	TRIAC		SC141EX125	CF
Q5006A	TCE	TRIAC		SC240E4	1393
Q5006B	TCE	TRIAC		SC240E2	1393
Q5006G	TCE	TRIAC		SC241E	1393
Q5006H	TCE	TRIAC		SC240E	1393
Q5006L4	TCE	TRIAC		SC140EX125	CF
Q5006N	TCE	TRIAC		SC240E2	1393
Q5006R4	TCE	TRIAC		SC141EX125	CF
Q5008A	TCE	TRIAC		SC245E4	1393
Q5008B	TCE	TRIAC		SC245E2	1393
Q5008G	TCE	TRIAC		SC246E	1393
Q5008H	TCE	TRIAC		SC245E	1393
Q5008L4	TCE	TRIAC		SC142EX125	CF
Q5008N	TCE	TRIAC		SC245E2	1393
Q5008R4	TCE	TRIAC		SC143EX125	CF
Q5010A	TCE	TRIAC		SC245E4	1393
Q5010B	TCE	TRIAC		SC245E2	1393
Q5010G	TCE	TRIAC		SC246E	1393
Q5010H	TCE	TRIAC		SC245E	1393
Q5010L4	TCE	TRIAC		SC147EX125	CF
Q5010N	TCE	TRIAC		SC245E2	1393
Q5010R4	TCE	TRIAC		SC146EX125	CF
Q5015A	TCE	TRIAC		SC250E4	1393
Q5015B	TCE	TRIAC		SC250E2	1393
Q5015G	TCE	TRIAC		SC251E	1393
Q5015H	TCE	TRIAC		SC250E	1393
Q5015N	TCE	TRIAC		SC250E2	1393
Q5015R5	TCE	TRIAC		SC151E	1381
Q5025C	TCE	TRIAC		SC260E4	1393
Q5025D	TCE	TRIAC		SC260E2	1393
Q5025G	TCE	TRIAC		SC261E	1393
Q5025H	TCE	TRIAC		SC260E	1393
Q5025N	TCE	TRIAC		SC260E2	1393
Q5040C	TCE	TRIAC		SC265E4	1393
Q5040D	TCE	TRIAC		SC265E2	1393
Q6004A	TCE	TRIAC		SC240M4	1393
Q6004B	TCE	TRIAC		SC240M2	1393
Q6004L4	TCE	TRIAC		SC140MX125	CF

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement	
				Type	Page
Q6004R4	TCE	TRIAC		SC141MX125	CF
Q6006A	TCE	TRIAC		SC240M4	1393
Q6006B	TCE	TRIAC		SC240M2	1393
Q6006G	TCE	TRIAC		SC241M	1393
Q6006H	TCE	TRIAC		SC240M	1393
Q6006L4	TCE	TRIAC		SC140MX125	CF
Q6006N	TCE	TRIAC		SC240M2	1393
Q6006R4	TCE	TRIAC		SC141MX125	CF
Q6008A	TCE	TRIAC		SC245M4	1393
Q6008B	TCE	TRIAC		SC245M2	1393
Q6008G	TCE	TRIAC		SC246M	1393
Q6008H	TCE	TRIAC		SC245M	1393
Q6008L4	TCE	TRIAC		SC142MX125	CF
Q6008N	TCE	TRIAC		SC245M2	1393
Q6008R4	TCE	TRIAC		SC143MX125	CF
Q6010A	TCE	TRIAC		SC245M4	1393
Q6010B	TCE	TRIAC		SC245M2	1393
Q6010G	TCE	TRIAC		SC246M	1393
Q6010H	TCE	TRIAC		SC245M	1393
Q6010L4	TCE	TRIAC		SC147MX125	CF
Q6010N	TCE	TRIAC		SC245M2	1393
Q6010R4	TCE	TRIAC		SC146MX125	CF
Q6015A	TCE	TRIAC		SC250M4	1393
Q6015B	TCE	TRIAC		SC250M2	1393
Q6015G	TCE	TRIAC		SC251M	1393
Q6015H	TCE	TRIAC		SC250M	1393
Q6015N	TCE	TRIAC		SC250M2	1393
Q6015R5	TCE	TRIAC		SC151M	1381
Q6025C	TCE	TRIAC		SC260M4	1393
Q6025D	TCE	TRIAC		SC260M2	1393
Q6025G	TCE	TRIAC		SC261M	1393
Q6025H	TCE	TRIAC		SC260M	1393
Q6025N	TCE	TRIAC		SC260M2	1393
Q6040C	TCE	TRIAC		SC265M4	1393
Q6040D	TCE	TRIAC		SC265M2	1393
R502**08	WEST	RECT		A177	577
R502**10	WEST	RECT		A177	577
R600**20	WEST	RECT		A190	643
R600**25	WEST	RECT		A190	643
R602**20	WEST	RECT		A197	588
R602**25	WEST	RECT		A197	588
R610**20	WEST	RECT		A190	643
R610**25	WEST	RECT		A190	643
R620**30	WEST	RECT		A390	592
R620**40	WEST	RECT		A390	592
R622**35	WEST	RECT		A397	596
R622**40	WEST	RECT		A397	596
R720**06	WEST	RECT		A430/A540	600
R720**09	WEST	RECT		A430/	600
R720**12	WEST	RECT		A570/A640	613
R722**05	WEST	RECT		A437	603
R722**06	WEST	RECT		A437	603
R722**08	WEST	RECT		A696	616
R920**11	WEST	RECT		A570/A640	613
RCA105		PWR TRAN		D45H4	1171
RCA205		PWR TRAN		D45H4	1171
RCA29		PWR TRAN		D44C4	1147
RCA29A		PWR TRAN		D44C7	1147
RCA29B		PWR TRAN		D44C10	1147
RCA30		PWR TRAN		D45C4	1163
RCA30A		PWR TRAN		D45C7	1163
RCA30B		PWR TRAN		D45C10	1163
RCA31		PWR TRAN		D44C3	1147
RCA31A		PWR TRAN		D44C6	1147
RCA31B		PWR TRAN		D44C9	1147
RCA32		PWR TRAN		D45C3	1163
RCA32A		PWR TRAN		D45C6	1163
RCA32B		PWR TRAN		D45C9	1163
RCA370		PWR TRAN		D45C2	1163
RCA371		PWR TRAN		D45C6	1163
RCA41		PWR TRAN		D44HF	1155
RCA41A		PWR TRAN		D44H7	1155
RCA41B		PWR TRAN		D44H10	1155
RCA42		PWR TRAN		D45H4	1171
RCA42A		PWR TRAN		D45H7	1171
RCA42B		PWR TRAN		D45H10	1171
RCA520		PWR TRAN		D44C2	1147
RCA521		PWR TRAN		D44C6	1147
RM3005		PWR TRAN		D40E7	1109
RM3022		PWR TRAN		D40C4	1101
RT116		PWR TRAN		D40E5	1109
RTB0103	TEC	SCR		C5F	653
RTB0106	TEC	SCR		C5A	653
RTB0110	TEC	SCR		C5A	653
RTB0120	TEC	SCR		C5B	653
RTB0130	TEC	SCR		C5C	653
RTB0140	TEC	SCR		C5D	653
RTC0103	TEC	SCR		C103Y	716
RTC0106	TEC	SCR		C103YY	716
RTC0110	TEC	SCR		C103A	716

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
RTC0120	TEC	SCR		C103B	716
RTC0130	TEC	SCR		C103C	716
RTC0140	TEC	SCR		C103D	716
RTJ0103	TEC	SCR		C203Y	858
RTJ0106	TEC	SCR		C203YY	858
RTJ0110	TEC	SCR		C203A	858
RTJ0120	TEC	SCR		C203B	858
RTJ0130	TEC	SCR		C203C	858
RTJ0140	TEC	SCR		C203D	858
RTJ0201	TEC	SCR		C203Q	858
RTJ0203	TEC	SCR		C203Y	858
RTJ0206	TEC	SCR		C203YY	858
RTJ0210	TEC	SCR		C203A	858
RTJ0215	TEC	SCR		C203G	858
RTJ0220	TEC	SCR		C203B	858
RTJ0225	TEC	SCR		C203C	858
RTJ0230	TEC	SCR		C203C	858
RTL1510	TEC	SCR		ZJ436A	CF
RTL1520	TEC	SCR		ZJ436B	CF
RTL1540	TEC	SCR		ZJ436D	CF
RTL1560	TEC	SCR		ZJ436M	CF
RTN0102	TEC	SCR		C15U	671
RTN0105	TEC	SCR		C15F	671
RTN0110	TEC	SCR		C15A	671
RTN0120	TEC	SCR		C15B	671
RTN0130	TEC	SCR		C15C	671
RTN0140	TEC	SCR		C15D	671
RTN0150	TEC	SCR		C15E	671
RTN0160	TEC	SCR		C15M	671
RTN0202	TEC	SCR		C220U	862
RTN0205	TEC	SCR		C220F	862
RTN0210	TEC	SCR		C220A	862
RTN0220	TEC	SCR		C220B	862
RTN0230	TEC	SCR		C220C	862
RTN0240	TEC	SCR		C220D	862
RTN0250	TEC	SCR		C220E	862
RTN0260	TEC	SCR		C220M	862
RTN0302	TEC	SCR		C220U	862
RTN0305	TEC	SCR		C220F	862
RTN0310	TEC	SCR		C220A	862
RTN0320	TEC	SCR		C220B	862
RTN0330	TEC	SCR		C220C	862
RTN0340	TEC	SCR		C220D	862
RTN0350	TEC	SCR		C220E	862
RTN0360	TEC	SCR		C220M	862
RTN0802	TEC	SCR		C15U	671
RTN0805	TEC	SCR		C15F	671
RTN0810	TEC	SCR		C15A	671
RTN0820	TEC	SCR		C15B	671
RTN0840	TEC	SCR		C15D	671
RTN0860	TEC	SCR		C15M	671
RTR0202	TEC	SCR		C122U	747
RTR0205	TEC	SCR		C122F	747
RTR0210	TEC	SCR		C122A	747
RTR0220	TEC	SCR		C122B	747
RTR0230	TEC	SCR		C122C	747
RTR0240	TEC	SCR		C122D	747
RTR0250	TEC	SCR		C122E	747
RTR0260	TEC	SCR		C122M	747
RTR0302	TEC	SCR		C122U	747
RTR0305	TEC	SCR		C122F	747
RTR0310	TEC	SCR		C122A	747
RTR0320	TEC	SCR		C122B	747
RTR0330	TEC	SCR		C122C	747
RTR0340	TEC	SCR		C122D	747
RTR0350	TEC	SCR		C122E	747
RTR0360	TEC	SCR		C122M	747
RTR0620	TEC	SCR		C122B2	747
RTR0660	TEC	SCR		C122M2	747
RTR1005	TEC	SCR		C126F2	763
RTR1010	TEC	SCR		C126A2	763
RTR1020	TEC	SCR		C126B2	763
RTR1040	TEC	SCR		C126D2	763
RTR1060	TEC	SCR		C126M2	763
RTS0202	TEC	SCR		C222U	862
RTS0205	TEC	SCR		C222F	862
RTS0210	TEC	SCR		C222A	862
RTS0220	TEC	SCR		C222B	862
RTS0230	TEC	SCR		C222C	862
RTS0240	TEC	SCR		C222D	862
RTS0250	TEC	SCR		C222E	862
RTS0260	TEC	SCR		C222M	862
RTS0502	TEC	SCR		C222UX304	CF
RTS0505	TEC	SCR		C222FX304	CF
RTS0510	TEC	SCR		C222AX304	CF
RTS0520	TEC	SCR		C222BX304	CF
RTS0530	TEC	SCR		C222CX304	CF
RTS0540	TEC	SCR		C222DX304	CF
RTS0550	TEC	SCR		C222EX304	CF
RTS0602	TEC	SCR		C232UX245	CF

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
RTS0605	TEC	SCR		C232FX245	CF
RTS0610	TEC	SCR		C232AX245	CF
RTS0620	TEC	SCR		C232BX245	CF
RTS0630	TEC	SCR		C232CX245	CF
RTS0640	TEC	SCR		C232DX245	CF
RTS0650	TEC	SCR		C232EX245	CF
RTS0660	TEC	SCR		C232MX245	CF
RTS0702	TEC	SCR		C229U	868
RTS0705	TEC	SCR		C229F	868
RTS0710	TEC	SCR		C229A	868
RTS0720	TEC	SCR		C229B	868
RTS0730	TEC	SCR		C229C	868
RTS0740	TEC	SCR		C229D	868
RTS0750	TEC	SCR		C229E	868
RTS0760	TEC	SCR		C229M	868
RTS1002	TEC	SCR		C222U	862
RTS1005	TEC	SCR		C222F	862
RTS1010	TEC	SCR		C222A	862
RTS1020	TEC	SCR		C222B	862
RTS1040	TEC	SCR		C222D	862
RTS1060	TEC	SCR		C222M	862
RTS1605	TEC	SCR		C232FX201	CF
RTS1610	TEC	SCR		C232AX201	CF
RTS1620	TEC	SCR		C232BX201	CF
RTS1640	TEC	SCR		C232DX201	CF
RTS1660	TEC	SCR		C232MX201	CF
RTS2505	TEC	SCR		C229F	868
RTS2510	TEC	SCR		C229A	868
RTS2520	TEC	SCR		C229B	868
RTS2540	TEC	SCR		C229D	868
RTS2560	TEC	SCR		C229M	868
RTT0502	TEC	SCR		C140F	783
RTT0505	TEC	SCR		C140F	783
RTT0510	TEC	SCR		C140A	783
RTT0520	TEC	SCR		C140B	783
RTT0530	TEC	SCR		C140C	783
RTT0540	TEC	SCR		C140D	783
RTT0550	TEC	SCR		C144E15E	791
RTT0560	TEC	SCR		C144M15M	791
RTT2505	TEC	SCR		C228F	868
RTT2510	TEC	SCR		C228A	868
RTT2520	TEC	SCR		C228B	868
RTT2540	TEC	SCR		C228D	868
RTT2560	TEC	SCR		C228M	868
RTU0102	TEC	SCR		C230U	874
RTU0105	TEC	SCR		C230F	874
RTU0110	TEC	SCR		C230A	874
RTU0120	TEC	SCR		C230B	874
RTU0130	TEC	SCR		C230C	874
RTU0140	TEC	SCR		C230D	874
RTU0150	TEC	SCR		C230E	874
RTU0160	TEC	SCR		C230M	874
RTU0202	TEC	SCR		C230U	874
RTU0205	TEC	SCR		C230F	874
RTU0210	TEC	SCR		C230A	874
RTU0220	TEC	SCR		C230B	874
RTU0230	TEC	SCR		C230C	874
RTU0240	TEC	SCR		C230D	874
RTU0250	TEC	SCR		C230E	874
RTU0260	TEC	SCR		C230M	874
RTU0602	TEC	SCR		C230UX245	CF
RTU0605	TEC	SCR		C230FX245	CF
RTU0610	TEC	SCR		C230AX245	CF
RTU0620	TEC	SCR		C230BX245	CF
RTU0630	TEC	SCR		C230CX245	CF
RTU0640	TEC	SCR		C230DX245	CF
RTU0650	TEC	SCR		C230EX245	CF
RTU0660	TEC	SCR		C230MX245	CF
RTU0705	TEC	SCR		C228F	868
RTU0710	TEC	SCR		C228A	868
RTU0720	TEC	SCR		C228B	868
RTU0730	TEC	SCR		C228C	868
RTU0740	TEC	SCR		C228D	868
RTU0750	TEC	SCR		C228E	868
RTU0760	TEC	SCR		C228M	868
RTU1005	TEC	SCR		C220F	862
RTU1010	TEC	SCR		C220A	862
RTU1020	TEC	SCR		C220B	862
RTU1040	TEC	SCR		C220D	862
RTU1060	TEC	SCR		C220M	862
RTU1605	TEC	SCR		C230FX201	CF
RTU1610	TEC	SCR		C230AX201	CF
RTU1620	TEC	SCR		C230BX201	CF
RTU1640	TEC	SCR		C230DX201	CF
RTU1660	TEC	SCR		C230MX201	CF
RTU2505	TEC	SCR		C228F	868
RTU2510	TEC	SCR		C228A	868
RTU2520	TEC	SCR		C228B	868
RTU2540	TEC	SCR		C228D	868
RTU2560	TEC	SCR		C228M	868

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
S0300K	TCE	SCR		C103YX180	716
S0300KS1	TCE	SCR		C103YX180	C
S0300KS2	TCE	SCR		C103Y	716
S0300KS3	TCE	SCR		C103YX193	C
S0301M	TCE	SCR		C6F	659
S0301MS2	TCE	SCR		C5F	653
S0301MS3	TCE	SCR		C6F	659
S0303M	TCE	SCR		C107Y1X1	C
S0303MS1	TCE	SCR		C106Y1X177	C
S0303MS2	TCE	SCR		C106Y1	720
S0303MS3	TCE	SCR		C107Y1	728
S0303R	TCE	SCR		C107Y1X1	C
S0303RS1	TCE	SCR		C106Y2X177	C
S0303RS2	TCE	SCR		C106Y2	720
S0303RS3	TCE	SCR		C107Y2	728
S0306B	TCE	SCR		C220U2	862
S0306G	TCE	SCR		C222U	862
S0306H	TCE	SCR		C220U	862
S0306L	TCE	SCR		C122U	747
S0308B	TCE	SCR		C220U2	862
S0308G	TCE	SCR		C222U	862
S0308H	TCE	SCR		C220U	862
S0308L	TCE	SCR		C122U	747
S0310B	TCE	SCR		C220U2	862
S0310G	TCE	SCR		C222U	862
S0310H	TCE	SCR		C220U	862
S0310L	TCE	SCR		C123F	755
S0316B	TCE	SCR		C230U2	874
S0316G	TCE	SCR		C232U	874
S0316H	TCE	SCR		C230U	874
S0325B	TCE	SCR		C230U2	874
S0325G	TCE	SCR		C232U	874
S0325H	TCE	SCR		C230U	874
S0335G	TCE	SCR		C229U	868
S0335H	TCE	SCR		C228U	868
S0500K	TCE	SCR		C103YYX193	C
S0500KS1	TCE	SCR		C103YYX180	C
S0500KS2	TCE	SCR		C103YY	716
S0500KS3	TCE	SCR		C103YYX193	C
S0501M	TCE	SCR		C6F	659
S0501MS2	TCE	SCR		C5F	653
S0501MS3	TCE	SCR		C6F	659
S0503M	TCE	SCR		C107F1X1	C
S0503MS1	TCE	SCR		C106F1X177	C
S0503MS2	TCE	SCR		C106F1	720
S0503MS3	TCE	SCR		C107F1	728
S0506B	TCE	SCR		C220F2	862
S0506G	TCE	SCR		C222F	862
S0506H	TCE	SCR		C220F	862
S0506L	TCE	SCR		C122F	747
S0508B	TCE	SCR		C220F2	862
S0508G	TCE	SCR		C222F	862
S0508H	TCE	SCR		C220F	862
S0508L	TCE	SCR		C122F	747
S0510B	TCE	SCR		C220F2	862
S0510G	TCE	SCR		C222F	862
S0510H	TCE	SCR		C220F	862
S0510L	TCE	SCR		C123F	755
S0516B	TCE	SCR		C230F2	874
S0516G	TCE	SCR		C232F	874
S0516H	TCE	SCR		C230F	874
S0525B	TCE	SCR		C230F2	874
S0525G	TCE	SCR		C232F	874
S0525H	TCE	SCR		C230F	874
S0535G	TCE	SCR		C229F	868
S0535H	TCE	SCR		C228F	868
S1000		PWR TRAN		D42C1	1135
S1000K	TCE	SCR		C103AX193	C
S1000KS1	TCE	SCR		C103AX180	C
S1000KS2	TCE	SCR		C103A	716
S1000KS3	TCE	SCR		C103AX193	C
S1001M	TCE	SCR		C6A	659
S1001MS2	TCE	SCR		C5A	653
S1001MS3	TCE	SCR		C6A	659
S1003M	TCE	SCR		C107A1X1	C
S1003MS1	TCE	SCR		C106A1X177	C
S1003MS2	TCE	SCR		C106A1	720
S1003MS3	TCE	SCR		C107A1	728
S1003RS1	TCE	SCR		C106A1X177	C
S1003RS2	TCE	SCR		C106A1	720
S1003RS3	TCE	SCR		C107A1	728
S1006B	TCE	SCR		C220A2	862
S1006G	TCE	SCR		C222A	862
S1006H	TCE	SCR		C220A	862
S1006L	TCE	SCR		C122A	747
S1008B	TCE	SCR		C220A2	862
S1008G	TCE	SCR		C222A	862
S1008H	TCE	SCR		C220A	862
S1008L	TCE	SCR		C122A	747
S1010B	TCE	SCR		C220A2	862
S1010G	TCE	SCR		C222A	862
S1010H	TCE	SCR		C220A	862
S1010L	TCE	SCR		C123A	755
S1016B	TCE	SCR		C230A2	874
S1016G	TCE	SCR		C232A	874
S1016H	TCE	SCR		C230A	874
S1016L	TCE	SCR		ZJ436A	CF
S1025B	TCE	SCR		C232A2	874
S1025G	TCE	SCR		C232A	874
S1025H	TCE	SCR		C230A	874
S1035G	TCE	SCR		C229A	868
S1035H	TCE	SCR		C228A	868
S106A1	HUT	SCR		C106A1	720
S106A2	HUT	SCR		C106A2	720
S106A	RCA	SCR		C106A1	720
S106B1	HUT	SCR		C106B1	720
S106B2	HUT	SCR		C106B2	720
S106B	RCA	SCR		C106B1	720
S106C1	HUT	SCR		C106C1	720
S106C2	HUT	SCR		C106C2	720
S106C	RCA	SCR		C106C1	720
S106D1	HUT	SCR		C106D1	720
S106D2	HUT	SCR		C106D2	720
S106D	RCA	SCR		C106D1	720
S106E1	HUT	SCR		C106E1	720
S106E2	HUT	SCR		C106E2	720
S106E	RCA	SCR		C106E1	720
S106F1	HUT	SCR		C106F1	720
S106F2	HUT	SCR		C106F2	720
S106F	RCA	SCR		C106F1	720
S106M1	HUT	SCR		C106M1	720
S106M2	HUT	SCR		C106M2	720
S106M	RCA	SCR		C106M1	720
S106Q	RCA	SCR		C106Q1	720
S106-05	SSCF	SCR		C108F1	733
S106-1	SSCF	SCR		C108A1	733
S106-2	SSCF	SCR		C108B1	733
S106-4	SSCF	SCR		C108D1	733
S106Y1	HUT	SCR		C106Y1	720
S106Y2	HUT	SCR		C106Y2	720
S106Y	RCA	SCR		C106Y1	720
S107A1	HUT	SCR		C107A1	728
S107A2	HUT	SCR		C107A2	728
S107B1	HUT	SCR		C107B1	728
S107B2	HUT	SCR		C107B2	728
S107C1	HUT	SCR		C107C1	728
S107C2	HUT	SCR		C107C2	728
S107D1	HUT	SCR		C107D1	728
S107D2	HUT	SCR		C107D2	728
S107E1	HUT	SCR		C107E1	728
S107E2	HUT	SCR		C107E2	728
S107F1	HUT	SCR		C107F1	728
S107F2	HUT	SCR		C107F2	728
S107M1	HUT	SCR		C107M1	728
S107M2	HUT	SCR		C107M2	728
S107-05	SSCF	SCR		C108F1	733
S107-1	SSCF	SCR		C108A1	733
S107-2	SSCF	SCR		C108B1	733
S107-4	SSCF	SCR		C108D1	733
S107Y1	HUT	SCR		C107Y1	728
S107Y2	HUT	SCR		C107Y2	728
S1N1189	GE	HI-REL REC	CF		
S1N1204A	GE	HI-REL REC	CF		
S1N1616	GE	HI-REL REC	CF		
S1N3911	GE	HI-REL REC	CF		
S2000K	TCE	SCR		C103BX193	C
S2000KS1	TCE	SCR		C103BX180	C
S2000KS2	TCE	SCR		C103B	716
S2000KS3	TCE	SCR		C103BX193	C
S2001M	TCE	SCR		C6B	659
S2001MS2	TCE	SCR		C5B	653
S2001MS3	TCE	SCR		C6B	659
S2003M	TCE	SCR		C107B1X1	728
S2003MS1	TCE	SCR		C106B1X177	720
S2003MS2	TCE	SCR		C106B1	720
S2003MS3	TCE	SCR		C107B1	728
S2003RS1	TCE	SCR		C106B1X177	720
S2003RS2	TCE	SCR		C106B1	720
S2003RS3	TCE	SCR		C107B1	728
S2006B	TCE	SCR		C220B2	862
S2006G	TCE	SCR		C222B	862
S2006H	TCE	SCR		C220B	862
S2006L	TCE	SCR		C122B	747
S2008B	TCE	SCR		C220B2	862
S2008G	TCE	SCR		C222B	862
S2008H	TCE	SCR		C220B	862
S2008L	TCE	SCR		C122B	747
S2010B	TCE	SCR		C220B2	862
S2010G	TCE	SCR		C222B	862
S2010H	TCE	SCR		C220B	862

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement	
				Type	Page
S2010L	TCE	SCR		C123B	755
S2016B	TCE	SCR		C230B2	874
S2016G	TCE	SCR		C232B	874
S2016H	TCE	SCR		C230B	874
S2025B	TCE	SCR		C230B2	874
S2025G	TCE	SCR		C232B	874
S2025H	TCE	SCR		C230B	874
S2030G	TCE	SCR		C229B	868
S2030H	TCE	SCR		C228B	868
S2060A	RCA	SCR		C106A1	720
S2060B	RCA	SCR		C106B1	720
S2060C	RCA	SCR		C106C1	720
S2060D	RCA	SCR		C106D1	720
S2060E	RCA	SCR		C106E1	720
S2060F	RCA	SCR		C106F1	720
S2060M	RCA	SCR		C106M1	720
S2060Q	RCA	SCR		C106Q1	720
S2060Y	RCA	SCR		C106Y1	720
S2061A	RCA	SCR		C107A1	728
S2061B	RCA	SCR		C107B1	728
S2061C	RCA	SCR		C107C1	728
S2061D	RCA	SCR		C107D1	728
S2061E	RCA	SCR		C107E1	728
S2061F	RCA	SCR		C107F1	728
S2061M	RCA	SCR		C107M1	728
S2061Q	RCA	SCR		C107Q1	728
S2061Y	RCA	SCR		C107Y1	728
S2062A	RCA	SCR		C107A1	728
S2062B	RCA	SCR		C107B1	728
S2062C	RCA	SCR		C107C1	728
S2062D	RCA	SCR		C107D1	728
S2062E	RCA	SCR		C107E1	728
S2062F	RCA	SCR		C107F1	728
S2062M	RCA	SCR		C107M1	728
S2062Q	RCA	SCR		C107Q1	728
S2062Y	RCA	SCR		C107Y1	728
S2400A	RCA	SCR		C116A	741
S2400B	RCA	SCR		C116B	741
S2400D	RCA	SCR		C116D	741
S2400M	RCA	SCR		C116M	741
S2600B	RCA	SCR		C122B	747
S2600D	RCA	SCR		C122D	747
S2600M	RCA	SCR		C122M	747
S2610B	RCA	SCR		C122B	747
S2610D	RCA	SCR		C122D	747
S2610M	RCA	SCR		C122M	747
S2620B	RCA	SCR		C122B	747
S2620D	RCA	SCR		C122D	747
S2620M	RCA	SCR		C122M	747
S2800A	RCA	SCR		C122A	747
S2800B	RCA	SCR		C122B	747
S2800D	RCA	SCR		C122D	747
S2N491B	GE	HI-REL UJT	CF		
S3700B	RCA	SCR		C234B	880
S3700D	RCA	SCR		C234D	880
S3700M	RCA	SCR		C234M	880
S4000K	TCE	SCR		C203DX193	CF
S4000KS1	TCE	SCR		C203DX180	CF
S4000KS2	TCE	SCR		C203D	858
S4000S3	TCE	SCR		C203DX193	CF
S4001M	TCE	SCR		C6D	659
S4001MS2	TCE	SCR		C5D	653
S4001MS3	TCE	SCR		C6D	659
S4003M	TCE	SCR		C107D1X1	C
S4003MS1	TCE	SCR		C106D1X177	C
S4003MS2	TCE	SCR		C106D1	720
S4003MS3	TCE	SCR		C107D1	728
S4003RS1	TCE	SCR		C106D1X177	C
S4003RS2	TCE	SCR		C106D1	720
S4003RS3	TCE	SCR		C107D1	728
S4006B	TCE	SCR		C220D2	862
S4006G	TCE	SCR		C222D	862
S4006H	TCE	SCR		C220D	862
S4006L	TCE	SCR		C122D	747
S4008B	TCE	SCR		C220D2	862
S4008G	TCE	SCR		C222D	862
S4008H	TCE	SCR		C220D	862
S4008L	TCE	SCR		C122D	747
S4010B	TCE	SCR		C220D2	862
S4010G	TCE	SCR		C222D	862
S4010H	TCE	SCR		C220D	862
S4010L	TCE	SCR		C123D	755
S4016B	TCE	SCR		C230D2	874
S4016G	TCE	SCR		C232D	874
S4016H	TCE	SCR		C230D	874
S4025B	TCE	SCR		C230D2	874
S4025G	TCE	SCR		C232D	874
S4025H	TCE	SCR		C230D	874
S4035G	TCE	SCR		C229D	868
S4035H	TCE	SCR		C228D	868

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement	
				Type	Page
S5010B	RCA	SCR		ZJ465B	CF
S5010D	RCA	SCR		ZJ465D	CF
S5010M	RCA	SCR		ZJ465M	CF
S6000C	RCA	SCR		C126C	763
S6000E	RCA	SCR		C126E	763
S6000K	TCE	SCR		C107M2X1	C
S6000KS1	TCE	SCR		C106M2X177	C
S6000KS2	TCE	SCR		C106M2	720
S6000KS3	TCE	SCR		C107M2	728
S6000S	RCA	SCR		C126S	763
S6001M	TCE	SCR		C107M1X1	C
S6001MS1	TCE	SCR		C106M1X177	C
S6001MS2	TCE	SCR		C106M1	720
S6001MS3	TCE	SCR		C107M1	728
S6003M	TCE	SCR		C107M1X1	C
S6003MS1	TCE	SCR		C106M1X177	C
S6003MS2	TCE	SCR		C106M1	720
S6003MS3	TCE	SCR		C107M1	728
S6003RS1	TCE	SCR		C106M1X177	C
S6003RS2	TCE	SCR		C106M1	720
S6003RS3	TCE	SCR		C107M1	728
S6006B	TCE	SCR		C220M2	862
S6006G	TCE	SCR		C222M	862
S6006H	TCE	SCR		C220M	862
S6006L	TCE	SCR		C122M	747
S6008B	TCE	SCR		C220M2	862
S6008G	TCE	SCR		C222M	862
S6008H	TCE	SCR		C220M	862
S6008L	TCE	SCR		C122M	747
S6010B	TCE	SCR		C220M2	862
S6010G	TCE	SCR		C222M	862
S6010H	TCE	SCR		C220M	862
S6010L	TCE	SCR		C123M	755
S6016B	TCE	SCR		C230M2	874
S6016G	TCE	SCR		C232M	874
S6016H	TCE	SCR		C230M	874
S6025B	TCE	SCR		C230M2	874
S6025G	TCE	SCR		C232M	874
S6025H	TCE	SCR		C230M	874
S6035G	TCE	SCR		C229M	868
S6035H	TCE	SCR		C228M	868
S6100C	RCA	SCR		ZJ436C	CF
S6100E	RCA	SCR		ZJ436E	CF
S6100S	RCA	SCR		ZJ436S	CF
S6200A	RCA	SCR		C232A	874
S6200B	RCA	SCR		C232B	874
S6200D	RCA	SCR		C232D	874
S6200M	RCA	SCR		C232M	874
S6210A	RCA	SCR		C230A	874
S6210B	RCA	SCR		C230B	874
S6210D	RCA	SCR		C230D	874
S6210M	RCA	SCR		C230M	874
S6220A	RCA	SCR		C230A2	874
S6220B	RCA	SCR		C230B2	874
S6220D	RCA	SCR		C230D2	874
S6220M	RCA	SCR		C230M2	874
S6230A	RCA	SCR		C230A8	874
S6230B	RCA	SCR		C230B8	874
S6230D	RCA	SCR		C230D8	874
S6230M	RCA	SCR		C230M8	874
S6240A	RCA	SCR		C230A4	874
S6240B	RCA	SCR		C230B4	874
S6240D	RCA	SCR		C230D4	874
S6240M	RCA	SCR		C230M4	874
S6250A	RCA	SCR		C230A6	874
S6250B	RCA	SCR		C230B6	874
S6250D	RCA	SCR		C230D6	874
S6250M	RCA	SCR		C230M6	874
S6430A	RCA	SCR		C228A8	868
S6430B	RCA	SCR		C228B8	868
S6430D	RCA	SCR		C228D8	868
S6430M	RCA	SCR		C228M8	868
S6430N	RCA	SCR		C228N8	868
S6431M	RCA	SCR		C144M30M	791
S6440A	RCA	SCR		C228A4	868
S6440B	RCA	SCR		C228B4	868
S6440D	RCA	SCR		C228D4	868
S6440M	RCA	SCR		C228M4	868
S6440N	RCA	SCR		C228N4	868
S6450A	RCA	SCR		C228A6	868
S6450B	RCA	SCR		C228B6	868
S6450D	RCA	SCR		C228D6	868
S6450M	RCA	SCR		C228M6	868
S6450N	RCA	SCR		C228N6	868
S715		PWR TRAN		D40E1	1109
S7410M	RCA	SCR		C144M15M	791
S7412M	RCA	SCR		C139M10M	775
S7430M	RCA	SCR		C144M15M	791
S8006H	TCE	SCR		C37N	679
S8008H	TCE	SCR		C37N	679

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
S8010H	TCE	SCR		C37N	679
S8016H	TCE	SCR		C37N	679
S801		PWR TRAN		D42C1	1135
S8025H	TCE	SCR		C37N	679
S8035H	TCE	SCR		C137N	775
SC116	GE	TRIAC	1374		
SC136A	GE	TRIAC	1377		
SC136B	GE	TRIAC	1377		
SC136D	GE	TRIAC	1377		
SC137A	GE	SCR	CF		
SC137B	GE	SCR	CF		
SC137D	GE	SCR	CF		
SC140	GE	TRIAC	1381		
SC141B	GE	TRIAC	1381		
SC141D	GE	TRIAC	1381		
SC141E	GE	TRIAC	1381		
SC141M	GE	TRIAC	1381		
SC142B	GE	TRIAC	1381		
SC142D	GE	TRIAC	1381		
SC142E	GE	TRIAC	1381		
SC142M	GE	TRIAC	1381		
SC143	GE	TRIAC	1381		
SC146B	GE	TRIAC	1381		
SC146D	GE	TRIAC	1381		
SC146E	GE	TRIAC	1381		
SC146M	GE	TRIAC	1381		
SC147	GE	TRIAC	1381		
SC149	GE	TRIAC	1381		
SC151B	GE	TRIAC	1381		
SC151D	GE	TRIAC	1381		
SC151E	GE	TRIAC	1381		
SC151M	GE	TRIAC	1381		
SC160	GE	TRIAC	CF		
SC240B12	GE	TRIAC	1393		
SC240B13	GE	TRIAC	1393		
SC240B22,32	GE	TRIAC	1393		
SC240B23,33	GE	TRIAC	1393		
SC240B2,3	GE	TRIAC	1393		
SC240B	GE	TRIAC	1393		
SC240D12	GE	TRIAC	1393		
SC240D13	GE	TRIAC	1393		
SC240D22,32	GE	TRIAC	1393		
SC240D23,33	GE	TRIAC	1393		
SC240D2,3	GE	TRIAC	1393		
SC240D	GE	TRIAC	1393		
SC240E12	GE	TRIAC	1393		
SC240E13	GE	TRIAC	1393		
SC240E22,32	GE	TRIAC	1393		
SC240E23,33	GE	TRIAC	1393		
SC240E2,3	GE	TRIAC	1393		
SC240E	GE	TRIAC	1393		
SC240M12	GE	TRIAC	1393		
SC240M13	GE	TRIAC	1393		
SC240M22,32	GE	TRIAC	1393		
SC240M23,33	GE	TRIAC	1393		
SC240M2,3	GE	TRIAC	1393		
SC240M	GE	TRIAC	1393		
SC241B12	GE	TRIAC	1393		
SC241B13	GE	TRIAC	1393		
SC241B	GE	TRIAC	1393		
SC241D12	GE	TRIAC	1393		
SC241D13	GE	TRIAC	1393		
SC241D	GE	TRIAC	1393		
SC241E12	GE	TRIAC	1393		
SC241E13	GE	TRIAC	1393		
SC241E	GE	TRIAC	1393		
SC241M12	GE	TRIAC	1393		
SC241M13	GE	TRIAC	1393		
SC241M	GE	TRIAC	1393		
SC245B12	GE	TRIAC	1393		
SC245B13	GE	TRIAC	1393		
SC245B22,32	GE	TRIAC	1393		
SC245B23,33	GE	TRIAC	1393		
SC245B2,3	GE	TRIAC	1393		
SC245B	GE	TRIAC	1393		
SC245D12	GE	TRIAC	1393		
SC245D13	GE	TRIAC	1393		
SC245D22,32	GE	TRIAC	1393		
SC245D23,33	GE	TRIAC	1393		
SC245D2,3	GE	TRIAC	1393		
SC245D	GE	TRIAC	1393		
SC245E12	GE	TRIAC	1393		
SC245E13	GE	TRIAC	1393		
SC245E22,32	GE	TRIAC	1393		
SC245E23,33	GE	TRIAC	1393		
SC245E2,3	GE	TRIAC	1393		
SC245E	GE	TRIAC	1393		
SC245M12	GE	TRIAC	1393		
SC245M13	GE	TRIAC	1393		
SC245M22,32	GE	TRIAC	1393		

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
SC245M23,33	GE	TRIAC	1393		
SC245M2,3	GE	TRIAC	1393		
SC245M	GE	TRIAC	1393		
SC246B12	GE	TRIAC	1393		
SC246B13	GE	TRIAC	1393		
SC246B	GE	TRIAC	1393		
SC246D12	GE	TRIAC	1393		
SC246D13	GE	TRIAC	1393		
SC246D	GE	TRIAC	1393		
SC246E12	GE	TRIAC	1393		
SC246E13	GE	TRIAC	1393		
SC246E	GE	TRIAC	1393		
SC246M12	GE	TRIAC	1393		
SC246M13	GE	TRIAC	1393		
SC246M	GE	TRIAC	1393		
SC250B12	GE	TRIAC	1393		
SC250B13	GE	TRIAC	1393		
SC250B22,32	GE	TRIAC	1393		
SC250B23,33	GE	TRIAC	1393		
SC250B2,3	GE	TRIAC	1393		
SC250B	GE	TRIAC	1393		
SC250D12	GE	TRIAC	1393		
SC250D13	GE	TRIAC	1393		
SC250D22,32	GE	TRIAC	1393		
SC250D23,33	GE	TRIAC	1393		
SC250D2,3	GE	TRIAC	1393		
SC250D	GE	TRIAC	1393		
SC250E12	GE	TRIAC	1393		
SC250E13	GE	TRIAC	1393		
SC250E22,32	GE	TRIAC	1393		
SC250E23,33	GE	TRIAC	1393		
SC250E2,3	GE	TRIAC	1393		
SC250E	GE	TRIAC	1393		
SC250M12	GE	TRIAC	1393		
SC250M13	GE	TRIAC	1393		
SC250M22,32	GE	TRIAC	1393		
SC250M23,33	GE	TRIAC	1393		
SC250M2,3	GE	TRIAC	1393		
SC250M	GE	TRIAC	1393		
SC251B12	GE	TRIAC	1393		
SC251B13	GE	TRIAC	1393		
SC251B	GE	TRIAC	1393		
SC251D12	GE	TRIAC	1393		
SC251D13	GE	TRIAC	1393		
SC251D	GE	TRIAC	1393		
SC251E12	GE	TRIAC	1393		
SC251E13	GE	TRIAC	1393		
SC251E	GE	TRIAC	1393		
SC251M12	GE	TRIAC	1393		
SC251M13	GE	TRIAC	1393		
SC251M	GE	TRIAC	1393		
SC260B12	GE	TRIAC	1393		
SC260B13	GE	TRIAC	1393		
SC260B22, 32	GE	TRIAC	1393		
SC260B23, 33	GE	TRIAC	1393		
SC260B2, 3	GE	TRIAC	1393		
SC260B	GE	TRIAC	1393		
SC260D12	GE	TRIAC	1393		
SC260D13	GE	TRIAC	1393		
SC260D22, 32	GE	TRIAC	1393		
SC260D23,33	GE	TRIAC	1393		
SC260D2, 3	GE	TRIAC	1393		
SC260D	GE	TRIAC	1393		
SC260E12	GE	TRIAC	1393		
SC260E13	GE	TRIAC	1393		
SC260E22, 32	GE	TRIAC	1393		
SC260E23, 33	GE	TRIAC	1393		
SC260E2, 3	GE	TRIAC	1393		
SC260E	GE	TRIAC	1393		
SC260M12	GE	TRIAC	1393		
SC260M13	GE	TRIAC	1393		
SC260M22, 32	GE	TRIAC	1393		
SC260M23, 33	GE	TRIAC	1393		
SC260M2, 3	GE	TRIAC	1393		
SC260M	GE	TRIAC	1393		
SC261B12	GE	TRIAC	1393		
SC261B13	GE	TRIAC	1393		
SC261B	GE	TRIAC	1393		
SC261D12	GE	TRIAC	1393		
SC261D13	GE	TRIAC	1393		
SC261D	GE	TRIAC	1393		
SC261E12	GE	TRIAC	1393		
SC261E13	GE	TRIAC	1393		
SC261E	GE	TRIAC	1393		
SC261M12	GE	TRIAC	1393		
SC261M13	GE	TRIAC	1393		
SC261M	GE	TRIAC	1393		
SC265B2,3	GE	TRIAC	1393		
SC265B	GE	TRIAC	1393		
SC265D2,3	GE	TRIAC	1393		

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
SC265D	GE	TRIAC	1393		
SC265E2,3	GE	TRIAC	1393		
SC265E	GE	TRIAC	1393		
SC265M2,3	GE	TRIAC	1393		
SC265M	GE	TRIAC	1393		
SC266B	GE	TRIAC	1393		
SC266D	GE	TRIAC	1393		
SC266E	GE	TRIAC	1393		
SC266M	GE	TRIAC	1393		
SC40B	GE	TRIAC	1393		
SC40D	GE	TRIAC	1393		
SC40E	GE	TRIAC	1393		
SC41B	GE	TRIAC	1393		
SC41D	GE	TRIAC	1393		
SC41E	GE	TRIAC	1393		
SC45B	GE	TRIAC	1393		
SC45D	GE	TRIAC	1393		
SC45E	GE	TRIAC	1393		
SC46B	GE	TRIAC	1393		
SC46D	GE	TRIAC	1393		
SC46E	GE	TRIAC	1393		
SC50B	GE	TRIAC	1393		
SC50D	GE	TRIAC	1393		
SC50E	GE	TRIAC	1393		
SC51B	GE	TRIAC	1393		
SC51D	GE	TRIAC	1393		
SC51E	GE	TRIAC	1393		
SC60B	GE	TRIAC	1393		
SC60D	GE	TRIAC	1393		
SC60E	GE	TRIAC	1393		
SD0345		PWR TRAN		D44C11	1147
SD0445		PWR TRAN		D45C11	1163
SD1023		PWR TRAN		D40E1	1109
SD1335		PWR TRAN		D44C5	1147
SD1445		PWR TRAN		D45C5	1163
SD5410-1	SPT	OPTO DET		L14F1	1335
SD5410-2	SPT	OPTO DET		L14F1	1335
SD5410-3	SPT	OPTO DET		L14F1	1335
SD5440-1	SPT	OPTO DET		L14G2	1337
SD5440-2	SPT	OPTO DET		L14G2	1337
SD5440-3	SPT	OPTO DET		L14G2	1337
SD5440-4	SPT	OPTO DET		L14G1	1337
SD5440-5	SPT	OPTO DET		L14G1	1337
SDJ345		PWR TRAN		D44C6	1147
SDJ445		PWR TRAN		D45C6	1163
SDK345		PWR TRAN		D44C6	1147
SDK445		PWR TRAN		D45C6	1163
SDL345		PWR TRAN		D44C8	1147
SDL445		PWR TRAN		D45C8	1163
SDM345		PWR TRAN		D44C5	1147
SDM445		PWR TRAN		D45C5	1163
SDN345		PWR TRAN		D44C8	1147
SDN445		PWR TRAN		D45C8	1163
SDT3321		PWR TRAN		D42C6	1135
SDT3322		PWR TRAN		D43C8	1143
SDT3325		PWR TRAN		D43C6	1143
SDT3326		PWR TRAN		D42C8	1135
SDT3421		PWR TRAN		D42C6	1135
SDT3422		PWR TRAN		D42C8	1135
SDT3425		PWR TRAN		D42C6	1135
SDT3426		PWR TRAN		D42C5	1135
SDT3501		PWR TRAN		D43C5	1143
SDT3502		PWR TRAN		D43C7	1143
SDT3505		PWR TRAN		D43C6	1143
SDT3506		PWR TRAN		D43C3	1143
SDT3550		PWR TRAN		D43C7	1143
SDT3552		PWR TRAN		D43C4	1143
SDT3553		PWR TRAN		D43C7	1143
SDT3575		PWR TRAN		D45C6	1163
SDT3576		PWR TRAN		D45C8	1163
SDT3578		PWR TRAN		D45C6	1163
SDT3579		PWR TRAN		D45C7	1163
SDT3701		PWR TRAN		D45C6	1163
SDT3702		PWR TRAN		D45C8	1163
SDT3703		PWR TRAN		D45C5	1163
SDT3704		PWR TRAN		D45C8	1163
SDT3706		PWR TRAN		D45C2	1163
SDT3707		PWR TRAN		D45C5	1163
SDT3708		PWR TRAN		D45C8	1163
SDT3709		PWR TRAN		D45C3	1163
SDT3710		PWR TRAN		D45C6	1163
SDT3711		PWR TRAN		D45C8	1163
SDT3712		PWR TRAN		D45C8	1163
SDT3713		PWR TRAN		D45C8	1163
SDT3715		PWR TRAN		D45C6	1163
SDT3716		PWR TRAN		D45C4	1163
SDT3717		PWR TRAN		D45C7	1163
SDT3720		PWR TRAN		D45C6	1163
SDT3721		PWR TRAN		D45C6	1163
SDT3722		PWR TRAN		D45C8	1163

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
SDT3725		PWR TRAN		D45C6	1163
SDT3726		PWR TRAN		D45C6	1163
SDT3727		PWR TRAN		D45C8	1163
SDT3729		PWR TRAN		D45C6	1163
SDT3730		PWR TRAN		D45C8	1163
SDT3733		PWR TRAN		D45C6	1163
SDT3775		PWR TRAN		D43C6	1143
SDT3776		PWR TRAN		D43C8	1143
SDT3778		PWR TRAN		D43C6	1143
SDT4301		PWR TRAN		D42C5	1135
SDT4302		PWR TRAN		D42C8	1135
SDT4304		PWR TRAN		D42C6	1135
SDT4305		PWR TRAN		D42C8	1135
SDT4307		PWR TRAN		D42C6	1135
SDT4308		PWR TRAN		D42C8	1135
SDT4310		PWR TRAN		D42C6	1135
SDT4311		PWR TRAN		D42C8	1135
SDT4455		PWR TRAN		D40E5	1109
SDT4483		PWR TRAN		D40E5	1109
SDT4551		PWR TRAN		D42C4	1135
SDT4553		PWR TRAN		D42C4	1135
SDT4583		PWR TRAN		D42C4	1135
SDT4611		PWR TRAN		D42C5	1135
SDT4612		PWR TRAN		D42C8	1135
SDT4614		PWR TRAN		D42C5	1135
SDT4615		PWR TRAN		D42C8	1135
SDT5001		PWR TRAN		D40E5	1109
SDT5002		PWR TRAN		D40E7	1109
SDT5006		PWR TRAN		D40E5	1109
SDT5007		PWR TRAN		D40E7	1109
SDT5011		PWR TRAN		D40E5	1109
SDT5012		PWR TRAN		D40E7	1109
SDT5501		PWR TRAN		D40E5	1109
SDT5502		PWR TRAN		D40E7	1109
SDT5506		PWR TRAN		D40E5	1109
SDT5507		PWR TRAN		D40E7	1109
SDT5511		PWR TRAN		D40E5	1109
SDT5512		PWR TRAN		D40E7	1109
SDT5901		PWR TRAN		D42C6	1135
SDT5902		PWR TRAN		D42C8	1135
SDT5906		PWR TRAN		D42C5	1135
SDT5907		PWR TRAN		D42C7	1135
SDT6001		PWR TRAN		D44C7	1147
SDT6011		PWR TRAN		D44C5	1147
SDT6013		PWR TRAN		D44C6	1147
SDT6031		PWR TRAN		D44C5	1147
SDT6101		PWR TRAN		D42C2	1135
SDT6102		PWR TRAN		D42C4	1135
SDT6103		PWR TRAN		D42C7	1135
SDT6104		PWR TRAN		D42C2	1135
SDT6105		PWR TRAN		D42C4	1135
SDT6106		PWR TRAN		D42C4	1135
SDT7401		PWR TRAN		D42C6	1135
SDT7402		PWR TRAN		D42C8	1135
SDT7411		PWR TRAN		D42C6	1135
SDT7412		PWR TRAN		D42C8	1135
SDT7414		PWR TRAN		D42C6	1135
SDT7415		PWR TRAN		D42C8	1135
SDT7511		PWR TRAN		D42C6	1135
SDT7512		PWR TRAN		D44C8	1147
SDT7514		PWR TRAN		D44C6	1147
SDT7515		PWR TRAN		D44C8	1147
SDT9001		PWR TRAN		D42C3	1135
SDT9002		PWR TRAN		D42C5	1135
SDT9003		PWR TRAN		D42C8	1135
SDT9004		PWR TRAN		D42C3	1135
SDT9005		PWR TRAN		D42C5	1135
SDT9006		PWR TRAN		D42C8	1135
SDT9007		PWR TRAN		D42C3	1135
SDT9008		PWR TRAN		D42C5	1135
SDT9009		PWR TRAN		D42C8	1135
SE3450-1	SPT	IRLED		LED56F	1347
SE3450-2	SPT	IRLED		LED56F	1347
SE3450-3	SPT	IRLED		LED56F	1347
SE3451-1	SPT	IRLED		LED56F	1347
SE3451-2	SPT	IRLED		LED55BF	1347
SE3451-3	SPT	IRLED		LED56CF	1347
SE3453-1	SPT	IRLED		LED56F	1347
SE3453-2	SPT	IRLED		LED56F	1347
SE3453-3	SPT	IRLED		LED55BF	1347
SE3453-4	SPT	IRLED		LED55CF	1347
SE3455-1	SPT	IRLED		LED55BF	1347
SE3455-2	SPT	IRLED		LED55CF	1347
SE5450-1	SPT	IRLED		LED56	1347
SE5450-2	SPT	IRLED		LED56	1347
SE5450-3	SPT	IRLED		LED55B	1347
SE5451-1	SPT	IRLED		LED56	1347
SE5451-2	SPT	IRLED		LED55B	1347
SE5451-3	SPT	IRLED		LED55B	1347
SE5453-1	SPT	IRLED		LED56	1347

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement	
				Type	Page
SE5453-2	SPT	IRLED		LED55B	1347
SE5453-3	SPT	IRLED		LED55B	1347
SE5453-4	SPT	IRLED		LED55B	1347
SE5455-1	SPT	IRLED		LED55B	1347
SE5455-2	SPT	IRLED		LED55C	1347
SE5455-3	SPT	IRLED		LED55C	1347
SE5455-4	SPT	IRLED		LED55C	1347
SE7001		PWR TRAN		D40N1	1117
SE7002		PWR TRAN		D40N1	1117
SE7006		PWR TRAN		D44R1	1159
SE7020		PWR TRAN		D44R4	1159
SE7055		PWR TRAN		D40N1	1117
SE7056		PWR TRAN		D40N3	1117
SE8001		PWR TRAN		D40E1	1109
SE8002		PWR TRAN		D40E5	1109
SE8042		PWR TRAN		D40E1	1109
SE8542		PWR TRAN		D41E1	1129
SFT186		PWR TRAN		D40N1	1117
SFT187		PWR TRAN		D44R1	1159
SFT445		PWR TRAN		D40E7	1109
SG1009	SPT	IRLED		LED55B	1347
SG1009A	SPT	IRLED		LED55C	1347
SIPT010	HUT	TRIAC		SC245B2	1393
SIPT015	HUT	TRIAC		SC250B2	1393
SIPT025	HUT	TRIAC		SC260B2	1393
SIPT040	HUT	TRIAC		SC265B2	1393
SIPT06	HUT	TRIAC		SC240B2	1393
SIPT08	HUT	TRIAC		SC245B2	1393
SIPT110	HUT	TRIAC		SC245B2	1393
SIPT115	HUT	TRIAC		SC250B2	1393
SIPT125	HUT	TRIAC		SC260B2	1393
SIPT140	HUT	TRIAC		SC265B2	1393
SIPT16	HUT	TRIAC		SC240B2	1393
SIPT18	HUT	TRIAC		SC245B2	1393
SIPT210	HUT	TRIAC		SC245B2	1393
SIPT215	HUT	TRIAC		SC250B2	1393
SIPT225	HUT	TRIAC		SC260B2	1393
SIPT230	HUT	TRIAC		SC265B2	1393
SIPT240	HUT	TRIAC		SC265B2	1393
SIPT26	HUT	TRIAC		SC240B2	1393
SIPT28	HUT	TRIAC		SC245B2	1393
SIPT310	HUT	TRIAC		SC245D2	1393
SIPT315	HUT	TRIAC		SC250D2	1393
SIPT325	HUT	TRIAC		SC260D2	1393
SIPT330	HUT	TRIAC		SC265D2	1393
SIPT340	HUT	TRIAC		SC265D2	1393
SIPT36	HUT	TRIAC		SC240D2	1393
SIPT38	HUT	TRIAC		SC245D2	1393
SIPT410	HUT	TRIAC		SC245D2	1393
SIPT415	HUT	TRIAC		SC250D2	1393
SIPT425	HUT	TRIAC		SC260D2	1393
SIPT430	HUT	TRIAC		SC265D2	1393
SIPT440	HUT	TRIAC		SC265D2	1393
SIPT46	HUT	TRIAC		SC240D2	1393
SIPT48	HUT	TRIAC		SC245D2	1393
SIPT510	HUT	TRIAC		SC245E2	1393
SIPT515	HUT	TRIAC		SC250E2	1393
SIPT525	HUT	TRIAC		SC260E2	1393
SIPT530	HUT	TRIAC		SC265E2	1393
SIPT540	HUT	TRIAC		SC265E2	1393
SIPT56	HUT	TRIAC		SC240E2	1393
SIPT58	HUT	TRIAC		SC245E2	1393
SIPT610	HUT	TRIAC		SC245M2	1393
SIPT615	HUT	TRIAC		SC250M2	1393
SIPT625	HUT	TRIAC		SC260M2	1393
SIPT630	HUT	TRIAC		SC265M2	1393
SIPT640	HUT	TRIAC		SC265M2	1393
SIPT66	HUT	TRIAC		SC240M2	1393
SIPT68	HUT	TRIAC		SC245M2	1393
SPS020	HUT	SCR		C230F	874
SPS030	HUT	SCR		C228FX11	CF
SPS035	HUT	SCR		C228FX11	CF
SPS08	HUT	SCR		C220F	862
SPS120	HUT	SCR		C230A	874
SPS130	HUT	SCR		C228AX11	CF
SPS135	HUT	SCR		C228AX11	CF
SPS18	HUT	SCR		C220A	862
SPS220	HUT	SCR		C230B	874
SPS230	HUT	SCR		C228BX11	CF
SPS235	HUT	SCR		C228BX11	CF
SPS28	HUT	SCR		C220B	862
SPS320	HUT	SCR		C230C	874
SPS330	HUT	SCR		C228CX11	CF
SPS335	HUT	SCR		C228CX11	CF
SPS38	HUT	SCR		C220C	862
SPS420	HUT	SCR		C230D	874
SPS430	HUT	SCR		C228DX11	CF
SPS435	HUT	SCR		C228DX11	CF
SPS48	HUT	SCR		C220D	862
SPS520	HUT	SCR		C230E	874

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement	
				Type	Page
SPS530	HUT	SCR		C228EX11	CF
SPS535	HUT	SCR		C228EX11	CF
SPS58	HUT	SCR		C220E	862
SPS620	HUT	SCR		C230M	874
SPS630	HUT	SCR		C228MX11	CF
SPS635	HUT	SCR		C228MX11	CF
SPS68	HUT	SCR		C220M	862
SPT010	HUT	TRIAC		SC245B	1393
SPT015	HUT	TRIAC		SC250B	1393
SPT025	HUT	TRIAC		SC260B	1393
SPT040	HUT	TRIAC		SC265B	1393
SPT06	HUT	TRIAC		SC240B	1393
SPT08	HUT	TRIAC		SC245B	1393
SPT110	HUT	TRIAC		SC245B	1393
SPT115	HUT	TRIAC		SC250B	1393
SPT125	HUT	TRIAC		SC260B	1393
SPT140	HUT	TRIAC		SC265B	1393
SPT16	HUT	TRIAC		SC240B	1393
SPT18	HUT	TRIAC		SC245B	1393
SPT210	HUT	TRIAC		SC245B	1393
SPT215	HUT	TRIAC		SC250B	1393
SPT225	HUT	TRIAC		SC260B	1393
SPT230	HUT	TRIAC		SC265B	1393
SPT240	HUT	TRIAC		SC265B	1393
SPT26	HUT	TRIAC		SC240B	1393
SPT28	HUT	TRIAC		SC245B	1393
SPT310	HUT	TRIAC		SC245D	1393
SPT315	HUT	TRIAC		SC250D	1393
SPT325	HUT	TRIAC		SC260D	1393
SPT330	HUT	TRIAC		SC265D	1393
SPT340	HUT	TRIAC		SC265D	1393
SPT3440		PWR TRAN		D44R2	1159
SPT36	HUT	TRIAC		SC240D	1393
SPT38	HUT	TRIAC		SC245D	1393
SPT410	HUT	TRIAC		SC245D	1393
SPT415	HUT	TRIAC		SC250D	1393
SPT425	HUT	TRIAC		SC260D	1393
SPT430	HUT	TRIAC		SC265D	1393
SPT440	HUT	TRIAC		SC265D	1393
SPT46	HUT	TRIAC		SC240D	1393
SPT48	HUT	TRIAC		SC245D	1393
SPT510	HUT	TRIAC		SC245E	1393
SPT515	HUT	TRIAC		SC250E	1393
SPT525	HUT	TRIAC		SC260E	1393
SPT530	HUT	TRIAC		SC265E	1393
SPT540	HUT	TRIAC		SC265E	1393
SPT56	HUT	TRIAC		SC240E	1393
SPT58	HUT	TRIAC		SC245E	1393
SPT610	HUT	TRIAC		SC245M	1393
SPT615	HUT	TRIAC		SC250M	1393
SPT625	HUT	TRIAC		SC260M	1393
SPT630	HUT	TRIAC		SC265M	1393
SPT640	HUT	TRIAC		SC265M	1393
SPT66	HUT	TRIAC		SC240M	1393
SPT68	HUT	TRIAC		SC245M	1393
SPX1873-1	SPT	OPTO COUPL		H13A1	1309
SPX1873-2	SPT	OPTO COUPL		H13A1	1309
SPX1873-3	SPT	OPTO COUPL		H13B1	1311
SPX1873-4	SPT	OPTO COUPL		H13B1	1311
SPX1876-1	SPT	OPTO COUPL		H13A1	1309
SPX1876-2	SPT	OPTO COUPL		H13A1	1309
SPX1876-3	SPT	OPTO COUPL		H13B1	1311
SPX26	SPT	OPTO COUPL		H11A520	1285
SPX28	SPT	OPTO COUPL		H11A520	1285
SPX2	SPT	OPTO COUPL		H11A550	1285
SPX2E	SPT	OPTO COUPL		H11A550	1285
SPX35	SPT	OPTO COUPL		H11A5100	1285
SPX36	SPT	OPTO COUPL		H11A5100	1285
SPX37	SPT	OPTO COUPL		H11A5100	1285
SPX4	SPT	OPTO COUPL		H11A550	1285
SPX5	SPT	OPTO COUPL		H11A550	1285
SPX6	SPT	OPTO COUPL		H11A5100	1285
ST2	GE	TRIGGER	1405		
ST4	GE	TRIGGER	1406		
ST84027		PWR TRAN		D44R2	1159
ST84028		PWR TRAN		D44R2	1159
ST84029		PWR TRAN		D44R2	1159
STB567	GE	STABISTER	1410		
STB568	GE	STABISTER	1410		
STB569	GE	STABISTER	1410		
STC1300		PWR TRAN		D44C5	1147
STC1336		PWR TRAN		D44C5	1147
STC1800		PWR TRAN		D42C5	1135
STC1850		PWR TRAN		D42C7	1135
STC1860		PWR TRAN		D42C8	1135
STC1862		PWR TRAN		D42C5	1135
STC4401		PWR TRAN		D44C6	1147
STC5202		PWR TRAN		D45C5	1163
STC5203		PWR TRAN		D45C8	1163
STC5205		PWR TRAN		D45C4	1163

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
STC5206		PWR TRAN		D45C7	1163
STC5802		PWR TRAN		D45C5	1163
STC5803		PWR TRAN		D45C8	1163
STC5805		PWR TRAN		D45C4	1163
STC5806		PWR TRAN		D45C7	1163
STT4451		PWR TRAN		D42C5	1135
T1S92		SIG TRAN		GES92	CF
T1S93		SIG TRAN		GES93	CF
T1S97		SIG TRAN		GES97	CF
T1S98		SIG TRAN		GES98	CF
T2313A	RCA	TRIAC		SC136A	1377
T2313B	RCA	TRIAC		SC136B	1377
T2313D	RCA	TRIAC		SC136D	1377
T2500B	RCA	TRIAC		SC141BX125	CF
T2500D	RCA	TRIAC		SC141DX125	CF
T2700B	RCA	TRIAC		SC146BX125	CF
T2700D	RCA	TRIAC		SC146DX125	CF
T2800B	RCA	TRIAC		SC143BX125	CF
T2800C	RCA	TRIAC		SC143DX125	CF
T2800D	RCA	TRIAC		SC143DX125	CF
T2800E	RCA	TRIAC		SC143EX125	CF
T2800M	RCA	TRIAC		SC143MX125	CF
T2801B	RCA	TRIAC		SC141B	1381
T2801C	RCA	TRIAC		SC141D	1381
T2801D	RCA	TRIAC		SC141D	1381
T2801E	RCA	TRIAC		SC141E	1381
T2801M	RCA	TRIAC		SC141M	1381
T2802B	RCA	TRIAC		SC143B	1381
T2802C	RCA	TRIAC		SC143D	1381
T2802D	RCA	TRIAC		SC143D	1381
T2802E	RCA	TRIAC		SC143E	1381
T2802M	RCA	TRIAC		SC143M	1381
T2850A	RCA	TRIAC		SC142B	1381
T2850B	RCA	TRIAC		SC142BX125	CF
T2850D	RCA	TRIAC		SC142DX125	CF
T400001008	WESY	SCR		C230FX682	CF
T400001608	WESY	SCR		C230FX240	CF
T400002208	WESY	SCR		C228F	1044
T400011008	WESY	SCR		C230AX683	CF
T400011608	WESY	SCR		C230AX240	CF
T400012208	WESY	SCR		C228A	1044
T400021008	WESY	SCR		C230BX685	CF
T400021608	WESY	SCR		C230BX240	CF
T400022208	WESY	SCR		C228B	1044
T400031008	WESY	SCR		C230CX687	CF
T400031608	WESY	SCR		C230CX240	CF
T400032208	WESY	SCR		C228C	1044
T400041008	WESY	SCR		C230DX688	CF
T400041608	WESY	SCR		C230DX240	CF
T400042208	WESY	SCR		C228D	1044
T400051008	WESY	SCR		C230EX689	CF
T400051608	WESY	SCR		C230EX240	CF
T400052208	WESY	SCR		C228E	868
T400061008	WESY	SCR		C230MX690	CF
T400061608	WESY	SCR		C230MX240	CF
T400062208	WESY	SCR		C228M	868
T400072208	WESY	SCR		C137S	771
T400082208	WESY	SCR		C137N	771
T400092208	WESY	SCR		C137T	771
T400102208	WESY	SCR		C137P	771
T400112208	WESY	SCR		C137PA	771
T400122208	WESY	SCR		C137PB	771
T4100M	RCA	TRIAC		SC251M	1393
T4101M	RCA	TRIAC		SC246M13	1393
T4110M	RCA	TRIAC		SC250M	1393
T4111M	RCA	TRIAC		SC250M13	1393
T4120D	RCA	TRIAC		SC250D3	1393
T4120M	RCA	TRIAC		SC250M3	1393
T4121B	RCA	TRIAC		SC250B33	1393
T4121D	RCA	TRIAC		SC250D33	1393
T4121M	RCA	TRIAC		SC250M33	1393
T4130B	RCA	TRIAC		SC250B8	1393
T4130D	RCA	TRIAC		SC250D8	1393
T4130M	RCA	TRIAC		SC250M8	1393
T4131B	RCA	TRIAC		SC245B83	1393
T4131D	RCA	TRIAC		SC245D83	1393
T4131M	RCA	TRIAC		SC245M83	1393
T4140B	RCA	TRIAC		SC250B4	1393
T4140D	RCA	TRIAC		SC250D4	1393
T4140M	RCA	TRIAC		SC250M4	1393
T4141B	RCA	TRIAC		SC245B43	1393
T4141D	RCA	TRIAC		SC245D43	1393
T4141M	RCA	TRIAC		SC245M43	1393
T4150B	RCA	TRIAC		SC250B6	1393
T4150D	RCA	TRIAC		SC250D6	1393
T4150M	RCA	TRIAC		SC250M6	1393
T4151B	RCA	TRIAC		SC245B63	1393
T4151D	RCA	TRIAC		SC245D63	1393
T4151M	RCA	TRIAC		SC245M63	1393
T4700B	RCA	TRIAC		SC151B2	1381

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
T4700D	RCA	TRIAC		SC151D2	1381
T500**4005	WEST	SCR		C150	818
T500**8005	WEST	SCR		C50/C150	707
T507014064AQ	WESY	SCR		C165A	838
T507014084AQ	WESY	SCR		C164A	838
T507024054AQ	WESY	SCR		C158B	830
T507024064AQ	WESY	SCR		C165B	838
T507024084AQ	WESY	SCR		C164B	838
T507034054AQ	WESY	SCR		C158C	830
T507034064AQ	WESY	SCR		C165C	838
T507034084AQ	WESY	SCR		C164C	838
T507044054AQ	WESY	SCR		C158D	830
T507044064AQ	WESY	SCR		C165D	838
T507044084AQ	WESY	SCR		C164D	838
T507054054AQ	WESY	SCR		C158E	830
T507054064AQ	WESY	SCR		C165E	838
T507054084AQ	WESY	SCR		C164E	838
T507064054AQ	WESY	SCR		C158M	830
T507064064AQ	WESY	SCR		C165M	838
T507064084AQ	WESY	SCR		C164M	838
T507074054AQ	WESY	SCR		C158S	830
T507074064AQ	WESY	SCR		C165S	838
T507084054AQ	WESY	SCR		C158N	830
T507084064AQ	WESY	SCR		C165N	838
T507094054AQ	WESY	SCR		C158T	830
T507104054AQ	WESY	SCR		C158P	830
T507114054AQ	WESY	SCR		C158PA	830
T507124054AQ	WESY	SCR		C158PB	830
T507**40##	WEST	SCR		C48/C49	694
T507**70##	WEST	SCR		C164/C165	838
T507**80##	WEST	SCR		C164/C165	838
T510**5007	WEST	SCR		C49	701
T510**8007	WEST	SCR		C164/C165	838
T520**1305	WEST	SCR		C350	886
T600**1304	WEST	SCR		C180X500	842
T600**1504	WEST	SCR		C180X500	842
T600**1804	WEST	SCR		C180X500	847
T607**13##	WEST	SCR		C184/C186	851
T607**15##	WEST	SCR		C184/C186	851
T620**1304	WEST	SCR		C380	912
T620**2004	WEST	SCR		C380	912
T620**3004	WEST	SCR		C380X500	917
T625**10##	WEST	SCR		C384	921
T62J**15##	WEST	SCR		C384	92
T62J**20##	WEST	SCR		C384	921
T6401B	RCA	TRIAC		SC266BX50	CF
T6401D	RCA	TRIAC		SC266DX50	CF
T6401M	RCA	TRIAC		SC266MX50	CF
T6411B	RCA	TRIAC		SC265BX50	CF
T6411D	RCA	TRIAC		SC265DX50	CF
T6411M	RCA	TRIAC		SC265MX50	CF
T6420B	RCA	TRIAC		SC265B3X50	CF
T6420D	RCA	TRIAC		SC265D3X50	CF
T6420M	RCA	TRIAC		SC265M3X50	CF
T6421B	RCA	TRIAC		SC265B3X50	CF
T6421D	RCA	TRIAC		SC265D3X50	CF
T6421M	RCA	TRIAC		SC265M3X50	CF
T6430B	RCA	TRIAC		SC265B8X50	CF
T6430D	RCA	TRIAC		SC265D8X50	CF
T6430M	RCA	TRIAC		SC265M8X50	CF
T6431B	RCA	TRIAC		SC265B8X50	CF
T6431D	RCA	TRIAC		SC265D8X50	CF
T6431M	RCA	TRIAC		SC265M8X50	CF
T6440B	RCA	TRIAC		SC265B4X50	CF
T6440D	RCA	TRIAC		SC265D4X50	CF
T6440M	RCA	TRIAC		SC265M4X50	CF
T6441B	RCA	TRIAC		SC265B4X50	CF
T6441D	RCA	TRIAC		SC265D4X50	CF
T6441M	RCA	TRIAC		SC265M4X50	CF
T6450B	RCA	TRIAC		SC265B6X50	CF
T6450D	RCA	TRIAC		SC265D6X50	CF
T6450M	RCA	TRIAC		SC265M6X50	CF
T6451B	RCA	TRIAC		SC265B6X50	CF
T6451D	RCA	TRIAC		SC265D6X50	CF
T6451M	RCA	TRIAC		SC265M6X50	CF
T720**3504	WEST	SCR		C390/C391	936
T720**4504	WEST	SCR		C390/C391	936
T720**5504	WEST	SCR		C602/C440	1005
T727**25##	WEST	SCR		C388/C392	928
T727**35##	WEST	SCR		C388/C392	928
T727**45##	WEST	SCR		C398/C394	958
T72H**25##	WEST	SCR		C398/C394	958
T72H**35##	WEST	SCR		C398/C394	958
T72H**45##	WEST	SCR		C398/C394	958
T920**0603	WEST	SCR		C440/C441	966
T920**0703	WEST	SCR		C450/C451	C
T920**0803	WEST	SCR		C450/C451	C
T920**0903	WEST	SCR		C450/C451	C
TA7554		PWR TRAN		D44C8	1147
TA7555		PWR TRAN		D44C6	1147

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
TA7556		PWR TRAN		D45C8	1163
TA7557		PWR TRAN		D45C6	1163
TA7739		PWR TRAN		D40N1	1117
TA7740		PWR TRAN		D40N3	1117
TAG2-100	TAGS	SCR		C6A	659
TAG2-200	TAGS	SCR		C6B	659
TAG2-300	TAGS	SCR		C6C	659
TAG2-400	TAGS	SCR		C6D	659
TC106A2	SES	SCR		C106A2	720
TC106A3	SES	SCR		C106A3	720
TC106A4	SES	SCR		C106A4	720
TC106B2	SES	SCR		C106B2	720
TC106B3	SES	SCR		C106B3	720
TC106B4	SES	SCR		C106B4	720
TC106C2	SES	SCR		C106C2	720
TC106C3	SES	SCR		C106C3	720
TC106C4	SES	SCR		C106C4	720
TC106D2	SES	SCR		C106D2	720
TC106D3	SES	SCR		C106D3	720
TC106D4	SES	SCR		C106D4	720
TC106F2	SES	SCR		C106F2	720
TC106F3	SES	SCR		C106F3	720
TC106F4	SES	SCR		C106F4	720
TC106Q2	SES	SCR		C106Q2	720
TC106Q3	SES	SCR		C106Q3	720
TC106Q4	SES	SCR		C106Q4	720
TC106Y2	SES	SCR		C106Y2	720
TC106Y3	SES	SCR		C106Y3	720
TC106Y4	SES	SCR		C106Y4	720
TD261	GE	TUNNEL DIO	1416		
TD261A	GE	TUNNEL DIO	1416		
TD262	GE	TUNNEL DIO	1416		
TD262A	GE	TUNNEL DIO	1416		
TD263	GE	TUNNEL DIO	1416		
TD263A	GE	TUNNEL DIO	1416		
TD263B	GE	TUNNEL DIO	1416		
TD264	GE	TUNNEL DIO	1416		
TD264A	GE	TUNNEL DIO	1416		
TD265	GE	TUNNEL DIO	1416		
TD265A	GE	TUNNEL DIO	1416		
TD266	GE	TUNNEL DIO	1416		
TD266A	GE	TUNNEL DIO	1416		
TD9	GE	TUNNEL DIO	1415		
TE105	SSCF	SCR		C203A	858
TE155	SSCF	SCR		C203G	858
TE205	SSCF	SCR		C203B	858
TE305	SSCF	SCR		C203C	858
TE35	SSCF	SCR		C203Y	858
TE405	SSCF	SCR		C203D	858
TE55	SSCF	SCR		C203YY	858
TI486		PWR TRAN		D42C8	1135
TI487		PWR TRAN		D42C8	1135
TIC106A	TI	SCR		C108A1	733
TIC106B	TI	SCR		C108B1	733
TIC106C	TI	SCR		C108C1	733
TIC106D	TI	SCR		C108D1	733
TIC106F	TI	SCR		C108F1	733
TIC106Y	TI	SCR		C108Y1	733
TIC116A	TI	SCR		C122A1X88	CF
TIC116B	TI	SCR		C122B1X88	CF
TIC116C	TI	SCR		C122C1X88	CF
TIC116D	TI	SCR		C122D1X88	CF
TIC116E	TI	SCR		C122E1X88	CF
TIC116F	TI	SCR		C122F1X88	CF
TIC116M	TI	SCR		C122M1X88	CF
TIC126A	TI	SCR		C126A	763
TIC126B	TI	SCR		C126B	763
TIC126C	TI	SCR		C126C	763
TIC126D	TI	SCR		C126D	763
TIC126E	TI	SCR		C126E	763
TIC126F	TI	SCR		C126F	763
TIC126M	TI	SCR		C126M	763
TIC226B	TI	TRIAC		SC146B	1381
TIC226D	TI	TRIAC		SC146D	1381
TIC236B	TI	TRIAC		SC149B	1381
TIC236D	TI	TRIAC		SC149D	1381
TIC246B	TI	TRIAC		SC151B	1381
TIC246D	TI	TRIAC		SC151D	1381
TIC3010	TI	SCR		C222F	862
TIC3011	TI	SCR		C222A	862
TIC3012	TI	SCR		C222B	862
TIC3013	TI	SCR		C222C	862
TIC3014	TI	SCR		C222D	862
TIC44	TI	SCR		C103Y	716
TIC45	TI	SCR		C103YY	716
TIC46	TI	SCR		C103A	716
TIC47	TI	SCR		C103B	716
TIL111	TII	OPTO COUPL		H11A4	1277
TIL112	TII	OPTO COUPL		H11A5	1279
TIL113	TII	OPTO COUPL		H11B2	1293

CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
TIL114	TII	OPTO COUPL		H11A3	1277
TIL115	TII	OPTO COUPL		H11A3	1277
TIL116	TII	OPTO COUPL		H11A3	1277
TIL117	TII	OPTO COUPL		H11A1	1275
TIL118	TII	OPTO COUPL		H11A5	1279
TIL119	TII	OPTO COUPL		H11B2	1293
TIL138	TII	OPTO COUPL		H13A1	1275
TIL31	TII	IRLED		LED55B	1359
TIL33	TII	IRLED		LED55B	1359
TIL34	TII	IRLED		LED56	1359
TIL81	TII	IRLED		L14G1	1337
TIP110		PWR TRAN		D44E2	1151
TIP111		PWR TRAN		D44E3	1151
TIP115		PWR TRAN		D45E2	1167
TIP116		PWR TRAN		D45E3	1167
TIP120		PWR TRAN		D44E2	1151
TIP121		PWR TRAN		D44E3	1151
TIP125		PWR TRAN		D45E2	1167
TIP126		PWR TRAN		D45E3	1167
TIP29		PWR TRAN		D44C4	1147
TIP29A		PWR TRAN		D44C7	1147
TIP29B		PWR TRAN		D44C10	1147
TIP30		PWR TRAN		D45C4	1163
TIP30A		PWR TRAN		D45C7	1163
TIP30B		PWR TRAN		D45C10	1163
TIP31		PWR TRAN		D44C5	1147
TIP31A		PWR TRAN		D44C8	1147
TIP31B		PWR TRAN		D44C11	1147
TIP32		PWR TRAN		D45C5	1163
TIP32A		PWR TRAN		D45C8	1163
TIP32B		PWR TRAN		D45C1	1163
TIP33		PWR TRAN		D44H4	1155
TIP33A		PWR TRAN		D44H7	1155
TIP33B		PWR TRAN		D44H10	1155
TIP34		PWR TRAN		D45H4	1171
TIP34A		PWR TRAN		D45H7	1171
TIP34B		PWR TRAN		D45H10	1171
TIP41		PWR TRAN		D44H4	1155
TIP41A		PWR TRAN		D44H7	1155
TIP41B		PWR TRAN		D44H10	1155
TIP42		PWR TRAN		D45H4	1171
TIP42A		PWR TRAN		D45H7	1171
TIP42B		PWR TRAN		D45H10	1171
TIP47		PWR TRAN		D44R1	1159
TIP48		PWR TRAN		D44R3	1159
TIS82		PWR TRAN		D40E5	1109
TIXL143	TII	OPTO COUPL		H13A1	1275
TIXL144	TII	OPTO COUPL		H13A2	1309
TIXL145	TII	OPTO COUPL		H13B1	1293
TIXL146	TII	OPTO COUPL		H13B2	1293
TN53		PWR TRAN		D40E5	1109
TN59		PWR TRAN		D40E5	1109
TN61		PWR TRAN		D40E5	1109
TN63		PWR TRAN		D40E1	1109
TN79		PWR TRAN		D40E1	1109
TRS1204		PWR TRAN		D44R1	1159
TRS1205		PWR TRAN		D44R1	1159
TRS1404		PWR TRAN		D44R1	1159
TRS1405		PWR TRAN		D44R1	1159
TRS140HP		PWR TRAN		D40N1	1117
TRS140MP		PWR TRAN		D44R1	1159
TRS1604		PWR TRAN		D44R1	1159
TRS1605		PWR TRAN		D44R1	1159
TRS160HP		PWR TRAN		D40N1	1117
TRS160MP		PWR TRAN		D44R1	1159
TRS1804		PWR TRAN		D44R1	1159
TRS1805		PWR TRAN		D44R1	1159
TRS180HP		PWR TRAN		D40N1	1117
TRS180MP		PWR TRAN		D44R1	1159
TRS2004		PWR TRAN		D44R1	1159
TRS2005		PWR TRAN		D44R1	1159
TRS2006		PWR TRAN		D44R2	1159
TRS200HP		PWR TRAN		D40N1	1117
TRS200MP		PWR TRAN		D44R1	1159
TRS2254		PWR TRAN		D44R1	1159
TRS2255		PWR TRAN		D44R2	1159
TRS225HP		PWR TRAN		D40N1	1117
TRS225MP		PWR TRAN		D44R1	1159
TRS2504		PWR TRAN		D44R1	1159
TRS2505		PWR TRAN		D44R2	1159
TRS250HP		PWR TRAN		D40N1	1117
TRS250MP		PWR TRAN		D44R1	1159
TRS2754		PWR TRAN		D44R3	1159
TRS2755		PWR TRAN		D44R3	1159
TRS275HP		PWR TRAN		D40N1	1117
TRS275MP		PWR TRAN		D44R3	1159
TRS2804S		PWR TRAN		D44R3	1159
TRS2805S		PWR TRAN		D44R3	1159
TRS3006		PWR TRAN		D44R4	1159
TRS3014		PWR TRAN		D44R3	1159

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
TRS3015		PWR TRAN		D44R3	1159
TRS301HP		PWR TRAN		D44N3	
TRS301LC		PWR TRAN		D44R3	1159
TRS301MP		PWR TRAN		D44R3	1159
TRS3204S		PWR TRAN		D44R3	1159
TRS3205S		PWR TRAN		D44R3	1159
TRS3254		PWR TRAN		D44R3	1159
TRS3255		PWR TRAN		D44R4	1159
TRS325MP		PWR TRAN		D44R3	1159
TRS3742		PWR TRAN		D44R4	1159
TRS4296		PWR TRAN		D44R2	1159
TRS4297		PWR TRAN		D44R2	1159
UP12217		PWR TRAN		D40E1	1109
UP12218		PWR TRAN		D40E1	1109
UP14046		PWR TRAN		D40E5	1109
UP14047		PWR TRAN		D40E5	1109
V1000LB160B	GE	GE-MOV	1418		
V1000LB160A	GE	GE-MOV	1418		
V1000LB80A	GE	GE-MOV	1418		
V100MA4A	GE	GE-MOV	1426		
V100MA4B	GE	GE-MOV	1426		
V100ZA15	GE	GE MOV	1438		
V100ZA3	GE	GE MOV	1438		
V120MA1A	GE	GE-MOV	1426		
V120MA2B	GE	GE-MOV	1426		
V120ZA1	GE	GE MOV	1438		
V120ZA6	GE	GE MOV	1438		
V130LA10A	GE	GE-MOV	1418		
V130LA1	GE	GE-MOV	1418		
V130LA20A	GE	GE-MOV	1418		
V130LA20B	GE	GE-MOV	1418		
V130LA2	GE	GE-MOV	1418		
V130PA10A	GE	GE-MOV	1432		
V130PA20A	GE	GE-MOV	1432		
V130PA20B	GE	GE-MOV	1432		
V130PA20C	GE	GE-MOV	1432		
V150LA10A	GE	GE-MOV	1418		
V150LA1	GE	GE-MOV	1418		
V150LA20A	GE	GE-MOV	1418		
V150LA20B	GE	GE-MOV	1418		
V150LA2	GE	GE-MOV	1418		
V150MA1A	GE	GE-MOV	1426		
V150MA2B	GE	GE-MOV	1426		
V150PA10A	GE	GE-MOV	1432		
V150PA20A	GE	GE-MOV	1432		
V150PA20B	GE	GE-MOV	1432		
V150PA20C	GE	GE-MOV	1432		
V150ZA1	GE	GE MOV	1438		
V150ZA8	GE	GE MOV	1438		
V180MA1A	GE	GE-MOV	1426		
V180MA3B	GE	GE-MOV	1426		
V180ZA10	GE	GE MOV	1438		
V180ZA1	GE	GE MOV	1438		
V220MA2A	GE	GE-MOV	1426		
V220MA4B	GE	GE-MOV	1426		
V22ZA1	GE	GE MOV	1438		
V22ZA3	GE	GE MOV	1438		
V24ZA1	GE	GE MOV	1438		
V24ZA4	GE	GE MOV	1438		
V250LA15A	GE	GE-MOV	1418		
V250LA20A	GE	GE-MOV	1418		
V250LA2	GE	GE-MOV	1418		
V250LA40A	GE	GE-MOV	1418		
V250LA40B	GE	GE-MOV	1418		
V250LA4	GE	GE-MOV	1418		
V250PA10A	GE	GE-MOV	1432		
V250PA20A	GE	GE-MOV	1432		
V250PA40A	GE	GE-MOV	1432		
V250PA40B	GE	GE-MOV	1432		
V250PA40C	GE	GE-MOV	1432		
V270MA2A	GE	GE-MOV	1426		
V270MA4B	GE	GE-MOV	1426		
V275LA15A	GE	GE-MOV	1418		
V275LA20A	GE	GE-MOV	1418		
V275LA2	GE	GE-MOV	1418		
V275LA40A	GE	GE-MOV	1418		
V275LA40B	GE	GE-MOV	1418		
V275LA4	GE	GE-MOV	1418		
V275PA10A	GE	GE-MOV	1432		
V275PA20A	GE	GE-MOV	1432		
V275PA40A	GE	GE-MOV	1432		
V275PA40B	GE	GE-MOV	1432		
V275PA40C	GE	GE-MOV	1432		
V27ZA1	GE	GE MOV	1438		
V27ZA4	GE	GE MOV	1438		
V300LA2	GE	GE-MOV	1418		
V300LA4	GE	GE-MOV	1418		
V320LA15A	GE	GE-MOV	1418		
V320LA20A	GE	GE-MOV	1418		
V320LA40A	GE	GE-MOV	1418		

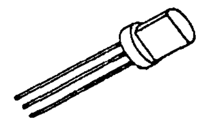
CF = CONTACT FACTORY

Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Suggested GE Replacement Page
V320LA40B	GE	GE-MOV	1418		
V320PA40A	GE	GE-MOV	1432		
V320PA40B	GE	GE-MOV	1432		
V320PA40C	GE	GE-MOV	1432		
V330MA2A	GE	GE MOV	1426		
V330MA5B	GE	GE MOV	1426		
V33MA1A	GE	GE-MOV	1426		
V33MA1B	GE	GE-MOV	1426		
V33ZA1	GE	GE MOV	1438		
V33ZA5	GE	GE MOV	1438		
V390MA3A	GE	GE MOV	1426		
V390MA6B	GE	GE MOV	1426		
V39MA2A	GE	GE-MOV	1426		
V39MA2B	GE	GE-MOV	1426		
V39ZA1	GE	GE MOV	1438		
V39ZA6	GE	GE MOV	1438		
V409		PWR TRAN		D44C5	1147
V40LA2A	GE	GE-MOV	1418		
V40LA2B	GE	GE-MOV	1418		
V420LB20A	GE	GE-MOV	1418		
V420LB40A	GE	GE-MOV	1418		
V420LB40B	GE	GE-MOV	1418		
V420PA20A	GE	GE-MOV	1432		
V420PA40A	GE	GE-MOV	1432		
V420PA40B	GE	GE-MOV	1432		
V420PA40C	GE	GE-MOV	1432		
V430MA3A	GE	GE-MOV	1426		
V430MA7B	GE	GE-MOV	1426		
V460LB20A	GE	GE-MOV	1418		
V460LB40A	GE	GE-MOV	1418		
V460LB40B	GE	GE-MOV	1418		
V460PA20A	GE	GE-MOV	1432		
V460PA40A	GE	GE-MOV	1432		
V460PA40B	GE	GE-MOV	1432		
V460PA40C	GE	GE-MOV	1432		
V47MA2A	GE	GE-MOV	1426		
V47MA2B	GE	GE-MOV	1426		
V47ZA1	GE	GE MOV	1438		
V47ZA7	GE	GE MOV	1438		
V480LB20A	GE	GE-MOV	1418		
V480LB40A	GE	GE-MOV	1418		
V480LB80A	GE	GE-MOV	1418		
V480LB80B	GE	GE-MOV	1418		
V480PA20A	GE	GE-MOV	1432		
V480PA40A	GE	GE-MOV	1432		
V480PA80A	GE	GE-MOV	1432		
V480PA80B	GE	GE-MOV	1432		
V480PA80C	GE	GE-MOV	1432		
V510LB20A	GE	GE-MOV	1418		
V510LB40A	GE	GE-MOV	1418		
V510LB80A	GE	GE-MOV	1418		
V510LB80B	GE	GE-MOV	1418		
V510PA20A	GE	GE-MOV	1432		
V510PA40A	GE	GE-MOV	1432		
V510PA80A	GE	GE-MOV	1432		
V510PA80B	GE	GE-MOV	1432		
V510PA80C	GE	GE-MOV	1432		
V550LB20A	GE	GE-MOV	1418		
V550LB40A	GE	GE-MOV	1418		
V550LB80A	GE	GE-MOV	1418		
V550LB80B	GE	GE-MOV	1418		
V550PA20A	GE	GE-MOV	1432		
V550PA40A	GE	GE-MOV	1432		
V550PA80A	GE	GE-MOV	1432		
V550PA80B	GE	GE-MOV	1432		
V550PA80C	GE	GE-MOV	1432		
V56MA2A	GE	GE-MOV	1426		
V56MA2B	GE	GE-MOV	1426		
V56ZA2	GE	GE MOV	1438		
V56ZA8	GE	GE MOV	1438		
V575LB20A	GE	GE-MOV	1418		
V575LB40A	GE	GE-MOV	1418		
V575LB80A	GE	GE-MOV	1418		
V575LB80B	GE	GE-MOV	1418		
V575PA20A	GE	GE-MOV	1432		
V575PA40A	GE	GE-MOV	1432		
V575PA80A	GE	GE-MOV	1432		
V575PA80B	GE	GE-MOV	1432		
V575PA80C	GE	GE-MOV	1432		
V60LA3A	GE	GE-MOV	1418		
V60LA3B	GE	GE-MOV	1418		
V68MA3A	GE	GE-MOV	1426		
V68MA3B	GE	GE-MOV	1426		
V68ZA10	GE	GE MOV	1438		
V68ZA2	GE	GE MOV	1438		
V82MA3A	GE	GE-MOV	1426		
V82MA3B	GE	GE-MOV	1426		
V82ZA12	GE	GE MOV	1438		
V82ZA2	GE	GE MOV	1438		
V95LA7A	GE	GE-MOV	1418		

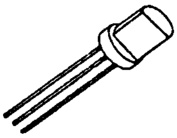
Type	Mfg.	Prod. Line	Page	Suggested GE Replacement Type	Page
V95LA7B	GE	GE-MOV	1418		
VX3375		PWR TRAN		D42C5	1135
VX3733		PWR TRAN		D44C4	1147
W2AA50C	GE	PWR MODULE	1444		
W2AA50E	GE	PWR MODULE	1444		
W2BA25C	GE	PWR MODULE	1444		
W2BA25E	GE	PWR MODULE	1444		
W2BC25C	GE	PWR MODULE	1444		
W2BC25E	GE	PWR MODULE	1444		
W2BE25C	GE	PWR MODULE	1444		
W2BE25E	GE	PWR MODULE	1444		
W2BH25C	GE	PWR MODULE	1444		
W2BH25E	GE	PWR MODULE	1444		
W2BJ25C	GE	PWR MODULE	1444		
W2BJ25E	GE	PWR MODULE	1444		
W2BK25C	GE	PWR MODULE	1444		
W2BK25E	GE	PWR MODULE	1444		
W2CA25C	GE	PWR MODULE	1444		
W2CA25E	GE	PWR MODULE	1444		
W2DA25C	GE	PWR MODULE	1444		
W2DA25E	GE	PWR MODULE	1444		
W2DC25C	GE	PWR MODULE	1444		
W2DC25E	GE	PWR MODULE	1444		
WV2AA50C	GE	PWR MODULE	1444		
WV2AA50E	GE	PWR MODULE	1444		
WV2BA25C	GE	PWR MODULE	1444		
WV2BA25E	GE	PWR MODULE	1444		
WV2BC25C	GE	PWR MODULE	1444		
WV2BC25E	GE	PWR MODULE	1444		
WV2BE25C	GE	PWR MODULE	1444		
WV2BE25E	GE	PWR MODULE	1444		
WV2BH25C	GE	PWR MODULE	1444		
WV2BH25E	GE	PWR MODULE	1444		
WV2BJ25C	GE	PWR MODULE	1444		
WV2BJ25E	GE	PWR MODULE	1444		
WV2BK25C	GE	PWR MODULE	1444		
WV2BK25E	GE	PWR MODULE	1444		
WV2CA25C	GE	PWR MODULE	1444		
WV2CA25E	GE	PWR MODULE	1444		
WV2DA25C	GE	PWR MODULE	1444		
WV2DA25E	GE	PWR MODULE	1444		
WV2DC25C	GE	PWR MODULE	1444		
WV2DC25E	GE	PWR MODULE	1444		
XB401		PWR TRAN		D40E5	1109
XB404		PWR TRAN		D44C4	1147
XB408		PWR TRAN		D44C4	1147
XB476		PWR TRAN		D44C1	1147
ZA SERIES	GE	GE-MOV	1438		
ZT1479		PWR TRAN		D40E5	1109
ZT1480		PWR TRAN		D40E7	1109
ZT1481		PWR TRAN		D40E5	1109
ZT1482		PWR TRAN		D40E7	1109
ZT1483		PWR TRAN		D44C5	1147
ZT1484		PWR TRAN		D44C8	1147
ZT1485		PWR TRAN		D44C5	1147
ZT1486		PWR TRAN		D44C8	1147
ZT1613		PWR TRAN		D40E5	1109
ZT1700		PWR TRAN		D40E5	1109
ZT1701		PWR TRAN		D44C4	1147
ZT1711		PWR TRAN		D40E7	1109
ZT2102		PWR TRAN		D40E1	1109
ZT2270		PWR TRAN		D40E5	1109
ZT2876		PWR TRAN		D42C7	1135
ZT3375		PWR TRAN		D42C5	1135
ZT3440		PWR TRAN		D44R4	1159

CF = CONTACT FACTORY

SILICON SIGNAL TRANSISTORS
GENERAL PURPOSE AMPLIFIERS
TO-98 PACKAGE



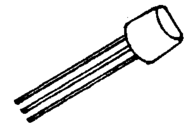
Device	Type	BV_{CEO} @ 10mA (V)	h_{FE} Min.-Max.	@ I_C, V_{CE} (V)	$V_{CE(SAT)}$ (V) Max.	@ I_C, I_B	f_T Typical (MHz)	C_{cb} @ 10V, 1 MHz Typical (Pf)	P_T @ 25°C (mW)
2N2711	NPN	18	30-90	2mA, 5	1.6	50mA, 3mA	120	7	360
2N2712	NPN	18	75-225	2mA, 5	1.6	50mA, 3mA	120	7	360
2N2713	NPN	18	30-90	2mA, 5	0.3	50mA, 3mA	120	5	360
2N2714	NPN	18	75-225	2mA, 5	0.3	50mA, 3mA	120	5	360
2N2923	NPN	25	90-180*	2mA, 10	1.6	50mA, 3mA	120	7	360
2N2924	NPN	25	150-300*	2mA, 10	1.6	50mA, 3mA	120	7	360
2N2925	NPN	25	235-470*	2mA, 10	1.6	50mA, 3mA	120	7	360
2N2926	NPN	18	35-470*	2mA, 10	1.6	50mA, 3mA	120	7	360
2N3390	NPN	25	400-800	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3391	NPN	25	250-500	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3391A	NPN	25	250-500	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3392	NPN	25	150-300	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3393	NPN	25	90-180	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3394	NPN	25	55-110	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3395	NPN	25	150-500	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3396	NPN	25	90-500	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3397	NPN	25	55-500	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3398	NPN	25	55-800	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3402	NPN	25	75-225	2mA, 5	0.3	50mA, 3mA	150	5	560
2N3403	NPN	25	180-540	2mA, 5	0.3	50mA, 3mA	150	5	560
2N3404	NPN	50	75-225	2mA, 5	0.3	50mA, 3mA	150	5	560
2N3405	NPN	50	180-540	2mA, 5	0.3	50mA, 3mA	150	5	560
2N3414	NPN	25	75-225	2mA, 5	0.3	50mA, 3mA	150	5	360
2N3415	NPN	25	180-540	2mA, 5	0.3	50mA, 3mA	150	5	360
2N3416	NPN	50	75-225	2mA, 5	0.3	50mA, 3mA	150	5	360
2N3417	NPN	50	180-540	2mA, 5	0.3	50mA, 3mA	150	5	360
2N3662	NPN	12	20-	8mA, 10	0.6	10mA, 1mA	1000	.9	200
2N3663	NPN	12	20-	8mA, 10	0.6	10mA, 1mA	1000	.9	200
2N3843	NPN	30	20-40	2mA, 5	0.2	10mA, 1mA	150	2	360
2N3843A	NPN	30	20-40	2mA, 5	0.2	10mA, 1mA	150	2	360
2N3844	NPN	30	35-70	2mA, 5	0.2	10mA, 1mA	150	2	360
2N3844A	NPN	30	35-70	2mA, 5	0.2	10mA, 1mA	150	2	360
2N3845	NPN	25	60-120	2mA, 5	0.2	10mA, 1mA	150	2	360
2N3845A	NPN	25	60-120	2mA, 5	0.2	10mA, 1mA	150	2	360
2N3854	NPN	36	35-70	2mA, 5	0.2	10mA, 1mA	200	1.7	360
2N3854A	NPN	36	35-70	2mA, 5	0.2	10mA, 1mA	200	1.7	360
2N3855	NPN	36	60-120	2mA, 5	0.2	10mA, 1mA	200	1.7	360
2N3855A	NPN	36	60-120	2mA, 5	0.2	10mA, 1mA	200	1.7	360
2N3856	NPN	36	100-200	2mA, 5	0.2	10mA, 1mA	200	1.7	360
2N3856A	NPN	36	100-200	2mA, 5	0.2	10mA, 1mA	200	1.7	360
2N3858	NPN	40	60-120	2mA, 5	0.125	10mA, 1mA	150	2	360
2N3858A	NPN	60	60-120	2mA, 5	0.125	10mA, 1mA	150	2	360
2N3859	NPN	40	100-200	2mA, 5	0.125	10mA, 1mA	150	2	360
2N3859A	NPN	60	100-200	2mA, 5	0.125	10mA, 1mA	150	2	360
2N3860	NPN	40	150-300	2mA, 5	0.125	10mA, 1mA	150	2	360
2N3877	NPN	70	20-	2mA, 5	0.125	10mA, 1.0mA	120	2	360
2N3877A	NPN	85	20-	2mA, 5	0.125	10mA, 1.0mA	120	2	360
2N3900	NPN	18	250-500	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3900A	NPN	18	250-500	2mA, 5	1.6	50mA, 3mA	120	7	360
2N3901	NPN	25	350-700	2mA, 5	1.6	50mA, 3mA	120	7	360



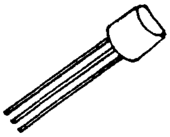
SILICON SIGNAL TRANSISTORS
GENERAL PURPOSE AMPLIFIERS
TO-98 PACKAGE

Device	Type	BV_{CEO} @ 10mA (V)	h_{FE} Min.-Max.	@ I_C, V_{CE} (V)	$V_{CE(SAT)}$ (V) Max. @	I_C, I_B	f_T Typical (MHz)	C_{cb} @ 10V 1 MHz Typical (Pf)	P_T @ 25°C (mW)
2N4256	NPN	40	100-500	2mA, 5	0.125	10mA, 1.0mA	120	2	360
2N4424	NPN	40	180-540	2mA, 5	0.3	50mA, 3mA	150	5	360
2N4425	NPN	40	180-540	2mA, 5	0.3	50mA, 3mA	150	5	360
2N5172	NPN	25	100-500	10mA, 10	0.25	10mA, 1mA	100	2	360
2N5174	NPN	75	40-600	10mA, 5	0.95	10mA, 1.0mA	120	2	360
2N5232	NPN	50	250-500	2mA, 5	0.125	10mA, 1mA	150	2	360
2N5232A	NPN	50	250-500	2mA, 5	0.125	10mA, 1mA	150	2	360
2N5249	NPN	50	400-800	2mA, 5	0.125	10mA, 1mA	150	2	360
2N5249A	NPN	50	400-800	2mA, 5	0.125	10mA, 1mA	150	2	360
2N5305	NPN	25	2K-20K	2mA, 5	1.4	200mA, 0.2mA	60	4	400
2N5306	NPN	25	7K-70K	2mA, 5	1.4	200mA, 0.2mA	60	4	400
2N5307	NPN	40	2K-20K	2mA, 5	1.4	200mA, 0.2mA	60	4	400
2N5308	NPN	40	7K-70K	2mA, 5	1.4	200mA, 0.2mA	60	4	400
2N5309	NPN	50	60-120	10μA, 5	0.125	10mA, 1mA	150	2	360
2N5310	NPN	50	100-300	10μA, 5	0.125	10mA, 1mA	150	2	360
2N5311	NPN	50	250-500	10μA, 5	0.125	10mA, 1mA	150	2	360
2N5354	PNP	25	40-120	50mA, 1	0.25	50mA, 2.5mA	200	5	360
2N5355	PNP	25	100-300	50mA, 1	0.25	50mA, 2.5mA	200	5	360
2N5356	PNP	25	250-500	50mA, 1	0.25	50mA, 2.5mA	200	5	360
2N5365	PNP	40	40-120	50mA, 1	0.25	50mA, 2.5mA	350	5	360
2N5366	PNP	40	100-300	50mA, 1	0.25	50mA, 2.5mA	350	5	360
2N5418	NPN	25	40-120	50mA, 1	0.25	50mA, 2.5mA	250	4	400
2N5419	NPN	25	100-300	50mA, 1	0.25	50mA, 2.5mA	250	4	400
2N5420	NPN	25	250-500	50mA, 1	0.25	50mA, 2.5mA	250	4	400
2N6076	PNP	25	100-500	10mA, 10	0.25	10mA, 1.0mA	300	5	360
D16G6	NPN	12	20-	8mA, 10	0.6	10mA, 1.0mA	1000	.9	200
D29E1	PNP	25	60-200	2mA, 2	0.75	500mA, 50mA	150	9.4	500
D29E2	PNP	25	150-500	2mA, 2	0.75	500mA, 50mA	165	9.4	500
D29E4	PNP	40	60-120	2mA, 2	0.75	500mA, 50mA	120	9.4	500
D29E5	PNP	40	100-200	2mA, 2	0.75	500mA, 50mA	135	9.4	500
D29E6	PNP	40	150-300	2mA, 2	0.75	500mA, 50mA	150	9.4	500
D29E9	PNP	60	60-120	2mA, 2	0.75	500mA, 50mA	120	9.4	500
D29E10	PNP	60	100-200	2mA, 2	0.75	500mA, 50mA	135	9.4	500
D33D21	NPN	25	60-200	2mA, 2	0.75	500mA, 50mA	150	9.4	625
D33D22	NPN	25	150-500	2mA, 2	0.75	500mA, 50mA	165	9.4	625
D33D24	NPN	40	60-120	2mA, 2	0.75	500mA, 50mA	120	9.4	625
D33D25	NPN	40	100-200	2mA, 1	0.75	500mA, 50mA	135	9.4	625
D33D26	NPN	40	150-300	2mA, 2	0.75	500mA, 50mA	150	9.4	625
D33D29	NPN	60	60-120	2mA, 2	0.75	500mA, 50mA	120	9.4	625
D33D30	NPN	60	100-200	2mA, 2	0.75	500mA, 50mA	135	9.4	625

SILICON SIGNAL TRANSISTORS
GENERAL PURPOSE AMPLIFIERS
TO-92 PACKAGE



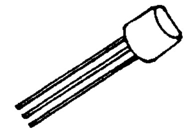
Device	Type	BV_{CEO} @ 10mA (V)	h_{FE} Min.	Max.	@ I_C(mA)	V_{CE} (V)	$V_{CE(sat)}$ Max.	@ I_C(mA)	I_B(mA)	f_T Typical (MHz)	C_{cb} @ 10V 1 MHz Typical (P_F)	I_C Continuous (mA)	P_T @ 25°C (mW)
2N3903	NPN	40	50	150	10	1	.3	50	5	300	2.5	200	350
2N3904	NPN	40	100	300	10	1	.3	50	5	350	2.5	200	350
2N3905	PNP	40	50	150	10	1	.4	50	5	250	2.5	200	350
2N3906	PNP	40	100	300	10	1	.4	50	5	300	2.5	200	350
2N4123	NPN	30	50	150	2	1	.3	50	5	300	2.5	200	350
2N4124	NPN	25	120	360	2	1	.3	50	5	350	2.5	200	350
2N4125	PNP	30	50	150	2	1	.4	50	5	250	2.5	200	350
2N4126	PNP	25	120	360	2	1	.4	50	5	300	2.5	200	350
2N4400	NPN	40	50	150	150	1	.4	150	15	225	3.5	600	350
2N4401	NPN	40	100	300	150	1	.4	150	15	275	3.5	600	350
2N4402	PNP	40	50	150	150	2	.4	150	15	300	5.0	600	350
2N4403	PNP	40	100	300	150	2	.4	150	15	350	5.0	600	350
2N4409	NPN	50	60	400	10	1	.2	1	.1	100	5.0	250	625
2N4410	NPN	80	60	400	10	1	.2	1	.1	100	5.0	250	625
2N5088	NPN	30	300	900	.1	5	.5	10	1	75	2.0	50	350
2N5089	NPN	25	400	1200	.1	5	.5	10	1	75	2.0	50	350
2N5219	NPN	15	35	500	2	10	.4	10	1	200	2.0	100	350
2N5220	NPN	15	30	600	50	10	.5	150	15	125	5.0	500	350
2N5221	PNP	15	30	600	50	10	.5	150	15	125	7.0	500	350
2N5223	NPN	20	50	800	2	10	.7	10	1	200	2.0	100	350
2N5225	NPN	25	30	600	50	10	.8	100	10	75	6.0	200	350
2N5226	PNP	25	30	600	50	10	.8	100	10	100	7.0	500	350
2N5227	PNP	30	50	700	2	10	.4	10	1	125	4.0	50	350
GES929	NPN	50	60	120	.01	5	.125	10	1	100	2.0	100	360
GES930	NPN	50	100	300	.01	5	.125	10	1	100	2.0	100	360
GES2221	NPN	30	40	120	150	10	.3	150	15	275	3.5	400	360
GES2221A	NPN	40	40	120	150	10	.3	150	15	275	3.5	400	360
GES2222	NPN	30	100	300	150	10	.3	150	15	275	3.5	400	360
GES2222A	NPN	40	100	300	150	10	.3	150	15	325	3.5	400	360
GES2483	NPN	60	75	—	.1	5	.125	10	1	100	2.0	100	360
GES2906	PNP	40	40	120	150	10	.4	150	15	225	3.0	350	360
GES2907	PNP	40	100	300	150	10	.4	150	15	225	3.0	350	360
GES5305	NPN	25	2K	20K	2	5	1.4	200	.2	50	3.5	300	400
GES5306	NPN	25	7K	70K	2	5	1.4	200	.2	50	3.5	300	400
GES5307	NPN	40	2K	20K	2	5	1.4	200	.2	50	3.5	300	400
GES5308	NPN	40	7K	70K	2	5	1.4	200	.2	50	3.5	300	400
GES5368	NPN	30	60	200	150	10	.3	150	15	200	3.5	500	360
GES5369	NPN	30	100	300	150	10	.3	150	15	200	3.5	500	360
GES5370	NPN	30	200	600	150	10	.3	150	15	200	3.5	500	360
GES5371	NPN	30	60	600	150	10	.3	150	15	200	3.5	500	360
GES5372	PNP	30	40	200	150	10	.3	150	15	200	4.0	500	360
GES5373	PNP	30	100	300	150	10	.3	150	15	200	4.0	500	360
GES5374	PNP	30	200	400	150	10	.3	150	15	200	4.0	500	360



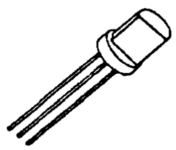
SILICON SIGNAL TRANSISTORS
GENERAL PURPOSE AMPLIFIERS
TO-92 PACKAGE

Device	Type	BV_{CEO} @ 10mA (V)	h_{FE} Min.	Max.	@ I_C(mA)	$V_{CE(sat)}$ V_{CE} (V)	Max.	@ I_C(mA)	I_B(mA)	f_T Typical (MHz)	C_{cb} @ 10V 1 MHz Typical (P_F)	I_C Continuous (mA)	P_T @ 25°C (mW)
GES5822	NPN	60	100	200	2	2	.75	500	50	150	6.0	750	500
GES5823	PNP	60	100	200	2	2	.75	500	50	150	8.0	750	500
GES5824	NPN	40	60	120	2	5	.125	10	1	100	2.0	100	360
GES5825	NPN	40	100	200	2	5	.125	10	1	100	2.0	100	360
GES5826	NPN	40	150	300	2	5	.125	10	1	100	2.0	100	360
GES5827	NPN	40	250	500	2	5	.125	10	1	100	2.0	100	360
GES5828	NPN	40	400	800	2	5	.125	10	1	10	2.0	100	360
GES6000	NPN	25	100	300	10	1	.2	100	10	150	6.0	500	400
GES6001	PNP	25	100	300	10	1	.4	100	10	250	8.0	500	400
GES6002	NPN	25	200	500	10	1	.2	100	10	170	6.0	500	400
GES6003	PNP	25	200	500	10	1	.4	100	10	250	8.0	500	400
GES6004	NPN	40	100	300	10	1	.2	100	10	150	6.0	500	400
GES6005	PNP	40	100	300	10	1	.4	100	10	250	8.0	500	400
GES6006	NPN	40	200	500	10	1	.2	100	10	170	6.0	500	400
GES6007	PNP	40	200	500	10	1	.4	100	10	250	8.0	500	400
GES6010	NPN	40	100	300	10	1	.5	500	50	125	6.0	800	500
GES6011	PNP	40	100	300	10	1	.75	500	50	100	8.0	800	500
GES6012	NPN	40	200	500	10	1	.5	500	50	150	6.0	800	500
GES6013	PNP	40	200	500	10	1	.75	500	50	125	8.0	800	500
GES6014	NPN	60	100	300	10	1	.5	500	50	125	6.0	800	500
GES6015	PNP	60	100	300	10	1	.75	500	50	100	8.0	800	500
GES6016	NPN	60	200	500	10	1	.5	500	50	150	6.0	800	500
GES6017	PNP	60	200	600	10	1	.75	500	50	125	8.0	800	500
GES6218	NPN	300	20	—	20	10	1.0	10	1	65	4.0	50	500
GES6219	NPN	350	20	—	20	10	1.0	10	1	65	4.0	50	500
GES6220	NPN	200	20	—	20	10	2.0	20	2	65	4.0	50	500
GES6221	NPN	150	20	—	20	10	2.3	20	2	65	4.0	50	500
GES6222	NPN	60	75	200	2	5	.125	10	1	100	2.0	100	360
GES6224	NPN	60	150	300	2	5	.125	10	1	100	2.0	100	360
GES5375	PNP	30	40	400	150	10	.3	150	15	200	4.0	500	360
GES5447	PNP	25	60	300	50	5	.25	50	5	150	5.0	200	360
GES5448	PNP	30	30	150	50	5	.25	50	5	150	5.0	200	360
GES5449	NPN	30	100	300	60	2	.6	100	5	100	6.0	800	360
GES5450	NPN	30	50	150	50	2	.8	100	5	100	6.0	800	360
GES5451	NPN	20	30	600	50	2	1.0	100	5	100	6.0	800	360
GES5810	NPN	25	60	200	2	2	.75	500	50	125	8.0	750	500
GES5811	PNP	25	60	200	2	2	.75	500	50	125	8.0	750	500
GES5812	NPN	25	150	500	2	2	.75	500	50	150	6.0	750	500
GES5813	PNP	25	150	500	2	2	.75	500	50	150	8.0	750	500
GES5814	NPN	40	60	160	2	2	.75	500	50	125	6.0	750	500
GES5815	PNP	40	60	160	2	2	.75	500	50	125	8.0	750	500
GES5816	NPN	40	100	200	2	2	.75	500	50	150	6.0	750	500
GES5817	PNP	40	100	200	2	2	.75	500	50	150	8.0	750	500
GES5818	NPN	40	150	300	2	2	.75	500	50	150	6.0	750	500

SILICON SIGNAL TRANSISTORS
GENERAL PURPOSE AMPLIFIERS
TO-92 PACKAGE

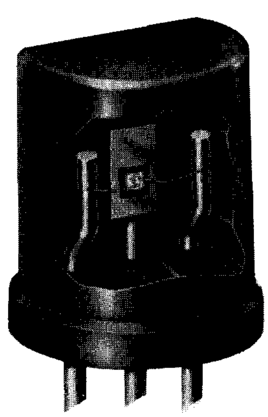


Device	Type	BV_{CEO} @ 10mA (V)	h_{FE} Min.	h_{FE} Max.	h_{FE} @ I_C(mA)	$V_{CE(sat)}$ V_{CE} (V)	$V_{CE(sat)}$ Max.	$V_{CE(sat)}$ @ I_C(mA)	$V_{CE(sat)}$ I_B(mA)	f_T Typical (MHz)	C_{cb} @ 10V 1 MHz Typical (P_F)	I_C Continuous (mA)	P_T @ 25°C (mW)
GES5819	PNP	40	150	300	2	2	.75	500	50	150	8.0	750	500
GES5820	NPN	60	60	160	2	2	.75	500	50	125	6.0	750	500
GES5821	PNP	60	60	160	2	2	.75	500	50	125	8.0	750	500
MPSA05	NPN	60	50	–	100	1	.25	100	10	100	7.0	500	625
MPSA06	NPN	80	50	–	100	1	.25	100	10	100	7.0	500	625
MPSA12	NPN	20	20,000	–	10	5	1.0	10	.01	50	4.0	500	625
MPSA13	NPN	30	10,000	–	100	5	1.5	100	.1	50	4.0	500	625
MPSA14	NPN	30	20,000	–	100	5	1.5	100	.1	50	4.0	500	625
MPSA20	NPN	40	40	400	5	10	.25	10	1	140	2.0	100	350
MPSA55	PNP	60	50	–	100	1	.25	100	10	100	11.0	500	625
MPSA56	PNP	80	50	–	100	1	.25	100	10	100	11.0	500	625
MPSA65	PNP	30	50,000	–	10	5	1.5	10	.1	100	6.0	300	625
MPSA66	PNP	30	75,000	–	10	5	1.5	10	.1	100	6.0	300	625
MPS3638	PNP	25	30	–	50	1	.25	50	2.5	125	5.0	500	350
MPS3638A	PNP	25	100	–	50	1	.25	50	2.5	175	5.0	500	350
MPS3702	PNP	25	60	300	50	5	.25	50	5	150	5.0	200	360
MPS3703	PNP	30	30	150	50	5	.25	50	5	150	5.0	200	360
MPS3704	NPN	30	100	300	50	2	.6	100	5	100	6.0	800	360
MPS3705	NPN	30	50	150	50	2	.8	100	5	100	6.0	800	360
MPS3706	NPN	20	30	600	50	2	1.0	100	5	100	6.0	800	360
MPS5172	NPN	25	100	500	10	10	.25	10	1	100	5.0	100	360
MPS6076	PNP	25	100	500	10	10	.25	10	1	100	5.0	100	360
MPS6512	NPN	30	50	100	2	10	.5	50	5	275	2.0	100	350
MPS6513	NPN	30	90	180	2	10	.5	50	5	275	2.0	100	350
MPS6514	NPN	25	150	300	2	10	.5	50	5	425	2.0	100	350
MPS6515	NPN	25	250	500	2	10	.5	50	5	425	2.0	100	350
MPS6516	PNP	40	50	100	2	10	.5	50	5	225	2.5	100	350
MPS6517	PNP	40	90	180	2	10	.5	50	5	225	2.5	100	350
MPS6518	PNP	40	150	300	2	10	.5	50	5	350	2.5	100	350
MPS6519	PNP	25	250	500	2	10	.5	50	5	350	2.5	100	350
MPS6530	NPN	40	25	–	500	10	.5	100	10	250	3.5	600	350
MPS6531	NPN	40	50	–	500	10	.3	100	10	250	3.5	600	350
MPS6532	NPN	30	30	–	100	1	.5	100	10	250	3.5	600	350
MPS6533	PNP	40	25	–	500	10	.5	100	10	350	5.0	600	350
MPS6534	PNP	40	50	–	500	10	.3	100	10	350	5.0	600	350
MPS6535	PNP	30	30	–	100	1	.5	100	10	350	5.0	600	350
MPS6565	NPN	45	40	160	10	10	.4	10	1	225	2.0	200	350
MPS6566	NPN	45	100	100	400	10	.4	10	1	225	2.0	200	350
D39C1-6	PNP	25/40	2,000	70,000		2	1.5	500	.5	90	5.0	500	500
D38H1-6	NPN	60/80	60	500	10	1	.125	100	10	100	7.0	500	500
D39J1-6	PNP	60/80	60	500	10	1	.26	100	10	80	10.0	500	500
D38L1-6	NPN	25/40	2,000	70,000	2	5	1.75	500	.5	90	5.0	500	500
D38S1-10	NPN	30/60	400	3,000	.10	5	.1	10	.5	200	2.0	100	400
D38Y1-3	NPN	200/300	30	–	20	10	1.0	40	4	100	5.0	100	500
D38W5-11	NPN	80	150	1,200	.1	5	.1	10	1	250	2.0	100	400

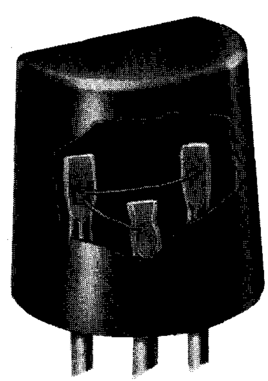


SILICON SIGNAL TRANSISTORS
COMPLEMENTARY PAIRS
TO-98 PACKAGE

DEVICE		BV_{CEO}	h_{FE}		$V_{CE(SAT)}$		COMPLEMENT
NPN	PNP	(V)	Min.-Max.	@ I_C, V_{CE} (V)	(V) Max.	@ I_C, I_B	
	2N5354	25	40-120	50mA, 1	0.25	50mA, 2.5mA	2N5418
	2N5355	25	100-300	50mA, 1	0.25	50mA, 2.5mA	2N5419
2N5418		25	40-120	50mA, 1	0.25	50mA, 2.5mA	2N5354
2N5419		25	100-300	50mA, 1	0.25	50mA, 2.5mA	2N5355
	2N6076	25	100-500	10mA, 10	0.25	10mA, 1.0mA	2N5172
	D29E1	25	60-200	2mA, 2	0.75	500mA, 50mA	D33D21
	D29E2	25	150-500	2mA, 2	0.75	500mA, 50mA	D33D22
	D29E4	40	60-120	2mA, 2	0.75	500mA, 50mA	D33D24
	D29E5	40	100-200	2mA, 2	0.75	500mA, 50mA	D33D25
	D29E6	40	150-300	2mA, 2	0.75	500mA, 50mA	D33D26
	D29E9	60	60-120	2mA, 2	0.75	500mA, 50mA	D33D29
	D29E10	60	100-200	2mA, 2	0.75	500mA, 50mA	D33D30
D33D21		25	60-200	2mA, 2	0.75	500mA, 50mA	D29E1
D33D22		25	150-500	2mA, 2	0.75	500mA, 50mA	D29E2
D33D24		40	60-120	2mA, 2	0.75	500mA, 50mA	D29E4
D33D25		40	100-200	2mA, 2	0.75	500mA, 50mA	D29E5
D33D26		40	150-300	2mA, 2	0.75	500mA, 50mA	D29E6
D33D29		60	60-120	2mA, 2	0.75	500mA, 50mA	D29E9
D33D30		60	100-200	2mA, 2	0.75	500mA, 50mA	D29E10

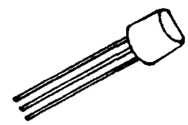


ENCAPSULATED TO-98



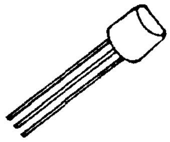
ENCAPSULATED TO-92

SILICON SIGNAL TRANSISTORS
COMPLEMENTARY PAIRS
TO-92 PACKAGE



DEVICE NPN	DEVICE PNP	BV_{CEO} (V)	h_{FE} MIN.-MAX.	h_{FE} @ I_C, V_{CE} (V)	$V_{CE(SAT)}$ (V) MAX.	$V_{CE(SAT)}$ @ I_C, I_B	COMPLEMENT
2N3903		40	50-150	10mA, 1	0.3	50mA, 5mA	2N3905
2N3904		40	100-300	10mA, 1	0.3	50mA, 5mA	2N3906
	2N3905	40	50-150	10mA, 1	0.4	50mA, 5mA	2N3903
	2N3906	40	100-300	10mA, 1	0.4	50mA, 5mA	2N3904
2N4400		40	50-150	150mA, 1	0.4	150mA, 15mA	2N4402
2N4401		40	100-300	150mA, 1	0.4	150mA, 15mA	2N4403
	2N4402	40	50-150	150mA, 2	0.4	150mA, 15mA	2N4400
	2N4403	40	100-300	150mA, 2	0.4	150mA, 15mA	2N4401
2N4123		30	50-150	2mA, 1	0.3	50mA, 5mA	2N4125
2N4124		25	120-360	2mA, 1	0.3	50mA, 5mA	2N4126
	2N4125	30	50-150	2mA, 1	0.4	50mA, 5mA	2N4123
	2N4126	25	120-360	2mA, 1	0.4	50mA, 5mA	2N4124
GES5368		30	60-200	150mA, 10	0.3	150mA, 15mA	GES5372
GES5369		30	100-300	150mA, 10	0.3	150mA, 15mA	GES5373
GES5370		30	200-600	150mA, 10	0.3	150mA, 15mA	GES5374
GES5371		30	60-600	150mA, 10	0.3	150mA, 15mA	GES5375
	GES5372	30	40-200	150mA, 10	0.3	150mA, 15mA	GES5368
	GES5373	30	100-300	150mA, 10	0.3	150mA, 15mA	GES5369
	GES5374	30	200-400	150mA, 10	0.3	150mA, 15mA	GES5370
	GES5375	30	40-400	150mA, 10	0.3	150mA, 15mA	GES5371
	GES5447	25	60-300	50mA, 5	0.25	50mA, 5mA	GES5449
	GES5448	30	30-150	50mA, 5	0.25	50mA, 5mA	GES5450
GES5449		30	100-300	50mA, 2	0.6	100mA, 5mA	GES5447
GES5450		30	50-150	50mA, 2	0.8	100mA, 5mA	GES5448
GES5451		20	30-600	50mA, 2	1.0	100mA, 5mA	GES5447
GES5810		25	60-200	2mA, 2	0.75	500mA, 50mA	GES5811
	GES5811	25	60-200	2mA, 2	0.75	500mA, 50mA	GES5810
GES5812		25	150-500	2mA, 2	0.75	500mA, 50mA	GES5813
	GES5813	25	150-500	2mA, 2	0.75	500mA, 50mA	GES5812
GES5814		40	60-160	2mA, 2	0.75	500mA, 50mA	GES5815
	GES5815	40	60-160	2mA, 2	0.75	500mA, 50mA	GES5814
GES5816		40	100-200	2mA, 2	0.75	500mA, 50mA	GES5817
	GES5817	40	100-200	2mA, 2	0.75	500mA, 50mA	GES5816
GES5818		40	150-300	2mA, 2	0.75	500mA, 50mA	GES5819
	GES5819	40	150-300	2mA, 2	0.75	500mA, 50mA	GES5818
GES5820		60	60-160	2mA, 2	0.75	500mA, 50mA	GES5821
	GES5821	60	60-160	2mA, 2	0.75	500mA, 50mA	GES5820
GES5822		60	100-200	2mA, 2	0.75	500mA, 50mA	GES5823
	GES5823	60	100-200	2mA, 2	0.75	500mA, 50mA	GES5822
GES6000		25	100-300	10mA, 1	0.2	100mA, 30mA	GES6001
	GES6001	25	100-300	10mA, 1	0.4	100mA, 10mA	GES6000
GES6002		25	200-500	10mA, 1	0.2	100mA, 10mA	GES6003
	GES6003	25	200-500	10mA, 1	0.4	100mA, 10mA	GES6002
GES6004		40	100-300	10mA, 1	0.2	100mA, 10mA	GES6005
	GES6005	40	100-300	10mA, 1	0.4	100mA, 10mA	GES6004
GES6006		40	200-500	10mA, 1	0.2	100mA, 10mA	GES6007
	GES6007	40	200-500	10mA, 1	0.4	100mA, 10mA	GES6006
GES6010		40	100-300	10mA, 1	0.5	500mA, 50mA	GES6011
	GES6011	40	100-300	10mA, 1	0.75	500mA, 50mA	GES6010
GES6012		40	200-500	10mA, 1	0.5	500mA, 50mA	GES6013
	GES6013	40	200-500	10mA, 1	0.75	500mA, 50mA	GES6012
GES6014		60	100-300	10mA, 1	0.5	500mA, 50mA	GES6015
	GES6015	60	100-300	10mA, 1	0.75	500mA, 50mA	GES6014
GES6016		60	200-500	10mA, 1	0.5	500mA, 50mA	GES6017
	GES6017	60	200-500	10mA, 1	0.75	500mA, 50mA	GES6016
GES2221		30	40-120	150, 10	0.3	150mA, 15mA	GES2906
GES2222		30	100-300	150, 10	0.3	150mA, 15mA	GES2907
	GES2906	40	40-120	150, 10	0.4	150mA, 15mA	GES2221
	GES2907	40	100-300	150, 10	0.4	150mA, 15mA	GES2222

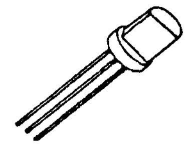
(Continued)



SILICON SIGNAL TRANSISTORS
COMPLEMENTARY PAIRS
TO-92 PACKAGE

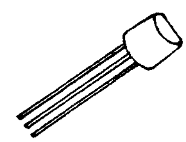
DEVICE		BV_{CEO}	h_{FE}		$V_{CE(SAT)}$		COMPLEMENT
NPN	PNP	(V)	MIN.-MAX.	@ I_C, V_{CE} (V)	(V) MAX.	@ I_C, I_B	
MPS A05		60	50-	100mA, 1	0.25	100mA, 10mA	MPS A55
MPS A06		80	50-	100mA, 1	0.25	100mA, 10mA	MPS A56
	MPS A55	60	50-	100mA, 1	0.25	100mA, 10mA	MPS A05
	MPS A56	80	50-	100mA, 1	0.25	100mA, 10mA	MPS A06
	MPS3702	25	60-300	50mA, 5	0.25	50mA, 5mA	MPS3704
	MPS3703	30	30-150	50mA, 5	0.25	50mA, 5mA	MPS3705
MPS3704		30	100-300	50mA, 2	0.6	100mA, 5mA	MPS3702
MPS3705		30	50-150	50mA, 2	0.8	100mA, 5mA	MPS3703
MPS3706		20	30-600	50mA, 2	1.0	100mA, 5mA	MPS3702
MPS6512		30	50-100	2mA, 10	0.5	50mA, 5mA	MPS6516
MPS6513		30	90-180	2mA, 10	0.5	50mA, 5mA	MPS6517
MPS6514		25	150-300	2mA, 10	0.5	50mA, 5mA	MPS6518
MPS6515		25	250-500	2mA, 10	0.5	50mA, 5mA	MPS6519
	MPS6516	40	50-100	2mA, 10	0.5	50mA, 5mA	MPS6512
	MPS6517	40	90-180	2mA, 10	0.5	50mA, 5mA	MPS6513
	MPS6518	40	150-300	2mA, 10	0.5	50mA, 5mA	MPS6514
	MPS6519	25	250-500	2mA, 10	0.5	50mA, 5mA	MPS6515
MPS6530		40	40-120	100mA, 1	0.5	100mA, 10mA	MPS6533
MPS6531		40	90-270	100mA, 1	0.3	100mA, 10mA	MPS6534
MPS6532		30	30-	100mA, 1	0.5	100mA, 10mA	MPS6535
	MPS6533	40	40-120	100mA, 1	0.5	100mA, 10mA	MPS6530
	MPS6534	40	90-270	100mA, 1	0.3	100mA, 10mA	MPS6531
	MPS6535	30	30-	100mA, 1	0.5	100mA, 10mA	MPS6532
MPS5172		25	100-500	10mA, 10	0.25	10mA, 1mA	MPS6076
	MPS6076	25	100-500	10mA, 10	0.25	10mA, 1mA	MPS5172
D38H1-3		60	60-500	10mA, 1	0.125	100mA, 10mA	D39J1-3
	D39J1-3	60	60-500	10mA, 1	0.260	100mA, 10mA	D38H1-3
D38H4-6		80	60-500	10mA, 1	0.125	100mA, 10mA	D39J4-6
	D39J4-6	80	60-500	10mA, 1	0.260	100mA, 10mA	D38H4-6
D38L1-3		40	2K-70K	2mA, 5	1.5	500mA, .5mA	D39C1-3
	D39C1-3	40	2K-70K	2mA, 5	1.75	500mA, .5mA	D38L1-3
D38L4-6		25	2K-70K	2mA, 5	1.5	500mA, .5mA	D39C4-6
	D39C4-6	25	2K-70K	2mA, 5	1.75	500mA, .5mA	D38L4-6

SILICON SIGNAL
LOW NOISE AMPLIFIERS
TO-98 PACKAGE

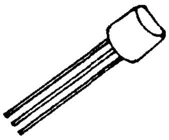


Device	Type	BV_{CEO} (V)	h_{FE} Min.-Max.	@ I_C, V_{CE} (V)	NF (db)	Conditions
2N3391A	NPN	25	250-500	2mA, 5	5.0	V_{CE} = 5V, I_C = 10μA, R_s = 5K, BW = 15.7KHz, f = 10Hz to 15.7KHz
2N3844	NPN	30	35-70	2mA, 5	10.2	V_{CE} = 10V, I_C = 1mA, R_s = 20, BW = 100KHz, f = 2MHz
2N3844A	NPN	30	35-70	2mA, 5	8.5	V_{CE} = 10V, I_C 1mA, R_s = 20, BW = 100KHz, f = 2MHz
2N3845	NPN	30	60-120	2mA, 5	10.2	V_{CE} = 10V, I_C = 1mA, R_s = 20, BW = 100KHz, f = 2MHz
2N3845A	NPN	30	60-120	2mA, 5	8.5	V_{CE} = 10V, I_C = 1mA, R_s = 20, BW = 100KHz, f = 2MHz
2N3900A	NPN	18	250-500	2mA, 5	5.0	V_{CE} = 5V, I_C = 100μA, R_s = 5K, BW = 15.7KHz, f = 10Hz to 15.7KHz
2N3901	NPN	18	350-700	2mA, 5	5.0	V_{CE} = 5V, I_C = 10μA, R_s = 5K, BW = 15.7KHz, f = 10Hz to 15.7KHz
2N5232A	NPN	50	250-500	2mA, 5	5.0	V_{CE} = 5V, I_C = 10μA, R_s = 5K, BW = 15.7KHz, f = 10Hz to 15.7KHz
2N5249A	NPN	50	400-800	2mA, 5	3.0	V_{CE} = 5V, I_C = 100μA, R_s = 5K, BW = 15.7KHz, f = 10Hz to 15.7KHz
2N5306A	NPN	25	7K-70K	2mA, 5	5.0	V_{CE} = 5V, I_C = 600μA, R_s = 160K, BW = 15.7KHz, f = 10Hz to 10KHz
2N5308A	NPN	40	7K-70K	2mA, 5	5;0	V_{CE} = 5V, I_C = 600μA, R_s = 160K, BW = 15.7KHz, f = 10Hz to 10KHz
2N5309	NPN	50	60-120	10μA, 5	4.0	V_{CE} = 5V, I_C = 20μA, R_s = 5K, BW = 15.7KHz, f = 1KHz
2N5310	NPN	50	100-300	10μA, 5	3.0	V_{CE} = 5V, I_C = 20μA, R_s = 5K, BW = 15.7KHz, f = 1KHz
2N5311	NPN	50	250-500	10μA, 5	3.0	V_{CE} = 5V, I_C = 20μA, R_s = 5K, BW = 15.7KHz, f = 1KHz

SILICON SIGNAL
LOW NOISE AMPLIFIERS
TO-92 PACKAGE



Device	Type	BV_{CEO} (V)	h_{FE} Min.-Max.	@ I_C, V_{CE} (V)	NF (db)	Conditions
GES5827A	NPN	40	250-500	2mA, 5	5	V_{CE} = 5V, I_C = 100μA, Rg = 5K, BW = 15.7KHz
GES5828A	NPN	40	400-800	2mA, 5	5	V_{CE} = 5V, I_C = 100μA, Rq = 5K, BW = 15.7KHz
GES6000	NPN	25	100-300	10mA, 1	3	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz
GES6001	PNP	25	100-300	10mA, 1	3	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz
GES6004	NPN	40	100-300	10mA, 1	3	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz
GES6005	PNP	40	100-300	10mA, 1	3	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz
GES6010	NPN	40	100-300	10mA, 1	5	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz
GES6011	PNP	40	100-300	10mA, 1	3	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz
GES6014	NPN	60	100-300	10mA, 1	5	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz
GES6015	PNP	60	100-300	10mA, 1	3	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz
GES929	NPN	50	60-120	10 μA, 5	4	V_{CE} = 5V, I_C = 10μA, Rs = 10K, BW = 15.7KHz, f = 10Hz to 10KHz
GES930	NPN	50	100-300	10 μA, 5	3	V_{CE} = 5V, I_C = 10μA, Rs = 10K, BW = 15.7KHz, f = 10Hz to 10KHz
GES5306A	NPN	25	7K-70K	2mA, 5	5	V_{CE} = 5V, I_C = 600μA, Rg = 160K, BW = 15.7KHz, f = 10Hz to 10KHz
GES5308A	NPN	10	7K-70K	2mA, 5	5	V_{CE} = 5V, I_C = 600μA, Rg = 160K, BW = 15.7KHz, f = 10Hz to 10KHz
D38S1-4	NPN	30	400-3K	100 μA, 5	Typ 1.3	V_{CE} = 5V, I_C = 100μA, Rg = 100K, F = 1KHz
D38S7	NPN	45	400-2K	100 μA, 5	Typ 1.3	V_{CE} = 5V, I_C = 100μA, Rg = 100K, F = 1KHz
D38S8-10	NPN	60	250-1.2K	100 μA, 5	Typ 1.3	V_{CE} = 5V, I_C = 100μA, Rg = 100K, F = 1KHz
D38W8-10	NPN	80	150-1.2K	100 μA, 5	2	V_{CE} = 5V, I_C = 100μA, Rg = 10K, BW = 15.7KHz, f = 10Hz to 10KHz
D38W13-14	NPN	100	150-800	100 μA, 5	2	V_{CE} = 5V, I_C = 100μA, Rg = 10K, BW = 15.7KHz, f = 10Hz to 10KHz
GES6012	NPN	40	200-500	10mA, 1	3	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz
GES6013	PNP	40	200-500	10mA, 1	2	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz
GES6016	NPN	60	200-500	10mA, 1	3	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz
GES6017	PNP	60	200-500	10mA, 1	2	V_{CE} = 5V, I_E = 100μA, Rs = 5K, BW = 15.7KHz



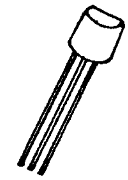
SILICON SIGNAL TRANSISTORS
SWITCHES
TO-92 PACKAGE

Device	Type	BV_{CEO}	T_{ON}	T_{OFF}	I_C (mA)	I_B (mA)	I_{B2} (T_{OFF}) (mA)	V_{CE} (V)	$V_{EB(OFF)}$ (T_{ON}) (V)
2N3903	NPN	40	70	225	10	1	1	3	0.5
2N3904	NPN	40	70	250	10	1	1	3	0.5
2N3905	PNP	40	70	260	10	1	1	3	0.5
2N3906	PNP	40	70	300	10	1	1	3	0.5
2N4400	NPN	40	35	255	150	15	15	30	2.0
2N4401	NPN	40	35	255	150	15	15	30	2.0
2N4402	PNP	40	35	255	150	15	15	30	2.0
2N4403	PNP	40	35	255	150	15	15	30	2.0
GES5368	NPN	30	40	350	150	15	15	30	–
GES5369	NPN	30	40	350	150	15	15	30	–
GES5370	NPN	30	40	400	150	15	15	30	–
GES5371	NPN	30	40	400	150	15	15	30	–
GES5372	PNP	30	50	150	150	15	15	30	–
GES5373	PNP	30	50	150	150	15	15	30	–
GES5374	PNP	30	50	175	150	15	15	30	–
GES5375	PNP	30	50	175	150	15	15	30	–
GES6000	NPN	25	20	205	150	15	15	30	–
GES6002	NPN	25	20	250	150	15	15	30	–
GES6004	NPN	40	20	180	150	15	15	30	–
GES6006	NPN	40	20	240	150	15	15	30	–
GES6001	PNP	25	20	155	150	15	15	30	–
GES6003	PNP	25	20	200	150	15	15	30	–
GES6005	PNP	40	20	155	150	15	15	30	–
GES6007	PNP	40	20	200	150	15	15	30	–
GES6010	NPN	40	40	400	150	15	15	30	–
GES6012	NPN	40	40	500	150	15	15	30	–
GES6014	NPN	60	40	400	150	15	15	30	–
GES6016	NPN	60	40	500	150	15	15	30	–
GES6011	PNP	40	40	425	150	15	15	30	–
GES6013	PNP	40	40	525	150	15	15	30	–
GES6015	PNP	60	40	425	150	15	15	30	–
GES6017	PNP	60	40	525	150	15	15	30	–
GES2221A	NPN	40	35	285	150	15	15	30	–
GES2222A	NPN	40	35	285	150	15	15	30	–
GES2906	PNP	40	50	110	150	15	15	30	–
GES2907	PNP	40	50	110	150	15	15	30	–
MPS3638	PNP	25	75	170	300	30	30	10	3.1
MPS3638A	PNP	25	75	170	300	30	30	10	3.1

SILICON SIGNAL DARLINGTON TRANSISTORS

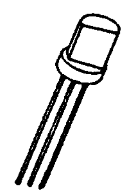
TO-92 PACKAGE

Device	Type	BV_{CEO} (V)	h_{FE} Min.-Max.	@ I_C, V_{CE} (V)	$V_{CE(SAT)}$ (V) Max.	@ I_C, I_B
GES5305	NPN	25	2K-20K	2mA, 5	1.4	200mA, 200μA
GES5306	NPN	25	7K-70K	2mA, 5	1.4	200mA, 200μA
GES5306A	NPN	25	7K-70K	2mA, 5	1.4	200mA, 200μA
GES5307	NPN	40	2K-20K	2mA, 5	1.4	200mA, 200μA
GES5308	NPN	40	7K-70K	2mA, 5	1.4	200mA, 200μA
GES5308A	NPN	40	7K-70K	2mA, 5	1.4	200mA, 200μA
D38L1-3	NPN	40	2K-70K	2mA, 5	1.5	500mA, 500μA
D39C1-3	PNP	40	2K-70K	2mA, 5	1.75	500mA, 500μA
D39C4-6	PNP	25	2K-70K	2mA, 5	1.75	500mA, 500μA



TO-98 PACKAGE

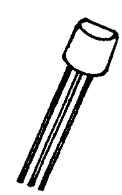
Device	Type	BV_{CEO} (V)	h_{FE} Min.-Max.	@ I_C, V_{CE} (V)	$V_{CE(SAT)}$ (V) Max.	@ I_C, I_B
2N5305	NPN	25	2K-20K	2mA, 5	1.4	200mA, 200μA
2N5306	NPN	25	7K-70K	2mA, 5	1.4	200mA, 200μA
2N5306A	NPN	25	7K-70K	2mA, 5	1.4	200mA, 200μA
2N5307	NPN	40	2K-20K	2mA, 5	1.4	200mA, 200μA
2N5308	NPN	40	7K-70K	2mA, 5	1.4	200mA, 200μA
2N5308A	NPN	40	7K-70K	2mA, 5	1.4	200mA, 200μA
D16P1	NPN	12	2K-70K	2mA, 5	1.4	200mA, 200μA



SILICON SIGNAL HIGH VOLTAGE TYPES

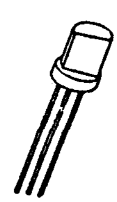
TO-92 PACKAGE

Device NPN	BV_{CEO} (V)	h_{FE} Min.-Max.	@ I_C, V_{CE} (V)	I_{CBO} Max.	@ V_{CE} (V)	$V_{CE(SAT)}$ (V) Max.	@ I_C, I_B
GES6218	300	20	20mA, 10	500nA	250	1.0	10mA, 1mA
GES6219	250	20	20mA, 10	1μA	200	1.0	10mA, 1mA
GES6220	200	20	20mA, 10	1μA	150	2.0	20mA, 2mA
GES6221	150	20	20mA, 10	10μA	100	2.3	20mA, 2mA



TO-98 PACKAGE

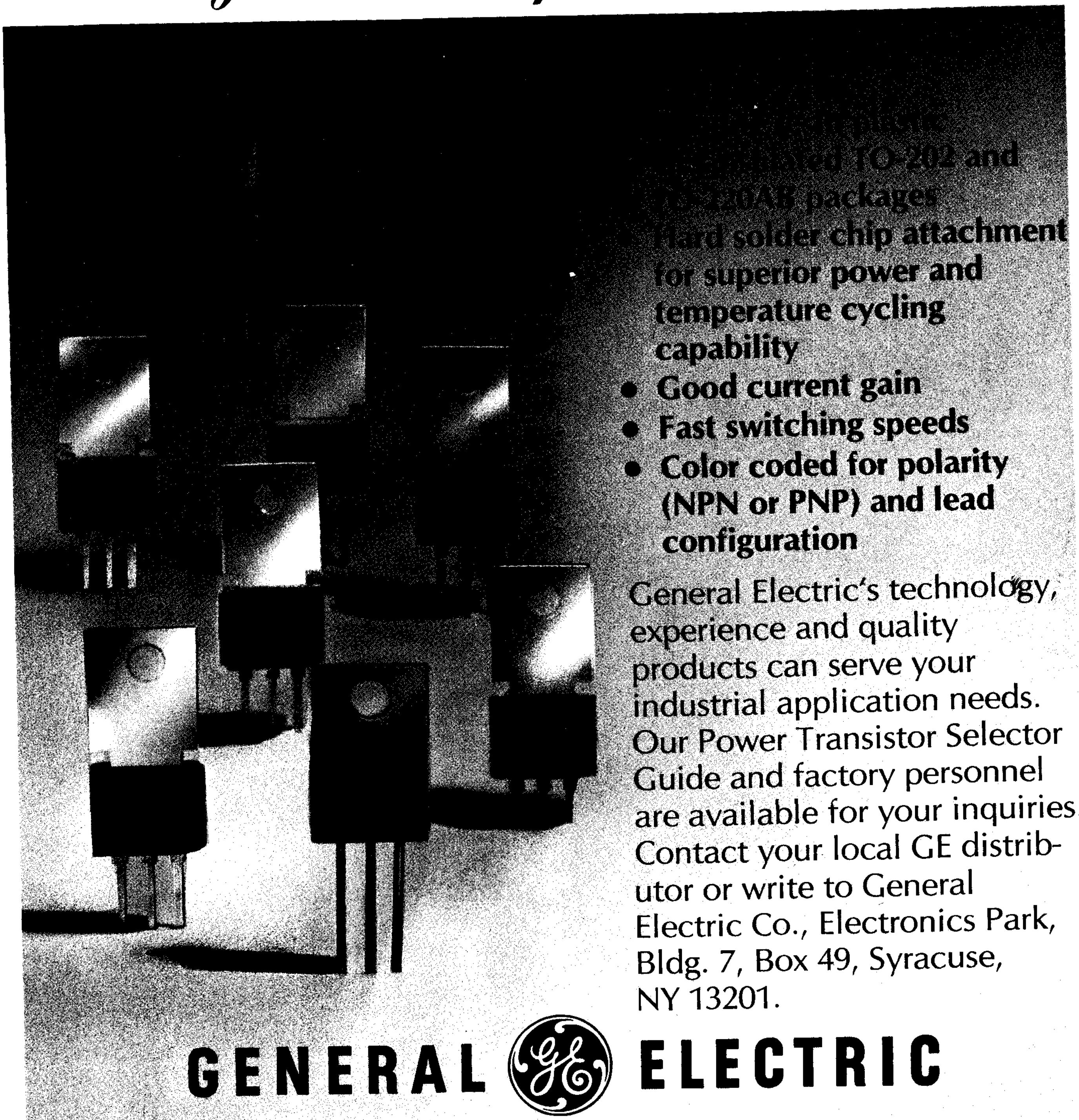
Device NPN	BV_{CEO} (V)	h_{FE} Min.-Max.	@ I_C, V_{CE} (V)	I_{CBO} Max.	@ V_{CE} (V)	$V_{CE(SAT)}$ (V) Max.	@ I_C, I_B
2N3877	70	20	2mA, 5	100nA*	40	.125	10mA, 1mA
2N3877A	85	20	2mA, 5	100nA*	40	.125	10mA, 1mA
2N5174	75	40-600	10mA, 5	500nA	60	.950	10mA, 1mA
2N5175	100	55-160	10mA, 5	500nA	60	.950	10mA, 1mA
2N5176	100	140-300	10mA, 5	500nA	60	.950	10mA, 1mA

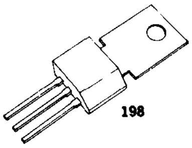


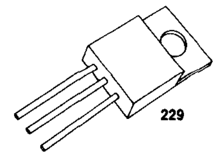
From the leader in power device technology and innovator in plastic packaging . . .

POWER TRANSISTORS

The Designer's Choice from General Electric







SILICON POWER DARLINGTON TRANSISTORS
NPN – HIGH GAIN

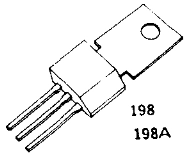
GE Type	Pt $T_C = 25°C$ Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 5V, 200mA Min.	h_{FE} @ 5V, 200mA Max.	ft Typical (MHz)	COMMENTS	Package Type	Package Outline No.
D40C1	6.25	30	.5	10,000	60,000	75	• **Very High Gain:** 60k typical. High input impedance; 50k ohm typ. 1.2 watts Pr @ 25°C ambient. • **Applications:** audio output, touch switch, oscillator, buffer, high power transistor driver, relay replacement.	BROWN Power Tab	198
D40C2	6.25	30	.5	40,000	–	75		BROWN Power Tab	198
D40C3	6.25	30	.5	90,000	–	75		BROWN Power Tab	198
D40C4	6.25	40	.5	10,000	60,000	75		BROWN Power Tab	198
D40C5	6.25	40	.5	40,000	–	75		BROWN Power Tab	198
D40C7	6.25	50	.5	10,000	60,000	75		BROWN Power Tab	198
D40C8	6.25	50	.5	40,000	–	75		BROWN Power Tab	198

SILICON POWER DARLINGTON TRANSISTORS
COMPLEMENTARY – 2 AMPERES

GE Type NPN	GE Type PNP	Pt $T_C = 25°C$ Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 5V, 200 mA Min.	h_{FE} @ 5V, 200 mA Max.	ft Typical (MHz)	COMMENTS	Package Type	Package Outline No.
D40K1	–	10	30	2	10,000	–	75	TYPICAL APPLICATIONS • Driver • Regulator • Touch Switch • IC Interface • Lamp Driver • Audio Output • Relay Substitute • Servo-Amplifier	BROWN Power Tab	198
–	D41K1	10	–30	–2	10,000	–	75		BLACK Power Tab	198
D40K2	–	10	50	2	10,000	–	75		BROWN Power Tab	198
–	D41K2	10	–50	–2	10,000	–	75		BLACK Power Tab	198
–	D41K3	10	–30	–2	10,000	–	75		BLACK Power Tab	198
–	D41K4	10	–50	–2	10,000	–	75		BLACK Power Tab	198

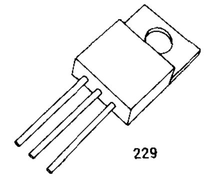
SILICON POWER DARLINGTON TRANSISTORS
COMPLEMENTARY – 10 AMPERES

GE Type NPN	GE Type PNP	Pt $T_C = 25°C$ Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 5V, 5A Min.	h_{FE} @ 5V, 5A Max.	COMMENTS	Package Type	Package Outline No.
D44E1	–	50	40	10	1000	–	TYPICAL APPLICATIONS • Relay and Solenoid Driver • Regulator • Inverter Power Supply Switch • Audio Output • Relay Substitute • Oscillator • Servo Amplifier	RED Power Pac	229
–	D45E1	50	–40	–10	1000	–		GREEN Power Pac	229
D44E2	–	50	60	10	1000	–		RED Power Pac	229
–	D45E2	50	–60	–10	1000	–		GREEN Power Pac	229
D44E3	–	50	80	10	1000	–		RED Power Pac	229
–	D45E3	50	–80	–10	1000	–		GREEN Power Pac	229



198
198A

SILICON POWER TRANSISTORS
NPN HIGH VOLTAGE



229

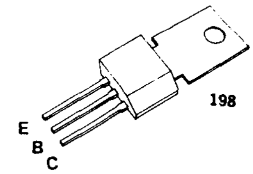
GE Type	Pt T_C = 25°C Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 10V, 20mA Min.	h_{FE} @ 10V, 20mA Max.	h_{FE} @ 10V, 500mA Min.	h_{FE} @ 10V, 500mA Max.	ft Typical (MHz)	COMMENTS	Package Type	Package Outline No.
D40N1	6.25	250	.1	30	90	–	–	80		BROWN Power Tab	198
D40N2	6.25	250	.1	60	180	–	–	80		BROWN Power Tab	198
D40N3	6.25	300	.1	30	90	–	–	80		BROWN Power Tab	198
D40N4	6.25	300	.1	60	180	–	–	80		BROWN Power Tab	198
D40N5	6.25	375	.1	20	–	–	–	80		BROWN Power Tab	198
D40P1	6.25	120	.5	40[1]	–	20[2]	–	–		BROWN Power Tab	198
D40P3	6.25	180	.5	40[1]	–	20[2]	–	–		BROWN Power Tab	198
D40P5	6.25	225	.5	40[1]	–	20[2]	–	–		BROWN Power Tab	198
D42R1	15	250	1.0	–	–	30	–	55		RED Power Tab	198A
D42R2	15	300	1.0	–	–	30	–	55		RED Power Tab	198A
D42R3	15	250	1.0	–	–	30	–	55		RED Power Tab	198A
D42R4	15	300	1.0	–	–	30	–	55		RED Power Tab	198A
D44Q1	31.25	125	4.0	30[3]	–	20[4]	–	50		RED Power Pac	229
D44Q3	31.25	175	4.0	30[3]	–	20[4]	–	50		RED Power Pac	229
D44Q5	31.25	225	4.0	30[3]	–	20[4]	–	50		RED Power Pac	229
D44R1	31.25	250	1.0	–	–	30	90	40		RED Power Pac	229
D44R2	31.25	250	1.0	–	–	75	175	40		RED Power Pac	229
D44R3	31.25	300	1.0	–	–	30	90	40		RED Power Pac	229
D44R4	31.25	300	1.0	–	–	75	175	40		RED Power Pac	229
D44R5	31.25	250	1.0	–	–	30	–	40		RED Power Pac	229
D44R6	31.25	300	1.0	–	–	30	–	40		RED Power Pac	229
D44R7	31.25	250	1.0	–	–	150	300	40		RED Power Pac	229
D44R8	31.25	300	1.0	–	–	150	300	40		RED Power Pac	229

TYPICAL APPLICATIONS
- 120V AC Line Operated Amplifiers
- Regulators
- TV Video and Chroma Output
- Inverters/Converters

FEATURES
- Glass Passivated Mesa Construction
- Fast Switching
- High Voltage

1 Measured at 80mA
2 Measured at 2mA
3 Measured at 200mA
4 Measured at 2A

SILICON POWER TRANSISTORS
COMPLEMENTARY – 1 AMPERE



GE Type NPN	GE Type PNP	Pt $T_C = 25°C$ Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 2V, 100mA Min.	h_{FE} @ 2V, 100mA Max.	h_{FE} @ 2V, 1A Min.	COMMENTS	Package Type	Package Outline No.
D40D1	–	6.25	30	1.0	50	150	10		BROWN Power Tab	198
–	D41D1	6.25	–30	–1.0	50	150	10		BLACK Power Tab	198
D40D2	–	6.25	30	1.0	120	360	20		BROWN Power Tab	198
–	D41D2	6.25	–30	–1.0	120	360	20		BLACK Power Tab	198
D40D3	–	6.25	30	1.0	290	–	10		BROWN Power Tab	198
D40D4	–	6.25	45	1.0	50	150	10		BROWN Power Tab	198
–	D41D4	6.25	–45	–1.0	50	150	10		BLACK Power Tab	198
D40D5	–	6.25	45	1.0	120	360	10		BROWN Power Tab	198
–	D41D5	6.25	–45	–1.0	120	360	10		BLACK Power Tab	198
D40D7	–	6.25	60	1.0	50	150	10		BROWN Power Tab	198
–	D41D7	6.25	–60	–1.0	50	150	10		BLACK Power Tab	198
D40D8	–	6.25	60	1.0	120	360	10		BROWN Power Tab	198
–	D41D8	6.25	–60	–1.0	120	360	10		BLACK Power Tab	198
D40D10	–	6.25	75	1.0	50	150	10		BROWN Power Tab	198
–	D41D10	6.25	–75	–1.0	50	150	10		BLACK Power Tab	198
D40D11	–	6.25	75	1.0	120	360	10		BROWN Power Tab	198
–	D41D11	6.25	–75	–1.0	120	360	10		BLACK Power Tab	198
D40D13	–	6.25	75	1.0	50	150	–		BROWN Power Tab	198
–	D41D13	6.25	–75	–1.0	50	150	–		BLACK Power Tab	198
D40D14		6.25	75	1.0	120	360	–		BROWN Power Tab	198
–	D41D14	6.25	–75	–1.0	120	360	–		BLACK Power Tab	198

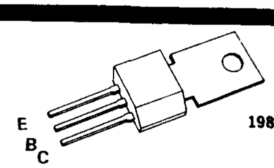
TYPICAL APPLICATIONS

- Amplifier Output and Driver Stages
- Regulators series, shunt and switching
- Inverters/Converters

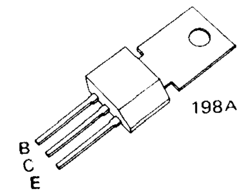
FEATURES

- High Free Air Dissipation (1.25 Watts @ 25°C)
- Low Collector Saturation Voltage (0.5V Typ. @ 1.0A)
- Excellent Linearity
- Fast Switching
- TO-5 Compatible
- Typical f_t, 150 MHz

SILICON POWER TRANSISTORS
COMPLEMENTARY – 2 AMPERES



GE Type NPN	GE Type PNP	Pt $T_C = 25°C$ Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 2V, 100Ma Min.	h_{FE} @ 2V, 100Ma Max.	h_{FE} @ 2V, 1A Min.	h_{FE} @ 2V, 1A Max.	Package Type	Outline No.
D40E1	–	8	30	2	50	–	10	–	BROWN Power Tab	198
–	D41E1	8	–30	2	50	–	10	–	BLACK Power Tab	198
D40E5	–	8	60	2	50	–	10	–	BROWN Power Tab	198
–	D41E5	8	–60	2	50	–	10	–	BLACK Power Tab	198
D40E7	–	8	80	2	50	–	10	–	BROWN Power Tab	198
–	D41E7	8	–80	2	50	–	10	–	BLACK Power Tab	198



SILICON POWER TRANSISTORS
COMPLEMENTARY – 3 AMPERES

GE Type NPN	GE Type PNP	P_T $T_C = 25°C$ Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 1V, 200mA Min.	h_{FE} @ 1V, 200mA Max.	h_{FE} @ 1V, 1A Min.	Package Type	Package Outline No.
D42C1	–	12.5	30	3.0	25	–	10	RED Power Tab	198A
–	D43C1	12.5	–30	–3.0	25	–	10	GREEN Power Tab	198A
D42C2	–	12.5	30	3.0	40	120	20	RED Power Tab	198A
–	D43C2	12.5	–30	–3.0	40	120	20	GREEN Power Tab	198A
D42C3	–	12.5	30	3.0	40	120	20[1]	RED Power Tab	198A
–	D43C3	12.5	–30	–3.0	40	120	20[1]	GREEN Power Tab	198A
D42C4	–	12.5	45	3.0	25	–	10	RED Power Tab	198A
–	D43C4	12.5	–45	–3.0	25	–	10	GREEN Power Tab	198A
D42C5	–	12.5	45	3.0	40	120	20	RED Power Tab	198A
–	D43C5	12.5	–45	–3.0	40	120	20	GREEN Power Tab	198A
D42C6	–	12.5	45	3.0	40	120	20[1]	RED Power Tab	198A
–	D43C6	12.5	–45	–3.0	40	120	20[1]	GREEN Power Tab	198A
D42C7	–	12.5	60	3.0	25	–	10	RED Power Tab	198A
–	D43C7	12.5	–60	–3.0	25	–	10	GREEN Power Tab	198A
D42C8	–	12.5	60	3.0	40	120	20	RED Power Tab	198A
–	D43C8	12.5	–60	–3.0	40	120	20	GREEN Power Tab	198A
D42C9	–	12.5	60	3.0	40	120	20[1]	RED Power Tab	198A
–	D43C9	12.5	–60	–3.0	40	120	20[1]	GREEN Power Tab	198A
D42C10	–	12.5	80	3.0	25	–	10	RED Power Tab	198A
–	D43C10	12.5	–80	–3.0	25	–	10	GREEN Power Tab	198A
D42C11	–	12.5	80	3.0	40	120	20	RED Power Tab	198A
–	D43C11	12.5	–80	–3.0	40	120	20	GREEN Power Tab	198A
D42C12	–	12.5	80	3.0	40	120	20[1]	RED Power Tab	198A
–	D43C12	12.5	–80	–3.0	40	120	20[1]	GREEN Power Tab	198A

COMMENTS

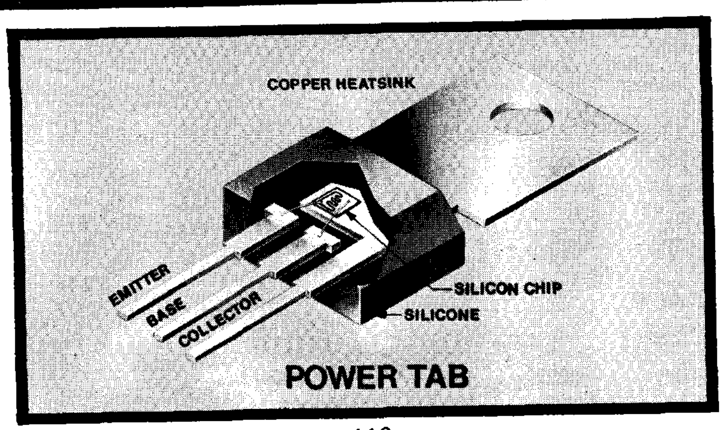
TYPICAL APPLICATIONS

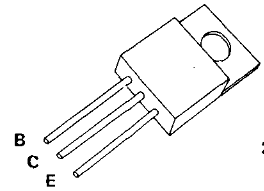
- Amplifier Output and Driver Stages
- Regulators series, shunt and switching
- Inverters/Converters

FEATURES

- High Free Air Dissipation (2.1 Watts @ 25°C)
- Very Low collector Saturation Voltage (0.2V Typ. @ 1.0A)
- Excellent Linearity
- Fast Switching
- TO-5 Compatible
- Typical f_t, 50 MHz

[1] h_{FE} measured at I_C = 2A.





229

SILICON POWER TRANSISTORS
COMPLEMENTARY – 4 AMPERES

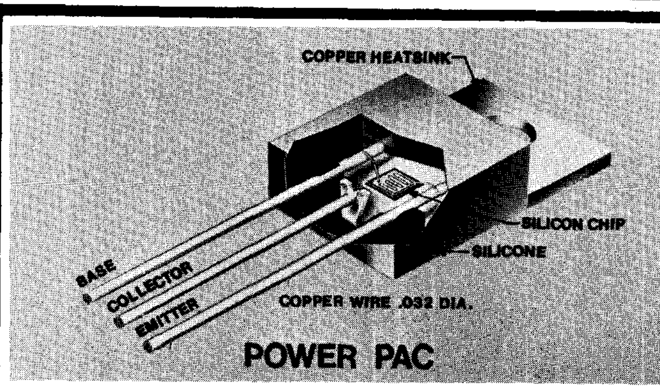
GE Type NPN	GE Type PNP	Pt $T_C = 25°C$ Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @ 1V, 200mA Min.	h_{FE} @ 1V, 200mA Max.	h_{FE} @ 1V, 1A Min.	Package Type	Package Outline No.
D44C1	–	30.0	30	4.0	25	–	10	RED Power Pac	229
–	D45C1	30.0	–30	–4.0	25	–	10	GREEN Power Pac	229
D44C2	–	30.0	30	4.0	40	120	20	RED Power Pac	229
–	D45C2	30.0	–30	–4.0	40	120	20	GREEN Power Pac	229
D44C3	–	30.0	30	4.0	40	120	20[1]	RED Power Pac	229
–	D45C3	30.0	–30	–4.0	40	120	20[1]	GREEN Power Pac	229
D44C4	–	30.0	45	4.0	25	–	10	RED Power Pac	229
–	D45C4	30.0	–45	–4.0	25	–	10	GREEN Power Pac	229
D44C5	–	30.0	45	4.0	40	120	20	RED Power Pac	229
–	D45C5	30.0	–45	–4.0	40	120	20	GREEN Power Pac	229
D44C6	–	30.0	45	4.0	40	120	20[1]	RED Power Pac	229
–	D45C6	30.0	–45	–4.0	40	120	20[1]	GREEN Power Pac	229
D44C7	–	30.0	60	4.0	25	–	10	RED Power Pac	229
–	D45C7	30.0	–60	–4.0	25	–	10	GREEN Power Pac	229
D44C8	–	30.0	60	4.0	40	120	20	RED Power Pac	229
–	D45C8	30.0	–60	–4.0	40	120	20	GREEN Power Pac	229
D44C9	–	30	60	4.0	40	120	20[1]	RED Power Pac	229
–	D45C9	30	–60	–4.0	40	120	20[1]	GREEN Power Pac	229
D44C10	–	30	80	4.0	25	–	10	RED Power Pac	229
–	D45C10	30	–80	–4.0	25	–	10	GREEN Power Pac	229
D44C11	–	30	80	4.0	40	120	20	RED Power Pac	229
–	D45C11	30	–80	–4.0	40	120	20	GREEN Power Pac	229
D44C12	–	30	80	4.0	40	120	20[1]	RED Power Pac	229
–	D45C12	30	–80	–4.0	40	120	20[1]	GREEN Power Pac	229

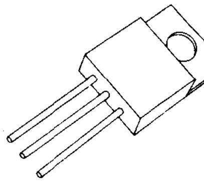
COMMENTS

TYPICAL APPLICATIONS
- Amplifier Outputs
- Regulators: series, shunt, and switching
- Inverters/Converters

FEATURES
- Low Collector Saturation Voltage (0.5V Typ. @ 3.0A Ic)
- Excellent Linearity
- Fast Switching
- Round Leads
- TO-66 Compatible
- Typical fr, 50 MHz

[1] h_{FE} measured at $I_C = 2A$




229

SILICON POWER TRANSISTORS
COMPLEMENTARY – 10 AMPERES

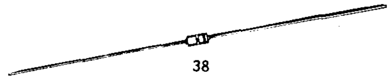
GE Type NPN	GE Type PNP	Pt T_C = 25°C Max. (W)	V_{CEO} Min. (V)	I_C Cont. (A)	h_{FE} @1V,2A Min.	h_{FE} @1V,4A Min.	COMMENTS	Package Type	Package Outline No.
D44H1	–	50	30	10	35	20		RED Power Pac	229
–	D45H1	50	–30	–10	35	20		GREEN Power Pac	229
D44H2	–	50	30	10	60	40		RED Power Pac	229
–	D45H2	50	–30	–10	60	40		GREEN Power Pac	229
D44H4	–	50	45	10	35	20		RED Power Pac	229
–	D45H4	50	–45	–10	35	20		GREEN Power Pac	229
D44H5	–	50	45	10	60	40		RED Power Pac	229
–	D45H5	50	–45	–10	60	40		GREEN Power Pac	229
D44H7	–	50	60	10	35	20		RED Power Pac	229
–	D45H7	50	–60	–10	35	20		GREEN Power Pac	229
D44H8	–	50	60	10	60	40		RED Power Pac	229
–	D45H8	50	–60	–10	60	40		GREEN Power Pac	229
–	D45H9	50	–60	–10	60	40		GREEN Power Pac	229
D44H10	–	50	80	10	35	20		RED Power Pac	229
–	D45H10	50	–80	–10	35	20		GREEN Power Pac	229
D44H11	–	50	80	10	60	40		RED Power Pac	229
–	D45H11	50	–80	–10	60	40		GREEN Power Pac	229
–	D45H12	50	–80	–10	60	40		GREEN Power Pac	229

TYPICAL APPLICATIONS
- Amplifier Outputs
- Regulators: series, shunt and switching
- Inverters/Converters

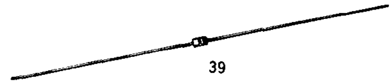
FEATURES
- Low Collector Saturation Voltage (0.24V Typ. @ 3.0A I_C)
- Excellent Linearity
- Fast Switching
- Round Leads
- TO-66 Compatible
- Typical f_T, 50 MHz

SILICON SIGNAL DIODES

100 MA TYPES



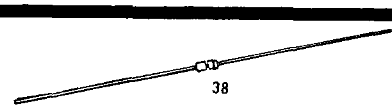
38



39

Part Number	BV @ 100μA Min. (V)	I_R @ 25°C Max. (ηA)	I_R @ 25°C Max. @ V_R (V)	V_F Max. (V)	V_F Max. @ I_F (mA)	C_O @ DV (pf)	t_{rr} (ηSEC)	Package Outline	Package Outline Number
1N914	100	25	30	1.00	10	4	4	D035	38
1N914A	100	25	20	1.00	20	4	4	D035	38
1N914B	100	25	20	1.00	100	4	4	D035	38
1N916	100	25	20	1.00	10	2	4	D035	38
1N916A	100	25	20	1.00	20	2	4	D035	38
1N916B	100	25	20	1.00	30	2	4	D035	38
1N4148*	100	25	20	1.00	10	4	4	D035	38
1N4149	100	25	20	1.00	10	2	4	D035	38
1N4151	75[1]	50	50	1.00	50	2	2	D035	38
1N4152	40	50	30	.880	20	2	2	D035	38
1N4153*	75	50	50	.880	20	2	2	D035	38
1N4154	35	100	25	1.00	30	4	2	D035	38
1N4305	75	100	50	.850	10	2	2	D035	38
1N4444	70	50	50	1.00	100	2	7	D035	38
1N4446	100	25	20	1.00	20	4	4	D035	38
1N4447	100	25	20	1.00	20	2	4	D035	38
1N4448	100	25	20	1.00	100	4	4	D035	38
1N4449	100	25	20	1.00	30	2	4	D035	38
1N4454*	75	100	50	1.00	10	2	2	D035	38
1N4531*	100	25	20	1.00	10	4	4	D034	39
1N4532	75	100	50	1.00	10	2	2	D034	39
1N4533	40	50	30	.880	20	2	2	D034	39
1N4534	75	50	50	.880	20	2	2	D034	39
1N4536	35	100	25	1.00	30	4	2	D034	39
1N4727	30	100	20	.850	10	4	4	D035	38
1N4863	70	50	50	1.20	100	2	7	D035	38
DA1701	100	30	30	1.00	50	1	4	D035	38
DA1702	75	30	30	1.00	50	1	4	D035	38
DA1703	40	50	30	1.00	50	2	4	D035	38
DA1704	25	100	20	1.00	30	3	4	D035	38
MA1701	100	30	30	1.00	50	1	4	D034	39
MA1702	75	30	30	1.00	50	1	4	D034	39
MA1703	40	50	30	1.00	50	2	4	D034	39
MA1704	25	100	20	1.00	30	3	4	D034	39
DZ800	2	2000	2	.800	10	–	–	D035	38
DZ805	15	2000	12	.80	10	–	–	D035	38
DZ806	25	2000	22	.800	10	–	–	D035	38

LOW LEAKAGE DIODES

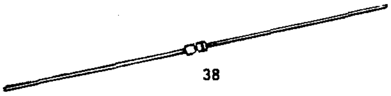


38

DE104	40	.02	20	.890	10	4	200	D035	38
DE110	40	2	30	.880	10	4	200	D035	38
DE111	40	.2	20	.880	10	4	200	D035	38
DE112	40	.1	20	1.0	50	6	200	D035	38
DE113	40	.25	20	1.0	50	6	200	D035	38
DE114	40	1	30	.880	10	4	200	D035	38
DE115	40	2	50	.880	10	4	200	D035	38

* JAN and JANTX types available

1 Measured at 5μA



38

SIGNAL DIODES

100 – 200 MA TYPES

Part Number	BV @ 100µA Min. (V)	I_R @ 25°C Max. (nA)	@ V_R(V)	V_F Max. (V)	@ I_F(mA)	Co @ 0V (pf)	t_{rr} (nsec)	Package Type	Package Outline No.
1N4150 *	50	100	50	1.00	200	2.5	4	D035	38
1N4450	30	50	30	1.00	200	4	4	D035	38
1N4606	85	100	50	1.00	200	2.5	4	D035	38

200 – 400 MA TYPES

Part Number	BV @ 100µA Min. (V)	I_R @ 25°C Max. (nA)	@ V_R(V)	V_F Max. (V)	@ I_F(mA)	Co @ 0V (pf)	t_{rr} (nsec)	Package Type	Package Outline No.
1N4451	40	50	30	1.00	300	6	10	D035	38
1N4607	85	100	50	1.00	400	4	10	D035	38
1N4608	85	100	50	.96	400	4	10	D035	38
DT230C	300	1000	300	1.20	250	5	300	D035	38
DT230H	250	1000	250	1.00	200	5	300	D035	38
DT230HI	250	1000	250	1.10	250	5	300	D035	38
DT230B	200	1000	200	1.10	250	5	300	D035	38
DT230G	150	1000	150	1.10	250	5	300	D035	38
DT230A	100	1000	100	1.10	250	5	300	D035	38
DT230F	50	1000	50	1.10	250	5	300	D035	38

* JAN and JANTX types available

MULTIPELLET SILICON SIGNAL DIODES

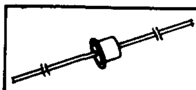
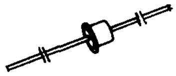
40, 41, 42

Part Number	BV @ 5µA (V)	I_R @ 25°C Max. (nA)	@ V_R(V)	V_F Max. (V)	@ I_F(mA)	Co @ 0V Max. (pf)	t_{rr} (nsec)	Package Type	Package Outline No.
1N4156	30	50	20	1.58	10	25	—	D035	42
1N4157	30	50	20	2.32	10	20	—	D035	41
1N4453	30	50	20	.800	10	30	—	D035	38
1N4828	30	100	20	.830	10	35	—	D035	38
1N4829	30 [1]	100	20	1.61	10	25	—	D035	42
1N4830	30 [1]	100	20	2.35	10	20	—	D035	41
1N5179	30	50	20	3.20	10	20	—	D035	40
MPD200	70	30	30	1.54	10	15	—	D035	42
MPD201	50	50	20	1.57	10	15	—	D035	42
MPD202	50	90	20	1.60	10	15	—	D035	42
MPD203	50	90	20	1.51	10	15	—	D035	42
STB567	50	500	20	1.61	10	15	—	D035	42
MPD300	100	30	30	2.33	10	10	—	D035	41
MPD301	60	40	20	2.32	10	10	—	D035	41
MPD302	60	90	20	2.32	10	10	—	D035	41
STB568	60	500	20	2.31	10	10	—	D035	41
MPD400	120	30	30	3.07	10	7	—	D035	40
MPD401	75	50	20	3.01	10	7	—	D035	40
MPD402	75	90	20	3.01	10	7	—	D035	40
STB569	75	500	20	3.01	10	7	—	D035	40

[1] Measured @ 100µA

TUNNEL DIODES

PACKAGES

APPLICATIONS

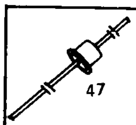
UHF Oscillator Level Detector Peak Sensing Frequency Divider Converter High Speed Logic Sampling Circuits	Detectors Mixers Limiters Compressors Power Monitors	Fast rise time pulse generators Amplitude Discriminator Sampling Circuits Fast threshold detectors Ultra High Speed Logic Level Sensing	Amplifiers and self oscillating mixers through X band Phase array radar Frequency converters Low level digital phase shifters Pulse position modulators	Doppler mixers Detectors Limiters Compressors

TYPES AVAILABLE

FREQUENCY IN GH_Z (F_{RO})					
65–40				TD400 Tunnel Diodes Microwave	BD400 Back Diodes Microwave
40–20					
20–3.4			TD 260 Tunnel Diodes Ultra High Speed Switch		
3.4–DC	1N3712 Tunnel Diodes General Purpose	BDI Back Diodes General Purpose			

FEATURES

• Low Cost • Hermetically Sealed • Electrically & *Mechanically* Rugged • Mil. Versions Available	• Low Cost • Hermetically Sealed • Electrically & *Mechanically* Rugged	• Very fast switching. • Very stable at elevated operating *temperatures.* • Low functional cost.	• Controlled negative conductance • Controlled cutoff *frequencies* • Low noise • Low package inductance • Stable at elevated operating temperatures	• Low capacitance • Low inductance • Low "on" voltage • Very high frequency capability • Low I/F noise ratio

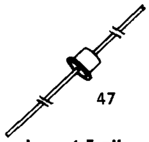


TUNNEL DIODES GENERAL PURPOSE

+100°C Operation TD-1	I_P Peak Point Current (mA)	I_V Valley Point Current Max. (mA)	C Capacitance Max. (pF)	V_P Peak Point Voltage Typ. (mV)	V_V Valley Voltage Typ. (mV)	V_{FP} Forward Peak Voltage Typ. (mV)	R_S Series Resist. Max. (Ohms)	—G Negative Conductance (mhos × 10^{-3})	f_{RO} Resistive Cutoff Frequency Typical (GHz)
1N3712	1.0 ± 10%	0.18	10	65	350	500	4.0	8 Typ.	2.3
1N3713 [1]	1.0 ± 2.5%	0.14	5	65	350	510	4.0	8.5 ± 1	3.2
1N3714	2.2 ± 10%	0.48	25	65	350	500	3.0	18 Typ.	2.2
1N3715 [1]	2.2 ± 2.5%	0.31	10	65	350	510	3.0	19 ± 3	3.0
1N3716	4.7 ± 10%	1.04	50	65	350	500	2.0	40 Typ.	1.8
1N3717 [1]	4.7 ± 2.5%	0.60	25	65	350	510	2.0	41 ± 5	3.4
1N3718	10.0 ± 10%	2.20	90	65	350	500	1.5	80 Typ.	1.6
1N3719 [1]	10.0 ± 2.5%	1.40	50	65	350	510	1.5	85 ± 10	2.8
1N3720	22.0 ± 10%	4.80	150	65	350	500	1.0	180 Typ.	1.6
1N3721 [1]	22.0 ± 2.5%	3.10	100	65	350	510	1.0	190 ± 30	2.6
TD-9	0.5 ± 10%	0.10	5	60	—	—	6.0	4.0 Typ.	1.3

[1] Mil. Versions Available.

BACK DIODES
GENFRAL PURPOSE

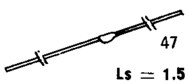


47

Ls = 1.5 nH

GE Type	I_P Peak Point Current Max. (mA)	C Total Capacitance Max. (pF)	Reverse Voltage Min. V_{R1} @ $I_R = I_P$ max (mV)	Reverse Voltage Min. V_{R2} @ 1 mA (mV)	I_{F1} Forward Current @ $V_{F1} = 90 \pm 10$ mV (mA)	V_{F2} Forward Voltage @ $I_{F2} = 3\ I_{F1}$ Typical (mV)	t_r Rise Time Typical (psec.)
BD-1	1.0	20	440	440	10.0	120	1.0
BD-2	0.5	10	420	465	5.0	130	0.7
BD-3	0.2	10	400	465	2.0	170	0.5
BD-4	0.1	10	380	465	1.0	170	0.4
BD-5	0.05	10	350	465	0.5	160	0.4
BD-6	0.02	10	330	465	0.2	160	0.4
BD-7	0.01	10	300	465	0.1	160	0.4

TUNNEL DIODES
ULTRA HIGH-SPEED SWITCHING



47

Ls = 1.5 nH

+ 100°C Operation TD-260 (1)	I_P Peak Point (mA) Current	I_V Valley Point Current Max. (mA)	C Capacitance Max. (pF)	V_P Peak Point Voltage Typical (mV)	V_V Valley Voltage Typical (mV)	V_{FP} Forward Voltage @ $I_F = I_P$ Typ. (mV)	R_S Series Resist. Typical (Ω)	t_r Rise Time Typical (psec.)
TD-261	2.2 ± 10%	0.31	3.0	70	390	500-700	5.0	430
TD-261A	2.2 ± 10%	0.31	1.0	80	390	500-700	7.0	160
TD-262	4.7 ± 10%	0.60	6.0	80	390	500-700	3.5	320
TD-262A	4.7 ± 10%	0.60	1.0	90	400	500-700	4.0	74
TD-263	10.0 ± 10%	1.40	9.0	75	400	500-700	1.7	350
TD-263A	10.0 ± 10%	1.40	5.0	80	410	520-700	2.0	190
TD-263B	10.0 ± 10%	1.40	2.0	90	420	550-700	2.5	68
TD-264	22.0 ± 10%	3.80	18.0	90	425	600 Typ.	1.8	185
TD-264A	22.0 ± 10%	3.80	4.0	100	425	550-700	2.0	64
TD-265	50.0 ± 10%	8.50	25.0	110	425	625 Typ.	1.4	100
TD-265A	50.0 ± 10%	8.50	5.0	130	425	640 Typ.	1.5	35
TD-266	100 ± 10%	17.50	35.0	150	450	650 Typ.	1.1	57
TD-266A	100 ± 10%	17.50	6.0	180	450	660 Typ.	1.2	22

BACK DIODES
MICROWAVE

49

Ls = 0.1 nH

GE Type	I_P Peak Point Current Max. (mA)	C Total Capacitance Max. (pF)	Reverse Voltage Min. V_{R1} @ $I_R = I_P$ max (mV)	Reverse Voltage Min. V_{R2} @ $I_R = 1$ mA (mV)	I_{F1} Forward Current @ $V_{F1} = 90 \pm 10$ mV (mA)	V_{F2} Forward Voltage Typical @ $I_{F2} = 3\ I_{F1}$ (mV)
BD-402	0.5	3	420	465	5.0	138
BD-403	0.2	1	400	465	2.0	170
BD-404	0.1	1	380	465	1.0	170
BD-405	0.05	1	350	465	0.5	160
BD-406	0.02	1	330	465	0.2	160
BD-407	0.01	1	330	465	0.1	160

UNIJUNCTIONS, TRIGGERS AND SWITCHES

Since the introduction of the commercial silicon unijunction transistor in 1956, General Electric has continued developing an extensive line of negative resistance threshold and four-layer switch devices. Each of these devices can be used as a power thyristor trigger, and each offers a special advantage for a particular trigger function. In addition, each can be used for various non-trigger applications.

The features—both in design and characteristics—which you receive with these products are concisely defined for each series:

TYPES

CONVENTIONAL UNIJUNCTIONS 2N489-494—proved reliability, MIL spec version.
2N2646-47—low cost, proved hermetic sealed device.

PROGRAMMABLE UNIJUNCTION TRANSISTOR (PUT)—variable threshold, low cost, fast switching speed, and circuit adjustable electrical characteristics.

COMPLEMENTARY UNIJUNCTION TRANSISTOR—ultimate in temperature stability for timing and oscillator applications.

SILICON UNILATERAL SWITCH (SUS)—a stable fixed low voltage threshold, low cost, high performance "4-layer diode."

SILICON BILATERAL SWITCH (SBS)—low voltage triac trigger, two silicon unilateral switches connected back to back.

SILICON CONTROLLED SWITCH (SCS)—high triggering sensitivity, 4-lead capability for multiple loads or dv/dt suppression.

APPLICATIONS

	Device	Unijunctions				Triggers	
		Conventional		Complementary	Programmable		
Use		2N489-94, 2N1671, 2N2160	2N2646 2N2647	D5K1 D5K2	2N6027 2N6028	SUS 2N4983-90	SBS 2N4991-93
Trigger for SCR's	DC, Lo Cost	P	F	P	E	E	E
	DC, Hi Perf.	F	F	F	E	P	F
	DC, Volt Regulator	P	P	F	F	E	E
	DC, Inverter	F	F	E	E	F	F
	DC, Hi ΔI/ΔT	P	P	P	E[1]	P	P
	AC, φ, Hi Perf.	F	F	E	E[1]	F	F
	AC, φ, Hi f	F	F	F	E	P	P
	AC, Lo RFI	P	P	F	F	E	E
	AC, φ, Lo Cost	P	F	P	E	E	E
Timers	>1 hr.	F[1]	P	F[1]	E[1]	N	N
	>1 min, Lo Cost	P	F	P	E	N	N
	>1 min, Stable	F	P	E	P	N	N
	<1 min, Lo Cost	P	F	P	E	F	F
	<1 min, Stable	F	P	E	P	F	N
	<10V	P	P	F	E	N	N
	10V-25V	E	E	E	E	F	F
	>25V	P	P	P	E	F	F
Oscillators	Stability	F	F	E	F	N	N
	Cost	P	F	P	E	N	N
	Adjust, Range	E	E	F	F[1]	N	N
Markets	Military	E	P	F	F[2]	P	P
	Hi-Rel	E	P	E	F[2]	F	F
	Economy	P	F	P	E	E	E

E = Excellent, F = Fair, P = Poor, N = Not Applicable
[1] With additional circuitry
[2] Hermetic version 2N6116-18

CONVENTIONAL UNIJUNCTIONS

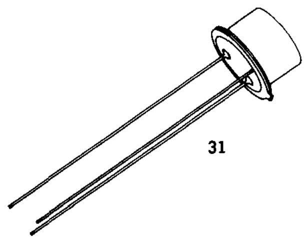
General Electric produces a very broad line of standard UJT's. The TO-5 ceramic disc bar structure device has been the workhorse of the unijunction industry for over 10 years. MIL versions are available on the 2N489-494 series.

The cube structure TO-18 series offers excellent value for those requiring proved, low cost units.

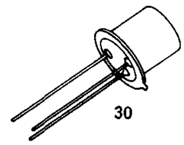
Applications

Oscillators
Timers
Sawtooth Generators

SCR Triggers
Frequency Divider
Stable Voltage Sensing



31



30

	GE Type	R_{BBO} Interbase Resistance @ V_{BB} = 3V I_E = 0 (KΩ)	η Intrinsic Standoff Ratio @ V_{BB} = 10V	I_V Valley Current Min. (mA)	I_P Peak Point Emitter Current Max. (μA)	I_{EO} Emitter Reverse Current Max. (μA)	I_{EO} T_J=25°C @ V_{B2E}	V_{OB1} Base One Peak Pulse Voltage Min. (V)	Comments	Package
TO-5 Bar Structure	2N489	4.7-6.8	.51-.62	8	12	2	60	—		31
	2N489A *				12	2	60	3		
	2N489B				6	0.2	30	3		
	2N490	6.2-9.1	.51-.62	8	12	2	60	—	"A" versions are guaranteed in recommended circuit to trigger GE SCR's over range T_A = −55°C to 125°C.	31
	2N490A *				12	2	60	3		
	2N490B				6	0.2	30	3		
	2N490C				2	.02	30	3		
	2N491	4.7-6.8	.56-.68	8	12	2	60	—		31
	2N491A *				12	2	60	3		
	2N491B				6	0.2	30	3		
	2N492	6.2-9.1	.56-.68	8	12	2	60	—	"B" versions in addition to SCR triggering guarantees lower I_{EO} and I_P for long timing periods with a smaller capacitor.	31
	2N492A *				12	2	60	3		
	2N492B				6	0.2	30	3		
	2N492C				2	.02	30	3		
	2N493	4.7-6.8	.62-.75	8	12	2	60	—		31
	2N493A *				12	2	60	3		
	2N493B				6	0.2	30	3		
	2N494	6.2-9.1	.62-.75	8	12	2	60	—		31
	2N494A *				12	2	60	3		
	2N494B				6	0.2	30	3		
	2N494C				2	.02	30	3		
	2N1671	4.7-9.1	.47-.62	8	25	12	30	—	Industrial types.	31
	2N1671A				25	12	30	3		
	2N1671B				6	0.2	30	3		
	2N1671C				2	.02	30	3		
	2N2160	4.0-12.0	.47-.80	8	25	12	30	3	General purpose—low cost.	31
TO-18 Cube Structure	2N2646	4.7-9.1	.56-.75	4	5	12	30	3	General purpose.	30
	2N2647	4.7-9.1	.68-.82	8	2	0.2	30	6	For long timing periods and triggering high current SCR's.	30
	D5J-43	4.7-9.1	.68-.82	6	2	1	30	5	General purpose.	30
	D5J-44	4.7-9.1	.68-.82	4	5	12	30	4	General purpose—low cost.	30
	2N2840	4.7-9.1 [2]	.62 Typical	.2	10	1	30	—	For 1.5 volt applications.	30

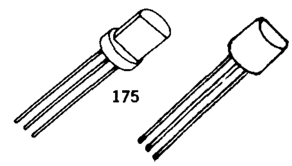
* JAN & JANTX types available
[2] V_{BB}=1.5V

PROGRAMMABLE UNIJUNCTIONS
(PUT – D13T SERIES)

The 2N6028 is specifically characterized for long interval timers and other applications requiring low leakage and low peak point current. The 2N6027 has been characterized for general use where the low peak point current of the 2N6028 is not essential.

Applications:

- SCR Trigger
- Pulse & Timing Circuits
- Oscillators
- Sensing Circuits
- Sweep Circuits

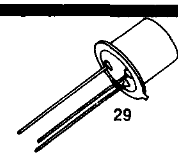


Outstanding Features of the PUT:

- Low Cost
- Low Leakage Current
- Low Peak Point Current
- Low Forward Voltage
- Fast, High Energy Trigger Pulse
- Programmable η
- Programmable R_{BB}
- Programmable I_P
- Programmable I_V
- Planar Passivated Structure

JEDEC Types	Gate to Anode Reverse Voltage Max. (V)	DC Anode Current Max. (mA)	Peak Anode Current 20 μsec. 1% D.C. Max. (A)	I_{GAO} Leakage Current @ 40V Max. (nA)	Pk. Point Current Max. @ R_G = 10 k (μA)	Pk. Point Current Max. @ R_G = 1 Meg. (μA)	I_V Valley Current Min. @ R_G = 10 k (μA)	V_O Output Voltage Min. (V)	t_r Pulse Rate of Rise Max. (nsec.)	Package
2N6027	40	150	2	10	5	2	70	6	80	175
2N6028	40	150	2	10	1	.15	25	6	80	175

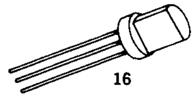
COMPLEMENTARY UNIJUNCTIONS
(D5K SERIES)



The D5K offers the ultimate in unijunction stability and uniformity. Low frequency oscillators and timers can be built using the D5K with better than 1.0% accuracy over extended temperature ranges. The D5K has characteristics like those of a standard unijunction except the currents and voltages applied to it are of opposite polarity than those of the standard devices.

GE Type	R_{BO} Interbase Resistance @ I_{B_2} = 0.1mA kΩ	η Intrinsic Standoff Ratio	I_V Valley Current Min. (mA)	I_P Peak Point Emitter Current Max. (μA)	I_{EO} Emitter Reverse Current Max. (nA)	V_O Peak Pulse Voltage Min. (V)	Operating Temp. Range Top (°C)	Frequency Stability from 25°C —55 to +150°C %	Package
D5K1	5.5-8.2	.58-.62	1	5	10	3.5	—55 to +150	1.0	29
D5K2	5-15	.58-.62	1	15	10	3.5	—55 to +100	2.0	29

SILICON UNILATERAL AND BILATERAL SWITCHES
(SUS, SBS)



16

262

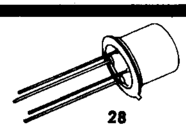
The General Electric SUS is a silicon, planar monolithic integrated circuit having thyristor electrical characteristics closely approximating those of an "ideal" four-layer diode. The device is designed to switch at 8 volts with a typical temperature coefficient of 0.02%/°C. A gate lead is provided to eliminate rate effect, obtain triggering at lower voltages, and to obtain transient-free waveforms.

The SBS is a bilateral version of the forward characteristics of the SUS. It provides excellently matched characteristics in both directions with the same low temperature coefficient.

	GE Type	V_{ACR} Reverse Voltage Max. (V)	I_F Continuous Forward Current Max. (mA)	I_F Peak Recurrent Forward Current @ 100°C, 10 μs, 1% duty cycle (A)	P_T Dissipation (mW)	T_C Temperature Coefficient of Switching Voltage (%/°C)	V_S Switching Voltage Min. (V)	V_S Switching Voltage Max. (V)	I_S Switching Current Max. (μA)	I_B Forward Blocking Current @ 5V (μA)	V_F Forward Voltage @ 200mA (V)	I_H Holding Current (mA)	V_O Peak Pulse Voltage Min. (V)	Package
Unilateral	2N4987	30	175	1.0	300	—	6	10	500	1.0	1.5	1.5	3.5	16
	2N4988	30	200	1.0	350	±.05	7.5	9	150	0.1	1.5	.5	3.5	
	2N4989	30	200	1.0	350	±.02	7.5	8.2	300	0.01	1.5	1.0	3.5	H
	2N4990	30	175	1.0	300	—	7	9	200	0.1	1.5	.75	3.5	
	2N4983	30	175	1.0	300	—	6	10	500	1.0	1.5	1.5	3.5	G
	2N4984	30	200	1.0	350	±.05	7.5	9	150	0.1	1.5	.5	3.5	
	2N4985	30	200	1.0	350	±.02	7.5	8.2	300	0.01	1.5	1.0	3.5	262
	2N4986	30	175	1.0	300	—	7	9	200	0.1	1.5	.75	3.5	
Bilateral	2N4991	—	175	1.0	300	—	6	10	500	1.0	1.7	1.5	3.5	16
	2N4992	—	200	1.0	350	±.05	7.5	9	120	0.1	1.7	.5	3.5	
	2N4993	—	175	1.0	300	—	6	10	500	1.0	1.7	1.5	3.5	262

SILICON CONTROL SWITCHES
(SCS)

High triggering sensitivity. 4 lead capability for multiple load or dv/dt suppression.



28

GE Type	V_{AK} Anode Voltage Blocking (V)	I_F Continuous DC Forward Current (mA)	Peak Recurrent Forward Current @ 100μsec (A)	Cathode Gate Peak Current (mA)	P_T (mW)	Cutoff Characteristics: I_B @ V_{AK} R_{GK}=10KΩ 150°C (μA)	Conducting Characteristics: I_H R_{GK}=10KΩ (mA)	Max. Gate Ratings: V_{GK} I_{GK}=20μA (V)	Max. Gate Ratings: V_{GA} I_{GA}=1μA (V)	Gate triggering Characteristics: I_{GTK} @ V_{AK}=40V, R_L=800Ω, R_{GA}=∞ (μA)	Gate triggering Characteristics: V_{GTK} @ V_{AK}=40V, R_L=800Ω, R_{GA}=∞ (V)	Gate triggering Characteristics: I_{GTA} @ V_{AK}=40V, R_L=800Ω, R_{GK}=10K (mA)	Gate triggering Characteristics: V_{GTA} @ V_{AK}=40V, R_L=800Ω, R_{GK}=10K (V)	Package
3N81	65	200	1.0	500	400	20	1.5	5	65	1.0	.4 to .65	1.5	—.4 to —.8	28
3N82	100	200	1.0	500	400	20	1.5	5	100	1.0	.4 to .65	1.5	—.4 to —.8	28
3N83	70	50	0.1	50	200	20 *	4.0 †	5	70	150 †	.4 to .80	—	—	28
3N84	40	175	0.5	100	320	20 *	2.0	5	40	10	.4 to .65	—	—	28
3N85	100	175	0.5	100	320	20 *	2.0	5	100	10	.4 to .65	—	—	28
3N86	65	200	1.0	500	400	20	0.2	5	65	1.0	.4 to .65	0.1	—.4 to —.8	28

* Measured @125°C. † Measured in special test circuit (See specification sheet).

ADDITIONAL REFERENCE PUBLICATIONS
ORDER BY PUBLICATION NUMBER

90.10 The Unijunction Transistor Characteristics and Applications
90.12 Unijunction Temperature Compensation
90.19 Unijunction Frequency Divider
90.70 The D13T—A Programmable Unijunction Transistor
90.72 Complementary Unijunction Transistors

... Electric
New Opt... Manual

... any authorized ... Electronic ... or by sending ... to General ... Products ... Park, Bldg. 7-49, ... 13201

- Theory
- System ...
- Reliability
- Measurements
- Circuits
- Symbols & Terms
- Specifications

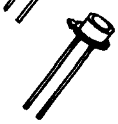
In Europe send ... to ETC, County ... Dundalk, Republic of Ireland.

GENERAL ELECTRIC

OPTOELECTRONICS

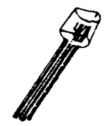
INFRARED EMITTERS

GE TYPE	PAGE NO.	MIN. P_O @ I_F=100mA	MAX. V_F @ I_F=100mA	PEAK EMISSION WAVELENGTH TYP. n. METERS	RISE TIME TYP. n. SEC.	FALL TIME TYP. n. SEC.	MAX. P_D mW	MAX. I_F CONT. mA
LED55C	1341	5.4mW	1.7V	940	300	200	1300	100
LED55B	1341	3.5mW	1.7V	940	300	200	1300	100
LED56	1341	1.5mW	1.7V	940	300	200	1300	100
LED55CF	1341	5.4mW	1.7V	940	300	200	1300	100
LED55BF	1341	3.5mW	1.7V	940	300	200	1300	100
LED56F	1341	1.5mW	1.7V	940	300	200	1300	100

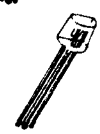
DETECTORS

PHOTO TRANSISTORS

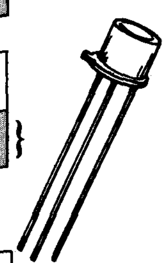
GE TYPE	PAGE NO.	SENSITIVITY (ma/mw/cm²) MIN.	SENSITIVITY (ma/mw/cm²) MAX.	BV_{CEO} (V)	BV_{BCO} (V)	I_D (nA) MAX.	SWITCHING TYP. t_r (μSEC.)	SWITCHING TYP. t_f (μSEC.)	TYP. $V_{CE(SAT)}$
L14G1	1337	.6	–	45	45	100	5	5	.4
L14G2	1337	.3	–	45	45	100	5	5	.4
L14G3	1337	1.2	–	45	45	100	5	5	.4
L14H1	1339	.05	–	60	60	100	5	5	.4
L14H2	1339	.2	–	30	30	100	5	5	.4
L14H3	1339	.2	–	60	60	100	5	5	.4
L14H4	1339	.05	–	30	30	100	5	5	.4

PHOTO DARLINGTONS

GE TYPE	PAGE NO.	SENSITIVITY MIN.	SENSITIVITY MAX.	BV_{CEO} (V)	BV_{BCO} (V)	I_D (nA) MAX.	t_r (μSEC.)	t_f (μSEC.)	TYP. $V_{CE(SAT)}$
2N5777	508	.25	–	25	25	100	75	50	.8
2N5778	508	.25	–	40	40	100	75	50	.8
2N5779	508	1.0	–	25	25	100	75	50	.8
2N5780	508	1.0	–	40	40	100	75	50	.8
L14F1	1335	15.0	–	25	25	100	75	50	.8
L14F2	1335	5.0	–	25	25	100	75	50	.8

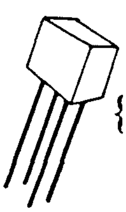
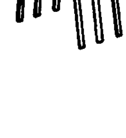
PHOTO SWITCHES



GE TYPE	PAGE NO.	IRRADIANCE TO TRIGGER (mw/cm²)		BLOCKING VOLTAGE	I_D (nA) MAX.	Vr (V)
L8	1329	–	10	25-200	10μA	1.4
L9	1329	–	4.2	25-200	10μA	1.4

OPTO COUPLERS

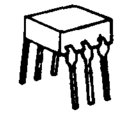
PHOTO TRANSISTOR OUTPUT

GE TYPE	PAGE NO.	ISOLATION VOLTAGE (V_{pk}) MIN.	CURRENT TRANSFER RATIO MIN.	I_D (nA) MAX.	BV_{CEO} (VOLTS) MIN.	TYPICAL (μSEC.) T_R	TYPICAL (μSEC.) T_F	$V_{CE(SAT)}$ MAX.
H11A1	1275	2500	50%	50	30	2	2	.4
H11A2	1275	1500	20%	50	30	2	2	.4
H11A3	1277	2500	20%	50	30	2	2	.4
H11A4	1277	1500	10%	50	30	2	2	.4
H11A5	1279	1500	30%	100	30	2	2	.4
H11A520	1285	5656	20%	50	30	2	2	.4
H11A550	1285	5656	50%	50	30	2	2	.4
H11A5100	1285	5656	100%	50	30	2	2	.4
H15A1	1313	4000 V_{RMS}	20%	100	30	3	3	.4
H15A2	1313	4000 V_{RMS}	10%	100	30	3	3	.4
4N25	531	2500	20%	50	30	3	3	.5
4N25A	531	1775 V_{RMS}	20%	50	30	3	3	.5
4N26	531	1500	20%	50	30	3	3	.5
4N27	531	1500	10%	50	30	3	3	.5
4N28	531	500	10%	50	30	3	3	.5
4N35	525	2500 V_{RMS}	100%	50	30	5	5	.3
4N36	525	1750 V_{RMS}	100%	50	30	5	5	.3
4N37	525	1050 V_{RMS}	100%	50	30	5	5	.3
H74A1	1327	1500		100	15			

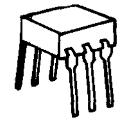
PROGRAMMABLE THRESHOLD COUPLER

GE TYPE	PAGE NO.	ISOLATION VOLTAGE (V_{pk}) MIN.	CURRENT TRANSFER RATIO MIN.	I_D (nA) MAX.	BV_{CEO} (VOLTS) MIN.	TYPICAL (µSEC.)		$V_{CE(SAT)}$ MAX.
						T_R	T_F	
H11A10	1281	1500	10%	50	30	2	2	.4



AC INPUT COUPLER

GE TYPE	PAGE NO.	ISOLATION VOLTAGE (V_{pk}) MIN.	CURRENT TRANSFER RATIO MIN.	I_D (nA) MAX.	BV_{CEO} (VOLTS) MIN.	T_R	T_F	$V_{CE(SAT)}$ MAX.
H11AA1	1289	1500	20%	100	30	2	2	.4
H11AA2	1289	1500	10%	200	30	2	2	.4



HIGH VOLTAGE COUPLER

GE TYPE	PAGE NO.	ISOLATION VOLTAGE (V_{pk}) MIN.	CURRENT TRANSFER RATIO MIN.	I_D (nA) MAX.	BV_{CEO} (VOLTS) MIN.	T_R	T_F	$V_{CE(SAT)}$ MAX.
H11D1	1307	2500	20%	100	300	5	5	.4
H11D2	1307	1500	20%	100	300	5	5	.4
H11D3	1307	1500	20%	100	200	5	5	.4
H11D4	1307	1500	10%	100	200	5	5	.4
4N38	539	1500	10%	50	80	5	5	1.0
4N38A	539	1775 V_{RMS}	10%	50	80	5	5	1.0

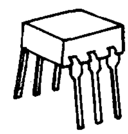
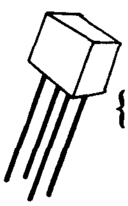
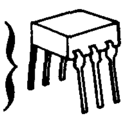


PHOTO DARLINGTON OUTPUT



GE TYPE	PAGE NO.	ISOLATION VOLTAGE (V_{pk}) MIN.	CURRENT TRANSFER RATIO MIN.	I_D (nA) MAX.	BV_{CEO} (VOLTS) MIN.	T_R	T_F	$V_{CE(SAT)}$ MAX.
H11B1	1293	2500	500%	100	25	125	100	1.0
H11B2	1293	1500	200%	100	25	125	100	1.0
H11B3	1293	1500	100%	100	25	125	100	1.0
H11B255	1295	1500	100%	100	55	125	100	1.0
H15B1	1315	4000 V_{RMS}	400%	100	25	125	100	1.4
H15B2	1315	4000 V_{RMS}	200%	100	25	125	100	1.4
4N29	533	2500	100%	100	30	5	40	1.0
4N29A	533	1775 V_{RMS}	100%	100	30	5	40	1.0
4N30	533	1500	100%	100	30	5	40	1.0
4N31	533	1500	50%	100	30	5	40	1.2
4N32	533	2500	500%	100	30	5	100	1.0
4N32A	533	1775 V_{RMS}	500%	100	30	5	100	1.0
4N33	533	1500	500%	100	30	5	100	1.0



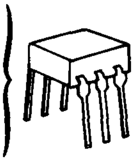
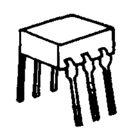


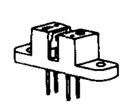
PHOTO SCR OUTPUT

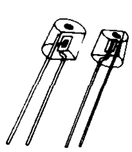
GE TYPE	PAGE NO.	ISOLATION VOLTAGE MIN.	I_F TRIGGER (MAX.)	I_D 100°C (MAX.) µA	BLOCKING VOLTAGE (MIN.)	TYPICAL TON (µSEC.)	V_F (MAX.)
H11C1	1299	2500	20mA	50	200	1	1.5
H11C2	1299	1500	20mA	50	200	1	1.5
H11C3	1299	1500	30mA	50	200	1	1.5
H11C4	1303	2500	20mA	100	400	1	1.5
H11C5	1303	1500	20mA	100	400	1	1.5
H11C6	1303	1500	30mA	100	400	1	1.5
4N39	541	1500	14mA	50	200	1	1.5
4N40	541	1500	14mA	150	400	1	1.5
H74C1	1327	1500			200		
H74C2	1327	1500			400		



PHOTON COUPLED INTERRUPTER MODULE

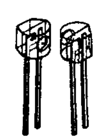
GE TYPE	PAGE NO.	OUTPUT CURRENT		I_D (nA)	BV_{ECO} (V)	TYPICAL		$V_{CE(SAT)}$ MAX.
						TON (µSEC.)	t_f (µSEC.)	
H13A1	1309	I_F = 20mA	200µA	100	30	5	5	.4
H13A2	1309	I_F = 20mA	50µA	100	30	5	5	.4
H13B1	1311	I_F = 20mA	2500µA	100	25	150	150	1.2
H13B2	1311	I_F = 20mA	1000µA	100	25	150	150	1.2



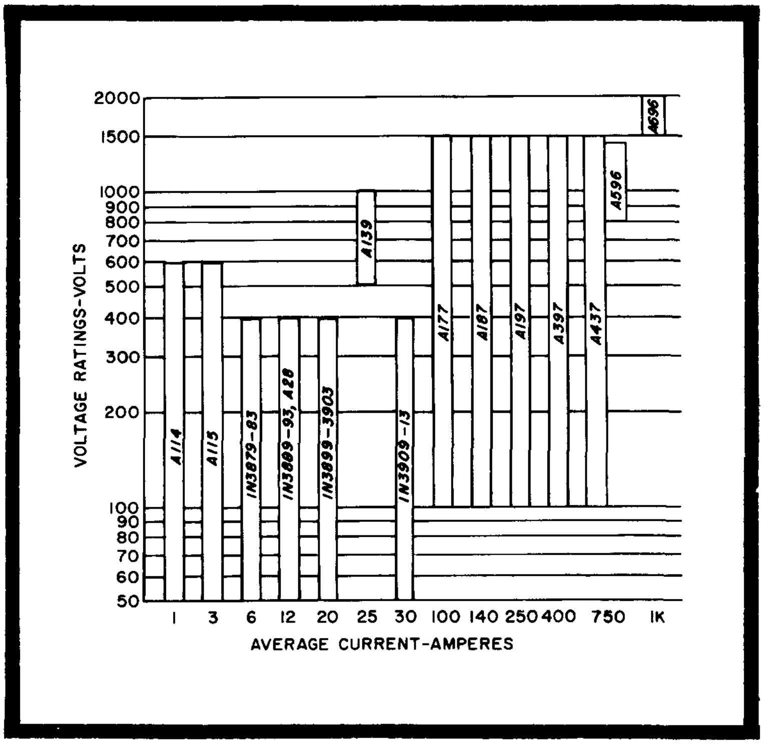


MATCHED EMITTER DETECTOR PAIRS

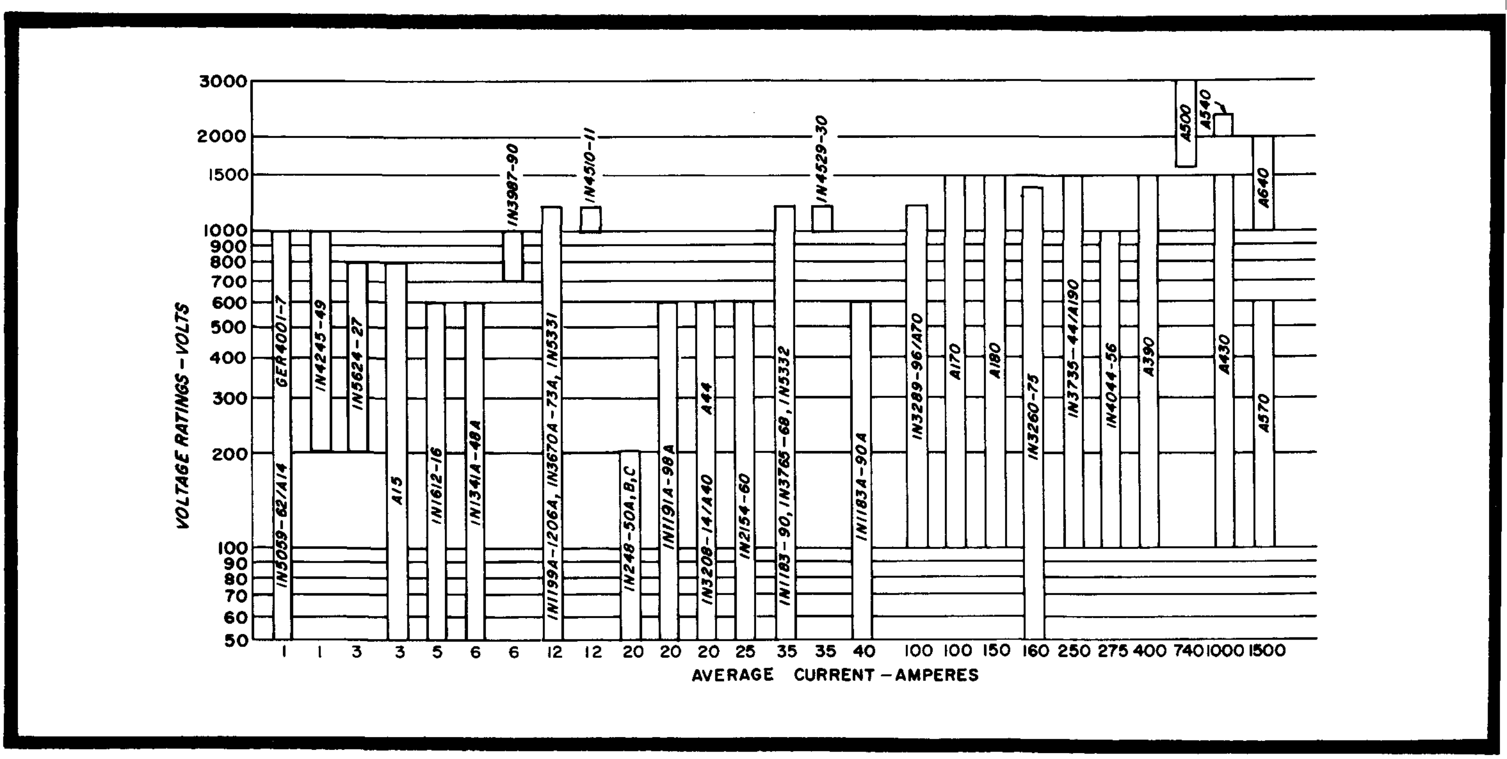
GE TYPE	PAGE NO.	OUTPUT CURRENT		I_D (nA)	BV_{ECO} (V)	TON (µSEC.)	t_f (µSEC.)	$V_{CE(SAT)}$ MAX.
H17A1	1317	I_F = 20mA	50µA	100	30	5	5	.4
H17B1	1319	I_F = 20mA	1000µA	100	25	150	150	1.2
H19A1	1321	I_F = 20mA	100µA	100	30	5	5	.4
H19B1	1325	I_F = 20mA	2000µA	100	25	150	150	1.2



FAST RECOVERY RECTIFIERS SELECTOR GUIDE



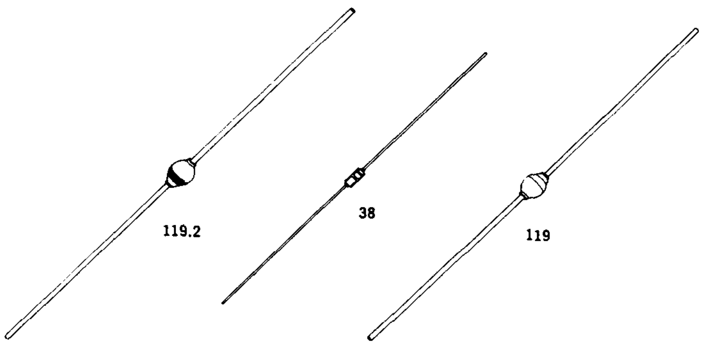
STANDARD RECTIFIERS SELECTOR GUIDE



RECTIFIERS

THE INDUSTRY'S BROADEST LINE OF POWER RECTIFIERS—.250 TO 1500 AMPERES, UP TO 3000 VOLTS

- CURRENT/VOLTAGE RATINGS
- PACKAGING
- MOUNTING AND COOLING
- HIGH-SPEED FAST RECOVERY
- TRANSIENT SELF-PROTECTION
- GENERAL PURPOSE

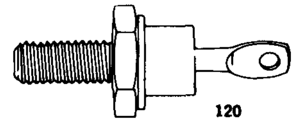


RECTIFIERS
.25 TO 3 AMPERES

JEDEC		—	1N5059-62	1N4245-49	—	—	1N5624-27	—	—
GE TYPE		DT230	A14A-P	—	GER4001-7	A114A-M	—	A15A-N	A115A-M
SPECIFICATIONS									
$I_{FM(AV)}$	(A)	.25	1	1	1	1	3	3	3
	@ T_A(°C)	50	100	55	75	55	70	70	55
$V_{RM(rep)}$ — Max. repetitive peak reverse voltage (V)									
	50	DT230F	A14F	—	GER4001	A114F	—	A15F	A115F
	100	DT230A	A14A	—	GER4002	A114A	—	A15A	A115A
	150	DT230G	—	—	—	—	—	—	—
	200	DT230B	1N5059	1N4245 *	GER4003	A114B	1N5624	A15B	A115B
	250	DT230H	—	—	—	—	—	—	—
	300	—	A14C	—	—	A114C	—	A15C	A115C
	400	—	1N5060	1N4246 *	GER4004	A114D	1N5625	A15D	A115D
	500	—	A14E	—	—	A114E	—	A15E	A115E
	600	—	1N5061	1N4247 *	GER4005	A114M	1N5626	A15M	A115M
	800	—	1N5062	1N4248 *	GER4006	—	1N5627	A15N	—
	1000	—	A14P [1]	1N4249	GER4007	—	—	—	—
$I_{FM(surge)}$	Max. peak one cycle, non-recurrent surge current (60 Hz sine wave, 1 phase operation) @ max. rated load conditions (A)	5	50	25	30	40	125	125	110
I^2t	Max. non-repetitive for 8.3 msec. (A^2sec)	—	4	4	—	3.5	25	25	20
T_J	Operating junction temperature range (°C)	−65 to 150	−65 to 175 [1]	−65 to 160	−65 to 175	−65 to 125	−65 to 175	−65 to 175	−65 to 150
T_{stg}	Storage temperature range (°C)	−65 to 200	−65 to 175	−65 to 200	−65 to 175	−65 to 175	−65 to 200	−65 to 175	−65 to 175
V_{FM}	Max. peak forward voltage drop @ rated $I_{F(AV)}$ (1 phase operation)	1.1	1.0	1.2@ +55°C	1.1	1.1	1.0	1.0	1.0
t_{rr}	Max. reverse recovery time (μsec)	0.3	6	5	—	0.2	5	5	0.2
PACKAGE OUTLINE NO.		38	119	119	119	119	119.2	119.2	119.2

NOTE:
[1] Average forward current 1 amp. @ T_A=90°C. Junction, operating and storage temperature range −65 to +165°C.
* JAN & JANTX types available

RECTIFIERS
5 TO 12 AMPERES

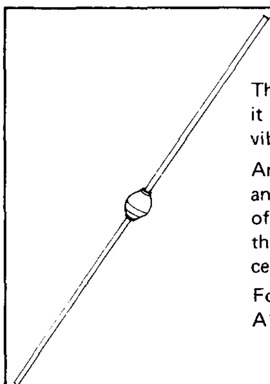


120

JEDEC		1N1612-16	1N1341A-48A	1N3987-90	1N3879-83	1N1199A-1206A 1N3670A-73A 1N5331	1N3889-93		1N4510-11
GE TYPES		–	–	–	–	–	–	A28**	–
SPECIFICATIONS									
$I_{FM(AV)}$	(A)	5	6	6	6	12	12	12	12
	@ T_C = (°C)	150	150	150	100	150	100	135	135
$V_{RM(rep)}$	Max. repetitive peak reverse voltage (V)	–	–	–	–	–	–	–	–
	50	1N1612	1N1341A	–	1N3879	1N1199A	1N3889	A28F	–
	100	1N1613	1N1342A	–	1N3880	1N1200A	1N3890*	A28A	–
	150	–	1N1343A	–	–	1N1201A	–	–	–
	200	1N1614*	1N1344A	–	1N3881	1N1202A*	1N3891*	A28B	–
	300	–	1N1345A	–	1N3882	1N1203A	1N3892	A28C	–
	400	1N1615*	1N1346A	–	1N3883	1N1204A*	1N3893*	A28D	–
	500	–	1N1347A	–	–	1N1205A	–	–	–
	600	1N1616*	1N1348A	–	–	1N1206A*	–	–	–
	700	–	–	1N3987	–	1N3670A	–	–	–
	800	–	–	1N3988	–	1N3671A*	–	–	–
	900	–	–	1N3989	–	1N3672A	–	–	–
	1000	–	–	1N3990	–	1N3673A*	–	–	1N4510
	1200	–	–	–	–	1N5331	–	–	1N4511
$I_{FM\ (surge)}$	Max. peak one-cycle, non-recurrent surge current (60 Hz sine wave, 1/ phase operation) @ max. rated load conditions (A)	150	150	150	75	240	150	240	240
I^2t	Max. non-repetitive for 1.0 msec (A^2 sec)	25	25	25	–	60	–	67	67
T_J	Operating junction temperature range (°C)	–65 to +190	–65 to +200	–65 to +200	–65 to +150	–65 to +200	–65 to +150	–65 to +175	–65 to +175
T_{stg}	Storage temperature range (°C)	–65 to +200	–65 to +200	–65 to +200	–65 to +175	–65 to +200	–65 to +200	–65 to +175	–65 to +200
$R_{\theta JC}$	Max. thermal resistance, junction-to-case (°C/W)	7.0	4.25	4.25	2.5	2.5	2.0	2.0	2.0
V_{FM}	Max. peak forward voltage drop @ rated $I_{F(AV)}$ (1 phase operation) (V)	1.1	1.1	1.1	1.4	1.1	1.4	1.1	1.4
	@ T_C = (°C)	150	25	25	25	25	25	25	135
T_{rr}	Max. reverse recovery time (nsec)	–	–	–	200	–	200	100	–
PACKAGE OUTLINE NO.		120	120	120	120	120	120	120	120

*JAN & JANTX types available.

**A28 reverse polarity is an A29.



The best way to assure reliability in a low-current rectifier pellet is to put it in a package that really protects it. Protects it from shock, humidity, vibration and temperature.

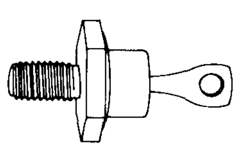
And that's just what we do with General Electric's glassivated 1-amp (A14) and 3-amp (A15) rectifiers. Solid glass provides passivation and protection of the silicon pellet's P-N junction – no organic material is present within the hermetically sealed package. In addition, rigid mechanical support and excellent thermal characteristics are provided by the dual heat sink construction.

For high-frequency applications, GE offers a fast-recovery rectifier, the 1-amp A114, with a 200 nsec. max. reverse recovery.

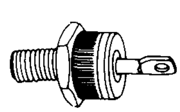
RECTIFIERS
20 TO 25 AMPERES

JEDEC		1N249B-50B	1N1195A-98A	1N2154-60	1N1183-90 1N3765-68 1N5332	1N4529-30	1N1183A-90A	1N3899-3903	1N3909-13	1N3208-14		
GE TYPE		–	–	–	–	–	–	–	–	A40F	A44F	A139
SPECIFICATIONS												
$I_{FM(AV)}$	Max. average forward current (1 phase operation) (A)	20	20	25	35	35	40	20	30	20	20	25
	@ T_C = (°C)	150	150	145	140	115	150	100	100	110	110	75
$V_{RM(rep)}$	Max. repetitive peak reverse voltage (V)											
	50	1N248B	1N1191A	1N2154	1N1183	–	1N1183A	1N3899*	1N3909*	1N3208 A40F	A44F	–
	100	1N249B	1N1192A	1N2155	1N1184*	–	1N1184A	1N3900*	1N3910*	1N3209 A40A	A44A	–
	150	–	1N1193A	–	1N1185	–	1N1185A	–	–	–	–	–
	200	1N250B	1N1194A	1N2156	1N1186*	–	1N1186A	1N3901*	1N3911*	1N2110 A40B	A44B	–
	300	–	1N1195A	1N2157	1N1187	–	1N1187A	1N3902*	1N3912*	1N3211 A40C	A44C	–
	400	–	1N1196A	1N2158	1N1188*	–	1N1188A	1N3903*	1N3913*	1N3212 A40D	A44D	–
	500	–	1N1197A	1N2159	1N1189	–	1N1189A	–	–	1N3213 A40E	A44E	A139E
	600	–	1N1198A	1N2160	1N1190*	–	1N1190A	–	–	1N3214 A40M	A44M	A139M
	700	–	–	–	1N3765	–	–	–	–	–	–	–
	800	–	–	–	1N3766	–	–	–	–	–	–	A139N
	900	–	–	–	1N3767	–	–	–	–	–	–	–
	1000	–	–	–	1N3768	1N4529	–	–	–	–	–	A139P
	1200	–	–	–	1N5332	1N4530	–	–	–	–	–	–
$I_{FM(surge)}$	Max. peak one cycle, non-recurrent surge current (60 Hz sine wave, 1 phase operation) @ max. rated load conditions (A)	350	350	400	500	500	800	225	300	300	300	400
I^2t	Max. I^2t rating (non-repetitive for 8.3 msec) A^2 sec	–	–	250	500	500	–	–	–	100	100	500
T_J	Operating junction temperature range (°C)	–65 to +175	–65 to +175	–65 to +200	–65 to +200	–65 to +175	–65 to +200	–65 to +150	–65 to +150	–65 to +175	–65 to +175	–40 to +125
T_{stg}	Storage temperature range (°C)	–65 to +175	–65 to +175	–65 to +200	–65 to +200	–65 to +200	–65 to +200	–65 to +175	–65 to +175	–65 to +175	–65 to +175	–40 to +200
$R\theta_{JC}$	Max. thermal resistance, junction-to-case (°C/W)	1.2	1.2	1.4	1.0	1.0	1.0	1.5	1.0	1.5 Typical	1.5 Typical	1.0
V_{FM}	Max. peak forward voltage drop @ rated $I_{F(AV)}$ (1 phase operation) (V)	1.5	1.2	1.2	1.8	1.4	1.3	1.4	1.4	1.00 Typical	1.00 Typical	1.85
	@ T_C = (°C)	25	25	145	140	115	25	25	25	25	25	75
T_{rr}	Max. reverse recovery time (nsec)	–	–	–	–	–	–	200	200	–	–	500
PACKAGE OUTLINE NO.		123	123	123	123	123	123	123	123	125	126	123

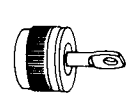
* JAN & JANTX types available.



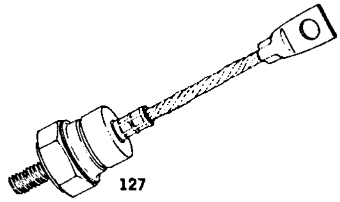
123



125

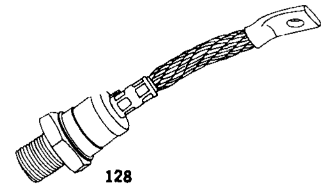


126



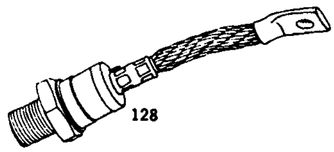
127

RECTIFIERS
100 TO 150 AMPERES



128

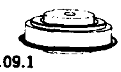
JEDEC TYPE		1N3289-96			1N3260-75		
GE TYPE		**A70**	**A170**	**A177**	–	**A180**	**A187**
SPECIFICATIONS							
$I_{FM(AV)}$	Max. average forward current (1 phase operation)	100	100	100	160	150	150
	T_C = (°C)	130	130	130	125	143	110
V_{RM} (surge)	Max. repetitive peak reverse voltage (V)	–	–	–	–	–	–
	50	–	–	–	1N3260	–	–
	100	A70A	A170A	A177A	1N3261	A180A	A187A
	150	–	–	–	1N3262	–	–
	200	A70B 1N3289	A170B	A177B	1N3263	A180B	A187B
	250	–	–	–	1N3264	–	–
	300	A70C 1N3290	A170C	A177C	1N3265	A180C	A187C
	350	–	–	–	1N3266	–	–
	400	A70D 1N3291	A170D	A177D	1N3267	A180D	A187D
	500	A70E 1N3292	A170E	A177E	1N3268	A180E	A187E
	600	A70M 1N3293	A170M	A177M	1N3269	A180M	A187M
	700	A70S	A170S	A177S	1N3270	A180S	A187S
	800	A70N 1N3294	A170N	A177N	1N3271	A180N	A187N
	900	A70T	A170T	A177T	1N3272	A180T	A187T
	1000	A70P 1N3295	A170P	A177P	1N3273	A180P	A187P
	1100	A70PA	A170PA	A177PA	–	A180PA	A187PA
	1200	A70PB 1N3296	A170PB	A177PB	1N3274	A180PB	A187PB
	1300	–	A170PC	A177PC	–	A180PC	A187PC
	1400	–	A170PD	A177PD	1N3275	A180PD	A187PD
	1500	–	A170PE	A177PE	–	A180PE	A187PE
I_{FM} (surge)	Max. peak one cycle, non-recurrent surge current (60 Hz sine wave, 1 phase operation) @ max. rated load conditions (A)	1600	2500	2500	2000	3400	2800
I^2t	Max. non-repetitive for 8.3 msec (A^2 sec)	10,000	28,000	23,500	16,000	46,000	33,000
T_J	Operating junction temperature range (°C)	-40 to +200	-40 to +200	-40 to +175	-55 to +190	-40 to +200	-40 to +175
T_{stg}	Storage temperature range (°C)	-40 to +200	-40 to +200	-40 to +200	-55 to +190	-40 to +200	-40 to +200
$R_{\theta JC}$	Max. thermal resistance, junction-to-case (°C/W)	.4	.4	.4	.3	.3	.3
V_{FM}	Max. Peak forward voltage drop @ rated $I_{F(AV)}$ (1 phase operation)	1.15	1.3	1.3	1.6	1.3	–
	@ T_C = (°C)	25	130	25	125	143	–
Q_{rr}	Max. reverse recovered charge, T_J = 25°C	–	–	25	–	–	30
PACKAGE OUTLINE NO.		127	127	127	128	127	127



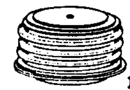
128

RECTIFIERS

250 TO 740 AMPERES

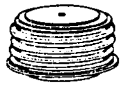


109.1

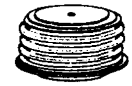


182

JEDEC		—	1N3735-44	—	1N4044-56	—	—	—
GE TYPE		A190	—	A197	—	A390	A397	A500
SPECIFICATIONS								
$I_{FM(AV)}$	Max. average forward current (1 phase operation) (A)	250	250	250	275	400	400	740
	@ T_C = (°C)	144	130	110	120	145	110	100
$V_{FM(rep)}$	Max. repetitive peak reverse voltage (V)							
	100	A190A	1N3735	A197A	1N4045	A390A	A397A	—
	200	A190B	1N3736	A197B	1N4047	A390B	A397B	—
	300	A190C	1N3737	A197C	1N4049	A390C	A397C	—
	400	A190D	1N3738	A197D	1N4050	A390D	A397D	—
	500	A190E	1N3739	A197E	1N4051	A390E	A397E	—
	600	A190M	1N3740	A197M	1N4052	A390M	A397M	—
	700	A190S	—	A197S	1N4053	A390S	A397S	—
	800	A190N	1N3741	A197N	1N4054	A390N	A397N	—
	900	A190T	—	A197T	1N4055	A390T	A397T	—
	1000	A190P	1N3742	A197P	1N4056	A390P	A397P	—
	1100	A190PA	—	A197PA	—	A390PA	A397PA	—
	1200	A190PB	1N3743	A197PB	—	A390PB	A397PB	—
	1300	A190PC	—	A197PC	—	A390PC	A397PC	—
	1400	A190PD	1N3744	A197PD	—	A390PD	A397PD	—
	1500	A190PE	—	A197PE	—	A390PE	A397PE	—
	1600	—	—	—	—	—	—	A500PM
	1700	—	—	—	—	—	—	A500PS
	1800	—	—	—	—	—	—	A500PN
	1900	—	—	—	—	—	—	A500PT
	2000	—	—	—	—	—	—	A500L
	2100	—	—	—	—	—	—	A500LA
	2200	—	—	—	—	—	—	A500LB
	2300	—	—	—	—	—	—	A500LC
	2400	—	—	—	—	—	—	A500LD
	2500	—	—	—	—	—	—	A500LE
	2600	—	—	—	—	—	—	A500LM
	2700	—	—	—	—	—	—	A500LS
	2800	—	—	—	—	—	—	A500LN
	2900	—	—	—	—	—	—	A500LT
	3000	—	—	—	—	—	—	A500LP
I_{FM} (surge)	Max. peak one cycle, non-recurrent surge current (60 Hz sine wave, 1 phase operation) @ max. rated load conditions (A)	6500	4500	5000	5000	7000	5000	10,000
I^2t	Max. non-repetitive for 8.3 msec (A^2 sec)	160,000	84,000	100,000	100,000	200,000	95,000	415,000
T_J	Operating junction temperature range (°C)	-40 to +200	-40 to +200	-40 to +175	-65 to +190	-40 to +200	-40 to +175	-40 to +175
T_{stg}	Storage temperature range (°C)	-40 to +200	-40 to +200	-40 to +200	-65 to +200	-40 to +200	-40 to +200	-40 to +200
$R_{\theta JC}$	Max. thermal resistance, junction-to-case (°C/W)	.18	.18	.18	.18	.15	.095	.057
V_{FM}	Max. peak forward voltage drop @ rated $I_{F(AV)}$ (1 phase operation)	1.3	1.3	1.25	1.35	1.15	1.25	1.25
	@ T_C = (°C)	144	130	25	120	25	25	25
Q_{rr}	Max. reverse recovered charge @ T_J = 25°C	—	—	60	—	—	60	—
PACKAGE NO.		128	128	128	128	109.1	109.1	182

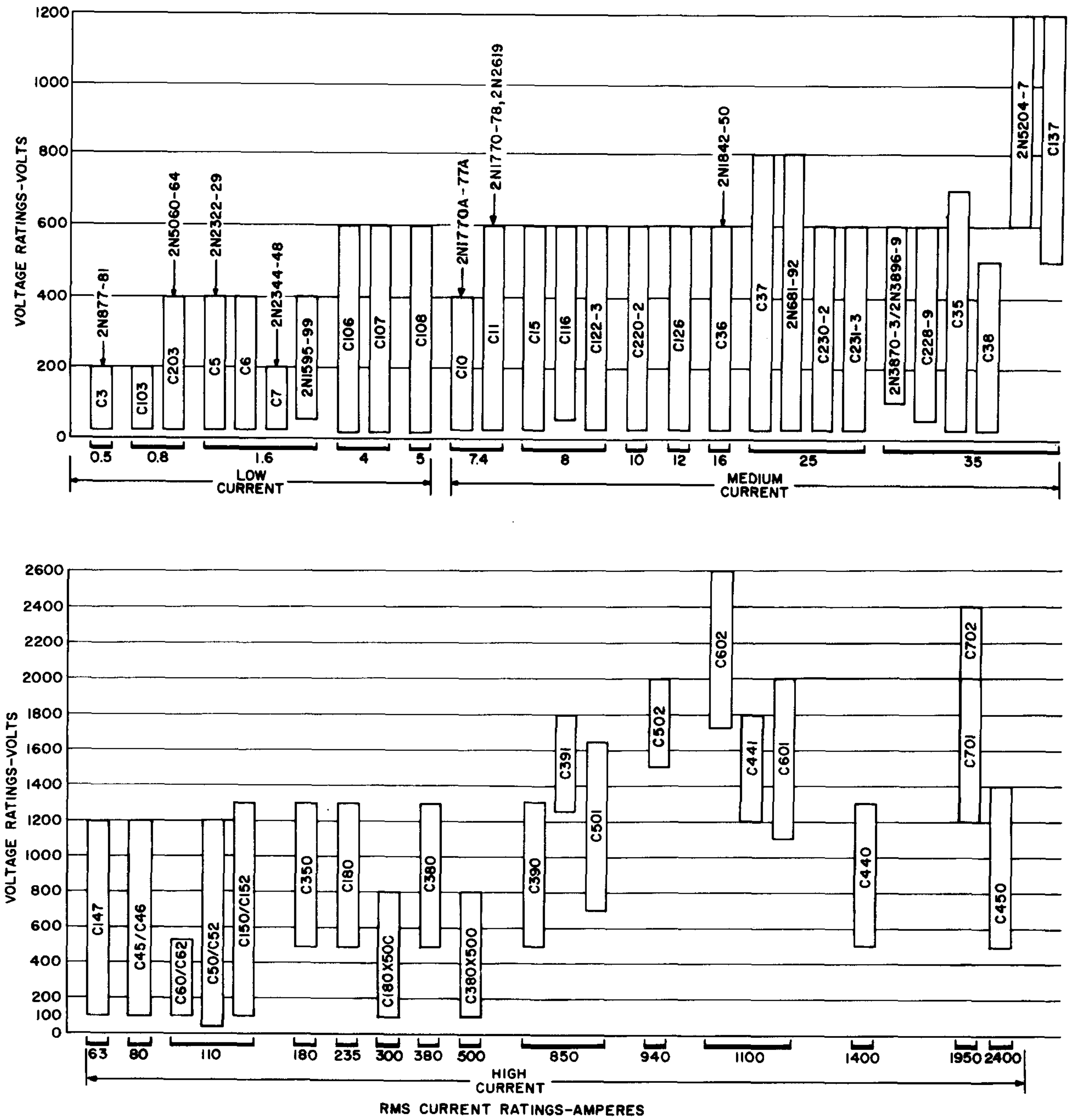

182

RECTIFIERS
750 TO 1500 AMPERES

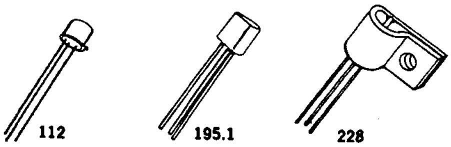

183

GE TYPE		A437	A596	A430	A540	A696	A570	A640
JEDEC		–	–	–	–	–	–	–
SPECIFICATIONS								
$I_{FM(AV)}$	Max. average forward current (1 phase operation) (A)	750	750	1000	1000	1000	1500	1500
	@ T_C = (°C)	65	65	126	100	–	80	80
$V_{FM(rep)}$	Max. repetitive peak reverse voltage (V)							
	100	A437A	–	A430A	–	–	A570A	–
	200	A437B	–	A430B	–	–	A570B	–
	300	A437C	–	A430C	–	–	A570C	–
	400	A437D	–	A430D	–	–	A570D	–
	500	A437E	–	A430E	–	–	A570E	–
	600	A437M	–	A430M	–	–	A570M	–
	700	A437S	–	A430S	–	–	–	–
	800	A437N	A596N	A430N	–	–	–	–
	900	A437T	A596T	A430T	–	–	–	–
	1000	A437P	A596P	A430P	–	–	–	A640P
	1100	A437PA	A596PA	A430PA	–	–	–	A640PA
	1200	A437PB	A596PB	A430PB	–	–	–	A640PB
	1300	A437PC	A596PC	A430PC	–	–	–	A640PC
	1400	A437PD	A596PD	A430PD	–	–	–	A640PD
	1500	A437PE	–	A430PE	–	A696PE	–	A640PE
	1600	–	–	–	–	A696PM	–	A640PM
	1700	–	–	–	–	A696PS	–	A640PS
	1800	–	–	–	–	A696PM	–	A640PM
	1900	–	–	–	–	A696PT	–	A640PT
	2000	–	–	–	A540L	A696L	–	A640L
	2100	–	–	–	A540LA	–	–	–
	2200	–	–	–	A540LB	–	–	–
	2300	–	–	–	A540LC	–	–	–
	2400	–	–	–	A540LD	–	–	–
	2500	–	–	–	–	–	–	–
	2600	–	–	–	–	–	–	–
	2700	–	–	–	–	–	–	–
	2800	–	–	–	–	–	–	–
	2900	–	–	–	–	–	–	–
	3000	–	–	–	–	–	–	–
I_{FM} (surge)	Max. peak one cycle, non-recurrent surge current (60 Hz sine wave, 1 phase operation) @ max. rated load conditions (A)	10,000	10,000	10,000	12,000	14,000	18,000	16,000
I^2t	Max. non-repetitive for 8.3 msec (A^2 sec)	415,000	415,000	416,000	597,000	–	1,300,000	1,062,000
T_J	Operating junction temperature range (°C)	-40 to +175	-40 to +175	-40 to +200	-40 to +200	-40 to +150	-40 to +200	-40 to +200
T_{stg}	Storage temperature range (°C)	-40 to +200	-40 to +200	-40 to +200	-40 to +200	-40 to +150	-40 to +200	-40 to +200
$R_{\theta JC}$	Max. thermal resistance, junction-to-case (°C/W)	.057	.057	.06	.057	.036	.057	.045
V_{FM}	Max. peak forward voltage drop @ rated $I_{F(AV)}$ (1 phase operation)	2.0	2.3	1.55	1.15	–	1.0	1.0
	@ T_C = (°C)	25	125	25	150	–	25	25
Q_{rr}	Max. reverse recovered charge @ T_J = 25°C	100	300	–	–	500	–	–
PACKAGE NO.		183	182	183	182	183	182	183

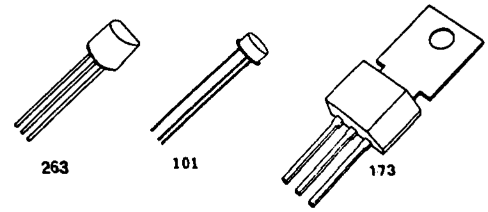
PHASE CONTROL SCR's SELECTOR GUIDE



"Phase Control" is a term used to describe SCR's where fast turn-off time is not a prime requirement. The trade-offs in SCR design are such that turn-off time has an inverse relationship to current and voltage capability for any given junction size. Primary applications for a device with relatively slow turn-off are AC phase control—hence the name "Phase Control." This type of device is also used for zero voltage switching and select pulse applications. See pages 36-41.

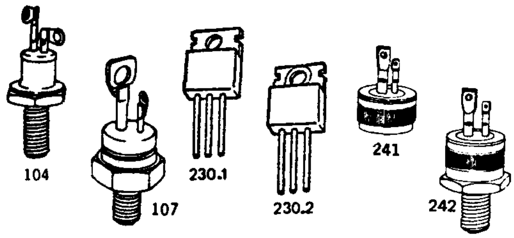


PHASE CONTROL SCR's
.5 TO 5 AMPERES

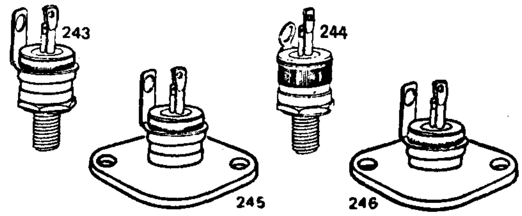


GE TYPE		C3	C103	C203	C5	C6	C7	–	C106	C107	C108
JEDEC		2N877-81[1]	–	2N5060-64	2N2322-29	–	2N2344-48	2N1595-99,A	–	–	–
ELECTRICAL SPECIFICATIONS											
VOLTAGE RANGE		30-200	30-200	30-400	25-400	25-400	25-200	50-400	15-600	15-600	15-600
FORWARD CONDUCTION											
$I_{T(RMS)}$	Max. RMS on-state current (A)	0.5	0.8	0.8	1.6	1.6	1.6	1.6	4.0	4.0	5.0
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C	0.32 @ 85°C	0.50 @ 25°C	0.50 @ 25°C	1.0 @ 85°C	1.0 @ 85°C	1.0 @ 55°C	1.0 @ 110°C	2.5 @ 30°C	2.5 @ 30°C	3.75 @ 30°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	7	8	8	15	10	15	15	20	15	30
I^2t	Max. I^2t for fusing for > 1.5 msec (A^2 sec)	–	–	–	0.5	0.5	–	0.5	0.5	0.5	1
V_{TM}	Max. peak on-state voltage @ 25°C, 180° conduction, rated $I_{T(AV)}$ (V)	1.6	1.5	1.5	2.2	1.4	2	2	2.2	2.5	1.35
$R_{\theta JC}$	Max. internal thermal resistance, dc junction-to-case (°C/W)	80	125	75	10	10	–	–	10	10	10
I_H	Max. holding current @ 25°C (mA)	5	5	5	2	5	1	–	3	8	3
t_q	Typical turn-off time (μsec) @ max. T_J	15	15	15	40	40	20	40	40	40	40
	Maximum turn-off time (μsec @ 110°C)	–	–	–	–	–	–	–	100	100	100
$t_d + t_r$	Typical turn-on time (μsec @ 110°C)	1	1.4	1.4	1.4	1.4	1.4	1.2	1	1	1
di/dt	Max. rate-of-rise of turned-on current (A/μsec)	–	–	–	50	–	–	–	50	50	50
T_J	Junction operating temperature range (°C)	−65 to 125	−65 to 125	−65 to 125	−65 to 125	−40 to 125	−65 to 100	−65 to 150	−40 to 110	−40 to 110	−40 to 110
BLOCKING											
dv/dt	Typical critical rate-of-rise of off-state voltage, exponential to rated V_{DRM} @ max. rated T_J (V/μsec)	40	20	20	20	20	20	20	8	8	8
FIRING											
I_{GT}	Max. required gate current to trigger (μA) @ −65°C	300	500	500	350	–	75	–	–	–	–
	@ −40°C	–	–	–	–	–	–	–	500	–	500
	@ 25°C	200	200	200	200	1000	20	10,000	200	500	200
V_{GT}	Max. required gate voltage to trigger (V) @ −65°C	–	1	1	1	1	1	–	–	–	–
	@ −40°C	–	–	–	–	1	–	–	1	–	1
	@ 25°C	0.8	0.8	0.8	0.8	0.8	0.8	3	0.8	0.8	0.8
V_{GT}	Min. required gate voltage to trigger (V) @ 110°C	–	–	–	–	–	–	–	0.2	0.2	0.2
	@ 125°C	0.05	0.1	0.1	0.1	0.1	–	–	–	–	–
VOLTAGE TYPES											
Repetitive Peak Forward and Reverse Voltages											
15		–	–	–	–	–	–	–	C106Q1	C107Q1	C108Q1
25		–	–	–	2N2322 C5U	C6U	2N2344	–	–	–	–
30		2N877	C103Y	2N5060 C203Y	–	–	–	–	C106Y1	C107Y1	C108Y1
50		–	–	–	2N2323* C5F	C6F	2N2345	2N1595, A	C106F1	C107F1	C108F1
60		2N878	C103YY	2N5061 C203YY	–	–	–	–	–	–	–
100		2N879	C103A	2N5062 C203A	2N2324* C5A	C6A	2N2346	2N1596, A	C106A1	C107A1	C108A1
150		2N880	–	2N5063	2N2325 C5G	C6G	2N2347	–	–	–	–
200		2N881	C103B	2N5064 C203B	2N2326* C5B	C6B	2N2348	2N1597, A	C106B1	C107B1	C108B1
250		–	–	–	2N2327 C5H	–	–	–	–	–	–
300		–	–	C203C	2N2328* C5C	C6C	–	2N1598, A	C106C1	C107C1	C108C1
400		–	–	C203D	2N2329* C5D	C6D	–	2N1599, A	C106D1	C107D1	C108D1
500		–	–	–	–	–	–	–	C106E1	C107E1	C108E1
600		–	–	–	–	–	–	–	C106M1	C107M1	C108M1
PACKAGE OUTLINE NO.		112	195.1, 228	263	101	101	101	101	173	173	173

*JAN & JANTX types available.
1. 2N885-89 available 20 mA max. I_{GT}.
2. 2N2322A-28A available 20 mA max. I_{GT}.

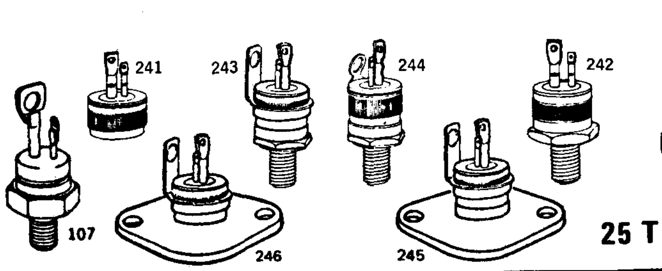


PHASE CONTROL SCR's
7.4 TO 25 AMPERES



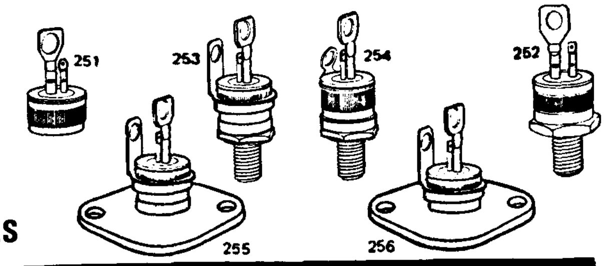
		C10	C11	C15	C116	C122-3*	C220-2	C126	C36	C37
GE TYPE		C10	C11	C15	C116	C122-3*	C220-2	C126	C36	C37
JEDEC		2N1770A-77A	2N1770-78	–	–	–	–	–	2N1842-50	–
ELECTRICAL SPECIFICATIONS										
VOLTAGE RANGE		25-400	25-600	25-600	50-600	25-600	25-600	25-600	25-600	25-800
FORWARD CONDUCTION										
$I_{T(RMS)}$	Max. RMS on-state current (A)	7.4	7.4	8	8	8	10	12	16	25
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C (°C)	4.7 @ 106°C	4.7 @ 105°C	5.1 @ 50°C	5.1 @ 40°C	5.2 @ 78°C	6.3 @ 68°C	7.8 @ 78°C	10.0 @ 35°C	16.0 @ 35°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	60	60	60	90	80	90	120	125	125
I^2t	Max. I^2t for fusing for ≥ 1.5 msec (A^2 sec)	.5	.5	–	27	27	27	–	–	40
V_{TM}	Max. peak on-state voltage @ 25°C, 180° conduction, rated $I_{T(AV)}$ (V)	1.8	1.8	1.85	1.57	2.2	2.0	1.82	2.9	2.25
$R_{\theta JC}$	Max. internal thermal resistance, dc, junction-to-case (°C/W)	3.1	3.1	3.1	8.0	2.0	–	1.8	2.5	1.0
I_H	Max. holding current @ 25°C (mA)	25	–	30	30	30	30	30	20	10
t_q	Typical turn-off time (μsec) @ 100°C	–	–	–	50	–	–	–	50	–
	@ 125°C	40	40	–	–	–	–	–	–	–
$t_d + t_r$	Typical turn-on time (μsec)	1.0	1.0	1.0	–	–	2.5	–	3	3
di/dt	Max. rate-of-rise turned-on current (A/μsec)	60	40	40	30	100	100	100	20	20
T_J	Junction operating temperature range (°C)	−65 to 150	−65 to 125	−65 to 105	−40 to 110	−40 to 100	−40 to 100	−40 to 110	−40 to 100	−40 to 105
BLOCKING										
dv/dt	Typical critical rate-of-rise of off-state voltage. Exponential @ max. rated T_J (V/μsec)	20	50	50	50	50	50	50	100	100
FIRING										
I_{GT}	Max. required gate current to trigger (mA) @ −65°C	30	30	50	–	–	–	–	–	–
	@ −40°C	–	–	–	40	40	40	40	150	150
	@ 25°C	15	15	35	25	25	25	25	80	80
V_{GT}	Max. required gate voltage to trigger (V) @ −65°C	2	2	2.5	–	–	–	–	–	–
	@ −40°C	–	–	–	2.0	2.0	2.0	2.0	3.5	3.5
	@ 25°C	1.35	1.35	–	1.5	1.5	1.5	1.5	–	–
V_{GT}	Min. required gate voltage to trigger (V) @ 100°C	–	–	0.3	–	0.2	0.2	–	0.3	0.25
	@ 110°C	–	–	–	0.2	–	–	0.2	–	–
	@ 125°C	–	0.3	–	–	–	–	–	–	–
	@ 150°C	0.2	–	–	–	–	–	–	–	–
VOLTAGE TYPES										
Repetitive Peak Forward and Reverse Voltages										
	25	2N1770A C10U	2N1770 C11U	C15U	–	–	C220U C222U	–	2N1842 C36U	C37U
	50	2N1771A C10F	2N1771 C11F	C15F	C116F1	C122F C123F	C220F C222F	C126F	2N1843 C36F	C37F
	100	2N1772A C10A	2N1772 C11A	C15A	C116A1	C122A C123A	C220A C222A	C126A	2N1844 C36A	C17A
	150	2N1773A C10G	2N1773 C11G	C15G	–	–	–	–	2N1845 C36G	–
	200	2N1774A C10B	2N1774 C11B	C15B	C116B1	C122B C123B	C220B C222B	C126B	2N1846 C36B	C37B
	250	2N1775A C10H	2N1775 C11H	C15H	–	–	–	–	2N1847 C36H	–
	300	2N1776A C10C	2N1776 C11C	C15C	C116C1	C122C C123C	C220C C222C	C126C	2N1848 C36C	C37C
	400	2N1777A C10D	2N1777 C11D	C15D	C116D1	C122D C123D	C220D C222D	C126D	2N1849 C36D	C37D
	500	–	2N1778 C11E	C15E	C116E1	C122E C123E	C220E C222E	C126E	2N1850 C36E	C37E
	600	–	2N2619 C11M	C15M	C116M1	C122M C123M	C220M C222M	C126M	C36M	C37M
	700	–	–	–	–	–	–	–	C26S	C37S
	800	–	–	–	–	–	–	–	C26N	C37N
PACKAGE OUTLINE NO.		104	104	104	173	230.2 (C122) 230.1 (C123)	241 (C222) 242, 3, 4, 5 & 6 (C220).	230.2	107	107

*C123 isolated version of C122.



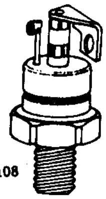
PHASE CONTROL SCR's

25 TO 35 AMPERES

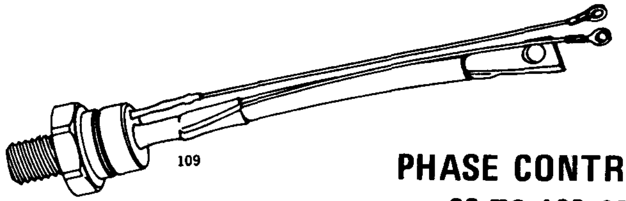


GE TYPE		–	C230-2	C231-3	–	C228-9	C35	C38	–	C137
JEDEC		2N681-92*	–	–	2N3870-3 2N3896-9	–	–	–	2N5204-7	–
ELECTRICAL SPECIFICATIONS										
VOLTAGE RANGE		25-800	25-600	25-600	100-600	50-600	25-700	25-500	600-1200	500-1200
FORWARD CONDUCTION										
$I_{T(RMS)}$	Max. RMS on-state current (A)	25	25	25	35	35	35	35	35	35
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C (°C)	16 @ 65°C	16 @ 70°C	16 @ 70°C	22.5 @ 65°C	20 @ 73°C	22.3 @ 35°C	22.5 @ 70°C	22.3 @ 40°C	22.3 @ 40°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	150	300	300	350	300	150	150	300	360
I^2t	Max. I^2t for fusing for ≥ 1.5 msec. (A^2 sec)	75	260	260	260	260	75	75	260	350
V_{TM}	Peak on-state voltage @ 25°C, 180° conduction, rated $I_{T(AV)}$ (V)	2.0	1.5	1.5	1.85	1.5	1.6	1.6	1.8	1.8
$R_{\theta JC}$	Max. internal thermal resistance, dc, junction-to-case (°C/W)	1.7	1.0	1.0	.9	1.7	1.7	1.5	1.5	1.0
I_H	Max. holding current @ 25°C (mA)	100	50	50	70	75	100	80	100	100
t_q	Typical turn-off time (μsec) at rated T_J (max.)	–	–	–	40	–	–	25	–	–
$t_d + t_r$	Typical turn-on time (μsec)	1.6	3	3	2	–	1.6	1.6	1.6	1.6
di/dt	Max. rate-of-rise turned-on current (A/μsec)	80	20	20	100	–	80	80	150	150
T_J	Junction operating temperature range (°C)	–65 to 125	–40 to 100	–40 to 100	–40 to 100	–40 to 125	–65 to 125	–65 to 150	–40 to 125	–65 to 125
BLOCKING										
dv/dt	Typical critical rate-of-rise of off-state voltage. Exponential @ max. rated T_J (V/μsec)	50	100	100	50	50	50	20	200	200
FIRING										
I_{GT}	Max. required gate current to trigger (mA) @ –65°C	80	–	–	–	–	80	80	–	80
	@ –40°C	–	40	20	80	80	–	–	80	–
	@ 25°C	40	25	9	40	40	40	40	40	40
V_{GT}	Max. required gate voltage to trigger (V) @ –65°C	3.0	–	–	–	–	3.0	3.0	–	3.0
	@ –40°C	–	2.0	2.0	3.0	3.0	–	–	3.0	–
	@ 25°C	3.0	1.5	1.5	2.0	2.5	3.0	3.0	3.0	3.0
V_{GT}	Min. required gate voltage to trigger @ 100°C	–	0.2	0.2	0.2	–	–	–	–	–
	@ 125°C	0.25	–	–	–	0.2	0.25	–	0.25	0.25
	@ 150°C	–	–	–	–	–	–	0.15	–	–
VOLTAGE TYPES										
Repetitive Peak Forward and Reverse Voltages										
	25	2N681	C230/2U	C231/3U	–	C228/9U	C35U	C38U	–	–
	50	2N682*	C230/2F	C231/3F	–	C228/9F	C35F	C38F	–	–
	100	2N683*	C230/2A	C231/3A	2N3870 2N3896	C228/9A	C35A	C38A	–	–
	150	2N684	–	–	–	–	C35G	C38G	–	–
	200	2N685*	C230/2B	C231/3B	2N3871 2N3897	C228/9B	C35B	C38B	–	–
	250	2N686*	–	–	–	–	C35H	C38H	–	–
	300	2N687*	C230/2C	C231/3C	–	C228/9C	C35C	C38C	–	–
	400	2N688*	C230/2D	C231/3D	2N3872 2N3898	C228/9D	C35D	C38D	–	–
	500	2N689*	C230/2E	C231/3E	–	C228/9E	C35E	C38E	–	C137E
	600	2N690	C230/2M	C231/3M	2N3873 2N3899	C228/9M	C35M	–	2N5204	C137M
	700	2N691	–	–	–	–	C35S	–	–	C137S
	800	2N692	–	–	–	–	–	–	2N5205	C137N
	900	–	–	–	–	–	–	–	–	C137T
	1000	–	–	–	–	–	–	–	2N5206	C137P
	1100	–	–	–	–	–	–	–	–	C137PA
	1200	–	–	–	–	–	–	–	2N5207	C137PB
PACKAGE OUTLINE NO.		107	241 (C232) 2, 3, 4, 5 & 6 (C230)	241 (C233) 2, 3, 4, 5 & 6 (C231)	241 242	251 (C229) 2, 3, 4, 5 & 6 (C228)	107	107	107	107

*JAN & JANTX types available.

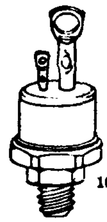


108

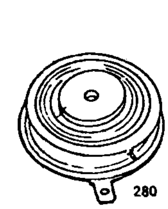


109

PHASE CONTROL SCR's
63 TO 190 AMPERES

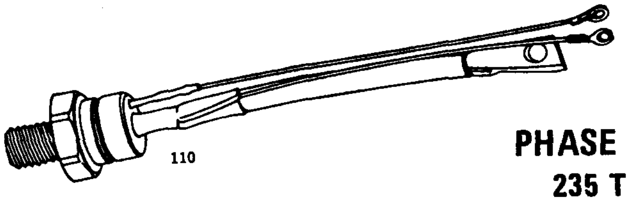


108.1



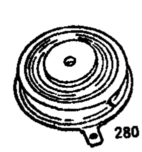
280

GE TYPE		C45, 46	C147	C50, 52	C150, 152	C60, 62	C350
JEDEC				2N1909-16 2N1792-98		2N2023-30	
ELECTRICAL SPECIFICATIONS							
VOLTAGE RANGE		25-1200	25-1200	25-1200	500-1300	25-500	500-1300
FORWARD CONDUCTION							
$I_{T(RMS)}$	Max. RMS on-state current (A)	80	63	110	110	110	190
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C	35 @ 87°C	40 @ 102°C	70 @ 62°C	70 @ 80°C	70 @ 88°C	110 @ 90°C
$I_{T(AV)}$	Max. average on-state current for 3φ conduction (A) @ T_C	32 @ 90°C	36 @ 101°C	62 @65°C	59 @ 87°C	59 @ 90°C	95 @ 85°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	800	1000	1000	1600	1000	1600
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	2600	4150	4150	7000	4000	10,600
V_{TM}	Peak on-state voltage @ 125°C, 180° conduction rated $I_{T(AV)}$ (V)	2.1	1.4	1.8	2.0	1.8	2.5
$R_{\theta JC}$	Max. internal thermal resistance, dc, junction-to-case (°C/W)	.4	.35	.4	.3	.4	.135
t_q	Typical turn-off time (μsec)	80	125	80	100	80	125
t_d t_r	Typical turn-on time (μsec)	5	5	5	8	5	8
di/dt	Rate-of-rise turned-on current (A/μsec)	100	100	100	200	30	200
T_J	Junction operating temperature range (°C)	−40 to 125°C	−40 to 125°C	−40 to 125°C	−40 to 125°C	−65 to 150°C	−40 to 125°C
BLOCKING							
dv/dt	Min. critical rate-of-rise of off-stage voltage, exponential @ max. rated T_J (V/μsec)	100	200	200	200	30 TYP.	200
FIRING							
I_{GT}	Max. required gate current to trigger (mA) @ −40°C	130	300	125	200	125	200
	@ 125°C	40	125	40	125	40	125
V_{GT}	Max. required gate voltage to trigger (V) @ −40°C	3	3.0	3	3	3	3
V_{GT}	Min. required gate voltage to trigger (V) @ −40°C	.25	.25	.25	.15	.25	.15
VOLTAGE TYPES							
Repetitive Peak Forward and Reverse Voltages							
25		C45U C46U	C147U	2N1909 C52U	CONSULT FACTORY	2N2023 C62U	–
50		C45F C46F	C147F	2N1910 2N1792		2N2024 C62F	–
100		C45A C46A	C147A	2N1911 2N1793		2N2025 C62A	–
150		C45G C46G	C147G	2N1912 2N1794		2N2026 C62G	–
200		C45B C46B	C147B	2N1913 2N1795		2N2027 C62B	–
250		C45H C46H	C147H	2N1914 2N1796		2N2028 C62H	–
300		C45C C46C	C147C	2N1915 2N1797		2N2029 C62C	–
400		C45D C46D	C147D	2N1916 2N1798		2N2030 C62D	–
500		C45E C46E	C147E	C50E C52E	C150E C152E	C60E C62E	C350E
600		C45M C46M	C147M	C50M C52M	C150M C152M		C350M
700		C45S C46S	C147S	C50S C52S	C150S C152S		C350S
800		C45N C46N	C147N	C50N C52N	C150N C152N		C350N
900		C45T C46T	C147T	C50T C52T	C150T C152T		C350T
1000		C45P C46P	C147P	C50P C52P	C150P C152P		C350P
1100		C45PA C46PA	C147PA	C50PA C52PA	C150PA C152PA		C350PA
1200		C45PB C46PB	C147PB	C50PB C52PB	C150PB C152PB		C350PB
1300					C150PC C152PC		C350PC
PACKAGE TYPE		½" STUD	¼" STUD	½" STUD	½" STUD	½" STUD	½" PRESS PAK
PACKAGE OUTLINE NO.		108, 109	108.1	109, 108	109, 108	109, 108	280

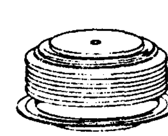


110

PHASE CONTROL SCR's
235 TO 850 AMPERES

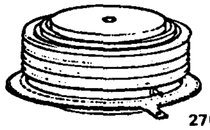


280



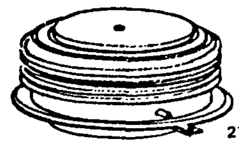
185

GE TYPE		C180	C380	C390	C391	C501	C502
ELECTRICAL SPECIFICATIONS							
VOLTAGE RANGE		500-1300	100-1300	500-1300	1300-1800	700-1700	1500-2000
FORWARD CONDUCTION							
$I_{T(RMS)}$	Max. RMS On-State Current (A)	235	380	850	850	850	850
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C	150 @ 88°C	235 @ 80°C	550 @ 65°C	550 @ 65°C	550 @ 67°C	550 @ 67°C
$I_{T(AV)}$	Max. average on-state current for 3_ϕ conduction (A) @ T_C	135 @ 80°C	180 @ 80°C	500 @ 65°C	550 @ 57°C	525 @ 70°C	525 @ 70°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	3500	3500	8000	8000	8000	8000
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	50,000	50,000	265,000	265,000	265,000	265,000
V_{TM}	Peak on-state voltage @ 125°C, 180° conduction, rated $I_{T(AV)}$ (V)	1.7	1.8	1.75	1.9	1.9	1.9
$R_{\theta JC}$	Max. internal thermal resistance, dc, Junction-to-Case (°C/W)	.14	.095	.06	.06	.05	.05
t_q	Typical turn-off time (μsec)	250	250	125	200	300	125
$t_d + t_r$	Typical turn-on time (μsec)	8	8	1	1.5	1.5	1.5
di/dt	Rate-of-rise turned-on current (A/μsec)	200	200	500	150	30-75	100
T_J	Junction operating temperature range (°C)	−40 to 125°C	−40 to 125°C	−40 to 125°C	−40 to 125°C	−40 to 125°C	−40 to 125°C
BLOCKING							
dv/dt	Min. critical rate-of-rise of off-state voltage, exponential @ max. rated T_J (V/μsec)	200	200	200	200	200	500
FIRING							
I_{GT}	Max. required gate current to trigger (mA) @ −40°C	200	200	300	300	225	275
	@ 125°C	125	125	125	125	75	50
V_{GT}	Max. required gate voltage to trigger (V) @ −40°C	3	3	5	5	6.5	4.5
V_{GT}	Min. required gate voltage to trigger (V) @ 125°C	.15	.15	.35	.15	.15	.3
VOLTAGE TYPES							
Repetitive Peak Forward and Reverse Voltages							
100		CONSULT FACTORY	C380A	CONSULT FACTORY		CONSULT FACTORY	
200			C380B				
300			C380C				
400			C380D				
500		C180E	C380E	C390E			
600		C180M	C380M	C390M			
700		C180S	C380S	C390S		C501S	
800		C180N	C380N	C390N		C501N	
900		C180T	C380T	C390T		C501T	
1000		C180P	C380P	C390P		C501P	
1100		C180PA	C380PA	C390PA		C501PA	
1200		C180PB	C380PB	C390PB		C501PB	
1300		C180PC	C380PC	C390PC	C391PC	C501PC	
1400					C391PD	C501PD	
1500					C391PE	C501PE	C502PE
1600					C391PM	C501PM	C502PM
1700					C391PS	C501PS	C502PS
1800					C391PN		C502PN
1900							C502PT
2000							C502L
PACKAGE TYPE		⅜" STUD	½" PRESS PAK	PRESS PAK	PRESS PAK	PRESS PAK	PRESS PAK
PACKAGE OUTLINE NO.		110	280	276	276	185	185



276

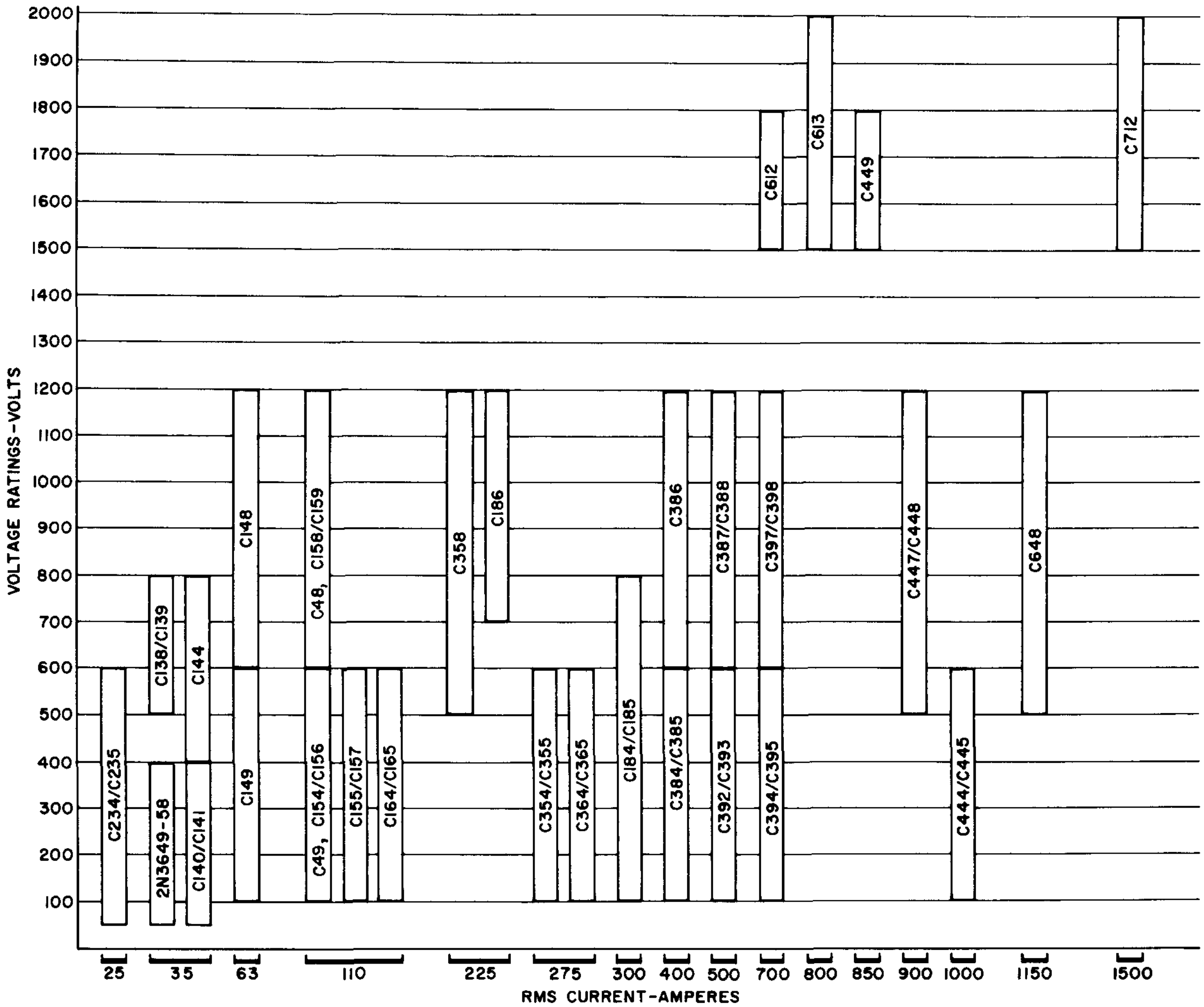
PHASE CONTROL SCR's
940 TO 1950 AMPERES



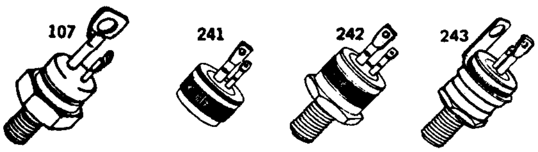
276.1

GE TYPE		C602	C601	C441	C440	C701	C702
ELECTRICAL SPECIFICATIONS							
VOLTAGE RANGE		1700-2600	1100-2000	1200-1800	500-1300	1100-2000	2000-2400
FORWARD CONDUCTION							
$I_{T(RMS)}$		940	1100	1100	1400	1950	1950
$I_{T(AV)}$	Max. average on-state current @ 180° conduction (A) @ T_C	600 @ 72°C	750 @ 72°C	700 @ 65°C	800 @ 75°C	1250 @ 70°C	1250 @ 70°C
$I_{T(AV)}$	Max. average on-state current for 3φ conduction (A) @ T_C	510 @ 80°C	620 @ 80°C	575 @ 80°C	650 @ 80°C	1040 @ 80°C	1040 @ 80°C
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	10,000	11,000	11,000	13,000	18,000	15,000
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	415,000	516,000	500,000	700,000	1,300,000	933,000
V_{TM}	Peak on-state voltage @ 125°C, 180° conduction, rated $I_{T(AV)}$ (V)	1.9	1.5	1.5	1.3	1.8	2.0
$R_{\theta JC}$	Max. internal thermal resistance, dc, junction-to-case (°C/W)	.036	.041	.04	.04	.025	.023
t_q	Typical turn-off time (μsec)	125	175	125	125	125	125
$t_d + t_r$	Typical turn-on time (μsec)	1.5	1.5	5	1.5	1.5	–
di/dt	Rate-of-rise turned-on current (A/μsec)	35-75	80-150	150	800	100	125
T_J	Junction operating temperature range (°C)	-40 to 125°C	-40 to 125°C	-40 to 125°C	-40 to 125°C	-40 to 125°C	-40 to 125°C
BLOCKING							
dv/dt	Min. critical rate-of-rise of off-state voltage. Exponential @ rated T_J (V/μsec)	200	200	200	200	200	200
FIRING							
I_{GT}	Max. required gate current to trigger (mA) @ −40°C	275	275	300	300	275	275
	@ 125°C	75	75	125	125	50	35
V_{GT}	Max. required gate voltage to trigger (V) @ −40°C	4.5	4.5	5	5	5.5	4.5
V_{GT}	Min. required gate voltage to trigger (V) @ 125°C	.2	.2	.15	.15	.3	.3
VOLTAGE TYPES							
Repetitive Peak Forward and Reverse Voltages							
	500	–	–	–	C440E	–	–
	600	–	–	–	C440M	–	–
	700	–	–	–	C440S	–	–
	800	–	–	–	C440N	–	–
	900	–	–	–	C440T	–	–
	1000	–	–	–	C440P	–	–
	1100	–	C601PA	–	C440PA	C701PA	–
	1200	–	C601PB	C441PB	C440PB	C701PB	–
	1300	–	C601PC	C441PC	C440PC	C701PC	–
	1400	–	C601PD	C441PD	–	C701PD	–
	1500	–	C601PE	C441PE	–	C701PE	–
	1600	–	C601PM	C441PM	–	C701PM	–
	1700	C602PS	C601PS	C441PS	–	C701PS	–
	1800	C602PN	C601PN	C441PN	–	C701PN	–
	1900	C602PT	C601PT	–	–	C701PT	–
	2000	C602L	C601L	–	–	C701L	C702L
	2100	C602LA	–	–	–	–	C702LA
	2200	C602LB	–	–	–	–	C702LB
	2300	C602LC	–	–	–	–	C702LC
	2400	C602LD	–	–	–	–	C702LD
	2500	C602LE	–	–	–	–	–
	2600	C602LM	–	–	–	–	–
PACKAGE TYPE		PRESS PAK	PRESS PAK	PRESS PAK	PRESS PAK	PRESS PAK	PRESS PAK
PACKAGE OUTLINE NO.		276	276	276	276	276.1	276.1

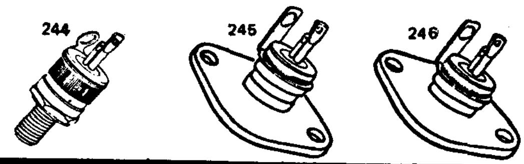
INVERTER SCR's SELECTOR GUIDE



SCR's in this use category are characterized for turn-off time (commutation speed) capability and other speed characteristics. When designing for speed, the parameter trade offs must be carefully weighed. Thus the large matrix of speed, current and voltage capability for inverter SCR's. As the name implies, major applications for these devices are DC/AC inverters. Additionally, they are used in cycloconverters and other pulse applications requiring high speed capability.

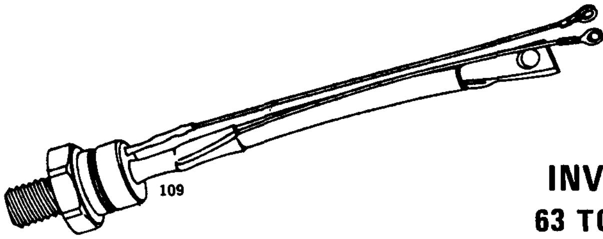


INVERTER SCR's
25 TO 35 AMPERES



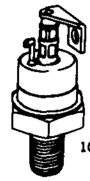
		C234, C235	C138[1]	C139	C140	C141	C144
GE TYPE		C234, C235	C138[1]	C139	C140	C141	C144
JEDEC		–	–	–	2N3649-53	2N3654-58	–
ELECTRICAL SPECIFICATIONS							
VOLTAGE RANGE		50-600	500-800	500-800	50-400	50-400	500-800
FORWARD CONDUCTION							
$I_{T(RMS)}$	Max. RMS on-state current @ T_C = 65°C, 50% duty (A)	25	35	35	35	35	35
	1 KHz	25	26	26	26	26	35
	5 KHz	–	22	22	26	26	32
	10 KHz	–	18	18	20	20	30
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	250	200	200	200	200	200
I^2t	Max. I^2t for fusing @ < 1.5 msec. (A^2 Sec.)	220	165	165	165	165	165
$R_{\theta JC}$	Max. internal thermal resistance, dc, junction-to-case (°C/W)	1.0	1.0	1.0	1.7	1.7	1.0
$t_d + t_r$	Typical turn-on time (µsec)	3.0	3.1	3.1	3.1	3.1	3.1
t_q	Max. turn-off time @ rated voltage and T_J (µsec) @ 20V/µsec reapplied	20	–	–	–	–	–
	@ 200V/µsec reapplied	–	10	10	15	10	15
di/dt	Critical rate-of-rise of on-state current (A/µsec)	40	100	100	400	400	100
T_J	Junction operating temperature range (°C)	–40 to 100	–65 to 125	–65 to 125	–65 to 125	–65 to 125	–65 to 125
BLOCKING							
dv/dt	Min. critical rate-of-rise of off-state voltage exponential to rated V_{DRM} @ Max. rated T_J (V/µsec)	20	200	200	200	200	200
FIRING							
I_{GT}	Max. required gate current to trigger (mA) @ –65°C	–	500	500	500	500	450
	@ –40°C	80	–	–	–	–	–
	@ 25°C	40	180	180	180	180	150
V_{GT}	Max. required voltage to trigger (V) @ –65°C	–	4.5	4.5	4.5	4.5	4.0
	@ –40°C	2.0	–	–	–	–	–
	@ 25°C	1.5	3.0	3.0	3.0	3.0	2.5
V_{GT}	Min. required voltage to trigger (V) @ 100°C	0.2	–	–	–	–	–
	@ 125°C	–	0.25	0.25	0.25	0.25	.03
VOLTAGE TYPES							
Repetitive Peak Forward and Reverse Voltages							
50		C234F C235F			C140F 2N3649	C141F 2N3654	
100		C234A C235A			C140A 2N3650	C141A 2N3655	
200		C234B C235B			C140B 2N3651	C141B 2N3656	
300		C234C C235C			C140C 2N3652	C141C 2N3657	
400		C234D C235D			C140D 2N3653	C141D 2N3658	
500		C234E C235E	C138E10 C138E20	C139E10 C139E20			C144E15 C144E30
600		C234M C235M	C138M10 C138M20	C139M10 C139M20			C144M15 C144M30
700			C138S10 C138S20	C139S10 C139S20			C144S15 C144S30
800			C138N10 C138N20	C139N10 C139N20			C144N15 C144N30
PACKAGE OUTLINE NO.		241 (C235) 2, 3, 4, 5 & 6 (C234)	107	107	107	107	107

(1) V_{RRM} = 50V



109

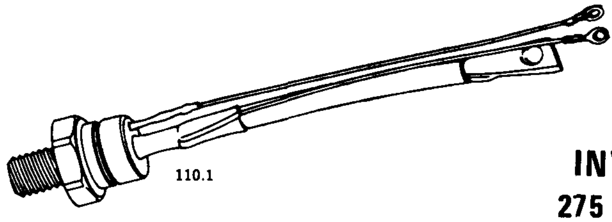
INVERTER SCR's
63 TO 270 AMPERES



108

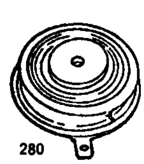
108.1

GE TYPE		C48/C148	C49/C149	C154, 156	C155, 157	C158, 159	C164, 165	C354, 355	C358
CONSTRUCTION		ALL DIFFUSED	ALL DIFFUSED	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE
ELECTRICAL SPECIFICATIONS									
VOLTAGE RANGE		600-1200	100-600	100-600	100-600	500-1200	100-600	100-600	500-1200
FORWARD CONDUCTION									
$I_{T(RMS)}$	Max. forward conduction sinusoidal @ T_C = 65°C, 50% duty (A)								
	@ 60 Hz	110/63	110/63	110	110	110	110	270	225
	@ 600 Hz	110/63	110/63	110	110	110	110	250	225
	@ 1200 Hz	110/63	110/63	110	110	110	110	225	225
	@ 2500 Hz	110/63	110/63	110	110	100	110	150	175
	@ 5000 Hz	110/63	110/63	110	110	90	110	–	140
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	700	1000	1800	1800	1600	1800	1800	1600
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	2000	4150	13,200	13,200	10,500	13,500	13,200	10,500
$R_{\theta JC}$	Max. thermal Impedance (°C)	.35	.35	.3	.3	.3	.3	.13	.135
$t_d + t_r$	Typical turn-on time (μsec)	2	2	2	2	5	2.0	2	5
t_q	Turn-off time @ rated voltage and T_J V_R = 50V min. (μsec) @ 20V/μsec reapplied	30, 40	10, 15	10	20	30	<10, 15	10	30
	@ 100V/μsec reapplied	–		15	25	35	<10, 15	15, 25	35
	@ 200V/μsec reapplied	40, 50	20, 25	20		40	10, 20	20, –	40
di/dt	Critical rate-of-rise of on-state current (A/μsec)	100	100	100	100	500	500	100	500
T_J	Junction operating temperature range (°C)	←				-40 to 125°C			→
BLOCKING									
dv/dt	Critical rate-of-rise off-state voltage exponential to rated V_{DRM} @ Max. T (V/μsec)	200	200	200	100	200	200	200	200
FIRING									
I_{GT}	Max. required gate current to trigger (mA) @ −40°C	300	300	200	200	300	400	200	300
	@ 125°C	120	120	120	120	125	175	120	125
V_{GT}	Max. required voltage to trigger (V) @ −40°C	3	3	3	3	5	5	3	5
	@ 125°C (Min.)	.15	.15	.15	.15	.15	.15	.15	.15
VOLTAGE TYPES									
Repetitive Peak Forward and Reverse Voltages									
100			C49A C149A	C154A C156A	C155A C157A		C164A C165A	C354A C355A	
150			C49G C149G	C154G C156G	C155G C157G			C354G C355G	
200			C49B C149B	C154B C156B	C155B C157B		C164B C165B	C354B C355B	
300			C49C C149C	C154C C156C	C155C C157C		C164C C165C	C354C C355C	
400			C49D C149D	C154D C156D	C155D C157D		C164D C165D	C354D C355D	
500			C49E C149E	C154E C156E	C155E C157E	C158E C159E	C164E C165E	C354E C355E	C358E
600		C48M C148M	C49M C149M	C154M C156M	C155M C157M	C158M C159M	C164M C165M	C345M C355M	C358M
700		C48S C148S				C158S C159S	C165S		C358S
800		C48N C148N				C158N C159N	C165N		C358N
900		C48T C148T				C158T C159T			C358T
1000		C48P C148P				C158P C159P			C358P
1100		C48PA C148PA				C158PA C159PA			C358PA
1200		C48PB C148PB				C158PB C159PB			C358PB
PACKAGE TYPE		½"/¼" STUD	½"/¼" STUD	½" STUD	½" STUD	½" STUD	½" STUD	½" PRESSPAK	½" PRESS PAK
PACKAGE OUTLINE NO.		109/108.1	109/108.1	109, 108	109, 108	109, 108	109	280	280



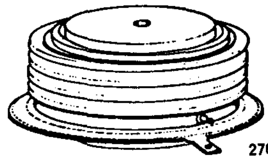
110.1

INVERTER SCR's
275 TO 400 AMPERES



280

GE TYPE		C184/C185	C186	C364	C365	C384/C385	C386
CONSTRUCTION		AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE
ELECTRICAL SPECIFICATIONS							
VOLTAGE RANGE		100-800	700-1200	100-600	100-800	100-800	700-1200
FORWARD CONDUCTION							
$I_{T(RMS)}$	Max. forward conduction sinusoidal @ T_C = 65°C, 50% duty (A)						
	@ 60 Hz	300		275	275	400	400
	@ 600 Hz	250		275	275	275	300
	@ 1200 Hz	190	235	270	270	275	300
	@ 2500 Hz	–		200	200	–	
	@ 5000 Hz	–		140	140	–	
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	3500	3500	1800	1800	3500	3500
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	50,000	50,000	13,500	13,500	50,000	50,000
$R_{\theta JC}$	Max. thermal impedance (°C/W)	.15	.15	.135	.135	.095	.095
$t_d + t_r$	Typical turn-on time (µsec)	2	2	2	2	2	2
t_q	Turn-off time @ rated voltage and T_J V_R = 50 volts min. (µsec) @ 20V/µsec reapplied		30				
	@ 100V/µsec reapplied		35				
	@ 200V/µsec reapplied	10-20	40	10	20	10-20	30
di/dt	Critical rate-of-rise of on-state current (A/µsec)	800	500	800	800	800	500
T_J	Junction operating temperature range (°C)	−40 to 125°C	−40 to 125°C	−40 to 125°C	−40 to 125°C	−40 to 125°C	−40 to 125°C
BLOCKING							
dv/dt	Min. critical rate-of-rise of off-state voltage exponential to rated V_{DRM} @ Max. T_J (V/µsec)	200	200	500	500	200	200
FIRING							
I_{GT}	Max. required gate current to trigger (mA) @ −40°C	500	300	400	400	500	300
	@ 125°C	250	250	175	175	250	250
V_{GT}	Max. required voltage to trigger (V) @ −40°C	5	5	5	5	5	5
	@ 125°C (Min.)	.15	.15	.15	.15	.15	.25
VOLTAGE TYPES							
Repetitive Peak Forward and Reverse Voltages							
	100	C184A/C185A		C364A	C365A	C384A/C385A	
	150	C185G				C385G	
	200	C184B/C185B		C364B	C365B	C384B/C385B	
	300	C184C/C185C		C364C	C365C	C384C/C385C	
	400	C184D/C185D		C364D	C365D	C384D/C385D	
	500	C184E/C185E		C364E	C365E	C384E/C385E	
	600	C184M/C185M		C364M	C365M	C384M/C385M	
	700	C185S	C186S		C365S	C385S	C386S
	800	C185N	C186N		C365N	C385N	C386N
	900		C186T				C386T
	1000		C186P				C386P
	1100		C186PA				C386PA
	1200		C186PB				C386PB
	1300						
PACKAGE TYPE		¾" STUD	¾" STUD	½" PRESS PAK	½" PRESS PAK	½" PRESS PAK	½" PRESS PAK
PACKAGE OUTLINE NO.		110.1	110.1	280	280	280	280



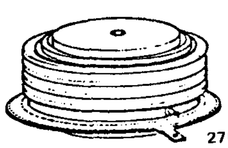
276

INVERTER SCR's
500 TO 700 AMPERES

GE TYPE		C387	C388	C397	C398	C392	C393
CONSTRUCTION		AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE
ELECTRICAL SPECIFICATIONS							
VOLTAGE RANGE		500-1200	500-1200	500-1200	500-1200	100-600	100-600
FORWARD CONDUCTION							
$I_{T(RMS)}$	Max. forward conduction sinusoidal @ T_C = 65°C, 50% duty (A)						
	@ 60 Hz	550	550	700	700	500	500
	@ 600 Hz	530	530	650	650	450	450
	@ 1200 Hz	455	455	550	550	400	400
	@ 2500 Hz	225	225	275	275	210	210
	@ 5000 Hz	120	120	150	150	145	145
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	5500	5500	7500	7500	5500	5500
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	120,000	120,000	230,000	230,000	100,000	100,000
$R\theta_{JC}$	Max. thermal impedance (°C/W)	.06	.06	.06	.06	.06	.06
$t_d + t_r$	Typical turn-on time (µsec)	2	2	2	2	2	2
t_q	Turn-off time @ rated voltage and T_J V_R = 50 V min. (µsec) @ 20V/µsec reapplied	30	20	40	30	10	15
	@ 100V/µsec reapplied	35	25	50	35	12	18
	@ 200V/µsec reapplied	40	30	60	40	14	20
di/dt	Critical rate-of-rise of on-state current (A/µsec)	500	500	800	800	800	800
T_J	Junction operating temperature range (°C)	−40 to +125°C	−40 to +125°C	−40 to +125°C	−40 to +125°C	−40 to +125°C	−40 to +125°C
BLOCKING							
dv/dt	Min. critical rate-of-rise off-state voltage exponential to rated V_{DRM} @ Max. T_J (V/µsec)	200	200	200	200	200	200
FIRING							
I_{GT}	Max. required gate current to trigger (mA) @ −40°C	300	300	300	300	400	400
	@ 125°C	125	125	125	125	150	150
V_{GT}	Max. required voltage to trigger (V) @ −40°C	5	5	5	5	5	5
	@ 125°C (Min.)	.15	.15	.15	.15	.15	.15
VOLTAGE TYPES							
Repetitive Peak Forward and Reverse Voltages							
100						C392A	C393A
200						C392B	C393B
300						C392C	C393C
400						C392D	C393D
500		C387E	C388E	C397E	C398E	C392E	C393E
600		C387M	C388M	C397M	C398M	C392M	C393M
700		C387S	C388S	C397S	C398S		
800		C387N	C388N	C397N	C398N		
900		C387T	C388T	C397T	C398T		
1000		C387P	C388P	C397P	C398P		
1100		C387PA	C388PA	C397PA	C398PA		
1200		C387PB	C388PB	C397PB	C398PB		
PACKAGE TYPE		1" PRESS PAK	1" PRESS PAK	1" PRESS PAK	1" PRESS PAK	1" PRESS PAK	1" PRESS PAK
PACKAGE OUTLINE NO.		276	276	276	276	276	276

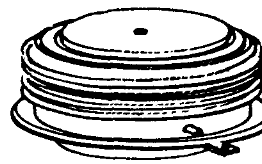
INVERTER SCR's
700 TO 1000 AMPERES

GE TYPE		C394	C395	C444/C445	C447/C448	C449
CONSTRUCTION		AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE
ELECTRICAL SPECIFICATIONS						
VOLTAGE RANGE		100-600	100-600	100-600	500-1200	1500-1800
FORWARD CONDUCTION						
$I_{T(RMS)}$	Max. forward conduction sinusoidal @ T_C = 65°C, 50% duty (A)					
	@ 60 Hz	700	700	1000	900	850
	@ 600 Hz	650	650	1000	900	800
	@ 1200 Hz	550	550	1000	900	750
	@ 2500 Hz	275	275	1000	800	–
	@ 5000 Hz	150	150	800	615	–
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	8000	8000	12,000	10,000	6500
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	250,000	250,000	600,000	415,000	–
$R\theta_{JC}$	Max. thermal impedance (°C/W)	.06	.06	.04	.04	.04
$t_d + t_r$	Typical turn-on time (µsec)	2.0	2.0	2.0	2.0	–
t_q	Turn-off time @ rated voltage and T_J V_R = 50V min. (µsec) @ 20V / µsec reapplied	10	15	–	–	–
	@ 200V / µsec reapplied	14	20	10-20	–	40
	@ 400V / µsec reapplied	–	–	15	40-25	–
di/dt	Critical rate-of-rise of on-state current (A/µsec)	800	800	800	800	500
T_J	Junction operating temperature range (°C)	−40 to 125°C	−40 to 125°C	−40 to 125°C	−40 to 125°C	−40 to 125°C
BLOCKING						
dv/dt	Min. critical rate-of-rise off-state voltage exponential to rated V_{DRM} @ Max. T_J (V/µsec)	200	200	200	400	200
FIRING						
I_{GT}	Max. required gate current to trigger (mA) @ −40°C	400	400	400	400	200
	@ 125°C	150	150	150	150	150
V_{GT}	Max. required voltage to trigger (V) @ −40°C	5	5	5	5	5
	@ 125°C (Min.)	.15	.15	.15	.25	.15
VOLTAGE TYPES						
Repetitive Peak Forward and Reverse Voltages						
100		C394A	C395A	C444/C445A		
200		C394B	C395B	C444/C445B		
300		C394C	C395C	C444/C445C		
400		C394D	C395D	C444/C445D		
500		C394E	C395E	C444/C445E	C447/C448E	
600		C394M	C395M	C444/C445M	C447/C448M	
700					C447/C448S	
800					C447/C448N	
900					C447/C448T	
1000					C447/C448P	
1100					C447/C448PA	
1200					C447/C448PB	
1300						
1400						
1500						C449PE
1600						C449PM
1700						C449PS
1800						C449PN
PACKAGE TYPE		1" PRESS PAK	1" PRESS PAK	1" PRESS PAK	1" PRESS PAK	1" PRESS PAK
PACKAGE OUTLINE NO.		276	276	276	276	276



276

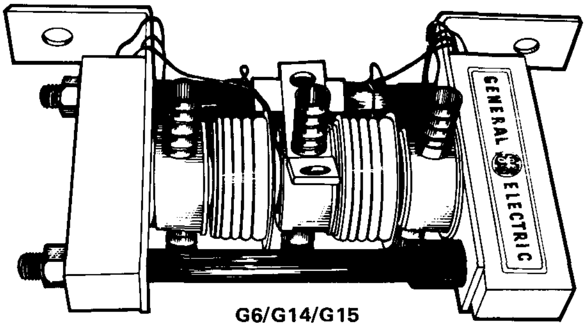
INVERTER SCR's
700 TO 1500 AMPERES



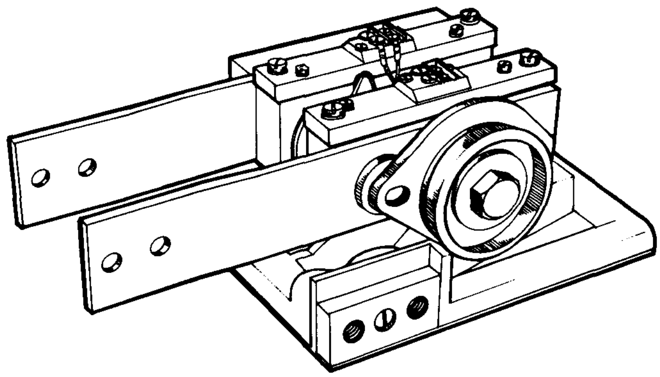
276.1

GE TYPE		C648	C612	C613	C712
CONSTRUCTION		AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE	AMPLIFYING GATE
ELECTRICAL SPECIFICATIONS					
VOLTAGE RANGE		500-1200	1500-1800	1500-2000	1500-2000
FORWARD CONDUCTION					
$I_{T(RMS)}$	Max. forward conduction sinusoidal @ T_C = 65°C, 50% duty (A)				
	@ 60 Hz	1150	700	800	1500
	@ 600 Hz	1150	700	800	1500
	@ 1200 Hz	1150	–	800	1500
	@ 2500 Hz	1100	–	750	1500
	@ 5000 Hz	1100	–	675	1100
I_{TSM}	Max. peak one cycle, non-repetitive surge current (A)	10,000	6500	6500	20,000
I^2t	Max. I^2t for fusing for 5 to 8.3 msec (A^2 sec)	415,000	150,000	80,000	1,660,000
$R_{\theta JC}$	Max. thermal impedance (°C/W)	.04	.04	.04	.023
$t_d + t_r$	Typical turn-on time (μsec)	2.5	2.0	–	–
t_q	Turn-off time @ rated voltage and T_J V_R = 50V min. (μsec) @ 20V/μsec	–	–	–	–
	@ 200V/μsec reapplied	–	–	40	50
	@ 400V/μsec reapplied	40	60	40	–
di/dt	Critical rate-of-rise of on-state current (A/μsec)	800	500	500	800
T_J	Junction operating temperature range (°C)	–40 to 125°C	–40 to 125°C	–40 to 125°C	–40 to 125°C
BLOCKING					
dv/dt	Min. critical rate-of-rise of off-state voltage exponential to rated V_{DRM} @ Max. T_J (V/μsec)	400	200	400	500
FIRING					
I_{GT}	Max. required gate current to trigger (mA) @ –40°C	350	200 Typ	200	200
	@ 125°C	100	125 Typ	30	30
V_{GT}	Max. required voltage to trigger (V) @ –40°C	5	5	5	5
	@ 125°C	3	3	3	3
VOLTAGE TYPES					
Repetitive Peak Forward and Reverse Voltages					
	100	–	–	–	–
	200	–	–	–	–
	300	–	–	–	–
	400	–	–	–	–
	500	C648E	–	–	–
	600	C648M	–	–	–
	700	C648S	–	–	–
	800	C648N	–	–	–
	900	C648T	–	–	–
	1000	C648P	–	–	–
	1100	C648PA	–	–	–
	1200	C648PB	–	–	–
	1300	–	–	–	–
	1400	–	–	–	–
	1500	–	C612PE	C613PE	C712PE
	1600	–	C612PM	C613PM	C712PM
	1700	–	C612PS	C613PS	C712PS
	1800	–	C612PN	C613PN	C712PN
	1900	–	–	C613PT	C712PT
	2000	–	–	C613L	C712L
PACKAGE TYPE		1" PRESS PAK	1" PRESS PAK	1" PRESS PAK	1" PRESS PAK
PACKAGE OUTLINE NO.		276	276	276	276.1

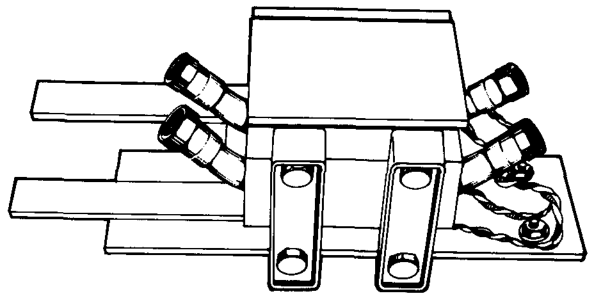
HEAT EXCHANGER MODULES
for
HIGH CURRENT RECTIFIERS & SCRs



G6/G14/G15



G9/G10/3N221/3N222



G11

CELL DATA			180° CONDUCTION, LIQUID COOLED AT 40°C (1 GPM)		
CELL NO.	MAX. VOLTS PER CELL	SINGLE SURGE AMPS	AVG. CURRENT PER CELL G6/G14/G15	AVG. CURRENT PER CELL G11	RMS CURRENT FOR SWITCH G9/G10/3N221/3N222
A390	1500	7,000	600	–	–
A430	1500	10,000	1100	–	–
A540	2400	12,000	1150	–	–
A570	600	18,000	1500	–	–
C350	1300	1,600	190	190	–
C380	1300	3,500	260	260	–
C390	1300	8,000	500	–	–
C391	1800	8,000	450	–	–
C398	1200	7,500	450	–	–
C440	1300	11,000	760	–	–
C441	1800	10,000	640	–	–
C501	2000	8,000	550	–	1500
C502	2100	8,000	475	–	–
C602	2600	10,000	525	–	1600
C701	2000	18,000	–	–	3000
C702	2400	15,000	–	–	2500

Medium & High Current Rectifier Modules

NOMENCLATURE

A2011BC1AD1 is a 200V, single phase center tap, using A20 cells on type 11 Fins, capable of conducting 6.3A ave. per cell at 180° C conduction angle in free air or 9.8A per cell in 2000 linear feet per minute forced air.

A20	11	B	C	1	A	D	1
Cell Data	Fin Data	Cell Peak Reverse Voltage Rating	Circuit Designator	Number of cells in series each leg	Polarity	Mechanical Features	Number of cells in parallel each leg

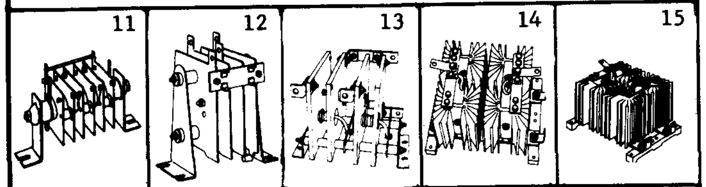
NUMBER OF CELLS IN PARALLEL EACH LEG.

MECHANICAL FEATURES
A. NO BRACKETS OR MOUNTING FEET.
D. STANDARD
OTHERS AVAILABLE ON SPECIAL ORDER.

POLARITY
A. POSITIVE B. NEGATIVE

NUMBER OF CELLS IN SERIES EACH LEG

CELL DATA / FIN DATA



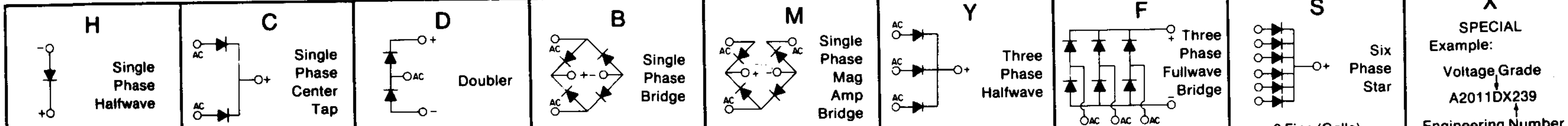
CELL NUMBER	MAX VOLT PER CELL	SINGLE ∿ SURGE-AMPS	11 FREE CONVECT	11 2000 LFPM	12 FREE CONVECT	12 2000 LFPM	13 FREE CONVECT	13 2000 LFPM	14 FREE CONVECT	14 2000 LFPM	15 FREE CONVECT	15 2000 LFPM
A20	600	150	6.3	9.8								
A25	600	240	9.4	15.5								
A28	400	150			6.3	9.8						
A27	1200	240			12.5	18.4						
A35	600	400	12.5	25.0	20.0	29.0						
A38	1200	500	12.5	25.0	20.0	29.0						
A70	1000	1600	60.4*	99.4*	44.2	80.6	64.4	99.4	78.2	96.9		
A190	1000	4500					83.7	220			160	250

* 3½" X 3½" extrusion

CELL PEAK REVERSE VOLTAGE RATING

25V - U	200V - B	500V - E	800V - N	2000V - L	NOTE: FOR PRV RATINGS NOT LISTED USE MULTIPLE LETTERS FOR ie. - PB = 1200V
50V - F	300V - C	600V - M	900V - T		
100V - A	400V - D	700V - S	1000V - P		

CIRCUIT DESIGNATOR



H	C	D	B	M	Y	F	S	X
Single Phase Halfwave	Single Phase Center Tap	Doubler	Single Phase Bridge	Single Phase Mag Amp Bridge	Three Phase Halfwave	Three Phase Fullwave Bridge	Six Phase Star	SPECIAL Example: Voltage Grade A2011DX239 Engineering Number Used For All Specials
1 Fin (Cell) In Basic Circuit	2 Fins (Cells) In Basic Circuit	2 Fins (Cells) In Basic Circuit	4 Fins (Cells) In Basic Circuit	4 Fins (Cells) In Basic Circuit	3 Fins (Cells) In Basic Circuit	6 Fins (Cells) In Basic Circuit	6 Fins (Cells) In Basic Circuit	

SCR Medium & High Current Modules

NOMENCLATURE

C10 12BA1AD1 is a 200V, full wave (back to back) bridge connected C10 cells on type 12 Fins, capable of controlling 4.7 amp average per SCR in free air or 6.2 amp average per cell with 1000 linear feet per minute forced air.

C10	12	B	A	1	A	D	1

NUMBER OF CELLS IN PARALLEL EACH LEG.

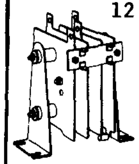
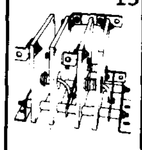
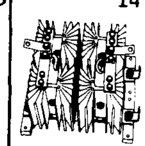
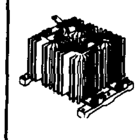
MECHANICAL FEATURES
A. NO BRACKETS OR MOUNTING FEET.
D. STANDARD
OTHERS AVAILABLE ON SPECIAL ORDER.

POLARITY & MINOR ELECTRICAL MODIFICATIONS
A. POSITIVE OR STANDARD
B. NEGATIVE
C.} D.} OTHER DEPENDING ON CIRCUIT

NUMBER OF CELLS IN SERIES EACH LEG

CELL DATA

FIN DATA

12

13

14

15


CELL NUMBER	MAX VOLT PER CELL	SINGLE ∿ SURGE-AMPS	COMPATIBLE RECTIFIER	12 FREE CONVECT	12 1000 LFPM	13 FREE CONVECT	13 1000 LFPM	14 FREE CONVECT	14 1000 LFPM	15 FREE CONVECT	15 1000 LFPM
C10	400	60	1N1341-46A	4.7	6.2	4.7	6.2				
C11	600	60	1N1341A-46A	4.7	6.2	3.98	6.0				
C35	800	150	1N2154-59	10.1	16.3	6.3	12.2				
C150	1300	1500	1N3292-96					44.0			
C50	500	1000	1N3289-92					52.0	62.9		
C60	400	1000	1N3289-91					64	78.1		
C180	1300	3500	1N3735-42							106	
C185	500	3500	1N3735-39							106	

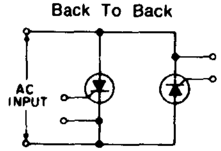
CELL PEAK REVERSE VOLTAGE RATING

25V - U	200V - B	500V - E	800V - N	2000V - L
50V - F	300V - C	600V - M	900V - T	
100V - A	400V - D	700V - S	1000V - P	

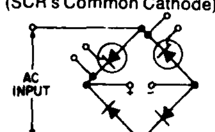
NOTE: FOR PRV RATINGS NOT LISTED USE MULTIPLE LETTERS: FOR ie. - PB = 1200V

CIRCUIT DESIGNATOR

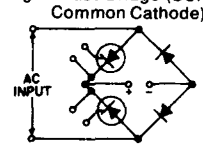
A Back To Back



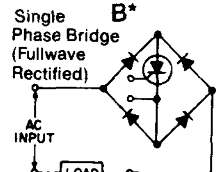
B* Single Phase Bridge (SCR's Common Cathode)



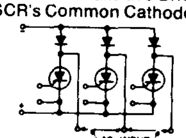
B* Single Phase Bridge (SCR Common Cathode)



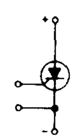
B* Single Phase Bridge (Fullwave Rectified)



F* Three Phase Fullwave Bridge (SCR's Common Cathode)



H Single Phase Halfwave

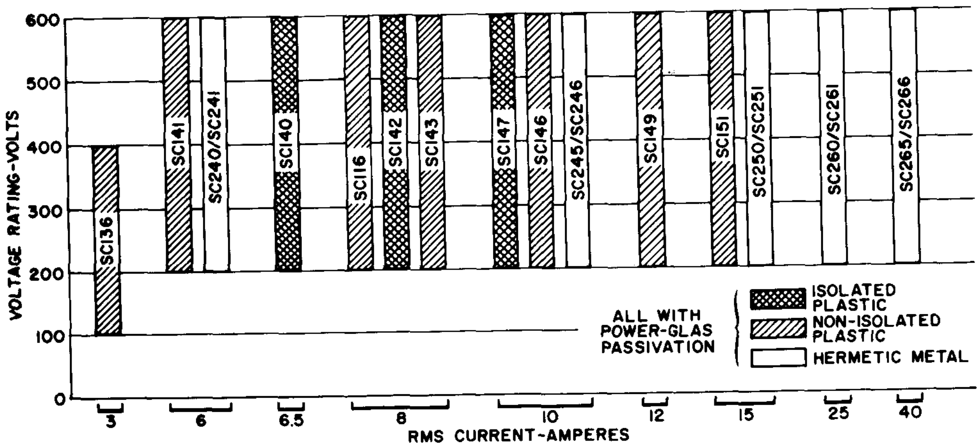


X SPECIAL (Followed By Arbitrary Number)
Example:
Voltage Grade
C1012DX239
Engineering Number Used For All Specials

(Many Additional Variations Are Available Upon Request)

*Note: Circuit description is necessary when ordering stacks to this circuit configuration.

TRIAC SELECTOR GUIDE



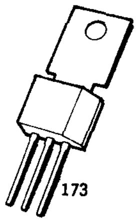
TRIAC TRIGGERS

The ST2 (diac) is a silicon bi-directional diode which may be used for triggering triacs or SCR's. It has a three layer structure with negative resistance switching characteristics in both directions.

The ST4 is an asymmetrical AC trigger integrated circuit for use in triac phase control applications. This device reduces the snap-on effects that are present in conventional trigger circuits by eliminating control circuit hysteresis. This performance is possible with a single RC time constant where as a symmetrical circuit of comparable performance would require at least three more passive components.

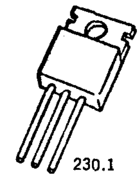
GE Type	V_{S2} Switching Voltage Min. (V)	V_{S2} Switching Voltage Max. (V)	V_{S1} Switching Voltage Min. (V)	V_{S1} Switching Voltage Max. (V)	I_{S2}, I_{S1} Switching Current Max. (μA)	Pulse Output Min. (V)	Package Outline No.
ST2	28[1]	36[1]	28[1]	36[1]	200	3.0	B
ST4	7	9	14	18	80	3.5	A

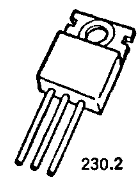
[1] For ST2, $V_{S2} = V_{S1} \pm 10\%$



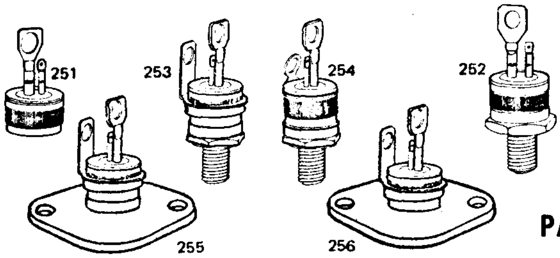
TRIACS – ENCAPSULATED PACKAGE

POWER GLAS™ PASSIVATED PELLETS



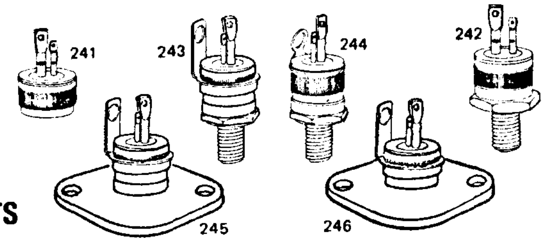


			POWER TAB™		ISOLATED POWER PAC™			NON-ISOLATED POWER PAC™				
GE TYPE			SC136	SC116	SC140	SC142	SC147	SC141	SC143	SC146	SC149	SC151
ELECTRICAL SPECIFICATIONS												
VOLTAGE CHARACTERISTICS												
V_{DRM}	Repetitive Peak Off-State Voltage @ T_C = -40°C to +100°C											
	100 V		SC136A	–	–	–	–	–	–	–	–	–
	200 V		SC136B	SC116B	SC140B	SC142B	SC147B	SC141B	SC143B	SC146B	SC149B	SC151B
	400 V		SC136D	SC116D	SC140D	SC142D	SC147D	SC141D	SC143D	SC146D	SC149D	SC151D
	500 V		–	SC116E	SC140E	SC142E	SC147E	SC141E	SC142E	SC146E	SC149E	SC151E
	600 V		–	SC116M	SC140M	SC142M	SC147M	SC141M	SC142M	SC146M	SC149M	SC151M
V_{TM}	Max. On-State Voltage at Peak of RMS Current Rating (V)		1.8	1.63	1.85	1.75	1.50	1.83	1.55	1.65	1.65	1.52
CURRENT CHARACTERISTICS												
$I_{T(RMS)}$	Max. RMS On-State Current (A)		3	8	6.5	8	10	6	8	10	12	15
$T_{C(MAX)}$	Max. Case Temperature at Rated RMS Current (°C)		65	32	80	75	80	80	80	80	75	80
I_{TSM}	Max. Peak One Cycle Non-Repetitive Surge Current (A)											
	@ 50 Hz		–	90	74	104	104	74	110	110	110	110
	@ 60 Hz		30	100	80	110	110	80	120	120	120	120
I_{DRM}	Max. Leakage Current at T_C = 25°C (mA)		.01	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
I_H	Max. DC Holding Current (mAdc)											
	@ +25°C		50	50	50	50	50	50	50	50	50	50
	@ -40°C		100	100	100	100	100	100	100	100	100	100
I_L	Max. DC Latching Current (mAdc)											
	@ T_C = +25°C	MT2+ Gate+	50	100	100	100	100	100	100	100	100	100
		MT2– Gate–	50	100	100	100	100	100	100	100	100	100
		MT2+ Gate–	100	200	200	200	200	200	200	200	200	200
	@ T_C = -40°C	MT2+ Gate+	100	200	200	200	200	200	200	200	200	200
		MT2– Gate–	100	200	200	200	200	200	200	200	200	200
		MT2+ Gate–	200	400	400	400	400	400	400	400	400	400
BLOCKING												
dv/dt	Typical Static dv/dt at Rated V_{DRM}, Gate Open Circuited (V/μsec)											
	@ T_C = 100°C		–	150	100	150	150	100	150	150	200	200
	@ T_C = 110°C		50	–	–	–	–	–	–	–	–	–
$dv/dt_{(c)}$	Min. Commutating dv/dt at Rated V_{DRM} and di/dt = (0.54) $I_{T(RMS)}$ A/msec. Gate Open Circuited, (V/μsec).		5	4	4	4	4	4	4	4	4	4
TRIGGERING												
I_{GT}	Max. Required DC Gate Current (mAdc) to Trigger, @ V_D = 12 Vdc											
	@ T_C = +25°C	MT2+ Gate+	25	50	50	50	50	50	50	50	50	50
		MT2– Gate–	25	50	50	50	50	50	50	50	50	50
		MT2+ Gate–	25	80	50	50	50	50	50	50	50	50
	@ T_C = -40°C	MT2+ Gate+	50	80	80	80	80	80	80	80	80	80
		MT2– Gate–	50	80	80	80	80	80	80	80	80	80
		MT2+ Gate–	50	130	80	80	80	80	80	80	80	80
V_{GT}	Max. Required DC Gate Voltage to Trigger, MT2+ Gate+, MT2– Gate–, MT2+ Gate–. @ V_D = 12 Vdc, (V).											
	@ T_C = +25°C		2.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	@ T_C = -40°C		3.0	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
MECHANICAL SPECIFICATIONS												
PACKAGE OUTLINE NO.												
	Non-Isolated Tab		173	173	–	–	–	230.2 ←——→				230.2
	Isolated Tab		–	–	230.1	230.1	230.1	–	–	–	–	–

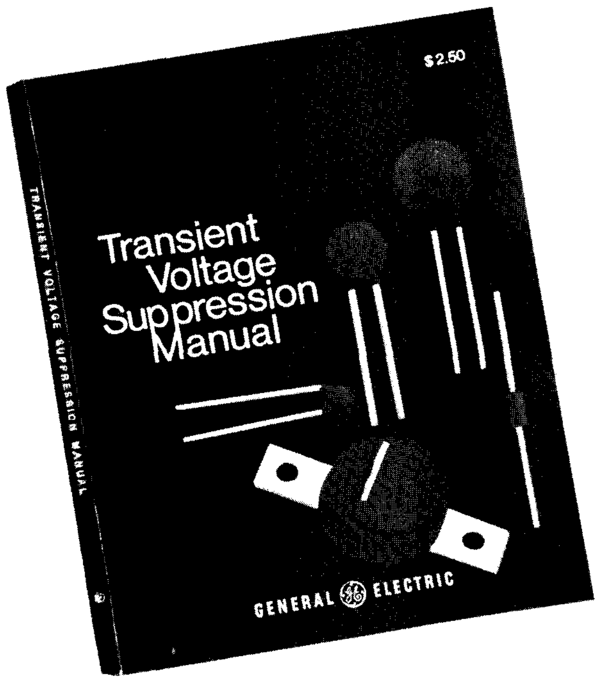


TRIACS HERMETIC PACKAGES

POWER GLAS™ PASSIVATED PELLETS



GE TYPE		STUD/TO-3 FLANGE	SC240	SC245	SC250	SC260	SC265
		PRESS-FIT	SC241	SC246	SC251	SC261	SC266
ELECTRICAL SPECIFICATIONS							
VOLTAGE CHARACTERISTICS							
V_{DRM}	Repetitive Peak Off-State Voltage @ T_C = -40°C to +100°C	200 V	SC240/1B	SC245/6B	SC250/1B	SC260/1B	SC265/6B
		400 V	SC240/1D	SC245/6D	SC250/1D	SC260/1D	SC265/6D
		500 V	SC240/1E	SC245/6E	SC250/1E	SC260/1E	SC265/6E
		600 V	SC240/1M	SC245/6M	SC250/1M	SC260/1M	SC265/6M
V_{TM}	Max. On-State Voltage at Peak of RMS Current Rating (V)		1.83	1.65	1.65	1.58	1.38
CURRENT CHARACTERISTICS							
$I_{T(RMS)}$	Max. RMS On-State Current (A)		6	10	15	25	40
$T_{C(MAX)}$	Max. Case Temperature at Rated RMS Current (°C) for	Non-Isolated Stud/Press-Fit	82	80	86	80	81
		Isolated Stud/Non-Isolated TO-3 Flange	80	78	83	75	74
		Isolated TO-3 Flange	79	76	80	71	68
I_{TSM}	Max. Peak One Cycle Non-Repetitive Surge Current (A)	@ 50 Hz	74	90	90	230	275
		@ 60 Hz	80	100	100	250	300
I_{DRM}	Max. Leakage Current at T_C = 25°C (mA)		0.1	0.1	0.1	0.2	0.2
I_H	Max. DC Holding Current (mAdc)	@ T_C = +25°C	50	50	50	75	75
		@ T_C = -40°C	100	100	100	150	150
I_L	Max. DC Latching Current (mAdc)	@ T_C = +25°C MT2+ Gate+	100	100	100	100	100
		MT2− Gate−	100	100	100	100	100
		MT2+ Gate−	200	200	200	200	200
		@ T_C = -40°C MT2+ Gate+	200	200	200	200	200
		MT2− Gate−	200	200	200	200	200
		MT2+ Gate−	400	400	400	400	400
BLOCKING							
dv/dt	Typical Static dv/dt at Rated V_{DRM} Gate Open Circuited (V/µsec)		100	150	250	150	150
$dv/dt_{(c)}$	Min. Commutating dv/dt at Rated V_{DRM} and di/dt = (0.54) $I_{T(RMS)}$ A/µsec, Gate Open Circuited (V/µsec)		4	4	4	5	5
TRIGGERING							
I_{GT}	Max. Required DC Gate Current to Trigger, MT2+ Gate+, MT2− Gate−, MT2+ Gate−, @ V_D = 12 Vdc (mAdc)	@ T_C = +25°C	50	50	50	50	80
		@ T_C = -40°C	80	80	80	80	120
V_{GT}	Max. Required DC Gate Voltage to Trigger, MT2+ Gate+, MT2− Gate−, MT2+ Gate−, @ V_D = 12 Vdc	@ T_C = +25°C	2.5	2.5	2.5	2.5	2.5
		@ T_C = -40°C	3.5	3.5	3.5	3.5	3.5
MECHANICAL SPECIFICATIONS							
PACKAGE OUTLINE NUMBER			241 (SC241) 242, 3, 4, 5 & 6 (SC240)	241 (SC241) 242, 3, 4, 5 & 6 (SC240)	241 (SC241) 242, 3, 4, 5 & 6 (SC240)	251 (SC261) 252, 3, 4, 5, & 6 (SC260)	251 (SC261) 252, 3, 4, 5, & 6 (SC260)



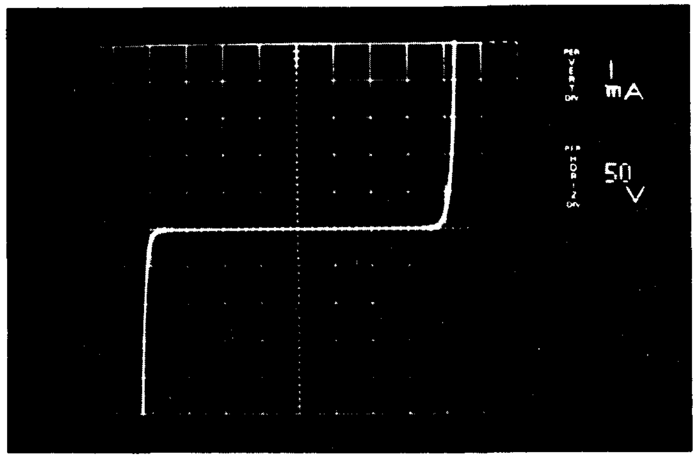
From General Electric
New Transient Protection Manual

New 112 page manual combines in one publication theory, knowledge and experience relating to transient cause, detection and protection accumulated by General Electric scientists and engineers...includes a comprehensive selection guide and product specification sheets for determining the optimum GE-MOV™ Varistor.

Copies are available from any authorized GE distributor, GE OEM Electronic Components Sales Office, or by sending $2.50 plus applicable tax to General Electric, Semiconductor Products Department, Electronics Park, Bldg. 7-49, Syracuse, New York 13201.

GE-MOV™ VARISTORS

General Electric zinc oxide varistors are voltage dependent, symmetrical resistors which perform in a manner similar to back-to-back zener diodes in circuit protective functions and offer advantages in performance and economics. When exposed to high energy voltage transients, the varistor impedance changes from a very high standby value to a very low conducting value thus clamping the transient voltage to a safe level. The dangerous energy of the incoming high voltage pulse is absorbed by the GE-MOV® varistor, thus protecting voltage sensititive circuit components.



I-V Oscillograph
(Actual Photo)

SELECTOR GUIDE

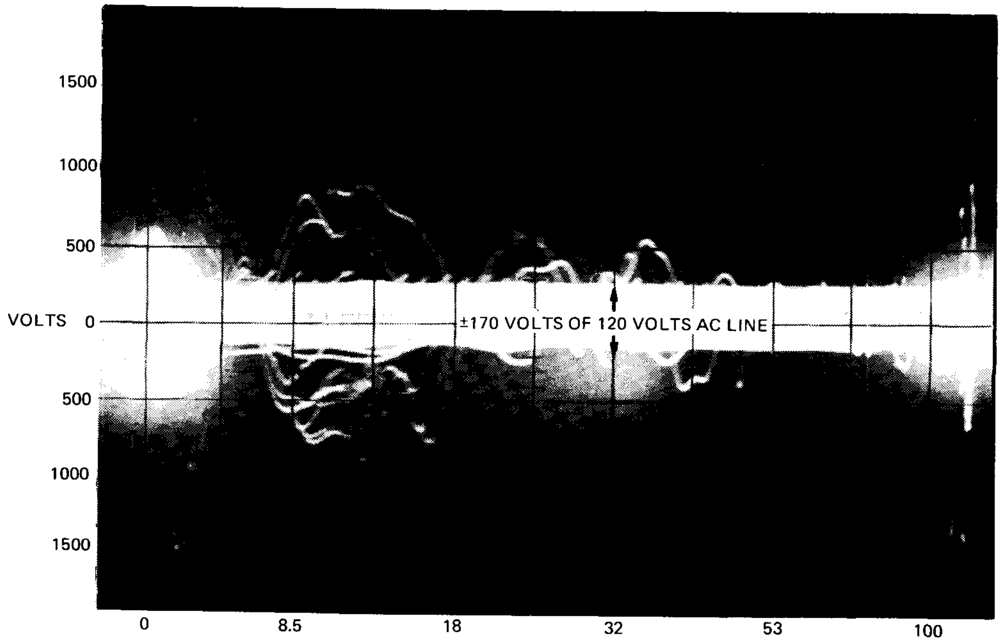
1. Determine maximum (steady-state) voltage appearing across the varistor when no transients are present. Include any high line conditions that may occur. For example: 117VRMS-10% high line = 129VRMS. Locate voltage on horizontal scale. Drop down to appropriate GE-MOV™ varistor series (i.e., MA, L and PA series).

2. Locate level of energy transient on the left-most vertical scale. Match with series determined in Step No. 1. Example: 129VRMS, 20 Joules (L and PA series). For unknown energy level, estimate by type of application. Less than 20 Amps. max. transient current, stored energy is low (e.g., relay contact protection). Or if varistor is placed after a transient-absorbing component (i.e., transformer, inductor, capacitor), then the MA series (.1-.7 Joules) is a good choice. For higher peak pulse current requirements, check the ZA, L, or PA series, depending on voltage.

3. After energy and applied voltage level considerations, average power dissipation needs must be considered. For infrequent transients (once/hour, once/day), any series is adequate. For frequent transients, or where rigid mounting is required, use the PA series. For specific selection, refer to individual spec sheets and application notes.

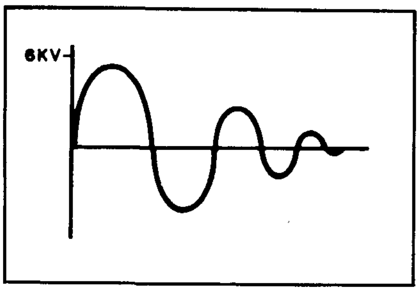
ENERGY (Joules)	AVERAGE POWER DISSIPATION (Watts)	MAXIMUM STEADY-STATE APPLIED VOLTAGE VOLTS – AC RMS: 15 35 75 95 130 150 275 290 420 480 550 575 1000 VOLTS – DC: 20 40 60 80 100 120 140 160 180 200 300 400 500 600 700 800	PACKAGES
.7	0.2	MA SERIES 18-264 VRMS 23-365 VDC	MAX. PEAK PULSE CURRENT 10-20A
.6-15	.17-.55	ZA SERIES 10-115 VRMS 14-.153 VDC	MAX. PEAK PULSE CURRENT 250-500A 1000-2000A
1-160	.24-1.3	L SERIES 95-1000 VRMS 120- 675 VDC	MAX. PEAK PULSE CURRENT 400A 2000A 4000A
10-80	3-15	PA SERIES 130-575 VRMS 170-750 VDC	MAX. PEAK PULSE CURRENT 4000A

THE CASE FOR GE-MOV™ VARISTORS

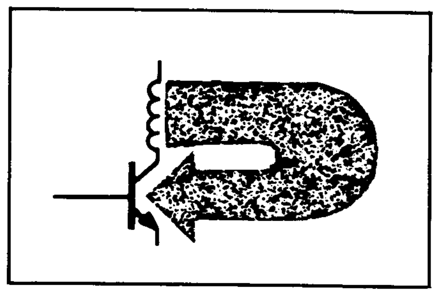


Actual photograph of oscilloscope recording of a household power line input (24 hours)

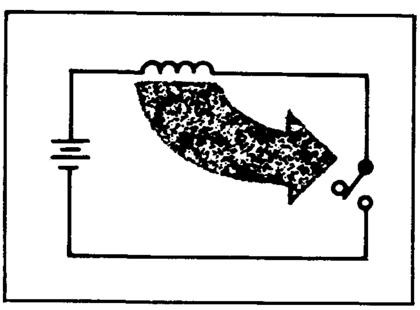
Voltage transient problems can be caused by:



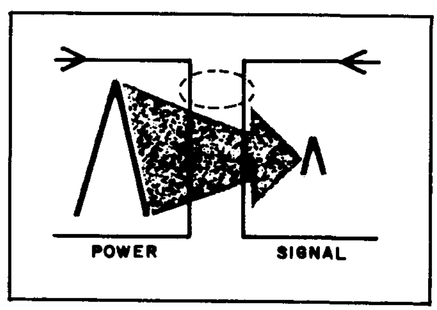
Lightning



Turning off inductive components



Contact switching



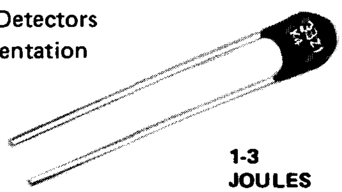
Electromagnetic coupling (noise)

GE-MOV™ VARISTOR CLAMP DANGEROUS VOLTAGE TRANSIENTS AND DISSIPATE THEM AS HARMLESS HEAT ENERGY.

ZA SERIES

APPLICATIONS

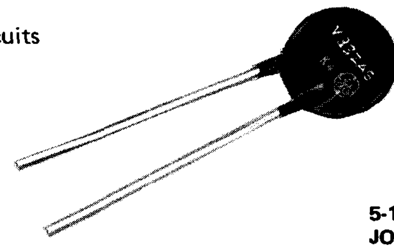
- Solid State Motor Control
- Solid State Relays/Timers
- AC Line Cord Protection
- Control Arc Suppression
- Traffic Controllers
- Communication Equipment
- Automobiles
- Calculators
- Smoke Detectors
- Instrumentation



1-3
JOULES

REPLACEMENT FOR the following when used as transient suppressor:

- Selenium Tryectors
- Zener Diodes
- Silicon Carbide
- Gas Discharge Tubes
- R-C Networks (non-dv/dt)
- Neon Bulbs
- Electronic Crowbar Circuits

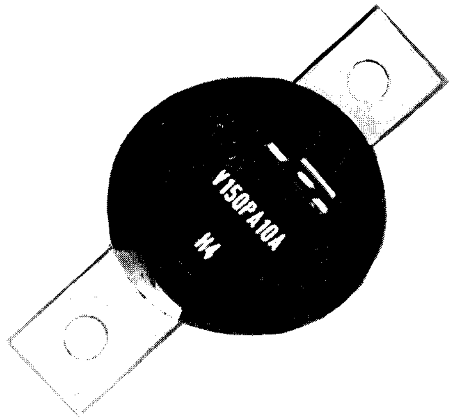


5-15
JOULES

Replaces Many Zeners • Voltages 12-115 VRMS, 16-153 VDC • Energy Absorption to 15 Joules • Peak Pulse Current to 1000A • Characterized @ 1mA DC • For Complete Specifications, see *Page No. 1438.*

MODEL NUMBER	MAXIMUM APPLIED VOLTAGE AC-RMS	MAXIMUM APPLIED VOLTAGE AC-PEAK 50-60Hz	MAXIMUM APPLIED VOLTAGE DC	MAXIMUM ENERGY JOULES	MAXIMUM NON-REPETITIVE PEAK PULSE CURRENT $t_p \leqslant 6\ \mu s$	MAXIMUM AVERAGE POWER DISSIPATION	MAXIMUM VARISTOR VOLTAGE AT 1 AMP/ PEAK
	VOLTS	VOLTS	VOLTS	(WATT-SECS)	AMPS	WATTS	VOLTS
V18ZA1 V18ZA3	10	14	14	0.5 3.0	250 1000	0.18 0.40	35 32
V22ZA1 V22ZA3	12	17	16	0.6 3.0	250 1000	0.17 0.40	46 43
V24ZA1 V24ZA4	15	21	19	0.8 4.0	250 1000	0.18 0.40	46 43
V27ZA1 V27ZA4	15	21	20	0.8 4.0	250 1000	0.18 0.40	54 52
V33ZA1 V33ZA5	20	28	26	1.0 5.0	250 1000	0.19 0.40	60 58
V39ZA1 V39ZA6	25	35	31	1.2 6.0	250 1000	0.20 0.45	70 65
V47ZA1 V47ZA7	30	42	38	1.4 7.0	250 1000	0.21 0.45	82 76
V56ZA2 V56ZA8	35	49	45	1.7 8.0	250 1000	0.22 0.45	86 91
V68ZA2 V68ZA10	40	57	56	2.0 10.0	250 1000	0.24 0.50	112 108
V82ZA2 V82ZA12	50	71	66	2.5 12.0	250 1000	0.25 0.50	135 130
V100ZA3 V100ZA15	60	85	81	3.0 15.0	250 1000	0.26 0.55	160 154
V120ZA1 V120ZA6	75 75	106 106	102 102	1.0 6.0	500 2000	0.20 0.45	200 190
V150ZA1 V150ZA8	85 95	134 134	127 127	1.2 8.0	500 2000	0.20 0.45	245 240
V180ZA1 V180ZA10	115 115	163 163	153 153	1.5 10.0	500 2000	0.20 0.45	285 290

PA SERIES



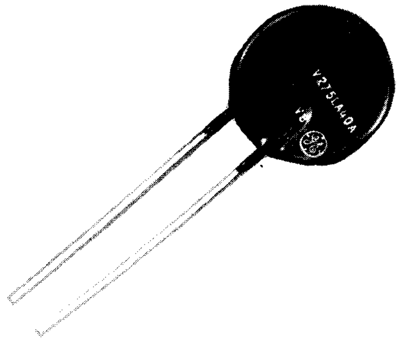
Rigid Mounting • Up to 15W Dissipation • Voltage Range 130-575 VRMS, 170-750 VDC • Peak Pulse Current to 4000A • Meets NEMA Creep and Strike Distance • For Complete Specifications, see *Page No. 1432.*

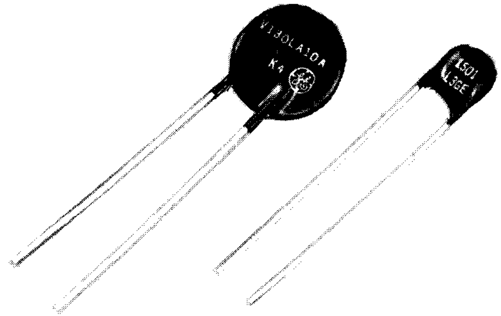
MODEL NUMBER	MAXIMUM APPLIED VOLTAGE AC-RMS	MAXIMUM APPLIED VOLTAGE AC-PEAK 50-60Hz	MAXIMUM APPLIED VOLTAGE DC	MAXIMUM ENERGY JOULES	MAXIMUM NON-REPETITIVE PEAK PULSE CURRENT tp ⩽ 6 μS	MAXIMUM AVERAGE POWER DISSIPATION	MAXIMUM VARISTOR VOLTAGE AT 10 AMP/PEAK
	VOLTS	VOLTS	VOLTS	(WATT-SEC)	AMPS	WATTS	VOLTS
V130PA10A	130	184	170	10		8	350
V130PA20A				20		15	350
V130PA20B				20		15	340
V130PA20C				20		15	320
V150PA10A	150	212	195	10		8	410
V150PA20A				20		15	410
V150PA20B				20		15	390
V150PA20C				20		15	360
V250PA10A	250	354	330	10		4	670
V250PA20A				20		7	670
V250PA40A				40		13	670
V250PA40B				40		13	640
V250PA40C				40		13	600
V275PA10A	275	389	360	10		4	740
V275PA20A				20		7	740
V275PA40A				40		13	740
V275PA40B				40		13	700
V275PA40C				40		13	650
V320PA40A	320	452	415	40		12	850
V320PA40B				40		12	810
V320PA40C				40		12	780
V420PA20A	420	595	540	20		5	1120
V420PA40A				40		10	1120
V420PA40B				40		10	1090
V420PA40C				40	4000	10	1000
V460PA20A	460	650	600	20		5	1280
V460PA40A				40		10	1280
V460PA40B				40		10	1200
V460PA40C				40		10	1120
V480PA20A	480	679	625	20		3	1320
V480PA40A				40		5	1320
V480PA80A				80		10	1320
V480PA80B				80		10	1250
V480PA80C				80		10	1180
V510PA20A	510	721	655	20		3	1400
V510PA40A				40		5	1400
V510PA80A				80		10	1400
V510PA80B				80		10	1310
V510PA80C				80		10	1280
V550PA20A	550	778	720	20		3	1500
V550PA40A				40		5	1500
V550PA80A				80		9	1500
V550PA80B				80		9	1410
V550PA80C				80		9	1340
V575PA20A	575	813	750	20		3	1620
V575PA40A				40		5	1520
V575PA80A				80		9	1520
V575PA80B				80		9	1460
V575PA80C				80		9	1400

MA SERIES

Low Cost • Designed for Automatic Insertion • Molded Axial Package • Voltages 18-264 VRMS, 26-365 VDC • Energy Absorption to 700 milli Joules • Peak Pulse Current to 20A • For Complete Specifications see *Page No. 1426.*

MODEL NUMBER	MAXIMUM APPLIED VOLTAGE AC-RMS	MAXIMUM APPLIED VOLTAGE AC-PEAK 50-60Hz	MAXIMUM APPLIED VOLTAGE DC	MAXIMUM ENERGY JOULES	MAXIMUM NON-REPETITIVE PEAK PULSE CURRENT tp ⩽ 6 μS	MAXIMUM AVERAGE POWER DISSIPATION	MAXIMUM VARISTOR VOLTAGE AT 1 AMP/PEAK
	VOLTS	VOLTS	VOLTS	(WATT-SECS)	AMPS	M-WATTS	VOLTS
NOTE: GE-MOV™ Varistor MA Series Models from 20-75 VRMS, 26-102 VDC See page 1426							
V150MA1A	88	124	121	.10	10	200	280
V150MA2B	92	130	137	.20	20		250
V180MA1A	105	148	144	.15	10	200	350
V180MA3B	110	156	152	.30	20		320
V220MA2A	132	187	181	.20	10	200	420
V220MA4B	138	195	191	.40	20		390
V270MA2A	163	230	224	.20	10	200	530
V270MA4B	171	242	235	.40	20		460
V330MA2A	188	266	257	.25	10	200	640
V330MA5B	200	283	274	.50	20		560
V390MA3A	234	331	322	.30	10	200	750
V390MA6B	242	342	334	.60	20		700
V430MA3A	253	358	349	.35	10	200	840
V430MA7B	264	373	365	.70	20		750





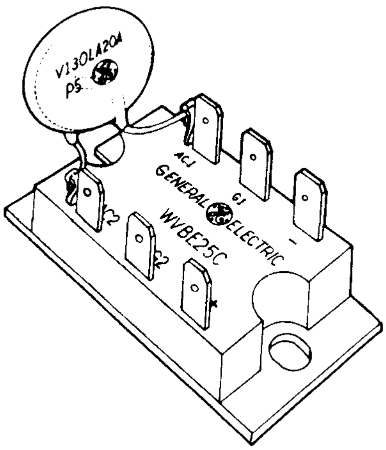
L SERIES

Protection Up to 120, 240, 277, 480 VRMS, 130-625 VDC

• 4000A Peak Pulse Current Capability • Energy Absorption to 160 Joules

• For Complete Specifications, see *Page No. 1418.*

MODEL NUMBER	MAXIMUM APPLIED VOLTAGE AC-RMS	AC-PEAK 50-60Hz	DC	MAXIMUM ENERGY JOULES	MAXIMUM NON-REPETITIVE PEAK PULSE CURRENT tp ≤ 6 μS	MAXIMUM AVERAGE POWER DISSIPATION	MAXIMUM VARISTOR VOLTAGE AT 1 AMP/ PEAK
	VOLTS	VOLTS	VOLTS	(WATT-SECS)	AMPS	WATTS	VOLTS
V95LA7A	95	134	130	7	2000	0.45	245
V95LA7B							220
V130LA1	130	184	175	1	400	.24	360
V130LA2				2	400	.24	360
V130LA10A				10	2000	.50	340
V130LA20A				20	4000	.85	340
V130LA20B				20	4000	.85	305
V150LA1	150	212	200	1	400	0.24	420
V150LA2				2	400	0.24	420
V150LA10A				10	2000	0.50	390
V150LA20A				20	4000	0.85	390
V150LA20B				20	4000	0.85	355
V250LA2	250	354	330	2	400	0.28	690
V250LA4				4	400	0.28	690
V250LA15A				15	2000	0.60	640
V250LA20A				20	2000	0.60	640
V250LA40A				40	4000	0.90	640
V250LA40B				40	4000	0.90	580
V275LA2	275	389	369	2	400	0.28	750
V275LA4				4	400	0.28	750
V275LA15A				15	2000	0.60	700
V275LA20A				20	2000	0.60	700
V275LA40A				40	4000	0.90	700
V275LA40B				40	4000	0.90	645
V300LA2	300	424	405	2	400	0.28	830
V300LA4				4	400	0.28	830
V320LA15A	320	452	420	15	2000	.6	780
V320LA20A				20	2000	.6	780
V320LA40A				40	4000	.9	780
V320LA40B				40	4000	.9	740
V420LB20A	420	595	560	20	2000	0.55	1050
V420LB40A				40	4000	0.90	1050
V420LB40B				40	4000	0.90	980
V460LB20A	460	650	615	20	2000	0.55	1180
V460LB40A				40	4000	0.90	1180
V460LB40B				40	4000	0.90	1080
V480LB20A	480	679	640	20	2000	0.55	1200
V480LB40A				40	2000	0.70	1200
V480LB80A				80	4000	1.00	1110
V480LB80B				80	4000	1.00	1110
V510LB20A	510	721	675	20	2000	0.55	1300
V510LB40A				40	2000	0.70	1300
V510LB80A				80	4000	1.00	1300
V510LB80B				80	4000	1.00	1200
V550LB20A	550	778	–	20	2000	0.60	1400
V550LB40A				40	2000	0.70	1400
V550LB80A				80	4000	1.00	1400
V550LB80B				80	4000	1.00	1300
V575LB20A	575	813	–	20	2000	0.65	1480
V575LB40A				40	2000	0.80	1480
V575LB80A				80	4000	1.10	1480
V575LB80B				80	4000	1.10	1340
V1000LB80A	1000	1414	–	80	2000	0.9	2500
V1000LB160A				160	4000	1.3	2500
V1000LB160B				160	4000	1.3	2400

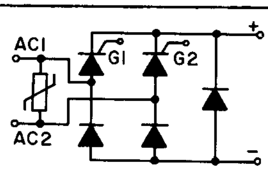
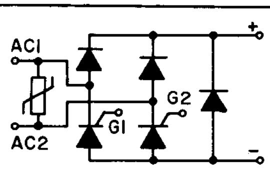
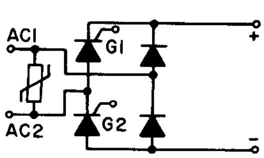


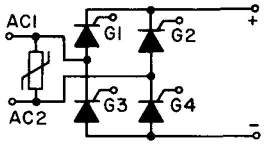
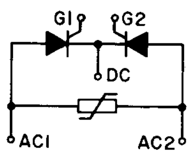
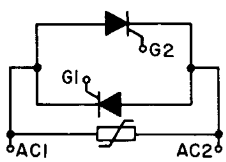
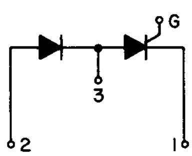
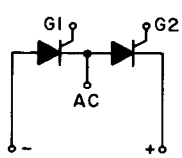
POWER MODULES

New General Electric power modules are miniaturized, self-contained, Epoxy encapsulated modules capable of performing basic AC to DC conversion functions. Typical applications include – DC power supplies, DC motor controls, battery chargers, magnetic clutches and brakes.

All General Electric power modules incorporate Power Glas™ passivated semiconductors with the latest pellet mountdown and interconnect techniques, thereby assuring the utmost in reliability.

COMMON CHARACTERISTICS @ 25°C	
Isolation Breakdown	2,500 V_{PEAK}
Surge, Peak One Cycle	300 A
Fusing, I^2t @ 8.3 msec	370 A^2SEC
Gate Current to Trigger (Max.)	40 mA
Gate Voltage to Trigger (Max.)	2.5 V
On-State Current Rate of Rise (di/dt)	100 A/μSEC
Off-State Voltage Rate of Rise (dv/dt)	20 V/μSEC
Operating Temperature	-40 to 125°C

			GE TYPES			
BASIC CIRCUIT SCHEMATIC	I_O AVERAGE @ 85° (A)	V_{IN} (V)	BASIC CIRCUIT	WITHOUT FREE WHEELING DIODE	WITHOUT GE-MOV ® VARISTOR	WITHOUT EITHER DIODE OR VARISTOR
	25	120	WV2BE25C	WV2BC25C	W2BE25C	W2BC25C
		240	WV2BE25E	WV2BC25E	W2BE25E	W2BC25E
	25	120	WV2BJ25C	WV2BK25C	W2BJ25C	W2BK25C
		240	WV2BJ25E	WV2BK25E	W2BJ25E	W2BK25E
	25	120	WV2BA25C	–	W2BA25C	–
		240	WV2BA25E	–	W2BA25E	–

BASIC CIRCUIT SCHEMATIC	I_O AVER. @ 85°C (A)	V_{IN} (V)	GE TYPES: BASIC CIRCUIT	GE TYPES: WITHOUT GE-MOV® VARISTOR
	25	120	WV2BH25C	W2BH25C
		240	WV2BH25E	W2BH25E
	25	120	WV2CA25C	W2CA25C
		240	WV2CA25E	W2CA25E
	50A RMS	120	WV2AA50C	W2AA50C
		240	WV2AA50E	W2AA50E
	**BASIC BUILDING BLOCK MODULES**			
	For further information on these and other custom circuit types, contact: GE Semiconductor, Electronics Park, 7-49, Syracuse, New York 13201, Phone: (315) 456-2633			

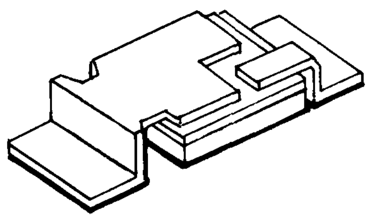
For outline dimensions and pinout configurations, see PAGE 1444

SUBSCRETE™ DEVICES

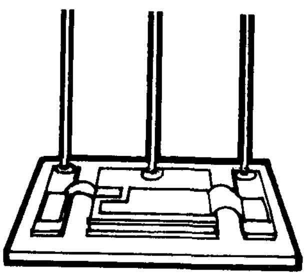
DESCRIPTION:

The new family of Subscrete™ Devices from General Electric is a series of chip-like devices designed specifically for hybrid circuits or similar circuit manufacturing techniques. Available in three basic configurations, Subscrete™ Triacs, SCR's and Rectifiers utilize Power Glas™ passivated pellets providing the ultimate in device performance and reliability. The intimate, void-free bond between the silicon chip and the stress-matched, glass coating provides stable, low level leakage current and long-term reliability. When properly mounted and heat sinked, these fully tested Subscrete™ Devices can provide equivalent performance and reliability of comparable discrete devices at substantial cost savings to the user.

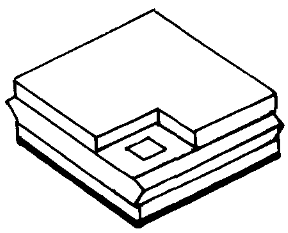
PACKAGE CONFIGURATIONS:



- **STEP LEAD CONFIGURATION**
  - Completely ready to reflow solder with copper step lead attached to the chip top contact and a soft soldered stress-relief plate attached to the chip bottom contact.
  - Current and thermal spreading accomplished by attached step lead and stress-relief plate.
  - No additional connections to chip required by user.
  - All contact areas are solder-clad and in a common seating plane.



- **ISOLATED CONFIGURATION**
  - Soft soldered, stress-relief plate between chip and metallized pad on substrate.
  - Bottom of substrate metallized and solder coated allowing reflow attachment to heat dissipator.
  - Current and thermal spreading accomplished by attached step lead and stress-relief plate.
  - External leads available for electrical connectors.
  - No additional connections to substrate required by user.



- **SANDWICH CONFIGURATION**
  - Soft-soldered, stress-relief plates attached to both top contact and bottom contact areas, providing for current and thermal spreading.
  - Top and bottom contact plates can provide for customized mounting by user without coming in contact with the chip metallization.

SUBSCRETE™ DEVICES

POWER SERIES

• Triacs • SCR's • Rectifiers

PACKAGE CONFIGURATION
0 = Step Lead
1 = Isolated Step Lead
2 = Sandwich

VOLTAGE GRADE
A = 100 D = 400
B = 200 E = 500
C = 300 M = 600

EXAMPLE: 6 amp, 400 volt, Step Lead, Subscrete™ Triac is a MPA1060D.

	CURRENT RATINGS (RMS)	GE TYPE	I_{TSM} PEAK ONE FULL CYCLE SURGE (NON-REP) ON-STATE CURRENT @ 60 Hz AMPERES (MAXIMUM)	I_{DRM} PEAK OFF-STATE CURRENT mA (MAXIMUM)	V_{TM} PEAK ON-STATE VOLTAGE VOLTS (MAXIMUM)	dv/dt (STATIC) CRITICAL RATE-OF-RISE OF OFF-STATE VOLTAGE T_J = 100°C VOLTS/μ SEC
TRIACS	6 Amperes	MPA106	80	0.1	1.83 @ I_{TM} = 8.5A pk.	25
	10 Amperes	MPA110	100	0.1	1.65 @ I_{TM} = 14.0A pk.	50
	15 Amperes	MPA115	120	0.1	1.52 @ I_{TM} = 21.0A pk	100
	25 Amperes	MPA125	250	0.2	1.58 @ I_{TM} = 35.0A pk.	25
	40 Amperes	MPA140	300	0.2	1.38 @ I_{TM} = 56.0A pk.	25

	CURRENT RATINGS (RMS)	GE TYPE	I_{TSM} PEAK ONE FULL CYCLE SURGE (NON-REP) ON-STATE CURRENT @ 60 Hz AMPERES (MAXIMUM)	I_{DRM}/I_{RRM} PEAK OFF-STATE OR REVERSE CURRENT mA (MAXIMUM)	V_{TM} PEAK ON-STATE VOLTAGE VOLTS (MAXIMUM)	dv/dt (STATIC) CRITICAL RATE-OF-RISE OF OFF-STATE VOLTAGE T_J = 100°C VOLTS/μ SEC (TYPICAL)
SCR's	10 Amperes	MPA210	90	0.1	1.95 @ I_{TM} = 20.0A pk.	50
	25 Amperes	MPA225	250	0.2	1.5 @ I_{TM} = 50.0A pk.	50
	35 Amperes	MPA235	300	0.2	1.9 @ I_{TM} = 70.0A pk.	50

	CURRENT RATINGS (RMS)	GE TYPE	I_{FSM} PEAK ONE CYCLE SURGE (NON-REP) FORWARD CURRENT @ 60 Hz AMPERES (MAXIMUM)	I_{RRM} PEAK REVERSE CURRENT mA (MAXIMUM)	V_{FM} MAXIMUM PEAK FORWARD VOLTAGE, VOLTS (MAXIMUM)
RECTIFIERS	30 Amperes	MPA330	300	0.2	1.5 @ I_{FM} = 60A pk.

dv/dt OMMUTATING) RITICAL RATE- -RISE OF OFF- ATE VOLTAGE = 100°C, 60 Hz RATED RMS CURRENT VOLTS/μ SEC (MINIMUM)	I_{GT} DC GATE TRIGGER CURRENT MT2+ GATE+ MT2– GATE– MT2+ GATE– mAdc (MAXIMUM)	V_{GT} DC GATE TRIGGER VOLTAGE Vdc (MAXIMUM)	I_H HOLDING CURRENT mAdc (MAXIMUM)	I_L LATCHING CURRENT MT2+ GATE+ MT2– GATE– MT2+ GATE– mAdc (MAXIMUM)	$R_{\Theta JC}$ MAXIMUM APPARENT THERMAL IMPEDANCE @ 60 Hz °C/WATT (MAX.) NON-ISOL.	ISOL.	T_J JUNCTION OPERATING TEMP. RANGE °C
4	50	2.5	50	200	2.2	3.4	-40 to +100
4	50	2.5	50	200	1.5	2.7	-40 to +100
4	50	2.5	50	200	1.3	2.5	-40 to +100
4	50	2.5	75	200	1.2	1.9	-40 to +100
4	80	2.5	75	200	0.8	1.2	-40 to +100

t_q CIRCUIT COMMUTATED URN-OFF TIME T_J = 100°C μ SEC (TYPICAL)	I_{GT} DC GATE TRIGGER CURRENT mAdc (MAXIMUM)	V_{GT} DC GATE TRIGGER VOLTAGE Vdc (MAXIMUM)	I_H HOLDING CURRENT mAdc MAXIMUM)	I_L LATCHING CURRENT mAdc (MAXIMUM)	$R_{\Theta JC}$ STEADY-STATE THERMAL RESISTANCE °C/WATT (MAXIMUM) NON-ISOL.	ISOL.	T_J JUNCTION OPERATING TEMP. RANGE °C
50	25	1.5	30	60	1.8	4.0	-40 to +100
50	25	1.5	50	100	1.7	2.5	-40 to +100
50	40	2.5	75	150	1.7	2.5	-40 to +100

Θ_{JC} STEADY-STATE IERMAL RESISTANCE C/WATT (MAXIMUM) ION-ISOL.	ISOL.	T_J JUNCTION OPERATING TEMP. RANGE °C
1.7	2.5	-40 to +175

NOTES:

1. All characteristics given for T_J = 25°C unless otherwise stated.
2. $R_{\Theta JC}$ Definition:
   - **For Non-Isolated Configurations:** Thermal resistance from junction to geometric center of bottom plate.
   - **For Isolated Configurations:** Thermal resistance from junction to bottom of substrate under geometric center of chip.
3. Most maximum allowable ratings depend almost entirely on the quality and thermal characteristics of the bond when mounting the Subscrete™ Device. For this reason, normal ratings such as average current, surge current and operating temperature range, are obtainable when the solder thickness is limited to ≤3 mils and good wetting is achieved.

MILITARY TYPES AVAILABLE

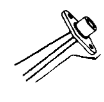
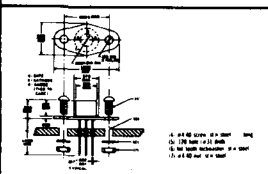
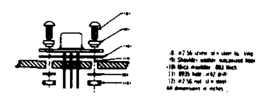
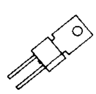
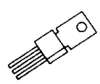
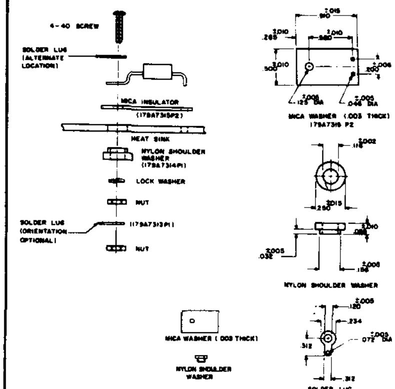
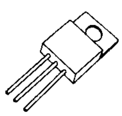
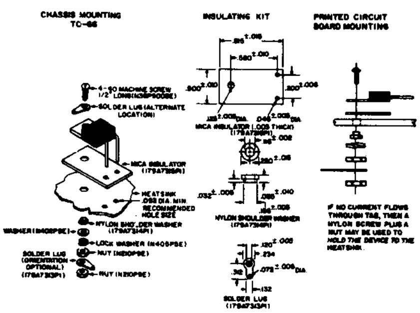
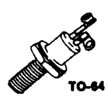
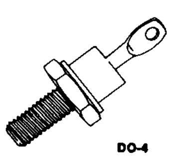
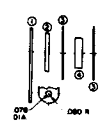
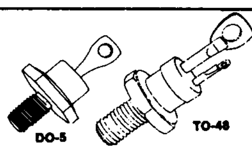
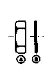
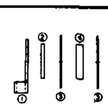
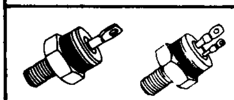
Type	TX Type	Military Specification
JAN 1N1184 thru 1N1190	JANTX 1N1184 thru 1N1190,R	MIL-S-19500/297
JAN 1N1202A, 04A	JANTX 1N1202A, 04A,R	MIL-S-19500/260
JAN 1N1206A	JANTX 1N1206A,R	MIL-S-19500/260
JAN 1N1614, 15, 16		MIL-S-19500/162
JAN 1N3289, 91, 93 94, 95		MIL-S-19500/246
JAN 1N3673A	JANTX 1N3673A,R	MIL-S-19500/260A
JAN 1N3713, 15, 17 19, 21		MIL-S-19500/269
JAN 1N3766	JANTX 1N3766,R	MIL-S-19500/297
JAN 1N3768	JANTX1N3768,R	MIL-S-19500/297
JAN 1N3890, 91, 93 & R	JANTX 1N3890, 91, 93 & R	MIL-S-19500/304
JAN 1N3909, 10, 11 12, 13	JANTX 1N3909, 10, 11 12, 13,R	MIL-S-19500/308

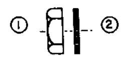
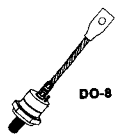
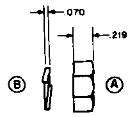
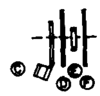
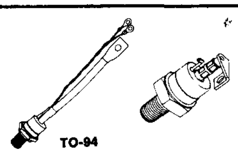
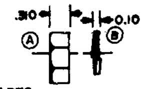
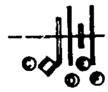
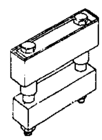
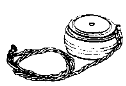
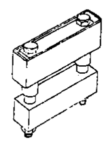
Type	TX Type	Military Specification
JAN 1N4148/-1	JANTX 1N4148/-1	MIL-S-19500/116
JAN 1N4150/-1	JANTX 1N4150/-1	MIL-S-19500/231
JAN 1N4153/-1	JANTX 1N4153/-1	MIL-S-19500/337
JAN 1N4454/-1	JANTX 1N4454/-1	MIL-S-19500/144
JAN 1N4459,R		MIL-S-19500/162
JAN 1N4531	JANTX 1N4531	MIL-S-19500/116
JAN 1N4532	JANTX 1N4532	MIL-S-19500/144
JAN 2N489A-94A	JANTX 2N489A-94A	MIL-S-19500/75
JAN 2N682, 3, 5, 6 7, 8, 9	JANTX 2N682, 3, 5, 6 7, 8, 9	MIL-S-19500/108
JAN 2N2323, 4, 6, 8, 9 & A	JANTX 2N2323, 4, 6, 8, 9 & A	MIL-S-19500/276

HIGH RELIABILITY SPECIFICATIONS

High Rel. Type	Commercial Type	Conservative Design Maximum Conditions				Estimated Maximum Failure Rate in Conservatively Designed Equipment %/1000 hrs.
		Io	TSTG, TJOP	VDRM, VRRM	VRSM	
A27BR1200	1N1202	12A	−65 to +100°C	100V	200V	.001
A27DR1200	1N1204	12A	−65 to +100°C	200V	400V	.001
A27MR1200	1N1206	12A	−65 to +100°C	400V	600V	.001
A28BR1200	A28B	12A	−65 to +100°C	100V	200V	.001
A28DR1200	A28D	12A	−65 to +100°C	200V	400V	.001
A28BR1201	1N3891	12A	−65 to +100°C	100V	200V	.001
A28DR1201	1N3893	12A	−65 to +100°C	200V	400V	.001
A38BR1200	1N2156	25A	−65 to +100°C	100V	200V	.001
A38DR1200	1N2158	25A	−65 to +100°C	200V	400V	.001
A38MR1200	1N2160	25A	−65 to +100°C	400V	600V	.001
A38BR1202	1N3911	30A	−65 to +100°C	100V	200V	.001
A38DR1202	1N3913	30A	−65 to +100°C	200V	400V	.001
C5AR1200	2N2324	1.6A	−65 to +85°C	50V	100V	.001
C5BR1200	2N2326	1.6A	−65 to +85°C	100V	200V	.001
C5DR1200	2N2329	1.6A	−65 to +85°C	200V	400V	.001
C10AR1200	2N1772A	4.7A	−65 to +100°C	50V	100V	.001
C10BR1200	2N1774A	4.7A	−65 to +100°C	100V	200V	.001
C10DR1200	2N1777A	4.7A	−65 to +100°C	200V	400V	.001
C11AR1200	2N1772	4.7A	−65 to +85°C	50V	100V	.001
C11BR1200	2N1774	4.7A	−65 to +85°C	100V	200V	.001
C11DR1200	2N1777	4.7A	−65 to +85°C	200V	400V	.001
C11MR1200	2N2619	4.7A	−65 to +85°C	300V	600V	.001
C35AR1200	2N683	16A	−65 to +85°C	50V	100V	.001
C35BR1200	2N685	16A	−65 to +85°C	100V	200V	.001
C35DR1200	2N688	16A	−65 to +85°C	200V	400V	.001
C35ER1200	2N689	16A	−65 to +85°C	250V	500V	.001
C35MR1200	2N690	16A	−65 to +85°C	300V	600V	.001
C38BR1200	2N685	16A	−65 to +100°C	100V	200V	.001
C38HR1200	2N686	16A	−65 to +100°C	125V	250V	.001
C38DR1200	2N688	16A	−65 to +100°C	200V	400V	.001
C137MR1200	2N5204	22.3A	−65 to +85°C	300V	600V	.001

HARDWARE

STUD	PACKAGE	MOUNTING KIT	INSULATING KITS NOT SUPPLIED WITH UNITS UNLESS STATED ORDER BY PART #
	 T-05 DIAMOND BASE	 STANDARD HARDWARE SUPPLIED WITH UNIT. PART # A7149416GR1	 PART # A7149416GR2
	 POWER TAB WITH 2 LEADS  POWER TAB WITH 3 LEADS	NO HARDWARE SUPPLIED WITH UNIT. SUGGESTED MOUNTINGS: 1) 6-32 SCREW, LOCK WASHER AND NUT 2) RIVET OF EQUIVALENT SIZE 3) DIRECT SOLDER MOUNT	TYPICAL ISOLATED MOUNTING: INSULATING KIT  PART # 138B8189GR11 PART # 138B8189GR4
	 POWER PAC *TO-220*		 PART # 138B8189GR3
10-32 STUD	 TO-64  DO-4	 BOTH PARTS CAD PLATED STEEL STANDARD HARDWARE SUPPLIED WITH UNIT PART # 138B8021GR10N	 ① COPPER TERMINAL, .016 THICK, TIN PLATED ② BRASS WASHER, .036 THICK NICKEL PLATED ③ MICA WASHERS, TWO, .625 OD, .204 I.D., .005 THICK ④ TEFLON WASHER, .270 OD, .204 I.D., .060 THICK * AVAILABLE UPON REQUEST PART # 138B8021GR10P
¼-28 STUD	 DO-5 TO-48	 (A) ¼-28 STEEL NUT, NI. CAD PLATED, .178 MIN. THK. (B) EXT. TOOTH LOCKWASHER, STEEL CAD PLATED, .023 MIN. THK.	 ① COPPER TERMINAL, .030 THICK, TIN PLATED ② BRASS WASHER, .047 THICK, NICKEL PLATED ③ MICA WASHERS (2) .975 OD x .260 I.D. x .005 THICK ④ TEFLON WASHER .315 OD x .260 I.D. x .090 THICK PART # 138B8021GR20Y
		STANDARD HARDWARE SUPPLIED WITH UNIT. PART # 138B8021GR-20X	THIS PACKAGE IS AVAILABLE IN ISOLATED STUD. REFER TO APPROPRIATE SPECIFICATIONS OR USE 138B8021GR20Y AS ABOVE.

STUD	PACKAGE	MOUNTING KIT	INSULATING KITS NOT SUPPLIED WITH UNITS UNLESS STATED ORDER BY PART #
⅞-24 STUD		 (1) ⅞-24 STEEL NUT, CAD PLATED 180 MIN. THICK NOT AVAILABLE (2) EXTERNAL TOOTH LOCKWASHER, CAD PLATED STEEL .028 MIN THICK STANDARD HARDWARE SUPPLIED WITH UNIT. PART # 138B8021GR25	PART # 138B8025GR24
¼-24 STUD	 DO-8	 BOTH CAD PLATED STEEL STANDARD HARDWARE SUPPLIED WITH UNIT. PART # 138B8021GR36	 (C) COPPER TERMINAL .050 THICK, TIN PLATED (D) (F) MICA WASHERS 1.375 O.D. X .386 I.D. X .005 THICK (E) TEFLON WASHER .450 O.D. X .373 I.D. PART # 138B8021GR33
½-20 STUD	 TO-94	 BOTH PARTS CAD PLATED STEEL STANDARD HARDWARE SUPPLIED WITH UNIT. PART # 138B8021GR46	 (C) COPPER TERMINAL .050 THICK, TIN PLATED (D) (F) MICA WASHERS 1.375 O.D. X .505 I.D. X .050 THICK (E) TEFLON WASHER .565 O.D. X .505 I.D. X .050 THICK PART # 138B8021GR42
¾-16 STUD	 DO-9	¾ X 16 CAD PLATED STEEL NUT, .312 THICK AND INTERNAL TOOTH LOCK WASHER, .050 THICK STANDARD HARDWARE SUPPLIED WITH UNIT. PART # 138B8021GR53	NOT RECOMMENDED FOR THIS PACKAGE OR LARGER
	 ½" PRESS PAK	SERIES 1000 	See Specification Sheet, Page 1411
	 1" PAK	SERIES 2500 	See Specification Sheet, Page 1413

Semiconductor product application and circuit design information is provided in these application notes and article reprints from professional and technical journals. Prepared and written by General Electric's Semiconductor Application Engineering Center, these publications give you a valuable solid state reference library.

Particular publications which interest you may be ordered by publication number from: **Inquiry Clerk, General Electric Company, Semiconductor Products Dept., Bldg. #7, Mail Drop 49, Electronics Park, Liverpool, N.Y. 13088.**

PLEASE ORDER BY PUBLICATION NUMBER General References: *451.138 Semiconductor Data Handbook*

1. General Applications of Signal Diodes and Transistors

- **90.28** The Use of "y" Parameters in Transistor Circuit Design
- **90.30** Measurement of Stored Charge in High Speed Diodes
- **90.62** Y Parameters: Their Accuracy and Measurement
- **90.86** Transistor Models for CACD
- **200.52** The Characterization of Power Transistors to Avoid Forward Bias Second Breakdown
- **200.56** On Switching Inductive Loads With Power Transistors
- **660.22** The Computerized Use of Transient Thermal Resistance to Avoid Forward Biased Second Breakdown in Transistors

2. Audio Amplifier Circuits

- **90.59** Low Cost Audio for Line-Operated Radio, TV, Phonographs, Etc.
- **90.78** Portable TV Sound System
- **90.89** 1 to 2 Watt Amplifier Circuits Requiring Minimum Components
- **90.91** TV Audio Amplifier
- **90.98** Monolithic Darlington Preamplifier
- **90.99** Medium Power Amplifier Circuits
- **90.100** High Power Audio Amplifier

3. Receiving And Tuning Circuits

- **90.76** Complementary Audio Outputs Make A High Performance, Low Cost Audomobile Receiver
- **90.81** TV Color Difference Amplifiers Using High Voltage Transistors
- **90.82** Video Output Considerations Using a High Voltage Transistor
- **90.86** Transistor Models for CACD
- **90.87** A Four Transistor Line Operated Radio Receiver
- **90.88** RGB Video Amplifiers for Color TV Offer High Performance
- **90.97** Heatsink-Less RGB Amplifier for Color TV
- **200.63** Complementary Vertical Deflection – Two Approaches
- **200.64** Horizontal Deflection Under Normal And Arcing Conditions
- **660.23** Using Improved Transistor Models in Computer-Aided Analysis of a RGB Video Amplifier

4. Converters and Inverters

- **90.75** Designing A 12-Volt DC to High Voltage DC Converter
- **200.57** An Assortment of High Frequency, Transistor Inverters/Converters Utilizing Saturating Core Transformers
- **200.75** Optimizing Battery-Powered Transistor Inverter Design
- **201.25** A High Input Voltage Converter

5. Miscellaneous Transistor

- **90.14** Tape Erase and Bias Oscillator
- **90.90** A Practical R-C Tone Generator System for Electronic Organs
- **92.4** Sound Effect Generator

6. Rectifier Application Notes

- **200.1** Characteristics of Common Rectifier Circuits
- **200.30** Capacitor Input Filter Design with Silicon Rectifier Diodes (Revision)

7. General Applications of Thyristors

- **90.24** A Ring Counter For Driving Incandescent Bulbs
- **90.58** Reversible Ring Counter Utilizing the Silicon Controlled Switch
- **90.94** The Complementary SCR
- **200.01** Semiconductor Application Information
- **200.9** Power Semiconductor Ratings Under Transient and Intermittent Loads
- **200.19** Using Low-Current SCR's (Revision)
- **200.35** Using the Triac Control for AC Power (Revision)
- **200.48** Flashers, Ring Counters and Chasers (Revision)
- **200.54** Design of Triggering Circuits for Power SCR's
- **200.55** Handling & Thermal Considerations for GE Plastic Power Devices
- **200.78** Application of General Electric SubscreteTM Devices
- **201.23** SCR-Ignitron Comparison

Liquid Cooling of Power Thyristors

Technological Trends in Power Semiconductors Significant for Electric Vehicle Controls

Ratings & Applications of Power Thyristors for Resistance Welding

8. General Phase Control Circuits

- **200.21** Three Phase SCR Firing Circuits for DC Power Supplies
- **200.31** Phase Control of SCR's With Transformer And Other Inductive AC Loads
- **200.33** Regulated Battery Chargers Using the Silicon Controlled Rectifier
- **200.46** AC Voltage or Current Regulator Featuring Closed-Loop Feedback Control
- **201.6, 9–11** Applications for C106 Economy SCR
- **201.12** 500-Watt AC Line Voltage and Power Regulator
- **201.14** Automatic Liquid Level Control
- **201.18** High Voltage Power Supply for Low Current Applications

9. Lighting Control

- **200.18** Fluorescent Lamp Dimming With SCR's and Associated Semiconductors
- **200.53** Solid State Incandescent Lighting Control

10. Motor Control

- **200.43** Solid State Control for DC Motors Provides Variable Speed With Synchronous-Motor Performance
- **200.44** Speed Control for Shunt-Wound Motors
- **200.47** Speed Control for Universal Motors
- **201.16** Fan Motor Speed Control – "Hi-Intensity" Lamp Dimmer

11. Temperature Control

- **200.61** A Zero Voltage Switching Temperature Control
- **200.70** Low Resistance Sensor - Zero Voltage Switching Temperature Control
- ***671.12** Optimum Solid-State Control Parameters for Improved Performance of In-Space Electric Heating Systems

12. SCR Inverter Circuits

- **200.49** A Low Cost, Ultrasonic-Frequency Inverter Using A Single SCR
- **660.14** Basic Magnetic Functions in Converters and Inverters Including New Soft Commutation
- **660.15** SCR Inverter Commutated By An Auxiliary Impulse
- **660.16** An SCR Inverter With Good Regulation & Sine-Wave Output
- **671.21** Resonant Bridge Inverter

13. Protection of Power Semiconductors

- **200.10** Overcurrent Protection of Semiconductor Rectifiers
- **200.60** GE-MOVTM Varistors – Voltage Transient Suppressors
- **200.71** Using GE-MOVTM Varistors for Voltage Suppression Due to Switching Inductive Load
- **200.73** Testing GE-MOVTM Varistors
- **200.77** Detecting and Suppressing Nanosecond Wide Spikes With GE-MOVTM Varistors
- **201.28** Energy Dissipation in GE-MOVTM Varistors For Various Pulse Shapes
- **660.21** Take the Guesswork Out of Fuse Selection
- **660.24** Analysis and Design of Optimized Snubber Circuits for dv/dt Protection in Power Thyristor Applications
- **660.28** Metal-Oxide Varistor: A New Way to Suppress Transients

14. Optoelectronic Applications

- **200.34** The Light Activated SCR
- **200.59** How to Evaluate Light Emitters & Optical Systems for Light Sensitive Silicon Devices
- **200.67** How to Use the Plastic Photodarlington Transistor
- **200.68** High Performance Circuits Using the Plastic Photodarlington

15. Unijunction Applications

- **90.10** The Unijunction Transistor Characteristics and Applications
- **90.16** Silicon Controlled Switches
- **90.57** Using the Silicon Bilateral/Unilateral Switch
- **90.68** The Silicon Unilateral Switch Provides Stable, Economical Frequency Division
- **90.70** The 2N6027 – A Programmable Unijunction Transistor
- **90.72** Complementary Unijunction Transistors
- **90.93** Optimizing PUT Oscillator and Timer Designs
- **671.13** Innovation for Circuit Simplification

16. Tunnel Diode Applications

- **90.32** Tunnel Diodes as Amplifiers and Switches
- **90.43** A Tunnel Diode R.F. Radiation Detector
- **90.44** Practical Tunnel Diode Converter Circuit Considerations
- **90.45** Tunnel Diode Sinewave Oscillators
- **90.66** Applications for the 1N3712 Series Tunnel Diodes

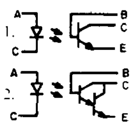
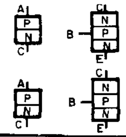
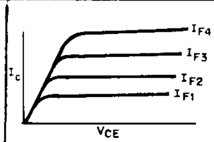
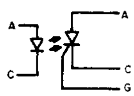
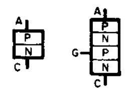
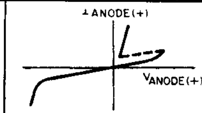
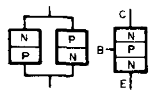
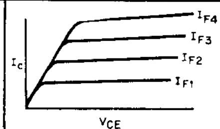
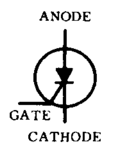
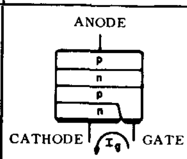
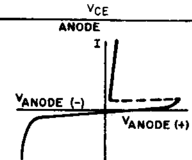
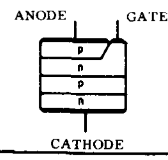
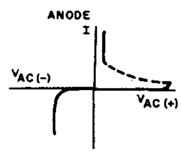
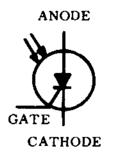
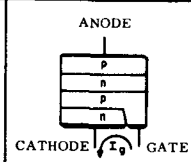
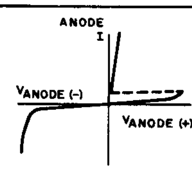
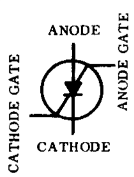
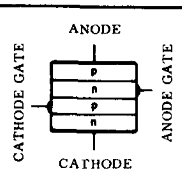
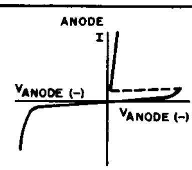
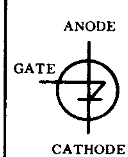
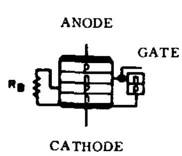
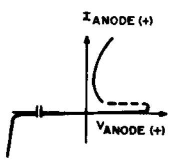
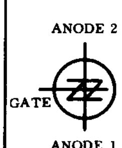
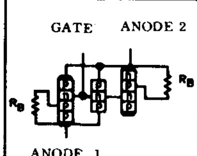
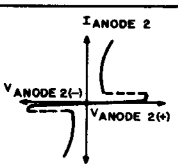
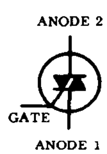
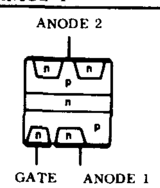
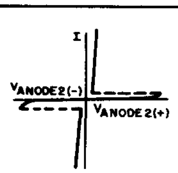
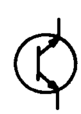
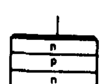
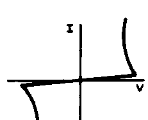
17. Test Circuits

- **201.3** Portable SCR and Silicon Rectifier Tester
- **201.27** DIAC Test Circuit

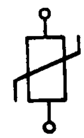
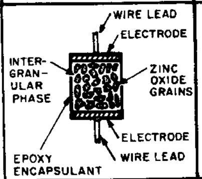
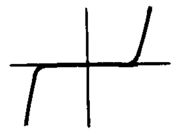
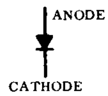
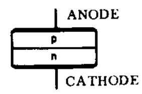
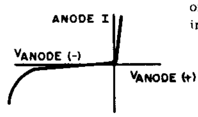
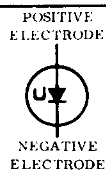
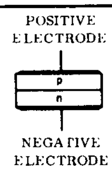
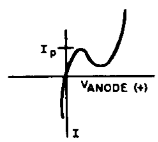
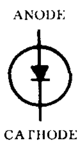
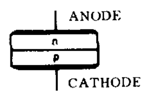
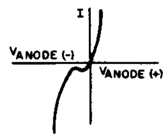
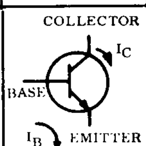
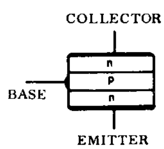
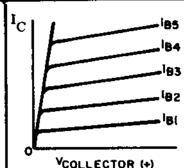
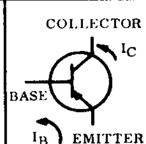
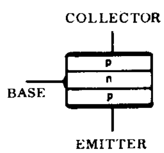
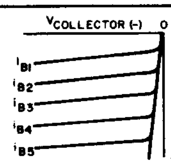
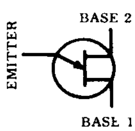
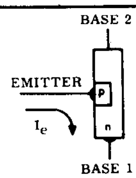
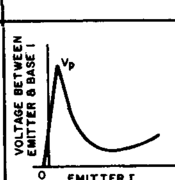
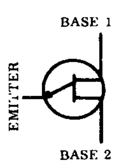
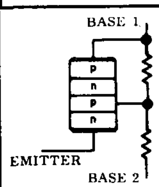
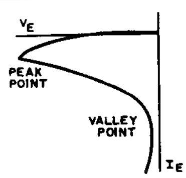
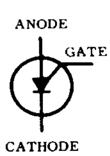
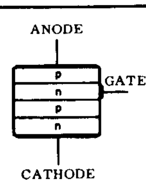
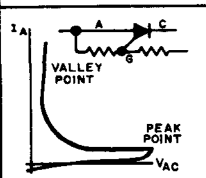
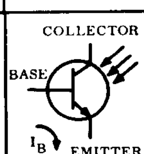
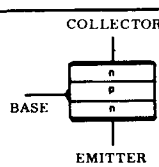
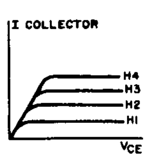
18. Reliability

- **95.10** A Report On The Reliability of General Electric Unijunction Transistor Types, etc. – dated material
- **95.14** Unijunction Transistor Types 2N2646, 2N2647
- **95.29** Improved Triac Reliability Through Power-GlasTM
- **95.31** Reliability of Double Heatsink Diodes
- **95.37** GE Unijunction Transistor Reliability
- **95.39** Guide to Designing for Reliability in Power Semiconductor Device Applications
- **95.43** Semiconductor Reliability Report
- **95.44** Reliability of General Electric GE-MOVTM Varistors
- **95.45** Plastic Encapsulated Signal and Power Transistor Reliability
- **95.46** General Electric Meta-BondTM Diodes
- **671.14** What the Reliability of Plastic Encapsulated Devices Means To You

MAJOR GENERAL ELECTRIC SEMICONDUCTOR COMPONENTS

NAME OF DEVICE	CIRCUIT SYMBOL	COMMONLY USED JUNCTION SCHEMATIC	ELECTRICAL CHARACTERISTICS	MAJOR APPLICATIONS
Opto Coupler 1) Transistor (H11A, H15A) 2) Darlington (H11B, H15B) Outputs			 Output characteristics are identical to a normal transistor/Darlington except that the LED current (I_F) replaces the base drive (I_B).	Isolated interfacing of logic systems with other logic systems, power semiconductors and electro-mechanical devices. Solid state relays.
Opto Coupler SCR Output (H11C)			 With Anode voltage (+) the SCR can be triggered with a forward LED current. (Characteristics identical to a normal SCR except that LED current (I_F) replaces gate trigger current – I_{GT}).	Isolated interfacing of logic systems with AC power switching functions. Replacement of relays; microswitches.
AC Input Opto Coupler (H11AA)			 Identical to a "standard" transistor coupler except that LED current can be of either polarity.	Telecommunications – ring signal detection, monitoring line usage. Polarity insensitive solid state relay. Zero voltage detector.
Silicon Controlled Rectifier (SCR)			 With anode voltage (+), SCR can be triggered by I_g, remaining in conduction until anode I is reduced to zero	Power switching Phase control Inverters Choppers
Complementary Silicon Controlled Rectifier (CSCR)			 Polarity complement to SCR	Ring counters Low speed logic Lamp driver
Light Activated SCR* L8, L9			 Operates similar to SCR, except can also be triggered into conduction by light falling on junctions	Relay Replacement Position controls Photoelectric applications Slave flashes
Silicon Controlled Switch* (SCS)			 Operates similar to SCR except can also be triggered on by a negative signal on anode-gate. Also several other specialized modes of operation	Logic applications Counters Nixie drivers Lamp drivers
Silicon Unilateral Switch (SUS)			 Similar to SCS but zener added to anode gate to trigger device into conduction at ~ 8 volts. Can also be triggered by negative pulse at gate lead.	Switching Circuits Counters SCR Trigger Oscillator
Silicon Bilateral Switch (SBS)			 Symmetrical bilateral version of the SUS. Breaks down in both directions as SUS does in forward.	Switching Circuits Counters TRIAC Phase Control
Triac			 Operates similar to SCR except can be triggered into conduction in either direction by (+) or (-) gate signal	AC switching Phase control Relay replacement
Diac Trigger			 When voltage reaches trigger level (about 35 volts), abruptly switches down about 10 volts.	Triac and SCR trigger Oscillator

MAJOR GENERAL ELECTRIC SEMICONDUCTOR COMPONENTS

NAME OF DEVICE	CIRCUIT SYMBOL	COMMONLY USED JUNCTION SCHEMATIC	ELECTRICAL CHARACTERISTICS	MAJOR APPLICATIONS
GE-MOV ® Varistor			 When exposed to high energy transients, the varistor impedance changes from a high standby value to a very low conducting value, thus clamping the transient voltage to a safe level.	Voltage transient protection High voltage sensing Regulation
Diode or Rectifier			 Conducts easily in one direction, blocks in the other	Rectification Blocking Detecting Steering
Tunnel Diode			 Displays negative resistance when current exceeds peak point current I_p	UHF converter Logic circuits Microwave circuits Level sensing
Back Diode			 Similar characteristics to conventional diode except very low forward voltage drop	Microwave mixers and low power oscillators
n-p-n Transistor			 Constant collector current for given base drive	Amplification Switching Oscillation
p-n-p Transistor			 Complement to n-p-n transistor	Amplification Switching Oscillation
Unijunction Transistor (UJT)			 Unijunction emitter blocks until its voltage reaches V_p; then conducts	Interval timing Oscillation Level Detector SCR Trigger
Complementary Unijunction Transistor (CUJT)			 Functional complement to UJT	High stability timers Oscillators and level detectors
Programmable Unijunction Transistor (PUT)			 Programmed by two resistors for V_p, I_p, I_v. Function equivalent to normal UJT.	Low cost timers and oscillators Long period timers SCR trigger Level detector
Photo Transistor			 Incident light acts as base current of the photo transistor	Tape readers Card readers Position sensor Tachometers

GENERAL ELECTRIC WORLDWIDE ELECTRONIC COMPONENTS SALES OFFICES

ALABAMA
Huntsville 35801
3322 S. Memorial Pkwy.
Suite 4
Area Code: 205
883-9220

ARIZONA
Phoenix 85016
5320 North 16th St.
Area Code: 602
264-1751

CALIFORNIA
Los Angeles 90064
11840 W. Olympic Blvd.
Area Code: 213
479-7763

Palo Alto 94304
1801 Page Mill Rd.
Suite 223
Area Code: 415
493-2600

COLORADO
Denver 80201
201 University Blvd.
Mailing Address:
P.O. Box 2331, 80201
Area Code: 303
320-3031

CONNECTICUT
Bridgeport 06602
1285 Boston Ave.
Building 28-CE
Area Code: 203
334-1012

DISTRICT OF COLUMBIA
(Washington)
Falls Church, Va. 22043
7777 Leesburg Pike
Area Code: 703
790-1700

FLORIDA
North Palm Beach 33408
321 Northlake Blvd.
Suite 101
Area Code: 305
844-5202

ILLINOIS
Chicago 60641
3800 N. Milwaukee Ave.
Area Code: 312
777-1600

INDIANA
Ft. Wayne 46805
2109 E. State Blvd.
Area Code: 219
482-4557

Indianapolis 46208
3750 N. Meridian St.
Area Code: 317
923-7221

MASSACHUSETTS
Wellesley 02181
1 Washington St.
Area Code: 617
237-2050

MICHIGAN
Southfield 48075
24681 Northwestern
Area Code: 313
355-3552

MINNESOTA
Minneapolis 55435
4900 Viking Dr.
Room 108
Area Code: 612
835-2550

MISSOURI
Kansas City 64105
911 Main St.
Suite 518
Area Code: 816
221-4033

St. Louis 63132
1530 Fairview St.
Area Code: 314
429-6941

NEW JERSEY
Fairfield 07006
420 Route 46
Area Code: 201
227-6050

NEW YORK
Albany 12205
11 Computer Dr., W.
Area Code: 518
458-7755

New York City – call:
Jericho 11753
400 Jericho Tnpk.
Area Code: 516
681-0900

Rochester 14623
3000 Winton Rd., S.
Area Code: 716
461-5400

Syracuse 13201
Bldg. 1, Room 227
Electronics Pk.
Area Code: 315
456-2196

NORTH CAROLINA
Greensboro 27408
1828 Banking St.
P.O. Box 9476
Area Code: 919
273-6981

OHIO
Cleveland 44132
26250 Euclid Ave.
Area Code: 216
266-2900

Dayton 45439
3430 S. Dixie Highway
Mailing Address:
P.O. Box 2143
Kettering Branch 45429
Area Code: 513
298-0311

OKLAHOMA
Oklahoma City 73112
3022 Northwest Expressway
May-Ex Building
Room 412
Area Code: 405
943-9015

PENNSYLVANIA
Erie 16531
Building 63-2
1100 Lawrence Pkwy.
Area Code: 814
455-5466

(Philadelphia)
Wayne 19087
999 Old Eagle School Rd.
Area Code: 215
962-1500

Pittsburgh 15220
3 Parkway Center
Room 304
Area Code: 412
921-4134

TEXAS
Dallas 75240
6530 LBJ Freeway
Suite 119-B
Area Code: 214
661-8582

Houston 77036
7011 S.W. Freeway
Suite 106
Area Code: 713
777-3443

VIRGINIA
Waynesboro 22980
Suites 19 and 20
Skyline Motor Court
Rt. 250 East
Area Code: 703
943-1151

Portsmouth 23707
808 Loudon Ave.
Area Code: 804
397-8752

WASHINGTON
Seattle 98188
112 Andover Park, E.
P.O. Box 88850, 98188
Area Code: 206
575-2866

WISCONSIN
Milwaukee 53202
615 E. Michigan St.
Area Code: 414
271-5000

AFRICA
S.A. General Electric (Pty) Ltd.
P.O. Box 24
Maitland 7405
R.S.A.
Tel: 511251

S.A. General Electric Ltd.
P.O. Box 1482
Capetown, R.S.A.
Tel: 51-1251

AUSTRALIA
Australian General Electric Ltd.
86-90 Bay St.
Ultimo, N.S.W., 2007
Tel: 212-3711

AUSTRIA
General Electric Technical
Service Company, Inc.
East Central Europe Liaison
Peter Jordan Strasse 99
A-1180 Vienna, Austria

BELGIUM
General Electric Company (USA)
Chaussee De La Hulpe 150
B-1170 Brussels
Tel: 660 20 10

CANADA
Canadian General Electric Co.
189 Dufferin St.
Toronto, Ontario, Canada
Area Code: 416
Tel: 537-4481

ENGLAND
International General Electric
Company of New York, Ltd.
Park Lorne,
111 Park Rd.
London NW87 JL
Tel: 01-402-4100

FRANCE
General Electric Technical Service
Company Inc., France
42 Avenue Montaigne
Paris-8e
Tel: 225-52-32

GERMANY
General Electric Germany
Postfach 2963
Eschersheimer Landstrasse 60-62
6000 Frankfurt/Ma 1
Tel: (0611)-15641

INDIA
Elpro International Ltd.
Producer Goods Dept.
Nirmal, 17th Floor
Nariman Point, Bombay 400 021
Tel: 292471

IRELAND
Electronic Trading Co.
The Demesne
County Louth
Dundalk
Tel: (042) 32371

ITALY
Compagnia Generale Di
Elettricita S.P.A.
Via Pergolesi 25
20124 Milan
Tel: 202808-203208

JAPAN
General Electric Japan, Ltd.
Tonichi Bldg., 5th Floor
2-31, Roppongi, 6-Chome,
Minato-Ku
Tokyo, 106 Japan
Tel: 03-405-2920

MEXICO
General Electric De Mexico, S.A.
Apartado 53-983
Marina Nacional No. 365
Mexico 17 D.F.
Tel: 545-63-60

SINGAPORE
General Electric (USA) Asia Co.
Cathay Building, Suite 104
Orchard Road
Singapore, 9

SPAIN
International General Electric
Company of Spain, S.A.
Edificio Espana Apartado 700
Avenida Jose Antonio 88
Madrid
Tel: 247.16.05

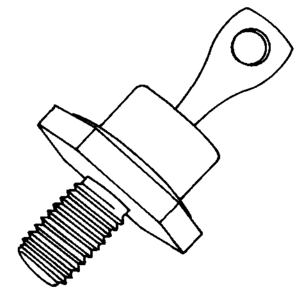
SWEDEN
International General Electric AB
Fack, Tritonvagen 27
17120 Solna
Sweden
Tel: 081730 07 40

VENEZUELA
General Electric De Venezuela S.A.
Sabana Grande
Caracas

Silicon
Rectifier

1N248-50,A,B

10A & 20A Types



These stud mounted diffused junction silicon rectifiers are designed for all rectifier applications in the 10 to 20 ampere range. A high junction temperature rating and an extremely low forward voltage drop and thermal impedance permit high current operation with minimum space requirements. These rectifiers may be mounted directly to a chassis or a fin or may be electrically insulated from the heat sink by using the mica washer insulating kit

General Electric research, advanced development and product design have resulted in a highly efficient rectifying junction. This feature, plus a mechanical design employing high temperature hard solders and welds for all internal and external joints and seals, which eliminates common sources of thermal fatigue failure, has produced a silicon rectifier with outstanding reliability under all operating conditions.

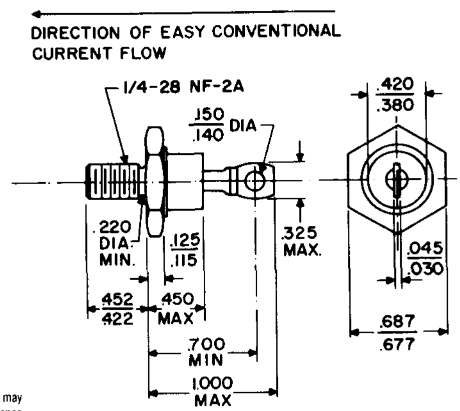
electrical ratings and specifications (60 CPS, Resistive or Inductive Load)

	1N248	1N249	1N250	1N248A	1N249A	1N250A	1N248B	1N249B‡	1N250B‡	
Max. Allow. Peak Reverse Voltage (Repetitive, −65°C to +175°C)*	50	100	200	50	100	200	50	100	200	Volts
Max. Allow. Peak Reverse Voltage (Repetitive at 25°C)*	50	100	200	50	100	200	55	110	220	Volts
Max. Allow. RMS Voltage	35	70	140	35	70	140	35	70	140	Volts
Max. Allow. DC Blocking Voltage†	50	100	200	50	100	200	50	100	200	Volts
Max. Allow. Forward Current (Single Phase or Three Phase 150°C stud temp.)	← 10 Amp DC →			← 20 Amp DC →			← 20 Amp DC →			
Peak Recurrent Forward Current	← 45 Amp →			← 90 Amp →			← 90 Amp →			
Max. Allow. Peak One-Cycle Surge Current	← 200 Amp →			← 350 Amp →			← 350 Amp →			
Max. Full Load Voltage Drop (T_j = 25°C) At 25A	← 1.5 Volts →									
At 50A				← 1.5 Volts →			← 1.5 Volts →			
Max. Leakage Current at Full Load (Single Phase, Full Cycle Average, 150°C stud temp.)	← 5 milliamp →									
Junction Operating and Storage Temp. Range	← −65°C to +175°C →									
Maximum Stud Torque	30 inch-pounds.									

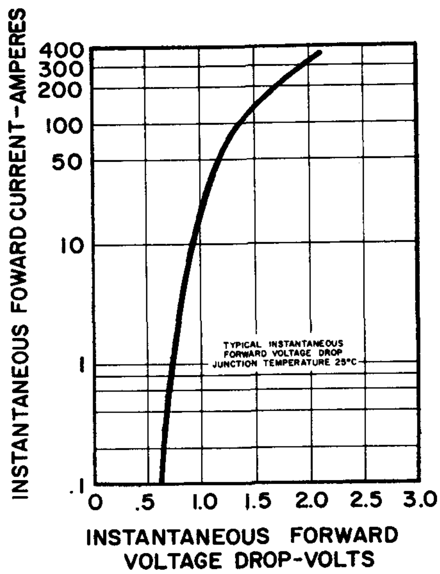
*Maximum voltages apply with a heat sink thermal resistance of 12°C/watt or less at maximum rated junction temperature.
†Maximum voltages apply with a heat sink thermal resistance of 5°C/watt or less at maximum rated junction temperature.

OUTLINE DRAWING

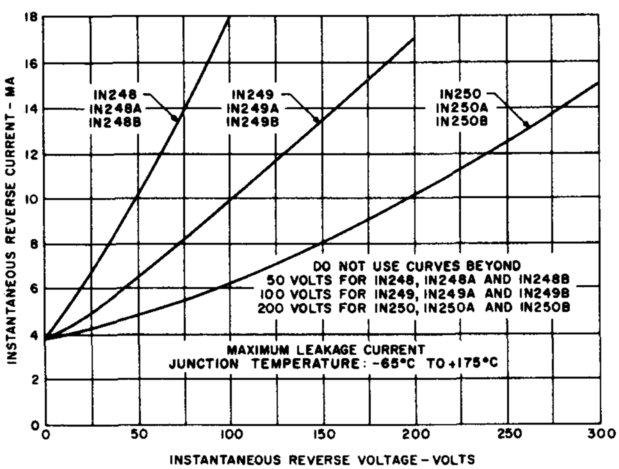
INSULATING HARDWARE KIT*



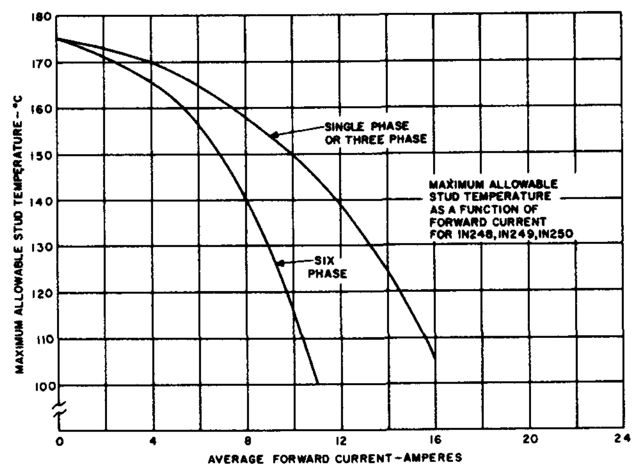
NOTE 1: Unit weight—.5 oz.
NOTE 2: Mica washer in mounting kit may add approx 2.5°C/watt thermal resistance stud to heatsink.
Complies with EIA registered outline DO-5
*Available upon request.



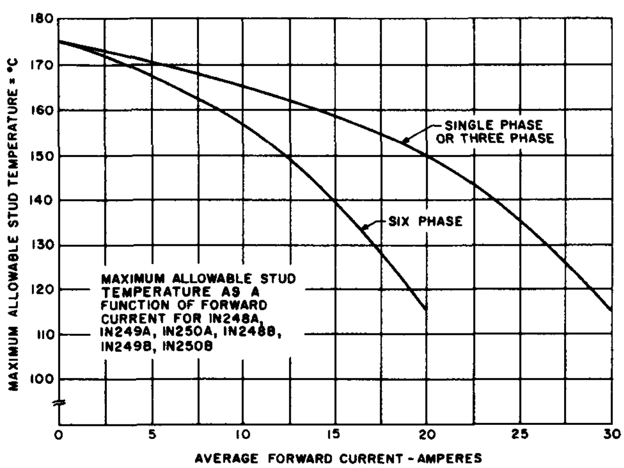
1. TYPICAL FORWARD CHARACTERISTICS



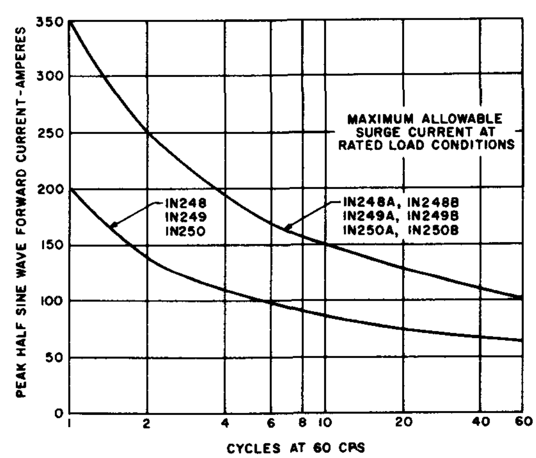
2. REVERSE CHARACTERISTICS



3. MAXIMUM ALLOWABLE STUD TEMPERATURE 1N248, 1N249, 1N250



4. MAXIMUM ALLOWABLE STUD TEMPERATURE 1N248A, 1N249A, 1N250A 1N248B, 1N249B, 1N250B



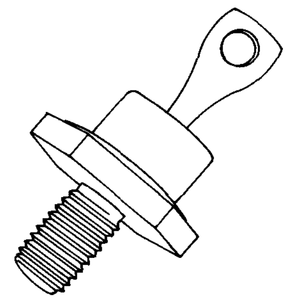
5. SURGE RATING

Silicon Rectifier

1N248C-50C
1N1195A-98A

20 A Types

These stud mounted diffused junction silicon rectifiers are designed for all rectifier applications in the 20 ampere range. A high junction temperature rating and an extremely low forward voltage drop and thermal impedance permit high current operation with minimum space requirements. *These rectifiers may be mounted directly to a chassis or a* fin or may be electrically insulated from the heat sink by using the mica washer insulating kit



General Electric research, advanced development and product design have resulted in a highly efficient rectifying junction. *This feature, plus a mechanical design employing* high temperature hard solders and welds for all internal and external joints and seals, which eliminates common sources of thermal fatigue failure, has produced a silicon rectifier with outstanding reliability under all operating conditions.

electrical ratings and specifications (60 cps, Resistive or Inductive Load)

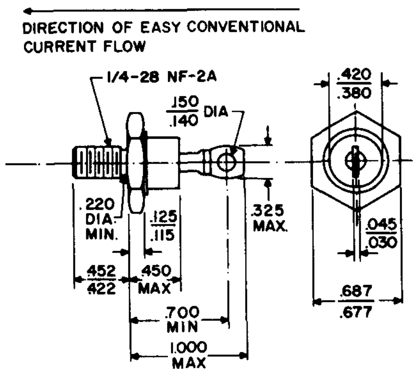
	1N248C	1N249C	1N250C	1N1195A	1N1196A	1N1197A	1N1198A	
Max. Allow. Peak Reverse Voltage (Repetitive)*	55	110	220	300	400	500	600	Volts
Max. Allow. RMS Voltage	39	77	154	212	284	355	424	Volts
Max. Allow. DC Blocking Voltage**	50	100	200	300	400	500	600	Volts
Max. Allow. Forward Current (Single Phase or Three Phase −150°C stud temp.)	← 20 Amp DC →							
Peak Recurrent Forward Current	← 90 Amp →							
Max. Allow. Peak One-Cycle Surge Current	← 350 Amp →							
Max. Full Load Voltage Drop (Full Cycle Average when operated at Max. I_{DC} and PRV)	← 0.6 Volts →							
Max. Leakage Current at Full Load (Single Phase, Full Cycle Average, 150°C stud temp.)	3.8	3.6	3.4	3.2	2.5	2.2	1.5	ma.
Junction Operating and Storage Temp. Range	← −65°C to +175°C →							
Maximum Stud Torque	30 inch-pounds.							

*Maximum voltages apply with a heat sink thermal resistance of 12°C/watt or less at maximum rated junction temperature.

**Maximum voltages apply with a heat sink thermal resistance of 5°C/watt or less at maximum rated junction temperature.

1N248C-50C
1N1195A-98A

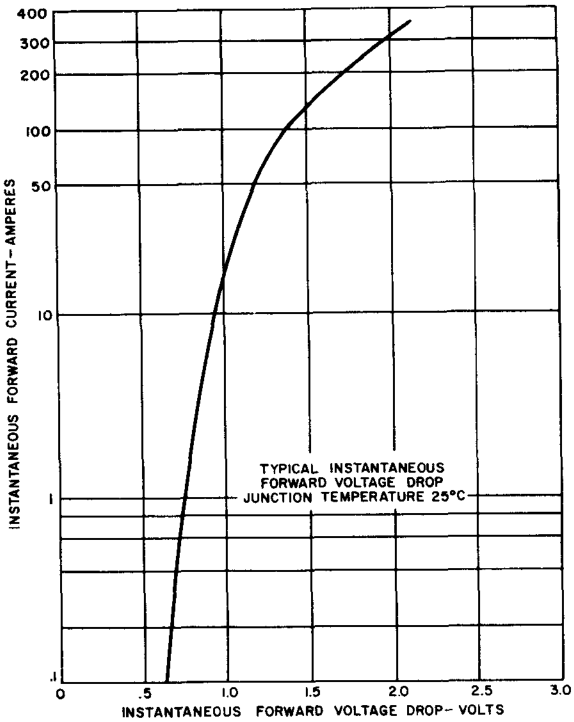
OUTLINE DRAWING



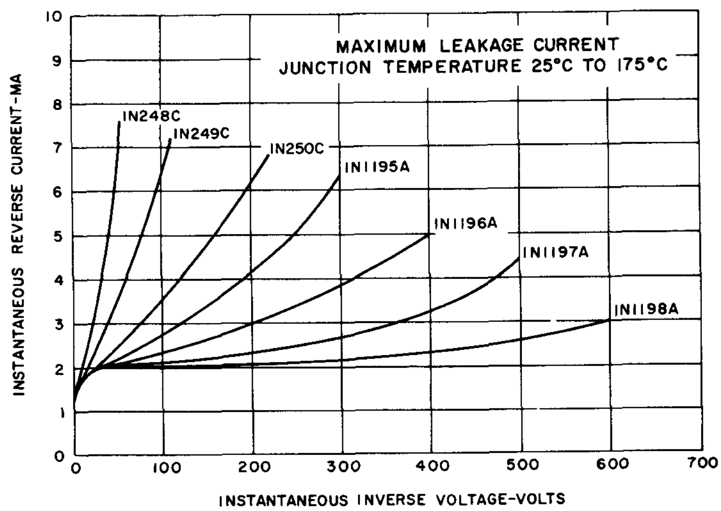
NOTES: (1) UNIT WEIGHT -.5 OZ.
(2) MICA WASHER IN MOUNTING KIT MAY ADD APPROX 2.5°C/WATT THERMAL RESISTANCE STUD TO HEATSINK

*AVAILABLE UPON REQUEST.

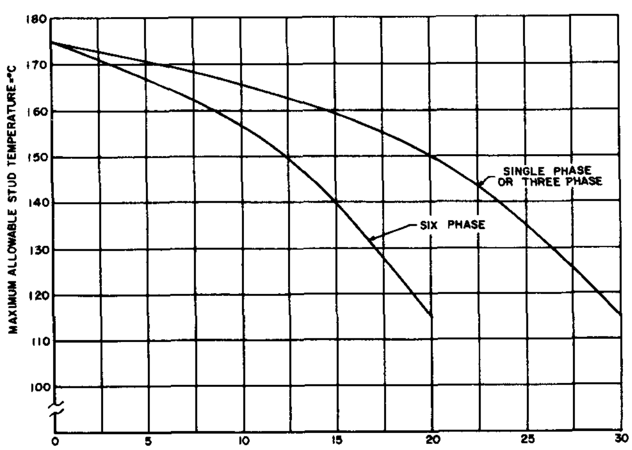
COMPLIES WITH
EIA REGISTERED OUTLINE DO-5



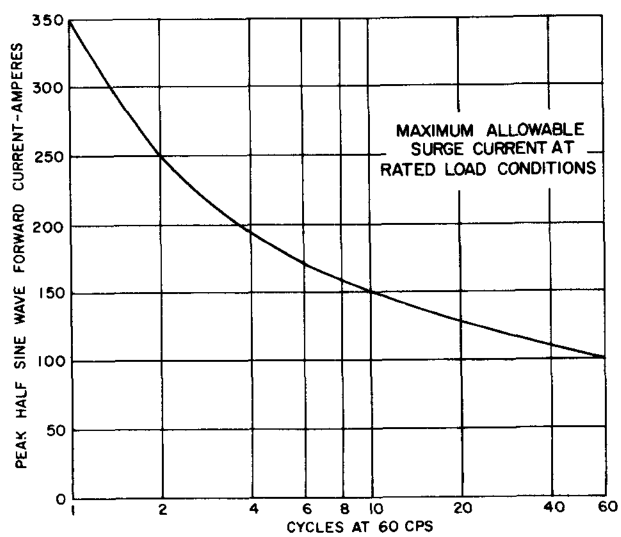
I. TYPICAL FORWARD CHARACTERISTICS



II. REVERSE CHARACTERISTICS



III. MAXIMUM ALLOWABLE STUD TEMPERATURE

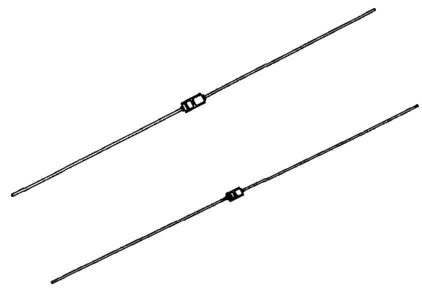


IV. SURGE RATING

Silicon Diodes

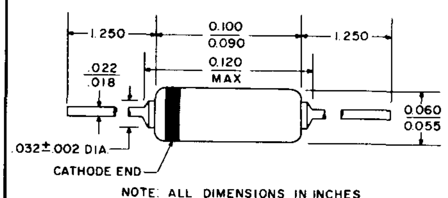
1N914,A,B
1N916,A,B
1N4148,49
1N4154
1N4446-49
1N4531
1N4536

This family of General Electric silicon signal diodes are very high speed switching diodes for computer circuits and general purpose applications. These diodes incorporate an oxide passivated planar structure. This structure makes possible a diode having high conductance, fast recovery time, low leakage, and low capacitance combined with improved uniformity and reliability. These diodes are contained in two different packages; double heat sink miniature package, and milli-heat sink package.
They are electrically the same as their equivalent types in each of the two different packages (see page two for groupings of electrically equivalent types in each of the two packages).



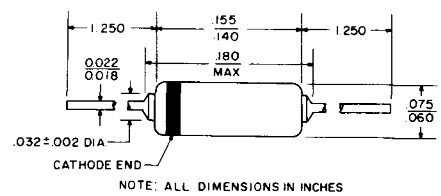
PLANAR EPITAXIAL PASSIVATED
with Controlled Conductance

MILLI-HEATSINK DIODE (MHD)
1N4531, 1N4536



Dissipation: 500mW @ 25°C free air
Derate: 2.85mW/°C for temp. above 25°C amb. based on max. T_J = 200°C

DOUBLE HEATSINK DIODE (DHD)
1N914,A,B; 1N916,A,B*
1N4148,49,54; 1N4446—49



Dissipation: 500mW @ 25°C free air
Derate: 2.85mW/°C for temp. above 25°C amb. based on max. T_J = 200°C

FEATURES	1N914 1N914A 1N914B	1N4148 1N4446 1N4448 1N4531	1N916 1N916A 1N916B	1N4149 1N4447 1N4449	1N4536 1N4154
Reverse Recovery Time of 2 nanoseconds maximum					●
Reverse Recovery Time of 4 nanoseconds maximum	●	●	●	●	
Capacitance of 2 pF maximum			●	●	
Capacitance of 4 pF maximum	●	●			●
Power Dissipation to 500 mW		●		●	●
Power Dissipation to 250 mW					
Meets all MIL-S-19500C requirements	●	●	●	●	●

Figure 1

HEATSINK SPACING FROM END OF DIODE BODY	STEADY STATE THERMAL RESISTANCE °C/mW (NOTE 1)		POWER DISSIPATION AT 25°C mW (NOTE 2)	
	MHD	DHD	MHD	DHD
.062"	.230	.250	760	700
.250"	.319	.319	550	550
.500"	.438	.438	400	400

NOTE 1 See Figure 7 for thermal resistance for short pulses.
NOTE 2 This power rating is based on a maximum junction temperature of 200°C.

1N914, A, B	1N4154	1N4536
1N916, A, B	1N4446-49	
1N4148, 49	1N4531	

absolute maximum ratings: (25°C) (unless otherwise specified)

	MHD & DHD	MHD & DHD	
Voltage			
Reverse	75	25	Volts
Current			
Average Rectified	150	150	mA
Recurrent Peak Forward	450	450	mA
Forward Steady-State DC	200	200	mA
Peak Forward Surge (1µsec. pulse)	2000	2000	mA
Power			
Dissipation	500	500	mW
Temperature			
Operating	←—65 to +200—→		°C
Storage	←—65 to +200—→		°C

electrical characteristics: (25°C) (unless otherwise specified)

Type	Minimum Breakdown Voltage @ 100µA	Forward Voltage		Maximum Reverse Current, I_R			C_o (1)	t_{rr} (2)	V_f (3)
		I_F	V_F	20V		75V			
				25°C	150°C	25°C			
	Volts	mA	V	nA	µA	µA	pF	ns	V
1N914 1N4148 1N4531	100	10	1.0	25	50	5	4	4	
1N914A 1N4446	100	20	1.0	25	50	5	4	4	
1N914B 1N4448	100	5 100	0.62–0.72 1.0	25(4)	50	5	4	4	2.5
1N916 1N4149	100	10	1.0	25	50	5	2	4	
1N916A 1N4447	100	20	1.0	25	50	5	2	4	
1N916B 1N4449	100	5 30	0.63–0.73 1.0	25	50	5	2	4	2.5
1N4154 1N4536	35 @ 5µA	30	1.0	100 @ 25V	100 @ 25V		4	2	

*Except as noted.

NOTES
(1) Maximum Capacitance is measured on Boonton model 75A capacitance bridge at a signal level of 50 mV at $V_R = 0$
(2) Maximum Reverse Recovery Time, I_f = 10mA, V_R = −6V, R_L = 100Ω, Recovery to 1.0mA (Figure 6)
(3) Maximum Forward Recovery Voltage, −50mA peak square wave, 0.1 µsec. pulse width, 5 to 100 kHz repetition rate, generator rise time (t_r) ≦ 30nsec.
(4) Also 3µA at 20 V at 100°C

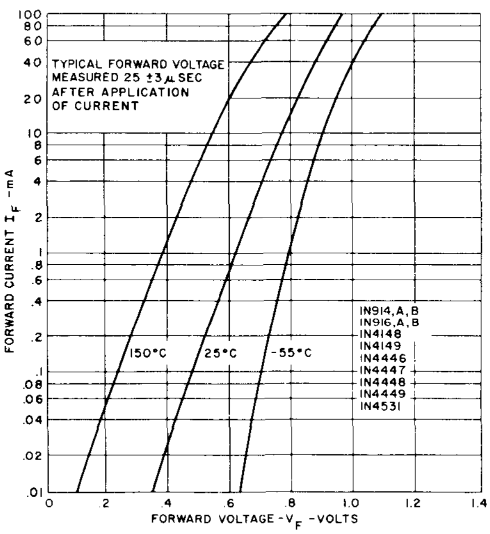


Figure 2

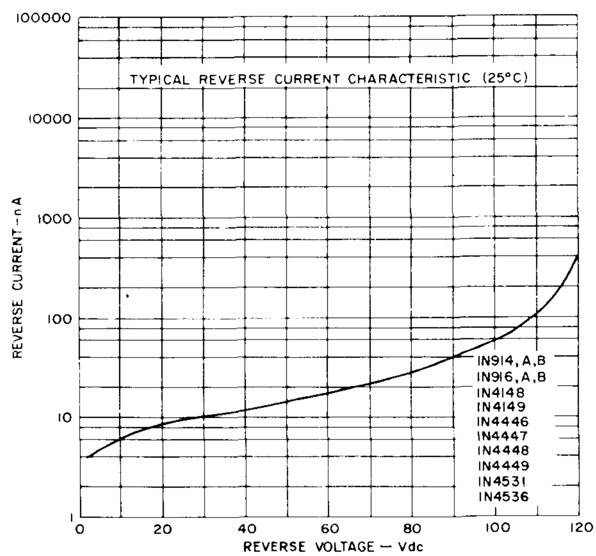


Figure 3

1N914, A, B	1N4154	1N4536
1N916, A, B	1N4446-49	
1N4148, 49	1N4531	

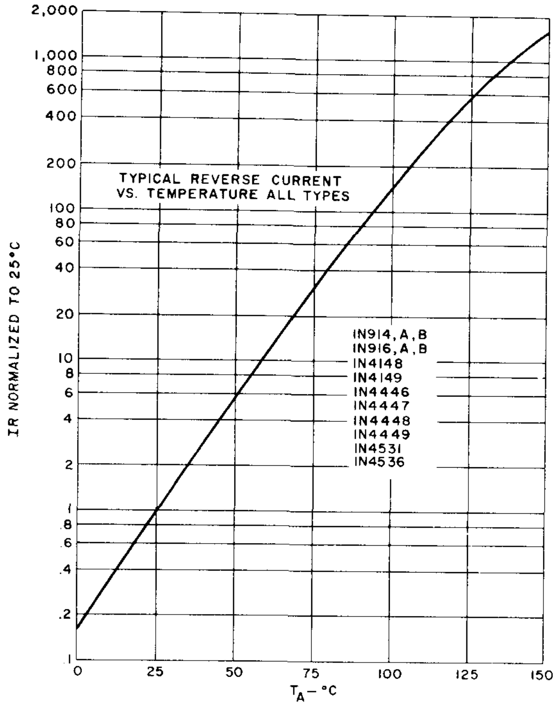


Figure 4

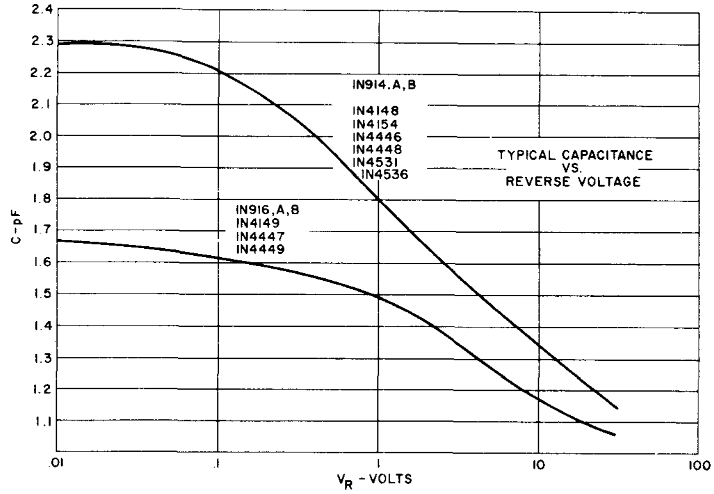
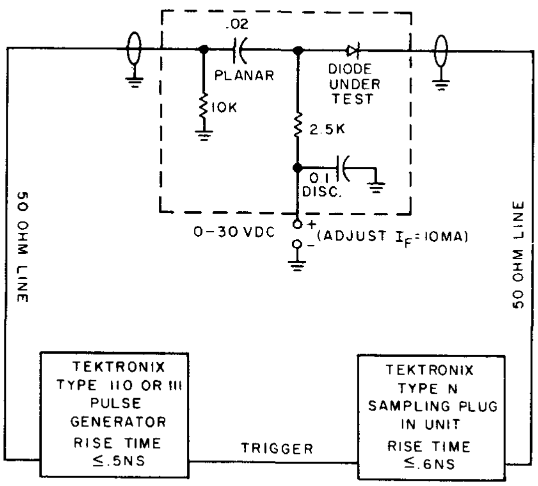


Figure 5



LOW CURRENT t_{rr} TEST CIRCUIT

Figure 6

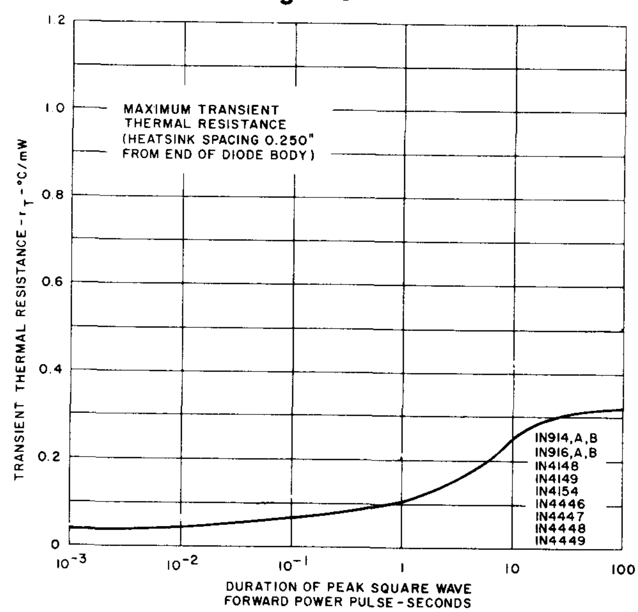


Figure 7

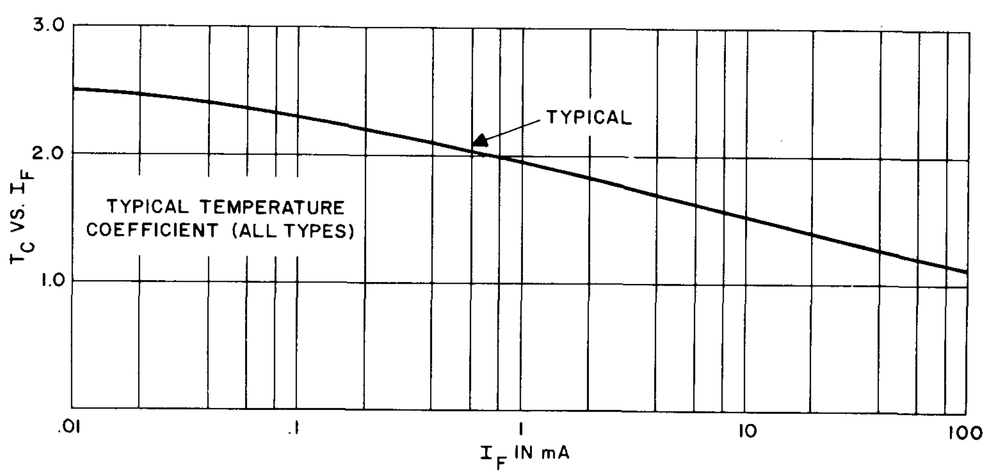


Figure 8

1N914, A, B	1N4154	1N4536
1N916, A, B	1N446-49	
1N4148, 49	1N4531	

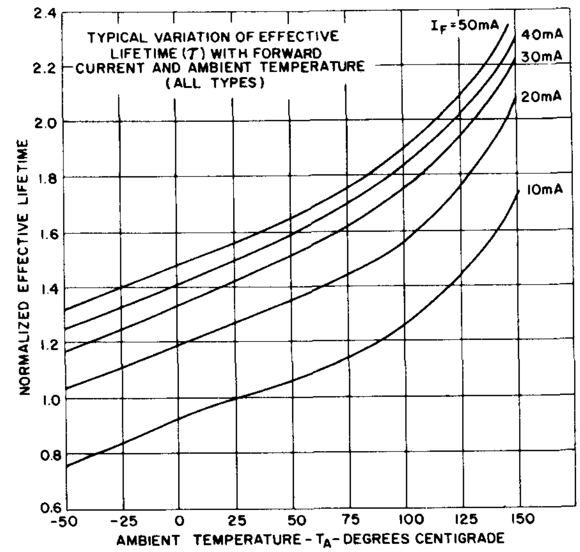


Figure 9

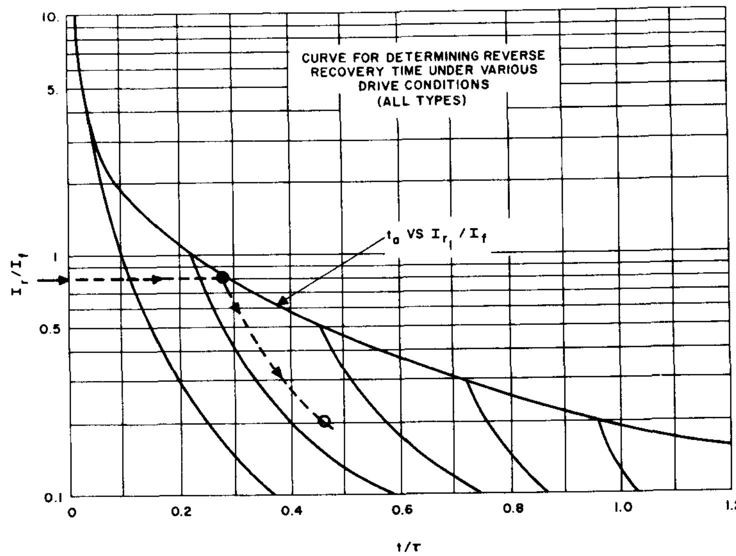
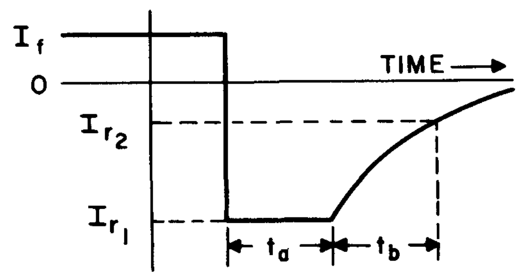


Figure 10

ESTIMATION OF REVERSE RECOVERY TIME UNDER VARIOUS DRIVE CONDITIONS

The reverse recovery time of a silicon signal diode has been shown* to be determined by a quantity called the effective lifetime, τ, and the ratio of forward and reverse current. The exact equations expressing times t_a and t_b (as defined in the sketch at right) are somewhat inconvenient for numerical evaluation, but in many cases an estimation of response time is sufficient. Figure 10 is a graphical solution to the response time equations and its use can best be illustrated by the following example:



FIND: Recovery time to 5 mA reverse current when the forward current is 25 mA and the maximum reverse current is 20 mA.

SOLUTION: Enter the left side of Figure 10 at $I_{r1}/I_f = 20/25 = 0.8$ and follow horizontally until the t_a vs. I_{r1}/I_f line is reached (see dotted line). From the t/τ scale of the horizontal axis, it is seen that t_a is 0.28τ. The t_b portion of the recovery curve is estimated by moving downward parallel to the general contour lines until the $I_{r2}/I_f = 5/25 = 0.2$ line is reached. The total switching time is thus 0.46τ. The delay time, t_b, is $0.46\tau - 0.28\tau$ or 0.18τ.

The value of τ on the spec sheet should be corrected for current level. Figure 9 shows the typical variation of effective lifetime with forward current. Since the current level of the example is 25 mA, the maximum effective lifetime is approximately (6.8) (1.35) or 9.3 nsec., therefore:

$t_a \approx (9.3)\ (.28) \approx 2.6$ nsec. maximum

$t_b \approx (9.3)\ (.18) \approx 1.7$ nsec. maximum

Total reverse recovery time $\approx$ 4.3 nsec. maximum

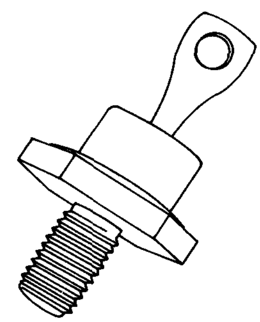
Additional information on this method of diode recovery time calculation is contained in a paper entitled "Predicting Reverse Recovery Time of High Speed Semiconductor Junction Diodes" by C. H. Chen, (Publication #90.36) available on request.

*Ko, W. H., "The Reverse Transient Behavior of Semiconductor Junction Diodes," IRE Trans. ED-8, March 1961, pp. 123-131.

Silicon
Rectifier

1N1183-90
1N3765-68
1N5332

These diffused junction rectifiers are intended to be applied under the most stringent Military environment. The glass seal is specially designed to give a reasonable creepage distance at voltages through 1200 volts. The all hard-solder construction used in the assembly of these devices will promote long thermal fatigue free life even under cyclic load conditions.



Features:
- New High Voltage—Up To 1200V
- Thermal Fatigue Free—Uses Hard-Solders
- Popular JEDEC DO-5 Outline
- Ratings up to 200°C Junction Temperature
- Available in Reverse Polarity

ratings & specifications (60 cps, Resistive or Inductive Load)

	1N1183	1N1184	1N1185	1N1186	1N1187	1N1188	1N1189	1N1190	1N3765	1N3766	1N3767	1N3768	1N5332	
*Maximum Allowable Repetitive and Working Peak Reverse Voltage, V_{RM} (rep) & V_{RM} (wkg.)[1]	50	100	150	200	300	400	500	600	700	800	900	1000	1200	volts
Maximum Allowable RMS Voltage, V_r	* 35.5	* 71	* 106	* 142	* 212	* 284	* 355	* 424	495	565	635	710	852	volts
*Maximum Allowable DC Blocking Voltage, V_R[2]	40	80	120	160	240	320	400	480	700	800	900	1000	1200	volts
*Maximum Allowable Average Forward Current (180° conduction angle, 60 cps, half sine wave current at T_C = 140°C), I_O	← 35 Adc →													
*Maximum Allowable Peak One Cycle Surge Current (non-recurrent), I_{FM} (surge)	← 500 →								← 400 →				← 500 →	amperes
I^2t Rating (for t greater than .001 sec. and less than .0083 sec., non-recurrent)	← 500 (Amp RMS) ²Sec min. value, See Chart 6 →													
*Maximum Peak Forward Voltage Drop (I_O = 35 Adc at T_C = 140°C), $V_{F(AV)}$	← 1.7 →								← 1.8 →				← 1.7 →	Vdc
*Maximum Average Reverse Current (I_O = 35 Adc at T_C = 140°C), $I_{R(AV)}$	10	10	10	10	10	10	10	10	5	4	3	2	2	mA
Maximum Effective Thermal Resistance Junction to Case, $R_{\theta JC}$	* 1.0	* 1.0	* 1.0	* 1.0	* 1.0	* 1.0	* 1.0	* 1.0	1.0	1.0	1.0	1.0	1.0	°c/w
Junction Operating & Storage Temperature Range, T_J & T_{stg}	← −65° C to +200°C →													
Stud Torque	← 30 inch pounds (35K_g-cm) →													

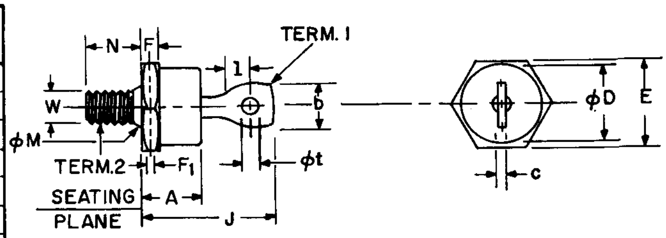
[1]Maximum voltages apply with a heat sink thermal resistance of 10°C/w or less at maximum rated junction temperature.
[2]Maximum voltages apply with a heat sink thermal resistance of 5°C/w or less at maximum rated junction temperature.
NOTE: Case temperature is measured at the center of any one of the hex flats.
*The asterisk denotes JEDEC (EIA) registered information.

1N1183-90	1N5332
1N3765-68	

OUTLINE DRAWING

DO-5

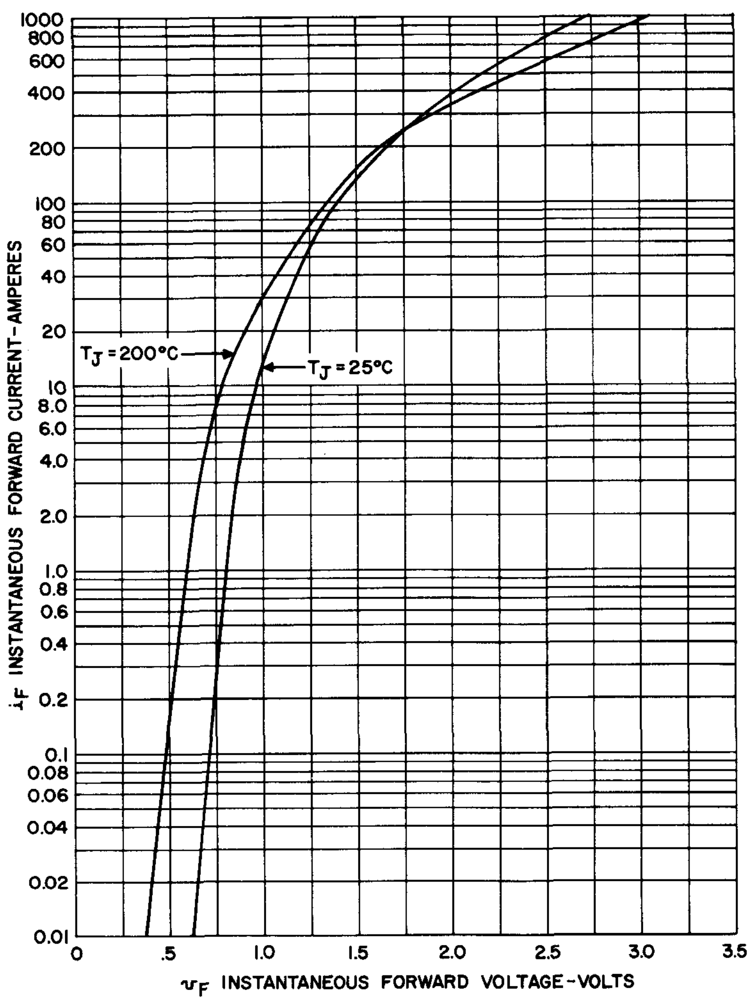
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.450		11.43	
b		.375		9.53	2
c		.080		2.03	
φD		.667		16.94	
E	.667	.687	16.94	17.45	
F	.115	.200	2.92	5.08	
F_1	.060		1.52		
J		1.000		25.40	
1	.156		3.96		4
φM	.220	.249	5.59	6.32	1
N	.422	.453	10.72	11.51	
φt	.140	.175	3.56	4.45	
W					1,3



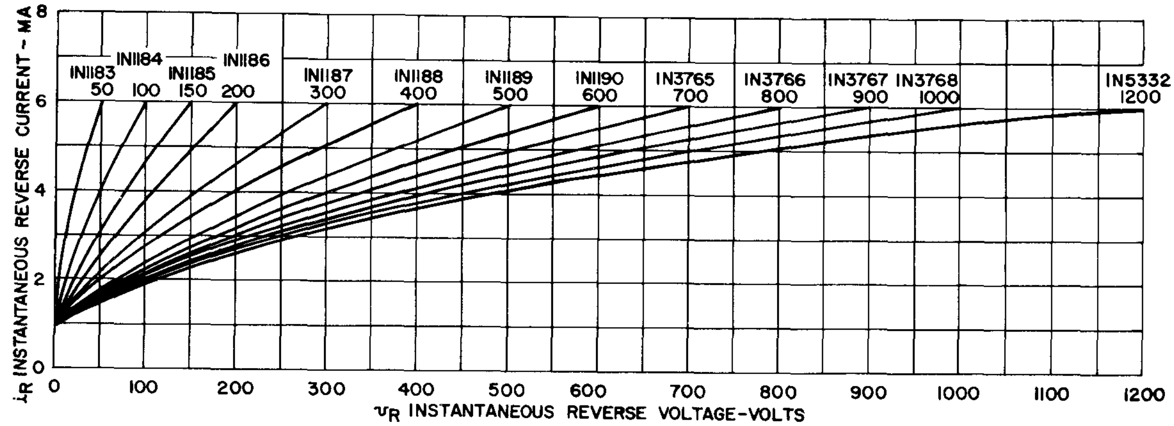
NOTES:
1. COMPLETE THREADS TO EXTEND TO WITHIN 2-1/2 THREADS OF SEATING PLANE.
2. ANGULAR ORIENTATION OF TERMINAL IS UNDEFINED.
3. 1/4-28 UNF-2A. MAXIMUM PITCH DIAMETER OF PLATED THREADS SHALL BE BASIC PITCH DIAMETER (.2268", 5.74 MM) REF. (SCREW THREAD STANDARDS FOR FEDERAL SERVICES 1957) HANDBOOK H28 1957 P1.
4. MINIMUM FLAT.

EIA-NEMA STANDARD OUTLINE, NEMA SK-51 - EIA RS-241.
INSULATING HARDWARE IS AVAILABLE UPON REQUEST.

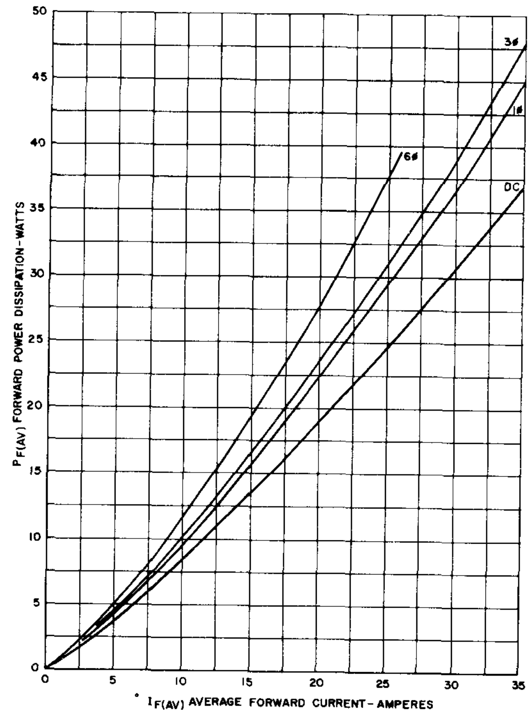
5. FOR REVERSE POLARITY TYPES ADD THE LETTER R, EXAMPLE: 1N1183R.



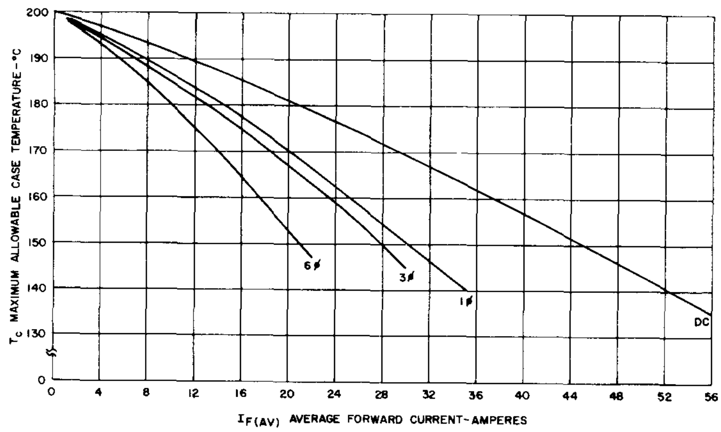
1. MAXIMUM FORWARD CHARACTERISTICS



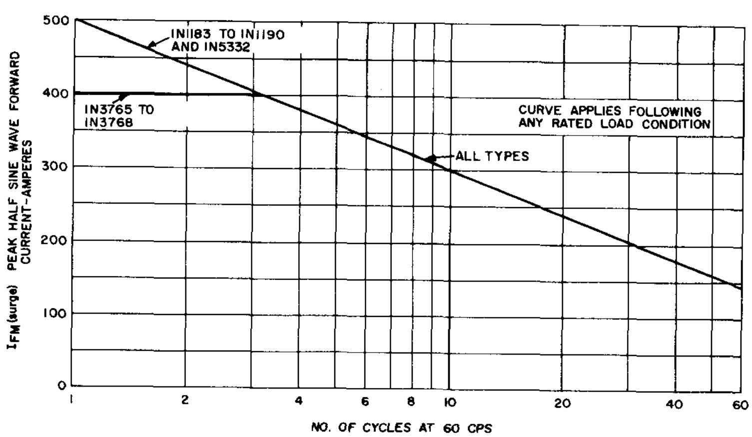
2. TYPICAL REVERSE CHARACTERISTICS
$T_J = 200°C$ FOR VARIOUS VOLTAGE GRADES



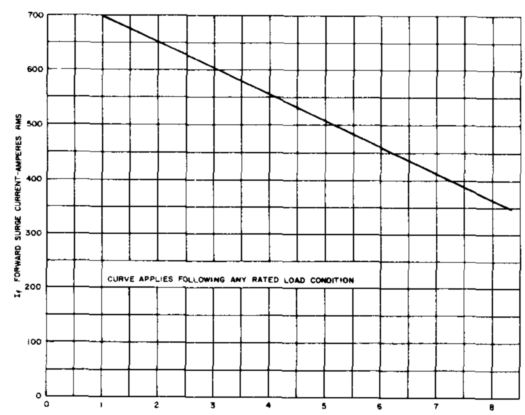
3. AVERAGE FORWARD POWER
AS A FUNCTION OF AVERAGE FORWARD CURRENT
$T_J = 200°C$



4. AVERAGE CURRENT RATING AS A FUNCTION OF CASE TEMPERATURE

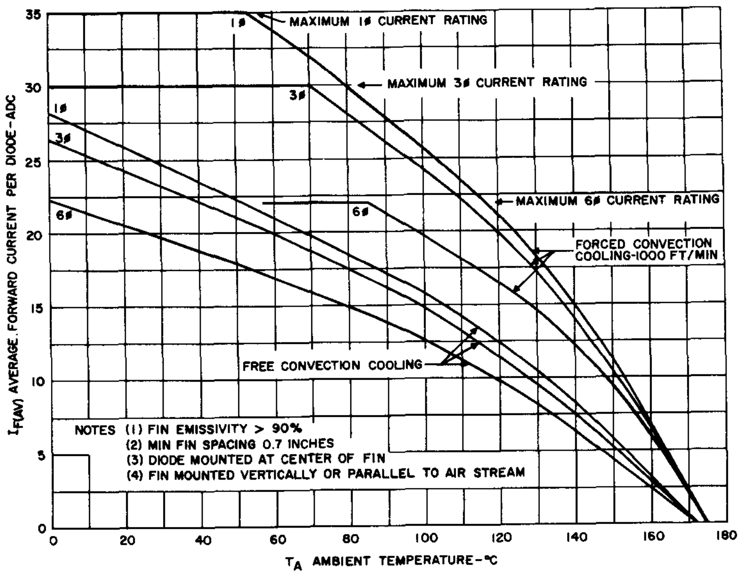


5. NON-RECURRENT FORWARD CURRENT
SURGE CURVE, MULTICYCLE

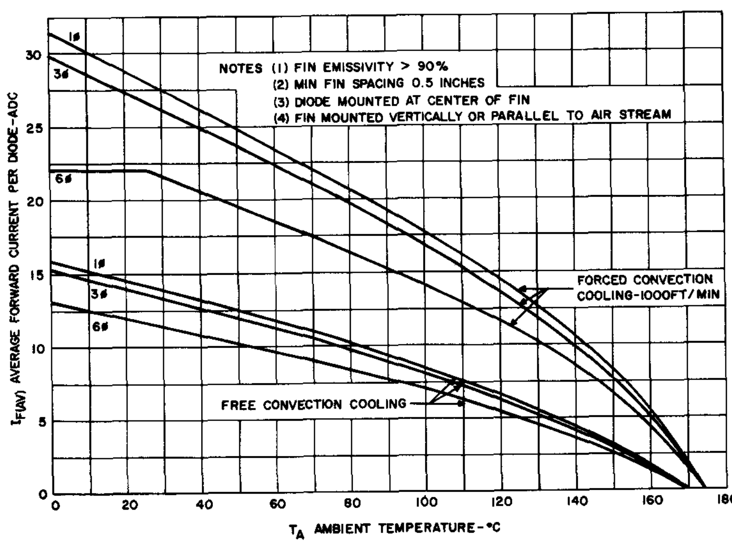


6. NON-RECURRENT FORWARD CURRENT SURGE
CURVE, SUBCYCLE

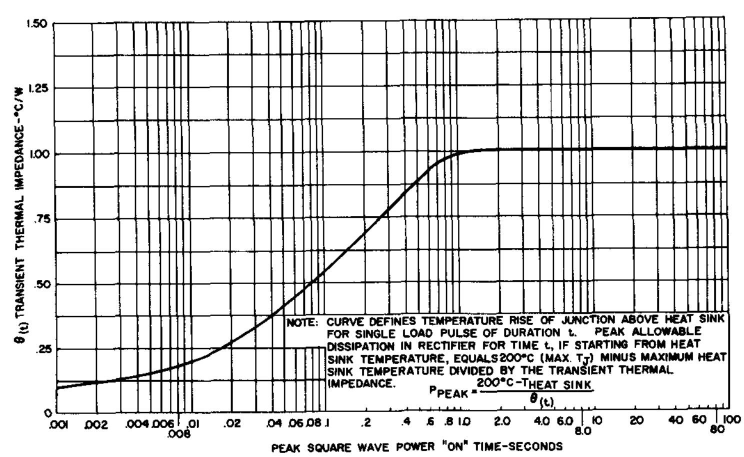
1N1183-90
1N3765-68
1N5332



7. CURRENT RATING FOR DEVICE MOUNTED ON 5″ x 5″ x .050″ COPPER FIN



8. CURRENT RATING FOR DEVICE MOUNTED ON 2½″ x 2½″ x .043″ COPPER FIN



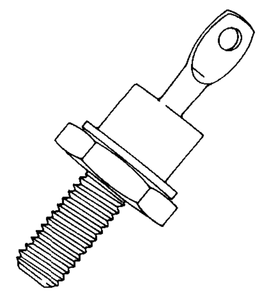
9. TRANSIENT THERMAL IMPEDANCE, JUNCTION TO CASE

1N1195 SEE PAGE 203

Silicon Rectifiers

1N1199A-1N1206A
1N1199RA-1N1206RA
1N3670A-1N3673A
1N5331

These diffused junction rectifiers are designed specifically to provide high performance for applications up to 22 amperes Average Forward Current in single-phase applications with repetitive peak reverse voltages of 50 through 1200 volts. High junction temperature rating plus low forward drop and thermal impedance permit high current operation with minimum space requirements.



General Electric research, advance development and product design have resulted in a highly efficient rectifying junction. This feature, plus a mechanical design employing high-temperature hard solders and welds for all internal and external joints and seals, which eliminates common sources of thermal fatigue failure, have produced a silicon rectifier with outstanding reliability under all operating conditions.

FEATURES:

- High Voltage
- Ratings up to 200°C Junction Temperature
- Popular DO-4 Outline
- Uses Hard Solders for Thermal Fatigue Protection
- Transient Voltage Ratings 200 Volts Above PRV Ratings

MAXIMUM ALLOWABLE RATINGS

Types	Repetitive Peak Reverse Voltage, $V_{RM}(rep)^{(1)}$	RMS Voltage	DC Blocking Voltage$^{(2)}$	Non-Repetitive Peak Reverse Voltage, $V_{RM}(non\text{-}rep)$	Full-Load Reverse Current (full-cycle avg., 150°C T_C, 1 ϕ), $I_{R(AV)}$
	Volts*	Volts*	Volts*	Volts*	Milliamperes*
1N1199A, RA	50	35	50	100	3.0
1N1200A, RA	100	70	100	200	2.5
1N1201A, RA	150	105	150	300	2.25
1N1202A, RA	200	140	200	350	2.0
1N1203A, RA	300	210	300	450	1.75
1N1204A, RA	400	280	400	600	1.5
1N1205A, RA	500	350	500	700	1.25
1N1206A, RA	600	420	600	800	1.0
1N3670A, RA	700	490	700	900	0.9
1N3671A, RA	800	560	800	1000	0.8
1N3672A, RA	900	650	900	1100	0.7
1N3673A, RA	1000	700	1000	1200	0.6
1N5331, R	1200	840	1200	1400	0.5

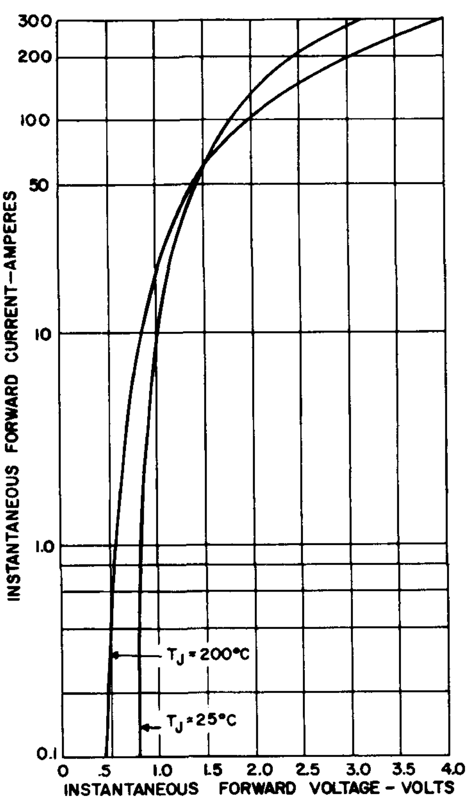
Average Forward Current (T_C = 150°C, single-phase) .... 12 Amperes*
Peak One-Cycle Surge Current (non-repetitive), I_{FM} (surge) .... 240 Amperes*
Minimum I^2t Rating (for times > .0008 sec. and < .0083 sec., non-recurrent) .... 60 Ampere^2 seconds
Maximum Full-Load Voltage Drop (T_C = 150°C, single-phase, full-cycle avg.) .... 0.55 Volts*
Maximum Thermal Resistance, $\theta_{J\text{-}C}$ .... 2.5°C/Watt
Storage and Operating Junction Temperature, T_J .... −65°C to +200°C*
Stud Torque .... 12 Lb-in (Min), 15 Lb-in (Max)*
14 Kg-cm (Min), 17.5 Kg-cm (Max)*

NOTES:

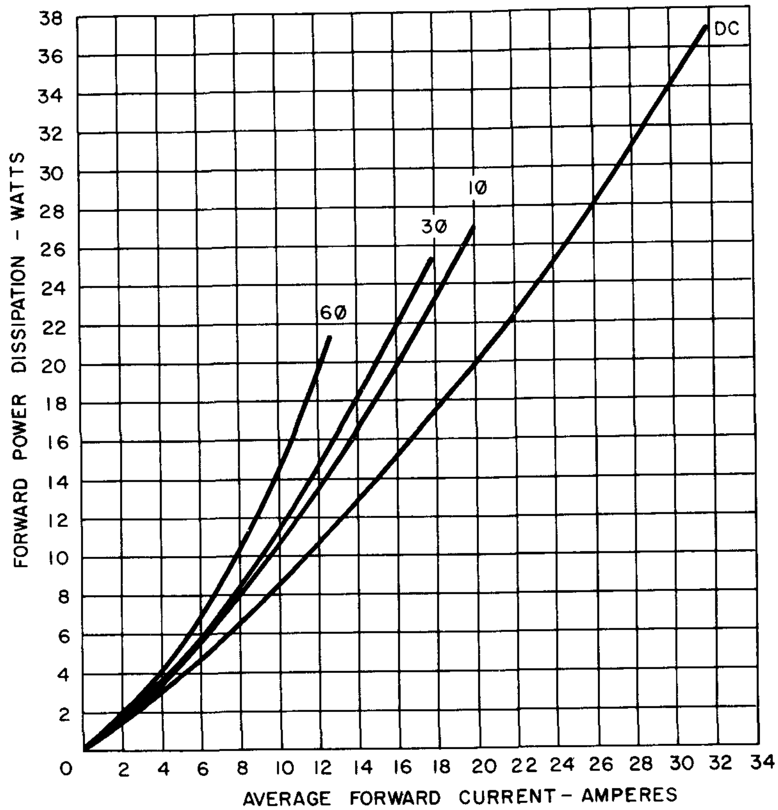
(1) Maximum voltages apply with a heatsink thermal resistance of 22°C/watt, or less, at maximum rated junction temperature.
(2) Maximum voltages apply with a heatsink thermal resistance 7°C/watt, or less, at maximum rated junction temperature.
(3) Case temperature, T_C, is measured at the center of any one of the hex flats.

*Indicates values included in JEDEC Type Number Registration.

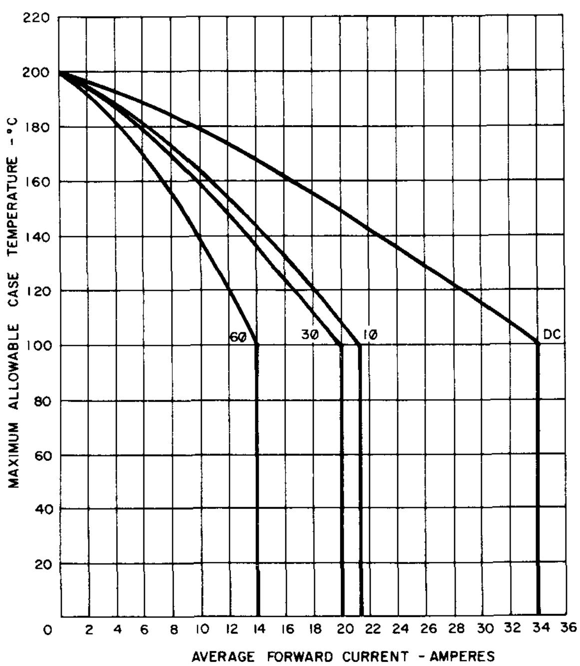
1N1199A-1N1206A
1N1199RA-1N1206RA
1N3670A-1N3673A
1N5331



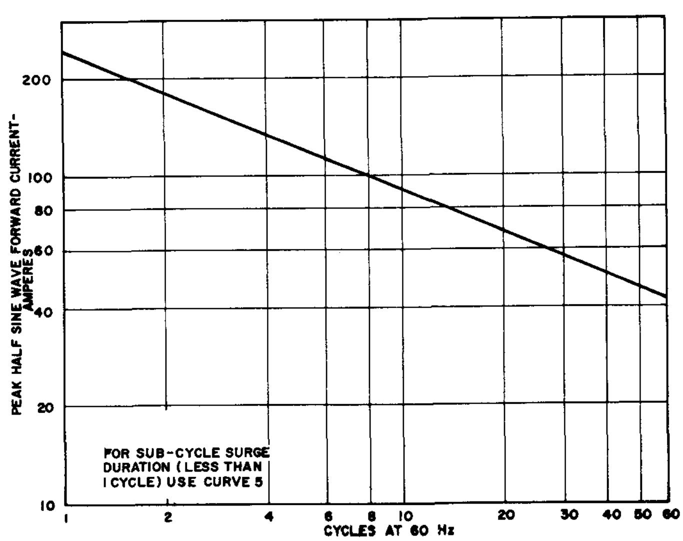
1. MAXIMUM FORWARD CHARACTERISTICS



2. FORWARD POWER AS A FUNCTION OF AVERAGE FORWARD CURRENT (T_J = +200°C)

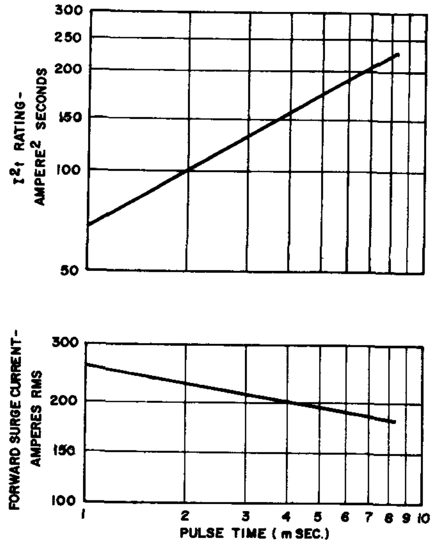


3. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT

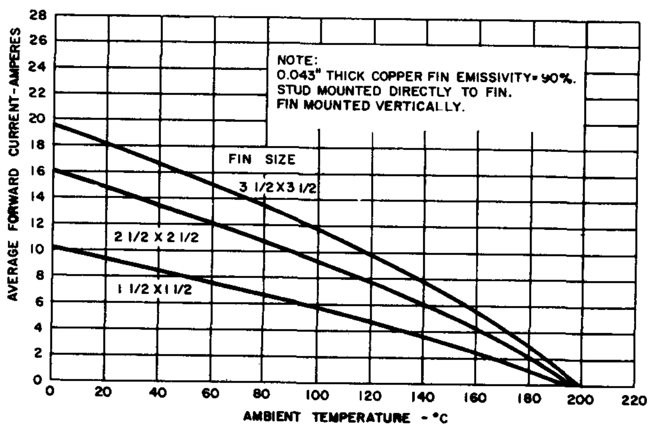


4. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

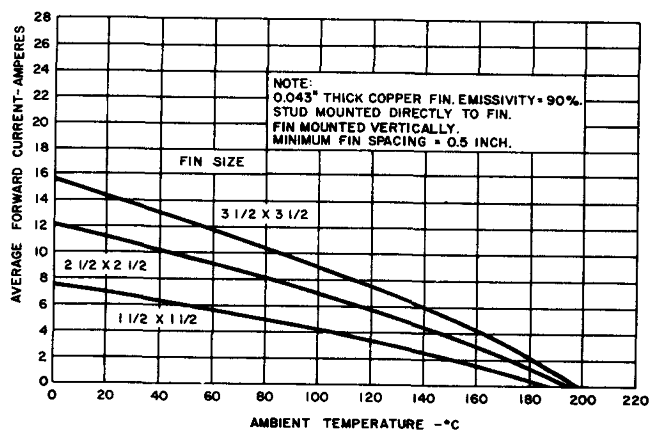
1N1199A-1N1206A
1N1199RA-1N1206RA
1N3670A-1N3673A
1N5331



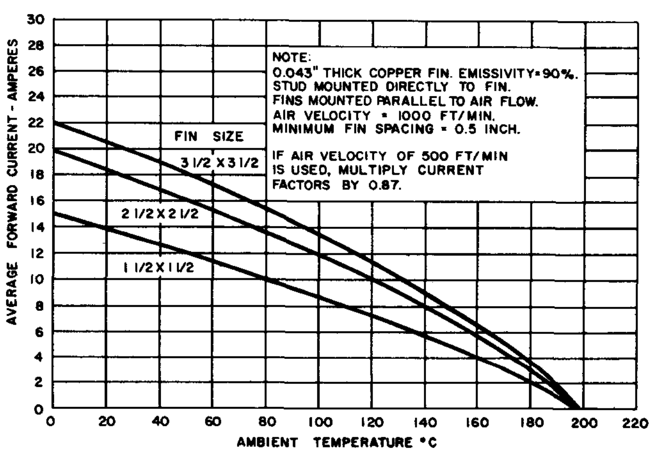
5. SUBCYCLE SURGE FORWARD CURRENT AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS



6. REQUIRED FIN SIZE — FREE CONVECTION, SINGLE FIN, UNIMPEDED RADIATION



7. REQUIRED FIN SIZE — FREE CONVECTION, IMPEDED RADIATION



8. REQUIRED FIN SIZE — FORCED CONVECTION, IMPEDED RADIATION

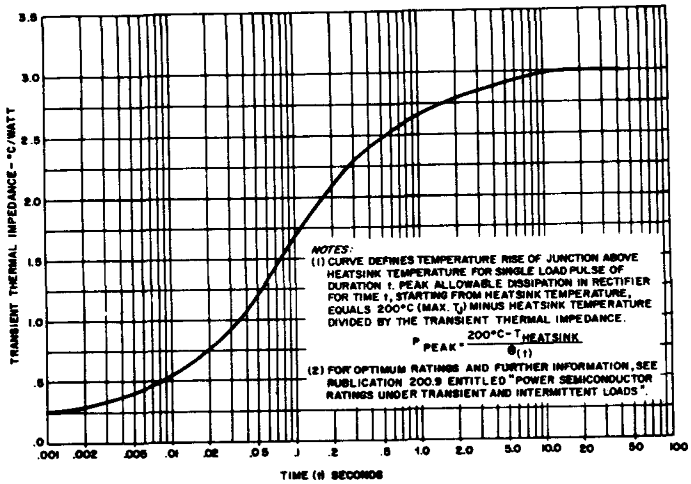
TO USE GRAPHS 6, 7 AND 8

1. Enter graph at vertical axis with desired current multiplied by proper current factor:

   DC-0.80   3ϕ-1.15
   1ϕ-1.00   6ϕ-1.40

2. Intercept desired fin curve
3. Read on horizontal axis the maximum allowable ambient temperature

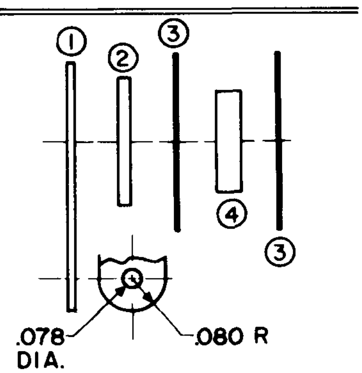
1N1199A-1N1206A
1N1199RA-1N1206RA
1N3670A-1N3673A
1N5331



9. MAXIMUM TRANSIENT THERMAL IMPEDANCE — JUNCTION TO HEATSINK

OUTLINE DRAWING

INSULATING HARDWARE KIT *



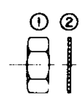
① COPPER TERMINAL, .016 THICK, TIN PLATED

② BRASS WASHER, .035 THICK NICKEL PLATED

③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK

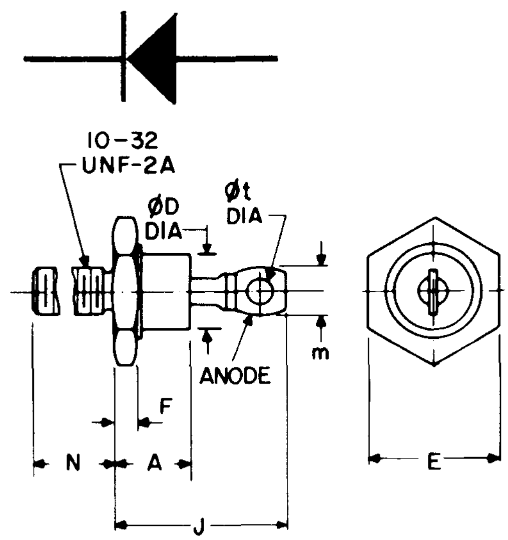
④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK

* AVAILABLE UPON REQUEST



① 10-32 STEEL NUT CADMIUM PLATED

② LOCKWASHER, CADMIUM PLATED STEEL



COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

NOTES:

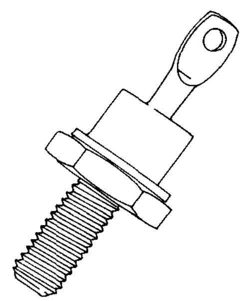
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM). Ref: (Screw thread standards for Federal Services 1957) Handbook H28, P1.

Silicon Rectifiers

IN1341A-48A
IN1341RA-48RA

MEDIUM CURRENT 6A TYPE

These stud mounted diffused junction silicon rectifiers, (designed to meet MIL-E-1/1108) are recommended for all rectifier applications in the 2 to 8 ampere range. A high junction temperature rating and an extremely low forward voltage drop and thermal impedance permit high current operation with minimum space requirements. These rectifiers may be mounted directly to a chassis or a fin or may be electrically insulated from the heat sink by using the mica washer insulating kit Versatility is further increased by the availability of a negative polarity unit (stud is anode), described by the suffix "R" appearing after the type number. The use of positive and negative polarity units facilitates the construction of bridge circuits and permits the use of either a positive or negative heat sink in half-wave and center-tap applications.



General Electric research, advanced development and product design have resulted in a highly efficient rectifying junction. This feature, plus a mechanical design employing high temperature hard solders and welds for all internal and external joints and seals, which eliminates common sources of thermal fatigue failure, have produced a silicon rectifier with outstanding reliability under all operating conditions.

electrical ratings and specifications (60 cps, Resistive or Inductive Load)

	1N1341A 1N1341RA	1N1342A 1N1342RA	1N1343A 1N1343RA	1N1344A 1N1344RA	1N1345A 1N1345RA	1N1346A 1N1346RA	1N1347A 1N1347RA	1N1348A 1N1348RA
Max. Allow. Transient Peak Reverse Voltage (Non-recurrent, 5 millisec. max. duration, $T_j = 0$ to 200°C)	100	200	300	350	450	600	700	800 Volts
Max. Allow. Peak Reverse Voltage (Repetitive)*	50	100	150	200	300	400	500	600 Volts
Max. Allow. RMS Voltage	35	70	105	140	210	280	350	420 Volts
Max. Allow. DC Blocking Voltage**	50	100	150	200	300	400	500	600 Volts
Max. Allow. Forward Current (Single Phase —150°C stud temp.)	←———6 amperes———→							
Max. Allow. Peak One Cycle Surge Current (non-recurrent)	←——— 150 amperes ———→							
I^2t Rating (for t greater than .0008 sec. and less than .0083 sec. (non-recurrent)	←— 25 ampere² sec. — min. rating (T_j =−65°C to +200°C) —→							
Max. Full Load Voltage Drop (Single Phase, Full Cycle Average —150°C stud temp.)	←———.64 Volts———→							
Max. Leakage Current at Full Load (Single Phase, Full Cycle Average —150°C stud temp.)	3.0	2.5	2.25	2.0	1.75	1.5	1.25	1.0 ma
Max. Thermal Resistance (junction to stud)	←———4.25°C/Watt———→							
Junction Operating and Storage Temp. Range	←——— −65°C to +200°C ———→							
Stud Torque	Minimum 12 in.-lbs.; Maximum 15 in.-lbs.							

*Maximum voltages apply with a heat sink thermal resistance of 22°C/ Watt or less at maximum rated junction temperature.
**Maximum voltages apply with a heat sink thermal resistance of 7°/Watt or less at maximum rated junction temperature.

1N1341A-48A
1N1341RA-48RA

OUTLINE DRAWING

DIRECTION OF EASY CONVENTIONAL CURRENT FLOW – IN1199A-IN1206A

DIRECTION OF EASY CONVENTIONAL CURRENT FLOW – IN1199RA - IN1206RA

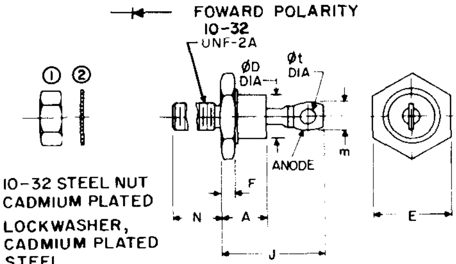
INSULATING HARDWARE KIT*

OUTLINE DRAWING

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM). Ref: (Screw thread standards for Federal Services 1957) Handbook H28, P1

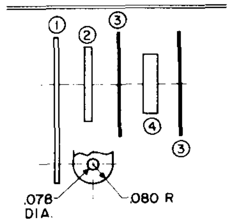
DIRECTION OF FOWARD CURRENT FLOW:
REVERSE POLARITY
FOWARD POLARITY



① 10-32 STEEL NUT CADMIUM PLATED
② LOCKWASHER, CADMIUM PLATED STEEL

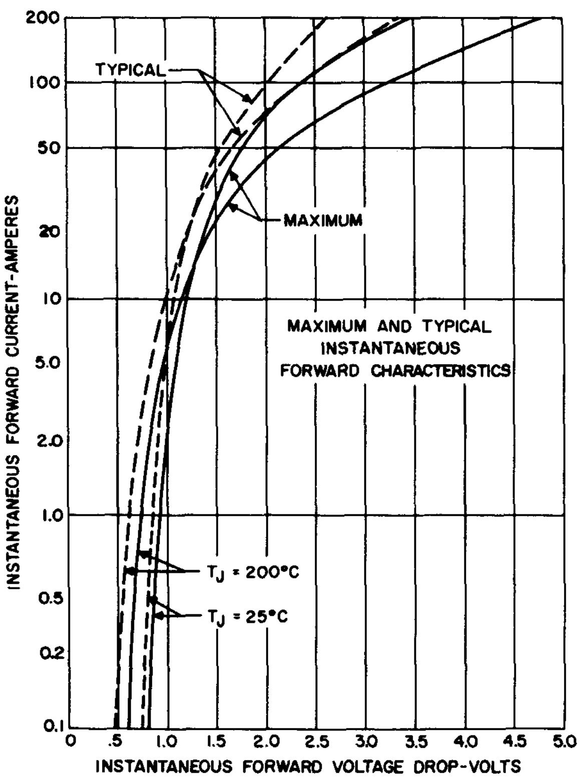
COMPLIES WITH EIA REGISTERED OUTLINE DO-4

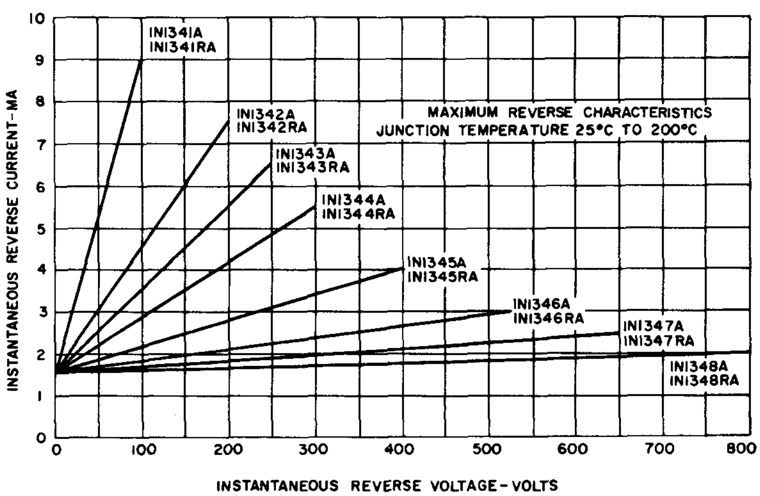
INSULATING HARDWARE KIT*



① COPPER TERMINAL, .016 THICK, TIN PLATED
② BRASS WASHER, .035 THICK NICKEL PLATED
③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK
④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK
* AVAILABLE UPON REQUEST

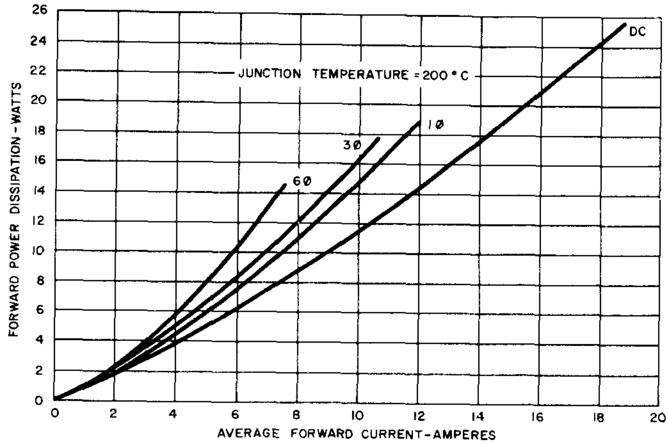
NOTES: (1) UNIT WEIGHT — .25 OZ
(2) MICA WASHER IN MOUNTING KIT MAY ADD APPROX 6.5°C/WATT THERMAL RESISTANCE STUD TO HEAT SINK



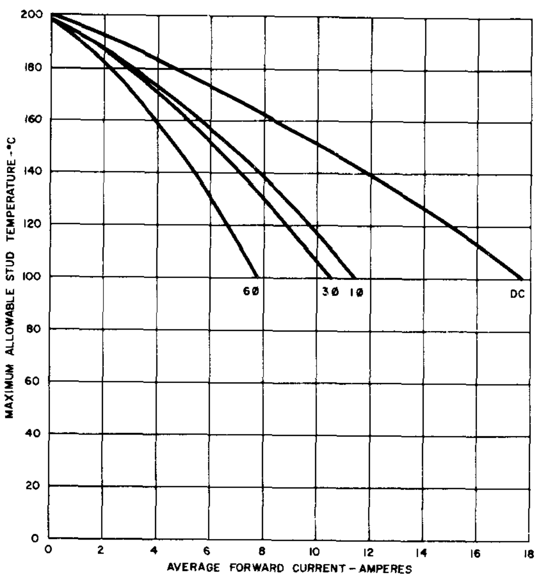


2. REVERSE CHARACTERISTICS

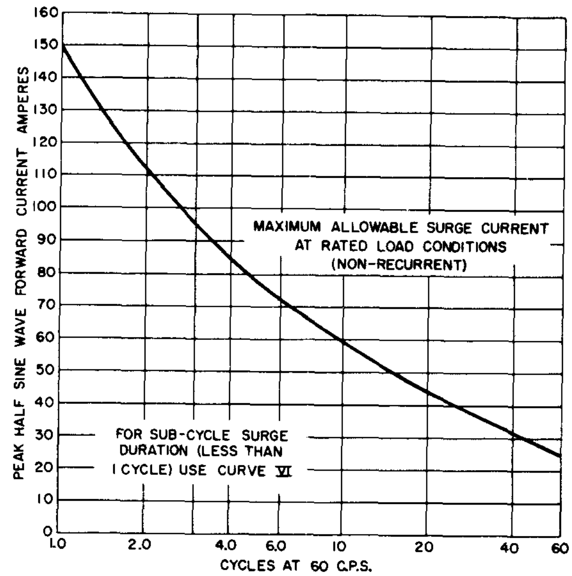
1. MAXIMUM AND TYPICAL FORWARD CHARACTERISTICS



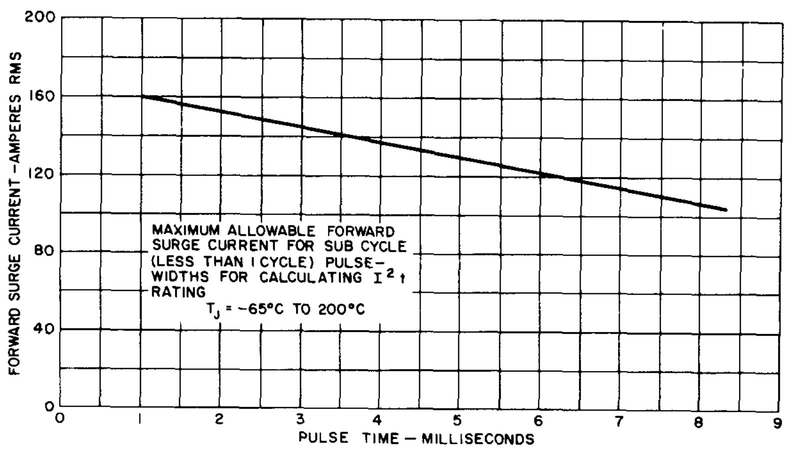
3. FORWARD POWER DISSIPATION



4. MAXIMUM ALLOWABLE STUD TEMPERATURE



5. SURGE RATING (1-60 cycles)



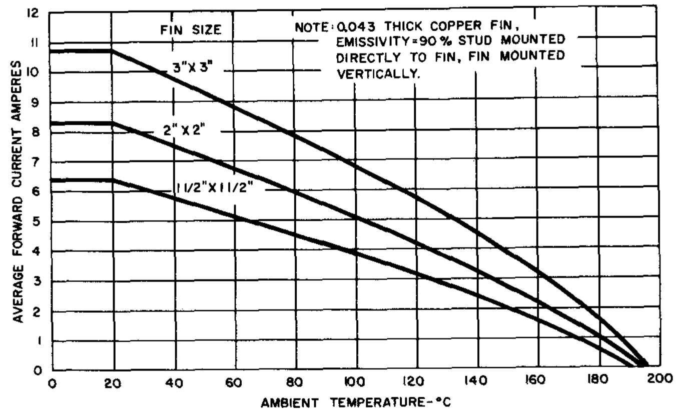
6. SUB-CYCLE SURGE RATING

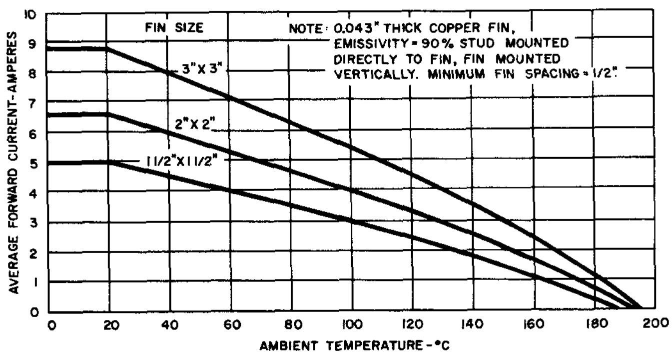
TO USE GRAPHS 7, 8, 9

1. Enter graph at vertical axis with desired current multiplied by proper current factor:

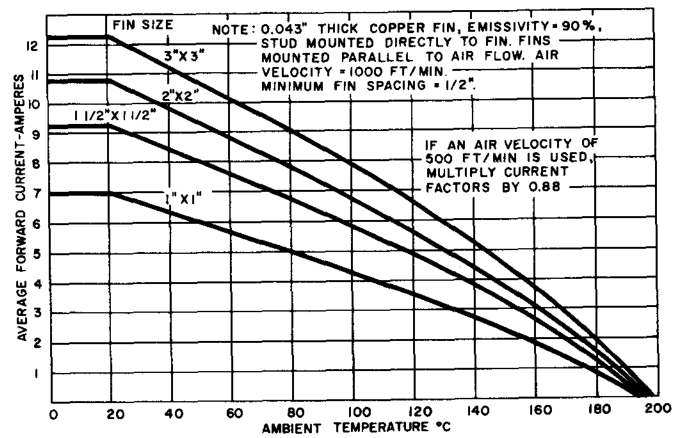
DC-0.80	3ϕ-1.15
1ϕ-1.00	6ϕ-1.40

2. Intercept desired fin curve
3. Read on horizontal axis the maximum allowable ambient temperature.

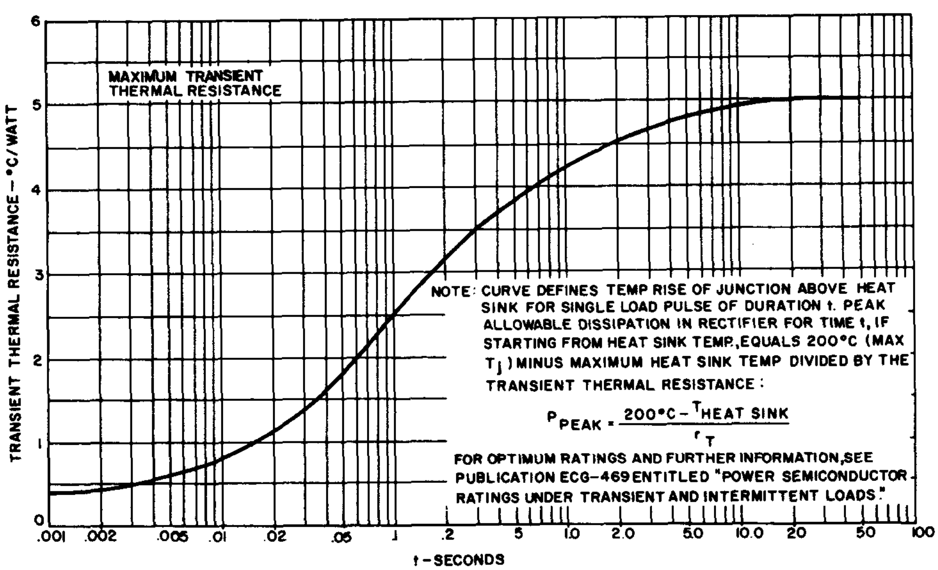




8. REQUIRED FIN SIZE—FREE CONVECTION, IMPEDED RADIATION



9. REQUIRED FIN SIZE—FORCED CONVECTION, IMPEDED RADIATION



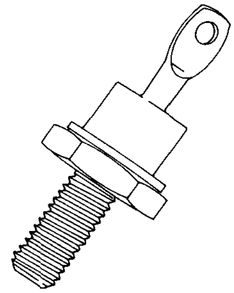
10. MAXIMUM TRANSIENT THERMAL RESISTANCE

Silicon Rectifier

IN1612-16,R

MEDIUM CURRENT 5A

These popular stud mounted 5 ampere rectifiers are the commercial version of the MIL-19500/162 rectifiers. They were designed specifically to meet this military specification. Hermetic seals, one piece terminals, and all-hard-solder construction are the major features of this design. The all-hard-solder or welded construction is an important feature for the designer to consider. Temperature excursions caused by heating and cooling when the rectifier is used intermittently at maximum rating will cause thermal fatigue in a soft-solder construction. The hard-solder and welded construction provides freedom from thermal fatigue failures.



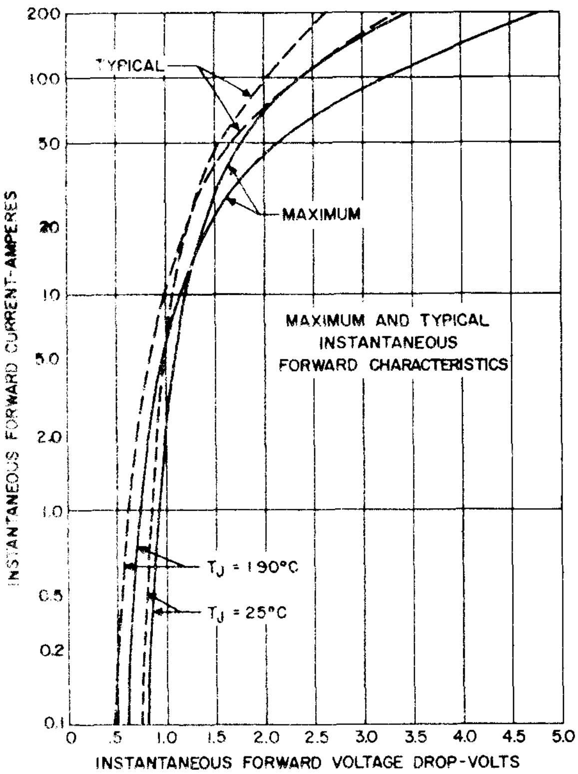
The major features of this design are:

- Hard-Solder, Thermal Fatigue Free
- Solid One-Piece Terminal
- Low Thermal Impedance
- Transient PRV Ratings

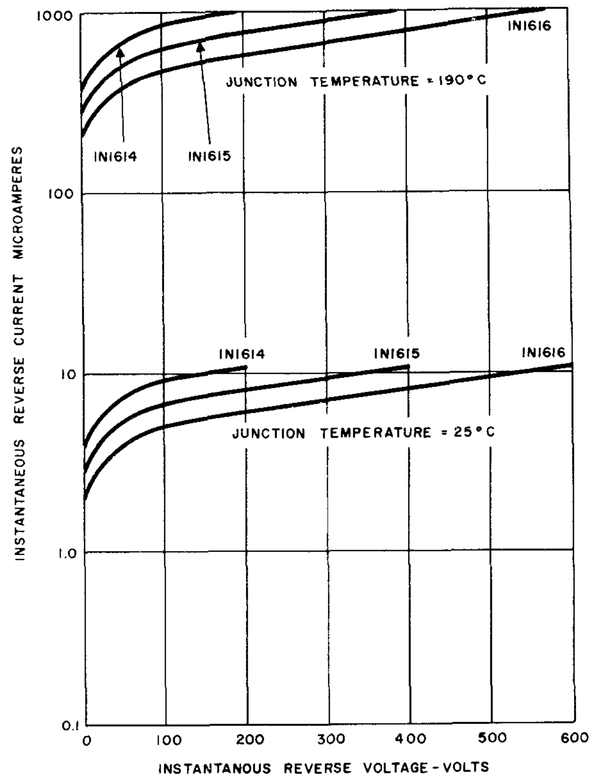
electrical ratings and specifications (60 cps, Resistive or Inductive Load)

	1N1612 1N1612R	1N1613 1N1613R	1N1614‡ 1N1614R	1N1615‡ 1N1615R	1N1616‡ 1N1616R	
Max. Allow. Transient Peak Reverse Voltage (Non-recurrent, 5 millisec. max. duration, $T_J = 0$ to 190°C)	100	200	350	600	800	Volts
Max. Allow. Peak Reverse Voltage (Repetitive) *	50	100	200	400	600	Volts
Max. Allow. RMS Voltage	35	70	140	280	420	Volts
Max. Allow. DC Blocking Voltage**	50	100	200	400	600	Volts
Max. Allow. Forward Current (Single Phase +150°C stud temp.)	← 5 amperes →					
Max. Allow. Peak One Cycle Surge Current (non-recurrent)	← 150 amperes →					
I^2t Rating [for t greater than .0008 sec. and less than .0083 sec. (non-recurrent)]	← 25 ampere^2 sec. — min. rating ($T_J = -65$°C to +190°C) →					
Max. Full Load Voltage Drop (Single Phase, Full Cycle Average +150°C stud temp.)	← .64 Volts →					
Max. Leakage Current at Full Load (Single Phase, Full Cycle Average 150°C stud temp.)	1.0	1.0	1.0	1.0	1.0	ma
Max. Thermal Resistance (junction to stud)	← 7.0°C/Watt →					
Junction Operating and Storage Temp. Range	← −65°C to +190°C →					
Stud Torque	Minimum 12 in.-lbs.; Maximum 15 in.-lbs.					

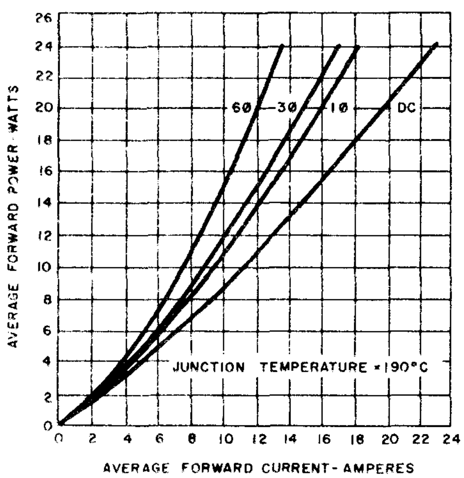
*Maximum voltages apply with a heat sink thermal resistance of 22°C/Watt or less at maximum rated junction temperature.
**Maximum voltages apply with a heat sink thermal resistance of 7°/Watt or less at maximum rated junction temperature.
‡Available as MIL-S-19500/162 devices.



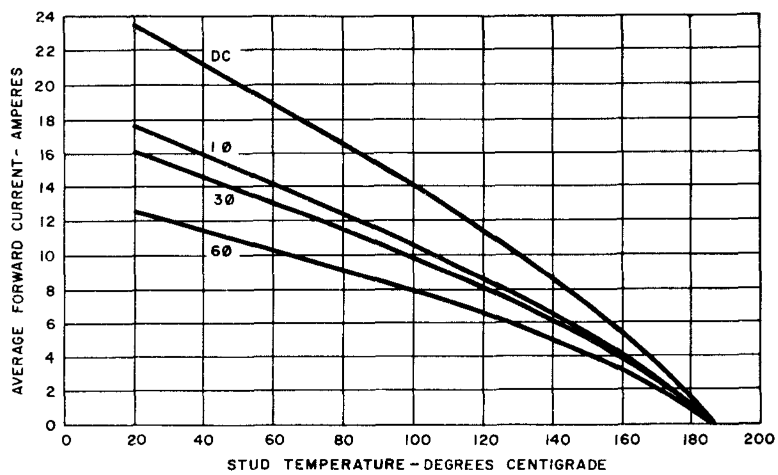
1. MAXIMUM AND TYPICAL FORWARD CHARACTERISTICS



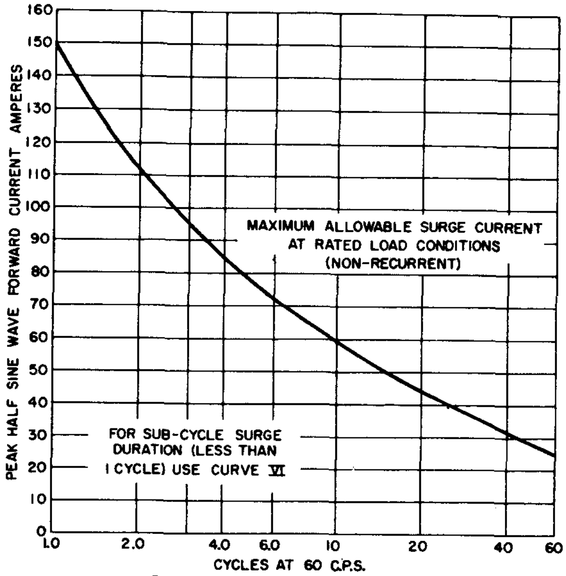
2. REVERSE CHARACTERISTICS



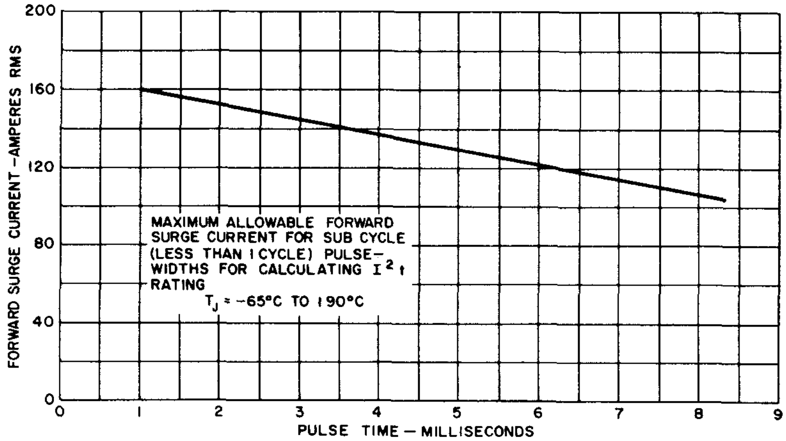
3. FORWARD POWER DISSIPATION



4. MAXIMUM ALLOWABLE STUD TEMPERATURE



5. SURGE RATING (1-60 cycles)



6. SUB-CYCLE SURGE RATING

* TO USE GRAPHS 7, 8, 9

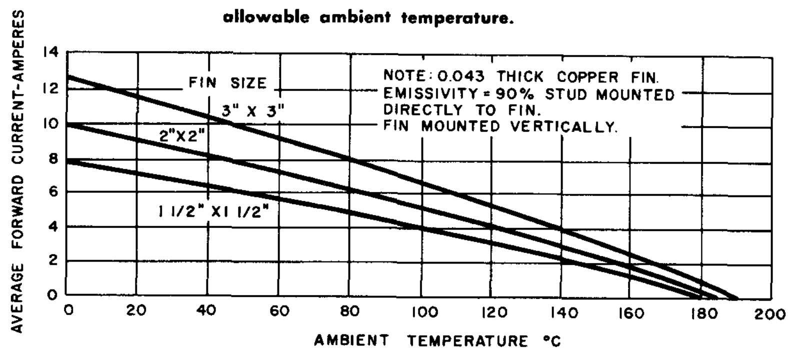
1. Enter graph at vertical axis with desired current multiplied by proper current factor:

   DC-0.80 3φ-1.15

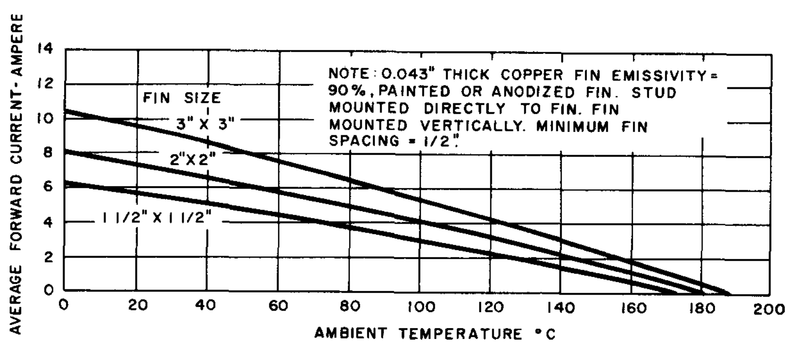
   1φ-1.00 6φ-1.40

2. Intercept desired fin curve
3. Read on horizontal axis the maximum allowable ambient temperature.

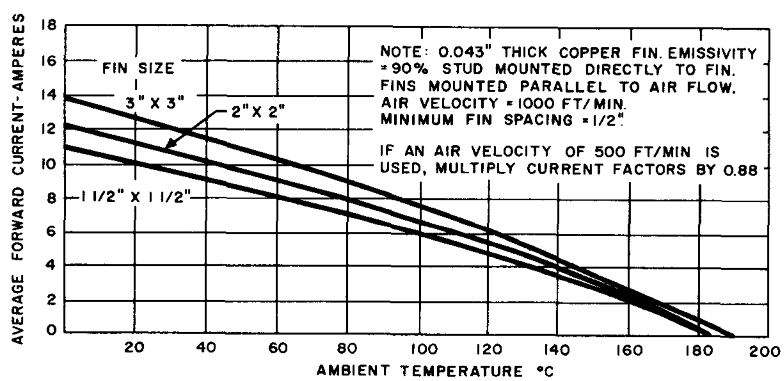
*7. REQUIRED FIN SIZE—FREE CONVECTION, SINGLE FIN, UNIMPEDED RADIATION

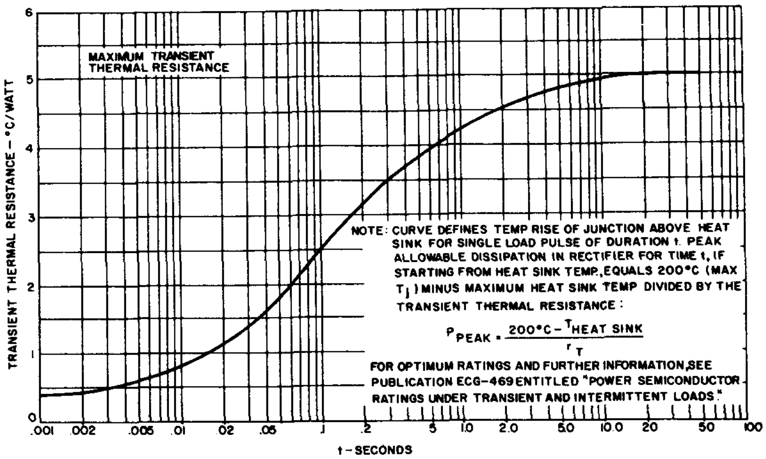


*8. REQUIRED FIN SIZE—FREE CONVECTION, IMPEDED RADIATION



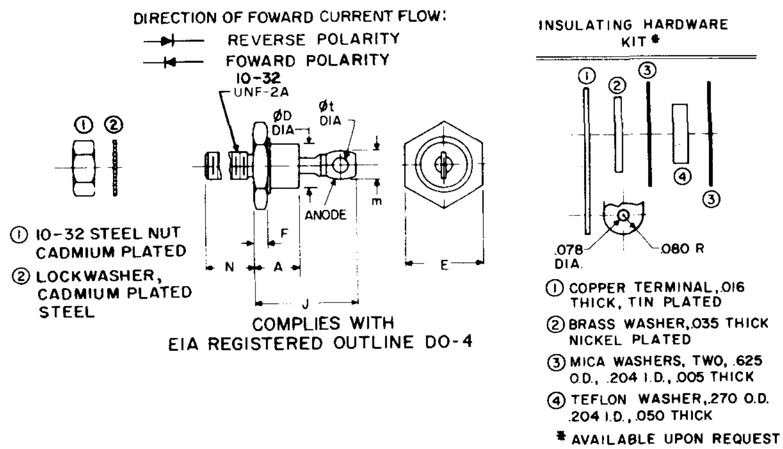
*9. REQUIRED FIN SIZE—FORCED CONVECTION, IMPEDED RADIATION





10. MAXIMUM TRANSIENT THERMAL RESISTANCE

OUTLINE DRAWING



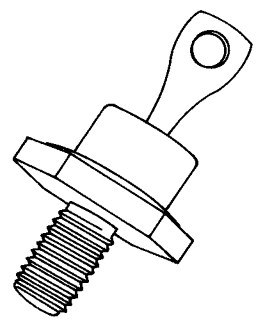
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM). Ref: (Screw thread standards for Federal Services 1957) Handbook H28, P1

Silicon Rectifiers
Medium Current

1N2154-60,R

These stud mounted diffused junction silicon rectifiers are designed for all rectifier applications in the 2 to 30 ampere range. A high junction temperature rating and an extremely low forward voltage drop and thermal impedance permit high current operation with minimum space requirements. These rectifiers may be mounted directly to a chassis or a fin or may be electrically insulated from the heat sink by using the mica washer insulating kit Versatility is further increased by the availability of a negative polarity unit (stud is anode), described by the suffix "R" appearing after the type number. The use of positive and negative polarity units facilitates the construction of bridge circuits and permits the use of either a positive or negative heat sink in half-wave and center-tap applications. Stacked fin assemblies (4JA3511 series) are also available.



General Electric research, advance development and product design have resulted in a highly efficient rectifying junction. This feature, plus a mechanical design employing high temperature hard solders and welds for all internal and external joints and seals, which eliminates common sources of thermal fatigue failure, has produced a silicon rectifier with outstanding reliability under all operating conditions.

electrical ratings and specifications (60 cps, Resistive or Inductive Load)

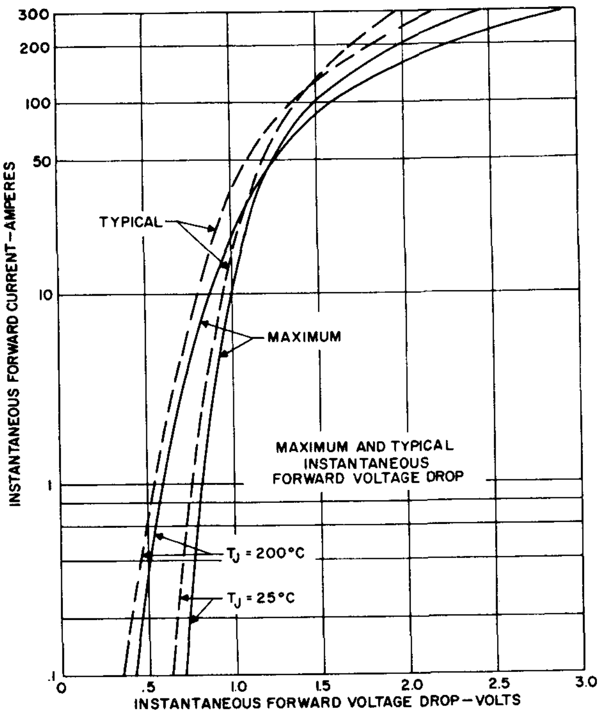
	1N2154 1N2154R	1N2155 1N2155R	1N2156 1N2156R	1N2157 1N2157R	1N2158 1N2158R	1N2159 1N2159R	1N2160 1N2160R
Max. Allow. Transient Peak Reverse Voltage (Non-Recurrent 5 millisec. max. duration)	100	200	350	450	600	700	800 volts
Max. Allow. Peak Reverse Voltage* (Repetitive)	50	100	200	300	400	500	600 volts
Max. Allow. RMS Voltage	35	70	140	210	280	350	420 volts
Max. Allow. DC Blocking Voltage**	50	100	200	300	400	500	600 volts
Max. Allow. Forward Current (Single Phase — 145°C stud temp.)				← 25 amperes →			
Max. Allow. Peak One-Cycle Surge Current				← 400 amperes →			
I^2t Ratings (for fusing) (for t = .0008 < t < .0083 seconds)				← 250 ampere² sec. →			
Max. Full Load Voltage Drop (Full Cycle Average — 145°C stud temp.)				← 0.60 volts →			
Max. Leakage Current at Full Load (Full Cycle Average, Single Phase 145°C stud temp.)	5	4.5	4	3.5	3	2.5	2 ma
Max. Thermal Resistance (junction to stud)				← 1.5°C/watt →			
Junction Operating and Storage Temperature Range				← −65°C to +200°C →			

*Maximum voltages apply with a heat sink thermal resistance of 12°C/watt or less at maximum rated junction temperature.
**Maximum voltages apply with a heat sink thermal resistance of 5°C/watt or less at maximum rated junction temperature.
***For RMS surge current ratings in sub-cycle region (less than one cycle) as a function of t, see Curve IX.

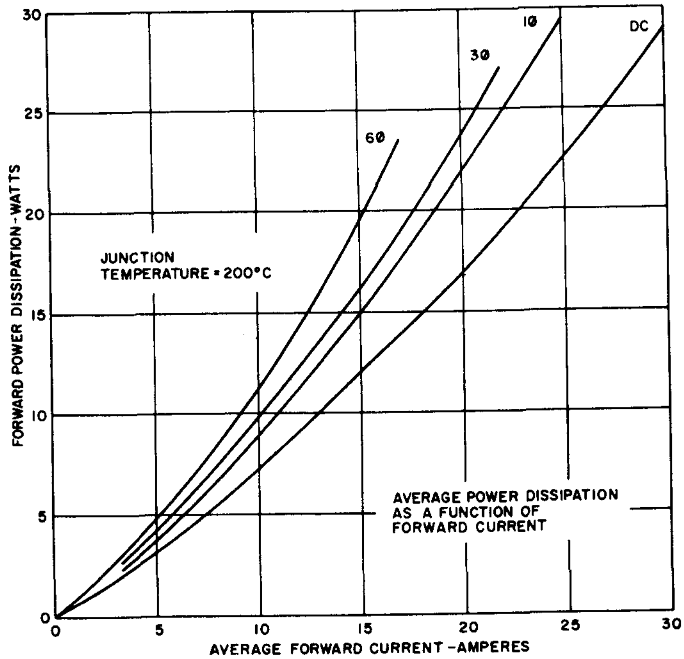
mechanical specifications

Maximum Stud Torque	30 inch-pounds
Mechanical Shock	MIL-STD-202, Method 202 500G for 1 millisec. 5 times in each of 3 directions
Vibration (Fatigue)	Any frequency between 45-100 cps with constant peak acceleration of 10G
Vibration (High Acceleration)	100 to 1000 cps with constant peak of 10G
Centrifuge	5000G
Moisture Resistance	MIL-STD-202, Method 106
Temperature Cycling	5 cycles, −65°C to +175°C

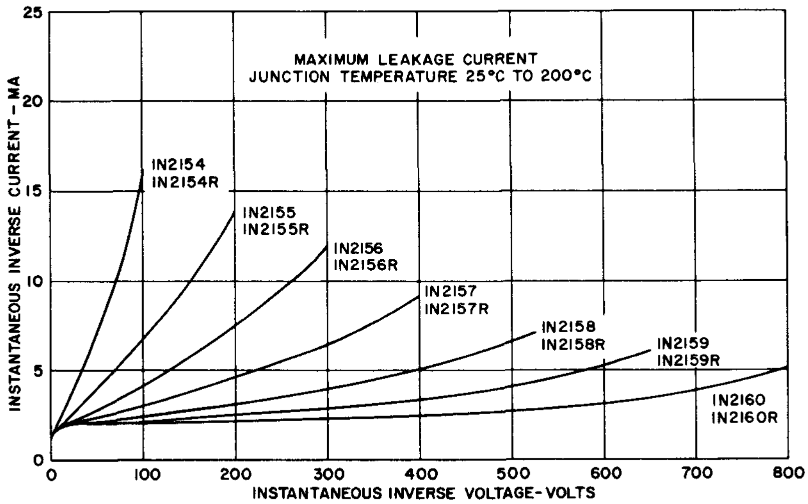
1N2154-60, R



1. MAXIMUM AND TYPICAL FORWARD CHARACTERISTICS

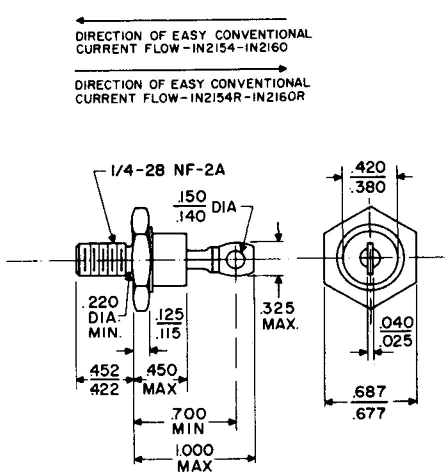


3. FORWARD POWER DISSIPATION

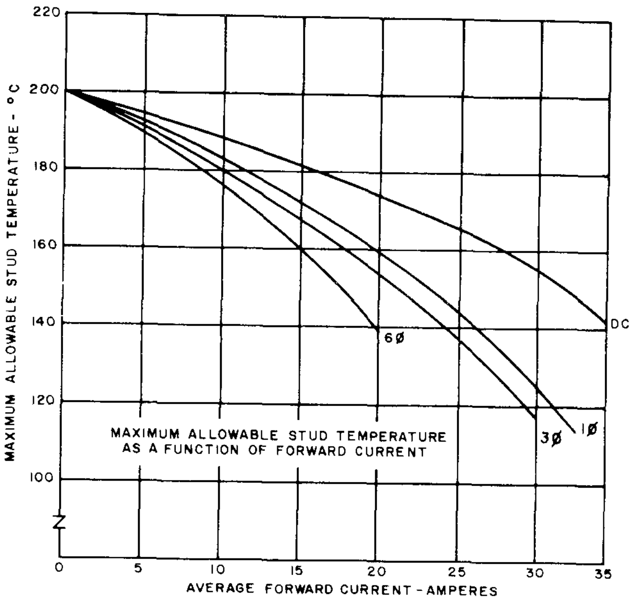


2. REVERSE CHARACTERISTICS

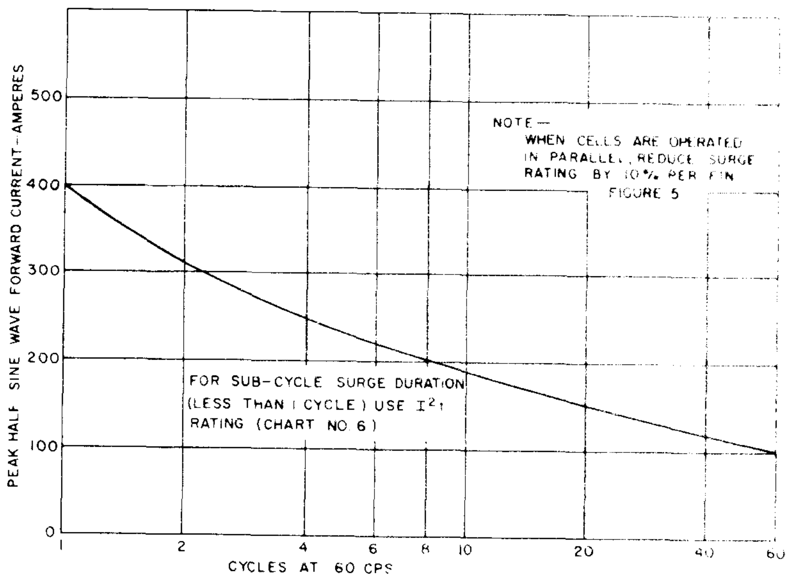
OUTLINE DRAWING



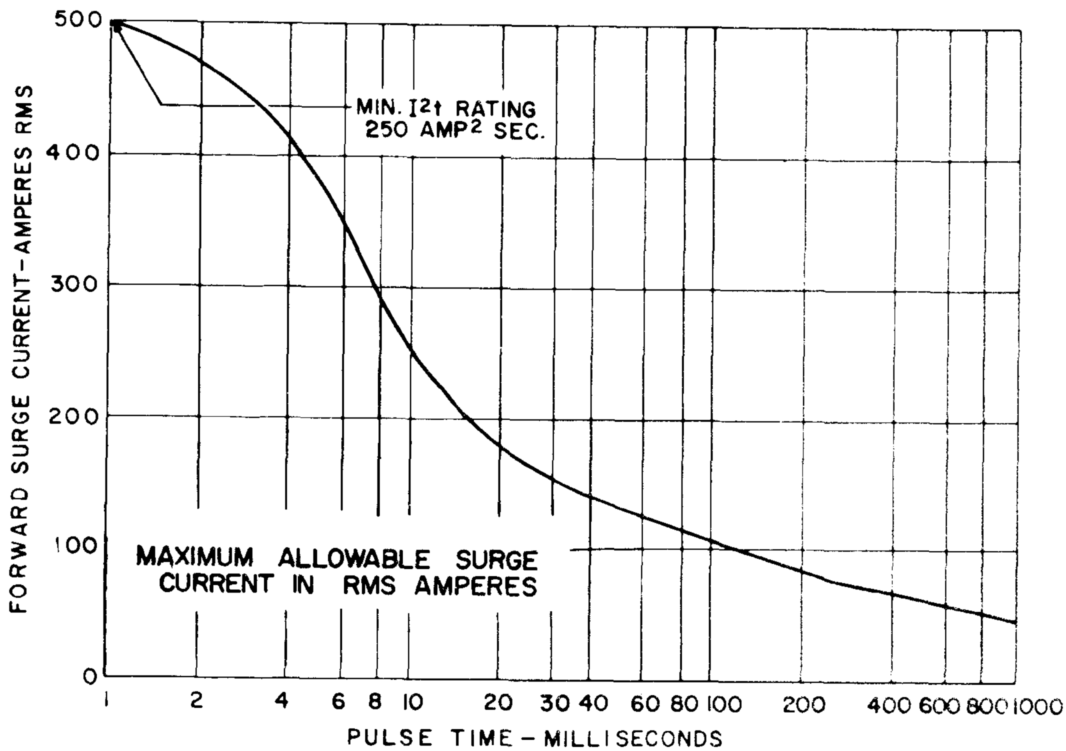
COMPLIES WITH
EIA REGISTERED OUTLINE DO-5



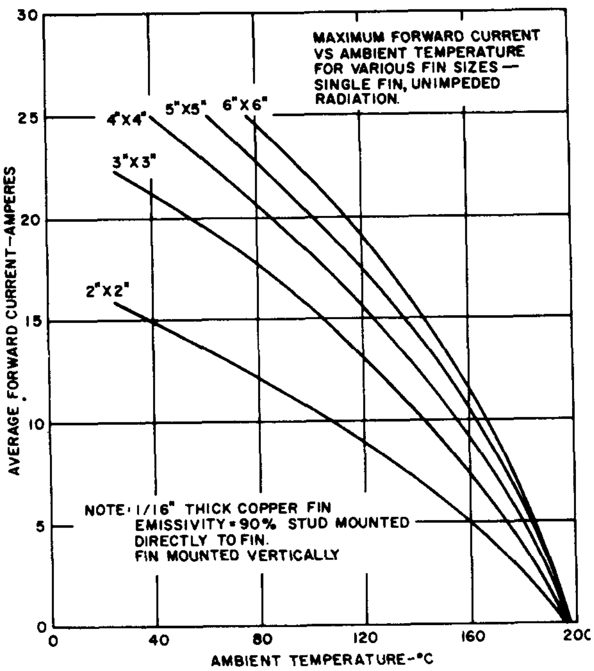
4. MAXIMUM ALLOWABLE STUD TEMPERATURE



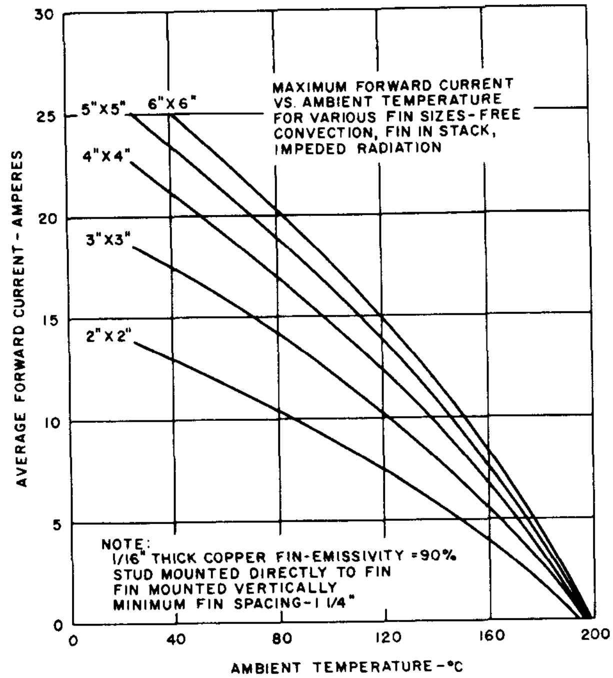
5. MAXIMUM ALLOWABLE NON-RECURRENT SURGE CURRENT AT RATED LOAD CONDITIONS



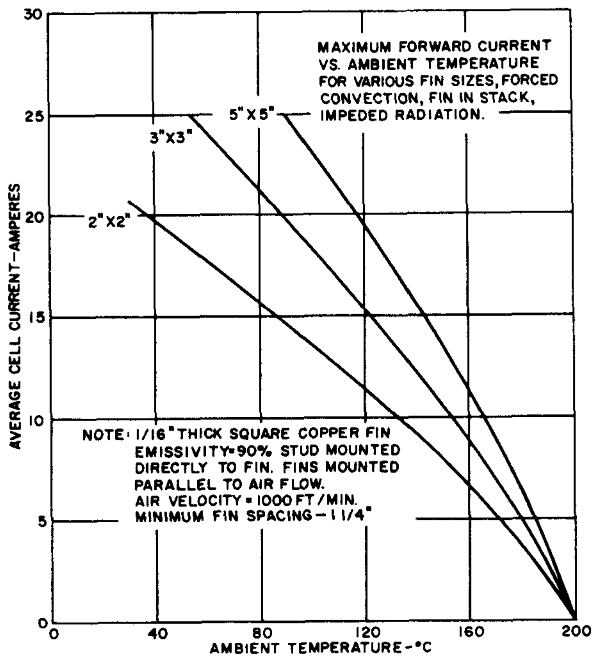
6. SUB-CYCLE SURGE RATING



7. *REQUIRED FIN SIZE—FREE CONVECTION SINGLE FIN, UNIMPOSED RADIATION



8. *REQUIRED FIN SIZE— FREE CONVECTION, IMPEDED RADIATION



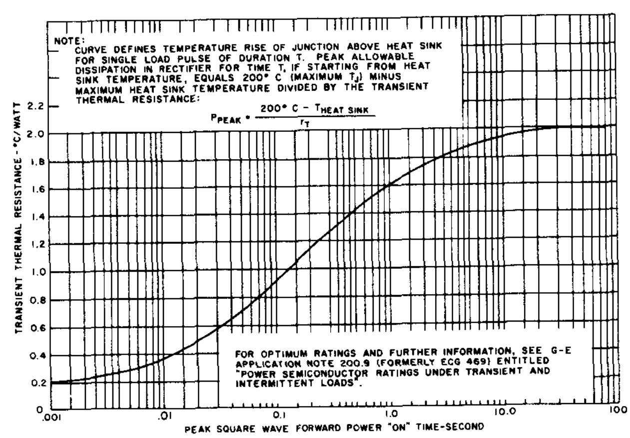
9. *REQUIRED FIN SIZE— FORCED CONVECTION, IMPEDED RADIATION

***TO USE GRAPHS 7, 8 AND 9**

1. Enter graph at vertical axis with desired current multiplied by proper current factor:

   DC-0.80   3φ-1.15
   1φ-1.00   6φ-1.40

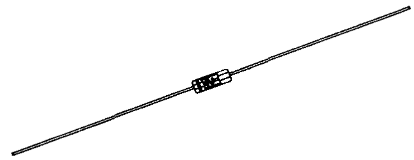
2. Intercept desired fin curve
3. Read on horizontal axis the maximum allowable ambient temperature



10. TRANSIENT THERMAL RESISTANCE

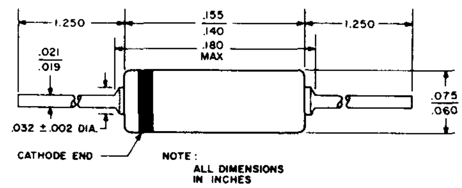
Silicon
Diode

IN4305



The 1N4305 is a very high speed silicon switching diode for computer circuits and general purpose applications. This oxide passivated planar diode features fast recovery time, low leakage and low capacitance. The maximum and minimum forward voltages are specified at four forward currents from 250 uamps to 10 ma. This guaranteed, closely controlled conductance is necessary for the design of clamping circuits, logic circuits and other types of circuits that require tolerances on voltage levels. The double heatsink 1N4305 offers springless construction, 500 mw dissipation, reduced package size, and is recommended for new design.

Double Heatsink Diode (DHD) 1N4305



		1N4305	
Reverse Voltage		50	volts
Average Rectified Current		150	ma
Forward Steady-State DC Current		200	ma
Recurrent Peak Forward Current		225	ma
Peak Forward Surge Current (1 usec. pulse)		2000	ma
Power Dissipation (25°C free air)		500	mw
Operating Temperature	-65 to	+200	°C
Storage Temperature	-65 to	+200	°C

electrical characteristics: (25°C) (unless otherwise specified)

		1N4305 Min.	1N4305 Max.	
Breakdown Voltage (I_R =5 ua)	B_V	75		volts
Forward Voltage (I_F=250 uamps)	V_{F1}	.505	.575	volts
(I_F =1 ma)	V_{F2}	.550	.650	volts
(I_F =2 ma)	V_{F3}	.610	.710	volts
(I_F =10 ma)	V_{F4}	.700	.850	volts
Reverse Current (V_R = -50 v)	I_R		.1	uamps
Reverse Current (150°C) (V_R = -50v)	I_R		100	uamps
Reverse Recovery Time (I_f=10 ma, I_r=10 ma) (Note 1)	t_{rr}		4	nsec.
Reverse Recovery Time (I_f=10 ma, V_r= -6V, R_L=100) (Note 1)	t_{rr}		2	nsec.
Capacitance (V_R =0 v) (Note 2)	C_o		2	pf
Rectification Efficiency (100 mc) (Note 3)	R_E	45		%

Note 1: Recovery time to 1 ma.

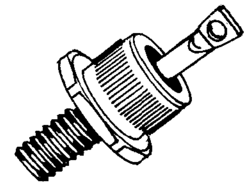
2: Capacitance as measured on Boonton Model 75A Capacitance Bridge at a signal level of 50 mv and a frequency of 1 mc.

3: Rectification Efficiency is defined as the ratio of DC load voltage to peak rf input voltage to the detector circuit, measured with 2.0 v rms input to the circuit. Load resistance 5KΩ, load capacitance 20 uuf.

Silicon Rectifiers

1N3208,R
IN3214,R

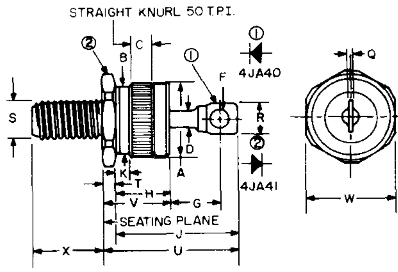
A40F—M
A41F—M



General Electric has designed this 20 Ampere rectifier specifically for the normal industrial and consumer low ambient temperature applications. The design utilizers the smallest practical size for the rating with particular attention to rigidity and rugged construction. The solid one-piece terminal and the case-to-hex solder mounting technique provides good mechanical strength, minimizes breakage problems, and promotes stability of heat transfer characteristics from the diffused junction to the stud.

OUTLINE DRAWING

- **High Surge Current Capabilities (Up to 300 Amperes)**
- **One-piece Terminal**
- **Positive Solder Case-to-hex Mounting**
- **Small Size— 9/16" Hex, 1/2" Diameter Barrel**
- **Reverse Polarity Devices Available**

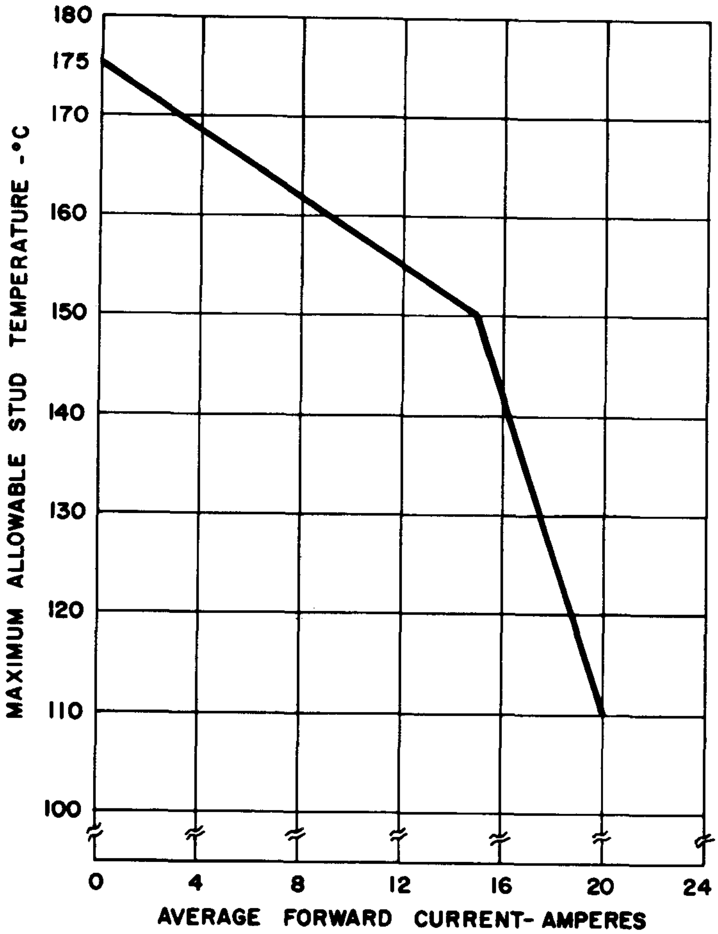


SYM	DECIMAL INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.
A	.501	.505	12.73	12.83
B	.467	.465	11.86	12.07
C	.177	REF.	4.50	REF.
D	.109	REF.	2.77	REF.
F	.104	.115	2.65	2.91
G	.285	.350	7.24	8.88
H	.330	.375	8.39	9.52
J	—	.810	—	20.56
K	.083	.097	2.11	2.46
Q	.034	REF.	.86	REF.
R	—	.250	—	6.34
S	THREAD SIZE-1/4"- 28OUNF- 2A			
T	.086	.098	2.18	2.49
U	—	.920	—	23.36
V	—	.485	—	12.31
W	.552	.562	14.02	14.27
X	.432	.442	10.97	11.23

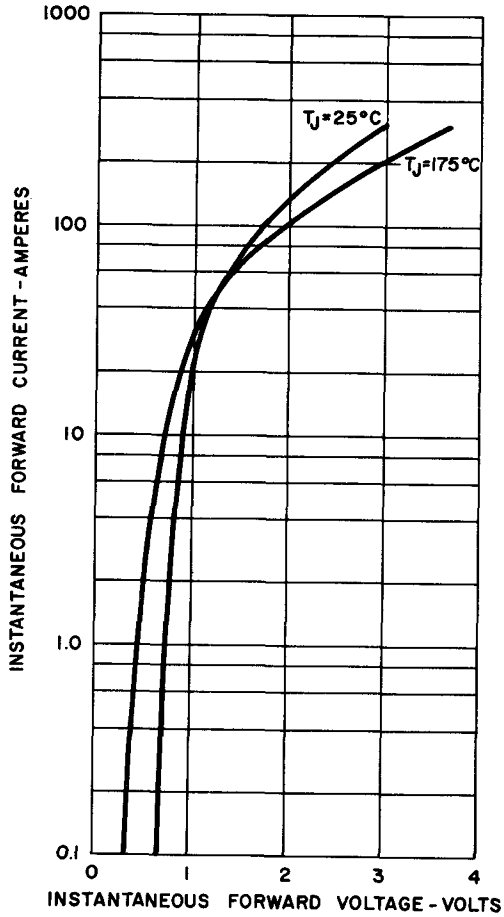
RATINGS AND CHARACTERISTICS (Single Phase Resistive Load)

Forward Polarity	A40F	A40A	A40B	A40C	A40D	A40E	A40M	
Reverse Polarity	A41F	A41A	A41B	A41C	A41D	A41E	A41M	
Max. Peak Reverse Voltage	50	100	200	300	400	500	600	volts
Max. Continuous D-C Reverse Voltage	50	100	200	300	400	500	600	volts
Max. Sine Wave RMS Voltage	35	70	140	210	280	350	420	volts
Max. Avg. D-C Forward Current At 110°C Stud	← 20 amps →							
At 150°C Stud	← 15 amps →							
Peak One-Cycle Forward Surge Current (60 cps, $T_J = 25°C$)	← 300 amps →							
I^2t Rating for Fusing or Capacitor Inrush	← 100 amp² sec →							
Max. Forward Voltage at 20 Amps D-C Forward Current ($T_J = 25°C$)	← 1.2 volts →							
Max. Avg. Forward Voltage Drop (15 amps d-c single phase, $T_J = 150°C$)	← 0.75 volts →							
Max. Reverse Current at Rated D-C Reverse Voltage ($T_J = 25°C$)	← 1.0 ma →							
Max. Full Load Reverse Current (full cycle avg., single phase)	10	9	8	6	5	4.5	4.0	ma
Typical Thermal Resistance (junction to stud)	← 1.5°C/watt →							
Operating Junction Temperature Range	← −65°C to +175°C →							
Storage Temperature Range	← −65°C to +175°C →							
Maximum Stud Torque	← 25 in.-lbs →							

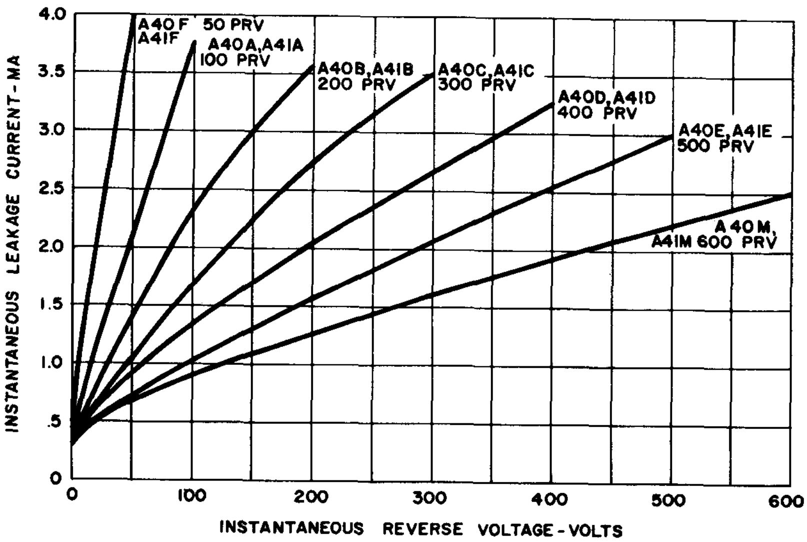
NOTE: 1N3208-1N3214 or 1N3208R-1N3214R are available when desired and are identical to A40F-A40M or A41F-A41M respectively, except that hex size will be 11/16" across the flats on the 1N3208 series.



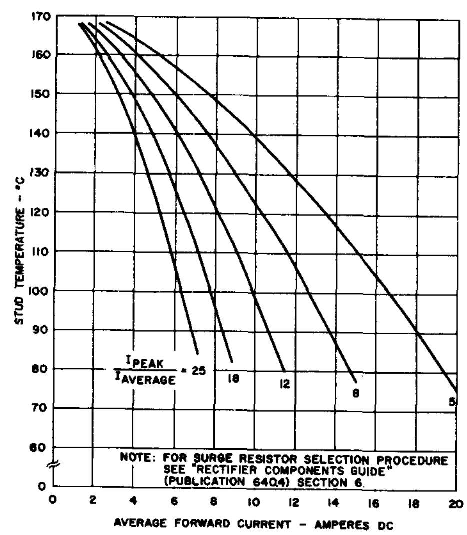
1. SINGLE PHASE AND THREE PHASE CURRENT RATING AS A FUNCTION OF STUD TEMPERATURE



2. TYPICAL FORWARD CHARACTERISTICS



3. TYPICAL REVERSE CHARACTERISTICS ($T_J = 175°C$)

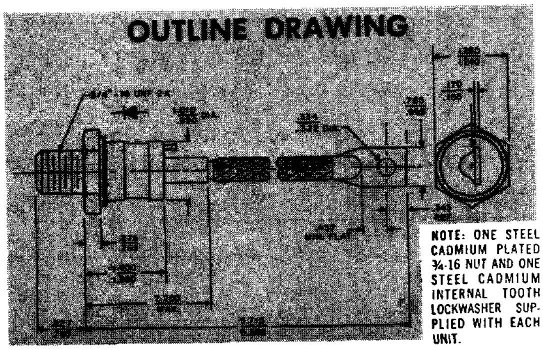


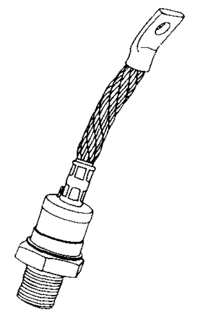
4. HALFWAVE CAPACITIVE LOAD RATING

Silicon Rectifiers

1N3260-73,R

General Electric now offers 160 ampere silicon rectifier diodes of the EIA Types 1N3260 through 1N3273.





This product features:

- Choice of stud anode or stud cathode types
- Thermal fatigue resistant
- Low reverse current
- Great uniformity of product
- High surge current capabilities

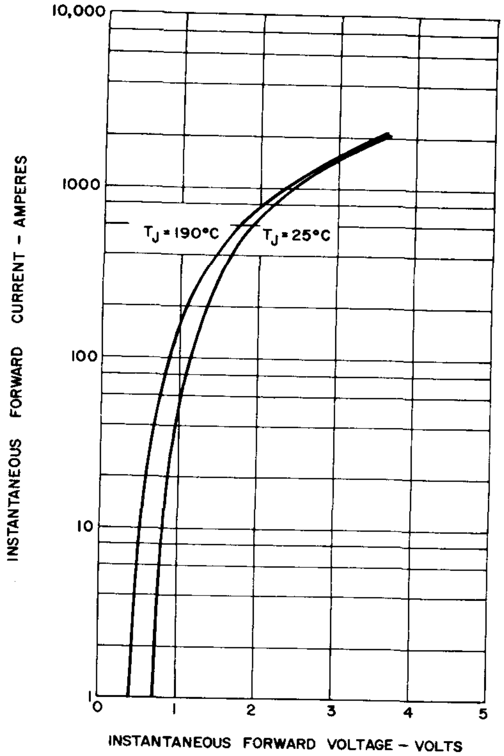
RATINGS AND SPECIFICATIONS:[1]

	1N3260	1N3261	1N3262	1N3263	1N3264	1N3265	1N3266	1N3267	1N3268	1N3269	1N3270	1N3271	1N3272	1N3273
*Maximum Allowable Repetitive Peak Reverse Voltage, V_{RRM}(rep)[2]	50	100	150	200	250	300	350	400	500	600	700	800	900	1000
*Maximum Allowable DC Blocking Voltage, V_R[3]	40	80	120	160	200	240	280	320	400	480	560	640	720	800

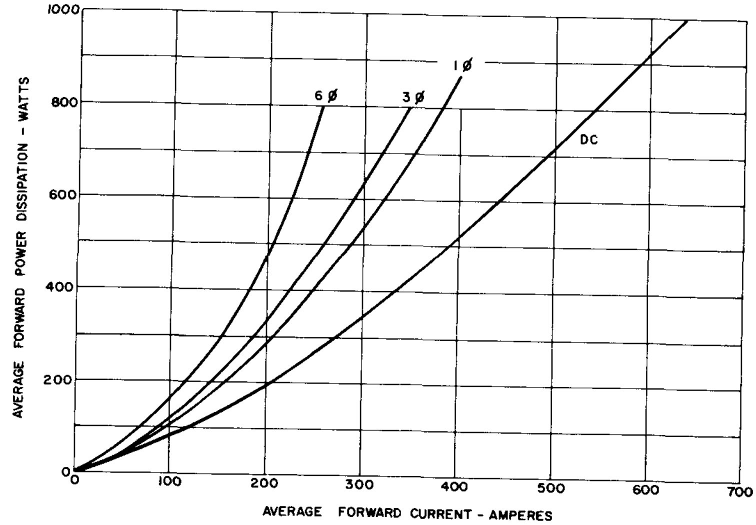
	1N3260–1N3273
*Maximum Allowable Average Forward Current, I_F (AV) (single phase, 125°C case temperature)	160 amperes
*Maximum Allowable Peak One-Cycle Surge Current, I_{TSM}(surge) (60 cps single-phase basis, non-repetitive)	2000 amperes
Minimum I^2t Rating (non-repetitive)	8,250 amperes² seconds (see Chart 7)
*Maximum Peak Forward Voltage Drop, V_{FM} (I_T= 160 amps DC, T_C=125°C)	1.6 volts
*Maximum Full Load Reverse Current, $I_{R(AV)}$ (full-cycle average, 125°C case temperature, single phase)	12 milliamperes
*Maximum Thermal Resistance, $R_{\theta JC}$ (junction to case)	0.3°C/watt
*Storage Temperature, T_{stg}	65°C to +175°C
*Operating Temperature, T_J	55°C to +190°C
Stud Torque[4]—Maximum	325 inch-pounds (375 kg-cm)
—Minimum	275 inch-pounds (320 kg-cm)

NOTES: [1]Models listed are stud cathode (forward polarity) types. Order 1N32__R for stud anode (reverse polarity) types. Ratings and specifications are for frequencies from 50 up to 400 cycles/second, except where noted differently.
[2]Rating assumes a rectifier diode heat sink dissipation of 2.0°C/watt, or less.
[3]Rating assumes a rectifier diode heat sink dissipation of 1.0°C/watt, or less.
[4]Use of a silicone grease (G-E #G623) between the rectifier base and heat sink is recommended.

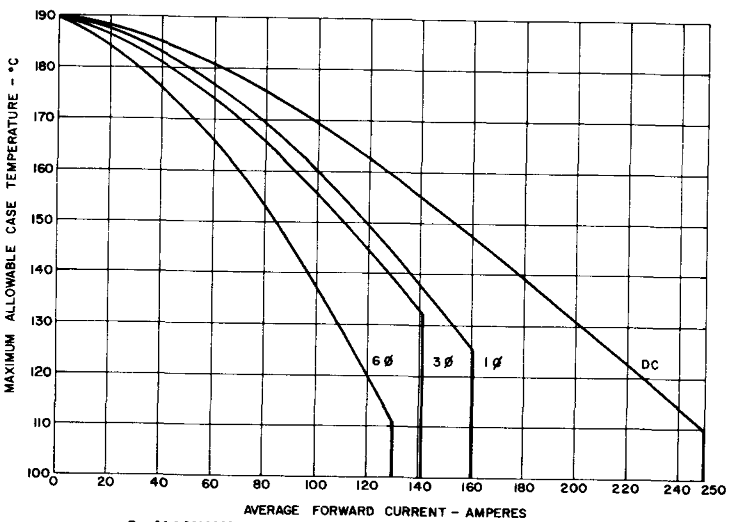
***Indicates JEDEC Registration Parameters.**



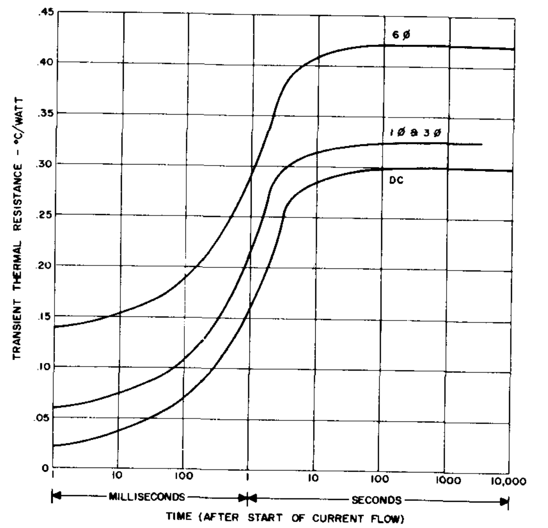
1. MAXIMUM FORWARD CHARACTERISTICS



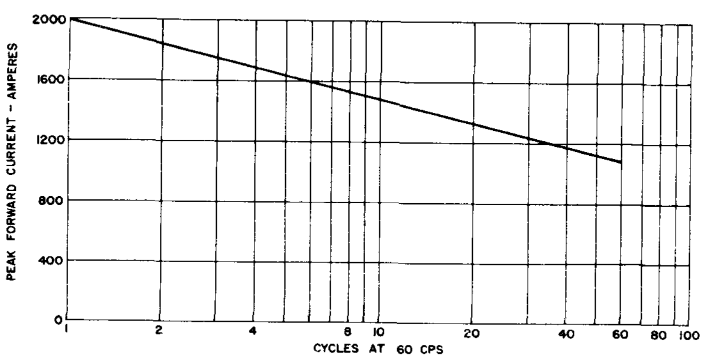
2. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT (T_J = +190°C)



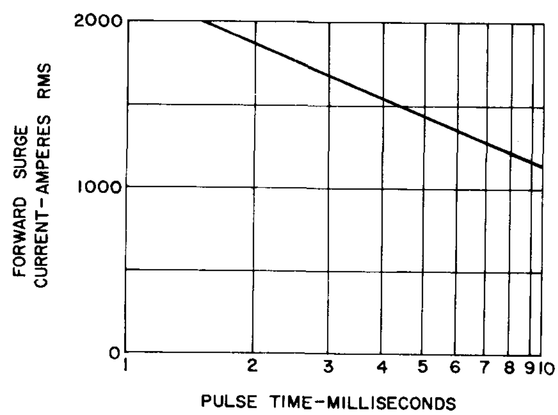
3. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



4. TRANSIENT THERMAL RESISTANCE — JUNCTION TO CASE



5. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS (T_J = −55°C TO +190°C)

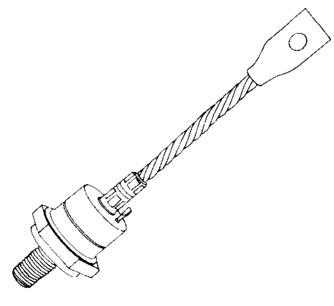


6. SUBCYCLE SURGE FORWARD CURRENT FOLLOWING RATED LOAD CONDITIONS (T_J = −55°C TO +190°C)

Silicon Rectifier s

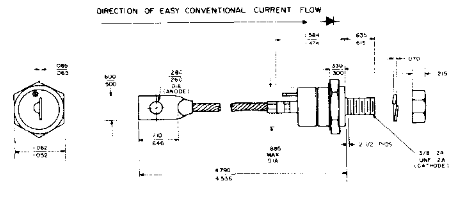
1N3289-96,R
A70S,A70T
A71S,A71T

The 1N3289-1N3296 Series is the ultimate in today's High Current Silicon Rectifier field. By taking full advantage of the most advanced semiconductor component manufacturing techniques, General Electric now offers the industry's first double diffused, all hard solder 100-ampere rectifier in PRV ratings up to 1,200 volts. As a result, circuit designers now receive:



Features:

- Freedom from Thermal Fatigue Failure
- Higher Surge Current Capabilities
- NEMA Overload Ratings
- Forward and Reverse Polarities



CONFORMS TO JEDEC OUTLINE DO-8

RATINGS AND SPECIFICATIONS

	1N3289 1N3289R	1N3290 1N3290R	1N3291 1N3291R	1N3292 1N3292R	1N3293 1N3293R	A70S A71S	1N3294 1N3294R	A70T A71T	1N3295 1N3295R	1N3296 1N3296R	
Maximum Allowable Transient Peak Reverse Voltage (non-recurrent, 5 millisecond maximum duration)	300	400	525	650	800	925	1050	1175	1300	1500	volts
Maximum Allowable Repetitive Peak Reverse Voltage, V_{RM} (rep)	200	300	400	500	600	700	800	900	1000	1200	volts
Maximum Allowable RMS Reverse Voltage	140	210	280	350	420	490	560	630	700	840	volts
Maximum Allowable DC Blocking Voltage**	200	300	400	500	600	700	800	900	1000	1200	volts
Maximum Allowable Average Forward Current (single phase, 130°C stud temperature)	← 100 amperes →										
Maximum Allowable Peak One-Cycle Surge Current (60 cps single-phase basis, non-recurrent)	← 1600 amperes →										
Minimum I^2t Rating (non-recurrent)	← 4000 amperes^2-seconds (See Curve 8) →										
Maximum Full Load Voltage Drop (full-cycle average, 130°C stud temperature, 100 amperes average single phase)	← 0.6 volts →										
Maximum Full Load Reverse Current (full-cycle average, 130° stud temperature, single phase)	9.5	9.0	9.0	8.0	6.5	6.0	5.5	5.5	4.5	3.5	ma
Maximum Thermal Resistance (junction to stud)	← DC = 0.4°C/w; 1ϕ & 3ϕ = .55°C/w; 6ϕ = .72°C/w →										
Storage and Junction Operating Temperature	← −40°C to +200°C →										
Max. Stud Torque***	← 100 Lb-in (120 Kg-cm) →										
Min. Stud Torque	← 90 Lb-in (105 Kg-cm) →										
Weight	← Approximately 2½ ounces →										

NOTES:

† "R" indicates reverse polarity

* Rating assumes rectifier cell heat sink of less than 3°C/watt.

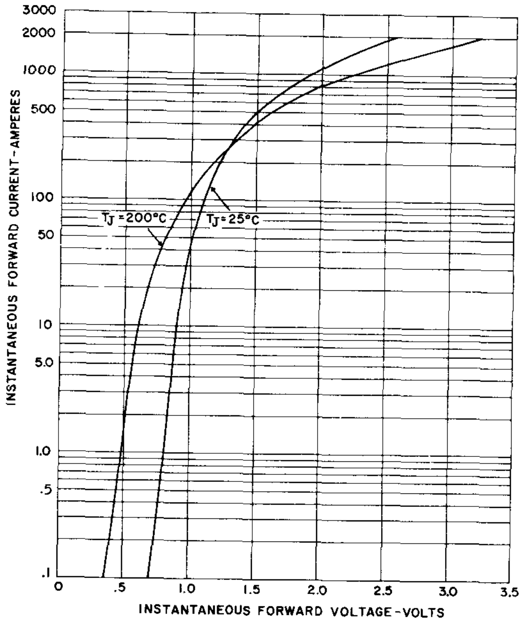
** Rating assumes rectifier cell heat sink of less than 1.5°C/watt.

*** Use of silicone grease between rectifier base and heat sink is recommended.

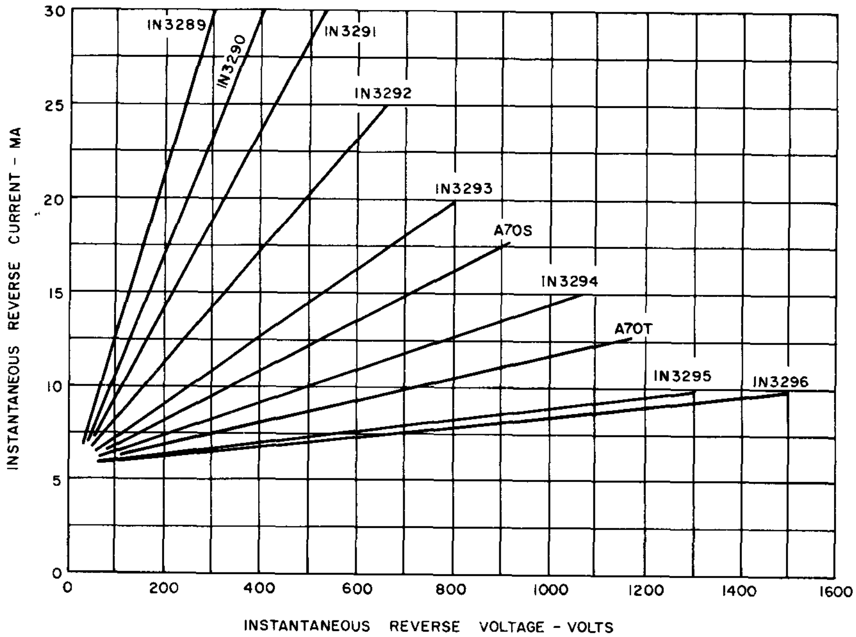
Non-recurrent voltage and current ratings, as contrasted to repetitive ratings, are ratings which apply for occasional or unpredicable overloads. For example, the forward surge current ratings are non-recurrent ratings that are used in fault coordination design work.

DIODE SPECIFICATIONS

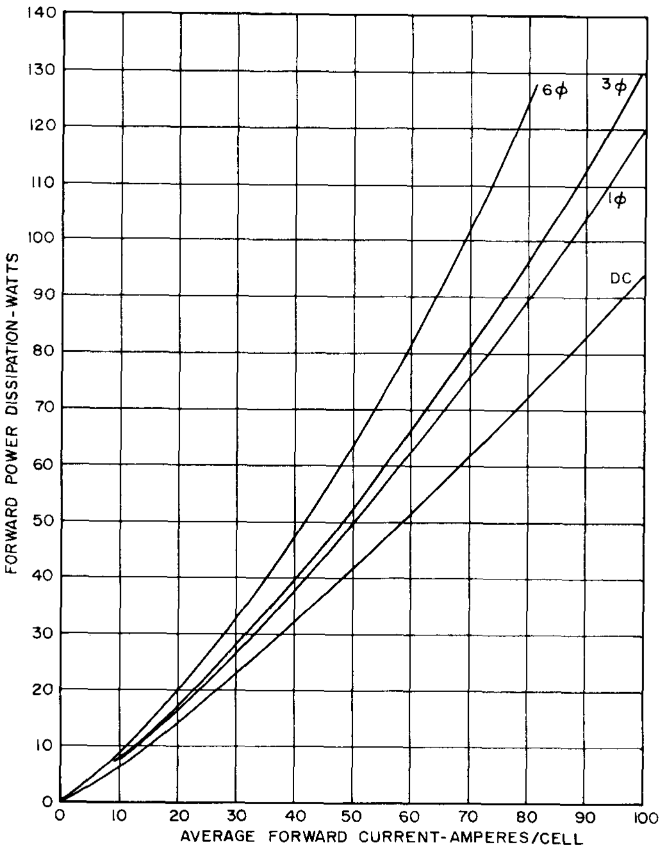
1N3289-96, R
A70S, A70T
A71S, A71T



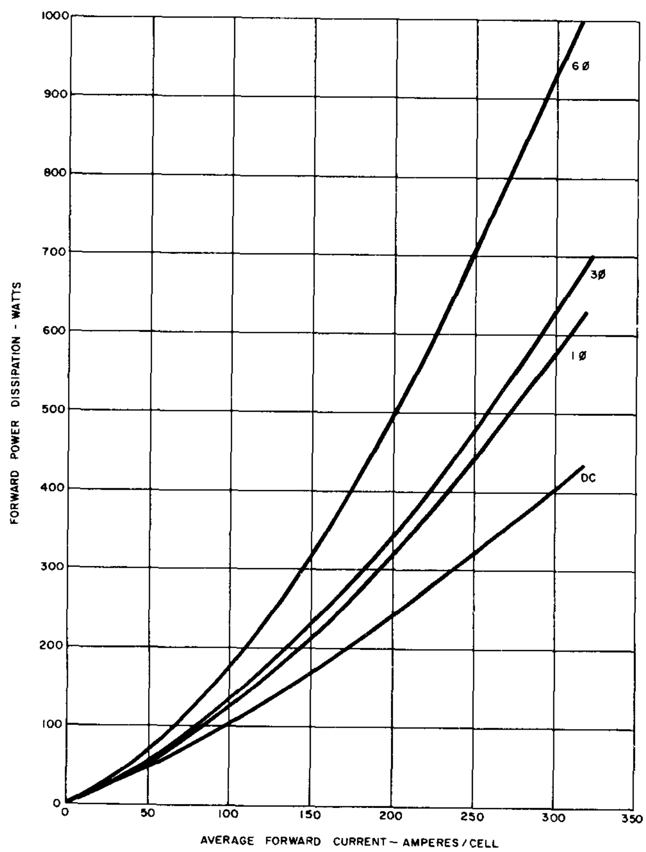
1. MAXIMUM FORWARD CHARACTERISTICS



2. MAXIMUM TRANSIENT REVERSE CHARACTERISTICS (T_J = −40°C to +200°C)



3. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT

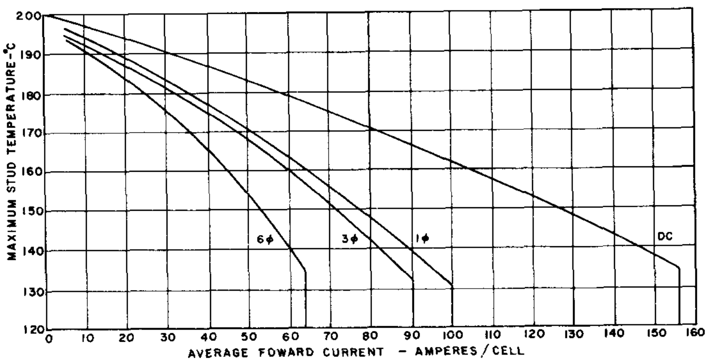


4. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT, HIGH LEVEL

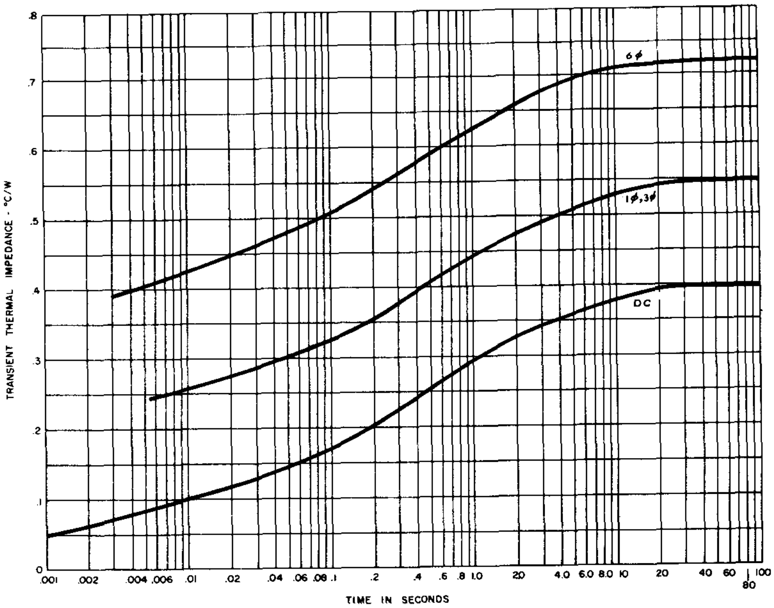
INSTALLATION INSTRUCTIONS

Following these installation instructions will result in a diode-to-heatsink thermal resistance of .10°C/watt.

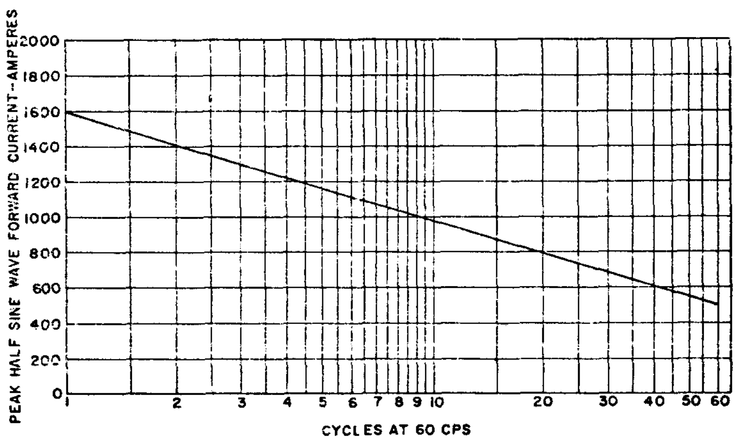
1. Be sure mounting surface is clean and flat at (.001 inch/inch).
2. Mounting hole diameter should not exceed rectifier stud OD by more than ¹⁄₆₄" and should be deburred.
3. Use Burndy's "Penetrox A" or equivalent on mounting surfaces which come in contact with the heatsink.
4. Use suitable hardware. (Nut and split lockwasher are supplied.)
5. Tighten nut with a torque wrench, to 100 inch-pounds.



5. MAXIMUM STUD TEMPERATURE VS. AVERAGE FORWARD CURRENT

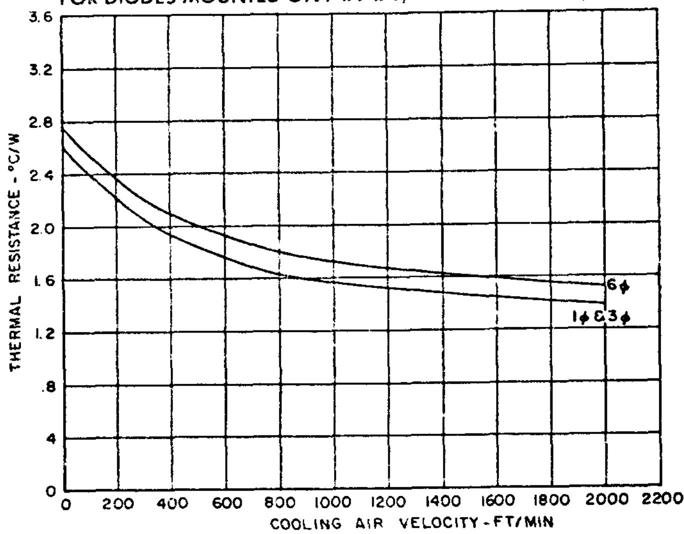


6. JUNCTION TO CASE TRANSIENT THERMAL IMPEDANCE

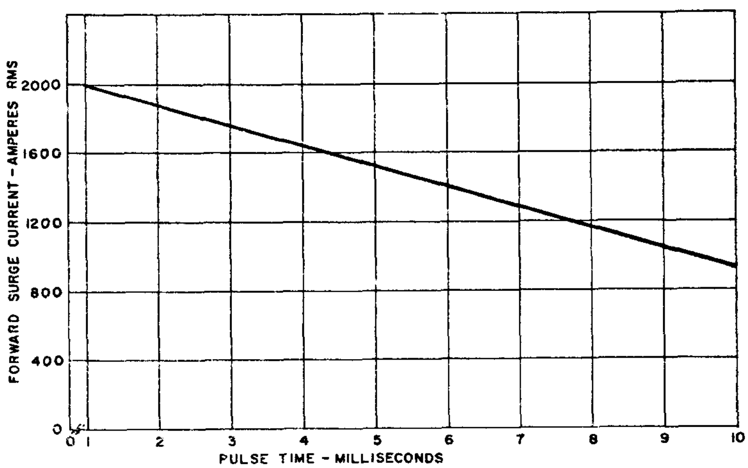


7. MAXIMUM SURGE CURRENT AT RATED LOAD CONDITIONS
(Non-Recurrent) T_J = −40°C to +200°C

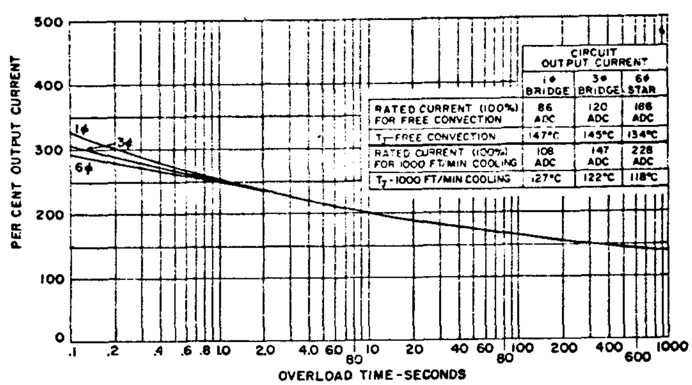
RECURRENT OVERLOAD RATINGS
FOR DIODES MOUNTED ON 7 x 7 x 1/4" COPPER FIN (E ≅ 0.9)



STEADY-STATE THERMAL RESISTANCE, JUNCTION TO AMBIENT



8. MAXIMUM SURGE CURRENT FOR SUB-CYCLE PULSES AT RATED LOAD CONDITIONS
(Non-Recurrent) T_J = −40°C to +200°C



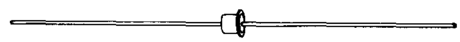
	CIRCUIT OUTPUT CURRENT		
	1ϕ BRIDGE	3ϕ BRIDGE	6ϕ STAR
RATED CURRENT (100%) FOR FREE CONVECTION	86 ADC	120 ADC	186 ADC
T_J - FREE CONVECTION	147°C	145°C	134°C
RATED CURRENT (100%) FOR 1000 FT/MIN COOLING	108 ADC	147 ADC	228 ADC
T_J - 1000 FT/MIN COOLING	127°C	122°C	118°C

RECURRENT OVERLOAD CURVE MEETING NEMA STANDARDS FOR "General Purpose Rectifier Equipments Under 100 KW" AT 40°C AMBIENT

Germanium Diodes

1N3712-21

The General Electric 1N3712 through 1N3720 and 1N3713 through 1N3721 are Germanium Tunnel Diodes offering peak currents of 1.0, 2.2, 4.7, 10, and 22 ma. These devices, which make use of the quantum mechanical tunneling phenomenon to obtain a negative conductance characteristic, are designed for low level switching and small signal applications at very high frequencies. All 1N3713-1N3721 version parameters are closely controlled for use in critical applications such as level detection, frequency converters, etc. These devices are housed in General Electric's new hermetically sealed subminiature axial package.



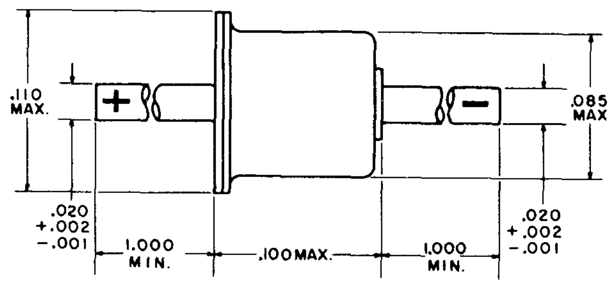
FEATURES:

- V_{FS} Specified for more accurate designing of load lines
- Low capacitance
- Fast speed

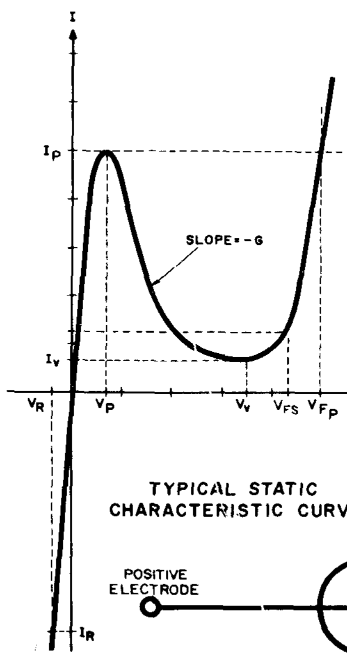
	1N3712 / 1N3713	1N3714 / 1N3715	1N3716 / 1N3717	1N3718 / 1N3719	1N3720 / 1N3721	
Forward Current*	5	10	25	50	100	ma
Reverse Current*	10	20	50	50	100	ma
Storage Temperature	←		−55 to +100		→	°C
Lead Temperature $\frac{1}{16}'' \pm \frac{1}{32}''$ from case for 10 seconds	←		260		→	°C

*Derate maximum currents 1% per °C ambient temperature above 25°C.

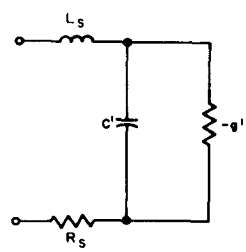
AXIAL DIODE OUTLINE



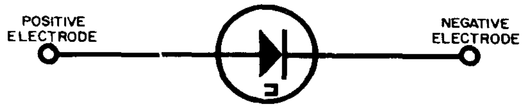
ALL DIMENSIONS IN INCHES.
DIMENSIONS ARE REFERENCE UNLESS TOLERANCED.



TYPICAL STATIC CHARACTERISTIC CURVE



EQUIVALENT CIRCUIT (BIASED IN NEGATIVE CONDUCTANCE REGION)



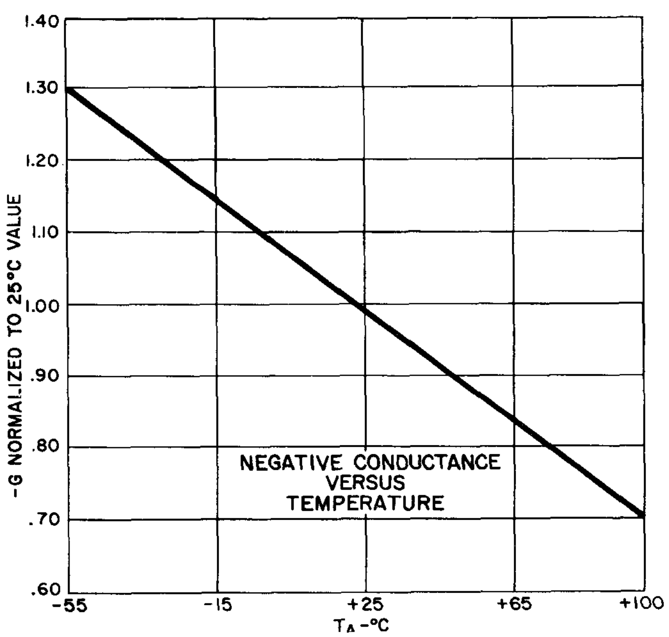
TUNNEL DIODE SYMBOL

electrical characteristics:

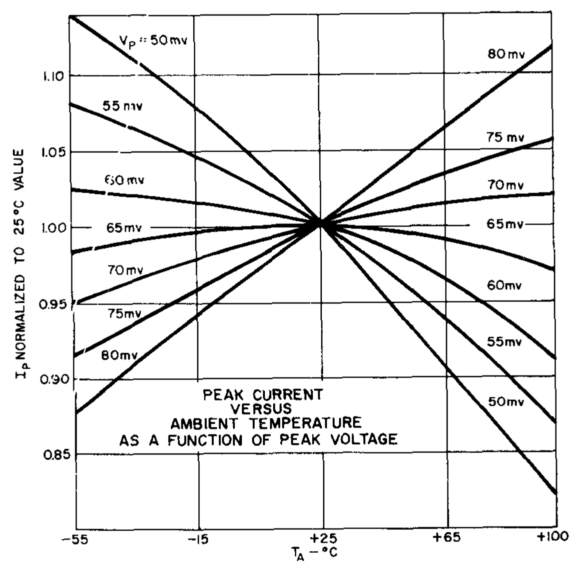
STATIC CHARACTERISTICS		1N3712 Min.	1N3712 Typ.	1N3712 Max.	1N3713 Min.	1N3713 Typ.	1N3713 Max.	1N3714 Min.	1N3714 Typ.	1N3714 Max.	1N3715 Min.	1N3715 Typ.	1N3715 Max.
Peak Point Current	I_P	0.9	1.0	1.1	0.975	1.000	1.025	2.0	2.2	2.4	2.15	2.20	2.25
Valley Point Current	I_V		0.12	0.18	.075	.095	.140		0.29	0.48	.165	.210	.310
Peak Point Voltage	V_P		65		58	65	72		65		58	65	72
Valley Point Voltage	V_V		350		315	355	395		350		315	355	395
Reverse Voltage ($I_R = I_P$ typ.)	V_R			40		20	40			40		20	40
Forward Voltage ($I_F = I_P$ typ.)	V_{FP}		500		475	510	535		500		475	510	535
► ($I_F = .25\ I_P$ typ.)	V_{FS}*				410	450					410	450	
DYNAMIC CHARACTERISTICS													
Total Series Inductance	L_S		0.5			0.5			0.5			0.5	
Total Series Resistance	R_S		1.5	4.0		1.7	4.0		1.0	3.0		1.1	3.0
► Valley Point Terminal Capacitance	C		5	10		3.5	5.0		10	25		7.0	10.0
Max. Negative Terminal Conductance	-G		8		7.5	8.5	9.5		18		16	19	22
Resistive Cutoff Frequency	f_{ro}		2.3			3.2			2.2			3.0	
Self-Resonant Frequency	f_{xo}		3.2			3.8			2.2			2.7	
Frequency of Oscillation	F_{osc}**		3.2			3.8			2.2			2.7	
► Rise Time	t_r***					1.7						1.6	

*V_{FS} is defined as the value of forward voltage at a forward current of one quarter the typical peak current.
**The frequency of oscillation (under short circuit conditions) for steady state large signal sinusoidal oscillation is given by equation (3) which is the maximum frequency attainable without capacitance compensation.

***Switching speed with constant current drive. $t_r \approx \frac{V_{FP} - V_P}{I_P - I_V} C$



NEGATIVE CONDUCTANCE VERSUS TEMPERATURE



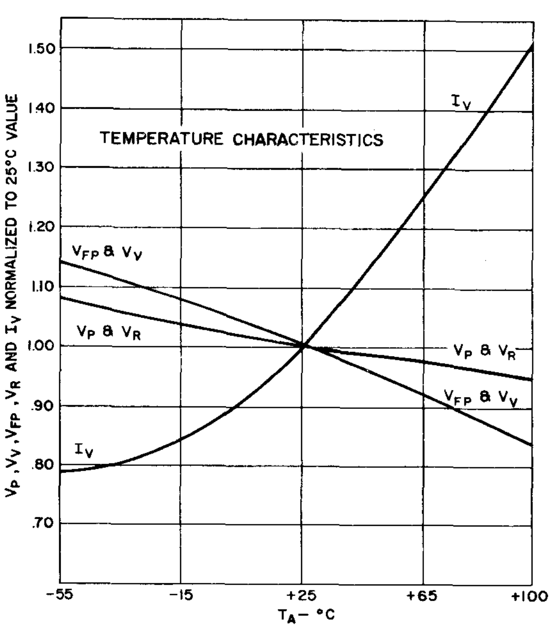
PEAK CURRENT VERSUS AMBIENT TEMPERATURE AS A FUNCTION OF PEAK VOLTAGE

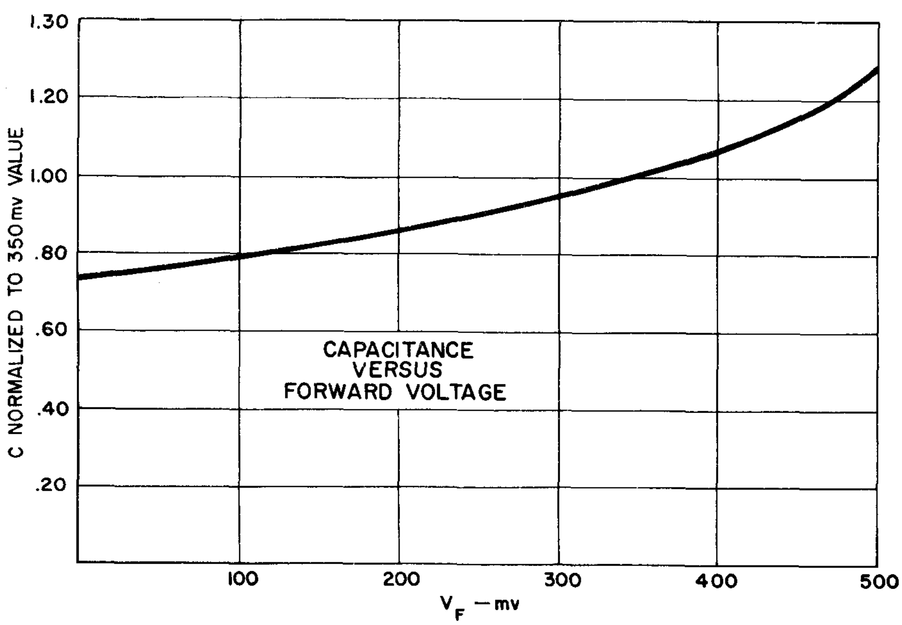
1N3716			1N3717			1N3718			1N3719			1N3720			1N3721			
Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
4.2	4.7	5.2	4.58	4.70	4.82	9.0	10.0	11.0	9.75	10.00	10.25	20	22	24	21.5	22	22.5	ma
	0.60	1.04	.350	.45	.60		1.3	2.2	.75	.95	1.40		2.9	4.8	1.65	2.10	3.10	ma
	65		58	65	72		65		58	65	72		65		58	65	72	mv
	350		315	355	395		350		315	355	395		350		315	355	395	mv
		40		20	40			40		20	40			40		20	40	mv
	500		475	510	535		500		475	510	535		500		475	510	575	mv
			410	450					410	450					410	450		
	0.5			0.5			0.5			0.5			0.5			0.5		nh
	.50	2.0		.52	2.0		.30	1.5		.36	1.5		.20	1.0		.22	1.0	ohms
	25	50		13	25		50	90		27	50		90	150		55	100	pf
	40		36	41	46		80		75	85	95		180		160	190	220	10^{-3} mho
	1.8			3.4			1.6			2.8			1.6			2.6		KMC
	1.4			1.9			.97			1.3			.67			.78		KMC
	1.4			2.0			1.0			1.4			.74			.95		KMC
				1.4						1.3						1.2		nsec

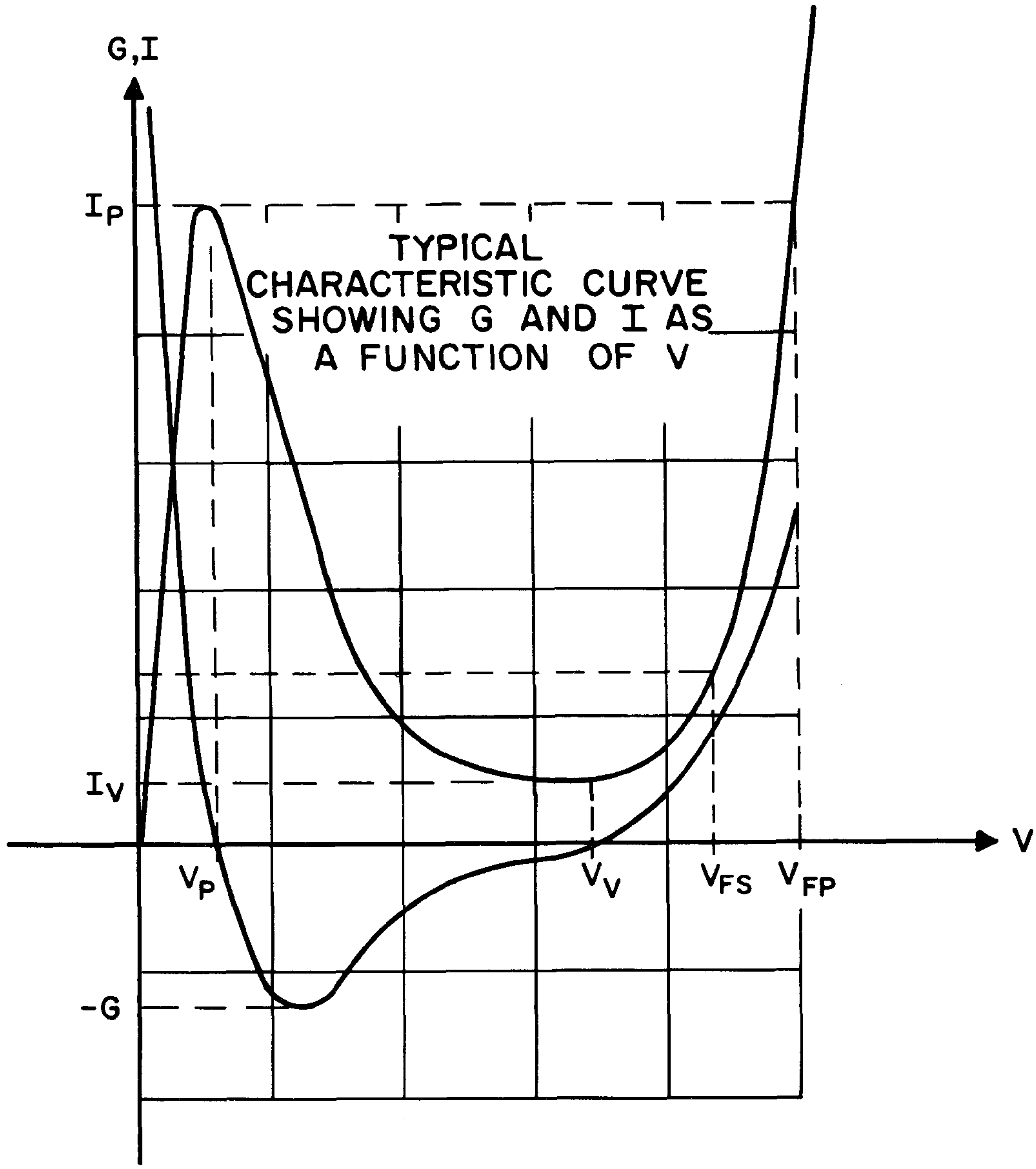
$$f_{ro} = \frac{|g'|}{2\pi C'}\sqrt{\frac{1}{R_S|g'|} - 1} \quad (1)$$

$$f_{xo} = \frac{1}{2\pi}\sqrt{\frac{1}{L_S C'} - \left(\frac{|g'|}{C'}\right)^2} \quad (2)$$

$$f_{osc} = \frac{1}{2\pi}\sqrt{\frac{1}{L_S C} - \left(\frac{R_T}{L}\right)^2} \quad (3)$$






G,I
I_P
I_V
-G
TYPICAL
CHARACTERISTIC CURVE
SHOWING G AND I AS
A FUNCTION OF V
V_P
V_V
V_FS
V_FP
V

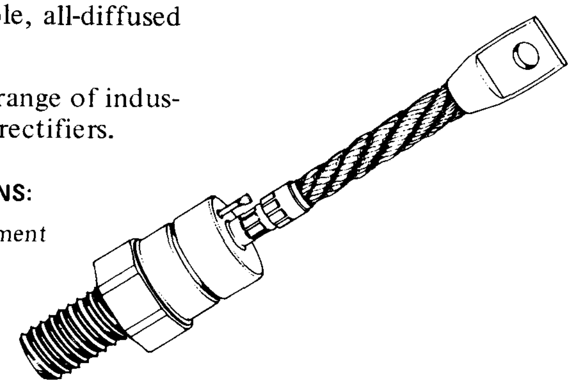
High Power Silicon Rectifier

1500 Volts 250A Avg.

1N3735-44
A190

The A190 (1N3735 Series) is General Electric's highly reliable, all-diffused Pic-Pac[4] 250 ampere silicon rectifier diode.

This series of rectifier diodes is particularly suited to a wide range of industrial applications, expecially those requiring high performance rectifiers.



FEATURES:

- Thermal Fatigue Resistant Pic-Pac[4] Construction
- Cathode Strain Buffer
- Soft Recovery
- 1500 Volt V_{RRM}
- Rugged Hermetic Package

TYPICAL APPLICATIONS:

- Transportation Equipment
- DC Motor Control
- DC Power Supplies
- Battery Vehicles

MAXIMUM ALLOWABLE RATINGS AND SPECIFICATIONS

TYPES*		REPETITIVE PEAK[1] REVERSE VOLTAGE V_{RRM} T_J = -40°C to +200°C	NON-REPETITIVE[2] PEAK REVERSE VOLTAGE, V_{RSM} T_J = 25°C to +200°C	DC REVERSE[3] VOLTAGE, V_R T_J = -40°C to +200°C	REPETITIVE PEAK REVERSE CURRENT I_{RRM} @ V_{RRM} T_J = 200°C
A190A	1N3735	100 Volts	200 Volts	100 Volts	100 Volts
A190B	1N3736	200	300	300	200
A190C	1N3737	300	400	300	300
A190D	1N3738	400	525	400	400
A190E	1N3739	500	650	500	500
A190M	1N3740	600	800	600	600
A190S	–	700	925	700	700
A190N	1N3741	800	1050	800	800
A190T	–	900	1175	900	900
A190P	1N3742	1000	1300	1000	1000
A190PA	–	1100	1400	1100	1100
A190PB	1N3743	1200	1500	1200	1200
A190PC	–	1300	1600	1300	1300
A190PD	1N3744	1400	1700	1400	1400
A190PE	–	1500	1800	1800	1500

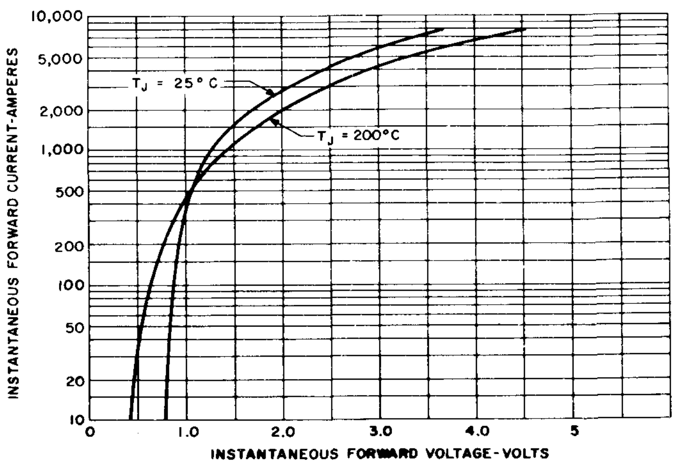
*Models listed are stud cathode (forward polarity) types. Specify A190R-for stud anode (reverse polarity) types. Ratings and specifications are for frequencies from 50 to 400 Hz, except where noted otherwise.

Average Forward Current, $I_{F(AV)}$ (T_C = +144°C, Single-Phase, Half Sine Wave) .... 250 Amperes
Peak One-Cycle Surge (Non-Repetitive), Forward Current, I_{FSM} .... 6500 Amperes
Minimum I^2t Rating (See Curve 4), t $\geq$ 1 msec. (Non-Repetitive) .... 55,000 (RMS Ampere)^2 Seconds
Peak Forward Voltage Drop, V_{FM} (T_C = +144°C, $I_{F(AV)}$ = 250 Amps. Average, 785 Amps. Peak) .... 1.3 Volts
Thermal Resistance, $R_{\theta JC}$ (DC) .... 0.18°C/Watt
1ϕ & 3ϕ (50 to 400 Hz) .... 0.24°C/Watt
6ϕ (50 to 400 Hz) .... 0.30°C/Watt
Storage Temperature, T_{stg} .... -40°C to +200°C
Operating Junction Temperature, T_J .... -40°C to +200°C
Stud Torque (See Mounting Guide) .... 275 Lb-in (Min.), 325 Lb-in (Max.)
31 N-m (Min.), 36.7 N-m (Max.)

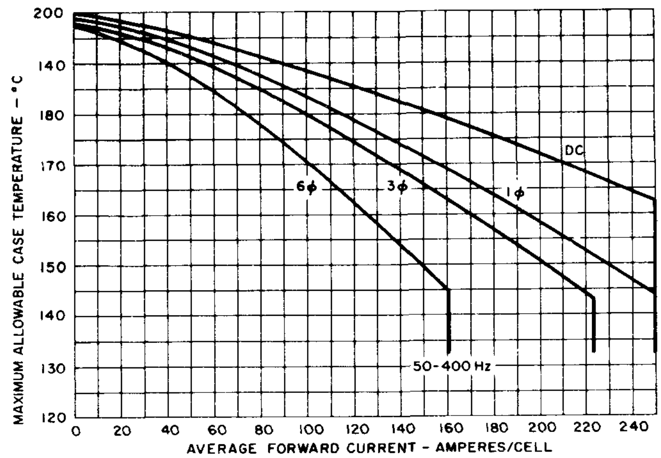
NOTES:

[1] Assumes a heatsink thermal resistance of less than 2.0°C/watt.
[2] Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetitive ratings that are used in fault coordination work.
[3] Assumes a heatsink thermal resistance of less than 1.0°C/watt.
[4] "Pic-Pac" is an acronym for Pressure Internal Contact Package.

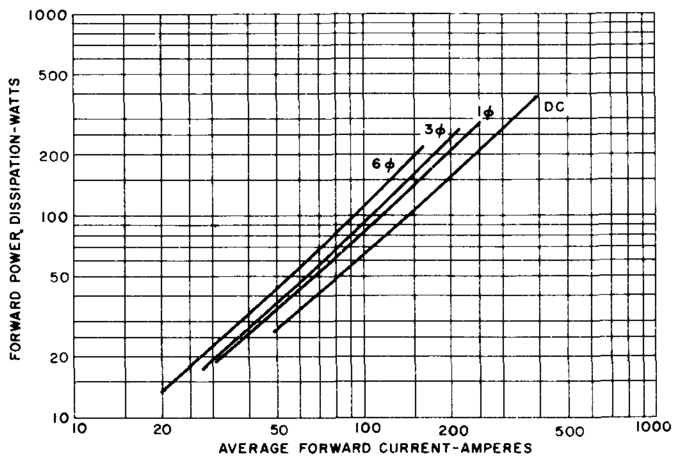
DEVICE SPECIFICATIONS



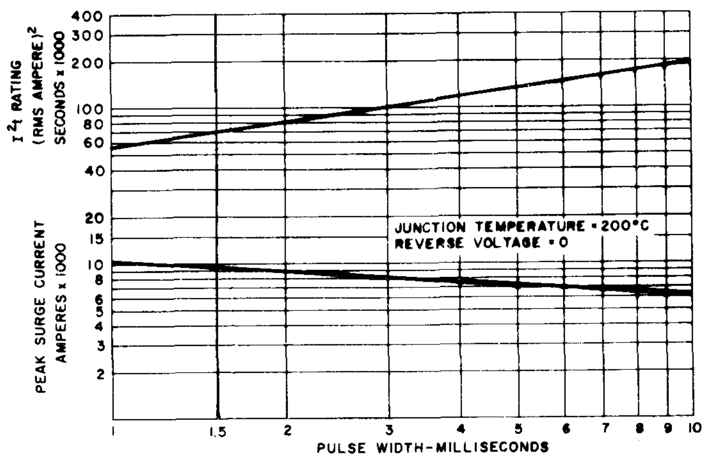
1. MAXIMUM FORWARD CHARACTERISTICS



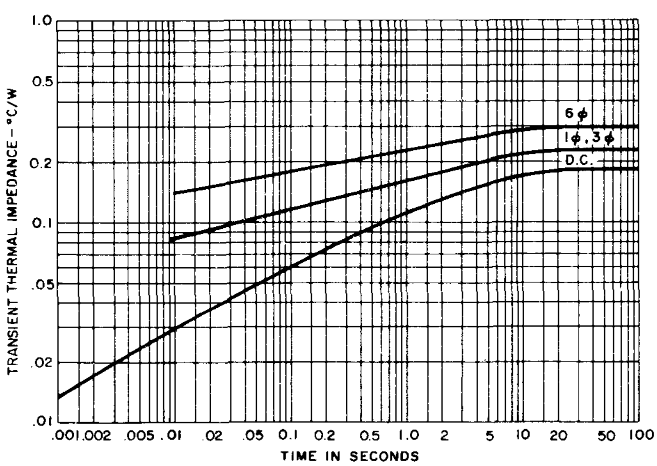
2. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



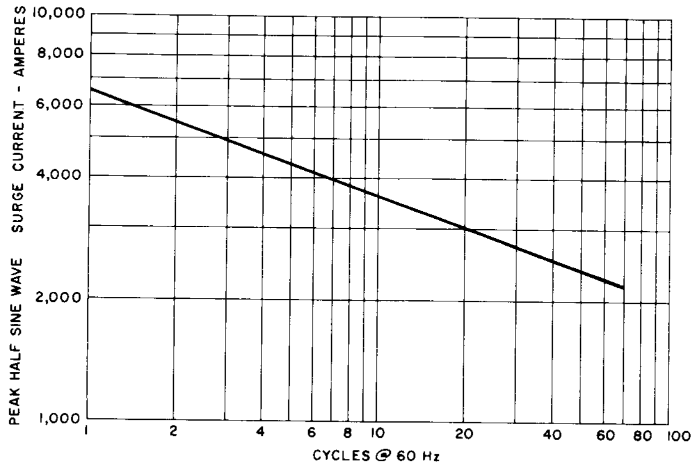
3. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT



4. SUB-CYCLE SURGE FORWARD CURRENT AND I^2t RATING VS. PULSE TIME FOLLOWING RATED LOAD CONDITIONS



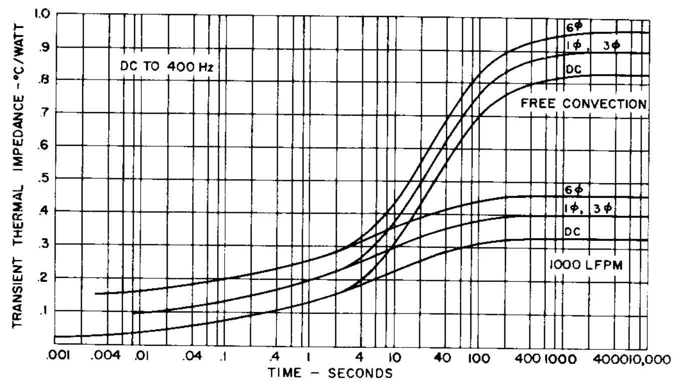
5. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



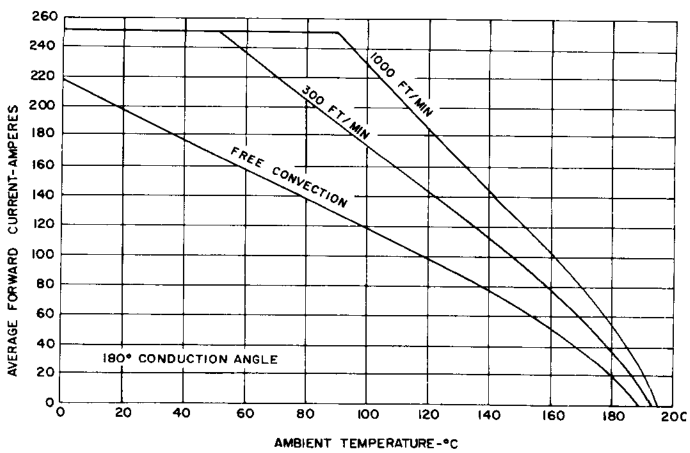
6. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

MAXIMUM CIRCUIT RATINGS

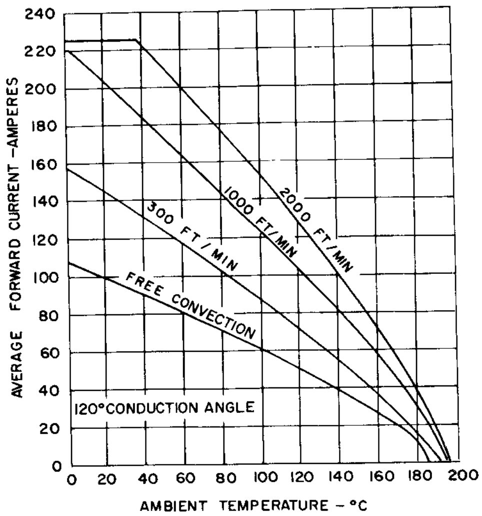
DEVICE MOUNTED ON A 5″ x 5″ x 6″ ALUMINUM EXTRUSION (GE#15)



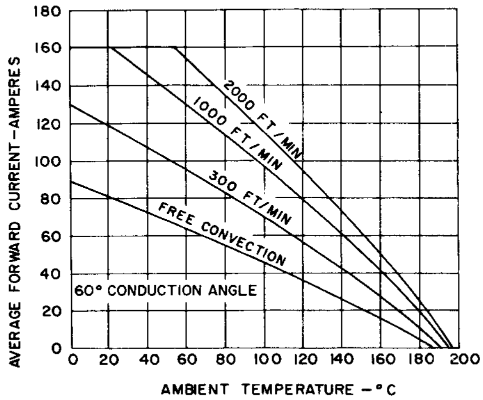
7. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-AMBIENT



8. SINGLE-PHASE, HALF-WAVE FORWARD CURRENT VS. AMBIENT TEMPERATURE

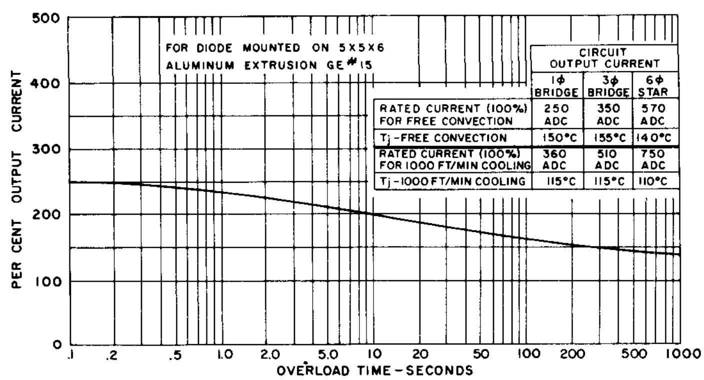


9. THREE-PHASE FORWARD CURRENT VS. AMBIENT TEMPERATURE



10. SIX-PHASE FORWARD CURRENT VS. AMBIENT TEMPERATURE

RECURRENT OVERLOAD RATINGS



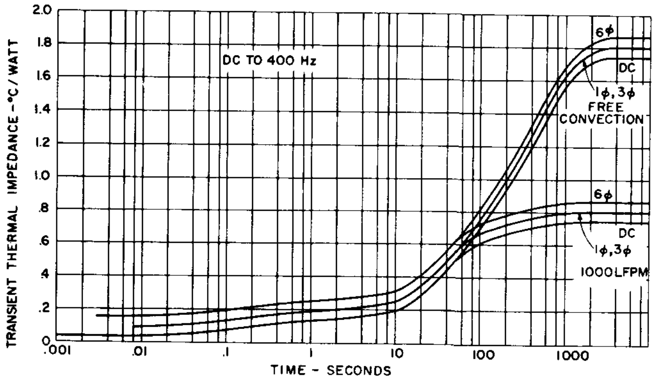
	CIRCUIT OUTPUT CURRENT		
	1φ BRIDGE	3φ BRIDGE	6φ STAR
RATED CURRENT (100%) FOR FREE CONVECTION	250 ADC	350 ADC	570 ADC
Tj -FREE CONVECTION	150°C	155°C	140°C
RATED CURRENT (100%) FOR 1000 FT/MIN COOLING	360 ADC	510 ADC	750 ADC
Tj -1000 FT/MIN COOLING	115°C	115°C	110°C

11. REPETITIVE OVERLOAD CURVE MEETING NEMA STANDARDS FOR "General Purpose Rectifier Equipments Under 100 KW" AT 40°C AMBIENT (For Overload Conditions Other Than As Shown, Refer To Application Note 200.9)

DEVICE SPECIFICATIONS

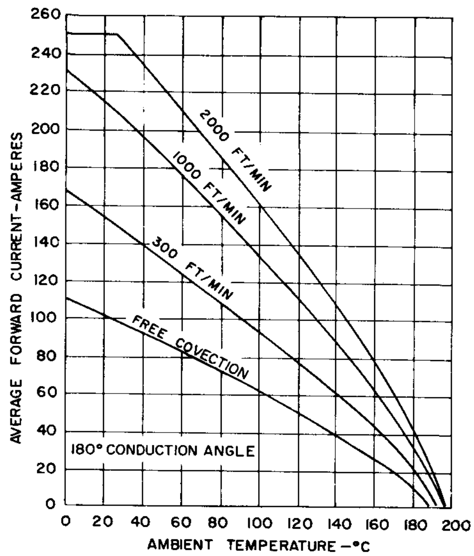
MAXIMUM CIRCUIT RATINGS

DEVICE MOUNTED ON A 7" x 7" x 3/8" ALUMINUM FIN (GE #13) OR A 7" x 7" x 1/4" COPPER FIN
MINIMUM FIN SPACING 1 INCH FINS MOUNTED VERTICALLY OR PARALLEL TO FORCED AIR FLOW

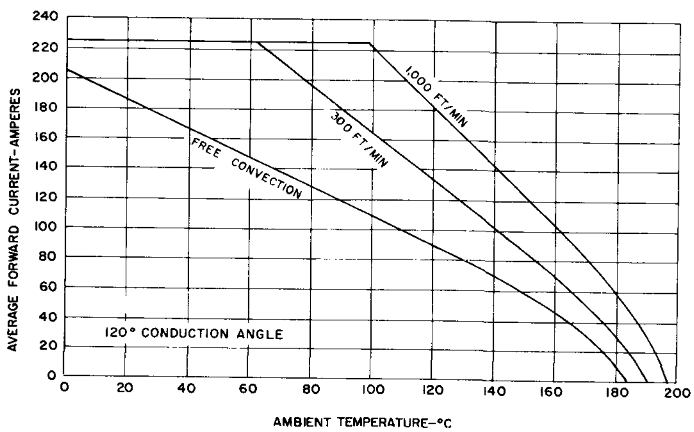


8. TRANSIENT THERMAL IMPEDANCE
- JUNCTION TO AMBIENT

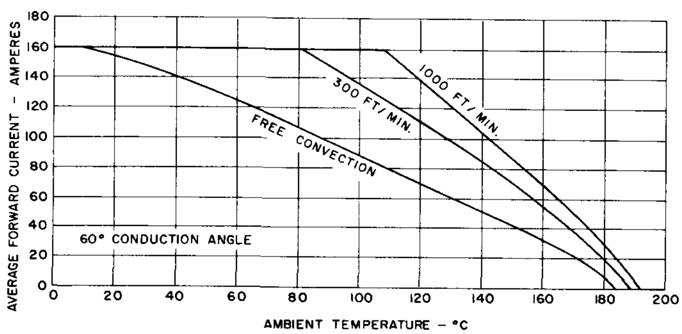
12. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-AMBIENT



13. SINGLE-PHASE, HALF-WAVE FORWARD CURRENT VS. AMBIENT TEMPERATURE



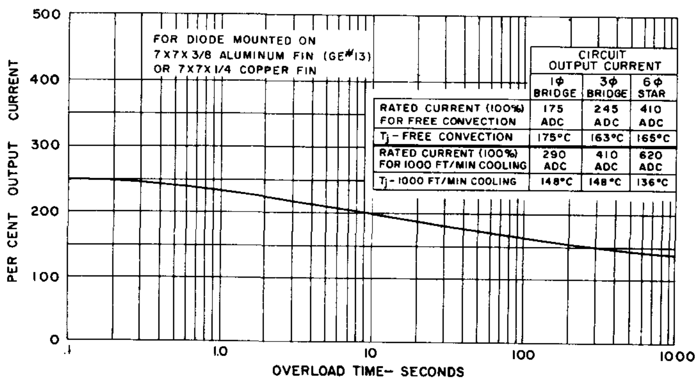
14. THREE-PHASE FORWARD CURRENT VS. AMBIENT TEMPERATURE



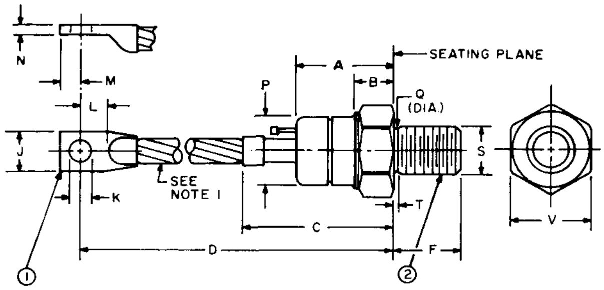
15. SIX-PHASE FORWARD CURRENT VS. AMBIENT TEMPERATURE

REPETITIVE OVERLOAD RATINGS

16. REPETITIVE OVERLOAD CURVE MEETING NEMA STANDARDS FOR "General Purpose Rectifier Equipments Under 100 KW" AT 40°C AMBIENT (For Overload Conditions Other Than As Shown, Refer To Application Note 200.9)



OUTLINE DRAWING



MODEL	TERMINAL 1	TERMINAL 2	S THREAD SIZE
A190 FORWARD POLARITY	ANODE	CATHODE	3/4 – 16
A190R REVERSE POLARITY	CATHODE	ANODE	UNF – 2A

TABLE OF DIMENSIONS
Conversion Table

SYM.	DECIMAL INCHES		METRIC MM		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	1.450	1.550	36.83	39.37	
B	.500	.750	12.70	19.05	
C	2.300	2.500	58.42	63.50	
D	5.300	5.700	134.62	144.78	
F	.797	.827	20.24	21.01	
J	.665	.755	16.89	19.18	
K	.322	.333	8.17	8.46	
L	.437	–	11.99	–	
M	.325	.360	8.25	9.14	
N	.155	.170	–	–	
P	1.060	1.100	26.92	27.94	
Q	.660	.749	16.76	19.02	
T	–	.156	–	3.96	3
V	1.240	1.250	31.49	31.75	

NOTES:
1. Flexible Copper Lead.
2. One Nut and One Lockwasher Supplied With Each Unit. Material of Hardware is Steel, Cad Plated.
3. "T" Dimension is Area of Unthreaded Portion. Complete Threads are Within 2.5 Threads of Seating Plane.
4. Angular Orientation of Terminals is Undefined.

MOUNTING INSTRUCTIONS

Following these installation instructions will result in a rectifier diode-to-heatsink contact thermal resistance of 0.08°C/watt or less.

1. Be sure mounting surface is clean and flat within .001 inch/inch.
2. Mounting hole diameter should not exceed the outside diameter of the rectifier diode stud by more than 1/16 inch, and should be deburred.
3. Use Dow Corning's DC3, 4, 340 or 640 or GE G322L or equivalent, on mounting surfaces that come in contact with the heatsink.
4. Use only hardware furnished with each rectifier diode.
5. Tighten with a torque wrench, from nut side, to 300 lb-in.

1N3765-68 SEE PAGE 209

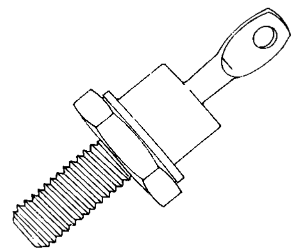
Silicon RECTIFIERS

FAST RECOVERY

IN3879-83,R

Features:

- Fast Recovery Time . . . 200 Nanoseconds Maximum
- Diffused Construction
- For Use in:
  - — Inverters
  - — Choppers
  - — Low RF Interference Applications
  - — Free-Wheeling Rectifier Applications
  - — Sonar Power Supplies
  - — Ultrasonic Systems
  - — DC-DC Power Supplies



maximum allowable ratings (Resistive or Inductive Load)

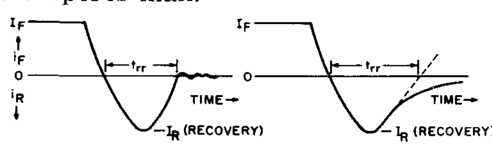
	1N3879,R	1N3880,R	1N3881,R	1N3882,R	1N3883,R	
*Maximum Repetitive Peak Reverse Voltage, $T_J = -65°C$ to $+150°C$, V_{RM} (rep) (Note 1)	50	100	200	300	400	Volts
Maximum RMS Voltage, $T_J = -65°C$ to $+150°C$, V_r (Note 1)	35	70	140	210	280	Volts
*Maximum DC Blocking Voltage, $T_J = -65°C$ to $+100°C$, V_R (Note 1)	50	100	200	300	400	Volts
*Maximum Average Forward Current, Single Phase, $T_C = +100°C$, I_O	← 6 Amperes →					
*Maximum Peak One Cycle Surge Current, 60 Cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM}(surge)	← 75 Amperes →					
*Maximum Peak Ten Cycle Surge Current, 60 Cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM}(surge)	← 35 Amperes →					
*Maximum Forward Voltage Drop, $I_F = 6$ A DC, $T_C = +25°C$, V_F	← 1.4 Volts →					
*Maximum Reverse Current at Full Load, Single Phase Full-Cycle Average, $I_O = 6$ Amp at $T_C = +100°C$, $I_{R(AV)}$	← 3.0 mA →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +100°C$, I_R	← 1.0 mA →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +25°C$, I_R	← 15 μA →					
*Junction Operating Temperature Range, T_J	← −65°C to +150°C →					
*Storage Temperature Range, T_{stg}	← −65°C to +175°C →					
*Stud Torque	← 15 in-lbs. Maximum →					
*Maximum Reverse Recovery Characteristics: (See figure below) Recovery Time, t_{rr}	← 200 Nanoseconds Maximum →					
Peak Recovery Current, I_R (recovery) (Note 2)	← 2.0 Amperes Maximum →					

*The asterisk denotes JEDEC (EIA) registered information.

test conditions

These rectifiers are factory tested to reverse recovery limits which correlate with EIA registered values. This testing is in accordance with NEMA-EIA recommendations for silicon rectifier diodes and stacks.

Recovery characteristic test conditions: $I_{FM} = 5.0$ amps; di/dt = 50 amps/μsec switching rate, and a reverse bias of 50% V_R for 200, 300 and 400 volt grades or 100% V_R for 50 and 100 volt grades; $T_C = 25°C$; $t_{rr} = 150$ nanoseconds; and I_R (recovery) = 5.0 amperes max.

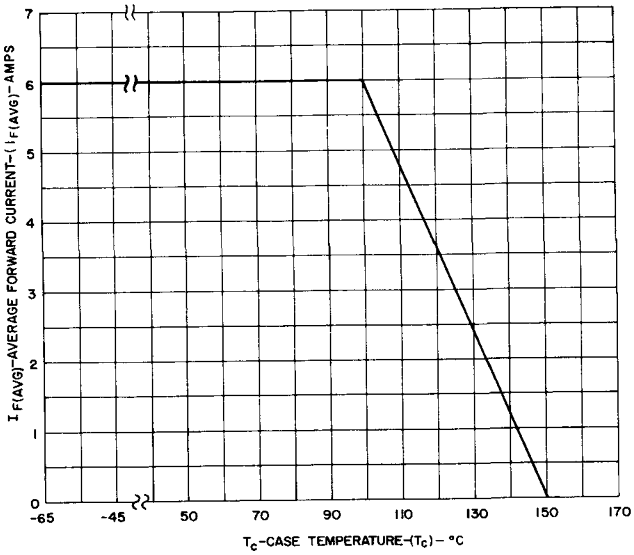


TYPICAL RECOVERY WAVE FORMS

TYPICAL RECOVERY WAVE FORMS

NOTES:

1. Rating assumes rectifier heatsink ≦6°C/W at max. T_J.
2. Some manufacturers call this Overshoot Current and use the symbol I_{OS}.

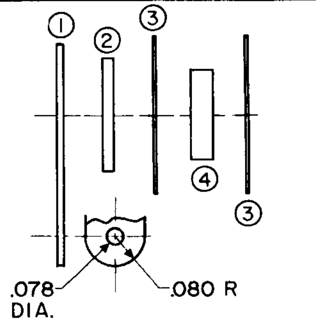


1. Forward Current Rating vs. Case Temperature

NOTE: Case temperature is measured at the center of any flat on the hex base.

OUTLINE DRAWING

INSULATING HARDWARE KIT *



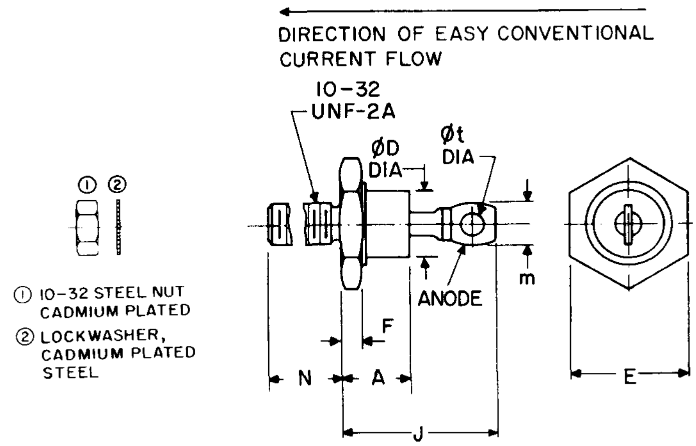
① COPPER TERMINAL,.016 THICK, TIN PLATED

② BRASS WASHER,.035 THICK NICKEL PLATED

③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK

④ TEFLON WASHER,.270 O.D. .204 I.D., .050 THICK

* AVAILABLE UPON REQUEST



COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM) Ref. (Screw thread standards for Federal Services 1957) Handbook H28 1957 P1.

Silicon

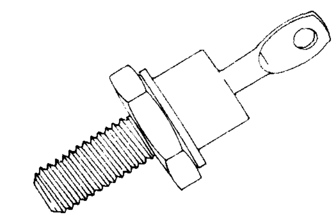
Rectifiers

FAST RECOVERY

IN3889-93,R

Features:

- Fast Recovery Time . . . 200 Nanoseconds Maximum
- Diffused Construction
- For Use in:
  - — Inverters
  - — Choppers
  - — Low RF Interference Applications
  - — Free-Wheeling Rectifier Applications
  - — Sonar Power Supplies
  - — Ultrasonic Systems
  - — DC-DC Power Supplies



maximum allowable ratings (Resistive or Inductive Load)

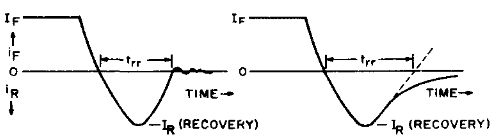
	1N3889,R	1N3890,R	1N3891,R	1N3892,R	1N3893,R	
*Maximum Repetitive Peak Reverse Voltage, T_J = −65°C to +150°C, V_{RM} (rep) (Note 1)	50	100	200	300	400	Volts
Maximum RMS Voltage, T_J = −65°C to +150°C, V_r (Note 1)	35	70	140	210	280	Volts
*Maximum DC Blocking Voltage, T_J = −65°C to +100°C, V_R (Note 1)	50	100	200	300	400	Volts
*Maximum Average Forward Current, Single Phase, T_C = +100°C, I_O	← 12 Amperes →					
*Maximum Peak One Cycle Surge Current, 60 Cycle, Non-Recurrent, T_J = −65°C to +150°C, I_{FM} (surge)	← 150 Amperes →					
*Maximum Peak Ten Cycle Surge Current, 60 cycle, Non-Recurrent, T_J = −65°C to +150°C, I_{FM} (surge)	← 70 Amperes →					
*Maximum Forward Voltage Drop, I_F = 12 ADC, T_C = +25°C, V_F	← 1.4 Volts →					
*Maximum Reverse Current at Full Load, Single Phase Full-Cyle Average, I_O = 12 Amp. at T_C = +100°C, $I_{R(AV)}$	← 5.0 mA →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and T_C = +100°C, I_R	← 3.0 mA →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and T_C = +25°C, I_R	← 25 μA →					
*Junction Operating Temperature Range, T_J	← −65°C to +150°C →					
*Storage Temperature Range, T_{stg}	← −65°C to +175°C →					
*Stud Torque	← 15 in-lbs. Maximum →					
*Maximum Reverse Recovery Characteristics: (See figure below) Recovery Time, t_{rr}	← 200 Nanoseconds Maximum →					
Peak Recovery Current, I_R (recovery) (Note 2)	← 2.0 Amperes Maximum →					

*The asterisk denotes JEDEC (EIA) registered information.

test conditions

These rectifiers are factory tested to reverse recovery limits which correlate with EIA registered values. This testing is in accordance with NEMA-EIA recommendations for silicon rectifier diodes and stacks.

Recovery characteristic test conditions: I_{FM} = 5.0 amps; di/dt = 50 amps/μsec switching rate, and a reverse bias of 50% V_R for 200, 300 and 400 volt grades or 100% V_R for 50 and 100 volt grades; T_C = 25°C; t_{rr} = 150 nanoseconds; and I_R (recovery) = 5.0 amperes max.

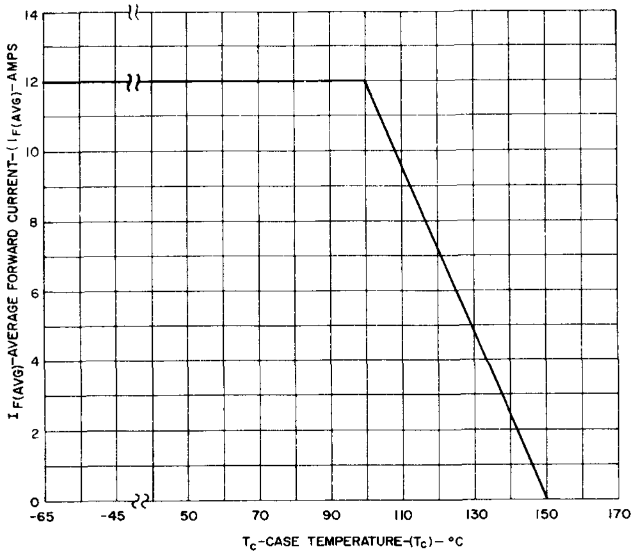


TYPICAL RECOVERY WAVE FORMS

TYPICAL RECOVERY WAVE FORMS

NOTES:

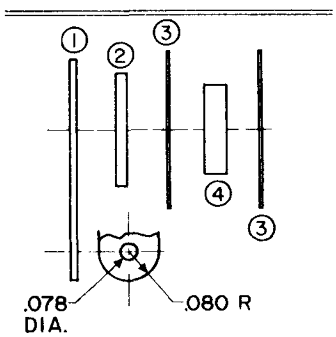
1. Rating assumes rectifier heatsink ≦6°C/W at max. T_J.
2. Some manufacturers call this Overshoot Current and use the symbol I_{OS}.



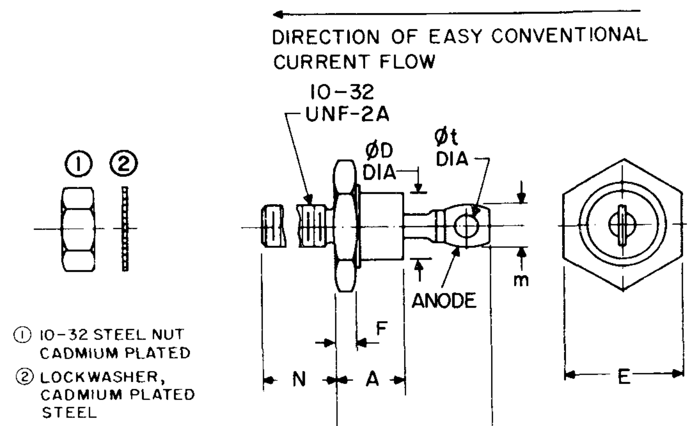
1. Forward Current Rating vs. Case Temperature

NOTE: Case temperature is measured at the center of any flat on the hex base.

OUTLINE DRAWING



① COPPER TERMINAL,.016 THICK, TIN PLATED
② BRASS WASHER,.035 THICK NICKEL PLATED
③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK
④ TEFLON WASHER,.270 O.D. .204 I.D., .050 THICK
* AVAILABLE UPON REQUEST



COMPLIES WITH
EIA REGISTERED OUTLINE DO-4

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

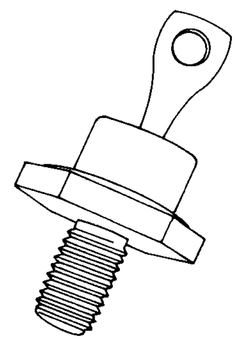
NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM) Ref. (Screw thread standards for Federal Services 1957) Handbook H28 1957 P1.

Silicon Diodes

1N3899-3903,R

Features:

- Fast Recovery Time—200 Nanoseconds Maximum
- Recovery Characteristics match the High Frequency capability of the new General Electric High Speed SCR's such as the C140 and 141, the C155 and C185
- For Use in:
  - — Inverters
  - — Choppers
  - — Low RF Interference Applications
  - — Free-Wheeling Rectifier Applications
  - — Sonar Power Supplies
  - — Ultrasonic Systems
  - — DC-DC Power Supplies



maximum allowable ratings (Resistive or Inductive Load)

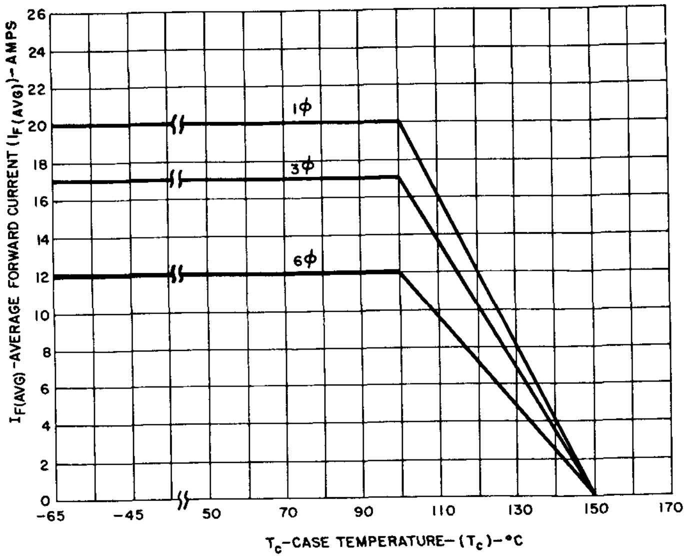
	1N3899,R	1N3900,R	1N3901,R	1N3902,R	1N3903,R	
*Maximum Repetitive Peak Reverse Voltage, $T_J = -65°C$ to $+150°C$, V_{RM} (rep) (Note 1)	50	100	200	300	400	Volts
Maximum RMS Voltage, $T_J = -65°C$ to $+150°C$, V_r	35	70	140	210	280	Volts
*Maximum DC Blocking Voltage, $T_J = -65°C$ to $+100°C$, V_R (Note 1)	50	100	200	300	400	Volts
*Maximum Average Forward Current, Single Phase, $T_C = +100°C$, I_O	← 20 Amperes →					
*Maximum Peak One Cycle Surge Current, 60 cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM} (surge)	← 225 Amperes →					
*Maximum Peak Ten Cycle Surge Current, 60 cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM} (surge)	← 120 Amperes →					
*Maximum Forward Voltage Drop, $I_F = 20$ ADC, $T_C = +25°C$, V_F	← 1.4 Volts →					
*Maximum Reverse Current at Full Load, Single Phase Full-Cycle Average, $I_O = 20$ Amp. at $T_C = +100°C$, $I_{R(AV)}$	← 10.0 mA →					
Maximum Effective Thermal Resistance (Junction to Case), θ_{J-C}	← 1.5° C/W →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +100°C$, I_R	← 6.0 mA →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R and $T_C = +25°C$, I_R	← 50 μA →					
*Junction Operating Temperature Range, T_J	← −65°C to +150°C →					
*Storage Temperature Range, T_{stg}	← −65°C to +175°C →					
*Stud Torque	← 30 in-lbs. Maximum →					
*Maximum Reverse Recovery Characteristics: Recovery Time (Note 2), t_{rr}	← 200 Nanoseconds Maximum →					
Peak Recovery Current (Note 2), I_R (recovery) (or Overshoot Current, I_{OS})	← 3.0 Amperes Maximum →					

*The asterisk denotes JEDEC (EIA) registered information.

NOTES:

1. The ratings assume the rectifier heatsink thermal resistance to be 6°C/W or less at maximum junction temperature.
2. These rectifiers are factory tested to reverse recovery limits which correlate with EIA registered values. This testing is in accordance with NEMA-EIA recommendations for silicon rectifier diodes and stacks.
   Recovery characteristic test conditions: $I_{FM} = 5.0$ amps; di/dt = 50 amps/μsec switching rate, and a reverse bias of 50% V_R for 200, 300 and 400 volt grades or 100% V_R for 50 and 100 volt grades; $T_C = 25°C$; $t_{rr} = 150$ nanoseconds; and I_R (recovery) = 6.0 amperes max.

1N3899-3903, R



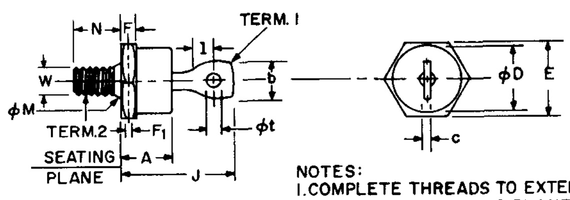
1. Forward Current Rating vs. Case Temperature

Note: Case temperature, T_C, is measured at center of any flat on hex base.

OUTLINE DRAWING

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.450		11.43	
b		.375		9.53	2
c		.080		2.03	
φD		.667		16.94	
E	.667	.687	16.94	17.45	
F	.115	.200	2.92	5.08	
F_1	.060		1.52		
J		1.000		25.40	
1	.156		3.96		4
φM	.220	.249	5.59	6.32	1
N	.422	.453	10.72	11.51	
φt	.140	.175	3.56	4.45	
W					1,3

DIRECTION OF FOWARD CURRENT FLOW:
—|◄— FORWARD POLARITY
—►|— REVERSE POLARITY



NOTES:
1. COMPLETE THREADS TO EXTEND TO WITHIN 2-1/2 THREADS OF SEATING PLANE.
2. ANGULAR ORIENTATION OF TERMINAL IS UNDEFINED.
3. 1/4-28 UNF-2A. MAXIMUM PITCH DIAMETER OF PLATED THREADS SHALL BE BASIC PITCH DIAMETER (.2268", 5.74 MM) REF. (SCREW THREAD STANDARDS FOR FEDERAL SERVICES 1957) HANDBOOK H28 1957 P1.
4. MINIMUM FLAT.

EIA-NEMA STANDARD OUTLINE, NEMA SK-51 - EIA RS-241.
INSULATING HARDWARE IS AVAILABLE UPON REQUEST.

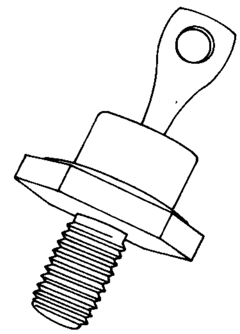
COMPLIES WITH EIA REGISTERED OUTLINE DO-5

Fast Recovery Rectifiers

1N3909-13,R

Features:

- Fast Recovery Time—200 Nanoseconds Maximum
- Recovery Characteristics match the High Frequency capability of the new General Electric High Speed SCR's such as the C140 and 141, the C155 and C185
- For Use in:
  - — Inverters
  - — Choppers
  - — Low RF Interference Applications
  - — Free-Wheeling Rectifier Applications
  - — Sonar Power Supplies
  - — Ultrasonic Systems
  - — DC-DC Power Supplies



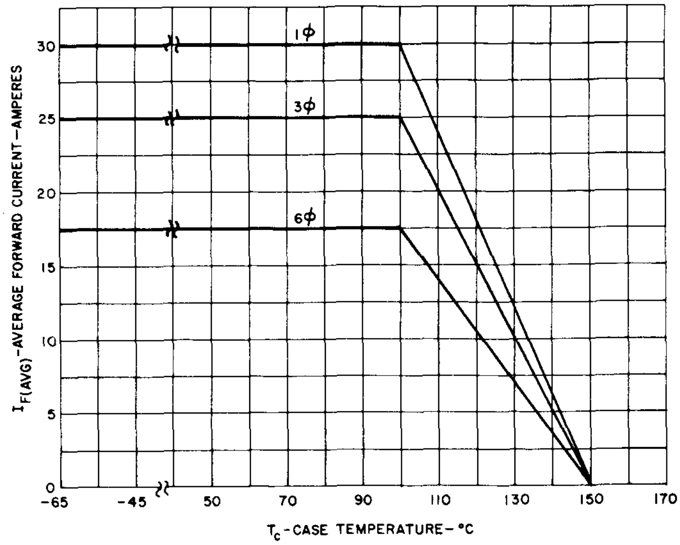
maximum allowable ratings (Resistive or Inductive Load)

	1N3909,R	1N3910,R	1N3911,R	1N3912,R	1N3913,R	
*Maximum Repetitive Peak Reverse Voltage, $T_J = -65°C$ to $+150°C$, V_{RM}(rep) (Note 1)	50	100	200	300	400	Volts
Maximum RMS Voltage, $T_J = -65°C$ to $+150°C$, V_r	35	70	140	210	280	Volts
*Maximum DC Blocking Voltage, $T_J = -65°C$ to $+100°C$, V_R (Note 1)	50	100	200	300	400	Volts
*Maximum Average Forward Current, Single Phase, $T_C = +100°C$, I_O	← 30 Amperes →					
*Maximum Peak One Cycle Surge Current, 60 cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM} (surge)	← 300 Amperes →					
*Maximum Peak Ten Cycle Surge Current, 60 cycle, Non-Recurrent, $T_J = -65°C$ to $+150°C$, I_{FM} (surge)	← 160 Amperes →					
*Maximum Forward Voltage Drop, $I_F = 30$ ADC, $T_C = +25°C$, V_F	← 1.4 Volts →					
*Maximum Reverse Current at Full Load, Single Phase Full-Cycle Average, $I_O = 30$ Amp. at $T_C = +100°C$, $I_{R(AV)}$	← 15.0 mA →					
Maximum Effective Thermal Resistance (Junction to Case), $\theta_{J\text{-}C}$	← 1.0° C/W →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +100°C$, I_R	← 10.0 mA →					
*Maximum DC Reverse Current at Rated DC Blocking Voltage, V_R, and $T_C = +25°C$, I_R	← 80 μA →					
*Junction Operating Temperature Range, T_J	← −65°C to +150°C →					
*Storage Temperature Range, T_{stg}	← −65°C to +175°C →					
*Stud Torque	← 30 in-lbs. Maximum →					
*Maximum Reverse Recovery Characteristics: Recovery Time (Note 2), t_{rr}	← 200 Nanoseconds Maximum →					
Peak Recovery Current (Note 2), I_R (recovery) (or Overshoot Current, I_{OS})	← 3.0 Amperes Maximum →					

*The asterisk denotes JEDEC (EIA) registered information.

NOTES:

1. The ratings assume the rectifier heatsink thermal resistance to be 6°C/W or less at maximum junction temperature.
2. These rectifiers are factory tested to reverse recovery limits which correlate with EIA registered values. This testing is in accordance with NEMA-EIA recommendations for silicon rectifier diodes and stacks.
   Recovery characteristic test conditions: $I_{FM} = 5.0$ amps; di/dt = 50 amps/μsec switching rate, and a reverse bias of 50% V_R for 200, 300 and 400 volt grades or 100% V_R for 50 and 100 volt grades; $T_C = 25°C$; $t_{rr} = 150$ nanoseconds; and I_R (recovery) = 6.0 amperes max.

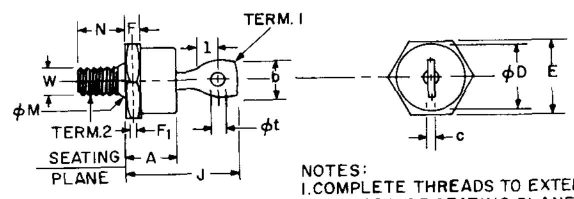


1. Forward Current Rating vs. Case Temperature

Note: Case temperature, T_C, is measured at center of any flat on hex base.

OUTLINE DRAWING

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.450		11.43	
b		.375		9.53	2
c		.080		2.03	
φD		.667		16.94	
E	.667	.687	16.94	17.45	
F	.115	.200	2.92	5.08	
F_1	.060		1.52		
J		1.000		25.40	
1	.156		3.96		4
φM	.220	.249	5.59	6.32	1
N	.422	.453	10.72	11.51	
φt	.140	.175	3.56	4.45	
W					1,3



NOTES:
1. COMPLETE THREADS TO EXTEND TO WITHIN 2-1/2 THREADS OF SEATING PLANE.
2. ANGULAR ORIENTATION OF TERMINAL IS UNDEFINED.
3. 1/4-28 UNF-2A. MAXIMUM PITCH DIAMETER OF PLATED THREADS SHALL BE BASIC PITCH DIAMETER (.2268", 5.74 MM) REF. (SCREW THREAD STANDARDS FOR FEDERAL SERVICES 1957) HANDBOOK H28 1957 P1.
4. MINIMUM FLAT.

EIA-NEMA STANDARD OUTLINE, NEMA SK-51 - EIA RS-241.
INSULATING HARDWARE IS AVAILABLE UPON REQUEST.

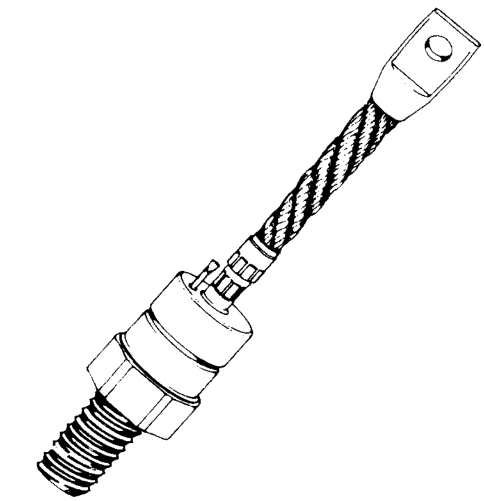
COMPLIES WITH EIA REGISTERED OUTLINE DO-5

Silicon
RECTIFIERS

1N4044-56,R

The A190 (1N3735) Series is General Electric's highly reliable, all-diffused Pic Pac 250 ampere silicon rectifier diode.

The proven benefits of G. E.'s high current rectifier diodes are:



- Choice of stud anode or stud cathode types
- Thermal fatigue resistant
- Low reverse current
- Great uniformity of product
- Higher surge current capabilities

RATINGS AND SPECIFICATIONS:(1)

	1N4044	1N4045	1N4046	1N4047	1N4048	1N4049	1N4050	1N4051	1N4052	1N4053	1N4054	1N4055	1N4056
*Maximum Allowable Transient Peak Reverse Voltage, V_{RM}(non-rep) (non-repetitive, 8.33 millisecond half sine wave pulse)(2)	100	200	250	300	350	400	525	650	800	925	1050	1175	1300
*Maximum Allowable Working and Repetitive Peak Reverse Voltage, V_{RM}(wkg) & V_{RM}(rep)(3), and DC Blocking Voltage, V_R(4)	50	100	150	200	250	300	400	500	600	700	800	900	1000
*Maximum Allowable Average Forward Current, I_T(AV) (single phase, 120°C case temperature)	← 275 amperes →												
*Maximum Allowable Peak One-Cycle Surge Current, I_{TSM} (60 cps single-phase basis, non-repetitive)	← 5000 amperes →												
Minimum I^2t Rating (non-repetitive)	← 50,000 amperes² seconds (see Chart 6) →												
*Maximum Peak Forward Voltage Drop, V_{TM} (I_O=275 amps DC, T_C=120°C)	← 1.35 volts →												
*Maximum Full Load Reverse Current, $I_{R(AV)}$ (full-cycle average, 120°C case temperature, single phase)	← 15 milliamperes →												
Maximum Thermal Resistance, $R_{\theta JC}$ (junction to case)	← 0.18°C/watt →												
*Storage and Junction Operating Temperature, T_C	← −65°C to +190°C →												
Stud Torque(5)—Maximum	← 325 inch-pounds (375 kg-cm) →												
—Minimum	← 275 inch-pounds (320 kg-cm) →												

NOTES: (1)Models listed are stud cathode (forward polarity) types. Order 1N40__R for stud anode (reverse polarity) types. Ratings and specifications are for frequencies from 50 up to 400 cycles/second, except where noted differently.

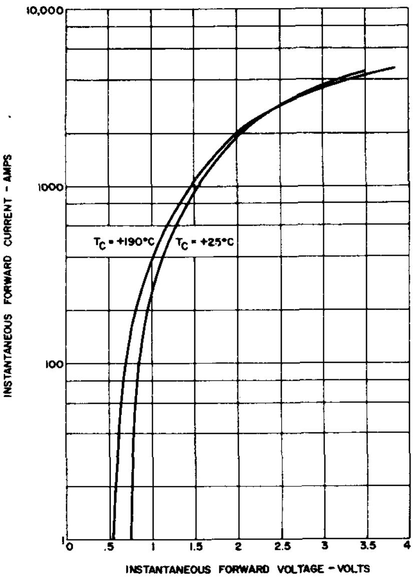
(2)Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, are ratings which apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetitive ratings that are used in fault co-ordination work.

(3)Rating assumes a rectifier diode heat sink dissipation of 2.0°C/watt, or less.

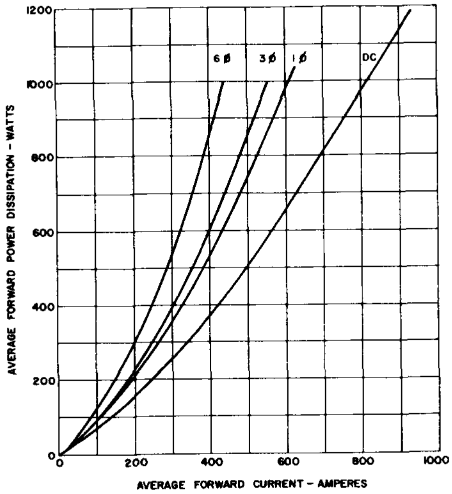
(4)Rating assumes a rectifier diode heat sink dissipation of 1.0°C/watt, or less.

(5)Use of a silicone grease (G-E #G623) between the rectifier base and heat sink is recommended.

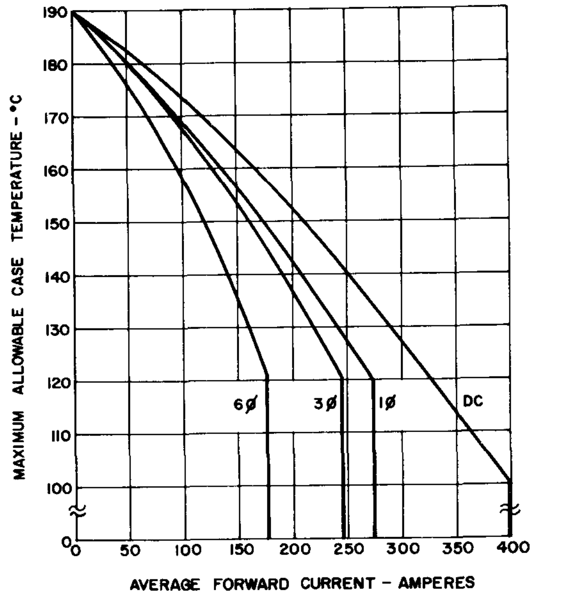
***Indicates JEDEC Registration Parameters.**



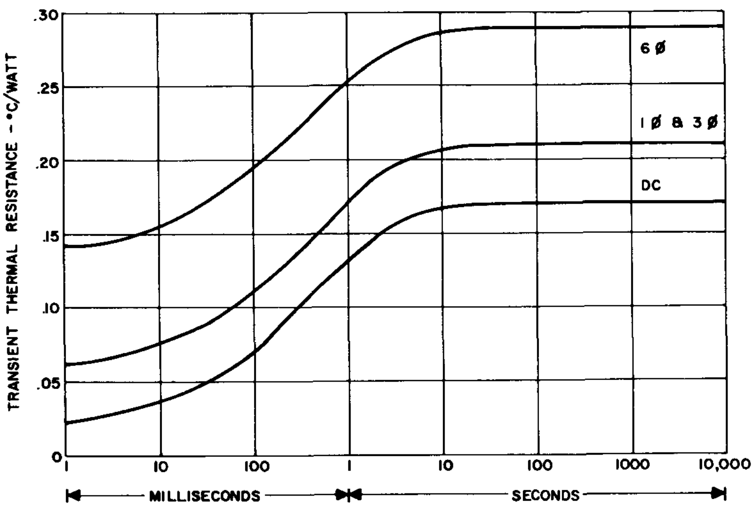
1. MAXIMUM FORWARD CHARACTERISTICS



2. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT (Tc = +190°C)

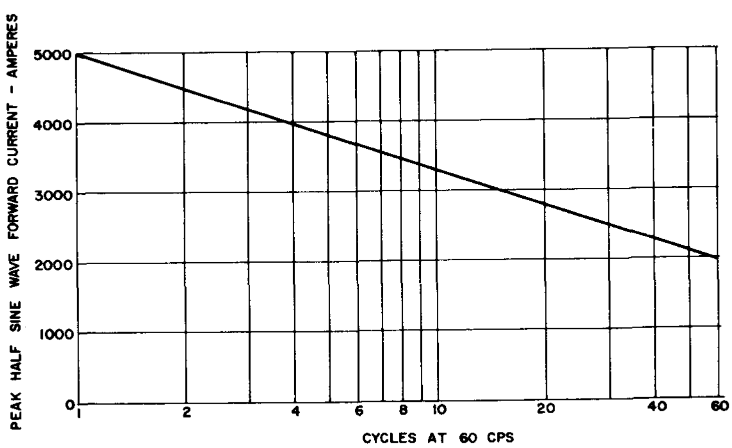


3. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT

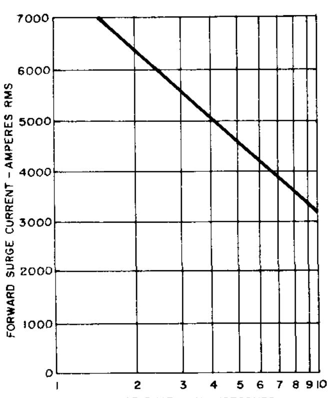


TIME (AFTER START OF CURRENT FLOW)

4. TRANSIENT THERMAL RESISTANCE — JUNCTION TO CASE

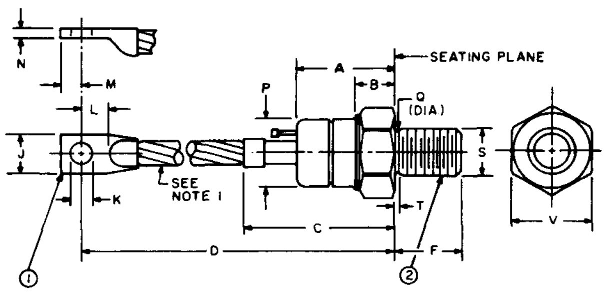


5. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS (Tc = −65°C TO +190°C)



6. SUBCYCLE SURGE FORWARD CURRENT FOLLOWING RATED LOAD CONDITIONS (Tc = −65°C TO +190°C)

OUTLINE DRAWING



MODEL	TERMINAL 1	TERMINAL 2	S THREAD SIZE
1N4044-56	− (ANODE)	+ (CATHODE)	3/4 − 16
1N4044-56R	+ (CATHODE)	− (ANODE)	UNF − 2A

TABLE OF DIMENSIONS
Conversion Table

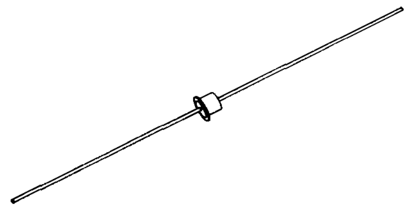
SYM.	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.450	1.550	36.83	39.37	
B	.500	.750	12.70	19.05	
C	2.300	2.500	58.42	63.50	
D	5.300	5.700	134.62	144.78	
F	.797	.827	20.24	21.01	
J	.665	.755	16.89	19.18	
K	.322	.333	8.17	8.46	
L	.437	–	11.99	–	
M	.325	.360	8.25	9.14	
N	.155	.170	–	–	
P	1.060	1.100	26.92	27.94	
Q	.660	.749	16.76	19.02	
T	–	.156	–	3.96	3
V	1.240	1.250	31.49	31.75	

NOTES:
1. Flexible Copper Lead.
2. One Nut and One Lockwasher Supplied With Each Unit. Material of Hardware is Steel, Cad Plated.
3. "T" Dimension is Area of Unthreaded Portion. Complete Threads are Within 2.5 Threads of Seating Plane.
4. Angular Orientation of Terminals is Undefined.

Germanium Diode

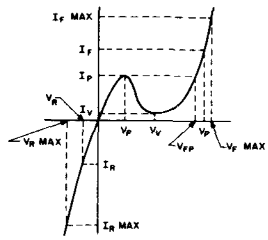
1N4090

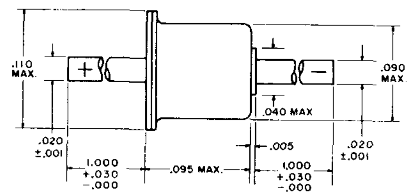
The General Electric Germanium Tunnel Mixer Diode - Type 1N4090 is an alloy-junction Tunnel device designed for use as UHF and microwave mixer. Exhibiting a nonlinear VI characteristic, going through zero at the origin, makes this unit also very attractive for use as low level detector. The 1N4090 features very low capacitance, series resistance, video and I.F. impedances as well as extremely low turn-on and turn-off characteristics. The 1/f noise contribution is much lower than in point-contact mixers.



absolute maximum ratings: (25°C) (unless otherwise specified)

Forward Current (-55° to +100°C)	5 ma
Reverse Current (-55° to +100°C)	5 ma
Lead Temperature 1/16" ± 1/31" from case for 10 seconds	260°C
Storage Temperature Range	- 55°C to +100°C





ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

electrical characteristics: (25°C) (unless otherwise specified)

		Min.	Typ.	Max.	
Total Terminal Capacitance	C	-	1.0	1.5	pfd
Total Series Resistance	R_s	-	4.5	10.0	
Total Series Inductance	L_s	-	0.2	-	nh
Peak-Point Current	I_p	130	160	180	ua
Peak-Point Voltage	V_p	50	62	75	mv
Forward Voltage at I_F =180 ua	V_{FP}	430	-	-	mv
Forward Voltage at I_F =1 ma	V_F	500	-	-	mv
Reverse Voltage at I_R =2 ma	V_R	80	100	120	mv
Reverse Voltage at I_{Rmax} =5 ma	V_{Rmax}	110	-	250	mv
Forward Voltage at I_{Fmax} =5 ma	V_{Fmax}	520	-	-	mv
Valley Voltage	V_v	275	-	-	mv
Peak to Valley Ratio	I_p/I_v	4:1	-	-	ratio
Recovery Time*	t_r	-	0.1	-	nsec

*The recovery time is measured to a reverse current of 1 ma when switching from 0.1 volt forward to 0.4 volt reverse from a 50 source. Since this diode does not exhibit charge storage, the recovery time is determined by the charging time of the total device capacity.

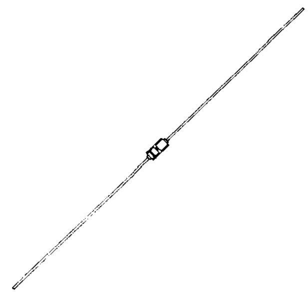
1N4148-49 SEE PAGE 205

Silicon Signal Diodes

1N4150
1N4450
1N4606

This family of General Electric Double Heatsink diodes are high conductance, high speed low capacitance switching units for core and hammer driver circuits and general purpose applications. These diodes incorporate an oxide passivated planar structure built in a high resistivity, epitaxial layer grown on a low resistivity substrate.

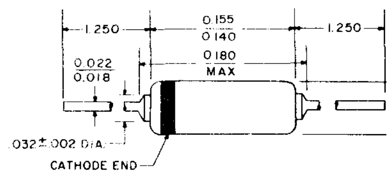
The 1N4150 and 1N4606 feature controlled conductance, with minimum and maximum forward voltages at five levels of forward current. The 1N4450 offers controlled conductance at four levels of I_F from 100μA to 50mA with a maximum voltage of 1.0 volts at 200mA. This closely controlled conductance is necessary for the design of clamping and logic circuits where tight tolerances on voltage levels are required.



absolute maximum ratings: (25°C)

	1N4450	1N4150	1N4606	
Voltage				
Reverse	30	50	70	Volts
Current				
Average Rectified	←	200	→	mA
Recurrent Peak Forward	←	600	→	mA
Forward Steady-State DC	←	250	→	mA
Peak Forward Surge (1 μsec. pulse)	←	4	→	Amps
Power				
Dissipation*	←	500	→	mW
Temperature				
Operating	←	−65 to +200	→	°C
Storage	←	−65 to +200	→	°C

*Derate 2.85 mW/°C for ambient temperatures above 25°C based on a maximum junction temperature of 200°C.



NOTE: ALL DIMENSIONS IN INCHES

electrical characteristics: (25°C) (unless otherwise specified)

		1N4450		1N4150		1N4606		
		Min.	Max.	Min.	Max.	Min.	Max.	
Forward Voltage								
(I_F = 100μA)	V_F	420	540					mV
(I_F = 1mA)	V_F	520	640	540	620	540	660	mV
(I_F = 10mA)	V_F	640	720	660	740	650	770	mV
(I_F = 50mA)†	V_F	800	920	760	860	740	860	mV
(I_F = 100mA)†	V_F			820	920	790	920	mV
(I_F = 200mA)†	V_F		1000	870	1000	860	1000	mV
(I_F = 250mA)†	V_F						1100	mV
Breakdown Voltage								
(I_R = 5μA)	B_V	40						Volts
(I_R = 100μA)	B_V					85		Volts
Reverse Current								
(V_R = 30V)	I_R		50					nA
(V_R = 30V, T_A = +150°C)	I_R		50					μA
(V_R = 50V)	I_R				100		100	nA
(V_R = 50V, T_A = +100°C)	I_R						25	μA
(V_R = 50V, T_A = +150°C)	I_R				100			μA
(V_R = 70V)	I_R						250	nA

1N4150
1N4450
1N4606

electrical characteristics: (25°C) (unless otherwise specified)

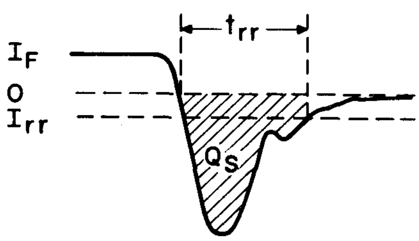
		1N4450 Min.	1N4450 Max.	1N4150 Min.	1N4150 Max.	1N4606 Min.	1N4606 Max.	
Capacitance (V_R= OV)‡	C_o		4		2.5		2.5	pF
Reverse Recovery Time								
($I_F = I_R$ = 10 to 200mA, $I_{rr} = 0.1I_F$, Fig. 3)	t_{rr}				4			ns
($I_F = I_R$ = 200 to 400mA, $I_{rr} = 0.1I_F$, Fig. 3)	t_{rr}				6			ns
(I_F = 10mA, I_R = 1mA, I_{rr} = 0.1mA, Fig. 1)	t_{rr}				6			ns
($I_F = I_R$ = 10 mA, I_{rr} = 1mA, Figs. 1, 2 & 6)	t_{rr}						6	ns
($I_F = I_R$ = 10 to 200mA, $I_{rr} = 0.1I_F$, Fig. 4)	t_{rr}						4	ns
($I_F = I_R$ = 200 to 400mA, $I_{rr} = 0.1I_F$, Fig. 4)	t_{rr}						6	ns
Forward Recovery Time								
(I_F = 200mA, t_r = 0.4 nsec., t_p = 100 nsec., V_{fr} = 1.0V, Fig. 5)	t_{fr}				10			ns
Stored Charge (Note 1)								
(I_F = 10mA)§	Q_S		42		42		42	pC

†Pulsed measurement. Pulse width ≤ 300 μsec. Duty Cycle ≤ 2%.
‡Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mV and a frequency of 1MHz.
§Stored charge is measured on B-Line Electronics Model QS-3 stored charge meter. Pulse amplitude = 5 volts, pulse width = 50 nsec., rise time = 0.4 nsec., source impedence = 10 ohms.

NOTE: 1: STORED CHARGE

When a forward biased diode is subjected to a reverse voltage step a reverse current will flow for a short time as a result of the stored charge consisting of minority carriers in the vicinity of the junction. The typical waveform of reverse current vs time for a diode subjected to a large reverse voltage is shown in Figure 1. The time required for the diode to recover its reverse blocking condition will depend on the quantity of charge stored and the rate at which the charge is removed by recombination inside the diode and by current flowing in the external circuit. Conventionally, the speed of a diode is characterized by the reverse recovery time, t_{rr}, measured to some arbitrary current level as in Figure 1. However, for higher speed diodes reverse recovery time is not a satisfactory parameter for characterizing the speed of the diode since it is dependent on arbitrary circuit conditions and is very dependent on the construction of the test circuit. Stored charge, on the other hand, is measured by integrating the reverse current of the diode (as shown by the shaded area in Figure 1), and is consequently much less dependent on the construction of the test circuit and on arbitrary circuit conditions. Stored charge is a more ideal parameter for characterizing the speed of a diode since it represents an intrinsic characteristic of the diode and can be measured with good reproducibility on low cost instruments which have direct meter readout.

Stored charge can be correlated with reverse recovery time measurements on a specific t_{rr} test jig. Typical correlation curves are shown on the graph below.



TYPICAL REVERSE RECOVERY WAVEFORM FOR A HIGH SPEED DIODE
Figure 1

References:

(1) JEDEC Proposed Method for Direct Measurement of Diode Stored Charge, JS-2-65-11
(2) "Measurement of Stored Charge in High Speed Diodes," T. P. Sylvan Application Note #90.30 (available on request)

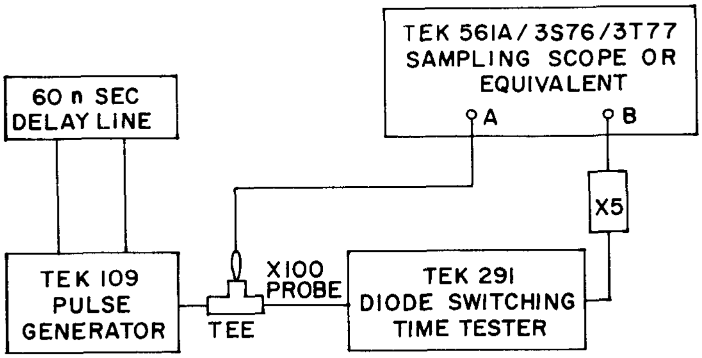
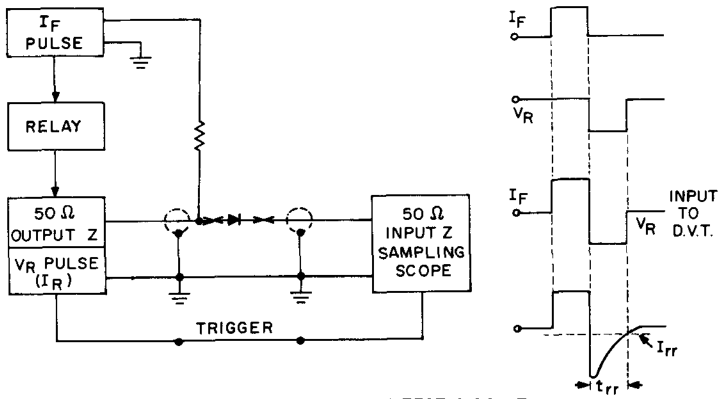
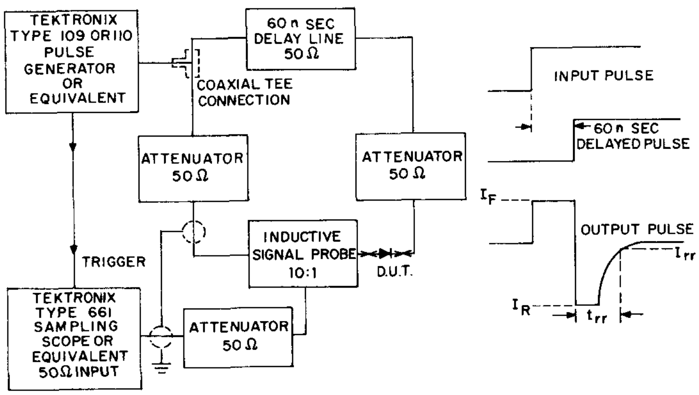


Figure 2



HIGH CURRENT REVERSE RECOVERY TEST CIRCUIT

Figure 3



HIGH CURRENT REVERSE RECOVERY TEST CIRCUIT

Figure 4

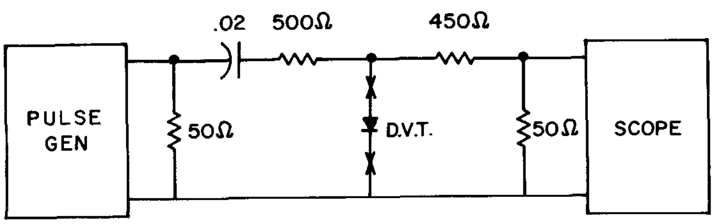


Figure 5

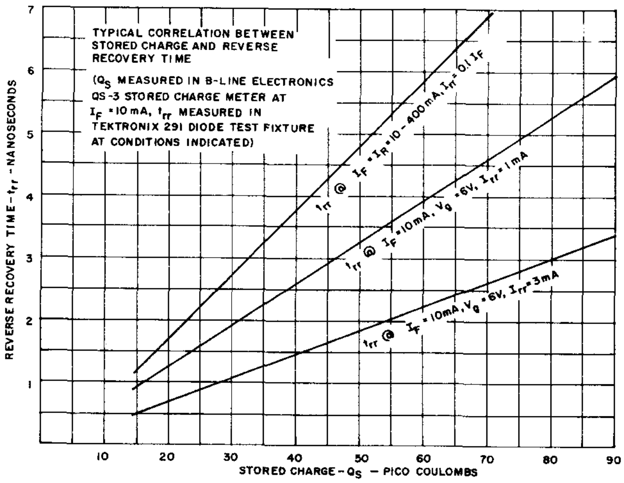


Figure 6

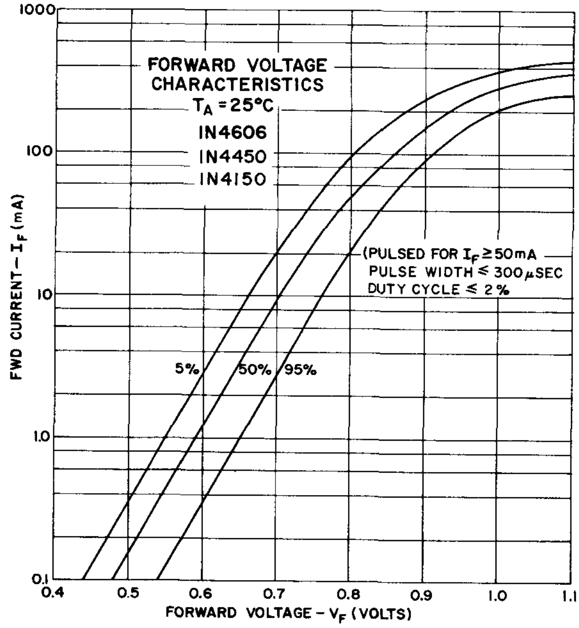


Figure 7

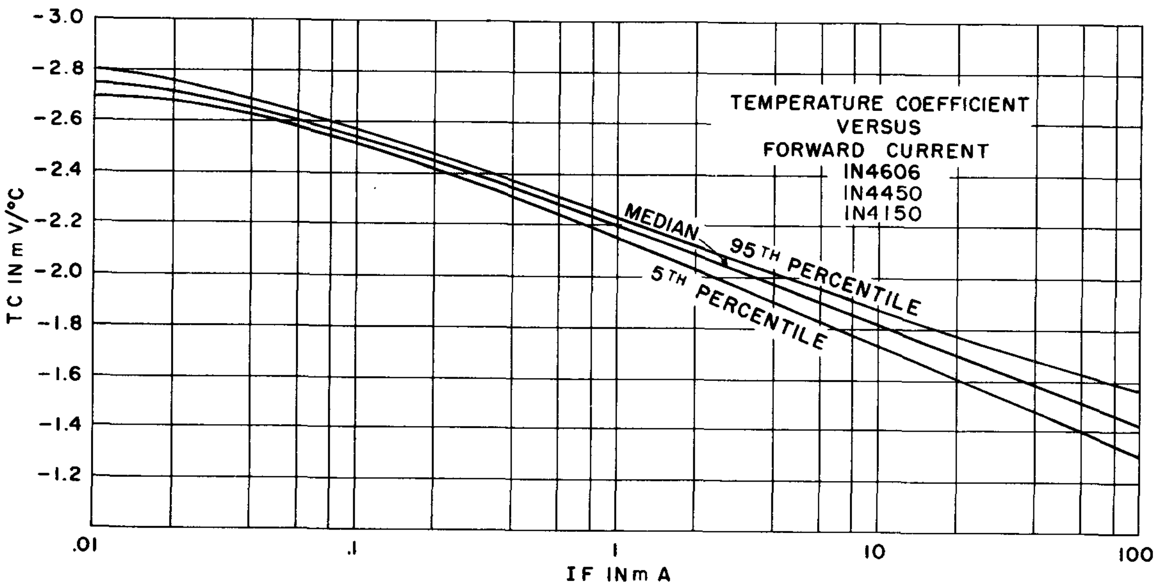


Figure 8

HEATSINK SPACING FROM END OF DIODE BODY	STEADY STATE THERMAL RESISTANCE °C/mW	POWER DISSIPATION AT 25°C mW †
	DHD	DHD
.062"	.250	700
.250"	.319	550
.500"	.380	460

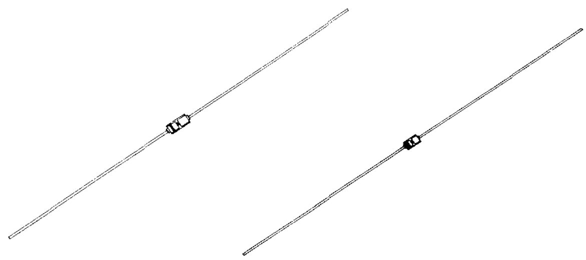
Figure 9

1N4154 SEE PAGE 205

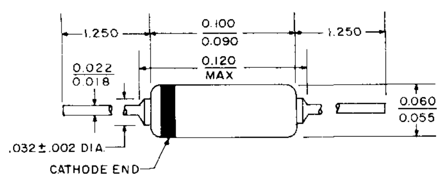
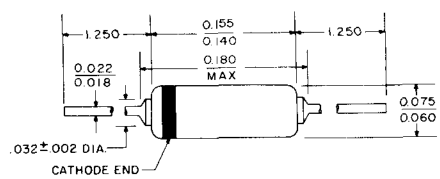
Silicon Diodes

1N4151,2,3
1N4454
1N4532,3,4

This family of General Electric silicon signal diodes are very high speed switching diodes for computer circuits and general purpose applications. These diodes incorporate an oxide passivated planar structure. This structure makes possible a diode having high conductance, fast recovery time, low leakage, and low capacitance combined with improved uniformity and reliability. These diodes are contained in two different packages;
double heat sink miniature package and milli-heat sink package and are electrically the same as their equivalent types in each of the different packages. (see page two for groupings of electrically equivalent types in each of the packages).



PLANAR EPITAXIAL PASSIVATED
with Controlled Conductance

MILLI-HEATSINK DIODE (MHD) 1N4532-1N4534	DOUBLE HEATSINK DIODE (DHD) 1N4151-1N4153 1N4454
	

Dissipation: 500mW @ 25°C free air
Derate: 2.85mW/°C for temp. above 25°C amb. based on max. $T_J = 200°C$

Dissipation: 500mW @ 25°C free air
Derate: 2.85mW/°C for temp. above 25°C amb. based on max. $T_J = 200°C$

FEATURES	1N4151 1N4454 MHD618 1N4532	1N4152 1N4153 1N4533 1N4534
Reverse Recovery Time of 4 nanoseconds maximum	●	●
Min.-Max. V_F specified at 6 Forward Current Levels		●
Capacitance of 2 pF maximum	●	●
Power Dissipation to 500 mW	●	●
Power Dissipation to 250 mW		
Meets all MIL-S-19500 requirements	●	●

Figure 1

HEATSINK SPACING FROM END OF DIODE BODY	STEADY STATE THERMAL RESISTANCE °C/mW*			POWER DISSIPATION AT 25°C mW†		
	MHD		DHD	MHD		DI
.062″	.230		.250	760		7
.250″	.319		.319	550		5.
.500″	.380		.380	460		4

*See Figure 5 for thermal resistance for short pulses.
†This power rating is based on a maximum junction temperatur 200°C.

1N4151, 2, 3
1N4454
1N4532, 3, 4

absolute maximum ratings: (25°C) (unless otherwise specified)

	1N4454 1N4532	1N4151 MHD618	1N4152 1N4533	1N4153 1N4534	DHD MHD
Voltage					
Reverse	50	50	30	50	Volts
	MHD & DHD Units				
Current					
Average Rectified	150				mA
Recurrent Peak Forward	450				mA
Forward Steady State DC	200				mA
Peak Forward Surge (1 μsec. pulse)	2000				mA
Power					
Dissipation	500				
Temperature					
Operating	← −65 to +200 →				°C
Storage	← −65 to +200 →				°C

electrical characteristics: (25°C) (unless otherwise specified)

		1N4454* 1N4532		1N4151 MHD618		1N4152 1N4533		1N4153 1N4534		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Breakdown Voltage										
($I_R = 5\mu A$)	B_V	75		75		40		75		Volts
Forward Voltage										
($I_F = 100\mu A$)	V_F					0.490	0.550	0.490	0.550	Volts
($I_F = 250\mu A$)	V_F					0.530	0.590	0.530	0.590	Volts
($I_F = 1mA$)	V_F					0.590	0.670	0.590	0.670	Volts
($I_F = 2mA$)	V_F					0.620	0.700	0.620	0.700	Volts
($I_F = 10mA$)	V_F		1.00			0.700	0.810	0.700	0.810	Volts
($I_F = 20mA$)	V_F					0.740	0.880	0.740	0.880	Volts
($I_F = 50mA$)	V_F				1.00					Volts
Reverse Current										
($V_R = 30V$)	I_R						50			nA
($V_R = 30V$, $T_A = +150°C$)	I_R						50			μA
($V_R = 50V$)	I_R		100		50				50	nA
($V_R = 50V$, $T_A = +150°C$)	I_R		100		50				50	μA
Reverse Recovery Time										
($I_F = I_R = 10mA$, $I_{rr} = 1mA$, Figs. 9 & 10)	t_{rr}		4		4		4		4	nsec.
($I_F = 10mA$, $V_R = 6V$, $I_{rr} = 1mA$, $R_L = 100$ ohms, Figs. 9 & 10)	t_{rr}		2		2		2		2	nsec.
Peak Forward Voltage†	V_{peak}		3.0							Volts
Capacitance										
($V_R = 0V$)‡	C_o		2		2		2		2	pF
Stored Charge (Note 1)										
($I_F = 10mA$)§ (See Figures 9 and 10)	Q_S		32		32		32		32	pC

*MIL type available
†50mV peak square wave, 0.1 usec. pulse width, 5 to 100 kHz repetitive rate, generator t_r = 30 nsec.
‡Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mV and a frequency of 1 MHz at V_R = 0 volts.
§Stored Charge as measured on B-Line Electronics Model QS-3 stored charge meter. Pulse amplitude = 5 volts, pulse width = 50 nsec., rise time = 0.4 nsec., source impedance = 10 ohms.

1N4151, 2, 3
1N4454
1N4532, 3, 4

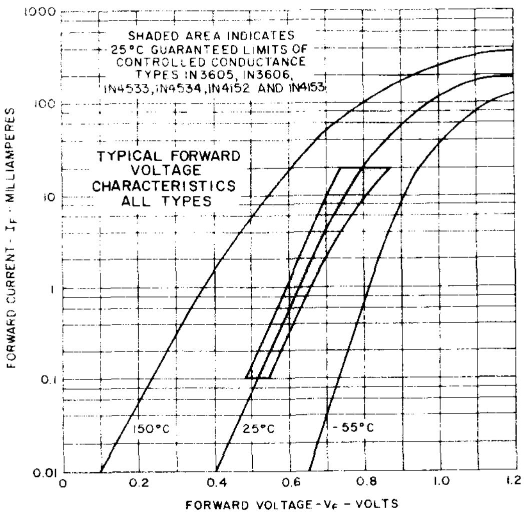


Figure 2

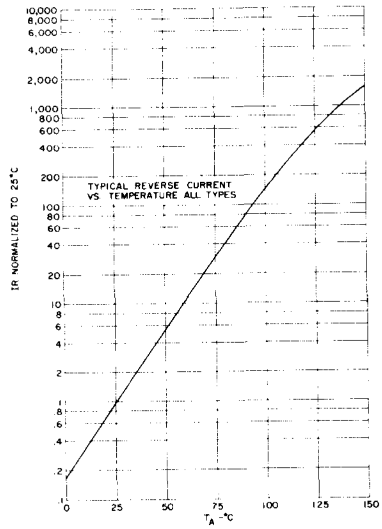


Figure 3

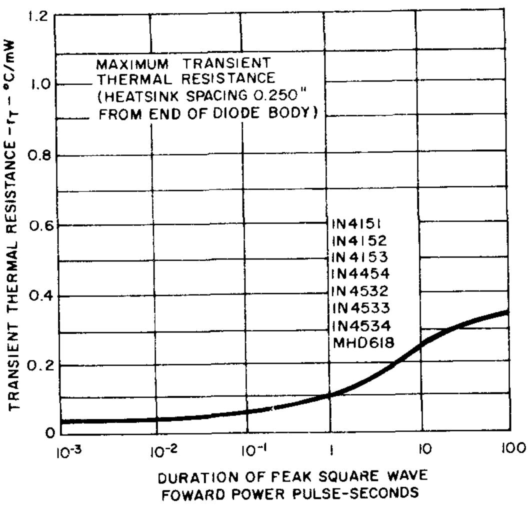


Figure 4

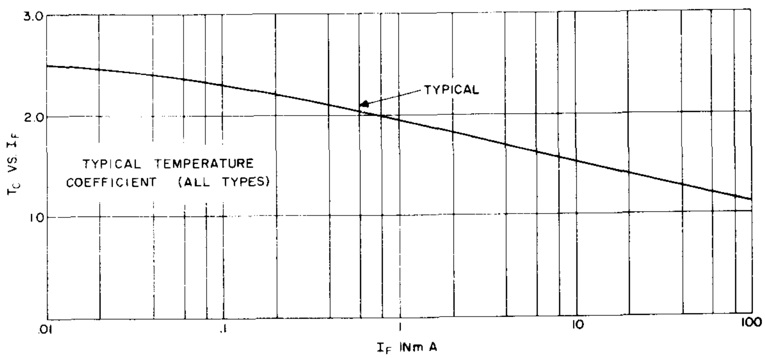


Figure 5

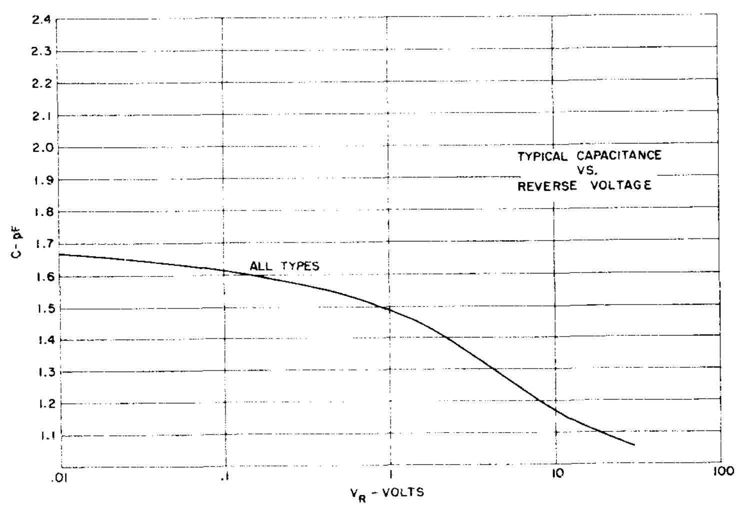


Figure 6

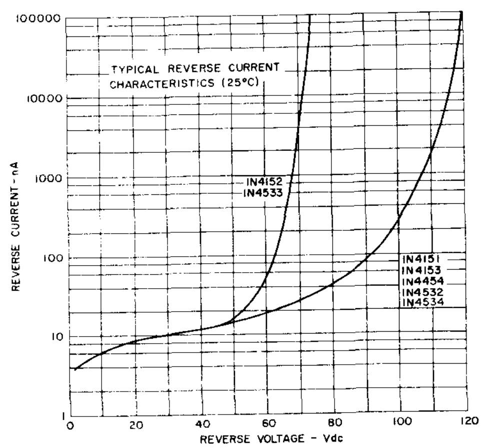


Figure 7

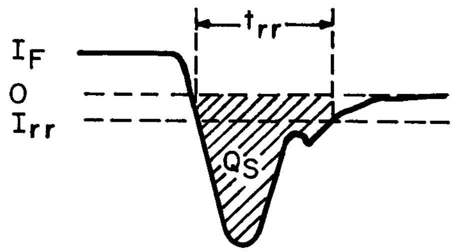
NOTE 1: STORED CHARGE

When a forward biased diode is subjected to a reverse voltage step a reverse current will flow for a short time as a result of the stored charge consisting of minority carriers in the vicinity of the junction. The typical waveform of reverse current vs time for a diode subjected to a large reverse voltage is shown in Figure 8. The time required for the diode to recover its reverse blocking condition will depend on the quantity of charge stored and the rate at which the charge is removed by recombination inside the diode and by current flowing in the external circuit. Conventionally, the speed of a diode is characterized by the reverse recovery time, t_{rr}, measured to some arbitrary current level as in Figure 8. However, for higher speed diodes reverse recovery time is not a satisfactory parameter for characterizing the speed of the diode since it is dependent on arbitrary circuit conditions and is very dependent on the construction of the test circuit. Stored charge, on the other hand, is measured by integrating the reverse current of the diode (as shown by the shaded area in Figure 8), and is consequently much less dependent on the construction of the test circuit and on arbitrary circuit conditions. Stored charge is a more ideal parameter for characterizing the speed of a diode since it represents an intrinsic characteristic of the diode and can be measured with good reproducibility on low cost instruments which have direct meter readout.

Stored charge can be correlated with reverse recovery time measurements on a specific t_{rr} test jig. Typical correlation curves are shown on the graph below.

References:

(1) JEDEC Proposed Method for Direct Measurement of Diode Stored Charge, JS-2-65-11
(2) "Measurement of Stored Charge in High Speed Diodes," T. P. Sylvan Application Note #90.30 (available on request)



TYPICAL REVERSE RECOVERY WAVEFORM FOR A HIGH SPEED DIODE
Figure 8

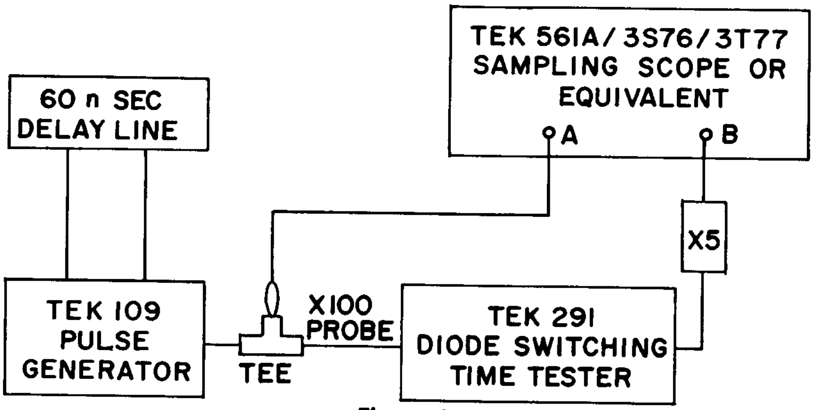


Figure 9

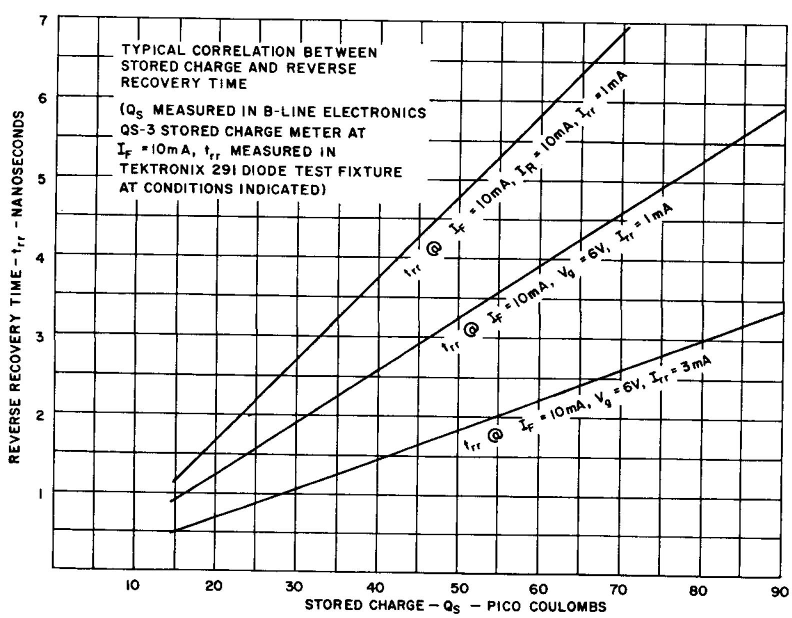


Figure 10

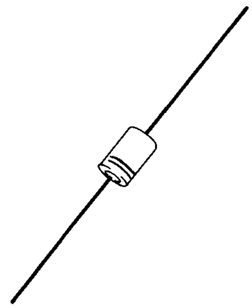
Silicon Diodes

MULTI-PELLET

1N4156,7
1N4453
1N4829,30
1N5179
MPD200
MPD300
MPD400

These General Electric high speed multi-pellet diodes are for use in computer circuits and general purpose applications. They consist of one, two, three, or four planar passivated epitaxial diode pellets in series, mounted in a subminiature double heatsink package. This structure makes possible stabistors having controlled conductance and low leakage.
This controlled conductance is necessary for the design of clippers, dc coupling circuits, clamping circuits, meter protectors, bias regulators, and other types of circuits that require tight tolerances on voltage levels.
The MPD200, 300, and 400 series may be used as signal limiters or level shifting diodes in transistor logic circuits, and also as dc coupling devices in dc amplifiers and digital circuits like multivibrators. Other lower cost stabistors are the STB567, 8, 9 devices. See publication 75.46.

absolute maximum ratings: (25°C)



	1N4156,7 1N4453 1N4829,30 1N5179	MPD200	MPD300	MPD400	
Voltage					
Reverse	20	30	60	90	Volts
Power					
Dissipation (Derate 2.67 mW/°C for ambient temperature above 25°C)	400	400	400	400	mW
Temperature					
Operating	−65 to +175°C				
Storage	−65 to +200°C				

electrical characteristics: (25°C) (unless otherwise specified)

Type	Minimum Breakdown Voltage, B_V @ 5μA, Volts	Forward Voltage	Maximum Reverse Current @ 25°C nA	Maximum Reverse Current @ 150°C μA	Maximum Reverse Current @ Volts	Maximum Capacitance* @ 0 Volts f = 1MHz, pF	Q_S† @ 1mA Min. pC	Q_S† @ 1mA Max. pC
1N4156	30	Table 1	50	50	20	25	50	500
1N4157	30	Table 2	50	50	20	20	50	500
1N4453	30	Table 3	50	50	20	30	50	500
1N5179	30	Table 4	50	50	20	20	50	500
1N4829	30 @ 100 μA	Table 5	100	25 @ 100°C	20	25	—	—
1N4830	30 @ 100 μA	Table 6	100	25 @ 100°C	20	20	—	—
MPD200	30	Table 7	30	—	30	15 (typ.)	75	400
MPD300	60	Table 8	30	—	30	10 (typ.)	75	400
MPD400	90	Table 9	30	—	30	7 (typ.)	60	300

I_f mA	Forward Voltage, V_f, Volts — Table 1 Min. Max	Table 2 Min. Max	Table 3 Min. Max	Table 4 Min. Max	Table 5 Min. Max	Table 6 Min. Max	Table 7 Min. Max	Table 8 Min. Max	Table 9 Min. Max
0.010	0.74-1.09	1.19-1.54	.430-.550	1.40-2.10			0.90-1.00	1.40-1.54	1.82-2.01
0.100	0.97-1.22	1.52-1.77	.510-.630	1.80-2.50	0.84-1.25	1.35-1.80	1.05-1.16	1.62-1.78	2.14-2.36
1.0	1.21-1.41	1.85-2.05	.600-.710	2.20-2.80	0.99-1.44	1.63-2.08	1.22-1.34	1.84-2.03	2.47-2.71
10	1.38-1.58	2.12-2.32	.690-.800	2.60-3.20	1.16-1.61	1.90-2.35	1.39-1.54	2.10-2.33	2.80-3.07
100‡	1.54-1.84	2.36-2.66	.800-.920	3.00-3.70	1.35-1.87	2.15-2.69	1.60-1.76	2.40-2.65	3.16-3.49

*Capacitance as measured on Boonton Electronics model 75A Capacitance Bridge at a signal level of 50 mA rms and a frequency of 1MHz.
†Stored charge as measured on B-Line Electronics model QS-3 Stored Charge Meter. (Pulse amplitude = 5 volts, pulse width = 50 nsec, rise time ≤ 0.4 nsec, source impedance = 10 ohms.) See Notes 2, 3 and Figure 1.
‡Pulsed measurement. Pulse width ≤ 300 nsec, Duty Cycle ≤ 2%.

1N4156, 7
1N4453
1N4829, 30
1N5179
MPD200
MPD300
MPD400

NOTES:

(1) For typical temperature coefficients see Fig. 2.

(2) Stored Charge is measured in the circuit given in MIL-STD-750, 19 January 1962, Method 4061. In this circuit (See Fig. 4) D_1 should be an ultra fast recovery diode having a stored charge less than 5% of that for the diode under test, with breakdown voltage greater than V_r, the turn-off pulse voltage. D_2 should be a high speed planar epitaxial diode (1N4150) with rapid turn-on time. The pulse used for measuring stored charge should have V_r equal to 10 volts, a rise time <0.5 nanosecond, a repetition rate of 100 kHz and a width greater than 10 nanoseconds. The stored charge is first measured with no current (I_1 in method 4061) and then with $I_F = 1$ mA (I_2 in method 4061). The stored charge specified is the difference between these two readings.

(3) The Tektronix diode recovery time plug-in unit, type S, can be used for approximate stored charge measurements. The stored charge reading in the type S under the conditions $I_F = 1$ mA, $I_R = 2$ mA, measuring to $V_F = 0$ volts, will be up to a factor of 2 lower than the stored charge measured according to method 4061, because of the lower rate of charge withdrawal using the type S.

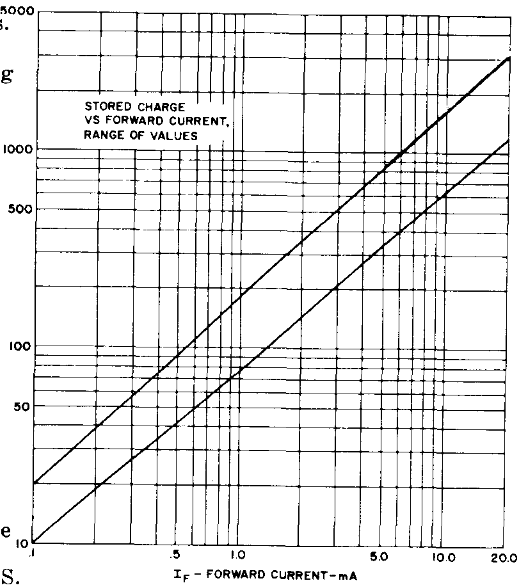


Figure 1

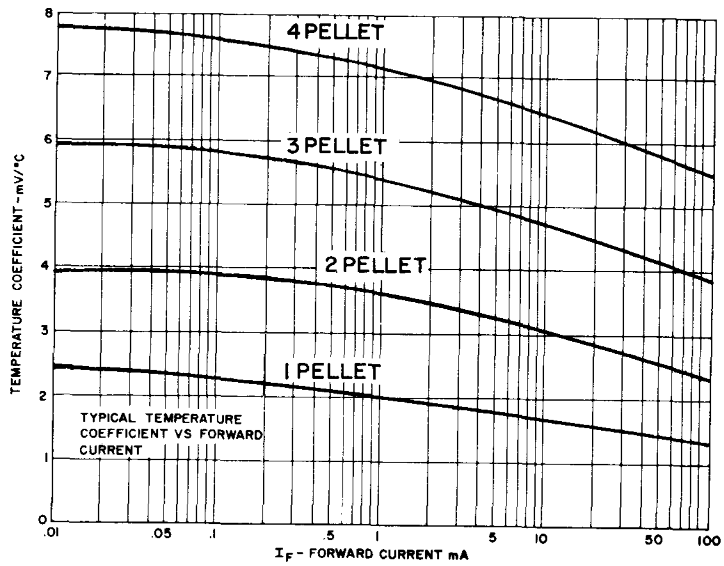


Figure 2

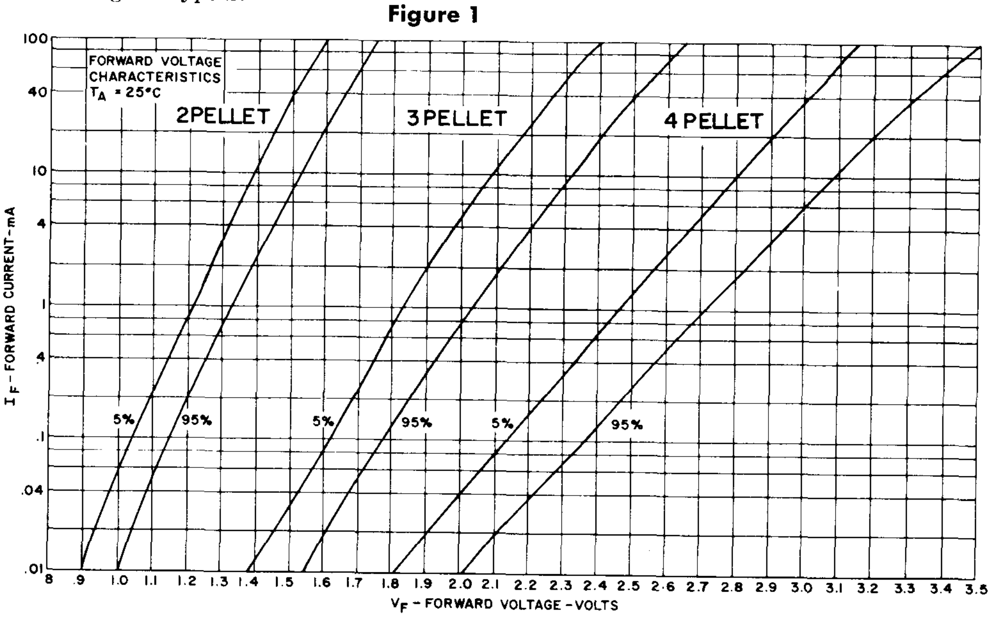


Figure 3

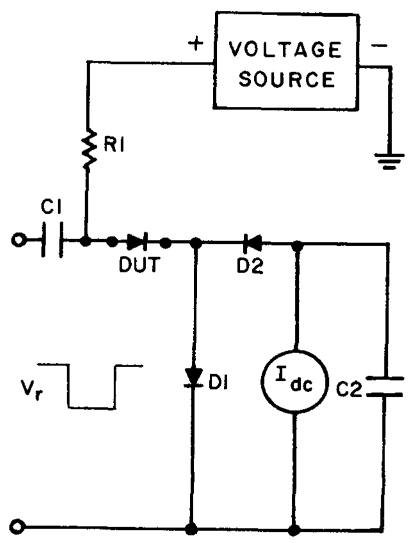
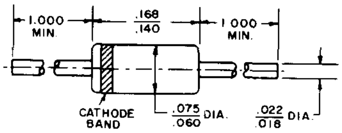
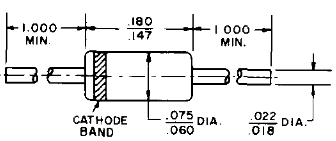


Figure 4

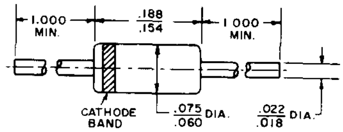
1N4453



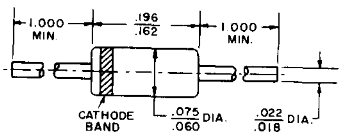
1N4829
1N4156
MPD200



1N4830
1N4157
MPD300



1N5179
MPD400



NOTES:

1. ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.
2. LEAD DIAMETER NOT CONTROLLED WITHIN .050" OF THE BODY.
3. BODY CONTOUR IS OPTIONAL WITHIN THE DIMENSIONS GIVEN. SLUGS, IF ANY, ARE INCLUDED WITHIN THIS CYLINDER AND ARE NOT SUBJECT TO THE MINIMUM BODY DIAMETER.
4. NOMINAL LEAD LENGTH IS 1.250.

TYPICAL APPLICATIONS

(Also—See Multi-pellet Diode Application Notes 90.60 and 90.61)

Level-shifting in DTL Circuits

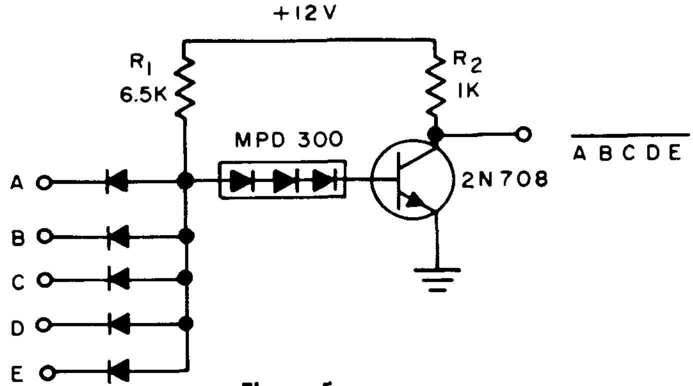


Figure 5

For the NAND gate in Fig. 5, the MPD300 multi-pellet diode provides for level-shifting so that only one power supply is required. Due to its high stored charge and the subsequent long recovery time, the MPD300 speeds up the transistor turn-off time by providing it with a reverse base current large enough to draw the stored charge out of the base of the transistor. Turn-off time is reduced by a factor of 2 to 3 compared to the use of 3 ordinary diodes in series. When a faster transistor, like the 2N2368 is used, similar improvement in performance is achieved. For a slow non-gold-doped type transistor, like the 2N3973 similar improvement is also obtained provided that a resistor in the vicinity of 1.5K is connected from the base to ground. In multi-level logic application, a propagation delay time of about 10 nsecs and with a fan-out of 1 to 5 is attainable when 2N708 or 2N2368 transistors are used.

Split Power Supply and Voltage Regulator for Transistor Circuits

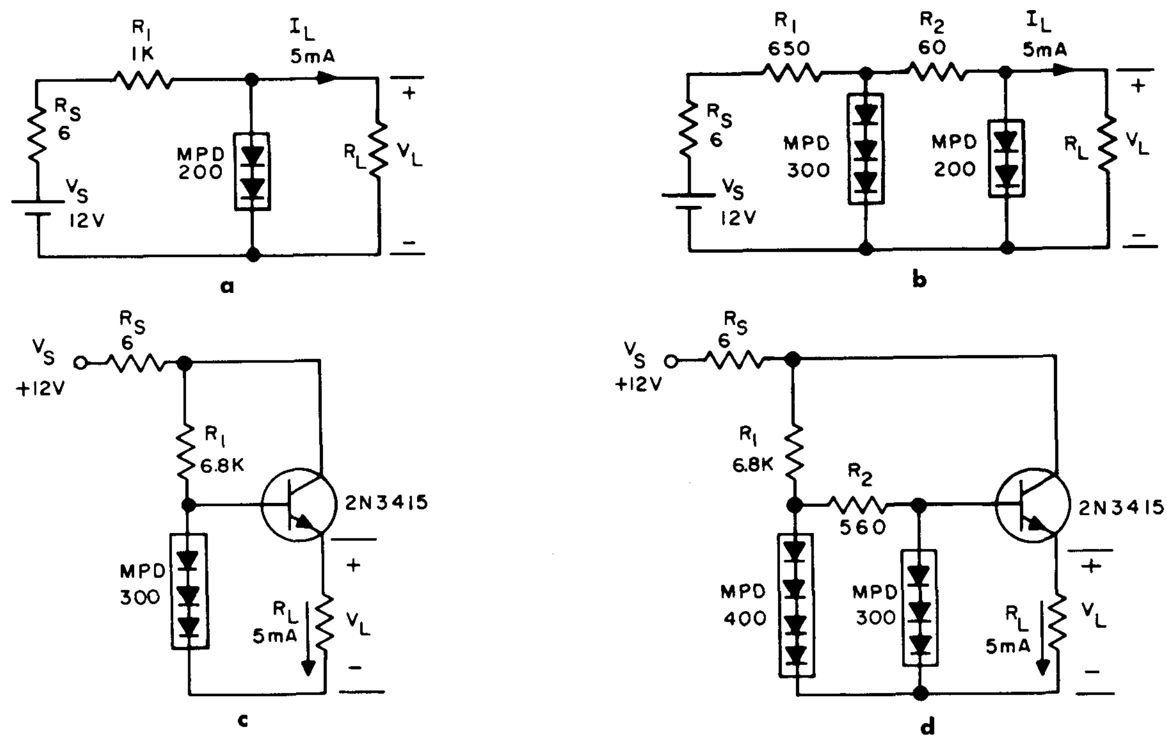


Figure 6

The very simple voltage regulator in Fig. 6a provides good regulation against change in voltage source (about ½%) and has a low output impedance equal to dynamic impedance of the multi-pellet diode, which is approximately 5 ohms for this circuit. Efficiency is high compared to a resistive voltage divider regulator for the same output impedance. The latter regulator also gives no regulation against change in voltage source. In Fig. 6b, better regulation against change in voltage source is acquired by the use of a double diode shunt type configuration. Output impedance is the same as in Fig. 6a. Efficiency is lowered somewhat but a much better regulation against change in voltage source is achieved (about 0.07%).

In Fig. 6c and d an emitter follower is added to the output. Output impedance is a little higher than the 2 preceding circuits, but higher efficiency and higher regulation against change in voltage source are obtained.

1N4156, 7
1N4453
1N4829, 30
1N5179
MPD200
MPD300
MPD400

DC Coupling for Multivibrators

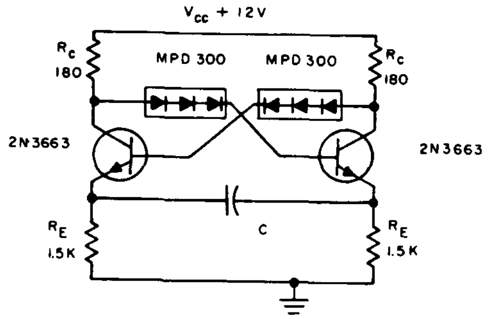


Figure 7

The use of MPD300's in this astable multivibrator (Fig. 7) provides dc level-shifting to give the desired output voltage swing. Only one capacitor is required. Stable operation is achieved from a few cycles per second to about 10MHz. This circuit operates out of saturation region and switching transistors are not required. A risetime of about 5 nsecs is obtainable when high frequency transistors like the 2N3663's are used. Typical 2N3859's and 2N3901's will give risetimes of 10 and 20 nsecs respectively.

Temperature Compensated Constant Current Source

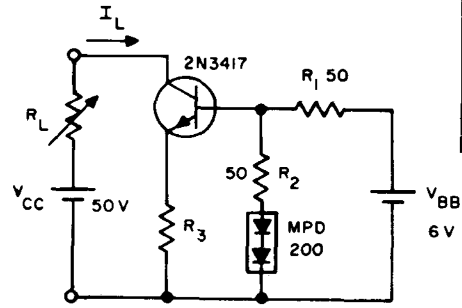


Figure 8

In Fig. 8 the 2-pellet diode is used to compensate for the variation of V_{BE} due to temperature changes. Output resistance is approximately h_{ob}, the collector output impedance of the transistor.

Biasing and Current Limiting for Push-pull Amplifiers

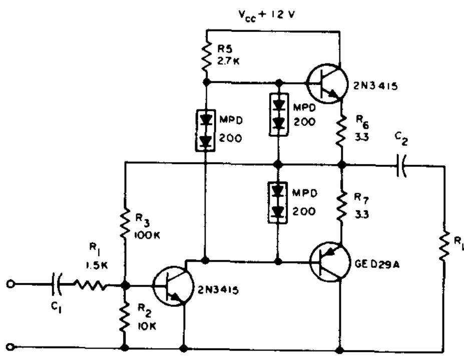


Figure 9

The power amplifier in Fig. 9 is based upon a complementary push-pull operation driven by a class A driver amplifier. Ac and dc feedback is provided through R_3. A MPD200 not only biases the quiescent operating point so that crossover distortion is eliminated but also provides temperature compensation. The other 2 MPD200's limit the emitter current and hence protect the output transistors.

Signal Limiting

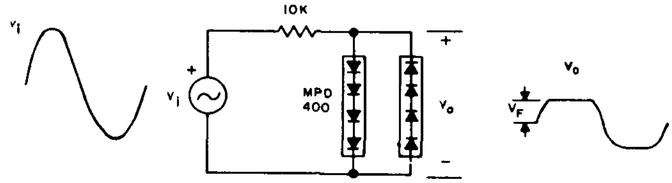


Figure 10

Using the multi-pellet diodes there is a variety of signal limiting at various thresholds (Fig. 10).

DC Coupling for Transistor Amplifiers

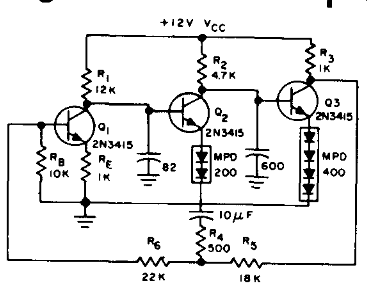


Figure 11

Very simple amplifiers as shown in Fig. 11 can be built using MPD's to provide low ac impedance voltage bias. When feedback is appropriately applied, temperature stability can be obtained. Simplicity, compactness and good low frequency response are the main advantages of this type of circuit.

Current Limiting

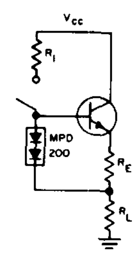


Figure 12

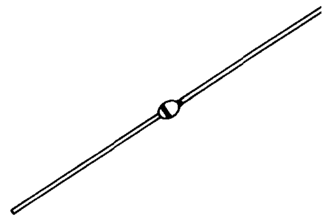
The emitter current is limited by the 2-pellet MPD200, thereby the transistor is protected (Fig. 12). The maximum emitter current is $(V_D - V_{BE})/R_E$ which is independent of load, base drive and power supply. Using this configuration, current limiting can be applied to switching circuits, amplifiers, voltage and current regulators.

1N4305 SEE PAGE 229

Passivated Rectifier

TRANSIENT VOLTAGE PROTECTED
2.5 Amps 200-1000 Volts

1N4245
1N4246
1N4247
1N4248
1N4249



THE GENERAL ELECTRIC 1N4245-49 SERIES ARE A14 TYPES, 2.5 AMPERE RATED, AXIAL-LEADED, GENERAL PURPOSE RECTIFIERS. DUAL HEAT-SINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLET'S PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY-SEALED PACKAGE.

The 1N4245-49 series (A14's) are "Transient-Voltage Protected." These devices will dissipate up to 1000 watts in the reverse direction without damage. Voltage transients generated by household or industrial power lines are dissipated.

absolute maximum ratings: (25°C unless otherwise specified)

	1N4245	1N4246	1N4247	1N4248	1N4249	
*Reverse Voltage (−65 to +160°C, T_J)						
Working Peak, V_{RWM}	200	400	600	800	1000	Volts
DC, V_R	200	400	600	800	1000	Volts
*Average Forward Current, I_O						
55°C ambient (see rating curves)	← 1.0 →					Amp
25°C " "	← 2.5 →					Amp
*Peak Surge Forward Current, I_{FSM} Non-repetitive, .0083 sec Half sine wave Full load JEDEC method	← 25 →					Amps
Peak Surge Forward Current, I_{FSM} Non-repetitive, .001 sec Half sine wave						
Full load 160°C, T_J	← 90 →					Amps
No Load (25°C Case)	← 100 →					Amps
*Junction Operating Temperature Range, T_J	← −65°C to +160°C →					
*Storage Temperature Range, T_{STG}	← −65°C to +200°C →					
I^2t, RMS for fusing, .001 to .01 sec.	← 4.0 →					Amps² sec.
Peak Non-Repetitive Reverse Power Rating, P_{RM} (20 μsec. half sine wave, at Max. T_J)	← 1000 →					Watts

Mounting: Any position. Lead temperature 290°C maximum to 1/8" from body for 5 seconds maximum during mounting.

electrical characteristics: (25°C unless otherwise specified)

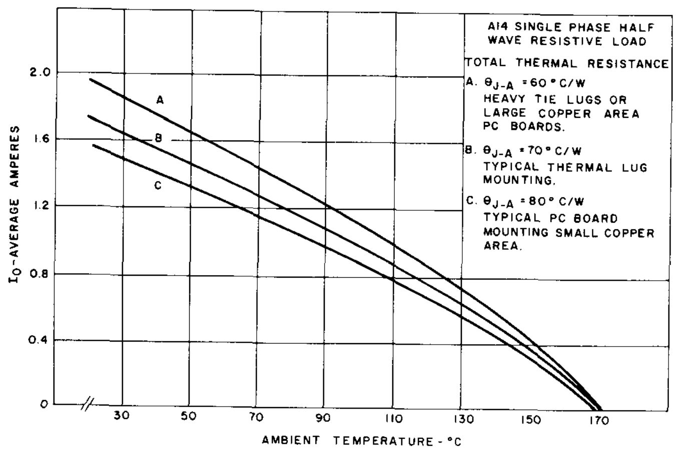
* Maximum Forward Voltage Drop, V_{FM} $I_F = 1.0A$, $T_A = +55°C$	← 1.2 →	Volts
* Maximum Reverse Current, I_{RM} at rated V_R		
$T_J = +25°C$	← 1.0 →	μA
$T_J = +125°C$	← 25 →	μA
Typical Reverse Recovery Time, t_{rr}	← 2.5 →	μsec
Maximum Reverse Recovery Time, t_{rr} (Recovery Circuit Per MIL-S-19500/286B)	← 5.0 →	μsec

*JEDEC Registered data.

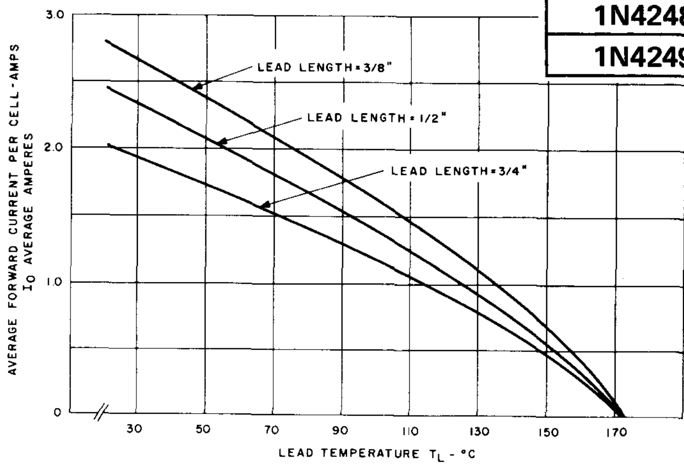
MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

1N4245
1N4246
1N4247
1N4248
1N4249

SINGLE PHASE
600 VOLTS & BELOW

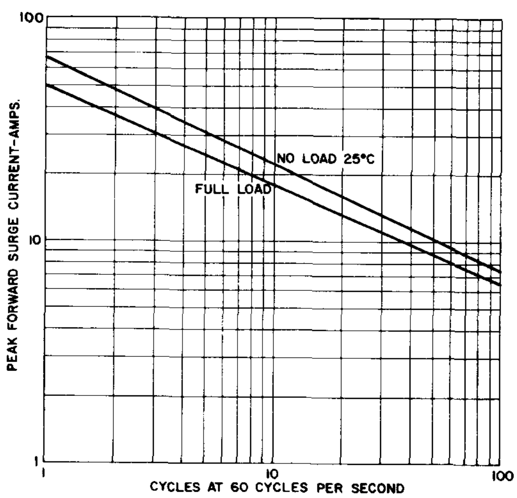


AMBIENT OPERATION
(See Typical Mounting Below)

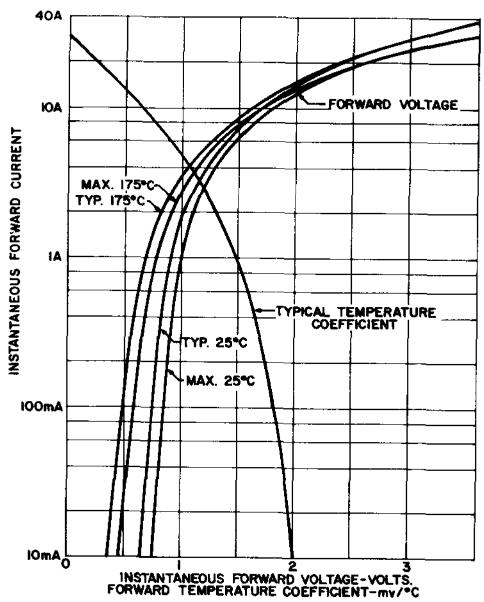


TIE POINT OPERATION

TYPICAL CHARACTERISTICS

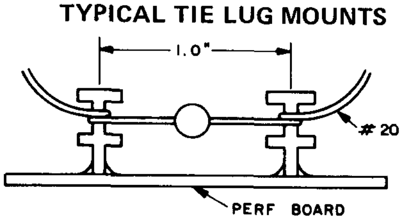


MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT

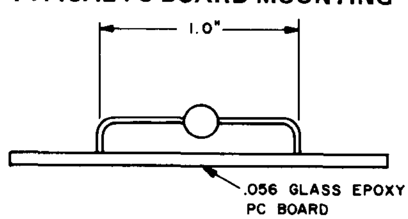


FORWARD CHARACTERISTICS

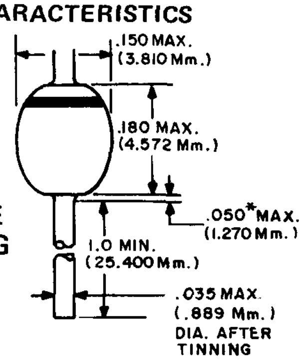
TYPICAL TIE LUG MOUNTS



TYPICAL PC BOARD MOUNTING



OUTLINE DRAWING



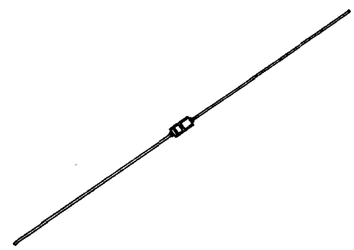
ALL DIMENSIONS ARE IN INCHES AND (METRIC)
*WELD AND SOLDER FLASH NOT CONTROLLED IN THIS AREA

1N4450 SEE PAGE 258
1N4446-49 SEE PAGE 205

Silicon Diode

1N4444

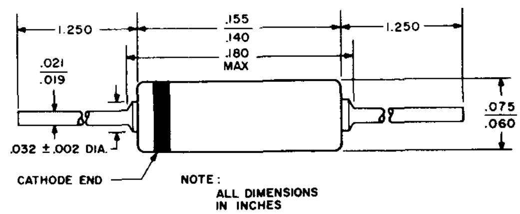
The General Electric 1N4444 Double Heatsink Diode is a low capacitance diode for low and high current high speed switching circuits and general purpose applications. The diode incorporates an oxide passivated planar structure built on a high resistivity, epitaxial layer grown on a low resistivity silicon substrate. The 1N4444 offers controlled conductance, minimum and maximum forward voltages at four levels of forward current. This closely controlled conductance is necessary for the design of clamping and logic circuits where tight tolerances on voltage levels are required.



All Double Heatsink Diodes receive a one hour glass anneal bake at 425°C. This processing optimizes DHD hermetic integrity under temperature cycling and thermal shock conditions exceeding MIL-S-19500C requirements. All DHD's then receive a 300°C stabilization bake for 168 hours to assure paramenter stability and reliability under maximum storage and operating junction temperature.

absolute maximum ratings:

	1N4444	
Voltage		
Reverse	50	volts
Current		
Average Rectified	200	ma
Recurrent Peak Forward	600	ma
Forward Steady-State DC	250	ma
Peak Forward Surge (1 μsec)	4	amps
Power		
Dissipation	500	mw
Temperature		
Operating	←−65 to +200→	°C
Storage	←−65 to +200→	°C
Lead, 1/16" ± 1/32" from case for 10 sec.	←300→	°C

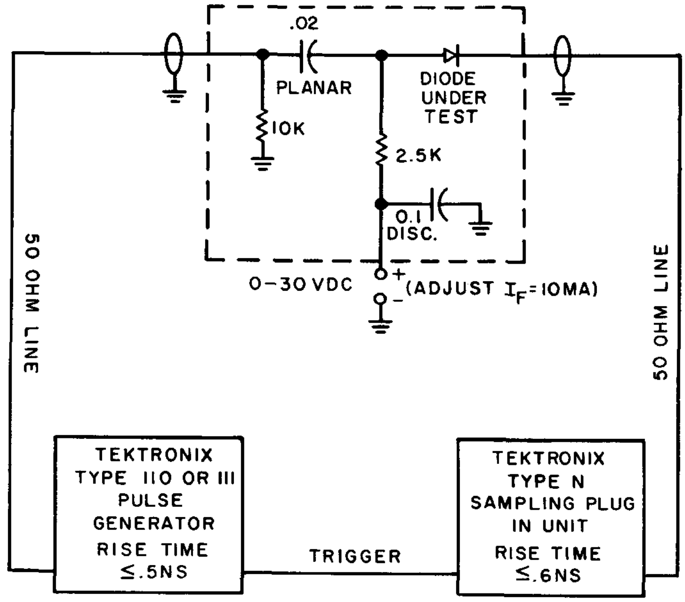


electrical characteristics: (25°C) (unless otherwise specified)

		1N4444 Min.	1N4444 Max.
Forward Voltage			
(I_F = 0.1 ma)	V_F	440	550
(I_F = 1.0 ma)	V_F	560	680
(I_F = 10 ma)	V_F	690	820
(I_F = 100 ma)	V_F	850	1000
Breakdown Voltage			
(I_R = 5 μa)	B_V	70	
(I_R = 100 μa)	B_V		
Reverse Current			
(V_R = 50 V)	I_R		50
(V_R = 50 V, T_A = +150°C)	I_R		50
(V_R = 80 V)	I_R		
(V_R = 80 V, T_A = +150°C)	I_R		
Capacitance			
(V_R = 0 V) (Note 1)	C_o		2
Reverse Recovery Time			
(I_F = I_R = 10 ma, Recover to 1 ma) (Fig. 1)	t_{rr}		7

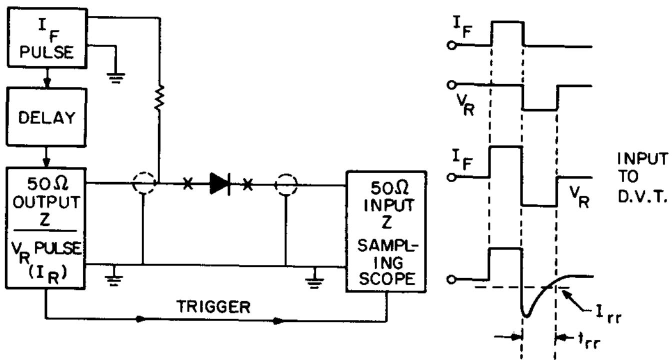
note:

(1) Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mv and a frequency of 1 mc.



LOW CURRENT t_{rr} TEST CIRCUIT

FIGURE 1



HIGH CURRENT TEST CIRCUIT

FIGURE 2

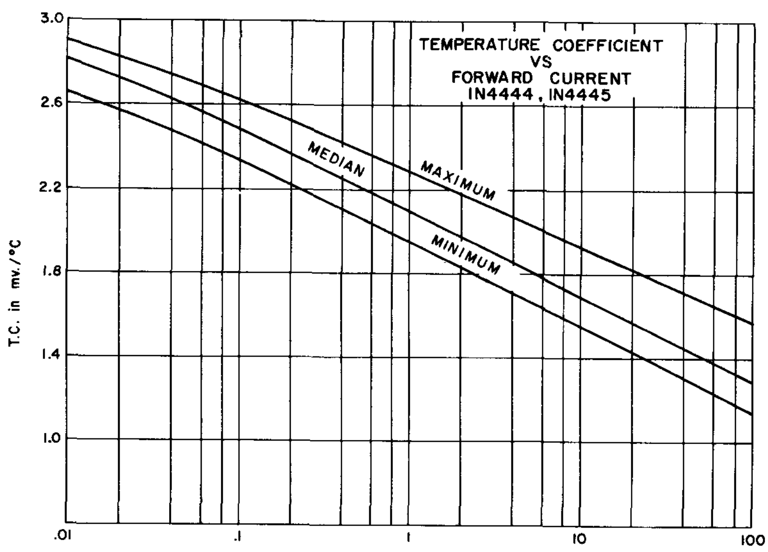


FIGURE 3

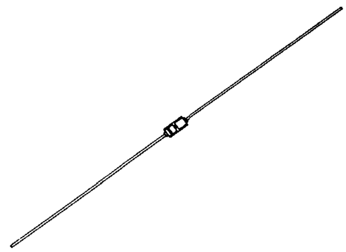
1N4453 SEE PAGE 266
1N4454 SEE PAGE 262

Silicon Diodes

1N4451
1N4607,8

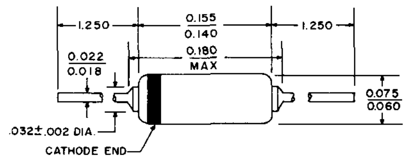
This family of General Electric Double Heatsink Diodes are high conductance, high speed switching units for logic, core and hammer driver circuits, and general purpose applications. These diodes incorporate an oxide passivated planar structure built in a high resistivity, epitaxial layer grown on a low resistivity silicon substrate.

The 1N4451, 1N4607, and 1N4608 feature controlled conductance with minimum and maximum forward voltages at four levels of forward current. This closely controlled conductance is necessary for the design of clamping and logic circuits where tight tolerances on voltage levels are required.



absolute maximum ratings: (25°C)

	1N4451	1N4607	1N4608	
Voltage				
Reverse	30	70	70	Volts
Current				
Average Rectified	←	200	→	mA
Recurrent Peak Forward	←	600	→	mA
Forward Steady-State DC	←	250	→	mA
Peak Forward Surge (1 μsec. pulse)	←	4	→	Amps
Power				
Dissipation*	←	500	→	mW
Temperature				
Operating	←	−65 to +200	→	°C
Storage	←	−65 to +200	→	°C



NOTE: ALL DIMENSIONS IN INCHES

*Derate 2.85 mW/°C for ambient temperatures above 25°C based on a maximum junction temperature of 200°C.

electrical characteristics: (25°C) (unless otherwise specified)

		1N4451		1N4607		1N4608		
		Min.	Max.	Min.	Max.	Min.	Max.	
Forward Voltage								
(I_F = 100μA)	V_F	400	500	390	500	390	490	mV
(I_F = 1mA)	V_F	510	610	500	610	500	600	mV
(I_F = 10mA)	V_F	620	720	610	720	610	710	mV
(I_F = 100mA)†	V_F	750	875	740	870	740	850	mV
(I_F = 250mA)†	V_F			810	950	810	930	mV
(I_F = 300mA)†	V_F		1000					mV
(I_F = 350mA)†	V_F				1000	840	960	mV
(I_F = 400mA)†	V_F				1100			mV
(I_F = 450mA)†	V_F						1000	mV
(I_F = 500mA)†	V_F						1100	mV
Breakdown Voltage								
(I_R = 5μA)	B_V	40						Volts
(I_R = 100μA)	B_V			85		85		Volts

electrical characteristics: (25°C) (unless otherwise specified)

		1N4451 Min.	1N4451 Max.	1N4607 Min.	1N4607 Max.	1N4608 Min.	1N4608 Max.	
Reverse Current								
($V_R = 30V$)	I_R		50					nA
($V_R = 30V$, $T_A = 150°C$)	I_R		50					μA
($V_R = 50V$)	I_R				100		100	nA
($V_R = 50V$, $T_A = 100°C$)	I_R				25		25	μA
($V_R = 70V$)	I_R				250		250	nA
Capacitance								
($V_R = 0V$)‡	C_o		6		4		4	pF
Reverse Recovery Time								
($I_F = I_R = 10mA$, Recover to 1mA, Fig. 3)	t_{rr}		10		10		10	ns
($I_F = I_R = 500mA$, Recover to 50mA, Fig. 4)	t_{rr}				15		15	ns
Stored Charge (Note 1)								
($I_F = 10mA$)§	Q_S		64		64		64	pC

†Pulsed measurement. Pulse width ≤ 300 μsec. Duty Cycle ≤ 2%.
‡Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mV and a frequency of 1 MHz.
§Stored Charge as measured on B-Line Electronics Model QS-3 stored charge meter. Pulse amplitude = 5 volts, pulse width = 5 nsec., rise time = 0.4 nsec., source impedance = 10 ohms.

NOTE 1: STORED CHARGE

When a forward biased diode is subjected to a reverse voltage step a reverse current will flow for a short time as a result of the stored charge consisting of minority carriers in the vicinity of the junction. The typical waveform of reverse current vs time for a diode subjected to a large reverse voltage is shown in Figure 1. The time required for the diode to recover its reverse blocking condition will depend on the quantity of charge stored and the rate at which the charge is removed by recombination inside the diode and by current flowing in the external circuit. Conventionally, the speed of a diode is characterized by the reverse recovery time, t_{rr}, measured to some arbitrary current level as in Figure 1. However, for higher speed diodes reverse recovery time is not a satisfactory parameter for characterizing the speed of the diode since it is dependent on arbitrary circuit conditions and is very dependent on the construction of the test circuit. Stored charge, on the other hand, is measured by integrating the reverse current of the diode (as shown by the shaded area in Figure 1), and is consequently much less dependent on the construction of the test circuit and on arbitrary circuit conditions. Stored charge is a more ideal parameter for characterizing the speed of a diode since it represents an intrinsic characteristic of the diode and can be measured with good reproducibility on low cost instruments which have direct meter readout.

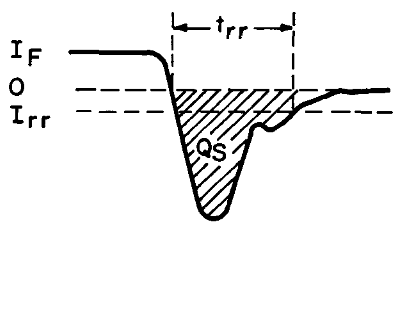
Stored charge can be correlated with reverse recovery time measurements on a specific t_{rr} test jig. Typical correlation curves are shown on the graph below.

References:

(1) JEDEC Proposed Method for Direct Measurement of Diode Stored Charge, JS-2-65-11
(2) "Measurement of Stored Charge in High Speed Diodes," T. P. Sylvan Application Note #90.30 (available on request)

TYPICAL REVERSE RECOVERY WAVEFORM FOR A HIGH SPEED DIODE

FIGURE 1



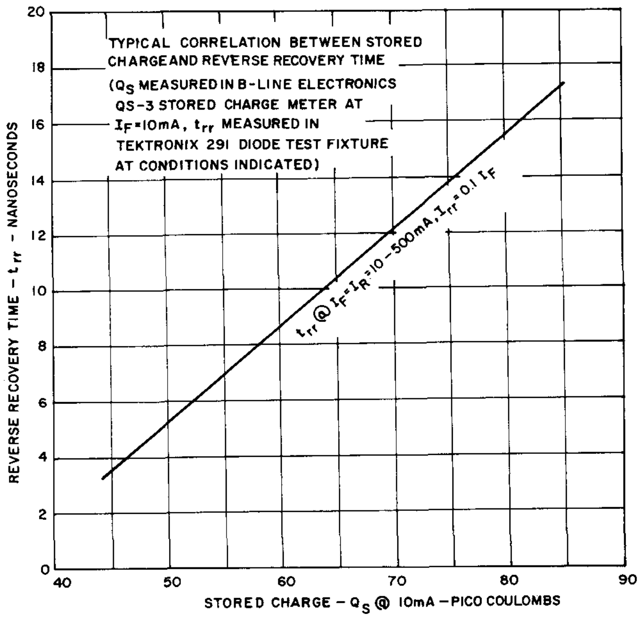
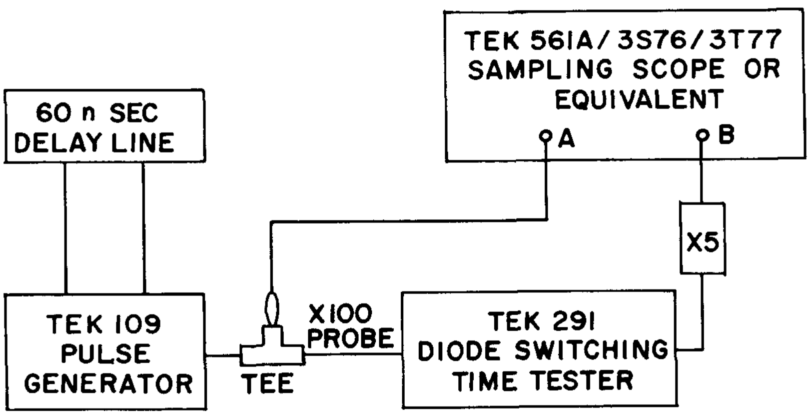
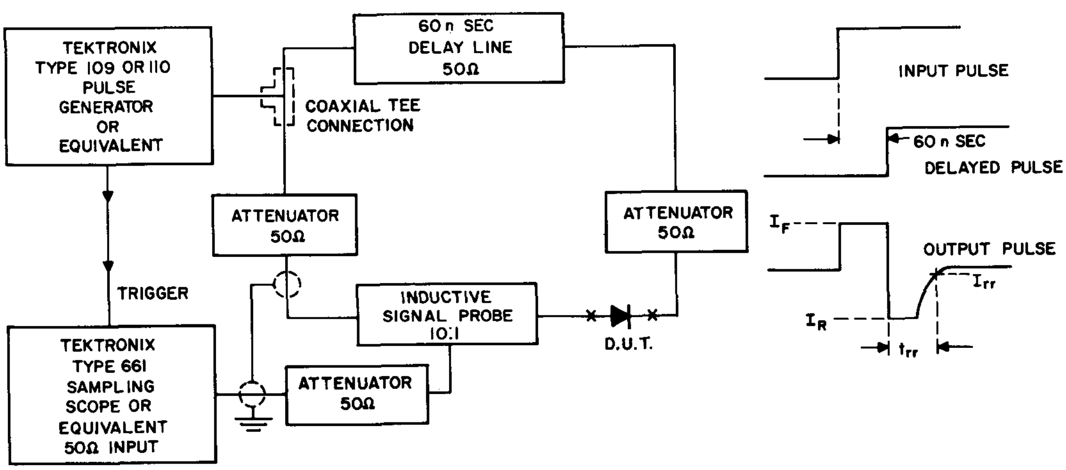


FIGURE 2



LOW CURRENT REVERSE RECOVERY TEST CIRCUIT

FIGURE 3



HIGH CURRENT REVERSE RECOVERY TEST CIRCUIT

FIGURE 4

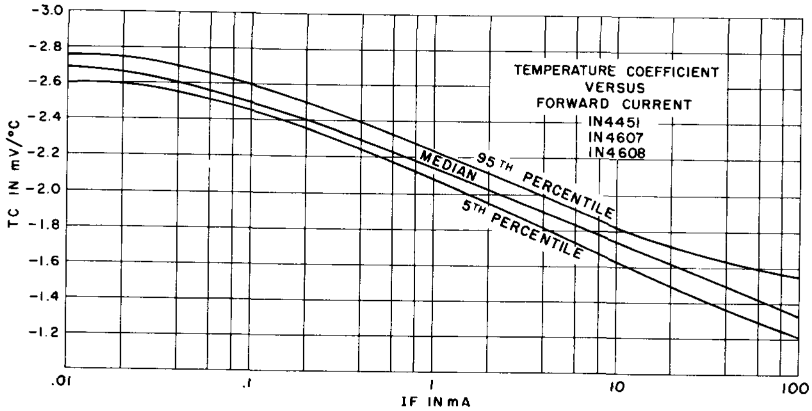


FIGURE 5

HEATSINK SPACING FROM END OF DIODE BODY	STEADY STATE THERMAL RESISTANCE °C/mW	POWER DISSIPATION AT 25°C mW†
	DHD	DHD
.062"	.250	700
.250"	.319	550
.500"	.380	460

FIGURE 6

† This power rating is based on a maximum junction temperature of 200°C.

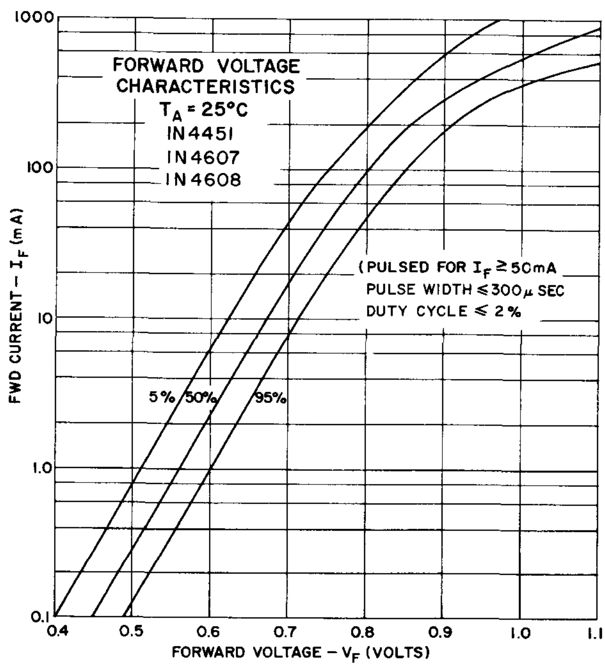


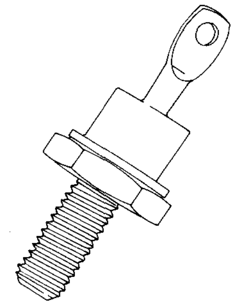
FIGURE 7

Silicon Rectifier

1N4510-11

CONTROLLED AVALANCHE RECTIFIERS FROM GENERAL ELECTRIC

Feature These Advances in Silicon Rectifier Diode Applications:



- Self-protection against normal voltage transients. Dissipates up to 3900 watts peak power in the reverse direction. Permits decreased PRV safety factors in equipment due to greatly reduced transient voltage vulnerability.
- Unmatched standards of reliability at PRV's up to 1200 volts, as well as at lower voltages.
- Protection of other circuit components against overvoltage through rigidly specified maximum/minimum avalanche characteristics.
- Make ideal voltage equalizing elements for series connected SCR's and conventional rectifier diodes. Also for anode triggering SCR's to prevent damage from voltage transients in the forward direction.
- Simplified series operation of rectifiers in high-voltage applications . . . no shunting resistors necessary for Controlled Avalanche Rectifiers. Makes possible compact high-voltage assemblies.
- Can operate in the avalanche breakdown region at high voltages . . . unharmed by hi-pot and megger tests.

To be designated *"Controlled Avalanche"* a GE silicon rectifier diode must:

1. Have rigidly specified maximum and minimum avalanche voltage characteristics;
2. Be able to operate in its avalanche region without damage at any junction temperature up to a maximum of 175°C; and
3. Be able to absorb momentary power surges in the avalanche region, and have ratings defining this capability at starting junction temperatures of 25°C and 175°C.

For information on the application of Controlled Avalanche Rectifiers, see Publication No. 200.27, "An Introduction To The Controlled Avalanche Silicon Rectifier". Copies may be obtained from: General Electric Company, Distribution Services, Bldg. 6, Room 208, 1 River Road, Schenectady, New York 12305.

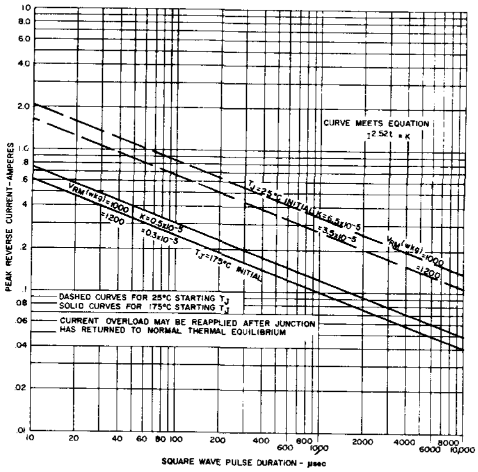
MAXIMUM ALLOWABLE RATINGS

Type	Repetitive & Working Peak Reverse Voltage* V_{RM}(rep), V_{RM}(wkg) $T_J = -65°C$ to $+175°C$ (Note: 1)	MINIMUM Avalanche Breakdown Voltage, BV_R, (5 mA test current at $T_J = 25°C$)	MAXIMUM Avalanche Breakdown Voltage, BV_R, (5 mA test current at $T_J = 25°C$)	Full-Load Reverse Current (full-cycle avg., 135°C T_C, 1 ϕ), $I_{R(AV)}$
	Volts**	Volts	Volts	Milliamperes**
1N4510,R	1000	1250	1550	1.75
1N4511,R	1200	1500	1930	1.5

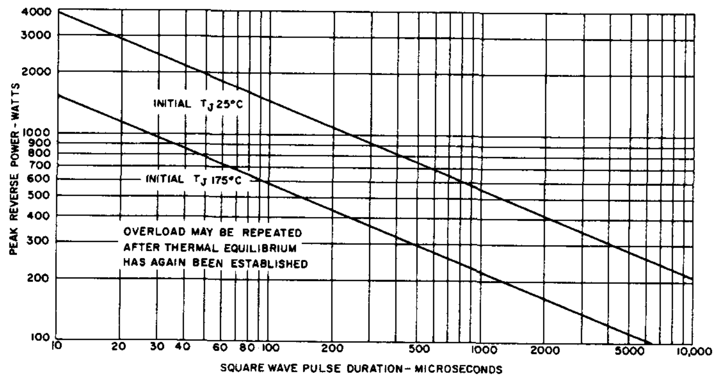
Average Forward Current, I_O ($T_C = +135°C$, single phase)	12 Amperes**
Peak Once-Cycle Surge Current (non-repetitive), I_{FM} (surge)	240 Amperes**
Minimum I^2t Rating (see Curve 6)	67 Ampere² seconds
Reverse Power Surge (non-repetitive, 10 μsec., square wave)	
$T_J = +25°C$	3.9 Kilowatts
$T_J = +175°C$	1.5 Kilowatts
(For other conditions, see Curve 2)	
Average DC Reverse Power in Breakdown Region ($-65°C \leq T_C \leq +135°C$) (Note: 2)	10 Watts**
Peak Reverse Power in Breakdown Region (repetitive) (Note: 2)	50 Watts
Forward Peak Voltage Drop, V_{FM} ($T_C = +135°C$, $I_O = 12$ ampere avg.)	1.4 Volts**
Thermal Resistance, $\theta_{J\text{-}C}$	2.0°C/Watt
Operating Junction Temperature, T_J	−65°C to +175°C**
Storage Temperature, T_{stg}	−65°C to +200°C**
Stud Torque	12 Lb-in (Min), 15 Lb-in (Max) 14 Kg-cm (Min), 17.5 Kg-cm (Max)

*Maximum voltages apply with a heatsink thermal resistance of 10°C/watt, or less, at maximum rated junction temperature.
**Indicates values included in JEDEC Type Number Registration.

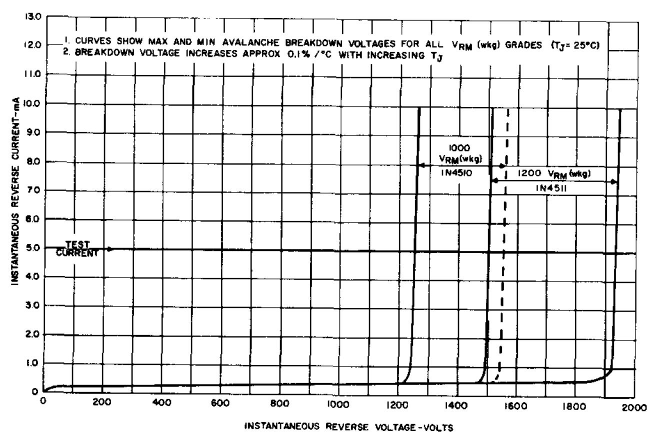
NOTES:
(1) V_{RM}(rep) applies for a conventional AC to DC conversion application. V_{RM}(rep) and V_{RM}(wkg) can be considered unlimited providing that the additional reverse power generation is taken into account by allowing for its influence on the forward current rating. Considerations similar to voltage regulator diode applications would apply.
(2) These ratings assume no forward power dissipation. In applications requiring both forward and reverse average power dissipation, reduce case temperature as determined from the maximum case temperature versus average forward current curve by 2.0°C for every watt of average reverse power dissipation.
(3) Case temperature, T_C, is measured at the center of any one of the hex flats.



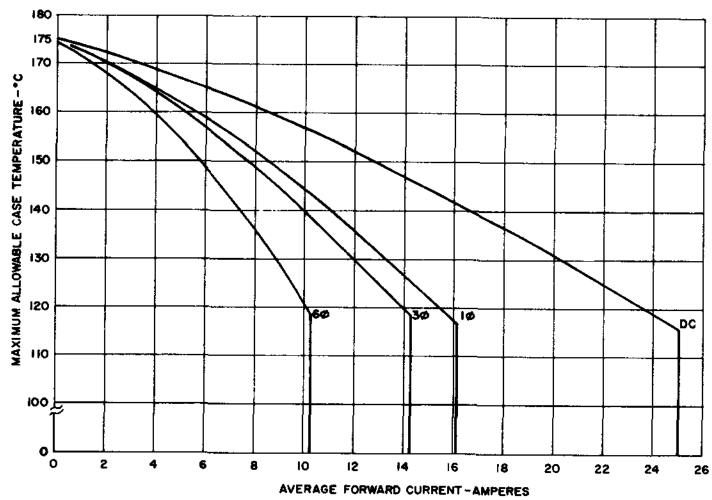
1. NON-RECURRENT REVERSE SURGE CURRENT RATINGS



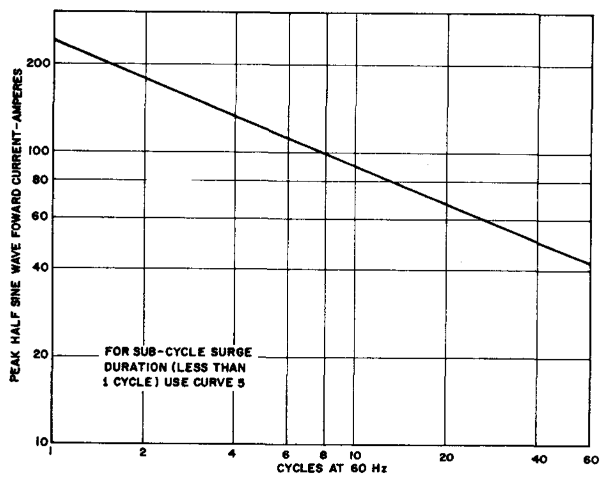
2. NON-RECURRENT REVERSE POWER SURGE



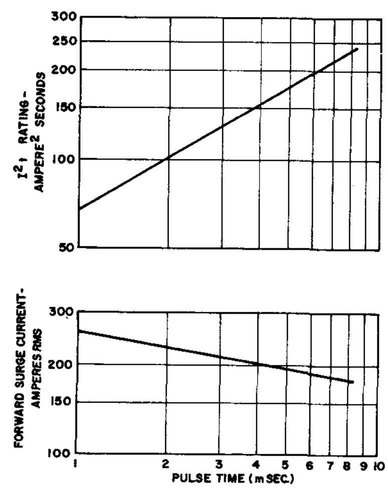
3. REVERSE CHARACTERISTICS



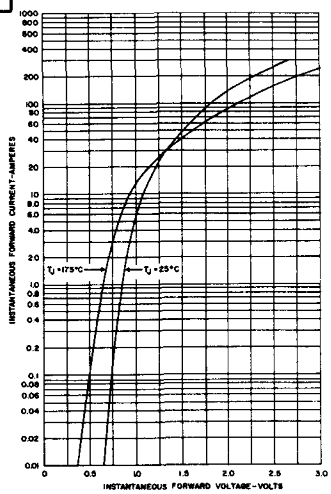
4. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



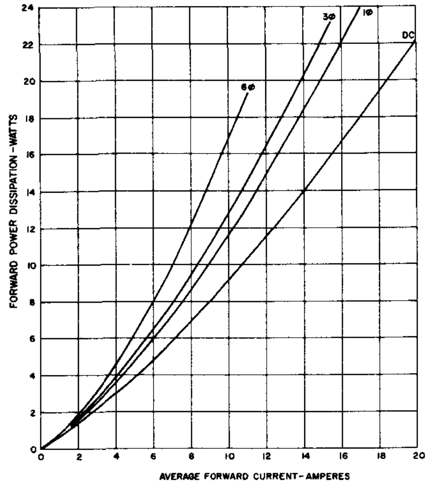
5. MAXIMUM FORWARD SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



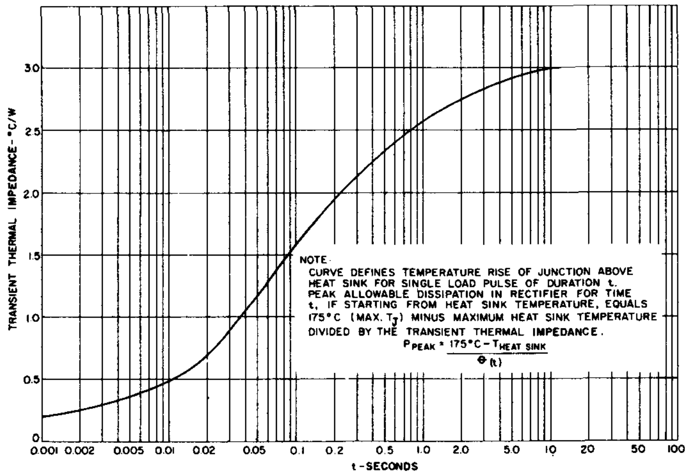
6. SUBCYCLE SURGE FORWARD CURRENT AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS



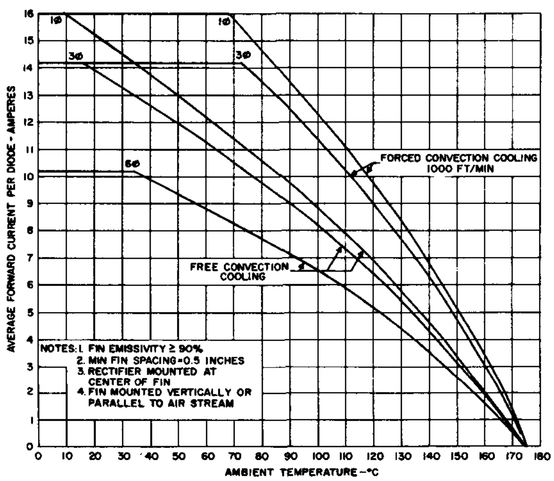
7. MAXIMUM FORWARD CHARACTERISTICS



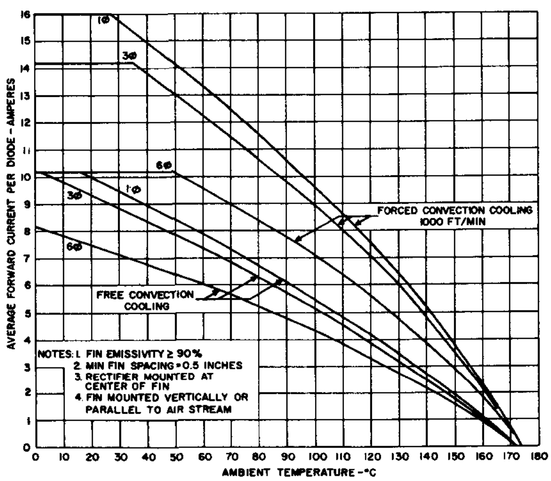
8. FORWARD POWER AS A FUNCTION OF AVERAGE FORWARD CURRENT ($T_J = +175°C$)



9. MAXIMUM TRANSIENT THERMAL IMPEDANCE—JUNCTION TO HEATSINK



10. CURRENT RATING FOR DEVICE MOUNTED ON A 5" x 5" x 0.050" COPPER FIN



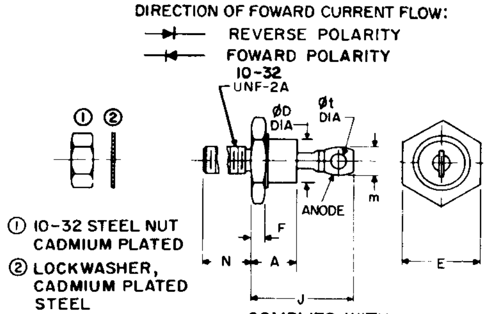
11. CURRENT RATING FOR DEVICE MOUNTED ON A 2½" x 2½" x 0.043" COPPER FIN

OUTLINE DRAWING

1N4510-11

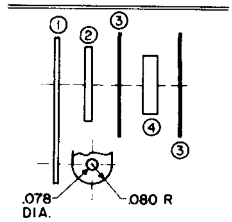
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A		.405		10.29	
ϕD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
ϕt	.060		1.52		
W					2

NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697", 4.29 MM). Ref: (Screw thread standards for Federal Services 1957) Handbook H28, P1



COMPLIES WITH EIA REGISTERED OUTLINE DO-4

INSULATING HARDWARE KIT*



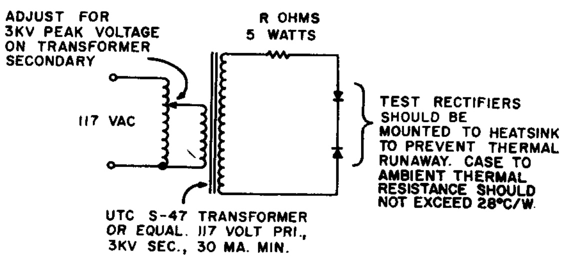
① COPPER TERMINAL, .016 THICK, TIN PLATED
② BRASS WASHER, .035 THICK NICKEL PLATED
③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK
④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK
* AVAILABLE UPON REQUEST

TRY THESE SIMPLE TESTS TO PROVE HOW SUPERIOR *CONTROLLED AVALANCHE RECTIFIERS* ARE COMPARED TO OTHER RECTIFIERS:

True Controlled Avalanche Rectifiers Will Not Be Damaged In Any Way By These Tests.

STEADY-STATE

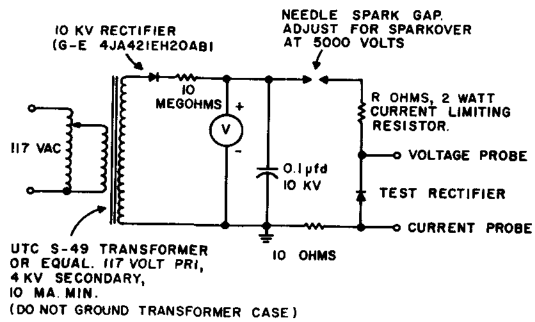
This test operates the rectifier in its high voltage avalanche region at a continuous power dissipation level of approximately 5 watts, at avalanche voltages over 800 volts. This is a test for surface stability at high voltage.



Test Rectifier	R Ohms
1N4510	100K
1N4511	100K

REVERSE IMPULSE

This tests the ability of the rectifier to withstand high transient voltages and to dissipate high levels of peak power in the reverse direction. Peak reverse power for rectifiers with avalanche voltages above 800 volts is over 250 watts in this circuit.



Test Rectifier	R Ohms
1N4510	12K
1N4511	12K

The impulse voltage and current in the test rectifier can be viewed by connecting a scope between the indicated voltage and current taps and ground.

FACTORY CONTROL TESTS

General Electric Controlled Avalanche Rectifiers are subjected to rigorous tests to assure capability to the above conditions. In addition, production units undergo tests to control:

- Minimum/maximum avalanche voltage
- Elevated temperature reverse current
- Package leaks (helium leak test)
- Internal thermal resistance
- 5 temperature cycles (−65°C to +175°C)
- 240 ampere forward surge current capability
- Forward voltage drop
- Reverse power surge

CONTROLLED AVALANCHE

Silicon Rectifier

35A Avg. Up to 1200V

1N4529-30

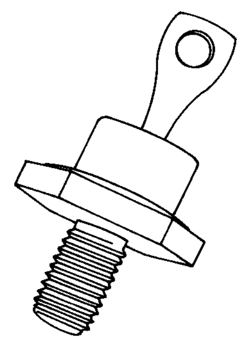
1N4531	SEE PAGE 205
1N4532-34	SEE PAGE 262
1N4536	SEE PAGE 205

CONTROLLED AVALANCHE RECTIFIERS FROM GENERAL ELECTRIC

Feature These Advances in Silicon Rectifier Diode Applications:

Self-protection against normal voltage transients. Dissipates up to 12,000 watts peak power in the reverse direction. Permits decreased PRV safety factors in equipment due to greatly reduced transient voltage vulnerability.

- Unmatched standards of reliability at PRV's up to 1200 volts, as well as at lower voltages.
- Protection of other circuit components against overvoltage through rigidly specified maximum/minimum avalanche characteristics.
- Make ideal voltage equalizing elements for series connected SCR's and conventional rectifier diodes. Also for anode triggering SCR's to prevent damage from voltage transients in the forward direction.
- Simplified series operation of rectifiers in high-voltage applications . . . no shunting resistors necessary for Controlled Avalanche Rectifiers. Makes possible compact high-voltage assemblies.
- Can operate in the avalanche breakdown region at high voltages . . . unharmed by hi-pot and megger tests.



To be designated *"Controlled Avalanche"* a GE silicon rectifier diode must:

1. Have rigidly specified maximum and minimum avalanche voltage characteristics;
2. Be able to operate in its avalanche region without damage at any junction temperature up to a maximum of 175°C; and
3. Be able to absorb momentary power surges in the avalanche region, and have ratings defining this capability at starting junction temperatures of 25°C and 175°C.

For information on the application of Controlled Avalanche Rectifiers, see Publication No. 200.27, "An Introduction To The Controlled Avalanche Silicon Rectifier". Copies may be obtained from: General Electric Company, Distribution Services, Bldg. 6, Room 208, 1 River Road, Schenectady, New York 12305.

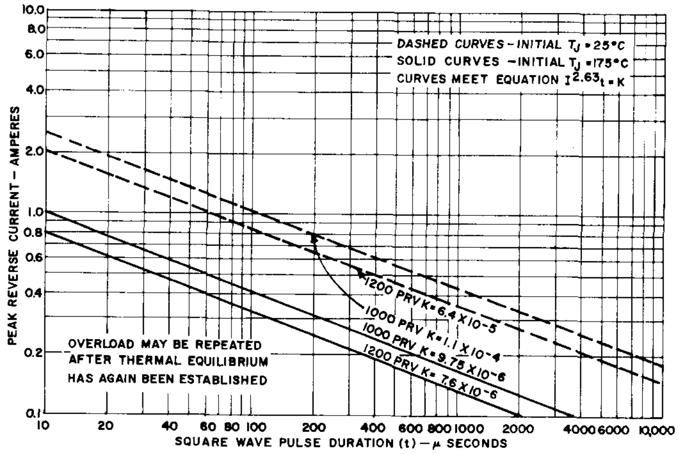
MAXIMUM ALLOWABLE RATINGS

Type	Repetitive & Working Peak Reverse Voltage* V_{RM}(rep), V_{RM}(wkg) $T_J = -65°C$ to $+175°C$ (Note: 1)	MINIMUM Avalanche Breakdown Voltage, BV_R, (5 mA test current at $T_J = 25°C$)	MAXIMUM Avalanche Breakdown Voltage, BV_R, (5 mA test current at $T_J = 25°C$)	Full-Load Reverse Current (full-cycle avg., 115°C T_C, 1 ϕ), $I_{R(AV)}$
	Volts**	Volts	Volts	Milliamperes**
1N4529,R	1000	1250	1550	2.5
1N4530,R	1200	1500	1930	2.0

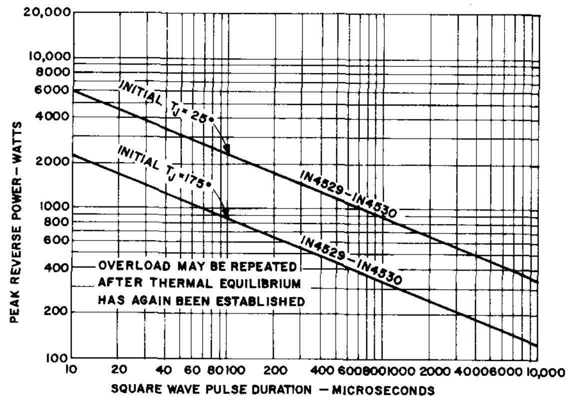
Average Forward Current, I_O ($T_C = +115°C$, single phase) .... 35 Amperes**
Peak One-Cycle Surge Current (non-repetitive), I_{FM} (surge) .... 500 Amperes**
Minimum I^2t Rating (see Curve 6) .... 500 Ampere² seconds
Reverse Power Surge (non-repetitive, 10 μsec., square wave)
$T_J = +25°C$ .... 12 Kilowatts
$T_J = +175°C$ .... 4.5 Kilowatts
(For other conditions, see Curve 2)
Average DC Reverse Power in Breakdown Region ($-65°C \leq T_C \leq +115°C$) (Note: 2) .... 20 Watts**
Peak Reverse Power in Breakdown Region (repetitive) (Note: 2) .... 100 Watts
Forward Peak Voltage Drop, V_{FM} ($T_C = +115°C$, $I_O = 12$ ampere avg.) .... 1.4 Volts**
Thermal Resistance, θ_{J-C} .... 1.0°C/Watt
Operating Junction Temperature, T_J .... −65°C to +175°C**
Storage Temperature, T_{stg} .... −65°C to +200°C**
Stud Torque .... 30 Lb-in
35 Kg-cm

*Maximum voltages apply with a heatsink thermal resistance of 8°C/watt, or less, at maximum rated junction temperature.
**Indicates values included in JEDEC Type Number Registration.

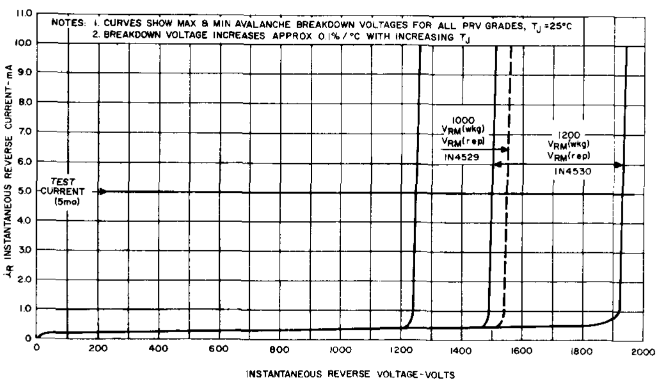
NOTES:
(1) V_{RM}(rep) applies for a conventional AC to DC conversion application. V_{RM}(rep) and V_{RM}(wkg) can be considered unlimited providing that the additional reverse power generation is taken into account by allowing for its influence on the forward current rating. Considerations similar to voltage regulator diode applications would apply.
(2) These ratings assume no forward power dissipation. In applications requiring both forward and reverse average power dissipation, reduce case temperature as determined from the maximum case temperature versus average forward current curve by 2.0°C for every watt of average reverse power dissipation.
(3) Case temperature, T_C, is measured at the center of any one of the hex flats.



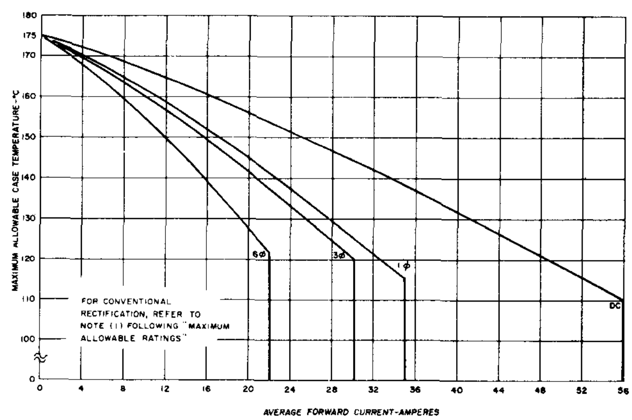
1. NON-RECURRENT REVERSE SURGE CURRENT RATINGS



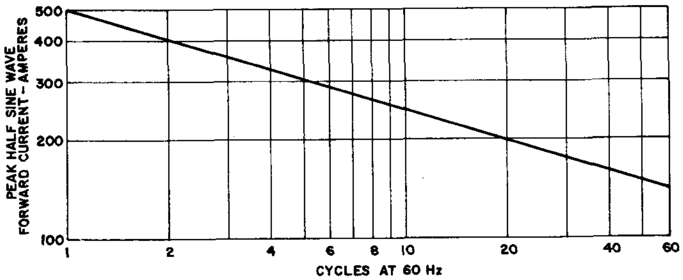
2. NON-RECURRENT REVERSE POWER SURGE



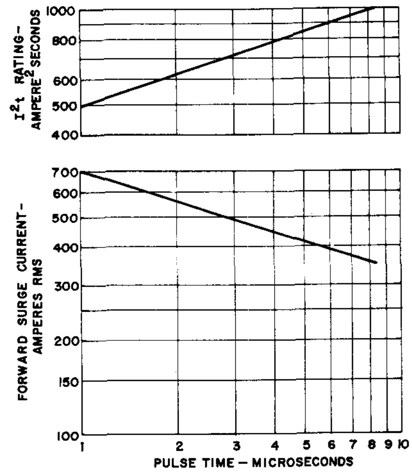
3. REVERSE CHARACTERISTICS



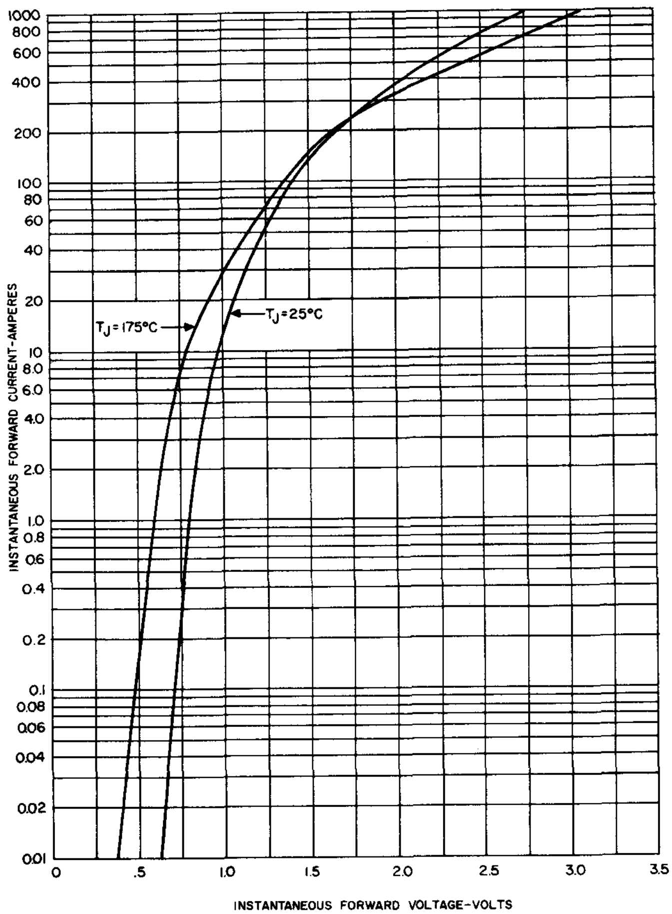
4. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



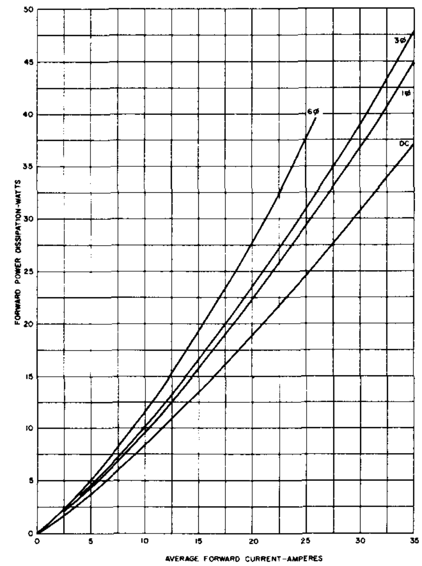
5. MAXIMUM FORWARD SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



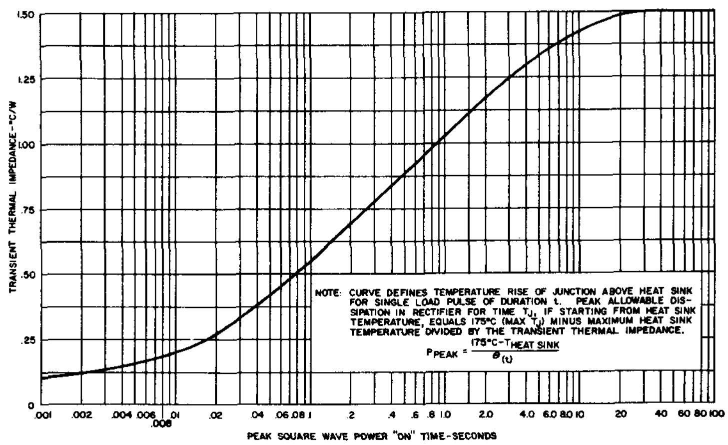
6. SUBCYCLE SURGE FORWARD CURRENT AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS



7. MAXIMUM FORWARD CHARACTERISTICS



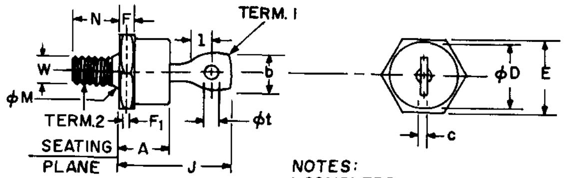
8. FORWARD POWER AS A FUNCTION OF AVERAGE FORWARD CURRENT (T_J = +175°C)



9. MAXIMUM TRANSIENT THERMAL IMPEDANCE— JUNCTION TO HEATSINK

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.450		11.43	
b		.375		9.53	2
c		.080		2.03	
φD		.667		16.94	
E	.667	.687	16.94	17.45	
F	.115	.200	2.92	5.08	
F_1	.060		1.52		
J		1.000		25.40	
l	.156		3.96		4
φM	.220	.249	5.59	6.32	1
N	.422	.453	10.72	11.51	
φt	.140	.175	3.56	4.45	
W					1,3

OUTLINE DRAWING



NOTES:
1. COMPLETE THREADS TO EXTEND TO WITHIN 2-1/2 THREADS OF SEATING PLANE.
2. ANGULAR ORIENTATION OF TERMINAL IS UNDEFINED.
3. 1/4-28 UNF-2A. MAXIMUM PITCH DIAMETER OF PLATED THREADS SHALL BE BASIC PITCH DIAMETER (.2268", 5.74 MM) REF. (SCREW THREAD STANDARDS FOR FEDERAL SERVICES 1957) HANDBOOK H28 1957 P1.
4. MINIMUM FLAT.

EIA-NEMA STANDARD OUTLINE, NEMA SK-51-EIA RS-241.
INSULATING HARDWARE IS AVAILABLE UPON REQUEST.

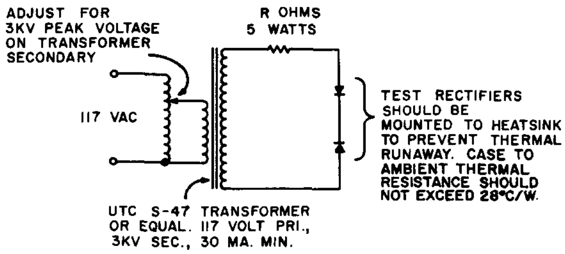
COMPLIES WITH EIA REGISTERED OUTLINE DO-5

TRY THESE SIMPLE TESTS TO PROVE HOW SUPERIOR *CONTROLLED AVALANCHE RECTIFIERS* ARE COMPARED TO OTHER RECTIFIERS:

True Controlled Avalanche Rectifiers Will Not Be Damaged In Any Way By These Tests.

STEADY-STATE

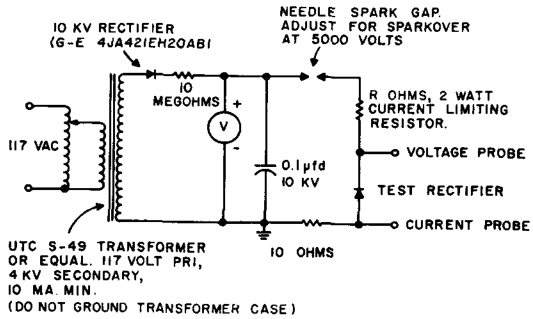
This test operates the rectifier in its high voltage avalanche region at a continuous power dissipation level of approximately 10 watts, at avalanche voltages over 800 volts. This is a test for surface stability at high voltage.



Test Rectifier	R Ohms
1N4529	50K
1N4530	50K

REVERSE IMPULSE

This tests the ability of the rectifier to withstand high transient voltages and to dissipate high levels of peak power in the reverse direction. Peak reverse power for rectifiers with avalanche voltages above 800 volts is over 500 watts in this circuit.



Test Rectifier	R Ohms
1N4529	6K
1N4530	6K

The impulse voltage and current in the test rectifier can be viewed by connecting a scope between the indicated voltage and current taps and ground.

FACTORY CONTROL TESTS

General Electric Controlled Avalanche Rectifiers are subjected to rigorous tests to assure capability to the above conditions. In addition, production units undergo tests to control:

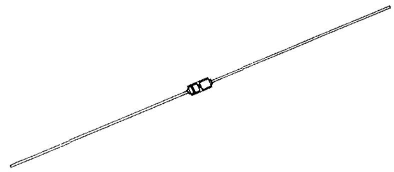
- Minimum/maximum avalanche voltage
- Elevated temperature reverse current
- Package leaks (helium leak test)
- Internal thermal resistance
- 5 temperature cycles (−65° to +175°C)
- 500 ampere forward surge current capability
- Forward voltage drop
- Reverse power surge

1N4606 SEE PAGE 258
1N4607-8 SEE PAGE 274

Silicon Diode

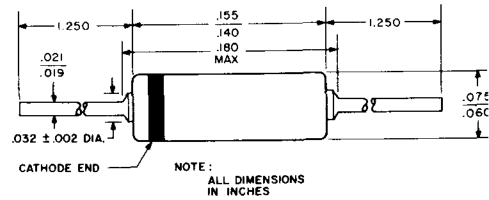
IN4727

The General Electric type 1N4727 is a very high speed silicon planar epitaxial passivated diode for computer circuits, switching circuits and general purpose applications. It features maximum limits on junction capacitance and stored charge to ensure reproducible performance in high speed switching circuits.
The A291 is a power silicon rectifier diode for use in applications requiring blocking voltages up to 2000 volts and forward current ratings up to 250 amperes average in single phase applications. This device was formerly known as 6RW51, and is reverse polarity device. The stud is the anode.



absolute maximum ratings: (25°C) (unless otherwise specified)

	1N4727	
Voltage		
Reverse (continuous operating)	20	volts
Current		
Average Rectified	75	mA
Forward Steady-State DC	115	mA
Recurrent Peak Forward	225	mA
Peak Forward Surge (1 μsec. @ 1% Duty Cycle)	2000	mA
Power		
(with Heatsinking .250" from end of diode body)		
Dissipation (Note 1)	500	mW
Dissipation (125°C) (Note 2)	200	mW
Temperature		
Operating	← −65 to +175 →	°C
Storage	← −65 to +200 →	°C
Lead (1/16 ± 1/32 inch from case for 10 sec.)	← 300 →	°C
Derate		
Note 1: For ambient temperature above 25°C	3.0	mW/°C
Note 2: For ambient temperature above 125°C	4.0	mW/°C



1N4727, DHD

electrical characteristics: (25°C) (unless otherwise specified)

		1N4727			
		Min.	Typ.	Max.	
Breakdown Voltage ($I_R = 5\ \mu A$)	B_V	30			Volts
Forward Voltage ($I_F = 10$ mA)	V_F		0.79	0.85	Volts
Reverse Current ($V_R = 20V$)	I_R		.02	0.1	μamp
($V_R = 20V$, $T_A = 100°C$)	I_R		3	10	μamp
Stored Charge (Note 5) ($I_F = 10$ mA) (Note 3)	Q_S		24	40	pCoul
Capacitance ($V_R = 0V$) (Note 4)	C_o		1.5	4	pf

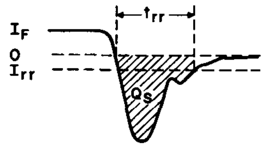
Note 3: Stored charge as measured on B-Line Electronics model QS-3 Stored Charge Meter (pulse amplitude = 5 volts, pulse width = 50 ns, rise time = 0.4 ns, source impedance = 10 ohms)

Note 4: Capacitance as measured on Boonton Electronics model 75A Capacitance Bridge at a signal level of 50 mv rms and a frequency of 1 mc.

NOTE 5: STORED CHARGE

When a forward biased diode is subjected to a reverse voltage step a reverse current will flow for a short time as a result of the stored charge consisting of minority carriers in the vicinity of the junction. The typical waveform of reverse current vs time for a diode subjected to a large reverse voltage is shown in Figure 1. The time required for the diode to recover its reverse blocking condition will depend on the quantity of charge stored and the rate at which the charge is removed by recombination inside the diode and by current flowing in the external circuit. Conventionally, the speed of a diode is characterized by the reverse recovery time, t_{rr}, measured to some arbitrary current level as in Figure 1. However, for higher speed diodes reverse recovery time is not a satisfactory parameter for characterizing the speed of the diode since it is dependent on arbitrary circuit conditions and is very dependent on the construction of the test circuit. Stored charge, on the other hand, is measured by integrating the reverse current of the diode (as shown by the shaded area in Figure 1), and is consequently much less dependent on the construction of the test circuit and on arbitrary circuit conditions. Stored charge is a more ideal parameter for characterizing the speed of a diode since it represents an intrinsic characteristic of the diode and can be measured with good reproducibility on low cost instruments which have direct meter readout.

Stored charge can be correlated with reverse recovery time measurements on a specific t_{rr} test jig. Typical correlation curves are shown on the graph below.



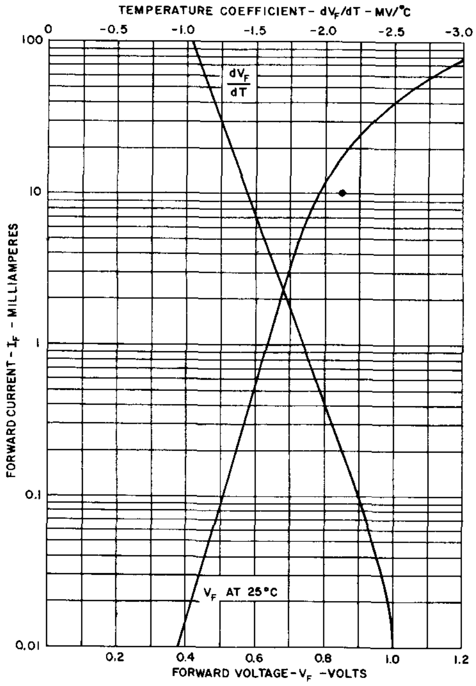
TYPICAL REVERSE RECOVERY WAVEFORM FOR A HIGH SPEED DIODE

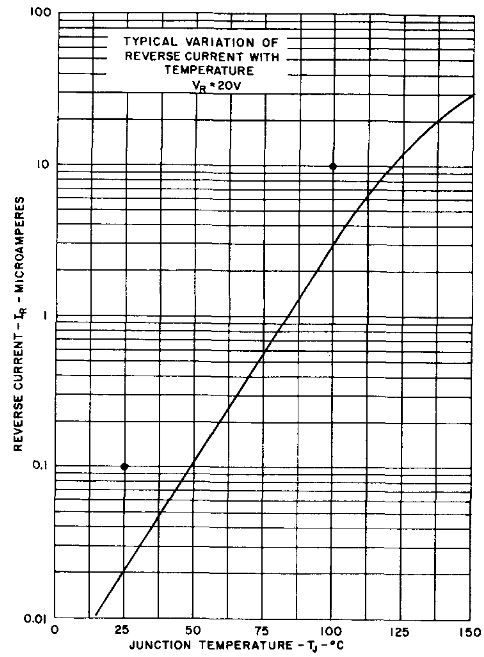
FIGURE 1

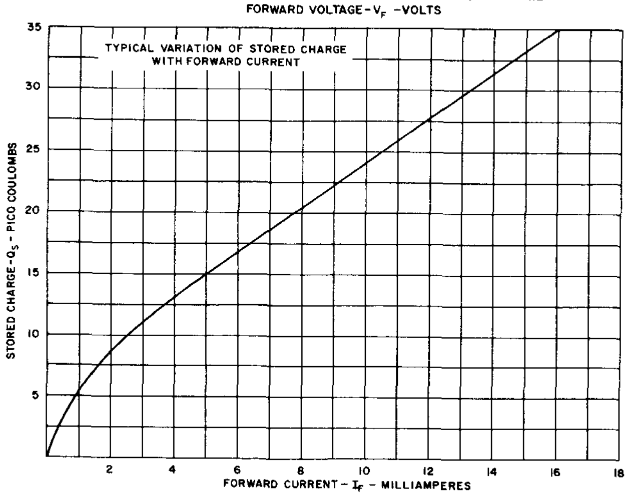
References:

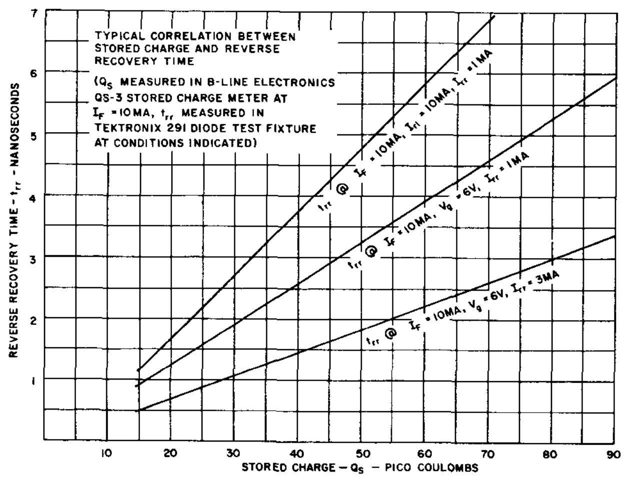
(1) JEDEC Proposed Method for Direct Measurement of Diode Stored Charge, JS-2-65-11

(2) "Measurement of Stored Charge in High Speed Diodes," T. P. Sylvan Application Note #90.30 (available on request)









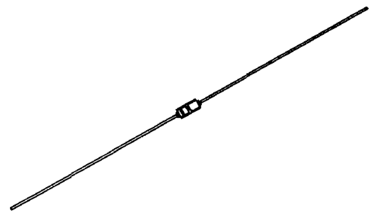
1N4829-30 SEE PAGE 266

Silicon Diodes

IN4863

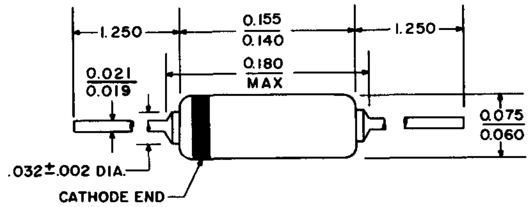
The General Electric 1N4863 Double Heatsink Diode is a high voltage, low capacitance diode for low- and high-current, high-speed switching circuits and general purpose applications. This diode incorporates an oxide-passivated, planar structure built on a high resistivity, epitaxial layer grown on a low resistivity silicon substrate. The 1N4863 offers controlled conductance, minimum and maximum forward voltage at four levels of forward current. This closely-controlled conductance is necessary for the design of clamping and logic circuits where tight tolerances on voltage levels are required.

All Double Heatsink Diodes receive a one-hour glass anneal bake at 425°C. This processing optimizes DHD hermetic integrity under temperature cycling and thermal shock conditions exceeding MIL-S-19 19500C requirements. All DHD's then receive a 300°C stabilization bake for 168 hours to assure parameter stability and reliability under maximum storage and operating junction temperature(s).



absolute maximum ratings:

	1N4863	
Voltage		
Reverse (Continuous)	50	volts
Current		
Average Rectified	200	ma
Recurrent Peak Forward	600	ma
Forward Steady-State DC	250	ma
Peak Forward Surge (1 μsec)	4	amps
Power		
Dissipation	500	mw
Temperature		
Operating	−65 to +200	°C
Storage	−65 to +200	°C
Lead, 1/16" ± 1/32" from case for 10 sec.	300	°C



electrical characteristics: (25°C) (unless otherwise specified)

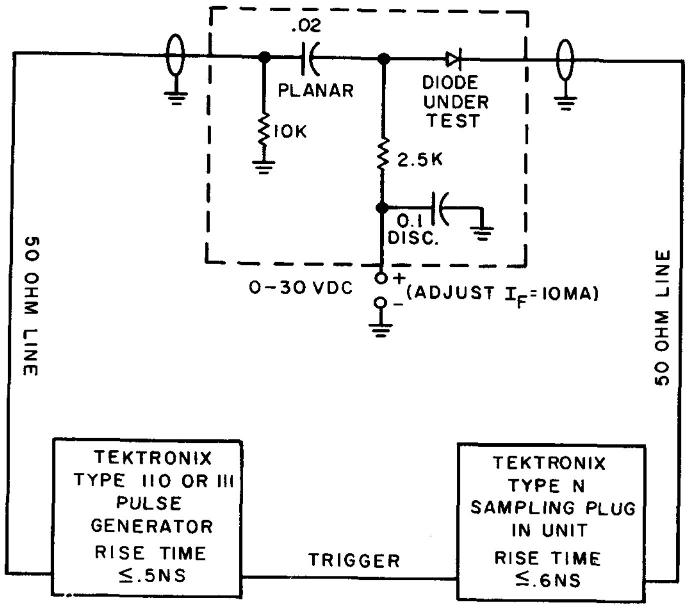
		1N4863 Min.	1N4863 Max.	
Forward Voltage				
(I_F = 0.1 ma)	V_F	440	550	mv
(I_F = 1.0 ma)	V_F	560	680	mv
(I_F = 10 ma)	V_F	690	820	mv
(I_F = 100 ma) (Note 1)	V_F	830	1200	mv
Breakdown Voltage				
(I_R = 5 μa)	B_V	70		volts
(I_R = 100 μa)	B_V			volts
Reverse Current				
(V_R = 50 V)	I_R		50	na
(V_R = 50 V, T_A = +150°C)	I_R		50	μa
(V_R = 80 V)	I_R			na
(V_R = 80 V, T_A = +150°C)	I_R			μa
Capacitance				
(V_R = 0 V) (Note 2)	C_o		2	pf
Reverse Recovery Time				
(I_F = I_R = 10 ma, Recover to 1 ma) (Fig. 1)	t_{rr}		7	nsec
(I_F = 10 ma, V_R = 6 V, R_L = 100Ω, Recover to 1 ma) (Fig. 1)	t_{rr}			nsec
(I_F = I_R = 100 ma, Recover to 10 ma) (Fig. 2)	t_{rr}			nsec

note:

(1) Pulsed measurement (Pulse width ≤ 300 μsec, Duty cycle ≤ 2%).

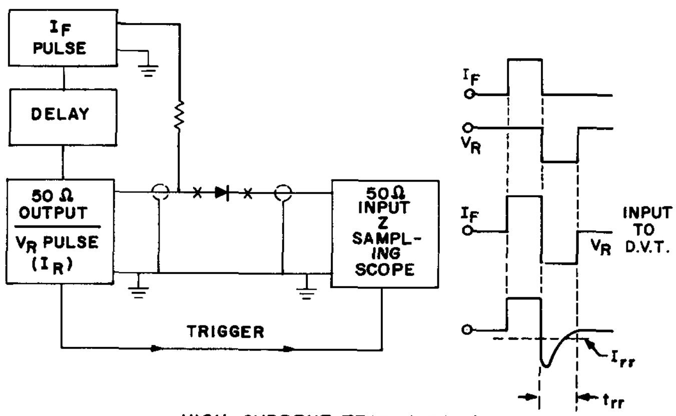
(2) Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mv and a frequency of 1 mc.

1N4863



LOW CURRENT t_{rr} TEST CIRCUIT

FIGURE 1



HIGH CURRENT TEST CIRCUIT

FIGURE 2

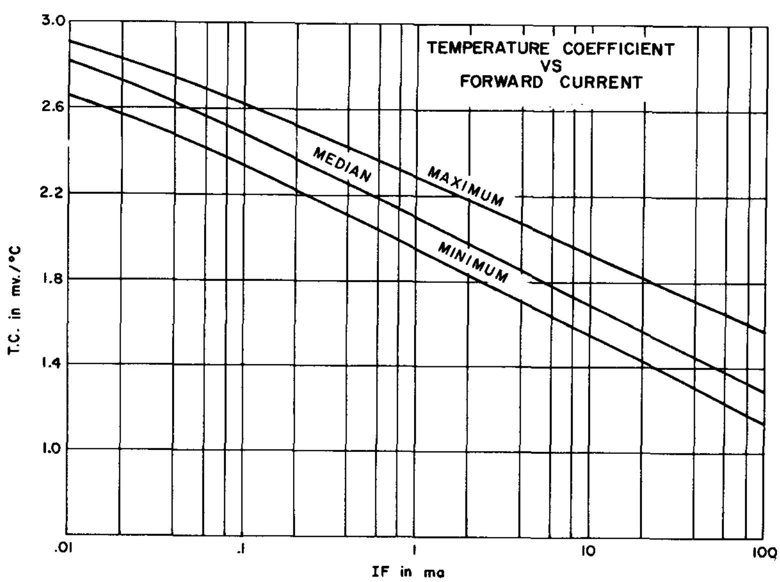


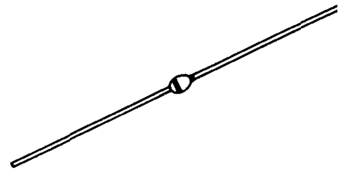
FIGURE 3

Passivated Rectifier

TRANSIENT VOLTAGE PROTECTED
2.5 Amps **200-1000 Volts**

A14 SERIES
1N5059
1N5060
1N5061
1N5062
A14P

THE GENERAL ELECTRIC A14 IS A 2.5 AMPERE RATED, AXIAL-LEADED GENERAL PURPOSE RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLETS PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY SEALED PACKAGE.



The A14 is "Transient-Voltage Protected." This device will dissipate up to 1000 watts in the reverse direction without damage. Voltage Transients generated by household or industrial power lines are dissipated.

absolute maximum ratings: (25°C unless otherwise specified)

	1N5059 (A14B)	1N5060 (A14D)	1N5061 (A14M)	1N5062 (A14N)	A14P	
*Reverse Voltage (−65°C to +175°C, T_J) (−65°C to +165°C for 1N5062 and A14P)						
Working Peak, V_{RWM}	200	400	600	800	1000	Volts
DC, V_R	200	400	600	800	1000	Volts
*Average Forward Current, I_O						
*100°C Ambient (90°C for 1N5062 and A14P)	←		1.0		→	Amp
25°C Ambient (See Rating Curves)	←		2.5		→	Amp
*Peak Surge Forward Current, I_{FSM} Non-repetitive, .0083 sec., half sine wave,						
Full Load JEDEC Method	←		50		→	Amps
No Load (25°C Case)	←		65		→	Amps
Peak Surge Forward Current, I_{FSM} Non-repetitive, .001 sec., half sine wave,						
Full Load	←		90		→	Amps
No Load (25°C Case)	←		100		→	Amps
*Junction Operating and Storage Temperature Range, T_J & T_{STG}	← −65 to +175	→		← −65 to +165	→	°C
I^2t, RMS (for fusing), .001 to .01 sec.	←		4.0		→	$Amps^2$ sec.
Maximum Avalanche Voltage	←		1600		→	Volts
Peak Non-repetitive Reverse Power Rating, P_{RM} 20 μsec., half sine wave, at Max. T_J	←		1000		→	Watts
*100 μsec., JEDEC	←		450		→	Watts

*Mounting: Any position. Lead Temperature 290°C maximum to ⅛ inch from body for 5 seconds maximum during mounting.

electrical characteristics: (25°C unless otherwise specified)

	1N5059	1N5060	1N5061	1N5062	A14P	
*Maximum Forward Voltage Drop, V_F, 1A, T_J = 75°C	←		1.2		→	Volts
Maximum Reverse Current, I_R, at Rated V_{RRM}:						
T_J = 25°C	←		5.0		→	μA
*T_J = 165°C	—	—	—	200	200	μA
*T_J = 175°C	300	300	200	—	—	μA
Typical Reverse Current, I_R, at Rated V_{RRM}	←		1.0		→	μA
Typical Reverse Current, I_R						
T_J = 25°C	0.2	0.2	0.3	0.5	0.5	μA
T_J = 100°C	20	20	20	30	30	μA
Typical Reverse Recovery Time, T_{RR}	←		3		→	μsec.
Maximum Reverse Recovery Time, T_{RR}	←		6		→	μsec.

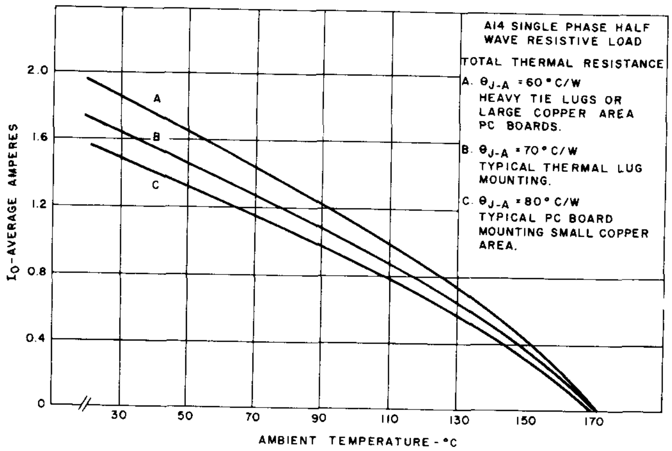
Recovery circuit per MIL-S-19500/286C.

*JEDEC Registered data.

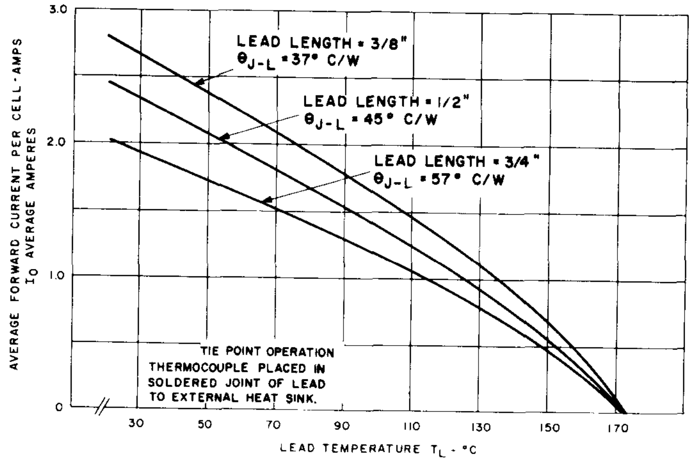
1N5059
1N5060
1N5061
1N5062
A14P

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE
600 VOLTS & BELOW

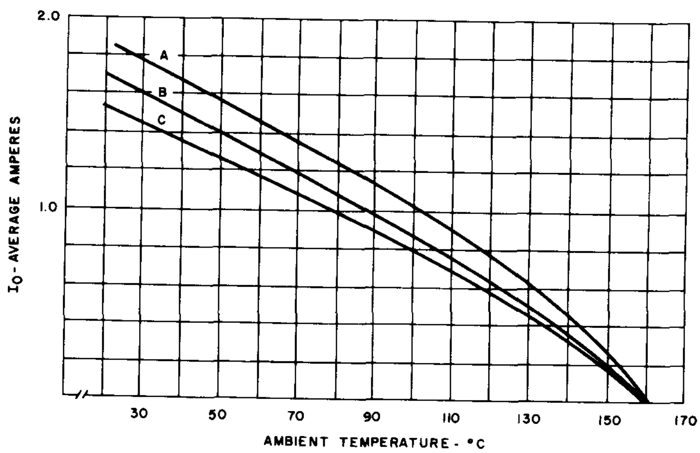


AMBIENT OPERATION

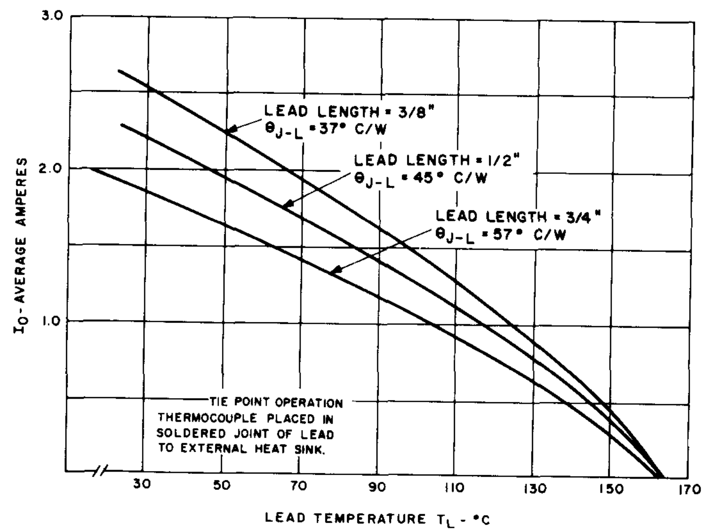


TIE POINT OPERATION

RESISTIVE OR INDUCTIVE LOAD
800 AND 1000 VOLTS

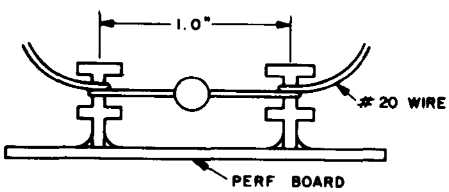


AMBIENT OPERATION

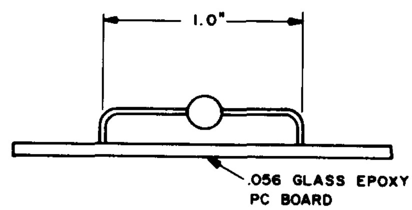


TIE POINT OPERATION

TYPICAL TIE LUG MOUNTS

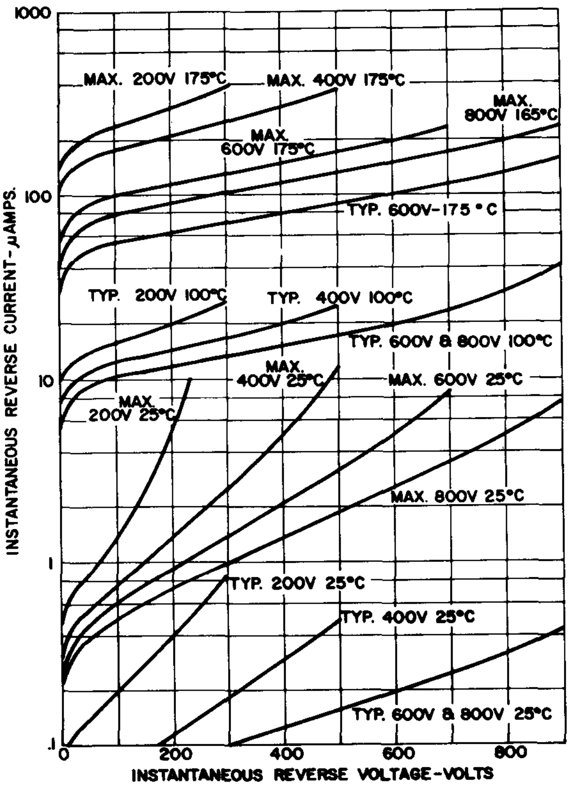


TYPICAL PC BOARD MOUNTING

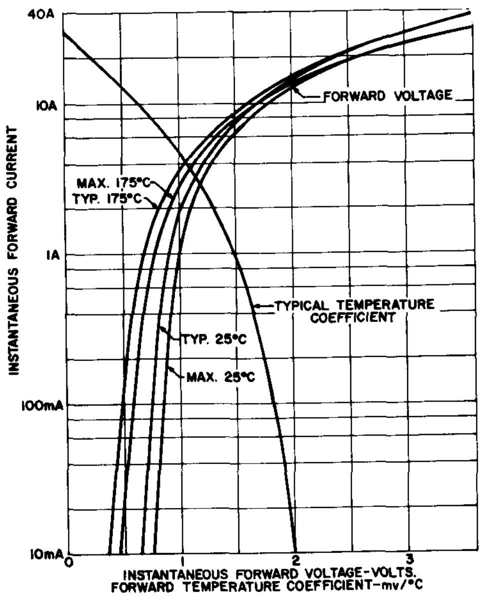


1N5059
1N5060
1N5061
1N5062
A14P

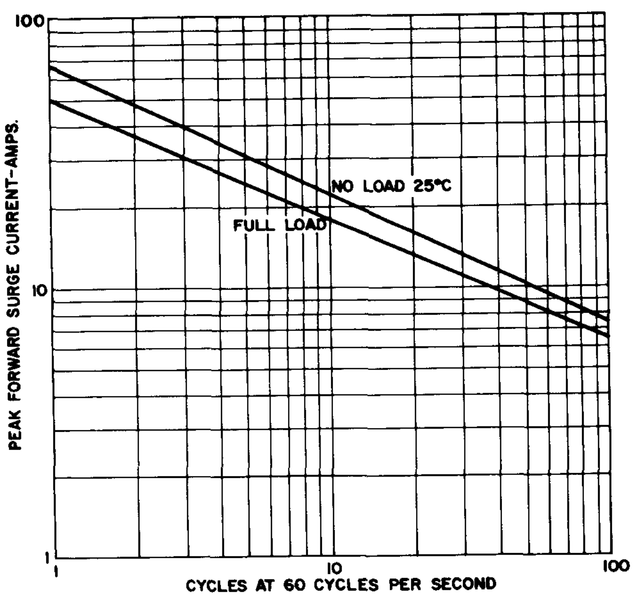
TYPICAL CHARACTERISTICS



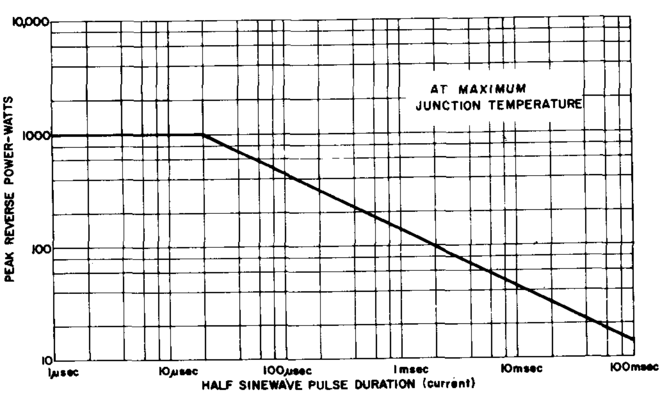
REVERSE CHARACTERISTICS AT SELECTED JUNCTION TEMPERATURES



FORWARD CHARACTERISTICS



MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT



MAXIMUM NON-REPETITIVE AVALANCHE SURGE POWER

CAPACITIVE LOADS

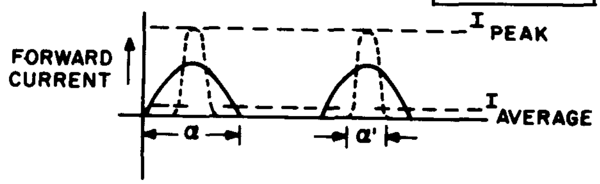
Current Derating (capacitive load)

Average forward current as specified under MAXIMUM RATINGS page 1 and derating curves for high temperature operation page 2, must be corrected for applications with capacitive loads. As the current conduction angle, ∝', is decreased, the peak current required to maintain the *same average current* increases, i.e., the peak-to-average current ratio increases from 3.14. Figure 9 gives the derating required based on this increase in peak to average current ratio for sine wave operation. For more complete information consult Application Note 200.30.

METHOD:
1. Determine conduction angle ∝' in degrees for *particular circuit as designed.*
2. Enter Figure 9 for the particular conduction angle and read corresponding percent of forward current per cell.
3. Multiply this value times average forward current for resistive load from figures on page 2 as given for the actual ambient or tiepoint temperature required.

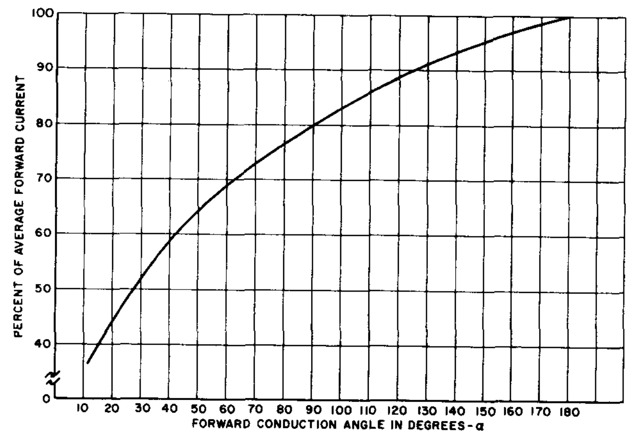
TYPICAL EXAMPLES (25°C Ambient Temperature)

	Example No. 1	Example No. 2	Example No. 3	Example No. 4	Units
Input Voltage	100	100	300	300	Volts
D.C. (Average) Output Voltage	34	75	180	270	Volts
Surge Resistor	1	1	3.5	3.5	Ohms
Load Current	0.5	0.5	0.5	0.5	Amps.
Input Filter Capacitance	30	100	30	100	μF.
Conduction Angle	170	70	90	50	Degrees
Rated Average Current (Resistive Load)	1	1	1	1	Amp.
Rated Average Current (Capacitive Load)	0.98	0.73	0.80	0.65	Amp.



α = CONDUCTION ANGLE (180°)
α' = SHORTENED CONDUCTION ANGLE

OSCILLOSCOPE PRESENTATION

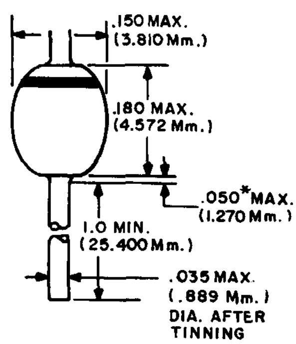


9. DERATING FOR SHORTENED CONDUCTION ANGLE

INTERNAL CONSTRUCTION

1. Dual heatsink design for maximum heat dissipation under both surge and continuous duty. No fragile "whiskers" or S leads with their potential trouble spots.
2. Glass Package. No internal cavity to act as potential source of moisture or contamination on junction. Temperature coefficient of the glass is matched with the internal parts.
3. Diffused silicon junction passivated surface.

Marking band to appear on cathode end.



OUTLINE DRAWING

ALL DIMENTIONS ARE IN INCHES AND (METRIC)
*WELD AND SOLDER FLASH NOT CONTROLLED IN THIS AREA

TYPICAL APPLICATIONS

- FREE-WHEELING RECTIFIERS
- TIME DELAY CIRCUITS
- POWER LOGIC CIRCUITS
- ARC SUPPRESSION
- BATTERY CHARGERS
- TV DAMPER DIODES
- TV AND RADIO POWER SUPPLIES
- COMMUNICATION EQUIPMENT
- S.C.R. TRIGGER CIRCUITS
- SMALL PORTABLE APPLIANCES
- GENERAL PURPOSE POWER SUPPLIES
- LOW LEVEL LIMITERS

1N5179 SEE PAGE 266
1N5332 SEE PAGE 209

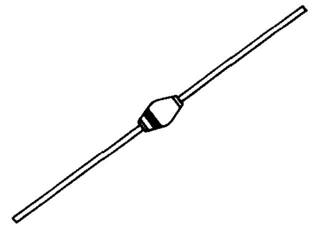
Lead Mounted Rectifier

TRANSIENT VOLTAGE PROTECTED

5.0 Amps 200-800 Volts

A15 SERIES

1N5624
1N5625
1N5626
1N5627



THE GENERAL ELECTRIC A15 IS A 5.0 AMPERE RATED, AXIAL LEADED GENERAL PURPOSE RECTIFIER. ITS DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLET'S PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY SEALED PACKAGE.

The A15 is "Transient Voltage Protected." This device will dissipate up to 1000 watts in the reverse direction without damage. Voltage Transients generated by household or industrial power lines are dissipated.

absolute maximum ratings: (25°C unless otherwise specified)

	1N5624 (A15B)	1N5625 (A15D)	1N5626 (A15M)	1N5627 (A15N)	
*Reverse Voltage (−65°C to +175°C, T_J)					
Repetitive Peak, V_{RRM}	200	400	600	800	Volts
DC, V_R	200	400	600	800	Volts
Average Forward Current, I_F					
*70°C ambient, see rating curves	←	3.0		→	Amps
25°C ambient, see rating curves	←	5.0		→	Amps
*Peak Surge Forward Current, I_{FSM} Non repetitive, .0083 sec., half sine wave, Full Load JEDEC Method	←	125		→	Amps
Peak Surge Forward Current, I_{FSM} Non-repetitive, .001 sec., half sine wave, Full load 175°C, T_J	←	225		→	Amps
*Junction Operating Temperature Range	←	−65 to +175		→	°C
*Storage Temperature Range	←	−65 to +200		→	°C
I^2t, RMS for fusing .001 to .01 sec.	←	25		→	Amp^{2}se
Peak Non-repetitive Reverse Power Rating					
20 μsec half sine wave at Max T_J	←	1000		→	Watts
*100 μsec., JEDEC	←	450		→	Watts

*Mounting: Any position. Lead temperature 290°C maximum to 1/8" from body for 5 seconds maximum during mounting.

electrical characteristics:

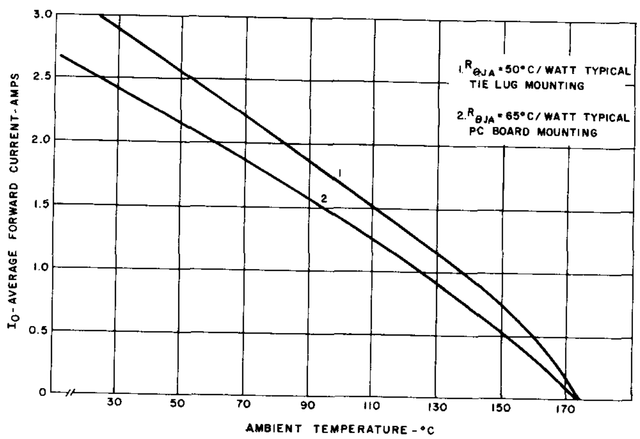
	1N5624	1N5625	1N5626	1N5627	
Maximum Forward Voltage Drop, V_F					
I_F = 5.0A, T_A = 25°C	←	1.1		→	Volts
*I_F = 3.0A, T_A = 70°C	←	0.95		→	Volts
Maximum Reverse Current, I_R, at rated V_{RRM}					
T_J = 25°C	←	5.0		→	μA
*T_J = 175°C	300	300	200	200	μA
Typical Reverse Current @ 25°C	←	1.0		→	μA
Typical Reverse Recovery Time, T_{rr}	←	2.5		→	μsec
Maximum Reverse Recovery Time, T_{rr} Recovery Circuit Per MIL-S-19500/286C	←	5.0		→	μsec

*JEDEC Registered data.

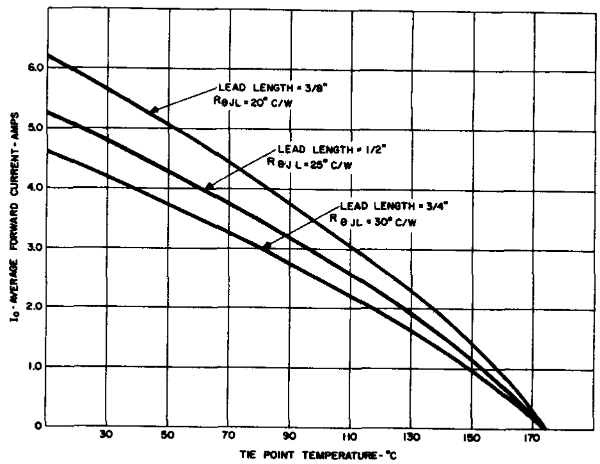
CIRCUIT DESIGN INFORMATION

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS

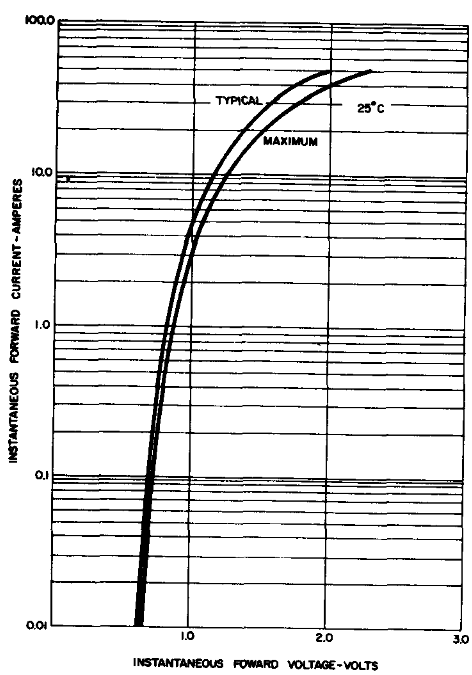


AMBIENT OPERATION
(See Tie Point Mounting Below)

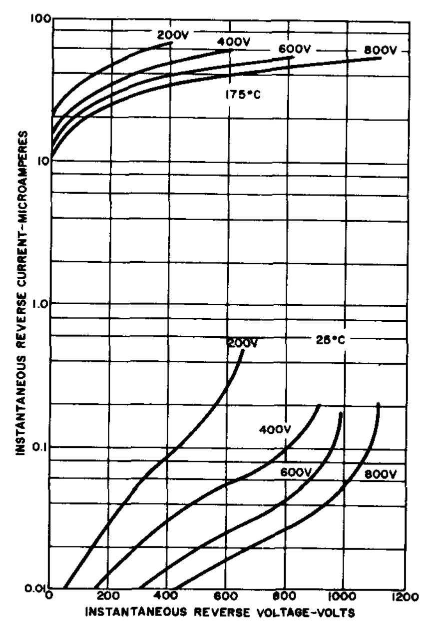


TIE POINT OPERATION

TYPICAL CHARACTERISTICS

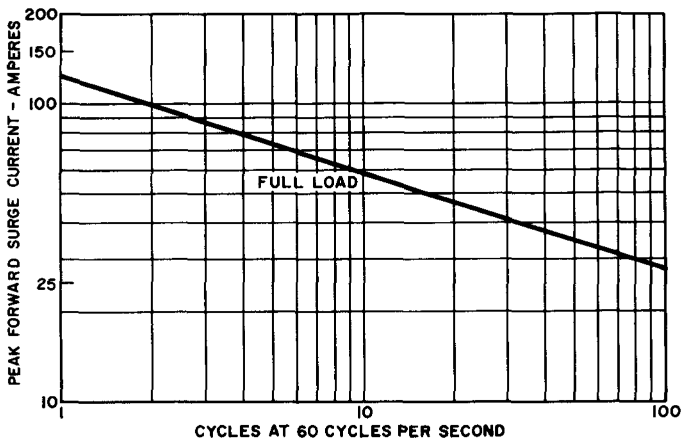


FORWARD CHARACTERISTICS

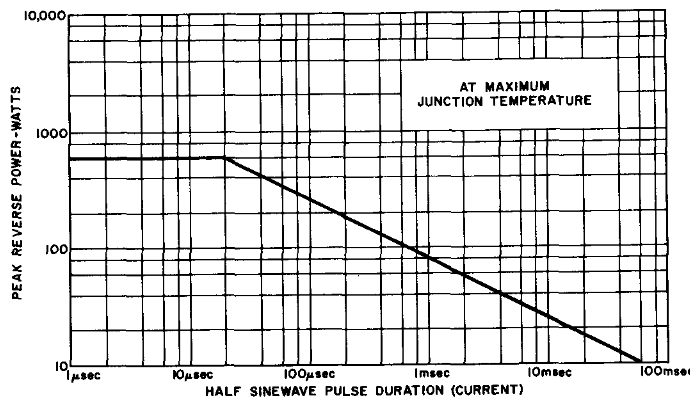


REVERSE CHARACTERISTICS

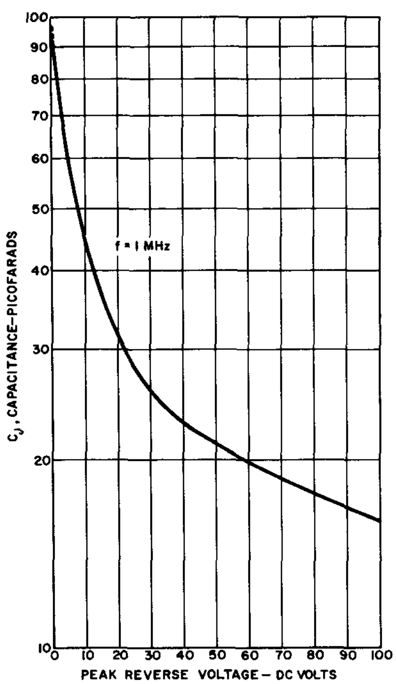
TYPICAL CHARACTERISTICS



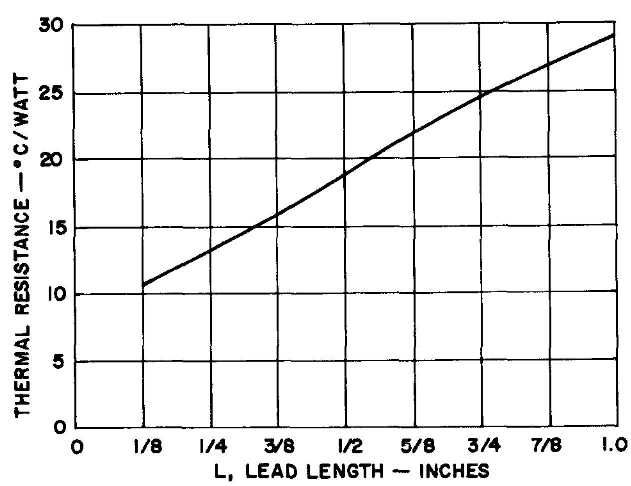
MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT



MAXIMUM NON-REPETITIVE AVALANCHE SURGE POWER



JUNCTION CAPACITANCE



STEADY STATE THERMAL RESISTANCE

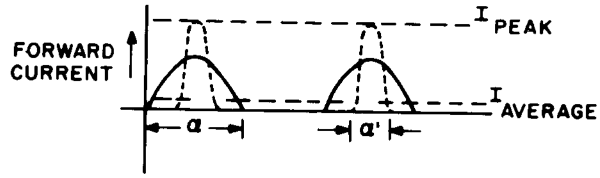
Current Derating (capacitive load)

Average forward current as specified under maximum ratings, page 1, and derating curves for high temperature operation, above, must be corrected for applications with capacitive loads. As the current conduction angle, α', is decreased, the peak current required to maintain the *same average current* increases, i.e., the peak-to-average current ratio increases from 3.14. Figure 3 gives the derating required based on this increase in peak to average current ratio for sine wave operation. For more complete information consult Application Note 200.30.

METHOD:
1. Determine conduction angle α' in degrees for *particular circuit as designed.*
2. Enter Figure 3 for the particular conduction angle and read corresponding percent of forward current per cell.
3. Multiply this value times average forward current for resistive load from igures 1 and 2 as given for the actual ambient or tiepoint temperature required.

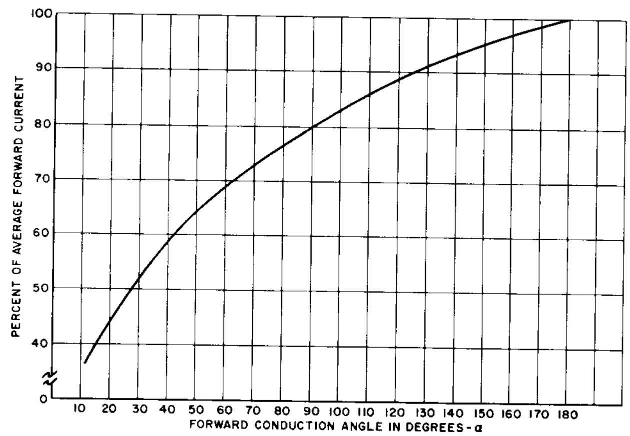
See Typical Examples Below

TYPICAL EXAMPLES (25°C Ambient Temperature)					
	Example No. 1	Example No. 2	Example No. 3	Example No. 4	Units
Conduction Angle (α)	170	110	130	70	Degrees
Rated Average Current (Resistive Load)	3	3	3	3	Amp.
% of Average Current	0.98	0.86	0.92	0.73	%
Rated Average Current (Capacitive Load)	2.9	2.6	2.8	2.2	Amps.



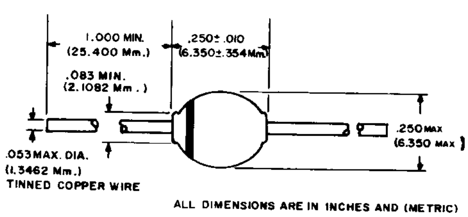
α = CONDUCTION ANGLE (180°)
α' = SHORTENED CONDUCTION ANGLE

OSCILLOSCOPE PRESENTATION

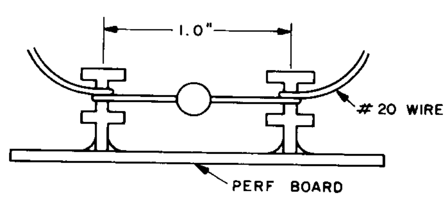


DERATING FOR SHORTENED CONDUCTION ANGLE

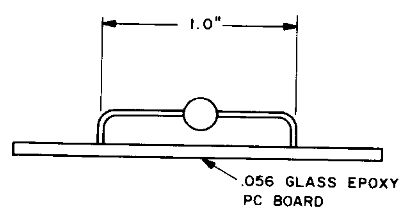
OUTLINE DRAWING



TYPICAL TIE LUG MOUNTS



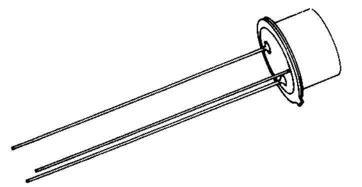
TYPICAL PC BOARD MOUNTING

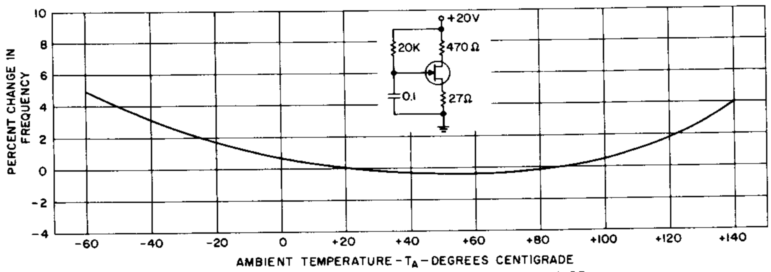


Silicon Unijunction Transistors

2N489-94,A,B

The General Electric Silicon Unijunction Transistors are three-terminal devices having a stable "N" type negative resistance characteristic over a wide temperature range. A stable peak point and a high peak current rating make these devices useful in oscillators, timing circuits, trigger circuits, and bistable circuits, where it can serve the purpose of two conventional silicon transistors. General Electric's Fixed'Bed Construction makes these transistors extremely reliable under severe conditions of mechanical shock, vibration, centrifugal force, and thermal shock. It also provides a lower terminal resistance and improved uniformity of electrical characteristics. These transistors are hermetically sealed in welded cases.





ONLY THE UNIJUNCTION SUBMITTED TO TEMPERATURE

FEATURES

- **Stable Operation over Wide Temperature Range**
- **Low Leakage Current**
- **Low Peak Point Current**
- **Guaranteed Minimum Pulse Voltage**

absolute maximum ratings*

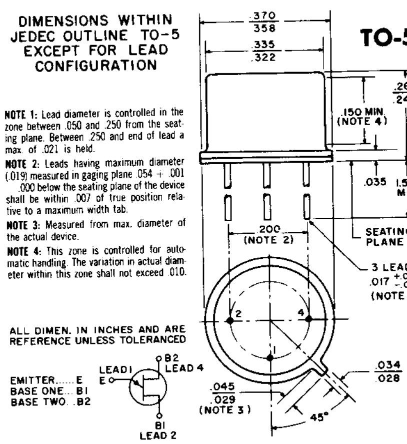
	2N489, A, B THROUGH 2N494, A, B	
Total RMS Power Dissipation—Unstabilized[3]	450[1]	mw
Total RMS Power Dissipation—Stabilized[3]	600[1]	mw
RMS Emitter Current	70	ma
Peak Emitter Current[3, 4] (T_J = 150°C)	2	amps
Emitter Reverse Voltage (T_J = 150°C)	60	volts
Operating Temperature Range	−65 to +140	°C
Operating Temperature Range—Stabilized[3]	−65 to +175	°C
Storage Temperature Range	−65 to +175	°C

1. Derate 3.9 mw/°C increase in amb. temp. (Thermal resistance to case = 0.16°C/mw)
2. Derate 2.6 mw/°C increase in amb. temp. (Thermal resistance to case = 0.08°C/mw)
3. Under normal operation, thermal runaway conditions cannot exist with the UJT up to a junction temperature of 140°C since the temperature coefficient of R_{BB} is positive below this temperature and I_{EO} is negligible. For this reason an unstabilized power rating can be used with the UJT which is derated to zero at 140°C. The UJT can be used at temperatures above 140°C but in this case external resistance must be used in the emitter and interbase circuits to limit the power dissipation and prevent thermal runaway. The power rating for this condition is the stabilized power rating and is derated to zero at 175°C. It is also important to provide circuit stabilization in the interbase circuit when the UJT is used in pulse type applications since the instantaneous temperature of the silicon could rise to a high enough value to permit runaway.
4. Emitter peak current should be limited to two amperes for discharge capacitances up to 10μfd, with a peak point voltage of 30 volts. For higher values of C or V_P, resistance must be added in series with the capacitor to protect the emitter circuit.

description

General Electric's Silicon Unijunction Transistor consists of an "N" type silicon bar mounted between two ohmic base contacts with a "P" type emitter near base-two. The device operates by conductivity modulation of the silicon between the emitter and base-one when the emitter is forward biased. In the cutoff, or standby condition, the emitter and interbase power supplies establish potentials between the base contacts, and at the emitter, such that the emitter is back biased. If the emitter potential is increased sufficiently to overcome this bias, holes (minority carriers) are injected into the silicon bar. These holes are swept toward base-one by the internal field in the bar. The increased charge concentration, due to these holes, decreases the resistance and hence decreases the internal voltage drop from the emitter to base-one. The emitter current then increases regeneratively until it is limited by the emitter power supply. The effect of this conductivity modulation is also noticed as an effective modulation of the interbase current.

*25°C, unless otherwise specified.



2N489, A, B THROUGH **2N494, A, B**

electrical characteristics: (at 25°C unless otherwise noted)

General Electric Unijunction Transistors are specified primarily in three ranges of stand-off ratio and two ranges of interbase resistance. Each range of stand-off ratio has limits of ±10% from the center value and each range of interbase resistance has limits of ±20% from the center value.

Type No. TO-5	Intrinsic Standoff Ratio (See note 1) V_{BB} = 10V η Min.	Max.	Interbase Resistance (See note 2) V_{BB} = 3V R_{BBO} ohms Min.	Max.	Modulated Interbase Current I_E = 50 ma V_{BB} = 10V $I_{B2(MOD)}$ ma Min.	Max.	MAXIMUM: Emitter Saturation Voltage I_E = 50 ma V_{BB} = 10V $V_{E(SAT)}$ volts	MAXIMUM: Emitter Reverse Current V_{B2E} = 60V I_{EB20} μa	Emitter Reverse Current T_J = 150°C V_{B2E} = 10V I_{EB20} μa	Emitter Reverse Current V_{B2E} = 30V I_{EB20} μa	MAXIMUM: Peak Point Current V_{BB} = 25V I_P μa	MINIMUM: Valley Point Current R_{B2} = 100Ω V_{BB} = 20V I_V ma	MINIMUM: Base One Peak Pulse Voltage (See note 3) V_{OB1} volts
2N489	.51	.62	4.7	6.8	6.8	22	5	2	20		12	8	
2N489A	.51	.62	4.7	6.8	6.8	22	4	2	20		12	8	3
2N489B	.51	.62	4.7	6.8	6.8	22	4	2	20	0.2	6	8	3
2N490	.51	.62	6.2	9.1	6.8	22	5	2	20		12	8	
2N490A	.51	.62	6.2	9.1	6.8	22	4	2	20		12	8	3
2N490B	.51	.62	6.2	9.1	6.8	22	4	2	20	0.2	6	8	3
2N491	.56	.68	4.7	6.8	6.8	22	5	2	20		12	8	
2N491A	.56	.68	4.7	6.8	6.8	22	4.3	2	20		12	8	3
2N491B	.56	.68	4.7	6.8	6.8	22	4.3	2	20	0.2	6	8	3
2N492	.56	.68	6.2	9.1	6.8	22	5	2	20		12	8	
2N492A	.56	.68	6.2	9.1	6.8	22	4.3	2	20		12	8	3
2N492B	.56	.68	6.2	9.1	6.8	22	4.3	2	20	0.2	6	8	3
2N493	.62	.75	4.7	6.8	6.8	22	5	2	20		12	8	
2N493A	.62	.75	4.7	6.8	6.8	22	4.6	2	20		12	8	3
2N493B	.62	.75	4.7	6.8	6.8	22	4.6	2	20	0.2	6	8	3
2N494	.62	.75	6.2	9.1	6.8	22	5	2	20		12	8	
2N494A	.62	.75	6.2	9.1	6.8	22	4.6	2	20		12	8	3
2N494B	.62	.75	6.2	9.1	6.8	22	4.6	2	20	0.2	6	8	3

notes:

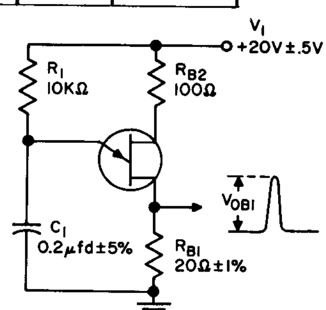
1. The intrinsic standoff ratio, η, is essentially constant with temperature and interbase voltage. η is defined by the equation:

$$V_P = \eta\, V_{BB} + \frac{200}{T_J}$$

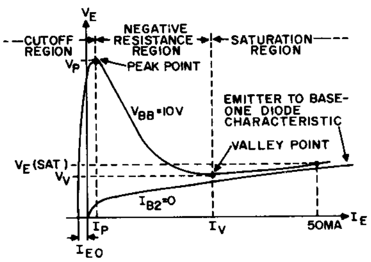
Where
V_P = Peak point emitter voltage
V_{BB} = Interbase voltage
T_J = Junction Temperature (Degrees Kelvin)

2. The interbase resistance is nearly ohmic and increases with temperature in a well defined manner. The temperature coefficient at 25°C is approximately 0.8%/°C.

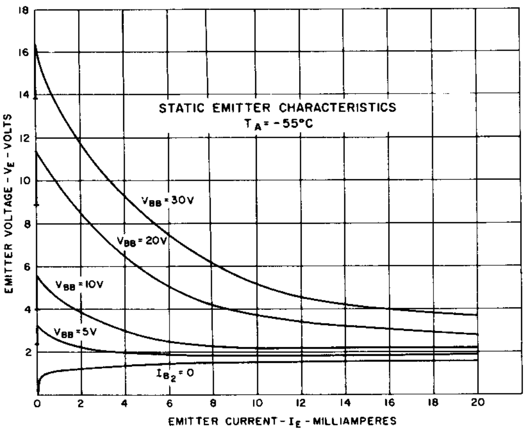
3. The base-one peak pulse voltage is measured in the circuit at right. This specification on the A and B versions is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.

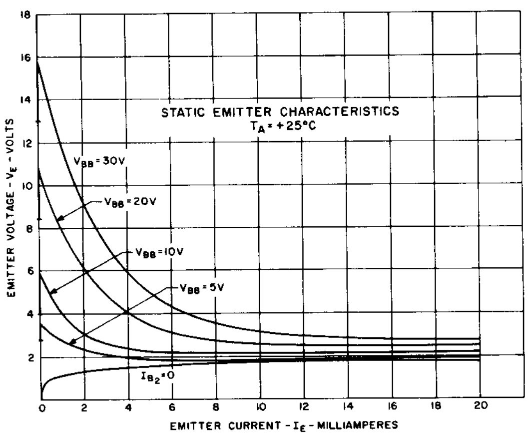


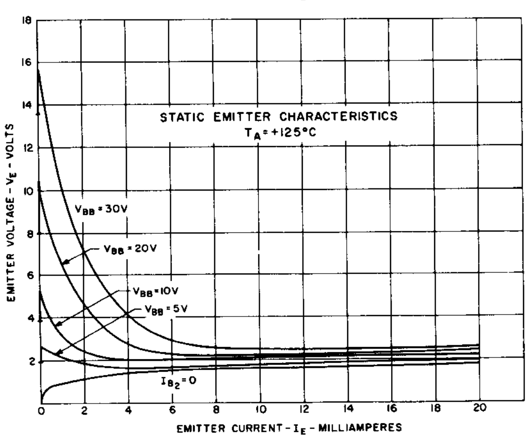
2N489-94, A, B EMITTER CHARACTERISTICS



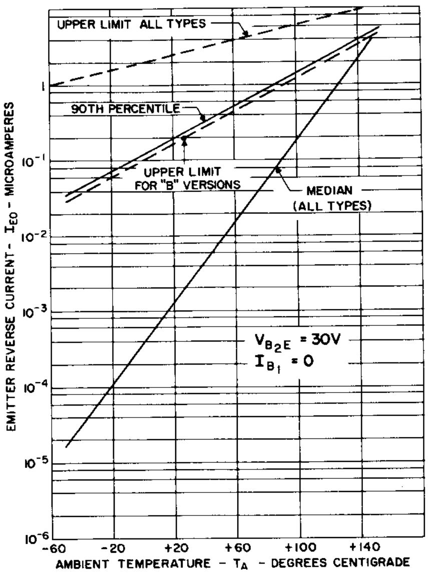
Static Emitter Characteristic curves showing important parameters and measurement points (exaggerated to show details).

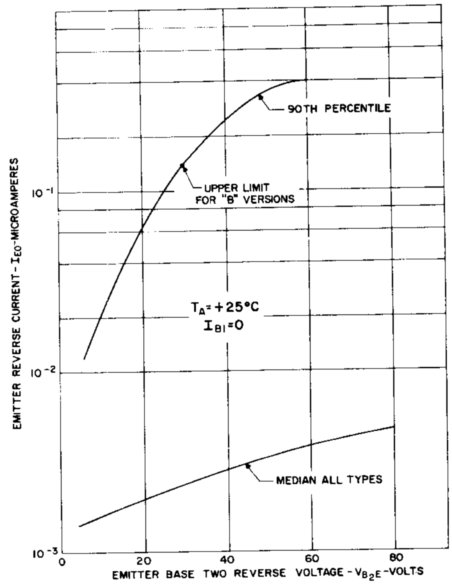




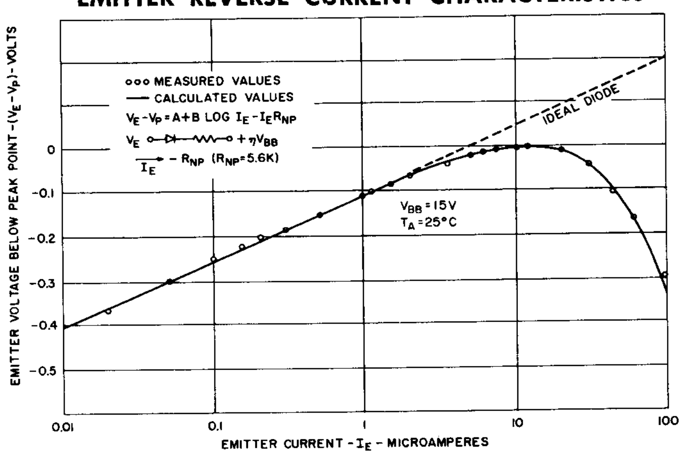


STATIC EMITTER CHARACTERISTICS

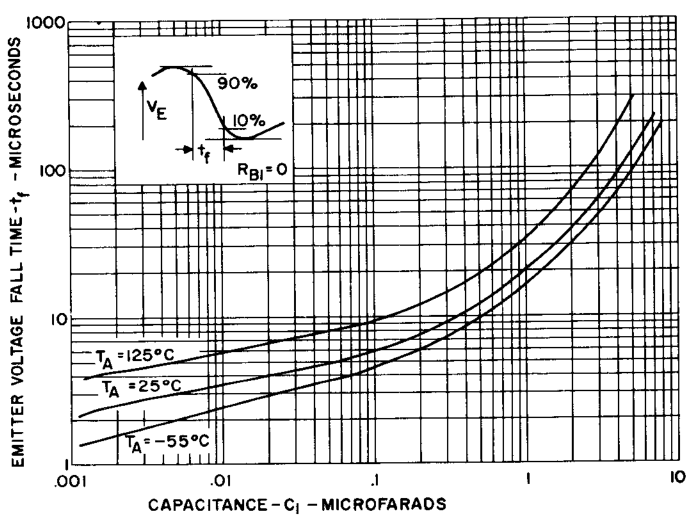




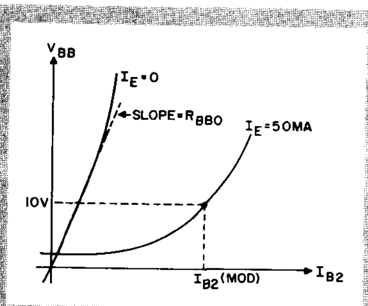
EMITTER REVERSE CURRENT CHARACTERISTICS



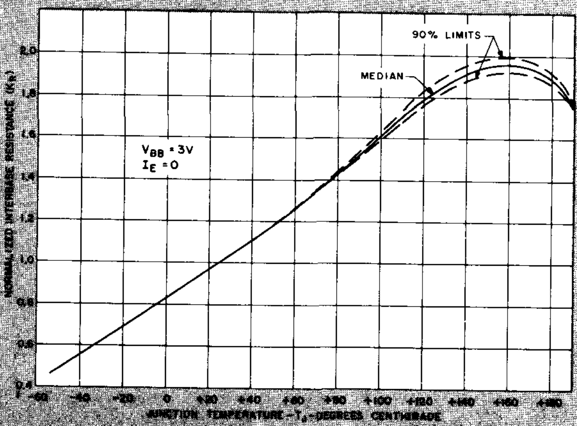
STATIC EMITTER CHARACTERISTICS AT PEAK POINT



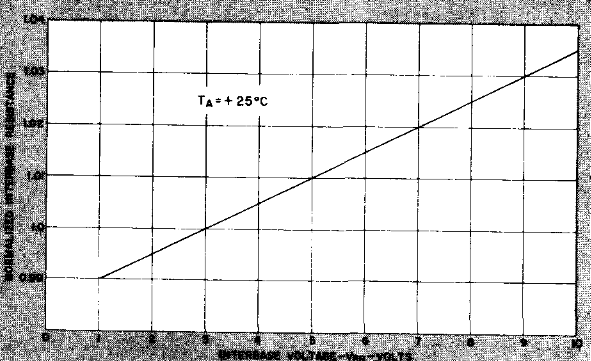
EMITTER VOLTAGE FALL TIME VS. CAPACITANCE IN RELAXATION OSCILLATOR



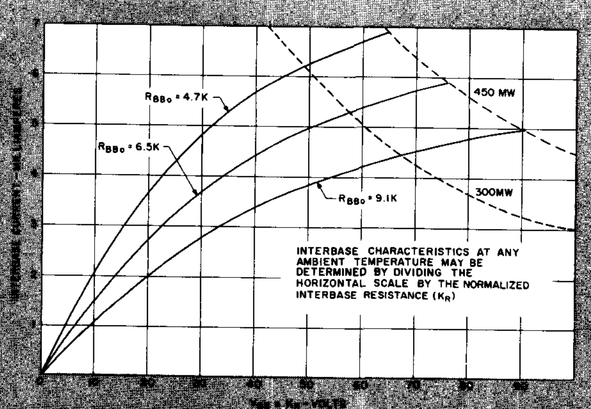
Static interbase characteristic curves showing important parameters and measurement points.



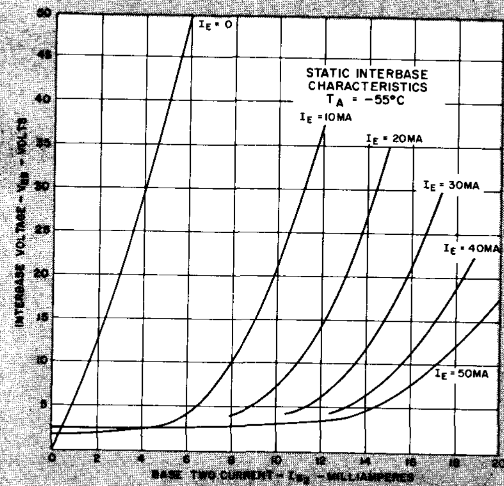
VARIATION OF R_{BB} WITH TEMPERATURE

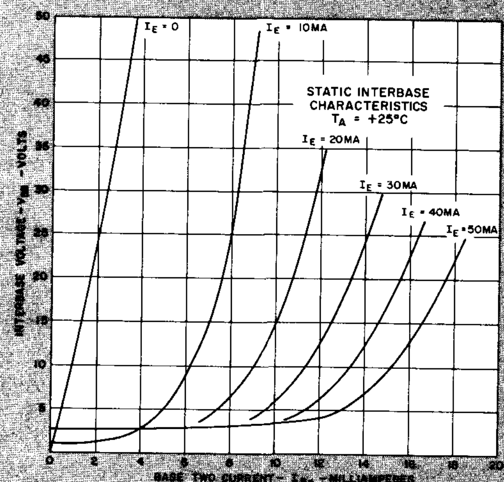


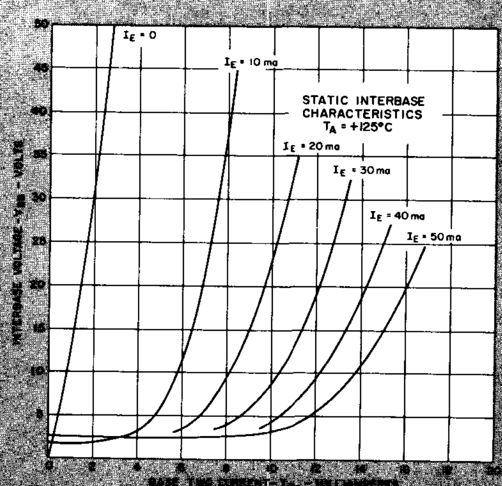
VARIATION OF R_{BB} WITH VOLTAGE



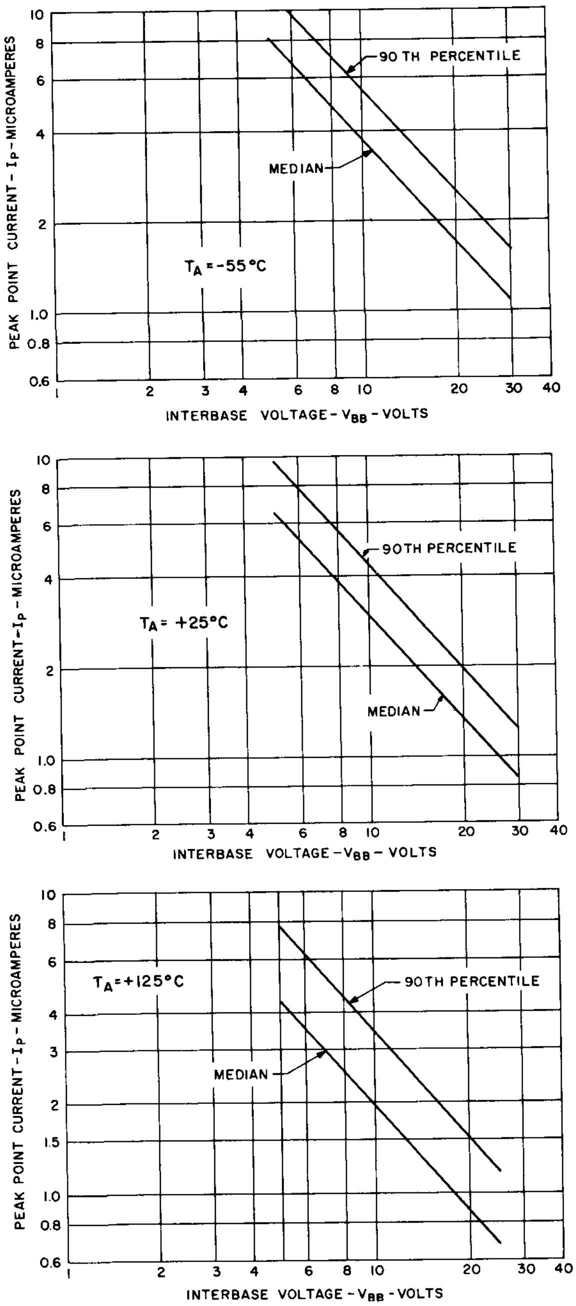
INTERBASE CHARACTERISTIC CURVES



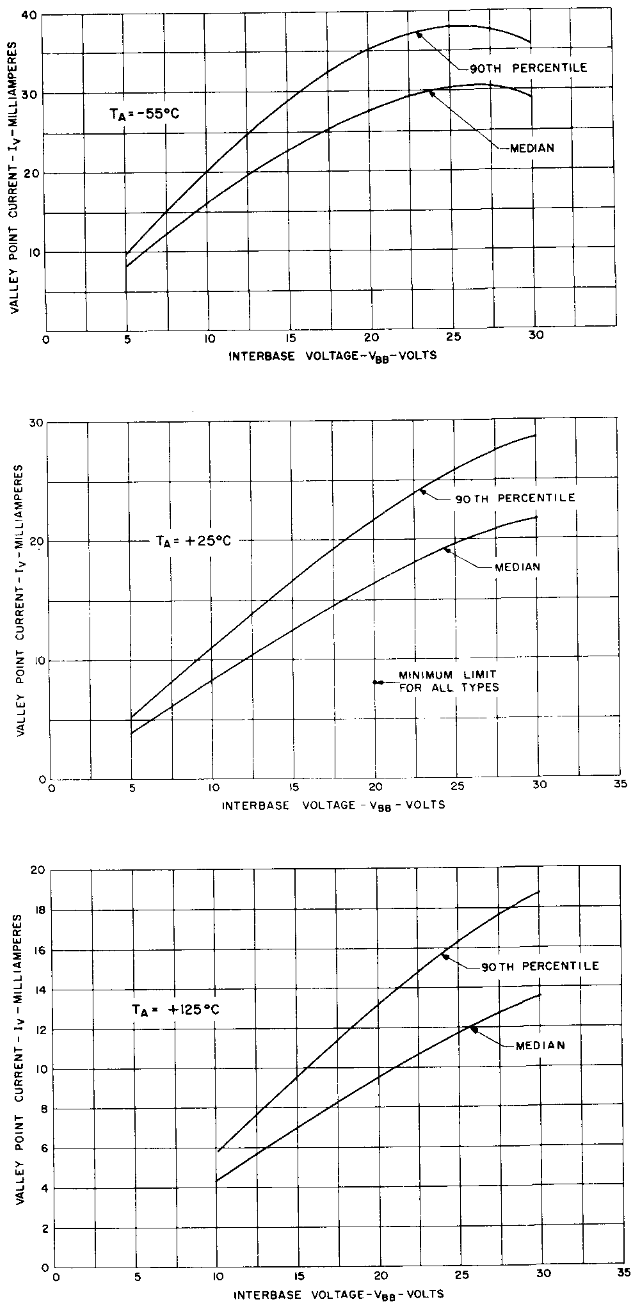




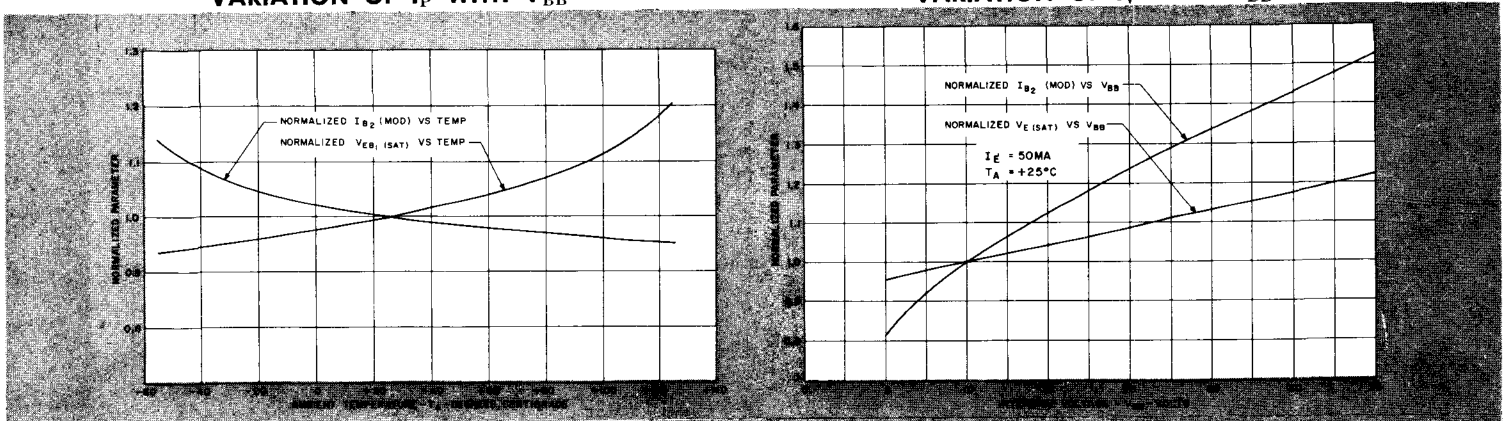
STATIC INTERBASE CHARACTERISTICS



VARIATION OF I_P WITH V_{BB}

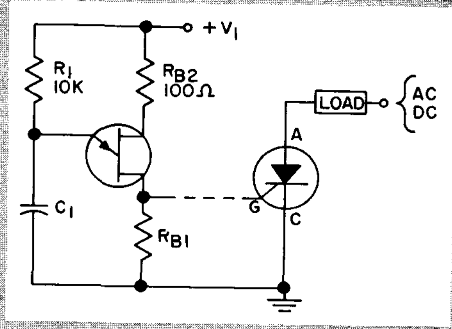


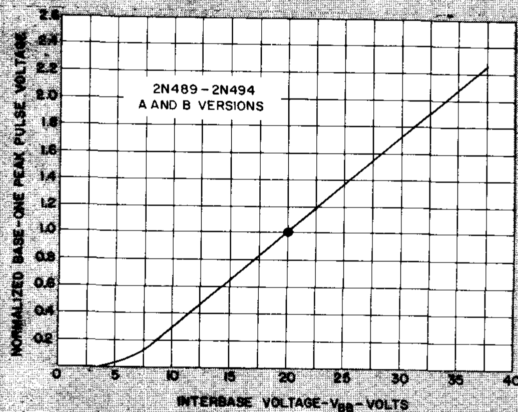
VARIATION OF I_V WITH V_{BB}



NORMALIZING CURVES FOR $I_{B2(MOD)}$ AND $V_{E(SAT)}$

DESIGNING SCR FIRING CIRCUITS



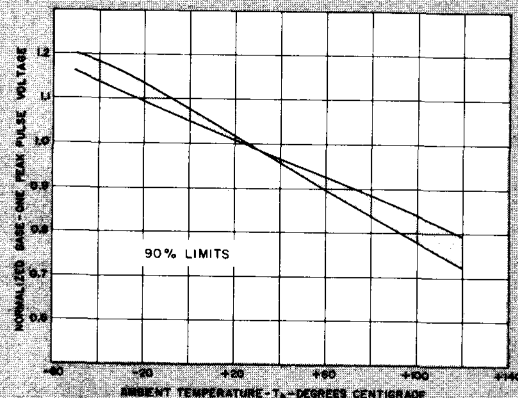


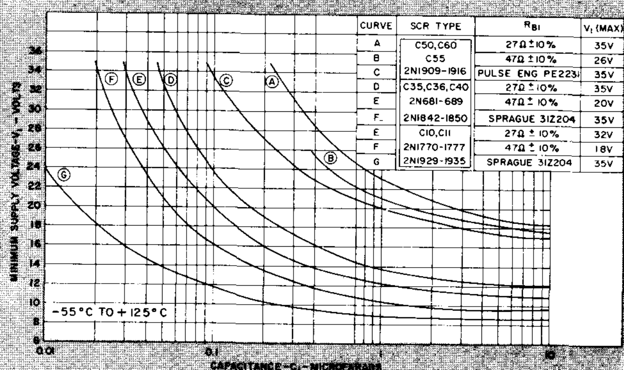
Period of Relaxation Oscillator

$\tau = R_1C_1 \ln \left(\frac{1}{1-\eta}\right)$

Maximum Value of R_1 for oscillation
(−55°C to +140°C)

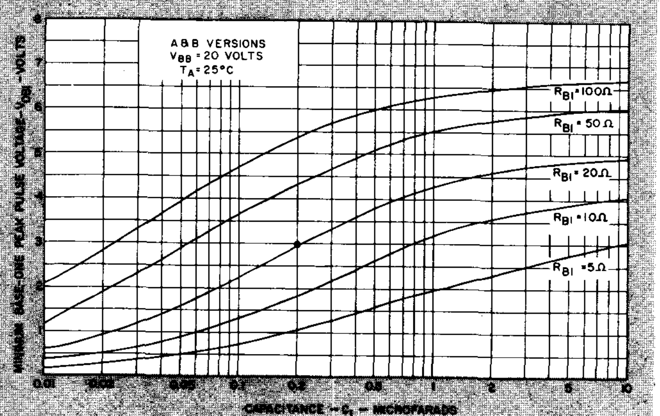
R_1 (max) = 480 V_1^2 (except B versions)
R_1 (max) = 1800 V_1^2 (B versions only)
τ = Period in Seconds
C_1 = Capacitance in Farads
R_1 = Resistance in ohms
V_1 = Supply voltage in volts



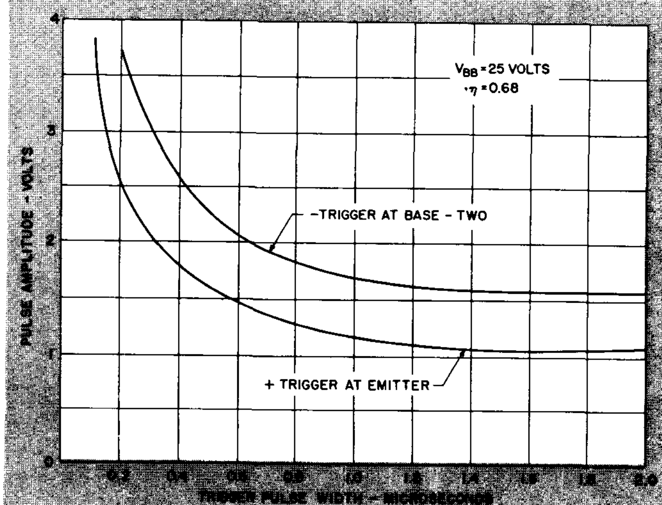


CURVE	SCR TYPE	R_{B1}	V_1 (MAX)
A	C50, C60	27Ω ± 10%	35V
B	C55	47Ω ± 10%	26V
C	2N1909-1916	PULSE ENG PE2231	35V
D	C35, C36, C40	27Ω ± 10%	35V
E	2N681-689	47Ω ± 10%	20V
F	2N1842-1850	SPRAGUE 31Z204	35V
E	C10, C11	27Ω ± 10%	32V
F	2N1770-1777	47Ω ± 10%	18V
G	2N1929-1935	SPRAGUE 31Z204	35V

$V_{BB(MIN)}$ VS. C_1 FOR SCR FIRING



V_{OB1} CHARACTERISTICS



MINIMUM TRIGGER AMPLITUDE AS A FUNCTION OF TRIGGER PULSE WIDTH FOR TURN-ON OF UJT TRANSISTORS

REFERENCES:

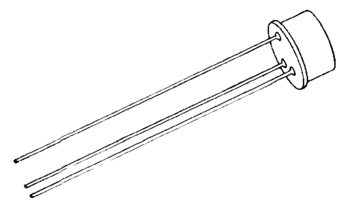
1. "Notes on the Application of the Silicon Unijunction Transistor," 90.10.
2. "General Electric Controlled Rectifier Manual," Fifth Edition.

Silicon Unijunction Transistors

N P N

2N490C,2C,4C

The General Electric Silicon Unijunction Transistor is a three terminal device having a stable "N" type negative resistance characteristic over a wide temperature range. These devices have a stable peak point voltage, a low peak point current, and a low emitter reverse current making them useful in timing and sensing circuits. They are intended for applicatins where a low emitter leakage current (high input impedance) and a low peak point emitter current (sensitive trigger current) are required (i.e., level sensing and long time delay applications), and also for triggering Silicon Controlled Rectifiers or other pulse sensitive circuitry.



*Revisions included in this issue consist of adding the 2N490C and 2N492C. Secondly, the Emitter Reverse Current parameter, I_{EX}, is now shown for the first time.

See 2N489-94 specification sheet 60.10 for detailed curves.

absolute maximum ratings: (25°C)*

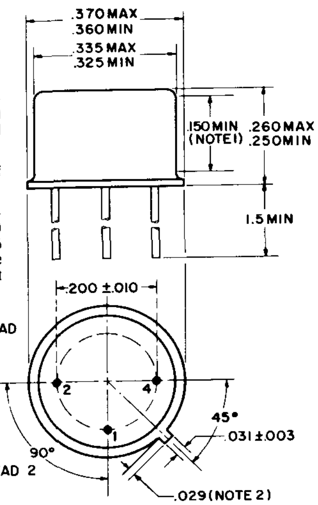
Voltages		
Emitter Reverse	60	volts
Interbase	65	volts
Current		
RMS Emitter	70	ma
Peak Emitter	2	amperes†
Power		
Dissipation	600	mw**
Temperatures		
Operating	−65 to +175	°C
Storage	−65 to +175	°C

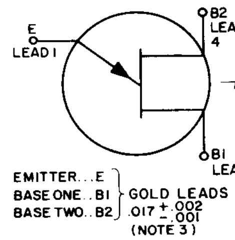
†Capacitor discharge—10 μfd or less, 30 volts or less.
**Derate 3.9 mw/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.

NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

NOTE 2: Measured from max. diameter of the actual device.

NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and 1.5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.





electrical characteristics: (25°C)

		2N490C MIN.	2N490C MAX.	2N492C MIN.	2N492C MAX.	2N494C MIN.	2N494C MAX.	
Intrinsic Standoff Ratio ($V_{BB} = 10V$)	η	.51	.62	.56	.68	.62	.75	
Interbase Resistance ($V_{BB} = 3V$, $I_E = 0$)	R_{BBO}	6.2	9.1	6.2	9.1	6.2	9.1	KΩ
Emitter Saturation Voltage ($V_{BB} = 10V$, $I_E = 50$ ma)	$V_{E(SAT)}$		4		4.3		4.6	volts
Modulated Interbase Current ($V_{BB} = 10V$, $I_E = 50$ ma)	$I_{B2(MOD)}$	6.8	22	6.8	22	6.8	22	ma
Emitter Reverse Current ($V_{B2E} = 30V$, $I_{B1} = 0$)	I_{EO}		0.02		0.02		0.02	μa
Emitter Reverse Current ($V_{BB} = 25V$, $V_{EB1} = V_P - .3V$) (Fig. 2)	I_{EX}		0.05		0.05		0.05	μa
Peak Point Emitter Current ($V_{BB} = 25V$)	I_P		2		2		2	μa
Valley Point Current ($V_{BB} = 20V$, $R_{B2} = 100Ω$)	I_V	8.0		8.0		8.0		ma
Base-One Peak Pulse Voltage‡	V_{OB1}	3.0		3.0		3.0		volts

‡The base-one peak pulse voltage is measured in Figure 1 below. This specification is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.

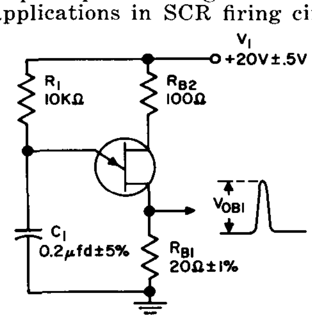


Figure 1

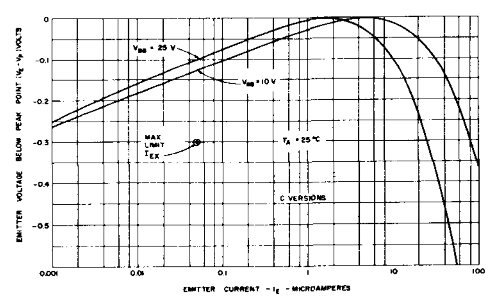
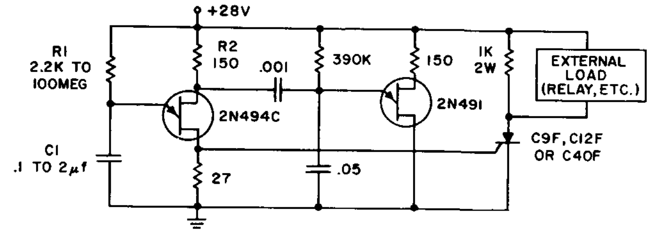
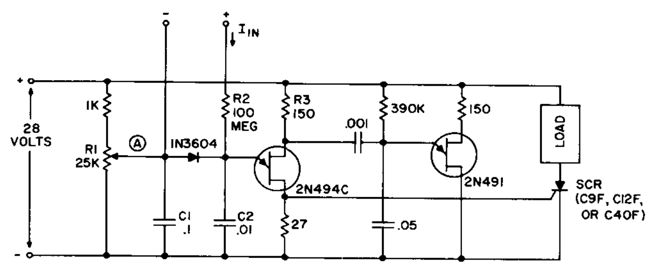


Figure 2



PRECISION SOLID STATE TIME DELAY CIRCUIT



NANOAMPERE SENSING CIRCUIT WITH
100 MEGOHM INPUT IMPEDANCE

PRECISION SOLID STATE TIME DELAY CIRCUIT

Time delays from 0.3 milliseconds to over three minutes is possible with this circuit without using a tantalum or electrolytic capacitor. The timing interval is initiated by applying power to the circuit. At the end of the timing interval, which is determined by the value of R1C1, the 2N494C fires the controlled rectifier. This places the supply voltage minus about one volt across the load. Load currents are limited only by the rating of the controlled rectifier which is from 1 ampere up to 25 amperes for the types specified in the circuit. A calibrated potentiometer could be used in place of R1 to permit setting a predetermined time delay after one initial calibration.

The charging resistor, R1, must be small enough to supply the minimum firing current (peak point current, I_P) of the 2N494C plus the leakage current of the capacitor when the emitter of the unijunction is biased at its peak point voltage. The 2N494C requires a minimum I_P of 2.0 microamperes. This would place a limit of 3 megohms for R1 and permit time delays of 6 seconds ($C1 = 2\ \mu f$, without using the additional 2N491 relaxation oscillator.

The circuit as shown effectively reduces the minimum I_P requirement up to a 1000X by pulsing the upper base of the 2N494C with a ¾ volt negative pulse. This negative pulse rate is not critical but it should have a period that is less than .02 (R1 x C1). This negative pulse causes the peak point voltage (firing point voltage level required at the emitter of the 2N494C) to drop slightly and if the voltage level at C1 is greater than this, the unijunction will fire with the necessary I_P supplied from C1. By use of this technique, this circuit has given time delays of about one hour with 2000 megohms at R1 and 2 μf at C1. The low leakage requirement for C1 is easily obtained with a mylar capacitor. R2 can be adjusted or selected for best stabilization of the firing point over the required temperature range.

A pulse transformer can be used in place of the 27 ohm resistor if it is necessary to have the timing circuit isolated from the power switching (controlled rectifier) circuit which, for instance, might be connected to the AC line.

The input impedance of the 2N494C is greater than 1500 megohms before it is fired. The maximum time delay that can be achieved by this circuit is mainly dependent upon the maximum values that can be obtained for R1 and C1 consistent with the low leakage requirement.

NANOAMPERE SENSING CIRCUIT WITH 100 MEGOHM INPUT IMPEDANCE

The circuit shown may be used as a sensitive current detector or as a voltage detector having high input impedance. R1 is set so that the voltage at point (A) is ½ to ¾ volts below the level that fires the 2N494C. A small input current (I_{in}) of only 40 nanoamperes will charge C2 and raise the voltage at the emitter to the firing level. When the 2N494C fires, both capacitors, C1 and C2, are discharged through the 27 ohm resistor, which generates a positive pulse with sufficient amplitude to trigger a controlled rectifier (SCR), or other pulse sensitive circuitry.

C2 is kept small for faster firing response time and C1 is used to provide the pulse output energy. Rapid recovery is obtained after the 2N494C fires since both capacitors are charged through R1. This configuration has the advantage that the leakage current of the silicon diode effectively subtracts from the leakage current of the unijunction and thus providing some temperature compensation.

The input current available (I_{in}) through the 100 MΩ resistor will be much lower than the minimum firing current of the 2N494C (peak point current (I_P) = 2.0 μa). Use of a sampling technique described above, however, permits a reduction in the external firing current (I_{in}) by as much as 1000 times below I_P. By pulsing the upper base of the 2N494C with a 0.75 volt amplitude negative pulse the peak point voltage (firing point voltage level required at the emitter) will drop slightly and if the voltage level at C2 is greater than this, the unijunction will fire with the necessary I_P supplied from C2. By use of this technique, the 2N494C has been fired with external input currents (I_{in}) as low as 1 nanoampere with a 2000 megohm resistor for R2.

The period of the 2N491 relaxation oscillation is not critical, but it should have a time constant of .02 or less than that of the 2N494C.

A floating power supply for this sensing circuit using a zener diode will permit grounding one of the sensing input terminals if this is desirable. R1 should be adjusted so the circuit will not fire at the maximum ambient temperature in the absence of the current or voltage sensing signal. R3 can be adjusted or selected for best stabilization of the firing point over the required temperature range.

SCR

2N681-92

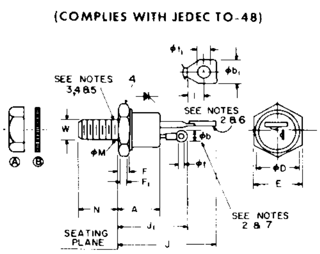
The 2N681 through 2N692 Series of Silicon Controlled Rectifiers are reverse blocking triode thyristor semiconductor devices for use in medium power switching and phase control applications requiring blocking voltages up to 800 volts, and average load currents (single-phase, 180° conduction angle) up to 16 amperes.

General Electric's C35 SCR and C137 SCR are recommended where a higher level of performance is required for a device of this size.

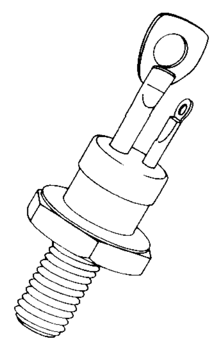
OUTLINE DRAWING
(COMPLIES WITH JEDEC TO-48)

NOTES:
1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

A. ¼-28 steel nut, Ni. plated, .178 min. thk.
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb₁	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F₁	.060		1.52		
J		1.193		30.30	
J₁		.875		22.23	
t	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φT	.060	.075	1.52	1.91	
φT₁	.125	.165	3.18	4.19	
W					3



MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} $T_C = -65°C +125°C$	PEAK FORWARD VOLTAGE, PFV(2) $T_C = -65°C +125°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep)(1) $T_C = -65°C +125°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE (<5 MILLISEC.), V_{ROM} (non-rep)(1) $T_C = -65°C +125°C$
2N681	25 Volts*	35 Volts	25 Volts*	35 Volts*
2N682	50 Volts*	75 Volts	50 Volts*	75 Volts*
2N683	100 Volts*	150 Volts	100 Volts*	150 Volts*
2N684	150 Volts*	225 Volts	150 Volts*	225 Volts*
2N685	200 Volts*	300 Volts	200 Volts*	300 Volts*
2N686	250 Volts*	350 Volts	250 Volts*	350 Volts*
2N687	300 Volts*	400 Volts	300 Volts*	400 Volts*
2N688	400 Volts*	500 Volts	400 Volts*	500 Volts*
2N689	500 Volts*	600 Volts	500 Volts*	600 Volts*
2N690	600 Volts*	720 Volts	600 Volts*	720 Volts*
2N691	700 Volts*	840 Volts	700 Volts*	840 Volts*
2N692	800 Volts*	960 Volts	800 Volts*	960 Volts*

(1) Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C per watt.
(2) Cells with higher PFV ratings are available upon request.

RMS Forward Current, On-State .... 25 amperes (all conduction angles)
Average Forward Current, On-State .... Depends on conduction angle (see Charts 3, 5 and 7)
Rate of Rise of Forward Current, On-State, di/dt .... 10 amperes per microsecond
Peak One-cycle Surge Forward Current, I_{FM} (surge) .... 150 amperes*
I^2t (for fusing) .... 75 ampere² seconds (for times ≧1.5 milliseconds)
Peak Gate Power Dissipation, P_{GM} .... 5 watts*
Average Gate Power Dissipation, $P_{G(AV)}$ .... 0.5 watt*
** Peak Forward Gate Current, I_{GFM} .... 2 amperes*
** Peak Forward Gate Voltage, V_{GFM} .... 10 volts*
Peak Reverse Gate Voltage, V_{GRM} .... 5 volts*
Storage Temperature, T_{stg} .... −65°C to +150°C*
Operating Temperature, T_J .... −65°C to +125°C*
Stud Torque .... 30 lb-in (35 kg-cm)

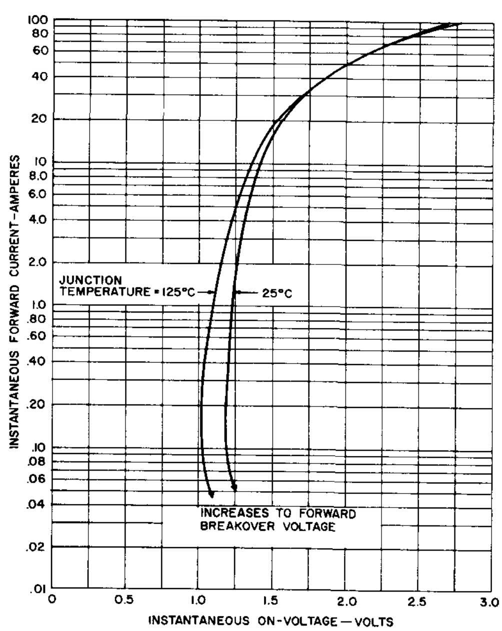
***Indicates Data included on JEDEC type number registration.**

****NOT TO EXCEED GATE POWER RATINGS**

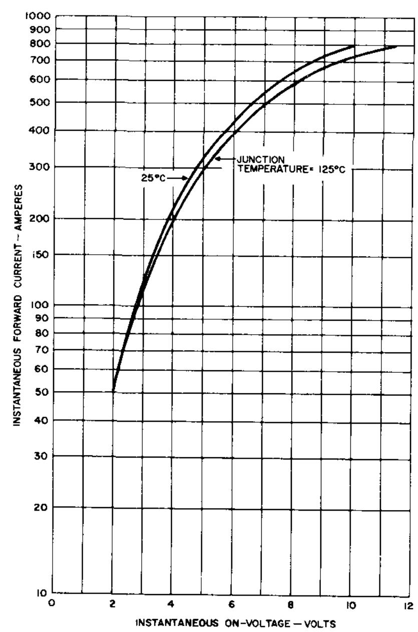
CHARACTERISTICS

TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE OR FORWARD BLOCKING CURRENT†	I_{ROM} or I_{FOM}			mA	$T_C = -65°C$ to $+125°C$
2N681		—	13.0		$V_{ROM} = V_{FOM} =$ 25V Peak
2N682		—	13.0		= 50V
2N683		—	13.0		= 100V
2N684		—	13.0		= 150V
2N685		—	12.0		= 200V
2N686		—	11.0		= 250V
2N687		—	10.0		= 300V
2N688		—	8.0		= 400V
2N689		—	6.0		= 500V
2N690		—	5.0		= 600V
2N691		—	4.5		= 700V
2N692		—	4.0		= 800V
FULL CYCLE AVG. REVERSE OR FORWARD BLOCKING CURRENT†	$I_{RX(AV)}$ or $I_{FX(AV)}$			mA	$T_C = +65°C$, $I_O = 16A$ 180° Conduction Angle
2N681		—	6.5*		$V_{RXM} = V_{FXM} =$ 25V Peak
2N682		—	6.5*		= 50V
2N683		—	6.5*		= 100V
2N684		—	6.5*		= 150V
2N685		—	6.0*		= 200V
2N686		—	5.5*		= 250V
2N687		—	5.0*		= 300V
2N688		—	4.0*		= 400V
2N689		—	3.0*		= 500V
2N690		—	2.5*		= 600V
2N691		—	2.25*		= 700V
2N692		—	2.0*		= 800V
GATE TRIGGER CURRENT	I_{GT}	—	40	mAdc	$T_C = +25°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
		—	80*	mAdc	$T_C = -65°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	—	3.0*	Vdc	$T_C = -65°C$ to $+125°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
		0.25*	—	Vdc	$T_C = +125°C$, V_{FXM} = Rated V_{FOM}, $R_L = 1000$ ohms
PEAK ON-VOLTAGE	V_{FM}	—	2.0	V	$T_C = +25°C$, $I_{FM} = 50A$ Peak, 1 mlilisecond wide pulse
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	—	1.7	°C/watt	

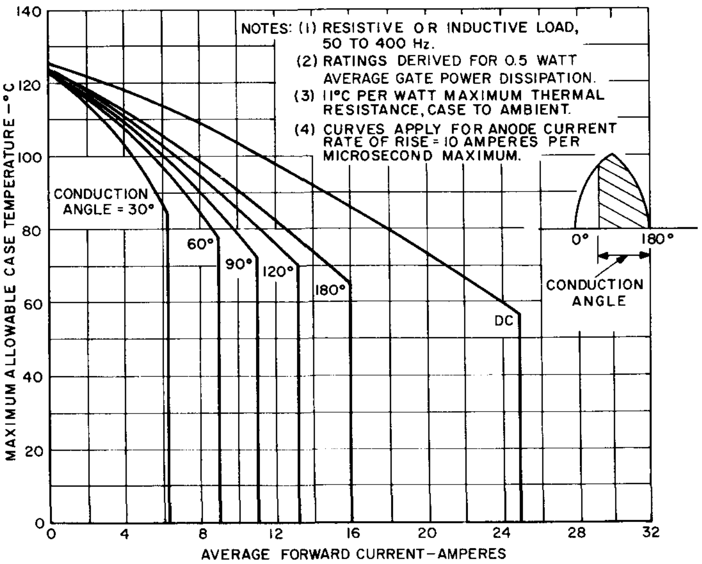
†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C/watt.
*Indicates data included on JEDEC type number registration.



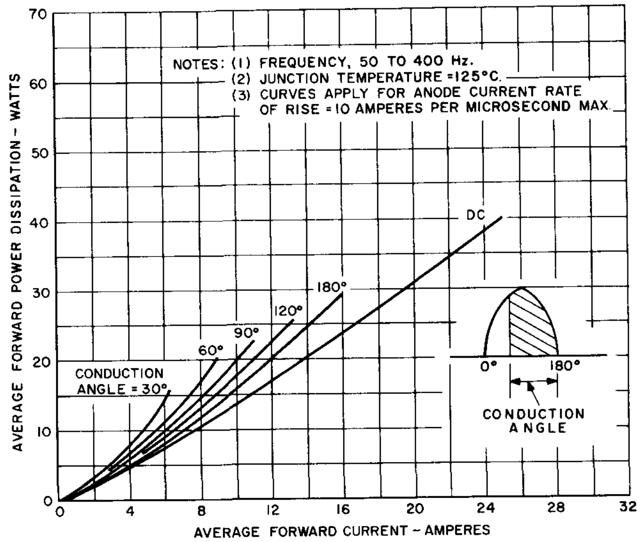
1. MAXIMUM FORWARD CHARACTERISTICS—ON-STATE



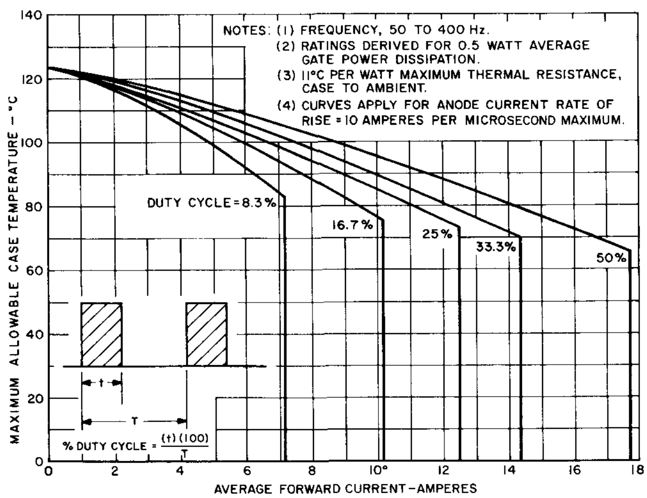
2. MAXIMUM FORWARD CHARACTERISTICS—HIGH CURRENT LEVEL—ON-STATE



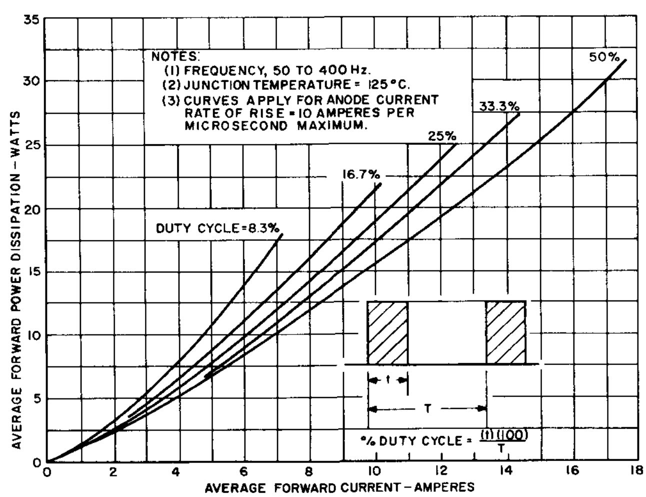
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



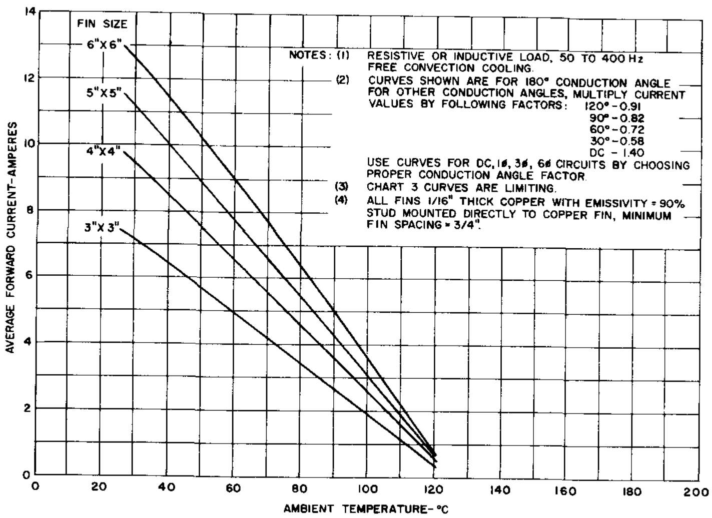
4. FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



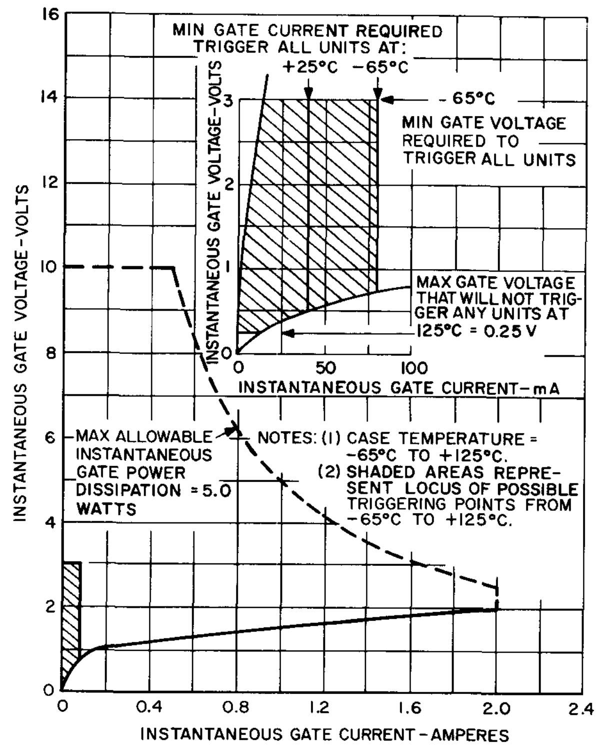
5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



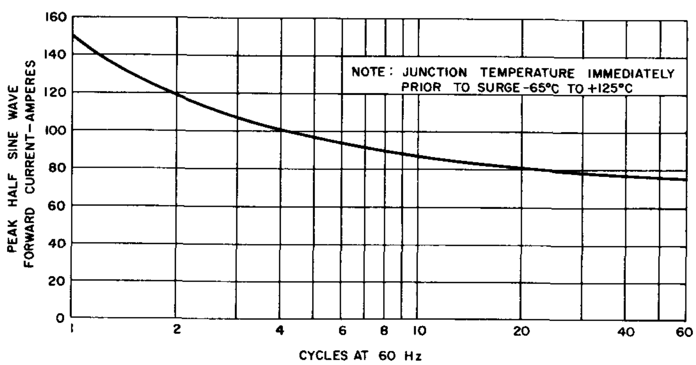
6. FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



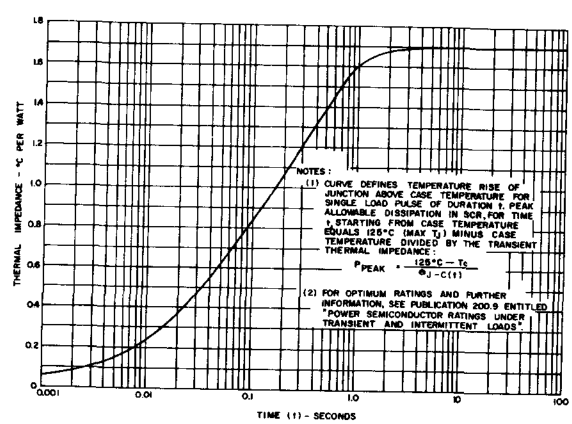
7. MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES



8. GATE TRIGGERING CHARACTERISTICS



9. MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE FORWARD CURRENT AT RATED LOAD CONDITIONS



10. MAXIMUM TRANSIENT THERMAL IMPEDANCE— JUNCTION TO CASE

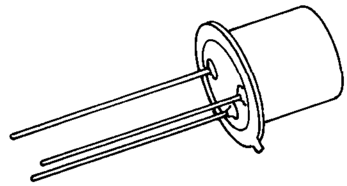
2N706 SEE GES706

SCR

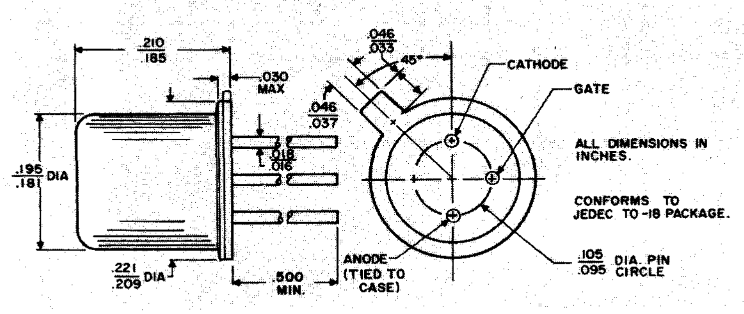
2N877-81
2N885-89

FEATURES:

- All-diffused for Proved Reliability
- Miniature Package TO-18
- Two Ranges of Gate Sensitivity:
  2N877-881 — 200 ua max.
  2N885-889 — 20ua max.
- Low Holding Current:
  2N877-881 — 5 ma. max.
  2N885-889 — 3 ma. mas.
- Voltage Ratings up to 200 volts
- Designed for Military Applications



OUTLINE DRAWING



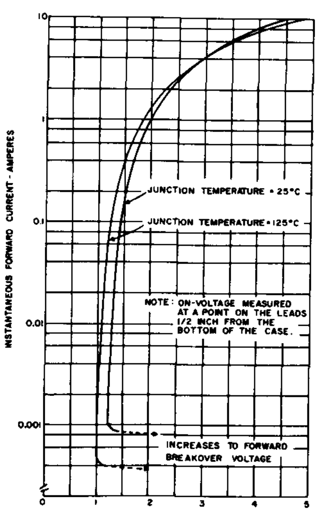
MAXIMUM ALLOWABLE RATINGS

TYPES	PEAK FORWARD BLOCKING VOLTAGE, V_{FXM}, $T_J = -65°C$ to $+125°C$. $R_{GK} = 1000$ OHMS MAXIMUM.	WORKING AND REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (wkg) and V_{ROM} (rep). $T_J = -65°C$ to $+150°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (non-rep) < 5 Milliseconds. $T_J = -65°C$ to $+125°C$
2N877, 2N885	30 volts	30 volts	45 volts
2N878, 2N886	60 volts	60 volts	90 volts
2N879, 2N887	100 volts	100 volts	130 volts
2N880, 2N888	150 volts	150 volts	200 volts
2N881, 2N889	200 volts	200 volts	275 volts

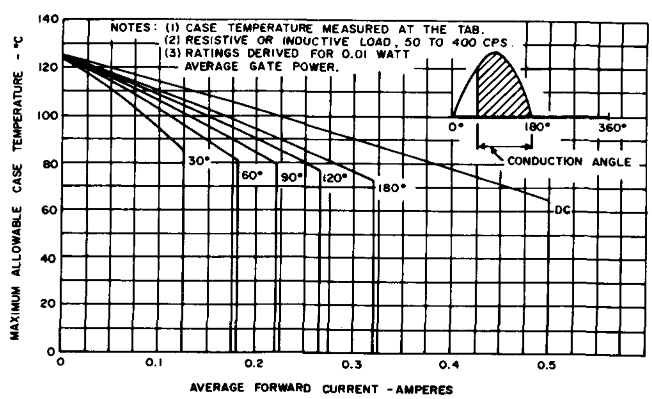
Peak Forward Voltage, PFV .... 300 Volts
RMS Forward Current, On-state .... 0.5 Ampere
Average Forward Current, On-state .... Depends on conduction angle (see charts 2, 3, 11 & 12)
Peak One Cycle Surge Forward Current (Non-repetitive), I_{FM} (surge) .... 7 Amperes
Peak Forward Gate Power Dissipation, P_{GM} .... 0.1 Watt
Average Forward Gate Power Dissipation, $P_{G(AV)}$ .... 0.01 Watt
Peak Gate Voltage, Forward and Reverse, V_{GFM} and V_{GRM} .... 6 Volts
Storage Temperature, T_{stg} .... −65°C to +150°C
Operating Temperature .... −65°C to +150°C

CHARACTERISTICS

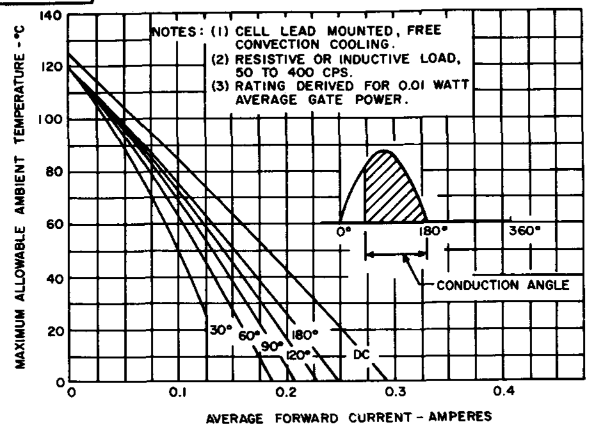
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
FORWARD BLOCKING CURRENT	I_{FX}				μAdc	V_{FX} = Rated V_{FXM}, R_{GK} = 1000 ohms
2N877-2N881		—	0.03	10		T_J = +25°C
		—	10	100		T_J = +125°C
2N885-2N889		—	0.03	1		T_J = +25°C
		—	10	20		T_J = +125°C
REVERSE BLOCKING CURRENT	I_{RX}				μAdc	V_{RX} = Rated V_{ROM} (rep)
2N877-2N881		—	0.1	10		T_J = +25°C
		—	10	100		T_J = +125°C
2N885-2N889		—	0.1	1		T_J = +25°C
		—	10	20		T_J = +125°C
REVERSE GATE CURRENT	I_{GRM}	—	1	10	μAdc	V_{GRM} = 2 Volts, T_J = +25°C.
PEAK ON-VOLTAGE	V_{FM}	—	1.3	1.9	volts	T_J = +25°C, I_{FM} = 1 Ampere, single half sine wave pulse, 2.0 milliseconds wide max.
HOLDING CURRENT	I_{HX}				mAdc	T_J = +25°C, R_{GK} = 1000 ohms, V_{FX} = 24 Volts dc.
2N877-2N881		0.4	1.7	5.0		
2N885-2N889		0.4	1.1	3.0		
RATE OF RISE OF APPLIED FORWARD VOLTAGE	dv/dt	—	40	—	volts/μsec	T_J = +125°C, R_{GK} = 1000 ohms, V_{FXM} = Rated V_{FXM}
TURN-ON TIME (Delay Time + Rise Time)	t_d+t_r	—	1.0	—	μsec	T_J = +25°C, V_{FX} = Rated V_{FXM}, I_{FM} = 1 Ampere, Gate Supply: 6 Volts, 300 ohms
CIRCUIT COMMUTATED TURN-OFF TIME All Types	t_{off}	—	15	—	μsec	T_J = +125°C, R_{GK} = 1000 ohms, I_{FM} = 1 Ampere, I_R (recovery) = 1 Ampere Reapplied V_{FXM} = Rated, Rate of Rise of Reapplied Forward Blocking Voltage = 20 V/μsec
GATE TRIGGER CURRENT	I_{GT}				μAdc	V_{FX} = 6 Vdc, R_{GK} = 1000 ohms, R_L = 100 ohms maximum.
2N877-2N881		—	40	200		T_J = +25°C
2N885-2N889		—	10	20		T_J = +25°C
GATE TRIGGER VOLTAGE	V_{GT}				Vdc	V_{FX} = 6 Vdc, R_{GK} = 1000 ohms, R_L = 100 ohms maximum.
2N877-2N881		0.4	0.5	0.8		T_J = +25°C
2N885-2N889		0.44	0.5	0.6		T_J = +25°C
All Types		0.05	—	—		V_{FX} = Rated V_{FXM}, R_{GK} = 1000 ohms, T_J = +125°C



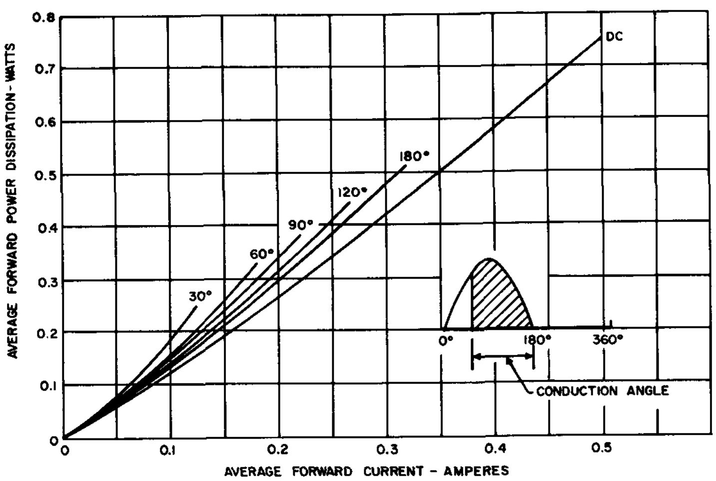
1. MAXIMUM FORWARD CHARACTERISTICS, ON-STATE



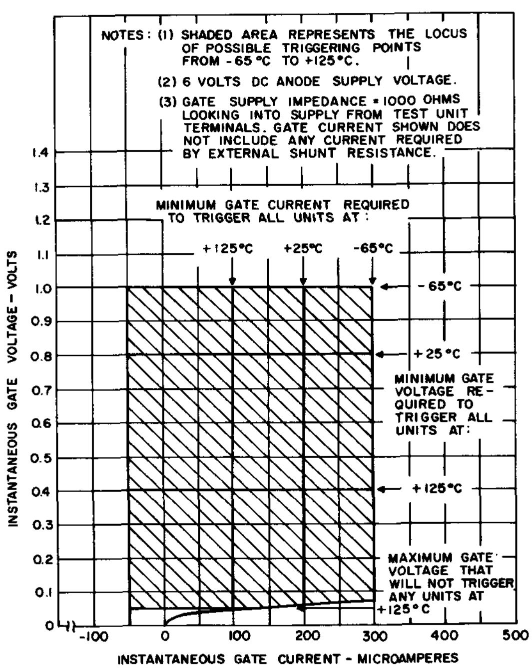
2. MAXIMUM ALLOWABLE CASE TEMPERATURE (125°C JUNCTION TEMP.)



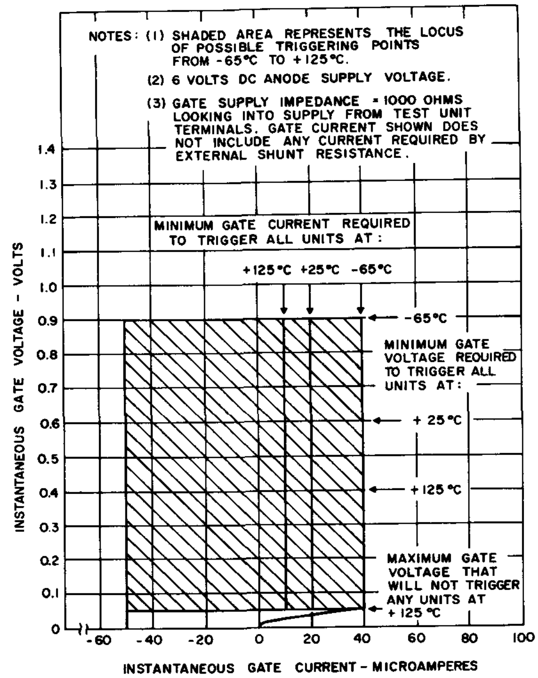
3. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE (125°C JUNCTION TEMP.)



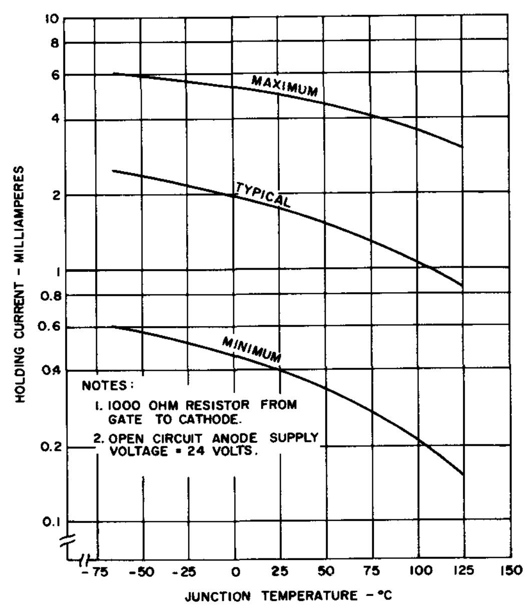
4. FORWARD POWER DISSIPATION



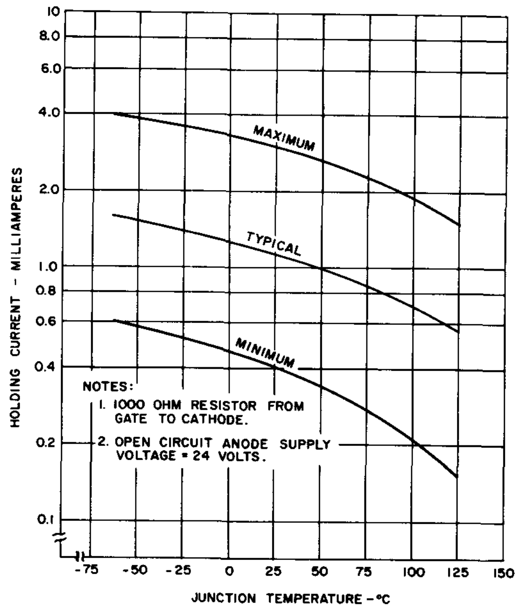
5. GATE TRIGGERING CHARACTERISTICS (2N877-2N881)



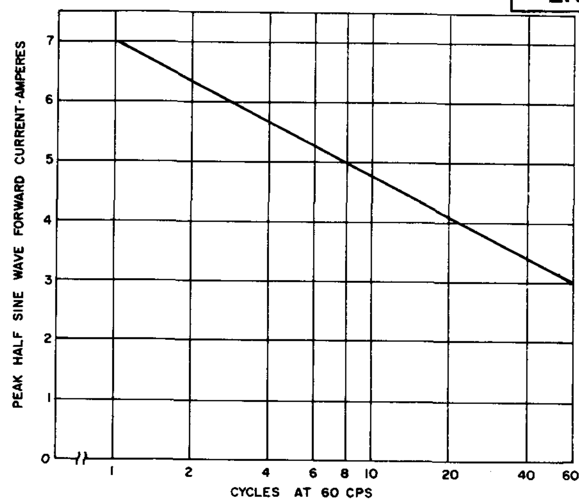
6. GATE TRIGGERING CHARACTERISTICS (2N885-2N889)



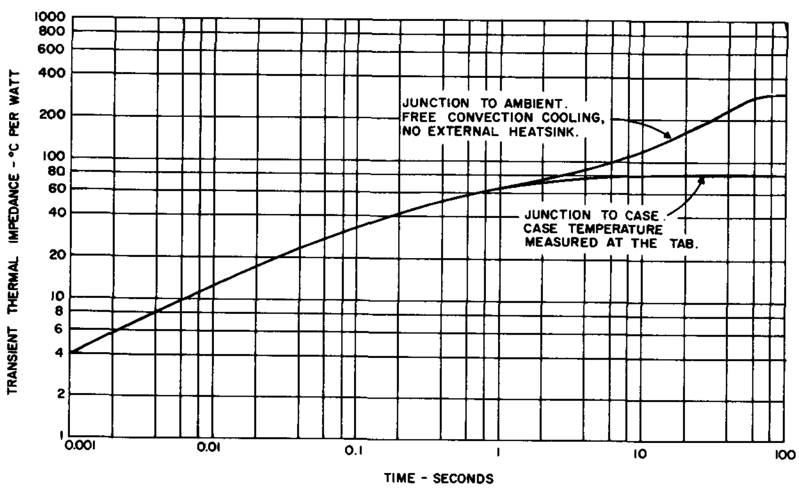
7. HOLDING CURRENT AS A FUNCTION OF JUNCTION TEMPERATURE (2N877-2N881)



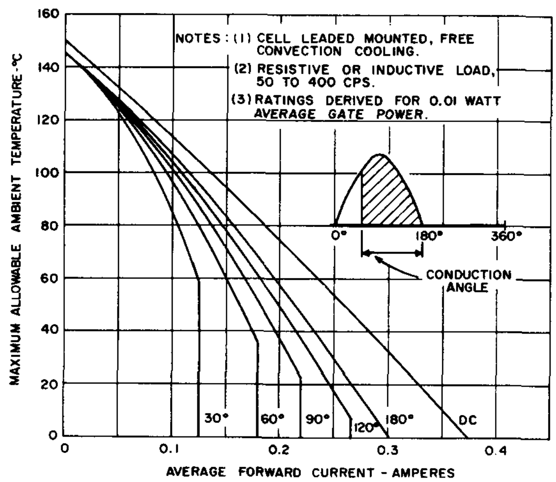
8. HOLDING CURRENT AS A FUNCTION OF JUNCTION TEMPERATURE (2N885-2N889)



9. MAXIMUM ALLOWABLE NON-RECURRENT SURGE CURRENT AT RATED LOAD CONDITIONS

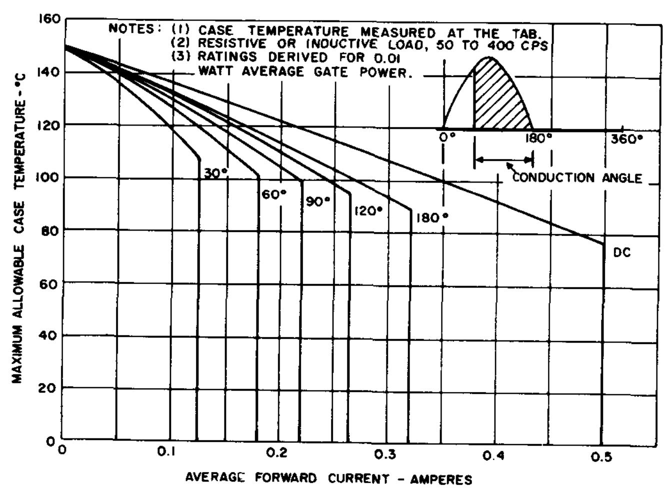


10. MAXIMUM TRANSIENT THERMAL IMPEDANCE



11. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE (150°C JUNCTION TEMP.)

Charts 11 and 12 apply to latching applications where SCR need not block forward voltage after being turned on, since the V_{FXM} rating does not apply above 125°C junction temperature. SCR will again block rated forward voltage after junction temperature drops below 125°C.



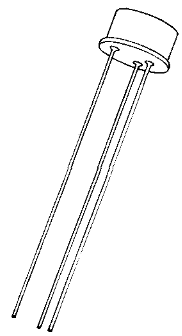
12. MAXIMUM ALLOWABLE CASE TEMPERATURE (150°C JUNCTION TEMP.)

SCR

2N1595-99

2N929	SEE GES929
2N930	SEE GES930

The 2N1595 series of Silicon Controlled Rectifiers are planar-passivated, all-diffused, three junction, reverse blocking triode thyristors for low power switching and control applications. The 2N2322 series, which is also available, offers additional maximum specified electrical parameters.



- Painted external surface for maximum heat dissipation
- Single-ended package, ideal for printed circuit applications
- All-welded construction
- All-diffused, planar passivated
- Glass-to-metal seals

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}(1)	PEAK POSITIVE ANODE VOLTAGE PFV	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}
	T_C = −65°C to +125°C		
2N1595	50 Volts*	500 Volts	50 Volts*
2N1596	100 Volts*	500 Volts	100 Volts*
2N1597	200 Volts*	500 Volts	200 Volts*
2N1598	300 Volts*	500 Volts	300 Volts*
2N1599	400 Volts*	500 Volts	400 Volts*

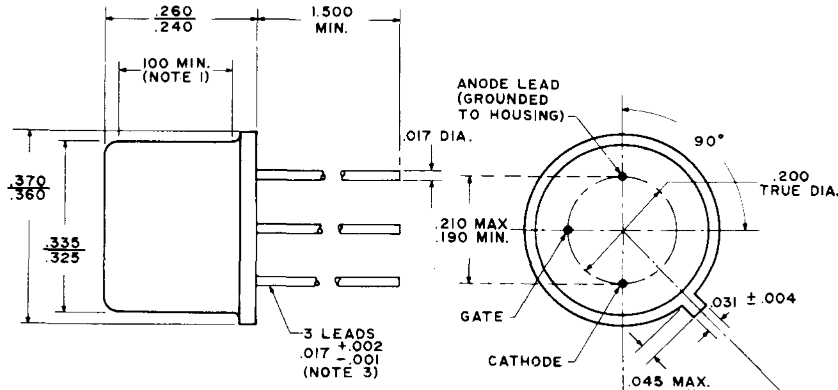
(1) Applies for 1000 ohms maximum, connected gate-to-cathode.

RMS On-State Current, $I_{T(RMS)}$ .... 1.6 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$ .... Depends on conduction angle (see Charts 3, 4, 5 and 6)
Peak One-Cycle Surge (Non-rep) On-State Current, I_{TSM} .... 15 Amperes*
Peak Gate Power Dissipation, P_{GM} .... 0.1 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ .... 0.01 Watts
Peak Positive Gate Current, I_{GM} .... 0.1 Amperes
Peak Positive Gate Voltage, V_{GM} .... 6 Volts
Peak Negative Gate Voltage, V_{GM} .... −6 Volts
Storage Temperature, T_{STG} .... −65°C to +150°C*
Operating Temperature, T_J .... −65°C to +150°C

* Indicates data included in JEDEC type number registration.

OUTLINE DRAWING
(Conforms to JEDEC TO-5 Package Outline)

2N1595-99



NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THIS ZONE SHALL NOT EXCEED .010.

NOTE 2: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

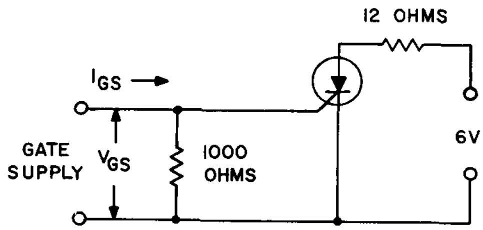
NOTE 3: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050 AND .250 FROM THE BASE SEAT. BETWEEN .250 AND 1.5 MAXIMUM OF .021 DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED. LEADS MAY BE INSERTED, WITHOUT DAMAGE, IN .031 HOLES WHILE DEVICE ENTERS .371 HOLE CONCENTRIC WITH LEAD HOLE CIRCLE.

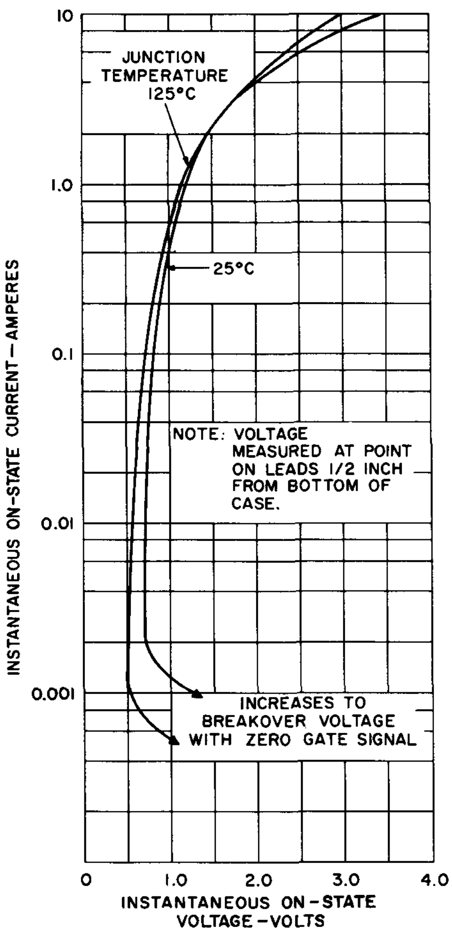
APROX WEIGHT: .05 OZ
ALL DIMENSIONS IN INCHES

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Off-State and Reverse Current	I_{DRM} & I_{RRM}	— —	2.0 100	10 1000*	μA	$V_{DRM} = V_{RRM}$ = Rated volts peak, R_{GK} = 1000 ohms. $T_C = +25°C$ $T_C = +125°C$
D.C. Gate Trigger Current	I_{GS} (1)	—	0.9	10*	mAdc	$T_C = +25°C$, V_D = 6 Vdc, R_L = 12 ohms
D.C. Gate Trigger Voltage	V_{GT}	—	0.6	3.0*	Vdc	$T_C = +25°C$, V_D = 6 Vdc, R_L = 12 ohms
Peak On-State Voltage	V_{TM}	—	1.25	2.0*	Volts	$T_C = +25°C$, I_{TM} = 1.0 A peak, 1 msec. wide pulse. Duty cycle ≦2%.
Holding Current	I_H	—	1.0	—	mAdc	$T_C = +25°C$, Anode Source Voltage = 12 Vdc, R_{GK} = 1000 ohms.
Circuit Commutated Turn-Off Time	t_q	—	40	—	μsec	$T_C = +125°C$, I_{TM} = 1.0 A peak. Rectangular current pulse, 50 μsec duration. Rate of rise of current < 10A/μsec. Commutation rate ≦ 5 A/μsec. Peak reverse voltage = Rated V_{RRM} volts max. Reverse voltage at end of turn-off time interval 15 volts. Repetition rate = 60 pps. Rate of rise of re-applied off-state voltage (dv/dt) = 20 V/μsec. Off-state voltage = Rated V_{DRM} volts. Gate bias during turn-off time interval = 0 volts, 100 ohms.
Turn-On Time	$t_d + t_r$	—	1.2	—	μsec	$T_C = +25°C$, V_D = Rated V_{DRM} value. I_{TM} = 1.0 A. Gate trigger pulse = 6 volts, 300 ohms, 5 μsec wide, 0.1 μsec rise time. Gate bias = 0 volts, 300 ohms.

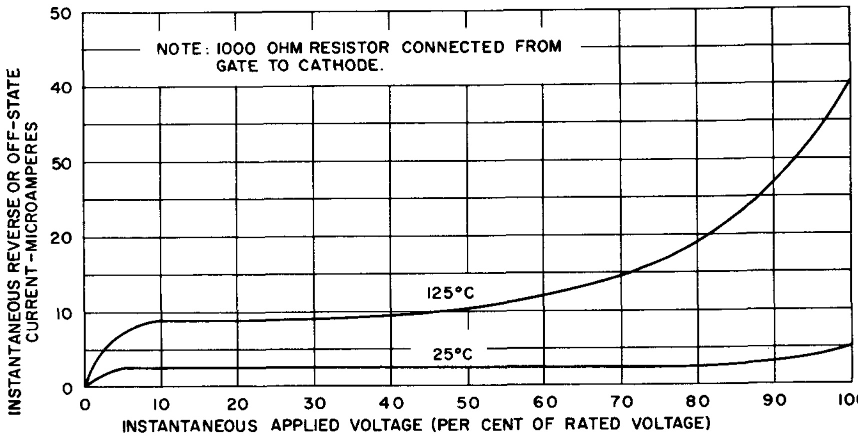
* Indicates data included in JEDEC type number registration.

NOTE: (1) I_{GS} is defined in the circuit below:

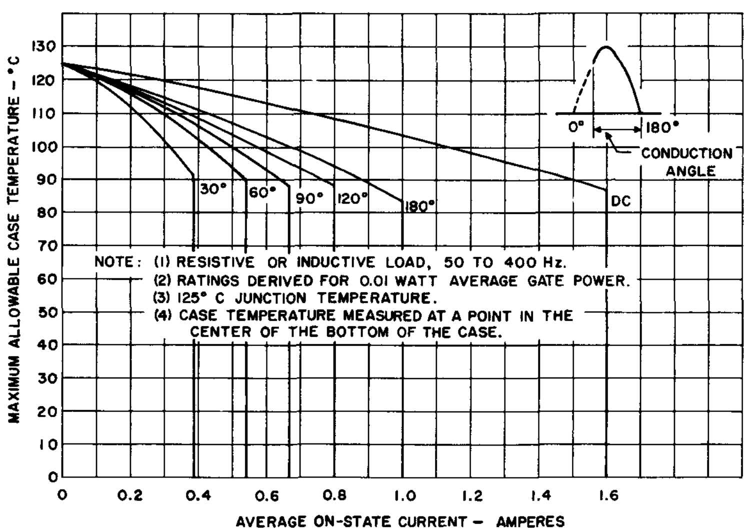




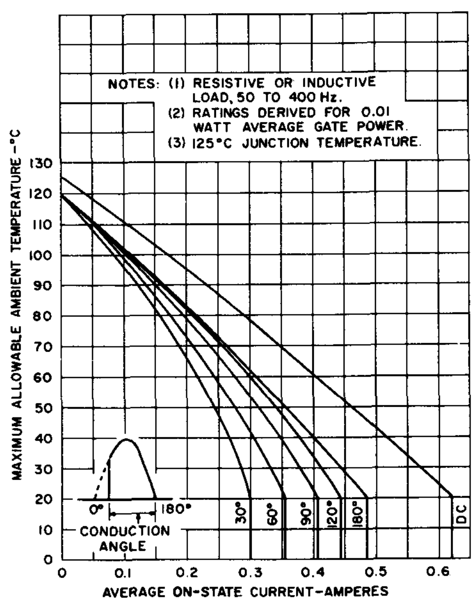
1. TYPICAL ON-STATE CHARACTERISTICS



2. TYPICAL OFF-STATE AND REVERSE BLOCKING CHARACTERISTICS

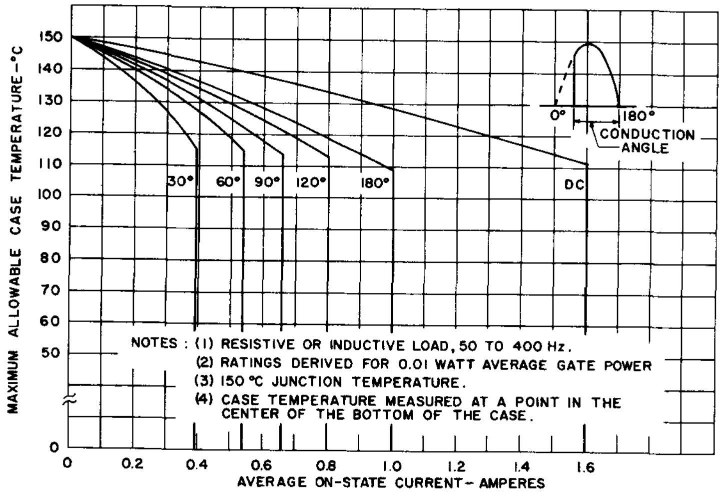


3. MAXIMUM ALLOWABLE CASE TEMPERATURE
(150°C Junction Temp.)

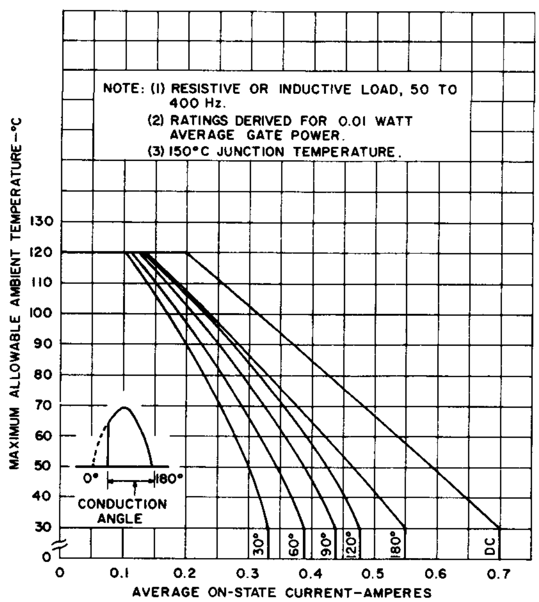


4. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE
(125°C Junction Temp.)

Charts 5 and 6 apply to latching applications where SCR need not block off-state voltage after being turned on, since the V_{DRM} specification does not apply above + 125°C junction temperature. SCR will again block rated off-state voltage after junction temperature drops below + 125°C.



5. MAXIMUM ALLOWABLE CASE TEMPERATURE (125°C Junction Temp.)



6. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE (150°C Junction Temp.)

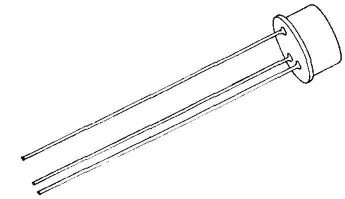
Silicon Unijunction Transistors

2N1671,1A,B,C

The General Electric Silicon Unijunction Transistor is a three terminal device having a stable "N" type negative resistance characteristic over a wide temperature range. A stable peak point voltage, a low peak point current, and a high pulse current rating make this device useful in oscillators, timing circuits, trigger circuits and pulse generators where it can serve the purpose of two conventional silicon or germanium transistors.

The 2N1671 is intended for general purpose industrial applications where circuit economy is of primary importance. The 2N1671A is intended for industrial use in firing circuits for Silicon Controlled Rectifiers and other applications where a guaranteed minimum pulse amplitude is required. The 2N1671C is intended for applications where a low emitter leakage current and a low peak emitter current (trigger current) are required.

These transistors feature Fixed-Bed Construction and are hermetically sealed in a welded case. All leads are electrically isolated from the case.



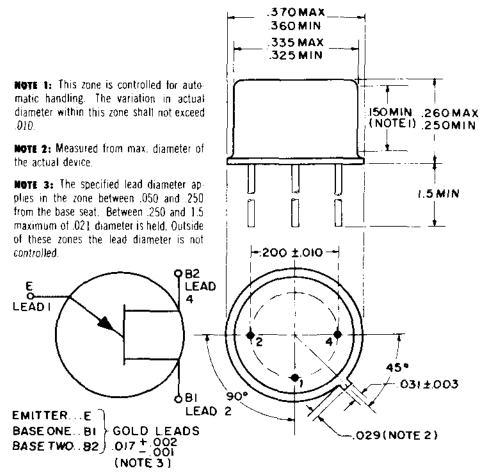
absolute maximum ratings (25°C)

RMS Power Dissipation	450	mw[1]
RMS Emitter Current	50	ma
Peak Emitter Current[2]	2	amperes
Emitter Reverse Voltage	30	volts
Interbase Voltage	35	volts
Operating Temperature Range	−65°C	to +140°C
Storage Temperature Range	−65°C	to +150°C

NOTE 1: This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.

NOTE 2: Measured from max. diameter of the actual device.

NOTE 3: The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and 1.5 maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.



electrical characteristics (25°C)

PARAMETER	SYMBOL	2N1671 MIN.	2N1671 MAX.	2N1671A MIN.	2N1671A MAX.	2N1671B MIN.	2N1671B MAX.	2N1671C MIN.	2N1671C MAX.	UNITS
Intrinsic Standoff Ratio ($V_{BB}=10V$) (Note 3)	η	0.47	0.62	0.47	0.62	0.47	0.62	0.47	0.62	
Interbase Resistance ($V_{BB}=3V, I_E=0$) (Note 4)	R_{BBO}	4.7	9.1	4.7	9.1	4.7	9.1	4.7	9.1	KΩ
Emitter Saturation Voltage ($V_{BB}=10V, I_E=50$ ma)	V_E(SAT)		5		5		5		5	volts
Modulated Interbase Current ($V_{BB}=10V, I_E=50$ ma)	I_{B2}(MOD)	6.8	22	6.8	22	6.8	22	6.8	22	ma
Emitter Reverse Current ($V_{B2E}=30V, I_{B1}=0$) (Fig. 6)	I_{EO}		12		12		0.2		.02	μa
Peak Point Emitter Current ($V_{BB}=25V$) (Fig. 8)	I_P		25		25		6		2	μa
Valley Point Current ($V_{BB}=20V, R_{B2}=100\Omega$) (Fig. 9)	I_V	8		8		8		8		ma
Base-One Peak Pulse Voltage (Note 5)	V_{OB1}			3.0		3.0		3.0		volts
Emitter Reverse Current ($V_{BB}=25V, V_{EB1}=V_P-.3V$) (Fig.3)	I_{EX}								0.05	μa

NOTES:

(1) Derate 3.9 MW/°C increase in ambient temperature (Thermal resistance to case =0.16°C/MW.)

(2) Capacitor discharge—10μfd or less, 30 volts or less—Total interbase power dissipation must be limited by external circuitry.

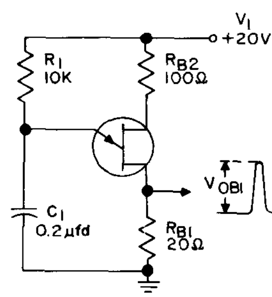
(3) The intrinsic standoff ratio, η, is essentially constant with temperature and interbase voltage. η is defined by the equation:

$$V_P=\eta V_{BB}+\frac{200}{T_J}$$

Where V_P=Peak point emitter voltage
V_{BB}=interbase voltage
T_J=Junction Temperature (Degrees Kelvin)

(4) The interbase resistance is nearly ohmic and increases with temperature in a well defined manner as shown in figures 10 and 11. The temperature coefficient at 25°C is approximately 0.8%/°C.

(5) The base-one peak pulse voltage is measured in the circuit below. This specification on the 2N1671A is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits. The variation of pulse amplitude with temperature and circuit parameters is shown in figures 12 to 15.



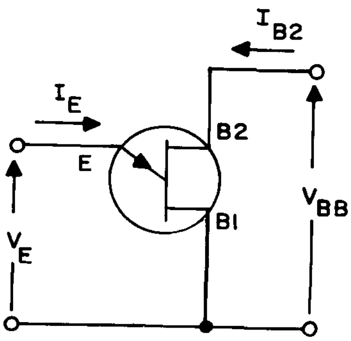


FIG. 1

Unijunction Transistor Symbol with Nomenclature used for voltage and currents.

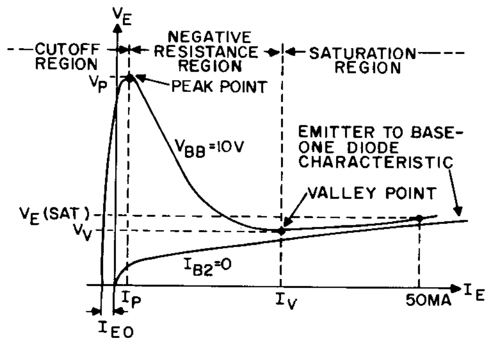


FIG. 2

Static Emitter Characteristic curves showing important parameters and measurement points (exaggerated to show details).

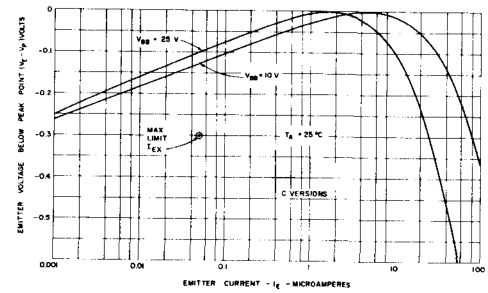


FIG. 3

Static Emitter Characteristics at Peak Point.

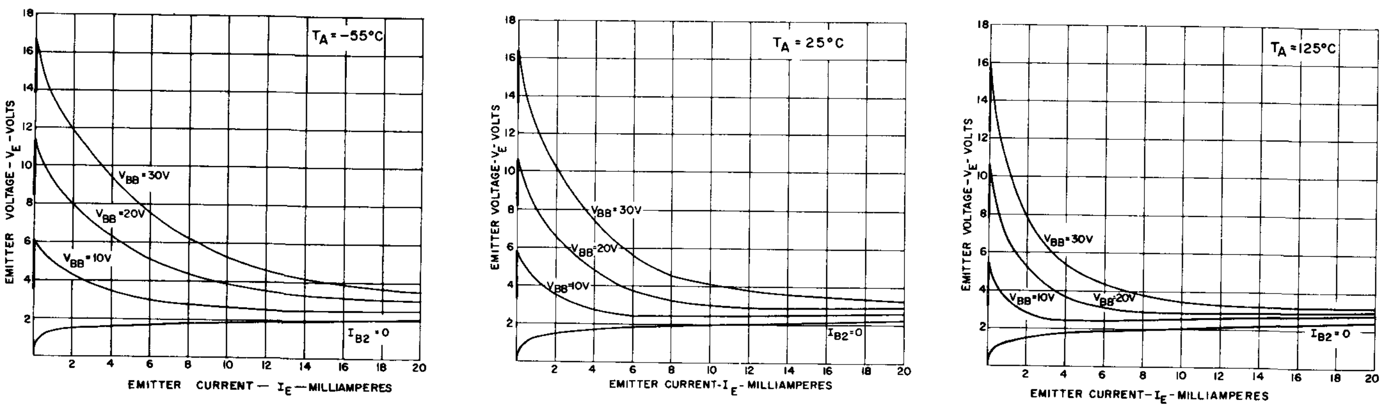


FIG. 4

Static emitter characteristics for a typical 2N1671 unijunction transistor at three different ambient temperatures.

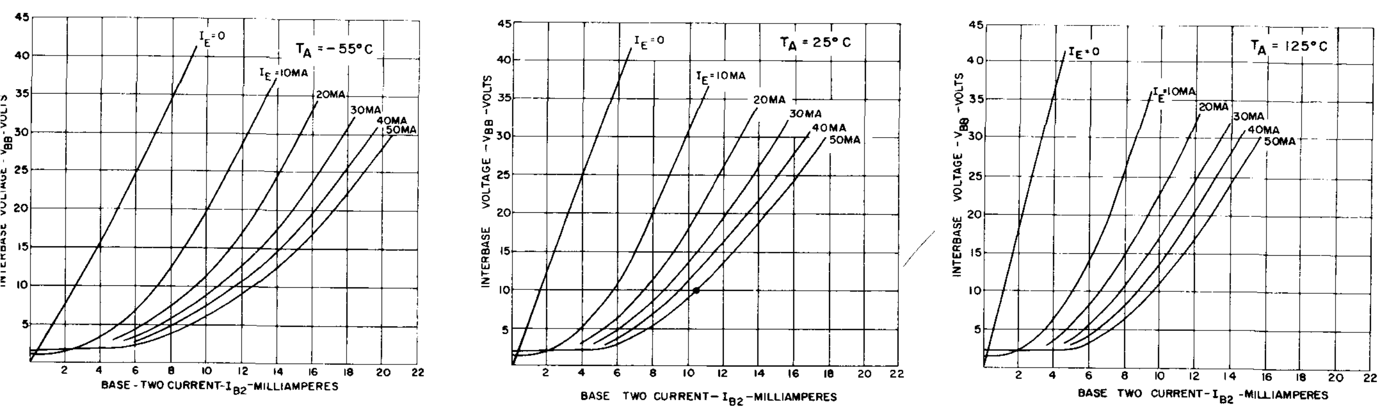


FIG. 5

Static interbase characteristics for a typical 2N1671 unijunction transistor at three different ambient temperatures.

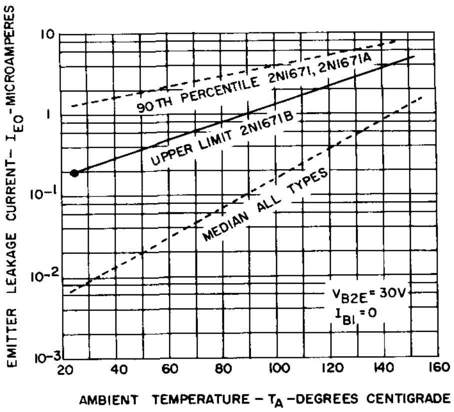


FIG. 6

Emitter reverse current vs. temperature.

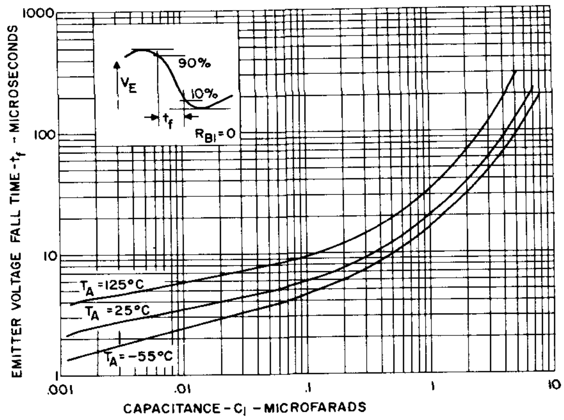


FIG. 7

Emitter voltage fall time vs. capacitance and ambient temperature for a typical unit in relaxation oscillator circuit.

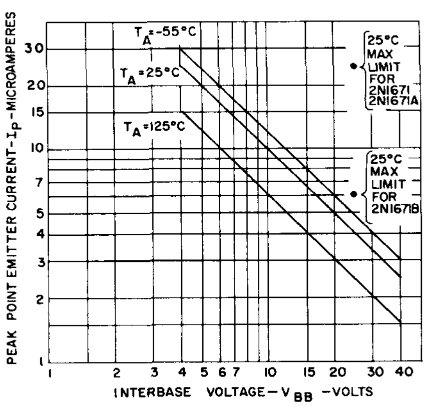


FIG. 8

Peak Point Emitter Current vs. interbase voltage and ambient temperature for a typical unit.

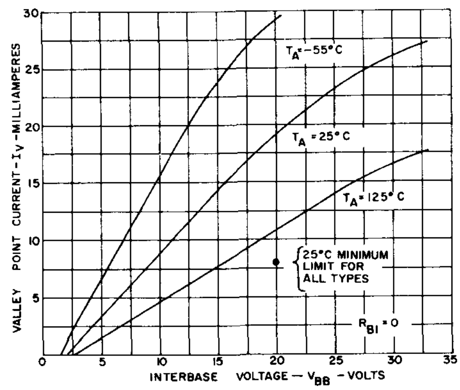


FIG. 9

Valley Point Current vs. interbase voltage and ambient temperature for a typical unit.

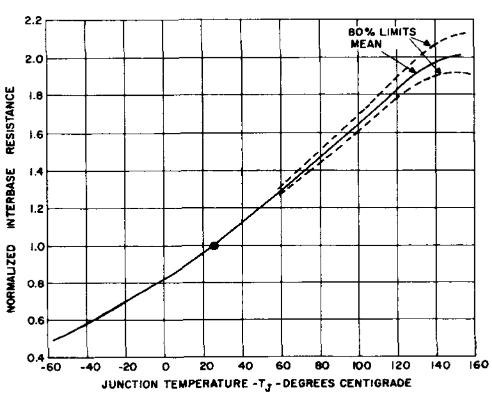


FIG. 10

Normalized interbase resistance vs. junction temperature.

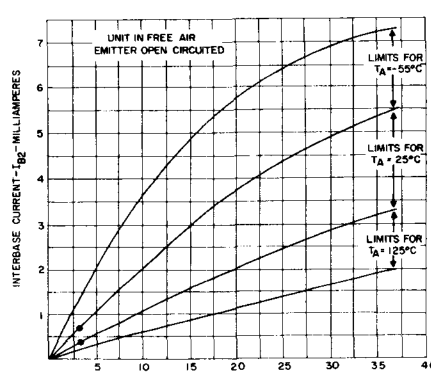


FIG. 11

Limit values of static interbase characteristics with zero emitter current.

2N1671A - 2N1671B

GENERAL PURPOSE PULSE CIRCUITS AND FIRING CIRCUITS FOR SILICON CONTROLLED RECTIFIERS

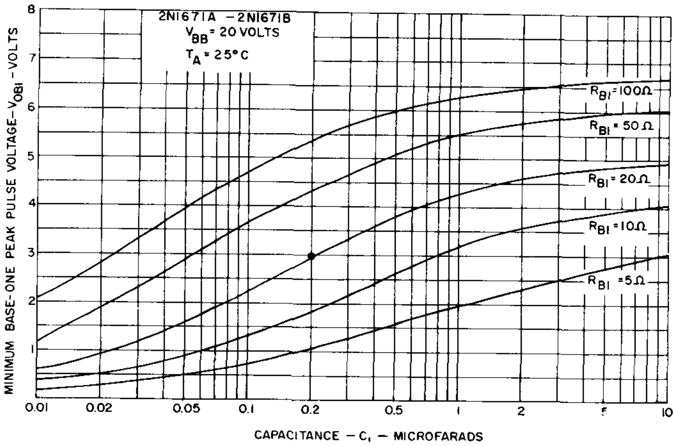


FIG. 12

Minimum base-one peak pulse voltage vs. capacitance and base-one resistance in relaxation oscillator circuit.

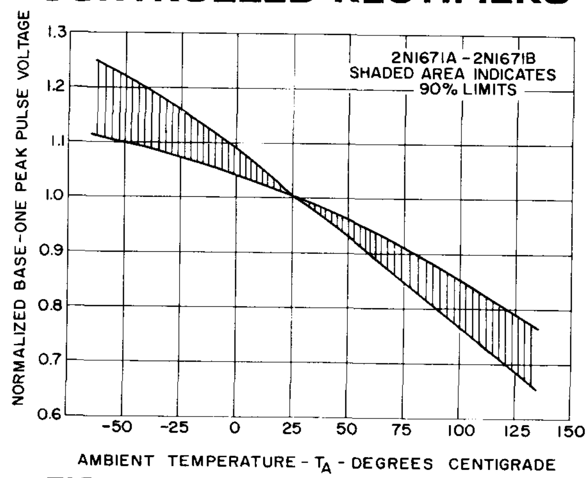


FIG. 13

Normalized base-one peak pulse voltage vs. temperature in relaxation oscillator circuit.

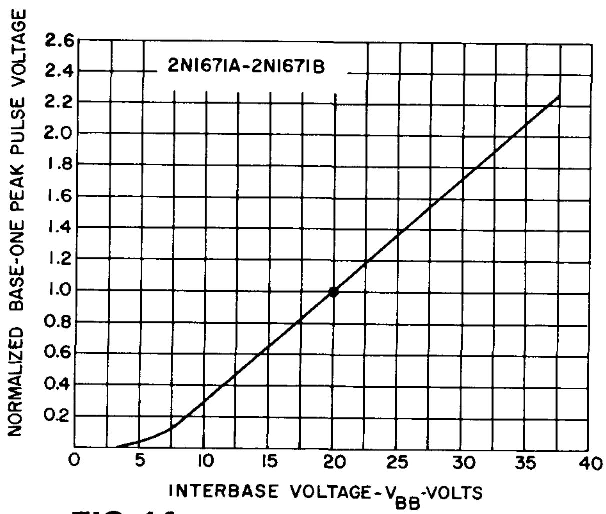


FIG. 14

Normalized base-one peak pulse voltage vs. interbase voltage in relaxation oscillator circuit.

UJT TYPE	SCR TYPE	CURVE	R1	$V_{1(MAX)}$
2N489A & B THROUGH 2N494A, B, AND C (ALSO USAF TYPES)	C60(2N2023-30) C55 AND C56 C52(2N1792-98) C50(2N1909-16) C46 C45 C37 C36(2N1842-50)	A	27Ω ± 10%	35V
		B	47Ω ± 10%	26V
		C	PULSE TRANS. PE2231	35V
2N2417A & B THROUGH 2N2422A, B, AND C	C40 C38* C35(2N681-92) C30 AND C32** C20 AND C22** C15	D	27Ω ± 10%	35V
		E	47Ω ± 10%	20V
		G	PULSE TRANS. SPRAGUE 31Z204	35V
2N1671A, B, AND C	C12 C11(2N1770-78, 2N2619) C10(2N1770A-77A) C9 C8(2N1929-35) 2N1595-99	E	27Ω ± 10%	32V
2N2646		G	47Ω ± 10%	18V
		I	PULSE TRANS. SPRAGUE 31Z204	35V
2N2647***	C7(2N2344-48) C6 C5	F	15Ω ± 10%	35V
		H	27Ω ± 10%	20V
		J	SPRAGUE 31Z204	35V

NOTES: *LIMITED TO 27 VOLTS MAX ON "D" CURVE AND 15 VOLTS ON "E" CURVE.
**TRIGGER REQUIREMENTS LESS THAN OTHERS IN THIS GROUP.
***MINIMUM TRIGGER PULSE IS TWICE THE AMPLITUDE OF OTHER UJT'S, THIS ASSURES 2:1 OVER MINIMUM SCR TRIGGER REQUIREMENTS.

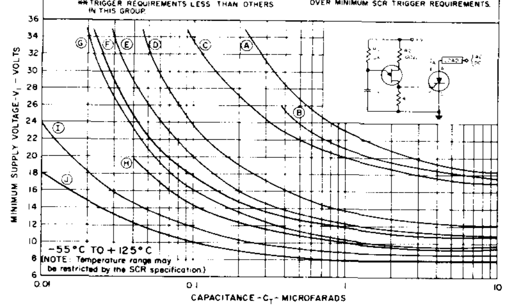


FIG. 15

Minimum supply voltage required to fire standard types of silicon controlled rectifiers vs. capacitance in circuit below.

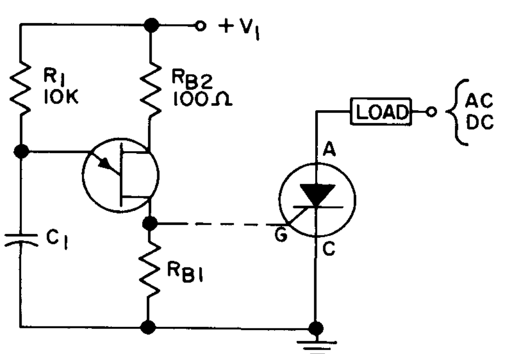


FIG. 16

Basic unijunction transistor firing circuit for silicon controlled rectifiers.

Period of Relaxation Oscillator

$\tau = 0.80\ R_1C_1\ (\pm\ 0.21\ R_1C_1)$

Maximum Value of R_1 for oscillation (−55°C to +140°C)

R_1 (max) = 430 V_1^2 (2N1671-2N1671A)

R_1 (max) = 1800 V_1^2 (2N1671B)

τ = Period in Seconds

C_1 = Capacitance in Farads

R_1 = Resistance in ohms

V_1 = Supply voltage in volts

REFERENCES:

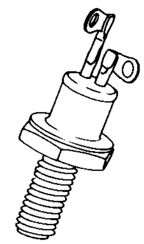
1. "Notes on the Application of the Silicon Unijunction Transistor," 90.10.
2. "General Electric Controlled Rectifier Manual," Fifth Edition.

SCR

C11 SERIES
2N1770-78,
2N2619

2N1770A SERIES SEE PAGE 663

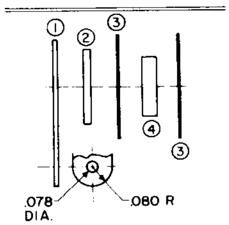
The C11 Silicon Controlled Rectifier is a three junction semiconductor device for use in low power switching and control applications requiring blocking voltages up to 600 volts and RMS load currents up to 7.4 amperes.

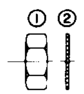


- **Broad Voltage Range (Up to 600V)**
- **Long Electical Creepage Path**
- **Over Three Years of Successful Field Experience**
- **No Gate Bias Required**
- **High Gate Sensitivity**

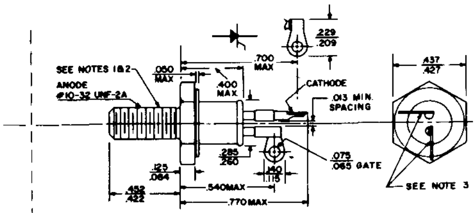
INSULATING HARDWARE KIT *

① COPPER TERMINAL, .016 THICK, TIN PLATED
② BRASS WASHER, .035 THICK NICKEL PLATED
③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK
④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK
* AVAILABLE UPON REQUEST





① 10-32 STEEL NUT CADMIUM PLATED
② LOCKWASHER, CADMIUM PLATED STEEL



NOTES: 1. COMPLETE THREADS EXTEND TO WITHIN 2-1/2 THREADS OF HEAD.
2. DIAMETER OF UNTHREADED PORTION .190 MAX.
3. ANGULAR ORIENTATION OF THESE TERMINALS IS UNDEFINED.
4. CASE IS ANODE CONNECTION.
5. ALL DIMENSIONS IN INCHES.

Type	Minimum Forward Breakover Voltage (V_{BO})† $T_J = -65°C$ to $+125°C$	Repetitive Peak Reverse Voltage (PRV)† $T_J = -65°C$ to $+125°C$	Transient Peak Reverse Voltage (Non-recurrent < 5 Millisec.)† $T_J = -65°C$ to $+125°C$
C11U (2N1770)	25 Volts*	25 Volts*	40 Volts*
C11F (2N1771)	50 Volts*	50 Volts*	75 Volts*
C11A (2N1772)	100 Volts*	100 Volts*	150 Volts*
C11G (2N1773)	150 Volts*	150 Volts*	225 Volts*
C11B (2N1774)	200 Volts*	200 Volts*	300 Volts*
C11H (2N1775)	250 Volts*	250 Volts*	350 Volts*
C11C (2N1776)	300 Volts*	300 Volts*	400 Volts*
C11D (2N1777)	400 Volts*	400 Volts*	500 Volts*
C11E (2N1778)	500 Volts*	500 Volts*	600 Volts*
C11M (2N2619)	600 Volts*	600 Volts*	720 Volts*

†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum PRV ratings apply equals 18°C/watt.

MAXIMUM ALLOWABLE RATINGS

Repetitive Peak Forward Blocking Voltage (PFV)	(C11U thru C11D)	480	Volts
	(C11E and C11M)	720	Volts
RMS Forward Current	(All conduction angles)	7.4	Amperes
Average Forward Current (I_O)	4.7 Amperes* at 60°C Case (Half Wave Rectified) For other operating conditions see Chart 3.		
Peak One Cycle Non-recurrent Surge Current (i_{surge})		60	Amperes*
Peak Surge Current During Turn-on Time Interval			See Chart 7
I^2t (for fusing)			Calculate from Chart 8
Peak Gate Power (p_G)		5	Watts*
Average Gate Power (P_G)		0.5	Watt*
** Peak Gate Current (i_G)		2.0	Amperes*
Peak Gate Voltage (v_G) (Forward and Reverse)		10	Volts*
Operating Temperature		−65°C to +125°C*	
Storage Temperature		−65°C to +150°C*	
Stud Torque		15	inch-pounds

*Indicates data included on JEDEC type number registration.

**NOT TO EXCEED GATE POWER RATINGS

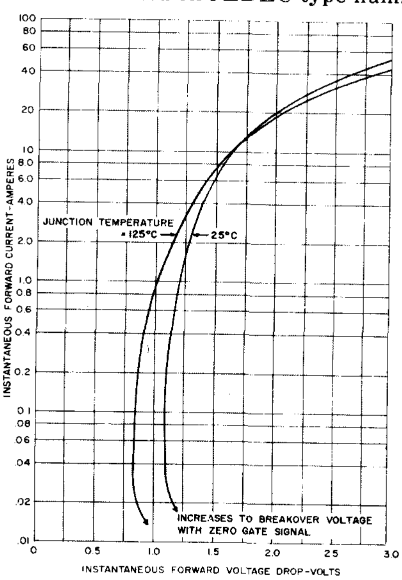
C11 SERIES
2N1770-78
2N2619

CHARACTERISTICS

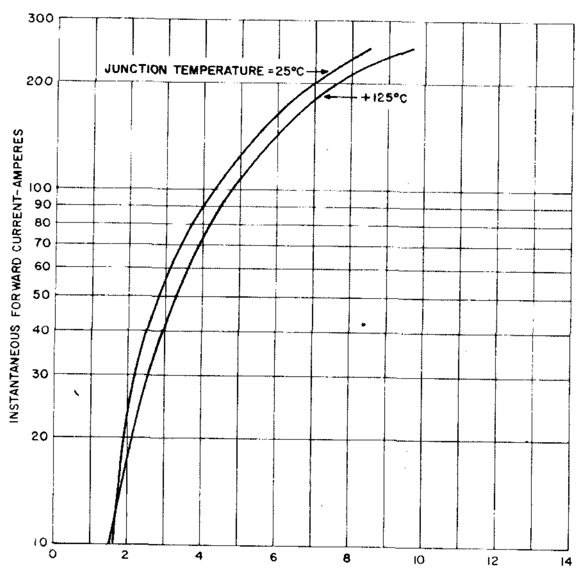
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Reverse and Forward Blocking Current†	i_R and i_S					$T_J = 125°C$, Gate Open
C11U (2N1770)		——	4.5	9.0	ma	$v_{AC} = v_{CA} =$ 25 Volts Peak
C11F (2N1771)		——	4.5	9.0	ma	50
C11A (2N1772)		——	4.5	9.0	ma	100
C11G (2N1773)		——	4.0	8.0	ma	150
C11B (2N1774)		——	3.0	6.0	ma	200
C11H (2N1775)		——	2.5	5.0	ma	250
C11C (2N1776)		——	1.5	4.0	ma	300
C11D (2N1777)		——	1.0	2.0	ma	400
C11E (2N1778)		——	1.0	2.0	ma	500
C11M (2N2619)		——	1.0	2.0	ma	600
Full Cycle Avg. Reverse and Forward Blocking Current†	$I_{R(AV)}$ and $I_{S(AV)}$					$T_C = 60°C$, $I_O = 4.7A$, half sine wave 180° Conduction Angle
C11U (2N1770)		——	2.3	4.5*	mAdc	$v_{AC} = v_{CA} =$ 25 Volts Peak
C11F (2N1771)		——	2.3	4.5*	mAdc	50
C11A (2N1772)		——	2.3	4.5*	mAdc	100
C11G (2N1773)		——	2.0	4.0*	mAdc	150
C11B (2N1774)		——	1.5	3.0*	mAdc	200
C11H (2N1775)		——	1.3	2.5*	mAdc	250
C11C (2N1776)		——	0.8	2.0*	mAdc	300
C11D (2N1777)		——	0.5	1.0*	mAdc	400
C11E (2N1778)		——	0.5	1.0*	mAdc	500
C11M (2N2619)		——	0.5	1.0*	mAdc	600
Gate Current to Fire	I_{GF}	——	10	15	mAdc	$V_{AC} = 12Vdc$, $T_J = 25°C$, $R_L = 250$ ohms
		——	20	30*	mAdc	$V_{AC} = 12Vdc$, $T_J = -65°C$, $R_L = 250$ ohms
		——	4	8	mAdc	$V_{AC} = 12Vdc$, $T_J = 125°C$, $R_L = 250$ ohms
Gate Voltage to Fire	V_{GF}	——	1.3	2.0*	Vdc	$V_{AC} = 12$ Vdc, $T_J = -65°$ to $+125°C$, $R_L = 250$ ohms
		0.3*	0.7	——	Vdc	$v_{AC} =$ Rated, $T_J = 125°C$, $R_L = 250$ ohms
Peak Forward Voltage Drop	v_F	——	1.6	1.85	v	$T_J = 25°C$, $i_F = 15$ a (single sinusoidal pulse, 4 ms wide)
Holding Current	I_H	——	8.0	——	mAdc	Anode Supply = 6 Vdc, $T_J = 25°C$
Turn-on Time	$t_d + t_r$	——	1.0	——	μsec	$T_J = 25°C$, $i_F = 10$ a, v_{AC} = Rated Gate Supply: 7 volt open circuit, 20 ohm, 0.1 μsec max. rise time.
Turn-off Time	t_{off}	——	15	——	μsec	$T_J = 125°C$, $i_F = 5$ a, $i_R = 5$ a v_{AC} (Reapplied) = Rated. Rate of Rise of Reapplied Forward Blocking Voltage = 20 volts per microsecond maximum.
Thermal Resistance	θ_{J-C}	——	1.5	3.1	°C/Watt	Junction to Case.

†Values apply for zero or negative gate voltage. Maximum case to ambient thermal resistance for which maximum PRV ratings apply = 18°C per watt.

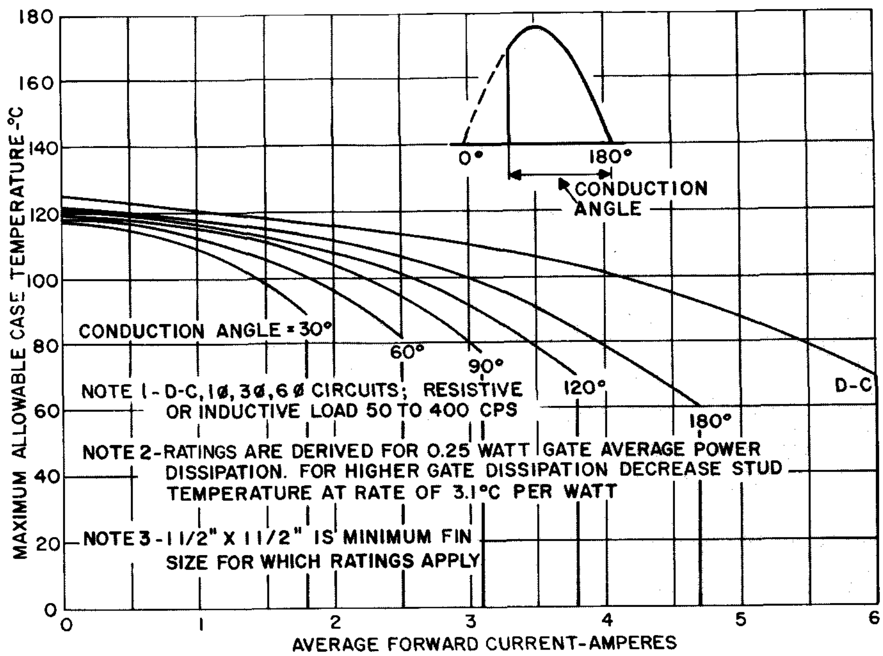
*Indicates data included on JEDEC type number registration.



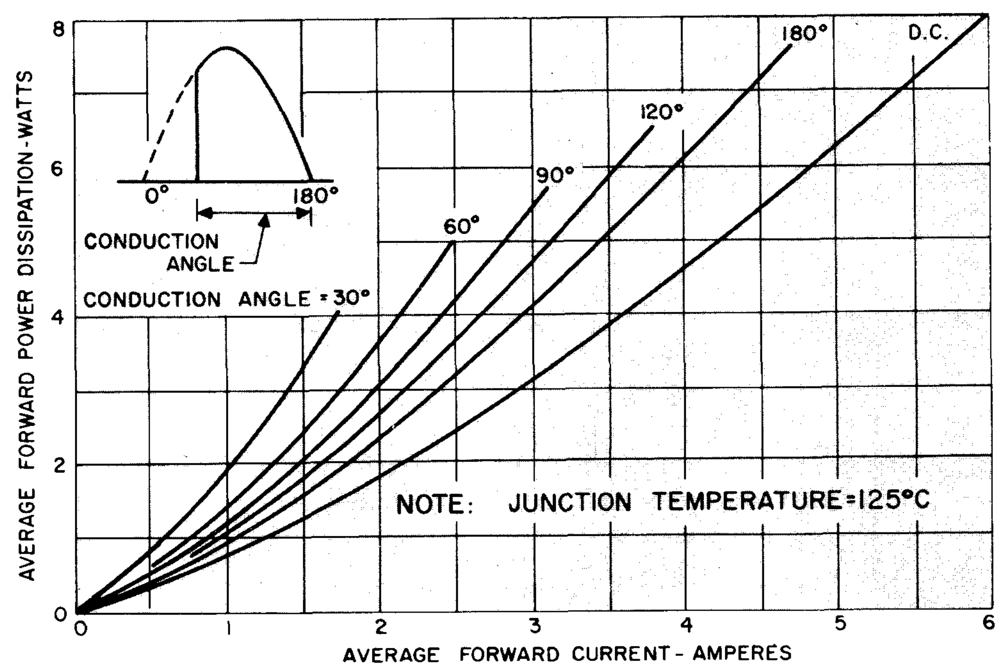
1. MAXIMUM FORWARD CHARACTERISTICS CONDUCTING STATE



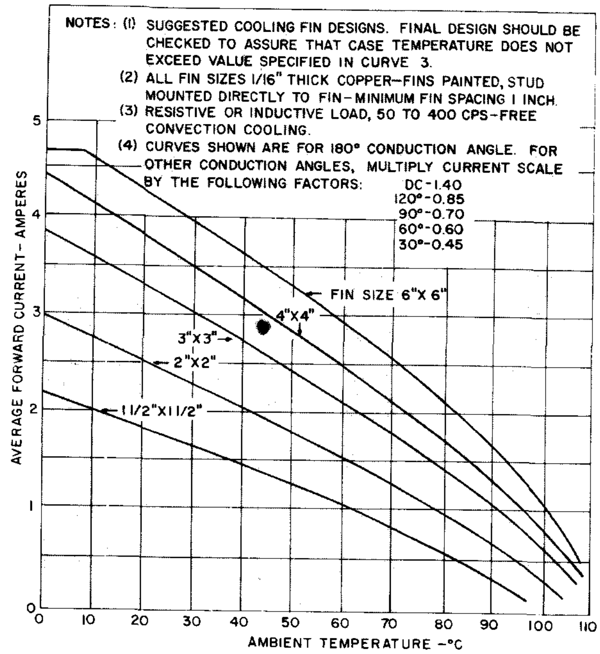
2. MAXIMUM FORWARD CHARACTERISTICS HIGH CURRENT LEVEL — CONDUCTING STATE



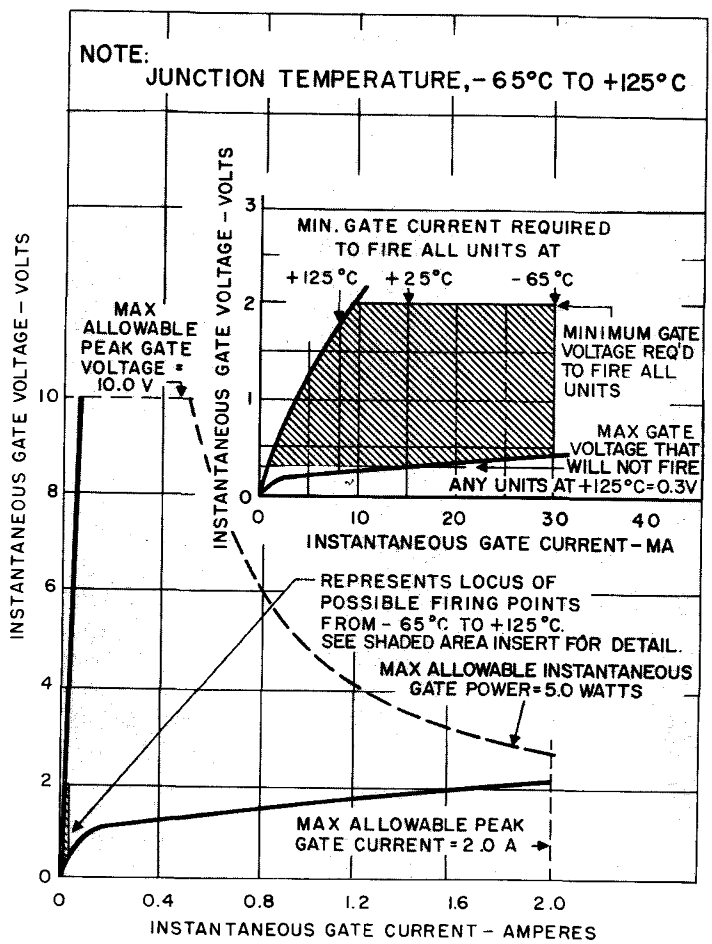
3. MAXIMUM ALLOWABLE CASE TEMPERATURE



4. FORWARD POWER DISSIPATION

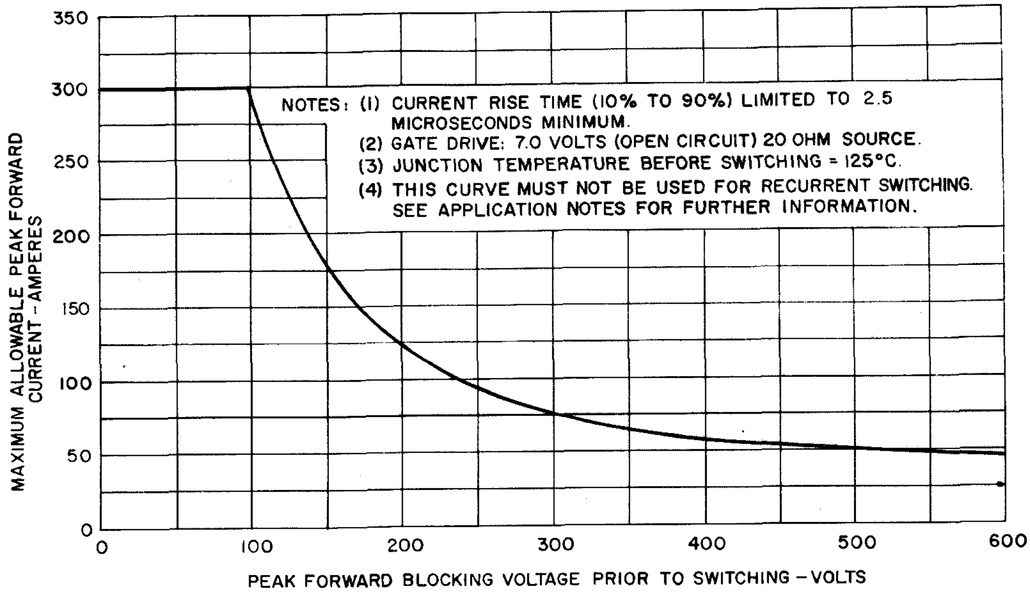


5. MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES

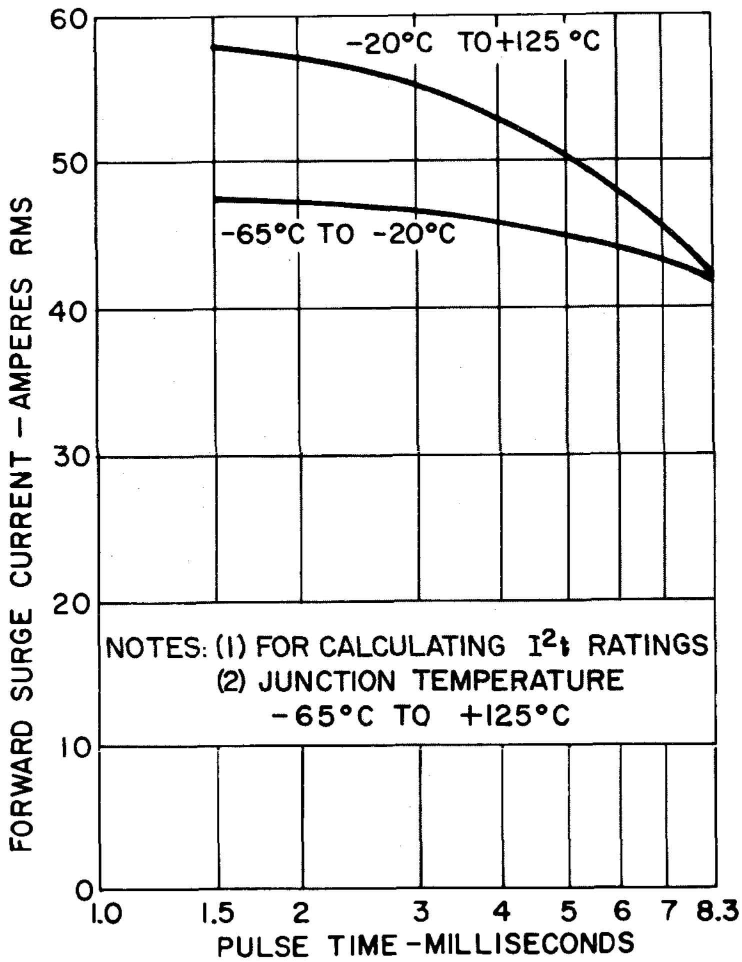


6. FIRING CHARACTERISTICS

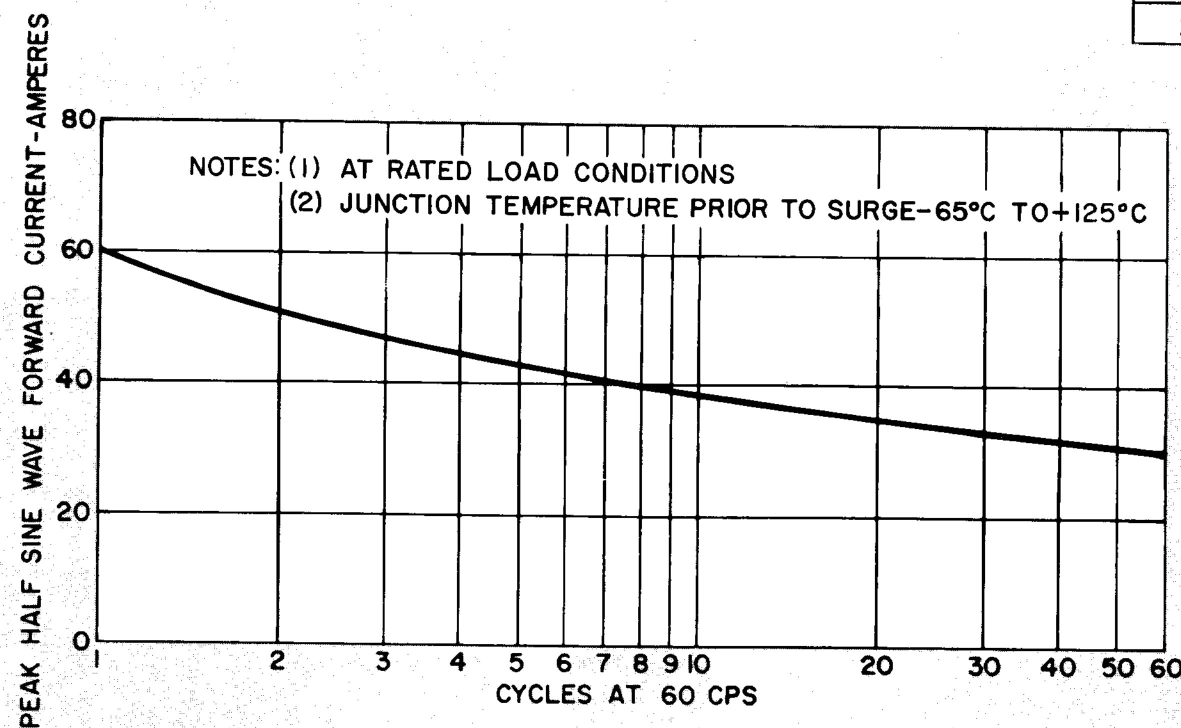
C11 SERIES
2N1770-78
2N2619



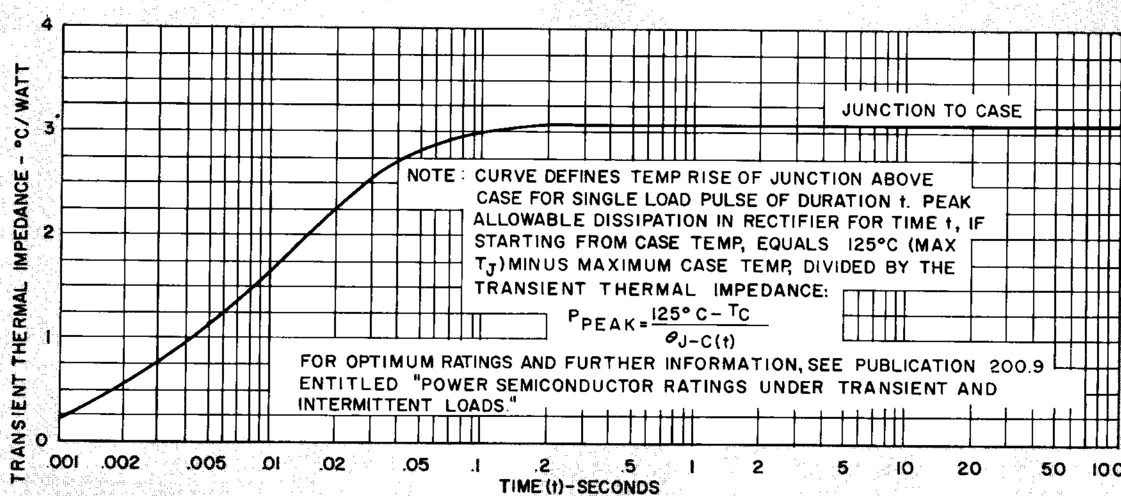
7. PEAK NON-RECURRENT SURGE CURRENT DURING TURN-ON TIME INTERVAL



8. MAXIMUM ALLOWABLE NON-RECURRENT SUB-CYCLE SURGE CURRENT RATING



9. MAXIMUM ALLOWABLE NON-RECURRENT SURGE CURRENT RATING



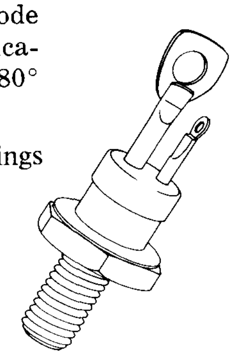
10. MAXIMUM TRANSIENT THERMAL RESISTANCE

SCR

2N1842-50

2N1792	SEE C52 SERIES
2N2023-31	SEE C60 SERIES

The 2N1842 through 2N1850 Series of Silicon Controlled Rectifiers are reverse blocking triode thyristor semiconductor devices for use in medium power switching and phase control applications requiring blocking voltages up to 500 volts, and average load currents (single-phase, 180° conduction angle) up to 10 amperes.



General Electric's types C35, C37 and C137 SCR's are recommended for higher voltage ratings and where higher levels of performance are required for a device of this size.

Type	Publication Number
C35	160.20
C37	160.23
C137	160.45

MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} $T_C = -40°C +100°C$	PEAK FORWARD VOLTAGE, PFV[2] $T_C = -40°C +100°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep)[1] $T_C = -40°C +100°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE (<5 MILLISEC.) V_{ROM} (non-rep)[1] $T_C = -40°C +100°C$
2N1842	25 Volts*	35 Volts	25 Volts*	35 Volts*
2N1843	50 Volts*	75 Volts	50 Volts*	75 Volts*
2N1844	100 Volts*	150 Volts	100 Volts*	150 Volts*
2N1845	150 Volts*	225 Volts	150 Volts*	225 Volts*
2N1846	200 Volts*	300 Volts	200 Volts*	300 Volts*
2N1847	250 Volts*	350 Volts	250 Volts*	350 Volts*
2N1848	300 Volts*	400 Volts	300 Volts*	400 Volts*
2N1849	400 Volts*	500 Volts	400 Volts*	500 Volts*
2N1850	500 Volts*	600 Volts	500 Volts*	600 Volts*

(1) Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C per watt.
(2) Cells with higher PFV ratings are available upon request.

RMS Forward Current, On-State	16 amperes (all conduction angles)
Average Forward Current, On-State	Depends on conduction angle (see Charts 3 and 4)
Rate of Rise of Forward Current, On-State, di/dt	10 amperes per microsecond
Peak One-cycle Surge Forward Current, I_{FM} (surge)	125 amperes*
I^2t (for fusing)	40 ampere² seconds (for times ≧1.5 milliseconds)
Peak Gate Power Dissipation, P_{GM}	5 watts*
Average Gate Power Dissipation, $P_{G(AV)}$	0.5 watt*
** Peak Forward Gate Voltage, V_{GFM}	10 volts*
Peak Reverse Gate Voltage, V_{GRM}	5 volts*
Storage Temperature, T_{stg}	−40°C to +125°C*
Operating Temperature, T_J	−40°C to +100°C*
Stud Torque	30 lb-in (35 kg-cm)

***Indicates Data included on JEDEC type number registration.**
****NOT TO EXCEED GATE POWER RATINGS**

CHARACTERISTICS

TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE OR FORWARD BLOCKING CURRENT†	I_{ROM} or I_{FOM}			mA	$T_C = -40°C$ to $+100°C$
2N1842		—	45.0		$V_{ROM} = V_{FOM} =$ 25V Peak
2N1843		—	38.0		= 50V
2N1844		—	25.0		= 100V
2N1845		—	13.0		= 150V
2N1846		—	12.0		= 200V
2N1847		—	11.0		= 250V
2N1848		—	10.0		= 300V
2N1849		—	8.0		= 400V
2N1850		—	6.0		= 500V
FULL CYCLE AVG. REVERSE OR FORWARD BLOCKING CURRENT†	$I_{RX(AV)}$ or $I_{FX(AV)}$			mA	$T_C = +35°C$, $I_O = 10A$ 180° Conduction Angle
2N1842		—	22.5*		$V_{RXM} = V_{FXM} =$ 25V Peak
2N1843		—	19.0*		= 50V
2N1844		—	12.5*		= 100V
2N1845		—	6.5*		= 150V
2N1846		—	6.0*		= 200V
2N1847		—	5.5*		= 250V
2N1848		—	5.0*		= 300V
2N1849		—	4.0*		= 400V
2N1850		—	3.0*		= 500V
GATE TRIGGER CURRENT	I_{GT}	—	80	mAdc	$T_C = +25°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
		—	150*	mAdc	$T_C = -40°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	—	3.5*	Vdc	$T_C = 40°C$ to $+100°C$, $V_{FX} = 12Vdc$, $R_L = 50$ ohms
		0.30*	—	Vdc	$T_C = +100°C$, $V_{FXM} =$ Rated V_{FOM}, $R_L = 1000$ ohms
PEAK ON-VOLTAGE	V_{FM}	—	2.9	V	$T_C = +25°C$, $I_{FM} = 50A$ Peak, 1 millisecond wide pulse
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	—	2.5	°C/watt	

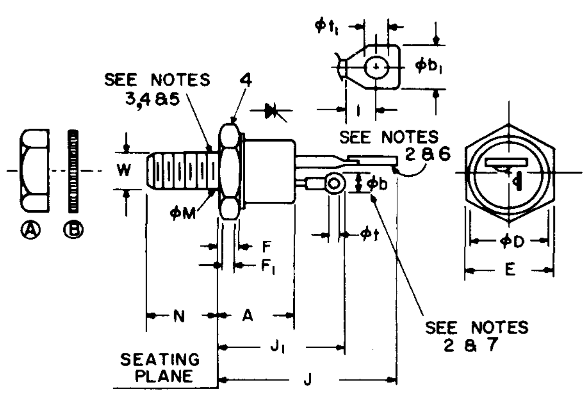
†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C/watt.
*Indicates data included on JEDEC type number registration.

OUTLINE DRAWING

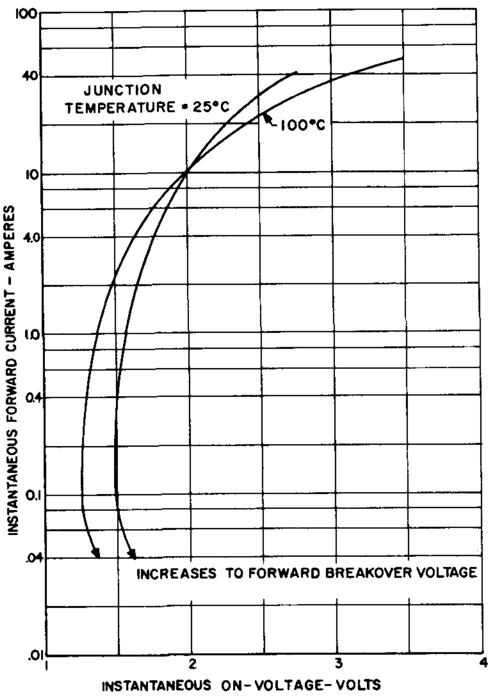
NOTES:
1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

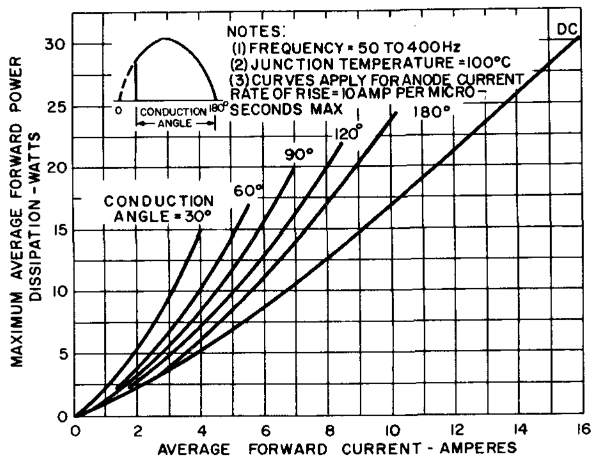
A. ¼-28 steel nut, Ni. plated, .178 min. thk.
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.

(COMPLIES WITH JEDEC TO-48)



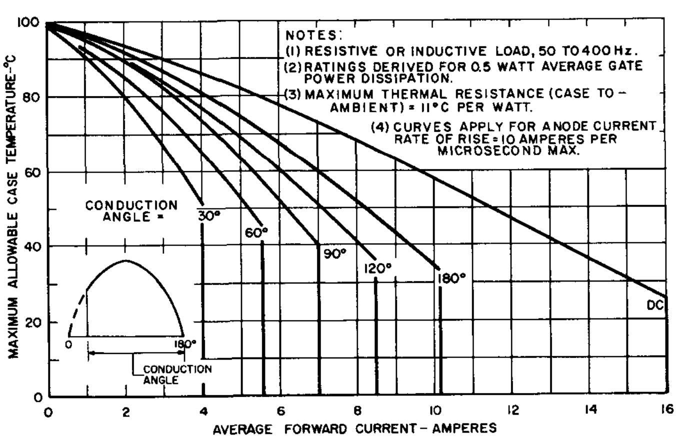
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb1	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F1	.060		1.52		
J		1.193		30.30	
J1		.875		22.23	
I	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φt	.060	.075	1.52	1.91	
φt1	.125	.165	3.18	4.19	
W					3

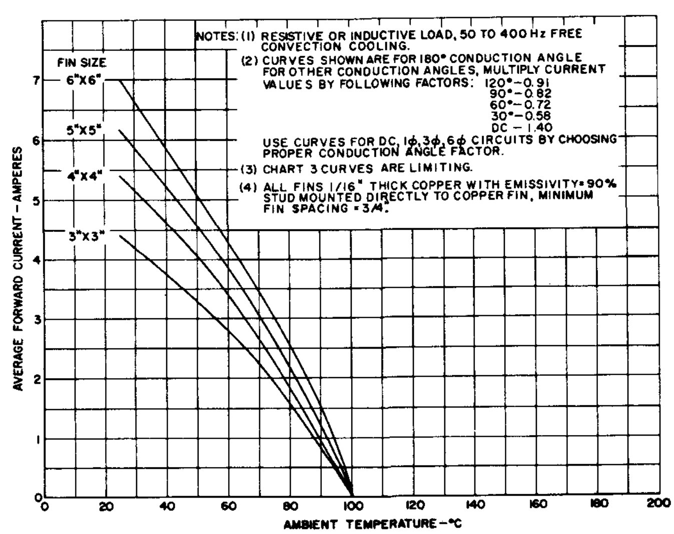




2. FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM

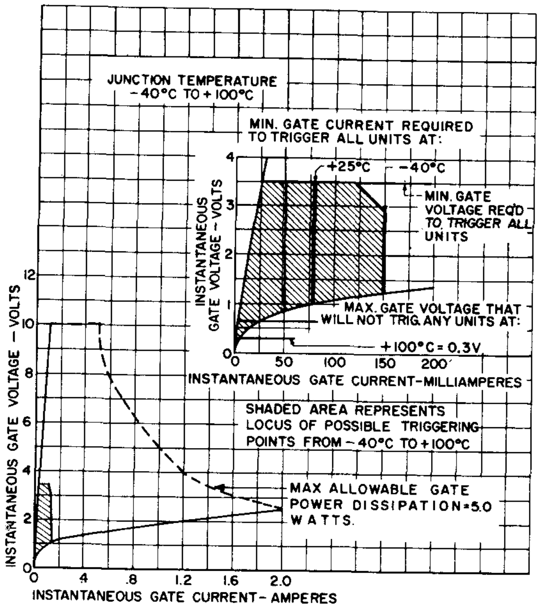
1. MAXIMUM FORWARD CHARACTERISTICS—ON-STATE



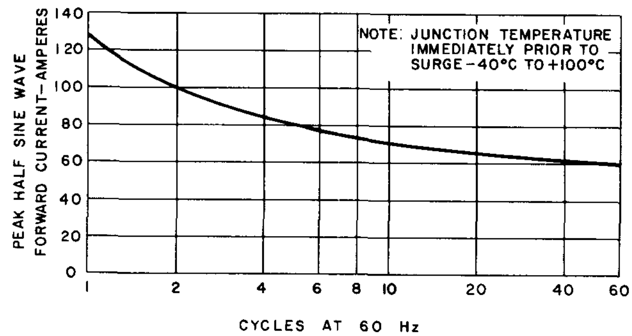


3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM

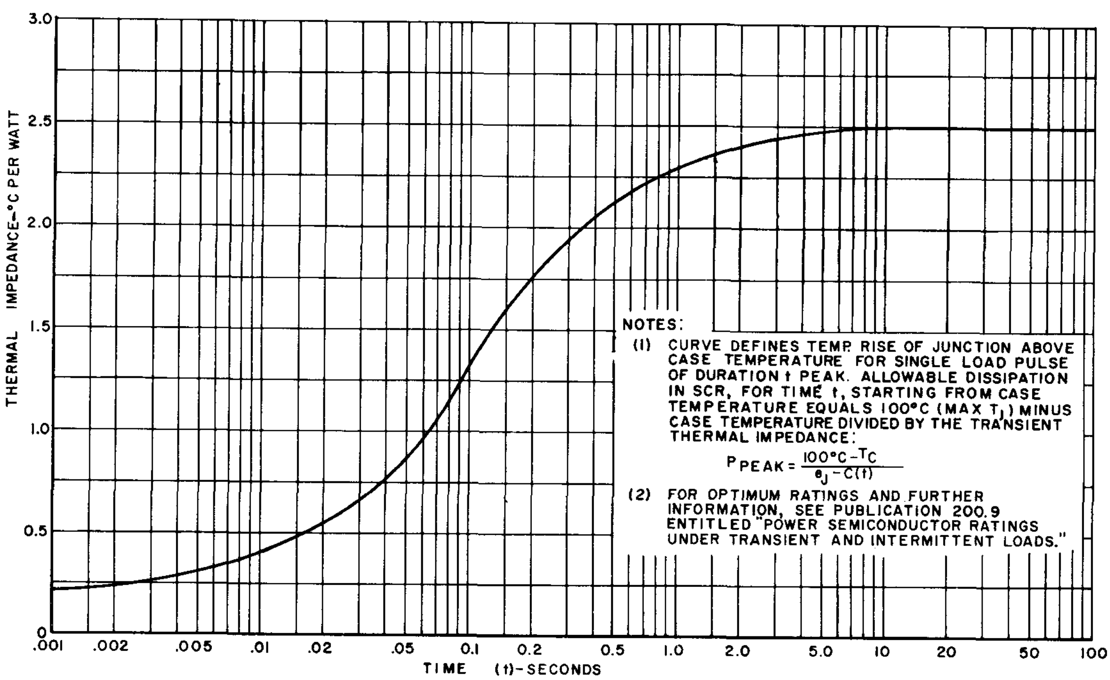
4. SUGGESTED MAXIMUM CURRENT VS. AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES



5. GATE TRIGGERING CHARACTERISTICS



6. MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE FORWARD CURRENT AT RATED LOAD CONDITIONS



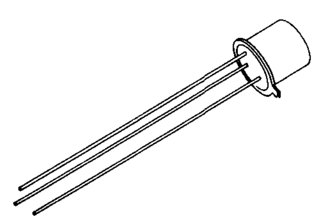
7. MAXIMUM TRANSIENT THERMAL IMPEDANCE— JUNCTION TO CASE

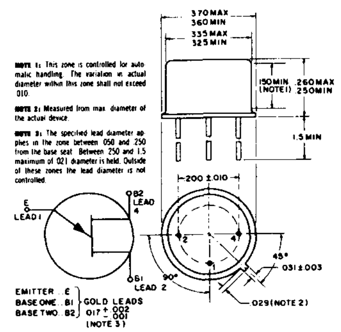
Silicon Unijunction Transistor

2N2160	
2N2221	SEE GES2221
2N2222	SEE GES2222
2N2322-29	SEE C5 SERIES

The General Electric Silicon Unijunction Transistor is a three terminal device having a stable "N" type negative resistance characteristic over a wide temperature range. A stable peak point voltage, a low peak point current, and a high pulse current rating make this device useful in oscillators, timing circuits, trigger circuits and pulse generators where it can serve the purpose of two conventional silicon or germanium transistors.

The 2N2160 is intended for hobbyist applications where circuit economy is of primary importance. This transistor features Fixed-Bed Construction and is hermetically sealed in a welded case. All leads are electrically isolated from the case.





absolute maximum ratings: (25°C) (unless otherwise specified)

RMS Power Dissipation	450 mw[1]
RMS Emitter Current	50 ma
Peak Emitter Current	2 amperes
Emitter Reverse Voltage	30 volts
Interbase Voltage	35 volts
Operating Temperature Range	-65°C to +140°C
Storage Temperature Range	-65°C to +150°C

electrical characteristics: (25°C) (unless otherwise specified)

		Note	Min.	Max.	Units
Intrinsic Standoff Ratio (V_{BB} =10V)	N	2	0.47	0.80	
Interbase Resistance (V_{BB} =3V, I_E=0)	R_{BBO}	3	4.0	12.0	Kohms
Modulated Interbase Current (V_{BB} =10V, I_E=50ma)	$I_{B2(MOD)}$		6.8	30	ma
Emitter Reverse Current (V_{B2E} =30V, I_{B1} =O)	I_{EO}			12	ua
Peak Point Emitter Current (V_{BB} =25V)	I_P			25	ua
Valley Point Current (V_{BB} =20V, R_{B2} =100 ohms)	I_V		8		ma
Base-One Peak Pulse Voltage (See Circuit Shown)	V_{OB1}		3.0		volts

Notes:

(1) Derate 3.9 mw/°C increase in ambient temperature (Thermal Resistance to case = 0.16°C/mw).

(2) The intrinsic standoff ratio, η, is essentially constant with temperature and interbase voltage. is defined by the equation:

$$V_P = \eta V_{BB} + \frac{200}{T_j}$$

Where V_P = Peak point emitter voltage
V_{BB} = Interbase voltage
T_j = Junction Temperature (Degrees Kelvin)

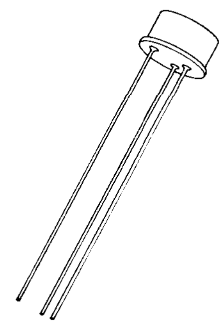
(3) The interbase resistance is nearly ohmic and increases with temperature in a well-defined manner. The temperature coefficient at 25°C is approximately 0.8%/°C.

SCR

2N2344-48

2N2417-22	SEE GES2417
2N2483	SEE GES2483

The 2N2344 series of Silicon Controlled Rectifiers are reverse blocking thyristors for use in low power switching and control applications. This series features maximum gate sensitivity and high external gate-cathode shunting resistance. The specified blocking voltages are consistent with the Maximum Junction Temperature limit, permitting simple, straightforward circuit design.



- All welded construction
- Glass to metal seals
- Low holding current
- Extremely high gate sensitivity (I_{GT} = 20 μA)
- Single-ended package ideal for printed circuit applications

maximum allowable ratings

Type	Peak Forward Blocking Voltage, V_{FXM}† T_J = −65°C to +100°C	Working and Repetitive Peak Reverse Voltage V_{ROM}(wkg) & V_{ROM}(rep) T_J = −65°C to +100°C	Non-Repetitive Peak Reverse Voltage (<5 Millisec.), V_{ROM}(non-rep) T_J = −65°C to +100°C
2N2344	25 Volts*	25 Volts*	40 Volts*
2N2345	50 Volts*	50 Volts*	75 Volts*
2N2346	100 Volts*	100 Volts*	150 Volts*
2N2347	150 Volts*	150 Volts*	225 Volts*
2N2348	200 Volts*	200 Volts*	300 Volts*

†With 40,000 ohms or less connected from gate to cathode.

Peak Forward Voltage, PFV	300 Volts
RMS Forward Current	1.6 Amperes
Average Forward Current, On-state	Depends on conduction angle (see charts 3 and 4)
Peak One Cycle Surge Forward Current, non-repetitive, I_{FM} (surge)	15 Amperes*
Peak Gate Power, P_{GM}	0.1 Watt*
Average Gate Power, $P_{G(AV)}$	0.01 Watt*
Peak Gate Current, I_{GFM}	0.1 Ampere*
Peak Gate Voltage, Forward & Reverse, V_{GFM} & V_{GRM}	6 Volts*
Storage Temperature	−65°C to +150°C*
Operating Temperature	−65°C to +100°C*

*Indicates data included on JEDEC type number registration.

characteristics

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
REVERSE BLOCKING CURRENT	I_{RX}	—	2.0	10	μA	V_{RX} = Rated V_{ROM}(rep), $T_J = +25°C$, R_{GK} = 40,000 ohms
		—	40	100*	μA	V_{RX} = Rated V_{ROM}(rep), $T_J = +100°C$, R_{GK} = 40,000 ohms
FORWARD BLOCKING CURRENT	I_{FX}	—	2.0	10	μA	V_{FX} = Rated V_{FXM}, $T_J = +25°C$, R_{GK} = 40,000 ohms
		—	40	100*	μA	V_{FX} = Rated V_{FXM}, $T_J = +100°C$, R_{GK} = 40,000 ohms
GATE TRIGGER CURRENT	I_{GT}	—	5	20	μAdc	$V_{FX} = +6$ Vdc, $T_J = +25°C$, R_L = 100 ohms max.
		—	—	75*	μAdc	$V_{FX} = +6$ Vdc, $T_J = -65°C$, R_L = 100 ohms max.
GATE SUPPLY TRIGGER CURRENT	I_{GS}	—	10	40	μAdc	$V_{FX} = +6$ Vdc, $T_J = +25°C$, R_L = 100 ohms max. R_{GK} = 40,000 ohms
GATE TRIGGER VOLTAGE	V_{GT}	0.35	0.5	0.8	Vdc	$V_{FX} = +6$ Vdc, $T_J = +25°C$, R_L = 100 ohms max.
		—	—	1.0*	Vdc	$V_{FX} = +6$ Vdc, $T_J = -65°C$, R_L = 100 ohms max.
PEAK ON-VOLTAGE	V_{FM}	—	1.6	2.0*	V	I_{FM} = 3.14 amps, $T_J = +25°C$, R_{GK} = 40,000 ohms
HOLDING CURRENT	I_{HX}	—	0.2	1.0*	mA	R_{GK} = 40,000 ohms, $T_J = 25°C$
TURN-ON TIME	$t_d + t_r$	—	1.4	—	μsec.	I_F = 1 amp, $T_J = 25°C$
DELAY TIME	t_d	—	0.6	—	μsec.	I_F = 1 amp, $T_J = 25°C$
RISE TIME	t_r	—	0.8	—	μsec.	I_F = 1 amp, $T_J = 25°C$
TURN-OFF TIME	t_o	—	20	—	μsec.	i_F = 1 amp, i_R = 1 amp dv/dt = 20v/μsec. R_{GK} = 100 ohms, $T_J = 100°C$ (See Application Notes)

*Includes data included on JEDEC type number registration.

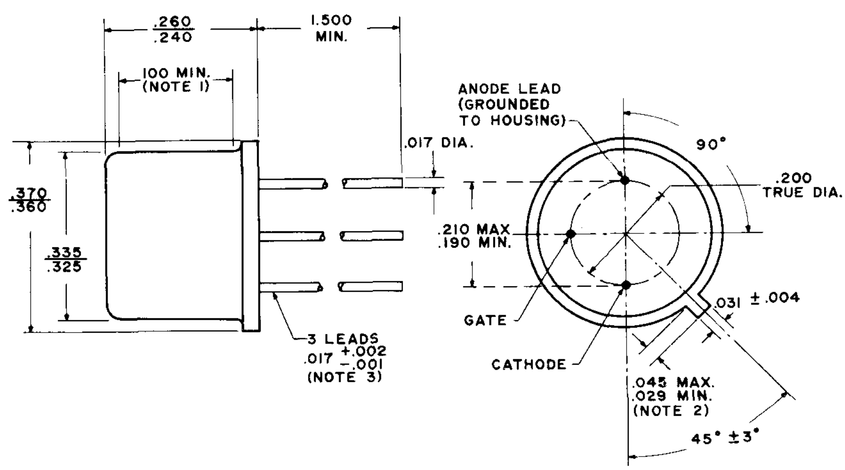
OUTLINE DRAWING
(Conforms to JEDEC TO-5 Package Outline)

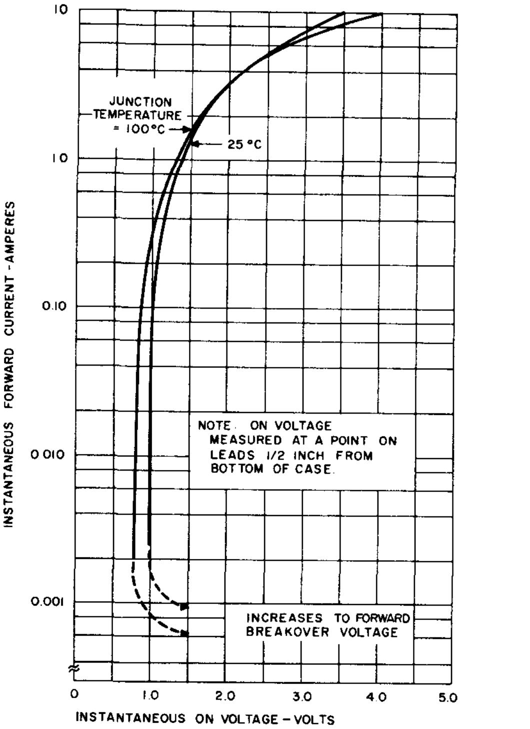
NOTE 1: THIS ZONE IS CONTROLLED FOR AUTOMATIC HANDLING. THE VARIATION IN ACTUAL DIAMETER WITHIN THIS ZONE SHALL NOT EXCEED .010.

NOTE 2: MEASURED FROM MAX. DIAMETER OF THE ACTUAL DEVICE.

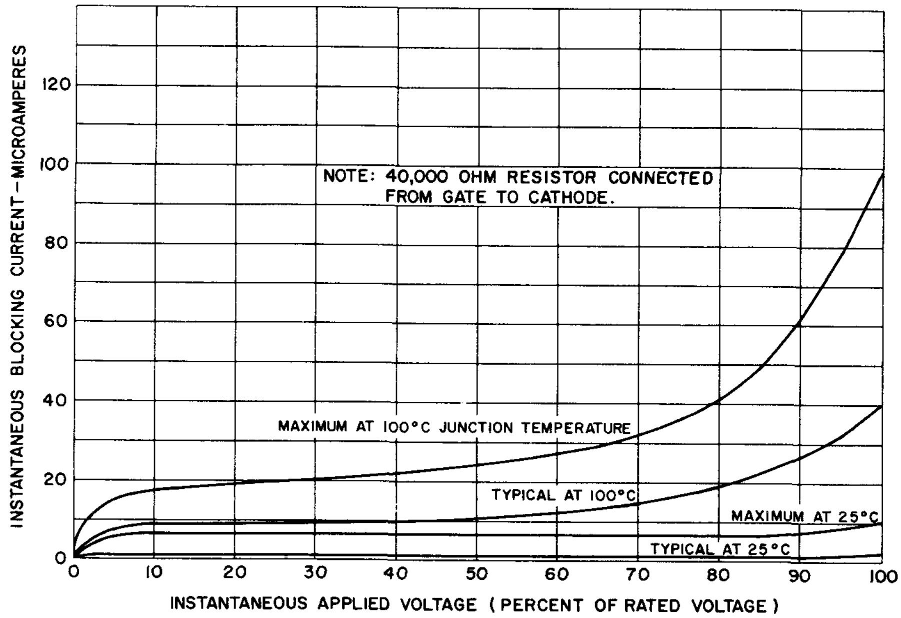
NOTE 3: THE SPECIFIED LEAD DIAMETER APPLIES IN THE ZONE BETWEEN .050 AND .250 FROM THE BASE SEAT. BETWEEN .250 AND 1.5 MAXIMUM OF .021 DIAMETER IS HELD. OUTSIDE OF THESE ZONES THE LEAD DIAMETER IS NOT CONTROLLED. LEADS MAY BE INSERTED, WITHOUT DAMAGE, IN .031 HOLES WHILE DEVICE ENTERS .371 HOLE CONCENTRIC WITH LEAD HOLE CIRCLE.

APROX WEIGHT: .05 OZ
ALL DIMENSIONS IN INCHES

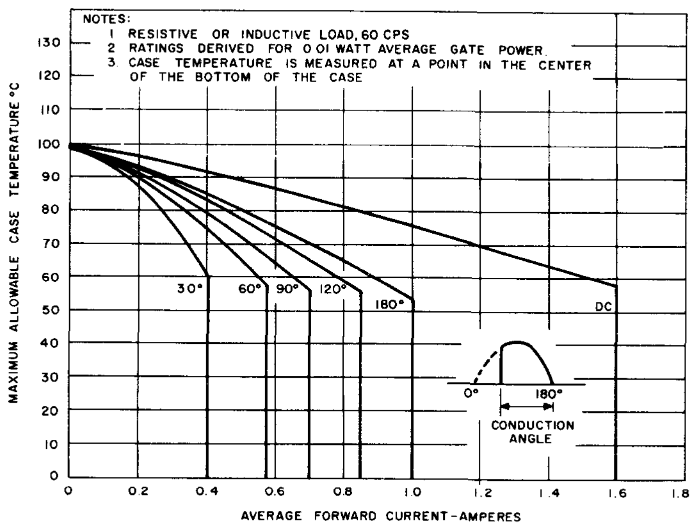




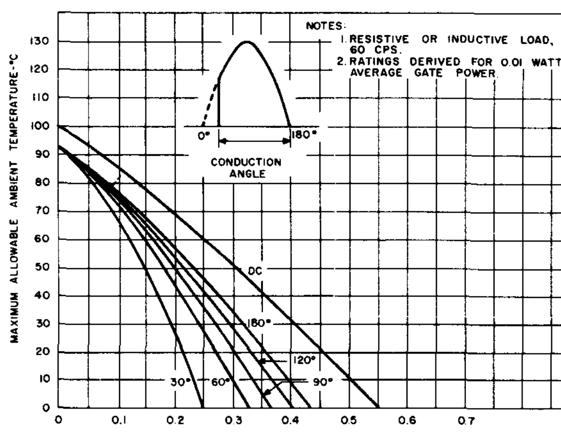
1. MAXIMUM FORWARD CHARACTERISTICS CONDUCTING STATE



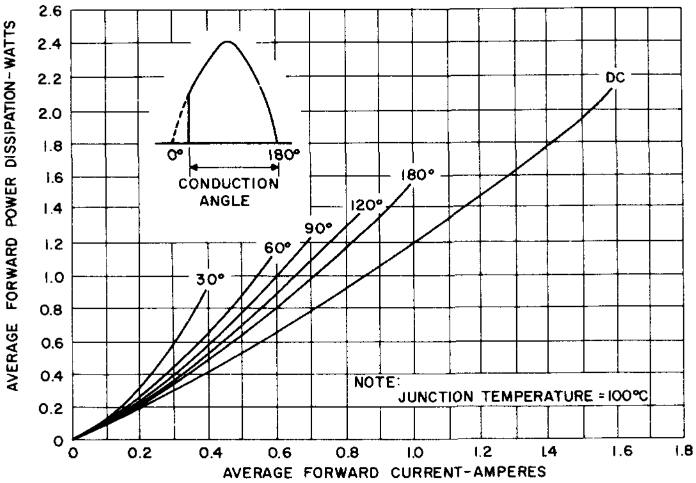
2. TYPICAL AND MAXIMUM FORWARD AND REVERSE BLOCKING CHARACTERISTICS



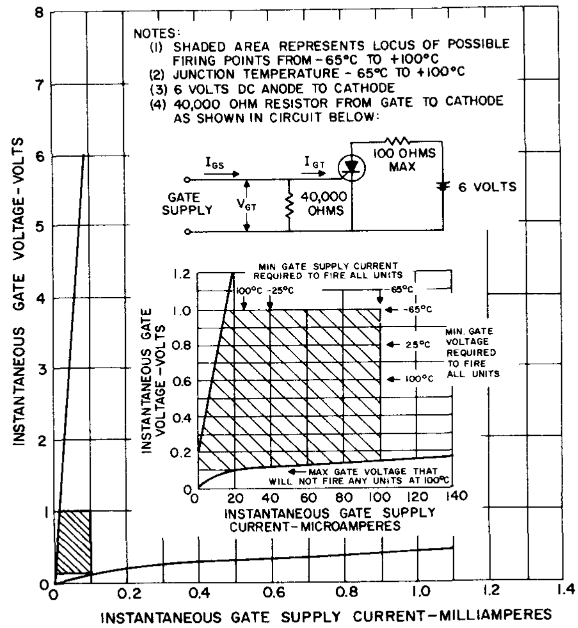
3. MAXIMUM ALLOWABLE CASE TEMPERATURE



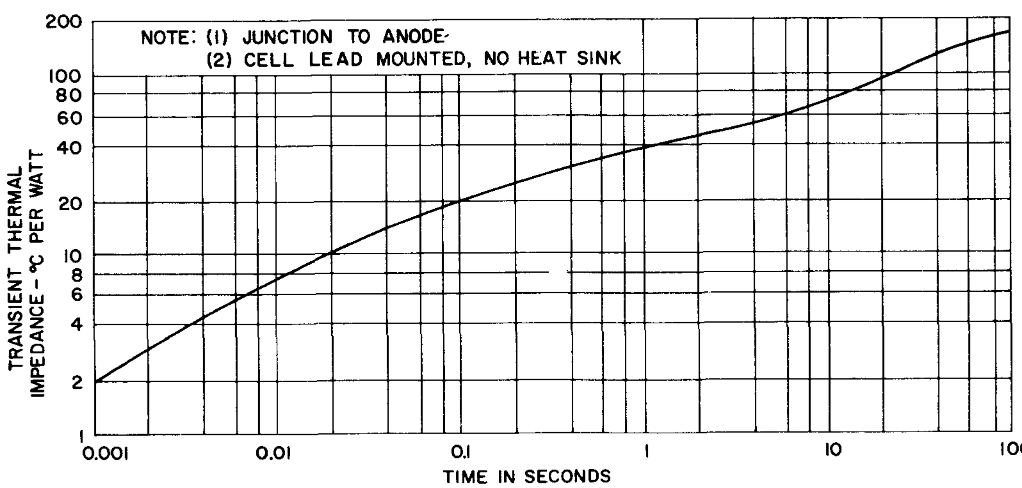
4. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE



5. FORWARD POWER DISSIPATION



6. GATE TRIGGERING CHARACTERISTICS

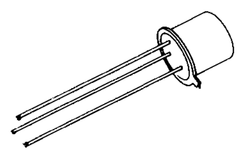


7. MAXIMUM TRANSIENT THERMAL IMPEDANCE

Silicon Unijunction Transistors

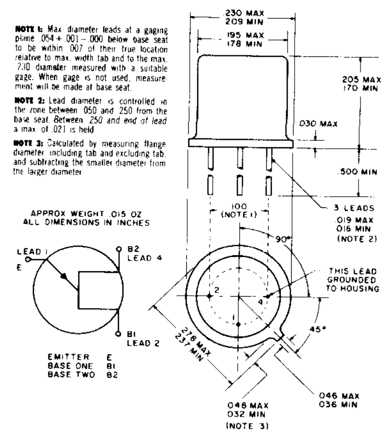
2N2646,7

The General Electric 2N2646 and 2N2647 Silicon Unijunction Transistors have an entirely new structure resulting in lower saturation voltage, peak-point current and valley current as well as a much higher base-one peak pulse boltage. In addition, these devices are much faster switches.
The 2N2646 is intended for general purpose industrial applications where circuit economy is of primary importance, and is ideal for use in firing circuits for Silicon Controlled Rectifiers and other applications where a guaranteed minimum pulse amplitude is required. The 2N2647 is intended for applications where a low emitter leakage current and a low peak point emitter current (trigger current) are required (i.e. long timing applications), and also for triggering high power SCR's.



absolute maximum ratings: (25°C) (unless otherwise specified)

Power Dissipation (Note 1)	300 mw
RMS Emitter Current	50 ma
Peak Emitter Current (Note 2)	2 amperes
Emitter Reverse Voltage	30 volts
Interbase Voltage	35 volts
Operating Temperature Range	−65°C to +125°C
Storage Temperature Range	−65°C to +150°C



electrical characteristics: (25°C) (unless otherwise specified)

PARAMETER		**2N2646** Min.	Typ.	Max.	**2N2647** Min.	Typ.	Max.	
Intrinsic Standoff Ratio ($V_{BB} = 10V$)	η	0.56	0.69	0.75	0.68	0.77	0.82	
Interbase Resistance ($V_{BB} = 3V$, $I_E = 0$)	R_{BBO}	4.7	6.7	9.1	4.7	6.7	9.1	KΩ
Emitter Saturation Voltage ($V_{BB} = 10V$, $I_E = 50$ ma)	$V_{E(SAT)}$		2			2		volts
Modulated Interbase Current ($V_{BB} = 10V$, $I_E = 50$ ma)	$I_{B2(MOD)}$		24			27		ma
Emitter Reverse Current ($V_{B2E} = 30V$, $I_{B1} = 0$)	I_{EO}		.001	12		.001	.200	µa
Peak Point Emitter Current ($V_{BB} = 25V$)	I_P		0.8	5		1.0	2	µa
Valley Point Current ($V_{BB} = 20V$, $R_{B2} = 100\Omega$)	I_V	4	5		8	9	18	ma
Base-One Peak Pulse Voltage (Note 3)	V_{OB1}	3.0	8.5		6.0	9.5		volts
SCR Firing Conditions (See Figure 26, back page)								

1. Derate 3.0 MW/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.
2. Capacitor discharge—10µfd or less, 30 volts or less.
3. The Base-One Peak Pulse Voltage is measured in the circuit below. This specification on the 2N2646 and 2N2647 is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.
4. The intrinsic standoff ratio, η, is essentially constant with temperature and interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + V_D$$

Where V_P = Peak Point Emitter Voltage
V_{BB} = Interbase Voltage
V_D = Junction Diode Drop (Approx. .5V)

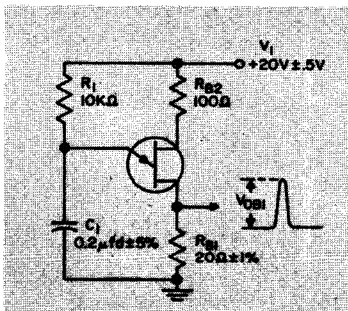


FIGURE 1

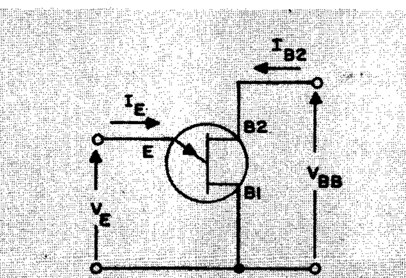


FIGURE 2
Unijunction Transistor Symbol with Nomenclature used for voltage and currents.

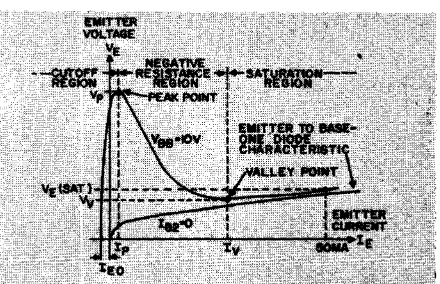


FIGURE 3
Static Emitter Characteristics curves showing important parameters and measurement points (exaggerated to show details).

$T_A = 125°C$

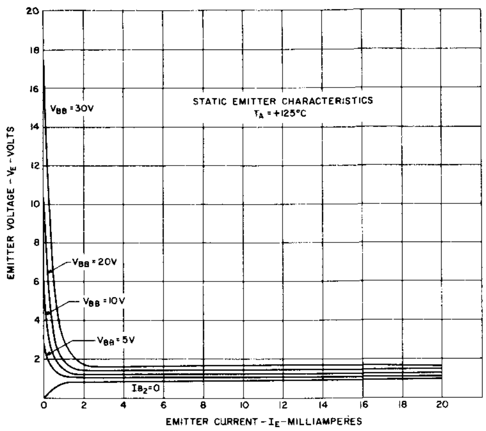


FIGURE 4

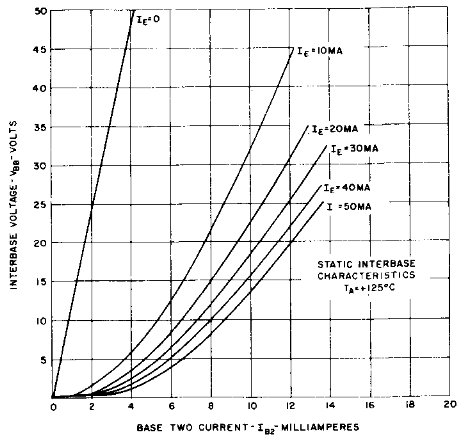


FIGURE 5

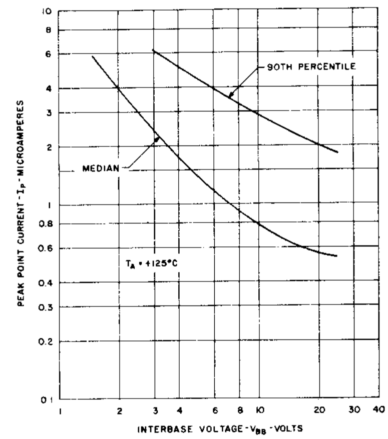


FIGURE 6

$T_A = 25°C$

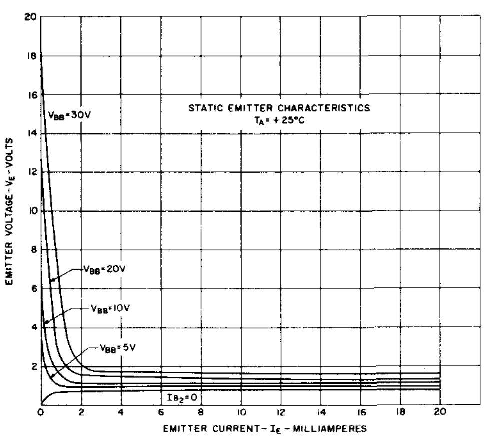


FIGURE 7

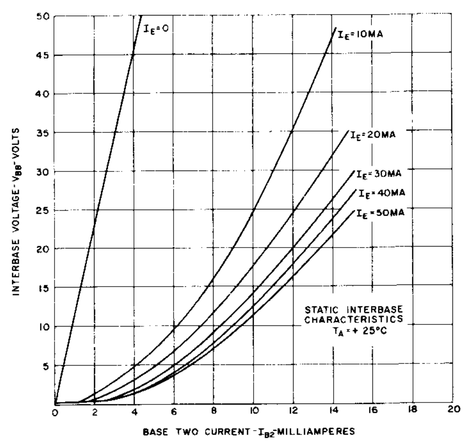


FIGURE 8

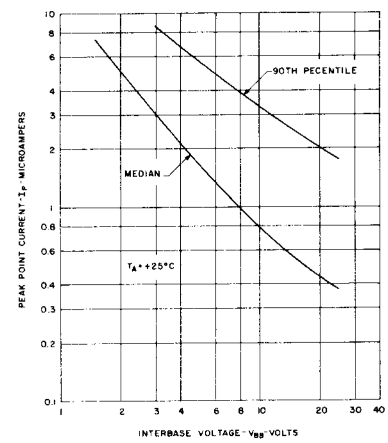


FIGURE 9

$T_A = -55°C$

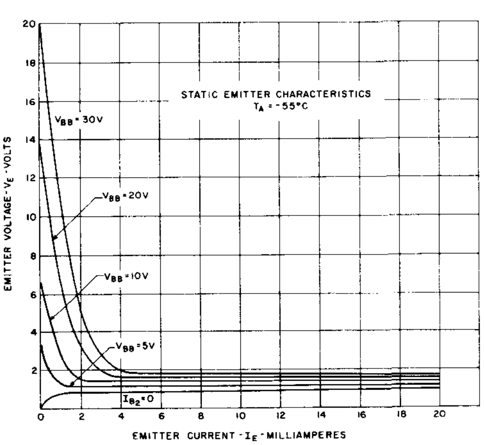


FIGURE 10

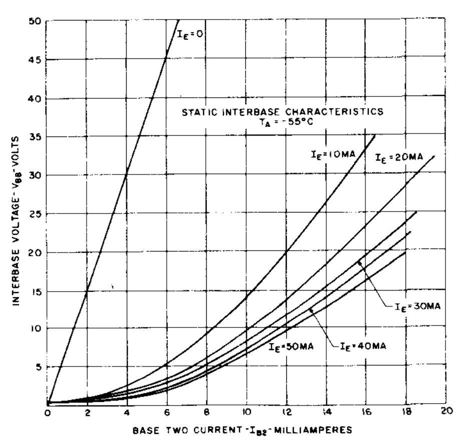


FIGURE 11

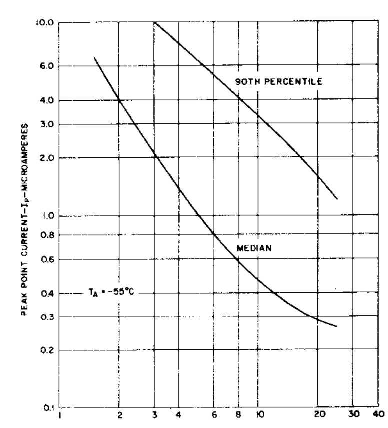


FIGURE 12

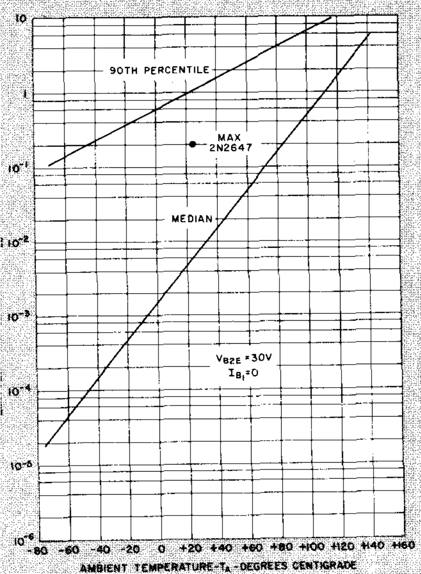


FIGURE 13

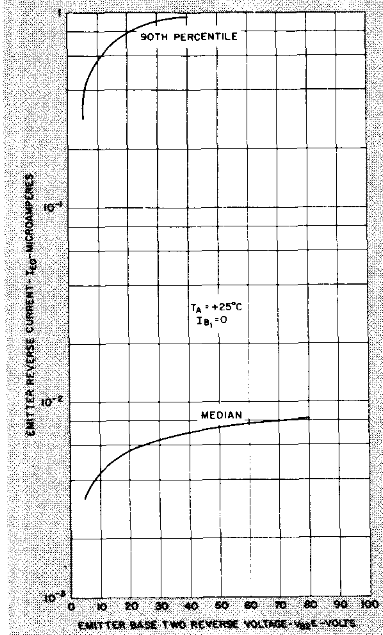


FIGURE 14

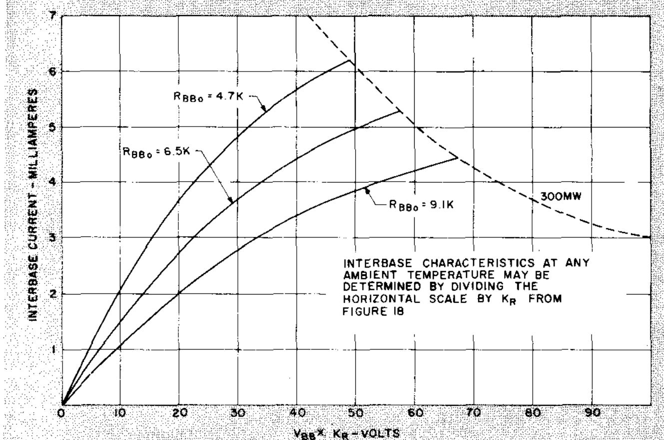


FIGURE 15

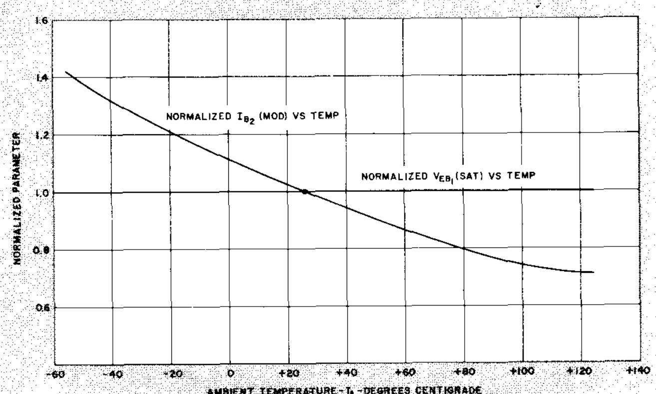


FIGURE 16

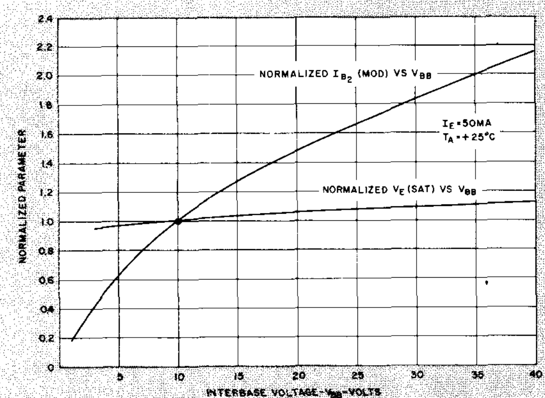


FIGURE 17

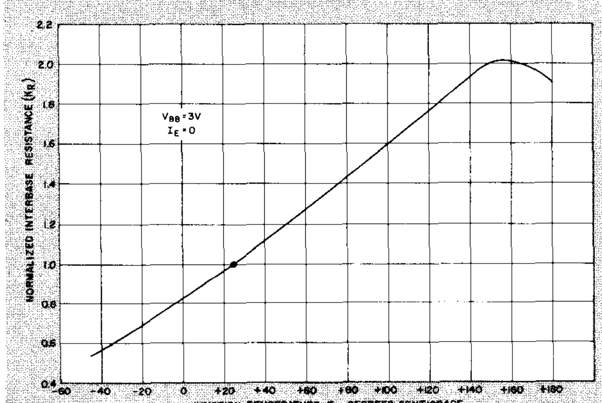


FIGURE 18

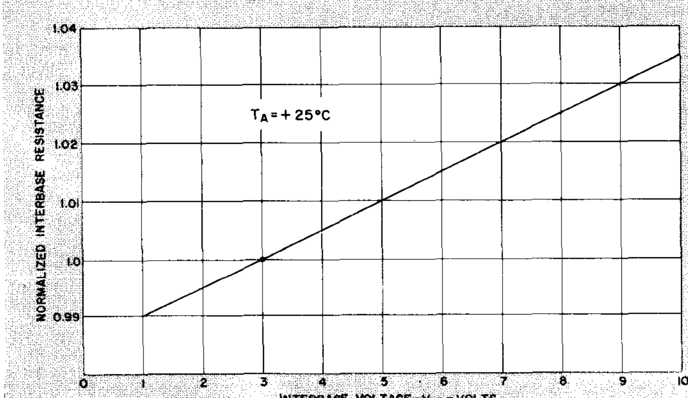


FIGURE 19

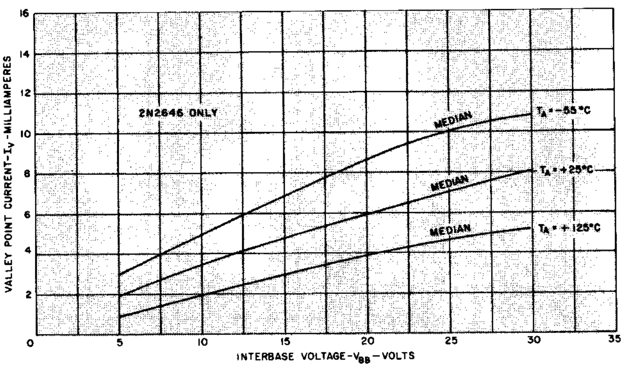


FIGURE 20

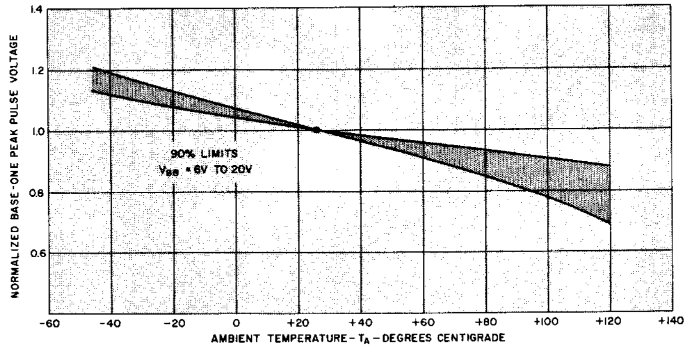


FIGURE 21

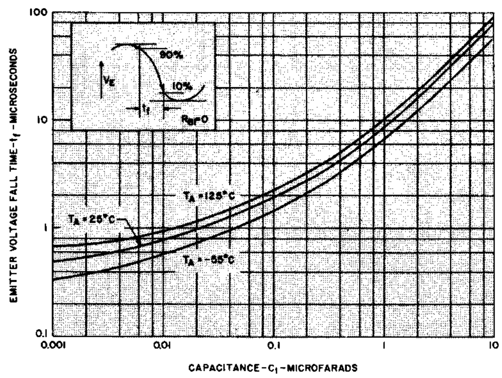
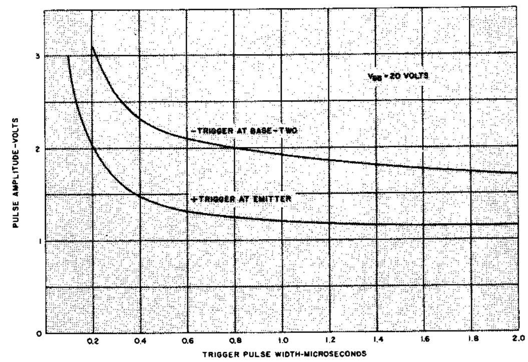


FIGURE 22



MINIMUM TRIGGER AMPLITUDE AS A FUNCTION OF TRIGGER PULSE WIDTH FOR TURN ON OF UNIJUNCTION TRANSISTOR

FIGURE 23

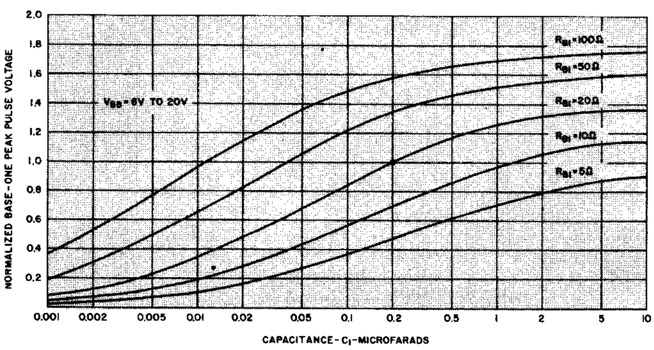


FIGURE 24

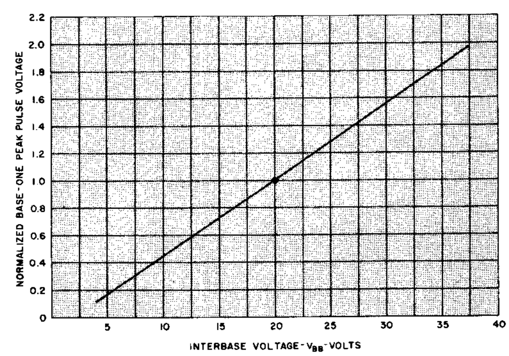


FIGURE 25

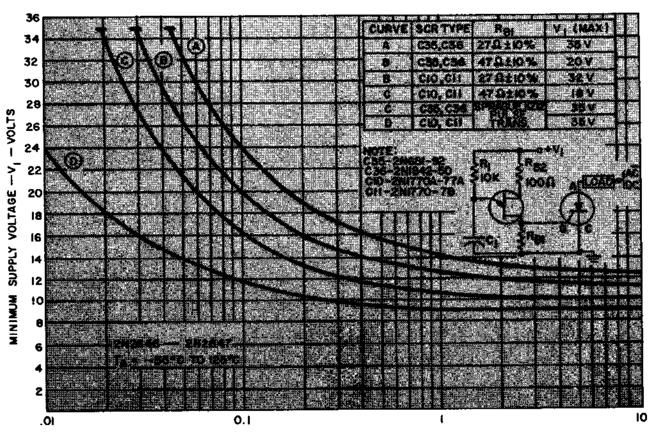


FIGURE 26A-Both types- Lo &Med. SCR's

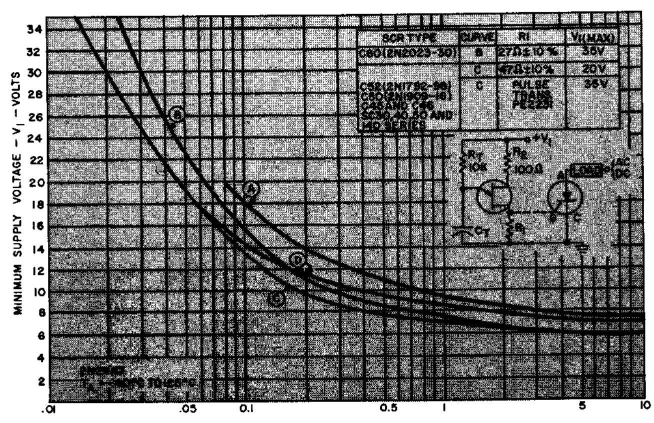


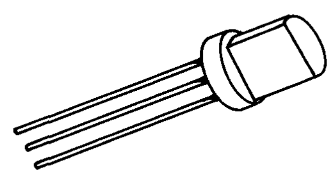
FIGURE 26B-2N2647-Hi Current SCR's

Silicon Transistors

NPN

2N2711,2

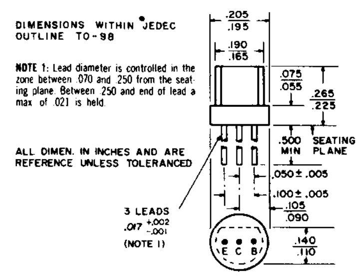
The 2N2711 and 2N2712 are planar passivated NPN Silicon transistors specifically manufactured for radio and general purpose commercial applications. They are housed in an epoxy case and are intended to perform all small signal functions in a conventional AM radio.



absolute maximum ratings: (25°C) (unless otherwise specified)

		2N2711 2N2712	
Voltages			
Collector to Emitter	V_{CEO}	18	volts
Emitter to Base	V_{EBO}	5	volts
Collector to Base	V_{CBO}	18	volts
Current			
Collector* (Steady State)	I_C	100	mA
Dissipation			
Total Power (Free air @ 25°C)**	P_T	200	mW
Total Power (Free air @ 55°C)**	P_T	120	mW
Temperature			
Storage	T_{STG}	−55 to +125	°C
Operating	T_J	+100	°C

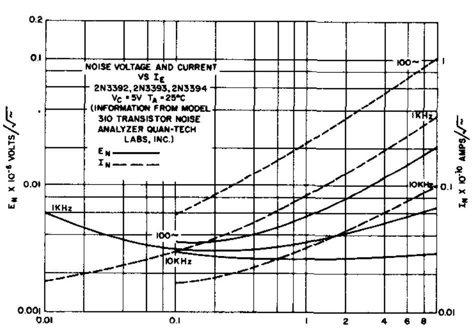
*Determined from power limitations due to saturation voltage at this current.
**Derate 2.67 mW/°C increase in ambient temperature above 25°C.



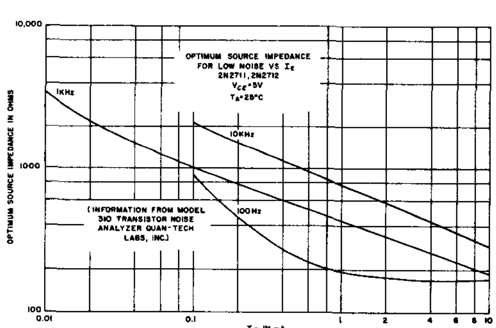
electrical characteristics: (25°C) (unless otherwise specified)

		2N2711 Min.	2N2711 Typ.	2N2711 Max.	2N2712 Min.	2N2712 Typ.	2N2712 Max.
D-C CHARACTERISTICS							
Collector Cutoff Current ($V_{CB} = 18V$)	I_{CBO}			0.5			0.5 μA
($V_{CB} = 18V$, $T_A = 100°C$)	I_{CBO}			15			15 μA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}			0.5			0.5 μA
Forward Current Transfer Ratio ($V_{CE} = 4.5V$, $I_C = 2$ mA)	h_{FE}	30		90	75		225
SMALL SIGNAL CHARACTERISTICS							
Common Emitter ($V_{CE} = 5V$, $I = 2$ mA, $f = 455$ kHz)							
Forward Current Transfer Ratio: Output a.c. Short Circuited	h_{fe}		55∠−11°			169∠−42°	
Input Impedance: Output a.c. Short Circuited	h_{ie}		1040∠−10°			2580∠−41°	ohms
Reverse Voltage Transfer Ratio: Input a.c. Open Circuited	h_{re}		.027∠79°			.071∠48°	
Output Admittance: Input a.c. Open Circuited	h_{oe}		1610∠79°			4770∠48°	μmhos
Forward Transfer Admittance: Output a.c. Short Circuited	y_{fe}		.053∠0°			.066∠0°	mho
Input Admittance: Output a.c. Short Circuited	y_{ie}		960∠10°			388∠41°	μmho
Reverse Transfer Admittance: Input a.c. Short Circuited	y_{re}		−26∠90°			−28∠90°	μmho
Output Admittance: Input a.c. Short Circuited	y_{oe}		170∠90°			71∠45°	μmho
HIGH FREQUENCY CHARACTERISTICS							
Collector Capacitance ($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{cbo}	4.5	9	12	4.5	9	12 pF
NOISE							
Noise Figure ($I_C = 100$ μA, $V_{CE} = 5V$, $f = 10$ kHz, BW = 1 Hz, Rg = 2000 Ω)	N.F.		2.8			2.8	dB
Signal to Noise Ratio in Typical RF Circuit (1600 kHz, 12 μV signal)	S/N		22			22	dB

NOISE VOLTAGE AND CURRENT vs. I_E

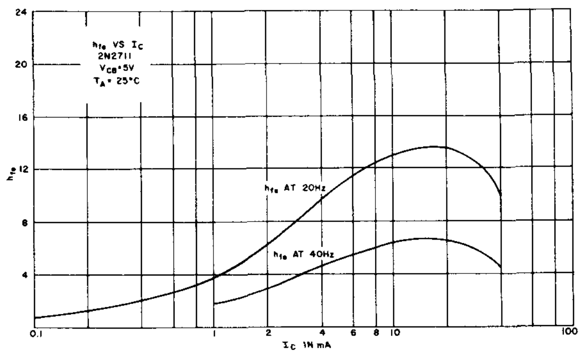


OPTIMUM SOURCE IMPEDANCE FOR LOW NOISE vs. I_E

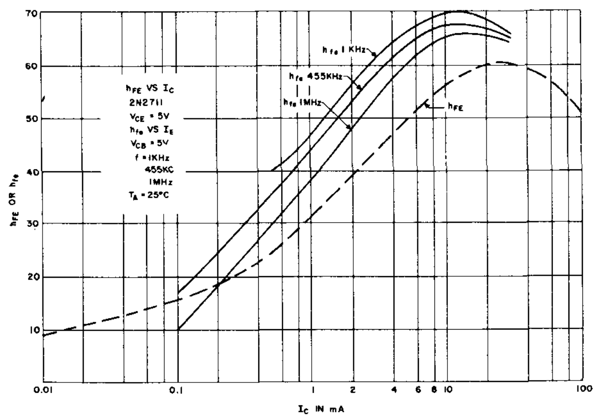


TYPE 2N2711,

h_{fe} vs. I_C

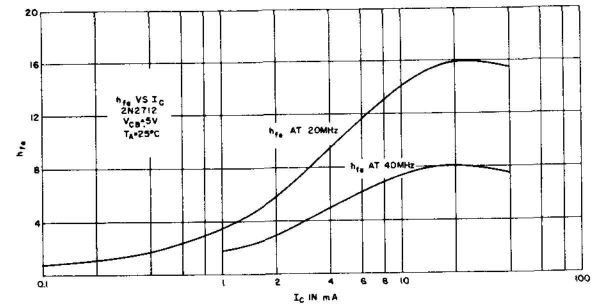


h_{fe} or h_{FE} vs. I_C

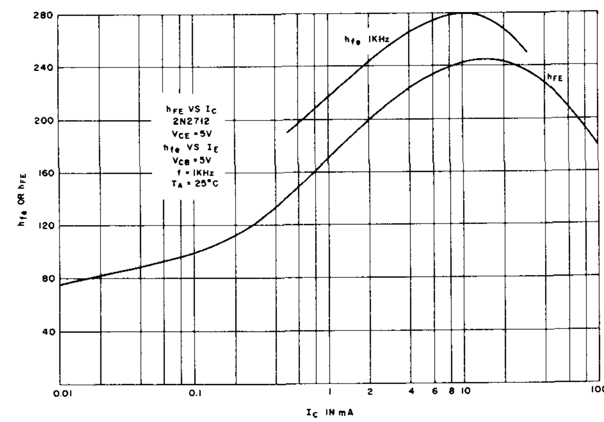


TYPE 2N2712

h_{fe} vs. I_C

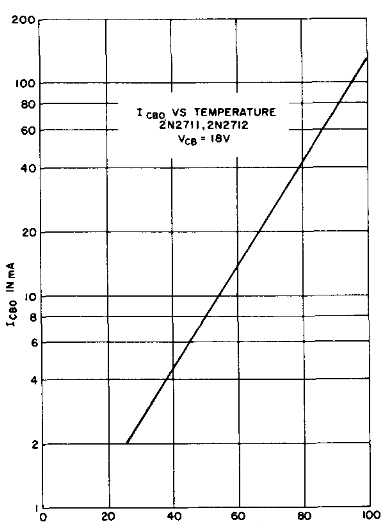


h_{fe} or h_{FE} vs. I_C

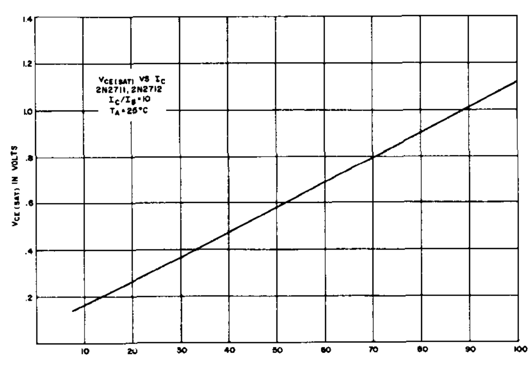


TYPE 2N2711, 2N2712

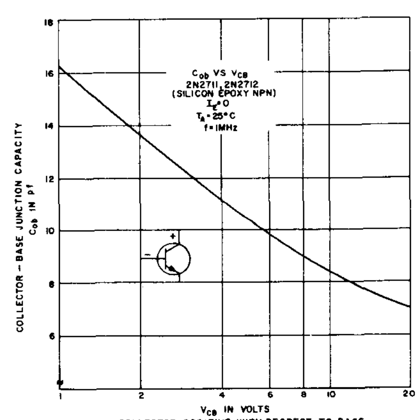
I_{CBO} vs. TEMPERATURE



$V_{CE\ (SAT)}$ vs. I_C



C_{ob} vs. V_{CB}

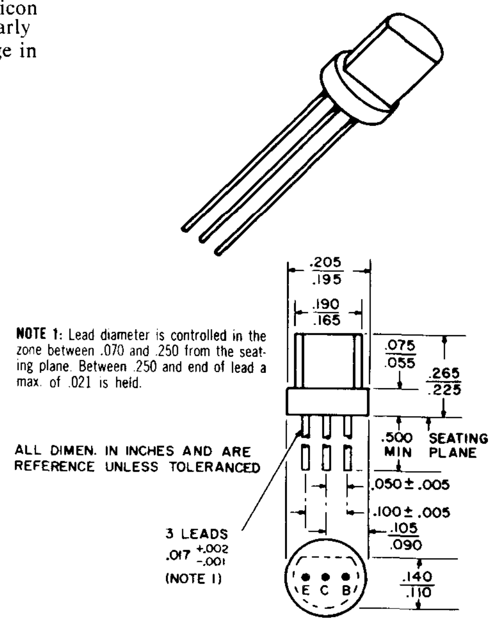


Silicon Transistors

NPN

2N2713,4

The General Electric 2N2713 and 2N2714 are epoxy encapsulated planar epitaxial passivzted NPN silicon transistors specifically manufactured for general purpose commercial applications. They are particularly useful in output stages where low saturation voltage is desirable. They may also be used to advantage in switching applications due to their low storage time, good beta holdup to beyond 150 ma and low $V_{CE(SAT)}$.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	18	volts
Emitter to Base	V_{EBO}	5	volts
Collector to Base	V_{CBO}	18	volts
Current			
Collector* (Steady State)	I_C	200	mA
Dissipation			
Total Power (Free air @ 25°C)**	P_T	360	mW
Temperature			
Storage	T_{STG}	−55°C to +125	°C
Operating	T_J	+100	°C

*Determined from power limitations due to saturation voltage at this current.
**Derate 3.6 mw/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C)

DC CHARACTERISTICS		Min.	Typ.	Max.	
Collector Cutoff Current (V_{CB} = 18V)	I_{CBO}			0.1	μA
(V_{CB} = 18V, T_A = 100°C)	I_{CBO}			15	μA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}			0.5	μA
Forward Current Transfer Ratio (V_{CE} = 4.5V, I_C = 2 mA)					
2N2713	h_{FE}	30		90	
2N2714	h_{FE}	75		225	
Collector Saturation Voltage (I_B = 3 mA, I_C = 50 mA)	$V_{CE(SAT)}$			0.30	volts
Base Saturation Voltage (I_B = 3 mA, I_C = 50 mA)	$V_{BE(SAT)}$			1.3	volts
LARGE SIGNAL CHARACTERISTICS					
Input Impedance ($\frac{V_{BE2} - V_{BE1}}{I_{B2} - I_{B1}}$; where condition "1" is I_B = .05 mA and condition "2" is I_B = .5 mA, V_{CE} = 1V)	h_{IE}		200		ohms
SWITCHING SPEEDS (See Figure 1)					
Delay Time	t_d		60		ns
Rise Time	t_r		85		ns
Storage Time	t_s		85		ns
Fall Time	t_f		40		ns

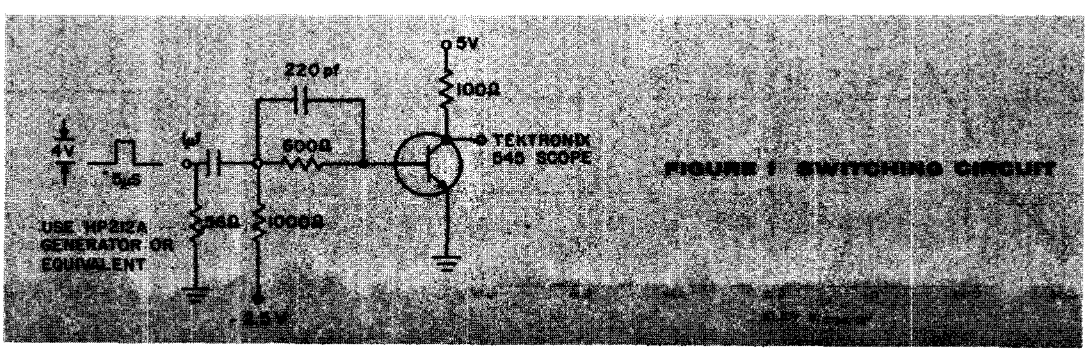
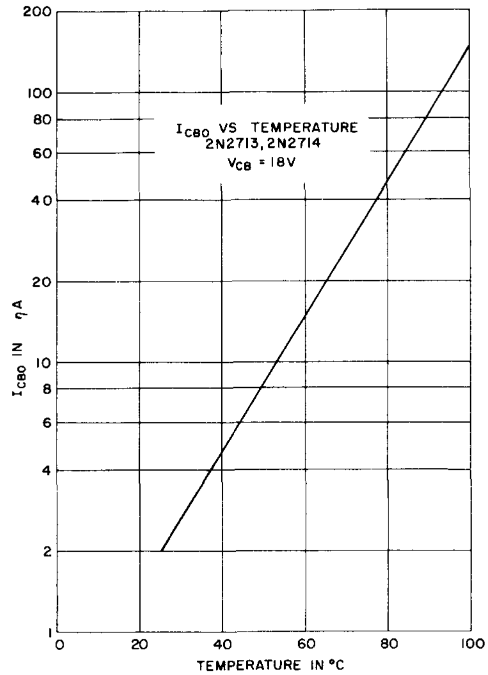
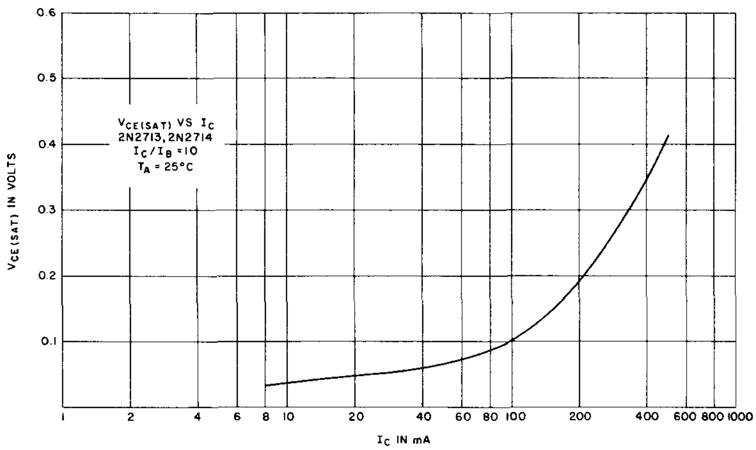
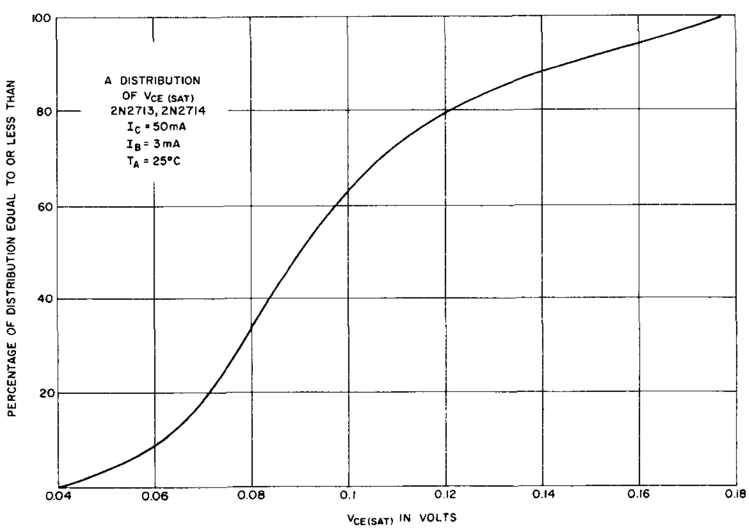


FIGURE 1 SWITCHING CIRCUIT

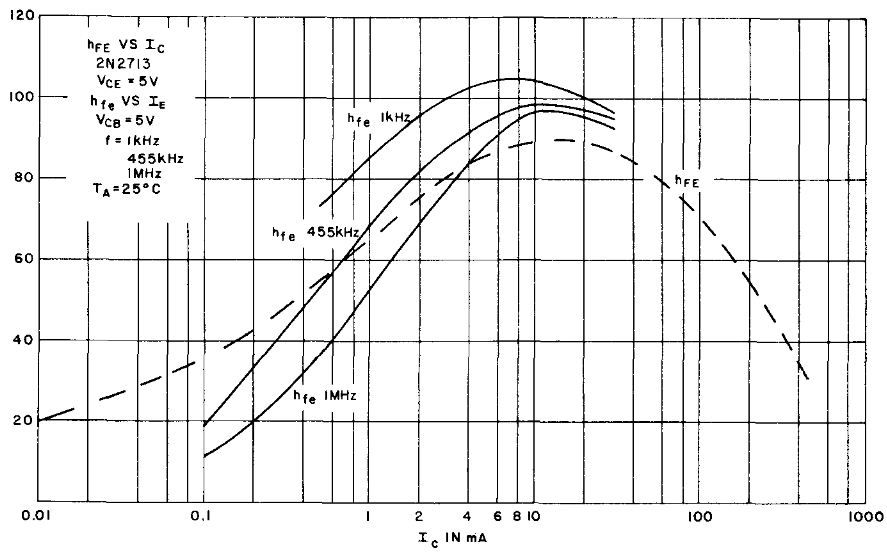
TYPES 2N2713, 2N2714



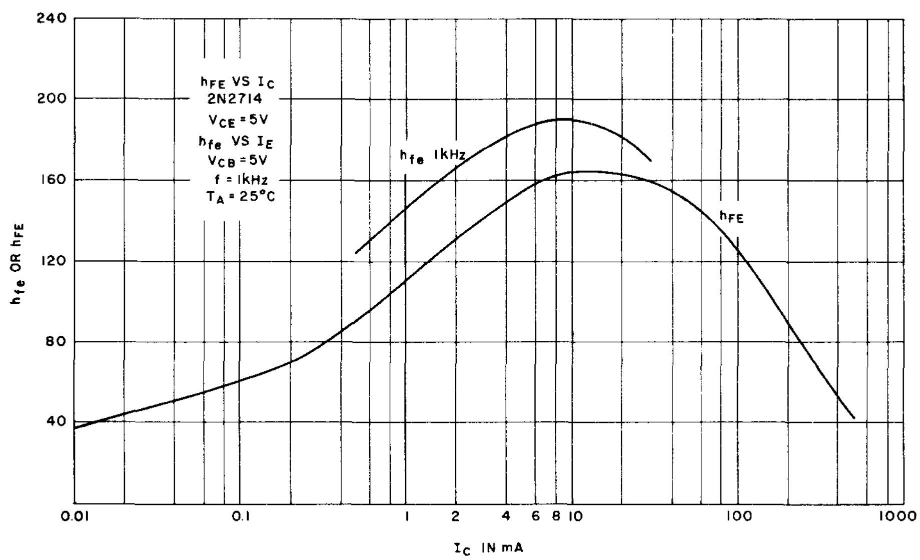




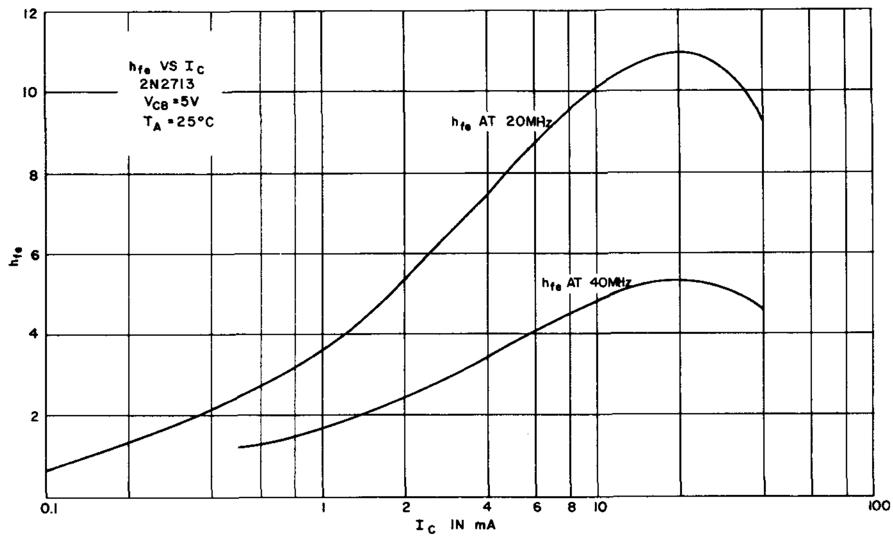
h_{fe} or h_{FE} vs. I_C - TYPE 2N2713



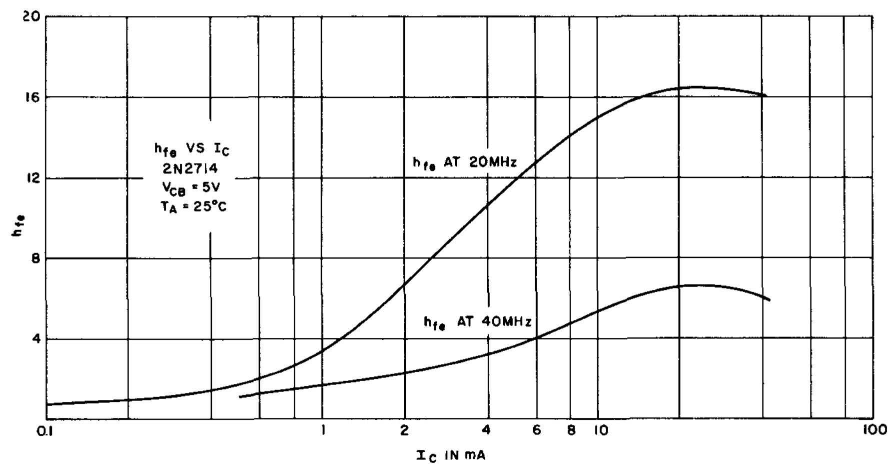
h_{fe} or h_{FE} vs. I_C - TYPE 2N2714

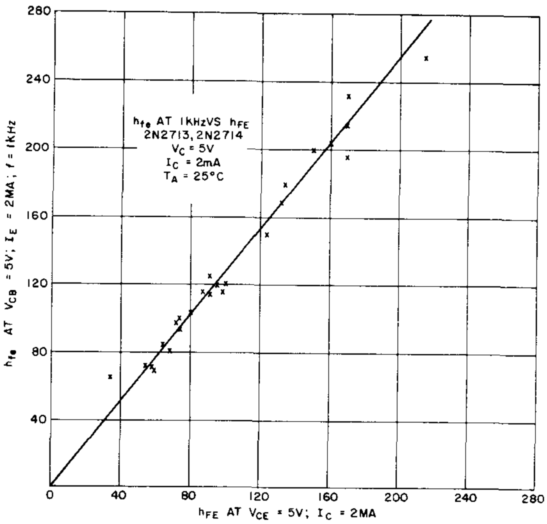


h_{fe} vs. I_C - TYPE 2N2713

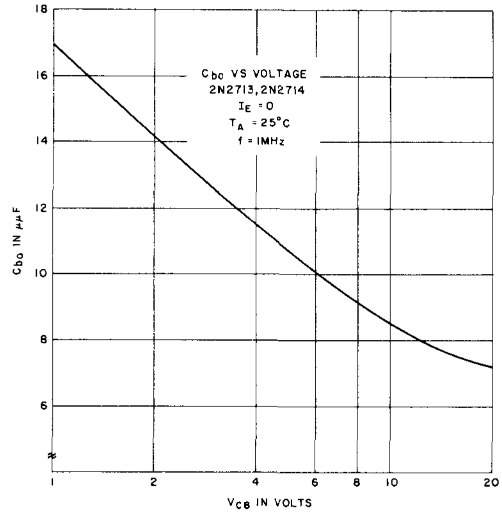


h_{fe} vs. I_C - TYPE 2N2714

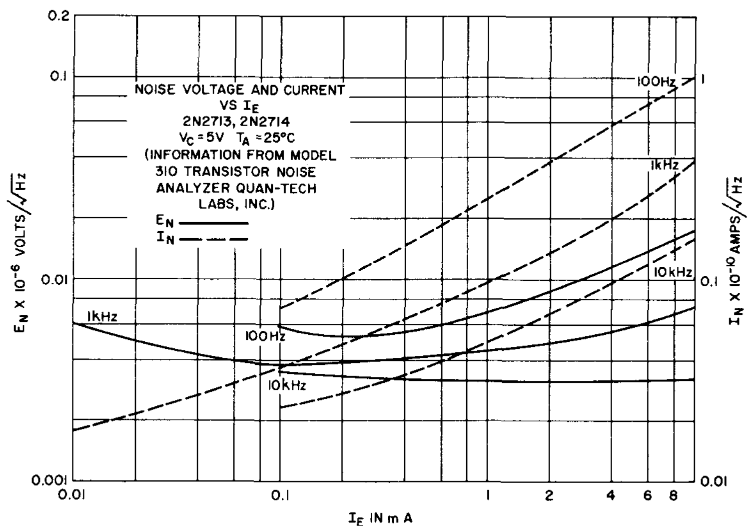




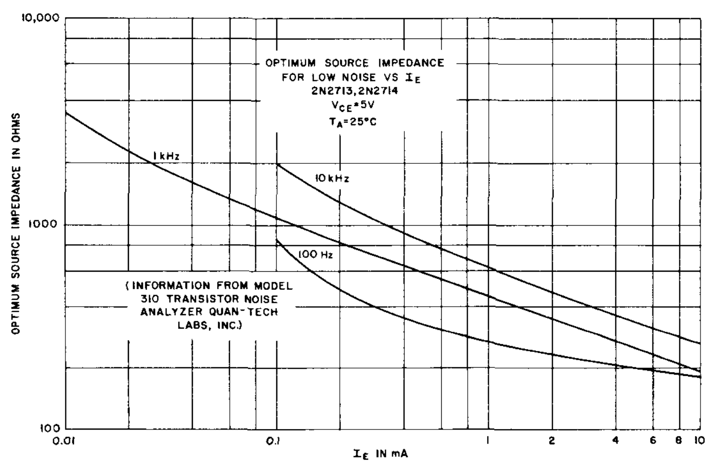
h_{fe} AT 1KHz VS h_{FE}
2N2713, 2N2714
V_C = 5V
I_C = 2mA
T_A = 25°C
h_{fe} AT V_{CB} = 5V; I_E = 2MA; f = 1kHz
h_{FE} AT V_{CE} = 5V; I_C = 2MA



C_{bo} VS VOLTAGE
2N2713, 2N2714
I_E = 0
T_A = 25°C
f = 1MHz
C_{bo} IN μμF
V_{CB} IN VOLTS



NOISE VOLTAGE AND CURRENT
VS I_E
2N2713, 2N2714
V_C = 5V T_A = 25°C
(INFORMATION FROM MODEL
310 TRANSISTOR NOISE
ANALYZER QUAN-TECH
LABS, INC.)
E_N
I_N
100Hz
1kHz
10kHz
E_N X 10^{-6} VOLTS/$\sqrt{Hz}$
I_N X 10^{-10} AMPS/$\sqrt{Hz}$
I_E IN mA



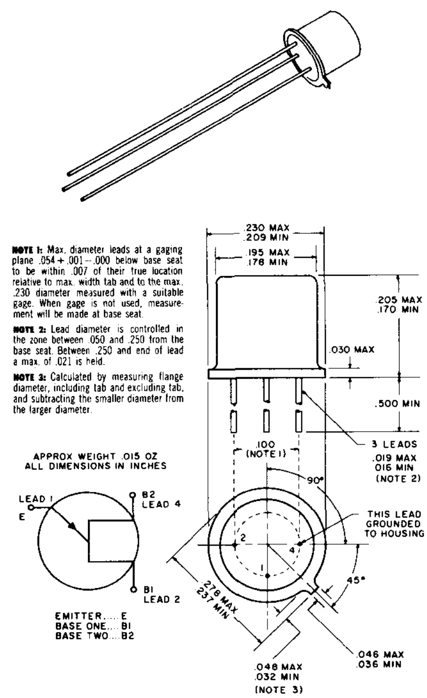
OPTIMUM SOURCE IMPEDANCE
FOR LOW NOISE VS I_E
2N2713, 2N2714
V_{CE} = 5V
T_A = 25°C
1kHz
10kHz
100 Hz
(INFORMATION FROM MODEL
310 TRANSISTOR NOISE
ANALYZER QUAN-TECH
LABS, INC.)
OPTIMUM SOURCE IMPEDANCE IN OHMS
I_E IN mA

Silicon Unijunction Transistor

2N2840

2N2906-7 SEE GES2906-7

The General Electric Type 2N2840 Silicon Unijunction transistor maintains its negative resistance region for extremely low interbase voltages. This transistor is specifically characterized for use at interbase voltages less than 10 volts and as low as 1.5 volts. The transistor is hermetically sealed in a welded case equivalent to the TO-18, except for lead orientation. Base-two is electrically common to case.



absolute maximum ratings: (25°C)

Power Dissipation*	300	mw
RMS Emitter Current	50	ma
Peak Emitter Current**	2	amps
Emitter Reverse Voltage	30	volts
Interbase Voltage	35	volts
Operating Temperature Range	−65 to +150	°C
Storage Temperature Range	−65 to +175	°C

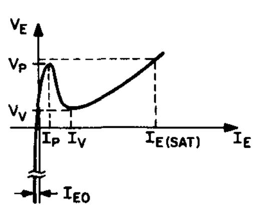
*Derate 2.4 mw/°C increase in ambient temperature. Maximum power available to the transistor must be limited by external circuitry to be within this rating.

**Capacitor Discharge—10 μfd or less, 30 volts or less.

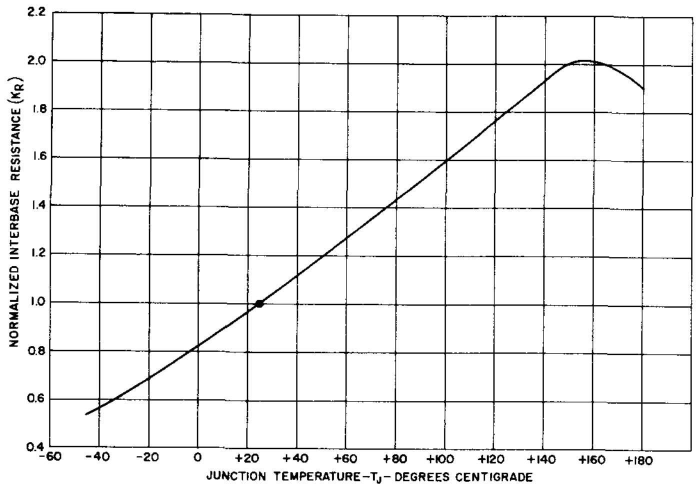
electrical characteristics: (25°C)

PARAMETER		Min.	Typ.	Max.	
Emitter Peak Point Voltage ($V_{BB} = 1.50V$)	V_P	1.30	1.4	1.50	volts
Emitter Peak Point Current ($V_{BB} = 1.50V$)	I_P		7.5	10	μa
Intrinsic Standoff Ratio ($V_{BB} = 10V$)***	η		.62		
Emitter Valley Point Voltage ($V_{BB} = 1.50V$)	V_V		.95	1.10	volts
Emitter Valley Point Current ($V_{BB} = 1.50V$)	I_V	.20	.40	.70	ma
Emitter Base Saturation Current ($V_{BB} = 1.50V$; $V_{EB1} = 1.50V$)	$I_{E(SAT)}$	20	40		ma
Emitter Reverse Current ($V_{B2E} = 30V$; $I_{B1} = 0$)	I_{EO}		.05	1	μa
Interbase Resistance ($V_{BB} = 1.50V$; $I_E = 0$)	R_{BB}	4.7	7	9.1	KΩ

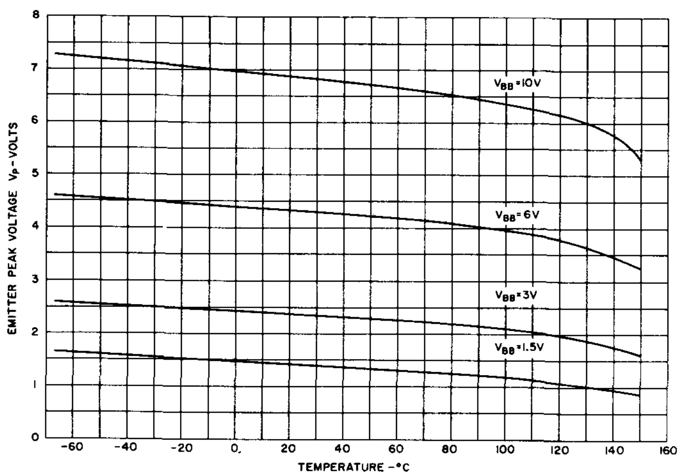
***η is defined by the equation $V_P = \eta V_{BB} + V_D$ where $V_D \sim .5V$.



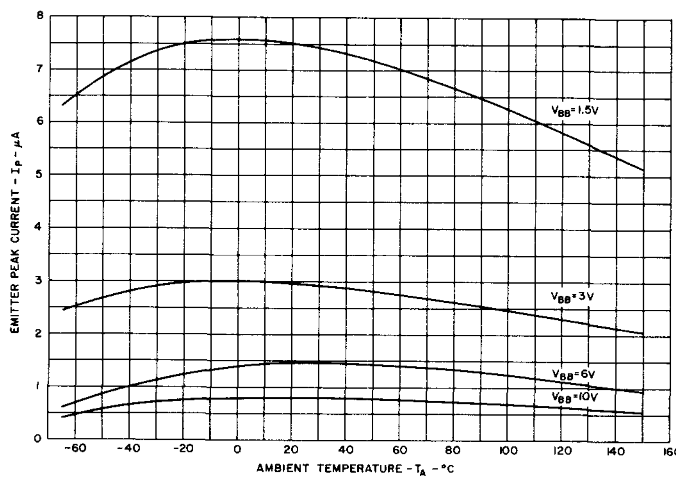
	TEMPERATURE COEFFICIENT, MV/°C		
	10%	MED	90%
V_P	-2.8	-3.4	-4.0
V_B	-1.7	-2.0	-2.4



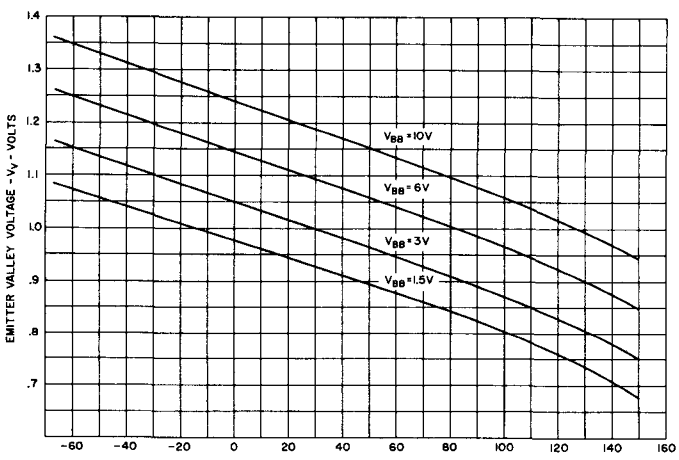
NORMALIZED INTERBASE RESISTANCE (K_R)
JUNCTION TEMPERATURE - T_J - DEGREES CENTIGRADE



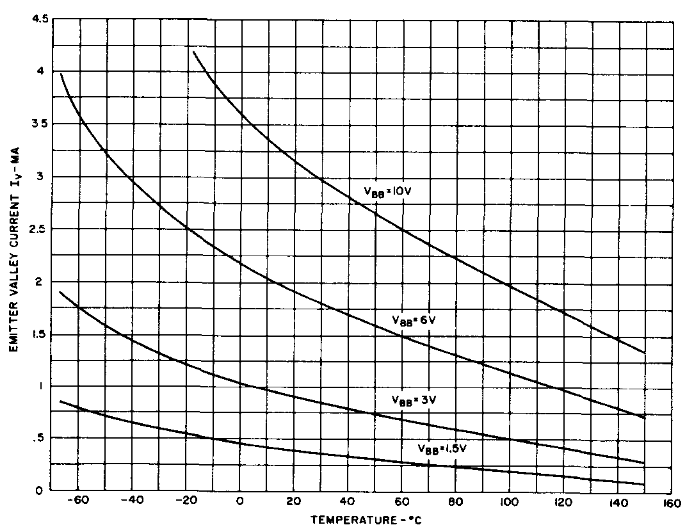
EMITTER PEAK VOLTAGE V_P - VOLTS
TEMPERATURE - °C
V_{BB} = 10V
V_{BB} = 6V
V_{BB} = 3V
V_{BB} = 1.5V



EMITTER PEAK CURRENT - I_P - μA
AMBIENT TEMPERATURE - T_A - °C
V_{BB} = 1.5V
V_{BB} = 3V
V_{BB} = 6V
V_{BB} = 10V



EMITTER VALLEY VOLTAGE - V_V - VOLTS
TEMPERATURE - °C
V_{BB} = 10V
V_{BB} = 6V
V_{BB} = 3V
V_{BB} = 1.5V



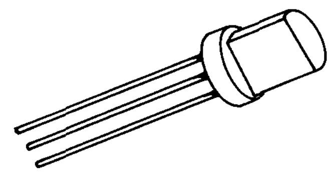
EMITTER VALLEY CURRENT I_V - MA
TEMPERATURE - °C
V_{BB} = 10V
V_{BB} = 6V
V_{BB} = 3V
V_{BB} = 1.5V

Silicon Transistors

NPN

2N2923,4,5

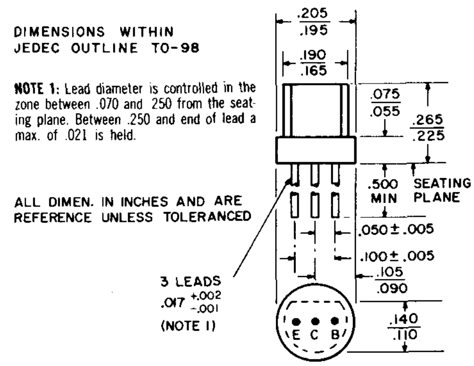
The General Electric 2N2923, 2N2924 and 2N2925 are a family of planar passivated NPN silicon transistors intended for general purpose applications. The planar passivated construction assures excellent device stability and life. These high performance, high value devices are made possible by utilizing advanced manufacturing techniques and epoxy encapsulation.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages		
Collector to Emitter	V_{CEO}	25 V
Emitter to Base	V_{EBO}	5 V
Collector to Base	V_{CBO}	25 V
Current		
Collector (Steady State)*	I_C	100 mA
Dissipation		
Total Power (Free air at 25°C)**	P_T	360 mW
Total Power (Free air at 55°C)**	P_T	250 mW
Temperature		
Storage	T_{stg}	−55 to +150°C
Operating	T_J	+125°C

*Determined from power limitations due to saturation voltage at this current.
**Derate 3.6 mW/°C increase in ambient temperature above 25°C.



electrical characteristics: (25°C) (unless otherwise specified)

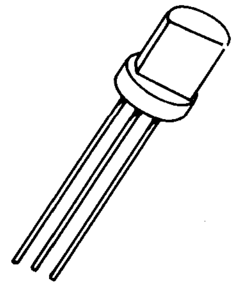
		Min.	Typ.	Max.	
D-C CHARACTERISTICS					
Collector Cutoff Current ($V_{CB} = 25V$)	I_{CBO}			0.1	μA
($V_{CB} = 25V$, $T_A = 100°C$)	I_{CBO}			15	μA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}			0.1	μA
Forward Current Transfer Ratio ($V_{CE} = 4.5V$, $I_C = 2$ mA)	h_{FE}				
2N2923			115		
2N2924			155		
2N2925			215		
SMALL SIGNAL CHARACTERISTICS					
Forward Current Transfer Ratio ($V_{CE} = 10V$, $I_C = 2$ mA, f = 1kHz)	h_{fe}				
2N2923		90		180	
2N2924		150		300	
2N2925		235		470	
Input Impedance ($V_{CE} = 10V$, $I_C = 2$ mA, f = 1kHz)	h_{ib}		15		ohms
HIGH FREQUENCY CHARACTERISTICS					
Collector Capacitance ($V_{CB} = 10V$, $I_E = 0$, f = 1MHz)	C_{cbo}	4.5	7	10	pF
Gain Bandwidth Product ($I_C = 4$ mA, $V_{CB} = 5V$)	f_T		160		MHz
NOISE					
Noise Figure ($I_C = 100$ μA, $V_{CE} = 5V$, f = 10kHz, BW = 1 Hz, Rg = 2000Ω)	N. F.		2.8 (2N2925 only)		dB

Silicon Transistor

NPN

2N2926

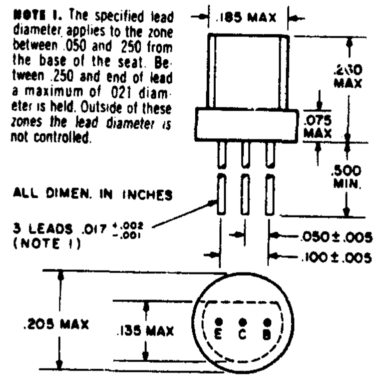
The General Electric 2N2926 is a planar passivated silicon transistor intended for general purpose applications. The planar passivated construction assures excellent device stability and life. This high performance, high value device is made possible by advanced manufacturing techniques, epoxy encapsulation, and utilization of the full line distribution of hfe. This full line distribution is supplied in five beta categories, each with a 2-1 beta spread. Each beta category is color coded and the per cent of the total order shipped in each category is shown below. Significant savings may be realized by designing equipment utilizing all beta categories in proportions compatible with this "full line distribution" type.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	25	V
Current			
Collector (Steady State)*	I_C	100	mA
Dissipation			
Total Power (Free air at 25°C)**	P_T	200	mW
Total Power (Free air at 25°C)**	P_T	120	mW
Temperature			
Storage	T_{STG}	-55 to +150°C	
Operating	T_J	+100°C	
Lead Temperature, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260°C	

*Determined from power limitations due to saturation voltage at this current.
**Derate 2.67 mW/°C increase in ambient temperature above 25°C.



electrical characteristics: (25°C) (unless otherwise specified)

D-C CHARACTERISTICS				
Collector Cutoff Current				
(V_{CB} = 18V)	I_{CBO}		0.5	μa
(V_{CB} = 18V, T_A = 100°C)	I_{CBO}		15	μa
Emitter Cutoff Current				
(V_{EB} = 5V)	I_{EBO}		0.5	μa
SMALL SIGNAL CHARACTERISTICS				
Forward Current Transfer Ratio				
(V_{CE} = 10V, I_C = 2ma, f = 1kc)	h_{fe}	35	470	

Each unit will be branded with the 2N2926 type number and will also be color coded to identify the A-C beta range into which it falls. Segregation of the beta distribution into the following five groups is provided, though it is not a requirement of the JEDEC registration. Typical D-C beta is also shown for guidance purposes.

Color Code	(V_{CE} = 10V, I_C = 2ma, f = 1kc) Min.	Max.	(V_{CE} = 4.5V, I_C = 2ma) Typ.	Content
Brown	35	70	36	0-6%
Red	55	110	62	5-10%
Orange	90	180	115	20-26%
Yellow	150	300	155	35-45%
Green	235	470	215	20-30%

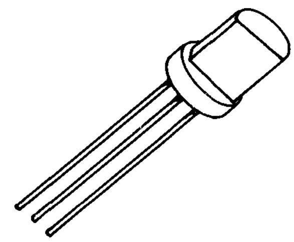
		Min.	Typ.	Max.	
Input Impedance: (V_{CE} = 10V, I_C = 2ma, f = 1kc)	h_{ib}		15		ohm
HIGH FREQUENCY CHARACTERISTICS					
Collector Capacitance (V_{CB} = 10V, I_E = 0, f = 1mc)	C_{ob}	4.5	7	10	pf
Gain Bandwidth Product (I_C = 2ma, V_{CB} = 5V)	f_t		120		mc

Silicon Transistors

NPN

2N3390

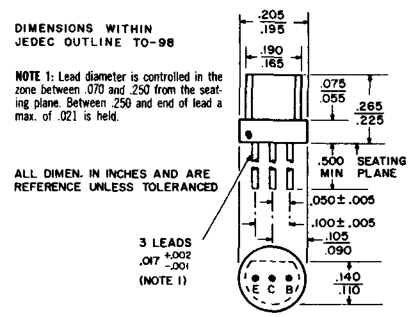
The General Electric 2N3390 is an NPN silicon planar passivated transistor designed as a small signal industrial amplifier. This device features tight beta control at an extremely low price.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	18	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	18	V
Current			
Collector (Steady State)*	I_C	100	ma
Dissipation			
Total Power (Free air at 25°C)**	P_T	360	mw
Total Power (Free air at 55°C)**	P_T	260	mw
Temperature			
Storage	T_{STG}	-55 to +125°C	
Operating	T_J	+125°C	

*Determined from power limitations due to saturation voltage at this current.
**Derate 2.67 mw/°C increase in ambient temperature above 25°C.



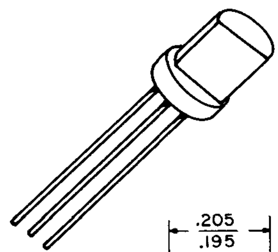
electrical characteristics: (25°C) (unless otherwise specified)

	Sym.	Min.	Max.	Units
STATIC CHARACTERISTICS				
Collector Cutoff Current				
(V_{CB} = 18V)	I_{CBO}		0.1	μA
(V_{CB} = 18V, T_A = 100°C)	I_{CBO}		10.0	μA
Emitter Cutoff Current				
(V_{EB} = 5V)	I_{EBO}		0.1	μA
Collector Cutoff Current				
(V_{CE} = 25V)	I_{CES}		0.1	μA
Forward Current Transfer Ratio				
(V_{CE} = 4.5V, I_C = 2mA)	h_{FE}	400	800	
Collector-Emitter Breakdown Voltage				
(I_C = 1mA)	$V_{(BR)CEO}$	25		V
DYNAMIC CHARACTERISTICS				
Forward Current Transfer Ratio				
(V_{CE} = 4.5V, I_C = 2mA, f = 1kHz)	h_{fe}	400	1250	
Output Capacitance, Common Base				
(V_{CB} = 10V, I_E = 0, f = 1MHz)	C_{cbo}	2	10	pF

Silicon Transistors

NPN 2N3391,A

The General Electric 2N3391 and 2N3391A are NPN silicon planar passivated devices intended for low noise preamplifier applications. The planar passivated construction assures excellent device stability and life. These high performance, high value transistors are made possible by utilizing advanced manufacturing techniques.



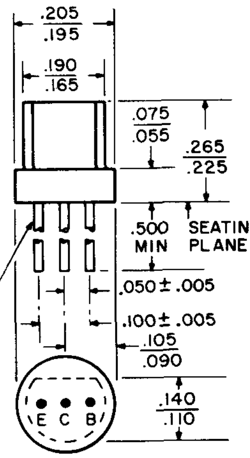
absolute maximum ratings (25°C) unless otherwise specified

Voltages			
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	25	V
Current			
Collector (Steady State)[1]	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C)[2]	P_T	360	mW
	P_T		
Temperature			
Storage	T_{stg}	−55 to +150	°C
Operating	T_J	+125	°C
Lead Soldering, $\frac{1}{16}$" ± $\frac{1}{32}$" from case for 10 seconds max.	T_L	+260	°C

[1] Determined from power limitations due to saturation voltage at this current.
[2] Derate 3.6 mW/°C increase in ambient temperautre above 25°C.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98



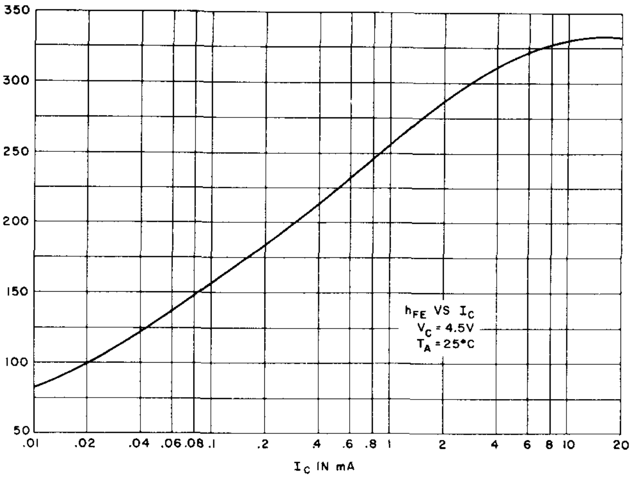
electrical characteristics (25°C) unless otherwise specified

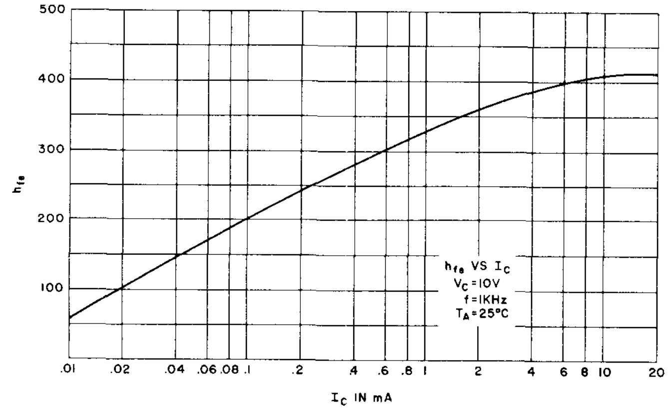
		Min.	Typ.	Max.	
Collector Cutoff Current					
(V_{CB} = 25V)	I_{CBO}			.1	μA
(V_{CB} = 25V, T_A = 100°C)	I_{CBO}			10	μA
Emitter Cutoff Current					
(V_{EB} = 5V)	I_{EBO}			.1	μA
Forward Current Transfer Ratio					
(V_{CE} = 4.5V, I_C = 2 mA)	h_{FE}	250		500	
SMALL SIGNAL CHARACTERISTICS					
Forward Current Transfer Ratio					
(V_{CE} = 10V, I_C = 100 μA, f = 1 KHz)	h_{fe}	170[3]	200		
Input Impedance					
(V_{CB} = 10V, I_C = 2 mA, f = 1 KHz)	h_{ib}		15		ohms
Output Capacitance					
(V_{CB} = 10V, I_E = 0, f = 1 MHz)	C_{cbo}	2.0	7	10	pF
Gain Bandwidth Product					
(I_C = 2 mA, V_{CE} = 5 V)	f_t		120		MHz
NOISE					
(wide band—15 Hz to 10 KHz, Equivalent Noise Bandwidth = 15.7 KHz)					
Noise Figure					
(I_C = 100 μA, V_{CE} = 4.5V, R_g = 5000 ohms)	NF		1.9	5[4]	db

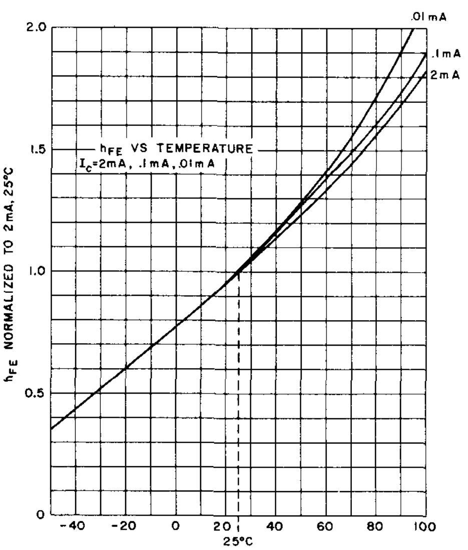
[3] Typically a minimum of 95% of the distribution is above this value.
[4] Type 2N3391A only.

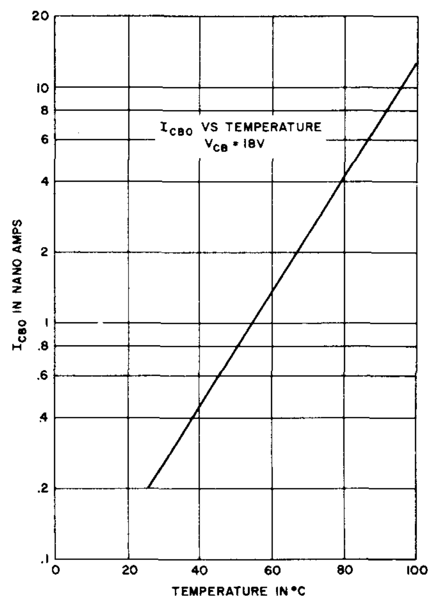
TYPICAL CURVES

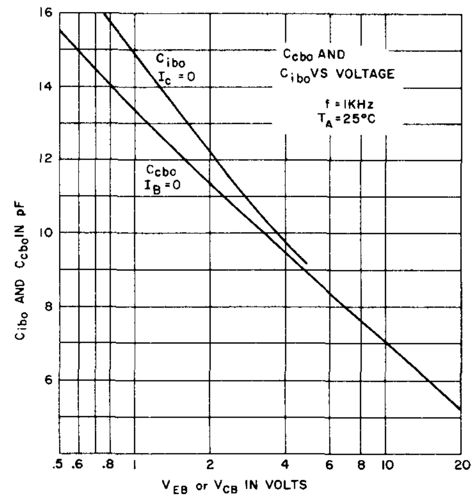
2N3391, A

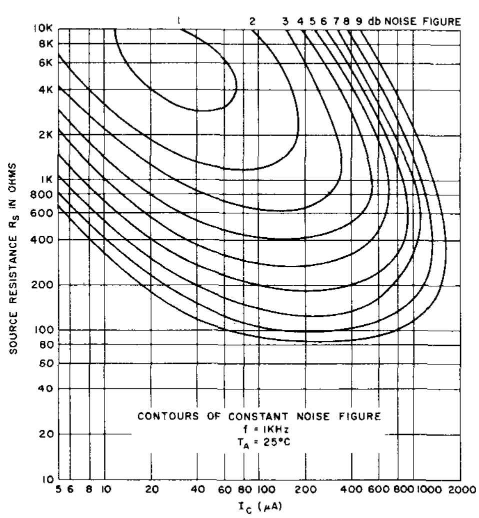


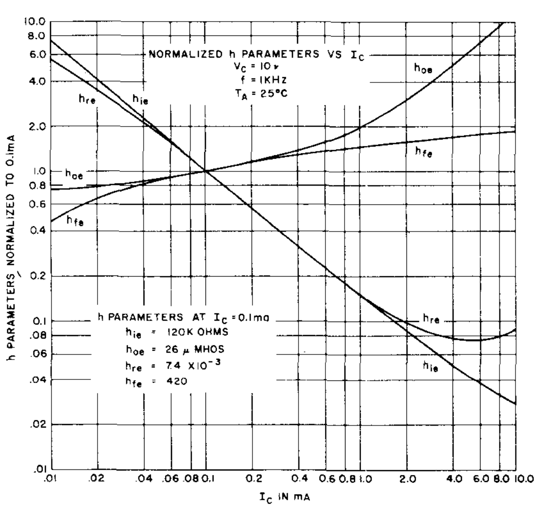










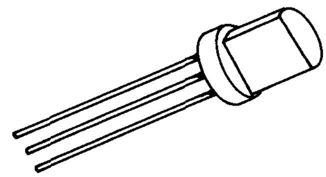


Silicon Transistors

NPN

2N3392,3,4

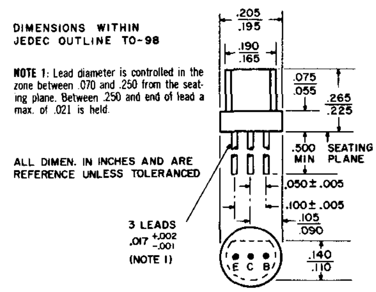
The General Electric 2N3392, 2N3393 and 2N3394 are NPN silicon planar passivated transistors designed as small signal amplifiers. These devices feature tight beta control at an extremely low price.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	25	V
Current			
Collector (Steady State) [1]	I_C	100	mA
Dissipation			
Total Power (free air at 25°C) [2]	P_T	360	mW
Total Power (free air at 55°C) [2]	P_T	260	mW
Temperature			
Storage	T_{stg}	−55 to +125	°C
Operating	T_j	+125	°C
Lead Temperature, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260	°C

[1] Determined from power limitations due to saturation voltage at this current.
[2] Derate 2.67 mw/°C increase in ambient temperature above 25°C.

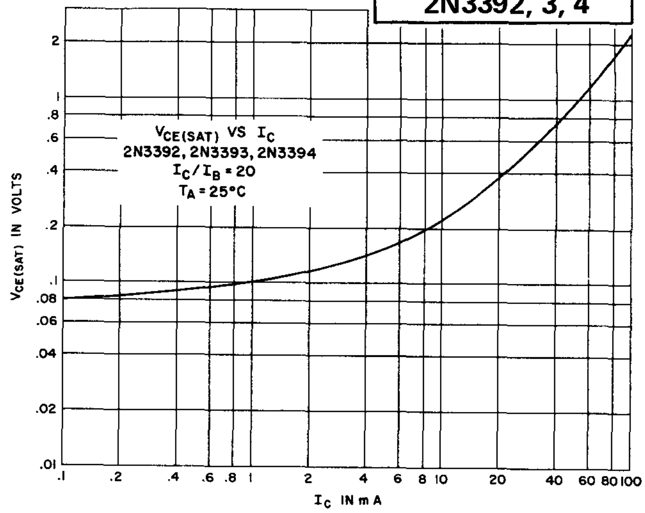


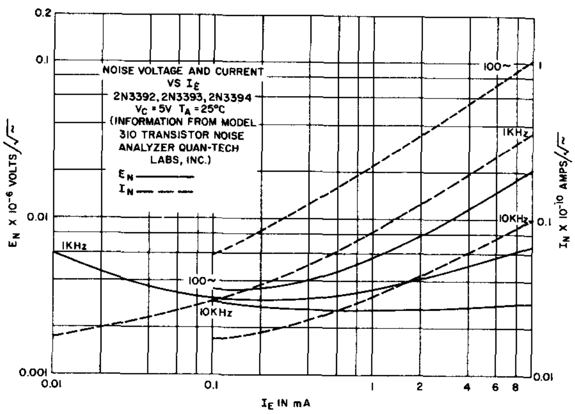
electrical characteristics: (25°C) (unless otherwise specified)

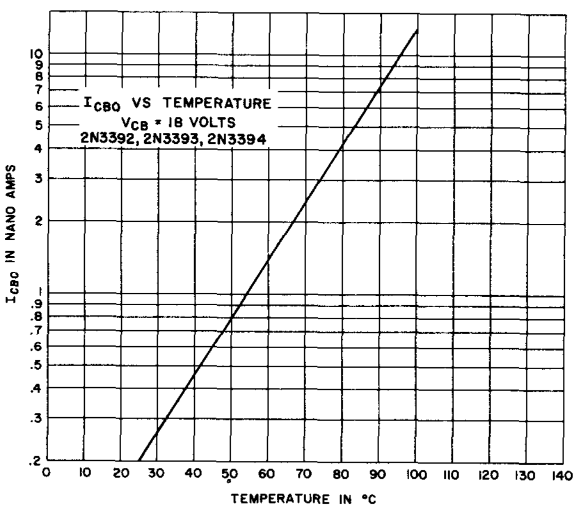
DC CHARACTERISTICS			Min.	Typ.	Max.	
Collector Cutoff Current						
(V_{CB} = 25V, I_E = 0)		I_{CBO}			0.1	μA
(V_{CB} = 25V, T_A = 100°C)		I_{CBO}			10	μA
Emitter Cutoff Current						
(V_{EB} = 5V, I_C = 0)		I_{EBO}			0.1	μA
Collector to Emitter Voltage						
(I_C = 1 mA)		V_{CEO}	25			volts
Forward Current Transfer Ratio						
(V_{CE} = 4.5V, I_C = 2 mA)	2N3392	h_{FE}	150		300	
	2N3393	h_{FE}	90		180	
	2N3394	h_{FE}	55		110	
SMALL SIGNAL CHARACTERISTICS						
Output Capacitance						
(V_{CB} = 10V, I_E = 0, f = 1 MHz)	2N3393,4	C_{cb}	4.5	7	10	pf
	2N3392	C_{cb}	2	7	10	pf
Input Impedance						
(V_{CB} = 10V; I_C = 2 mA; f = 1 KHz)		h_{ib}		15		ohms
Gain Bandwidth Product						
(I_C = 2 mA; V_{CB} = 5V)		f_t		120		MHz
Forward Current Transfer Ratio						
(I_C = 20 mA; V_{CE} = 5V, f = 20 MHz)		h_{fe}		15		

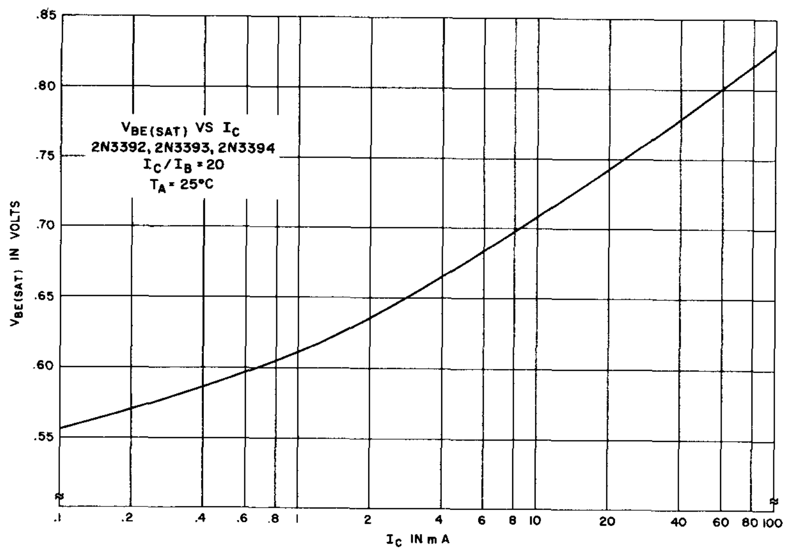
$V_{CE} = 10v; I_C = 1mA; f = 1KHz$

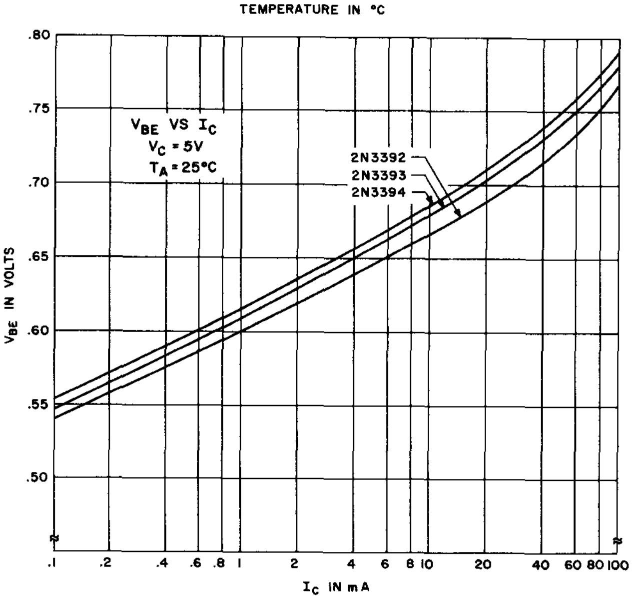
		2N3392	2N3393	2N3394	
Forward Current Transfer Ratio	h_{fe}	208	150	100	
Input Impedance	h_{ie}	6000	3400	2750	ohms
Output Admittance	h_{oe}	14.0	10.0	7.7	µmhos
Voltage Feedback Ratio	h_{re}	.33	.225	.175	$x10^{-3}$

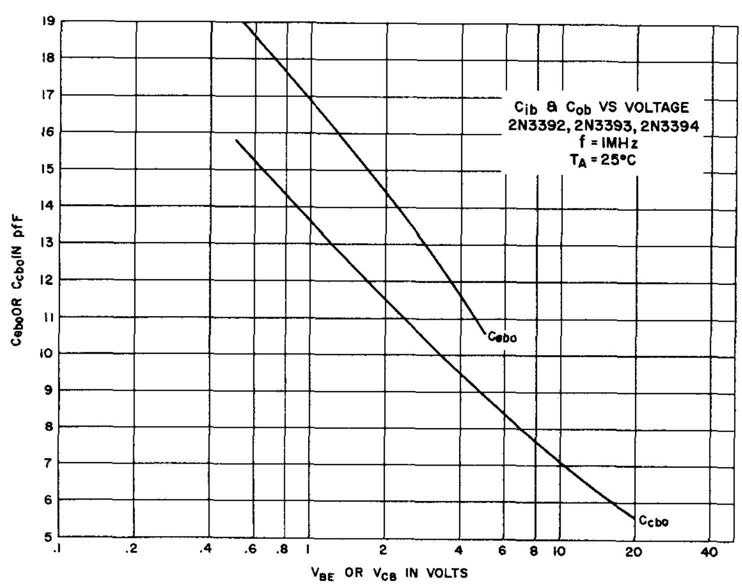


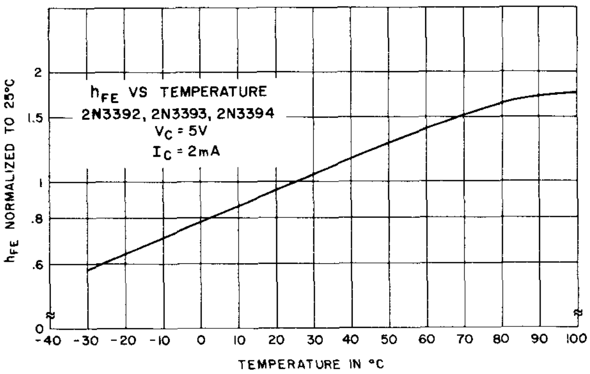




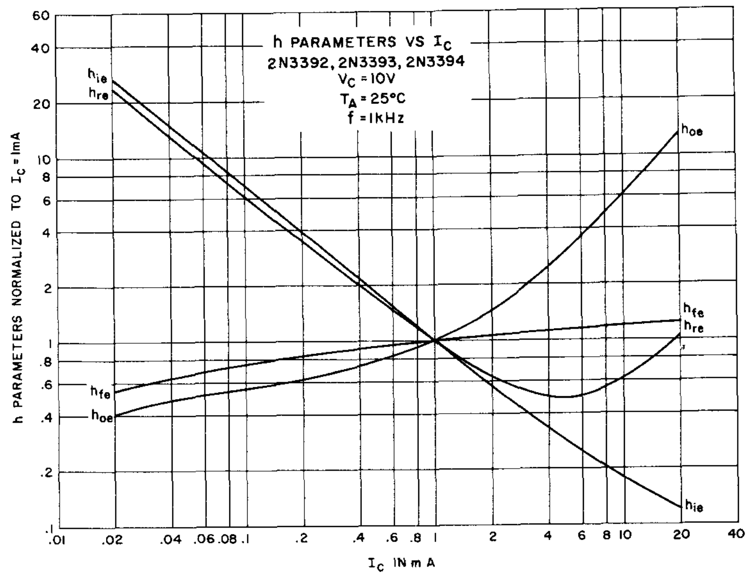




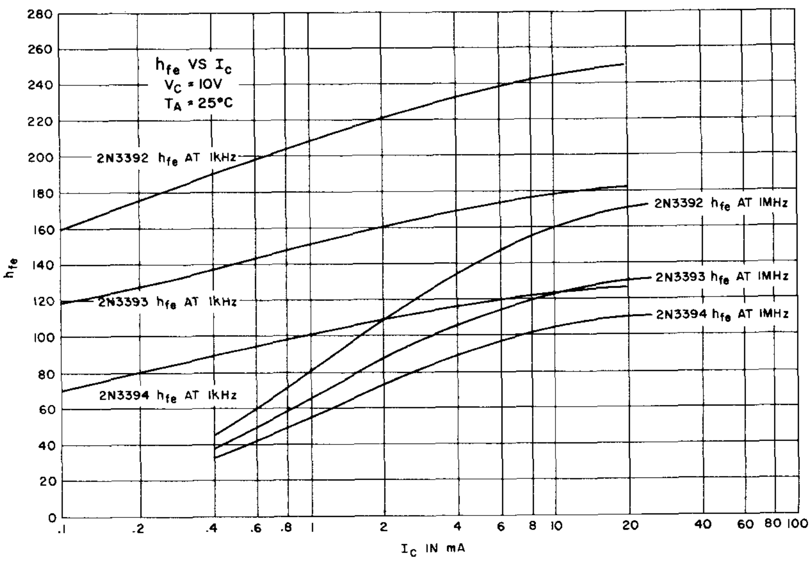




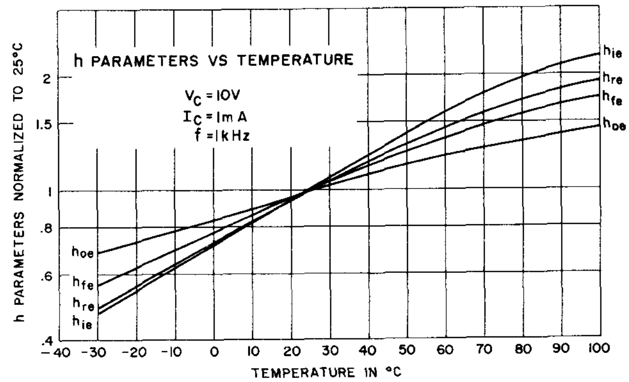
h_{FE} VS TEMPERATURE
2N3392, 2N3393, 2N3394
V_C = 5V
I_C = 2mA
h_{FE} NORMALIZED TO 25°C
2
1.5
1
.8
.6
0
-40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
TEMPERATURE IN °C



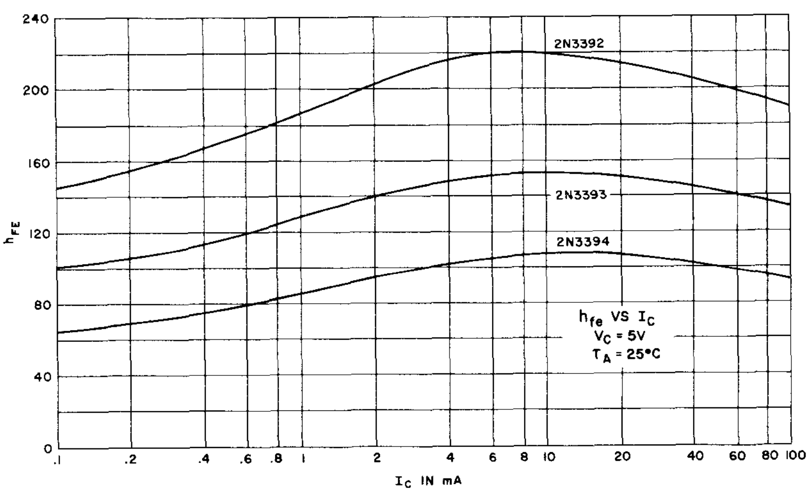
h PARAMETERS VS I_C
2N3392, 2N3393, 2N3394
V_C = 10V
T_A = 25°C
f = 1KHz
h PARAMETERS NORMALIZED TO I_C = 1mA
h_{ie}
h_{re}
h_{oe}
h_{fe}
60 40 20 10 8 6 4 2 1 .8 .6 .4 .2 .1
.01 .02 .04 .06 .08 .1 .2 .4 .6 .8 1 2 4 6 8 10 20 40
I_C IN mA



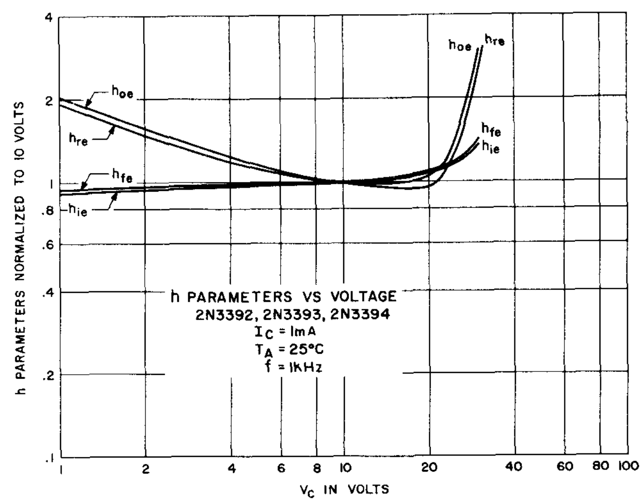
h_{fe} VS I_C
V_C = 10V
T_A = 25°C
2N3392 h_{fe} AT 1KHz
2N3393 h_{fe} AT 1KHz
2N3394 h_{fe} AT 1KHz
2N3392 h_{fe} AT 1MHz
2N3393 h_{fe} AT 1MHz
2N3394 h_{fe} AT 1MHz
h_{fe}
280 260 240 220 200 180 160 140 120 100 80 60 40 20 0
.1 .2 .4 .6 .8 1 2 4 6 8 10 20 40 60 80 100
I_C IN mA



h PARAMETERS VS TEMPERATURE
V_C = 10V
I_C = 1mA
f = 1kHz
h PARAMETERS NORMALIZED TO 25°C
h_{ie}
h_{re}
h_{fe}
h_{oe}
2 1.5 1 .8 .6 .4
-40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
TEMPERATURE IN °C



2N3392
2N3393
2N3394
h_{fe} VS I_C
V_C = 5V
T_A = 25°C
h_{FE}
240 200 160 120 80 40 0
.1 .2 .4 .6 .8 1 2 4 6 8 10 20 40 60 80 100
I_C IN mA



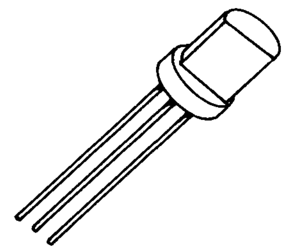
h PARAMETERS VS VOLTAGE
2N3392, 2N3393, 2N3394
I_C = 1mA
T_A = 25°C
f = 1KHz
h PARAMETERS NORMALIZED TO 10 VOLTS
h_{oe}
h_{re}
h_{fe}
h_{ie}
4 2 1 .8 .6 .4 .2 .1
1 2 4 6 8 10 20 40 60 80 100
V_C IN VOLTS

Silicon Transistors

NPN

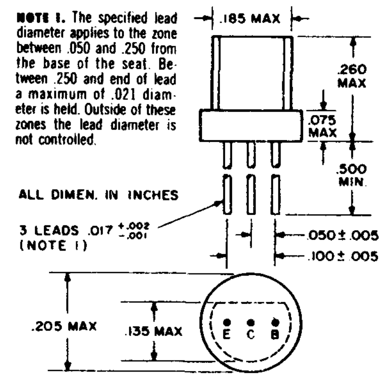
2N3395,6,7,8

The General Electric 2N3395 through 2N3398 are NPN silicon planar passivated transistors designed specifically for application in small signal industrial amplifiers. These devices are spread types which offer tightly controlled beta groups with a guaranteed distribution of groups. Each group is a 2 to 1 beta category and is color coded. The percent of the total order to be shipped in each category is shown on the chart on the back of this specification sheet. Significant savings may be realized by designing equipment using all beta categories in proportions compatible with these spread types.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	25	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	25	V
Current			
Collector (Steady State)*	I_C	100	ma
Dissipation			
Total Power (Free air at 25°C)**	P_T	360	mw
Total Power (Free air at 55°C)**	P_T	250	mw
Temperature			
Storage	T_{STG}	-55°C to +150°C	
Operating	T_J	+125°C	
Lead Temperature, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260°C	



* Determined from power limitations due to saturation voltage at this current.
** Derate 3.6 mw/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

DC Characteristics

	Sym.	Min.	Max.	Units
Collector cutoff current (V_{CB} =25V, I_E =0)	I_{CBO}		0.1	ua
Emitter cutoff current (V_{EB} =5V, I_C =0)	I_{EBO}		0.1	ua
Forward current transfer ratio (V_{CE} =4.5V, I_C =2 ma)	h_{FE}			
2N3395		150	500	
2N3396		90	500	
2N3397		55	500	
2N3398		55	800	
Grounded-base, open circuit output (V_{CE} =10V) Collector Capacitance (I_E =0, f=1 mc)	C_{ob}	4.5	10	pf

electrical characteristics:

GUARANTEED DISTRIBUTION

h_{FE} Color Code	55-110 Red	90-180 Orange	150-300 Yellow	250-500 White	400-800 Blue
2N3395			35-65%	35-65%	
2N3396		10-60%	10-60%	5-35%	
2N3397	0-15%	10-50%	10-50%	5-35%	
2N3398	0-15%	10-50%	10-50%	5-35%	0-15%

A transistor line generates product with parameter variations. On General Electric Company's economy lines the beta is divided into three to five separate groups from the total line.

On the spread types, General Electric guarantees that a certain percentage of each transistor group will be shipped when you order the type. As an example, suppose you order 1000 pieces of the 2N3396. You may receive 100 orange pieces (h_{FE} =90-180) 600 yellow pieces (h_{FE} =150-300) and 300 white pieces (h_{FE} =250-500). On the other hand, you may receive 600 orange pieces, 300 yellow pieces and 100 white pieces. This flexibility allows us to balance order requirements against actual production types. The savings achieved is passed on to you. If you can't use the spread types, you can still purchase our single line types such as the 2N3391, 2N3392 and 2N3393 at extremely low prices.

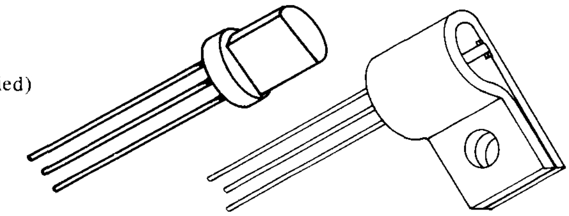
Silicon Transistors

NPN

2N3402 - 5
2N3414 - 7

2N3638	SEE **GES3638**
2N3649-58	SEE C140 SERIES

The General Electric Types 2N3402-2N3405 and 2N3414-2N3417 are NPN silicon planar epitaxial passivated transistors intended for general purpose industrial circuits. These transistors are especially suited for high level linear amplifiers or medium speed switching circuits in industrial control applications.



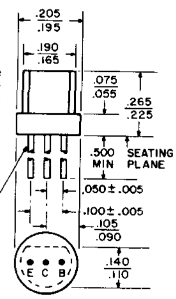
absolute maximum ratings: (25°C) (unless otherwise specified)

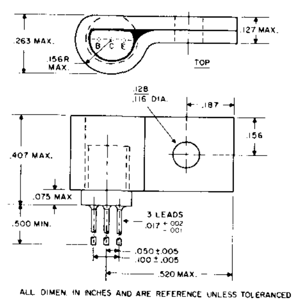
		2N3402,3 2N3414,15	2N3404,5 2N3416,17	
Voltages				
Collector to Emitter	V_{CEO}	25	50	V
Emitter to Base	V_{EBO}	5	5	V
Collector to Base	V_{CBO}	25	50	V
Current				
Collector (Steady State)*	I_C	500	500	ma
Dissipation				
Heatsink @ 25°C (2N3402-5)**	P_T	900		mw
Total Power (Free Air @ 25°C)† (2N3402-5)	P_T	560		mw
Total Power (Free Air @ 25°C)‡ (2N3414-17)	P_T	360		mw
Total Power (Free Air @ 65°C)‡ (2N3414-17)	P_T	260		mw
Temperature				
Storage	T_{stg}	−55 to +150		°C
Operating	T_J	+150		°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260		°C

*Determined from power limitations due to saturation voltage at this current.
**Derate 7.2 mw/°C increase in case temperature above 25°C.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED





†Derate 4.47 mw/°C increase in ambient temperature above 25°C.
‡Derate 2.67 mw/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C)

(unless otherwise specified)

DC CHARACTERISTICS

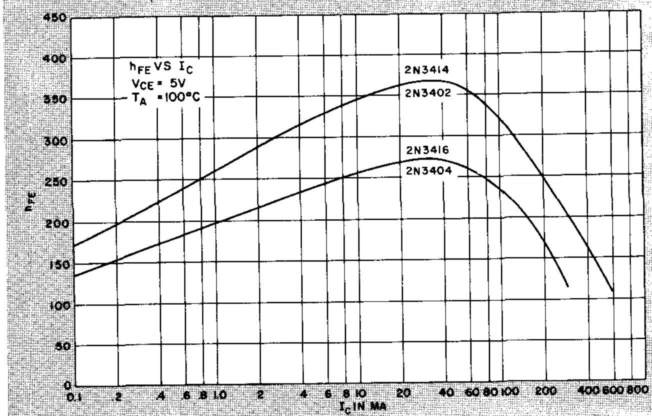
		2N3402,3 2N3414,5 Min.	2N3402,3 2N3414,5 Max.	2N3404,5 2N3416,7 Min.	2N3404,5 2N3416,7 Max.	
Collector Cutoff Current (V_{CB} = 25V)	I_{CBO}		0.1			μa
(V_{CB} = 25V, T_A = 100°C)	I_{CBO}		15			μa
Collector Cutoff Current (V_{CB} = 50V)	I_{CBO}				0.1	μa
(V_{CB} = 50V, T_A = 100°C)	I_{CBO}				15	μa
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}		0.1		0.1	μa
Collector Saturation Voltage (I_B = 3 ma, I_C = 50 ma)	$V_{CE(SAT)}$		0.30		0.30	V
Base Saturation Voltage (I_B = 3 ma, I_C = 50 ma)	$V_{BE(SAT)}$		0.85		0.85	V

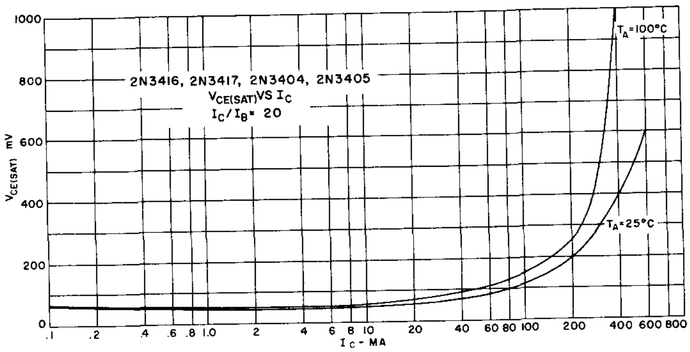
		2N3402,4 2N3414,6 Min.	2N3402,4 2N3414,6 Max.	2N3403,5 2N3415,7 Min.	2N3403,5 2N3415,7 Max.
Forward Current Transfer Ratio (V_{CE} = 4.5V, I_C = 2 ma)	h_{FE}	75	225	180	540

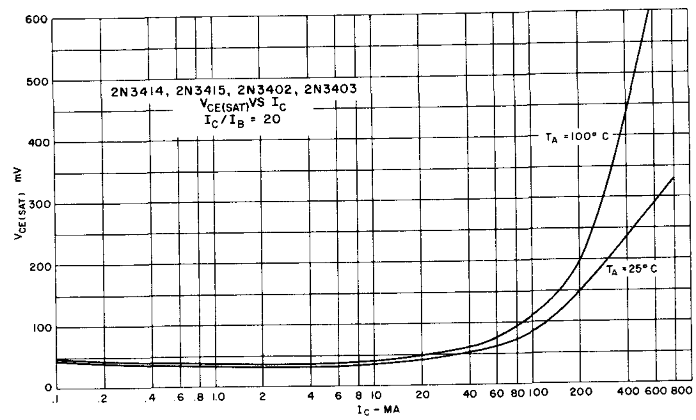
SMALL SIGNAL CHARACTERISTICS

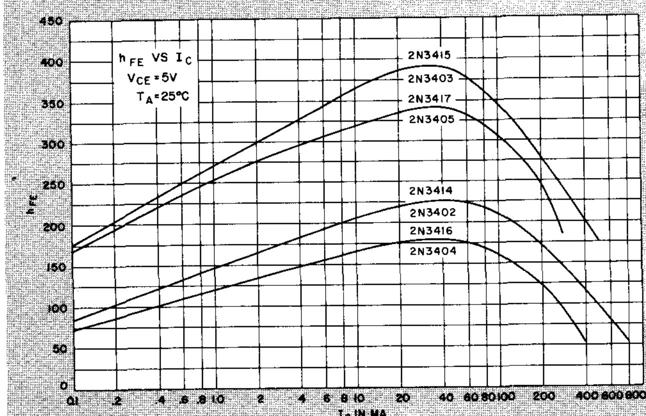
Forward Current Transfer Ratio Collector Voltage, V_C = 4.5V, Frequency of measurement = 1000 cps	h_{fe}	75		180	

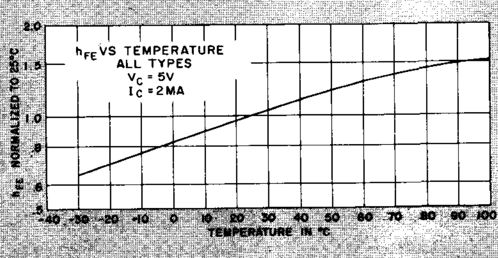
V_{CE} = 10V; I_C = 1 ma; f = 1 Kc; T_A = 25°C		2N3402 2N3414	2N3403 2N3415	2N3404 2N3416	2N3405 2N3417	
Forward Current Transfer Ratio	h_{fe}	180	330	150	300	
Input Impedance	h_{ie}	5100	9000	4200	8300	ohms
Output Admittance	h_{oe}	14	21	10	20	μmhos
Voltage Feedback Ratio	h_{re}	.27	.45	.2	.4	× 10^{-3}

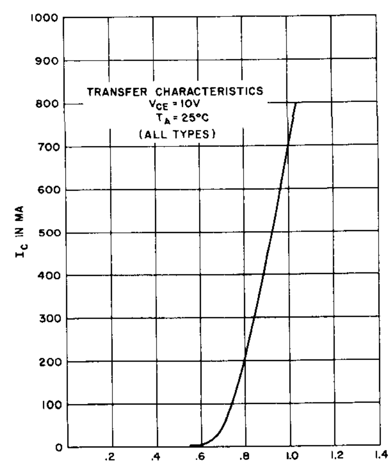

h_{FE} VS I_C
V_{CE} = 5V
T_A = 100°C
2N3414
2N3402
2N3416
2N3404
h_{FE}
I_C IN MA

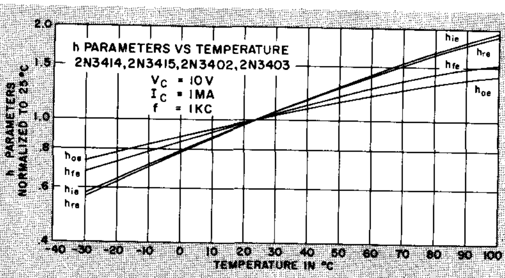

2N3416, 2N3417, 2N3404, 2N3405
$V_{CE(SAT)}$ VS I_C
I_C/I_B = 20
T_A = 100°C
T_A = 25°C
$V_{CE(SAT)}$ mV
I_C - MA

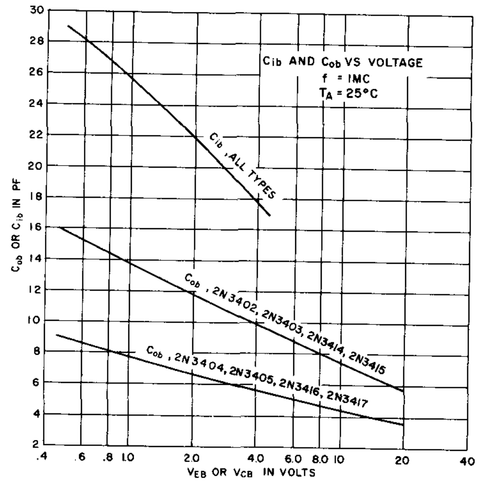

2N3414, 2N3415, 2N3402, 2N3403
$V_{CE(SAT)}$ VS I_C
I_C/I_B = 20
T_A = 100° C
T_A = 25° C
$V_{CE(SAT)}$ mV
I_C - MA

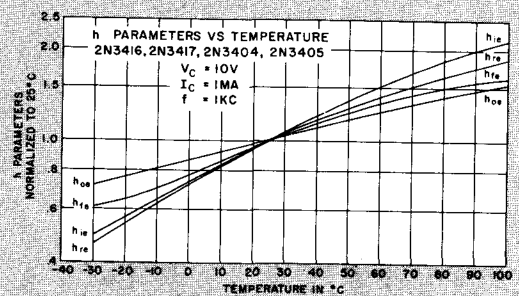

h_{FE} VS I_C
V_{CE} = 5V
T_A = 25°C
2N3415
2N3403
2N3417
2N3405
2N3414
2N3402
2N3416
2N3404
h_{FE}
I_C IN MA

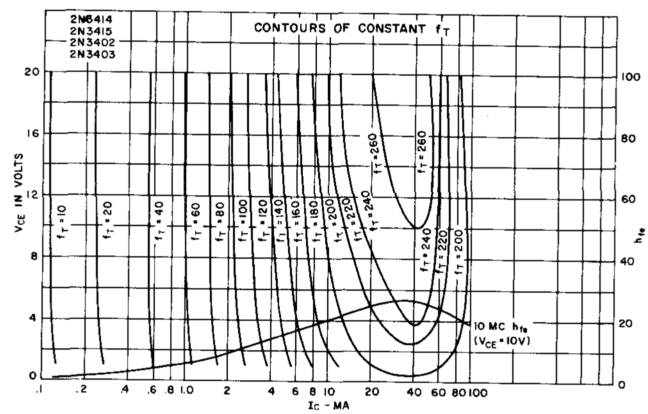

h_{FE} VS TEMPERATURE
ALL TYPES
V_C = 5V
I_C = 2MA
h_{FE} NORMALIZED TO 25°C
TEMPERATURE IN °C

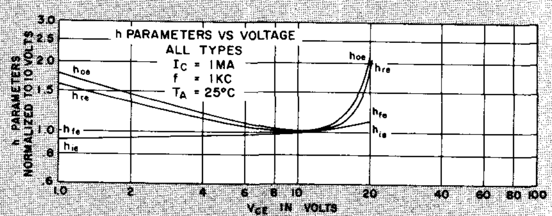

TRANSFER CHARACTERISTICS
V_{CE} = 10V
T_A = 25°C
(ALL TYPES)
I_C IN MA
V_{BE} IN VOLTS

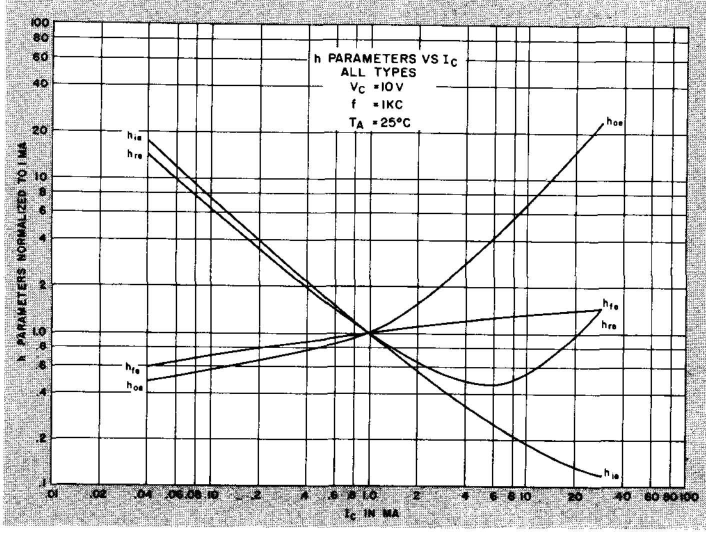

h PARAMETERS VS TEMPERATURE
2N3414, 2N3415, 2N3402, 2N3403
V_C = 10V
I_C = 1MA
f = 1KC
h PARAMETERS NORMALIZED TO 25°C
TEMPERATURE IN °C
h_{ie}
h_{re}
h_{fe}
h_{oe}

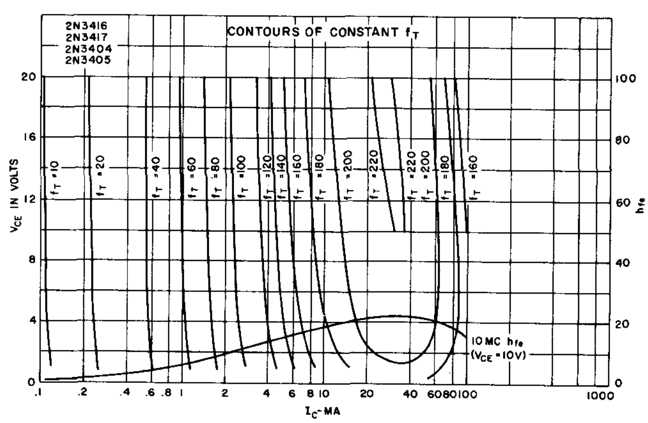

Cib AND Cob VS VOLTAGE
f = 1MC
T_A = 25°C
C_{ib}, ALL TYPES
C_{ob}, 2N3402, 2N3403, 2N3414, 2N3415
C_{ob}, 2N3404, 2N3405, 2N3416, 2N3417
C_{ob} OR C_{ib} IN PF
V_{EB} OR V_{CB} IN VOLTS


h PARAMETERS VS TEMPERATURE
2N3416, 2N3417, 2N3404, 2N3405
V_C = 10V
I_C = 1MA
f = 1KC
h PARAMETERS NORMALIZED TO 25°C
TEMPERATURE IN °C
h_{ie}
h_{re}
h_{fe}
h_{oe}

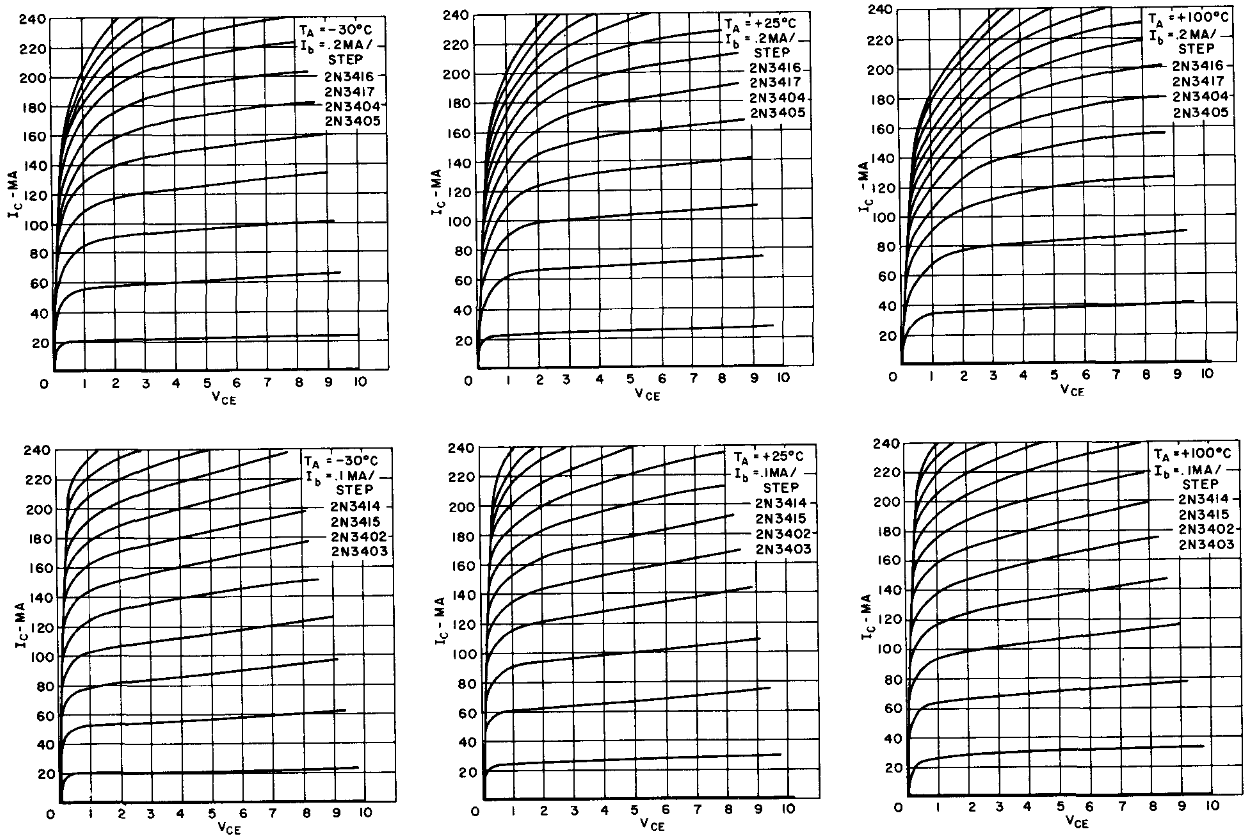

2N3414
2N3415
2N3402
2N3403
CONTOURS OF CONSTANT f_T
V_{CE} IN VOLTS
h_{fe}
10 MC h_{fe}
(V_{CE} = 10V)
I_C - MA


h PARAMETERS VS VOLTAGE
ALL TYPES
I_C = 1MA
f = 1KC
T_A = 25°C
h PARAMETERS NORMALIZED TO 10 VOLTS
V_{CE} IN VOLTS
h_{oe}
h_{re}
h_{fe}
h_{ie}

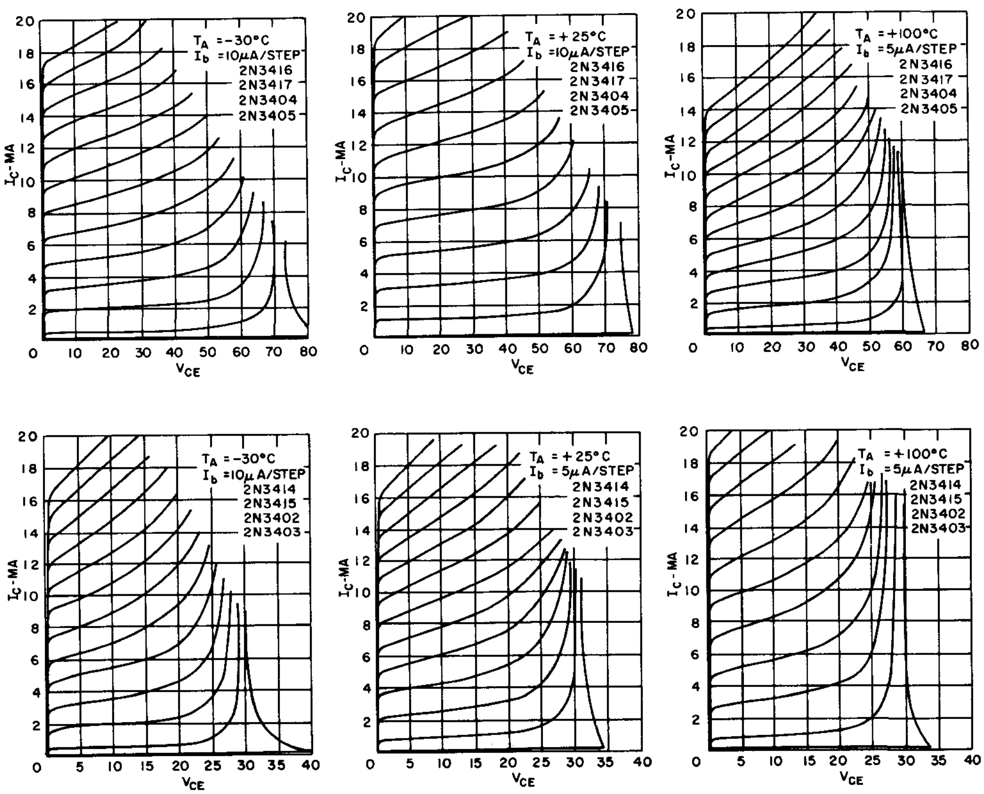

h PARAMETERS VS I_C
ALL TYPES
V_C = 10V
f = 1KC
T_A = 25°C
h PARAMETERS NORMALIZED TO 1 MA
I_C IN MA
h_{ie}
h_{re}
h_{fe}
h_{oe}


2N3416
2N3417
2N3404
2N3405
CONTOURS OF CONSTANT f_T
V_{CE} IN VOLTS
h_{fe}
10 MC h_{fe}
(V_{CE} = 10V)
I_C - MA

Typical Common Emitter Collector Current Characteristic Curves



Typical Common Emitter Characteristic Curves

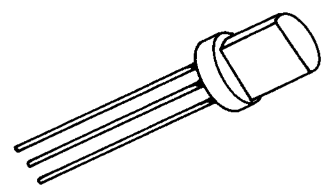


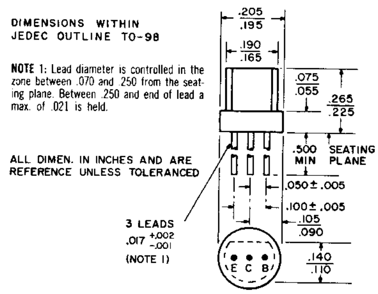
Silicon Transistors

NPN

2N3662,3

The General Electric 2N3662 and 2N3663 are NPN silicon planar epitaxial transistors designed specifically for high frequency applications. The units are suitable for use as oscillators in UHF television tuners. The units feature a typical circuit power gain of 19 db at 200 MHz.





absolute maximum ratings: (25°C) (unless otherwise specified)

		2N3662	2N3663	
Voltages				
Collector to Base	V_{CBO}	18	30	volts
Emitter to Base	V_{EBO}	3	3	volts
Collector to Emitter	V_{CEO}	12	12	volts
Current				
Collector (Steady State)*	I_C	25	25	mA
Dissipation				
Total Power (Free air @ 55°C)*	P_T	120	120	mW
Total Power (Free air @ 25°C)*	P_T	200	200	mW
Temperature				
Storage Temp.	T_{stg}	−55 to +125°C		
Soldering Temp. 10 sec. 1/16 ± 1/32" from case		260	260	°C
Operating Junction	T_J	100	100	°C

*Derate 2.67 mW/°C for ambient above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics

		Min.	Typ.	Max.	
Collector Cutoff Current ($I_E = 0$, $V_{CB} = 15V$)	I_{CBO}			0.5	μA
($I_E = 0$, $V_{CB} = 18V$, $T_A = 85°C$)	I_{CBO}			5.0	μA
Emitter Cutoff Current ($I_C = 0$, $V_{EB} = 2V$)	I_{EBO}			0.5	μA
Forward Current Transfer Ratio ($I_C = 8$ mA, $V_{CE} = 10V$)	h_{FE}	20	75		
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1.0$ mA)	$V_{CE(SAT)}$			0.6	volts
Breakdown Voltage, Emitter to Base, Collector Open ($I_E = 100$ μA)	BV_{EBO}	3			volts
Breakdown Voltage, Collector to Emitter Base Open ($I_{CEO} = 3$ mA pulsed, pulse width = 1 μsec., 1% duty cycle)	BV_{CEO}	12			volts
Breakdown Voltage, Collector to Base, emitter open ($I_C = 100$ μA) 2N3662	BV_{CBO}	18			volts
2N3663	BV_{CBO}	30			volts

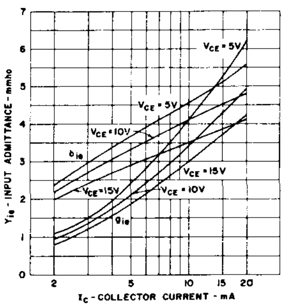
Dynamic Characteristics

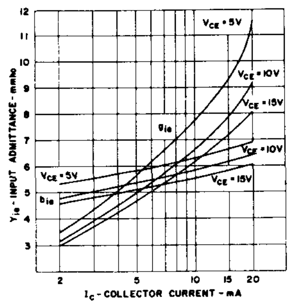
		Min.	Typ.	Max.	
Output Capacitance ($I_E = 0$, $V_{CB} = 10$, $f = 1$ MHz)	C_{ob}	0.8		1.5	pF
($I_E = 0$, $V_{CB} = 0$, $f = 1$ MHz)	C_{ob}			3.0	pF
Input Capacitance ($I_C = 0$, $V_{EB} = 0.5V$, $f = 1$ MHz)	C_{ib}			2	pF
Forward Current Transfer Ratio ($I_C = 5$ mA, $V_{CE} = 10V$, $f = 100$ MHz)	h_{fe}	7.0	10	21	
Power Gain (See Fig. 2) ($I_C = 6$ mA, $V_{CE} = 12V$, $f = 200$ MHz) 2N3662	A_p	12	16		db
2N3663	A_p	15	19		db
Power Output (See Fig. 1) ($I_C = 10$ mA, $V_{CE} = 12V$, $f = 500$ MHz)	P_o		30		mW
Power Output (See Fig. 3) ($I_C \approx 10$ mA, $V_{CC} = 12V$, $f \approx 940$ MHz)	V_o		5.5		mV
Noise Figure ($I_C = 1$ mA, $V_{CE} = 6V$, $f = 60$ MHz) ($Rg = 400\ \Omega$)	N.F.		4	6.5	db

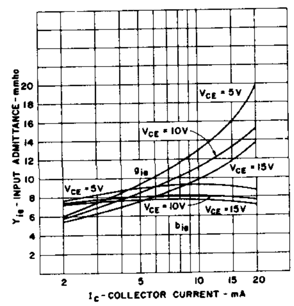
TYPICAL COMMON EMITTER "y" PARAMETERS

f=45 MHz | f=100 MHz | f=200 MHz

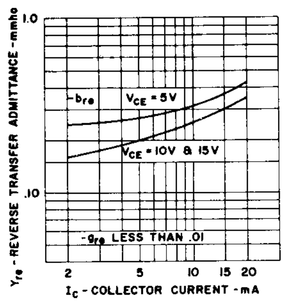
y_{ie} Input Admittance vs. Collector Current

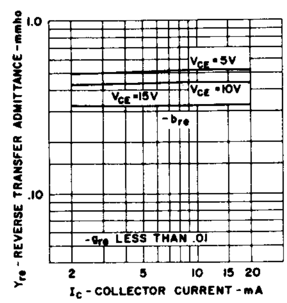


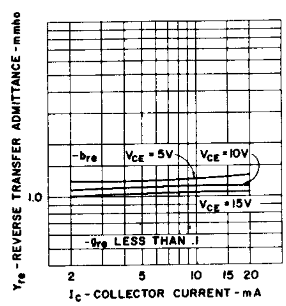




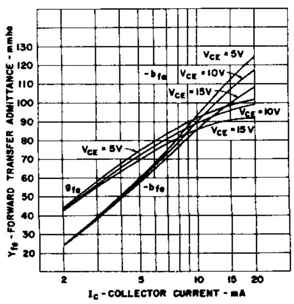
y_{re} Reverse Transfer Admittance vs. Collector Current

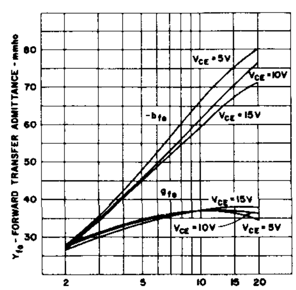


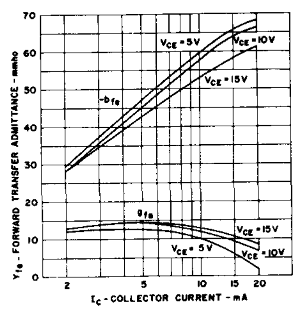




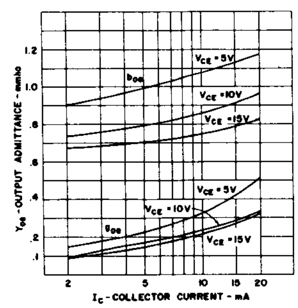
y_{fe} Forward Transfer Admittance vs. Collector Current

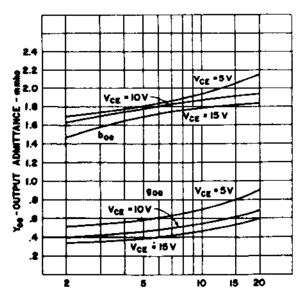


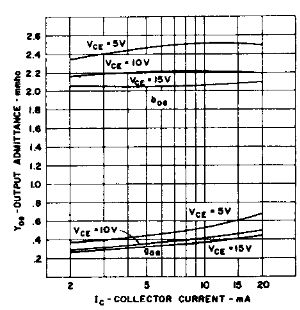




y_{oe} Output Admittance vs. Collector Current



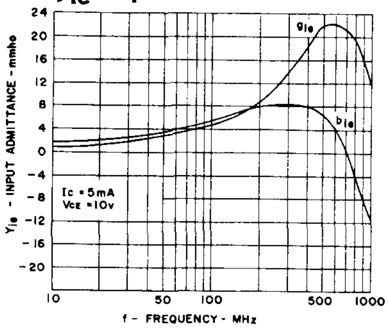




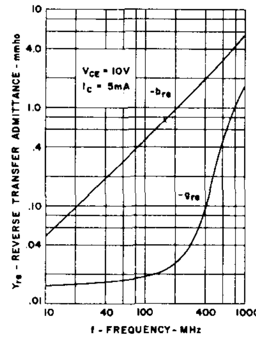
TYPICAL COMMON EMITTER "y" PARAMETERS VERSUS FREQUENCY

2N3662, 2N3663

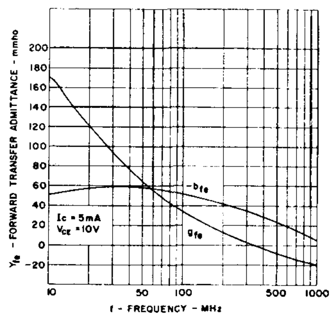
y_{ie} Input Admittance



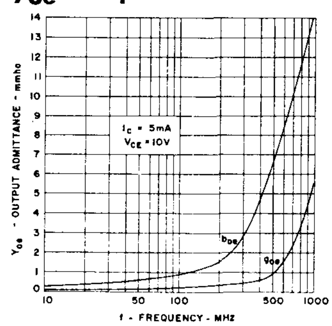
y_{re} Reverse Transfer Admittance



y_{fe} Forward Transfer Admittance

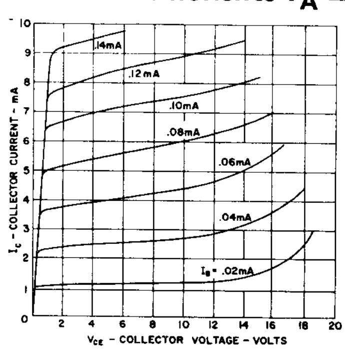


y_{oe} Output Admittance

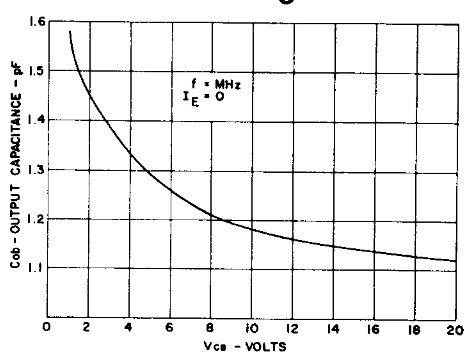


TYPICAL ELECTRICAL CHARACTERISTICS

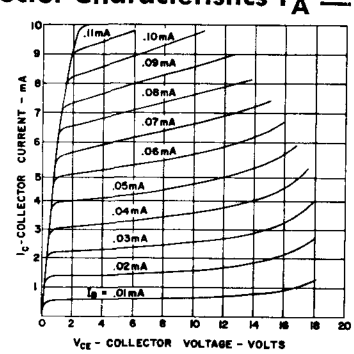
Collector Characteristics $T_A = 25°C$



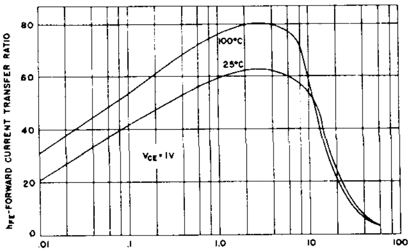
Output Capacity vs. Reverse Voltage Bias



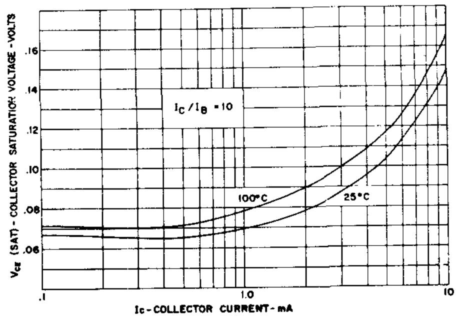
Collector Characteristics $T_A = 100°C$



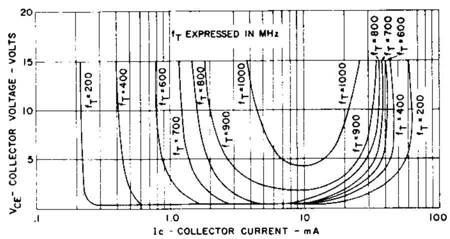
h_{FE} vs. Collector Current



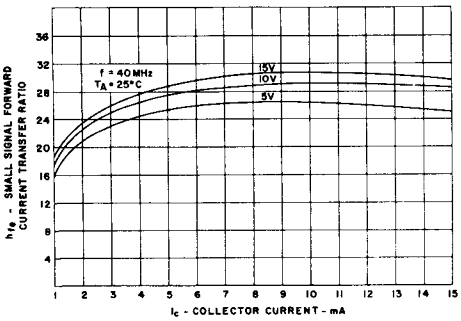
$V_{CE(SAT)}$ vs. Collector Current



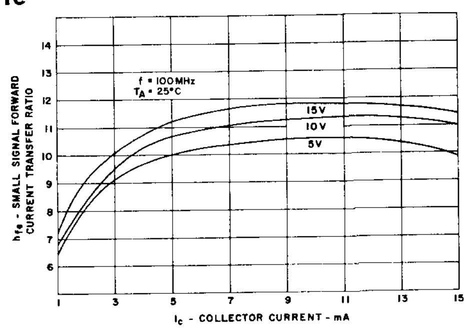
Contours of Gain Bandwidth Product, f_T vs. Collector Current



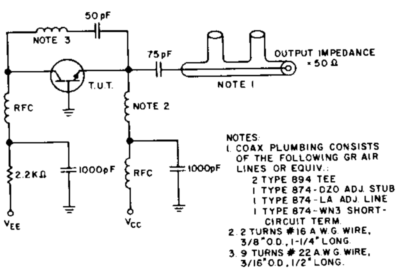
h_{fe} vs. Collector Current, f = 40 MHz



h_{fe} vs. Collector Current, f = 100 MHz

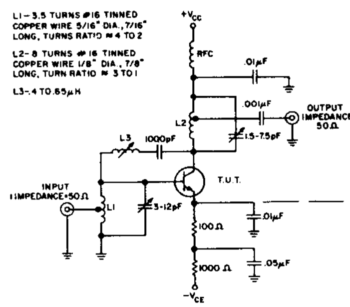


TEST CIRCUITS



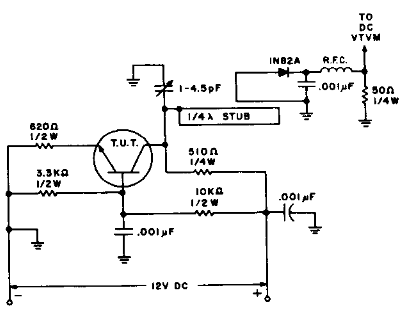
500 MHz OSCILLATOR TEST CIRCUIT (P_O)

Figure 1



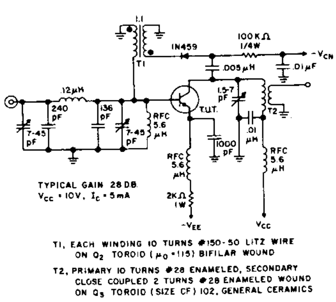
NEUTRALIZED 200 MHz POWER GAIN AMPLIFIER TEST CIRCUIT (G_{PE})

Figure 2



940MHz OSCILLATOR TEST CIRCUIT

Figure 3



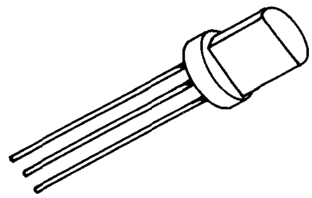
45MHz I.F. POWER GAIN

Figure 4

Silicon Transistor

2N3721

The General Electric 2N3721 is a NPN silicon transistor intended for general purpose applications. The planar passivated construction assures excellent device stability and life. This high performance, high value device is made possible by utilizing advanced manufacturing techniques and epoxy encapsulation.



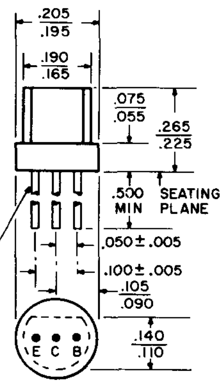
absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to emitter	V_{CEO}	18	V
Emitter to base	V_{EBO}	5	V
Collector to base	V_{CBO}	18	V
Current			
Collector (steady state)	I_{C*}	100	mA
Dissipation			
Total Power (Free air @ 25°C)	P_{T**}	360	mW
Total Power (Free air @ 55°C)	P_{T**}	260	mW
Temperature			
Storage	T_{STG}	-55 to	+125°C
Operating	T_J		+125° C

* Determined from power limitations due to saturation voltage at this current.
** Derate 2.67 mW/°C increase in ambient temperature above 25°C.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



electrical characteristics: (25°C) (unless otherwise specified)

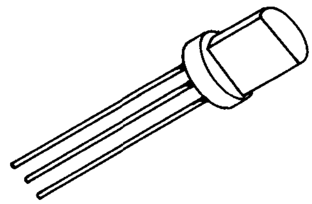
DC Characteristics		Min.	Typ.	Max.	Units
Collector cutoff current: (VCB = 18V)	I_{CBO}			0.5	μA
(VCB = 18V, TA=100°C)	I_{CBO}			15	μA
Emitter cutoff current: (VEB=5V)	I_{EBO}			0.5	μA
Small Signal Characteristics					
Forward current transfer ratio: (VCE=10V, IC = 2 ma, f = lk Hz†)	h_{FE}	60		660	
Input impedance: (VCE=10V,IC=2mA, f=lk Hz)	h_{IB}		15		ohms
High Frequency Characteristics					
Collector capacitance: (VCB=10V, IE=O, f=l MHz)	C_{cb}	4.5	7	10	pF
Gain bandwidth product: (IC=4mA, VCB=5V)	f_t		120		MHz

† Hz=Hertz, equivalent to cycles per second.

Silicon Transistors

NPN
2N3843A,4A,5A

The General Electric 2N3843,4,5, and 2N3843A, 4A, 5A are NPN silicon planar, epitaxial passivated transistors designed primarily for RF and converter applications in high performance A.M. radios. The A versions feature high signal to noise ratio in RF amplifier service.



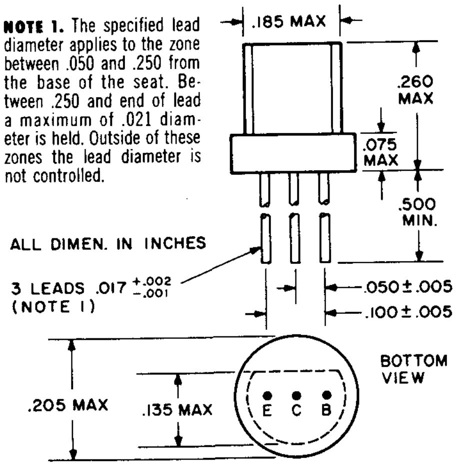
absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages		
Collector to Emitter	V_{CEO}	30 volts
Emitter to Base	V_{EBO}	4 volts
Collector to Base	V_{CBO}	30 volts
Current		
Collector (Steady State)*	I_C	100 mA
Dissipation		
Total Power (25°C Ambient)**	P_T	200 mW
Total Power (55°C Ambient)**	P_T	120 mW
Temperature		
Storage	T_{STG}	−30 to 125 °C
Operating	T_J	100 °C
Lead Soldering 1/16" ± 1/32" from case for 10 seconds maximum	T_L	260 °C

*Determined from power limitation due to saturation voltage at this current.

**Derate 2.67mW/°C increase in ambient temperature above 25°C.

NOTE 1. The specified lead diameter applies to the zone between .050 and .250 from the base of the seat. Between .250 and end of lead a maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.



electrical characteristics: (25°C) (unless otherwise specified).

		Min.	Typ.	Max.
Collector Cutoff Current (V_{CB} = 18V)	I_{CBO}			0.5 μA
(V_{CB} = 18V, T_A = 100°C)	I_{CBO}			15 μA
Collector-Emitter Breakdown Voltage (I_C = 1mA)	BV_{CEO}	30		volts
Emitter-Base Breakdown Voltage (I_E = 500 μA)	BV_{EBO}	4		volts
Forward Current Transfer Ratio (V_{CE} = 4.5V, I_C = 2mA)				
2N3843,A	h_{FE}	20		40
2N3844,A	h_{FE}	35		70
2N3845,A	h_{FE}	60		120
Collector Saturation Voltage (I_C = 10mA, I_B = 1mA)	$V_{CE(SAT)}$			1 volt
Output Capacitance (V_{CB} = 10V, I_E = 0, f = 1Mc)	C_{ob}	2.0	3	4.0 pF
Input Capacitance (V_{EB} = 0.5V, I_E = 0, f = 1Mc)	C_{ib}		15	pF
Case Capacitance			.66	pF
Gain Band-Width Product (V_{CE} = 10V, I_C = 2mA)				
2N3843,A	f_T	60		230 Mc
2N3844,A	f_T	90		250 Mc
2N3845,A	f_T	120		290 Mc
Collector Base Time Constant	$r_b' C_c$			150 psec
Noise Figure (f = 2Mc, I_C = 1mA, V_{CE} = 12V, R_g = 20Ω)				
2N3843A, 2N3844A, 2N3845A,	N.F.		6.0	8.5 db
2N3843, 2N3844, 2N3845	N.F.			10.2 db
(f = 2Mc, I_C = 1mA, V_{CE} = 12V, R_g = 50Ω)				
2N3843A, 2N3844A, 2N3845A	N.F.		5.5	db

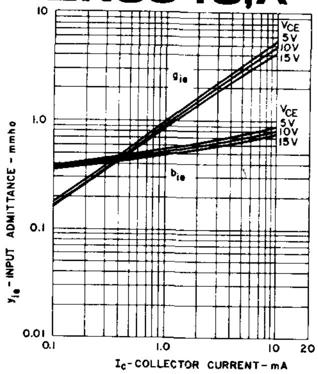
TYPICAL COMMON EMITTER "Y" PARAMETERS

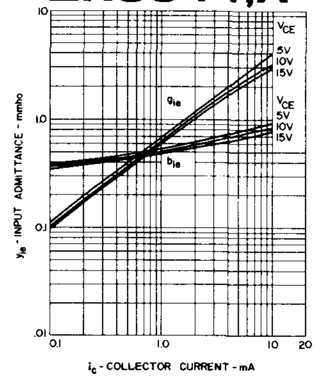
1.6 Mc

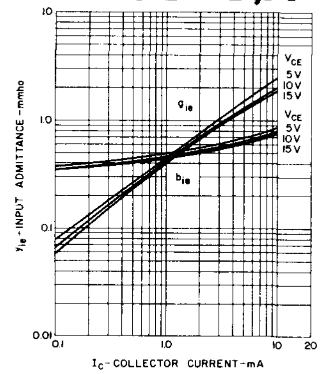
$T_A = 25°$ C

	2N3843,A	2N3844,A	2N3845,A

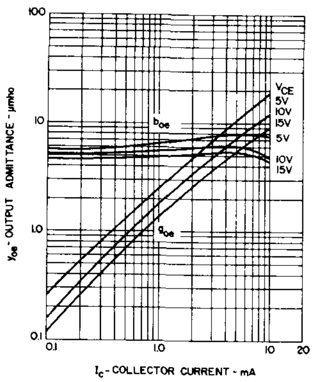
Y_{ie}
Input Admittance
vs.
Collector Current
(OUTPUT SHORT CIRCUIT)

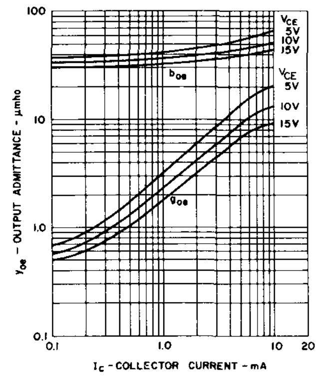


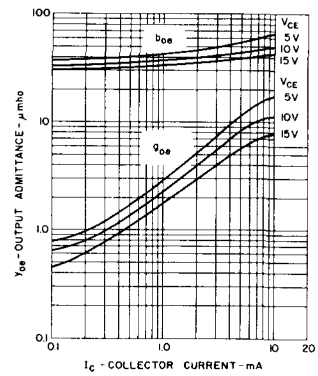




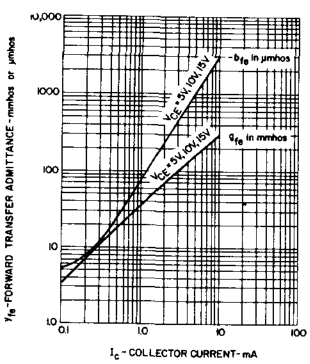
Y_{oe}
Output Admittance
vs
Collector Current
(INPUT SHORT CIRCUIT)

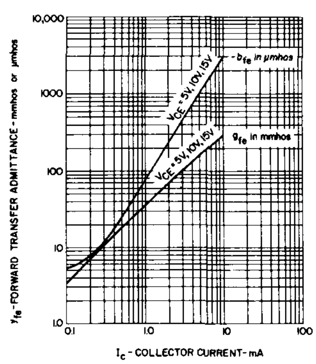


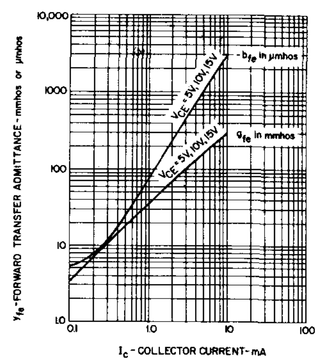




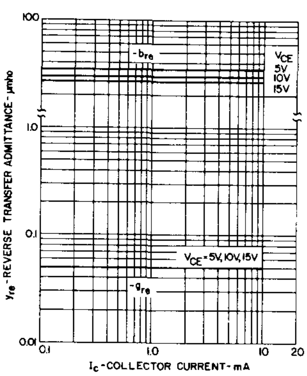
Y_{fe}
Forward Transfer
Admittance
vs
Collector Current
(OUTPUT SHORT CIRCUIT)

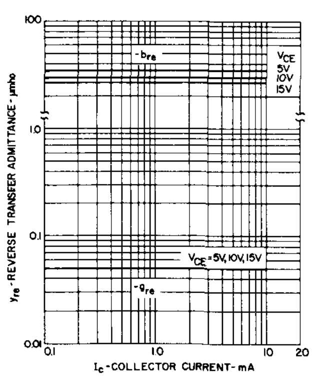


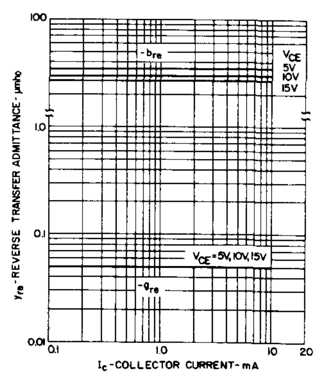




Y_{re}
Reverse
Transfer Admittance
vs
Collector Current
(INPUT SHORT CIRCUIT)







2N3843A, 4A, 5A

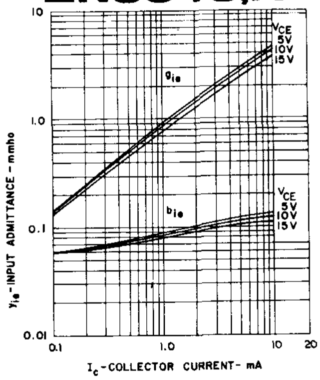
TYPICAL COMMON EMITTER "Y" PARAMETERS

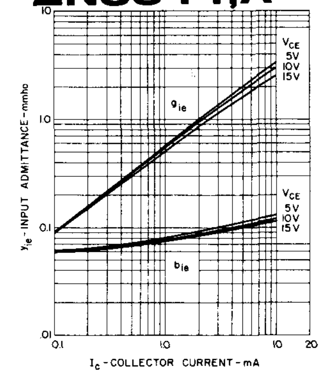
262.5 Kc

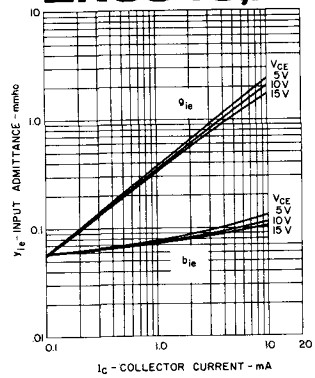
$T_A = 25°$ C

	2N3843,A	2N3844,A	2N3845,A

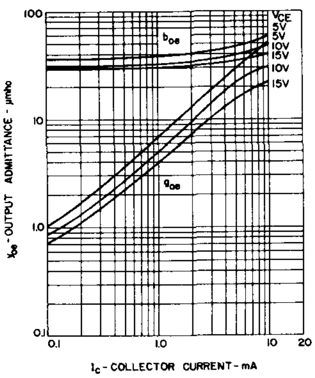
Y_{ie}
Input Admittance vs. Collector Current
(OUTPUT SHORT CIRCUIT)

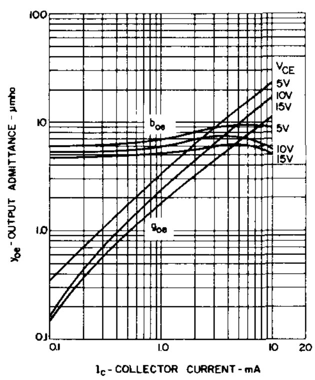


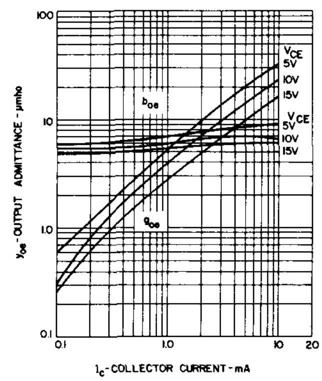




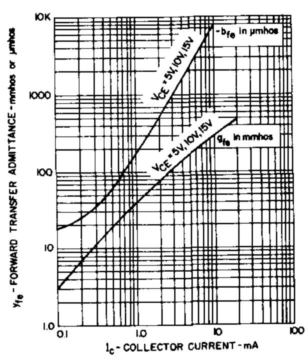
Y_{oe}
Output Admittance vs Collector Current
(INPUT SHORT CIRCUIT)

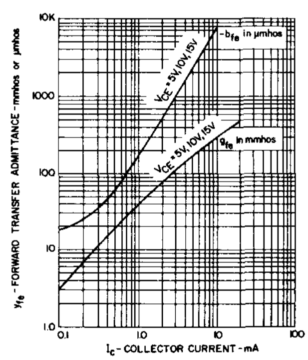


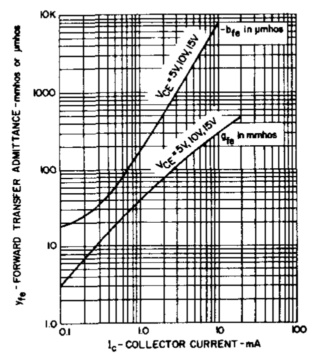




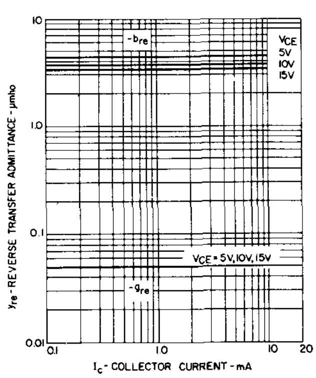
Y_{fe}
Forward Transfer Admittance vs Collector Current
(OUTPUT SHORT CIRCUIT)

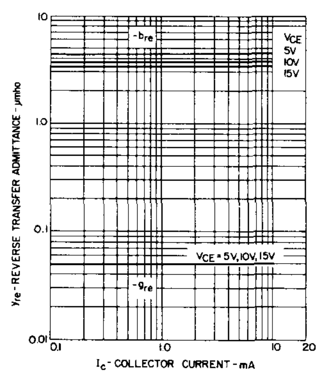


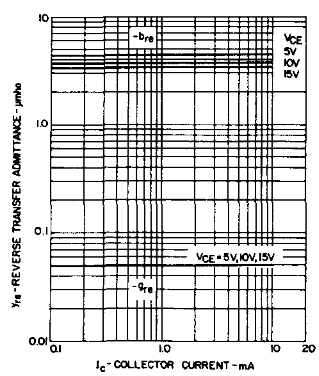




Y_{re}
Reverse Transfer Admittance vs Collector Current
(INPUT SHORT CIRCUIT)

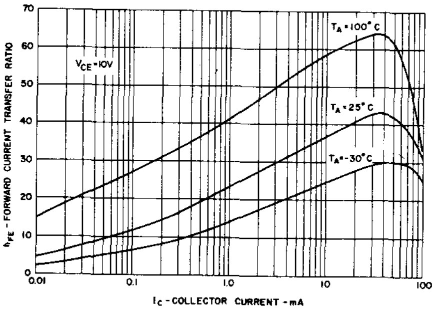




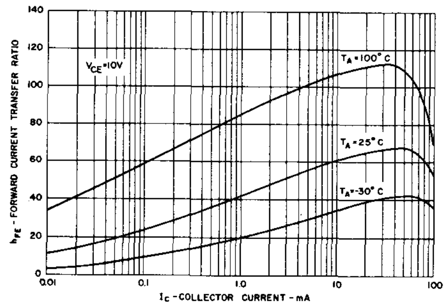


TYPICAL ELECTRICAL CHARACTERISTICS

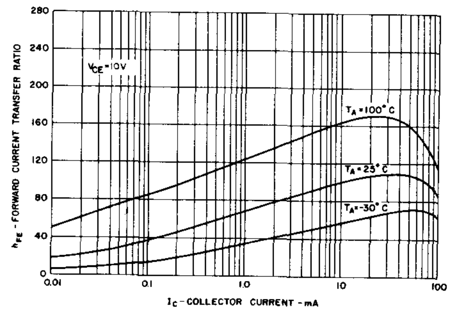
FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



2N3843,A

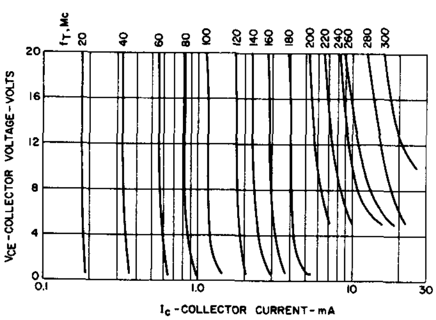


2N3844,A

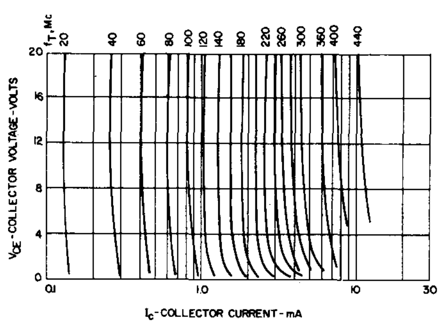


2N3845,A

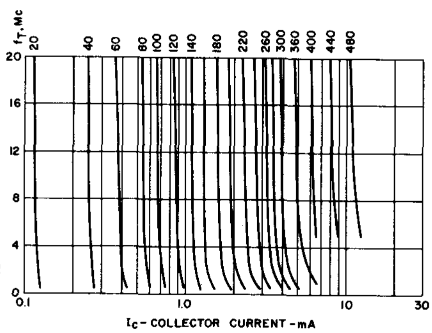
GAIN BAND-WIDTH PRODUCT(f_T)VS. COLLECTOR CURRENT



2N3843,A

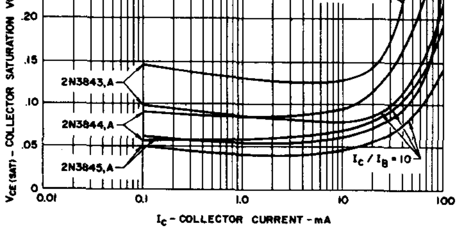


2N3844,A

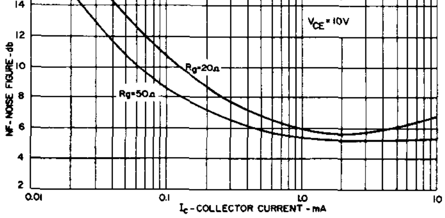


2N3845,A

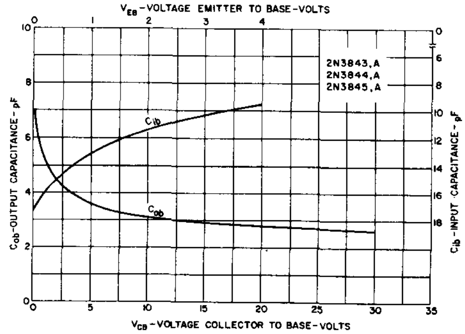
COLLECTOR SATURATION VOLTAGE



2Mc NOISE FIGURE



INPUT & OUTPUT CAPACITANCE



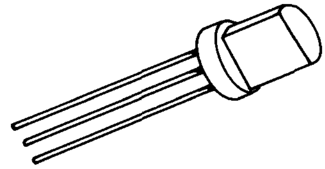
Silicon Transistors

NPN

2N3854,5,6

2N3854A,5A,6A

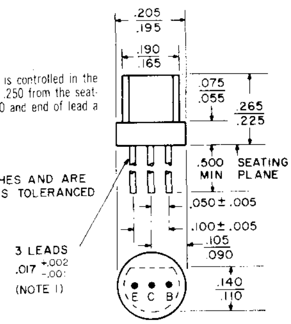
The General Electric 2N3854,A, 2N3885,A, 2N3856,A, are NPN silicon planar epitaxial passivated transistors designed primarily for RF, IF and converter applications in AM and FM receivers. Selected high voltage units are available for TV video amplifiers. (See typical BVceo)



- FM-IF STAGE GAIN OF 25 dB
- 30 dB GAIN AT 4.5 MHz
- FM-RF GAIN OF 15 dB
- TV VIDEO IF GAIN OF 21 dB

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages				
Collector to Emitter	2N3854, 5, 6	V_{CEO}	18	volts
	2N3854A, 5A, 6A	V_{CEO}	30	volts
Emitter to Base		V_{EBO}	4	volts
Collector to Base	2N3854, 5, 6,	V_{CBO}	18	volts
	2N3854A, 5A, 6A	V_{CBO}	30	volts
Current				
Collector (Steady State)†		I_C	100	mA
Dissipation				
Total Power (Free air at 25°C)‡		P_T	200	mW
Total Power (Free air at 55°C)‡		P_T	120	mW
Temperature				
Storage		T_S	−30 to 150°C	
Operating		T_J	100°C	
Lead soldering, 1/16 ± 1/32" from case for 10 sec. max.		T_L	260°C	

†Determined from power limitations due to saturation voltage at this point.
‡Derate 2.67 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics		Min.	Typ.	Max.	Units
Collector Cutoff Current ($V_{CB} = 18V$)	I_{CBO}			0.5	μA
($V_{CB} = 18V$, $T_A = 100°C$)	I_{CBO}			15	μA
Forward Current Transfer Ratio ($V_{CE} = 4.5V$, $I_C = 2mA$)					
2N3854, 2N3854A	h_{FE}	35		70	
2N3855, 2N3855A	h_{FE}	60		120	
2N3856, 2N3856A	h_{FE}	100		200	
Emitter—Base Breakdown Voltage ($I_E = 500\mu A$)	BV_{EBO}	4			volts
Collector—Emitter Breakdown Voltage ($I_C = 1mA$)					
2N3854, 2N3855, 2N3856	BV_{CEO}	18	70		volts
2N3854A, 2N3855A, 2N3856A	BV_{CEO}	30	70		volts
Collector—Base Breakdown Voltage ($I_C = 0.1mA$)					
2N3854, 2N3855, 2N3856	BV_{CBO}	18			volts
2N3854A, 2N3855A, 2N3856A	BV_{CBO}	30			volts
Collector Saturation Voltage ($I_C = 10mA$, $I_B = 1mA$)	$V_{CE(SAT)}$			0.200	volts
Dynamic Characteristics					
Gain Bandwidth Product ($V_{CE} = 10V$, $I_C = 5mA$)					
2N3854, 2N3854A	f_T	100		350	MHz
2N3855, 2N3855A	f_T	130		450	MHz
2N3856, 2N3856A	f_T	140		500	MHz
Collector—Base Time Constant ($V_{CB} = 10V$, $I_C = 5mA$)					
2N3854, 2N3854A	$r_b' C_c$		25	90	psec.
2N3855, 2N3855A	$r_b' C_c$		35	90	psec.
2N3856, 2N3856A	$r_b' C_c$		40	90	psec.
Output Capacitance ($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{ob}			3.5	pF
Input Capacitance ($V_{EB} = 0.5V$, $I_B = 0$, $f = 1$ MHz)	C_{ib}		16		pF
Case Capacitance			0.66		pF

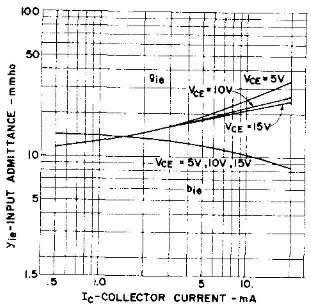
TYPICAL
COMMON EMITTER "y" PARAMETERS

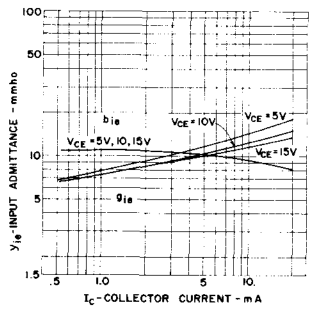
2N3854, 5, 6
2N3854A, 5A, 6A

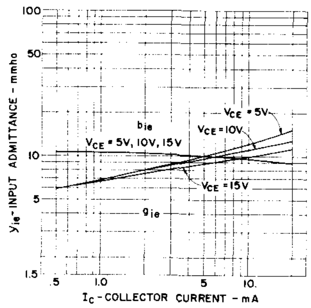
f = 100 MHz

	2N3854, A	2N3855, A	2N3856, A

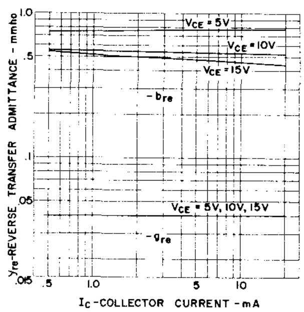
y_{ie} Input Admittance vs. Collector Current

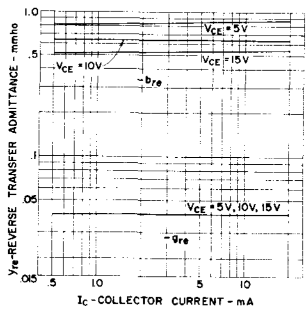


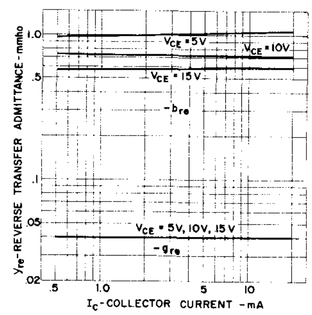




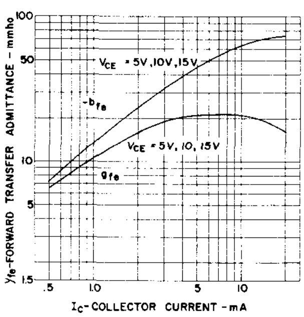
y_{re} Reverse Transfer Admittance vs. Collector Current

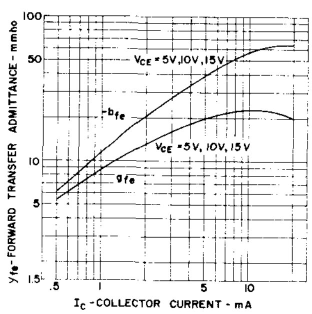


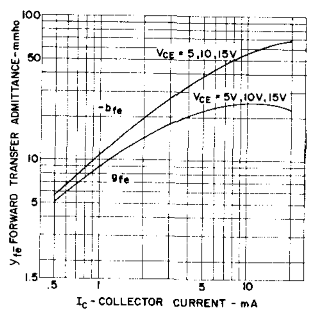




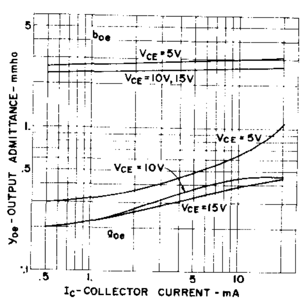
y_{fe} Forward Transfer Admittance vs. Collector Current

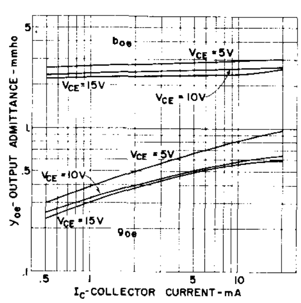


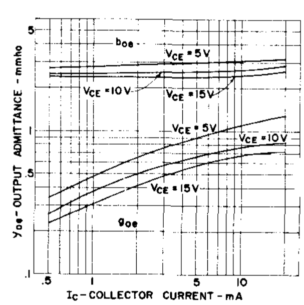




y_{oe} Output Admittance vs. Collector Current







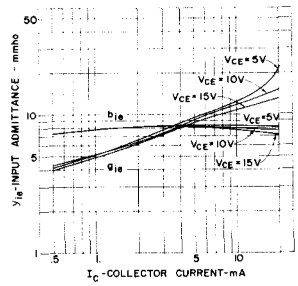
2N3854, 5, 6
2N3854A, 5A, 6A

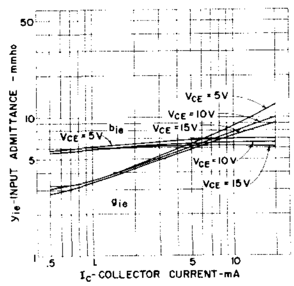
TYPICAL COMMON EMITTER "y" PARAMETERS

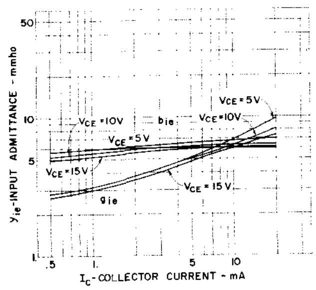
f = 45 MHz

2N3854, A | **2N3855, A** | **2N3856, A**

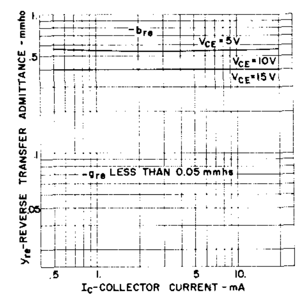
y_{ie} Input Admittance vs. Collector Current

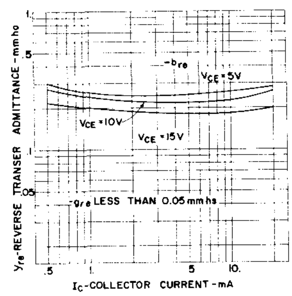


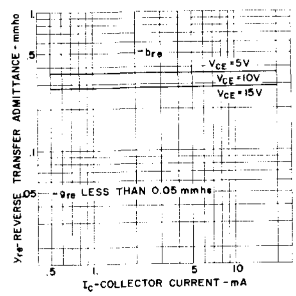




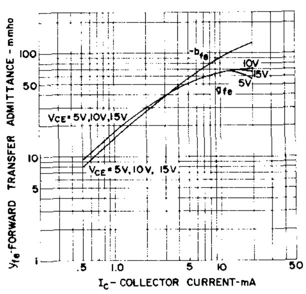
y_{re} Reverse Transfer Admittance vs. Collector Current

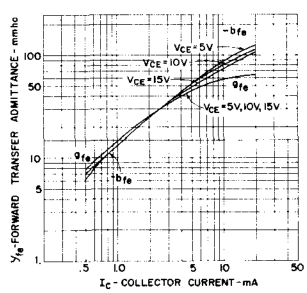


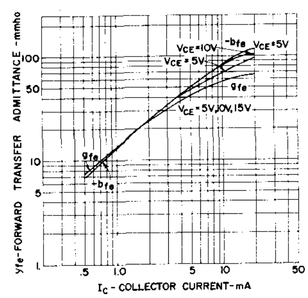




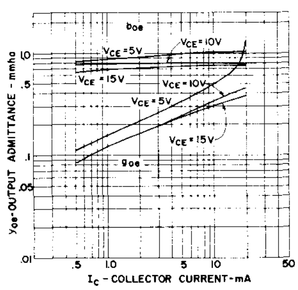
y_{fe} Forward Transfer Admittance vs. Collector Current

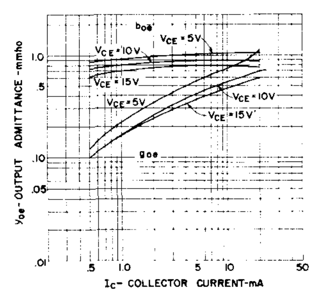


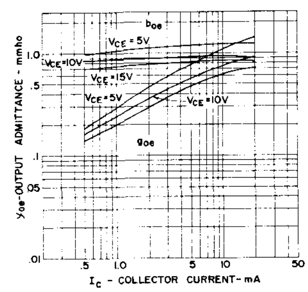




y_{oe} Output Admittance vs. Collector Current







TYPICAL COMMON EMITTER "y" PARAMETERS

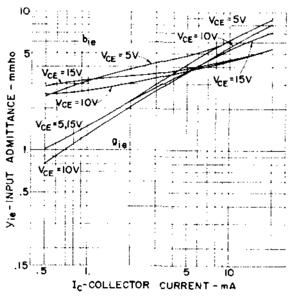
2N3854, 5, 6
2N3854A, 5A, 6A

f = 10.7 MHz

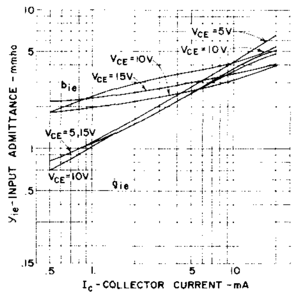
2N3854, A | **2N3855, A** | **2N3856, A**

y_{ie} Input Admittance vs. Collector Current

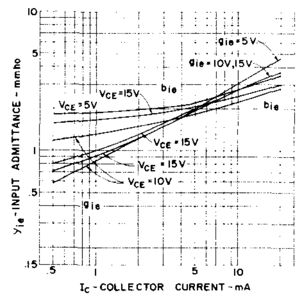
2N3854, A



2N3855, A

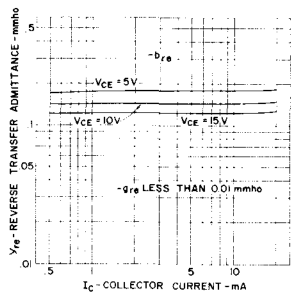


2N3856, A

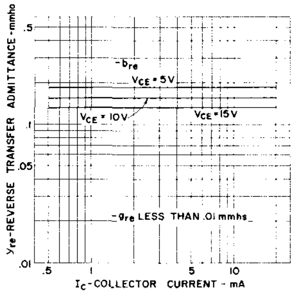


y_{re} Reverse Transfer Admittance vs. Collector Current

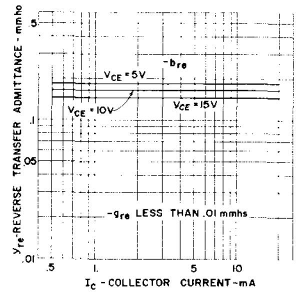
2N3854, A



2N3855, A

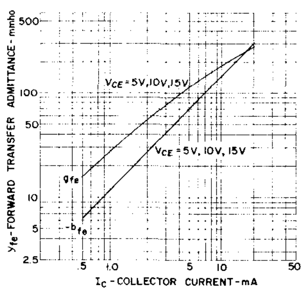


2N3856, A

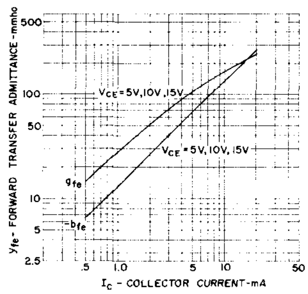


y_{fe} Forward Transfer Admittance vs. Collector Current

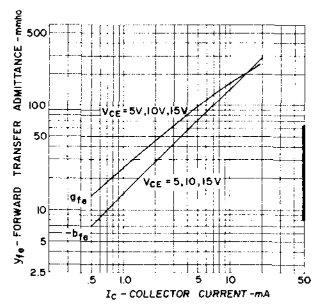
2N3854, A



2N3855, A

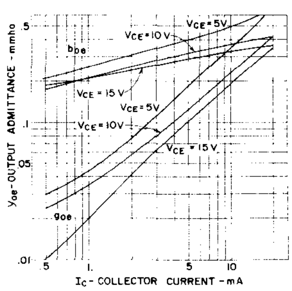


2N3856, A

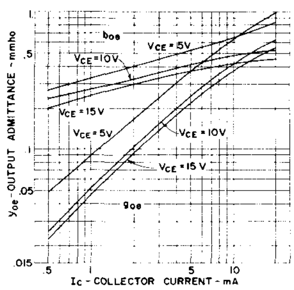


y_{oe} Output Admittance vs. Collector Current

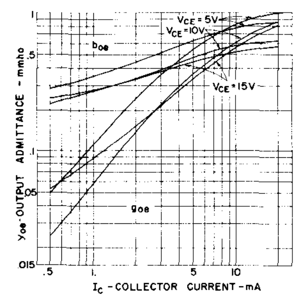
2N3854, A



2N3855, A



2N3856, A

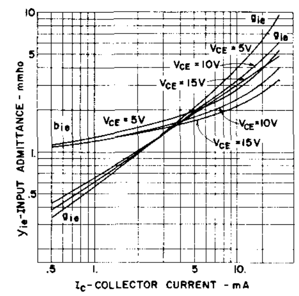


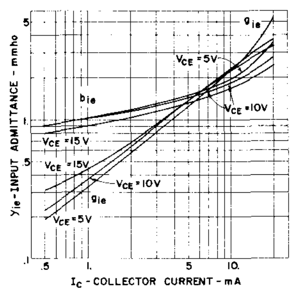
TYPICAL COMMON EMITTER "y" PARAMETERS

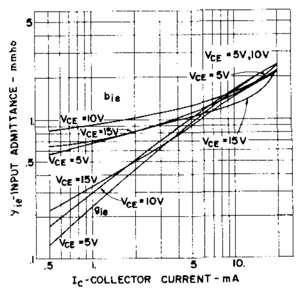
f = 4.5 MHz

	2N3854, A	2N3855, A	2N3856, A

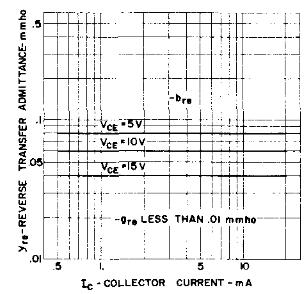
y_{ie} Input Admittance vs. Collector Current

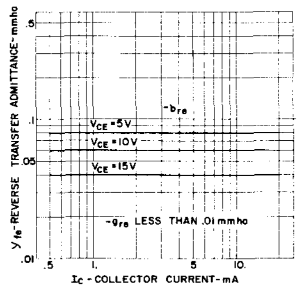


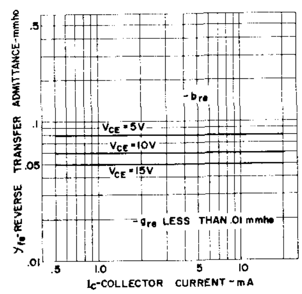




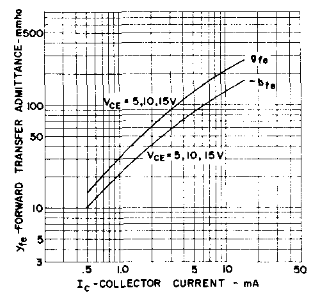
y_{re} Reverse Transfer Admittance vs. Collector Current

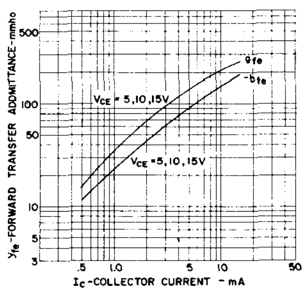


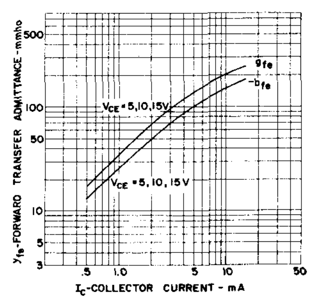




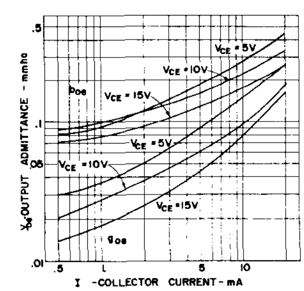
y_{fe} Forward Transfer Admittance vs. Collector Current

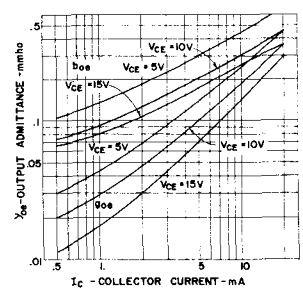


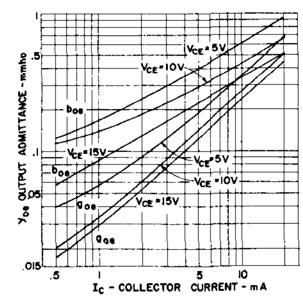




y_{oe} Output Admittance vs. Collector Current







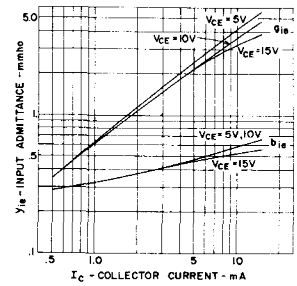
TYPICAL COMMON EMITTER "y" PARAMETERS

2N3854, 5, 6
2N3854A, 5A, 6A

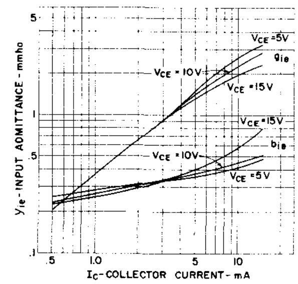
f = 1.0 MHz

Yie Input Admittance vs. Collector Current

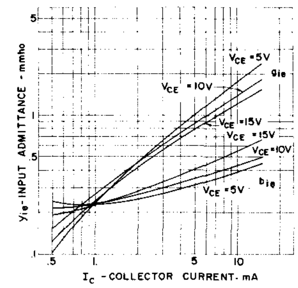
2N3854, A



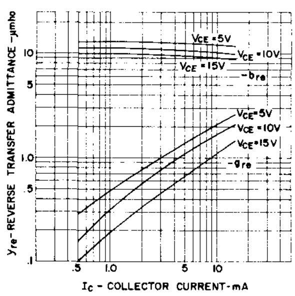
2N3855, A

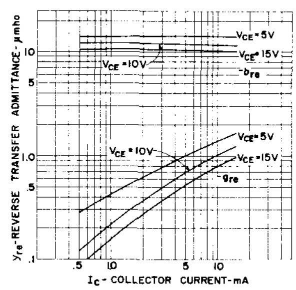


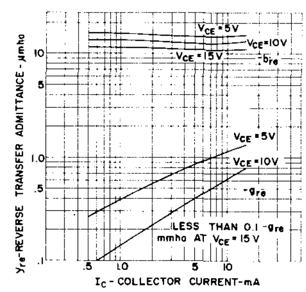
2N3856, A



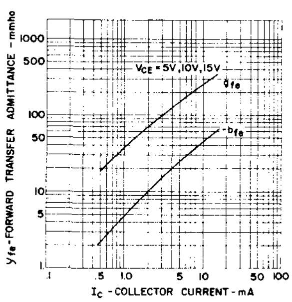
Yre Reverse Transfer Admittance vs. Collector Current

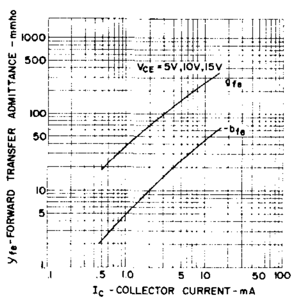


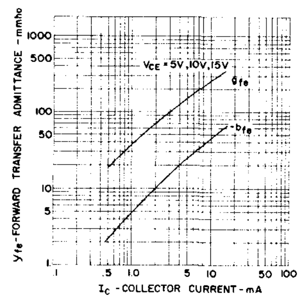




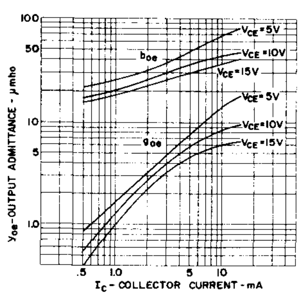
Yfe Forward Transfer Admittance vs. Collector Current

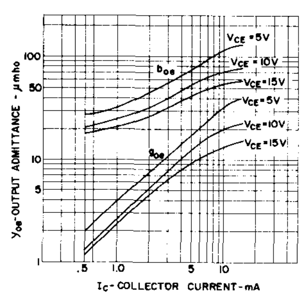


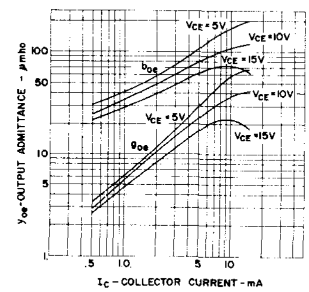




Yoe Output Admittance vs. Collector Current





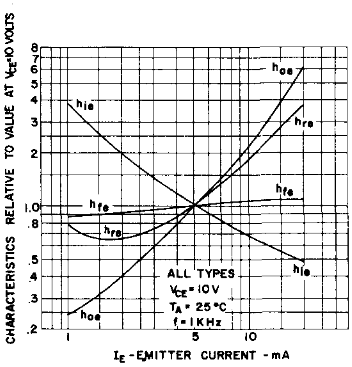


TYPICAL SMALL SIGNAL CHARACTERISTICS

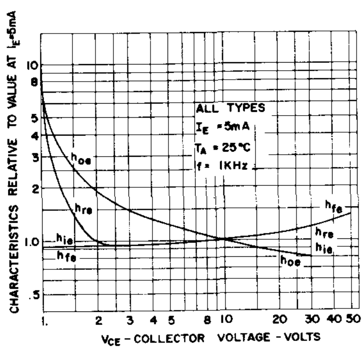
f = 1 kHz, V_{CE} = 10V, I_E = 5mA

Symbol	Characteristic	2N3854 2N3854A	2N3855 2N3855A	2N3856 2N3856A	Units
h_{ie}	Input resistance	454	741	1140	ohms
h_{oe}	Output conductance	10.4	16.2	23.1	μmhos
h_{fe}	Forward current transfer ratio	65.5	113	173	
h_{re}	Reverse voltage feedback ratio	10.5	11.3	11.8	X10^{-5}

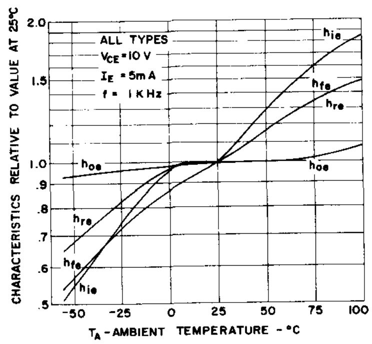
SMALL SIGNAL CHARACTERISTICS VS. EMITTER CURRENT



SMALL SIGNAL CHARACTERISTICS VS. COLLECTOR VOLTAGE



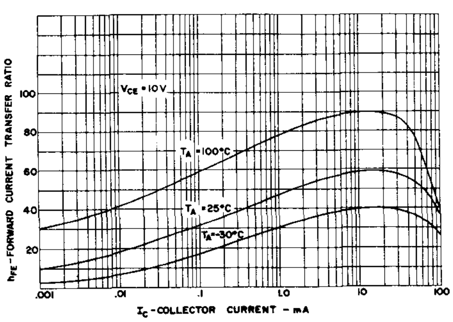
SMALL SIGNAL CHARACTERISTICS VS. AMBIENT TEMPERATURE



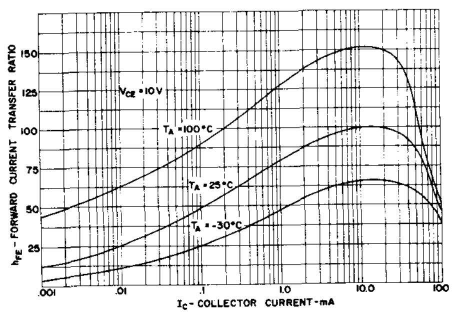
TYPICAL ELECTRICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO, h_{FE}, VS. COLLECTOR CURRENT

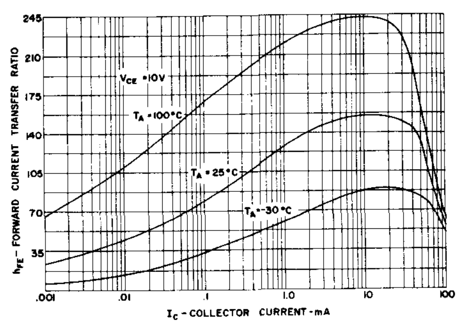
2N3854, A



2N3855, A



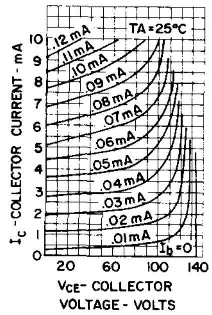
2N3856, A



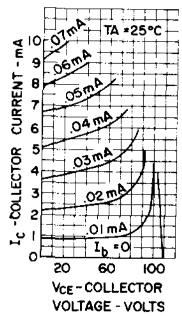
TYPICAL ELECTRICAL CHARACTERISTICS

COLLECTOR CHARACTERISTICS

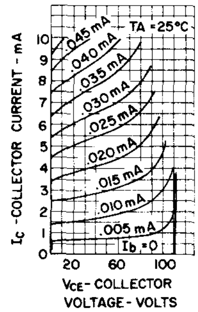
2N3854, A



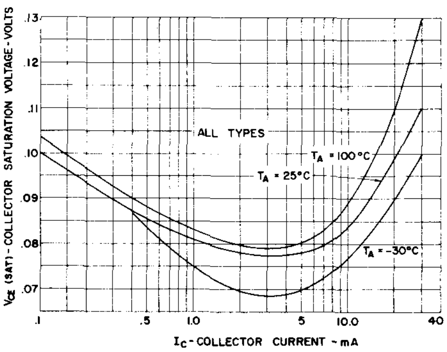
2N3855, A



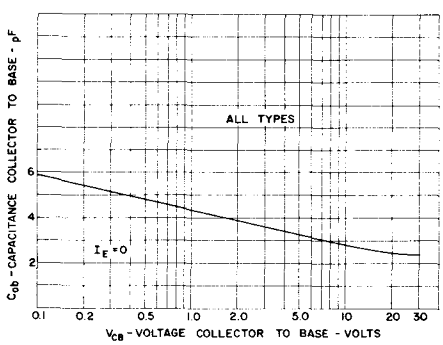
2N3856, A



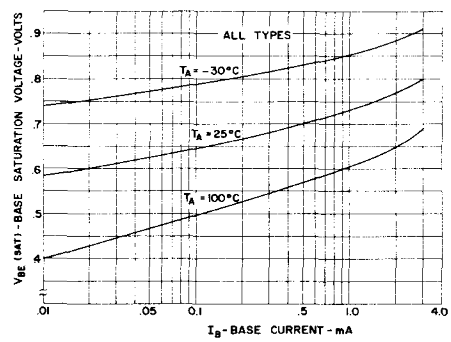
COLLECTOR SATURATION VOLTAGE VS. COLLECTOR CURRENT



OUTPUT CAPACITY VS. REVERSE VOLTAGE BIAS

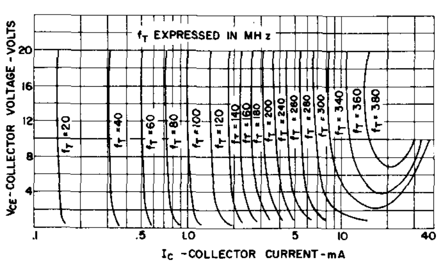


BASE SATURATION VOLTAGE VS. BASE CURRENT

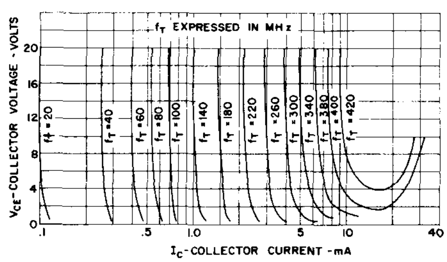


CONTOURS OF GAIN BANDWIDTH PRODUCT, f_T, vs. COLLECTOR CURRENT

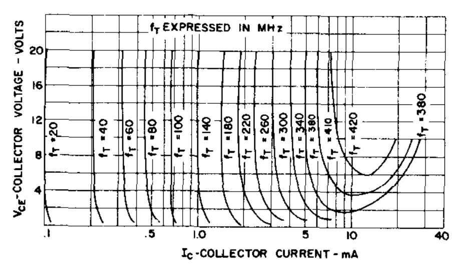
2N3854, A



2N3855, A



2N3856, A

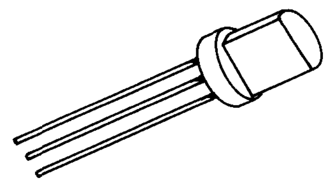


Silicon Transistors

NPN

2N3858,9,60

The General Electric 2N3858, 2N3859 and 2N3860 are NPN silicon, planar, epitaxial, passivated transistors designed primarily for AM radio I.F. and converter applications.



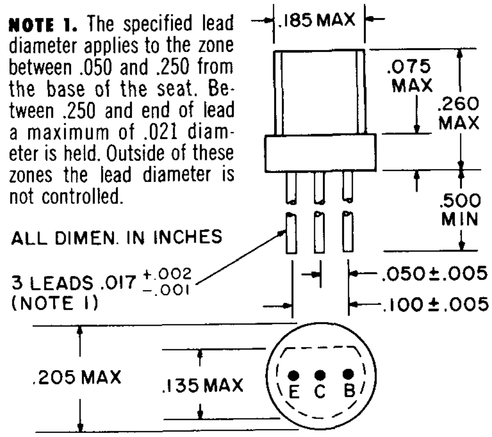
absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	30	volts
Emitter to Base	V_{EBO}	4	volts
Collector to Base	V_{CBO}	30	volts
Current			
Collector (Steady State)*	I_C	100	mA
Dissipation			
Total Power (Free air at 25°C)†	P_T	360	mW
Temperature			
Storage	T_{STG}	−55 to 150°C	
Operating	T_J	125°C	
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	260°C	

*Determined from power limitations due to saturation voltage at this current.

†Derate 3.6 mW/°C increase in ambient temperature above 25°C.

NOTE 1. The specified lead diameter applies to the zone between .050 and .250 from the base of the seat. Between .250 and end of lead a maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.



electrical characteristics: (25°C) (unless otherwise specified)

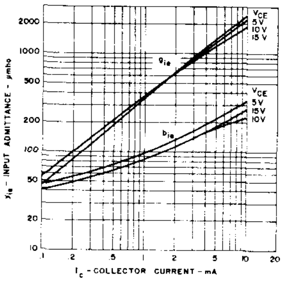
STATIC CHARACTERISTICS	Sym.	Min.	Typ.	Max.	Units
Collector Cutoff Current ($V_{CB} = 40V$)	I_{CBO}			50	NA
($T_A = 100°C$)	I_{CBO}			10	μA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}			100	NA
Forward Current Transfer Ratio ($V_{CE} = 4.5V, I_C = 2mA$)					
2N3858	h_{FE}	60		120	
2N3859	h_{FE}	100		200	
2N3860	h_{FE}	150		300	
Collector—Base Breakdown Voltage ($I_C = 0.1mA$)	BV_{CBO}	40			volts
Emitter—Base Breakdown Voltage ($I_E = 0.1mA$)	BV_{EBO}	5			volts
Collector—Emitter Breakdown Voltage ($I_C = 1mA$)	BV_{CEO}	40			volts
Collector Saturation Voltage ($I_C = 10mA, I_B = 1mA$)	$V_{CE(SAT)}$			0.125	volts
DYNAMIC CHARACTERISTICS					
Gain Bandwidth Product ($V_{CE} = 10V, I_C = 2mA$)					
2N3858	f_T	90	125	250	Mc
2N3859	f_T	90	140	250	Mc
2N3860	f_T	90	170	250	Mc
Collector—Base Time Constant ($V_{CE} = 10V, I_C = 2mA$)	$r_b'C_c$		65	150	psec.
Output Capacitance, Common Base ($V_{CB} = 10V, I_E = 0, f = 1Mc$)	C_{cbo}	2.0	2.7	4.0	pF
Input Capacitance, Common Base ($V_{EB} = 0.5V, I_E = 0, f = 1Mc$)	C_{ibo}		10		pF
Case Capacitance			0.66		pF

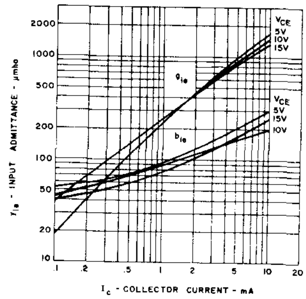
TYPICAL COMMON EMITTER "y" PARAMETERS vs. Ic

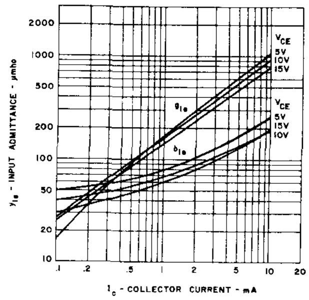
f = 262.5 Kc   TA = 25°C

2N3858   2N3859   2N3860

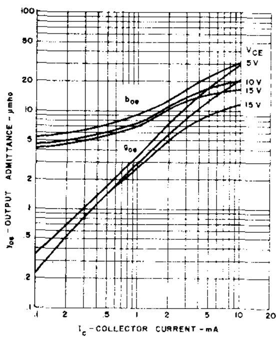
yie
Input Admittance vs. Collector Current
(OUTPUT SHORT CIRCUIT)

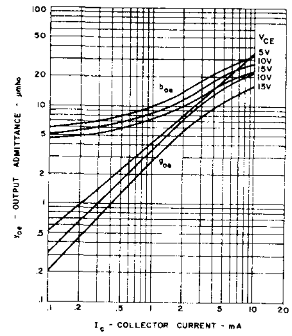


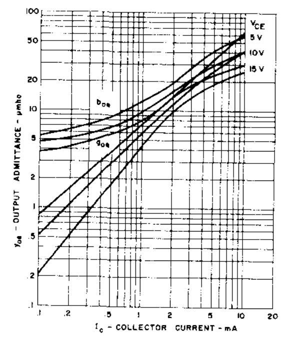




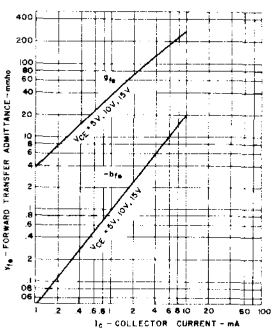
yoe
Output Admittance vs. Collector Current
(INPUT SHORT CIRCUIT)

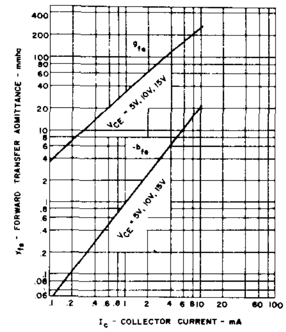


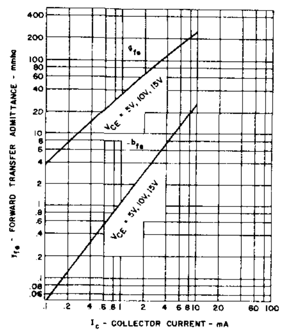




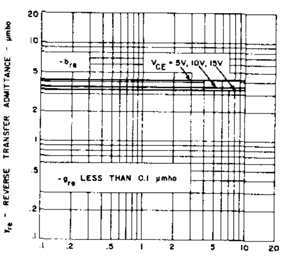
yfe
Forward Transfer Admittance vs. Collector Current
(OUTPUT SHORT CIRCUIT)

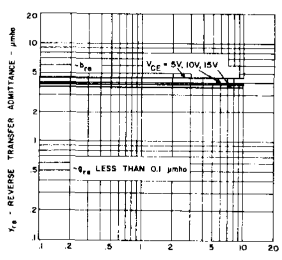


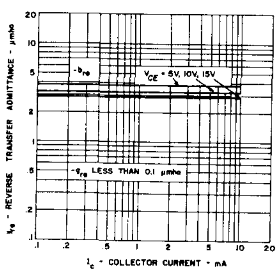




yre
Reverse Transfer Admittance vs. Collector Current
(INPUT SHORT CIRCUIT)





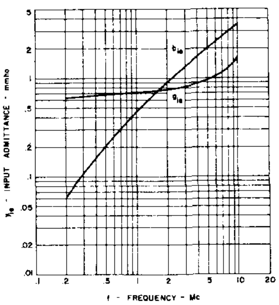


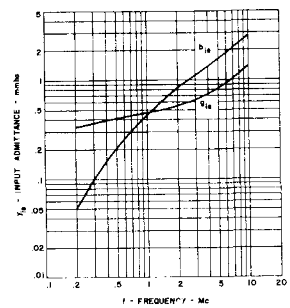
TYPICAL COMMON EMITTER "y" PARAMETERS vs. f

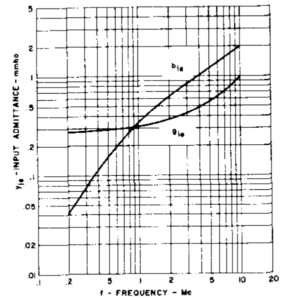
V_{CE}=10V, I_C=2mA, T_A=25°C

2N3858 | **2N3859** | **2N3860**

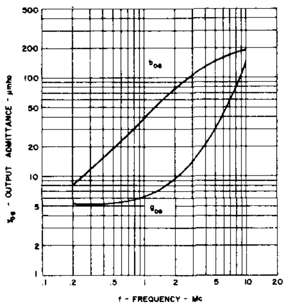
y_{ie} Input Admittance vs. Frequency (OUTPUT SHORT CIRCUIT)

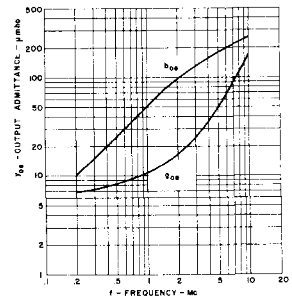


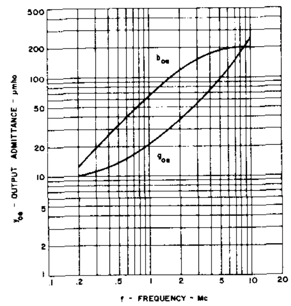




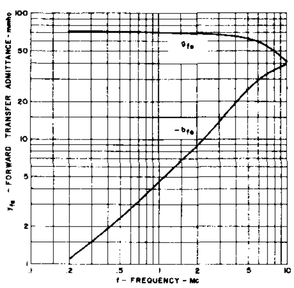
y_{oe} Output Admittance vs. Frequency (INPUT SHORT CIRCUIT)

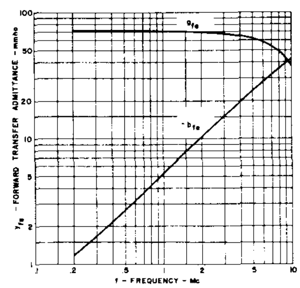


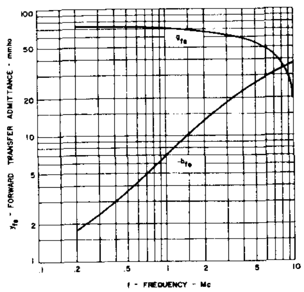




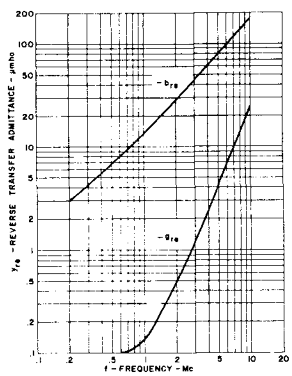
y_{fe} Forward Transfer Admittance vs. Frequency (OUTPUT SHORT CIRCUIT)

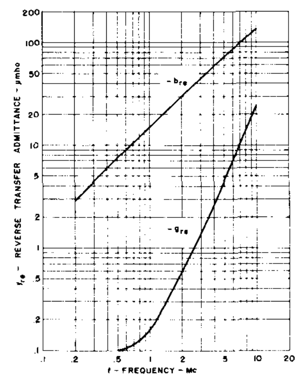


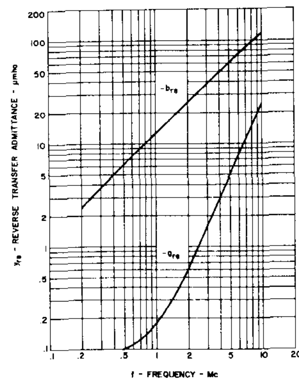




y_{re} Reverse Transfer Admittance vs. Frequency (INPUT SHORT CIRCUIT)

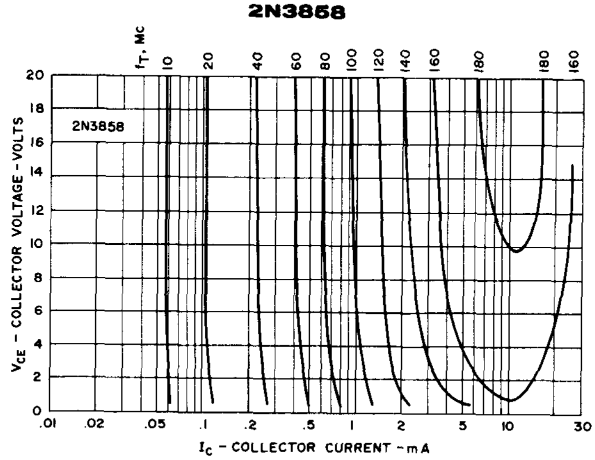




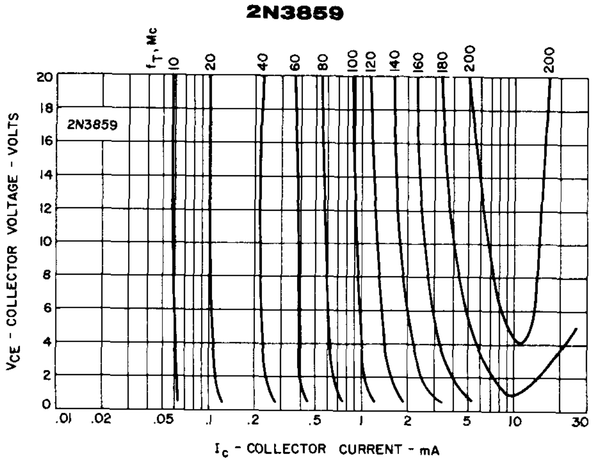


GAIN BAND-WIDTH PRODUCT vs. COLLECTOR CURRENT

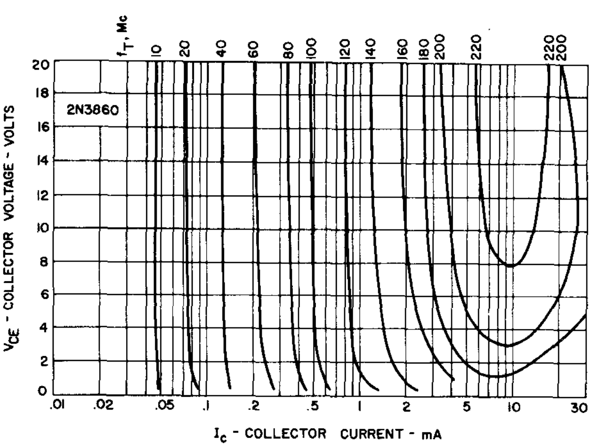
2N3858



2N3859

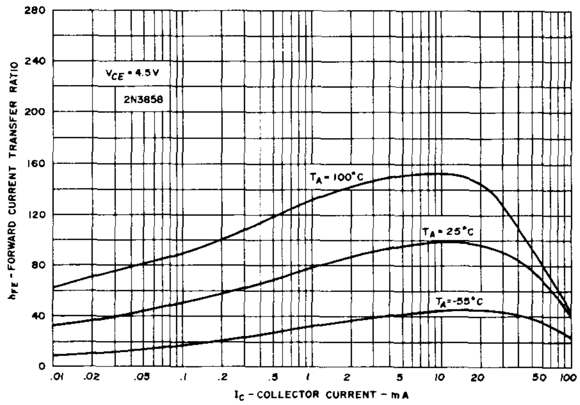


2N3860

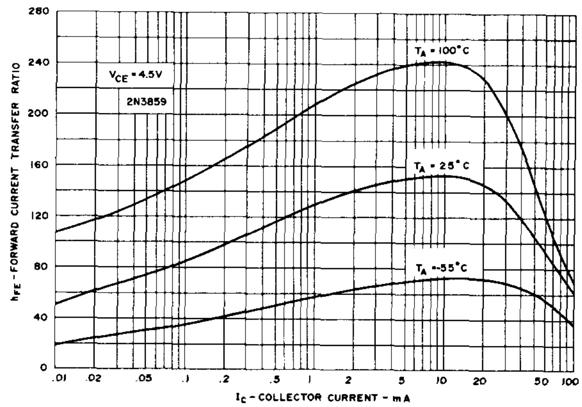


FORWARD CURRENT TRANSFER RATIO vs. COLLECTOR CURRENT

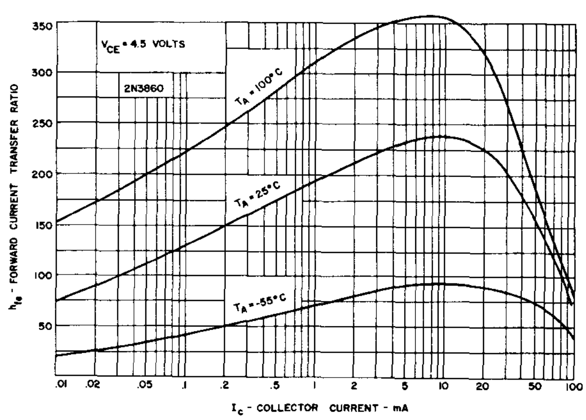
2N3858



2N3859

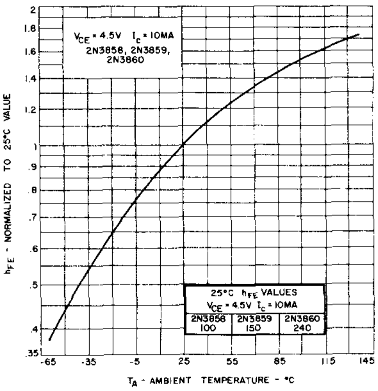


2N3860

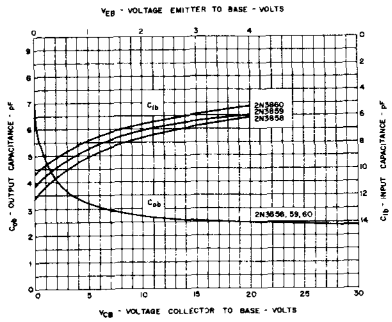


TYPICAL ELECTRICAL CHARACTERISTICS

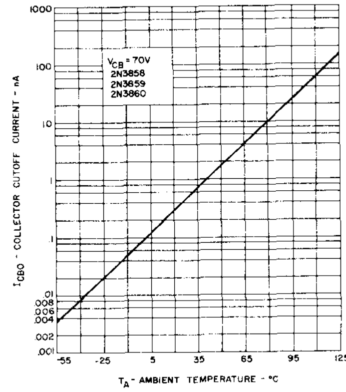
h_{FE} vs. TEMPERATURE



INPUT AND OUTPUT CAPACITANCE

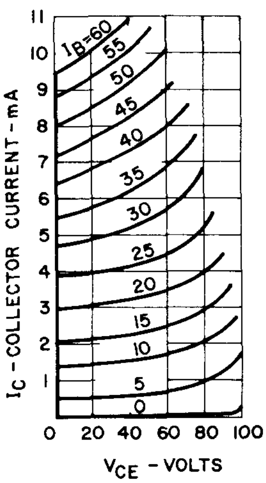


I_{CBO} vs. TEMPERATURE

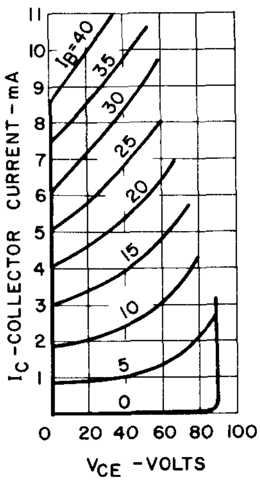


COLLECTOR CHARACTERISTICS

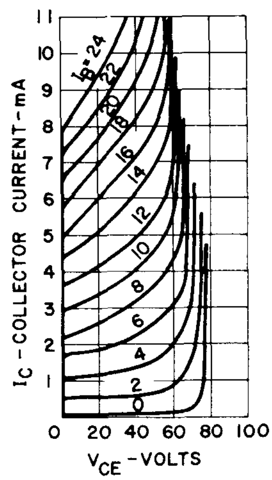
2N3858



2N3859



2N3860

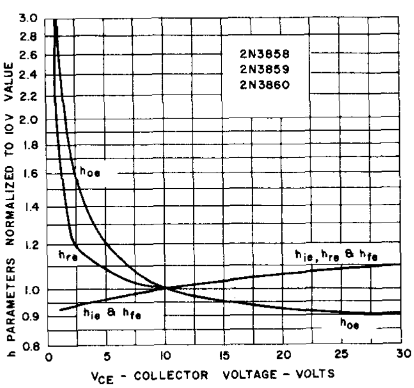


TYPICAL SMALL SIGNAL CHARACTERISTICS

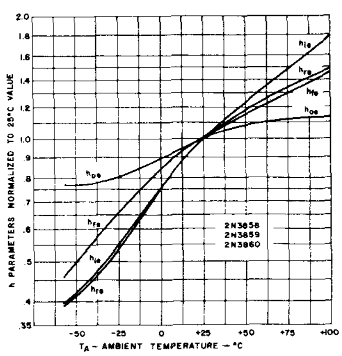
f=1 Kc, V_{CE}=10V, I_E=2mA, T_A=25°C

Symbol	Characteristics	2N3858	2N3859	2N3860	Units
h_{ie}	Input Resistance	1680	2480	3660	ohms
h_{oe}	Output Conductance	8.2	11	17	μmhos
h_{fe}	Forward Current Transfer Ratio	110	175	275	
h_{re}	Voltage Feedback Ratio	8.2	10.5	14.6	$X10^{-5}$

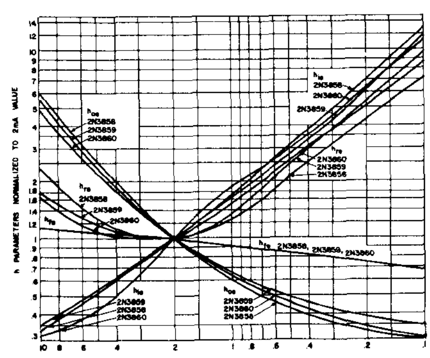
h PARAMETERS vs. V_{CE}



h PARAMETERS vs. TEMPERATURE



h PARAMETERS vs. I_C

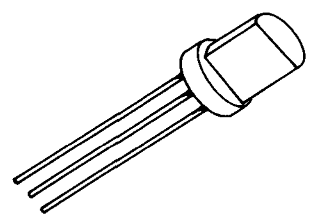


Silicon Transistors

NPN

2N3858A,9A

The General Electric 2N3858A and 2N3859A are NPN silicon, planar, epitaxial, passivated transistors. They are well suited as high voltage, high gain amplifiers and switches. Useful applications include drivers for audio output stages, high level video amplifiers and output stages of operational amplifiers. Selected higher voltage units are available.



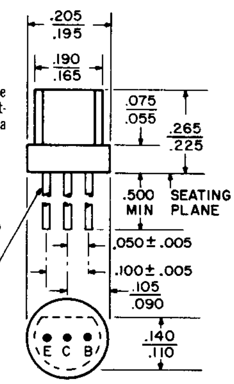
absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	60	volts
Emitter to Base	V_{EBO}	6	volts
Collector to Base	V_{CBO}	60	volts
Current			
Collector (Steady State)*	I_C	100	mA
Dissipation			
Total Power (Free air at 25°C)**	P_T	360	mW
Temperature			
Storage	T_{STG}	−55 to 150	°C
Operating	T_J	125	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	260	°C

*Determined from power limitations due to saturation voltage at this current.
**Derate 3.6 mW/°C increase in ambient temperature above 25°C.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS

	Sym.	Min.	Typ.	Max.	Units
Collector Cutoff Current ($V_{CB} = 60V$)	I_{CBO}			50	NA
($T_A = 100°C$)	I_{CBO}			10	μA
Emitter Cutoff Current ($V_{EB} = 6V$)	I_{EBO}			0.1	μA
Forward Current Transfer Ratio					
2N3858A ($V_{CE} = 1V$, $I_C = 10$ mA)	h_{FE}	60			
2N3859A ($V_{CE} = 1V$, $I_C = 10$ mA)	h_{FE}	100			
2N3858A ($V_{CE} = 4.5V$, $I_C = 2mA$)	h_{FE}	60		120	
2N3859A ($V_{CE} = 4.5V$, $I_C = 2mA$)	h_{FE}	100		200	
Collector—Base Breakdown Voltage ($I_C = 0.1$ mA)	BV_{CBO}	60			volts
Emitter—Base Breakdown Voltage ($I_E = 0.1$ mA)	BV_{EBO}	6			volts
Collector—Emitter Breakdown Voltage ($I_C = 1$ mA)	BV_{CEO}	60			volts
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$			0.125	volts
Base—Emitter Voltage ($I_C = 10$ mA, $V_{CE} = 1$ volt)	$V_{BE(Drive)}$		.68		volts
Base—Emitter Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$		.70	.78	volts

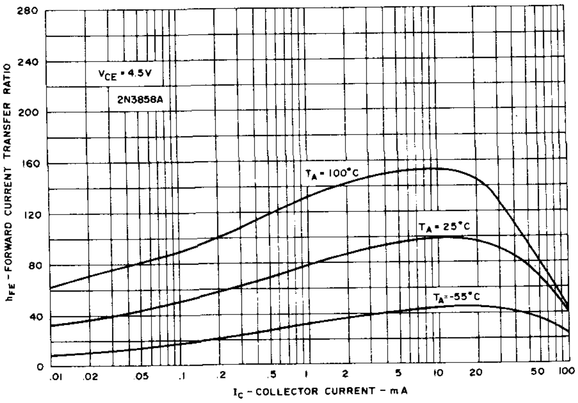
DYNAMIC CHARACTERISTICS

	Sym.	Min.	Typ.	Max.	Units
Gain Bandwidth Product ($V_{CE} = 10V$, $I_C = 2$ mA)					
2N3858A	f_T	90	125	250	MHz
2N3859A	f_T	90	140	250	MHz
Collector—Base Time Constant ($V_{CE} = 10V$, $I_C = 2$ mA)	$r_b'C_c$		65	150	psec.
Output Capacitance, Common Base ($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{cbo}	2.0	2.7	4.0	pF
Input Capacitance, Common Base ($V_{EB} = 0.5V$, $I_E = 0$, $f = 1$ MHz)	C_{ibo}		10		pF
Case Capacitance			0.66		pF

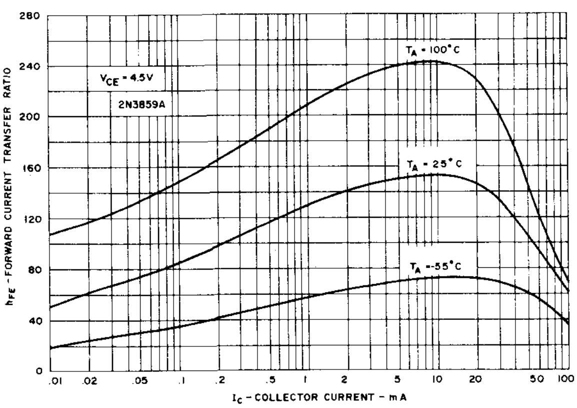
2N3858A, 9A

FORWARD CURRENT TRANSFER RATIO vs. COLLECTOR CURRENT

2N3858A

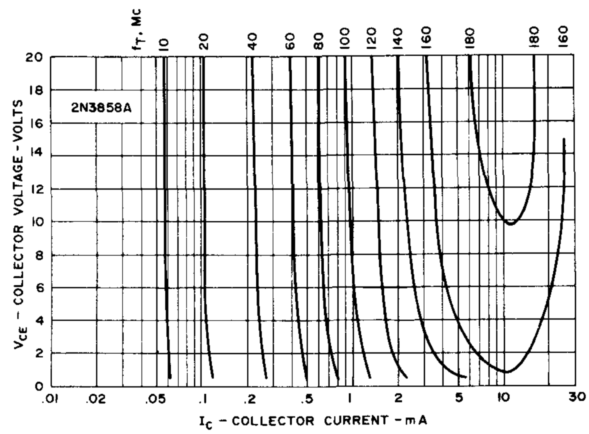


2N3859A

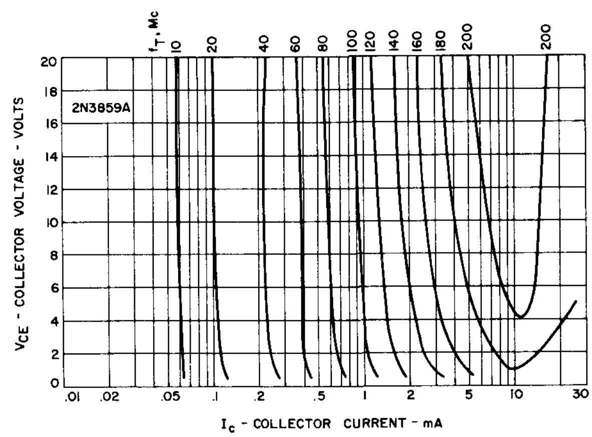


GAIN BAND-WIDTH PRODUCT vs. COLLECTOR CURRENT

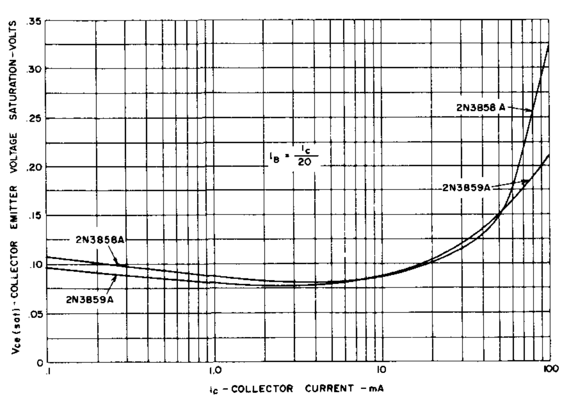
2N3858A



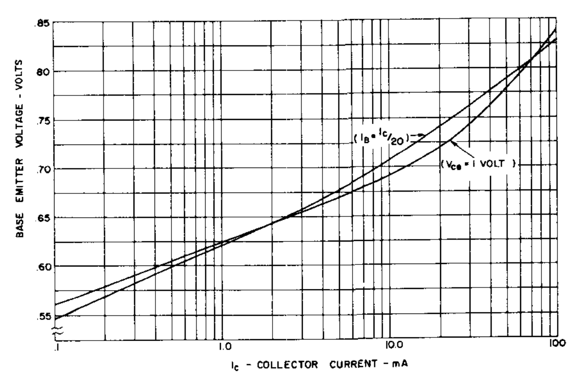
2N3859A



$V_{CE(SAT)}$ vs. Collector Current

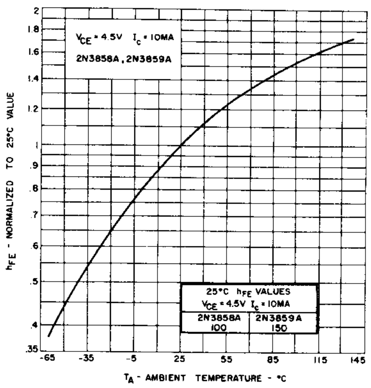


$V_{BE(SAT)}$, $V_{BE(DRIVE)}$ vs. Collector Current

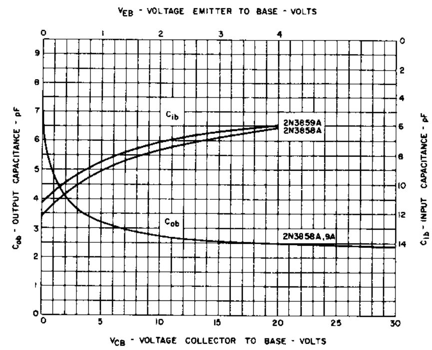


TYPICAL ELECTRICAL CHARACTERISTICS

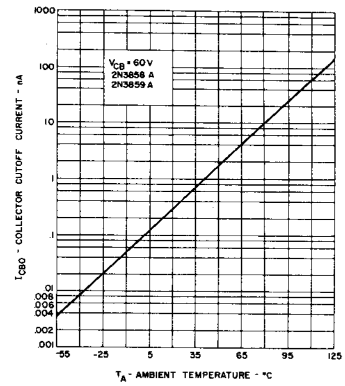
h_{FE} vs. TEMPERATURE



INPUT AND OUTPUT CAPACITANCE

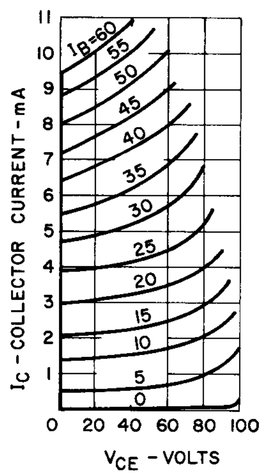


I_{CBO} vs. TEMPERATURE

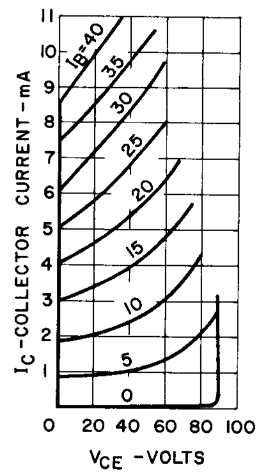


COLLECTOR CHARACTERISTICS

2N3858A



2N3859A

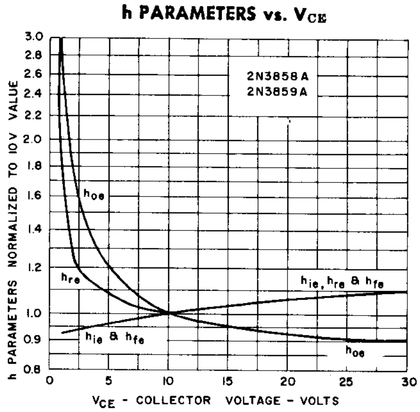


TYPICAL SMALL SIGNAL CHARACTERISTICS

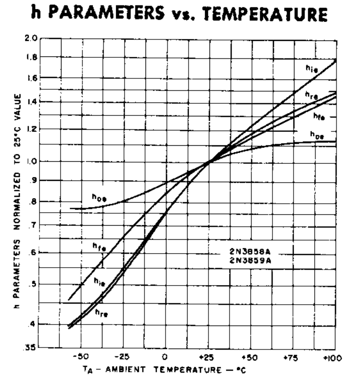
f = 1 Kc, V_{CE} = 10V, I_E = 2mA, T_A = 25°C

Symbol	Characteristics	2N3858A	2N3859A	Units
h_{ie}	Input Resistance	1680	2480	ohms
h_{oe}	Output Conductance	8.2	11	μmhos
h_{fe}	Forward Current Transfer Ratio	110	175	
h_{re}	Voltage Feedback Ratio	8.2	10.5	X10^{-5}

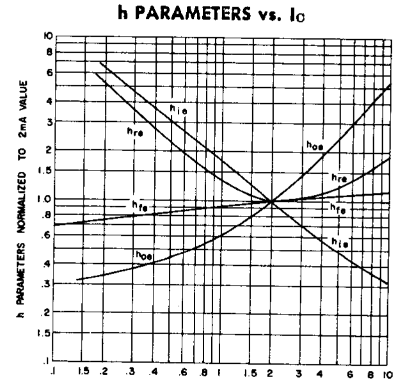
h PARAMETERS vs. V_{CE}



h PARAMETERS vs. TEMPERATURE



h PARAMETERS vs. I_C



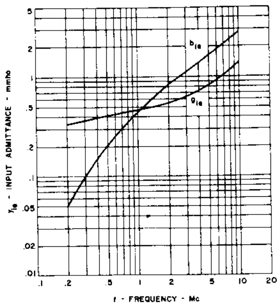
TYPICAL COMMON EMITTER "y" PARAMETERS

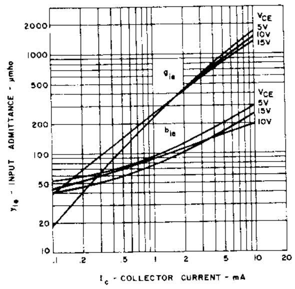
V_{CE}=10V

I_C = 2 mA

f = 250 KHz

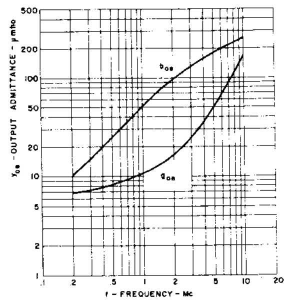
y_{ie}
Input Admittance
vs.
Frequency
(OUTPUT SHORT CIRCUIT)

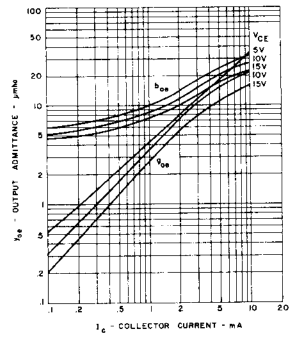




y_{ie}
Input Admittance
vs.
Collector Current
(OUTPUT SHORT CIRCUIT)

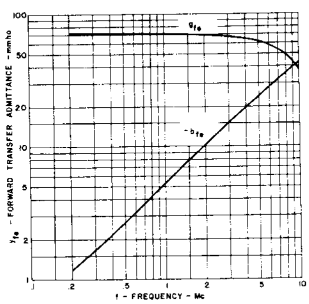
y_{oe}
Output Admittance
vs.
Frequency
(INPUT SHORT CIRCUIT)

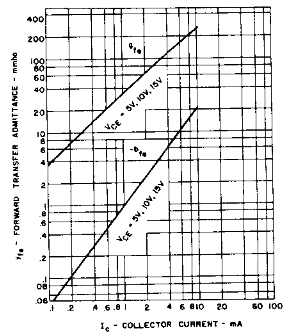




y_{oe}
Output Admittance
vs.
Collector Current
(INPUT SHORT CIRCUIT)

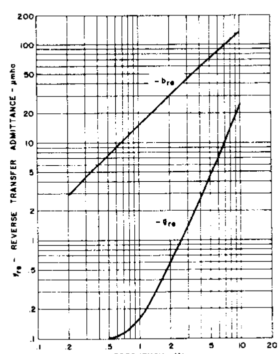
y_{fe}
Forward Transfer
Admittance
vs.
Frequency
(OUTPUT SHORT CIRCUIT)

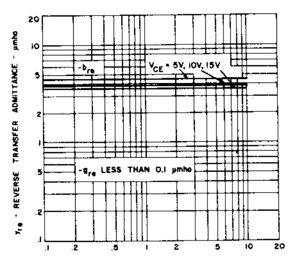




y_{fe}
Forward Transfer
Admittance
vs.
Collector Current
(OUTPUT SHORT CIRCUIT)

y_{re}
Reverse
Transfer Admittance
vs.
Frequency
(INPUT SHORT CIRCUIT)





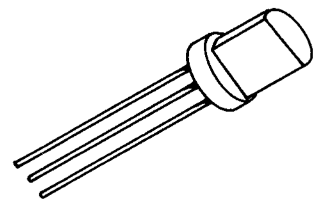
y_{re}
Reverse
Transfer Admittance
vs.
Collector Current
(INPUT SHORT CIRCUIT)

Silicon Transistors

NPN

2N3877,A

The General Electric 2N3877A and 2N3877 are NPN silicon planar passivated transistors designed for high voltage applications. The 2N3877A features a guaranteed minimum BVCEO of 85 volts. It is especially useful for driving high voltage indicating devices.

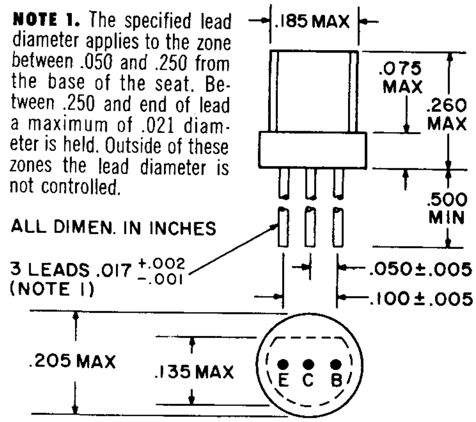


absolute maximum ratings: (25°C)

		2N3877A	2N3877	
Voltages				
Collector to Emitter (at 1 mA)	V_{CEO}	85	70	volts
Emitter to Base (at 1 mA)	V_{EBO}	4	4	volts
Collector to Base (at 1 mA)	V_{CBO}	85	70	volts
Current				
Collector* (Steady State)	I_C	50		mA
Dissipation				
Total Power (Free air @ 25°C)**	P_T	360	200	mW
Total Power (Free air @ 55°C)	P_T	250	100	mW
Temperature				
Storage	T_{STG}	−55°C to + 150		°C
Operating	T_J	−55°C to + 125		°C
Lead Soldering, 1/16" to 1/32" from case for 10 sec. max.	T_L	+ 260		°C

*Determined from power limitations due to saturation voltage at this current.
**Derate 2.67 mw/°C increase for temperature above 25°C.

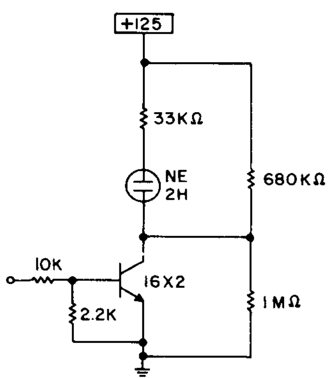
NOTE 1. The specified lead diameter applies to the zone between .050 and .250 from the base of the seat. Between .250 and end of lead a maximum of .021 diameter is held. Outside of these zones the lead diameter is not controlled.



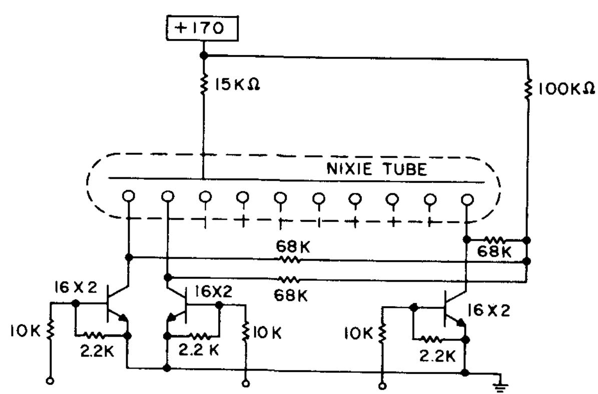
electrical characteristics: (25°C) (unless otherwise specified)

		Min.	Typ.	Max.	
Collector Cutoff Current ($V_{CB} = 70V$)	I_{CBO}			0.1	μA
($V_{CB} = 70V$, $T_A = 100°C$)	I_{CBO}			10	μA
Forward Current Transfer Ratio ($V_{CB} = 4.5V$, $I_C = 2$ mA)	h_{FE}	20			
Collector Saturation ($I_B = 1$ mA, $I_C = 10$ mA)	$V_{CE(SAT)}$			1.0	volts
Base Saturation Voltage ($I_B = 1$ mA, $I_C = 10$ mA)	$V_{BE(SAT)}$			.9	volts
Gain Bandwidth Product ($I_C = 10$mA, $V_C = 10V$)	f_T		160		Mc/s

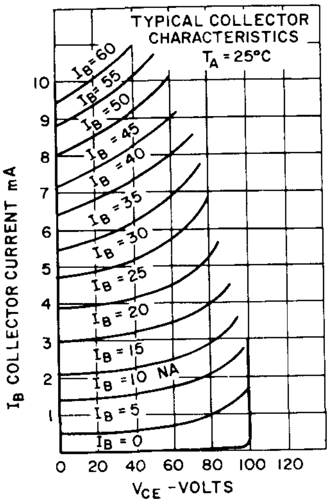
TYPICAL APPLICATIONS

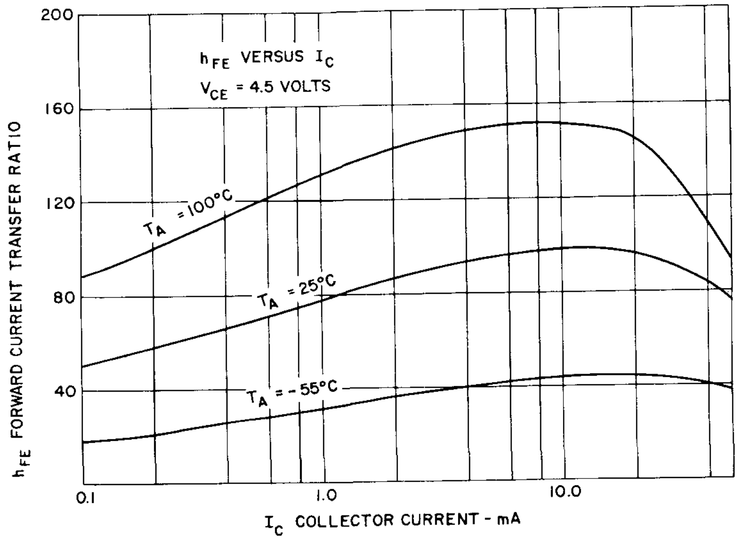


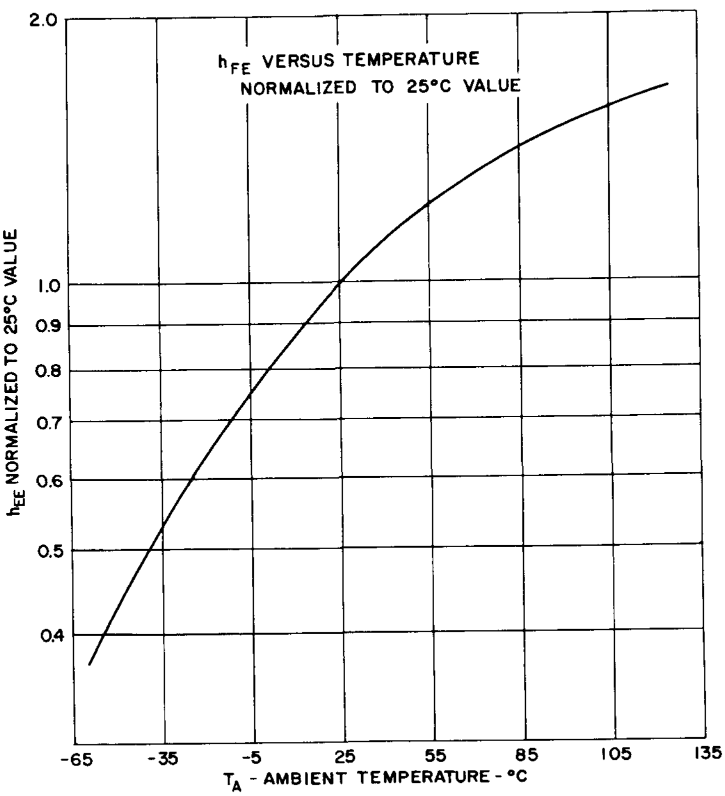
NEON DRIVER

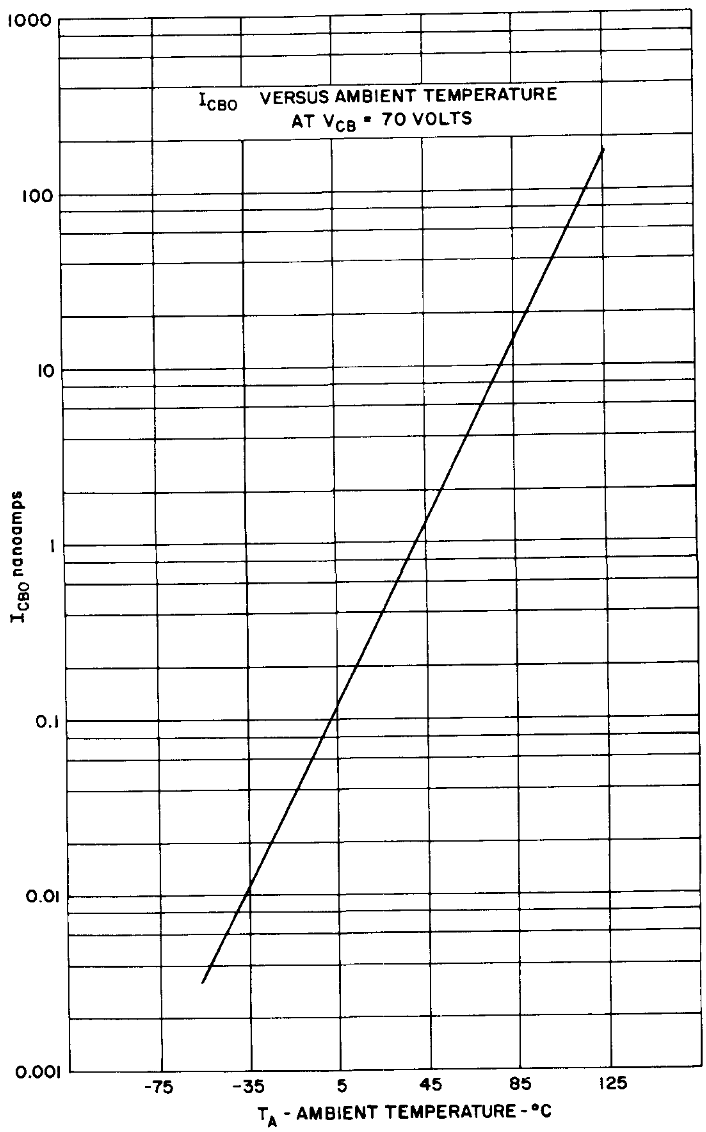


NIXIE DRIVERS


TYPICAL COLLECTOR CHARACTERISTICS
T_A = 25°C
I_B=60
I_B=55
I_B=50
I_B=45
I_B=40
I_B=35
I_B=30
I_B=25
I_B=20
I_B=15
I_B=10 NA
I_B=5
I_B=0
I_B COLLECTOR CURRENT mA
1 2 3 4 5 6 7 8 9 10
0 20 40 60 80 100 120
V_{CE} -VOLTS


h_{FE} VERSUS I_C
V_{CE} = 4.5 VOLTS
T_A = 100°C
T_A = 25°C
T_A = -55°C
h_{FE} FORWARD CURRENT TRANSFER RATIO
200
160
120
80
40
0.1
1.0
10.0
I_C COLLECTOR CURRENT - mA


h_{FE} VERSUS TEMPERATURE
NORMALIZED TO 25°C VALUE
h_{FE} NORMALIZED TO 25°C VALUE
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
-65 -35 -5 25 55 85 105 135
T_A - AMBIENT TEMPERATURE - °C

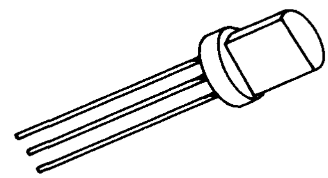

I_{CBO} VERSUS AMBIENT TEMPERATURE
AT V_{CB} = 70 VOLTS
I_{CBO} nanoamps
1000
100
10
1
0.1
0.01
0.001
-75 -35 5 45 85 125
T_A - AMBIENT TEMPERATURE - °C

Silicon Transistors

NPN

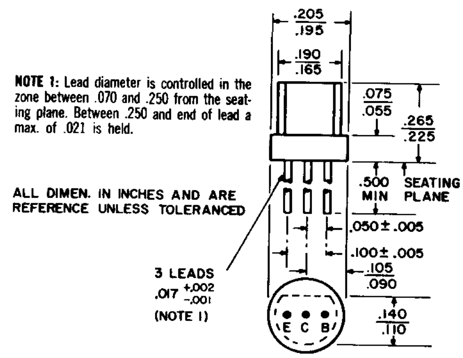
2N3900,A

The General Electric 2N3900 and 2N3900A are NPN silicon planar passivated devices intended for low noise preamplifier applications. The planar passivated construction assures excellent device stability and life. These high performance, high value transistors are made possible by utilizing advanced manufacturing techniques.



absolute maximum ratings (25°C) unless otherwise specified

Voltages			
Collector to Emitter	V_{CEO}	18	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	18	V
Current			
Collector (Steady State)[1]	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C)[2]	P_T	360	mW
Total Power (Free Air @ 55°C)[2]	P_T	260	mW
Temperature			
Storage	T_{stg}	−55 to +125	°C
Operating	T_J	+100	°C
Lead Soldering, 1/16″ ± 1/32″ from case for 10 seconds max.	T_L	+260	°C



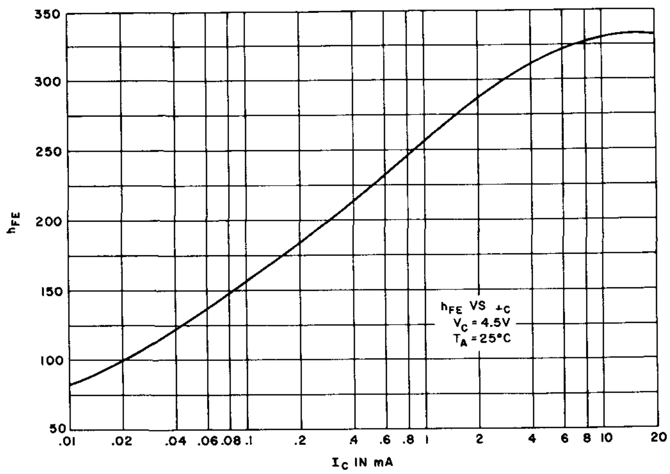
[1] Determined from power limitations due to saturation voltage at this current.
[2] Derate 3.6 mW °C increase in ambient temperature above 25°C.

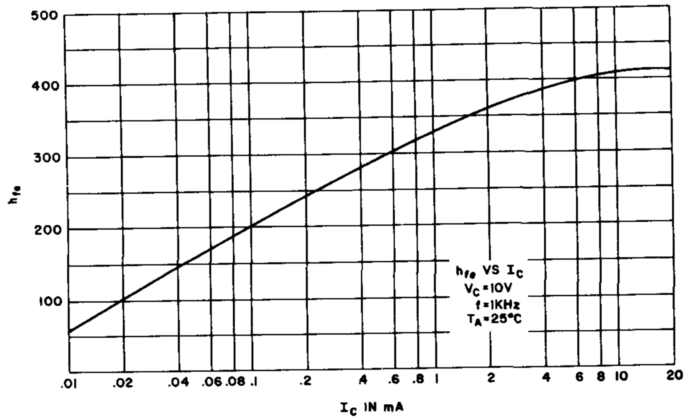
electrical characteristics (25°C) unless otherwise specified

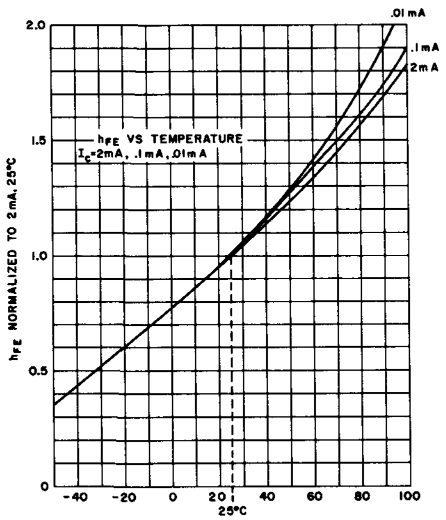
		Min.	Typ.	Max.	
Collector Cutoff Current					
(V_{CB} = 18V)	I_{CBO}			.1	μA
(V_{CB} = 18V, T_A = 100°C)	I_{CBO}			10	μA
Emitter Cutoff Current					
(V_{EB} = 5V)	I_{EBO}			.1	μA
Forward Current Transfer Ratio					
(V_{CE} = 4.5V, I_C = 2 mA)	h_{FE}	250		500	
SMALL SIGNAL CHARACTERISTICS					
Forward Current Transfer Ratio					
(V_{CE} = 10V, I_C = 100 μA, f = 1 kHz)	h_{fe}	170[3]	200		
Input Impedance					
(V_{CE} = 10V, I_C = 2 mA, f = 1 kHz)	h_{ib}		15		ohms
Output Capacitance					
(V_{CB} = 10V, I_E = 0, f = 1 MHz)	C_{obo}	2.0	7	12	pF
Gain Bandwidth Product					
(I_C = 4 mA, V_{CB} = 5 V)	f_t		160		MHz
NOISE					
(wide band—15 cps to 10 kHz, Equivalent Noise Bandwidth = 15.7 kHz)					
Noise Figure					
(I_C = 100 μA, V_{CE} = 4.5V, R_g = 5000 ohms)	NF		1.9	5[4]	dB

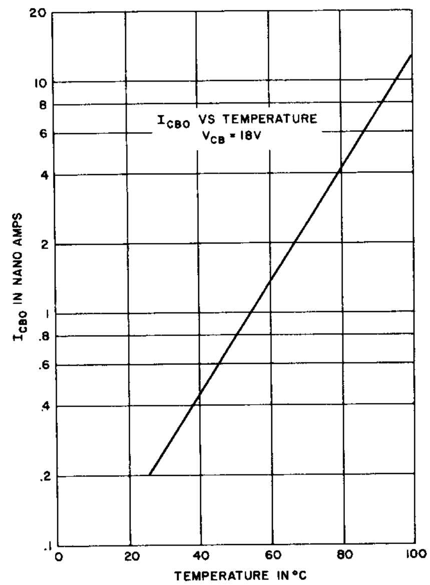
[3] Typically a minimum of 95% of the distribution is above this value.
[4] Type 2N3900A only.

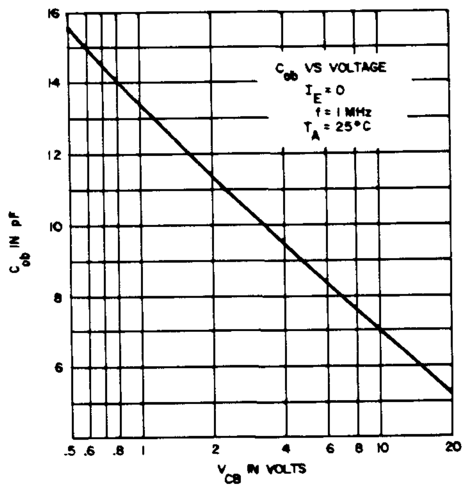
TYPICAL CURVES 2N3900 AND 2N3900A

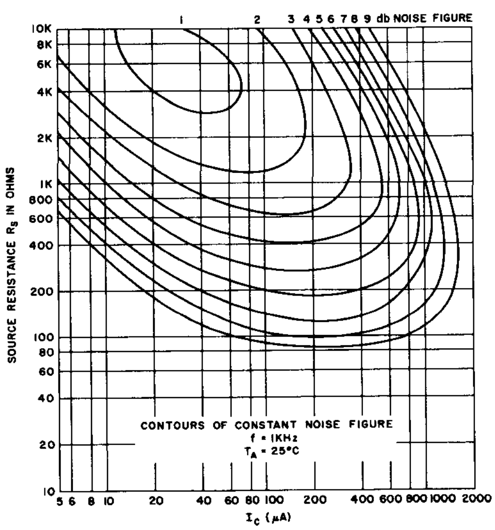


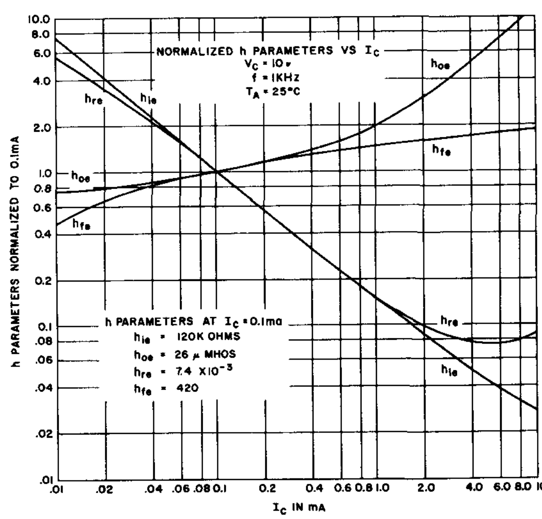










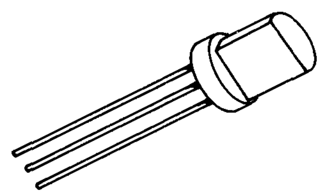


Silicon Transistors

NPN

2N3901

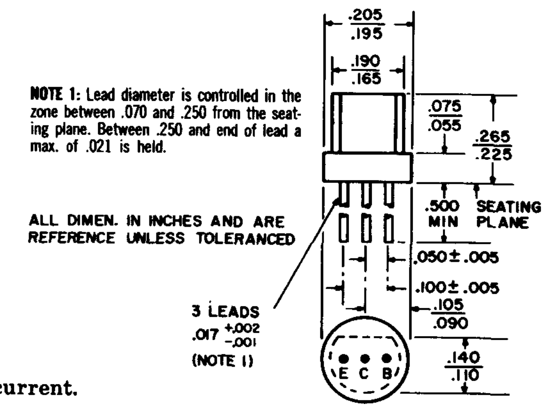
The General Electric 2N3901 is an NPN silicon planar transistor characterized for general industrial low signal level application. It features high current gain and ft, and low leakage current and collector capacitance. The planar construction assures excellent parameter stability with life.



absolute maximum ratings (25°C) unless otherwise specified

Voltages			
Collector to Emitter	V_{CEO}	18	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	18	V
Current			
Collector (Steady State)[1]	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C)[2]	P_T	360	mW
Total Power (Free Air @ 55°C)[2]	P_T	250	mW
Temperature			
Storage	T_{stg}	−55 to +125	°C
Operating	T_J	−55 to +125	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	+260	°C

[1] Determined from power limitations due to saturation voltage at this current.
[2] Derate 2.67 mw/°C increase in ambient temperature above 25°C.



electrical characteristics (25°C) unless otherwise specified

		Min.	Typ.	Max.	
Collector Cutoff Current					
($V_{CB} = 15V$)	I_{CBO}		0.2	10	nA[3]
($V_{CB} = 15V, T_A = 100°C$)	I_{CBO}		.013	10	μA
Emitter Cutoff Current					
($V_{EB} = 5V$)	I_{EBO}			0.1	μA
Forward Current Transfer Ratio					
($V_{CE} = 4.5V, I_C = 2$ mA)	h_{FE}	350		700	
SMALL SIGNAL CHARACTERISTICS					
Forward Current Transfer Ratio					
($V_{CE} = 4.5V, I_C = 2$ mA, f = 1 kHz)	h_{fe}	350			
Output Capacitance					
($V_{CB} = 10V, I_E = 0$, f = 1 MHz)	C_{cb}	4.5	7	10	pF
Gain Bandwidth Product					
($I_C = 4$ mA, $V_{CE} = 5V$)	f_t		200		MHz

NOISE

$$NF \approx 10 \log_{10} \left(\frac{1 + e_n^2/Rg + i_n^2 Rg}{4 KTB} \right)$$

where: e_n, i_n are transistor noise voltage and noise current as obtained in Fig. 8
B is the bandwidth in cycles
$4 KT = 1.66 \times 10^{-20}$

Optimum generator resistance for minimum noise, $R_{opt} = \frac{e_n}{i_n}$

[3] To 10% LTPD

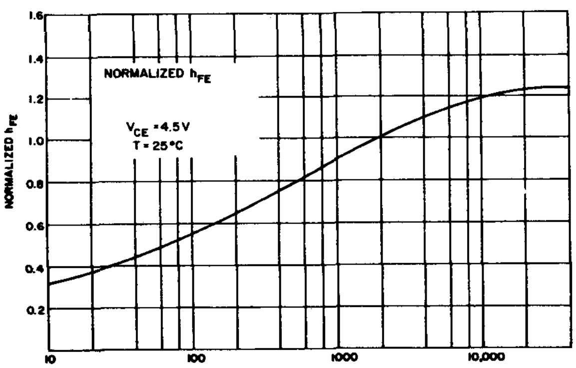


Fig. 1

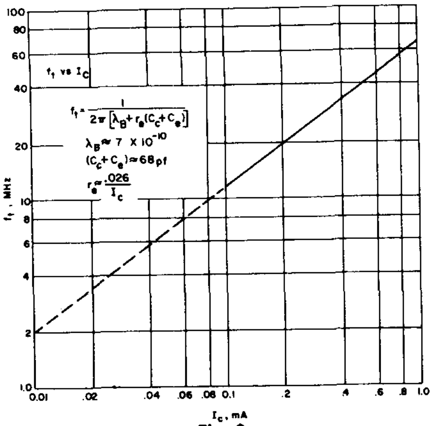


Fig. 2

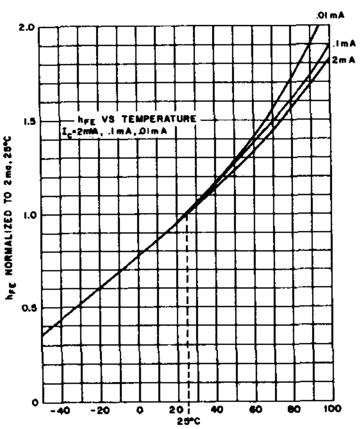


Fig. 3

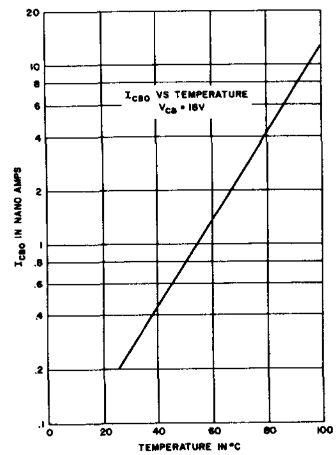


Fig. 4

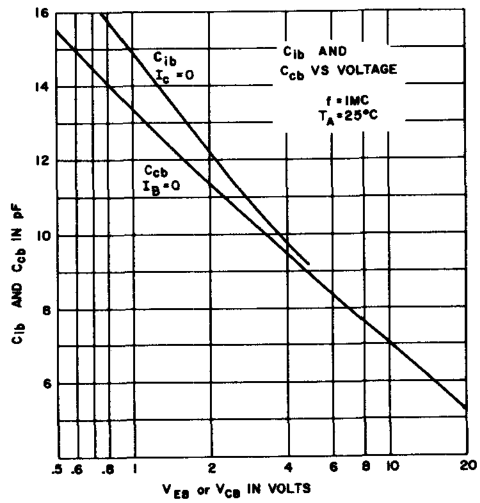


Fig. 5

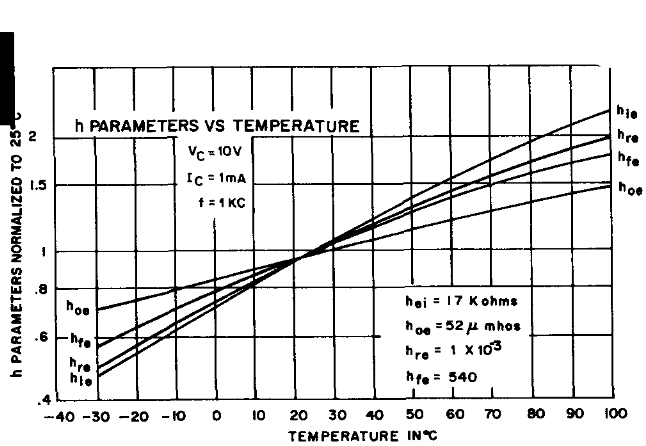


Fig. 6

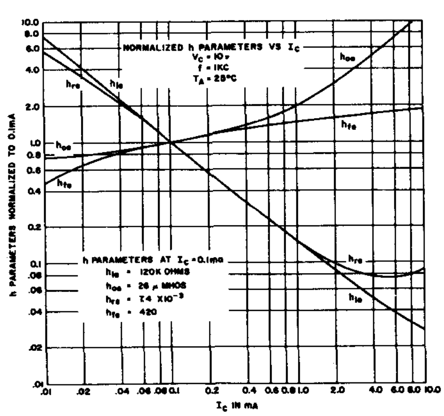


Fig. 7

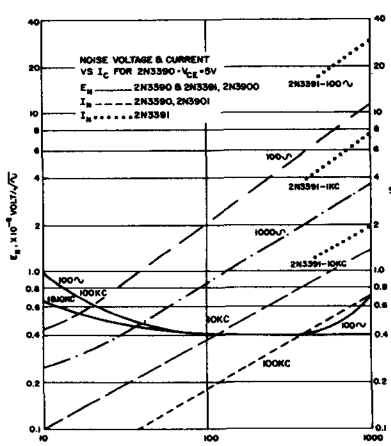
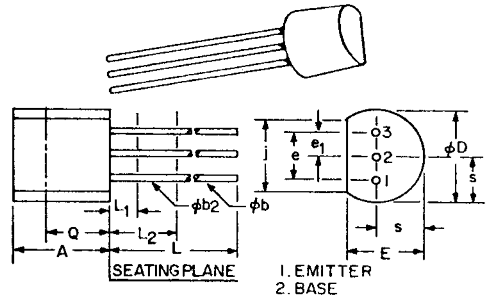


Fig. 8

Silicon Transistors

NPN

2N3903
2N3904



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L_1	–	1.270	–	.050	3
L_2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

The General Electric 2N3903 and 2N3904 are silicon NPN planar epitaxial transistors designed for general purpose switching and amplifier applications.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

VOLTAGES			
Collector to Emitter	V_{CEO}	40	Volts
Collector to Base	V_{CBO}	60	Volts
Emitter to Base	V_{EBO}	6	Volts
CURRENT			
Collector	I_C	200	mA
DISSIPATION			
Total Power $T_A \leq 25°C$	P_T	350	m Watts
Derate Factor $T_A > 25°C$	P_T	2.8	mW/°C
TEMPERATURE			
Operating	T_J	-55°C to +135°C	°C
Storage	T_{STG}	-55°C to +135°C	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230°C	°C

* electrical characteristics: (T_A = 25°C unless otherwise specified)

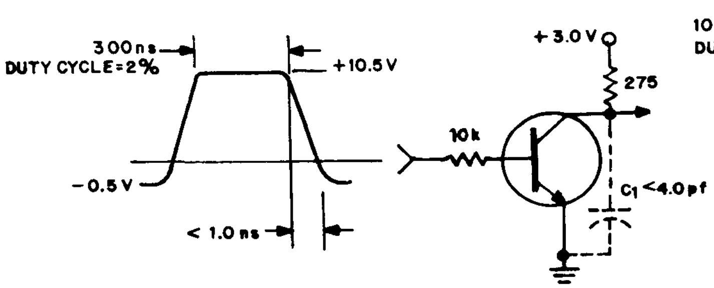
STATIC CHARACTERISTICS		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1mA, I_B = 0)		$V_{(BR)CEO}$	40	–	Volts
Collector-Base Breakdown Voltage (I_C = 10μA, I_E = 0)		$V_{(BR)CBO}$	60	–	Volts
Emitter-Base Breakdown Voltage (I_E = 10μA, I_C = 0)		$V_{(BR)EBO}$	6	–	Volts
Collector Cutoff Current (V_{CE} = 30V, V_{EB} (off) = 3V)		I_{CEV}	–	50	nA
Base Cutoff Current (V_{CE} = 30V, V_{EB} (off) = 3V)		I_{BEV}	–	50	nA
Forward Current Transfer Ratio					
(V_{CE} = 1V, I_C = 100μA)	2N3903	h_{FE}	20	–	
	2N3904	h_{FE}	40	–	
(V_{CE} = 1V, I_C = 1mA)	2N3903	h_{FE}	35	–	
	2N3904	h_{FE}	70	–	
(V_{CE} = 1V, I_C = 10mA)	2N3903	†h_{FE}	50	150	
	2N3904	†h_{FE}	100	300	
(V_{CE} = 1V, I_C = 50mA)	2N3903	†h_{FE}	30	–	
	2N3904	†h_{FE}	60	–	
(V_{CE} = 1V, I_C = 100mA)	2N3903	†h_{FE}	15	–	
	2N3904	†h_{FE}	30	–	

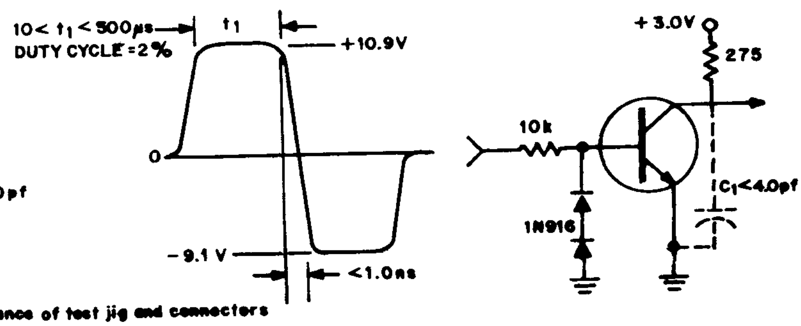
2N3903
2N3904

STATIC CHARACTERISTICS (Continued)		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Saturation Voltage					
(I_C = 10mA, I_B = 1mA)		†$V_{CE(sat)}$	–	.200	Volts
(I_C = 50mA, I_B = 5mA)		†$V_{CE(sat)}$	–	.300	Volts
Base-Emitter Saturation Voltage					
(I_C = 10mA, I_B = 1mA)		†$V_{BE(sat)}$	.65	.85	Volts
(I_C = 50mA, I_B = 5mA)		†$V_{BE(sat)}$	–	.95	
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 5V, I_E = O,f = 1 MHz)		C_{cb}	–	4	pF
Emitter-Base Capacitance (V_{EB} = .5V, I_C = O,f = 1 MHz)		C_{eb}	–	8	pF
Current – Gain – Bandwidth Product (V_{CE} = 20V, I_E = 10mA,f = 100 MHz)	2N3903	f_T	250	–	MHz
	2N3904	f_T	300	–	MHz
Noise Figure (I_E = 100μA, V_{CE} = 5V, R_G = 1 kHz) BW = 15.7 kHz	2N3903	NF	–	6	dB
	2N3904	NF	–	5	dB
Turn-On Delay		t_d	–	35	ns
Collector Current Rise Time (I_C = 10mA, I_{B1} = 1 mA, V_{BE} (off) = .5V) (R_L = 275Ω)		t_r	–	35	ns
Storage Delay Time	2N3903	t_s	–	175	ns
	2N3904	t_s	–	200	ns
Collector Current Fall Time (I_C = 10mA, I_{B1} = I_{B2} = 1 mA) (R_L = 275Ω, V_{CC} = 3V)		t_f	–	50	ns
Hybrid Parameters (I_E = 1mA, V_{CE} = 10V,f = 1 KHz)	2N3903	h_{fe}	50	200	
	2N3904	h_{fe}	100	400	
	2N3903	h_{ie}	.5	8	k Ω
	2N3904	h_{ie}	1	10	k Ω
	2N3903	h_{re}	.1	5	$X10^{-4}$
	2N3904	h_{re}	.5	.8	$X10^{-4}$
		h_{oe}	1.0	40	μmhos

†Pulse width ⩽ 300 μsec., Duty Cycle ⩽ 2%.
*JEDEC Registered Parameters.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

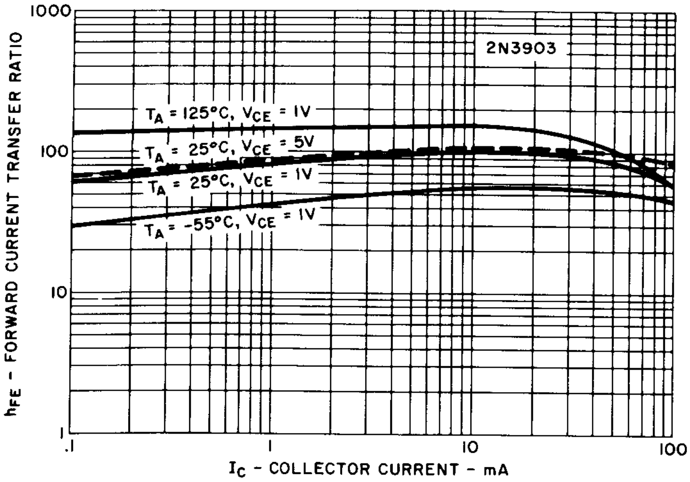




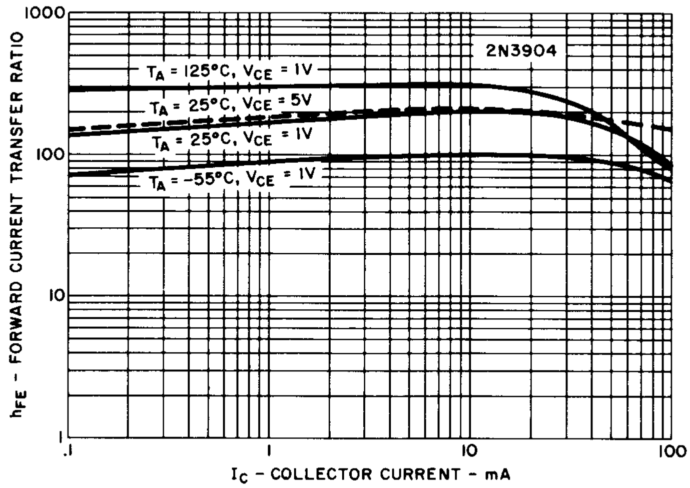
C_s = Total shunt capacitance of test jig and connectors

1. TURN-ON TIME TEST CIRCUIT t_d AND t_r

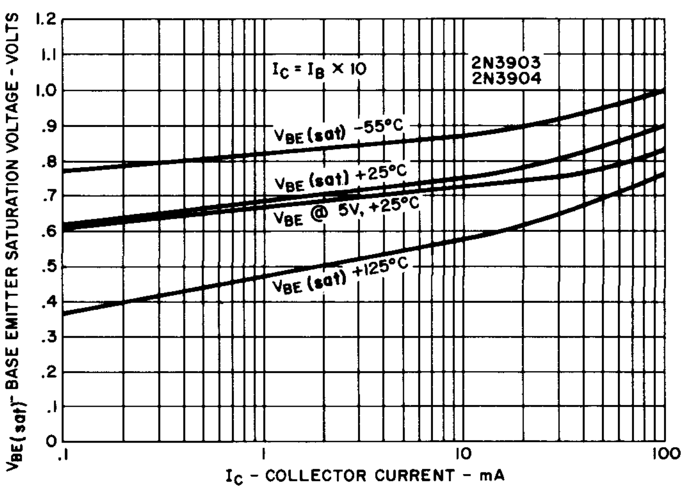
2. TURN-OFF TIME TEST CIRCUIT t_s AND t_f



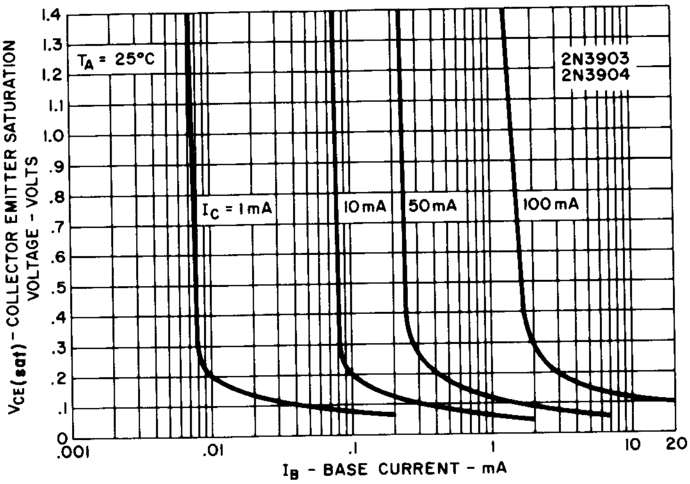
3. FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



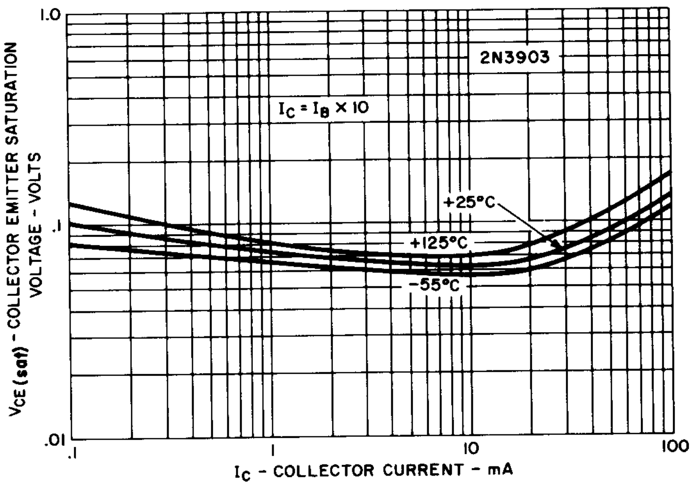
4. FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



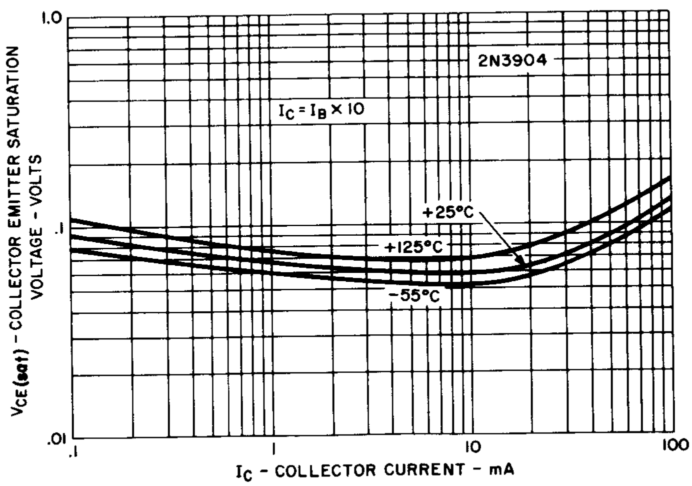
5. BASE EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



6. COLLECTOR EMITTER SATURATION VOLTAGE VS. BASE CURRENT



7. COLLECTOR EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



8. COLLECTOR EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

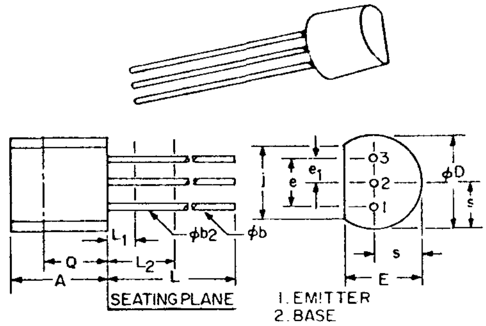
Silicon Transistors

PNP

2N3905
2N3906

The General Electric 2N3905 and 2N3906 are silicon PNP planar epitaxial transistors designed for general purpose switching and amplifier applications.

PNP values are negative: Observe proper polarity.



TO-92

1. EMITTER
2. BASE
3. COLLECTOR

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

VOLTAGES			
Collector to Emitter	V_{CEO}	40	Volts
Collector to Base	V_{CBO}	40	Volts
Emitter to Base	V_{EBO}	5	Volts
CURRENT			
Collector	I_C	200	mA
DISSIPATION			
Total Power $T_A \leq 25°C$	P_D	350	m Watts
Derate Factor $T_A > 25°C$		2.8	mW/°C
TEMPERATURE			
Operating	T_J	-55 to +135	°C
Storage	T_{STG}	-55 to +125	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230	°C

*electrical characteristics: (T_A = 25°C unless otherwise specified)

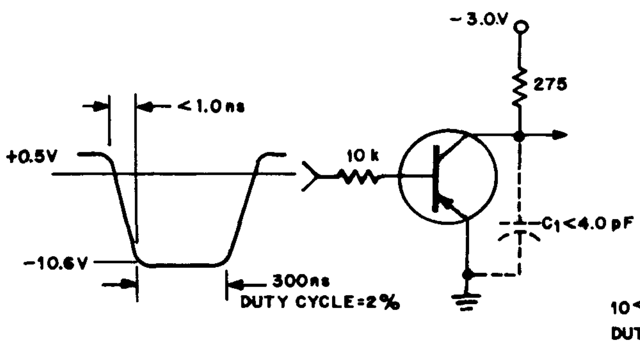
STATIC CHARACTERISTICS		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1mA, I_B = 0)		$V_{(BR)CEO}$	40	–	Volts
Collector-Base Breakdown Voltage (I_C = 10μA, I_E = 0)		$V_{(BR)CBO}$	40	–	Volts
Emitter-Base Breakdown Voltage (I_E = 10μA, I_C = 0)		$V_{(BR)EBO}$	5	–	Volts
Collector Cutoff Current (V_{CE} = 30V, $V_{BE(OFF)}$ = 3V)		I_{CEV}	–	50	nA
Base Cutoff Current (V_{CE} = 30V, $V_{BE(OFF)}$ = 3V)		I_{BEV}	–	50	nA
Forward Current Transfer Ratio (V_{CE} = 1V, I_C = 100μA)	2N3905	h_{FE}	30	–	
	2N3906	h_{FE}	60	–	
(V_{CE} = 1V, I_C = 1mA)	2N3905	h_{FE}	40		
	2N3906	h_{FE}	80	–	
(V_{CE} = 1V, I_C = 10mA)	2N3905	†h_{FE}	50	150	
	2N3906	†h_{FE}	100	300	
(V_{CE} = 1V, I_C = 50mA)	2N3905	†h_{FE}	30	–	
	2N3906	†h_{FE}	60	–	
(V_{CE} = 1V, I_C = 100mA)	2N3905	†h_{FE}	15	–	
	2N3906	†h_{FE}	30	–	

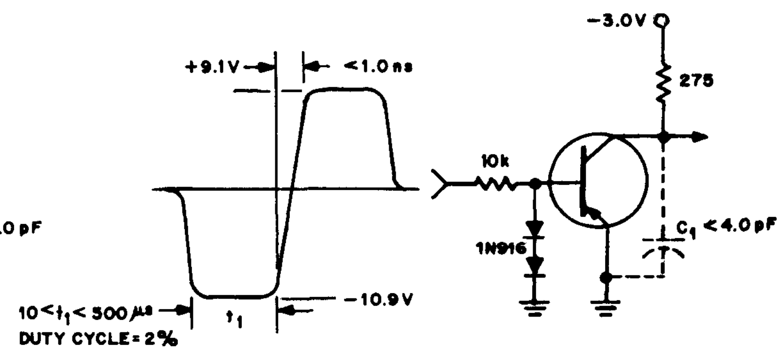
2N3905
2N3906

STATIC CHARACTERISTICS (Continued)		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Saturation Voltage					
(I_C = 10mA, I_B = 1mA)		†$V_{CE(sat)}$	–	.250	Volts
(I_C = 50mA, I_B = 5mA)		†$V_{CE(sat)}$	–	.400	Volts
Base-Emitter Saturation Voltage					
(I_C = 10mA, I_B = 1mA)		†$V_{BE(sat)}$	.65	.85	Volts
(I_C = 50mA, I_B = 5mA)		†$V_{BE(sat)}$	–	.95	Volts
DYNAMIC CHARACTERISTICS					
(V_{CB} = 5V, I_E = O,f = 1 MHz)		C_{cb}	–	4.5	pF
Emitter-Base Capacitance					
(V_{EB} = 5V, I_C = O,f = 1 MHz)		C_{eb}	–	10	pF
Current – Gain – Bandwidth Product					
(V_{CE} = 20V, I_E = 10mA, f = 100MHz)	2N3905	f_T	200	8	MHz
	2N3906	f_T	250	10	MHz
Noise Figure					
(I_E = 100μA, V_{CE} = 5V, R_G = 1KΩ)	2N3905	N F	–	5	dB
BW = 15.7 KHz	2N3906	N F	–	4	dB
Turn-On Delay Time		t_d	–	35	ns
Collector Current Rise Time					
(I_C = 10mA, I_{B1} = 1 mA, V_{BE} (off) = .5V) (R_L = 275Ω)		t_r	–	35	ns
Storage Delay Time	2N3905	t_s	–	200	ns
	2N3906	t_s	–	225	ns
Collector Current Fall Time					
(I_C = 10mA, I_{B1} = I_{B2} = 1 mA)	2N3905	t_f	–	60	ns
(R_L = 275Ω, V_{CC} = 3V)	2N3906	t_f	–	75	ns
Hybrid Parameters					
(I_E = 1mA, V_{CE} = 10V, f = 1 KHz)	2N3905	h_{fe}	50	200	
	2N3906	h_{fe}	100	400	
	2N3905	h_{ie}	.5	8	K Ω
	2N3906	h_{ie}	2	12	K Ω
	2N3905	h_{re}	.1	5	X10-4
	2N3906	h_{re}	1	10	X10-4
	2N3905	h_{oe}	1	40	μmhos
	2N3906	h_{oe}	3	60	μmhos

†Pulse width ≤ 300 μsec., Duty Cycle ≤ 2%.
*JEDEC Registered Parameters.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

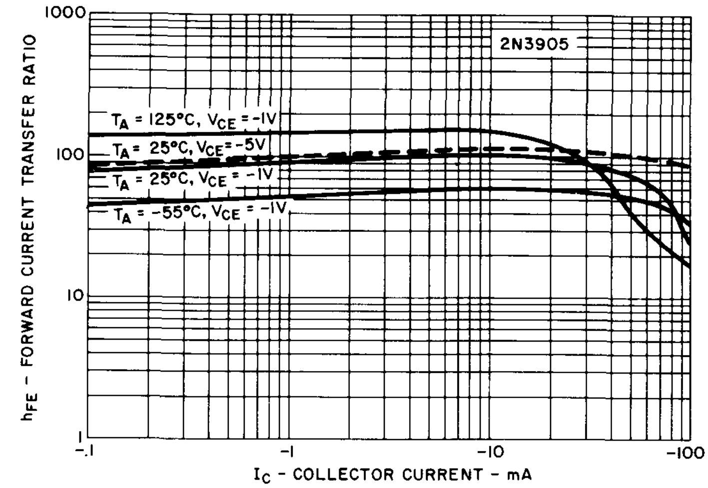




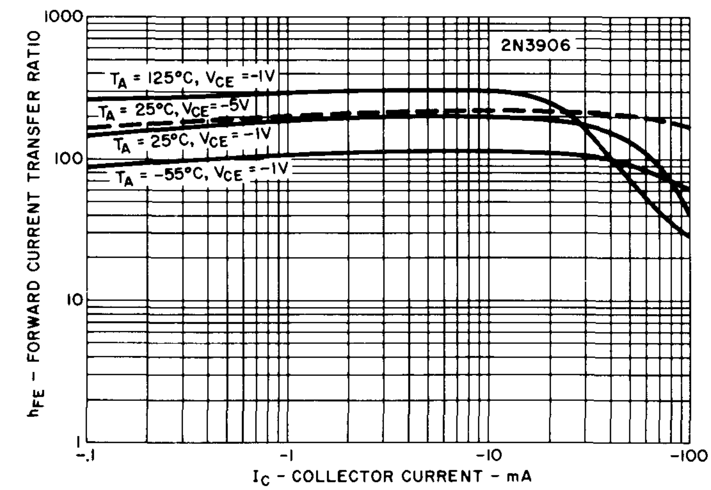
C_s = Total shunt capacitance of test jig and connectors.

1. TURN-ON TIME TEST CIRCUIT t_d AND t_r

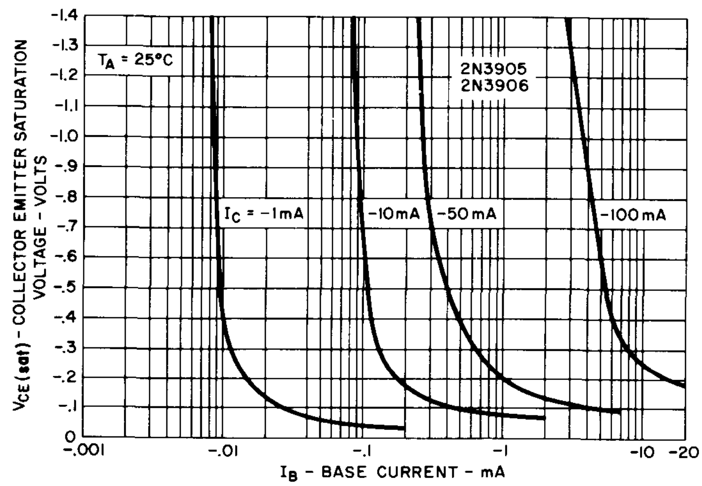
2. TURN-OFF TIME TEST CIRCUIT t_s AND t_f



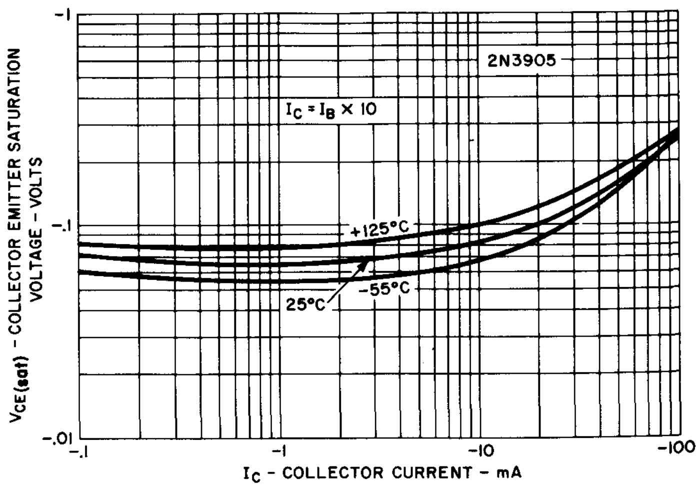
3. FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



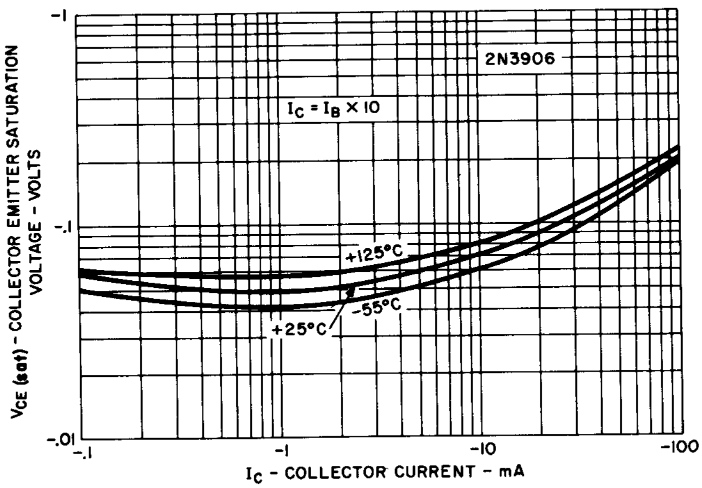
4. FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



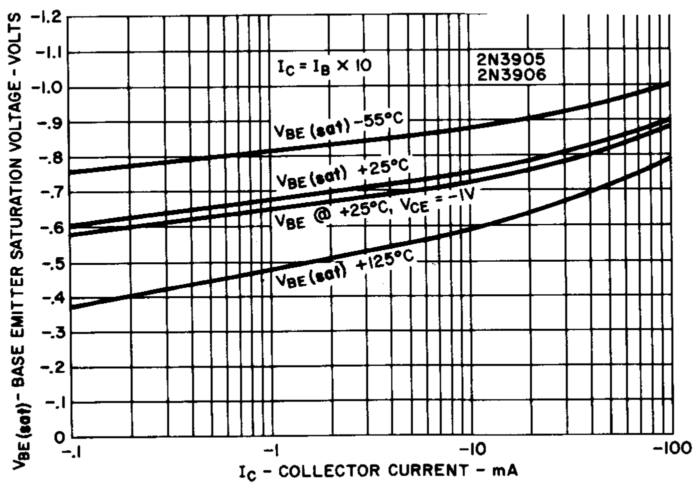
5. COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



6. COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



7. COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

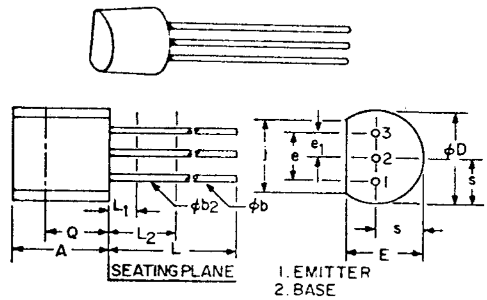


8. BASE EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

Silicon Transistors

NPN

2N4123
2N4124



TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L_1	–	1.270	–	.050	3
L_2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

The General Electric 2N4123 and 2N4124 are NPN Silicon Planar Epitaxial passivated transistors designed for general purpose amplifier applications.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

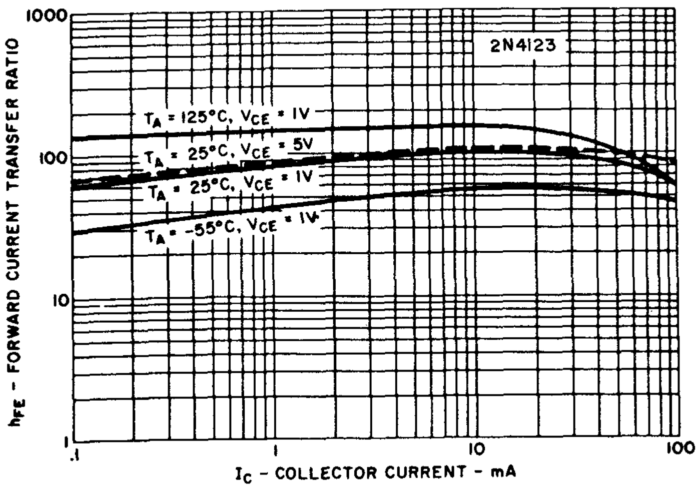
		2N4123	2N4124	
Voltages				
Collector to Emitter	V_{CEO}	30	25	Volts
Collector to Base	V_{CBO}	40	30	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	200	200	mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T	350	350	mW
Derate Factor $T_A > 25°C$	P_T	2.8	2.8	mW/°C
Total Power $T_C \leq 25°C$	P_T	1	1	Watt
Derate Factor $T_C > 25°C$	P_T	8	8	mW/°C
Temperature				
Operating	T_J	-55°C to +150°C		°C
Storage	T_{STG}	-55°C to +150°C		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260°C		°C

*electrical characteristics: (T_A = 25°C unless otherwise specified)

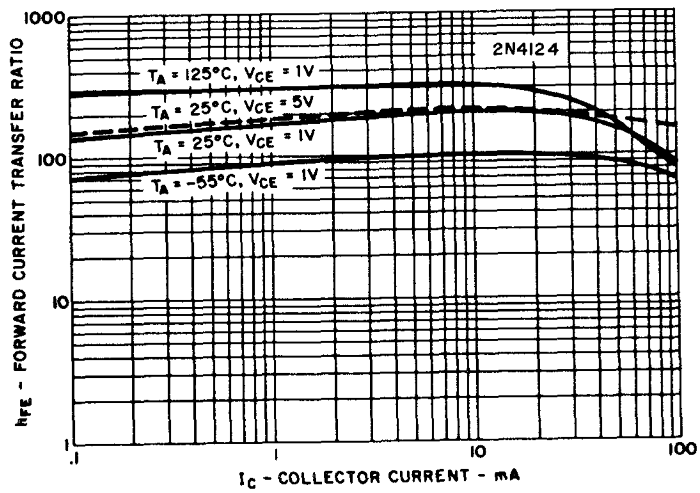
Static Characteristics		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	– 2N4123	$V_{(BR)CEO}$	30	–	Volts
Collector-Emitter Breakdown Voltage (I_C = 1 mA, V_{BE} = 0)	– 2N4124	$V_{(BR)CEO}$	25	–	Volts
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	– 2N4123	$V_{(BR)CBO}$	40	–	Volts
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	– 2N4124	$V_{(BR)CBO}$	30	–	Volts
Emitter-Base Breakdown Voltage (I_E = 10 μA, I_C = 0)		$V_{(BR)EBO}$	5	–	Volts
Collector Cutoff Current (V_{CB} = 20V, I_E = 0)		I_{CBO}	–	50	ηA
Emitter-Base Reverse Current (V_{EB} = 3V, I_C = 0)		I_{EBO}	–	50	ηA
Forward Current Transfer Ratio					
(V_{CE} = 1V, I_C = 2 mA)	– 2N4123	h_{FE}	50	150	
(V_{CE} = 1V, I_C = 2 mA)	– 2N4124	h_{FE}	120	360	
(V_{CE} = 1V, I_C = 50 mA)	– 2N4123	†h_{FE}	25	–	
(V_{CE} = 1V, I_C = 50 mA)	– 2N4124	†h_{FE}	60	–	

Static Characteristics (continued)	SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5 mA)	†$V_{CE(sat)}$	–	.3	Volts
Base-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5 mA)	†$V_{BE(sat)}$	–	.95	Volts
Dynamic Characteristics				
Collector-Base Capacitance (V_{CB} = 5V, I_E = 0, f = 100 KHz)	Cob	–	4	pF
Emitter-Base Capacitance (V_{EB} = .5V, I_E = 0, f = 100 KHz)	Cib	–	8	pF
Gain Bandwidth Product				
(V_{CE} = 20V, I_C = 10 mA, f = 100 MHz) – 2N4123	f_T	250	–	MHz
(V_{CE} = 20V, I_C = 10 mA, f = 100 MHz) – 2N4124	f_T	300	–	MHz
Forward Current Transfer Ratio				
(V_{CE} = 20V, I_C = 10 mA, f = 100 MHz) – 2N4123	hfe	2.5	–	
(V_{CE} = 20V, I_C = 10 mA, f = 100 MHz) – 2N4124	hfe	3	–	
Forward Current Transfer Ratio				
(V_{CE} = 1V, I_C = 2 mA, f = 1 KHz) – 2N4123	hfe	50	200	
(V_{CE} = 1V, I_C = 2 mA, f = 1 KHz) – 2N4124	hfe	120	480	
Noise Figure (Broad Band)				
(I_C = 100 μA, V_{CE} = 5V, Rs = 1 K – 2N4123	NF	–	6	dB
Bandwidth = 10 Hz to 15.7 KHz) – 2N4124	NF	–	5	dB

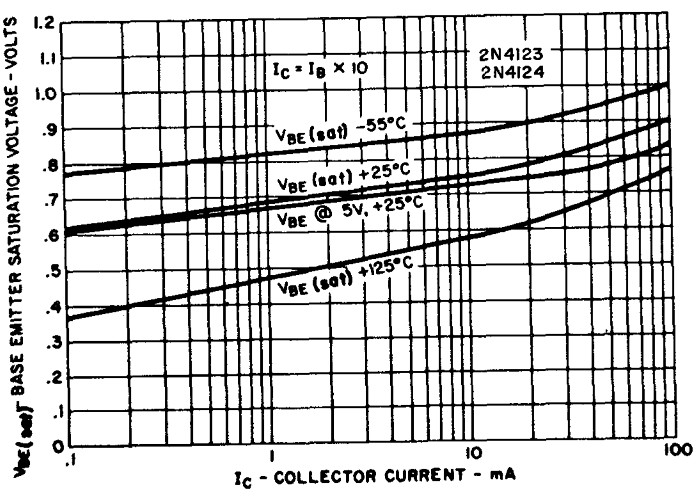
†Pulse Conditions: Pulse Width ⩽ 300μs, Duty Cycle ⩽ 2%.
*Indicates JEDEC Registered Data.



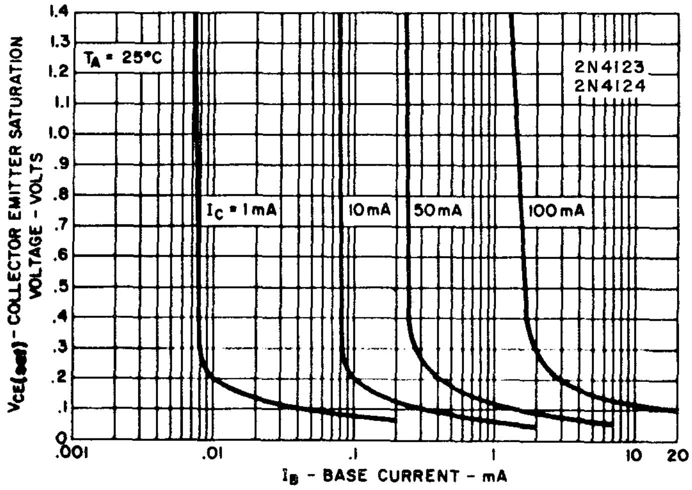
1. FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



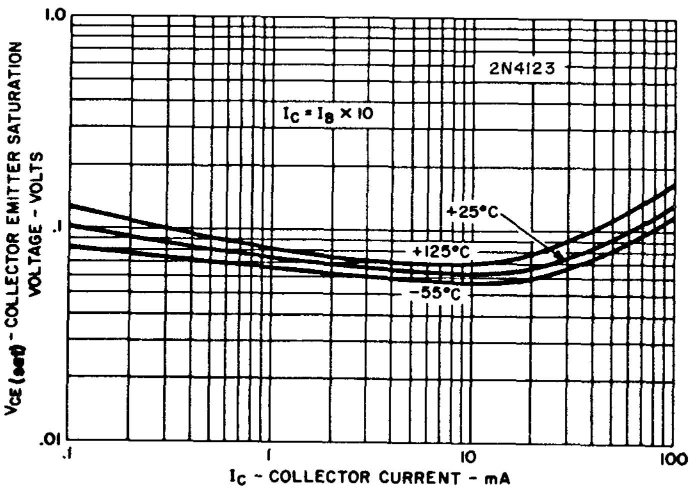
2. FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



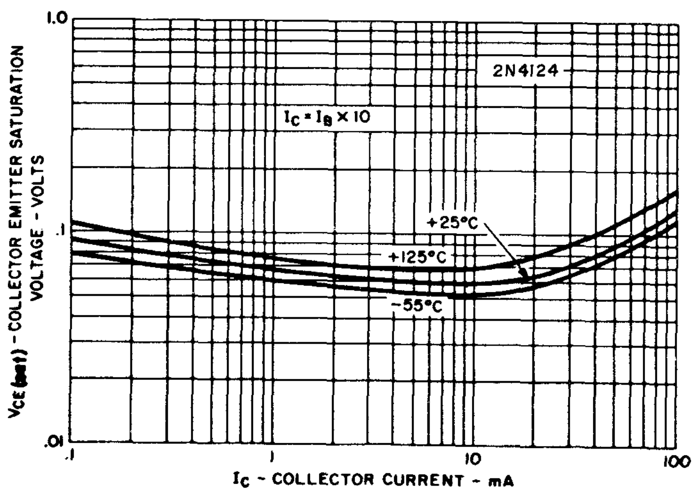
3. BASE EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



4. COLLECTOR EMITTER SATURATION VOLTAGE VS. BASE CURRENT



5. COLLECTOR EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

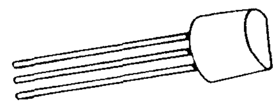


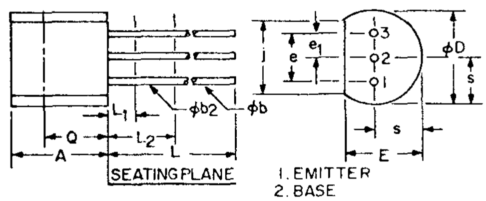
6. COLLECTOR EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

Silicon Transistors

PNP 2N4125 2N4126

The General Electric 2N4125 and 2N4126 are PNP Silicon Planar Epitaxial passivated transistors designed for general purpose amplifier applications. PNP Polarities are negative, observe proper bias.





TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

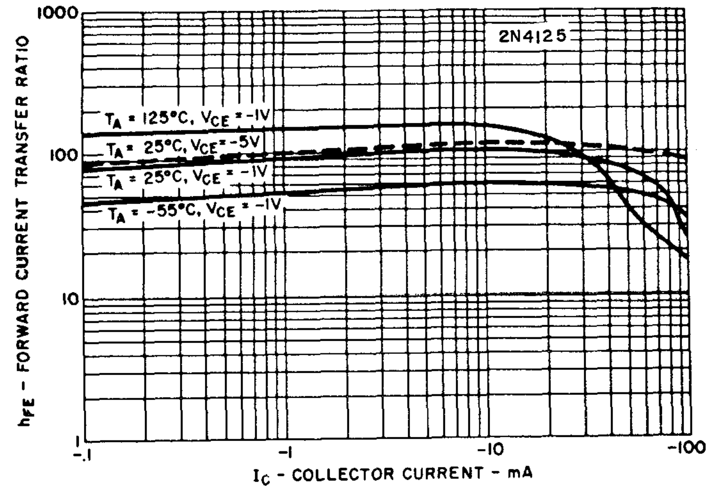
		2N4125	2N4126	
Voltages				
Collector to Emitter	V_{CEO}	30	25	Volts
Collector to Base	V_{CBO}	30	25	Volts
Emitter to Base	V_{EBO}	4	4	Volts
Current				
Collector	I_C	200	200	mA
Dissipation				
Total Power $T_A \leqslant 25°C$	P_T	350	350	mW
Derate Factor $T_A > 25°C$	P_T	2.8	2.8	mW/°C
Total Power $T_C \leqslant 25°C$	P_T	1	1	Watt
Derate Factor $T_C > 25°C$	P_T	8	8	mW/°C
Temperature				
Operating	T_J	-55°C to +150°C		°C
Storage	T_{STG}	-55°C to +150°C		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260°C		°C

*electrical characteristics: (T_A = 25°C unless otherwise specified)

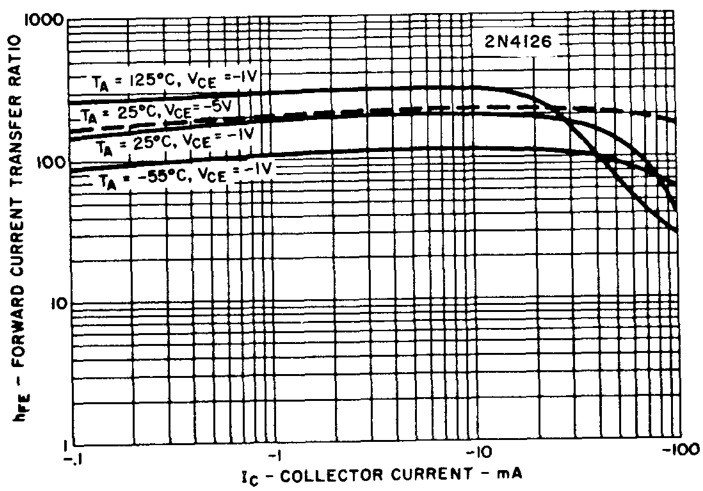
Static Characteristics		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	– 2N4125	$V_{(BR)CEO}$	30	–	Volts
Collector-Emitter Breakdown Voltage (I_C = 1 mA, V_{BE} = 0)	– 2N4126	$V_{(BR)CEO}$	25	–	Volts
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	– 2N4125	$V_{(BR)CBO}$	30	–	Volts
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	– 2N4126	$V_{(BR)CBO}$	25	–	Volts
Emitter-Base Breakdown Voltage (I_E = 10 μA, I_C = 0)		$V_{(BR)EBO}$	4	–	Volts
Collector Cutoff Current (V_{CB} = 20V, I_E = 0)		I_{CBO}	–	50	ηA
Emitter-Base Reverse Current (V_{EB} = 3V, I_C = 0)		I_{EBO}	–	50	ηA
Forward Current Transfer Ratio					
(V_{CE} = 1V, I_C = 2 mA)	– 2N4125	h_{FE}	50	150	
(V_{CE} = 1V, I_C = 2 mA)	– 2N4126	h_{FE}	120	360	
(V_{CE} = 1V, I_C = 50 mA)	– 2N4125	†h_{FE}	25	–	
(V_{CE} = 1V, I_C = 50 mA)	– 2N4126	†h_{FE}	60	–	

Static Characteristics (continued)	SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5 mA)	†$V_{CE(sat)}$	–	.4	Volts
Base-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5 mA)	†$V_{BE(sat)}$	–	.95	Volts
Dynamic Characteristics				
Collector-Base Capacitance (V_{CB} = 5V, I_E = 0, f = 100 kHz)	Ccb	–	4.5	pF
Emitter-Base Capacitance (V_{EB} = .5V, I_C = 0, f = 100 kHz)	Cib	–	10	pF
Gain Bandwidth Product				
(V_{CE} = 20V, I_C = 10 mA, f = 100 MHz) – 2N4125	f_T	200	–	MHz
(V_{CE} = 20V, I_C = 10 mA, f = 100 MHz) – 2N4126	f_T	250	–	MHz
Forward Current Transfer Ratio				
(V_{CE} = 20V, I_C = 10 mA, f = 100 MHz) – 2N4125	hfe	2	-	
(V_{CE} = 20V, I_C = 10 mA, f = 100 MHz) – 2N4126	hfe	2.5	–	
Forward Current Transfer Ratio				
(V_{CE} = 1V, I_C = 2 mA, f = 1 KHz) – 2N4125	hfe	50	200	
(V_{CE} = 1V, I_C = 2 mA, f = 1 KHz) – 2N4126	hfe	120	480	
Noise Figure (Broad Band)				
(I_C = 100 μA, V_{CE} = 5V, Rs = 1 KΩ – 2N4125	NF	–	5	dB
Bandwidth = 10 Hz to 15.7 KHz) – 2N4126	NF	–	4	dB

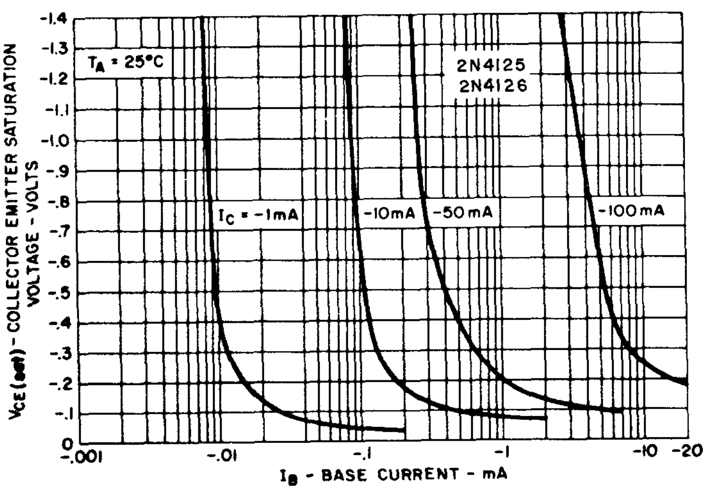
†Pulse Conditions: Pulse Width ⩽ 300 μs, Duty Cycle ⩽ 2%.
*Indicates JEDEC Registered Data.



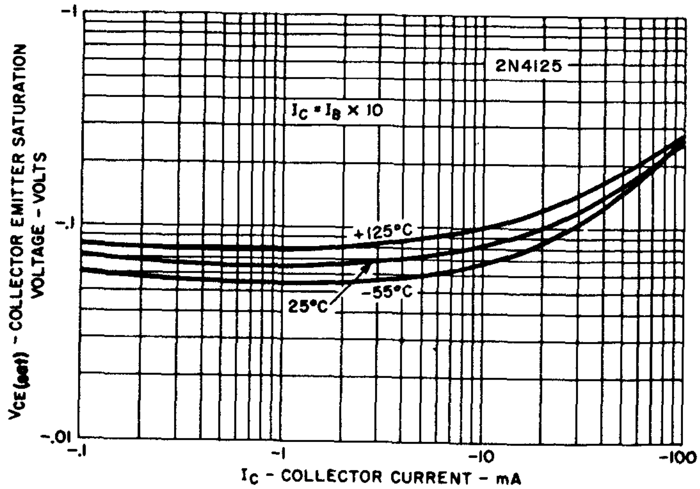
1. FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



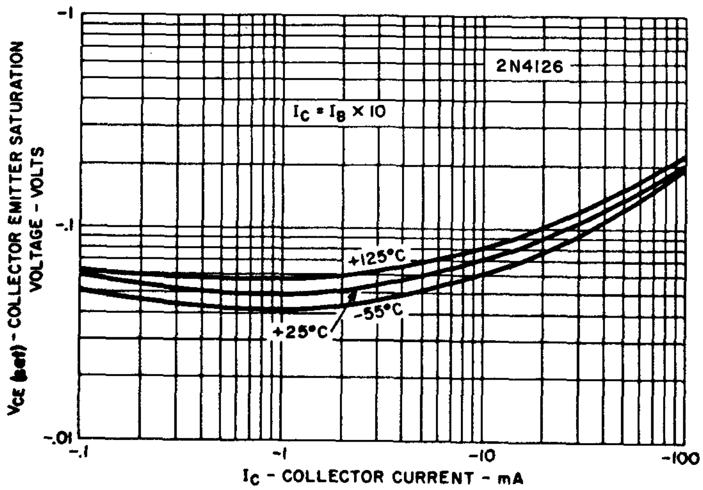
2. FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



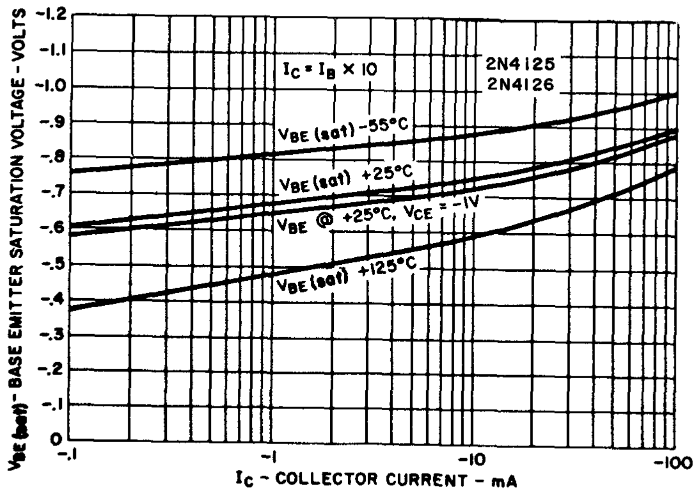
3. COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



4. COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



5. COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



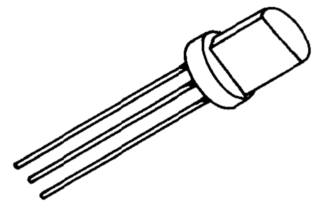
6. BASE EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

Silicon Transistor

NPN

2N4256

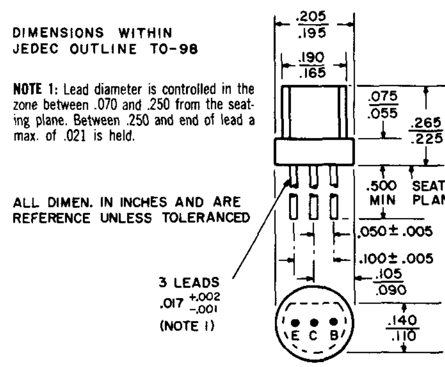
The General Electric 2N4256 is a planar epitaxial, passivated NPN transistor characterized for low level medium speed switching applications in industrial circuits. This transistor features a high current transfer ratio over a wide range of collector current, a low collector saturation voltage, and a guaranteed stored base charge.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages		
Collector to Emitter	V_{CES}	30 Volts
Emitter to Base	V_{EBO}	5 Volts
Collector to Base	V_{CBO}	30 Volts
Current		
Collector (Steady State)*	I_C	100 mA
Dissipation		
Total Power (Free air at 25°C)†	P_T	360 mW
Total Power (Free air at 55°C)†	P_T	250 mW
Temperature		
Storage	T_{STG}	—55 to 125°C
Operating	T_J	125°C
Lead Soldering, 1/16″ ± 1/32″ from case for 10 sec. max.	T_L	260°C

- Low Cost
- High Beta
- Low $V_{CE(SAT)}$
- Rugged Encapsulation



*Determined from power limitations due to saturation voltage at this current.

†Derate 2.67 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS

		Min.	Typ.	Max.	Units
Collector to Base Breakdown Voltage ($I_C = 100\mu A$)	V_{CBO}	30			V
Collector to Emitter Breakdown Voltage ($V_{EB} = 0, I_C = 1mA$)	V_{CES}	30			V
Emitter to Base Breakdown Voltage ($I_E = 100\mu A$)	V_{EBO}	5			V
Forward Current Transfer Ratio ($I_C = 2mA, V_{CE} = 4.5V$)	h_{FE}	100	220	500	
Forward Current Transfer Ratio ($I_C = 10mA, V_{CE} = 0.2V$)	h_{FE}	60	120		
Forward Current Transfer Ratio ($I_C = 50mA, V_{CE} = 0.2V$)	h_{FE}	20			

2N4256

STATIC CHARACTERISTICS

		Min.	Typ.	Max.	Units
Collector-Emitter Saturation Voltage ($I_C = 0.1$ to $10mA$, $I_B = I_C/50$)	$V_{CE(SAT)}$		0.16	0.20	V
Collector-Emitter Saturation Voltage ($I_C = 50mA$, $I_B = 2.5mA$)	$V_{CE(SAT)}$		0.14	0.20	V
Base-Emitter Saturation Voltage ($I_C = 50mA$, $I_B = 2.5mA$)	$V_{BE(SAT)}$		0.82	0.92	V
Collector Cutoff Current ($V_{CB} = 30V$)	I_{CBO}		0.1	500	nA
Collector Cutoff Current ($V_{CB} = 18V$, $T_A = 100°C$)	I_{CBO}			15	μA
Collector Cutoff Current ($V_{CE} = 30V$, $V_{EB} = 0$)	I_{CES}		0.1	500	nA
Emitter Cutoff Current ($V_{EB} = 5V$)	I_{EBO}		0.1	500	nA

DYNAMIC CHARACTERISTICS

		Min.	Typ.	Max.	Units
Collector Capacitance ($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{ob}		2.7	4.0	pF
Transition Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, $f = 1$ MHz)	C_{ib}		10		pF
Stored Base Charge (Circuit 1) ($I_B = 0.32mA$, $I_C = 10mA$)	Q_{SB}		250	600	pC
Gain Bandwidth product ($V_{CE} = 1V$, $I_C = 10mA$)	f_T		200		MHz
Turn-on Time (Figure 1) ($I_C = 10mA$)	t_{on}		4.0		nS
Turn-off Time (Figure 1) ($I_C = 10mA$)	t_{off}		40	100	nS
Turn-on Time (Figure 2) ($I_C = 10mA$, $I_{B1} = 0.32mA$, $I_{B2} = 54\mu A$)	t_{on}			180	nS
Turn-off Time (Figure 2) ($I_C = 10mA$, $I_{B1} = 0.32mA$, $I_{B2} = 54\mu A$)	t_{off}		2.5	3.5	μS

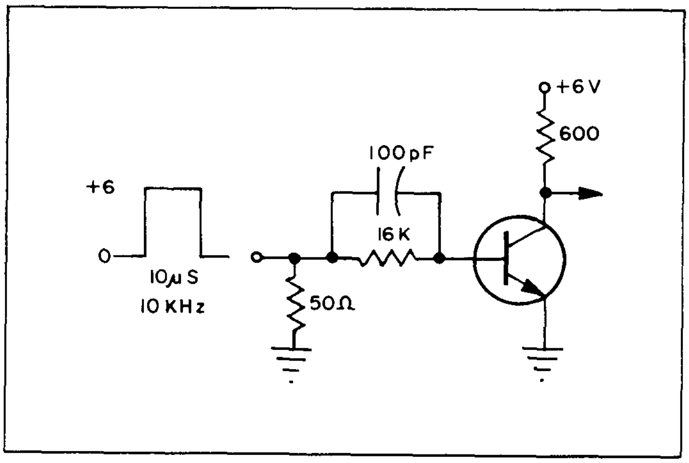


Figure 1

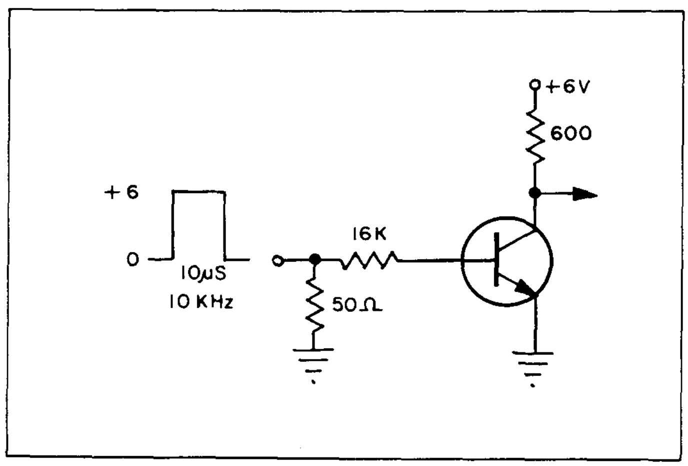


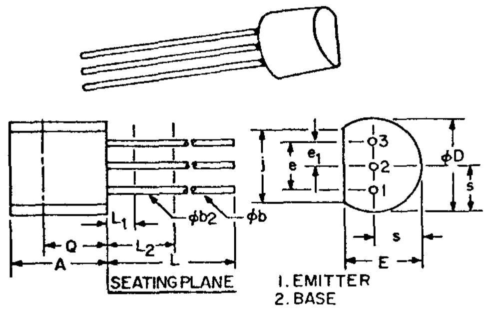
Figure 2

Q_{SB} measured in circuit of Figure 1, the capacitor is adjusted to give a turn off time of 100nS, and Q_{SB} is calculated from the equation $Q_{SB} = 6C$.

Silicon Transistors

NPN 2N4400 2N4401

The General Electric 2N4400 and 2N4401 are silicon NPN planar epitaxial passivated transistors designed for general purpose switching and amplifier applications.



TO-92

1. EMITTER
2. BASE
3. COLLECTOR

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

VOLTAGES			
Collector to Emitter	V_{CEO}	40	Volts
Collector to Base	V_{CBO}	60	Volts
Emitter to Base	V_{EBO}	6	Volts
CURRENT			
Collector	I_C	600	mA
DISSIPATION			
Total Power $T_A \leq 25°C$	P_T	350	m Watts
Total Power $T_C \leq 25°C$	P_T	1000	m Watts
Derate Factor $T_A > 25°C$		2.8	mW/°C
Derate Factor $T_C > 25°C$		8.0	mW/°C
TEMPERATURE			
Operating	T_J	-55 to +150	°C
Storage	T_{STG}	-55 to +150	°C
Lead (1/16" ± 1/32" From Case for 10 sec.)	T_L	+230	°C

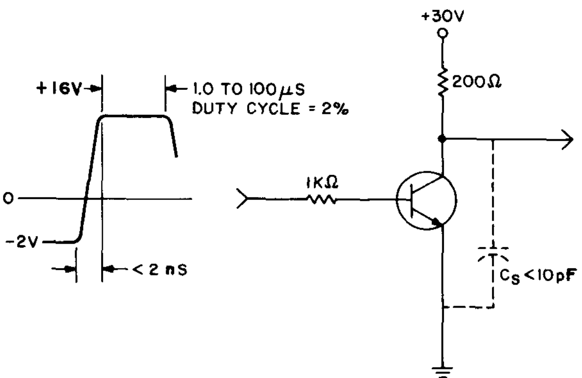
* electrical characteristics: (T_A = 25°C unless otherwise specified)

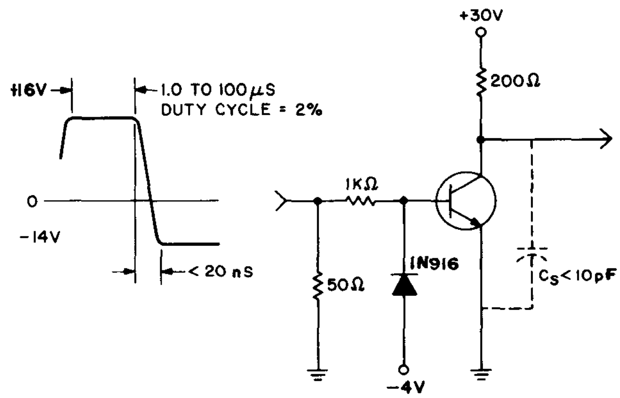
STATIC CHARACTERISTICS	SYMBOL	2N4400 MIN.	2N4400 MAX.	2N4401 MIN.	2N4401 MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1mA, I_B = 0)	$V_{(BR)CEO}$	40	–	40	–	Volts
Collector-Base Breakdown Voltage (I_C = 100μA, I_E = 0)	$V_{(BR)CBO}$	60	–	60	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100μA, I_C = 0)	$V_{(BR)EBO}$	6	–	6	–	Volts
Collector Cutoff Current (V_{CE} = 35V, V_{EB} (off) = .4V)	I_{CEV}	–	100	–	100	nA
Base Cutoff Current (V_{CE} = 35V, V_{EB} (off) = .4V)	I_{BEV}	–	100	–	100	nA
Forward Current Transfer Ratio						
(V_{CE} = 1V, I_C = .1mA)	h_{FE}	–	–	20	–	
(V_{CE} = 1V, I_C = 1.0mA)	h_{FE}	20	–	40	–	
(V_{CE} = 1V, I_C = 10mA)	†h_{FE}	40	–	80	–	
(V_{CE} = 1V, I_C = 150mA)	†h_{FE}	50	150	100	300	
(V_{CE} = 2V, I_C = 500mA)	†h_{FE}	20	–	30	–	
Collector-Emitter Saturation Voltage						
(I_C = 150mA, I_B = 15mA)	†$V_{CE(sat)}$	–	.4	–	.4	Volts
(I_C = 500mA, I_B = 50mA)	†$V_{CE(sat)}$	–	.75	–	.75	Volts

STATIC CHARACTERISTICS (Continued)	SYMBOL	2N4400 MIN.	2N4400 MAX.	2N4401 MIN.	2N4401 MAX.	UNITS
Base-Emitter Saturation Voltage						
(I_C = 150mA, I_B = 15mA)	†$V_{BE(sat)}$	.75	.95	.75	.95	Volts
(I_C = 500mA, I_B = 50mA)	†$V_{BE(sat)}$	–	1.2	–	1.2	Volts
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance						
(V_{CB} = 5V, I_E = 0,f = 1 MHz)	C_{CB}	–	6.5	–	6.5	pF
Emitter-Base Capacitance						
(V_{EB} = .5V, I_C = 0,f = 1 MHz)	C_{EB}	–	30	–	30	pF
Gain Bandwidth Product						
(V_{CE} = 10V, I_C = 20mA, f = 100 MHz)	f_t	–	200	–	250	MHz
Forward Current Transfer Ratio						
(V_{CE} = 10V, I_C = 1mA, f = 1 kHz)	h_{fe}	20	250	40	500	
Output Admittance						
(V_{CE} = 10V, I_C = 1mA, f = 1 kHz)	h_{oe}	1	30	1	30	μ mhos
Input Impedance						
(V_{CE} = 10V, I_C = 1mA, f = 1 kHz)	h_{ie}	.5	.75	1	15	kΩ
Voltage Feedback Ratio						
(V_{CE} = 10V, 1mA, f = 1 kHz)	h_{re}	.1	8	.1	8	$X10^{-4}$
SWITCHING CHARACTERISTICS						
Delay Time	t_d	–	15	–	15	ns
Rise Time	t_r	–	20	–	20	ns
(I_C = 150mA, I_{B1} = 15mA)						
(V_{CE} = 30, V_{EB} (off) = 2V)						
Storage Time	t_s	–	225	–	225	ns
Fall Time	t_f	–	30	–	30	ns
(I_{B1} = I_{B2} = 15 mA)						
(V_{CE} = 30V, I_C = 150 mA)						

†Pulse Conditions: Pulse width ⩽ 300 μsec., Duty Cycle ⩽ 2%.
*JEDEC Registered Parameters.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

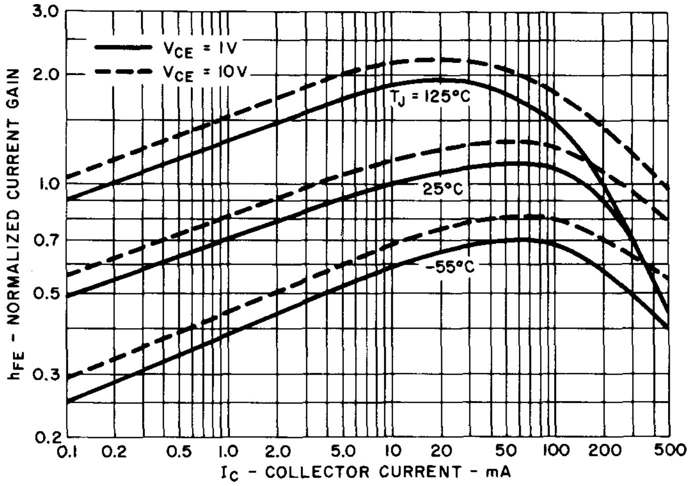




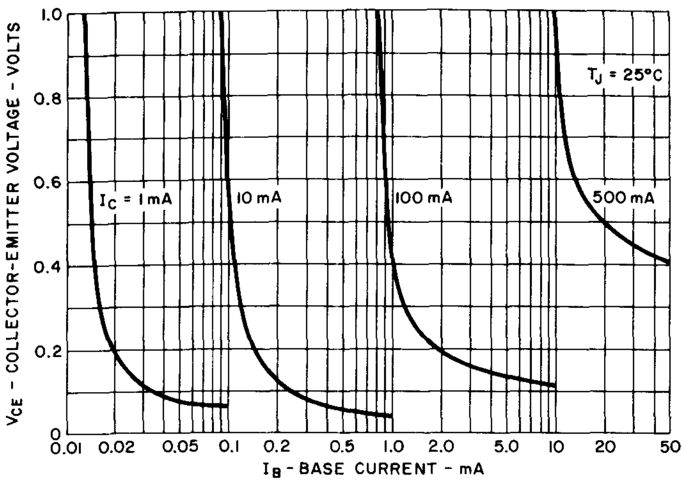
Scope Rise Time < 4ns
C_s is Total Shunt Capacitance of Test Jigs, Connectors and Oscilloscope.

1. TURN-ON TIME

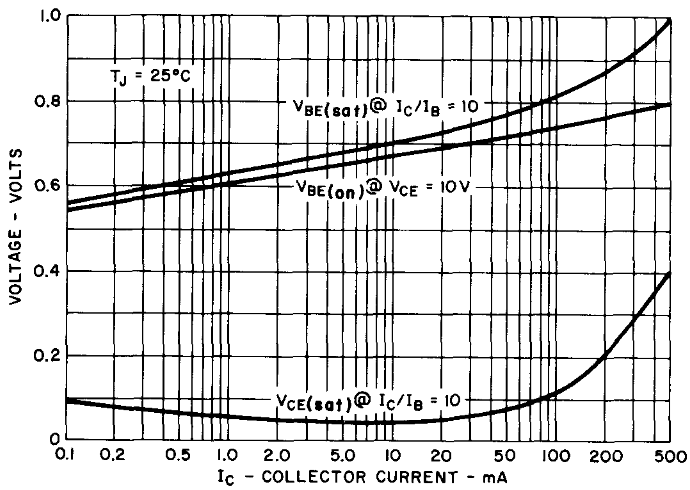
2. TURN-OFF TIME



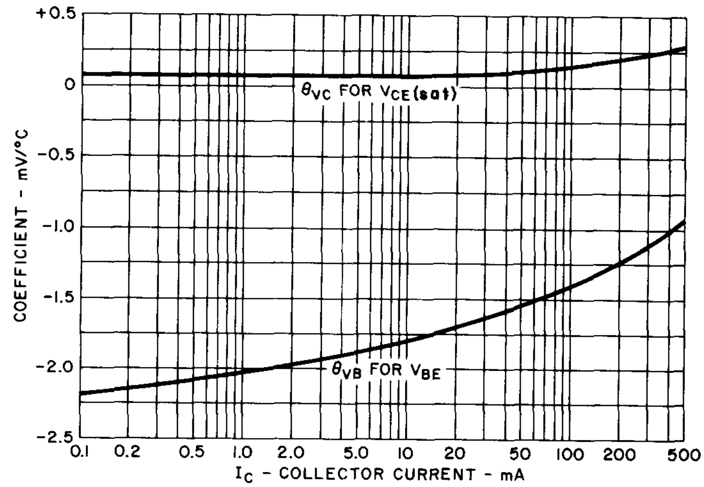
3. DC CURRENT GAIN



4. COLLECTOR SATURATION REGION



5. "ON" VOLTAGES

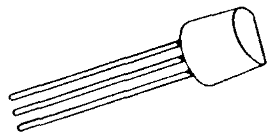


6. TEMPERATURE COEFFICIENTS

Silicon Transistors

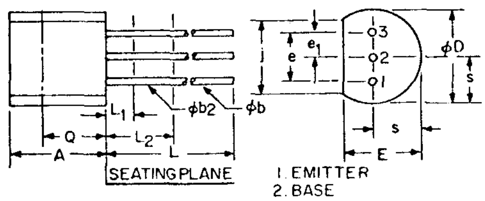
PNP

2N4402
2N4403



The General Electric 2N4402 and 2N4403 are silicon PNP planar epitaxial passivated transistors designed for general purpose switching and amplifier applications.

Current and voltage values for PNP are negative. Observe proper bias polarity.



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

VOLTAGES			
Collector to Emitter	V_{CEO}	40	Volts
Collector to Base	V_{CBO}	40	Volts
Emitter to Base	V_{EBO}	5	Volts
CURRENT			
Collector	I_C	600	mA
DISSIPATION			
Total Power $T_A \leq 25°C$	P_T	350	m Watts
Total Power $T_C \leq 25°C$	P_T	1000	m Watts
Derate Factor $T_A > 25°C$		2.8	mW/°C
Derate Factor $T_C > 25°C$		8.0	mW/°C
TEMPERATURE			
Operating	T_J	-55°C to +150°C	°C
Storage	$T_{STG.}$	-55°C to +150°C	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230°C	°C

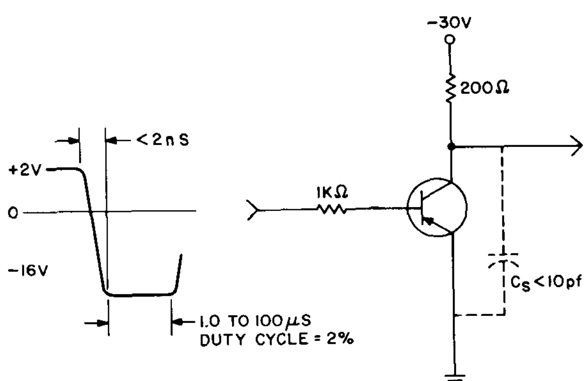
* electrical characteristics: (T_A = 25°C unless otherwise specified)

STATIC CHARACTERISTICS	SYMBOL	2N4402 MIN.	2N4402 MAX.	2N4403 MIN.	2N4403 MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1mA, I_B = 0)	$V_{(BR)CEO}$	40	–	40	–	Volts
Collector-Base Breakdown Voltage (I_C = 100μA, I_E = 0)	$V_{(BR)CBO}$	40	–	40	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100μA, I_C = 0)	$V_{(BR)EBO}$	5	–	5	–	Volts
Collector Cutoff Current (V_{CE} = 35V, V_{EB} (off) = .4V)	I_{CEV}	–	100	–	100	nA
Base Cutoff Current (V_{CE} = 35V, V_{EB} (off) = .4V)	I_{BEV}	–	100	–	100	nA
Forward Current Transfer Ratio						
(V_{CE} = 1V, I_C = .1mA)	h_{FE}	–	–	30	–	
(V_{CE} = 1V, I_C = 1mA)	h_{FE}	30	–	60	–	
(V_{CE} = 1V, I_C = 10mA)	†h_{FE}	50	–	100	–	
(V_{CE} = 2V, I_C = 150mA)	†h_{FE}	50	150	100	300	
(V_{CE} = 2V, I_C = 500mA)	†h_{FE}	20	–	20	–	

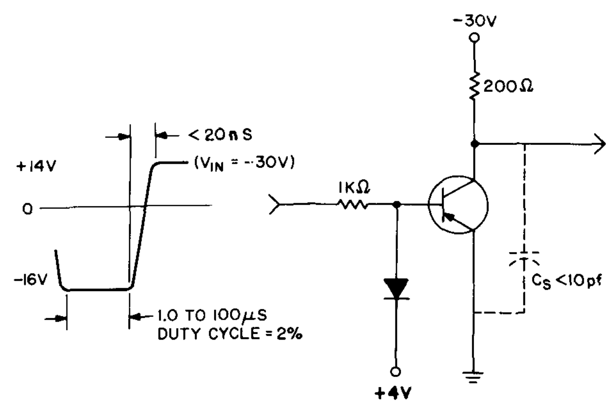
STATIC CHARACTERISTICS (Continued)	SYMBOL	2N4402 MIN.	2N4402 MAX.	2N4403 MIN.	2N4403 MAX.	UNITS
Collector-Emitter Saturation Voltage						
(I_C = 150mA, I_B = 15mA)	†$V_{CE(sat)}$	–	.4	–	.4	Volts
(I_C = 500mA, I_B = 50mA)	†$V_{CE(sat)}$	–	.75	–	.75	Volts
Base-Emitter Saturation Voltage						
(I_C = 150mA, I_B = 15mA)	†$V_{BE(sat)}$	.75	.95	.75	.95	Volts
(I_C = 500mA, I_B = 50mA)	†$V_{BE(sat)}$	–	1.3	–	1.3	Volts
DYNAMIC CHARACTERISTICS						
Collector Base Capacitance						
(V_{CB} = 10V, I_E = O,f = 1 MHz)	C_{cb}	–	8.5	–	8.5	pF
Emitter-Base Capacitance						
(V_{EB} = .5V, I_C = O,f = 1 MHz)	C_{eb}	–	30	–	30	pF
Gain Bandwidth Product						
(V_{CE} = 10V, I_C = 20mA, f = 100 MHz)	f_T	150	–	200	–	MHz
Forward Current Transfer Ratio						
(V_{CE} = 10V, I_C = 1mA, f = 1 kHz)	h_{fe}	30	250	60	500	
Input Impedance						
(I_C = 1mA, V_{CE} = 10V, f = 1 kHz)	h_{ie}	750	7.5k	1.5k	15k	Ohms
Voltage Feedback Ratio						
(I_C = 1mA, V_{CE} = 10V, f = 1 kHz)	h_{re}	.1	8	.1	8	$X10^{-4}$
Output Admittance						
(I_C = 1mA, V_{CE} = 10V, f = 1 kHz)	h_{oe}	1	100	1	100	μmhos
SWITCHING CHARACTERISTICS						
Delay Time	t_d	–	15	–	15	ns
Rise Time (I_C = 150mA, I_{B1} = 15 mA) (V_{CE} = 30, V_{EB} (off) = 2V)	t_r	–	20	–	20	ns
Storage Time	t_s	–	225	–	225	ns
Fall Time (I_{B1} = I_{B2} = 15 mA) (V_{CE} = 30V, I_C = 150mA)	t_f	–	30	–	30	ns

†Pulse width ⩽= 300 μsec., Duty Cycle ⩽ 2%.
*JEDEC Registered Parameters.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

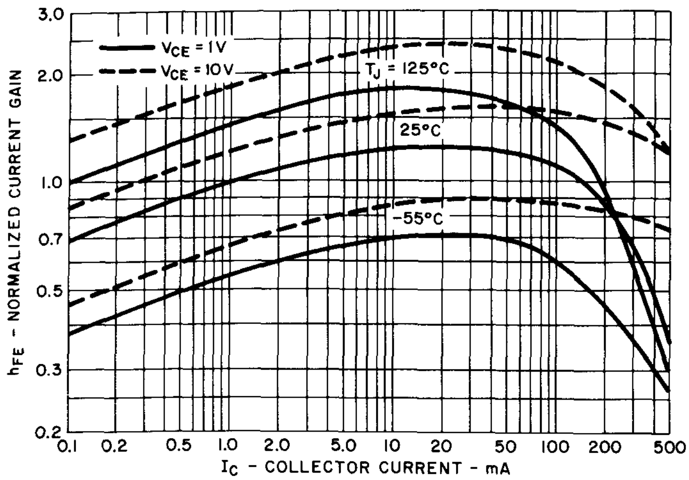


1. TURN-ON TIME

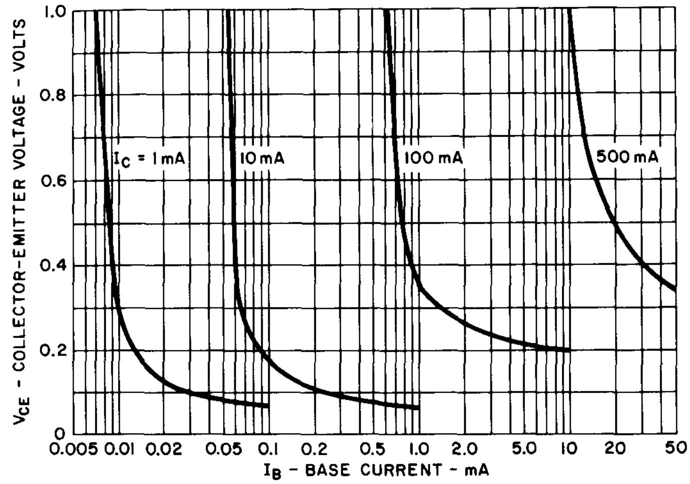


2. TURN-OFF TIME

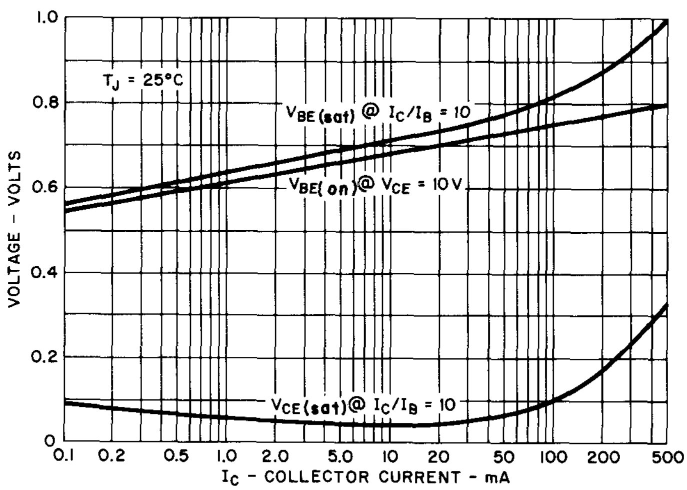
Scope Rise Time < 4nS.
C_s = Total Shunt Capacitance of Test Jig Connectors and Oscilloscope.



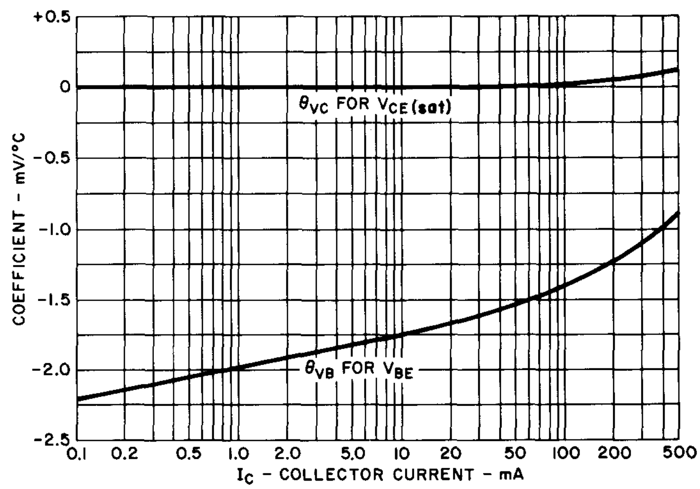
3. DC CURRENT GAIN



4. COLLECTOR SATURATION REGION



5. SATURATION VOLTAGE AND V_{BE} (on)



6. TEMPERATURE COEFFICIENTS

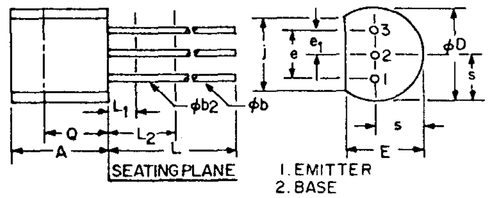
Silicon Transistors

2N4409
2N4410

The General Electric 2N4409 and 2N4410 are Silicon NPN Planar Epitaxial Passivated Transistors designed for high voltage amplifier applications and for Neon Display Tube Drivers.

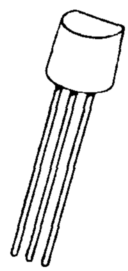
absolute maximum ratings:* (T_A = 25°C unless otherwise specified)

		2N4409	2N4410	
Voltages				
Collector to Emitter	V_{CEO}	50	80	Volts
Collector to Base	V_{CBO}	80	120	Volts
Emitter to Base	V_{EBO}	6	6	Volts
Current				
Collector	I_C	250	250	mA
Dissipation				
Total Power $T_A \leqslant 25°C$	P_T	625	625	mWatt
Total Power $T_C \leqslant 25°C$	P_T	1.5	1.5	Watts
Derating Factor $T_A > 25°C$	P_T	5	5	mW/°C
Derating Factor $T_C > 25°C$	P_T	12	12	mW/°C
Temperature				
Storage	T_{stg}	-55 to +150		°C
Operating	T_J	-55 to +150		°C
Lead (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260		°C



1. EMITTER
2. BASE
3. COLLECTOR

TO-92



SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	–	.050	3
L_2	6.350	—	.250	–	3
Q	2.920	—	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

electrical characteristics:*(T_A = 25°C unless otherwise specified)

Static Characteristics*	SYMBOL	2N4409 MIN.	2N4409 MAX.	2N4410 MIN.	2N4410 MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	$V_{(BR)CEO}$	50	–	80	–	Volts
Collector-Emitter Breakdown Voltage (I_C = 500 μA, $V_{BE(off)}$ = 5V, R_{BE} = 8.2 K Ohms)	$V_{(BR)CER}$	80	–	120	–	Volts
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	$V_{(BR)CBO}$	80	–	120	–	Volts
Emitter-Base Breakdown Voltage (I_E = 10 μA, I_C = 0)	$V_{(BR)EBO}$	5	–	5	–	Volts
Collector Cutoff Current						
(V_{CB} = 60V, I_E = 0)	I_{CBO}	–	10	–	–	nA
(V_{CB} = 60V, I_E = 0, T_A = 100°C)	I_{CBO}	–	1.0	–	–	μA
(V_{CB} = 100V, I_E = 0)	I_{CBO}	–	–	–	10	nA
(V_{CB} = 100V, I_E = 0, T_A = 100°C)	I_{CBO}	–	–	–	1.0	μA
Emitter Cutoff Current (V_{BE} = 4V, I_C = 0)	I_{EBO}	–	100	–	100	nA
Forward Current Transfer Ratio						
(V_{CE} = 1V, I_C = 1 mA)	h_{FE}	60	–	60	–	
(V_{CE} = 1V, I_C = 10 mA)	h_{FE}	40	400	60	400	
Collector-Emitter Saturation Voltage (I_C = 1 mA, I_B = 0.1 mA)	$V_{CE(sat)}$	–	0.2	–	0.2	Volts
Base-Emitter Saturation Voltage (I_C = 1 mA, I_B = 0.1 mA)	$V_{BE(sat)}$	–	0.8	–	0.8	Volts
Base-Emitter Voltage (I_C = 1 mA, V_{CE} = 5V)	$V_{BE(on)}$	–	0.8	–	0.8	Volts

Static Characteristics (continued)

Dynamic Characteristics	SYMBOL	2N4409 MIN.	2N4409 MAX.	2N4410 MIN.	2N4410 MAX.	UNITS
Current-Gain – Bandwidth Product (I_C = 10 mA, V_{CE} = 10V, f = 30 MHz)	*f_T	60	300	60	300	MHz
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 140 kHz)	*C_{cb}	–	12	–	12	pF
Emitter-Base Capacitance (V_{BE} = 0.5V, I_C = 0, f = 140 kHz)	C_{eb}	–	50	–	50	pF

*Indicates JEDEC Registered Data.

Silicon Transistors

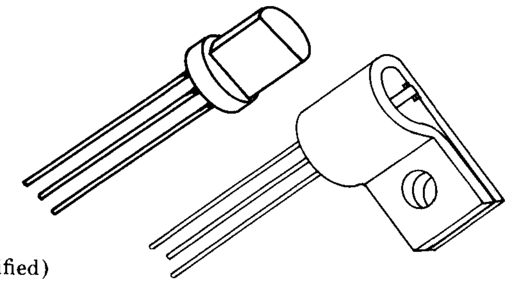
NPN

2N4424,5

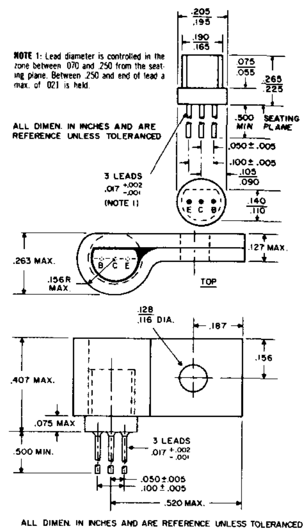
The General Electric 2N4424 and 2N4425 types are NPN, silicon, planar, passivated, epitaxial transistors intended for general purpose industrial circuits. These transistors are especially suited for high level linear amplifiers or medium speed switching circuits in industrial control applications.

FEATURES:

- **Low Saturation Voltage**
- **High Beta**
- **900 mW @ 25°C Case . . . 2N4424**
- **360 mW @ 25°C Free Air 2N4425**



absolute maximum ratings: (25°C) (unless otherwise specified)



		2N4424	2N4425	
Voltages				
Collector to Emitter	V_{CEO}	40	40	V
Emitter to Base	V_{EBO}	5	5	V
Collector to Base	V_{CBO}	60	60	V
Current				
Collector (Steady State)*	I_C	500	500	mA
Dissipation				
Total Power (Free Air at 25°C)**	P_T	360	560	mW
Total Power (Free Air at 65°C)**	P_T	250	380	mW
Total Power (Heatsink at 25°C)***	P_T	—	900	mW
Temperature				
Storage	T_{stg}	−55 to +150		°C
Operating	T_J		+150	°C
Lead soldering, 1/16" ± 1/32" from case for 10 sec. max.	T_L		+260	°C

*Determined from power limitations due to saturation voltage at this current.
**Derate 2.88mW/°C increase in ambient temperature above 25°C.
***Derate 7.2 mW/°C for rise in heatsink temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

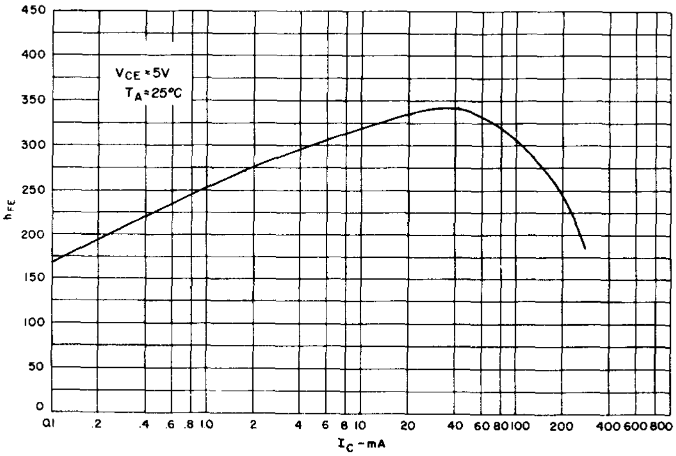
DC CHARACTERISTICS

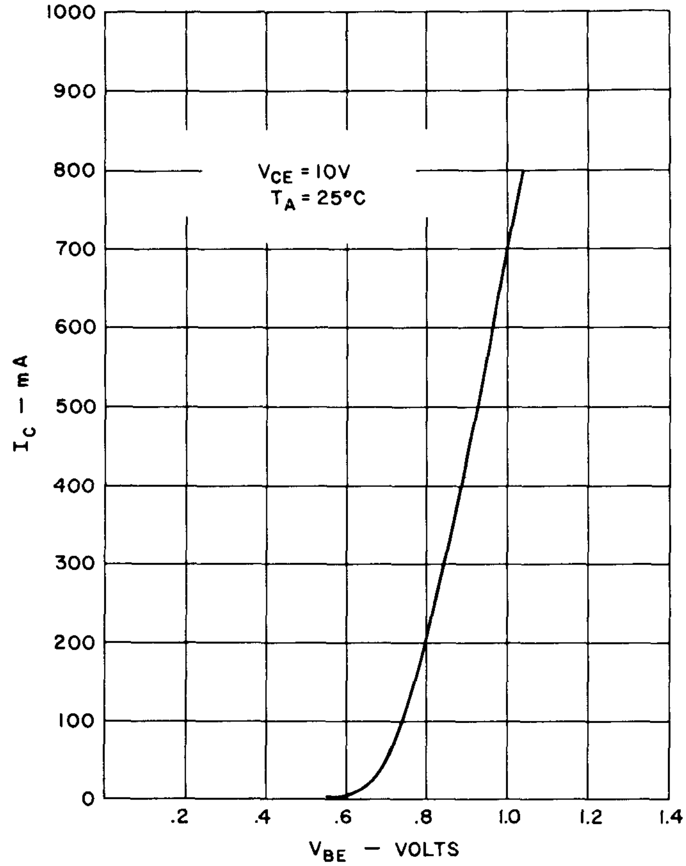
		Min.	Max.	
Collector Cutoff Current (V_{CB} = 40V)	I_{CBO}		30	nA
(V_{CB} = 40V, T_A = 100°C)	I_{CBO}		10	μA
(V_{CB} = 40V)	I_{CES}		30	nA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}		100	nA
Forward Current Transfer Ratio (V_{CE} = 4.5V, I_C = 2 mA)	h_{FE}	180	540	
Collector Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$	40		V
Collector Base Breakdown Voltage (I_C = 10 μA)	$V_{(BR)CBO}$	60		V
Emitter Base Breakdown Voltage (I_E =0.1 μA)	$V_{(BR)EBO}$	5		V
Collector Saturation Voltage (I_B = 3 mA, I_C = 50 mA)	$V_{CE(sat)}$		.30	V
Base Saturation Voltage (I_B = 3 mA, I_C = 50 mA)	$V_{BE(sat)}$		.85	V

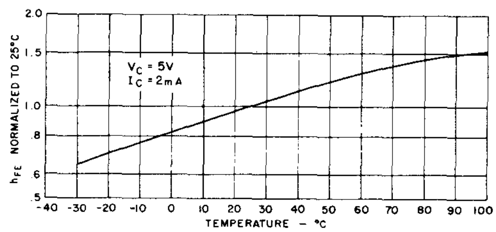
SMALL SIGNAL CHARACTERISTICS

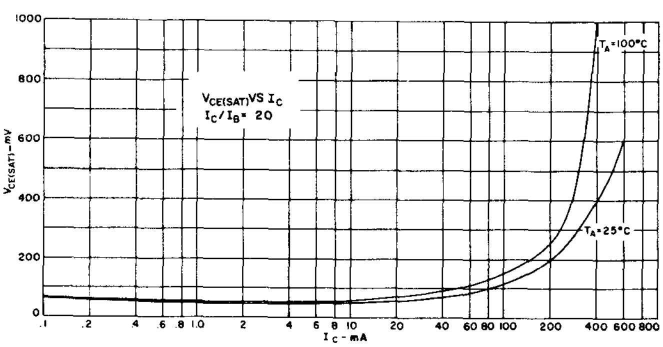
		Min.		
Forward Current Transfer Ratio Collector Voltage (V_C = 4.5V, I_C = 2 mA, f = 1 kHz)	h_{fe}	180		

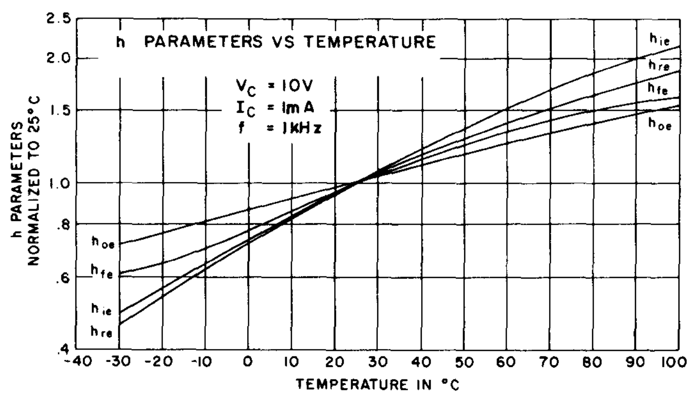
			Typical	
Forward Current Transfer Ratio	(V_{CE} = 10V, I_C = 1 mA, f = 1 kHz, T_A = 25°C)	h_{fe}	180	
Input Impedance		h_{ie}	5100	ohms
Output Admittance		h_{oe}	14	μmhos
Voltage Feedback Ratio		h_{re}	.27	$\times 10^{-3}$

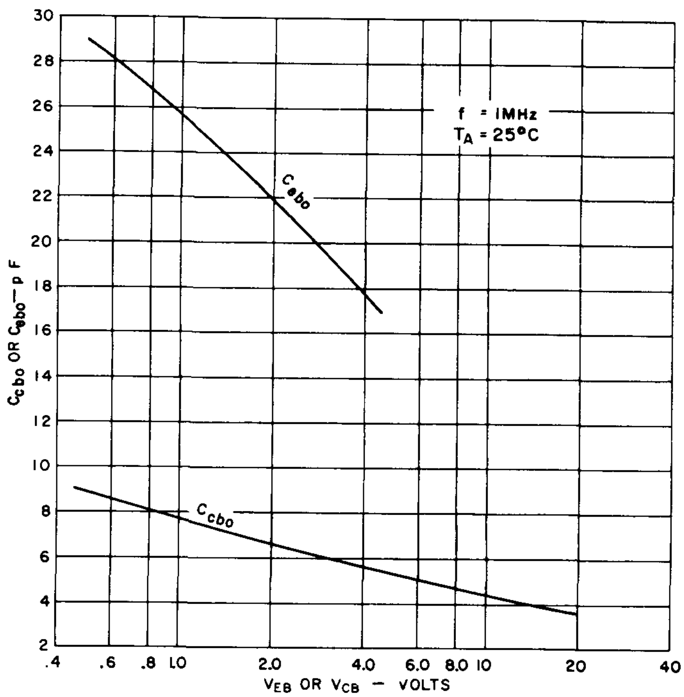

V_{CE} = 5V
T_A = 25°C
h_{FE}
450
400
350
300
250
200
150
100
50
0
.01 .2 .4 .6 .8 1.0 2 4 6 8 10 20 40 60 80 100 200 400 600 800
I_C – mA

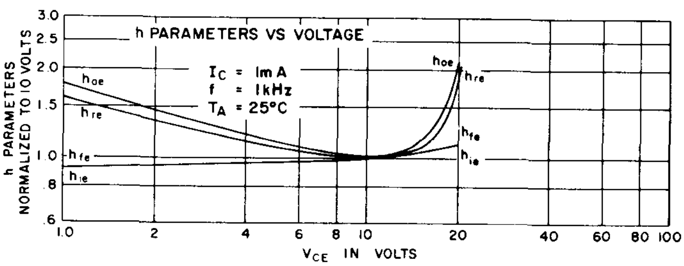

V_{CE} = 10V
T_A = 25°C
I_C — mA
1000
900
800
700
600
500
400
300
200
100
0
.2 .4 .6 .8 1.0 1.2 1.4
V_{BE} — VOLTS

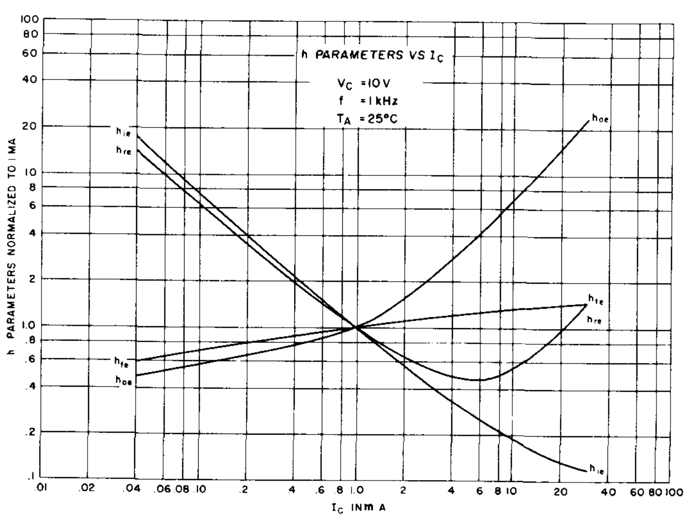

V_C = 5V
I_C = 2mA
h_{FE} NORMALIZED TO 25°C
2.0
1.5
1.0
.8
.6
.5
-40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
TEMPERATURE – °C

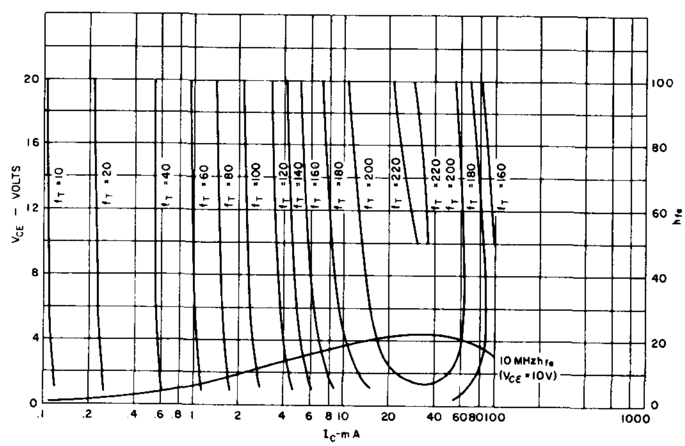

$V_{CE(SAT)}$ VS I_C
I_C/I_B = 20
T_A = 100°C
T_A = 25°C
$V_{CE(SAT)}$ – mV
1000
800
600
400
200
0
.1 .2 .4 .6 .8 1.0 2 4 6 8 10 20 40 60 80 100 200 400 600 800
I_C – mA

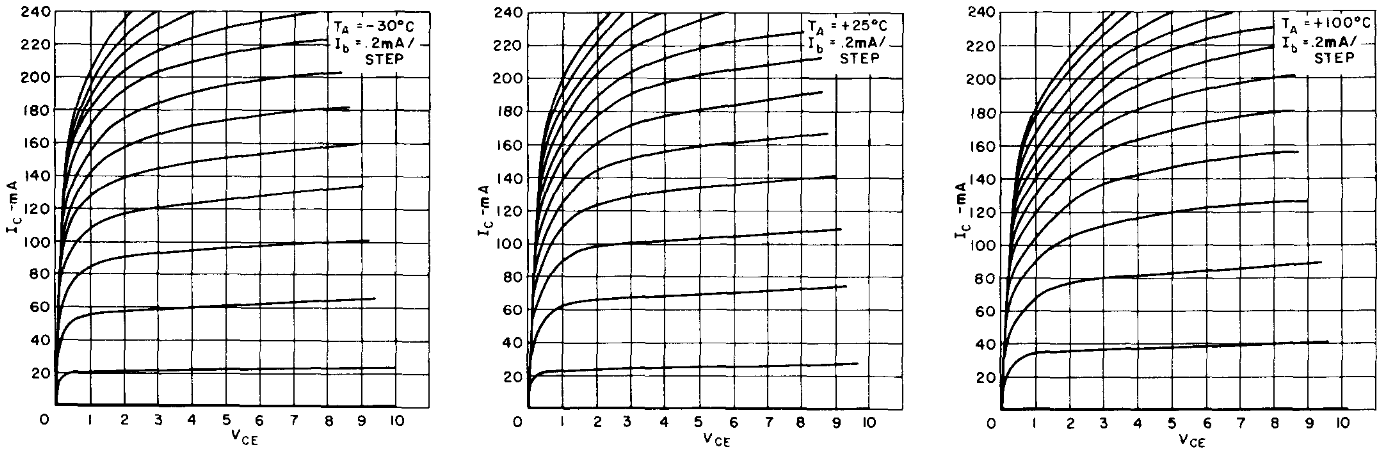

h PARAMETERS VS TEMPERATURE
V_C = 10V
I_C = 1mA
f = 1kHz
h_{ie}
h_{re}
h_{fe}
h_{oe}
h PARAMETERS NORMALIZED TO 25°C
2.5
2.0
1.5
1.0
.8
.6
.4
-40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
TEMPERATURE IN °C


f = 1MHz
T_A = 25°C
C_{ebo}
C_{cbo}
C_{cbo} OR C_{ebo} — pF
V_{EB} OR V_{CB} — VOLTS

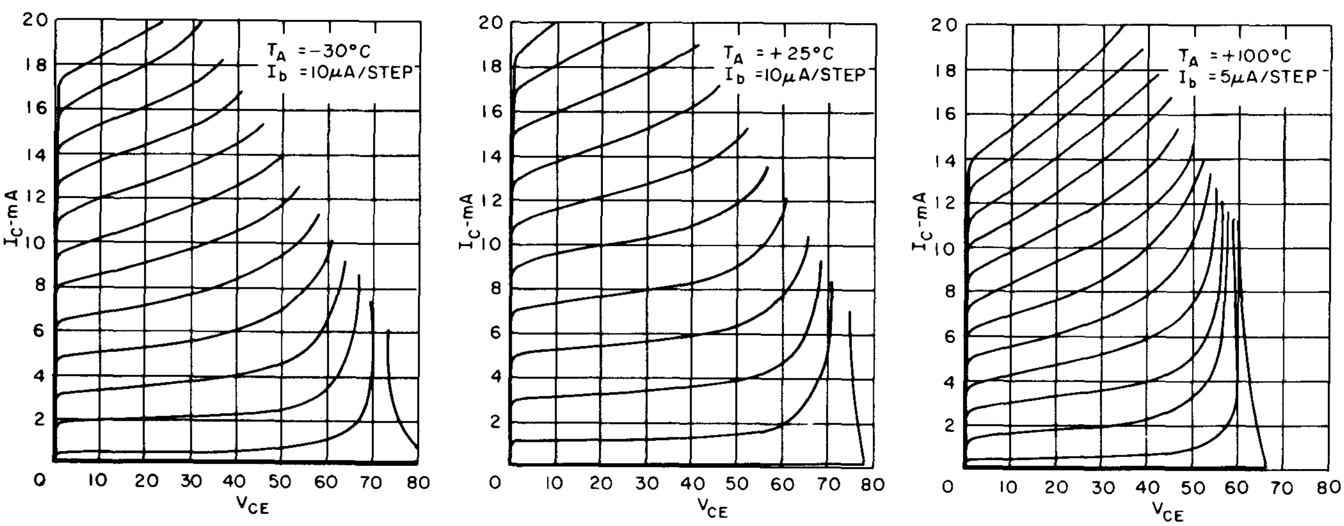

h PARAMETERS VS VOLTAGE
I_C = 1mA
f = 1kHz
T_A = 25°C
h_{oe}
h_{re}
h_{fe}
h_{ie}
h PARAMETERS NORMALIZED TO 10 VOLTS
V_{CE} IN VOLTS


h PARAMETERS VS I_C
V_C = 10V
f = 1kHz
T_A = 25°C
h_{ie}
h_{re}
h_{fe}
h_{oe}
h PARAMETERS NORMALIZED TO 1 MA
I_C IN mA


V_{CE} — VOLTS
h_{fe}
10 MHz h_{fe} (V_{CE} = 10V)
I_C-mA



Typical Common Emitter Current Characteristic Curves

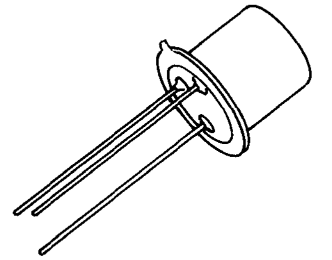


Typical Common Emitter Characteristic Curves

Silicon Transistors

2N4983,6

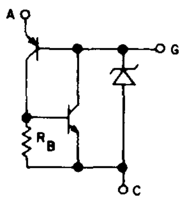
The General Electric SUS is a silicon planar, monolithic integrated circuit having thyristor electrical characteristics closely approximating those of an "ideal" four layer diode. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient. A gate lead is provided to eliminate rate effect, obtain triggering at lower voltages and to obtain transient free wave forms.



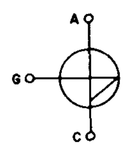
Silicon Unilateral Switches are specifically designed and characterized for use in monostable and bistable applications where low cost is of prime importance. These devices are in the TO-18 hermetic package.

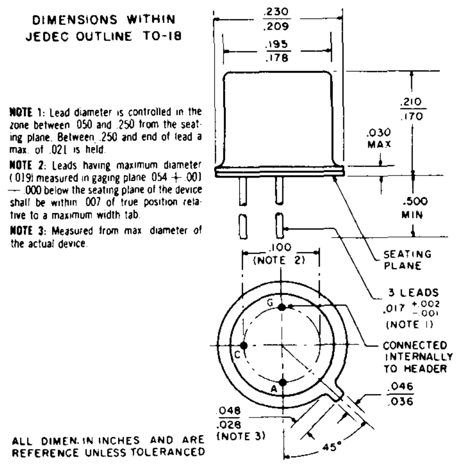
Applications Include:
- SCR Triggers
- Frequency Dividers
- Ring Counters
- Cross Point Switching
- Over-Voltage Sensors

EQUIVALENT CIRCUIT



CIRCUIT SYMBOL





absolute maximum ratings: (25°C free air) (unless otherwise specified)

Storage Temperature Range	−65 to +150	°C
Junction Temperature Range	−55 to +125	°C
Power Dissipation*	300	mW
Peak Reverse Voltage	−30	Volts
DC Forward Anode Current*	175	mA
DC Gate Current*†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

***Derate linearly to zero at 125°C.**
†This rating applicable only in OFF state.
Maximum gate current in conducting state limited by maximum power rating.

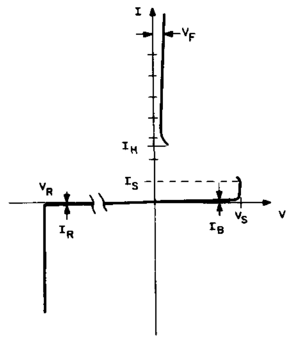
electrical characteristics: (25°C) (unless otherwise specified)

		2N4983			2N4986			
STATIC		**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	
Forward Switching Voltage	V_S	6.0		10.0	7.0		9.0	Volts
Forward Switching Current	I_S			500			200	μA
Holding Current	I_H			1.5			.75	mA
Reverse Current								
($V_R = -30V$, $T_A = 25°C$)	I_R			0.1			0.1	μA
($V_R = -30V$, $T_A = 100°C$)	I_R			10.0			10.0	μA
Forward Current (off state)								
($V_F = 5V$, $T_A = 25°C$)	I_B			1.0			0.1	μA
($V_F = 5V$, $T_A = 100°C$)	I_B			10.0			10.0	μA
Forward Voltage Drop (on state) ($I_F = 175$ mA)	V_F			1.5			1.5	Volts
Temperature Coefficient of Switching Voltage ($T_A = -55°C$ to $+100°C$)	T_C		±.02			±.02		%/°C
DYNAMIC								
Turn-on Time (See Circuit 1)	t_{on}			1.0			1.0	μsec
Turn-off Time (See Circuit 2)	t_{off}			25.0			25.0	μsec
Peak Pulse Voltage (See Circuit 3)	V_O	3.5			3.5			Volts
Capacitance (0V., f = 1 MHz)	C		2.5			2.5		pF

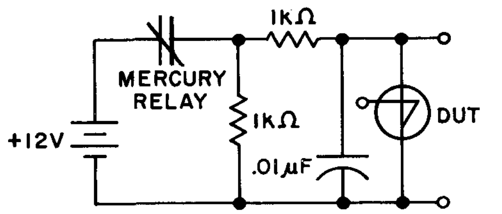
2N4983, 6

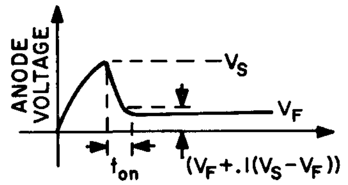
PARAMETER DEFINITIONS

Static
Characteristics



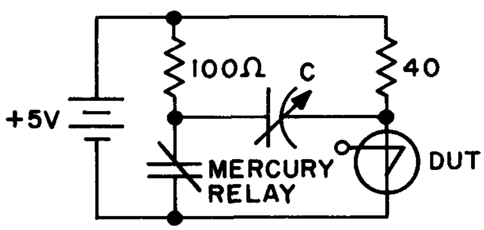
TEST CIRCUITS

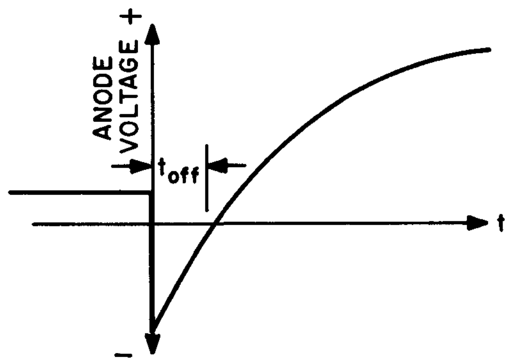




Circuit 1
Turn-on Time, t_{on}

Turn-on time is measured from the time the anode voltage first reaches V_S to the time where the anode voltage has fallen 90% of the difference between V_S and V_F.

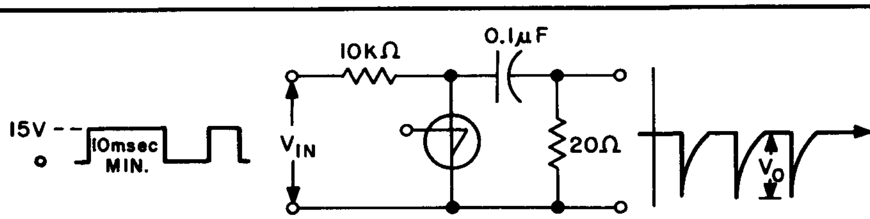


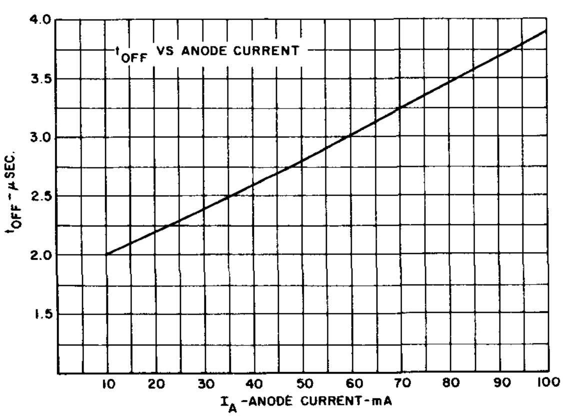


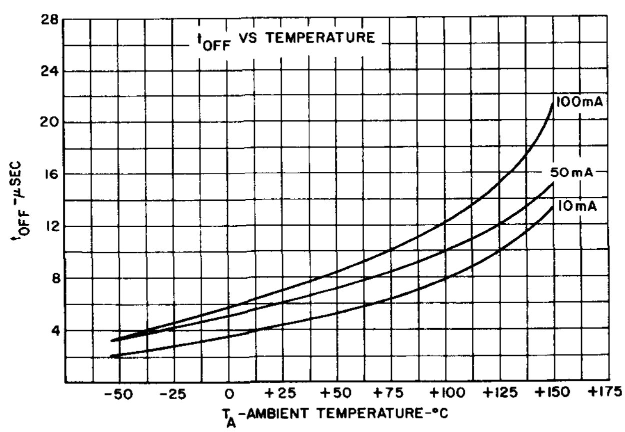
Circuit 2
Turn-off Time, t_{off}

The turn-off test is begun with the SUS in conduction and the relay contacts open. At $t = 0$ the contacts close and the anode is driven negative. C is adjusted downward, so that when the anode voltage becomes positive, the SUS just remains off. The turn-off time, t_{off}, is the time between initial contact closure and the point where the anode voltage passes up through zero volts. The capacitor is allowed to fully charge to 5 volts, at which time the contacts are reopened and the SUS triggers on.

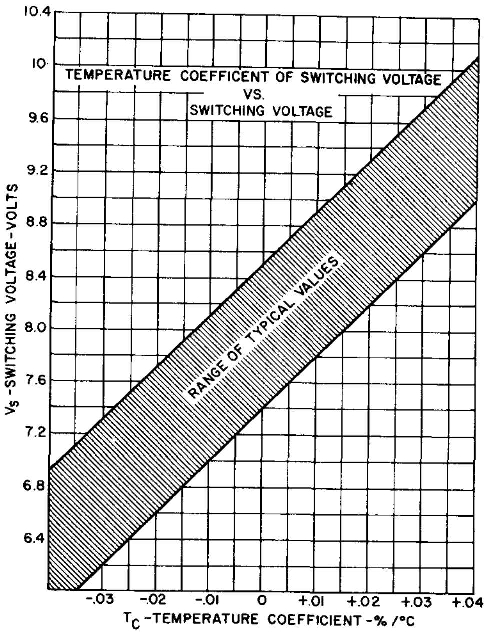
Circuit 3
V_o

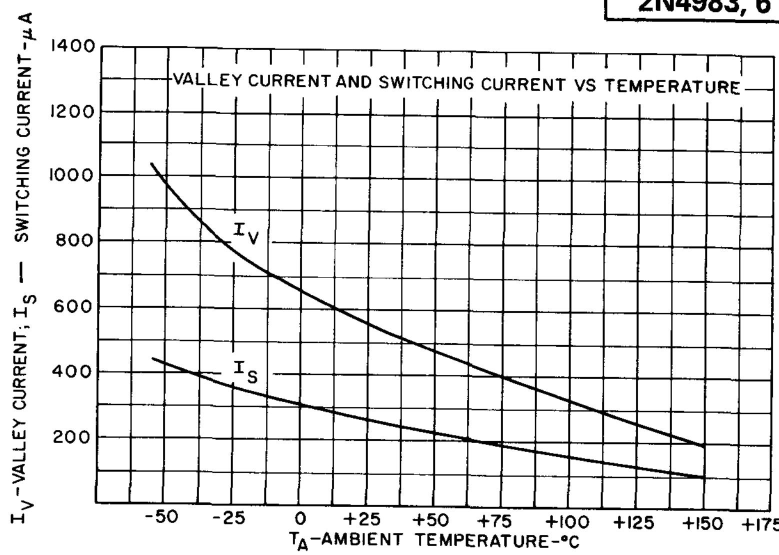


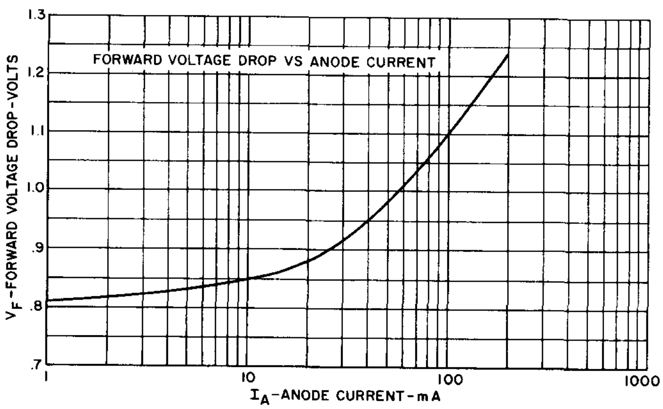


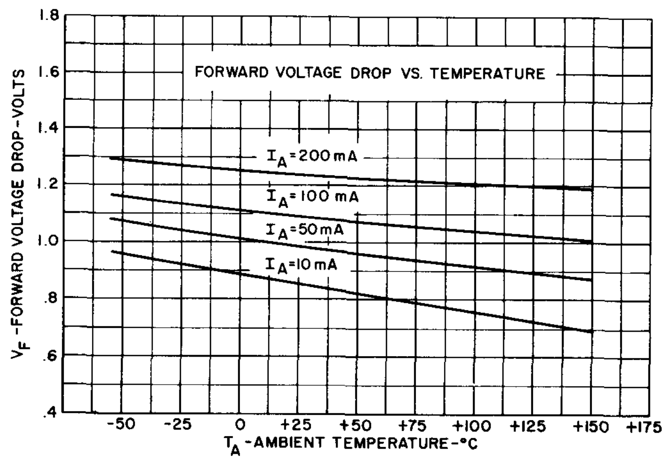


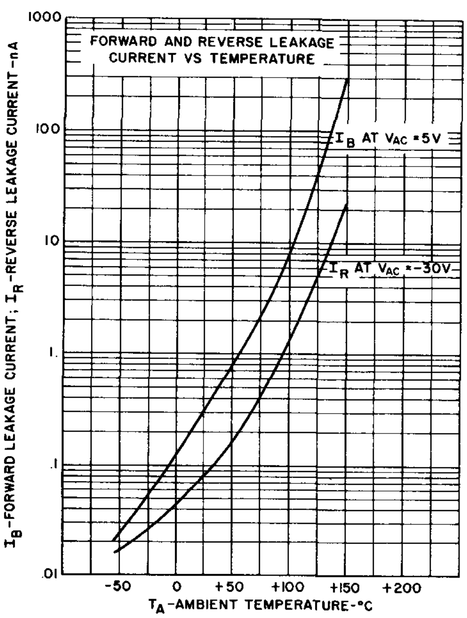
TYPICAL CHARACTERISTICS

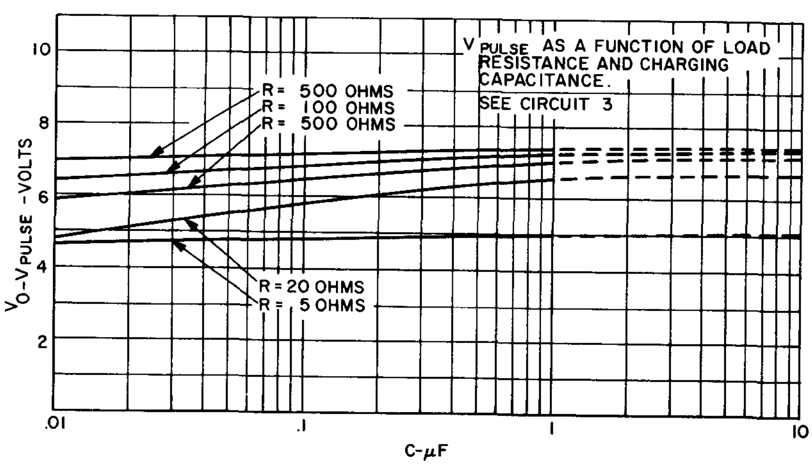








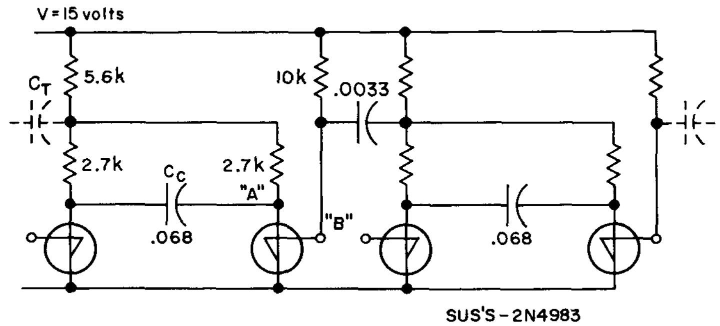




APPLICATIONS

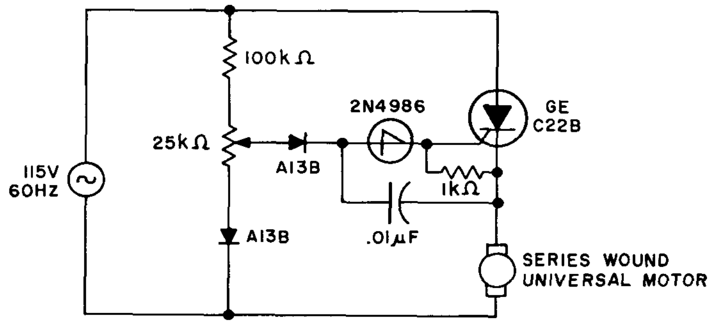
BINARY DIVIDER CHAIN

Uses fewer components than transistor flip flops. Output at "B" gives transient free waveform.



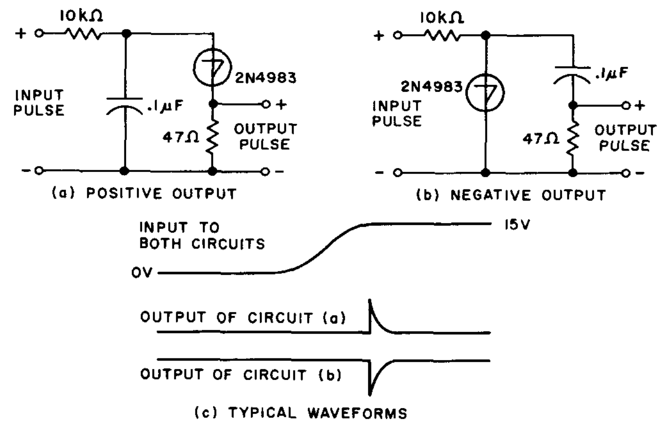
MOTOR SPEED CONTROL

Switching action of the 2N4986 allows smaller capacitors to be used while achieving reliable thyristor triggering.

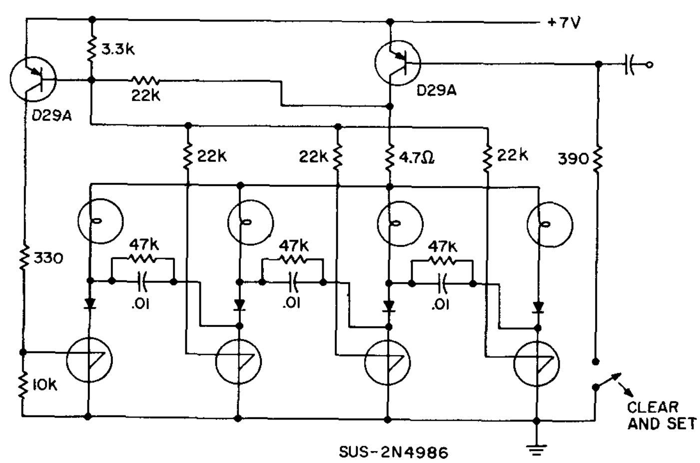


PULSE SHARPENERS

SUS is used to generate a rapid rise or fall time by using energy stored in a capacitor.



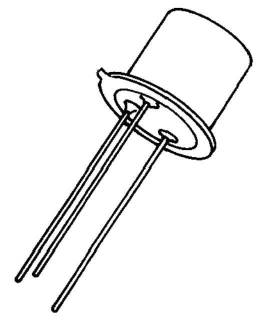
RING COUNTER FOR INCANDESCENT LAMPS



Silicon Unilateral Switch (SUS)

2N4984,5

The General Electric SUS is a silicon planar, monolithic integrated circuit having thyristor electrical characteristics closely approximating those of an "ideal" four layer diode. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient. A gate lead is provided to eliminate rate effect, obtain triggering at lower voltages and to obtain transient free wave forms.

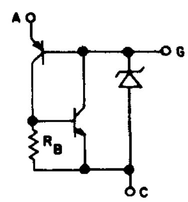


Silicon Unilateral Switches are specifically designed and characterized for use in monostable and bistable applications where stability of the switching voltage is required over wide temperature variations. These devices are in the TO-18 hermetic package.

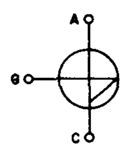
Applications Include:

- SCR Triggers
- Frequency Dividers
- Ring Counters
- Cross Point Switching
- Over-Voltage Sensors

EQUIVALENT CIRCUIT



CIRCUIT SYMBOL

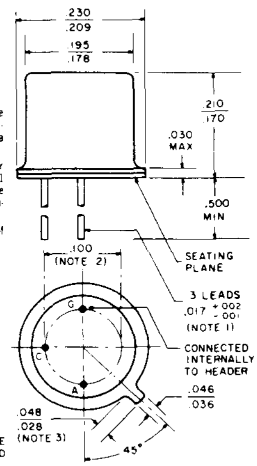


DIMENSIONS WITHIN JEDEC OUTLINE TO-18

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 — .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab

NOTE 3: Measured from max. diameter of the actual device



ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

absolute maximum ratings (25°C free air) (unless otherwise specified)

Storage Temperature Range	−65 to +200	°C
Junction Temperature Range	−55 to +150	°C
Power Dissipation*	350	mW
Peak Reverse Voltage	−30	Volts
DC Forward Anode Current*	200	mA
DC Gate Current*†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, T_A = 100°C)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, T_A = 25°C)	5.0	Amps

***Derate linearly to zero at 150°C.**

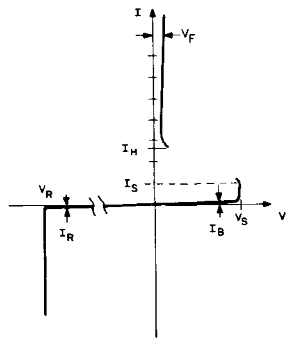
†This rating applicable only in OFF state.
Maximum gate current in conducting state limited by maximum power rating.

electrical characteristics: (25°C) (unless otherwise specified)

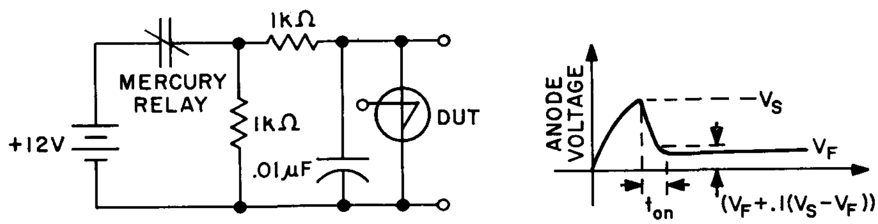
		2N4984			2N4985			UNITS
STATIC		Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Switching Voltage	V_S	7.5		9.0	7.5		8.2	Volts
Forward Switching Current	I_S			150			300	μA
Holding Current	I_H	.05		.5	.05		1.0	mA
Reverse Current								
(V_R = −30V, T_A = 25°C)	I_R			.1			.1	μA
(V_R = −30V, T_A = 150°C)	I_R			10.0			10.0	μA
Forward Current (off state)								
(V_F = 5V, T_A = 25°C)	I_B			.1			.010	μA
(V_F = 5V, T_A = 150°C)	I_B			10.0			1.0	μA
Forward Voltage Drop (on state) (I_F = 200 mA)	V_F			1.5			1.5	Volts
Temperature Coefficient of Switching Voltage (T_A = −55°C to +150°C)	T_C			±.05			±.02	%/°C
DYNAMIC								
Turn-on Time (See Circuit 1)	t_{on}			1.0			1.0	μsec
Turn-off Time (See Circuit 2)	t_{off}			25.0			25.0	μsec
Peak Pulse Voltage (See Circuit 3)	V_O	3.5			3.5			Volts
Capacitance (0V., f = 1 MHz)	C		2.5			2.5		pF

PARAMETER DEFINITIONS

Static Characteristics

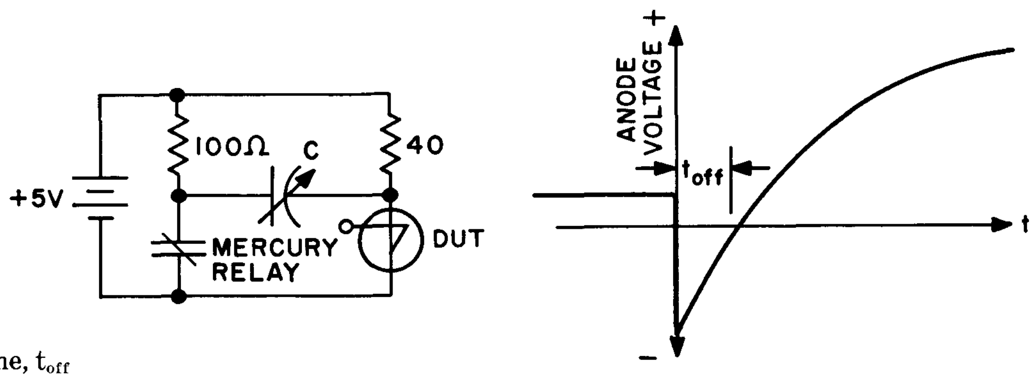


TEST CIRCUITS



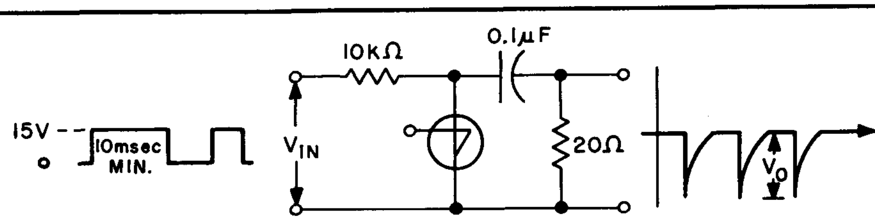
Circuit 1
Turn-on Time, t_{on}

Turn-on time is measured from the time the anode voltage first reaches V_S to the time where the anode voltage has fallen 90% of the difference between V_S and V_F.

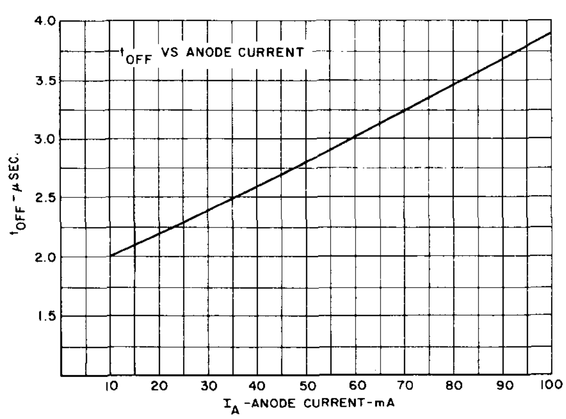


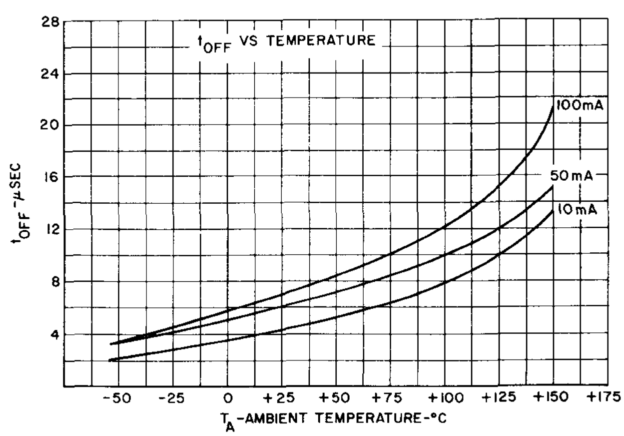
Circuit 2
Turn-off Time, t_{off}

The turn-off test is begun with the SUS in conduction and the relay contacts open. At t = 0 the contacts close and the anode is driven negative. C is adjusted downward, so that when the anode voltage becomes positive, the SUS just remains off. The turn-off time, t_{off}, is the time between initial contact closure and the point where the anode voltage passes up through zero volts. The capacitor is allowed to fully charge to 5 volts, at which time the contacts are reopened and the SUS triggers on.



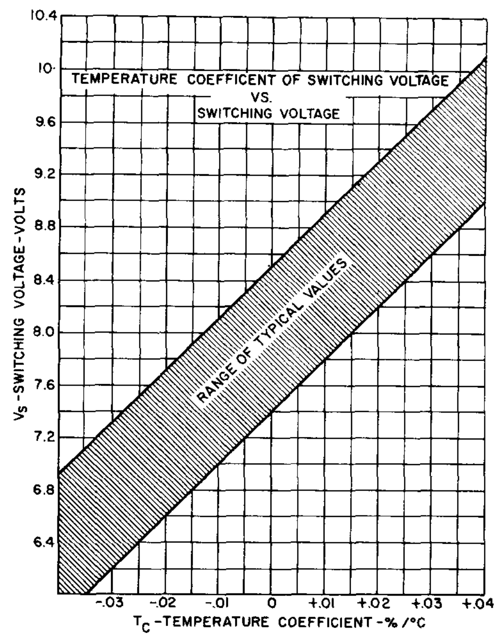
Circuit 3
V_o

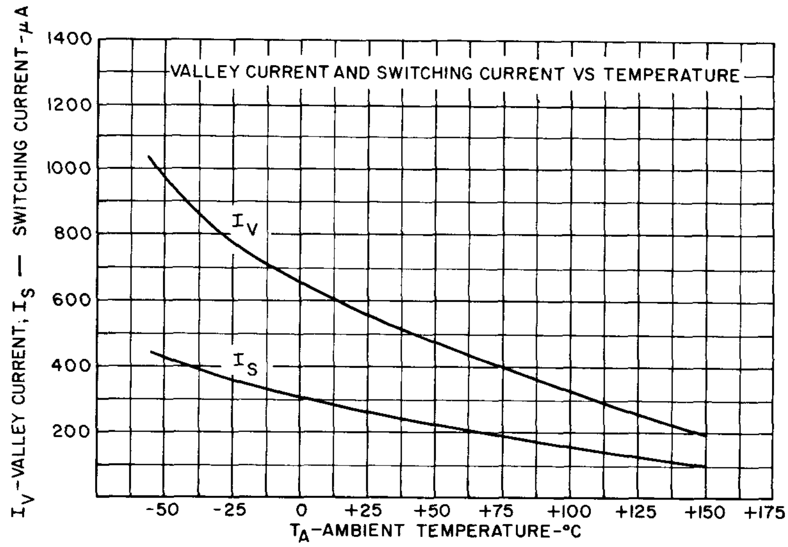


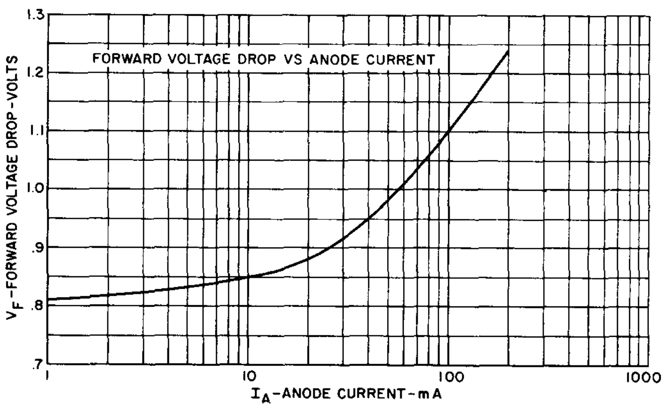


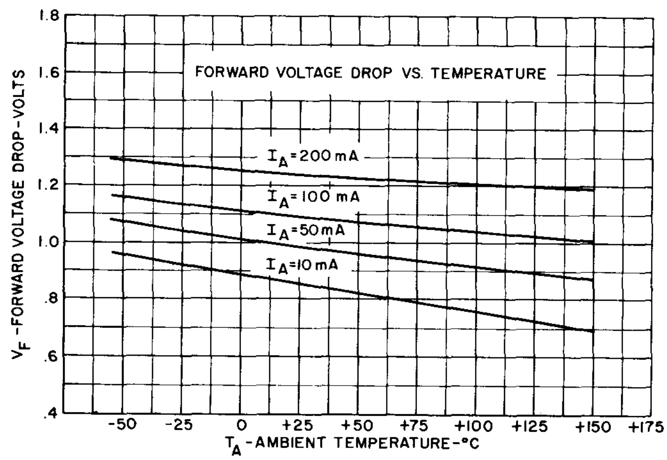
TYPICAL CHARACTERISTICS

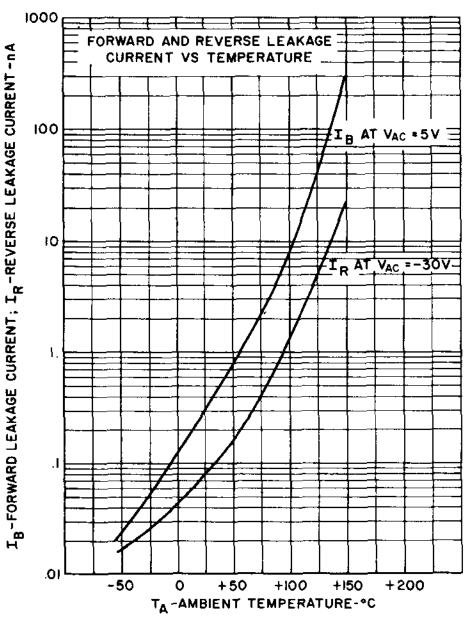
2N4984, 5

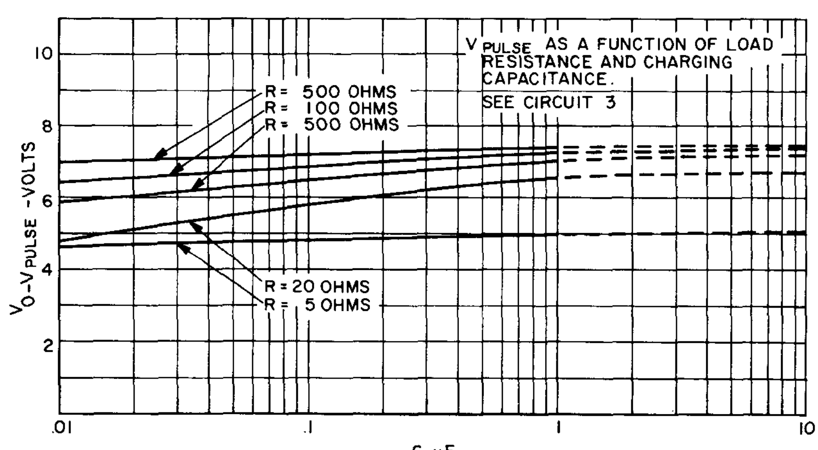








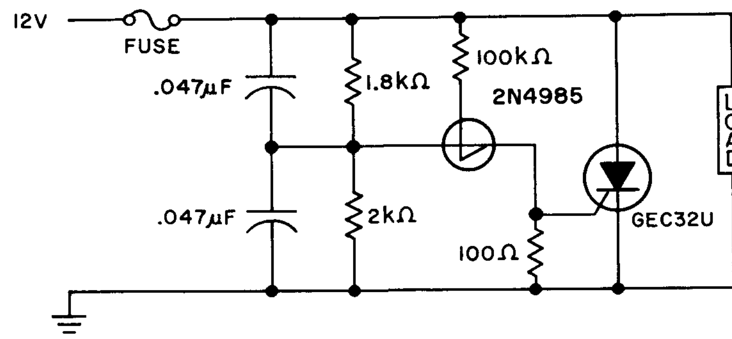




APPLICATIONS

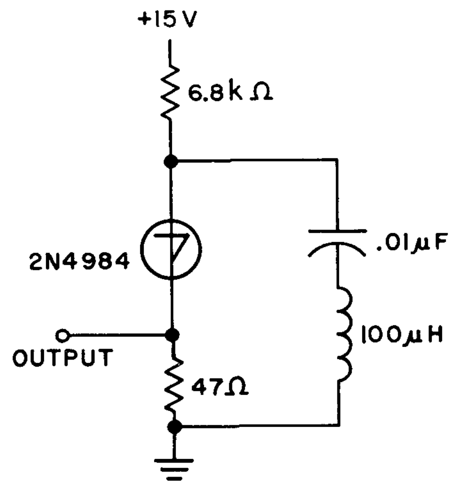
OVERVOLTAGE PROTECTION CIRCUIT

For overvoltages, SCR turns on and blows fuse. For rapidly rising voltages, circuit triggers between 13.2 & 14 volts. For slowly increasing voltages, circuit triggers between 14 & 17 volts.



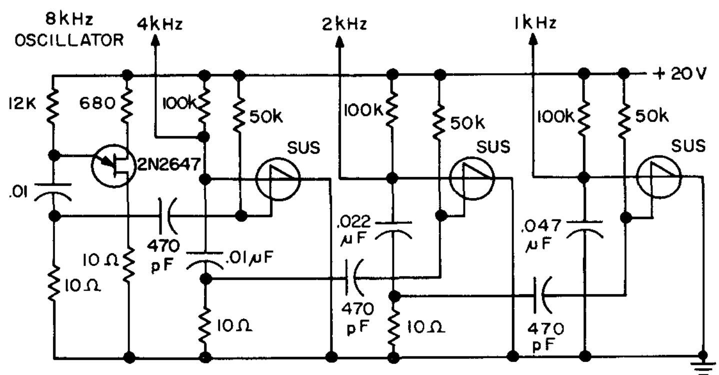
10kHz OSCILLATOR

Capacitor charges until switching voltage is reached. When SUS switches on, inductor causes current to ring. When current thru SUS drops below holding current, device turns off and cycle repeats.



FREQUENCY DIVIDER WITH TRANSIENT FREE OUTPUT

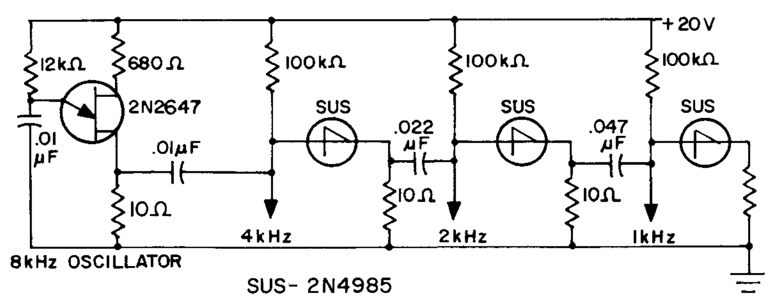
Spikes in center of sawtooth are eliminated in this circuit by triggering at gate.



SUS - 2N4985

FREQUENCY DIVIDER CHAIN

Sawtooth Output from each stage is one half frequency of preceding stage.



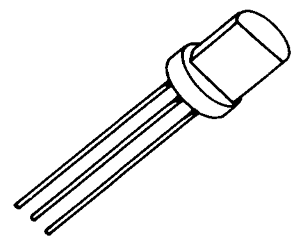
SUS- 2N4985

Silicon Economy Unilateral Switch (SUS)

2N4987,90

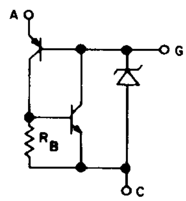
The General Electric SUS is a silicon planar, monolithic integrated circuit having thyristor electrical characteristics closely approximating those of an "ideal" four layer diode. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient. A gate lead is provided to eliminate rate effect, obtain triggering at lower voltages and to obtain transient free wave forms.

Silicon Unilateral Switches are specifically designed and characterized for use in monostable and bistable applications where low cost is of prime importance. These devices are in the low cost, TO-98 plastic package.

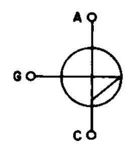


Applications Include:
- SCR Triggers
- Frequency Dividers
- Ring Counters
- Cross Point Switching
- Over-Voltage Sensors

EQUIVALENT CIRCUIT



CIRCUIT SYMBOL

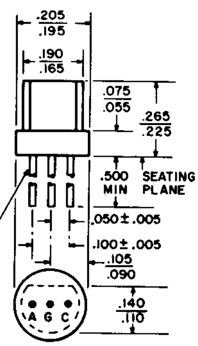


DIMENSIONS WITHIN JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

3 LEADS .017 +.002 −.001 (NOTE 1)



absolute maximum ratings: (25°C free air) (unless otherwise specified)

Storage Temperature Range	−65 to +150	°C
Junction Temperature Range	−55 to +125	°C
Power Dissipation*	300	mW
Peak Reverse Voltage	−30	Volts
DC Forward Anode Current*	175	mA
DC Gate Current*†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, T_A = 100°C)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, T_A = 25°C)	5.0	Amps

***Derate linearly to zero at 125°C.**
†This rating applicable only in OFF state.
Maximum gate current in conducting state limited by maximum power rating.

electrical characteristics: (25°C) (unless otherwise specified)

STATIC

		2N4987 Min.	2N4987 Typ.	2N4987 Max.	2N4990 Min.	2N4990 Typ.	2N4990 Max.	
Forward Switching Voltage	V_S	6.0		10.0	7.0		9.0	Volts
Forward Switching Current	I_S			500			200	μA
Holding Current	I_H			1.5			.75	mA
Reverse Current (V_R = −30V, T_A = 25°C)	I_R			0.1			0.1	μA
(V_R = −30V, T_A = 85°C)	I_R			10.0			10.0	μA
Forward Current (off state) (V_F = 5V, T_A = 25°C)	I_B			1.0			0.1	μA
(V_F = 5V, T_A = 85°C)	I_B			10.0			10.0	μA
Forward Voltage Drop (on state) (I_F = 175 mA)	V_F			1.5			1.5	Volts
Temperature Coefficient of Switching Voltage (T_A = −55°C to +85°C)	T_C		±.02			±.02		%/°C

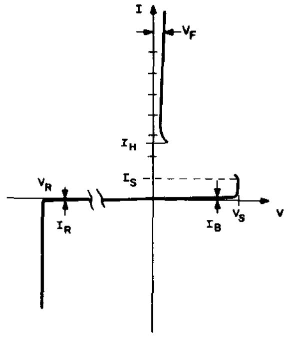
DYNAMIC

		2N4987 Min.	2N4987 Typ.	2N4987 Max.	2N4990 Min.	2N4990 Typ.	2N4990 Max.	
Turn-on Time (See Circuit 1)	t_{on}			1.0			1.0	μsec
Turn-off Time (See Circuit 2)	t_{off}			25.0			25.0	μsec
Peak Pulse Voltage (See Circuit 3)	V_O	3.5			3.5			Volts
Capacitance (0V., f = 1 MHz)	C		2.5			2.5		pF

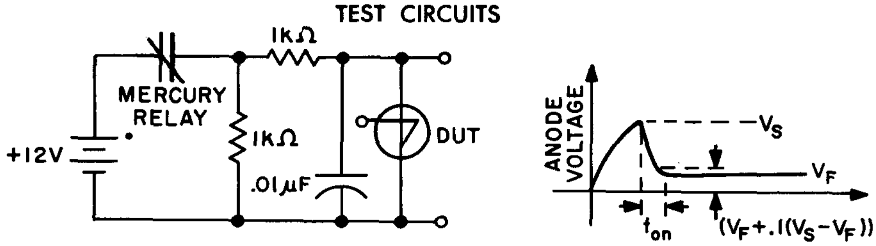
2N4987, 90

PARAMETER DEFINITIONS

Static Characteristics

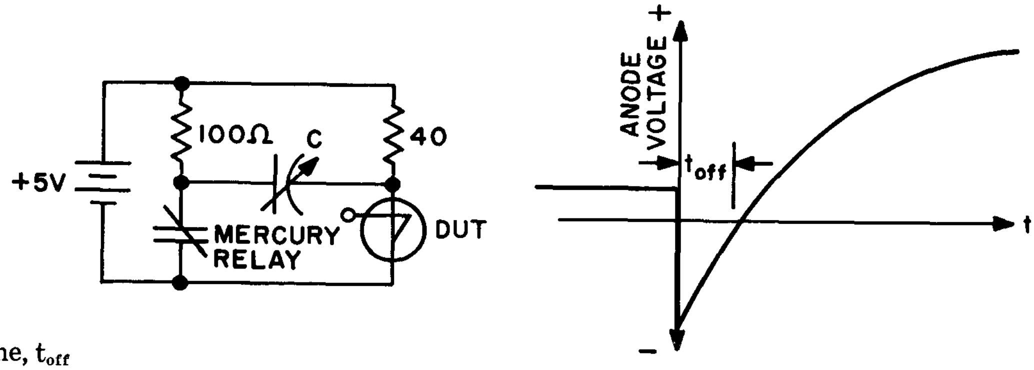


TEST CIRCUITS



Circuit 1
Turn-on Time, t_{on}

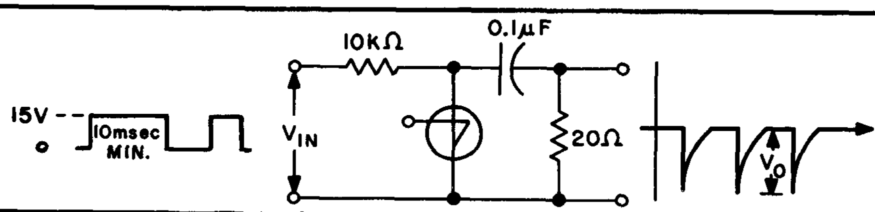
Turn-on time is measured from the time the anode voltage first reaches V_S to the time where the anode voltage has fallen 90% of the difference between V_S and V_F.

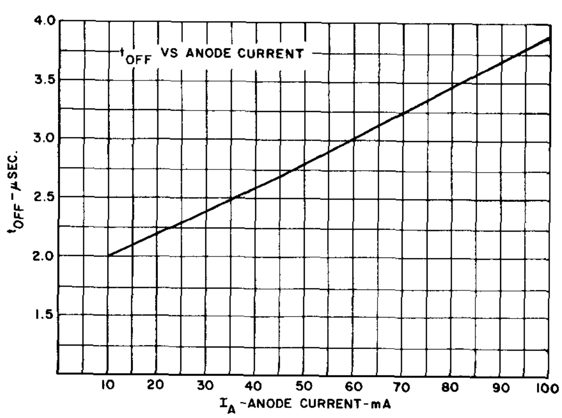


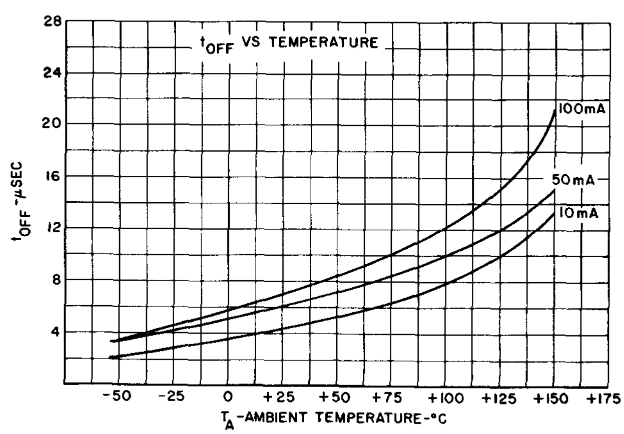
Circuit 2
Turn-off Time, t_{off}

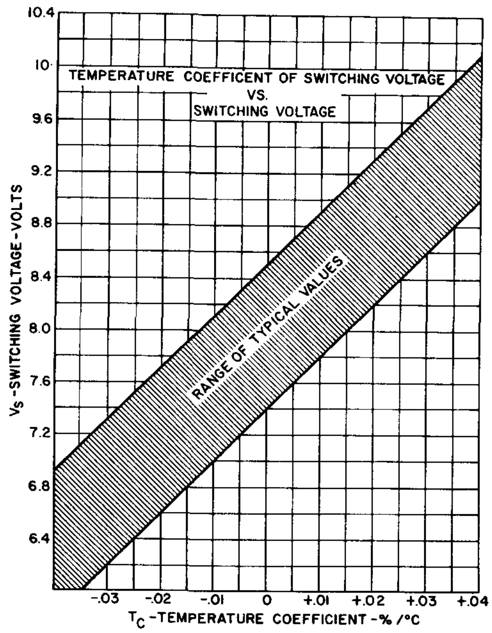
The turn-off test is begun with the SUS in conduction and the relay contacts open. At $t = 0$ the contacts close and the anode is driven negative. C is adjusted downward, so that when the anode voltage becomes positive, the SUS just remains off. The turn-off time, t_{off}, is the time between initial contact closure and the point where the anode voltage passes up through zero volts. The capacitor is allowed to fully charge to 5 volts, at which time the contacts are reopened and the SUS triggers on.

Circuit 3
V_o

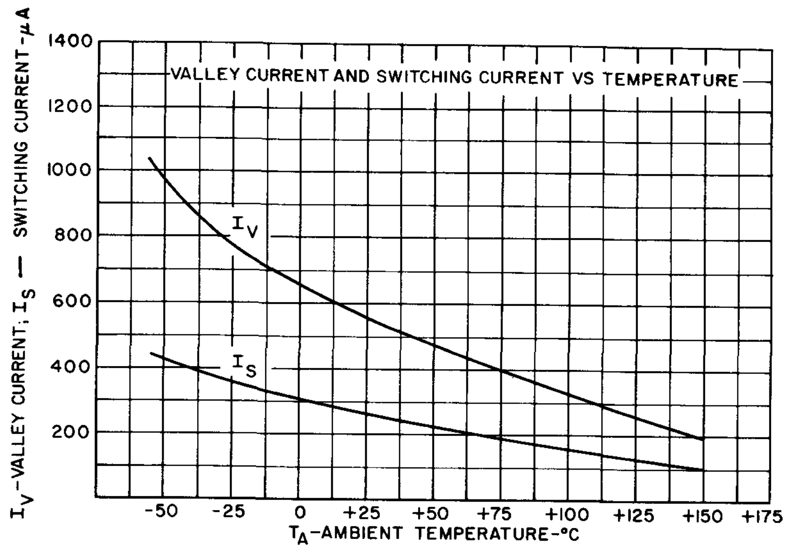




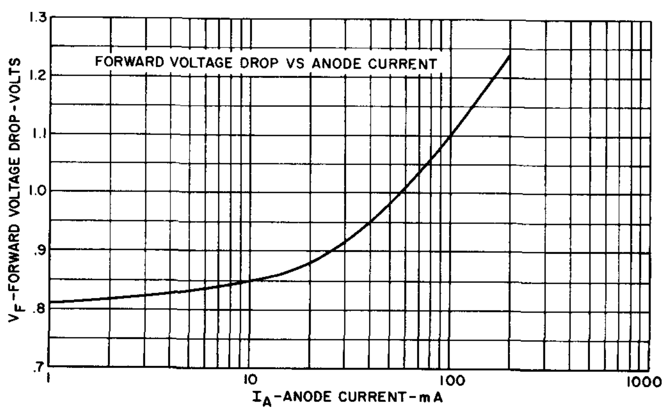




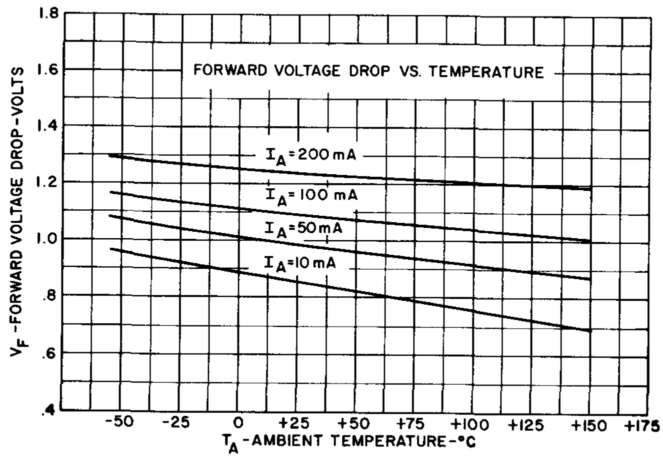
TEMPERATURE COEFFICENT OF SWITCHING VOLTAGE VS. SWITCHING VOLTAGE
RANGE OF TYPICAL VALUES
V_S-SWITCHING VOLTAGE-VOLTS
T_C-TEMPERATURE COEFFICIENT-% /°C



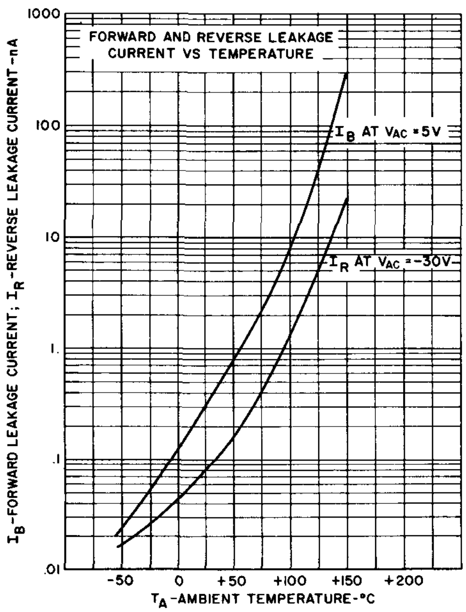
VALLEY CURRENT AND SWITCHING CURRENT VS TEMPERATURE
I_V
I_S
I_V-VALLEY CURRENT; I_S — SWITCHING CURRENT-μA
T_A-AMBIENT TEMPERATURE-°C



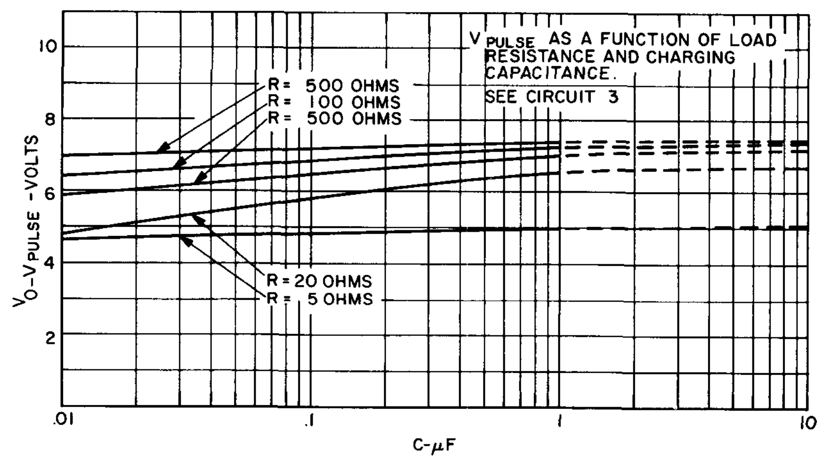
FORWARD VOLTAGE DROP VS ANODE CURRENT
V_F-FORWARD VOLTAGE DROP-VOLTS
I_A-ANODE CURRENT-mA



FORWARD VOLTAGE DROP VS. TEMPERATURE
I_A=200 mA
I_A=100 mA
I_A=50 mA
I_A=10 mA
V_F-FORWARD VOLTAGE DROP-VOLTS
T_A-AMBIENT TEMPERATURE-°C



FORWARD AND REVERSE LEAKAGE CURRENT VS TEMPERATURE
I_B AT V_{AC}=5V
I_R AT V_{AC}=-30V
I_B-FORWARD LEAKAGE CURRENT; I_R-REVERSE LEAKAGE CURRENT-nA
T_A-AMBIENT TEMPERATURE-°C

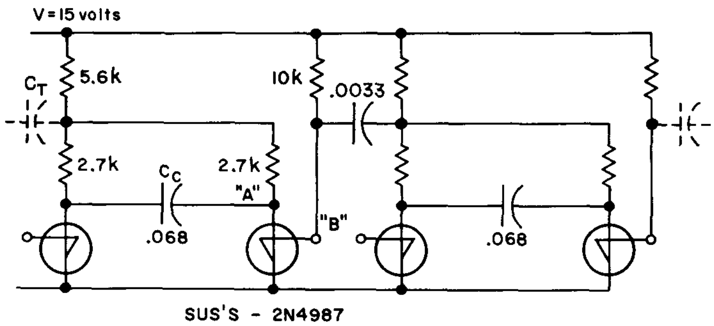


V_{PULSE} AS A FUNCTION OF LOAD RESISTANCE AND CHARGING CAPACITANCE.
SEE CIRCUIT 3
R= 500 OHMS
R= 100 OHMS
R= 500 OHMS
R= 20 OHMS
R= 5 OHMS
V_O-V_{PULSE} -VOLTS
C-μF

APPLICATIONS

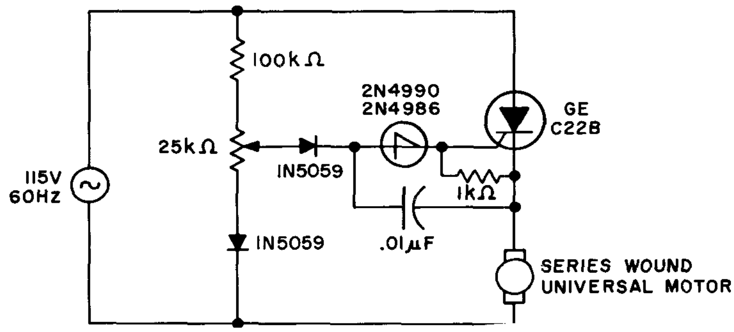
BINARY DIVIDER CHAIN

Uses fewer components than transistor flip flops. Output at "B" gives transient free waveform.



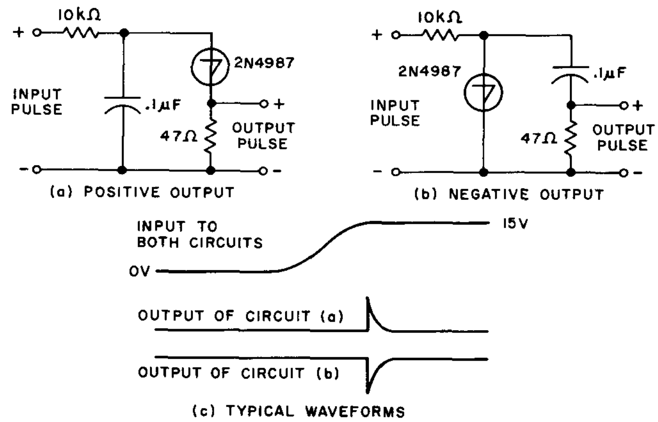
MOTOR SPEED CONTROL

Switching action of the 2N4990 allows smaller capacitors to be used while achieving reliable thyristor triggering.

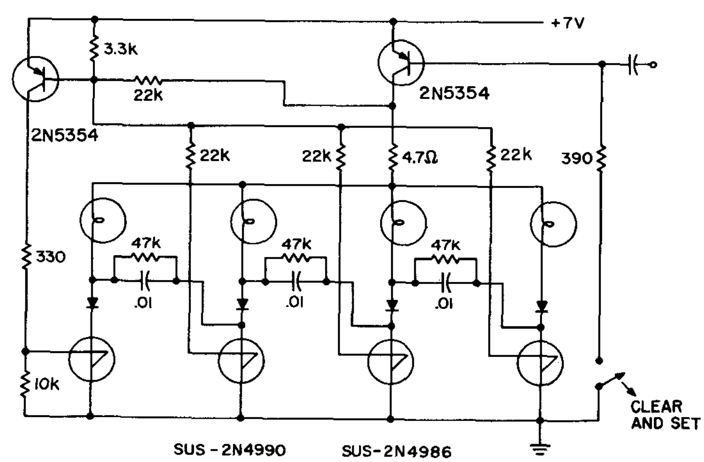


PULSE SHARPENERS

SUS is used to generate a rapid rise or fall time by using energy stored in a capacitor.



Ring Counter for Incandescent Lamps.

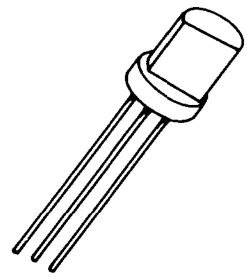


Silicon Economy Unilateral Switch (SUS)

2N4988,9

The General Electric SUS is a silicon planar, monolithic integrated circuit having thyristor electrical characteristics closely approximating those of an "ideal" four layer diode. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient. A gate lead is provided to eliminate rate effect, obtain triggering at lower voltages and to obtain transient free wave forms.

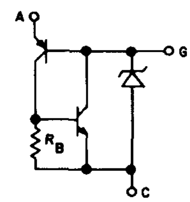
Silicon Unilateral Switches are specifically designed and characterized for use in monostable and bistable applications where stability of the switching voltage is required over wide temperature variations. These devices are in the low cost, TO-98 plastic package.



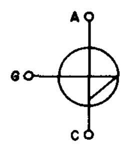
Applications Include:

- SCR Triggers
- Frequency Dividers
- Ring Counters
- Cross Point Switching
- Over-Voltage Sensors

EQUIVALENT CIRCUIT



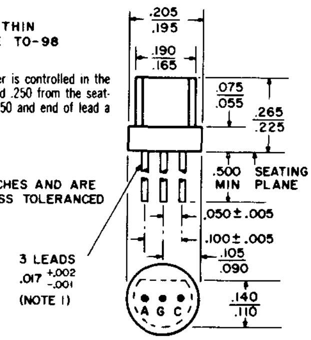
CIRCUIT SYMBOL



DIMENSIONS WITHIN JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED



absolute maximum ratings (25°C free air) (unless otherwise specified)

Storage Temperature Range	−65 to +200	°C
Junction Temperature Range	−55 to +150	°C
Power Dissipation*	350	mW
Peak Reverse Voltage	−30	Volts
DC Forward Anode Current*	200	mA
DC Gate Current*†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

***Derate linearly to zero at 150°C.**

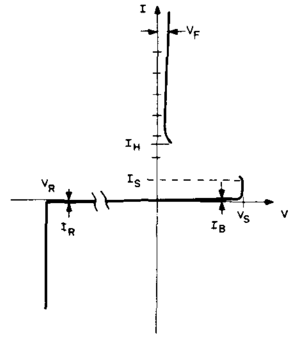
†This rating applicable only in OFF state.
Maximum gate current in conducting state limited by maximum power rating.

electrical characteristics: (25°C) (unless otherwise specified)

		2N4988			2N4989			UNITS
STATIC		Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Switching Voltage	V_S	7.5		9.0	7.5		8.2	Volts
Forward Switching Current	I_S			150			300	μA
Holding Current	I_H	.05		.5	.05		1.0	mA
Reverse Current ($V_R = -30V$, $T_A = 25°C$)	I_R			.1			.1	μA
($V_R = -30V$, $T_A = 100°C$)	I_R			10.0			10.0	μA
Forward Current (off state) ($V_F = 5V$, $T_A = 25°C$)	I_B			.1			.010	μA
($V_F = 5V$, $T_A = 100°C$)	I_B			10.0			1.0	μA
Forward Voltage Drop (on state) ($I_F = 200$ mA)	V_F			1.5			1.5	Volts
Temperature Coefficient of Switching Voltage ($T_A = -55°C$ to $+100°C$)	T_C			±.05			±.02	%/°C
DYNAMIC								
Turn-on Time (See Circuit 1)	t_{on}			1.0			1.0	μsec
Turn-off Time (See Circuit 2)	t_{off}			25.0			25.0	μsec
Peak Pulse Voltage (See Circuit 3)	V_O	3.5			3.5			Volts
Capacitance (0V., f = 1 MHz)	C		2.5			2.5		pF

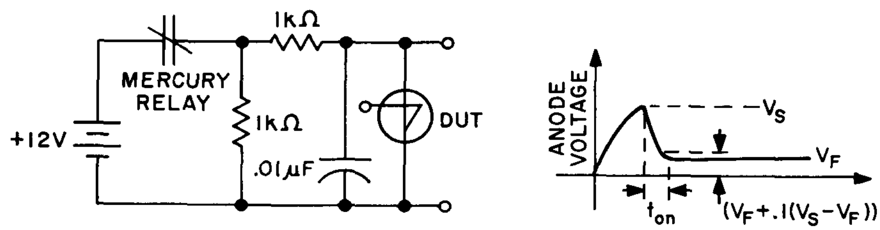
PARAMETER DEFINITIONS

Static
Characteristics



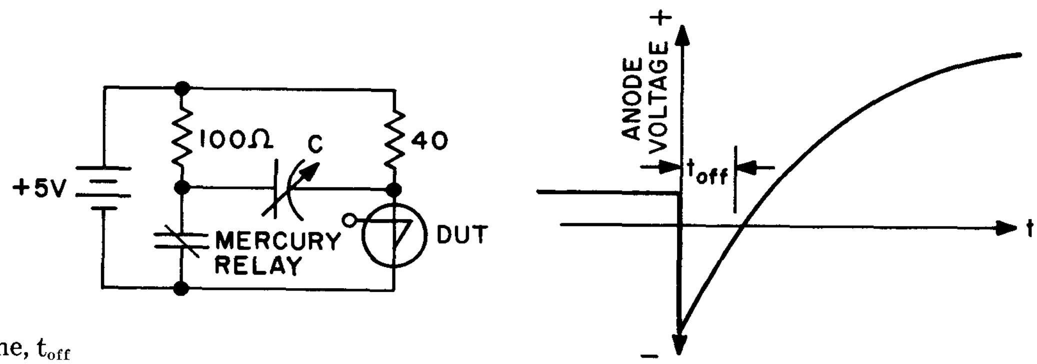
TEST CIRCUITS

Circuit 1
Turn-on Time, t_{on}



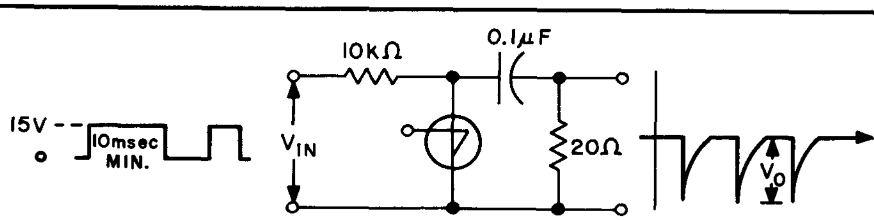
Turn-on time is measured from the time the anode voltage first reaches V_S to the time where the anode voltage has fallen 90% of the difference between V_S and V_F.

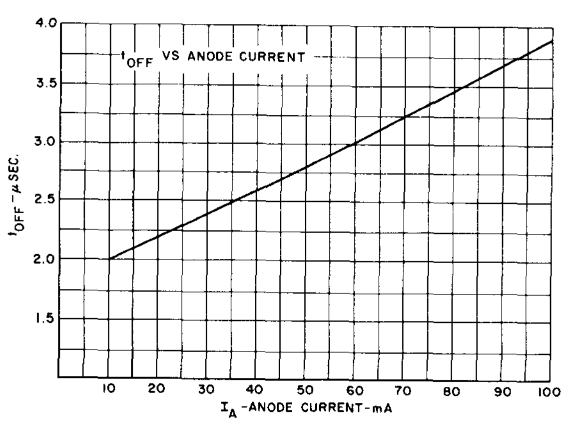
Circuit 2
Turn-off Time, t_{off}

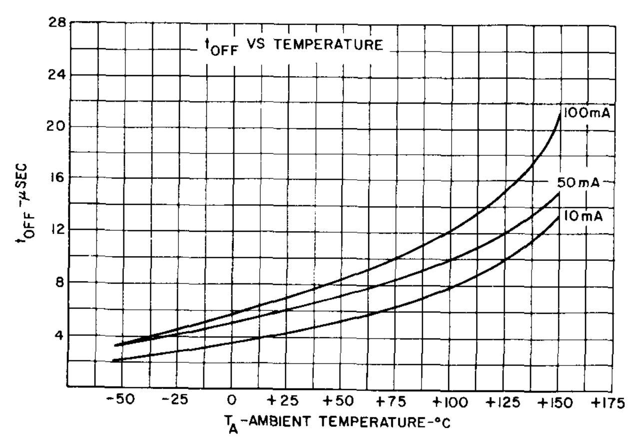


The turn-off test is begun with the SUS in conduction and the relay contacts open. At t = 0 the contacts close and the anode is driven negative. C is adjusted downward, so that when the anode voltage becomes positive, the SUS just remains off. The turn-off time, t_{off}, is the time between initial contact closure and the point where the anode voltage passes up through zero volts. The capacitor is allowed to fully charge to 5 volts, at which time the contacts are reopened and the SUS triggers on.

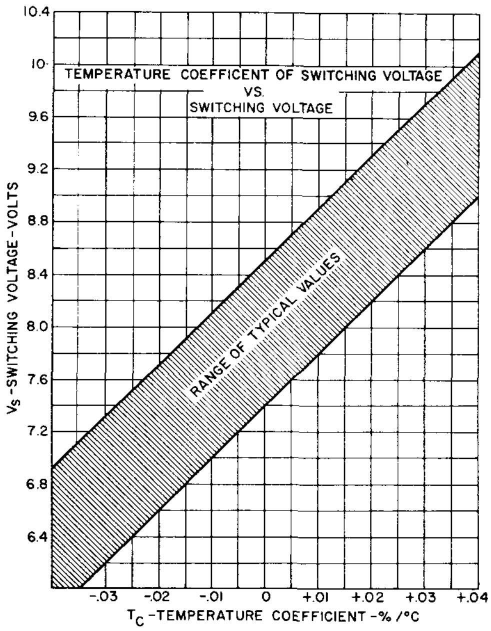
Circuit 3
V_o

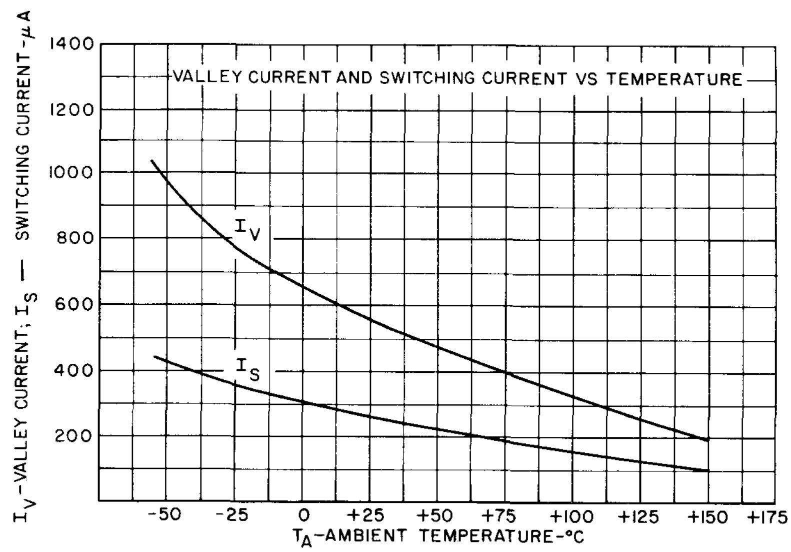


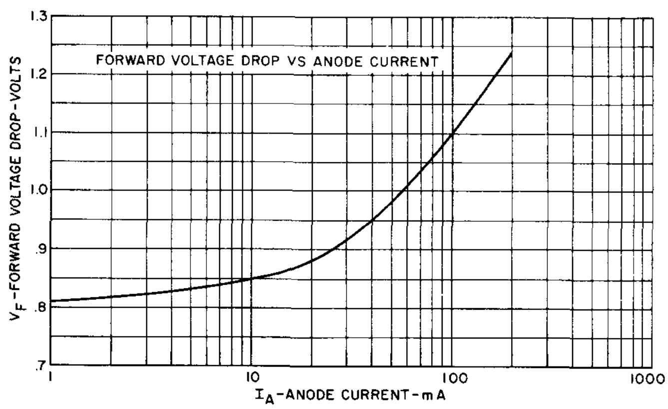


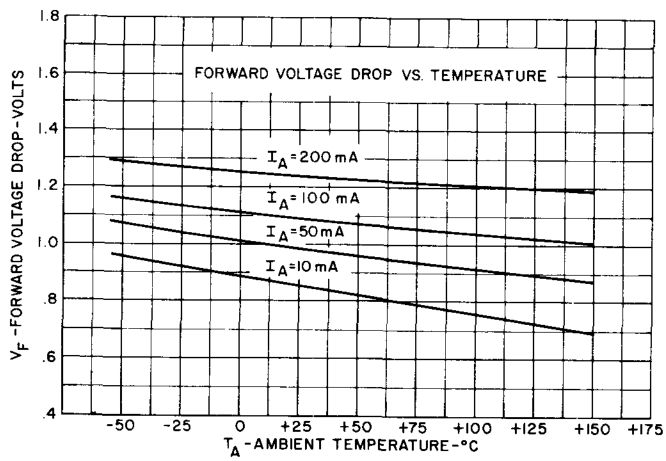


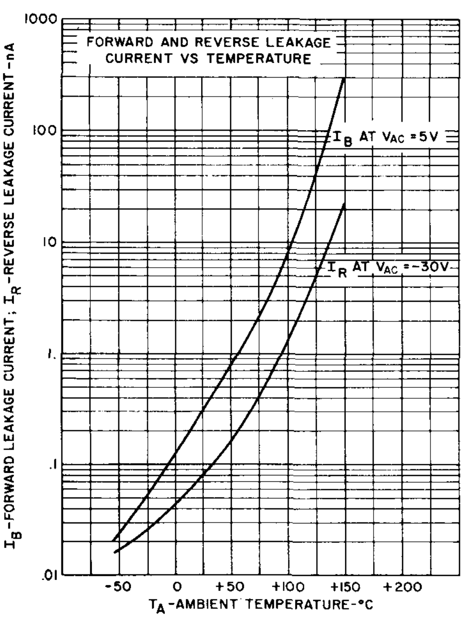
TYPICAL CHARACTERISTICS

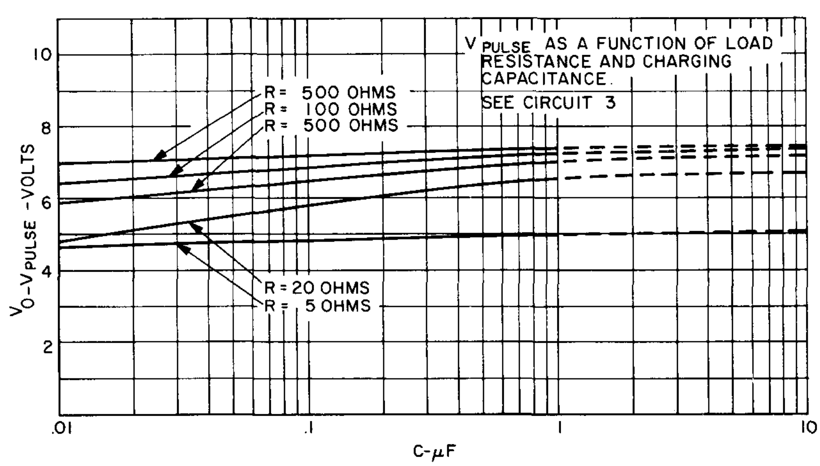








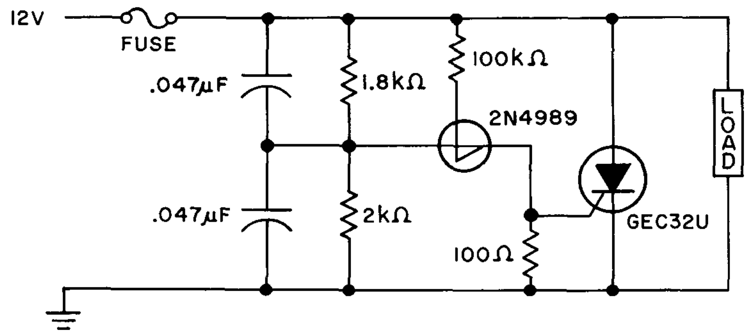




APPLICATIONS

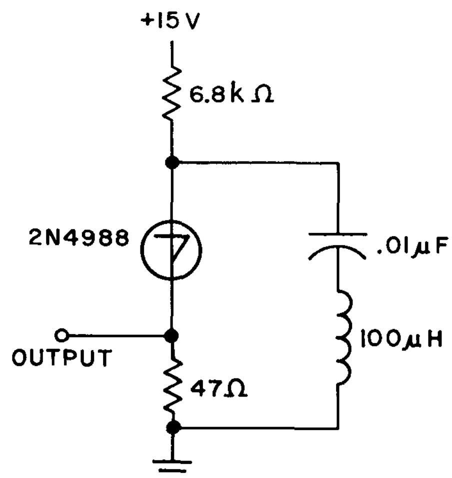
OVERVOLTAGE PROTECTION CIRCUIT

For overvoltages, SCR turns on and blows fuse. For rapidly rising voltages, circuit triggers between 13.2 & 14 volts. For slowly increasing voltages, circuit triggers between 14 & 17 volts.



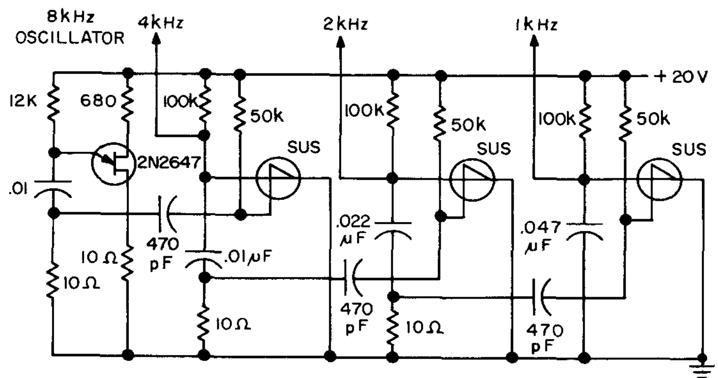
10kHz OSCILLATOR

Capacitor charges until switching voltage is reached. When SUS switches on, inductor causes current to ring. When current thru SUS drops below holding current, device turns off and cycle repeats.



FREQUENCY DIVIDER WITH TRANSIENT FREE OUTPUT

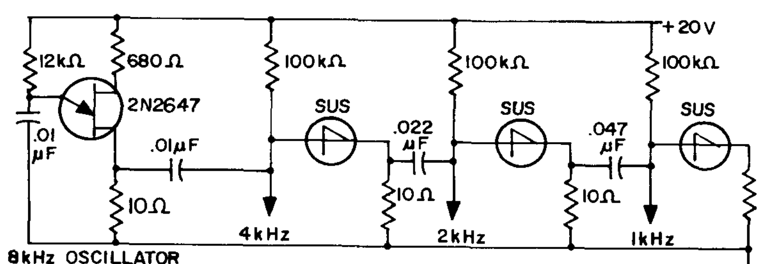
Spikes in center of sawtooth are eliminated in this circuit by triggering at gate.



SUS - 2N4989

FREQUENCY DIVIDER CHAIN

Sawtooth Output from each stage is one half frequency of preceding stage.



SUS - 2N4989

Silicon Economy

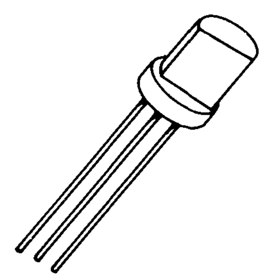
Bilateral Switch

(SBS)

2N4991

The General Electric SBS is a silicon planar, monolithic integrated circuit having the electrical characteristics of a bilateral thyristor. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient and excellently matched characteristics in both directions. A gate lead is provided to eliminate rate effect and to obtain triggering at lower voltages.

The Silicon Bilateral Switches are specifically designed and characterized for applications where stability of switching voltage over a wide temperature range and well matched bilateral characteristics are an asset. They are ideally suited for half wave and full wave triggering in low voltage SCR and Triac phase control circuits. The 2N4991 is in the low cost, TO-98 plastic package.

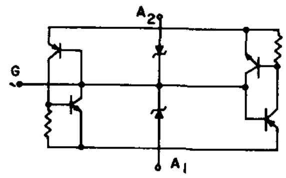


absolute maximum ratings: (25°C free air) (unless otherwise specified)

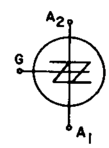
Storage Temperature Range	−65 to +150	°C
Operating Junction Temperature Range	−55 to +125	°C
Power Dissipation*	300	mW
DC Forward Anode Current*	175	mA
DC Gate Current *†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

*Derate linearly to zero at 125°C.

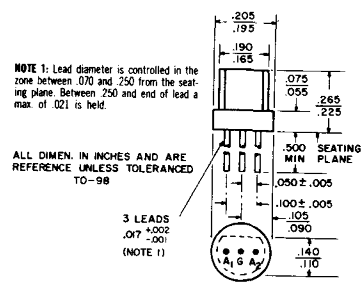
†This rating applicable only on OFF state. Maximum gate current in conducting state limited by maximum power rating.



EQUIVALENT CIRCUIT



CIRCUIT SYMBOL

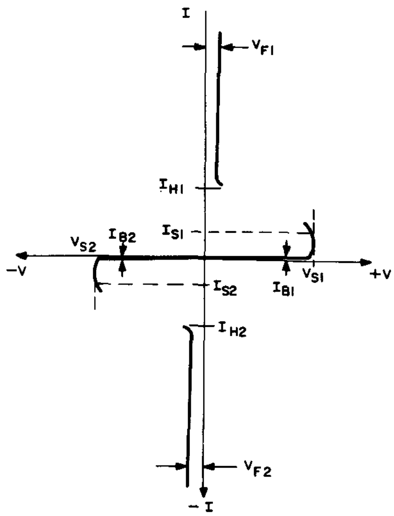


electrical characteristics:** (25°C) (unless otherwise specified)

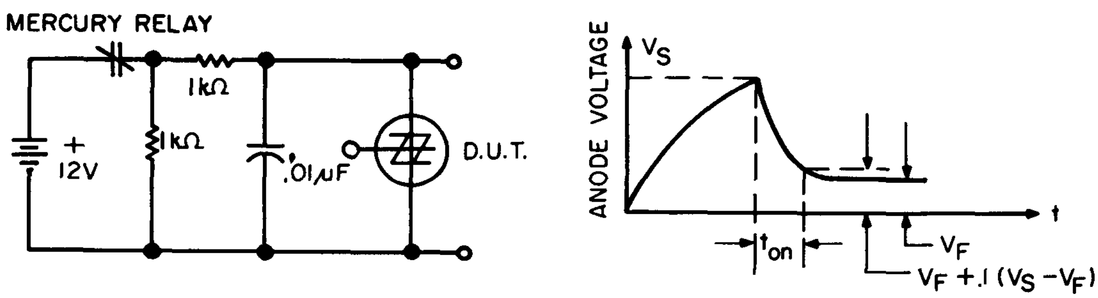
		Min.	Typ.	Max.	
STATIC					
Switching Voltage	V_S	6		10	V
Switching Current	I_S			500	μA
Absolute Switching Voltage Difference	$\lvert V_{S2} - V_{S1} \rvert$			.5	V
Absolute Switching Current Difference	$\lvert I_{S2} - I_{S1} \rvert$			100	μA
Holding Current	I_H			1.5	mA
Current (Off State) ($V_F = 5V$, $T_A = 25°C$)	I_B			1.0	μA
($V_F = 5V$, $T_A = 85°C$)	I_B			10.0	μA
Temperature Coefficient of Switching Voltage ($T_A = -55°C$ to $+85°C$)	T_C		±.02		%/°C
Forward Voltage Drop (On State) ($I_F = 175$ mA)	V_F			1.70	V
DYNAMIC					
Turn-on Time (See Circuit 1)	t_{on}			1.0	μsec
Peak Pulse Amplitude (See Circuit 3)	V_o	3.5			V
Turn-off Time (See Circuit 2)	t_{off}			30.0	μsec

**This device is a symmetrical negative resistance diode. All electrical limits shown apply in either direction of current flow.

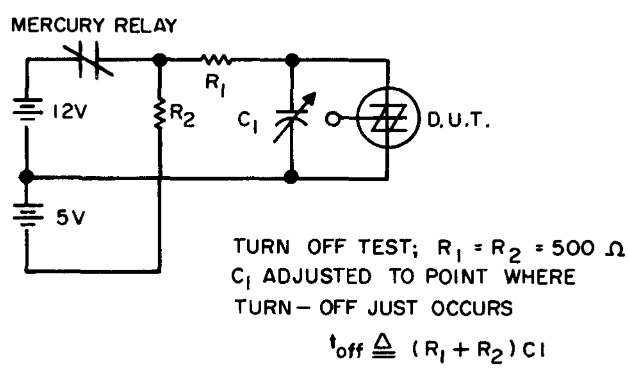
STATIC CHARACTERISTICS



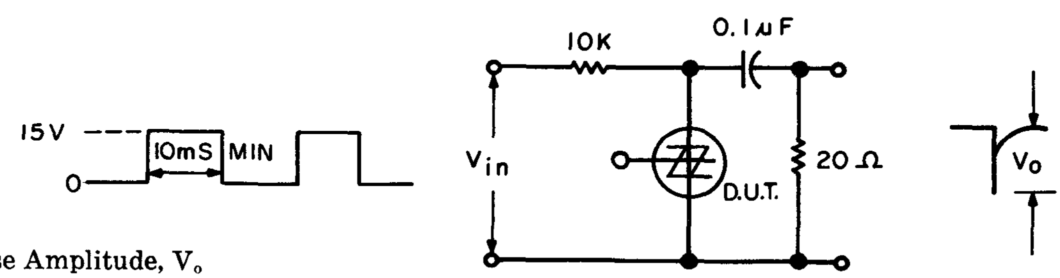
TEST CIRCUITS



Circuit 1
Turn-on Time, t_{on}

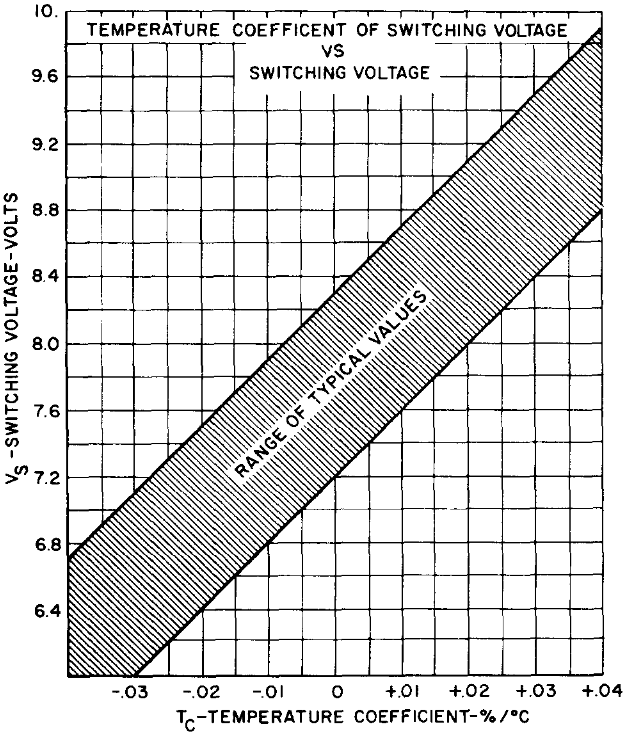


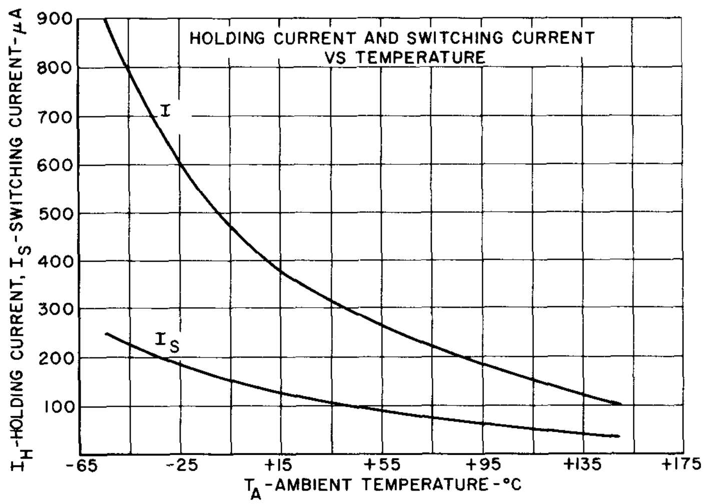
Circuit 2
Turn-off Time, t_{off}

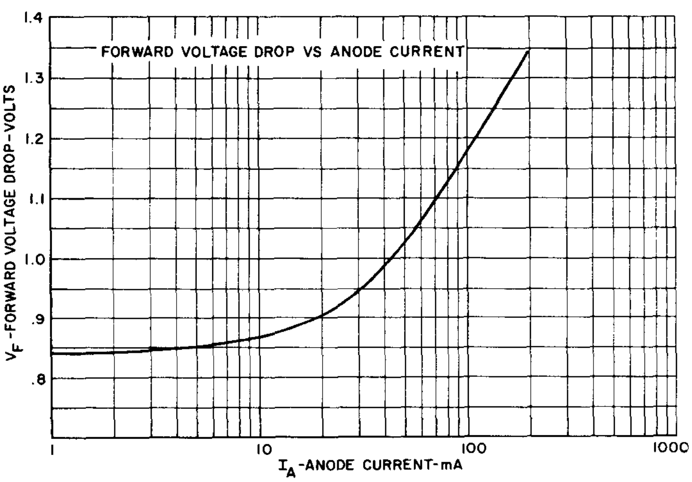


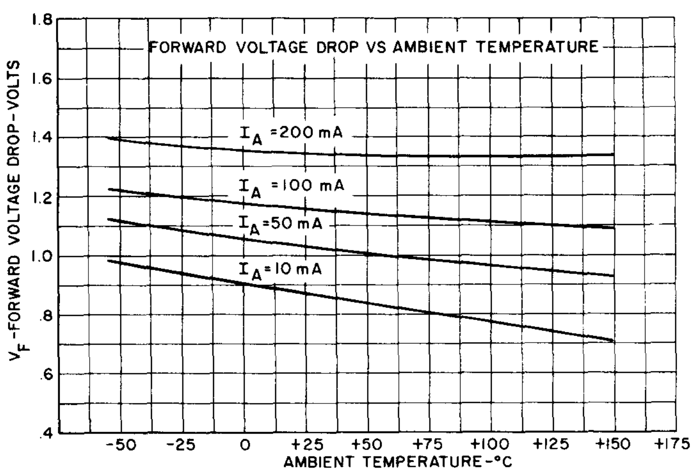
Circuit 3
Peak Pulse Amplitude, V_o

TYPICAL CHARACTERISTICS

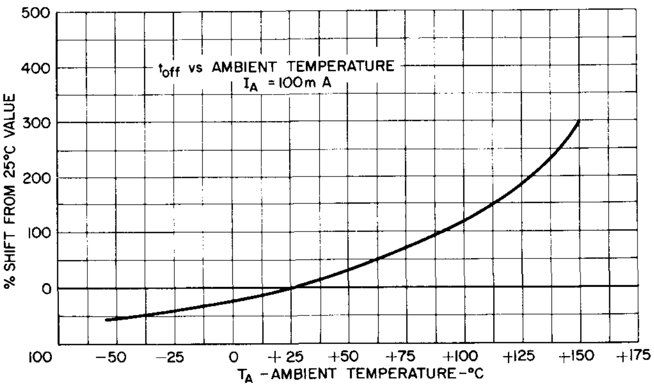


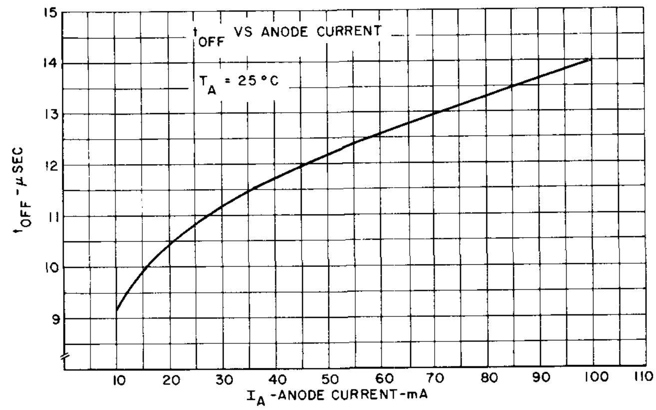


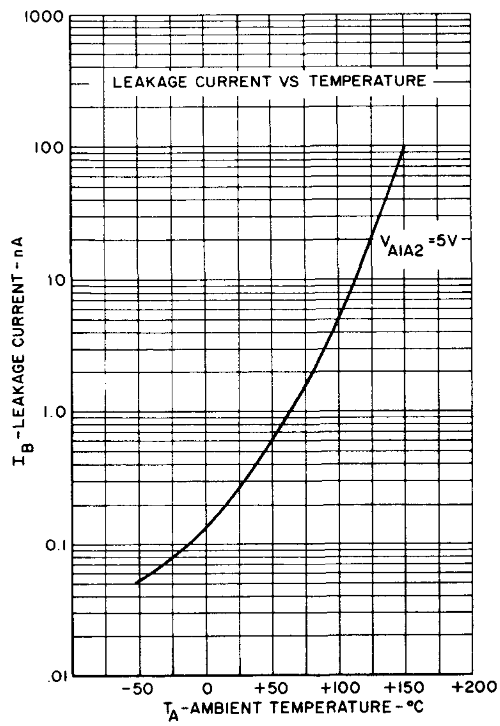


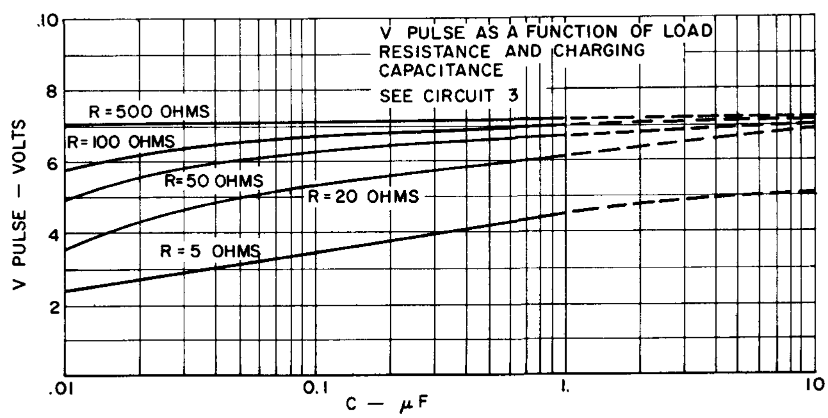


TYPICAL CHARACTERISTICS







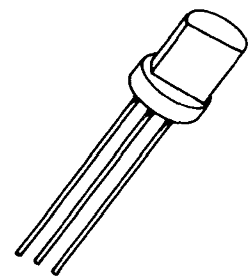


Silicon Economy

Bilateral Switch

(SBS)

2N4992



The General Electric SBS is a silicon planar, monolithic integrated circuit having the electrical characteristics of a bilateral thyristor. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient and excellently matched characteristics in both directions. A gate lead is provided to eliminate rate effect and to obtain triggering at lower voltages.

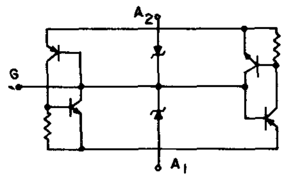
The Silicon Bilateral Switches are specifically designed and characterized for applications where stability of switching voltage over a wide temperature range and well matched bilateral characteristics are an asset. They are ideally suited for half wave and full wave triggering in low voltage SCR and Triac phase control circuits. The 2N4992 is in the low cost, TO-98 plastic package.

absolute maximum ratings: (25°C free air) (unless otherwise specified)

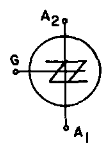
Storage Temperature Range	−65 to +150	°C
Operating Junction Temperature Range	−55 to +150	°C
Power Dissipation*	350	mW
DC Forward Anode Current*	200	mA
DC Gate Current*†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

*Derate linearly to zero at 150°C.

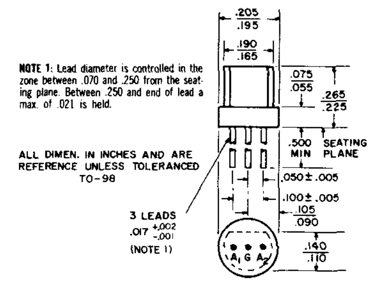
†This rating applicable only on OFF state. Maximum gate current in conducting state limited by maximum power ratings.



EQUIVALENT CIRCUIT



CIRCUIT SYMBOL

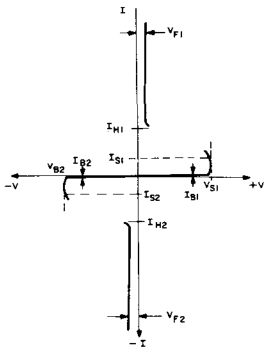


electrical characteristics:** (25°C) (unless otherwise specified)

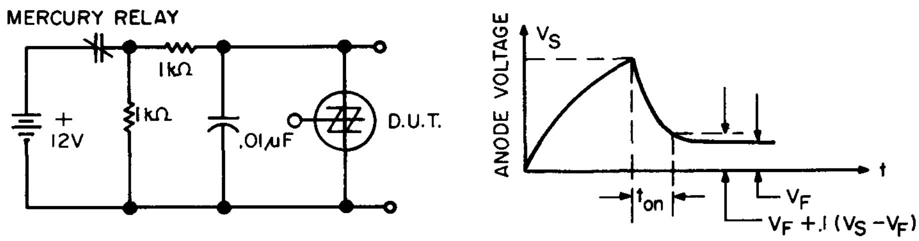
STATIC		Min.	Max.	
Switching Voltage	V_S	7.5	9.0	V
Switching Current	I_S		120	μA
Forward Gate Current to Trigger ($V_F = 5V$, $R_L = 1k\ \Omega$)	I_{GF}		100	μA
Absolute Switching Voltage Difference	$\mid V_{S2} - V_{S1} \mid$		.2	V
Absolute Switching Current Difference	$\mid I_{S2} - I_{S1} \mid$		10.0	μA
Holding Current	I_H		.5	mA
Current (Off State) ($V_F = 5V$, $T_A = 25°C$)	I_B		0.1	μA
($V_F = 5V$, $T_A = 100°C$)	I_B		10.0	μA
Temperature Coefficient of Switching Voltage ($T = -55°C$ to $+100°C$)	T_C		±.05	%/°C
Forward Voltage Drop (On State) ($I_F = 200$ mA)	V_F		1.70	V
DYNAMIC				
Turn-on Time (See Circuit 1)	t_{on}		1.0	μsec
Turn-off Time (See Circuit 2)	t_{off}		30	μsec
Peak Pulse Amplitude (See Circuit 3)	V_o	3.5		V

**This device is a symmetrical negative resistance diode. All electrical limits shown apply in either direction of current flow.

STATIC CHARACTERISTICS

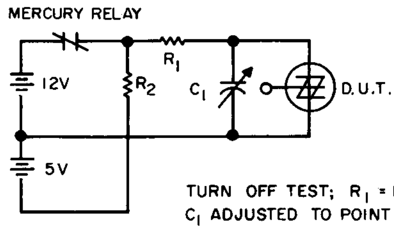


TEST CIRCUITS



Circuit 1

Turn-on Time, t_{on}

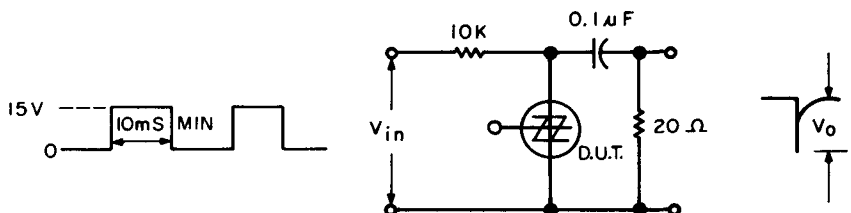


TURN OFF TEST; $R_1 = R_2 = 500\ \Omega$
C_1 ADJUSTED TO POINT WHERE
TURN– OFF JUST OCCURS

$t_{off} \triangleq (R_1 + R_2) C_1$

Circuit 2

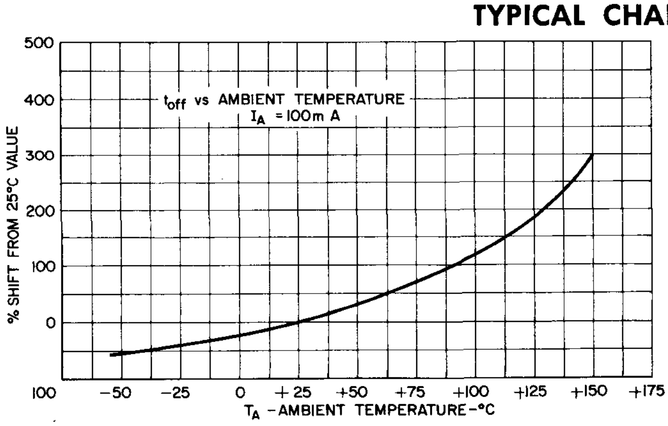
Turn-off Time, t_{off}

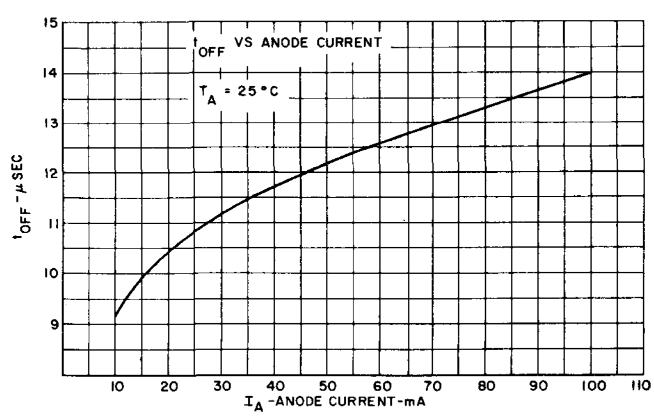


Circuit 3

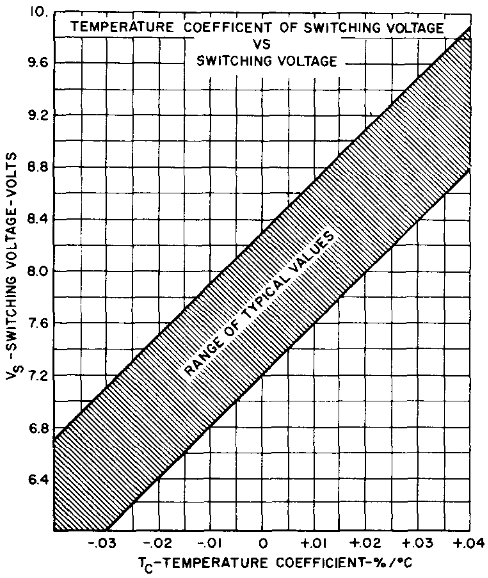
Peak Pulse Amplitude, V_o

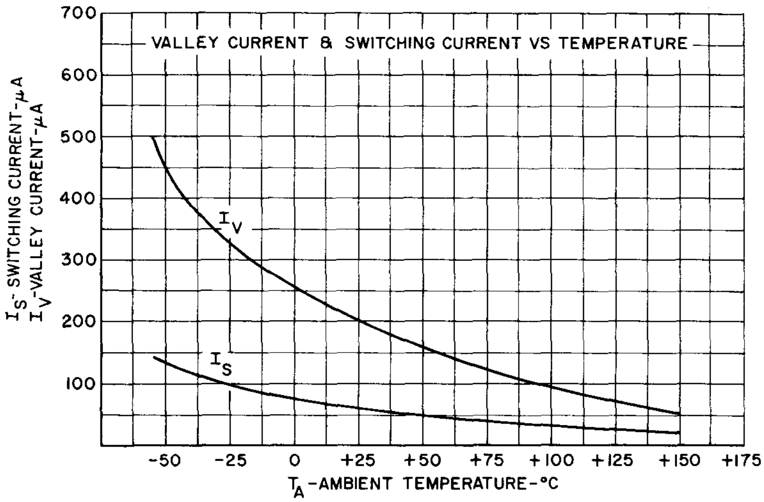
TYPICAL CHARACTERISTIC CURVES

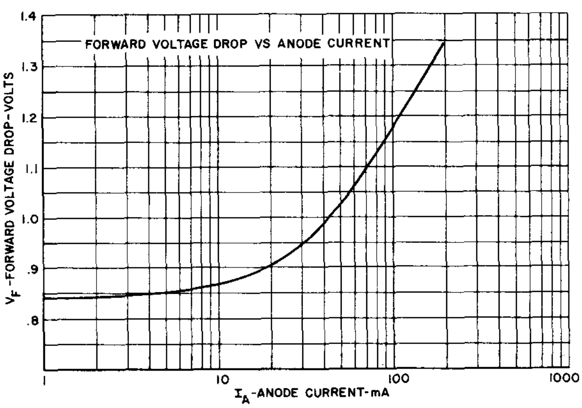


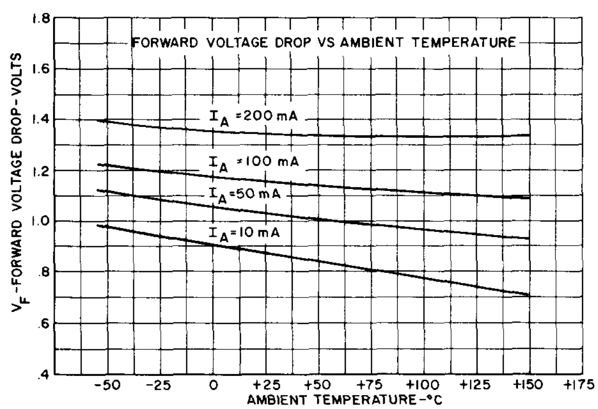


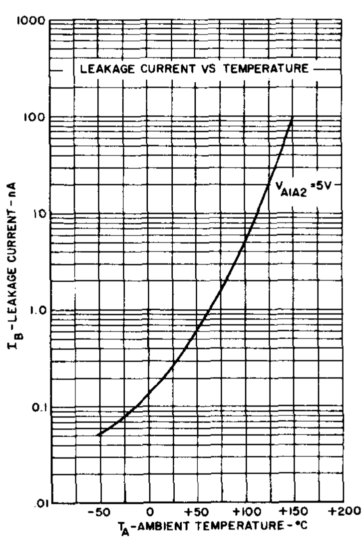
TYPICAL CHARACTERISTICS

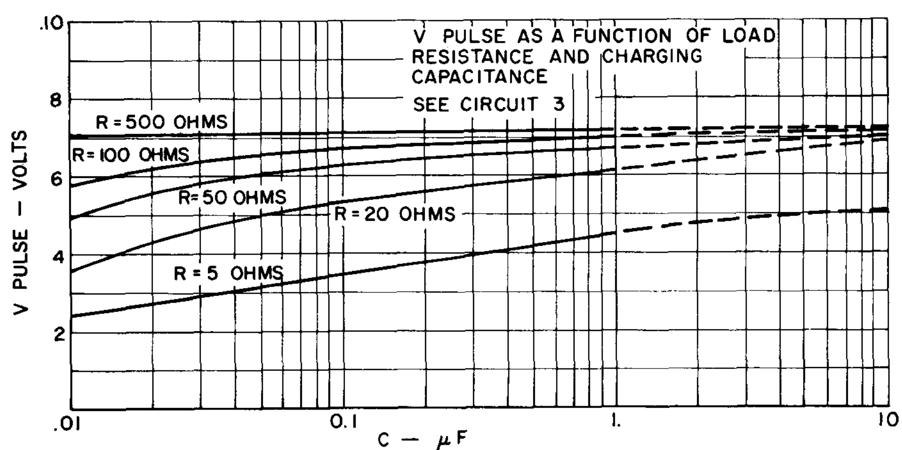












APPLICATION IN HYSTERESIS-FREE PHASE CONTROL CIRCUIT

The circuit in Figure 1 is a simple hysteresis-free phase control circuit intended for lamp dimming and similar applications. The circuit requires only one RC phase lag network. To avoid the hysteresis (or "snap-on") effect, the capacitor, C, is reset to approximately 0 volts at the end of every positive half cycle (for pot values such that no power is applied to the load). This is accomplished using the gate lead. At the end of the positive half, as the line voltage drops below the capacitor voltage, gate current flows from C out through the gate, D1 and 47k Ω resistor. The SBS fires and discharges C to 0 volts. In the negative half cycle diodes D2 and D1 clamp the gate voltage to ground and block the flow of gate current respectively. Electrical requirements of D1 and D2 are easily met. Any diode with $V_R > 10$ volts works fine. Forward conductance must be fairly good since the voltage across D2 at 3mA must be smaller than the drop across the Triac gate, the SBS gate, and D1 at the trigger current of the SBS. The General Electric 6RS5GC1UAJ1 (common cathode) dual diode makes an excellent choice. These are available from General Electric Semiconductor Products Department, Lynchburg, Virginia.

Figure 2 shows the excellent degree of phase control available in the circuit. For the worst case unit, $\phi max = 155°$ ($V_S = 7.5$ volts, $I_S = 120\mu A$).

FIGURE 1

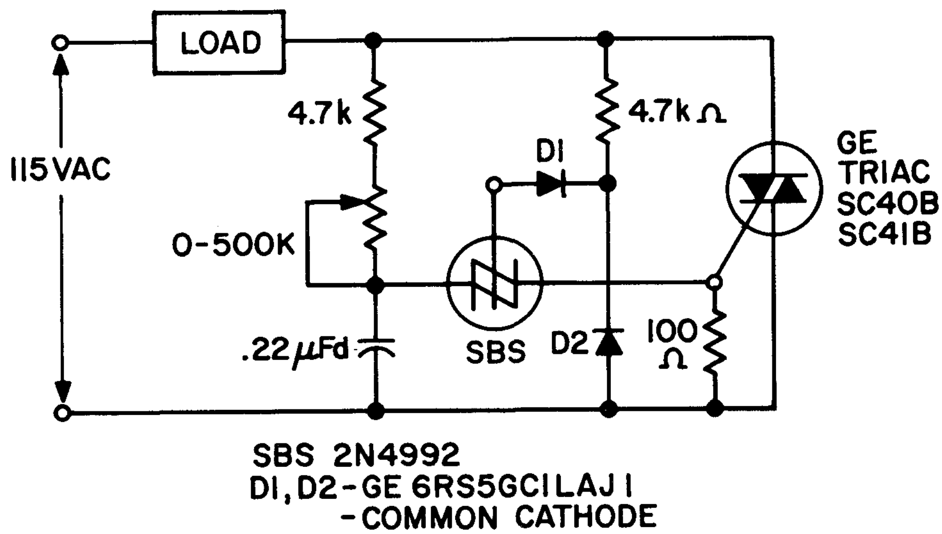
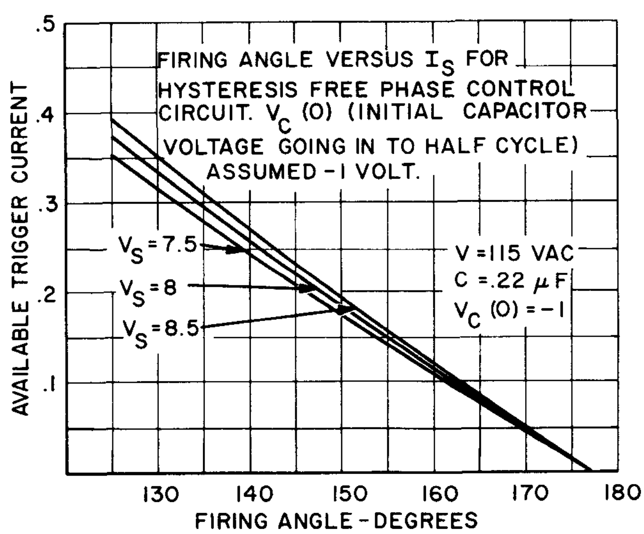


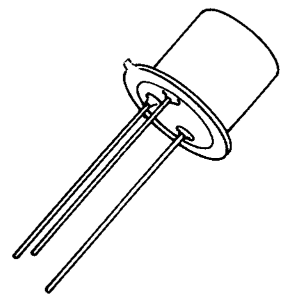
FIGURE 2



Silicon
Bilateral Switch
(SBS)

2N4993

The General Electric SBS is a silicon planar, monolithic integrated circuit having the electrical characteristics of a bilateral thyristor. The device is designed to switch at 8 volts with a 0.02%/°C temperature coefficient and excellently matched characteristics in both directions. A gate lead is provided to eliminate rate effect and to obtain triggering at lower voltages.



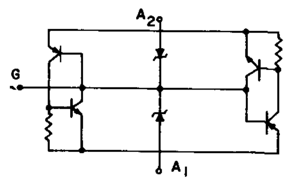
The Silicon Bilateral Switches are specifically designed and characterized for applications where stability of switching voltage over a wide temperature range and well matched bilateral characteristics are an asset. They are ideally suited for half wave and full wave triggering in low voltage SCR and Triac phase control circuits. The 2N4993 is in the TO-18 hermetic package.

absolute maximum ratings: (25°C free air) (unless otherwise specified)

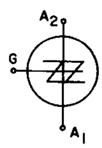
Storage Temperature Range	−65 to +200	°C
Operating Junction Temperature Range	−55 to +150	°C
Power Dissipation*	350	mW
DC Forward Anode Current*	200	mA
DC Gate Current *†	5	mA
Peak Recurrent Forward Current (1% duty cycle, 10 μsec pulse width, $T_A = 100°C$)	1.0	Amp
Peak Non-Recurrent Forward Current (10 μsec pulse width, $T_A = 25°C$)	5.0	Amps

*Derate linearly to zero at 150°C.

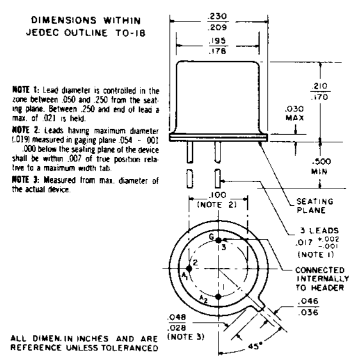
†This rating applicable only on OFF state. Maximum gate current in conducting state limited by maximum power rating.



EQUIVALENT CIRCUIT



CIRCUIT SYMBOL

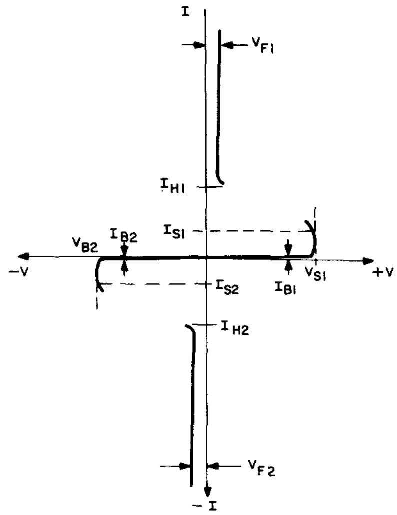


electrical characteristics:** (25°C) (unless otherwise specified)

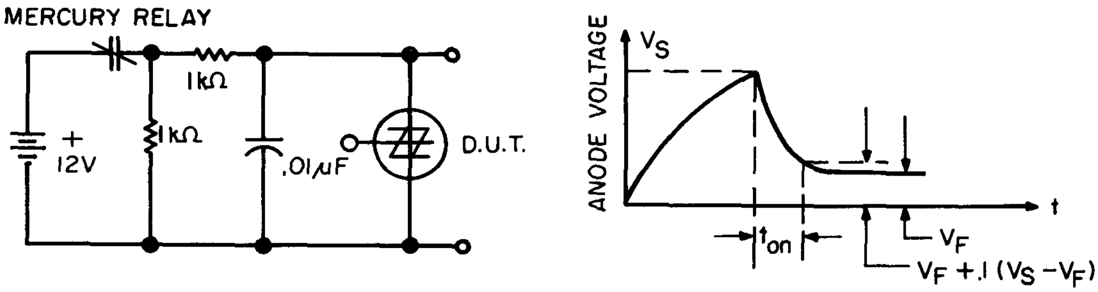
STATIC		Min.	Typ.	Max.	
Switching Voltage	V_S	6		10	V
Switching Current	I_S			500	μA
Absolute Switching Voltage Difference	$\lvert V_{S2} - V_{S1} \rvert$			.5	V
Absolute Switching Current Difference	$\lvert I_{S2} - I_{S1} \rvert$			100	μA
Holding Current	I_H			1.5	mA
Current (Off State) ($V_F = 5V$, $T_A = 25°C$)	I_B			1.0	μA
($V_F = 5V$, $T_A = 100°C$)	I_B			10.0	μA
Temperature Coefficient of Switching Voltage ($T = -55°C$ to $+100°C$)	T_C		+.02		%/°C
Forward Voltage Drop (On State) ($I_F = 200$ mA)	V_F			1.70	V
DYNAMIC					
Turn-on Time (See Circuit 1)	t_{on}			1.0	μsec
Peak Pulse Amplitude (See Circuit 2)	V_o	3.5			V
Turn-off Time (See Circuit 3)	t_{off}			30.0	μsec

**This device is a symmetrical negative resistance diode. All electrical limits shown apply in either direction of current flow.

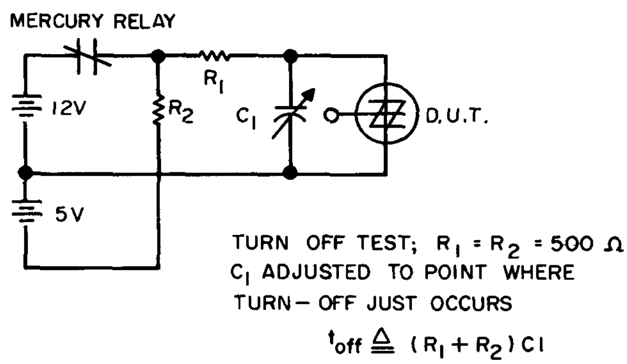
STATIC CHARACTERISTICS



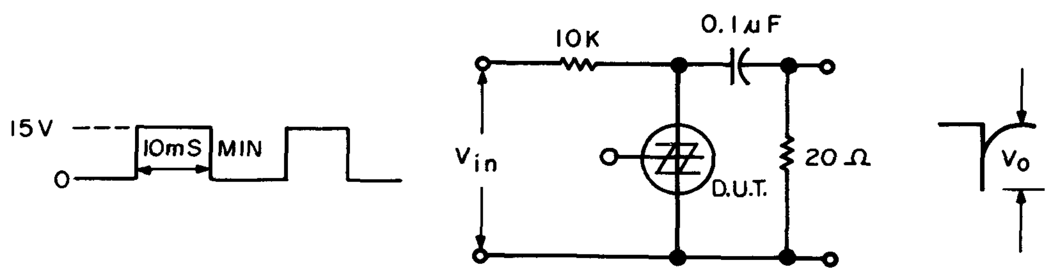
TEST CIRCUITS



Circuit 1
Turn-on Time, t_{on}

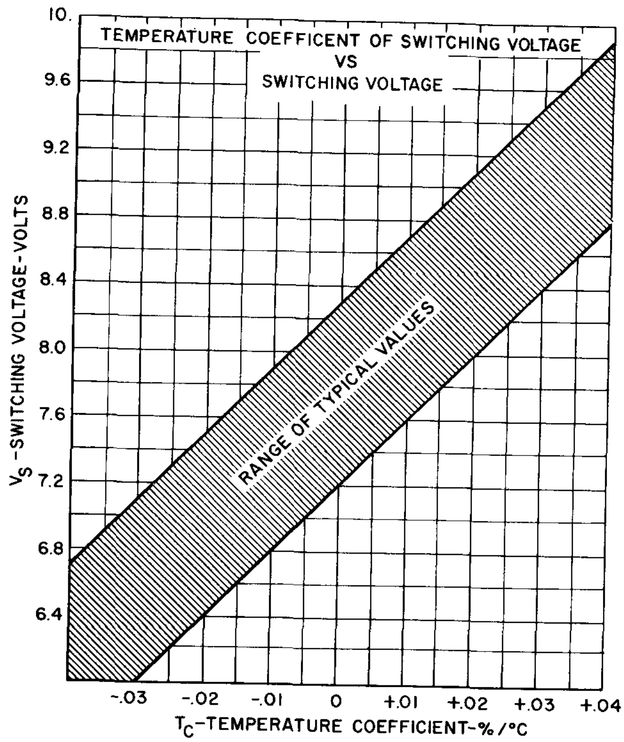


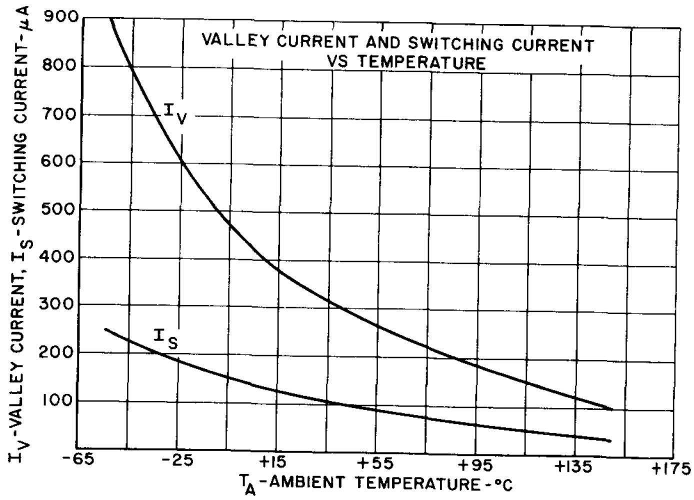
Circuit 2
Turn-off Time, t_{off}

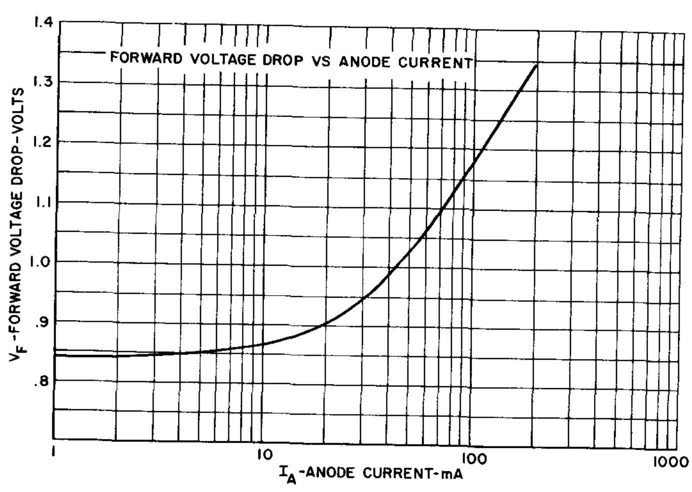


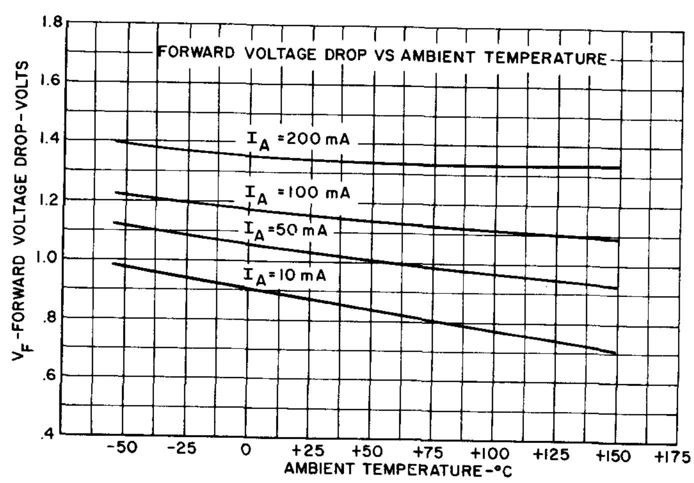
Circuit 3
Peak Pulse Amplitude, V_o

TYPICAL CHARACTERISTICS

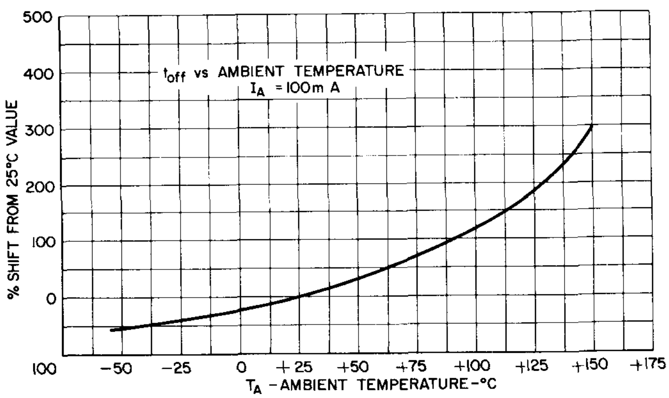


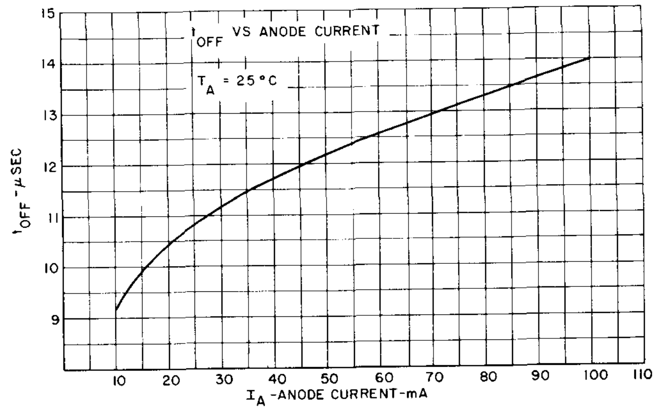


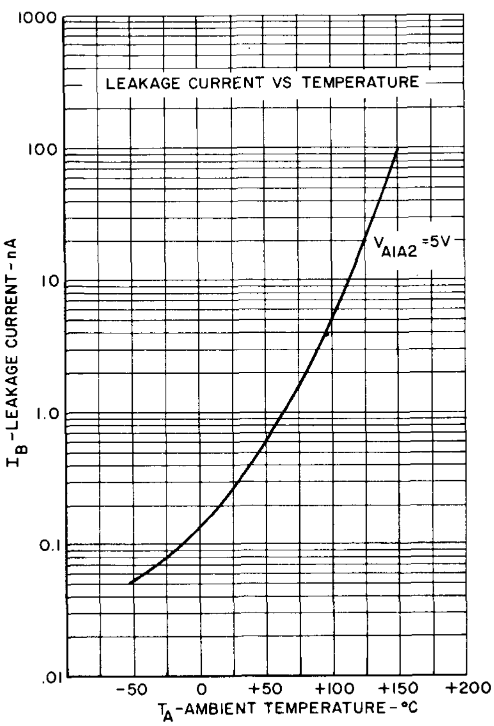


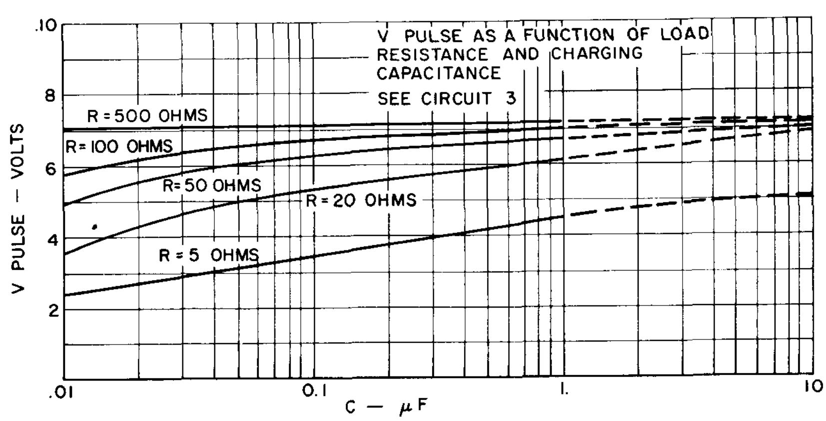


TYPICAL CHARACTERISTICS









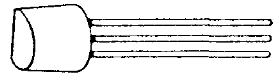
Silicon
Controlled Rectifier

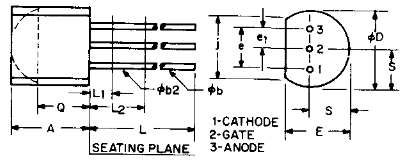
0.8A RMS UP TO 200 VOLTS

2N5060 thru 2N5064

TYPICAL APPLICATIONS:

- Sensors
  - Temperature
  - Pressure
  - Dryness
  - Proximity
  - Voltage
  - Current
- Amplifiers (gate)
- Timers
- Logic Circuits
- Controls
  - Small Motors
  - Small Lamps
  - Remote
- Switching
  - Solid-State Relay
  - Relay Driver
  - Counter
  - Low Power Inverter
- 120V AC Line Operation





SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.170	.210	4.58	5.33	
ϕb	.016	.021	.407	.533	1,3
ϕb2	.016	.019	.407	.482	3
ϕD	.175	.205	4.96	5.20	
E	.125	.165	3.94	4.19	
e	.095	.105	2.42	2.66	
e_1	.045	.055	1.15	1.39	
j	.135	–	3.43	–	
L	.500	–	12.70	–	1,3
L_1	–	.050	–	1.27	3
L_2	.250	–	6.35	–	3
Q	.115	–	2.93	–	2
S	.080	.105	2.42	2.66	

NOTES:
1. THREE LEADS.
2. CONTOUR OF THE PACKACE BEYOND THIS ZONE IS UNCONTROLLED.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND .5 INCH (12.70 MM) FROM SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND .5 INCH (12.70 MM FROM SEATING PLANE.

FEATURES:

- 200 μA Gate Sensitivity
- 6-Amp Surge
- 30 through 200 Volt Selection
- Plastic TO-92 Package
- Low V_F
- High dv/dt

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}(1) T_C = -65°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{DRM}(2) T_C = -65°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}(2,3) T_C = -65°C to +125°C
2N5060	30 Volts*	30 Volts*	45 Volts*
2N5061	60 Volts*	60 Volts*	80 Volts*
2N5062	100 Volts*	100 Volts*	125 Volts*
2N5063	150 Volts*	150 Volts*	180 Volts*
2N5064	200 Volts*	200 Volts*	230 Volts*

RMS On-State Current, $I_{T(RMS)}$(4) . . . . 0.8 Ampere*
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} . . . . 6 Amperes*
Peak Gate Power Dissipation, P_{GM} . . . . 5 Watts*
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 0.01 Watt*
Peak Forward Gate Current, I_{GM} . . . . 1 Ampere*
Peak Reverse Gate Voltage, V_{GM} . . . . 5 Volts*
Storage Temperature, T_{STG} . . . . -65°C to +150°C*
Operating Junction Temperature, T_J . . . . -65°C to +125°C*

1 R_{GK} = 1000 ohms.
2 Values apply for zero or negative gate voltage only.
3 Half sine wave voltage pulse, 5 millisecond duration.
4 Maximum Allowable Case Temperature is 67°C for half sine wave of current at 60 Hz.
*Indicates JEDEC Registered Data.

2N5060
THRU
2N5064

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Off-State Current (All Types)	I_{RRM} or I_{DRM}	–	–	1.0	μA	T_C = +25°C, R_{GK} = 1000 ohms V_{RRM} = V_{DRM} = Rated Value.
		–	–	*50		T_C = +125°C, R_{GK} = 1000 ohms V_{RRM} = V_{DRM} = Rated Value.
DC Gate Trigger Current	I_{GT}	–	–	200	μAdc	T_C = +25°C, V_D = 7Vdc, R_L = 100 ohms.
		–	–	*350		T_C = -65°C, V_D = 7Vdc, R_L = 100 ohms.
DC Gate Trigger Voltage	V_{GT}	–	–	0.8	Vdc	T_C = +25°C, V_D = 7Vdc, R_L = 100 ohms.
		–	–	*1.2		T_C = -65°C, V_D = 7Vdc, R_L = 100 ohms.
		*0.1	–	–		T_C = +125°C, Rated V_{DRM}, R_L = 100 ohms.
Peak On-State Voltage	V_{TM}	–	–	*1.7	V	T_C = +25°C, I_{TM} = 1.2A peak, 1 msec. wide pulse, Duty Cycle $\leqslant$ 2%
Holding Current	I_H	–	–	5.0	mAdc	Anode source voltage = 7Vdc, R_{GK} = 1000 ohms. T_C = +25°C
		–	–	*10.0		T_C = -65°C
Critical Rate-of-Rise of Off-State Voltage	dv/dt	–	20	–	V/μsec	T_C = +25°C, Rated V_{DRM}, R_{GK} = 1000 ohms.
Circuit Commutated Turn-Off Time	t_q	–	15	–	μsec	T_C = +125°C, rectangular current waveform. Rate-of-rise of current <10A/μsec. Rate reversal of current <5A/μsec. I_{TM} = 1A (50 μsec. pulse). Rep. Rate = 60 pps. V_{RRM} = Rated, V_{RX} = 15V Min., V_{DRM} = Rated. Rate-of-rise of reapplied off-state voltage = 20V/μsec.; Gate Bias = 0 Volts, 100 Ohms (during turn-off time interval).
Steady State Thermal Resistance	$R_{\theta JC}$	–	–	*75	°C/W	Junction-to-case (flat side of case is temperature reference point).
	$R_{\theta JA}$	–	–	230		Junction-to-ambient (free convection).

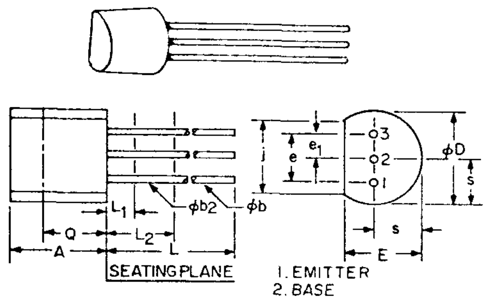
*Indicates JEDEC Registered Data.

NPN

2N5088
2N5089

Silicon Transistors

The General Electric 2N5088 and 2N5089 are Silicon NPN Planar Epitaxial Passivated Transistors designed for low level, low noise amplifier applications.



TO-92

1. EMITTER
2. BASE
3. COLLECTOR

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		2N5088	2N5089	UNITS
Voltages				
Collector to Emitter	V_{CEO}	30	25	Volts
Collector to Base	V_{CBO}	35	30	Volts
Emitter to Base	V_{EBO}	4.5	4.5	Volts
Current				
Collector	I_C	50		mA
Dissipation				
Total Power $T_A \leqslant 25°C$	P_t	350		mW
Total Power $T_C \leqslant 25°C$	P_t	1.0		Watt
Derating Factor $T_A > 25°C$		2.8		mW/°C
Derating Factor $T_C > 25°C$		8		mW/°C
Temperature				
Operating	T_J	-55°C to +150°C		°C
Storage	T_{STG}	-55°C to +150°C		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230°C		°C

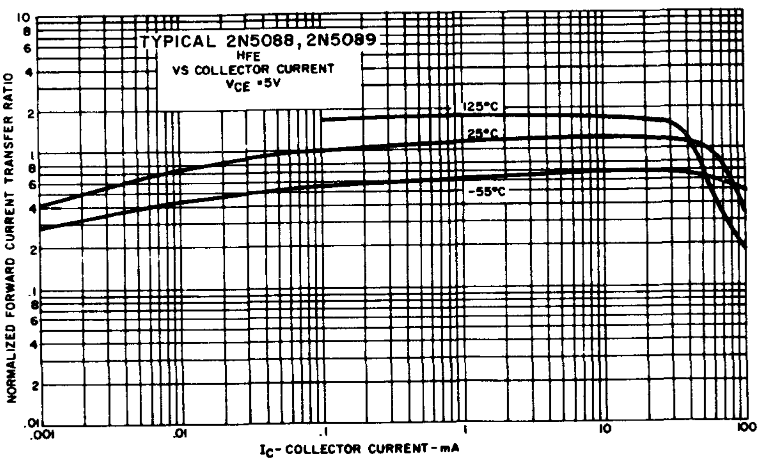
electrical characteristics: (T_A = 25°C unless otherwise specified)

	SYMBOL	2N5088 MIN.	2N5088 MAX.	2N5089 MIN.	2N5089 MAX.	UNITS
Static Characteristics						
Collector-Emitter Breakdown Voltage (I_C = 1mA, I_B = 0)	$V_{(BR)CEO}$	30	–	25	–	Volts
Collector-Base Breakdown Voltage (I_C = 100μA, I_E = 0)	$V_{(BR)CBO}$	35	–	30	–	Volts
Collector Cutoff Current (V_{CB} = 20V, I_E = 0)	I_{CBO}	–	50	–	–	ηA
(V_{CB} = 15V, I_E = 0)	I_{CBO}	–	–	–	50	ηA
Emitter Cutoff Current (V_{EB} = 3V, I_C = 0)	I_{EBO}	–	50	–	50	ηA
(V_{EB} = 4.5V, I_C = 0)	I_{EBO}	–	100	–	100	ηA
Forward Current Transfer Ratio (I_C = 100μA, V_{CE} = 5V)	h_{FE}	300	900	400	1200	
(I_C = 1mA, V_{CE} = 5V)	h_{FE}	350	–	450	–	
(I_C = 10mA, V_{CE} = 5V)	†h_{FE}	300	–	400	–	
Collector-Emitter Saturation Voltage (I_C = 10mA, I_B = 1mA)	†$V_{CE(sat)}$	–	.5	–	.5	Volts
Base-Emitter On-Voltage (I = 10mA, V_{CE} = 5V)	†$V_{BE(on)}$	–	.8	–	.8	Volts

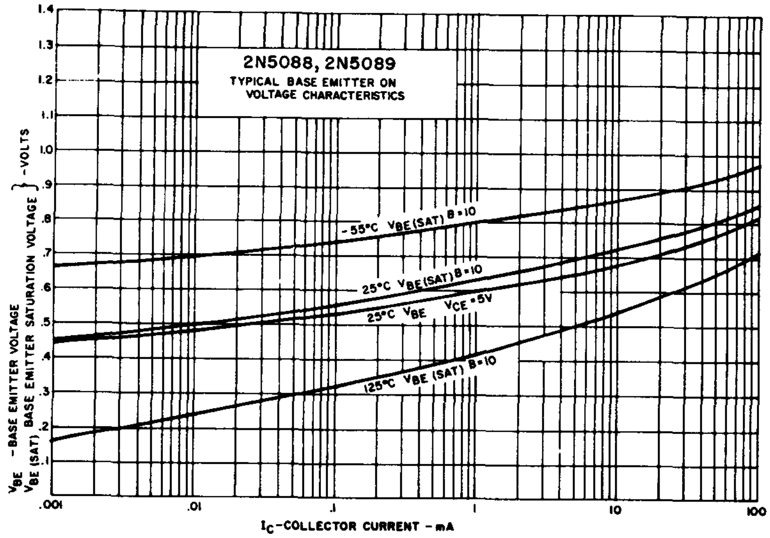
2N5088
2N5089

	SYMBOL	2N5088 MIN.	2N5088 MAX.	2N5089 MIN.	2N5089 MAX.	UNITS
Dynamic Characteristics						
Gain Bandwidth Product (V_{CE} = 5V, I_C = 500μA, f = 20 MHz)	f_t	50	–	50	–	MHz
Collector-Base Capacitance (V_{CB} = 5V, I_E = 0, f = 100 kHz)	C_{cb}	–	4.0	–	4.0	pF
Emitter-Base Capacitance (V_{BE} = .5V, I_C = 0, f = 100 kHz)	C_{eb}	–	10	–	10	pF
Forward Current & Transfer Ratio (V_{CE} = 5V, I_C = 1mA, F = 1 kHz)	h_{fe}	350	1400	450	1800	
Noise Figure (V_{CE} = 5V, I_C = 100μA, Rs, = 10KΩ, BW = 15.7 kHz f = 10Hz to 10kHz)	NF	–	3	–	2	dB

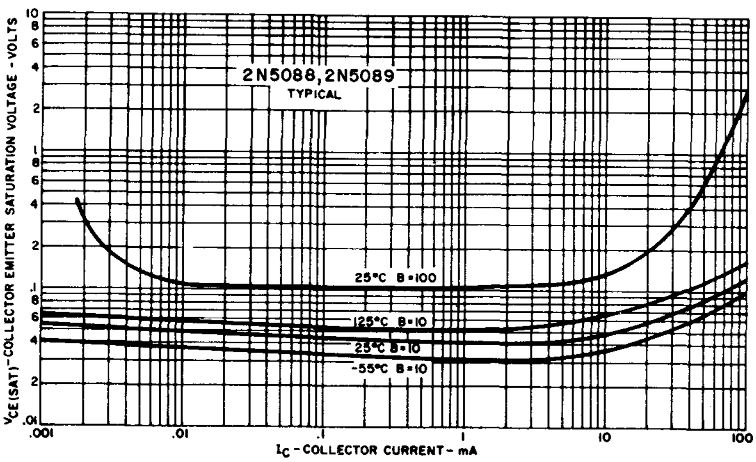
*Indicates JEDEC Registered Data.
†Pulse Width ≤ 300μs, Duty Cycle ≤ 2%.



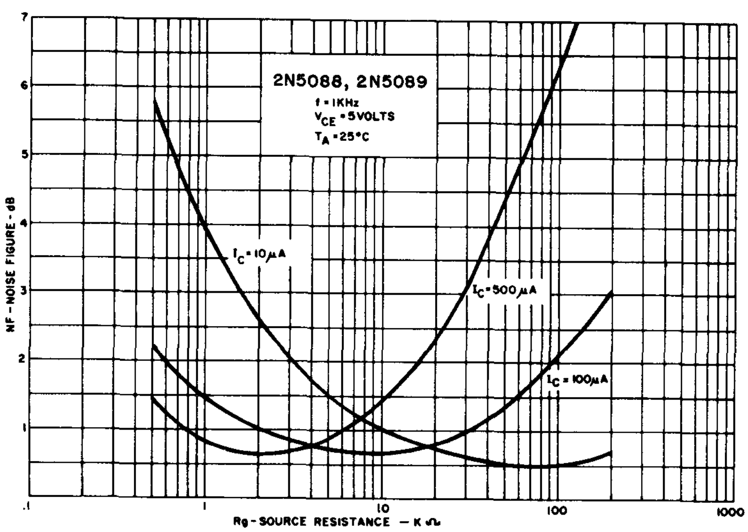
FORWARD CURRENT TRANSFER RATIO NORMALIZED TO .1mA VALUE VS. COLLECTOR CURRENT



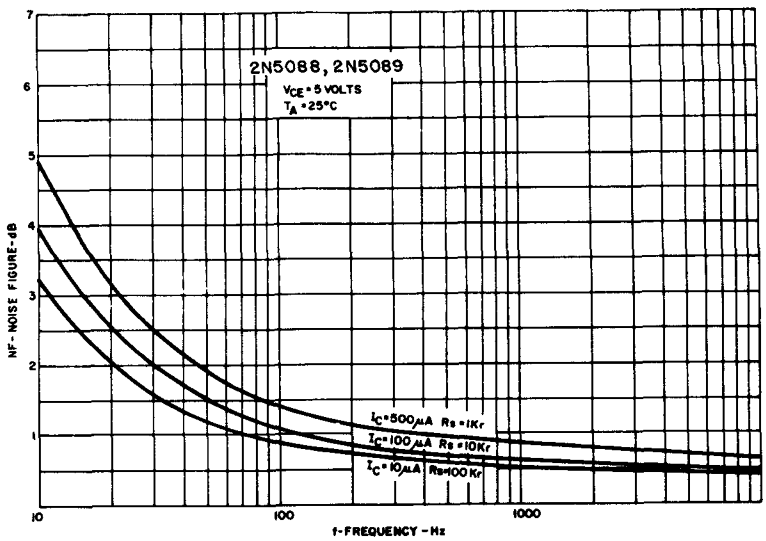
BASE EMITTER VOLTAGE AND BASE EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



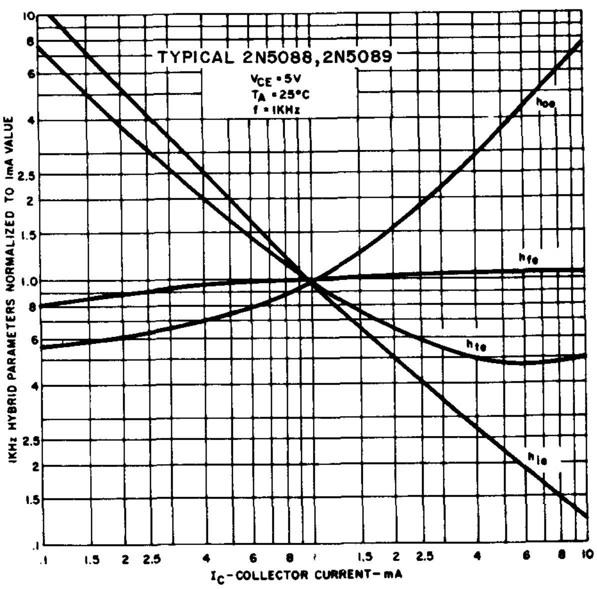
COLLECTOR EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



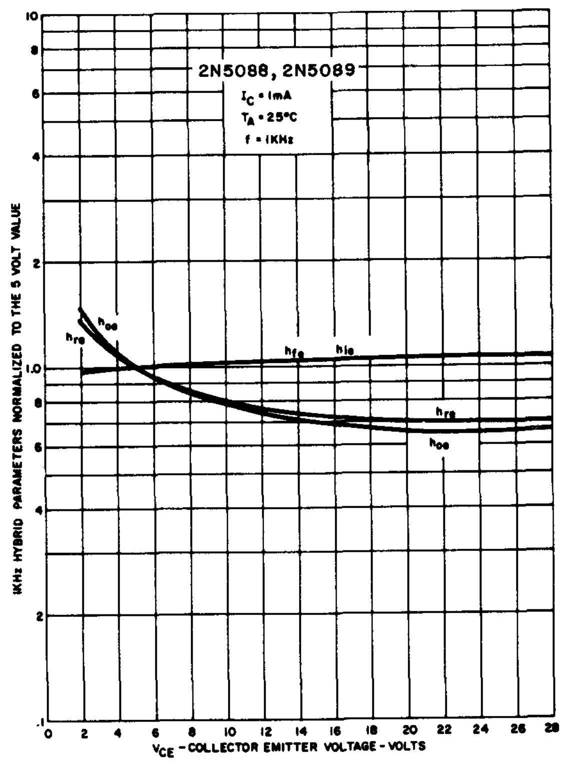
NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY



1kHz HYBRID PARAMETERS VS.
COLLECTOR CURRENT

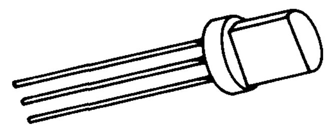


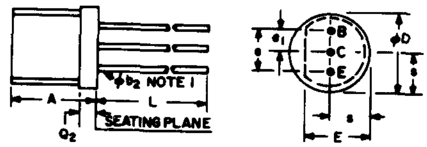
1kHz HYBRID PARAMETERS VS.
COLLECTOR CURRENT

Silicon Transistors

NPN	PNP
2N5172	2N6076

The General Electric 2N5172 and 2N6076 transistors are designed for general purpose applications. The planar, passivated construction assures excellent device stability and life. This high performance and high value is made possible by advanced manufacturing techniques, epoxy encapsulation and utilization of full line beta distribution. Significant savings may be realized by designing equipment utilizing these "full line distribution" type transistors.





SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.170	.265	4.32	6.73
φb2	.016	.019	.406	.483
φD	.165	.205	4.19	5.21
E	.110	.155	2.79	3.94
e	.095	.105	2.41	2.67
e1	.045	.055	1.14	1.40
L	.500		12.70	
Q2		.075		1.90
s	.080	.115	2.03	2.92

NOTE I: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .070 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to emitter*	V_{CEO}	25	Volts
Emitter to base*	V_{EBO}	5	Volts
Collector to base*	V_{CBO}	25	Volts
Current			
Collector (steady state)†*	I_C	100	mA
Dissipation			
Total Power (free air at 25° C)††*	P_T	360	mW
Temperature			
Storage*	T_{stg}	−55 to +150	°C
Operating	T_j	+125	°C
Lead Temperature, 1/16″ ± 1/32″ from case for 10 seconds maximum	T_L	+260	°C

†Determined from power limitations due to saturation voltage at this current.
††Derate 3.6 mW/°C increase in ambient temperature above 25° C.

electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics		Min.	Typ.	Max.	
Collector Cutoff Current (V_{CB} = 25V),*	I_{CBO}			100	nA
(V_{CB} = 25V; T_A = 100°C)	I_{CBO}			10	μA
Collector Cutoff Current (V_{CB} = 25V)	I_{CES}			100	nA
Emitter Cutoff Current (V_{EB} = 5V)* 2N5172	I_{EBO}			100	nA
(V_{EB} = 3V)* 2N6076	I_{EBO}			100	nA
Forward Current Transfer Ratio (V_{CE} = 10V, I_C= 10 mA)*	h_{FE} ‡	100		500	
Collector-Emitter Breakdown Voltage (I_C= 10 mA)*	$V_{(BR)CEO}$	25			Volts
Collector Saturation Voltage (I_C= 10 mA, I_B= 1 mA)*	$V_{CE(sat)}$			.25	Volts
Base Saturation Voltage (I_C= 10 mA, I_B= 1 mA)	$V_{BE(sat)}$			.80	Volts
Base Emitter Voltage (V_{CE} = 10V, I_C= 10 mA)*	V_{BE}	0.5		1.2	Volts
Dynamic Characteristics					
Forward Current Transfer Ratio (V_{CE} = 10V, I_C = 10 mA, f = 1 kHz)*	h_{fe}	100		750	
Output Capacitance, Common Base (V_{CB} = 10V, I_E = 0, f = 1 MHz)	C_{cb}	1.0		13	pF
Gain Bandwidth Product (V_{CB} = 5V, I_C = 2 mA)*	f_T		200		MHz

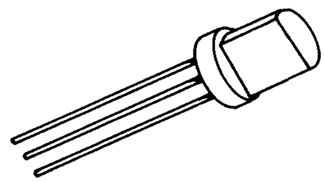
‡Typically a minimum of 50% of the distribution will have h_{FE} > 150 at stated conditions.
Note: Polarities are absolute.
*Registered Values

Silicon Transistors

NPN

2N5174,5,6

The General Electric 2N5174-2N5176 are NPN silicon planar passivated transistors designed for high voltage applications. They are especially suited for driving high voltage indicating devices. The planar, passivated construction assures excellent device stability and life. These high performance, high value transistors are made possible by advanced manufacturing techniques and epoxy encapsulation.



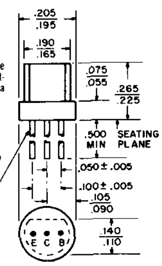
absolute maximum ratings: (25°C) (unless otherwise specified)

		2N5174	2N5175, 6	
Voltages				
Collector to Emitter	V_{CEO}	75	100	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	90	130	Volts
Current				
Collector (Steady State)*	I_C	25	25	mA
Dissipation				
Total Power (free air @ 25°C)†	P_T	360	200	mW
Total Power (free air @ 55°C)†	P_T	260	120	mW
Temperature				
Storage	T_{stg}	−55 to +150°C		
Operating	T_J	−55 to +125°C		
Lead soldering, 1/16" to 1/32" from case for 10 seconds max.	T_L	+260°C		

*Determined from power limitations due to saturation voltage at this current.
†Derate 2.67 mW/°C increase for temperature above 25°C.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED
TO-98



electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics

			Min.	Max.	
Collector Cutoff Current ($V_{CB} = 60V$)		I_{CBO}		.5	μA
Emitter Cutoff Current ($V_{EB} = 5V$)		I_{EBO}		100	μA
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)‡		$V_{CE(sat)}$		.95	Volts
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)‡		$V_{BE(sat)}$	.60	.80	Volts
Base Emitter Voltage ($I_C = 10$ mA, $V_{CE} = 5V$)‡		V_{BE}	.20	.80	Volts
Collector to Emitter Breakdown Voltage ($I_C = 10$ mA)‡		$V_{(BR)CEO}$			
	2N5174		75		Volts
	2N5175		100		Volts
	2N5176		100		Volts
Forward Current Transfer Ratio ($V_{CE} = 5V$, $I_C = .1$ mA)		h_{FE}			
	2N5174		30		
	2N5175		40		
	2N5176		100		
($V_{CE} = 5V$, $I_C = 10$ mA)‡		h_{FE}			
	2N5174		40	600	
	2N5175		55	160	
	2N5176		140	300	

‡Pulse test, 300 μsec, 2% duty cycle.

Dynamic Characteristics

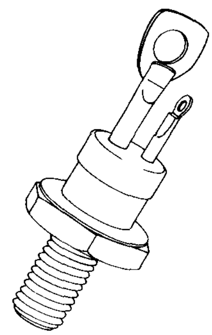
			Min.	Max.	
Forward Current Transfer Ratio ($V_{CE} = 5V$, $I_C = 10$ mA, f = 1 kHz		h_{fe}			
	2N5174		40	900	
	2N5175		55	240	
	2N5176		140	450	
Output Capacitance, Common Base ($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)		C_{ob}		5	pF

SCR

2N5204-07

The 2N5204-07 series of silicon controlled rectifiers are reverse blocking triode thyristor semiconductor devices for use in medium power switching and phase control applications requiring blocking voltage up to 1200 volts, and average load current (single-phase, 180° conduction angle) up to 22 amperes.

General Electric's C137 SCR is recommended where a higher level of performance is required for a device of this size.



MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM} (1) (2) $T_C = -40°C$ to $+125°C$	Repetitive Peak Reverse Voltage V_{RRM} (1) (2) $T_C = -40°C$ to $+125°C$	Non-repetitive Peak Reverse Voltage V_{RSM} (1) (3) $T_C = -40°C$ to $+125°C$
2N5204	600 Volts†	600 Volts†	720 Volts†
2N5205	800 Volts†	800 Volts†	960 Volts†
2N5206	1000 Volts†	1000 Volts†	1200 Volts†
2N5207	1200 Volts†	1200 Volts†	1440 Volts†

(1) Values apply for gate terminal open-circuited. (Negative gate bias is permissible.)
(2) Maximum case-to-ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 5.0°C per watt for full sine wave or full-wave rectified sinusoidal volatge waveform. (3.0°C per watt is maximum case-to-ambient thermal resistance for pure dc voltage waveform.)
(3) Half sine wave voltage pulse, 10 millisecond maximum duration.
(4) di/dt rating is established in accordance with EIA Standard RS-397, Section 5.2.2.6. Off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

RMS On-State Current, $I_{T(RMS)}$ .... 35 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$ .... Depends on conduction angle (See Charts 3 and 5)
Critical Rate-of-Rise of On-State Current, di/dt: (4)
Gate triggered operation .... (See Chart 6)
Switching from 1200 volts .... 75 Amperes per microsecond†
1000 volts .... 80 Amperes per microsecond†
800 volts .... 90 Amperes per microsecond†
600 volts .... 100 Amperes per microsecond†
Breakover voltage triggered operation .... 10 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} .... 300 Amperes†
I^2t (for fusing), for time = 1.0 milliseconds (See Chart 9) .... 200 Ampere² seconds
for time = 8.3 milliseconds (See Chart 9) .... 375 Ampere² seconds
Peak Gate Power Dissipation, P_{GM} .... 60 Watts for 500 microseconds†
Average Gate Power Dissipation, $P_{G(AV)}$ .... 10 Watts†
Peak Negative Gate Voltage, V_{GM} .... 5 Volts†
Storage Temperature, T_{STG} .... −40°C to +150°C†
Operating Temperature, T_J .... −40°C to +125°C†
Maximum Stud Torque .... 30 Lb-in (35 Kg-cm)

†Indicates data included on JEDEC Type Number Registration.

CHARACTERISTICS

Test	Symbol	Min.	Max.	Units	Test Conditions
Peak Off-State or Reverse Current (1) (2)	I_{DRM} or I_{RRM}			mA	$T_C = -40°$ to $+125°C$
2N5204		—	3.3†		$V_{DRM} = V_{RRM} =$ 600 Volts Peak
2N5205		—	2.5†		800
2N5206		—	2.0†		1000
2N5207		—	1.7†		1200
D.C. Gate Trigger Current	I_{T}	—	40	mAdc	$T_C = +25°C$, $V_D = 12$ Vdc, $R_L = 12$ ohms
		—	80†		$T_C = -40°C$, $V_D = 12$ Vdc, $R_L = 12$ ohms
D.C. Gate Trigger Voltage	V_{GT}	—	3.0	Vdc	$T_C = +25°C$, $V_D = 12$ Vdc, $R_L = 12$ ohms
		—	3.0†		$T_C = -40°C$, $V_D = 12$ Vdc, $R_L = 12$ ohms
		0.25†	—		$T_C = +125°C$, Rated V_{DRM}, $R_L = 1000$ ohms
Peak On-State Voltage	V_{TM}	—	2.3†	Volts	$T_C = +25°C$, $I_{TM} = 70$ A peak, 1 msec wide pulse. Duty cycle $\leq 2\%$.
Holding Current	I_H			mAdc	Anode supply = 24 Vdc, Gate supply = 10 V, 20 ohms. Initial Forward Current Pulse = 0.5 A, 0.1 to 10.0 msec. wide.
		—	100		$T_C = +25°C$
		—	200†		$T_C = -40°C$
Critical Rate of Rise of Forward Blocking Voltage. (Higher values may cause device switching.)	dv/dt	100†	—	Volts/μsec	$T_C = +125°C$, Rated V_{DRM}, Gate open circuited.
Thermal Resistance	Θ_{J-C}	—	1.5†	°C/watt	Junction-to-case, dc

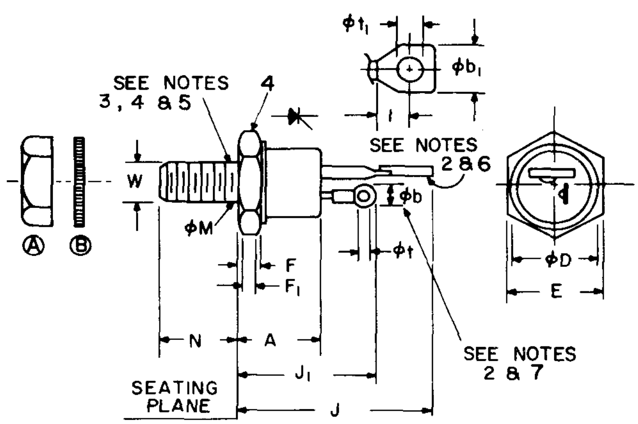
(1) Values apply for gate terminal open-circuited. (Negative gate bias is permissible.)
(2) Maximum case-to-ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 5.0°C per watt for full sine wave or full-wave rectified sinusoidal voltage waveform. (3.0°C per watt is maximum case-to-ambient thermal resistance for pure dc voltage waveform.)
†Indicates data included on JEDEC Type Number Registration.

OUTLINE DRAWING

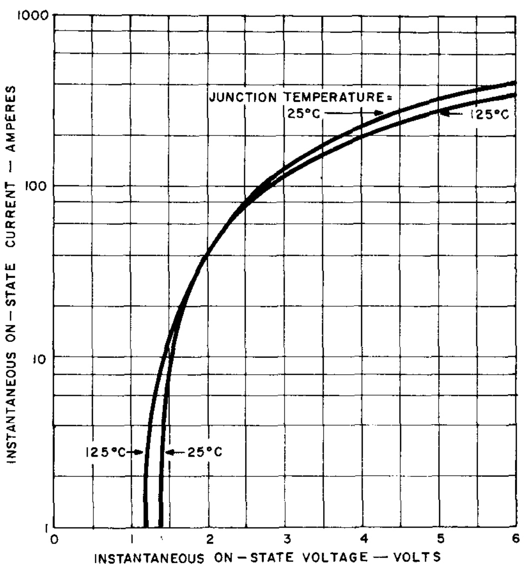
(COMPLIES WITH JEDEC TO-48)

NOTES:
1. Complete threads to extend within 2½ threads of seating plane. Diameter of unthreaded portion. 249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

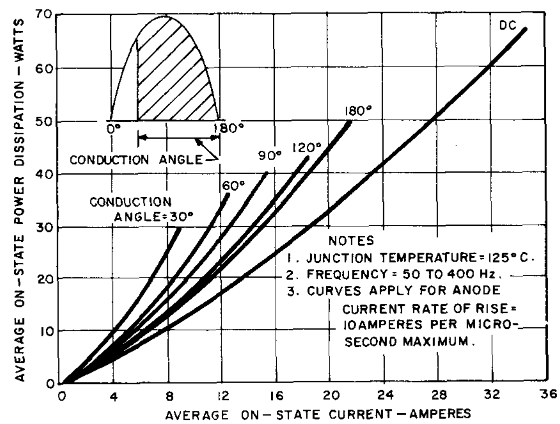
A. ¼-28 steel nut, Ni. plated, .178 min. thk.
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.



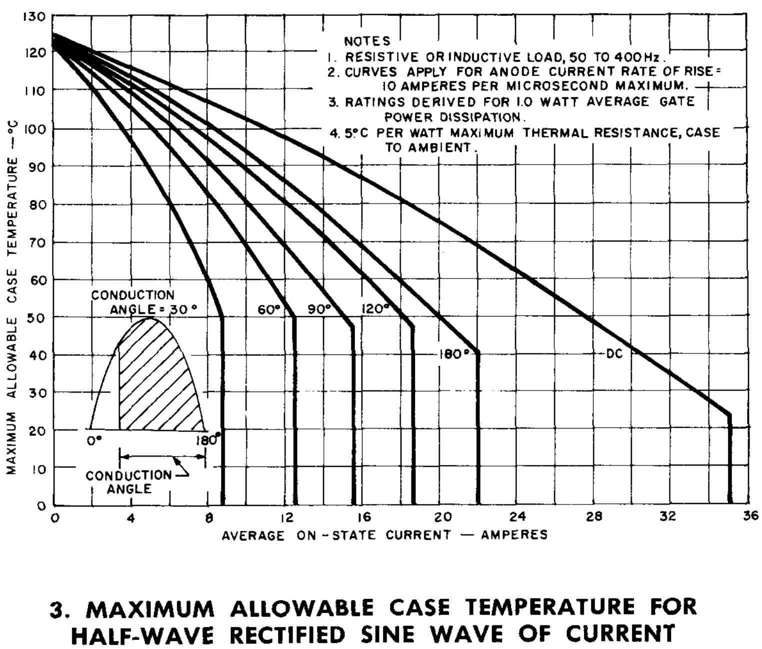
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb₁	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F₁	.060		1.52		
J		1.193		30.30	
J₁		.875		22.23	
l	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φt	.060	.075	1.52	1.91	
φt₁	.125	.165	3.18	4.19	
W					3



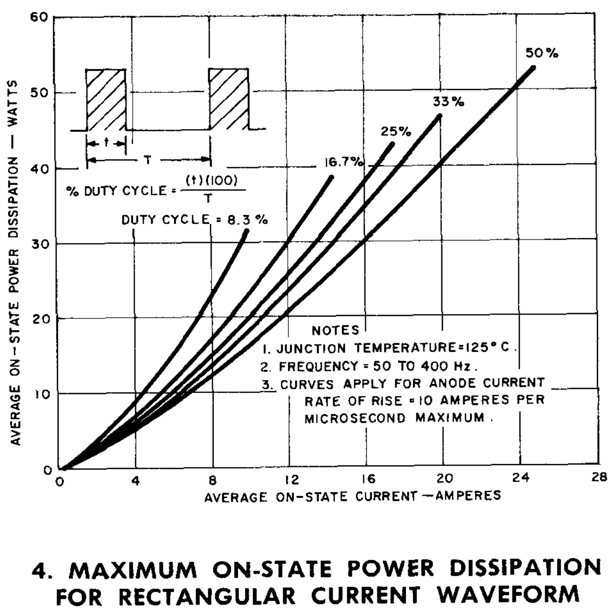
1. MAXIMUM ON-STATE CHARACTERISTICS



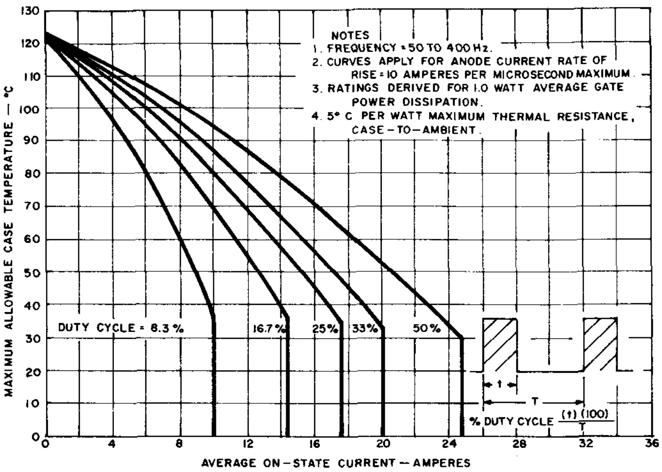
2. MAXIMUM ON-STATE POWER DISSIPATION FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT



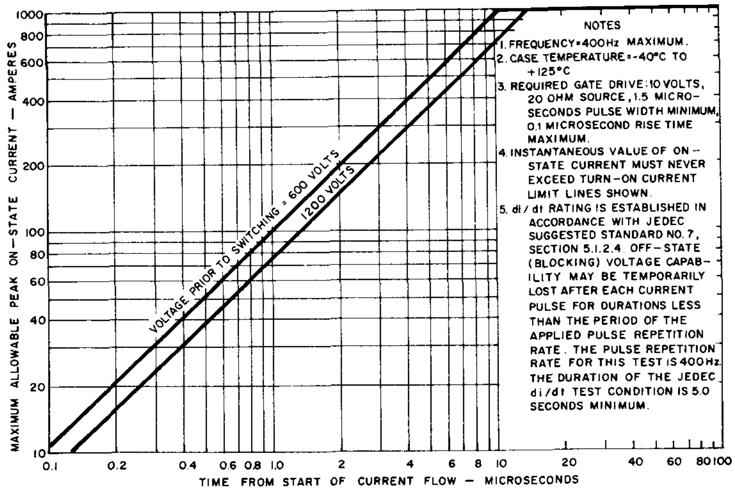
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT



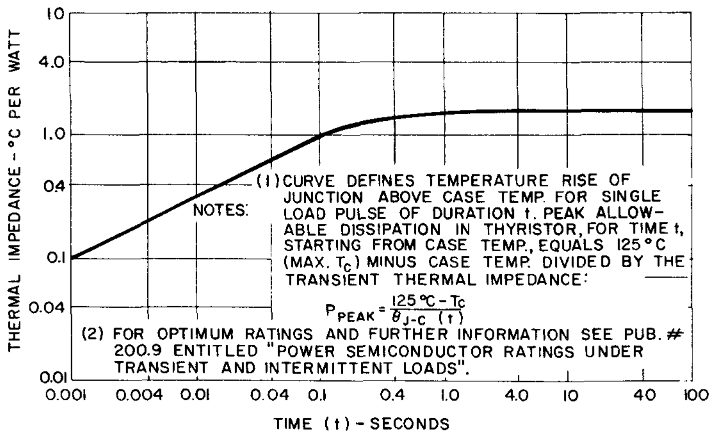
4. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



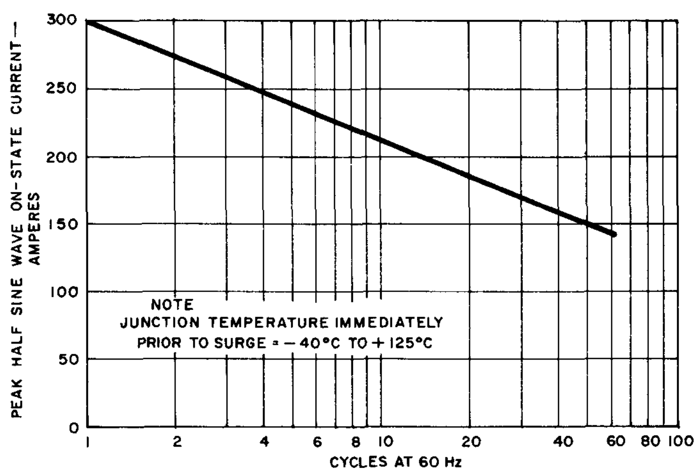
5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



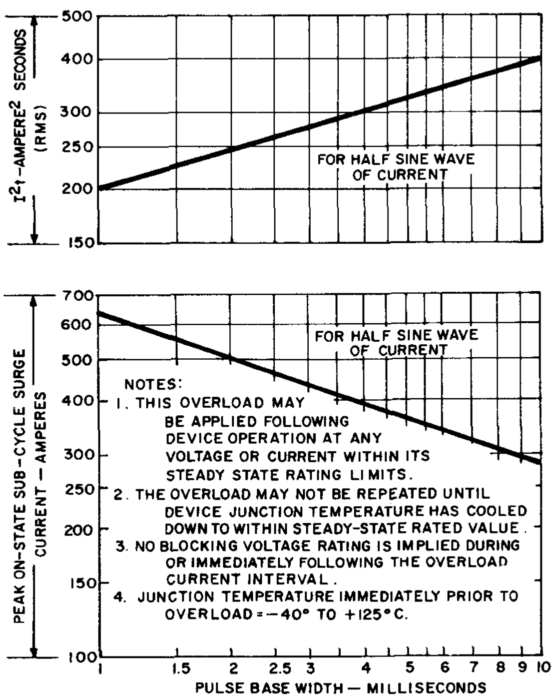
6. TURN-ON CURRENT LIMIT



7. MAXIMUM TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE



8. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT



9. MAXIMUM ALLOWABLE SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2T RATING

Silicon Transistor

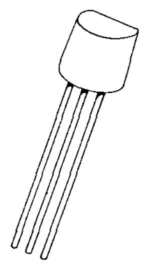
NPN

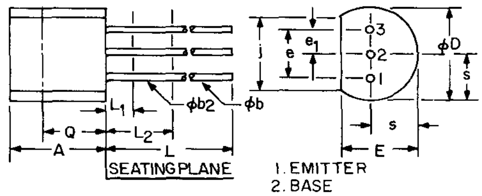
2N5219

The General Electric 2N5219 is a Silicon NPN Planar Epitaxial Passivated Transistor designed for general purpose amplifier applications.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	15	Volts
Collector to Base	V_{CBO}	20	Volts
Emitter to Base	V_{EBO}	3	Volts
Current			
Collector	I_C	100	mA
Dissipation			
Total Power $T_A \leqslant 25°C$	P_T	350	mW
Derating Factor $T_A > 25°C$	P_T	2.8	mW/°C
Total Power $T_C \leqslant 25°C$	P_T	1.0	Watt
Derating Factor $T_C > 25°C$	P_T	8.0	mW/°C
Temperature			
Operating	T_J	-55 to +150	°C
Storage	T_{stg}	-55 to +150	°C
Lead (1/16″ ± 1/32″ from case for 10 sec.)	T_L	+230	°C





1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	–	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

***electrical characteristics:** (T_A = 25°C unless otherwise specified)

	SYMBOL	MIN.	MAX.	UNITS
Static Characteristics				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)	$V_{(BR)CEO}$	15	–	Volts
Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)	$V_{(BR)CBO}$	20	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	$V_{(BR)EBO}$	3.0	–	Volts
Collector Cutoff Current (V_{CB} = 10V, I_E = 0)	I_{CBO}	–	100	nA
Emitter Cutoff Current (V_{BE} = 2.0V, I_C = 0)	I_{EBO}	–	500	nA
DC Current Gain (I_C = 2.0 mA, V_{CE} = 10V)	h_{FE}	35	500	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA)	$V_{CE(sat)}$	–	0.4	Volts
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA)	$V_{BE(sat)}$	–	1.0	Volts
Dynamic Characteristics				
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 10V, f = 20 MHz)	f_T	150	–	MHz
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 1.0 MHz)	C_{cb}	–	4.0	pF
Small Signal Current Gain (I_C = 2.0 mA, V_{CE} = 10V, f = 1.0 kHz)	h_{fe}	35	1500	

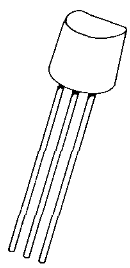
*Indicates JEDEC Registered Data.

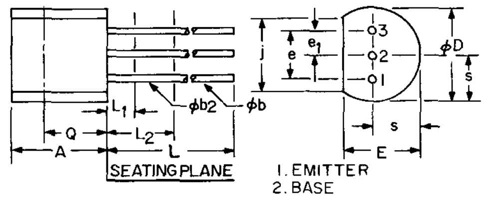
Silicon Transistor

NPN

2N5220

The General Electric 2N5220 is a Silicon NPN Planar Epitaxial Passivated Transistor designed for general purpose audio amplifier applications.





1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	15	Volts
Collector to Base	V_{CBO}	15	Volts
Emitter to Base	V_{EBO}	.3	Volts
Current			
Collector	I_C	500	mA
Dissipation			
Total Power $T_A \leq 25°C$	P_T	350	mW
Derating Factor $T_A > 25°C$	P_T	2.8	mW/°C
Total Power $T_C \leq 25°C$	P_T	1.0	Watt
Derating Factor $T_C > 25°C$	P_T	8.0	mW/°C
Temperature			
Operating	T_J	-55 to +150	°C
Storage	T_{stg}	-55 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230	°C

*electrical characteristics: (T_A = 25°C unless otherwise specified)

Static Characteristics	SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	†$V_{(BR)CEO}$	15	–	Volts
Collector-Base Breakdown Voltage (I_C = 100 µA, I_E = 0)	$V_{(BR)CBO}$	15	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100 µA, I_C = 0)	$V_{(BR)EBO}$	3.0	–	Volts
Collector Cutoff Current (V_{CB} = 10V, I_E = 0)	I_{CBO}	–	100	nA
Emitter Cutoff Current (V_{BE} = 3.0V, I_C = 0)	I_{EBO}	–	100	nA
DC Current Gain (I_C = 10 mA, V_{CE} = 10V)	†h_{FE}	25	–	
(I_C = 50 mA, V_{CE} = 10V)	†h_{FE}	30	600	
Collector-Emitter Saturation Voltage (I_C = 150 mA, I_B = 15 mA)	†$V_{CE(sat)}$	–	0.5	Volts
Base-Emitter Saturation Voltage (I_C = 150 mA, I_B = 15 mA)	†$V_{BE(sat)}$	–	1.1	Volts
Dynamic Characteristics				
Current-Gain Bandwidth Product (I_C = 20 mA, V_{CE} = 10V, f = 20 MHz)	f_T	100	–	MHz
Collector-Base Capacitance (V_{CB} = 5.0V, I_E = 0, f = 1.0 MHz)	C_{cb}	–	10	
Small Signal Current Gain (I_C = 50 mA, V_{CE} = 10V, f = 1.0 kHz)	h_{fe}	30	1800	

†Pulse Test: Pulse width = 300 µs, duty cycle = 2%.

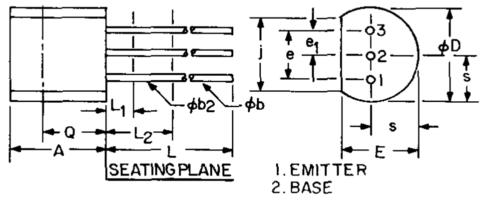
*Indicates JEDEC Registered Data.

Silicon Transistor

PNP

2N5221

The General Electric 2N5221 is a Silicon PNP Planar Epitaxial Passivated Transistor designed for general purpose amplifier applications. *PNP Polarities are Negative: Observe Proper Bias.*



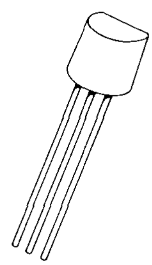
TO-92

1. EMITTER
2. BASE
3. COLLECTOR

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)



Voltages			
Collector to Emitter	V_{CEO}	15	Volts
Collector to Base	V_{CBO}	15	Volts
Emitter to Base	V_{EBO}	3	Volts
Current			
Collector	I_C	500	mA
Dissipation			
Total Power $T_A \leqslant 25°C$	P_T	350	mW
Derating Factor $T_A > 25°C$	P_T	2.8	mW/°C
Total Power $T_C \leqslant 25°C$	P_T	1.0	Watt
Derating Factor $T_C > 25°C$	P_T	8.0	mW/°C
Temperature			
Operating	T_J	-55 to +150	°C
Storage	T_{stg}	-55 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230	°C

*electrical characteristics: (T_A = 25°C unless otherwise specified)

Static Characteristics	SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	†$V_{(BR)CEO}$	15	–	Volts
Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)	$V_{(BR)CBO}$	15	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	$V_{(BR)EBO}$	3.0	–	Volts
Collector Cutoff Current (V_{CB} = 10V, I_E = 0)	I_{CBO}	–	100	nA
Emitter Cutoff Current (V_{BE} = 3.0V, I_C = 0)	I_{EBO}	–	100	nA
DC Current Gain (I_C = 10 mA, V_{CE} = 10V)	†h_{FE}	25	–	
(I_C = 50 mA, V_{CE} = 10V)	†h_{FE}	30	600	
Collector-Emitter Saturation Voltage (I_C = 150 mA, I_B = 15 mA)	†$V_{CE(sat)}$	–	0.5	Volts
Base-Emitter Saturation Voltage (I_C = 150 mA, I_B = 15 mA)	†$V_{BE(sat)}$	–	1.1	Volts
Dynamic Characteristics				
Current-Gain Bandwidth Product (I_C = 20 mA, V_{CE} = 10V, f = 20 MHz)	f_T	100	–	MHz
Collector-Base Capacitance (V_{CB} = 5.0V, I_E = 0, f = 1.0 MHz)	C_{cb}	–	15	pF
Small Signal Current Gain (I_C = 50 mA, V_{CE} = 10V, f = 1.0 kHz)	h_{fe}	30	1800	

†Pulse Test: Pulse width = 300 μs, duty cycle = 2%.

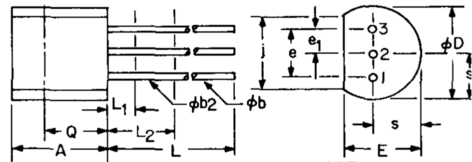
*Indicates JEDEC Registered Data.

Silicon Transistor

NPN

2N5223

The General Electric 2N5223 is a Silicon NPN Planar Epitaxial Passivated Transistor designed for general purpose amplifier applications.



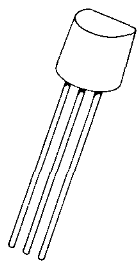
TO-92

1. EMITTER
2. BASE
3. COLLECTOR

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L_1	—	1.270	–	.050	3
L_2	6.350	–	.250	–	3
Q	2.920	—	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500 FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)



Voltages			
Collector to Emitter	V_{CEO}	20	Volts
Collector to Base	V_{CBO}	25	Volts
Emitter to Base	V_{EBO}	3	Volts
Current			
Collector	I_C	100	mA
Dissipation			
Total Power $T_A \leq 25°C$	P_T	350	mW
Derating Factor $T_A > 25°C$	P_T	2.8	mW/°C
Total Power $T_C \leq 25°C$	P_T	1.0	Watt
Derating Factor $T_C > 25°C$	P_T	8.0	mW/°C
Temperature			
Operating	T_J	-55 to +150	°C
Storage	t_{stg}	-55 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230	°C

*electrical characteristics: (T_A = 25°C unless otherwise specified)

	SYMBOL	MIN.	MAX.	UNITS
Static Characteristics				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)	$V_{(BR)CEO}$	20	–	Volts
Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)	$V_{(BR)CBO}$	25	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	$V_{(BR)EBO}$	3.0	–	Volts
Collector Cutoff Current (V_{CB} = 10V, I_E = 0)	I_{CBO}	–	100	nA
Emitter Cutoff Current (V_{BE} = 3.0V, I_C = 0)	I_{EBO}	–	500	nA
DC Current Gain (I_C = 2.0 mA, V_{CE} = 10V)	h_{FE}	50	800	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA)	$V_{CE(sat)}$	–	0.7	Volts
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA)	$V_{BE(sat)}$	–	1.2	Volts
Dynamic Characteristics				
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 10V, f = 20 MHz)	f_T	150	–	MHz
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 1.0 MHz)	C_{cb}	–	4.0	pF
Small Signal Current Gain (I_C = 2.0 mA, V_{CE} = 10V, f = 1.0 kHz)	h_{fe}	50	1600	

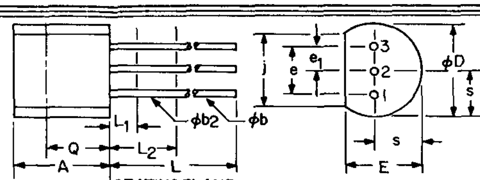
*Indicates JEDEC Registered Data.

Silicon Transistor

NPN

2N5225

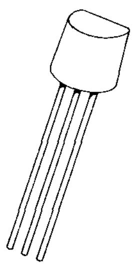
The General Electric 2N5225 is a Silicon NPN Planar Epitaxial Passivated Transistor designed for general purpose amplifier applications.



SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)



Voltages			
Collector to Emitter	V_{CEO}	25	Volts
Collector to Base	V_{CBO}	25	Volts
Emitter to Base	V_{EBO}	4	Volts
Current			
Collector	I_C	200	mA
Dissipation			
Total Power $T_A \leqslant 25°C$	P_T	350	mW
Derating Factor $T_A > 25°C$	P_T	2.8	mW/°C
Total Power $T_C \leqslant 25°C$	P_T	1.0	Watt
Derating Factor $T_C > 25°C$	P_T	8.0	mW/°C
Temperature			
Operating	T_J	-55 to +150	°C
Storage	T_{stg}	-55 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	260	°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

Static Characteristics	SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	†$V_{(BR)CEO}$	25	–	Volts
Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)	$V_{(BR)CBO}$	25	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	$V_{(BR)EBO}$	4.0	–	Volts
Collector Cutoff Current (V_{CB} = 15V, I_E = 0)	I_{CBO}	–	300	nA
Emitter Cutoff Current (V_{BE} = 4.0V, I_C = 0)	I_{EBO}	–	500	nA
DC Current Gain (I_C = 10 mA, V_{CE} = 10V)	†h_{FE}	25	–	
(I_C = 50 mA, V_{CE} = 10V)	†h_{FE}	30	600	
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	†$V_{CE(sat)}$	–	0.8	Volts
Base-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	†$V_{BE(sat)}$	–	1.0	Volts
Dynamic Characteristics				
Current-Gain Bandwidth Product (I_C = 20 mA, V_{CE} = 10V, f = 20 MHz)	f_T	50	–	MHz
Collector-Base Capacitance (V_{CB} = 5.0V, I_E = 0, f = 1.0 MHz)	C_{cb}	–	20	pF
Small Signal Current Gain (I_C = 50 mA, V_{CE} = 10V, f = 1.0 kHz)	h_{fe}	30	1800	

†Pulse Test: Pulse width = 300μs, duty cycle = 2%.

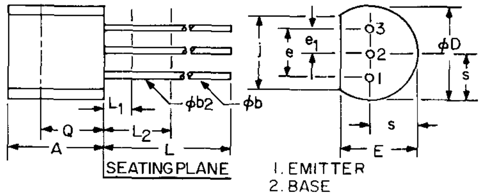
*Indicates JEDEC Registered Data.

Silicon Transistor

PNP

2N5226

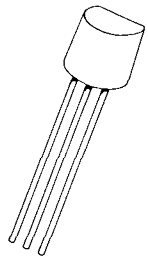
The General Electric 2N5226 is a Silicon PNP Planar Epitaxial Passivated Transistor designed for general purpose amplifier applications. *PNP Polarities are Negative: Observe Proper Bias.*



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.



absolute maximum ratings: (T_A = 25°C unless otherwise specified)

	Symbol	Value	Units
Voltages			
Collector to Emitter	V_{CEO}	25	Volts
Collector to Base	V_{CBO}	25	Volts
Emitter to Base	V_{EBO}	4	Volts
Current			
Collector	I_C	500	mA
Dissipation			
Total Power $T_A \leqslant 25°C$	P_T	350	mW
Derating Factor $T_A > 25°C$	P_T	2.8	MW/°C
Total Power $T_C > 25°C$	P_T	1.0	Watt
Derating Factor $T_C > 25°C$	P_T	8.0	mW/°C
Temperature			
Operating	T_J	-55 to +150	°C
Storage	T_{stg}	-55 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230	°C

*electrical characteristics: (T_A = 25°C unless otherwise specified)

	SYMBOL	MIN.	MAX.	UNITS
Static Characteristics				
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	†$V_{(BR)CEO}$	25	–	Volts
Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)	$V_{(BR)CBO}$	25	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	$V_{(BR)EBO}$	4.0	–	Volts
Collector Cutoff Current (V_{CB} = 15V, I_E = 0)	I_{CBO}	–	300	nA
Emitter Cutoff Current (V_{BE} = 4.0V, I_C = 0)	I_{EBO}	–	500	nA
DC Current Gain (I_C = 10 mA, V_{CE} = 10V)	†h_{FE}	25	–	
(I_C = 50 mA, V_{CE} = 10V)	†h_{FE}	30	600	
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	†$V_{CE(sat)}$	–	0.8	Volts
Base-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	†$V_{BE(sat)}$	–	1.0	Volts
Dynamic Characteristics				
Current-Gain Bandwidth Product (I_C = 20 mA, V_{CE} = 10V, f = 20 MHz)	f_T	50	–	MHz
Collector-Base Capacitance (V_{CB} = 5.0V, I_E = 0, f = 1.0 MHz)	C_{cb}	–	20	pF
Small Signal Current Gain (I_C = 50 mA, V_{CE} = 10V, f = 1.0 kHz)	h_{fe}	30	1800	

†Pulse Test: Pulse width = 300 μs, duty cycle = 2%.

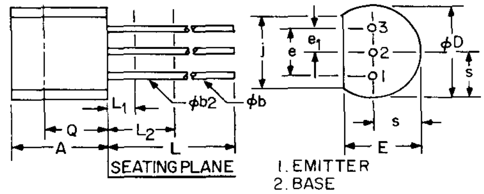
*Indicates JEDEC Registered Data.

Silicon Transistor

PNP

2N5227

The General Electric 2N5227 is a Silicon PNP Planar Epitaxial Passivated Transistor designed for general purpose amplifier applications. *PNP Polarities are Negative: Observe Proper Bias.*

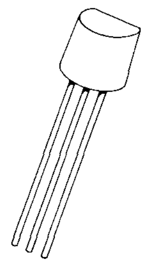


1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.



absolute maximum ratings: (T_A = 25°C unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	30	Volts
Collector to Base	V_{CBO}	30	Volts
Emitter to Base	V_{EBO}	3	Volts
Current			
Collector	I_C	50	mA
Dissipation			
Total Power $T_A \leqslant 25°C$	P_T	350	mW
Derating Factor $T_A > 25°C$	P_T	2.8	mW/°C
Total Power $T_C \leqslant 25°C$	P_T	1.0	Watt
Derating Factor $T_C > 25°$	P_T	8.0	mW/°C
Temperature			
Operating	T_J	-55 to +150	°C
Storage	T_{stg}	-55 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230	°C

*electrical characteristics: (T_A = 25°C unless otherwise specified)

Static Characteristics	SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)	$V_{(BR)CEO}$	30	–	Volts
Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)	$V_{(BR)CBO}$	30	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	$V_{(BR)EBO}$	3.0	–	Volts
Collector Cutoff Current (V_{CB} = 10V, I_E = 0)	I_{CBO}	–	100	nA
Emitter Cutoff Current (V_{BE} = 2.0V, I_C = 0)	I_{EBO}	–	500	nA
DC Current Gain (I_C = 100 μA, V_{CE} = 10V)	h_{FE}	30	–	
(I_C = 2.0 mA, V_{CE} = 10V)	h_{FE}	50	700	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA)	$V_{CE(sat)}$	–	0.4	Volts
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA)	$V_{BE(sat)}$	–	1.0	Volts
Dynamic Characteristics				
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 10V, f = 20 MHz)	f_T	100	–	MHz
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 1.0 MHz)	C_{cb}	–	5.0	pF
Small Signal Current Gain (I_C = 2.0 mA, V_{CE} = 10V, f = 1.0 kHz)	h_{fe}	50	1500	

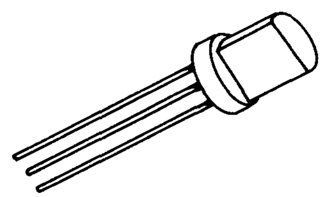
*Indicates JEDEC Registered Data.

Silicon Transistors

NPN

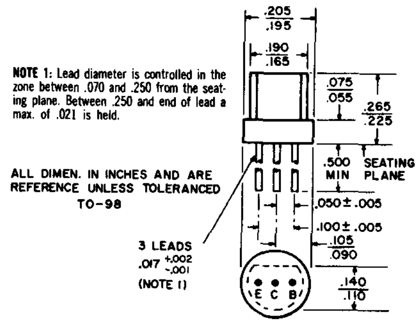
2N5232,A

The General Electric 2N5232 and 2N5232A are NPN silicon, planar, epitaxial, passivated transistors designed especially for low noise preamplifier and small signal industrial amplifier applications. The units feature low collector saturation voltage, tight beta control and excellent low noise characteristics. The 2N5232A includes a noise figure specification.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	50	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	70	V
Current			
Collector (Steady State)*	I_C	100	mA
Dissipation			
Total Power (Free Air at 25°C)†	P_T	360	mW
Temperature			
Storage	T_{stg}	−55 to +150°C	
Operating	T_J	+125°C	
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds maximum	T_L	+260°C	



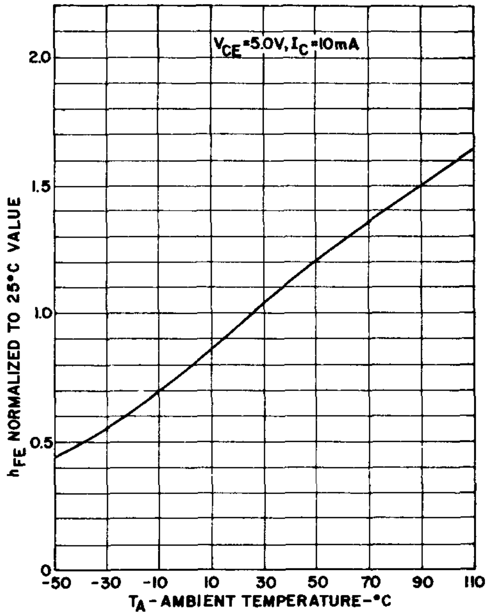
*Determined from power limitations due to saturation voltages at this current.
†Derate 3.6 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

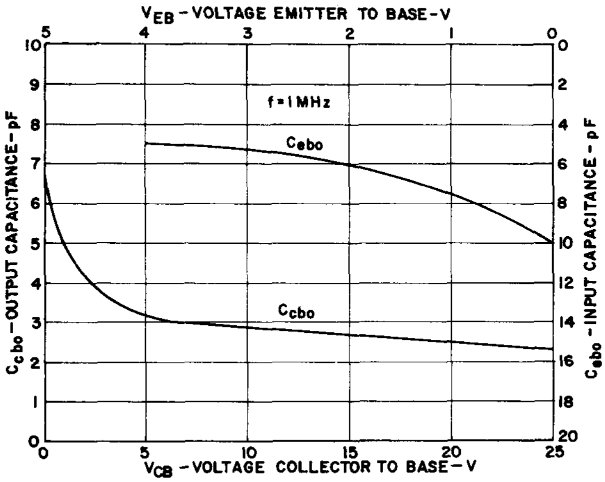
Static Characteristics		**Min.**	**Typ.**	**Max.**	
Collector Cutoff Current (V_{CB} = 50V)	I_{CBO}			30	nA
(V_{CB} = 50V, T_A = 100°C)	I_{CBO}			10	μA
Collector Cutoff Current (V_{CB} = 50V)	I_{CES}			30	nA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}			50	nA
Forward Current Transfer Ratio (V_{CE} = 5V, I_C = 2 mA)	h_{FE}	250		500	
(V_{CE} = 5V, I_C = 100 μA)	h_{FE}		170‡		
Collector Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$¶	50			Volts
Collector Base Breakdown Voltage (I_C = 10 μA)	$V_{(BR)CBO}$	70			Volts
Emitter Base Breakdown Voltage (I_E = 10 μA)	$V_{(BR)EBO}$	5			Volts
Collector Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{CE(sat)}$¶			.125	Volts
Base Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{BE(sat)}$¶			.78	Volts
Base Emitter Voltage (V_{CE} = 10V, I_C = 2 mA)	V_{BE}	0.5		0.9	Volts
Dynamic Characteristics					
Forward Current Transfer Ratio (V_{CE} = 5V, I_C = 2 mA, f = 1 kHz)	h_{fe}	250		750	
Output Capacitance, Common Base (V_{CB} = 10V, I_E = 0, f = 1 MHz)	C_{cb}			4.0	pF
Noise Figure (I_C = 100 μA, V_{CE} = 5V, R_g = 5 kΩ, f = 1 kHz, BW = 15.7 kHz) (2N5232A only)	NF		1.9	5	dB

‡Typically, a minimum of 95% of the distribution is above this value.
¶Pulse conditions: 300 μsec. duration, 2% duty cycle.

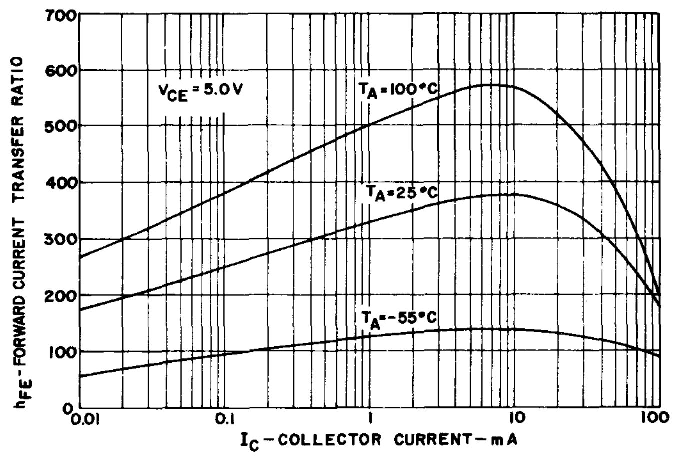
h_{FE} vs. Ambient Temperature



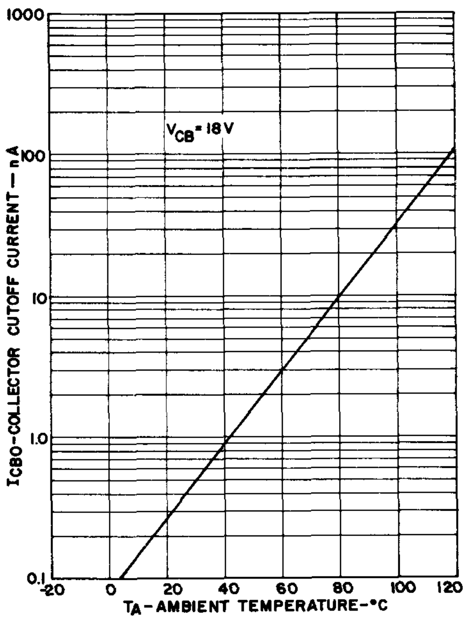
Input and Output Capacitance vs. Bias Voltage



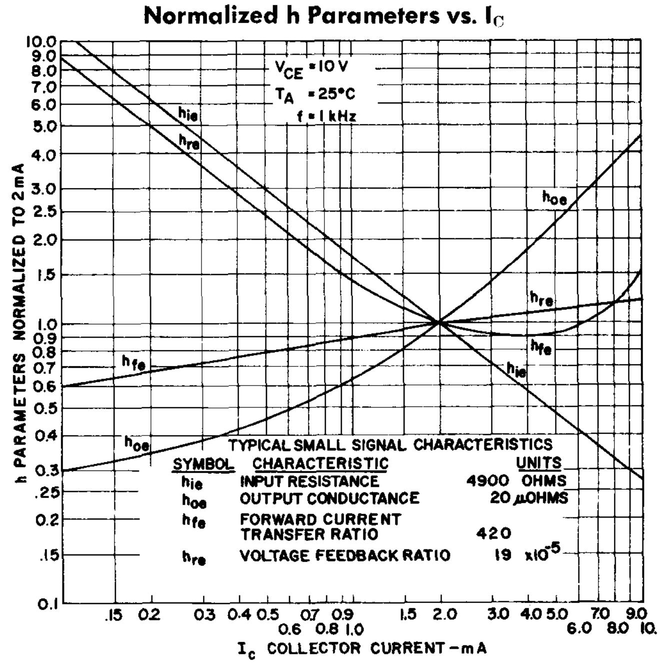
Forward Current Transfer Ratio vs. Collector Current



I_{CBO} vs. Ambient Temperature



Normalized h Parameters vs. I_C

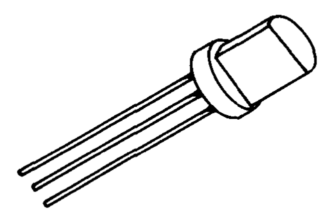


Silicon Transistors

NPN

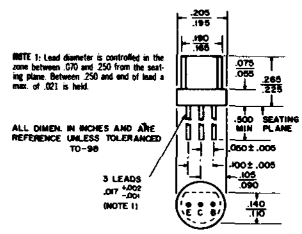
2N5249,A

The General Electric 2N5249 and 2N5249A are NPN silicon, planar, epitaxial, passivated transistors designed especially for low noise preamplifier and small signal industrial amplifier applications. The units feature low collector saturation voltage, tight beta control and excellent low noise characteristics. The 2N5249A includes a noise figure specification.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	50	V
Emitter to Base	V_{EBO}	5	V
Collector to Base	V_{CBO}	70	V
Current			
Collector (Steady State)*	I_C	100	mA
Dissipation			
Total Power (Free Air at 25°C)†	P_T	360	mW
Total Power (Free Air at 55°C)†	P_T	260	mW
Temperature			
Storage	T_{stg}	−55 to +150°C	
Operating	T_J	+125°C	
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds maximum	T_L	+260°C	



*Determined from power limitations due to saturation voltages at this current.
†Derate 3.3 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics

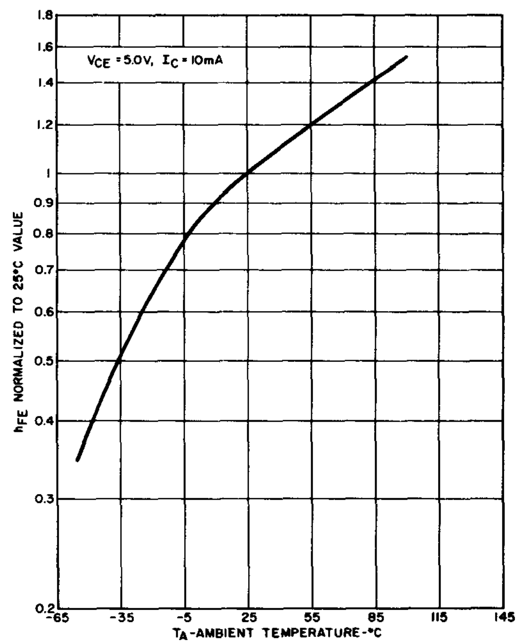
		Min.	Typ.	Max.	
Collector Cutoff Current (V_{CB} = 50V)	I_{CBO}			30	nA
(V_{CB} = 50V, T_A = 100°C)	I_{CBO}			10	μA
Collector Cutoff Current (V_{CB} = 50V)	I_{CES}			30	nA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}			50	nA
Forward Current Transfer Ratio (V_{CE} = 5V, I_C = 2 mA)	h_{FE}	400		800	
(V_{CE} = 5V, I_C = 100 μA)	h_{FE}		300‡		
Collector Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$¶	50			Volts
Collector Base Breakdown Voltage (I_C = 10 μA)	$V_{(BR)CBO}$	70			Volts
Emitter Base Breakdown Voltage (I_E = 10 μA)	$V_{(BR)EBO}$	5			Volts
Collector Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{CE(sat)}$¶			.125	Volts
Base Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{BE(sat)}$¶			.78	Volts
Base Emitter Voltage (V_{CE} = 10V, I_C = 2 mA)	V_{BE}	0.5		0.9	Volts

Dynamic Characteristics

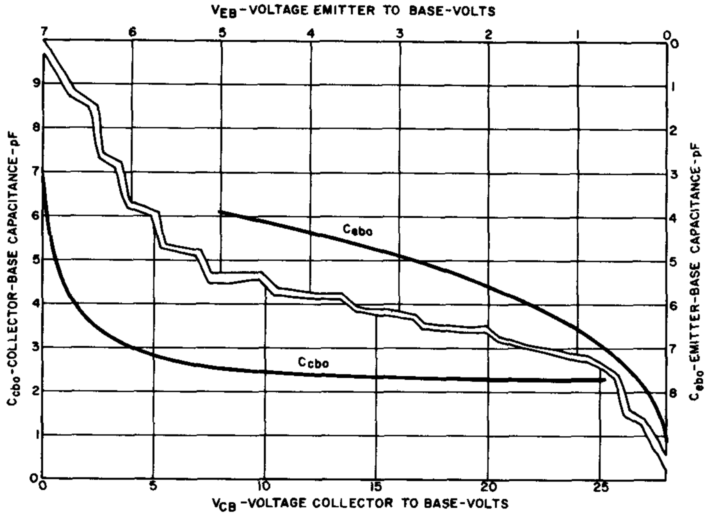
		Min.	Typ.	Max.	
Forward Current Transfer Ratio (V_{CE} = 5V, I_C = 2 mA, f = 1 kHz)	h_{fe}	400		1200	
Output Capacitance, Common Base (V_{CB} = 10V, I_E = 0, f = 1 MHz)	C_{cb}			4.0	pF
Noise Figure (I_C = 100 μA, V_{CE} = 5V, R_g = 5 kΩ, f = 1 kHz, BW = 15.7 kHz) (2N5249A only)	NF			3	dB

‡Typically, a minimum of 95% of the distribution is above this value.
¶Pulse conditions: 300 μsec. duration, 2% duty cycle.

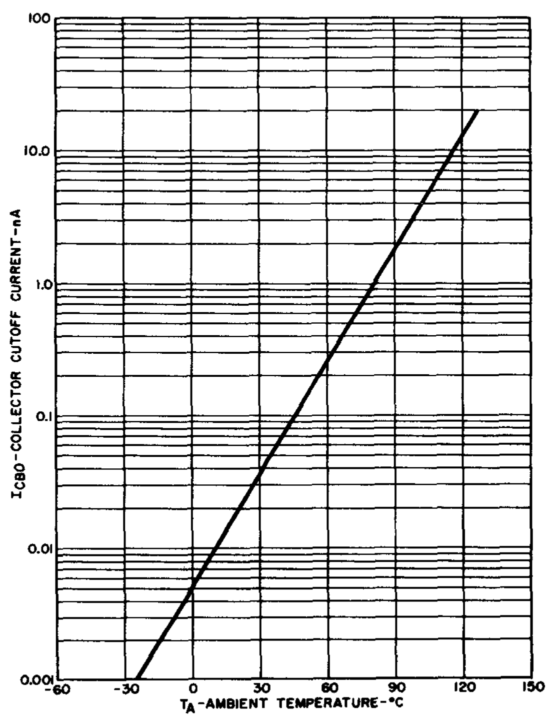
hFE vs. Ambient Temperature



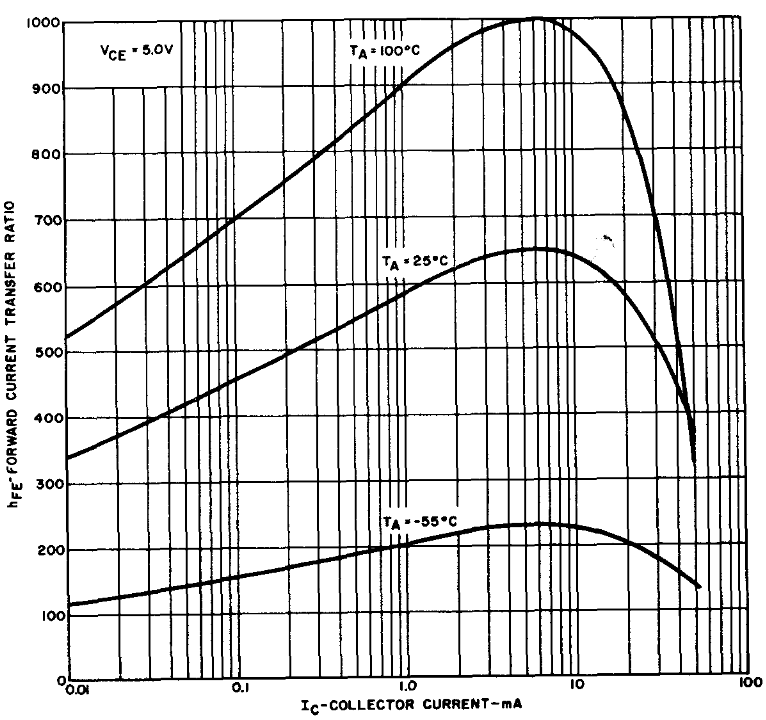
Input and Output Capacitance vs. Bias Voltage



ICBO vs. Ambient Temperature



Forward Current Transfer Ratio vs. Collector Current

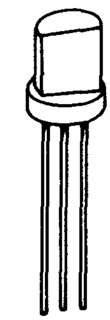


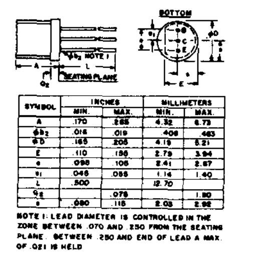
Silicon Transistors

NPN

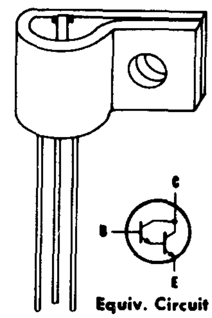
2N5305,6,6A

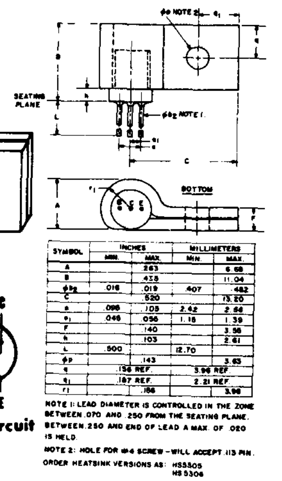
FOR TO-92 SERIES SEE GES5305





The General Electric 2N5305, 2N5306 and 2N5306A are NPN, silicon, planar, epitaxial, passivated Darlington monolithic amplifiers. These devices are especially suited for preamplifier input stages requiring input impedances of several megohms or extremely low level, high gain, low noise amplifier applications. Additional applications include medium speed switching circuits in consumer and industrial control applications.





Equiv. Circuit

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Base	V_{CBO}	25	Volts
Collector to Emitter	V_{CEO}	25	Volts
Emitter to Base	V_{EBO}	12	Volts
Current			
Collector (Steady State)	I_C	300	mA
Collector (Pulsed)*	I_C	500	mA
Base (Steady State)	I_B	50	mA
Dissipation			
Total Power ($T_A \leq 25°$ C)†	P_T	400	mW
Total Power with Heatsink ($T_A \leq 25°$ C)††	P_T	600	mW
Total Power with Heatsink ($T_C \leq 25°$ C)†††	P_T	900	mW
Temperature			
Storage	T_{stg}	−65 to +150° C	
Operating	T_J	−65 to +125° C	
Lead, 1/16" ± 1/32" from case for 10 sec. max.	T_L	+260° C	

*Pulse conditions: 300 μsec. pulse width, 2% duty cycle.
†Derate 4.0 mW/° C for increase in ambient temperature above 25° C.
††Derate 6.0 mW/° C for increase in ambient temperature above 25° C.
†††Derate 9.0 mW/° C for increase in case temperature above 25° C.

STATIC CHARACTERISTICS

			Min.	Max.	
Collector to Base Breakdown Voltage ($I_C = 0.1$ μA, $I_E = 0$)		$V_{(BR)CBO}$	25		Volts
Collector to Emitter Breakdown Voltage ($I_C = 10$mA, $I_B = 0$)		$V_{(BR)CEO}$	25		Volts
Emitter to Base Breakdown Voltage ($I_E = 0.1\mu$A, $I_C = 0$)		$V_{(BR)EBO}$	12		Volts
Forward Current Transfer Ratio					
($V_{CE} = 5$V, $I_C = 2$mA)	2N5305	h_{FE}	2000	20000	
($V_{CE} = 5$V, $I_C = 100$mA)	2N5305	h_{FE}	6000		
($V_{CE} = 5$V, $I_C = 2$mA)	2N5306, A	h_{FE}	7000	70000	
($V_{CE} = 5$V, $I_C = 100$mA)	2N5306, A	h_{FE}	20000		
Collector Cutoff Current					
($V_{CB} = 25$V, $I_E = 0$)		I_{CBO}		100	nA
($V_{CB} = 25$V, $I_E = 0$, $T_A = 100°$ C)		I_{CBO}		20	μA
Emitter Cutoff Current ($V_{EB} = 12$V, $I_C = 0$)		I_{EBO}		100	nA
Collector Emitter Saturation Voltage ($I_C = 200$mA, $I_B = 0.2$mA)		$V_{CE(SAT)}$		1.4	Volts
Base Emitter Saturation Voltage ($I_C = 200$mA, $I_B = 0.2$mA)		$V_{BE(SAT)}$		1.6	Volts
Base Emitter Voltage ($V_{CE} = 5$V, $I_C = 200$mA)		V_{BE}		1.5	Volts

DYNAMIC CHARACTERISTICS

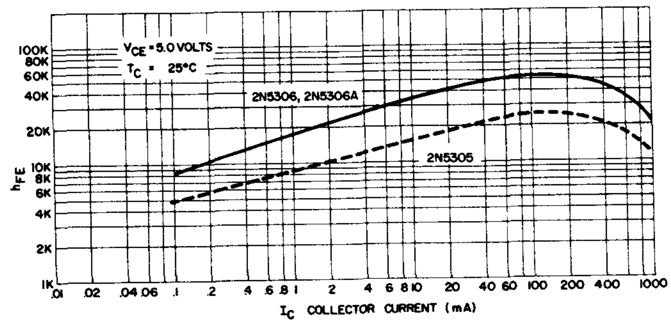
			Min.	Typ.	Max.	
Forward Current Transfer Ratio						
($V_{CE} = 5$V, $I_C = 2$mA, f = 1kHz)	2N5305	h_{fe}	2000			
($V_{CE} = 5$V, $I_C = 2$mA, f = 1kHz)	2N5306, A	h_{fe}	7000			
($V_{CE} = 5$V, $I_C = 2$mA, f = 10 MHz)		h_{fe}	15.6			dB
Gain Bandwidth Product ($V_{CE} = 5$V, $I_C = 2$mA, f = 10 MHz)		f_T	60			MHz
Input Impedance ($V_{CE} = 5$V, $I_C = 2$mA, f = 1 kHz)		h_{ie}		650		kohms
Collector Base Capacitance ($V_{CB} = 10$V, f = 1 MHz)		C_{cb}		7.6	10	pF
Emitter Capacitance ($V_{EB} = 0.5$V, f = 1 MHz)		C_{eb}		10.5		pF

		Min.	Typ.	Max.	Units
2N5306A only					
Noise Voltage	($I_C = 0.6$ mA, $V_{CE} = 5$V, $R_G = 160\text{k}\Omega$ f = 10 Hz to 10kHz, B.W. = 15.7 kHz)	$e_{\bar{n}}$	195	230	$\text{nV}/\sqrt{\text{Hz}}$

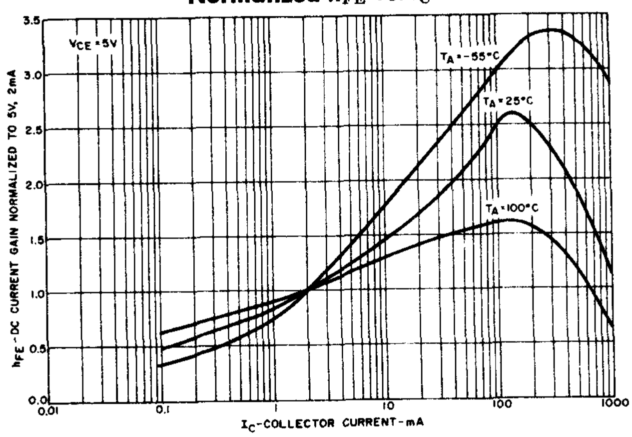
NOTE: As measured on a Quan-Tech Model 2283/2181M test set with 10 Hz filter modified by Quan-Tech to a wideband (f = 10 Hz to 10 kHz, B.W. = 15.7 kHz) filter.

Typical Curves

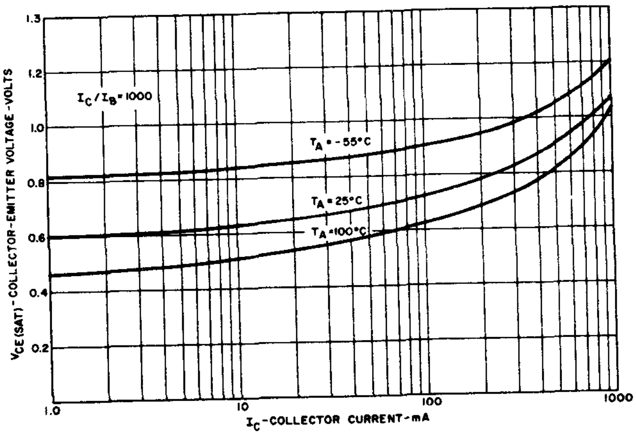
Typical h_{FE} vs. I_C



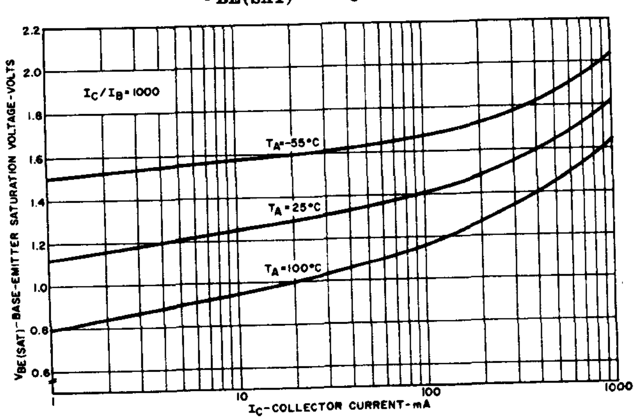
Normalized h_{FE} vs. I_C



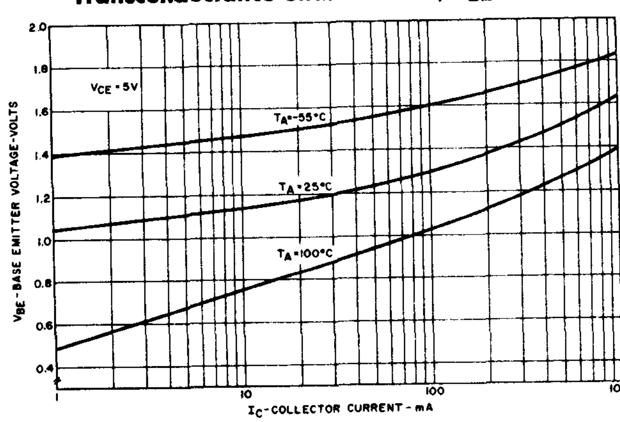
V_{CE} vs. I_C



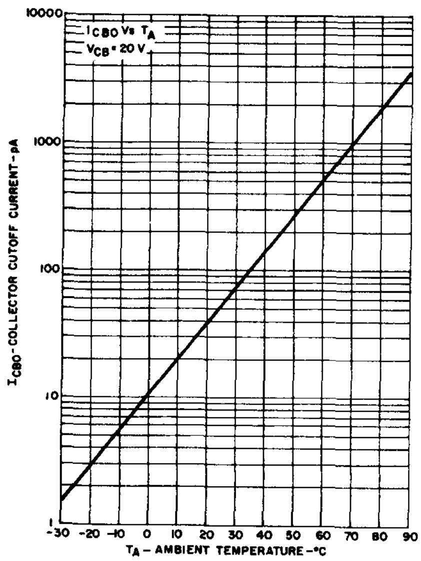
$V_{BE(SAT)}$ vs. I_C



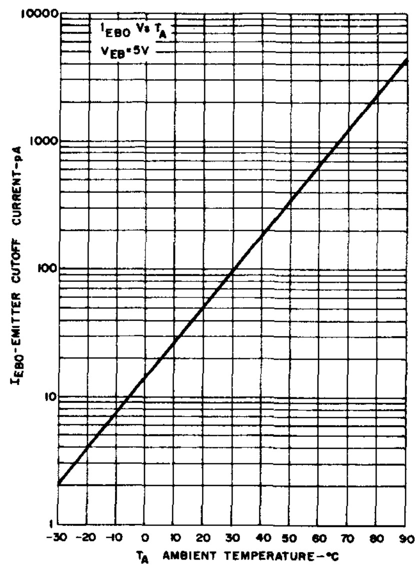
Transconductance Characteristic, V_{BE} vs. I_C



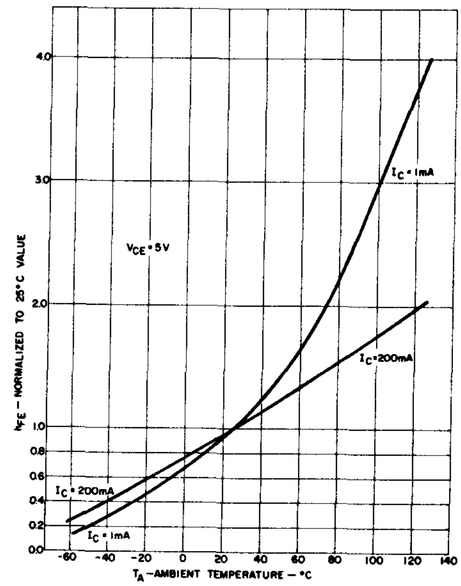
I_{CBO} vs. T_A



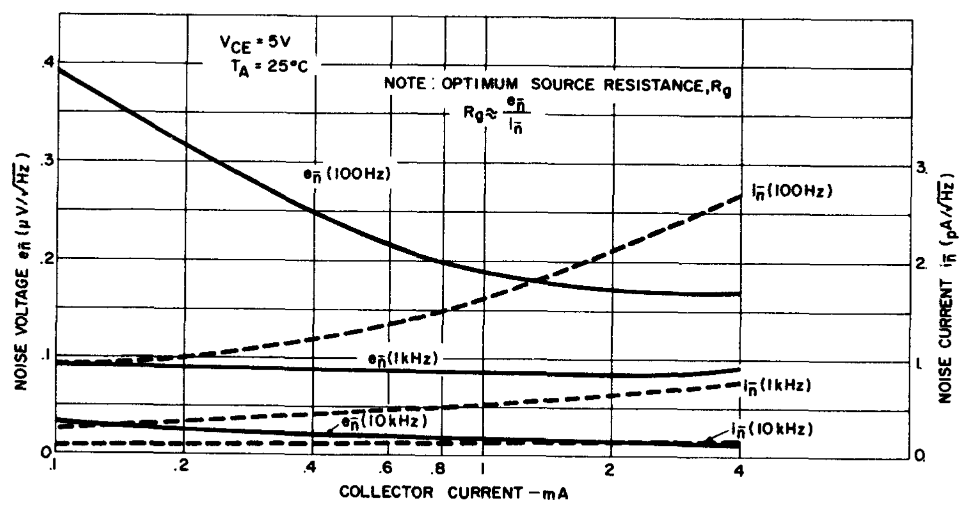
I_{EBO} vs. T_A



h_{FE} vs. T_A

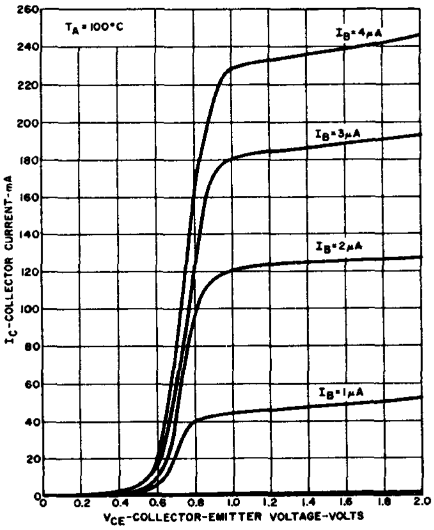


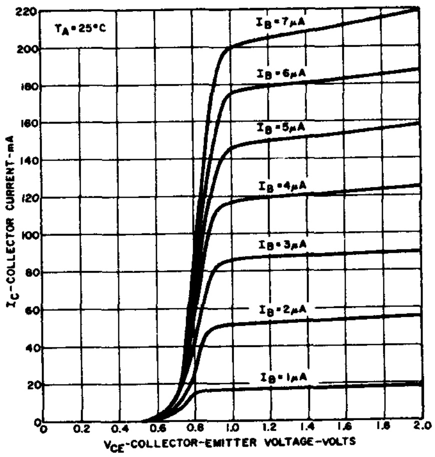
Equivalent Input Noise Voltage and Current vs. Bias Current

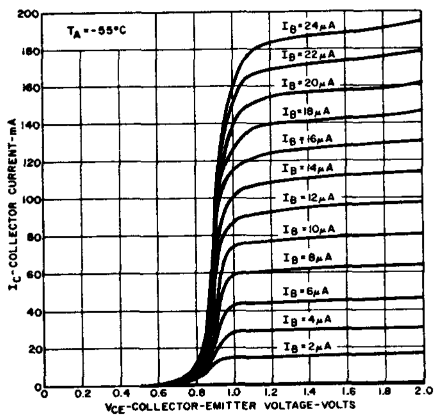


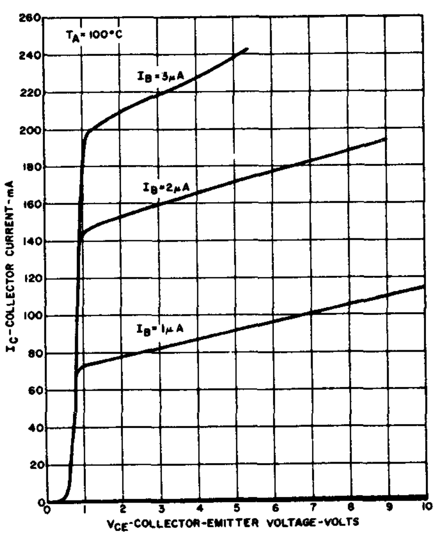
NOTE: Due to the noise characteristics of this device versus frequency, calculation of noise figure (N.F.) from $\bar{e_n}$, $\bar{i_n}$ values is not accurate [as is the case with field effect transistors (F.E.T.'s)].

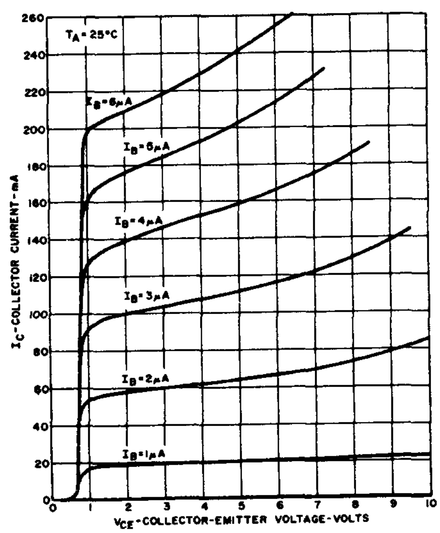
Typical Collector Characteristics

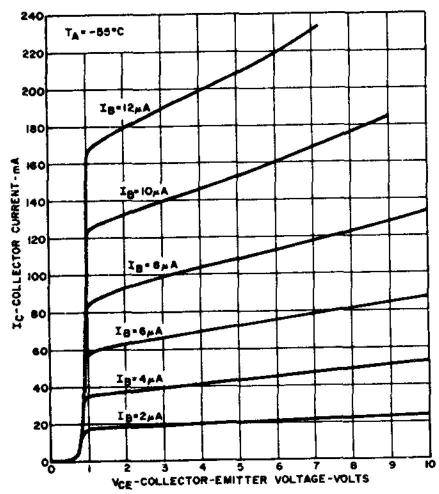








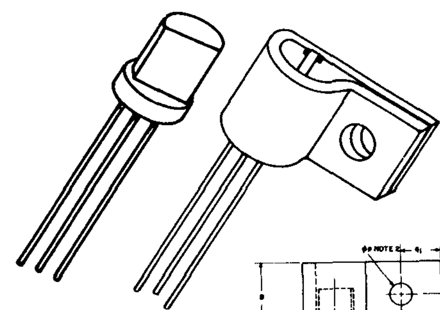




Silicon Transistors

2N5307,8,8A

The General Electric 2N5307, 2N5308 and 2N5308A are NPN, silicon, planar, epitaxial, passivated Darlington monolithic amplifiers. These devices are especially suited for preamplifier input stages requiring input impedances of several megohms or extremely low level, high gain, low noise amplifier applications. Additional applications include medium speed switching circuits in consumer and industrial control applications.



absolute maximum ratings: (25°C) (unless otherwise specified)

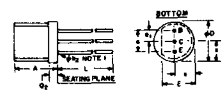
Voltages			
Collector to Base	V_{CBO}	40	Volts
Collector to Emitter	V_{CEO}	40	Volts
Emitter to Base	V_{EBO}	12	Volts
Current			
Collector (Steady State)	I_C	300	mA
Collector (Pulsed)*	I_C	500	mA
Base (Steady State)	I_B	50	mA
Dissipation			
Total Power ($T_A \leq 25°$ C)†	P_T	400	mW
Total Power with Heatsink ($T_A \leq 25°$ C)††	P_T	600	mW
Total Power with Heatsink ($T_C \leq 25°$ C)†††	P_T	900	mW
Temperature			
Storage	T_{stg}	−65 to +150° C	
Operating	T_J	−65 to +125° C	
Lead, 1/16″ ± 1/32″ from case for 10 sec. max.	T_L	+260° C	

*Pulse conditions: 300 μsec. pulse width, 2% duty cycle.

†Derate 4.0 mW/° C for increase in ambient temperature above 25° C.

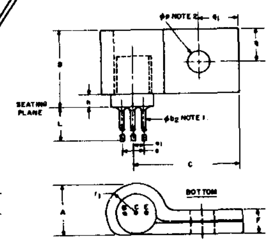
††Derate 6.0 mW/° C for increase in ambient temperature above 25° C.

†††Derate 9.0 mW/° C for increase in case temperature above 25° C.



SYMBOL	INCHES MIN	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.170	.265	4.32	6.73
ϕb2	.016	.019	.406	.483
ϕD	.165	.205	4.19	5.21
E	.110	.155	2.79	3.94
e	.095	.105	2.41	2.67
e1	.045	.055	1.14	1.40
L	.500		12.70	
Q2		.075		1.90
s	.080	.115	2.03	2.92

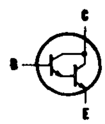
NOTE 1: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .070 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A		.263		6.68
B		.435		11.04
ϕb2	.016	.019	.407	.482
C		.520		13.20
e	.095	.105	2.42	2.66
e1	.045	.055	1.15	1.39
F		.140		3.56
h		.103		2.61
L	.500		12.70	
ϕP		.143		3.63
q	.156 REF.		3.96 REF.	
q1	.087 REF.		2.21 REF.	
r1		.156		3.96

NOTE 1: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .070 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .020 IS HELD

NOTE 2: HOLE FOR #4 SCREW – WILL ACCEPT 113 PIN. ORDER HEATSINK VERSIONS AS: HS5307 HS5308



Equiv. Circuit

STATIC CHARACTERISTICS			Min.	Max.	
Collector to Base Breakdown Voltage ($I_C = 0.1\mu A, I_E = 0$)		$V_{(BR)CBO}$	40		Volts
Collector to Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)		$V_{(BR)CEO}$	40		Volts
Emitter to Base Breakdown Voltage ($I_E = 0.1\mu A, I_C = 0$)		$V_{(BR)EBO}$	12		Volts
Forward Current Transfer Ratio					
($V_{CE} = 5V, I_C = 2mA$)	2N5307	h_{FE}	2000	20000	
($V_{CE} = 5V, I_C = 100mA$)	2N5307	h_{FE}	6000		
($V_{CE} = 5V, I_C = 2mA$)	2N5308, A	h_{FE}	7000	70000	
($V_{CE} = 5V, I_C = 100mA$)	2N5308, A	h_{FE}	20000		
Collector Cutoff Current					
($V_{CB} = 40V, I_E = 0$)		I_{CBO}		100	nA
($V_{CB} = 40V, I_E = 0, T_A = 100°$ C)		I_{CBO}		20	μA
Emitter Cutoff Current ($V_{EB} = 12V, I_C = 0$)		I_{EBO}		100	nA
Collector Emitter Saturation Voltage					
($I_C = 200mA, I_B = 0.2mA$)		$V_{CE(SAT)}$		1.4	Volts
Base Emitter Saturation Voltage					
($I_C = 200mA, I_B = 0.2mA$)		$V_{BE(SAT)}$		1.6	Volts
Base Emitter Voltage ($V_{CE} = 5V, I_C = 200mA$)		V_{BE}		1.5	Volts

DYNAMIC CHARACTERISTICS			Min.	Typ.	Max.	
Forward Current Transfer Ratio						
($V_{CE} = 5V, I_C = 2mA, f = 1kHz$)	2N5307	h_{fe}	2000			
($V_{CE} = 5V, I_C = 2mA, f = 1kHz$)	2N5308, A	h_{fe}	7000			
($V_{CE} = 5V, I_C = 2mA, f = 1kHz$)		$\|h_{fe}\|$	15.6			dB
Gain Bandwidth Product ($V_{CE} = 5V, I_C = 2mA, f = 10$ MHz)		f_T	60			MHz
Input Impedance ($V_{CE} = 5V, I_C = 2mA, f = 1$ kHz)		h_{ie}		650		kohms
Collector Base Capacitance ($V_{CB} = 10V, f = 1$ MHz)		C_{cb}		7.6	10	pF
Emitter Capacitance ($V_{EB} = 0.5V, f = 1$ MHz)		C_{eb}		10.5		pF

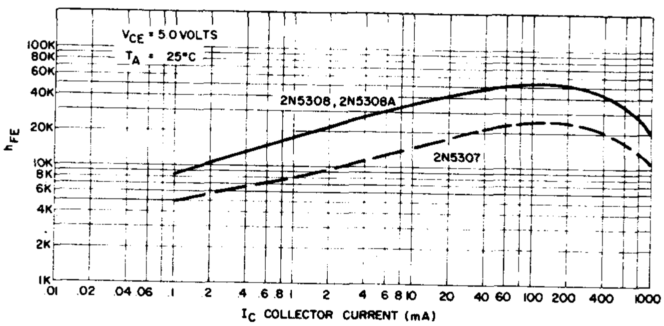
2N5308A only

	Conditions		Min.	Typ.	Max.	Units
Noise Voltage	($I_C = 0.6$ mA, $V_{CE} = 5$V, $R_G = 160$kΩ $f = 10$Hz to 10kHz, B.W. = 15.7 kHz)	$e_{\bar{n}}$		195	230	nV/$\sqrt{\text{Hz}}$

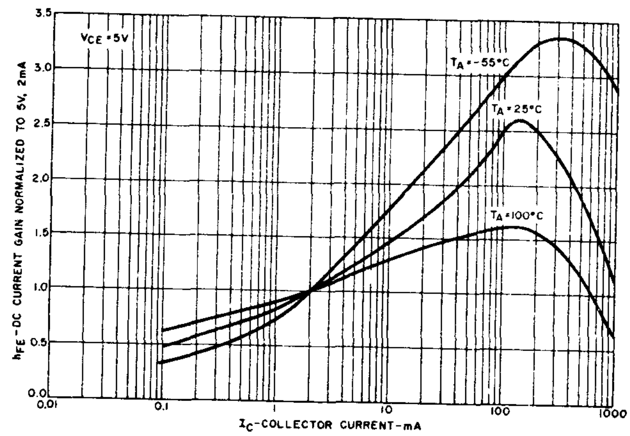
NOTE: As measured on a Quan-Tech Model 2283/2181M test set with 10 Hz filter modified by Quan-Tech to a wideband (f = 10 Hz to 10 kHz, B.W. = 15.7 kHz) filter.

Typical Curves

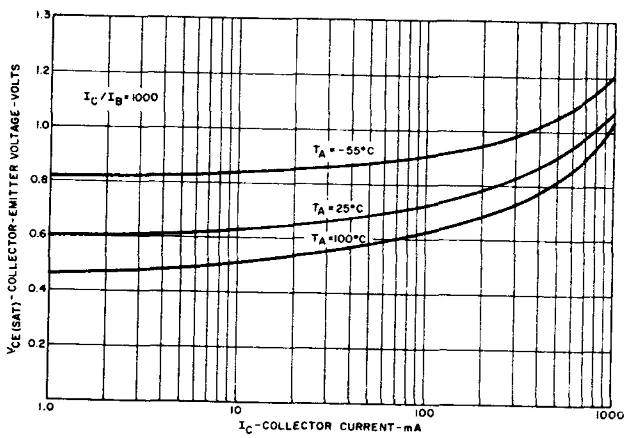
Typical h_{FE} vs. I_C



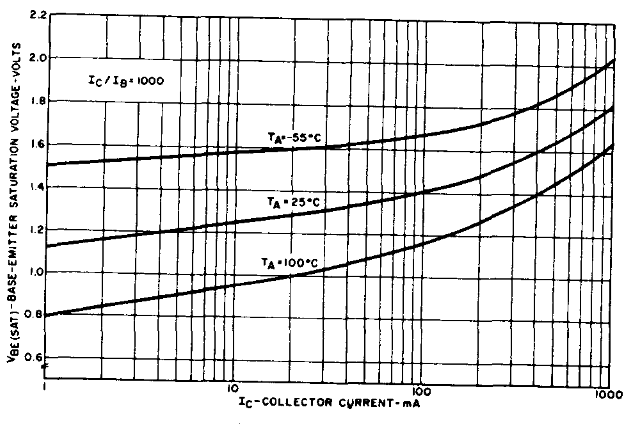
Normalized h_{FE} vs. I_C



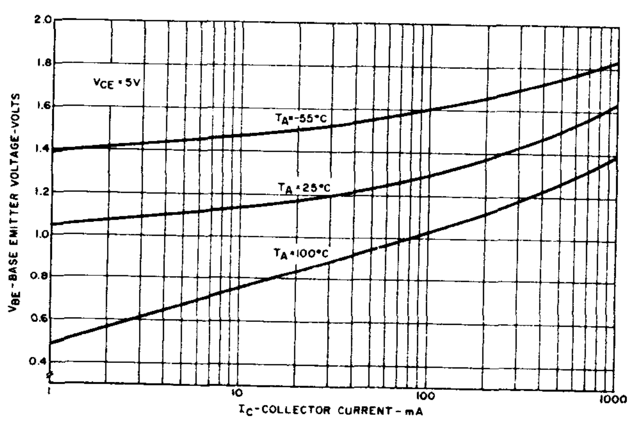
V_{CE} vs. I_C



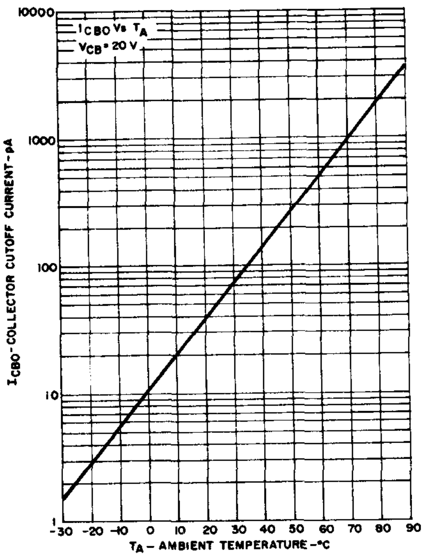
$V_{BE(SAT)}$ vs. I_C



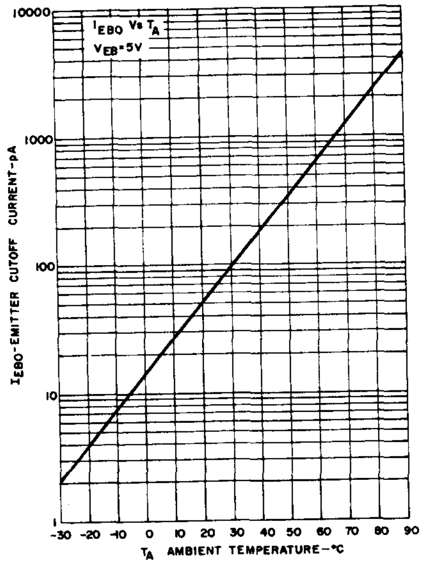
Transconductance Characteristic, V_{BE} vs. I_C



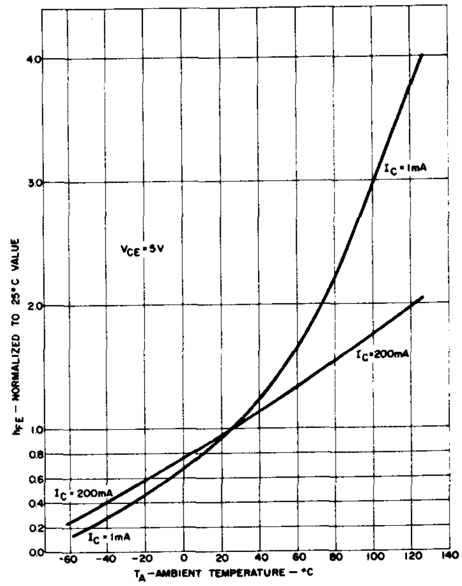
I_{CBO} vs. T_A



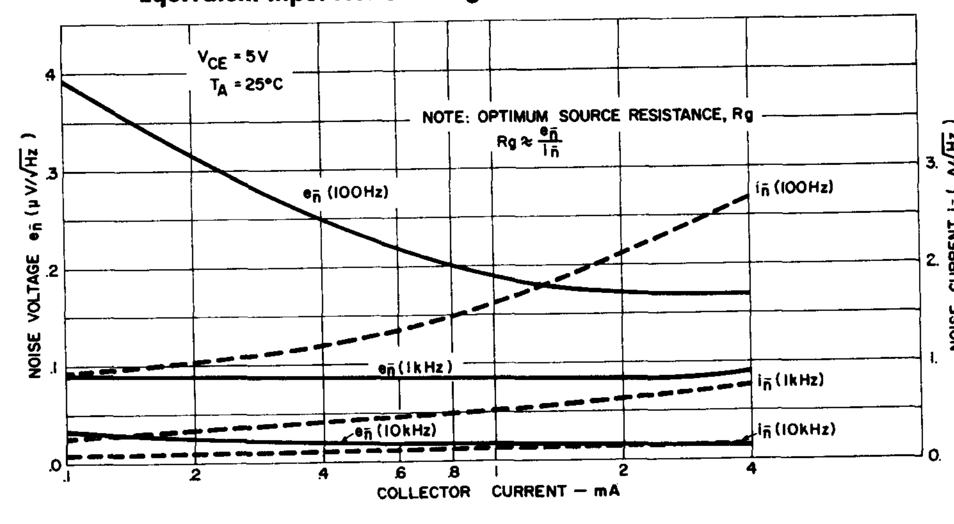
I_{EBO} vs. T_A



h_{FE} vs. T_A

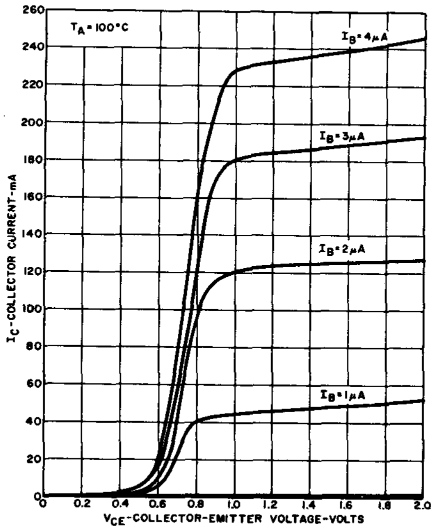


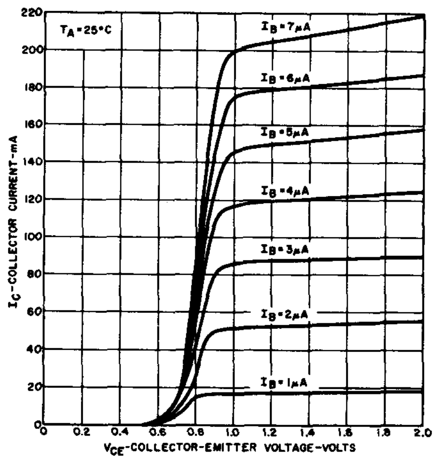
Equivalent Input Noise Voltage and Current vs. Bias Current

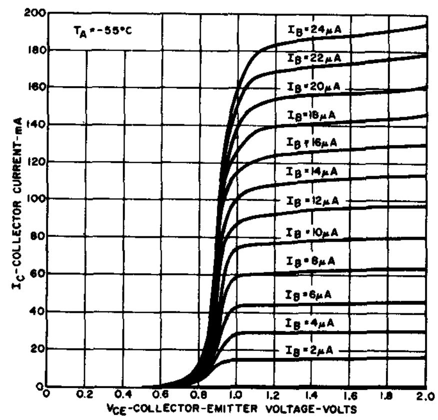


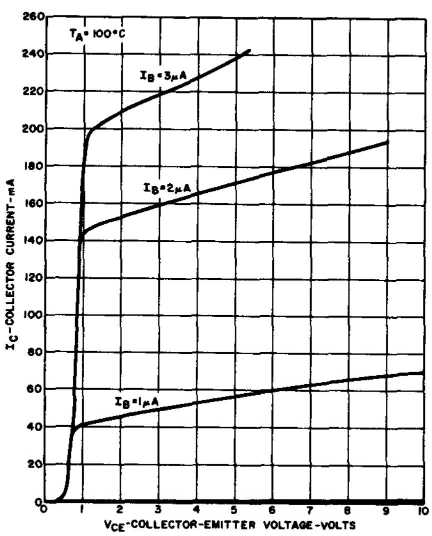
NOTE: Due to the noise characteristics of this device versus frequency, calculation of noise figure (N.F.) from $e_{\bar{n}}$, $i_{\bar{n}}$ values is not accurate [as is the case with field effect transistors (F.E.T.'s)].

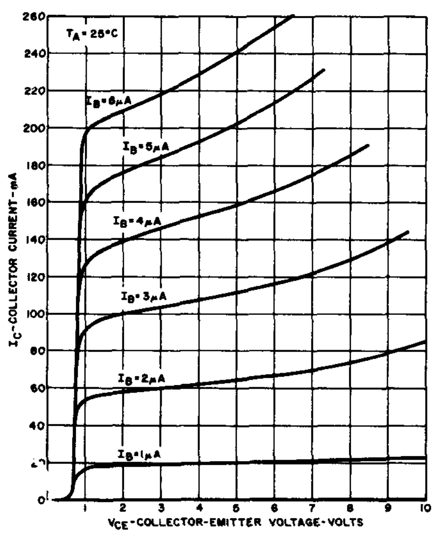
Typical Collector Characteristics

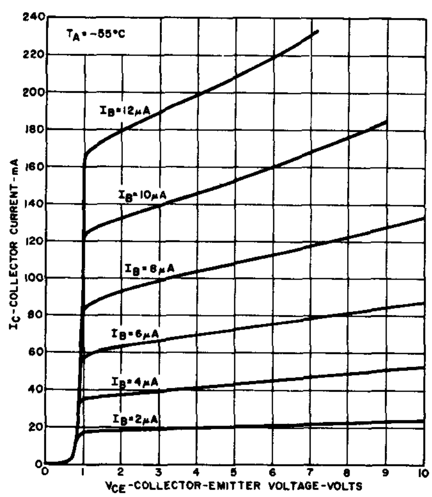










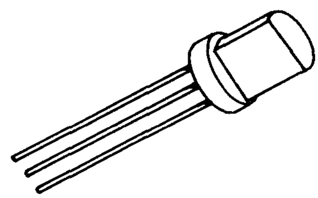


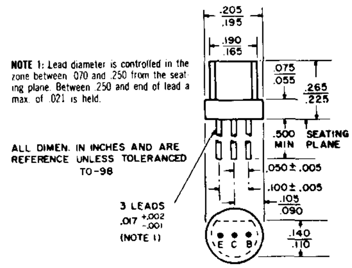
Silicon Transistors

NPN

2N5309,10

The General Electric 2N5309 and 2N5310 are NPN, silicon, planar, epitaxial, passivated transistors. These devices feature very high gain at extremely low collector currents, low leakage currents and inherent low noise characteristics. These transistors are ideally suited for low level amplifier applications and, with leads formed to a TO-18 pin configuration, are intended to be epoxy replacements for the 2N929 and 2N930 type devices.





absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	50	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	70	Volts
Current			
Collector (Steady State) *	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C) †	P_T	360	mW
Total Power (Free Air @ 55°C) †	P_T	250	mW
Temperature			
Storage	T_{stg}		−55 to +150°C
Operating	T_j		+125°C
Lead Soldering, 1/16″ ± 1/32″ from case for 10 sec. max.	T_L		+260°C

*Determined from power limitations due to saturation voltage at this current.
†Derate 3.6 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics

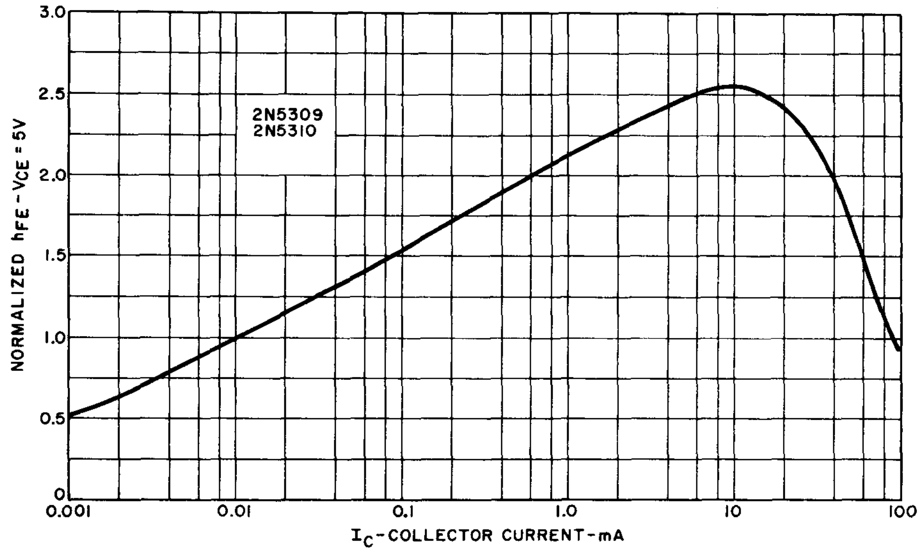
			Min.	Max.	
Collector Cutoff Current ($V_{CB} = 50V$)		I_{CBO}		10	nA
($V_{CB} = 50V$, TA = 100°C)		I_{CBO}		10	μA
($V_{CB} = 50V$)		I_{CES}		10	nA
Emitter Cutoff Current ($V_{EB} = 5V$)		I_{EBO}		50	nA
Forward Current Transfer Ratio ($V_{CE} = 5V$, $I_C = 10\ \mu A$)	2N5309	h_{FE}	60	120	
	2N5310	h_{FE}	100	300	
Collector Emitter Breakdown Voltage ($I_C = 10$ mA)‡		$V_{(BR)CEO}$	50		Volts
Collector Base Breakdown Voltage ($I_C = 10\ \mu A$)		$V_{(BR)CBO}$	70		Volts
Emitter Base Breakdown Voltage ($I_E = 10\ \mu A$)		$V_{(BR)EBO}$	5		Volts
Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)‡		$V_{CE(sat)}$		.125	Volts
Base Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)‡		$V_{BE(sat)}$		.78	Volts
Base Emitter Voltage ($V_{CE} = 10V$, $I_C = 2$ mA)		V_{BE}	.5	.9	Volts

Dynamic Characteristics

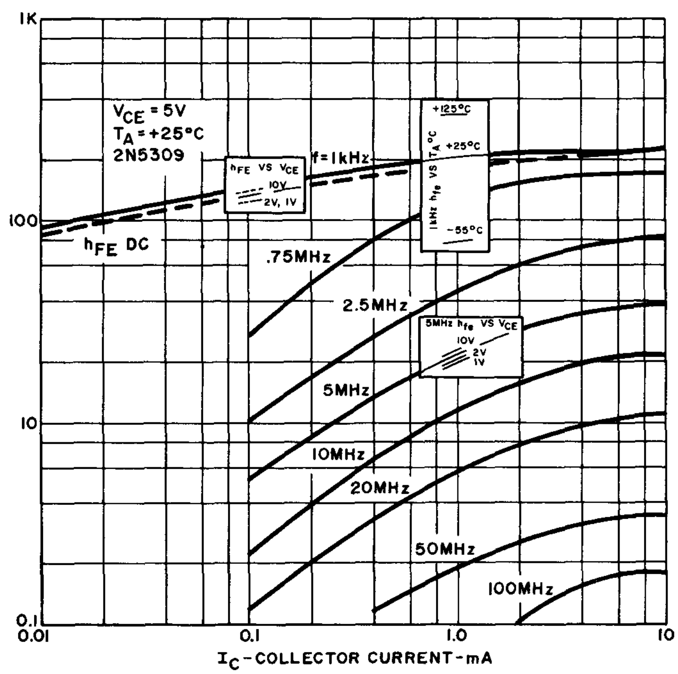
			Min.	Max.	
Forward Current Transfer Ratio ($V_{CE} = 10V$, $I_C = 10\ \mu A$, f = 1 kHz)	2N5309	h_{fe}	66		
	2N5310	h_{fe}	110		
Output Capacitance, Common Base ($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)		C_{cb}	1.0	4.0	pF

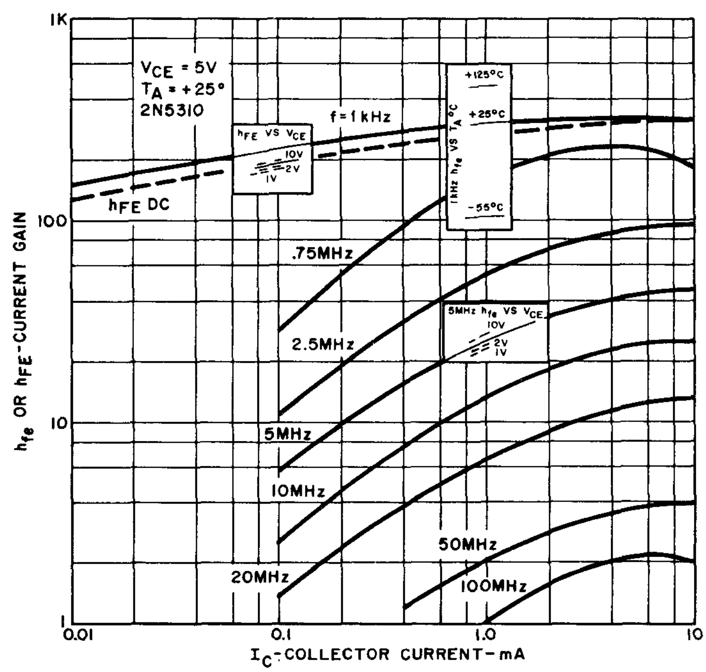
‡Pulse conditions 300 μsec. 2% duty cycle.

Normalized hFE vs. Ic

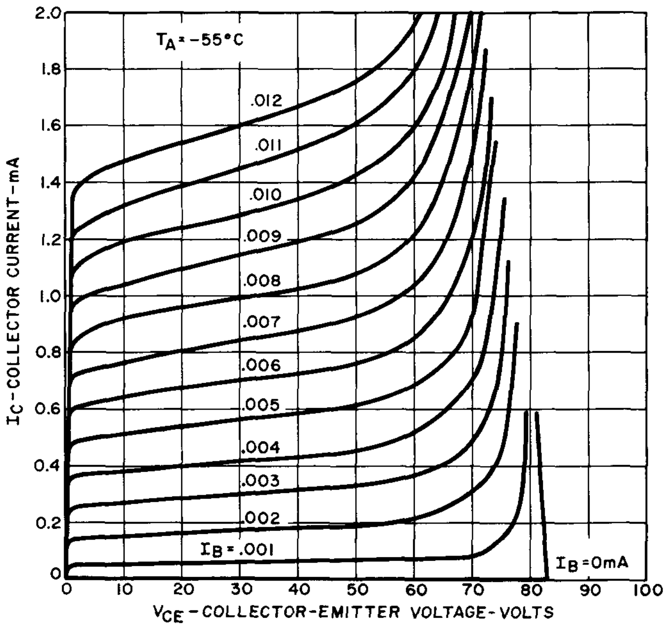


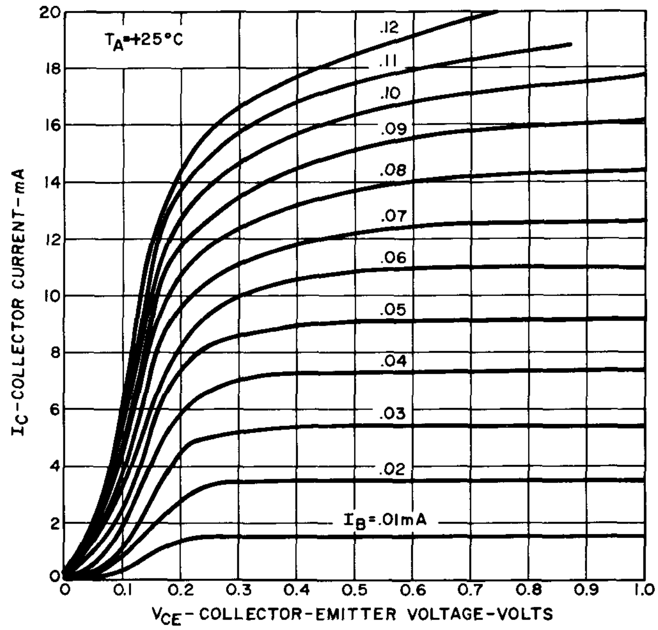
Small Signal Current Gain vs. Collector Current

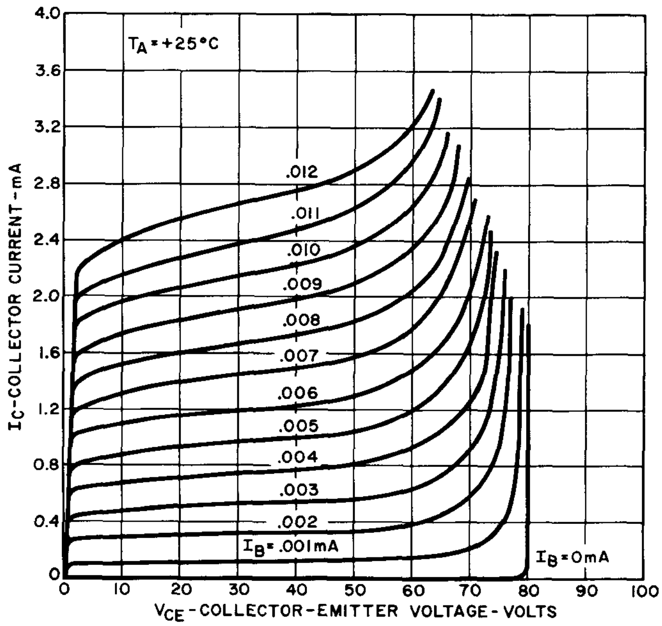


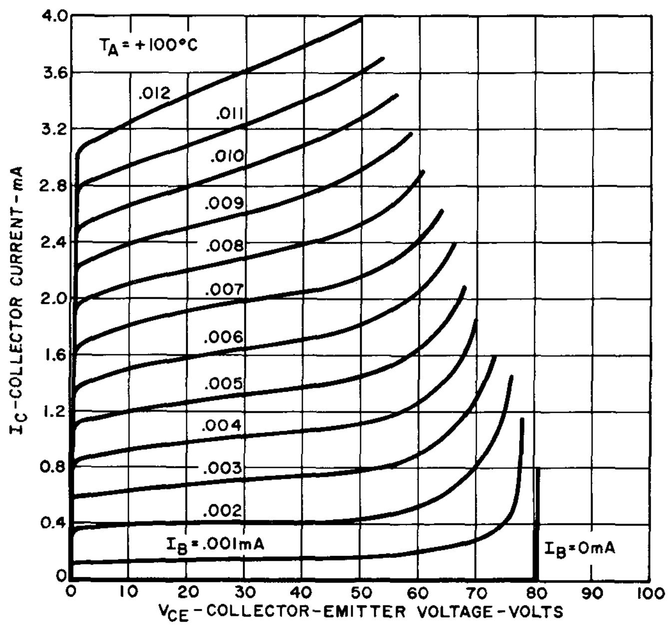


Typical Collector Characteristics
2N5309

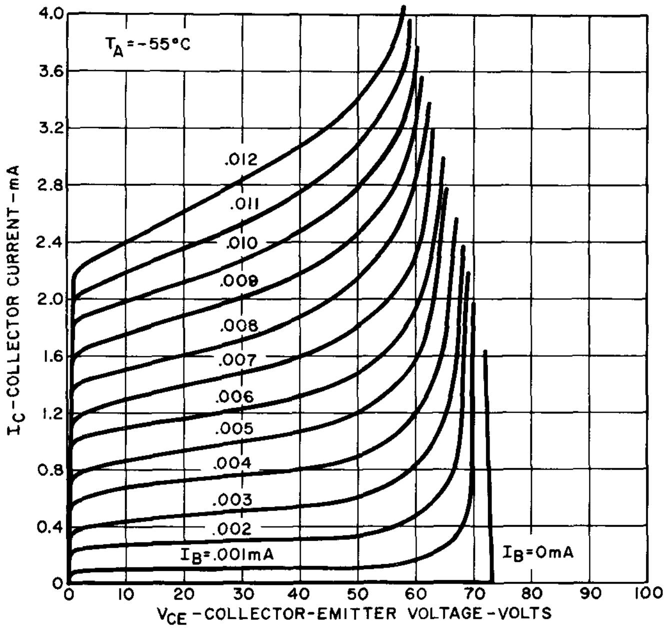


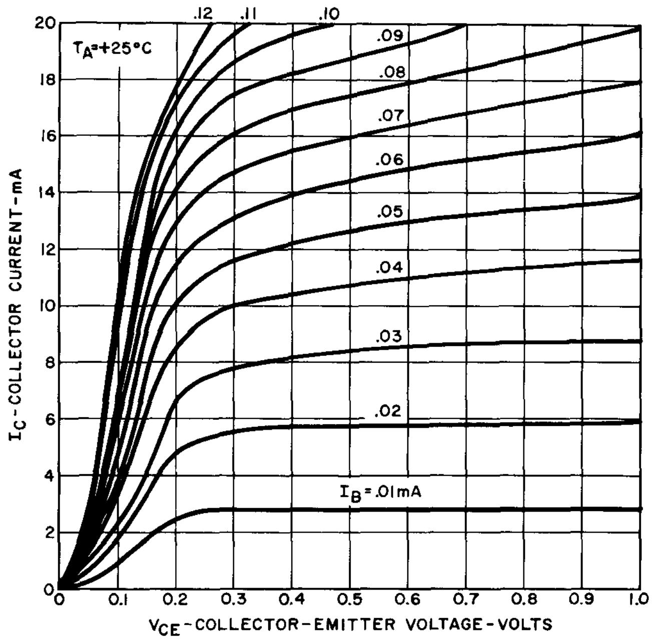


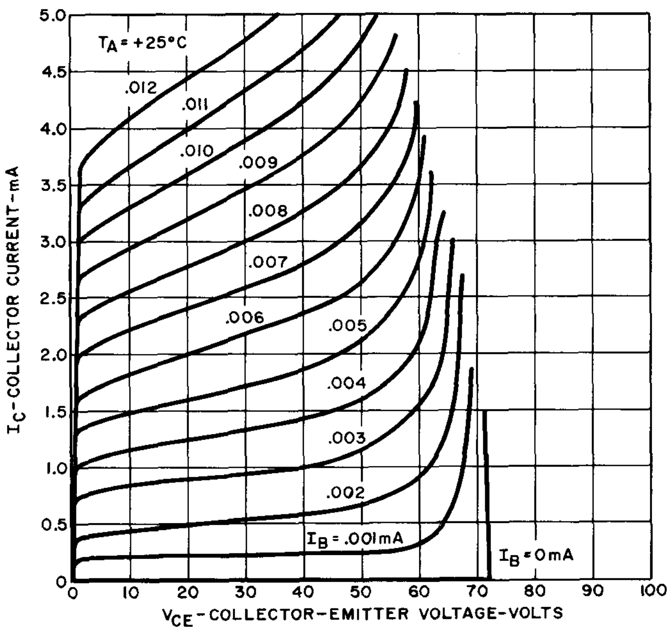


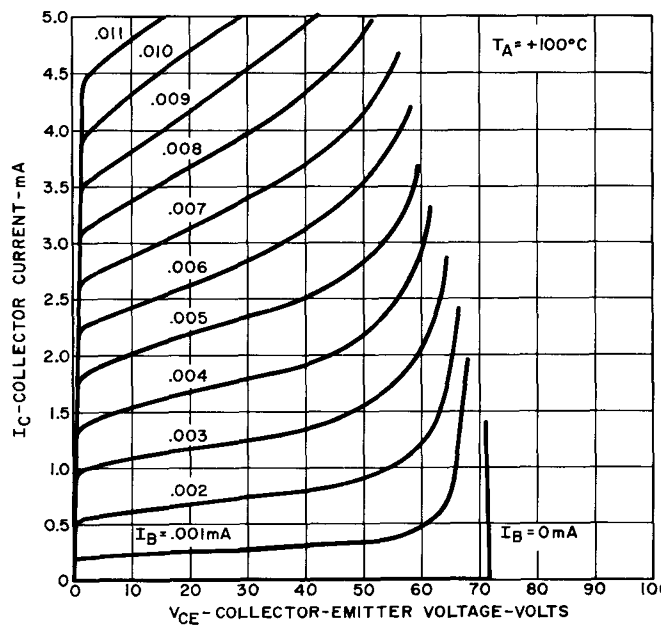


Typical Collector Characteristics
2N5310







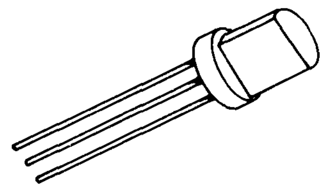


Silicon Transistors

PNP

2N5354,5,6

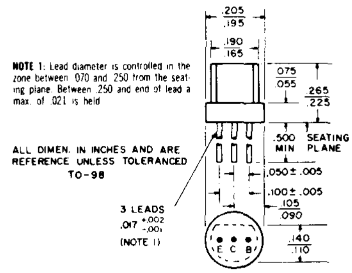
This series of economy transistors are PNP, silicon, planar, epitaxial, passivated devices. These units feature low collector saturation voltage, good current gain linearity over a wide collector current range, high gain-bandwidth product, and low noise. These characteristics make these units excellent for use in general purpose consumer and industrial amplifier and switching applications.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	-25	Volts
Emitter to Base	V_{EBO}	- 4	Volts
Collector to Base	V_{CBO}	-25	Volts
Current			
Collector (Continuous)	I_C	350	mA
Collector (Pulsed, 10 μsec pulse width, = 2% Duty Cycle)	I_C	700	mA
Dissipation			
Total Power (Free Air at 25°C)*	P_T	360	mW
Total Power (Free Air at 55°C)*	P_T	260	mW
Temperature			
Storage	T_{stg}	-65 to +150	°C
Operating	T_j	+125	°C
Lead temperature, 1/16" ± 1/32" from case for ten seconds maximum	T_L	+260	°C

* *Derate 3.6 mW/°C increase in ambient temperature above 25°C.*



electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics			**Min.**	**Typ.**	**Max.**	
Collector Cutoff Current						
(V_{CB}=-25V)		I_{CBO}			-100	nA
(V_{CB}= -25V, T_A=100°C)		I_{CBO}			- 10	μA
(V_{CB}=-25V)		I_{CES}			-100	nA
Emitter Cutoff Current (V_{EB}=-4V)		I_{EBO}			- 10	μA
Forward Current Transfer Ratio						
(V_{CE}=-10V, I_C=-2 mA)	2N5354	h_{FE}	32			
(V_{CE} =-1V, I_C=-50 mA)	2N5354	h_{FE}	40		120	
(V_{CE} = -5V, I_C= -300 mA)	2N5354	h_{FE}	20			
(V_{CE} =-10V, I_C=-2 mA)	2N5355	h_{FE}	80			
(V_{CE}=-1V, I_C=-50 mA)	2N5355	h_{FE}	100		300	
(V_{CE} = -5V, I_C= -300 mA)	2N5355	h_{FE}	40			
(V_{CE}=-10V, I_C=-2 mA)	2N5356	h_{FE}	200			
(V_{CE}=-1V, I_C=-50 mA)	2N5356	h_{FE}	250		500	
(V_{CE} = -5V, I_C= -300 mA)	2N5356	h_{FE}	75			
Collector Emitter Breakdown Voltage						
(I_C=-10 mA)		$V_{(BR)CEO}$	- 25			Volts
Collector Saturation Voltage						
(I_C=-50 mA, I_B=-2.5 mA)		$V_{CE(sat)}$			-.250	Volts
(I_C=-300 mA, I_B=-30 mA)		$V_{CE(sat)}$			-1.0	Volts

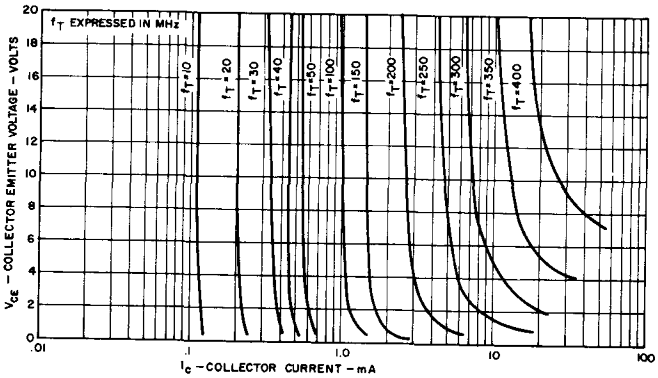
			Min.	Typ.	Max.	
Base Saturation Voltage						
(I_C=-50 mA, I_B=-2.5 mA)		$V_{BE(sat)}$			-1.1	Volts
(I_C=-300 mA, I_B=-30 mA)		$V_{BE(sat)}$			-2.0	Volts
Base Emitter Voltage						
(V_{CE}=-10V, I_C=-2 mA)		V_{BE}	-0.5		-0.8	Volts

Dynamic Characteristics

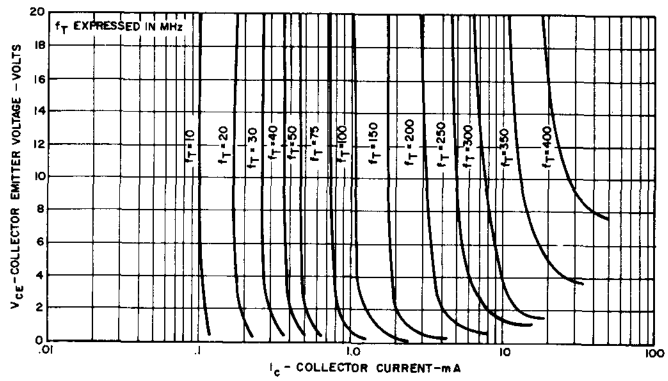
			Min.	Typ.	Max.	
Forward Current Transfer Ratio						
(V_{CE}=-10V, I_C=-2 mA, f=1 kHz)	2N5354	h_{fe}	32		180	
(V_{CE}=-10V, I_C=-2 mA, f=1 kHz)	2N5355	h_{fe}	80		450	
(V_{CE}=-10V, I_C=-2 mA, f=1 kHz)	2N5356	h_{fe}	200		750	
Output Capacitance, Common Base						
(V_{CB} =-10V, I_E=0, f=1 MHz)		C_{cb}			8	pF
Input Capacitance, Common Base						
(V_{EB}=-0.5V, I_C=0, f=1 MHz)		C_{eb}			35	pF
Gain Bandwidth Product						
(V_{CE}=-10V, I_C=-2 mA)		f_T		250		MHz

TYPICAL CONTOURS OF GAIN BANDWIDTH PRODUCT, (f_T) VS. COLLECTOR CURRENT

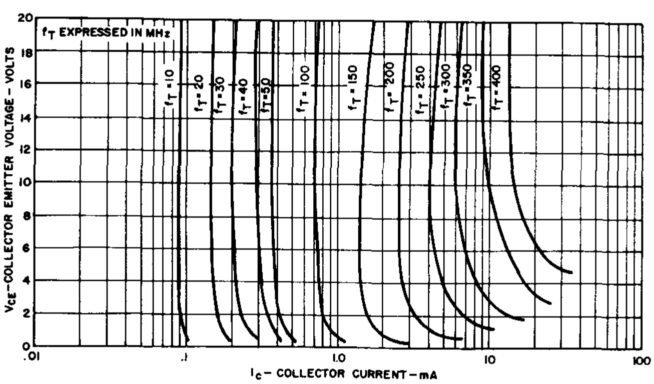
2N5354



2N5355

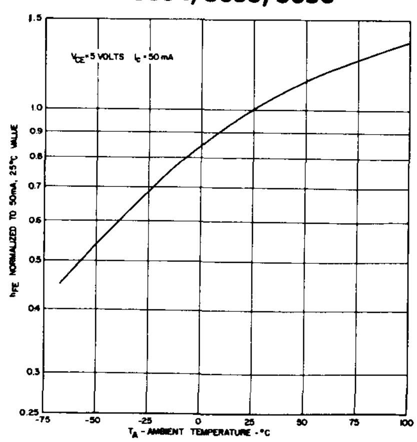


2N5356



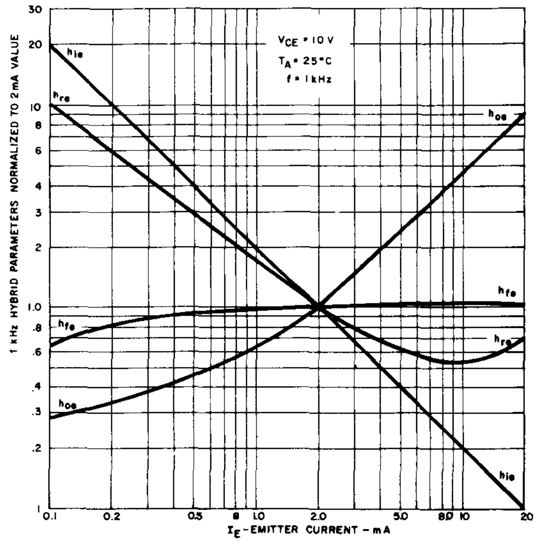
TYPICAL NORMALIZED H_{FE} VS. TEMPERATURE

2N5354, 5355, 5356



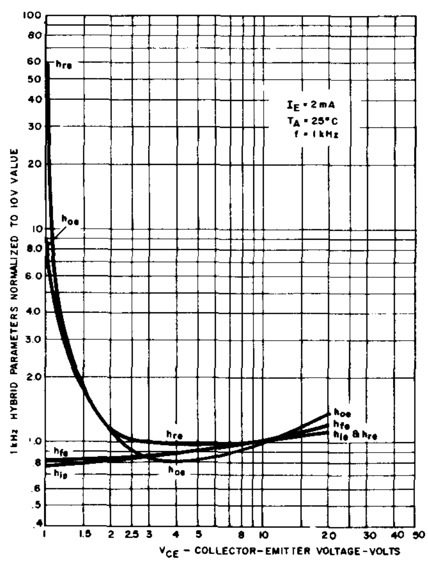
TYPICAL SMALL SIGNAL CHARACTERISTICS VS. EMITTER CURRENT

2N5354, 5355, 5356



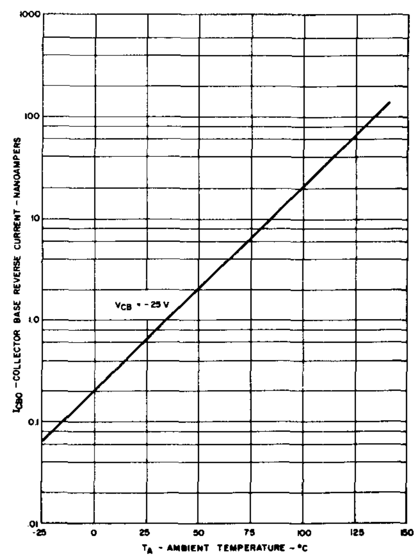
TYPICAL SMALL SIGNAL CHARACTERISTICS VS. COLLECTOR VOLTAGE

2N5354, 5355, 5356



TYPICAL COLLECTOR CUTOFF CURRENT (I_{cbo}) VS. TEMPERATURE

2N5354, 5355, 5356



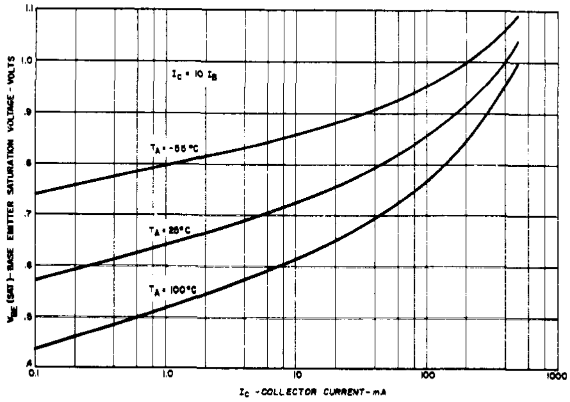
TYPICAL SMALL SIGNAL CHARACTERISTICS

f = 1 kHz, V_{CE} = 10V, I_E = 2 mA

Symbol	Characteristic	2N5354	2N5355	2N5356	Units
h_{ie}	Input Resistance	1300	2000	8700	ohms
h_{oe}	Output Conductance	24	37	100	μmhos
h_{fe}	Forward current transfer ratio	100	150	450	
h_{re}	Reverse voltage feedback ratio	1.5	2.0	4.0	$\times 10^{-4}$

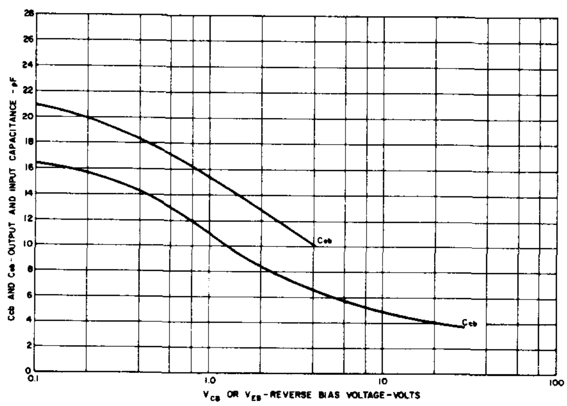
TYPICAL BASE SATURATION VOLTAGE VS. COLLECTOR CURRENT

2N5354, 5355, 5356



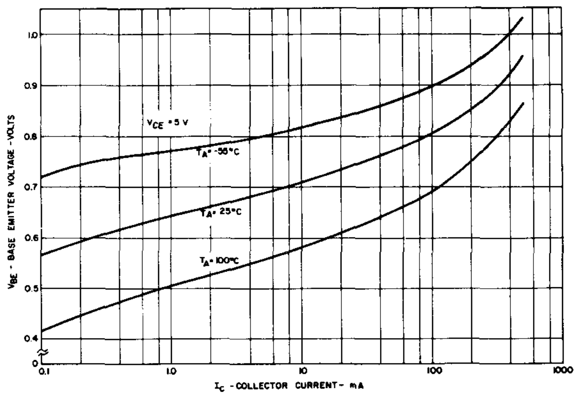
TYPICAL OUTPUT CAPACITANCE AND INPUT CAPACITANCE VS. REVERSE BIAS VOLTAGE

2N5354, 5355, 5356

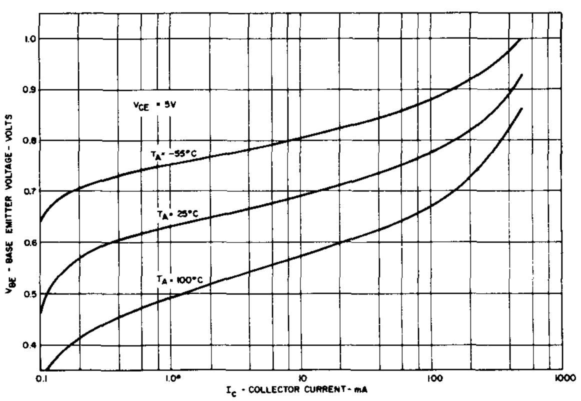


TYPICAL TRANSFER CHARACTERISTICS

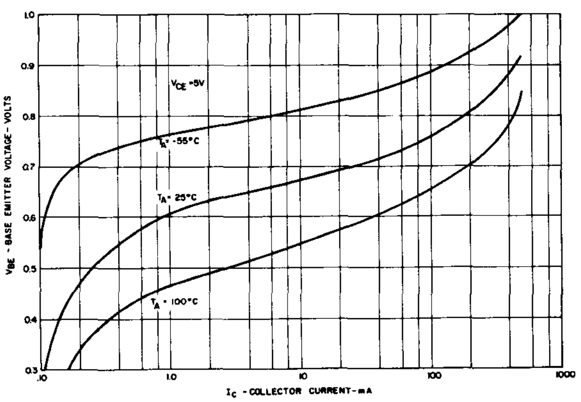
2N5354



2N5355

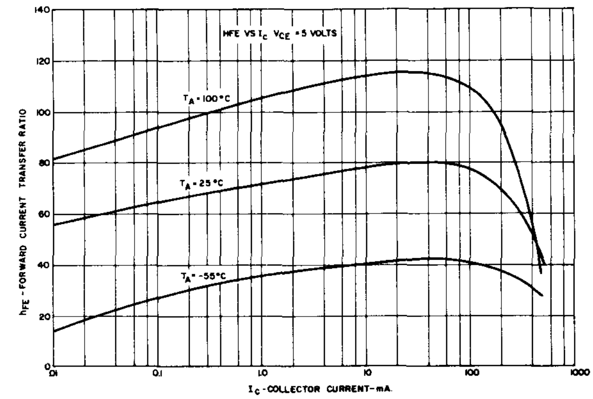


2N5356

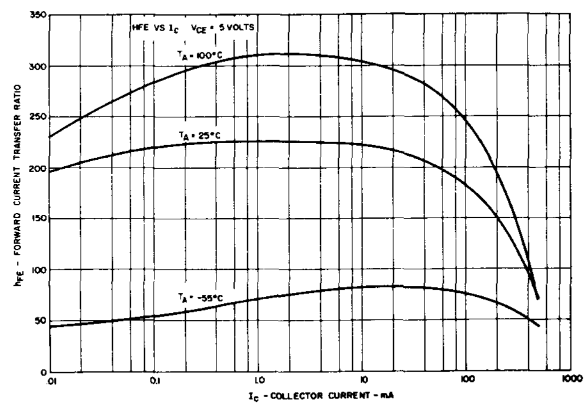


TYPICAL FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

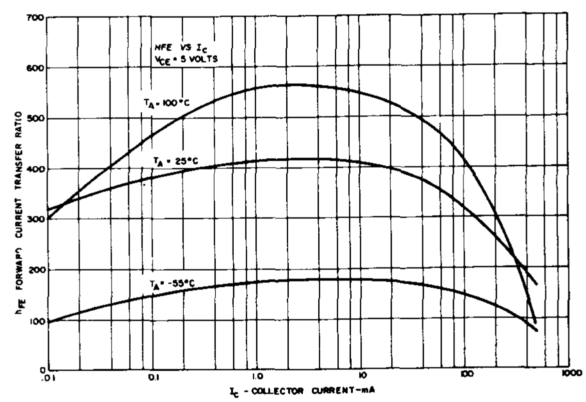
2N5354



2N5355

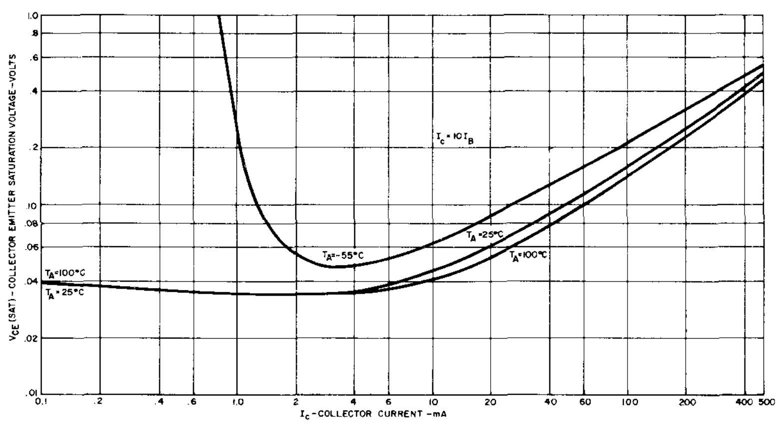


2N5356

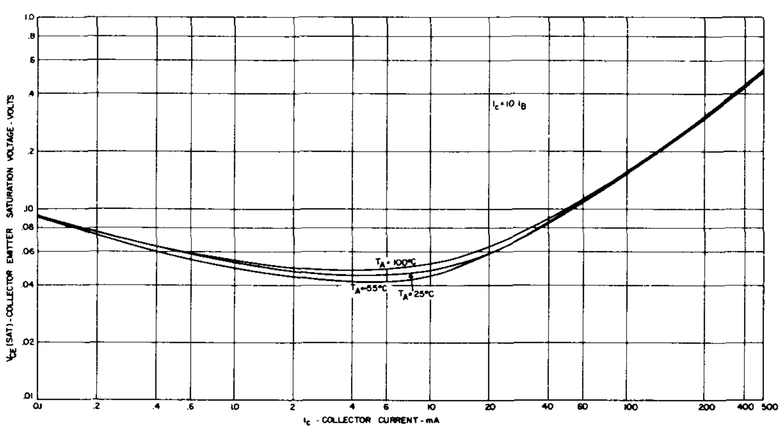


TYPICAL COLLECTOR SATURATION VOLTAGE VS. COLLECTOR CURRENT

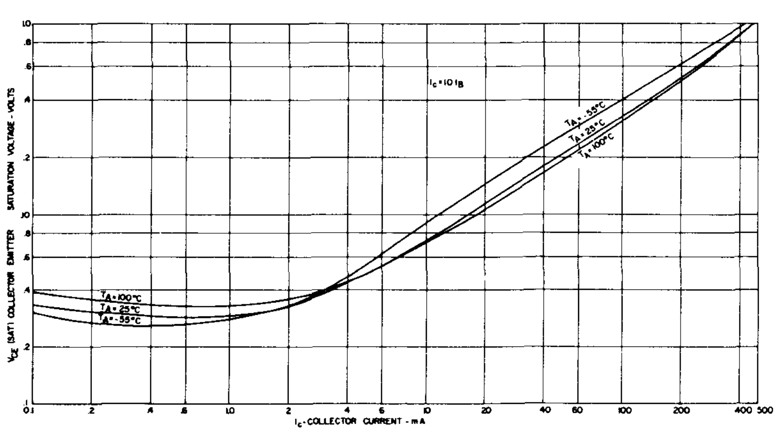
2N5354



2N5355

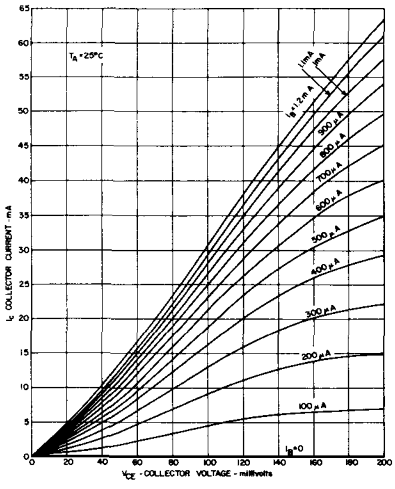


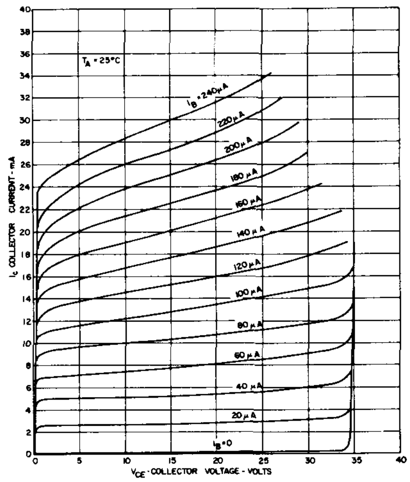
2N5356



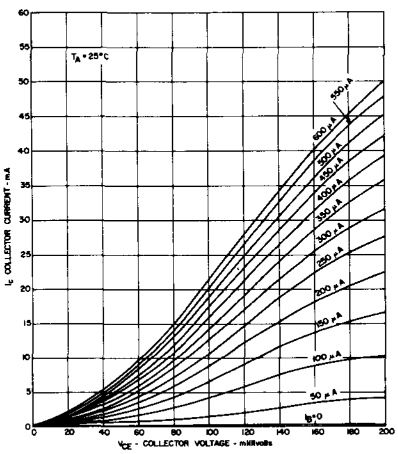
TYPICAL COLLECTOR CHARACTERISTICS

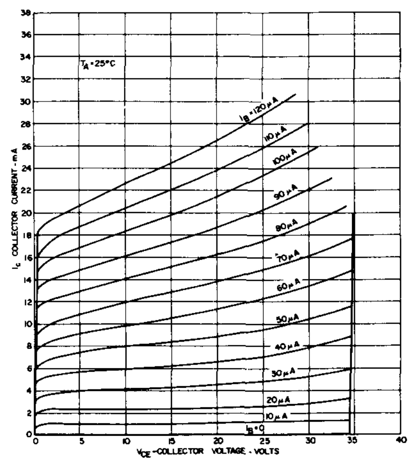
2N5354



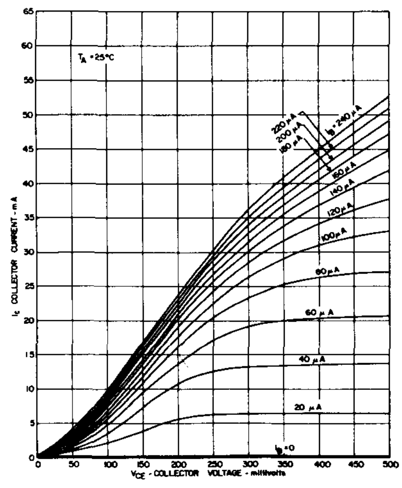


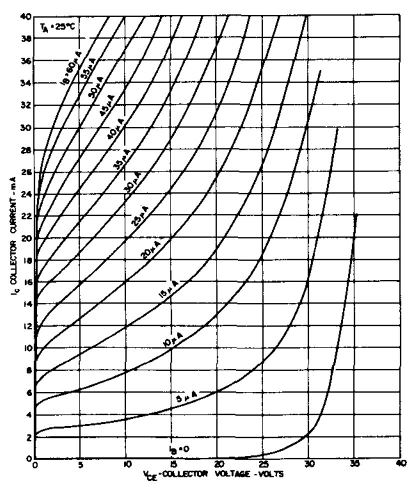
2N5355



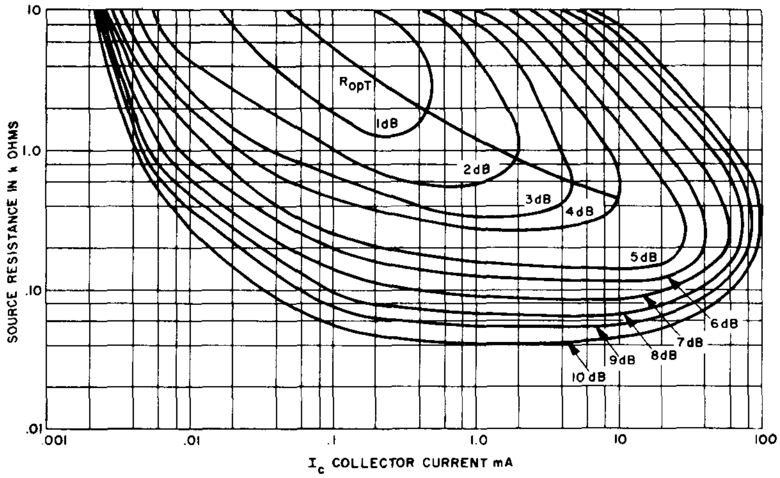


2N5356

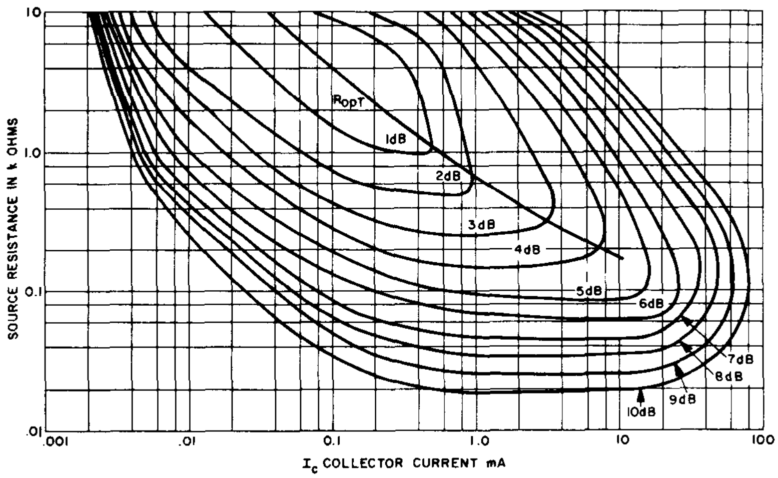




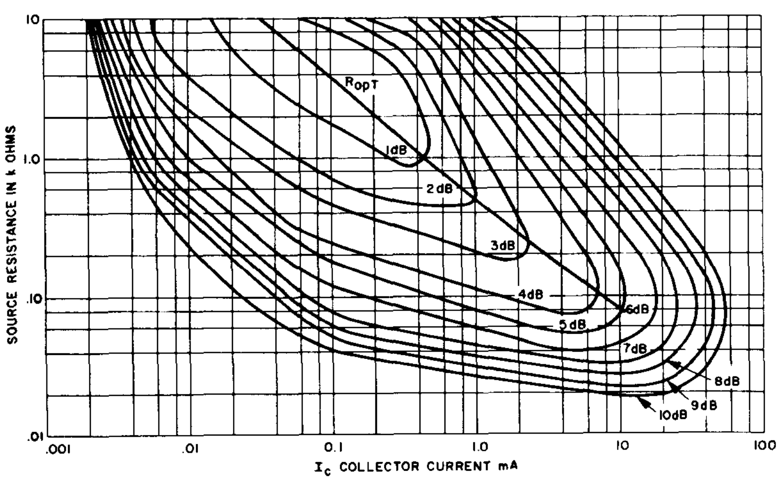
2N5354



2N5355



2N5356



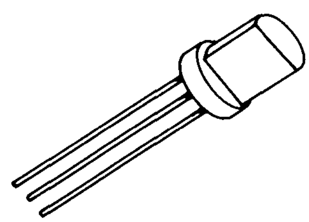
Silicon Transistors

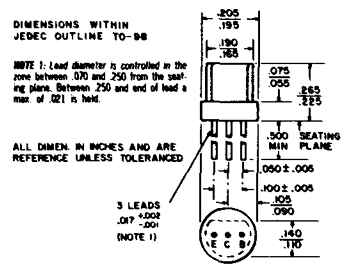
PNP

2N5365,6,7

2N5368-83 SEE GES5368-83

This series of economy transistors are PNP, silicon, planar, epitaxial, passivated devices. These units feature low collector saturation voltage, good current gain linearity over a wide collector current range, high gain-bandwidth product, and low noise. These characteristics make these units excellent for use in general purpose consumer and industrial amplifier and switching applications.





absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	−40	Volts
Emitter to Base	V_{EBO}	−4	Volts
Collector to Base	V_{CBO}	−40	Volts
Current			
Collector (Continuous)	I_C	300	mA
Collector (Pulsed, 10 μsec pulse width, = 2% Duty Cycle)	I_C	700	mA
Dissipation			
Total Power (Free Air at 25°C)*	P_T	360	mW
Total Power (Free Air at 55°C)*	P_T	260	mW
Temperature			
Storage	T_{stg}	−65 to +150	°C
Operating	T_J	+125	°C
Lead temperature, 1/16″ ± 1/32″ from case for ten seconds maximum	T_L	+260	°C

* *Derate 3.6 mW/°C increase in ambient temperature above 25°C.*

electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics

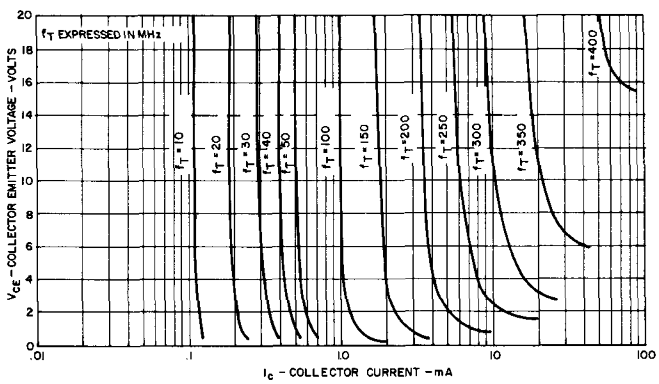
			Min.	Max.	
Collector Cutoff Current					
(V_{CB} = −40V)		I_{CBO}		−100	nA
(V_{CB} = −40V, T_A = 100°C)		I_{CBO}		−10	μA
(V_{CB} = −40V)		I_{CES}		−100	nA
Emitter Cutoff Current (V_{EB} = −4V)		I_{EBO}		−10	μA
Forward Current Transfer Ratio					
(V_{CE} = −10V, I_C = −2 mA)	2N5365	h_{FE}	32		
(V_{CE} = −1V, I_C = −50 mA)	2N5365	h_{FE}	40	120	
(V_{CE} = −5V, I_C = − 300 mA)	2N5365	h_{FE}	20		
(V_{CE} = −10V, I_C = −2 mA)	2N5366	h_{FE}	80		
(V_{CE} = −1V, I_C = −50 mA)	2N5366	h_{FE}	100	300	
(V_{CE} = −5V, I_C = − 300 mA)	2N5366	h_{FE}	40		
(V_{CE} = −10V, I_C = −2 mA)	2N5367	h_{FE}	200		
(V_{CE} = −1V, I_C = −50 mA)	2N5367	h_{FE}	250	500	
(V_{CE} = −5V, I_C = − 300 mA)	2N5367	h_{FE}	75		
Collector Emitter Breakdown Voltage					
(I_C = −10 mA)		$V_{(BR)CEO}$	−40		Volts
Collector Saturation Voltage					
(I_C = −50 mA, I_B = −2.5 mA)		$V_{CE(sat)}$		−.250	Volts
(I_C = −300 mA, I_B = −30 mA)		$V_{CE(sat)}$		−1.0	Volts
Base Saturation Voltage					
(I_C = −50 mA, I_B = −2.5 mA)		$V_{BE(sat)}$		−1.1	Volts
(I_C = −300 mA, I_B = −30 mA)		$V_{BE(sat)}$		−2.0	Volts
Base Emitter Voltage					
(V_{CE} = −10V, I_C = −2 mA)		V_{BE}	−0.5	−0.8	Volts

Dynamic Characteristics

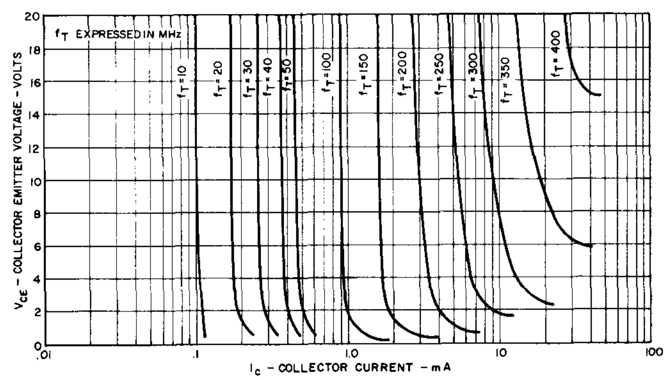
			Min.	Typ.	Max.	
Forward Current Transfer Ratio						
($V_{CE} = -10V, I_C = -2$ mA, f = 1 kHz)	2N5365	h_{fe}	32		180	
($V_{CE} = -10V, I_C = -2$ mA, f = 1 kHz)	2N5366	h_{fe}	80		450	
($V_{CB} = -10V, I_C = -2$ mA, f = 1 kHz)	2N5367	h_{fe}	200		750	
Output Capacitance, Common Base						
($V_{CB} = -10V, I_E = 0$, f = 1 MHz)		C_{cb}			8	pF
Input Capacitance, Common Base						
($V_{EB} = -0.5V, I_C = 0$, f = 1 MHz)		C_{eb}			35	pF
Gain Bandwidth Product						
($V_{CE} = -10V, I_C = -2$ mA)		f_T		250		MHz

TYPICAL CONTOURS OF GAIN BANDWIDTH PRODUCT, (f_T) VS. COLLECTOR CURRENT

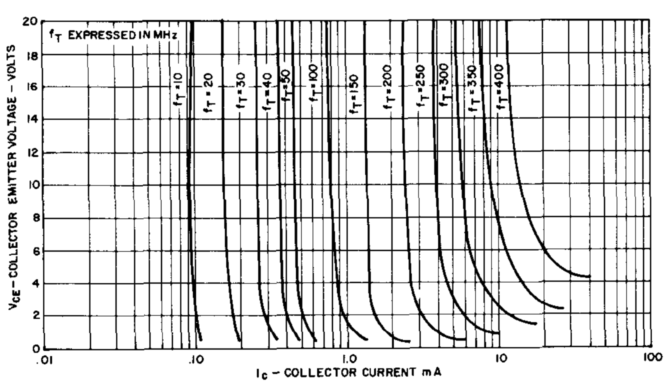
2N5365



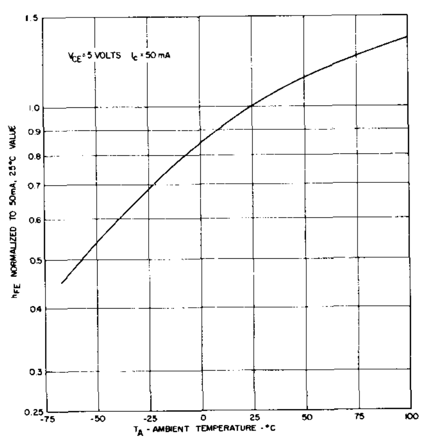
2N5366



2N5367

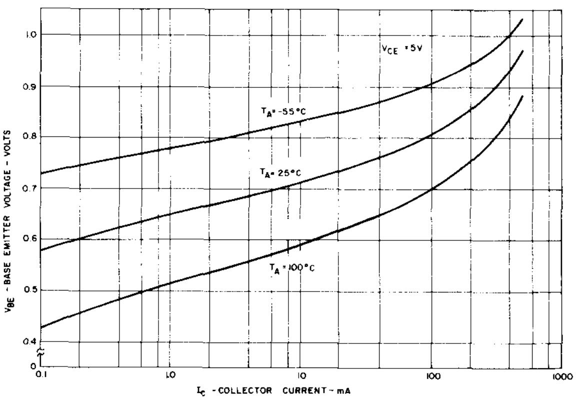


TYPICAL NORMALIZED H_{FE} VS. TEMPERATURE 2N5365, 5366, 5367

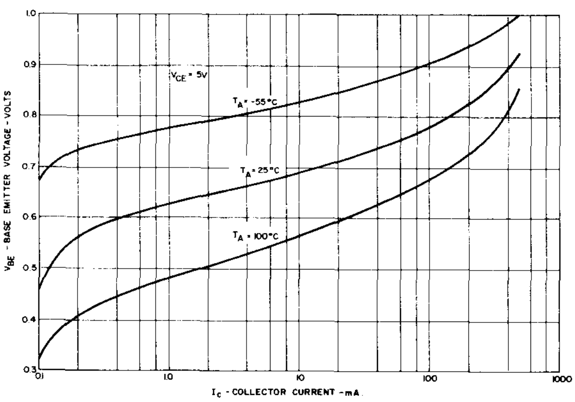


TYPICAL TRANSFER CHARACTERISTICS

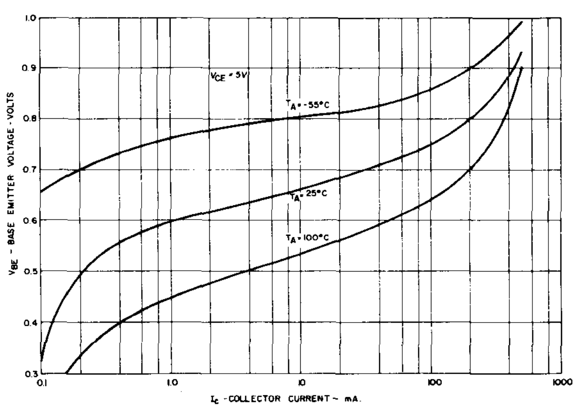
2N5365



2N5366

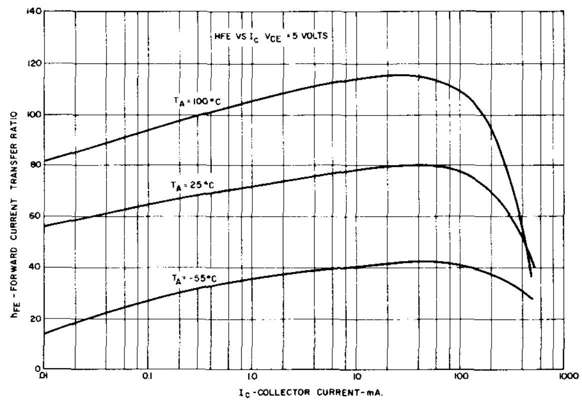


2N5367

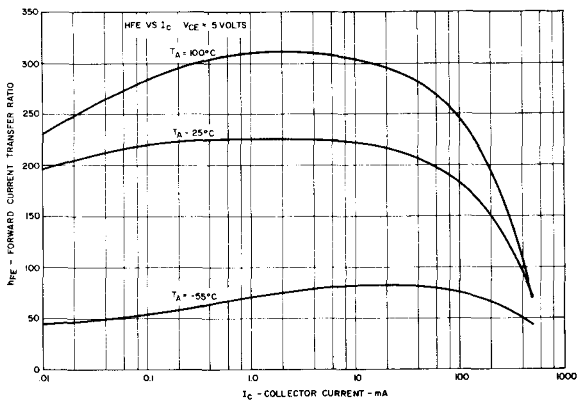


TYPICAL FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

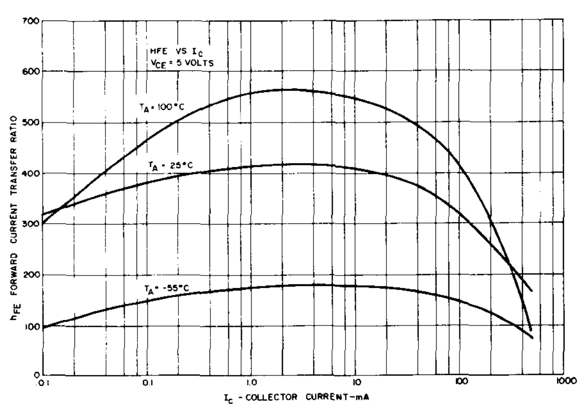
2N5365



2N5366

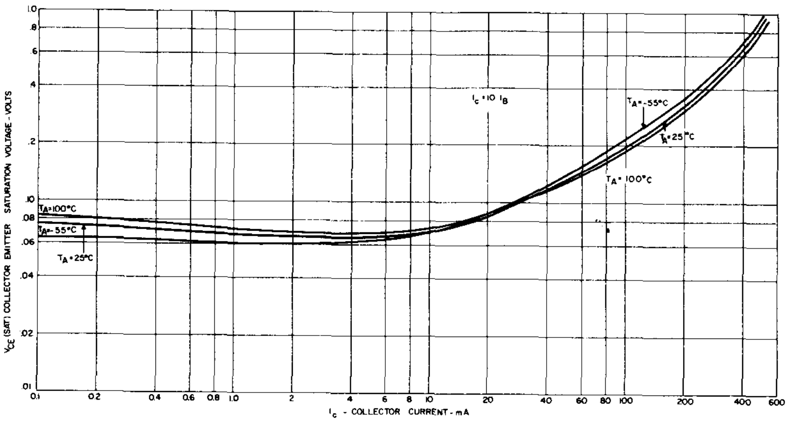


2N5367

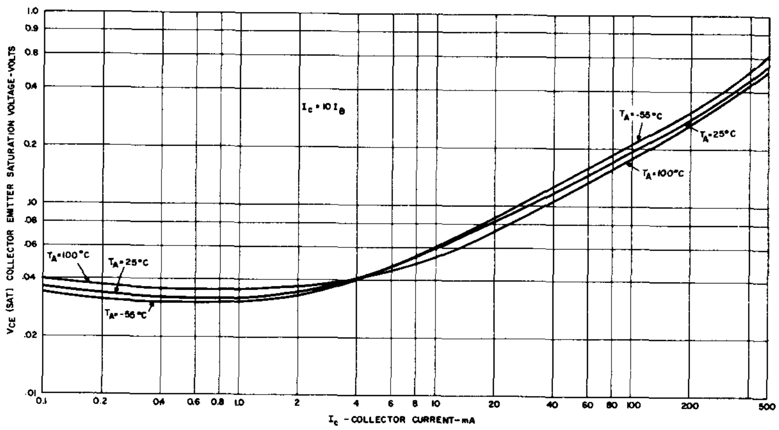


TYPICAL COLLECTOR SATURATION VOLTAGE VS. COLLECTOR CURRENT

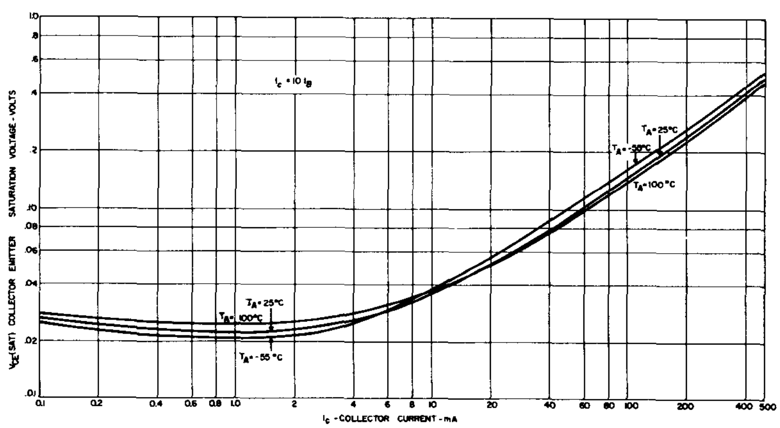
2N5365



2N5366

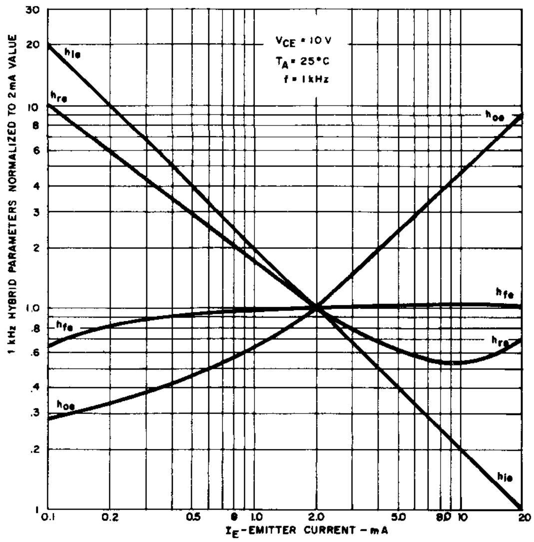


2N5367



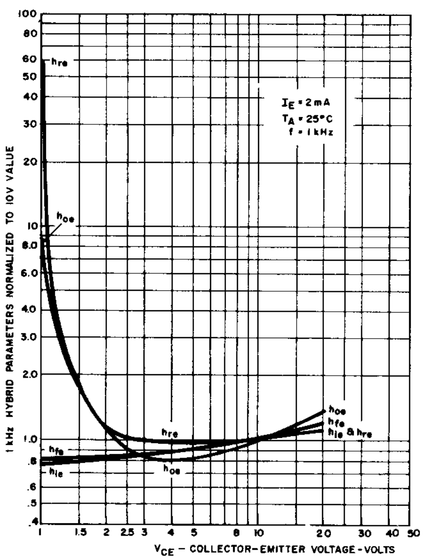
TYPICAL SMALL SIGNAL CHARACTERISTICS VS. EMITTER CURRENT

2N5365, 5366, 5367



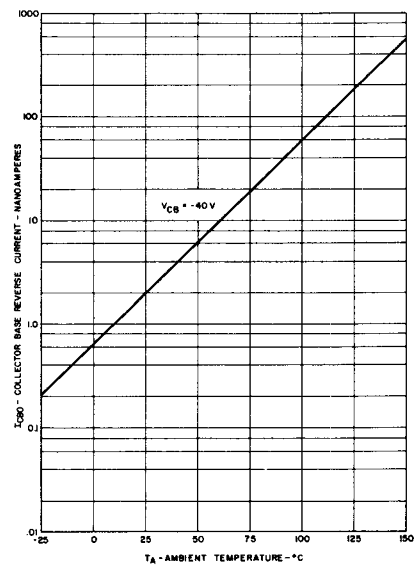
TYPICAL SMALL SIGNAL CHARACTERISTICS VS. COLLECTOR VOLTAGE

2N5365, 5366, 5367



TYPICAL COLLECTOR CUTOFF CURRENT (I_{cbo}) VS. TEMPERATURE

2N5365, 5366, 5367



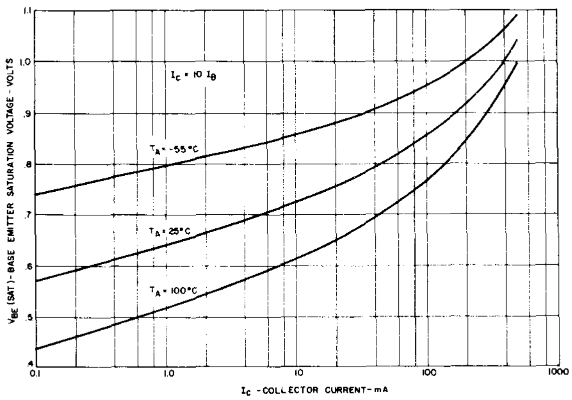
TYPICAL SMALL SIGNAL CHARACTERISTICS

f = 1 kHz, V_{CE} = 10V, I_E = 2 mA

Symbol	Characteristic	2N5365	2N5366	2N5367	Units
h_{ie}	Input Resistance	1100	3200	5800	ohms
h_{oe}	Output Conductance	18	35	58	μmhos
h_{fe}	Forward current transfer ratio	100	200	400	
h_{re}	Reverse voltage feedback ratio	1.2	3.0	5.0	$\times 10^{-4}$

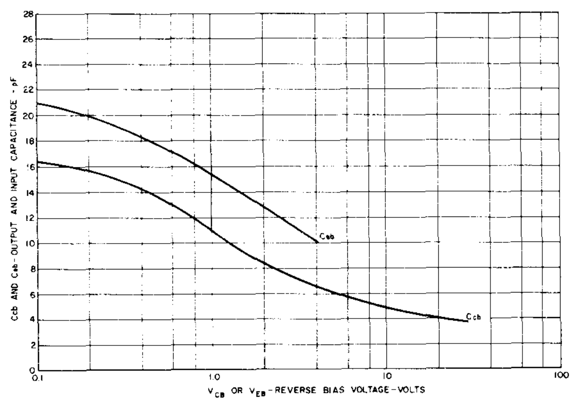
TYPICAL
BASE SATURATION VOLTAGE
VS.
COLLECTOR CURRENT

2N5365, 5366, 5367



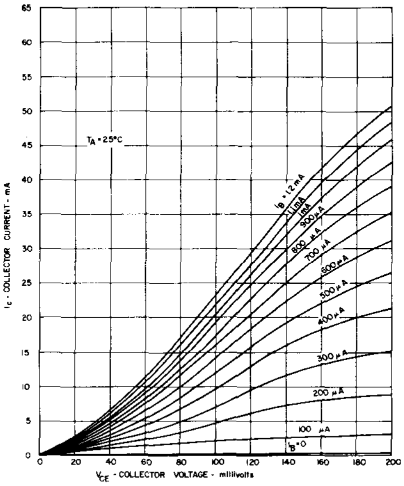
TYPICAL
OUTPUT CAPACITANCE AND INPUT CAPACITANCE
VS.
REVERSE BIAS VOLTAGE

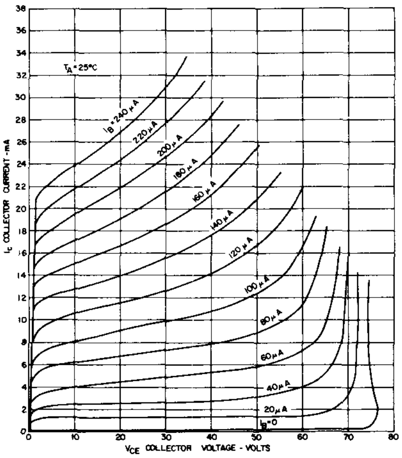
2N5365, 5366, 5367



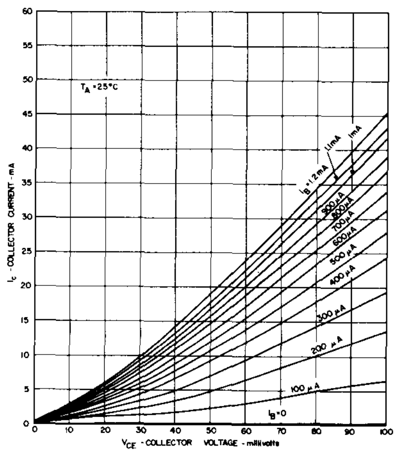
TYPICAL COLLECTOR CHARACTERISTICS

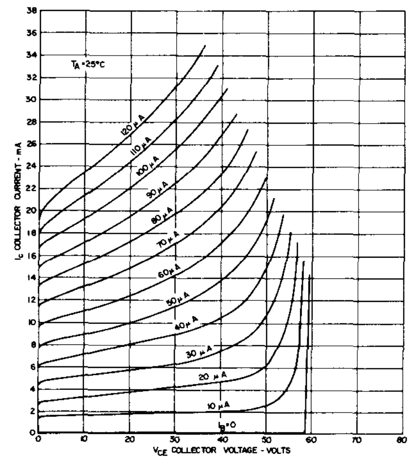
2N5365



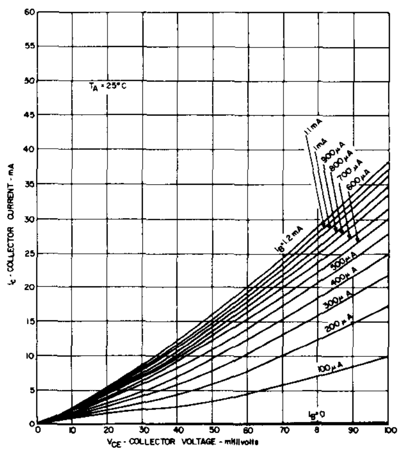


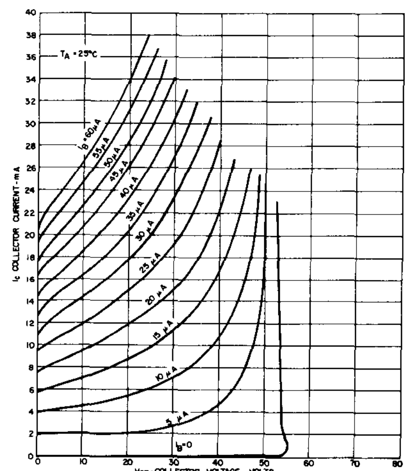
2N5366

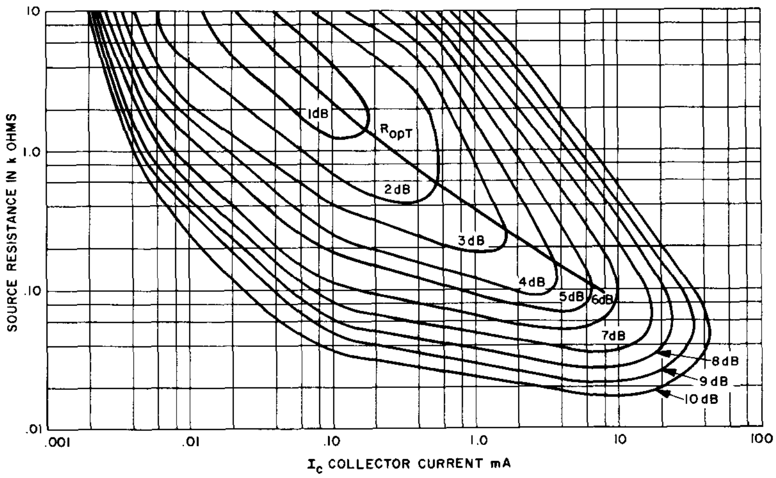


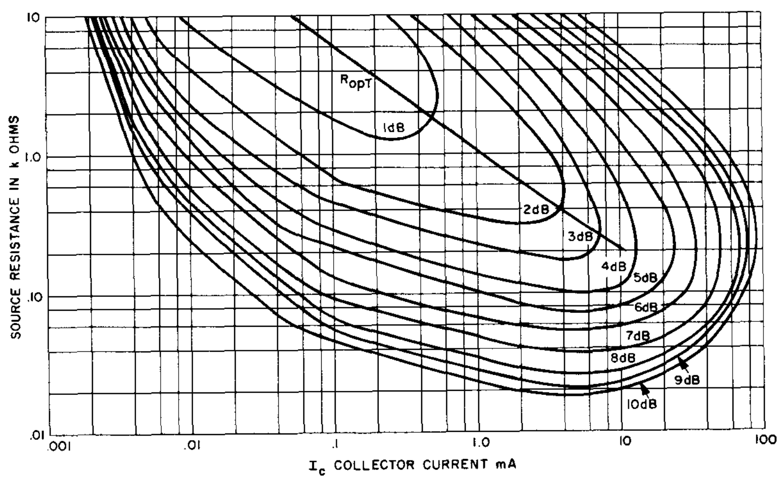


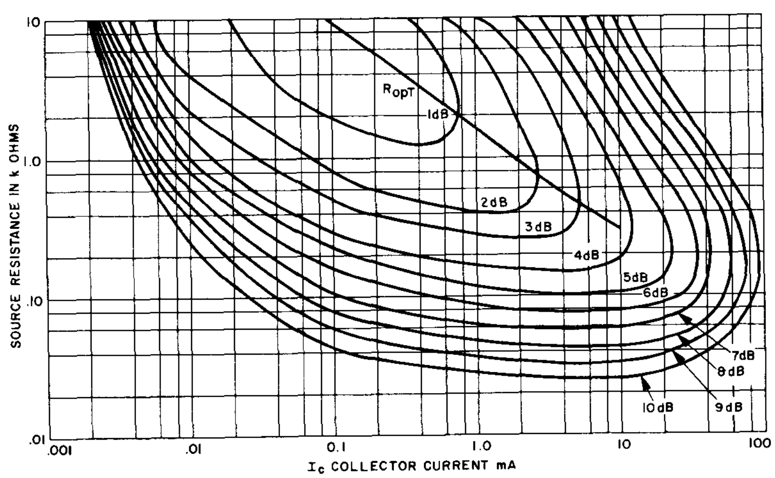
2N5367






10
1.0
.10
.01
SOURCE RESISTANCE IN k OHMS
.001
.01
.10
1.0
10
100
I_c COLLECTOR CURRENT mA
1dB
R_{opT}
2dB
3dB
4dB
5dB
6dB
7dB
8dB
9dB
10dB


10
1.0
.10
.01
SOURCE RESISTANCE IN k OHMS
.001
.01
.1
1.0
10
100
I_c COLLECTOR CURRENT mA
R_{opT}
1dB
2dB
3dB
4dB
5dB
6dB
7dB
8dB
9dB
10dB


10
1.0
.10
.01
SOURCE RESISTANCE IN k OHMS
.001
.01
0.1
1.0
10
100
I_c COLLECTOR CURRENT mA
R_{opT}
1dB
2dB
3dB
4dB
5dB
6dB
7dB
8dB
9dB
10dB

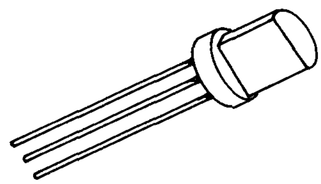
Silicon Transistors

NPN

2N5418,19,20

2N5447-51 SEE GES5447-51

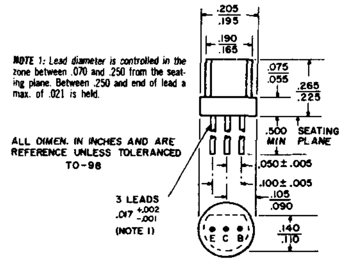
This series of transistors are NPN silicon, planar, epitaxial, passivated devices. These units feature low collector saturation voltage, good current gain linearity over a wide collector current range, high gain-bandwidth product, and low noise. These characteristics make these units excellent for use in general purpose consumer and industrial amplifier and switching applications.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	25	Volts
Emitter to Base	V_{EBO}	4	Volts
Collector to Base	V_{CBO}	25	Volts
Current			
Collector (Continuous)	I_C	500	mA
Dissipation			
Total Power (Free Air at 25°C)*	P_T	400	mW
Temperature			
Storage	T_{stg}	−65 to +150	°C
Operating	T_J	+125	°C
Lead temperature, 1/16″ ± 1/32″ from case for ten seconds maximum	T_L	+260	°C

**Derate 4.0 mW/°C increase in ambient temperature above 25°C.*



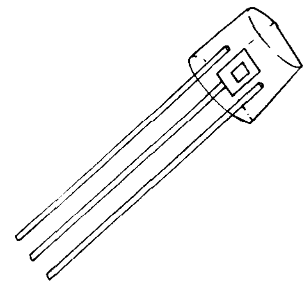
electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS			Min.	Max.	
Collector Cutoff Current					
(V_{CB} = 25V)		I_{CBO}		100	nA
(V_{CB} = 25V, T_A = 100°C)		I_{CBO}		10	μA
(V_{CB} = 25V)		I_{CES}		100	nA
Emitter Cutoff Current					
(V_{EB} = 5V)		I_{EBO}		10	μA
Forward Current Transfer Ratio					
(V_{CE} = 10V, I_C = 2 mA)	2N5418	h_{FE}	25		
(V_{CE} = 1V, I_C = 50 mA)	2N5418	h_{FE}	40	120	
(V_{CE} = 5V, I_C = 300 mA)	2N5418	h_{FE}	20		
(V_{CE} = 10V, I_C = 2 mA)	2N5419	h_{FE}	70		
(V_{CE} = 1V, I_C = 50 mA)	2N5419	h_{FE}	100	300	
(V_{CE} = 5V, I_C = 300 mA)	2N5419	h_{FE}	40		
(V_{CE} = 10V, I_C = 2 mA)	2N5420	h_{FE}	150		
(V_{CE} = 1V, I_C = 50 mA)	2N5420	h_{FE}	250	500	
(V_{CE} = 5V, I_C = 300 mA)	2N5420	h_{FE}	75		
Collector Emitter Breakdown Voltage					
(I_C = 10 mA)		$V_{(BR)CEO}$	25		Volts
Collector Saturation Voltage					
(I_C = 50 mA, I_B = 2.5 mA)		$V_{CE(SAT)}$		.250	Volts
(I_C = 300 mA, I_B = 30 mA)		$V_{CE(SAT)}$		1.0	Volts
Base Saturation Voltage					
(I_C = 50 mA, I_B = 2.5 mA)		$V_{BE(SAT)}$		1.1	Volts
(I_C = 300 mA, I_B = 30 mA)		$V_{BE(SAT)}$		2.0	Volts

			Min.	Typ.	Max.	
Base Emitter Voltage						
(V_{CE} = 10V, I_C = 2 mA)		V_{BE}	0.5		0.8	Volts
DYNAMIC CHARACTERISTICS						
Forward Current Transfer Ratio						
(V_{CE} = 10V, I_C = 2 mA, f = 1 kHz)	2N5418	h_{fe}	25		150	
(V_{CE} = 10V, I_C = 2 mA, f = 1 kHz)	2N5419	h_{fe}	70		400	
(V_{CE} = 10V, I_C = 2 mA, f = 1 kHz)	2N5420	h_{fe}	150		650	
Output Capacitance, Common Base						
(V_{CB} = 10V, I_E = 0, f = 1 MHz)		C_{ob}		4	6	pF
Input Capacitance, Common Base						
(V_{EB} = 0.5V, I_C = 0, f = 1 MHz)		C_{eb}			35	pF
Gain Bandwidth Product						
(V_{CE} = 10V, I_C = 2 mA)		f_T		250		MHz

Light Detector Planar Silicon Photo-Darlington Amplifier

NPN 2N5777-80



This General Electric Light Sensor Series is an NPN planar silicon photo-darlington amplifier. For many applications, only the collector and emitter leads are used. A base lead is provided to control sensitivity and the gain of the device. They are packaged in clear epoxy encapsulant and can be used in industrial and commercial applications requiring a low-cost, general purpose, photosensitive device.

absolute maximum ratings: (25°C) (unless otherwise specified)

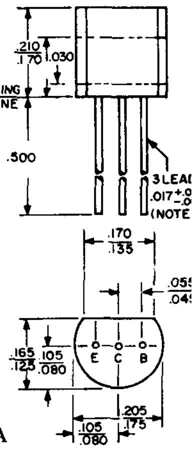
		2N5777, 79 (L14D1,3)	2N5778, 80 (L14D2,4)	
Voltages—Dark Characteristics				
Collector to Emitter	V_{CEO}	25	40	Volts
Collector to Base	V_{CBO}	25	40	Volts
Emitter to Base	V_{EBO}	8	12	Volts
Current				
Light Current	I_L	250	250	mA
Dissipation				
Power Dissipation*	P_T	200	200	mW
Temperature				
Junction Temperature	T_J	←100°C→		
Storage Temperature	T_{stg}	←-65°C to +100°C→		

*Derate 2.67mW/°C above 25°C ambient

DIMENSIONS WITHIN JEDEC OUTLINE TO-92.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

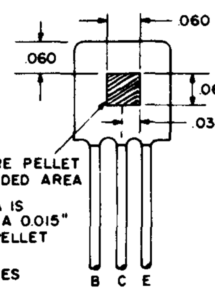


electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics		2N5777, 78 Min.	2N5777, 78 Max.	2N5779, 80 Min.	2N5779, 80 Max.	
Light Current (V_{CE} = 5V, H = 2mW/cm² **)	I_L	0.5	–	2.0	–	mA
Forward Current Transfer Ratio (V_{CE} = 5V, I_C = 2.0mA)	h_{FE}	1.0k	–	2.0k	–	

		2N5777, 79 Min.	2N5777, 79 Max.	2N5778, 80 Min.	2N5778, 80 Max.	
Dark Current (V_{CE} = 12V, I_B = 0)	I_D	–	100	–	100	nA
Collector-Emitter Breakdown Voltage (I_C = 10mA, H = 0)	$V_{(BR)CEO}$	25	–	40	–	Volts
Collector-Base Breakdown Voltage (I_C = 100μA, H = 0)	$V_{(BR)CBO}$	25	–	40	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100μA, H = 0)	$V_{(BR)EBO}$	8	–	12	–	Volts

Dynamic Characteristics		2N5777-80 Min.	Typ.	Max.	
Switching Speeds (V_{CE} = 10V, I_L = 10mA, R_L = 100 ohms, GaAs LED source)					
Delay Time	t_d	–	30	100	μsec.
Rise Time	t_r	–	75	250	μsec.
Storage Time	t_s	–	0.5	5	μsec.
Fall Time	t_f	–	45	150	μsec.
Collector-Base Capacitance (V_{CB} = 10V, f = 1MHz)	C_{cb}	–	7.6	10	pF
Emitter-Base Capacitance (V_{EB} = 0.5V, f = 1MHz)	C_{eb}	–	10.5	–	pF
Collector-Emitter Capacitance (V_{CEO} = 10V, f - 1MHz)	C_{ceo}	–	3.4	–	pF



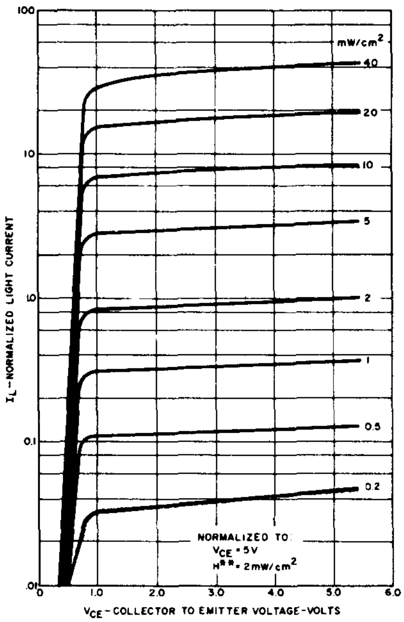
THE 0.026" SQUARE PELLET IS WITHIN THE SHADED AREA

THE ACTIVE AREA IS CENTERED WITHIN A 0.015" SQUARE ON THE PELLET SURFACE

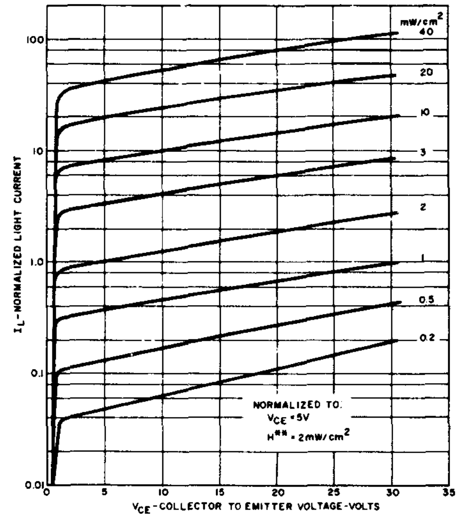
DIMENSIONS IN INCHES

PELLET LOCATION

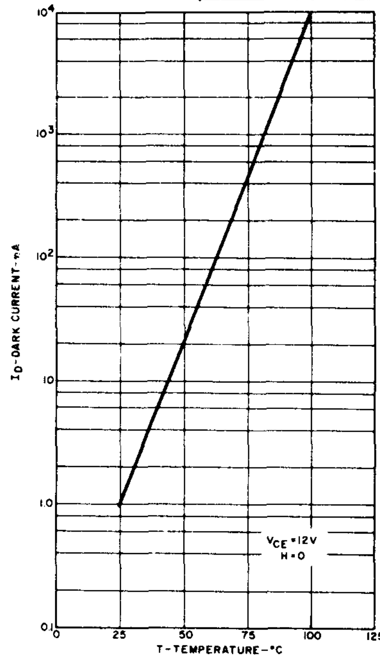
**H = Radiation Flux Density. Radiation source is an unfiltered tungsten filament bulb at 2870°K color temperature.



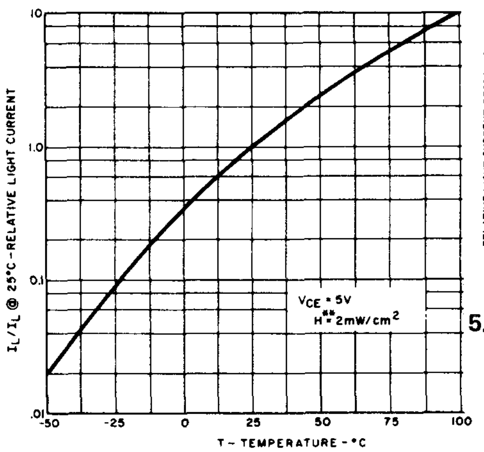
1. NORMALIZED LIGHT CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



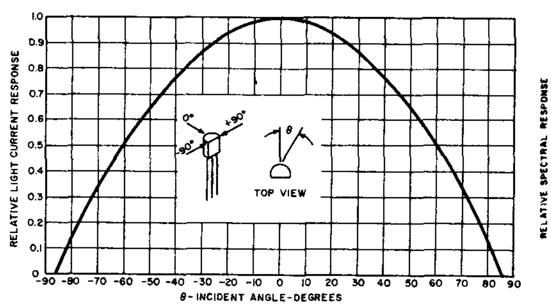
2. NORMALIZED LIGHT CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



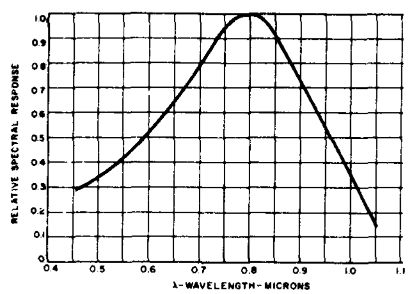
3. DARK CURRENT VS. TEMPERATURE



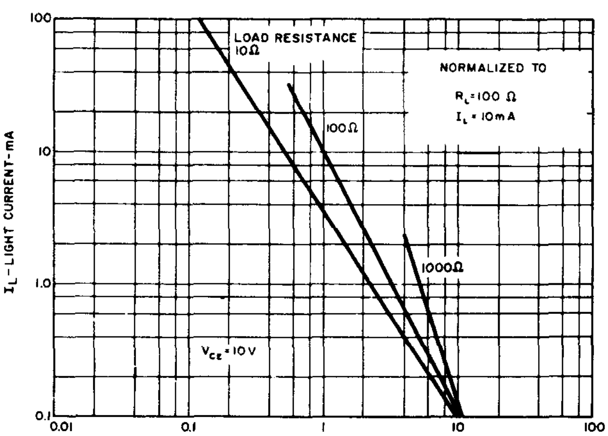
4. RELATIVE LIGHT CURRENT VS. AMBIENT TEMPERATURE



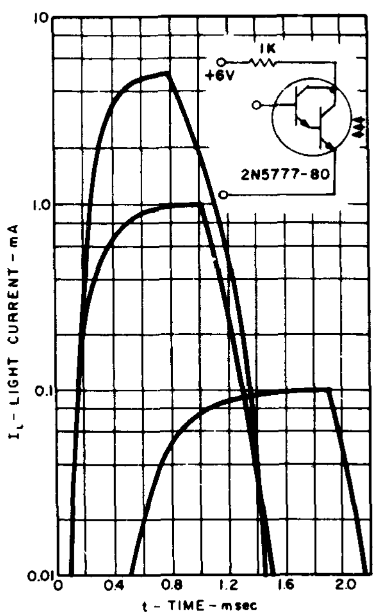
5. RELATIVE RESPONSE VS. INCIDENT ANGLE



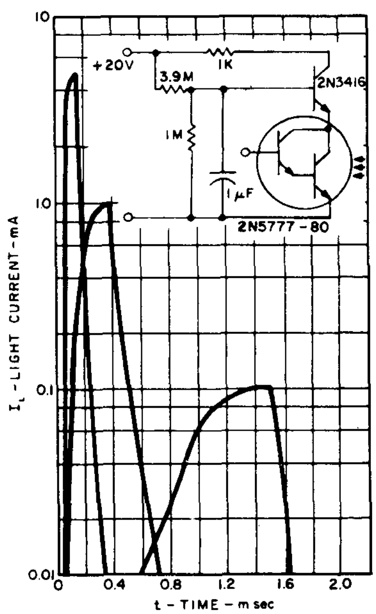
6. SPECTRAL RESPONSE CURVE



7. LIGHT CURRENT VS. RELATIVE SWITCHING SPEED



8. TRANSIENT RESPONSE WITH RESISTIVE BIASING



9. TRANSIENT RESPONSE WITH CASCODE BIASING

2N5810-6017 SERIES SEE GES5810-6017

Silicon Programmable Unijunction Transistor (PUT)

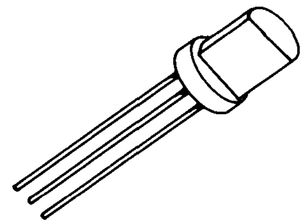
D13T SERIES

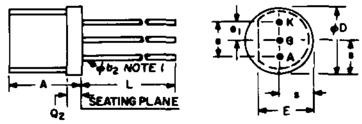
2N6027,8

The General Electric PUT is a three-terminal planar passivated PNPN device in the standard plastic low cost TO-98 package. The terminals are designated as anode, anode gate and cathode.

The 2N6027 and 2N6028 have been characterized as Programmable Unijunction Transistors (PUT), offering many advantages over conventional unijunction transistors. The designer can select R_1 and R_2 to program unijunction characteristics such as η, R_{BB}, I_P and I_V to meet his particular needs.

The 2N6028 is specifically characterized for long interval timers and other applications requiring low leakage and low peak point current. The 2N6027 has been characterized for general use where the low peak point current of the 2N6028 is not essential. Applications of the 2N6027 include timers, high gain phase control circuits and relaxation oscillators.





SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.170	.265	4.32	6.73
φb2	.016	.019	.406	.483
φD	.165	.205	4.19	5.21
E	.110	.155	2.79	3.94
e	.095	.105	2.41	2.67
e1	.045	.055	1.14	1.40
L	.500		12.70	
Q2		.075		1.90
s	.080	.115	2.03	2.92

NOTE 1: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .070 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

10 Outstanding Features of the PUT:

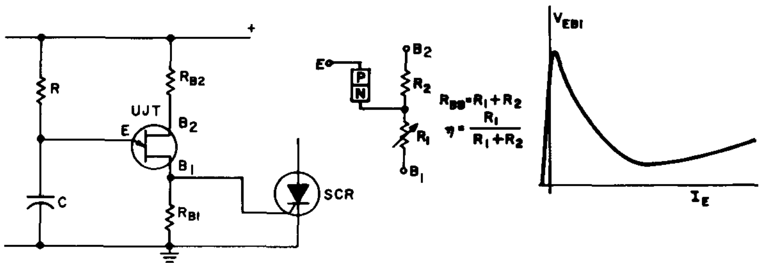
1. Planar Passivated Structure
2. Low Leakage Current
3. Low Peak Point Current
4. Low Forward Voltage
5. Fast, High Energy Trigger Pulse
6. Programmable η
7. Programmable R_{BB}
8. Programmable I_P
9. Programmable I_V
10. Low Cost

Applications:

- SCR Trigger
- Pulse and Timing Circuits
- Oscillators
- Sensing Circuits
- Sweep Circuits

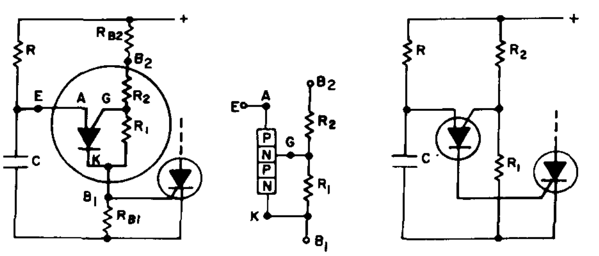
Operation of the PUT as a unijunction is easily understood. Figure 1(a) shows a basic unijunction circuit. Figure 2(a) shows identically the same circuit except that the unijunction transistor is replaced by the PUT plus resistors R_1 and R_2. Comparing the equivalent circuits of Figure 1(b) and 2(b), it is seen that both circuits have a diode connected to a voltage divider. When this diode becomes forward biased in the unijunction transistor, R_1 becomes strongly modulated to a lower resistance value. This generates a negative resistance characteristic between the emitter E and base one (B_1). For the PUT, the resistors R_1 and R_2 control the voltage at which the diode (anode to gate) becomes forward biased. After the diode conducts, the regeneration inherent in a PNPN device causes the PUT to switch on. This generates a negative resistance characteristic from anode to cathode (Figure 2(b)) simulating the modulation of R_1 for a conventional unijunction.

Resistors R_{B2} and R_{B1} (Figure 1(a)) are generally unnecessary when the PUT replaces a conventional UJT. This is illustrated in Figure 2(c). Resistor R_{B1} is often used to bypass the interbase current of the unijunction which would otherwise trigger the SCR. Since R_1 in the case of the PUT, can be returned directly to ground there is not current to bypass at the SCR gate. Resistor R_{B2} is used for temperature compensation and for limiting the dissipation in the UJT during capacitor discharge. Since R_2 (Figure 2) is *not* modulated, R_{B2} can be absorbed into it.



1(a) Typical Circuit **1(b) UJT Equivalent Circuit** **1(c) Negative Resistance Characteristic**

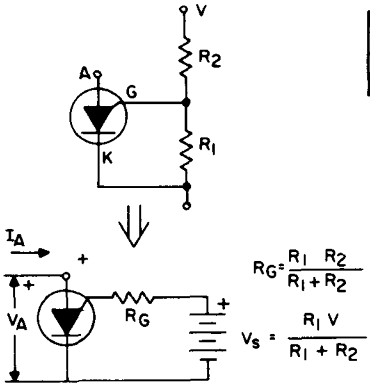
Figure 1 Unijunction Transistor



2(a) PUT Replacing UJT in Typical Circuit 1(a) **2(b) UJT Equivalent Circuit Using PUT** **2(c) Simplified Typical Circuit 1(a)**

Figure 2 PUT Equivalent of UJT

absolute maximum ratings: (25°C)



Voltage	
*Gate-Cathode Forward Voltage	+40 V
*Gate-Cathode Reverse Voltage	–5 V
*Gate-Anode Reverse Voltage	+40 V
*Anode-Cathode Voltage	±40 V
Current	
*DC Anode Current†	150 mA
Peak Anode, Recurrent Forward	
(100 μsec pulse width, 1% duty cycle)	1 A
*(20 μsec pulse width, 1% duty cycle)	2 A
Peak Anode, Non-recurrent Forward	
(10 μsec)	5 A
*Gate Current	±20 mA
Capacitive Discharge Energy††	250 μJ
Power	
*Total Average Power†	300 mW
Temperature	
*Operating Ambient† Temperature Range	–50°C to +100°C

†Derate currents and powers 1%/°C above 25°C

††E = ½ CV² capacitor discharge energy with no cutrent limiting

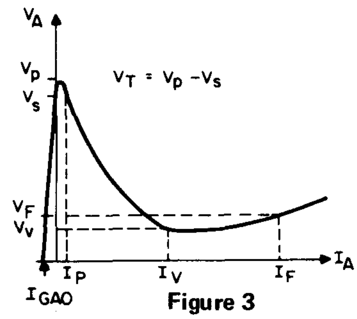


Figure 3

electrical characteristics: (25°C) (unless otherwise specified)

		Fig. No.	2N6027 (D13T1) Min.	2N6027 (D13T1) Max.	2N6028 (D13T2) Min.	2N6028 (D13T2) Max.
***Peak Current** (V_s = 10 Volts)	I_P	3				
(R_G = 1 Meg)				2		.15 μA
(R_G = 10 k)				5		1.0 μA
***Offset Voltage** (V_s = 10 Volts)	V_T	3				
(R_G = 1 Meg)			.2	1.6	.2	.6 Volts
(R_G = 10 k)			.2	.6	.2	.6 Volts
***Valley Current** (V_s = 10 Volts)	I_V	3				
(R_G = 1 Meg)				50		25 μA
(R_G = 10 k)			70		25	μA
(R_G = 200 Ω)			1.5		1.0	mA
Anode Gate-Anode Leakage Current						
*(V_s = 40 Volts, T = 25°C)	I_{GAO}	4		10		10 nA
(T = 75°C)				100		100 nA
Gate to Cathode Leakage Current						
(V_s = 40 Volts, Anode-cathode short)	I_{GKS}	5		100		100 nA
***Forward Voltage** (I_F = 50 mA)	V_F			1.5		1.5 Volts
***Pulse Output Voltage**	V_O	6	6		6	Volts
Pulse Voltage Rate of Rise	t_r	6		80		80 nsecs.

*JEDEC registered data

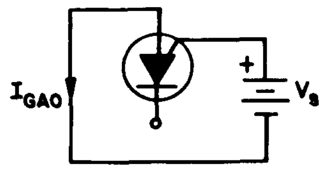


Figure 4

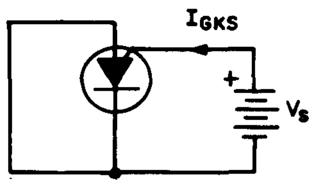
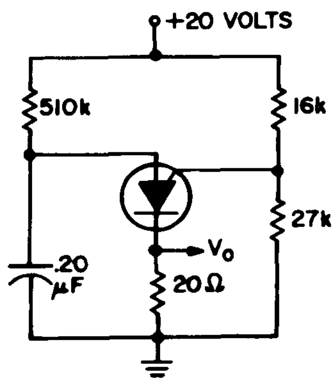


Figure 5



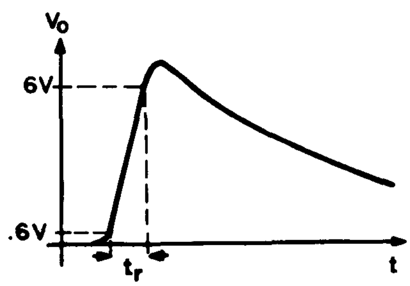
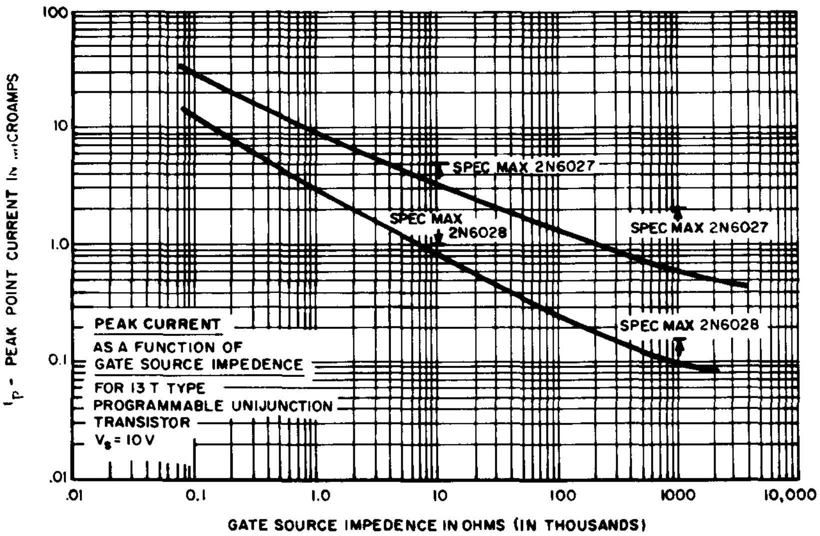
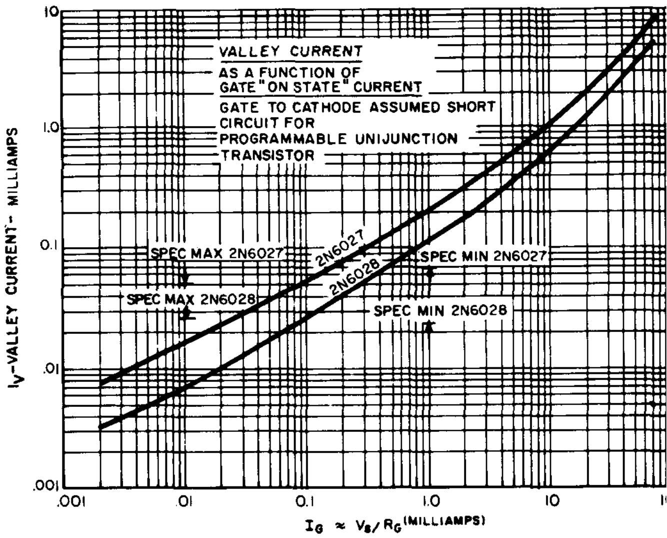


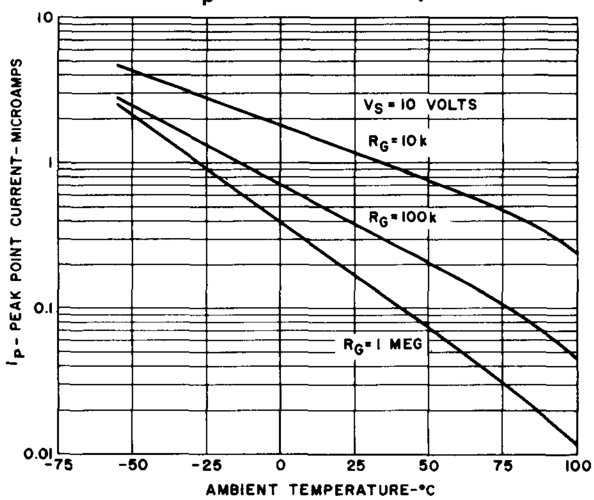
Figure 6



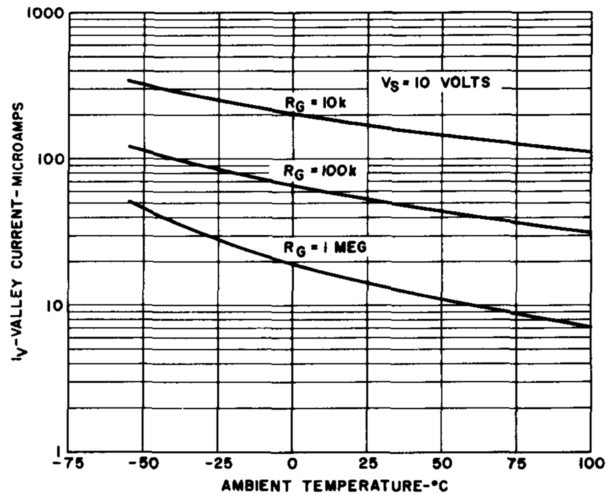
I_p vs Gate Source Impedance



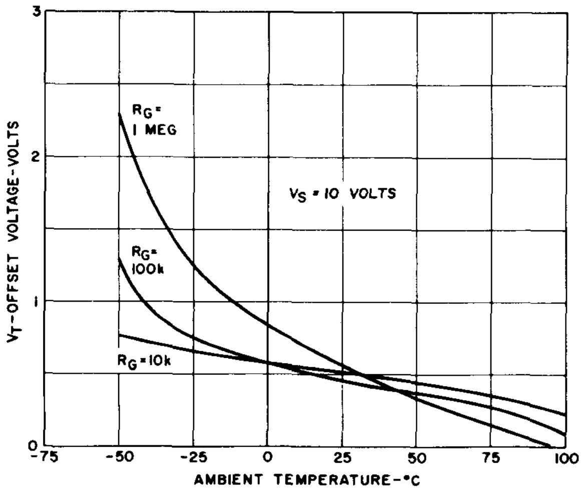
I_v vs Gate "on state" Current



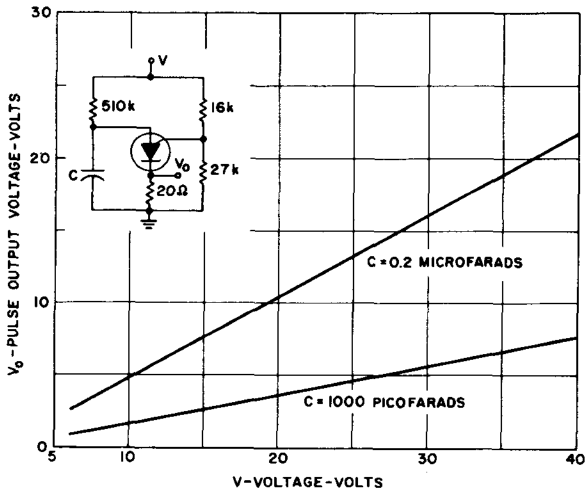
I_p vs Temperature and R_G



I_v vs Temperature and R_G



V_T vs Temperature and R_G

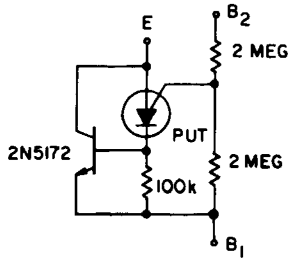


Peak Output Voltage

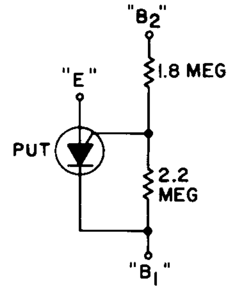
APPLICATIONS

TYPICAL UNIJUNCTION CIRCUIT CONFIGURATIONS

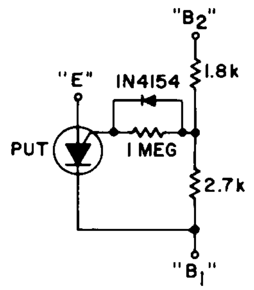
Here are four ways to use the PUT as a unijunction. Note the flexibility due to "programmability." Applications from long time interval latching timers to wide range relaxation oscillators are possible.



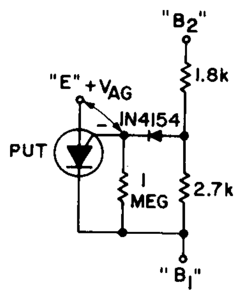
LOW I_P
VERY HIGH I_V
TEMPERATURE
AND V_{BB} COMPENSATION



LOW I_P, LOW I_V



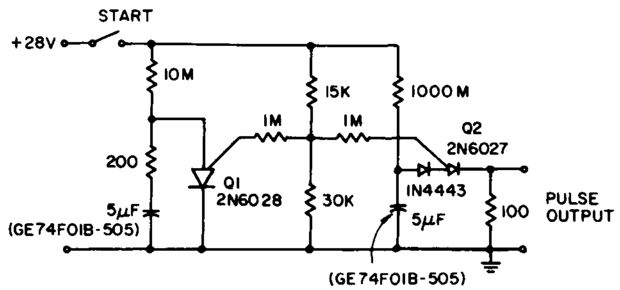
LOW I_P, MEDIUM I_V



LOW I_P, MEDIUM I_V
TEMPERATURE
COMPENSATION
V_{AG}

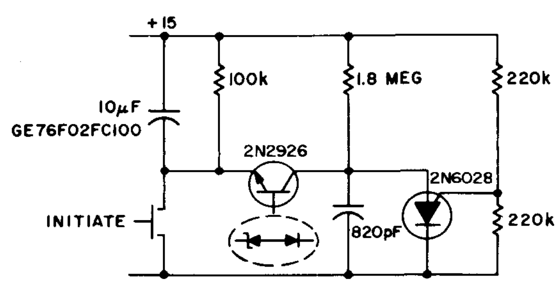
HOUR TIME DELAY SAMPLING CIRCUIT

This sampling circuit lowers the effective peak current of the output PUT, Q2. By allowing the capacitor to charge with high gate voltage and periodically lowering gate voltage, when Q1 fires, the timing resistor can be a value which supplies a much lower current than I_P. The triggering requirement here is that minimum charge to trigger flow through the timing resistor during the period of the Q1 oscillator. This is not capacitor size dependent, only capacitor leakage and stability dependent.



1 SECOND, 1kHz OSCILLATOR

Here is a handy circuit which operates as an oscillator *and* a timer. The 2N6028 is normally on due to excess holding current through the 100 kohm resistor. When the switch is momentarily closed, the 10 µF capacitor is charged to a full 15 volts and 2N6028 starts oscillating (1.8 Meg and 820 pF). The circuit latches when 2N2926 zener breaks down again.



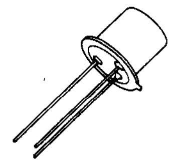
Silicon Complementary Unijunction Transistor

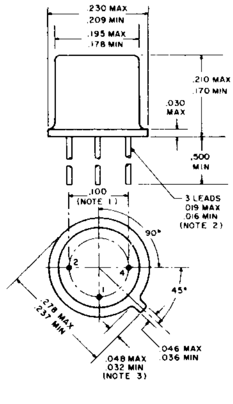
2N6114
2N6115

2N6218-24 SEE GES6218-24

COMPLEMENTARY UNIJUNCTION

The General Electric Complementary Unijunction Transistor is a silicon planar, monolithic integrated circuit. It has unijunction characteristics with superior stability, a much tighter intrinsic-standoff ratio distribution and lower saturation voltage.

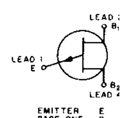




DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION

NOTES
1. MAX DIAMETER LEADS AT A GAGING PLANE .054 +.001 -.000 BELOW BASE SEAT TO BE WITHIN .007 OF THEIR TRUE LOCATION RELATIVE TO MAX WIDTH TAB AND TO THE MAX .230 DIAMETER MEASURED WITH A SUITABLE GAGE. WHEN GAGE IS NOT USED MEASUREMENT WILL BE MADE AT BASE SEAT.
2. LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE BASE SEAT. BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD.
3. CALCULATED BY MEASURING FLANGE DIAMETER, INCLUDING TAB AND EXCLUDING TAB, AND SUBTRACTING THE SMALLER DIAMETER FROM THE LARGER DIAMETER.
4. THE CASE IS ELECTRICALLY CONNECTED TO THE SUBSTRATE AND MUST BE ISOLATED FROM THE CIRCUIT.

APPROX WEIGHT .OI
DIMENSIONS IN INCH



EMITTER E
BASE ONE B_1
BASE TWO B_2

absolute maximum ratings: (25° C free air)

Voltage		
Interbase Voltage	30	V
* Emitter – Base 2 Voltage	8.0	V
Current (Note 2)		
*Average Emitter (Forward)	150	mA
*Peak Emitter (Forward) (Note 1)	2	A
*Peak Reverse Emitter	15	mA
Power		
*Average Total (Note 2)	300	mW
Temperature		
Operating	−55 to +150	°C
* Storage	−55 to +200	°C

electrical characteristics: (25° C free air)

			Min.	Typ.	Max.	
* **Intrinsic Standoff Ratio (Note 3)**		η	0.58	0.60	0.62	
* **Peak Point Voltage** (V_{BB} = 5V)		V_P	3.2	3.45	3.7	Volts
(V_{BB} = 10V)		V_P	6.1	6.45	6.8	Volts
* **Interbase Resistance** (I_{BB} = 0.1mA)	2N6114	R_{BBO}	5.5	6.8	8.2	kohms
	2N6115	R_{BBO}	5.0		15	kohms
* **Emitter Breakdown Voltage** (I_{EB1} = 10μA)		V_{EB1O}	8.0	9.5		Volts
* **Peak Point Current** (V_{BB} = 10V)	2N6114	I_P			5	μA
	2N6115	I_P			15	μA
* **Valley Point Current** (V_{BB} = 10V)		I_V	1	2		mA
Emitter Reverse Current (V_{EB1} = 5V)	2N6114	I_{EB1O}		0.1	10	nA
	2N6115	I_{EB1O}			100	nA
* **Emitter Saturation Voltage** (I_E = 50mA, V_{BB} = 10V)		$V_{E(sat)}$		1.1	1.5	Volts
* **Modulated Interbase Current** (I_E = 50mA, V_{BB} = 10V)		$I_{B2(mod)}$	1.0	4	10	mA
* **Peak Pulse Voltage** (Note 4)		V_{OUT}	3.5	4.5		Volts
Diode Voltage Drop (Note 3)		V_D	.30	.45	.60	Volts
Minimum Charge to Trigger (V_{BB} = 10V)		Q_t		50		pC
Turn-on Time (See Figure 7)		t_{on}			1	μsec.
Recovery Time (See Figure 7)		t_{rec}			10	μsec.
Relaxation Oscillator Frequency Shift from 25°C Value (See Figure 1, C = 0.1μF, R_{B2} = 950Ω, V_S = 12.5V)						
−15°C to +65°C				0.2	0.6	%
−55°C to +150°C				0.4	1.0	%

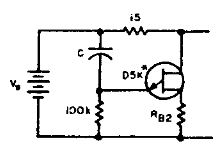
*JEDEC registered data

Notes:
1. For capacitor discharge, resistor current limiting is required for capacitors greater than 5 μF and recommended for all cases. (A minimum of 15 ohms is required for good temperature stability.)
2. Derate power and currents linearly to zero at maximum operating temperature.
3. The intrinsic-standoff ratio (η) is essentially constant with temperature and interbase voltage. It and the associated diode drop of peak point voltage are defined by the equations:

$$\eta = \frac{V_{P1} - V_{P2}}{V_{BB1} - V_{BB2}} \qquad V_D = V_{P2} - \eta V_{BB}$$

Where: V_{BB1} = 10V ± .001V
V_{BB2} = 5V ± .001V

4. The Base-One Peak Pulse Voltage is measured in the circuit shown in Figure 4. This specification is used to insure a minimum pulse amplitude for applications in SCR firing circuits and other types of firing circuits.



TEST CIRCUIT
*CUJT ONLY SUBJECTED TO TEMPERATURE CHANGE
ALL RESISTORS 1%

FIGURE 1

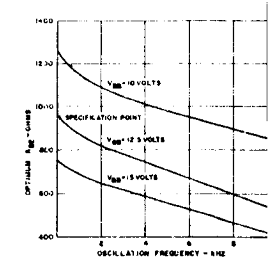


FIGURE 2

2N6114
2N6115

IGURE 3

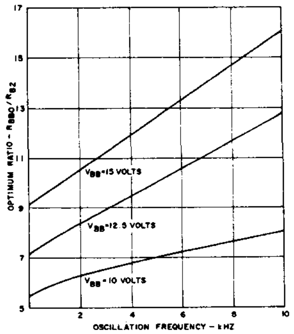


FIGURE 4

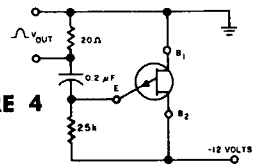
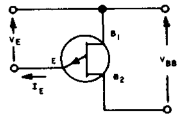


FIGURE 5



Complementary Unijunction Transistor symbol with nomenclature used for voltage and currents.

FIGURE 6

Static Emitter Characteristics curves showing important parameters and measurement points (exaggerated to show details).

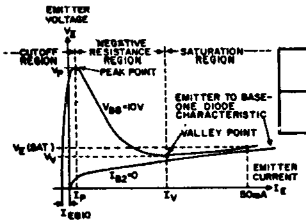
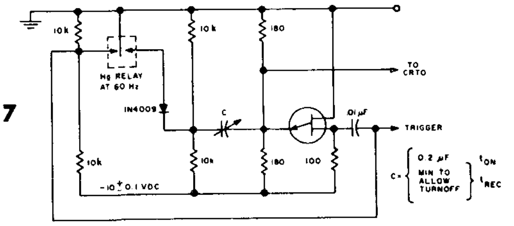
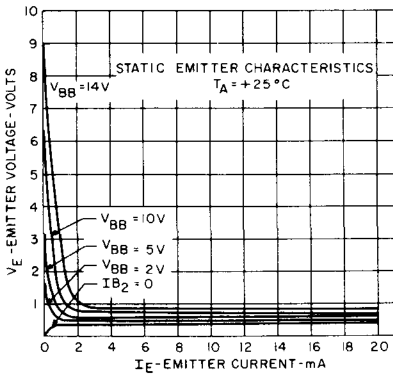
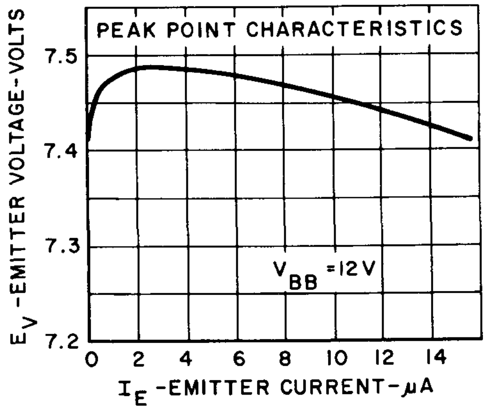


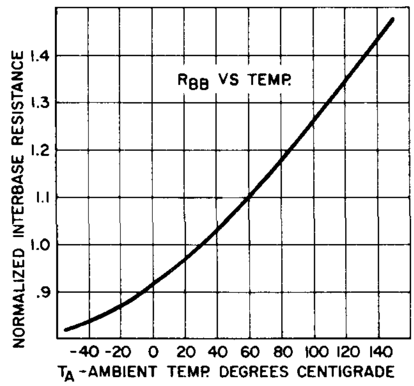
FIGURE 7

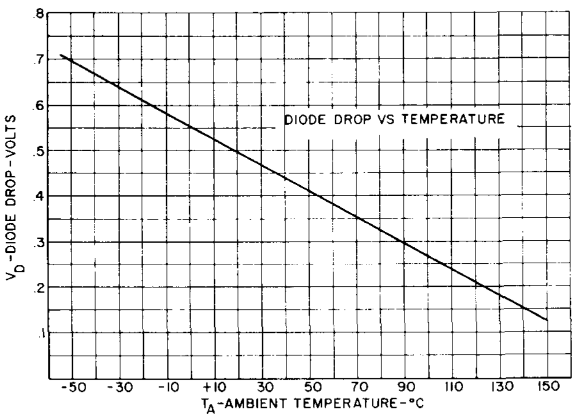


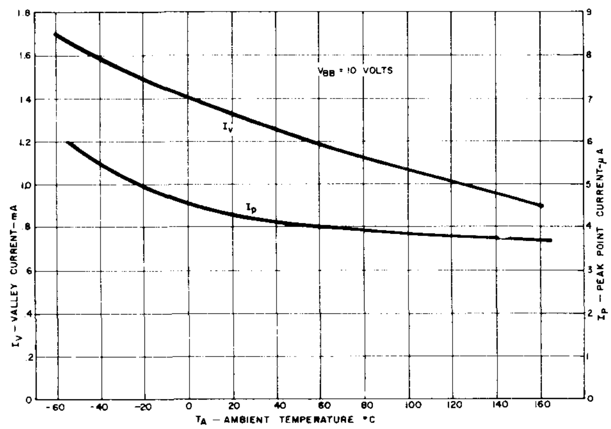
TYPICAL CHARACTERISTICS

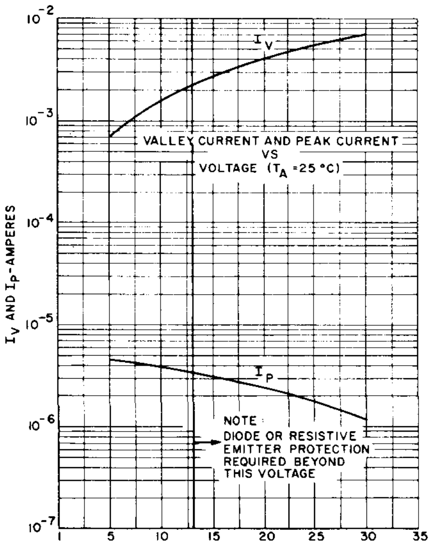


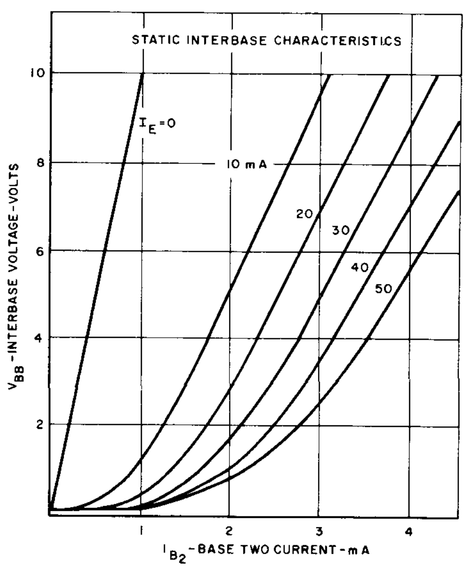


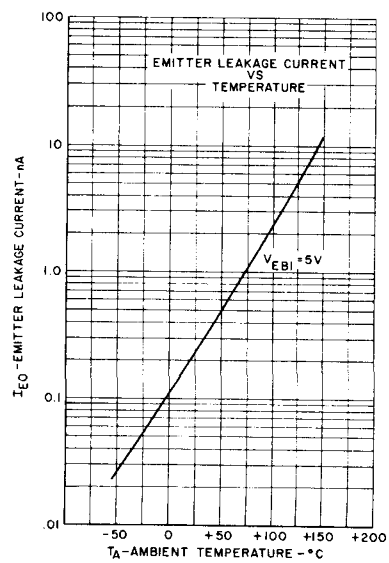










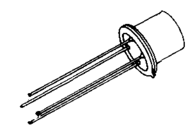


Silicon Control Switch

3N81,2

The General Electric Types 3N81 and 3N82 are PLANAR PNPN silicon controlled switches (SCS) offering outstanding circuit design flexibility by providing leads to all four semiconductor regions. Unique fabrication processes based on planar oxide passivation have resulted in high reliability and uniformity at low cost. The SCS is thoroughly characterized at temperature extremes to permit worst-case circuit design.

Types 3N81 and 3N82 can be considered an integrated PNP-NPN transistor pair in a positive feedback configuration. As such they offer fewer connections, fewer parts, lower cost and better characterization than are available from two separte transistors. Their characterization permits them to be used as an extremely sensitive SCR, as a complementary SCR, or as a "transistor" with "latching" capabilities.



FEATURES:

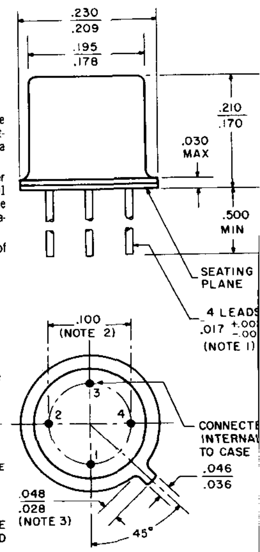
- **Completely eliminates rate effect problems**
- **Dynamic and static breakover voltages are identical**
- **Extremely high triggering sensitivity**
- **Design parameters specified at worst-case temperatures**
- **Characterized for SCR and complementary SCR type applications**
- **Characterized as PNPN and also as transistor integrated pair**
- **All planar, completely oxide passivated**
- **Leads to all four semiconductor regions**

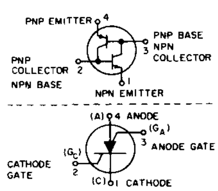
DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 + .001 − .000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.





ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

absolute maximum ratings:[1] (25°C) (unless otherwise specified)

	3N81	3N82	
Voltage			
Anode to cathode forward and reverse	65	100	volts
Anode gate to anode reverse	65	100	volts
Cathode gate to cathode reverse	5	5	volts
Total Current			
Continuous DC forward[2]	200	200	ma
Peak recurrent forward ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	1.0	1.0	amps
Peak non-recurrent forward (10 μsec. pulse width)	5.0	5.0	amps
Gate Current (Forward Bias)			
Continuous DC anode gate	100[2]	100[2]	ma
Peak anode gate ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	200	200	ma
Peak cathode gate ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	500	500	ma
Continuous DC cathode gate	20	20	ma
Dissipation			
Total power[2]	400	400	mw
Cathode gate power[2]	100	100	mw
Temperature			
Operating junction	−65 to +150		°C
Storage	−65 to +200		°C

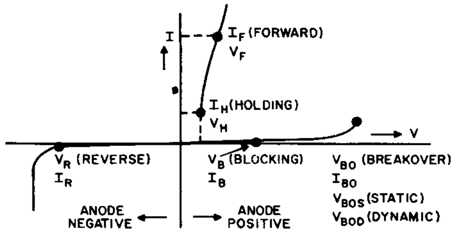
NOTE 1: Symbols and nomenclature are defined below.

NOTE 2: Derate currents and power linearly to 150°C, the maximum rated temperature. The absolute maximum rating at any given temperature shall be in terms of the more conservative of the two parameters, i.e. current or power.

definition of terms used in scs specifications

PNPN devices available at present do not have a common nomenclature. In part, this is due to their different construction and varied applications. SCS nomenclature permits the reverse characteristics of all three junctions to be specified.

The anode forward characteristics and gate triggering characteristics can also be specified fully. The principles used in assigning symbols are illustrated below, and with outline drawing above.



ANODE TO CATHODE CHARACTERISTICS

NOTE —ABSENCE OF G INDENTIFIES ANODE TO CATHODE SYMBOLS. DOT IDENTIFIES OPERATING POINT. BRACKETS INDICATE MEANING OF SUBSCRIPT LETTER.

FIG. 1

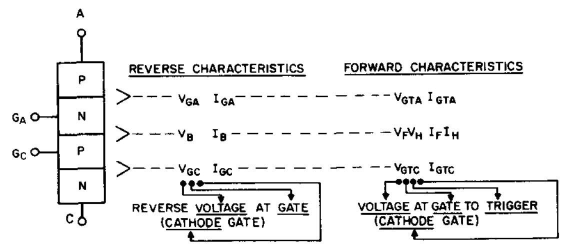


FIG. 2

NOTE: G IDENTIFIES GATE SYMBOLS. LAST LETTER (A OR C) MAY BE DROPPED IF NO AMBIGUITY RESULTS IN SPECIFIC CHARACTERIZATION. F MEANS "FORWARD" AND T MEANS "TRIGGER"

SCS CHARACTERIZATION

electrical characteristics:[1]

CUTOFF CHARACTERISTICS	Symbol[1]	Temp.	3N81	3N82		Typical Curves Fig. #
Forward Blocking Current ($R_{GC} = 10K$, V_{AC} = Rated Voltage)	$I_{B\ max}$	@ 25°C @ 150°C	1.0 20		μa max μa max	14
Reverse Blocking Current ($R_{GC} = 10K$, V_{CA} = Rated Voltage)	$I_{R\ max}$	@ 25°C @ 150°C	1.0 20		μa max μa max	20
Cathode Gate Reverse Cutoff Current (at Rated Voltage)	I_{GC}	@ 25°C	20		μa max	
Anode Gate Reverse Cutoff Current (at Rated Voltage)	I_{GA}	@ 25°C	1.0		μa max	
CONDUCTING CHARACTERISTICS						
Forward Voltage (at 200 ma Anode current $R_{GC} = 10K$)	$V_{F\ max}$	@ 25°C @ −65°C	2.0 2.5	2.0 2.5	V max V max	15, 16
Holding Current ($R_{GC} = 10K$)	$I_{H\ max}$	@ 25°C @ −65°C	1.5 6.0	1.5 6.0	ma max ma max	11, 12, 13
Saturation Voltage (G_A to C) (I_{GC} = 5ma, I_{GA} = 50ma, $I_A = 0$)	$V_{CEsat\ NPN}$	@ 25°C	2.0	2.0	V max	22, 23, 25
TRIGGERING CHARACTERISTICS						
Cathode Gate Current to Trigger (I_{GTC} from current source, $V_{AC} = 40V$, $R_A = 800\Omega$)	$I_{GTC\ max}$	@ 25°C @ −65°C	1.0 50	1.0 50	μa max μa max	4
Cathode Gate Voltage to Trigger ($V_{AC} = 40V$, $R_A = 800\Omega$, $R_{GC} = 10K$, $R_{GA} = \infty$, I_{GTC} from current source)	$V_{GTC\ max}$	@ 25°C @ −65°C	.65 1.0	.65 1.0	V max V max	5
	$V_{GTC\ min}$	@ 25°C @ 150°C	0.4 0.15	0.4 0.15	V min V min	
Anode Gate Current to Trigger (I_{GTA} from current source, $V_{AC} = 40V$, $R_C = 800\Omega$, $R_{GC} = 10K$)	$I_{GTA\ max}$	@ 25°C @ −65°C	1.0 3.0	1.0 3.0	ma max ma max	3
Anode Gate Voltage to Trigger (I_{GTA} from current source, $V_{AC} = 40V$, $R_C = 800\Omega$, $R_{GC} = 10K$, $R_{GA} = 1K$)	$V_{GTA\ max}$	@ 25°C @ −65°C	0.8 1.0	0.8 1.0	V max V max	6
	$V_{GTA\ min}$	@ 25°C @ 150°C	0.4 0.2	0.4 0.2	V min V min	
TRANSIENT CHARACTERISTICS						
Turn-On Time ($V_{AC} = 20V$, I_A = 100 ma, I_{GC} = 100 μa) (See circuits Fig. 9 and 10)	$t_{on\ max}$	@ 25°C @ −65°C	1.5 2.0	1.5 2.0	μs max μs max	7, 8
Recovery Time ($V_{AC} = 20V$, I_A = 100ma, $R_{GC} = 10K$) (See circuit Fig. 17)	$t_{rec\ max}$	@ 25°C @ 150°C	15 25	15 25	μs max μs max	18, 19
Collector Capacitance Voltage Gate to Gate = 20V	$C_{ob\ max}$	@ 25°C	15	15	pf	26
Rate of Rise of Forward Blocking Voltage	dv/dt max	@ 25°C	See Note 5		V/μs max	

NOTE 3: The transistor characterization is essentially a restatement of the SCS characterization and is meant to facilitate using the SCS as *a complementary PNP-NPN integrated transistor pair.*

NOTE 4: The [±] sign indicates that the PNP and NPN transistors require opposite polarites as identified by the test conditions.

NOTE 5: The dv/dt rating is unlimited when the anode gate lead is returned to the anode voltage through a current limiting resistor. An example of this technique is shown in Figure 33

TRANSISTOR CHARACTERIZATION[3]

electrical characteristics: (25°C) (unless otherwise specified)

DC CHARACTERISTICS		3N81 PNP[1] Min.	Max.	3N81 NPN[1] Min.	Max.	3N82 PNP[1] Min.	Max.	3N82 NPN[1] Min.	Max.		Typical Curves Fig. #
Collector to Base Breakdown Voltage (I_C = [±][4] 1.0μa, $I_E = 0$)	BV_{CBO}	−65		65		−100		100		volts	
Emitter to Base Breakdown Voltage ($I_C = 0$, I_E [NPN] = 20μa, I_E [PNP] = −1μa)	BV_{EBO}	−65		5		−100		5		volts	
Collector Saturation Voltage (I_C = 50ma, I_B = 5ma)	$V_{CE(SAT)}$				2				2	volts	22, 23, 25
Base Saturation Voltage (I_B = 1ma, I_C = 5ma)	$V_{BE(SAT)}$				0.9				0.9	volts	
Forward Current Transfer Ratio ($V_{CE} = 0.5V$, I_C = 3ma)	h_{FE}			15				15			21
Forward Current Transfer Ratio ($V_{CE} = -2.0V$, I_C = −1ma)	h_{FE}	0.1				0.1					24
CUTOFF CHARACTERISTICS (3N81 at 65 volts; 3N82 at 100 volts)											
Collector to Emitter Leakage Current ($T_A = 150°C$)	I_{CEO}		−20				−20			μa	
($R_B = 10K\ \Omega$ $T_A = 150°C$)	I_{CER}				20				20	μa	
Collector to Base Leakage Current ($I_E = 0$, $T_A = 150°C$)	I_{CBO}		−20		20		−20		20	μa	
Emitter to Base Leakage Current ($I_C = 0$, $T_A = 150°C$)	I_{EBO}		−20				−20			μa	
(V_{EB} = 5Vdc, $I_C = 0$)	I_{EBO}				20				20	μa	
TRANSIENT CHARACTERISTICS											
Collector Capacitance ($I_E = 0$, V_{CB} = [±][4] 20V)	C_{ob}		15		15		15		15	pf	26
Gain Bandwidth Product	f_T			75				75		mc	

turn-on time

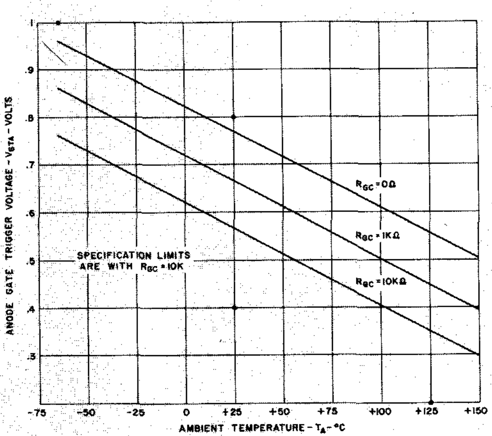


FIG. 6

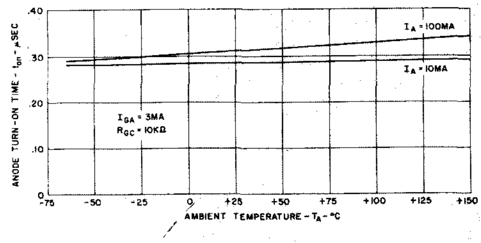


FIG. 7

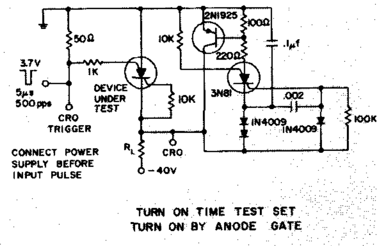


FIG. 9

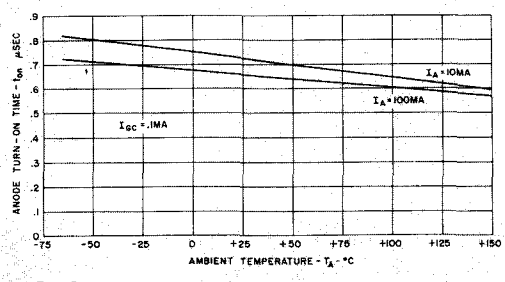


FIG. 8

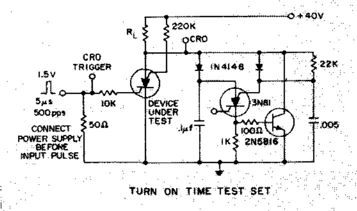


FIG. 10

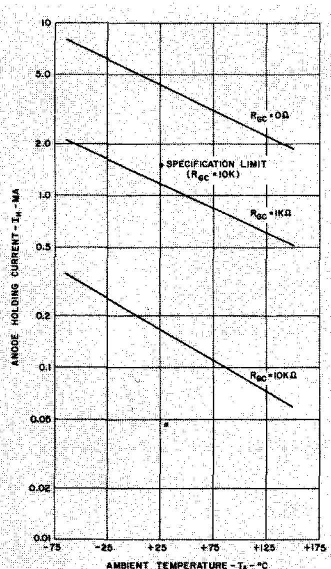


FIG. 11

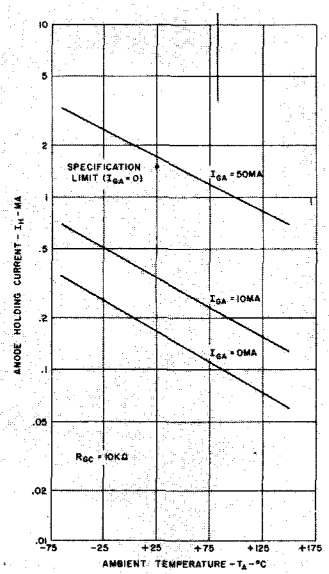


FIG. 12

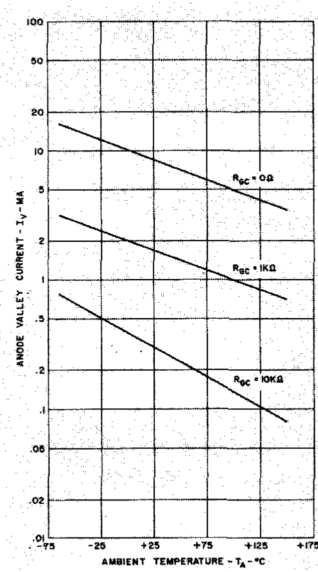


FIG. 13

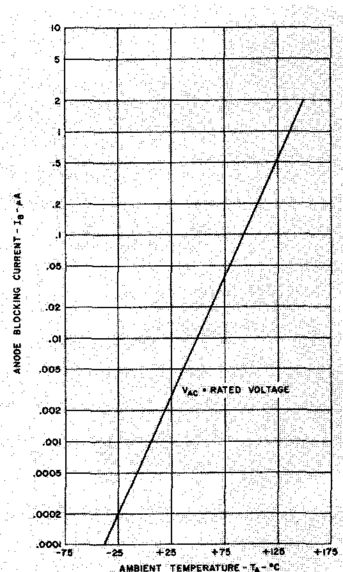


FIG. 14

forward characteristics

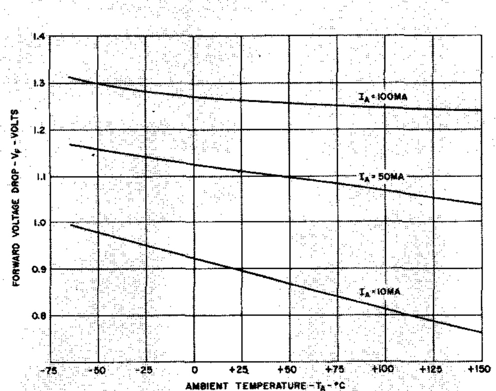


FIG. 15

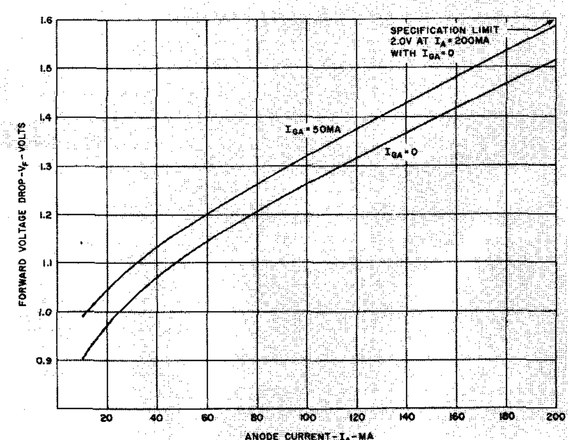
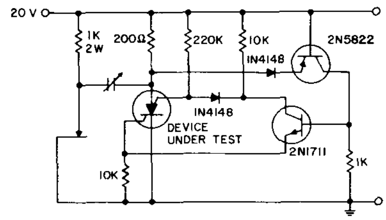


FIG. 16

reverse characteristics



RECOVERY TEST SET

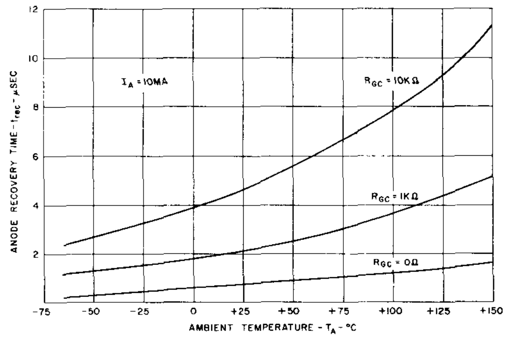


FIG. 18

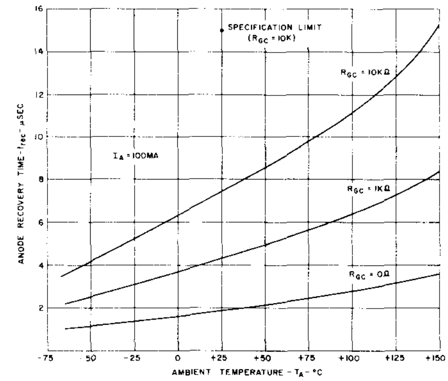


FIG. 19

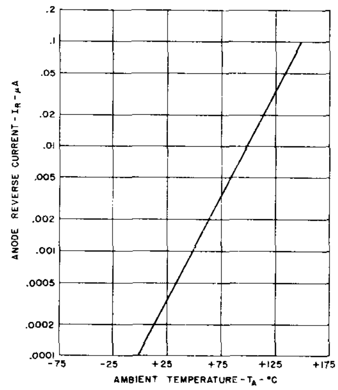


FIG. 20

triggering characteristics

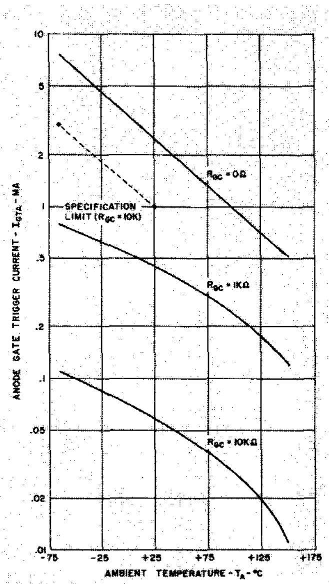


FIG. 3

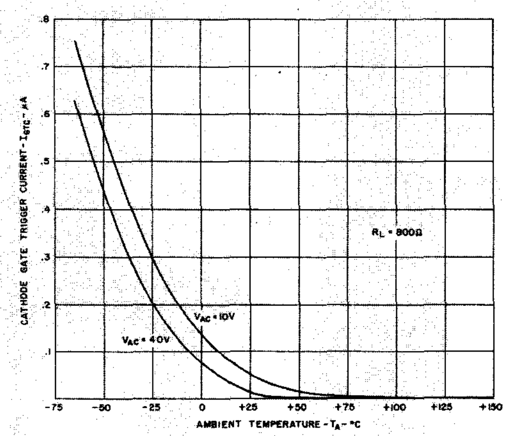


FIG. 4

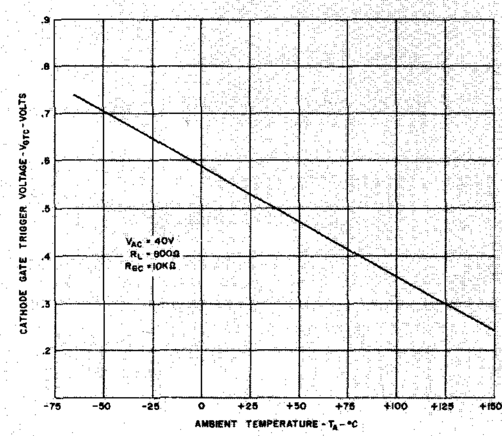


FIG. 5

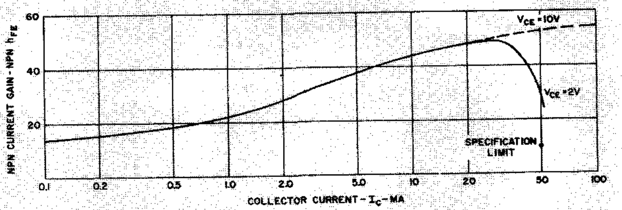


FIG. 21

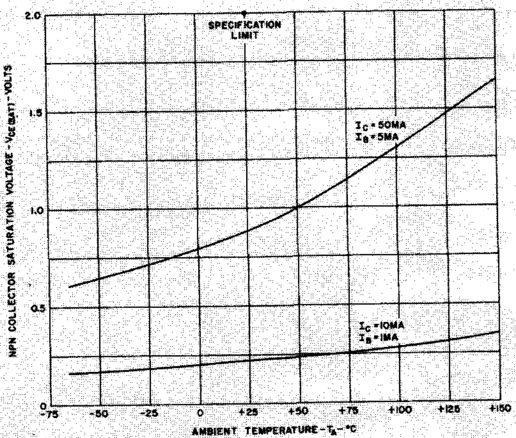


FIG. 22

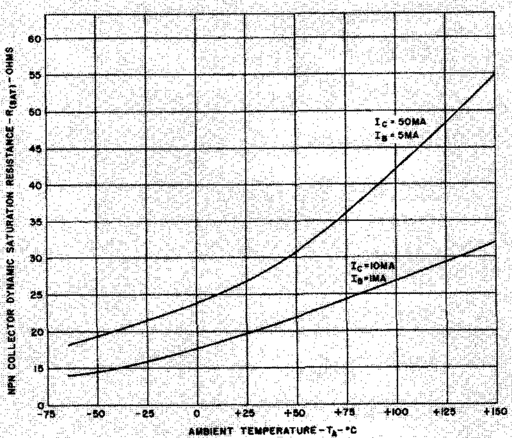


FIG. 23

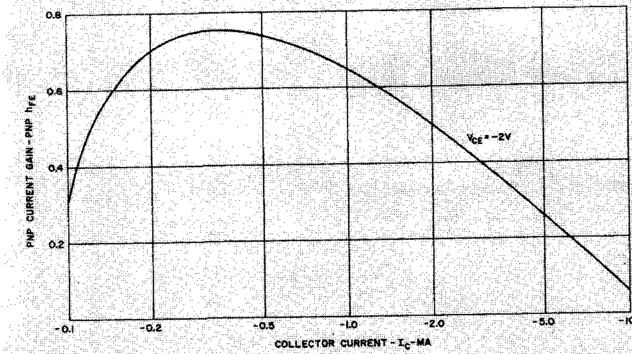


FIG. 24

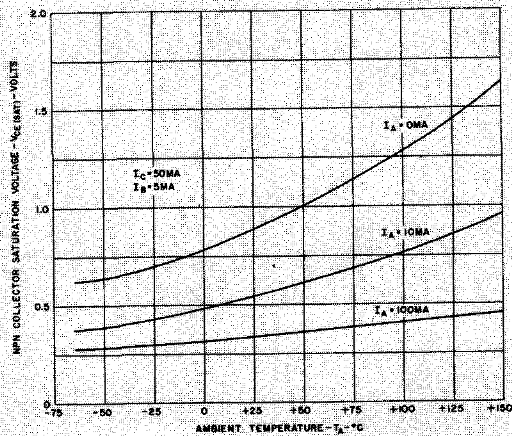


FIG. 25

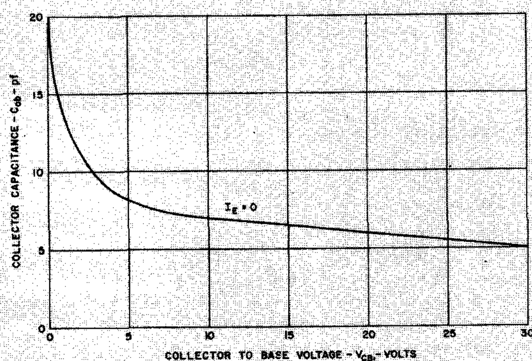
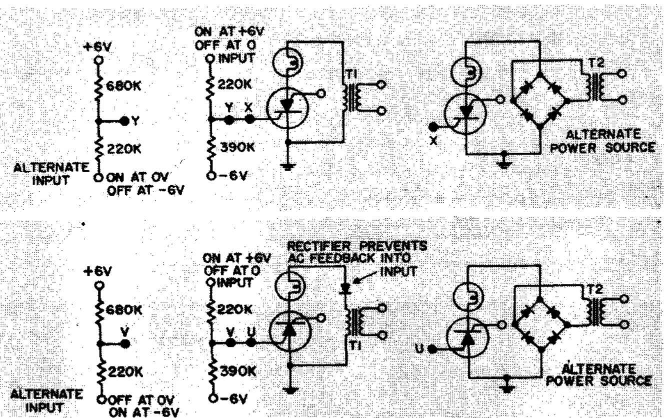


FIG. 26

APPLICATIONS

LAMP	RATING VOLTS	RATING AMPS	SCS	SEC. VOLTS RMS T1*	SEC. VOLTS RMS T2
24	24	.035	3N81	34	24
327	28	.04	3N81	40	28
330	14	.08	3N81	20	14
344	10	.015	3N81	14	10
1829	28	.07	3N81	40	28

*INCREASED VOLTAGE GIVES NORMAL BRIGHTNESS IN HALF WAVE CIRCUIT



INCANDESCENT LAMP DRIVERS

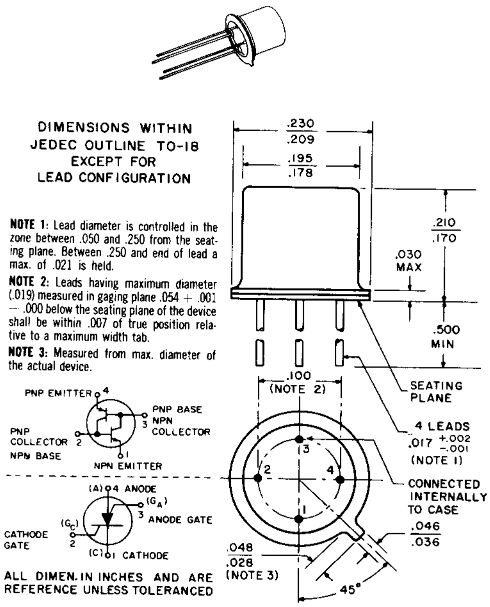
FIG. 27

Silicon Controlled Switch

3N83

The General Electric Type 3N83 is PLANAR PNPN switch with separate leads provided to each of its four semiconductor regions to form the equivalent of an integrated PNP-NPN complementary transistor pair. It has been characterized as a low-cost, latching-type driver for Nixie tubes, alphanumeric display tubes and neon lamps. As such, it is ideally suited for very simple counter circuitry and applicatins requiring gate turn-off as well as gate turn-on. Special features of the 3N83 neon driver include its ability to operate independently of the changes in ionization and deionization time of the lamp and its total freedom from inadvertant triggering caused by line transients (dv/dt).

The 3N83 is housed in a four-leaded TO-18 size package. All junctions are completely oxide passivated to provide maximum long term reliability. Other PNPN devices in this series provide characterization suitable for a wide variety of switching functions and are described in General Electric Publications 65.16, 65.18 and 65.19.



Features:

- Latching driver for neon lamps
- Design parameters specified at worst-case temperatures
- Gate turn-on and turn-off
- Eliminates lamp ionization and deionization-time problems
- All planar, completely oxide passivated
- TO-18 size

PNPN NEON DRIVER CHARACTERIZATION

THEORY OF OPERATION

Considering a PNPN device as an integrated circuit in which an NPN transistor drives the lamp load and a PNP transistor provides the NPN with latching characteristics results in a family of outstanding driver circuits.

Figure 1 compares the SCR and integrated circuit symbols of a PNPN.

Figure 2 illustrates operation in a typical circuit. Initially, assume the NPN transistor is reverse biased. Its collector voltage (pin 3) will be at the collector supply voltage minus the lamp extinction voltage. Typically this will be 50 volts, which reverse biases the PNP transistor. The lamp is extinquished.

Applying a positive trigger pulse saturates the NPN transistor lowering its collector voltage within 1.0 volt of ground. This forward biases the PNP transistor turning it on and supplying additional base drive to the NPN transistor. The 3N83 is characterized so that the NPN transistor remains saturated even after the triggering input is removed. The minimum PNP emitter current to guarantee this is defined as the holding current (I_H).

To turn off the 3N83 it is only necessary to interrupt the PNP emitter current momentarily. This removes the NPN base drive allowing the collector to rise to the lamp extinction voltage reverse biasing the PNP. The 3N83 is also characterized to turn off by a negative pulse at the NPN base. This is equivalent to gate turn-off of an SCR. The negative pulse diverts all the PNP collector current to reverse bias the NPN thus turning off the driver.

The advantages of this circuit include (a) latching characteristics (b) no rate effect problems because the PNP emitter is normally reverse biased (c) spikes and ripple on either power supply will not turn on the driver accidentally (d) turn-off is readily achieved in the low voltage, low power PNP emitter or NPN base circuits (e) lamp ionization and deionization characteristics do not affect the circuit (f) dissipation is low since I_H is generated from a low voltage supply and (g) the circuit is low cost.

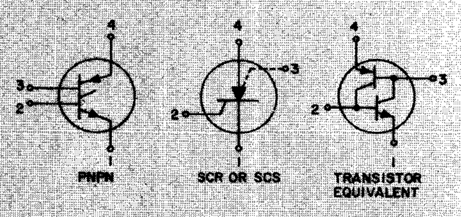


FIG. 1

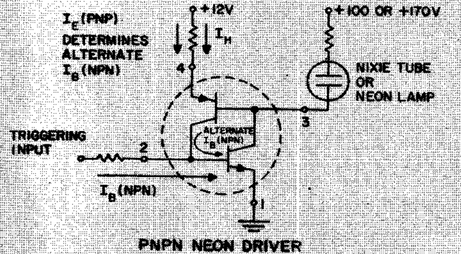


FIG. 2

absolute maximum ratings: (25°C) (unless otherwise noted)

		PNP[1]	NPN[1]	
Voltages				
Collector to Emitter (R = 10K)	V_{CER}	−70	70	volts
Collector to Base	V_{CBO}	−70	70	volts
Emitter to Base	V_{EBO}	−70	5	volts
Emitter Current				
Continuous DC[2]	I_E	50	−50	ma
Peak Recurrent (T_A = 100°C, 100 μsec. pulse width, 1% duty cycle)	$I_{E(PEAK)}$	0.1	−0.1	amp
Peak Non-Recurrent (10 μsec. pulse width)	$I_{E(PEAK)}$	0.5	−0.5	amp
Collector Current[3]				
Continuous DC[2]	I_C	−10	25	ma
Peak Recurrent (T_A = 100°C, 100 μsec. pulse width, 1% duty cycle)	$I_{C(PEAK)}$	−50	50	ma
Dissipation				
Total Power[2]	P_T	200	200	mw
Temperature				
Operating Junction	T_J	−55 to +125		°C
Storage	T_{STG}	−65 to +200		°C

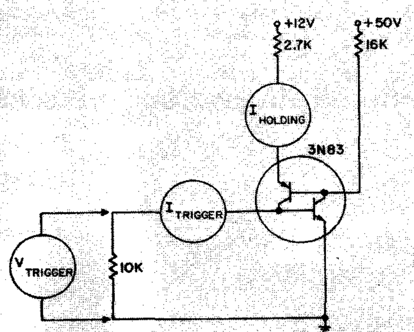
electrical characteristics: (25°C) (unless otherwise specified)

		PNP[2] Min.	PNP[2] Max.	NPN[2] Min.	NPN[2] Max.	
DC CHARACTERISTICS						
Collector to Emitter Breakdown Voltage						
(I_C = 0.1 μa)	BV_{CEO}	−70				volts
(I_C = 0.1 μa, R = 10 K Ω)	BV_{CER}			70		volts
Collector to Base Breakdown Voltage (I_C = [±][4] 0.1 μa, I_E = 0)	BV_{CBO}	−70		70		volts
Emitter to Base Breakdown Voltage (I_C = 0, I_E [NPN] = 20 μa, I_E [PNP] = −1 μa)	BV_{EBO}	−70		5		volts
Collector Saturation Voltage (I_C = 25 ma, I_B = 2.5 ma)	$V_{CE(SAT)}$[5]				1.2	volts
Base Saturation Voltage (I_B = 1 ma, I_C = 5 ma)	$V_{BE(SAT)}$				0.9	volts
Forward Current Transfer Ratio (V_{CE} = 0.5 V, I_C = 3 ma)	h_{FE}			15		
(V_{CE} = −2.0V, I_C = 1.0 ma)	h_{FE}	0.1				
CUTOFF CHARACTERISTICS						
Collector to Emitter Leakage Current (V_{CE} = −70 Vdc, T_A = 125°C)	I_{CEO}		−20			μa
(V_{CE} = 70 Vdc, R_B = 10K Ω, T_A = 125°C)	I_{CER}				20	μa
Collector to Base Leakage Current (V_{CB} = [±][4] 70 Vdc, I_E = 0, T_A = 125°C)	I_{CBO}		−20		20	μa
Emitter to Base Leakage Current (V_{EB} = −70 Vdc, I_C = 0, T_A = 125°C)	I_{EBO}		−20			μa
(V_{EB} = 5 Vdc, I_C = 0)	I_{EBO}				20	μa

COMBINED DEVICE CHARACTERISTICS		Min.	Max.	
Collector Capacitance[6] (I_E = 0, V_{CB} = 20 Vdc)	C_{ob}		20	pf
Forward Voltage (I_E = 50 ma)	V_F		1.4	volts
(I_E = 50 ma, T_A = −55°C)	V_F		1.9	volts
Holding Current (See test circuit below)	I_H		4.0	ma
Current to Trigger (See test circuit below)	$I_{TRIGGER}$		150	μa
Voltage to Trigger (See test circuit below, T_A = −55°C)	$V_{TRIGGER}$		1.1	volts
(See test circuit below, T_A = 125°C)	$V_{TRIGGER}$	0.2		volts
Turn-On Time (See test circuit below, I_B [NPN] = 0.4 ma)	t_{on}		1.5	μsec.
Turn-Off Time (See test circuit below, V_F = 0 during recovery)	t_{off}		8	μsec.
(See test circuit below, T_A = 125°C)	t_{off}		15	μsec.

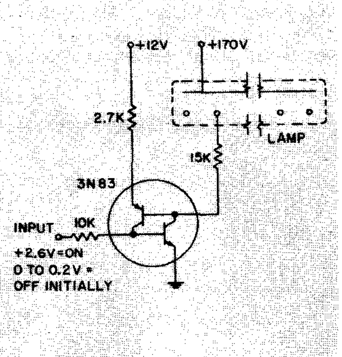
notes:

1. All individual transistor characteristics are given with the emitter of the complementary transistor open; e.g., for $V_{CE(SAT)}$ (NPN): I_C (NPN) = 25 ma, I_B (NPN) = 2.5 ma, I_E (PNP) = 0.
2. Derate current and power linearly to zero at 125°C. The absolute maximum rating at any given temperature shall be in terms of the more conservative of the two parameters, i.e., current or power.
3. The collector current of the PNP is identical to the base current of the NPN and the collector current of the NPN is identical to the base current of the PNP. (See outline drawing.)
4. ± indicates that appropriate polarity should be chosen for transistor under test.
5. $V_{CE(SAT)(NPN)}$ is modulated by the PNP emitter current.
6. Collector capacitance is measured between terminals 2 and 3. (See outline drawing.)



CIRCUIT DEFINING TEST CONDITIONS

FIG. 3



TYPICAL LATCHING LAMP DRIVER

FIG. 4

3N83

dc characteristics

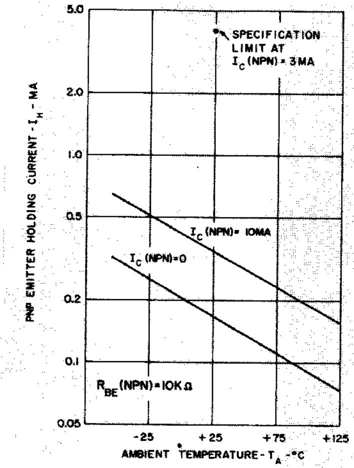


FIG. 5

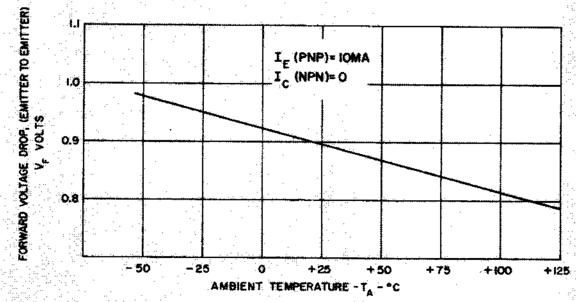


FIG. 6

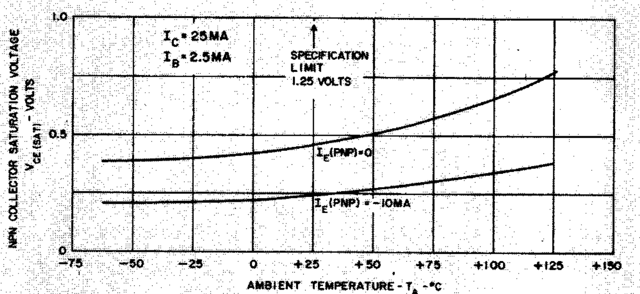


FIG. 7

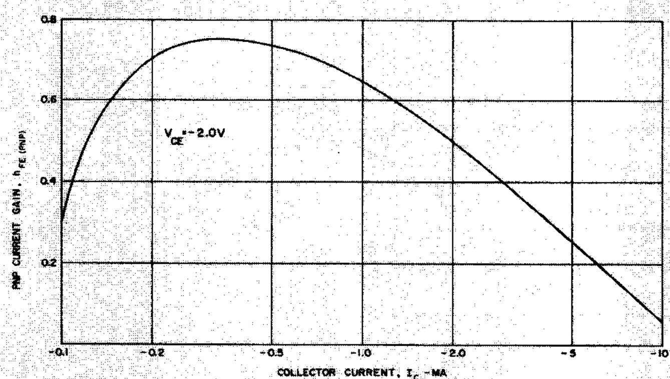


FIG. 8

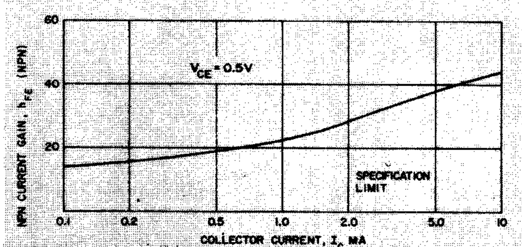


FIG. 9

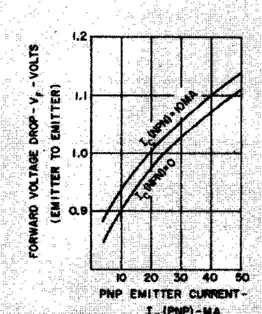


FIG. 10

dynamic characteristics

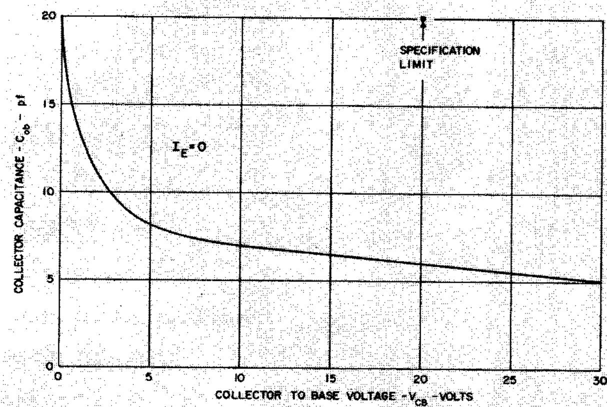


FIG. 11

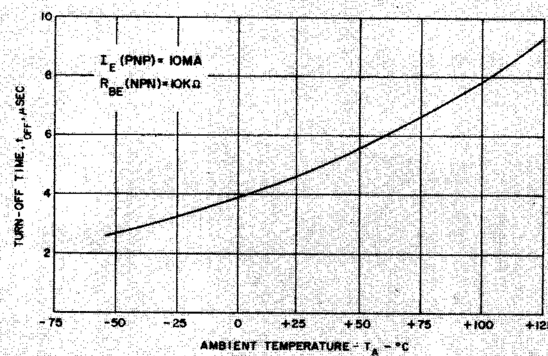


FIG. 12

triggering characteristics

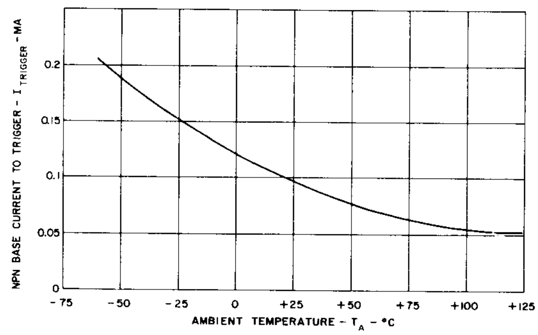


FIG. 13

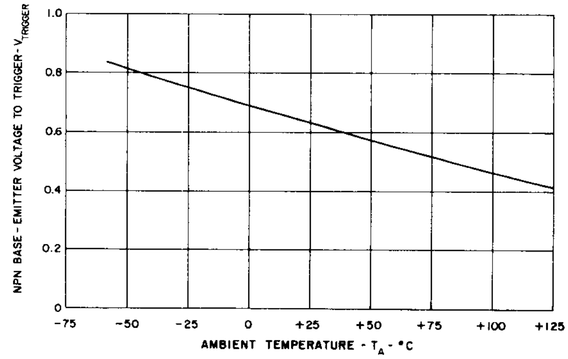
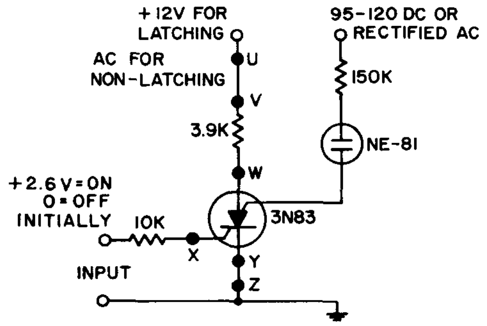
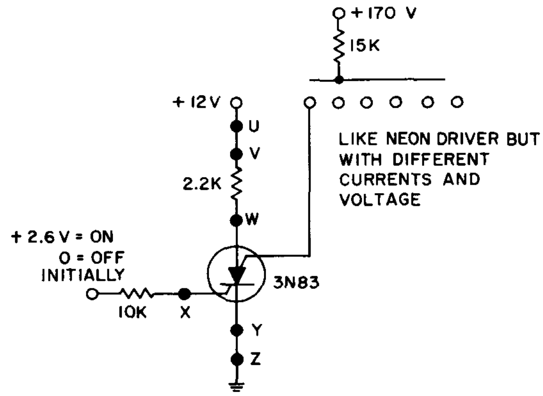


FIG. 14



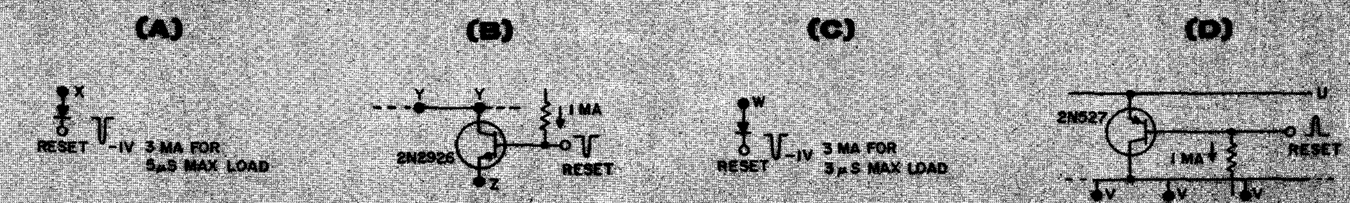
NEON DRIVER

FIG. 15



NIXIE TUBE

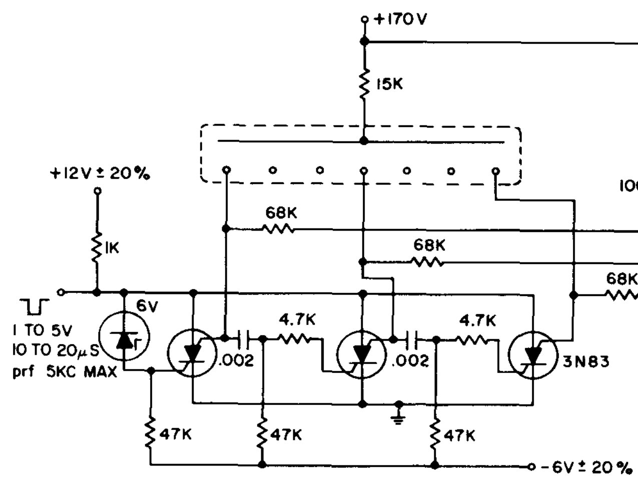
FIG. 16



reset methods

Four common reset methods are illustrated. The driver circuit is modified by connecting or inserting the turn-off circuitry to similarly lettered points. Method (A) reverse biases the NPN base. Method (B) illustrates that several stages can be turned off simultaneously by open circuiting the NPN emitter. Method (C) reverse biases the PNP emitter while method (D) open circuits one or more PNP emitters. In each case, rate effect problems are non-existent and no special care is required in shaping the reset waveforms.

FIG. 17



NIXIE TUBE RING COUNTER

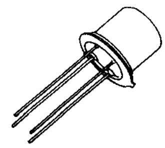
FIG. 18

Silicon Controlled Switch

PNPN 3N84,5

The General Electric Types 3N84 and 3N85 are PLANAR PNPN silicon controlled switches that feature an "extra lead" which completely eliminates rate effect (dv/dt) and voltage transient problems without compromising triggering sensitivity or transient response time. Unique fabrication processes based on planar oxide passivation have resulted in high reliability and uniformity at low cost. These devices are thoroughly characterized at temperature extremes to permit worst case circuit design.

The 3N84 and 3N85 are ideally suited for low-level SCR applications such as lamp and relay drivers, sensitive voltage-level detectors, bistable memory elements, binary counters, shift registers, ring counters, telemetry oscillators, time delay generators and pulse generators. These devices are housed in a four-leaded TO-18 size case and all junctions are completely oxide passivated. Other silicon controlled switches in this series provide characterizations suitable for a wide variety of low-level switching functions and are described in General Electric publications No. 65.16 and 65.17.



- **Fourth lead completely eliminates rate effects (dv/dt)**
- **Dynamic and static breakover voltages are equal**
- **40 and 100 volt ratings**
- **Characterized at temperature extremes**
- **Low cost**
- **TO-18 case**

absolute maximum ratings:[1] (25°C) (unless otherwise specified)

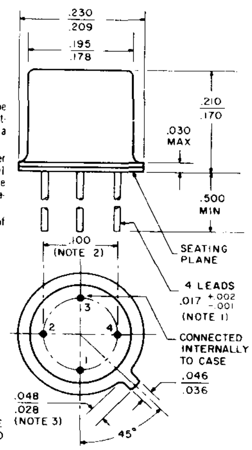
	3N84	3N85	
Voltage			
Anode to cathode forward and reverse	40	100	volts
Anode gate to anode reverse	40	100	volts
Cathode gate to cathode reverse	5	5	volts
Total Current			
Continuous DC forward[2]	175	175	ma
Peak recurrent forward (T_A = 100°C, 100 μsec. pulse width, 1% duty cycle)	0.5	0.5	amps
Peak non-recurrent forward (10 μsec. pulse width)	2.0	2.0	amps
Gate Current (Forward Bias)			
Continuous DC anode gate	10	10	ma
Peak anode gate (T_A = 100°C, 100 μsec. pulse width, 1% duty cycle)	10	10	ma
Peak cathode gate (T_A = 100°C, 100 μsec. pulse width, 1% duty cycle)	100	100	ma
Continuous DC cathode gate	10	10	ma
Dissipation			
Total power[2]	320	320	mw
Cathode gate power[2]	50	50	mw
Temperature			
Operating Junction	−55 to +125		°C
Storage	−65 to +200		°C

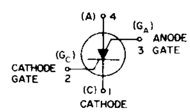
DIMENSIONS WITHIN JEDEC OUTLINE TO-18 EXCEPT FOR LEAD CONFIGURATION

NOTE 1: Lead diameter is controlled in the zone between .050 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

NOTE 2: Leads having maximum diameter (.019) measured in gaging plane .054 +.001 −.000 below the seating plane of the device shall be within .007 of true position relative to a maximum width tab.

NOTE 3: Measured from max. diameter of the actual device.





ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics:[1]

	Symbol[1]	Temp.	3N84[3]	3N85[3]		Typical Curves Fig. #
CUTOFF CHARACTERISTICS						
Forward Blocking Current (R_{GC} = 10K, V_{AC} = Rated Voltage)	$I_{B\ max}$	@ 25°C	1.0		μa max	12
		@ 125°C	20		μa max	
Reverse Blocking Current (R_{GC} = 10K, V_{CA} = Rated Voltage)	$I_{R\ max}$	@ 25°C	1.0		μa max	12
		@ 125°C	20		μa max	
Cathode Gate Reverse Cutoff Current (at Rated Voltage)	I_{GC}	@ 25°C	20		μa max	
Anode Gate Reverse Cutoff Current (at Rated Voltage)	I_{GA}	@ 25°C	1.0		μa max	
CONDUCTING CHARACTERISTICS						
Forward Voltage (at 175ma Anode Current R_{GC} = 10K)	$V_{F\ max}$	@ 25°C	1.9	1.9	V max	6, 7
		@ −55°C	2.5	2.5	V max	
Holding Current (R_{GC} = 10K)	$I_{H\ max}$	@ 25°C	2.0	2.0	ma max	8, 9, 11
		@ −55°C	10	10	ma max	
TRIGGERING CHARACTERISTICS						
Cathode Gate Current to Trigger[3] (I_{GTC} from current source, V_{AC} = 40V, R_A = 800Ω)	$I_{GTC\ max}$	@ 25°C	10	10	μa max	13
		@ −55°C	100	100	μa max	
Cathode Gate Voltage to Trigger[3] (V_{AC} = 40V, R_A = 800Ω, R_{GC} = 10K, R_{GA} = ∞) I_{GTC} from current source)	$V_{GTC\ max}$	@ 25°C	.65	.65	V max	14
		@ −55°C	1.0	1.0	V max	
	$V_{GTC\ min}$	@ 25°C	0.4	0.4	V min	
		@ 125°C	0.2	0.2	V min	
TRANSIENT CHARACTERISTICS[3]						
Turn-On Time (V_{AC} = 20V, I_A = 100ma, I_{GC} = 100 μa)	$t_{on\ max}$	@ 25°C	1.5	1.5	μs max	3, 10
		@ −55°C	2.0	2.0	μs max	
Recovery Time[3] (V_{AC} = 20V, I_A = 100ma, R_{GC} = 10K)	$t_{rec\ max}$	@ 25°C	15	15	μs max	4, 5, 15, 16
		@ 125°C	25	25	μs max	
Rate of Rise of Forward Blocking Voltage	dv/dt max	@ 25°C	See Note 4		V/μs max	

NOTE 1: Symbols and nomenclature are defined at the top of the next page.

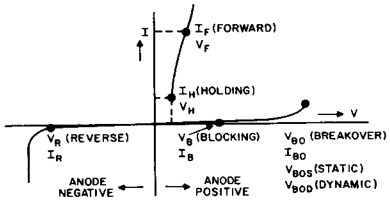
NOTE 2: Derate currents and power linearly to 125°C. The absolute maximum rating at any given temperature shall be in terms of the more conservative of the two parameters, i.e. current or power.

NOTE 3: The 3N84 and 3N85 test conditions include a 220K resistor added from the anode gate to the anode supply voltage. I_R is the only exception, the 220K resistor being deleted.

NOTE 4: The dv/dt rating is unlimited when the anode gate lead is returned to the anode voltage through a current limiting resistor. An example of this technique is shown in Figure 23.

definition of terms used in scs specifications

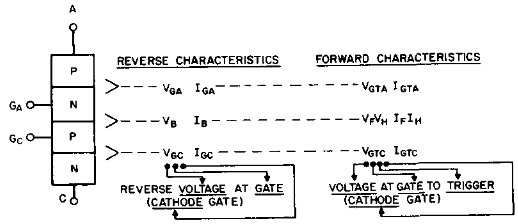
PNPN devices available at present do not have a common nomenclature. In part, this is due to their different construction and varied applications. SCS nomenclature permits the reverse characteristics of all three junctions to be specified. The anode forward characteristic and gate triggering characteristics can also be specified fully. The principles used in assigning symbols are illustrated at right and with the outline drawing on previous page.



ANODE TO CATHODE CHARACTERISTICS

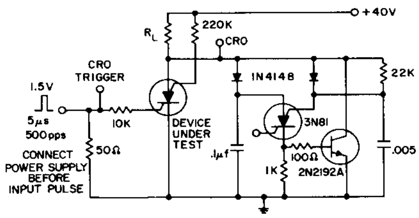
NOTE — ABSENCE OF G INDENTIFIES ANODE TO CATHODE SYMBOLS. DOT IDENTIFIES OPERATING POINT. BRACKETS INDICATE MEANING OF SUBSCRIPT LETTER.

FIG. 1



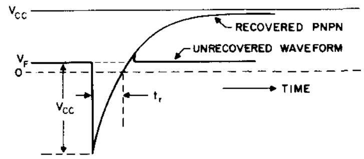
NOTE: G IDENTIFIES GATE SYMBOLS. LAST LETTER (A OR C) MAY BE DROPPED IF NO AMBIGUITY RESULTS IN SPECIFIC CHARACTERIZATION. F MEANS "FORWARD" AND T MEANS "TRIGGER"

FIG. 2



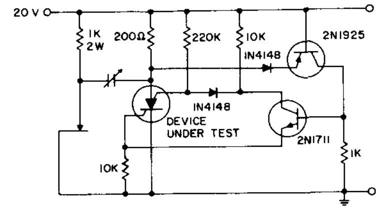
TURN ON TIME TEST SET

FIG. 3



ANODE WAVEFORM DEFINING RECOVERY

FIG. 4



RECOVERY TEST SET

FIG. 5

forward voltage characteristics, V_f

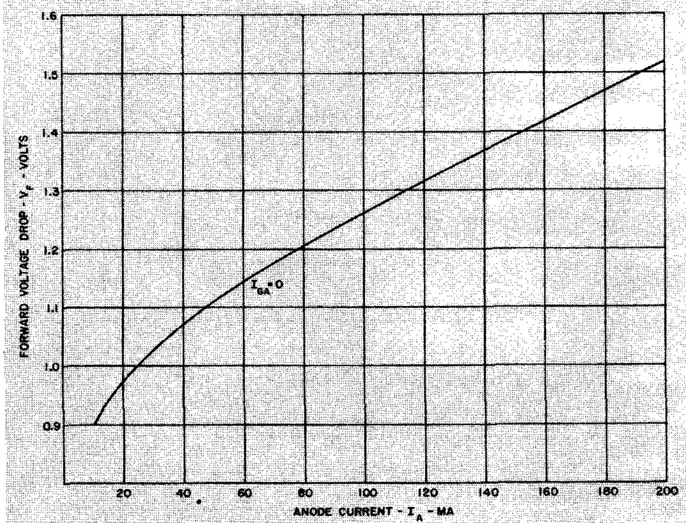


FIG. 6

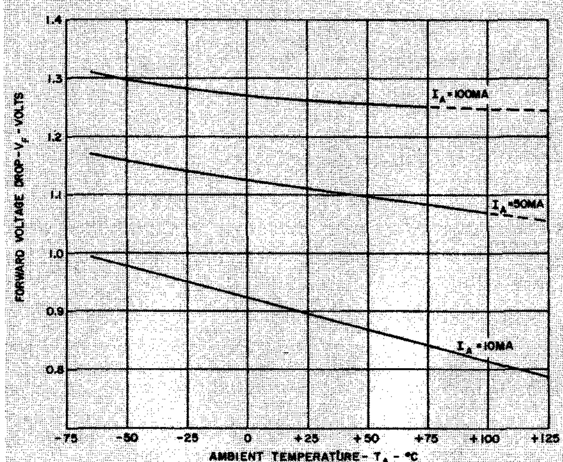


FIG. 7

holding current characteristics

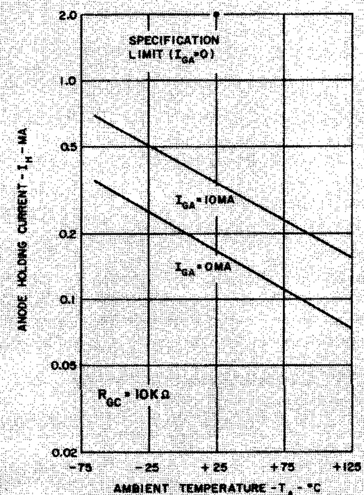


FIG. 8

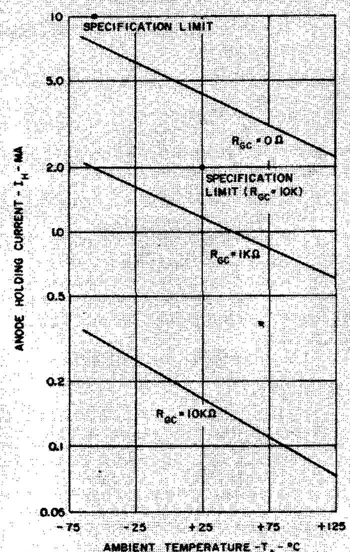


FIG. 9

forward and reverse blocking current, i_b, i_r

valley current, i_v

turn-on time

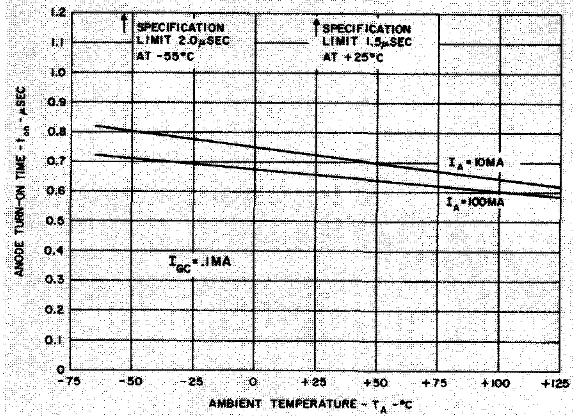


FIG. 10

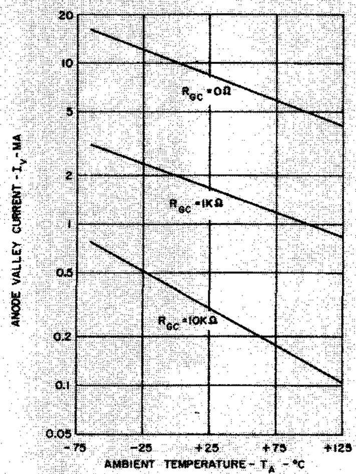


FIG. 11

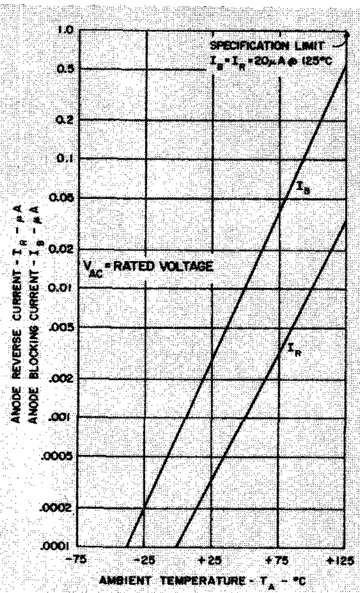


FIG. 12

triggering characteristics

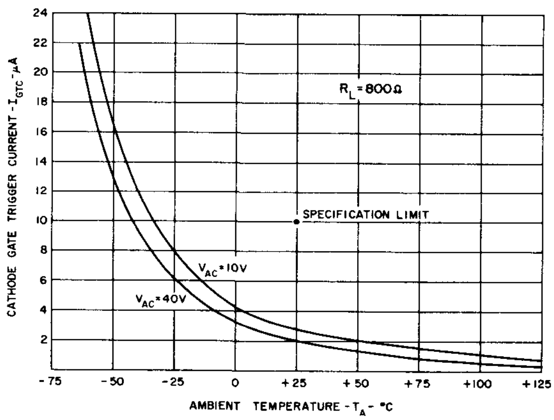


FIG. 13

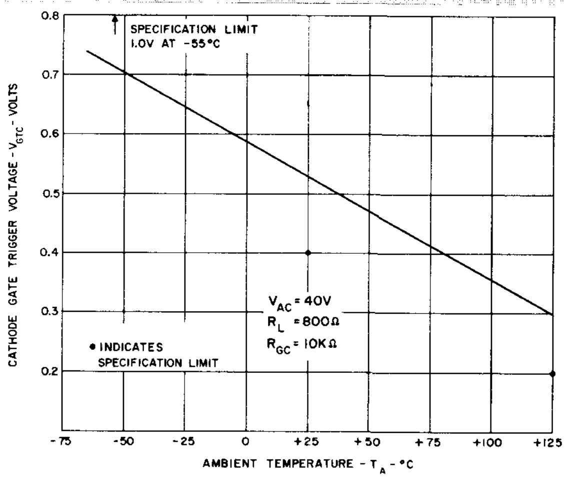


FIG. 14

recovery time

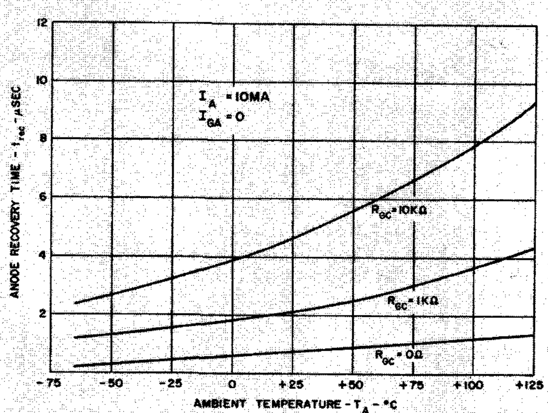


FIG. 15

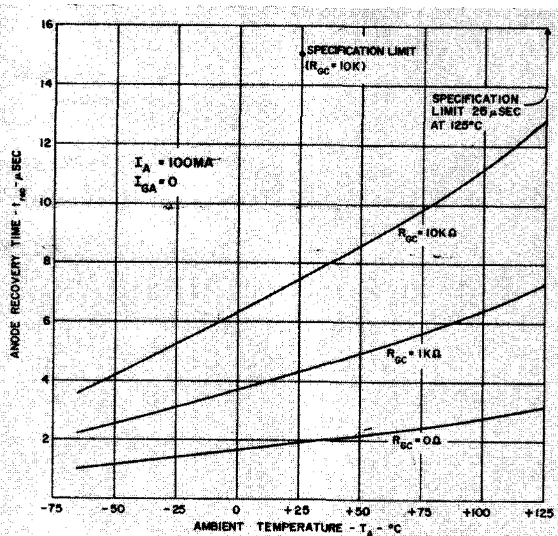
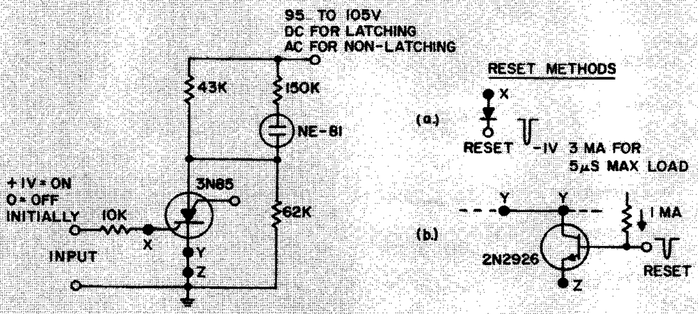


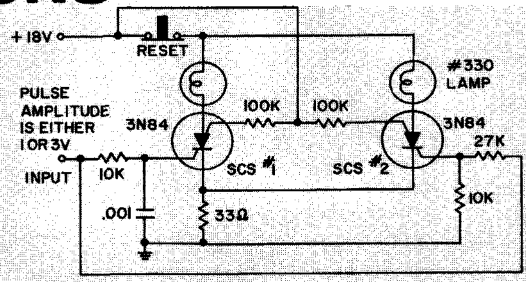
FIG. 16

APPLICATIONS



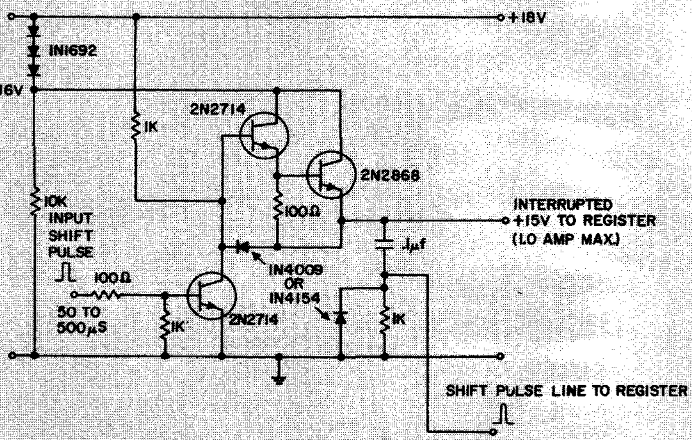
NEON LAMP DRIVER

FIG. 17



A ONE VOLT AMPLITUDE PULSE TRIGGERS SCS #1 BUT HAS INSUFFICIENT AMPLITUDE TO TRIGGER SCS #2. A THREE VOLT INPUT PULSE IS DELAYED IN REACHING SCS #1 BY THE 10K AND .001μf INTEGRATING NETWORK. INSTEAD, IT TRIGGERS SCS #2 THEN RAISES THE COMMON EMITTER VOLTAGE TO PREVENT SCS #1 FROM TRIGGERING. THE 100K RESISTORS SUPPRESS RATE EFFECT.

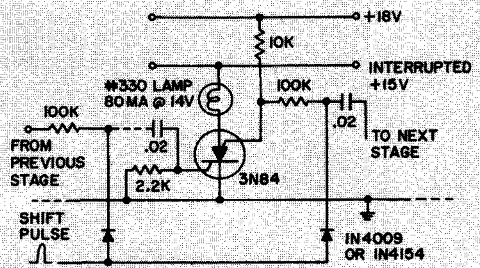
FIG. 18



A 16 VOLT POWER SUPPLY CAN BE SYNTHESIZED AS SHOWN USING 1N1692 RECTIFIERS. A SHIFT PULSE INPUT SATURATES THE 2N2714 DEPRIVING THE DARLINGTON COMBINATION (2N2714 AND 2N2868) OF BASE DRIVE. THE NEGATIVE PULSE SO GENERATED ON THE 15V LINE IS DIFFERENTIATED TO PRODUCE A POSITIVE TRIGGER PULSE AT ITS TRAILING EDGE.

SHIFT REGISTER DRIVER

FIG. 19

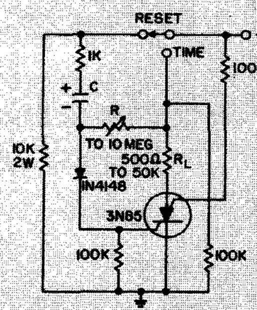


BASIC SHIFT REGISTER STAGE

THE SHIFT PULSE AMPLITUDE IS LESS THAN 15 VOLTS. IF A STAGE IS OFF, THE SHIFT PULSE WILL NOT BE COUPLED TO THE NEXT STAGE. IF IT IS ON, THE DIODE WILL CONDUCT TRIGGERING THE NEXT STAGE. JUST PRIOR TO THE SHIFT PULSE THE ANODE SUPPLY IS INTERRUPTED TO TURN OFF ALL STAGES. THE STORED CAPACITOR CHARGE DETERMINES WHICH STAGES WILL BE RETRIGGERED.

SHIFT REGISTER

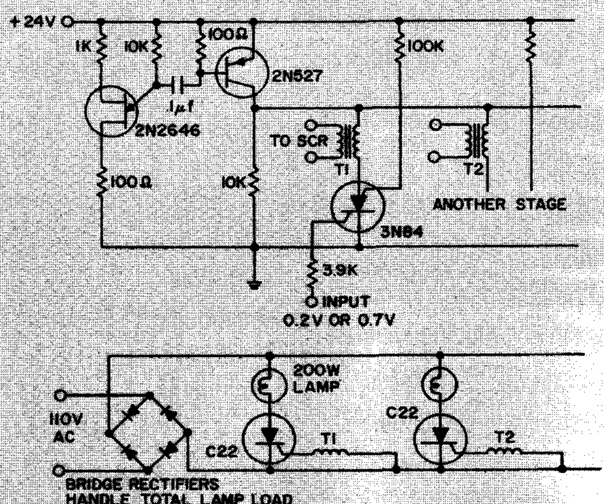
FIG. 20



LOAD CURRENT STARTS APPROX. 0.5 RC AFTER SWITCH IS THROWN

TIMING CIRCUIT

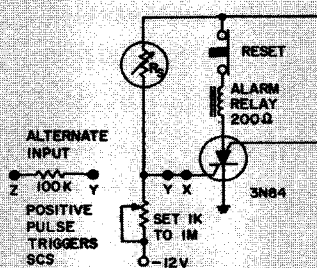
FIG. 21



THE 2N2646 OSCILLATOR TURNS ON THE 2N527 FOR APPROX. 20μSEC AT A 1KC RATE. IF THE INPUT IS AT 0.7 VOLTS THE SCS TURNS ON GENERATING A PULSE TO TRIGGER THE SCR DRIVING THE LAMP. BY USING A BRIDGE RECTIFIER AND A 1KC PULSE RATE THE LAMPS GIVE NORMAL BRILLIANCE. A 0.2V INPUT DOES NOT TURN ON THE SCS AND THEREFORE THE LAMP.

DRIVING 110V LAMPS FROM LOW LEVEL LOGIC

FIG. 22



WHEN R_s DECREASES SUFFICIENTLY TO FORWARD BIAS THE SCS, THE ALARM IS ACTIVATED.

INTERCHANGING R_s AND THE POTENTIOMETER TRIGGERS THE SCS WHEN R_s INCREASES.

TEMPERATURE, LIGHT, OR RADIATION SENSITIVE RESISTORS UP TO 1 MEGOHM READILY TRIGGER ALARM WHEN THEY DROP BELOW VALUE OF PRESET POTENTIOMETER. ALTERNATELY, 0.75V AT INPUT TO 100K TRIGGERS ALARM. CONNECTING SCS BETWEEN GROUND AND -12V PERMITS TRIGGERING ON NEGATIVE INPUT TO G_A.

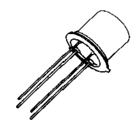
ALARM CIRCUIT

FIG. 23

Silicon Controlled Switch

3N86

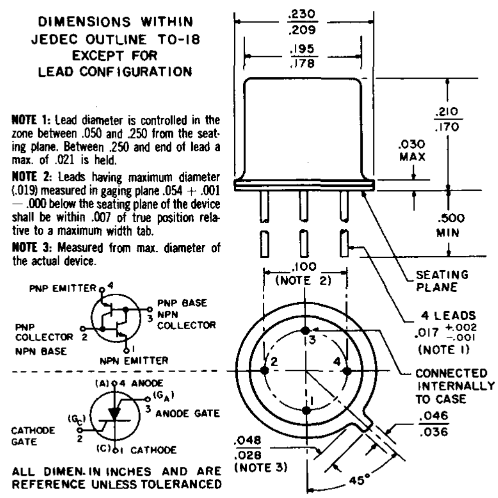
The General Electric Type 3N86 is a PLANAR PNPN silicon controlled switch (SCS) offering outstanding circuit design flexibility by providing leads to all four semiconductor regions. Unique fabrication processes based on planar oxide passivation have resulted in high rehability and uniformity atlow cost. The SCS is thoroughly characterized at temperature extremes to permit worst case circuit design.
The 3N86 can be considered an integrated PNP-NPN transistor pair in a positive feedback configuration. As such it offers fewer connections, fewer parts, lower cost and better characterization than is available from two separate transistors. Its characterization permits it to be used as an extremely sensitive SCR, as a complementary SCR, or as a "transistor" with "latching" capabilities. Type 3N86 is intended for applications requiring extremely low holding current, high triggering sensitivity at either gate and high turn-off gain.



FEATURES:
- **Completely eliminates rate effect problems**
- **Dynamic and static breakover voltages are identical**
- **Extremely high triggering sensitivity at both gates**
- **Low holding current**
- **High turn-off gain**
- **Design parameters specified at worst-case temperatures**
- **Characterized for SCR and complementary SCR type applications**
- **Characterized as PNPN and also as transistor integrated pair**
- **All planar, completely oxide passivated**
- **Leads to all four semiconductor regions**

absolute maximum ratings[1] (25°C) (unless otherwise specified)

Voltage		
Anode to cathode forward and reverse	65	volts
Anode gate to anode reverse	65	volts
Cathode gate to cathode reverse	5	volts
Total Current		
Continuous DC forward[2]	200	ma
Peak recurrent forward ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	1.0	amps
Peak non-recurrent forward (10 μsec. pulse width)	5.0	amps
Gate Current (Forward Bias)		
Continuous DC anode gate[2]	100	ma
Peak anode gate ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle)	200	ma
Peak cathode gate ($T_A = 100°C$, 100 μsec. pulse width, 1% duty cycle	500	ma
Continuous DC cathode gate	20	ma
Dissipation		
Total power[2]	400	mw
Cathode gate power[2]	100	mw
Temperature		
Operating junction	−65 to +150	°C
Storage	−65 to +200	°C



NOTE 1: Symbols and nomenclature are defined below.
NOTE 2: Derate currents and power linearly to 150°C, the maximum rated temperature. The absolute maximum rating at any given temperature shall be in terms of the more conservative of the two parameters, i.e., current or power.

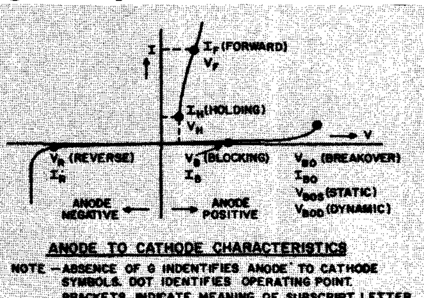


FIG. 1

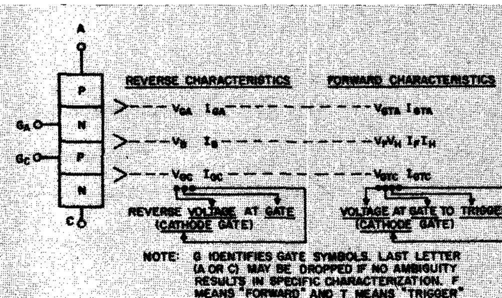


FIG. 2

DEFINITION OF TERMS USED IN SCS SPECIFICATIONS
PNPN devices available at present do not have a common nomenclature. In part, this is due to their different construction and varied applications. SCS nomenclature permits the reverse characteristics of all three junctions to be specified. The anode forward characteristic and gate triggering characteristics can also be specified fully. The principles used in assigning symbols are illustrated below and with outline drawing above.

SCS CHARACTERIZATION

3N86 electrical characteristics:[1]

	Symbol[1]	Temp.	3N86	
CUTOFF CHARACTERISTICS				
Forward Blocking Current ($R_{GC} = 10K$, $V_{AC} = 65V$)	$I_{B\ max}$	@ 25°C	1.0	μa max
		@ 150°C	20	μa max
Reverse Blocking Current ($R_{GC} = 10K$, $V_{CA} = 65V$)	$I_{R\ max}$	@ 25°C	1.0	μa max
		@ 150°C	20	μa max
Cathode Gate Reverse Cutoff Current ($V_{GC} = -5V$)	I_{GC}	@ 25°C	20	μa max
Anode Gate Reverse Cutoff Current ($V_{GA} = -65V$)	I_{GA}	@ 25°C	1.0	μa max
CONDUCTING CHARACTERISTICS				
Forward Voltage ($I_A = 200ma$, $R_{GC} = 10K$)	$V_{F\ max}$	@ 25°C	2.0	V max
		@ −65°C	2.5	V max
Forward Voltage ($I_A = 100ma$, $I_{GA} = 50ma$, $R_{GC} = 10K$)	$V_{F\ max}$	@ 25°C	1.5	V max
Holding Current ($R_{GC} = 10K$)	$I_{H\ max}$	@ 25°C	0.2	ma max
		@ −65°C	0.8	ma max
Holding Current ($R_{GC} = 10K$, $I_{GA} = 50ma$)	$I_{H\ max}$	@ 25°C	2.0	ma max
		@ −65°C	8.0	ma max
Saturation Voltage (G_A to C) ($I_{GC} = 5ma$, $I_{GA} = 50ma$, $I_A = 0$)	$V_{CEsat\ NPN}$	@ 25°C	2.0	V max
Saturation Voltage (G_A to C) ($I_{GC} = 0$, $I_{GA} = 50ma$, $I_A = 5ma$)	$V_{CEsat\ NPN}$	@ 25°C	2.0	V max
TRIGGERING CHARACTERISTICS				
Cathode Gate Current to Trigger (I_{GTC} from current source, $V_{AC} = 40V$, $R_A = 800\Omega$)	$I_{GTC\ max}$	@ 25°C	1.0	μa max
		@ −65°C	50	μa max
Cathode Gate Current to Trigger (I_{GTC} from current source, $V_{AC} = 40V$, $R_A = 800\Omega$, $I_{GA} = 50ma$)	$I_{GTC\ max}$	@ 25°C	50	μa max
Cathode Gate Voltage to Trigger ($V_{AC} = 40V$, $R_A = 800\Omega$, $R_{GC} = 10K$, $R_{GA} = \infty$, I_{GTC} from current source)	$V_{GTC\ max}$	@ 25°C	.65	V max
		@ −65°C	1.0	V max
	$V_{GTC\ min}$	@ 25°C	0.4	V min
		@ 150°C	0.15	V min
Cathode Gate Voltage to Trigger ($V_{AC} = 40V$, $R_A = 800\Omega$, $R_{GC} = 10K$, $I_{GA} = 50ma$, I_{GTC} from current source)	$V_{GTC\ max}$	@ 25°C	0.8	V max
	$V_{GTC\ min}$	@ 25°C	0.4	V min
Anode Gate Current to Trigger (I_{GTA} from current source, $V_{AC} = 40V$, $R_C = 800\Omega$, $R_{GC} = 10K$)	$I_{GTA\ max}$	@ 25°C	0.1	ma max
		@ −65°C	0.25	ma max
Anode Gate Voltage to Trigger (I_{GTA} from current source, $V_{AC} = 40V$, $R_C = 800\Omega$, $R_{GC} = 10K$, $R_{GA} = 1K$)	$V_{GTA\ max}$	@ 25°C	0.8	V max
		@ −65°C	1.0	V max
	$V_{GTA\ min}$	@ 25°C	0.4	V min
		@ 150°C	0.2	V min
TRANSIENT CHARACTERISTICS				
Turn-On Time ($V_{AC} = 20V$, $I_A = 100ma$, $I_{GC} = 100\mu a$) (See circuit, Figure 3)	$t_{on\ max}$	@ 25°C	1.5	μs max
		@ −65°C	2.0	μs max
Turn-On Time ($V_{AC} = 20V$, $I_A = 100ma$, $I_{GC} = 100\mu a$, $I_{GA} = 50ma$)	$t_{on\ max}$	@ 25°C	2.0	μsec max
Recovery Time ($V_{AC} = 20V$, $I_A = 100ma$, $R_{GC} = 10K$) (See circuit, Figure 4)	$t_{rec\ max}$	@ 25°C	15	μs max
		@ 150°C	25	μs max
Recovery Time ($V_{AC} = 20V$, $I_A = 100ma$, $R_{GC} = 10K$, $I_{GA} = 50ma$)	$t_{rec\ max}$	@ 25°C	15	μsec max
Collector Capacitance Voltage Gate to Gate = 20V	$C_{ob\ max}$	@ 25°C	15	pf
Rate of Rise of Forward Blocking Voltage	dv/dt max	@ 25°C	(see note 5)	V/μsec max

TRANSISTOR CHARACTERIZATION[3]

electrical characteristics (25°C) (unless otherwise specified)

		3N86 PNP[1] Min.	PNP[1] Max.	NPN[1] Min.	NPN[1] Max.	
DC CHARACTERISTICS						
Collector to Base Breakdown Voltage ($I_C = [\pm]^{(4)}\ 1.0\mu a$, $I_E = 0$)	BV_{CBO}	−65		65		volts
Emitter to Base Breakdown Voltage ($I_C = 0$, I_E [NPN] $= 20\mu a$, I_E [PNP] $= -1\mu a$)	BV_{EBO}	−65		5		volts
Collector Saturation Voltage ($I_C = 50ma$, $I_B = 5ma$)	$V_{CE(SAT)}$				2	volts
Base Saturation Voltage ($I_C = 1ma$, $I_B = 5ma$)	$V_{BE(SAT)}$				0.9	volts
Forward Current Transfer Ratio ($V_{CE} = 0.5V$, $I_C = 3ma$)	h_{FE}			20		
Forward Current Transfer Ratio ($V_{CE} = -2.0V$, $I_C = -1ma$)	h_{FE}	0.2				
CUTOFF CHARACTERISTICS ($V_{AC} = 65$ volts)						
Collector to Emitter Leakage Current ($T_A = 150°C$)	I_{CEO}		−20			μa
($R_B = 10K\Omega$, $T_A = 150°C$)	I_{CER}				20	μa
Collector to Base Leakage Current ($I_E = 0$, $T_A = 150°C$)	I_{CBO}		−20		20	μa
Emitter to Base Leakage Current ($I_C = 0$, $T_A = 150°C$)	I_{EBO}		−20			μa
($V_{EB} = 5Vdc$, $I_C = 0$)	I_{EBO}				20	μa
TRANSIENT CHARACTERISTICS						
Collector Capacitance ($I_E = 0$, $V_{EB} = [\pm]^{(4)}\ 20V$)	C_{ob}		15		15	pf
Gain Bandwidth Product	f_T			75		mc

NOTE 3: The transistor characterization is essentially a restatement of the SCS characterization and is meant to facilitate using the SCS as a complementary PNP-NPN integrated transistor pair.

NOTE 4: The [±] sign indicates that the PNP and NPN transistors require opposite polarities as identified by the test conditions.

NOTE 5: The dv/dt rating is unlimited when the anode gate lead is returned to the anode voltage through a current limiting resistor.

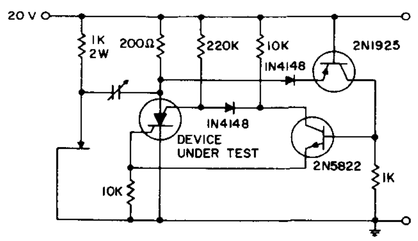


FIG. 3 RECOVERY TEST SET

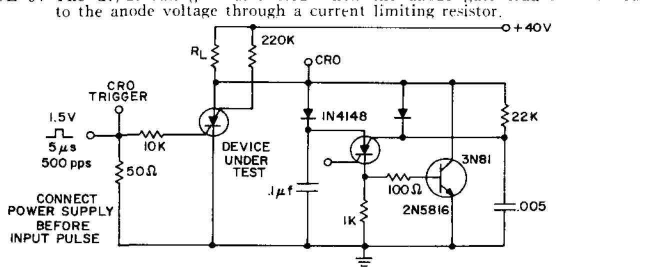
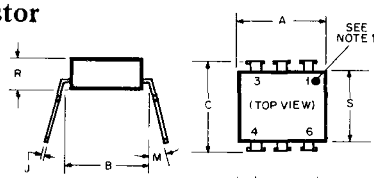


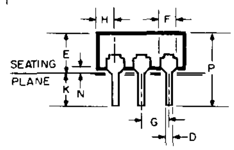
FIG. 4 TURN ON TIME TEST SET

Photon Coupled Isolator 4N25-4N25A-4N26-4N27-4N28

Ga As Infrared Emitting Diode & NPN Silicon Photo-Transistor

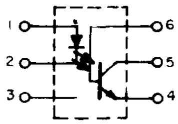
The General Electric 4N25-4N26-4N27-4N28 consist of a gallium arsenide infrared emitting diode coupled with a silicon photo transistor in a dual in-line package.





SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF	7.62	REF	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.



FEATURES:

- Fast switching speeds
- High DC current transfer ratio
- High isolation resistance
- 2500 volts isolation voltage
- I/O compatible with integrated circuits

†Parameters are JEDEC registered values.

absolute maximum ratings: (25°C) (unless otherwise specified)

†Storage Temperature -55 to 150°C. Operating Temperature -55 to 100°C. Lead Soldering Time (at 260°C) 10 seconds.

INFRARED EMITTING DIODE			PHOTO-TRANSISTOR		
† Power Dissipation	*150	milliwatts	†Power Dissipation	**150	milliwatts
†Forward Current (Continuous)	80	milliamps	†V_{CEO}	30	volts
†Forward Current (Peak) (Pulse width 300 μsec 2% duty cycle)	3	ampere	†V_{CBO}	70	volts
			†V_{ECO}	7	volts
†Reverse Voltage	3	volts	Collector Current (Continuous)	100	milliamps
*Derate 2.0mW/°C above 25°C ambient.			**Derate 2.0mW/°C above 25°C ambient.		

†Total device dissipation @ 24-25°C. P_D 250mW. †Derate 3.3 mW/°C above 25°C ambient.

individual electrical characteristics (25°C)

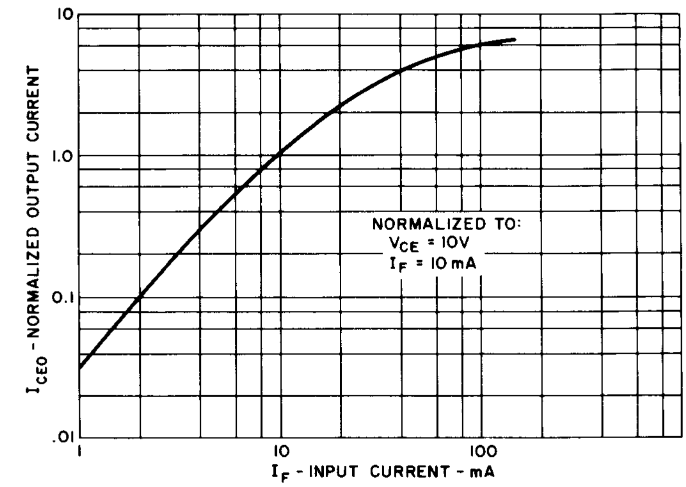
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
†Forward Voltage (I_F = 10 mA)	1.1	1.5	volts
†Reverse Current (V_R = 3V)	–	100	microamps
Capacitance V = O, f = 1 MHz	50	–	picofarads

PHOTO-TRANSISTOR	MIN.	TYP.	MAX.	UNITS
†Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 1mA, I_F = O)	30	–	–	volts
†Breakdown Voltage – $V_{(BR)CBO}$ (I_C = 100μA, I_F = O)	70	–	–	volts
†Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100μA, I_F = O)	7	–	–	volts
†Collector Dark Current I_{CEO} 4N25-27 (V_{CE} = 10V, I_F = O)	–	5	50	nanoamps
4N28	–	–	100	nanoamps
†Collector Dark Current – I_{CBO} (V_{CB} = 10V, I_F = O)	–	2	20	nanoamps

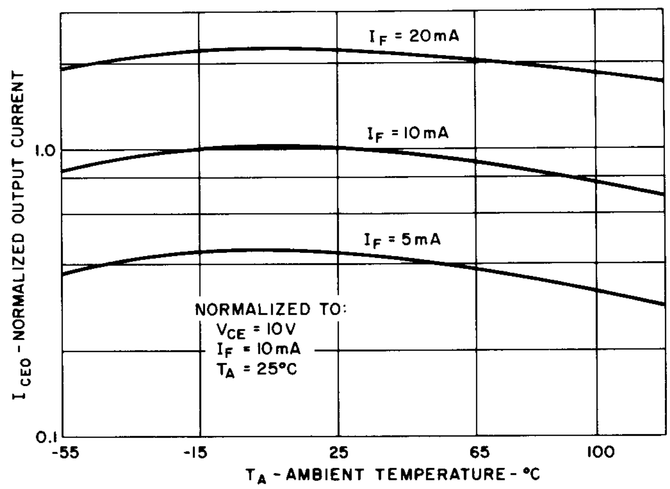
coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
†DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V)	4N25, 4N25A, 4N26	20	–	–	%
	4N27, 4N28	10	–	–	%
†Saturation Voltage – Collector – Emitter (I_F = 50mA, I_C = 2 mA)		–	0.1	0.5	volts
Resistance – IRED to Photo-Transistor (@ 500 volts)		–	100	–	gigaohms
Capacitance – IRED to Photo-Transistor (@ 0 volts, f = 1 MHz)		–	1	–	picofarad
†Isolation Voltage – voltage @ 60 Hz with the input terminals (diode) shorted together and the output terminals (transistor) shorted together.	4N25	2500	–	–	volts (peak)
	4N26, 4N27	1500	–	–	volts (peak)
	4N28	500	–	–	volts (peak)
	4N25A	1775	–	–	volts (RMS) (1 sec.)
Rise/Fall Time (V_{CE} = 10V, I_{CE} = 2mA, R_L = 100Ω)		–	2	–	microseconds
Rise/Fall Time (V_{CB} = 10V, I_{CB} = 50μA, R_L = 100Ω)		–	300	–	nanoseconds

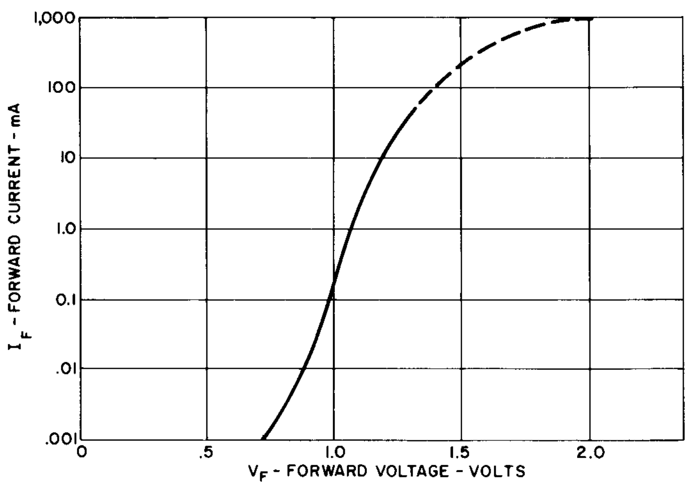
TYPICAL CHARACTERISTICS



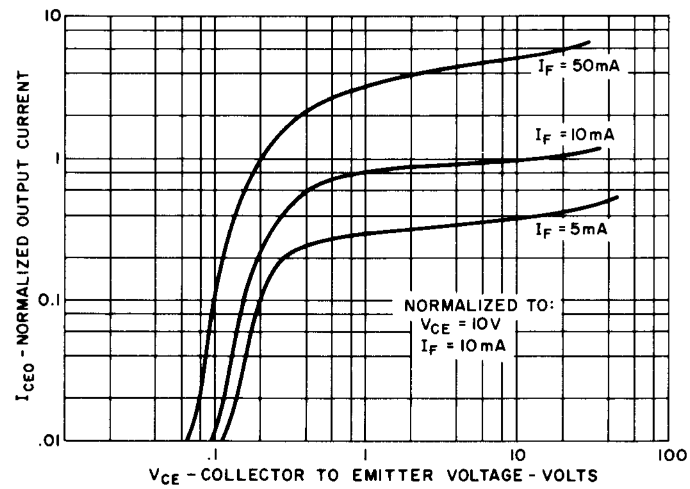
OUTPUT CURRENT VS INPUT CURRENT



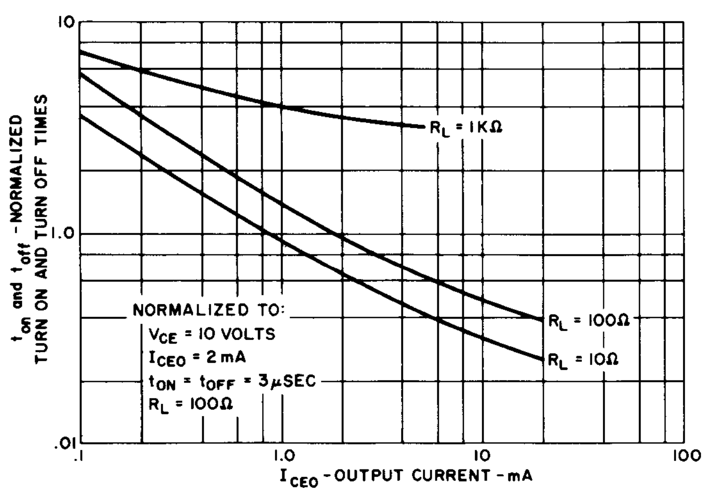
OUTPUT CURRENT VS TEMPERATURE



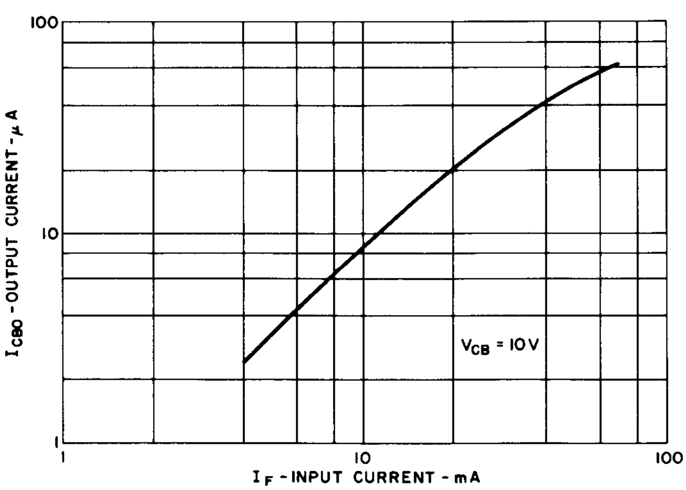
INPUT CHARACTERISTICS



OUTPUT CHARACTERISTICS



SWITCHING TIMES VS OUTPUT CURRENT



OUTPUT CURRENT (I_{CBO}) VS INPUT CURRENT

Photon Coupled Isolator 4N29-4N29A-4N30-4N31 4N32-4N32A-4N33

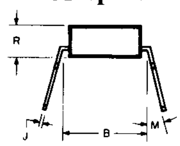
Ga As Infrared Emitting Diode & NPN Silicon Photo-Darlington Amplifier

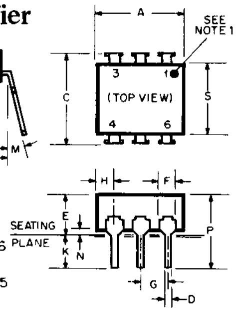
The General Electric 4N29 thru 4N33 consist of a gallium arsenide infrared emitting diode coupled with a silicon photo-darlington amplifier in a dual in-line package.

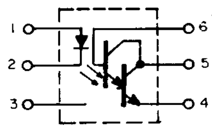
FEATURES:

- High DC current transfer ratio
- High isolation resistance
- 2500 volts isolation voltage
- I/O compatible with integrated circuits

†Parameters are JEDEC registered values.







SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF	7.62	REF	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C) (unless otherwise specified)

†Storage Temperature -55 to 150°C. Operating Temperature -55 to 100°C. Lead Soldering Time (at 260°C) 10 seconds.

INFRARED EMITTING DIODE			PHOTO-DARLINGTON		
†Power Dissipation	*150	milliwatts	†Power Dissipation	**150	milliwatts
†Forward Current (Continuous)	80	milliamps	†V_{CEO}	30	volts
†Forward Current (Peak) (Pulse width 300μsec, 2% duty cycle)	3	ampere	†V_{CBO}	30	volts
			†V_{ECO}	5	volts
†Reverse Voltage	3	volts	Collector Current (Continuous)	100	milliamps
*Derate 2.0mW/°C above 25°C ambient.			**Derate 2.0mW/°C above 25°C ambient.		

†Total device dissipation @ T_A = 25°C. P_D 250 mW. †Derate 3.3 mW/°C above 25°C ambient.

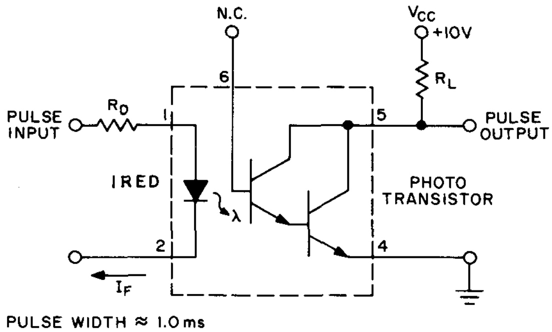
individual electrical characteristics (25°C)

INFRARED EMITTING DIODE	TYP.	MAX.	UNITS	PHOTO-DARLINGTON	MIN.	TYP.	MAX.	UNITS
†Forward Voltage (I_F = 10mA)	1.2	1.5	volts	†Breakdown Voltage – $V_{(BR)CBO}$ (I_C = 100μA, I_F = O)	30	–	–	volts
				†Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 1mA, I_F = O)	30	–	–	volts
†Reverse Current (V_R = 3V)	–	100	microamps	†Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100μA, I_F = O)	5	–	–	volts
Capacitance V = O,f = 1 MHz	50	–	picofarads	†Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = O)	–	–	100	nanoamps

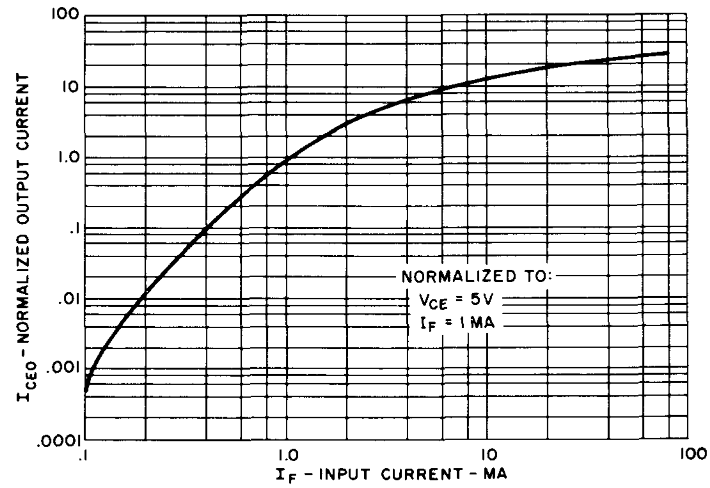
coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
†Collector Output Current (I_F = 10mA, V_{CE} = 10V)	4N32, 4N32A, 4N33	50	–	–	mA
	4N29, 4N29A, 4N30	10	–	–	mA
	4N31	5	–	–	mA
†Saturation Voltage – Collector – Emitter	4N29,29A,30,32,32A,33	–	–	1.0	volts
(I_F = 8mA, I_C = 2mA)	4N31	–	–	1.2	volts
Resistance – IRED to Photo-Transistor (@ 500 volts)		–	100	–	gigaohms
Capacitance – IRED to Photo-Transistor (@ 0 volts, f = 1 MHz)		–	1	–	picofarad
†Isolation Voltage 60 Hz with the input terminals (diode)	4N29,29A,32,32A	2500	–	–	volts (peak)
shorted together and the output terminals (transistor)	4N30, 4N31, 4N33	1500	–	–	volts (peak)
shorted together	4N29A, 4N32A	1775	–	–	volts (RMS) (1 sec.)
†Switching Speeds: I_C = 50mA, I_F = 200mA) Figure 1					
Turn-On Time – t_{on}		–	–	5	microseconds
Turn-Off Time – t_{off}	4N29, 4N29A, 4N30, 4N31	–	–	40	microseconds
Turn-Off Time – t_{off}	4N32, 4N32A, 4N33	–	–	100	microseconds

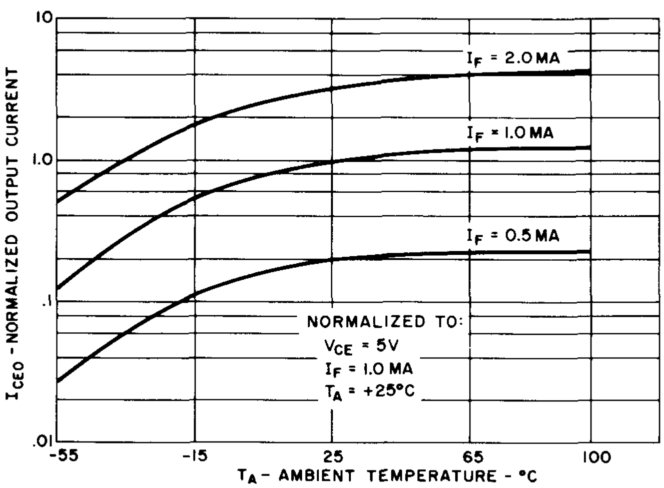
TYPICAL CHARACTERISTICS



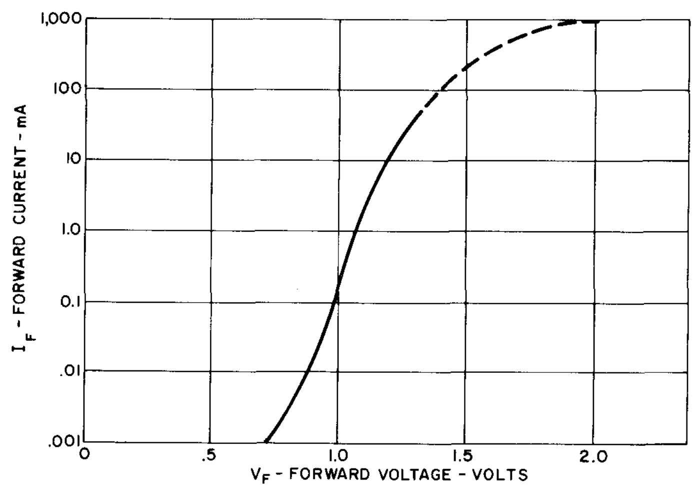
SWITCHING TIME TEST CIRCUIT



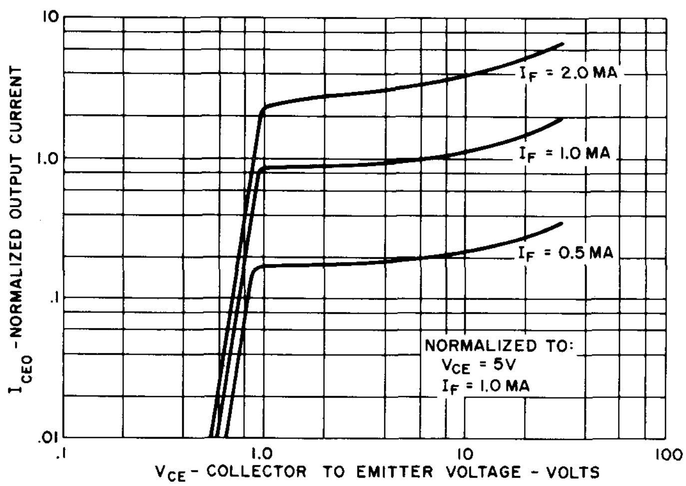
OUTPUT CURRENT VS INPUT CURRENT



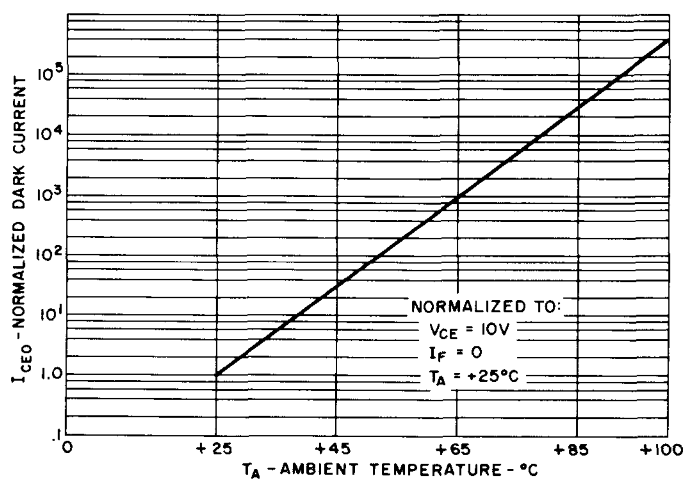
OUTPUT CURRENT VS TEMPERATURE



INPUT CHARACTERISTICS



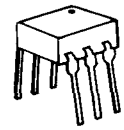
OUTPUT CHARACTERISTICS



NORMALIZED DARK CURRENT VS TEMPERATURE

Photon Coupled Isolator 4N35-4N36-4N37

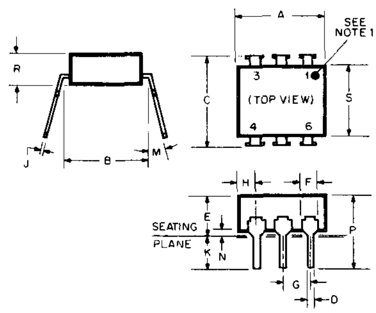
Ga As Infrared Emitting Diode & NPN Silicon Photo-Transistor



The General Electric 4N35-4N36-4N37 are gallium arsenide infrared emitting diodes coupled with a silicon photo-transistor in a dual in-line package.

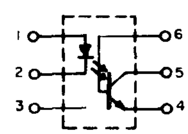
FEATURES:

- Fast switching speeds
- High DC current transfer ratio
- High isolation resistance
- High isolation voltage
- I/O compatible with integrated circuits
- Covered under U.L. component recognition program, reference file E51868



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF	7.62	REF	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.



absolute maximum ratings: (25°C) (unless otherwise specified)

INFRARED EMITTING DIODE

- * Power Dissipation T_A = 25°C ☆100 milliwatts
- * Power Dissipation T_C = 25°C ☆100 milliwatts
  (T_C indicates collector lead temperature 1/32″ from case)
- * Forward Current (Continuous) 60 milliamps
- * Forward Current (Peak) 3 ampere
  (Pulse width 1 usec, 300 pps)
- * Reverse Voltage 6 volts

☆Derate 1.33mW/°C above 25°C

PHOTO-TRANSISTOR

- * Power Dissipation T_A = 25°C ☆☆300 milliwatts
- * Power Dissipation T_C = 25°C ☆☆☆500 milliwatts
  (T_C indicates collector lead temperature 1/32″ from case)
- * V_{CEO} 30 volts
- * V_{CBO} 70 volts
- * V_{ECO} 7 volts
- * Collector Current (Continuous) 100 milliamps

☆☆Derate 4.0mW/°C above 25°C
☆☆☆Derate 6.7mW/°C above 25°C

TOTAL DEVICE

- * Storage Temperature -55 to 150°C
- * Operating Temperature -55 to 100°C.
- * Lead Soldering Time (at 260°C) 10 seconds.
- * Relative Humidity 85%@85°C
- * Input to Output Isolation Voltage

4N35	2500 $V_{(RMS)}$	3550 $V_{(peak)}$
4N36	1750 $V_{(RMS)}$	2500 $V_{(peak)}$
4N37	1050 $V_{(RMS)}$	1500 $V_{(peak)}$

* Indicates JEDEC registered values

individual electrical characteristics (25 °C) (unless otherwise specified)

INFRARED EMITTING DIODE	SYMBOL	MIN.	MAX.	UNITS
* Forward Voltage (I_F = 10 mA)	V_F	.8	1.5	volts
* Forward Voltage (I_F = 10 mA) T_A = -55°C	V_F	.9	1.7	volts
* Forward Voltage (I_F = 10 mA) T_A = +100°C	V_F	.7	1.4	volts
* Reverse Current (V_R = 6V)	I_R	–	10	microamps
Capacitance (V=O, f=1 MHz)	C_J		100	picofarads

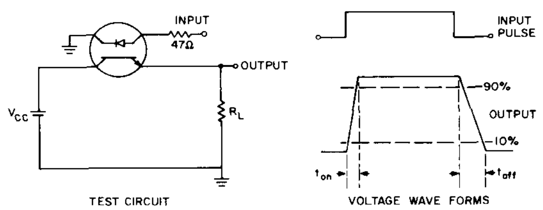
PHOTO-TRANSISTOR	SYMBOL	MIN.	TYP.	MAX.	UNITS
* Breakdown Voltage (I_C = 10 mA, I_F = O)	$V_{(BR)\ CEO}$	30	–	–	volts
* Breakdown Voltage (I_C = 100uA, I_F = O)	$V_{(BR)\ CBO}$	70	–	–	volts
* Breakdown Voltage (I_F = 100uA, I_F = O)	$V_{(BR)\ ECO}$	7	–	–	volts
Collector Dark Current (V_{CE} = 10V, I_F = O)	I_{CEO}	–	5	50	nanoamps
* Collector Dark Current (V_{CE} = 30V, I_F = O) T_A = 100°C	I_{CEO}	–		500	microamps
Capacitance (V_{CE} = 10V, f = 1MHz)	C_{CE}	–	2	–	picofarads

coupled electrical characteristics (25 °C) (unless otherwise specified)

	MIN.	TYP.	MAX.	UNITS
* DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V)	100	–	–	%
* DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V) T_A = -55°C	40	–	–	%
* DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V) T_A = +100°C	40	–	–	%
* Saturation Voltage–Collector To Emitter (I_F = 10mA, I_C = 0.5mA)	–	–	0.3	volts
* Input to Output Isolation Current (Pulse Width = 8 msec)				
(See Note 1) Input to Output Voltage = 3550 $V_{(peak)}$ 4N35	–	–	100	microamps
Input to Output Voltage = 2500 $V_{(peak)}$ 4N36	–	–	100	microamps
Input to Output Voltage = 1500 $V_{(peak)}$ 4N37	–	–	100	microamps
* Input to Output Resistance (Input to Output Voltage = 500V - See Note 1)	100	–	–	gigaohms
* Input to Output Capacitance (Input to Output Voltage = 0, f = 1MHz - See Note 1)	–	–	2.5	picofarads
* Turn on Time -- t_{on} (V_{CC} = 10V, I_C = 2MA, R_L = 100Ω) (See Figure 1)	–	5	10	microseconds
* Turn off Time – t_{off} (V_{CC} = 10V, I_C = 2MA, R_L = 100Ω) (See Figure 1)	–	5	10	microseconds

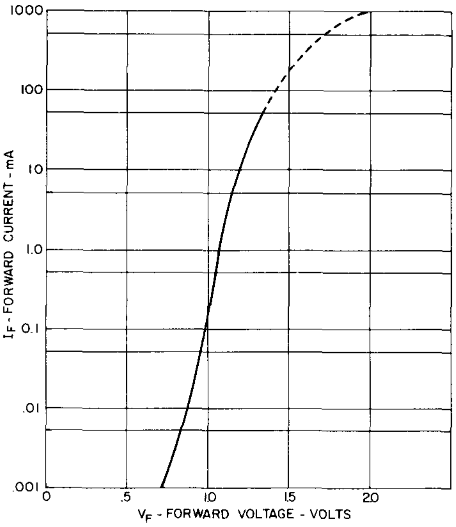
Note 1: Tests of input to output isolation current resistance, and capacitance are performed with the input terminals (diode) shorted together and the output terminals (transistor) shorted together

* Indicates JEDEC registered values.

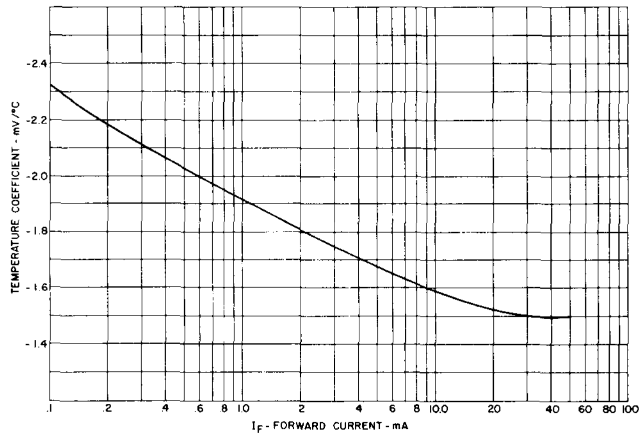


Adjust Amplitude of Input Pulse for Output (I_C) of 2 mA

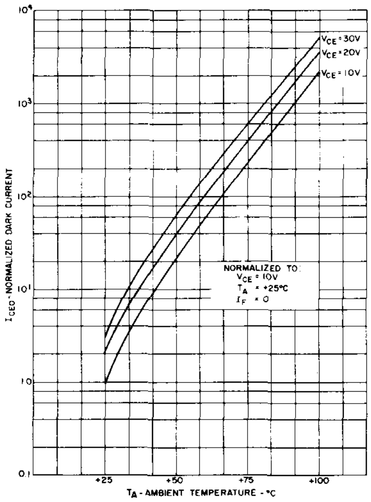
FIGURE 1



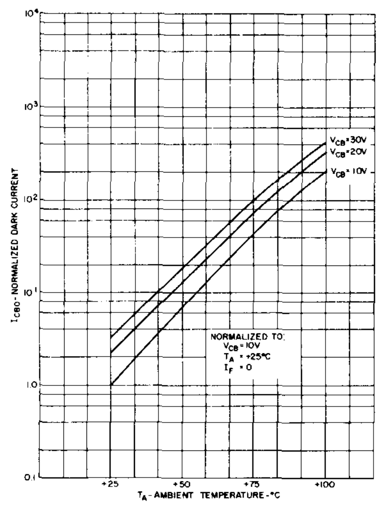
1. INPUT CHARACTERISTICS



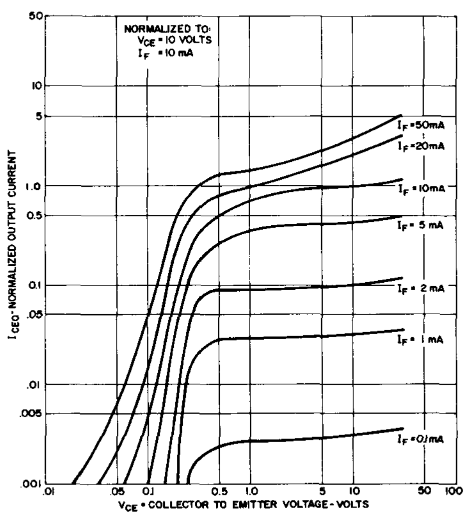
2. FORWARD CURRENT TEMPERATURE COEFFICIENT



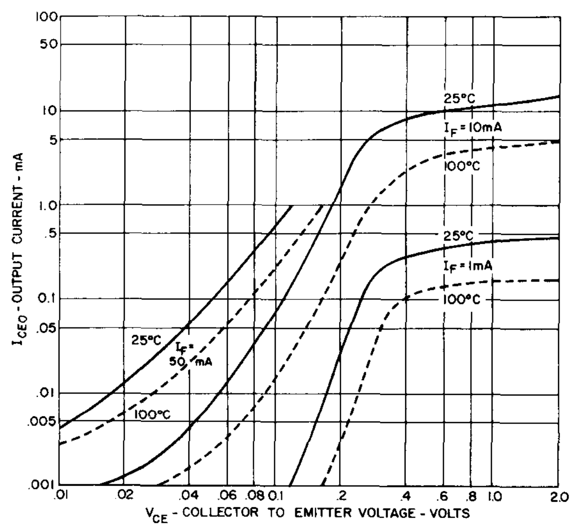
3. DARK I_{CEO} CURRENT VS TEMPERATURE



4. I_{CBO} VS TEMPERATURE

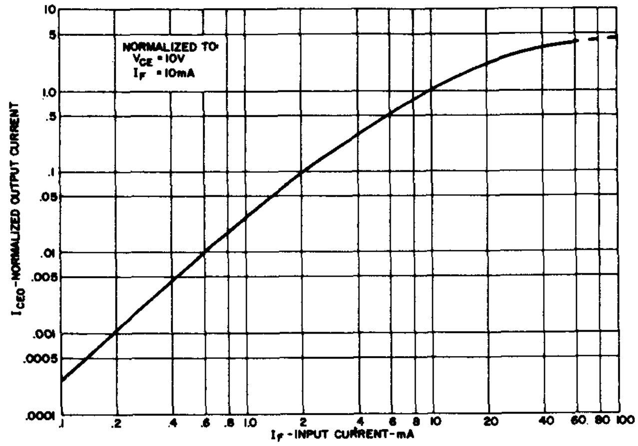


5. OUTPUT CHARACTERISTICS

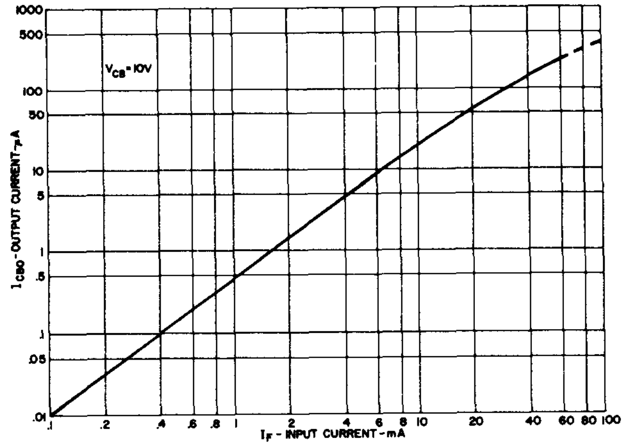


6. OUTPUT CHARACTERISTICS

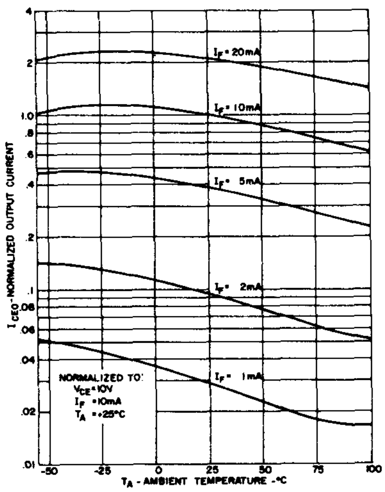
TYPICAL CHARACTERISTICS



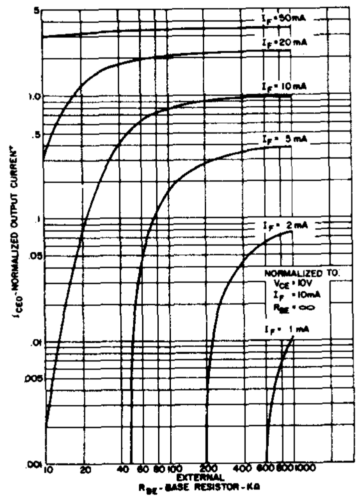
7. OUTPUT CURRENT VS INPUT CURRENT



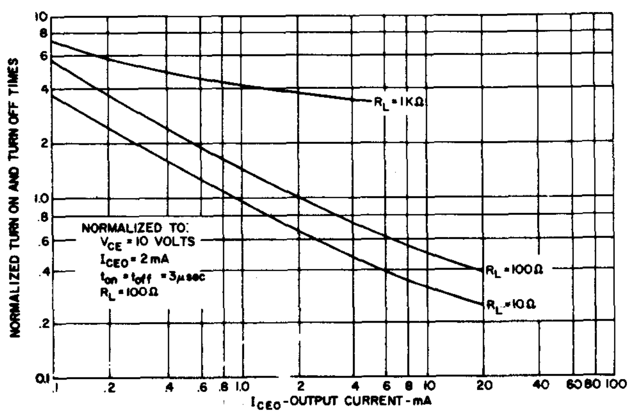
8. OUTPUT CURRENT – COLLECTOR TO BASE VS INPUT CURRENT



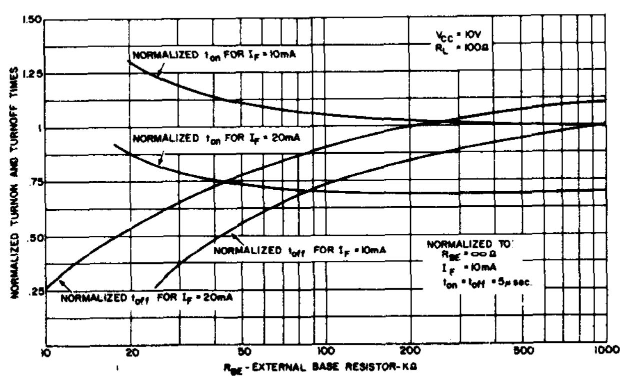
9. OUTPUT CURRENT VS TEMPERATURE



10. OUTPUT CURRENT VS BASE EMITTER RESISTANCE



11. SWITCHING TIMES VS OUTPUT CURRENT



12. SWITCHING TIME VS R_{BE}

Photon Coupled Isolator 4N38-4N38A

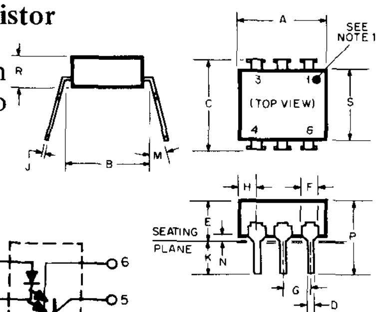
Ga As Infrared Emitting Diode & NPN Silicon Photo-Transistor

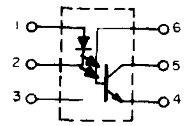
The General Electric 4N38 and 4N38A consist of a gallium arsenide infrared emitting diode coupled with a silicon photo transistor in a dual in-line package.

FEATURES:

- Fast switching speeds
- High DC current transfer ratio
- High isolation resistance
- 2500 volts isolation voltage
- I/O compatible with integrated circuits

†Indicates JEDEC registered values





SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF.	7.62	REF.	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C) (unless otherwise specified)

†Storage Temperature -55 to 150°C. Operating Temperature -55 to 100°C. Lead Soldering Time (at 260°C) 10 seconds.

INFRARED EMITTING DIODE		
†Power Dissipation	*150	milliwatts
†Forward Current (Continuous)	80	milliamps
†Forward Current (Peak) (Pulse width 300μsec, 2% duty cycle)	3	ampere
†Reverse Voltage	3	volts

*Derate 2.0 mW/°C above 25°C ambient.

PHOTO-TRANSISTOR		
†Power Dissipation	**150	milliwatts
†V_{CEO}	80	volts
†V_{CBO}	80	volts
†V_{ECO}	7	volts
Collector Current (Continuous)	100	milliamps

**Derate 2.0 mW/°C above 25°C ambient.

†Total device dissipation @ T_A = 25°C. P_D 250 mW. †Derate 3.3 mW/°C above 25°C ambient.

individual electrical characteristics (25°C)

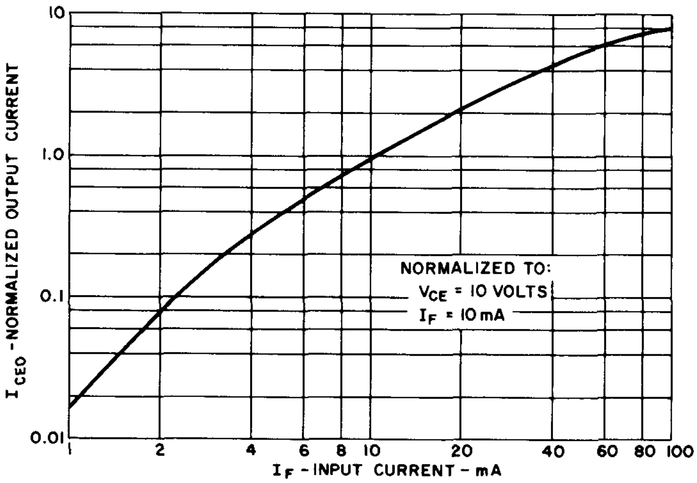
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
†Forward Voltage (I_F = 10mA)	1.2	1.5	volts
†Reverse Current (V_R = 3V)	–	100	microamps
Capacitance V = 0, f = 1 MHz	50	–	picofarads

PHOTO-TRANSISTOR	MIN.	TYP.	MAX.	UNITS
†Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 1mA, I_F = 0)	80	–	–	volts
†Breakdown Voltage – $V_{(BR)CBO}$ (I_C = 1μA, I_F = 0)	80	–	–	volts
†Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100μA, I_F = 0)	7	–	–	volts
†Collector Dark Current – I_{CEO} (V_{CE} = 60V, I_F = 0)	–	–	50	nanoamps
†Collector Dark Current – I_{CBO} (V_{CE} = 60V, I_F = 0)	–	–	20	nanoamps

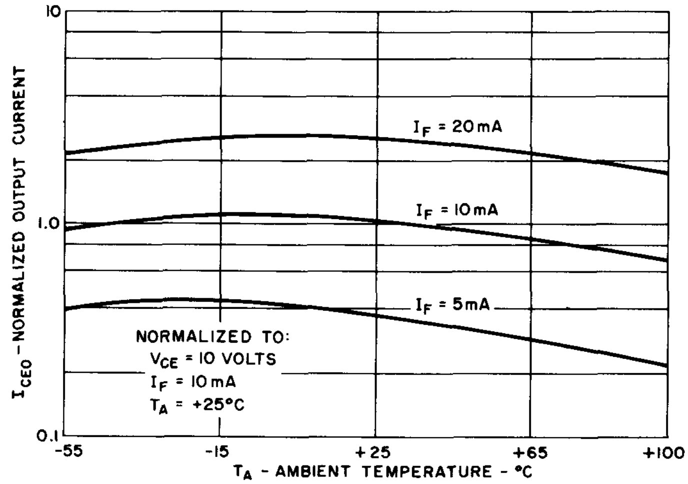
coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
†Isolation Voltage 60Hz with the input terminals (diode)	4N38	1500	–	–	volts (peak)
shorted together and the output terminals (transistor)	4N38A	2500	–	–	volts (peak)
shorted together.	4N38A	1775	–	–	volts (RMS) (1 sec.)
†Saturation Voltage – Collector – Emitter (I_F = 20mA, I_C = 4mA)		–	–	1.0	volts
Resistance – IRED to Photo-Transistor (@ 500 volts)		–	100	–	gigaohms
Capacitance – IRED to Photo-Transistor (@ 0 volts, f = 1 MHz)		–	1	–	picofarad
DC Current Transfer Ration (I_F = 10mA, V_{CE} = 10V)		10		–	%
Switching Speeds (V_{CE} = 10V, I_C, = 2mA, R_L = 100Ω)					
Turn-On Time – t_{on}		–	5	–	microseconds
Turn-Off Time – t_{off}		–	5	–	microseconds

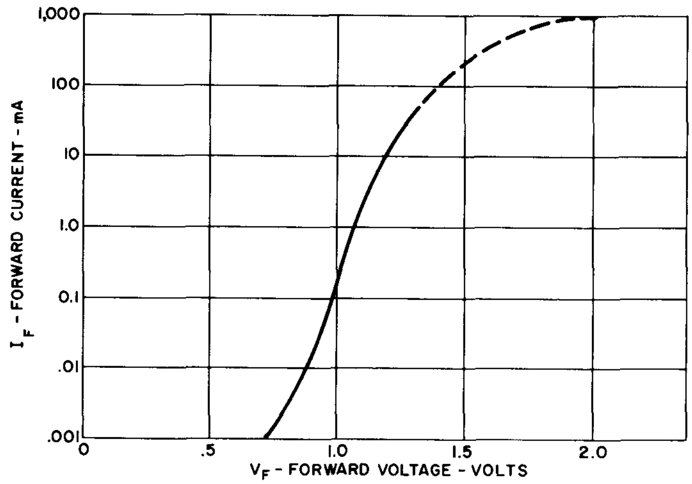
TYPICAL CHARACTERISTICS



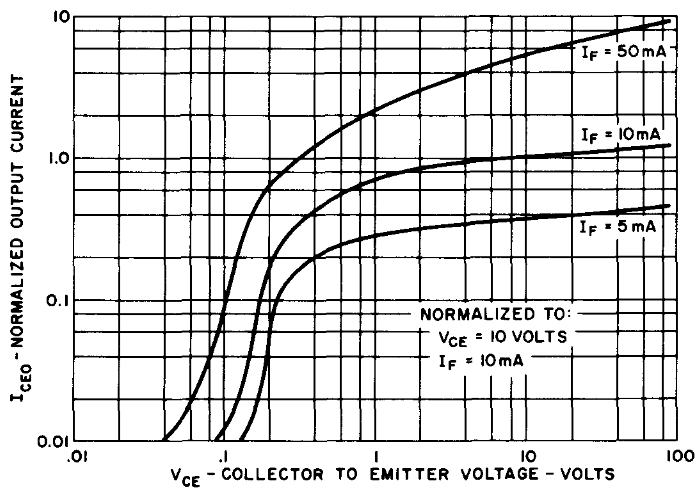
1. OUTPUT CURRENT VS INPUT CURRENT



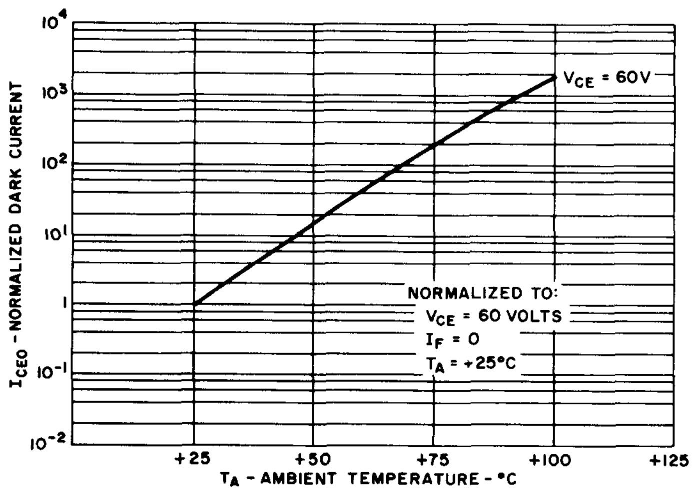
2. OUTPUT CURRENT VS TEMPERATURE



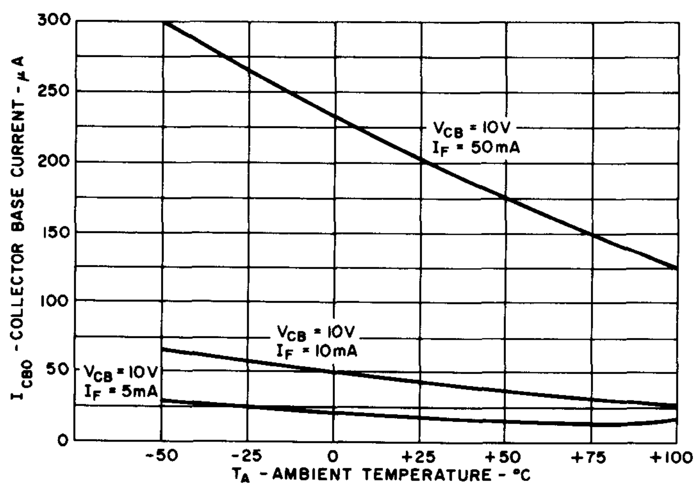
3. INPUT CHARACTERISTICS



4. OUTPUT CHARACTERISTICS



5. NORMALIZED DARK CURRENT VS TEMPERATURE

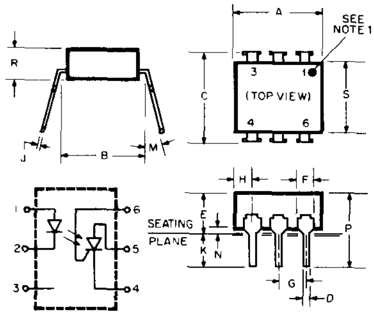


6. COLLECTOR BASE CURRENT VS TEMPERATURE

Photon Coupled Isolator 4N39-4N40

Ga As Infrared Emitting Diode & Light Activated SCR

The General Electric 4N39 and 4N40 consist of a gallium arsenide, infrared emitting diode coupled with a light activated silicon controlled rectifier in a dual in-line package.



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF.	7.62	REF.	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings

INFRARED EMITTING DIODE		
†Power Dissipation (-55°C to 50°C)	*100	milliwatts
†Forward Current (Continuous) (-55°C to 50°C)	60	milliamps
†Forward Current (Peak) (-55°C to 50°C) (100 μsec 1% duty cycle)	1	ampere
†Reverse Voltage (-55°C to 50°C)	6	volts

*Derate 2.0mW/°C above 50°C.

PHOTO-SCR			
†Off-State and Reverse Voltage (-55°C to +100°C)	4N39	200	volts
	4N40	400	volts
†Peak Reverse Gate Voltage (-55°C to 50°C)		6	volts
†Direct On-State Current (-55°C to 50°C)		300	milliamps
†Surge (non-rep) On-State Current (-55°C to 50°C)		10	amps
†Peak Gate Current (-55°C to 50°C)		10	milliamps
†Output Power Dissipation (-55°C to 50°C)		**400	milliwatts

**Derate 8mW/°C above 50°C.

TOTAL DEVICE

†Storage Temperature Range -55°C to 150°C
†Operating Temperature Range -55°C to 100°C
†Normal Temperature Range (No Derating) -55°C to 50°C
†Soldering Temperature (1/16" from case, 10 seconds) 260°C
†Total Device Dissipation (-55°C to 50°C), 450 milliwatts
†Linear Derating Factor (above 50°C), 9.0mW/°C
†Surge Isolation Voltage (Input to Output). See: Pg. 23
$1500V_{(peak)}$ $1060V_{(RMS)}$
†Steady-State Isolation Voltage (Input to Output). See: Pg. 23
$950V_{(peak)}$ $660V_{(RMS)}$

individual electrical characteristics (25°C) (unless otherwise specified)

INFRARED EMITTING DIODE		TYP.	MAX.	UNITS
†Forward Voltage (I_F = 10mA)	V_F	1.1	1.5	volts
†Reverse Current (V_R = 3V)	I_R	–	10	microamps
Capacitance (V = 0, f = 1MHz)		50	–	picofarads

PHOTO-SCR		MIN.	MAX.	UNITS
†Peak Off-State Voltage – V_{DM} (R_{GK} = 10KΩ, T_A = 100°C)	4N39	200	–	volts
	4N40	400	–	volts
†Peak Reverse Voltage – V_{RM} (T_A = 100°C)	4N39	200	–	volts
	4N40	400	–	volts
†On-State Voltage – V_T (I_T = 300mA)		–	1.3	volts
†Off-State Current – I_D (V_D=200V, T_A=100°C, I_F=0, R_{GK}=10K)	4N39	–	50	microamps
†Off-State Current – I_D (V_D=400V, T_A=100°C, I_F=0, R_{GK}=10K)	4N40	–	150	microamps
†Reverse Current – I_R (V_R = 200V, T_A = 100°C, I_F = 0)	4N39	–	50	microamps
†Reverse Current – I_R (V_R = 400V, T_A = 100°C, I_F = 0)	4N40	–	150	microamps
†Holding Current – I_H (V_{FX} = 50V, R_{GK} = 27KΩ)		–	200	microamps

coupled electrical characteristics (25°C)

			MIN.	MAX.	UNITS
†Input Current to Trigger	V_{AK} = 50V, R_{GK} = 10KΩ	I_{FT}	–	30	milliamps
	V_{AK} = 100V, R_{GK} = 27KΩ	I_{FT}	–	14	milliamps
†Isolation Resistance (Input to Output)	V_{io} = $500V_{DC}$	r_{io}	100	–	gigaohms
†Turn-On Time – V_{AK} = 50V, I_F = 30mA, R_{GK} = 10KΩ, R_L = 200Ω		t_{on}	–	50	microseconds
Coupled dv/dt, Input to Output (See Figure 13)			500	–	volts/microsec.
Input to Output Capacitance (Input to Output Voltage = 0, f = 1MHz)			–	2	picofarads

†Indicates JEDEC Registered Values.

TYPICAL CHARACTERISTICS

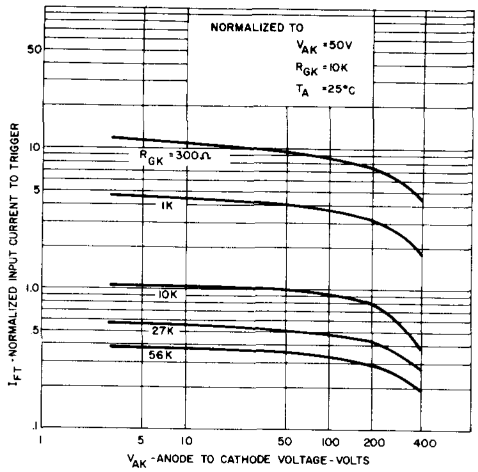


FIGURE 1. INPUT CURRENT TO TRIGGER VS. ANODE-CATHODE VOLTAGE

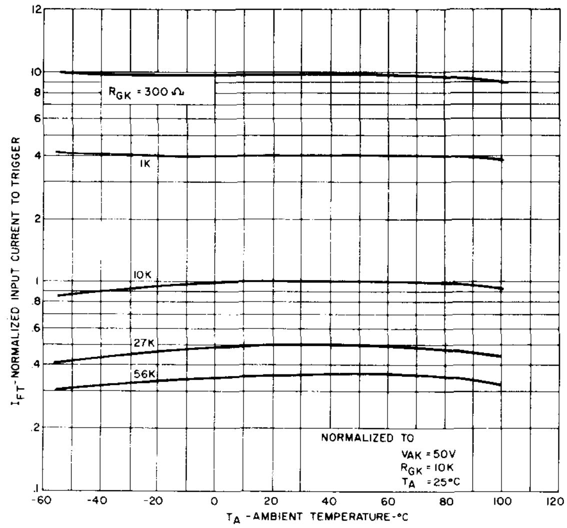


FIGURE 2. INPUT CURRENT TO TRIGGER VS. TEMPERATURE

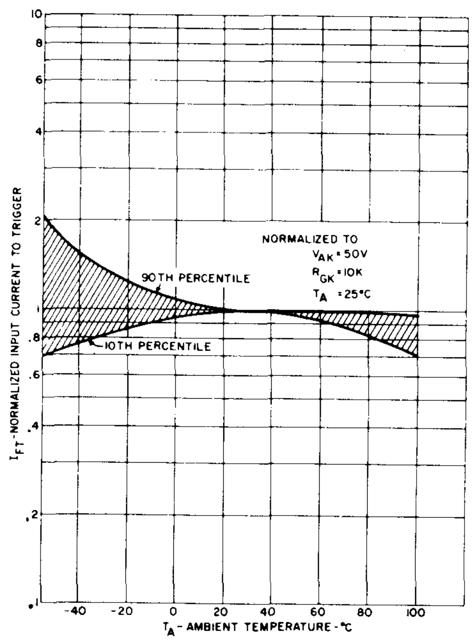


FIGURE 3. INPUT CURRENT TO TRIGGER DISTRIBUTION VS. TEMPERATURE

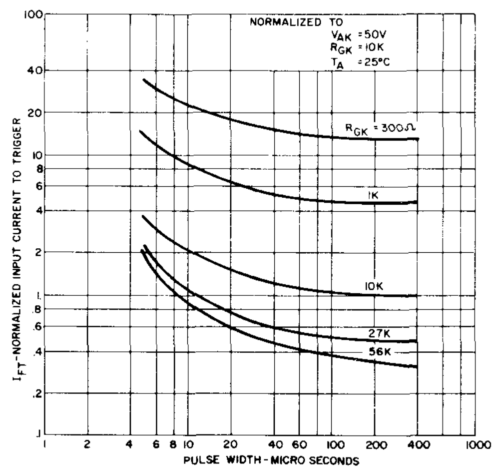


FIGURE 4. INPUT CURRENT TO TRIGGER VS. PULSE WIDTH

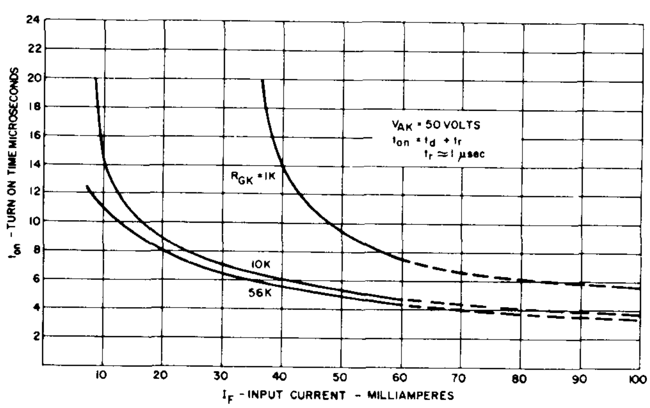


FIGURE 5. TURN-ON TIME VS. INPUT CURRENT

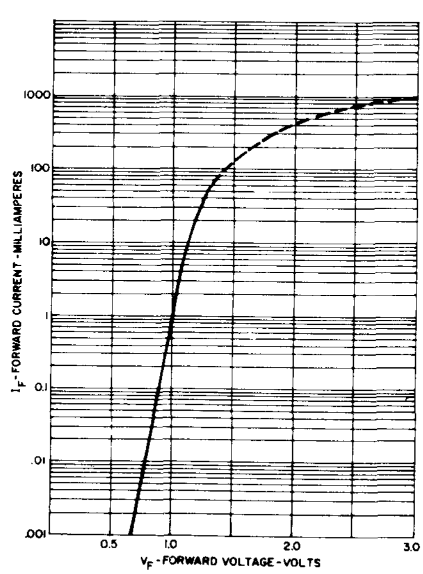


FIGURE 6. INPUT CHARACTERISTICS I_F VS. V_F

TYPICAL CHARACTERISTICS OF OUTPUT (SCR)

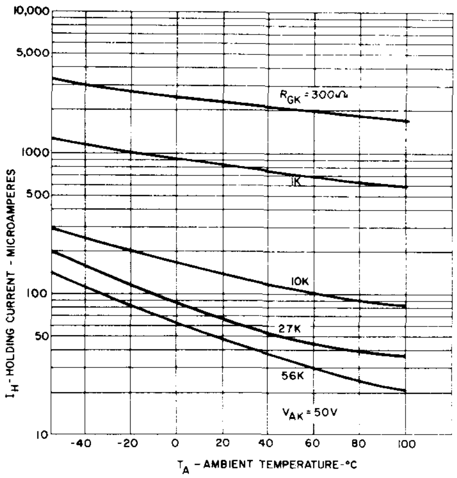


FIGURE 7. HOLDING CURRENT VS. TEMPERATURE

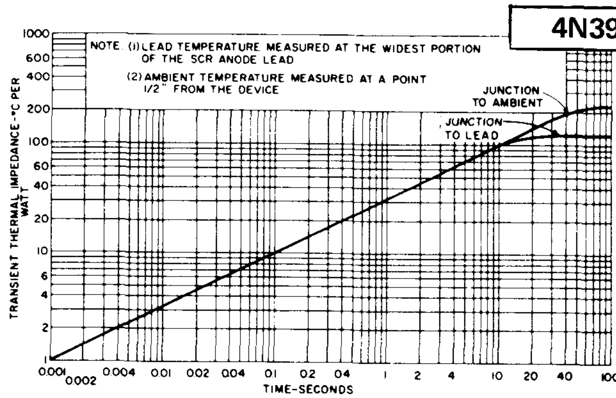


FIGURE 8. MAXIMUM TRANSIENT THERMAL IMPEDANCE

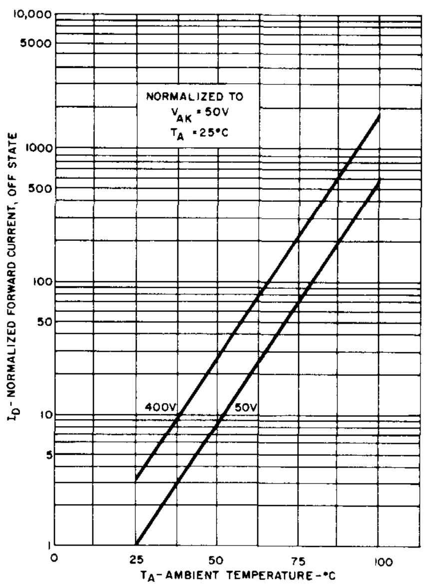


FIGURE 9. OFF-STATE FORWARD CURRENT VS. TEMPERATURE

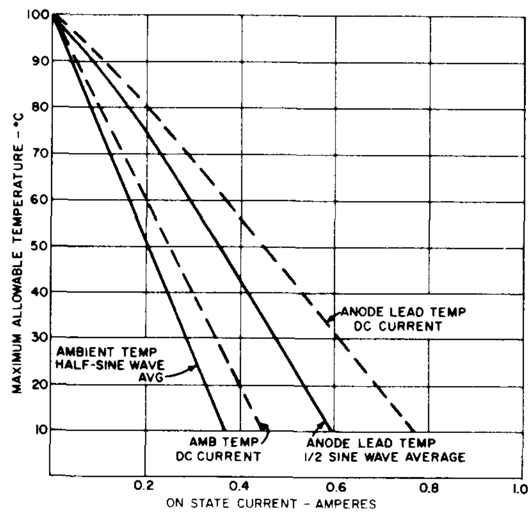


FIGURE 10. ON-STATE CURRENT VS. MAXIMUM ALLOWABLE TEMPERATURE

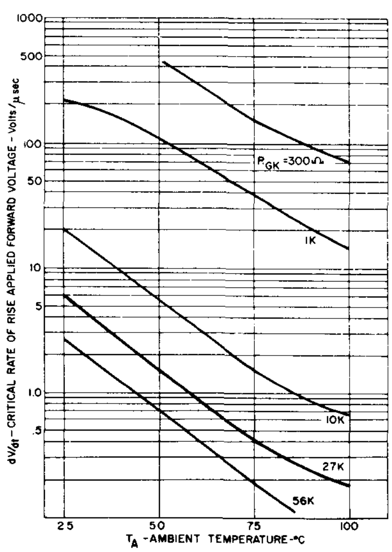


FIGURE 11. dv/dt VS. TEMPERATURE

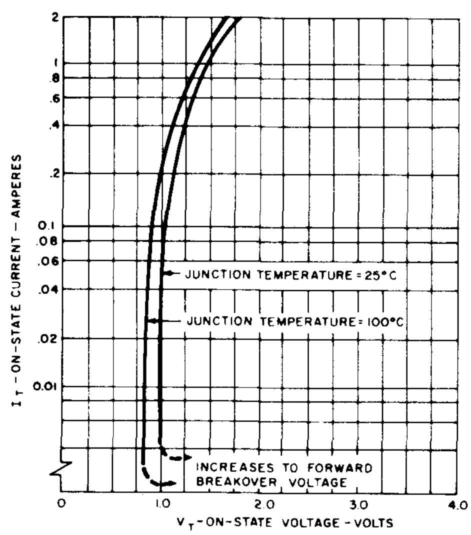
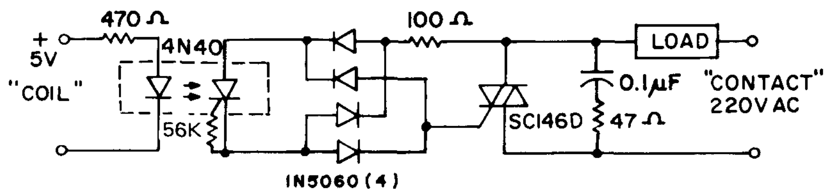


FIGURE 12. ON-STATE CHARACTERISTICS

TYPICAL CHARACTERISTICS

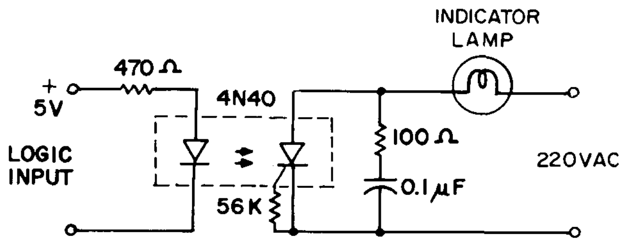
10A, T^2L COMPATIBLE, SOLID STATE RELAY

Use of the 4N40 for high sensitivity, 2500V isolation capability, provides this highly reliable solid state relay design. This design is compatible with 74, 74S and 74H series T^2L logic systems inputs and 220V AC loads up to 10A.



25W LOGIC INDICATOR LAMP DRIVER

The high surge capability and non-reactive input characteristics of the 4N40 allow it to directly couple, without buffers, T^2L and DTL logic to indicator and alarm devices, without danger of introducing noise and logic glitches.



400V SYMMETRICAL TRANSISTOR COUPLER

Use of the high voltage PNP portion of the 4N40 provides a 400V transistor capable of conducting positive and negative signals with current transfer ratios of over 1%. This function is useful in remote instrumentation, high voltage power supplies and test equipment. Care should be taken not to exceed the 400 mW power dissipation rating when used at high voltages.

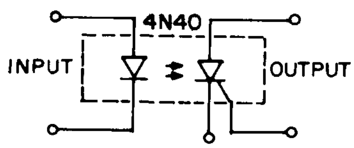
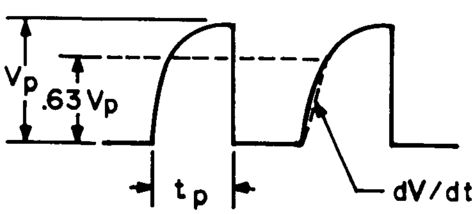
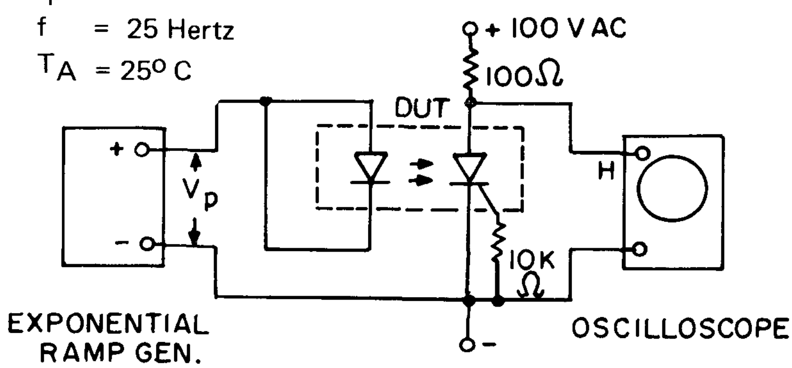


FIGURE 13
COUPLED dv/dt – TEST CIRCUIT

V_p = 800 Volts
t_p =.010 Seconds
f = 25 Hertz
T_A = 25° C



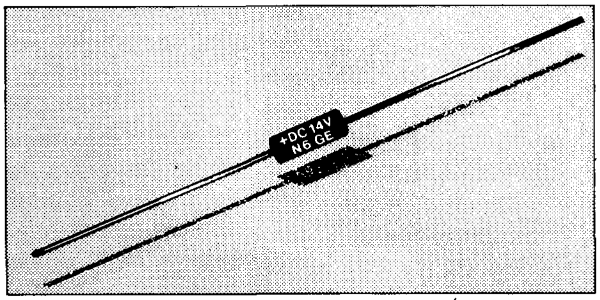


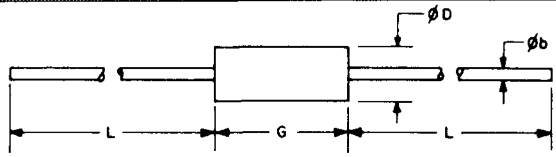
GE-MOV®

Metal Oxide Varistors

ECONOMY SERIES

GE-MOV® Varistors are voltage dependent resistors which perform in a manner similar to back-to-back zener diodes, protecting both AC and DC circuits from voltage transients due to lightning and inductive kickback.





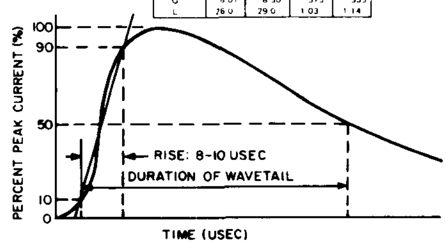
SYMBOL	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN	MAX.
Øb	.79	.83	.031	.033
ØD	3.43	3.68	.135	.145
G	8.01	8.50	.315	.335
L	26.0	29.0	1.03	1.14

MAXIMUM RATINGS

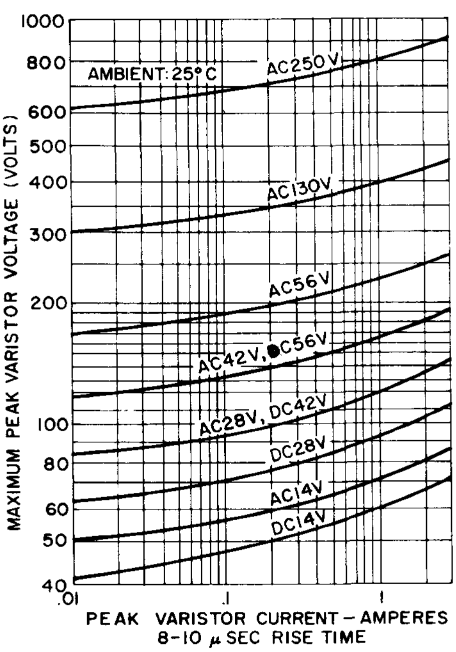
Storage Temperature . . . . -55°C to 125°C
Operating Ambient. . . . . .75°C
Average Power Dissipation*. . . . . 200 mw

CATALOG NUMBER	CONTINUOUS OPERATING VOLTS		PEAK IMPULSE CURRENT I_P (Amps)
	AC	DC	
AC14V	14	–	10
AC28V	28	–	10
AC42V	42	–	10
AC56V	56	–	20
AC130V	130	–	20
AC250V	250	–	20
DC14V	–	14	10
DC28V	–	28	10
DC42V	–	42	10
DC56V	–	56	10

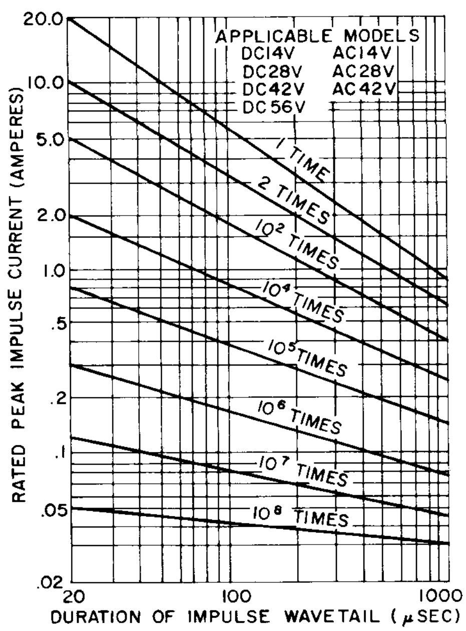
*Derate linearly from full rated value at 75°C to zero at 125°C.



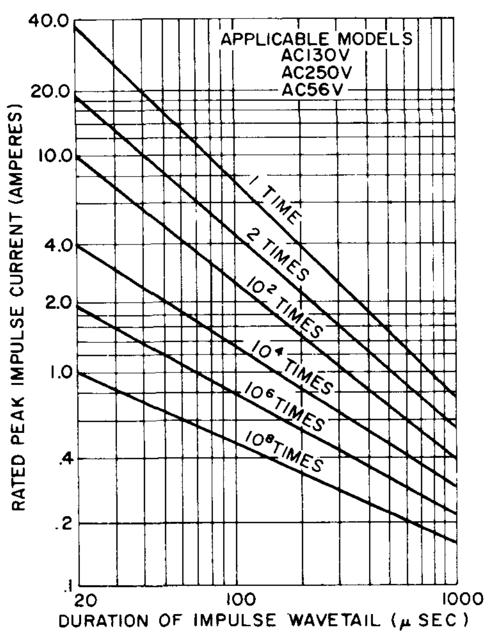
IMPULSE CURRENT WAVEFORM



PEAK CLAMPING VOLTAGE



PULSE LIFETIME



PULSE LIFETIME

LOW COST GE-MOV® VARISTOR APPLICATIONS

CONTACT ARCING AND NOISE SUPPRESSION:

Switch contacts interrupting an inductive load current will arc, causing deterioration of the contacts and creating interference-generating "spikes" on the power line. In circuits where the arc voltage exceeds approximately three times the peak of the steady-state voltage (AC rms volts x 1.4), this low-cost series of varistors can reduce these problems. (This type of arcing is found particularly in circuits having steady-state voltages below 120V AC and inductive load currents less than a few hundred milliamperes. It should be noted that the varistor will prevent only that portion of the arc which normally occurs at voltages greater than that given on the varistor peak clamping voltage curve.)

POWER-LINE TRANSIENTS:

Electrical systems powering electromechanical devices will frequently experience very brief and random high-voltage transients, largely due to the arcing described above. These transients will occasionally reach a voltage level potentially damaging to solid-state equipment or motor insulation.

Applying a low-cost GE-MOV® Varistor to this equipment provides economical protection against damage by these higher-voltage spikes, by reducing them to a level given by the characteristic curves.

VARISTOR SELECTION:

The varistor may be reliably used within its steady-state voltage ratings, its surge current ratings, and the given temperature limits.

1. Select the model having the varistor voltage rating (AC or DC, as applicable) which is closest to, but higher than, the maximum expected steady-state voltage ("high line" condition).
2. Determine the peak impulse current and wavetail duration (to one-half peak). Find the varistor's pulse lifetime rating.
3. Find the maximum clamping voltage of the varistor from the peak transient current and the characteristic curves.[3]

DETERMINING PEAK CURRENT AND PULSE WIDTH FOR COIL NOISE AND ARC SUPPRESSION:

1. Peak transient current = maximum load current (i.e., 100 mA AC RMS has a peak of 141 mA = peak transient current.

2. Applying a small 60 Hz a.c. voltage (v_{ac}), to the coil, measure the a.c. rms current (i_{ac}). With an ohmmeter, measure the DC resistance of the coil (R). The duration of the transient current pulse is then determined from:

$$T < 1.4\sqrt{\left(\frac{v_{ac}}{i_{ac}R}\right)^2 - 1}$$, where T is in *milliseconds.*

(Typically, T is less than one-third of that given by the above inequality.)

NOTES:

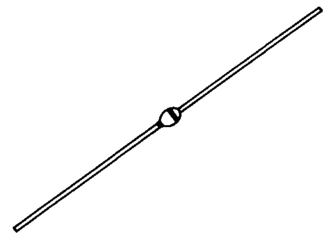
1. The catastrophic failure mode of the varistor is inherently to fail short-circuited. Failure to an open circuit will occur if sufficient follow-on current is available.
2. The criterion for failure is arbitrarily chosen to be a change on varistor voltage at 1 mA DC in excess of ± 10%. Catastrophic failure (to an open or short circuit) may ensue when maximum rating values are exceeded.
3. Upward changes over life of +10% are not included in the maximum volt-ampere characteristic.

A14B–M SEE PAGE 290

Passivated Rectifier

2.5 Amps **50-100 Volts**

A14 SERIES
A14A
A14F
A14U

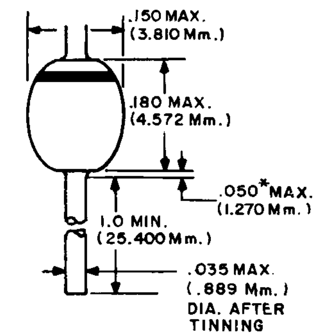


THE GENERAL ELECTRIC A14 IS A 2.5 AMPERE RATED, AXIAL-LEADED GENERAL PURPOSE RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLET'S PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY SEALED PACKAGE.

absolute maximum ratings: (25°C unless otherwise specified)

	A14U	A14F	A14A	
Reverse Voltage (−65° C to + 175° C T_J)				
Repetitive Peak, V_{RRM}	25	50	100	Volts
DC, V_R	25	50	100	Volts
Average Forward Current, I_F				
100° C Ambient	←	1.0	→	Amp
25° C	←	2.5	→	Amp
Peak Surge Forward Current I_{FSM}, Non-repetitive .0083 sec. half sine wave				
Full Load JEDEC Method	30	50	50	Amps
No Load (25° C Case)	45	65	65	Amps
Peak Surge Forward Current, Non-repetitive, .001 sec. Half sine wave				
Full Load	70	90	90 90	Amps
No Load (25° C Case)	80	100	100 100	Amps
Junction Operating and Storage Temperature Range	←	−65 to +175	→	°C
I^2t, RMS for fusing, .001 to .01 sec.	2.0	4.0	4.0	$Amps^2$ sec.

Mounting: Any position. Lead Temperature 290° C maximum to 1/8 inch from body for 5 seconds maximum during mounting.



ALL DIMENSIONS ARE IN INCHES AND (METRIC)

*WELD AND SOLDER FLASH NOT CONTROLLED IN THIS AREA

OUTLINE DRAWING

electrical characteristics: (25°C unless otherwise specified)

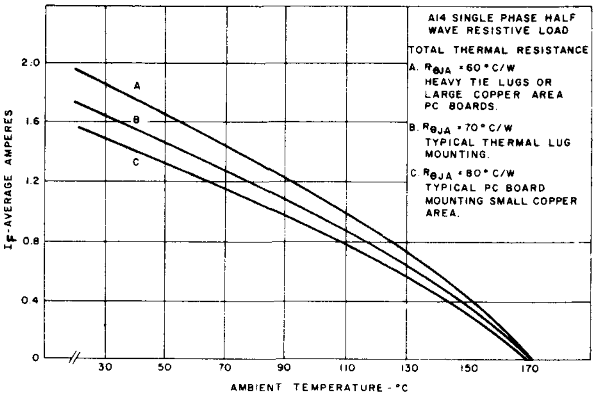
	A14U	A14F	A14A	
Maximum Forward Voltage Drop, V_F, 2.5A, $T_J = 25°$ C	1.25	1.25	1.25	Volt
Maximum Reverse Current, I_R, at Rated V_{RM} (rep):				
$T_J = 25°$ C	10	5.0	5.0	μA
$T_J = 175°$ C	500	300	300	μA
Typical Reverse Current				
$T_J = 25°$ C	←	0.3	→	μA
$T_J = 100°$ C	←	20	→	μA
Typical Reverse Recovery Time	←	3	→	μsec.
Maximum Reverse Recovery Time	←	6	→	μsec.

Recovery circuit per MIL-S-19500/286C.

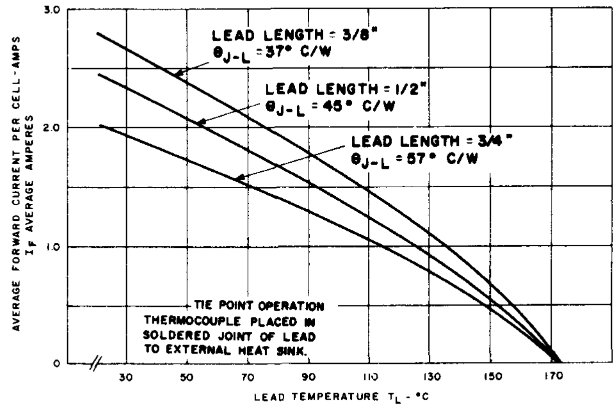
A14 SERIES
A14A
A14F
A14U

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE
600 VOLTS & BELOW

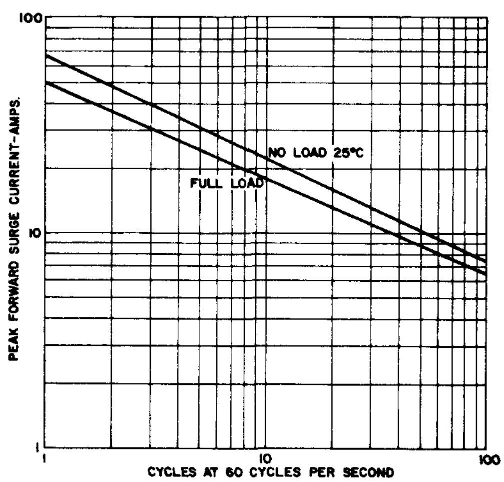


AMBIENT OPERATION
(SEE TYPICAL MOUNTING BELOW)

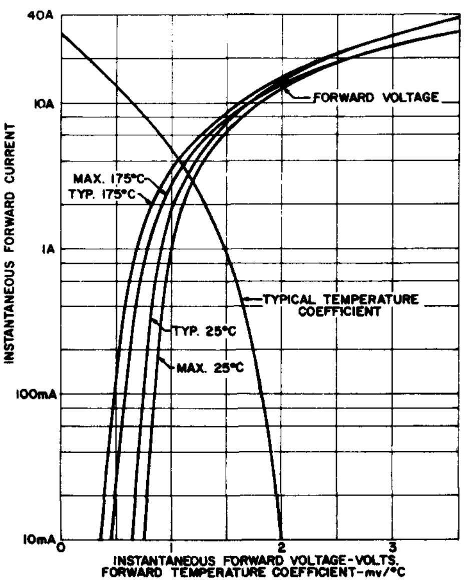


TIE POINT OPERATION

TYPICAL CHARACTERISTICS

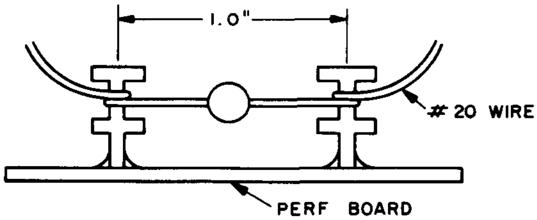


MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT

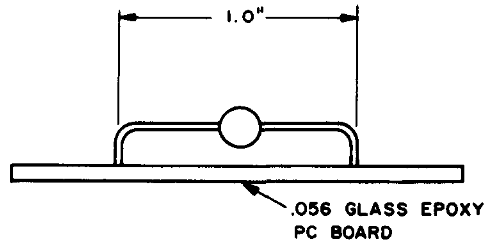


FORWARD CHARACTERISTICS

TYPICAL TIE LUG MOUNTS



TYPICAL PC BOARD MOUNTING



Passivated Rectifier

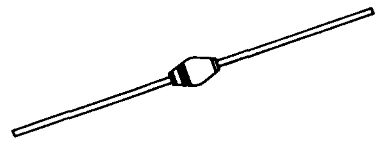
5.0 Amps **50-100 Volts**

A15 SERIES
A15A
A15F
A15U

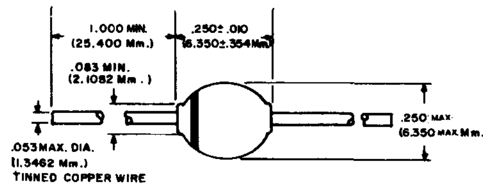
A15B-M SEE PAGE 294

A14 SEE PAGE 547

THE GENERAL ELECTRIC A15 IS A 5.0 AMPERE RATED, AXIAL-LEADED GENERAL PURPOSE RECTIFIER. ITS DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLET'S PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY SEALED PACKAGE.



OUTLINE DRAWING



ALL DIMENSIONS ARE IN INCHES AND (METRIC)

absolute maximum ratings: (25°C unless otherwise specified)

	A15U	A15F	A15A	
Reverse Voltage (−65 to +175°C T_J)				
Repetitive Peak, V_{RRM}	25	50	100	Volts
DC, VR	25	50	100	Volts
Average Forward Current, I_F				
70°C ambient, see rating curves	3.0	3.0	3.0	Amps
25°C ambient, see rating curves	5.0	5.0	5.0	Amps
Peak Surge Forward Current I_{FSM} non-repetitive .0083 sec half sine wave Full load JEDEC method	75	125	125	Amps
Peak Surge Forward Current Non-repetitive .001 sec Half sine wave Full load 175°C T_J	—	225	225	Amps
Junction Operating and Storage Temperature Range		−65 to +175°C		
I^2T, RMS for fusing .001 to .01 sec	—	25	25	Amp^2sec

Mounting: Any position. Lead temperature 290°C maximum to ⅛″ from body for 5 seconds maximum during mounting.

electrical characteristics: (25°C unless otherwise specified)

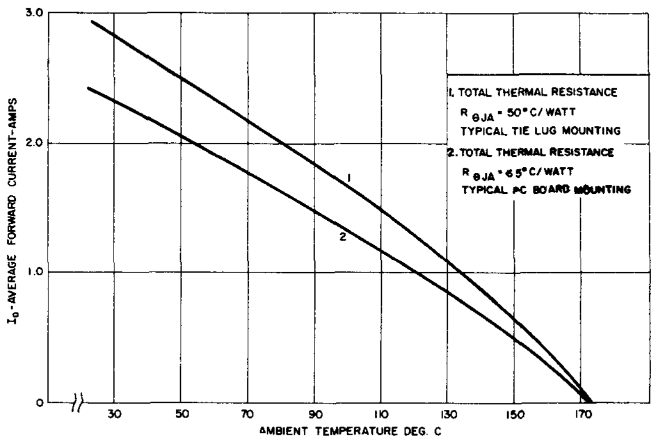
	A15U	A15F	A15A	
Maximum Forward Voltage Drop $I_F = 5.0\,A$, $T_A = 25°C$	1.2	1.1	1.1	Volts
Maximum Reverse Current, I_R at rated VR				
$T_J = 25°C$	10.0	5.0	5.0	μA
$T_J = 175°C$	500	300	300	μA
Typical I_R at 25°C	2.0	1.0	1.0	μA
Typical Reverse Recovery Time, T_{rr}		2.5	2.5	μsec
Maximum Reverse Recovery Time, T_{rr} Recovery Circuit Per MIL-S-19500/286C		5.0	5.0	μsec

A15 SERIES
A15A
A15F
A15U

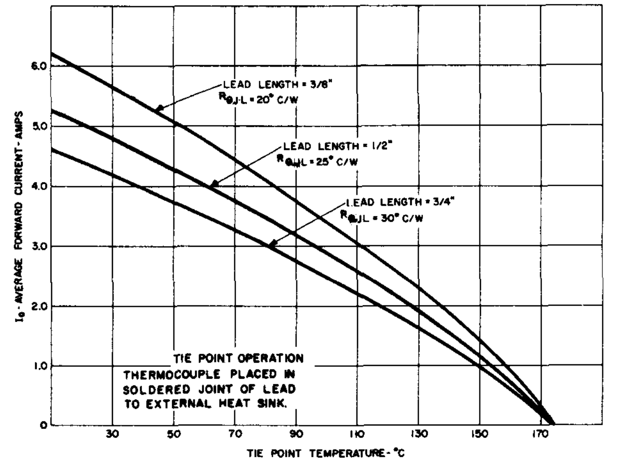
CIRCUIT DESIGN INFORMATION

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS

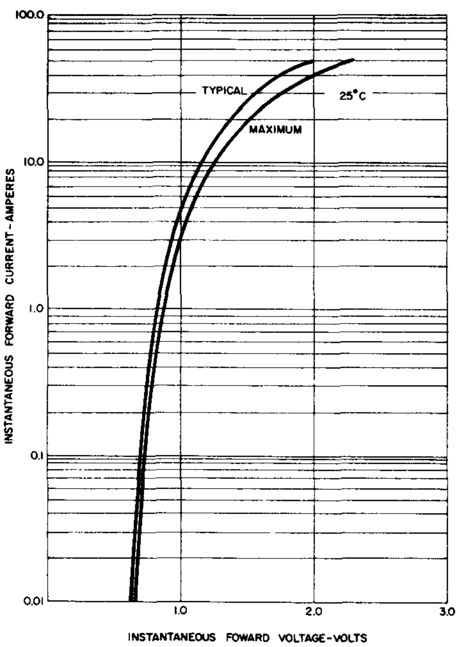


AMBIENT OPERATION
(See Tie Point Mounting Below)

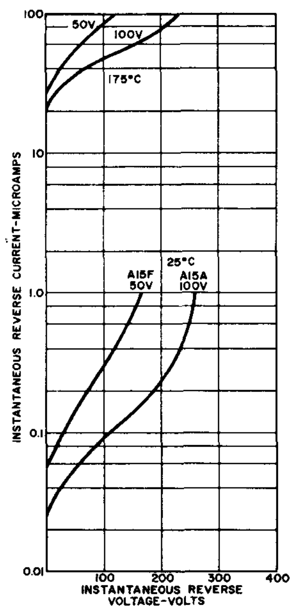


TIE POINT OPERATION

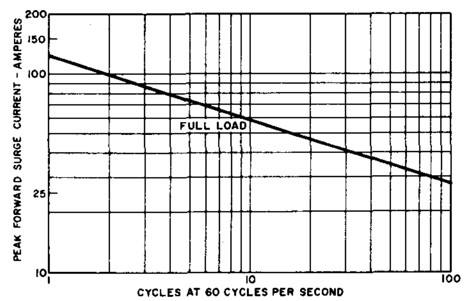
TYPICAL CHARACTERISTICS



FORWARD CHARACTERISTICS

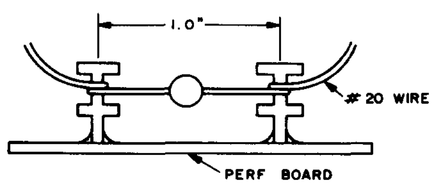


REVERSE CHARACTERISTICS

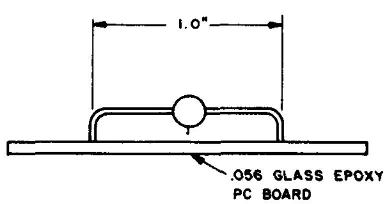


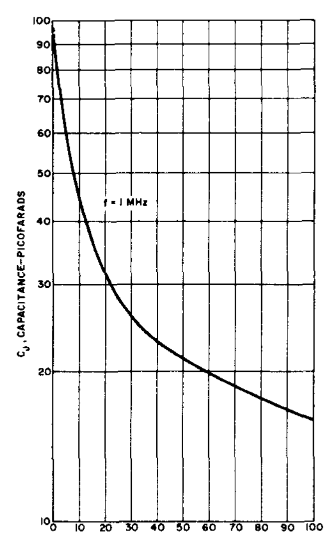
MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT

TYPICAL TIE LUG MOUNTS



TYPICAL PC BOARD MOUNTING





JUNCTION CAPACITANCE

A27 SERIES SEE PAGE 278

Rectifier

A28,9*

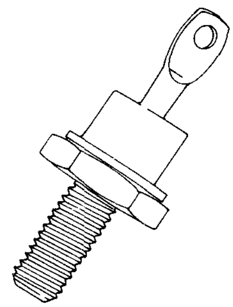
A38 SERIES SEE PAGE 282

12A AVG. V_{RRM} Up to 400V

*Reverse polarity type

Features:

- Fast Recovery Time . . . 100 Nanoseconds Maximum
- Recovered Charge Characteristics Shown on Charts 1, 2, and 3
- The Fast Recovery Characteristics of the A28/A29 Match the High Frequency Capability of the New General Electric High Speed SCR's, such as the C140 and C141.
- For Use in:
  - — Inverters
  - — Sonar Power Supplies
  - — Choppers
  - — Ultrasonic Systems
  - — Low RF Interference Applications
  - — Free Wheeling Rectifier Applications
  - — DC To DC Power Supplies



maximum allowable ratings (Resistive or Inductive Load)

	A28F A29F	A28A A29A	A28B A29B	A28C A29C	A28D A29D	
Maximum Repetitive and Working Peak Reverse Voltage*, V_{RRM} and V_{RWM}, T_J = −65°C to +175°C	50	100	200	300	400	Volts
Maximum RMS Voltage*, T_J = −65°C to +175°C, V_r	35	70	140	210	280	Volts
Maximum DC Blocking Voltage**, T_J = −65°C to +125°C, V_R	50	100	200	300	400	Volts
Maximum Average Forward Current (Single Phase, T_C = +135°C), I_O	←— 12 Amperes —→					
Maximum Peak One Cycle Surge Current, 60 Cycle Non-Recurrent, T_J = −65°C to +175°C, I_{FSM}	←— 240 Amperes —→					
I^2t Rating (.001 <t<.008 second), T_J = −65°C to +175°C	←— 67 Ampere² second Min. Rating —→					
Maximum Full Load Forward Voltage Drop, Single Phase Full Cycle Average, I_O = 12 Amp. at T_C = +135°C, $V_{F(AV)}$	←— 0.7 Volts —→					
Maximum Reverse Current at Full Load, Single Phase Full Cycle Average, I_O = 12 Amp. at T_C = +135°C, $I_{R(AV)}$	←— 8.0 mA —→					
Maximum Effective Thermal Resistance (Junction to Case) $R_{\theta JC}$	←— 2.0°C/W —→					
Junction Operating and Storage Temperature Range, T_J & T_{STG}	←— −65°C to +175°C —→					
Reverse Recovery Time (see reverse side)***, t_{rr}	←— 100 Nanosec. Max. —→					
Stud Torque	←— Min. 15 in-lbs.; Max. 20 in-lbs. —→ (Min. 17 Kg-cm; Max. 23 Kg-cm)					

*Rating assumes rectifier heatsink ≤ 3°C/W at max. T_J. If max. operating T_J ≤ 150°C, rectifier heatsink can be ≤ 6°C/W.

**Rating assumes rectifier heatsink ≤ 6°C/W at max. T_J.

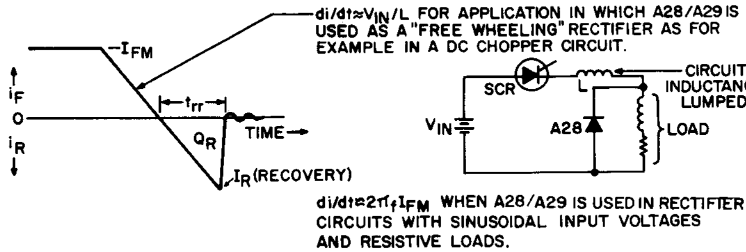
***Recovery characteristic factory test point:
I_{FM} = 5.0 Amp.; di/dt = 50 Amp./μsec; T_C = +25°C; t_{rr} = 100 nanoseconds max.; I_R (recovery) = 4.0 Amperes max.

NOTE: Case Temperature, T_C, is measured at the center of any flat on the hex base.

A28,9*

RECOVERY SPECIFICATIONS AND INFORMATION

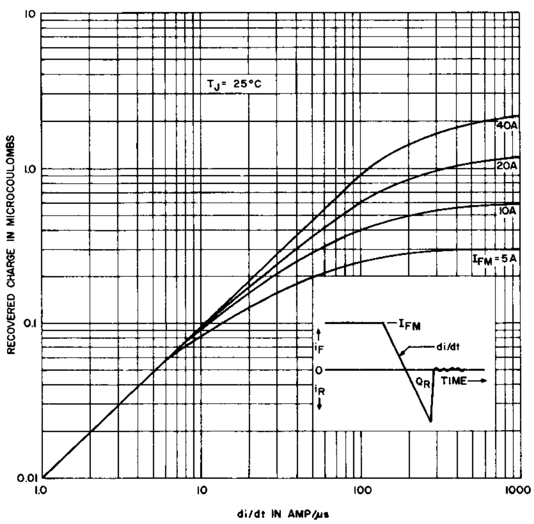
In most power circuits where the rectifier reverse loop L/R is large, the A28/A29 recovery characteristics are essentially as shown below:



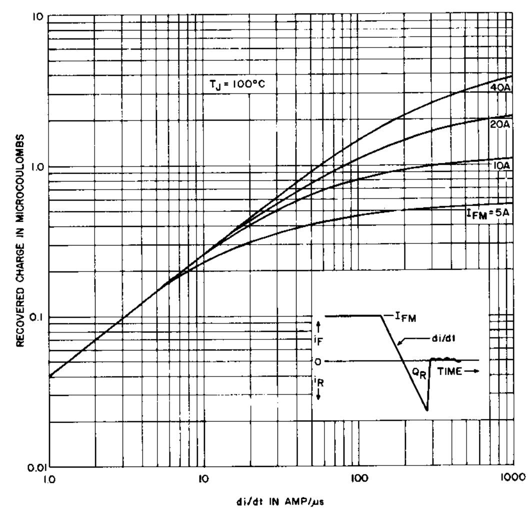
From the curves of recovered charge, Q_R (Charts 1, 2, 3), recovery time and peak recovery current (as defined above) may be very closely approximated using the following formulas if the application, I_R (recovery), di/dt, and A28/A29 operating junction temperatures are known.

$$I_R \text{ (recovery)} = \sqrt{2\, Q_R\, di/dt} \qquad t_{rr} = \sqrt{\frac{2\, Q_R}{di/dt}}$$

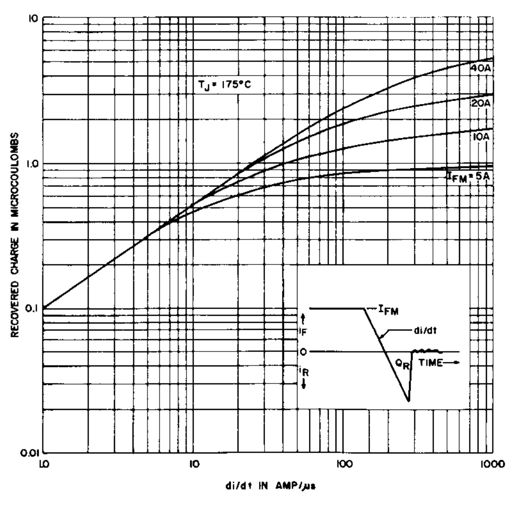
NOTE: At high values of di/dt, reverse voltage transients may be generated that will destroy the A28/A29 especially with high values of I_{FM} and T_J. In these cases R-C suppression should be connected across the A28/A29.



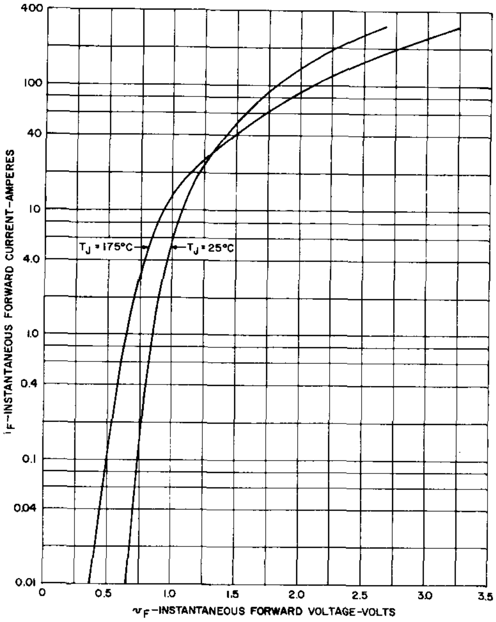
1. Recovered Charge Curves ($T_J = +25°C$)



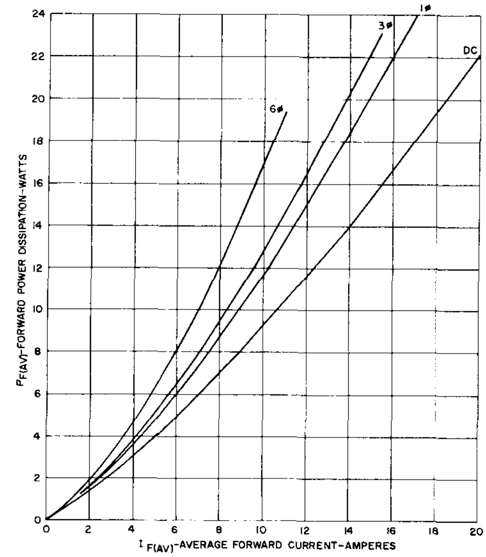
2. Recovered Charge Curves ($T_J = +100°C$)



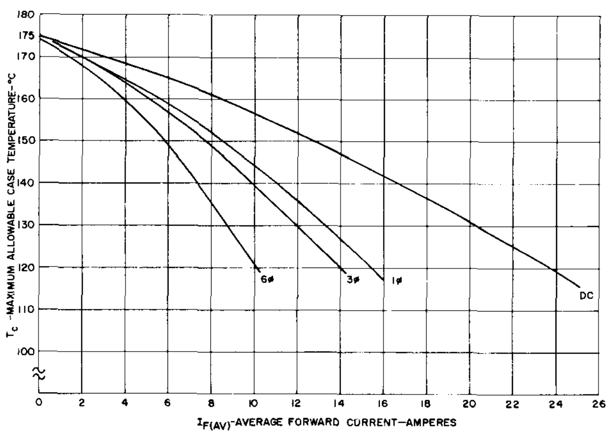
3. Recovered Charge Curves ($T_J = +175°C$)



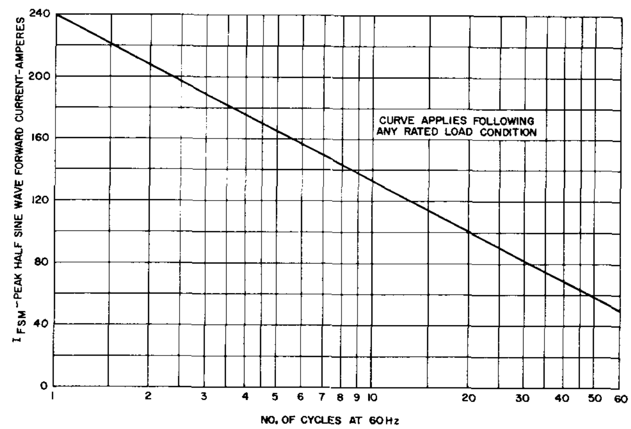
4. Maximum Forward Characteristics



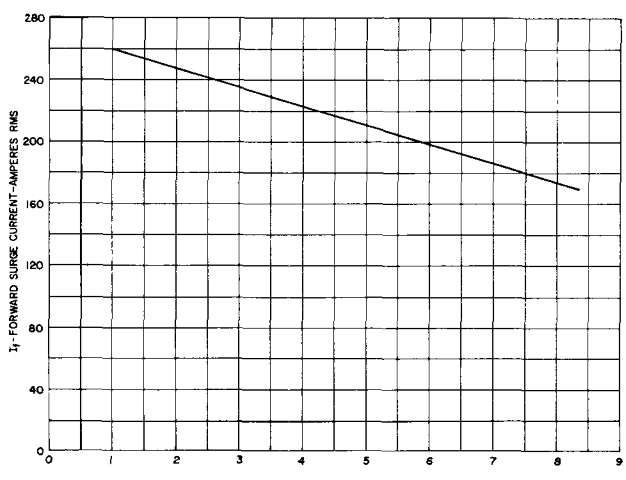
5. Average Forward Power as a Function of Average Forward Current (T_J = +175°C)



6. Current Rating vs. Case Temperature Curves

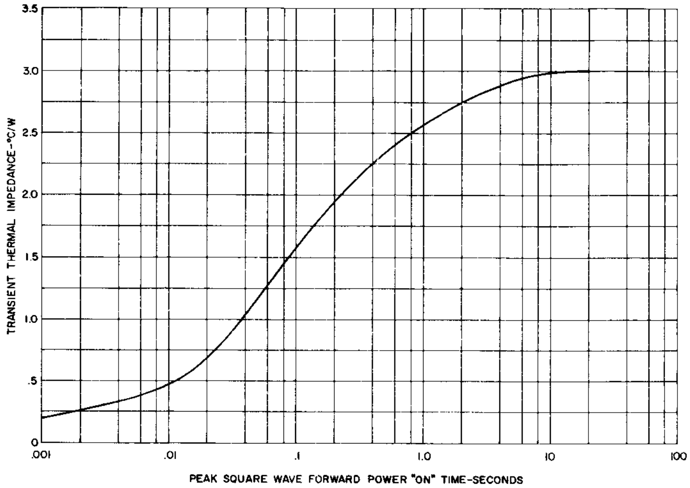


7. Non-Recurrent Multi-Cycle Surge Forward Current

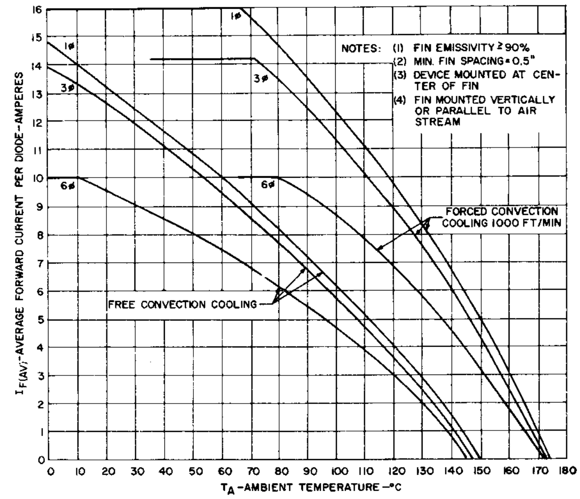


8. Non-Recurrent Sub-Cycle Surge Forward Current

A28, 9*



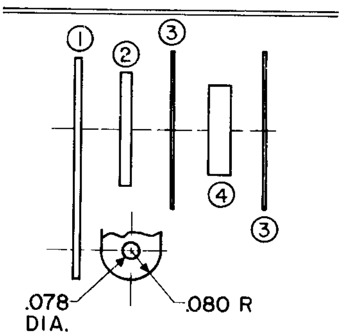
9. DC Transient Thermal Impedance, Junction to Heatsink



10. Current Rating as a Function of Ambient Air Temperature for Device Mounted on 5″ x 5″ x .050″ Copper Fin

OUTLINE DRAWING

INSULATING HARDWARE KIT *



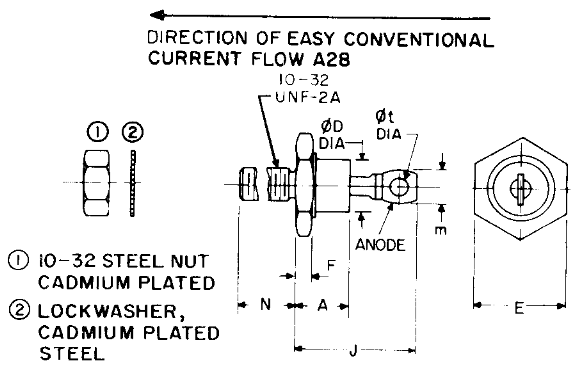
① COPPER TERMINAL, .016 THICK, TIN PLATED

② BRASS WASHER, .035 THICK NICKEL PLATED

③ MICA WASHERS, TWO, .625 O.D., .204 I.D., .005 THICK

④ TEFLON WASHER, .270 O.D. .204 I.D., .050 THICK

* AVAILABLE UPON REQUEST



COMPLIES WITH EIA REGISTERED OUTLINE DO-4

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.405		10.29	
φD		.424		10.77	
E	.424	.437	10.77	11.10	
F	.075	.175	1.91	4.45	
J		.800		20.32	
m		.250		6.35	1
N	.422	.453	10.72	11.51	
φt	.060		1.52		
W					2

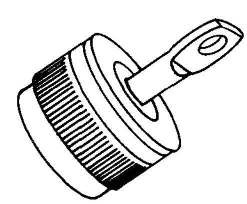
NOTES:
1. Angular orientation of this terminal is undefined.
2. 10-32 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter (.1697″, 4.29 MM) Ref. (Screw thread standards for Federal Services 1957) Handbook H28 1957 P1.

Silicon Rectifiers

A44F,M
A45F,M

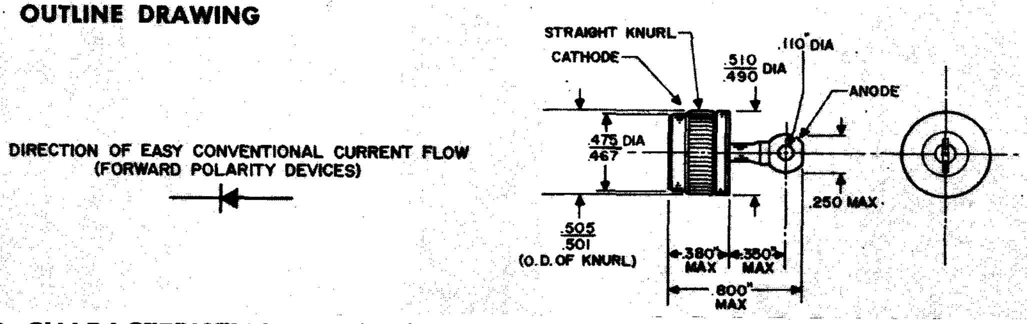
A40 SERIES SEE PAGE 230
A70 SERIES SEE PAGE 234

General Electric has designed this 20 Ampere rectifier specifically for the light industrial and consumer low ambient temperature applications. The design utilizes the smallest practical size for the rating with particular attention to rigidity and rugged construction. The solid one-piece terminal provides good mechanical strength, and minimizes breakage problems.



- **High Surge Current Capabilities (Up to 300 Amperes)**
- **One-Piece Terminal**
- **Reverse Polarity Devices Available**
- **Small Size**

OUTLINE DRAWING



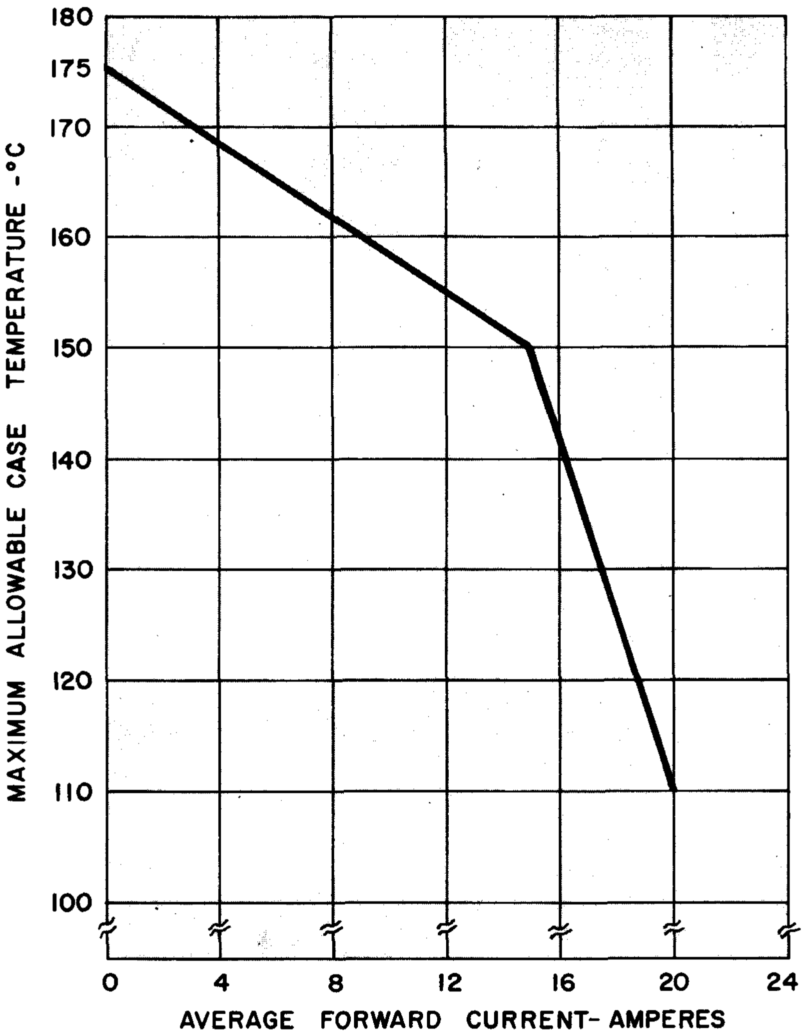
RATINGS AND CHARACTERISTICS (Single Phase Resistive Load)

	Forward Polarity	A44F	A44A	A44B	A44C	A44D	A44E	A44M	
	Reverse Polarity	A45F	A45A	A45B	A45C	A45D	A45E	A45M	
Max. Peak Reverse Voltage		50	100	200	300	400	500	600	volts
Max. Continuous D-C Reverse Voltage		50	100	200	300	400	500	600	volts
Max. Sine Wave RMS Voltage		35	70	140	210	280	350	420	volts
Max. Avg. D-C Forward Current At 110°C Case		← 20 amps →							
At 150°C Case		← 15 amps →							
Peak One-cycle Forward Surge Current (60 cps, $T_J = 25°C$)		← 300 amps →							
I^2t Rating for Fusing or Capacitor Inrush		← 100 amp^2 sec →							
Max. Forward Voltage at 20 Amps D-C Forward Current ($T_J = 25°C$)		← 1.2 volts →							
Max. Avg. Forward Voltage Drop (15 amps d-c single phase, $T_J = 150°C$)		← 0.75 volts →							
Max. Reverse Current at Rated D-C Reverse Voltage ($T_J = 25°C$)		← 1.0 ma →							
Max. Full Load Reverse Current (full cycle avg., single phase, $T_J = 150°C$)		10	9	8	6	5	4.5	4.0	ma
Typical Thermal Resistance (junction to case)		← 1.5°C/watt →							
Operating Junction Temperature Range		← −65°C to +175°C →							
Storage Temperature Range		← −65°C to +175°C →							

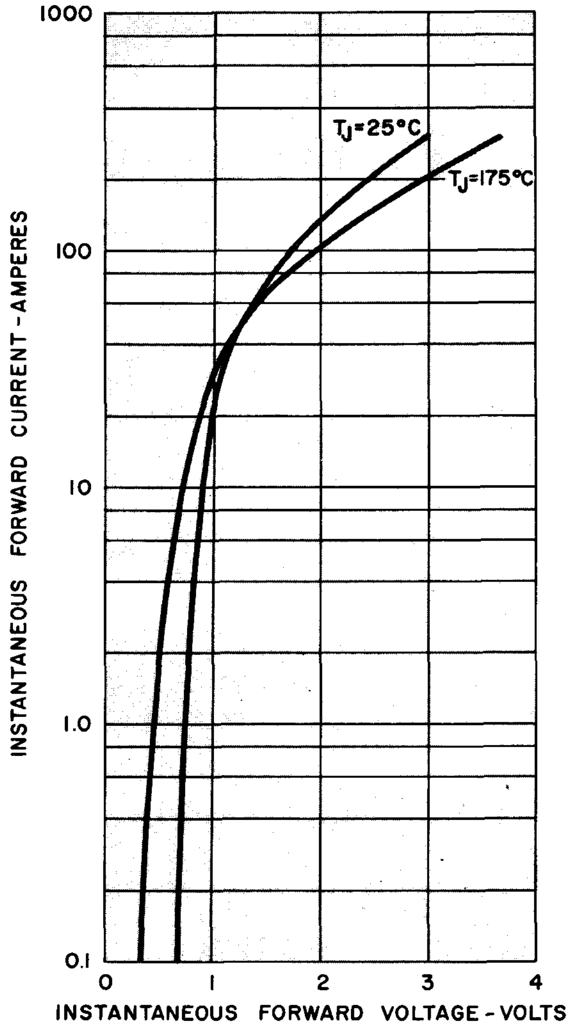
RECOMMENDED MOUNTING PROCEDURE FOR PRESS-FITTING IN A HEATSINK

When press-fitting these diodes into a heatsink, the following specifications and recommendations apply.

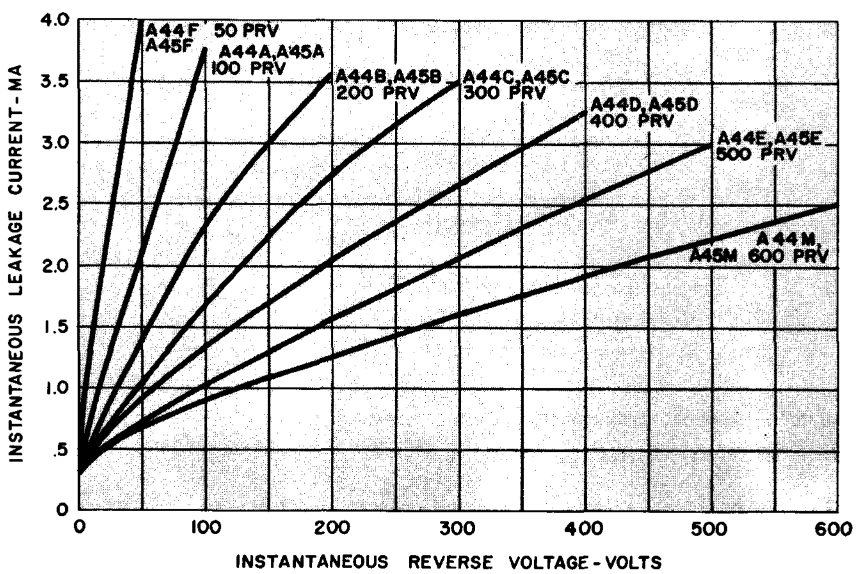
1. **The heatsink thickness should be at least ⅛".**
2. **The hole diameter into which the diode is pressed should be 0.4975 ± .001 inches. A slight chamfer of the hole should be used.**
3. **The entire knurled section of the diode should be in contact with the heatsink to insure maximum heat removal.**
4. **The diode insertion force should not exceed 800 pounds. This force should be uniformly applied to the top face of the diode within an annular ring of diameter .44 ± .05 inches.**
5. **The thermal resistance between the diode case and the heatsink will not exceed 0.5°C/W if the diode is installed in the manner described above.**



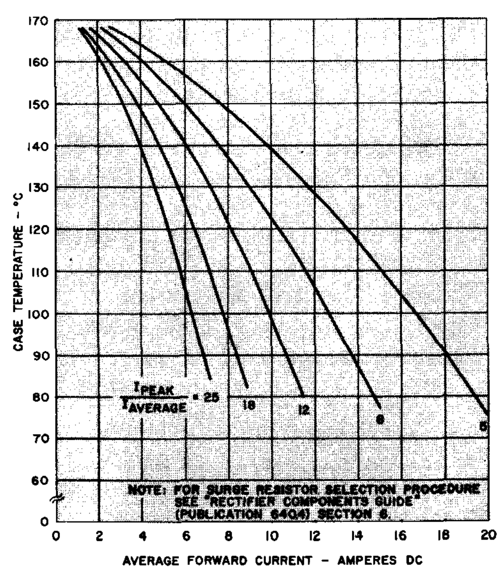
1. SINGLE PHASE AND THREE PHASE CURRENT RATING AS A FUNCTION OF STUD TEMPERATURE



2. TYPICAL FORWARD CHARACTERISTICS



3. TYPICAL REVERSE CHARACTERISTICS ($T_J = 175°C$)



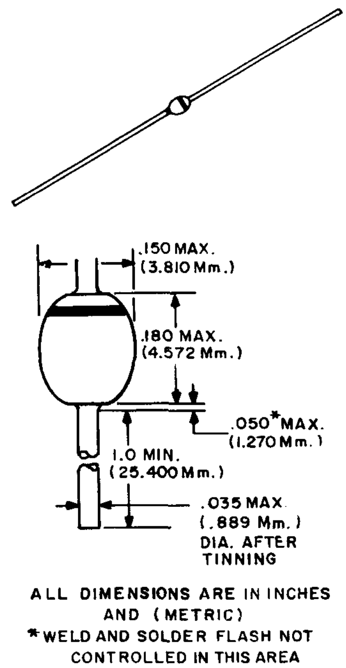
4. HALFWAVE CAPACITIVE LOAD RATING

Fast Recovery Rectifier

A114A
A114F

2.0 Amps **50-100 Volts**

THE GENERAL ELECTRIC A114 IS A 2.0 AMPERE, AXIAL LEADED, FAST RECOVERY RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE PN JUNCTION OF THE SILICON PELLET ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY-SEALED PACKAGE.



OUTLINE DRAWING

absolute maximum ratings: (25°C unless otherwise specified)

	A114F	A114A	
Reverse Voltage (−65°C to +150°C, T_J)			
Working Peak, V_{RWM}	50	100	Volts
Repetitive Peak, V_{RRM}	50	100	Volts
DC, V_R	50	100	Volts
Average Forward Current, I_O			
75°C ambient (see Rating Curves)	← 1.0 →		Amperes
25°C	← 2.0 →		Amperes
Peak Surge Forward Current, I_{FSM}			
Non-rep., .0083 sec., half sine wave, Full load JEDEC method	← 40 →		Amperes
Non-rep., .001 sec., half sine wave, Full load @ +150°C, T_J	← 85 →		Amperes
I^2t (for fusing), RMS			
.001 to .01 seconds	← 3.5 →		$Amp^2secs.$
Junction Temperature Range			
Operating, T_J	−65°C to +150°C		
Storage, T_{STG}	−65°C to +175°C		

Mounting: Any position. Lead temperature 290°C max. to 1/8″ from body for 5 seconds max. during mounting.

electrical characteristics: (25°C unless otherwise specified)

	A114F	A114A	
Maximum Forward Voltage Drop, V_{FM}			
I_{FM} = 1.0A, T_J = +25°C	← 1.1 →		Volts
Maximum Reverse Current, I_{RM} @ rated V_{RM}			
T_J = +25°C	5	5	Microamps.
T_J = +150°C	500	500	Microamps.
Typical Reverse Recovery Time, t_{rr}	← 140 →		Nanosecs.
Maximum Reverse Recovery Time, t_{rr}	← 200 →		Nanosecs.

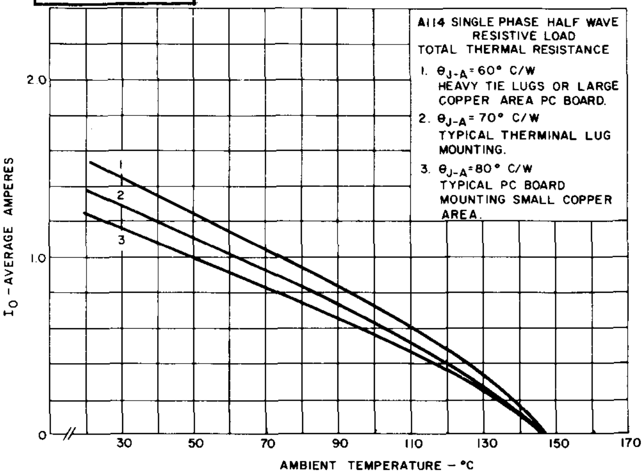
Recovery circuit per MIL-S-19500/286C.

CIRCUIT DESIGN INFORMATION

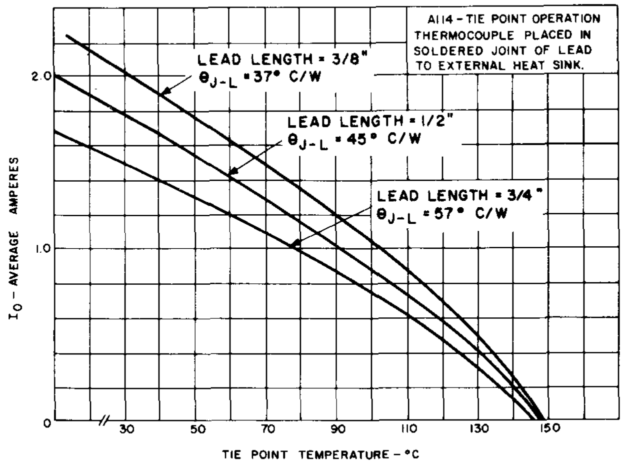
A114A
A114F

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS

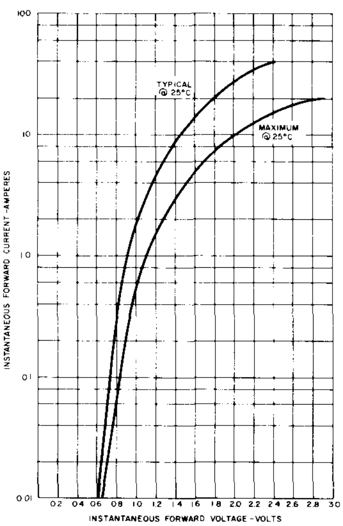


AMBIENT OPERATION

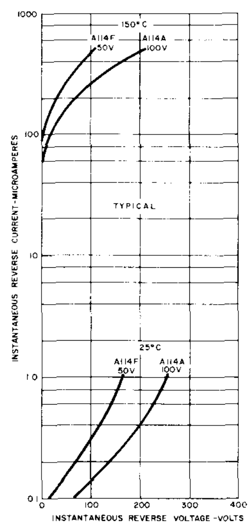


TIE POINT OPERATION

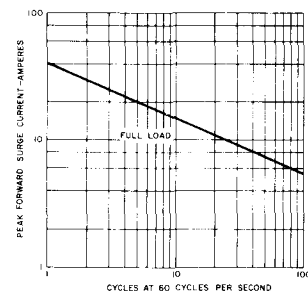
TYPICAL CHARACTERISTICS



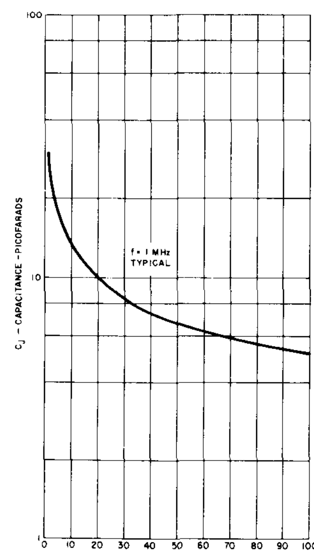
FORWARD CHARACTERISTICS



REVERSE CHARACTERISTICS

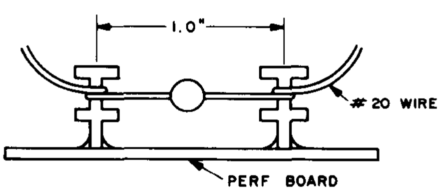


MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT

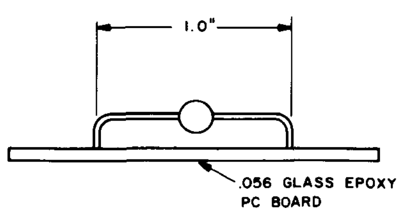


JUNCTION CAPACITANCE

TYPICAL TIE LUG MOUNTS



TYPICAL PC BOARD MOUNTING

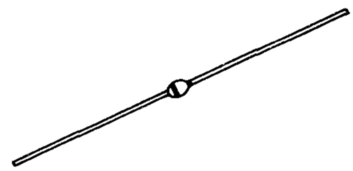


Fast Recovery Rectifier

2.0 Amps **200-600 Volts**

A114B
A114C
A114D
A114E
A114M

THE GENERAL ELECTRIC A114 IS A 2.0 AMPERE, AXIAL-LEADED, FAST RECOVERY RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE PN JUNCTION OF THE SILICON PELLET ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY-SEALED PACKAGE.



absolute maximum ratings: (25°C unless otherwise specified)

	A114B	A114C	A114D	A114E	A114M	
Reverse Voltage (-65°C to $+150$°C, T_J)						
Working Peak, V_{RWM}	200	300	400	500	600	Volts
Repetitive Peak, V_{RRM}	200	300	400	500	600	Volts
DC, V_R	200	300	400	500	600	Volts
Average Forward Current, I_O						
75°C ambient (see Rating Curves)	←		1.0		→	Amperes
25°C " "	←		2.0		→	Amperes
Peak Surge Forward Current, I_{FSM}						
Non-rep., .0083 sec., half sine wave, Full load JEDEC method	←		40		→	Amperes
Non-rep., .001 sec., half sine wave, Full load @ $+150$°C, T_J	←		85		→	Amperes
I^2t (for fusing), RMS .001 to .01 seconds	←		3.5		→	Amp²secs.
Junction Temperature Range						
Operating, T_J	←		-65°C to $+150$°C		→	
Storage, T_{STG}	←		-65°C to $+175$°C		→	

Mounting: Any position. Lead temperature 290°C max. to 1/8" from body for 5 seconds max. during mounting.

electrical characteristics: (25°C unless otherwise specified)

	A114B	A114C	A114D	A114E	A114M	
Maximum Forward Voltage Drop, V_{FM} $I_{FM} = 1.0A$, $T_A = +25$°C	←		1.1		→	Volts
Maximum Reverse Current, I_{RM} @ rated V_{RM}						
$T_J = +25$°C	5	5	5	5	5	Microamps.
$T_J = +150$°C	300	300	300	200	200	Microamps.
Typical I_{RM} @ 25°C	1	1	1	1	1	Microamps.
Typical Reverse Recovery Time, t_{rr}	←		140		→	Nanosecs.
Maximum Reverse Recovery Time, t_{rr}	←		200		→	Nanosecs.

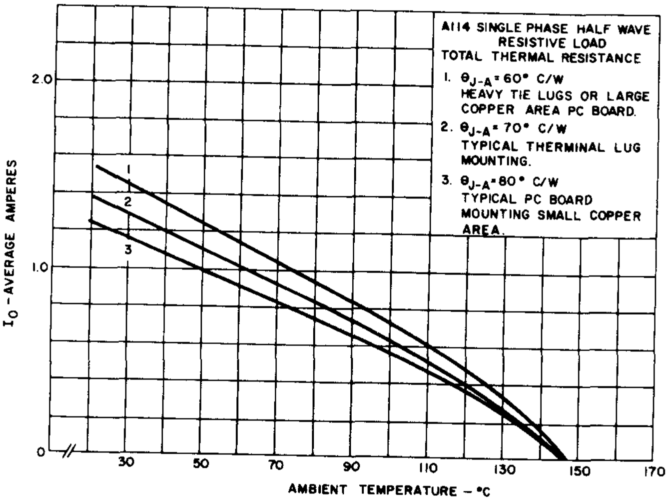
Recovery circuit per MIL-S-19500/286C.

A114B
A114C
A114D
A114E
A114M

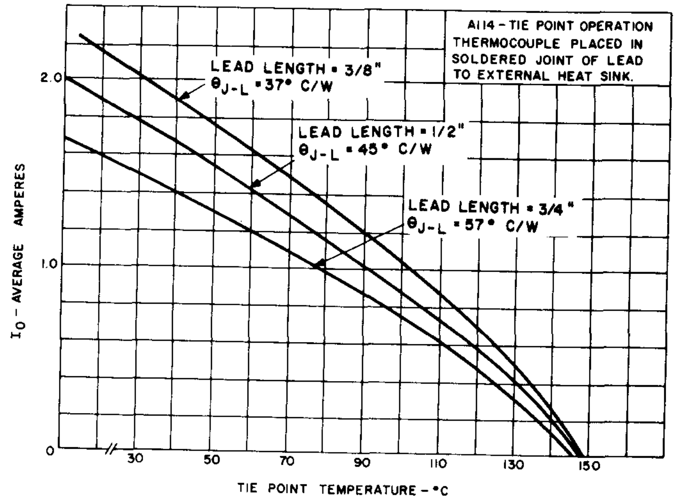
CIRCUIT DESIGN INFORMATION

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS



AMBIENT OPERATION



TIE POINT OPERATION

CAPACITIVE LOADS

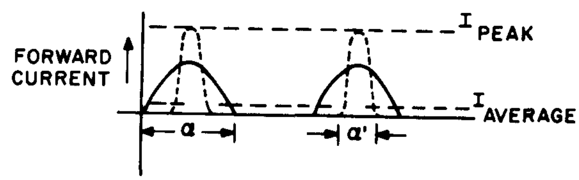
Current Derating (capacitive load)

Average forward current as specified under maximum ratings, page 1, and derating curves for high temperature operation, above, must be corrected for applications with capacitive loads. As the current conduction angle, α', is decreased, the peak current required to maintain the *same average current* increases, i.e., the peak-to-average current ratio increases from 3.14. Figure 3 gives the derating required based on this increase in peak to average current ratio for sine wave operation. For more complete information consult Application Note 200.30.

METHOD:
1. Determine conduction angle α' in degrees for *particular circuit as designed.*
2. Enter Figure 3 for the particular conduction angle and read corresponding percent of forward current per cell.
3. Multiply this value times average forward current for resistive load from figures 1 and 2 as given for the actual ambient or tie point temperature required.

See Typical Examples Below

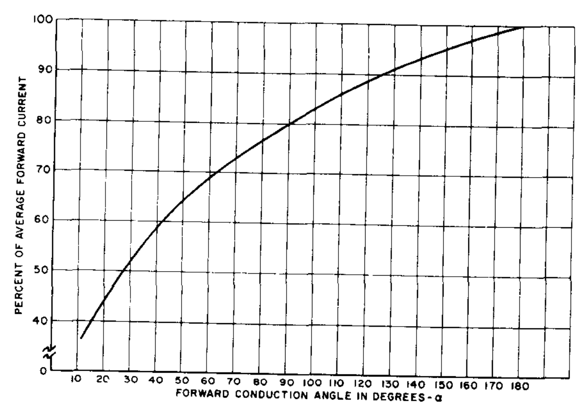
TYPICAL EXAMPLES (25°C Ambient Temperature)					
	Example No. 1	Example No. 2	Example No. 3	Example No. 4	Units
Conduction Angle (α)	170	110	130	70	Degrees
Rated Average Current (Resistive Load)	1	1	1	1	Amp.
% of Average Current	0.98	0.86	0.92	0.73	%
Rated Average Current (Capacitive Load)	0.98	0.86	0.92	0.73	Amps.



α = CONDUCTION ANGLE (180°)

α' = SHORTENED CONDUCTION ANGLE

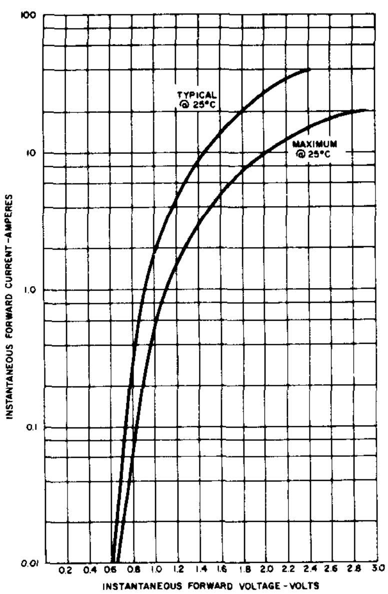
OSCILLOSCOPE PRESENTATION



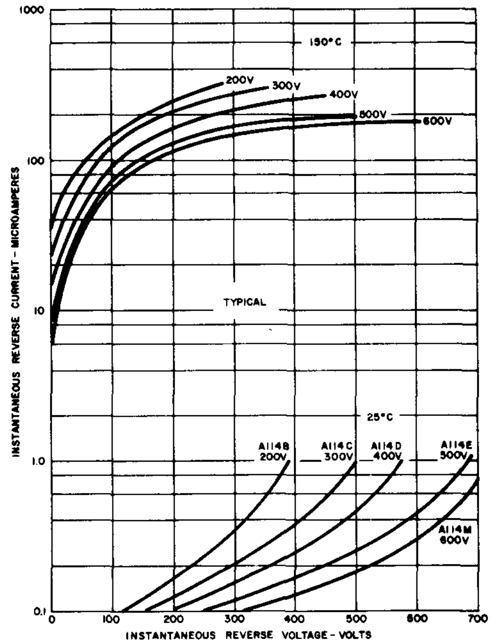
DERATING FOR SHORTENED CONDUCTION ANGLE

A114B
A114C
A114D
A114E
A114M

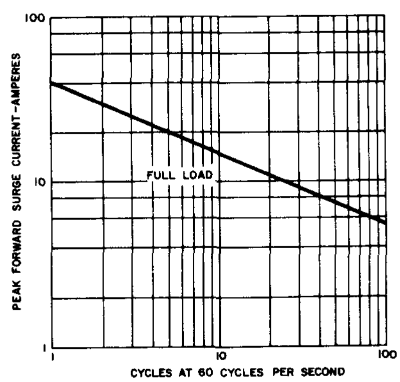
TYPICAL CHARACTERISTICS



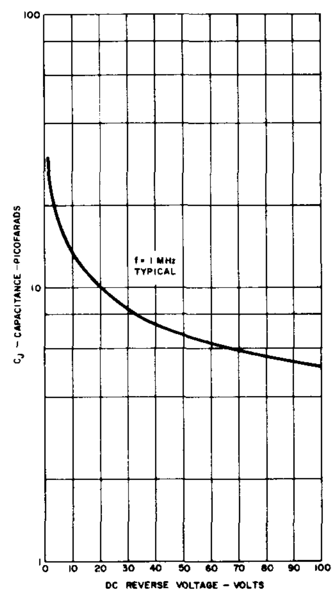
FORWARD CHARACTERISTICS



REVERSE CHARACTERISTICS

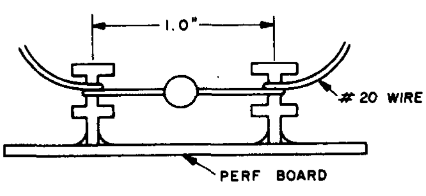


MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT

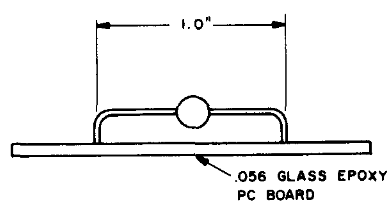


JUNCTION CAPACITANCE

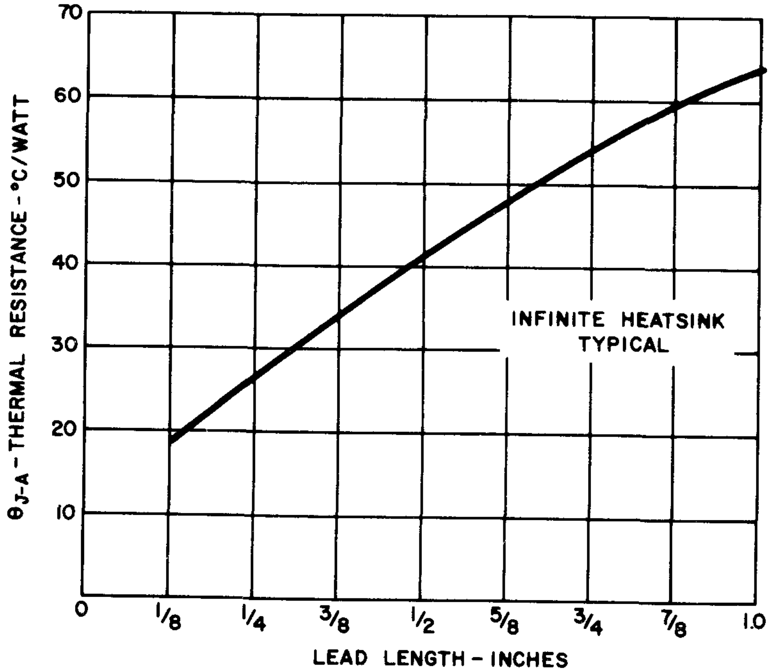
TYPICAL TIE LUG MOUNTS



TYPICAL PC BOARD MOUNTING

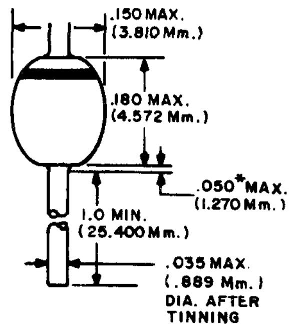


A114B
A114C
A114D
A114E
A114M



STEADY STATE THERMAL RESISTANCE

Marking band to appear on cathode end.



ALL DIMENTIONS ARE IN INCHES AND (METRIC)
*WELD AND SOLDER FLASH NOT CONTROLLED IN THIS AREA

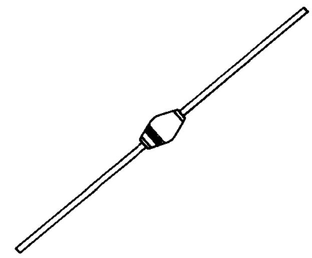
OUTLINE DRAWING

Fast Recovery Rectifier

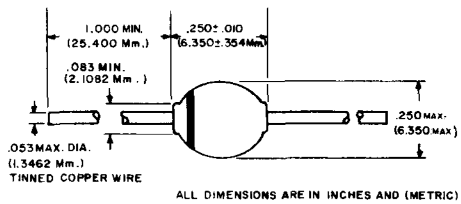
A115A
A115F

5.0 Amps **50-100 Volts**

THE GENERAL ELECTRIC A115 IS A 5.0 AMPERE, AXIAL-LEADED, FAST RECOVERY RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE PN JUNCTION OF THE SILICON PELLET ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY-SEALED PACKAGE.



absolute maximum ratings: (25°C unless otherwise specified)



	A115F	A115A	
Reverse Voltage (−65°C to +150°C, T_J)			
Repetitive, Peak, V_{RRM}	50	100	Volts
DC, V_R	50	100	Volts
Average Forward Current, I_o			
55°C ambient (see Rating Curves)	← 3.0 →		Amperes
25°C ambient (see Rating Curves)	← 5.0 →		Amperes
Peak Surge Forward Current, I_{FSM}			
Non-rep., .0083 sec., half sine wave, Full load JEDEC method	← 110 →		Amperes
Non-rep., .001 sec., half sine wave, Full load @ +150°C, T_J	← 200 →		Amperes
I^2t (for fusing), RMS			
.001 to .01 seconds	← 20.0 →		Amp^2 secs.
Junction Temperature Range			
Operating, T_J	−65°C to +150°C		
Storage, T_{STG}	−65°C to +175°C		

Mounting: Any position. Lead temperature 290°C max.. to 1/8" from body for 5 seconds max. during mounting.

electrical characteristics:

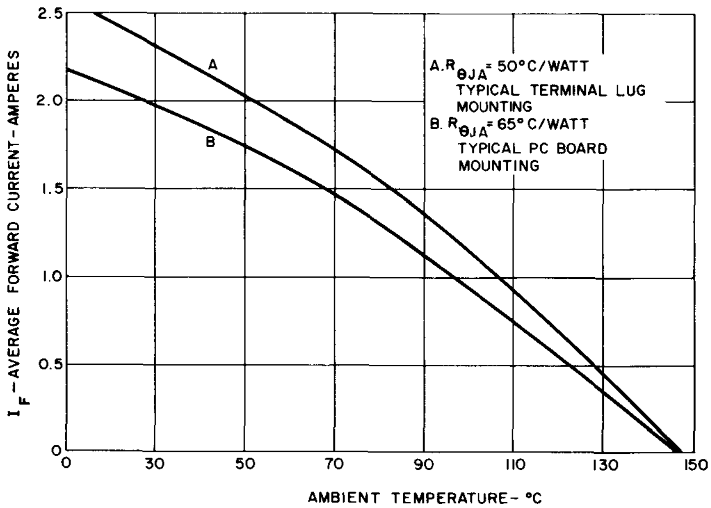
	A115F	A115A	
Maximum Forward Voltage Drop, V_{FM}			
I_{FM} = 5.0A, T_J = +25°C	← 1.1 →		Volts
Maximum Reverse Current, I_{RM} @ rated V_{RM}			
T_J = +25°C	5	5	Microamps.
T_J = +150°C	500	500	Microamps.
Typical Reverse Recovery Time, t_{rr}	← 140 →		Nanosecs.
Maximum Reverse Recovery Time, t_{rr}	← 200 →		Nanosecs.

Recovery circuit per MIL-S-19500/286C.

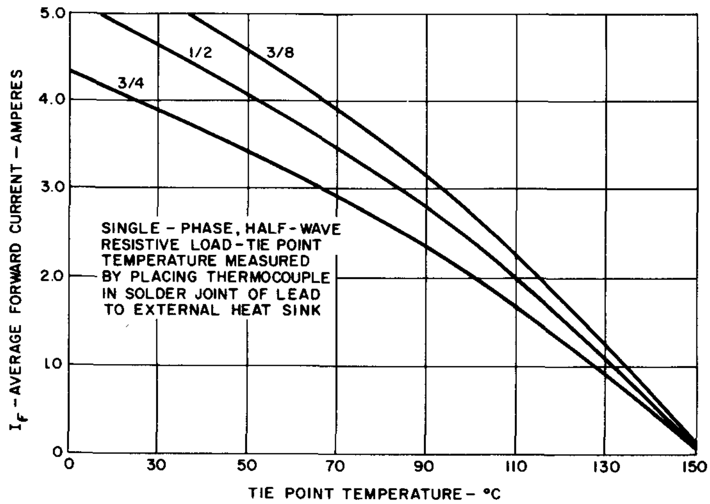
A115A
A115F

CIRCUIT DESIGN INFORMATION

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS
SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS

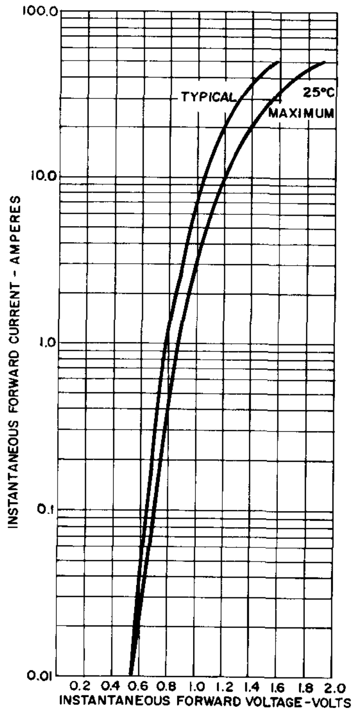


1. AMBIENT OPERATION

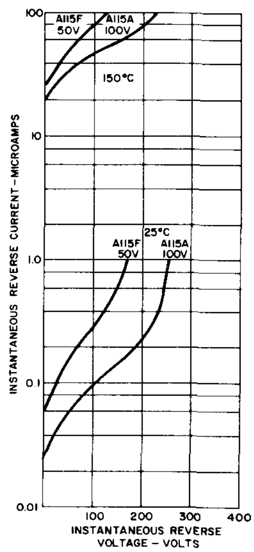


2. TIE POINT OPERATION

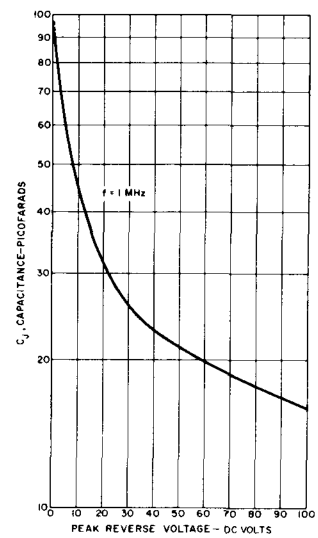
TYPICAL CHARACTERISTICS



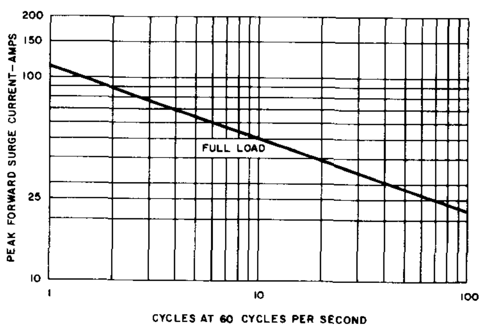
FORWARD CHARACTERISTICS



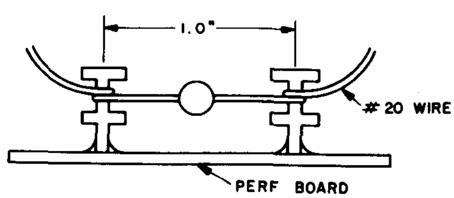
REVERSE CHARACTERISTICS



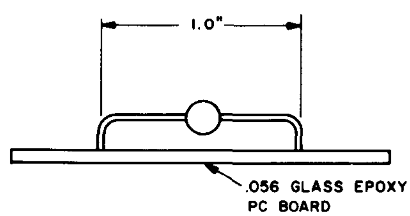
JUNCTION CAPACITANCE



MAXIMUM NON-REPETITIVE MULTICYCLE FORWARD SURGE CURRENT



TYPICAL TIE LUG MOUNTS



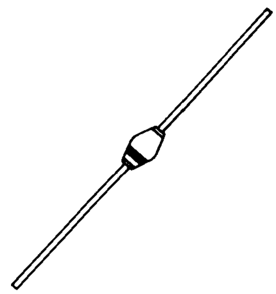
TYPICAL PC BOARD MOUNTING

Fast Recovery Rectifier

A115B
A115C
A115D
A115E
A115M

5.0 Amps **200-600 Volts**

THE GENERAL ELECTRIC A115 IS A 5.0 AMPERE, AXIAL-LEADED, FAST RECOVERY RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE PN JUNCTION OF THE SILICON PELLET ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY-SEALED PACKAGE.



absolute maximum ratings: (25°C unless otherwise specified)

	A115B	A115C	A115D	A115E	A115M	
Reverse Voltage (−65°C to +150°C, T_J)						
Repetitive Peak, V_{RRM}	200	300	400	500	600	Volts
DC, V_R	200	300	400	500	600	Volts
Average Forward Current, I_F						
55°C ambient (see Rating Curves)	←		3.0		→	Amperes
25°C ambient (see Rating Curves)	←		5.0		→	Amperes
Peak Surge Forward Current, I_{FSM}						
Non-rep., .0083 sec., half sine wave, Full load JEDEC method	←		110		→	Amperes
Non-rep., .001 sec. half sine wave, Full load @ +150°C, T_J	←		200		→	Amperes
I^2t (for fusing), RMS .001 to .01 seconds	←		20.0		→	Amp^2 secs.
Junction Temperature Range						
Operating, T_J	←		−65°C to +150°C		→	
Storage, T_{STG}	←		−65°C to +175°C		→	

Mounting: Any position. Lead temperature 290°C max. to 1/8" from body for 5 seconds max. during mounting.

electrical characteristics: (25°C unless otherwise specified)

	A115B	A115C	A115D	A115E	A115M	
Maximum Forward Voltage Drop, V_{FM} I_{FM} = 5.0A, T_A = +25°C	←		1.1		→	Volts
Maximum Reverse Current, I_{RM} @ rated V_{RM}						
T_J = +25°C	5	5	5	5	5	Microamps.
T_J = +150°C	300	300	300	200	200	Microamps.
Typical Reverse Recovery Time, t_{rr}	←		140		→	Nanosecs.
Maximum Reverse Recovery Time, t_{rr}	←		200		→	Nanosecs.

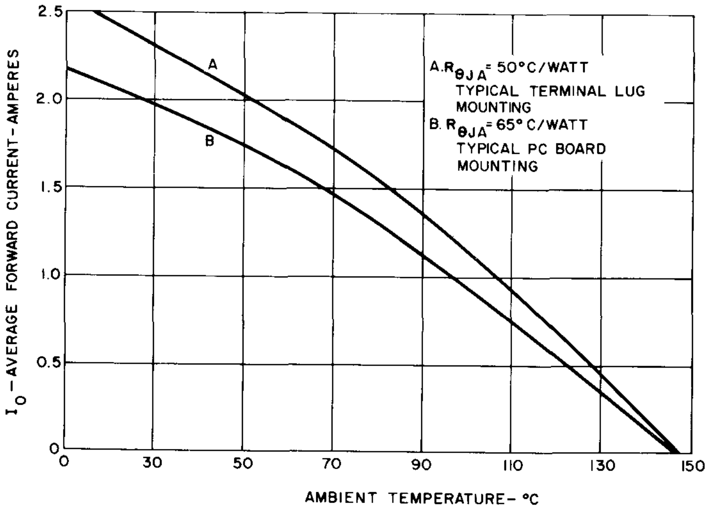
Recovery circuit per MIL-S-19500/286 C

A115B
A115C
A115D
A115E
A115M

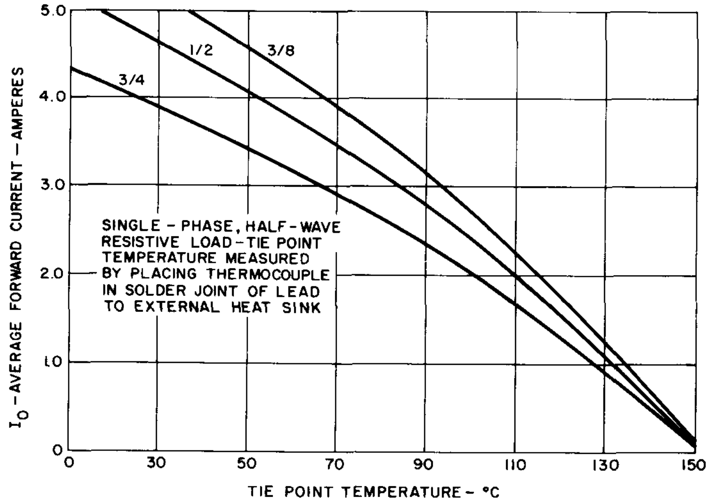
CIRCUIT DESIGN INFORMATION

MAXIMUM ALLOWABLE DC OUTPUT CURRENT RATINGS

SINGLE PHASE, RESISTIVE AND INDUCTIVE LOADS



AMBIENT OPERATION



TIE POINT OPERATION

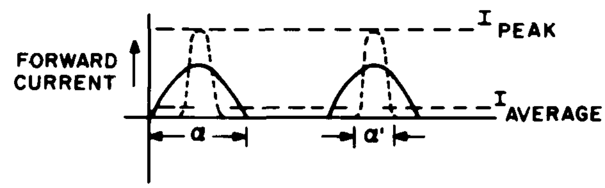
CAPACITIVE LOADS

Current Derating (capacitive load)

Average forward current as specified under maximum ratings, page 1, and derating curves for high temperature operation, above, must be corrected for applications with capacitive loads. As the current conduction angle, α', is decreased, the peak current required to maintain the *same average current* increases, i.e., the peak-to-average current ratio increases from 3.14. Figure 3 gives the derating required based on this increase in peak to average current ratio for sine wave operation. For more complete information consult Application Note 200.30.

METHOD:
1. Determine conduction angle α' in degrees for *particular circuit as designed.*
2. Enter Figure 3 for the particular conduction angle and read corresponding percent of forward current per cell.
3. Multiply this value times average forward current for resistive load from igures 1 and 2 as given for the actual ambient or tiepoint temperature required.

See Typical Examples Below

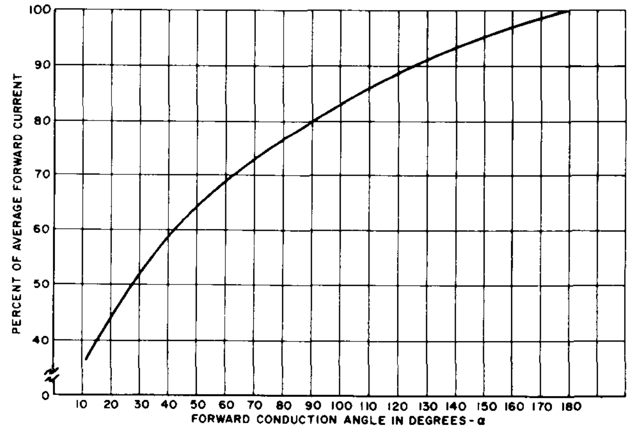


α = CONDUCTION ANGLE (180°)

α' = SHORTENED CONDUCTION ANGLE

OSCILLOSCOPE PRESENTATION

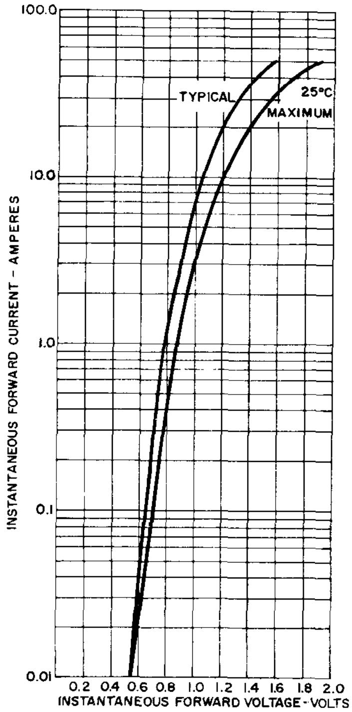
TYPICAL EXAMPLES (25°C Ambient Temperature)					
	Example No. 1	Example No. 2	Example No. 3	Example No. 4	Units
Conduction Angle (α)	170	110	130	70	Degrees
Rated Average Current (Resistive Load)	3	3	3	3	Amp.
% of Average Current	0.98	0.86	0.92	0.73	%
Rated Average Current (Capacitive Load)	2.9	2.6	2.8	2.2	Amps.



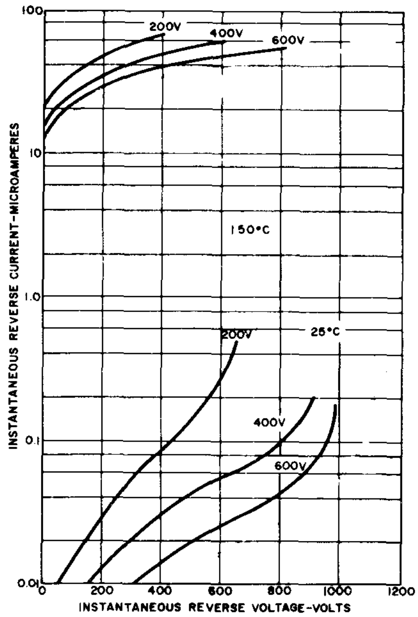
DERATING FOR SHORTENED CONDUCTION ANGLE

A115B
A115C
A115D
A115E
A115M

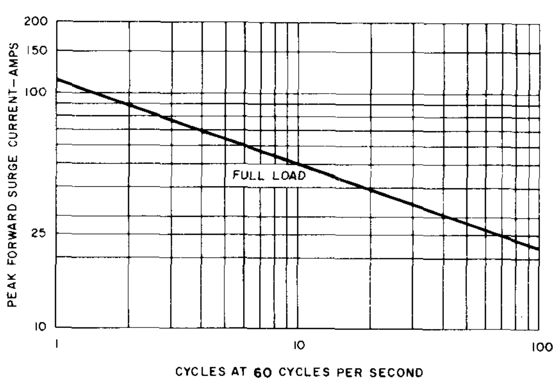
TYPICAL CHARACTERISTICS



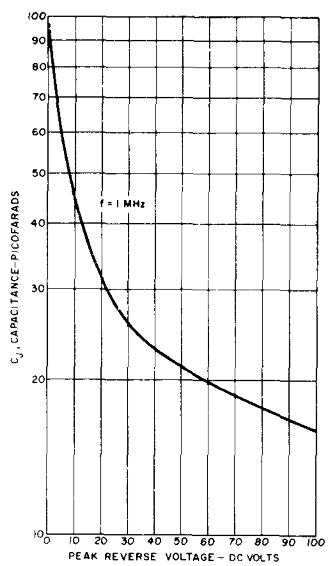
FORWARD CHARACTERISTICS



REVERSE CHARACTERISTICS

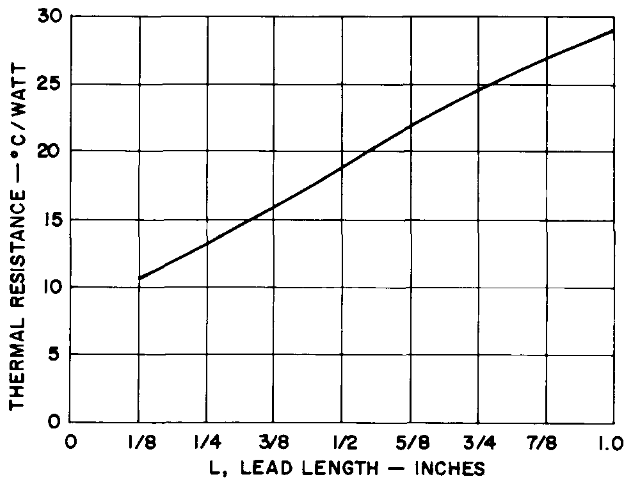


MAXIMUM NON-REPETITIVE
MULTICYCLE FORWARD SURGE CURRENT

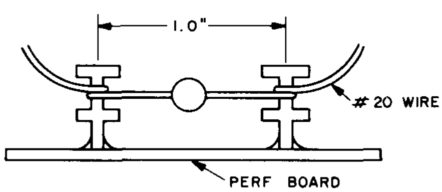


JUNCTION CAPACITANCE

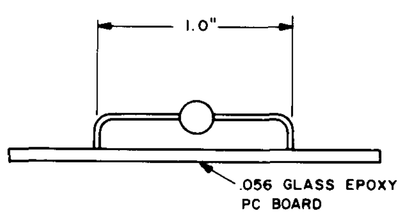
A115B
A115C
A115D
A115E
A115M



STEADY STATE THERMAL RESISTANCE

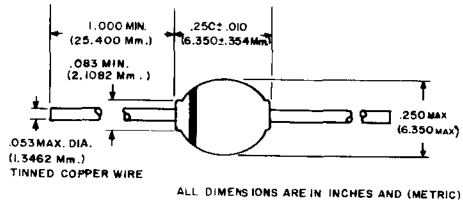


TYPICAL TIE LUG MOUNTS



TYPICAL PC BOARD MOUNTING

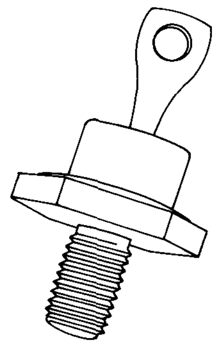
OUTLINE DRAWING



Fast Recovery Rectifier

A139

The General Electric Type A139 Series of power rectifier diodes is designed for use in applications where a fast recovery rectifier diode is a necessity. The A139 is rated up to 10,000 Hertz. It is available in both forward and reverse polarity versions.

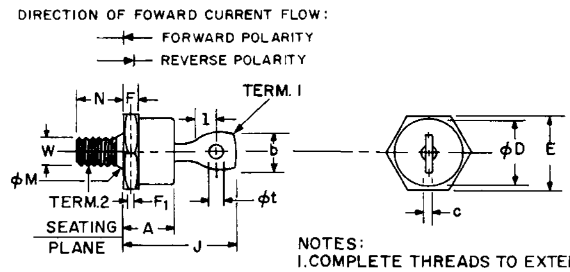


FEATURES:

- High Voltage – up to 1000 V
- Fast Recovery Time – 500 Nanoseconds Maximum
- The Fast Recovery Characteristics of the A139 Match the High Frequency Capability of General Electric High-Speed SCR's such as the C140, C141, C138, C139, and C144.
- For Use in:
  - Inverters
  - Choppers
  - Low RFI Applications
  - Sonar Power Supplies
  - Ultrasonic Systems
  - DC-DC Power Supplies
  - Free-Wheeling Rectifier Applications

SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A		.450		11.43	
b		.375		9.53	2
c		.080		2.03	
ϕD		.667		16.94	
E	.667	.687	16.94	17.45	
F	.115	.200	2.92	5.08	
F_1	.060		1.52		
J		1.000		25.40	
1	.156		3.96		4
ϕM	.220	.249	5.59	6.32	1
N	.422	.453	10.72	11.51	
ϕt	.140	.175	3.56	4.45	
W					1,3

OUTLINE DRAWING



NOTES:
1. COMPLETE THREADS TO EXTEND TO WITHIN 2-1/2 THREADS OF SEATING PLANE.
2. ANGULAR ORIENTATION OF TERMINAL IS UNDEFINED.
3. 1/4-28 UNF-2A. MAXIMUM PITCH DIAMETER OF PLATED THREADS SHALL BE BASIC PITCH DIAMETER (.2268", 5.74 MM) REF. (SCREW THREAD STANDARDS FOR FEDERAL SERVICES 1957) HANDBOOK H28 1957 P1.
4. MINIMUM FLAT.

EIA-NEMA STANDARD OUTLINE, NEMA SK-51-EIA RS-241.
INSULATING HARDWARE IS AVAILABLE UPON REQUEST.

COMPLIES WITH EIA REGISTERED OUTLINE DO-5

The fast recovery, A139, medium-current rectifier diode provides a superior combination of speed and blocking voltage capability. This high performance rectifier diode has been designed specifically for demanding, medium-current, high voltage applications.

ratings and specifications (Resistive or Inductive Load)

Forward Polarity:	A139E	A139M	A139N	A139P	
Reverse Polarity:	A139ER	A139MR	A139NR	A139PR	
Maximum Allowable Repetitive and Working Peak Reverse Voltage, V_{RM} (rep) & V_{RM} (wkg.)$^{(1)}$	500	600	800	1000	Volts
Maximum Allowable RMS Voltage, V_r	355	424	565	710	Volts
Maximum Allowable DC Blocking Voltage, V_R $^{(1)}$	500	600	800	1000	Volts
Maximum Allowable Non-Repetitive Reverse Voltage, V_{RSM}	600	720	960	1200	Volts
Maximum Allowable Average Forward Current (180° conduction angle, 60 cps, half sine wave current at T_C = 75°C), I_o	← 25 Amperes →				
Maximum Allowable Peak One Cycle Surge Current (non-recurrent), I_{FM}(surge)	← 400 Amperes →				

ratings and specifications (cont'd)

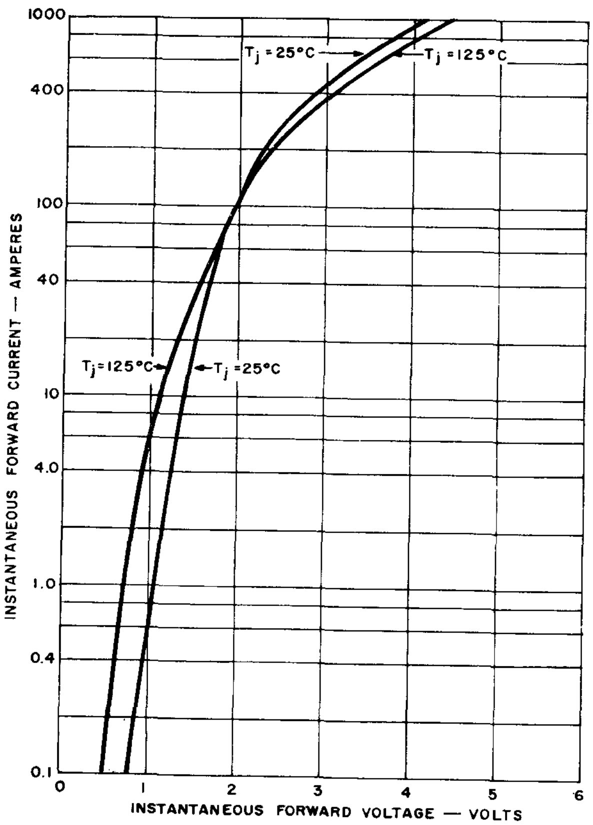
	A139E	A139M	A139N	A139P
Forward Polarity:	A139E	A139M	A139N	A139P
Reverse Polarity:	A139ER	A139MR	A139NR	A139PR
I^2t Rating (for t greater than .001 sec. and less than .0083 sec., non-recurrent)	← 500 Ampere²seconds →			
Maximum Peak Forward Voltage Drop (I_O = 25 Adc at T_C = 75°C), V_{FM}	← 1.85 Volts Peak →			
Maximum Average Reverse Current (I_O = 25 Adc at T_C = 75° C), $I_{R(AV)}$	← 3.0 mA →			
Maximum Reverse Recovery Time t_{rr} (2)	← 500 Nanoseconds →			
Maximum Effective Thermal Resistance Junction to Case, $R\theta_{JC}$	← 1.0 deg. C per watt →			
Junction Operating Temperature Range, T_J	← −40°C to +125°C →			
Storage Temperature Range, T_{stg}	← −40°C to +200°C →			
Stud Torque	← 30 Lb-in (35 Kg-cm) →			

(1) Maximum thermal resistance, case to ambient, for which maximum voltage and temperature ratings apply is:

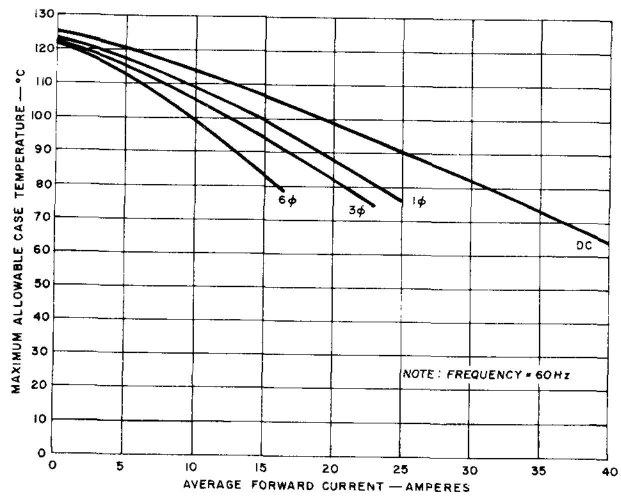
Voltage Type :	500	600	800	1000	Volts
Sinusoidal Voltage:	14.0	12.0	9.0	7.0	°C per watt
DC Voltage :	3.7	3.0	2.0	1.4	°C per watt

(2) Reverse recovery time measured at T_C = 25°C with I_{FM} = 5.0 Amp., commutating di/dt = 50 Amp/μsec, max. reverse recovery current = 15 Amp. peak.

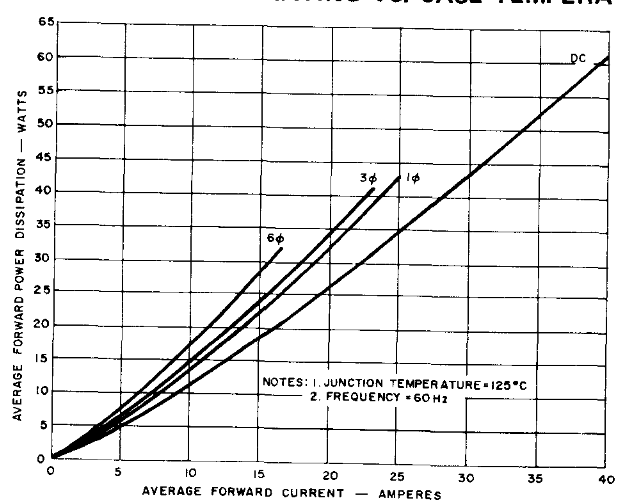
(3) To prevent possible device damage during reverse recovery, it is recommended that the rate of rise of reverse voltage be limited to 1200 volts per micro second maximum. An RC Snubber connected across the rectifier diode may be used to limit the rate of rise of reverse voltage.



MAXIMUM FORWARD CHARACTERISTICS



AVERAGE CURRENT RATING VS. CASE TEMPERATURE



MAXIMUM AVERAGE FORWARD POWER DISSIPATION

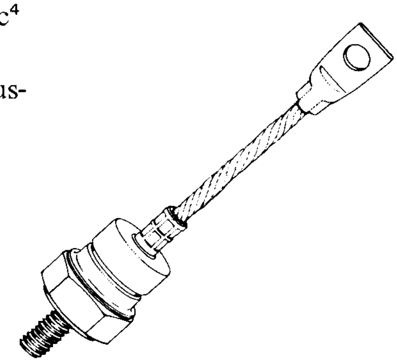
High Power Silicon Rectifier

1500 Volts 100A Avg.

A170

The A170 Series is General Electric's highly reliable, all-diffused Pic-Pac[4] 100 ampere silicon rectifier diode, similar to 1N3288-1N3297 Series.

This series of rectifier diodes is particularly suited to a wide range of industrial applications, especially those requiring high performance rectifiers.



FEATURES:

- Thermal Fatigue Resistant Pic-Pac[4] Construction
- Cathode Strain Buffer
- Soft Recovery
- 1500 Volt V_{RRM}
- Hermetic Package

TYPICAL APPLICATIONS:

- Transportation Equipment
- DC Motor Control
- DC Power Supplies
- Battery Vehicles

MAXIMUM ALLOWABLE RATINGS AND SPECIFICATIONS

TYPES*	REPETITIVE PEAK[1] REVERSE VOLTAGE V_{RRM} T_J = -40°C to +200°C	NON-REPETITIVE[2] PEAK REVERSE VOLTAGE, V_{RSM} T_J = 25°C to +200°C	DC REVERSE[3] VOLTAGE, V_R T_J = -40°C to +200°C	REPETITIVE PEAK REVERSE CURRENT I_{RRM} @ V_{RRM} T_J = 200°C
A170A	100 Volts	200 Volts	100 Volts	20 mA
A170B	200	300	200	20
A170C	300	400	300	20
A170D	400	525	400	20
A170E	500	650	500	20
A170M	600	800	600	20
A170S	700	925	700	20
A170N	800	1050	800	20
A170T	900	1175	900	20
A170P	1000	1300	1000	20
A170PA	1100	1400	1100	20
A170PB	1200	1500	1200	20
A170PC	1300	1600	1300	20
A170PD	1400	1700	1400	20
A170PE	1500	1800	1500	20

*Models listed are stud cathode (forward polarity) types. SpecifyA170R-for stud anode (reverse polarity) types. Ratings and specifications are for frequencies from 50 to 400 Hz, except where noted otherwise.

Average Forward Current, $I_{F(AV)}$ (T_C = +130°C, Single-Phase, Half Sine Wave) . . . . 100 Amperes
Peak One-Cycle Surge (Non-Repetitive), Forward Current, I_{FSM} . . . . 2500 Amperes
Minimum I^2t Rating (See Curve 6), t ⩾ 1 msec. (Non-Repetitive) . . . . 15,500 (RMS Ampere)^2 Seconds
Peak Forward Voltage Drop, V_{FM} (T_C = +130°C, $I_{F(AV)}$ = 100 Amps. Average, 314 Amps. Peak). . . . . 1.3 Volts
Thermal Resistance, $R_{\theta JC}$ (DC) . . . . 0.4 °C/Watt
1ϕ & 3ϕ (50 to 400 Hz) . . . . 0.55°C/Watt
6ϕ (50 to 400 Hz) . . . . 0.72°C/Watt
Storage Temperature, T_{stg} . . . . -40°C to +200°C
Operating Junction Temperature, T_J . . . . -40°C to +200°C
Stud Torque (See Mounting Guide) . . . . 90 Lb-in (Min.), 100 Lb-in (Max.)
10.1 N-m (Min.), 11.3 N-m (Max.)

NOTES:

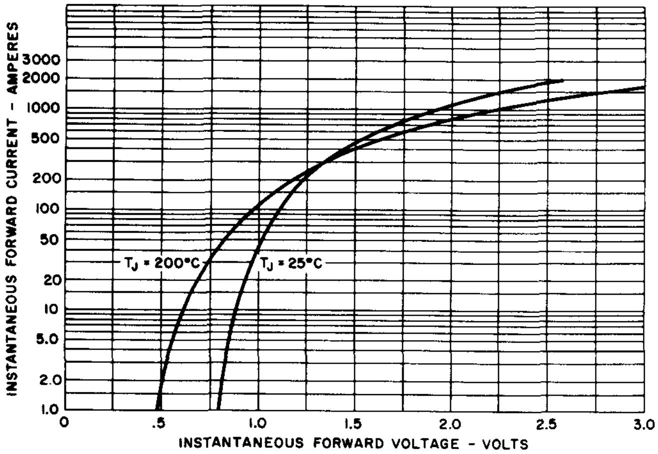
1 Assumes a heatsink thermal resistance of less than 2.0°C/watt.

2 Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetitive ratings that are used in fault coordination work.

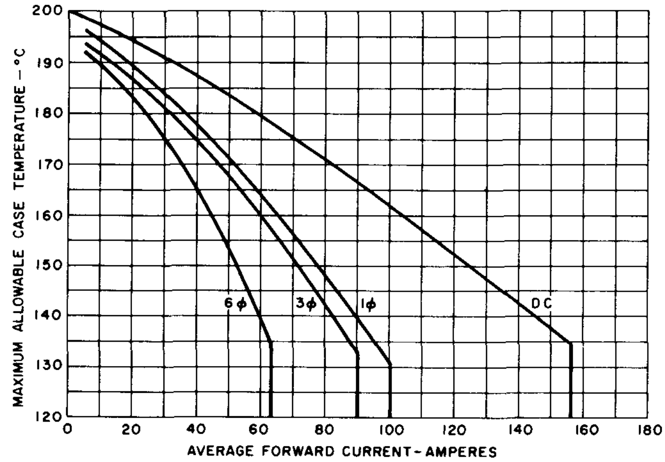
3 Assumes a heatsink thermal resistance of less than 1.0°C/watt.

4 "Pic-Pac" is an acronym for Pressure Internal Contact Package.

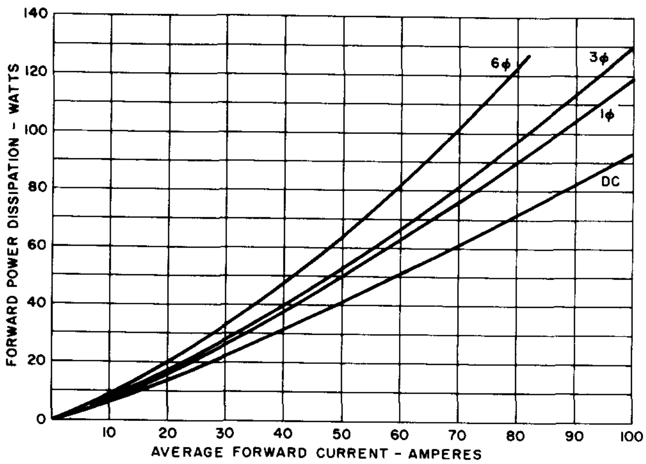
DEVICE SPECIFICATIONS



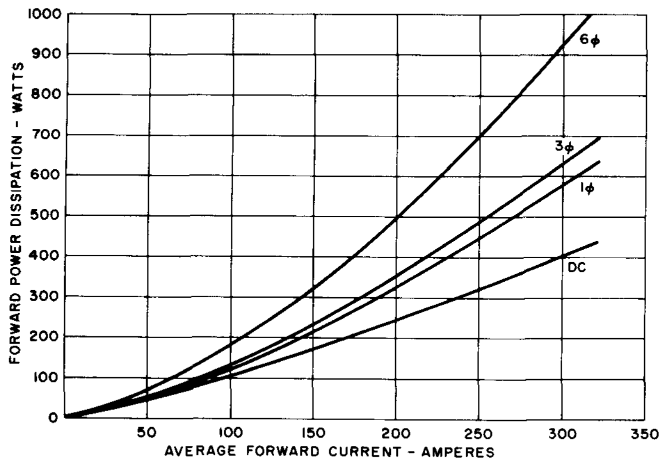
1. MAXIMUM FORWARD CHARACTERISTICS



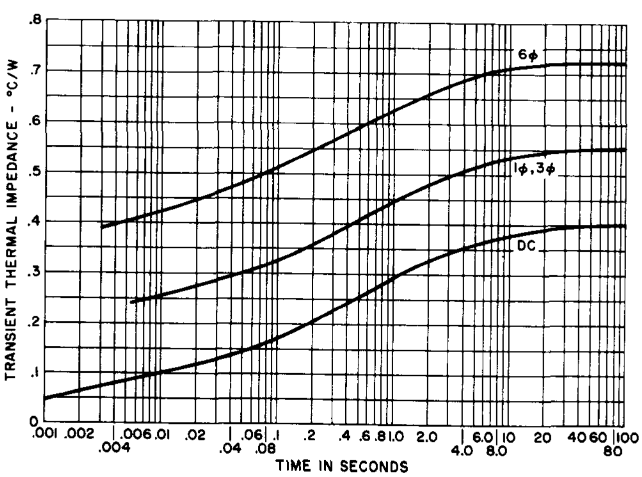
2. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT



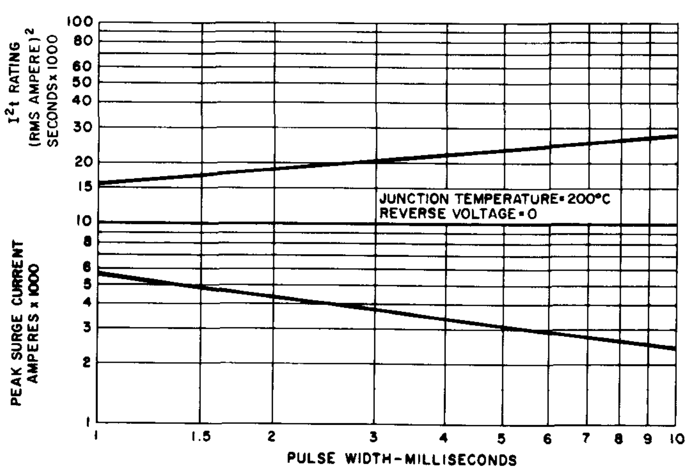
3. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT



4. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT, HIGH LEVEL



5. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE

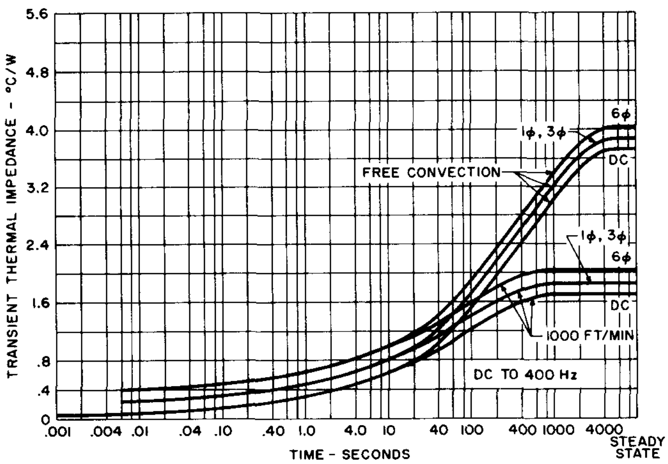


6. SUB-CYCLE SURGE FORWARD CURRENT AND I^2t RATING VS. PULSE TIME FOLLOWING RATED LOAD CONDITIONS

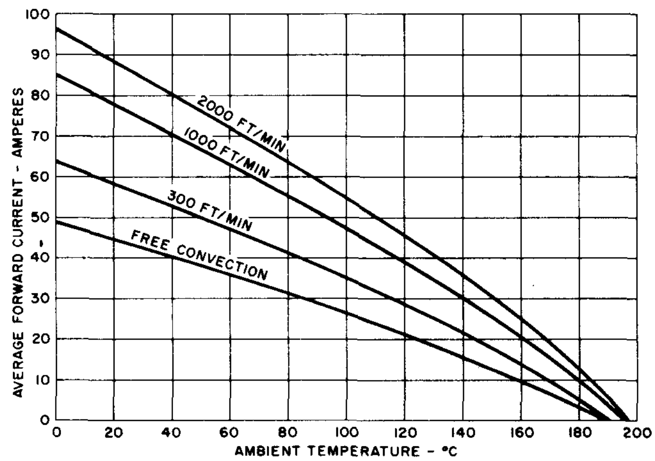
MAXIMUM CIRCUIT RATINGS

5" x 5" x 1/8" COPPER FIN (GE #12 FIN)

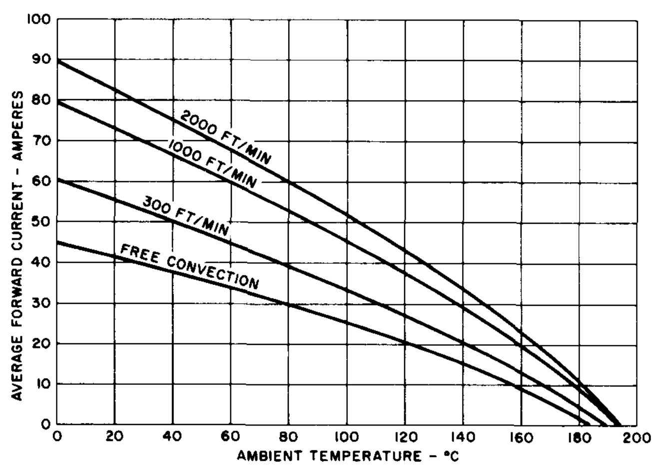
1. Minimum Fin Spacing 1 inch
2. Fin $\epsilon \geq 0.9$
3. Fins Mounted Vertically or
   Parallel to Forced Air Flow



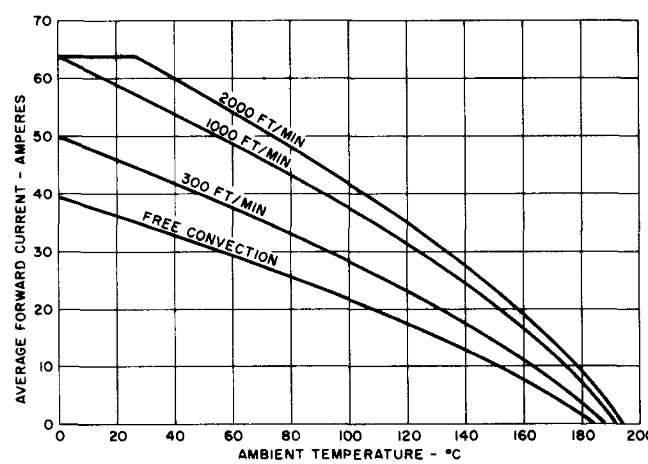
7. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-AMBIENT



8. SINGLE-PHASE HALF-WAVE FORWARD CURRENT (180°C Conduction) VS. AMBIENT TEMPERATURE



9. THREE-PHASE FORWARD CURRENT (120°C Conduction) VS. AMBIENT TEMPERATURE



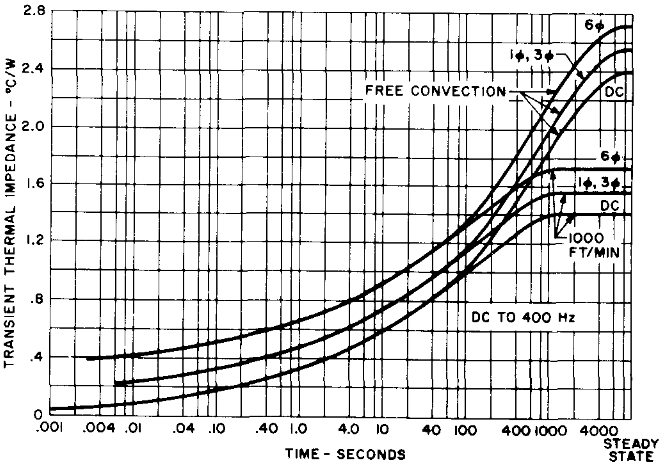
10. SIX-PHASE FORWARD CURRENT (60°C Conduction) VS. AMBIENT TEMPERATURE

A170

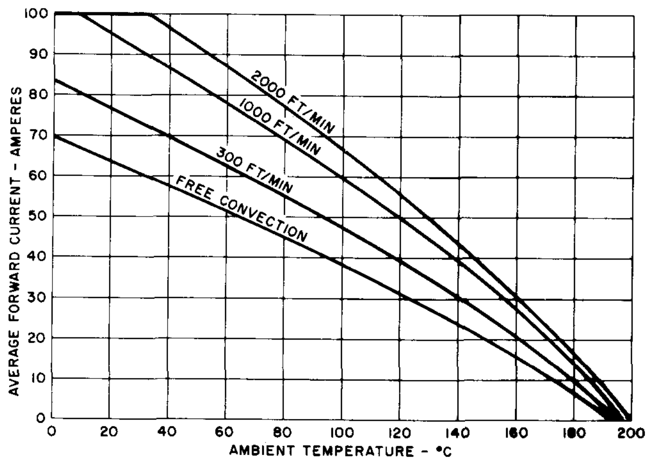
MAXIMUM CIRCUIT RATINGS

7" x 7" x 3/8" ALUMINUM FIN (GE #13 FIN)
7" x 7" x 1/4" COPPER FIN

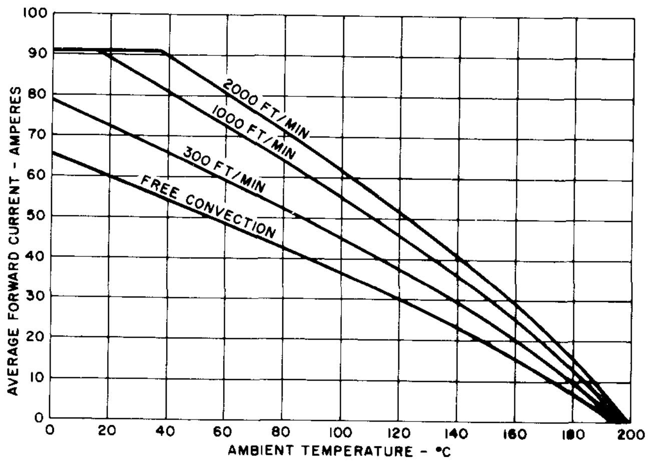
1. Minimum Fin Spacing 1 inch
2. Fin $\epsilon \geqslant 0.9$
3. Fins Mounted Vertically or Parallel to Forced Air Flow



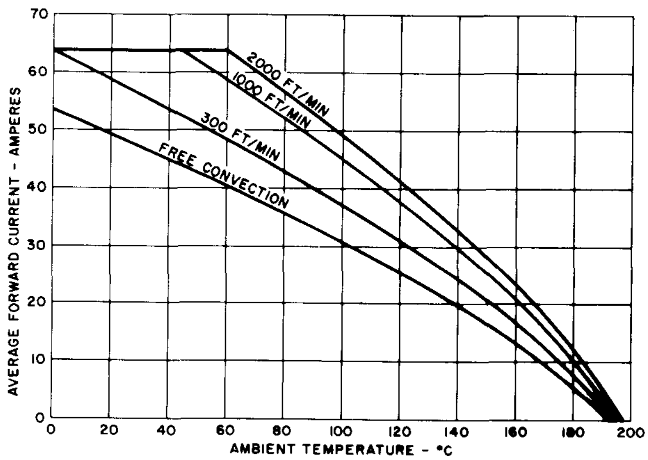
11. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-AMBIENT



12. SINGLE-PHASE HALF-WAVE FORWARD CURRENT (180°C Conduction) VS. AMBIENT TEMPERATURE



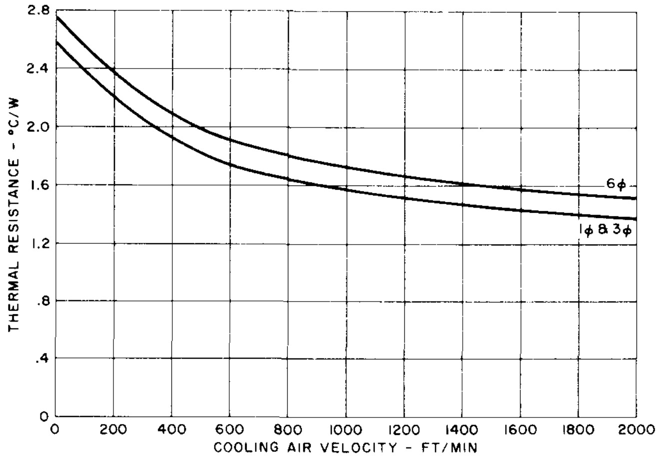
13. THREE-PHASE FORWARD CURRENT (120°C Conduction) VS. AMBIENT TEMPERATURE



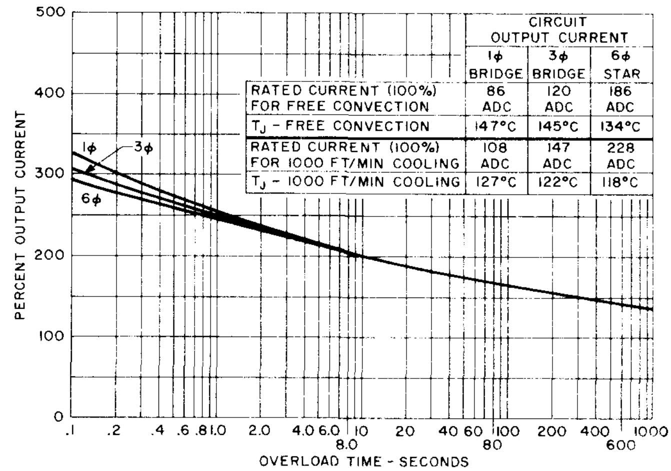
14. SIX-PHASE FORWARD CURRENT (60°C Conduction) VS. AMBIENT TEMPERATURE

REPETITIVE OVERLOAD RATINGS

FOR DIODES MOUNTED ON 7" x 7" x 3/8" ALUMINUM FIN (GE #13) OR A 7" x 7" x 1/4" COPPER FIN



15. STEADY-STATE THERMAL RESISTANCE – JUNCTION-TO-AMBIENT



16. REPETITIVE OVERLOAD CURVE MEETING NEMA STANDARDS FOR "General Purpose Rectifier Equipments Under 100 KW" AT 40°C AMBIENT

NOTES:

1. The repetitive overload calculation procedure outlined on the back cover was used to obtain the ratings shown by curve 16. This method can be used when the rectifier diode is mounted on any heat sink possessing:
   a) a heat dissipation surface of 100 square inches or more;
   b) a thermal capacity greater than 700 watt-seconds; and,
   c) a fin efficiency greater than 95% for free convection and 85% for forced air cooling.
2. The NEMA standard cited in curve 16 specifies 200% output current for 10 seconds and 150% output for one minute.

OUTLINE DRAWING

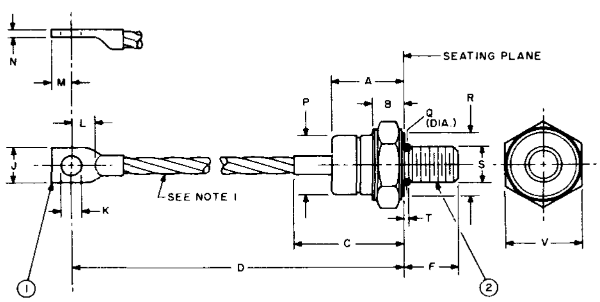


TABLE OF DIMENSIONS
Conversion Table

SYM.	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	
B	.390	.500	9.90	12.70	
C	1.570	1.750	39.87	44.45	
D	4.345	4.745	110.36	120.52	
J	.500	.625	12.70	13.20	
K	.259	.281	6.57	7.14	
L	.320	—	8.12	—	
M	.280	.320	7.11	8.13	
N	.060	.090	1.52	2.29	
F	.840	.910	21.33	23.11	
R	.920	—	23.36	—	3
T	—	.060	—	1.52	4
V	1.052	1.063	26.72	27.00	

MODEL	TERMINAL 1	TERMINAL 2	S THREAD SIZE	F THREAD LENGTH	Q RELIEF DIAMETER
A170 FORWARD POLARITY	ANODE	CATHODE	3/8 – 24	.640/.610 IN.	.373/.344 IN.
A170R REVERSE POLARITY	CATHODE	ANODE	UNF – 2A	16.26/15.49 MM	9.47/8.74 MM

NOTES:

1. Flexible Copper Lead, 9/32 Inch Nominal Diameter.
2. One Nut and One Lockwasher Supplied With Each Unit. Material of Hardware is Steel-Cad Plated.
3. "R" Dimension is Diameter of Effective Seating Area.
4. "T" Dimension is Area of Unthreaded Portion. Complete Threads are Within 2.5 Threads of Seating Plane.
5. Angular Orientation of Terminals is Undefined.
6. Approximate Weight: 105 Grams.

INSTALLATION INSTRUCTIONS

Following these installation instructions will result in a diode-to-heatsink thermal resistance of .10°C/watt or less.

1. Be sure mounting surface is clean and flat at (.001 inch/inch).
2. Mounting hole diameter should not exceed rectifier stud OD by more than 1/16" and should be deburred.
3. Use Dow Corning's DC3, 4, 340 or 640 or GE6332L or equivalent on mounting surfaces which come in contact with the heatsink.
4. Use suitable hardware. (Nut and split lockwasher are supplied.)
5. Tighten with a torque wrench, from nut side to 100 lb-in.

REPETITIVE OVERLOAD RATING DETERMINATION

FOR OVERLOAD CONDITIONS OTHER THAN SHOWN IN FIGURE 16

To determine the steady state current rating which will accommodate a given repetitive overload rating (for diode mounted on a 7 x 7 x 3/8" aluminum or 7 x 7 x 1/4" copper fin) the following "cut and try" method is suggested:

where T_J max. = $T_A + (P_{SS}) R_{\theta JA} + (P_{OL}\text{-}P_{SS}) Z_{\theta(t)}$

T_J max. = Max. Junction Temperature (200°C)

T_A = Max. Ambient in °C

P_{SS} = Steady State Diode Power Dissipation from curve 3 (reverse losses ignored).

$R_{\theta JA}$ = Steady State Thermal Resistance from curve 11.

P_{OL} = Diode Power Dissipation (under repetitive overload conditions) from curve 4.

$Z_{\theta(t)}$ = Transient Thermal Impedance (under overload conditions) from curve 11.

As a starting point, it is suggested that the steady state diode current without repetitive overload current be determined (see curves 12, 13, or 14).

To permit a repetitive overload rating, the maximum rated diode current must be reduced. Using a reduced value of steady state current as an estimate, the data for insertion into the formula can be obtained from curves 3, 4 and 11.

When the estimate is correct, the right side of the formula given above will equal the maximum T_J, which is 200°C.

Example: 200% repetitive overload required for 10 seconds;
3-phase bridge;
convection cooled;
maximum ambient = 30°C.

From curve 13, steady state rating without provision for repetitive overload equals 56 amps/diode. Therefore, a first approximation may be 40 amps steady state and 80 amps overload. Substituting these values in the formula, we have:

T_J max. = 30 + (40 x 2.55) + (97 – 40) .75

T_J max. = 175°C

The answer of 175°C indicates that our steady state selection was slightly low. By choosing 45 amps steady state and 90 amps overload, we come closer to the maximum rating permissible, based on T_J max. = 200°C.

Of course, the 3-phase-bridge output current will be three times the diode current, 135 amps average steady state, and 270 amps, or 200% current, for 10 seconds.

High Speed

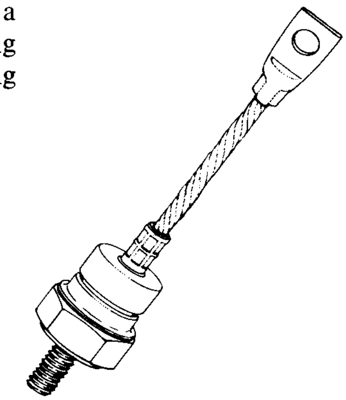
Fast Recovery Rectifier

A177

1500 Volts 100A Avg.

The A177 series is General Electric's highly reliable, all-diffused, Pic-Pac,[4] 100 ampere, fast recovery, silicon rectifier diode. These diodes are designed for use in high frequency applications or where a fast recovery diode is a necessity. These diodes provide a superior combination of speed, blocking voltage capability and soft recovery, which is required in such demanding applications as:

- Inverter Feedback Diode
- Free Wheeling Diode
- High Frequency Rectification
- Low EMI Power Supplies



FEATURES:

- Published Current Ratings Up To 20,000 Hz
- All-Diffused
- Thermal Fatigue Resistant Pic-Pac[4] Construction
- Cathode Strain Buffer
- Soft Recovery With Low Recovered Charge
- Rugged Hermetic Package
- Available in 3/8″ or 1/2″ Stud

MAXIMUM ALLOWABLE RATINGS AND SPECIFICATIONS

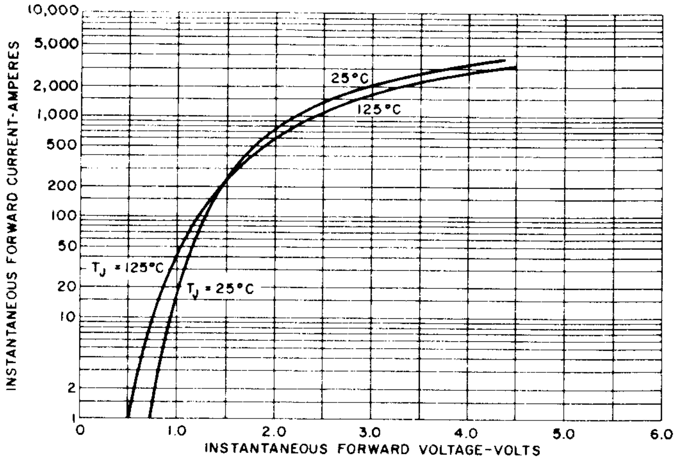
TYPES*	REPETITIVE PEAK [1] REVERSE VOLTAGE V_{RRM} T_J = -40°C to +125°C	NON-REPETITIVE[2] PEAK REVERSE VOLTAGE, V_{RSM} T_J = 25° to +125°C	DC REVERSE[3] VOLTAGE, V_R T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE CURRENT, I_{RRM} T_J = 125°C
A177A	100 Volts	200 Volts	100 Volts	20 mA
A177B	200	300	200	20
A177C	300	400	300	20
A177D	400	500	400	20
A177E	500	600	500	20
A177M	600	720	600	20
A177S	700	840	700	20
A177N	800	950	800	20
A177T	900	1075	900	20
A177P	1000	1200	1000	20
A177PA	1100	1300	1100	20
A177PB	1200	1400	1200	20
A177PC	1300	1500	1300	20
A177PD	1400	1600	1400	20
A177PE	1500	1700	1500	20

*Models listed are stud cathode (forward polarity) types. Specify A177R- for stud anode (reverse polarity) types. Ratings and specifications are for frequencies from 50 to 20,000 Hz, except where noted otherwise.

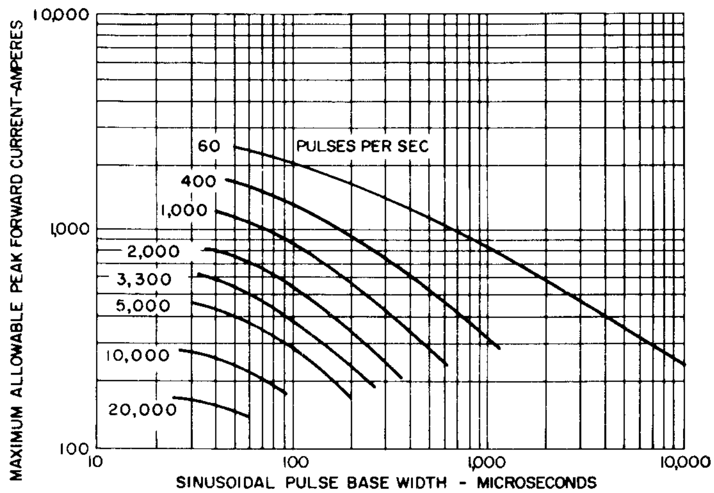
Peak Forward Current, I_{FM} (T_C = +65°C, Half Sine Wave Pulse Base Width = 8.3 msec., D.F. = 50%) . . . . . . 280 Amperes
Peak One-Cycle Surge (Non-Repetitive), Current, I_{FSM} . . . . 2500 Amperes
Minimum I^2t Rating (See Curve 11), t ⩾ 1 msec. (Non-Repetitive) . . . . 13,500 (RMS Ampere)^2 Seconds
Thermal Resistance, $R_{\theta JC}$ (D.C.) . . . . 0.4°C/Watt
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Junction Temperature, T_J . . . . -40°C to +125°C
Stud Torque . . . . 90 Lb-in (Min.), 100 Lb-in (Max.)
10.2 N-m (Min.), 11.3 N-m (Max.)

NOTES:

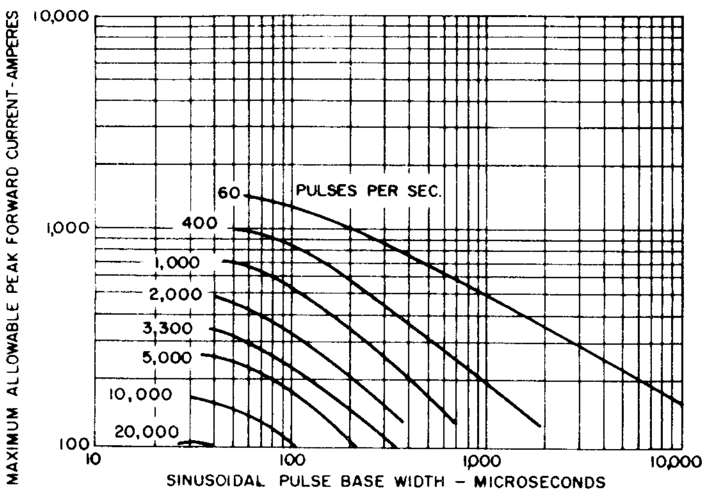
1 Assumes a heatsink thermal resistance of less than 2.0°C/watt.
2 Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetitive ratings that are used in fault coordination work.
3 Assumes a heatsink thermal resistance of less than 1.0°C/watt.
4 "Pic-Pac" is an acronym for Pressure Internal Contact Package.



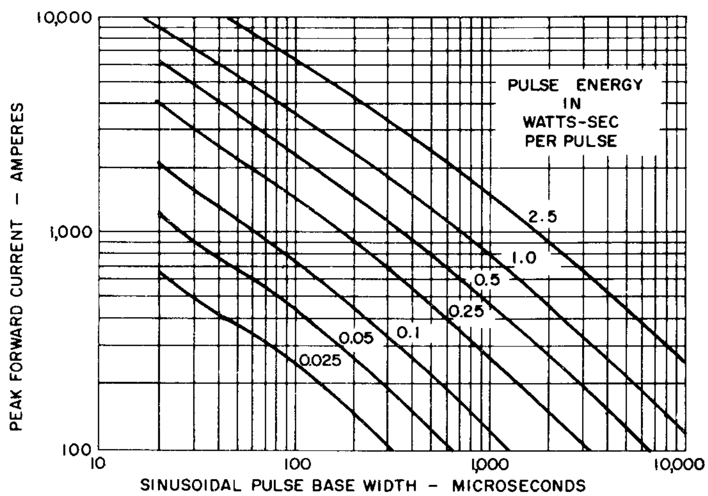
1. MAXIMUM FORWARD CHARACTERISTICS



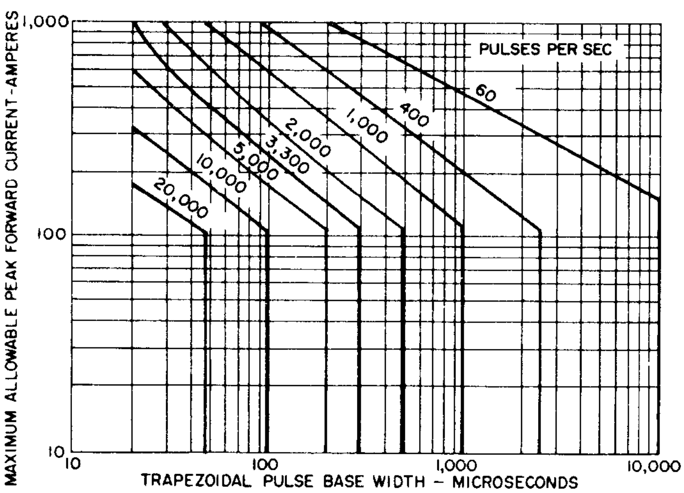
2. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT
SINUSOIDAL WAVEFORM (T_C = 65°C)



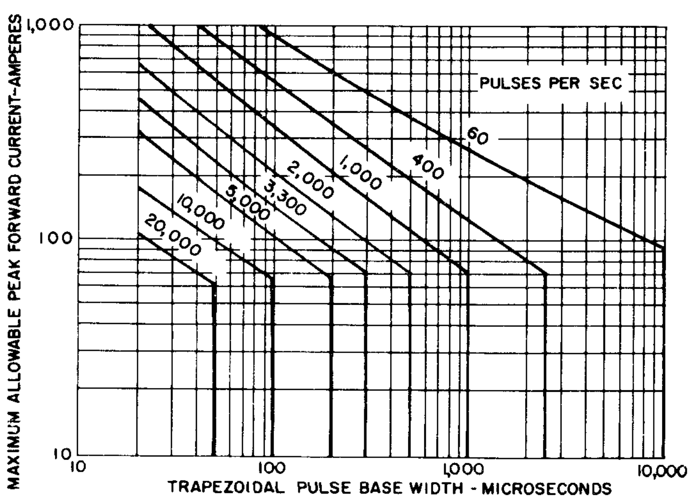
3. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT
SINUSOIDAL WAVEFORM (T_C = 90°C)



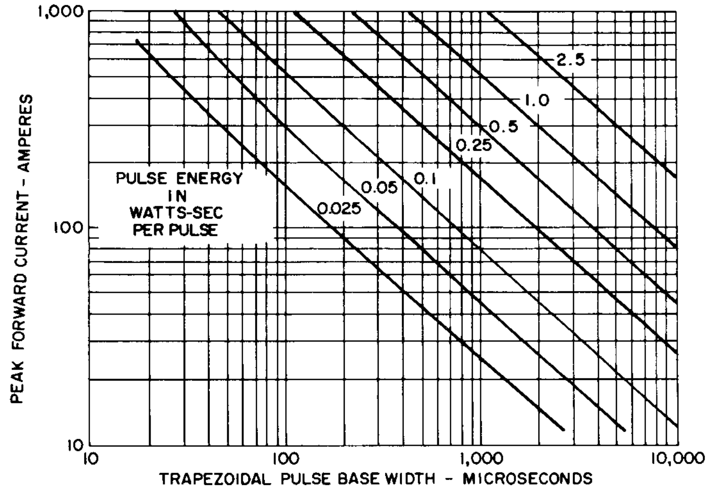
4. SINUSOIDAL PULSE ENERGY (T_C = 125°C)



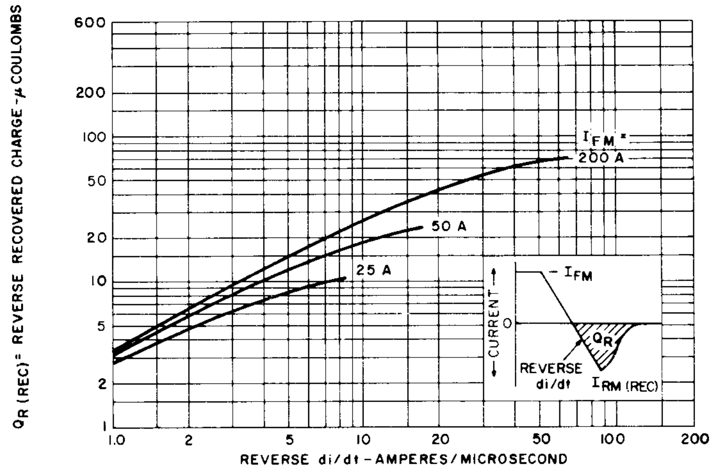
5. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT, TRAPEZOIDAL WAVEFORM (T_C = 65°C), DI/DT (RISING & FALLING) = 100 A/μS



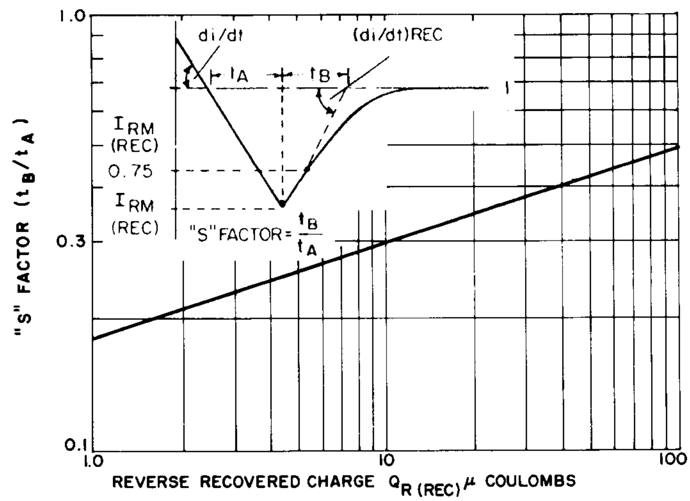
6. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT, TRAPEZOIDAL WAVEFROM (T_C = 90°C), DI/DT (RISING & FALLING) = 100 A/μS



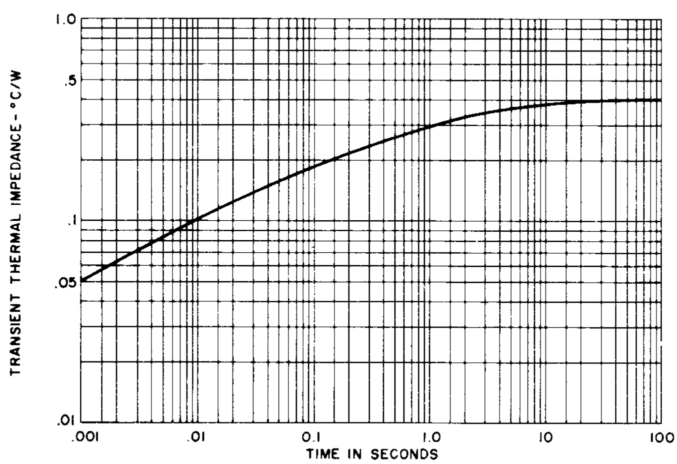
7. TRAPEZOIDAL PULSE ENERGY
DI/DT (RISING & FALLING) = 100 A/μS



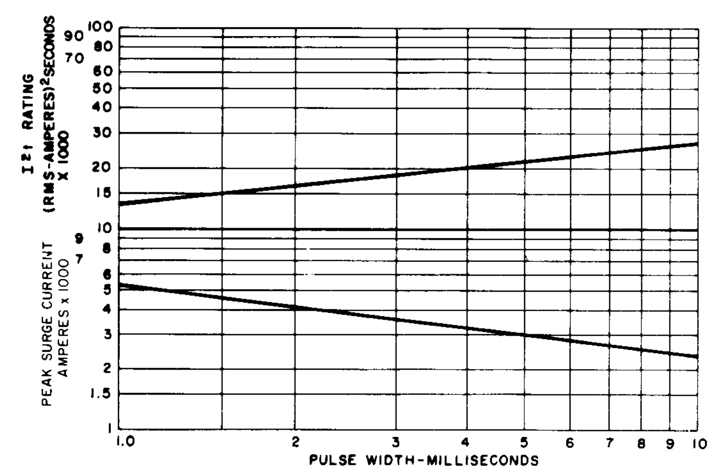
8. RECOVERED CHARGE (T_J = 125°C)
(Maximum Recovered Charge Group 12)
If maximum recovered charge group 12 is required, request A177__ X9, e.g. A177BX9, A177RBX9, etc.



9. TYPICAL "S" FACTOR VERSUS REVERSE RECOVERED CHARGE (T_J = 125°C)

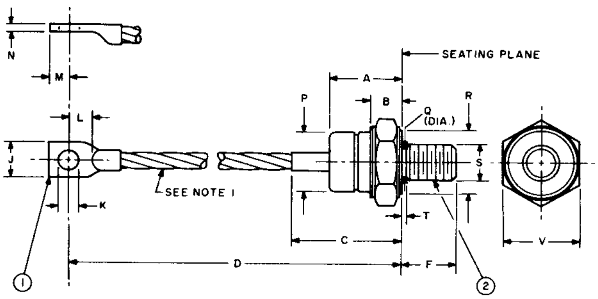


10. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



11. SUB-CYCLE SURGE FORWARD CURRENT AND I^2t RATING VERSUS PULSE TIME FOLLOWING RATED LOAD CONDITIONS

OUTLINE DRAWING



MODEL	TERMINAL 1	TERMINAL 2	S THREAD SIZE	F THREAD LENGTH	Q RELIEF DIAMETER
A177 FORWARD POLARITY	ANODE	CATHODE	3/8 – 24	.640/.610 IN.	.373/.344 IN.
A177R REVERSE POLARITY	CATHODE	ANODE	UNF – 2A	16.26/15.49 MM	9.47/8.74 MM

TABLE OF DIMENSIONS
Conversion Table

SYM.	DECIMAL INCHES		METRIC MM		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	1.020	1.140	25.90	28.96	
B	.390	.500	9.90	12.70	
C	1.570	1.750	39.87	44.45	
D	4.345	4.745	110.36	120.52	
J	.500	.625	12.70	13.20	
K	.259	.281	6.57	7.14	
L	.320	–	8.12	–	
M	.280	.320	7.11	8.13	
N	.060	.090	1.52	2.29	
P	.840	.910	21.33	23.11	
R	.920	–	23.36	–	3
T	–	.060	–	1.52	4
V	1.052	1.063	26.72	27.00	

NOTES:

1. Flexible Copper Lead, 3/16 Inch Nominal Diameter.
2. One Nut and One Lockwasher Supplied With Each Unit. Material of Hardware is Steel-Cad Plated.
3. "R" Dimension is Diameter of Effective Seating Area.
4. "T" Dimension is Area of Unthreaded Portion. Complete Threads are Within 2.5 Threads of Seating Plane.
5. Angular Orientation of Terminals is Undefined.
6. Approximate Weight: 105 Grams.

MOUNTING INSTRUCTIONS

Following these installation instructions will result in a rectifier diode-to-heatsink contact thermal resistance of 0.10°C/watt or less.

1. Be sure mounting surface is clean and flat within .001 inch/inch.
2. Mounting hole diameter should not exceed the outside diameter of the rectifier diode stud by more than 1/16 inch, and should be deburred.
3. Use Dow Corning's DC3, 4, 340 or 640 or GE G322L or equivalent, on mounting surfaces that come in contact with the heatsink.
4. Use only hardware furnished with each rectifier diode.
5. Tighten with a torque wrench, from nut side, to 100 lb-in max.

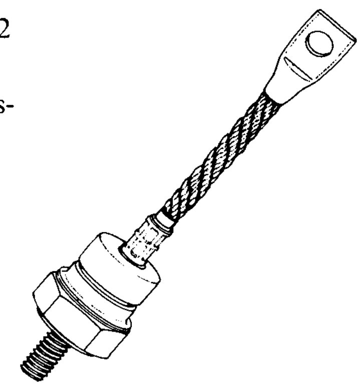
High Power Silicon Rectifier

1500 Volts   150A Avg.

A180

The A180 Series is General Electric's highly reliable, all-diffused, Pic-Pac[4] 150 ampere silicon rectifier diode. This diode is similar to the 1N3085-92 series and the 1N5162.

This series of rectifier diodes is particularly suited to a wide range of industrial applications, expecially those requiring high performance rectifiers.



FEATURES:

- Thermal Fatigue Resistant Pic-Pac[4] Construction
- Cathode Strain Buffer
- Soft Recovery
- 1500 Volt V_{RRM}
- Hermetic Package
- Available in 3/8″ or 1/2″ Stud

TYPICAL APPLICATIONS:

- Transportation Equipment
- DC Motor Control
- DC Power Supplies
- Battery Vehicles

MAXIMUM ALLOWABLE RATINGS AND SPECIFICATIONS

TYPES*	REPETITIVE PEAK[1] REVERSE VOLTAGE V_{RRM} T_J = -40°C to +200°C	NON-REPETITIVE[2] PEAK REVERSE VOLTAGE, V_{RSM} T_J = 25°C to +200°C	DC REVERSE[3] VOLTAGE, V_R T_J = -40°C to +200°C	REPETITIVE PEAK REVERSE CURRENT I_{RRM} @ V_{RRM} T_J = 200°C
A180A	100 Volts	200 Volts	100 Volts	20 mA
A180B	200	300	200	20
A180C	300	400	300	20
A180D	400	525	400	20
A180E	500	650	500	20
A180M	600	800	600	20
A180S	700	925	700	20
A180N	800	1050	800	20
A180T	900	1175	900	20
A180P	1000	1300	1000	20
A180PA	1100	1400	1100	20
A180PB	1200	1500	1200	20
A180PC	1300	1600	1300	20
A180PD	1400	1700	1400	20
A180PE	1500	1800	1500	20

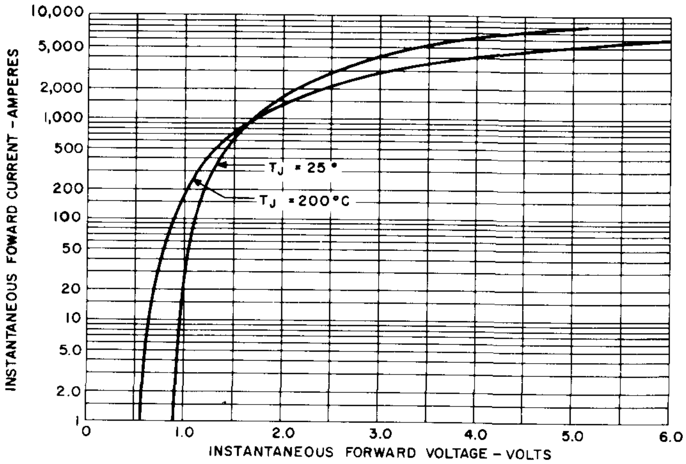
*Models listed are stud cathode (forward polarity) types. Specify A180R-for stud anode (reverse polarity) types. Ratings and specifications are for frequencies from 50 to 400 Hz, except where noted otherwise.

Average Forward Current, $I_{F(AV)}$ (T_C = +143°C, Single-Phase, Half Sine Wave) .... 150 Amperes
Peak One-Cycle Surge (Non-Repetitive), Forward Current, I_{FSM} .... 3400 Amperes
Minimum I^2t Rating (See Curve 4), t ⩾ 1 msec. (Non-Repetitive) .... 22,000 (RMS Ampere)^2 Seconds
Peak Forward Voltage Drop, V_{FM} (T_C = +143°C, $I_{F(AV)}$ = 150 Amps. Average, 471 Amps. Peak). .... 1.3 Volts
Thermal Resistance, $R_{\theta JC}$ (DC) .... 0.3°C/Watt
Storage Temperature, T_{stg} .... -40°C to +200°C
Operating Junction Temperature, T_J .... -40°C to +200°C
Stud Torque (See Mounting Guide) .... 90 Lb-in (Min.), 100 Lb-in (Max.)
10.2 N-m (Min.), 11.3 N-m (Max.)

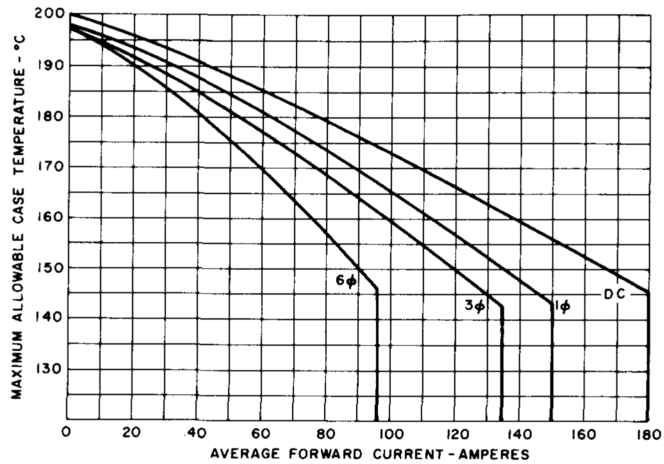
NOTES:

1 Assumes a heatsink thermal resistance of less than 2.0°C/watt.
2 Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetitive ratings that are used in fault coordination work.
3 Assumes a heatsink thermal resistance of less than 1.0°C/watt.
4 "Pic-Pac" is an acronym for Pressure Internal Contact Package.

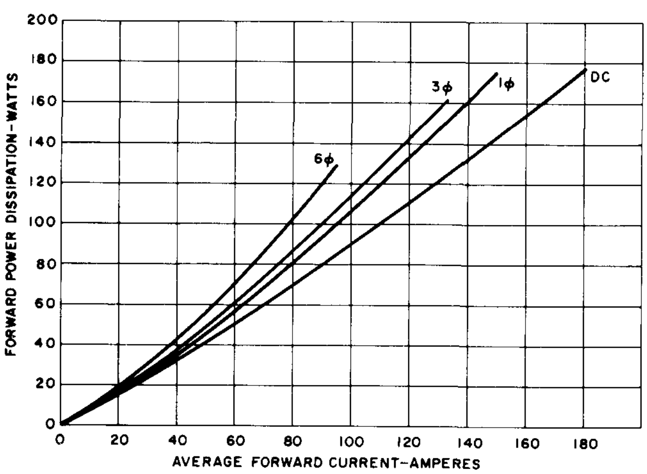
DEVICE SPECIFICATIONS



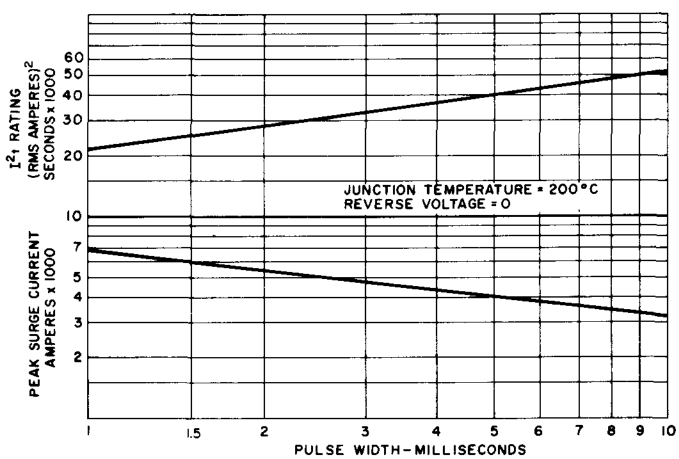
1. MAXIMUM FORWARD CHARACTERISTICS



2. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT

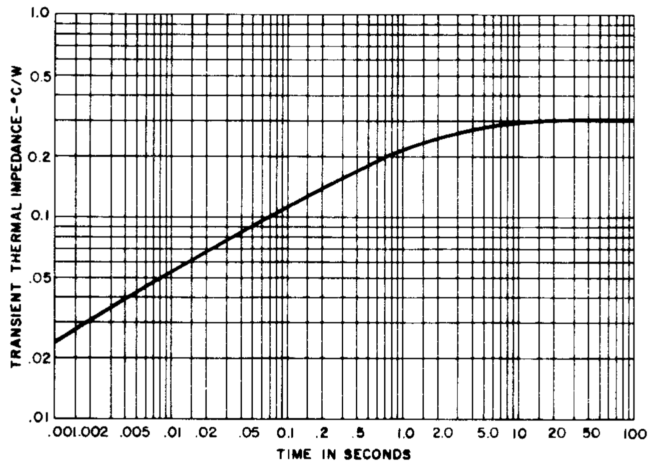


3. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT

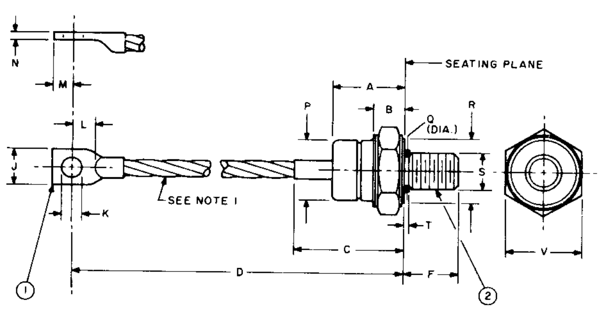


4. SUB-CYCLE SURGE FORWARD CURRENT AND I^2t RATING VS. PULSE TIME FOLLOWING RATED LOAD CONDITIONS

DEVICE SPECIFICATIONS



5. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



MODEL	TERMINAL 1	TERMINAL 2	S THREAD SIZE	F THREAD LENGTH	Q RELIEF DIAMETER
A180 FORWARD POLARITY	ANODE	CATHODE	3/8 – 24	.640/.610 IN.	.373/.344 IN.
A180R REVERSE POLARITY	CATHODE	ANODE	UNF – 2A	16.26/15.49 MM	9.47/8.74 MM

TABLE OF DIMENSIONS
Conversion Table

SYM.	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	
B	.390	.500	9.90	12.70	
C	1.570	1.750	39.87	44.45	
D	4.750	5.150	120.65	130.81	
J	.520	.625	13.20	15.88	
K	.270	.291	6.85	7.39	
L	.320	–	8.12	–	
M	.280	.320	7.11	8.13	
N	.070	.110	1.77	2.79	
P	.840	.910	21.33	23.11	
R	.920	–	23.36	–	3
T	–	.060	–	1.52	4
V	1.052	1.063	26.72	27.00	

NOTES:

1. Flexible Copper Lead, 9/32 Inch Nominal Diameter.
2. One Nut and One Lockwasher Supplied With Each Unit. Material of Hardware is Steel-Cad Plated.
3. "R" Dimension is Diameter of Effective Seating Area.
4. "T" Dimension is Area of Unthreaded Portion. Complete Threads are Within 2.5 Threads of Seating Plane.
5. Angular Orientation of Terminals is Undefined.
6. Approximate Weight: 105 Grams.

INSTALLATION INSTRUCTIONS

Following these installation instructions will result in a rectifier diode-to-heatsink contact thermal resistance of 0.10°C/watt or less.

1. Be sure mounting surface is clean and flat within .001 inch/inch.
2. Mounting hole diameter should not exceed the outside diameter of the rectifier diode stud by more than 1/16 inch, and should be deburred.
3. Use Dow Corning's DC3, 4, 340, 640 or GE G322L or equivalent, on mounting surfaces that come in contact with the heatsink.
4. Use only hardware furnished with each rectifier diode.
5. Tighten with a torque wrench, from nut side to 100 lb-in.

High Speed
Fast Recovery Rectifier

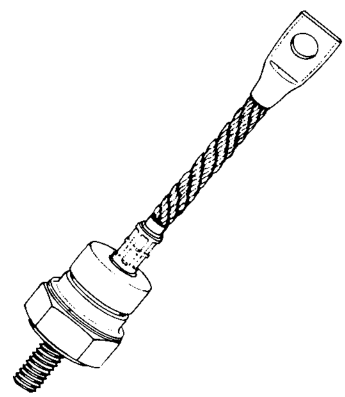
A187

A190 SEE 1N3735, PAGE 241

1500 Volts 150A Avg.

The A187 series is General Electric's highly reliable, all-diffused, Pic-Pac,[4] 150 ampere, fast recovery, silicon rectifier diode. These diodes are designed for use in high frequency applications or where a fast recovery diode is a necessity. These diodes provide a superior combination of speed, blocking voltage capability and soft recovery, which is required in such demanding applications as:

- Inverter Feedback Diode
- Free Wheeling Diode
- High Frequency Rectification
- Low EMI Power Supplies



FEATURES:

- Published Current Ratings Up To 20,000 Hz
- All-Diffused
- Thermal Fatigue Resistant Pic-Pac[4] Construction
- Cathode Strain Buffer
- Soft Recovery With Low Recovered Charge
- Rugged Hermetic Package
- Available in 3/8″ or 1/2″ Stud

MAXIMUM ALLOWABLE RATINGS AND SPECIFICATIONS

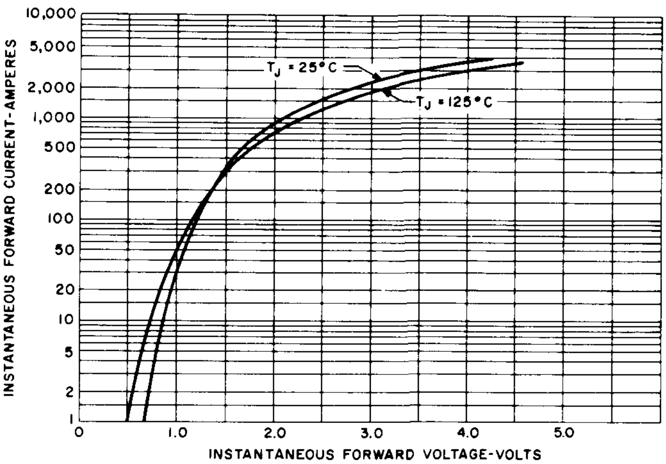
TYPES*	REPETITIVE PEAK [1] REVERSE VOLTAGE V_{RRM} T_J = -40°C to +125°C	NON-REPETITIVE[2] PEAK REVERSE VOLTAGE, V_{RSM} T_J = 25°C to +125°C	DC REVERSE[3] VOLTAGE, V_R T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE CURRENT, I_{RRM} T_J = 125°C
A187A	100 Volts	200 Volts	100 Volts	25 mA
A187B	200	300	200	25
A187C	300	400	300	25
A187D	400	500	400	25
A187E	500	600	500	25
A187M	600	720	600	25
A187S	700	840	700	25
A187N	800	950	800	25
A187T	900	1075	900	25
A187P	1000	1200	1000	25
A187PA	1100	1300	1100	25
A187PB	1200	1400	1200	25
A187PC	1300	1500	1300	25
A187PD	1400	1600	1400	25
A187PE	1500	1700	1500	25

*Models listed are stud cathode (forward polarity) types. Specify A187R- for stud anode (reverse polarity) types. Ratings and specifications are for frequencies from 50 to 20,000 Hz, except where noted otherwise.

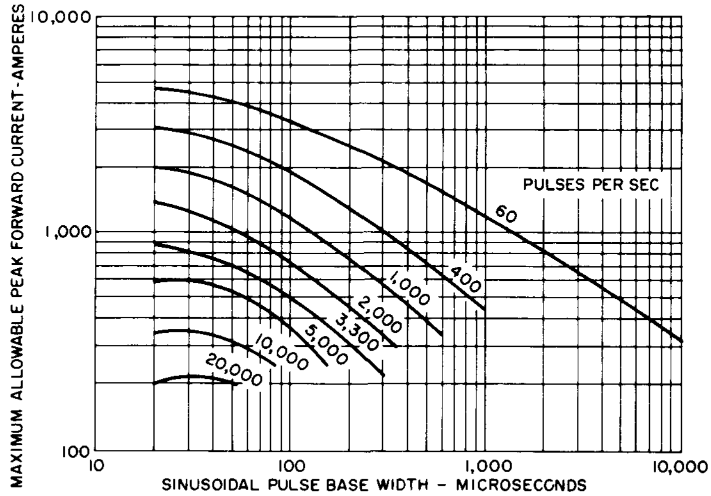
Peak Forward Current, I_{FM} (T_C = +65°C, Half Sine Wave Pulse Base Width = 8.3 msec., D.F. = 50%). . . . . . 380 Amperes
Peak One-Cycle Surge (Non-Repetitive), Forward Current, I_{FSM} . . . . 2800 Amperes
Minimum I^2t Rating (See Curve 11), t $\geqslant$ 1 msec. (Non-Repetitive) . . . . 21,000 (RMS Ampere)^2 Seconds
Thermal Resistance, $R_{\theta JC}$ (D.C.) . . . . 0.3°C/Watt
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Junction Temperature, T_J . . . . -40°C to +125°C
Stud Torque . . . . 90 Lb-in (Min.), 100 Lb-in (Max.)
10.2 N-m (Min.), 11.3 N-m (Max.)

NOTES:

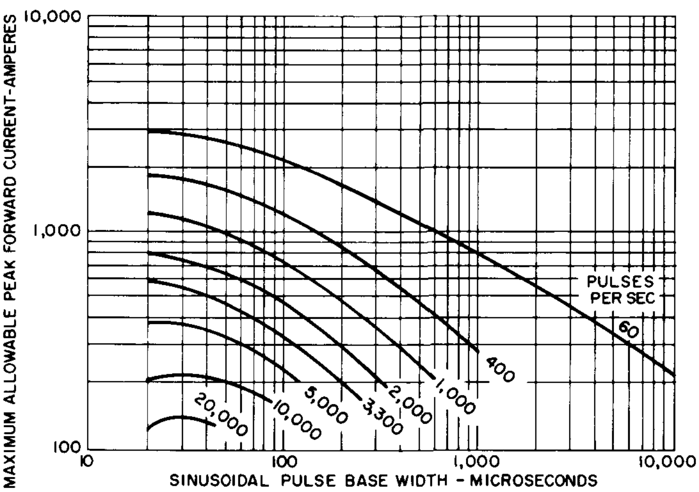
1 Assumes a heatsink thermal resistance of less than 2.0°C/watt.
2 Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetitive ratings that are used in fault coordination work.
3 Assumes a heatsink thermal resistance of less than 1.0°C/watt.
4 "Pic-Pac" is an acronym for Pressure Internal Contact Package.



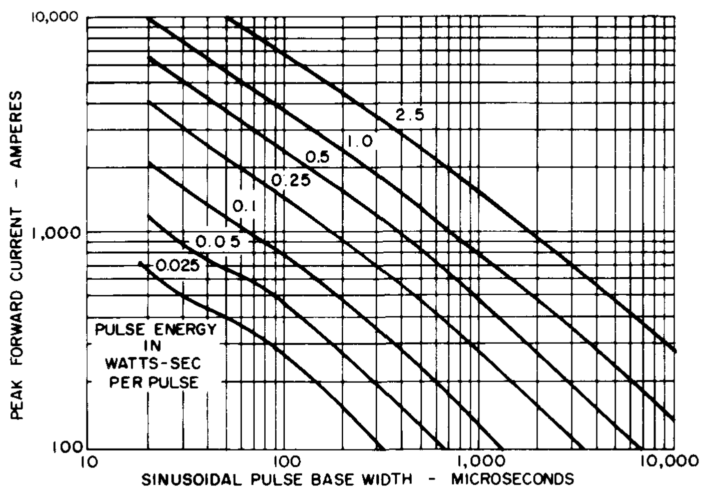
1. MAXIMUM FORWARD CHARACTERISTICS



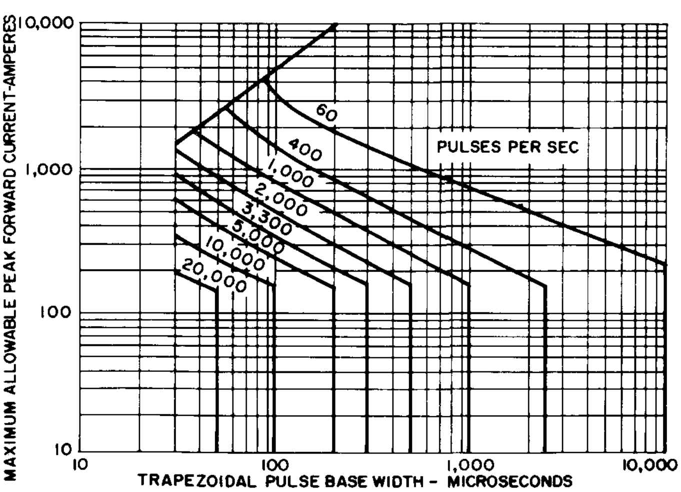
2. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT SINUSOIDAL WAVEFORM (T_C = 65°C)



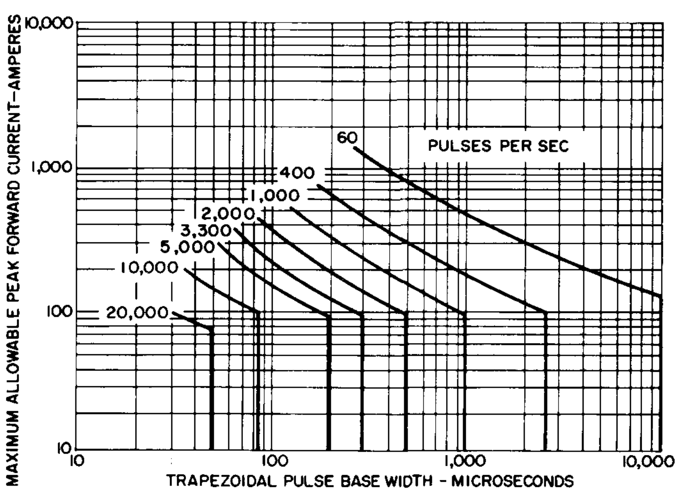
3. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT SINUSOIDAL WAVEFORM (T_C= 90°C)



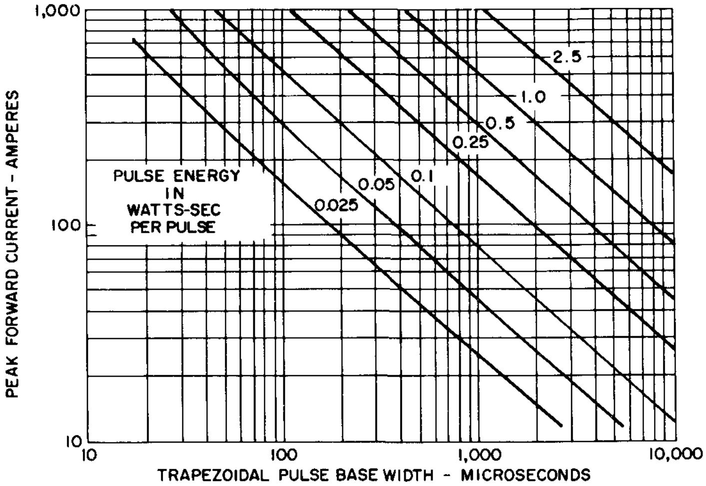
4. SINUSOIDAL PULSE ENERGY (T_J = 125°C)



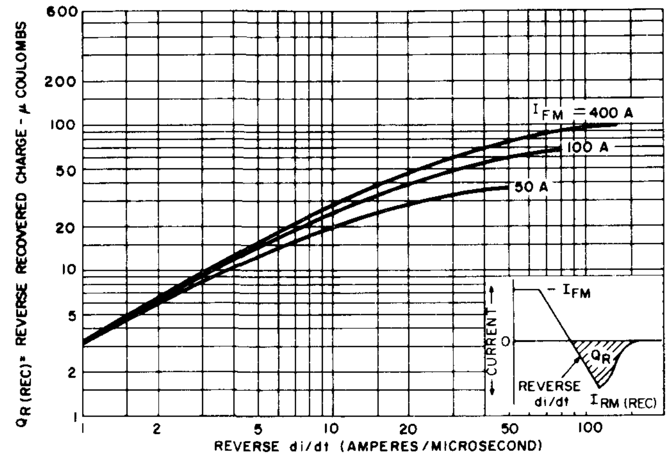
5. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT TRAPEZOIDAL WAVEFORM (T_C = 65°C)



6. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT TRAPEZOIDAL WAVEFORM (T_C = 90°C)

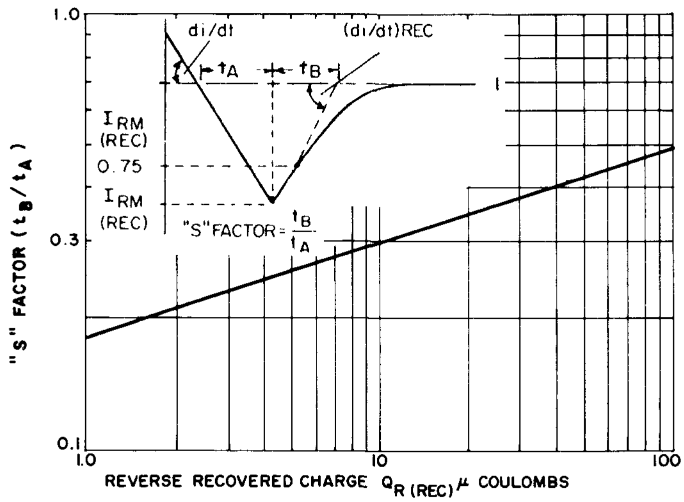


7. TRAPEZOIDAL PULSE ENERGY, DI/DT (RISING & FALLING) = 100 A/μS (T_J = 125°C)

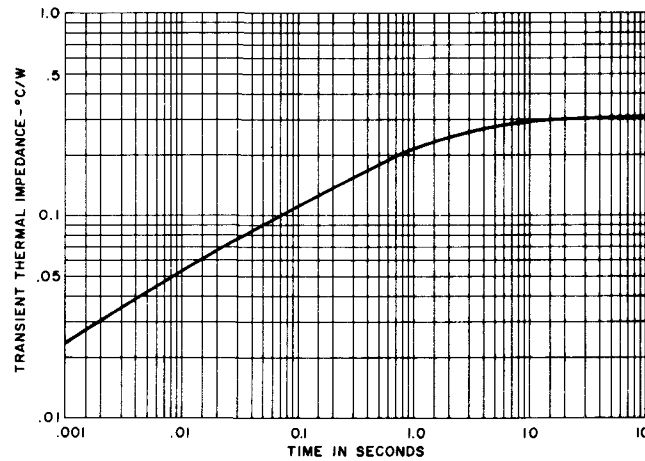


8. RECOVERED CHARGE (T_J = 125°C) (Maximum Recovered Charge Group 12)

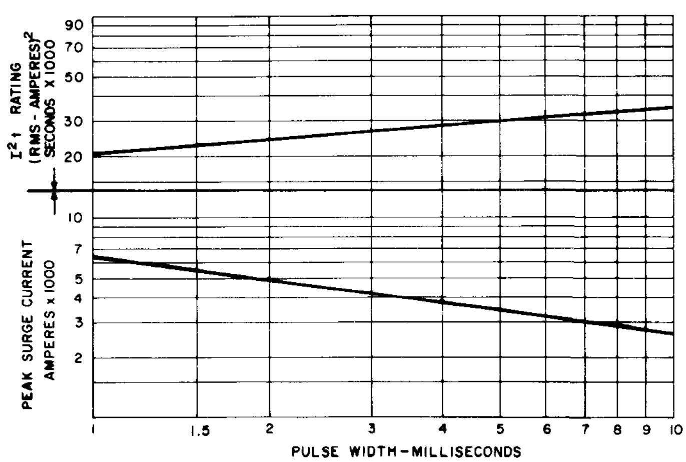
If maximum recovered charge group 12 is required, request A187__ X9, e.g. A187BX9, A187RBX9, etc.



9. TYPICAL "S" FACTOR VERSUS REVERSE RECOVERED CHARGE (T_J = 125°C)

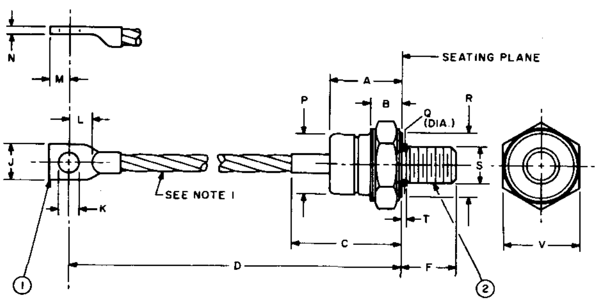


10. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



11. SUB-CYCLE SURGE FORWARD CURRENT AND I^2t RATINGS VERSUS PULSE TIME FOLLOWING RATED LOAD CONDITIONS

OUTLINE DRAWING



MODEL	TERMINAL 1	TERMINAL 2	S THREAD SIZE	F THREAD LENGTH	Q RELIEF DIAMETER
A187 FORWARD POLARITY	ANODE	CATHODE	3/8 – 24	.640/.610 IN.	.373/.344 IN.
A187R REVERSE POLARITY	CATHODE	ANODE	UNF – 2A	16.26/15.49 MM	9.47/8.74 MM

TABLE OF DIMENSIONS
Conversion Table

SYM.	DECIMAL INCHES		METRIC MM		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	1.020	1.140	25.90	28.96	
B	.390	.500	9.90	12.70	
C	1.570	1.750	39.87	44.45	
D	4.750	5.150	120.65	130.81	
J	.520	.625	13.20	15.88	
K	.270	.291	6.85	7.39	
L	.320	–	8.12	–	
M	.280	.320	7.11	8.13	
N	.070	.110	1.77	2.79	
P	.840	.910	21.33	23.11	
R	.920	–	23.36	–	3
T	–	.060	–	1.52	4
V	1.052	1.063	26.72	27.00	

NOTES:
1. Flexible Copper Lead, 9/32 Inch Nominal Diameter.
2. One Nut and One Lockwasher Supplied With Each Unit. Material of Hardware is Steel-Cad Plated.
3. "R" Dimension is Diameter of Effective Seating Area.
4. "T" Dimension is Area of Unthreaded Portion. Complete Threads are Within 2.5 Threads of Seating Plane.
5. Angular Orientation of Terminals is Undefined.
6. Approximate Weight: 105 Grams.

MOUNTING INSTRUCTIONS

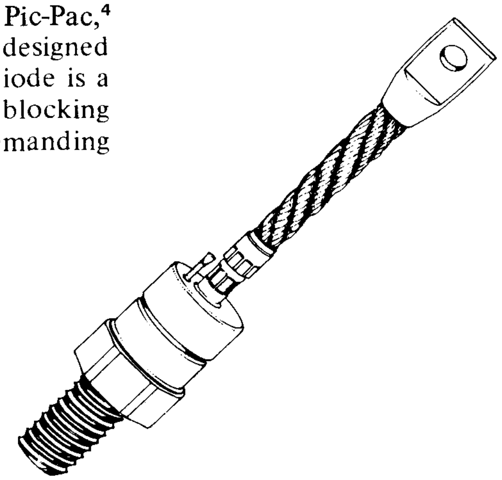
Following these installation instructions will result in a rectifier diode-to-heatsink contact thermal resistance of 0.10 C/watt or less.

1. Be sure mounting surface is clean and flat within .001 inch/inch.
2. Mounting hole diameter should not exceed the outside diameter of the rectifier diode stud by more than 1/16 inch, and should be deburred.
3. Use Dow Corning's DC3, 4, 340 or 640 or GE G3221 or equivalent, on mounting surfaces that come in contact with the heatsink.
4. Use only hardware furnished with each rectifier diode.
5. Tighten with a torque wrench, from nut side, to 100 lb-in max.

High Speed
Fast Recovery Rectifier

A197

1500 Volts 250A Avg.



The A197 series is General Electric's highly reliable, all-diffused, Pic-Pac,[4] 250 ampere, fast recovery, silicon rectifier diode. These diodes are designed for use in high frequency applications or where a fast recovery diode is a necessity. These diodes provide a superior combination of speed, blocking voltage capability and soft recovery, which is required in such demanding applications as:

- Inverter Feedback Diode
- Free Wheeling Diode
- High Frequency Rectification
- Low EMI Power Supplies

FEATURES:

- Published Current Ratings Up To 20,000 Hz
- All-Diffused
- Thermal Fatigue Resistant Pic-Pac[4] Construction
- Cathode Strain Buffer
- Soft Recovery With Low Recovered Charge
- Rugged Hermetic Package

MAXIMUM ALLOWABLE RATINGS AND SPECIFICATIONS

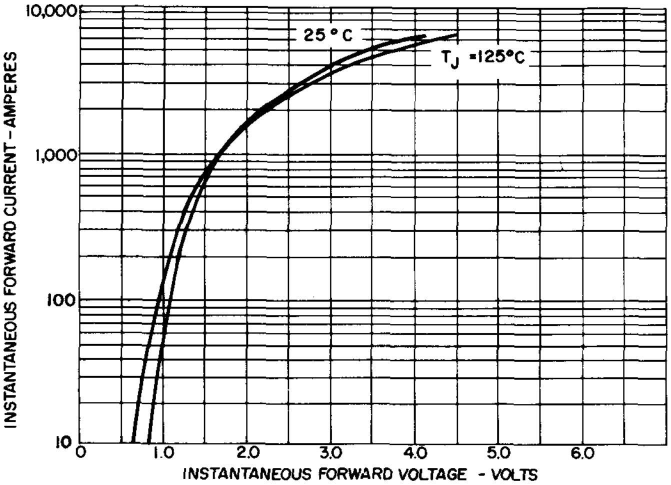
TYPES*	REPETITIVE PEAK[1] REVERSE VOLTAGE V_{RRM} T_J = -40°C to +125°C	NON-REPETITIVE[2] PEAK REVERSE VOLTAGE, V_{RSM} T_J = 25°C to +125°C	DC REVERSE[3] VOLTAGE, V_R T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE CURRENT, I_{RRM} T_J = 125°C
A197A	100 Volts	200 Volts	100 Volts	25 mA
A197B	200	300	200	25
A197C	300	400	300	25
A197D	400	500	400	25
A197E	500	600	500	25
A197M	600	720	600	25
A197S	700	840	700	25
A197N	800	950	800	25
A197T	900	1075	900	25
A197P	1000	1200	1000	25
A197PA	1100	1300	1100	25
A197PB	1200	1400	1200	25
A197PC	1300	1500	1300	25
A197PD	1400	1600	1400	25
A197PE	1500	1700	1500	25

*Models listed are stud cathode (forward polarity) types. Specify A197R- for stud anode (reverse polarity) types. Ratings and specifications are for frequencies from 50 to 20,000 Hz, except where noted otherwise.

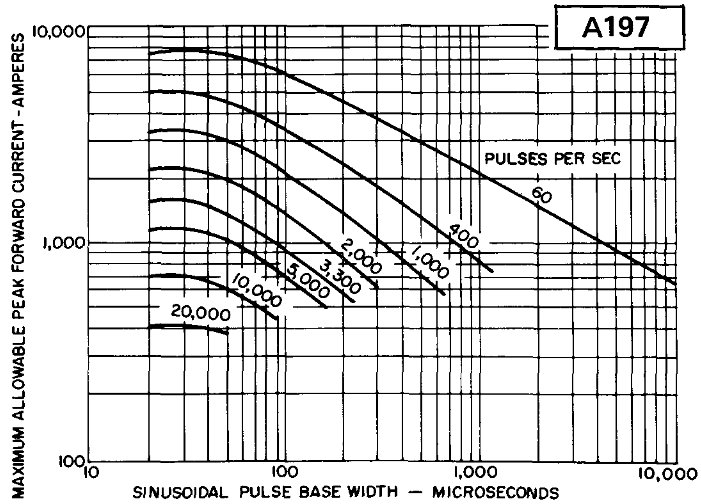
Peak Forward Current, I_{FM} (T_C = +65°C, Half Sine Wave Pulse Base Width = 8.3 msec., D.F. = 50%) . . . . . . 720 Amperes
Peak One-Cycle Surge (Non-Repetitive), Forward Current, I_{FSM} . . . . 5000 Amperes
Minimum I^2t Rating (See Curve 11), t ⩾ 1 msec. (Non-Repetitive) . . . . 44,000 (RMS Ampere)^2 Seconds
Thermal Resistance, $R_{\theta JC}$ (D. C.) . . . . 0.18°C/Watt
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Junction Temperature, T_J . . . . -40°C to +125°C
Stud Torque . . . . 275 Lb-in (Min.), 325 Lb-in (Max.)
31 N-m (Min.), 36.7 N-m (Max.)

NOTES:

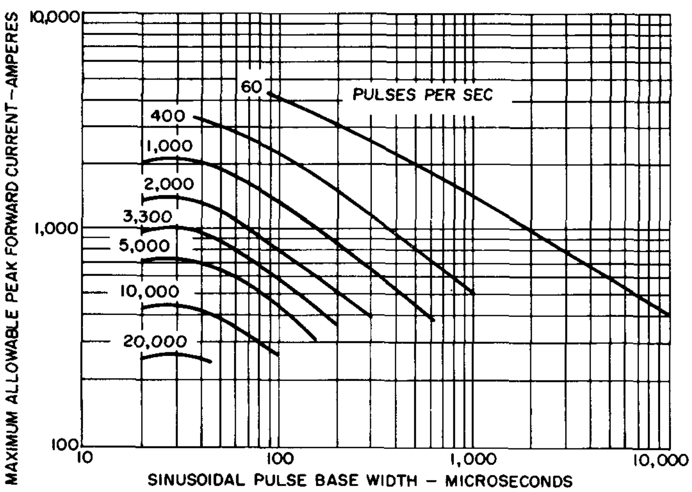
1 Assumes a heatsink thermal resistance of less than 2.0°C/watt.
2 Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetitive ratings that are used in fault coordination work.
3 Assumes a heatsink thermal resistance of less than 1.0°C/watt.
4 "Pic-Pac" is an acronym for Pressure Internal Contact Package.



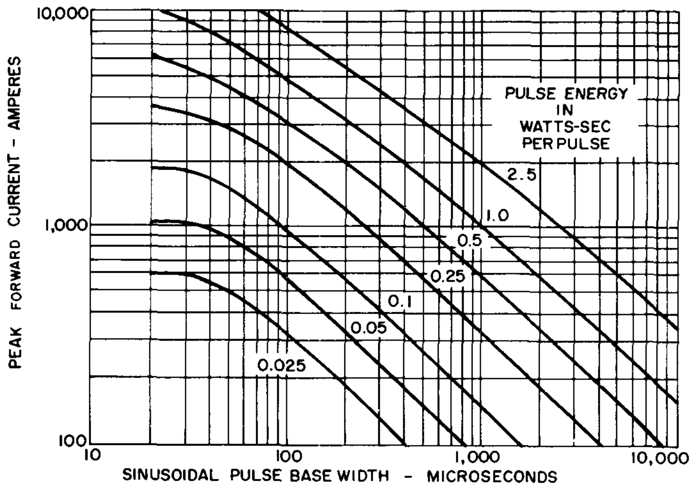
1. MAXIMUM FORWARD CHARACTERISTICS



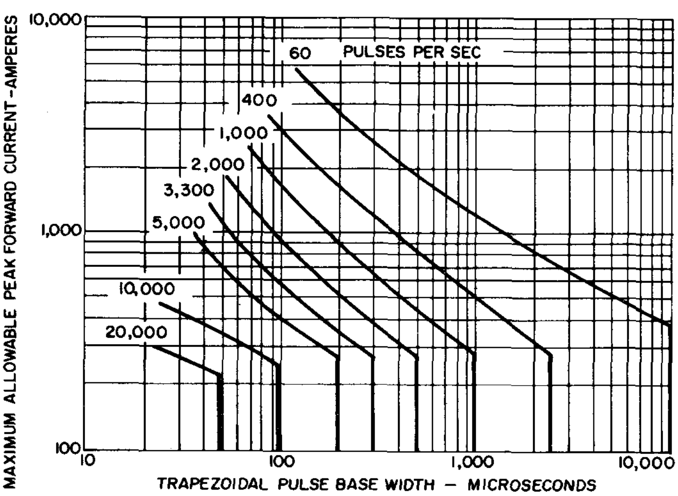
2. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT SINUSOIDAL WAVEFORM (T_C = 65°C)



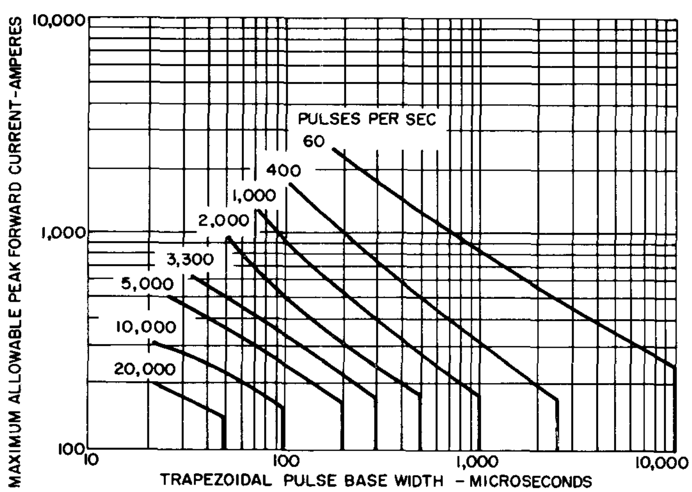
3. MAXIMUM ALLOWABLE FORWARD CURRENT SINUSOIDAL WAVEFORM (T_C = 90°C)



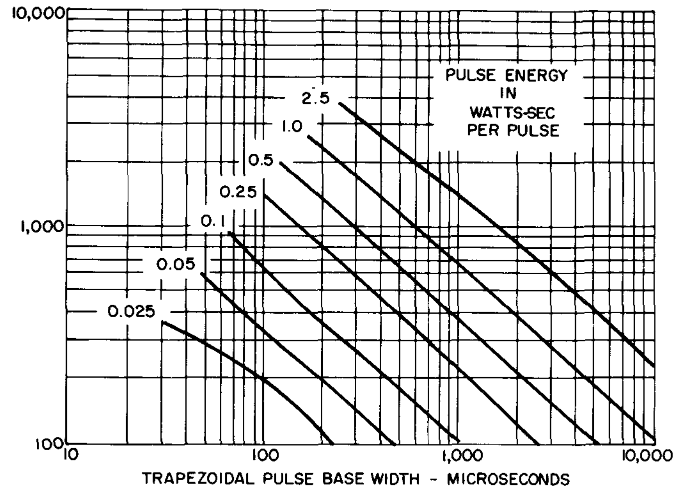
4. SINUSOIDAL PULSE ENERGY (T_J = 125°C)



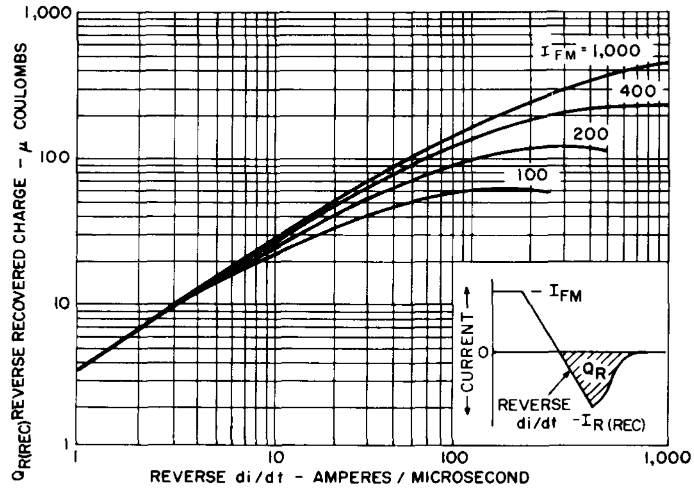
5. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT, TRAPEZOIDAL WAVEFORM (T_C = 65°C), DI/DT (RISING & FALLING) = 100 A/μS



6. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT, TRAPEZOIDAL WAVEFORM (T_C = 90°C), DI/DT (RISING & FALLING) = 100 A/μS

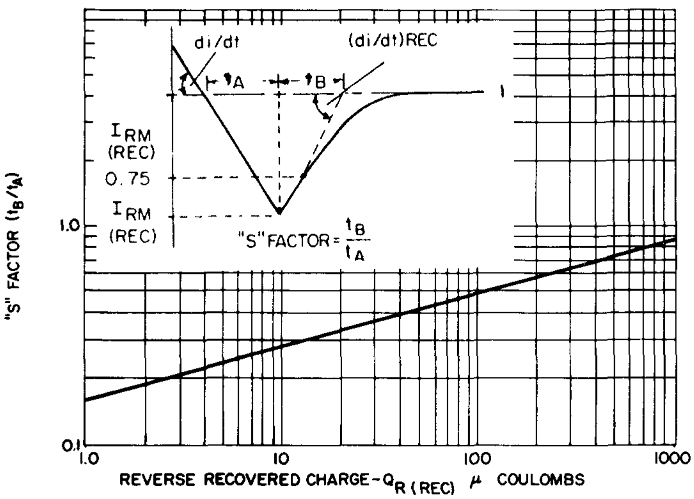


7. TRAPEZOIDAL PULSE ENERGY (T_J = 125°C) DI/DT (RISING & FALLING) = 100 A/μS

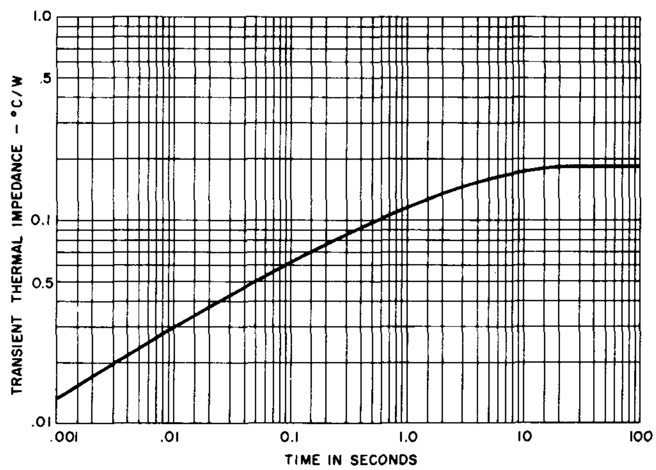


8. RECOVERED CHARGE (T_J = 125°C) (Maximum Recovered Charge Group 12)

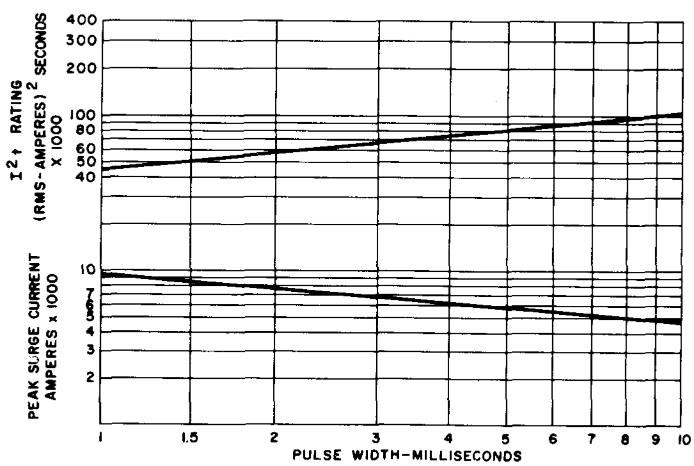
If maximum recovered charge group 12 is required, request A197____ X9, e.g. A197BX9, A197RBX9, etc.



9. TYPICAL "S" FACTOR VERSUS REVERSE RECOVERED CHARGE (T_J = 125°C)

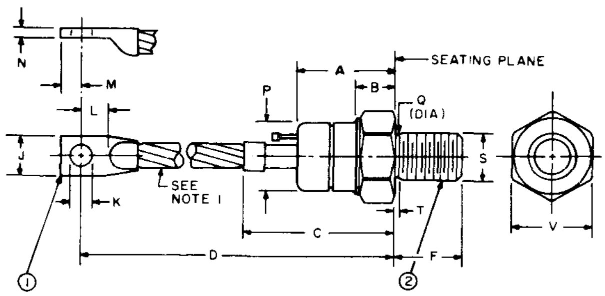


10. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE



11. SUB-CYCLE SURGE FORWARD CURRENT AND I^2t RATINGS VERSUS PULSE TIME FOLLOWING RATED LOAD CONDITIONS

OUTLINE DRAWING



MODEL	TERMINAL 1	TERMINAL 2	S THREAD SIZE
A197 FORWARD POLARITY	ANODE	CATHODE	3/4 – 16
A197R REVERSE POLARITY	CATHODE	ANODE	UNF – 2A

TABLE OF DIMENSIONS
Conversion Table

SYM.	DECIMAL INCHES		METRIC MM		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	1.450	1.550	36.83	39.37	
B	.500	.750	12.70	19.05	
C	2.300	2.500	58.42	63.50	
D	5.300	5.700	134.62	144.78	
F	.797	.827	20.24	21.01	
J	.665	.755	16.89	19.18	
K	.322	.333	8.17	8.46	
L	.437	–	11.99	–	
M	.325	.360	8.25	9.14	
N	.155	.170	–	–	
P	1.060	1.100	26.92	27.94	
Q	.660	.749	16.76	19.02	
T	–	.156	–	3.96	3
V	1.240	1.250	31.49	31.75	

NOTES:
1. Flexible Copper Lead.
2. One Nut and One Lockwasher Supplied With Each Unit. Material of *Hardware is Steel, Cad Plated.*
3. "T" Dimension is Area of Unthreaded Portion. Complete Threads are Within 2.5 Threads of Seating Plane.
4. Angular Orientation of Terminals is Undefined.

MOUNTING INSTRUCTIONS

Following these installation instructions will result in a rectifier diode-to-heatsink contact thermal resistance of 0.08°C/watt or less.

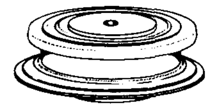
1. Be sure mounting surface is clean and flat within .001 inch/inch.
2. Mounting hole diameter should not exceed the outside diameter of the rectifier diode stud by more than 1/16 inch, and should be deburred.
3. Use Dow Corning's DC3, 4, 340 or 640 or GE G322L or equivalent, on mounting surfaces that come in contact with the heatsink.
4. Use only hardware furnished with each rectifier diode.
5. Tighten with a torque wrench, from nut side, to 325 lb-in max.

High Power Silicon Rectifier

A390

1500 Volts   400A Avg.

The A390 Series is General Electric's highly reliable, all-diffused Press-Pak 400 ampere silicon rectifier diode.



FEATURES:

- Soft Reverse Recovery
- High Reverse Blocking Voltage Capability
- Pressure Contacts
- Package Reversibility
- Rugged Glazed Ceramic Hermetic Package

MAXIMUM ALLOWABLE RATINGS AND SPECIFICATIONS

TYPES	REPETITIVE PEAK[1] REVERSE VOLTAGE V_{RRM} T_J = -40°C to +200°C	NON-REPETITIVE[2] PEAK REVERSE VOLTAGE, V_{RSM} T_J = 25°C to +200°C	DC REVERSE[3] VOLTAGE, V_R T_J = -40°C to +200°C	REPETITIVE PEAK REVERSE CURRENT I_{RRM} @ V_{RRM} T_J = 200°C
A390A	100 Volts	200 Volts	100 Volts	25 mA
A390B	200	300	200	25
A390C	300	400	300	25
A390D	400	525	400	25
A390E	500	650	500	25
A390M	600	800	600	25
A390S	700	925	700	25
A390N	800	1050	800	25
A390T	900	1175	900	25
A390P	1000	1300	1000	25
A390PA	1100	1400	1100	25
A390PB	1200	1500	1200	25
A390PC	1300	1600	1300	25
A390PD	1400	1700	1400	25
A390PE	1500	1800	1500	25

Average Forward Current, $I_{F(AV)}$ (T_C = 114°C, Single Phase, Half Sine Wave, Double-Side Cooled) . . . . . . 400 Amperes
Peak One-Cycle Surge (Non-Repetitive) Forward Current, I_{FSM} . . . . 7000 Amperes
Minimum I^2t Rating (for times ⩾ 1.5 msec, Non-Repetitive) . . . . 80,000 (RMS Ampere)^2 Seconds
Peak Forward Voltage Drop, V_{FM} ($I_{F(AV)}$ = 400 Amps. Avg., 1260 Amps. Peak, 144°C Case Temp., Single-Phase). . . 1.4 Volts
Maximum DC Thermal Resistance, $R_{\theta JC}$ – Double-Side Cooling . . . . 0.095°C/Watt
Storage Temperature, T_{stg} . . . . -40°C to +200°C
Operating Junction Temperature, T_J . . . . -40°C to +200°C
Mounting Force Required[4] . . . . 800 Lbs ± 10%
3.56KN ± 10%

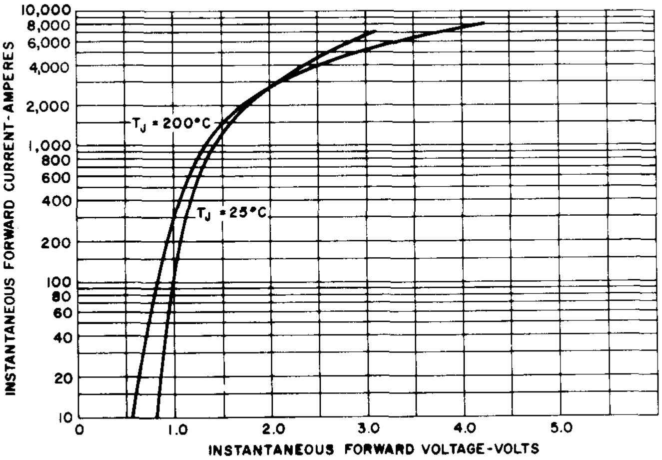
NOTES:

[1] Assumes a heatsink thermal resistance of less than 2.0°C/watt.

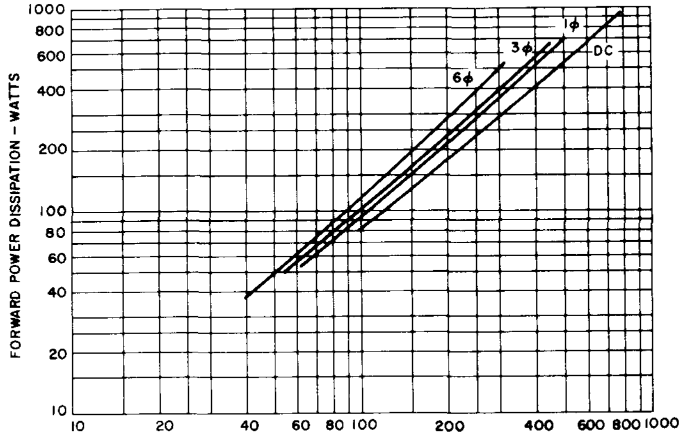
[2] Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetitive ratings that are used in fault coordination work.

[3] Assumes a heatsink thermal resistance of less than 1.0°C/watt.

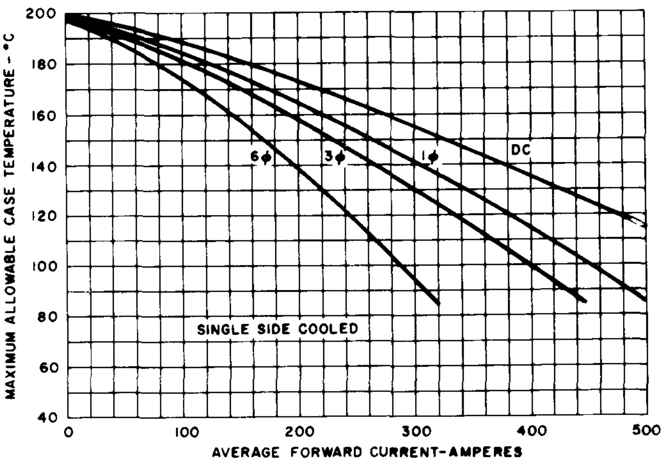
[4] Refer to the last page of this specification for Press-Pak mounting instructions. Also see SCR Manual, Fifth Edition, Chapter 18.



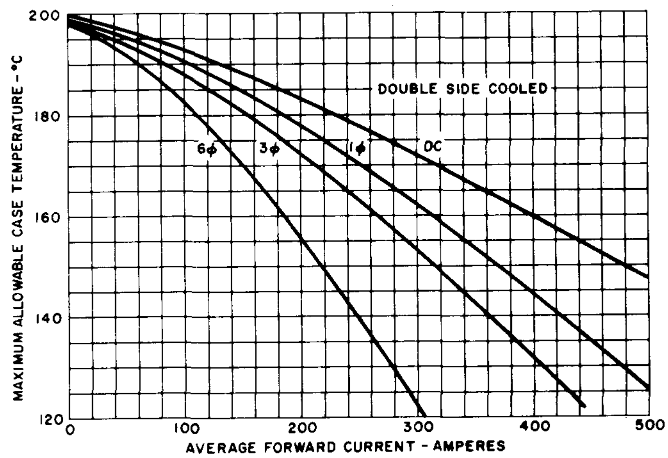
1. MAXIMUM FORWARD CHARACTERISTICS



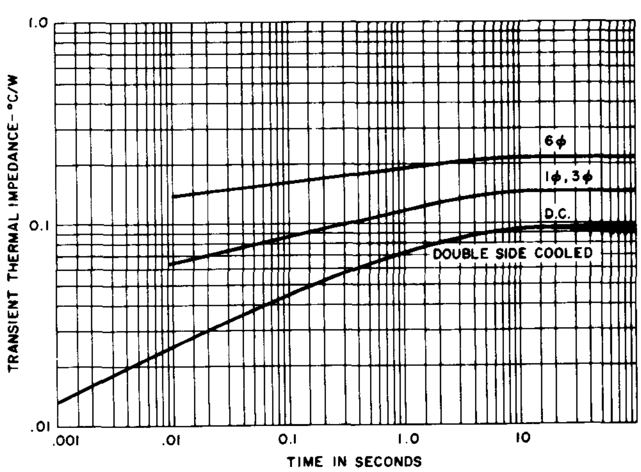
2. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT



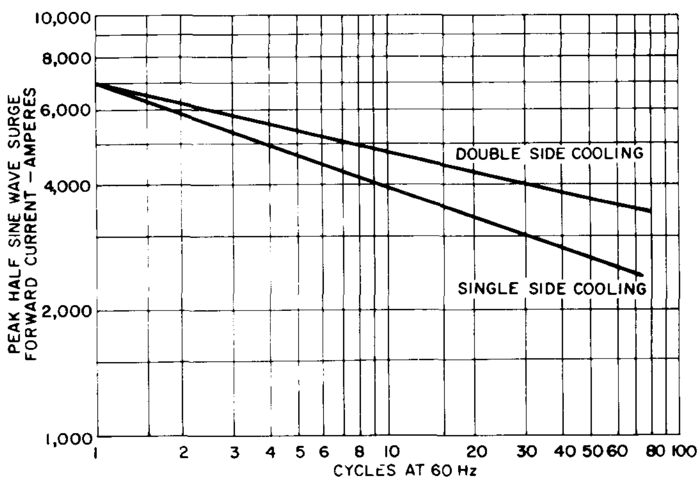
3. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT FOR SINGLE-SIDE COOLING



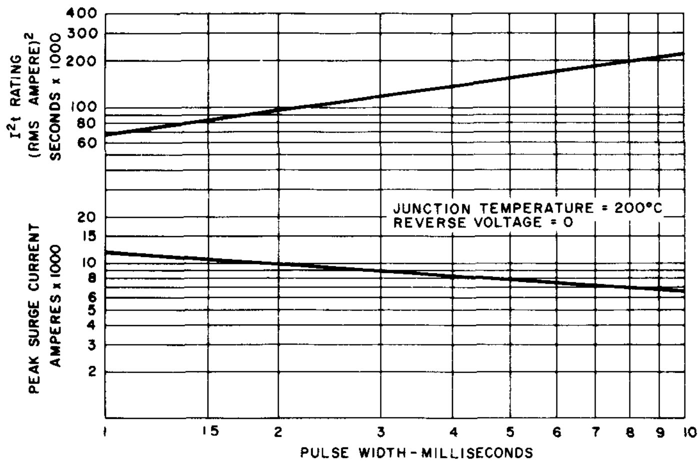
4. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT FOR DOUBLE-SIDE COOLING



5. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



6. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



7. SUB-CYCLE SURGE FORWARD CURRENT AND I^2t RATING VS. PULSE TIME FOLLOWING RATED LOAD CONDITIONS

OUTLINE DRAWING

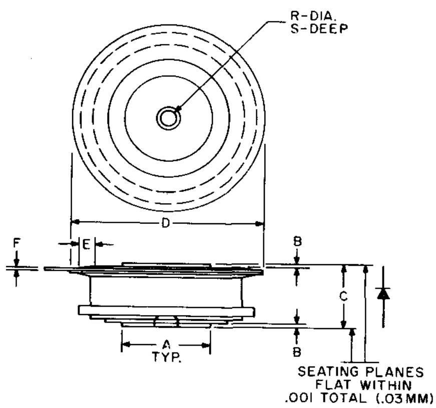


TABLE OF DIMENSIONS
Conversion Table

SYM	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.
A	.744	.752	18.89	19.10
B	.030	.060	.76	1.52
C	.515	.565	13.08	14.35
D	1.600	1.656	40.64	42.06
E	.110	–	2.79	–
F	.031	.017	.33	.43
R	.135	.145	3.42	3.68
S	.067	.083	1.70	2.11

SUGGESTED MOUNTING METHODS FOR PRESS-PAKS TO HEAT DISSIPATORS

When the Press-Pak is assembled to a heat sink in accordance with the following general instructions, a reliable and and low thermal resistance interface will result:

1. Check each mating surface for nicks, scratches, flatness and surface finish. The heat dissipator mating surfaces should be flat within .0005 inch/inches and have a surface finish of 63 micro-inches.

2. It is recommended that the heat dissipator mounting surfaces be plated with nickel, tin or silver. Bare aluminum or copper surfaces will oxidize in time resulting in excessively high thermal resistance.

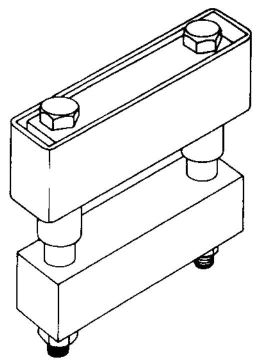
3. Sand each surface **lightly** with 600 grit paper just prior to assembly. Clean off and apply silicone oil (GE SF1154 200 centistoke viscosity) or silicone grease (GE G322L or Dow Corning DC 3, 4, 340 or 640). Clean off and apply again as a **thin** film. (A thick film will adversely affect the electrical and thermal resistances.)

4. Assemble with the specified mounting force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both top and bottom of the Press-Pak are for locating purposes only.

MOUNTING THE A390, ONE-HALF INCH PRESS-PAK USING THE SERIES 1000 CLAMP

CLAMP FEATURES:

- *Hardened Steel Pivot* insuring *constant pressure* in rugged applications over long periods.
- One-piece phenolic insulator gives added 1/2″ creep distance.
- Use of special *Force Indicator Gauge eliminates* need for torque wrenches, inaccurate “flex” gauges and *guesswork.*
- Various bolt lengths available to accommodate most mounting situations.
- No loose parts to complicate assembly.
- Stiffening *brace* to reinforce heat sink available upon request.
- Single-side cooling terminal available upon request.
- Positive, non-binding swivel action.



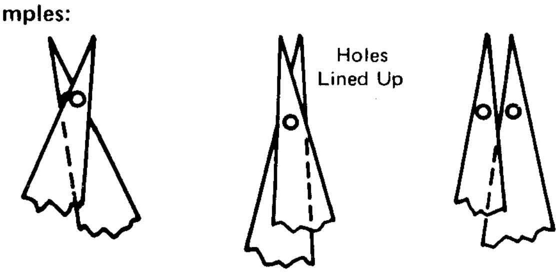
SERIES 1000

MOUNTING PROCEDURE:

With the semiconductor positively located in place on the heatsink(s), place the clamp in position with the bolts through the holes in the heatsink(s), and proceed as follows:

1. Refer to SCR Manual, Fifth Edition, “Mounting The Press-Pak SCR,” 18.2.7.
2. Tighten the nuts evenly until finger tight.
3. Tighten each bolt 1/2 turn, using a 7/16 socket wrench on the bolt heads.
4. Place the Force Indicator Gauge firmly against the springs, as shown on the Outline Drawing, so that both ends and the middle are in solid contact with the springs. The holes of the gauge will then indicate the spring deflection, or force; correct mounting force is indicated when the holes coincide.

Examples:



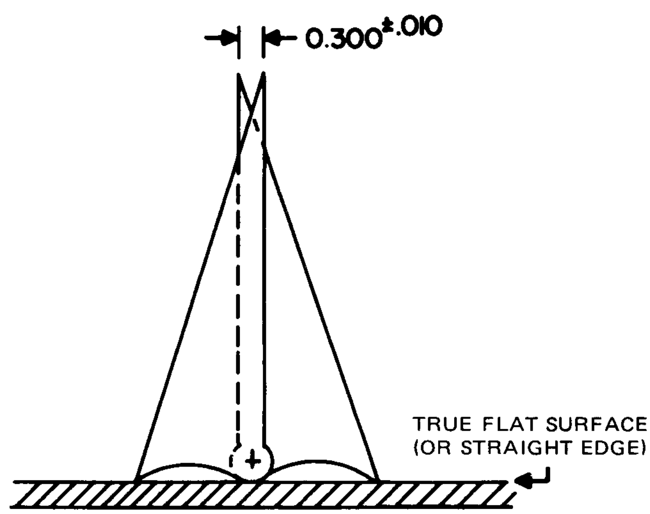
Less than rated force. Tighten nuts alternately ¼ turn at a time until points coincide.

Correct Force

Excessive force. Loosen nuts and start over. *NEVER* try to adjust spring force by backing off the nuts, spring friction will produce false readings. Always start at Step 1.

To Calibrate Force Gauge:

If the gauge is suspected of being out of calibration due to wear or damage, check it on a flat surface as shown below.



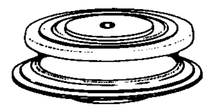
If the points are not 0.300 ± .010 apart, calibrate the gauge by filing the bottom contact points.

High Speed
Fast Recovery Rectifier

A397

1500 Volts 400A Avg.

The A397 series is General Electric's highly reliable, all-diffused, Press-Pak, 400 ampere, fast recovery, silicon rectifier diode. These diodes are designed for use in high frequency applications or where a fast recovery diode is a necessity. These diodes provide a superior combination of speed, blocking voltage capability and soft recovery, which is required in such demanding applications as:



- Inverter Feedback Diode
- Free Wheeling Diode
- High Frequency Rectification
- Low EMI Power Supplies

FEATURES:

- Published Current Ratings Up To 20,000 Hz
- Soft Recovery With Low Recovery Charge
- All-Diffused
- Package Reversibility
- Rugged Glazed Ceramic Hermetic Package

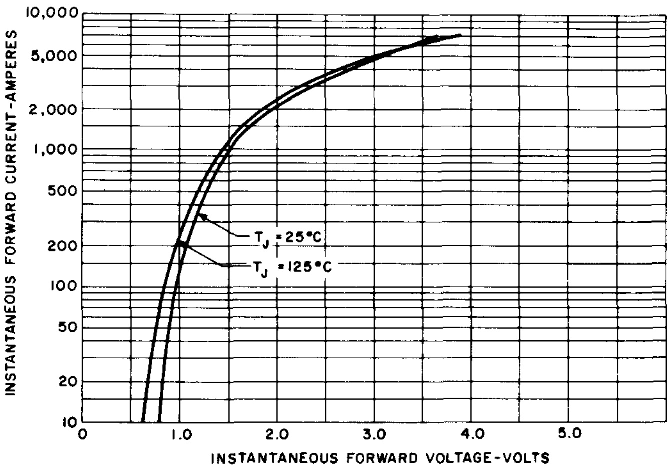
MAXIMUM ALLOWABLE RATINGS AND SPECIFICATIONS

TYPES	REPETITIVE PEAK[1] REVERSE VOLTAGE V_{RRM} T_J = -40°C to +125°C	NON-REPETITIVE[2] PEAK REVERSE VOLTAGE, V_{RSM} T_J = 25°C to 125°C	DC REVERSE[3] VOLTAGE, V_R T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE CURRENT, I_{RRM} T_J = 125°C
A397A	100 Volts	200 Volts	100 Volts	25 mA
A397B	200	300	200	25
A397C	300	400	300	25
A397D	400	500	400	25
A397E	500	600	500	25
A397M	600	720	600	25
A397S	700	840	700	25
A397N	800	950	800	25
A397T	900	1075	900	25
A397P	1000	1200	1000	25
A397PA	1100	1300	1100	25
A397PB	1200	1400	1200	25
A397PC	1300	1520	1300	25
A397PD	1400	1600	1400	25
A397PE	1500	1700	1500	25

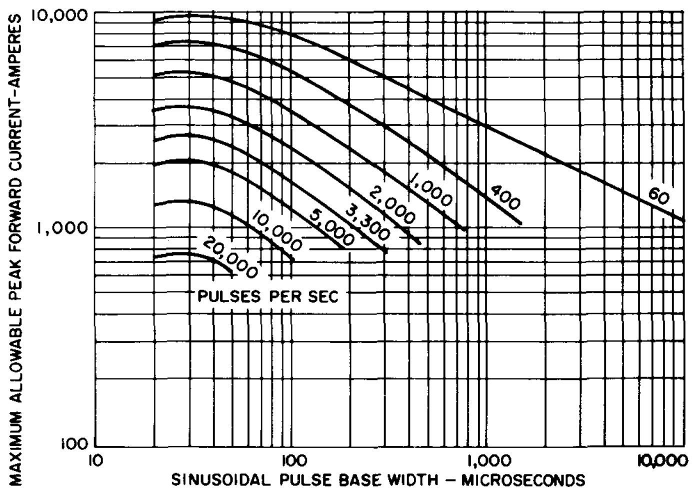
Peak Forward Current, I_{FM} (T_C = +65°C, Half Sine Wave Pulse Width = 8.3 msec., D.F. = 50%) . . . . 1200 Amperes
Peak One-Cycle Surge (Non-Repetitive), Forward Current, I_{FSM} . . . . 5000 Amperes
Minimum I^2t Rating (See Curve 11), t $\geq$ 1 msec. (Non-Repetitive) . . . . 44,000 (RMS Ampere)^2 Seconds
Thermal Resistance, $R_{\theta JC}$ (D.C.) . . . . .095°C/Watt
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Junction Temperature, T_J . . . . -40°C to +125°C
Mounting Force Required . . . . 800 Lbs ± 10%
3.56KN ± 10%

NOTES:

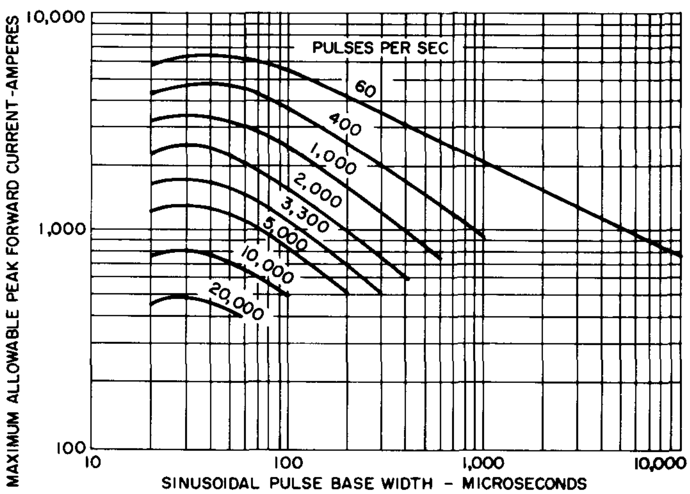
[1] Assumes a heatsink thermal resistance of less than 2.0°C/watt.
[2] Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetitive ratings that are used in fault coordination work.
[3] Assumes a heatsink thermal resistance of less than 1.0°C/watt.



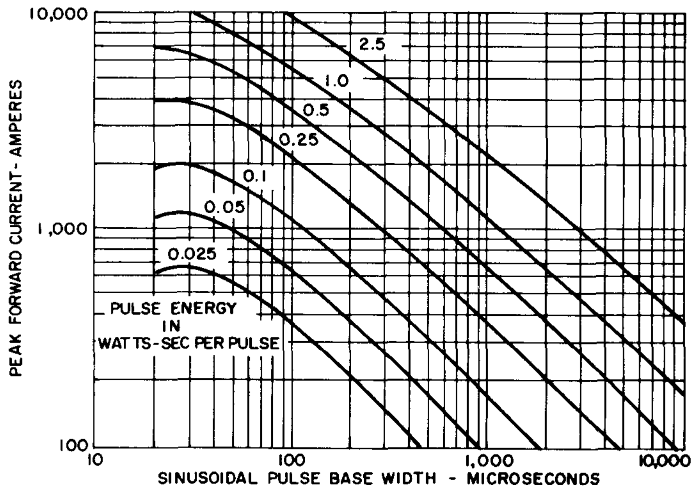
1. MAXIMUM FORWARD CHARACTERISTICS



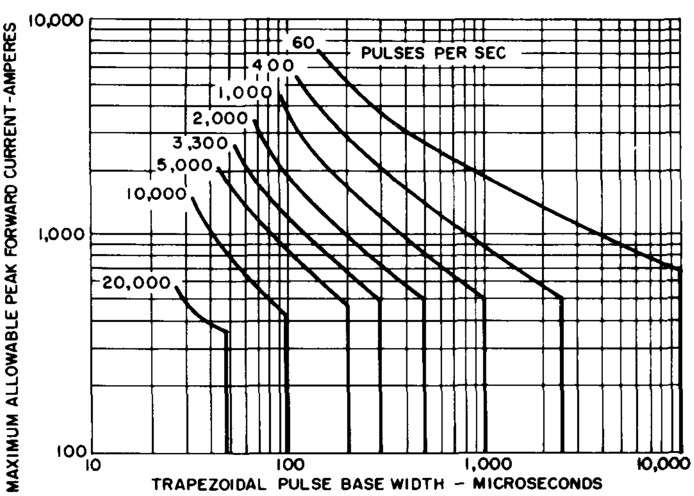
2. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT SINUSOIDAL WAVEFORM (T_C = 65°C) DOUBLE SIDE COOLED



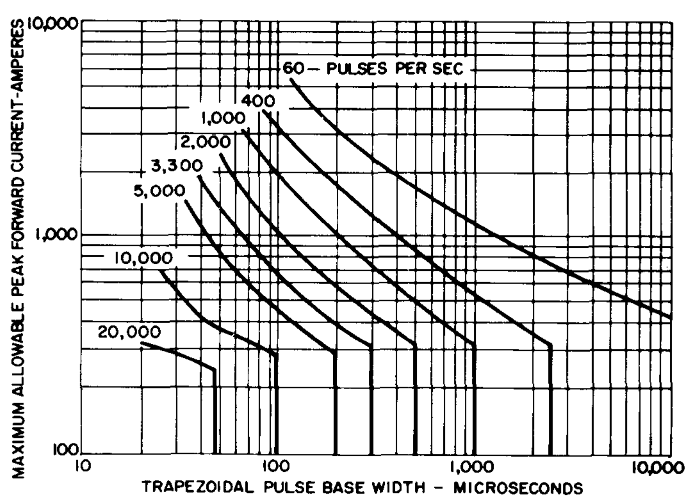
3. MAXIMUM ALLOWABLE FORWARD CURRENT SINUSOIDAL WAVEFORM (T_C = 90°C) DOUBLE SIDE COOLED



4. SINUSOIDAL PULSE ENERGY (T_J = 125°C)

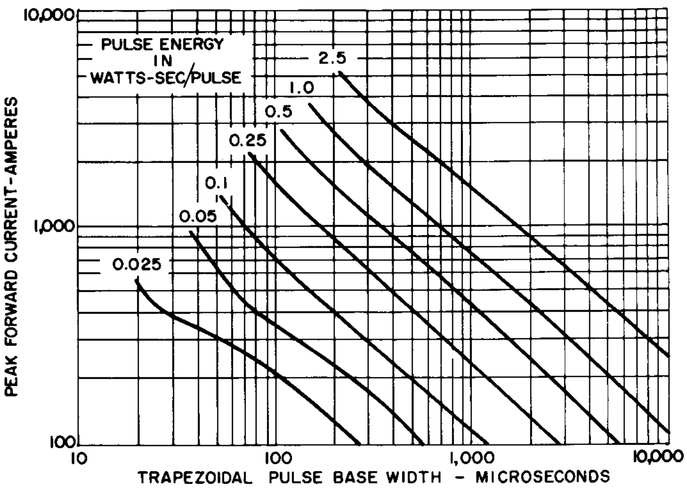


5. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT TRAPEZOIDAL WAVEFORM (T_C = 65°C) DI/DT (RISING & FALLING) = 100 A/μS DOUBLE SIDE COOLED

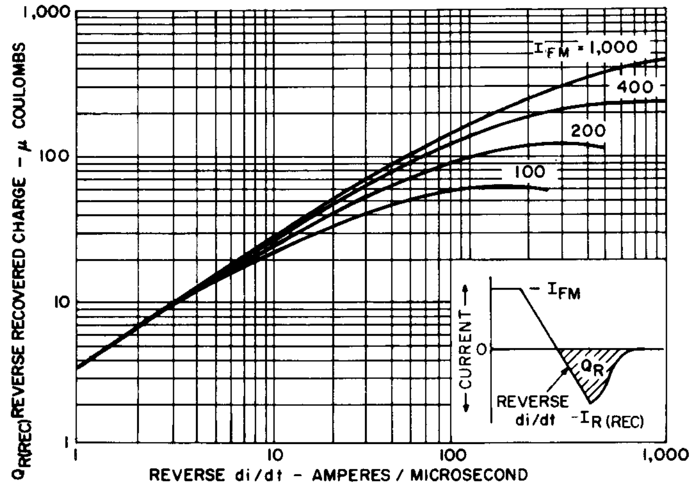


6. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT TRAPEZOIDAL WAVEFORM (T_C = 90°C) DI/DT (RISING & FALLING) = 100 A/μS DOUBLE SIDE COOLED

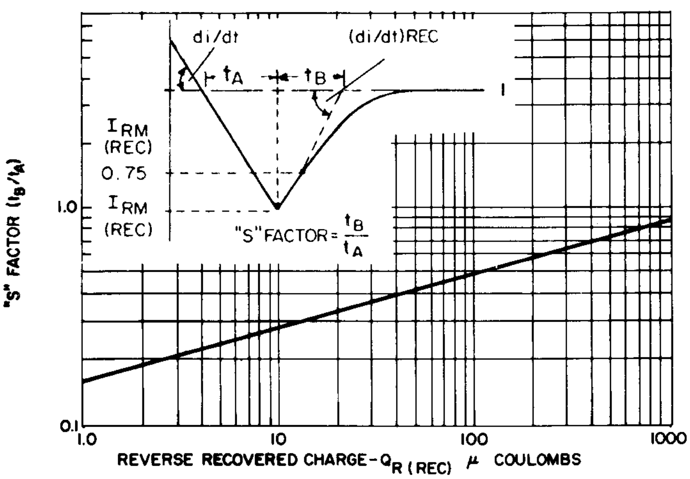
DEVICE SPECIFICATIONS



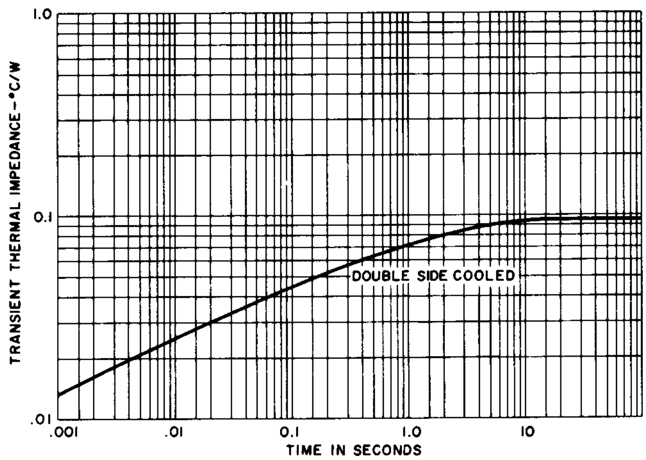
7. TRAPEZOIDAL PULSE ENERGY DI/DT (RISING & FALLING) = 100 A/μS (T_J = 125°C)



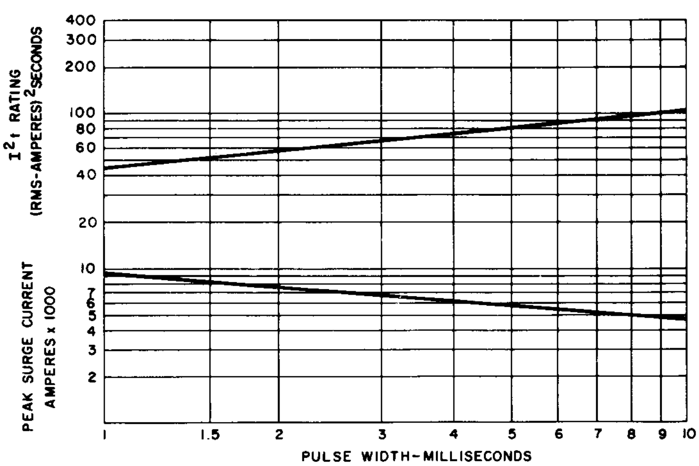
8. TYPICAL RECOVERED CHARGE
(Maximum Recovered Charge Group 12)
If maximum recovered charge group 12 is required, request A397__X9, e.g. A397BX9, etc.



9. TYPICAL "S" FACTOR VERSUS RECOVERY CHARGE (T_J = 125°C)



10. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE



11. SUB-CYCLE SURGE FORWARD CURRENT AND I^2t RATING VERSUS PULSE TIME FOLLOWING RATED LOAD CONDITIONS

OUTLINE DRAWING

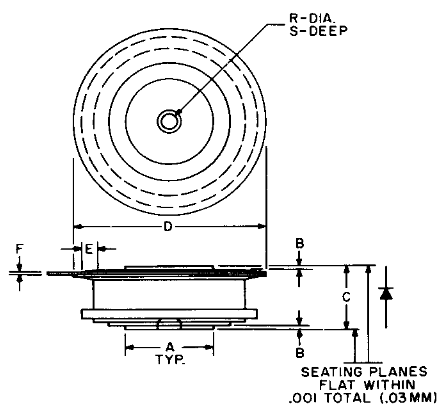


TABLE OF DIMENSIONS
Conversion Table

SYM	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.
A	.744	.752	18.89	19.10
B	.030	.060	.76	1.52
C	.515	.565	13.08	14.35
D	1.600	1.656	40.64	41.9
E	.110	–	2.79	–
F	.031	.017	.33	.43
R	.135	.145	3.42	3.68
S	.067	.083	1.70	2.1

SUGGESTED MOUNTING METHODS FOR PRESS-PAKS TO HEAT DISSIPATORS | A397

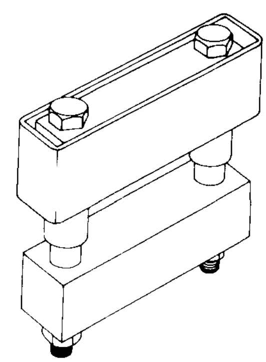
When the Press-Pak is assembled to a heat sink in accordance with the following general instructions, a reliable and low thermal resistance interface will result:

1. Check each mating surface for nicks, scratches, flatness and surface finish. The heat dissipator mating surfaces should be flat within .0005 inch/inch and have a surface finish of 63 micro-inches.
2. It is recommended that the heat dissipator be plated with nickel, tin, or silver. Bare aluminum or copper surfaces will oxidize in time resulting in excessively high thermal resistance.
3. Sand each surface **lightly** with 600 grit paper just prior to assembly. Clean off and apply silicone oil (GE SF1154 200 centistoke viscosity) or silicone grease (GE G322L or Dow Corning DC 3, 4, 340 or 640). Clean off and apply again as a **thin** film. (A thick film will adversely affect the electrical and thermal resistances.)
4. Assemble with the specified mounting force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both top and bottom of the Press-Pak are for locating purposes only.

MOUNTING THE A397, ONE-HALF INCH PRESS-PAK USING THE SERIES 1000 CLAMP

CLAMP FEATURES:

- *Hardened Steel Pivot* insuring *constant pressure* in rugged applications over long periods.
- One-piece phenolic insulator gives added 1/2″ creep distance.
- Use of special *Force Indicator Gauge eliminates* need for torque wrenches, inaccurate "flex" gauges and *guesswork.*
- Various bolt lengths available to accommodate most mounting situations.
- No loose parts to complicate assembly.
- Stiffening *brace* to reinforce heat sink available upon request.
- Single-side cooling terminal available upon request.
- Positive, non-binding swivel action.



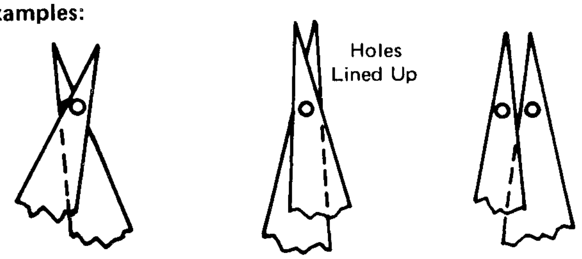
SERIES 1000

MOUNTING PROCEDURE:

With the semiconductor positively located in place on the heatsink(s), place the clamp in position with the bolts through the holes in the heatsink(s), and proceed as follows:

1. Refer to SCR Manual, Fifth Edition for Preparation of Mounting the Press-Pak SCR, 18.2.7.
2. Tighten the nuts evenly until finger tight.
3. Tighten each bolt 1/2 turn, using a 7/16 socket wrench on the bolt heads.
4. Place the Force Indicator Gauge firmly against the springs, as shown on the Outline Drawing, so that both ends and the middle are in solid contact with the springs. The holes of the gauge will then indicate the spring deflection, or force; correct mounting force is indicated when the holes coincide.

Examples:



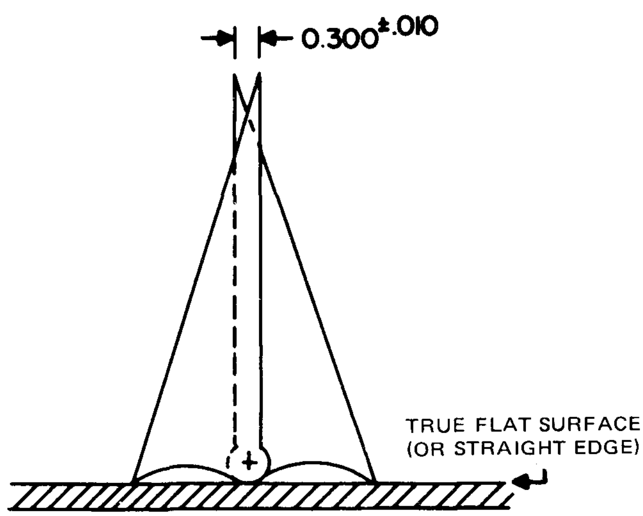
Less than rated force. Tighten nuts alternately ¼ turn at a time until points coincide.

Correct Force

Excessive force. Loosen nuts and start over. *NEVER* try to adjust spring force by backing off the nuts, spring friction will produce false readings. Always start at Step 1.

To Calibrate Force Gauge:

If the gauge is suspected of being out of calibration due to wear or damage, check it on a flat surface as shown below.



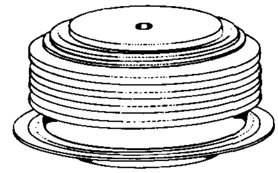
If the points are not 0.300 ± .010 apart, calibrate the gauge by filing the bottom contact points.

High Power Silicon Rectifier

A430

1500 Volts 1000A Avg.

The A430 Series is General Electric's highly reliable, all-diffused Press-Pak 1000 ampere silicon rectifier diode.



FEATURES:

- Soft Reverse Recovery
- High Reverse Blocking Voltage Capability
- Pressure Contacts
- Package Reversibility
- Rugged, Glazed Ceramic Hermetic Package With 1" Creepage Path

MAXIMUM ALLOWABLE RATINGS AND SPECIFICATIONS

TYPES	REPETITIVE PEAK[1] REVERSE VOLTAGE V_{RRM} T_J = -40°C to +200°C	NON-REPETITIVE[2] PEAK REVERSE VOLTAGE, V_{RSM} T_J = 25°C to +200°C	DC REVERSE[3] VOLTAGE, V_R T_J = -40°C to +200°C	REPETITIVE PEAK REVERSE CURRENT I_{RRM} @ V_{RRM} T_J = 200°C
A430E	500 Volts	650 Volts	500 Volts	50 mA
A430M	600	800	600	50
A430S	700	925	700	50
A430N	800	1050	800	50
A430T	900	1175	900	50
A430P	1000	1300	1000	50
A430PA	1100	1400	1100	50
A430PB	1200	1500	1200	50
A430PC	1300	1600	1300	50
A430PD	1400	1700	1400	50
A430PE	1500	1800	1500	50

Average Forward Current, $I_{F(AV)}$ (T_C = 113°C, Single Phase, Half Sinewave, Double-Side Cooled) . . . . 1,000 Amperes
Peak One-Cycle Surge (Non-Repetitive) Forward Current, I_{FSM} . . . . 10,000 Amperes
Minimum I^2t Rating (for times ⩾ 1.5 msec., Non-Repetitive) . . . . 200,000 (RMS Ampere)^2 Seconds
Minimum I^2t Rating (for times ⩾ 8.3 msec., Non-Repetitive) . . . . 415,000 (RMS Ampere)^2 Seconds
Peak Forward Voltage Drop, V_{FM} ($I_{F(AV)}$ = 1000 Amps.; 3140 Amps. Peak, 113°C Case Temp., Single-Phase) . . . 1.42 Volts
Maximum Thermal Resistance, $R_{\theta JC}$, Double-Side Cooling . . . . 0.06°C/Watt
Storage Temperature, T_{stg} . . . . -40°C to +200°C
Operating Junction Temperature, T_J . . . . -40°C to +200°C
Mounting Force Required[4] . . . . 2000 Lbs ± 10%
8.9 KN ± 10%

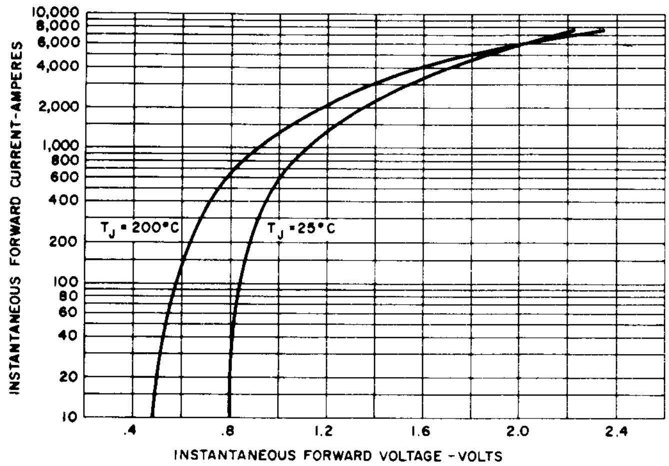
NOTES:

[1] Assumes a heatsink thermal resistance of less than 1.1°C/watt.

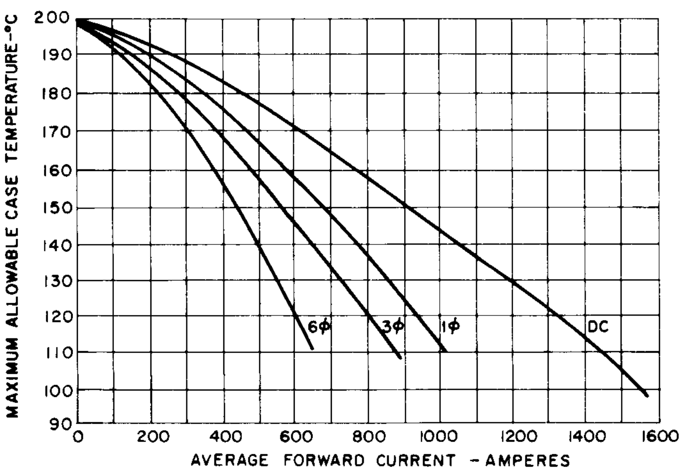
[2] Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetitive ratings that are used in fault coordination work.

[3] Assumes a heatsink thermal resistance of less than 0.5°C/watt.

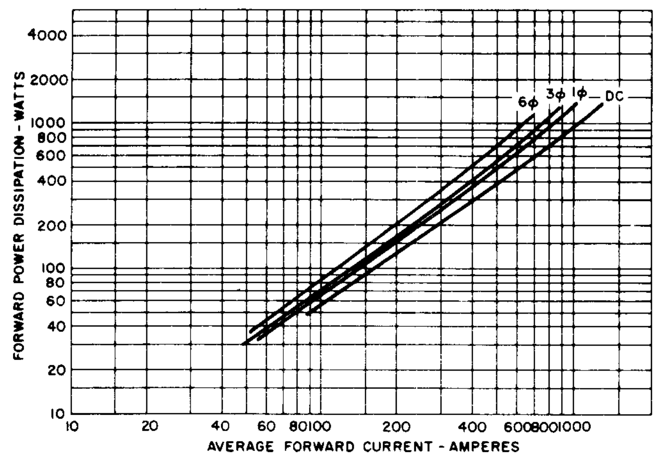
[4] Refer to the SCR Manual, Fifth Edition, Chapter 18 for Press-Pak mounting instructions.



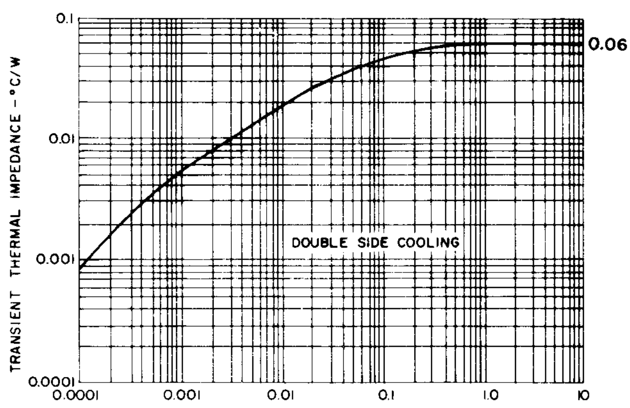
1. MAXIMUM FORWARD CHARACTERISTICS



2. MAXIMUM CASE TEMPERATURE VS. AVERAGE FORWARD CURRENT FOR DOUBLE-SIDE COOLING

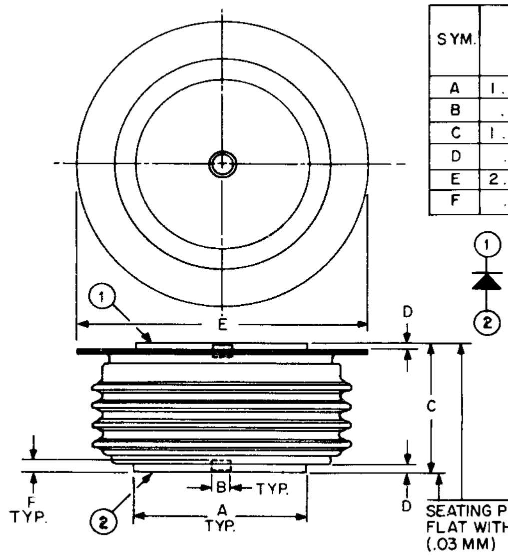


3. AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT



4. TRANSIENT THERMAL RESISTANCE — JUNCTION-TO-CASE

OUTLINE DRAWING

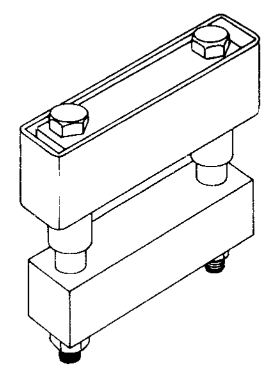


SYM.	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.
A	1.333	1.343	33.86	34.11
B	.135	.145	3.42	3.68
C	1.018	1.065	25.85	27.05
D	.030	.110	.76	—
E	2.240	2.300	56.89	58.42
F	.070	.090	3.55	4.06

MOUNTING THE A430, ONE INCH PRESS-PAK USING THE SERIES 2500 CLAMP

CLAMP FEATURES:

The General Electric Company offers the Series 2500 Press Pak, mounting clamp designed to facilitate single- or double-side cooling of all GE Press Pak's.



Special features of this clamp:

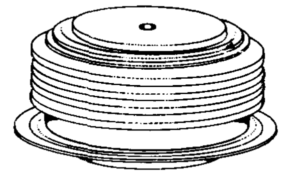
- Metal pivot insuring constant pressure in rugged applications over long periods.
- One-piece phenolic insulator gives 1" nominal creep distance.
- Use of special *Force Indicator Gauge* eliminates need for torque wrenches, inaccurate "flex" gauges, and *guesswork*.
- Various bolt lengths available to accommodate most mounting situations.
- No loose parts to complicate assembly.
- Stiffening *brace* to reinforce heat sink *available upon request*.
- *Single-side cooling terminal available upon request*.
- Positive, non-binding swivel action.

High Speed Fast Recovery Rectifier

A437

1500 Volts 600A Avg.

The A437 series is General Electric's highly reliable, all-diffused, Press-Pak, 600 ampere, fast recovery, silicon rectifier diode. These diodes are designed for use in high frequency applications or where a fast recovery diode is a necessity. These diodes provide a superior combination of speed, blocking voltage capability and soft recovery, which is required in such demanding applications as:



- Inverter Feedback Diode
- Free Wheeling Diode
- High Frequency Rectification
- Low EMI Power Supplies

FEATURES:

- Published Current Ratings Up To 20,000 Hz
- Soft Recovery With Low Recovered Charge
- All-Diffused
- Rugged Glazed Ceramic Hermetic Package With 1″ Creepage Path
- Package Reversibility

MAXIMUM ALLOWABLE RATINGS AND SPECIFICATIONS

TYPES	REPETITIVE PEAK [1] REVERSE VOLTAGE V_{RRM} T_J = -40°C to +125°C	NON-REPETITIVE[2] PEAK REVERSE VOLTAGE, V_{RSM} T_J = 25°C to +125°C	DC REVERSE[3] VOLTAGE, V_R T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE CURRENT, I_{RRM} T_J = 125°C
A437A	100 Volts	200 Volts	100 Volts	50 mA
A437B	200	300	200	50
A437C	300	400	300	50
A437D	400	500	400	50
A437E	500	600	500	50
A437M	600	720	600	50
A437S	700	840	700	50
A437N	800	950	800	50
A437T	900	1075	900	50
A437P	1000	1200	1000	50
A437PA	1100	1300	1100	50
A437PB	1200	1400	1200	50
A437PC	1300	1500	1300	50
A437PD	1400	1600	1400	50
A437PE	1500	1700	1500	50

Peak Forward Current, I_{FM} (T_C = +65°C, Half Sine Wave Pulse Base Width = 8.3 msec., D.F. 50%) . . . . . . 1,700 Amperes
Peak One-Cycle Surge (Non-Repetitive), Forward Current, I_{FSM} . . . . 10,000 Amperes
Minimum I^2t Rating (See Curve 11), t ⩾ 1 msec. (Non-Repetitive) . . . . 105,000 (RMS Ampere)^2 Seconds
Thermal Resistance, $R_{\theta JC}$ (D.C.) . . . . .06°C/Watt
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Junction Temperature, T_J . . . . -40°C to +125°C
Mounting Force Required . . . . 2000 Lbs ± 10%
8.9KN ± 10%

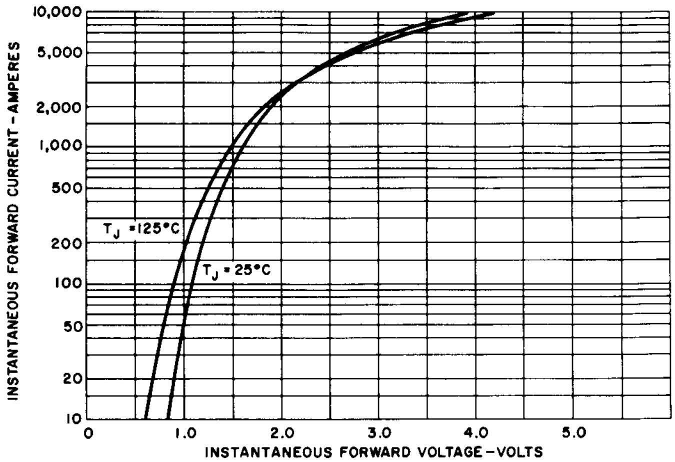
NOTES:

[1] Assumes a heatsink thermal resistance of less than 2.0°C/watt.

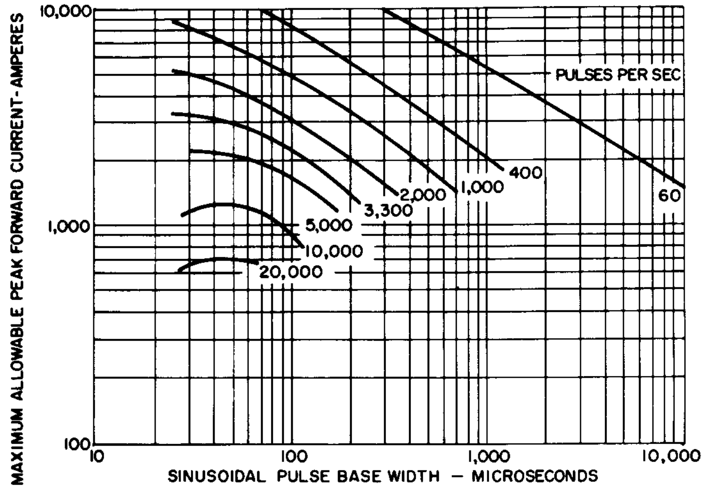
[2] Non-repetitive voltage and current ratings, as contrasted to repetitive ratings, apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-repetition ratings that are used in fault coordination work.

[3] Assumes a heatsink thermal resistance of less than 1.0°C/watt.

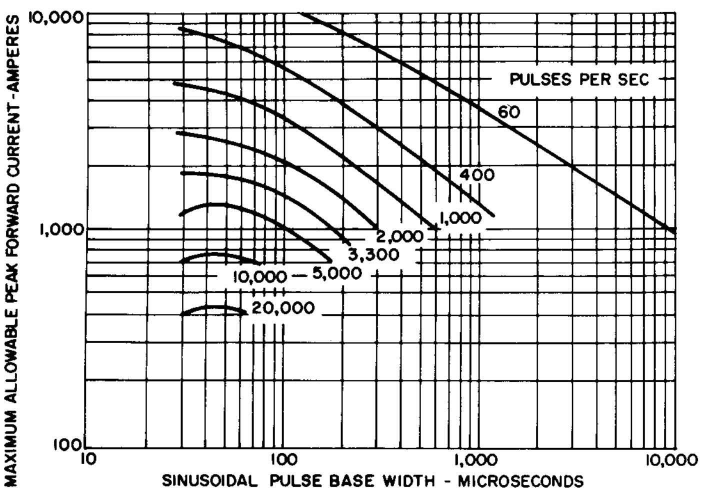
DEVICE SPECIFICATIONS



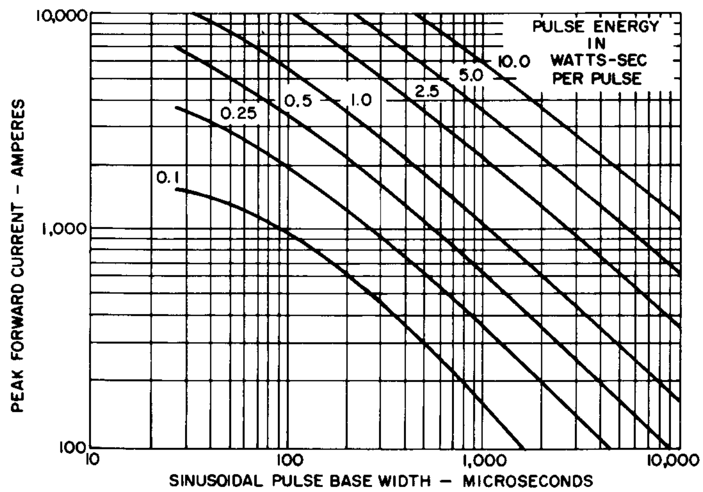
1. MAXIMUM FORWARD CHARACTERISTICS



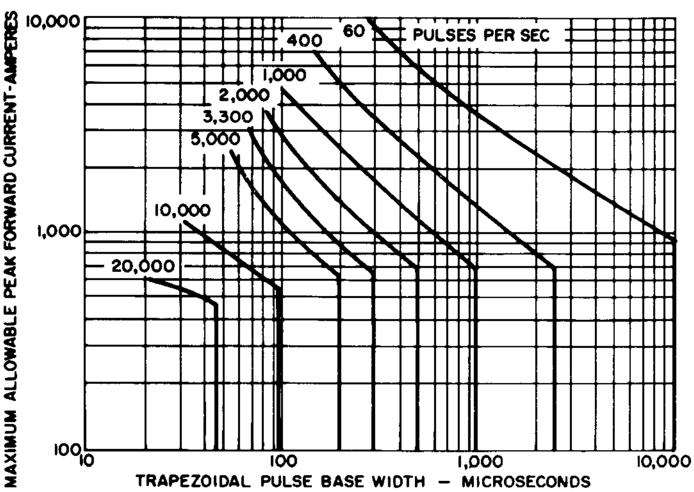
2. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT SINUSOIDAL WAVEFORM (T_C = 65°C) DOUBLE SIDE COOLED



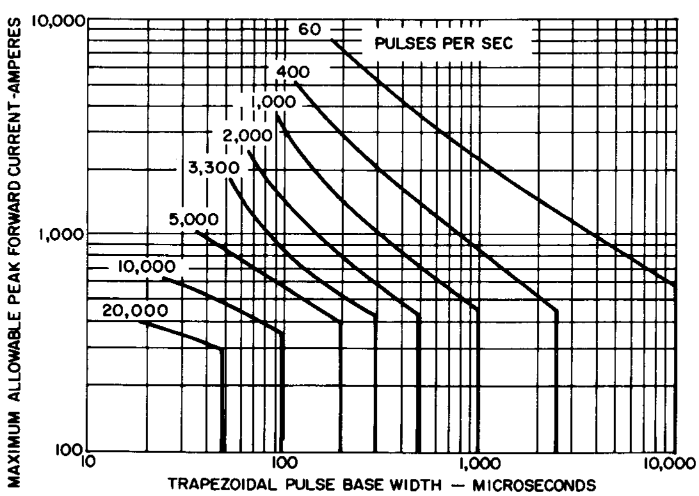
3. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT SINUSOIDAL WAVEFORM (T_C = 90°C) DOUBLE SIDE COOLED



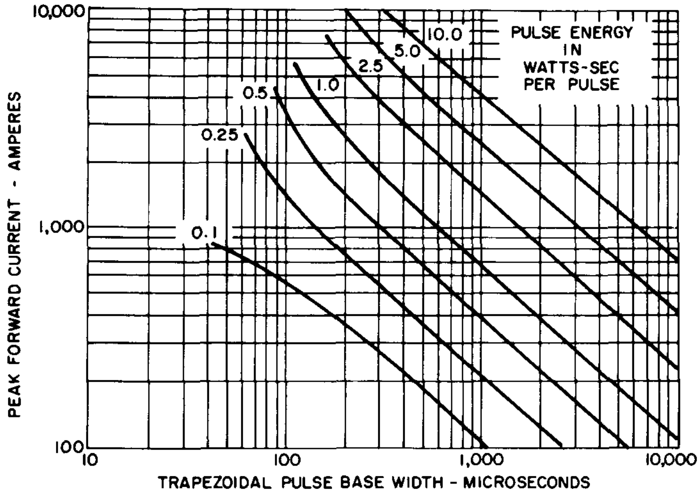
4. SINUSOIDAL PULSE ENERGY (T_J = 125°C)



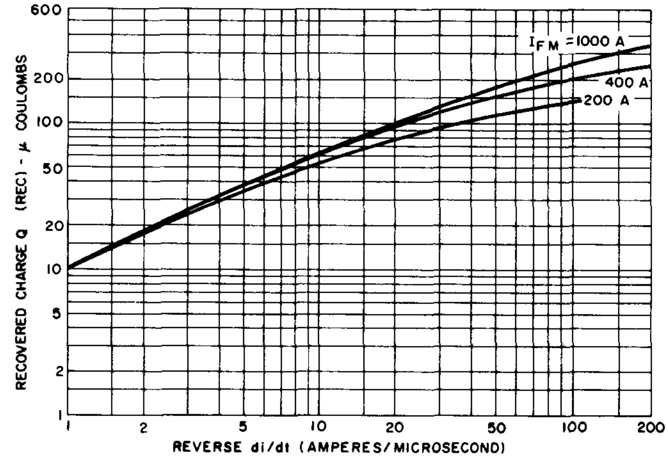
5. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT, TRAPEZOIDAL WAVEFORM (T_C = 65°C) DOUBLE SIDE COOLED DI/DT (RISING & FALLING) = 100 A/μS



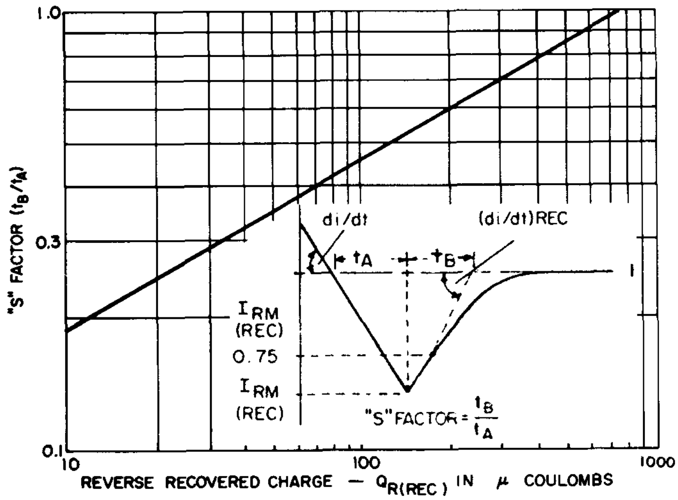
6. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT, TRAPEZOIDAL WAVEFORM (T_C = 90°C) DOUBLE SIDE COOLED



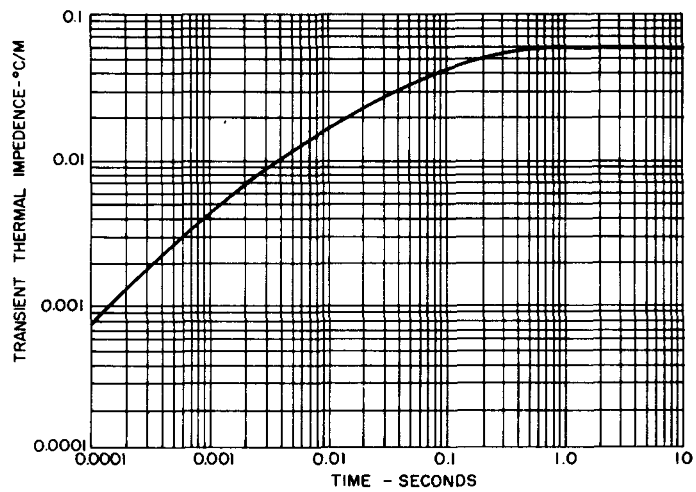
7. TRAPEZOIDAL PULSE ENERGY DI/DT (RISING & FALLING) = 100 A/μS (T_J = 125°C)



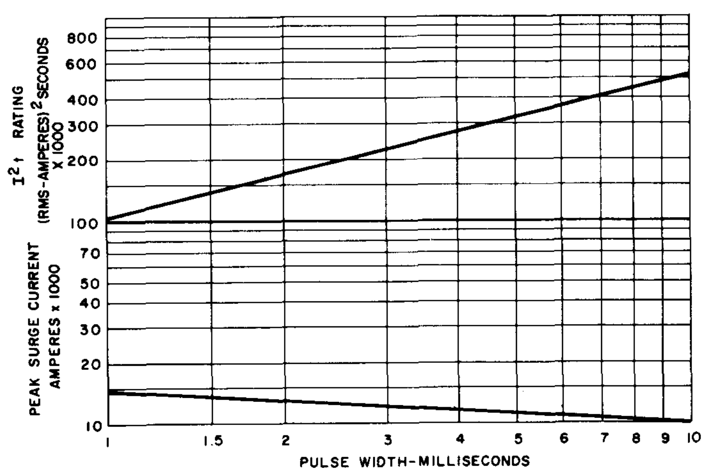
8. MAXIMUM RECOVERED CHARGE (T_J = 125°C)



9. TYPICAL "S" FACTOR VERSUS RECOVERY CHARGE (T_J = 125°C)



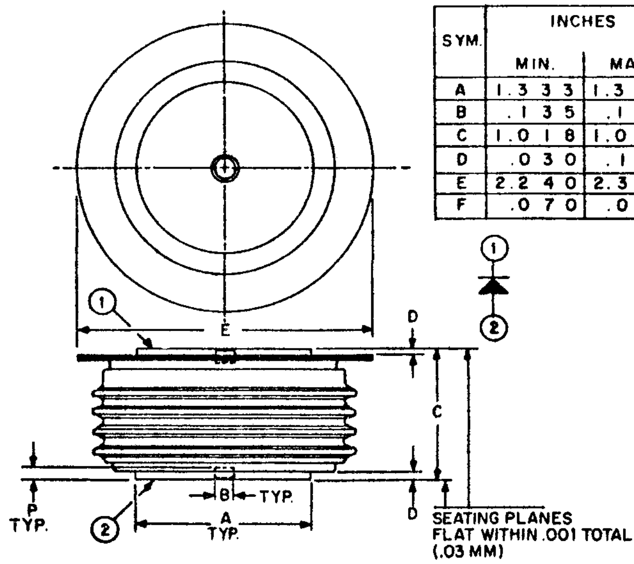
10. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE, DOUBLE SIDE COOLED



11. SUB-CYCLE SURGE FORWARD CURRENT AND I^2t RATINGS VERSUS PULSE TIME FOLLOWING RATED LOAD CONDITIONS

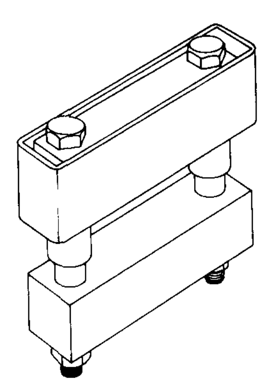
OUTLINE DRAWING

SYM.	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.
A	1.333	1.343	33.86	34.11
B	.135	.145	3.42	3.68
C	1.018	1.065	25.85	27.05
D	.030	.110	.76	—
E	2.240	2.300	56.89	58.42
F	.070	.090	3.55	4.06



MOUNTING INSTRUCTIONS

The General Electric Company offers the Series 2500, Press Pak, mounting clamp designed to facilitate single- or double-side cooling of all GE Press pak's.



Special features of this clamp:

- Metal pivot insuring constant pressure in rugged applications over long periods.
- One-piece phenolic insulator gives 1" nominal creep distance.
- Use of special *Force Indicator Gauge* eliminates need for torque wrenches, inaccurate "flex" gauges, and *guesswork*.
- Various bolt lengths available to accommodate most mounting situations.
- No loose parts to complicate assembly.
- Stiffening *brace* to reinforce heat sink *available upon request*.
- *Single-side cooling terminal available upon request.*
- Positive, non-binding swivel action.

SUGGESTED MOUNTING METHODS FOR PRESS-PAKS TO HEAT DISSIPATORS

When the Press-Pak is assembled to a heat sink in accordance with the following general instructions, a reliable and and low thermal resistance interface will result:

1. Check each mating surface for nicks, scratches, flatness and surface finish. The heat dissipator mating surfaces should be flat within .0005 inch/inch and have a surface finish of 63 micro-inches.
2. It is recommended that the heat dissipator mounting surfaces be plated with nickel, tin or silver. Bare aluminum or copper surfaces will oxidize in time resulting in excessively high thermal resistance.
3. Sand each surface **lightly** with 600 grit paper just prior to assembly. Clean off and apply silicone oil (GE SF1154 200 centistoke viscosity) or silicone grease (GE G322L or Dow Corning DC 3, 4, 340 or 640). Clean off and apply again as a **thin** film. (A thick film will adversely affect the electrical and thermal resistances.)
4. Assemble with the specified mounting force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both top and bottom of the Press-Pak are for locating purposes only.

Silicon RECTIFIER

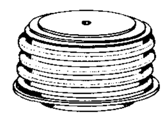
A500

3000 Volts 740 Amps Avg.

The A500 Series of high power rectifier diodes feature the newly developed, multi-diffused technology in a new General Electric pressure-mounted package.

FEATURES:

- High Current, *High Voltage*
- Pressure Contacts
- Glazed Ceramic Package with 1″ Creepage Path
- Reversibility (eliminates need for special reverse polarity units)
- Hermetic Seal
- Available in Factory Assembled Heat Exchangers or Ready-to-Mount



IMPORTANT: Mounting instructions on the last page of the C501 specification **must** be followed.

MAXIMUM ALLOWABLE RATINGS

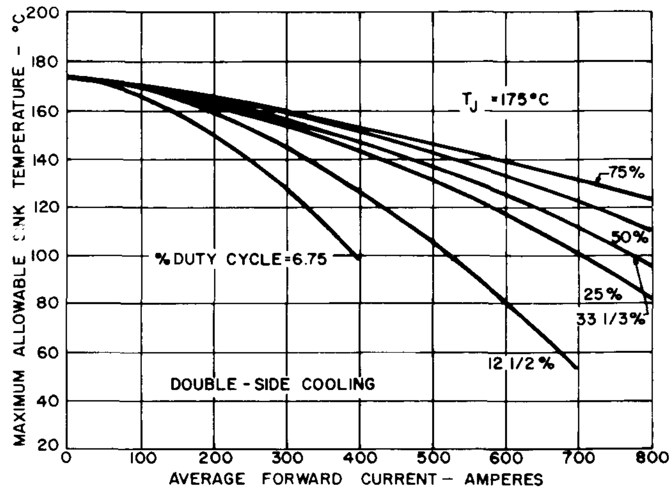
TYPE	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} T_J = -40°C to +175°C	NON-REPETITIVE REVERSE VOLTAGE, V_{RSM} T_J = 0°C to +175°C	V_{RRM}/V_{RSM} T_J = -40°C to +200°C
A500LP	3000 Volts	3100 Volts	2600 Volts
A500LT	2900	3000	2500
A500LN	2800	2900	2400
A500LS	2700	2800	2300
A500LM	2600	2700	2200
A500LE	2500	2600	2100
A500LD	2400	2500	2000
A500LC	2300	2400	1900
A500LB	2200	2300	1800
A500LA	2100	2200	1700
A500L	2000	2100	1600
A500PT	1900	2000	1500
A500PN	1800	1900	1400
A500PS	1700	1800	1300
A500PM	1600	1700	1200

Average Forward Current . . . . 740 Amperes, 1Φ Average
Peak One-Cycle Surge Current . . . . 10,000 Amperes
Minimum I^2t Rating (for times ⩾ 1.5 msec) . . . . 363,000 Ampere² Seconds
Minimum I^2t Rating (at 8.3 msec) . . . . 415,000 Ampere² Seconds
Maximum Forward Voltage Drop (T_C = 150°C, 1000 Amps. Peak) . . . . 1.26 Volts
Peak Reverse Leakage Current (T_J = 175°C, V = Rated V_{RRM}) 35mA
Maximum Thermal Resistance, $R_{\theta JS}$ (1ϕ) (Double-Side Cooling) . . . . 0.06°C/Watt
Storage Temperature, T_{STG} . . . . -40°C to +200°C
Operating Temperature, T_J . . . . 0°C to +175°C
Mounting Force Required . . . . 2200 Lbs. ± 10%
9.8 KN ± 10%

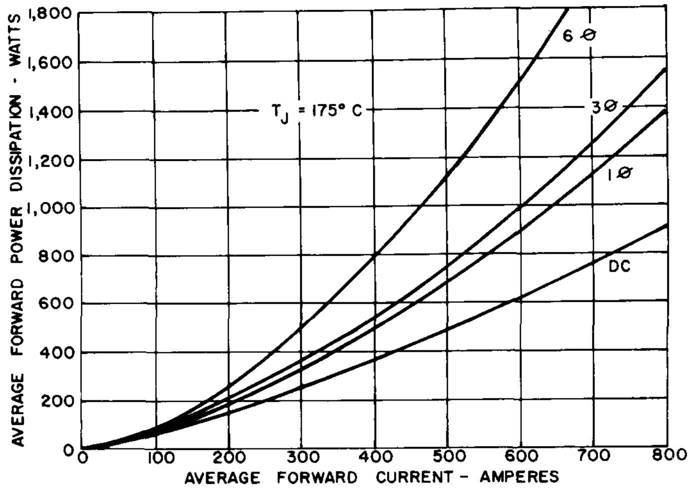
NOTES:

1 Assumes a heatsink thermal resistance of less than 1.1°C/watt.

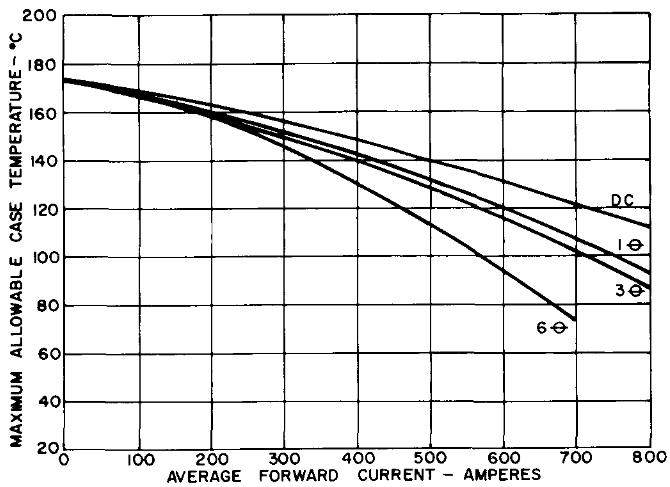
2 Non-recurrent voltage and current ratings, as contrasted to repetitive ratings which apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-recurrent ratings that are used in fault coordination work.



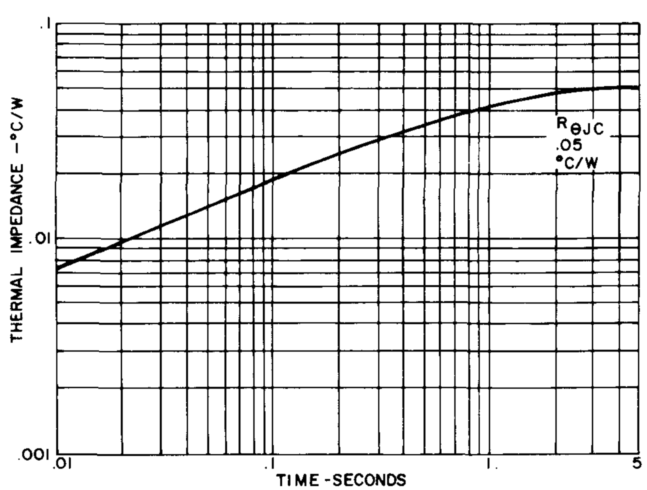
1. AVERAGE FORWARD CURRENT VERSUS MAXIMUM ALLOWABLE SINK TEMPERATURE



2. AVERAGE FORWARD POWER DISSIPATION VERSUS AVERAGE FORWARD CURRENT



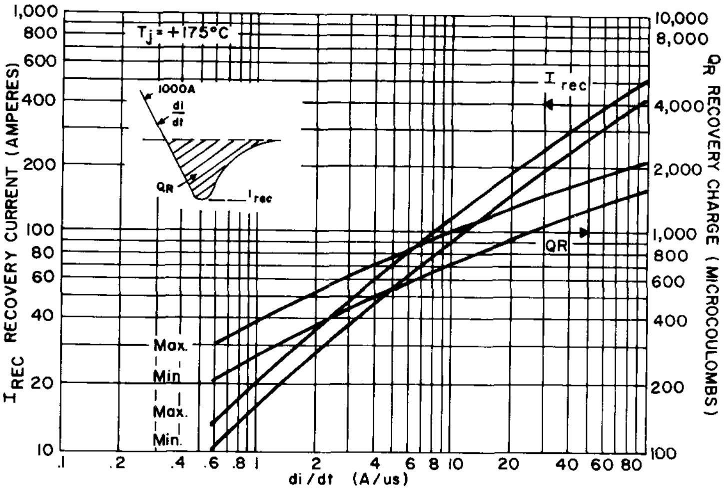
3. MAXIMUM HEAT EXCHANGER TEMPERATURE VERSUS AVERAGE FORWARD CURRENT FOR DOUBLE-SIDE COOLING



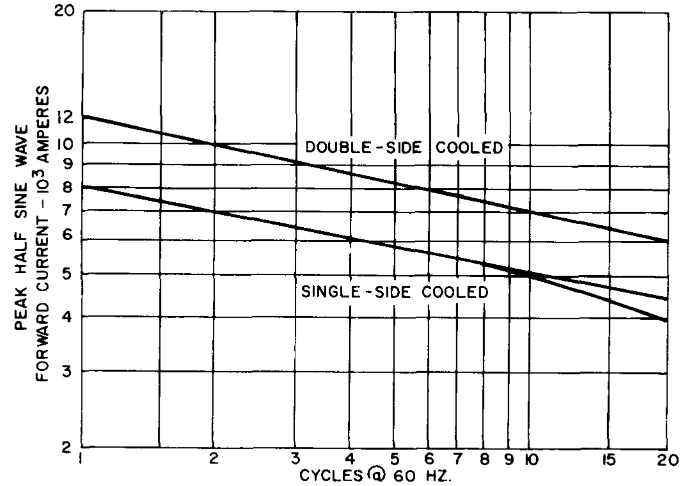
4. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE

NOTES:

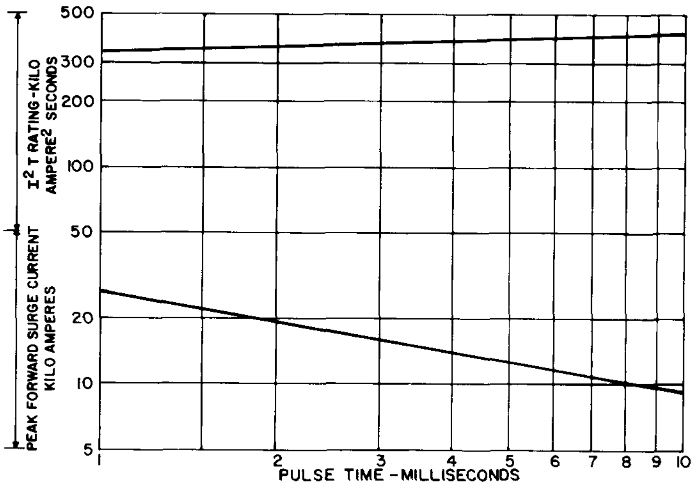
1. Power "D" adds .01°C/W to account for both case to dissipator interfaces, when properly mounted; e.g., $R_{\theta JS}$ = .06°C/W. See Mounting Instructions.
2. DC Thermal Impedance is based on average full cycle junction temperature. Instantaneous junction temperature may be calculated using the following modifications.
   - end of conducting portion of cycle
     - 120° sq. wave add .0065°C/W along entire curve
     - 180° sq, wave add ,0047°C/W along entire curve
     - 180°sine wave add .0026°C/W along entire curve
   - end of full cycle
     - any wave, subtract .0026°C/W along entire curve



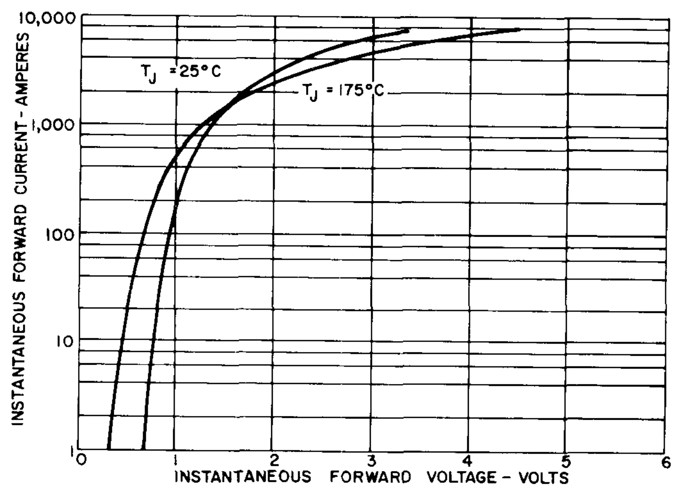
5. REVERSE RECOVERY CHARACTERISTICS



6. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

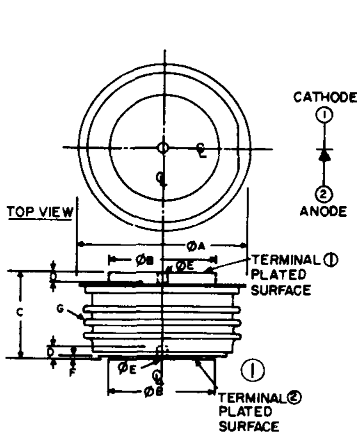


7. SUBCYCLE PEAK SURGE FORWARD CURRENT AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS



8. MAXIMUM ON-STATE CHARACTERISTICS

OUTLINE DRAWING



NOTE:
1. GLAZED CERAMIC INSULATOR WITH 1.00 INCH MIN. SURFACE CREEPAGE (25.40mm)

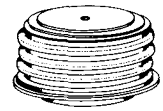
SYMBOL	INCHES		MILLIMETERS		NOTE
	MIN	MAX	MIN	MAX	
ØA	—	2.000	—	50.80	
ØB	1.240	1.260	31.50	32.00	
C	1.000	1.060	2540	26.92	
D	.080	—	2.03	—	
ØE	0.136	0.146	3.45	3.71	
F	.034	—	0.86	—	
G					1

Silicon RECTIFIER

A540

2400 Volts 1000 Amps Avg.

The A540 Series of high power rectifier diodes feature the newly developed, multi-diffusion technology in a new General Electric pressure-mounted package.



FEATURES:

- High Current, High Voltage
- Pressure Contacts
- Glazed Ceramic Package with 1" Creepage Path
- Reversibility (eliminates need for special reverse polarity units)
- Hermetic Seal
- Availabile in Factory Assembled Heat Exchangers or Ready-to-Mount

IMPORTANT: Mounting instructions on the last page of the C501 specification must be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} T_J = -40°C to +185°C	NON-REPETITIVE REVERSE VOLTAGE, V_{RSM} T_J = 0°C to +185°C	V_{RRM}/V_{RSM} T_J = 185°C to 200°C
A540LD	2400 Volts	2500 Volts	2000 Volts
A540LC	2300	2400	1950
A540LB	2200	2300	1850
A540LA	2100	2200	1750
A540L	2000	2100	1700

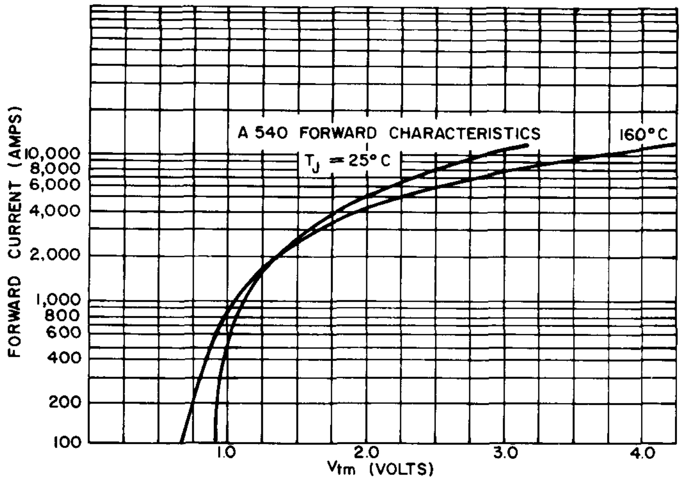
Lower voltages available – consult factory.

Average Forward Current . . . . 1000 Amperes, 1Φ Average
Peak One-Cycle Surge Current . . . . 12,000 Amperes
Minimum I^2t Rating (for times ⩾ 1.5 msec) . . . . 285,000 Ampere² Seconds
Minimum I^2t Rating (at 8.3 msec) . . . . 597,000 Ampere² Seconds
Maximum Forward Voltage Drop (T_C = 160°C Case Temperature, 1000 Amps. Peak) . . . . 1.08 Volts
Peak Reverse Leakage Current (T_J = 200°C, V = Rated V_{RRM}) 35mA
Maximum Thermal Resistance, $R_{\theta JS}$ (Double-Side Cooling) . . . . 0.06°C/Watt
Storage Temperature, T_{STG} . . . . -40°C to +200°C
Operating Junction Temperature, T_J . . . . -40°C to +200°C
Mounting Force Required . . . . 2200 Lbs. ± 10%
9.8 KN ± 10%

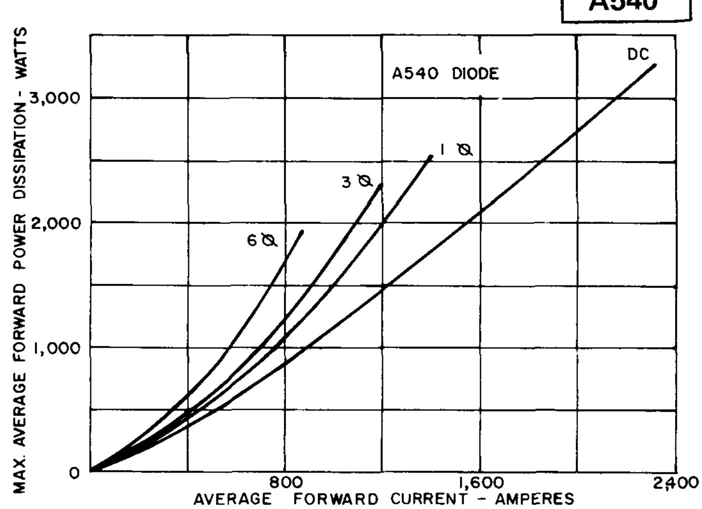
NOTES:

1 Assumes a heatsink thermal resistance of less than 1.1°C/watt.

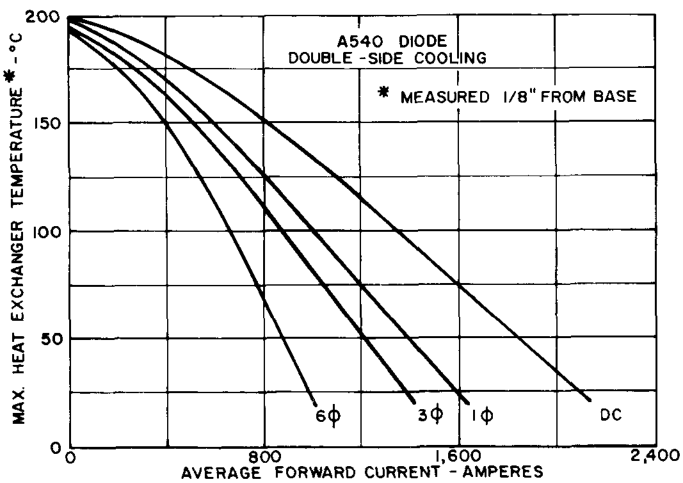
2 Non-recurrent voltage and current ratings, as contrasted to repetitive ratings which apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-recurrent ratings that are used in fault coordination work.



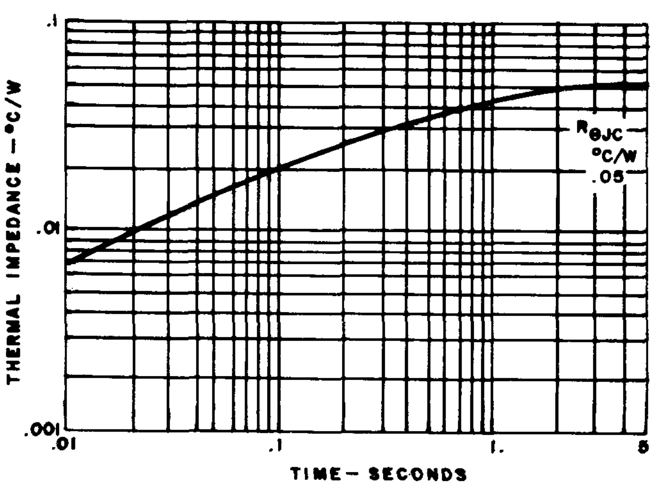
1. MAXIMUM ON-STATE CHARACTERISTICS



2. AVERAGE FORWARD POWER DISSIPATION VERSUS AVERAGE FORWARD CURRENT



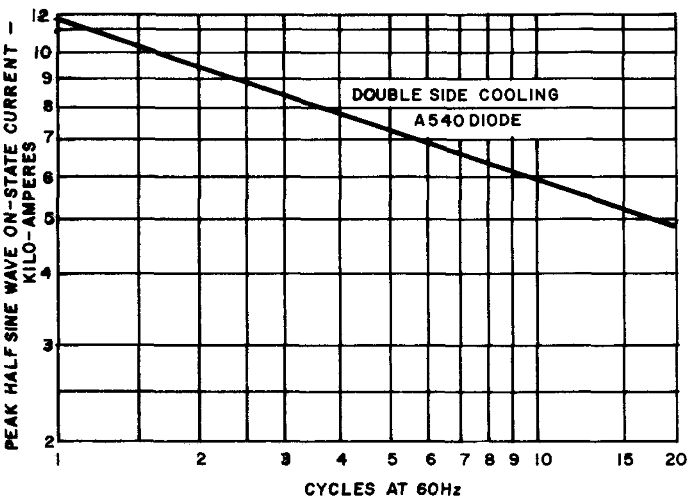
3. MAXIMUM HEAT EXCHANGER TEMPERATURE VERSUS AVERAGE FORWARD CURRENT FOR DOUBLE-SIDE COOLING



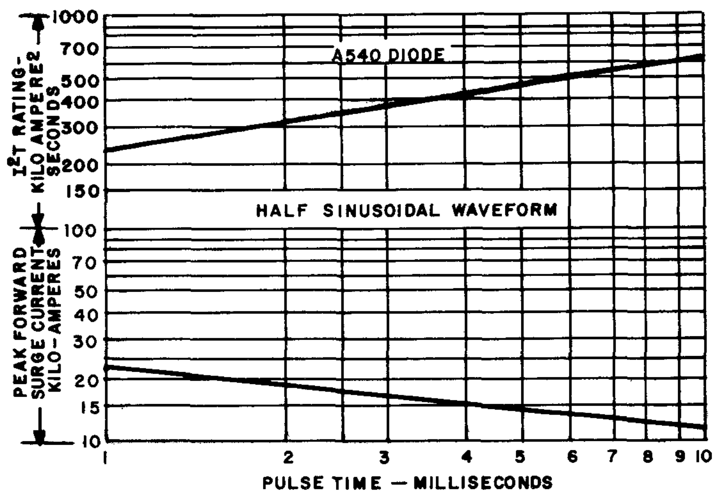
4. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

NOTES:

1. Power "D" adds .01°C/W to account for both case to dissipator interfaces, when properly mounted; e.g., $R\theta_{JS}$ = .06°C/W. See Mounting Instructions.
2. DC Thermal Impedance is based on average full cycle junction temperature. Instantaneous junction temperature may be calculated using the following modifications.
   - end of conducting portion of cycle
     - 120° sq. wave add .0065°C/W along entire curve
     - 180° sq. wave add .0047°C/W along entire curve
     - 180° sine wave add .0026°C/W along entire curve
   - end of full cycle
     - any wave, subtract .0026°C/W along entire curve

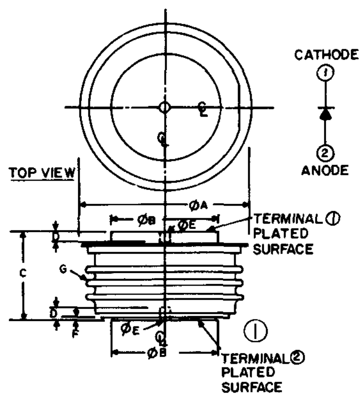


5. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



6. SUBCYCLE PEAK SURGE FORWARD CURRENT AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS

OUTLINE DRAWING



NOTE:
1. GLAZED CERAMIC INSULATOR WITH 1.00 INCH MIN. SURFACE CREEPAGE (25.40mm)

SYMBOL	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX	NOTE
ØA	—	2.000	—	50.80	
ØB	1.240	1.260	31.50	32.00	
C	1.000	1.060	25.40	26.92	
D	.080	—	2.03	—	
ØE	0.136	0.146	3.45	3.71	
F	.034	—	0.86	—	
G					1

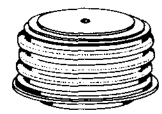
Silicon RECTIFIER

A570

600 Volts 1500A Avg.

The A570 Series of high power rectifier diodes feature the proven, alloy-diffused construction used in a new General Electric pressure-mounted package.

FEATURES:



- High Current Rectifier
- Pressure Contacts
- Glazed Ceramic Package with 1″ Creepage Path
- Reversibility (eliminates need for special reverse polarity units)
- Hermetic Seal
- Available in Factory Assembled Heat Exchangers or Ready-to-Mount

IMPORTANT: Mounting instructions on the last page of the C501 specification must be followed.

MAXIMUM ALLOWABLE RATINGS

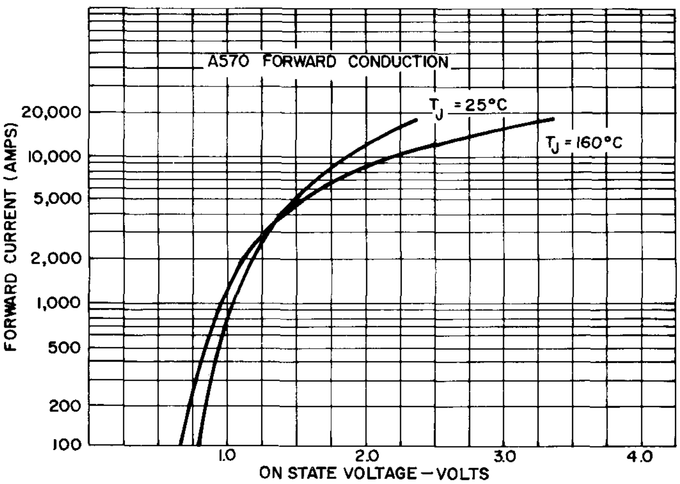
TYPE	REPETITIVE PEAK REVERSE VOLTAGE V_{RRM}, T_J = -40°C to +200°C	NON-REPETITIVE PEAK REVERSE VOLTAGE V_{RSM}, T_J = 0°C to +200°C
A570M	600 Volts	700 Volts
A570E	500	600
A570D	400	500
A570C	300	400
A570B	200	300
A570A	100	200

Average Forward Current . . . . 1500 Amperes, 1Φ Average
Peak One-Cycle Surge Current . . . . 18,000 Amperes
Minimum I^2t (for times ⩾ 1.5 msec) . . . . 1,050,000 Ampere² Seconds
Minimum I^2t (at 8.3 msec). . . . . 1,300,000 Ampere² Seconds
Peak Forward Voltage Drop (T_C = 160°C, 1000 Amps. Peak) . . . . 0.96 Volts
Peak Reverse Leakage Current (T_J = 200°C, V = Rated V_{RRM}) . . . . 50 mA
Maximum Thermal Resistance, $R_{\theta JS}$ (Double-Side Cooling) . . . . .06°C/Watt
Storage Temperature, T_{stg} . . . . -40°C to +200°C
Operating Junction Temperature, T_J . . . . -40°C to +200°C
Mounting Force Required . . . . 2200 Lbs. ± 10%
9.8 KN ± 10%

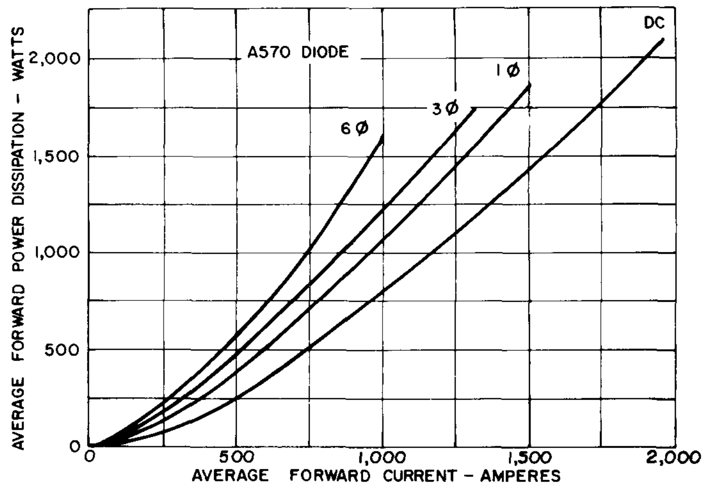
NOTES:

[1] Assumes a heatsink thermal resistance of less than 1.0°C/watt.

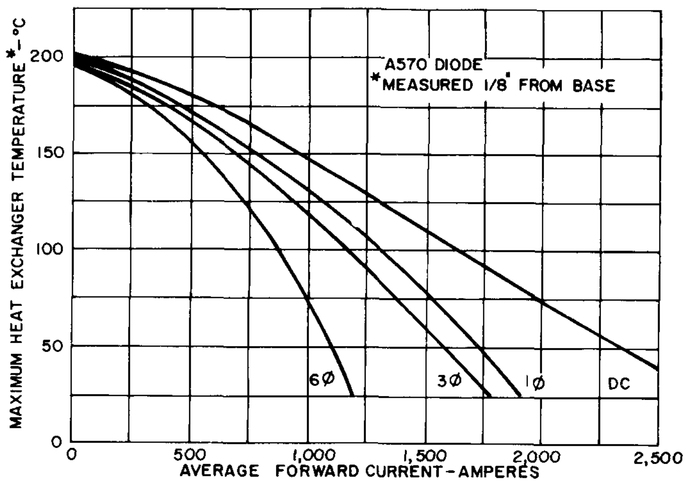
[2] Non-recurrent voltage and current ratings, as contrasted to repetitive ratings which apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-recurrent ratings are non-recurrent retings that are used in fault coordination work.



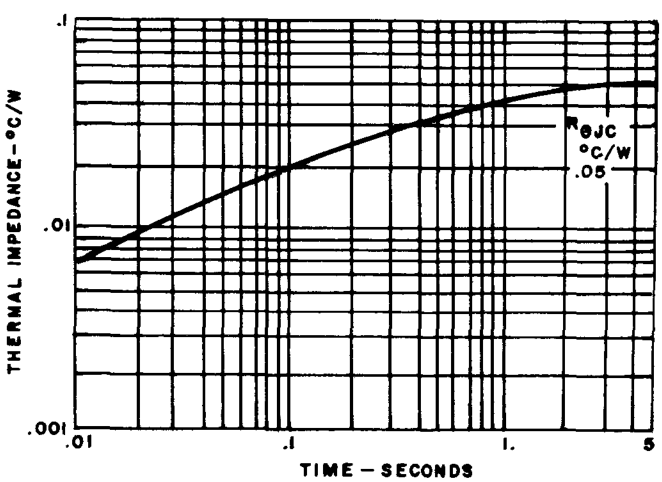
1. MAXIMUM ON-STATE CHARACTERISTICS



2. AVERAGE FORWARD POWER DISSIPATION VERSUS AVERAGE FORWARD CURRENT



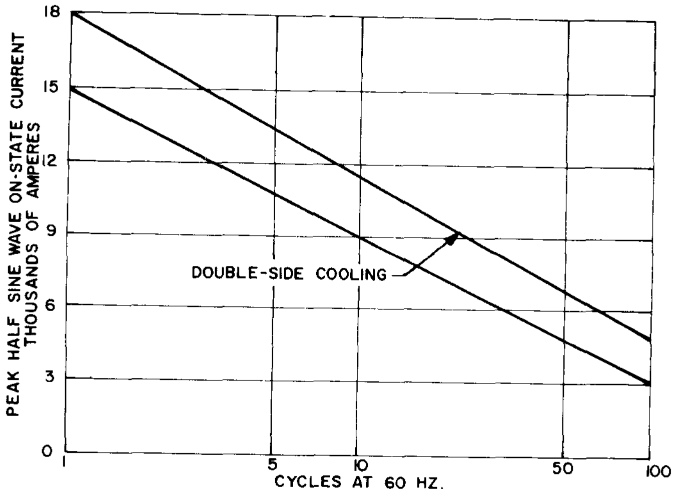
3. MAXIMUM HEAT EXCHANGER TEMPERATURE VERSUS AVERAGE FORWARD CURRENT FOR DOUBLE-SIDE COOLING



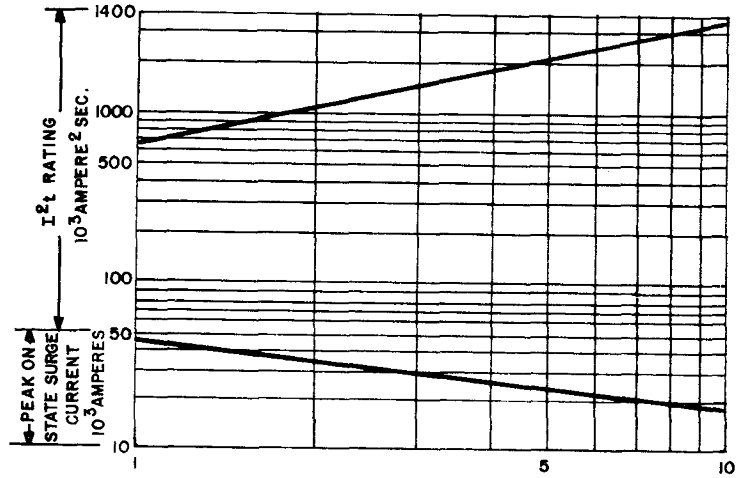
4. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE

NOTES:

1. Power "D" adds .01°C/W to account for both case to dissipator interfaces, when properly mounted; e.g., $R_{\theta JS}$ = .06°C/W. See Mounting Instructions.
2. DC Thermal Impedance is based on average full cycle junction temperature. Instantaneous junction temperature may be calculated using the following modifications.
   - end of conducting portion of cycle
     - 120° sq. wave add .0065°C/W along entire curve
     - 180° sq. wave add ,0047°C/W along entire curve
     - 180°sine wave add .0026°C/W along entire curve
   - end of full cycle
     - any wave, subtract .0026°C/W along entire curve

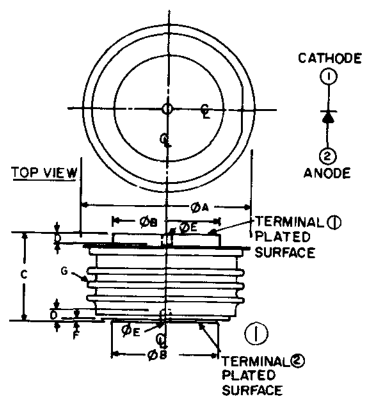


5. MAXIMUM SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



6. SUB-CYCLE PEAK SURGE ON-STATE CURRENT AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS

OUTLINE DRAWING



NOTE:
1. GLAZED CERAMIC INSULATOR WITH 1.00 INCH MIN. SURFACE CREEPAGE (25.40mm)

SYMBOL	INCHES		MILLIMETERS		NOTE
	MIN	MAX	MIN	MAX	
ØA	—	2.000	—	50.80	
ØB	1.240	1.260	31.50	32.00	
C	1.000	1.060	25.40	26.92	
D	.080	—	2.03	—	
ØE	0.136	0.146	3.45	3.71	
F	.034	—	0.86	—	
G					1

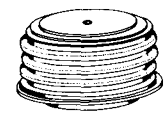
High Speed
Fast Recovery Rectifier

A596

750A Avg., Up to 1400 Volts

The A596 high power rectifier diode is designed for use in high frequency applications – or wherever a fast/soft recovery performance is required. The A596 is rated to 5 KHz.

FEATURES:



- Reverse Blocking Voltage to 1200 Volts
- Soft Recovery With Low Recovered Charge
- Pressure Contacts
- Diffused Construction
- Glazed Ceramic Package with 1″ Creepage Path
- Reversibility (eliminates need for special reverse polarity units)
- Fully Characterized to 5 KHz
- Available in Factory Assembled Heat Exchangers or Ready-to-Mount

IMPORTANT: Mounting instructions on the last page of the C501 specification **must** be followed.

MAXIMUM ALLOWABLE RATINGS

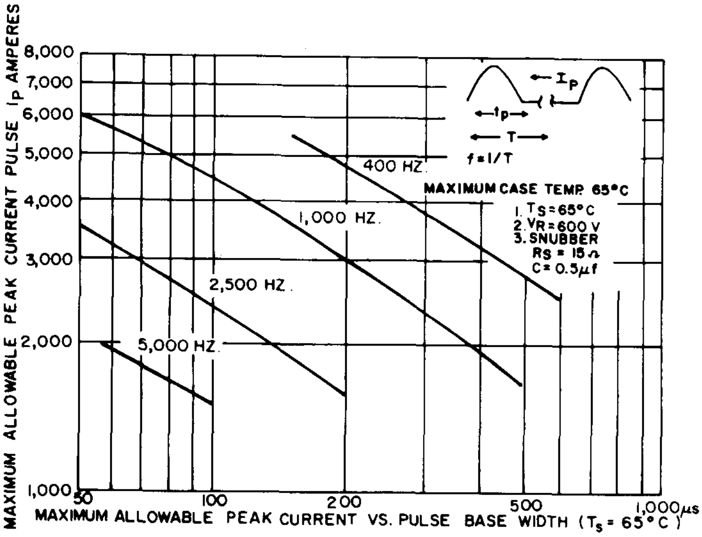
TYPES	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +175°C	TRANSIENT PEAK REVERSE VOLTAGE, V_{RSM}[2] (NON-RECURRENT 5 MSEC MAX.) T_J = -40°C to +175°C	PEAK REVERSE LEAKAGE CURRENT		
			125°C	150°C	175°C
A596N	800 Volts	900 Volts	15mA	40mA	125mA
A596T	900	1000	15	40	125
A596P	1000	1100	15	40	125
A596PA	1100	1200	15	40	125
A596PB	1200	1300	15	40	125
A596PC	1300	1400	16	50	150
A596PD	1400	1500	20	60	175

Average Forward Current . . . . 750 Amperes, 1Φ Average
Peak One-Cycle Surge Current . . . . 10,000 Amperes
Minimum I^2t Rating (for times ⩾ 1.5 msec) . . . . 320,000 Ampere² Seconds
Minimum I^2t Rating (at 8.3 msec) . . . . 415,000 Ampere² Seconds
Maximum On-State Voltage Drop (I_{TM} = 3500 Amps, T_J = 125°C) . . . . 2.3 Volts
Maximum Thermal Resistance, $R_{\theta JS}$ (1ϕ) (Double-Side Cooling) . . . . 0.06°C/Watt
Storage Temperature, T_{STG} . . . . -40°C to +200°C
Operating Temperature, T_J . . . . -40°C to +175°C
Mounting Force Required . . . . 2200 Lbs. ± 10%
9.8 KN ± 10%

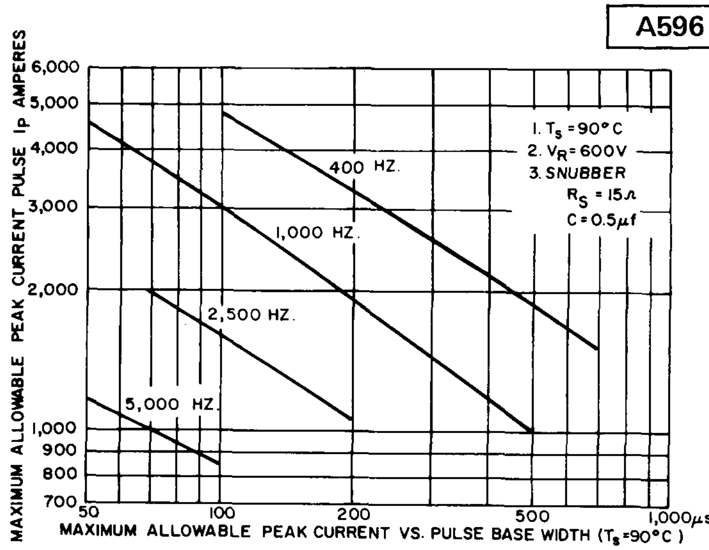
NOTES:

1 Assumes a heatsink Thermal Resistance of less than 1.1°C/watt.

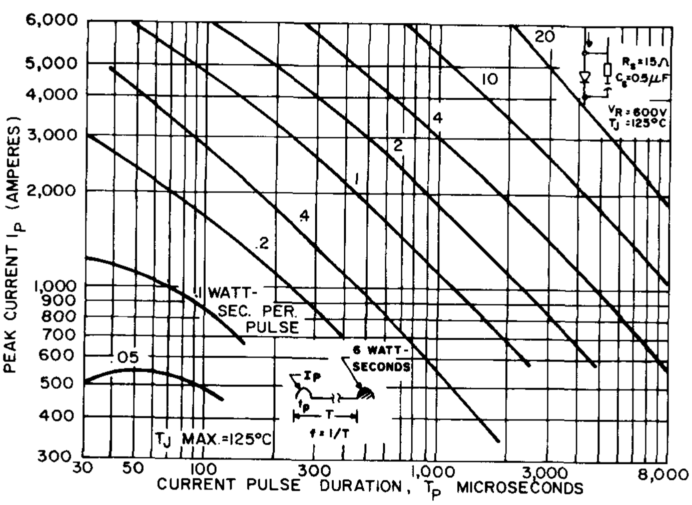
2 Non-recurrent voltage and current ratings, as contrasted to repetitive ratings which apply for occasional or unpredictable overloads. For example, the forward surge current ratings are non-recurrent ratings that are used in fault coordination work.



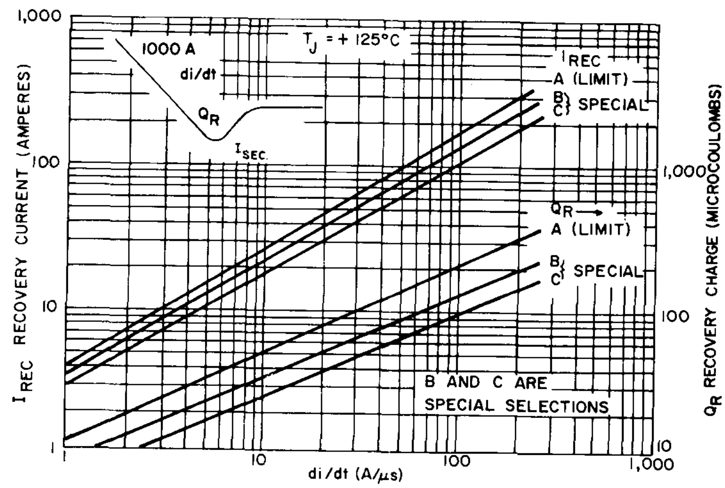
1. MAXIMUM ALLOWABLE PEAK CURRENT VERSUS PULSE BASE WIDTH (T_S = 65°C)



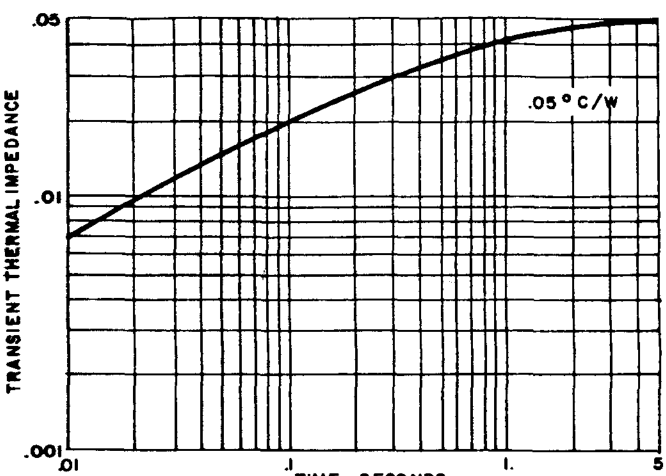
2. MAXIMUM ALLOWABLE PEAK CURRENT VERSUS PULSE BASE WIDTH (T_S = 90°C)



3. ENERGY PER PULSE FOR SINUSOIDAL PULSES



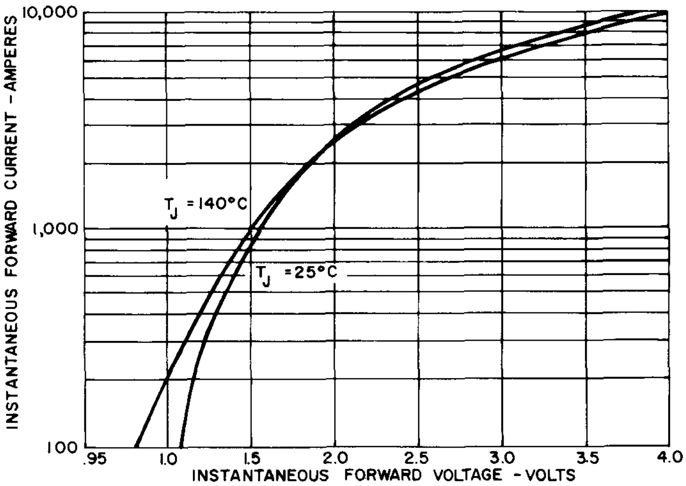
4. MAXIMUM RECOVERY CURRENT (LEFT HAND SCALE) AND MAXIMUM RECOVERY CHARGE (RIGHT HAND SCALE)



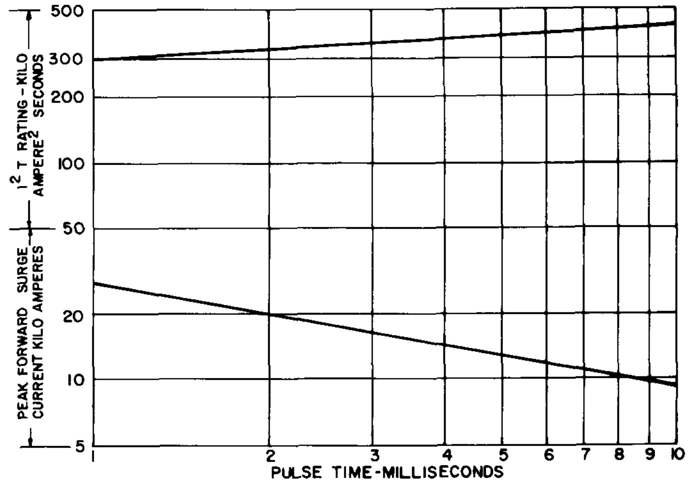
5. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE

NOTES:

1. Add .01°C/W to account for both case to dissipator interfaces, when properly mounted; e.g., $R\theta_{JS}$ = .06° C/W. See Mounting Instructions.
2. DC Thermal Impedance is based on average full cycle junction temperature. Instantaneous junction temperature may be calculated using the following modifications.
   - end of conducting portion of cycle
     – 120° sq. wave add .0065°C/W along entire curve
     – 180° sq. wave add .0047°C/W along entire curve
     – 180° sine wave add .0026°C/W along entire curve
   - end of full cycle
     – any wave, subtract .0026°C/W along entire curve

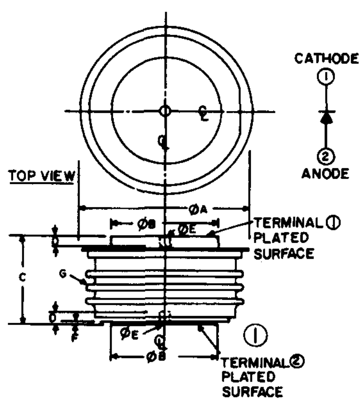


6. MAXIMUM ON-STATE CHARACTERISTICS



7. SUBCYCLE PEAK SURGE FORWARD CURRENT AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS

OUTLINE DRAWING



NOTE:
1. GLAZED CERAMIC INSULATOR WITH 1.00 INCH MIN. SURFACE CREEPAGE (25.40mm)

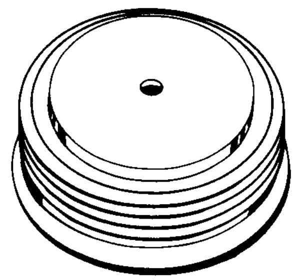
SYMBOL	INCHES		MILLIMETERS		NOTE
	MIN	MAX	MIN	MAX	
ØA	—	2.000	—	50.80	
ØB	1.240	1.260	31.50	32.00	
C	1.000	1.060	25.40	26.92	
D	.080	—	2.03	—	
ØE	0.136	0.146	3.45	3.71	
F	.034	—	0.86	—	
G					1

High Power Silicon Rectifier

A640

2100 Volts 1500A Avg.

The A640 Series of high power rectifier diodes feature the newly developed, multi-diffused technology in a new General Electric pressure-mounted package.



FEATURES:

- High Current, High Voltage
- Pressure Contacts
- Glazed Ceramic Package with 1″ Creepage Path
- Reversibility (eliminates need for special reverse polarity units)
- Hermetic Seal
- Available in Factory Assembled Heat Exchangers or Ready-to-Mount

IMPORTANT: Mounting instructions on the last page of the C501 specification **must** be followed.

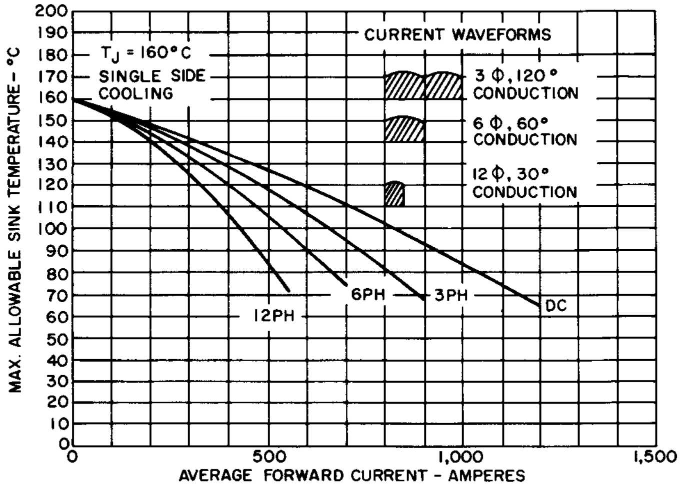
MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE V_{RRM} [1]	
	T_J = 0°C to +185°C	T_J = -40°C to +200°C
A640LA	2100 Volts	1800 Volts
A640L	2000	1700
A640PT	1900	1600
A640PN	1800	1500
A640PS	1700	1400
A640PM	1600	1300
A640PE	1500	1200
A640PD	1400	1100
A640PC	1300	1000
A640PB	1200	900
A640PA	1100	800
A640P	1000	700

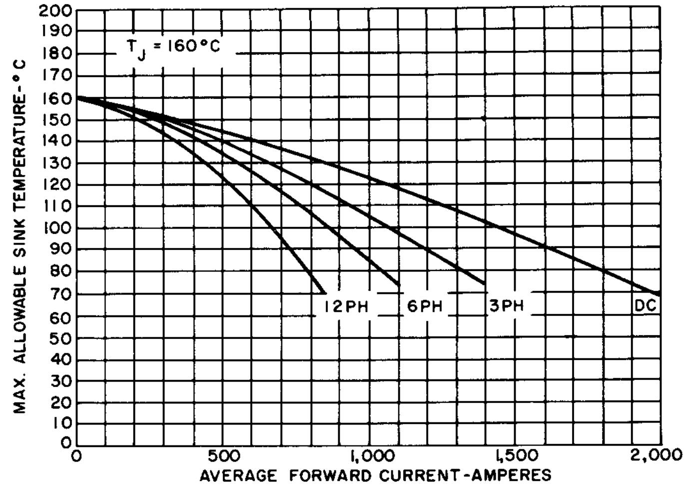
Average Forward Current . . . . 1500 Amperes, 1Φ Average
Peak One-Cycle Surge Current . . . . 16,000 Amperes
Minimum I^2t Rating (at 8.3 msec) . . . . 1,062,000 Ampere^2 Seconds
Maximum On-State Voltage Drop (at 1000 Amps.) . . . . 0.935 Volts
Peak Reverse Leakage Current (T_J = 200°C, V = Rated V_{RRM}) 50mA
Maximum Thermal Resistance (Double-Side Cooling) . . . . 0.045°C/Watt
Storage Temperature, T_{STG} . . . . -40°C to +200°C
Operating Junction Temperature, T_J . . . . -40°C to +200°C
Mounting Force Required . . . . 4000 Lbs. ± 10%
17.8 KN ±10%

NOTES:

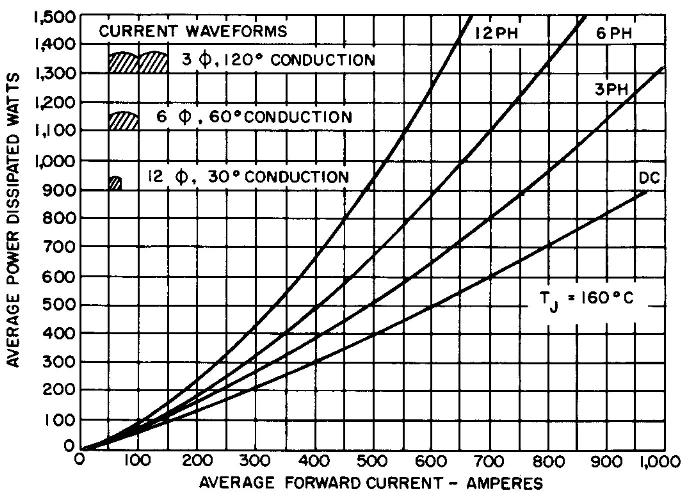
[1] Assumes a heatsink dissipation of less than 1.1°C/watt.



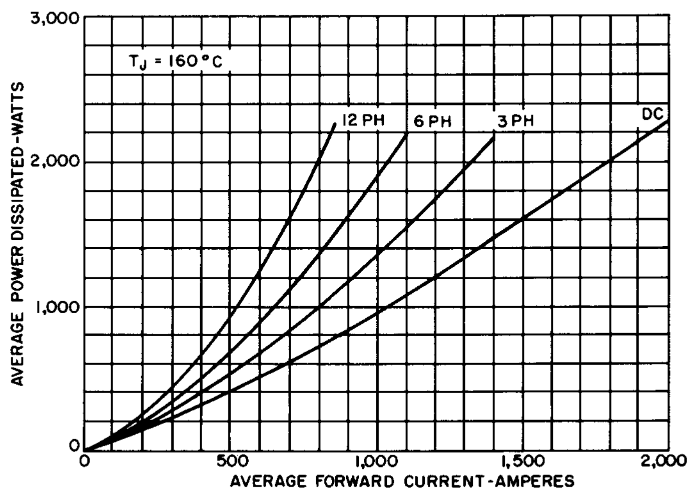
1. MAXIMUM ALLOWABLE HEAT SINK TEMPERATURE FOR SINUSOIDAL COOLING WAVEFORM – SINGLE-SIDE COOLING



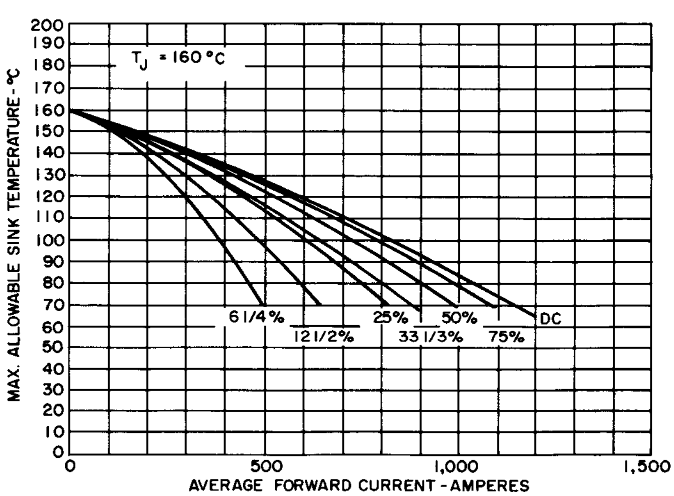
2. MAXIMUM ALLOWABLE HEAT SINK TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM – DOUBLE-SIDE COOLING



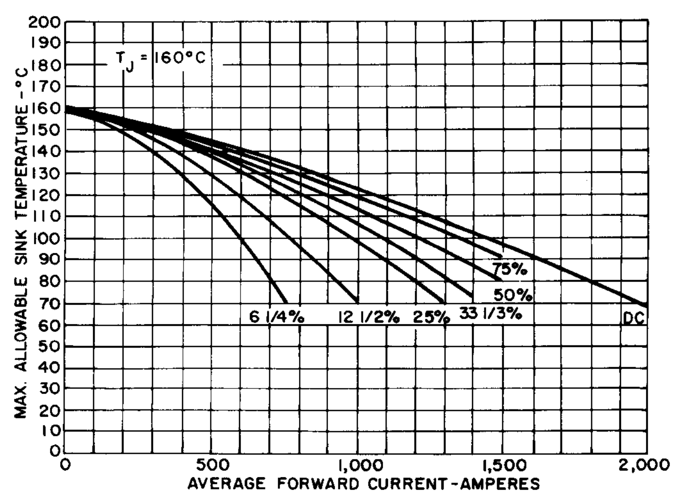
3. AVERAGE POWER DISSIPATION CURVES



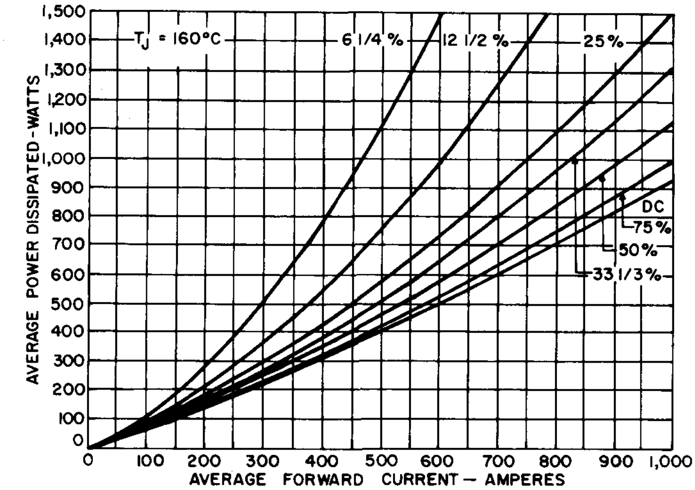
4. EXTENSED SINUSOIDAL POWER DISSIPATION CURVES



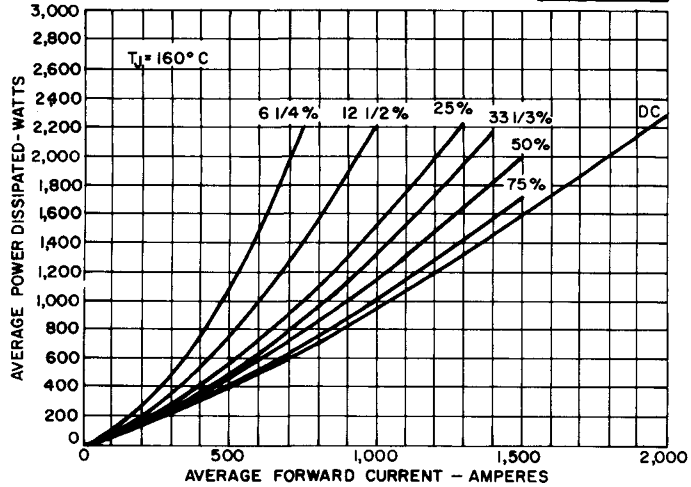
5. MAXIMUM ALLOWABLE HEAT SINK TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORMS – SINGLE-SIDE COOLING



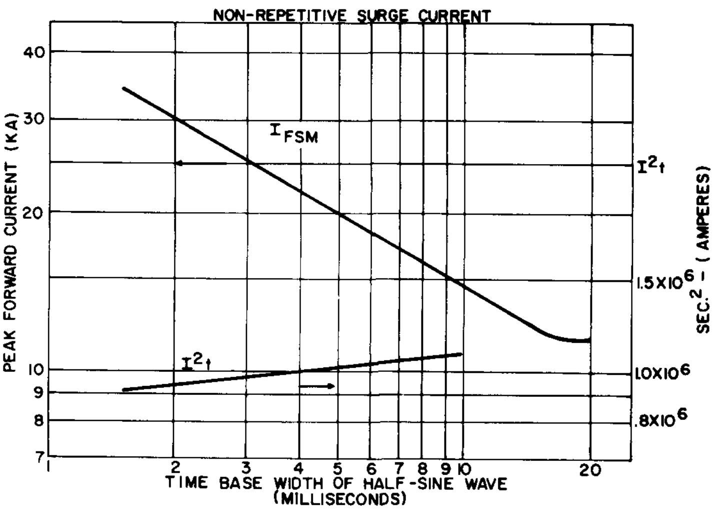
6. MAXIMUM ALLOWABLE HEAT SINK TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORMS – DOUBLE-SIDE COOLING



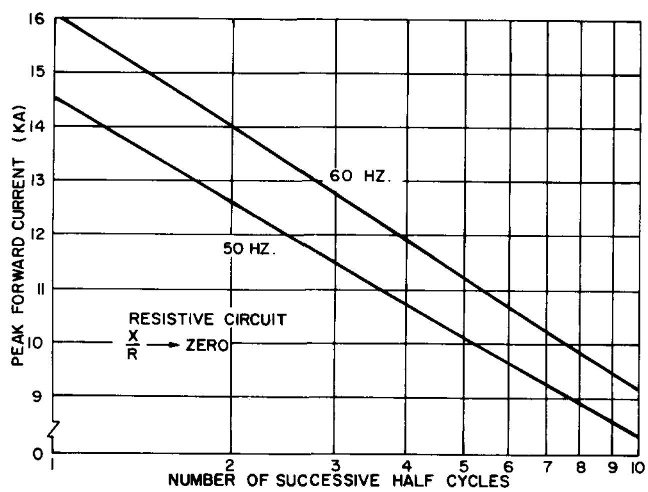
7. POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORMS



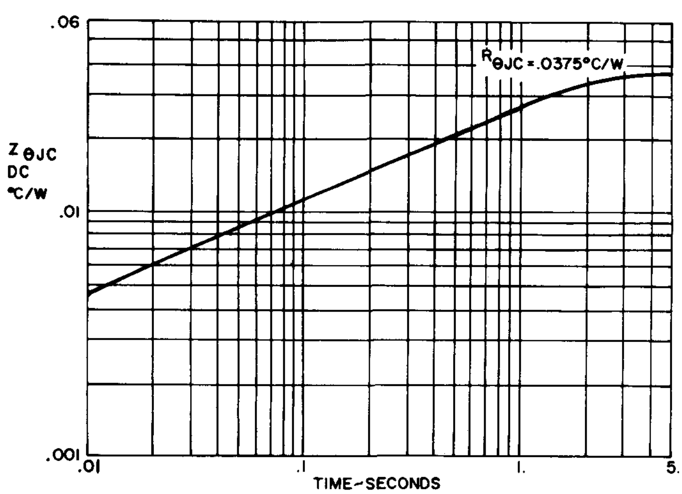
8. EXTENDED POWER DISSIPATION CURVES FOR RECTANGULAR CURRENT WAVEFORMS



9. SUBCYCLE SURGE CURRENT



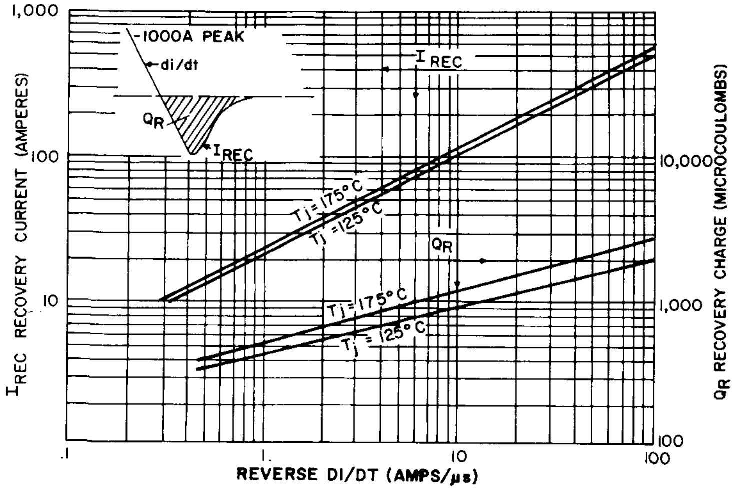
10. MULTICYCLE SURGE CURRENT



11. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

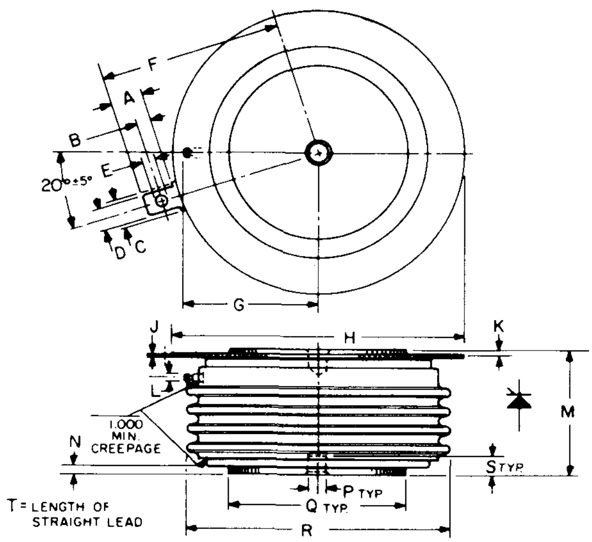
NOTES:

1. Add .0075°C/W to account for both case to dissipator interfaces when properly mounted; e.g., $R\theta_{JS}$ = .045°C/W.
2. DC Thermal Impedance is based on average full cycle junction temperature. Instantaneous junction temperature may be calculated using the following modifications:
   - end of conducting portion of cycle
     — 120° sq. wave add .0044°C/W along entire curve
     — 180° sq. wave add .0032°C/W along entire curve
     — 180° sine wave add .0018°C/W along entire curve
   - end of full cycle
     — any wave, subtract .0018°C/W along entire curve



12. TYPICAL REVERSE RECOVERY CHARACTERISTICS

OUTLINE DRAWING



SYM	DECIMAL INCHES MIN.	MAX.	METRIC M.M. MIN.	MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.702	2.11

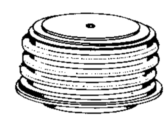
HIGH SPEED

Fast Recovery Rectifier

A696

2000 Volts 1000 Amps

The A696 Series of high power rectifier diodes is designed for use in high frequency applications (up to 5 KHz); or wherever a fast/soft recovery performance is required. It is recommended as a companion feedback device for the C712 thyristor.



FEATURES:

- Reverse blocking voltage to 2000 Volts
- Press-Pak Design for Double-Side Cooling
- Glazed Ceramic Package with 1″ Creepage Path
- Reversibility (eliminates need for special reverse polarity units)
- Available in Factory Assembled Heat Exchangers or Ready-to-Mount
- Three Microseconds Typical Recovery Time

MAXIMUM ALLOWABLE RATINGS

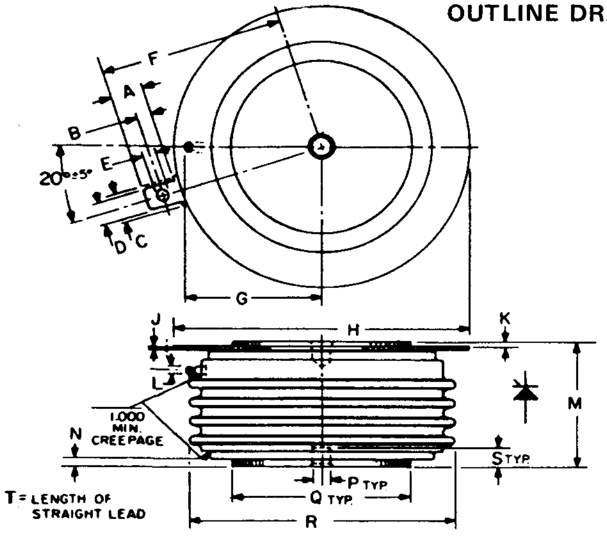
TYPE	REPETITIVE V_{RRM}[1] T_J = -40°C to +150°C	REPETITIVE V_{RRM}[1] T_J = 0°C to +150°C
A696L	2000 Volts	2100 Volts
A696PT	1900	2000
A696PN	1800	1900
A696PS	1700	1800
A696PM	1600	1700
A696PE	1500	1600

Average Forward Current . . . . 1000 Amperes, 1Φ Average
Peak One-Cycle Surge Current . . . . 14,000 Amperes
Maximum On-State Voltage Drop (at 1000 Amps, 25°C) . . . . 1.9 Volt
Peak Reverse Leakage Current (T_J = 150°C, V = Rated V_{RRM}) . . . . 50 mA
Maximum Thermal Resistance, $R_{\theta JC}$, Double-Side Cooling (DC) . . . . .036°C/Watt
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Junction Temperature, T_J . . . . -40°C to +150°C
Mounting Force Required . . . . 3500 – 4200 Lbs.
15.6 – 18.7 Kn
Switching, Conduction and Recovery Losses . . . . Consult Factory

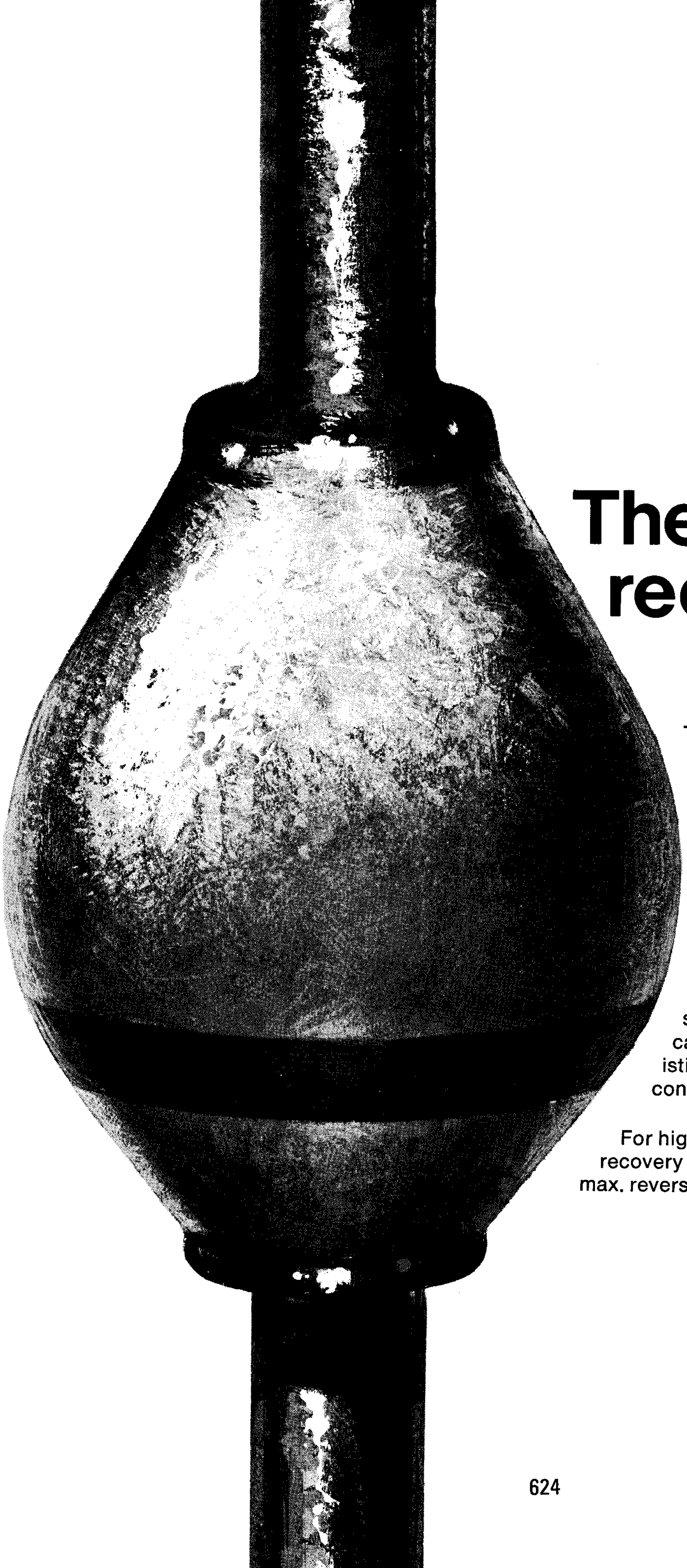
NOTE:

[1] Assumes a heatsink dissipation of less than 1.1°C/watt.

OUTLINE DRAWING



SYM	DECIMAL INCHES MIN.	MAX.	METRIC M.M. MIN.	MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.702	2.11



The reliable rectifier

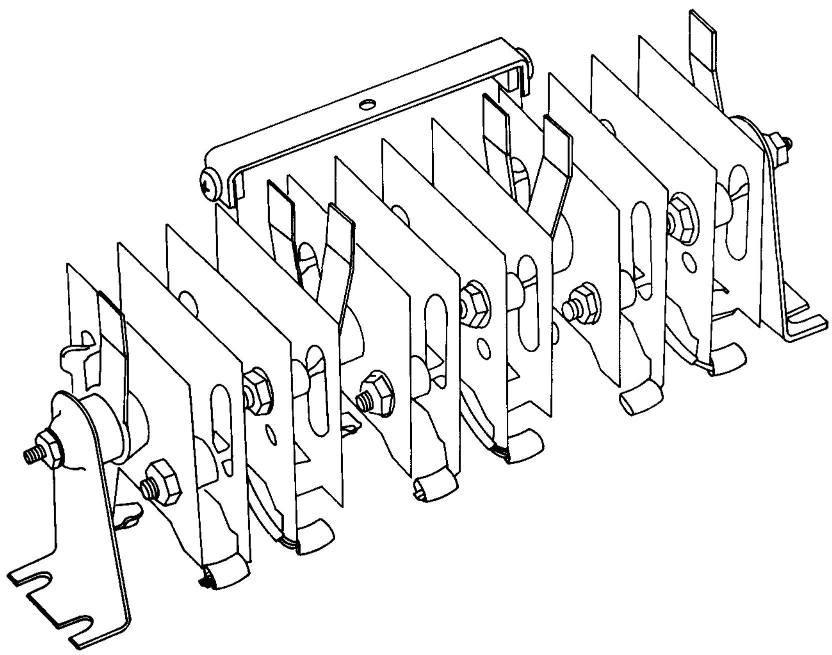
The best way to assure reliability in a low-current rectifier pellet is to put it in a package that really protects it. Protects it from shock, humidity, vibration and temperature.

And that's just what we do with General Electric's glassivated 1-amp (A14) and 3-amp (A15) rectifiers. Solid glass provides passivation and protection of the silicon pellet's P-N junction—no organic material is present within the hermetically sealed package. In addition, rigid mechanical support and excellent thermal characteristics are provided by the dual heat sink construction.

For high-frequency applications, GE offers a fast-recovery rectifier, the 1-amp A114, with a 200 nsec. max. reverse recovery.

Silicon
Rectifier Stacks

A2011



High Efficiency — Up to 99% in certain applications.

Excellent Regulation — Forward voltage drops of less than one volt per cell.

Low Leakage — Excellent for magnetic amplifier applications.

Wide Range of Operating and Storage Temperatures — Will operate from — 65°C to 175°C.

No Aging — Extremely long life — no transformer taps required — high reliability.

Rugged Construction — Meets stringent military environmental tests.

Small Size — Greatly reduces space and weight requirements.

Complete Packaged Rectifier Circuit — Requires only mounting bolts and electrical connections. No special fin design or insulating hardware.

Dependability — Backed by a General Electric one year written warranty.

Versatility — 140 stacked combinations with DC outputs up to 32.4 amperes to meet a variety of circuit conditions. Special circuits can be designed to your order.

A2011

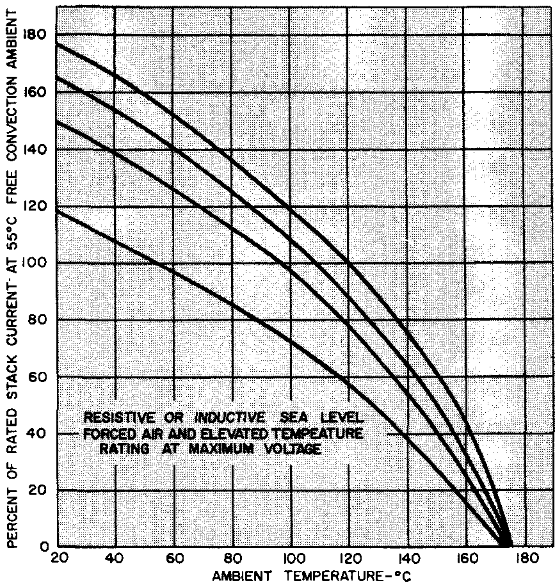


CHART NO. 1

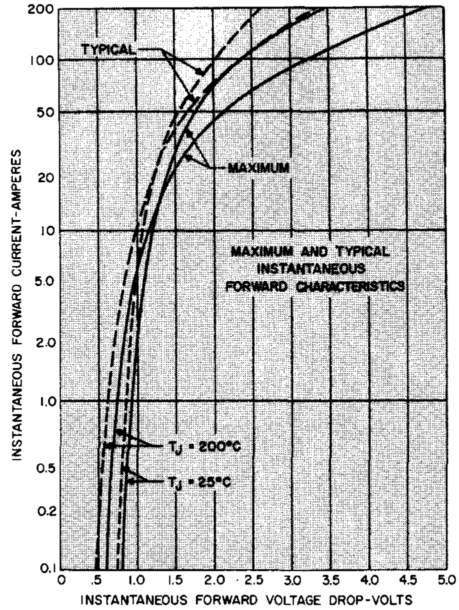


CHART NO. 2

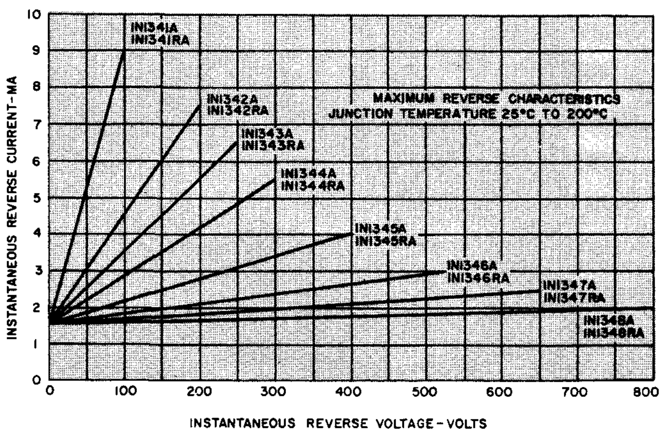


CHART NO. 3

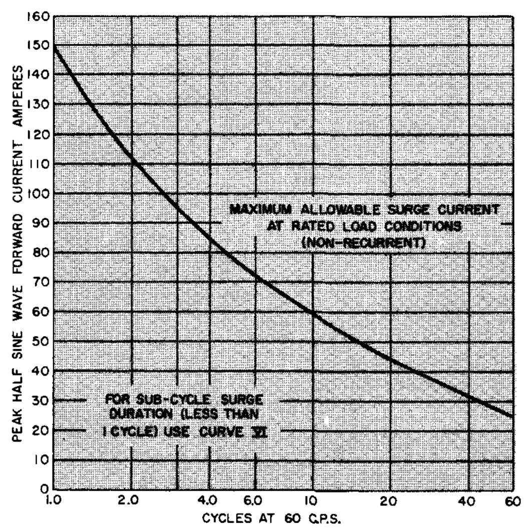


CHART NO. 4

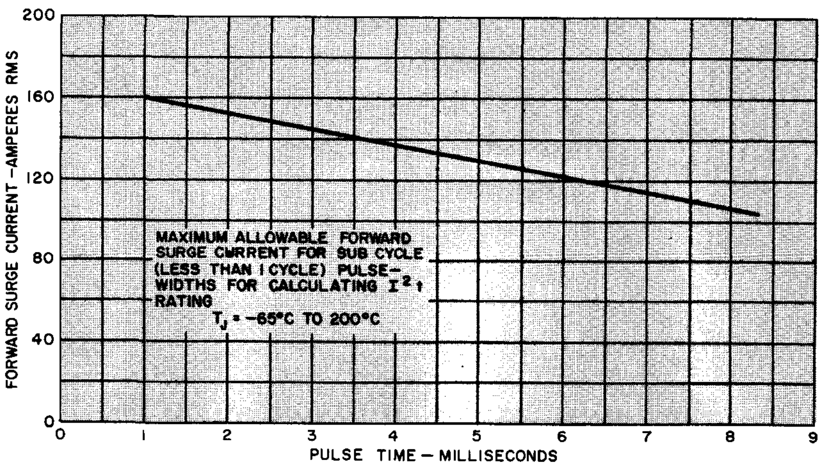
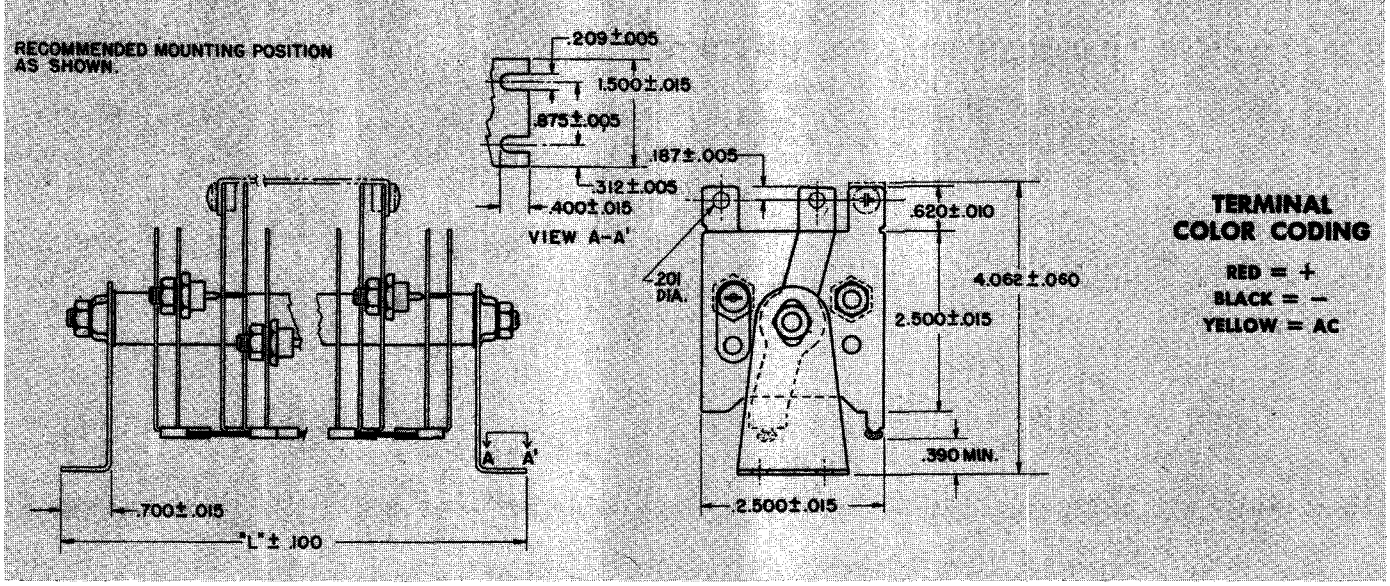


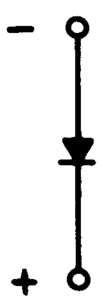
CHART NO. 5

OUTLINE DRAWING - A2011

A2011



SINGLE PHASE HALF WAVE*



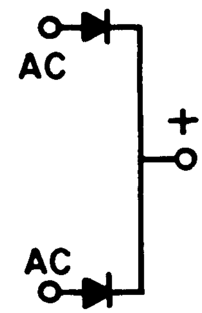
A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output Volts	DC Output Amps
FH1AD1	3.006	35	15	6.3
FH1AD2	3.492	35	15	11.3
AH1AD1	3.006	70	31	6.3
AH1AD2	3.492	70	31	11.3
BH1AD1	3.006	140	62	6.3
BH1AD2	3.492	140	62	11.3
CH1AD1	3.006	210	94	6.3
CH1AD2	3.492	210	94	11.3
DH1AD1	3.006	280	125	6.3
DH1AD2	3.492	280	125	11.3
EH1AD1	3.006	350	157	6.3
EH1AD2	3.492	350	157	11.3
MH1AD1	3.006	420	188	6.3
MH1AD2	3.492	420	188	11.3
DH2AD1	3.489	560	251	6.3
DH2AD2	4.515	560	251	11.3
CH3AD1	4.510	630	282	6.3
CH3AD2	6.004	630	282	11.3
EH2AD1	3.489	700	314	6.3
EH2AD2	4.515	700	314	11.3
MH2AD1	3.489	840	377	6.3
MH2AD2	4.515	840	377	11.3
MH3AD1	4.510	1260	564	6.3
MH3AD2	6.004	1260	564	11.3

Maximum Operating Ratings, Resistive or Inductive Load, 60 CPS Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1

SINGLE PHASE CENTER TAP*

A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output Volts	DC Output Amps
FC1AD1	3.512	17.5	14	12.6
FC1AD2	4.961	17.5	14	22.6
AC1AD1	3.512	35.0	30	12.6
AC1AD2	4.961	35.0	30	22.6
BC1AD1	3.512	70.0	62	12.6
BC1AD2	4.961	70.0	62	22.6
CC1AD1	3.512	105.0	93	12.6
CC1AD2	4.961	105.0	93	22.6
DC1AD1	3.512	140.0	125	12.6
DC1AD2	4.961	140.0	125	22.6
EC1AD1	3.512	175.0	156	12.6
EC1AD2	4.961	175.0	156	22.6
MC1AD1	3.512	210.0	188	12.6
MC1AD2	4.961	210.0	188	22.6
DC2AD1	4.998	280.0	250	12.6
DC2AD2	6.996	280.0	250	22.6
CC3AD1	5.924	315.0	280	12.6
CC3AD2	10.011	315.0	280	22.6
EC2AD1	4.998	350.0	313	12.6
EC2AD2	6.996	350.0	313	22.6
MC2AD1	4.998	420.0	376	12.6
MC2AD2	6.996	420.0	376	22.6
MC3AD1	5.924	630.0	564	12.6
MC3AD2	10.011	630.0	564	22.6

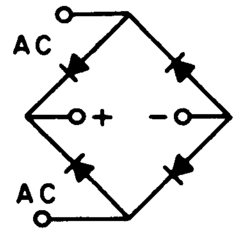
†Line to Center tap.
For negative output change second to last letter to "B".
For example: A2011BC2BD1



NOTE: Please designate full stack number by preceding Model No. desired with "A2011."

SINGLE PHASE BRIDGE*

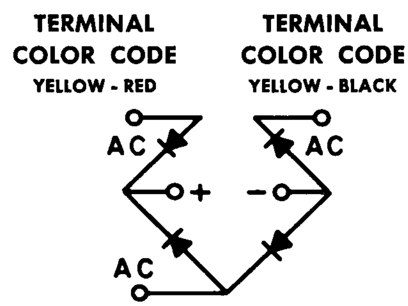
A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output Volts	DC Output Amps
FB1AD1	4.515	35	29	12.6
FB1AD2	7.502	35	29	22.6
AB1AD1	4.515	70	61	12.6
AB1AD2	7.502	70	61	22.6
BB1AD1	4.515	140	124	12.6
BB1AD2	7.502	140	124	22.6
CB1AD1	4.515	210	187	12.6
CB1AD2	7.502	210	187	22.6
DB1AD1	4.515	280	250	12.6
DB1AD2	7.502	280	250	22.6
EB1AD1	4.515	350	313	12.6
EB1AD2	7.502	350	313	22.6
MB1AD1	4.515	420	376	12.6
MB1AD2	7.502	420	376	22.6
DB2AD1	7.027	560	502	12.6
CB3AD1	9.519	630	564	12.6
EB2AD1	7.027	700	628	12.6
MB2AD1	7.027	840	754	12.6
MB3AD1	9.519	1260	1130	12.6



SINGLE PHASE MAGNETIC AMPLIFIER BRIDGE*

A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output †Volts	DC Output Amps
FM1AD1	4.478	35	29	12.6
FM1AD2	7.502	35	29	22.6
AM1AD1	4.478	70	61	12.6
AM1AD2	7.502	70	61	22.6
BM1AD1	4.478	140	124	12.6
BM1AD2	7.502	140	124	22.6
CM1AD1	4.478	210	187	12.6
CM1AD2	7.502	210	187	22.6
DM1AD1	4.478	280	250	12.6
DM1AD2	7.502	280	250	22.6
EM1AD1	4.478	350	313	12.6
EM1AD2	7.502	350	313	22.6
MM1AD1	4.478	420	376	12.6
MM1AD2	7.502	420	376	22.6
DM2AD1	6.990	560	502	12.6
DM3AD1	9.482	630	564	12.6
EM2AD1	6.990	700	628	12.6
MM2AD1	6.990	840	754	12.6
MM3AD1	9.482	1260	1130	12.6

†Neglecting gate winding drop.

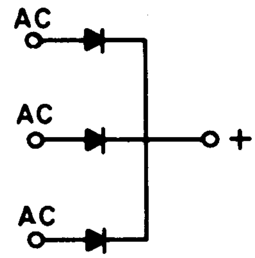


THREE PHASE HALF WAVE*

A2011

A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output Volts	DC Output Amps
FY1AD1	4.478	20	22	18.0
FY1AD2	5.990	20	22	32.4
AY1AD1	4.478	40	45	18.0
AY1AD2	5.990	40	45	32.4
BY1AD1	4.478	80	92	18.0
BY1AD2	5.990	80	92	32.4
CY1AD1	4.478	120	139	18.0
CY1AD2	5.990	120	139	32.4
DY1AD1	4.478	160	186	18.0
DY1AD2	5.990	160	186	32.4
EY1AD1	4.478	200	232	18.0
EY1AD2	5.990	200	232	32.4
MY1AD1	4.478	240	279	18.0
MY1AD2	5.990	240	279	34.2
DY2AD1	5.987	320	372	18.0
DY2AD2	9.494	320	372	32.4
CY3AD1	7.976	360	418	18.0
EY2AD1	5.987	400	465	18.0
EY2AD2	9.494	400	465	32.4
MY2AD1	5.987	480	558	18.0
MY2AD2	9.494	480	558	32.4
MY3AD1	7.976	720	838	18.0

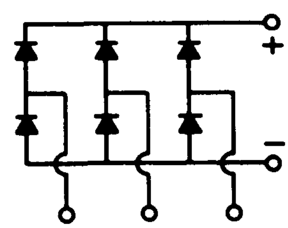
†Line to Neutral.
For negative output change second to last letter to "B".
For example: A2011FS1BD1



THREE PHASE BRIDGE*

A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output Volts	DC Output Amps
FF1AD1	5.987	35	45	18.0
FF1AD2	9.480	35	45	32.4
AF1AD1	5.987	70	92	18.0
AF1AD2	9.480	70	92	32.4
BF1AD1	5.987	140	186	18.0
BF1AD2	9.480	140	186	32.4
CF1AD1	5.987	210	281	18.0
CF1AD2	9.480	210	281	32.4
DF1AD1	5.987	280	375	18.0
DF1AD2	9.480	280	375	32.4
EF1AD1	5.987	350	470	18.0
EF1AD2	9.480	350	470	32.4
MF1AD1	5.987	420	564	18.0
MF1AD2	9.480	420	564	32.4
DF2AD1	9.485	560	751	18.0
EF2AD1	9.485	700	940	18.0
MF2AD1	9.485	840	1130	18.0

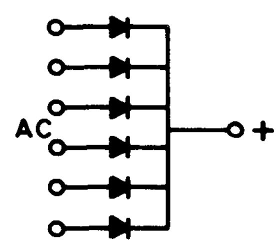
†Line to Line.



SIX PHASE STAR*

A2011 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output Volts	DC Output Amps
FS1AD1	6.536	17.5	22	28.8
AS1AD1	6.536	35.0	45	28.8
BS1AD1	6.536	70.0	93	28.8
CS1AD1	6.536	105.0	140	28.8
DS1AD1	6.536	140.0	187	28.8
ES1AD1	6.536	175.0	234	28.8
MS1AD1	6.536	210.0	282	28.8
DS2AD1	9.514	280.0	375	28.8
ES2AD1	9.514	350.0	469	28.8
MS2AD1	9.514	420.0	563	28.8

†Line to Center Tap.
For negative output change second to last letter to "B".
For example: A2011BC2BD1



Maximum Operating Ratings, Resistive or Inductive Load, 60 CPS Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1

NOTE: Please designate full stack number by preceding Model No. desired with "A2011."

ADDITIONAL RATING AND SPECIFICATION PER FIN

	A2011F	A	B	C	D	E	M
Maximum Allowable Transient Peak Reverse Voltage* (Non-recurrent 5 millisec. max. duration)	100	200	350	450	600	700	800 volts
Maximum Allowable Peak Reverse Voltage* (Repetitive)	50	100	200	300	400	500	600 volts
Maximum Allowable DC Blocking Voltage* (At Maximum Ambient of 150°C)	50	100	200	300	400	500	600 volts
Maximum Full Load Voltage Drop* (6.3A DC Single Phase, Full Cycle Aver., 55°C Amb.)				.5V DC			
Maximum Leakage Current At Full Load** (Single Phase, Full Cycle Average)	3	2.5	2.0	1.75	1.5	1.25	1.0 ma
I^2t Ratings (For Fusing) at Rated Forward Current and PRV for t greater than .0008 seconds and less than .0083 seconds**	Minimum 25 Amperes² Sec (−65°C to +200°C Tj)						

Ambient Temperature Range . . . . −65°C to +175°C

Storage Temperature Range . . . . −65°C to +175°C

Maximum Operating Frequency . . . . 50,000 cps

* Per Series Cell

**Per Parallel Cell

Determine Series and Parallel Cells as Follows

A2011FH1AD1
- Number of Series Cells
- Number of Parallel Cells

NOTE: In practical circuits the transient peak reverse voltage (PRV) rating of each leg in a rectifier stack should be approximately three times the operating peak voltage of the circuit. This precaution is necessary because of the possibility of transient voltage peaks in excess of the operating peak reverse voltage. The RMS voltage ratings for stacks on the preceding pages are based on the assumption that special precautions have been taken to minimize transient voltages.

Max. Hi-Pot Voltage to Mounting Brackets . . . . 2600 V. RMS @ 25°C Amb., Sea Level

Mechanical Shock . . . . Depends upon number of Fins per stack — For specific information, consult your General Electric District Sales Manager.

Vibration . . . . MIL-STD-202 A 10G Max. 10-50 CPS 2 Hours in each plane.

Salt Spray . . . . MIL-STD-202 A, Method 101A, 96 hours

Humidity . . . . MIL-STD-202 A, Method 103A, 240 hours

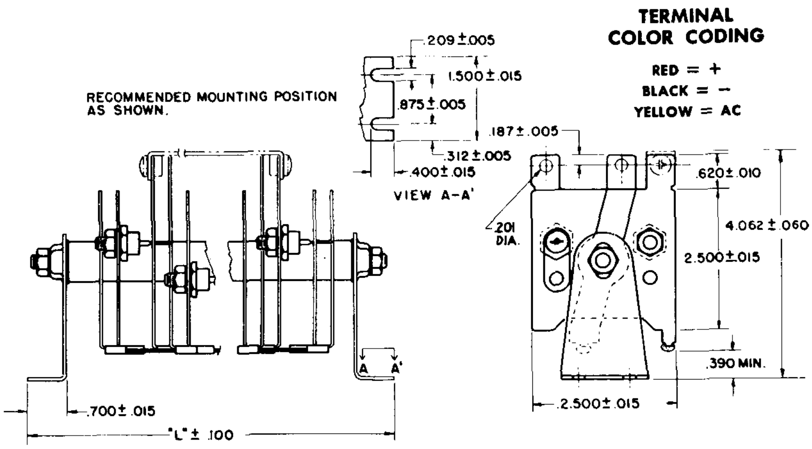
APPROXIMATE STACK WEIGHT

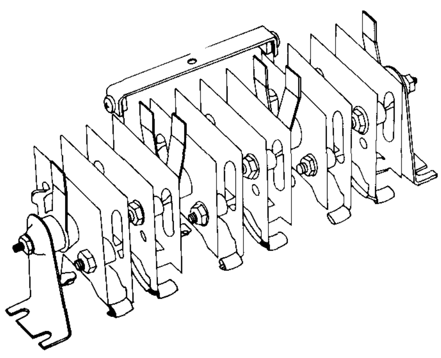
Number of Fins	Pounds
1	.40
2	.56
3	.66
4	.77
6	1.02
8	1.60
9	1.68
12	1.87

Silicon Rectifier Stacks

A2511

Up to 600 peak reverse volts (PRV) per cell
Up to 9.4 amps DC output per leg free convection rating





OUTLINE DRAWING-A2511

Features

High Efficiency—Up to 99% in certain applications.

Excellent Regulation—Forward voltage drops of less than one volt per cell.

Low Leakage—Excellent for magnetic amplifier applications.

Wide Range of Operating and Storage Temperatures—Will operate from —65°C to 175°C.

No Aging—Extremely long life—no transformer taps required—high reliability.

Rugged Construction—Meets stringent military environmental tests.

Small Size—Greatly reduces space and weight requirements.

Complete Packaged Rectifier Circuit—Requires only mounting bolts and electrical connections. No special fin design or insulating hardware.

Dependability—Backed by a General Electric one year written warranty.

Versatility—164 stacked combinations with DC outputs up to 50 amperes to meet a variety of circuit conditions. Special circuits can be designed to your order.

A2511

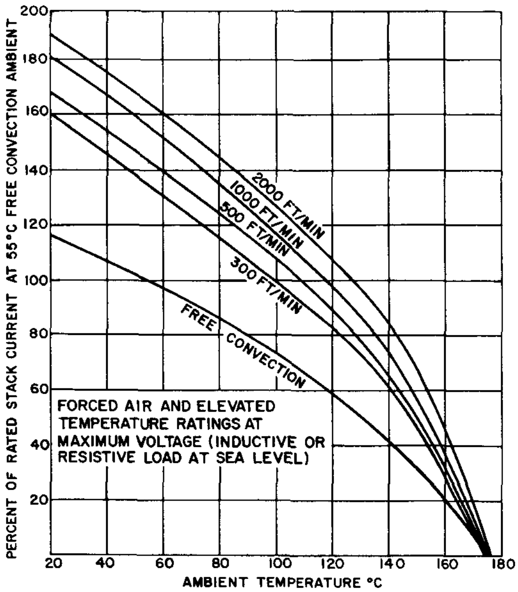


CHART NO. 1

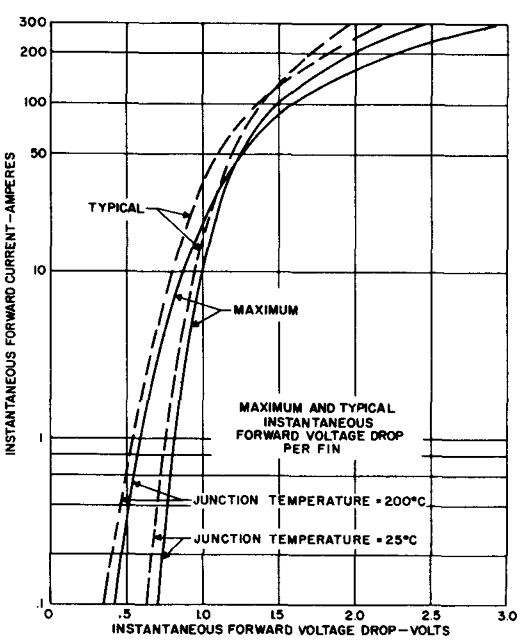


CHART NO. 2

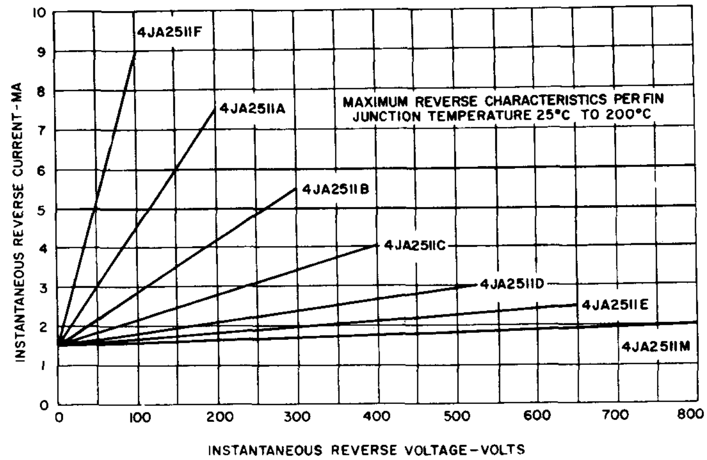
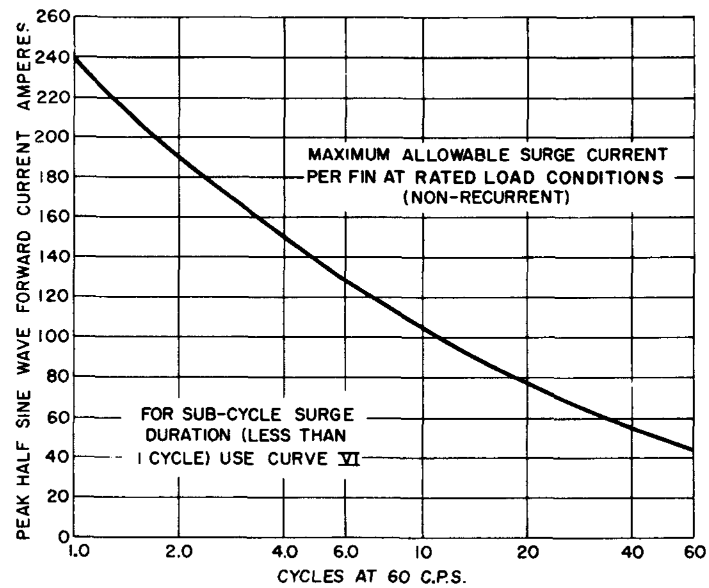


CHART NO. 3



NOTE:
WHEN FINS ARE OPERATED IN PARALLEL REDUCE SURGE RATING BY 10% PER FIN

CHART NO. 4

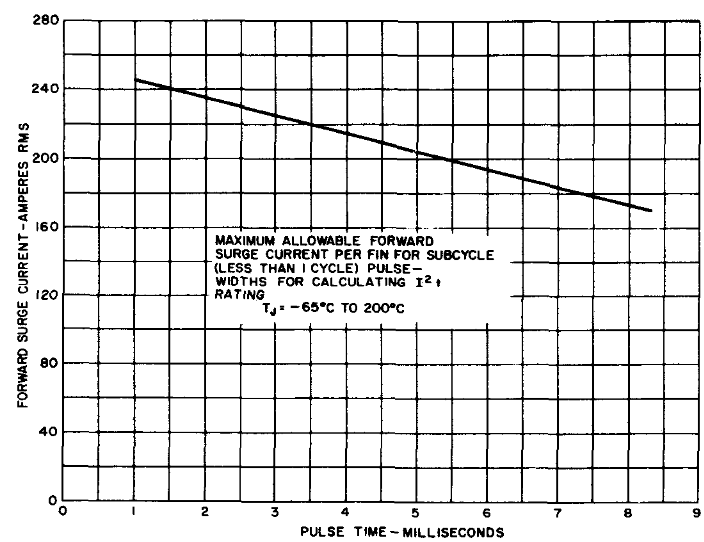


CHART NO. 5

SINGLE PHASE HALF WAVE*

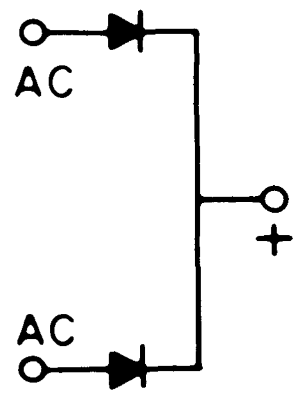
A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output Volts	DC Output Amps
FH1AD1	3.006	35	15	9.4
FH1AD2	3.492	35	15	16.9
AH1AD1	3.006	70	31	9.4
AH1AD2	3.492	70	31	16.9
BH1AD1	3.006	140	62	9.4
BH1AD2	3.492	140	62	16.9
CH1AD1	3.006	210	94	9.4
CH1AD2	3.492	210	94	16.9
DH1AD1	3.006	280	125	9.4
DH1AD2	3.492	280	125	16.9
EH1AD1	3.006	350	157	9.4
EH1AD2	3.492	350	157	16.9
MH1AD1	3.006	420	188	9.4
MH1AD2	3.492	420	188	16.9
DH2AD1	3.489	560	251	9.4
DH2AD2	4.515	560	251	16.9
CH3AD1	4.510	630	282	9.4
CH3AD2	6.004	630	282	16.9
EH2AD1	3.489	700	314	9.4
EH2AD2	4.515	700	314	16.9
MH2AD1	3.489	840	377	9.4
MH2AD2	4.515	840	377	16.9
MH3AD1	4.510	1260	564	9.4
MH3AD2	6.004	1260	564	16.9

*** Maximum Operating Ratings, Resistive or Inductive Load, 60 CPS Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1**

SINGLE PHASE CENTER TAP*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output Volts	DC Output Amps
FC1AD1	3.512	17.5	14	18.8
FC1AD2	4.961	17.5	14	33.8
AC1AD1	3.512	35.0	30	18.8
AC1AD2	4.961	35.0	30	33.8
BC1AD1	3.512	70.0	62	18.8
BC1AD2	4.961	70.0	62	33.8
CC1AD1	3.512	105.0	93	18.8
CC1AD2	4.961	105.0	93	33.8
DC1AD1	3.512	140.0	125	18.8
DC1AD2	4.961	140.0	125	33.8
EC1AD1	3.512	175.0	156	18.8
EC1AD2	4.961	175.0	156	33.8
MC1AD1	3.512	210.0	188	18.8
MC1AD2	4.961	210.0	188	33.8
DC2AD1	4.998	280.0	250	18.8
DC2AD2	6.996	280.0	250	33.8
CC3AD1	5.484	315.0	280	18.8
CC3AD2	10.011	315.0	280	33.8
EC2AD1	4.998	350.0	313	18.8
EC2AD2	6.996	350.0	313	33.8
MC2AD1	4.998	420.0	376	18.8
MC2AD2	6.996	420.0	376	33.8
MC3AD1	5.484	630.0	564	18.8
MC3AD2	10.011	630.0	564	33.8

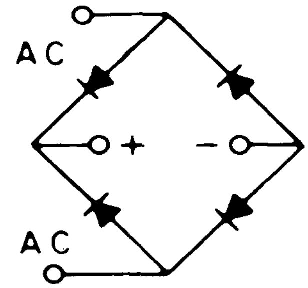
NOTE: Please designate full stack number by preceding Model No. desired with "A2511."



†Line to Center tap.
For negative output change second to last letter to "B".
For example: A2511BC2BD1

SINGLE PHASE BRIDGE*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output Volts	DC Output Amps
FB1AD1	4.515	35	29	18.8
FB1AD2	7.502	35	29	33.8
AB1AD1	4.515	70	61	18.8
AB1AD2	7.502	70	61	33.8
BB1AD1	4.515	140	124	18.8
BB1AD2	7.502	140	124	33.8
CB1AD1	4.515	210	187	18.8
CB1AD2	7.502	210	187	33.8
DB1AD1	4.515	280	250	18.8
DB1AD2	7.502	280	250	33.8
EB1AD1	4.515	350	313	18.8
EB1AD2	7.502	350	313	33.8
MB1AD1	4.515	420	376	18.8
MB1AD2	7.502	420	376	33.8
DB2AD1	7.027	560	502	18.8
CB3AD1	9.519	630	564	18.8
EB2AD1	7.027	700	628	18.8
MB2AD1	7.027	840	754	18.8
MB3AD1	9.519	1260	1130	18.8

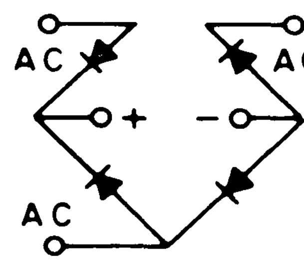


SINGLE PHASE MAGNETIC AMPLIFIER BRIDGE*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output †Volts	DC Output Amps
FM1AD1	4.478	35	29	18.8
FM1AD2	7.502	35	29	33.8
AM1AD1	4.478	70	61	18.8
AM1AD2	7.502	70	61	33.8
BM1AD1	4.478	140	124	18.8
BM1AD2	7.502	140	124	33.8
CM1AD1	4.478	210	187	18.8
CM1AD2	7.502	210	187	33.8
DM1AD1	4.478	280	250	18.8
DM1AD2	7.502	280	250	33.8
EM1AD1	4.478	350	313	18.8
EM1AD2	7.502	350	313	33.8
MM1AD1	4.478	420	376	18.8
MM1AD2	7.502	420	376	33.8
DM2AD1	6.990	560	502	18.8
DM3AD1	9.482	630	564	18.8
EM2AD1	6.990	700	628	18.8
MM2AD1	6.990	840	754	18.8
MM3AD1	9.482	1260	1130	18.8

†Neglecting gate winding drop.

TERMINAL COLOR CODE	TERMINAL COLOR CODE
YELLOW - RED	YELLOW - BLACK

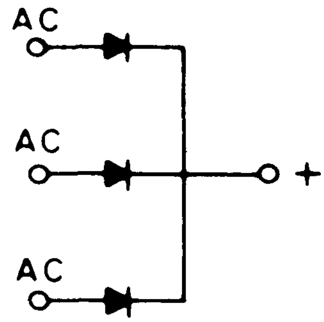


NOTE: Please designate full stack number by preceding Model No. desired with "A2511."

THREE PHASE HALF WAVE*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps
FY1AD1	4.478	20	22	26.4
FY1AD2	5.990	20	22	47.5
AY1AD1	4.478	40	45	26.4
AY1AD2	5.990	40	45	47.5
BY1AD1	4.478	80	92	26.4
BY1AD2	5.990	80	92	47.5
CY1AD1	4.478	120	139	26.4
CY1AD2	5.990	120	139	47.5
DY1AD1	4.478	160	186	26.4
DY1AD2	5.990	160	186	47.5
EY1AD1	4.478	200	232	26.4
EY1AD2	5.990	200	232	47.5
MY1AD1	4.478	240	279	26.4
MY1AD2	5.990	240	279	47.5
DY2AD1	5.987	320	372	26.4
DY2AD2	9.494	320	372	47.5
CY3AD1	7.976	360	418	26.4
EY2AD1	5.987	400	465	26.4
EY2AD2	9.494	400	465	47.5
MY2AD1	5.987	480	558	26.4
MY2AD2	9.494	480	558	47.5
MY3AD1	7.976	720	838	26.4

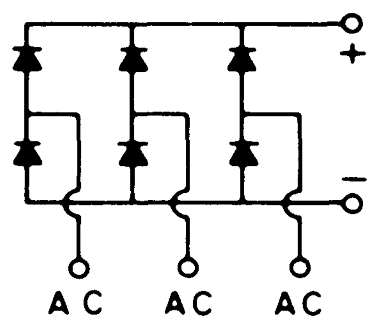
†Line to Neutral.
For negative output change second to last letter to "B".
For example: A2511FS1BD1



THREE PHASE BRIDGE*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps
FF1AD1	5.987	35	45	26.4
FF1AD2	9.480	35	45	47.5
AF1AD1	5.987	70	92	26.4
AF1AD2	9.480	70	92	47.5
BF1AD1	5.987	140	186	26.4
BF1AD2	9.480	140	186	47.5
CF1AD1	5.987	210	281	26.4
CF1AD2	9.480	210	281	47.5
DF1AD1	5.987	280	375	26.4
DF1AD2	9.480	280	375	47.5
EF1AD1	5.987	350	470	26.4
EF1AD2	9.480	350	425	47.5
MF1AD1	5.987	420	564	26.4
MF1AD2	9.480	420	564	47.5
DF2AD1	9.485	560	751	26.4
EF2AD1	9.485	700	940	26.4
MF2AD1	9.485	843	1130	26.4

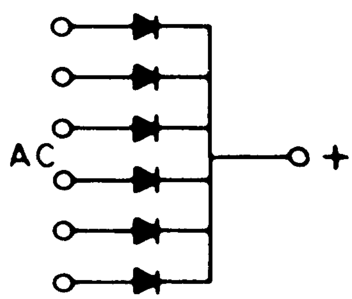
†Line to Line.
For negative output change second to last letter to "B".
For example: A2511BC2BD1



SIX PHASE STAR*

A2511 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps
FS1AD1	6.536	17.5	22	42
AS1AD1	6.536	35.0	45	42
BS1AD1	6.536	70.0	93	42
CS1AD1	6.536	105.0	140	42
DS1AD1	6.536	140.0	187	42
ES1AD1	6.536	175.0	234	42
MS1AD1	6.536	210.0	282	42
DS2AD1	9.514	280.0	375	42
ES2AD1	9.514	350.0	469	42
MS2AD1	9.514	420.0	563	42

†Line to Center tap.
For negative output change second to last letter to "B".
For example: A2511BC2BD1



*** Maximum Operating Ratings, Resistive or Inductive Load, 60 CPS Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1**

NOTE: Please designate full stack number by preceding Model No. desired with "A2511."

ADDITIONAL RATING AND SPECIFICATION PER FIN

	A2511F	A	B	C	D	E	M
Maximum Allowable Transient Peak Reverse Voltage* (Non-recurrent 5 millisec. max. duration)	100	200	350	450	600	700	800 volts
Maximum Allowable Peak Reverse Voltage* (Repetitive)	50	100	200	300	400	500	600 volts
Maximum Allowable DC Blocking Voltage* (At Maximum Ambient of 150°C)	50	100	200	300	400	500	600 volts
Maximum Full Load Voltage Drop* (9.4 A. DC Single Phase, Full Cycle Aver., 55°C Amb.)				.5 Volts DC			
Maximum Leakage Current At Full Load** (Single Phase, Full Cycle Average)	3.0	2.5	2.00	1.75	1.5	1.25	1.0 ma

I^2t Ratings (For Fusing) at Rated Forward Current and PRV for t greater than .0008 seconds and less than .0083 seconds Min. 60 Ampere²sec. ($T_j = -65°C$ to $+200°C$)

Ambient Temperature Range . . . . −65°C to +175°C

Storage Temperature Range . . . . −65°C to +175°C

Maximum Operating Frequency 50,000-cps

* Per Series Cell

**Per Parallel Cell

Determine Series and Parallel Cells as Follows

A2511FH1AD1
- H1 ← Number of Series Cells
- D1 ← Number of Parallel Cells

NOTE: In practical circuits the transient peak reverse voltage (PRV) rating of each leg in a rectifier stack should be approximately three times the operating peak voltage of the circuit. This precaution is necessary because of the possibility of transient voltage peaks in excess of the operating peak reverse voltage. The RMS voltage ratings for stacks on the preceding pages are based on the assumption that special precautions have been taken to minimize transient voltages.

Max. Hi-Pot Voltage to Mounting Brackets	2600 V. RMS @ 25°C Amb., Sea Level
Mechanical Shock	Depends upon number of Fins per stack — For specific information, consult your General Electric District Sales Manager.
Vibration	MIL-STD-202 A 10G Max. 10-50 CPS 2 Hours in each plane.
Salt Spray	MIL-STD-202 A, Method 101A, 96 hours
Humidity	MIL-STD-202 A, Method 103A, 240 hours

APPROXIMATE STACK WEIGHT

Number of Fins	Pounds
1	.40
2	.56
3	.66
4	.77
6	1.02
8	1.60
9	1.68
12	1.87

Silicon
Rectifier Stacks

A3512 SERIES

High Conversion Efficiency — Up to 99% in certain applications.

Excellent Regulation — Forward voltage drops of less than one volt per cell.

Low Reverse Current — Excellent for magnetic amplifier applications.

Wide Range of Operating and Storage Temperatures — Will operate from — 65°C to 175°C.

No Aging — Extremely long life — no transformer taps required — high reliability.

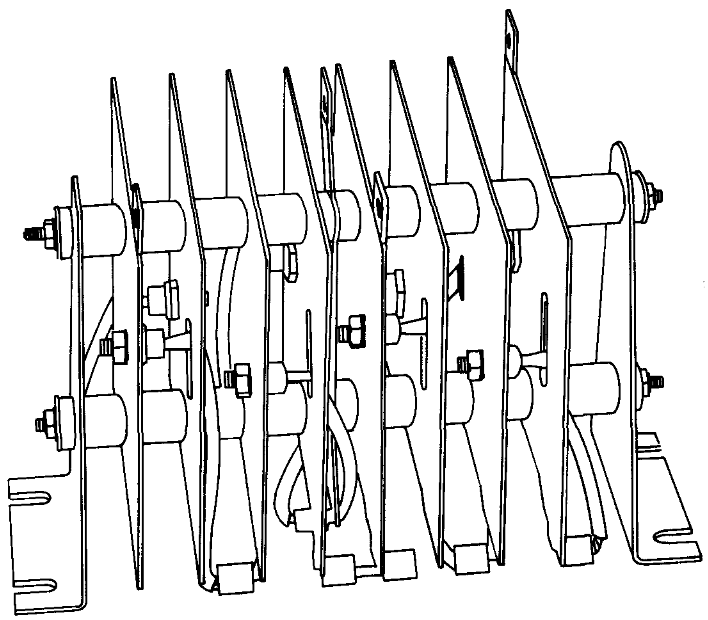
Rugged Construction — Meets stringent military environmental tests.

Small Size — Greatly reduces space and weight requirements.

Complete Packaged Rectifier Circuit — Requires only mounting bolts and electrical connections. No special fin design or insulating hardware.

Dependability — Backed by a General Electric one year written warranty.

Versatility — 171 stacked combinations with DC outputs up to 108 amperes to meet a variety of circuit conditions. Special circuits can be designed to your order.



A3512 SERIES

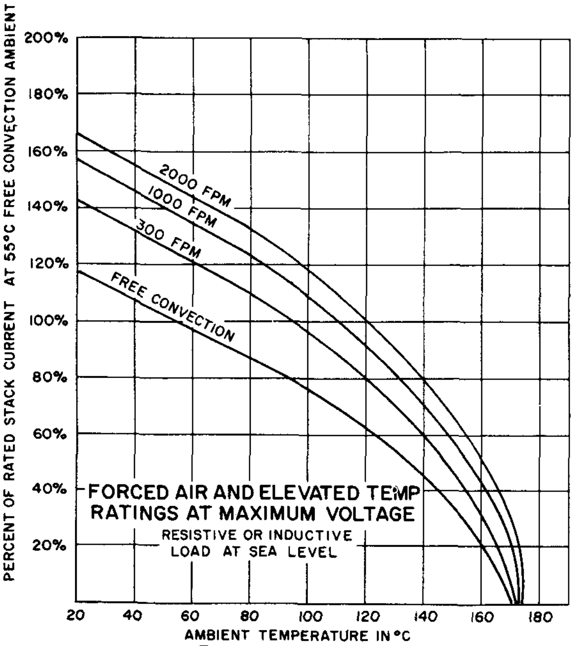
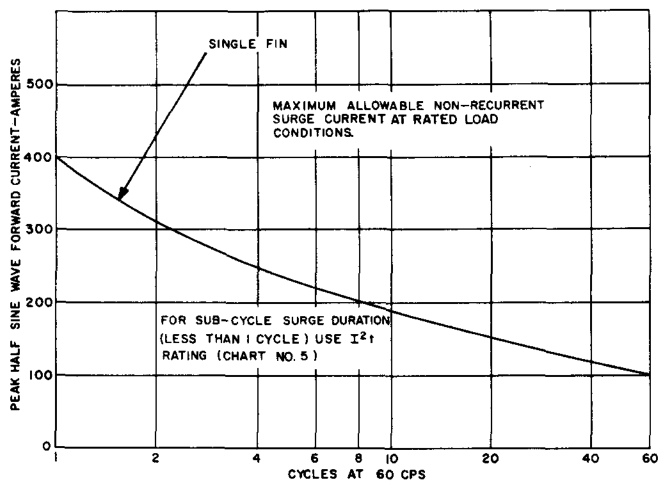


CHART NO. 1



NOTE—
WHEN FINS ARE OPERATED IN PARALLEL, REDUCE SURGE RATING BY 10% PER FIN

CHART NO. 4

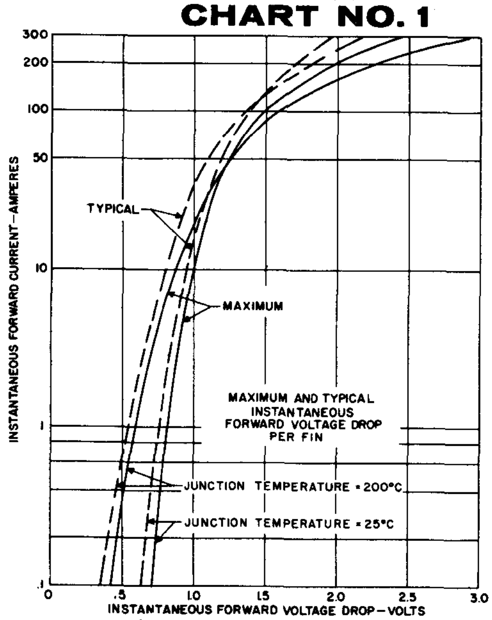


CHART NO. 2

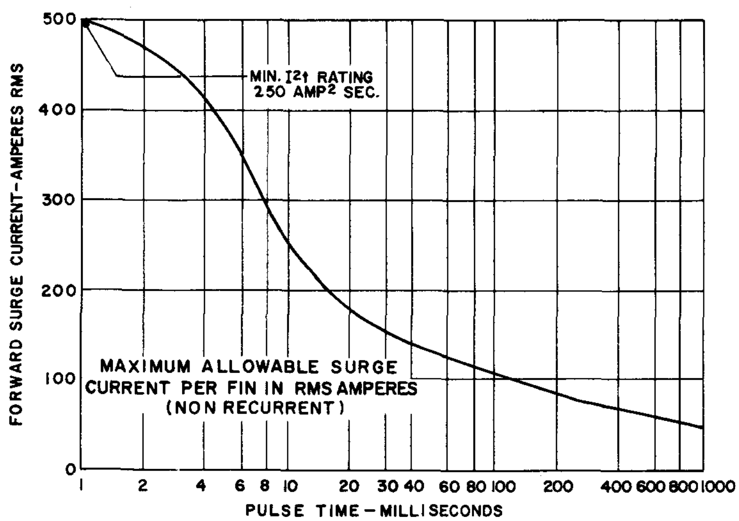


CHART NO. 5

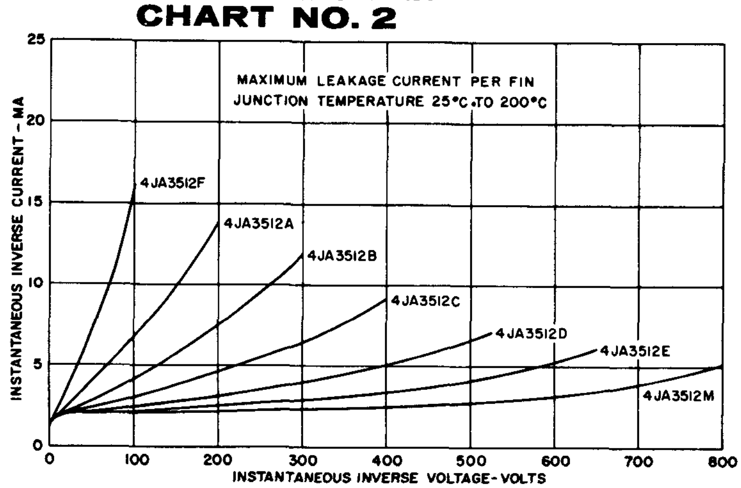
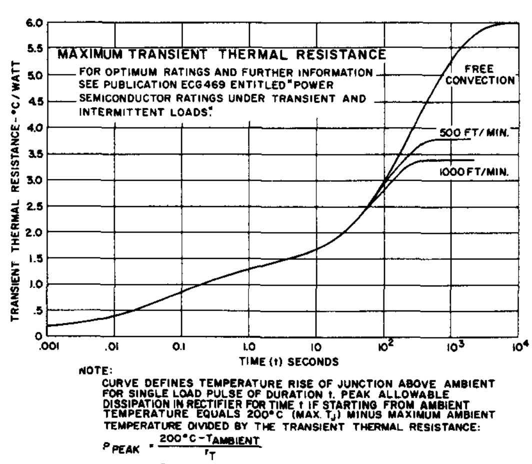


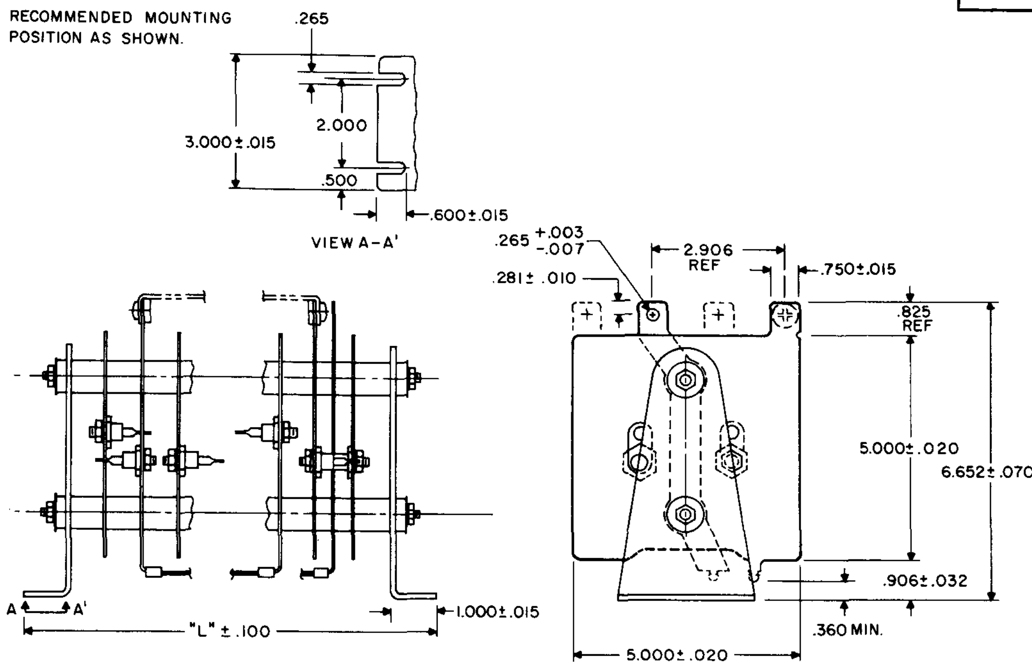
CHART NO. 3



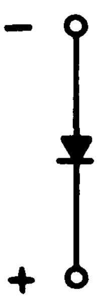
NOTE:
CURVE DEFINES TEMPERATURE RISE OF JUNCTION ABOVE AMBIENT FOR SINGLE LOAD PULSE OF DURATION t. PEAK ALLOWABLE DISSIPATION IN RECTIFIER FOR TIME t IF STARTING FROM AMBIENT TEMPERATURE EQUALS 200°C (MAX. T_J) MINUS MAXIMUM AMBIENT TEMPERATURE DIVIDED BY THE TRANSIENT THERMAL RESISTANCE:

$$P_{PEAK} = \frac{200°C - T_{AMBIENT}}{r_T}$$

CHART NO. 6



SINGLE PHASE HALF WAVE

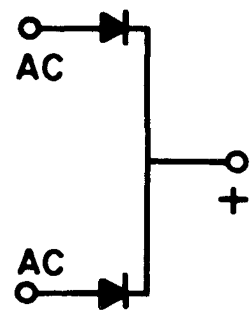


4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output	
			Volts	Amps*
FH1AD1	4.012	35	15	20
FH1AD2	5.000	35	15	36
FH1AD3	6.000	35	15	54
AH1AD1	4.012	70	30	20
AH1AD2	5.000	70	30	36
AH1AD3	6.000	70	30	54
BH1AD1	4.012	140	62	20
BH1AD2	5.000	140	62	36
BH1AD3	6.000	140	62	54
CH1AD1	4.012	210	93	20
CH1AD2	5.000	210	93	36
CH1AD3	6.000	210	93	54
DH1AD1	4.012	280	125	20
DH1AD2	5.000	280	125	36
DH1AD3	6.000	280	125	54
EH1AD1	4.012	350	156	20
EH1AD2	5.000	350	156	36
EH1AD3	6.000	350	156	54
MH1AD1	4.012	420	187	20
MH1AD2	5.000	420	187	36
MH1AD3	6.000	420	187	54
DH2AD1	4.512	560	250	20
DH2AD2	6.000	560	250	36
DH2AD3	8.012	560	250	54
CH3AD1	5.500	630	281	20
CH3AD2	7.500	630	281	36
CH3AD3	10.500	630	281	54
EH2AD1	4.512	700	313	20
EH2AD2	6.000	700	313	36
EH2AD3	8.012	700	313	54
MH2AD1	4.512	840	376	20
MH2AD2	6.000	840	376	36
MH2AD3	8.012	840	376	54
MH3AD1	5.500	1260	564	20
MH3AD2	7.500	1260	564	36
MH3AD3	10.500	1260	564	54

***Maximum Operating Ratings, Resistive or Inductive Load, 60 cps Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1**

SINGLE PHASE CENTER TAP

4JA3512 Series Model No.	Outline Dimension "L" (In.)	AC Input† RMS Volts	DC Output	
			Volts	Amps*
FC1AD1	5.000	17.5	14	40
FC1AD2	6.500	17.5	14	72
FC1AD3	8.000	17.5	14	108
AC1AD1	5.000	35.0	30	40
AC1AD2	6.500	35.0	30	72
AC1AD3	8.000	35.0	30	108
BC1AD1	5.000	70.0	61	40
BC1AD2	6.500	70.0	61	72
BC1AD3	8.000	70.0	61	108
CC1AD1	5.000	105.0	93	40
CC1AD2	6.500	105.0	93	72
CC1AD3	8.000	105.0	93	108
DC1AD1	5.000	140.0	124	40
DC1AD2	6.500	140.0	124	72
DC1AD3	8.000	140.0	124	108
EC1AD1	5.000	175.0	156	40
EC1AD2	6.500	175.0	156	72
EC1AD3	8.000	175.0	156	108
MC1AD1	5.000	210.0	187	40
MC1AD2	6.500	210.0	187	72
MC1AD3	8.000	210.0	187	108
DC2AD1	6.500	280.0	249	40
DC2AD2	9.500	280.0	249	72
DC2AD3	13.000	280.0	249	108
CC3AD1	7.500	315.0	280	40
CC3AD2	13.000	315.0	280	72
EC2AD1	6.500	350.0	312	40
EC2AD2	9.500	350.0	312	72
EC2AD3	13.000	350.0	312	108
MC2AD1	6.500	420.0	375	40
MC2AD2	9.500	420.0	375	72
MC2AD3	13.000	420.0	375	108
MC3AD1	7.500	630.0	562	40
MC3AD2	13.000	630.0	562	72

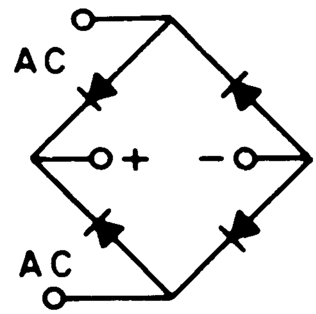


† Line to Center Tap
For negative output change second to last letter "B".
For example: 4JA3512BC1BD1

NOTE: Please designate full stack number by preceding Model No. desired with "4JA3512."

SINGLE PHASE BRIDGE

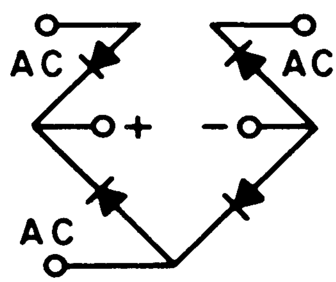
4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output Volts	DC Output Amps*
FB1AD1	6.000	35	29	40
FB1AD2	9.524	35	29	72
FB1AD3	13.000	35	29	108
AB1AD1	6.000	70	60	40
AB1AD2	9.524	70	60	72
AB1AD3	13.000	70	60	108
BB1AD1	6.000	140	123	40
BB1AD2	9.524	140	123	72
BB1AD3	13.000	140	123	108
CB1AD1	6.000	210	186	40
CB1AD2	9.524	210	186	72
CB1AD3	13.000	210	186	108
DB1AD1	6.000	280	249	40
DB1AD2	9.524	280	249	72
DB1AD3	13.000	280	249	108
EB1AD1	6.000	350	312	40
EB1AD2	9.524	350	312	72
EB1AD3	13.000	350	312	108
MB1AD1	6.000	420	375	40
MB1AD2	9.524	420	375	72
MB1AD3	13.000	420	375	108
DB2AD1	9.512	560	499	40
CB3AD1	12.500	630	558	40
EB2AD1	9.512	700	625	40
MB2AD1	9.512	840	751	40
MB3AD1	12.500	1260	1122	40



SINGLE PHASE MAGNETIC AMPLIFIER BRIDGE

4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input RMS Volts	DC Output Volts†	DC Output Amps*
FM1AD1	6.000	35	29	40
FM1AD2	9.524	35	29	72
FM1AD3	13.000	35	29	108
AM1AD1	6.000	70	60	40
AM1AD2	9.524	70	60	72
AM1AD3	13.000	70	60	108
BM1AD1	6.000	140	123	40
BM1AD2	9.524	140	123	72
BM1AD3	13.000	140	123	108
CM1AD1	6.000	210	186	40
CM1AD2	9.524	210	186	72
CM1AD3	13.000	210	186	108
DM1AD1	6.000	280	249	40
DM1AD2	9.524	280	249	72
DM1AD3	13.000	280	249	108
EM1AD1	6.000	350	312	40
EM1AD2	9.524	350	312	72
EM1AD3	13.000	350	312	108
MM1AD1	6.000	420	375	40
MM1AD2	9.524	420	375	72
MM1AD3	13.000	420	375	108
DM2AD1	9.512	560	499	40
CM3AD1	12.500	630	558	40
EM2AD1	9.512	700	625	40
MM2AD1	9.512	840	751	40
MM3AD1	12.500	1260	1122	40

† Neglecting gate winding drop.



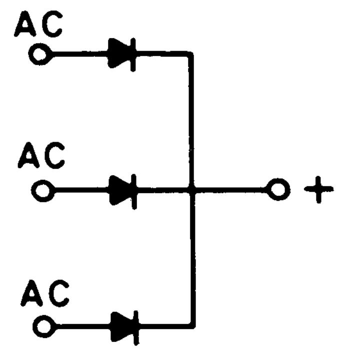
NOTE: Please designate full stack number by preceding Model No. desired with "4JA3512."

*Maximum Operating Ratings, Resistive or Inductive Load, 60 cps Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1

THREE PHASE HALF WAVE

4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output Volts	DC Output Amps*
FY1AD1	6.012	20	22	55
FY1AD2	8.000	20	22	100
AY1AD1	6.012	40	45	55
AY1AD2	8.000	40	45	100
BY1AD1	6.012	80	92	55
BY1AD2	8.000	80	92	100
CY1AD1	6.012	120	139	55
CY1AD2	8.000	120	139	100
DY1AD1	6.012	160	185	55
DY1AD2	8.000	160	185	100
EY1AD1	6.012	200	232	55
EY1AD2	8.000	200	232	100
MY1AD1	6.012	240	279	55
MY1AD2	8.000	240	279	100
DY2AD1	8.000	320	371	55
DY2AD2	12.512	320	371	100
CY3AD1	10.500	360	417	55
EY2AD1	8.000	400	465	55
EY2AD2	12.512	400	465	100
MY2AD1	8.000	480	558	55
MY2AD2	12.512	480	558	100
MY3AD1	10.500	720	838	55

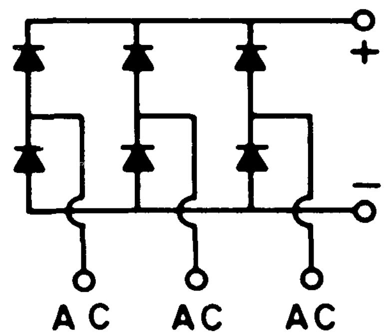
† Line to Neutral.
For negative output change second to last letter to "B".
For example: 4JA3512FS1BD1



THREE PHASE BRIDGE

4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output Volts	DC Output Amps*
FF1AD1	8.000	35	44	55
FF1AD2	12.500	35	44	100
AF1AD1	8.000	70	91	55
AF1AD2	12.500	70	91	100
BF1AD1	8.000	140	186	55
BF1AD2	12.500	140	186	100
CF1AD1	8.000	210	280	55
CF1AD2	12.500	210	280	100
DF1AD1	8.000	280	375	55
DF1AD2	12.500	280	375	100
EF1AD1	8.000	350	469	55
EF1AD2	12.500	350	469	100
MF1AD1	8.000	420	563	55
MF1AD2	12.500	420	563	100
DF2AD1	12.500	560	750	55
EF2AD1	12.500	700	939	55
MF2AD1	12.500	840	1127	55

†Line to line.

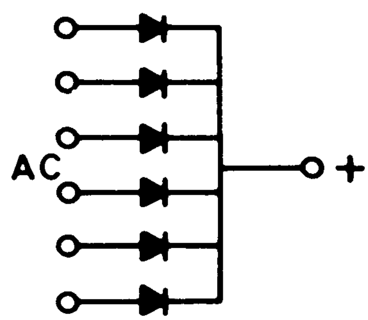


SIX PHASE STAR

4JA3512 Series Model No.	Outline Dimensions "L" (In.)	AC Input† RMS Volts	DC Output Volts	DC Output Amps*
FS1AD1	8.000	17.5	22	90
AS1AD1	8.000	35.0	45	90
BS1AD1	8.000	70.0	92	90
CS1AD1	8.000	105.0	140	90
DS1AD1	8.000	140.0	187	90
ES1AD1	8.000	175.0	234	90
MS1AD1	8.000	210.0	281	90
DS2AD1	12.512	280.0	374	90
ES2AD1	12.512	350.0	468	90
MS2AD1	12.512	420.0	562	90

†Line to Center Tap.

For negative output change second to last letter to "B". For example: 4JA3512BC2BD1



***Maximum Operating Ratings, Resistive or Inductive Load, 60 cps Sinusoidal at 55°C Ambient. For Other Ambient Conditions, Use Chart No. 1**

NOTE: Please designate full stack number by preceding Model No. desired with "4JA3512."

ADDITIONAL RATINGS AND SPECIFICATIONS PER FIN

4JA3512	F	A	B	C	D	E	M
*Maximum Allowable Transient Peak Reverse Voltage (*non-recurrent 5 millisec. max. duration*)	100	200	350	450	600	700	800 volts
*Maximum Allowable Peak Reverse Voltage (Repetitive	50	100	200	300	400	500	600 volts
*Maximum Allowable DC Blocking Voltage (At Maximum Ambient of 150°C)	50	100	200	300	400	500	600 volts
*Maximum Full Load Voltage Drop (20A DC Single Phase, Full Cycle Ave., 55°C Ambient)	← .6 Volts DC →						
**Maximum Reverse Current at Full Load (Single Phase, Full Cycle Average)	5	4.5	4.0	3.5	3	2.5	2.0 ma

**I_2t Ratings (For Fusing) at Rated Forward Current and PRV for t greater than .0008 seconds and less than .0083 sec. . . . 250 Ampere[2] Sec.

Ambient Temperature Range . . . . . −65°C to +175°C

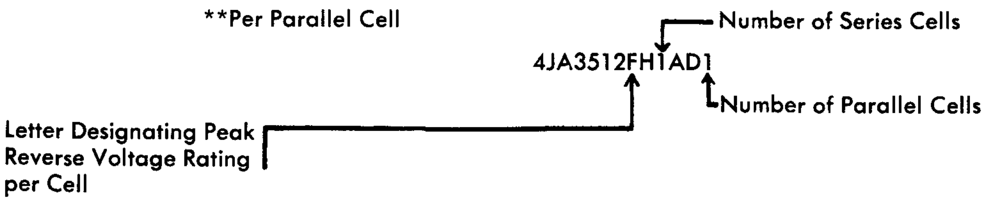
Storage Temperature Range . . . . . −65°C to +175°C

Maximum Operating Frequency . . . . . 50,000 cps

*Per Series Cell

**Per Parallel Cell

Determine Series and Parallel Cells as Follows:



NOTE: The RMS voltage ratings for stacks on the preceding pages are based on the assumption that the required precautions have been taken to keep transient voltage per fin within the ratings specified above. For a discussion of voltage transients and corrective action, request "Rectifier Voltage Transients: Their Generation, Detection, and Reduction," ECG-544.

Maximum Hi-Pot Voltage to Mounting Brackets . . . . 2600 V. RMS @ 25°C Ambient, Sea Level

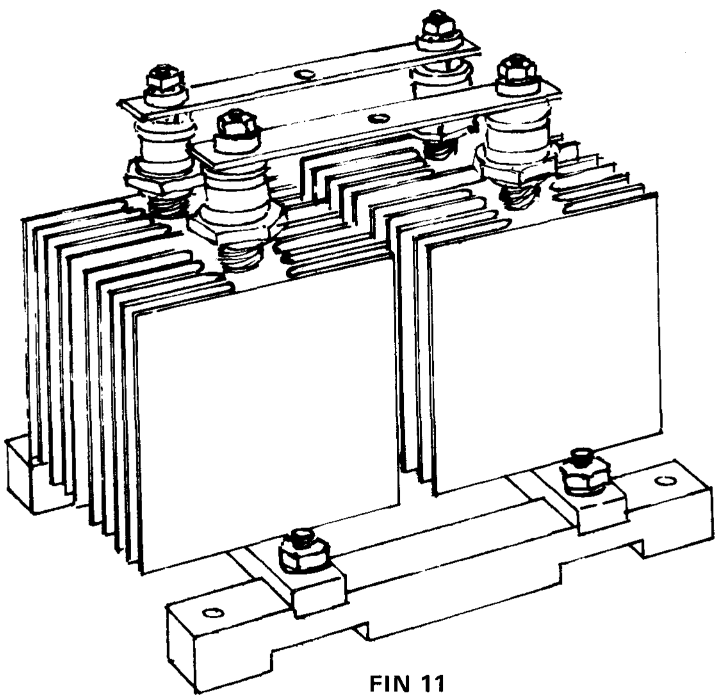
Salt Spray . . . . . MIL-STD-202 A, Method 101A, 96 hours

Humidity . . . . . MIL-STD-202 A, Method 103A, 240 hours

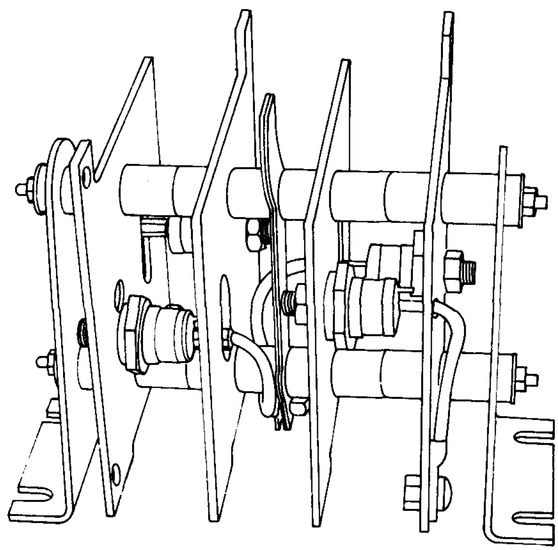
APPROXIMATE STACK WEIGHT

Number of Fins	Pounds
1	2.0
2	2.75
3	3.25
4	3.5
6	4.0
8	4.5
9	4.75
12	5.5

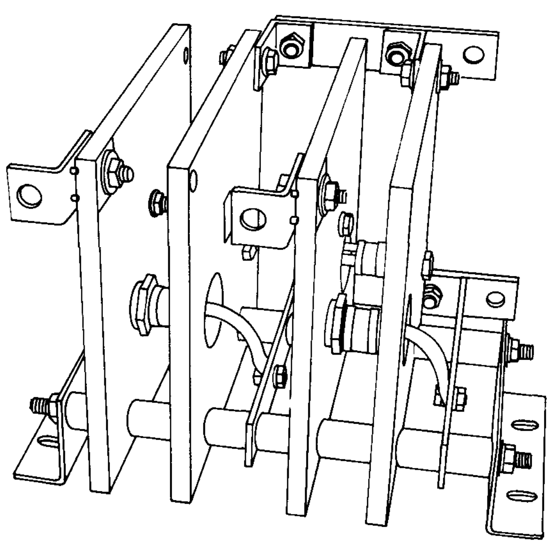
Silicon
Rectifier Stacks



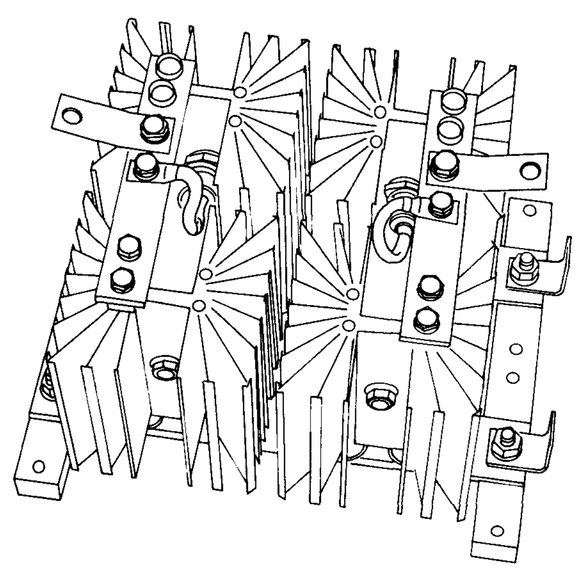
FIN 11



FIN 12



FIN 13



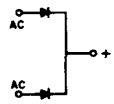
FIN 14/15

1. **RECTIFIER STACK SELECTION CHART** for 40°C ambient, free convection cooling, resistive or inductive load (for other conditions – see Figures 2 thru 7).

SINGLE PHASE HALF WAVE

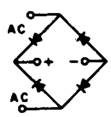
CIRCUIT OUTPUT CURRENT	48 ADC	65 ADC	70 ADC	85 ADC	90 ADC	175 ADC	Max. Repetitive AC Input Volts RMS*	Max. Circuit Output Volts DC	Max. Diode PRV	Max. Allow. Transient PRV Non-Recurrent
	A7012AH1AD1	A7011AH1AD1	A7013AH1AD1	A7014AH1AD1	A19013AH1AD1	A19015AH1AD1	70	29	100	200
	BH1AD1	BH1AD1	BH1AD1	BH1AD1	BH1AD1	BH1AD1	140	61	200	300
	CH1AD1	CH1AD1	CH1AD1	CH1AD1	CH1AD1	CH1AD1	210	92	300	400
	DH1AD1	DH1AD1	DH1AD1	DH1AD1	DH1AD1	DH1AD1	280	124	400	525
	EH1AD1	EH1AD1	EH1AD1	EH1AD1	EH1AD1	EH1AD1	350	155	500	650
	MH1AD1	MH1AD1	MH1AD1	MH1AD1	MH1AD1	MH1AD1	420	187	600	800
	NH1AD1	NH1AD1	NH1AD1	NH1AD1	NH1AD1	NH1AD1	560	250	800	1050
	PH1AD1	PH1AD1	PH1AD1	PH1AD1	PH1AD1	PH1AD1	700	313	1000	1300

SINGLE PHASE CENTER TAP



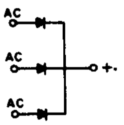
CIRCUIT OUTPUT CURRENT	96 ADC	130 ADC	140 ADC	170 ADC	180 ADC	350 ADC	(Line to Neutral)			
	A7012AC1AD1	A7011AC1AD1	A7013AC1AD1	A7014AC1AD1	A19013AC1AD1	A19015AC1AD1	35	28	100	200
	BC1AD1	BC1AD1	BC1AD1	BC1AD1	BC1AD1	BC1AD1	70	60	200	300
	CC1AD1	CC1AD1	CC1AD1	CC1AD1	CC1AD1	CC1AD1	105	91	300	400
	DC1AD1	DC1AD1	DC1AD1	DC1AD1	DC1AD1	DC1AD1	140	123	400	525
	EC1AD1	EC1AD1	EC1AD1	EC1AD1	EC1AD1	EC1AD1	175	154	500	650
	MC1AD1	MC1AD1	MC1AD1	MC1AD1	MC1AD1	MC1AD1	210	186	600	800
	NC1AD1	NC1AD1	NC1AD1	NC1AD1	NC1AD1	NC1AD1	280	249	800	1050
	PC1AD1	PC1AD1	PC1AD1	PC1AD1	PC1AD1	PC1AD1	350	312	1000	1300

SINGLE PHASE BRIDGE



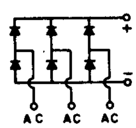
CIRCUIT OUTPUT CURRENT	96 ADC	130 ADC	140 ADC	170 ADC	180 ADC	350 ADC	(Line to Neutral)			
	A7012AB1AD1	A7011AB1AD1	A7013AB1AD1	A7014AB1AD1	A19013AB1AD1	A19015AB1AD1	70	59	100	200
	BB1AD1	BB1AD1	BB1AD1	BB1AD1	BB1AD1	BB1AD1	140	121	200	300
	CB1AD1	CB1AD1	CB1AD1	CB1AD1	CB1AD1	CB1AD1	210	185	300	400
	DB1AD1	DB1AD1	DB1AD1	DB1AD1	DB1AD1	DB1AD1	280	248	400	525
	EB1AD1	EB1AD1	EB1AD1	EB1AD1	EB1AD1	EB1AD1	350	311	500	650
	MB1AD1	MB1AD1	MB1AD1	MB1AD1	MB1AD1	MB1AD1	420	374	600	800
	NB1AD1	NB1AD1	NB1AD1	NB1AD1	NB1AD1	NB1AD1	560	500	800	1050
	PB1AD1	PB1AD1	PB1AD1	PB1AD1	PB1AD1	PB1AD1	700	626	1000	1300

THREE PHASE HALF WAVE



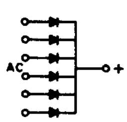
CIRCUIT OUTPUT CURRENT	135 ADC	180 ADC	195 ADC	240 ADC	270 ADC	500 ADC	(Line to Neutral)			
	A7012AY1AD1	A7011AY1AD1	A7013AY1AD1	A7014AY1AD1	A19013AY1AD1	A19015AY1AD1	40	44	100	200
	BY1AD1	BY1AD1	BY1AD1	BY1AD1	BY1AD1	BY1AD1	80	91	200	300
	CY1AD1	CY1AD1	CY1AD1	CY1AD1	CY1AD1	CY1AD1	120	138	300	400
	DY1AD1	DY1AD1	DY1AD1	DY1AD1	DY1AD1	DY1AD1	160	184	400	525
	EY1AD1	EY1AD1	EY1AD1	EY1AD1	EY1AD1	EY1AD1	200	231	500	650
	MY1AD1	MY1AD1	MY1AD1	MY1AD1	MY1AD1	MY1AD1	240	278	600	800
	NY1AD1	NY1AD1	NY1AD1	NY1AD1	NY1AD1	NY1AD1	320	371	800	1050
	PY1AD1	PY1AD1	PY1AD1	PY1AD1	PY1AD1	PY1AD1	400	465	1000	1300

THREE PHASE BRIDGE



CIRCUIT OUTPUT CURRENT	135 ADC	180 ADC	195 ADC	240 ADC	270 ADC	500 ADC				
	A7012AF1AD1	A7011AF1AD1	A7013AF1AD1	A7014AF1AD1	A19013AF1AD1	A19015AF1AD1	70	91	100	200
	BF1AD1	BF1AD1	BF1AD1	BF1AD1	BF1AD1	BF1AD1	140	185	200	300
	CF1AD1	CF1AD1	CF1AD1	CF1AD1	CF1AD1	CF1AD1	210	279	300	400
	DF1AD1	DF1AD1	DF1AD1	DF1AD1	DF1AD1	DF1AD1	280	374	400	525
	EF1AD1	EF1AD1	EF1AD1	EF1AD1	EF1AD1	EF1AD1	350	468	500	650
	MF1AD1	MF1AD1	MF1AD1	MF1AD1	MF1AD1	MF1AD1	420	563	600	800
	NF1AD1	NF1AD1	NF1AD1	NF1AD1	NF1AD1	NF1AD1	560	752	800	1050
	PF1AD1	PF1AD1	PF1AD1	PF1AD1	PF1AD1	PF1AD1	700	941	1000	1300

SIX PHASE STAR



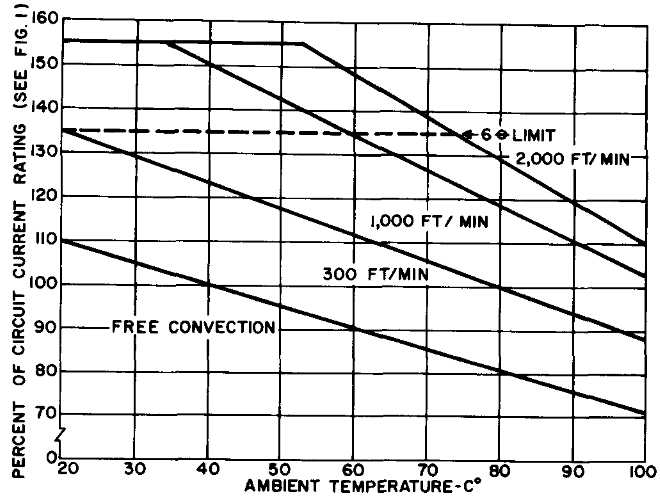
CIRCUIT OUTPUT CURRENT	240 ADC	294 ADC	318 ADC	390 ADC	420 ADC	840 ADC				
	A7012AS1AD1	A7011AS1AD1	A7013AS1AD1	A7014AS1AD1	A19013AS1AD1	A19015AS1AD1	35	44	100	200
	BS1AD1	BS1AD1	BS1AD1	BS1AD1	BS1AD1	BS1AD1	70	91	200	300
	CS1AD1	CS1AD1	CS1AD1	CS1AD1	CS1AD1	CS1AD1	105	139	300	400
	DS1AD1	DS1AD1	DS1AD1	DS1AD1	DS1AD1	DS1AD1	140	186	400	525
	ES1AD1	ES1AD1	ES1AD1	ES1AD1	ES1AD1	ES1AD1	175	233	500	650
	MS1AD1	MS1AD1	MS1AD1	MS1AD1	MS1AD1	MS1AD1	210	280	600	800
	NS1AD1	NS1AD1	NS1AD1	NS1AD1	NS1AD1	NS1AD1	280	375	800	1050
	PS1AD1	PS1AD1	PS1AD1	PS1AD1	PS1AD1	PS1AD1	350	469	1000	1300

NOTE: *The RMS voltage ratings are based on the assumption that the required precautions have been taken to keep transient voltage per fin within the transient ratings specified above. For a discussion of voltage transient and corrective action, request "Rectifier Voltage Transients: Their Generation, Detection and Reduction," 200.11.

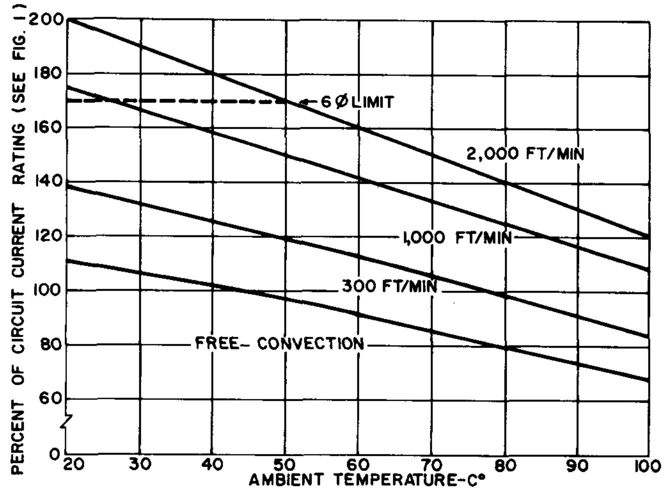
NOMENCLATURE IDENTIFICATION

A70	12	A	H	1	AD	1
(1)	(2)	(3)	(4)	(5)	(6)	(7)

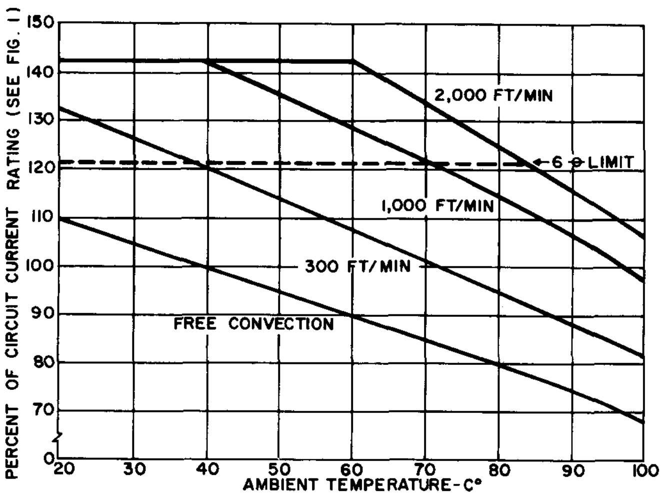
1. Basic rectifier diode used in stack. For further diode details, refer to A70, A190 specifications.
2. Identifies heat sink as follows:
   11 – 1-1/2 x 3-1/2 x 3-1/2 aluminum extrusion
   12 – 5 x 5 x 1/8 copper plate
   13 – 7 x 7 x 3/8 aluminum plate
   14 – 4 x 4 x 5 aluminum extrusion
   15 – 5 x 5 x 5-1/2 aluminum extrusion
3. *Diode voltage classification – see Figure 1, column headed "Max Diode PRV."*
4. Basic circuit.
5. Number of series diodes in each leg.
6. Mechanical construction.
7. Number of parallel diodes in each leg.



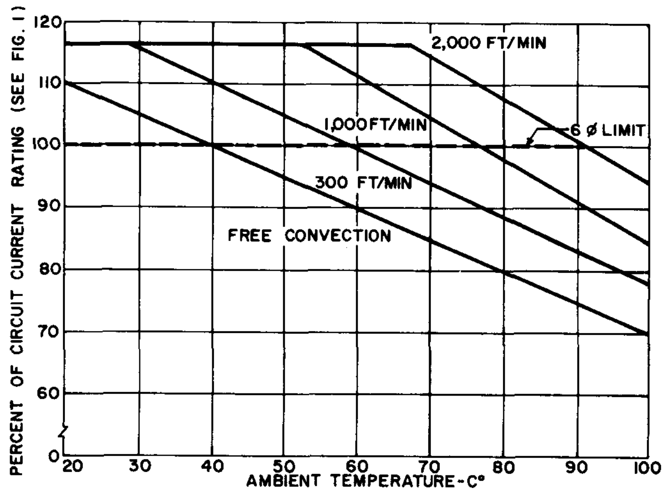
2. A7011 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE AND COOLING CONDITIONS



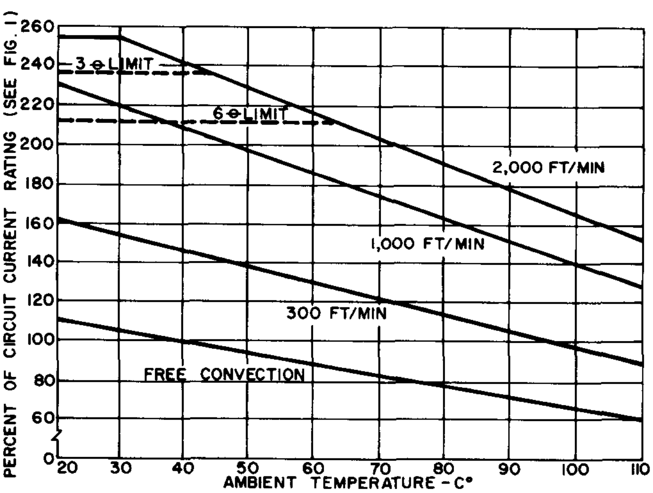
3. A7012 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE AND COOLING CONDITIONS



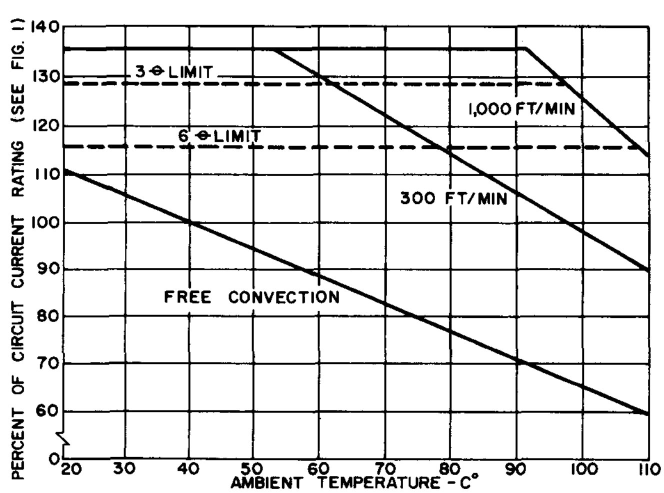
4. A7013 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE AND COOLING CONDITIONS



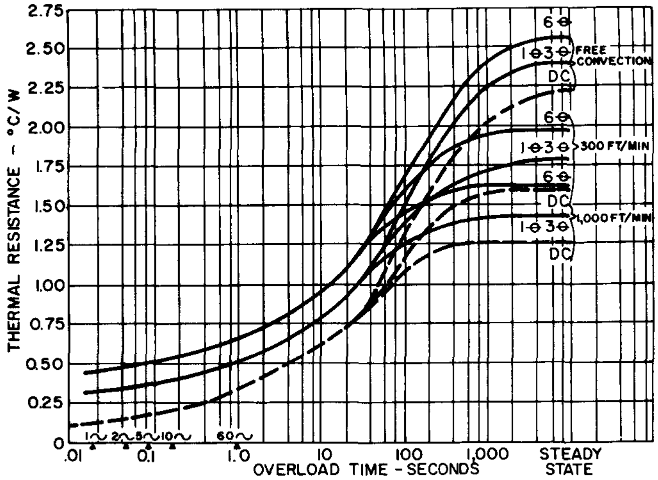
5. A7014 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE AND COOLING CONDITIONS



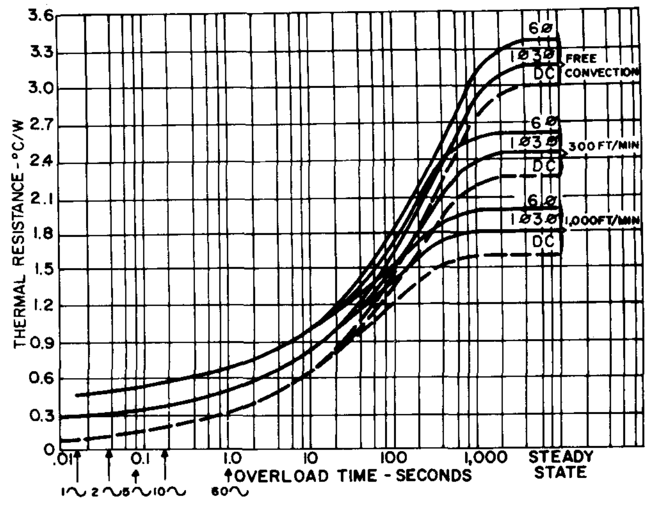
6. A19013 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE AND COOLING CONDITIONS



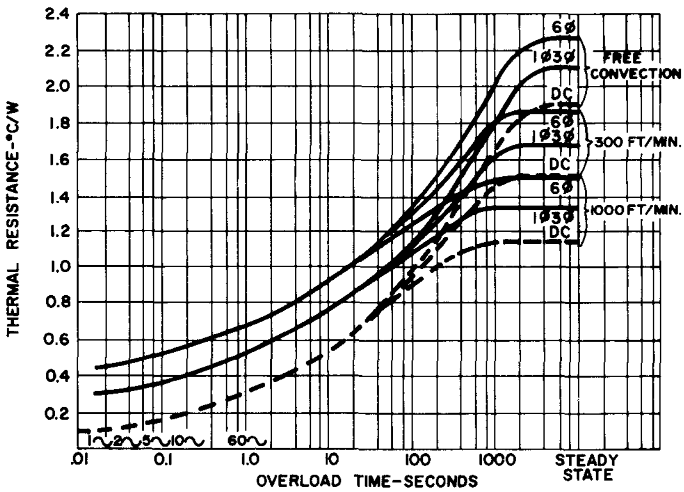
7. A19015 STACK CURRENT RATING AS A FUNCTION OF AMBIENT TEMPERATURE AND COOLING CONDITIONS



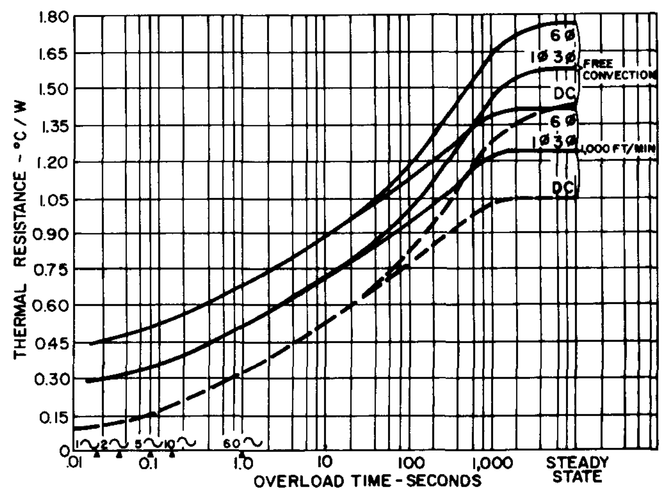
8. A7011 TRANSIENT THERMAL RESISTANCE – AT 60 CPS, JUNCTION-TO-AMBIENT VS. OVERLOAD TIME



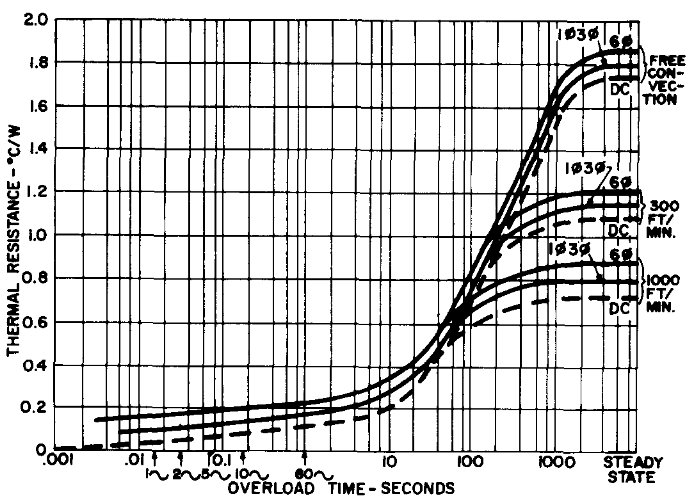
9. A7012 TRANSIENT THERMAL RESISTANCE – AT 60 CPS, JUNCTION-TO-AMBIENT VS. OVERLOAD TIME



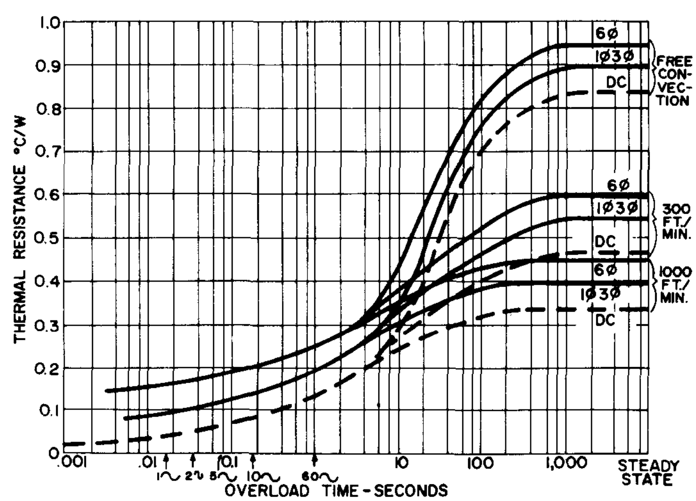
10. A7013 TRANSIENT THERMAL RESISTANCE – AT 60 CPS, JUNCTION-TO-AMBIENT VS. OVERLOAD TIME



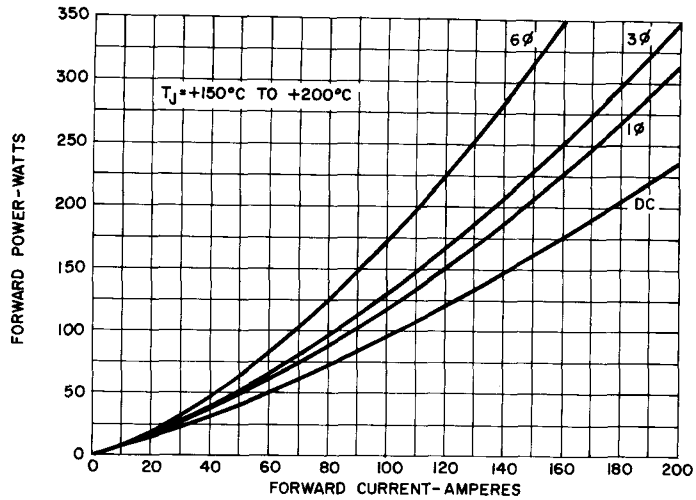
11. A7014 TRANSIENT THERMAL RESISTANCE – AT 60 CPS, JUNCTION-TO-AMBIENT VS. OVERLOAD TIME



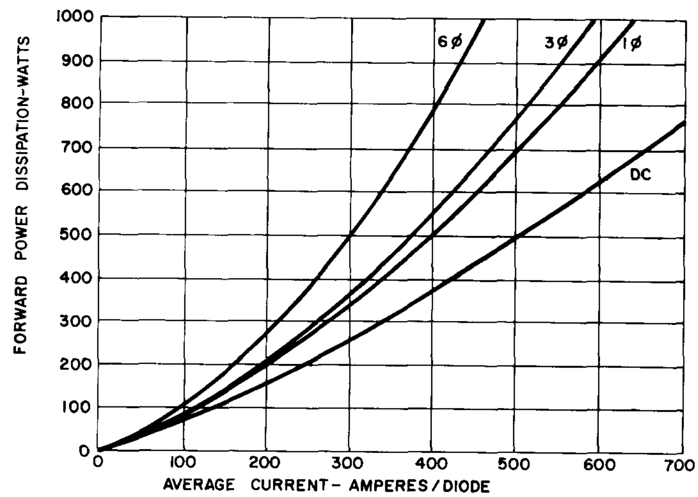
12. A19013 TRANSIENT THERMAL RESISTANCE – AT 60 CPS, JUNCTION-TO-AMBIENT VS. OVERLOAD TIME



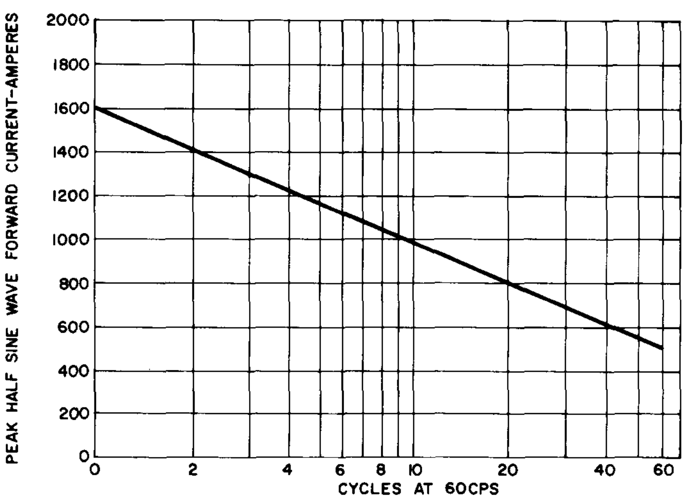
13. A19015 TRANSIENT THERMAL RESISTANCE – AT 60 CPS, JUNCTION-TO-AMBIENT VS. OVERLOAD TIME



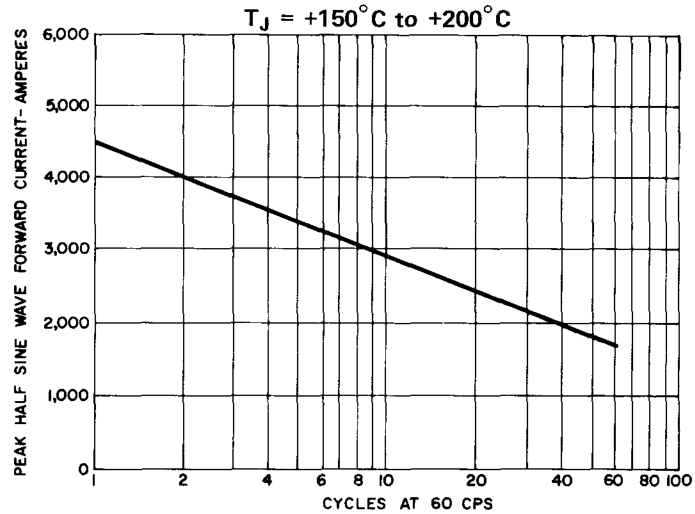
14. A7011, A7012, A7013, A7014
AVERAGE FORWARD POWER VS. AVERAGE FORWARD CURRENT – T_J = +150°C to +200°C



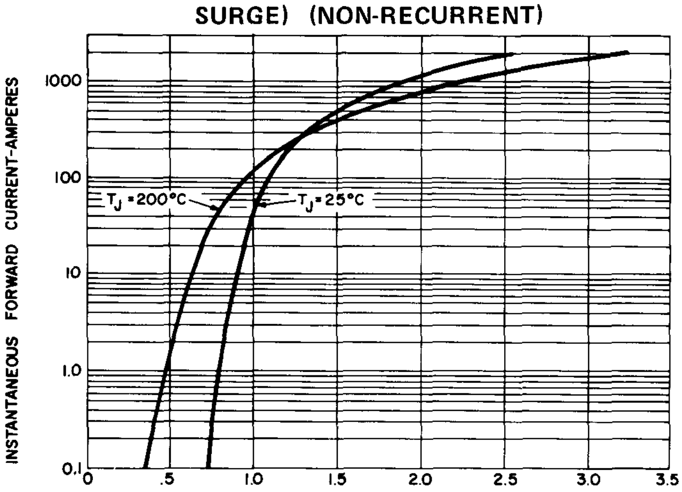
15. A19013, A19015
AVERAGE FORWARD POWER DISSIPATION VS. AVERAGE FORWARD CURRENT – T_J = +150°C to +200°C



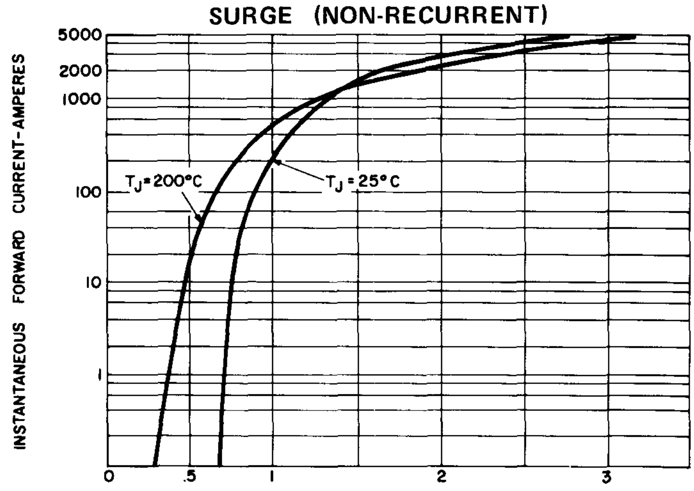
16. A7011, A7012, A7013, A7014
MAXIMUM SURGE CURRENT AT RATED LOAD CONDITIONS (PRV APPLIED AFTER SURGE) (NON-RECURRENT)



17. A19013, A19015
MAXIMUM SURGE CURRENT AT RATED LOAD CONDITIONS (PRV APPLIED AFTER SURGE) (NON-RECURRENT)



18. A7011, A7012, A7013, A7014
MAXIMUM FORWARD CHARACTERISTICS

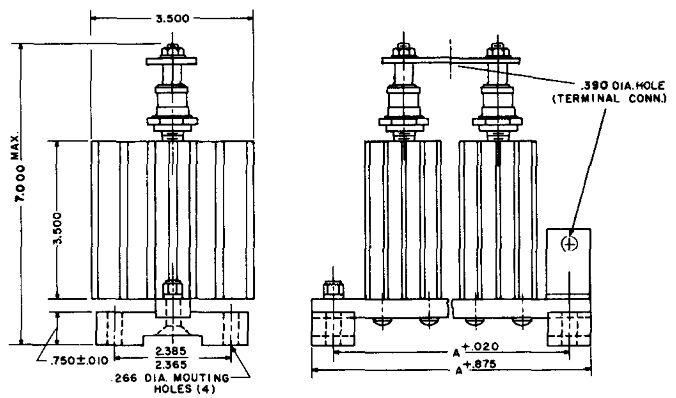


19. A19013, A19015
MAXIMUM FORWARD CHARACTERISTICS

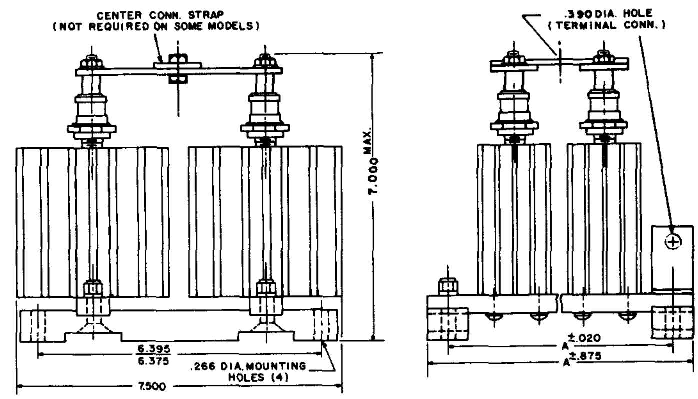
OUTLINE DRAWINGS

	A	APPROX. WEIGHT	OUTLINE NO.
Single Phase Half Wave	2.937	1.5 Lbs.	1
Single Phase Center Tap	4.875	3.0	1
Single Phase Bridge	4.875	5.5	2
3ϕ Half Wave	6.812	8.0	2
3ϕ Bridge	6.812	4.0	1
6ϕ Star	12.625	8.0	1

A7011



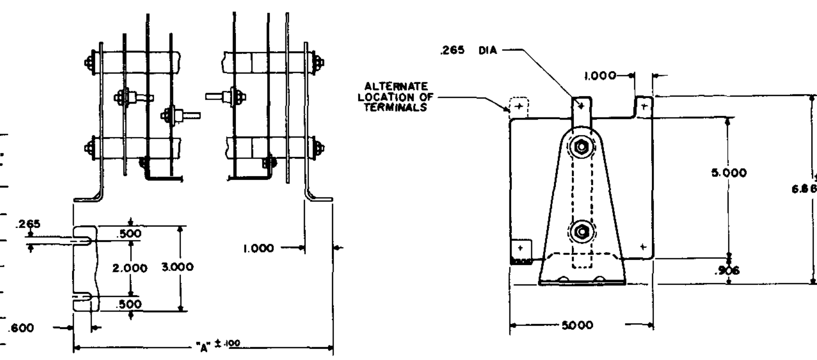
①



②

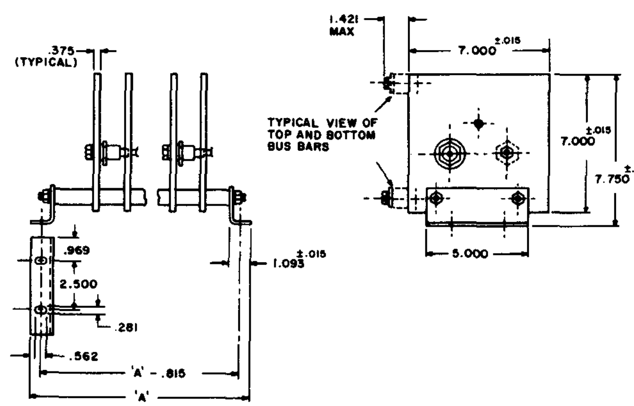
A7012

	A	APPROX. WEIGHT
Single Phase Half Wave	4.875	3 Lbs.
Single Phase Center Tap	5.750	4
Single Phase Bridge	8.750	7
3ϕ Half Wave	8.750	5
3ϕ Bridge	11.750	10
6ϕ Star	11.750	10

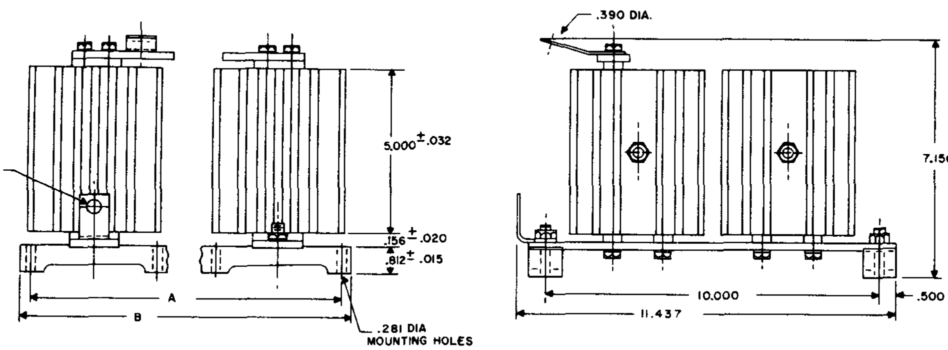


A7013
A19013

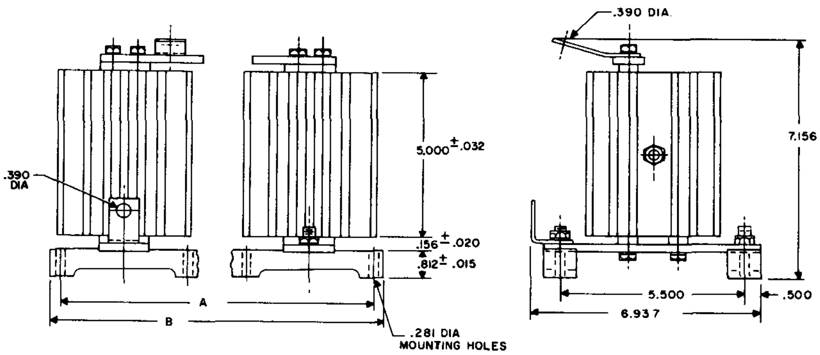
	A	APPROX. WEIGHT
Single Phase Half Wave	6.076±.060	6 Lbs.
Single Phase Center Tap	6.776±.060	8
Single Phase Bridge	10.500±.105	14
3 Phase Half Wave	10.500±.105	12
3 Phase Bridge	14.496±.150	19
6ϕ Star	14.496±.150	19



A7014



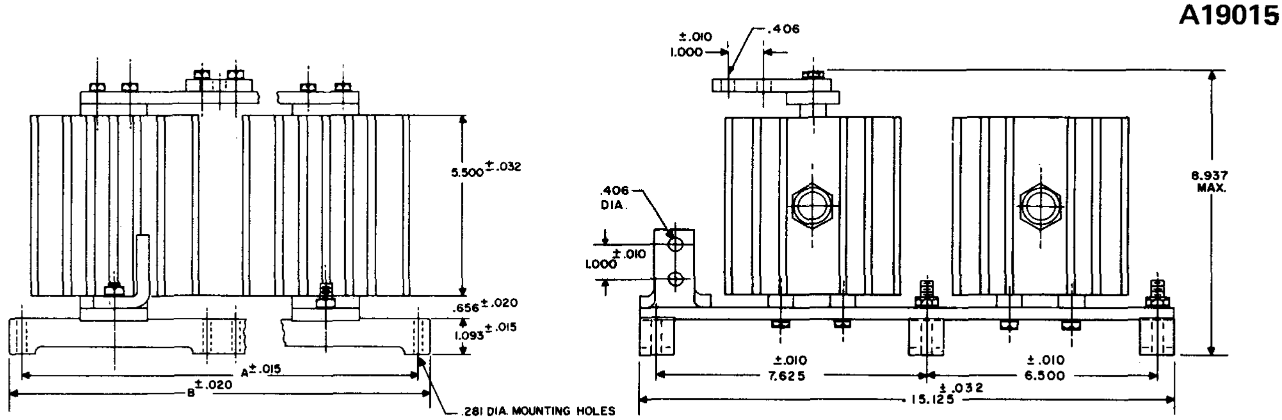
②



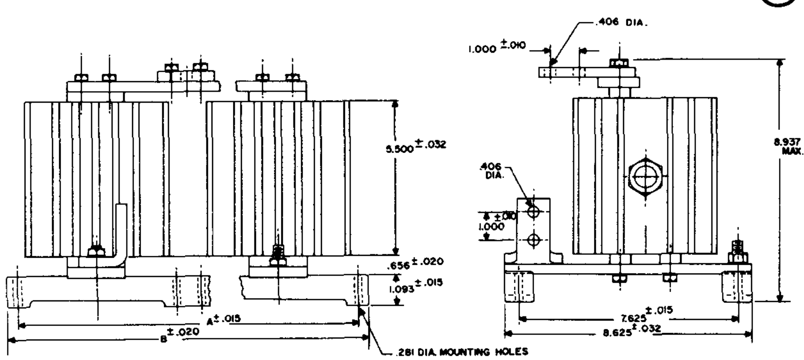
①

	A	B	APPROX. WEIGHT	OUTLINE NO.
Single Phase Half Wave	3.750	4.437	3 Lbs.	1
Single Phase Center Tap	8.250	8.937	5	1
Single Phase Bridge	8.250	8.937	10	2
3ϕ Half Wave	12.750	13.437	8	1
3ϕ Bridge	12.750	13.437	15	2
6ϕ Star	12.750	13.437	15	2

A19015

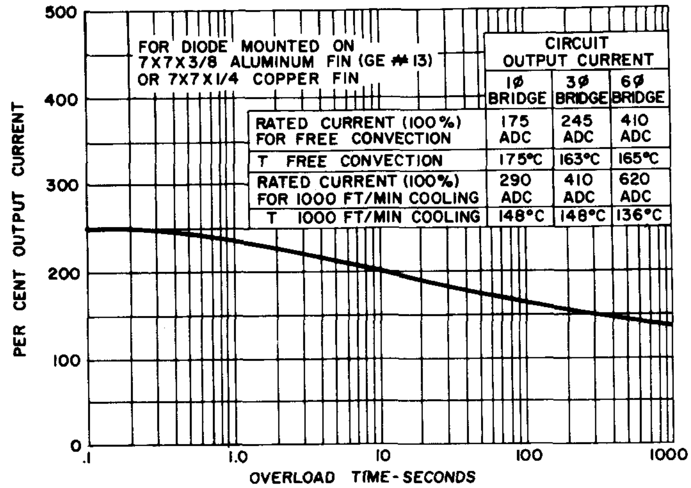


②



①

	A	B	APPROX. WEIGHT	OUTLINE NO.
Single Phase Half Wave	5.500	6.250	4 Lbs.	1
Single Phase Center Tap	11.812	12.562	8	1
Single Phase Bridge	11.812	12.562	17	2
3ϕ Half Wave	18.125	18.875	14	1
3ϕ Bridge	18.125	18.875	22	2
6ϕ Star	18.125	18.875	22	2



20. RECURRENT OVERLOAD CURVE MEETING NEMA STANDARDS
(For General Purpose Rectifier Equipments Over 100 KW) AT 40°C AMBIENT

RECURRENT OVERLOAD RATING DETERMINATION

(FOR OVERLOAD CONDITIONS OTHER THAN SHOWN IN FIGURE 20)

Many applications require that electrical equipment be designed to permit operation at higher than normal current for short periods of time. This planned overload requirement is called a recurrent overload condition. (For nonrecurrent current overloads, see the surge curve for the product being considered.)

Whenever a recurrent overload rating is required, it is possible to take advantage of the thermal capacity of the rectifier diode and the heat sink to which it is attached.

The following procedure will permit a recurrent overload providing another overload is not applied until sufficient time has elapsed to permit the rectifier diode to reach temperature equilibrium at the calculated continuous rating. In general, a cool-down period of twice the length of the overload time is sufficient for the rectifier diode to reach the calculated continuous rating temperature equilibrium.

If the reapplication time (of overload) is shorter, please contact the factory for application assistance.

To calculate the steady state current rating required to permit a recurrent overload, the following "cut and try" method is recommended. The example given is for the A19013 stacks; however, by using the appropriate curves, recurrent overload ratings can be determined for the other stacks listed.

$$T_J \text{ Max.} = T_A + P_{SS} \times R_{\theta JA} + (P_{OL} - P_{SS})\, Z_{\theta(E)}$$

where T_J Max. = Max. Junction Temperature (200°C)

T_A = Max. Ambient (in °C)

P_{SS} = Diode Power Dissipation (Steady State) from Curve 15

$R_{\theta JA}$ = Thermal Resistance (Steady State) from Curve 12

P_{OL} = Diode Power Dissipation (Under Recurrent Overload Conditions) from Curve 15

$Z_{\theta(t)}$ = Transient Thermal Resistance (Under Overload Conditions) from Curve 12

As a starting point, it is suggested that the steady state diode current without recurrent overload current be determined (see Figure 1).

To permit a recurrent overload rating, the maximum rated diode current must be reduced. Using a reduced value of steady state current as an estimate, the data for insertion into the formula can be obtained from Curves 15 and 12.

When the estimate is correct, the right side of the formula given above will equal the maximum T_J, which is 200°C.

Example: 200% recurrent overload required for 10 seconds;
three-phase bridge;
1000 ft./min. forced air;
maximum ambient = 40°C.

From Figures 1 and 6, steady state rating without provision for recurrent overload equals 185 amps/diode. Therefore, a first approximation may be 125 amps steady state and 250 amps overload. Substituting these values in the formula, we have:

$$T_J \text{ Max.} = 40 + 115 \times .82 + (280 - 115)\ .26$$

$$T_J \text{ Max.} = 117.2$$

The answer of 177.2 indicates that our steady state selection was slightly low. By choosing 140 amps steady state and 280 amps overload, we come closer to the maximum rating permissible, based on T_J max. = 200°C.

Of course, the 3-phase-bridge output current will be three times the diode current, 420 amps average steady state, and 840 amps, or 200% current, for 10 seconds.

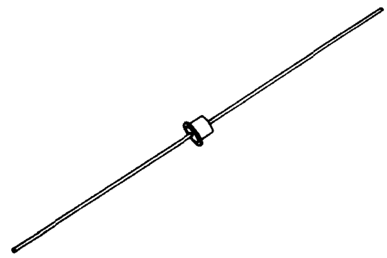
NOTES:

1. The recurrent overload calculation procedure outlined above was used to obtain the ratings shown by Curve 20.
2. NEMA overload ratings for semiconductor unit power supplies (100 KW or less) are:
   a. 100% rated load current and voltage continuously, then:
   b. 150% rated current for 1 minute, following 100% load; or
   c. 200% rated current for 10 seconds, following 100% load.

Germanium Diodes

BD1-7

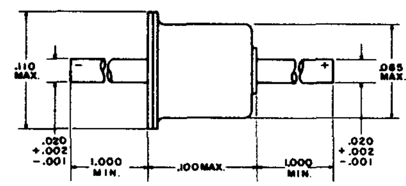
The General Electric types 4JFBD1-7 are germanium back diodes which make use of the quantum mechanical tunneling phenomenon, thereby attaining a very low forward voltage drop and eliminating charge storage effects. They feature closely controlled forward voltage characteristics with very small temperature coefficients. The very low forward voltage and low capacity of the back diode make it ideal for use in high frequency applications and in transistor and tunnel diode switching circuits. The germanium back diodes are characterized in seven types according to the forward current at a forward voltage of 90 millivolts and according to the maximum reverse leakage current.



absolute maximum ratings: (25°C) (unless otherwise specified)

Part Number	1	2	3	4	5	6	7	units
Forward Current (-55 to + 100°C)	30	15	10	5	5	5	5	ma
Reverse Current (-55 to + 100°C)	10	5	5	5	5	5	5	ma
Lead Temperature, 1/16" + 1/32" from case for 10 seconds	260°C							

AXIAL DIODE OUTLINE



ALL DIMENSIONS IN INCHES.
DIMENSIONS ARE REFERENCE UNLESS TOLERANCED.

electrical characteristics: (25°C) (unless otherwise specified)

	Sym.	BD1	BD2	BD3	BD4	BD5	BD6	BD7	Units
Forward Voltage, V_{F1} =90 MV ± 10 mv at I_{F1} =		10	5	2	1	.5	.2	.1 ma	
Forward Voltage at I_{F2} (I_{F2} =3I_{F1})	V_{F2}	120	130	170	170	170	160	160 mv	typ.
Reverse Voltage, I_R =I_P max	V_{R1}	440	420	400	380	350	330	330 mv	min.
Reverse Voltage, I_R =1 ma	V_{R2}	440	465	465	465	465	465	465 mv	min.
Reverse Peak Point Current	I_P	1	.5	.2	.1	.05	.02	.01 ma	max.
Series Inductance (Measured at case)	L_S	1.5	1.5	1.5	1.5	1.5	1.5	1.5 nh	typ.
Total Terminal Capacity	C	8	6	4	3	3	3	3 pf	typ.
(V_R =350 mv)		20	10	10	10	10	10	10 pf	max.
Recovery Time*	t_r	1.0	0.7	0.5	0.4	0.4	0.4	0.4 ns	typ.

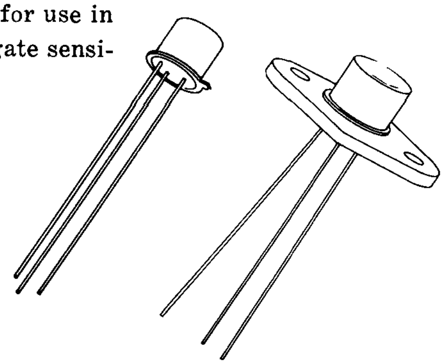
*The recovery time is measured to a reverse current of 1 ma. when switching from 0.1 volt forward to 0.4 volt reverse from a 50 ohm source. Since the back diode does not exhibit charge storage, the recovery time is determined by the charging time of the total device capacity.

SCR

1.6A RMS Up to 400 Volts

C5 Series
2N2322-29
2N2322A-28A
C511 (Diamond Base)‡

The C5 Series of Silicon Controlled Rectifiers are reverse blocking thyristors for use in low power switching and control applications. They feature two ranges of gate sensitivity and high external gate-cathode shunting resistance.



- All-diffused
- Two ranges of gate sensitivity—2N2322-29—200μA max. & 2N2322A-28A—20μA max.
- Diamond flange types (C511) for convenient power dissipation
- Low holding current
- Broad voltage range
- Designed to meet MIL-S-19500/276

MAXIMUM ALLOWABLE RATINGS

TYPES†		REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} $T_C = -65°C$ to $+125°C$ R_{GK} = 1000 OHMS (2N2322-29) = 2000 OHMS (2N2322A-28A)	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} $T_C = -65°C$ to $+125°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} (≦ 10 Millisec.) $T_C = -65°C$ to $+125°C$
JEDEC	GE			
2N2322	C5U	25V.*	25V.*	40V.*
2N2322A	—	25V.*	25V.*	40V.*
2N2323	C5F	50V.*	50V.*	75V.*
2N2323A	—	50V.*	50V.*	75V.*
2N2324	C5A	100V.*	100V.*	150V.*
2N2324A	—	100V.*	100V.*	150V.*
2N2325	C5G	150V.*	150V.*	225V.*
2N2325A	—	150V.*	150V.*	225V.*
2N2326	C5B	200V.*	200V.*	300V.*
2N2326A	—	200V.*	200V.*	300V.*
2N2327	C5H	250V.*	250V.*	350V.*
2N2327A	—	250V.*	250V.*	350V.*
2N2328	C5C	300V.*	300V.*	400V.*
2N2328A	—	300V.*	300V.*	400V.*
2N2329	C5D	400V.*	400V.*	500V.*

Peak Positive Anode Voltage, PFV .... 500 Volts

RMS On-State Current, $I_{T(RMS)}$ .... 1.6 Amperes (all conduction angles)

Average On-State Current, $I_{T(AV)}$ .... Depends on conduction angle (see Charts 2, 3, 5 and 6)

Critical Rate-of-Rise of On-State Current, di/dt:
Gate Triggered Operation, Switching from Rated Voltage .... 50 Amperes per microsecond

Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} .... 15 Amperes*

I^2t (for fusing), for times ⩾ 1.5 milliseconds .... 0.5 Ampere^{2}seconds

Peak Gate Power Dissipation, P_{GM} .... 0.1 Watts*

Average Gate Power Dissipation, $P_{G(AV)}$ .... 0.01 Watts*

Peak Positive Gate Current, I_{GM} .... 0.1 Amperes*

Peak Positive Gate Voltage, V_{GM} .... 6 Volts*

Peak Negative Gate Voltage, V_{GM} .... 6 Volts*

Storage Temperature, T_{STG} .... −65°C to +150°C*

Operating Temperature, T_J .... −65°C to +125°C*

*Indicates data included on JEDEC type number registration

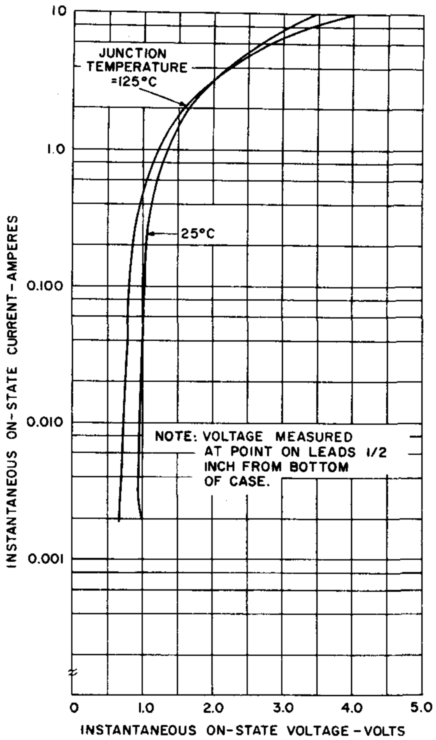
†When ordering the Diamond Base versions, be sure to include the proper voltage letter symbol. For example: The 25V Diamond Base version of the C5U (2N2322) is type number C511U.

‡The C511 series is identical to the C5 (2N2322-29) series except that a diamond base flange is soldered to the base of the unit. All ratings and characteristics are common to both series. See charts 17 thru 21 for Transient Thermal Impedance and Current Curves.

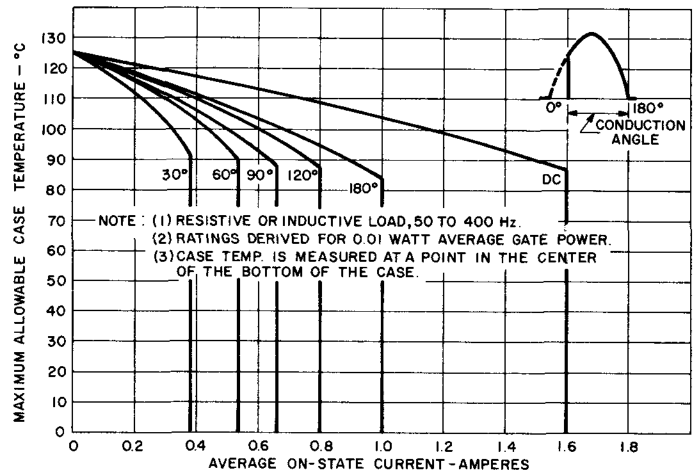
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE or OFF-STATE CURRENT	I_{RRM} or I_{DRM}				μA	$V_{RRM} = V_{DRM}$ = Rated.
		—	2.0	10.0		$T_C = +25°C$, R_{GK} = 1000 Ohms 2N2322-29 (C5 Series) = 2000 Ohms 2N2322A-28A
All Types		—	40	100*		$T_C = +125°C$, R_{GK} = 1000 Ohms 2N2322-29 (C5 Series) = 2000 Ohms 2N2322A-28A
GATE TRIGGER CURRENT	I_{GT}				μAdc	
2N2322-29 (C5 Series)		—	10	200		$T_C = +25°C$, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
2N2322A-28A		—	2	20		$T_C = +25°C$, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 2000 Ohms
2N2322-29 (C5 Series)		—	20.0	350*		$T_C = -65°C$, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
2N2322A-28A		—	10	75*		$T_C = -65°C$, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 2000 Ohms
GATE TRIGGER VOLTAGE	V_{GT}				Vdc	
2N2322-29 (C5 Series)		0.35	0.5	0.8		$T_C = +25°C$, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
2N2322A-28A		0.35	0.4	0.6		$T_C = +25°C$, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 2000 Ohms
2N2322-29 (C5 Series)		—	0.7	1.0*		$T_C = -65°C$, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
2N2322A-28A		—	—	0.9*		$T_C = -65°C$, V_D = 6Vdc, R_L = 100 Ohms R_{GK} = 2000 Ohms
2N2322-29 (C5 Series)		0.1*	0.25	0.5		$T_C = +125°C$, V_{DM} = Rated V_{DRM} Value R_{GK} = 1000 Ohms, R_L = 100 Ohms
2N2322A-28A		0.1*	—	—		$T_C = +125°C$, V_{DM} = Rated V_{DRM} Value R_{GK} = 2000 Ohms, R_L = 100 Ohms
PEAK ON-STATE VOLTAGE	V_{TM}	—	2.0	2.2	V	$T_C = +25°C$, I_{TM} = 4.0A, Single Half Sine Wave Pulse, 2.0 Millisec. Wide
All Types		—	1.9	2.0*		$T_C = +85°C$, $I_{T(AV)}$ = 1.0A, Half Sine Wave, 60 Hz, 180° Conduction Angle
HOLDING CURRENT	I_H				mAdc	R_{GK} = 1000 Ohms 2N2322-29 (C5 Series) = 2000 Ohms 2N2322A-28A
All Types		—	1.0	2.0		$T_C = +25°C$, R_L = 10K
All Types		—	1.5	3.0*		$T_C = -65°C$, R_L = 10K
2N2322-29		0.15*	0.4	—		$T_C = +125°C$, R_L = 50K
2N2322A-28A		0.10*	0.4	—		
TURN-ON TIME All Types	$t_d + t_r$	—	1.4	—	μsec	$T_C = +25°C$, I_F = 1.0A, V_{DM} = Rated V_{DRM} Value, Gate Supply: 6 Volt Open Circuit, 330 Ohm Load Line, 0.1 μsec. Rise Time, 5 μsec. Min. Pulse Width.
CIRCUIT-COMMUTATED TURN-OFF TIME All Types	t_q	—	40	—	μsec	$T_C = +125°C$, I_{TM} = 1.0A Peak. Rectangular current pulse, 50 μsec duration. Rate of rise of current <10 amperes/μsec. Commutation rate ≤5 amperes/μsec. Peak reverse voltage = rated V_{RRM} volts max. Reverse voltage at end of turn-off time interval = 15V. Repetition rate = 60 pps. Rate of rise of re-applied off-state voltage (dv/dt) = 20V/μsec. Off-state voltage = rated V_{DRM} volts. Gate bias during turn-off time interval = 0 volts, 100 ohms.

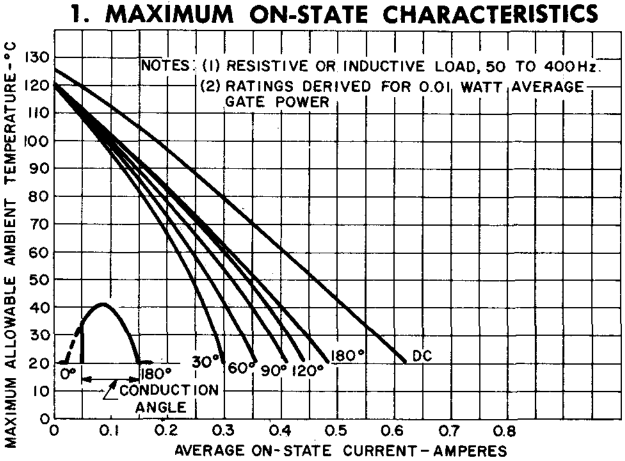
*Indicates data included on JEDEC type number registration



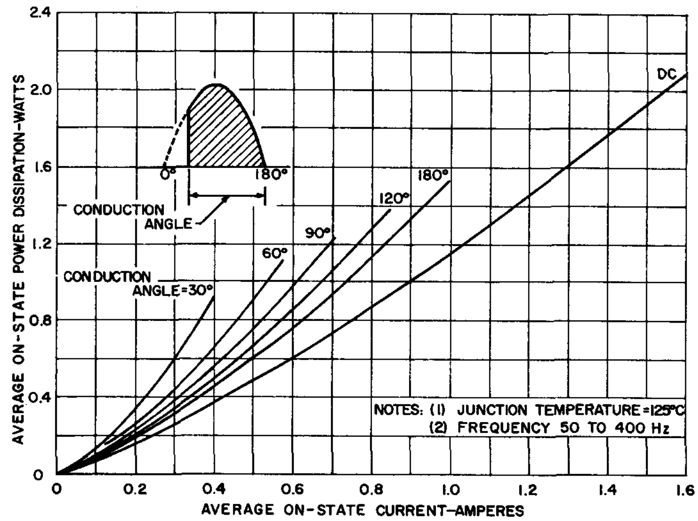
1. MAXIMUM ON-STATE CHARACTERISTICS



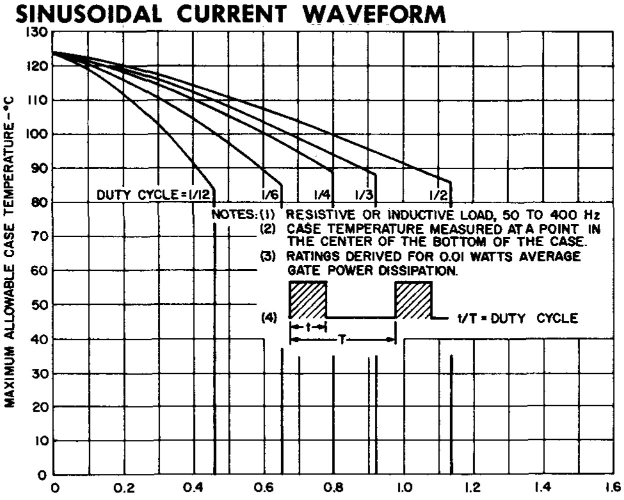
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



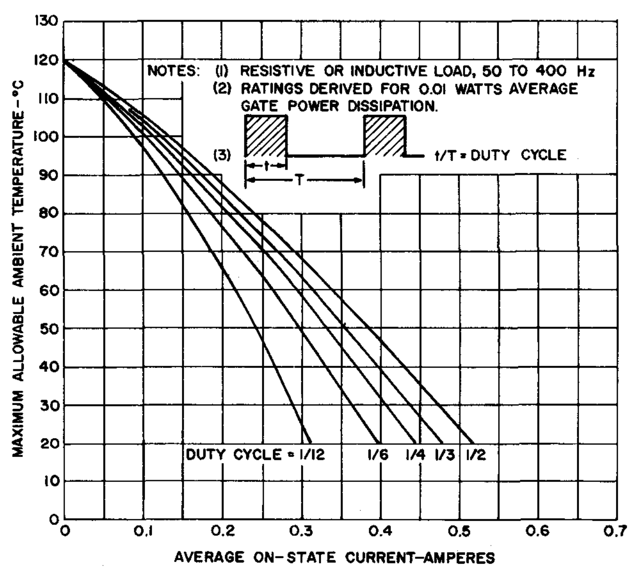
3. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



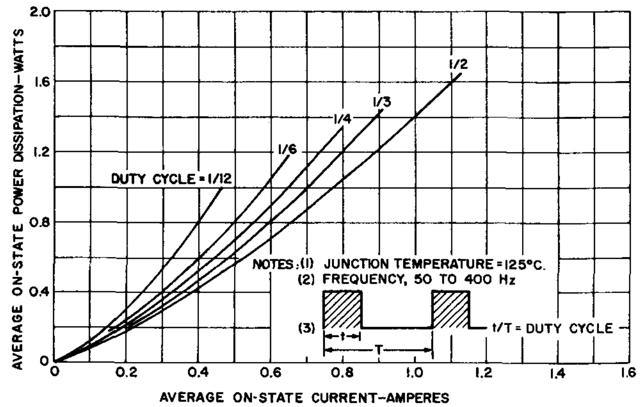
4. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



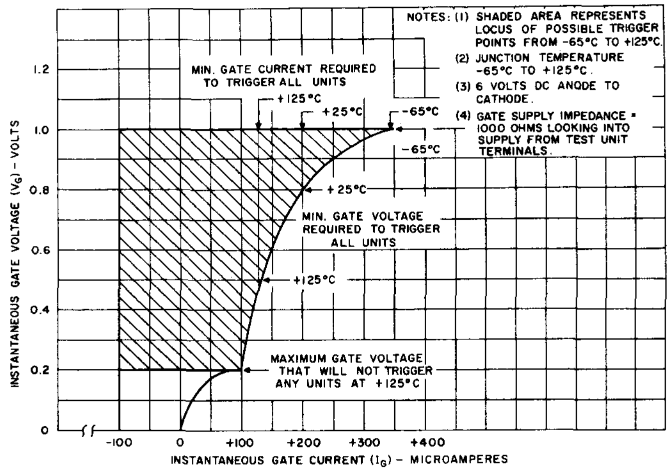
5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



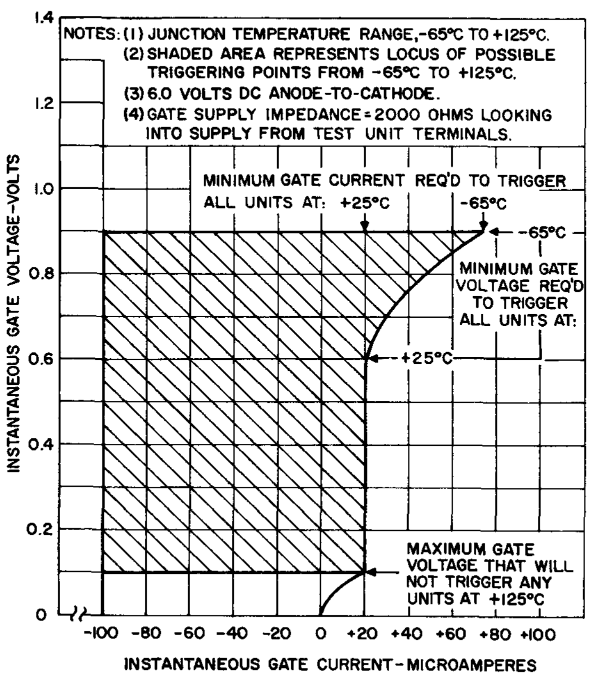
6. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



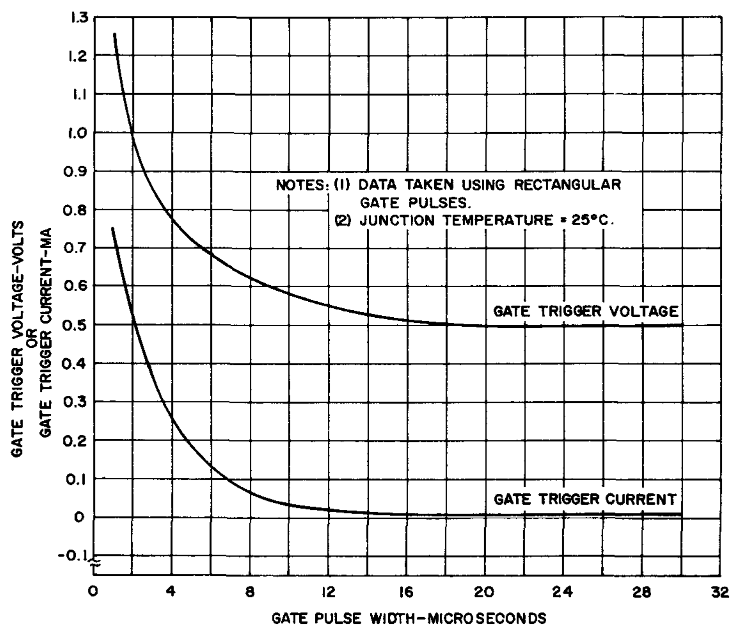
7. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



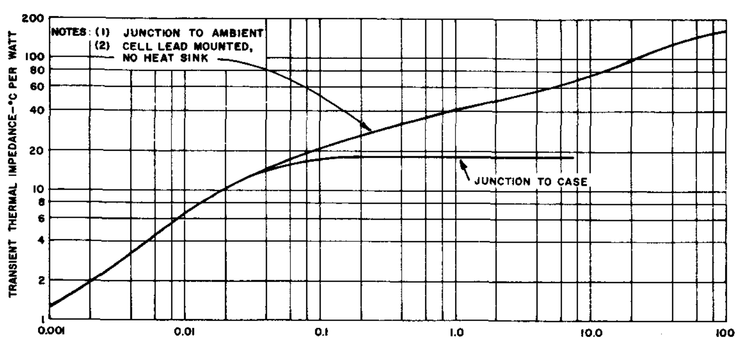
8. GATE TRIGGERING CHARACTERISTICS FOR 2N2322-29 (C5 SERIES) ONLY



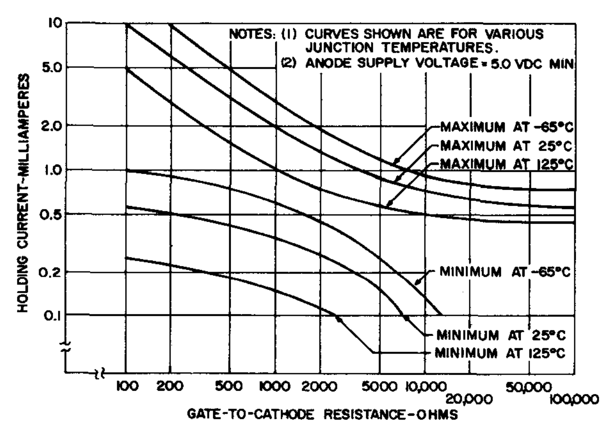
9. GATE TRIGGERING CHARACTERISTICS FOR 2N2322A-28A ONLY



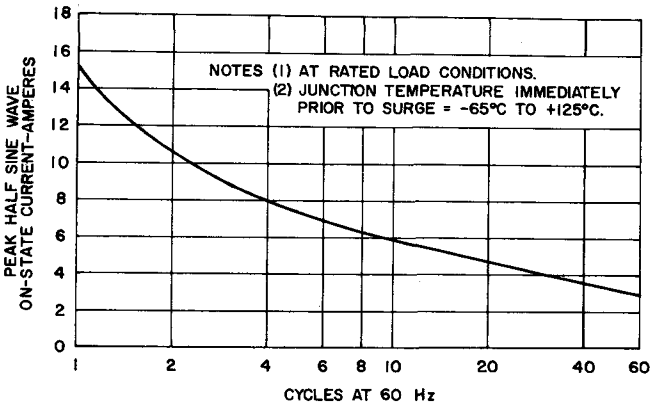
10. TYPICAL GATE TRIGGER CURRENT AND VOLTAGE VARIATION WITH GATE PULSE WIDTH



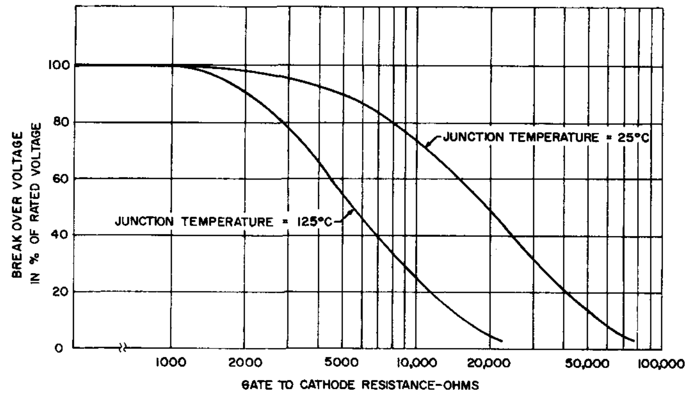
11. MAXIMUM TRANSIENT THERMAL IMPEDANCE



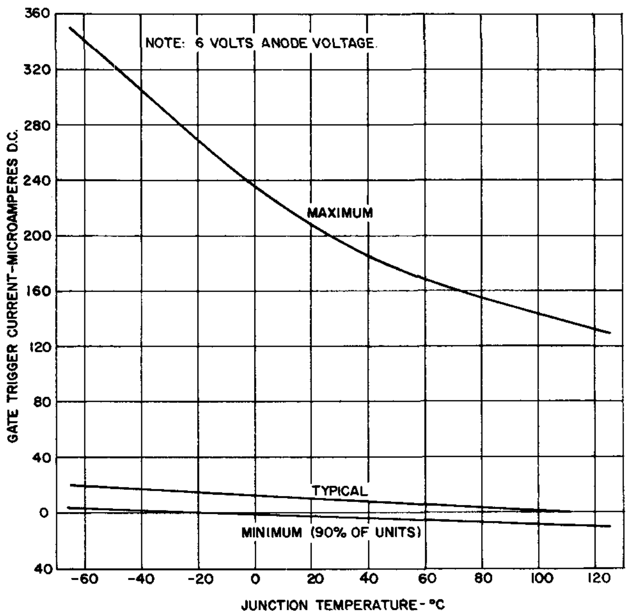
12. MAXIMUM AND MINIMUM HOLDING CURRENT VARIATION WITH EXTERNAL GATE-TO-CATHODE RESISTANCE FOR 2N2322-29 (C5 SERIES) ONLY



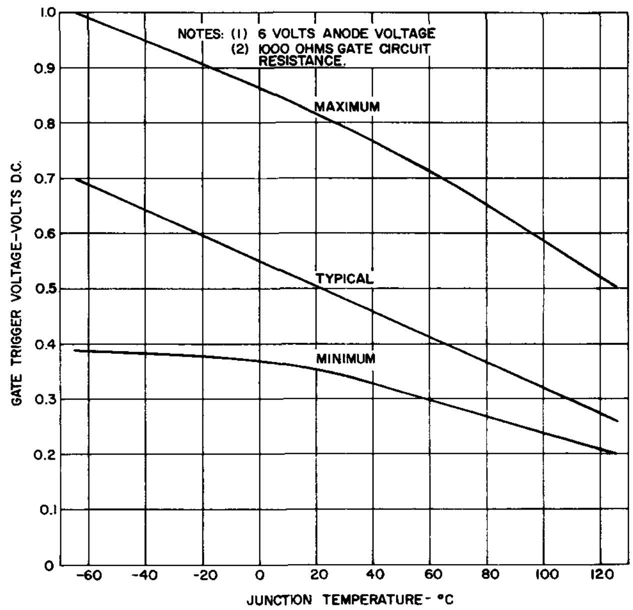
13. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT



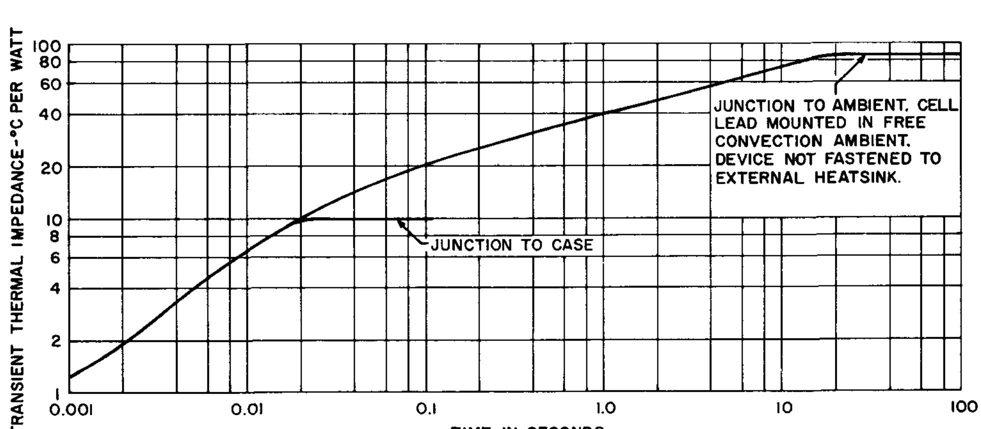
14. TYPICAL BREAKOVER VOLTAGE VARIATION WITH EXTERNAL GATE-TO-CATHODE RESISTANCE 2N2322-29 (C5 SERIES) ONLY



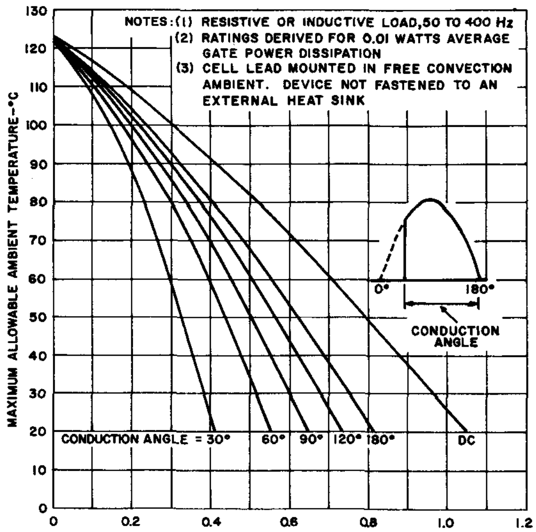
15. VARIATION OF GATE TRIGGER CURRENT WITH TEMPERATURE FOR 2N2322-29 (C5 SERIES) ONLY



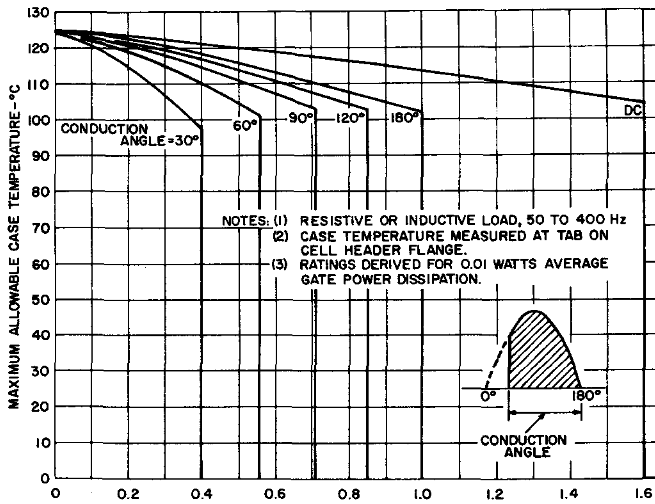
16. VARIATION OF GATE TRIGGER VOLTAGE WITH TEMPERATURE FOR 2N2322-29 (C5 SERIES) ONLY



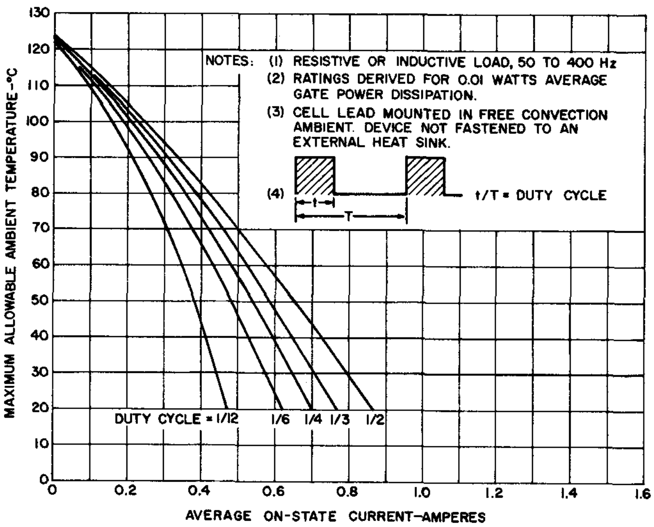
17. MAXIMUM TRANSIENT THERMAL IMPEDANCE (DIAMOND BASE)



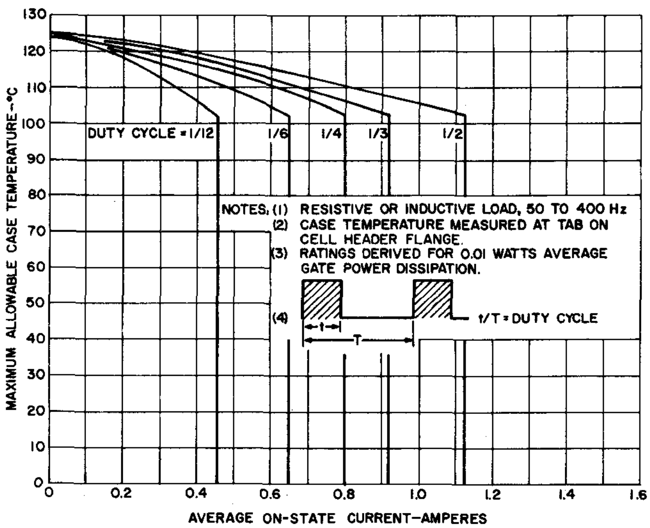
18. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT (DIAMOND BASE)



19. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT (DIAMOND BASE)



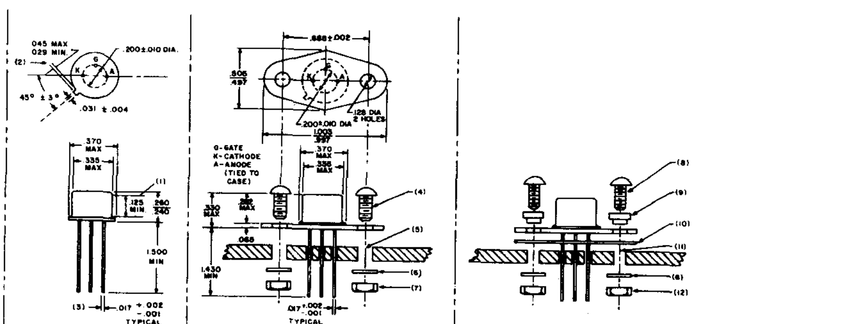
20. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM (DIAMOND BASE)



21. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM (DIAMOND BASE)

OUTLINE DRAWING

(1) This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.
(2) Measured from max. diameter of the actual device.
(3) The specified lead diameter applies in the zone between .050 and .250 from the base seat. Between .250 and 1.5 maximum of .021 diameter is held. Outside of these the lead diameter is not controlled. Leads may be inserted, without damage in .031 holes while device enters .371 hole concentric with lead hole circle.
(4) #4-40 screw, st'n steel " long
(5) .120 hole (#31 drill)
(6) Int tooth lockwasher, st'n steel
(7) #4-40 nut, st'n steel
(8) #2-56 screw, st'n steel ⅜" long
(9) Shoulder washer, vulcanized fiber
(10) Mica insulator, .003 thick
(11) .0935 hole (#42 drill)
(12) #2-56 nut, st'n steel
All dimensions in inches



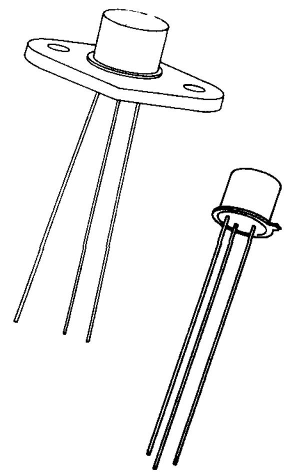
CONFORMS TO JEDEC TO-5 OUTLINE — DIAMOND BASE STANDARD MOUNTING — DIAMOND BASE INSULATED MOUNTING

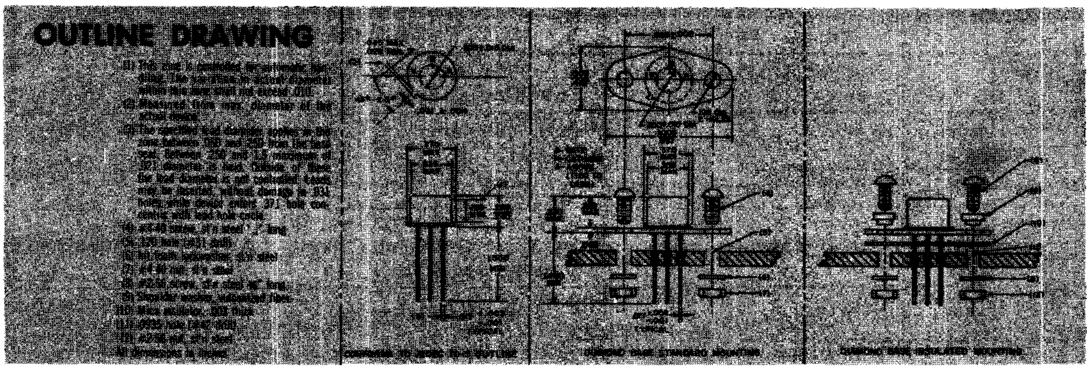
SCR

C6,C611

C7 SERIES SEE PAGE 3·33

For High Volume Light Industrial, Computer, and Consumer Applications
- **Low Cost**
- **All-diffused for Proved Reliability**
- **Popular Voltage Range—up to 200V**
- **Sensitive Gate (1 ma to Trigger)**
- **Standard TO-5 Package (C6) for Convenient Mounting**
- **Diamond Flange Option (C611) Simplifies Heat Dissipation**





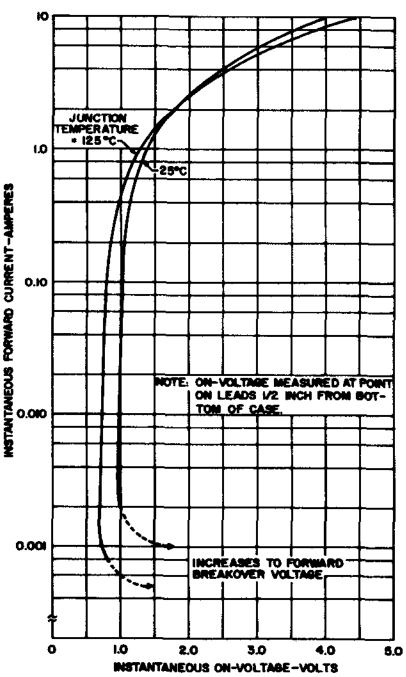
Types	Peak Forward Blocking Voltage, V_{FXM} $T_J = -40°C$ to $+125°C$ R_{GK} = 1000 OHMS	Working and Repetitive Peak Reverse Voltage V_{ROM}(wkg) and V_{ROM}(rep) $T_J = -40°C$ to $+125°C$	Non-Repetitive Peak Reverse Voltage, V_{ROM}(non-rep) (<5 Millisec.) $T_J = -40°C$ to $+125°C$
C6U, C611U	25 Volts	25 Volts	40 Volts
C6F, C611F	50 Volts	50 Volts	75 Volts
C6A, C611A	100 Volts	100 Volts	150 Volts
C6G, C611G	150 Volts	150 Volts	225 Volts
C6B, C611B	200 Volts	200 Volts	300 Volts

MAXIMUM ALLOWABLE RATINGS

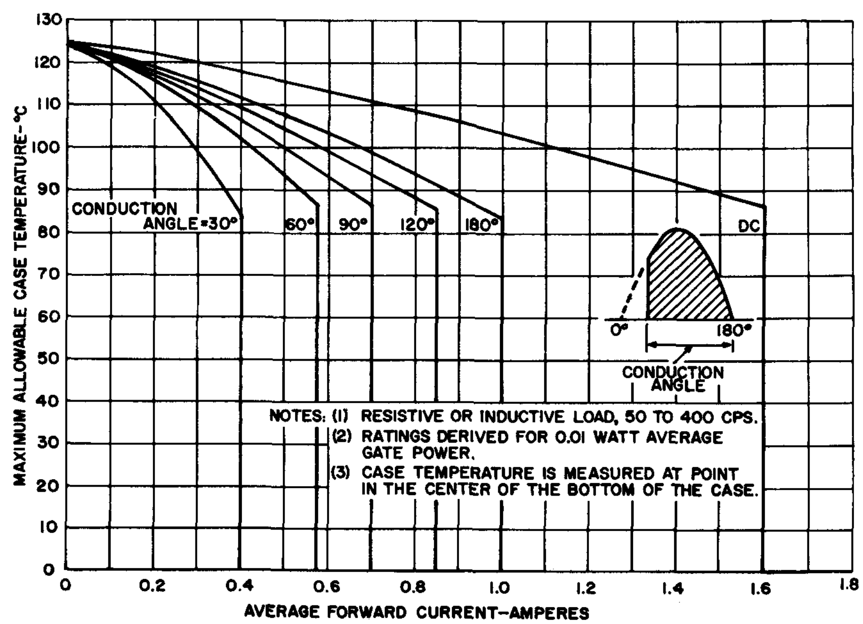
Peak Forward Voltage, PFV .... 300 Volts
RMS Forward Current, On-state (independent of conduction angle) .... 1.6 Amperes
Average Forward Current, On-state .... Depends on conduction angle (See Charts)
Peak One Cycle Surge Forward (Non-repetitive) Current, I_{FM} (surge) .... 10 Amperes
Peak Gate Power, P_{GM} .... 0.1 Watt
Average Gate Power, $P_{G(AV)}$ .... 0.01 Watt
Peak Gate Current, I_{GFM} .... 0.1 Ampere
Peak Gate Voltage, Forward & Reverse, V_{GFM} & V_{GRM} .... 6 Volts
Storage Temperature, T_{stg} .... −40°C to +150°C
Operating Temperature .... −40°C to +125°C
Peak non-recurrent surge forward current during turn-on time interval (Current rise time = 5.0 μsec Minimum) .... 40 Amperes

CHARACTERISTICS

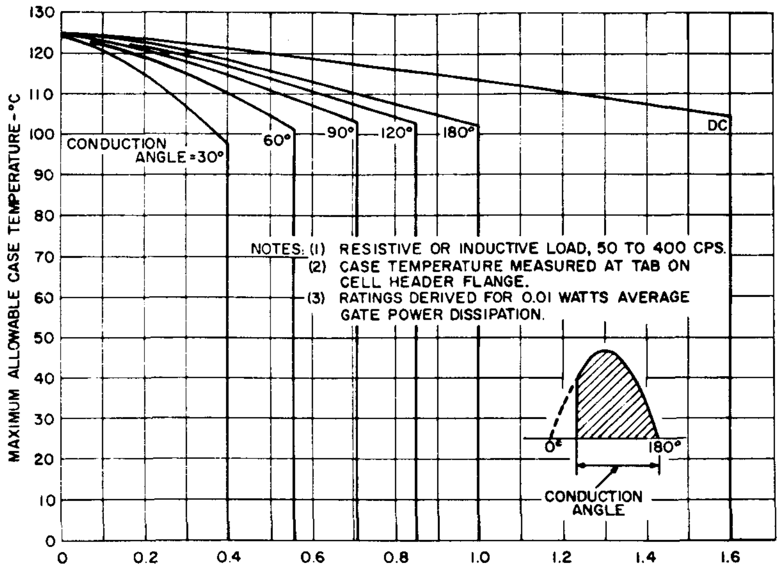
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Forward Breakover Voltage	$V_{(BR)FX}$				Volts	$T_J = -40°C$ to $+125°C$ $R_{GK} = 1000$ ohms Sinusoidal Waveform, 50 to 400 CPS
C6U, C611U		25	....	....		
C6F, C611F		50	....	....		
C6A, C611A		100	....	....		
C6G, C611G		150	....	....		
C6B, C611B		200	....	....		
Reverse or Forward Blocking Current	I_{RX} or I_{FX}					$V_{RX} = V_{FX} =$ Rated $V_{ROM}(rep)$ Value
		....	2.0	100	μAdc	$T_J = 25°C$, $R_{GK} = 1000$ ohms
		....	40	100	μAdc	$T_J = 125°C$, $R_{GK} = 1000$ ohms
Gate Trigger Current	I_{GT}	....	0.2	1.0	mAdc	$T_J = 25°C$, $V_{FX} = 6Vdc$, $R_L = 100$ ohms
Gate Trigger Voltage	V_{GT}	0.35	0.5	0.8	Vdc	$R_L = 100$ ohms, $R_G = 1000$ ohms $T_J = 25°C$, $V_{FX} = 6Vdc$
		....	0.7	1.0	Vdc	$T_J = -40°C$, $V_{FX} = 6Vdc$
		0.1	0.25	0.8	Vdc	$T_J = 125°C$, $V_{FX} =$ Rated V_{FXM} Value.
Peak On-Voltage	V_{FM}	....	1.2	1.4	V	$T_J = 25°C$, $I_{FM} = 1.0A$, Single Half Sine Wave Pulse, 2.0 Millisec. Wide
Holding Current	I_{HX}	....	1.0	5.0	mAdc	$R_{GK} = 1000$ ohms $T_J = 25°C$, $R_L = 10K$ ohms
		0.15	0.4	....	mAdc	$T_J = 125°C$, $R_L = 50K$ ohms
Turn-On Time	$t_d + t_r$	....	1.4	....	μsec	$T_J = 25°C$, $I_F = 1.0A$, $V_{FX} =$ Rated V_{FXM} Value. Supply: 6 Volt Open Circuit, 330 ohm Load Line, 0.1 μsec Rise Time.
Circuit-Commutated Turn-off Time	t_{off}	....	40	....	μsec	$T_J = 125°C$, $I_{FM} = 1.0A$, I_R (Recovery) $= 1.0A$, Reapplied $V_{FXM} =$ Rated V_{FXM} Value, Rate of Rise of Reapplied $V_{FXM} =$ 20 Volts per μsec, $R_{GK} = 100$ ohms.
Thermal Resistance, C6, Junction to Ambient	θ_{J-A}	....	....	160	°C/watt	Steady State
C611, Junction to Case	θ_{J-C}	....	....	10	°C/watt	Steady State



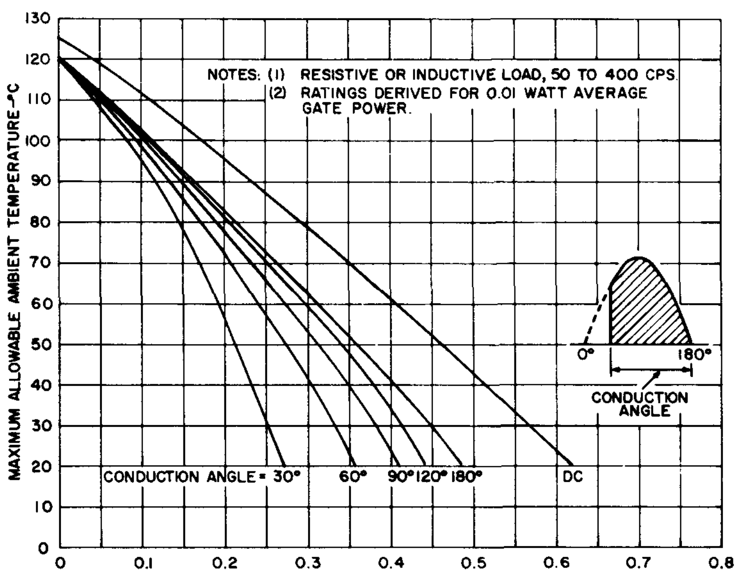
1. MAXIMUM FORWARD CHARACTERISTICS—ON-STATE



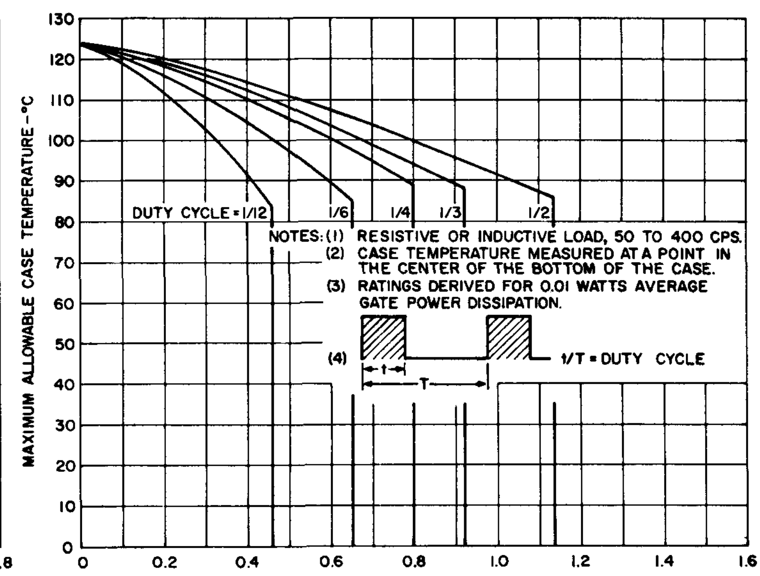
2. C6—MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



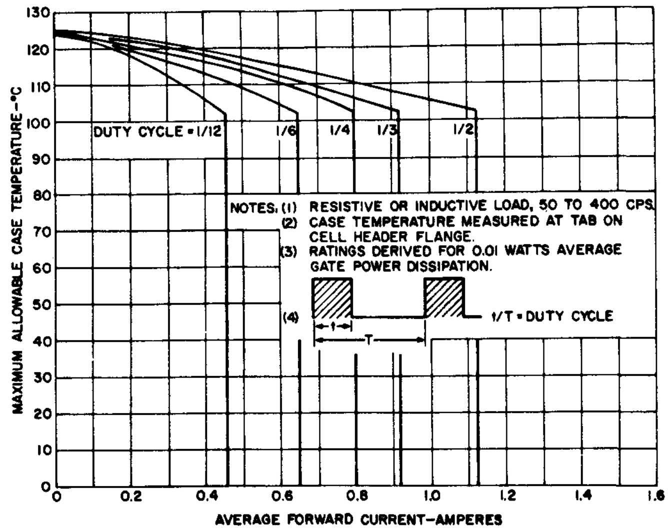
3. C611—MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



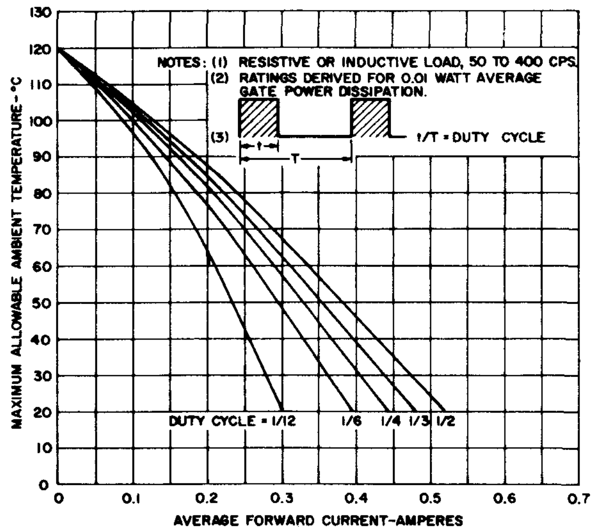
4. C6—MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



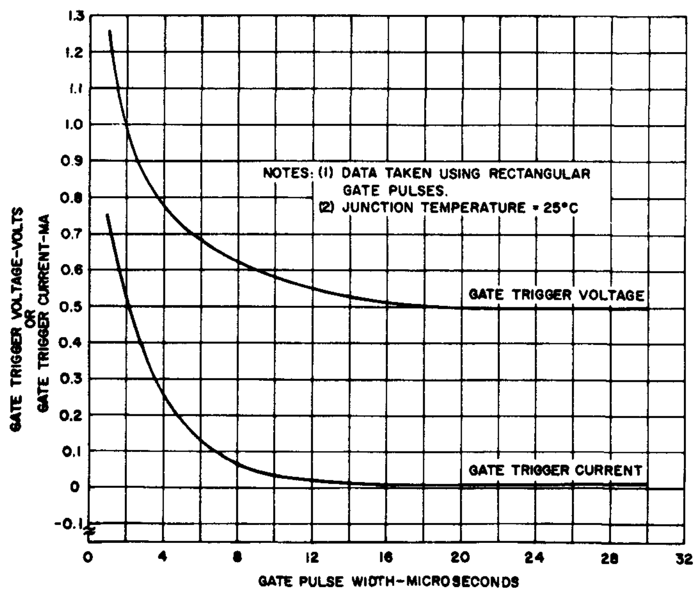
5. C6—MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



6. C611—MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



7. C6—MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



8. TYPICAL VARIATION OF GATE TRIGGER VOLTAGE AND CURRENT WITH GATE PULSE WIDTH

SCR

C10 SERIES

2N1770A-2N1777A

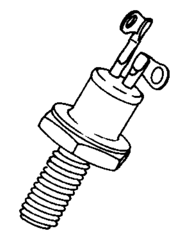
The General Electric C10 Series (2N1770A-2N1777A) Silicon Controlled Rectifier is a reverse blocking triode thyristor semiconductor for use in low power switching and phase control applications requiring blocking voltages up to 400 volts, and RMS load currents up to 7.4 amperes.

This series device is designed to meet MIL-S-19500/168 , and has full blocking voltage ratings from −65°C to +150°C.

The following G. E. Co., low-current SCR types are also available in the same package outline:

C11 (2N1770-2N1778, 2N2619) (Pub. #150.21)—T_J = 125°C, up to 600V PRV

C15 (Pub. #150.22)—T_J = 105°C, up to 600V PRV



MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} $T_C = -65°C$ to $+150°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep)(1) $T_C = -65°C$ to $+150°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE (<5.0 MILLISEC.), V_{ROM} (non-rep)(1) $T_C = -65°C$ to $+150°C$
C10U (2N1770A)	25 Volts*	25 Volts*	35 Volts*
C10F (2N1771A)	50 Volts*	50 Volts*	75 Volts*
C10A (2N1772A)	100 Volts*	100 Volts*	150 Volts*
C10G (2N1773A)	150 Volts*	150 Volts*	225 Volts*
C10B (2N1774A)	200 Volts*	200 Volts*	300 Volts*
C10H (2N1775A)	250 Volts*	250 Volts*	350 Volts*
C10C (2N1776A)	300 Volts*	300 Volts*	400 Volts*
C10D (2N1777A)	400 volts*	400 Volts*	500 Volts*

(1) Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply = 18°C per watt.

Peak Forward Voltage, PFV	480 volts
RMS Forward Current, On-State	7.4 amperes (all conduction angles)
Average Forward Current, On-State, Half Sine Wave, I_O	4.7 amperes at T_C = 105°C*
Average Forward Current, On-State	Depends on conduction angle (see Chart 3, 5 and 7)
Peak One-cycle Surge Forward Current, I_{FM} (surge)	60 amperes*
I^2t (for fusing)	Calculate from Chart 9
Turn-On Current Limit	See Chart 10
Peak Gate Power Dissipation, P_{GM}	5 watts*
Average Gate Power Dissipation, $P_{G\ (AV)}$	0.5 watts*
** Peak Gate Current, I_{GFM}	2 amperes*
** Peak Gate Voltage, Forward and Reverse, V_{GFM} and V_{GRM}	10 volts*
Storage Temperature, T_{stg}	−65°C to +150°C*
Operating Temperature, T_J	−65°C to +150°C*
Stud Torque	15 lb-in (17 kg-cm)

*Indicates data included on JEDEC type number registration.

**NOT TO EXCEED GATE POWER RATINGS

CHARACTERISTICS

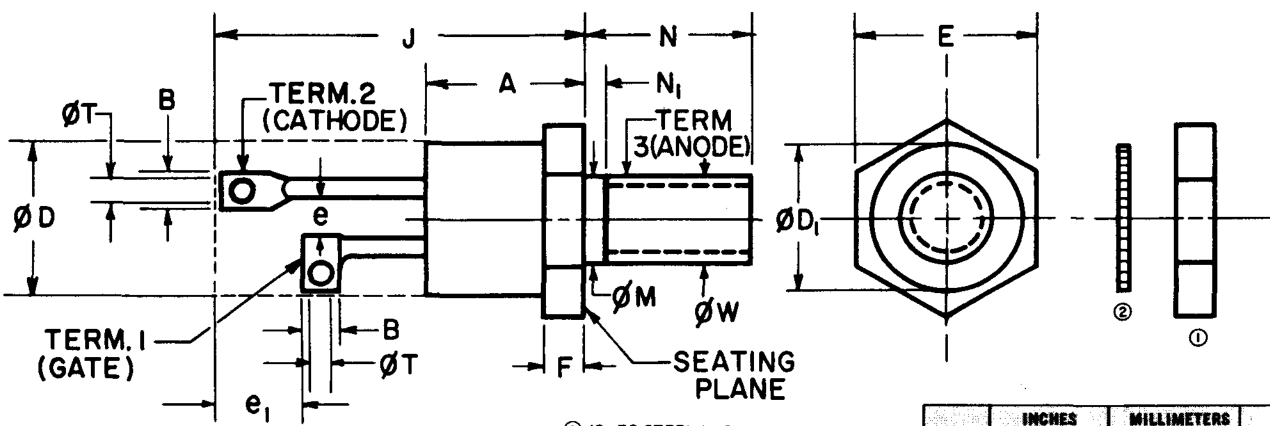
TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE OR FORWARD BLOCKING CURRENT†	I_{ROM} or I_{FOM}			mA	$T_C = -65°C$ to $+150°C$
C10U (2N1770A)		—	9.0		$V_{ROM} = V_{FOM} =$ 25V Peak
C10F (2N1771A)		—	9.0		$V_{ROM} = V_{FOM} =$ 50V Peak
C10A (2N1772A)		—	9.0		$V_{ROM} = V_{FOM} =$ 100V Peak
C10G (2N1773A)		—	8.0		$V_{ROM} = V_{FOM} =$ 150V Peak
C10B (2N1774A)		—	6.0		$V_{ROM} = V_{FOM} =$ 200V Peak
C10H (2N1775A)		—	5.0		$V_{ROM} = V_{FOM} =$ 250V Peak
C10C (2N1776A)		—	4.0		$V_{ROM} = V_{FOM} =$ 300V Peak
C10D (2N1777A)		—	2.0		$V_{ROM} = V_{FOM} =$ 400V Peak
FULL CYCLE AVG. REVERSE OR FORWARD BLOCKING CURRENT†	$I_{RX\ (AV)}$ or $I_{FX\ (AV)}$			mA	$T_C = +105°C$, $I_o = 4.7A$ 180° Conduction Angle
C10U (2N1770A)		—	4.5*		$V_{RXM} = V_{FXM} =$ 25V Peak
C10F (2N1771A)		—	4.5*		$V_{RXM} = V_{FXM} =$ 50V Peak
C10A (2N1772A)		—	4.5*		$V_{RXM} = V_{FXM} =$ 100V Peak
C10G (2N1773A)		—	4.0*		$V_{RXM} = V_{FXM} =$ 150V Peak
C10B (2N1774A)		—	3.0*		$V_{RXM} = V_{FXM} =$ 200V Peak
C10H (2N1775A)		—	2.5*		$V_{RXM} = V_{FXM} =$ 250V Peak
C10C (2N1776A)		—	2.0*		$V_{RXM} = V_{FXM} =$ 300V Peak
C10D (2N1777A)		—	1.0*		$V_{RXM} = V_{FXM} =$ 400V Peak
GATE TRIGGER CURRENT	I_{GT}	—	15	mAdc	$T_C = +25°C$, $V_{FX} = 12$ Vdc, $R_L = 250$ ohms
		—	30*	mAdc	$T_C = -65°C$, $V_{FX} = 12$ Vdc, $R_L = 250$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	—	2.0*	Vdc	$T_C = -65°C$ to $+150°C$, $V_{FX} = 12$ Vdc, $R_L = 250$ ohms
		0.2*	—	Vdc	$T_C = +150°C$, $V_{FXM} =$ Rated V_{FOM}, $R_L = 250$ ohms
PEAK ON-VOLTAGE	V_{FM}	—	1.85	V	$T_C = +25°C$, $I_{FM} = 15A$ Peak, 1 millisecond wide pulse. Duty cycle $\leq 1\%$.
HOLDING CURRENT	I_{HO}	—	25	mAdc	$T_C = +25°C$, Anode supply = 24 Vdc, Gate Supply = 7V, 20 ohms. Initial forward current pulse = 0.5A, 0.1 millisecond to 10 milliseconds wide.
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	—	3.1	°C/watt	Junction to case.

†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 18°C/watt.

*Indicates data included on JEDEC type number registration.

OUTLINE DRAWING

(Complies with JEDEC registered TO-64 outline)

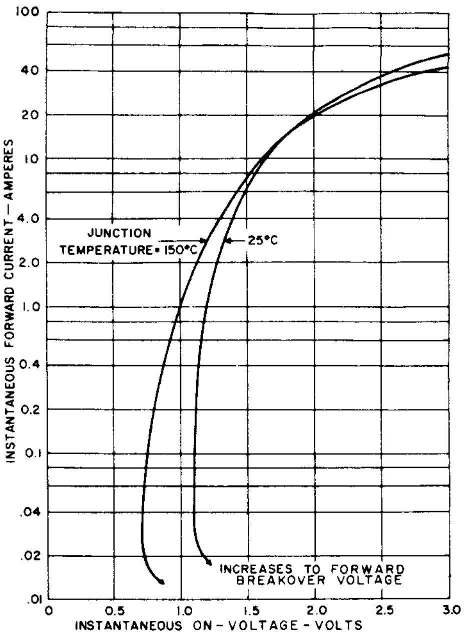


① 10-32 STEEL NUT CADMIUM PLATED

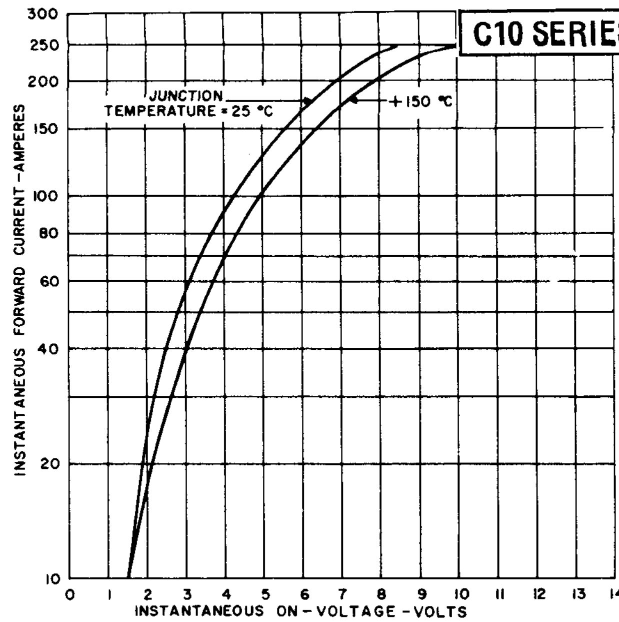
② LOCKWASHER, CADMIUM PLATED STEEL

NOTES:
(1) Contour and orientation of fixed terminal lugs are optional.
(2) The outline contour (with exception of hexagon) is optional within zone defined by φD and J.
(3) Minimum diameter of seating plane.
(4) A chamfer (or undercut) on one or both ends of hexagonal portion is optional.
(5) Minimum difference in terminal lengths to establish datum line for numbering terminals.
(6) Pitch diameter—thread 10-32 NF-2A (Coated). Reference (Screw Thread Standards for Federal Services 1957) Handbook 1957 H28.
(7) Minimum spacing between terminals.
(8) Insulating kit available upon request.

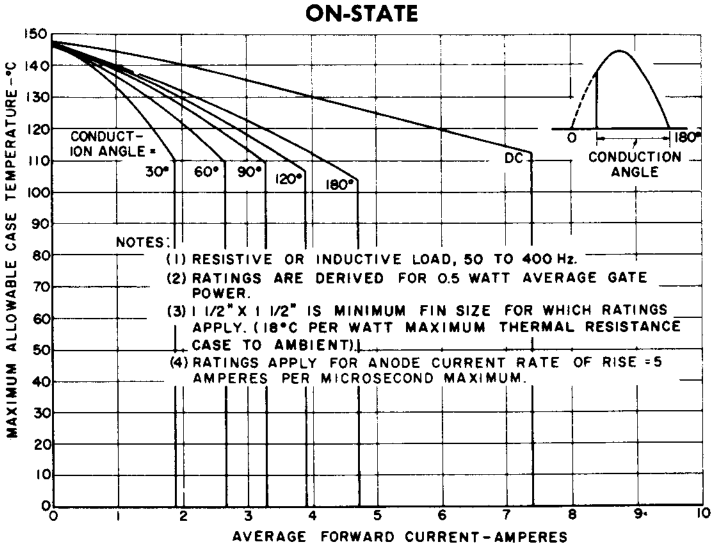
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.300	.400	7.62	10.16	
B	.080	.136	2.03	3.45	1
φD		.424		10.77	2
φD1	.400		10.16		3, 4
E	.424	.437	10.77	11.10	
e	.013		.330		7
e1	.060		1.52		5
F	.060	.175	1.52	4.45	4
J	.700	.855	17.78	21.72	2
φM	.163	.189	4.14	4.80	
N	.400	.453	10.16	11.51	
N1		.078		1.98	
φT	.040	.075	1.02	1.91	
φW	.1658	.1697	4.212	4.310	6



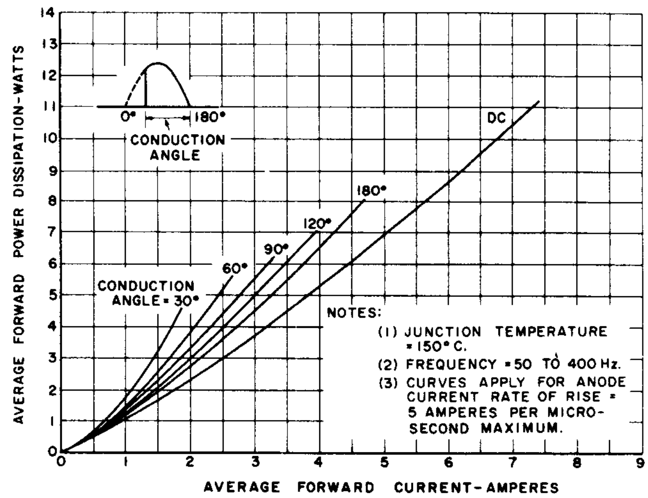
1 MAXIMUM FORWARD CHARACTERISTICS— ON-STATE



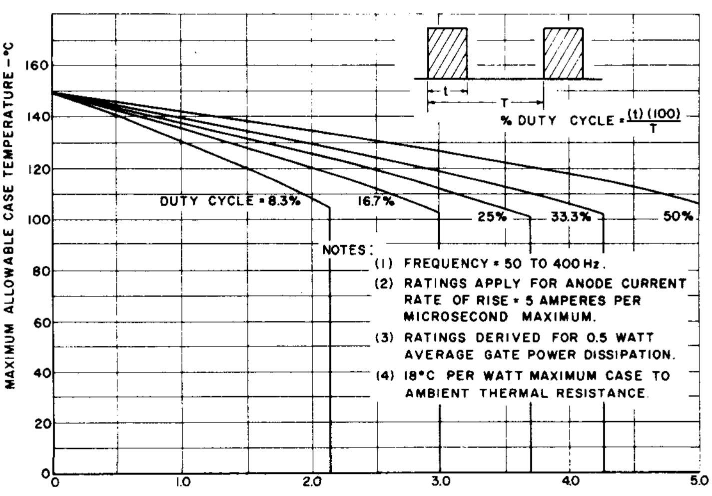
2 MAXIMUM FORWARD CHARACTERISTICS, HIGH CURRENT LEVEL—ON-STATE



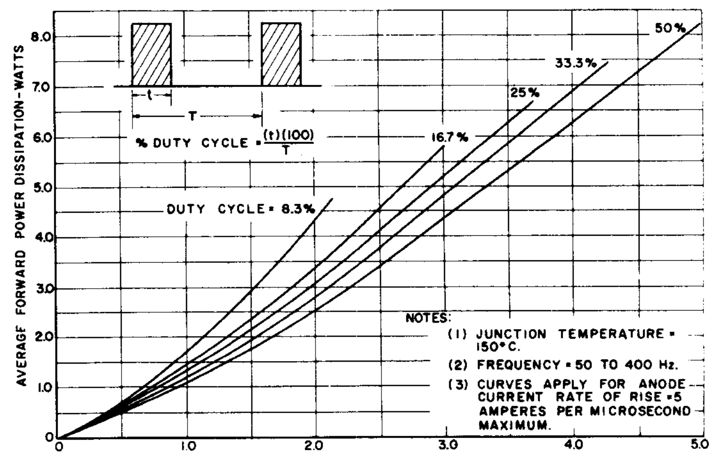
3 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



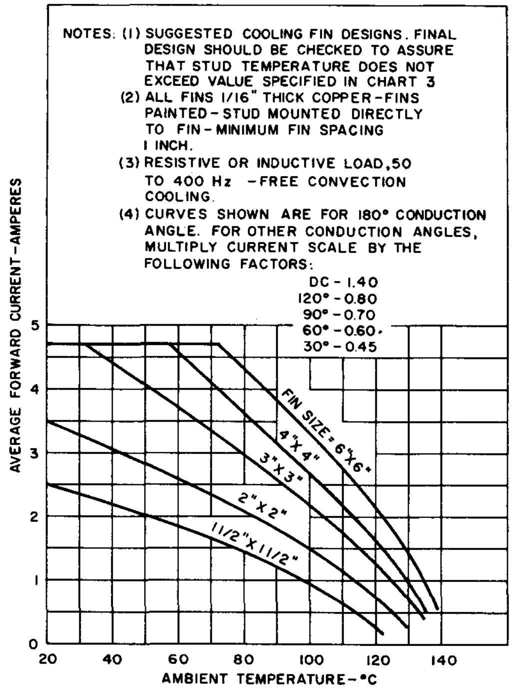
4 FORWARD POWER DISSIPATION FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



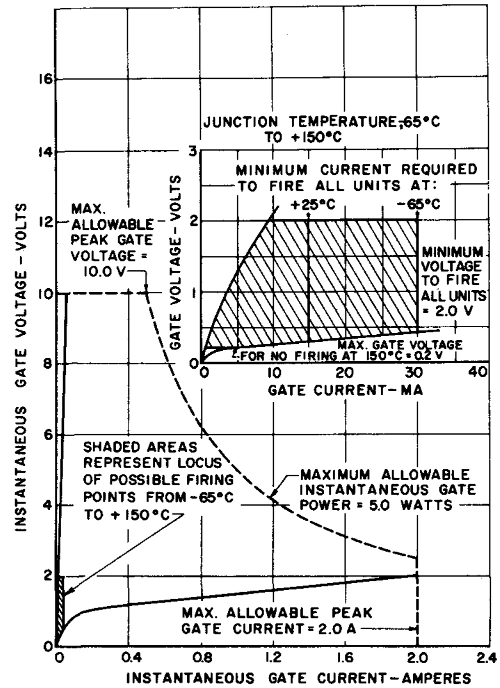
5 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



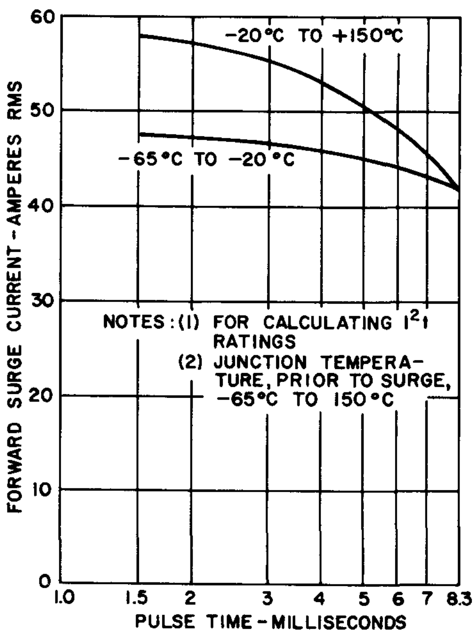
6 FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



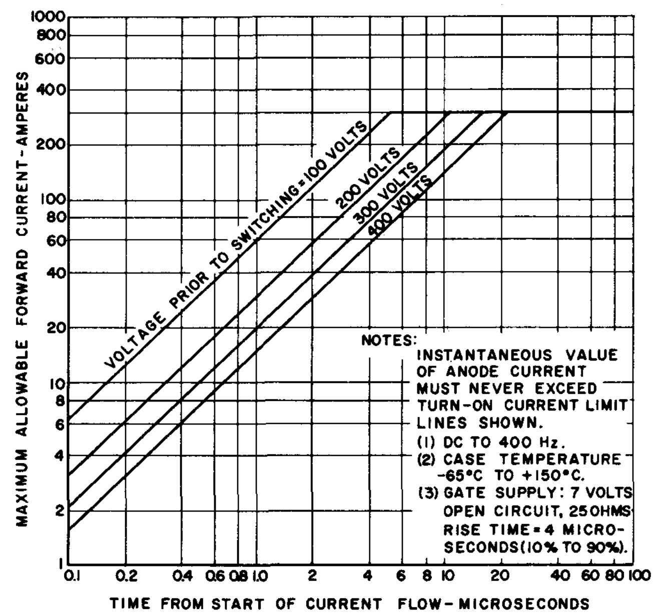
7 MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES



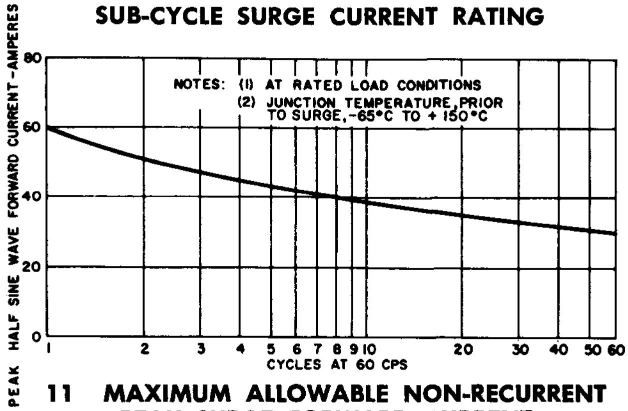
8 TRIGGERING CHARACTERISTICS



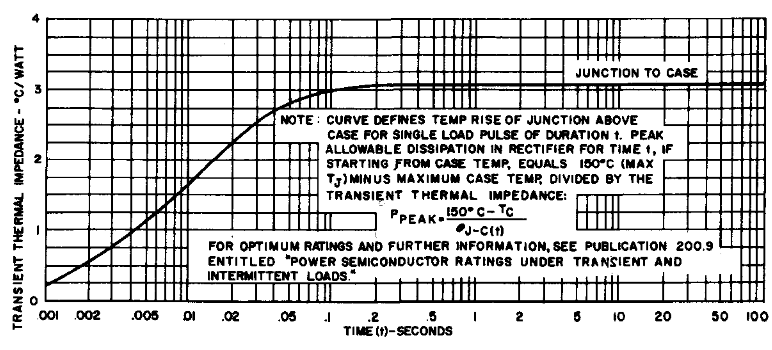
9 MAXIMUM ALLOWABLE NON-RECURRENT SUB-CYCLE SURGE CURRENT RATING



10 TURN-ON CURRENT LIMIT

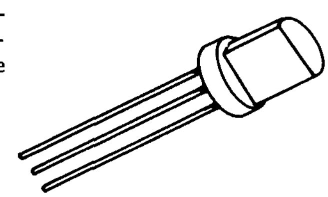


11 MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE FORWARD CURRENT



12 MAXIMUM TRANSIENT THERMAL IMPEDANCE

The General Electric C13 Complementary Silicon Controlled Rectifier (CSCR) is a three-terminal, planar-passivated PNPN device in the standard, low-cost plastic TO-98 JEDEC package. As CSCR's, the C13F and the C13Y offer greater flexibility in circuit design through the use of the anode gate. The three leads are designatd as anode, anode gate and cathode.

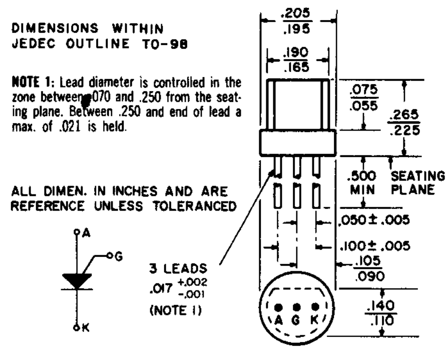


Outstanding Features

- Planar Passivated Structure
- Low Leakage Current
- Low Triggering Current
- Low Forward Voltage Drop
- Low Cost
- High Gate Breakdown Voltage

Applications

- Automotive Switching
- SCR Triggering
- Low Level Logic
- Memory Circuits
- Ring Counters
- Level Detectors
- Fuse Circuits
- Miniature Lamp Drivers



The C13 CSCR operates similarly to the conventional SCR. The major difference is that the device is turned on by forward biasing the junction between the anode and the anode gate. The voltage on the anode gate is made negative with respect to the voltage on the anode. "Conventional" SCR's are turned on by injecting current into the lower p-base (cathode gate), while those that are turned on through the upper n-base (anode gate) are called "complementary" SCR's. A four-terminal, Silicon Controlled Switch (SCS) has connections to both bases and either, or both, bases may be used to initiate switching.

MAXIMUM ALLOWABLE RATINGS

Types	Peak Forward Blocking Voltage, V_{DWM} (R_{GA} = 1K)	Working and Repetitive Peak Reverse Voltage, V_{RWM} & V_{RRM} (Open Gate)	Non-Repetitive Peak Reverse Voltage, V_{RSM} (Open Gate)
C13Y	30 volts	30 volts	30 volts
C13F	50 volts	50 volts	50 volts

*Reverse Blocking Voltage, V_{RM} (Finite gate resistance) .... 5 Volts
Continuous Forward Current, I_{TM} .... 250 Milliamperes
Peak Forward Current, I_{TRM} (10 μsec., 1% Duty Cycle, 100°C) .... 3 Amperes
Peak Forward Current, I_{TRM} (100 μsec., 1% Duty Cycle, 100°C) .... 1 Ampere
Peak Forward Surge Current, I_{TSM} (non-repetitive, 5 μsec., 25°C) .... 10 Amperes
Peak Forward Gate Current, I_{GM} .... 50 Milliamperes
Peak Reverse Gate Current, I_{GM} .... 50 Milliamperes
Peak Reverse Gate Voltage, V_{GM} .... 30 Volts
Average Gate Power Dissipation, $P_{G(AV)}$ .... 10 Milliwatts
Storage Temperature, T_{STG} .... −65°C to +150°C
Operating Temperature .... −55°C to +100°C
Total Power, P_T (Derate linearly to 0 at 100°C) .... 450 mW

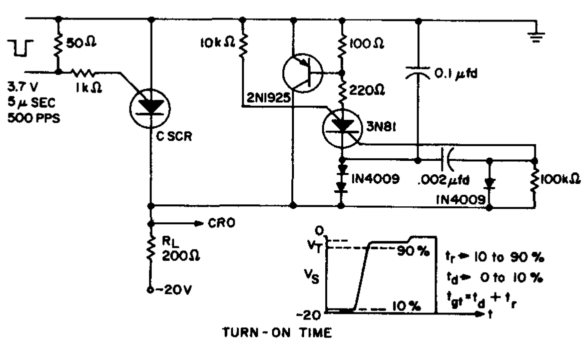
*When used on AC operation with finite gate resistance, a diode must be added in series with the cathode to absorb the reverse voltage.

CHARACTERISTICS

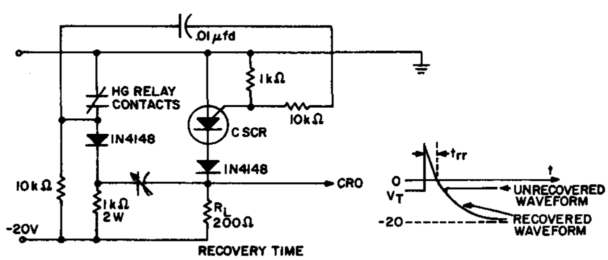
(at 25°C, unless otherwise noted)

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Forward Blocking Current	I_D	—	.01	0.10	μA	V_D = rated, R_G = 1K
		—	0.10	100		V_D = rated, R_G = 1K, T_A = 100°C
Reverse Blocking Current	I_R	—	.001	0.10		V_R = rated, Open Gate
		—	.10	100		V_R = rated, Open Gate, T_A = 100°C
Gate Trigger Current*	I_{GT}	—	.05	—		V_D = 6 volts, R_L = 100 ohms
		—	2.0	20		V_D = 6 volts, R_L = 100 ohms, T_A = −55°C
Gate Trigger Voltage**	V_{GT}	—	0.45	0.60	Volts	V_D= 6 volts, R_L = 100 ohms
		—	0.25	0.40		V_D= 6 volts, R_L = 100 ohms, T_A = 100°C
Forward Voltage Drop	V_T	—	1.4	1.8		I_T = 250mA
		—	1.4	—		I_T = 250 mA, T_A = 100°C
Holding Current	I_H	—	0.70	—	mA	R_G = 1K
		—	0.42	—		R_G = 1K, T_A = 100°C
Turn-On Time	t_{gt}	—	—	0.10	μsec	see Circuit A
Recovery Time	t_{rr}	—	—	10		see Circuit B

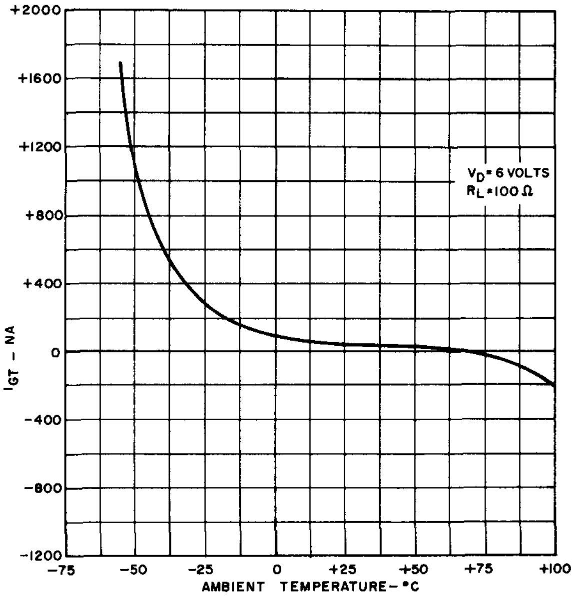
*I_{GT} measured using current source. **V_{GT} measured using voltage source.



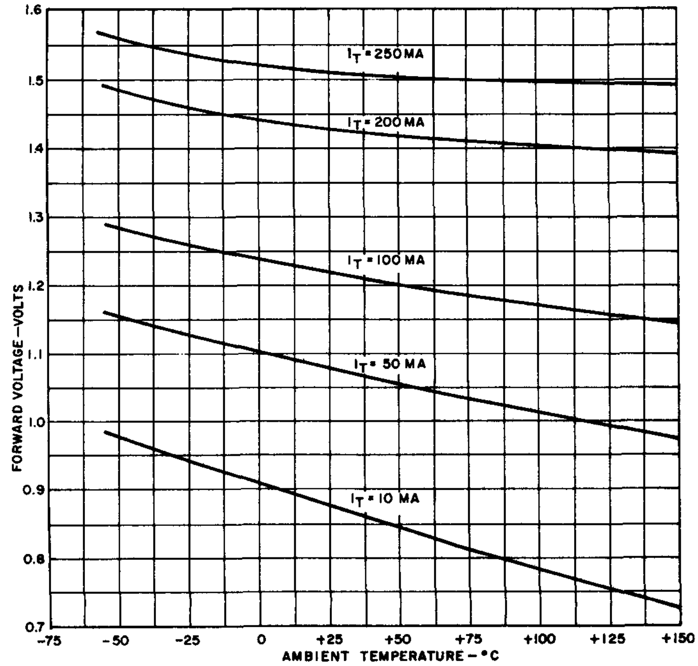
CIRCUIT A



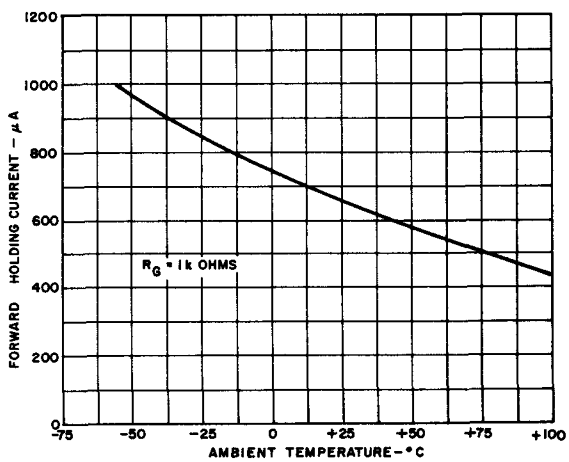
CIRCUIT B



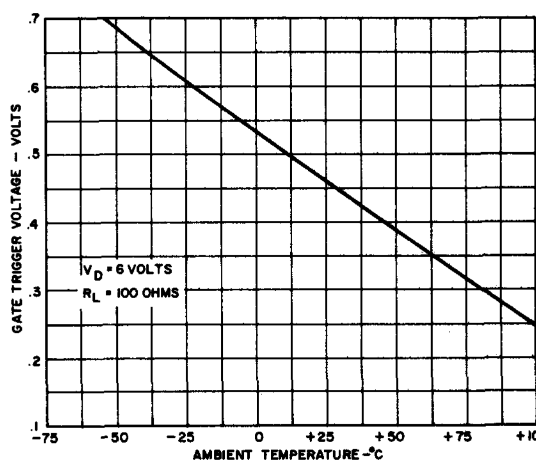
1. **TYPICAL GATE TRIGGER CURRENT vs. AMBIENT TEMPERATURE**



2. **TYPICAL FORWARD BLOCKING VOLTAGE AND ANODE CURRENT vs. AMBIENT TEMPERATURE**

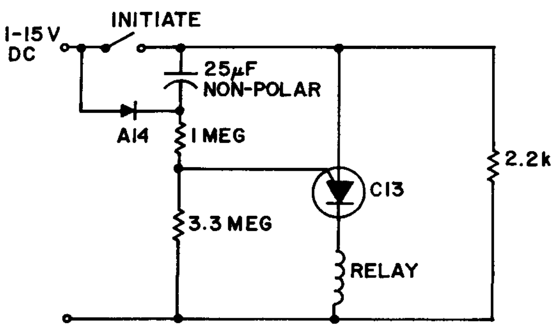


3. **TYPICAL FORWARD HOLDING CURRENT vs. AMBIENT TEMPERATURE**



4. **TYPICAL GATE TRIGGER VOLTAGE vs. AMBIENT TEMPERATURE**

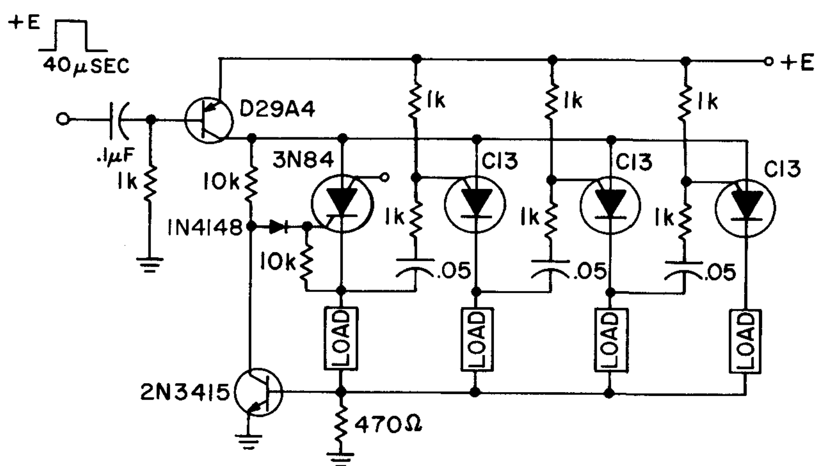
APPLICATIONS



TIME DELAY 40–60 SECS WITH COMPONENTS SHOWN

C13 DOUBLES AS TIMING THRESHOLD AND LOAD DRIVER

This circuit is an interesting twist in timers. Here the C13 is used as both the sensitive timing element *and* the load driver. Power is applied to the circuit with the initiate switch open circuited. The 25μF capacitor charges through the A14 diode and 2.2K resistor to full supply voltage. When the initiate switch is closed, the "low" side of the capacitor is suddenly raised to +12. This raises the diode side of the capacitor to approximately +24. The capacitor immediately begins discharging through the 1 meg in series with 3.3 megs. Eventually, the C13 gate becomes forward biased and the device turns on thereby applying power to the relay. The delay is virtually independent of supply voltage.



LOW COST RING COUNTER

C13's can also be used for ordinary thyristor applications. This ring counter makes an efficient, low cost circuit featuring automatic resetting via the first stage 3N84. As many stages as desired may be cascaded.

SCR

C15 SERIES

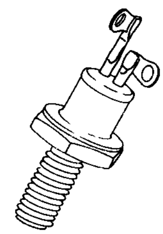
The General Electric C15 Series Silicon Controlled Rectifier is a reverse blocking triode thyristor semiconductor device for use in power switching and phase control applications requiring blocking voltages up to 600 volts, and RMS load currents up to 8.0 amperes.

This series device is particularly suitable for high-volume, consumer/industrial applications.

The following G. E. Co., low-current SCR types are also available in the same package outline:

C10 (2N1770A-2N1777A) (Pub. #150.20)—$T_J = 150°C$, up to 400V PRV
(JAN Types 2N1770A-2N1777A to MIL-S-19500/168B also available)

C11 (2N1770-2N1778, 2N2619) (Pub. #150.21)—$T_J = 125°C$, up to 600V PRV



MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} $T_C = -65°C$ to $+105°C$	PEAK FORWARD VOLTAGE, PFV $T_C = -65°C$ to $+105°C$	WORKING AND REPETITIVE PEAK REVERSE VOLTAGE V_{ROM} (wkg) and V_{ROM} (rep)(1) $T_C = -65°C$ to $+105°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (non-rep) (<5 Millisec.)(1) $T_C = -65°C$ to $+105°C$
C15U	25 volts	480 volts	25 volts	40 volts
C15F	50 volts	480 volts	50 volts	75 volts
C15A	100 volts	480 volts	100 volts	150 volts
C15G	150 volts	480 volts	150 volts	220 volts
C15B	200 volts	480 volts	200 volts	300 volts
C15C	300 volts	480 volts	300 volts	400 volts
C15D	400 volts	480 volts	400 volts	500 volts
C15E	500 volts	600 volts	500 volts	600 volts
C15M	600 volts	720 volts	600 volts	720 volts

(1) Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 18°C per watt.

RMS Forward Current, On-State .... 8.0 amperes (all conduction angles)
Average Forward Current, On-State .... 3.0 amperes at 75°C case (half-wave rectified)
5.0 amperes at 75°C case (full-wave rectified)
(See Charts 3 and 5)
Peak One Cycle Surge Forward Current, I_{FM} (surge) .... 60 amperes
I^2t (for fusing) .... (Calculate from Chart 8)
Peak Gate Power Dissipation, P_{GM} .... 5 watts
Average Gate Power Dissipation, P_G (AV) .... 0.5 watts
Peak Reverse Gate Voltage, V_{GRM} .... 10 volts
Storage Temperature, T_{stg} .... −65°C to +150°C
Operating Temperature, T_J .... −65°C to +105°C
Stud Torque .... 15 lb-in (17 kg-cm)

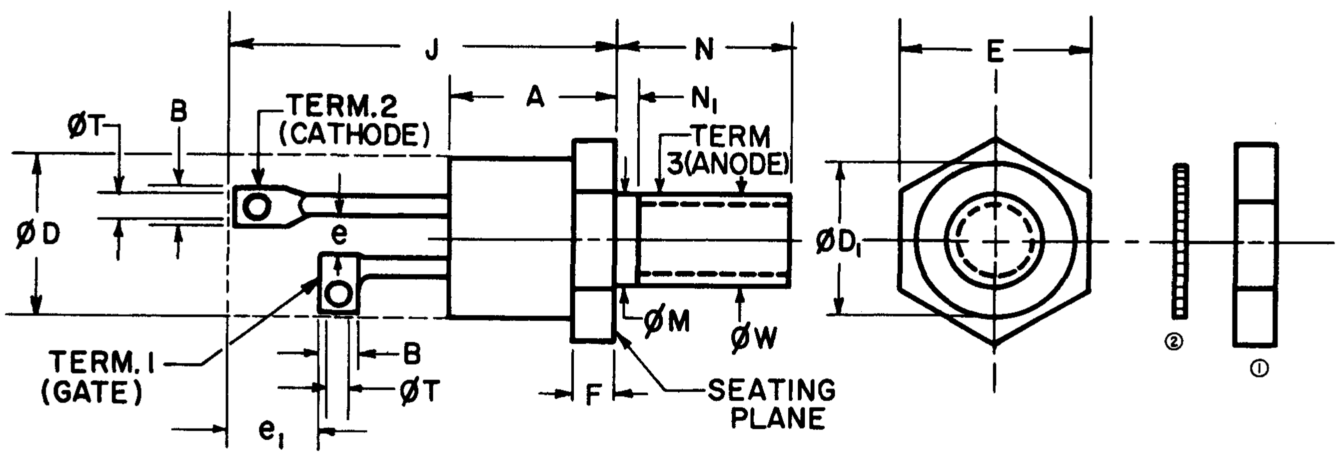
CHARACTERISTICS

TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE OR FORWARD BLOCKING CURRENT[(1)]	I_{ROM} or I_{FOM}			mA	$T_C = -65°C$ to $+105°C$
C15U		—	9.0		$V_{ROM} = V_{FOM} =$ 25V Peak
C15F		—	9.0		$V_{ROM} = V_{FOM} =$ 50V Peak
C15A		—	9.0		$V_{ROM} = V_{FOM} =$ 100V Peak
C15G		—	8.0		$V_{ROM} = V_{FOM} =$ 150V Peak
C15B		—	6.0		$V_{ROM} = V_{FOM} =$ 200V Peak
C15C		—	4.0		$V_{ROM} = V_{FOM} =$ 300V Peak
C15D		—	2.0		$V_{ROM} = V_{FOM} =$ 400V Peak
C15E		—	2.0		$V_{ROM} = V_{FOM} =$ 500V Peak
C15M		—	2.0		$V_{ROM} = V_{FOM} =$ 600V Peak
GATE TRIGGER CURRENT	I_{GT}	—	25	mAdc	$T_C = +25°C$, $V_{FX} = 6$ Vdc, $R_L = 125$ ohms
		—	50	mAdc	$T_C = -65°C$, $V_{FX} = 6$ Vdc, $R_L = 125$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	—	2.5	Vdc	$T_C = -65°C$ to $+105°$ C, $V_{FX} = 6$ Vdc, $R_L = 125$ ohms
		0.3	—	Vdc	$T_C = +105°C$, $V_{FXM} =$ Rated V_{FOM}, $R_L = 250$ ohms
PEAK ON-VOLTAGE	V_{FM}	—	1.85	V	$T_C = +25°C$, $I_{FM} = 15A$ Peak, 1 millisecond wide pulse. Duty cycle $\leqq 1\%$.
HOLDING CURRENT	I_{HO}	—	30	mA	$T_C = +25°C$, Anode supply = 24 Vdc, Gate Supply = 7V, 20 ohms. Initial forward current pulse = 0.5A, 0.1 millisecond to 10 milliseconds wide.
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	—	3.1	°C/watt	Junction to case.

(1) Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 18°C/watt.

OUTLINE DRAWING

(Complies with JEDEC registered TO-64 outline)

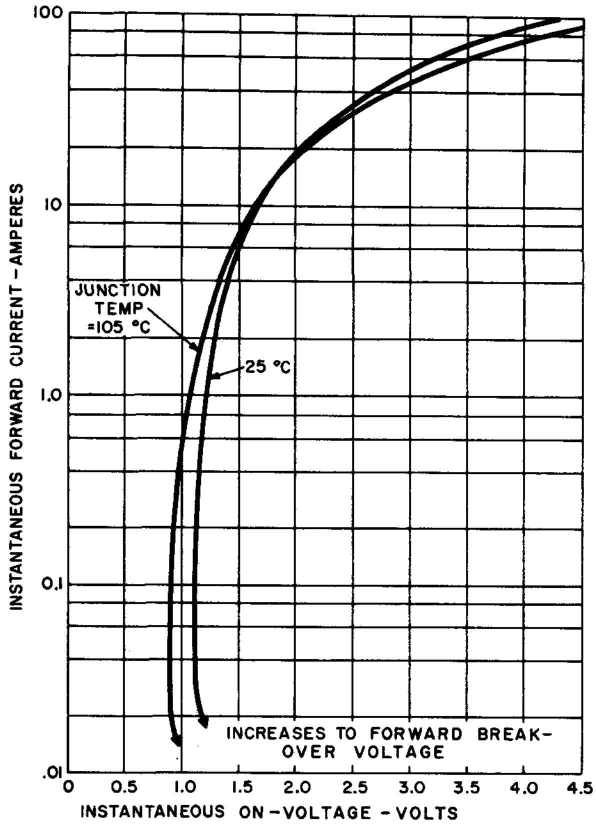


① 10-32 STEEL NUT CADMIUM PLATED

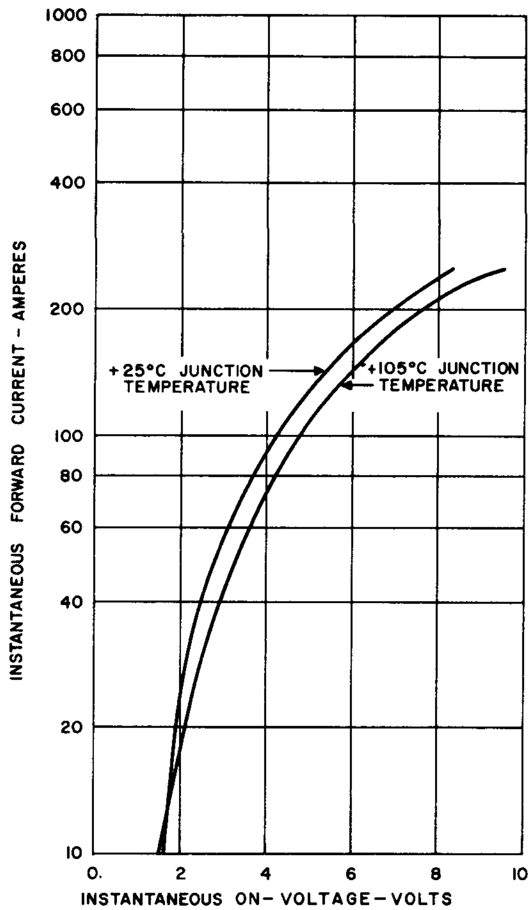
② LOCKWASHER, CADMIUM PLATED STEEL

NOTES:
(1) Contour and orientation of fixed terminal lugs are optional.
(2) The outline contour (with exception of hexagon) is optional within zone defined by ϕD and J.
(3) Minimum diameter of seating plane.
(4) A chamfer (or undercut) on one or both ends of hexagonal portion is optional.
(5) Minimum difference in terminal lengths to establish datum line for numbering terminals.
(6) Pitch diameter—thread 10-32 NF-2A (Coated). Reference (Screw Thread Standards for Federal Services 1957) Handbook 1957 H28.
(7) Minimum spacing between terminals.
(8) Insulating kit available upon request.

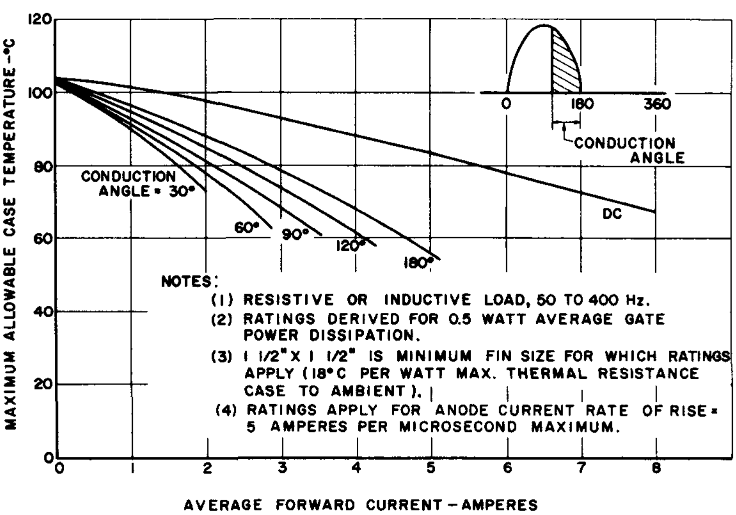
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.300	.400	7.62	10.16	
B	.080	.136	2.03	3.45	1
ϕD		.424		10.77	2
ϕD_1	.400		10.16		3, 4
E	.424	.437	10.77	11.10	
e	.013		.330		7
e_1	.060		1.52		5
F	.060	.175	1.52	4.45	4
J	.700	.855	17.78	21.72	2
ϕM	.163	.189	4.14	4.80	
N	.400	.453	10.16	11.51	
N_1		.078		1.98	
ϕT	.040	.075	1.02	1.91	
ϕW	.1658	.1697	4.212	4.310	6



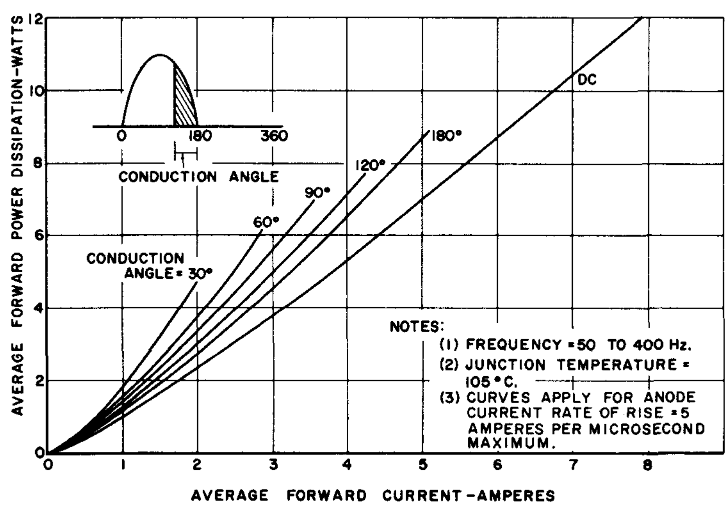
1 MAXIMUM FORWARD CHARACTERISTICS— ON-STATE



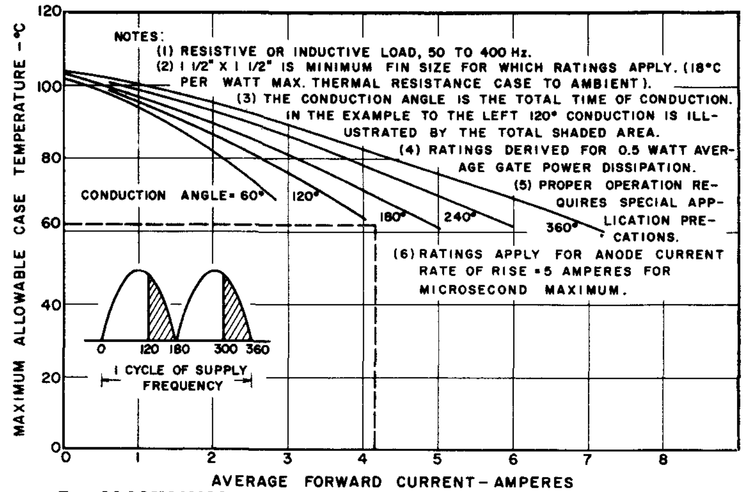
2 MAXIMUM FORWARD CHARACTERISTICS, HIGH CURRENT LEVEL—ON-STATE



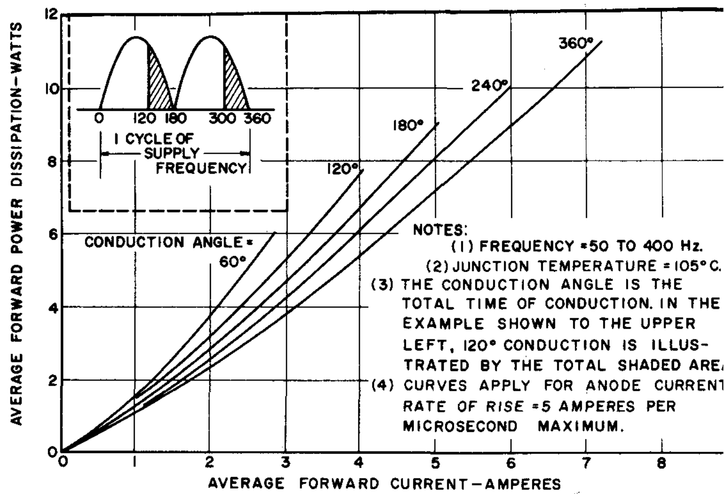
3 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



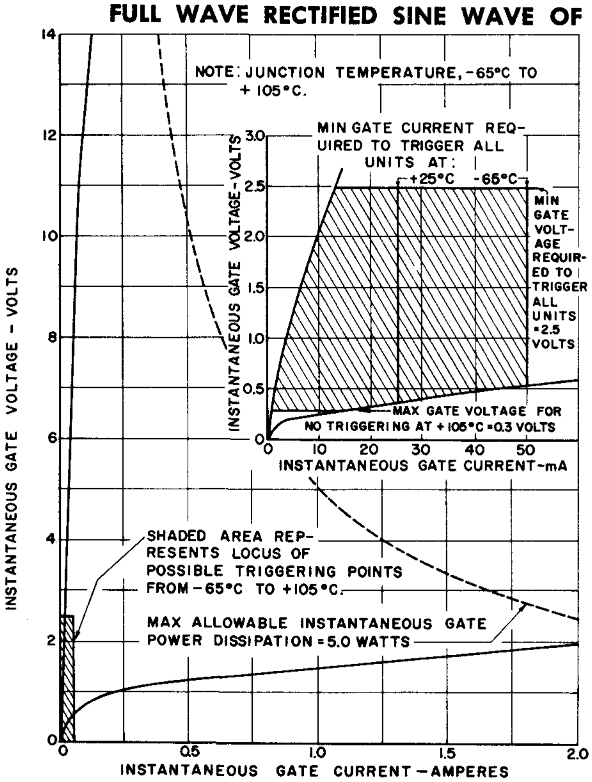
4 FORWARD POWER DISSIPATION FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



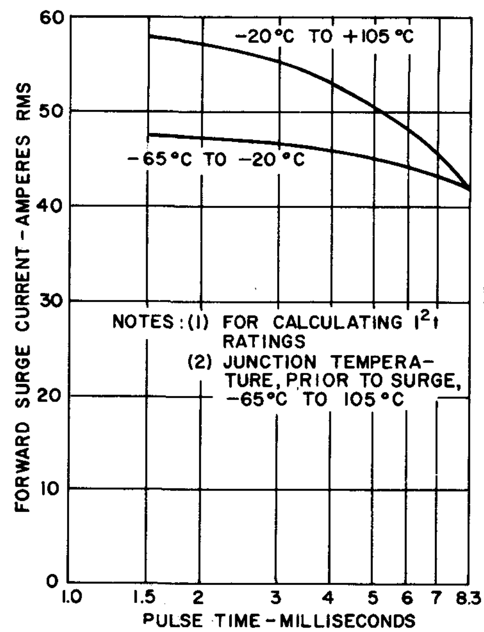
5 MAXIMUM ALLOWABLE CASE TEMPERATURE FOR FULL WAVE RECTIFIED SINE WAVE OF CURRENT



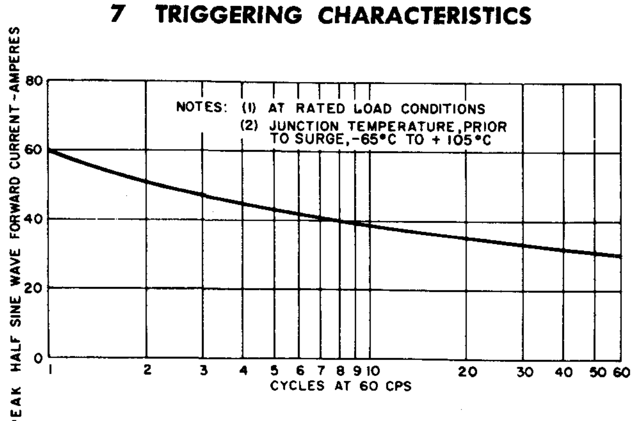
6 FORWARD POWER DISSIPATION FOR FULL WAVE RECTIFIED SINE WAVE OF CURRENT



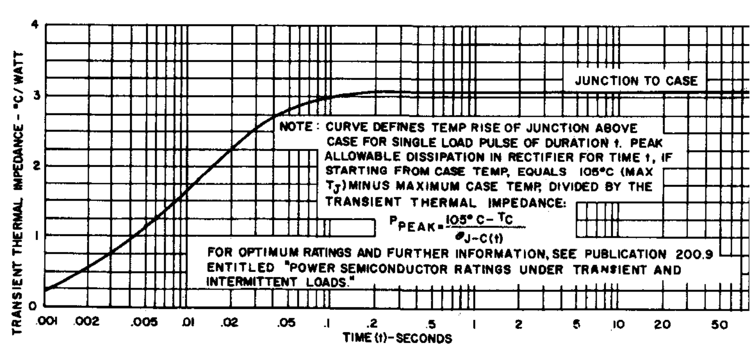
7 TRIGGERING CHARACTERISTICS



8 MAXIMUM ALLOWABLE NON-RECURRENT SUB-CYCLE SURGE CURRENT RATING



9 MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE FORWARD CURRENT



10 MAXIMUM TRANSIENT THERMAL IMPEDANCE

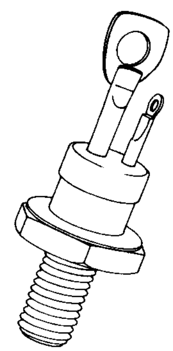
C20 SERIES SEE C220
C30 SERIES SEE C230

Controlled Rectifier

C35

35A RMS max. Up to 800 Volts

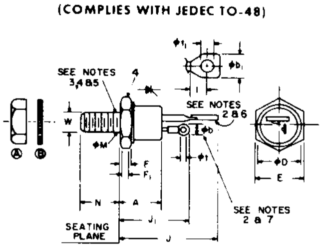
- No Peak Forward Voltage Limitation
- Broad Voltage Range-Up to 700V (400 Volt RMS Applications)
- Standard TO-48 Outline
- Designed to Meet MIL-S-19500/108D
- Backed by 20 Years of Design and Field Experience



OUTLINE DRAWING
(COMPLIES WITH JEDEC TO-48)

NOTES:
1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

A. ¼-28 steel nut, Ni. plated, .178 min. thk.
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb1	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F1	.060		1.52		
J		1.193		30.30	
J1		.875		22.23	
T	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φ	.060	.075	1.52	1.91	
φ1	.125	.165	3.18	4.19	
W					3

C. Mica washer in insulating kit adds 0°C/W junction-to-heatsink.

MAXIMUM ALLOWABLE RATINGS

TYPE†	PEAK FORWARD BLOCKING VOLTAGE V_{FOM} $T_C = -65°C$ to $+125°C$	REPETITIVE PEAK REVERSE VOLTAGE V_{ROM} (rep)* $T_C = -65°C$ to $+125°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE (<5.0 MILLISEC.) V_{ROM} (non-rep)* $T_C = -65°C$ to $+125°C$
C35U	25 Volts	25 Volts	35 Volts
C35F	50 Volts	50 Volts	75 Volts
C35A	100 Volts	100 Volts	150 Volts
C35G	150 Volts	150 Volts	225 Volts
C35B	200 Volts	200 Volts	300 Volts
C35H	250 Volts	250 Volts	350 Volts
C35C	300 Volts	300 Volts	400 Volts
C35D	400 Volts	400 Volts	500 Volts
C35E	500 Volts	500 Volts	600 Volts
C35M	600 Volts	600 Volts	720 Volts
C35S	700 Volts	700 Volts	840 Volts

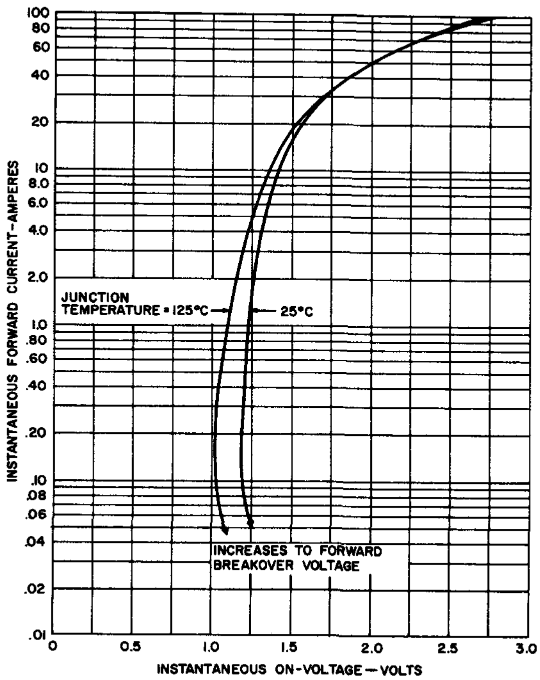
*Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C/watt.
†Devices are marked as indicated in this column.

RMS Forward Current, On-State .... 35 amperes (all conduction angles)
Average Forward Current, On-State .... Depends on conduction angle (see Chart 3, 5, and 7)
Peak One-cycle Surge Forward Current, I_{FM} (surge) .... 225 amperes
I^2t (for fusing) .... 75 ampere² seconds (for times ≧1.5 milliseconds)
Peak Gate Power Dissipation, P_{GM} .... 5 watts
Average Gate Power Dissipation, $P_{G(AV)}$ .... 0.5 watts
Peak Reverse Gate Voltage, V_{GRM} .... 5 volts
Storage Temperature, T_{stg} .... −65°C to +150°C
Operating Temperature, T_J .... −65°C to +125°C
Stud Torque .... 30 lb.-inch, (35 kg-cm)
Turn-On Current Limit .... See Chart 11

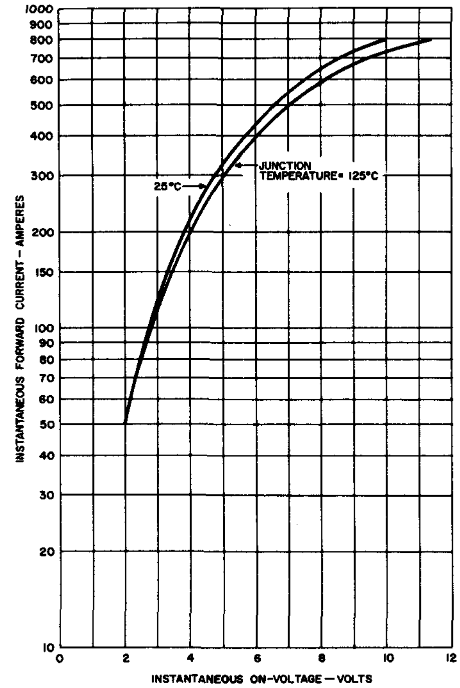
CHARACTERISTICS

TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
PEAK REVERSE OR FORWARD BLOCKING CURRENT†	I_{ROM} or I_{FOM}			mA	$T_C = -65°C$ to $+125°C$
C35U		—	13.0		$V_{ROM} = V_{FOM} =$ 25V Peak
C35F		—	13.0		= 50V
C35A		—	13.0		= 100V
C35G		—	13.0		= 150V
C35B		—	12.0		= 200V
C35H		—	11.0		= 250V
C35C		—	10.0		= 300V
C35D		—	8.0		= 400V
C35E		—	6.0		= 500V
C35M		—	5.0		= 600V
C35S		—	4.5		= 700V
FULL CYCLE AVG. REVERSE OR FORWARD BLOCKING CURRENT†	$I_{RX(AV)}$ or $I_{FX(AV)}$			mA	$T_C = +65°C$, $I_o = 16A$ 180° Conduction Angle
C35U		—	6.5		$V_{RXM} = V_{FXM} =$ 25V Peak
C35F		—	6.5		= 50V
C35A		—	6.5		= 100V
C35G		—	6.5		= 150V
C35B		—	6.0		= 200V
C35H		—	5.5		= 250V
C35C		—	5.0		= 300V
C35D		—	4.0		= 400V
C35E		—	3.0		= 500V
C35M		—	2.5		= 600V
C35S		—	2.25		= 700V
GATE TRIGGER CURRENT	I_{GT}	—	40	mAdc	$T_C = +25°C$, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
		—	80	mAdc	$T_C = -65°C$, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	—	3.0	Vdc	$T_C = -65°C$ to 125°C, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
		0.25	—	Vdc	$T_C = +125°C$, V_{FXM} = Rated V_{FOM}, $R_L = 1000$ ohms
PEAK ON-VOLTAGE	V_{FM}	—	2.0	V	$T_C = +25°C$, $I_{FM} = 50A$ Peak, 1 millisecond wide pulse
HOLDING CURRENT	I_{HO}	—	100	mAdc	$T_C = +25°C$, Anode supply = 24 Vdc, Gate Supply = 10V, 20 ohms, 45 μsec min. pulse width. Initial forward current pulse = 0.5A, 0.1 millisecond to 10 milliseconds wide.
CRITICAL RATE OF RISE OF FORWARD BLOCKING VOLTAGE (Higher values may cause device switching)	dv/dt			V/μsec.	$T_C = +125°C$. Gate open circuited. V_{FOM} = Rated.
C35U		10	—		
C35F		10	—		
C35A		20	—		
C35G		20	—		
C35B		20	—		
C35H		20	—		
C35C		25	—		
C35D		25	—		
C35E		25	—		
C35M		10	—		
C35S		10	—		
CIRCUIT COMMUTATED TURN-OFF TIME	t_{off}	—	75	μsec.	$T_C = 125°C$, Rectangular current waveform. Rate of rise of current <10A/μsec. Rate of fall of current ≦ 5A/μsec. $I_{FM} = 10A$ (50 μsec pulse). Repetition rate = 60 Hz. V_{RXM} ≦ Rated. Reverse voltage at end of turn-off time interval $V_{RX} = 15V$. V_{FXM} = Rated. Rate of rise of reapplied forward voltage = 10V/μsec (C35U, C35F, C35M, C35S). Rate of rise of reapplied forward voltage = 20V/μsec (C35A, C35G, C35B, C35H, C35C, C35D, C35E). Gate bias = 0 Volts, 100 ohms (during turnoff interval).
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	—	1.7	°C/watt	

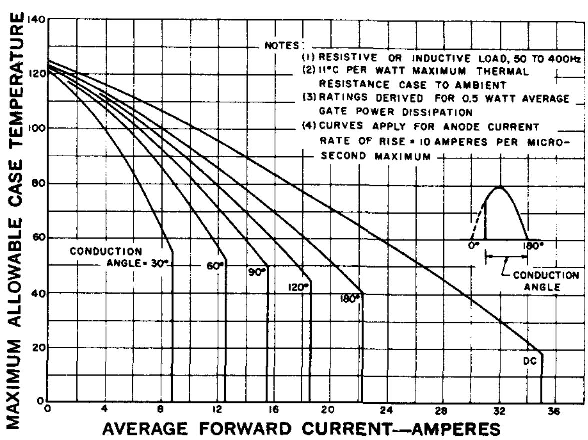
†Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C/watt.



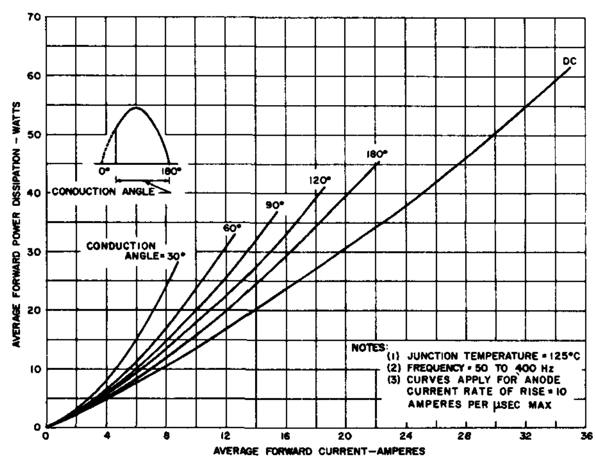
1. MAXIMUM FORWARD CHARACTERISTICS—ON-STATE



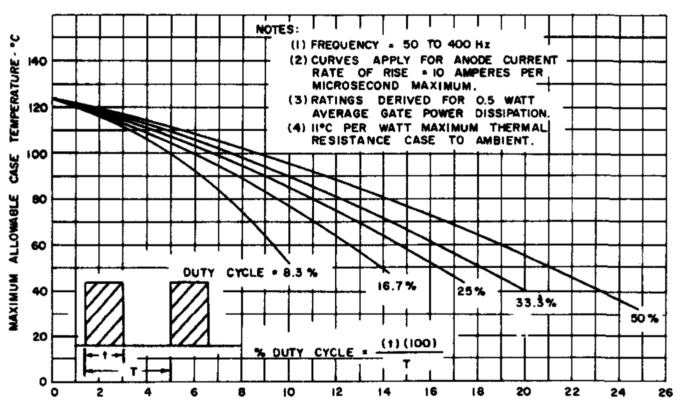
2. MAXIMUM FORWARD CHARACTERISTICS—HIGH CURRENT LEVEL—ON-STATE



3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM

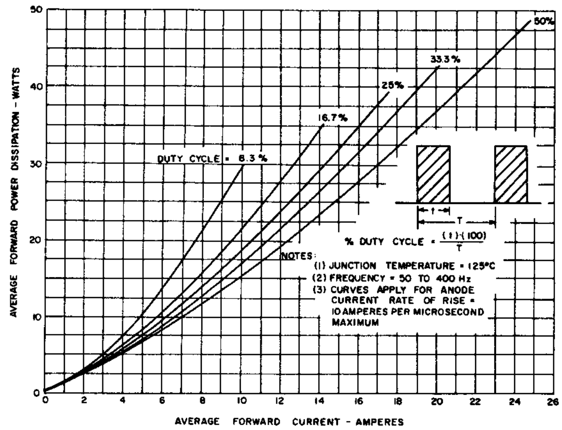


4. FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM

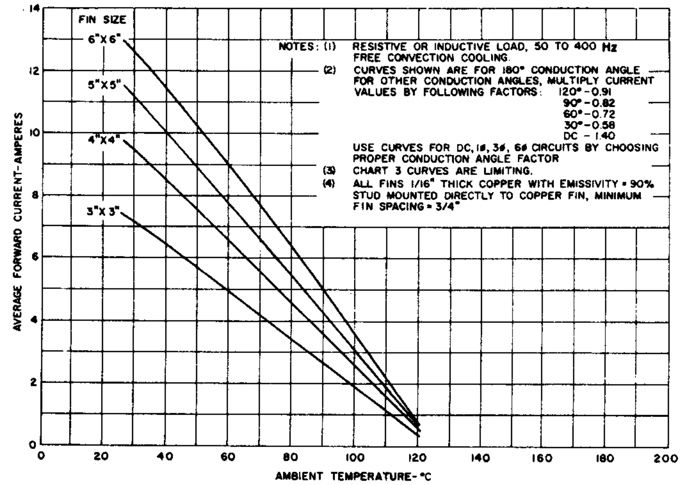


5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM

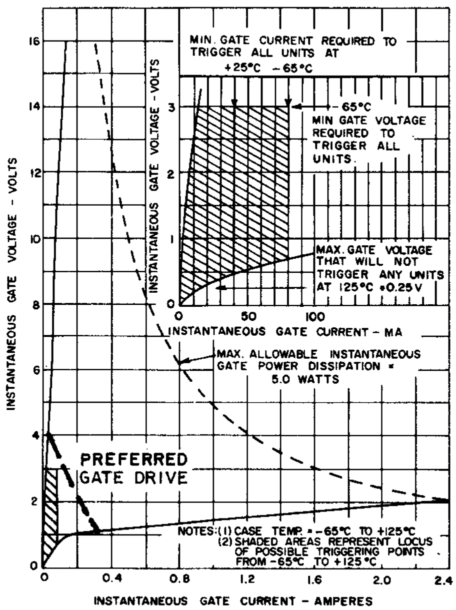
C35



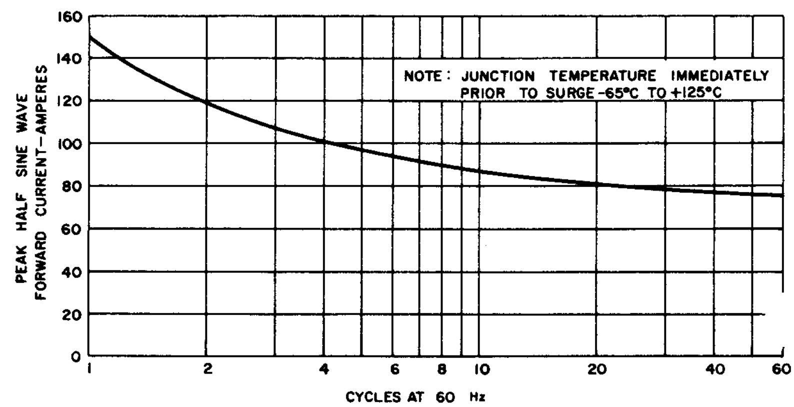
6. FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



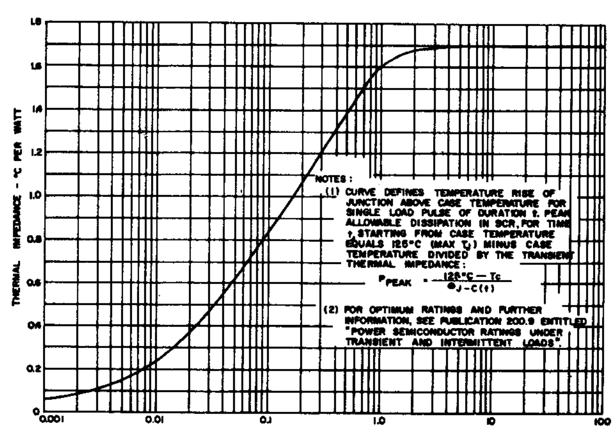
7. MAXIMUM FORWARD CURRENT VS. AMBIENT TEMPERATURE FOR VARIOUS FIN SIZES



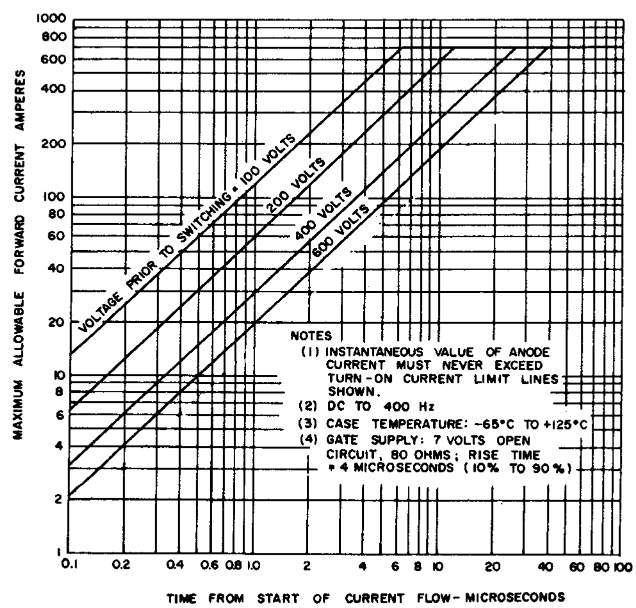
8. GATE TRIGGERING CHARACTERISTICS



9. MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE FORWARD CURRENT AT RATED LOAD CONDITIONS



10. MAXIMUM TRANSIENT THERMAL IMPEDANCE—JUNCTION TO CASE



11. TURN-ON CURRENT LIMIT

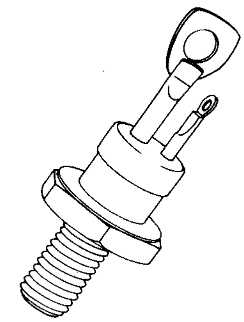
C36 SERIES SEE PAGE 328

C37

SCR

800 Volts 25 A. RMS Max. 105°C Max. Case Temperature

The C37 Silicon Controlled Rectifier is a three-junction semiconductor device for use in power switching and control applications requiring a blocking voltage of 800 volts or less and average load currents up to 16 amperes. Its low cost makes it suitable for high volume consumer/industrial applications.
An ideal inexpensive trigger device for this Controlled Rectifier is a Silicon Unijunction transistor, such as type 2N2647.



MAXIMUM ALLOWABLE RATINGS

TYPE	PEAK FORWARD BLOCKING VOLTAGE, V_{FOM} $T_C = -40°C$ to $+105°C$	PEAK FORWARD VOLTAGE, PFV $T_C = -40°C$ to $+105°C$	REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (rep)[1] $T_C = -40°C$ to $+105°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{ROM} (non-rep)[1] $T_C = -40°C$ to $+105°C$
C37U	25 volts	480 volts	25 volts	40 volts
C37F	50 volts	480 volts	50 volts	75 volts
C37A	100 volts	480 volts	100 volts	150 volts
C37B	200 volts	480 volts	200 volts	300 volts
C37C	300 volts	480 volts	300 volts	400 volts
C37D	400 volts	500 volts	400 volts	500 volts
C37E	500 volts	600 volts	500 volts	600 volts
C37M	600 volts	720 volts	600 volts	720 volts
C37S	700 volts	840 volts	700 volts	840 volts
C37N	800 volts	960 volts	800 volts	960 volts

[1] Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C per watt.

RMS Forward Current, On-State	25 amperes
Average Forward Current, On-State	Depends on conduction angle (See Charts 3 and 5)
Peak One Cycle Surge Forward Current, I_{FM} (surge)	125 amperes
I^2t (for fusing)	40 ampere² seconds (for times ≧1.5 milliseconds)
Peak Gate Power Dissipation, P_{GM}	5.0 watts
Average Gate Power Dissipation, P_G (AV)	0.5 watts
Peak Reverse Gate Voltage, V_{GRM}	10 volts
Storage Temperature, T_{stg}	−40°C to +105°C
Operating Temperature, T_J	−40°C to +105°C
Stud Torque	30 inch-pounds (35 kg-cm)

CHARACTERISTICS

TEST	SYMBOL	MIN	MAX	UNITS	TEST CONDITIONS
PEAK FORWARD OR REVERSE BLOCKING CURRENT(1)	I_{FOM} or I_{ROM}			ma	$T_C = -40°C$ to $+105°C$
C37U		—	13.0		$V_{FOM} = V_{ROM} = 25$ Volts Peak
C37F		—	13.0		$V_{FOM} = V_{ROM} = 50$ Volts Peak
C37A		—	13.0		$V_{FOM} = V_{ROM} = 100$ Volts Peak
C37B		—	12.0		$V_{FOM} = V_{ROM} = 200$ Volts Peak
C37C		—	10.0		$V_{FOM} = V_{ROM} = 300$ Volts Peak
C37D		—	8.0		$V_{FOM} = V_{ROM} = 400$ Volts Peak
C37E		—	6.0		$V_{FOM} = V_{ROM} = 500$ Volts Peak
C37M		—	5.0		$V_{FOM} = V_{ROM} = 600$ Volts Peak
C37S		—	4.5		$V_{FOM} = V_{ROM} = 700$ Volts Peak
C37N		—	4.0		$V_{FOM} = V_{ROM} = 800$ Volts Peak
FULL CYCLE AVERAGE FORWARD OR REVERSE BLOCKING CURRENT(1)	$I_{FX(AV)}$ or $I_{RX(AV)}$			ma	$T_C = +60°C$, $I_O = 11.0$ Amperes 180° Conduction Angle
C37U		—	6.5		$V_{FXM} = V_{RXM} = 25$ Volts Peak
C37F		—	6.5		$V_{FXM} = V_{RXM} = 50$ Volts Peak
C37A		—	6.5		$V_{FXM} = V_{RXM} = 100$ Volts Peak
C37B		—	6.0		$V_{FXM} = V_{RXM} = 200$ Volts Peak
C37C		—	5.0		$V_{FXM} = V_{RXM} = 300$ Volts Peak
C37D		—	4.0		$V_{FXM} = V_{RXM} = 400$ Volts Peak
C37E		—	3.0		$V_{FXM} = V_{RXM} = 500$ Volts Peak
C37M		—	2.5		$V_{FXM} = V_{RXM} = 600$ Volts Peak
C37S		—	2.25		$V_{FXM} = V_{RXM} = 700$ Volts Peak
C37N		—	2.0		$V_{FXM} = V_{RXM} = 800$ Volts Peak
GATE TRIGGER CURRENT	I_{GT}	—	80.0	madc	$T_C = +25°C$, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
		—	150.0	madc	$T_C = -40°C$, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	—	3.5	Vdc	$T_C = -40°C$ to $105°C$, $V_{FX} = 12$ Vdc, $R_L = 50$ ohms
		0.25	—	Vdc	$T_C = +105°C$, V_{FXM} = Rated V_{FOM}, $R_L = 1000$ ohms
PEAK ON-VOLTAGE	V_{FM}	—	2.25	Volts	$T_C = +25°C$, $I_{FM} = 30$ amperes peak, 1 millisecond wide pulse, Duty Cycle ≤ 1%.

(1) Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum V_{FOM} and V_{ROM} ratings apply equals 11°C per watt.

NOTE:

For applications where the rate of anode current rise (di/dt) exceeds 10 amperes per microsecond, please contact your Local G-E Sales Representative for component selection.

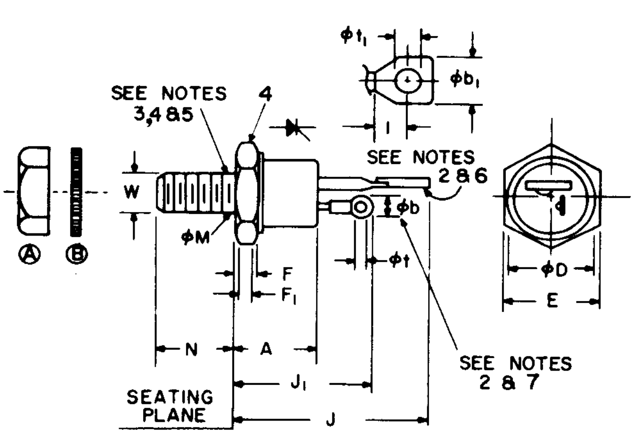
OUTLINE DRAWING

(COMPLIES WITH JEDEC TO-48)

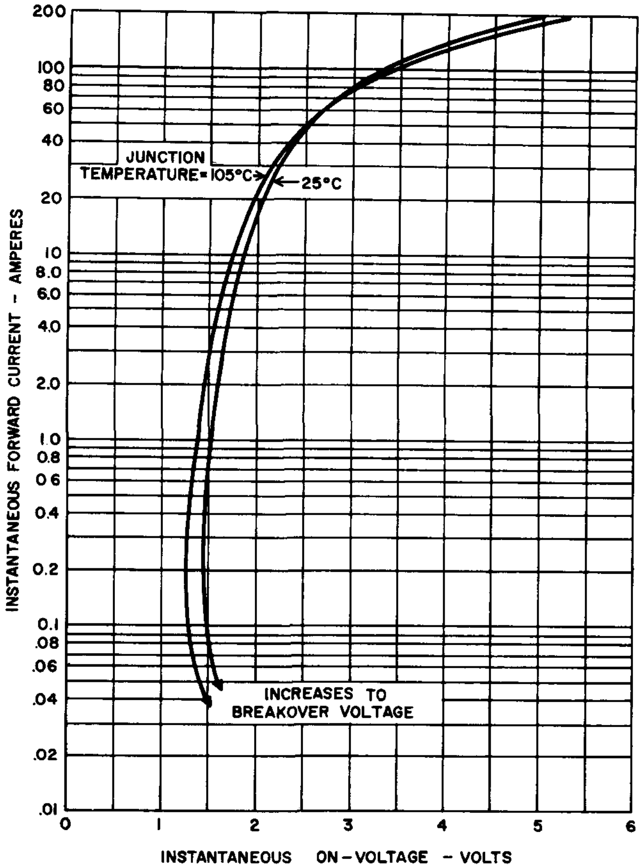
NOTES:
1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

A. ¼-28 steel nut, Ni. plated, .178 min. thk.
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.

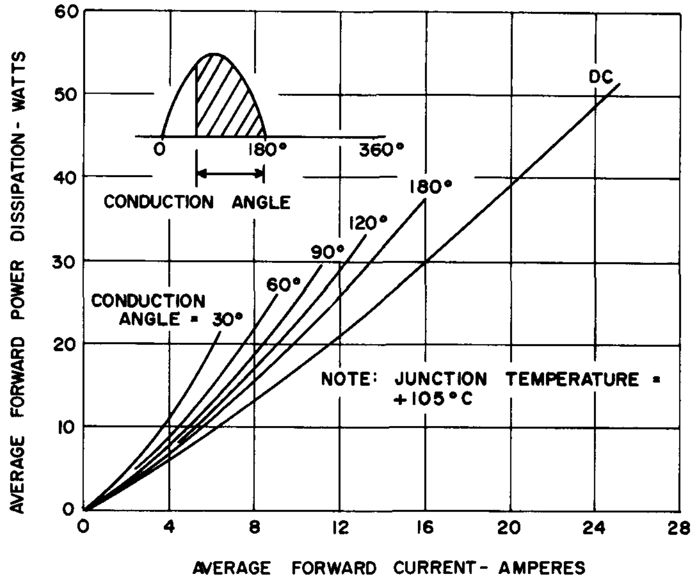
(COMPLIES WITH JEDEC TO-48)



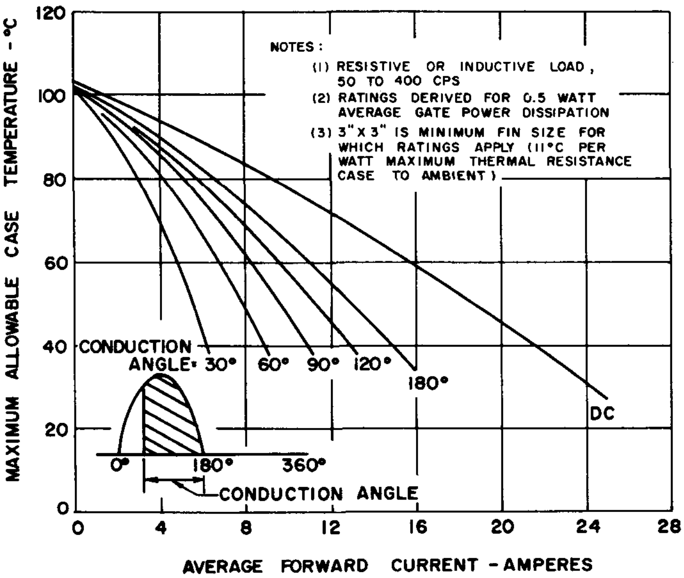
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb1	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F1	.060		1.52		
J		1.193		30.30	
J1		.875		22.23	
l	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φt	.060	.075	1.52	1.91	
φt1	.125	.165	3.18	4.19	
W					3



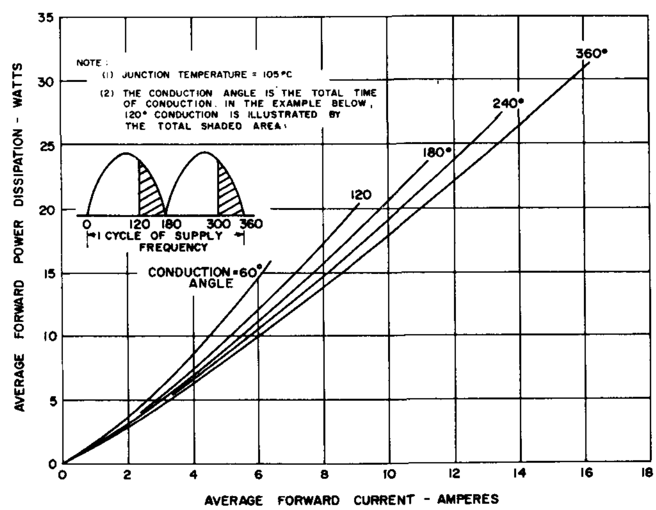
1. MAXIMUM FORWARD CHARACTERISTICS, CONDUCTING STATE



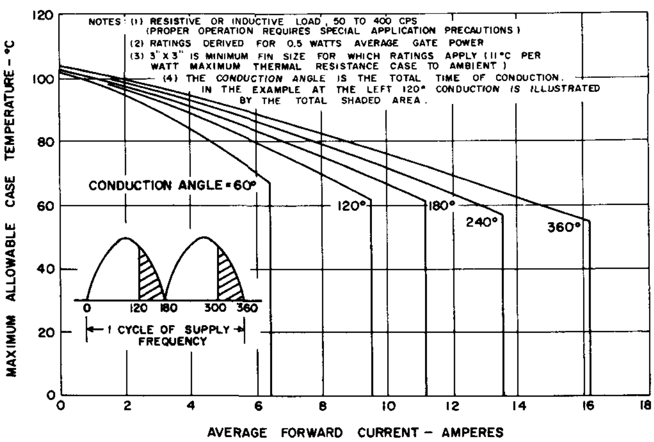
2. MAXIMUM POWER DISSIPATION FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



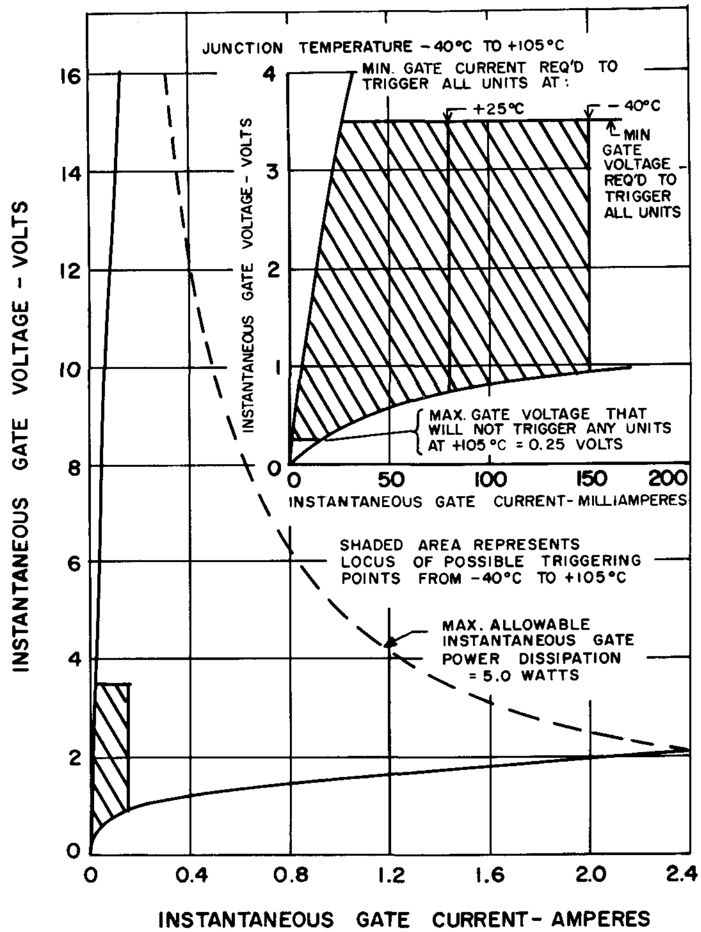
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT



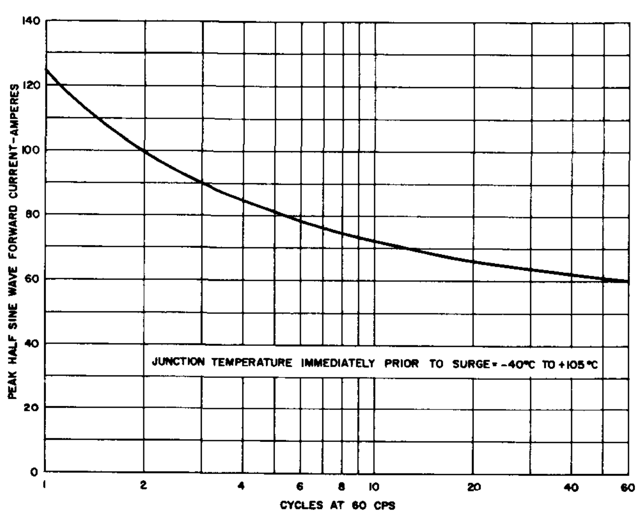
4. MAXIMUM FORWARD POWER DISSIPATION FOR FULL WAVE RECTIFIED SINE WAVE OF CURRENT



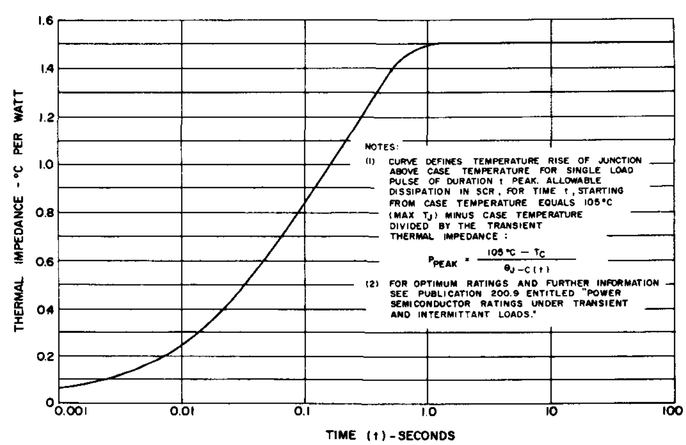
5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR FULL WAVE RECTIFIED SINE WAVE OF CURRENT



6. GATE TRIGGER CHARACTERISTICS



7. MAXIMUM ALLOWABLE NON-RECURRENT PEAK SURGE FORWARD CURRENT AT RATED LOAD CONDITIONS



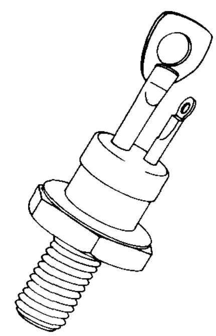
8. MAXIMUM TRANSIENT THERMAL IMPEDANCE — JUNCTION TO CASE

SCR

C38

The C38 Silicon Controlled Rectifier is a three junction semiconductor device for use in power switching and control applications requiring a blocking voltage of 500 volts or less and RMS Forward Currents up to 35 amperes. Because of its higher Junction Temperature Rating than the C35 (2N681-92) series, it will prove useful in applications calling for higher ambient temperatures or smaller heat sinks than the C35 series permits.

- **No Peak Forward Voltage Limitation**
- **Thermal Fatigue Free**
- **High Junction Temperature (150°C)**
- **Standard TO-48 Outline**
- **Long Creepage Path**
- **Low Thermal Resistance**

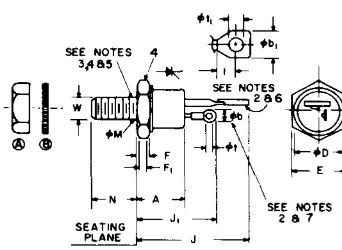


OUTLINE DRAWING
(COMPLIES WITH JEDEC TO-48)

NOTES:
1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

A. ¼-28 steel nut, Ni. plated, .178 min. thk.
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.

(COMPLIES WITH JEDEC TO-48)



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb1	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F1	.060		1.52		
J		1.193		30.30	
J1		.875		22.23	
I	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φt	.060	.075	1.52	1.91	
φt1	.125	.165	3.18	4.19	
W					3

Type	Minimum Forward Breakover Voltage (V_{BO})* $T_J = -65°C$ to $+150°C$	Repetitive Peak Reverse Voltage (PRV)* $T_J = -65°C$ to $+150°C$	Transient Peak Reverse Voltage (Non-recurrent <5.0 Millisec.)* $T_J = -65°C$ to $+150°C$
C38U	25 volts	25 volts	35 volts
C38F	50 volts	50 volts	75 volts
C38A	100 volts	100 volts	150 volts
C38G	150 volts	150 volts	225 volts
C38B	200 volts	200 volts	300 volts
C38H	250 volts	250 volts	350 volts
C38C	300 volts	300 volts	400 volts
C38D	400 volts	400 volts	500 volts
C38E	500 volts	500 volts	600 volts

*Values apply for zero or negative gate voltage only. Maximum case to ambient thermal resistance for which maximum PRV ratings apply — equals 11°C/watt.

MAXIMUM ALLOWABLE RATINGS

RMS Forward Current .... 35 amperes (all conduction angles)
Average Forward Current (I_O) .... Depends on conduction angle (see charts 3 & 5)
Peak One-cycle Non-recurrent Surge Current (i_{surge}) .... 150 amperes
Peak Non-recurrent Surge Current during Turn-on time Interval .... See Chart 10
I^2t (for fusing) .... 75 ampere² seconds (for times ≧ 1.5 milliseconds)
Peak Gate Power (p_G) .... 12 watts
Average Gate Power (P_G) .... 0.5 watt
** Peak Gate Current (i_G) .... 2.0 amperes
** Peak Gate Voltage (v_G) (Forward and Reverse) .... 10 volts
Storage Temperature .... −65°C to + 150°C
Operating Temperature .... −65°C to + 150°C
Stud Torque .... 30 inch-pounds

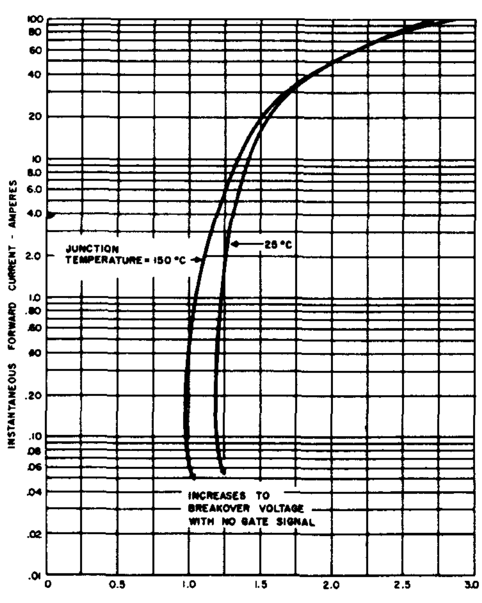
**NOT TO EXCEED GATE POWER RATINGS

CHARACTERISTICS

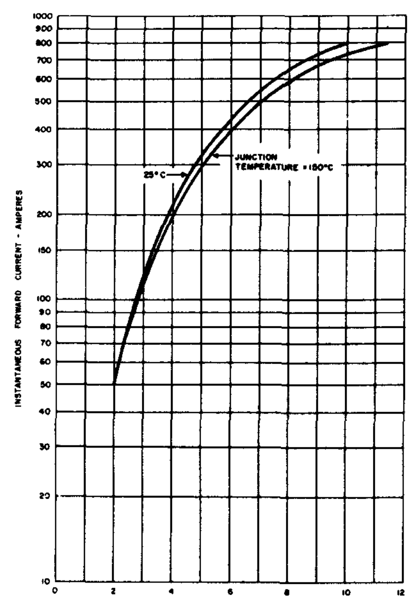
C38

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Reverse and Forward Blocking Current*	i_R and i_S					T_J = 25°C
C38U		——	6.0	10.0	ma	$v_{AC} = v_{CA}$ = 25v peak
C38F		——	5.5	10.0	ma	50
C38A		——	5.0	10.0	ma	100
C38G		——	4.5	10.0	ma	150
C38B		——	4.0	8.0	ma	200
C38H		——	3.0	6.0	ma	250
C38C		——	2.5	5.0	ma	300
C38D		——	2.0	4.0	ma	400
C38E		——	1.5	3.0	ma	500
Peak Reverse and Forward Blocking Current*	i_R and i_S					T_J = 150°C
C38U		——	9.0	13.0	ma	$v_{AC} = v_{CA}$ = 25v peak
C38F		——	8.9	13.0	ma	50
C38A		——	7.8	13.0	ma	100
C38G		——	7.7	13.0	ma	150
C38B		——	7.5	12.0	ma	200
C38H		——	7.3	11.0	ma	250
C38C		——	6.8	10.0	ma	300
C38D		——	5.3	8.0	ma	400
C38E		——	2.6	6.0	ma	500
Rate of Rise of Forward Voltage that Will Not Turn on SCR**	dv/dt	20.0	40.0	——	volts/ μsec	T_J = 150°C. Gate open circuited. v_{AC} = Rated.
Gate Current to Fire	I_{GF}	——	15	40	mAdc	T_J = 25°C, V_{AC} = 6 Vdc, R_L = 50 ohms
		——	35	80	mAdc	T_J = −65°C, V_{AC} = 6 Vdc, R_L = 50 ohms
		——	7.5	20	mAdc	T_J = 150°C, V_{AC} = 6 Vdc, R_L = 50 ohms
Gate Voltage to Fire	V_{GF}	——	1.2	3.0	Vdc	V_{AC}= 6 Vdc, T_J = 25°C, R_L = 50 ohms
		——	2.0	3.0	Vdc	V_{AC} = 6 Vdc, T_J = −65°C, R_L = 50 ohms
		0.15	——	——	Vdc	v_{AC} = Rated, T_J = 150°C, R_L = 1000 ohms
Forward Voltage Drop	v_F	——	1.7	2.0	v	i_F = 50a peak, T_J = 25°C
Holding Current	I_H	——	10	80	mAdc	T_J = 25°C, Anode Supply = 6 Vdc
Turn-on Time	$t_d + t_r$	——	1.4	——	μsec	T_J = 25°C, I_F = 5.0 Adc, v_{AC} = Rated. Gate supply: 10 volt open circuit, 25 ohm, 0.1 μsec. max. rise time.
Turn-off Time	t_{off}	——	24	——	μsec	T_J = 150°C, i_F = 10a, i_R = 5a, v_{AC} (reapplied) = Rated, dv/dt = 20v/μsec Linear
Thermal Resistance	θ_{J-C}	——	.75	1.5	°C/watt	Junction to case

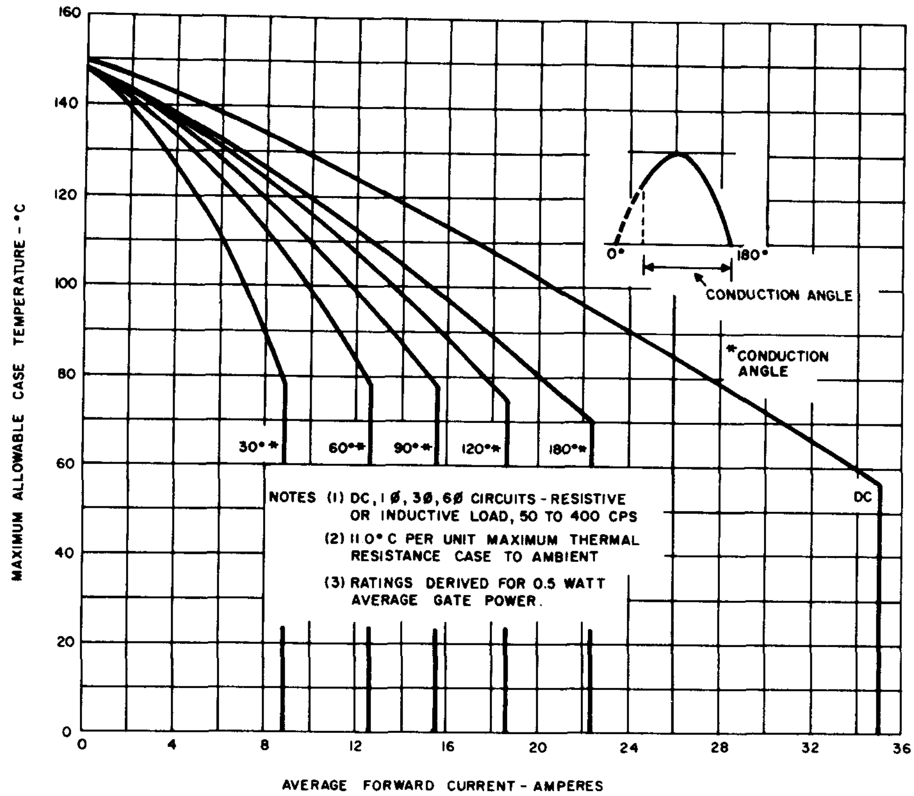
*Values apply for zero or negative gate voltage. Max. case to ambient thermal resistance for which max. PRV ratings apply = 11°C per watt.
**See Chart 8.



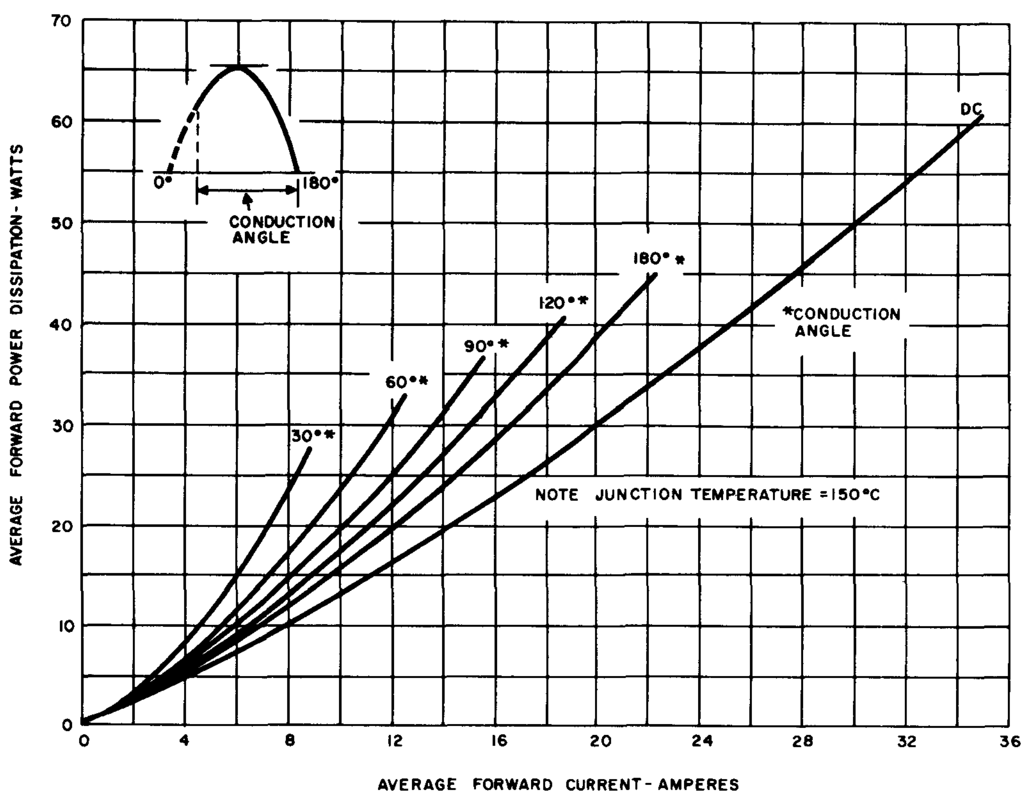
1. MAXIMUM FORWARD CHARACTERISTICS CONDUCTING STATE



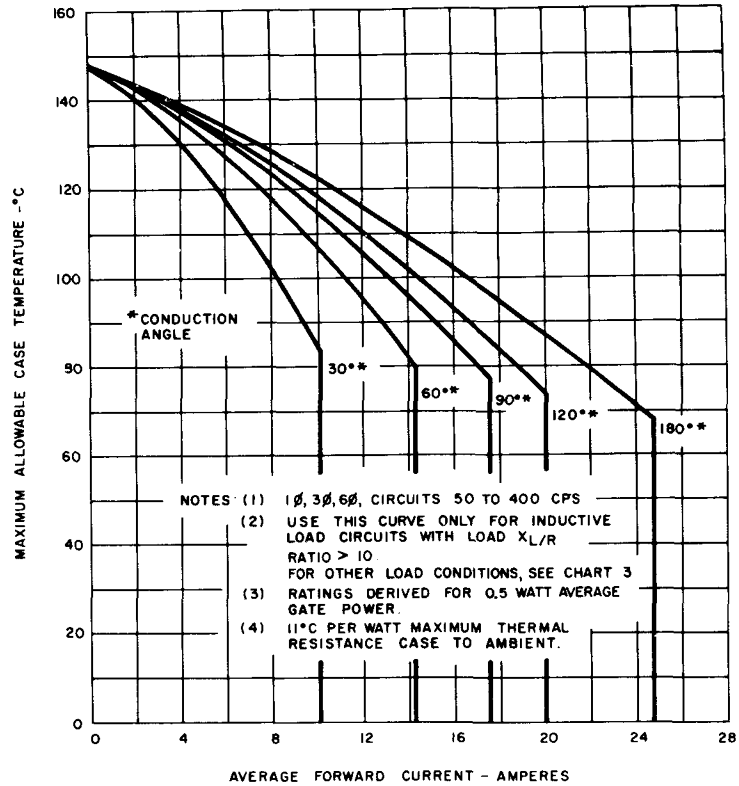
2. MAXIMUM FORWARD CHARACTERISTICS HIGH CURRENT LEVEL—CONDUCTING STATE



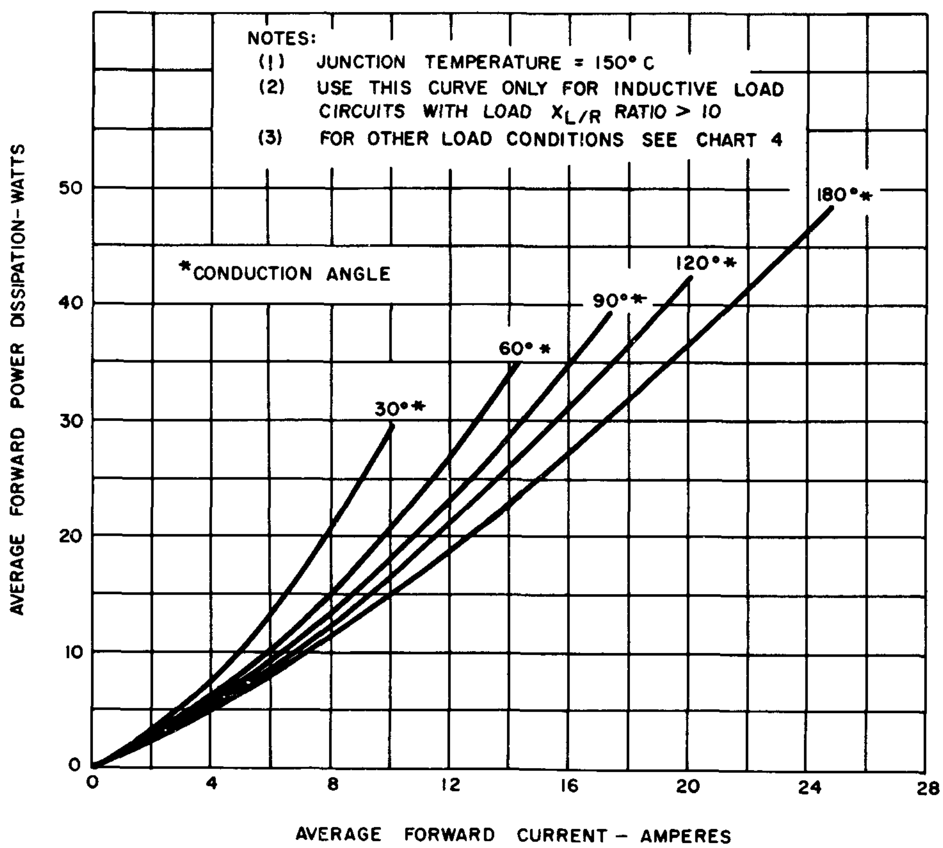
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



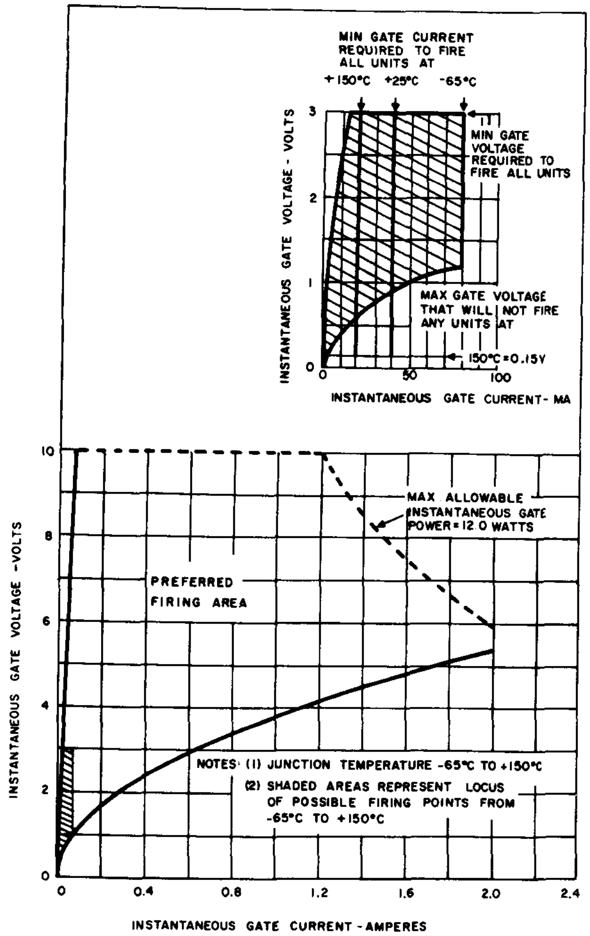
4. FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



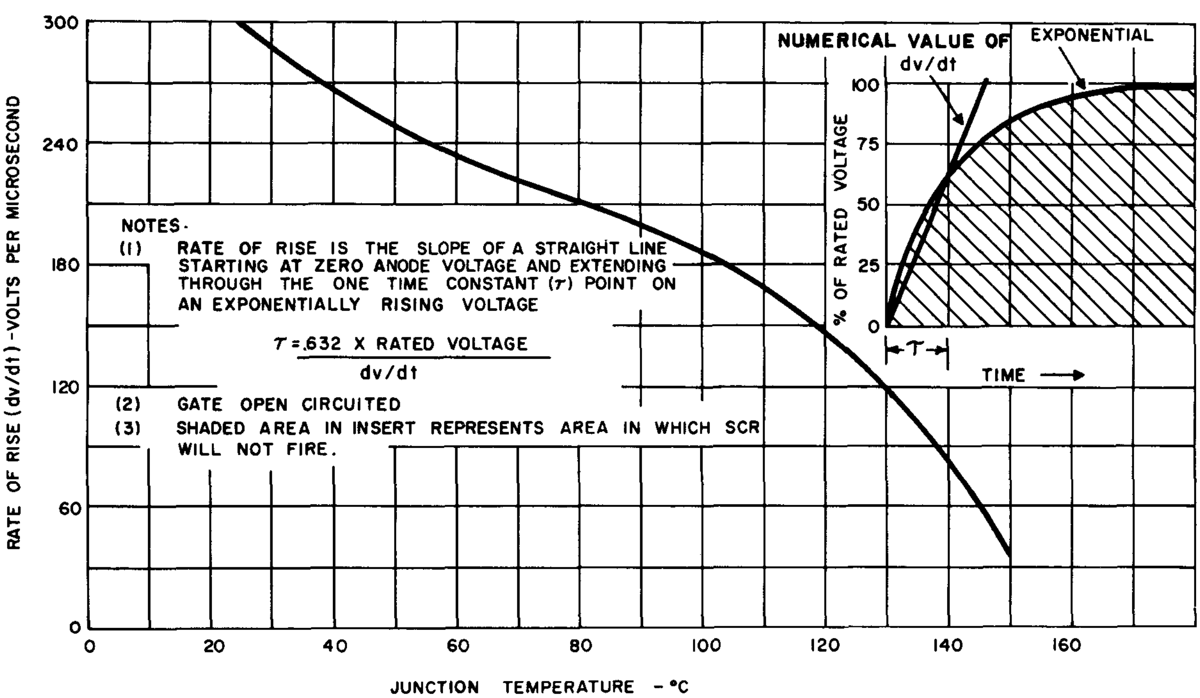
5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



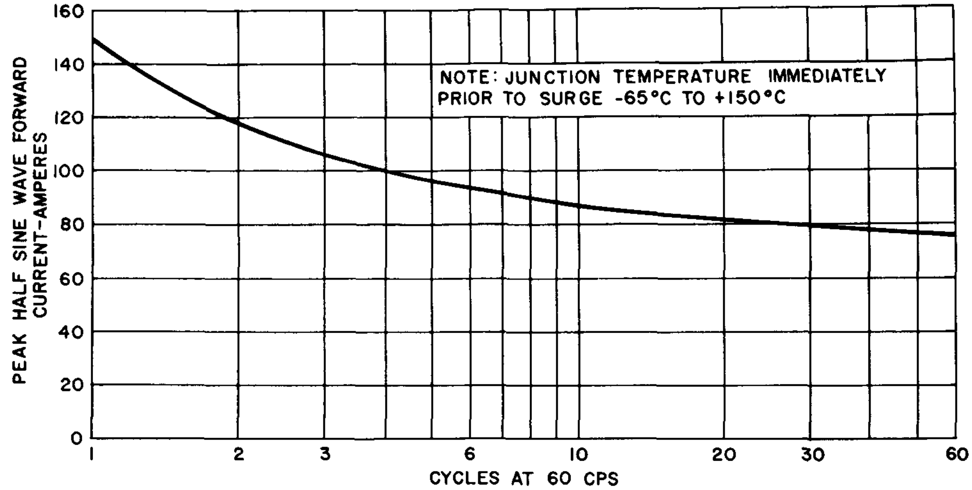
6. FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



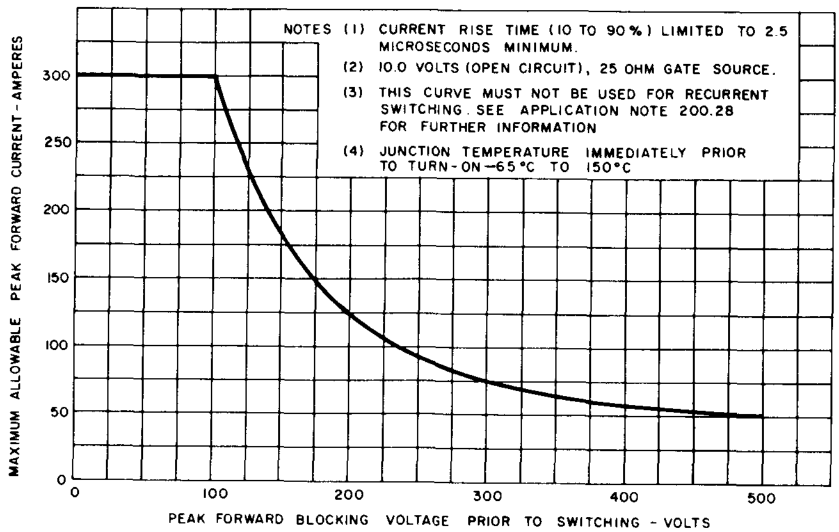
7. FIRING CHARACTERISTICS



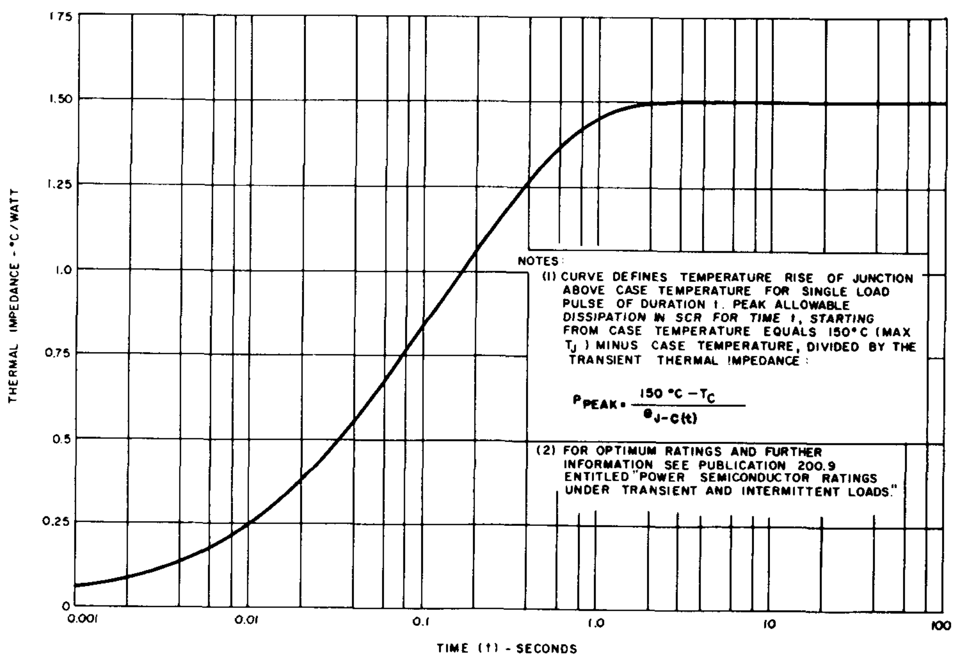
8. TYPICAL RATE OF RISE (dv/dt) OF FORWARD VOLTAGE THAT WILL NOT TURN ON SCR



9. MAXIMUM ALLOWABLE NON-RECURRENT SURGE CURRENT AT RATED LOAD CONDITIONS



10. PEAK NON-RECURRENT SURGE CURRENT DURING TURN-ON TIME INTERVAL



11. MAXIMUM TRANSIENT THERMAL IMPEDANCE JUNCTION TO CASE

SCR

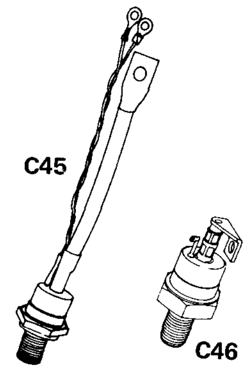
C45
C46

80 A RMS 25 to 1200 Volts

The C45 and C46 SCR's are rated 80 amperes RMS to 1200 volts, for use in industrial phase control applications where high voltage and general purpose performance are required.

FEATURES:
- Broad Voltage Range – Up to 1200V
- Standard TO-94 Outline

APPLICATIONS:
- DC Motor Drives
- Plating Supplies
- Battery Charging
- AC Regulators



MAXIMUM ALLOWABLE RATINGS

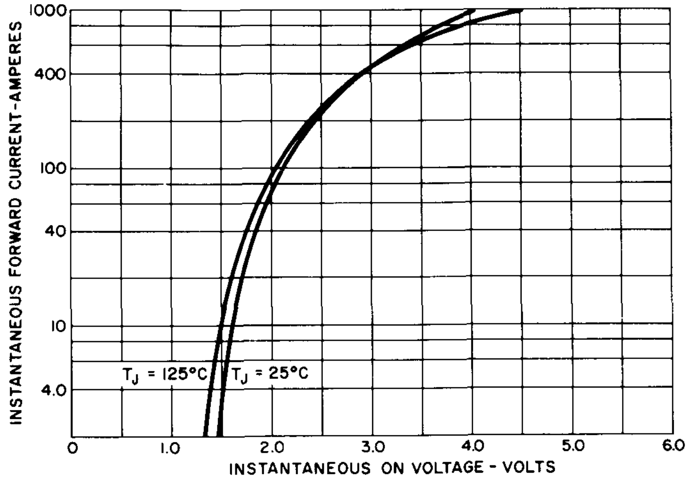
TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} T_J = -40°C to +125°C	TRANSIENT PEAK REVERSE VOLTAGE, V_{RSM} (1) T_J = +125°C
C45, C46 U	25 Volts	25 Volts	35 Volts
C45, C46 F	50	50	75
C45, C46 A	100	100	150
C45, C46 G	150	150	225
C45, C46 B	200	200	300
C45, C46 H	250	250	350
C45, C46 C	300	300	400
C45, C46 D	400	400	500
C45, C46 E	500	500	600
C45, C46 M	600	600	720
C45, C46 S	700	700	840
C45, C46 N	800	800	960
C45, C46 T	900	900	1080
C45, C46 P	1000	1000	1200
C45, C46 PA	1100	1100	1320
C45, C46 PB	1200	1200	1440

(1)Half sine wave waveform, 10 msec. maximum pulse width.

RMS Forward Current, On-State, $I_{T(RMS)}$ . . . . 80 Amperes (All Conduction Angles)
Average Forward Current, On-State, $I_{T(AV)}$ . . . . Depends on Conduction Angle (See Charts 2 and 3)
Peak One-Cycle Surge Forward Current, I_{TSM} . . . . 800 Amperes
Maximum Repetitive Rate-of-Rise of Anode Current During Turn-On Interval 100A/μs
I^2t (for fusing), for times ≥ 8.3 milliseconds (See Figure 8) . . . . 2600 (RMS Ampere)^2 Seconds
1.5 milliseconds (See Figure 8) . . . . 2100 (RMS Ampere)^2 Seconds
Peak Gate Power Dissipation, P_{GM} (See Figure 6) . . . . 100 Watts for 150 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2.0 Watts
Peak Negative Gate Voltage, V_{GM} . . . . 10 Volts
Storage Temperature, T_{STG} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Stud Torque . . . . 125 Lbs.-In. (Min.), 150 Lbs.-In. (Max.)
. . . . 14 N-m (Min.), 17 N-m (Max.)

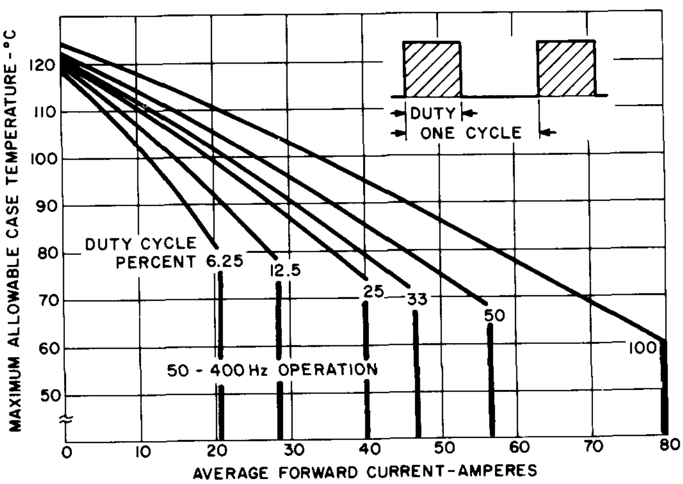
CHARACTERISTICS

TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
Peak Off-State or Reverse Current	I_{DRM} or I_{RRM}	–	–	mA	T_J = -40°C to +125°C
C45, C46U		–	10		V_{DRM} = V_{RRM} = 25= Volts – Peak
C45, C46F					50
C45, C46A					100
C45, C46G					150
C45, C46B					200
C45, C46H					250
C45, C46C					300
C45, C46D					400
C45, C46E					500
C45, C46M					600
C45, C46S					700
C45, C46N					800
C45, C46T					900
C45, C46P					1000
C45, C46PA					1100
C45, C46PB					1200
Gate Trigger Current	I_{GT}	–	75	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 ohms, $t_p \geqslant$ 20 μsec.
		–	130		T_C = -40°C, V_D = 6 Vdc, R_L = 3 ohms, $t_p \geqslant$ 20 μsec.
		–	40		T_C = +125°C, V_D = 6 Vdc, R_L = 3 ohms, $t_p \geqslant$ 20 μsec.
Gate Trigger Voltage	V_{GT}	–	3.0	Vdc	T_C = -40°C to +120°C, V_D = 6 Vdc, R_L = 50 ohms, $t_p \geqslant$ 20 μsec.
		.25	–		T_C = +125°C, V_D = Rated, R_L = 1000 ohms, t_p = 20 μsec.
Peak On-State Voltage	V_{TM}	–	3.1	Volts	T_C = +25°C, $I_{TM.}$ = 500 Amps. Peak, Duty Cycle $\leqslant$ .01%.
Holding Current	I_H	–	100	mAdc	T_C = +25°C, Anode Supply = 25 Vdc, Initial Forward Current = 2 Amps.
Effective Thermal Resistance	$R_{\theta JC}$	–	0.4	°C/W	D.C.
Critical Rate-of-Rise of Forward Blocking Voltage. (Higher values may cause device switching.)	dv/dt	100	–	V/μs	T_J = +125°C Rated V_{DRM}, Gate Open Circuited.



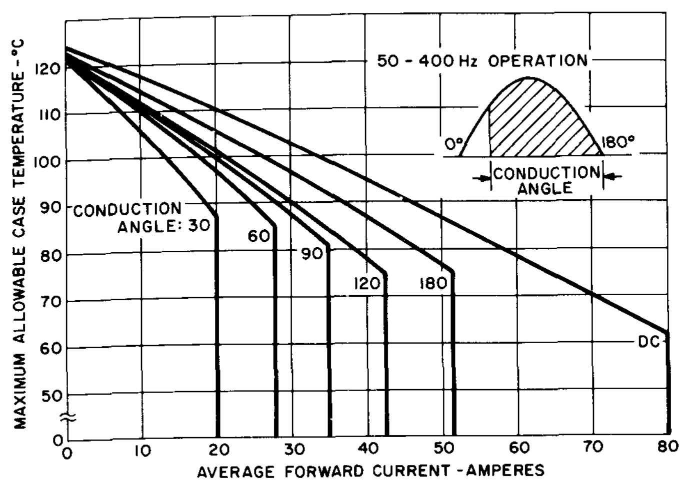
1. MAXIMUM FORWARD CHARACTERISTICS — ON-STATE

SQUARE WAVE

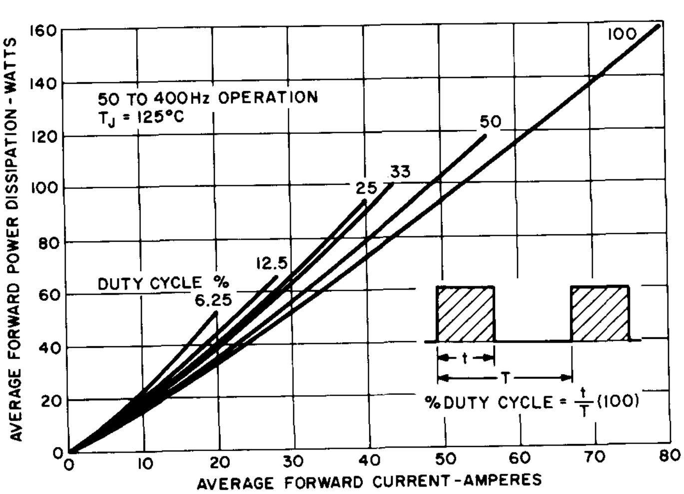


2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM

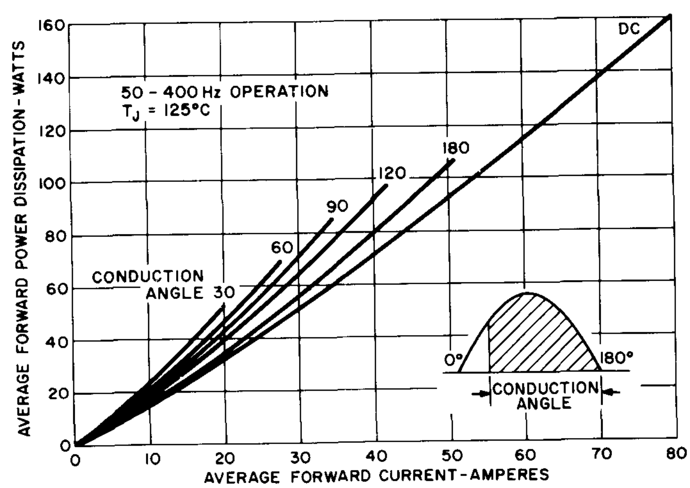
SINUSOIDAL



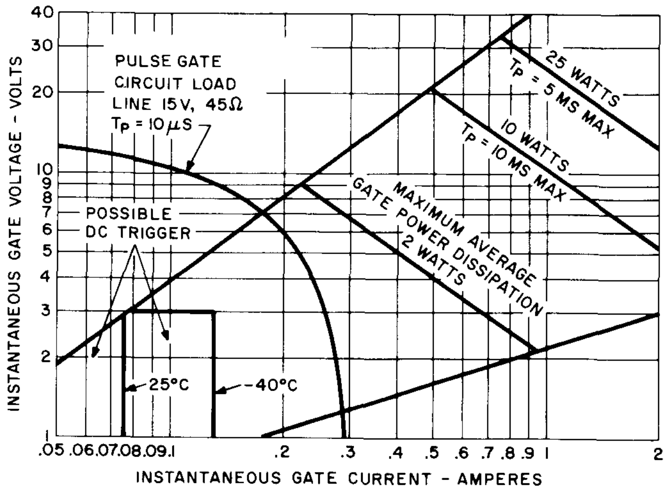
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



4. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM

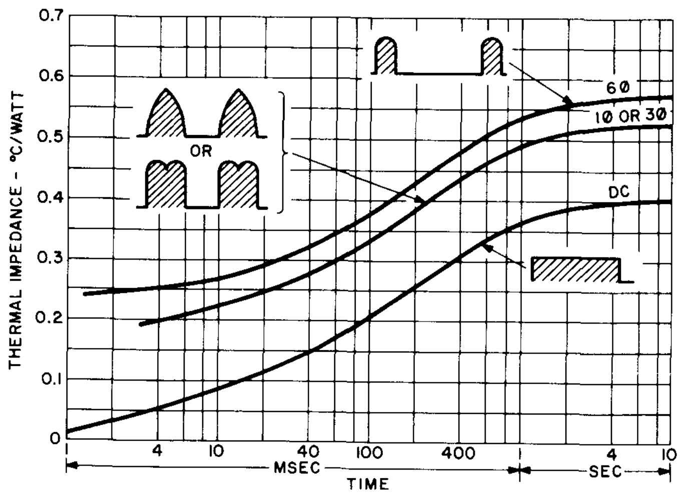


5. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM

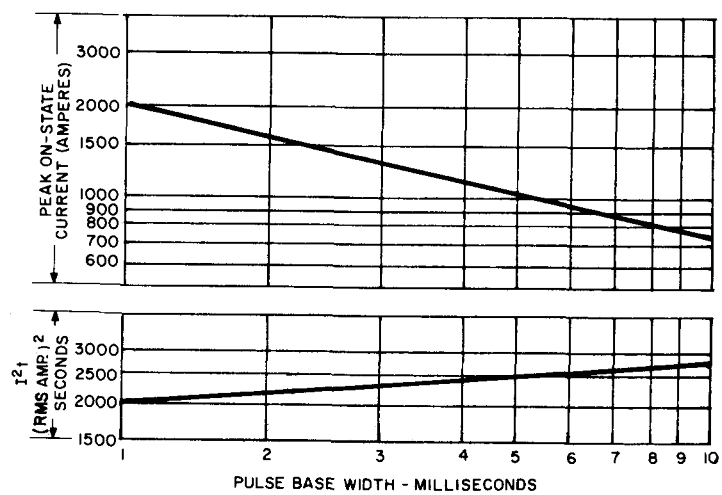


NOTES:
1. MAXIMUM ALLOWANCE AVERAGE GATE DISSIPATION = 2.0 WATTS.
2. RECTANGULAR GATE PULSE.
3. T_P = GATE CURRENT PULSE WIDTH
4. CASE TEMPERATURE −40°C TO +25°C
5. 20V, 20 Ω, .1μSEC RISE TIME IS MINIMUM GATE SOURCE LOAD LINE FOR DI/DT ≤ 100A/μSEC. REPETIVE LONG LIFE RATING.
6. FOR 15V, 45Ω, .5μSEC. RISE TIME, DI/DT ≤ 30A/μSEC. HAS BEEN CONFIRMED BY LIFE TEST.

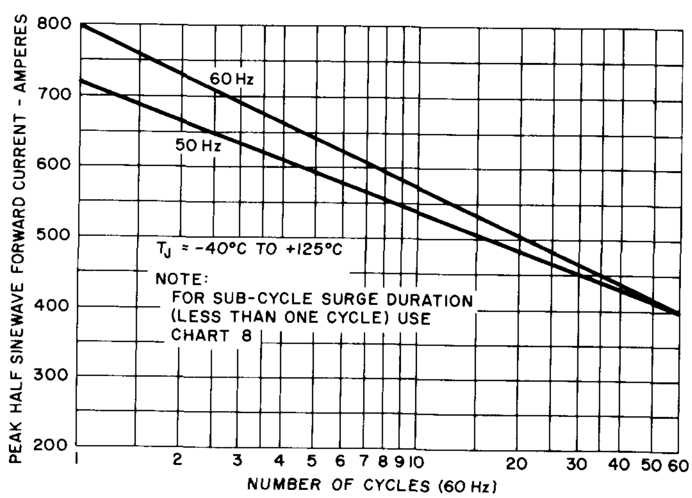
6. INSTANTANEOUS GATE CURRENT – AMPERES



7. TRANSIENT THERMAL IMPEDANCE JUNCTION-TO-CASE



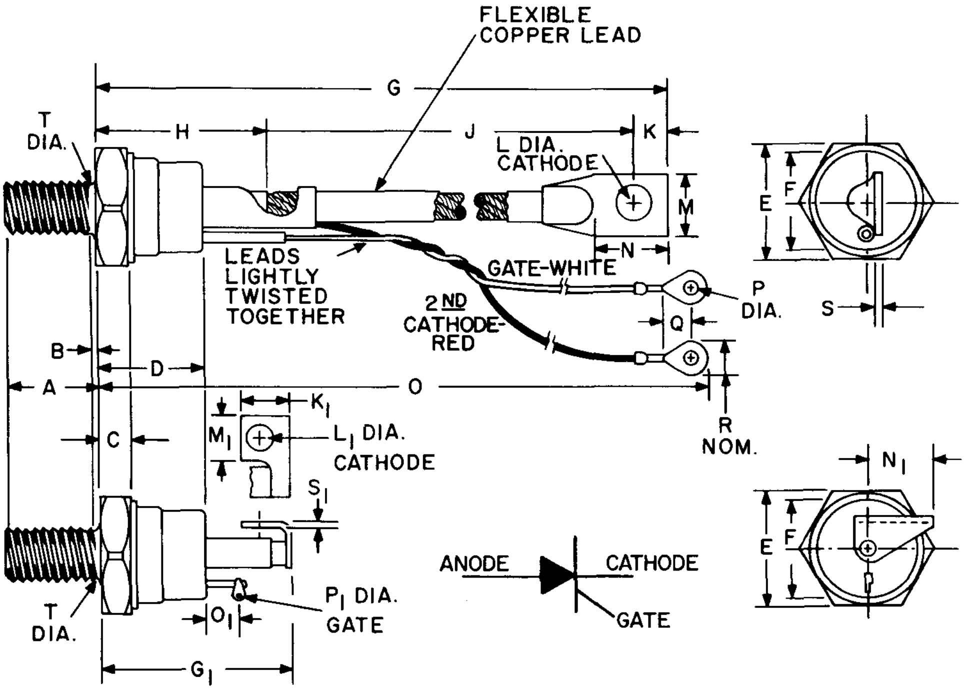
8. I^2t AND I_{TSM} FOLLOWING RATED LOAD CONDITIONS (NON-RECURRENT)



9. MULTICYCLE SURGE CURRENT – T_J = 125°C (NON-RECURRENT)

OUTLINE DRAWINGS

C45 OUTLINE (Conforms to JEDEC TO-94 Outline)



C46 OUTLINE

TABLE OF DIMENSIONS
Conversion Table

SYM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.797	.827	20.243	21.005
B	–	.080	–	2.032
C	.278	.350	7.060	8.890
D	.874	1.030	22.099	26.162
E	1.049	1.062	26.644	26.975
F	.840	.910	21.335	23.115
G	6.204	6.512	157.619	165.443
G_1	–	1.750	–	44.450
H	1.484	1.640	37.653	41.656
J	4.437	5.623	112.698	142.824
K	.275	.325	6.985	8.255
K_1	.445	.485	11.302	12.319
L	.251	.281	6.375	7.137
L_1	.198	.212	5.029	5.385
M	.500	.600	12.700	15.240
M_1	.385	.415	9.778	10.541
N	.632	.725	16.052	18.390
N_1	.590	.640	14.985	16.256
O	7.000	7.342	177.799	186.487
O_1	.312 Ref.		7.925 Ref.	
P	.140	.150	3.555	3.811
P_1	.060	.075	1.524	1.905
Q	.250 Nom.		6.350 Nom.	
R	.290 Nom		7.366 Nom.	
S	.065	.095	1.651	2.413
S_1	.058	.070	1.473	1.778
T	.463	.498	11.760	12.649

NOTES

1. Complete stud threads (½-20 UNF 2A) to within 2½ threads of head.
2. Flexible lead covered with silicon rubber insulation (Class H), 600 volt ASTM standard wall.
3. Orientation of cathode and gate terminals not defined.
4. One, ½-20 steel, cadmium plated nut and one cadmium plated spring washer supplied with each unit.
5. Approximate weights:

	WITH HARDWARE		WITHOUT HARDWARE	
UNIT	OUNCES	GRAMS	OUNCES	GRAMS
C45	4.25	120	3.50	99
C46	3.50	99	2.75	78

HIGH SPEED

Silicon Controlled Rectifier

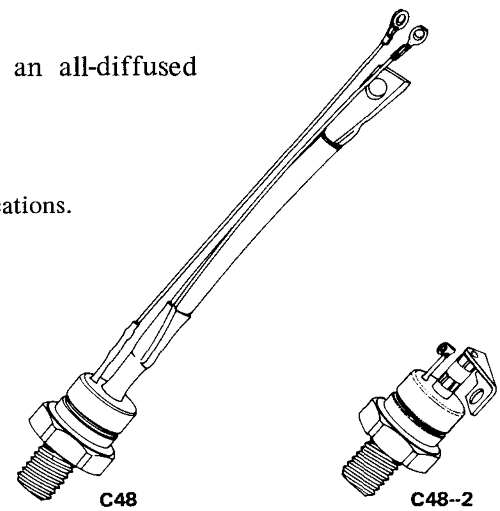
1200 VOLTS 110A RMS

C48

The General Electric C48 Silicon Controlled Rectifier is an all-diffused device designed for power switching at high frequencies.

FEATURES:

- Fully characterized for operation in inverter and chopper applications.
- High dv/dt with selections available.
- Excellent surge and I^2t ratings providing easy fusing.
- Rugged hermetic package.



MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} [1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} [1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} [1] T_J = +125°C
C48M	600 Volts	600 Volts	720 Volts
C48S	700	700	840
C48N	800	800	940
C48T	900	900	1080
C48P	1000	1000	1200
C48PA	1100	1100	1320
C48PB	1200	1200	1440

[1] Half sinewave waveform, 10 ms max. pulse width.

RMS On-State Current, $I_{T(RMS)}$ . . . . . 110 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . . 700 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . . 670 Amperes
I^2t (for fusing) for times $\geq$ 1.5 milliseconds . . . . . 1,360 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times $\geq$ 8.3 milliseconds . . . . . 2,000 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive . . . . . 100 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive . . . . . 75 A/μs †
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . . 2 Watts
Storage Temperature, T_{stg} . . . . . -40°C to +150°C
Operating Temperature, T_J . . . . . -40°C to +125°C
Stud Torque . . . . . 125 – 150 Lb.-In.
14.1 – 17 N-m

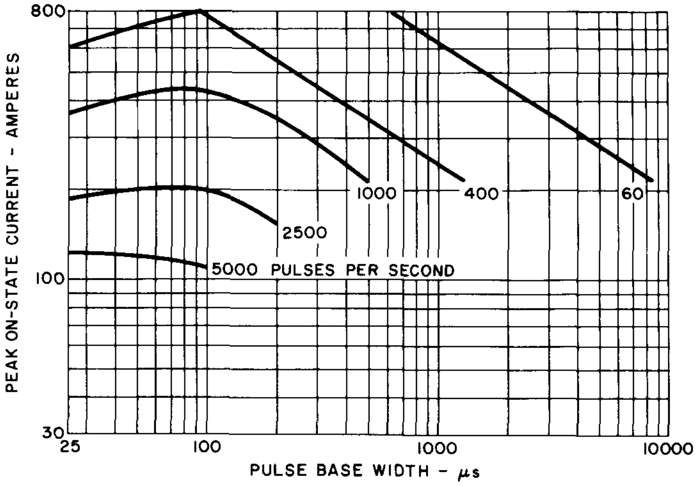
†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5 μs short circuit trigger current rise time.

CHARACTERISTICS

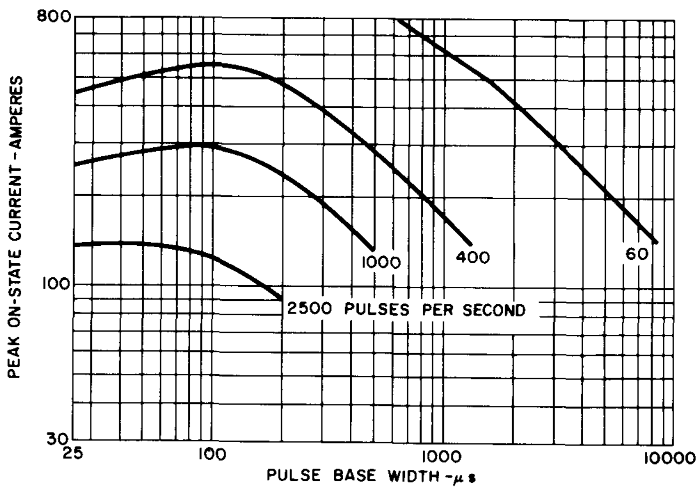
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	7	12	mA	T_J = -40°C to +125°C $V = V_{DRM} = V_{RRM}$
Thermal Resistance	$R_{\theta JC}$	–	–	.3	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	–	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated, Using Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
DC Gate Trigger Current	I_{GT}	–	–	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	3.0	Vdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	3.5		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.25	–	–		T_C +125°C, Rated V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	4.0	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak, 1 ms. wide pulse. Duty Cycle ≤ 1 %
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q				μsec	(1) T_C = +125°C (2) I_T = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 20 V/μsec (linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition rate = 1 pps (8) Gate bias during turn-off interval = 0 volts, 100 ohms
C48 – 30		–	–	30		
C48 – 40		–	–	40		
C48 – 30		–	38	†	μsec	(1) T_C = +125°C (2) I_T = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 200 V/μsec (linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition rate = 1 pps (8) Gate bias during turn-off interval = 0 volts, 100 ohms
C48 – 40		–	48	†		
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	t_q				μsec	(1) T_C = 125°C (2) I_T = 150 Amps. (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-rise of off-state voltage = 200 V/μsec (linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition rate = 1 pps (8) Gate bias during turn-off interval = 0 volts, 100 ohms
C48 – 30		–	45	–		
C48 – 40		–	55	–		

†Consult factory for a specified maximum turn-off time.

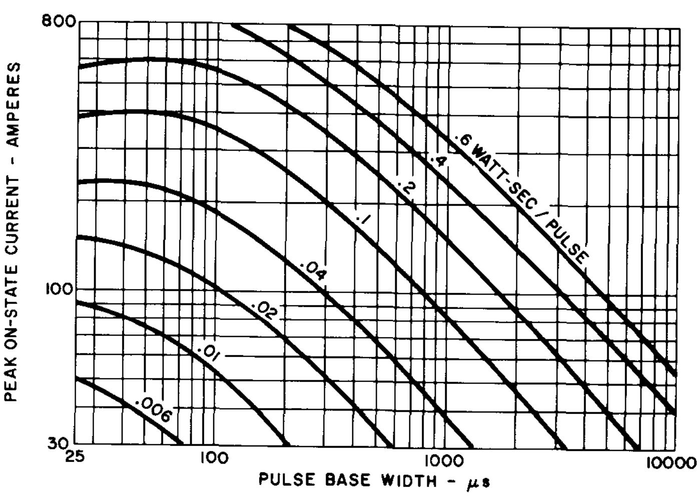
SINE WAVE CURRENT RATING DATA



1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



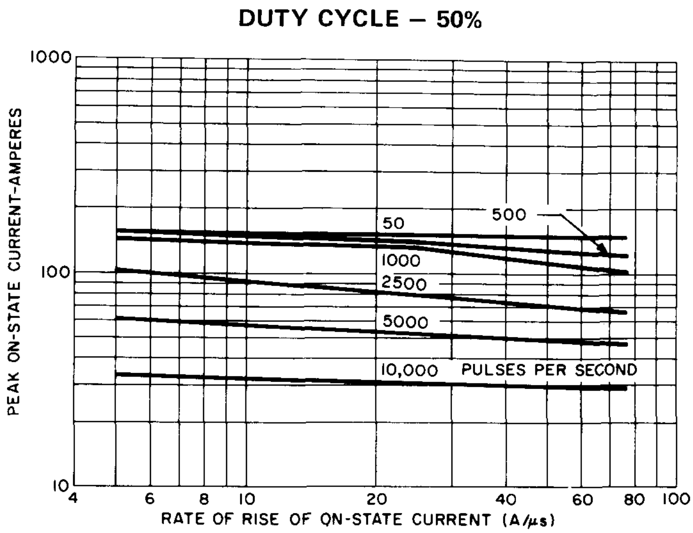
3. ENERGY PER PULSE FOR SINUSOIDAL PULSES (T_J = 125°C)

NOTES:

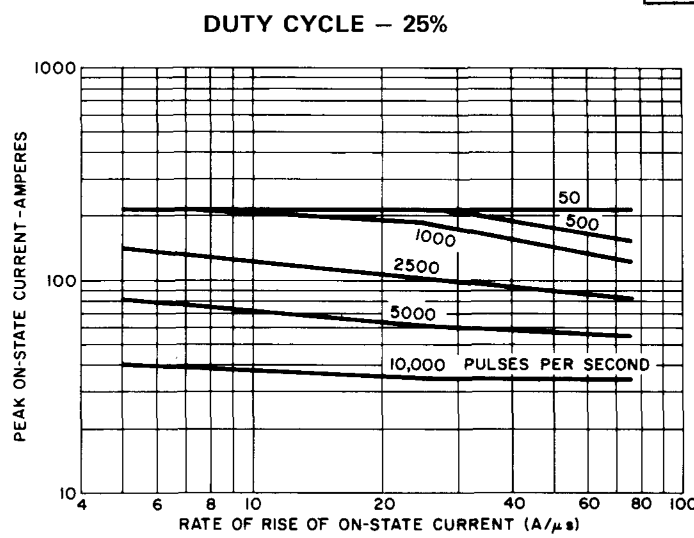
(Pertaining to Sine and Rectangular or Wave Current Ratings)

1. Switching voltage = 800 volts.
2. Maximum circuit dv/dt = 200 V/μsec
3. Reverse voltage applied = $V_R \leqslant$ 800V.
4. Required gate drive:
   20 volts, 20 ohms, .1 μsec risetime for 75 A/μsec repetitive rating.
5. RC Snubber Circuit = .25 μf, 20Ω

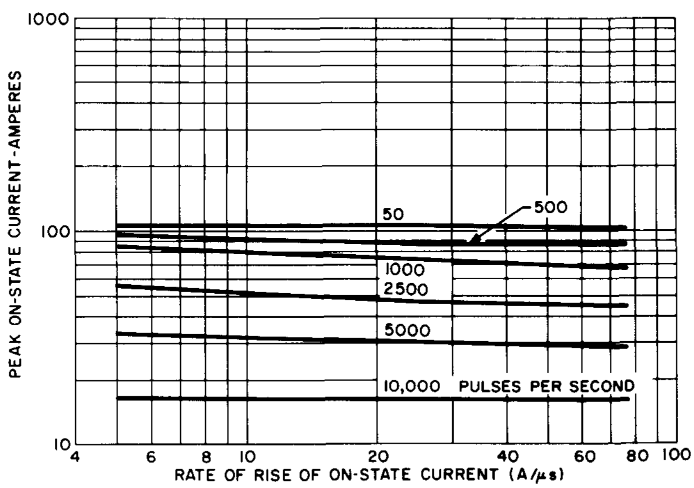
RECTANGULAR WAVE CURRENT RATING DATA



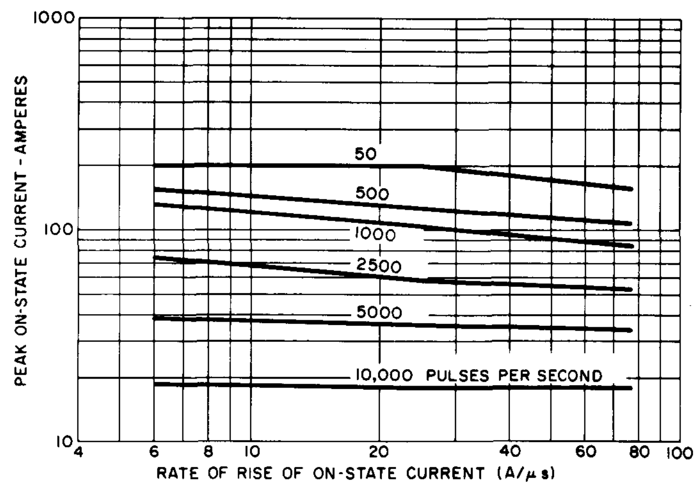
4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)



5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

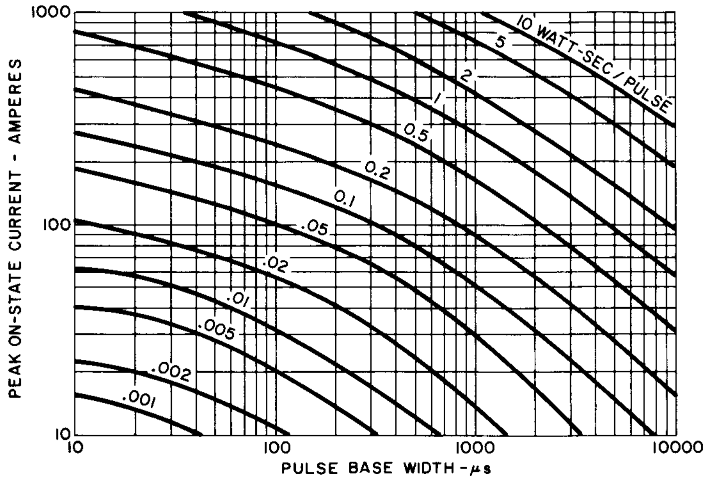


6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

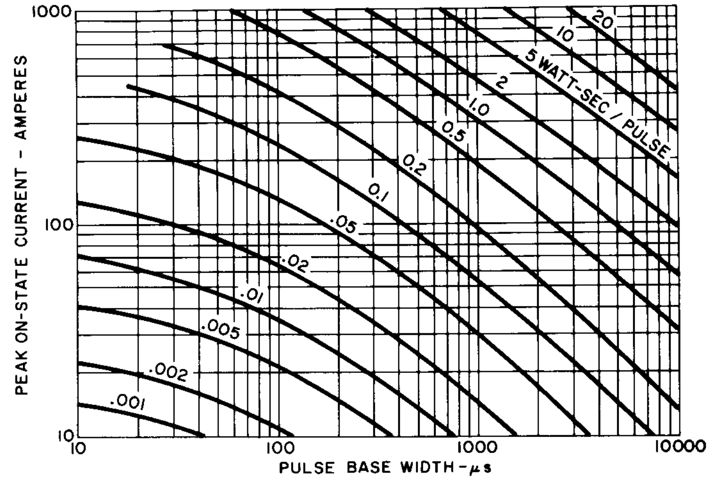


7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

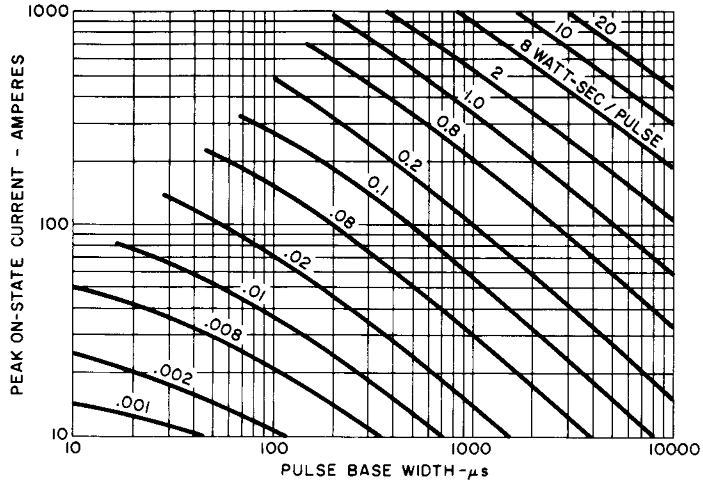
WATT-SECOND PER PULSE



8. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100A/μsec) T_J = 125°C

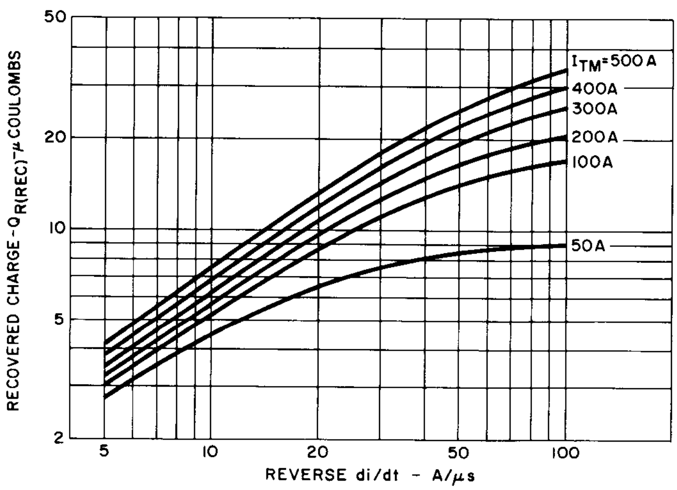


9. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25A/μsec) T_J = 125°C

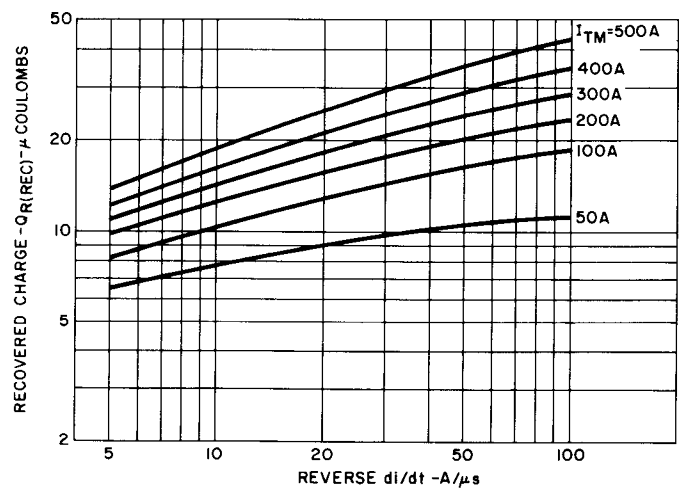


10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5A/μsec) T_J = 125°C

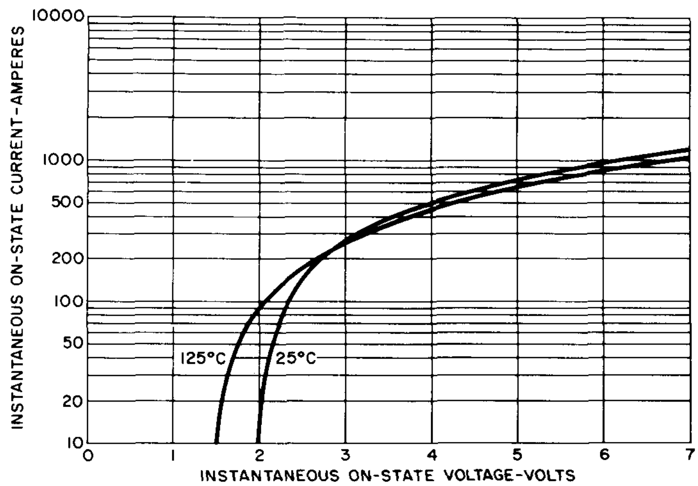
RECOVERED CHARGE DATA



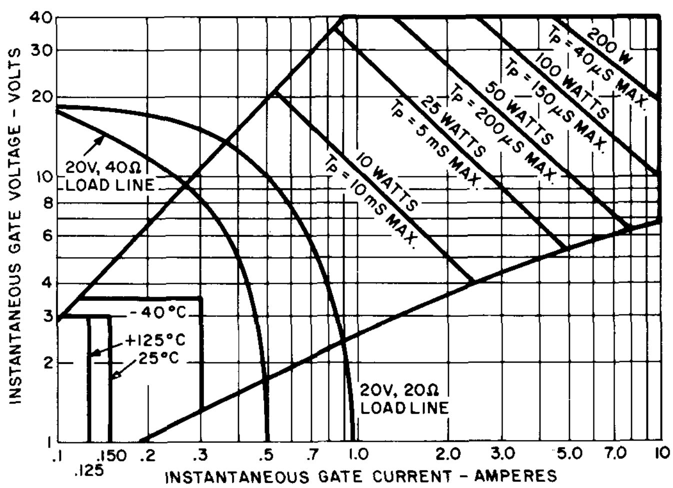
11. TYPICAL RECOVERED CHARGE DATA (T_J = 25°C) SINEWAVE CURRENT WAVEFORM



12. TYPICAL RECOVERED CHARGE DATA (T_J = 125°C) SINEWAVE CURRENT WAVEFORM



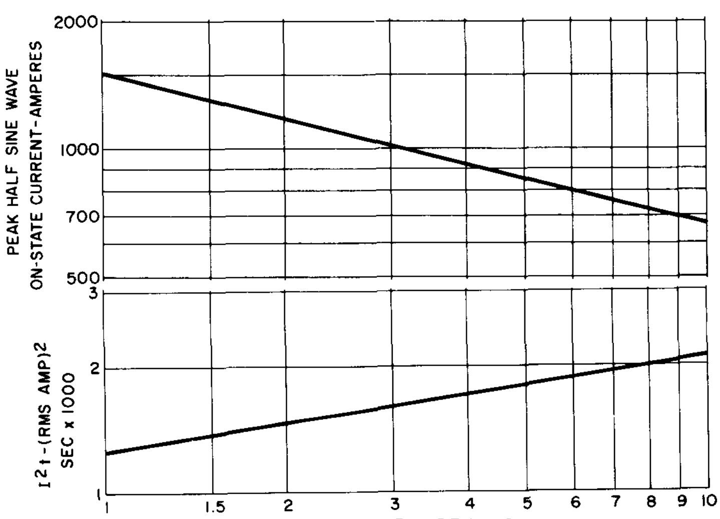
13. MAXIMUM ON-STATE CHARACTERISTICS



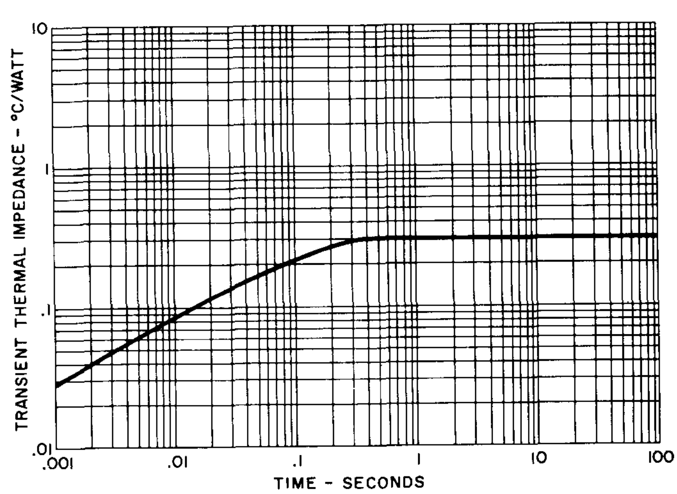
14. GATE TRIGGERING CHARACTERISTICS AND POWER RATINGS

NOTES:

1. Locus of possible dc trigger points lies outside the boundaries shown at the various case temperatures.
2. Rectangular gate pulses.
3. Tp = gate current pulse width.

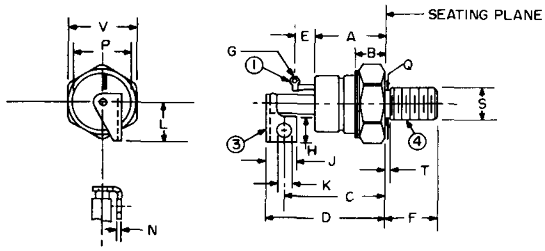


15. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



16. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

OUTLINE DRAWING

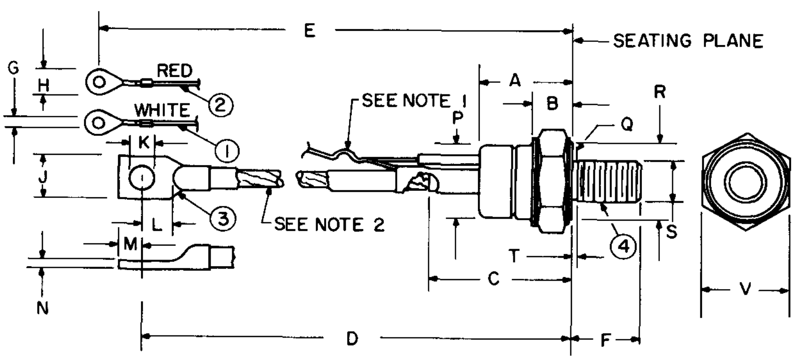


MODEL	TERMINAL ①	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C48-2	GATE	CATHODE +	ANODE −	1/2-20 UNF-2A

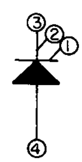
NOTES:

1. ONE NUT AND ONE LOCKWASHER SUPPLIED WITH EACH UNIT. MATERIAL OF HARDWARE IS STEEL, CAD PLATED.
2. "T" DIM. IS AREA OF UNTHREADED PORTION. COMPLETE THDS. ARE WITHIN 2.5 THREADS OF SEATING PLANE.
3. ANGULAR ORIENTATION OF TERMINALS IS UNDEFINED.

SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.590	.640	14.98	16.26	
B	.390	.500	9.90	12.70						
C	1.460 REF.		7.92 REF.		N	.058	.070	1.47	1.78	
D	1.660	1.800	42.16	45.72						
E	.312 REF.		7.92 REF.		P	.840	.910	21.33	23.11	
F	.797	.827	20.24	21.01						
G	.060	.075	1.52	1.91	Q	.425	.499	10.79	12.67	
H	.385	.415	9.77	10.54	T	—	.060	—	1.52	2
J	.445	.485	11.30	12.32	V	1.052	1.063	26.72	27.00	
K	.198	.212	5.02	5.38						



SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.330	—	8.38	—	
B	.390	.500	9.90	12.70	M	.275	.325	6.98	8.26	
C	1.570	1.750	39.87	44.45	N	.065	.095	1.65	2.41	
D	6.000	6.390	152.40	162.31	P	.840	.910	21.33	23.11	
E	6.850	7.500	173.99	190.50	Q	.425	.499	10.79	12.67	
F	.797	.827	20.24	21.01	R	.920	—	23.36	—	4
G	.140	.150	3.55	3.81	T	—	.060	—	1.57	5
H	—	.300		7.62						
J	.500	.610	12.70	15.49	V	1.052	1.063	26.72	27.00	
K	.260	.281	6.60	7.14						



MODEL	TERMINAL ①	TERMINAL ②	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C48	GATE	AUX CATHODE	CATHODE +	ANODE −	1/2 20UNF-2A

NOTES:

1. GATE & AUX. CATHODE LEADS SUPPLIED LIGHTLY TWISTED TOGETHER.
2. FLEXIBLE COPPER LEAD.
3. ONE NUT AND ONE LOCKWASHER SUPPLIED WITH EACH UNIT. MATERIAL OF HARDWARE IS STEEL, CAD PLATED.
4. "R" DIM. IS DIA. OF EFFECTIVE SEATING AREA.
5. "T" DIM. IS AREA OF UNTHREADED PORTION. COMPLETE THDS. ARE WITHIN 2.5 THREADS OF SEATING PLANE.
6. ANGULAR ORIENTATION OF TERMINALS IS UNDEFINED.

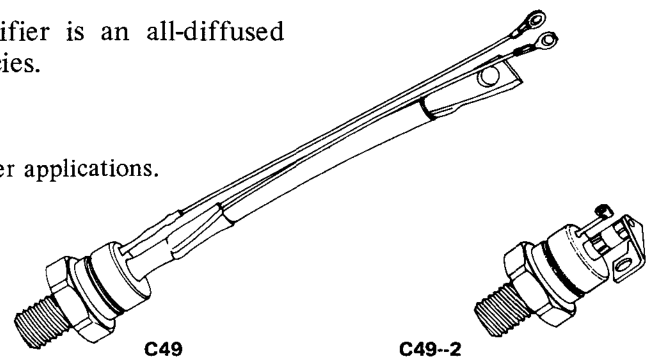
HIGH SPEED

Silicon Controlled Rectifier

C49

600 VOLTS 110 A RMS

The General Electric C49 Silicon Controlled Rectifier is an all-diffused device designed for power switching at high frequencies.



FEATURES:

- Fully characterized for operation in inverter and chopper applications.
- High dv/dt with selections available.
- Excellent surge and I^2t ratings providing easy fusing.
- Rugged hermetic package.

Equipment designers can use the C49 in demanding applications, such as:

- Choppers
- Inverters
- Induction Heaters
- High Frequency Lighting
- Cycloconverters
- DC to DC Conversion

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} (1)	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} (1)	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} (1)
	T_J = -40°C to +125°C	T_J = -40°C to +125°C	T_J = 125°C
C49A10, C49A20	100 Volts	100 Volts	150 Volts
C49B10, C49B20	200	200	300
C49C10, C49C20	300	300	400
C49D10, C49D20	400	400	500
C49E10, C49E20	500	500	600
C49M10, C49M20	600	600	720

[1] Half sinewave waveform, 10 ms max. pulse width.

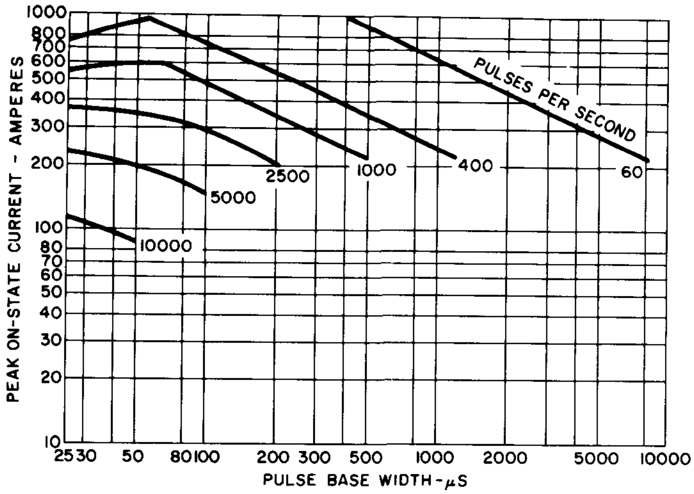
RMS On-State Current, $I_{T(RMS)}$	110 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz)	1000 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz)	920 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds	2,850 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds	4,150 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive	200 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive	100 A/μs †
Average Gate Power Dissipation, $P_{G(AV)}$	2 Watts
Storage Temperature, T_{stg}	-40°C to +150°C
Operating Temperature, T_J	-40°C to +125°C
Stud Torque	125 – 150 Lb.-In. 14.1 – 17 N-m

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5 μs short circuit trigger current rise time.

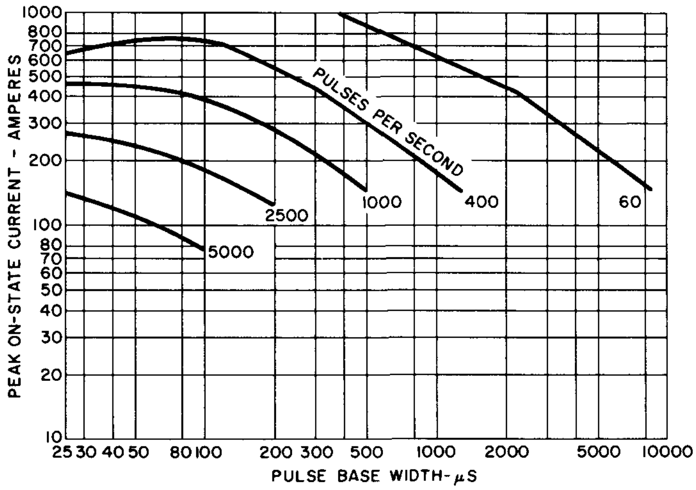
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	7	12	mA	T_J = -40°C to +125°C V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	.35	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	–	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated, Using Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
DC Gate Trigger Current	I_{GT}	–	–	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	3.0	Vdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	3.5		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.25	–	–		T_C = +125°C, Rated V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	3.0	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak, 1 ms. wide pulse. Duty Cycle ≤ 1%.
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage) C49 – 10 C49 – 20	t_q	 – –	 8 15	 10 20	μsec	(1) T_C = +125°C (2) I_T = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 20 V/μsec (linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
C49 – 10 C49 – 20		– –	13 20	† †		(1) T_C = +125°C (2) I_T = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 200 V/μsec (linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode) C49 – 10 C49 – 20	$t_{q(diode)}$	 – –	 20 35	 † †	μsec	(1) T_C = +125°c (2) I_T = 150 Amps. (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 200V/μsec (linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition Rate = 1 pps (8) Gate bias during turn-off interval = 0 volts, 100 ohms

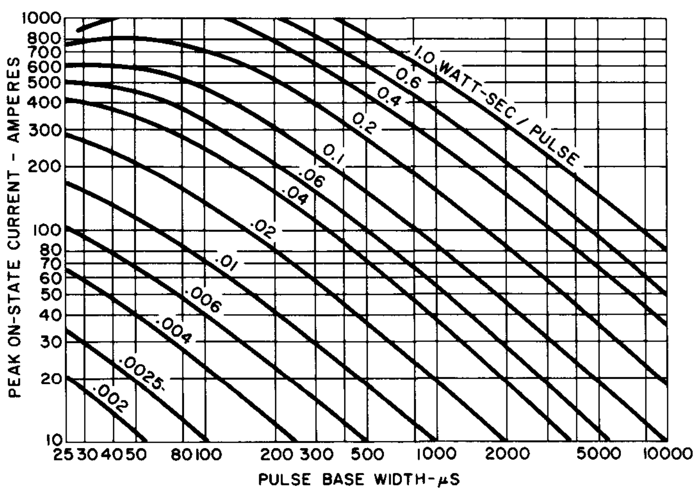
†Consult factory for maximum turn-off times for these conditions



1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



3. ENERGY PER PULSE FOR SINUSOIDAL PULSES (T_J = 125°C)

NOTES:
(Pertaining to Sine and Rectangular Wave Current Ratings)

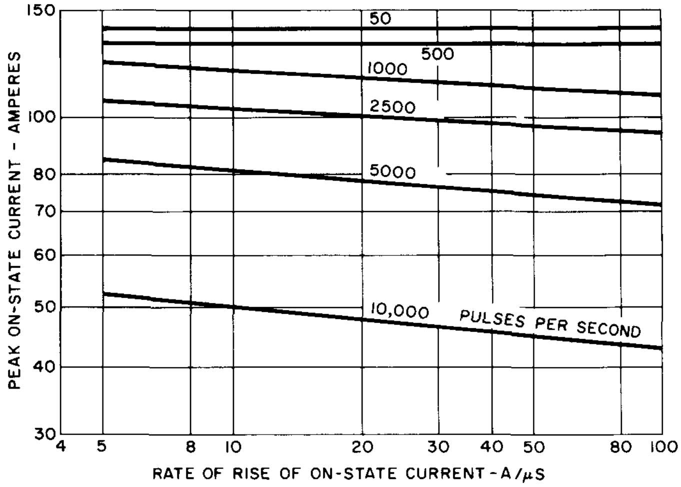
1. Switching voltage = 400 volts.
2. Maximum ckt. dv/dt = 200 volts/μsec.
3. Reverse voltage applied = $V_R \leqslant$ 400V.
4. Required gate drive:
   20 volts, 20 ohms, .1 μsec risetime for 100 amps/μsec repetitive rating.
   20 volts, 40 ohms, .5 μsec risetime for 30 amps/μsec repetitive rating.
5. RC Snubber ckt. = .25 μf, 5Ω.

If the circuit di/dt remains below 30 amps/μs, and normally constructed snubbers using the components specified are employed, then the "soft" gate drive is sufficient. (20V, 40Ω, 0.5 μsec risetime.)

If the circuit di/dt exceeds 30 amps/μs, then the stiff gate source (20V — 20Ω), t_r = .1 μs, must be used. In addition the total device di/dt must be checked to insure that it is the long term repetitive limit for stiff gate source. (20V, 20Ω, 0.1 μsec risetime.)

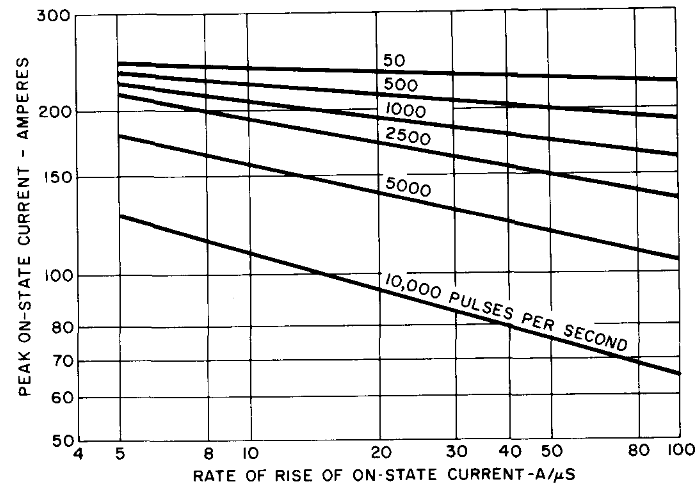
RECTANGULAR WAVE CURRENT RATING DATA

DUTY CYCLE – 50%

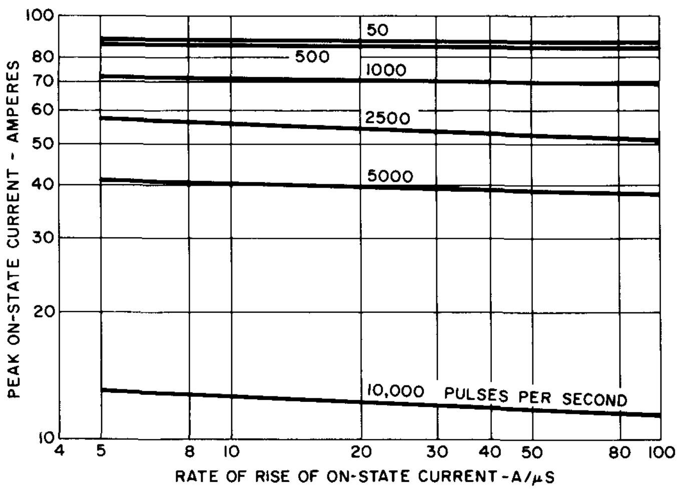


4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

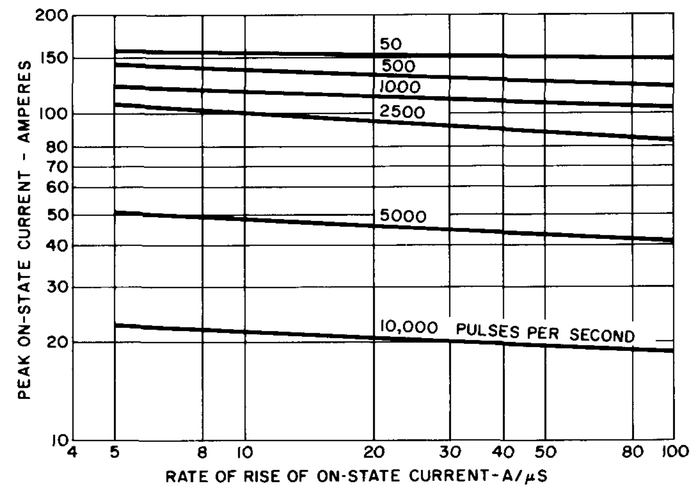
DUTY CYCLE – 25%



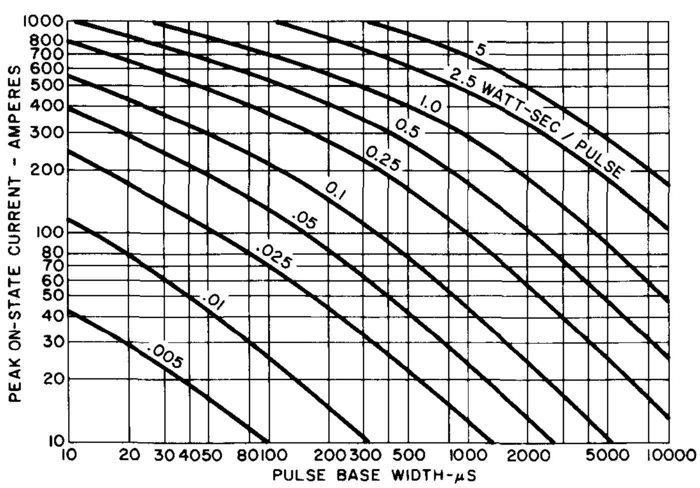
5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)



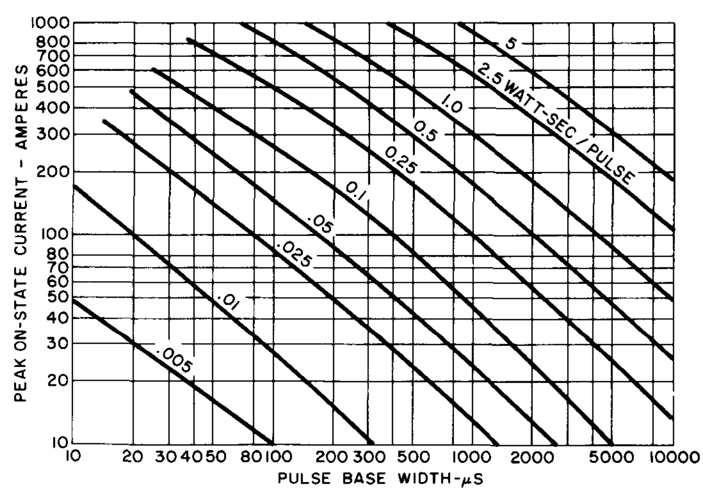
6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)



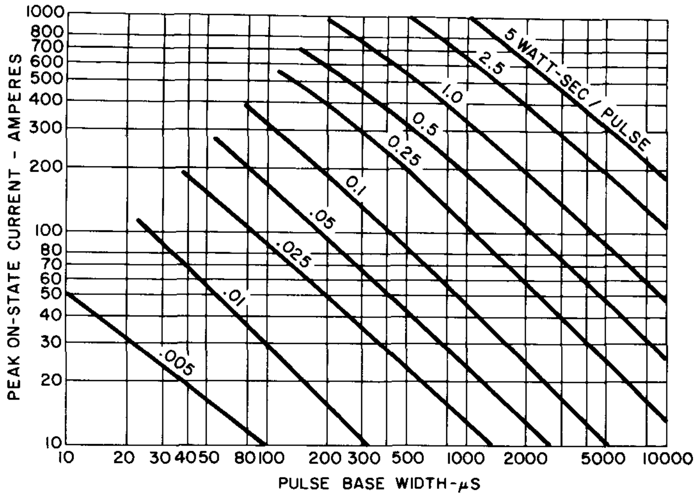
7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)



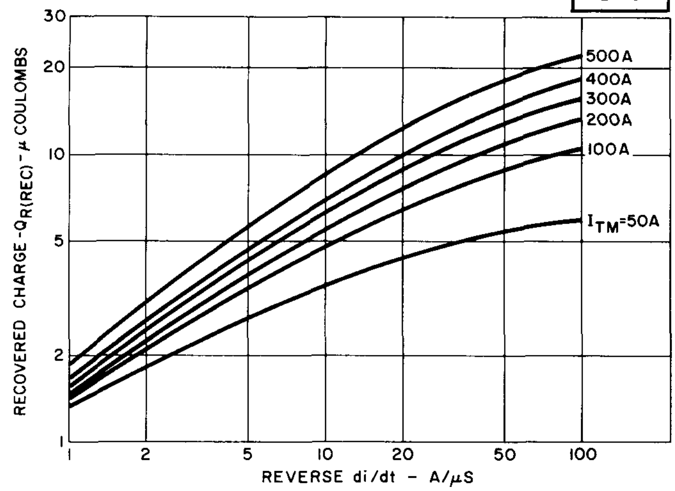
8. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100A/μsec) T_J = 125°C



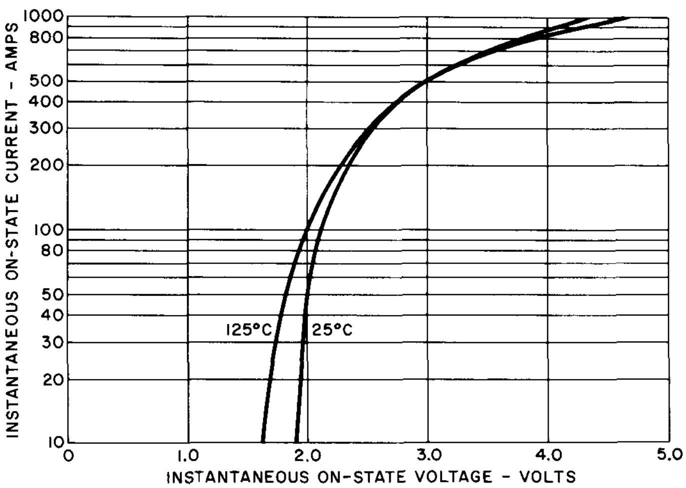
9. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25A/μsec) T_J = 125°C



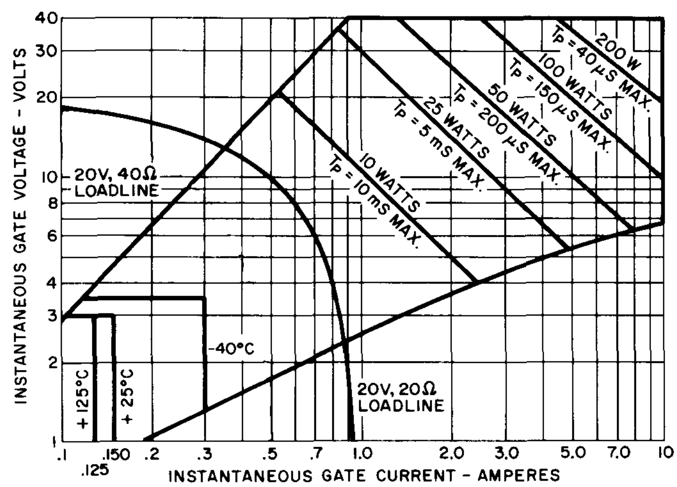
10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5A/μsec) T_J = 125°C



11. TYPICAL RECOVERED CHARGE DATA (T_J = 125°C)



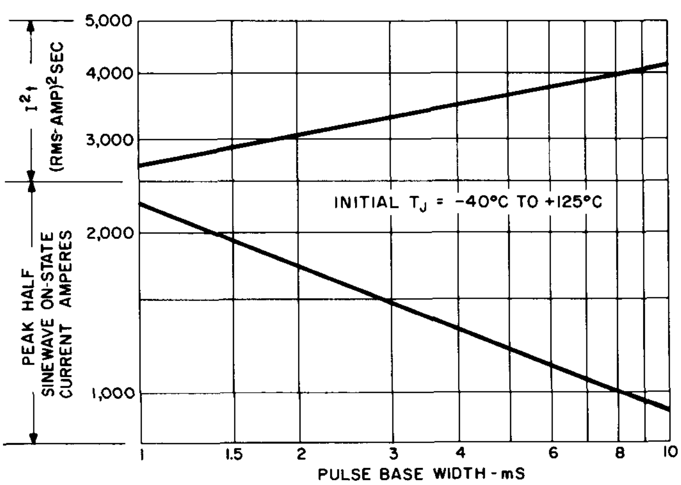
12. MAXIMUM ON-STATE CHARACTERISTICS



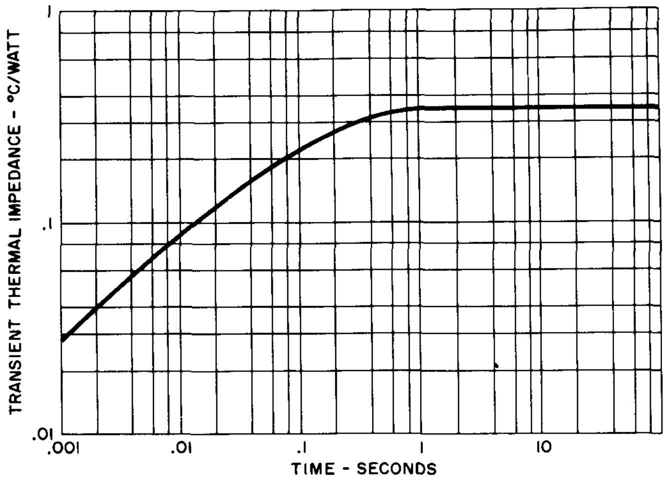
13. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

NOTES:

1. Locus of possible dc trigger points lies outside the boundaries shown at the various case temperatures.
2. Rectangular gate pulses.
3. Tp = gate current pulse width.



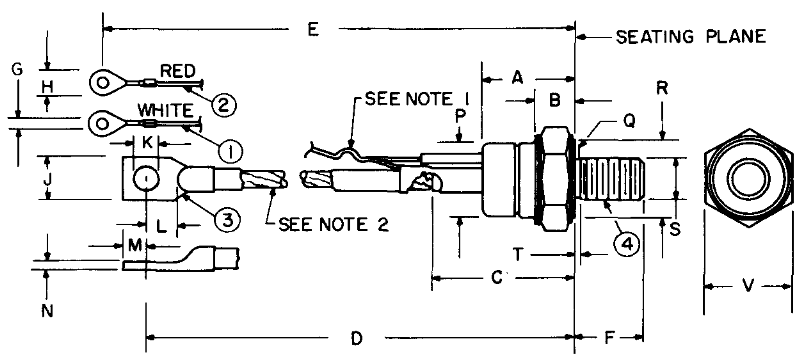
14. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



15. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

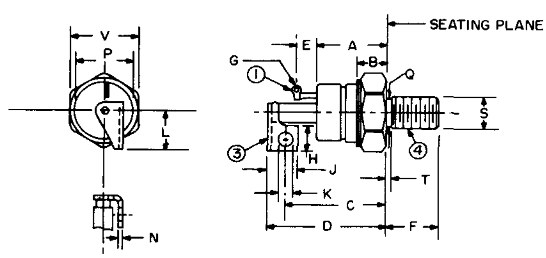
OUTLINE DRAWING

SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.330	—	8.38	—	
B	.390	.500	9.90	12.70	M	.275	.325	6.98	8.26	
C	1.570	1.750	39.87	44.45	N	.065	.095	1.65	2.41	
D	6.000	6.390	152.40	162.31	P	.840	.910	21.33	23.11	
E	6.850	7,500	173.99	190.50	Q	.425	.499	10.79	12.67	
F	.797	.827	20.24	21.01	R	.920	—	23.36	—	4
G	.140	.150	3.55	3.81	T	—	.060	—	1.57	5
H	—	.300		7.62						
J	.500	.610	12.70	15.49	V	1.052	1.063	26.72	27.00	
K	.260	.281	6.60	7.14						



MODEL	TERMINAL ①	TERMINAL ②	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C49	GATE	AUX CATHODE	CATHODE +	ANODE —	1/2 20UNF-2A

NOTES:
1. GATE & AUX. CATHODE LEADS SUPPLIED LIGHTLY TWISTED TOGETHER.
2. FLEXIBLE COPPER LEAD.
3. ONE NUT AND ONE LOCKWASHER SUPPLIED WITH EACH UNIT. MATERIAL OF HARDWARE IS STEEL, CAD PLATED.
4. "R" DIM. IS DIA. OF EFFECTIVE SEATING AREA.
5. "T" DIM. IS AREA OF UNTHREADED PORTION. COMPLETE THDS. ARE WITHIN 2.5 THREADS OF SEATING PLANE.
6. ANGULAR ORIENTATION OF TERMINALS IS UNDEFINED.



MODEL	TERMINAL ①	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C49-2	GATE	CATHODE +	ANODE —	1/2-20 UNF-2A

NOTES:
1. ONE NUT AND ONE LOCKWASHER SUPPLIED WITH EACH UNIT. MATERIAL OF HARDWARE IS STEEL, CAD PLATED.
2. "T" DIM. IS AREA OF UNTHREADED PORTION. COMPLETE THDS. ARE WITHIN 2.5 THREADS OF SEATING PLANE.
3. ANGULAR ORIENTATION OF TERMINALS IS UNDEFINED.

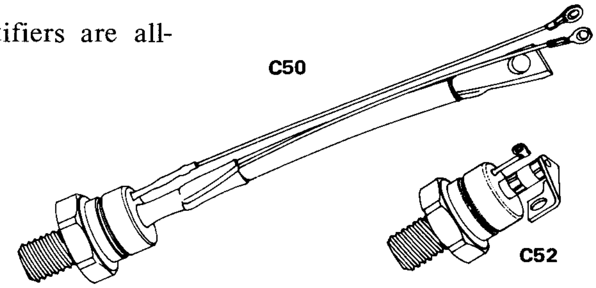
SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.590	.640	14.98	16.26	
B	.390	.500	9.90	12.70						
C	1.460 REF.		7.92 REF.		N	.058	.070	1.47	1.78	
D	1.660	1.800	42.16	45.72						
E	.312 REF.		7.92 REF.		P	.840	.910	21.33	23.11	
F	.797	.827	20.24	21.01						
G	.060	.075	1.52	1.91	Q	.425	.499	10.79	12.67	
H	.385	.415	9.77	10.54	T	—	.060	—	1.52	2
J	.445	.485	11.30	12.32	V	1.052	1.063	26.72	27.00	
K	.198	.212	5.02	5.38						

High Power Silicon Controlled Rectifier

110 A RMS 25 to 1200 Volts

C50
C52

The General Electric C50 and C52 Silicon Controlled Rectifiers are all-diffused devices designed for phase control applications.



FEATURES:

- High dv/dt With Selection Available
- Excellent Surge and I^2t Ratings Providing Easy Fusing
- Rugged Hermetic Package

MAXIMUM ALLOWABLE RATINGS

TYPE				REPETITIVE PEAK OFF-STATE VOLTAGE V_{DRM} [1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE V_{RRM} [1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE V_{RSM} [1] T_J = +125°C
C50U	(2N1909)	C52U		25 Volts	25 Volts	25 Volts
C50F	(2N1910)	C52F	(2N1792)	50	50	75
C50A	(2N1911)	C52A	(2N1793)	100	100	150
C50G	(2N1912)	C52G	(2N1794)	150	150	225
C50B	(2N1913)	C52B	(2N1795)	200	200	300
C50H	(2N1914)	C52H	(2N1796)	250	250	350
C50C	(2N1915)	C52C	(2N1797)	300	300	400
C50D	(2N1916)	C52D	(2N1798)	400	400	500
C50E		C52E		500	500	600
C50M		C52M		600	600	720
C50S		C52S		700	700	840
C50N		C52N		800	800	960
C50T		C52T		900	900	1040
C50P		C52P		1000	1000	1200
C50PA		C52PA		1100	1100	1320
C50PB		C52PB		1200	1200	1440

[1] Half sine wave waveform, 10 msec, maximum pulse width.

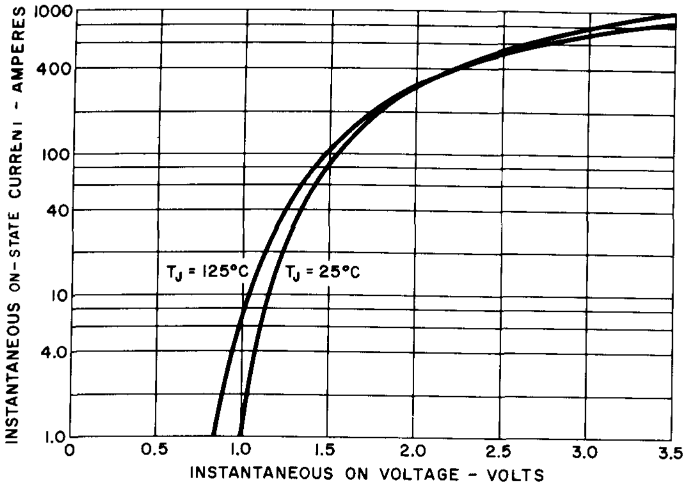
RMS On-State Current, $I_{T(RMS)}$ . . . . 110 Amperes (All Conduction Angles)
Average On-State Current, $I_{T(AV)}$ . . . . Depends on Conduction Angles (See Charts 3 and 4)
Critical Rate-of-Rise of On-State Current (Non-Repetitive) di/dt:*
  Switching From 1200 Volts . . . . 100 Amperes Per Microsecond
  Switching From 600 Volts . . . . 200 Amperes Per Microsecond
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 1000 Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 910 Amperes
I^2t (for fusing), for times ≥ 8.3 milliseconds (See Figure 9) . . . . 4150 (RMS Ampere)^2 Seconds
I^2t (for fusing), for times ≥ 1.5 milliseconds (See Figure 9) . . . . 2850 (RMS Ampere)^2 Seconds
Peak Gate Power Dissipation, P_{GM} (See Figure 7) . . . . .100 Watts for 150 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Stud Torque . . . . 125 Lbs.-In. (Min.) – 150 Lbs.-In. (Max.)
14 N-m (Min.) – 17 N-m (Max.)

*di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of V_{DRM} stated above; 20 volts, 20 ohms gate trigger source with 0.5 μsec short circuit trigger current rise time.

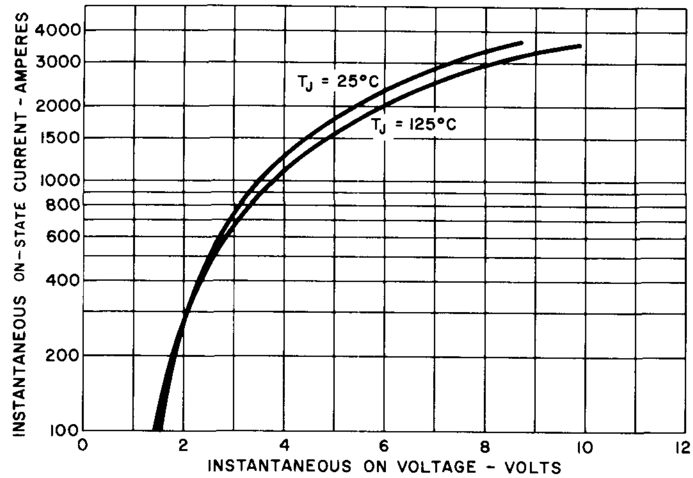
CHARACTERISTICS

TEST	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}	–	10	mA	T_J = -40°C to +125°C $V_{DRM} = V_{RRM}$
C50, C52U (2N1909)					25 Volts Peak
C50, C52F					50
C50, C52A (2N1910) (2N1792)					100
C50, C52G (2N1911) (2N1793)					150
C50, C52B (2N1912) (2N1794)					200
C50, C52H					250
C50, C52C (2N1913) (2N1795)					300
C50, C52D (2N1914) (2N1796)					400
C50, C52E (2N1915) (2N1797)					500
C50, C52M					600
C50, C52S (2N1916) (2N1798)					700
C50, C52N					800
C50, C52T					900
C50, C52P					1000
C50, C52PA					1100
C50, C52PB					1200
DC Gate Trigger Current	I_{GT}	–	75	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms $t_p \geqslant$ 20 μsec
		–	130		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms $t_p \geqslant$ 20 μsec
		–	40		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms $t_p \geqslant$ 20 μsec
DC Gate Trigger Voltage	V_{GT}	–	3.0	Vdc	T_C = -40°C to +125°C, V_D = 6 Vdc, R_L = 50 Ohms, $t_p \geqslant$ 20 μsec
		.25	–		T_C = +125°C, V_D = Rated, R_L = 1000 Ohms, t_p = 20 μsec
Peak On-State Voltage	V_{TM}	–	2.5	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak. Duty Cycle $\leqslant$ 0.01%
Holding Current	I_H	–	100	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial Forward Current = 2 Amperes
Thermal Resistance	$R_{\theta JC}$	–	0.4	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage. (Higher values may cause device switching.)	dv/dt	200	–	Volts/ μsec	T_J = +125°C, Rated V_{DRM} Using Linear Exponential Rising Waveform, Gate Open Circuited. Exponential dv/dt = V_{DRM} (.632).
Circuit Commutated Turn-Off Time (Typical)	t_q	–	80	μsec	(1) T_C = +120°C (2) I_T = 50 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) = Rated (5) Rate-of-Rise of Reapplied Forward Blocking Voltage = 20 V/μsec (Linear) (6) Gate Bias; 0 Volts, 100 Ohms During Turn-Off Interval (7) Duty Cycle $\leqslant$ .01%.

Higher minimum dv/dt selections available, consult factory.



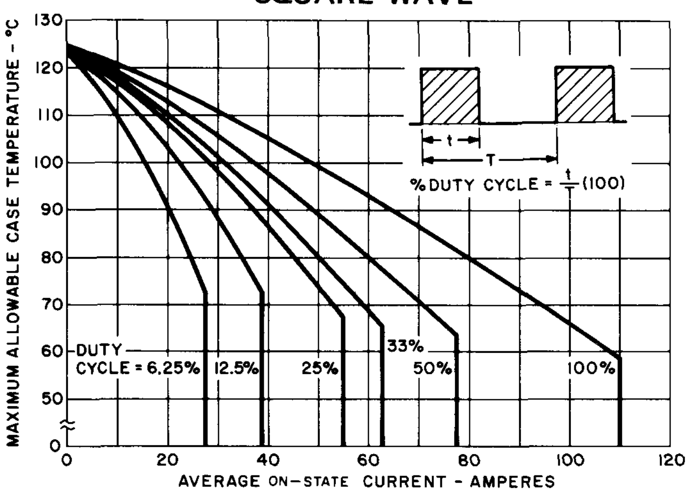
1. MAXIMUM ON-STATE CHARACTERISTICS



2. MAXIMUM ON-STATE CHARACTERISTICS (HIGH CURRENT LEVEL)

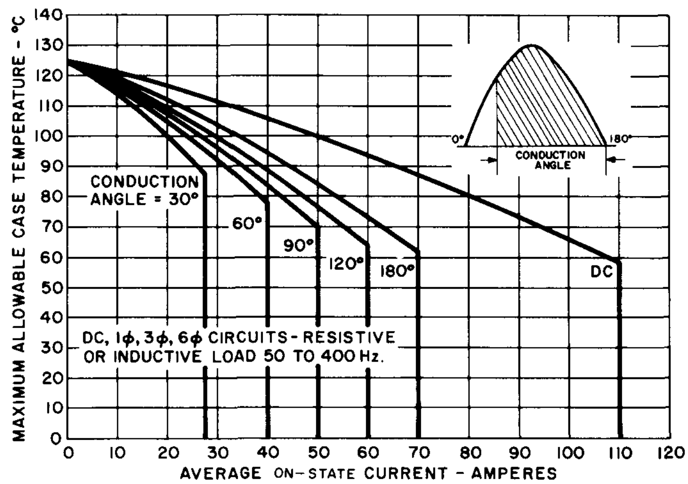
50 TO 400 Hz AC LINE OPERATION

SQUARE WAVE

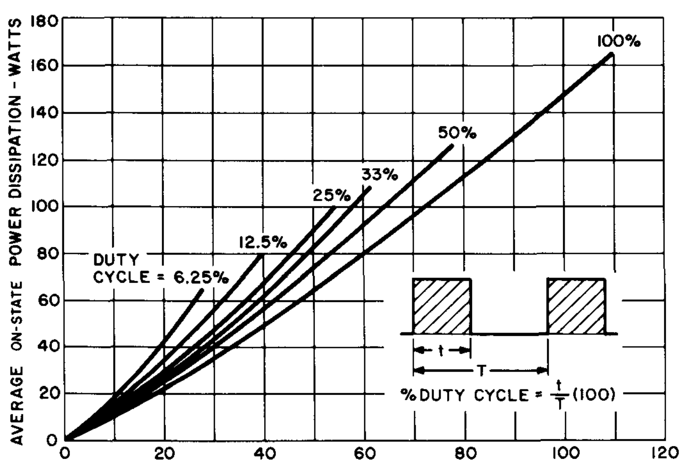


3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM

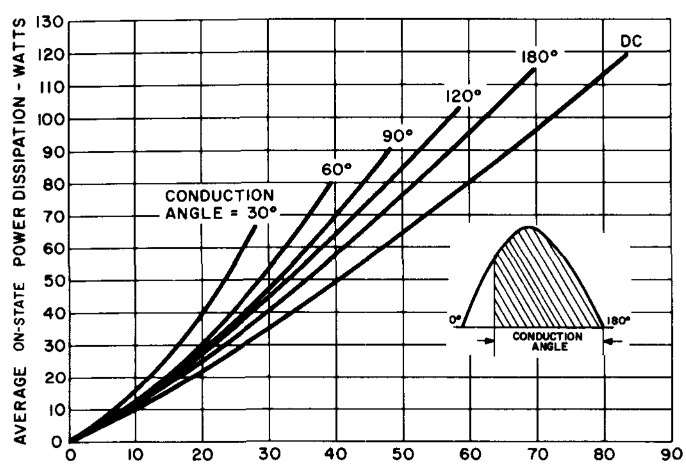
SINUSOIDAL



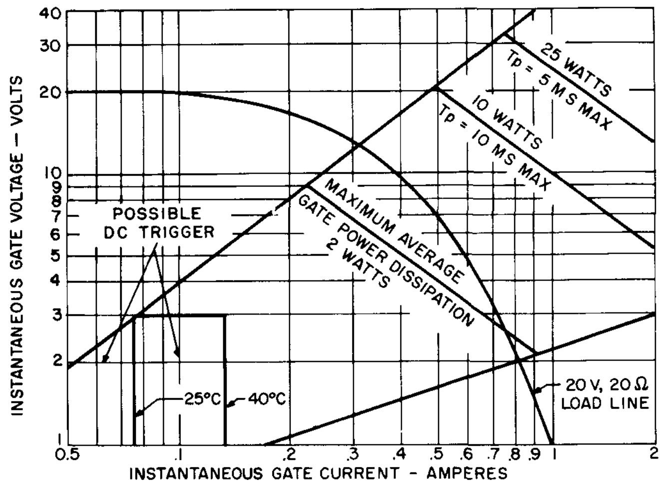
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



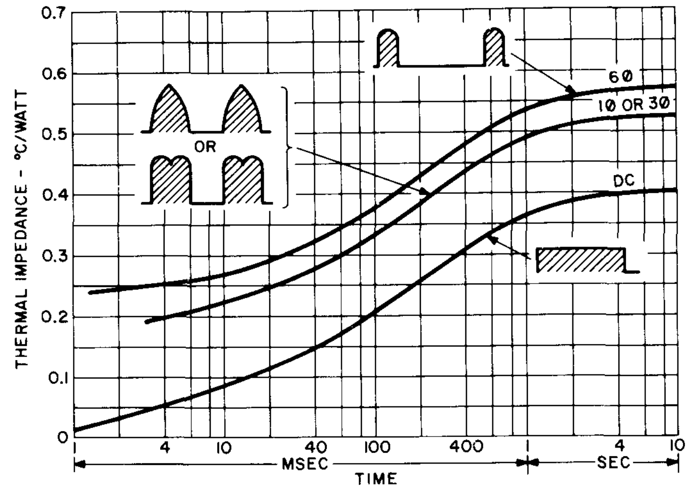
5. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



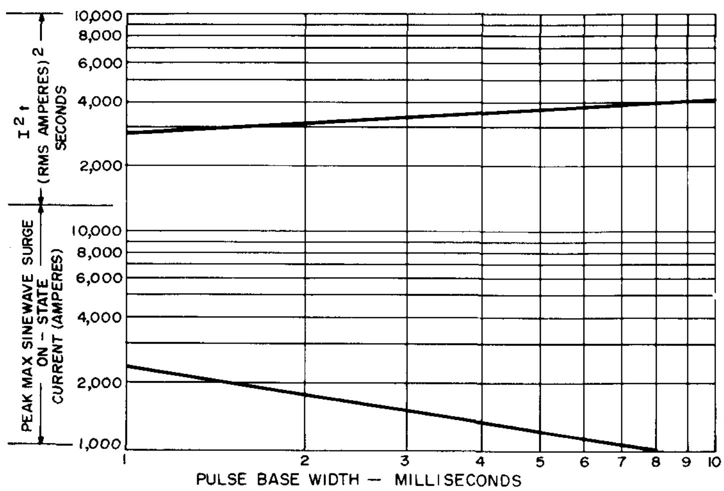
6. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



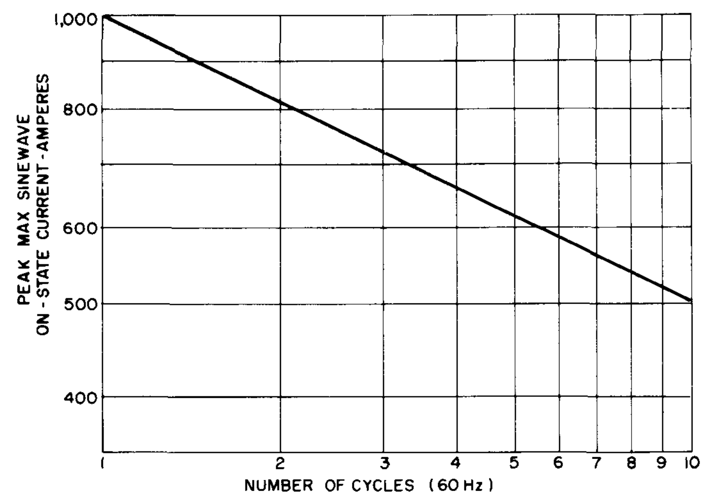
7. GATE TRIGGERING CHARACTERISTICS AND POWER RATINGS



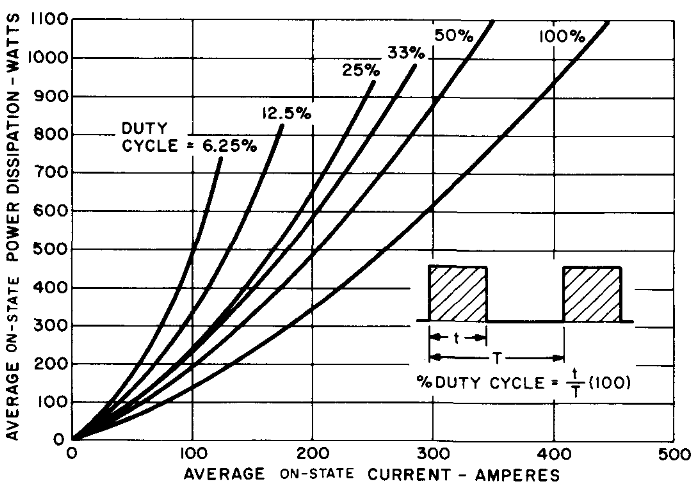
8. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



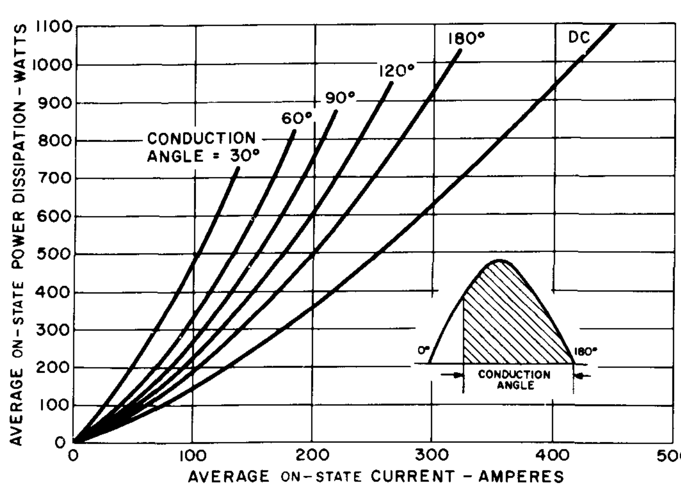
9. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



10. SURGE (NON-REPETITIVE) ON-STATE CURRENT

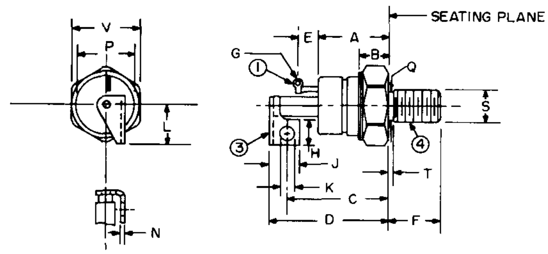


11. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM (EXTENDED RANGE)



12. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM (EXTENDED RANGE)

OUTLINE DRAWINGS

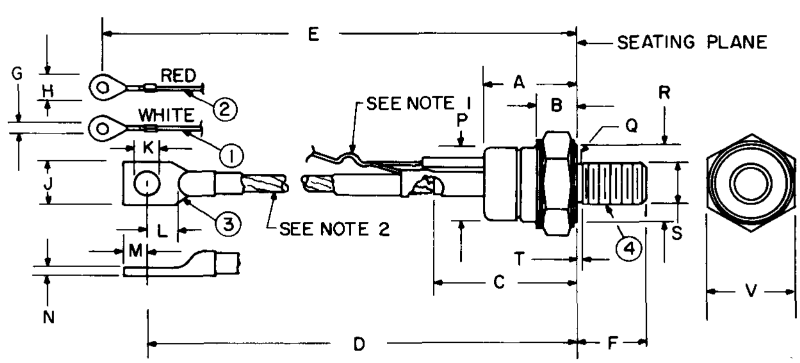


MODEL	TERMINAL ①	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C52	GATE	CATHODE +	ANODE −	1/2-20 UNF-2A

SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.590	.640	14.98	16.26	
B	.390	.500	9.90	12.70						
C	1.460 REF.		7.92 REF.		N	.058	.070	1.47	1.78	
D	1.660	1.800	42.16	45.72						
E	.312 REF.		7.92 REF.		P	.840	.910	21.33	23.11	
F	.797	.827	20.24	21.01						
G	.060	.075	1.52	1.91	Q	.425	.499	10.79	12.67	
H	.385	.415	9.77	10.54	T	—	.060	—	1.52	2
J	.445	.485	11.30	12.32	V	1.052	1.063	26.72	27.00	
K	.198	.212	5.02	5.38						

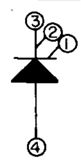
NOTES:

1. One nut and one lockwasher supplied with each unit. Material of hardware is steel, cad plated.
2. "T" dimension is area of unthreaded portion. Complete threads are within 2.5 threads of seating plane.
3. Angular orientation of terminals is undefined.



SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.330	—	8.38	—	
B	.390	.500	9.90	12.70	M	.275	.325	6.98	8.26	
C	1.570	1.750	39.87	44.45	N	.065	.095	1.65	2.41	
D	6.000	6.390	152.40	162.31	P	.840	.910	21.33	23.11	
E	6.850	7.500	173.99	190.50	Q	.425	.499	10.79	12.67	
F	.797	.827	20.24	21.01	R	.920	—	23.36	—	4
G	.140	.150	3.55	3.81	T	—	.060	—	1.57	5
H	—	.300		7.62						
J	.500	.610	12.70	15.49	V	1.052	1.063	26.72	27.00	
K	.260	.281	6.60	7.14						

MODEL	TERMINAL ①	TERMINAL ②	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C50	GATE	AUX CATHODE	CATHODE +	ANODE −	1/2 20UNF-2A



NOTES:

1. Gate and auxiliary cathode leads supplied lightly twisted together.
2. Flexible copper lead.
3. One nut and one lockwasher supplied with each unit. Material of hardware is steel, cad plated.
4. "R" dimension is diameter of effective seating area.
5. "T" dimension is area of unthreaded portion. Complete threads are within 2.5 threads of seating plane.
6. Angular orientation of terminals is undefined.

NOTES:

UNIT	WITH HARDWARE OUNCES	WITH HARDWARE GRAMS	WITHOUT HARDWARE OUNCES	WITHOUT HARDWARE GRAMS
C50	4.25	120	3.50	99
C52	3.50	99	2.75	78

SCR

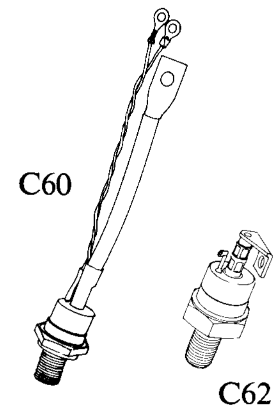
C60,2

500 Volts 110 A RMS

The General Electric C60 (2N2023-2N2030) and C62 Series Silicon Controlled Rectifiers are designed for high-current operation at extreme temperatures. Rated as high as 110 amperes DC—with a maximum junction temperature of 150°C—they are especially suited for applications where high ambients or small heat sinks preclude the use of other controlled rectifiers at a required current level.

The C60 (2N2023-2N2030) and C62 Series have guaranteed low temperature limits of −65°C. In all other respects they are identical and offer these features:

- Hard soldered joints
- Welded seals
- Guaranteed value of di/dt
- Thermal fatigue resistant
- Silicone-rubber insulated leads



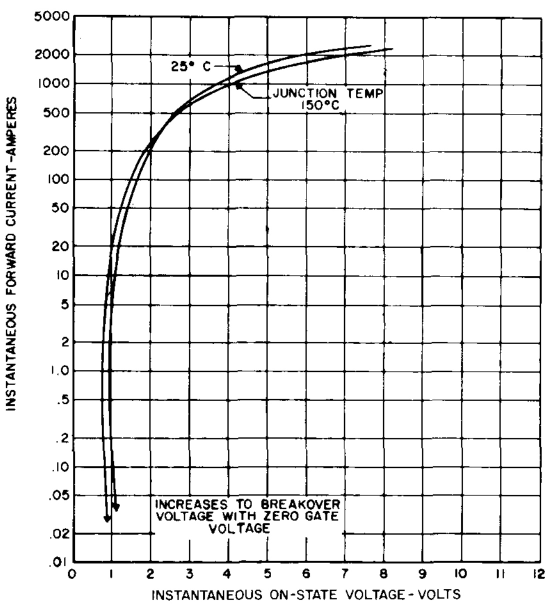
TYPE		PEAK FORWARD BLOCKING VOLTAGE, V_{DRM} (1)	REPETITIVE PEAK REVERSE (1) VOLTAGE, V_{RRM}	TRANSIENT PEAK REVERSE VOLTAGE V_{RSM} (1)
		T_C = −65°C to +145°C	T_C = −65°C to +145°C	T_C = +145°C
C60U (2N2023)	C62U	25 Volts	25 Volts	35 Volts
C60F (2N2024)	C62F	50 Volts	50 Volts	75 Volts
C60A (2N2025)	C62A	100 Volts	100 Volts	150 Volts
C60G (2N2026)	C62G	150 Volts	150 Volts	225 Volts
C60B (2N2027)	C62B	200 Volts	200 Volts	300 Volts
C60H (2N2028)	C62H	250 Volts	250 Volts	350 Volts
C60C (2N2029)	C62C	300 Volts	300 Volts	400 Volts
C60D (2N2030)	C62D	400 Volts	400 Volts	500 Volts
C60E	C62E	500 Volts	500 Volts	650 Volts

(1)Half sinewave waveform, 10ms max duration.

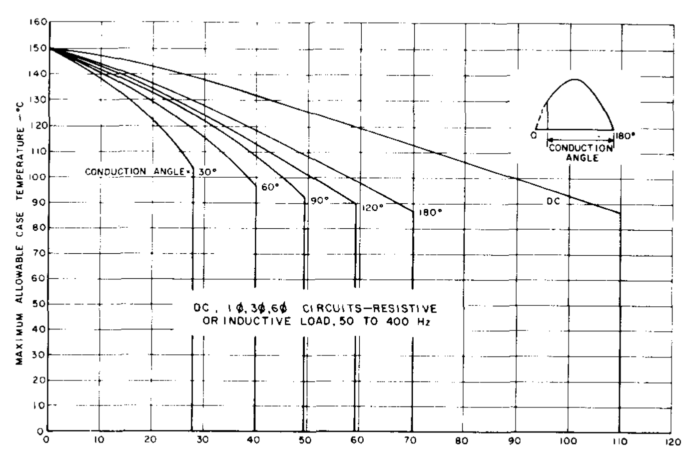
RMS Forward Current, On-State . . . . . 110 amperes
Average Forward Current, On-State . . . . . Depends on conduction angle (see Charts 2 and 3)
Peak One-cycle Surge Forward Current, I_{TSM} . . . . . 1000 amperes (see Chart 7)
Maximum Rate of Rise of Anode Current During Turn-On Interval . . . . . (see Chart 9)
I^2t (for fusing) . . . . . Up to 4000 ampere² seconds (see Chart 8)
Peak Gate Power Dissipation, P_{GM} . . . . . 5 watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . . 0.5 watts
Peak Gate Current, I_{GFM} . . . . . 2 amperes
Peak Forward Gate Voltage, V_{GTM} . . . . . 20 volts
Peak Reverse Gate Voltage, V_{GRM} . . . . . 5 volts
Storage Temperature, T_{STG} . . . . . −65°C to +150°C
Stud Torque . . . . . 125 Lbs.-in. (min.), 150 Lbs.-in. (max.)
150 Kg.-cm. (min.), 175 Kg.-cm. (max.)

CHARACTERISTICS

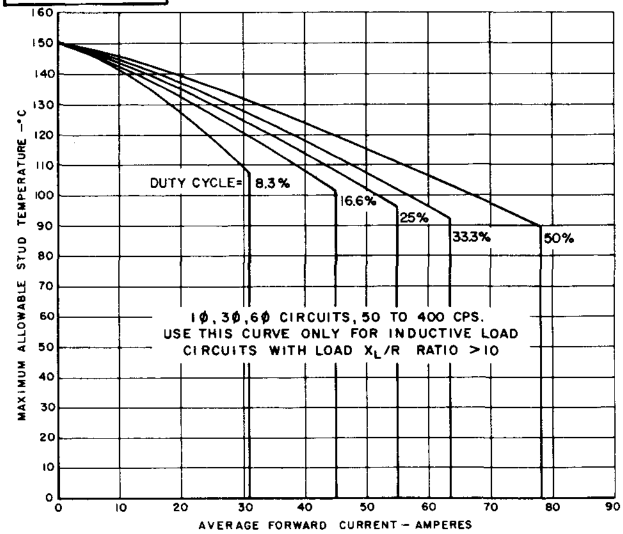
TEST	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Gate Trigger Current	I_{GT}	....	30 50 15	75 125 25	mAdc	$T_C = +25°C$, $V_D = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq 20$ μsec. $T_C = -65°C$, $V_D = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq 20$ μsec. $T_C = +145°C$, $V_D = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq 20$ μsec.
Gate Trigger Voltage	V_{GT}	.... .25	1.5	3.0	Vdc	$T_C = -65°C$ to $+125°C$. $V_D = 6$ Vdc, $R_L = 12$ ohms, $t_p \geqq$ 20 μsec. $T_C = +145°C$, V_D = Rated, $R_L = 1000$ ohms, $t_p \geqq 20$ μsec.
Peak On-Voltage	V_{TM}	....	2.0	2.5	V	$T_C = +25°C$, $I_{TM} = 1500$A Peak, Duty cycle $\leqq$ .01%
Holding Current	I_{HO}	....	20	100	mAdc	$T_C = +25°C$, Anode supply = 24 Vdc, Initial forward current = 2.5A
Turn-On Time (Delay Time + Rise Time)	$t_d + t_r$	....	5	....	μsec	$T_C = +25°C$, $I_F = 50$ Adc, V_D = rated, Gate supply: 10 volt open circuit, 25 ohm, 0.1 μsec. max. rise time
Circuit Commutated Turn-Off Time	tq	....	80	....	μsec	$T_C = +125°C$, $I_M = 50$A, $i_{RM} = 5$A min., $V_R = 50$ volts min., V_{DRM} (reapplied) = Rated, Rate of rise of reapplied forward blocking voltage = 20V/μsec linear. Gate bias: 0 volts, 100 ohms during turn-off interval, Duty cycle $\leqq$ .01%
Effective Thermal Resistance (DC)		....	.3	.4	°C/watt	
Peak Reverse and Forward Blocking Current	I_{DRM} and I_{RRM}				mA	$T_C = 145°C$
C60, C62U		....	13	15		$V_{DRM} = V_{RRM} =$ 25 Volts peak
C60, C62F		....	13	15		50 Volts peak
C60, C62A		....	13	15		100 Volts peak
C60, C62G		....	13	15		150 Volts peak
C60, C62B		....	13	15		200 Volts peak
C60, C62H		....	13	15		250 Volts peak
C60, C62C		....	13	15		300 Volts peak
C60, C62D		....	10	12		400 Volts peak
C60, C62E		....	7	9		500 Volts peak



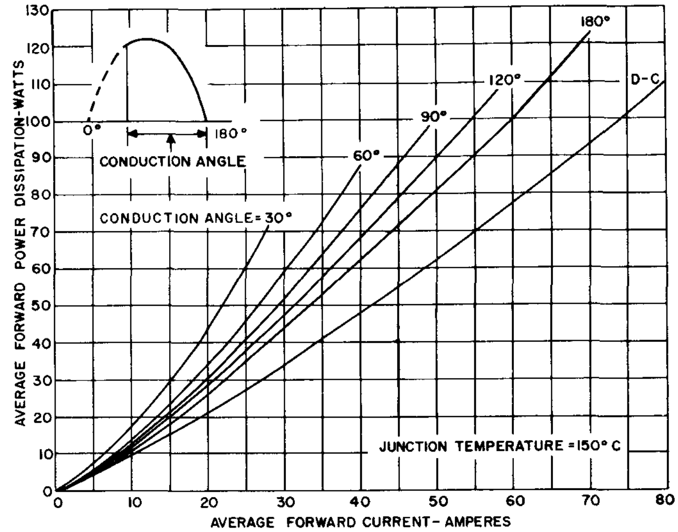
1. MAXIMUM ON-STATE VOLTAGE



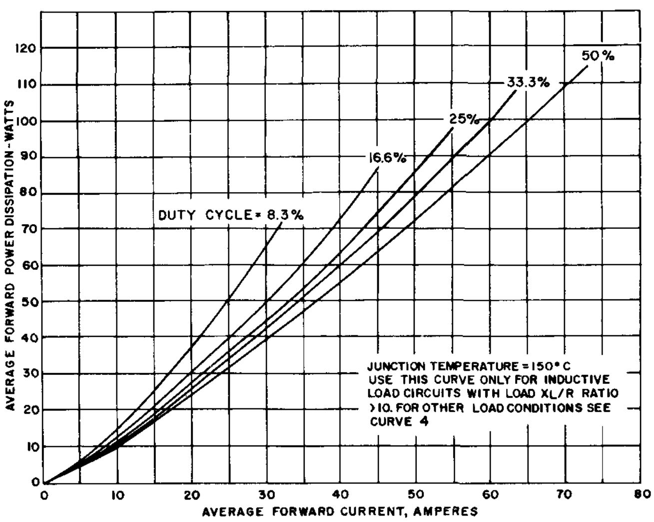
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



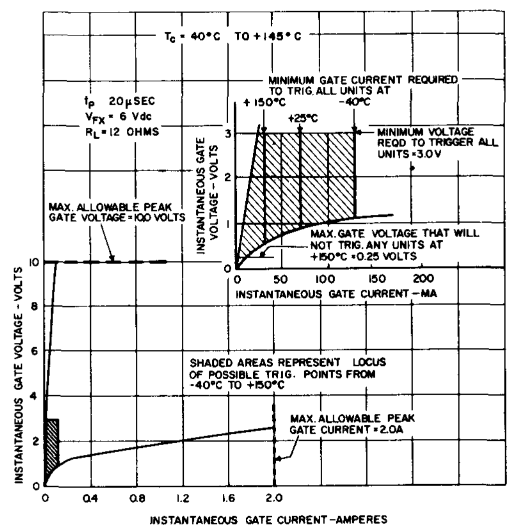
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



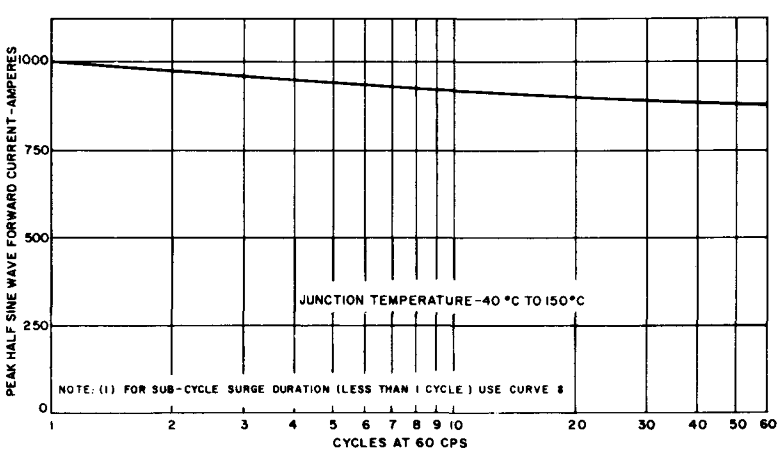
4. FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



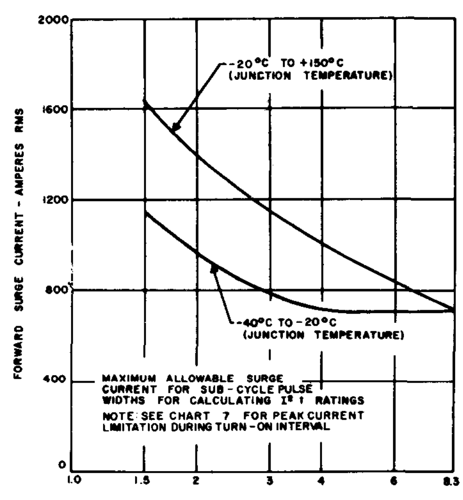
5. FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



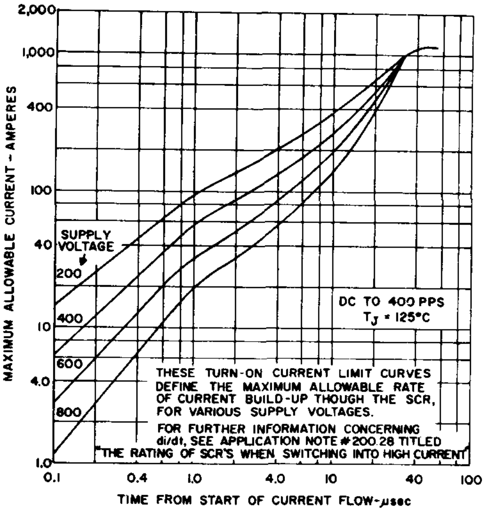
6. GATE TRIGGERING CHARACTERISTICS



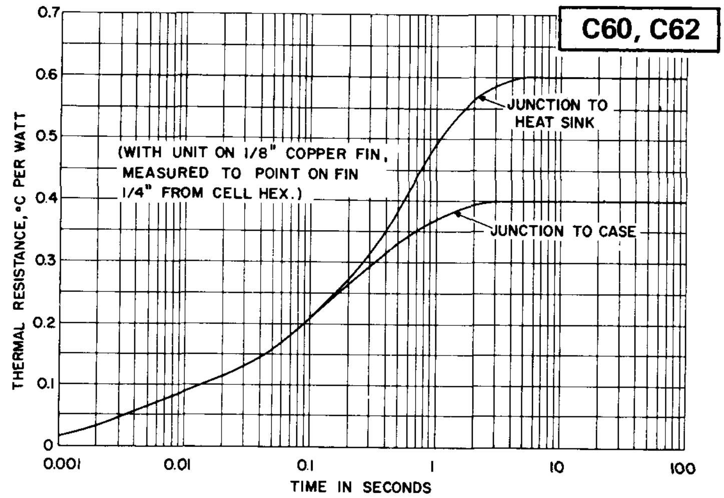
7. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



8. SUB-CYCLE SURGE RATING FOLLOWING RATED LOAD CONDITIONS



9. CURRENT LIMIT FOR STEEP WAVEFORM OPERATION



10. TRANSIENT THERMAL IMPEDANCE (JUNCTION TO CASE)

OUTLINE DRAWINGS

C60 OUTLINE (Conforms to JEDEC TO-94 Outline)

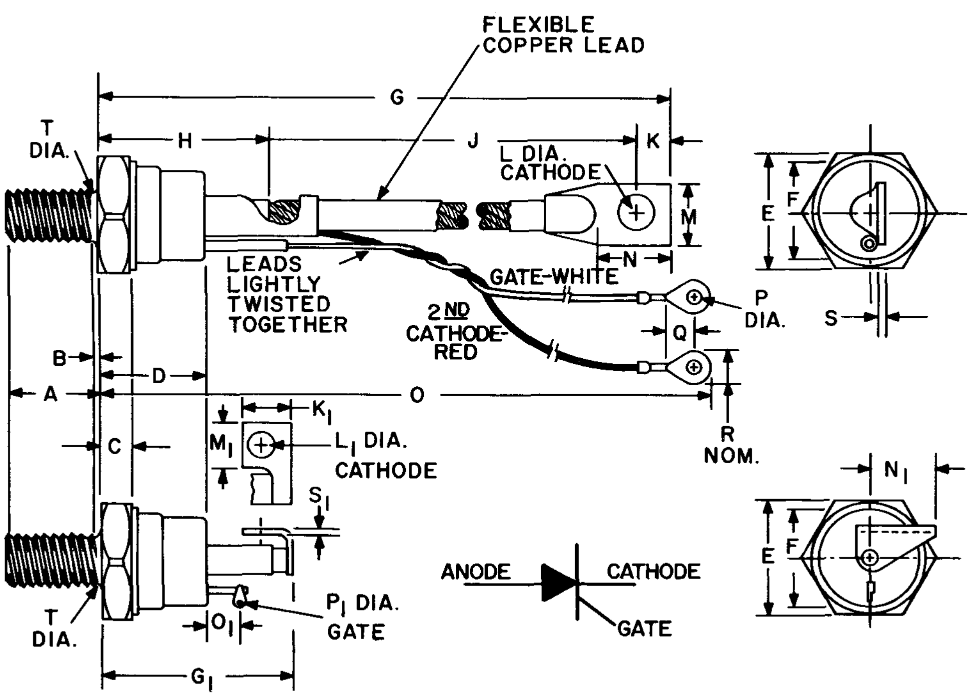


TABLE OF DIMENSIONS

Conversion Table

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.797	.827	20.243	21.005
B	—	.080	—	2.032
C	.278	.350	7.060	8.890
D	.874	1.030	22.099	26.162
E	1.049	1.062	26.644	26.975
F	.840	.910	21.335	23.115
G	6.204	6.512	157.619	165.443
G_1	—	1.750	—	44.450
H	1.484	1.640	37.653	41.656
J	4.437	5.623	112.698	142.824
K	.275	.325	6.985	8.255
K_1	.445	.485	11.302	12.319
L	.251	.281	6.375	7.137
L_1	.198	.212	5.029	5.385
M	.500	.600	12.700	15.240
M_1	.385	.415	9.778	10.541
N	.632	.725	16.052	18.390
N_1	.590	.640	14.985	16.256
O	7.000	7.342	177.799	186.487
O_1	.312 Ref.		7.925 Ref.	
P	.140	.150	3.555	3.811
P_1	.060	.075	1.524	1.905
Q	.250 Nom.		6.350 Nom.	
R	.290 Nom.		7.366 Nom.	
S	.065	.095	1.651	2.413
S_1	.058	.070	1.473	1.778
T	.463	.498	11.760	12.649

C62 OUTLINE

NOTES

1. Complete stud threads (½-20 UNF 2A) to within 2½ threads of head.
2. Flexible lead covered with silicon rubber insulation (Class H), 600 volt ASTM standard wall.
3. Orientation of cathode and gate terminals not defined.
4. One, ½-20 steel, cadmium plated nut and one cadmium plated spring washer supplied with each unit.
5. Approximate weights:

Unit	With Hardware		Without Hardware	
	Ounces	Grams	Ounces	Grams
C60	4.25	120	3.50	99
C62	3.50	99	2.75	78

SCR

C103

TYPICAL APPLICATIONS:

SENSORS —

Temperature
Pressure
Dryness
Proximity
Voltage
Current

AMPLIFIERS — (gate)

TIMERS

CONTROLS —

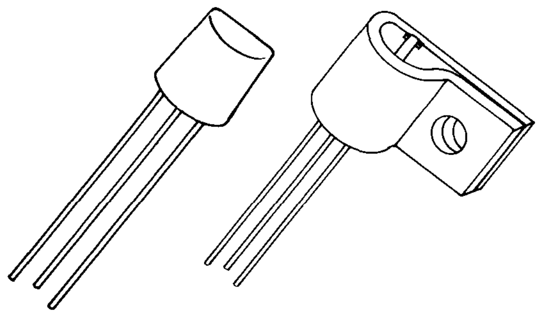
Small motors
Small lamps
Remote

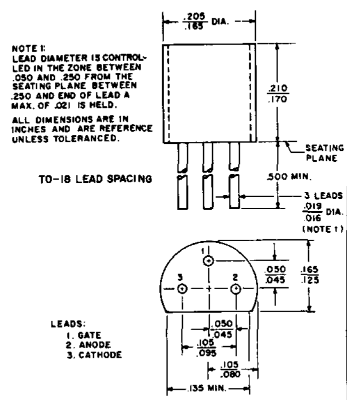
SWITCHING —

Solid-state relay
Relay driver
Counter
Low power inverter

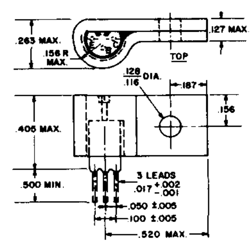
LOGIC CIRCUITS

120V AC LINE OPERATION





Type 1



Type 2 (with P-Strap)

FEATURES:

- 200 μA Gate sensitivity
- 8-amp surge
- 30-thru 200-volt selection
- Plastic TO-18 package
- Low V_F
- High dv/dt

MAXIMUM ALLOWABLE RATINGS

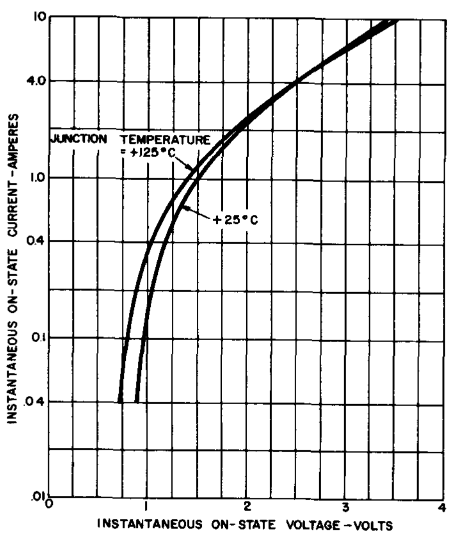
Type	Repetitive Peak Off-State Voltage, V_{DRM}[1] $T_C = -65°C$ to $+125°C$	Repetitive Peak Reverse Voltage, V_{RRM}[2] $T_C = -65°C$ to $+125°C$
C103Y	30 Volts	30 Volts
C103YY	60 Volts	60 Volts
C103A	100 Volts	100 Volts
C103B	200 Volts	200 Volts

[1] R_{GK} = 1000 ohms maximum.
[2] Values apply for zero or negative gate voltage only.

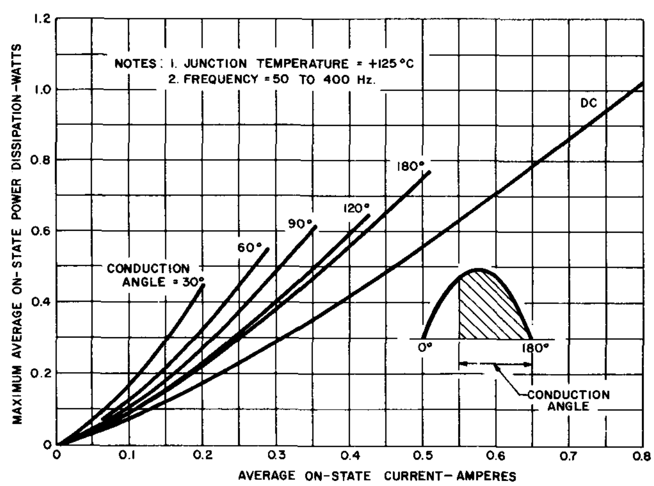
RMS On-State Current, $I_{T(RMS)}$ (all Conduction Angles) .... 0.8 Amperes
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} .... 8.0 Amperes
Peak Gate Power Dissipation, P_{GM} .... 1.0 Watts for 8.3 msec.
Average Gate Power Dissipation, $P_{G(AV)}$ .... 0.01 Watts
Peak Positive Gate Current, I_{GM} .... 0.5 Amperes
Peak Negative Gate Voltage, V_{GM} .... 8 Volts
Storage Temperature, T_{STG} .... −65°C to +150°C
Operating Junction Temperature, T_J .... −65°C to +125°C

CHARACTERISTICS

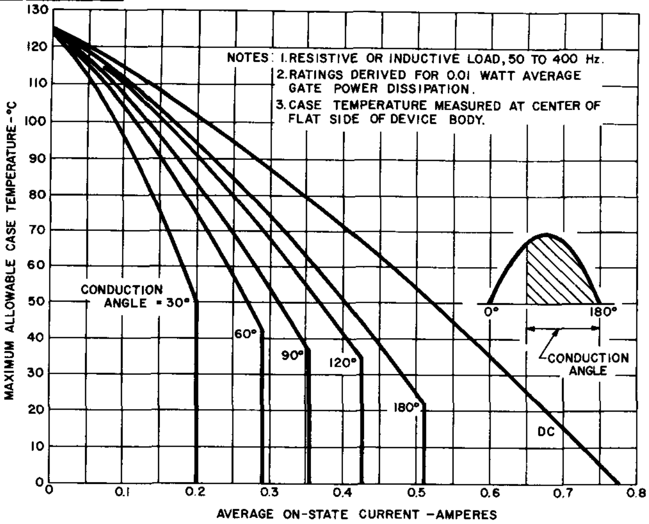
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Reverse and Off-State Current (All types)	I_{RRM} or I_{DRM}	—	—	1.0	μA	$T_C = +25°C$, $R_{GK} = 1000$ ohms $V_{RRM} = V_{DRM}$ = Rated Value.
		—	—	50		$T_C = +125°C$, $R_{GK} = 1000$ ohms $V_{RRM} = V_{DRM}$ = Rated Value.
DC Gate Trigger Current	I_{GT}	—	—	200	μAdc	$T_C = +25°C$, $V_D = 6Vdc$, $R_L = 100$ ohms.
		—	—	500		$T_C = -65°C$, $V_D = 6Vdc$, $R_L = 100$ ohms.
DC Gate Trigger Voltage	V_{GT}	—	—	0.8	Vdc	$T_C = +25°C$, $V_D = 6Vdc$, $R_L = 100$ ohms.
		—	—	1.0		$T_C = -65°C$, $V_D = 6Vdc$, $R_L = 100$ ohms.
		0.1	—	—		$T_C = +125°C$, Rated V_{DRM}, $R_L = 1000$ ohms.
Peak On-State Voltage	V_{TM}	—	—	1.5	V	$T_C = +25°C$, $I_{TM} = 1.0A$ peak, 1 msec. wide pulse, Duty Cycle $\leqq 2\%$
Holding Current	I_H	—	—	5.0	mAdc	Anode source voltage = 12Vdc, $R_{GK} = 1000$ ohms. $T_C = +25°C$
		—	—	10.0		$T_C = -65C$
Critical Rate of Rise of Off-State Voltage	dv/dt	—	20	—	V/μsec	$T_C = +125°C$, Rated V_{DRM}, $R_{GK} = 1000$ ohms.
Circuit Commutated Turn-Off Time	t_q	—	15	—	μsec	$T_C = +125°$ C, rectangular current waveform. Rate of rise of current <10A/μsec. Rate reversal of current <5A/μsec. $I_{TM} = 1A$ (50 μsec. pulse). Rep. Rate = 60 pps. V_{RRM} = Rated, $V_{RX} = 15V$ Min., V_{DRM} = Rated. Rate of Rise of reapplied off-state voltage = 20V/ μsec.; Gate Bias = 0 Volts, 100 Ohms (during turn-off time interval).
Steady-State Thermal Resistance	$R_{\theta JC}$	—	—	125	°C/W	Junction-to-case (flat side of case is temp. ref. point).
	$R_{\theta JA}$	—	—	230		Junction-to-ambient (free convection).
	$R_{\theta JC}$	—	—	110		Junction to P-strap dissipator (rounded surface is temp. ref. point).
	$R_{\theta JA}$	—	—	170		Junction-to-ambient, with P-strap dissipator (free convection).



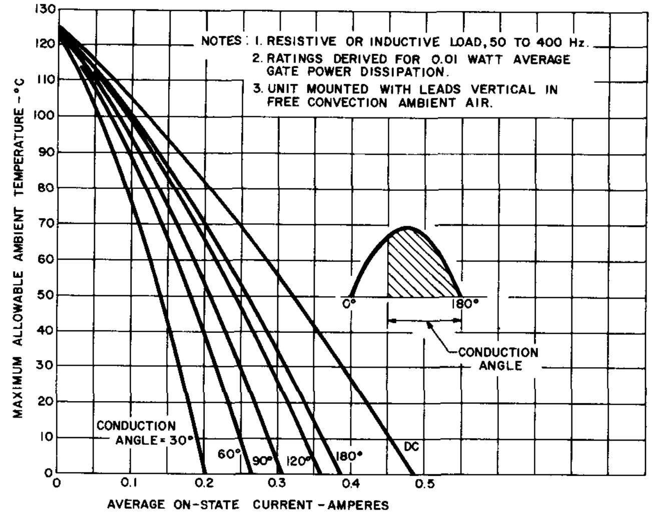
1. MAXIMUM ON-STATE CHARACTERISTICS



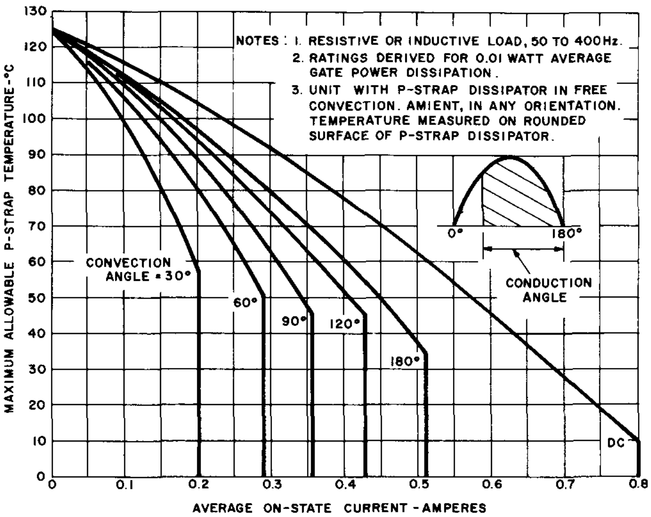
2. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



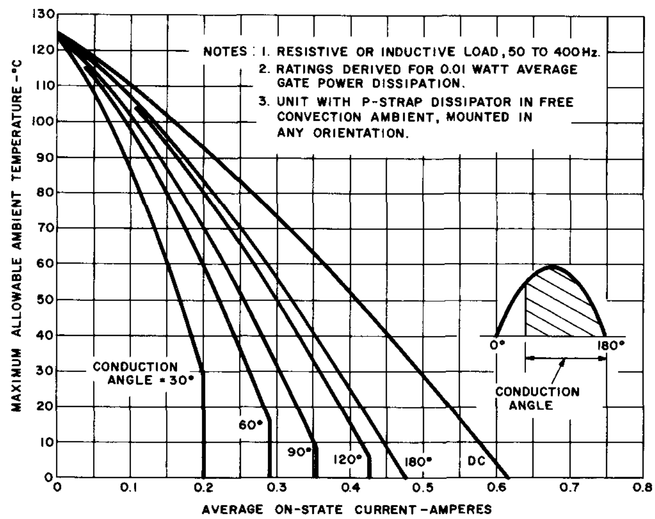
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM— WITHOUT P-STRAP DISSIPATOR



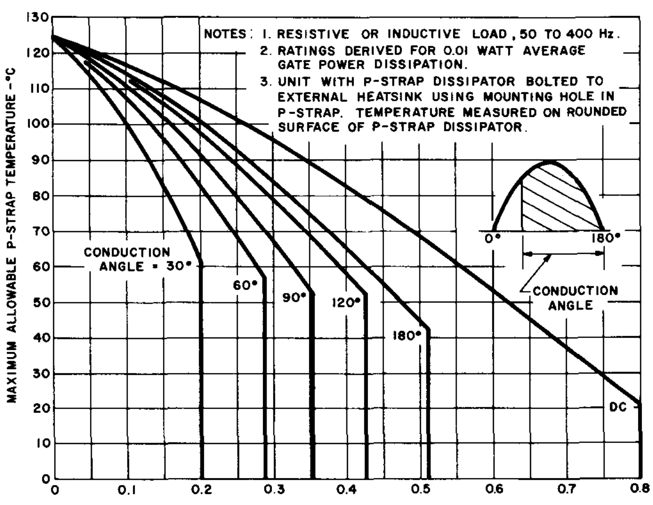
4. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM— WITHOUT P-STRAP DISSIPATOR



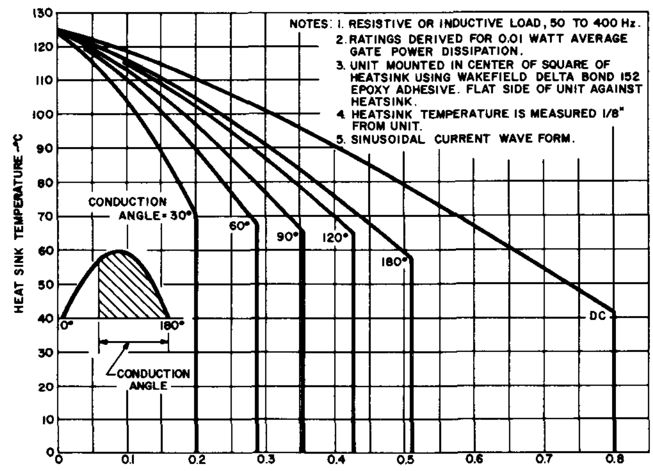
5. MAXIMUM ALLOWABLE P-STRAP TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM— NO EXTERNAL HEATSINK



6. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM— WITH P-STRAP DISSIPATOR

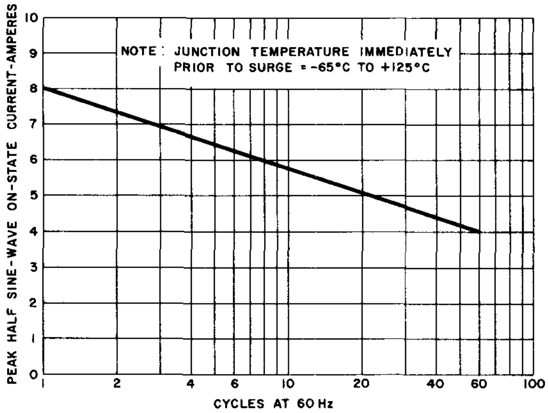


7. MAXIMUM ALLOWABLE P-STRAP TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM— MOUNTED TO EXTERNAL HEATSINK

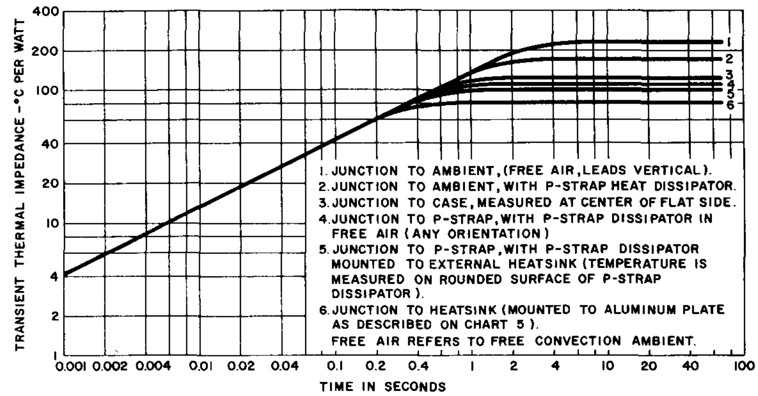


***8. TYPICAL CURRENT CARRYING CAPABILITY FOR DEVICE MOUNTED ON 1" x 1" x 1/16" ALUMINUM HEATSINK**

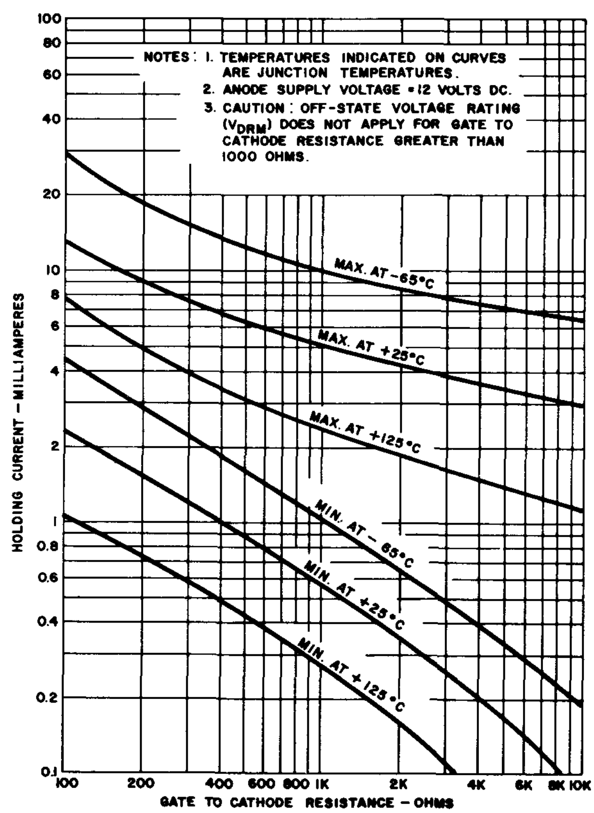
*Chart 8. For Reference only, units are not available in this configuration.



9. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT



10. MAXIMUM TRANSIENT THERMAL IMPEDANCE



11. MAXIMUM AND MINIMUM HOLDING CURRENT VARIATION WITH GATE TO CATHODE RESISTANCE

Silicon Controlled Rectifier

Flat Pack Design

Up to 600 Volts 4 Amperes (RMS)

Model C106

PRODUCT FEATURES

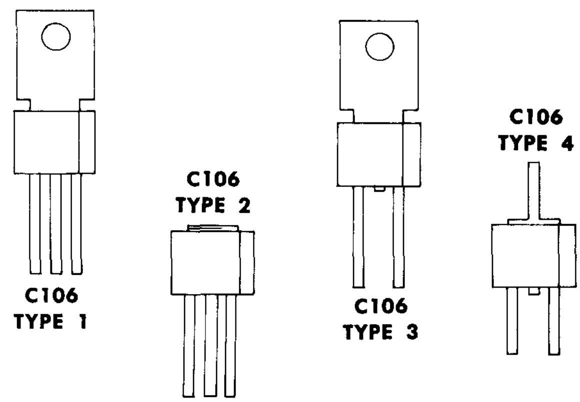
The Type C106 Silicon Controlled Rectifier (SCR) has the following outstanding features:

LOW COST

SENSITIVE Operates directly from low signal sensors such as thermistors, photo-conductive cells, etc.

VERSATILE Designed for a variety of mount-down methods—printed circuit, plug-in socket, screws, or point-to-point soldering

RUGGED, COMPACT Uses a solid plastic encapsulant in rectangular shape for high density packaging



(FULL SIZE)

TYPICAL APPLICATIONS

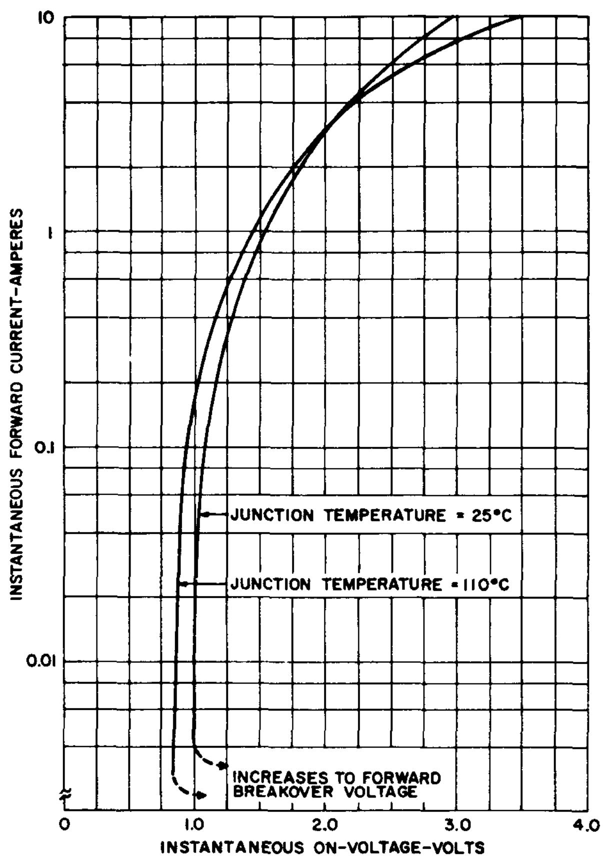
MOTOR CONTROL	Electric Model Trains Sewing Machines Movie Projectors Food Mixers Electric Fans Slot Racing Cars
LIGHT	Flame Detectors Moving-Light Signs (Chasers) Driver for Computer Readout Lights Harbor Buoy Flashers Automotive Warning Systems Nixie & Neon Drivers
TEMPERATURE	Range Surface Unit (Hybrid) Chemical Processing (Photographic, etc.) Food Warmer Tray Bearing Temperature Sensor Electric Blanket Control
PRESSURE	Auto Oil Pressure Gage Hot Water Boiler Safety Monitor
TIME	Photo Darkroom Exposure Oven Timer Vending Machine Logic Industrial Process Control
LIQUID LEVEL	Basement Sump Pump Automatic Coffee Maker Automatic Shutoff for Vending Machines
REMOTE CONTROL	Armchair TV Control Master Switching Stations for Home Garage Door Openers Power Switch
DRYNESS	Clothes Dryness Sensor
PROXIMITY	Burglar Alarm Touch Switch Electric Door Openers
COUNTING	Low Speed Ring Counters Shift Registers
SWITCHING	Relay Replacement Solenoid Drivers Latching Relay Replacement Power Flip Flops Low Power Inverters Thyratron Tube Replacement
AMPLIFIERS	Gate Amplifier for Larger SCR's, Triacs —Blenders —Hand Tools
IGNITION	Small Gas Engines Gas Appliances
DETECTION	Voltage (Battery Charger) Current (Crowbar)

MAXIMUM ALLOWABLE RATINGS

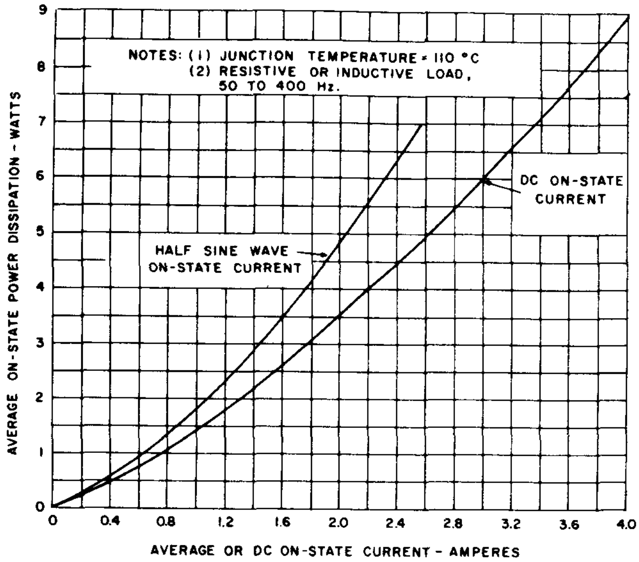
Type	Repetitive Peak Forward Blocking Voltage, V_{FXM} R_{GK} = 1000 Ohms T_J = -40°C to +110°C	Working and Repetitive Peak Reverse Voltage, V_{ROM}(wkg) and V_{ROM}(rep) T_J = -40°C to +110°C
C106Q1, C106Q2, C106Q3, C106Q4	15 Volts	15 Volts
C106Y1, C106Y2, C106Y3, C106Y4	30 Volts	30 Volts
C106F1, C106F2, C106F3, C106F4	50 Volts	50 Volts
C106A1, C106A2, C106A3, C106A4	100 Volts	100 Volts
C106B1, C106B2, C106B3, C106B4	200 Volts	200 Volts
C106C1, C106C2, C106C3, C106C4	300 Volts	300 Volts
C106D1, C106D2, C106D3, C106D4	400 Volts	400 Volts
C106E1, C106E2, C106E3, C106E4	500 Volts	500 Volts
C106M1, C106M2, C106M3, C106M4	600 Volts	600 Volts

RMS Forward Current, On-State .... 4 Amperes
Rate of Rise of Forward Current (non-repetitive), di/dt (See Chart 9) .... 50 Amperes/Microsecond
Peak Forward Current, On-State (repetitive) .... 75 Amperes*
Peak One Cycle Surge Forward Current, Non-Repetitive, I_{FM} (surge) .... 20 Amperes
I^2t (for fusing) .... 0.5 Ampere^2 seconds (for times > 1.5 Milliseconds
Peak Gate Power, P_{GM} .... 0.5 Watt
Average Gate Power, $P_{G(AV)}$ .... 0.1 Watt
Peak Gate Current, I_{GFM} .... 0.2 Amperes
Peak Reverse Gate Voltage, V_{GRM} .... 6 Volts
Storage Temperature, T_{stg} .... −40°C to +150°C
Operating Temperature .... −40°C to +110°C

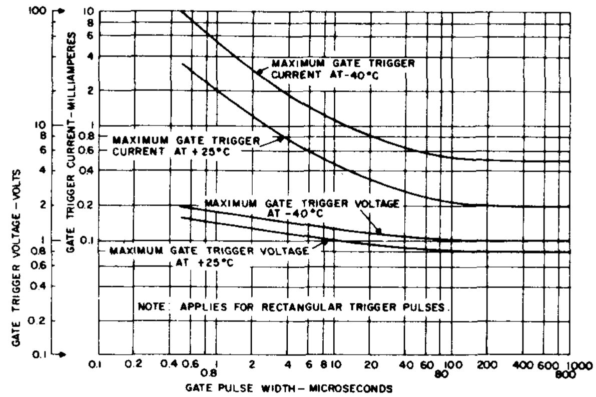
*This rating applies for operation at 60 Hz, 75°C maximum tab (or anode) lead temperature, switching from 80 volts peak, sinusoidal current pulse width 10 μsec. minimum, 15 μsec. maximum.



1. Maximum Forward Characteristics, On State



2. Maximum On-State Power Dissipation

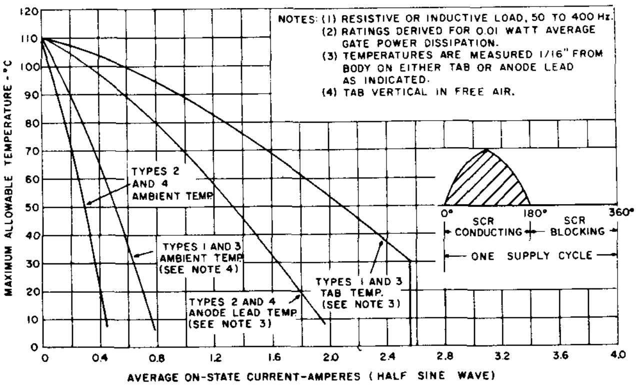


3. Maximum Gate Trigger Current and Voltage Variation with Trigger Pulse Width

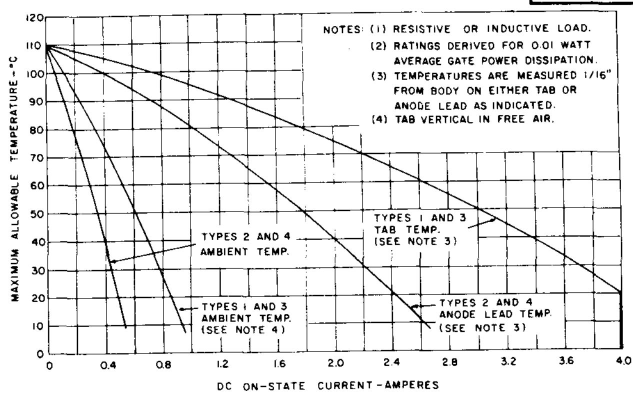
CHARACTERISTICS

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Reverse or Forward Blocking Current (All Types)	I_{RRM} or I_{DRM}	–	0.1	10	μA	$V_{RRM} = V_{DRM}$ = Rated Value. T_L = 25°C, R_{GK} = 1000 Ohms
		–	10	100	μA	$V_{RRM} = V_{DRM}$ = Rated Value. T_L = 110°C, R_{GK} = 1000 Ohms.
DC Gate Trigger Current	I_{GT}	–	30	200	μAdc	T_L = 25°C, V_D = 6 Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
		–	75	500	μAdc	T_L = -40°C, V_D = 6 Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
DC Gate Trigger Voltage	V_{GT}	0.4	0.5	0.8	Volts DC	T_L = 25°C, V_D = 6 Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
		0.5	0.7	1.0	Volts DC	T_L = -40°C, V_D = 6 Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
		0.2	–	–	Volts DC	T_L = 110°C, V_D = Rated V_{DRM} Value R_L = 3000 Ohms, R_{GK} = 1000 Ohms
Peak On-Voltage	V_{TM}	–	1.8	2.2	Volts	T_L = 25°C, I_{TM} = 4 Amperes Peak, Single Half Sine Wave Pulse, 2 Millisec. Wide
Holding Current	I_H	0.3	1.0	3.0	mAdc	T_L = 25°C, V_D = 12 Vdc, R_{GK} = 1000 Ohms
		0.4	2.0	6.0	mAdc	T_L = -40°C, V_D = 12 Vdc, R_{GK} = 1000 Ohms
		0.14	0.6	2.0	mAdc	T_L = 110°C, V_D = 12 Vdc, R_{GK} = 1000 Ohms
Latching Current	I_L	0.3	1.5	4.0	mAdc	T_L = 25°C, V_D = 12 Vdc, R_{GK} = 1000 Ohms
		0.4	3.0	8.0	mAdc	T_L = -40°C, V_D = 12 Vdc, R_{GK} = 1000 Ohms
Critical Rate of Rise of Forward Blocking Voltage	dv/dt	–	8	–	Volts/ Micro-second	T_L = 110°C, V_D = Rated V_{DRM} Value R_{GK} = 1000 Ohms
Turn On Time	t_d+t_r	–	1.2	–	Micro-seconds	T_L = 25°C, Rated V_{DRM} Value I_T = 1 Ampere, Gate Pulse = 4 Volts, 300 Ohms, 5 Microseconds Wide.
Circuit Commutated Turn-Off Time	t_q	–	40	100	Micro-seconds	T_L = 110°C, rectangular current waveform. Rate of rise of current < 10 amps/μsec. Rate of reversal of current <5 amps/μsec. I_T = 1 Amp (50 μsec pulse). Repetition Rate = 60 pps. V_{RRM} = Rated. V_R = 15 Volts Minimum. V_D = Rated. Rate of Rise Reapplied Forward Blocking Voltage = 5 Volts/μsec. Gate Bias = 0 Volts, 100 Ohms (during turn-off time interval).

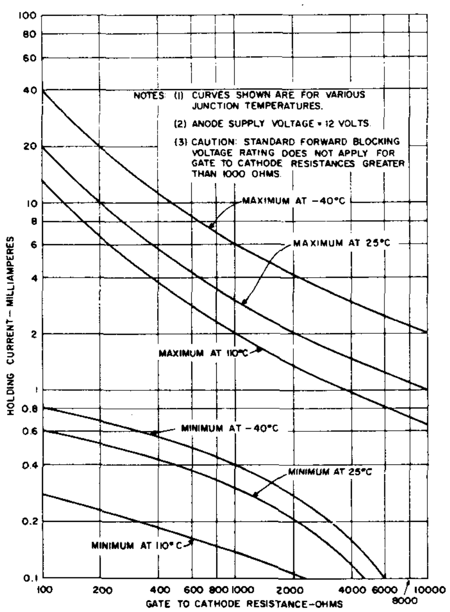
The lead temperature (T_J) is measured in the center of the tab, 1/16 inch from the body on Type 1 and Type 3 devices, and in the center of the anode lead, 1/16 inch from the body on Type 2 and Type 4 devices.



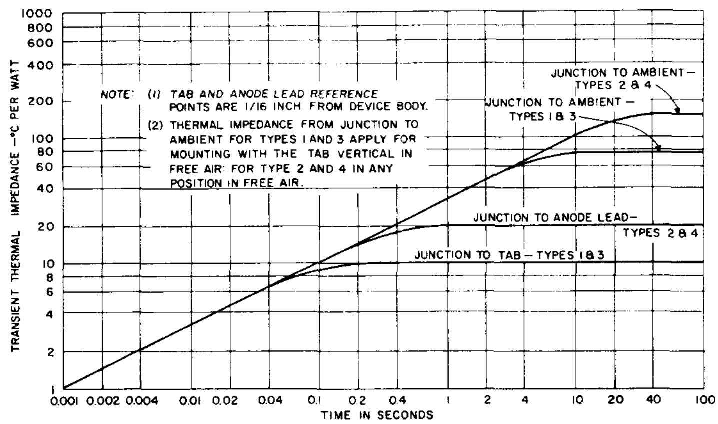
4. Maximum Allowable Temperatures for Half Sine Wave On-State Current



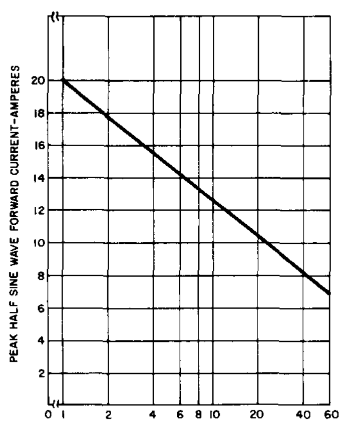
5. Maximum Allowable Temperatures for DC On-State Current



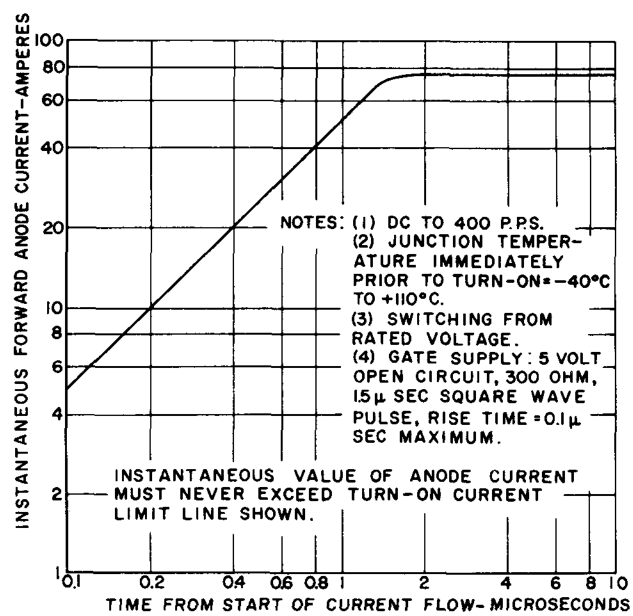
6. Maximum and Minimum Holding Current Variation with External Gate-to-Cathode Resistance



7. Maximum Transient Thermal Impedance



8. Maximum Allowable Non-Repetitive Peak Surge Forward Current



9. Turn-On Current Limit

C106

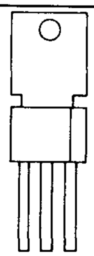
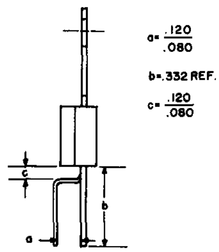
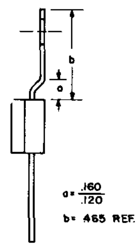
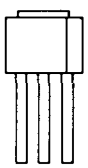
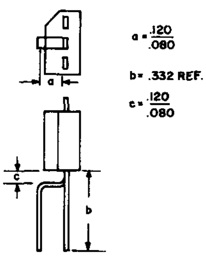
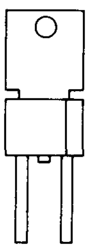
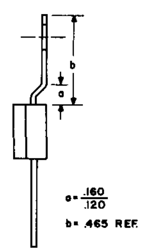
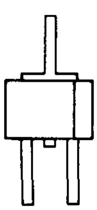
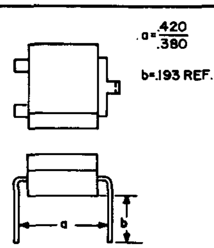
MOUNTING METHODS

The C106, because of its unique package design, is capable of being mounted in a variety of methods; depending upon the heatsink requirements and the circuit packaging methods.

The leads will bend easily, either perpendicular to the flat or to any angle, and may also be bent, if desired, immediately next to the plastic case. For sharp angle bends (90° or larger), a lead should be bent only once; since repeated bending will fatigue or break the lead. Bending in other directions may be performed as long as the lead is held firmly between the case and the bend, so that the strain on the lead is not transmitted to the plastic case.

The mounting tab may also be bent or formed into any convenient shape so long as it is held firmly between the plastic case and the area to be formed or bent. Without this precaution, bending may fracture the plastic case and permanently damage the unit.

As a service to its customers, the General Electric Company provides a lead and tab shaping capability. Any of the derived types shown in the following chart are available direct from the factory to original equipment manufacturers.

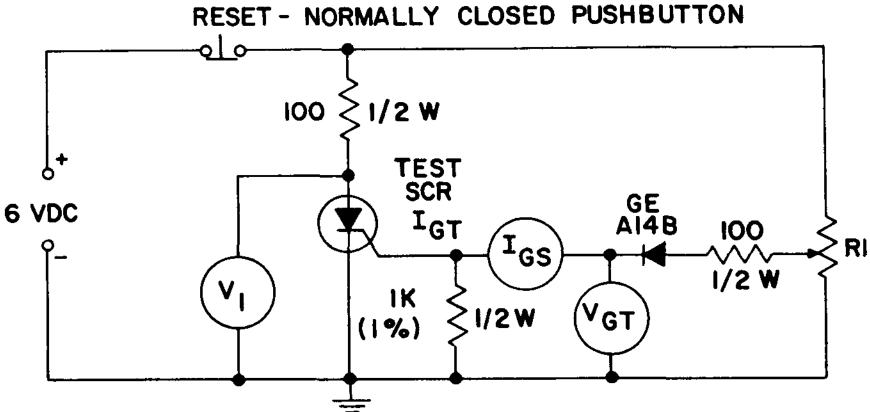
BASIC TYPES	DERIVED TYPES (The types shown below are derived from the basic types illustrated in the left-hand column.)		
	PRINTED CIRCUIT BOARD MOUNTING (Upright or Flat)	RIVET OR SCREW MOUNTING TO FLAT SURFACE	
 C106 Type 1	 C106 Type 11	 C106 Type 12	
 C106 Type 2	 C106 Type 21		
 C106 Type 3		 C106 Type 32	
 C106 Type 4	 C106 Type 41		

C106 CONVERSIONS

INCHES	MILLIMETERS	INCHES	MILLIMETERS
.120/.080	3.048/2.031	.332 REF.	8.433 REF.
.160/.120	4.064/3.047	.420/.380	10.668/9.651
.193 REF.	4.902 REF.	.465 REF.	11.811 REF.

SIMPLE TEST CIRCUIT FOR THE C106 SCR*

Gate Trigger Voltage and Current Measurement



V_1 — 0-10 volt DC meter
V_{GT} — 0-1 volt DC meter
I_{GS} — 0-1mA DC milliameter
R1 — 1K potentiometer

To measure gate trigger voltage and current, raise gate voltage (V_{GT}) until meter reading V_1 drops from 6 volts to 1 volt. Gate trigger voltage is the reading on V_{GT} *just prior* to V_1 dropping. Gate trigger current I_{GT} can be computed from the relationship:

$$I_{GT} = I_{GS} - \frac{V_{GT}}{1000} \text{ amps}$$

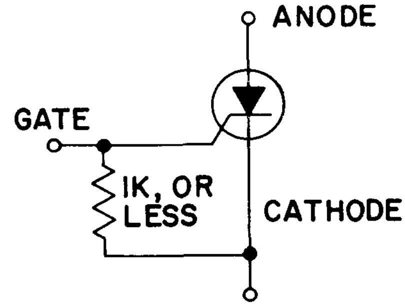
where I_{GS} is reading (in amps) on meter *just prior* to V_1 dropping. NOTE: I_{GT} may turn out to be a negative quantity (trigger current flows *out* from gate lead).

* *For more sophisticated equipment suitable for testing the C106 SCR see GE Application Note 200. 19 "Using Low Current SCR's".*

CIRCUIT DESIGN

1. Use of Gate Resistor

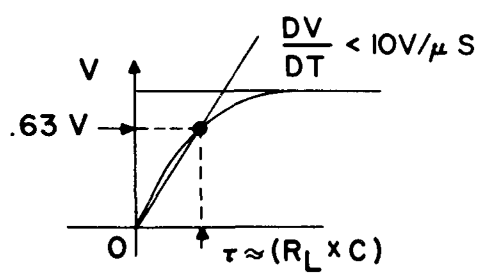
The C106 SCR is guaranteed to block rated voltage over its rated operating temperature range *only* if a resistance of not more than 1000 ohms, or equivalent, ** is connected between its gate and cathode terminals as follows:

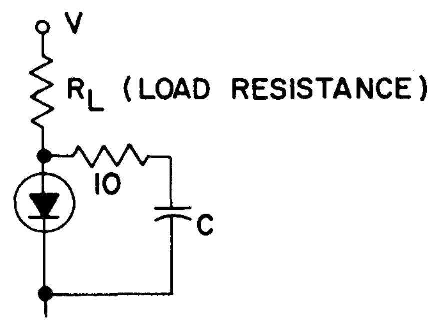


** *For alternative acceptable gate biasing methods see Application Note 200. 19 "Using Low Current SCR's".*

2. Suppression of Rate Effect

In circuits where the C106 is subjected to fast rising anode voltages, as for instance where voltage is applied suddenly with a switch, RC "slow down" filters may be required to prevent the SCR from triggering spontaneously. C should be selected in conjunction with R_L so that dv/dt is less than 10 volts per microsecond thus:

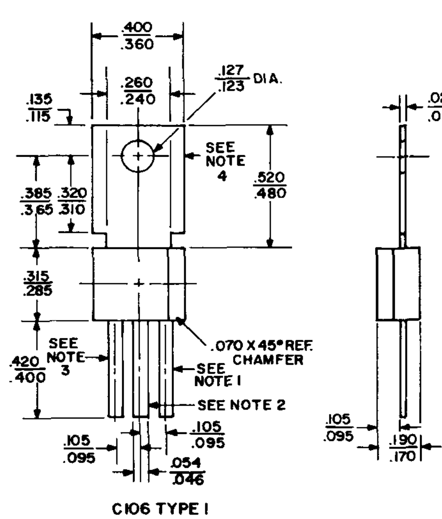


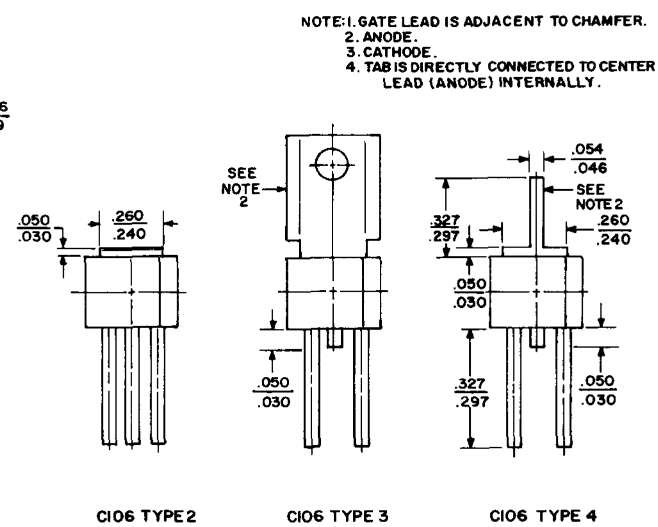


(The 10 ohm resistor limits turn on current through the SCR to a safe value when the SCR turns on.)

OUTLINE DRAWINGS

C106 CONVERSIONS	
INCHES	MILLIMETERS
.026/.019	.660/.483
.050/.030	1.270/.761
.054/.046	1.372/1.168
.070	1.778
.105/.095	2.667/2.412
.127/.123	3.226/3.124
.135/.115	3.429/2.920
.190/.170	4.826/4.318
.260/.240	6.604/6.095
.272/.232	6.908/5.892
.315/.285	8.001/7.239
.320/.290	8.128/7.366
.320/.310	8.128/7.874
.327/.297	8.306/7.544
.385/.365	9.779/9.271
.400/.360	10.160/9.144
.420/.400	10.668/10.160
.520/.480	13.208/12.191



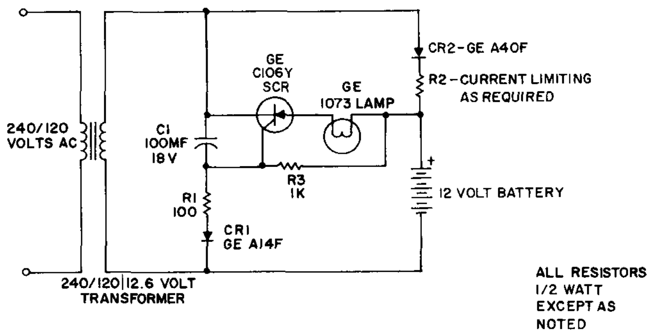


REPRESENTATIVE APPLICATIONS OF THE C106 SCR

1. Emergency Light

This simple circuit provides battery operated emergency lighting instantaneously upon failure of the regular AC service. When line power is restored, the emergency light turns off and the battery recharges automatically. The circuit is ideal for use in elevator cars, corridors and similar places where loss of light due to power failure would be undesirable. Completely static in operation, the circuit requires no maintenance.

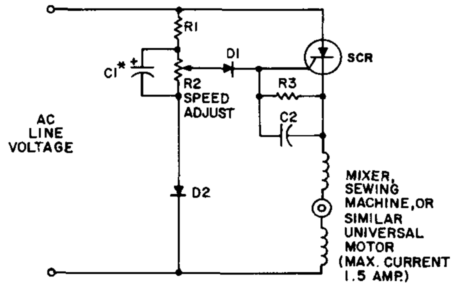
With AC power "on", capacitor C1 charges through rectifier CR1 and resistor R1 to develop a negative DC voltage at the gate of the C106Y SCR. By this means the SCR is prevented from triggering, and the emergency light stays off. At the same time, the battery is kept fully charged by rectifier CR2 and resistor R2. Should the AC power fail, C1 discharges and the SCR is triggered on by battery power through resistor R3. The SCR then energizes the emergency light. Reset is automatic when AC is restored, because the peak AC line voltage biases the SCR and turns it off.



2. Universal Motor Speed Control

This circuit can replace the carbon-pile speed controller commonly supplied with household sewing machines. It is equally effective for use with other small AC-DC motors, such as those found in food mixers and similar traffic appliances. Maximum current capability is 1.5 amps. Provision of speed-dependent feedback gives excellent torque characteristics to the motor, even at low speeds where other types of controllers are completely ineffective.

The resistor capacitor network R1-R2-C1 provides a ramp-type reference voltage superimposed on top of a DC voltage adjustable with the speed-setting potentiometer R2. This reference voltage appearing at the wiper of R2 is balanced against the residual counter emf of the motor through the SCR gate. As the motor slows down due to heavy loading, its counter emf falls, and the reference ramp triggers the SCR earlier in the AC cycle. More voltage is thereby applied to the motor causing it to pick up speed again. Performance with the C106 SCR is particularly good because the low trigger current requirements of this device allow use of a flat top reference voltage, which provides good feedback gain and close speed regulation.



Line Voltage	120V	240V
R1	47K	100K
R2	10K	20K
R3	1K	1K
C1	1μF, 50V	1μF, 100V
C2	0.1μF, 50V	0.1μF, 50V
D1	1N5059	1N5060
D2	1N5059	1N5060
SCR	C106B1	C106D1

Note

* *C_1 optional, contributes to performance in some circumstances.*

Silicon Controlled Rectifier

Flat Pack Design

Up to 600 Volts 4 Amperes (RMS)

Model C107

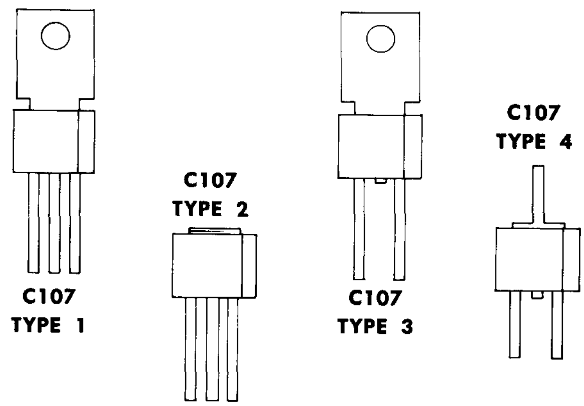
PRODUCT FEATURES

The Type C107 Silicon Controlled Rectifier (SCR) has the following outstanding features:

LOW COST

VERSATILE Designed for a variety of mount-down methods—printed circuit, plug-in socket, screws, or point-to-point soldering

RUGGED, COMPACT Uses a solid plastic encapsulant in rectangular shape for high density packaging



(FULL SIZE)

TYPICAL APPLICATIONS

MOTOR CONTROL
- Electric Model Trains
- Sewing Machines
- Movie Projectors
- Food Mixers
- Electric Fans
- Slot Racing Cars

LIGHT
- Flame Detectors
- Moving-Light Signs (Chasers)
- Driver for Computer Readout Lights
- Harbor Buoy Flashers
- Automotive Warning Systems
- Nixie & Neon Drivers

TEMPERATURE
- Range Surface Unit (Hybrid)
- Chemical Processing (Photographic, etc.)
- Food Warmer Tray
- Bearing Temperature Sensor
- Electric Blanket Control

PRESSURE
- Auto Oil Pressure Gage
- Hot Water Boiler Safety Monitor

TIME
- Photo Darkroom Exposure
- Oven Timer
- Vending Machine Logic
- Industrial Process Control

LIQUID LEVEL
- Basement Sump Pump
- Automatic Coffee Maker
- Automatic Shutoff for Vending Machines

REMOTE CONTROL
- Armchair TV Control
- Master Switching Stations for Home
- Garage Door Openers
- Power Switch

DRYNESS
- Clothes Dryness Sensor

PROXIMITY
- Burglar Alarm
- Touch Switch
- Electric Door Openers

COUNTING
- Low Speed Ring Counters
- Shift Registers

SWITCHING
- Relay Replacement
- Solenoid Drivers
- Latching Relay Replacement
- Power Flip Flops
- Low Power Inverters
- Thyratron Tube Replacement

AMPLIFIERS
- Gate Amplifier for Larger SCR's, Triacs
  - —Blenders
  - —Hand Tools

IGNITION
- Small Gas Engines
- Gas Appliances

DETECTION
- Voltage (Battery Charger)
- Current (Crowbar)

MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM} R_{GK} = 1000 Ohms T_C = −40°C to +110°C	Working and Repetitive Peak Reverse Voltage, V_{RWM} and V_{RRM} T_C = −40°C to +110°C
C107Q1, C107Q2, C107Q3, C107Q4	15 Volts	15 Volts
C107Y1, C107Y2, C107Y3, C107Y4	30 Volts	30 Volts
C107F1, C107F2, C107F3, C107F4	50 Volts	50 Volts
C107A1, C107A2, C107A3, C107A4	100 Volts	100 Volts
C107B1, C107B2, C107B3, C107B4	200 Volts	200 Volts
C107C1, C107C2, C107C3, C107C4	300 Volts	300 Volts
C107D1, C107D2, C107D3, C107D4	400 Volts	400 Volts
C107E1, C107E2, C107E3, C107E4	500 Volts	500 Volts
C107M1, C107M2, C107M3, C107M4	600 Volts	600 Volts

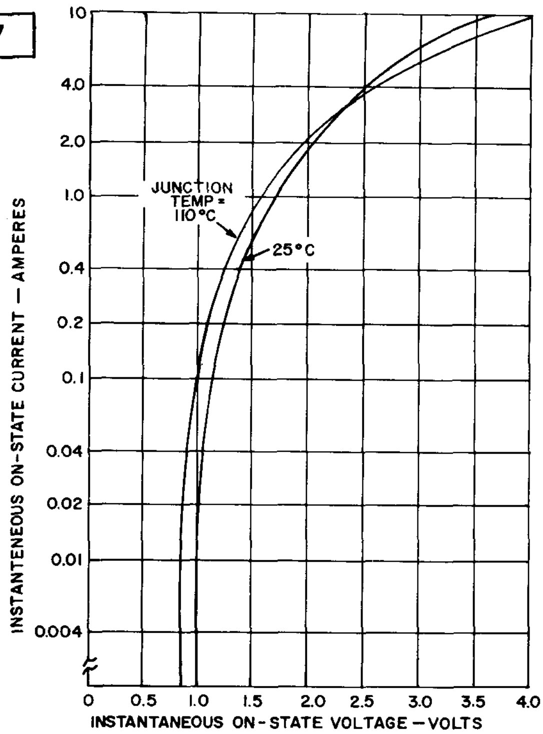
RMS On-State Current, $I_{T(RMS)}$ . . . . . 4 Amperes
Repetitive Peak On-State Current, I_{TRM} . . . . . 75 Amperes†
Critical Rate-Of-Rise of
On-State Current, di/dt (see Chart 8) . . . . . 50 Amperes/Microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} . . . . . 15 Amperes
I^2t (for fusing), for times ≥ 1.5 milliseconds . . . . . 0.5 Ampere² seconds
Peak Gate Power Dissipation, P_{GM} . . . . . 0.5 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . . 0.1 Watts
Peak Positive Gate Current, I_{GM} . . . . . 0.2 Amperes
Peak Negative Gate Voltage, V_{GM} . . . . . 6 Volts
Storage Temperature, T_{STG} . . . . . −40°C to +150°C
Operating Temperature, T_J . . . . . −40°C to +110°C

†This rating applies for operation at 60 Hz, 75°C maximum tab (or anode lead) temperature, switching from 80 volts peak, sinusoidal current pulse, width 10 μsec. minimum, 15 μsec. maximum.

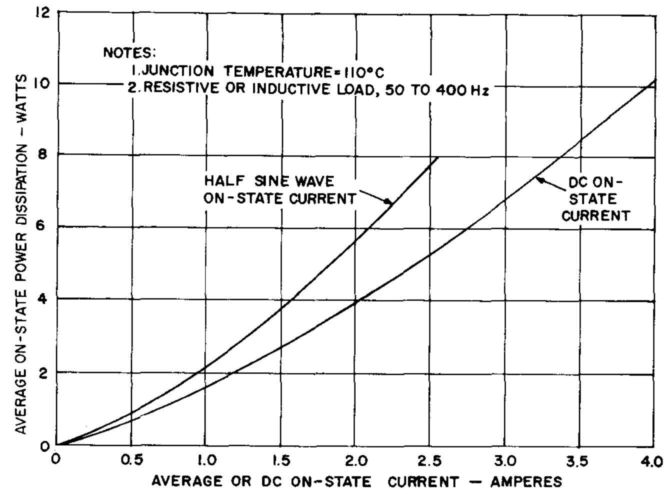
CHARACTERISTICS

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Reverse and Off-State Current (All Types)	I_{RRM} or I_{DRM}	–	0.1	10	μA	$V_{RRM} = V_{DRM}$ = Rated Value. T_L = 25°C, R_{GK} = 1000 Ohms
		–	10	100	μA	$V_{RRM} = V_{DRM}$ = Rated Value. T_L = 110°C, R_{GK} = 1000 Ohms.
*DC Gate Trigger Current	I_{GT}	–	–	500	μAdc	T_L = 25°C, V_D = 6 Vdc, R_L = 100 Ohms. R_{GK} = 1000 Ohms.
DC Gate Trigger Voltage	V_{GT}	0.4	0.5	0.8	Volts DC	T_L = 25°C, V_D = 6 Vdc, R_L = 100 Ohms. R_{GK} = 1000 Ohms.
		0.2	–	–	Volts DC	T_L = 110°C, Rated V_{DRM} R_L = 3000 Ohms, R_{GK} = 1000 Ohms.
Peak On-State Voltage	V_{TM}	–	2.2	2.5	Volts	T_L = 25°C, I_{TM} = 4 Amperes Peak, Single Half Sine Wave Pulse, 2 Millisec. Wide.
Holding Current	I_H	0.3	2.0	6.0	mAdc	T_L = 25°C, Anode Supply = 12 Vdc, R_{GK} = 1000 Ohms.
		0.14	1.2	4.0	mAdc	T_L = 110°C, Anode Supply = 12 Vdc, R_{GK} = 1000 Ohms.
Latching Current	I_L	0.3	3.0	8.0	mAdc	T_L = 25°C, Anode Supply = 12 Vdc, R_{GK} = 1000 Ohms.
Critical Rate of Rise of Off-State Voltage	dv/dt	–	8	–	Volts/ Micro-second	T_L = 110°C, Rated V_{DRM} R_{GK} = 1000 Ohms.
Turn-On Time	$t_d + t_r$	–	1.2	–	Micro-seconds	T_L = 25°C, Rated V_{DRM} I_{TM} = 1 Ampere, Gate Pulse = 4 Volts, 300 Ohms, 5 Microseconds Wide.
Circuit Commutated Turn-Off Time	t_q	–	40	100	Micro-seconds	T_L = 110°C, rectangular current waveform. Rate of Rise of current < 10 amps/μsec. Rate of reversal of current < 5 amps/μsec. I_{TM} = 1 Amp (50 μsec. pulse). Repetition Rate = 60 pps. Rated V_{RRM} V_R = 15 Volts Minimum. Rated V_{DRM} Rate of Rise Reapplied Forward Blocking Voltage = 5 Volts/μsec. Gate Bias = 0 Volts, 100 Ohms (during turn-off time interval).

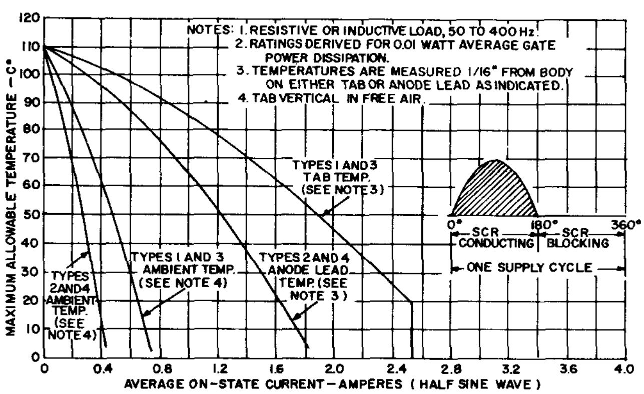
The lead temperature (T_L) is measured in the center of the tab, 1/16 inch from the body on Type 1 and Type 3 devices, and in the center of the anode lead, 1/16 inch from the body on Type 2 and Type 4 devices.
**Devices with an I_{GT} max. of 1mA and 2mA are available as C107-X1, or C107-X2 at reduced prices.*



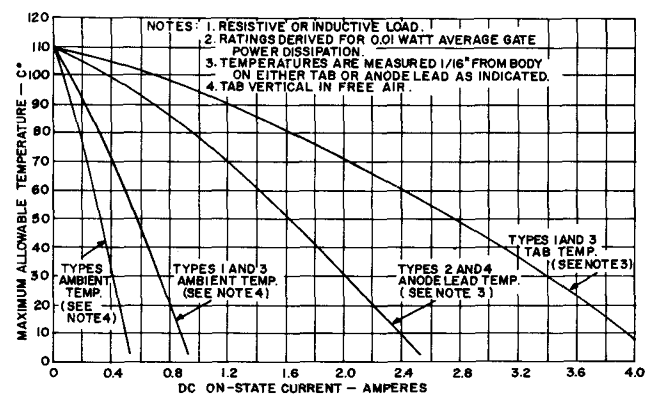
1. Maximum On-State Characteristics



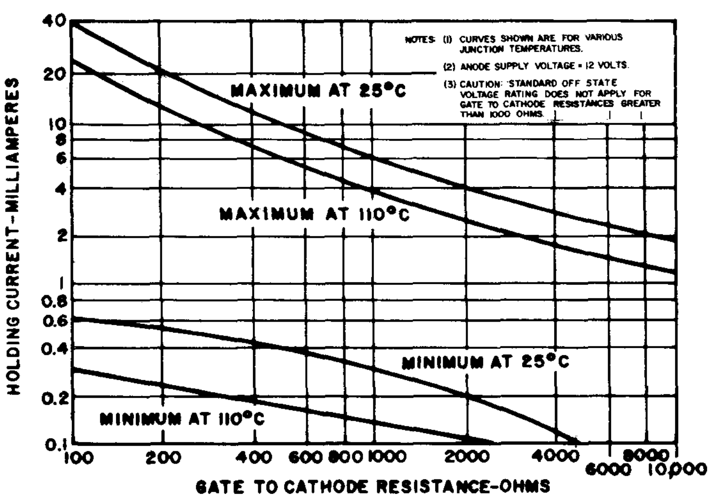
2. Maximum On-State Power Dissipation



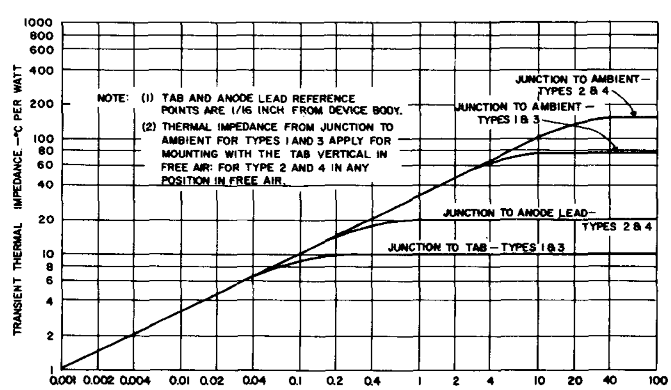
3. Maximum Allowable Temperatures for Half Sine Wave On-State Current



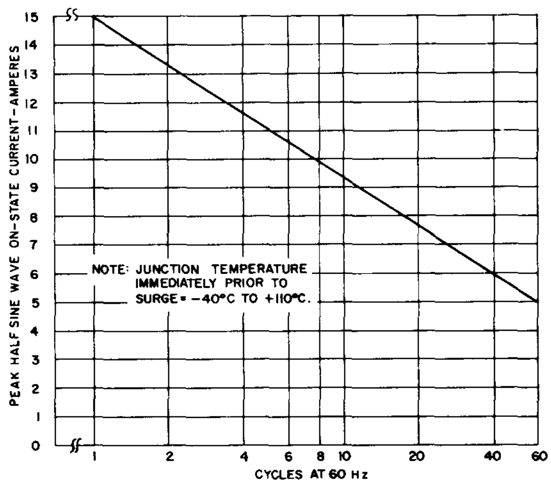
4. Maximum Allowable Temperatures for DC On-State Current



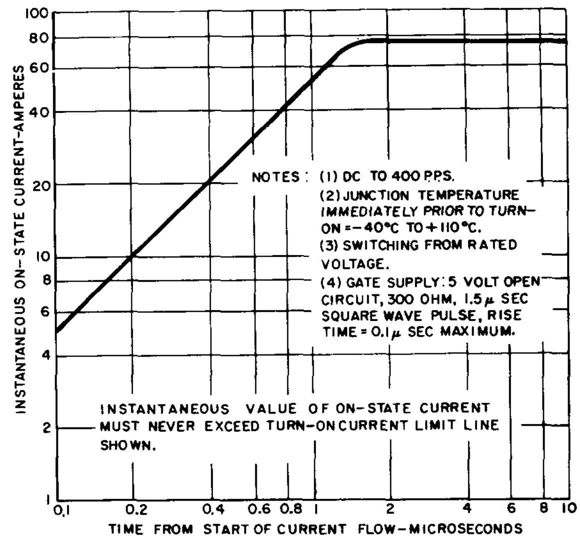
5. Maximum and Minimum Holding Current Variation with External Gate-to-Cathode Resistance



6. Maximum Transient Thermal Impedance



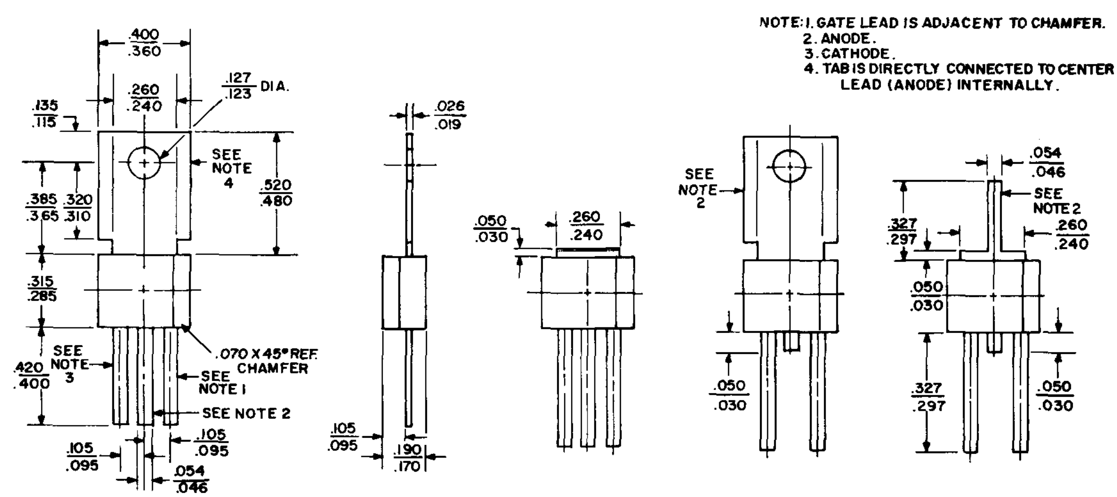
7. Maximum Allowable Peak Surge On-State Current (Non-repetitive)



8. Turn-On Current Limit

OUTLINE DRAWINGS

C106 CONVERSIONS	
INCHES	MILLIMETERS
.026 / .019	.660 / .483
.050 / .030	1.270 / .761
.054 / .046	1.372 / 1.168
.070	1.778
.105 / .095	2.667 / 2.412
.127 / .123	3.226 / 3.124
.135 / .115	3.429 / 2.920
.190 / .170	4.826 / 4.318
.260 / .240	6.604 / 6.095
.272 / .232	6.908 / 5.892
.315 / .285	8.001 / 7.239
.320 / .290	8.128 / 7.366
.320 / .310	8.128 / 7.874
.327 / .297	8.306 / 7.544
.385 / .365	9.779 / 9.271
.400 / .360	10.160 / 9.144
.420 / .400	10.668 / 10.160
.520 / .480	13.208 / 12.191



C107 TYPE 1 C107 TYPE 2 C107 TYPE 3 C107 TYPE 4

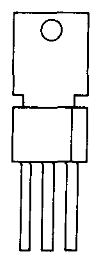
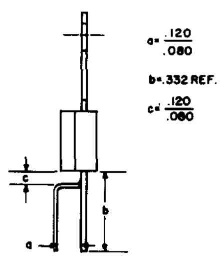
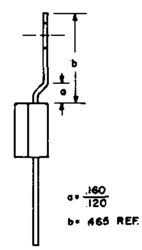
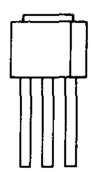
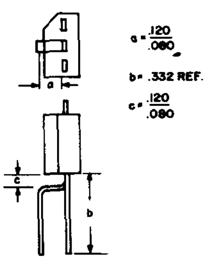
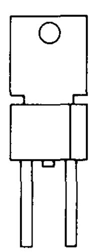
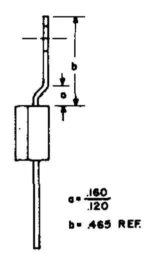
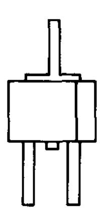
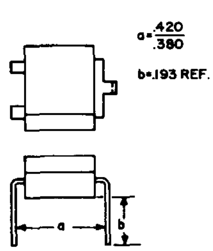
MOUNTING METHODS

The C107, because of its unique package design, is capable of being mounted in a variety of methods; depending upon the heatsink requirements and the circuit packaging methods.

The leads will bend easily, either perpendicular to the flat or to any angle, and may also be bent, if desired, immediately next to the plastic case. For sharp angle bends (90° or larger), a lead should be bent only once; since repeated bending will fatigue or break the lead. Bending in other directions may be performed as long as the lead is held firmly between the case and the bend, so that the strain on the lead is not transmitted to the plastic case.

The mounting tab may also be bent or formed into any convenient shape so long as it is held firmly between the plastic case and the area to be formed or bent. Without this precaution, bending may fracture the plastic case and permanently damage the unit.

As a service to its customers, the General Electric Company provides a lead and tab shaping capability. Any of the derived types shown in the following chart are available direct from the factory to original equipment manufacturers.

BASIC TYPES	DERIVED TYPES (The types shown below are derived from the basic types illustrated in the left-hand column.)		
	PRINTED CIRCUIT BOARD MOUNTING (Upright or Flat)	RIVET OR SCREW MOUNTING TO FLAT SURFACE	
 C107 Type 1	 C107 Type 11	 C107 Type 12	
 C107 Type 2	 C107 Type 21		
 C107 Type 3		 C107 Type 32	
 C107 Type 4	 C107 Type 41		

C107 CONVERSIONS

INCHES	MILLIMETERS	INCHES	MILLIMETERS
.120/.080	3.048/2.031	.332 REF.	8.433 REF.
.160/.120	4.064/3.047	.420/.380	10.668/9.651
.193 REF.	4.902 REF.	.465 REF.	11.811 REF.

Silicon Controlled Rectifier

Flat Pack Design

Up to 600 Volts 5 Amperes (RMS)

Model C108

PRODUCT FEATURES

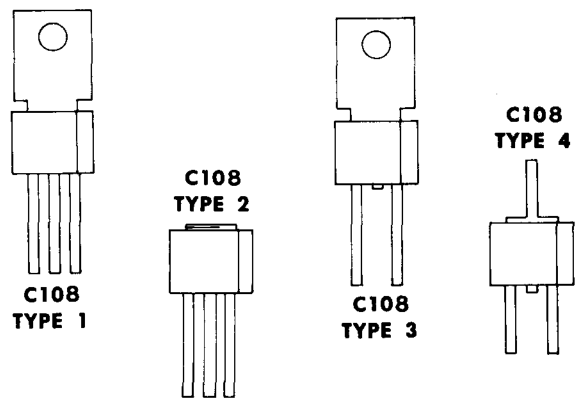
The Type C108 Silicon Controlled Rectifier (SCR) has the following outstanding features:

LOW COST

SENSITIVE Operates directly from low signal sensors such as thermistors, photo-conductive cells, etc.

VERSATILE Designed for a variety of mount-down methods—printed circuit, plug-in socket, screws, or point-to-point soldering

RUGGED, COMPACT Uses a solid plastic encapsulant in rectangular shape for high density packaging



(FULL SIZE)

TYPICAL APPLICATIONS

MOTOR CONTROL
- Electric Model Trains
- Sewing Machines
- Movie Projectors
- Food Mixers
- Electric Fans
- Slot Racing Cars

LIGHT
- Flame Detectors
- Moving-Light Signs (Chasers)
- Driver for Computer Readout Lights
- Harbor Buoy Flashers
- Automotive Warning Systems
- Nixie & Neon Drivers

TEMPERATURE
- Range Surface Unit (Hybrid)
- Chemical Processing (Photographic, etc.)
- Food Warmer Tray
- Bearing Temperature Sensor
- Electric Blanket Control

PRESSURE
- Auto Oil Pressure Gage
- Hot Water Boiler Safety Monitor

TIME
- Photo Darkroom Exposure
- Oven Timer
- Vending Machine Logic
- Industrial Process Control

LIQUID LEVEL
- Basement Sump Pump
- Automatic Coffee Maker
- Automatic Shutoff for Vending Machines

REMOTE CONTROL
- Armchair TV Control
- Master Switching Stations for Home
- Garage Door Openers
- Power Switch

DRYNESS
- Clothes Dryness Sensor

PROXIMITY
- Burglar Alarm
- Touch Switch
- Electric Door Openers

COUNTING
- Low Speed Ring Counters
- Shift Registers

SWITCHING
- Relay Replacement
- Solenoid Drivers
- Latching Relay Replacement
- Power Flip Flops
- Low Power Inverters
- Thyratron Tube Replacement

AMPLIFIERS
- Gate Amplifier for Larger SCR's, Triacs
  - —Blenders
  - —Hand Tools

IGNITION
- Small Gas Engines
- Gas Appliances

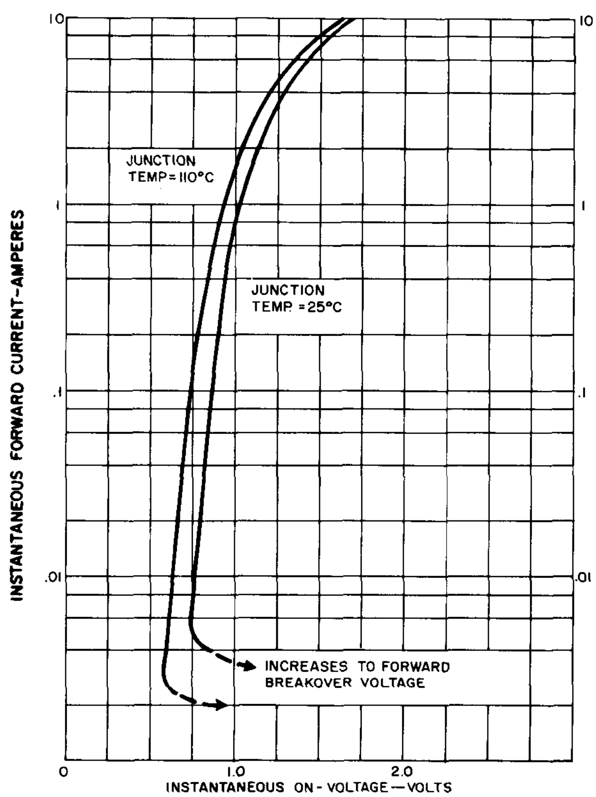
DETECTION
- Voltage (Battery Charger)
- Current (Crowbar)

MAXIMUM ALLOWABLE RATINGS

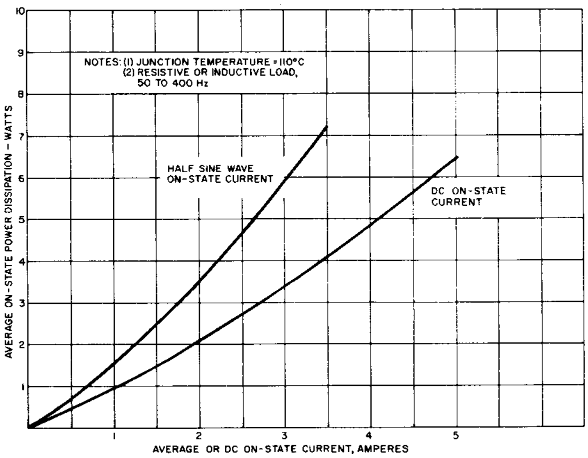
Type	Repetitive Peak Forward Blocking Voltage, V_{FXM} R_{GK} = 1000 Ohms T_J = -40°C to +110°C	Working and Repetitive Peak Reverse Voltage, V_{ROM}(wkg) and V_{ROM}(rep) T_J = -40°C to +110°C
C108Q1, C108Q2, C108Q3, C108Q4	15 Volts	15 Volts
C108Y1, C108Y2, C108Y3, C108Y4	30 Volts	30 Volts
C108F1, C108F2, C108F3, C108F4	50 Volts	50 Volts
C108A1, C108A2, C108A3, C108A4	100 Volts	100 Volts
C108B1, C108B2, C108B3, C108B4	200 Volts	200 Volts
C108C1, C108C2, C108C3, C108C4	300 Volts	300 Volts
C108D1, C108D2, C108D3, C108D4	400 Volts	400 Volts
C108E1, C108E2, C108E3, C108E4	500 Volts	500 Volts
C108M1, C108M2, C108M3, C108M4	600 Volts	600 Volts

RMS Forward Current, On-State . . . . 5 Amperes
Rate of Rise of Forward Current (non-repetitive), di/dt (See Chart 9) . . . . 50 Amperes/Microsecond
Peak Forward Current, On-State (repetitive) . . . . 75 Amperes*
Peak One Cycle Surge Forward Current, Non-Repetitive, I_{FM} (surge) . . . . 30 Amperes
I^2t (for fusing) . . . . 1.0 Ampere² seconds (for times 1.5 Milliseconds)
Peak Gate Power, P_{GM} . . . . 0.5 Watt
Average Gate Power, $P_{G(AV)}$ . . . . 0.1 Watt
Peak Gate Current, I_{GFM} . . . . 0.2 Amperes
Peak Reverse Gate Voltage, V_{GRM} . . . . 6 Volts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature . . . . -40°C to +110°C

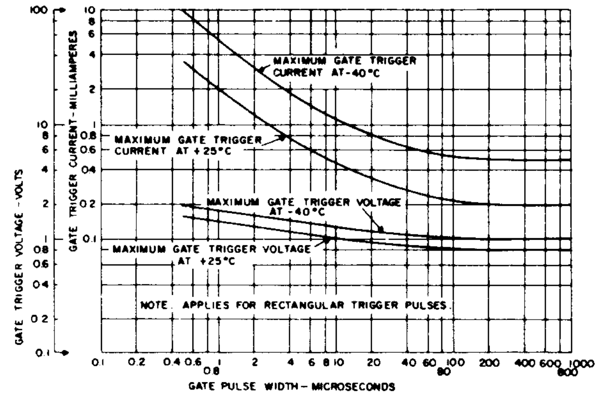
*This rating applies for operation at 60 Hz, 75°C maximum tab (or anode) lead temperature, switching from 80 volts peak, sinusoidal current pulse width 10 μsec, minimum, 15 μsec. maximum.



1. Maximum Forward Characteristics, On State



2. Maximum On-State Power Dissipation

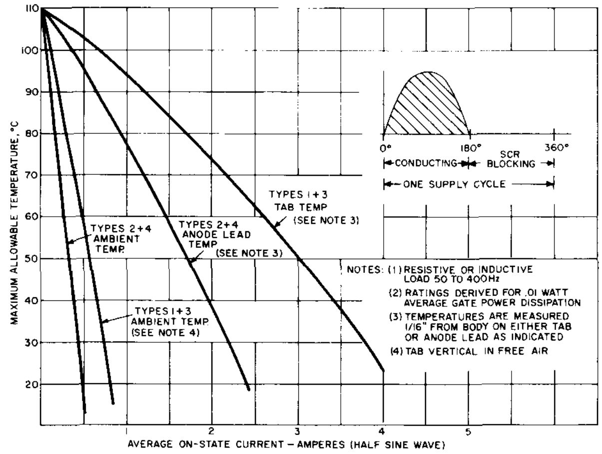


3. Maximum Gate Trigger Current and Voltage Variation with Trigger Pulse Width

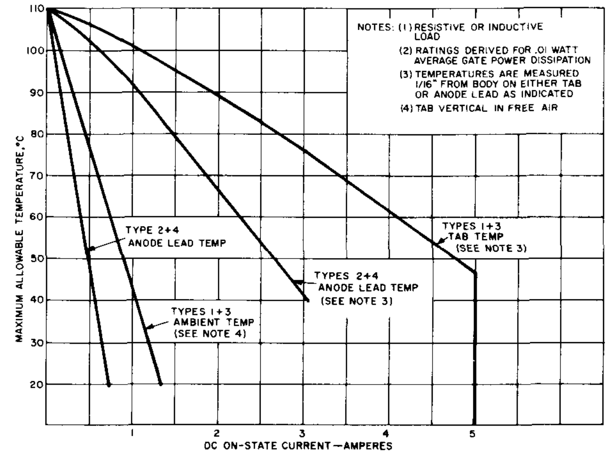
CHARACTERISTICS

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Reverse or Forward Blocking Current (All Types)	I_{RRM} or I_{DRM}	–	0.1	10	μA	$V_{RRM} = V_{DRM}$ = Rated Value. T_L = 25°C, R_{GK} = 1000 Ohms
		–	10	100	μA	$V_{RRM} = V_{DRM}$ = Rated Value. T_L = 110°C, R_{GK} = 1000 Ohms.
*DC Gate Trigger Current	I_{GT}	–	30	200	μAdc	T_L = 25°C, V_D = 6 Fdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
		–	75	500	μAdc	T_L = -40°C, V_D = 6 Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
DC Gate Trigger Voltage	V_{GT}	0.4	0.5	0.8	Volts DC	T_L = 25°C, V_D = 6 Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
		0.5	0.7	1.0	Volts DC	T_L = -40°C, V_D = 6 Vdc, R_L = 100 Ohms R_{GK} = 1000 Ohms
		0.2	–	–	Volts DC	T_L = 110°C, V_D = Rated V_{DRM} Value R_L = 3000 Ohms, R_{GK} = 1000 Ohms
Peak On-Voltage	V_{TM}	–	1.2	1.35	Volts	T_L = 25°C, I_{TM} = 5 Amperes Peak, Single Half Sine Wave Pulse, 2 Millisec. Wide
Holding Current	I_H	0.3	1.0	3.0	mAdc	T_L = 25°C, V_D = 12 Vdc, R_{GK} = 1000 Ohms
		0.4	2.0	6.0	mAdc	T_L = -40°C, V_D = 12 Vdc, R_{GK} = 1000 Ohms
		0.14	0.6	2.0	mAdc	T_L = 110°C, V_D = 12 Vdc, R_{GK} = 1000 Ohms
Latching Current	I_L	0.3	1.5	4.0	mAdc	T_L = 25°C, V_D = 12 Vdc, R_{GK} = 1000 Ohms
		0.4	3.0	8.0	mAdc	T_L = -40°C, V_D = 12 Vdc, R_{GK} = 1000 Ohms
Critical Rate of Rise of Forward Blocking Voltage	dv/dt	–	8	–	Volts/ Micro-second	T_L = 110°C, V_D = Rated V_{DRM} Value R_{GK} = 1000 Ohms
Turn On Time	t_d+t_r	–	1.2	–	Micro-seconds	T_L = 25°C, V_{DX} = Rated V_{DRM} Value I_{FM} = 1 Ampere, Gate Pulse = 4 Volts, 300 Ohms, 5 Microseconds Wide.
Circuit Commutated Turn-Off Time	t_q	–	40	100	Micro-seconds	T_L = 110°C, rectangular current waveform. Rate of rise of current $<$ 10 amps/μsec. Rate of reversal of current $<$5 amps/μsec. I_{TM} = 1 Amp (50 μsec pulse). Repetition Rate = 60 pps. V_{RRM} = Rated. V_R = 15 Volts Minimum. V_{DRM}= Rated. Rate of Rise Reapplied Forward Blocking Voltage = 5 Volts/μsec. Gate Bias = 0 Volts, 100 Ohms (during turn-off time interval).

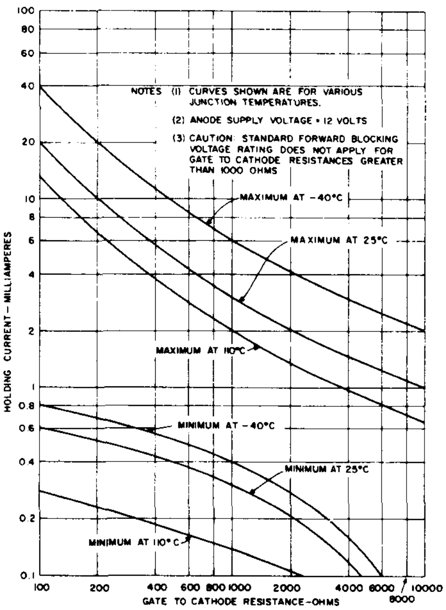
The lead temperature (T_L) is measured in the center of the tab, 1/16 inch from the body on Type 1 and Type 3 devices and in the center of the anode lead, 1/16 inch from the body on Type 2 and Type 4 devices.



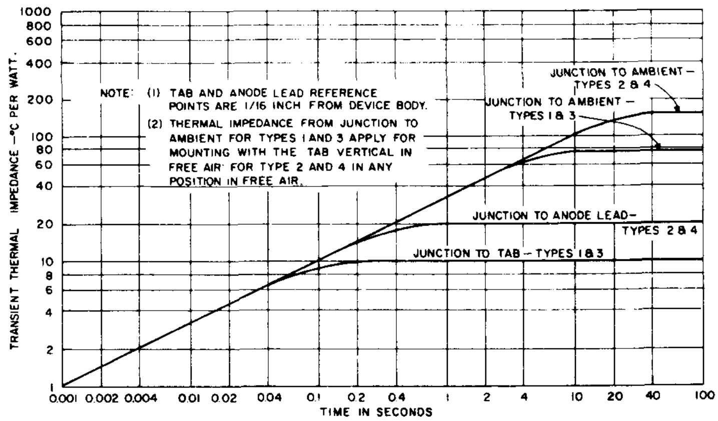
4. Maximum Allowable Temperatures for Half Sine Wave On-State Current



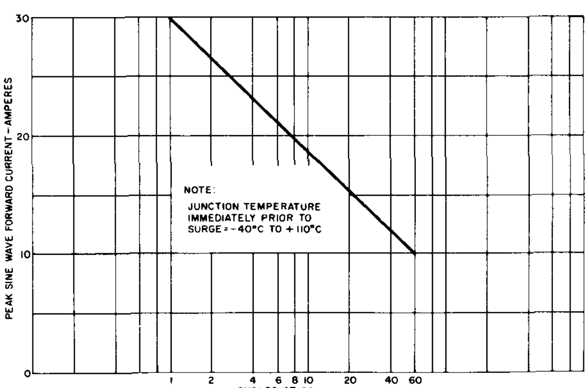
5. Maximum Allowable Temperatures for DC On-State Current



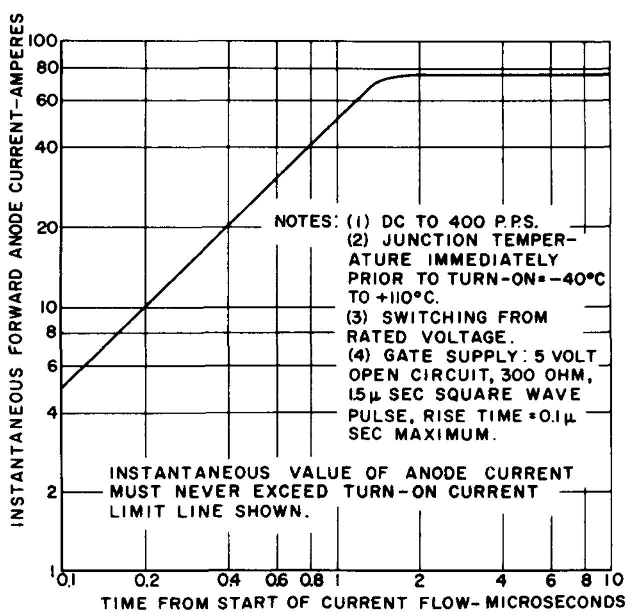
6. Maximum and Minimum Holding Current Variation with External Gate-to-Cathode Resistance



7. Maximum Transient Thermal Impedance



8. Maximum Allowable Non-Repetitive Peak Surge Forward Current



9. Turn-On Current Limit

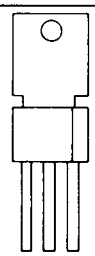
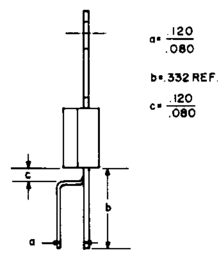
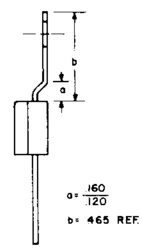
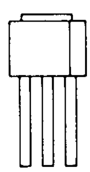
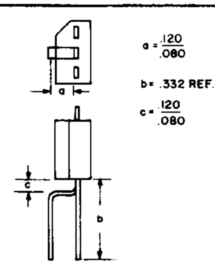
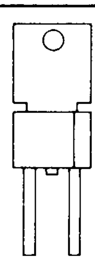
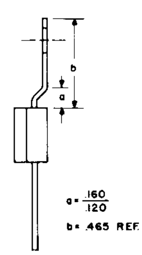
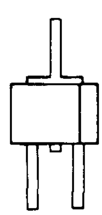
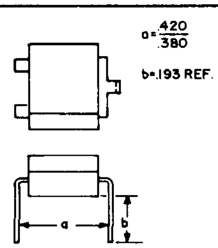
MOUNTING METHODS

The C108, because of its unique package design, is capable of being mounted in a variety of methods; depending upon the heatsink requirements and the circuit packaging methods.

The leads will bend easily, either perpendicular to the flat or to any angle, and may also be bent, if desired, immediately next to the plastic case. For sharp angle bends (90° or larger), a lead should be bent only once; since repeated bending will fatigue or break the lead. Bending in other directions may be performed as long as the lead is held firmly between the case and the bend, so that the strain on the lead is not transmitted to the plastic case.

The mounting tab may also be bent or formed into any convenient shape so long as it is held firmly between the plastic case and the area to be formed or bent. Without this precaution, bending may fracture the plastic case and permanently damage the unit.

As a service to its customers, the General Electric Company provides a lead and tab shaping capability. Any of the derived types shown in the following chart are available direct from the factory to original equipment manufacturers.

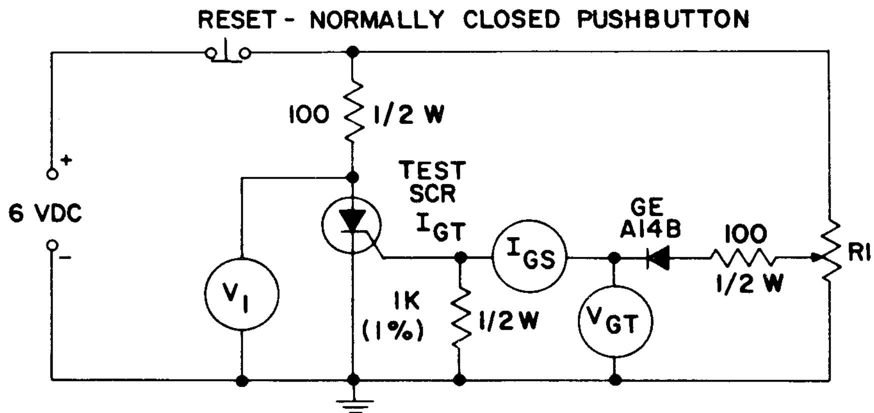
BASIC TYPES	DERIVED TYPES (The types shown below are derived from the basic types illustrated in the left-hand column.)		
	PRINTED CIRCUIT BOARD MOUNTING (Upright or Flat)	RIVET OR SCREW MOUNTING TO FLAT SURFACE	
 C108 Type 1	 C108 Type 11	 C108 Type 12	
 C108 Type 2	 C108 Type 21		
 C108 Type 3		 C108 Type 32	
 C108 Type 4	 C108 Type 41		

C108 CONVERSIONS

INCHES	MILLIMETERS	INCHES	MILLIMETERS
.120/.080	3.048/2.031	.332 REF.	8.433 REF.
.160/.120	4.064/3.047	.420/.380	10.668/9.651
.193 REF.	4.902 REF.	.465 REF.	11.811 REF.

SIMPLE TEST CIRCUIT FOR THE C108 SCR*

Gate Trigger Voltage and Current Measurement



V_1 — 0-10 volt DC meter
V_{GT} — 0-1 volt DC meter
I_{GS} — 0-1mA DC milliameter
R1 — 1K potentiometer

To measure gate trigger voltage and current, raise gate voltage (V_{GT}) until meter reading V_1 drops from 6 volts to 1 volt. Gate trigger voltage is the reading on V_{GT} *just prior* to V_1 dropping. Gate trigger current I_{GT} can be computed from the relationship:

$$I_{GT} = I_{GS} - \frac{V_{GT}}{1000} \text{ amps}$$

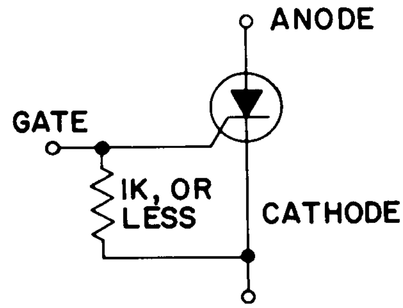
where I_{GS} is reading (in amps) on meter *just prior* to V_1 dropping. NOTE: I_{GT} may turn out to be a negative quantity (trigger current flows *out* from gate lead).

** For more sophisticated equipment suitable for testing the C108 SCR see GE Application Note 200.19 "Using Low Current SCR's".*

CIRCUIT DESIGN

1. Use of Gate Resistor

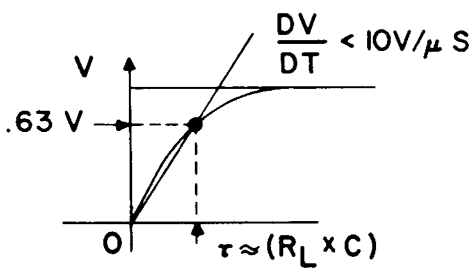
The C108 SCR is guaranteed to block rated voltage over its rated operating temperature range *only* if a resistance of not more than 1000 ohms, or equivalent, ** is connected between its gate and cathode terminals as follows:

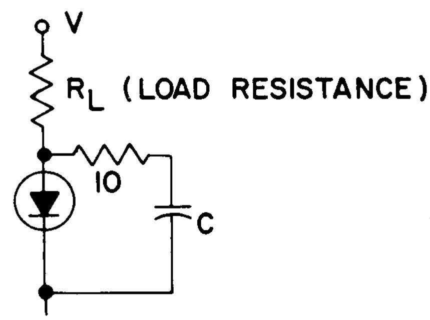


** *For alternative acceptable gate biasing methods see Application Note 200. 19 "Using Low Current SCR's".*

2. Suppression of Rate Effect

In circuits where the C108 is subjected to fast rising anode voltages as for instance where voltage is applied suddenly with a switch, RC "slow down" filters may be required to prevent the SCR from triggering spontaneously. C should be selected in conjunction with R_L so that dv/dt is less than 10 volts per microsecond thus:

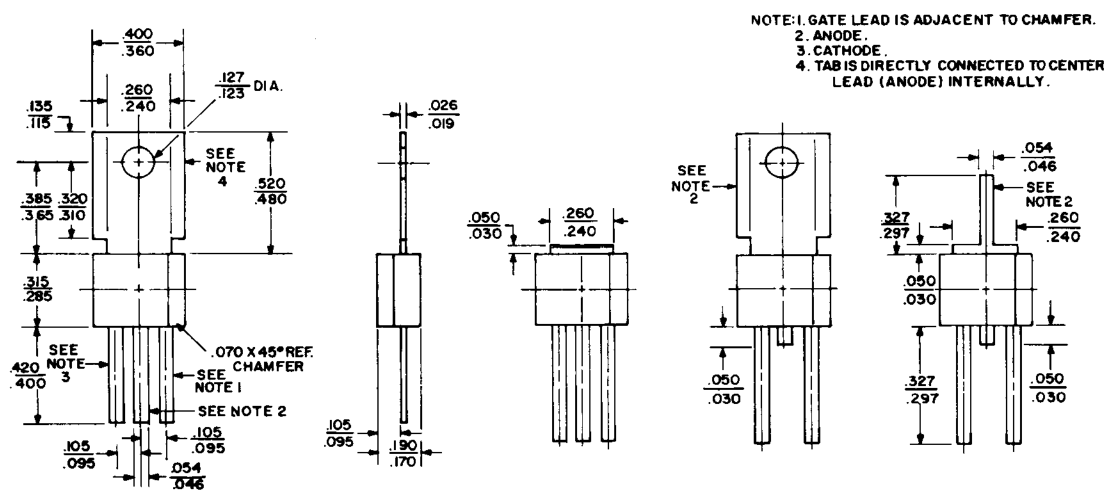




(The 10 ohm resistor limits turn on current through the SCR to a safe value when the SCR turns on.)

OUTLINE DRAWINGS

C108 CONVERSIONS	
INCHES	MILLIMETERS
.026 / .019	.660 / .483
.050 / .030	1.270 / .761
.054 / .046	1.372 / 1.168
.070	1.778
.105 / .095	2.667 / 2.412
.127 / .123	3.226 / 3.124
.135 / .115	3.429 / 2.920
.190 / .170	4.826 / 4.318
.260 / .240	6.604 / 6.095
.272 / .232	6.908 / 5.892
.315 / .285	8.001 / 7.239
.320 / .290	8.128 / 7.366
.320 / .310	8.128 / 7.874
.327 / .297	8.306 / 7.544
.385 / .365	9.779 / 9.271
.400 / .360	10.160 / 9.144
.420 / .400	10.668 / 10.160
.520 / .480	13.208 / 12.191



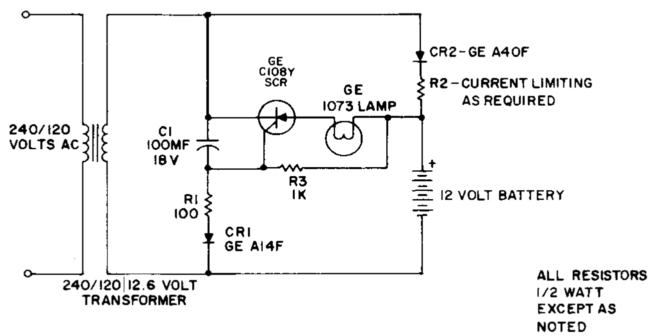
C108 TYPE 1 C108 TYPE 2 C108 TYPE 3 C108 TYPE 4

REPRESENTATIVE APPLICATIONS OF THE C108 SCR

1. Emergency Light

This simple circuit provides battery operated emergency lighting instantaneously upon failure of the regular AC service. When line power is restored, the emergency light turns off and the battery recharges automatically. The circuit is ideal for use in elevator cars, corridors and similar places where loss of light due to power failure would be undesirable. Completely static in operation, the circuit requires no maintenance.

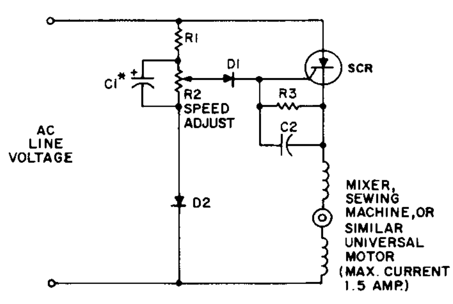
With AC power "on", capacitor C1 charges through rectifier CR1 and resistor R1 to develop a negative DC voltage at the gate of the C108Y SCR. By this means the SCR is prevented from triggering, and the emergency light stays off. At the same time, the battery is kept fully charged by rectifier CR2 and resistor R2. Should the AC power fail, C1 discharges and the SCR is triggered on by battery power through resistor R3. The SCR then energizes the emergency light. Reset is automatic when AC is restored, because the peak AC line voltage biases the SCR and turns it off.



2. Universal Motor Speed Control

This circuit can replace the carbon-pile speed controller commonly supplied with household sewing machines. It is equally effective for use with other small AC-DC motors, such as those found in food mixers and similar traffic appliances. Maximum current capability is 1.5 amps. Provision of speed-dependent feedback gives excellent torque characteristics to the motor, even at low speeds where other types of controllers are completely ineffective.

The resistor capacitor network R1-R2-C1 provides a ramp-type reference voltage superimposed on top of a DC voltage adjustable with the speed-setting potentiometer R2. This reference voltage appearing at the wiper of R2 is balanced against the residual counter emf of the motor through the SCR gate. As the motor slows down due to heavy loading, its counter emf falls, and the reference ramp triggers the SCR earlier in the AC cycle. More voltage is thereby applied to the motor causing it to pick up speed again. Performance with the C108 SCR is particularly good because the low trigger current requirements of this device allow use of a flat top reference voltage, which provides good feedback gain and close speed regulation.



Line Voltage	120V	240V
R_1	47K	100K
R_2	10K	20K
R_3	1K	1K
C_1	1μF, 50V	1μF, 100V
C_2	0.1μF, 50V	0.1μF, 50V
D_1	1N5059	1N5060
D_2	1N5059	1N5060
SCR	C108B1	C108D1

Note

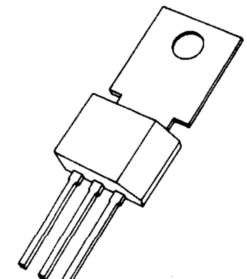
* *C_1 optional, contributes to performance in some circumstances.*

Reverse Blocking Triode Thyristor (SCR)

Model C116

8A RMS Up to 600 Volts

The C116 is a molded silicon plastic SCR which incorporates General Electric's new POWER-GLAS glassivation process. This process provides for an intimate void-free bond between the silicon chip and the glass coating significantly improving performance and reliability.



JEDEC TO-202

FEATURES:

- Glassivated silicon chip for maximum reliability in AC or DC circuitry.
- Special selections for non-standard gate requirements available upon request.
- Designed for a variety of mount-down methods.

TYPICAL SCR APPLICATIONS

	GENERAL FUNCTIONS				
Application	Motor Control	Temperature Control	Relay & Solenoid Driver	Power Regulator	Capacitor Discharge Circuit
Process Control Equipment	X	X	X	X	
Reproduction Equipment		X	X	X	
Blender, Mixers	X				
Hand Tools	X				
Machine Tools/Misc. Mfg.	X		X		
Sewing Machines	X				
Laundry			X		X
Farm Equipment	X		X		X
Photographic Equipment	X	X			
Clutches/Brakes			X		
Industrial Timers			X		
Vending Machines	X	X	X		
Battery Chargers				X	
Business Machines	X		X	X	
Gas & Oil Ignitors			X		X
Internal Combustion Engine Ignitions					X

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} (3) T_C = -40° C to +110°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} (1) (3) T_C = -40°C to +110°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} (1) (2) T_C = -40°C to +110°C
C116F	50 Volts	50 Volts	75 Volts
C116A	100 Volts	100 Volts	200 Volts
C116B	200 Volts	200 Volts	300 Volts
C116C	300 Volts	300 Volts	400 Volts
C116D	400 Volts	400 Volts	500 Volts
C116E	500 Volts	500 Volts	600 Volts
C116M	600 Volts	600 Volts	720 Volts

RMS On-State Current, $I_{T(RMS)}$ . . . . . 8 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$ . . . . . Depends on conduction angle (See Charts 3 and 4)
Critical Rate-of-Rise of On-State Current, di/dt: (4)

Gate Triggered Operation . . . . . (See Chart 10)
  Switching from 200 volts . . . . . 100 Amperes Per Microsecond
  Switching from 400 volts . . . . . 65 Amperes Per Microsecond
  Switching from 600 volts . . . . . 30 Amperes Per Microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} 50 Hz . . . . . 82 Amperes
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} 60 Hz . . . . . 90 Amperes
I^2t (for fusing), for times at 8.3 milliseconds . . . . . See Chart 12 . . . . . 34 Ampere^2 Seconds
I^2t (for fusing), for times at 1.5 milliseconds . . . . . 27 Ampere^2 Seconds
Peak Gate Power Dissipation, P_{GM} . . . . . 5 Watts for 10 microseconds (See Chart 6)
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . . 0.5 Watts
Peak Positive Gate Current, I_{GM} . . . . . (See Chart 6)
Peak Positive Gate Voltage, V_{GM} . . . . . (See Chart 6)
Peak Negative Gate Voltage, V_{GM} . . . . . 5 Volts
Storage Temperature, T_{STG} . . . . . -40°C to +125°C
Operating Temperature, T_J . . . . . -40°C to +110°C

NOTES:

(1) Values apply for zero or negative gate voltage only.
(2) Half sine wave voltage pulse, 10 millisecond duration.
(3) During performance of the off-state and reverse blocking tests, the thyristor should not be tested with a constant source which would permit applied voltage to exceed the device rating.
(4) di/dt rating is established in accordance with JEDEC Standard P.S.397 Section 5.2.2.6. Off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 60 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

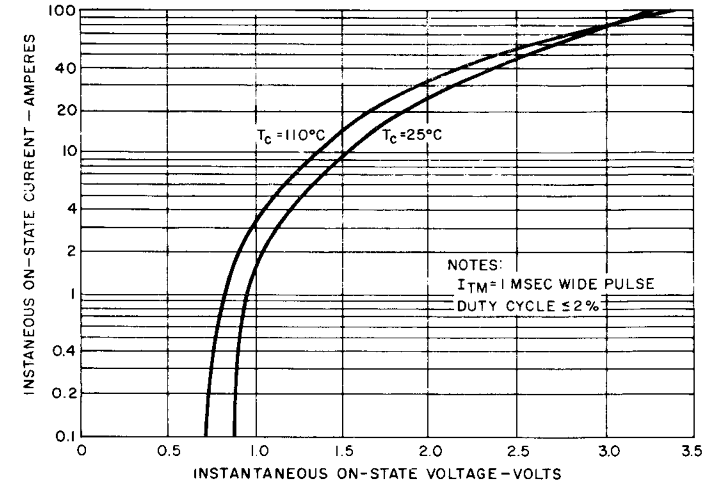
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Off-State or Reverse Current (1)	I_{DRM} or I_{RRM}				mA	$V_{DRM} = V_{RRM}$ = Max. allowable volts peak
		–	–	0.1		T_C = + 25°C
		–	–	0.5		T_C = +110°C
Peak On-State Voltage	V_{TM}	–	–	1.57	Volts	T_C = + 25°C, I_{TM} = 16A peak. 1 Millisecond wide pulse, Duty cycle ≤ 2%.
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	– 10	100	–	Volts/μsec	T_C = +110°C, Rated V_{DRM}. Gate Open Circuited, Linear Waveform.
Circuit Commutated Turn-Off Time	t_q	–	50	–	μsec	T_C = +110°C, I_{TM} = 10 A peak. Rectangular current pulse, 40 μsec duration. Commutation rate = 5A/μsec. Peak reverse voltage = Rated volts max. Reverse voltage at end of turn-off time interval 12 volts min. Repetition rate = 60 pps. Rate-of-Rise reapplied off-stage voltage (dv/dt) = 10V/μsec. Off-State voltage = Rated V Gate bias during turn-off time interval = 0 volts, 100 ohms.
D.C. Gate Trigger Current	I_{GT}	–	–	25	mAdc	T_C = + 25°C; V_D = 6 Vdc; R_L = 91 ohms.
		–	–	40		T_C = - 40°C; V_D = 6 Vdc; R_L = 45 ohms.
D.C. Gate Trigger Voltage	V_{GT}	–	–	1.5	Vdc	T_C = + 25°C; V_D = 6 Vdc; R_L = 91 ohms.
		–	–	2.0		T_C = - 40°C; V_D = 6 Vdc; R_L = 45 ohms.
		0.2	–	–		T_C = +110°C; V_D = 6 Vdc; R_L = 1000 ohms.
Holding Current	I_H				mAdc	Anode source voltage = 24 Vdc, Peak initiating On-State current = 0.5A, 0.1 msec to 10 msec wide pulse. Gate trigger source = 7V, 20 ohms.
		–	–	30		T_C = +25°C
		–	–	60		T_C = -40°C
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15V, 100 ohms, 50 μsec rise and fall times max.
		–	–	60		T_C = +25°C
		–	–	120		T_C = -40°C
Steady-State (2) Thermal Resistance					°C/Watt	
	$R_{\theta JC}$	–	–	8.0		Junction-to-Case (Types 11 and 12)
	$R_{\theta JA}$	–	–	75		Junction-to-Ambient (Types 11 and 12)

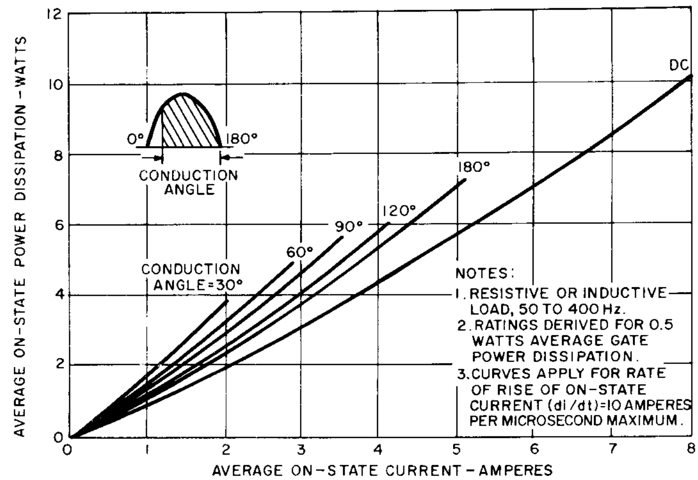
NOTES:

(1) Values apply for zero or negative gate voltage only.

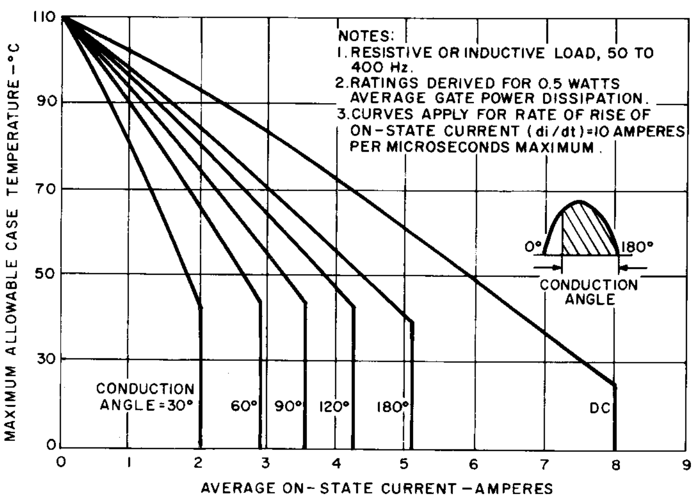
(2) T_L is approximately equal to T_C, see outline drawing. The junction-to-ambient value is under worst case conditions, i.e., with #22 copper wire used for electrical contact to the terminals and natural convection.



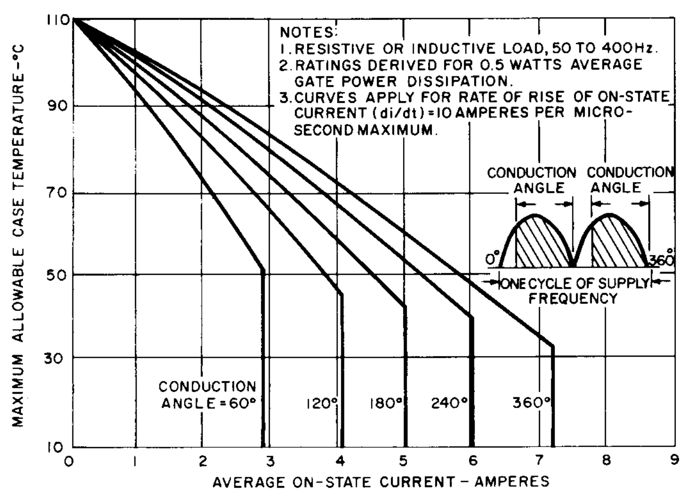
1. Max. On-State Voltage vs. On-State Current



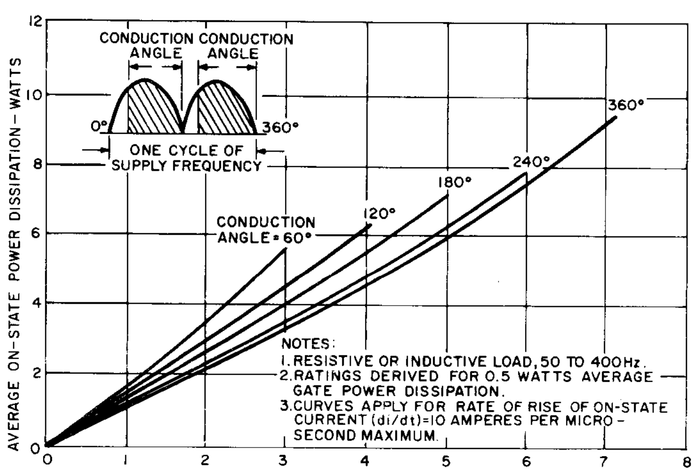
2. Max. On-State Power Dissipation for Half-Wave Rectified Sine Wave of Current



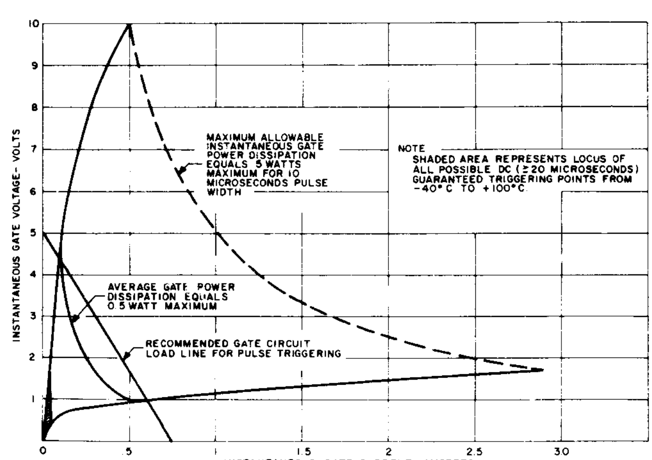
3. Max. Allowable Case Temperature For Half-Wave Rectified Sine Wave of Current



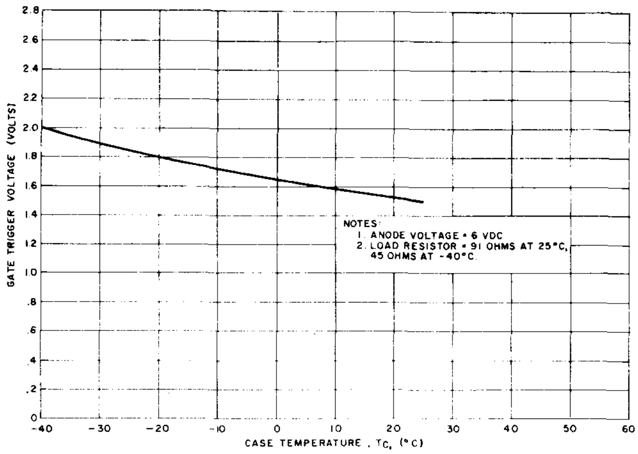
4. Max. Allowable Case Temperature For Full-Wave Rectified Sine Wave of Current



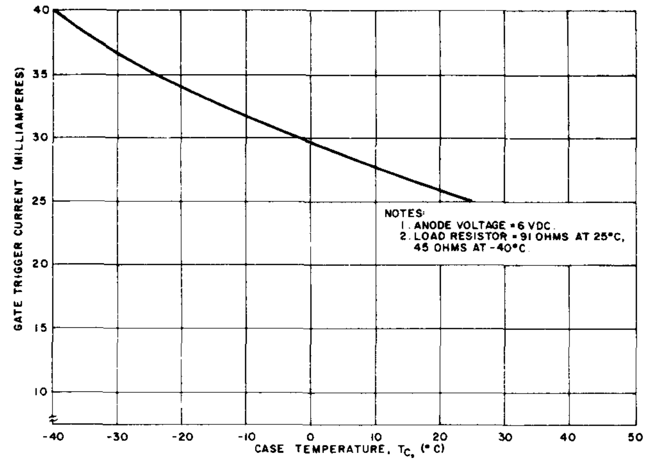
5. Max. Allowable On-State Power Dissipation for Full-Wave Sine Wave of Current



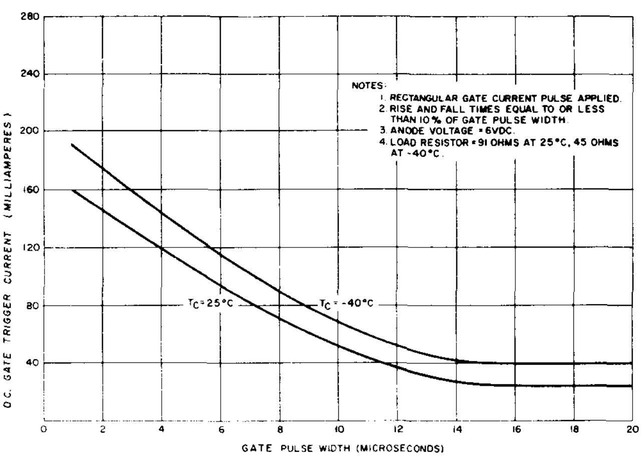
6. Gate Trigger Characteristics



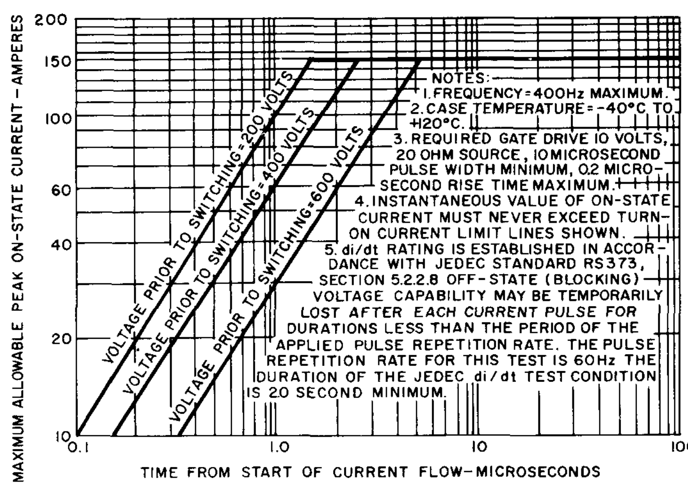
7. Max. DC Gate Voltage to Trigger vs. Case Temperature



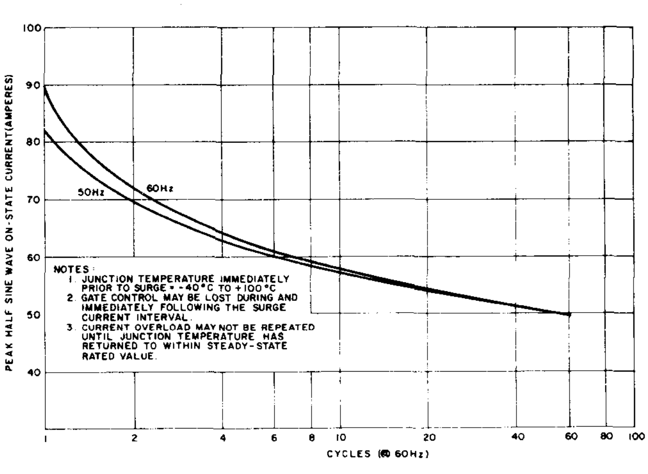
8. Max. DC Gate Current to Trigger vs. Case Temperature



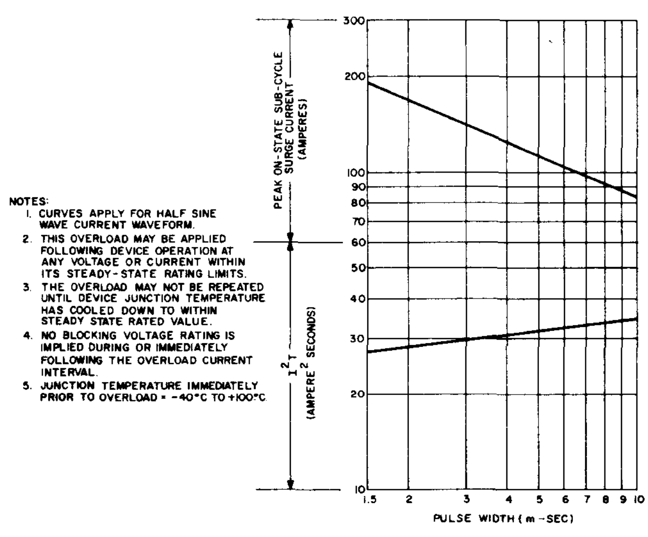
9. Max. DC Gate Current to Trigger vs. Gate Pulse Width



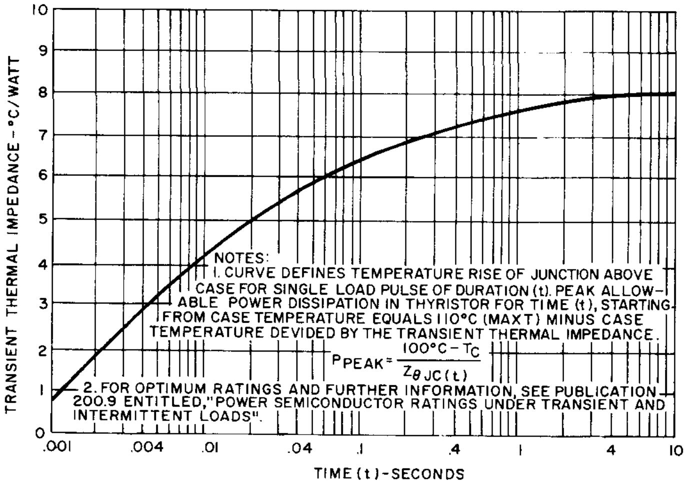
10. Turn-On Current Limit



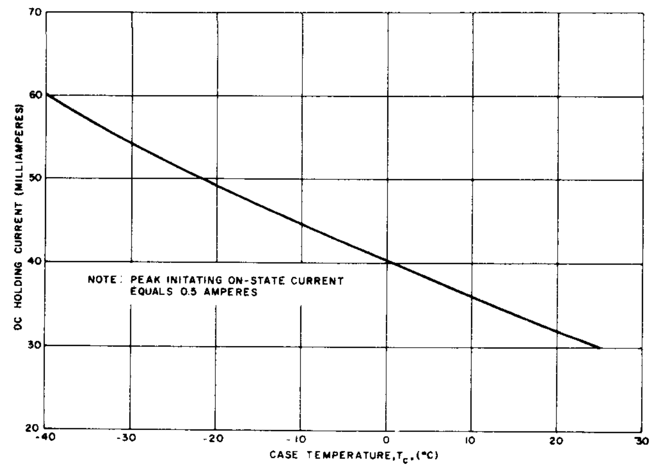
11. Max. Allowable Surge Current
Following Rated Load Conditions



12. Sub-cycle Surge and I^2t Rating
Following Rated Load Conditions



13. Max. Transient Thermal Impedance, Junction to Case Types 1 and 3



14. Max. DC Holding Current vs. Case Temperature

MOUNTING METHODS

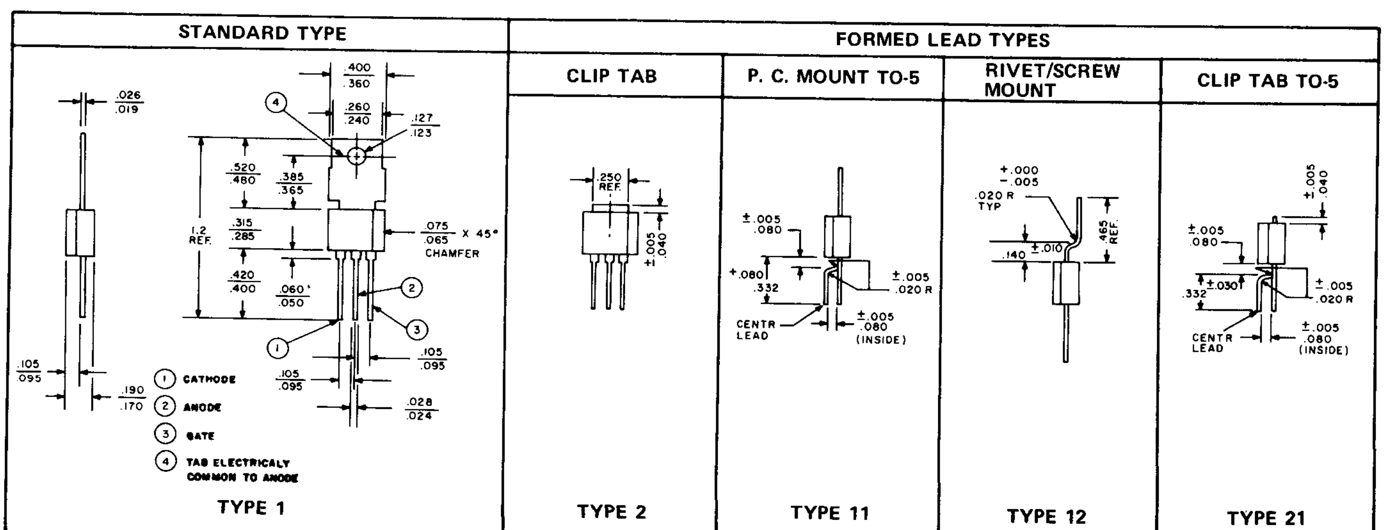
The C116, because of its unique package design, is capable of being mounted in a variety of methods; depending upon the heatsink requirements and the circuit packaging methods.

The leads will bend easily, either perpendicular to the flat or to any angle, and may also be bent, if desired, immediately next to the plastic case. For sharp angle bends (90° or larger), a lead should be bent only once; since repeated bending will fatigue or break the lead. Bending in other directions may be performed as long as the lead is held firmly between the case and the bend, so that the strain on the lead is not transmitted to the plastic case.

The mounting tab may also be bent or formed into any convenient shape so long as,it is held firmly between the plastic case and the area to be formed or bent. Without this precaution, bending may fracture the plastic case and permanently damage the unit.

As a service to its customers, the General Electric Company provides a lead and tab shaping capability. Any of the derived types shown in the following chart are available direct from the factory to original equipment manufacturers.

OUTLINE DRAWINGS

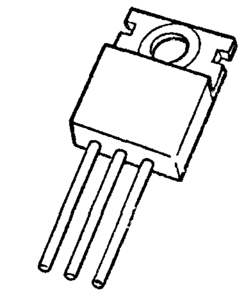


SCR

C122

8 A RMS Up to 600 Volts

The C122 is a molded silicon plastic SCR which incorporates General Electric's new POWER-GLAS glassivation process. This process provides for an intimate void-free bond between the silicon chip and the glass coating significantly improving performance and reliability.



JEDEC TO-220AB

FEATURES:

- Glassivated silicon chip for maximum reliability in AC or DC circuitry
- No maximum torque limit on mounting screw
- Round leads – greatly simplifies customer assembly
- Six standard lead forming configurations available from factory (including TO-66 compatibility)
- Special selections for non-standard gate requirements available upon request

TYPICAL SCR APPLICATIONS

	GENERAL FUNCTIONS				
Application	**Motor Control**	**Temperature Control**	**Relay & Solenoid Driver**	**Power Regulator**	**Capacitor Discharge Circuit**
Process Control Equipment	X	X	X	X	
Reproduction Equipment		X	X	X	
Blender, Mixers	X				
Hand Tools	X				
Machine Tools/Misc. Mfg.	X		X		
Sewing Machines	X				
Laundry			X		X
Farm Equipment	X		X		X
Photographic Equipment	X	X			
Clutches/Brakes			X		
Industrial Timers			X		
Vending Machines	X	X	X		
Battery Chargers				X	
Business Machines	X		X	X	
Gas & Oil Ignitors			X		X
Internal Combustion Engine Ignitions					X

MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM}(3) T_C = -40°C to +100°C	Repetitive Peak Reverse Voltage, V_{RRM}(1)(3) T_C = -40°C to +100°C	Non-Repetitive Peak Reverse Voltage, V_{RSM}(1)(2) T_C = -40°C to +100°C
C122F	50 Volts	50 Volts	75 Volts
C122A	100 Volts	100 Volts	200 Volts
C122B	200 Volts	200 Volts	300 Volts
C122C	300 Volts	300 Volts	400 Volts
C122D	400 Volts	400 Volts	500 Volts
C122E	500 Volts	500 Volts	600 Volts
C122M	600 Volts	600 Volts	700 Volts

Peak positive anode voltage (T_C = -40°C to +100°C) . . . . 560 Volts
RMS On-State Current, $I_{T(RMS)}$ . . . . 8 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$ . . . . Depends on conduction angle (See Charts 3 and 4)
Critical Rate-Of-Rise of On-State Current, di/dt: (4)
Gate triggered operation . . . . (see Chart 10)
Switching from 200 volts. . . . . 100 Amperes per microsecond
Switching from 500 volts . . . . 50 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} 50 Hz . . . . 82 Amperes
60 Hz . . . . 90 Amperes
I^2t (for fusing), for times at 8.3 milliseconds . . . . } see Chart 12 { . . . . 34 Ampere² seconds
1.5 milliseconds . . . . 27 Ampere² seconds
Peak Gate Power Dissipation, P_{GM} . . . . 5 Watts for 10 microseconds (see Chart 6)
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 0.5 Watts
Peak Positive Gate Current I_{GM} . . . . see Chart 6
Peak Positive Gate Voltage, V_{GM} . . . . see Chart 6
Peak Negative Gate Voltage, V_{GM} . . . . 5 Volts
Storage Temperature, T_{stg} . . . . -40°C to +125°C
Operating Temperature, T_J . . . . -40°C to +100°C

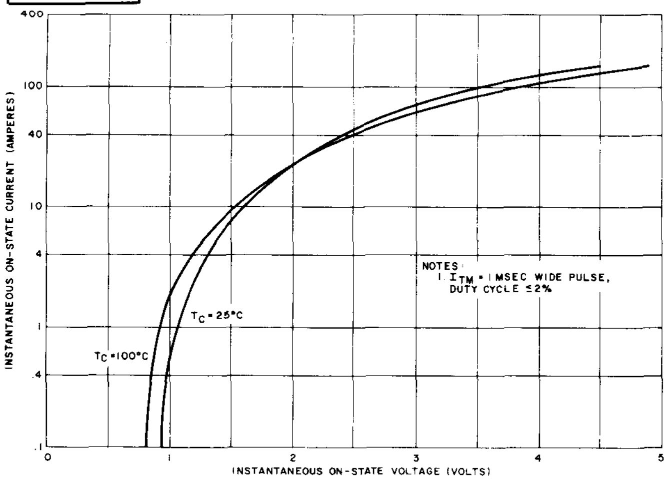
NOTES:

1. Values apply for zero or negative gate voltage only.
2. Half sine wave voltage pulse, 10 millisecond duration.
3. During performance of the off-state and reverse blocking tests, the thyristor should not be tested with a constant source which would permit applied voltage to exceed the device rating.
4. di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4. Off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum).

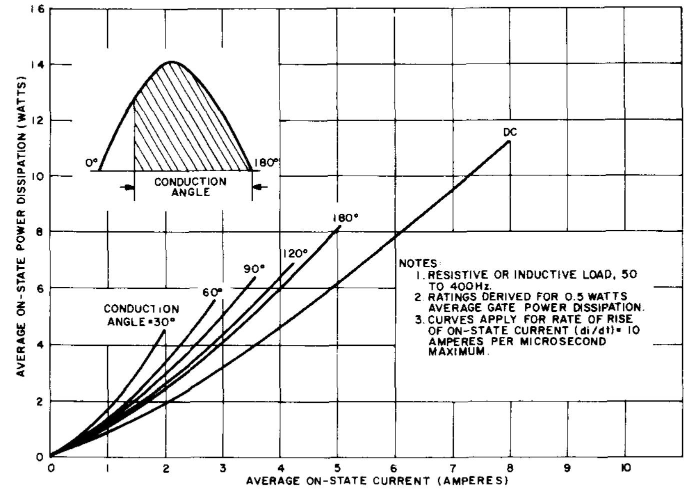
CHARACTERISTICS

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Off-state or Reverse Current (1)	I_{DRM} or I_{RRM}				mA	$V_{DRM} = V_{RRM}$ = Max. allowable volts peak
		–	–	0.1		T_c = + 25°C
		–	–	0.5		T_c = +100°C
Peak-On-State Voltage	V_{TM}	–	–	1.83	Volts	T_c = +25°C, I_{TM} = 16A peak. 1 Millisecond wide pulse. Duty cycle ≤ 2%
Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	10	50	–	Volts/μsec	T_c = +100°C, Rated V_{DRM} Gate Open Circuited, Linear Waveform
Circuit Commutated Turn-Off Time	t_q	–	50	–	μsec	T_c = +100°C, I_{TM} = 10 A peak. Rectangular current pulse, 40 μsec duration. Commutation rate = -5 A/μsec. Peak reverse voltage = Rated volts max. Reverse voltage at end of turn-off time interval 12 volts min. Repetition rate = 60 pps. Rate of rise of re-applied off-stage voltage (dv/dt) = 10 V/μsec. Off-state voltage = Rated V. Gate bias during turn-off time interval = 0 volts, 100 ohms.
D.C. Gate Trigger Current	I_{GT}	–	–	25	mAdc	T_c = +25°C, V_D = 6 Vdc, R_L = 91 ohms
		–	–	40		T_c = -40°C, V_D = 6 Vdc, R_L = 45 Ohms
D.C. Gate Trigger Voltage	V_{GT}	–	–	1.5	Vdc	T_c = +25°C, V_D = 6 Vdc, R_L = 91 Ohms
		–	–	2.0		T_c = -40°C, V_D = 6 Vdc, R_L = 45 ohms
		0.2	–	–		T_c = +100°C, Rated V_{DRM}, R_L = 1000 ohms
Holding Current	I_H				mAdc	Anode source voltage = 24 Vdc, Peak initiating on-state current = 0.5 A, 0.1 msec to 10 msec wide pulse. Gate trigger source = 7V, 20 ohms
		–	–	30		T_c = +25°C
		–	–	60		T_c = -40°C
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15V, 100 ohms, 50 μsec rise and fall times max.
		–	–	60		T_c = +25°C
		–	–	120		T_c = -40°C
Steady-State (2) Thermal Resistance					°C/Watt	
	$R_{\theta JC}$	–	–	1.8		Junction to Case
	$R_{\theta JA}$	–	–	75		Junction to Ambient

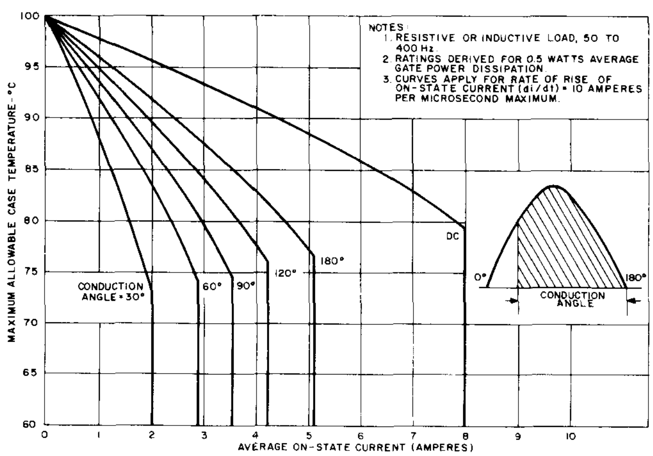
NOTES:
1. Values apply for zero or negative gate voltage only.
2. T_L is approximately equal to T_C, see outline drawing. The junction to ambient value is under worst case conditions, i.e., with #22 copper wire used for electrical contact to the terminals and natural convection.



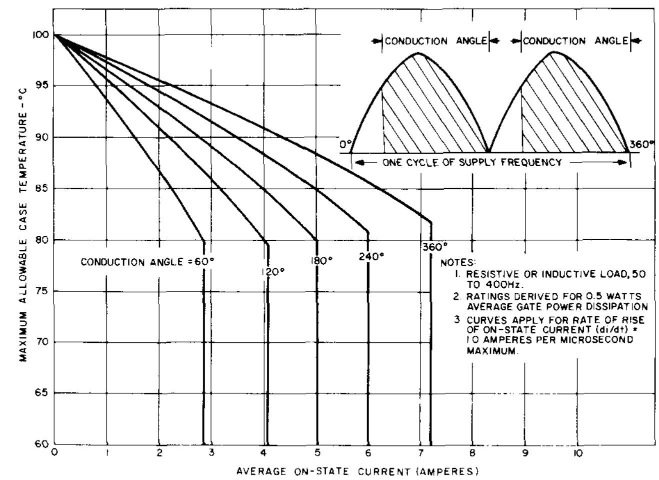
1. Max. On-State Voltage vs. On-State Current



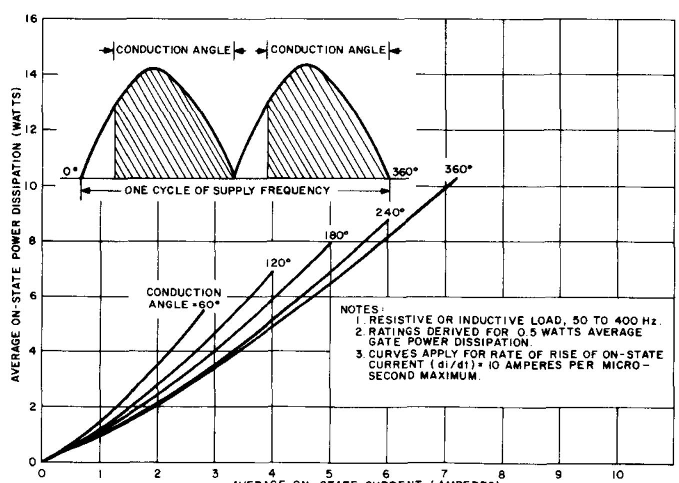
2. Max. On-State Power Dissipation for Half-Wave Rectified Sine Wave of Current



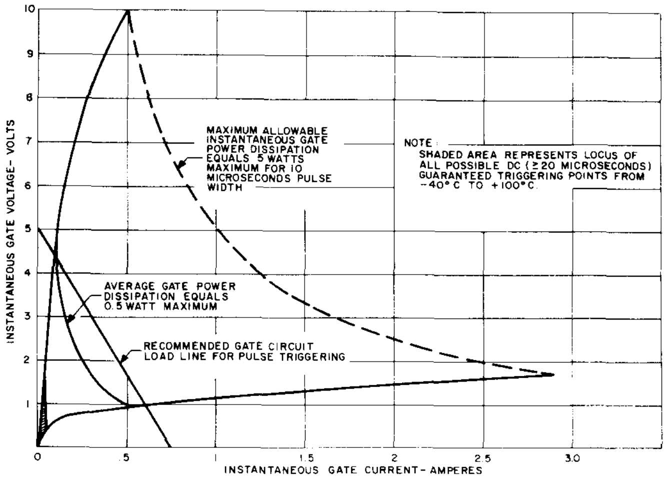
3. Max. Allowable Case Temperature For Half-Wave Rectified Sine Wave of Current



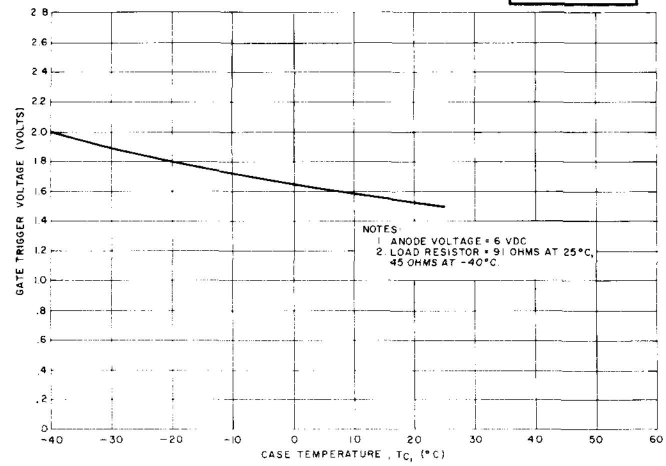
4. Max. Allowable Case Temperature For Full-Wave Rectified Sine Wave of Current



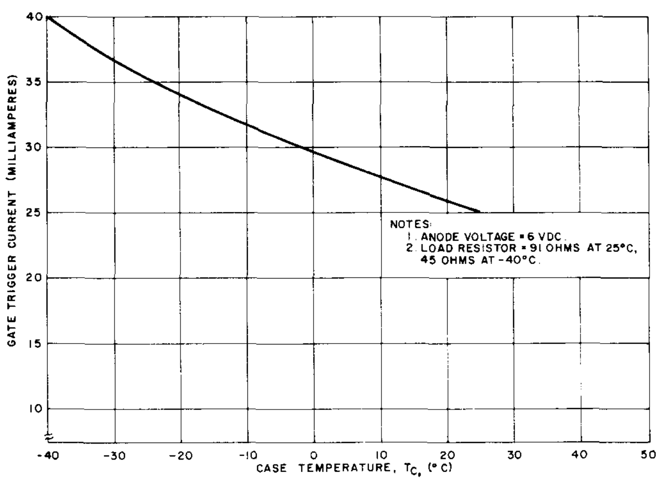
5. Max. Allowable On-State Power Dissipation for Full-Wave Sine Wave of Current



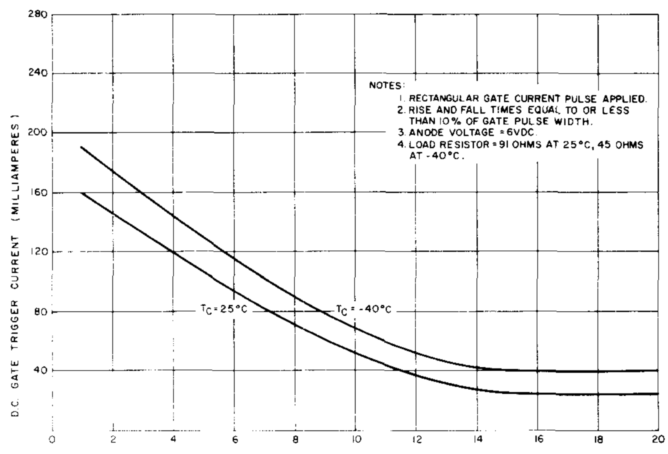
6. Gate Trigger Characteristics



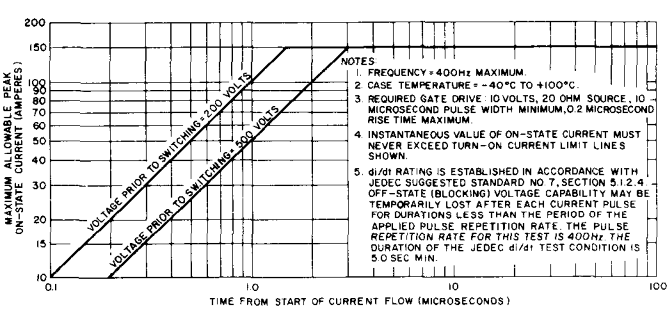
7. Max. DC Gate Voltage to Trigger vs. Case Temperature



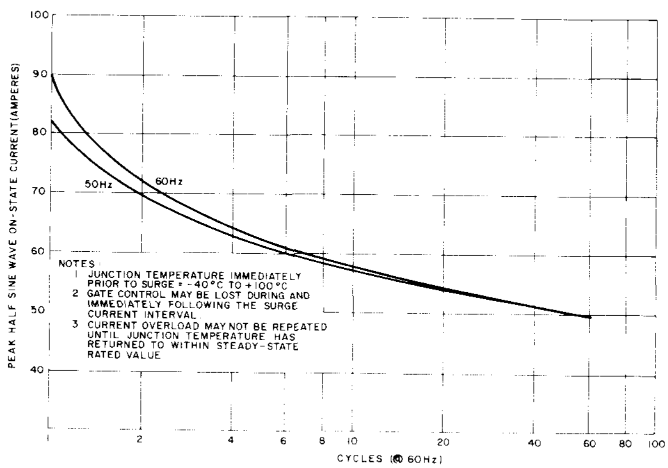
8. Max. DC Gate Current to Trigger vs. Case Temperature



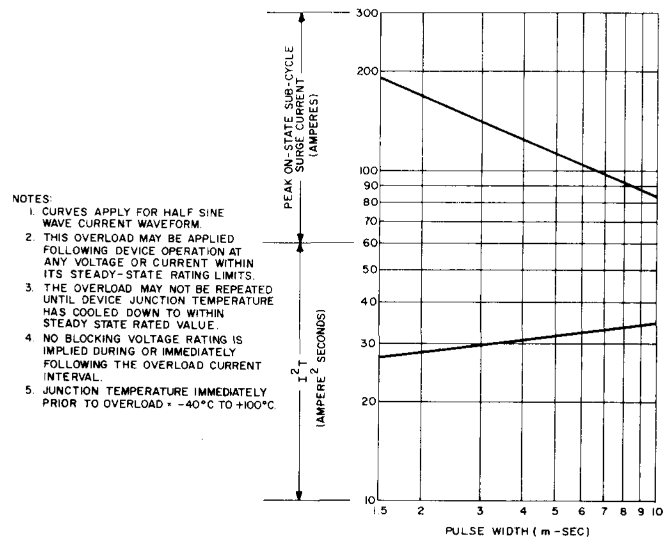
9. Max. DC Gate Current to Trigger vs. Gate Pulse Width



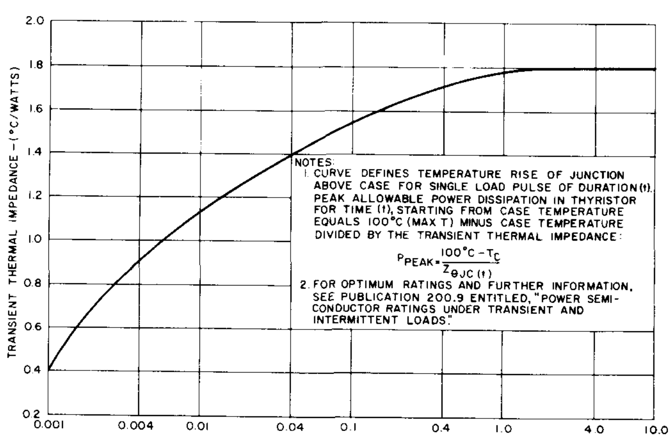
10. Turn-On Current Limit



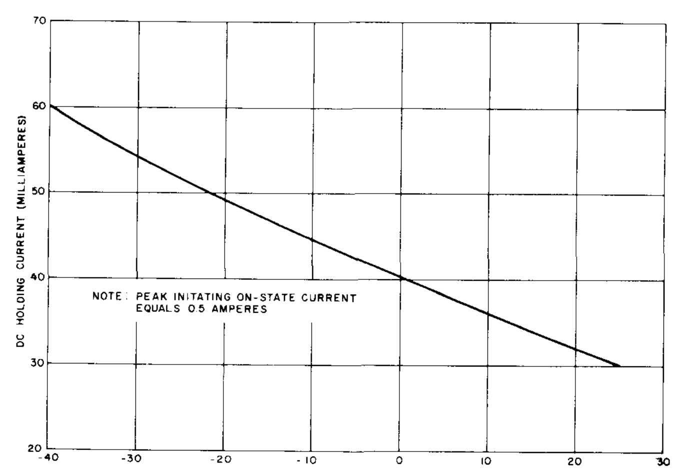
11. Max. Allowable Surge Current Following Rated Load Conditions



12. Sub-cycle Surge and I^2t Rating Following Rated Load Conditions



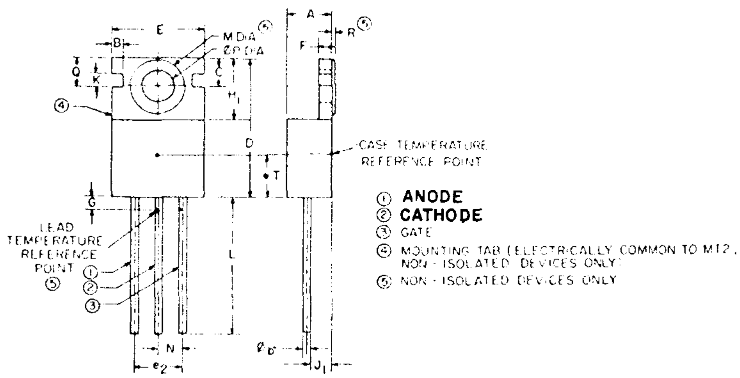
13. Max. Transient Thermal Impedance, Junction to Case



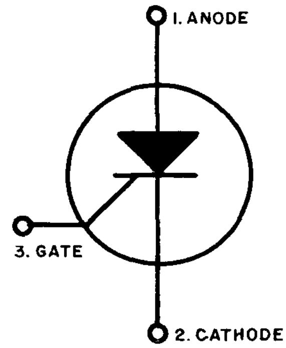
14. Max. DC Holding Current vs. Case Temperature

OUTLINE DRAWINGS

STANDARD TYPE



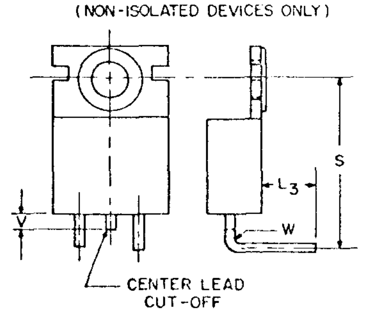
TYPE I



TERMINAL ARRANGEMENT

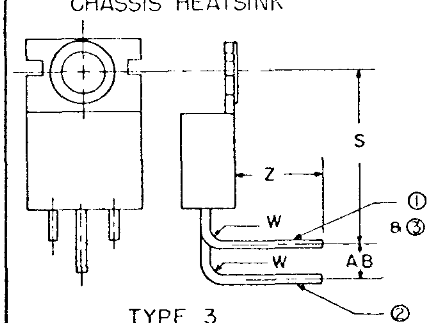
SYMBOL	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX	SYMBOL	INCHES MIN	INCHES MAX	METRIC MM MIN	METRIC MM MAX
A	.160	.190	4.06	4.83	N	.095	.105	2.41	2.67
B	.054 TYP.		1.37 TYP.		Ø P	.141	.145	3.58	3.68
Ø b	.029	.035	.73	.89	Q	.118 REF.		3.00 REF.	
C	.110	.120	2.79	3.05	R	.0015	.004	—	.10
D	.560	.650	14.23	16.51	S	.570	.590	14.47	14.99
E	.390	.420	9.90	10.67	T	—	.220	—	5.59
e_2	.190	.210	4.82	5.33	V	.040	.070	1.01	1.78
F	.040	.055	1.01	1.39	W	.020	.030	.50	.76
G	—	.065	—	1.65	Z	.172	.202	4.36	5.13
H_1	.240	.260	6.09	6.60	AA	.087	.097	2.20	2.46
J_1	.085	.115	2.15	2.92	AB	.120	.130	3.04	3.30
K	.054 REF.		1.37 REF.		AC	.025	.035	.63	.89
L	.500	—	12.70	—	AD	.045	.055	1.14	1.40
L_3	.360	—	9.14	—	AE	.353	.433	8.96	11.00
M	.232	.236	5.89	5.99					

TO-66 EQUIVALENT
(NON-ISOLATED DEVICES ONLY)



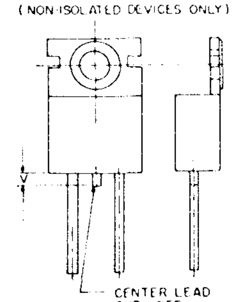
TYPE 2

FLAT MOUNTING CHASSIS HEATSINK



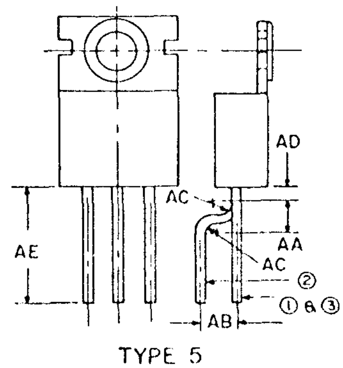
TYPE 3

CENTER LEAD CUT
(NON-ISOLATED DEVICES ONLY)



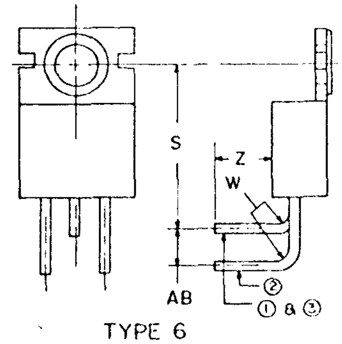
TYPE 4

UPRIGHT MOUNTING



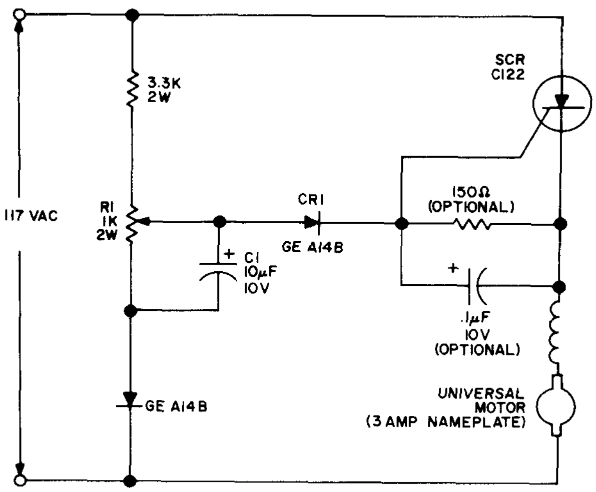
TYPE 5

FLAT MOUNTING RADIATOR HEATSINK



TYPE 6

TYPICAL CIRCUIT



This circuit uses the counter EMF of the motor armature due to residual field as a feedback signal of motor speed to maintain essentially constant speed characteristics with varying torque requirements. There will be some variation in the effectiveness of speed control from one motor to another depending on the magnitude of the residual field for the particular motor.

During the positive half cycle of the supply voltage, a reference voltage is established on the arm of the potentiometer R_1 which is compared with the counter EMF of the motor through the gate of the SCR. When the "pot" voltage rises above the counter EMF, current flows through CR_1 into the gate of the SCR, and thus applying the remainder of that half cycle of supply voltage to the motor. If load is applied to the motor, its speed tends to decrease, thus decreasing counter EMF in proportion to speed. The "pot" reference voltage thus causes current to flow into the SCR gate earlier in the cycle. The SCR triggers earlier in the cycle, and additional voltage is applied to the armature to compensate for the increased load and to maintain the preset speed. The particular speed at which the motor operates can be selected by R_1. Stable operation is possible over approximately a 10 to 1 speed range. Stability at very low speeds can be improved by reducing the value of C_1 at the expense of feedback gain.

OTHER APPLICATION NOTES OF INTEREST

Publication Number	Application Notes
200.31	Phase Control of SCR's With Transformer and Other Inductive AC Loads
200.33	Regulated Battery Charges Using the Silicon Controlled Rectifier
200.43	Solid State Control for DC Motors Provides Variable Speed With Synchronous – Motor Performance
200.44	Speed Control for Shunt-Wound Motors
200.47	Speed Control for Universal Motors
200.48	Flashers, Ring Counters and Chasers
200.55	Thermal Mounting Considerations for Plastic Power Semiconductor Packages
201.1	A Plug-In Speed Control for Standard Portable Tools and Appliances
201.13	Universal Motor Control With Built-in Self-Timer

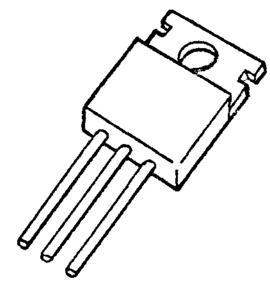
SCR

ISOLATED TAB

8A RMS Up to 600 Volts

C123

The C123 is a molded silicon plastic SCR which incorporates General Electric's new POWER-GLAS glassivation process. This process provides for an intimate void-free bond between the silicon chip and the glass coating significantly improving performance and reliability.



JEDEC TO-220AB

FEATURES:

- Glassivated silicon chip for maximum reliability in AC or DC circuitry
- Round leads – greatly simplifies customer assembly
- Four standard lead forming configurations available from factory (including T0-66 compatibility)
- Special selections for non-standard gate requirements available upon request

TYPICAL SCR APPLICATIONS

	GENERAL FUNCTIONS				
Application	**Motor Control**	**Temperature Control**	**Relay & Solenoid Driver**	**Power Regulator**	**Capacitor Discharge Circuit**
Process Control Equipment	X	X	X	X	
Reproduction Equipment		X	X	X	
Blender, Mixers	X				
Hand Tools	X				
Machine Tools/Misc. Mfg.	X		X		
Sewing Machines	X				
Laundry			X		X
Farm Equipment	X		X		X
Photographic Equipment	X	X			
Clutches/Brakes			X		
Industrial Timers			X		
Vending Machines	X	X	X		
Battery Chargers				X	
Business Machines	X		X	X	
Gas & Oil Ignitors			X		X
Internal Combustion Engine Ignitions and Magneto Regulators				X	X

MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM}(3) T_C = -40°C to +100°C	Repetitive Peak Reverse Voltage, V_{RRM}(1)(3) T_C = -40°C to +100°C	Non-Repetitive Peak Reverse Voltage, V_{RSM}(1)(2) T_C = -40°C to +100°C
C123F	50 Volts	50 Volts	75 Volts
C123A	100 Volts	100 Volts	200 Volts
C123B	200 Volts	200 Volts	300 Volts
C123C	300 Volts	300 Volts	400 Volts
C123D	400 Volts	400 Volts	500 Volts
C123E	500 Volts	500 Volts	600 Volts
C123M	600 Volts	600 Volts	700 Volts

Peak positive anode voltage (T_C = -40°C to +100°C) . . . . . 560 Volts
RMS On-State Current, $I_{T(RMS)}$ . . . . . 8 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$ . . . . . Depends on conduction angle (See Charts 1 and 2)
Critical Rate-Of-Rise of On-State Current, di/dt: (4)
Gate triggered operation . . . . . (see Chart 11)
Switching from 200 volts . . . . . 100 Amperes per microsecond
Switching from 500 volts . . . . . 50 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} 50 Hz . . . . . 82 Amperes
60 Hz . . . . . 90 Amperes
I^2t (for fusing), for times at 8.3 milliseconds . . . . . see Chart 14 . . . . . 33.7 Ampere^2 seconds
1.5 milliseconds . . . . . 27 Ampere^2 seconds
Peak Gate Power Dissipation, P_{GM} . . . . . 5 Watts for 10 microseconds (see Chart 6)
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . . 0.5 Watts
Peak Positive Gate Current I_{GM} . . . . . see Chart 6
Peak Positive Gate Voltage, V_{GM} . . . . . see Chart 6
Peak Negative Gate Voltage, V_{GM} . . . . . 5 Volts
Storage Temperature, T_{stg} . . . . . -40°C to +125°C
Operating Temperature, T_J . . . . . -40°C to +100°C
Isolation Withstand Voltage (5) . . . . . 1800 Volts Peak

NOTES:

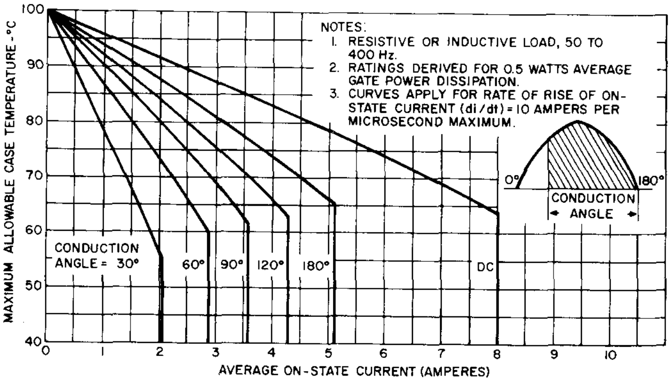
1. Values apply for zero or negative gate voltage only.
2. Half sine wave voltage pulse, 10 millisecond duration.
3. During performance of the off-state and reverse blocking tests, the thyristor should not be tested with a constant source which would permit applied voltage to exceed the device rating.
4. di/dt rating is established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6. Off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 60 p/s.
5. Isolation Withstand Voltage rating is established in accordance with Mil-Std-202, Method 301 for D.C. and sinusoidal waveforms to 60 Hz.

*It should be recognized that the General Electric C123 is a developmental device and that the ratings and characteristics listed in this specification are typical of the device at the time this specification is issued.

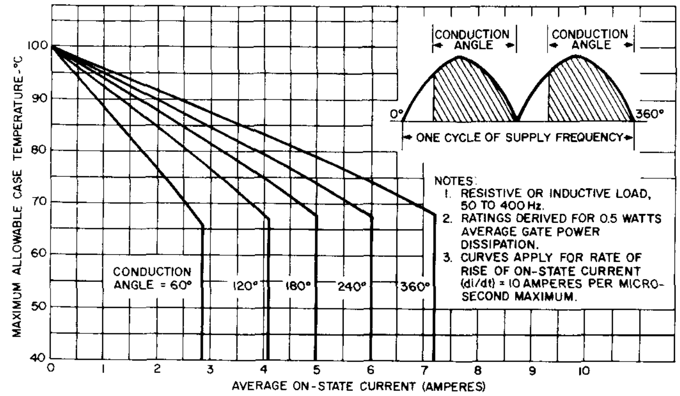
CHARACTERISTICS

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Peak Off-state or Reverse Current (1)	I_{DRM} or I_{RRM}				mA	V_{DRM} = V_{DRM} = Max. allowable volts peak
		–	–	0.1		T_C = +25°C
		–	–	0.5		T_C = +100°C
Peak-On-State Voltage	V_{TM}	–	–	1.44	Volts	T_C = +25°C, I_{TM} = 16A peak 1 Millisecond wide pulse, Duty cycle ≦ 2%
Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	10	50	–	Volts/μsec	T_C = +100°C, Rated V_{DRM} Gate Open Circuited, Linear Waveform
Circuit Commutated Turn-Off Time	tq	–	50	–	μsec	T_C = +100°C, I_{TM} = 10 A peak. Rectangular current pulse, 40 μsec duration. Commutation rate = -5 A/μsec. Peak reverse voltage = Rated volts max. Reverse voltage at end of turn-off time interval 12 volts min. Repetition rate = 60 pps. Rate of rise of re-applied off-state voltage (dv/dt) = 10 V/μsec. Off-state voltage = Rated V. Gate bias during turn-off time interval = 0 volts, 100 ohms.
D.C. Gate Trigger Current	I_{GT}	–	–	25	mAdc	T_C = +25°C V_D = 6 Vdc R_I = 91 ohms
		–	–	40		T_C = -40°C V_D = 6 Vdc R_L = 45 ohms
D.C. Gate Trigger Voltage	V_{GT}	–	–	1.5	Vdc	T_C = +25°C V_D = 6 Vdc R_L = 91 ohms
		–	–	2.0		T_C = -40°C V_D = 6 Vdc R_L = 45 ohms
		0.2	–	–		T_C = +100°C Rated V_{DRM} R_L = 1000 ohms
Holding Current	I_H				mAdc	Anode source voltage = 24 Vdc, Peak initiating on-state current = 0.5 A, 0.1 msec to 10 msec wide pulse. Gate trigger source = 7V, 20 ohms
		–	–	30		T_C = +25°C
		–	–	60		T_C = -40°C
Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15V, 100 ohms, 50 μsec rise and fall times max.
		–	–	60		T_C = +25°C
		–	–	120		T_C = -40°C
Steady-State (2) Thermal Resistance					°C/Watt	
	$R_{\theta JC}$	–	–	4.0		Junction to Case
	$R_{\theta JA}$	–	–	75		Junction to Ambient

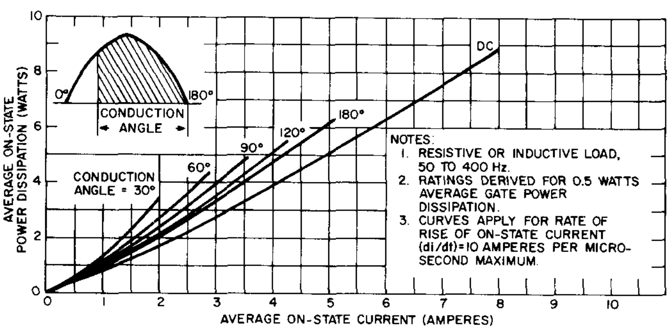
NOTES:
1. Values apply for zero or negative gate voltage only.
2. T_L is approximately equal to T_C, see outline drawing. The junction to ambient value is under worst case conditions, i.e., with #22 copper wire used for electrical contact to the terminals and natural convection.



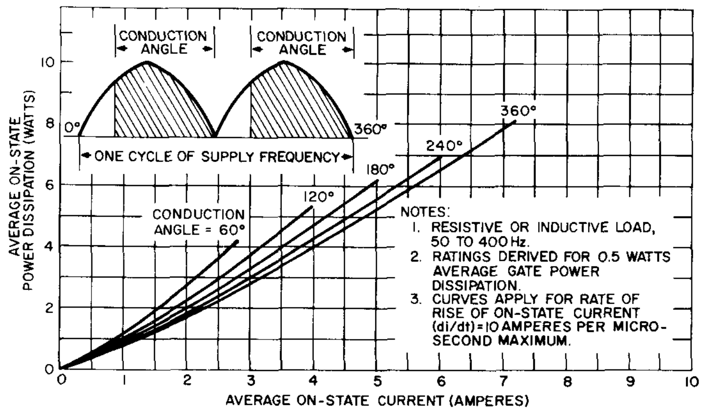
1. Max. Allowable Case Temperature for Half-Wave Rectified Sine Wave of Current



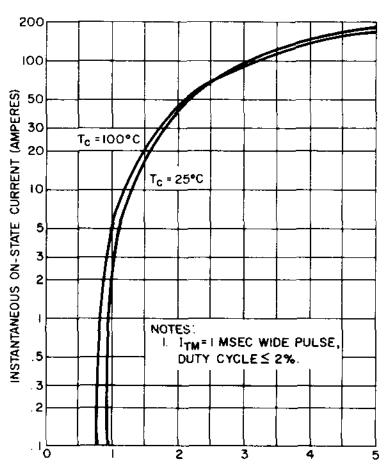
2. Max. Allowable Case Temperature for Full-Wave Rectified Sine Wave of Current



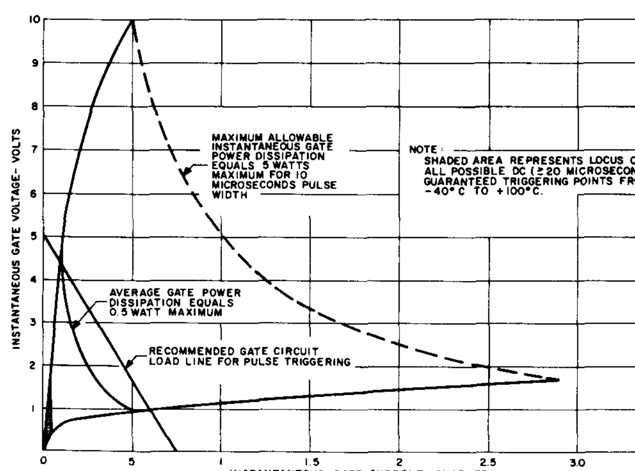
3. Max. On-State Power Dissipation for Half-Wave Rectified Sine Wave of Current



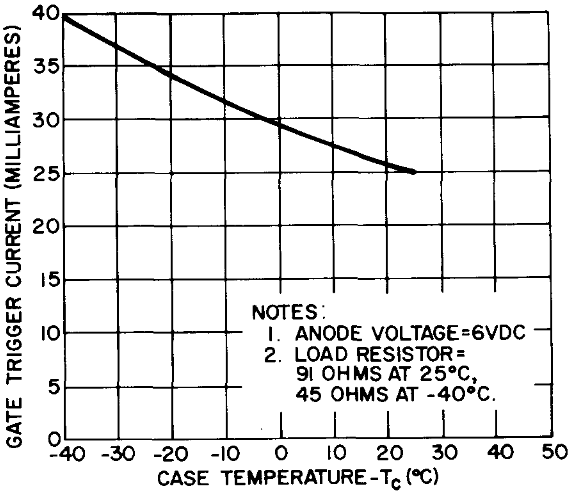
4. Max. On-State Power Dissipation for Full-Wave Rectified Sine Wave of Current



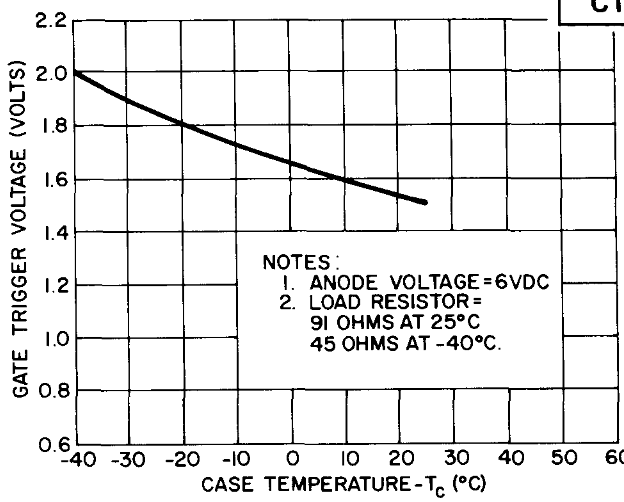
5. Max. On-State Voltage vs. On-State Current



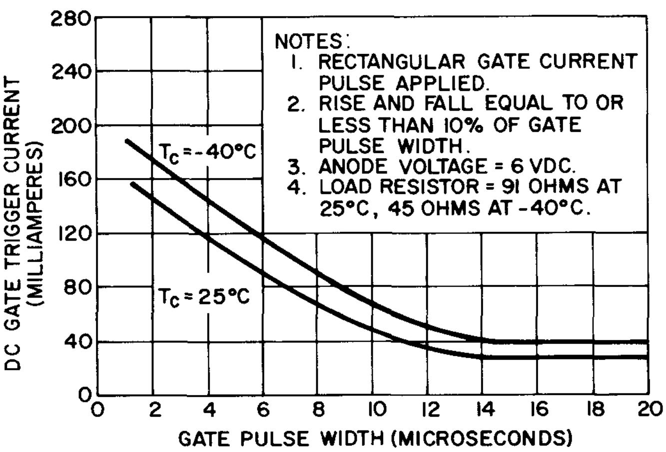
6. Gate Trigger Characteristics



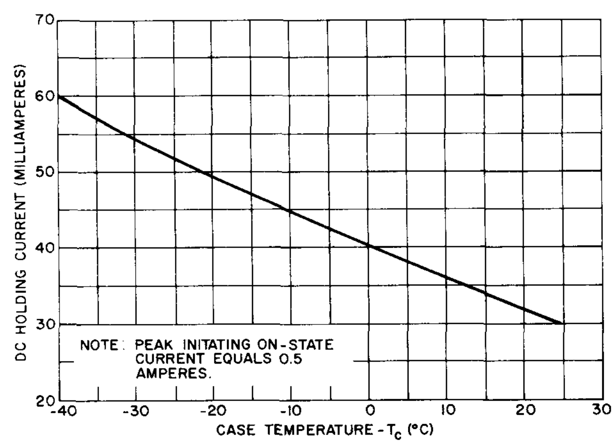
7. **Max. DC Gate Current to Trigger vs. Case Temperature**



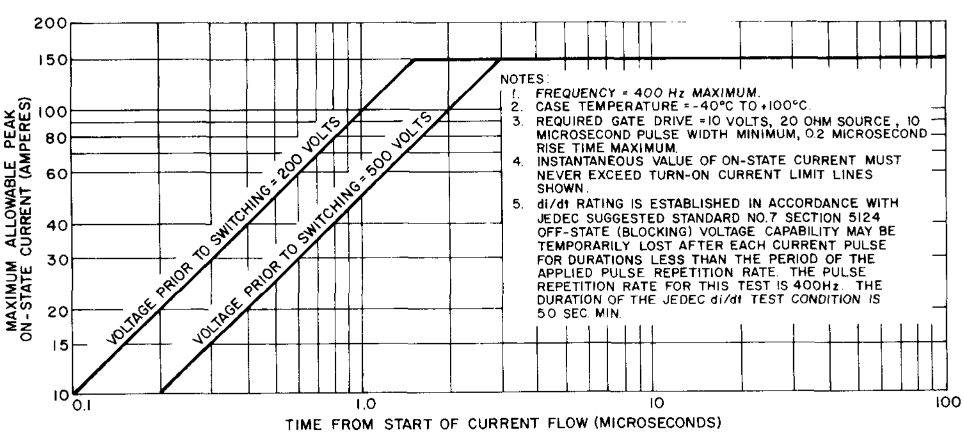
8. **Max. DC Gate Voltage to Trigger vs. Case Temperature**



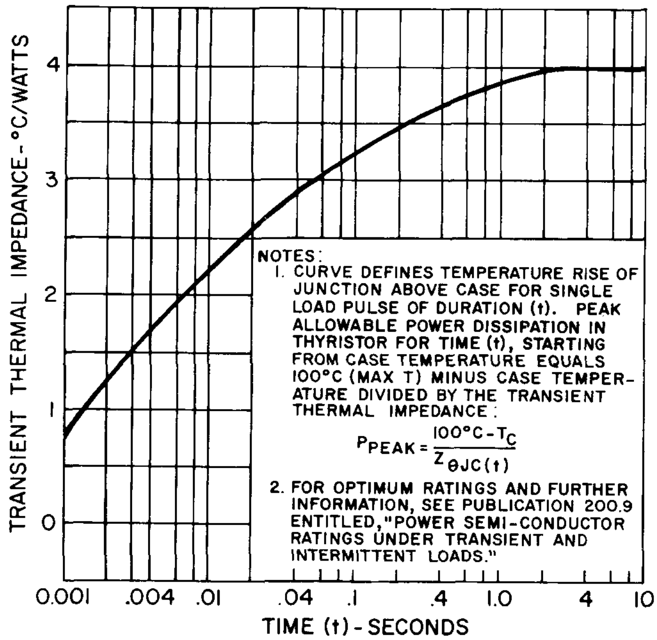
9. **Max. DC Gate Current to Trigger vs. Gate Pulse Width**



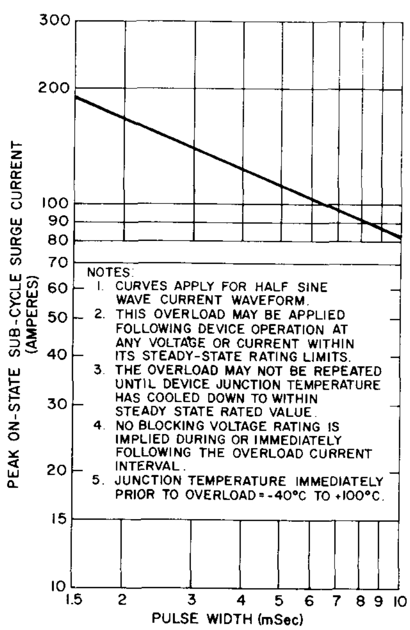
10. **Max DC Holding Current vs. Case Temperature**



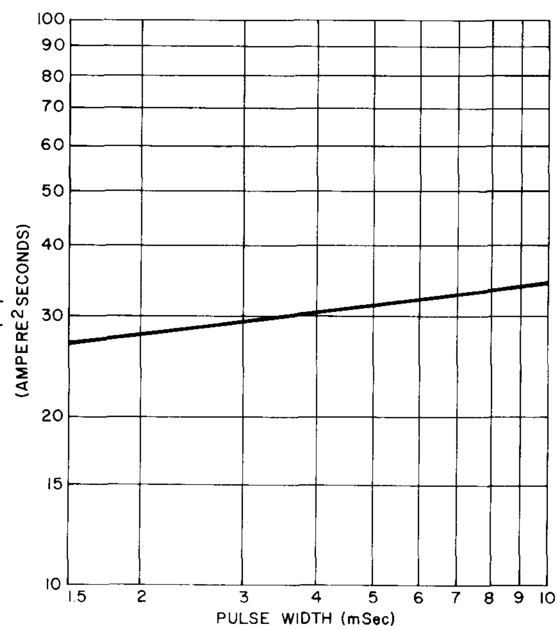
11. **Turn-On Current Limit**



12. Max. Transient Thermal Impedance, Junction to Case

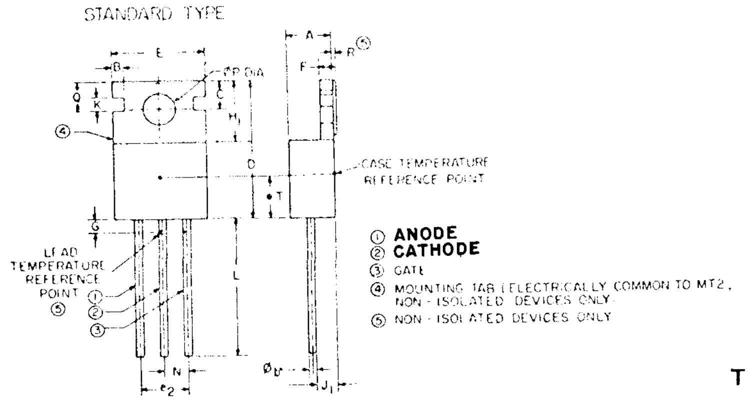


13. Sub-Cycle Surge Following Rated Load Conditions

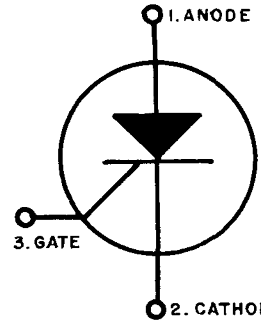


14. I^2t Rating Following Rated Load Conditions

OUTLINE DRAWINGS



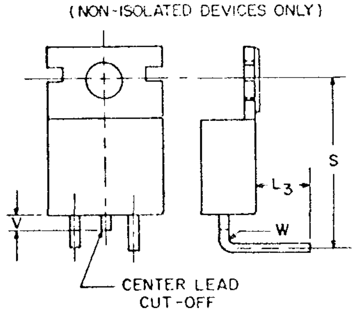
TYPE 1



TERMINAL ARRANGEMENT

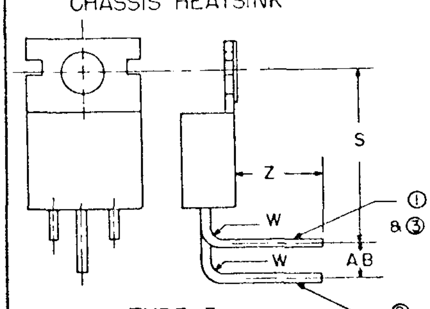
SYMBOL	INCHES		METRIC MM		SYMBOL	INCHES		METRIC MM	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	.160	.190	4.06	4.83	N	.095	.105	2.41	2.67
B	.054 TYP.		1.37 TYP.		Ø P	.141	.145	3.58	3.68
Ø b	.029	.035	.73	.89	Q	.118 REF.		3.00 REF.	
C	.110	.120	2.79	3.05	R	.0015	.004	—	.10
D	.560	.650	14.23	16.51	S	.570	.590	14.47	14.99
E	.390	.420	9.90	10.67	T	—	.220	—	5.59
e_2	.190	.210	4.82	5.33	V	.040	.070	1.01	1.78
F	.040	.055	1.01	1.39	W	.020	.030	.50	.76
G	—	.065	—	1.65	Z	.172	.202	4.36	5.13
H_1	.240	.260	6.09	6.60	AA	.087	.097	2.20	2.46
J_1	.085	.115	2.15	2.92	AB	.120	.130	3.04	3.30
K	.054 REF.		1.37 REF.		AC	.025	.035	.63	.89
L	.500	—	12.70	—	AD	.045	.055	1.14	1.40
L_3	.360	—	9.14	—	AE	.353	.433	8.96	11.00
M	.232	.236	5.89	5.99					

TO-66 EQUIVALENT
(NON-ISOLATED DEVICES ONLY)



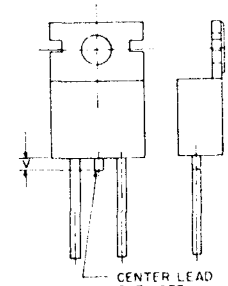
TYPE 2

FLAT MOUNTING
CHASSIS HEATSINK



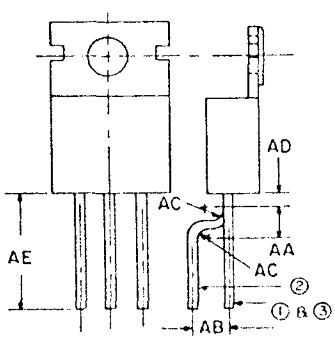
TYPE 3

CENTER LEAD CUT
(NON-ISOLATED DEVICES ONLY)



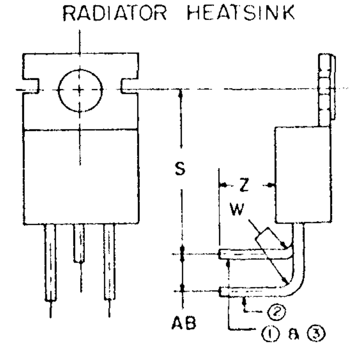
TYPE 4

UPRIGHT MOUNTING



TYPE 5

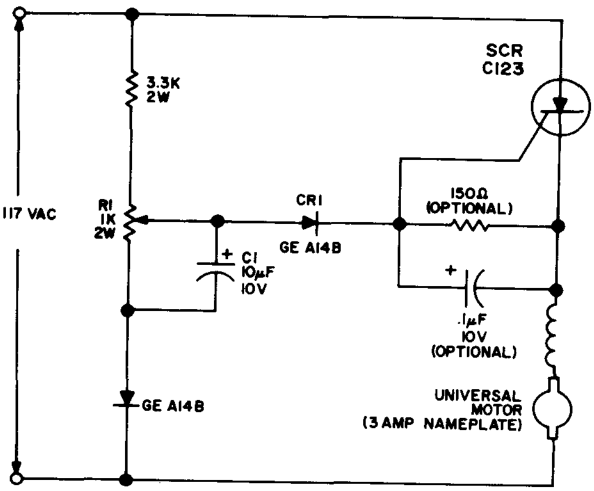
FLAT MOUNTING
RADIATOR HEATSINK



TYPE 6

TYPICAL CIRCUIT

UNIVERSAL MOTOR CONTROL WITH FEEDBACK



This circuit uses the counter EMF of the motor armature due to residual field as a feedback signal of motor speed to maintain essentially constant speed characteristics with varying torque requirements. There will be some variation in the effectiveness of speed control from one motor to another depending on the magnitude of the residual field for the particular motor.

During the positive half cycle of the supply voltage, a reference voltage is established on the arm of the potentiometer R_1 which is compared with the counter EMF of the motor through the gate of the SCR. When the "pot" voltage rises above the counter EMF, current flows through CR_1 into the gate of the SCR, and thus applying the remainder of that half cycle of supply voltage to the motor. If load is applied to the motor, its speed tends to decrease, thus decreasing counter EMF in proportion to speed. The "pot" reference voltage thus causes current to flow into the SCR gate earlier in the cycle. The SCR triggers earlier in the cycle, and additional voltage is applied to the armature to compensate for the increased load and to maintain the preset speed. The particular speed at which the motor operates can be selected by R_1. Stable operation is possible over approximately a 10 to 1 speed range. Stability at very low speeds can be improved by reducing the value of C_1 at the expense of feedback gain.

OTHER APPLICATION NOTES OF INTEREST

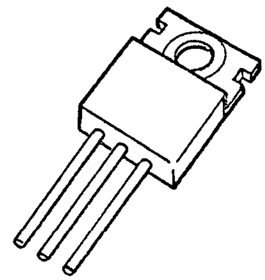
Publication Number	Application Notes
200.31	Phase Control of SCR's With Transformer and Other Inductive AC Loads
200.33	Regulated Battery Charges Using the Silicon Controlled Rectifier
200.43	Solid State Control for DC Motors Provides Variable Speed With Synchronous – Motor Performance
200.44	Speed Control for Shunt-Wound Motors
200.47	Speed Control for Universal Motors
200.48	Flashers, Ring Counters and Chasers
200.55	Thermal Mounting Considerations for Plastic Power Semiconductor Packages
201.1	A Plug-In Speed Control for Standard Portable Tools and Appliances
201.13	Universal Motor Control With Built-in Self-Timer

Reverse Blocking Triode Thyristor (SCR)

C126

12 A RMS   Up to 600 Volts

The C126 is a molded silicon plastic SCR which incorporates General Electric's new POWER-GLAS glassivation process. This process provides for an intimate void-free bond between the silicon chip and the glass coating significantly improving performance and reliability.



JEDEC TO-220AB

FEATURES:

- Glassivated silicon chip for maximum reliability in AC or DC circuitry.
- Round leads – greatly simplifies customer assembly.
- Six standard lead forming configurations available from factory (including TO-66 compatibility).
- Special selections for non-standard gate requirements available upon request.
- Excellent surge current capability.

TYPICAL SCR APPLICATIONS

APPLICATION	GENERAL FUNCTIONS				
	MOTOR CONTROL	TEMPERATURE CONTROL	RELAY AND SOLENOID DRIVER	POWER REGULATOR	CAPACITOR DISCHARGE CIRCUIT
Process Control Equipment	X	X	X	X	
Reproduction Equipment		X	X	X	
Blender, Mixers	X				
Hand Tools	X				
Machine Tools/Misc. Mfg.	X		X		
Sewing Machines	X				
Laundry			X		X
Farm Equipment	X		X		X
Photographic Equipment	X	X			
Clutches/Brakes			X		
Industrial Timers			X		
Vending Machines	X	X	X		
Battery Chargers				X	
Business Machines	X		X	X	
Gas & Oil Ignitors			X		X
Internal Combustion Engine Ignitions					X

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} (1) (3) T_C = -40°C to +110°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} (1) (3) T_C = -40°C to +110°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} (1) (2) T_C = -40°C to +110°C
C126F	50 Volts	50 Volts	75 Volts
C126A	100 Volts	100 Volts	200 Volts
C126B	200 Volts	200 Volts	300 Volts
C126C	300 Volts	300 Volts	400 Volts
C126D	400 Volts	400 Volts	500 Volts
C126E	500 Volts	500 Volts	600 Volts
C126M	600 Volts	600 Volts	700 Volts

RMS On-State Current, $I_{T(RMS)}$ . . . 12 Amperes (All Conduction Angles)
Average On-State Current, $I_{T(AV)}$ . . . Depends on Conduction Angle (See Charts 3 and 4)
Critical Rate-of-Rise of On-State Current, di/dt:(4)
Gate Triggered Operation . . . (See Chart 10)
Switching from 200 Volts . . . 100 Amperes Per Microsecond
Switching from 600 Volts . . . 50 Amperes Per Microsecond
Peak One Cycle Surge (Non-Rep) On-State Current, I_{TSM} 50 Hz . . . 113 Amperes
60 Hz . . . 120 Amperes
I^2t (For Fusing), at 8.3 milliseconds . . . (See Chart 12) . . . 60 Ampere² Seconds
1.0 milliseconds . . . 25 Ampere² Seconds
Peak Gate Power Dissipation, P_{GM} . . . 5 Watts for 10 Microseconds (See Chart 6)
Average Gate Power Dissipation, $P_{G(AV)}$ . . . 0.5 Watts
Peak Positive Gate Current, I_{GM} . . . (See Chart 6)
Peak Positive Gate Voltage, V_{GM} . . . (See Chart 6)
Peak Negative Gate Voltage, V_{GM} . . . 5 Volts
Storage Temperature, T_{stg} . . . -40°C to +125°C
Operating Temperature, T_J . . . -40°C to +110°C

NOTES:

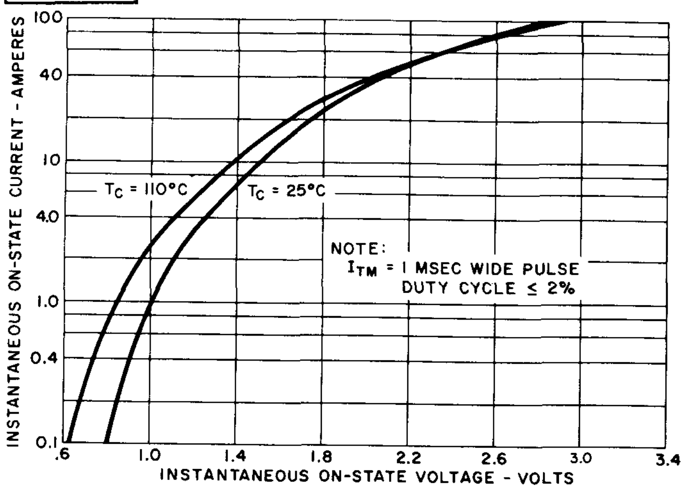
1. Values apply for zero or negative gate voltage only.
2. Half sine wave voltage pulse, 10 millisecond duration.
3. During performance of the off-state and reverse blocking tests, the thyristor should not be tested with a constant source which would permit applied voltage to exceed the device rating.
4. di/dt rating is established in accordance with JEDEC Standard RS397, Section 5.2.2.6. Off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 60 Hz. The number of on-state current pulses is 300.

CHARACTERISTICS

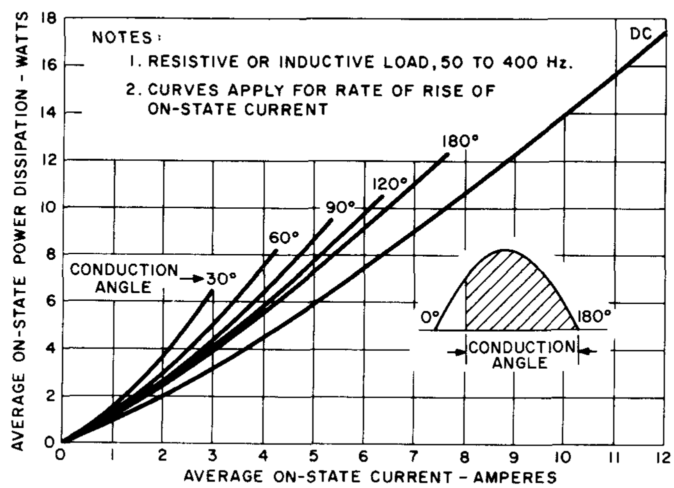
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Off-State and Reverse Current(1)	I_{DRM} or I_{RRM}				mA	$V_{DRM} = V_{RRM}$ = Max. allowable volts peak
		–	–	0.1		T_C = + 25°C
		–	–	0.5		T_C = +110°C
Peak On-State Voltage	V_{TM}	–	–	1.82	Volts	T_C = +25°C, I_{TM} = 24 Amps Peak. 1 Milli-second-wide pulse, Duty Cycle ≤ 2%
Critical Rate-of-Rise of Off-State Voltage. (Higher values may cause device switching)	dv/dt	10	50	–	Volts/μsec	T_C = +110°C; Rated V_{DRM}. Gate Open Circuited, Linear Waveform.
Circuit Commutated Turn-Off Time	t_q	–	50	–	μsec	T_C = +110°C, I_{TM} = 10 Amps Peak. Rectangular current pulse, 40μsec duration. Commutation rate = -5A/μsec. Peak reverse voltage = Rated volts max. Reverse voltage at end of turn-off time interval 12 volts min. Repetition rate = 60 pps. Rate-of-rise of re-applied off-state voltage (dv/dt) = 10 V/μsec. Off-state voltage = Rated V_{DRM}. Gate bias during turn-off time interval = 0 volts, 100 ohms.
D.C. Gate Trigger Current	I_{GT}	–	–	25	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 91 ohms
		–	–	40		T_C = -40°C, V_D = 6 Vdc, R_L = 45 ohms
D.C. Gate Trigger Voltage	V_{GT}	–	–	1.5	Vdc	T_C = +25°C, V_D = 6 Vdc, R_L = 91 ohms
		–	–	2.0		T_C = -40°C, V_D = 6 Vdc, R_L = 45 ohms
		0.2	–	–		T_C = +110°C, Rated V_{DRM}, R_L = 1000 ohms
D.C. Holding Current	I_H				mAdc	V_D = 24 Vdc, Peak initiating on-state current = 0.5 Amps, 0.1 msec to 10 msec wide pulse. R_L = Variable Gate Trigger Source = 7 Volts, 20 Ohms.
		–	–	30		T_C = +25°C
		–	–	60		T_C = -40°C
Latching Current	I_L				mAdc	V_D = 24 Vdc, R_L = Variable. Gate trigger source = 15 Volts, 100 ohms, 50μsec rise and fall times max.
		–	–	60		T_C = +25°C
		–	–	120		T_C = -40°C
Steady-State Thermal Resistance	$R_{\theta JC}$	–	–	1.8	°C/Watt	Junction-to-Case(2)
	$R_{\theta JA}$	–	–	75		Junction-to-Ambient(3)

NOTES:

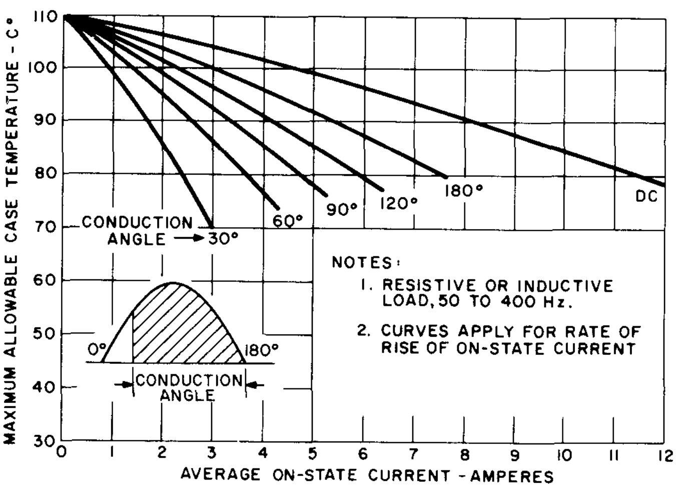
1. Values apply for zero or negative gate voltage only.
2. T_L is approximately equal to T_C, see outline drawing.
3. The junction-to-ambient value is under worse case conditions, i.e., with #22 copper wire used for electrical contact to the terminals and natural convection.



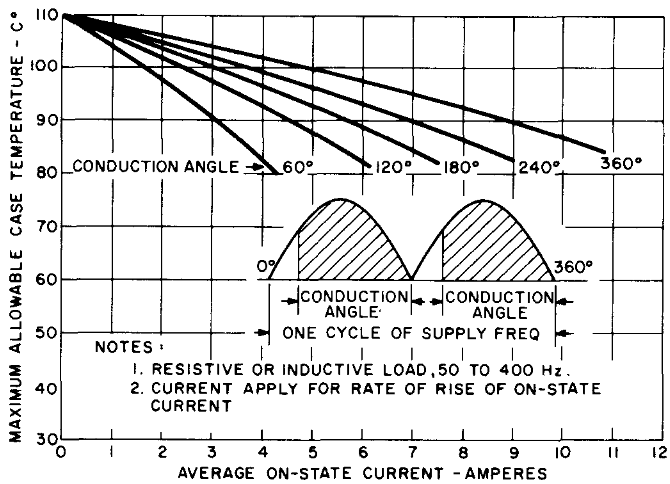
1. MAXIMUM ON-STATE VOLTAGE VS. ON-STATE CURRENT



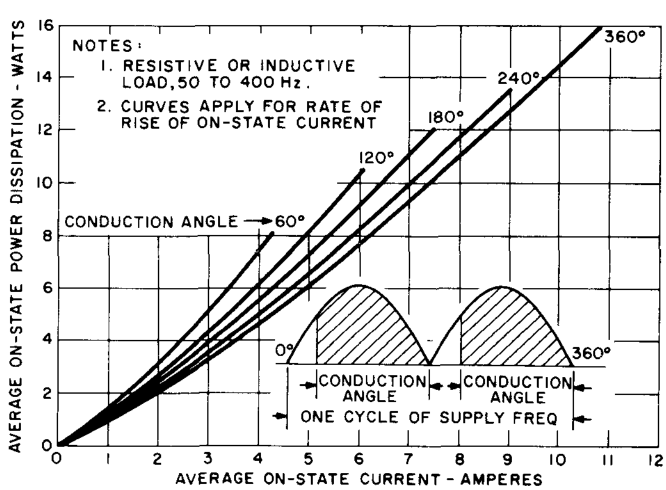
2. MAXIMUM ON-STATE POWER DISSIPATION FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT



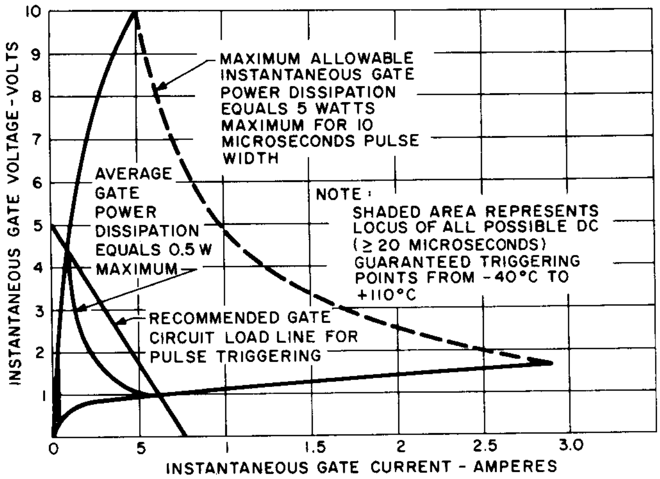
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT



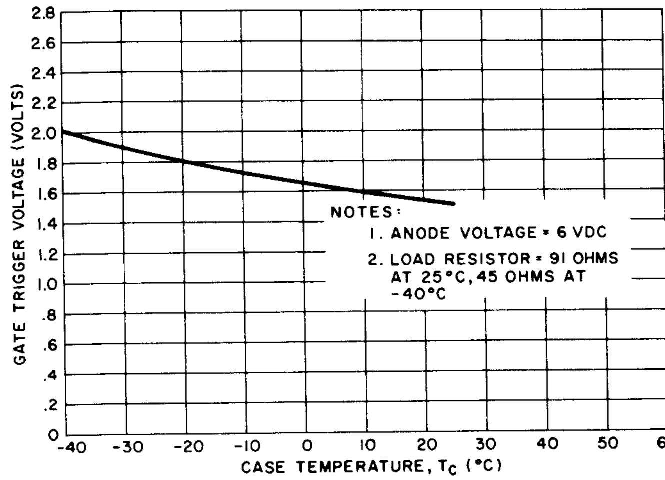
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR FULL-WAVE RECTIFIED SINE WAVE OF CURRENT



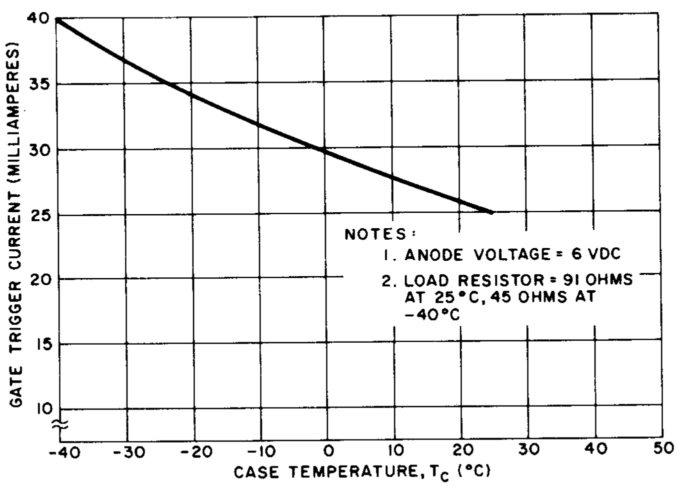
5. MAXIMUM ALLOWABLE ON-STATE POWER DISSIPATION FOR FULL-WAVE SINE WAVE OF CURRENT



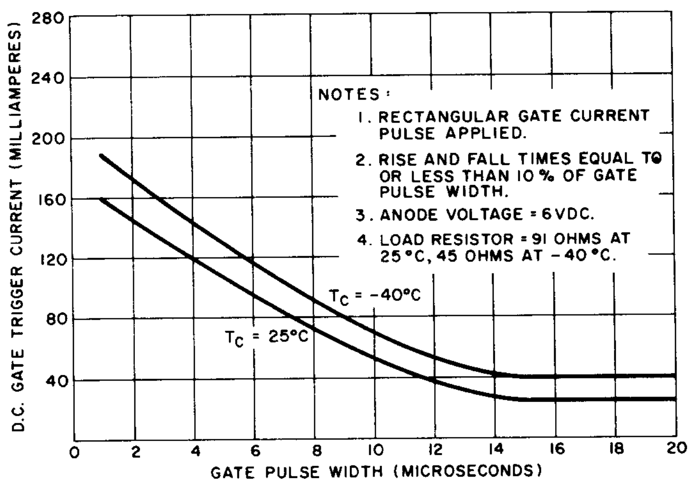
6. GATE TRIGGER CHARACTERISTICS



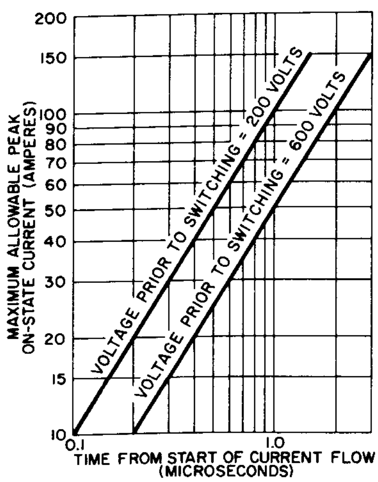
7. MAXIMUM DC GATE VOLTAGE TO TRIGGER VS. CASE TEMPERATURE



8. MAXIMUM DC GATE CURRENT TO TRIGGER VS. CASE TEMPERATURE

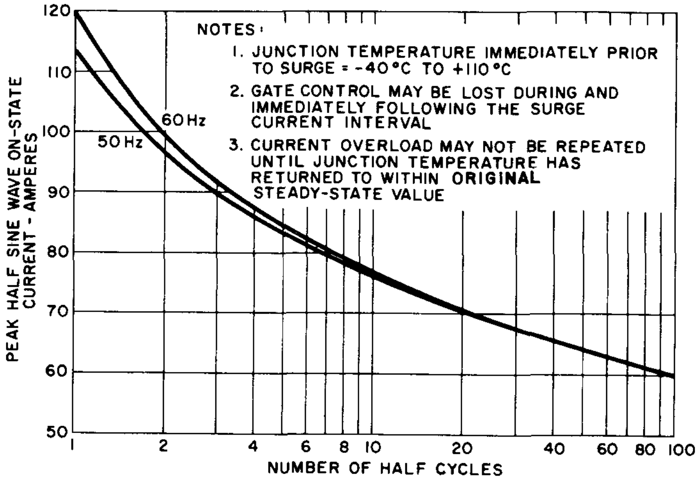


9. MAXIMUM DC GATE CURRENT TO TRIGGER VS. GATE PULSE WIDTH



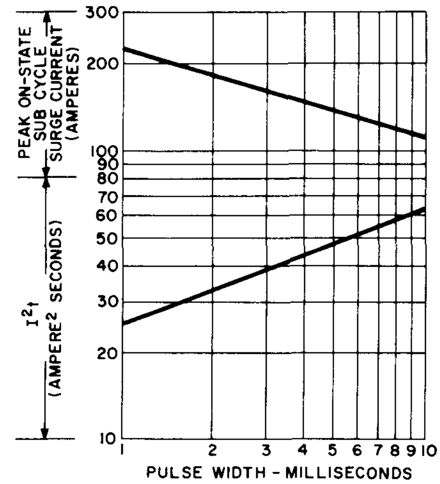
NOTES:
1. FREQUENCY 60Hz MAXIMUM.
2. CASE TEMPERATURE = -40°C TO +110°C.
3. REQUIRED GATE DRIVE 5 VOLTS, 7 OHM SOURCE, 10 MICROSECOND PULSE WIDTH MINIMUM, 0.2 MICROSECOND RISE TIME MAXIMUM.
4. INSTANTANEOUS VALUE OF ON-STATE CURRENT MUST NEVER EXCEED TURN-ON CURRENT LIMIT LINES SHOWN.
5. di/dt RATING IS ESTABLISHED IN ACCORDANCE WITH JEDEC STANDARD RS397 SECTION 5.2.2.6. OFF-STATE (BLOCKING) VOLTAGE CAPABILITY MAY BE TEMPORARILY LOST AFTER EACH CURRENT PULSE FOR DURATIONS LESS THAN THE PERIOD OF THE APPLIED PULSE REPETITION RATE. THE PULSE REPETITION RATE FOR THIS TEST IS 60Hz. THE DURATION OF THE JEDEC di/dt TEST CONDITION IS 5.0 SEC MIN., **(300 PULSES)**.

10. TURN-ON CURRENT LIMIT

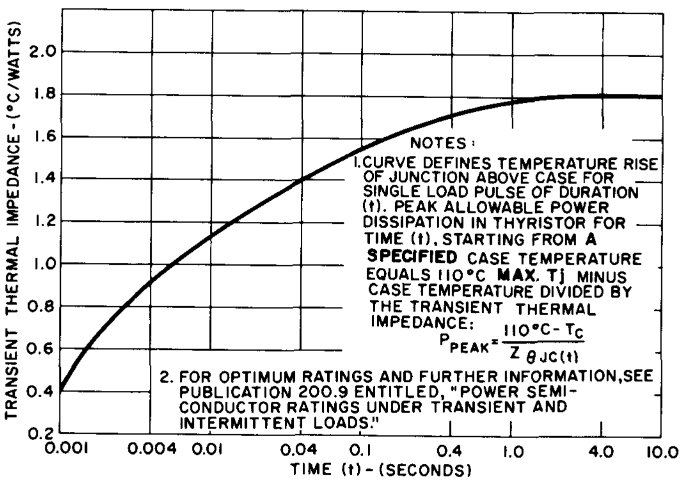


11. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

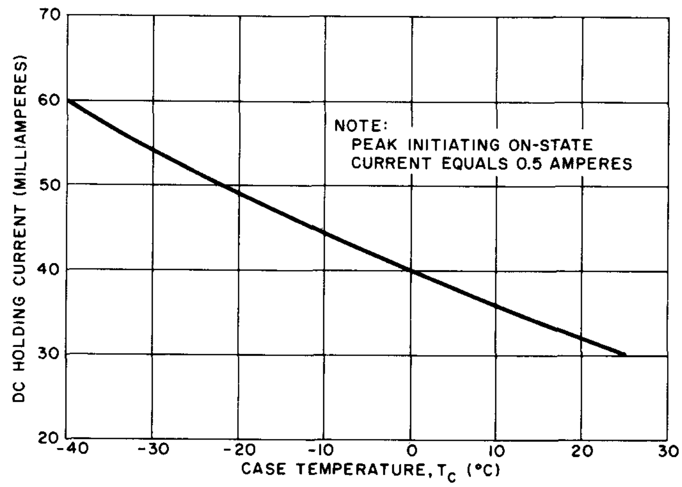
NOTES:
1. CURVES APPLY FOR HALF SINE WAVE CURRENT WAVEFORM.
2. THIS OVERLOAD MAY BE APPLIED FOLLOWING DEVICE OPERATION AT ITS STEADY STATE RATING LIMITS.
3. THE OVERLOAD MAY NOT BE REPEATED UNTIL DEVICE JUNCTION TEMPERATURE HAS COOLED DOWN TO WITHIN STEADY STATE RATED VALUE.
4. NO BLOCKING VOLTAGE RATING IS IMPLIED DURING OR IMMEDIATELY FOLLOWING THE OVERLOAD CURRENT INTERVAL.
5. JUNCTION TEMPERATURE IMMEDIATELY PRIOR TO OVERLOAD = -40°C TO + 110°C.



12. SUB-CYCLE SURGE AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS



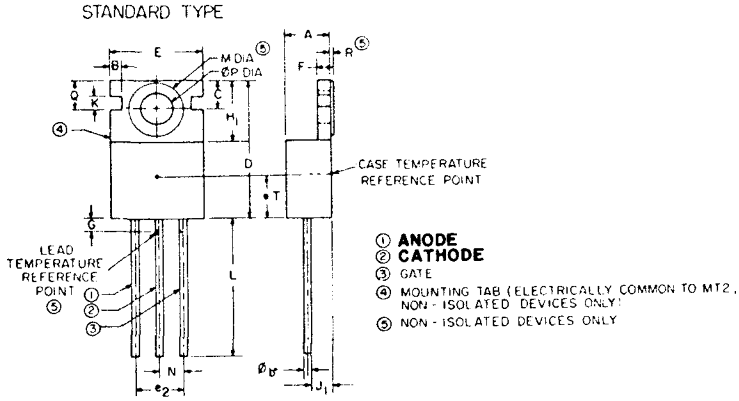
13. MAXIMUM TRANSIENT THERMAL IMPEDANCE (JUNCTION-TO-CASE)



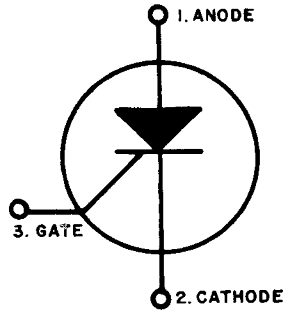
14. MAXIMUM DC HOLDING CURRENT VS. CASE TEMPERATURE

OUTLINE DRAWINGS

STANDARD TYPE



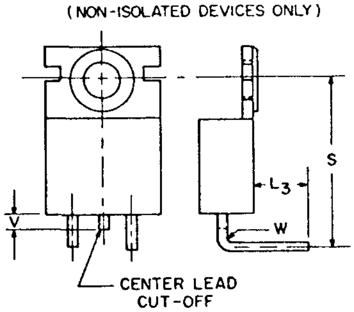
TYPE I



TERMINAL ARRANGEMENT

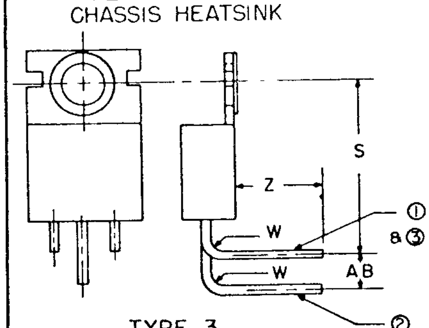
SYMBOL	INCHES		METRIC MM		SYMBOL	INCHES		METRIC MM	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	.160	.190	4.06	4.83	N	.095	.105	2.41	2.67
B	.054 TYP.		1.37 TYP.		Ø P	.141	.145	3.58	3.68
Ø b	.029	.035	.73	.89	Q	.118 REF.		3.00 REF.	
C	.110	.120	2.79	3.05	R	.0015	.004	—	.10
D	.560	.650	14.23	16.51	S	.570	.590	14.47	14.99
E	.390	.420	9.90	10.67	T	—	.220	—	5.59
e_2	.190	.210	4.82	5.33	V	.040	.070	1.01	1.78
F	.040	.055	1.01	1.39	W	.020	.030	.50	.76
G	—	.065	—	1.65	Z	.172	.202	4.36	5.13
H_1	.240	.260	6.09	6.60	AA	.087	.097	2.20	2.46
J_1	.085	.115	2.15	2.92	AB	.120	.130	3.04	3.30
K	.054 REF.		1.37 REF.		AC	.025	.035	.63	.89
L	.500	–	12.70	—	AD	.045	.055	1.14	1.40
L_3	.360	–	9.14	—	AE	.353	.433	8.96	11.00
M	.232	.236	5.89	5.99					

TO-66 EQUIVALENT
(NON-ISOLATED DEVICES ONLY)



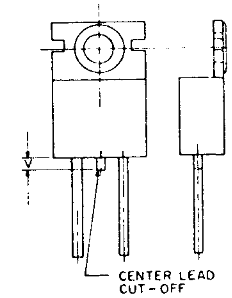
TYPE 2

FLAT MOUNTING
CHASSIS HEATSINK



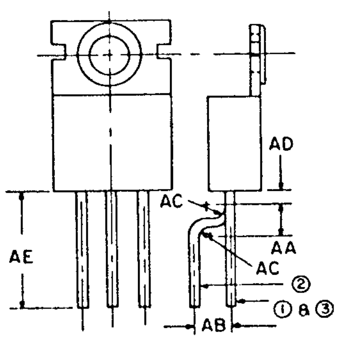
TYPE 3

CENTER LEAD CUT
(NON-ISOLATED DEVICES ONLY)



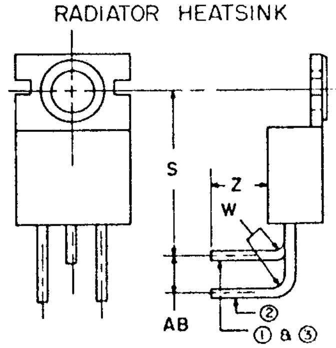
TYPE 4

UPRIGHT MOUNTING



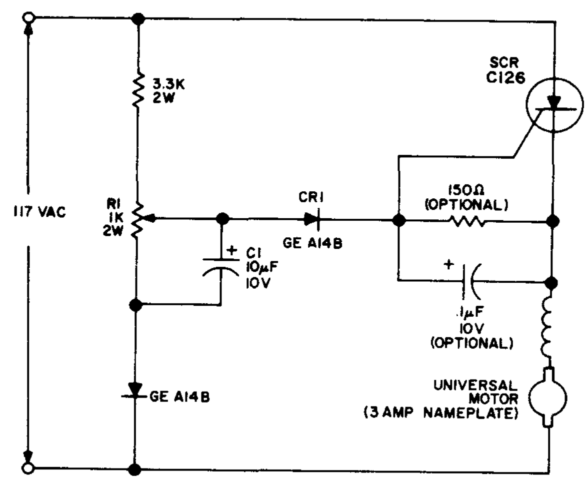
TYPE 5

FLAT MOUNTING
RADIATOR HEATSINK



TYPE 6

TYPICAL CIRCUIT



This circuit uses the counter EMF of the motor armature due to residual field as a feedback signal of motor speed to maintain essentially constant speed characteristics with varying torque requirements. There will be some variation in the effectiveness of speed control from one motor to another depending on the magnitude of the residual field for the particular motor.

During the positive half cycle of the supply voltage, a reference voltage is established on the arm of the potentiometer R_1 which is compared with the counter EMF of the motor through the gate of the SCR. When the "pot" voltage rises above the counter EMF, current flows through CR_1 into the gate of the SCR, and thus applying the remainder of that half cycle of supply voltage to the motor. If load is applied to the motor, its speed tends to decrease, thus decreasing counter EMF in proportion to speed. The "pot" reference voltage thus causes current to flow into the SCR gate earlier in the cycle. The SCR triggers earlier in the cycle, and additional voltage is applied to the armature to compensate for the increased load and to maintain the preset speed. The particular speed at which the motor operates can be selected by R_1. Stable operation is possible over approximately a 10 to 1 speed range. Stability at very low speeds can be improved by reducing the value of C_1 at the expense of feedback gain.

OTHER APPLICATION NOTES OF INTEREST

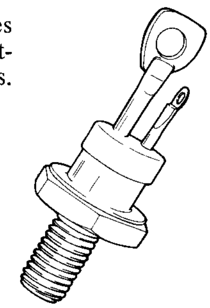
Publication Number	Application Notes
200.31	Phase Control of SCR's With Transformer and Other Inductive AC Loads
200.33	Regulated Battery Charges Using the Silicon Controlled Rectifier
200.43	Solid State Control for DC Motors Provides Variable Speed With Synchronous – Motor Performance
200.44	Speed Control for Shunt-Wound Motors
200.47	Speed Control for Universal Motors
200.48	Flashers, Ring Counters and Chasers
200.55	Thermal Mounting Considerations for Plastic Power Semiconductor Packages
201.1	A Plug-In Speed Control for Standard Portable Tools and Appliances
201.13	Universal Motor Control With Built-in Self-Timer

Silicon
Controlled Rectifier

C137

35A RMS max., 500-1200 Volts,
125° C max. Junction Temperature

The C137 series of silicon controlled rectifiers are reverse blocking triode thyristor semiconductor devices for use in medium power switching and phase control (50 to 400 Hz) applications requiring blocking voltages up to 1200 volts, and overage load current (single-phase, 180° conduction angle) up to 22 amperes.



Special features of these SCR's:

- No peak forward voltage limitation
- Minimum dv/dt rating of 100 volts/μsec.
- Maximum di/dt rating of 150 amps/μsec when switching from 600 volts
- High surge current capability for overcurrent protection.

MAXIMUM ALLOWABLE RATINGS

Type	Repetitive Peak Off-State Voltage, V_{DRM} (1) (2) T_C = −65°C to +125°C	Repetitive Peak Reverse Voltage V_{RRM} (1) (2) T_C = −65°C to +125°C	Non-repetitive Peak Off-State and Reverse Voltage V_{DSM} and V_{RSM} (1) (3) T_C = −65°C to +125°C
C137E	500 Volts	500 Volts	600 Volts
C137M	600 Volts	600 Volts	720 Volts
C137S	700 Volts	700 Volts	840 Volts
C137N	800 Volts	800 Volts	960 Volts
C137T	900 Volts	900 Volts	1080 Volts
C137P	1000 Volts	1000 Volts	1200 Volts
C137PB	1200 Volts	1200 Volts	1400 Volts

(1) Values apply for gate terminal open-circuited. (Negative gate bias is permissible.)
(2) Maximum case-to-ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 5.0°C per watt for full sine wave or full-wave rectified sinusoidal voltage waveform. (3.0°C per watt is maximum case-to-ambient thermal resistance for pure dc voltage waveform.)
(3) Half sine wave voltage pulse, 10 millisecond maximum duration.

RMS On-State Current, $I_{T(RMS)}$ . . . . 35 Amperes (all conduction angles)
Average On-State Current, $I_{T(AV)}$ . . . . Depends on conduction angle (See Charts 3 and 5)
Critical Rate-of-Rise of On-State Current, di/dt: (4)
  Gate triggered operation . . . . (See Chart 6)
    Switching from 1001 volts min. to 1200 volts max. . . . . 75 Amperes per microsecond
    801 volts min. to 1000 volts max. . . . . 100 Amperes per microsecond
    601 volts min. to 800 volts max. . . . . 125 Amperes per microsecond
    600 volts max. . . . . 150 Amperes per microsecond
  Breakover voltage triggered operation . . . . 10 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} . . . . 360 Amperes
I^2t (for fusing), for time = 1.0 milliseconds (See Chart 9) . . . . 300 Ampere^2 seconds
  for time = 8.3 milliseconds (See Chart 9) . . . . 540 Ampere^2 seconds
Peak Gate Power Dissipation, P_{GM} . . . . 60 Watts for 500 microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 1.0 Watts
Peak Negative Gate Voltage, V_{GM} . . . . 10 Volts
Storage Temperature, T_{STG} . . . . −65°C to +150°C
Operating Temperature, T_J . . . . −65°C to +125°C
Maximum Stud Torque . . . . 30 Lb-in (35 Kg-cm)

(4) di/dt rating is established in accordance with EIA Standards Proposal No. 1101, Section 5.2.2.6. Off-state (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 60 Hz. The duration of the JEDEC di/dt test condition is 300 pulses minimum at 60 Hz.

CHARACTERISTICS

Test	Symbol	Min.	Max.	Units	Test Conditions
Peak Off-State or Reverse Current (1) (2)	I_{DRM} or I_{RRM}			mA	T_C = −65°C to +125°C
C137E		–	4.0		V_{DRM} = V_{RRM} = 500 Volts Peak
C137M		–	3.0		600
C137S		–	2.8		700
C137N		–	2.5		800
C137T		–	2.3		900
C137P		–	2.0		1000
C137PB		–	1.7		1200
D.C. Gate Trigger Current	I_{GT}	–	40	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 12 ohms
		–	80		T_C = −65°C, V_D = 12 Vdc, R_L = 12 ohms
D.C. Gate Trigger Voltage	V_{GT}	–	2.2	Vdc	T_C = +25°C, V_D = 6 Vdc, R_L = 12 ohms
		–	3.0		T_C = −65°C, V_D = 12 Vdc, R_L = 12 ohms
		0.25	–		T_C = +125°C, Rated V_{DRM}, R_L = 1000 ohms
Peak On-State Voltage	V_{TM}	–	2.3	Volts	T_C = +25°C, I_{TM} = 70 A peak, 1 msec wide pulse. Duty cycle ≦ 2%.
Holding Current	I_H			mAdc	Anode supply = 24 Vdc, Gate supply = 10 V, 20 ohms. Initial Forward Current Pulse = 0.5 A, 0.1 to 10.0 msec wide.
		–	100		T_C = +25°C
		–	200		T_C = −65°C
Critical Rate of Rise of Off-state Voltage. (Higher values may cause device switching.)	dv/dt	100	–	Volts/ μsec	T_C = +125°C, Rated V_{DRM}, Gate open circuited.
Thermal Resistance	$R_{\theta JC}$	–	1.0	°C/watt	Junction-to-case, dc
Circuit Commutated Turn-Off Time	t_q	–	–(3)	μsec	T_C = 125°C, I_{TM} = 10A Peak Rectangular Current Pulse, 50 μsec duration. DI/DT < 10 Amps per microsecond. Commutation Rate ≤ 5 A per μsec. PRV = Rated V_{RRM} Volts max. Reverse Voltage at end of Turn-Off Time interval = 15 volts. Repetition Rate = 60 PPS. Rate of Rise of Re-applied Off-State Voltage (dv/dt) = 100V/μsec. Off-State Voltage = Rated V_{DRM} Volts. Gate Bias during Turn-Off Time interval = 0 Volts, 100 ohms.

NOTES:

(1) Values apply for gate terminal open-circuited. (Negative gate bias is permissible.)

(2) Maximum case-to-ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 5.0°C per watt for full sine wave or full-wave rectified sinusoidal voltage waveform. (3.0°C per watt is maximum case-to-ambient thermal resistance for pure dc voltage waveform.)

(3) Turn-off time is not 100% factory tested. Special selections are available upon request. Consult factory. The test conditions shown represent standard factory test conditions for special selections.

NOTES:

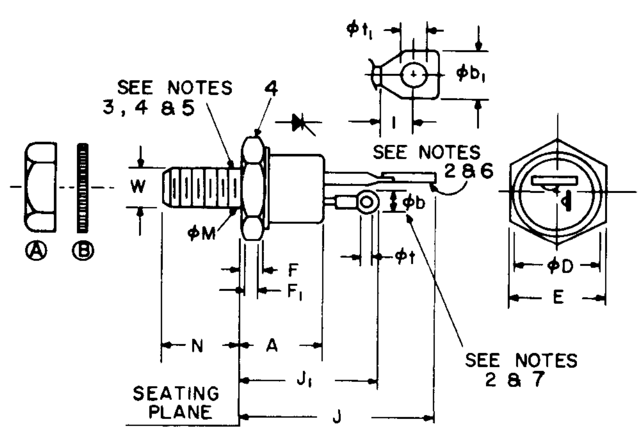
1. Complete threads to extend within 2½ threads of seating plane. Diameter of unthreaded portion. 249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

A. ¼-28 steel nut, Ni. plated, .178 min. thk.

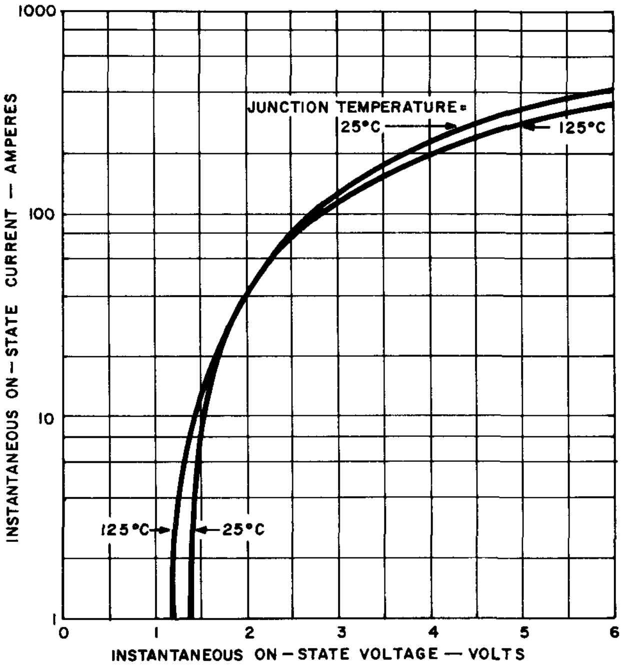
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.

OUTLINE DRAWING

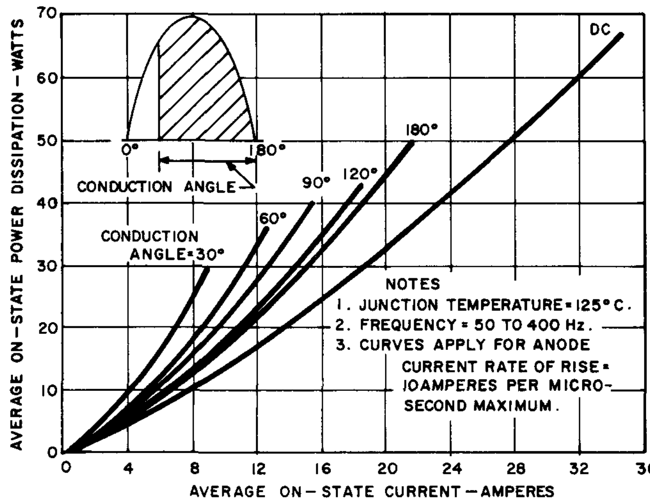
(COMPLIES WITH JEDEC TO-48)



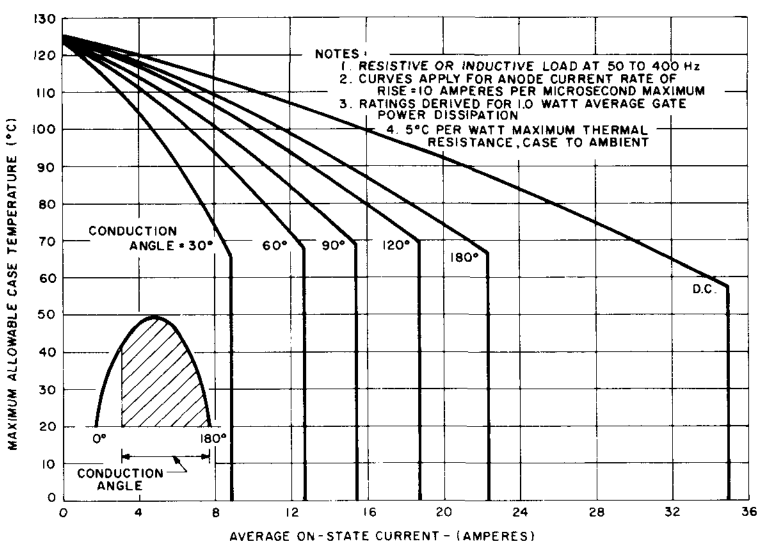
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.330	.505	8.38	12.83	
ϕb	.115	.140	2.92	3.56	2
ϕb1	.210	.300	5.33	*7.62	2
ϕD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F1	.060		1.52		
J		1.193		30.30	
J1		.875		22.23	
I	.120		3.05		
ϕM					1
N	.422	.453	10.72	11.51	
ϕt	.060	.075	1.52	1.91	
ϕt1	.125	.165	3.18	4.19	
W					3



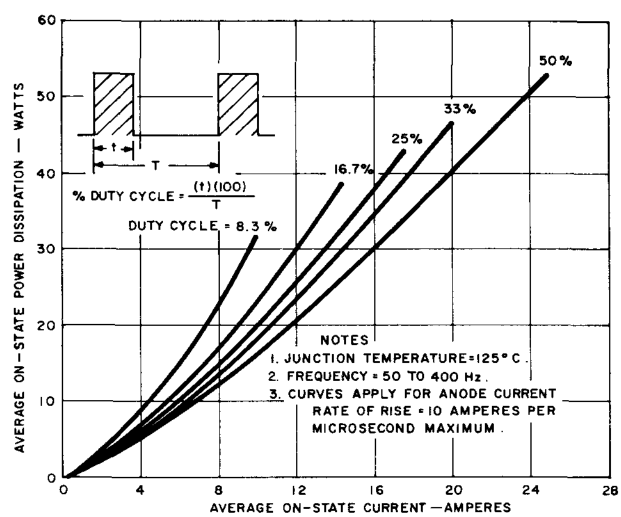
1. MAXIMUM ON-STATE CHARACTERISTICS



2. MAXIMUM ON-STATE POWER DISSIPATION FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT

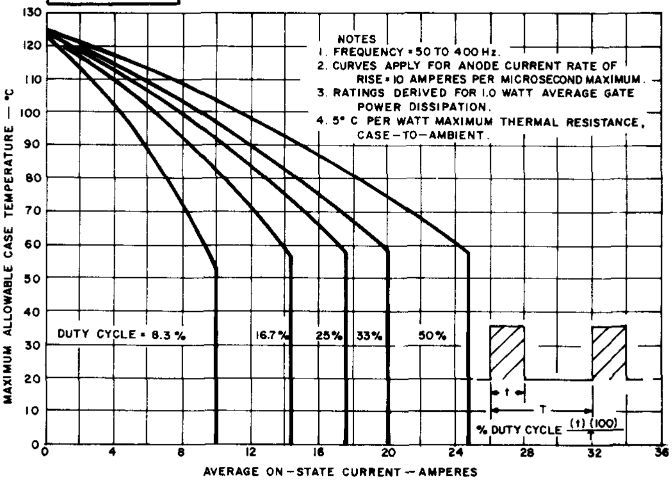


3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE OF CURRENT

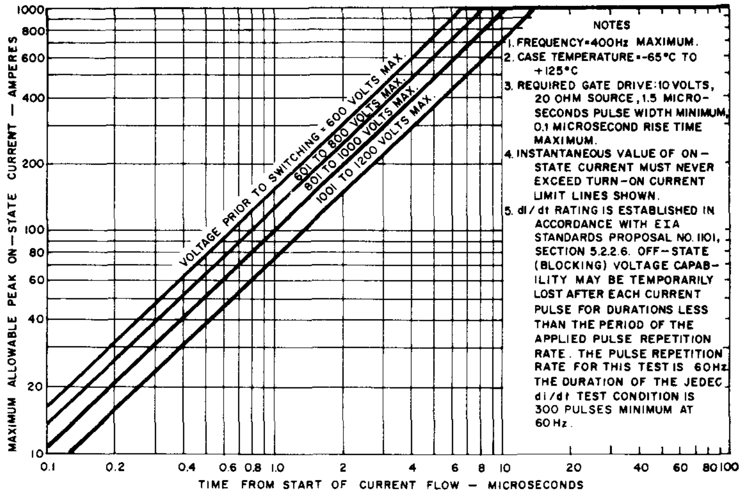


4. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM

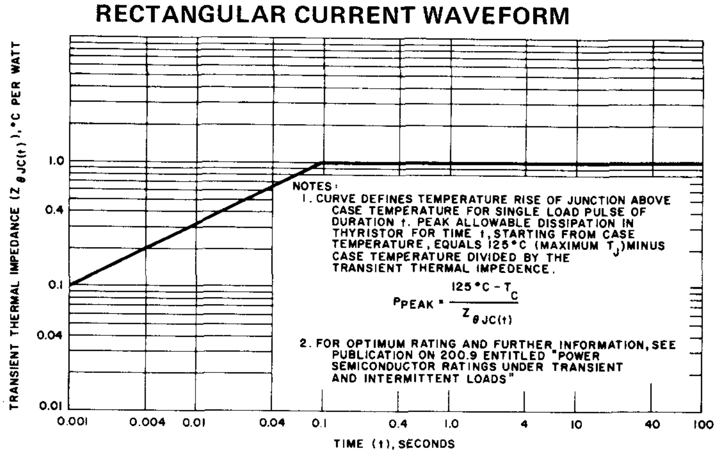
C137



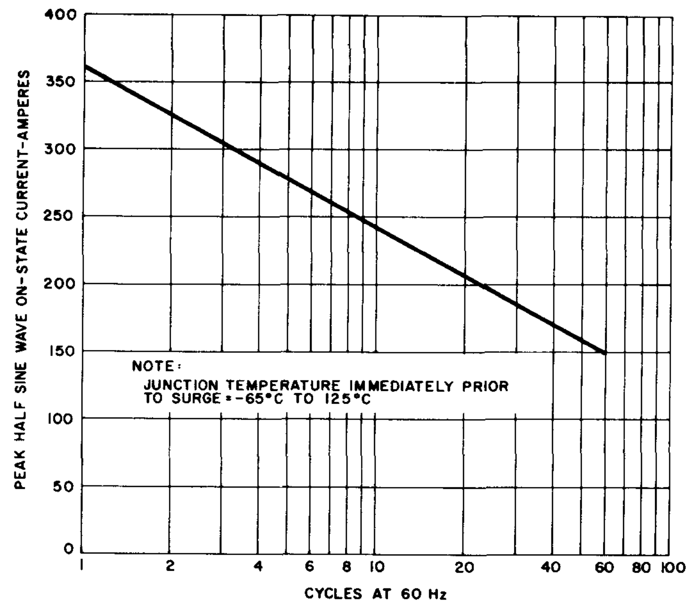
5. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



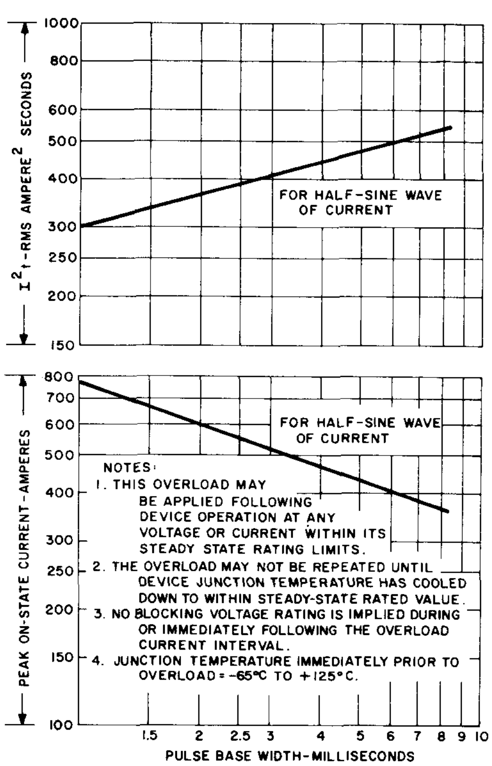
6. TURN-ON CURRENT LIMIT



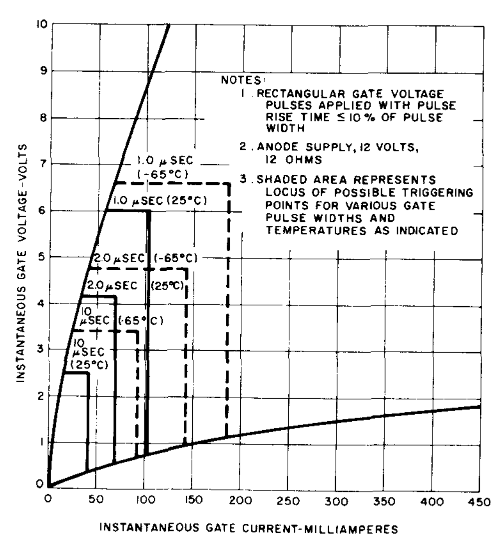
7. MAXIMUM TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE



8. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT



9. MAXIMUM ALLOWABLE SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I²T RATING

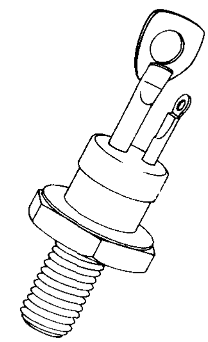


10. PULSE GATE TRIGGER CHARACTERISTICS

SCR

C138,9

The General Electric C138 and C139 Series of Silicon Controlled Rectifiers are reverse blocking triode thyristor semiconductor devices designed primarily for high-frequency power switching applications which require blocking voltages from 500 to 800 volts and load currents up to 35 amperes RMS, at frequencies up to 25 kHz. Refer to C140 and C141 series for blocking voltages from 100 to 400 volts.



The C138, C139 family of inverter SCR's utilizes a new voltage rating system which, for the first time allows high voltage blocking capability with the short turn-off time characteristics of a low blocking voltage SCR.

Equipment designers can use the C138 and C139 SCR's in demanding applications such as: choppers, inverters, regulated power supplies, cycloconverters, ultrasonic generators, high frequency lighting, sonar transmitters, radar transmitters, and induction heaters.

MAXIMUM ALLOWABLE RATINGS

Type (1)	Repetitive Peak Off-State Voltage, V_{DRM} (2)(3), T_C = −65°C to +125°C	Peak or DC Switching Voltage V_{DM} or V_D (2)(3) T_C = −65°C to +125°C	Repetitive Peak Reverse Voltage V_{RRM} (2)(3) T_C = −65°C to +125°C	Non-Rep. Peak Reverse Voltage V_{RSM} (2)(4) T_C = −65°C to +125°C
C139E10E, C139E20E	500 Volts	500 Volts	500 Volts	600 Volts
C138E10E, C138E20E	500	500	50	–
C139M10M, C139M20M	600	600	600	720
C138M10M, C138M20M	600	600	50	–
C139S10M, C139S20M	700	600	600	720
C138S10M, C138S20M	700	600	50	–
C139N10M, C139N20M	800	600	600	720
C138N10M, C138N20M	800	600	50	–

RMS On-State Current, $I_{T(RMS)}$ . . . . 35 Amperes (all conduction angles)

Critical Rate-of-Rise of On-State Current, di/dt: (5)

Gate triggered operation:

Switching from 500 volts (500 volt types) . . . . 100 Amperes per microsecond

Switching from 600 volts (600, 700, 800 volt types) . . . . 100 Amperes per microsecond

Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} . . . . 200 Amperes

Peak Rectangular Pulse Surge (non-rep) On-State Current (5.0 Msec, t_r=5.0μsec) I_{TSM} . . . . 180 Amperes

I^2t (for fusing), for times ≧ 0.5 milliseconds . . . . 165 Ampere² seconds

Peak Gate Power Dissipation, P_{GM} . . . . 40 Watts for 100 Microseconds

Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 1.0 Watts

Peak Reverse Gate Voltage, V_{GM} . . . . 10 Volts

Storage Temperature, T_{STG} . . . . −65°C to +150°C

Operating Temperature, T_j . . . . −65°C to +125°C

Maximum Stud Torque . . . . 30 Lb-in (35 Kg-cm)

CHARACTERISTICS

Test	Symbol	Min.	Max.	Units	Test Conditions
Peak Off-State Current (2)(6)	I_{DRM}				T_C = −65°C to +125°C
C139E10E, C139E20E		–	4.7	mA	V_{DRM} = 500 Volts Peak
C138E10E, C138E20E		–	4.7		500 " "
C139M10M, C139M20M		–	4.0		600 " "
C138M10M, C138M20M		–	4.0		600 " "
C139S10M, C139S20M		–	4.0		700 " "
C138S10M, C138S20M		–	4.0		700 " "
C139N10M, C139N20M		–	4.0		800 " "
C138N10M, C138N20M		–	4.0		800 " "
Peak Reverse Current (2)(6)	I_{RRM}				T_C = −65°C to +125°C
C139E10E, C139E20E		–	8.5	mA	V_{RRM} = 500 Volts Peak
C138E10E, C138E20E		–	7.5		50 " "
C139M10M, C139M20M		–	7.5		600 " "
C138M10M, C138M20M		–	7.5		50 " "
C139S10M, C139S20M		–	7.5		600 " "
C138S10M, C138S20M		–	7.5		50 " "
C139N10M, C139N20M		–	7.5		600 " "
C138N10M, C138N20M		–	7.5		50 " "
Critical Rate of Rise of Off-State Voltage	dv/dt	200	–	Volts/ µsec	T_C = 125°C, Rated V_{DRM}, Gate Open Circuited, Exponential Waveform
D.C. Gate Trigger Current	I_{GT}	–	180 500	mAdc	T_C = 25°C, V_D = 6Vdc, R_L = 4 ohms T_C = −65°C, V_D = 6Vdc, R_L = 2 ohms
D.C. Gate Trigger Voltage	V_{GT}	– 0.25	3.0 4.5	Vdc	T_C = 25°C, V_D = 6 Volts, R_L = 4 ohms T_C = −65°C, V_D = 6 Volts, R_L = 2 ohms T_C = 125°C, Rated V_{DRM}, R_L = 500 ohms
Peak On-State Voltage	V_{TM}	–	4.0	Volts	T_C = 25°C, I_{TM} = 100 A Peak, ≥ 1, ≤ 2 msec. wide pulse. Duty cycle ≦ 2%.
Holding Current	I_H	– –	150 350	mAdc	Anode Source Voltage = 24 Vdc Peak Initiating On-State Current = 3A, 0.1 to 10 msec pulse. T_C = 25°C, Gate source = 10V, Open Circuit, 20 ohms, 100 µsec pulse T_C = −65°C, Gate source = 20V, Open Circuit, 20 ohms, 100 µsec pulse.
Pulse Circuit Commutated Turn-Off Time	t_q (pulse)				T_C = 115°C, I_{TM} = 100A Peak Approximately Sinusoidal Current Waveform. See Chart for time references. On-State Current Pulse Time to peak (t_2–t_1) = 1.0 µsec. On-State Current Pulse Base (t_3–t_1) = 2.0 µsec (+0.5–0 µsec).Repetition Rate = 400 PPS. PRV (t_5) = 250 Volts max. Reverse voltage (t_6): C138 (with inv. para. diode) = 1 Volt. C139 = 30 Volts. Peak Off-State Voltage (t_8) = Rated V_{DRM}. Peak Off-State Voltage (t_o) equals: 500 Volts for 500 Volt types; 600 Volts for 600, 700 and 800 Volt types. Rate of Rise of Re-applied Off-State Voltage (Linear Ramp): (t_6 to t_8) = 200 Volts per µsec. Gate Trigger Pulse = 20 Volts, 20 ohms. Gate Trigger Pulse Width (90% points) = 1.5 µsec. Gate Trigger Pulse Rise Time (10% to 90%) = 0.1 µsec. Gate Bias during Turn-Off time interval = 0 Volts, 20 ohms.
C138 - 10, C139 - 10, Types		–	10	µsec	
C138 - 20, C139 - 20, Types		–	20	µsec	

CHARACTERISTICS (Contd)

Test	Symbol	Min.	Max.	Units	Test Conditions
Steady State Thermal Resistance	$R_{\theta JC}$	–	1.0	°C/Watt	Junction to Case
Conventional Circuit Commutated Turn-Off Time	t_q				T_C = 125°, I_{TM} = 10A Peak Rectangular Current Pulse, 50 μsec duration. DI/DT < 10 Amps per microsecond. Commutation Rate ≤ 5A per μsec. PRV = Rated V_{RRM} Volts max. Reverse Voltage at end of Turn-Off Time interval: C139 = 15 volts. C138 (with inv. para. diode) = 1 volt. Repetition Rate = 60 PPS. Rate of Rise of Re-applied Off-State Voltage (dv/dt) = 200V/μsec. Off-State Voltage = Rated V_{DRM} Volts. Gate Bias during Turn-Off Time interval = 0 Volts. 100 ohms.
C138 - 10 -, C139 - 10 -, Types			10	μsec	
C138 - 20 - , C139 - 20 -, Types			20	μsec	

NOTES:

(1) Type designations are defined as follows, using C139S20M as an example:

C 1 3 9 S 20 M
- M — Rated Switching Voltage
- 20 — Maximum Turn-Off Time (10 = 10μsec; 20 = 20 μsec.)
- S — Rated Repetitive Peak Off-State Voltage

C138 and C139 types differ in reverse voltage rating only.

(2) Values apply for gate terminal open circuited. (Negative gate bias is permissible).

(3) Maximum case to ambient thermal resistance for which maximum voltage ratings apply equals 1.2C degrees per watt for V_D (DC voltage), 3.0C degrees per watt for V_{DRM} and V_{RRM}. See paragraph, "Basis for Voltage Rating" for further information.

(4) Half sine wave voltage pulse, 10 millisecond max. duration.

(5) di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4 Off State (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 H_z. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum). Required gate drive = 20 volts, open circuit, 20 ohm source, 0.1 microsecond rise time, 1.5 microsecond pulse width. Repetitive di/dt capability is incorporated into peak current rating charts included in this specification sheet.

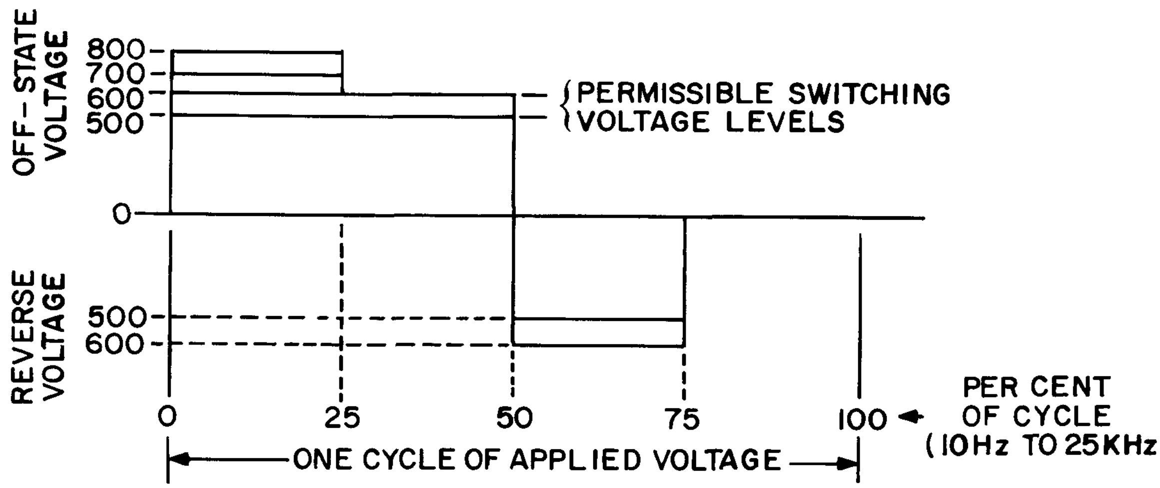
(6) Maximum case to ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 3.0 degrees C per watt. See paragraph entitled "Basis of Voltage Ratings", for further information.

PRELIMINARY DATA

These ratings and characteristics are not necessarily definitive and are based only on the tests and findings made to date. Inasmuch as further information may be acquired, General Electric Company reserves the right to change these preliminary data without notice. Please contact your local General Electric Electronic Component Sales Manager for the latest status of data prior to ordering devices to the limits indicated by the data.

BASIS OF VOLTAGE RATINGS
For The C139 and C138 Thyristors

The C139 and C138 thyristors are characterized primarily for inverter service. The voltage ratings, off-state current and reverse current values for the C139 are based on the voltage waveform shown below:



This waveform requires the use of a device case to ambient thermal resistance of 3.0 deg C per watt in order to assure thermal stability under maximum rated voltage and temperature conditions.

The waveforms of the actual application must stay within the envelope shown for each voltage type. If the actual waveforms do not stay within the envelopes shown for each voltage type then a heat sink with less than 3.0 deg C per watt must be used. Consult factory for assistance in heat sink selection to assure thermal stability.

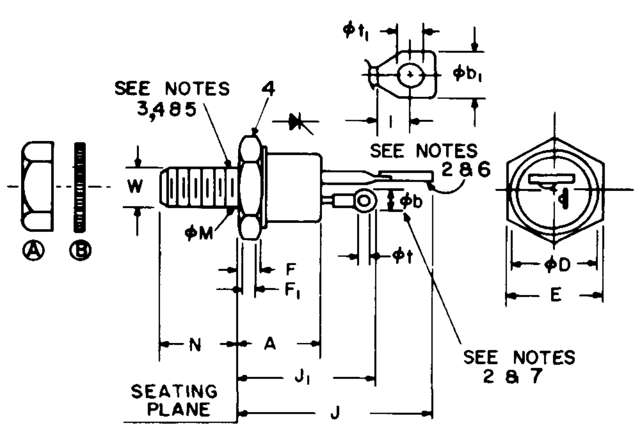
The C138 type thyristor has a rated PRV of 50 volts. It is intended for use in applications where an inverse parallel rectifier diode (sometimes called a feedback diode) is connected across the C138 which will limit the applied reverse voltage to the forward drop of the inverse parallel diode. Therefore in the waveform envelopes shown above for the C139 the reverse voltage portion does not apply for the C138. For the C138 it is permissible for the off-state voltage at the switching voltage level to be extended from 50% to 95% of the total cycle time.

OUTLINE DRAWING

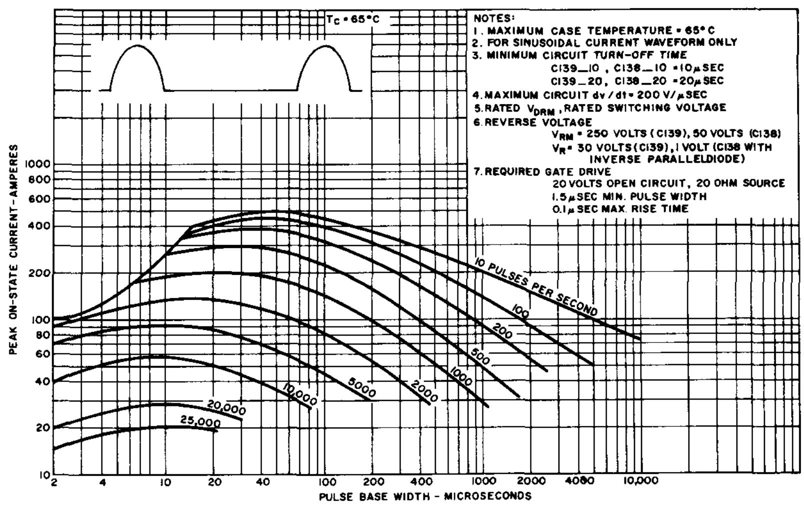
NOTES:
1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

A. ¼-28 steel nut, Ni. plated, .178 min. thk.
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.

(COMPLIES WITH JEDEC TO-48)

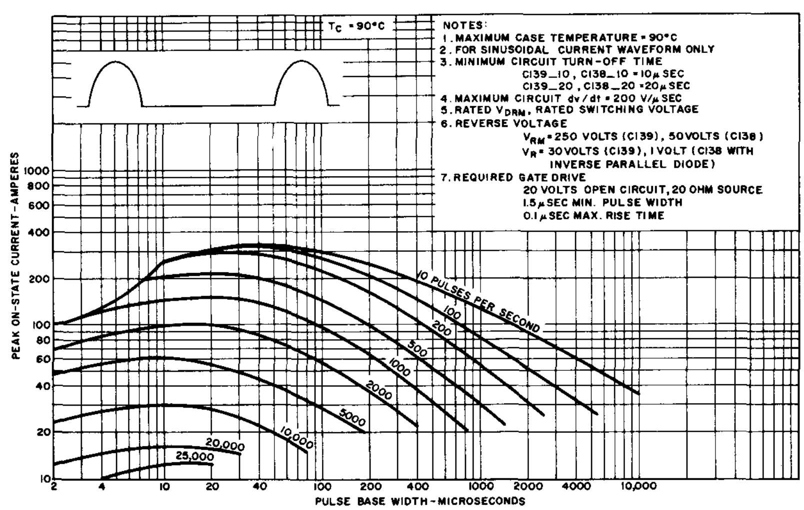


SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
$φb_1$	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F_1	.060		1.52		
J		1.193		30.30	
J_1		.875		22.23	
I	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φt	.060	.075	1.52	1.91	
$φt_1$	.125	.165	3.18	4.19	
W					3

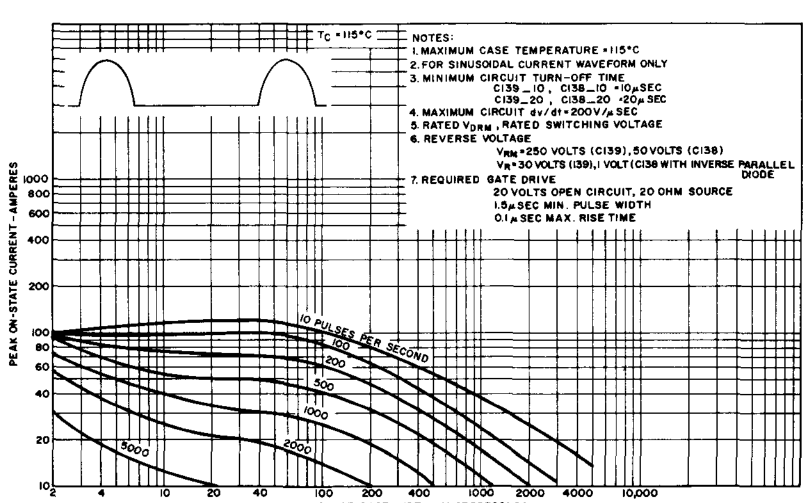


1. Maximum allowable peak on-state current vs. pulse width ($T_C = 65°C$)

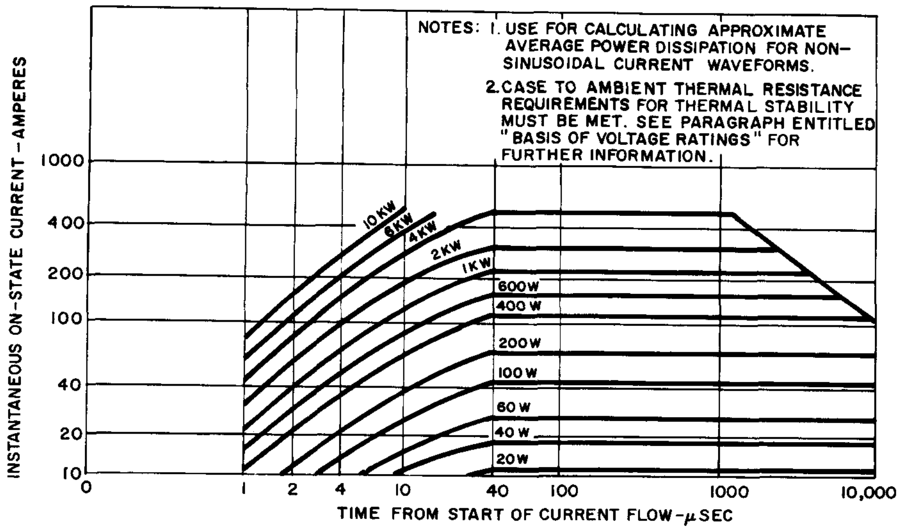
Charts 1, 2 and 3 give the maximum value of peak on-state current at which the specified turn-off-time and dv/dt *still apply.*



2. Maximum allowable peak on-state current vs. pulse width ($T_C = 90°C$)



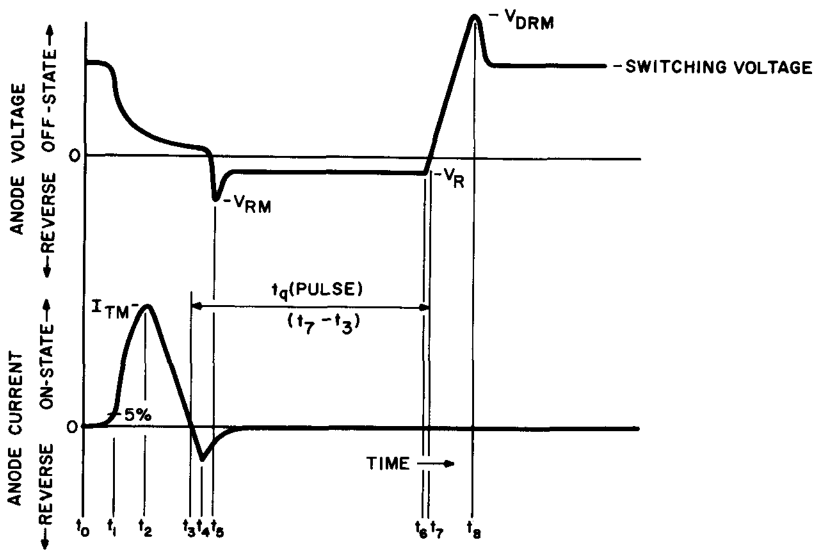
3. Maximum allowable peak on-state current vs. pulse width ($T_C = 115°C$)



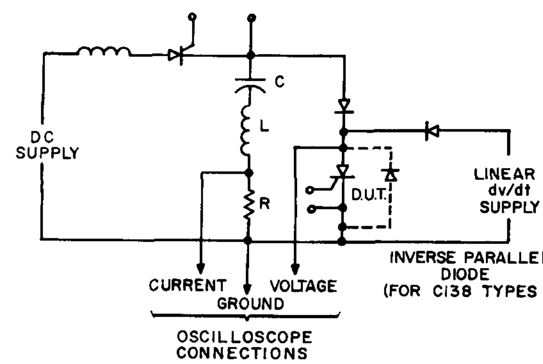
4. Instantaneous On-State Power Dissipation

This chart gives the instantaneous power dissipated within the SCR as a function of time from start of current flow and the instantaneous value of on-state anode current. Used as follows, this chart yields average dissipation information for any anode current wave-shapes:

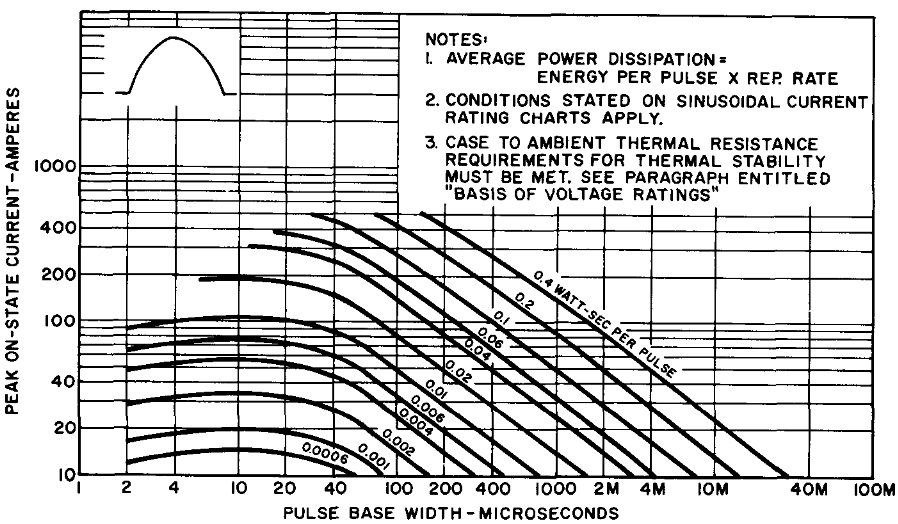
1. Plot the anode current waveform on this chart.
2. On linear paper, replot instantaneous on-state power dissipation versus time. The area under the curve gives watt seconds of energy dissipated per anode current pulse.
3. Multiply the energy by the repetition rate to give average power dissipation.



5. Waveforms For Pulse Turn-Off Time Test



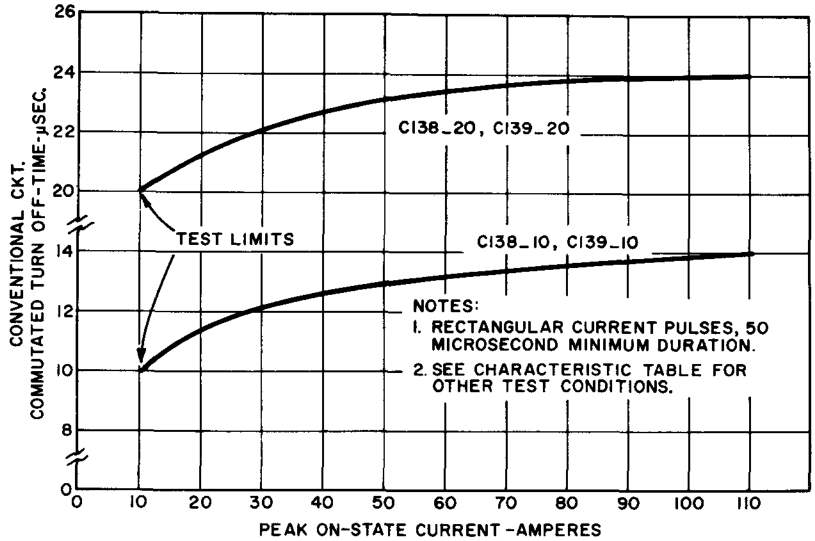
6. Pulse Turn-Off Time Basic Test Circuit



7. Energy Per Pulse For Sinusoidal Pulses

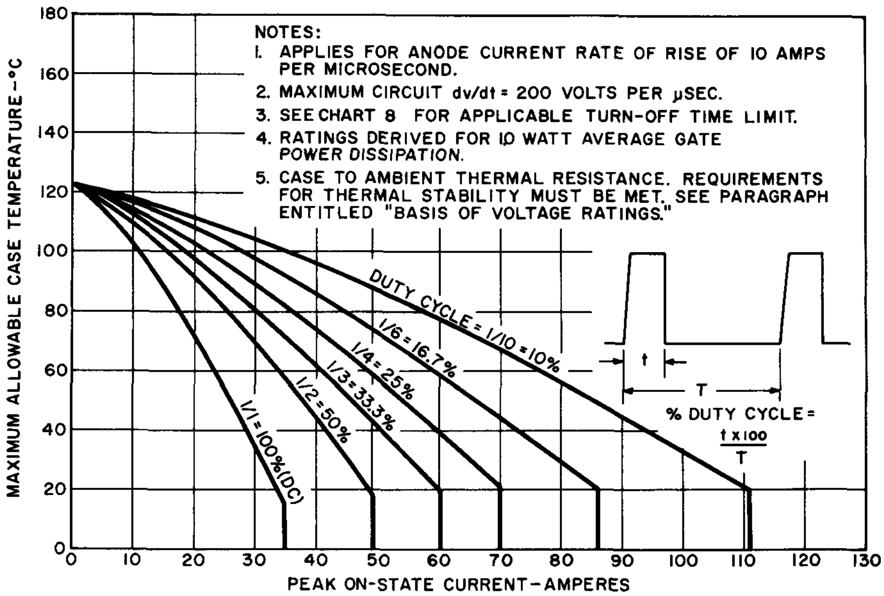
This chart provides a rapid means of determining anode dissipation with half-sine-wave pulses. Multiply the energy per pulse by the repetition rate to obtain average anode dissipation.

LOW di/dt RATE DATA



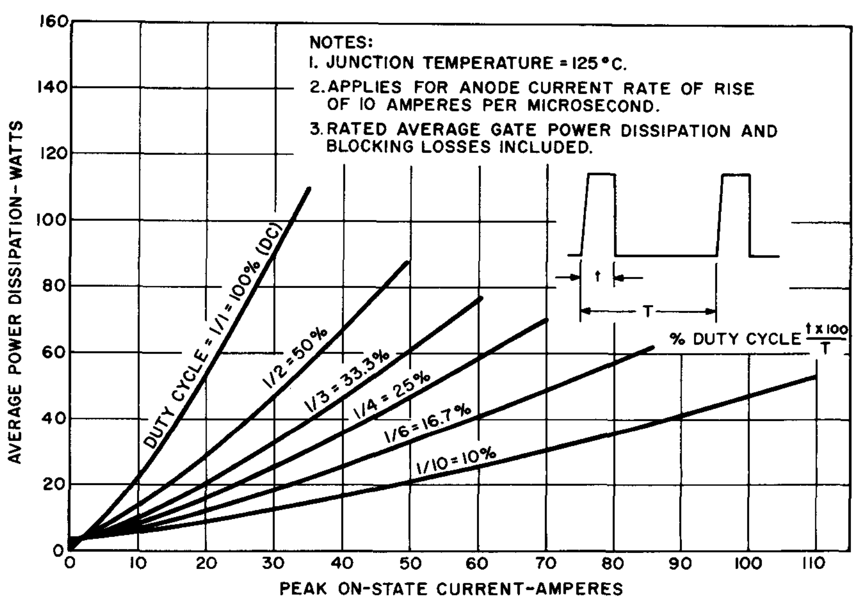
This chart gives the guaranteed maximum turn-off time of the C138 and C139 as a function of the on-state current. The use of this chart is necessary for rectangular anode current pulses of the specified pulse width and frequency.

8. Maximum Conventional Circuit-Commutated Turn-Off Time vs Peak On-State Current



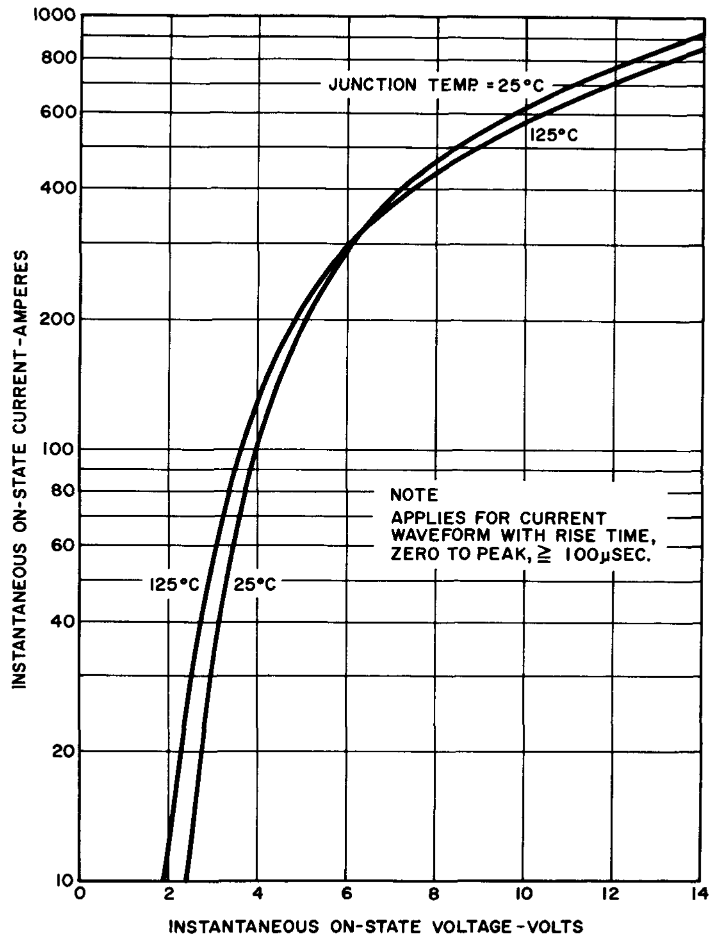
This chart is used when the SCR is carrying rectangular current with no significant turn-on switching duty.

9. Maximum Allowable Case Temperature For Rectangular Current Waveform



This chart provides a rapid means of determining SCR dissipation with low values of di/dt.

10. Average Power Dissipation For Rectangular Current Waveform



11. Maximum On-State Characteristics

SCR

C140(2N3649-53)

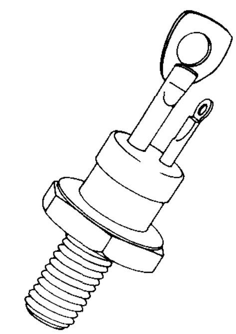
C141(2N3654-58)

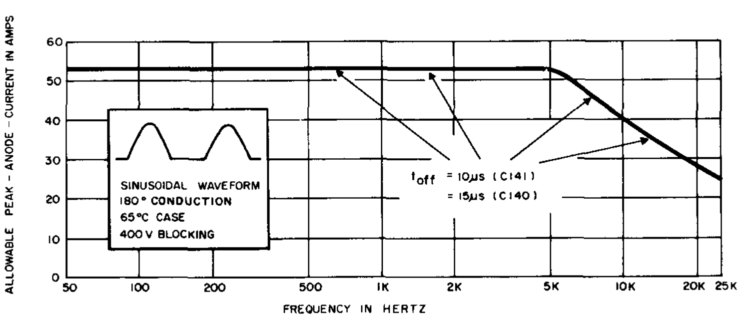
The General Electric C140 and C141 Series of Silicon Controlled Rectifiers are reverse blocking triode thyristor semiconductor devices designed primarily for high-frequency power switching applications which require blocking voltages up to 400 volts and load currents up to 35 amperes RMS, at frequencies up to 25 kHz.

For line commutated applications (phase control, AC switching) at power line frequencies, up to 35 amperes RMS, the following preferred SCR types are recommended: C35 (Pub. #160.20), and C137 (Pub. #160.45).

The C140 and C141 Series feature:

- Contoured junction surfaces for high-voltage stability
- Shorted emitters for high dv/dt (200V/μsec)
- Distributed gates for high di/dt (400A/μsec)





The improved dynamic characteristics and the interdynamic balance of these characteristics permit the operation of these General Electric SCR's up to 25 kHz with specified turn-off times and dv/dt maintained.

Equipment designers can use the C140 and C141 SCR's in demanding applications such as:

- **Choppers**
- **Inverters**
- **Regulated power supplies**
- **Cycloconverters**
- **Ultrasonic generators**
- **High frequency lighting**
- **Sonar transmitters**
- **Induction heaters**
- **Radio transmitters**

This specification sheet uses a simpligied and easy-to-use rating system which graphically presents:

- **Case Temperature**
- **Peak Anode Current**
- **dv/dt and Turn-off Times**

for rectangular and sinusoidal anode-current waveforms

MAXIMUM ALLOWABLE RATINGS

TYPE	DC FORWARD BLOCKING VOLTAGE V_{FO} (1) $T_C = -65°C$ to $+120°C$	PEAK FORWARD VOLTAGE PFV (1) $T_C = -65°C$ to $+120°C$	DC REVERSE VOLTAGE V_{RO} (1) $T_C = -65°C$ to $+120°C$	NON-REPETITIVE PEAK REVERSE VOLTAGE (Half Sine Wave) V_{ROM} (non-rep) (1) $T_C = -65°C$ to $+120°C$
C140F (2N3649) C141F (2N3654)	50 volts*	50 volts*	50 volts*	75 volts*
C140A (2N3650) C141A (2N3655)	100 volts*	100 volts*	100 volts*	150 volts*
C140B (2N3651) C141B (2N3656)	200 volts*	200 volts*	200 volts*	300 volts*
C140C (2N3652) C141C (2N3657)	300 volts*	300 volts*	300 volts*	400 volts*
C140D (2N3653) C141D (2N3658)	400 volts*	400 volts*	400 volts*	500 volts*

Turn-On Current Limit (See Chart 10) .... 400 amperes per μsec*
RMS Forward Current, On-State .... 35 amperes
DC Forward Current, On-State, $T_C = 40°C$ .... 25 amperes*
Peak Rectangular Surge Forward Current (5.0msec width, $t_r = 50\mu sec$) I_{FM} (surge) .... 180 amperes*
I^2t (for fusing) .... 165 ampere² seconds (for times ≧ 1.0 millisecond)
Peak Gate Power Dissipation, P_{GM} .... 40 watts*
Average Gate Power Dissipation, $P_{G(AV)}$ .... 1.0 watt*
Peak Reverse Gate Voltage, V_{GRM} .... 10 volts*
Peak Forward Gate Current, I_{GFM} .... 6.4 amperes*
Reverse Recovery Energy .... 0.002 watt sec.
Storage Temperature, T_{stg} .... −65°C to +150°C*
Operating Temperature, T_C .... −65°C to +120°C*
Stud Torque .... 30 Lb-in (35 Kg-Cm)

CHARACTERISTICS

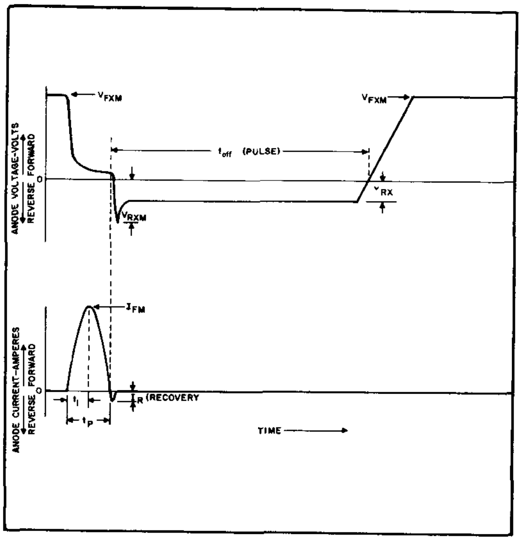
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
PULSE CIRCUIT COMMUTATED TURN-OFF TIME	t_{off} (pulse)					See Charts 1 and 4. $T_C = +115°C$, $I_{FM} = 100$ amps, Approx. Sinusoidal current waveform ($t_1 = 1.0$ μsec, $t_p = 2.05 ^{+0.5}_{-0}$ μsec), No delay reactor, Pulse rep. rate = 400 Hz. V_{FXM} = Rated, $V_{RXM} \leqq 200$ volts, $v_{RX} = 30$ volts. Rate of rise of reapplied forward blocking voltage (dv/dt) = 200 volts/μsec (linear ramp). Gate supply: 20 volts open circuit, 20 ohms, 1.5 μsec square wave pulse, Rise time = 0.1 μsec max.
C140 (2N3649-53)		—	—	15*	μsec	
C141 (2N3654-58)		—	—	10*	μsec	
CONVENTIONAL CIRCUIT COMMUTATED TURN-OFF TIME	t_{off}					$T_C = +120°C$, $I_{FM} = 10$ amps (50 μsec pulse), Rectangular current waveform, Test repetition rate = 60 Hz. V_{FXM} = Rated, V_{RXM} = Rated (see Chart 1), $v_{RX} = 15$ volts (see Chart 1). Rate of rise of current < 10 amps/μsec. Rate of fall of current ≦ 5 amps/μsec. Rate of rise of reapplied forward blocking voltage (dv/dt) = 200 volts/μsec (linear ramp). Gate bias = 0 volts, 100 ohms (during turn-off time internal).
C140 (2N3649-53)		—	—	15*	μsec	
C141 (2N3654-58)		—	—	10*	μsec	

CHARACTERISTICS (Cont.)

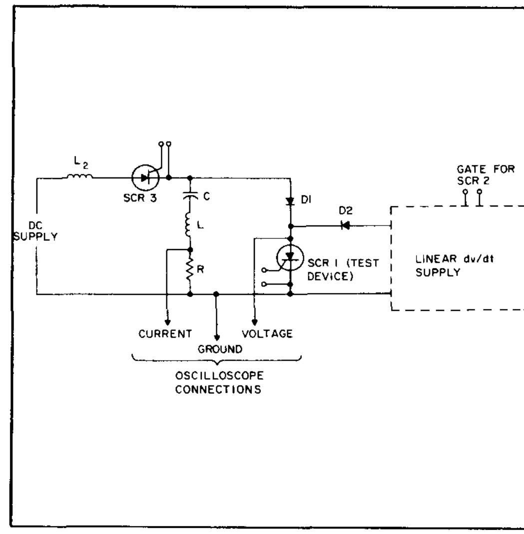
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC REVERSE OR FORWARD BLOCKING CURRENT (1)	I_{RO} or I_{FO}					$T_C = +25°C$
C140F (2N3649) C141F (2N3654)		—	1.0	6.0	mAdc	$V_{RO} = V_{FO} = 50V$ DC
C140A (2N3650) C141A (2N3655)		—	1.0	6.0	mAdc	$V_{RO} = V_{FO} = 100V$ DC
C140B (2N3651) C141B (2N3656)		—	1.0	6.0	mAdc	$V_{RO} = V_{FO} = 200V$ DC
C140C (2N3652) C141C (2N3657)		—	1.0	5.5	mAdc	$V_{RO} = V_{FO} = 300V$ DC
C140D (2N3653) C141D (2N3658)		—	1.0	4.0	mAdc	$V_{RO} = V_{FO} = 400V$ DC
DC REVERSE OR FORWARD BLOCKING CURRENT (1)	I_{RO} or I_{FO}					$T_C = +120°C$
C140F (2N3649) C141F (2N3654)		—	5.0	6.0*	mAdc	$V_{RO} = V_{FO} = 50V$ DC
C140A (2N3650) C141A (2N3655)		—	5.0	6.0*	mAdc	$V_{RO} = V_{FO} = 100V$ DC
C140B (2N3651) C141B (2N3656)		—	5.0	6.0*	mAdc	$V_{RO} = V_{FO} = 200V$ DC
C140C (2N3652) C141C (2N3657)		—	5.0	5.5*	mAdc	$V_{RO} = V_{FO} = 300V$ DC
C140D (2N3653) C141D (2N3658)		—	3.5	4.0*	mAdc	$V_{RO} = V_{FO} = 400V$ DC
GATE TRIGGER CURRENT	I_{GT}	—	80	180	mAdc	$T_C = +25°C$, $V_{FX} = 6$Vdc, $R_L = 4$ ohms
		—	150	500*	mAdc	$T_C = -65°C$, $V_{FX} = 6$Vdc, $R_L = 2$ ohms
GATE TRIGGER VOLTAGE	V_{GT}	—	1.5	3.0	Vdc	$T_C = +25°C$, $V_{FX} = 6$ Vdc, $R_L = 4$ ohms
		0.25*	—	—	Vdc	$T_C = +120°C$, V_{FX} = Rated, $R_L = 200$ ohms
		—	2.0	4.5*	Vdc	$T_C = -65°C$, $V_{FX} = 6$Vdc, $R_L = 2$ ohms
PEAK ON-VOLTAGE	V_F	—	1.8	2.05*	V	$T_C = +25°C$, $I_{FM} = 25A$ 1msec. pulse. Duty cycle = 1%
HOLDING CURRENT	I_{HO}					Anode supply = 24Vdc Initial forward current pulse, 0.1ms to 10ms wide, = 3.0A
		—	75	150	mAdc	$T_C = +25°C$. Gate supply: 10V open circuit, 20 ohms, 45 μsec min. pulse width.
		—	150	350*	mAdc	$T_C = -65°C$. Gate supply: 20V open circuit, 20 ohms, 45 μsec min. pulse width.
EFFECTIVE THERMAL RESISTANCE (DC)	θ_{J-C}	—	0.85	1.7*	°C/watt	
RATE OF RISE OF FORWARD BLOCKING VOLTAGE THAT WILL NOT TURN ON SCR	dv/dt	200*	—	—	volts/μsec	$T_C = +120°C$. Gate open circuited. V_{FO} = Rated

(1) Maximum case to ambient thermal resistance for which maximum V_{FO}, V_{RO} ratings apply equals 5°C/watt.
*Indicates values included in Jedec Type Number Registration.

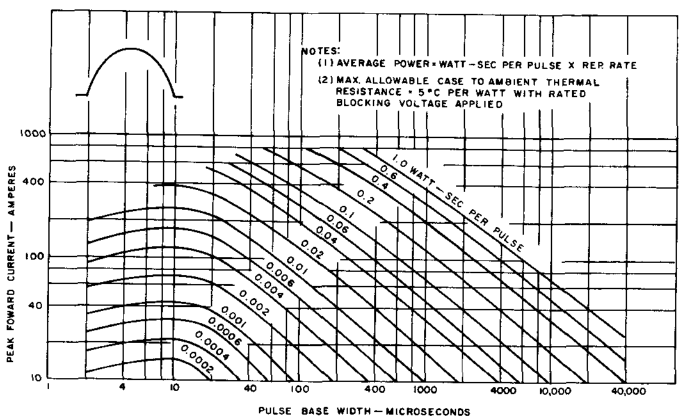
C140, C141



1. WAVEFORMS FOR PULSE TURN-OFF TIME TEST

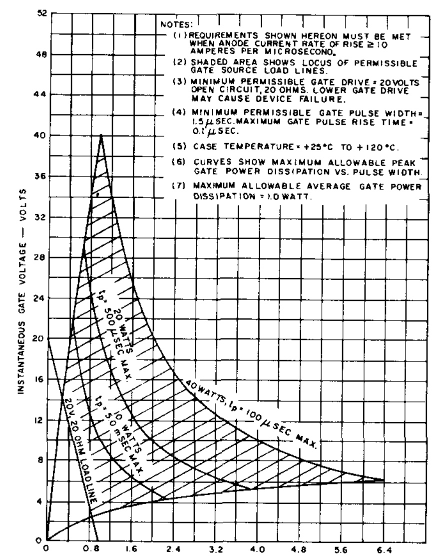


2. PULSE TURN-OFF TIME BASIC TEST CIRCUIT



3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

This chart provides a rapid means of determining anode dissipation with half-sine-wave pulses. Multiply the energy per pulse by the repetition rate to obtain average anode dissipation.

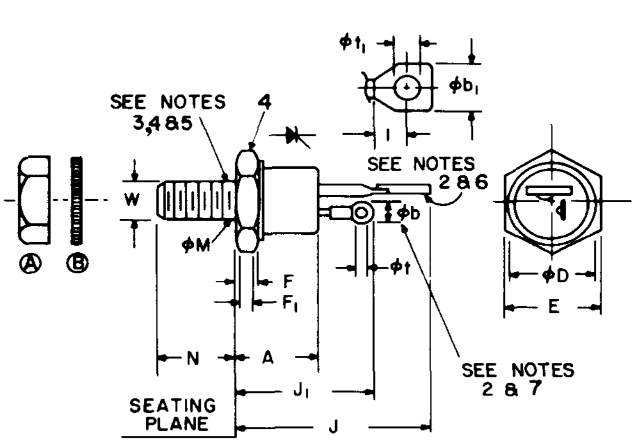


4. GATE TRIGGER REQUIREMENTS FOR HIGH FREQUENCY AND HIGH di/dt OPERATION

OUTLINE DRAWING
(COMPLIES WITH JEDEC TO-48)

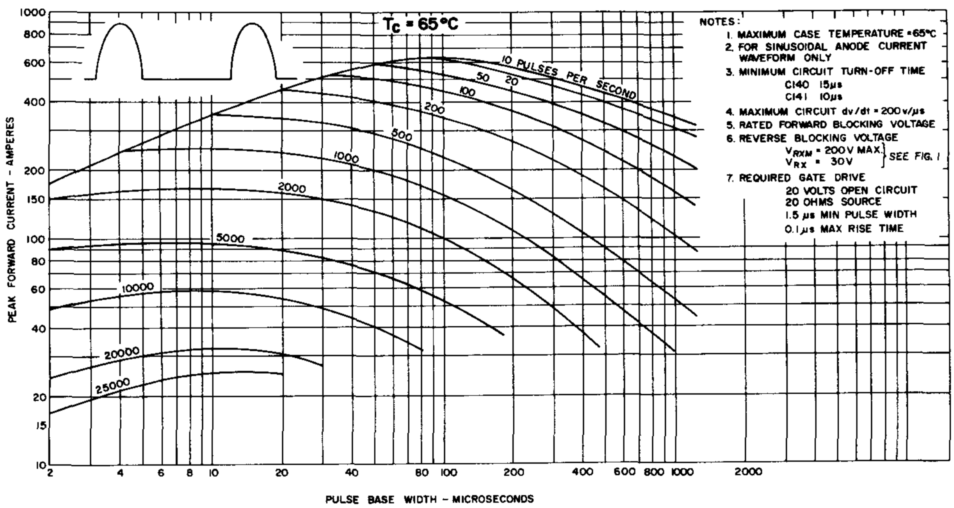
NOTES:
1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.
A. ¼-28 steel nut, Ni. plated, .178 min. thk.
B. Ext. tooth lockwasher, steel, Ni. plated, .023 min. thk.

(COMPLIES WITH JEDEC TO-48)

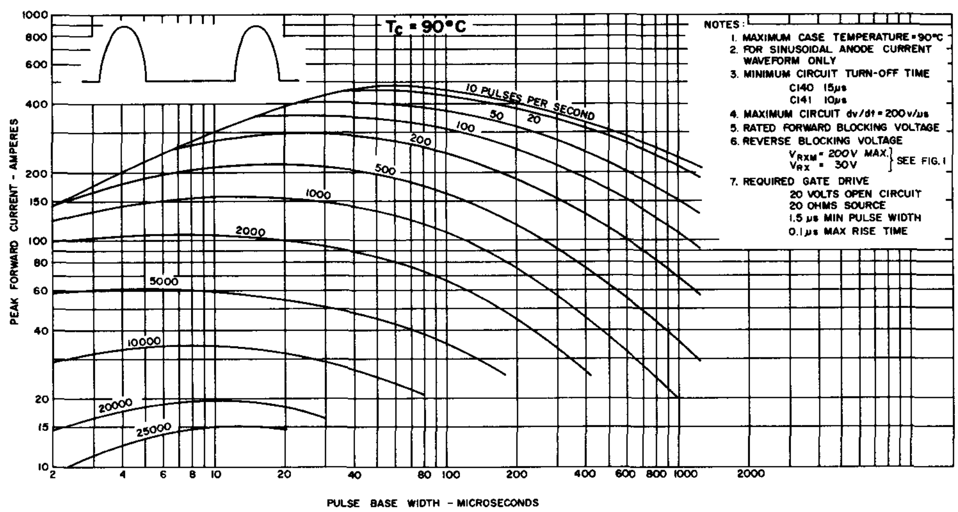


SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.330	.505	8.38	12.83	
φb	.115	.140	2.92	3.56	2
φb1	.210	.300	5.33	7.62	2
φD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F1	.060		1.52		
J		1.193		30.30	
J1		.875		22.23	
l	.120		3.05		
φM					1
N	.422	.453	10.72	11.51	
φt	.060	.075	1.52	1.91	
φt1	.125	.165	3.18	4.19	
W					3

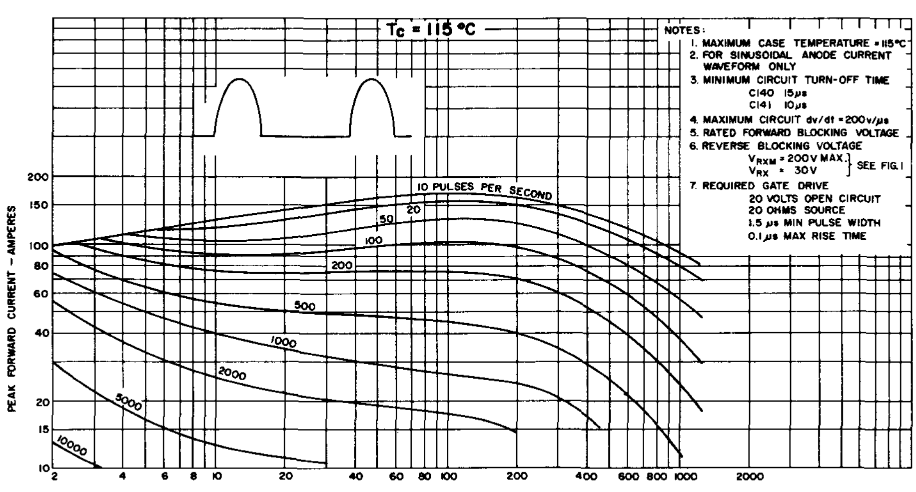
SINE WAVE DATA



5. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT vs PULSE WIDTH (T_C = 65°C)



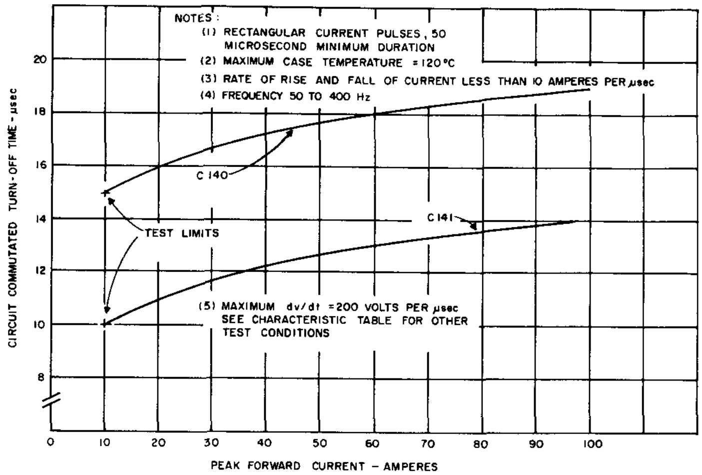
6. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT vs PULSE WIDTH (T_C = 90°C)



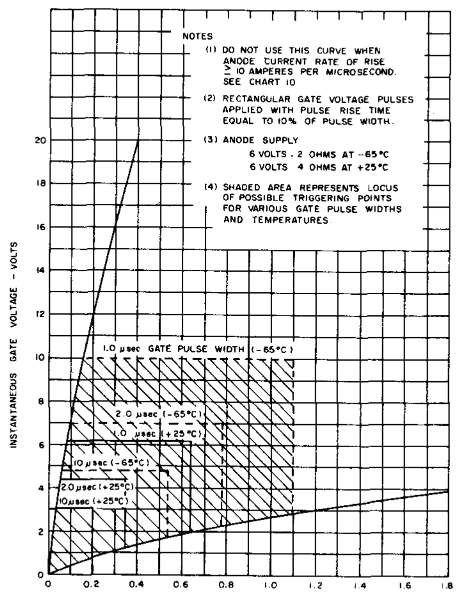
7. MAXIMUM ALLOWABLE PEAK FORWARD CURRENT vs PULSE WIDTH (T_C = 115°C)

Charts 5, 6 and 7, for three case temperatures 65°C, 90°C, and 115°C, give the maximum value of peak forward current at which the specified turn-off time and dv/dt still apply. The specified gate drive requirements *must* be adhered to.

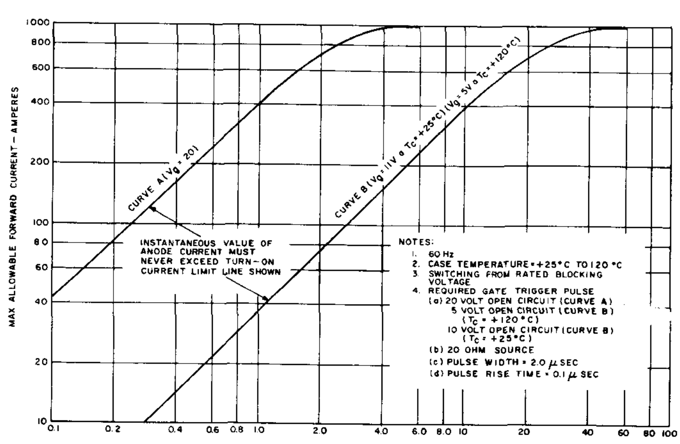
LOW REPETITION RATE DATA



8. MAXIMUM CONVENTIONAL CIRCUIT-COMMUTATED TURN-OFF TIME vs PEAK FORWARD CURRENT, ON-STATE



9. PULSE GATE TRIGGER CHARACTERISTICS



10. TURN-ON CURRENT LIMIT

This chart gives the guaranteed maximum turn-off time of the C140 and C141 as a function of the forward current. The use of this chart is necessary for rectangular anode current pulses of the specified pulse width and frequency.

Specification Sheets

140.12	1N3879 Series (6 amp) Fast Recovery Diode
140.22	1N3889 Series (12 amp) Fast Recovery Diode
140.23	A28 Series (12 amp) Very Fast Recovery Diode
140.47	1N3899 Series (20 amp) Fast Recovery Diode
140.48	1N3909 Series (30 amp) Fast Recovery Diode
145.55	A96 Series (250 amp) Fast Recovery Diode
160.35	C140 Series (35A) 50-400V High Speed SCR
160.39	C144 Series (35A) 500-800V High Speed SCR
170.35	C154-7 Series (110 amp) High Speed SCR
170.36	C158, 9 Series (110 amp) High Speed SCR
170.37	C385 Series (250 amp) High Speed SCR
170.38	C358 Series (225A) High Speed SCR
170.42	C395 Series (550A) up to 600V, High Speed SCR
170.44	C388, C387 Series (550A) High Speed SCR
170.45	C398, C397 Series (700A) High Speed SCR
170.53	C185 Series (235 amp) High Speed SCR
170.57	C354, 5 Series (115 amp) High Speed SCR
170.76	C506 Series (625 amp) High Speed SCR
170.80	C510 Series (625 amp) High Speed SCR

Application Notes

200.38	"Application of Fast Recovery Rectifiers"
200.41	"Simple Circuits For Triggering SCR's Into Fast-Rising Load Currents"
200.42	"Commutation Behavior of Diffused High Current Rectifier Diodes"
200.49	"A Low Cost Ultrasonic Frequency Inverter Using A Single SCR"

Technical Paper Reprints

660.13	"The Rating and Application of SCR's Designed for Switching at High Frequencies"
660.14	"Basic Magnetic Functions in Converters and Inverters Including New Soft Commutations"
660.15	"SCR Inverter Commutated By An Auxiliary Impulse"
660.16	"An SCR Inverter With Good Regulation and Sine Wave Output"

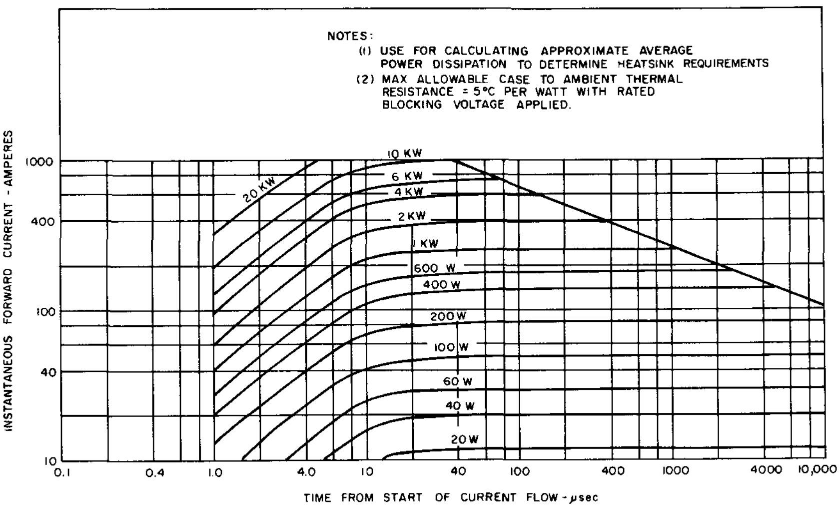
Seminar Notes

671.4	"The Widening World of The Fast Recovery Rectifier Diode"
671.15	"The Amplifying Gate SCR"

***For copies of any published information, please order by decimal publication number from: General Electric Company, Distribution Services, 1 River Road, Schenectady, N. Y. 12305.**

In no circumstances may the SCR anode current waveform, when plotted in this curve, cross the turn-on current limit line. If it does, the SCR may be destroyed. Two lines are given; one for required gate drive in high di/dt applications and the other for gate drive that will just turn the SCR on. The user must take care that, in a circuit capable of producing high di/dt anode current, no gate pulses of insufficient magnitude (due to noise for example) triggers, and thus possibly damages, the SCR.

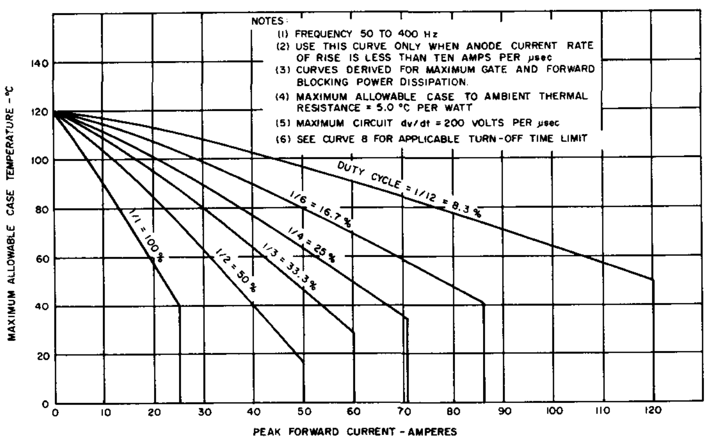
LOW REPETITION RATE DATA



11. INSTANTANEOUS FORWARD POWER DISSIPATION

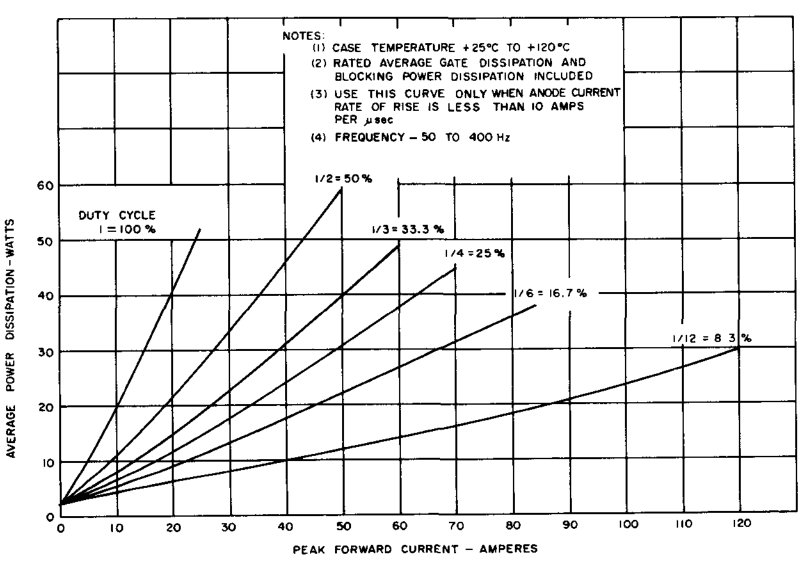
This chart gives the instantaneous power dissipated within the SCR as a function of time from start of current flow and the instantaneous value of forward anode current. Used as follows, this chart yields average dissipation information for any anode current waveshapes:

1. Plot the anode current waveform on this chart.
2. On linear paper, replot instantaneous forward power dissipation versus time. The area under the curve gives watt seconds of energy dissipated per anode current pulse.
3. Multiply the energy by the repetition rate to give average power dissipation.



12. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM

This chart is used when the SCR is carrying rectangular current with no significant turn-on switching duty at a repetition rate between 50 and 400 pulses per second.



13. AVERAGE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM

This chart provides a rapid means of determining SCR dissipation with low values of di/dt. It is applicable only between 50 Hz and 400 Hz.

HOW TO USE THIS SPECIFICATION SHEET

EXAMPLE I. (High Frequency Sinusoidal Pulse)

Problem:

Find the maximum allowable average anode current that can be carried by a C141 if the pulse is 50 μseconds wide and the repetition rate is 5000 Hz. The case is held at 80°C. What is the dissipation in the SCR? Find the maximum permitted thermal resistance between case and cooling air at 45°C. Assume the gate and blocking losses total 1 watt.

Answer:

From Chart 5 (65°C) the maximum permitted peak current at 5000 Hz, 50 μsec pulse width is 72 amperes; Chart 6 (90°C), 45 amperes; Chart 7 (115°C), 10 amperes. Interpolation gives the permitted peak current at 80°C as 55 amperes peak.

$$\text{The average current} = I_{pk} \times \frac{2}{\pi} \times \frac{\text{Pulse Width}}{\text{Pulse Period}}$$

$$= 55 \times \frac{2}{\pi} \times \frac{50}{200} = 8.8 \text{ amps average}$$

From Chart 3 at 50 μseconds pulse width and 55 amperes peak current the energy dissipated per pulse is 0.004 watt-seconds per pulse. The average anode dissipation is 0.004 × 5000 = 20 watts.

From this information the heatsink can be chosen using the equation:

Maximum case to cooling fluid thermal resistance

$$= \frac{\text{Case Temperature} - \text{Cooling Fluid Temp.}}{\text{Anode Dissipation} + \text{Gate \& Blocking Losses}}$$

$$= \frac{80 - 45}{20 + 1} = 1.7°\text{C/watt.}$$

Note that a turn-off of 10 μseconds and a dv/dt of 200 volts/μsecond can be applied concurrently to the C141 at the above current and temperature conditions.

EXAMPLE II. (Low Frequency, Low di/dt Pulse)

Problem:

A C140 is carrying a 20 amp rectangular pulse, 833 μseconds wide at a repetition rate of 400 pulses per second. The initial di/dt is 5 amps per μsecond. What is the maximum allowable case temperature? What is the power dissipation? What turn-off time and dv/dt may be applied to the C140?

Answer:

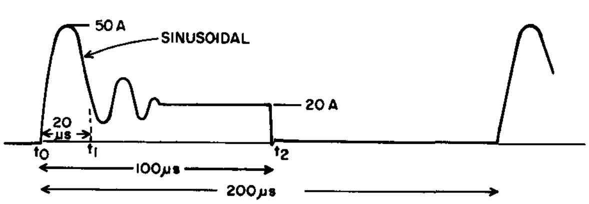
An 833 μsecond pulse in a 2.5 ms period gives a duty cycle of $\frac{833}{2500} \times 100 = 30\%$. Chart 12 shows that with this duty cycle a 20 amp rectangular pulse has a maximum allowable case temperature of 98°C. Chart 13 gives the total dissipation as 13.5 watts.

From Chart 8, 20 amps forward current permits a turn-off time of 16 μseconds and a dv/dt of 200 volts/μsecond to be applied concurrently.

EXAMPLE III. (High Frequency, Irregular Pulses)

Problem:

What is the maximum allowable case temperature for a C141 carrying the following anode current waveform: What turn-off time and dv/dt may be applied?



Answer:

No rigorous method has yet been developed for handling this case. The following method is approximate only but provides a conservative answer.

The di/dt of the initial pulse imposes the most severe strain on the SCR during the cycle. Use the initial half cycle to establish a case temperature and then lower the case temperature by an amount = effective thermal resistance (DC) of the SCR × wattage dissipated during the rest of the cycle (t_1 to t_2) to establish the maximum permitted case temperature.

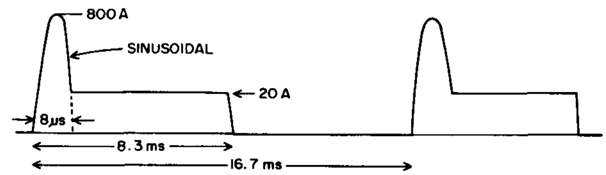
The average anode dissipation (time t_1 to t_2) can be found by means of Chart 11 (for method see Example IV). The energy dissipated per pulse is 0.0032 watt-seconds. The average anode dissipation = 0.0032 watt-seconds × 5000 pulses per second = 16 watts.

Chart 6 shows that a 5000 Hertz, 50 ampere, 20 μsecond pulse requires a case temperature of less than 90°C. Subtract from this case temperature a temperature of 1.7 °C/watt × 16 watts = 27°C to give the maximum permitted case temperature, with the given waveform, of 90°C − 27°C = 63°C. As the end of the current pulse is rectangular, Chart 8 will have to be used to find the required turn-off time which is 16μseconds. The concurrent dv/dt is 200 volts/μsecond.

EXAMPLE IV. (Low Frequency, Irregular Pulses With High Initial di/dt)

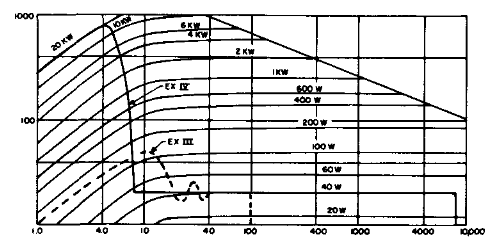
Problem:

What is the maximum allowable case temperature for a C141 carrying the following anode current waveform?

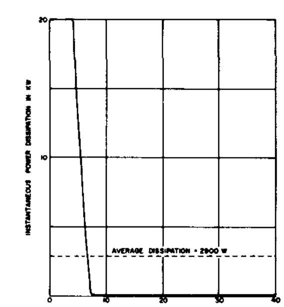


Answer:

Check the initial di/dt by plotting the first 10 μseconds of current flow on Chart 10. The waveform is found to be within safe limits provided that the high gate pulse shown on Chart 4 is used. Note that an inadequate gate pulse could destroy the SCR. To find the anode dissipation, plot the anode current waveform on Chart 11.



Replot the intersections of anode current with the instantaneous power lines. In this case it is convenient to replot the first 40 μseconds of current flow separately in order to use a convenient scale.



By graphical integration, the energy per pulse for the first 40 μseconds is seen to be 0.12 watt-second. To this must be added the energy dissipated during the rectangular portion of the pulse which is 40 watts × 8.3 ms = 0.33 watt-seconds.

Thus the total energy dissipated per pulse is 0.12 + 0.33 = 0.45 watt-seconds. The average dissipation due to anode current flow is 0.45 watt-seconds × 60 pulses per second = 27 watts.

As the repetition rate is within the limits of 50 to 400 Hz a convenient way of ascertaining the maximum permitted case temperature is to convert the high di/dt irregular waveform to a low di/dt rectangular pulse with the same dissipation.

From Chart 13, a 27 watt, 50% duty cycle pulse gives an average anode current of 25 amperes peak.

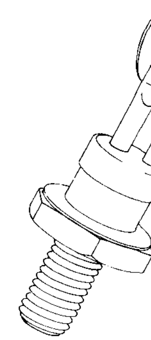
From Chart 12, a 25 ampere, 50% duty cycle current gives a maximum allowable case temperature of 75°C.

Note: For repetition rates lower than 50 Hz, the temperature excursion within the SCR each cycle becomes too high for the use of Charts 12 and 13. The procedure for dealing with these very-low-frequency pulses is discussed in the General Electric SCR Manual, 3rd Edition, Chapter 3.

SCR

C144

The General Electric C144 Silicon Controlled Rectifier is a reverse blocking triode thyristor semiconductor device designed primarily for high-frequency power switching applications which requires blocking voltages from 500 to 800 volts and load currents up to 35 amperes RMS, at frequencies up to 10 kHz. The C144 is characterized for rectangular and sine wave operation.



The C144 utilizes a new voltage rating system which allows high voltage blocking capability while approaching the short turn-off time characteristics of a low blocking voltage SCR.

Equipment designers can use the C144 SCR in demanding applications such as: choppers, inverters, regulated power supplies, cycloconverters, ultrasonic generators, high frequency lighting, induction heaters, radar and sonar transmitters, laser pulsers, pulse modulators.

MAXIMUM ALLOWABLE RATINGS

Type (1)	Repetitive Peak Off-State Voltage, V_{DRM} (2)(3), T_C = −65°C to +125°C	Peak or DC Switching Voltage V_{DM} or V_D (2)(3) T_C = −65°C to +125°C	Repetitive Peak Reverse Voltage V_{RRM} (2)(3) T_C = -65°C to +125°C	Non-Rep. Peak Off-State and Reverse Voltage V_{DSM} and V_{RSM} (2)(4) T_C = −65°C to +125°C
C144E15E, C144E30E	500 Volts	500 Volts	500 Volts	600 Volts
C144M15M, C144M30M	600	600	600	720
C144S15M, C144S30M	700	600	700	840
C144N15M, C144N30M	800	600	800	1000

RMS On-State Current, $I_{T(RMS)}$ . . . . 35 Amperes (all conduction angles)
Critical Rate-of-Rise of On-State Current, di/dt: (5)
Gate triggered operation:
Switching from 500 volts (500 volt types) . . . . 100 Amperes per microsecond
Switching from 600 volts (600, 700, 800 volt types) . . . . 100 Amperes per microsecond
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} . . . . 250 Amperes
Peak Rectangular Pulse Surge (non-rep) On-State Current (5.0 Msec, t_r=50µsec) I_{TSM} . . . . 225 Amperes
I^2t (for fusing), for times ≧ 0.5 milliseconds . . . . 165 Ampere² seconds
Peak Gate Power Dissipation, P_{GM} . . . . 40 Watts for 100 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 1.0 Watts
Peak Negative Gate Voltage, V_{EM} . . . . 10 Volts
Storage Temperature, T_{stg} . . . . −65°C to +150°C
Operating Temperature, T_J . . . . −65°C to +125°C
Maximum Stud Torque . . . . 30 Lb-in (35 Kg-cm)

CHARACTERISTICS

Test	Symbol	Min.	Max.	Units	Test Conditions
Peak Reverse and Off-State Current (2)(6)	I_{RRM} or I_{DRM}	– – – –	5.5 4.6 3.9 3.3	mA	T_C = –65°C to +125°C V_{RRM} = V_{DRM} = 500 Volts Peak 600 " " 700 " " 800 " "
Critical Rate of Rise of Off-State Voltage	dv/dt	200	–	Volts/ µsec	T_C = 125°C, Rated V_{DRM}, Gate Open Circuited, Exponential Waveform
D.C. Gate Trigger Current	I_{GT}	–	150 400	mAdc	T_C = 25°C, V_D = 6Vdc, R_L = 4 ohms T_C = –65°C, V_D = 6Vdc, R_L = 2 ohms
D.C. Gate Trigger Voltage	V_{GT}	– 0.25	3.0 4.5	V_{DC}	T_C = 25°C, V_D = 6 Volts, R_L = 4 ohms T_C = –65°C, V_D = 6 Volts, R_L = 2 ohms T_C = 125°C, Rated V_{DRM}, R_L = 500 ohms
Peak On-State Voltage	V_{TM}	–	3.0	Volts	T_C = 25°C, I_{TM} = 100 A Peak, ≥ 1, ≤ 2 msec. wide pulse. Duty cycle ≦ 2%.
Holding Current	I_H	– –	125 325	mAdc	Anode Source Voltage = 24 Vdc. Peak Initiating On-State Current = 3A, 0.1 to 10 msec pulse. T_C = 25°C, Gate source = 10V, Open Circuit, 20 ohms, 100 µsec pulse T_C = –65°C, Gate source = 20V, Open Circuit, 20 ohms, 100 µsec pulse.
Pulse Circuit Commutated Turn-Off Time C144-15- Types C144-30- Types	t_q (pulse)	 – –	 15 30	 µsec µsec	T_C = 115°C, I_{TM} = 100A Peak. Approximately Sinusoidal Current Waveform. See Chart II for time references. On-State Current Pulse Time to peak (t_2–t_1) = 7.5 µsec. On-State Current Pulse Base (t_3–t_1) = 15. µsec (+1.5-0 µsec). Repetition Rate = 400 PPS. PRV (t_5) = 500 Volts max. Reverse Voltage (t_6) = 30 Volts. Peak Off-State Voltage (t_8) = Rated V_{DRM}. Peak Off-State Voltage (t_0) equals: 500 Volts for 500 Volt types; 600 Volts for 600, 700 and 800 Volt types. Rate of Rise of Re-applied Off-State Voltage (Linear Ramp): (t_6 to t_8) = 200 Volts per µsec. Gate Trigger Pulse = 20 Volts, 20 ohms. Gate Trigger Pulse Width (90% points) = 1.5 µsec. Gate Trigger Pulse Rise Time (10% to 90%) = 0.1 µsec. Gate Bias during Turn-Off Time interval = 0 Volts, 20 ohms.

CHARACTERISTICS (Contd)

Test	Symbol	Min.	Max.	Units	Test Conditions
Steady State Thermal Resistance	$R_{\theta JC}$	–	1.0	°C/ Watt	Junction to Case
Conventional Circuit Commutated Turn-Off Time	t_q				T_C = 125°, I_{TM} = 10A Peak Rectangular Current Pulse, 50 μsec duration. DI/DT < 10 Amps per microsecond. Commutation Rate ≤ 5A per μsec. PRV = Rated V_{RRM} Volts max. Reverse Voltage at end of Turn-Off Time interval = 15 volts. Repetition Rate = 60 PPS. Rate of Rise of Re-applied Off-State Voltage (dv/dt) = 200V/μsec. Off-State Voltage = Rated V_{DRM} Volts. Gate Bias during Turn-Off Time interval = 0 Volts, 100 ohms.
C144-15- Types			15	μsec	
C144-30- Types			30	μsec	

NOTES:

(1) Type designations are defined as follows, using C144N30M as an example:

C 1 4 4 N 30 M
- M — Rated Switching Voltage
- 30 — Maximum Turn-Off Time (30 = 30 μsec; 15 = 15 μsec)
- N — Rated Repetitive Peak Off-State and Reverse Voltage

(2) Values apply for gate terminal open circuited. (Negative gate bias is permissible).

(3) Maximum case to ambient thermal resistance for which maximum voltage ratings apply equals 3.0C degrees per watt for V_D (DC voltage), 5.0C degrees per watt for V_{DRM} and V_{RRM}. See paragraph, "Basis for Voltage Rating" for further information.

(4) Half sine wave voltage pulse, 10 millisecond max. duration.

(5) di/dt rating is established in accordance with JEDEC Suggested Standard No. 7, Section 5.1.2.4 Off State (blocking) voltage capability may be temporarily lost immediately after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 H_Z. The duration of the JEDEC di/dt test condition is 5.0 seconds (minimum). Required gate drive = 20 volts, open circuit, 20 ohm source, 0.1 microsecond rise time, 1.5 microsecond pulse width. Repetitive di/dt capability is incorporated into peak current rating charts included in this specification sheet.

(6) Maximum case to ambient thermal resistance for which maximum V_{DRM} and V_{RRM} ratings apply equals 5.0 degrees C per watt. See paragraph entitled "Basis of Voltage Ratings", for further information.

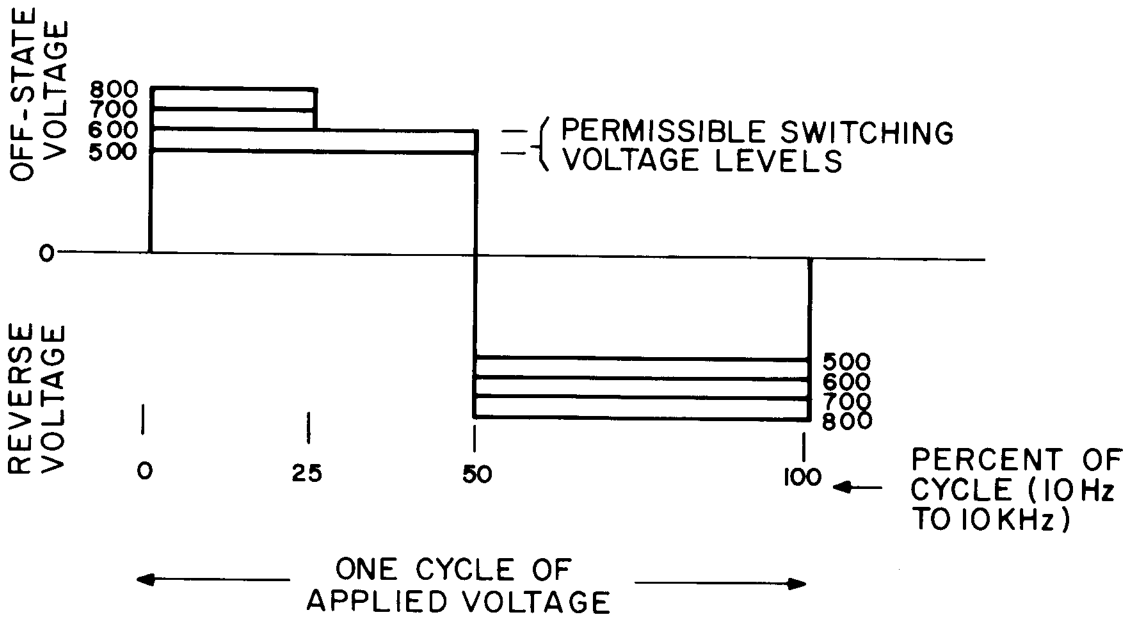
PRELIMINARY DATA

These ratings and characteristics are not necessarily definitive and are based only on the tests and findings made to date. Inasmuch as further information may be acquired, General Electric Company reserves the right to change these preliminary data without notice. Please contact your local General Electric Electronic Component Sales Manager for the latest status of data prior to ordering devices to the limits indicated by the data.

BASIS OF VOLTAGE RATINGS
For The C144 Thyristor

The C144 Thyristor is characterized for both inverter service and phase controlled service. Voltage ratings are given applicable to both types of service.

For inverter service, the off-state and reverse voltage ratings are based on the waveform shown below:



This waveform requires the use of a device case to ambient thermal resistance of 3.0 deg C per watt in order to assure thermal stability under maximum rated voltage and temperature conditions.

The waveforms of the actual application must stay within the envelope shown for each voltage type. If the actual waveforms do not stay within the envelopes shown for each voltage type then a heat sink with less than 3.0 deg C per watt must be used. Consult factory for assistance in heat sink selection to assure thermal stability.

For phase controlled service, sinusoidal voltage waveform is assumed. A device case to ambient thermal resistance of 5.0 deg C per watt maximum is required to assure thermal stability at maximum rated voltage and temperature conditions.

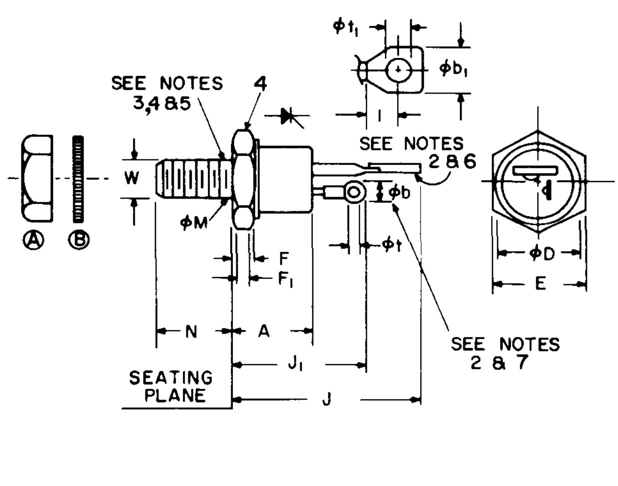
It should be noted that the above thermal stability criteria apply even when no on-state conduction losses are present.

OUTLINE DRAWING
(COMPLIES WITH JEDEC TO-48)

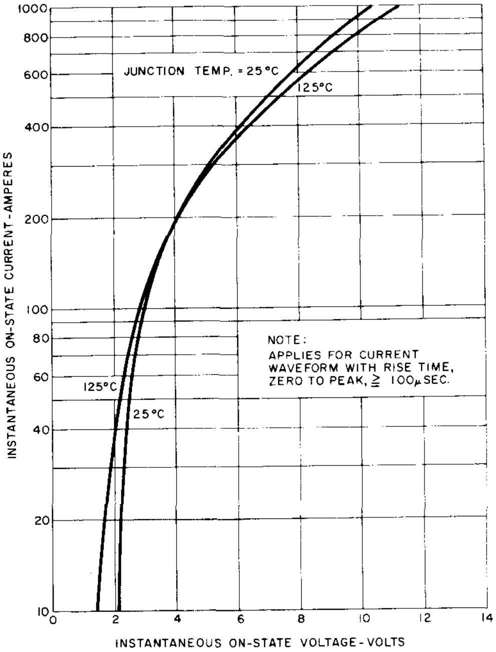
NOTES:
1. Complete threads to extend to within 2½ threads of seating plane. Diameter of unthreaded portion .249" (6.32MM) Maximum, .220" (5.59MM) Minimum.
2. Angular orientation of these terminals is undefined.
3. ¼-28 UNF-2A. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268" (5.76MM), minimum pitch diameter .2225" (5.66MM), reference: screw thread standards for Federal Service 1957, Handbook H28, 1957, P1.
4. A chamfer (or undercut) on one or both ends of hexagonal portions is optional.
5. Case is anode connection.
6. Large terminal is cathode connection.
7. Small terminal is gate connection.
8. Insulating kit available upon request.

A. ¼-28 steel nut, Ni. plated, .178 min. thk.

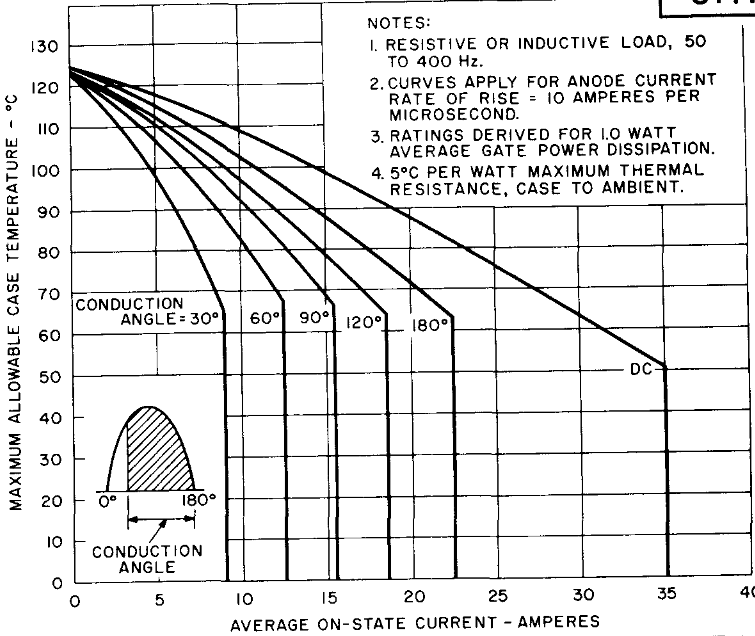
B. Ext. tooth lockwasher, steel , Ni. plated, .023 min. thk.



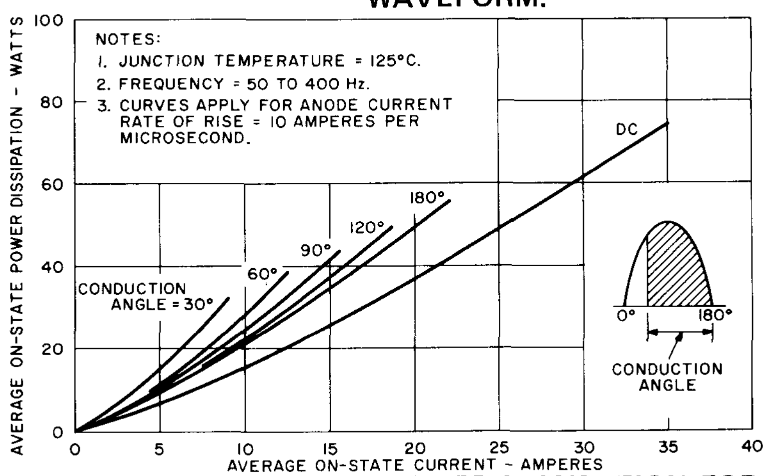
SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.330	.505	8.38	12.83	
ϕb	.115	.140	2.92	3.56	2
ϕb₁	.210	.300	5.33	7.62	2
ϕD		.544		13.82	
E	.544	.562	13.82	14.27	
F	.113	.200	2.87	5.08	4
F₁	.060		1.52		
J		1.193		30.30	
J₁		.875		22.23	
l	.120		3.05		
ϕM					1
N	.422	.453	10.72	11.51	
ϕt	.060	.075	1.52	1.91	
ϕt₁	.125	.165	3.18	4.19	
W					3



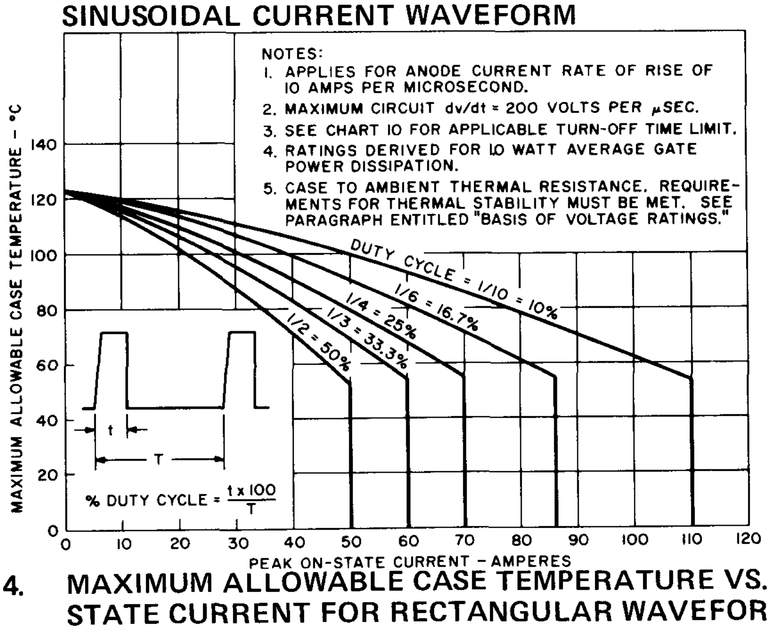
1. MAXIMUM ON-STATE CHARACTERISTICS



2. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. ON-STATE CURRENT FOR SINUSOIDAL CURRENT WAVEFORM.

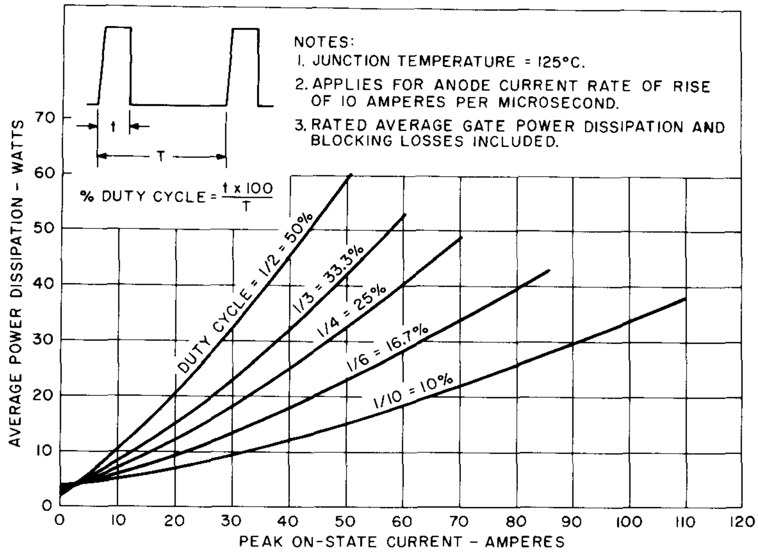


3. MAXIMUM AVERAGE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



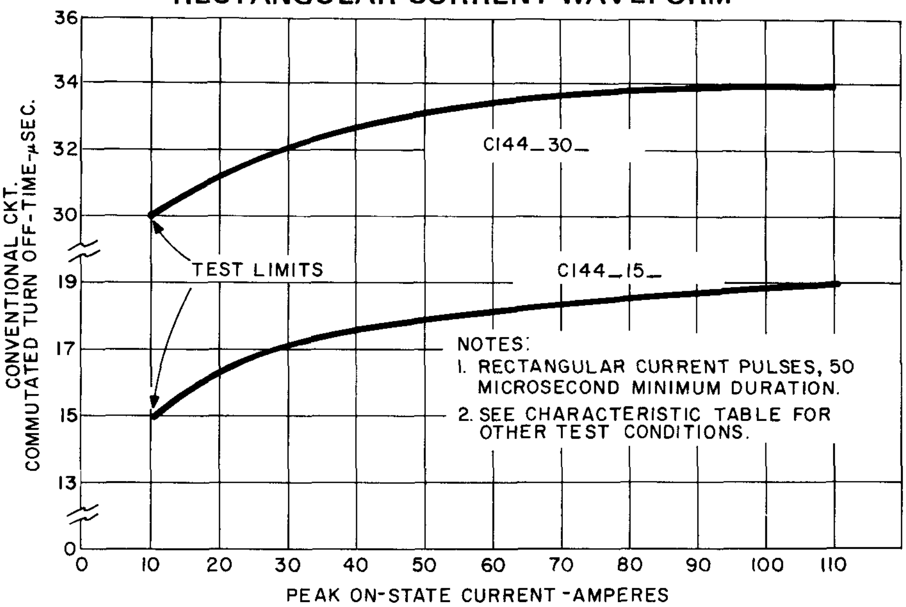
4. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. ON-STATE CURRENT FOR RECTANGULAR WAVEFORM

This chart is used when the SCR is carrying rectangular current with no significant turn-on switching duty.



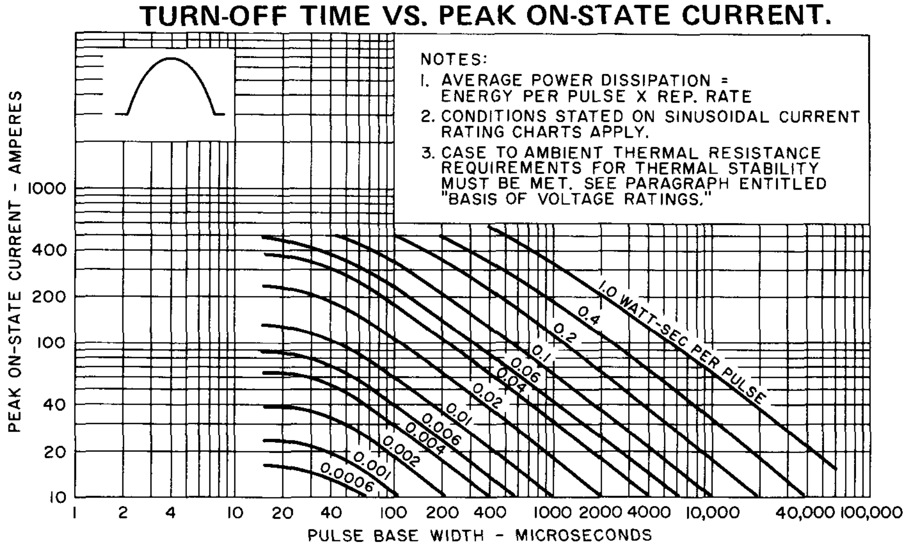
5. MAXIMUM AVERAGE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM

This chart provides a rapid means of determining SCR dissipation with low values of di/dt.



6. MAXIMUM CONVENTIONAL CIRCUIT-COMMUTATED TURN-OFF TIME VS. PEAK ON-STATE CURRENT.

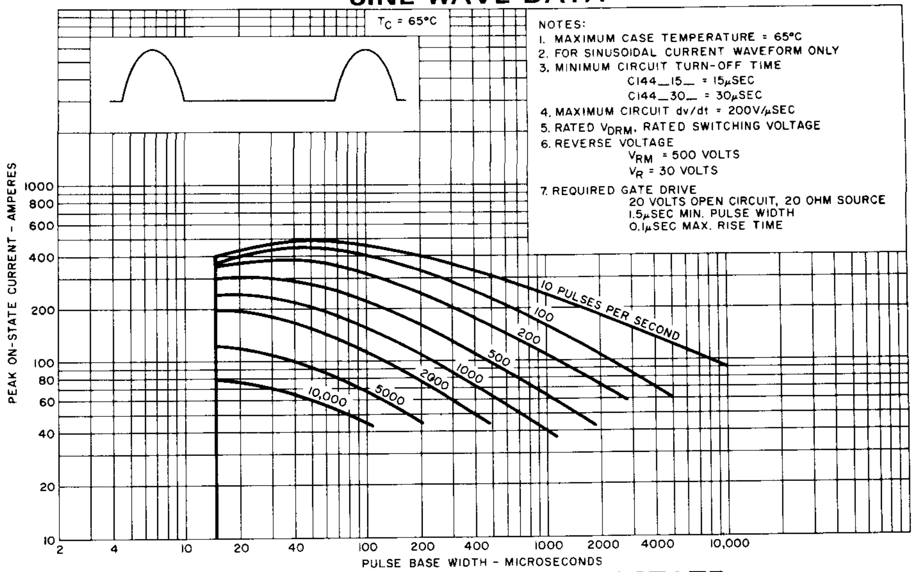
This chart gives the guaranteed maximum turn-off time of the C144 as a function of the forward current. The use of this chart is necessary for rectangular anode current pulses of the specified pulse width and frequency.



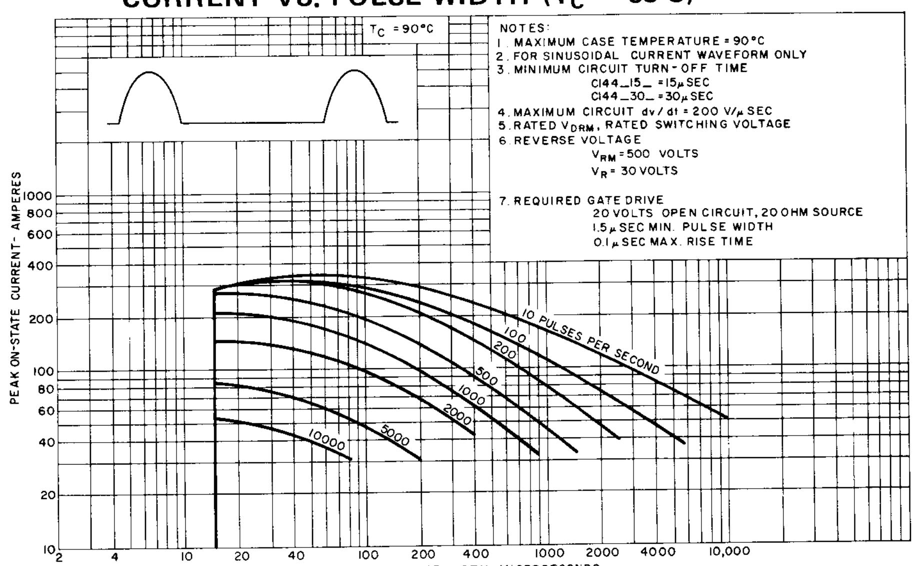
7. ENERGY PER PULSE FOR SINUSOIDAL PULSES

This chart provides a rapid means of determining anode dissipation with half-sine-wave pulses. Multiply the energy per pulse by the repetition rate to obtain average anode dissipation.

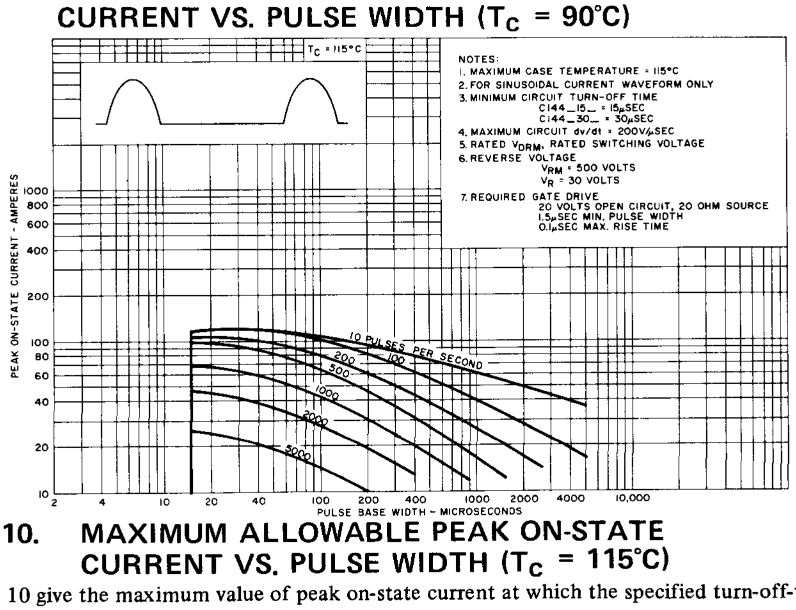
SINE WAVE DATA



8. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)

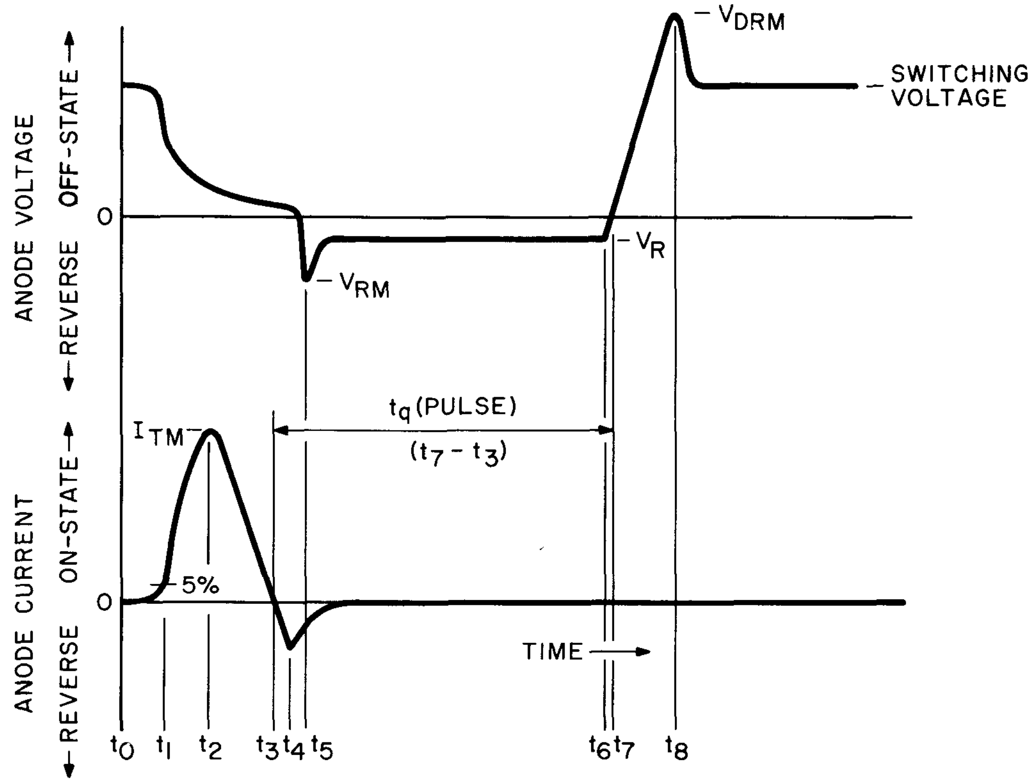


9. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



10. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 115°C)

Charts 8, 9 and 10 give the maximum value of peak on-state current at which the specified turn-off-time and dv/dt still apply.



11. WAVEFORMS FOR PULSE CIRCUIT-COMMUTATED TURN-OFF TIME TEST.

Specification Sheets

140.12	1N3879 Series (6 amp) Fast Recovery Diode
140.22	1N3889 Series (12 amp) Fast Recovery Diode
140.23	A28 Series (12 amp) Very Fast Recovery Diode
140.47	1N3899 Series (20 amp) Fast Recovery Diode
140.48	1N3909 Series (30 amp) Fast Recovery Diode
145.55	A96 Series (250 amp) Fast Recovery Diode
160.35	C140 Series (35A) 50-400V High Speed SCR
160.39	C144 Series (35A) 500-800V High Speed SCR
170.35	C154-7 Series (110 amp) High Speed SCR
170.36	C158, 9 Series (110 amp) High Speed SCR
170.37	C385 Series (250 amp) High Speed SCR
170.38	C358 Series (225A) High Speed SCR
170.42	C395 Series (550A) up to 600V, High Speed SCR
170.44	C388, C387 Series (550A) High Speed SCR
170.45	C398, C397 Series (700A) High Speed SCR
170.53	C185 Series (235 amp) High Speed SCR
170.57	C354, 5 Series (115 amp) High Speed SCR
170.76	C506 Series (625 amp) High Speed SCR
170.80	C510 Series (625 amp) High Speed SCR

Application Notes

200.38	"Application of Fast Recovery Rectifiers"
200.41	"Simple Circuits For Triggering SCR's Into Fast-Rising Load Currents"
200.42	"Commutation Behavior of Diffused High Current Rectifier Diodes"
200.49	"A Low Cost Ultrasonic Frequency Inverter Using A Single SCR"

Technical Paper Reprints

660.13	"The Rating and Application of SCR's Designed for Switching at High Frequencies"
660.14	"Basic Magnetic Functions in Converters and Inverters Including New Soft Commutations"
660.15	"SCR Inverter Commutated By An Auxiliary Impulse"
660.16	"An SCR Inverter With Good Regulation and Sine Wave Output"

Seminar Notes

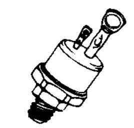
671.4	"The Widening World of The Fast Recovery Rectifier Diode"
671.15	"The Amplifying Gate SCR"

***For copies of any published information, please order by decimal publication number from: General Electric Company, Distribution Services, 1 River Road, Schenectady, N. Y. 12305.**

High Power
Silicon
Controlled Rectifier
1200 Volts 63A RMS

C147

The General Electric C147 Silicon Controlled Rectifier is designed for phase control applications. This is an all-diffused device which is considerably smaller in size than comparably rated high power SCR's.



FEATURES:

- High dv/dt With Selections Available
- Excellent Surge and I^2t Ratings, Providing Easy Fusing
- Compact, Hermetic Package, 1/4–28 Stud

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C147A	100 Volts	100 Volts	150 Volts
C147B	200	200	300
C147C	300	300	400
C147D	400	400	500
C147E	500	500	600
C147M	600	600	720
C147S	700	700	840
C147N	800	800	960
C147T	900	900	1080
C147P	1000	1000	1200
C147PA	1100	1100	1320
C147PB	1200	1200	1440

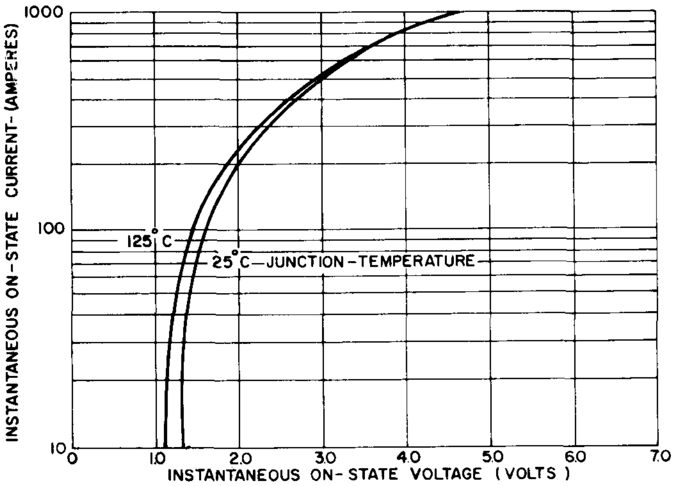
[1] Half sinewave waveform, 10 msec. maximum pulse width.

RMS On-State Current, $I_{T(RMS)}$ . . . . 63 Amperes (All Conduction Angles)
Average On-State Current, $I_{T(AV)}$ . . . . Depends on Conduction Angles (See Charts 2 and 3)
Critical Rate-of-Rise of On-State Current (Non-Repetitive) di/dt:*
Switching From 1200 Volts . . . . 100 Amperes Per Microsecond
Switching From 600 Volts . . . . 200 Amperes Per Microsecond
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 1000 Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 910 Amperes
I^2t (for fusing), for times ⩾ 8.3 milliseconds (See Figure 6) . . . . 4150 (RMS Ampere)^2 Seconds
I^2t (for fusing), for times ⩾ 1.5 milliseconds (See Figure 6) . . . . 2850 (RMS Ampere)^2 Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 100 Watts for 150 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Maximum Stud Torque . . . . 30 Lb.-In.
3-4 N-m

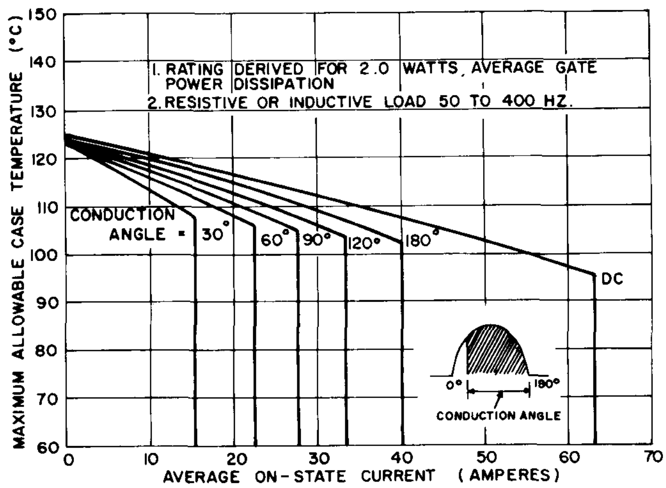
*di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of V_{DRM} stated above; 20 volts, 20 ohms gate trigger source with 0.5 μsec short circuit trigger current rise time.

CHARACTERISTICS

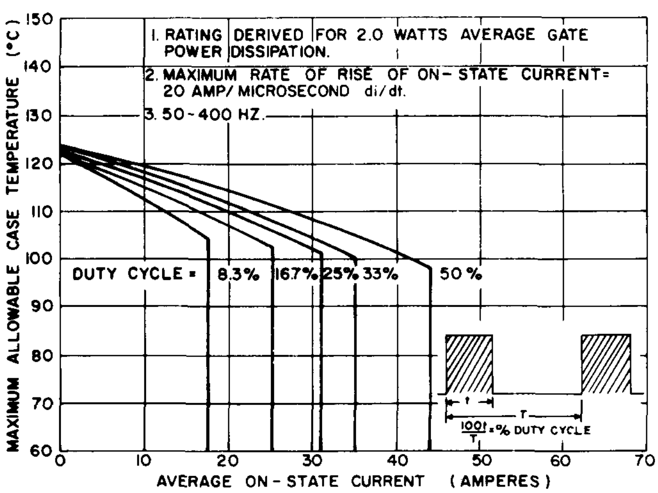
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Off-State and Reverse Current	I_{DRM} and I_{RRM}				mA	T_J = -40°C to +125°C $V_{DRM} = V_{RRM}$ =
C147A		–	–	12		100 Volts Peak
C147B		–	–	12		200
C147C		–	–	12		300
C147D		–	–	10		400
C147E		–	–	10		500
C147M		–	–	10		600
C147S		–	–	10		700
C147N		–	–	9		800
C147T		–	–	8		900
C147P		–	–	7		1000
C147PA		–	–	6.5		1100
C147PB		–	–	6		1200
DC Gate Trigger Current	I_{GT}	–	–	150	mAdc	T_C = 25°C, V_D = 12 Vdc, R_L = 12 Ohms
		–	–	300		T_C = -40°C, V_D = 12 Vdc, R_L = 12 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	3	Vdc	T_C = 25°C, V_D = 12 Vdc, R_L = 12 Ohms
		–	–	3.5		T_C = -40°C, V_D = 12 Vdc, R_L = 12 Ohms
		0.25	–	–		T_C = +125°C, Rated V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	3	Volts	T_C = +25°C, I_{TM} = 500 Amperes Peak, 1 Millisecond Wide Pulse. Duty Cycle ≤ 1%
Holding Current	I_H	–	–	250	mAdc	T_C = +25°C, Anode Supply = 24 Vdc, Gate Supply = 10V/20 Ohms. Initial Forward Pulse = 2 Amps., 0.1 Millisecond to 10 Milliseconds Wide.
Critical Rate-of-Rise of Off-State Voltage. (Higher values may cause device switching)	dv/dt	200	–	–	Volts/ μsec	T_C = +125°C, Rated V_{DRM}, Using Linear Exponential Rising Waveform. Gate Open Circuited. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selection available – consult factory.						
Thermal Resistance	$R_{\theta JC}$	–	–	.35	°C/Watt	Junction-to-Case
Turn-Off Time	t_q	–	125	–	μsec	(1) T_J = +125°C (2) I_{TM} = 150 Amps. Peak (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20V/μsec (Linear) (6) Commutation di/dt = 5 A/μsec (7) Repetition Rate = 1 PPS. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms



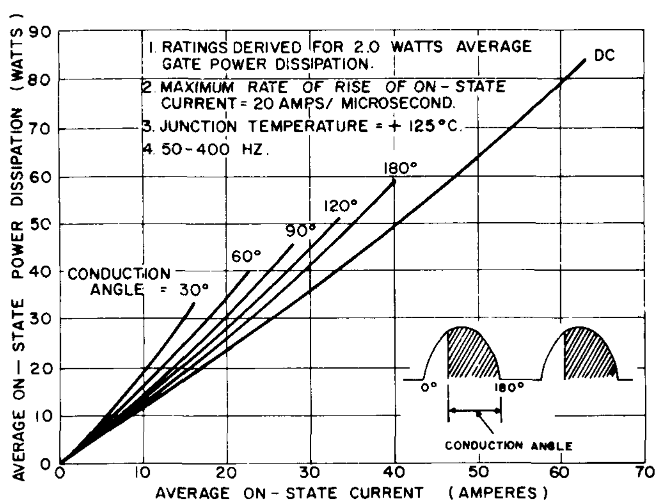
1. MAXIMUM ON-STATE CHARACTERISTICS



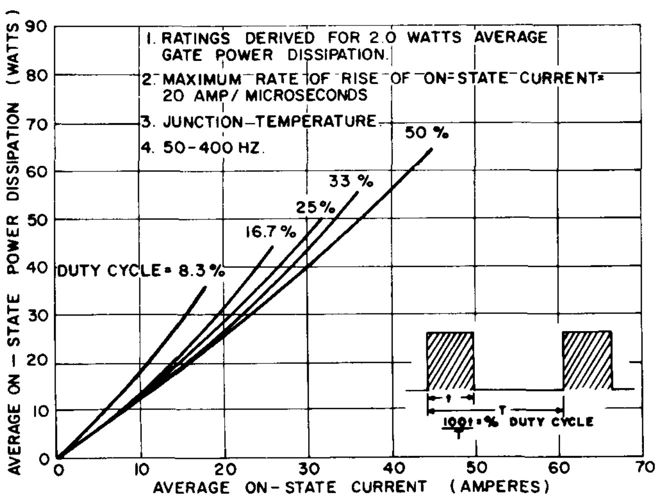
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



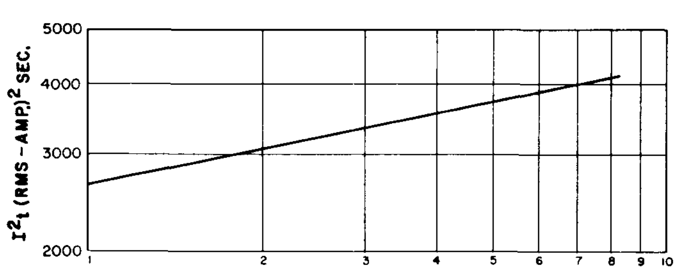
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



4. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM

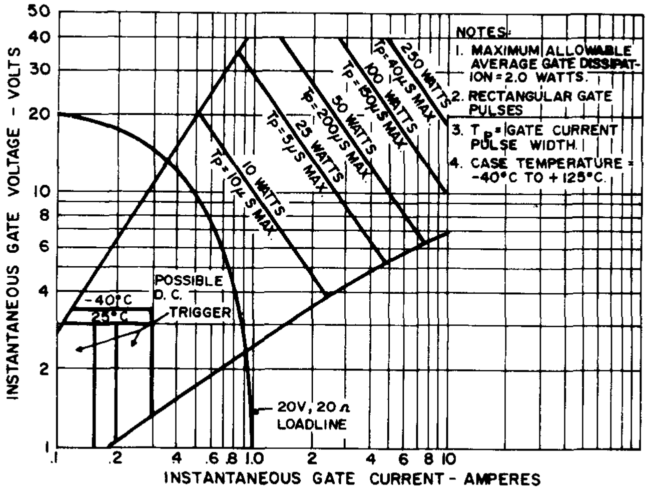


5. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM

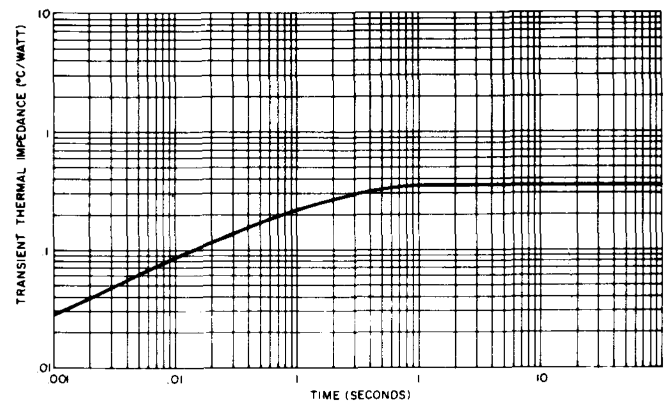


I²t RATING FOLLOWING RATED LOAD CONDITIONS

6. MAXIMUM ALLOWABLE NON-REPETITIVE SURGE CURRENT

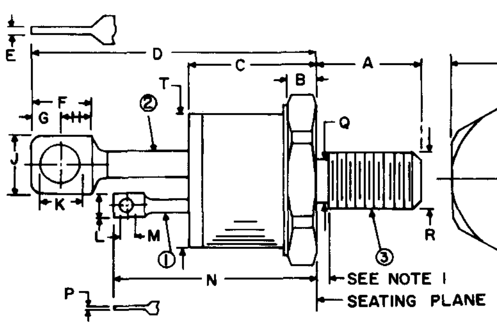


7. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS



8. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

OUTLINE DRAWING



TERMINAL 1	TERMINAL 2	TERMINAL 3	R THREAD SIZE
GATE	CATHODE +	ANODE −	1/4-28 UNF-2A

NOTE: 1. COMPLETE THREADS TO WITHIN 2 1/2 THD. OF SEATING PLANE.

2. ONE STEEL, CADMUIM PLATED NUT AND ONE STEEL, CADMUIM PLATED LOCKWASHER SUPPLIED WITH EACH DEVICE.

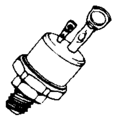
SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.
A	.422	.452	10.72	11.47	L	.090	.115	2.29	2.91
B	.120	.135	3.05	3.42	M	.055	.066	1.40	1.67
C	.534	.565	13.57	14.34	N	.831	.901	21.11	22.88
D	1.230	1.290	31.25	32.78	P	.012	—	.31	—
E	.029	.062	.74	1.56	Q	.220	—	5.59	—
F	.258	REF.	6.55	REF.	S	.676	.684	17.18	17.36
G	.138	REF.	3.50	REF.	T	—	.597	—	15.15
H	.115	—	2.83	—					
J	.240	.300	6.10	7.62					
K	.169	.182	4.30	4.62					

HIGH SPEED Silicon Controlled Rectifier

C148

1200 VOLTS **63A RMS**

The General Electric C148 Silicon Controlled Rectifier is designed for power switching at high frequencies. This is an all-diffused device which is considerable smaller in size than comparably rated high power SCR's.



FEATURES:

- Fully characterized for operation inverter and chopper applications.
- High dv/dt with selections available.
- Excellent surge and I^2t ratings providing easy fusing.
- Compact hermetic package, ¼ — 28 stud.

Equipment designers can use the C148 in demanding applications, such as:

- Choppers
- Inverters
- Induction Heaters
- High Frequency Lighting
- Cycloconverters
- DC to DC conversion

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C148M	600 Volts	600 Volts	720 Volts
C148S	700	700	840
C148N	800	800	960
C148T	900	900	1080
C148P	1000	1000	1200
C148PA	1100	1100	1320
C148PB	1200	1200	1440

[1] Half sinewave waveform, 10 ms max. pulse width.

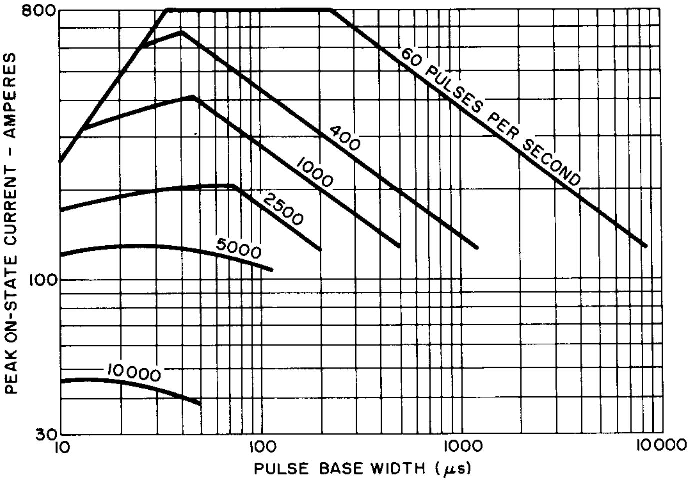
RMS On-State Current, $I_{T(RMS)}$ . . . 63 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . 700 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . 670 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds . . . 1360 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds . . . 2000 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive. . . 100 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive . . . 75 A/μs †
Average Gate Power Dissipation, $P_{G(AV)}$ . . . 2 Watts
Storage Temperature, T_{stg} . . . -40°C to +150°C
Operating Temperature, T_J . . . -40°C to +125°C
Stud Torque . . . 30 Lb.-In.
3.4 N-m

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5μs short circuit trigger current rise time.

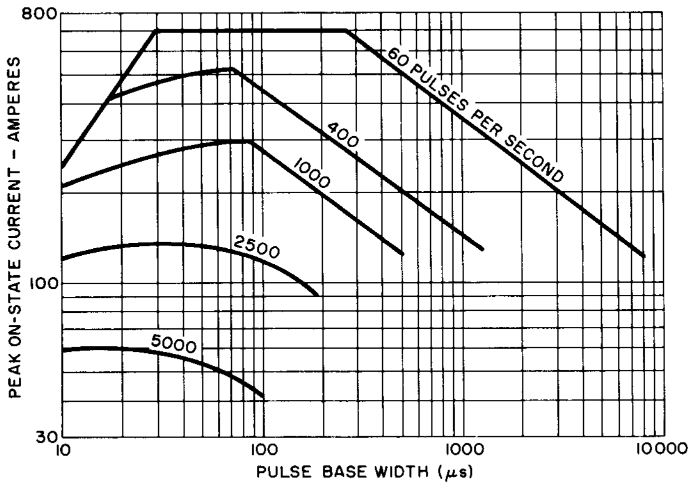
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	7	12	mA	T_J = -40°C to +125°C, $V = V_{DRM} = V_{RRM}$
Thermal Resistance	$R_{\theta JC}$	–	–	.35	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	–	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated using Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
DC Gate Trigger Current	I_{GT}	–	–	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	3.0	Vdc	T_C = 25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	3.5		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.25	–	–		T_C = +125°C, Rated V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	4.0	Volts	T_C = +25°C, I_{TM} = 500 Amps Peak, 1 millisecond wide pulse. Duty cycle ≤ 1%
Conventional Circuit Commutated Turn-Off Time C148 – 30 C148 – 40	t_q	 – –	 – –	 30 40	μsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20 V/μsec (linear). (6) Commutation di/dt = 5 Amps/μsec (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
C148 – 30 C148 – 40		– –	38 48	† †		(1) T_C = +125°C (2) I_{TM} = 150 Amps (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (linear). (6) Commutation di/dt = 5 Amps/μsec. (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms.
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode) C148 – 30 C148 – 40	t_q	 – –	 45 55	 – –	μsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps (3) V_R = 1 volt (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Off-State Voltage = 200 V/μsec (linear). (6) Commutation di/dt = 5 Amps/μsec. (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms.

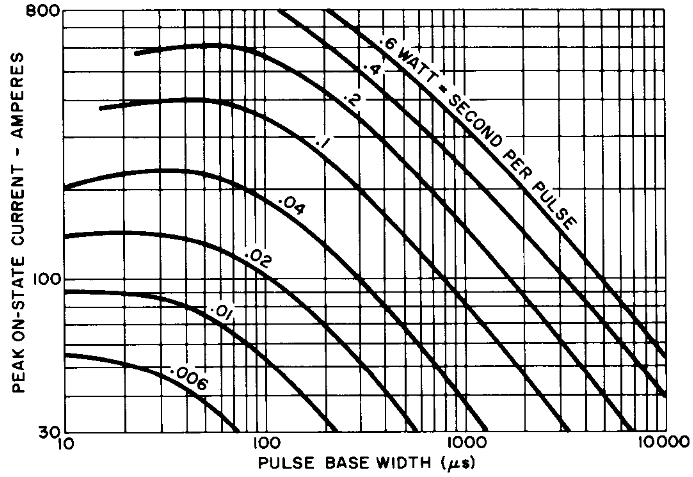
†Consult factory for a specified maximum turn-off time.



1. Maximum allowable peak on-state current vs. pulse width (T_C = 65°C)



2. Maximum allowable peak on-state current vs. pulse width (T_C = 90°C)



3. Energy per pulse for sinusoidal pulses (T_J = 125°C)

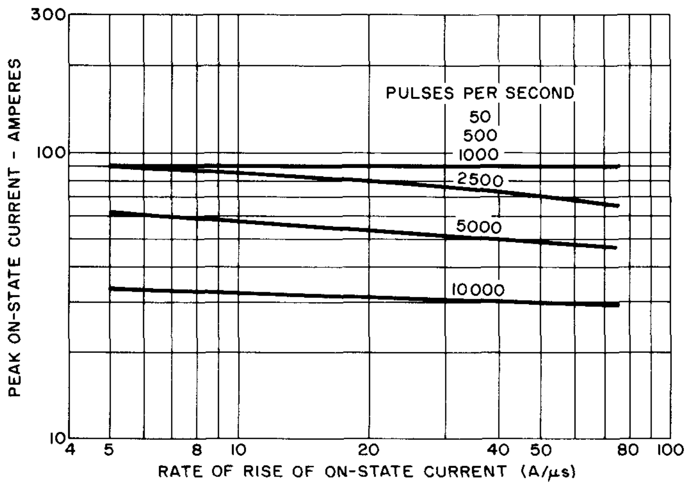
NOTES:

(Pertaining to Sine and Rectangular Wave Current Ratings)

1. Switching voltage = 800 volts.
2. Maximum ckt. dv/dt = 200 volts/μsec.
3. Reverse voltage applied = $V_R \leqslant 800$ volts.
4. R-C Snubber ckt. = .25 μf, 20Ω.

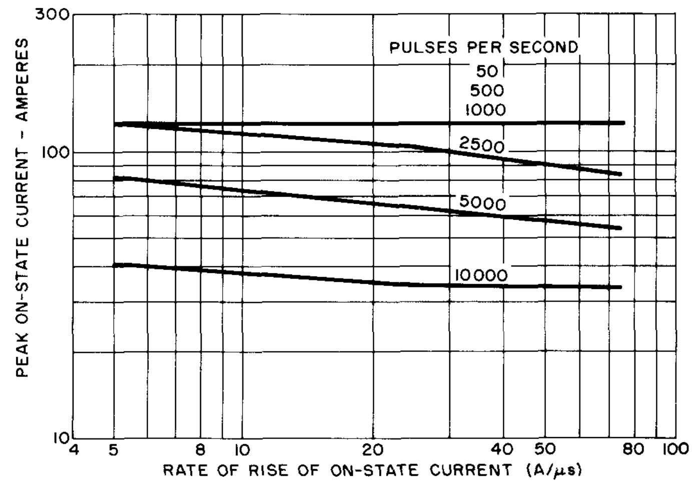
RECTANGULAR WAVE CURRENT RATING

50% DUTY CYCLE

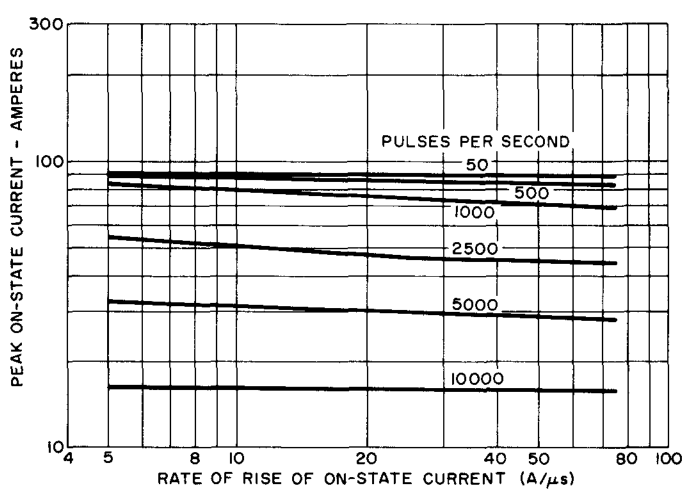


4. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)

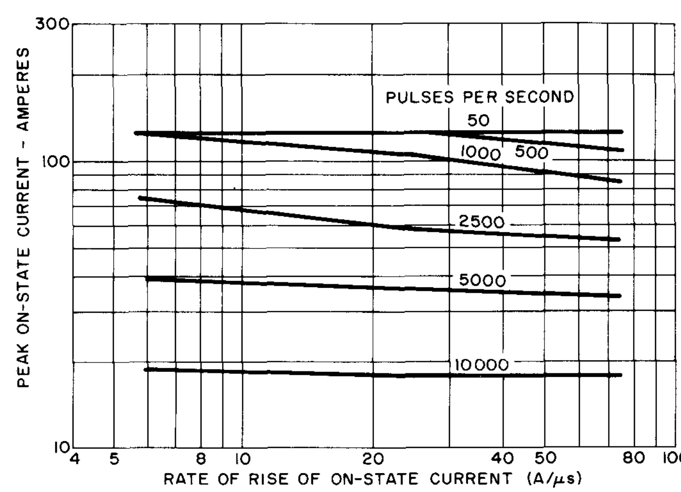
25% DUTY CYCLE



5. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)

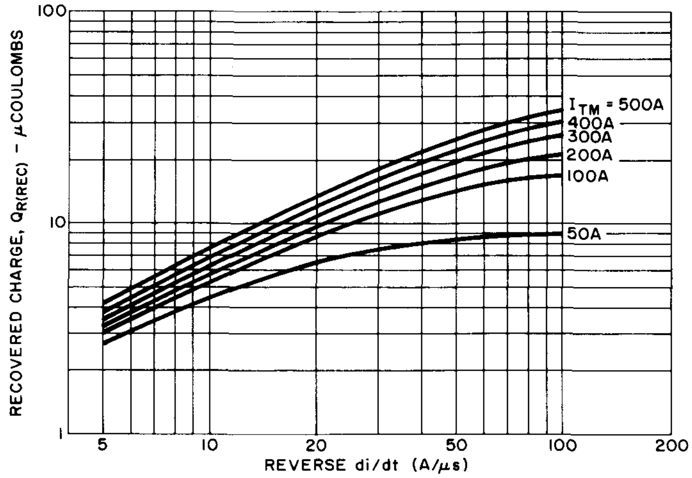


6. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

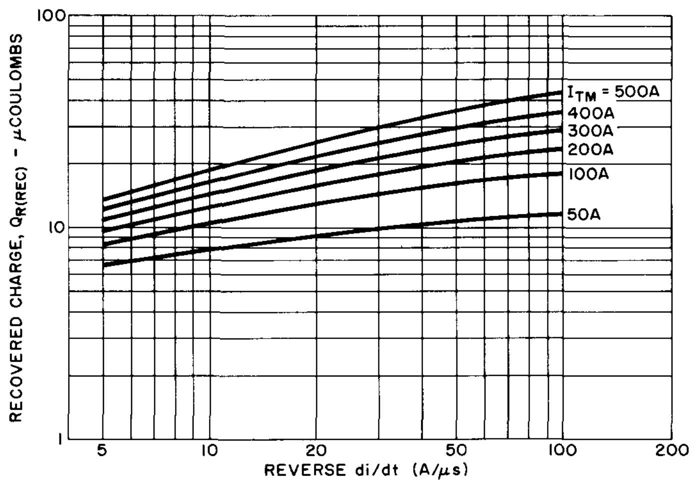


7. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

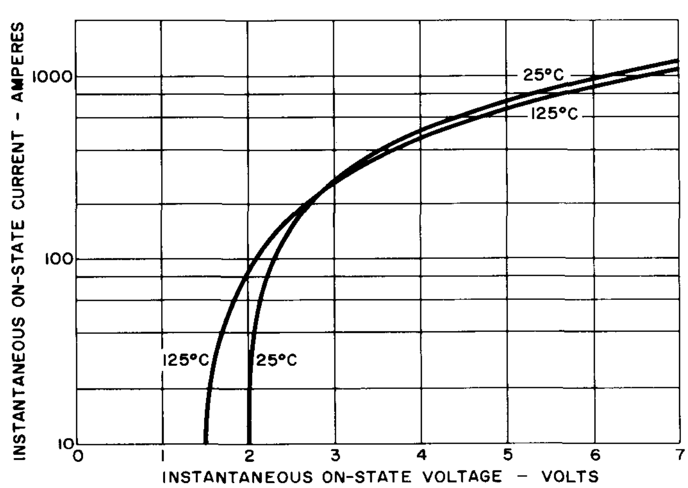
RECOVERED CHARGE DATA



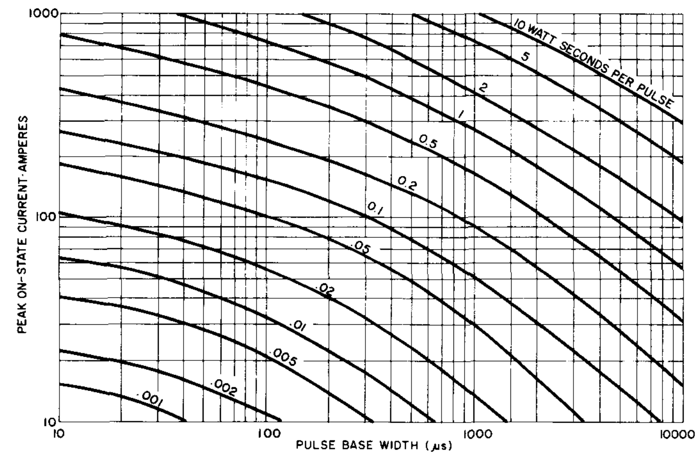
11. Typical recovered charge data (T_J = 25°C) (Sinewave Current Waveform)



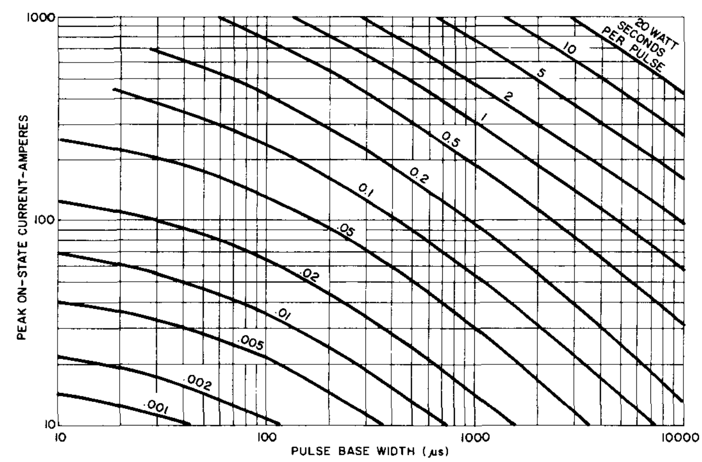
12. Typical recovered charge data (T_J = 125°C) (Sinewave Current Waveform)



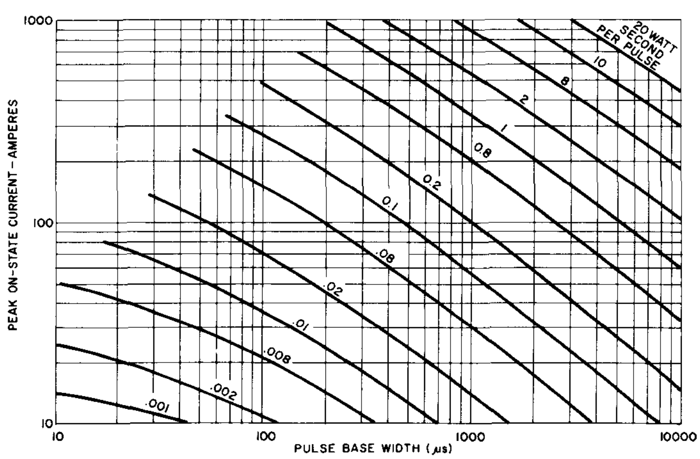
13. Maximum On-State Characteristics



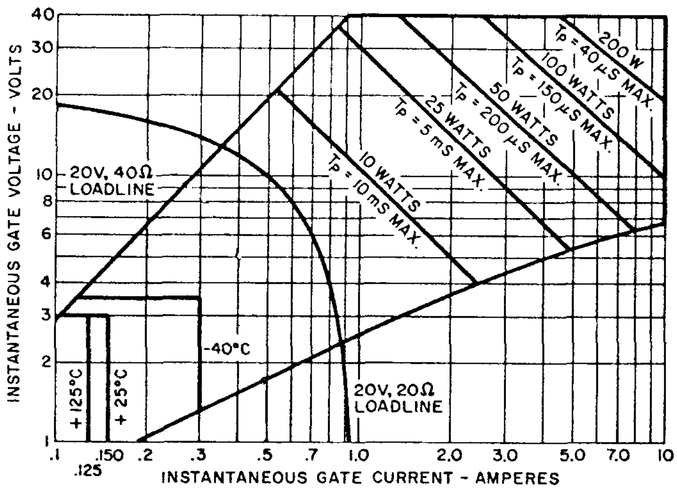
8. Energy per pulse vs. peak current and pulse width (di/dt = 100A/μsec) T_J = 125°C



9. Energy per pulse vs. peak current and pulse width (di/dt = 25A/μsec) T_J = 125°C



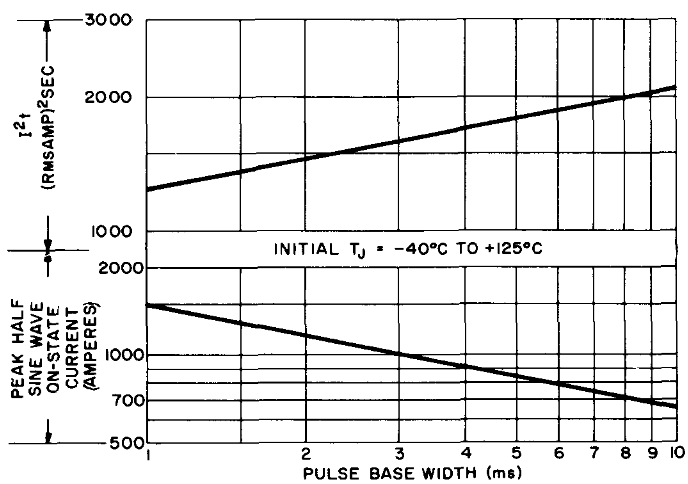
10. Energy per pulse vs. peak current and pulse width (di/dt = 5A/μsec) T_J = 125°C



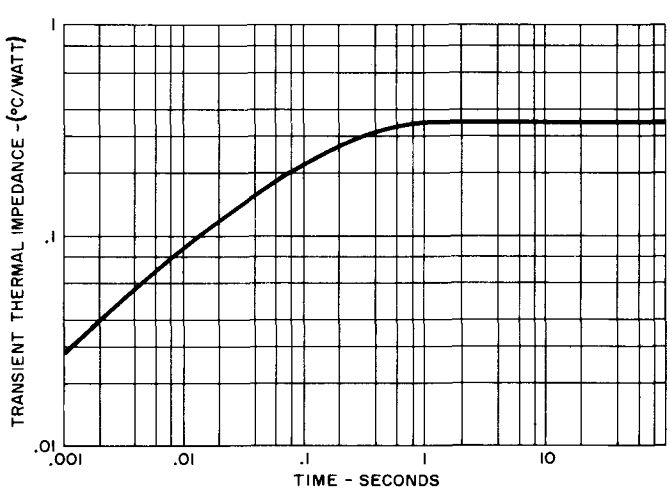
NOTES:

1. Locus of possible DC trigger points lies outside the boundaries shown at the various case temperatures.
2. Rectangular gate pulses.
3. T_p = gate current pulse width.

14. Gate Trigger Characteristics and Power Rating



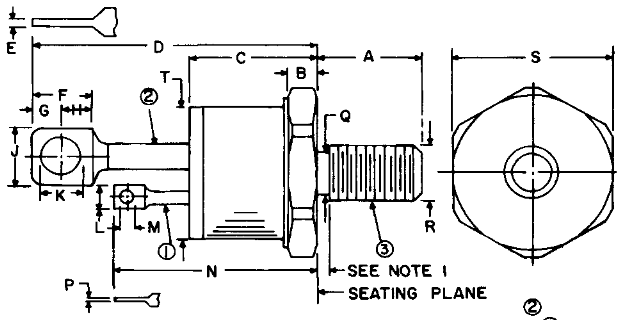
15. Sub-Cycle Surge (Non-Repetitive) On-State Current And I^2t Rating

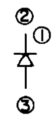


16. Transient Thermal Impedance — Junction-To-Case

C148

OUTLINE DRAWING





TERMINAL 1	TERMINAL 2	TERMINAL 3	R THREAD SIZE
CATE	CATHODE +	ANODE −	1/4-28 UNF-2A

NOTE: 1. COMPLETE THREADS TO WITHIN 2 1/2 THD. OF SEATING PLANE.
2. ONE STEEL, CADMUIM PLATED NUT AND ONE STEEL, CADMUIM PLATED LOCKWASHER SUPPLIED WITH EACH DEVICE.

SYM.	INCHES		METRIC MM		SYM.	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.		MIN.	MAX.	MIN.	MAX.
A	.422	.452	10.72	11.47	L	.090	.115	2.29	2.91
B	.120	.135	3.05	3.42	M	.055	.066	1.40	1.67
C	.534	.565	13.57	14.34	N	.831	.901	21.11	22.88
D	1.230	1.290	31.25	32.78	P	.012	—	.31	—
E	.029	.062	.74	1.56	Q	.220	—	5.59	—
F	.258	REF.	6.55	REF.	S	.676	.684	17.18	17.36
G	.138	REF.	3.50	REF.	T	—	.597	—	15.15
H	.115	—	2.83	—					
J	.240	.300	6.10	7.62					
K	.169	.182	4.30	4.62					

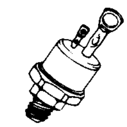
HIGH SPEED

Silicon Controlled Rectifier

600 VOLTS 63A RMS

C149

The General Electric C149 Silicon Controlled Rectifier is designed for power switching at high frequencies. This is an all-diffused device which is considerable smaller in size than comparably rated high power SCR's.



FEATURES:

- Fully characterized for operation in inverter and chopper applications.
- High dv/dt with selections available.
- Excellent surge and I^2t ratings providing easy fusing.
- Compact hermetic package, ¼ – 28 stud.

Equipment designers can use the C149 in demanding applications, such as:

- Choppers
- Inverters
- Induction Heaters
- High Frequency Lighting
- Cycloconverters
- DC to DC Conversion

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} [1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} [1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} [1] T_J = 125°C
C149A10, C149A20	100 Volts	100 Volts	150 Volts
C149B10, C149B20	200	200	300
C149C10, C149C20	300	300	400
C149D10, C149D20	400	400	500
C149E10, C149E20	500	500	600
C149M10, C149M20	600	600	720

[1] Half sinewave waveform, 10 ms max. pulse width.

RMS On-State Current, $I_{T(RMS)}$ . . . . . . 63 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . . . 1000 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . . . 920 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds . . . . . . 2850 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds . . . . . . 4150 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive . . . . . . 200 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive . . . . . . 100 A/μs †
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . . . 2 Watts
Storage Temperature, T_{stg} . . . . . . -40°C to +150°C
Operating Temperature, T_J . . . . . . -40°C to +125°C
Stud Torque . . . . . . 30 Lb.-In.
3.4 N-m

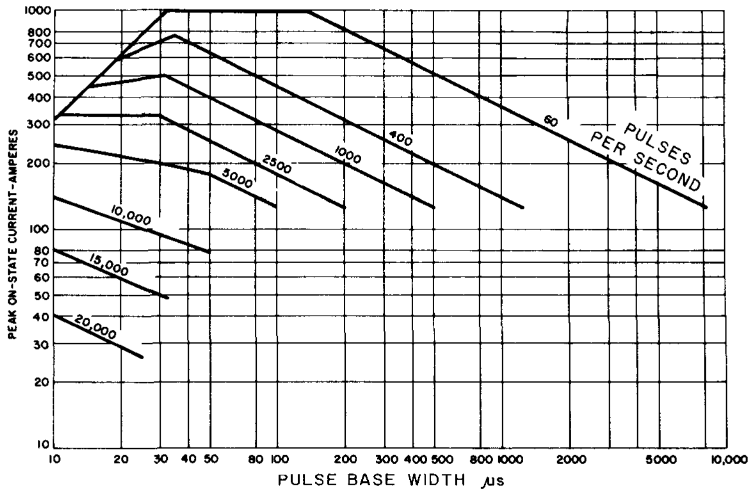
†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5μs short circuit trigger current rise time.

CHARACTERISTICS

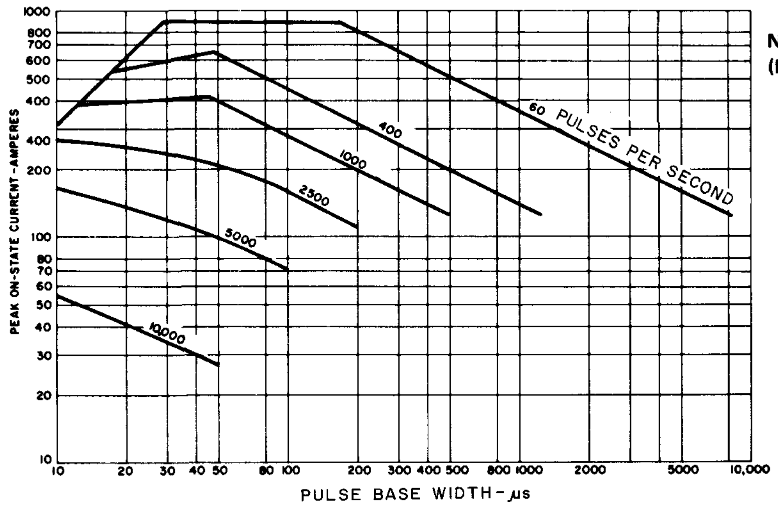
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	7	12	mA	T_J = -40°C to +125°C V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	.35	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	–	–	V/µsec	T_J = +125°C, Gate Open. V_{DRM} = Rated, using Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
DC Gate Trigger Current	I_{GT}	–	–	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	3.0	Vdc	T_C = 25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	3.5		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.25	–	–		T_C = +125°C, Rated V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	3.0	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak, 1 millisecond wide pulse. Duty Cycle ≤ 1%.
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q				µsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20 V/µsec (linear). (6) Commutation di/dt = 5 Amps/µsec (7) Repetition Rate = 1 pps (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
C149 – 10		–	8	10		
C149 – 20		–	15	20		
C149 – 10		–	13	†		(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/µsec (linear). (6) Commutation di/dt = 5 Amps/µsec (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
C149 – 20		–	20	†		
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	$t_{q(diode)}$				µsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/µsec (linear) (6) Commutation di/dt = 5 Amps/µsec (7) Repetition Rate = 1 pps (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
C149 – 10		–	20	†		
C149 – 20		–	35	†		

†Consult factory for a specified maximum turn-off time.

SINE WAVE CURRENT RATING DATA



1. Maximum allowable peak on-state current vs. pulse width (T_C = 65°C)



2. Maximum allowable peak on-state current vs. pulse width (T_C = 90°C)

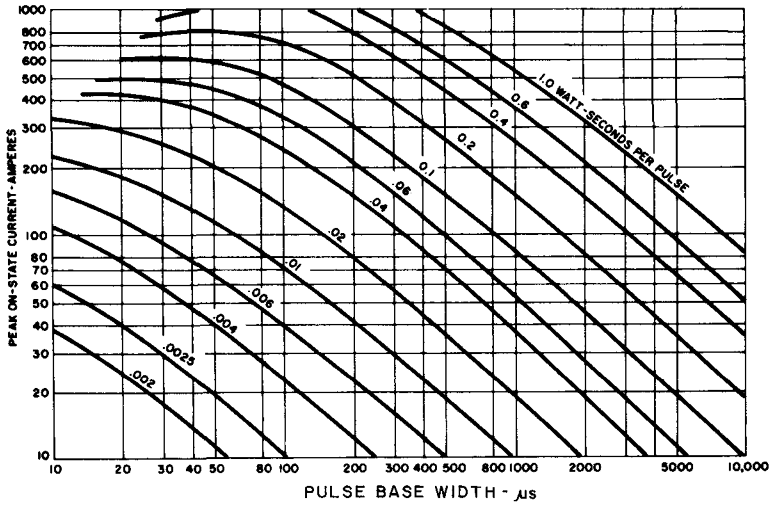
NOTES:

(Pertaining to Sine and Rectangular Wave Current Ratings)

1. Switching voltage = 400 volts.
2. Maximum ckt. dv/dt = 200 volts/µsec.
3. Reverse voltage applied $V_R \leqslant$ 400 volts.
4. Required gate drive: 20 volts, 20 ohms, .1 µsec rise time for 100 amps/µsec repetitive rating 20 volts, 40 ohms, .5 µsec rise time for 30 amps/µsec repetitive rating.
5. R-C Snubber ckt. = .25 µf, 5 Ω.

If the circuit di/dt remains below 30 amps/µs, and normally constructed snubbers using the components specified are employed, then the "soft" gate drive is sufficient. (20V, 40Ω, .5 µsec rise time.)

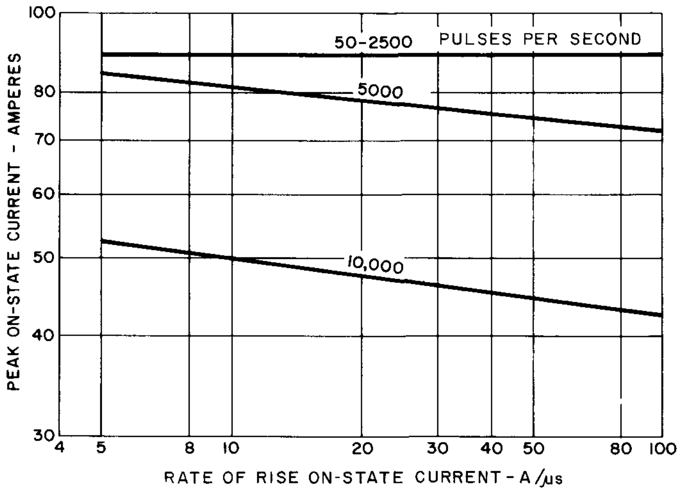
If the circuit di/dt exceeds 40 amps/µs, then the stiff gate source (20V – 20Ω) t_r = .1 µs must be used. In addition the total device di/dt must be checked to insure that it is not above 100 amps/µs which is the long-term repetitive limit for stiff gate source. (20V, 20Ω, 0.1 µsec rise time.)



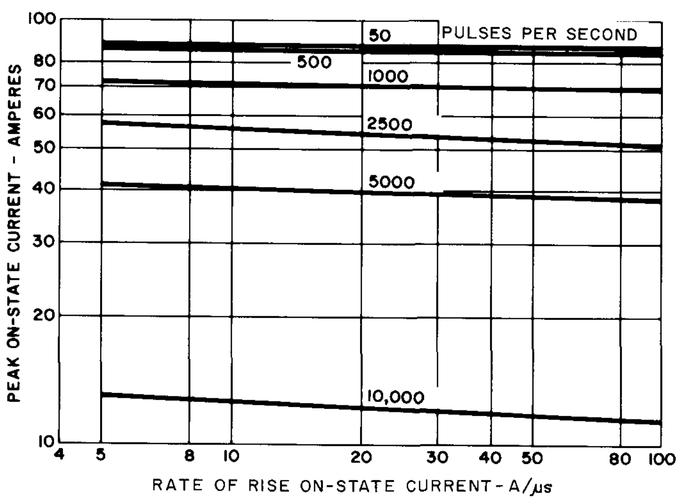
3. Energy per pulse for sinusoidal pulses

RECTANGULAR CURRENT RATING DATA

50% DUTY CYCLE

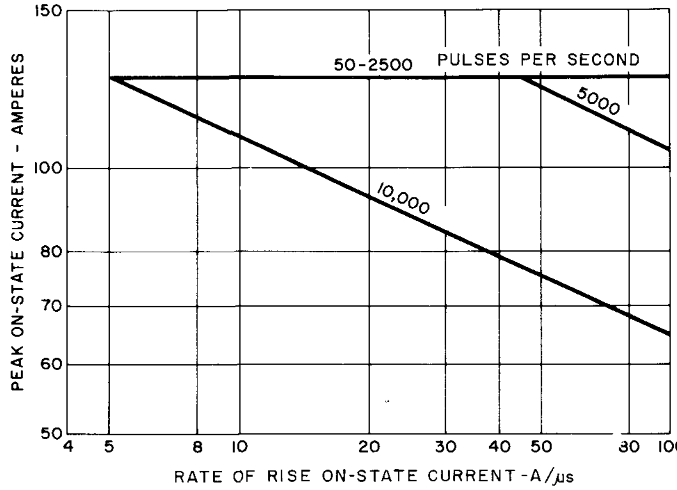


4. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)

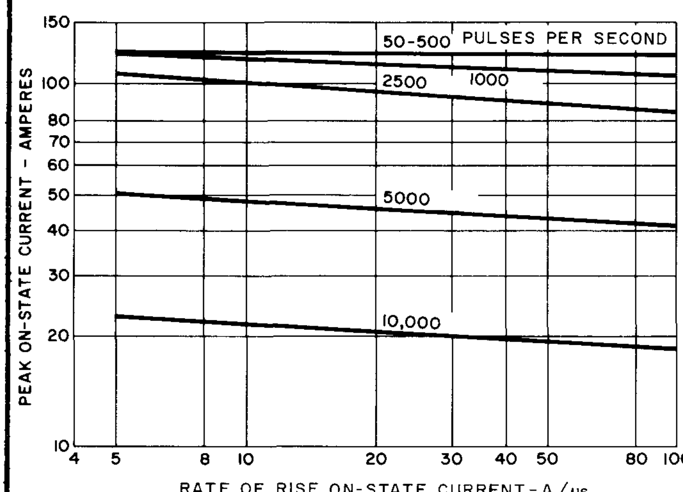


6. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)

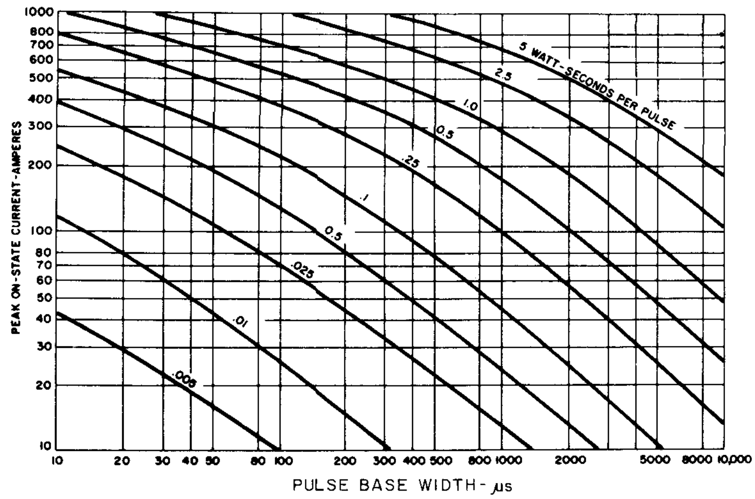
25% DUTY CYCLE



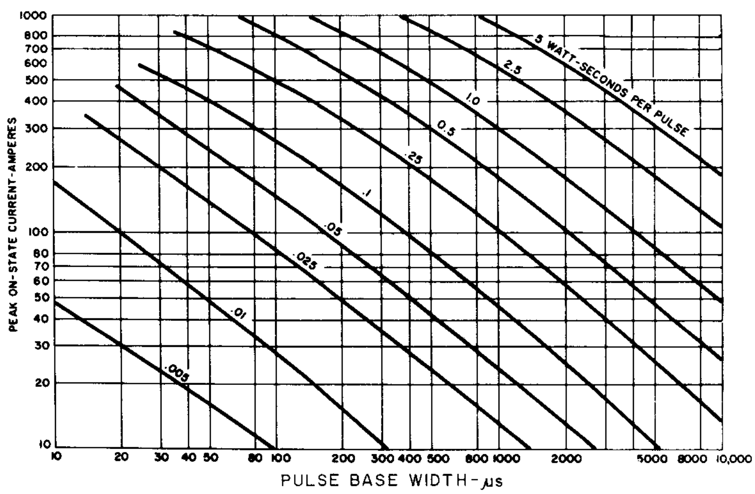
5. Maximum allowable peak on-state current vs. di/dt (T_C = 65°C)



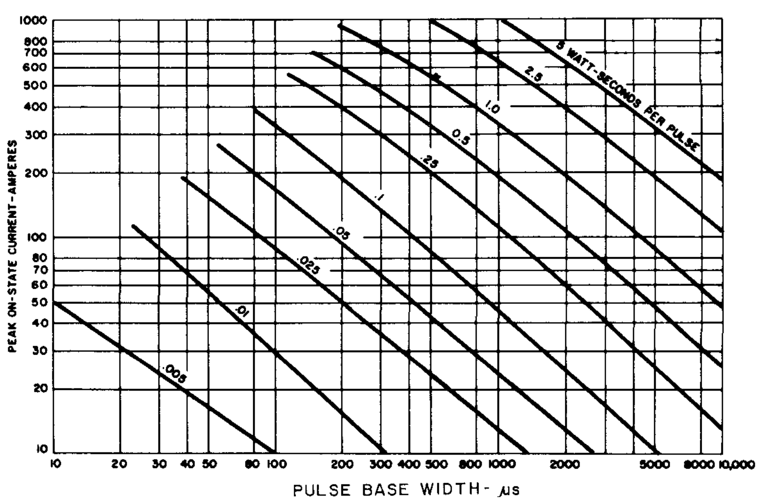
7. Maximum allowable peak on-state current vs. di/dt (T_C = 90°C)



8. Energy per pulse vs. peak current and pulse width (di/dt = 100A/μsec) T_J = 125°C

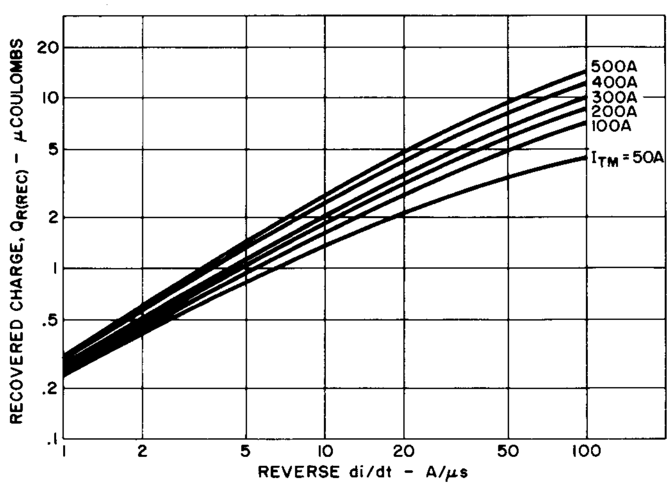


9. Energy per pulse vs. peak current and pulse width (di/dt = 25A/μsec) T_J = 125°C

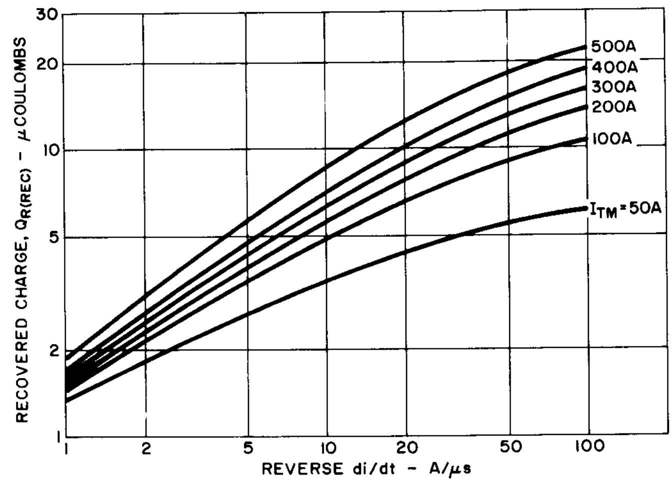


10. Energy per pulse vs. peak current and pulse width (di/dt = 5A/μsec) T_J = 125°C

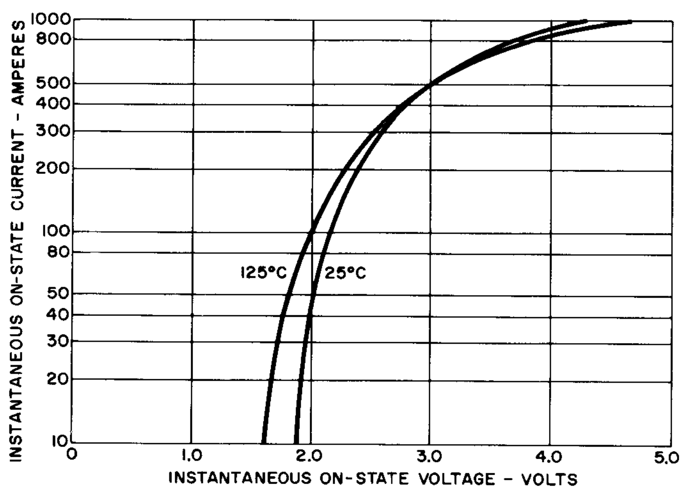
RECOVERED CHARGE DATA



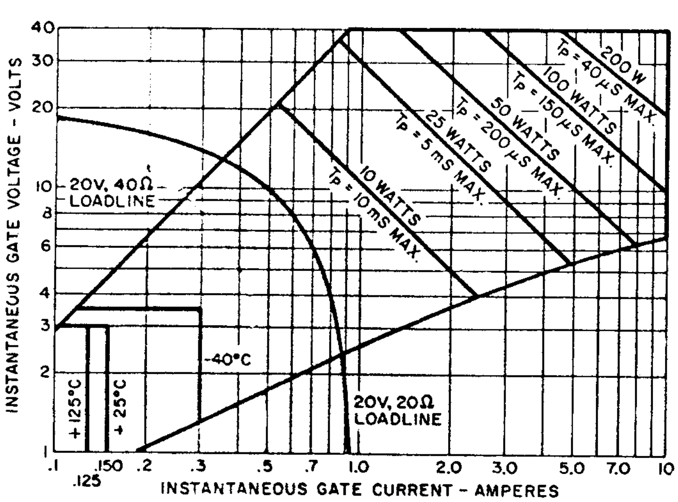
11. Sinewave Current Waveform



12. Sinewave Current Waveform



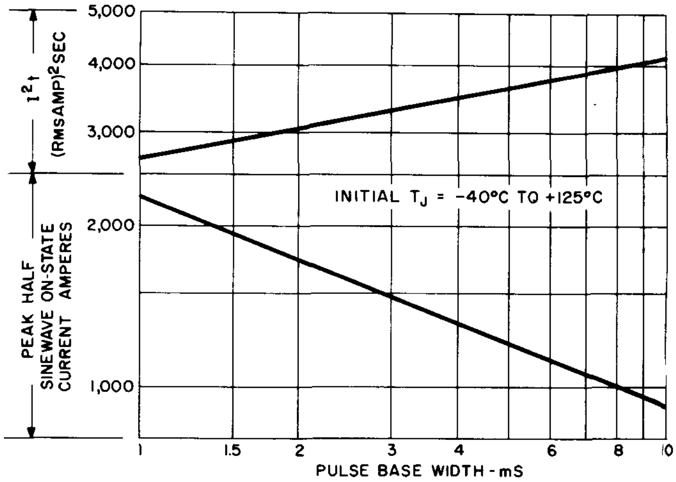
13. Maximum On-State Characteristics



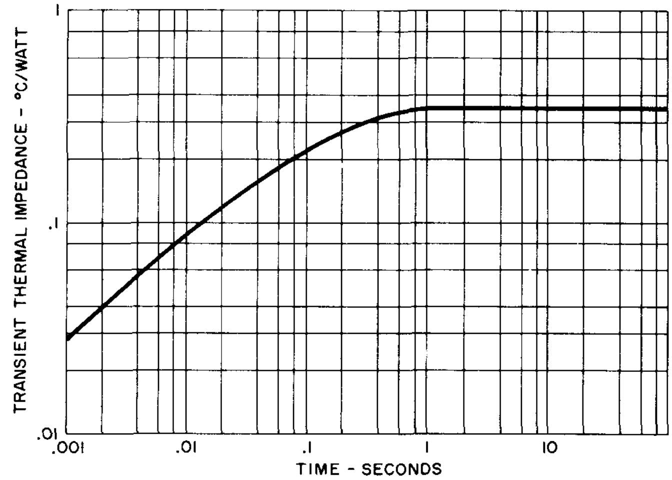
14. Gate Trigger Characteristics and Power Ratings

NOTES:

1. Locus of possible DC trigger points lies outside the boundaries shown at the various case temperatures.
2. Rectangular gate pulses.
3. T_p = gate current pulse width.

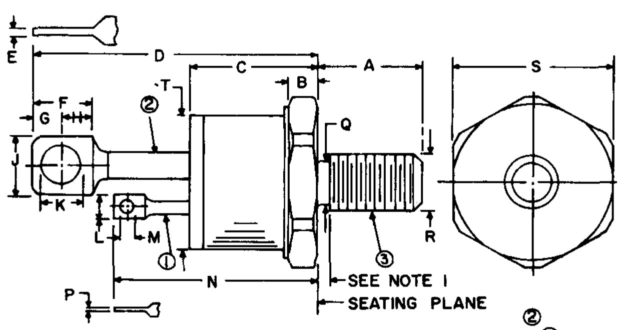


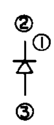
15. Sub-Cycle Surge (Non-Repetitive) On-State Current and I^2t Rating



16. Transient Thermal Impedance — Junction-To-Case

OUTLINE DRAWINGS





TERMINAL 1	TERMINAL 2	TERMINAL 3	R THREAD SIZE
GATE	CATHODE +	ANODE −	1/4-28 UNF-2A

NOTE: 1. COMPLETE THREADS TO WITHIN 2 1/2 THD. OF SEATING PLANE.

2. ONE STEEL, CADMUIM PLATED NUT AND ONE STEEL, CADMUIM PLATED LOCKWASHER SUPPLIED WITH EACH DEVICE.

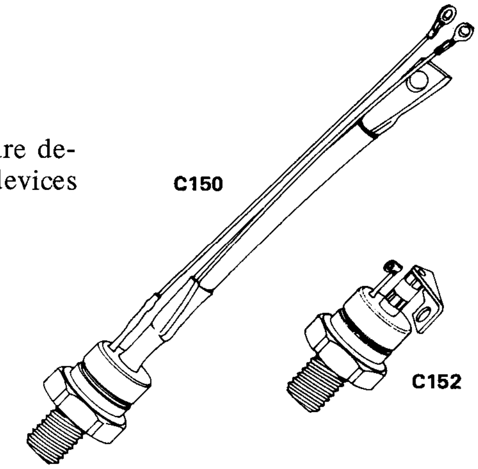
SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.
A	.422	.452	10.72	11.47	L	.090	.115	2.29	2.91
B	.120	.135	3.05	3.42	M	.055	.066	1.40	1.67
C	.534	.565	13.57	14.34	N	.831	.901	21.11	22.88
D	1.230	1.290	31.25	32.78	P	.012	—	.31	—
E	.029	.062	.74	1.56	Q	.220	—	5.59	—
F	.258	REF.	6.55	REF.	S	.676	.684	17.18	17.36
G	.138	REF.	3.50	REF.	T	—	.597	—	15.15
H	.115	—	2.83	—					
J	.240	.300	6.10	7.62					
K	.169	.182	4.30	4.62					

High Power
Silicon
Controlled Rectifier

1300 VOLTS   110 ARMS

C150,2

The General Electric C150 and C152 Silicon Controlled Rectifiers are designed for phase control applications. These are all-diffused, Pic-Pac devices employing the field-proven amplifying gate.



FEATURES:

- High di/dt Rating
- High dv/dt Capability with Selections Available
- Excellent Surge and I^2t Ratings Providing Easy Fusing
- Rugged Hermetic Package with Long Creepage Path

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C150, C152E	500 Volts	500 Volts	600 Volts
C150, C152M	600	600	720
C150, C152S	700	700	850
C150, C152N	800	800	950
C150, C152T	900	900	1075
C150, C152P	1000	1000	1200
C150, C152PA	1100	1100	1325
C150, C152PB	1200	1200	1450
C150, C152PC	1300	1300	1550

[1] Half sinewave waveform, 10 msec. max. pulse width.

RMS On-State Current, $I_{T(RMS)}$ . . . . 100 Amperes (All Conduction Angles)
Average On-State Current, $I_{T(AV)}$ . . . . Depends on Conduction Angle (See Charts 1 and 4)
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 1500 Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 1400 Amperes
Critical Rate-of-Rise of On-State Current (Non-Repetitive)* . . . . 800 A/μs
Critical Rate-of-Rise of On-State Current (Repetitive)* . . . . 500 A/μs
I^2t (for fusing), for times ⩾ 1.5 milliseconds . . . . 7000 (RMS Ampere)^2 Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 10 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Stud Torque . . . . 125 Lbs.-In. (Min.) – 150 Lbs.-In. (Max.)
14 N-m (Min.) – 17 N-m (Max.)

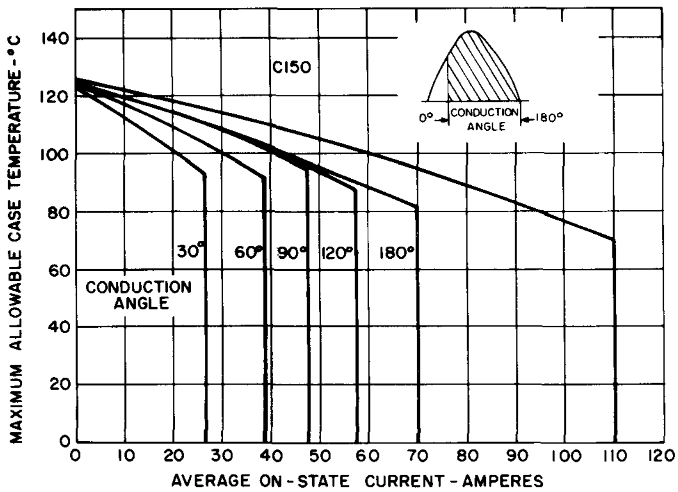
*di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of V_{DRM} stated above; 20 volts, 20 ohms gate trigger source with 0.5 μsec short circuit trigger current rise time.

CHARACTERISTICS

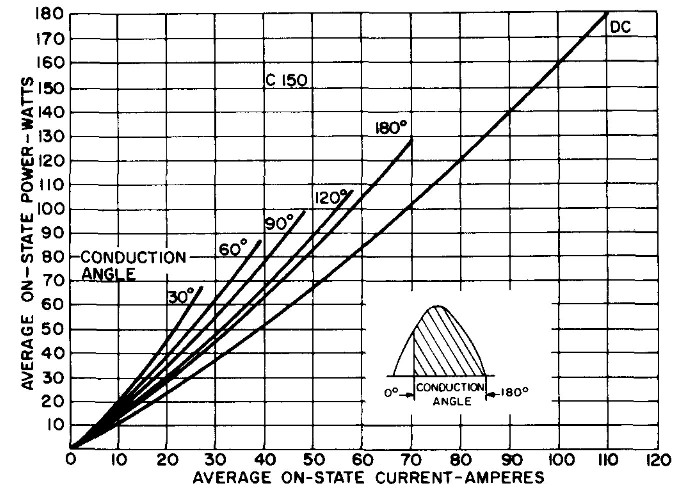
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = +25°C $V_{DRM} = V_{RRM}$ =
C150, C152E		–	3	10		500 Volts Peak
C150, C152M		–	3	10		600
C150, C152S		–	3	10		700
C150, C152N		–	3	10		800
C150, C152T		–	3	10		900
C150, C152P		–	3	10		1000
C150, C152PA		–	3	10		1100
C150, C152PB		–	3	6		1200
C150, C152PC		–	3	5		1300
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = +125°C $V_{DRM} = V_{RRM}$
C150, C152E		–	15	20		500 Volts Peak
C150, C152M		–	15	20		600
C150, C152S		–	15	20		700
C150, C152N		–	15	20		800
C150, C152T		–	15	20		900
C150, C152P		–	15	20		1000
C150, C152PA		–	15	20		1100
C150, C152PB		–	10	13		1200
C150, C152PC		–	8	11		1300
Thermal Resistance	$R_{\theta JC}$	–	.2	.3	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, Rated V_{DRM}, Using Linear Exponential Rising Waveform. Gate Open Circuited. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	20	500	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial Forward Current = 2 Amps.
Turn-On Delay Time	t_d	–	1	–	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM} = Rated. Gate Supply: 10 Volt Open Circuit, 20 Ohm, 0.1 μsec max. rise time
Gate Pulse Width Necessary to Trigger		–	8	10	μsec	T_C = +25°C. Gate Supply: 20 Volt Open Circuit, 40 Ohm, 0.5 μsec rise time. I_T = 1.0 Amps. for High di/dt Capability. See Chart 9.
DC Gate Trigger Current	I_{GT}	–	50	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	75	200		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	15	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	1.25	3.0	Vdc	T_C = -40°C to +120°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = +125°C, V_D = Rated, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	2.0	2.6	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak. Duty Cycle ⩽ 0.01%
Circuit Commutated Turn-Off Time**	t_q	–	100	†	μsec	(1) T_J = +125°C (2) I_{TM} = 50 Amps (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) = Rated (5) Rate-of-Rise of Reapplied Off-State Voltage = 20V/μsec Linear

† Consult factory if guaranteed turn-off time is required.

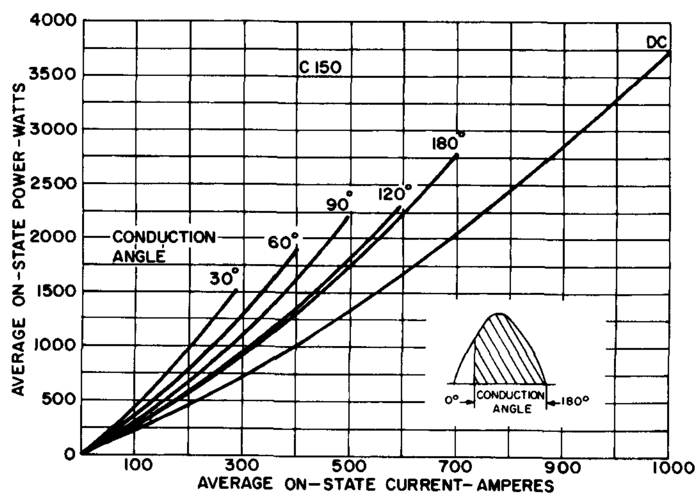
** Typical turn-off time increases 30%, if I_{TM} is increased to 500 amps.



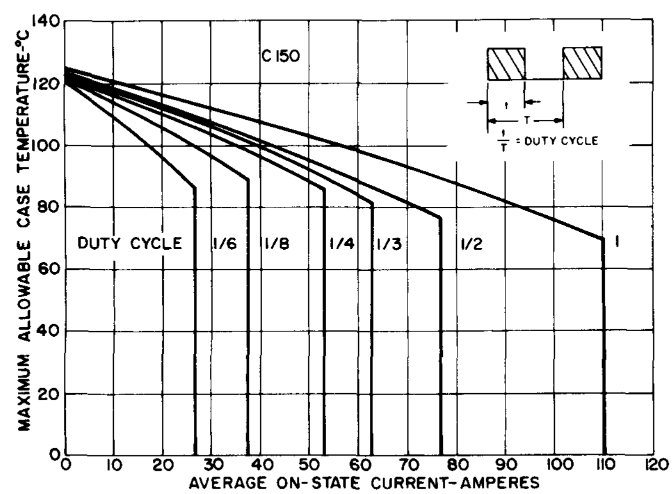
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM 50 TO 400 CPS



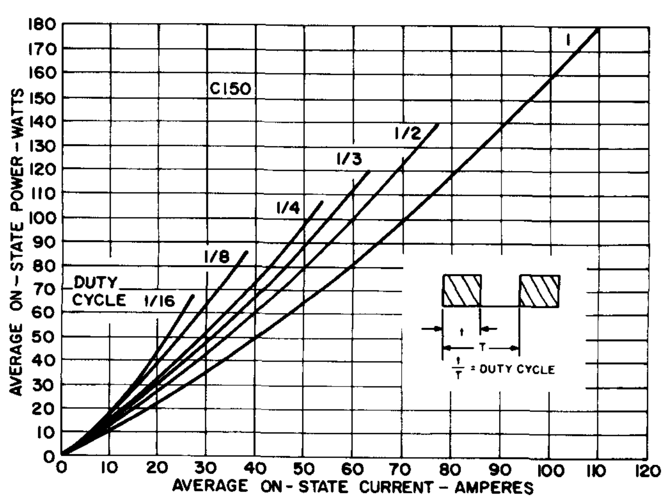
2. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



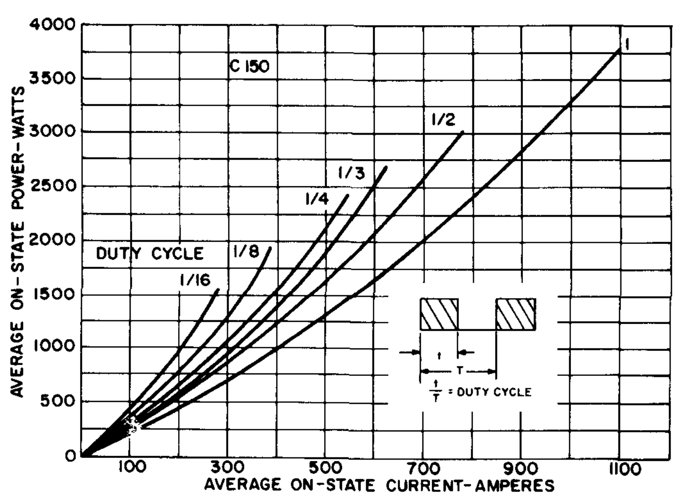
3. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM (EXTENDED RANGE)



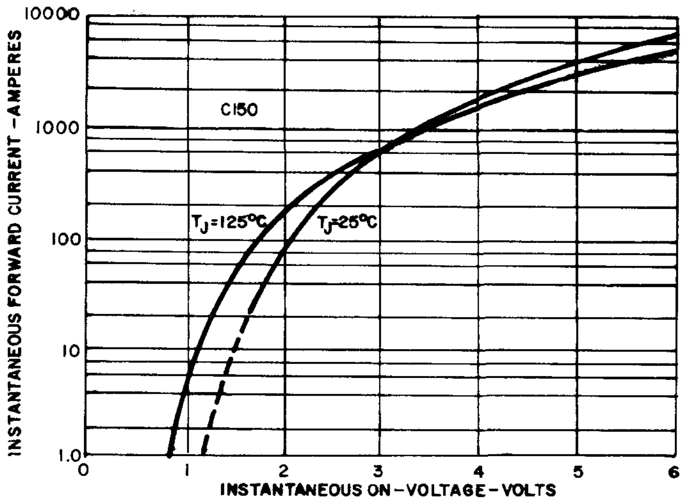
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM — 50 TO 400 CPS



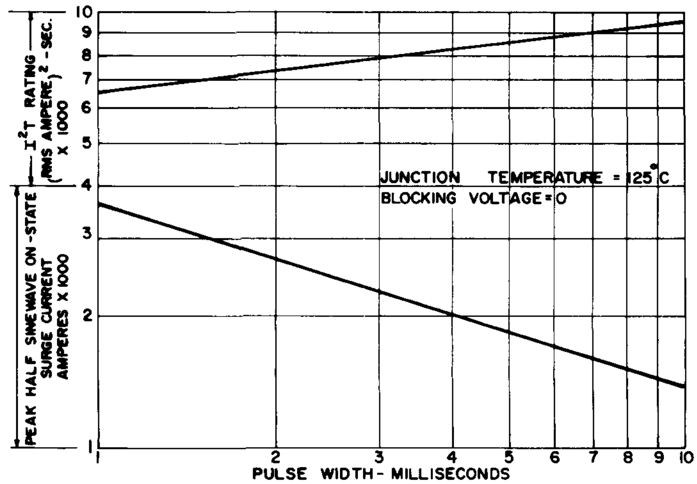
5. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



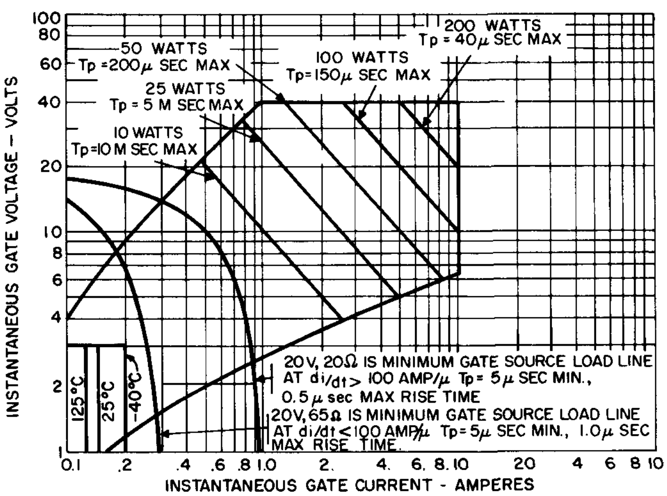
6. ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



7. C150 FORWARD CONDUCTION CHARACTERISTIC, ON-STATE



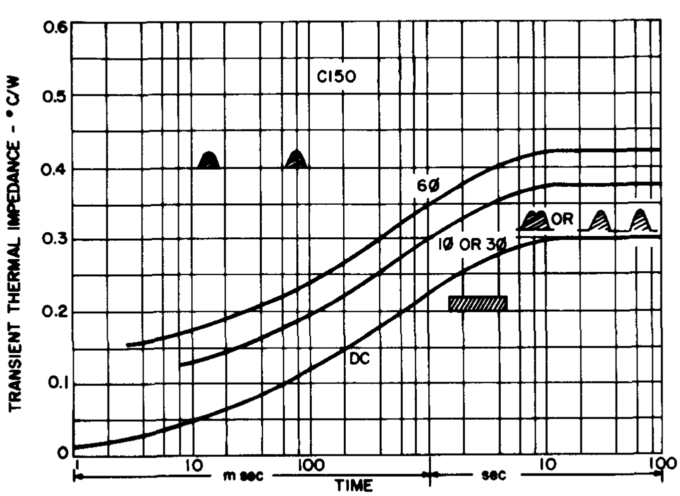
8. SUB-CYCLE SURGE RATING FOLLOWING RATED LOAD CONDITIONS



9. GATE TRIGGERING CHARACTERISTICS

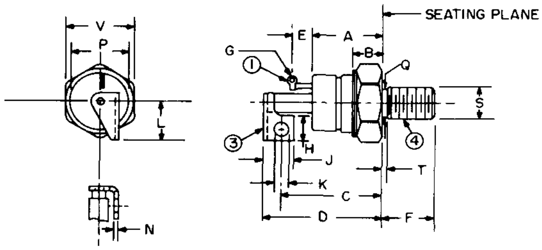
NOTES:

1. Maximum allowable gate power dissipation = 2 Watts.
2. The locus of possible DC trigger points lie outside the boundaries shown at various case temperatures.
3. T_p = Rectangular Gate Current Pulse Width.



10. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE

OUTLINE DRAWINGS

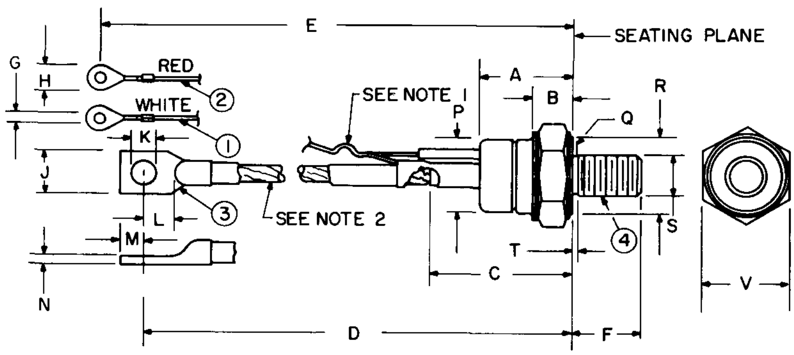


SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.590	.640	14.98	16.26	
B	.390	.500	9.90	12.70						
C	1.460 REF		7.92 REF.		N	.058	.070	1.47	1.78	
D	1.660	1.800	42.16	45.72						
E	.312 REF		7.92 REF		P	.840	.910	21.33	23.11	
F	.797	.827	20.24	21.01						
G	.060	.075	1.52	1.91	Q	.425	.499	10.79	12.67	
H	.385	.415	9.77	10.54	T	—	.060	—	1.52	2
J	.445	.485	11.30	12.32	V	1.052	1.063	26.72	27.00	
K	.198	.212	5.02	5.38						

MODEL	TERMINAL ①	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C152	GATE	CATHODE +	ANODE —	1/2-20 UNF-2A

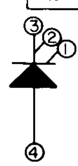
NOTES:

1. One nut and one lockwasher supplied with each unit. Material of hardware is steel, cad plated.
2. "T" dimension is area of unthreaded portion. Complete threads are within 2.5 threads of seating plane.
3. Angular orientation of terminals is undefined.



SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.330	—	8.38	—	
B	.390	.500	9.90	12.70	M	.275	.325	6.98	8.26	
C	1.570	1.750	39.87	44.45	N	.065	.095	1.65	2.41	
D	6.000	6.390	152.40	162.31	P	.840	.910	21.33	23.11	
E	6.850	7,500	173.99	190.50	Q	.425	.499	10.79	12.67	
F	.797	.827	20.24	21.01	R	.920	—	23.36	—	4
G	.140	.150	3.55	3.81	T	—	.060	—	1.57	5
H	—	.300		7.62						
J	.500	.610	12.70	15.49	V	1.052	1.063	26.72	27.00	
K	.260	.281	6.60	7.14						

MODEL	TERMINAL ①	TERMINAL ②	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C150	GATE	AUX CATHODE	CATHODE +	ANODE —	1/2 20UNF-2A



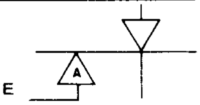
NOTES:

1. Gate and auxiliary cathode leads supplied lightly twisted together.
2. Flexible copper lead.
3. One nut and one lockwasher supplied with each unit. Material of hardware is steel, cad plated.
4. "R" dimension is diameter of effective seating area.
5. "T" dimension is area of unthreaded portion. Complete threads are within 2.5 threads of seating plane.
6. Angular orientation of terminals is undefined.

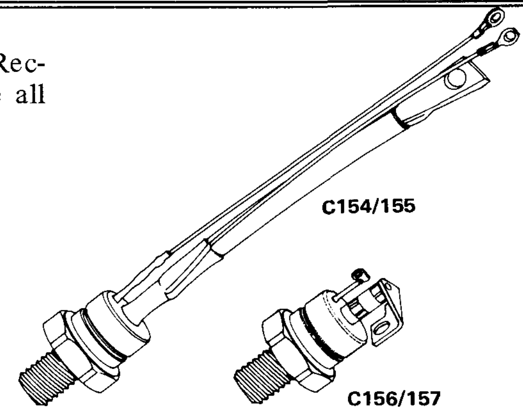
HIGH SPEED
Silicon Controlled Rectifier
600 VOLTS 110A RMS

C154, C156
C155, C157

AMPLIFYING GATE



The General Electric C154, C155, C156 and C157 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all diffused Pic-Pac devices employing the field proven amplifying gate.



FEATURES:

- High di/dt ratings.
- High dv/dt capability with selections available.
- Excellent surge and I^2t ratings providing easy fusing.
- Guaranteed maximum turn-off time with selections available.
- Rugged hermetic package with long creepage path.

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C154A, C155A, C156A, C157A	100 Volts	100 Volts	160 Volts
C154B, C155B, C156B, C157B	200	200	260
C154C, C155C, C156C, C157C	300	300	380
C154D, C155D, C156D, C157D	400	400	480
C154E, C155E, C156E, C157E	500	500	600
C154M, C155M, C156M, C157M	600	600	720

[1] Half sinewave waveform, 10 ms max. pulse width.

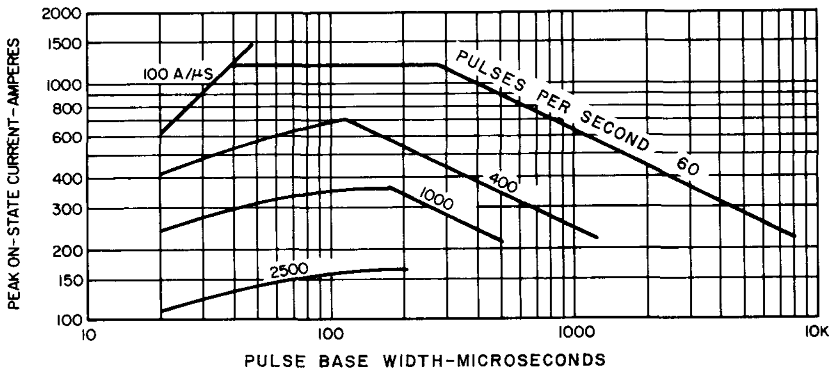
RMS On-State Current, $I_{T(RMS)}$ . . . . 110 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 1800 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 1700 Amperes
Critical Rate-of-Rise of On-State Current, Non-Repetitive . . . . 800 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive . . . . 500 A/μs †
I^2t (for fusing) for times ⩾ 1.5 milliseconds . . . . 9,500 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds . . . . 13,500 (RMS Ampere)^2 Seconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Stud Torque . . . . 150 Lb.-In. (Max.), 125 Lb.-In. (Min.)
17 N-m (Max.), 14 N-m (Min.)

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5μs short circuit trigger current rise time.

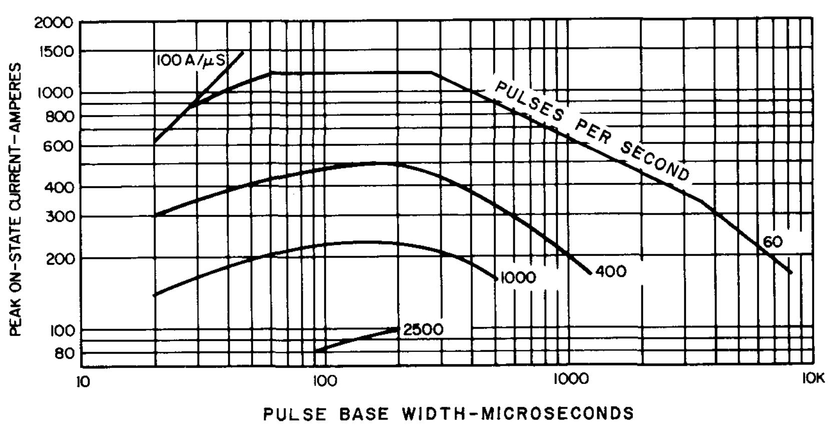
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	5	12	mA	T_J = +25°C V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	12	17	mA	T_J = 125°C V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	.2	.3	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt				V/µsec	T_J = +125°C, Gate Open. V_{DRM} = Rated, Linear or Exponential Rising Waveform Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
C154/C156		200	500	–		
C155/C157		100	300	–		
For higher minimum dv/dt selections – consult factory.						
Holding Current	I_H	–	100	–	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial On-State Current = 2 Amps.
DC Gate Trigger Current	I_{GT}	–	50	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	100	200		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	30	120		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Trigger Voltage	V_{GT}	–	3.0	5.0	Vdc	T_C = -40°C to 0°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	1.25	3.0		T_C = 0°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = +125°C, V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	2.2	3.0	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak Duty Cycle ⩽ .01%
Turn-On Delay Time	t_d	–	1	–	µsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}, Gate Supply: 20 Volt Open Circuit, 20 Ohms, 0.1 µsec max. rise time.
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q				µsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20 V/µsec (linear) (6) Commutation di/dt = 5 Amps/µsec. (7) Duty Cycle ⩽ .01% (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
C154/C156		–	8	10		
C155/C157		–	12	20		
Conventional Circuit Commutated Turn-Off Time (with Feedback) Diode)	$t_{q(diode)}$				µsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20 V/µsec (6) Commutation di/dt = 5 Amps/µsec (7) Duty Cycle ⩽ .01% (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
C154/C156		–	12	†		
C155/C157		–	15	†		

†Consult factory for specified maximum turn-off time.



1. **Maximum allowable peak on-state current vs. pulse width (T_C = 65°C)**



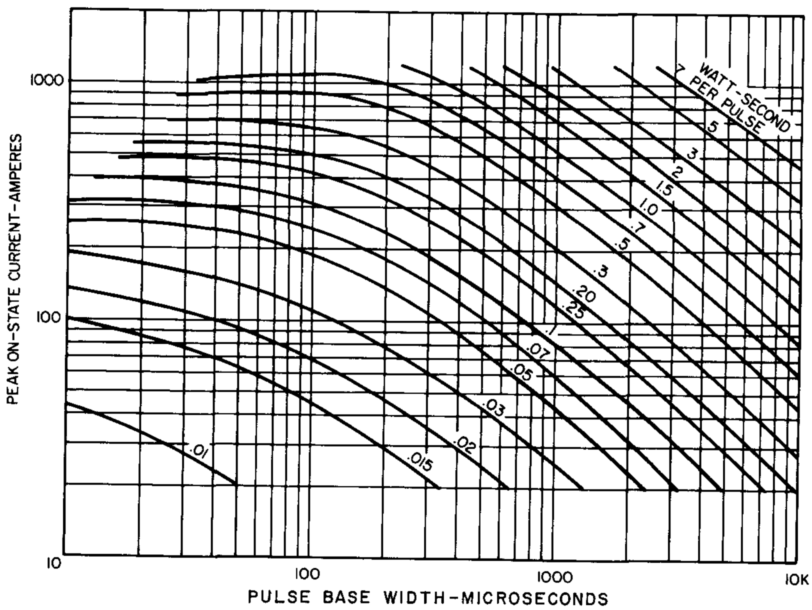
2. **Maximum allowable peak on-state current vs. pulse width (T_C = 90°C)**

NOTES:

(Pertaining to Sine and Rectangular Wave Current Ratings)

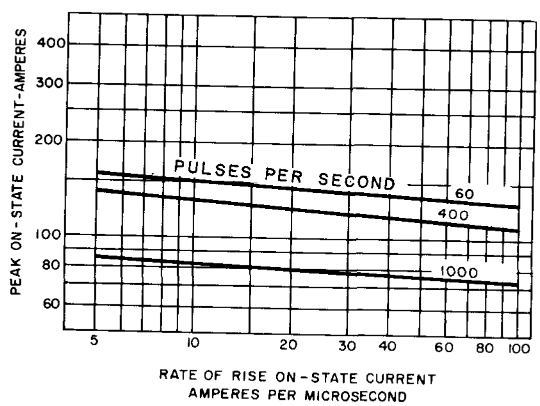
1. Switching voltage ⩽400 volts.
2. Maximum ckt. dv/dt = 100 volts/μsec.
3. Required gate drive:
   20 volts, 20 ohms, .5 μsec rise time.
4. Reverse voltage applied = V_R ⩽ 400 volts.
5. R-C Snubber ckt. = .25 μf, 5 ohms.
6. Max. energy dissipated during reverse recovery to be 15% of total W-S/P shown or 0.03 W-S/P, whichever is least.
7. Values of W-S/P are for T_j = 125°C.

SINE WAVE DATA



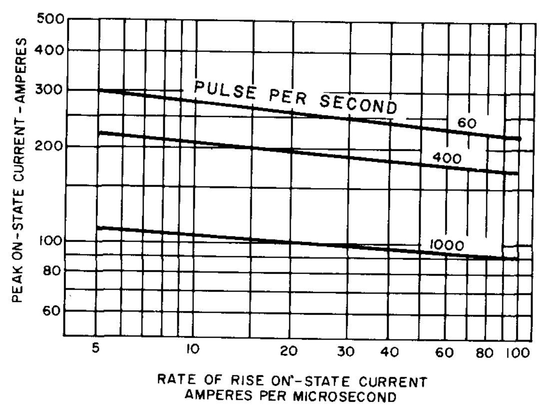
3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

50% DUTY CYCLE

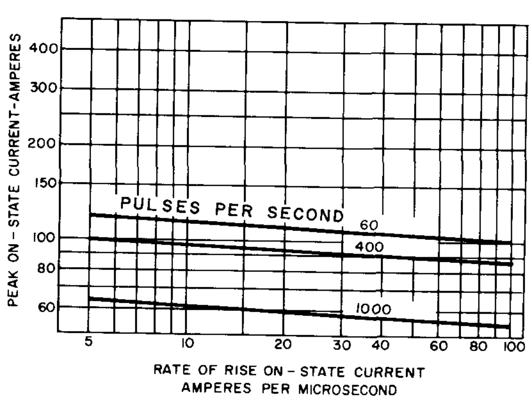


4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

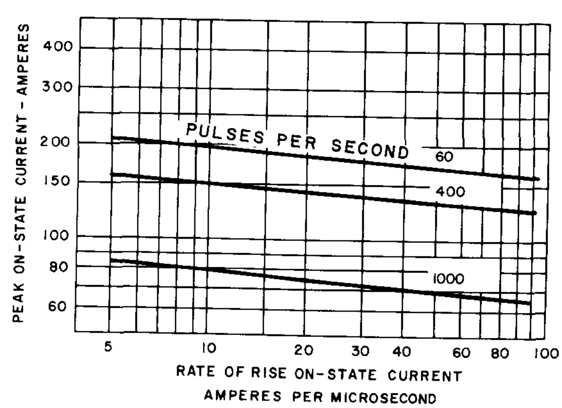
25% DUTY CYCLE



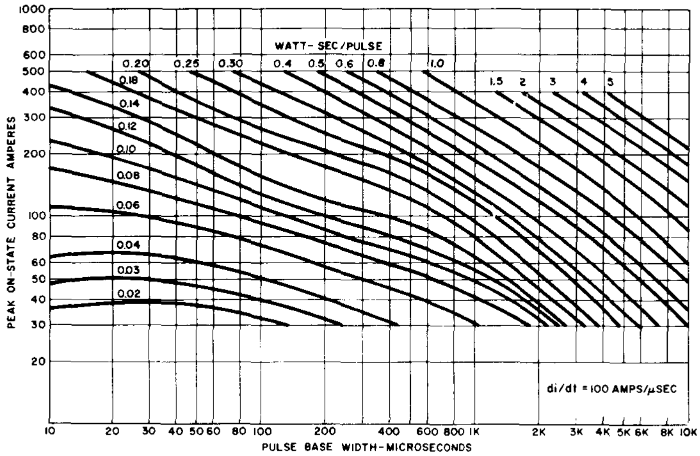
5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)



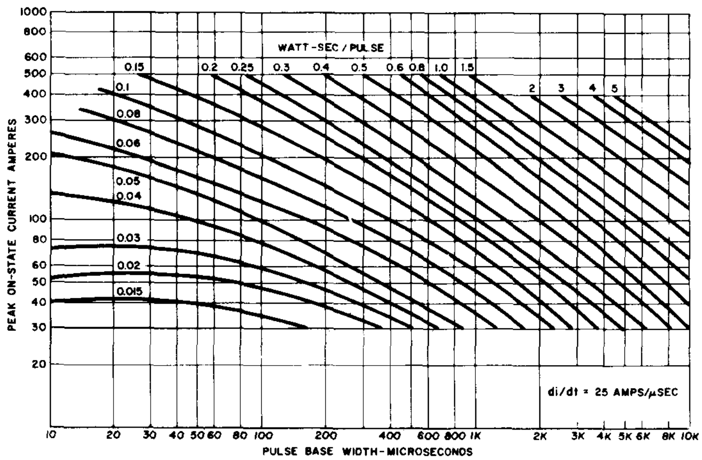
6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)



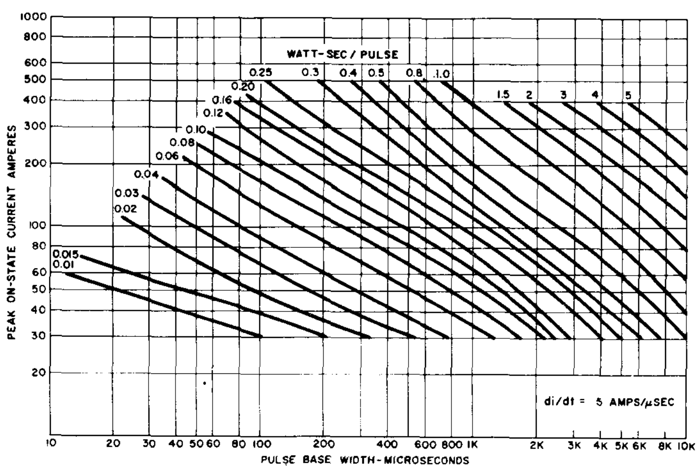
7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)



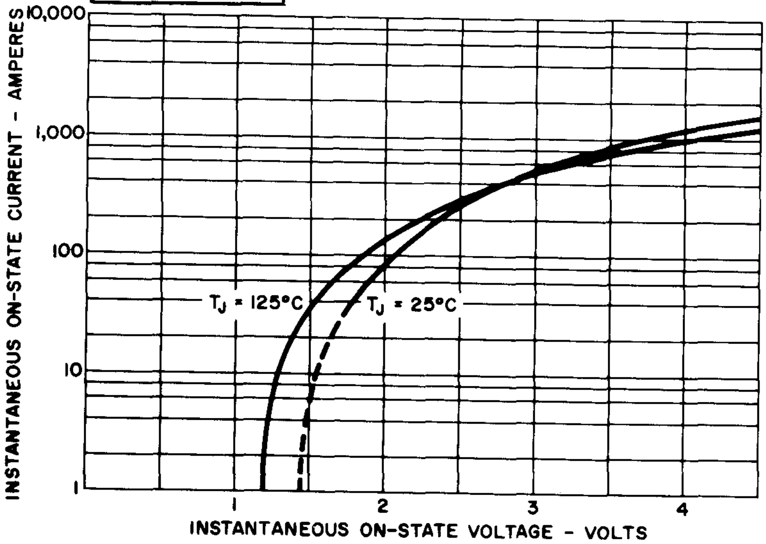
8. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec)



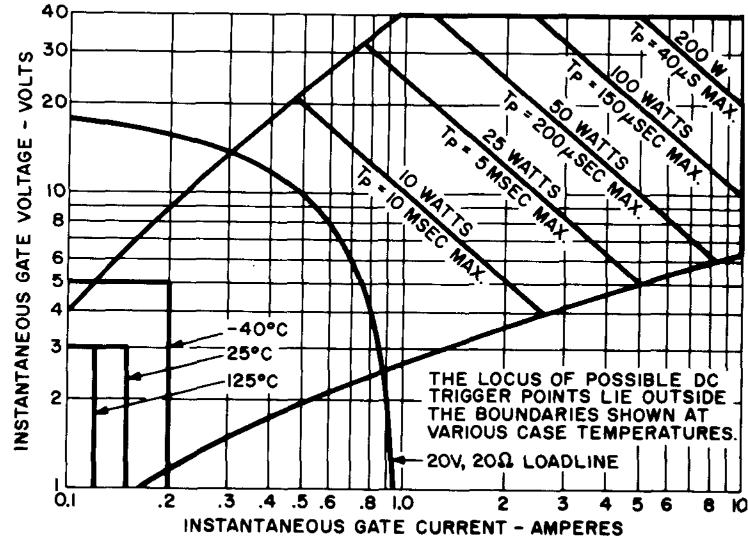
9. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec)



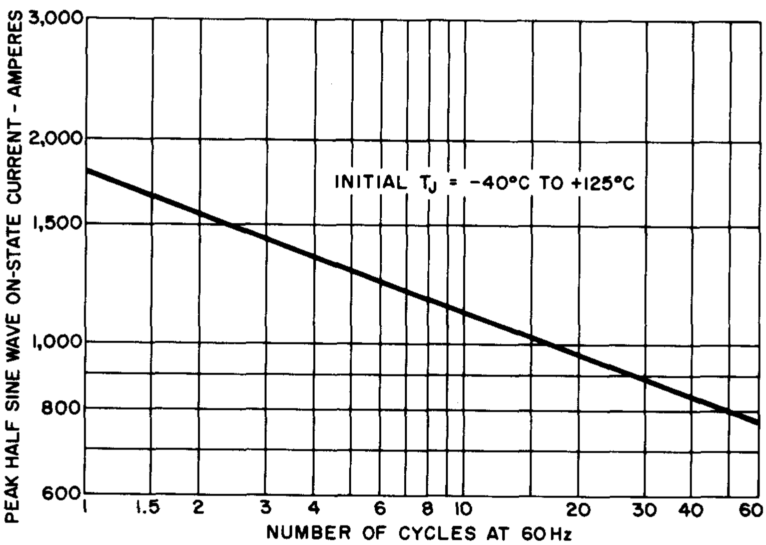
10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec)



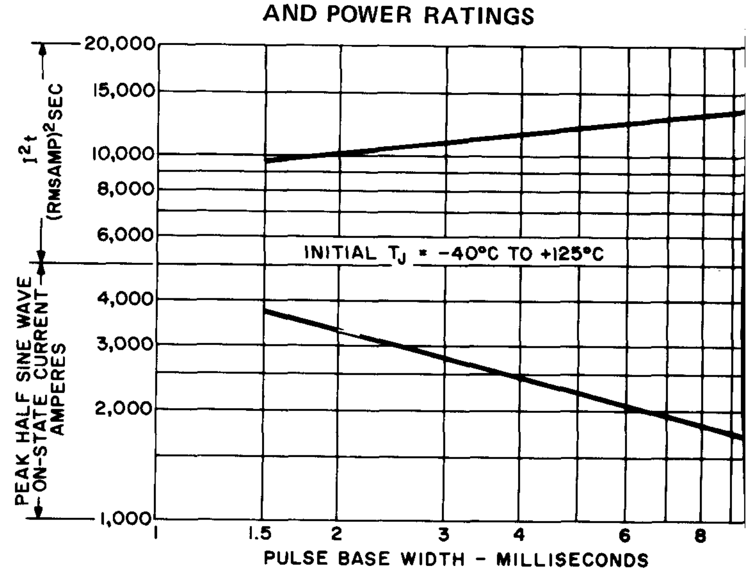
11. MAXIMUM ON-STATE CHARACTERISTICS



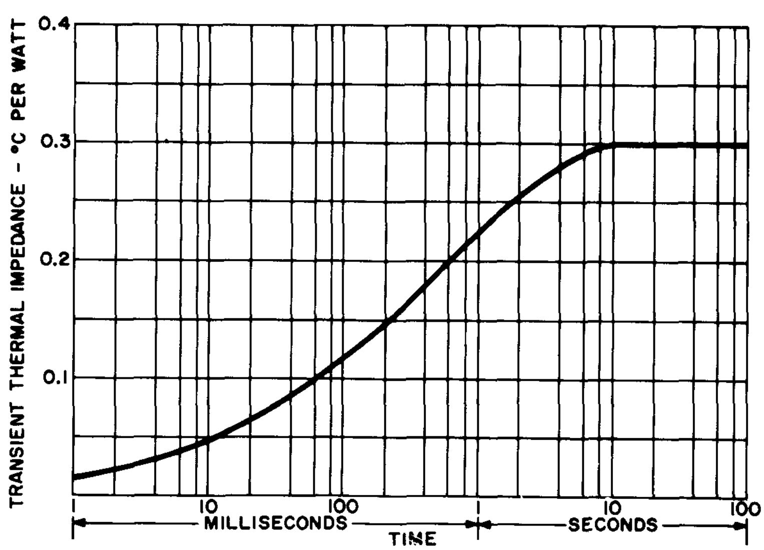
12. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS



13. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) CURRENT

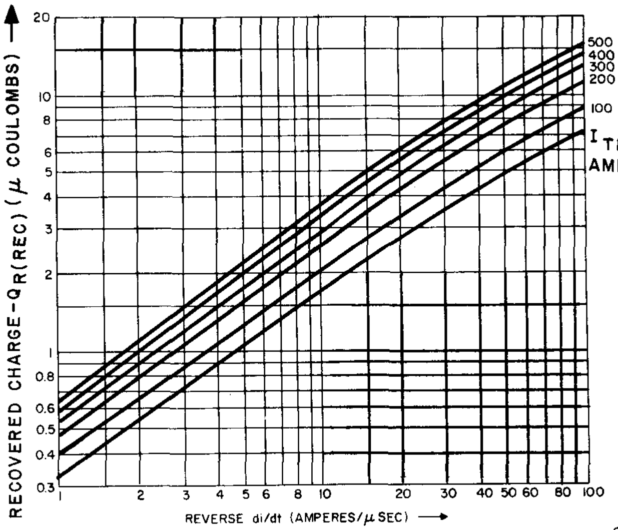


14. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING

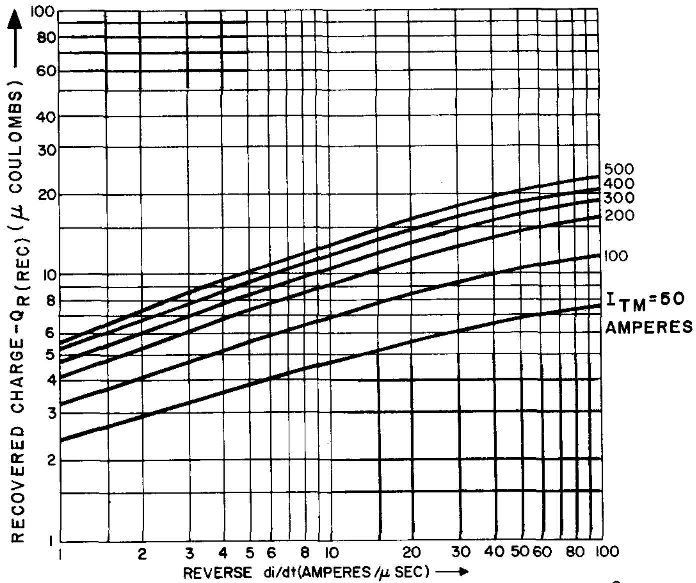


15. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

RECOVERED CHARGE DATA

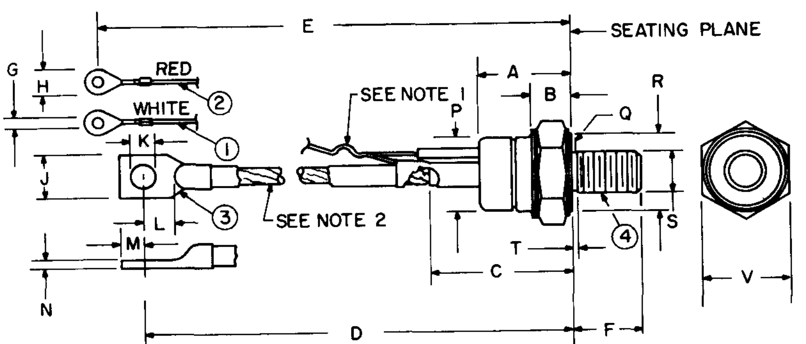


17. TYPICAL RECOVERED CHARGE DATA (T_J = 125°C) SINEWAVE CURRENT WAVEFORM



16. TYPICAL RECOVERED CHARGE DATA (T_J = 25°C) SINEWAVE CURRENT WAVEFORM

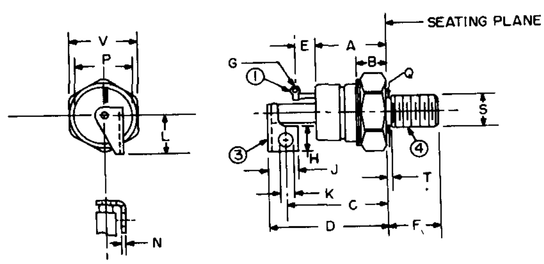
OUTLINE DRAWING



SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.330	—	8.38	—	
B	.390	.500	9.90	12.70	M	.275	.325	6.98	8.26	
C	1.570	1.750	39.87	44.45	N	.065	.095	1.65	2.41	
D	6.000	6.390	152.40	162.31	P	.840	.910	21.33	23.11	
E	6.850	7.500	173.99	190.50	Q	.425	.499	10.79	12.67	
F	.797	.827	20.24	21.01	R	.920	—	23.36	—	4
G	.140	.150	3.55	3.81	T	—	.060	—	1.57	5
H	—	.300		7.62						
J	.500	.610	12.70	15.49	V	1.052	1.063	26.72	27.00	
K	.260	.281	6.60	7.14						

MODEL	TERMINAL ①	TERMINAL ②	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C154, C155	GATE	AUX CATHODE	CATHODE +	ANODE −	1/2 20UNF-2A

NOTES:
1. GATE & AUX. CATHODE LEADS SUPPLIED LIGHTLY TWISTED TOGETHER.
2. FLEXIBLE COPPER LEAD.
3. ONE NUT AND ONE LOCKWASHER SUPPLIED WITH EACH UNIT. MATERIAL OF HARDWARE IS STEEL, CAD PLATED.
4. "R" DIM. IS DIA. OF EFFECTIVE SEATING AREA.
5. "T" DIM. IS AREA OF UNTHREADED PORTION. COMPLETE THDS. ARE WITHIN 2.5 THREADS OF SEATING PLANE.
6. ANGULAR ORIENTATION OF TERMINALS IS UNDEFINED.



MODEL	TERMINAL ①	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C156, C157	GATE	CATHODE +	ANODE −	1/2-20 UNF-2A

NOTES:
1. ONE NUT AND ONE LOCKWASHER SUPPLIED WITH EACH UNIT. MATERIAL OF HARDWARE IS STEEL, CAD PLATED.
2. "T" DIM. IS AREA OF UNTHREADED PORTION. COMPLETE THDS. ARE WITHIN 2.5 THREADS OF SEATING PLANE.
3. ANGULAR ORIENTATION OF TERMINALS IS UNDEFINED.

SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.590	.640	14.98	16.26	
B	.390	.500	9.90	12.70						
C	1.460 REF.		7.92 REF.		N	.058	.070	1.47	1.78	
D	1.660	1.800	42.16	45.72						
E	.312 REF.		7.92 REF.		P	.840	.910	21.33	23.11	
F	.797	.827	20.24	21.01						
G	.060	.075	1.52	1.91	Q	.425	.499	10.79	12.67	
H	.385	.415	9.77	10.54	T	—	.060	—	1.52	2
J	.445	.485	11.30	12.32	V	1.052	1.063	26.72	27.00	
K	.198	.212	5.02	5.38						

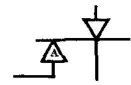
HIGH SPEED

Silicon Controlled Rectifier

C158 – C159

1200 Volts **110 A RMS**

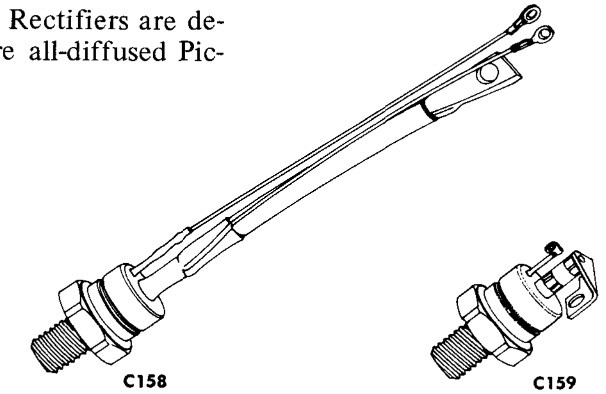
AMPLIFYING GATE



The General Electric C158 and C159 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Pic-Pac devices employing the field-proven amplifying gate.

FEATURES:

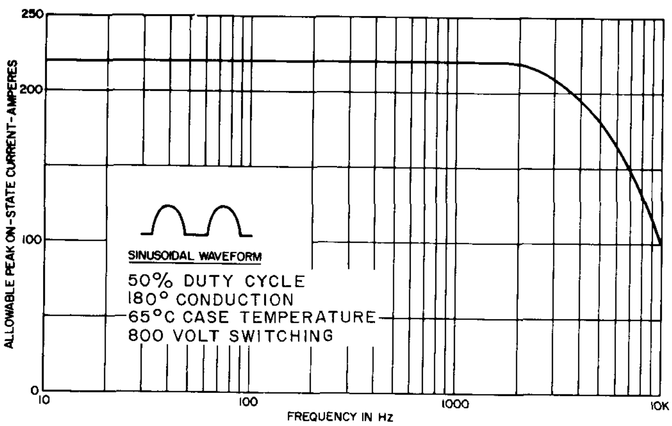
- High di/dt ratings.
- High dv/dt capability with selections available.
- Excellent surge and I^2t ratings providing easy fusing.
- Guaranteed maximum turn-off time with selections available.
- Rugged hermetic package with long creepage path.

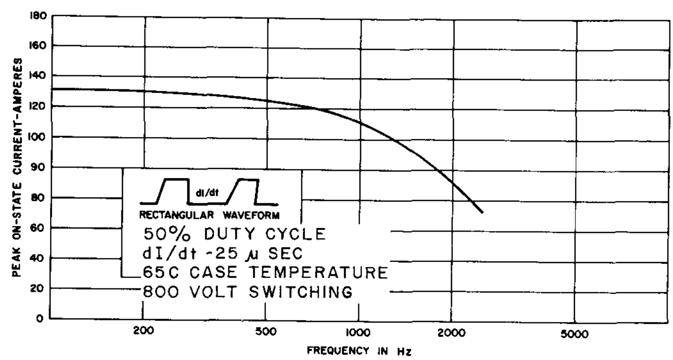


C158

C159

HIGH FREQUENCY CURRENT RATING





MAXIMUM ALLOWABLE RATINGS

TYPES		REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} [1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} [1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} [1] T_J = +125°C
C158E,	C159E	500 Volts	500 Volts	600 Volts
C158M,	C159M	600	600	720
C158S,	C159S	700	700	840
C158N,	C159N	800	800	960
C158T,	C159T	900	900	1080
C158P,	C159P	1000	1000	1200
C158PA,	C159PA	1100	1100	1300
C158PB,	C159PB	1200	1200	1400

[1] Half sinewave waveform, 10 ms max. pulse width.

RMS On-State Current, $I_{T(RMS)}$ . . . . . 110 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . . 1600 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . . 1500 Amperes
I^2t (for fusing) for times ≥ 1.5 milliseconds . . . . . 5,200 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ≥ 8.3 milliseconds . . . . . 10,500 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive. . . . . 800 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive . . . . . 500 A/μs †
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . . 2 Watts
Storage Temperature, T_{stg} . . . . . -40°C to +150°C
Operating Temperature, T_J . . . . . -40°C to +125°C
Stud Torque . . . . . 150 Lb.-In. (Max.), 125 Lb.-In. (Min.)
17 N-m (Max.), 14 N-m (Min.)

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5 μs short circuit trigger current rise time.

CHARACTERISTICS

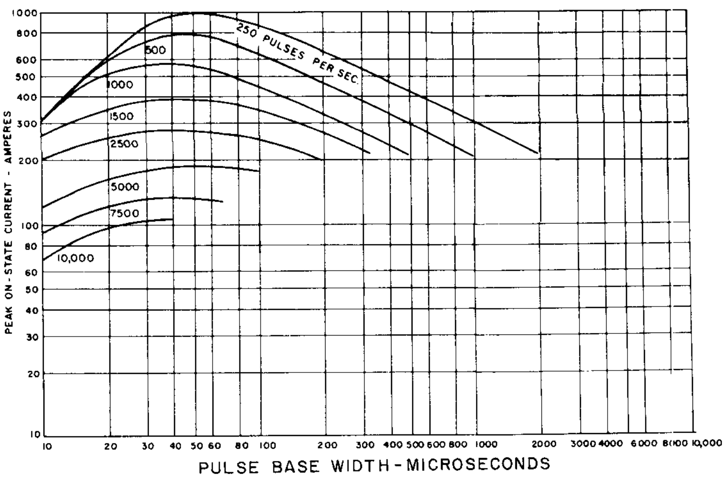
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}				mA	T_J = +25°C V_{DRM} = V_{RRM} =
C158E, C159E		–	3	10		500 Volts Peak
C158M, C159M		–	3	10		600
C158S, C159S		–	3	10		700
C158N, C159N		–	3	10		800
C158T, C159T		–	3	9		900
C158P, C159P		–	3	7		1000
C158PA,C159PA		–	3	7		1100
C158PB,C159PB		–	3	7		1200
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}				mA	T_J = 125°C V_{DRM} = V_{RRM} =
C158E, C159E		–	12	15		500 Volts Peak
C158M, C159M		–	12	15		600
C158S, C159S		–	12	15		700
C158N, C159N		–	12	15		800
C158T, C159T		–	12	15		900
C158P, C159P		–	12	15		1000
C158PA,C159PA		–	12	17		1100
C158PB,C159PB		–	12	18		1200
Thermal Resistance	$R_{\theta JC}$	–	.2	.3	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}(.632)}{\tau}$
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	100	–	mAdc	T_C = +25°C, Anode Supply = 25 Vdc. Initial On-State Current = 2 Amps.
DC Gate Trigger Current	I_{GT}	–	80	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	150	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	30	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms

CHARACTERISTICS (Continued)

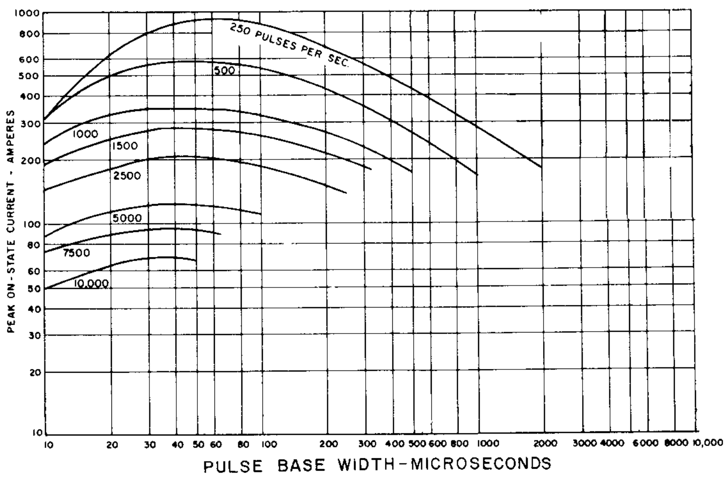
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
DC Gate Trigger Voltage	V_{GT}	–	3	5	Vdc	T_C = -40°C to 0°C, V_D = 6Vdc, R_L = 3 Ohms
		–	1.25	3.0		T_C = 0°C to 125°C, V_D = 6Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = 125°C, V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	2.8	3.5	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak. Duty Cycle ≤ .01%.
Turn-On Delay Time	t_d	–	0.5	–	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}, Gate Supply: 20 Volt Open Circuit, 20 Ohm, 0.1 μsec max. Rise Time, ††, †††
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q	–	20	†	μsec	(1) T_C = +125°C (2) I_T = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20 V/μsec (Linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
		–	25	40	μsec	(1) T_C = +125°C (2) I_T = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (Linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	$t_{q(diode)}$	–	40	†	μsec	(1) T_C = +125°C (2) I_T = 150 Amps. (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (Linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms

†Consult factory for specified maximum Turn-Off Time.
††Delay Time may increase significantly as the gate drive approaches the I_{GT} of the Device Under Test.
†††Current rise time as measured with a current probe, or voltage rise time across a non-inductive resistor.

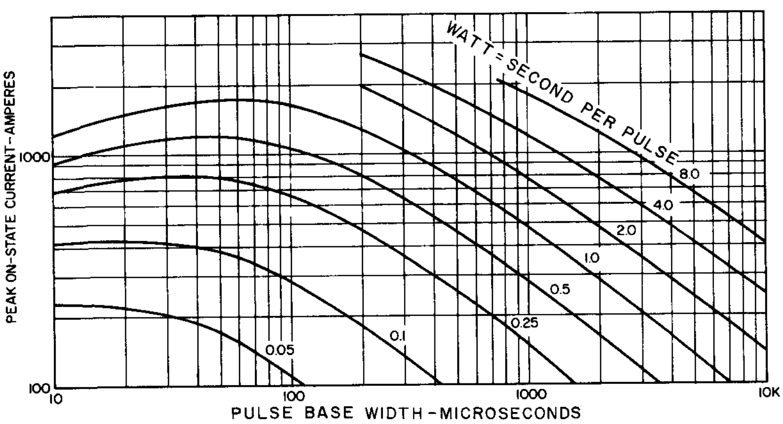
SINEWAVE CURRENT RATING DATA



1. **MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)**



2. **MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)**



3. **ENERGY PER PULSE FOR SINUSOIDAL PULSES**

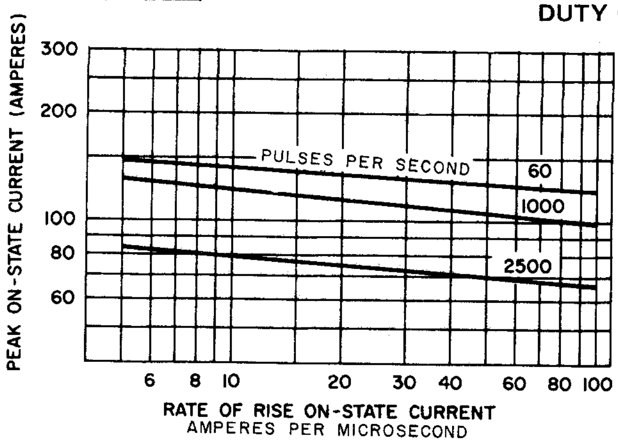
NOTES:
(Pertaining to Sine and Rectangular Wave Current Ratings)

1. Switching Voltage = 800 Volts.
2. Maximum ckt. dv/dt = 200 Volts/μsec
3. Reverse Voltage Applied = $V_R \leq$ 800 V.
4. Required Gate Drive:
   20 volts, 65 ohms, 1 μsec rise time for less than 100 amps/μsec
   20 volts, 20 ohms, .5 μsec rise time for greater than 100 amps/μsec.
5. RC Snubber ckt. = 0.25 μf, 5Ω
6. Max. energy dissipated during reverse recovery to be 15% of total W-S/P shown in chart 5 or 0.03 W-S/P whichever is least.
7. Values of W-S/P are for T_j = 125°C.

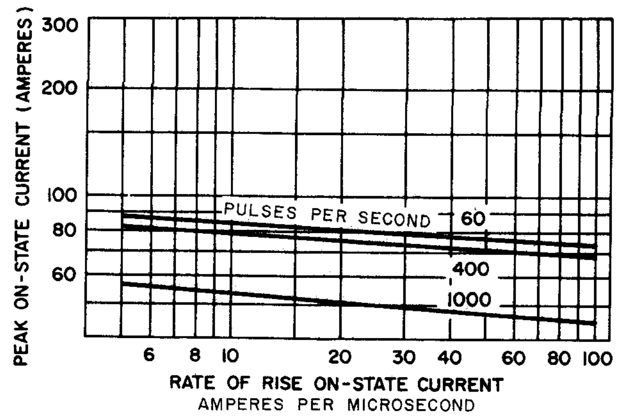
C158, C159

RECTANGULAR WAVE CURRENT RATING DATA

DUTY CYCLE – 50%

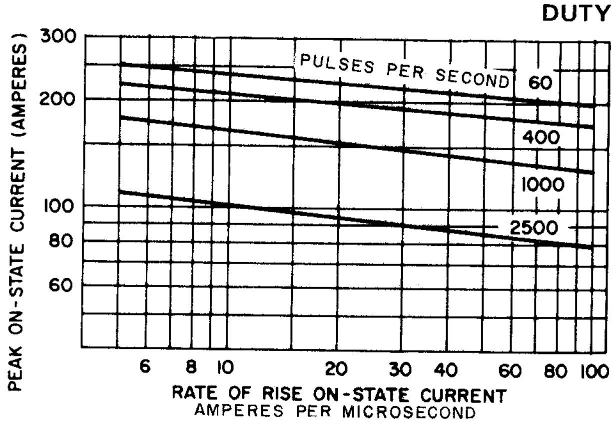


4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

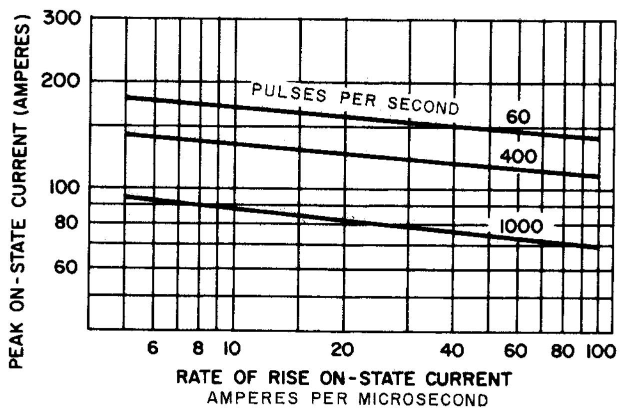


5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

DUTY CYCLE – 25%

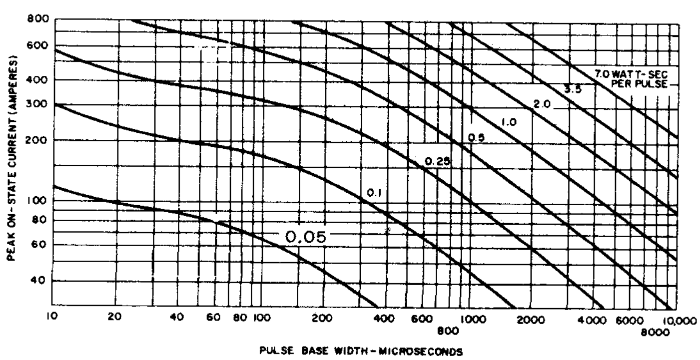


6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

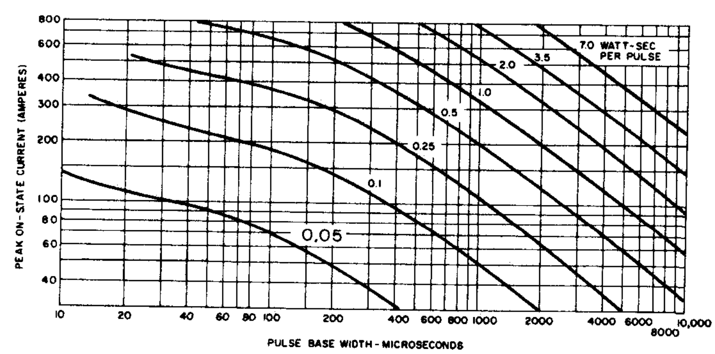


7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

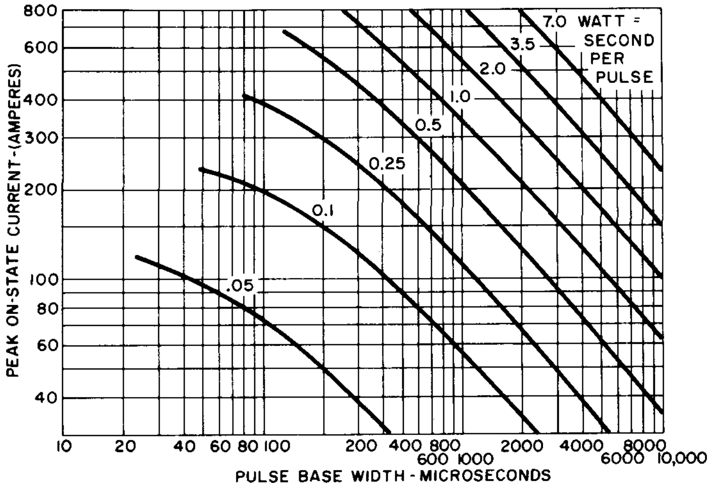
WATT-SECOND PER PULSE



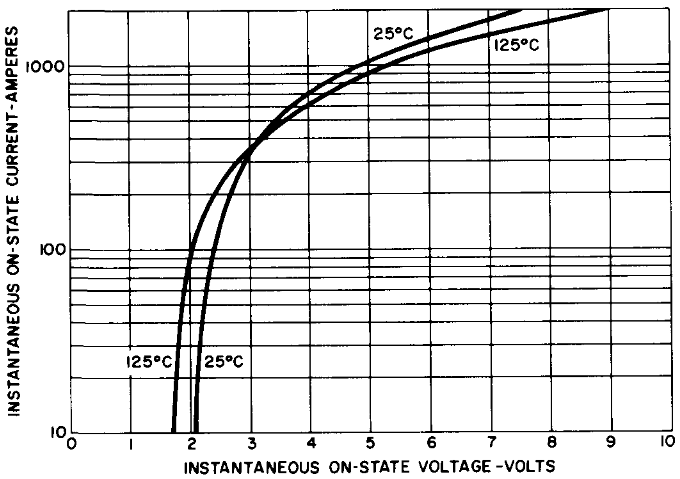
8. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec)



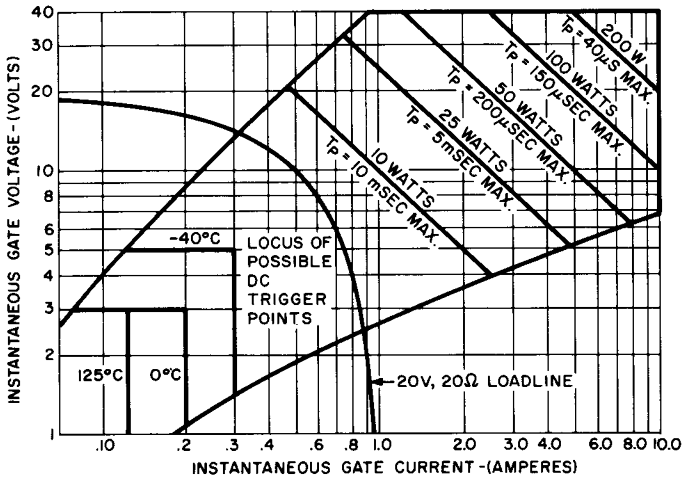
9. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec)



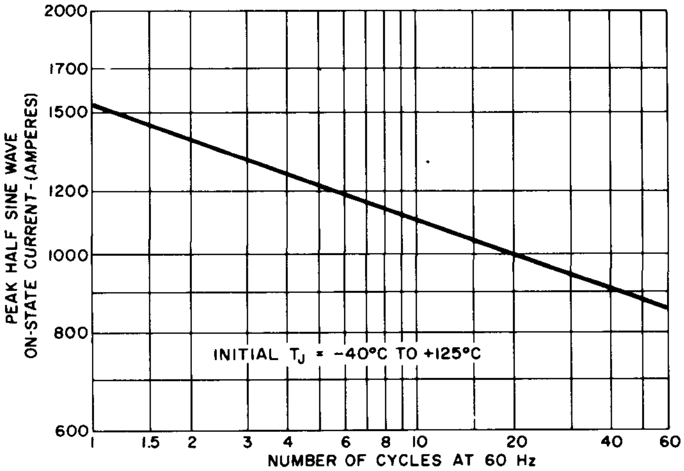
10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec)



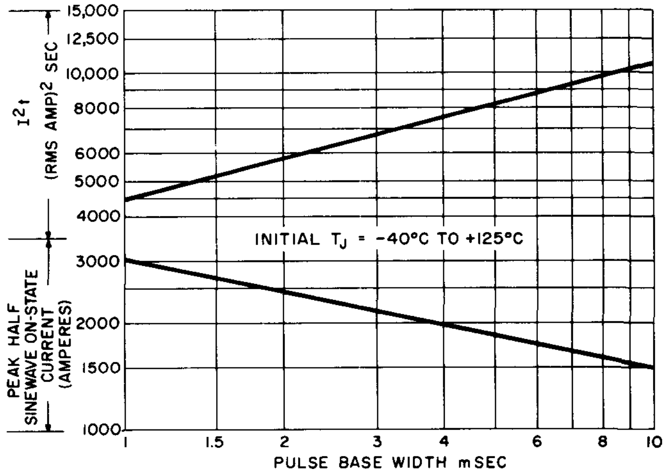
11. MAXIMUM ON-STATE CHARACTERISTICS



12. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

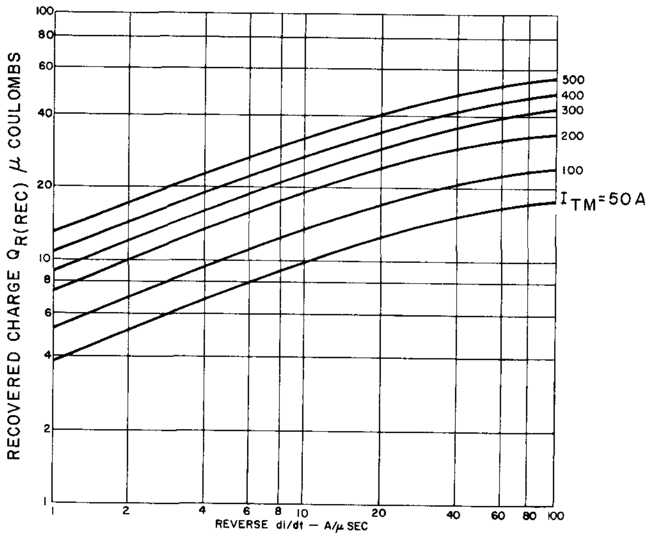


13. SURGE (NON-REPETITIVE) ON-STATE CURRENT

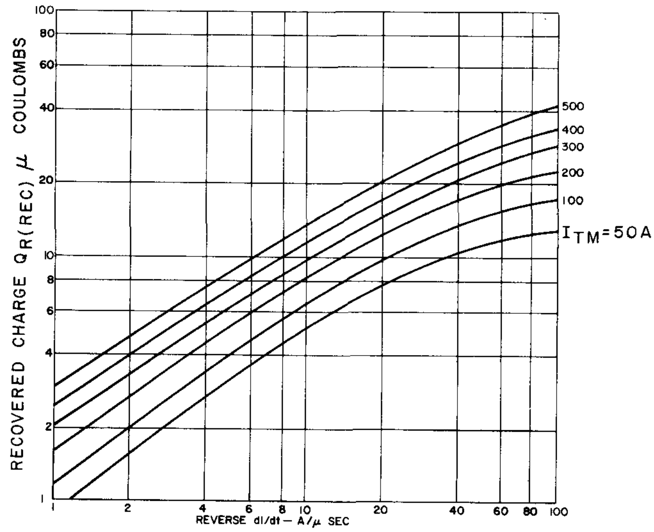


14. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING

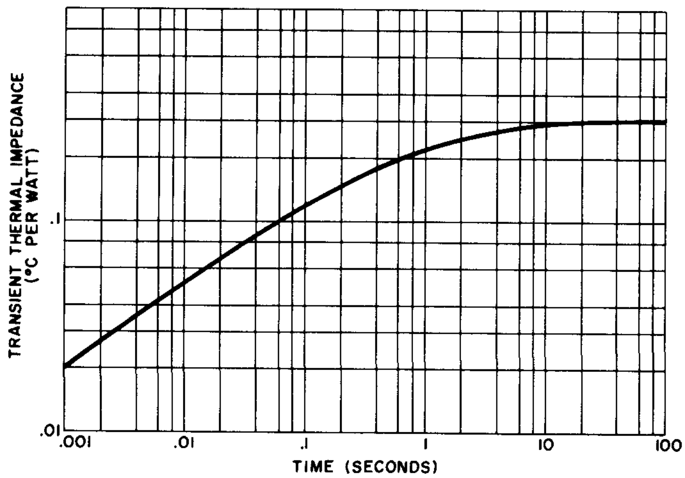
LOW FREQUENCY DATA



15. TYPICAL RECOVERED CHARGE (125°C) SINEWAVE CURRENT WAVEFORM

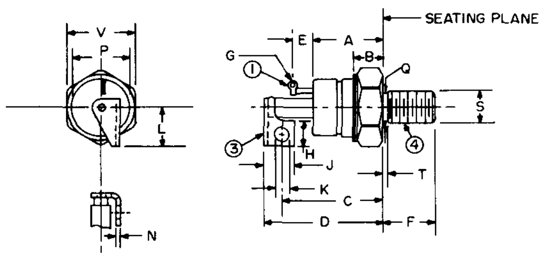


16. TYPICAL RECOVERED CHARGE (25°C) SINEWAVE CURRENT WAVEFORM



17. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

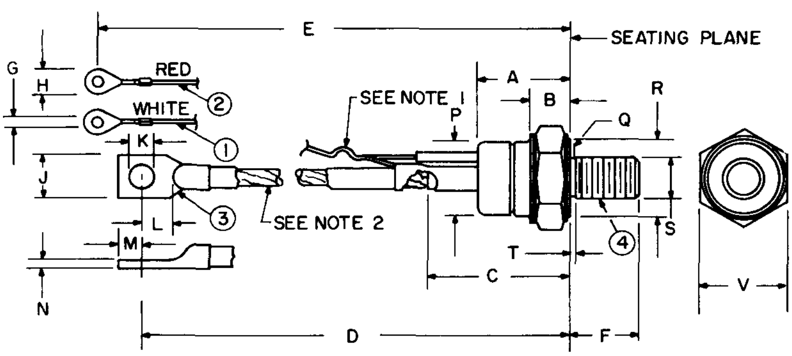
OUTLINE DRAWINGS



MODEL	TERMINAL ①	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C159	GATE	CATHODE +	ANODE −	1/2-20 UNF-2A

NOTES:
1. ONE NUT AND ONE LOCKWASHER SUPPLIED WITH EACH UNIT. MATERIAL OF HARDWARE IS STEEL, CAD PLATED.
2. "T" DIM. IS AREA OF UNTHREADED PORTION. COMPLETE THDS. ARE WITHIN 2.5 THREADS OF SEATING PLANE.
3. ANGULAR ORIENTATION OF TERMINALS IS UNDEFINED.

SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.590	.640	14.98	16.26	
B	.390	.500	9.90	12.70						
C	1.460 REF.		7.92 REF.		N	.058	.070	1.47	1.78	
D	1.660	1.800	42.16	45.72						
E	.312 REF.		7.92 REF.		P	.840	.910	21.33	23.11	
F	.797	.827	20.24	21.01						
G	.060	.075	1.52	1.91	Q	.425	.499	10.79	12.67	
H	.385	.415	9.77	10.54	T	—	.060	—	1.52	2
J	.445	.485	11.30	12.32	V	1.052	1.063	26.72	27.00	
K	.198	.212	5.02	5.38						



SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.330	—	8.38	—	
B	.390	.500	9.90	12.70	M	.275	.325	6.98	8.26	
C	1.570	1.750	39.87	44.45	N	.065	.095	1.65	2.41	
D	6.000	6.390	152.40	162.31	P	.840	.910	21.33	23.11	
E	6.850	7,500	173.99	190.50	Q	.425	.499	10.79	12.67	
F	.797	.827	20.24	21.01	R	.920	—	23.36	—	4
G	.140	.150	3.55	3.81	T	—	.060	—	1.57	5
H	—	.300		7.62						
J	.500	.610	12.70	15.49	V	1.052	1.063	26.72	27.00	
K	.260	.281	6.60	7.14						

MODEL	TERMINAL ①	TERMINAL ②	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C158	GATE	AUX CATHODE	CATHODE +	ANODE −	1/2 20UNF-2A

NOTES:
1. GATE & AUX. CATHODE LEADS SUPPLIED LIGHTLY TWISTED TOGETHER.
2. FLEXIBLE COPPER LEAD.
3. ONE NUT AND ONE LOCKWASHER SUPPLIED WITH EACH UNIT. MATERIAL OF HARDWARE IS STEEL, CAD PLATED.
4. "R" DIM. IS DIA. OF EFFECTIVE SEATING AREA.
5. "T" DIM. IS AREA OF UNTHREADED PORTION. COMPLETE THDS. ARE WITHIN 2.5 THREADS OF SEATING PLANE.
6. ANGULAR ORIENTATION OF TERMINALS IS UNDEFINED.

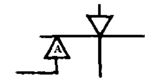
HIGH SPEED

Silicon Controlled Rectifier

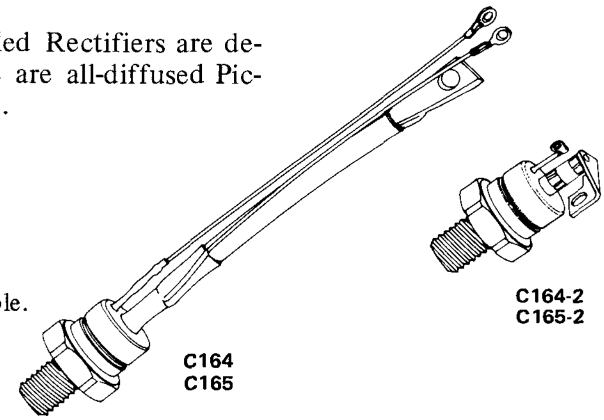
800Volts 110A RMS

C164 / C165

AMPLIFYING GATE



The General Electric C164 and C165 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Pic-Pic devices, employing the field-proven amplifying gate.



C164
C165

C164-2
C165-2

FEATURES:

- High di/dt Ratings.
- High dv/dt Capability with Selections Available.
- Excellent Surge and I^2t Ratings Providing Easy Fusing.
- Guaranteed Maximum Turn-Off Time with Selections Available.
- Rugged Hermetic Package with Long Creepage Path.

Equipment designers can use the C164 and C165 SCR's in demanding applications such as:

- Choppers
- Inverters
- Sonar Transmitters
- Induction Heaters
- Cycloconverters
- DC to DC Converters

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C164/C165A	100 Volts	100 Volts	200 Volts
C164/C165B	200	200	300
C164/C165C	300	300	400
C164/C165D	400	400	500
C164/C165E	500	500	600
C164/C165M	600	600	720
C165S	700	700	840
C165N	800	800	960

[1] Half sine wave waveform, 10 ms max. pulse width.

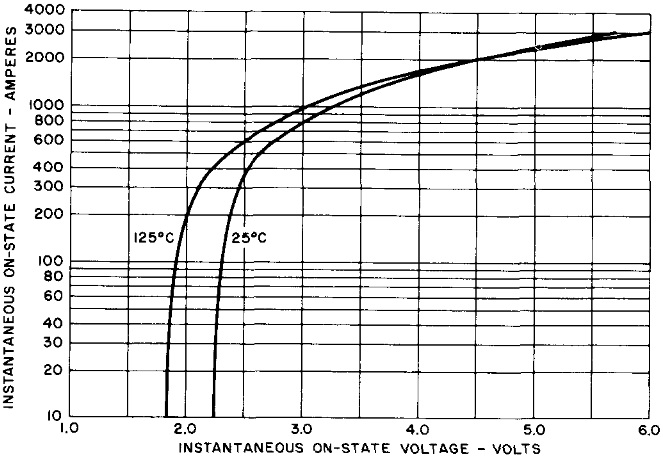
RMS On-State Current, $I_{T(RMS)}$ . . . . 110 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 1800 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 1700 Amperes
I^2t (for fusing) for times ≥ 1.5 milliseconds . . . . 9,500 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ≥ 8.3 milliseconds . . . . 13,500 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive† . . . . 800 A/μs
Critical Rate-of-Rise of On-State Current, Repetitive† . . . . 500 A/μs
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Stud Torque . . . . 125-150 In-Lb
14-17 N-m

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5μs short circuit trigger current rise time.

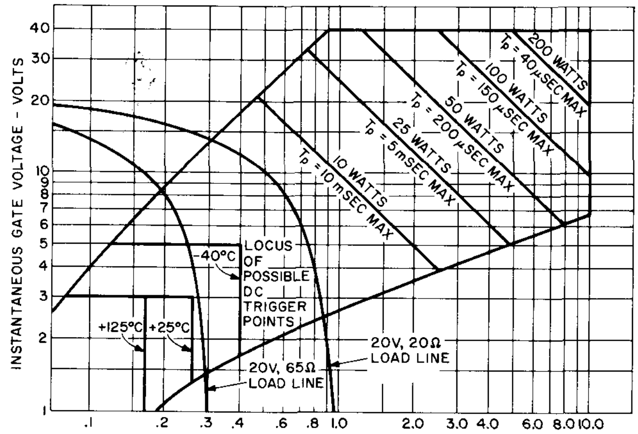
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	5	12	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	12	17	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	0.3	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated linear or exponential rising waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	40	1000	mAdc	T_J = +25°C, Anode Supply = 24 Vdc. Initial On-State Current = 2 Amps.
DC Gate Trigger Current	I_{GT}	–	70	250	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	100	400		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	25	175		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	3	5	Vdc	T_C = -40°C to 0°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	1.25	3.0		T_C = 0°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = 125°C, V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	1.9	2.6	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak. Duty Cycle ≤ .01%.
Delay Time	t_d	–	0.5	2.0	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}. Gate Supply: 20 Volt Open Circuit, 20 Ohm, 0.1 μsec max. rise time††, †††
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q				μsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} Reapplied (5) Rate-of-Rise of Reapplied Off-State Voltage = 200V/μsec (linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition Rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
	C164	–	8	10		
Faster Maximum Turn-Off Times Available, Consult Factory	C165	–	15	20		
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	t_q (diode)				μsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 1 Volt (4) V_{DRM}, Reapplied (5) Rate-of-Rise of Reapplied Off-State Voltage = 200V/μsec (linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition Rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
	C164	–	15	†		
	C165	–	20	†		

†Consult factory for specified maximum turn-off time.
††Delay time may increase significantly at the gate drive approaches the I_{GT} of the Device Under Test.
†††Current risetime as measured with a current probe, or voltage risetime across a non-inductive resistor.



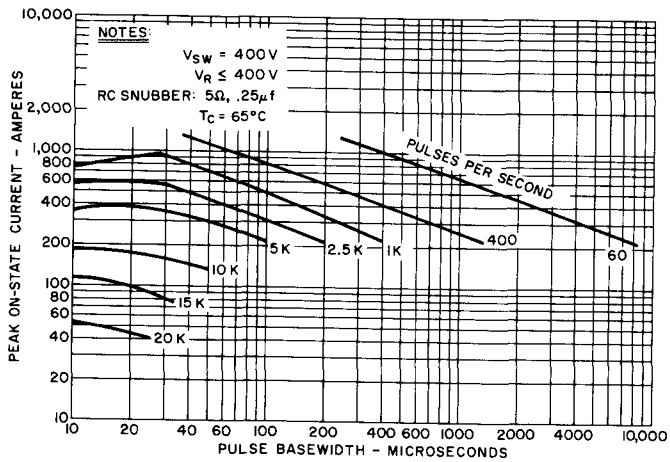
1. MAXIMUM ON-STATE CHARACTERISTICS



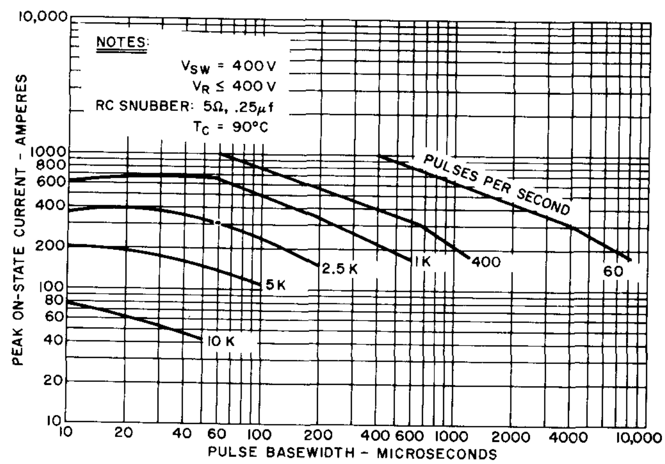
NOTES:

1. The locus of possible DC trigger points lies outside the boundaries shown at various case temperatures.

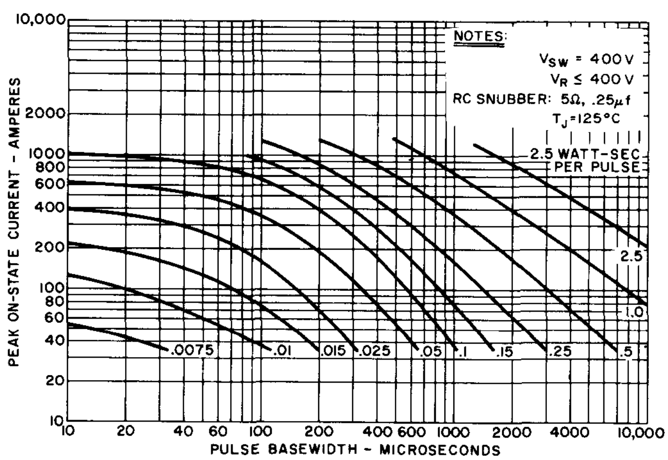
2. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS



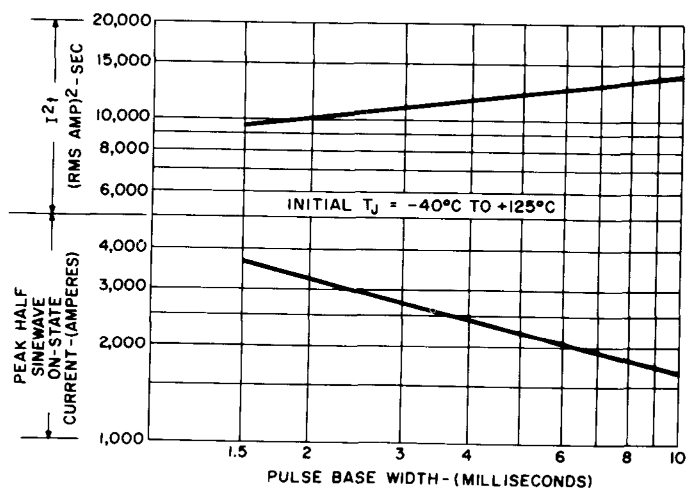
3. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



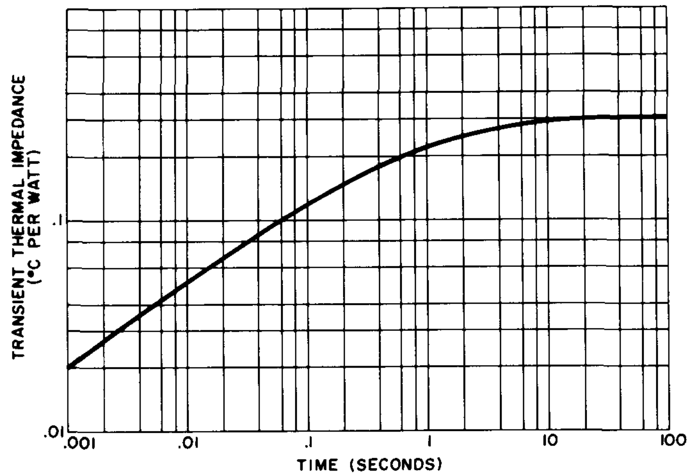
4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



5. ENERGY PER PULSE FOR SINUSOIDAL PULSES

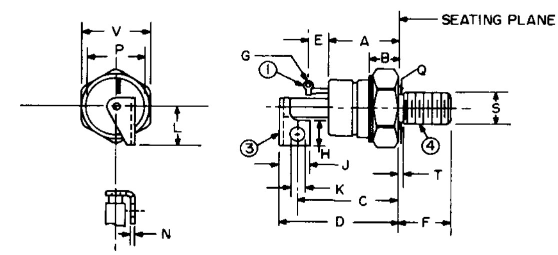


6. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



7. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE

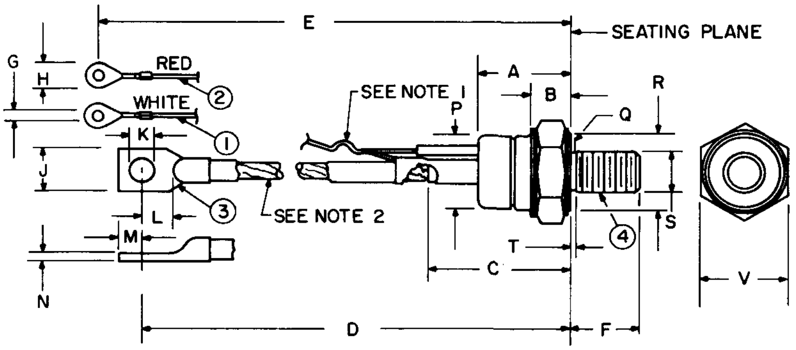
OUTLINE DRAWING



SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM.	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.590	.640	14.98	16.26	
B	.390	.500	9.90	12.70						
C	1.460 REF.		7.92 REF.		N	.058	.070	1.47	1.78	
D	1.660	1.800	42.16	45.72						
E	.312 REF.		7.92 REF.		P	.840	.910	21.33	23.11	
F	.797	.827	20.24	21.01						
G	.060	.075	1.52	1.91	Q	.425	.499	10.79	12.67	
H	.385	.415	9.77	10.54	T	—	.060	—	1.52	2
J	.445	.485	11.30	12.32	V	1.052	1.063	26.72	27.00	
K	.198	.212	5.02	5.38						

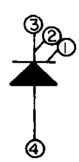
MODEL	TERMINAL ①	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C164-2 C165-2	GATE	CATHODE +	ANODE –	1/2-20 UNF-2A

NOTES:
1. ONE NUT AND ONE LOCKWASHER SUPPLIED WITH EACH UNIT. MATERIAL OF HARDWARE IS STEEL, CAD PLATED.
2. "T" DIM. IS AREA OF UNTHREADED PORTION. COMPLETE THDS. ARE WITHIN 2.5 THREADS OF SEATING PLANE.
3. ANGULAR ORIENTATION OF TERMINALS IS UNDEFINED.



SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	1.020	1.140	25.90	28.96	L	.330	—	8.38	—	
B	.390	.500	9.90	12.70	M	.275	.325	6.98	8.26	
C	1.570	1.750	39.87	44.45	N	.065	.095	1.65	2.41	
D	6.000	6.390	152.40	162.31	P	.840	.910	21.33	23.11	
E	6.850	7,500	173.99	190.50	Q	.425	.499	10.79	12.67	
F	.797	.827	20.24	21.01	R	.920	—	23.36	—	4
G	.140	.150	3.55	3.81	T	—	.060	—	1.57	5
H	—	.300		7.62						
J	.500	.610	12.70	15.49	V	1.052	1.063	26.72	27.00	
K	.260	.281	6.60	7.14						

MODEL	TERMINAL ①	TERMINAL ②	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C164 C165	GATE	AUX CATHODE	CATHODE +	ANODE –	1/2 20UNF-2A

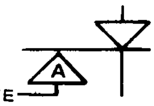


NOTES:
1. GATE & AUX. CATHODE LEADS SUPPLIED LIGHTLY TWISTED TOGETHER.
2. FLEXIBLE COPPER LEAD.
3. ONE NUT AND ONE LOCKWASHER SUPPLIED WITH EACH UNIT. MATERIAL OF HARDWARE IS STEEL, CAD PLATED.
4. "R" DIM. IS DIA. OF EFFECTIVE SEATING AREA.
5. "T" DIM. IS AREA OF UNTHREADED PORTION. COMPLETE THDS. ARE WITHIN 2.5 THREADS OF SEATING PLANE.
6. ANGULAR ORIENTATION OF TERMINALS IS UNDEFINED.

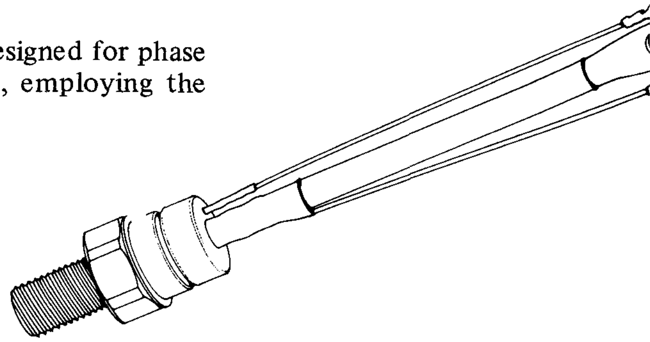
High Power Silicon Controlled Rectifier

1300 Volts 235 A RMS

C180

AMPLIFYING GATE 

The General Electric C180 Silicon Controlled Rectifier is designed for phase control applications. This is an all-diffused Pic-Pac device, employing the field-proven amplifying gate.



FEATURES:

- High di/dt Ratings
- High dv/dt Capability with Selections Available
- Excellent Surge and I^2t Ratings Providing Easy Fusing
- Rugged Hermetic Package with Long Creepage Path

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C180A	100 Volts	100 Volts	200 Volts
C180B	200	200	300
C180C	300	300	400
C180D	400	400	500
C180E	500	500	600
C180M	600	600	720
C180S	700	700	840
C180N	800	800	950
C180T	900	900	1075
C180P	1000	1000	1200
C180PA	1100	1100	1325
C180PB	1200	1200	1450
C180PC	1300	1300	1550

[1] Half sinewave waveform, 10 msec. max. pulse width.

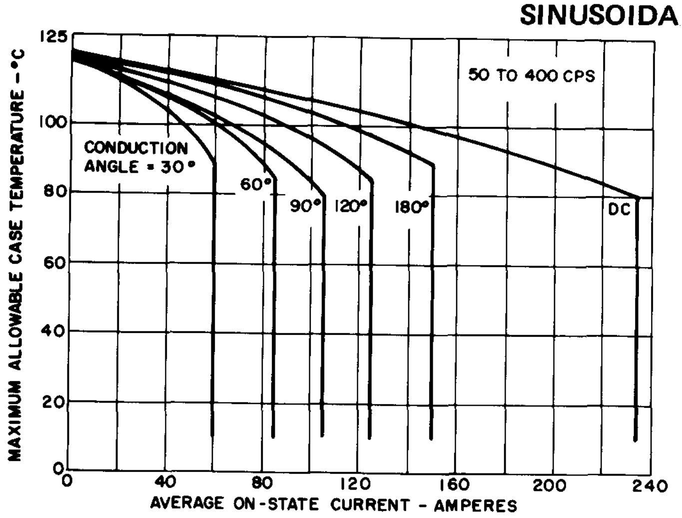
RMS On-State Current, $I_{T(RMS)}$ . . . . 235 Amperes (All Conduction Angles)
Average On-State Current, $I_{T(AV)}$ . . . . Depends on Conduction Angle (See Charts)
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 3500 Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 3200 Amperes
Critical Rate-of-Rise of On-State Current (Non-Repetitive)* . . . . 800 A/μs
Critical Rate-of-Rise of On-State Current (Repetitive)* . . . . 500 A/μs
I^2t (for fusing), for times ≥ 1.5 milliseconds . . . . 32,000 (RMS Ampere)^2 Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 10 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Stud Torque . . . . 250 Lb.-In. (Min.) – 300 Lb.-In. (Max.)
28 N-m (Min.) – 34 N-m (Max.)

*di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of V_{DRM} stated above; 20 volts, 20 ohms gate trigger source with 0.5 μsec short circuit trigger current rise time.

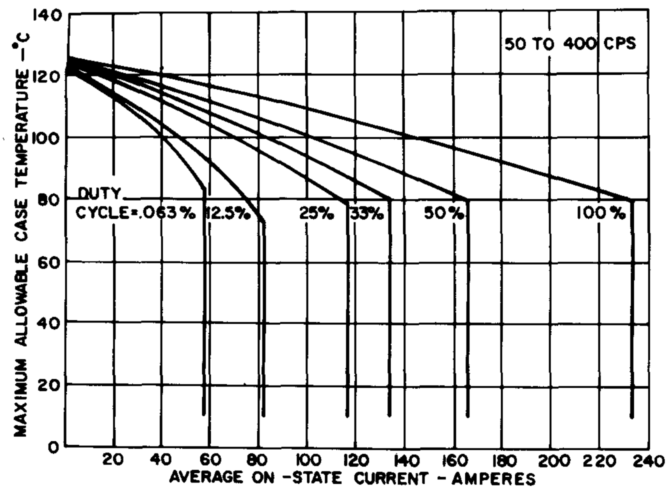
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = +25°C V_{DRM} = V_{RRM} =
C180A		–	3	10		100 Volts Peak
C180B		–	3	10		200
C180C		–	3	10		300
C180D		–	3	10		400
C180E		–	3	10		500
C180M		–	3	10		600
C180S		–	3	10		700
C180N		–	3	10		800
C180T		–	3	9		900
C180P		–	3	7		1000
C180PA		–	3	7		1100
C180PB		–	3	6		1200
C180PC		–	3	5		1300
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = +125°C V_{DRM} = V_{RRM} =
C180A		–	15	20		100 Volts Peak
C180B		–	15	20		200
C180C		–	15	20		300
C180D		–	15	20		400
C180E		–	15	20		500
C180M		–	15	20		600
C180S		–	15	20		700
C180N		–	15	20		800
C180T		–	15	18		900
C180P		–	12	15		1000
C180PA		–	11	14		1100
C180PB		–	10	13		1200
C180PC		–	8	11		1300
Thermal Resistance	$R_{\theta JC}$	–	.12	.14	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage. (Higher values may cause device switching.)	dv/dt	200	500	–	V/μsec	T_J = +125°C, V_{DRM} = Rated Using Linear or Exponential Rising Waveform, Gate Open Circuited. Exponential dv/dt = (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	75	500	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial On-State Current - 2.5 Amps.
Turn-On Delay Time	t_d	–	1	–	μsec	T_C = +25°C, I_T = 100 Adc, V_{DRM} = Rated Gate Supply: 10 Volt Open Circuit, 25 Ohm, 0.1 μsec max. rise time.
Gate Pulse Width Necessary to Trigger		–	8	10	μsec	T_C = 25°C, Gate Supply: 20 Volt Open Circuit, 40 Ohm, .5 μsec rise time. I_T = 1 Amp. For High di/dt Capability, See Chart 7.
DC Gate Trigger Current	I_{GT}	–	100	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	200		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	1.25	3.0	Vdc	T_C = -40°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = +125°C, V_D = Rated, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	2.3	2.85	Volts	T_C = +25°C, I_{TM} = 1500 Amps. Peak Duty Cycle ≤ 0.01%

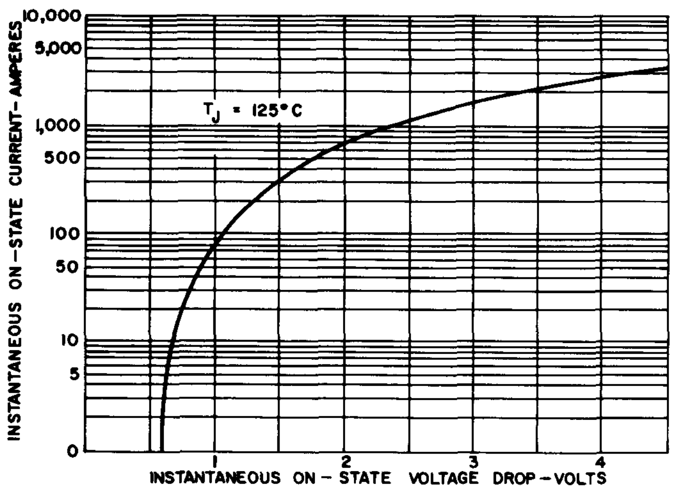
SINUSOIDAL WAVEFORM



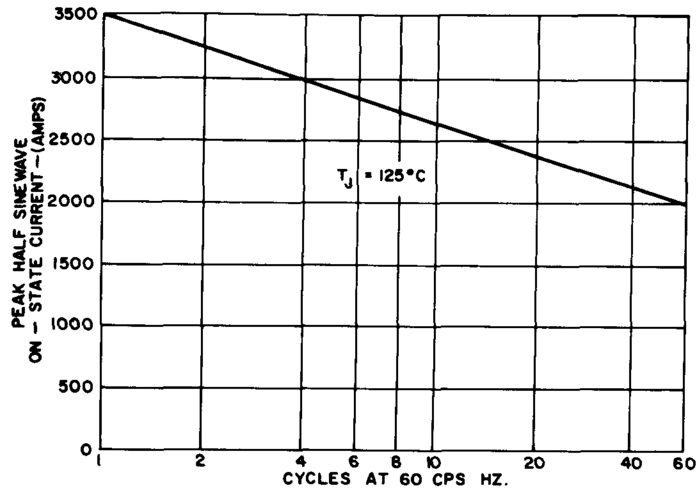
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



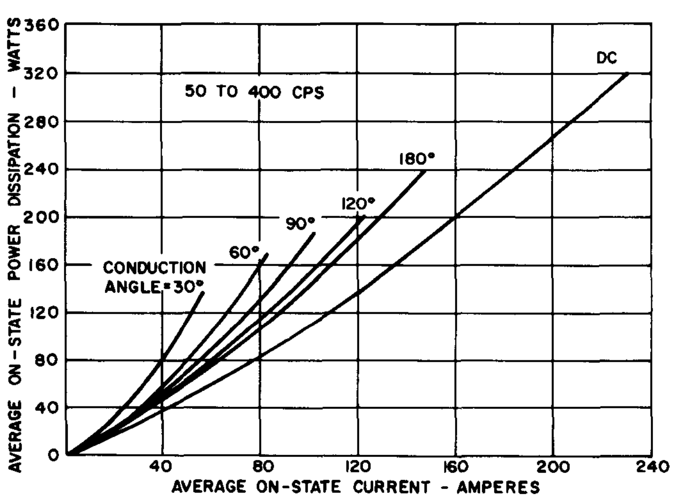
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



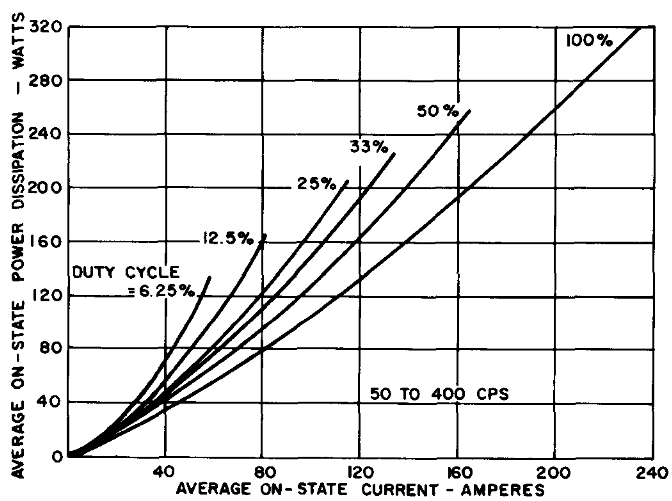
3. MAXIMUM ON-STATE CHARACTERISTICS



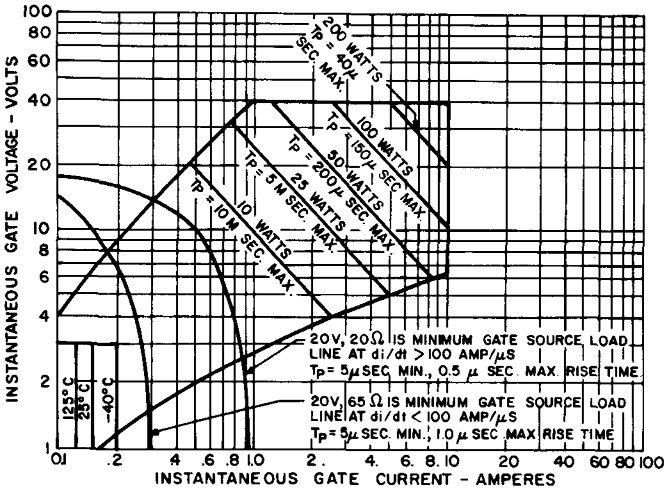
4. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE ON-STATE CURRENT RATING



5. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



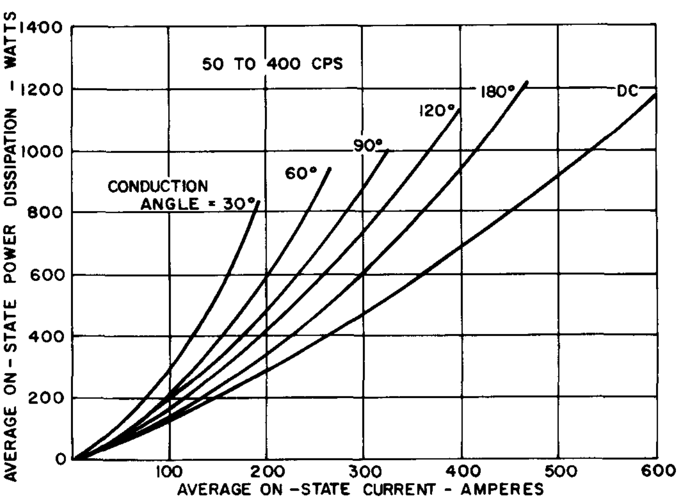
6. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



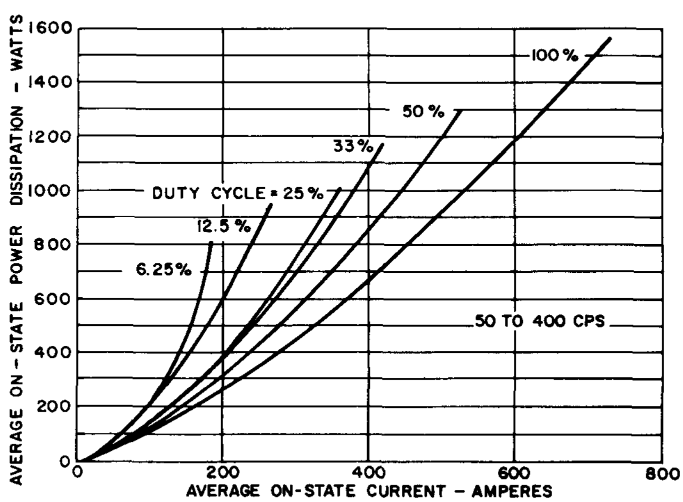
7. GATE TRIGGERING CHARACTERISTICS

NOTES:

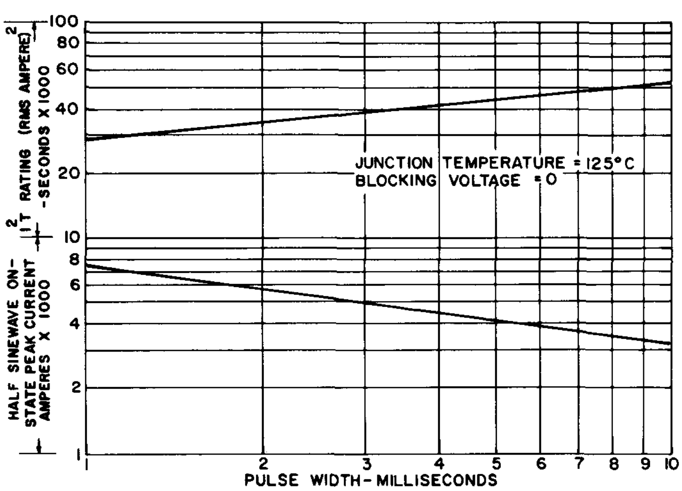
1. Maximum allowable gate power dissipation = 2 watts.
2. The locus of possible DC trigger points lie outside the boundaries shown at various case temperatures.
3. T_p = rectangular gate current pulse width.



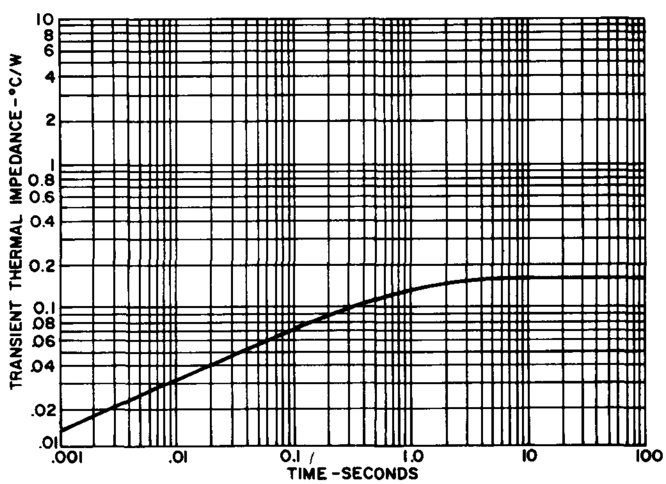
8. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM (EXTENDED RANGE)



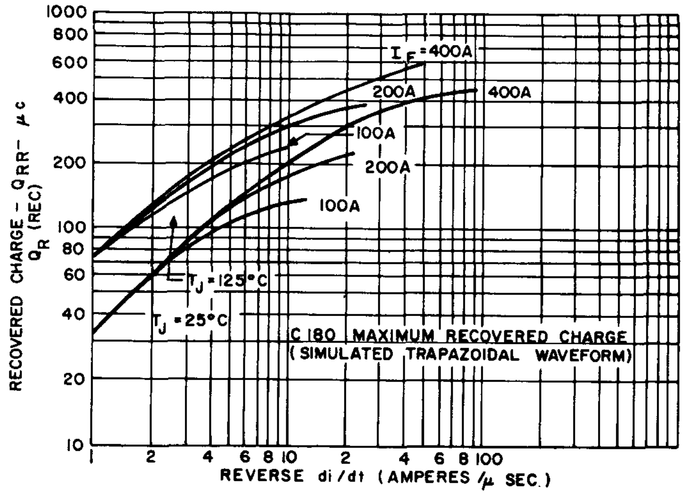
9. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM (EXTENDED RANGE)



10. SUB-CYCLE SURGE (NON-REPETITIVE) CURRENT RATING FOLLOWING ON-STATE RATED LOAD CONDITIONS

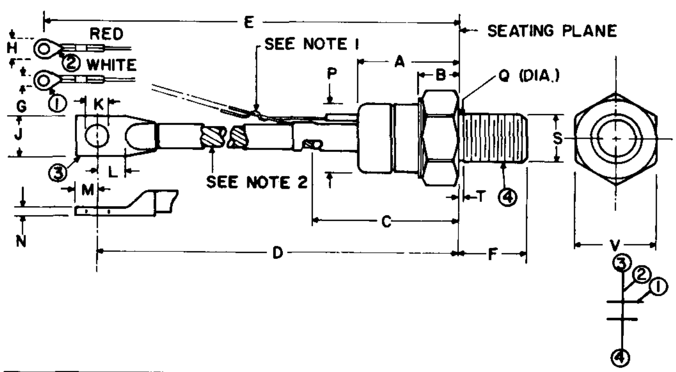


11. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE



12. MAXIMUM RECOVERED CHARGE

OUTLINE DRAWING



MODEL	TERMINAL ①	TERMINAL ②	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C180 C185 C186	GATE	AUX. CATHODE	CATHODE +	ANODE −	3/4-16 UNF-2A

SYM.	INCHES MIN.	INCHES MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.	NOTE	SYM.	INCHES MIN.	INCHES MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.	NOTE
A	1.450	1.550	36.83	39.37		L	.437	-	11.09	-	
B	.500	.750	12.70	19.05		M	.325	.360	8.25	9.14	
C	2.300	2.500	58.42	63.50		N	.093	.125	2.36	3.18	
D	7.350	8.100	186.69	205.74		P	1.060	1.100	26.92	27.94	
E	7.350	8.100	186.69	205.74		Q	.660	.749	16.76	19.02	
F	1.047	1.077	26.59	27.36							
G	.140	.150	3.55	3.81		T	-	.156	-	3.96	4
H	.215	.300	5.46	7.62							
J	.530	.687	13.46	17.45		V	1.240	1.250	31.49	31.75	
K	.322	.333	8.17	8.46							

NOTES:

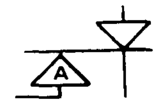
1. Gate and auxiliary cathode leads supplied lightly twisted together.
2. Flexible copper lead.
3. One nut and one lockwasher supplied with each unit. Material of hardware is steel, cad plated.
4. "T" dimension is area of unthreaded portion. Complete threads are within 2.5 threads of seating plane.
5. Angular orientation of terminals is undefined.

High Power
Silicon
Controlled Rectifier

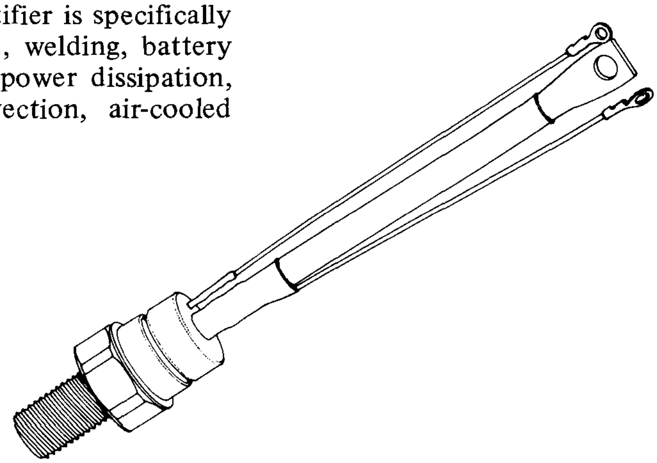
800 Volts 300ARMS

C180X500

AMPLIFYING GATE



The General Electric C180X500 Silicon Controlled Rectifier is specifically designed for low voltage phase control applications; e.g., welding, battery charging, plating supplies, etc. The SCR has very low power dissipation, thereby giving high current capability on free convection, air-cooled heatsinks.



FEATURES:

- Low On-State Voltage
- Excellent Surge and I^2t Ratings Providing Easy Fusing
- High di/dt Ratings
- High dv/dt Capability with Selections Available
- Rugged Hermetic Package with Long Creepage Path

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40° C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C180AX500	100 Volts	100 Volts	200 Volts
C180BX500	200	200	300
C180CX500	300	300	400
C180DX500	400	400	500
C180EX500	500	500	600
C180MX500	600	600	720
C180SX500	700	700	840
C180NX500	800	800	950

[1] Half sinewave waveform, 10 msec. max. pulse width.

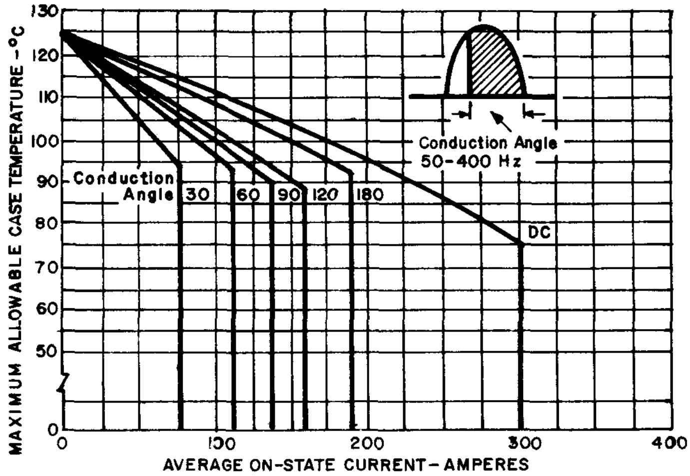
RMS On-State Current, $I_{T(RMS)}$ . . . . 300 Amperes (All Conduction Angles)
Average On-State Current, $I_{T(AV)}$ . . . . .Depends on Conduction Angle (See Charts)
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 5500 Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 5000 Amperes
Critical Rate-of-Rise of On-State Current (Non-Repetitive)* . . . . 800 A/μs
Critical Rate-of-Rise of On-State Current (Repetitive)* . . . . 500 A/μs
I^2t (for fusing), for times ≥ 1.5 milliseconds . . . . 75,000 (RMS Ampere)^2 Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 10 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Stud Torque . . . . 250 Lb.-In. (Min.) – 300 Lb.-In. (Max.)
28 N-m (Min.) – 34 N-m (Max.)

*di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of V_{DRM} stated above: 20 volts, 20 ohms gate trigger source with 0.5 μsec short circuit trigger current rise time.

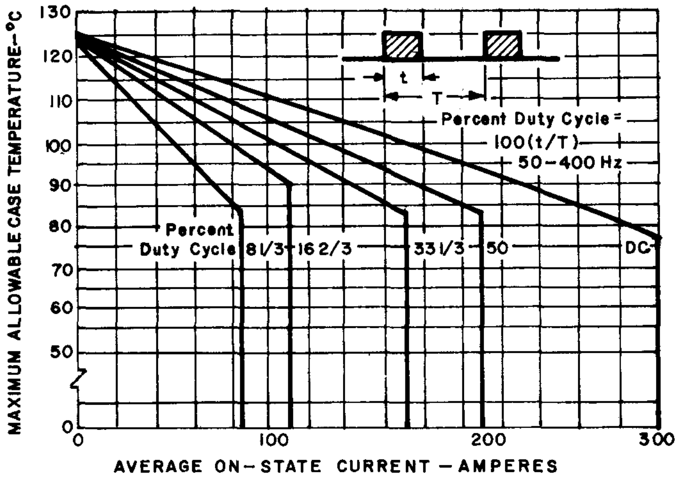
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = +25°C $V_{DRM} = V_{RRM}$ =
C180AX500		–	3	10		100 Volts Peak
C180BX500		–	3	10		200
C180CX500		–	3	10		300
C180DX500		–	3	10		400
C180EX500		–	3	10		500
C180MX500		–	3	10		600
C180SX500		–	3	10		700
C180NX500		–	3	10		800
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = +125°C $V_{DRM} = V_{RRM}$ =
C180AX500		–	15	20		100 Volts Peak
C180BX500		–	15	20		200
C180CX500		–	15	20		300
C180DX500		–	15	20		400
C180EX500		–	15	20		500
C180MX500		–	15	20		600
C180SX500		–	15	20		700
C180NX500		–	15	20		800
Thermal Resistance	$R_{\theta JC}$	–	.12	.14	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage. (Higher values may cause device switching.	dv/dt	200	500	–	V/µsec	T_J = +125°C, V_{DRM} = Rated Using Linear or Exponential Rising Waveform. Gate Open Circuited. Exponential dv/dt = (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	75	500	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial On-State Current = 2.5 Amps.
Turn-On Delay Time	t_d	–	1	–	µsec	T_C = +25°C, I_T = 100 Adc, V_{DRM} = Rated Gate Supply: 10 Volt Open Circuit, 25 Ohms, 0.1 µsec max. rise time.
Gate Pulse Width Necessary to Trigger		–	8	10	µsec	T_C = 25°C, Gate Supply: 20 Volt Open Circuit, 40 Ohms, 5 µsec rise time. I_T = 1 Amp For High di/dt Capability, See Chart 7
DC Gate Trigger Current	I_{GT}	–	100	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	200		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	1.25	3.0	Vdc	T_C = -40°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = +125°C, V_D = Rated, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	1.75	Volts	T_C = +25°C, I_{TM} = 900 Amps Peak. Duty Cycle ≤ 0.01%.

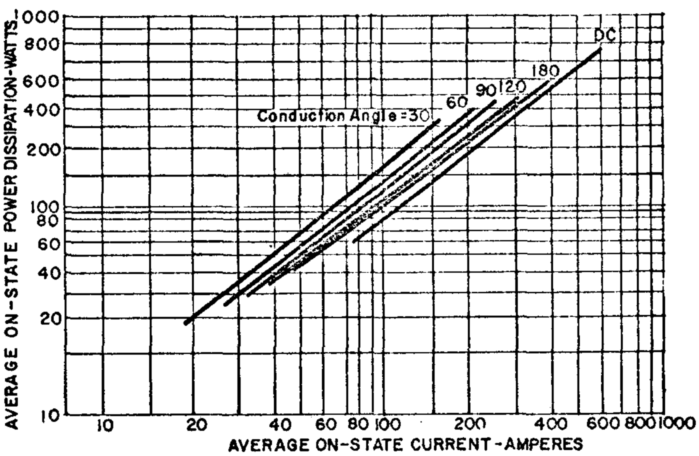
SINUSOIDAL WAVEFORM



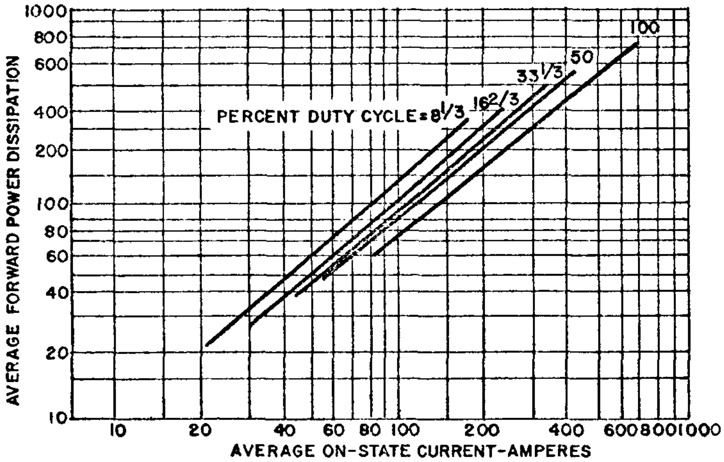
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



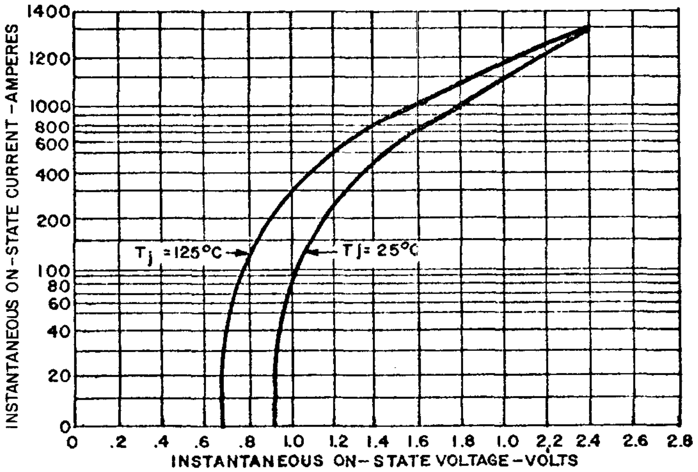
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



3. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



4. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM

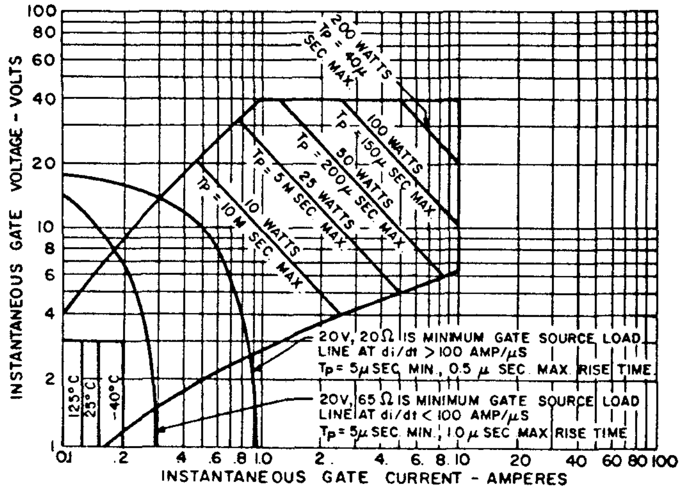


5. MAXIMUM ON-STATE CHARACTERISTICS

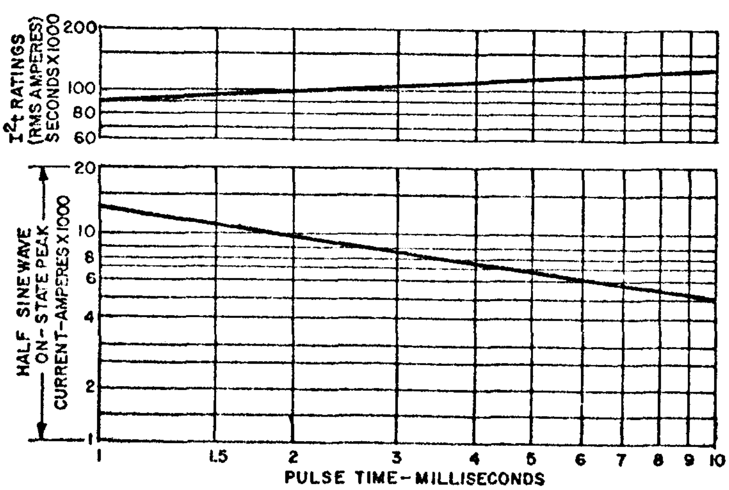
C180X500

NOTES:

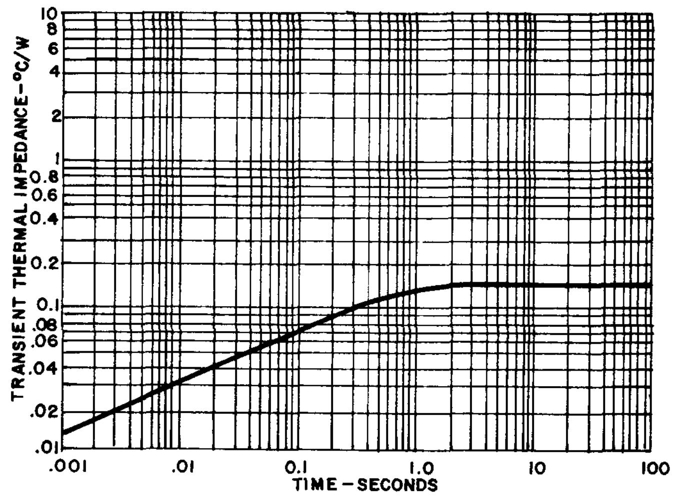
1. Maximum allowable gate power dissipation = 2 watts.
2. The locus of possible DC trigger points lie outside the boundaries shown at various case temperatures.
3. Tp = rectangular gate current pulse width.



6. GATE TRIGGERING CHARACTERISTICS

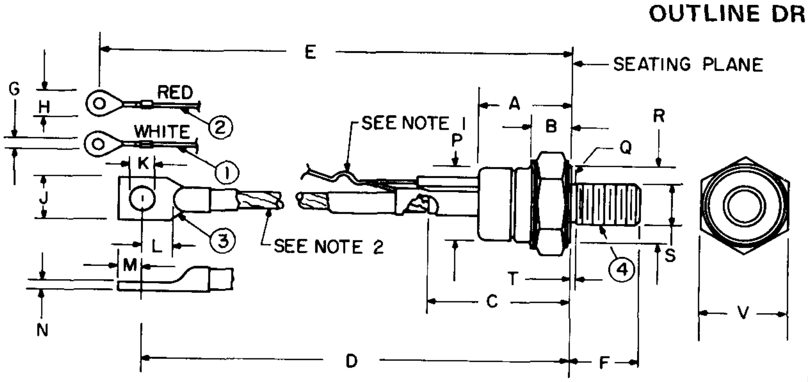


7. SUB-CYCLE SURGE (NON-REPETITIVE) CURRENT RATING FOLLOWING ON-STATE RATED LOAD CONDITIONS



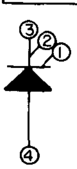
8. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE

OUTLINE DRAWING



SYM.	INCHES MIN.	INCHES MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.	NOTE	SYM.	INCHES MIN.	INCHES MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.	NOTE
A	1.450	1.550	36.83	39.37		L	.437	-	11.09	-	
B	.500	.750	12.70	19.05		M	.325	.360	8.25	9.14	
C	2.300	2.500	58.42	63.50		N	.093	.125	2.36	3.18	
D	7.350	8.100	186.69	205.74		P	1.060	1.100	26.92	27.94	
E	7.350	8.100	186.69	205.74		Q	.660	.749	16.76	19.02	
F	1.047	1.077	26.59	27.36							
G	.140	.150	3.55	3.81		T	-	.156	-	3.96	4
H	.215	.300	5.46	7.62							
J	.530	.687	13.46	17.45		V	1.240	1.250	31.49	31.75	
K	.322	.333	8.17	8.46							

MODEL	TERMINAL ①	TERMINAL ②	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C180X500	GATE	AUX CATHODE	CATHODE +	ANODE −	3/4 -16 UNF-2A



NOTES:

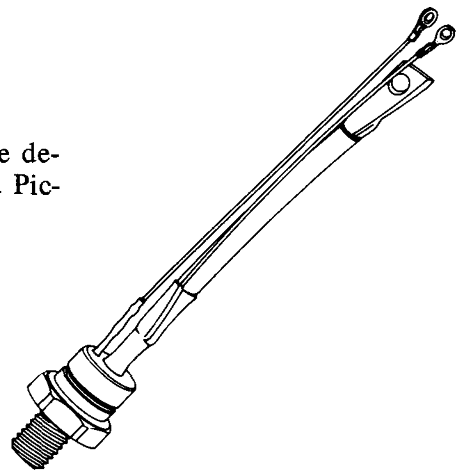
1. Gate and auxiliary cathode leads supplied lightly twisted together.
2. Flexible copper lead.
3. One nut and one lockwasher supplied with each unit. Material of hardware is steel, cad plated.
4. "T" dimension is area of unthreaded portion. Complete threads are within 2.5 threads of seating plane.
5. Angular orientation of terminals is undefined.

HIGH SPEED

Silicon Controlled Rectifier

C184, C185

800 Volts **300A RMS**



The General Electric C184 and C185 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Pic-Pac devices, employing the field-proven amplifying gate.

FEATURES:

- High di/dt Ratings.
- High dv/dt Capability.
- Excellent Surge and I^2t Ratings Providing Easy Fusing.
- Guaranteed Maximum Turn-Off Time with Selections Available.
- Rugged Hermetic Package with Long Creepage Path.

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C184/C185A	100 Volts	100 Volts	200 Volts
C184/C185B	200	200	300
C184/C185C	300	300	400
C184/C185D	400	400	500
C184/C185E	500	500	600
C184/C185M	600	600	720
C185S	700	700	840
C185N	800	800	960

[1] Half sinewave waveform, 10 ms max. pulse width.

RMS On-State Current, $I_{T(RMS)}$ .... 300 Amperes
Critical Rate-of-Rise of On-State Current, Non-Repetitive† .... 800 A/μs
Critical Rate-of-Rise of On-State Current, Repetitive† .... 500 A/μs
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) .... 3500 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) .... 3200 Amperes
I^2t (for fusing) for times ≥ 1.5 milliseconds .... 35,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ≥ 8.3 milliseconds .... 50,000 (RMS Ampere)^2 Seconds
Average Gate Power Dissipation, $P_{G(AV)}$ .... 2 Watts
Storage Temperature, T_{stg} .... -40°C to +150°C
Operating Temperature, T_J .... -40°C to +125°C
Stud Torque .... 300 Lb-In (Max.), 250 Lb-IN (Min.)
34 N-m (Max.), 28 N-m (Min.)

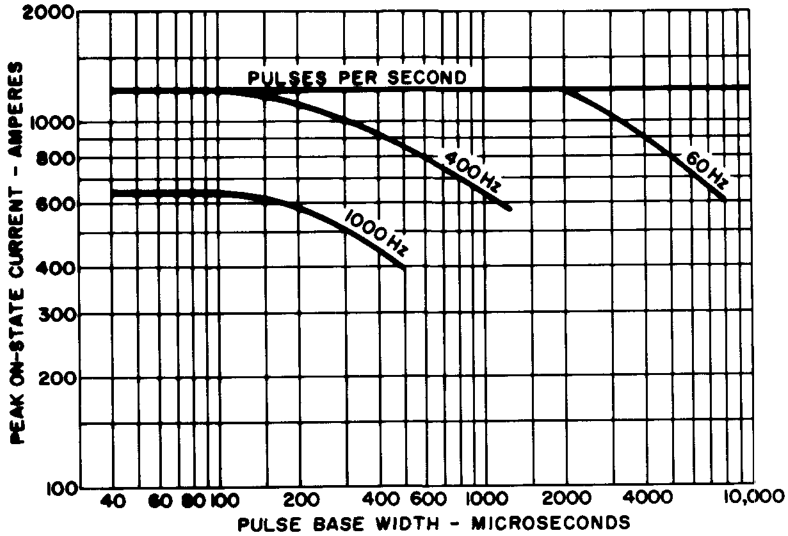
†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, wo ohms gate trigger source with 0.5μs short circuit trigger current rise time.

CHARACTERISTICS

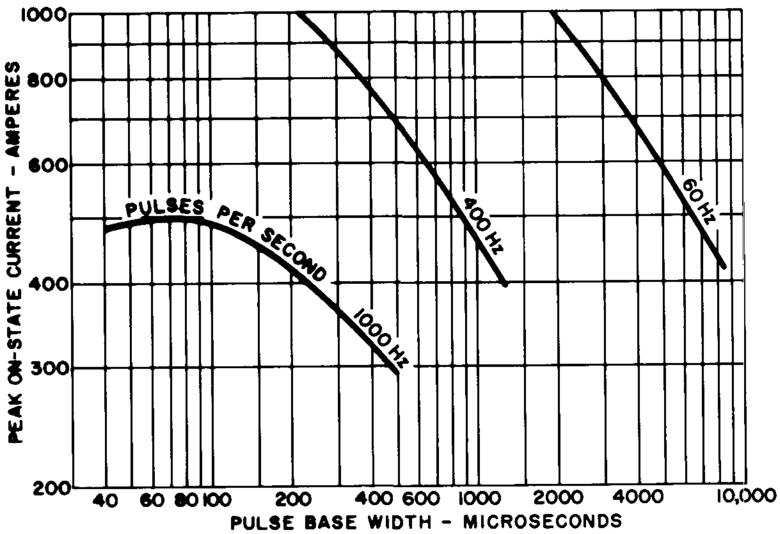
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	3	10	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	15	20	mA	T_J = 125°C, V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	.12	.15	°C/Watt	Junction-to-Case
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated, linear or exponential rising waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	75	500	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial On-State Current = 2.5 Amps.
DC Gate Trigger Current	I_{GT}	–	125	300	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	175	500		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	100	250		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	5.0	Vdc	T_C = -40°C to 0°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	3.0		T_C = 0°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = +125°C, V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	2.3	2.85	Volts	T_C = +25°C, I_{TM} = 1500 Amps Peak. Duty Cycle ⩽ .01%.
Turn-On Delay Time	t_d	–	1	–	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}. Gate Supply: 20 Volt Open Circuit, 20 Ohm, 0.1 μsec max. Rise Time.
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q C184 C185	 – –	 8 15	 10 20	μsec	(1) T_C = +125°C (2) I_{TM} = 250 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (linear) (6) Commutation di/dt = 12.5 Amps/μsec. (7) Duty Cycle ⩽ .01%. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms.
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	t_q (diode) C184 C185	 – –	 10 20	 † †	μsec	(1) T_C = +125°C (2) I_{TM} = 250 Amps. (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (linear) (6) Commutation di/dt = 12.5 Amps/μsec. (7) Duty Cycle ⩽ .01%. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms.

†Consult factory for maximum turn-off time.

SINE WAVE CURRENT RATING DATA



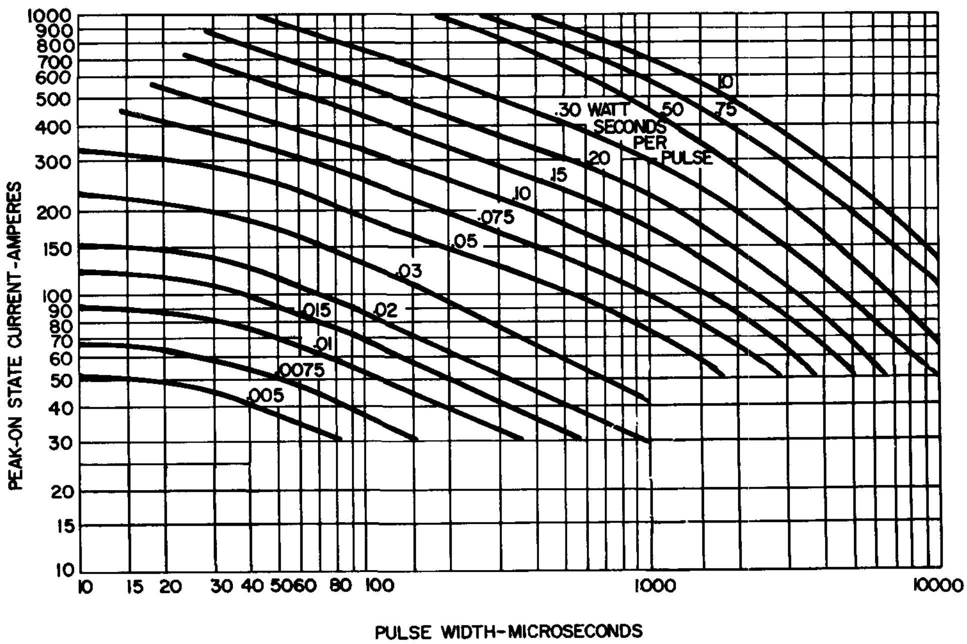
1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)

NOTES:
(Pertaining to Sine and Trapezoidal Wave Current Ratings)

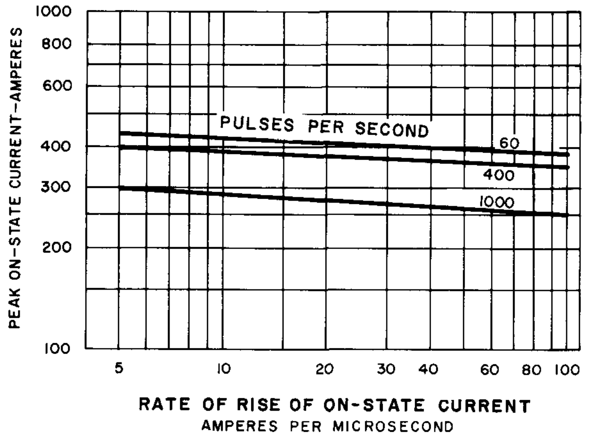
1. Switching voltage ≤ 400 volts.
2. RC Snubber – .22μf, 5 ohm.
3. Reverse voltage V_R ≤ 400 volts.
4. Values of W-S/D are for T_J = 125°C.



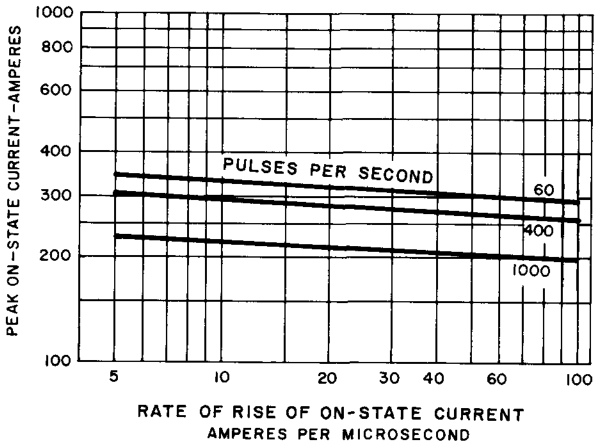
3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

TRAPEZOIDAL WAVE CURRENT RATING DATA

DUTY CYCLE—50%

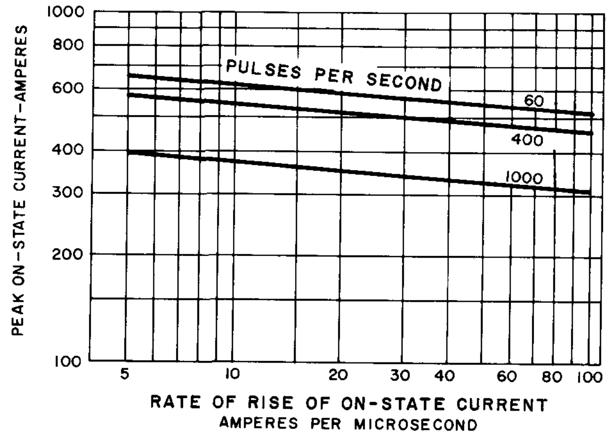


4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

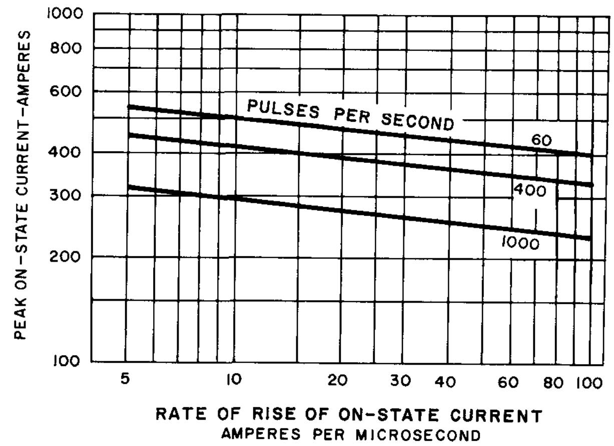


5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

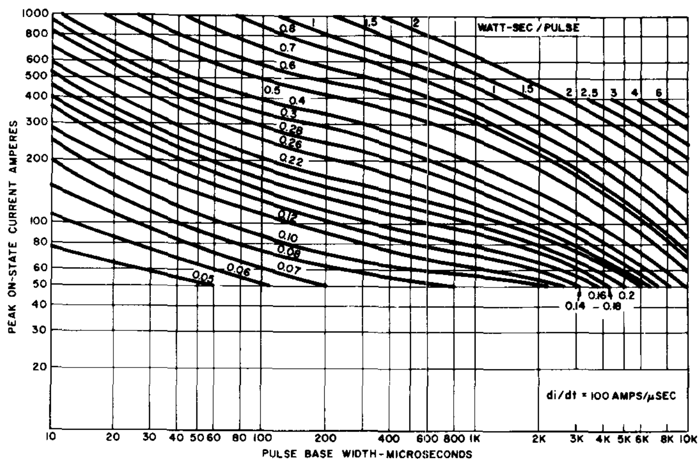
DUTY CYCLE—25%



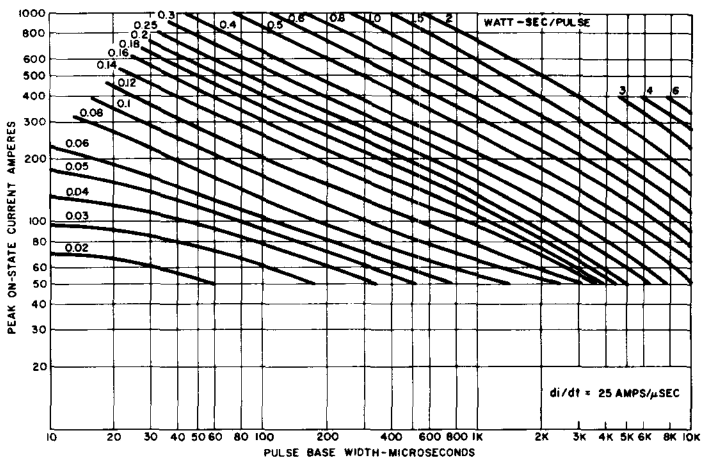
6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)



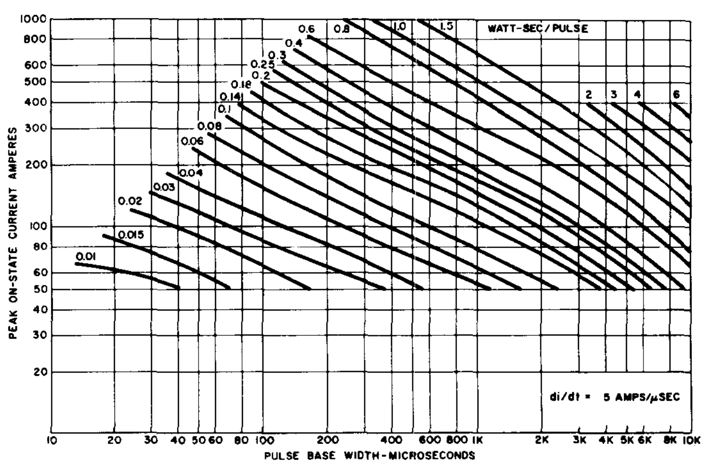
7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)



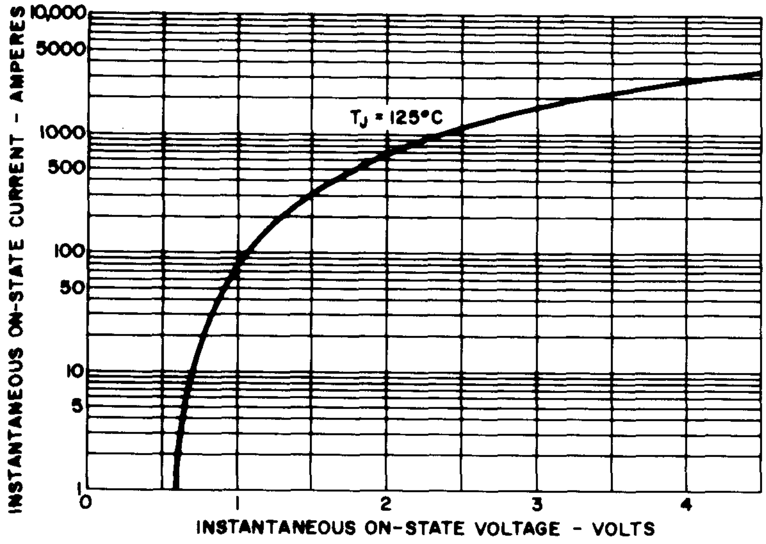
8. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec.)



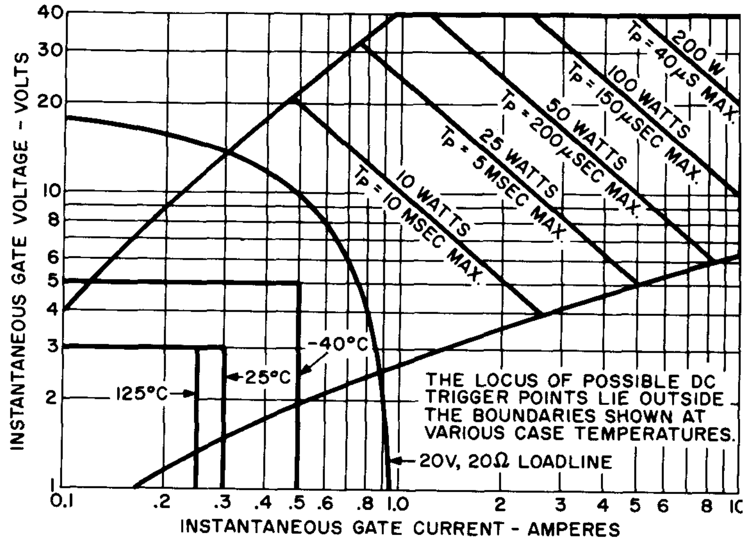
9. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec.)



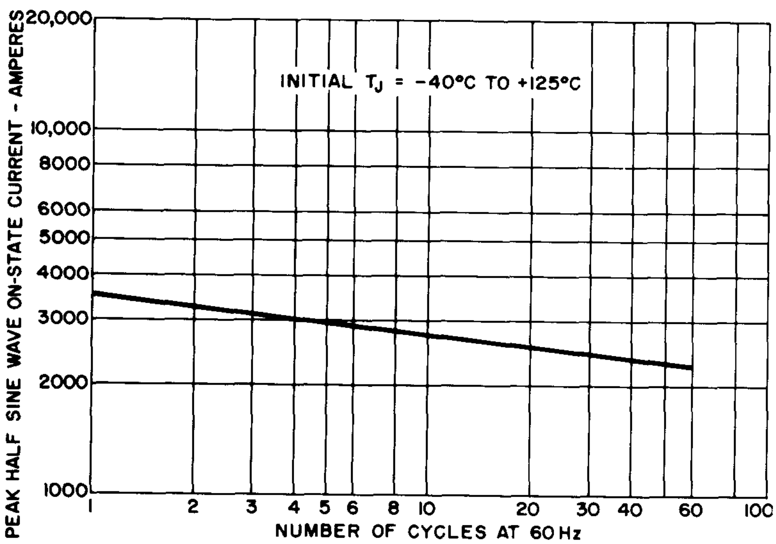
10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec.)



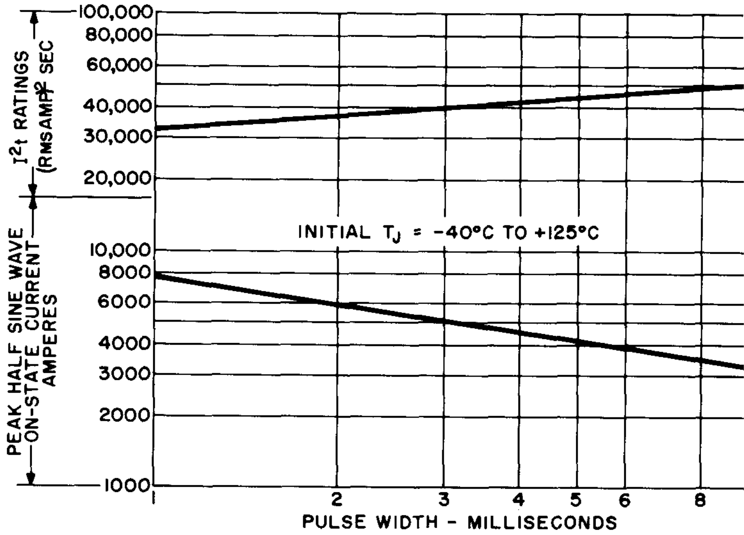
11. MAXIMUM ON-STATE CHARACTERISTICS



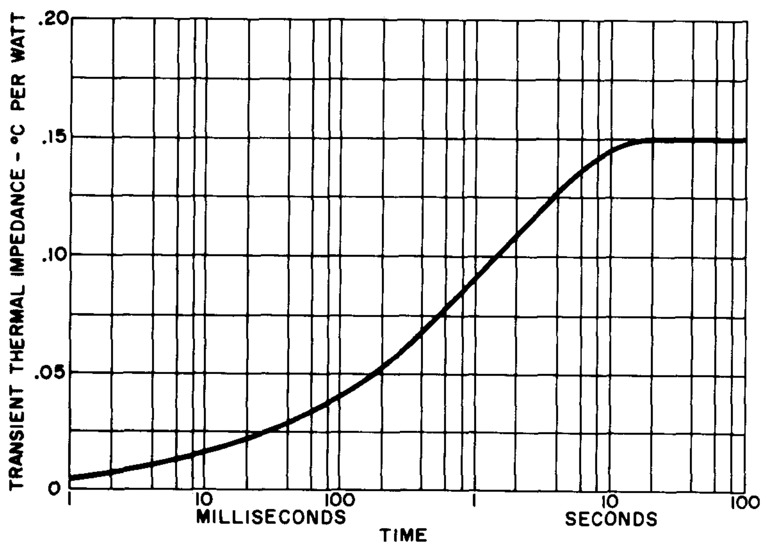
12. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS



13. SURGE (NON-REPETITIVE) ON-STATE CURRENT

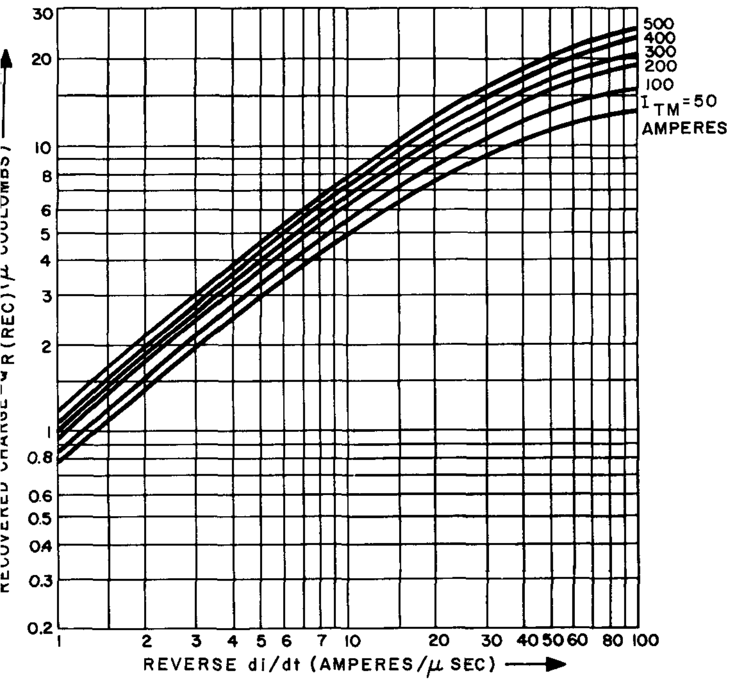


14. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATINGS

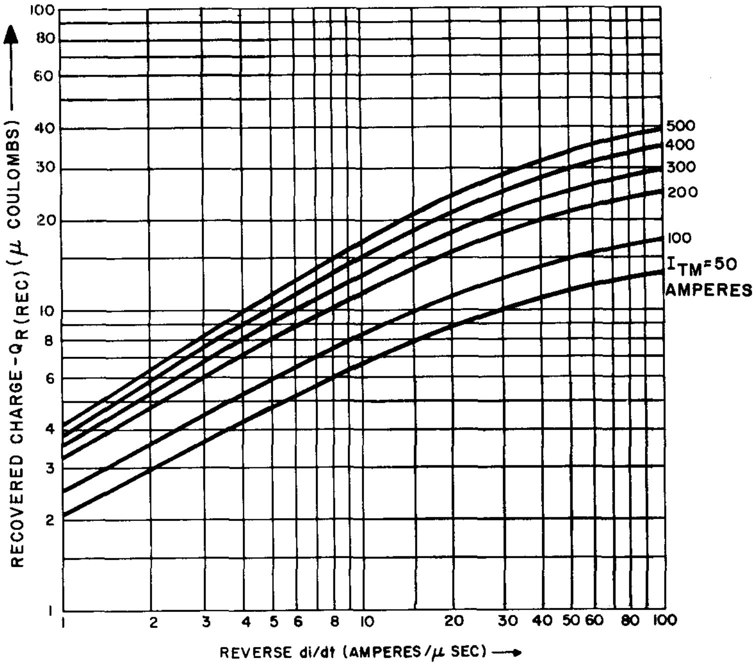


15. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

C185 RECOVERED CHARGE DATA

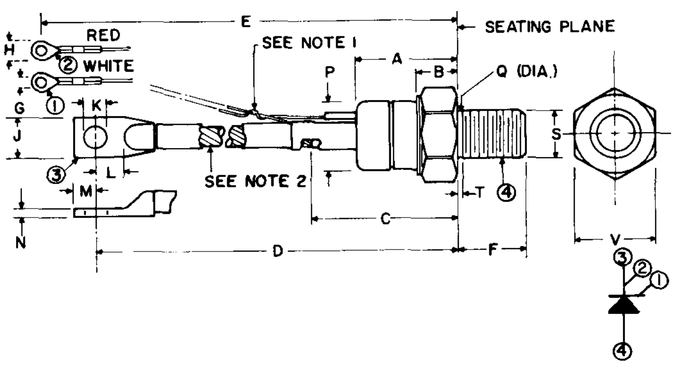


16. TYPICAL RECOVERED CHARGE DATA AT 25°C SINEWAVE CURRENT WAVEFORM



17. TYPICAL RECOVERED CHARGE DATA AT 125°C SINEWAVE CURRENT WAVEFORM

OUTLINE DRAWING



MODEL	TERMINAL ①	TERMINAL ②	TERMINAL ③	TERMINAL ④	S THREAD SIZE
C180 C185 C186	GATE	AUX. CATHODE	CATHODE +	ANODE −	3/4-16 UNF-2A

SYM.	INCHES MIN.	INCHES MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.	NOTE	SYM.	INCHES MIN.	INCHES MAX.	METRIC (MM) MIN.	METRIC (MM) MAX.	NOTE
A	1.450	1.550	36.83	39.37		L	.437	–	11.09	–	
B	.500	.750	12.70	19.05		M	.325	.360	8.25	9.14	
C	2.300	2.500	58.42	63.50		N	.093	.125	2.36	3.18	
D	7.350	8.100	186.69	205.74		P	1.060	1.100	26.92	27.94	
E	7.350	8.100	186.69	205.74		Q	.660	.749	16.76	19.02	
F	1.047	1.077	26.59	27.36							
G	.140	.150	3.55	3.81		T	–	.156	–	3.96	4
H	.215	.300	5.46	7.62							
J	.530	.687	13.46	17.45		V	1.240	1.250	31.49	31.75	
K	.322	.333	8.17	8.46							

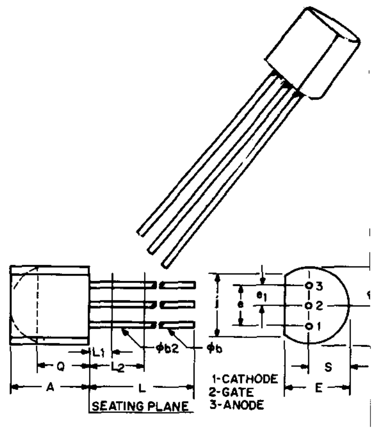
ELECTRONIC INNOVATIONS IN ACTION

SEMICONDUCTORS

Silicon Controlled Rectifier

C203

0.8A RMS UP TO 400 VOLTS



TYPICAL APPLICATIONS:

- Sensors
  - Temperature
  - Pressure
  - Dryness
  - Proximity
  - Voltage
  - Current
- Amplifiers (gate)
- Timers
- Logic Circuits
- Controls
  - Small Motors
  - Small Lamps
  - Remote
- Switching
  - Solid-State Relay
  - Relay Driver
  - Counter
  - Low Power Inverter
- 120V AC Line Operation

SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.170	.210	4.58	5.33	
ϕb	.016	.021	.407	.533	1,3
ϕb_2	.016	.019	.407	.482	3
ϕD	.175	.205	4.96	5.20	
E	.125	.165	3.94	4.19	
e	.095	.105	2.42	2.66	
e_1	.045	.055	1.15	1.39	
j	.135	–	3.43	–	
L	.500	–	12.70	–	1,3
L_1	–	.050	–	1.27	3
L_2	.250	–	6.35	–	3
Q	.115	–	2.93	–	2
S	.080	.105	2.42	2.66	

NOTES:
1. THREE LEADS.
2. CONTOUR OF THE PACKACE BEYOND THIS ZONE IS UNCONTROLLED.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND .5 INCH (12.70 MM) FROM SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND .5 INCH (12.70 MM FROM SEATING PLANE.

FEATURES:

- 200 μA Gate Sensitivity
- 8-Amp Surge
- 30 through 200 Volt Selection
- Plastic TO-92 Package
- Low V_F
- High dv/dt

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, $V_{DRM}^{(1)}$ T_C = -65°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, $V_{DRM}^{(2)}$ T_C = -65°C to +125°C
C203Y	30 Volts	30 Volts
C203YY	60 Volts	60 Volts
C203A	100 Volts	100 Volts
C203B	200 Volts	200 Volts
C203C	300 Volts	300 Volts
C203D	400 Volts	400 Volts

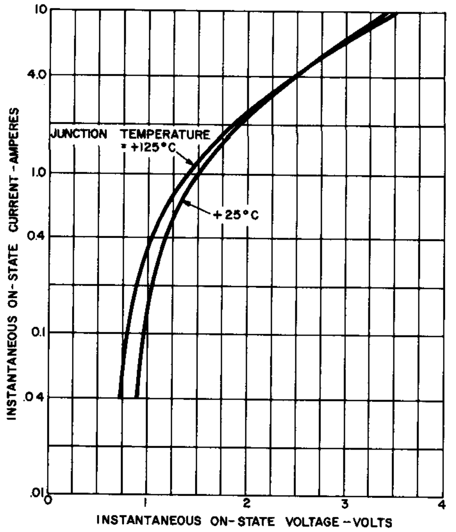
1 R_{GK} = 1000 ohms maximum.
2 Values apply for zero or negative gate voltage only.

RMS On-State Current, $I_{T(RMS)}$ (all Conduction Angles) . . . . 0.8 Amperes
Peak One Cycle Surge (non-rep) On-State Current, I_{TSM} . . . . 8.0 Amperes
Peak Gate Power Dissipation, P_{GM} . . . . 1.0 Watts for 8.3 msec.
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 0.01 Watts
Peak Positive Gate Current, I_{GM} . . . . 0.5 Amperes
Peak Negative Gate Voltage, V_{GM} . . . . 8 Volts
Storage Temperature, T_{STG} . . . . -65°C to +150°C
Operating Junction Temperature, T_J . . . . -65°C to +125°C

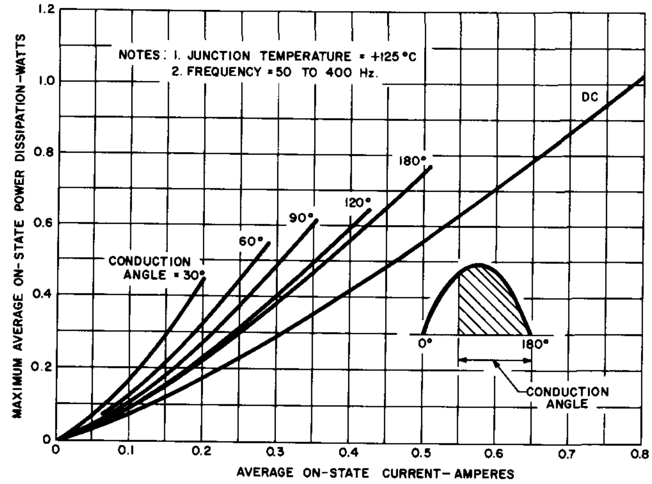
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Off-State Current (All Types)	I_{RRM} or I_{DRM}	–	–	1.0	μA	T_C = +25°C, R_{GK} = 1000 ohms V_{RRM} = V_{DRM} = Rated Value.
		–	–	50		T_C = +125°C, R_{GK} = 1000 ohms V_{RRM} = V_{DRM} = Rated Value.
DC Gate Trigger Current	I_{GT}	–	–	200	μAdc	T_C = +25°C, V_D = 6Vdc, R_L = 100 ohms.
		–	–	500		T_C = -65°C, V_D = 6Vdc, R_L = 100 ohms.
DC Gate Trigger Voltage	V_{GT}	–	–	0.8	Vdc	T_C = +25°C, V_D = 6Vdc, R_L = 100 ohms.
		–	–	1.0		T_C = -65°C, V_D = 6Vdc, R_L = 100 ohms.
		0.1	–	–		T_C = +125°C, Rated V_{DRM}, R_L = 1000 ohms.
Peak On-State Voltage	V_{TM}	–	–	1.5	V	T_C = +25°C, I_{TM} = 1.0A peak, 1 msec. wide pulse, Duty Cycle ⩽ 2%
Holding Current	I_H	–	–	5.0	mAdc	Anode source voltage = 12Vdc, R_{GK} = 1000 ohms. T_C = +25°C.
		–	–	10.0		T_C = -65°C
Critical Rate-of-Rise of Off-State Voltage	dv/dt	–	20	–	V/μsec	T_C = +125°C, Rated V_{DRM}, R_{GK} = 1000 ohms.
Circuit Commutated Turn-Off Time	t_q	–	15	–	μsec	T_C = +125°C, rectangular current waveform. Rate-of-rise of current <10A/μsec. Rate reversal of current <5A/μsec. I_{TM} = 1A (50μsec. pulse). Rep. Rate = 60 pps. V_{RRM} = Rated, V_{RX} = 15V Min., V_{DRM} = Rated. Rate-of-rise of reapplied off-state voltage = 20V/μsec.; Gate Bias = 0 Volts, 100 Ohms (during turn-off time interval).
Steady-State Thermal Resistance	$R_{\theta JC}$	–	–	125	°C/W	Junction-to-case (flat side of case is temperature reference point).
	$R_{\theta JA}$	–	–	230		Junction-to-ambient (free convection).

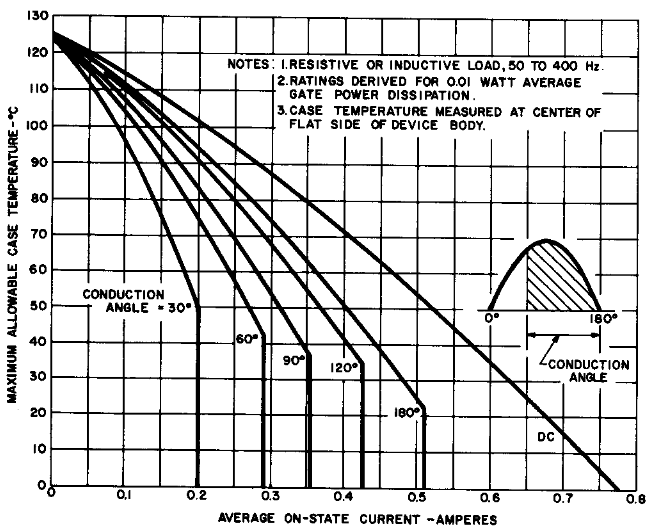
TYPICAL CHARACTERISTICS



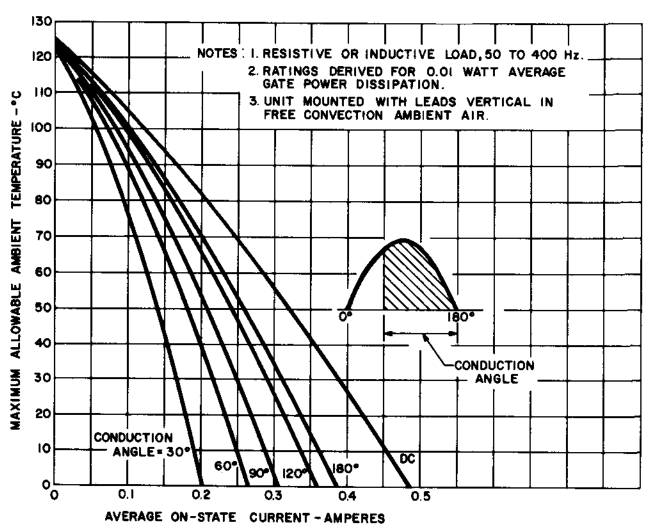
1. MAXIMUM ON-STATE CHARACTERISTICS



2. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM

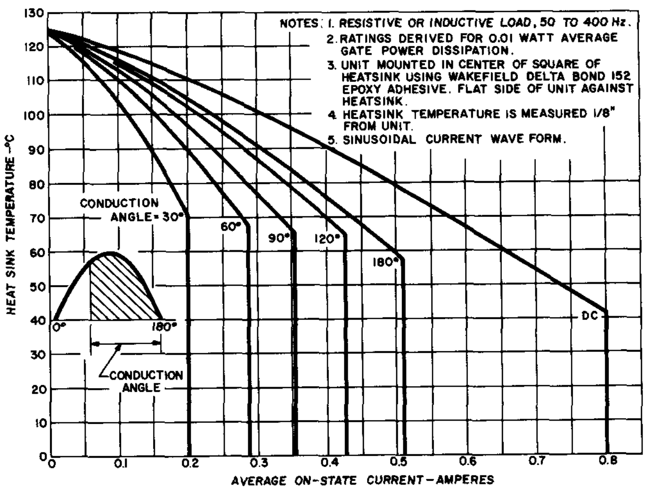


3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM

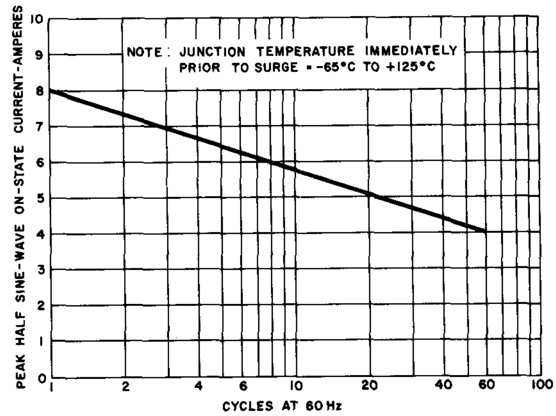


4. MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM

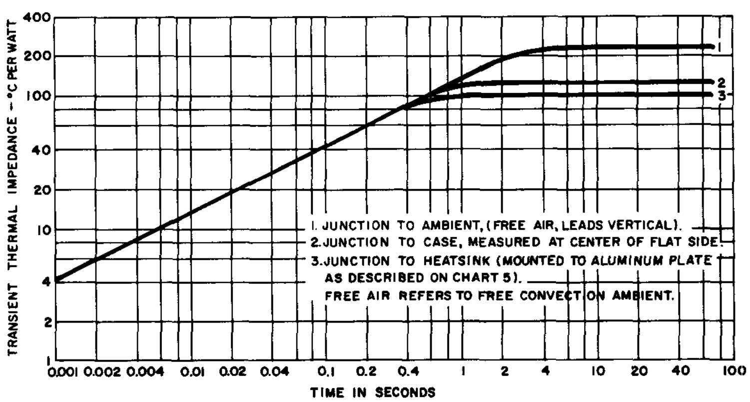
TYPICAL CHARACTERISTICS



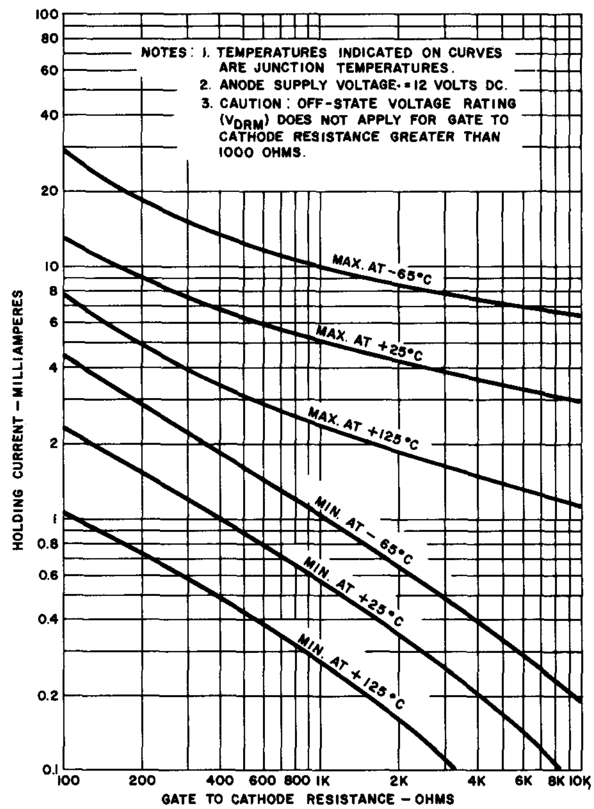
5. TYPICAL CURRENT CARRYING CAPABILITY FOR DEVICE MOUNTED ON 1" x 1" x 1/16" ALUMINUM HEATSINK



6. MAXIMUM ALLOWABLE SURGE (NON-REP) ON-STATE CURRENT



7. MAXIMUM TRANSIENT THERMAL IMPEDANCE



8. MAXIMUM AND MINIMUM HOLDING CURRENT VARIATION WITH GATE TO CATHODE RESISTANCE

*Chart 5. For reference only, units are not available in this configuration.

Silicon Controlled Rectifier

C220
C222

10 A RMS 25-600 Volts

The Silicon Controlled Rectifier C220/C222 is a reverse blocking triode thyristor. This SCR is a hermetically sealed device which incorporates General Electric's patented POWER-GLAS™ process that improves upon normal pellet passivation techniques. It provides an intimate bond between the silicon chip and the glass coating. The resulting stable, low-level leakage current provides excellent performance and demonstrated reliability.

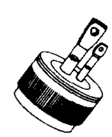
FEATURES:

- POWER-GLAS™ passivated silicon chip for maximum reliability.
- Very low off-state (leakage) current at room and elevated temperatures.
- Excellent surge current capability.
- 1800 Volts RMS surge isolation voltage on isolated SCR's.
- Attractive pricing for applications requiring medium power devices.

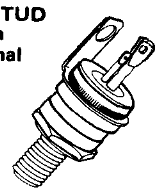
SIX BASIC PACKAGES

- Other packages available upon request.

PRESS-FIT

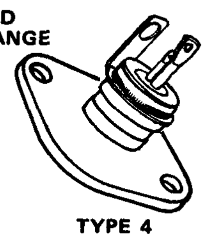


ISOLATED STUD
With Press-On Anode Terminal



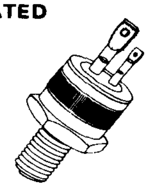
TYPE 2

ISOLATED TO-3 FLANGE



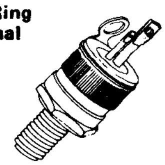
TYPE 4

NON-ISOLATED STUD



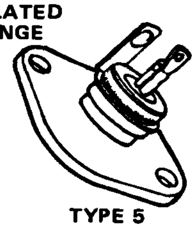
TYPE 1

ISOLATED STUD
With Solder Ring Anode Terminal



TYPE 3

NON-ISOLATED TO-3 FLANGE



TYPE 5

MAXIMUM ALLOWABLE RATINGS

VOLTAGE RATINGS								TEST CONDITIONS
U	F	A	B	C	D	E	M	
VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	
25	50	100	200	300	400	500	600	V_{DRM} – Repetitive Peak Off-State Voltage (1,3) V_{RRM} – Repetitive Peak Reverse Voltage T_C = -40°C to 100°C
35	75	150	300	400	500	600	720	V_{RSM} – Non-Repetitive Reverse Voltage (1,2) T_C = -40°C to 100°C

RMS On-State Current, $I_{T(RMS)}$ . . . . . . 10 Amperes (All Conduction Angles)
Average On-State Current, $I_{T(AV)}$ . . . . . . Depends on Conduction Angle (See Charts 1 and 2)
Critical Rate-of-Rise of On-State Current, di/dt (4) . . . . . . (See Chart 9)
Gate triggered operation – Switching from 200 Volts . . . . . . 100 Amperes Per Microsecond
– Switching from 500 Volts . . . . . . 50 Amperes Per Microsecond
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} 50 Hz . . . . . . 82 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} 60 Hz. . . . . . 90 Amperes
I^2t (for fusing) for times at 8.3 milliseconds (See Chart 11) . . . . . . 34 Ampere^2 Seconds
I^2t (for fusing) for times at 1.5 milliseconds (See Chart 11) . . . . . . 27 Ampere^2 Seconds
Peak Gate Power Dissipation, P_{GM} . . . . . . 5 Watts for 10 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . . . 0.5 Watts
Peak Positive Gate Current, I_{GM} . . . . . . (See Chart 6)
Peak Positive Gate Voltage, V_{GM} . . . . . . (See Chart 6)
Peak Negative Gate Voltage, V_{GM}. . . . . . 5 Volts
Storage Temperature, T_{stg}. . . . . . -40°C to +125°C
Operating Temperature, T_J . . . . . . -40°C to +100°C
Stud Torque (Isolated and Non-Isolated Stud Types) . . . . . . 25 Lb.-In. (29 Kg.-Cm.) (2.8N-M)
Insertion Pressure (Press-Fit Type) . . . . . . 800 Lbs. (364 Kg.) (3.56N x 10^3)
Isolation Breakdown Voltage Between any Terminal and Stud or Flange (Isolated Types)(5) . . . . . . 1800 Volts RMS

NOTES:
1. Values apply for zero or negative gate voltage only.
2. Half sine wave voltage pulse, 10 milliseconds maximum duration.
3. During performance of the Off-State and Reverse Blocking tests, the SCR should not be tested with a constant current source which would permit applied voltage to exceed the device rating.
4. di/dt rating is established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6.
5. Rating applies for 50, 60 and 400 Hz sinusoidal wave form.

PART NUMBER DESIGNATION

C 220 U 2

SILICON CONTROLLED RECTIFIER (C)

CURRENT RATING & PACKAGE STYLE (220)

220 = 10 A RMS Stud/TO-3 Flange
222 = 10 A RMS Press-Fit

VOLTAGE RATINGS (U)

U = 25 Volts
F = 50 Volts
A = 100 Volts
B = 200 Volts
C = 300 Volts
D = 400 Volts
E = 500 Volts
M = 600 Volts

STUD/TO-3 FLANGE PACKAGE VARIATIONS (2)

None = Non-Isolated Stud Mount
2 = Isolated Stud Mount with Press on Anode Terminal
3 = Isolated Stud Mount with Solder Ring Anode Terminal
4 = Isolated on TO-3 Outline Mounting Flange
5 = Non-Isolated on TO-3 Outline Mounting Flange
6 – 9 = Other Standard Variations

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current[1]	I_{RRM} and I_{DRM}				mA	$V_{DRM} = V_{RRM}$ = max. allowable volts peak
		–	–	0.1		T_C = + 25°C
		–	–	0.5		T_C = +100°C
Peak On-State Voltage	V_{TM}	–	–	1.95	Volts	T_C = +25°C, I_{TM} = 20 A Peak, 1 millisecond wide pulse, duty cycle ≤ 2%.
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	–	50	–	Volts/μsec	T_C = +100°C, Rated V_{DRM}. Gate open circuited, linear wave form.
DC Gate Trigger Current	I_{GT}	–	–	25	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 91 Ohms
		–	–	40		T_C = -40°C, V_D = 6 Vdc, R_L = 45 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	1.5	Vdc	T_C = +25°C, V_D = 6 Vdc, R_L = 91 Ohms
		–	–	2.0		T_C = -40°C, V_D = 6 Vdc, R_L = 45 Ohms
DC Gate Non-Trigger Voltage	V_{GD}	0.2	–	–	Vdc	T_C = +100°C, Rated V_{DRM}, R_L = 1000 Ohms
DC Holding Current	I_H				mAdc	Anode Source Voltage = 24 Vdc, Peak Initiating On-State Current = 0.5A, 0.1 msec to 10 msec Wide Pulse. Gate Trigger Source = 7 Volts, 20 Ohms.
		–	–	30		T_C = +25°C
		–	–	60		T_C = -40 °C
DC Latching Current	I_L				mAdc	Anode Source Voltage = 24 Vdc. Gate trigger source = 15 Volts, 100 Ohms, 50 μsec pulse width, 5 μsec rise and fall times maximum.
		–	–	60		T_C = +25°C
		–	–	120		T_C = -40°C
Steady-State Thermal Resistance[2]	$R_{\theta JA}$	–	–	45	°C/Watt	Junction-to-Ambient
Steady-State Thermal Resistance	$R_{\theta JC}$				°C/Watt	Junction-to-Case
		–	–	2.00		Non-Isolated Stud/Press Fit
		–	–	2.15		Isolated Stud
		–	–	2.15		Non-Isolated TO-3 Flange
		–	–	2.30		Isolated TO-3 Flange

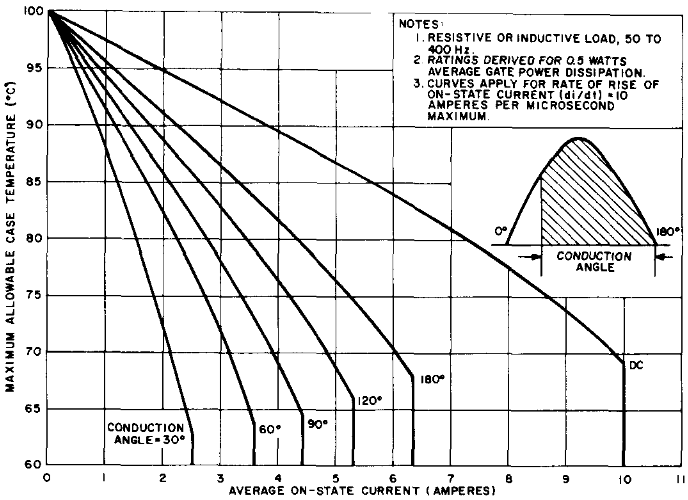
NOTES:

1. Values apply for zero or negative gate voltage only.
2. The junction-to-ambient value is under worst case conditions; i.e., with No. 22 copper wire used for electrical contact to the terminals and natural convection cooling.

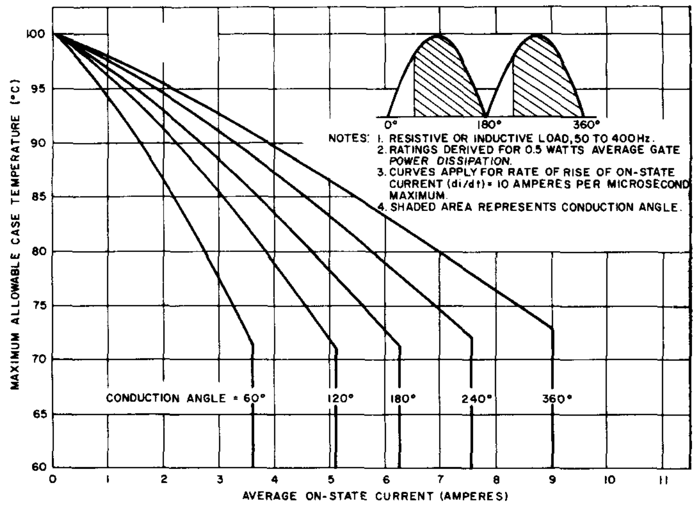
WARNING

Isolated products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

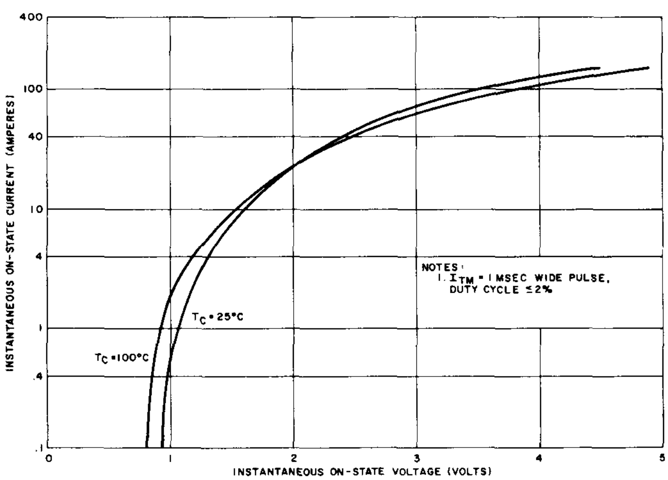
Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.



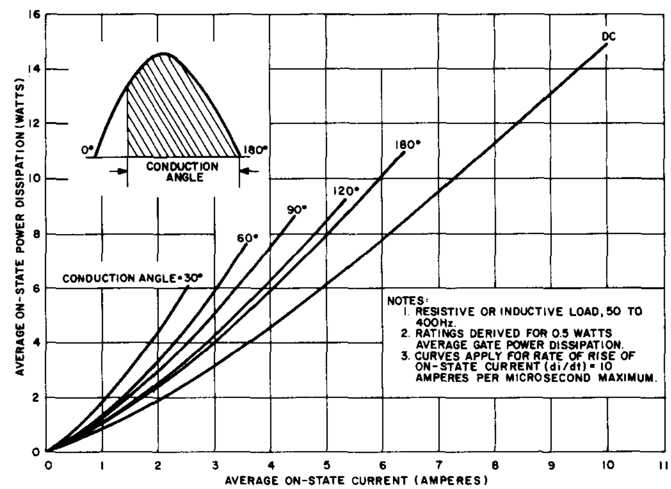
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT (FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)



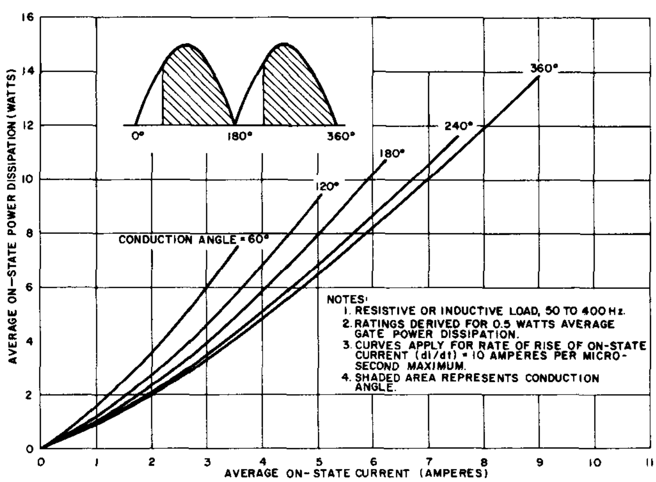
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR FULL-WAVE RECTIFIED SINE WAVE OF CURRENT (FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)



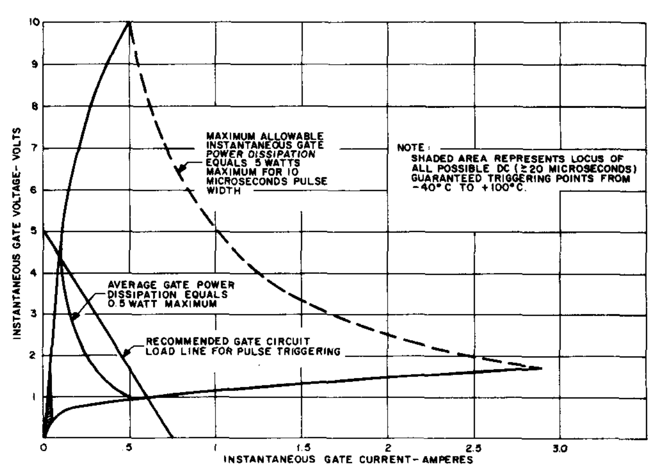
3. MAXIMUM ON-STATE VOLTAGE VS. ON-STATE CURRENT



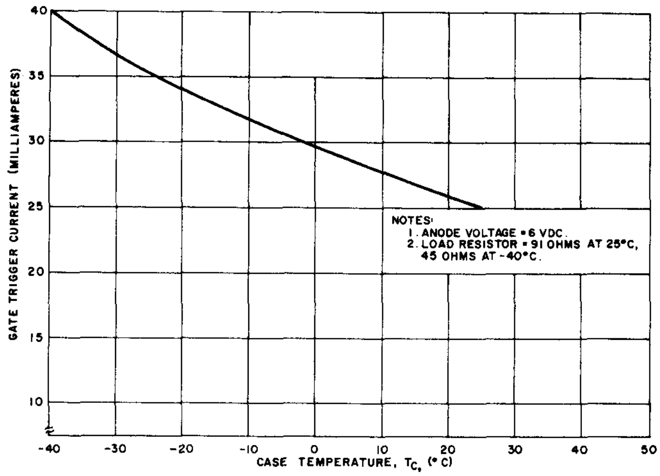
4. MAXIMUM ON-STATE POWER DISSIPATION FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT



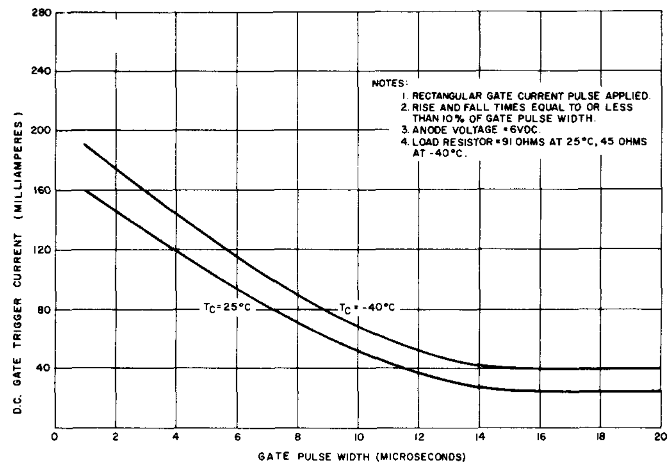
5. MAXIMUM ALLOWABLE ON-STATE POWER DISSIPATION FOR FULL-WAVE SINE WAVE OF CURRENT



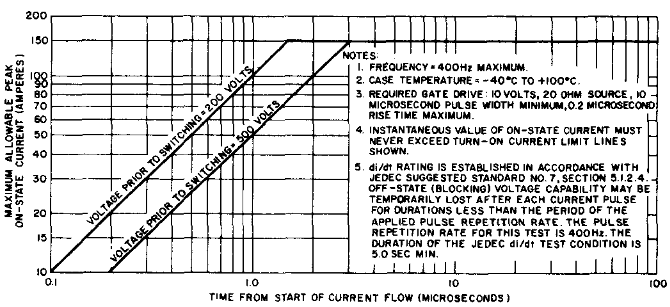
6. GATE TRIGGER CHARACTERISTICS



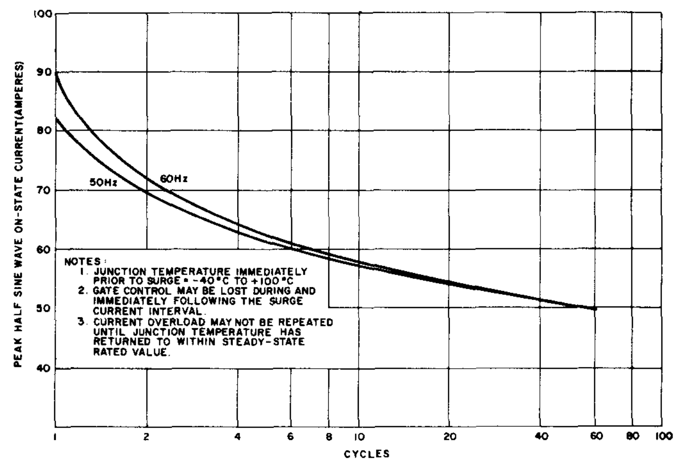
7. MAXIMUM DC GATE CURRENT TO TRIGGER VS. CASE TEMPERATURE



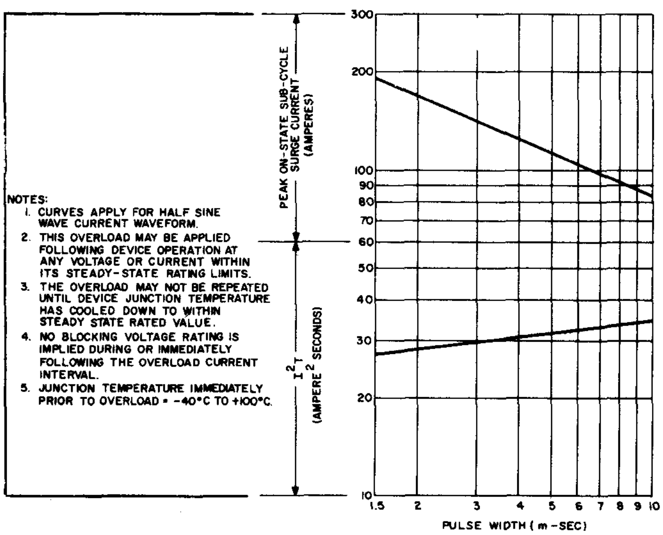
8. MAXIMUM DC GATE CURRENT TO TRIGGER VS. GATE PULSE WIDTH



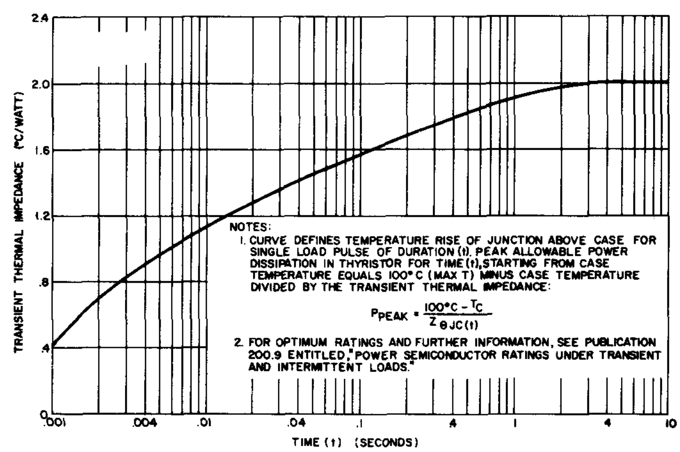
9. TURN-ON CURRENT LIMIT



10. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

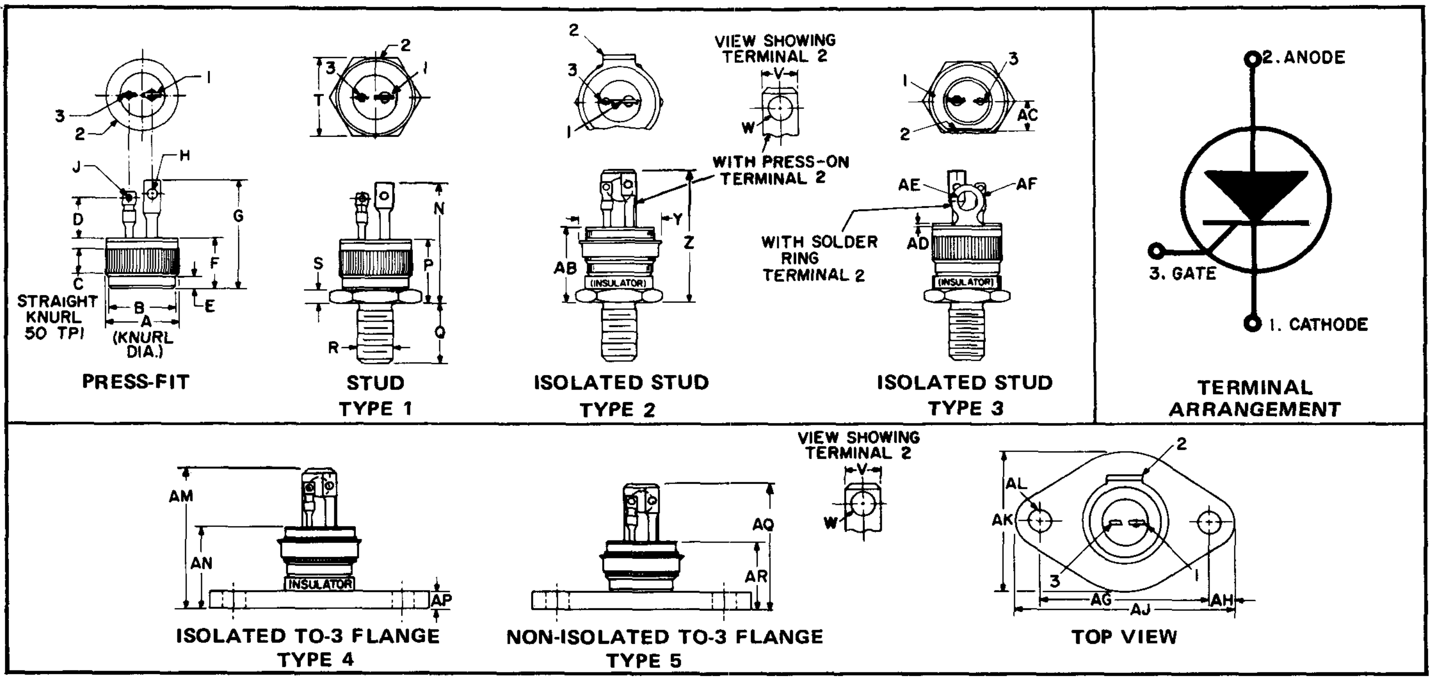


11. SUB-CYCLE SURGE AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS



12. MAXIMUM TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE

(FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)



SYMBOL	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.
A	.501	.505	12.73	12.82
B	.467	.475	11.87	12.06
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.083	.097	2.11	2.46
F	.340	.376	8.64	9.55
G	—	.782	—	19.86
H	.081	.089	2.06	2.26
J	.060	.069	1.53	1.75
N	—	.868	—	22.04
P	—	.475	—	12.06
Q	.432	.442	10.98	11.22
R(5)	1/4-28, UNF2A		—	—
S	.086	.098	2.19	2.48
T	.552	.562	14.03	14.27
V	.240	.260	6.10	6.60
W	.145	.160	3.68	4.06

SYMBOL	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.
Y	.580	.610	14.74	15.49
Z	—	.978	—	24.84
AB		.585	—	14.85
AC	.220 REF.		5.59 REF.	
AD	.012	.023	.31	.58
AE	.140	.150	3.56	3.81
AF	.229	.251	5.82	6.37
AG	1.182	1.192	30.03	30.27
AH	.160	—	4.07	—
AJ	1.507	1.567	38.28	39.80
AK	.975	1.025	24.77	26.03
AL	.150	.161	3.81	4.08
AM	—	1.018	—	25.92
AN	—	.630	—	16.00
AP	.119	.131	3.03	3.32
AQ	—	.913	—	23.25
AR	—	.515	—	13.08

NOTES:

1. Case temperature is measured for press-fit devices at the center of the base; for stud types 1, 2 and 3 at the center of any hex flat; for TO-3 outline mounting flange types 4 and 5 at the center of the bottom of the flange.
2. One external tooth lock washer and one nut (both steel, cadmium plated) are supplied with each stud and isolated stud unit.
3. Insulation hardware for stud devices consisting of solder terminal, mica washers and one nylon bushing are available at extra cost upon request.
4. Other standard package variations are available upon request.
5. Metric stud 8mm x 1.25 (.315 in. x .049 in.) is available upon request.

MOUNTING CONSIDERATIONS

Installation of Press-Fit SCR in Heat Sink

When press fitting SCR into a heatsink, the following specifications and recommendations apply:

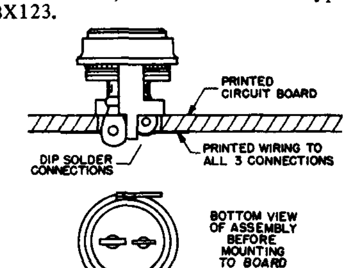
1. Heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the SCR should be 1/8 inch.
2. The hole diameter into which the SCR is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the SCR should be in contact with the heatsink to insure maximum heat transfer. The SCR must not be inserted into a heatsink deeper than the knurl height.
4. The SCR insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the SCR is misaligned with the hole or the SCR-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the SCR within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the SCR case and a copper heatsink will not exceed 0.5°C/W, if the SCR is inserted in the manner described.

Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heat sink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press Fit Device to Printed Circuit Board

For certain light load applications, the SCR can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and anode electrical connection. For SCRs preassembled into the bracket, add -X123 to the type number, for example C222BX123.



Attachment of the Stud & Isolated Stud Device to a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

Silicon Controlled Rectifier

C228
C229

35 A RMS   50 TO 600 VOLTS

The Silicon Controlled Rectifier C228/C229 is a reverse blocking triode thyristor. This SCR is a hermetically sealed device which incorporates General Electric's patented POWER-GLAS™ process that improves upon normal pellet passivation techniques. It provides an intimate bond between the silicon chip and the glass coating. The resulting stable, low-level leakage current provides excellent performance and demonstrated reliability.

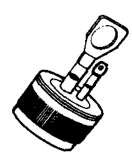
FEATURES:

- POWER-GLAS™ passivated silicon chip for maximum reliability.
- Very low off-state (leakage) current at room and elevated temperatures.
- Low power required for gate triggering.
- Power switching capabilities up to 10 KW.
- Excellent surge current capability.
- 1800 Volts RMS surge isolated voltage on isolated SCR's.
- Attractive pricing for applications requiring medium power devices.

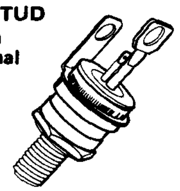
SIX BASIC PACKAGES

- Other packages available upon request.

PRESS-FIT

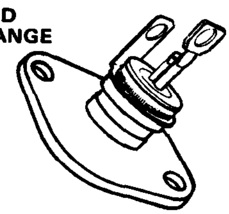


ISOLATED STUD
With Press-On Anode Terminal



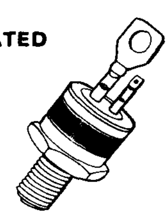
TYPE 2

ISOLATED TO-3 FLANGE



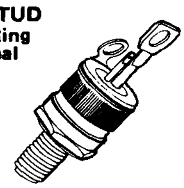
TYPE 4

NON-ISOLATED STUD



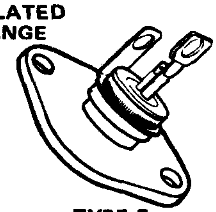
TYPE 1

ISOLATED STUD
With Solder Ring Anode Terminal



TYPE 3

NON-ISOLATED TO-3 FLANGE



TYPE 5

MAXIMUM ALLOWABLE RATINGS

VOLTAGE RATINGS								
U	F	A	B	C	D	E	M	TEST CONDITIONS
VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	
25	50	100	200	300	400	500	600	V_{DRM} – Repetitive Peak Off-State Voltage (1,3) V_{RRM} – Repetitive Peak Reverse Voltage T_C = -40°C to 100°C
35	75	150	300	400	500	600	720	V_{RSM} – Non-Repetitive Reverse Voltage (1,2) T_C = -40°C to 100°C

RMS On-State Current, $I_{T(RMS)}$ . . . . 35 Amperes (All Conduction Angles)
Average On-State Current, $I_{T(AV)}$ . . . . Depends on Conduction Angle (See Charts 1 and 2)
Critical Rate-of-Rise of On-State Current, di/dt (4) . . . . (See Chart 10)
Gate Triggered Operation – Switching from 200 Volts. . . . . 100 Amperes Per Microsecond
– Switching from 400 Volts. . . . . 65 Amperes Per Microsecond
– Switching from 500 Volts. . . . . 30 Amperes Per Microsecond
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} 60 Hz. . . . . 300 Amperes
I^2t (for fusing) at 8.3 milliseconds (See Chart 7) . . . . 3.70 Ampere² Seconds
I^2t (for fusing) at 1.0 milliseconds (See Chart 7) . . . . 2.60 Ampere² Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 5 Watts for 10 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 0.5 Watts
Peak Positive Gate Current, I_{GM}. . . . . (See Chart 9)
Peak Positive Gate Voltage, V_{GM} . . . . (See Chart 9)
Peak Negative Gate Voltage, V_{GM}. . . . . 5 Volts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Stud Torque (Isolated and Non-Isolated Stud Types). . . . . 25 Lb.-In. (29 Kg-Cm) (2.8 N-M)
Maximum Insertion Pressure (Press-Fit Types) . . . . 800 Lbs. (364 Kg) (3.56N x 10³)
Isolation Breakdown Voltage Between any Terminal, Stud or Flange (Isolated Types)(5) . . . . 1800 Volts RMS

NOTES:
1. Values apply for zero or negative gate voltage only.
2. Half sine wave voltage pulse, 10 millisecond maximum duration.
3. During performance of the Off-State and Reverse Blocking tests, the SCR should not be tested with a constant current source which would permit applied voltage to exceed the device rating.
4. di/dt rating is established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6.
5. Rating applies for 50, 60 and 400 Hz sinusoidal waveform.

PART NUMBER DESIGNATION

C 228 U 2

SILICON CONTROLLED RECTIFIER (C)

CURRENT RATING & PACKAGE STYLE (228)

228 = 35 A RMS Stud/TO-3 Flange
229 = 35 A RMS Press-Fit

VOLTAGE RATINGS (U)

U = 25 Volts
F = 50 Volts
A = 100 Volts
B = 200 Volts
C = 300 Volts
D = 400 Volts
E = 500 Volts
M = 600 Volts

STUD/TO-3 FLANGE PACKAGE VARIATIONS (2)

None = Non-Isolated Stud Mount
2 = Isolated Stud Mount with Press-on Anode Terminal
3 = Isolated Stud Mount with Solder Ring Anode Terminal
4 = Isolated on TO-3 Outline Mounting Flange
5 = Non-Isolated on TO-3 Outline Mounting Flange
6 – 9 = Other Standard Variations

CHARACTERISTICS

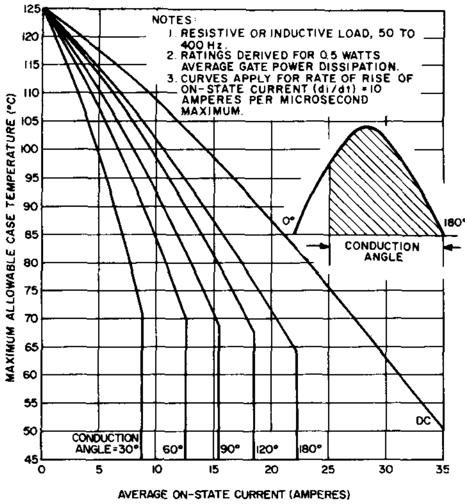
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Off-State and Reverse Current (1)	I_{RRM} and I_{DRM}				mA	$V_{DRM} = V_{RRM}$ = Max. allowable volts peak
		–	–	1.0		T_C = +25°C
		–	–	3.0		T_C = +125°C
Peak On-State Voltage	V_{TM}	–	–	1.9	Volts	T_C = +25°C, I_{TM} = 100 Amps. peak, 1 millisecond wide pulse. Duty Cycle ≤ 2%.
DC Gate Trigger Current	I_{GT}	–	–	40	mAdc	T_C = +25°C, V_D = 12 Vdc, R_L = 80 Ohms
		–	–	80		T_C = -40°C, V_D = 12 Vdc, R_L = 50 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	2.5	Vdc	T_C = +25°C, V_D = 12 Vdc, R_L = 80 Ohms
		–	–	3.0		T_C = -40°C, V_D = 12 Vdc, R_L = 80 Ohms
DC Gate Non-Trigger Voltage	V_{GD}	0.2	–	–	Vdc	T_C = +125°C, Rated V_{DRM}, R_L = 1000 Ohms
DC Holding Current	I_H				mAdc	Anode Source Voltage = 24 Vdc, Peak Initiating On-State Current = 0.5 Amps, 0.1 msec to 10 msec wide pulse. Gate Trigger Source = 7 Volts, 20 Ohms
		–	–	75		T_C = +25°C
		–	–	150		T_C = -40°C
DC Latching Current	I_L				mAdc	Anode Source Voltage = 24 Vdc. Gate trigger source = 15 Volts, 100 Ohms, 50 μsec pulse width, 5 μsec rise and fall times max.
		–	–	150		T_C = +25°C
		–	–	300		T_C = -40°C
Steady-State Thermal Resistance(2)	$R_{\theta JA}$	–	–	45	°C/Watt	Junction-to-Ambient
Steady-State Thermal Resistance	$R_{\theta JC}$				°C/Watt	Junction-to-Case
		–	–	1.70		Non-Isolated Stud/Press-Fit
		–	–	1.85		Isolated Stud
		–	–	1.85		Non-Isolated TO-3 Flange
		–	–	2.0		Isolated TO-3 Flange

NOTES:
1. Values apply for zero or negative gate voltage only.
2. The junction-to-ambient value is under worst case conditions; i.e. with No. 22 copper wire used for electrical contact to the terminals and natural convection cooling.

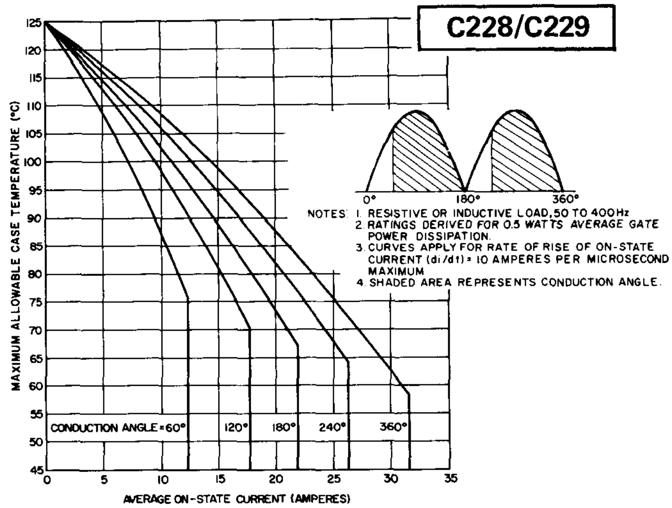
WARNING

Isolated products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

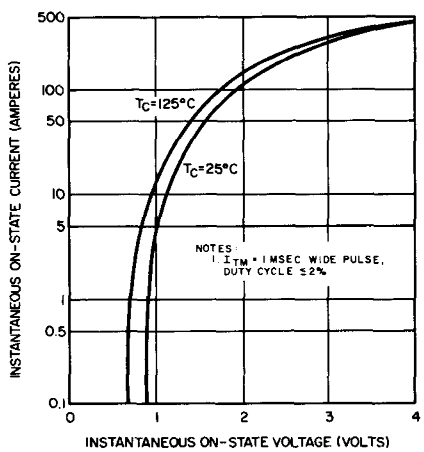
Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.



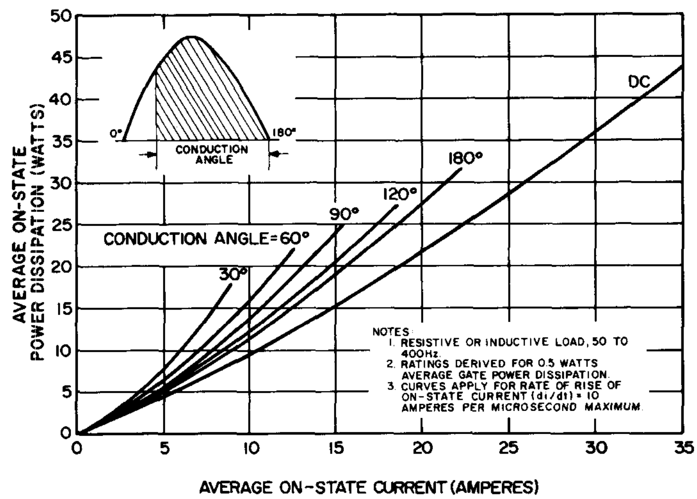
1. **MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT (FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)**



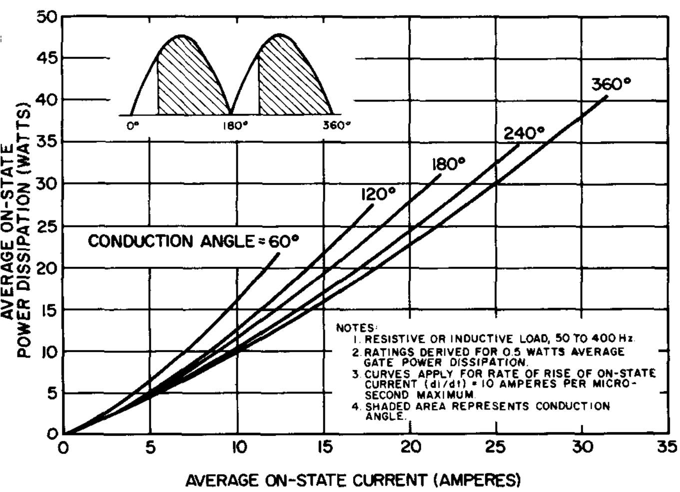
2. **MAXIMUM ALLOWABLE CASE TEMPERATURE FOR FULL-WAVE RECTIFIED SINE WAVE OF CURRENT (FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)**



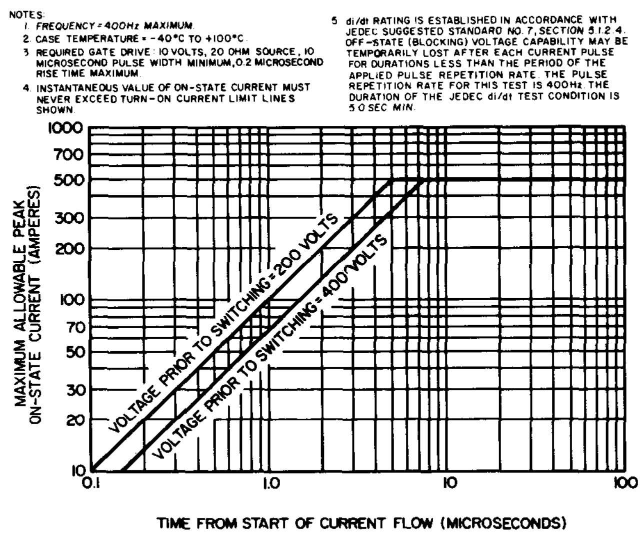
3. **MAXIMUM ON-STATE VOLTAGES VS. ON-STATE CURRENT**



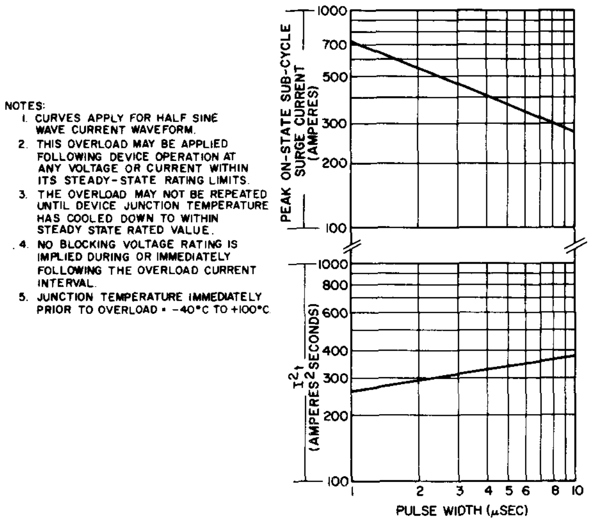
4. **MAXIMUM ON-STATE POWER DISSIPATION FOR HALF-WAVE RECTIFIED SINE WAVE OF RECTIFIED CURRENT**



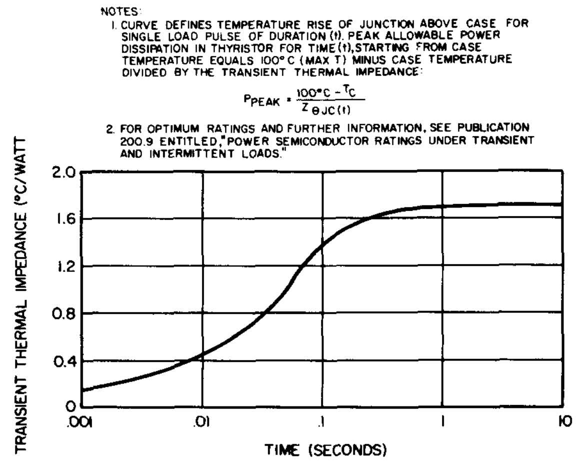
5. **MAXIMUM ALLOWABLE ON-STATE POWER DISSIPATION FOR FULL-WAVE SINE WAVE OF CURRENT**



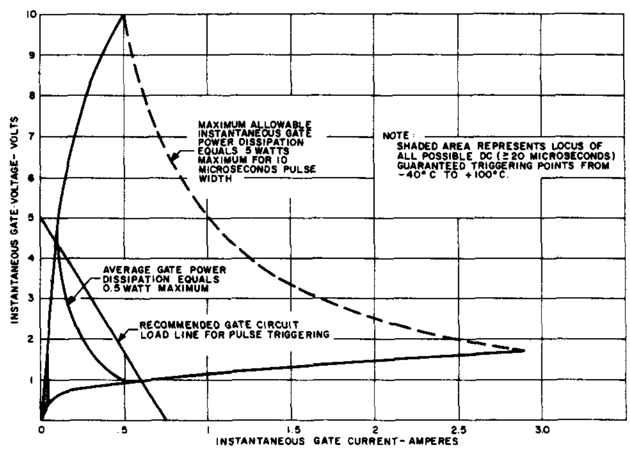
6. **TURN-ON CURRENT LIMIT**



7. SUB-CYCLE SURGE AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS



8. MAXIMUM TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE
(FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)

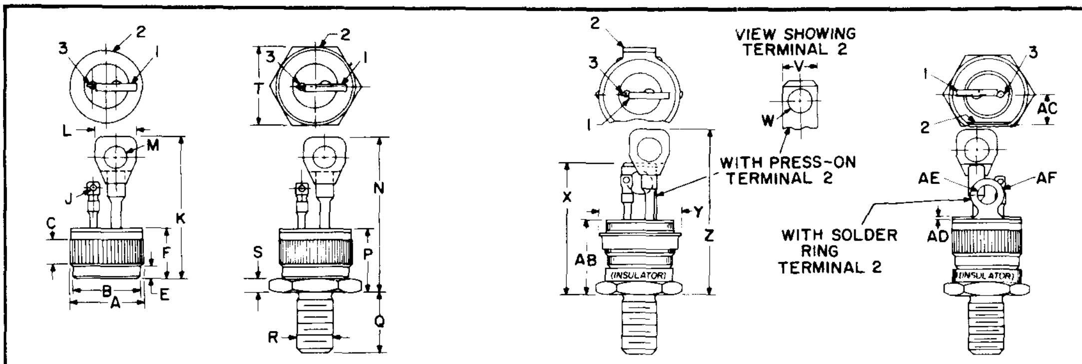


9. GATE TRIGGER CHARACTERISTICS

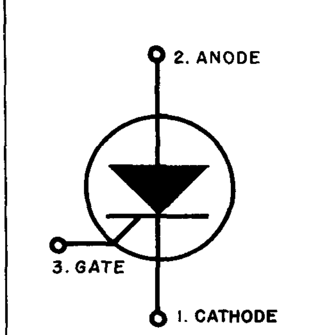
APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

PUBLICATION NUMBER	APPLICATION NOTES
200.31	Phase Control of SCR's With Transformer and Other Inductive AC Loads
200.32	A Variety of Mounting Techniques for Press-Fit SCR's and Rectifiers
200.33	Regulated Battery Charges Using the Silicon Controlled Rectifier
200.43	Solid State Control for DC Motors Provides Variable Speed with Synchronous – Motor Performance

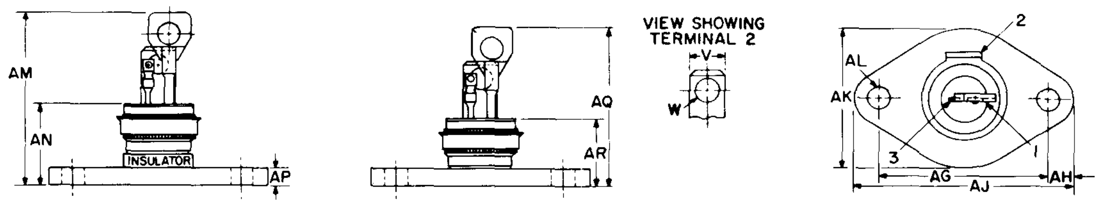
PUBLICATION NUMBER	APPLICATION NOTES
200.44	Speed Control for Shunt-Wound Motors
200.47	Speed Control for Universal Motors
200.48	Washers, Ring Counters and Chasers
201.1	A Plug-In Speed Control for Standard Portable Tools and Appliances
201.13	Universal Motor Control With Built-In Self-Timer
ETR 3875A	SCR Manual



PRESS-FIT — STUD TYPE 1 — ISOLATED STUD TYPE 2 — ISOLATED STUD TYPE 3



TERMINAL ARRANGEMENT



ISOLATED TO-3 FLANGE TYPE 4 — NON-ISOLATED TO-3 FLANGE TYPE 5

SYMBOL	INCHES		METRIC MM		SYMBOL	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.		MIN.	MAX.	MIN.	MAX.
A	.501	.505	12.73	12.82	X	—	.975	—	24.76
B	.467	.475	11.87	12.06	Y	.580	.610	14.74	15.49
C	.177 REF.		4.50 REF.		Z	—	1.260	—	32.00
D	.260	.301	6.60	7.65	AB		.585	—	14.85
E	.083	.097	2.11	2.46	AC	.220 REF.		5.59 REF.	
F	.340	.376	8.64	9.55	AD	.012	.023	.31	.58
G	—	.782	—	19.86	AE	.140	.150	3.56	3.81
H	.081	.089	2.06	2.26	AF	.229	.251	5.82	6.37
J	.060	.069	1.53	1.75	AG	1.182	1.192	30.03	30.27
K	—	1.064	—	27.02	AH	.160	—	4.07	—
L	.284	.302	7.22	7.67	AJ	1.507	1.567	38.28	39.80
M	.146	.160	3.71	4.06	AK	.975	1.025	24.77	26.03
N	—	1.150	—	29.21	AL	.150	.161	3.81	4.08
P	—	.475	—	12.06	AM	—	1.300	—	33.02
Q	.432	.442	10.98	11.22	AN	—	.630	—	16.00
R(5)	1/4-28, UNF2A		—	—	AP	.119	.131	3.03	3.32
S	.086	.098	2.19	2.48	AQ	—	1.195	—	30.35
T	.552	.562	14.03	14.27	AR	—	.515	—	13.08
V	.240	.260	6.10	6.60					
W	.145	.160	3.68	4.06					

NOTES:

1. Case temperature is measured for press-fit devices at the center of the base; for stud types 1, 2 and 3 at the center of any hex flat; for TO-3 outline mounting flange types 4 and 5 at the center of the bottom of the flange.
2. One external tooth lock washer and one nut (both steel, cadmium plated) are supplied with each stud and isolated stud unit.
3. Insulation hardware for stud devices consisting of solder terminal, mica washers and one nylon bushing are available at extra cost upon request.
4. Other standard package variations are available upon request.
5. Metric stud 8mm x 1.25 (.315 in. x .049 in.) is available upon request.

MOUNTING CONSIDERATIONS

Installation of Press-Fit SCR in Heat Sink

When press fitting SCR into a heatsink, the following specifications and recommendations apply:

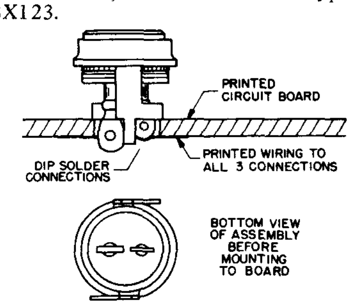
1. Heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the SCR should be 1/8 inch.
2. The hole diameter into which the SCR is pressed must be 0.4975 $\pm$ .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the SCR should be in contact with the heatsink to insure maximum heat transfer. The SCR must not be inserted into a heatsink deeper than the knurl height.
4. The SCR insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the SCR is misaligned with the hole or the SCR-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the SCR within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the SCR case and a copper heatsink will not exceed 0.5°C/W, if the SCR is inserted in the manner described.

Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heat sink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press Fit Device to Printed Circuit Board

For certain light load applications, the SCR can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and anode electrical connection. For SCRs pre-assembled into the bracket, add -X123 to the type number, for example C228BX123.



Attachment of the Stud & Isolated Stud Device to a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

Silicon Controlled Rectifier

C230-C232
C231-C233

25 A RMS TO 600 VOLTS

The Silicon Controlled Rectifier C230/C232 is a reverse blocking triode thyristor designed for power switching and control circuits for high volume light industrial and consumer applications.

The C231/C233 is basically the same as the C230/C232 device except for a specially selected gate trigger current of 9 milliamperes maximum.

This SCR is a hermetically sealed device which incorporates General Electric's patented POWER-GLAS™ process that improves upon normal pellet passivation techniques. It provides an intimate bond between the silicon chip and the glass coating. The resulting stable, low-level leakage current provides excellent performance and demonstrated reliability.

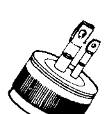
FEATURES:

- POWER-GLAS™ passivated silicon chip for maximum reliability.
- Very low off-state (leakage) current at room and elevated temperatures.
- Low power required for gate triggering.
- Power switching capabilities up to 10 KW.
- Excellent surge current capability.
- 1800 Volts RMS surge isolation voltage on isolated SCR's.
- Attractive pricing for applications requiring medium power devices.

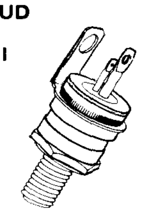
SIX BASIC PACKAGES

- Other packages available upon request.

PRESS-FIT

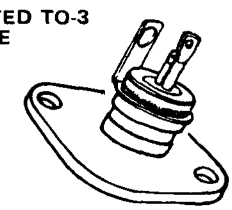


ISOLATED STUD
With Press-On Anode Terminal



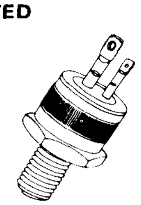
TYPE 2

ISOLATED TO-3 FLANGE



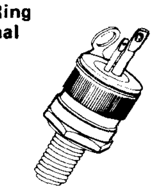
TYPE 4

NON-ISOLATED STUD



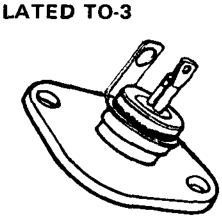
TYPE 1

ISOLATED STUD
With Solder Ring Anode Terminal



TYPE 3

NON-ISOLATED TO-3 FLANGE



TYPE 5

MAXIMUM ALLOWABLE RATINGS

VOLTAGE RATINGS								TEST CONDITIONS
U	F	A	B	C	D	E	M	
VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	
25	50	100	200	300	400	500	600	V_{DRM} – Repetitive Peak Off-State Voltage (1,3) V_{RRM} – Repetitive Peak Reverse Voltage T_C = -40°C to 100°C
35	75	150	300	400	500	600	720	V_{RSM} – Non-Repetitive Reverse Voltage (1,2) T_C = -40°C to 100°C

RMS On-State Current, $I_{T(RMS)}$ . . . . . 25 Amperes (All Conduction Angles)
Average On-State Current, $I_{T(AV)}$ . . . . . Depends on Conduction Angle (See Charts 1 and 2)
Critical Rate-of-Rise of On-State Current, di/dt (4) . . . . . (See Chart 11)
Gate Triggered Operation – Switching from 200 Volts . . . . . 100 Amperes Per Microsecond
– Switching from 400 Volts . . . . . 65 Amperes Per Microsecond
– Switching from 600 Volts . . . . . 30 Amperes Per Microsecond
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM}, 60 Hz . . . . . 250 Amperes
I^2t (for fusing) for times ⩾ 1.0 milliseconds . . . . . 260 Ampere² Seconds
Peak Gate Power Dissipation, P_{GM} . . . . . 5 Watts for 10 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . . 0.5 Watts
Peak Positive Gate Current, I_{GM} . . . . . (See Chart 7)
Peak Positive Gate Voltage, V_{GM} . . . . . (See Chart 7)
Peak Negative Gate Voltage, V_{GM} . . . . . 5 Volts
Storage Temperature, T_{stg} . . . . . -40°C to +125°C
Operating Temperature, T_J . . . . . -40°C to +100°C
Stud Torque (Isolated and Non-Isolated Stud Types) . . . . . 25 Lb.-In. (29 Kg-Cm) (2.8 N-M)
Maximum Insertion Pressure (Press-Fit Types) . . . . . 800 Lbs. (364 Kg)(3.56N x 10^3)
Isolation Breakdown Voltage Between any Terminal and Stud or Flange (Isolated Types)(5) . . . . . 1800 Volts RMS

NOTES:
1. Values apply for zero or negative gate voltage only.
2. Half sine wave voltage pulse, 10 millisecond maximum duration.
3. During performance of the Off-State and Reverse Blocking tests, the SCR should not be tested with a constant current source which would permit applied voltage to exceed the device rating.
4. di/dt rating is established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6.
5. Rating applies for 50, 60 and 400 Hz sinusoidal wave form.

PART NUMBER DESIGNATION

C 230 U 2

SILICON CONTROLLED RECTIFIER (C)

CURRENT RATING & PACKAGE STYLE (230)

230 = 25 A RMS Stud-TO-3 Flange
232 = 25 A RMS Press-Fit

231 = 25 A RMS Stud/TO-3 Flange
233 = 25 A RMS Press-Fit

VOLTAGE RATINGS (U)

U = 25 Volts
F = 50 Volts
A = 100 Volts
B = 200 Volts
C = 300 Volts
D = 400 Volts
E = 500 Volts
M = 600 Volts

STUD/TO-3 FLANGE PACKAGE VARIATIONS (2)

None = Non-Isolated Stud Mount
2 = Isolated Stud Mount with Press-on Anode Terminal
3 = Isolated Stud Mount with Solder Ring Anode Terminal
4 = Isolated on TO-3 Outline Mounting Flange
5 = Non-Isolated on TO-3 Outline Mounting Flange
6 – 9 = Other Standard Variations

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Off-State and Reverse Current(1)	I_{RRM} and I_{DRM}				mA	$V_{DRM} = V_{RRM}$ = Max. allowable volts peak
		–	–	0.5		T_C = +25°C
		–	–	1.0		T_C = +100°C
Peak On-State Voltage	V_{TM}	–	–	1.9	Volts	T_C = +25°C, I_{TM} = 100A Peak, 1 msec wide pulse. Duty Cycle ≤ 2%.
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	–	200	–	Volts/μsec	T_C = +100°C, Rated V_{DRM}, Gate Open Circuited, Linear Wave form.
DC Gate Trigger Current	I_{GT}				mAdc	
C230/C232		–	–	25		T_C = +25°C, V_D = 12 Vdc, R_L = 120 Ohms
		–	–	40		T_C = -40°C, V_D = 12 Vdc, R_L = 60 Ohms
C231/C233		–	–	9		T_C = +25°C, V_D = 12 Vdc, R_L = 120 Ohms
		–	–	20		T_C = -40°C, V_D = 12 Vdc, R_L = 60 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	1.5	Vdc	T_C = +25°C, V_D = 12 Vdc, R_L = 120 Ohms
		–	–	2.0		T_C = -40°C, V_D = 12 Vdc, R_L = 60 Ohms
DC Gate Non-Trigger Voltage	V_{GD}	0.2	–	–	Vdc	T_C = +100°C, Rated V_{DRM}, R_L = 1000 Ohms
DC Holding Current	I_H				mAdc	Anode Source Voltage = 24 Vdc, Peak Initiating On-State Current = 0.5 Amps, 0.1 msec to 10 msec Wide Pulse. Gate Trigger Source = 7 Volts, 20 Ohms
		–	–	50		T_C = +25°C
		–	–	100		T_C = -40°C
DC Latching Current	I_L				mAdc	Anode Source Voltage = 24 Vdc, Gate Trigger Source = 15 Volts, 100 Ohms, 50 μsec Pulse Width, 5 μsec rise and fall times max.
		–	–	100		T_C = +25°C
		–	–	200		T_C = -40°C
Steady-State Thermal Resistance(2)	$R_{\theta JA}$	–	–	45	°C/Watt	Junction-to-Ambient
Steady-State Thermal Resistance	$R_{\theta JC}$				°C/Watt	Junction-to-Case
		–	–	1.00		Non-Isolated Stud/Press-Fit
		–	–	1.15		Isolated Stud
		–	–	1.15		Non-Isolated TO-3 Flange
		–	–	1.30		Isolated TO-3 Flange

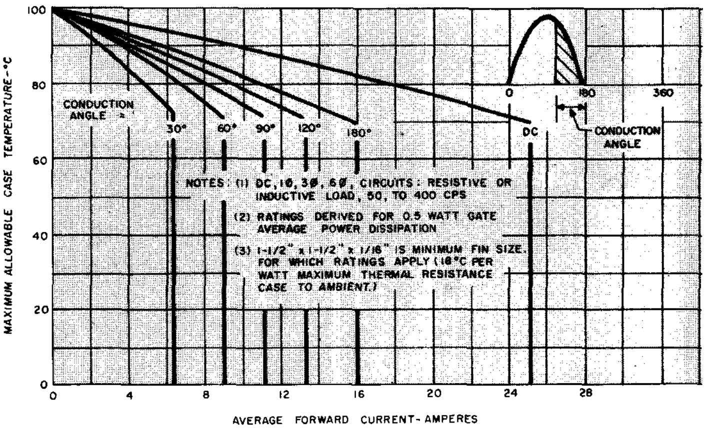
NOTES:

1. Values apply for zero or negative gate voltage only.
2. The junction-to-ambient value is under worst case conditions; i.e., with No. 22 copper wire used for electrical contact to the terminals and natural convection cooling.

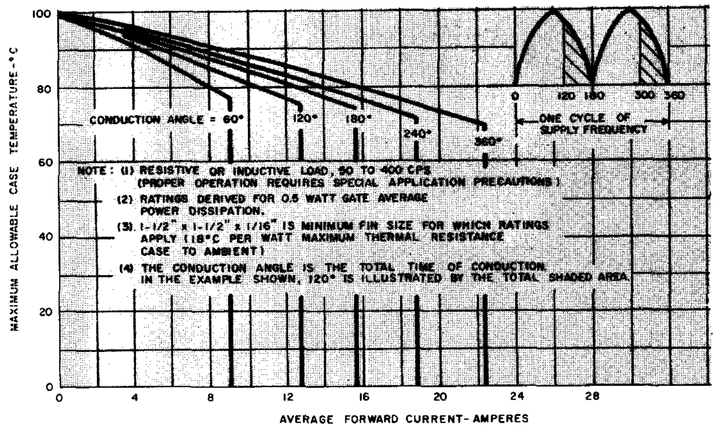
WARNING

Isolated products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

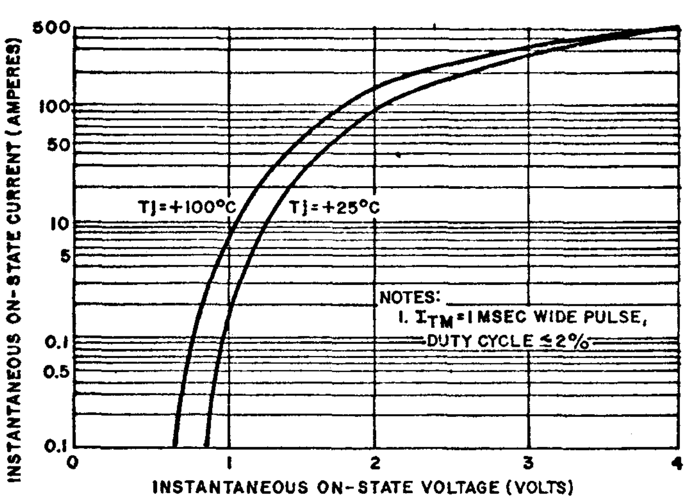
Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.



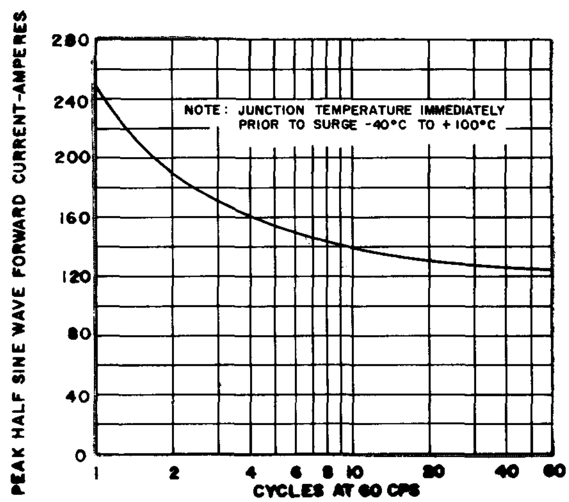
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT (FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)



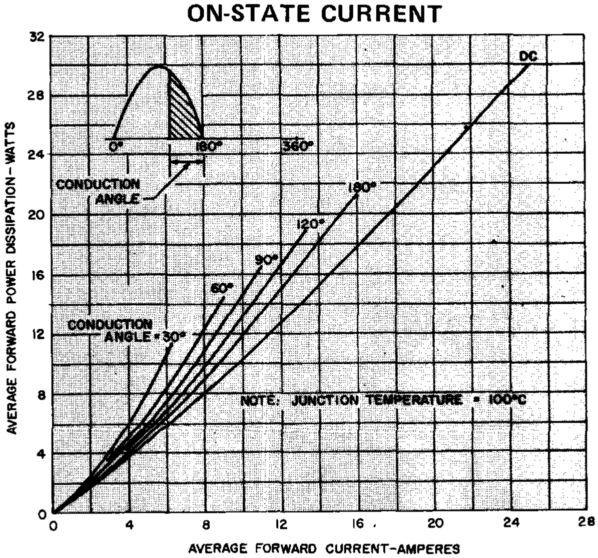
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR FULL-WAVE RECTIFIED FULL-WAVE OF CURRENT (FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)



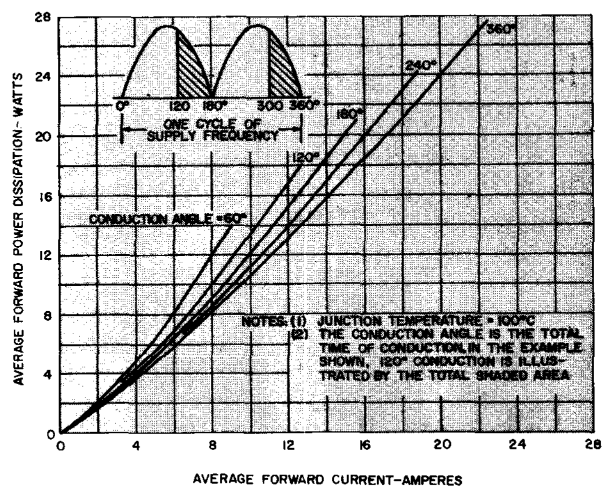
3. MAXIMUM ON-STATE VOLTAGE VS. ON-STATE CURRENT



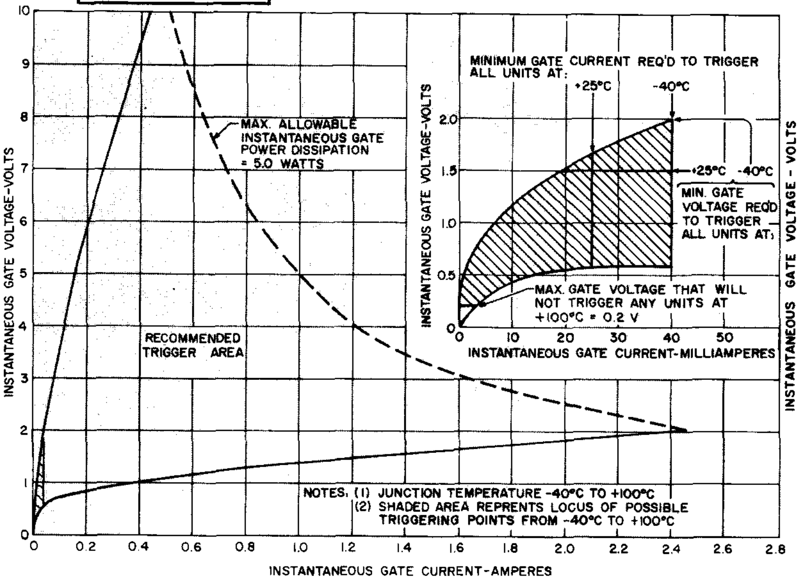
4. MAXIMUM ALLOWABLE PEAK SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



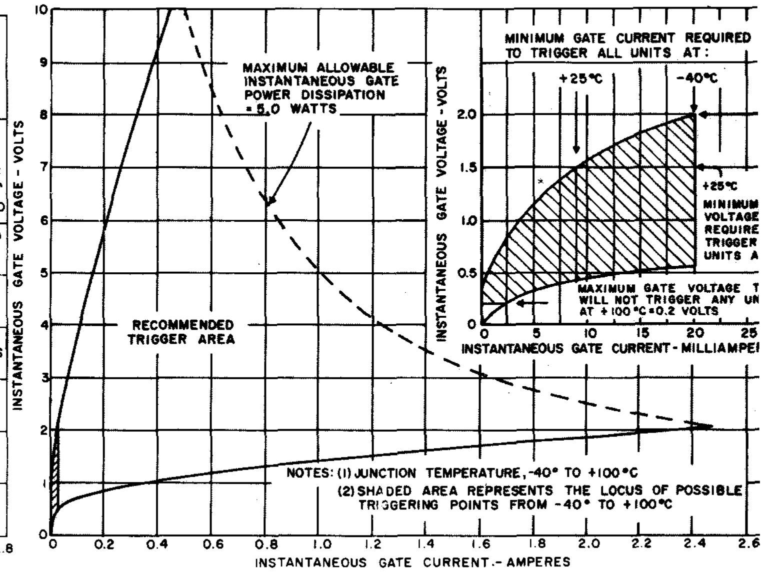
5. MAXIMUM FORWARD POWER DISSIPATION FOR HALF-WAVE RECTIFIED SINE WAVE OF CURRENT



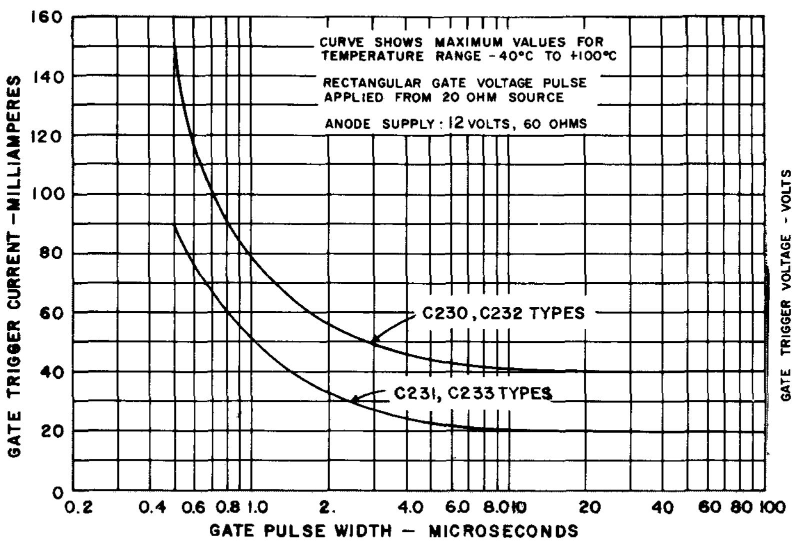
6. MAXIMUM FORWARD POWER DISSIPATION FOR FULL-WAVE RECTIFIED SINE WAVE OF CURRENT



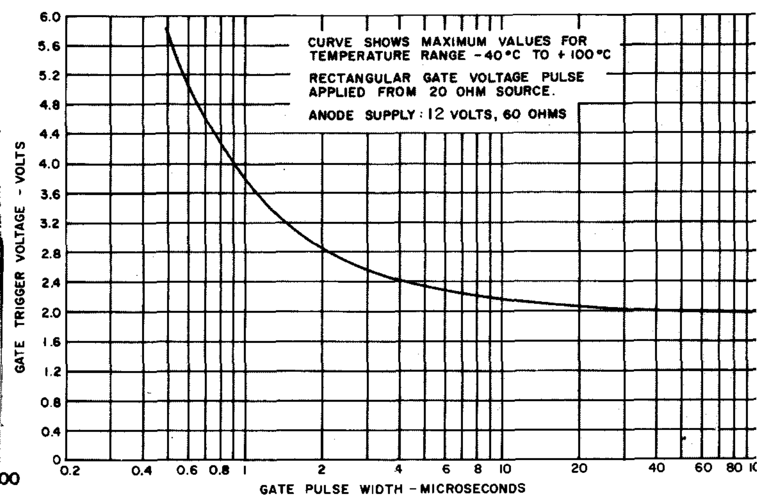
7. GATE TRIGGERING CHARACTERISTICS (C230 AND C232 TYPES)



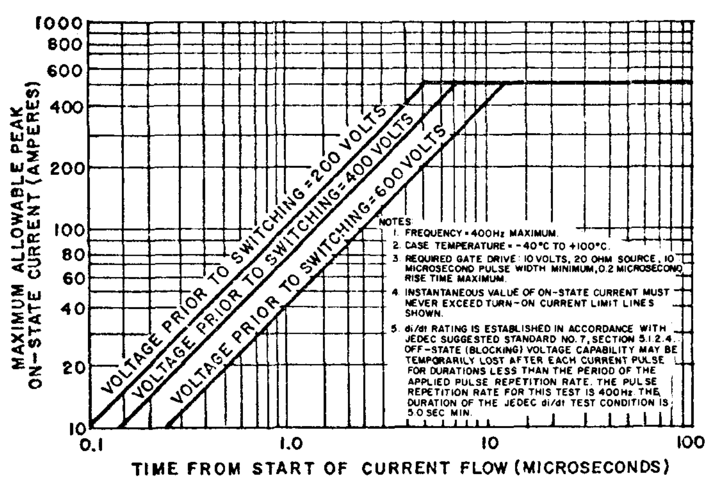
8. GATE TRIGGERING CHARACTERISTICS (C231 AND C233 TYPES)



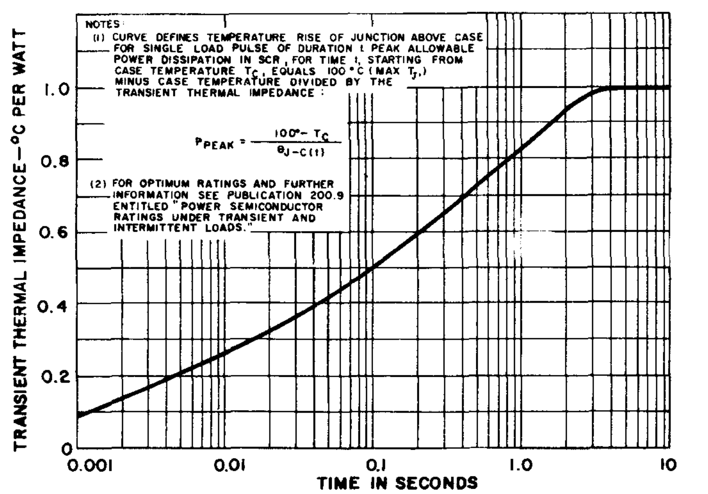
9. VARIATION OF GATE TRIGGER CURRENT WITH GATE PULSE WIDTH (ALL TYPES)



10. VARIATION OF GATE TRIGGER VOLTAGE WITH GATE PULSE WIDTH (ALL TYPES)

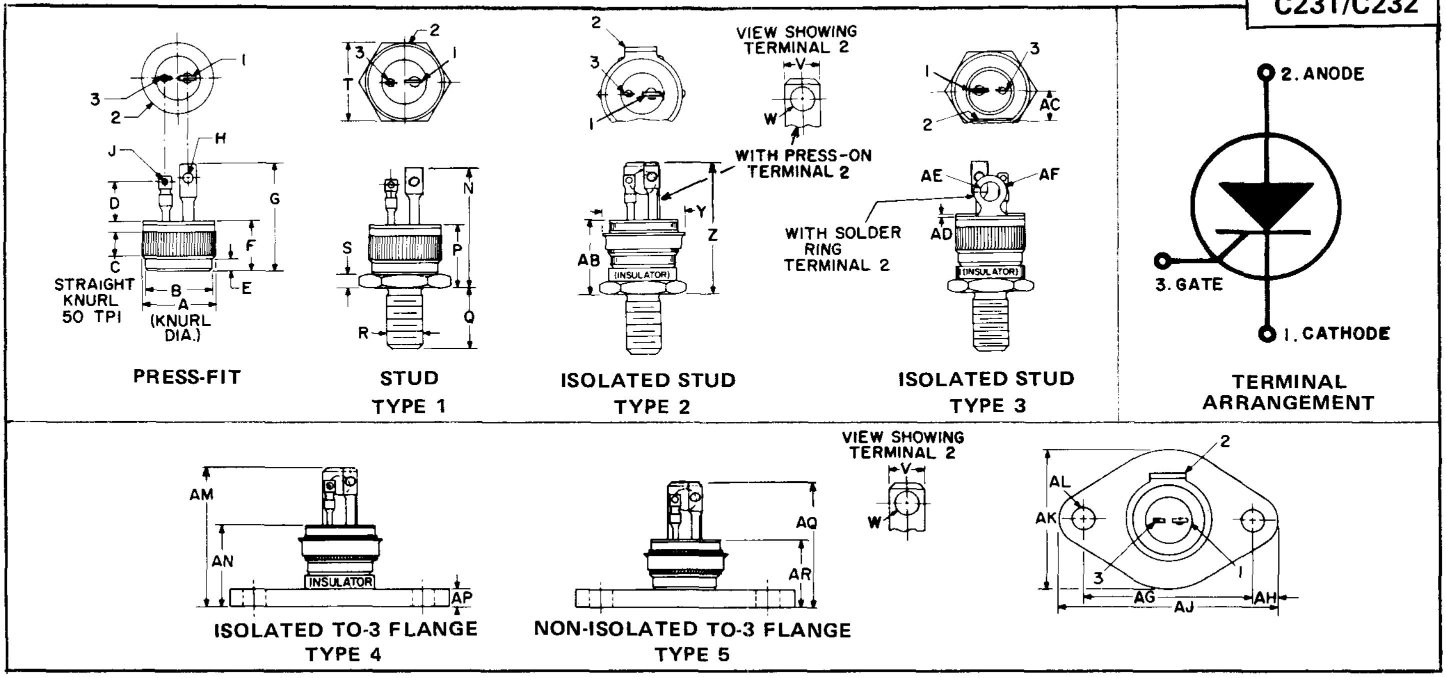


11. TURN-ON CURRENT LIMIT



12. MAXIMUM TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE (FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)

OUTLINE DRAWINGS



SYMBOL	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.
A	.501	.505	12.73	12.82
B	.467	.475	11.87	12.06
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.083	.097	2.11	2.46
F	.340	.376	8.64	9.55
G	—	.782	—	19.86
H	.081	.089	2.06	2.26
J	.060	.069	1.53	1.75
N	—	.868	—	22.04
P	—	.475	—	12.06
Q	.432	.442	10.98	11.22
R (5)	1/4-28, UNF2A		—	—
S	.086	.098	2.19	2.48
T	.552	.562	14.03	14.27
V	.240	.260	6.10	6.60
W	.145	.160	3.68	4.06

SYMBOL	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.
Y	.580	.610	14.74	15.49
Z	—	.978	—	24.84
AB		.585	—	14.85
AC	.220 REF.		5.59 REF.	
AD	.012	.023	.31	.58
AE	.140	.150	3.56	3.81
AF	.229	.251	5.82	6.37
AG	1.182	1.192	30.03	30.27
AH	.160	—	4.07	—
AJ	1.507	1.567	38.28	39.80
AK	.975	1.025	24.77	26.03
AL	.150	.161	3.81	4.08
AM	—	1.018	—	25.92
AN	—	.630	—	16.00
AP	.119	.131	3.03	3.32
AQ	—	.913	—	23.25
AR	—	.515	—	13.08

NOTES:

1. Case temperature is measured for press-fit devices at the center of the base; for stud types 1, 2 and 3 at the center of any hex flat; for TO-3 outline mounting flange types 4 and 5 at the center of the bottom of the flange.
2. One external tooth lock washer and one nut (both steel, *cadmium plated*) are supplied with each stud and isolated stud unit.
3. Insulation hardware for stud devices consisting of solder terminal, mica washers and one nylon bushing are available at extra cost upon request.
4. Other standard package variations are available upon request.
5. Metric stud 8mm x 1.25 (.315 in. x .049 in.) is available upon request.

MOUNTING CONSIDERATIONS

Installation of Press-Fit Device in Heat Sink

When press fitting SCR into a heatsink, the following specifications and recommendations apply:

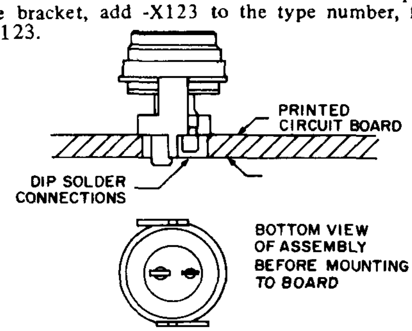
1. Heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the SCR should be 1/8 inch.
2. The hole diameter into which the SCR is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the SCR should be in contact with the heatsink to insure maximum heat transfer. The SCR must not be inserted into a heatsink deeper than the knurl height.
4. The SCR insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the SCR is misaligned with the hole or the SCR-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the SCR within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the SCR case and a copper heatsink will not exceed 0.5°C/W, if the SCR is inserted in the manner described.

Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heatsink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press Fit Device to Printed Circuit Board

For certain light load applications, the SCR can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and anode electrical connection. For SCRs preassembled into the bracket, add -X123 to the type number, for example C230BX123.



Attachment of the Stud & Isolated Stud Device To a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

Silicon Controlled Rectifier

C234-C235

25 A RMS TO 600 VOLTS

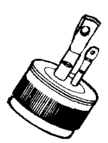
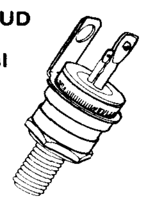
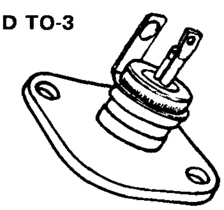
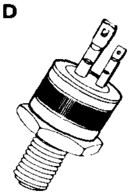
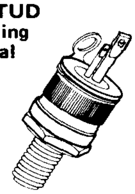
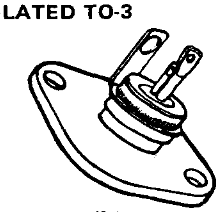
The Silicon Controlled Rectifier C234/C235 is a reverse blocking triode thyristor. This SCR is a hermetically sealed device which incorporates General Electric's patented POWER-GLAS™ process that improves upon normal pellet passivation techniques. It provides an intimate bond between the silicon chip and the glass coating. The resulting stable, low-level leakage current provides excellent performance and demonstrated reliability.

FEATURES:

- Ideal for use in applications where a low cost inverter is desired.
- Guaranteed maximum turn-off time of 20 μsec.
- POWER-GLAS™ passivated silicon chip for maximum reliability.
- Very low off-state (leakage) current at room and elevated temperatures.
- Forward and reverse blocking voltages to 600 volts.
- Characterization to 1000 Hz for both sinusoidal and rectangular anode current wave shapes.
- Excellent surge current capability.
- 1800 Volts RMS surge isolation voltage on isolated SCR's.

SIX BASIC PACKAGES

- Other packages available upon request.

PRESS-FIT 	**ISOLATED STUD** With Press-On Anode Terminal  TYPE 2	**ISOLATED TO-3 FLANGE**  TYPE 4
NON-ISOLATED STUD  TYPE 1	**ISOLATED STUD** With Solder Ring Anode Terminal  TYPE 3	**NON-ISOLATED TO-3 FLANGE**  TYPE 5

MAXIMUM ALLOWABLE RATINGS

VOLTAGE RATINGS								TEST CONDITIONS
U	F	A	B	C	D	E	M	
VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	
25	50	100	200	300	400	500	600	V_{DRM} – Repetitive Peak Off-State Voltage (1,3) V_{RRM} – Repetitive Peak Reverse Voltage T_C = -40°C to 100°C
35	75	150	300	400	500	600	720	V_{RSM} – Non-Repetitive Reverse Voltage (1, 2) T_C = -40°C to 100°C

RMS On-State Current, $I_{T(RMS)}$ . . . . 25 Amperes (All Conduction Angles)
Average On-State Current, $I_{T(AV)}$ . . . . Depends on Conduction Angle (See Charts 5 and 7)
Critical Rate-of-Rise of On-State Current, di/dt (4) . . . . (See Chart 11)
Gate Triggered Operation – Switching from 200 Volts. . . . . 100 Amperes Per Microsecond
– Switching from 400 Volts. . . . . 65 Amperes Per Microsecond
– Switching from 600 Volts. . . . . 30 Amperes Per Microsecond
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM}, 60 Hz . . . . 250 Amperes
I^2t (for fusing), for times ⩾ 1.0 milliseconds . . . . 260 Ampere² Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 5 Watts for 10 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 0.5 Watts
Peak Positive Gate Current, I_{GM} . . . . (See Chart 3)
Peak Positive Gate Voltage, V_{GM} . . . . (See Chart 3)
Peak Negative Gate Voltage, V_{GM} . . . . 5 Volts
Storage Temperature, T_{stg} . . . . -40°C to +125°C
Operating Temperature, T_J . . . . -40°C to +100°C
Stud Torque (Isolated and Non-Isolated Stud Types) . . . . 25 Lb.-In. (29 Kg-Cm) (2.8 N-M)
Maximum Insertion Pressure (Press-Fit Types) . . . . 800 Lbs. (364 Kg)(3.56N x 10^3)
Isolation Breakdown Voltage Between any Terminal and Stud or Flange (Isolated Types)(5) . . . . 1800 Volts RMS

NOTES:
1. Values apply for zero or negative gate voltage only.
2. Half sine wave voltage pulse, 10 millisecond maximum duration.
3. During performance of the Off-State and Reverse Blocking tests, the SCR should not be tested with a constant current source which would permit applied voltage to exceed the device rating.
4. di/dt rating is established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6.
5. Rating applies for 50, 60 and 400 Hz sinusoidal wave form.

PART NUMBER DESIGNATION

C 234 U 2

SILICON CONTROLLED RECTIFIER (C)

CURRENT RATING & PACKAGE STYLE (234)

234 = 25 A RMS Stud/TO-3 Flange
235 = 25 A RMS Press-Fit

VOLTAGE RATINGS (U)

U = 25 Volts
F = 50 Volts
A = 100 Volts
B = 200 Volts
C = 300 Volts
D = 400 Volts
E = 500 Volts
M = 600 Volts

STUD/TO-3 FLANGE PACKAGE VARIATIONS (2)

None = Non-Isolated Stud Mount
2 = Isolated Stud Mount with Press-on Anode Terminal
3 = Isolated Stud Mount with Solder Ring Anode Terminal
4 = Isolated on TO-3 Outline Mounting Flange
5 = Non-Isolated on TO-3 Outline Mounting Flange
6 – 9 = Other Standard Variations

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Off-State and Reverse Current(1)	I_{RRM} and I_{DRM}				mA	$V_{DRM} = V_{RRM}$ = Max. allowable volts peak
		–	–	0.5		T_C = +25°C
		–	–	1.0		T_C = +100°C
Peak On-State Voltage	V_{TM}	–	–	2.0	Volts	T_C = +25°C, I_{TM} = 100 A peak, 1 msec wide pulse. Duty Cycle ⩽ 2%.
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	50	200	–	Volts/μsec	T_C = +100°C, Rated V_{DRM}, Gate Open Circuited, Linear Wave form
DC Gate Trigger Current	I_{GT}	–	–	40	mAdc	T_C = +25°C, V_D = 12 Vdc, R_L = 120 Ohms
		–	–	80		T_C = -40°C, V_D = 12 Vdc, R_L = 60 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	1.5	Vdc	T_C = +25°C, V_D = 12 Vdc, R_L = 120 Ohms
		–	–	2.0		T_C = -40°C, V_D = 12 Vdc, R_L = 60 Ohms
DC Gate Non-Trigger Voltage	V_{GD}	0.2	–	–	Vdc	T_C = +100°C, Rated V_{DRM}, R_L = 1000 Ohms
DC Holding Current	I_H				mAdc	Anode Source Voltage = 24 Vdc, Peak Initiating On-State Current = 0.5 Amps, 0.1 msec to 10 msec Wide Pulse. Gate Trigger Source = 7 Volts, 20 Ohms
		–	–	75		T_C = +25°C
		–	–	150		T_C = -40°C
DC Latching Current	I_L				mAdc	Anode Source Voltage = 24 Vdc. Gate Trigger Source = 15 Volts, 100 Ohms, 50 μsec Pulse Width, 5 μsec rise and fall times max.
		–	–	100		T_C = +25°C
		–	–	200		T_C = -40°C
Circuit Commutated Turn-Off Time	t_q	–	–	20	μsec	(1) T_C = +100°C (2) I_{TM} = 35 Amperes Peak (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Off-State Voltage (dv/dt) = 20V/μsec (6) Commutation di/dt = -5 Amps/μsec (7) Repetition Rate = 60 pps. (8) V_{RRM} = rated volts max. Rectangular Current Pulse, 40 μsec duration. Reverse Voltage at end of turn-off time interval = 12 volts min. Off-State Voltage = Rated V. (9) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
Steady-State Thermal Resistance (2)	$R_{\theta JA}$	–	–	45	°C/Watt	Junction-to-Ambient
Steady-State Thermal Resistance	$R_{\theta JC}$				°C/Watt	Junction-to-Case
		–	–	1.00		Non-Isolated Stud/Press-Fit
		–	–	1.15		Isolated Stud
		–	–	1.15		Non-Isolated TO-3 Flange
		–	–	1.30		Isolated TO-3 Flange

NOTES:

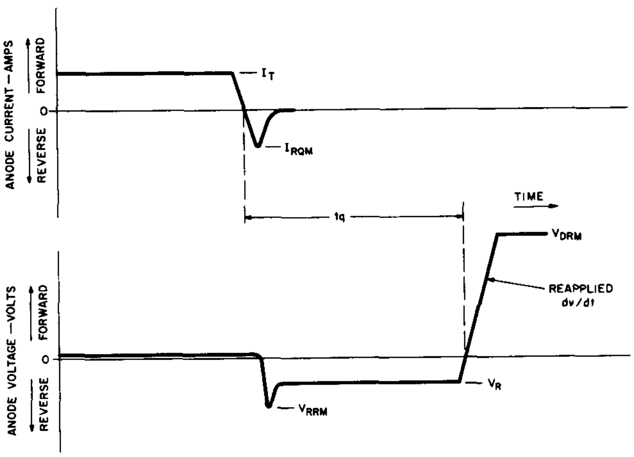
1. Values apply for zero or negative gate voltage only.
2. The junction-to-ambient value is under worst case conditions; i.e., with No. 22 copper wire used for electrical contact to the terminals and natural convection cooling.

WARNING

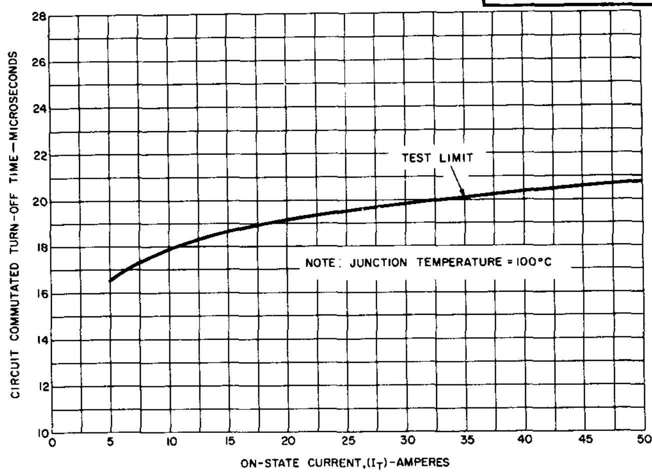
Isolated products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.

Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

TURN-OFF TIME DATA

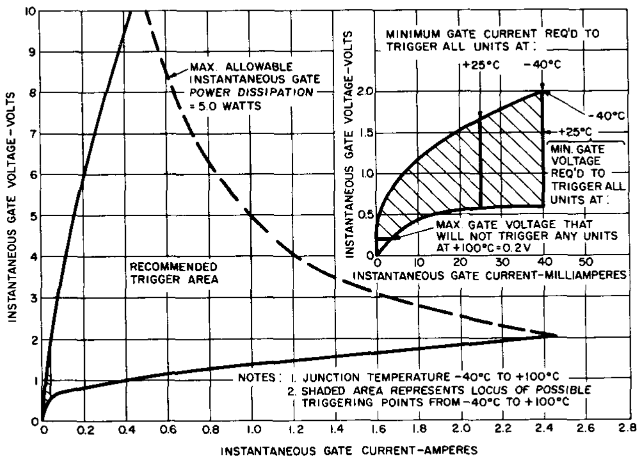


1. WAVEFORM DEFINITION OF TURN-OFF TIME WITH REVERSE VOLTAGE

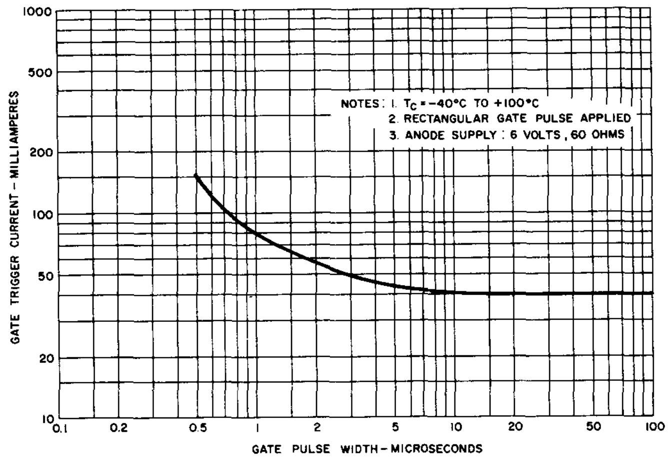


2. VARIATION OF MAXIMUM CIRCUIT COMMUTATED TURN-OFF TIME WITH ON-STATE CURRENT

TRIGGERING DATA

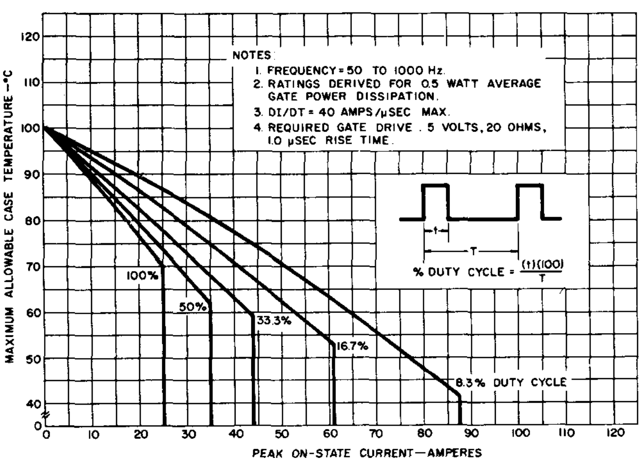


3. GATE TRIGGERING CHARACTERISTICS



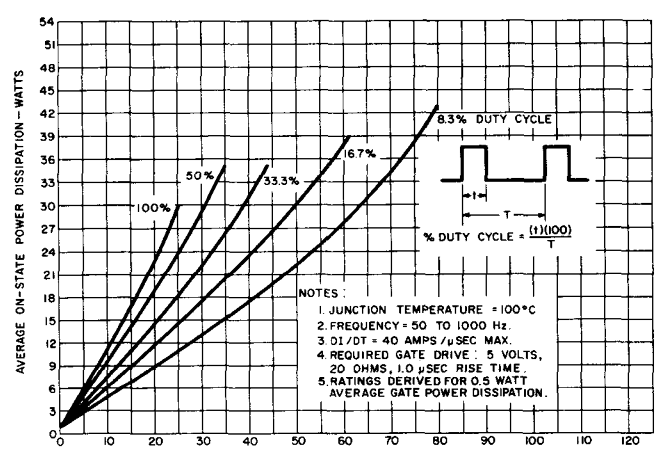
4. VARIATION OF MAXIMUM GATE TRIGGERING CURRENT WITH GATE PULSE WIDTH

RECTANGULAR WAVE DATA



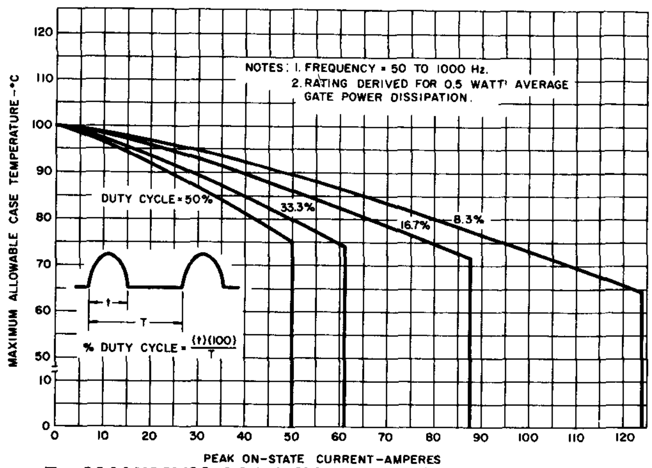
5. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. ON-STATE CURRENT

(FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)



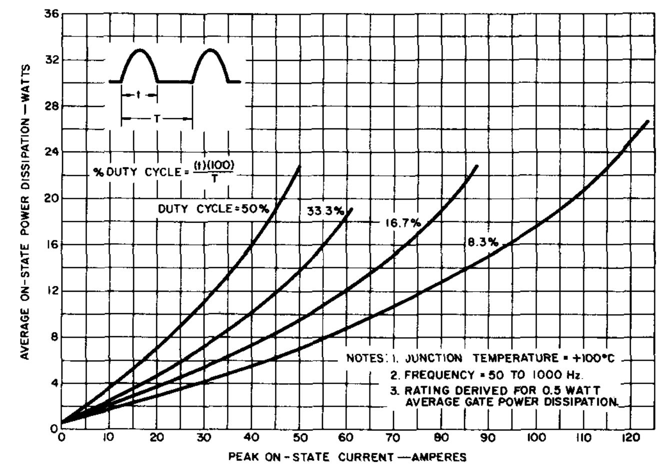
6. MAXIMUM ALLOWABLE POWER DISSIPATION VS. ON-STATE CURRENT

SINE WAVE DATA



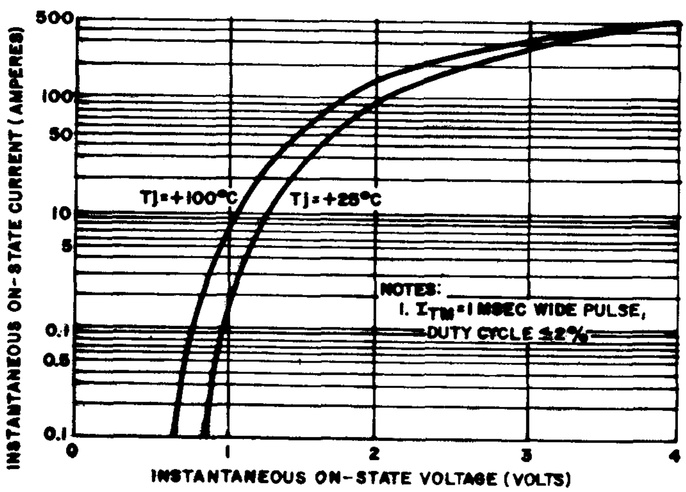
7. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. ON-STATE CURRENT

(FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)

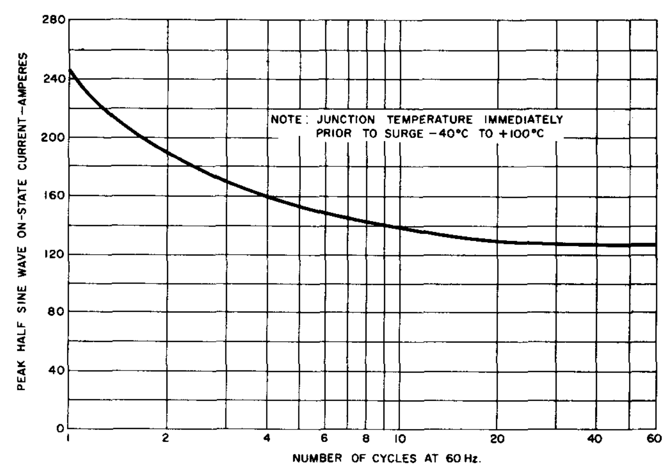


8. MAXIMUM ON-STATE POWER DISSIPATION VS. ON-STATE CURRENT

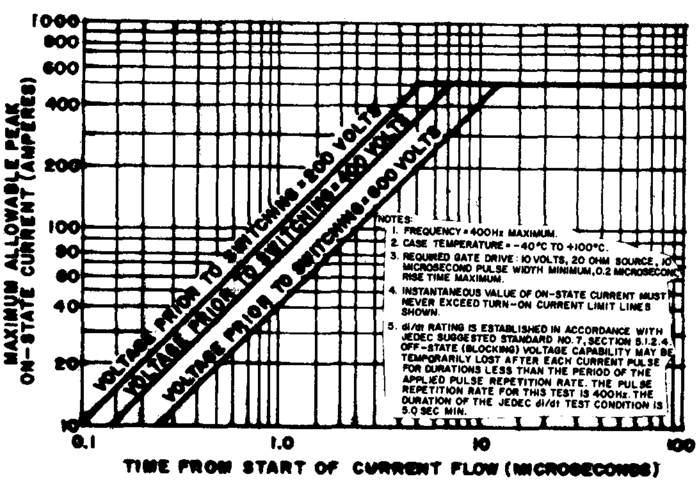
LOW FREQUENCY DATA



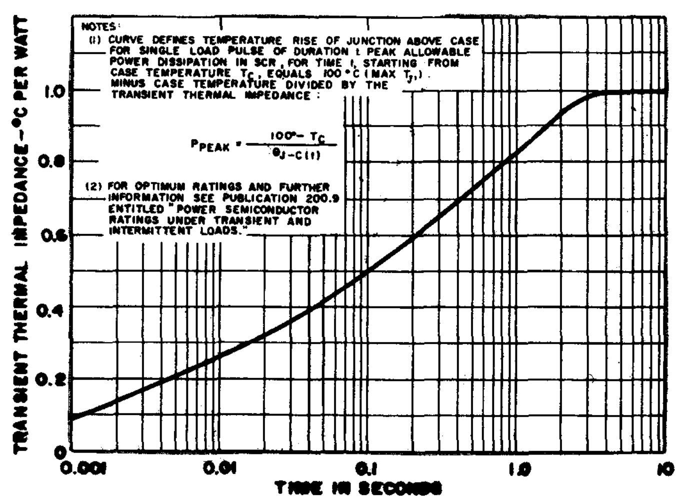
9. MAXIMUM ON-STATE VOLTAGE VS. ON-STATE CURRENT



10. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



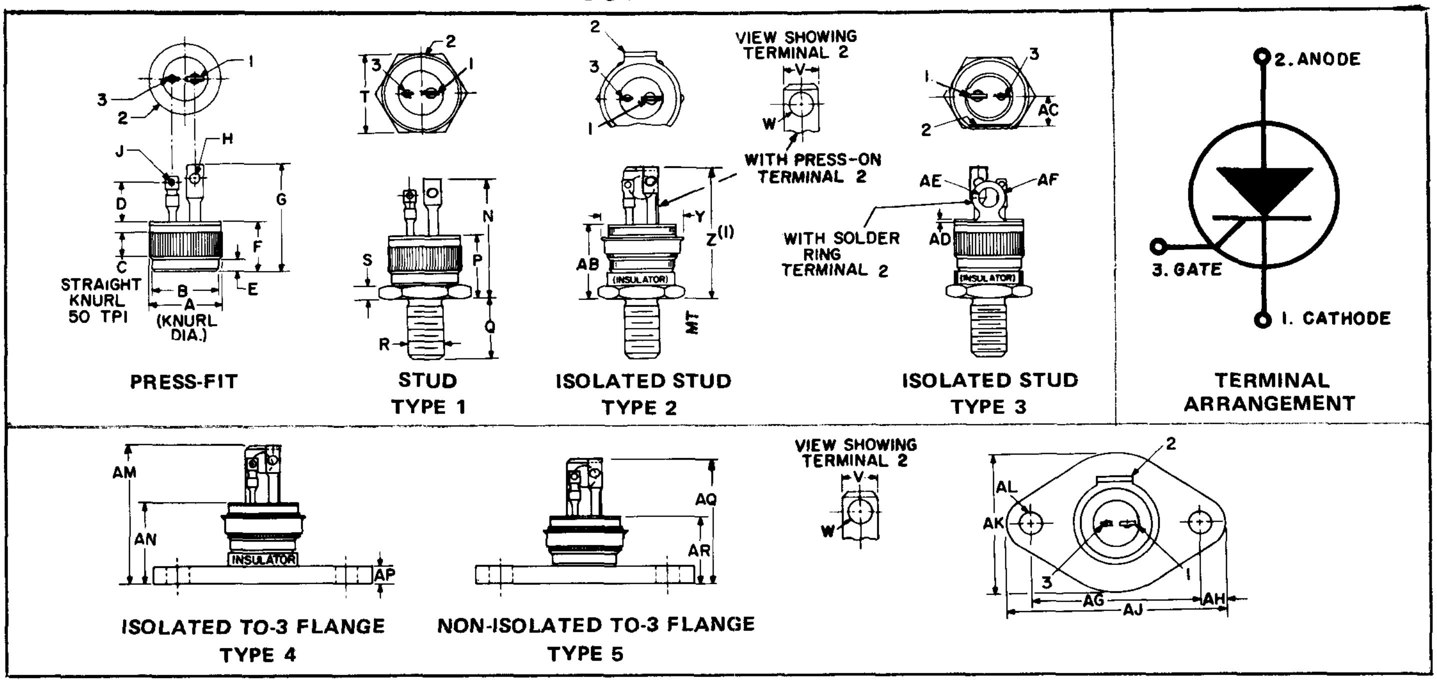
11. TURN-ON CURRENT LIMIT



12. MAXIMUM TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

(FOR NON-ISOLATED STUD AND PRESS-FIT CASE TYPES ONLY)

OUTLINE DRAWINGS



SYMBOL	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.
A	.501	.505	12.73	12.82
B	.467	.475	11.87	12.06
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.083	.097	2.11	2.46
F	.340	.376	8.64	9.55
G	—	.782	—	19.86
H	.081	.089	2.06	2.26
J	.060	.069	1.53	1.75
N	—	.868	—	22.04
P	—	.475	—	12.06
Q	.432	.442	10.98	11.22
R(5)	1/4-28, UNF2A		—	—
S	.086	.098	2.19	2.48
T	.552	.562	14.03	14.27
V	.240	.260	6.10	6.60
W	.145	.160	3.68	4.06

SYMBOL	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.
Y	.580	.610	14.74	15.49
Z	—	.978	—	24.84
AB		.585	—	14.85
AC	.220 REF.		5.59 REF.	
AD	.012	.023	.31	.58
AE	.140	.150	3.56	3.81
AF	.229	.251	5.82	6.37
AG	1.182	1.192	30.03	30.27
AH	.160	—	4.07	—
AJ	1.507	1.567	38.28	39.80
AK	.975	1.025	24.77	26.03
AL	.150	.161	3.81	4.08
AM	—	1.018	—	25.92
AN	—	.630	—	16.00
AP	.119	.131	3.03	3.32
AQ	—	.913	—	23.25
AR	—	.515	—	13.08

NOTES:

1. Case temperature is measured for press-fit devices at the center of the base; for stud types 1, 2 and 3 at the center of any hex flat; for TO-3 outline mounting flange types 4 and 5 at the center of the bottom of the flange.
2. One external tooth lock washer and one nut (both steel, cadmium plated) are supplied with each stud and isolated stud unit.
3. Insulation hardware for stud devices consisting of solder terminal, mica washers and one nylon bushing are available at extra cost upon request.
4. Other standard package variations are available upon request.
5. Metric stud 8mm x 1.25 (.315 in. x .049 in.) is available upon request.

MOUNTING CONSIDERATIONS

Installation of Press-Fit SCR in Heat Sink

When press fitting SCR into a heatsink, the following specifications and recommendations apply:

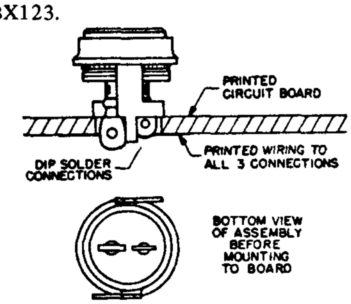
1. Heatsink materials may be copper, aluminum or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the SCR should be 1/8 inch.
2. The hole diameter into which the SCR is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the SCR should be in contact with the heatsink to insure maximum heat transfer. The SCR must not be inserted into a heatsink deeper than the knurl height.
4. The SCR insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the SCR is misaligned with the hole or the SCR-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the SCR within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the SCR case and a copper heatsink will not exceed 0.5°C/W, if the SCR is inserted in the manner described.

Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heat sink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press Fit Device to Printed Circuit Board

For certain light load applications, the SCR can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and anode electrical connection. For SCRs preassembled into the bracket, add -X123 to the type number, for example C234BX123.



Attachment of the Stud & Isolated Stud Device to a Heat Sink

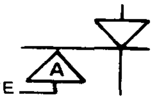
These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

High Power Silicon Controlled Rectifier

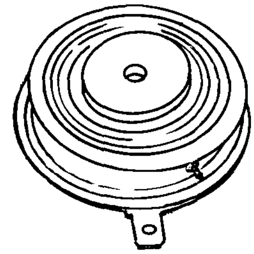
C350

1300 VOLTS **180 A RMS**

AMPLIFYING GATE



The General Electric C350 silicon controlled rectifier is designed for phase control applications. This is an all-diffused Press-Pak device employing the field-proven amplifying gate.



FEATURES:

- High di/dt Ratings
- High dv/dt Capability With Selections Available
- Excellent Surge I^2t Ratings Providing Easy Fusing
- Guaranteed Maximum Turn-Off Time With Selections Available
- Rugged Hermetic Glazed Ceramic Package

IMPORTANT: Mounting instructions on the mounting clamp specifications **must** be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C350E	500 Volts	500 Volts	600 Volts
C350M	600	600	720
C350S	700	700	850
C350N	800	800	950
C350T	900	900	1075
C350P	1000	1000	1200
C350PA	1100	1100	1325
C350PB	1200	1200	1450
C350PC	1300	1300	1550

[1] Half sinewave waveform 10 ms max. pulse width.

Average On-State Current, $I_{T(AV)}$ .... Depends on Conduction Angle (See Charts 1 and 3)
Peak One-Cycle Surge (Non-Repetitive) Current, I_{TSM} (60 Hz) .... 1600 Amperes
Peak One-Cycle Surge (Non-Repetitive) Current, I_{TSM} (50 Hz) .... 1480 Amperes
Critical Rate-of-Rise of On-State Current (Non-Repetitive)† .... 800 A/μs
Cirtical Rate-of-Rise of On-State Current (Repetitive)† .... 500 A/μs
I^2t (for fusing) (for times ≥ 1.5 milliseconds) .... 7,680 (RMS Ampere)^2 Seconds
I^2t (for fusing) (at 8.3 milliseconds) .... 10,600 (RMS Ampere)^2 Seconds
Peak Gate Power Dissipation, P_{GM} .... 10 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ .... 2 Watts
Storage Temperature, T_{STG} .... -40°C to +150°C
Operating Temperature, T_J .... -40°C to +125°C
Mounting Force Required .... 800 Lbs. ± 10%
3.56 Kn ± 10%

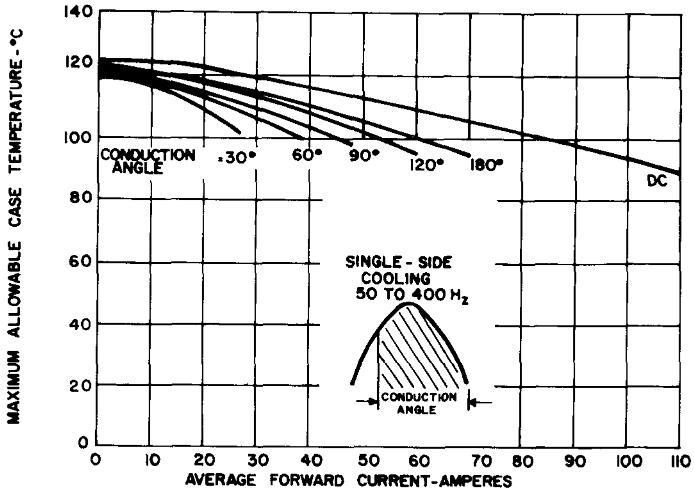
NOTES:

†di/dt ratings established in accordance with EIA-NEMA Standard RS397, Section 5.2.2.6 for conditions of maximum rated V_{DRM}: 20 volts, 20 ohms gate trigger source with 0.5 μs short circuit trigger current rise time.

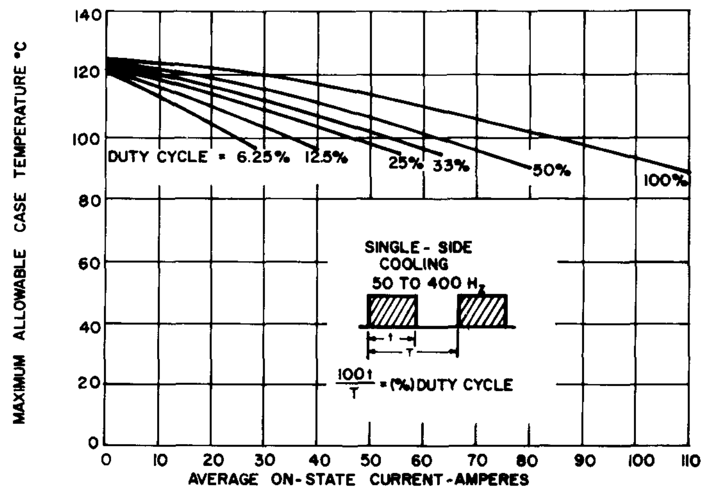
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = +25°C V_{DRM} = V_{RRM} =
C350E		–	3	10		500 Volts Peak
C350M		–	3	10		600
C350S		–	3	10		700
C350N		–	3	10		800
C350T		–	3	9		900
C350P		–	3	7		1000
C350PA		–	3	7		1100
C350PB		–	3	6		1200
C350PC		–	3	5		1300
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = +125°C V_{DRM} = V_{RRM} =
C350E		–	15	20		500 Volts Peak
C350M		–	15	20		600
C350S		–	15	20		700
C350N		–	15	20		800
C350T		–	15	18		900
C350P		–	12	15		1000
C350PA		–	11	14		1100
C350PB		–	10	13		1200
C350PC		–	8	11		1300
Effective Thermal Resistance	$R_{\theta JC}$	–	–	0.26	°C/Watt	Junction-to-Case (Single-Side Cooling)
		–	–	0.135		Junction-to-Case (Double-Side Cooling)
Critical Rate-of-Rise of Off-State Voltage. (Higher values may cause device switching.)	dv/dt	200	500	–	V/μsec	T_J = 125°C, Gate Open Circuited. V_{DRM} = Rated, Using Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selection available – consult factory.						
Holding Current	I_H	–	100	–	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial On-State Current = 2 Amps.
Turn-On Delay Time	t_d	–	1	–	μsec	T_C = +25°C, I_{TM} = 50 Adc, V_{DRM} = Rated, Gate Supply: 10 Volt Open Circuit, 20 Ohm, 0.1 μsec max. rise time.
DC Gate Trigger Current	I_{GT}	–	16	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	30	200		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	5	125		T_C = +120°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	1.25	3.0	Vdc	T_C = -40°C to +120°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = +120°C, V_{DRM} = Rated, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	2.0	2.6	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak. Duty Cycle ⩽ 0.01%
Circuited Commutated Turn-Off Time	t_q	–	200	–*	μsec	(1) T_J = +125°C (2) I_{TM} = 50 Amps Peak (3) V_R = 50 Volts Min. (4) V_{DRM} = Rated (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20V/μsec (Linear). (6) Gate Bias = 0 Volts, 100 Ohms During Turn-Off Interval. (7) Duty Cycle ⩽ 0.01%

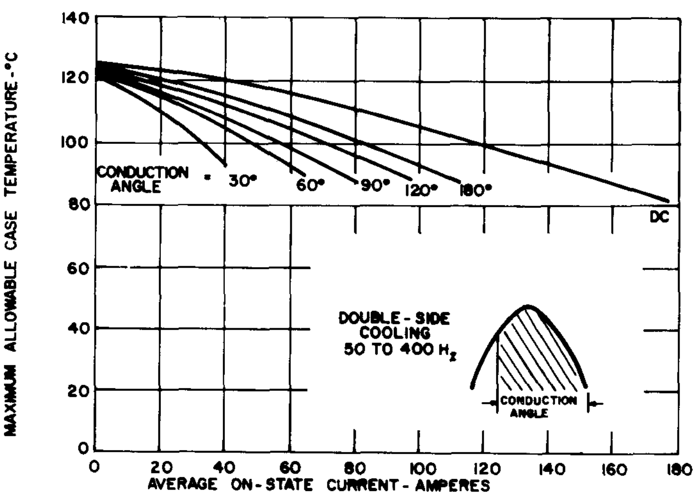
*Consult factory if guaranteed turn-off time is required.



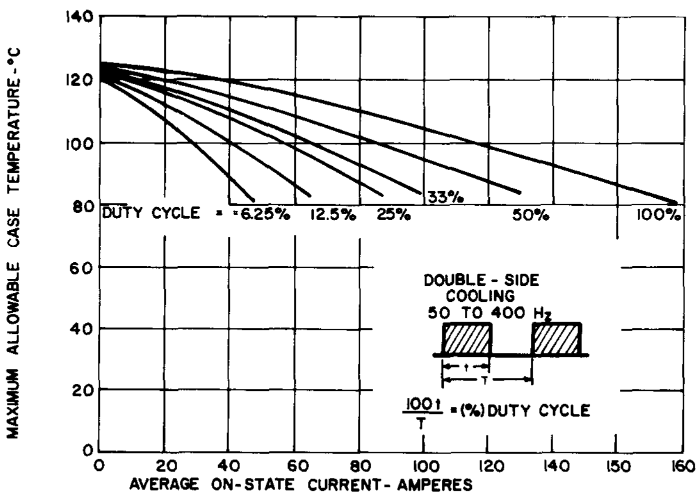
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



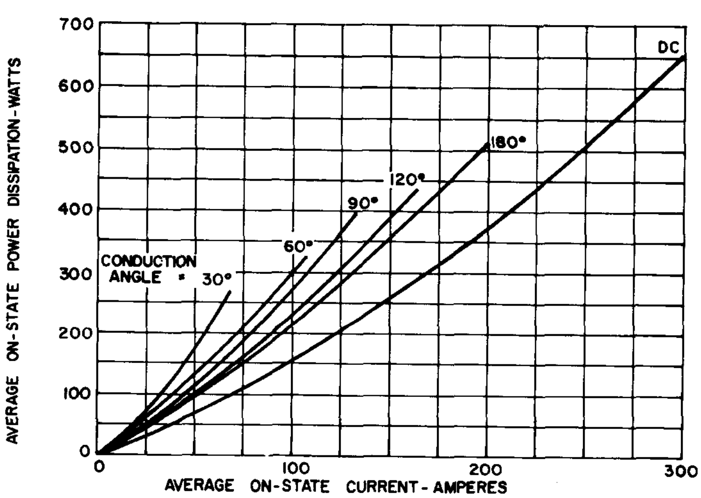
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



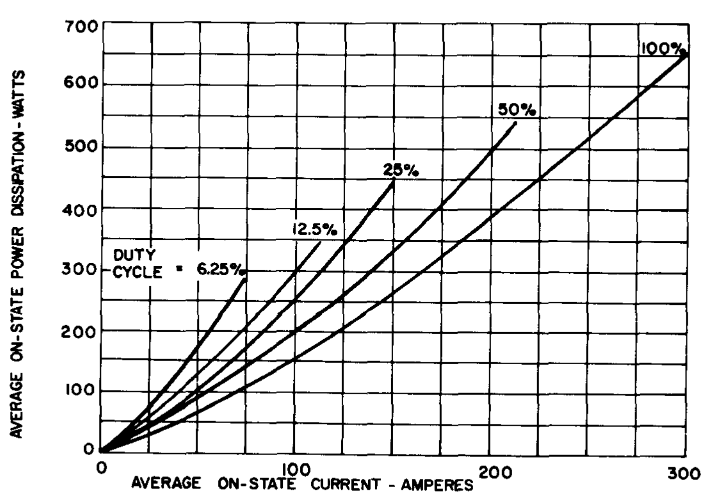
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



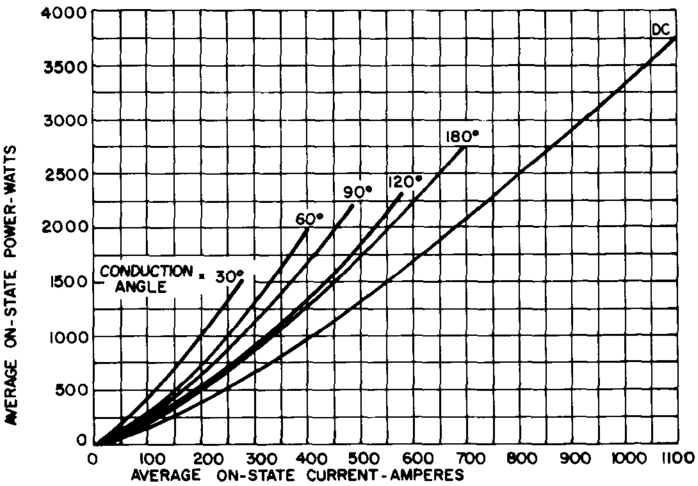
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



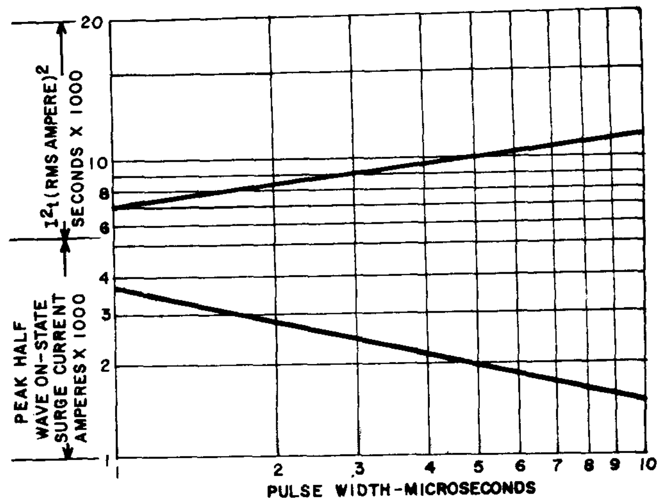
5. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



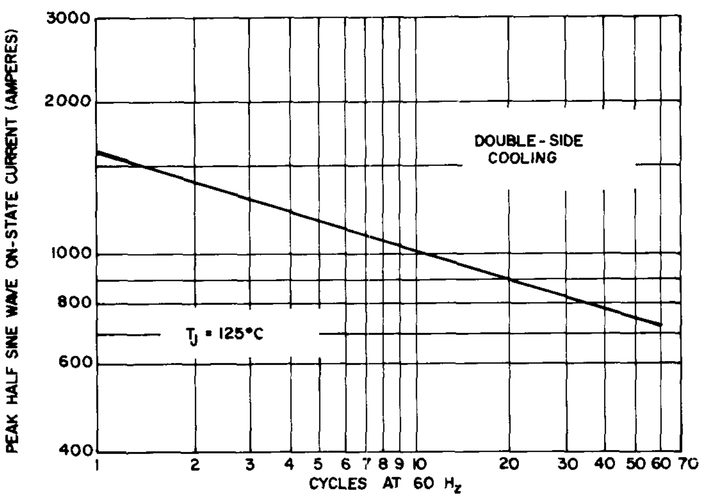
6. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



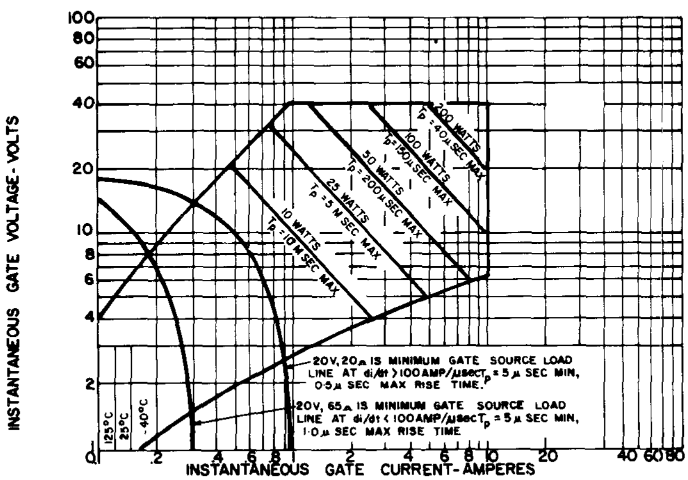
7. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



8. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



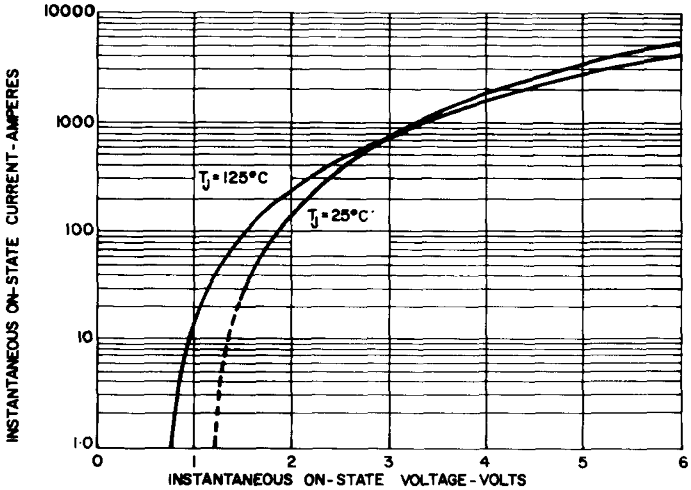
9. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT RATING



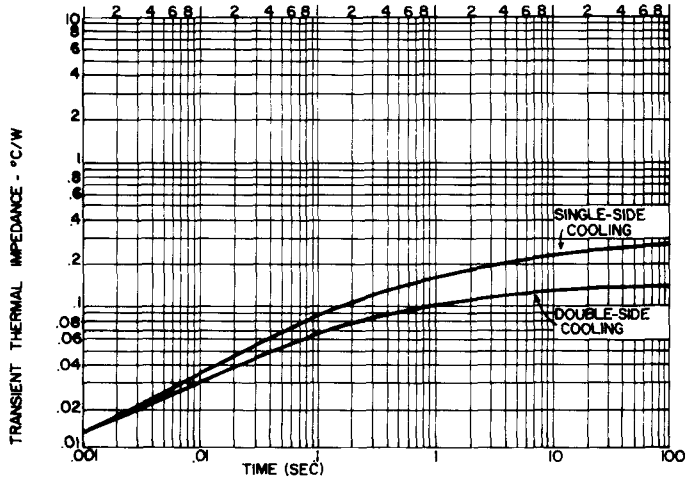
10. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

NOTES:

1. Maximum allowable gate power dissipation = 2 watts.
2. The locus of possible DC trigger points lie outside the boundaries shown at various case temperatures.
3. Tp = Rectangular Gate Current Pulse Width.

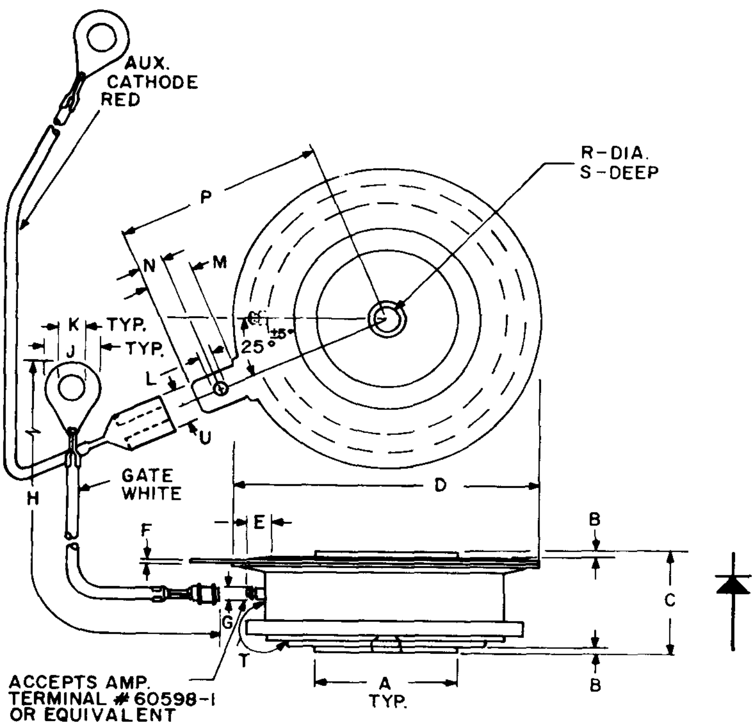


11. MAXIMUM ON-STATE CHARACTERISTICS



12. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

OUTLINE DRAWING



H - STRAIGHT LEAD LENGTH, TYP. 2 LEADS

T - SURFACE CREEPAGE

TABLE OF DIMENSIONS

Conversion Table

SYM	DECIMAL INCHES MIN	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE

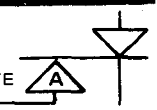
C354/C355

HIGH SPEED

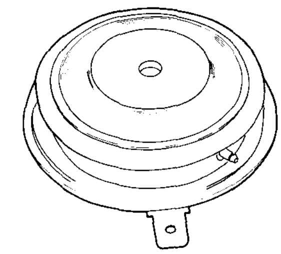
Silicon Controlled Rectifier

600 Volts 275A RMS

AMPLIFYING GATE



The General Electric C354 and C355 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Press-Pak devices employing the field-proven amplifying gate.



FEATURES:

- Fully characterized for operation in inverter and chopper applications.
- High di/dt ratings.
- High dv/dt capability with selections available.
- Rugged hermetic glazed ceramic package.

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C354A, C355A	100 Volts	100 Volts	200 Volts
C354B, C355B	200	200	300
C354C, C355C	300	300	400
C354D, C355D	400	400	500
C354E, C355E	500	500	600
C354M, C355M	600	600	720

[1] Half sinewave waveform 10 ms max. pulse width.

Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 1,800 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 1,700 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds . . . . 9.500 RMS Ampere² Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds . . . . 13,500 RMS Ampere² Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive . . . . 800 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive . . . . 500 A/μs †
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Stemperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force . . . . 800 Lbs. ± 10%
3.56 KN ± 10%

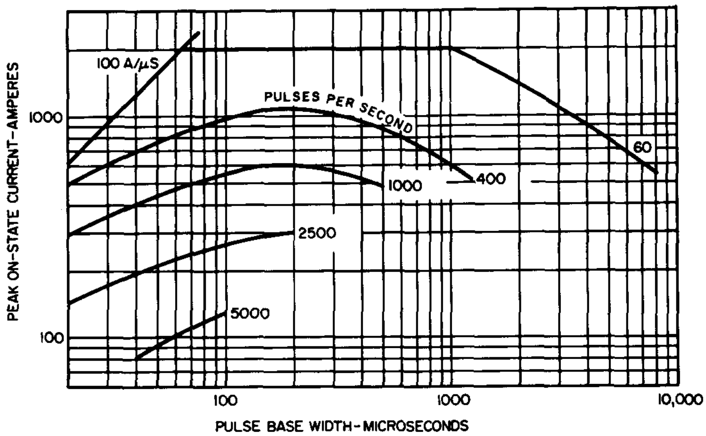
†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5μs short circuit trigger current rise time.

CHARACTERISTICS

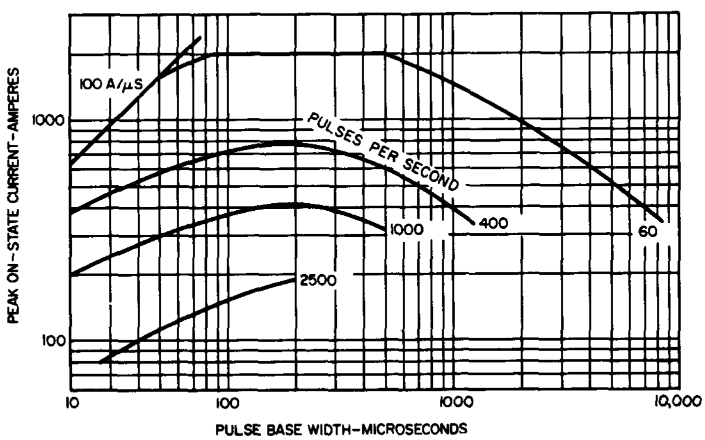
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	5	12	mA	T_C = +25°C, V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	12	17	mA	T_C = 125°C, V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	.26	°C/Watt	Junction-to-Case – Single-Side Cooled
		–	–	.13		Junction-to-Case – Double-Side Cooled
Critical Rate-of-Rise of Off-State Voltage (Higher Values May Cause Device Switching)	dv/dt				V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated, Using Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
C354		200	500	–		
C355		100	300	–		
Higher minimum dv/dt selections – consult factory.						
Holding Current	I_H	–	100	–	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial On-State Current = 2 Amps.
DC Gate Trigger Current	I_{GT}	–	50	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	100	200		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	30	120		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	3.0	5.0	Vdc	T_C = -40°C to 0°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	1.25	3.0		T_C = 0°C to +125°C, V_D = 6 Vdc R_L = 3 Ohms
		0.25	–	–		T_C = +125°C, V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	2.2	3.0	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak Duty Cycle ⩽ .01%
Turn-On Delay Time	t_d	–	1	2	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}. Gate Supply: 20 Volt Open Circuit, 20 Ohm, 0.1 μsec rise time
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q				μsec	(1) T_C = +125°C (2) I_{TM} = 50 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20 V/μsec (linear). (6) Commutation di/dt = 5 Amps/μsec. (7) Duty Cycle ⩽ .01% (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
C354		–	9	10		
C355		–	12	20		
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	$t_{q(diode)}$				μsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20 V/μsec (linear) (6) Commutation di/dt = 5 Amps/μsec (7) Duty Cycle ⩽ .01% (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
C354		–	12	†		
C355		–	15	†		

†Consult factory for specified maximum turn-off time.

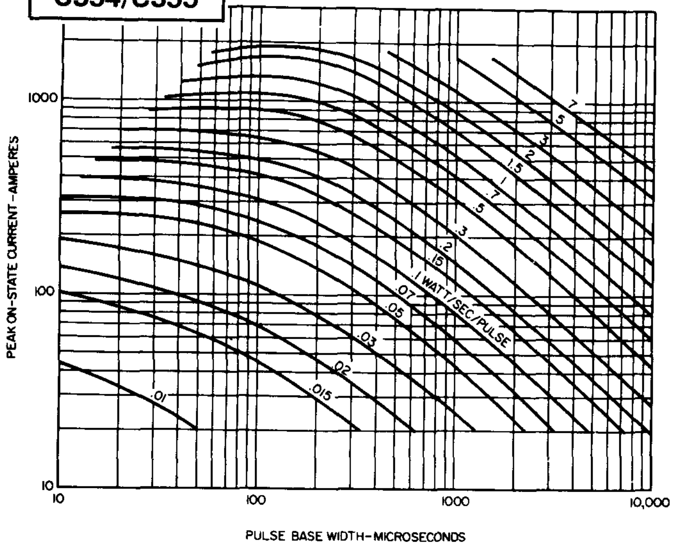
SINE WAVE CURRENT RATING DATA
DOUBLE-SIDE COOLING



1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



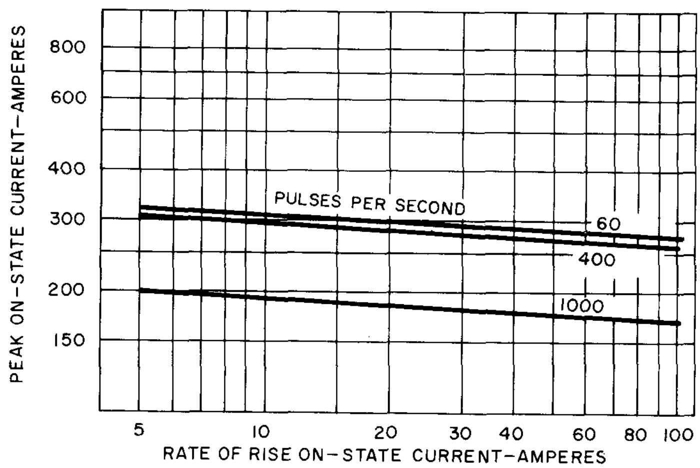
3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

NOTES:

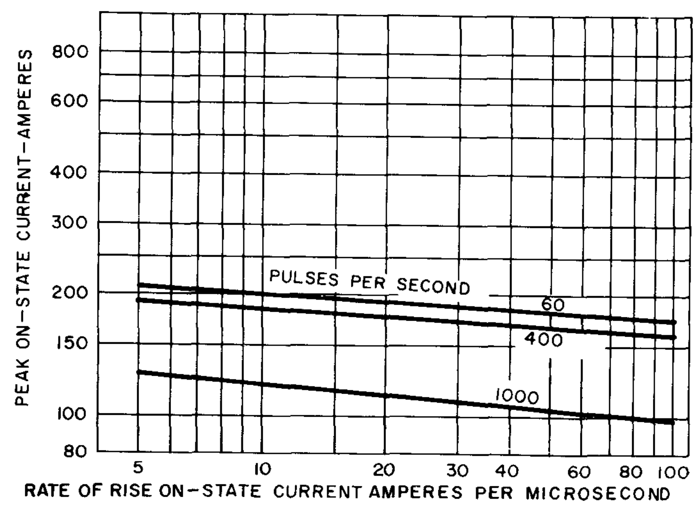
1. Switching voltage ⩽ 400 volts.
2. Maximum ckt. dv/dt = 100 volts/μsec
3. Reverse voltage applied = V_R < 400 volts.
4. Required gate drive:
   20 volts, 65 ohms, 1 μsec rise time for less than 100 amps/μsec
   20 volts, 20 ohms, .5 μsec rise time for greater than 100 amps/μsec
5. R-C Snubber ckt. = 0.25μf, 5Ω
6. Double-Side Cooled
7. Max. energy dissipated during reverse recovery to be 15% of total W-S/P shown in chart 5 or 0.03 W-S/P whichever is least.
8. Values of W-S/P are for T_J = 125°C.

RECTANGULAR WAVE CURRENT RATING DATA

DUTY CYCLE – 50%

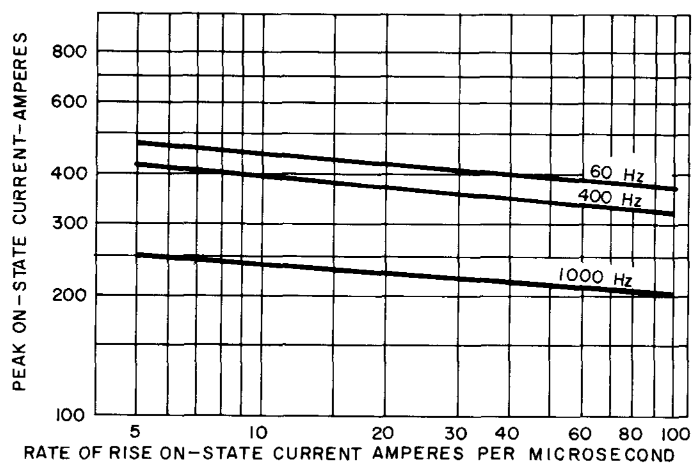


4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

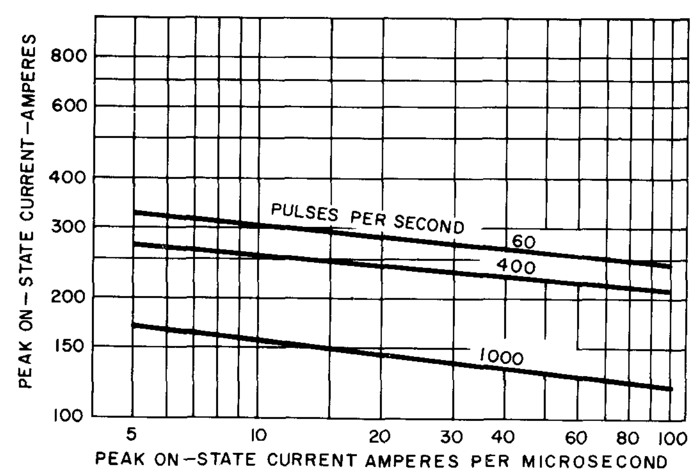


5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

DUTY CYCLE – 25%

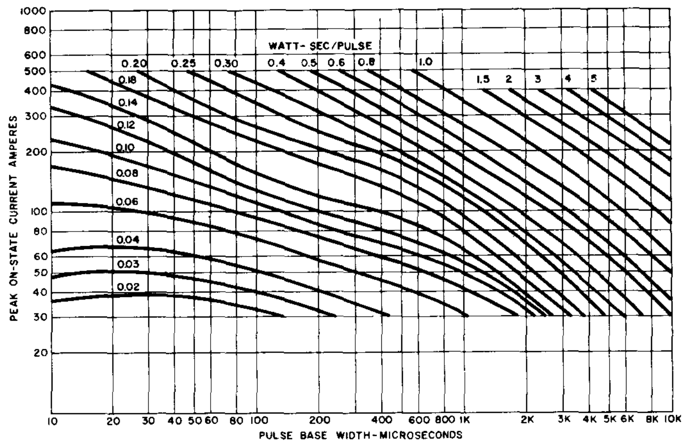


6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

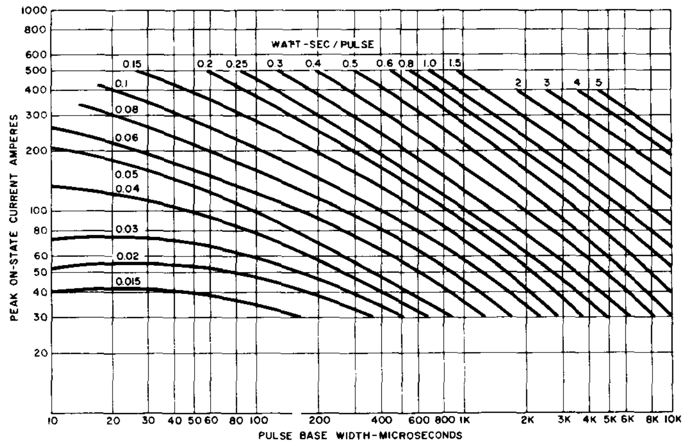


7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

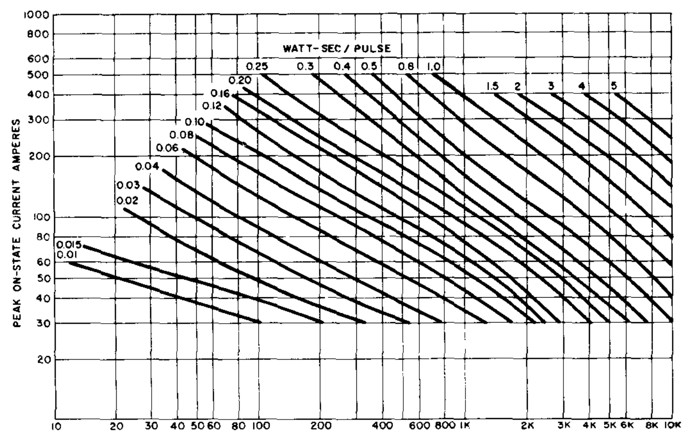
WATT-SECONDS PER PULSE



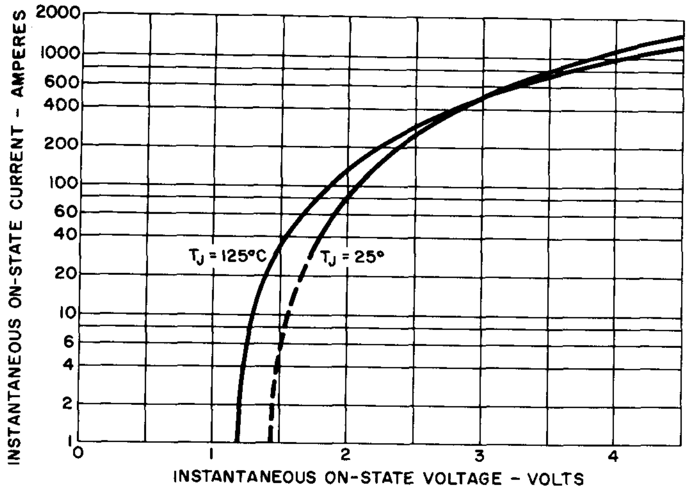
8. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec)



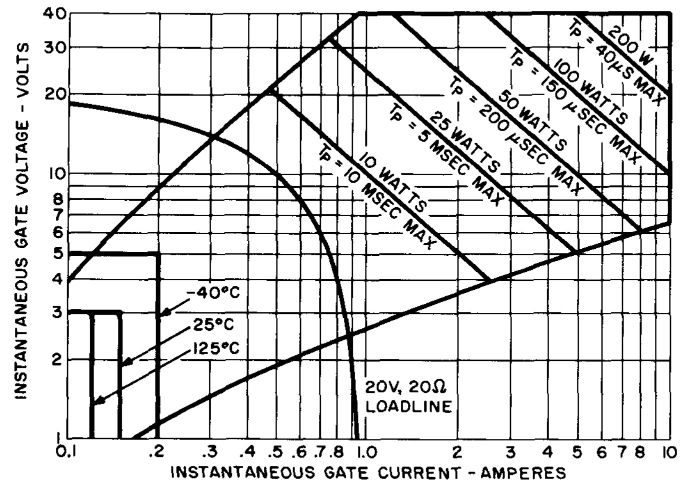
9. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec)



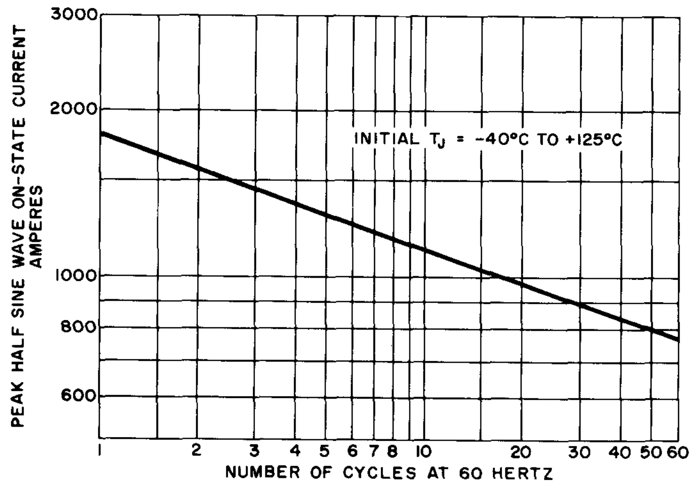
10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec)



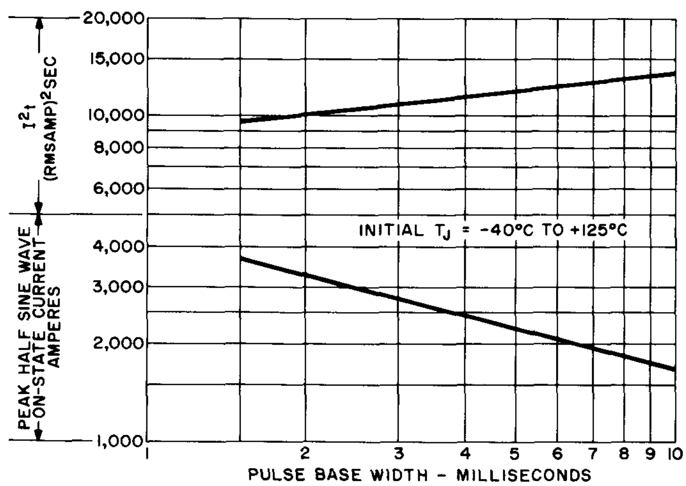
11. MAXIMUM ON-STATE CHARACTERISTICS



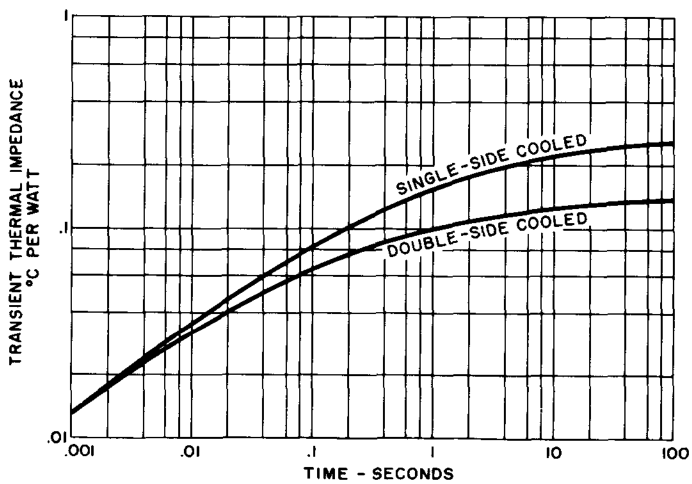
12. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS



13. SURGE (NON-REPETITIVE) ON-STATE CURRENT

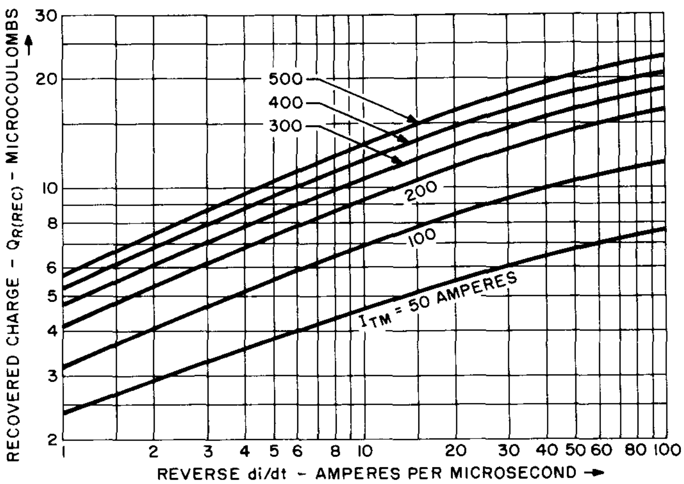


14. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT LOAD I^2t RATING



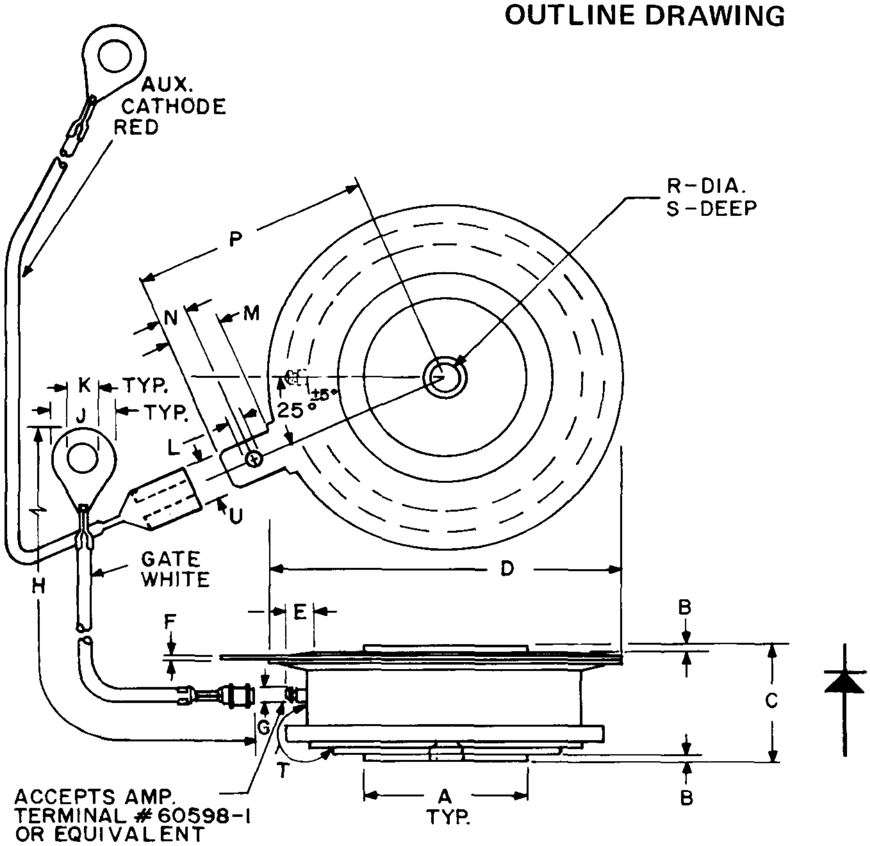
15. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

RECOVERED CHARGE DATA



16. TYPICAL RECOVERED CHARGE AT 125°C
SINEWAVE CURRENT WAVEFORM

OUTLINE DRAWING



ACCEPTS AMP. TERMINAL # 60598-1 OR EQUIVALENT

H - STRAIGHT LEAD LENGTH, TYP. 2 LEADS

T - SURFACE CREEPAGE

TABLE OF DIMENSIONS
Conversion Table

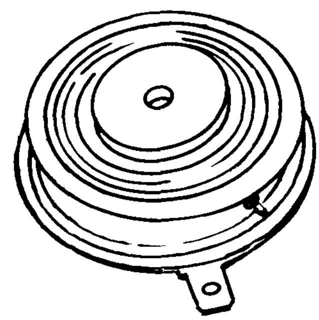
SYM	DECIMAL INCHES		METRIC MM	
	MIN	MAX.	MIN.	MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

HIGH SPEED
Silicon Controlled Rectifier

C358

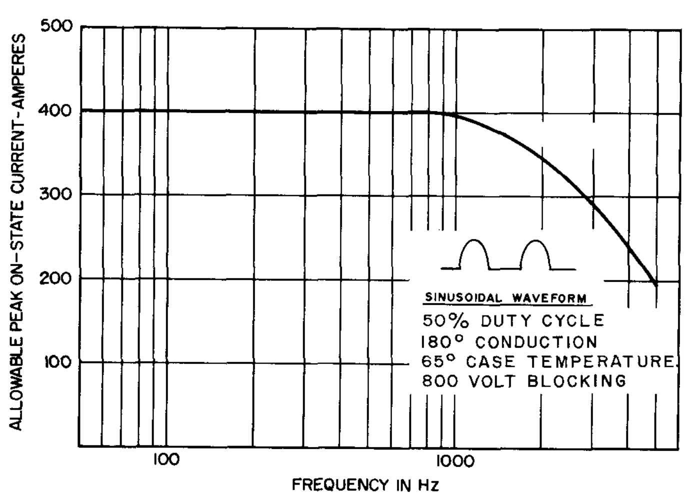
1200 Volts **225A RMS** AMPLIFYING GATE

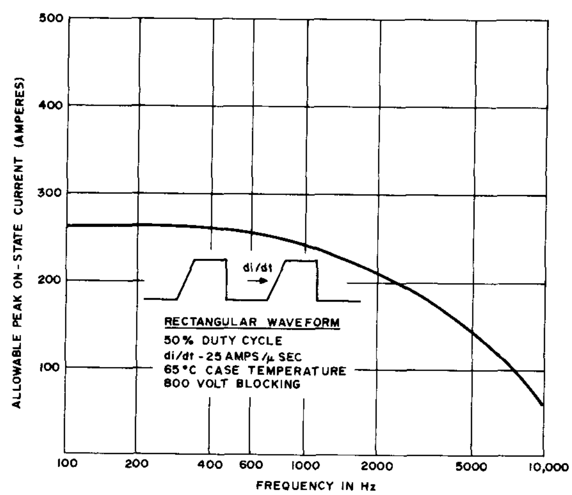
The General Electric C358 Silicon Controlled Rectifier is designed for power switching at high frequencies. This is an all-diffused Press-Pak device employing the field-proven amplifying gate.



FEATURES:

- Fully characterized for operation in inverted and chopper applications.
- High di/dt ratings.
- High dv/dt capability with selections available.
- Rugged hermetic glazed ceramic package.





MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} [1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} [1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} [1] T_J = +125°C
C358E	500 Volts	500 Volts	600 Volts
C358M	600	600	720
C358S	700	700	840
C358N	800	800	960
C358T	900	900	1080
C358P	1000	1000	1200
C358PA	1100	1100	1300
C358PB	1200	1200	1400

[1] Half sinewave waveform 10 ms max. pulse width.

RMS On-State Current, $I_{T(RMS)}$ . . . . 225 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 1600 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 1500 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds . . . . 5,200 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds . . . . 10,500 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive . . . . 800 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive . . . . 500 A/μs †
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force . . . . 800 Lbs. ± 10%
3.56 KN ± 10%

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5μs short circuit trigger current rise time.

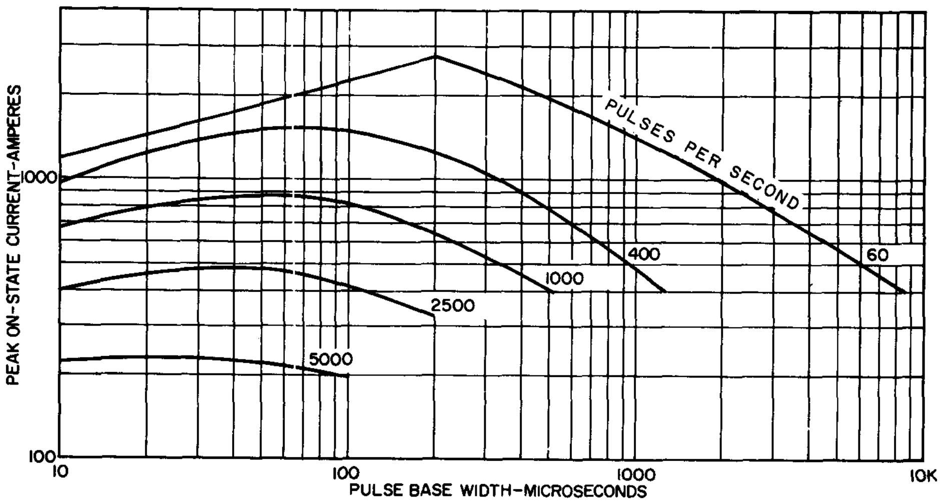
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}				mA	T_J = +25°C, V_{DRM} = V_{RRM} =
C358E		–	3	10		500 Volts
C358M		–	3	10		600
C358S		–	3	10		700
C358N		–	3	10		800
C358T		–	3	9		900
C358P		–	3	7		1000
C358PA		–	3	7		1100
C358PB		–	3	7		1200
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}				mA	T_J = 125°C, V_{DRM} = V_{RRM} =
C358E		–	12	15		500 Volts
C358M		–	12	15		600
C358S		–	12	15		700
C358N		–	12	15		800
C358T		–	12	15		900
C358P		–	12	15		1000
C358PA		–	12	17		1100
C358PB		–	12	18		1200
Thermal Resistance	$R_{\theta JC}$	–	.12	.135	°C/Watt	Junction-to-Case – Double-Side Cooled
		–	.15	.26		Junction-to-Case – Single-Side Cooled
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	100	500	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial On-State Current = 2 Amps.
DC Gate Trigger Current	I_{GT}	–	50	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	75	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	15	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	3	5	Vdc	T_C = -40°C to 0°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	1.25	3.0		T_C = 0°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = 125°C, V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	2.8	3.5	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak. Duty Cycle ⩽ .01%.

CHARACTERISTICS (continued)

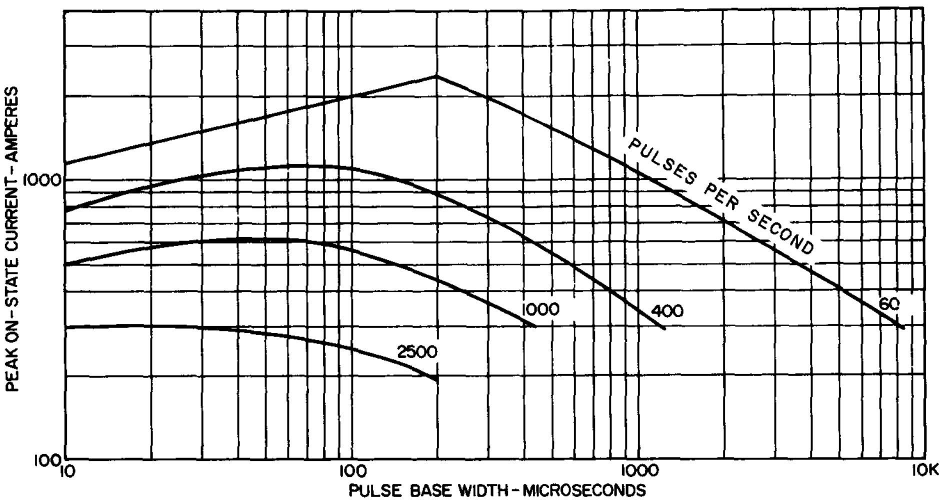
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Turn-On Delay Time	t_d	–	0.5	–	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}, Gate Supply: 20 volt open circuit, 20 ohm, 0.1 μsec max. rise time. ††, †††
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage) Faster Maximum Turn-Off Times Available, Consult Factory	t_q	–	25	40	μsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (Linear) (6) Commutation di/dt = 5 Amps/μsec. (7) Repetition Rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	t_q (diode)	–	40	†	μsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (Linear). (6) Commutation di/dt = 5 Amps/μsec. (7) Repetition Rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms

†Consult factory for specified maximum turn-off time.
††Delay time may increase significantly as the gate drive approaches the I_{GT} of the device under test (D.U.T.).
†††Current risetime as measured with a current probe, or voltage risetime across a non-inductive resistor.

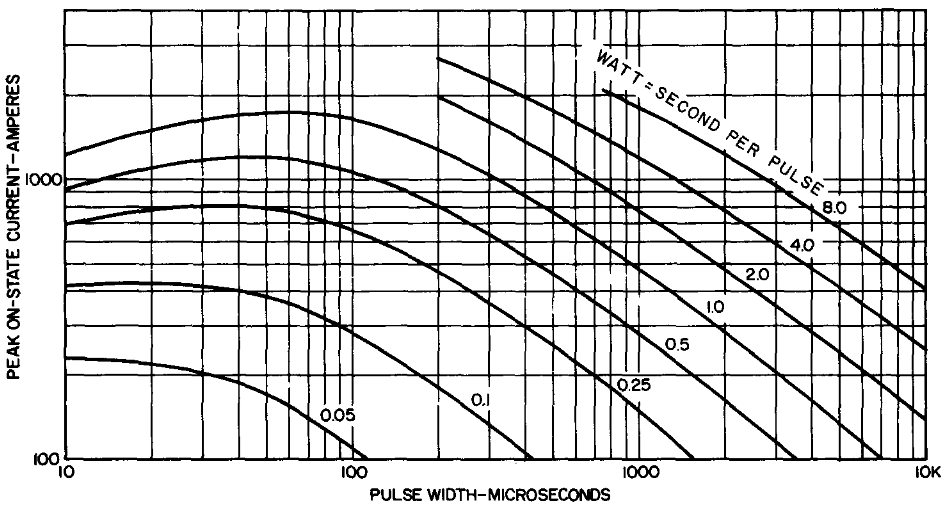


1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)

SINE WAVE CURRENT RATING DATA



2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

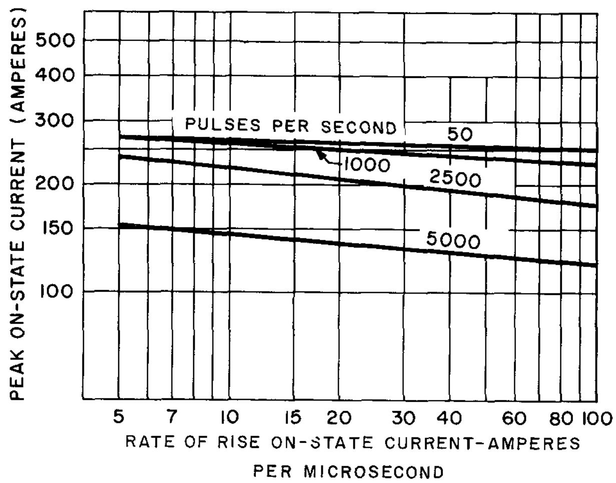
NOTES:
(Pertaining to Sine and Rectangular Wave Current Ratings)

1. Switching voltage = 800 volts.
2. Maximum ckt. dv/dt = 200 volts/μsec.
3. Reverse voltage applied = 50V ⩽ V_R ⩽ 800 volts.
4. Required gate drive:
   20 volts, 65 ohms, 1μsec rise time for less than 100 amps/μsec.
   20 volts, 20 ohms, .5μsec rise time for greater than 100 amps/μsec.
5. R-C Snubber ckt. = .2μF, 5Ω.
6. Double-Side Cooled.
7. Max. energy dissipated during reverse recovery to be 15% of total W-S/P shown in chart 5 or 0.03 W-S/P whichever is least.
8. Values of W-S/P are for T_j = 125°C.

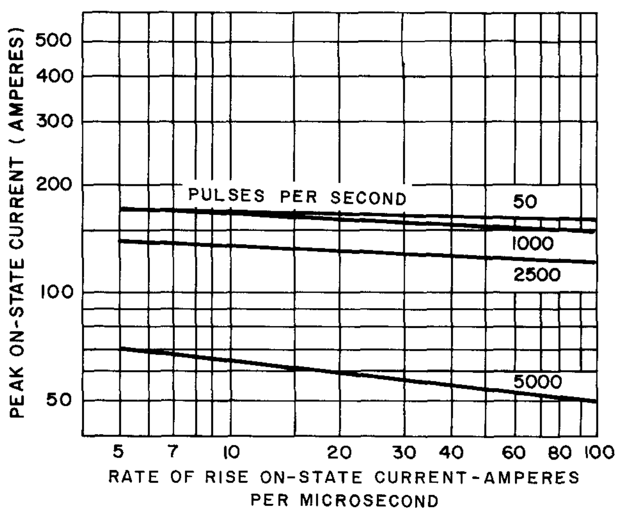
C358

TRAPEZOIDAL WAVE CURRENT RATING DATA

DUTY CYCLE – 50%

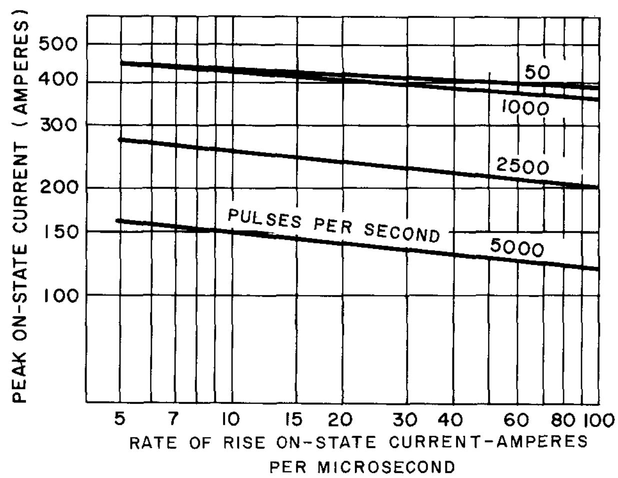


4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

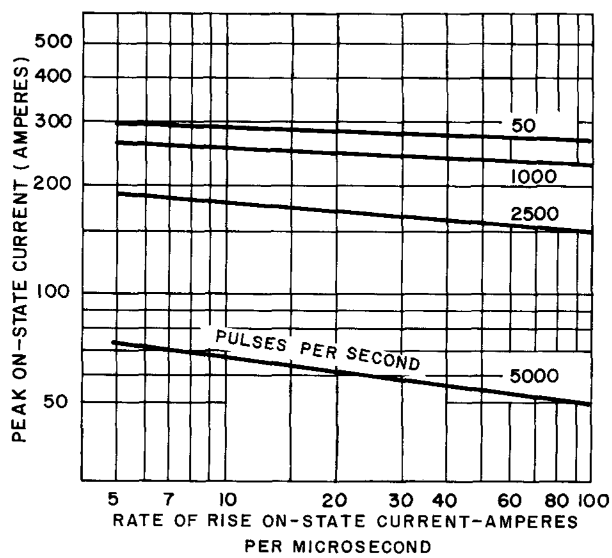


5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

DUTY CYCLE – 25%

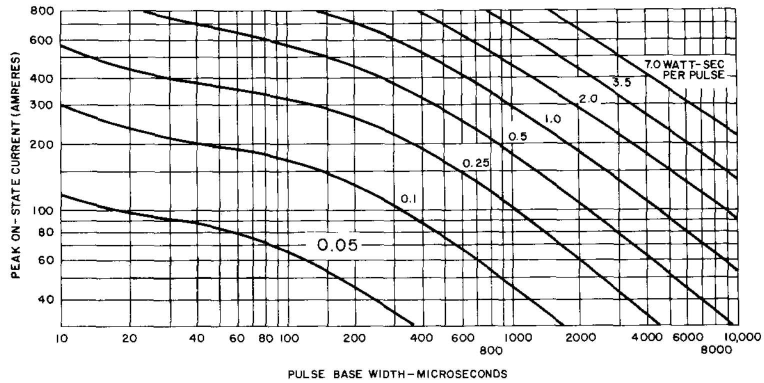


6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

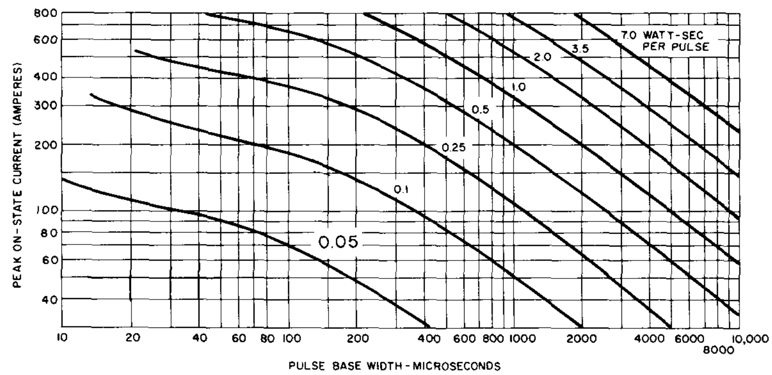


7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

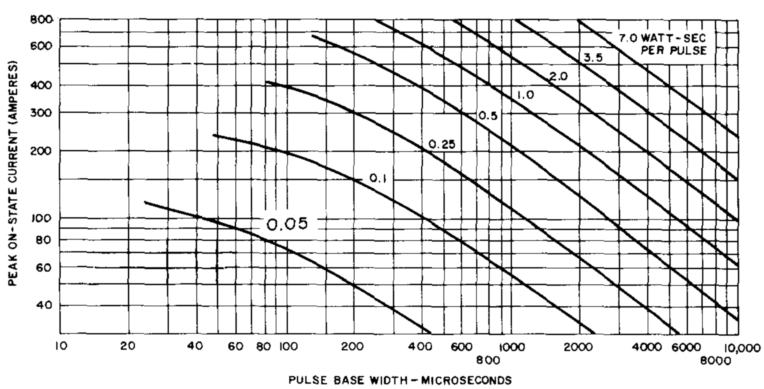
WATT-SECOND PER PULSE



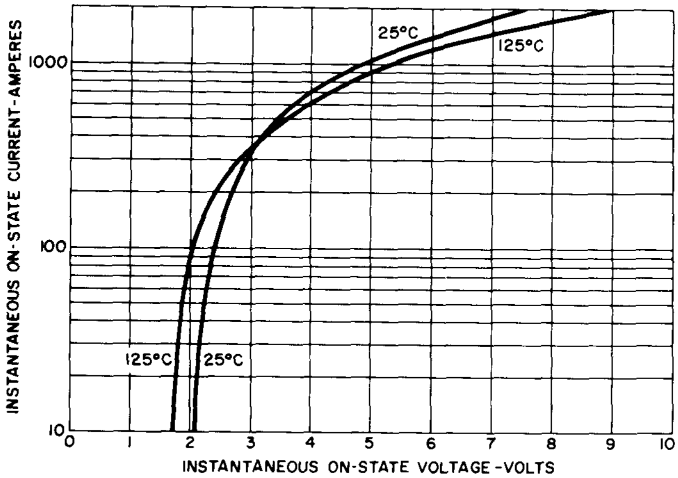
8. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec)



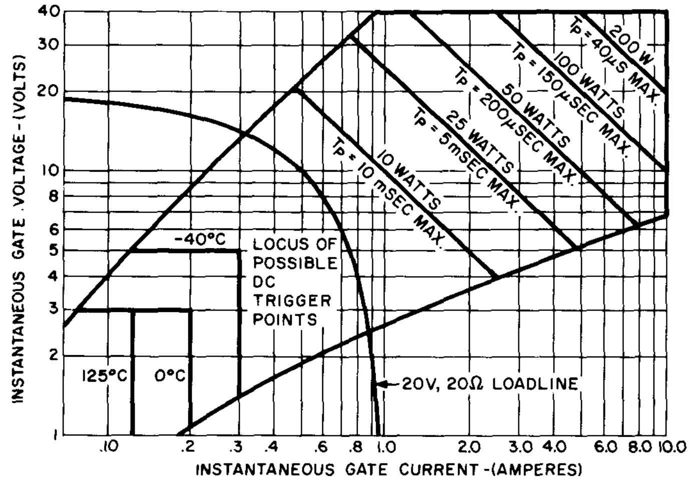
9. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec)



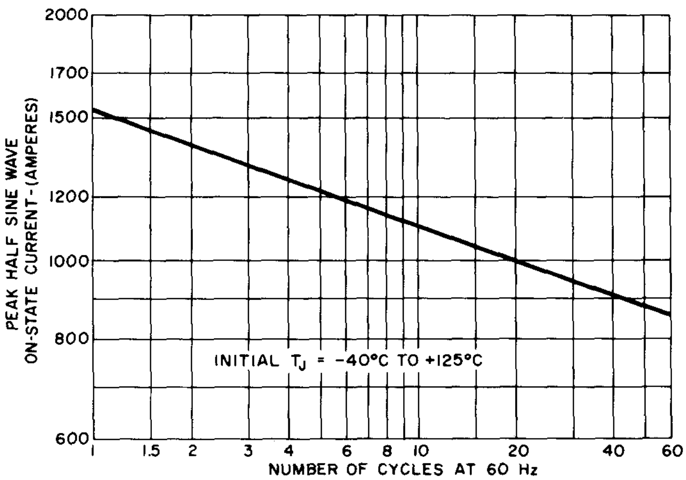
10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec)



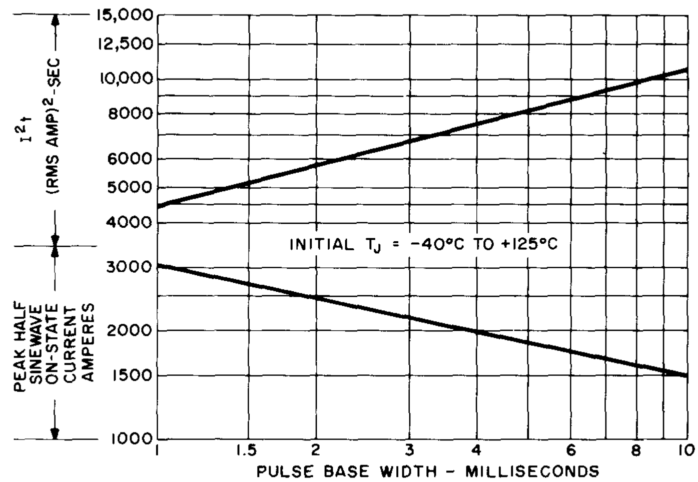
11. MAXIMUM ON-STATE CHARACTERISTICS



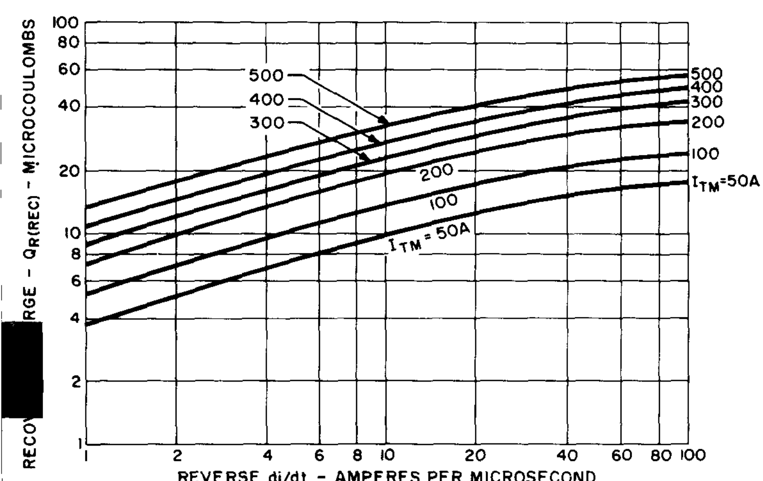
12. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS



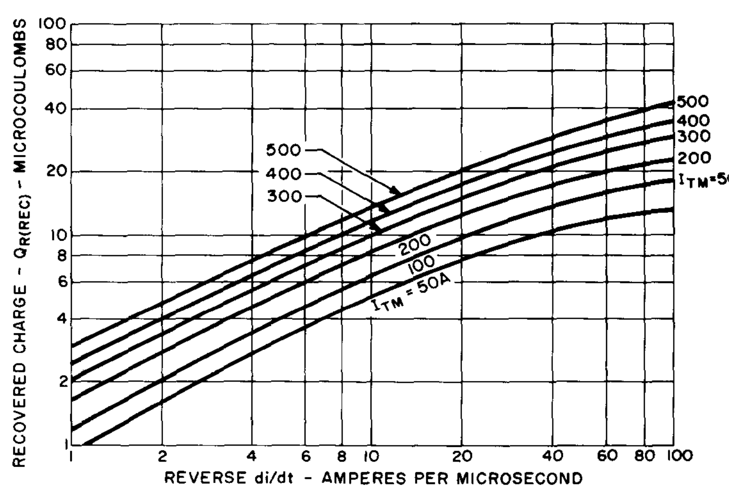
13. SURGE (NON-REPETITIVE) ON-STATE CURRENT



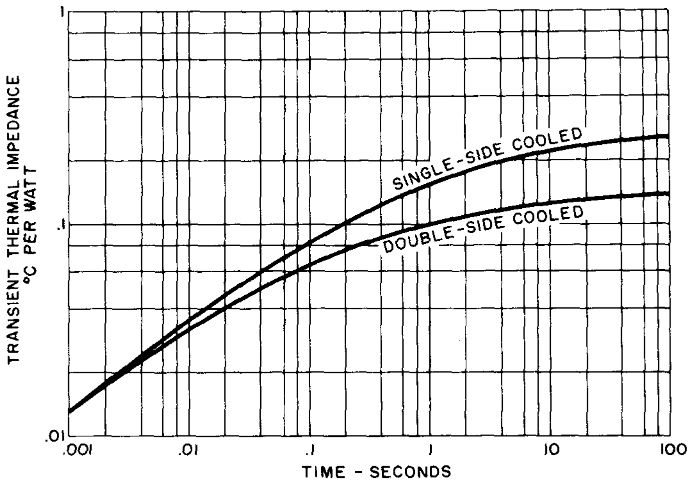
14. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



15. TYPICAL RECOVERED CHARGE (125°C) SINE WAVE CURRENT WAVEFORM

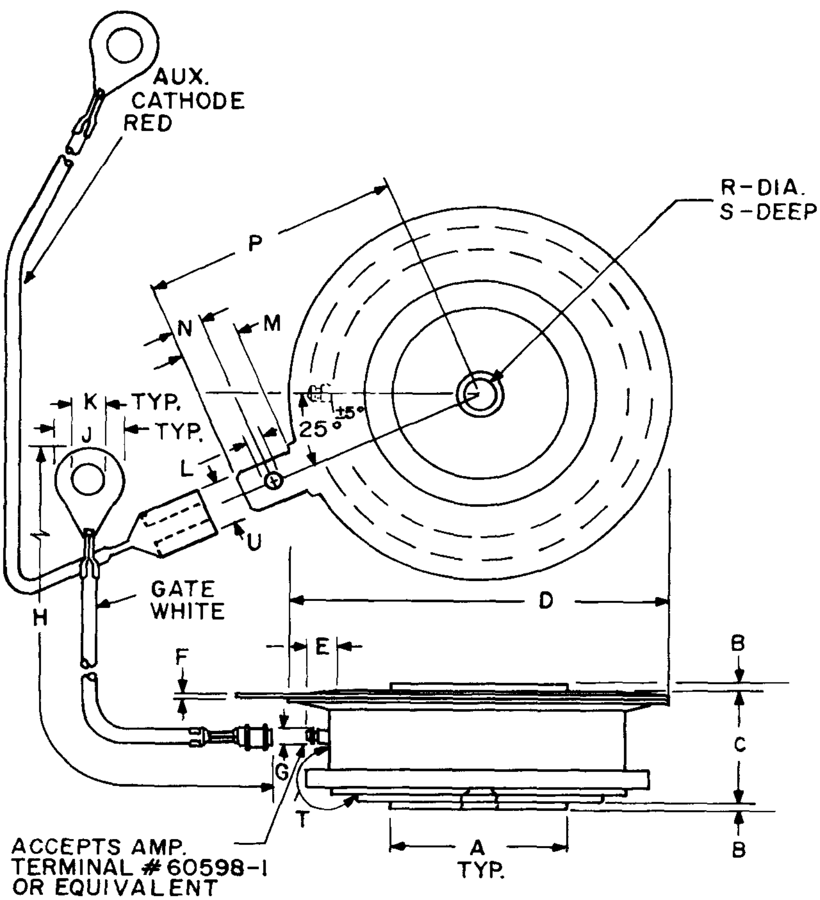


16. TYPICAL RECOVERED CHARGE (25°C) SINE WAVE CURRENT WAVEFORM



17. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE

OUTLINE DRAWING



H - STRAIGHT LEAD LENGTH, TYP. 2 LEADS

T - SURFACE CREEPAGE

TABLE OF DIMENSIONS

Conversion Table

	DECIMAL INCHES		METRIC MM	
SYM	MIN	MAX.	MIN.	MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

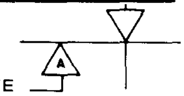
HIGH SPEED

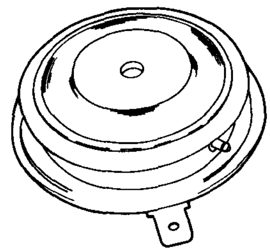
Silicon Controlled Rectifier

C364/C365

600 Volts **275 A RMS**

AMPLIFYING GATE





The General Electric C364 and C365 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Press-Pak devices employing the field-proven amplifying gate.

FEATURES:

- Fully characterized for operation in inverter and chopper applications.
- High di/dt ratings.
- High dv/dt capability with selections available.
- Rugged hermetic glazed ceramic package.

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C364/C365A	100 Volts	100 Volts	200 Volts
C364/C365B	200	200	300
C364/C365C	300	300	400
C364/C365D	400	400	500
C364/C365E	500	500	600
C364/C365M	600	600	720
C365S	700	700	840
C365N	800	800	960

[1] Half sinewave waveform, 10 ms max. pulse width.

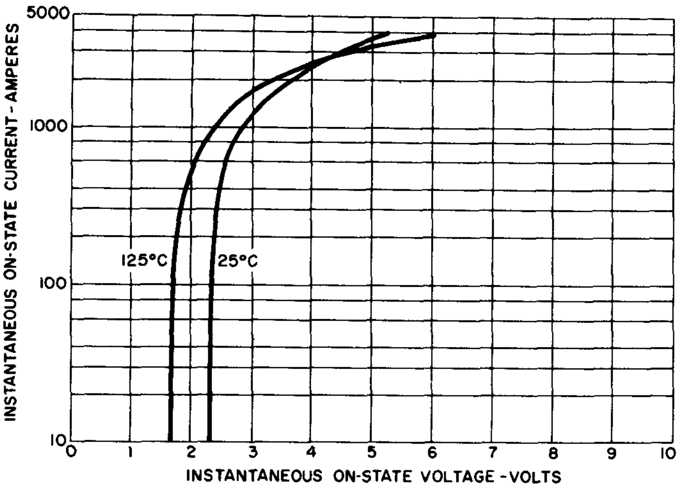
RMS On-State Current, $I_{T(RMS)}$ . . . . 275 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 1800 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 1700 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds . . . . 9,500 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds . . . . 13,500 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive . . . . 800 A/µs †
Critical Rate-of-Rise of On-State Current, Repetitive . . . . 500 A/µs †
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force Required . . . . 800 Lbs. ± 10%
3.56 KN ± 10%

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5 µs short circuit trigger current rise time.

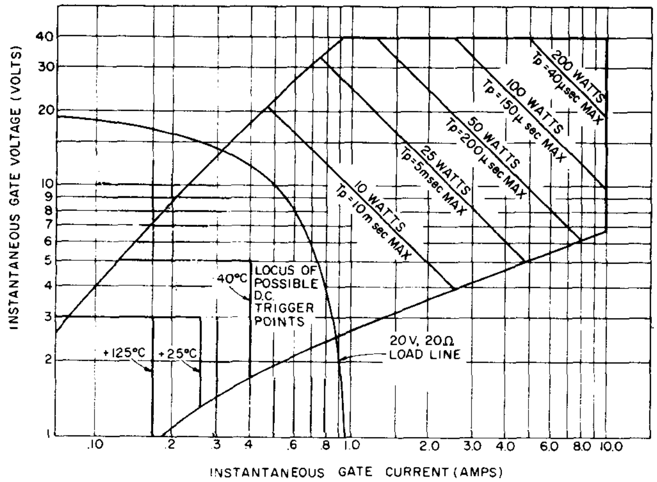
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	5	12	mA	T_J = +25°C V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	12	17	mA	T_J = 125°C V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	.12	.135	°C/Watt	Junction-to-Case (Double-Side Cooled)
		–	.15	.26		Junction-to-Case (Single-Side Cooled)
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated Linear or Exponential Rising Waveform. Exponential dv/dt = V_{DRM} (.632)/τ
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	40	1000	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial On-State Current = 2 Amps.
DC Gate Trigger Current	I_{GT}	–	70	250	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	100	400		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	25	175		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	3	5	Vdc	T_C = -40°C to 0°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	1.25	3.0		T_C = 0°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = 125°C, V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	1.9	2.6	Volts	T_C = +25°C, I_{TM} = 500 Amps. Peak Duty Cycle ≤ .01%
Turn-On Delay Time	t_d	–	0.5	–	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}, Gate Supply: 20 Volt Open Circuit, 20 Ohm, 0.1 μsec max. rise time. ††, †††
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q				μsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (linear) (6) Commutation di/dt = 5 Amps/μsec. (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
	C364	–	8	10		
Faster Maximum Turn-Off Times Available, Consult Factory	C365	–	15	20		
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	$t_{q(diode)}$				μsec	(1) T_C = +125°C (2) I_{TM} = 150 Amps. (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Forward Blocking Voltage = 200 V/μsec (linear) (6) Commutation di/dt = 5 Amps/μsec (7) Repetition Rate = 1 pss. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms.
	C364	–	15	†		
	C365	–	20	†		

†Consult factory for specified maximum Turn-Off Time.
††Delay time may increase significantly as the gate drive approaches the I_{GT} of the Device Under Test.
†††Current risetime as measured with a current probe, or voltage risetime across a non-inductive resistor.

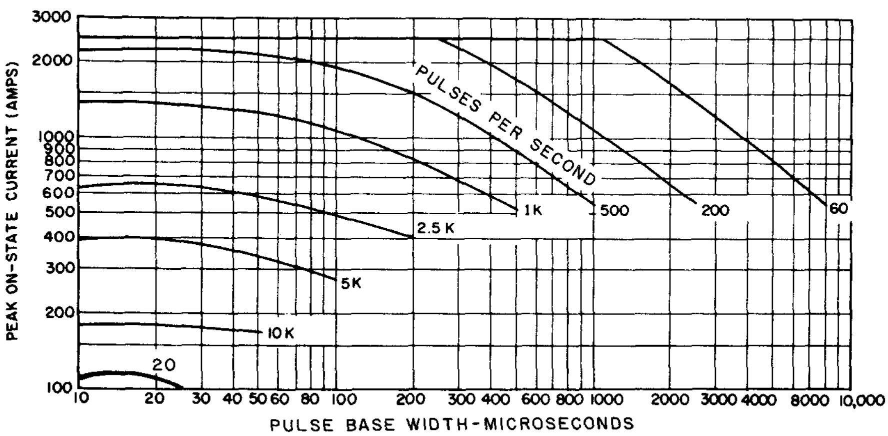


1. MAXIMUM ON-STATE CHARACTERISTICS

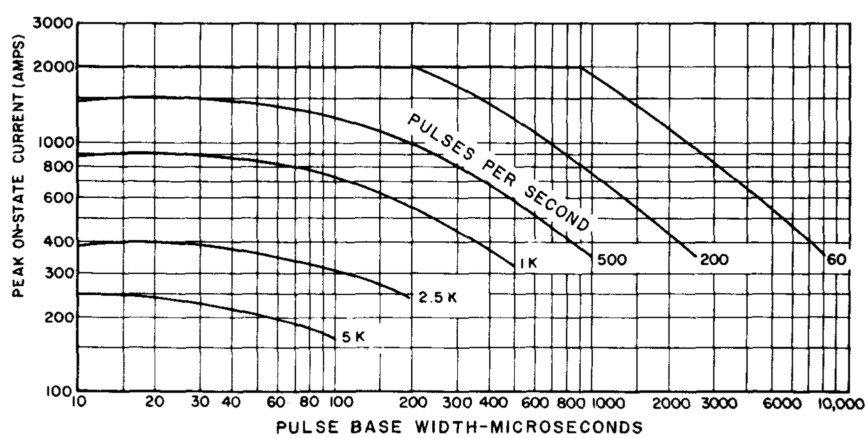


2. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

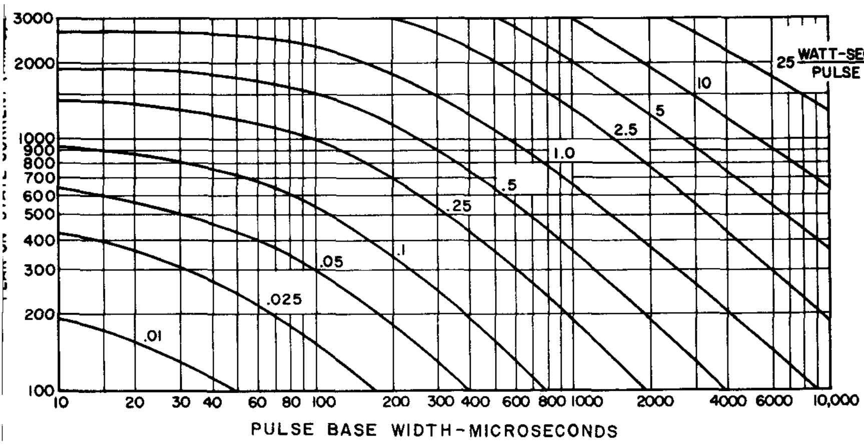
SINE WAVE CURRENT RATING DATA



3. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



5. ENERGY PER PULSE FOR SINUSOIDAL PULSES

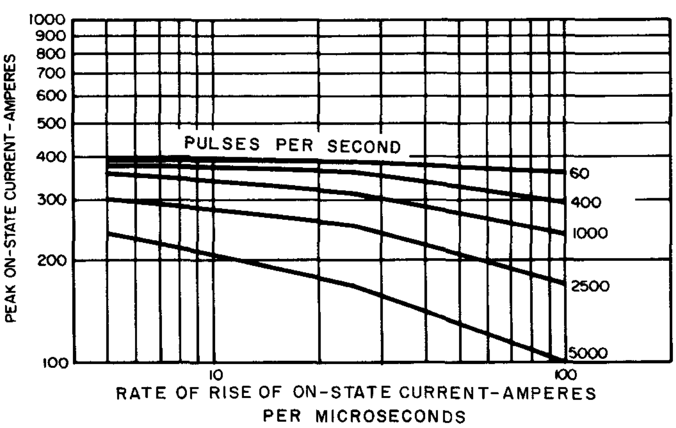
NOTES:

(Pertaining to Sine and Rectangular Wave Current Ratings)

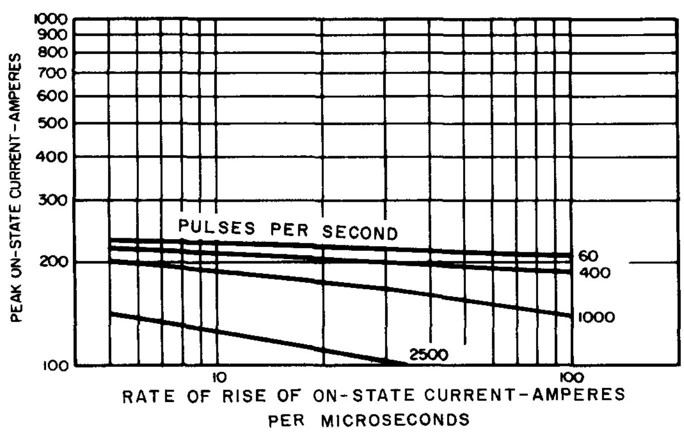
1. Switching voltage = 400 volts.
2. Reverse voltage applied = $V_R \leqslant 600$ volts.
3. Required gate drive:
   20 volts, 65 ohms, 1 μsec risetime for less than 100 amps/μsec.
   20 volts, 20 ohms, .5 μsec risetime for greater than 100 amps/μsec.
4. RC Snubber ckt. = 0.25 μf, 5 Ω.
5. Double-Side Cooled.
6. Maximum energy dissipated during reverse recovery to be 15% of total W-S/P shown in W-S/P chart or 0.03 W-S/P, whichever is least.
7. Values of W-S/P are for $T_j = 125°C$.

RECTANGULAR WAVE CURRENT RATING DATA

DUTY CYCLE – 50%

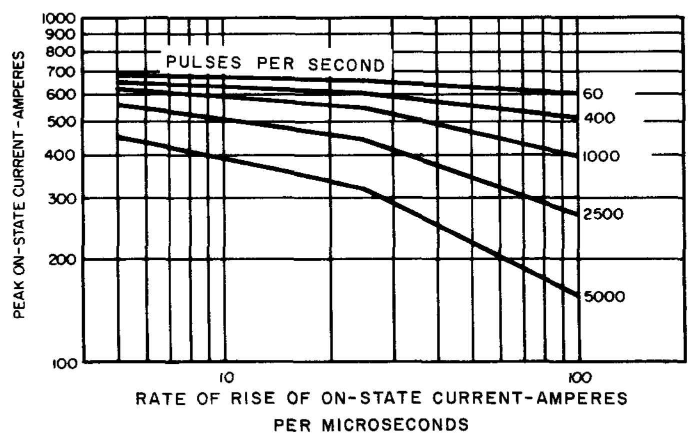


6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt ($T_C = 65°C$)

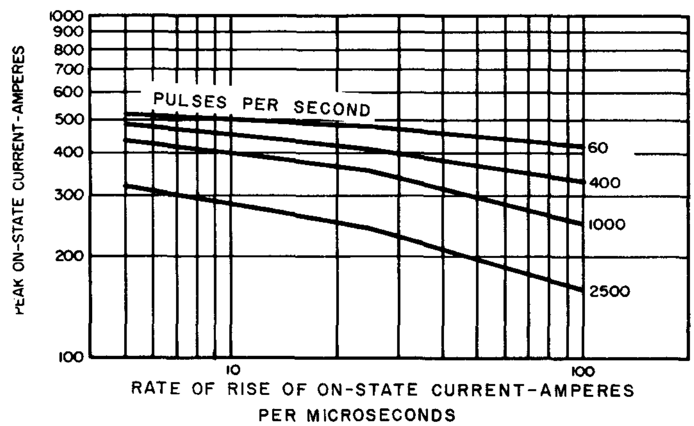


7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt ($T_C = 90°C$)

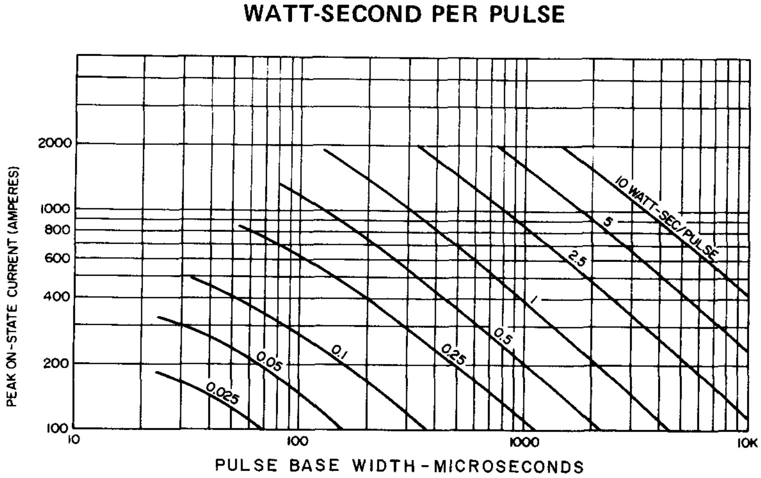
DUTY CYCLE – 25%



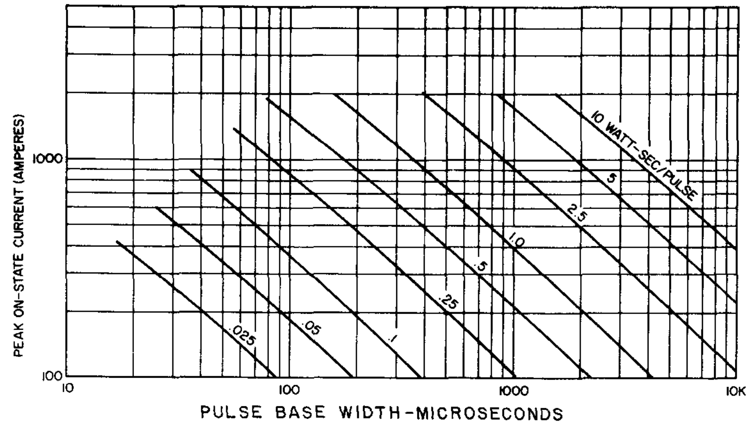
8. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt ($T_C = 65°C$)



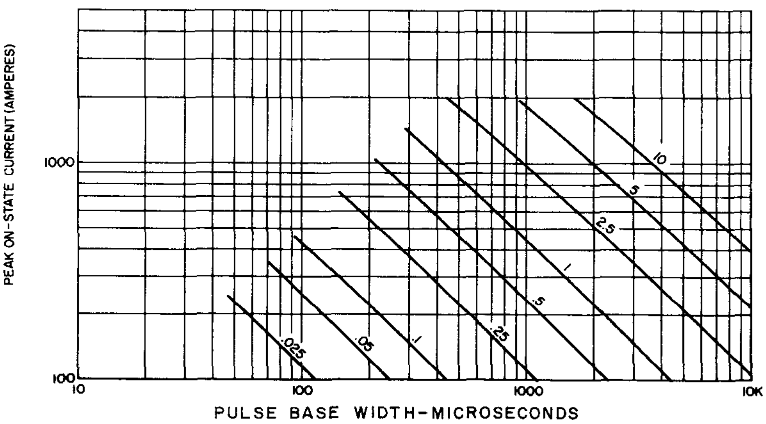
9. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt ($T_C = 90°C$)



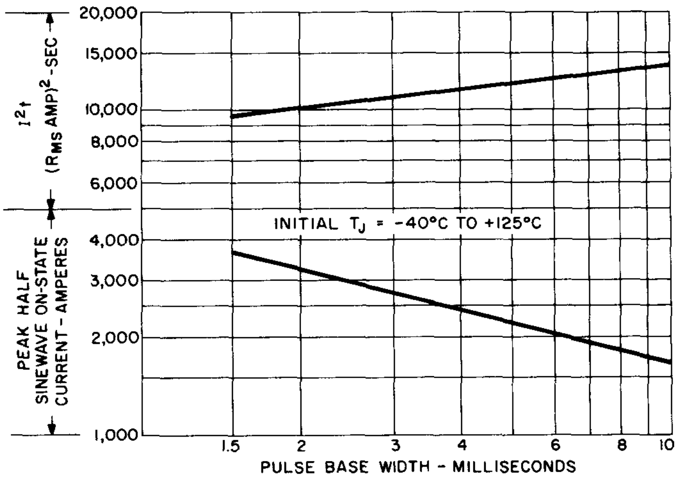
10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec)



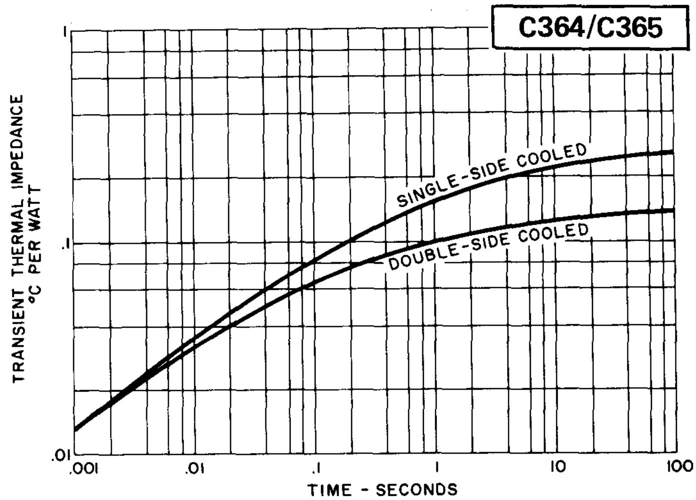
11. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec)



12. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec)

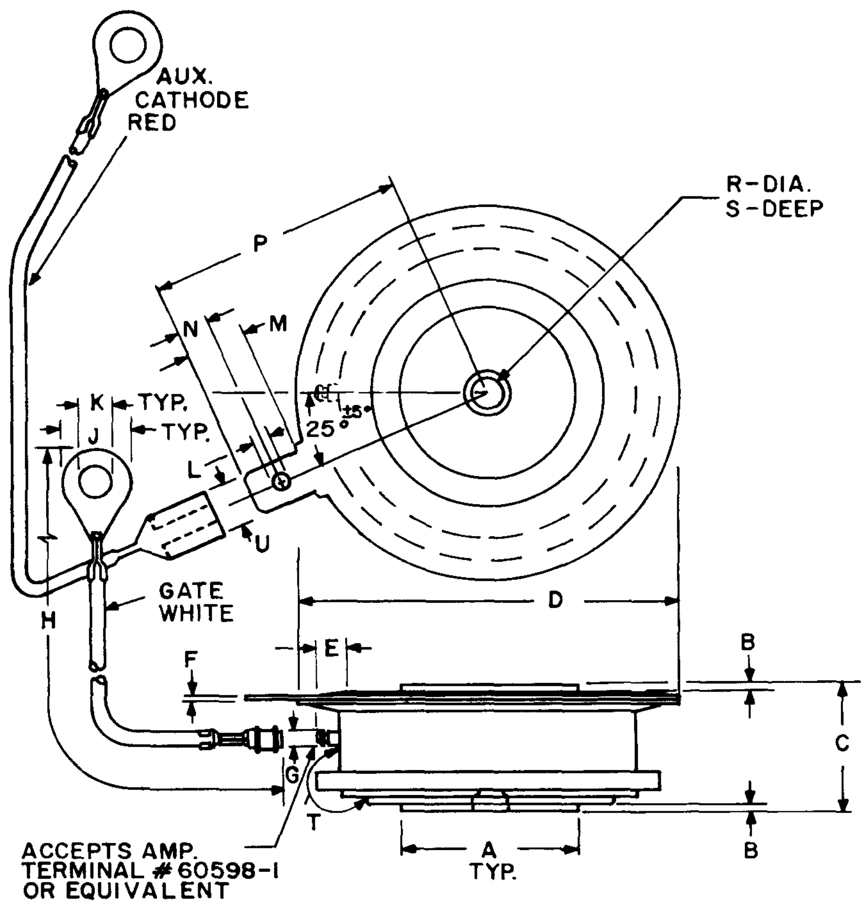


13. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



14. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE

OUTLINE DRAWING



H - STRAIGHT LEAD LENGTH, TYP. 2 LEADS

T - SURFACE CREEPAGE

TABLE OF DIMENSIONS

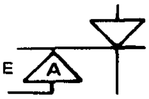
Conversion Table

SYM	DECIMAL INCHES MIN	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

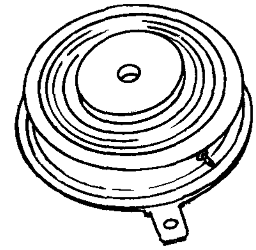
High Power Silicon Controlled Rectifier

1300 VOLTS 400A RMS

C380

AMPLIFYING GATE 

The General Electric C380 Silicon Controlled Rectifier is designed for phase control applications. This is an all-diffused Press-Pak device, employing the field-proven amplifying gate.



FEATURES:

- High di/dt Ratings
- High dv/dt Capability with Selections Available
- Excellent Surge and I^2t Ratings Providing Easy Fusing
- Guaranteed Maximum Turn-Off Time with Selections Available
- Rugged Hermetic Glazed Ceramic Package

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C380A	100 Volts	100 Volts	200 Volts
C380B	200	200	300
C380C	300	300	400
C380D	400	400	500
C380E	500	500	600
C380M	600	600	720
C380S	700	700	840
C380N	800	800	950
C380T	900	900	1075
C380P	1000	1000	1200
C380PA	1100	1100	1325
C380PB	1200	1200	1450
C380PC	1300	1300	1550

[1] Half sinewave waveform, 10 msec max. pulse width.

Average On-State Current, $I_{T(AV)}$ . . . . Depends on Conduction Angle. (See Charts 1 and 3)
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 3500 Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 3200 Amperes
Critical Rate-of-Rise of On-State Current (Non-Repetitive)* . . . . 800 A/μs
Critical Rate-of-Rise of On-State Current (Repetitive)* . . . . 500 A/μs
I^2t (for fusing) (for times ⩾ 1.5 milliseconds) . . . . 32,000 (RMS Ampere)² Seconds
I^2t (for fusing) (at 8.3 milliseconds) . . . . 50,000 (RMS Ampere)² Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 10 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force Required . . . . 800 Lbs. ± 10%
3.56 KN ± 10%

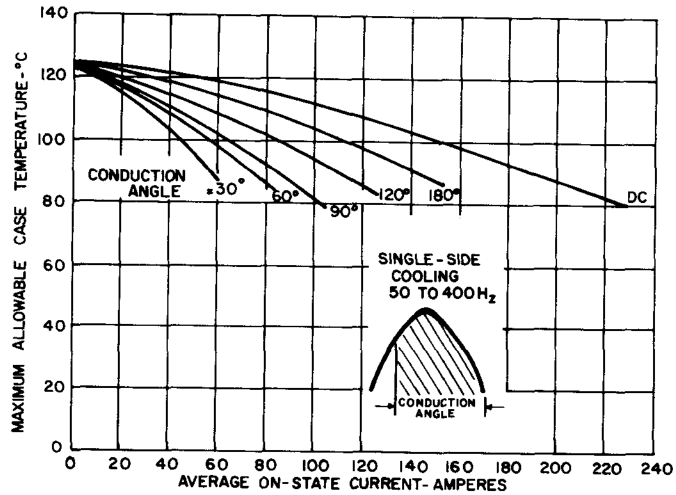
*di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of V_{DRM} stated above; 20 volts, 20 ohms gate trigger source with 0.5 μsec short circuit trigger current rise time.

CHARACTERISTICS

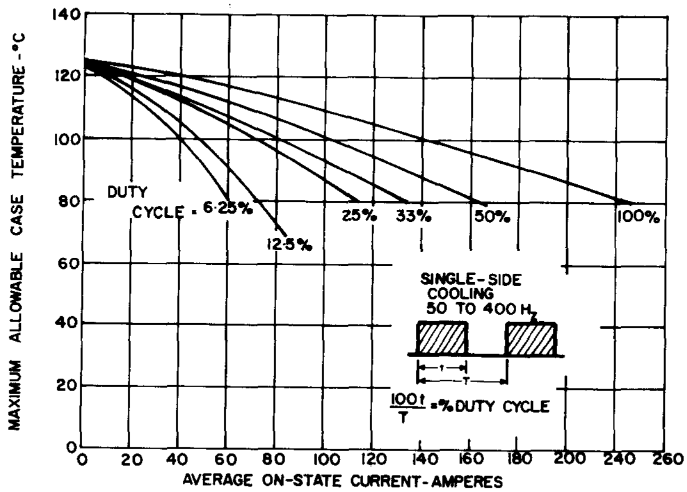
C380

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = 25°C $V_{DRM} = V_{RRM}$ =
C380A		–	3	10		100 Volts Peak
C380B		–	3	10		200
C380C		–	3	10		300
C380D		–	3	10		400
C380E		–	3	10		500
C380M		–	3	10		600
C380S		–	3	10		700
C380N		–	3	10		800
C380T		–	3	9		900
C380P		–	3	7		1000
C380PA		–	3	7		1100
C380PB		–	3	6		1200
C380PC		–	3	5		1300
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = 125°C $V_{DRM} = V_{RRM}$ =
C380A		–	15	20		100 Volts Peak
C380B		–	15	20		200
C380C		–	15	20		300
C380D		–	15	20		400
C380E		–	15	20		500
C380M		–	15	20		600
C380S		–	15	20		700
C380N		–	15	20		800
C380T		–	15	18		900
C380P		–	12	15		1000
C380PA		–	11	14		1100
C380PB		–	10	13		1200
C380PC		–	8	11		1300
Thermal Resistance	$R_{\theta JC}$	–	–	0.19	°C/Watt	Junction-to-Case (Single-Side Cooling)
		–	–	0.095		Junction-to-Case (Double-Side Cooling)
Critical Rate-of-Rise of Off-State Voltage. (Higher values may cause device switching.)	dv/dt	200	500	–	V/µsec	T_J = 125°C. Gate Open Circuited. V_{DRM} = Rated, Using Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ = (.632)
Higher minimum dv/dt selection available – consult factory.						
Holding Current	I_H	–	100	–	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial On-State Current = 2.5 Amps.
Turn-On Delay Time	t_d	–	1	–	µsec	T_C = +25°C, I_T = 100 Adc, V_{DRM} = Rated Gate Supply: 10 Volt Open Circuit, 25 Ohm, 0.1 µsec max. rise time.
DC Gate Trigger Current	I_{GT}	–	10	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	20	200		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	4	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	1.25	3.0	Vdc	T_C = -40°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
						T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
Peak On-State Voltage	V_{TM}	–	2.3	2.85	Volts	T_C = +25°C, I_{TM} = 1500 Amps Peak. Duty Cycle ⩽ 0.01%.
Circuit Commutated Turn-Off Time	t_q*	–	200	–	µsec	(1) T_C = +120°C, (2) I_{TM} = 250 Amps (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20Volts/µsec (Linear) (6) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms. Duty Cycle ⩽ 0.01%.

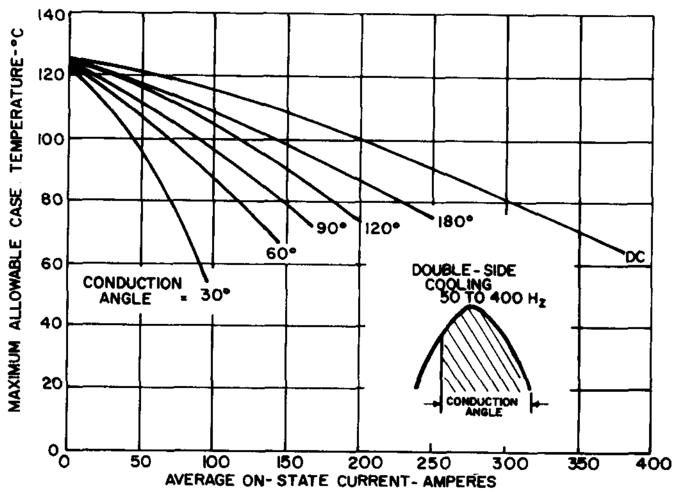
*Consult factory for maximum t_q specifications.



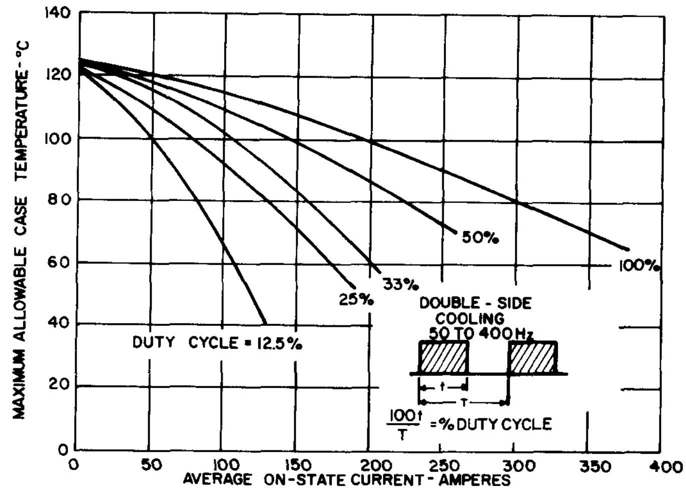
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



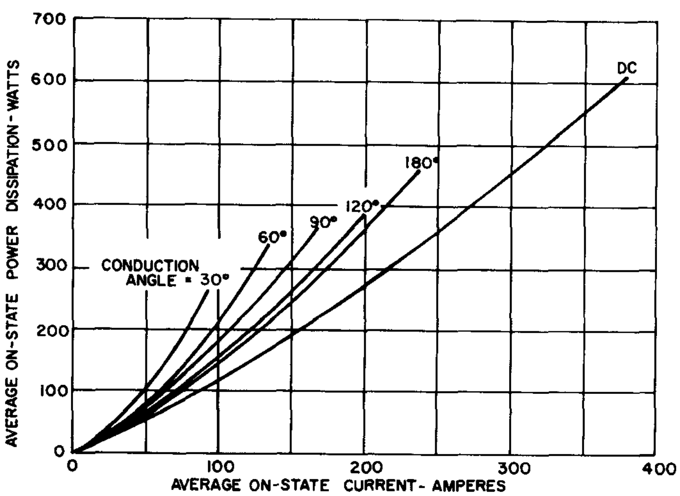
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



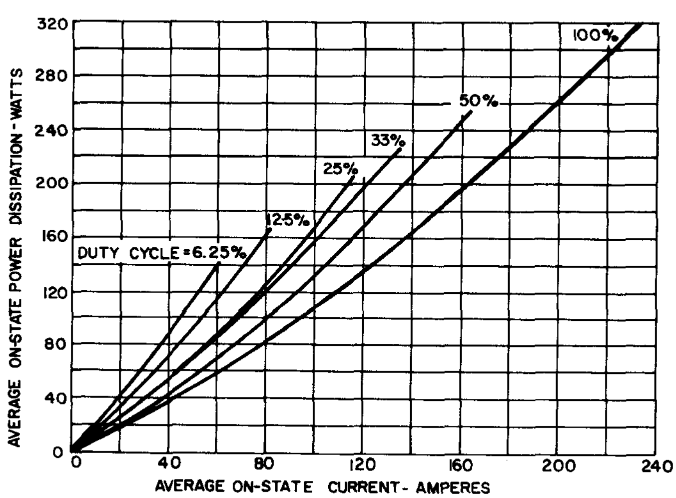
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



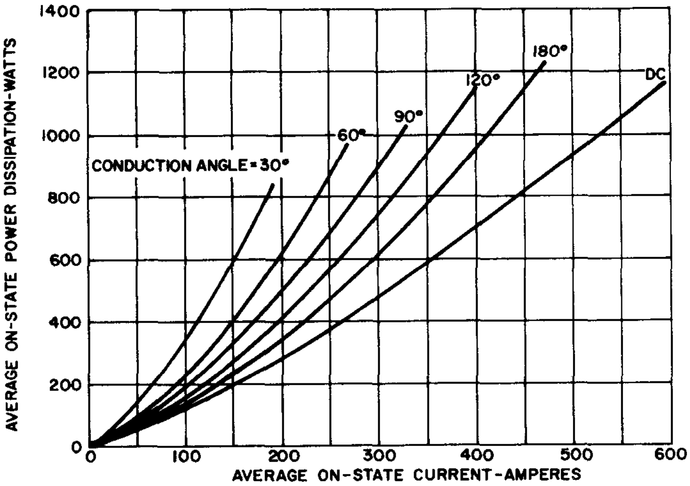
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



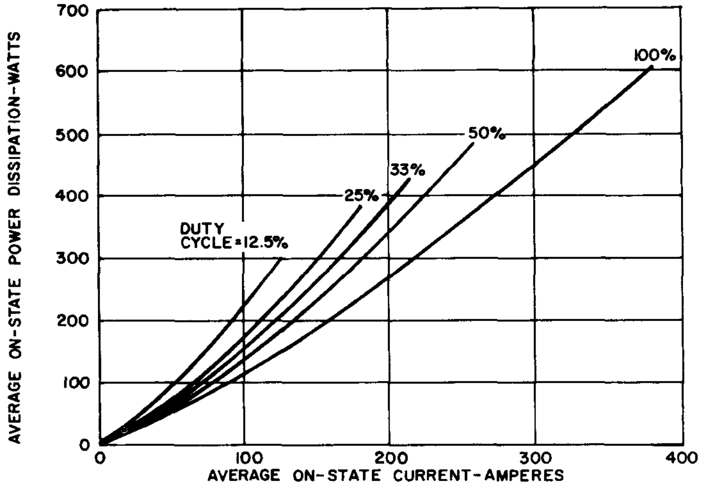
5. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



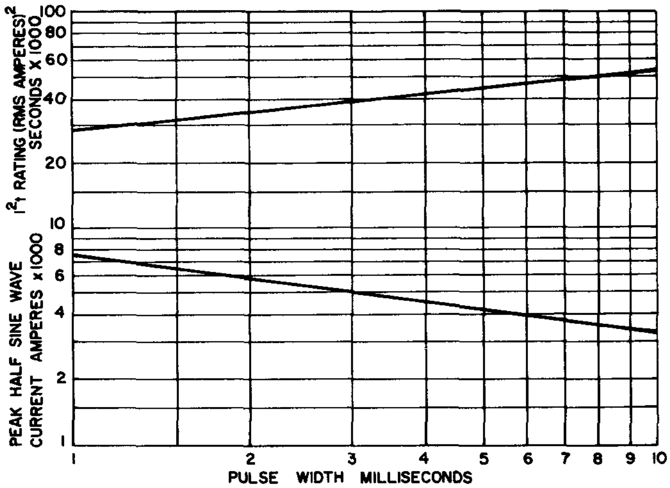
6. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



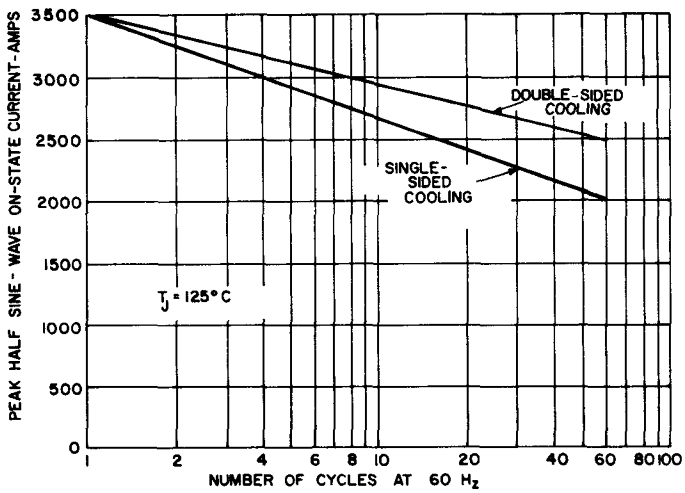
7. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM (EXTENDED RANGE)



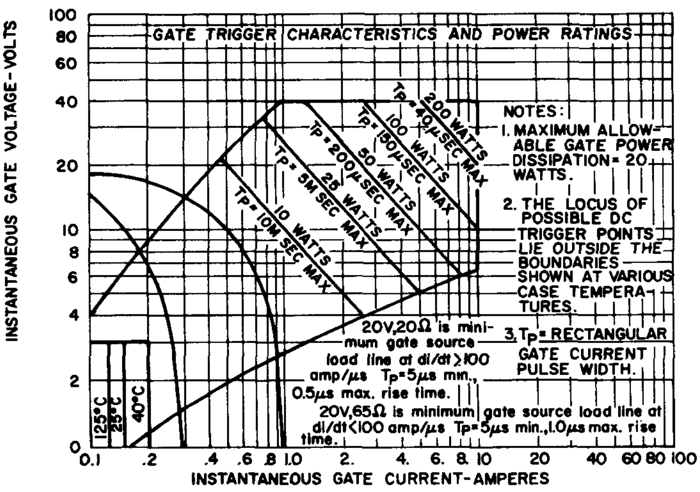
8. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM (EXTENDED RANGE)



9. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT FOLLOWING RATED LOAD CONDITIONS

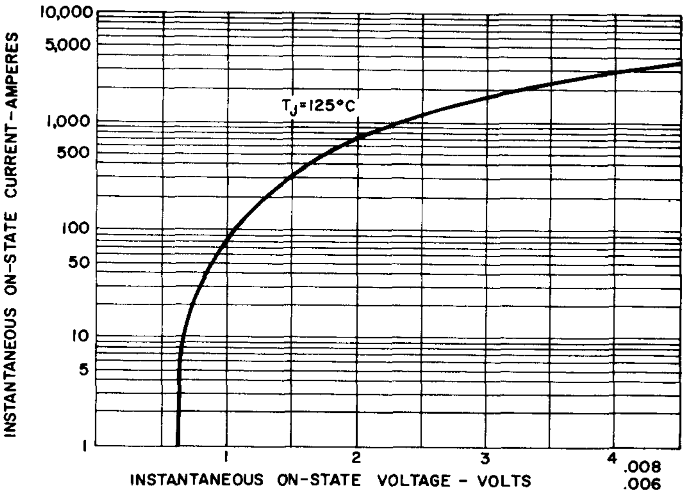


10. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT RATING

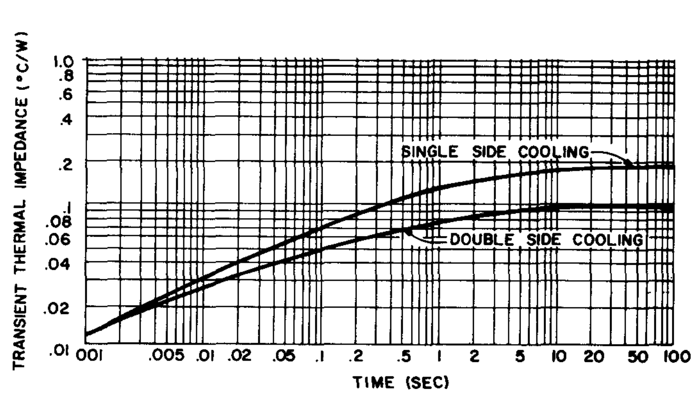


11. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

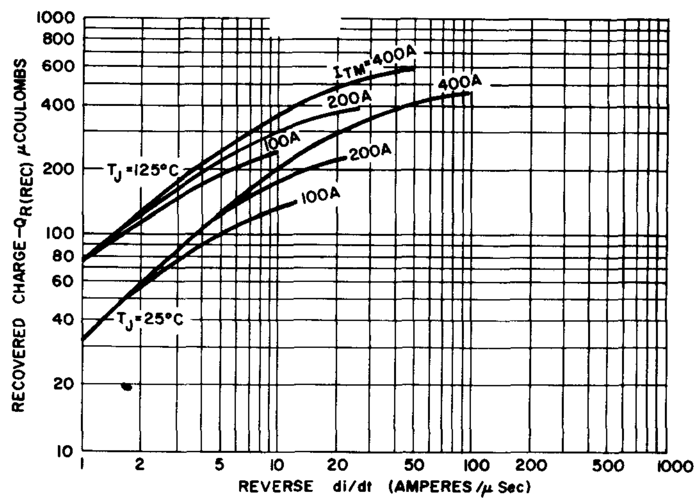
NOTES:
1. Maximum allowable gate power dissipation = 2 watts.
2. The locus of possible DC trigger points lie outside the boundaries shown at various case temperatures.
3. Tp = Rectangular Gate Current Pulse Width.



12. MAXIMUM ON-STATE CHARACTERISTICS

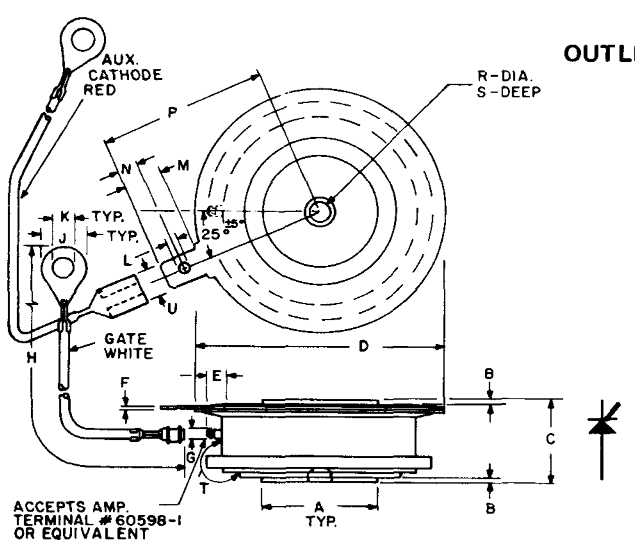


13. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



14. MAXIMUM RECOVERED CHARGE (SINUSOIDAL WAVEFORM)

OUTLINE DRAWING



H - STRAIGHT LEAD LENGTH, TYP. 2 LEADS

T - SURFACE CREEPAGE

TABLE OF DIMENSIONS
Conversion Table

	DECIMAL INCHES		METRIC MM	
SYM	MIN	MAX.	MIN.	MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

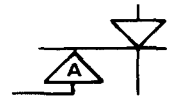
FOR MOUNTING HARDWARE SEE SELECTOR GUIDE

High Power
Silicon
Controlled Rectifier

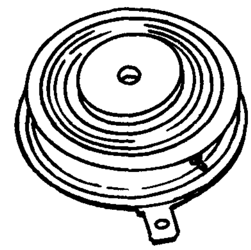
800 Volts **500A RMS**

C380X500

AMPLIFYING GATE



The General Electric C380X500 Silicon Controlled Rectifier is designed specifically for low voltage phase control applications; e.g., welding, battery charging, etc. The SCR has very low power dissipation thereby giving high current capability on free convection, air-cooled heatsinks.



FEATURES:

- Low On-State Voltage
- Excellent Surge and I^2t Ratings Providing Easy Fusing
- High di/dt Ratings
- High dv/dt Capability with Selections Available
- Rugged Hermetic Glazed Ceramic Package

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} [1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} [1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} [1] T_J = +125°C
C380AX500	100 Volts	100 Volts	200 Volts
C380BX500	200	200	300
C380CX500	300	300	400
C380DX500	400	400	500
C380EX500	500	500	600
C380MX500	600	600	720
C380SX500	700	700	840
C380NX500	800	800	950

[1] Half sinewave waveform, 10 msec max., pulse width.

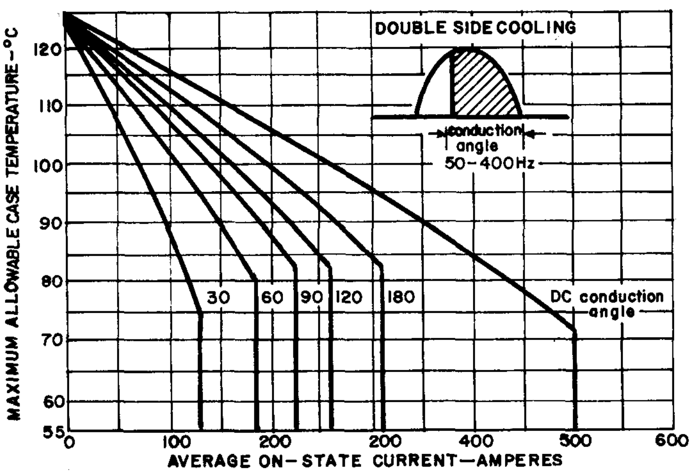
Average On-State Current, $I_{T(AV)}$ . . . . Depends on Conduction Angle (See Charts 1 and 2)
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 5500 Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 5000 Amperes
Critical Rate-of-Rise of On-State Current (Non-Repetitive). . . . . 800 A/μs †
Critical Rate-of-Rise of On-State Current (Repetitive) . . . . 500 A/μs †
I^2t (for fusing) (for times ≥ 1.5 milliseconds) . . . . 75,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) (at 8.3 milliseconds) . . . . 125,000 (RMS Ampere)^2 Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 10 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force Required . . . . 800 Lbs. ± 10%
3.56 KN ± 10%

*di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of V_{DRM} stated above; 20 volts, 20 ohms gate trigger source with 0.5 μsec short circuit trigger current rise time.

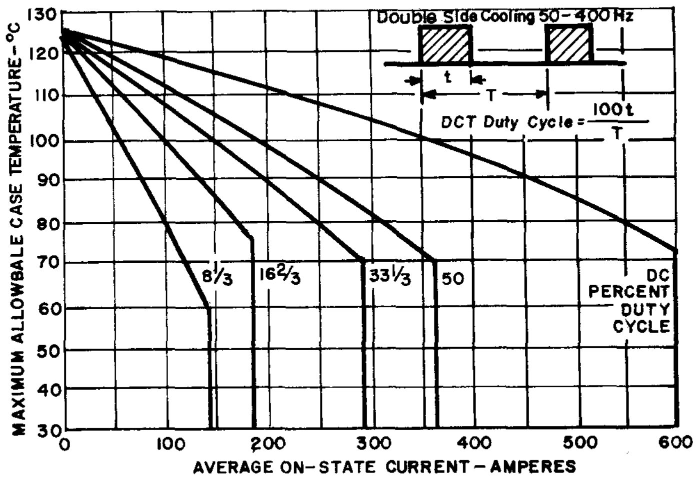
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = 25°C V_{DRM} = V_{RRM} =
C380AX500		–	3	10		100 Volts Peak
C380BX500		–	3	10		200
C380CX500		–	3	10		300
C380DX500		–	3	10		400
C380EX500		–	3	10		500
C380MX500		–	3	10		600
C380SX500		–	3	10		700
C380NX500		–	3	10		800
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{RRM}				mA	T_J = 125°C V_{DRM} = V_{RRM} =
C380AX500		–	15	20		100 Volts Peak
C380BX500		–	15	20		200
C380CX500		–	15	20		300
C380DX500		–	15	20		400
C380EX500		–	15	20		500
C380MX500		–	15	20		600
C380SX500		–	15	20		700
C380NX500		–	15	20		800
Thermal Resistance	$R_{\theta JC}$	–	–	0.19	°C/Watt	Junction-to-Case (Single-Side Cooling)
		–	–	0.095		Junction-to-Case (Double-Side Cooling)
Critical Rate-of-Rise of Off-State Voltage. (Higher values may cause device switching.)	dv/dt	200	500	–	V/μsec	T_J = 125°C. Gate Open Circuited. V_{DRM} = Rated, Using Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ = (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	100	–	mAdc	T_C = +25°C, Anode Supply = 24 Vdc, Initial On-State Current = 2.5 Amps.
Turn-On Delay Time	t_d	–	1	–	μsec	T_C = +25°C, I_T = 100 Adc, V_{DRM} = Rated Gate Supply: 10 Volt Open Circuit, 25 Ohms, 0.1 μsec max. rise time.
DC Gate Trigger Current	I_{GT}	–	10	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	20	200		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	4	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	1.25	3.0	Vdc	T_C = -40°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	–		T_C = +125C, V_D = 6 Vdc, R_L = 3 Ohms
Peak On-State Voltage	V_{TM}	–	–	1.75	Volts	T_C = +125°C, I_{TM} = 1500 Amps. Peak. Duty Cycle ⩽ 0.01%.
Circuit Commutated Turn-Off Time	t_q	–	200	–	μsec	(1) T_C = +120°C (2) I_{TM} = 250 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20 Volts/μsec (Linear) (6) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms. Duty Cycle ⩽ 0.01%.

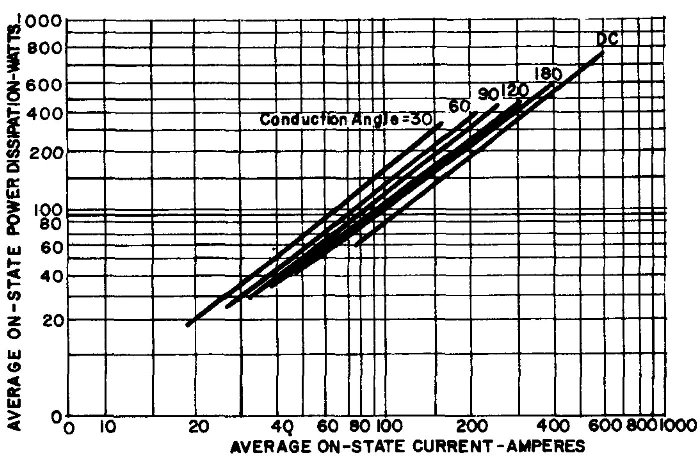
*Consult factory for maximum t_q specifications.



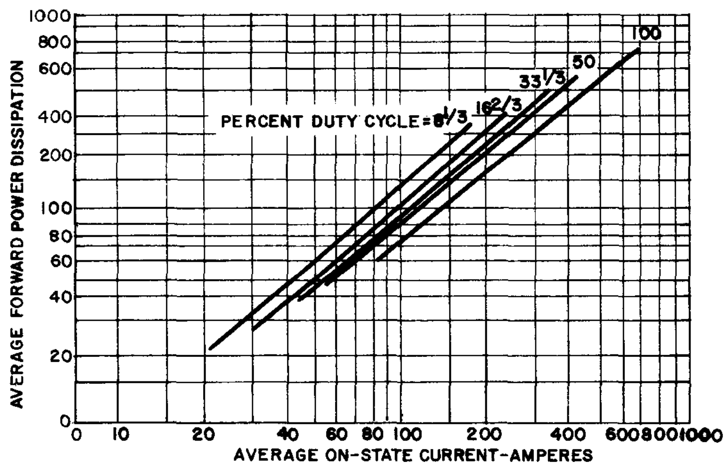
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM



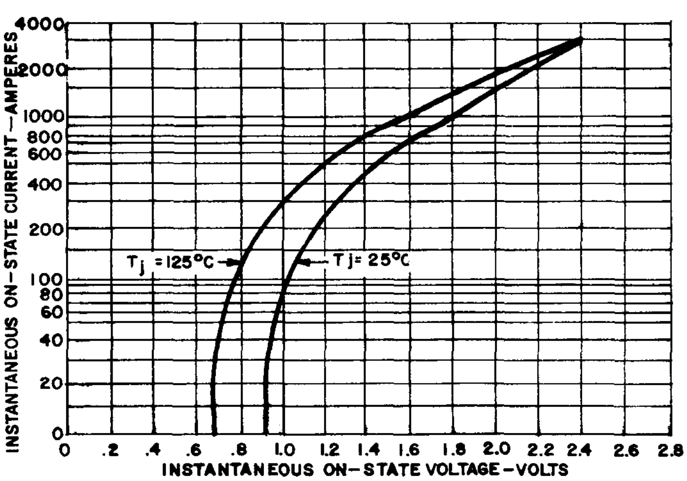
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM



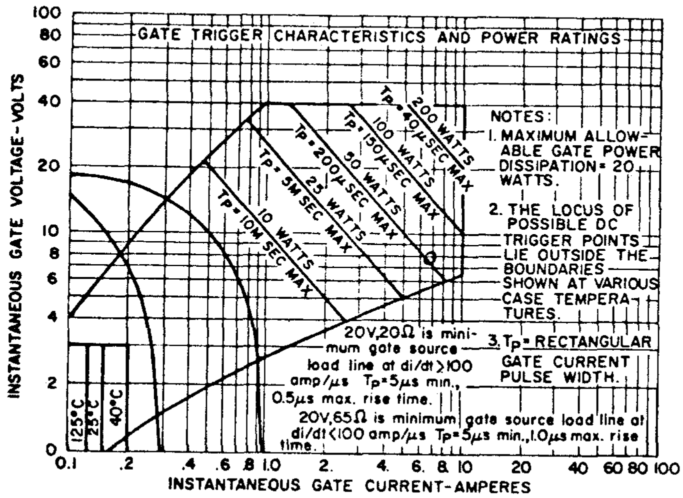
3. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



4. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



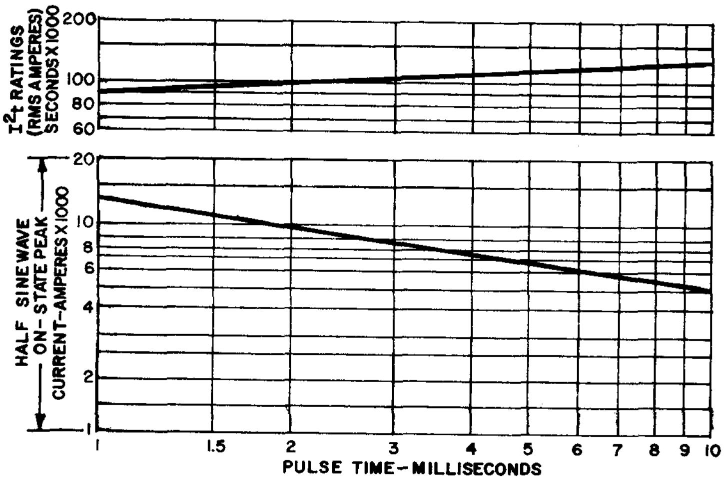
5. MAXIMUM ON-STATE CHARACTERISTICS



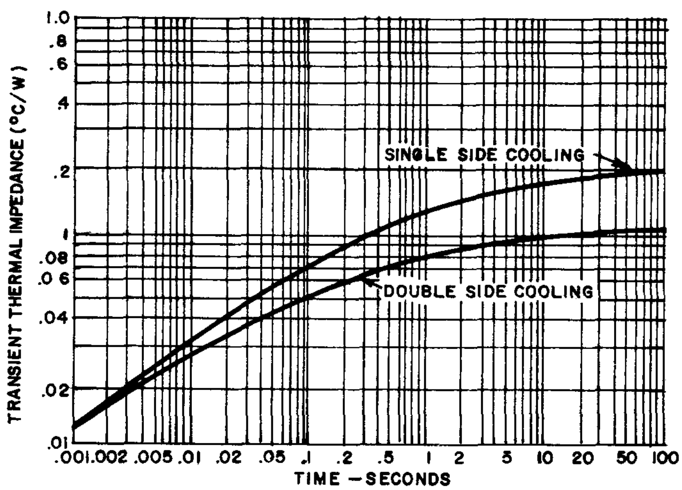
6. GATE TRIGGER CHARACTERISTICS AND POWER RATING

NOTES:

1. Maximum allowable gate power dissipation = 2 watts.
2. The locus of possible DC trigger points lie outside the boundaries shown at various case temperatures.
3. Tp = Rectangular Gate Current Pulse Width.



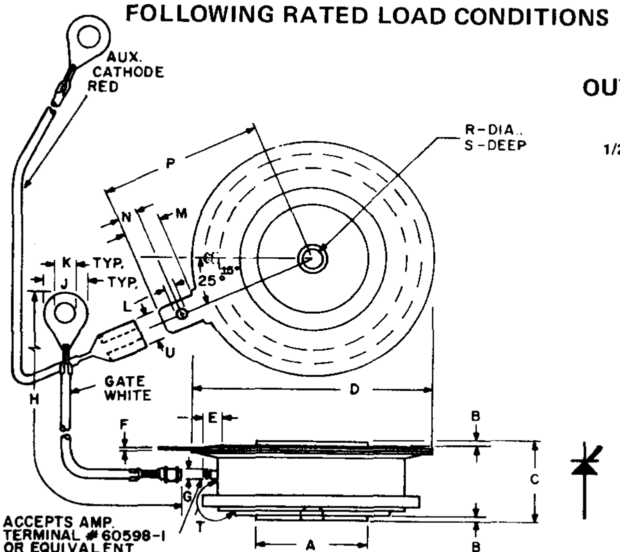
7. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE FOLLOWING RATED LOAD CONDITIONS



8. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

OUTLINE DRAWING

1/2" PRESS PAK PACKAGE



H - STRAIGHT LEAD LENGTH, TYP. 2 LEADS

T - SURFACE CREEPAGE

TABLE OF DIMENSIONS

Conversion Table

SYM	DECIMAL INCHES MIN	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

FOR MOUNTING HARDWARE SEE SELECTOR GUIDE

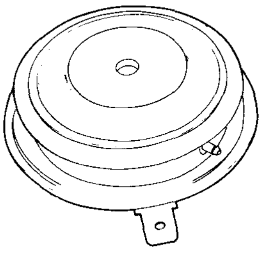
HIGH SPEED

Silicon Controlled Rectifier

C384/C385

800 Volts **400A RMS**

The General Electric C384 and C385 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Press-Pak devices, employing the field-proven amplifying gate.



FEATURES:

- Fully Characterized for Operation in Inverter and Chopper Applications.
- High di/dt Ratings.
- High dv/dt Capability with Selections Available.
- Rugged Hermetic Glazed Ceramic Package.

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = +125°C
C384/C385A	100 Volts	100 Volts	200 Volts
C384/C385B	200	200	300
C384/C385C	300	300	400
C384/C385D	400	400	500
C384/C385E	500	500	600
C384/C385M	600	600	720
C385S	700	700	940
C385N	800	800	960

[1] Half sinewave waveform, 10 ms max. pulse width.

Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz)	3500 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz)	3200 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds	35,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds	50,000 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive†	800 A/μs
Critical Rate-of-Rise of On-State Current, Repetitive†	500 A/μs
Average Gate Power Dissipation, $P_{G(AV)}$	2 Watts
Storage Temperature, T_{stg}	-40°C to +150°C
Operating Temperature, T_J	-40°C to +125°C
Mounting Force Required	800 Lbs. ± 10% 3.56 KN ± 10%

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5μs short circuit trigger current rise time.

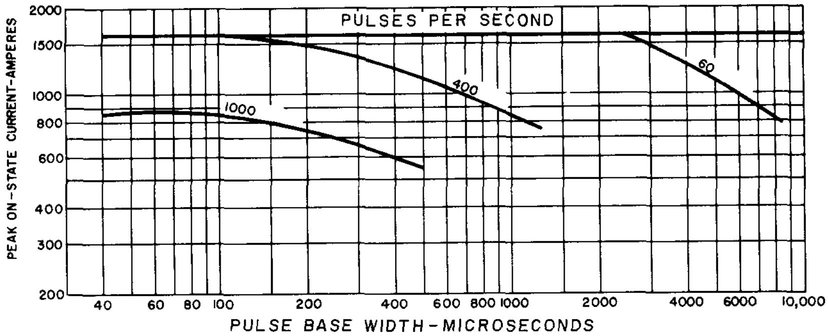
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	3	10	mA	T_J = +25°C V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	15	20	mA	T_J = 125°C V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	0.19	°C/Watt	Junction-to-Case – One-Side Cooled
		–	–	0.095		Junction-to-Case – Double-Side Cooled
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated linear or exponential rising waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	75	500	mAdc	T_C = +25°C, Anode Supply = 24 Vdc, Initial On-State Current = 2.5 Amps.
DC Gate Trigger Current	I_{GT}	–	125	300	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	175	500		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	100	250		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	5.0	Vdc	T_C = -40°C to 0°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	3.0		T_C = 0°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = +125°C, V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	2.3	2.85	Volts	T_C = +25°C, I_{TM} = 1500 Amps. Peak. Duty Cycle ≤ .01%
Turn-On Delay Time	t_d	–	1	–	μsec	T_C = +25°C, I_T = 50 Adc, V_{DRM}, Gate Supply: 20 Volt-Open Circuit, 20 Ohm, 0.1 μsec. max. rise time.
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q C385 C384	 – –	 15 8	 20 10	μsec	(1) T_C = +125°C (2) I_{TM} = 250 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (linear) (6) Commutation di/dt = 12.5 Amps/μsec. (7) Duty Cycle ≤ .01% (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms.
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	$t_{q(diode)}$ C385 C384	 – –	 20 10	 † †	μsec	(1) T_C = +125°C (2) I_{TM} = 250 Amps. (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (linear) (6) Commutation di/dt = 12.5 Amps/μsec (7) Duty Cycle ≤ .01% (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms

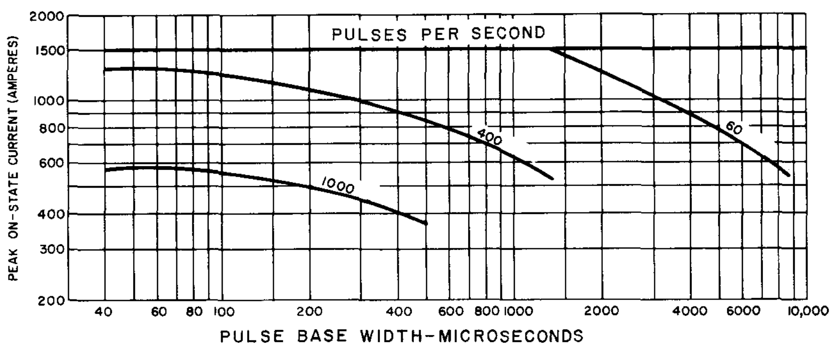
†Consult factory for maximum turn-off time.

SINE WAVE CURRENT RATING DATA

DOUBLE-SIDE COOLING



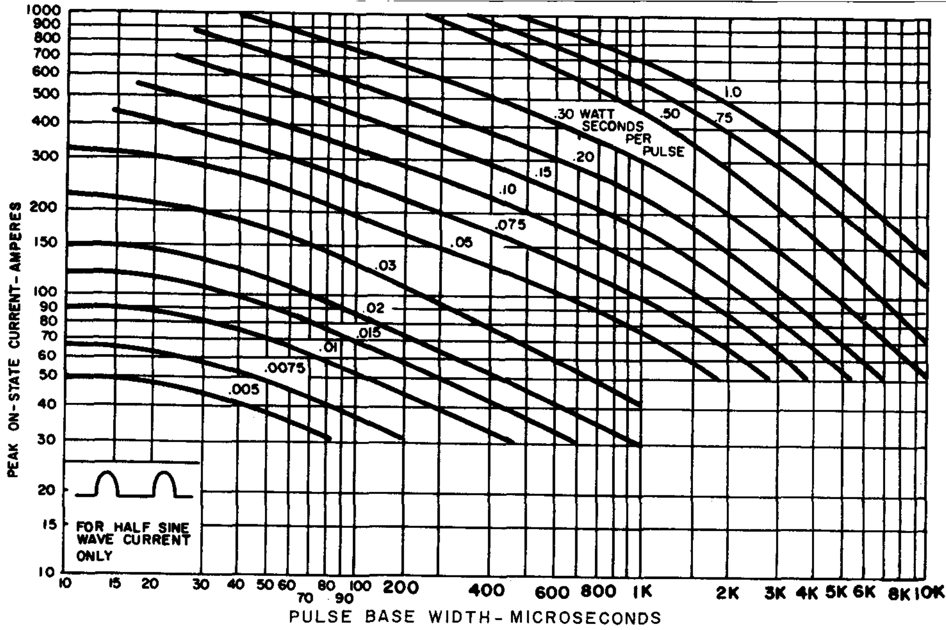
1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)

NOTES:
(Pertaining to Sine and Trapezoidal Wave Current Ratings)

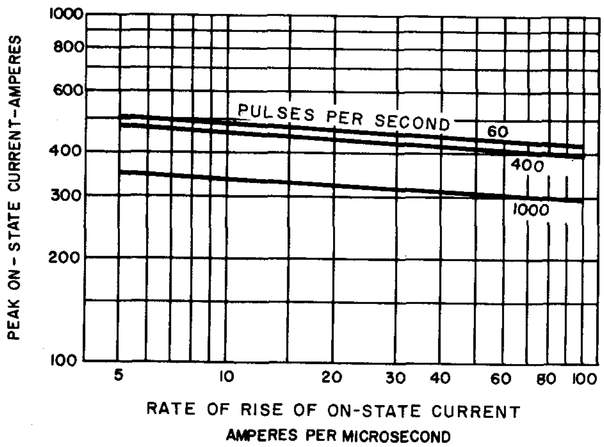
1. Switching voltage ⩽400 volts.
2. RC Snubber — .22μf, 5 ohm.
3. Max. energy dissipated during reverse recovery to be 15% of total W-S/P shown or 0.03 W-S/P whichever is least.
4. Values of W-S/P are for T_J = 125°C.



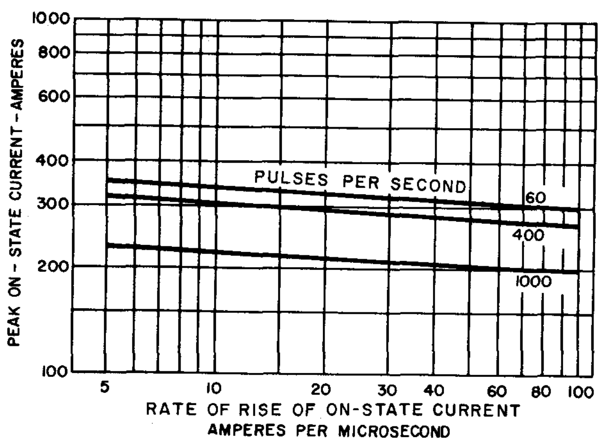
3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

TRAPEZOIDAL WAVE CURRENT RATING DATA

DUTY CYCLE – 50%

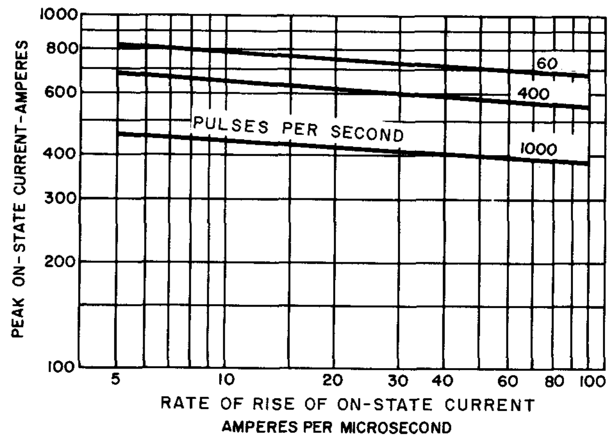


4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

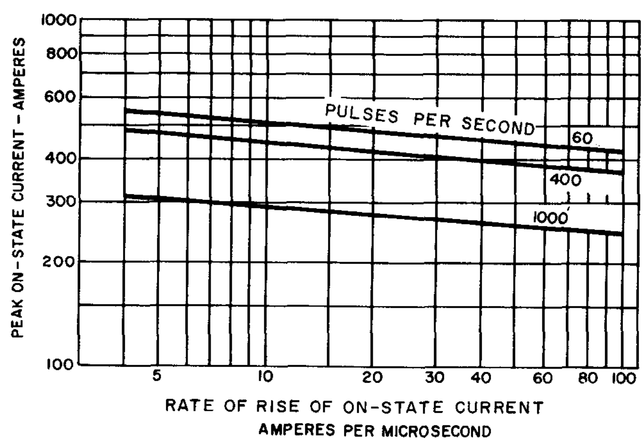


5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

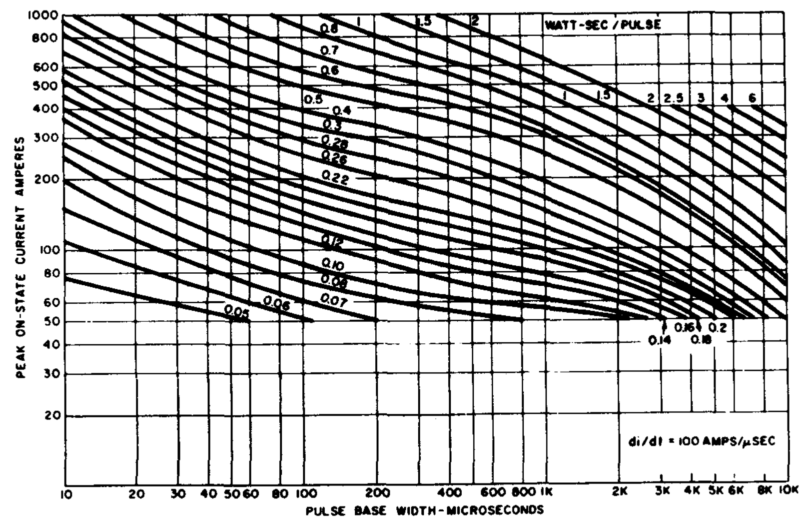
DUTY CYCLE – 25%



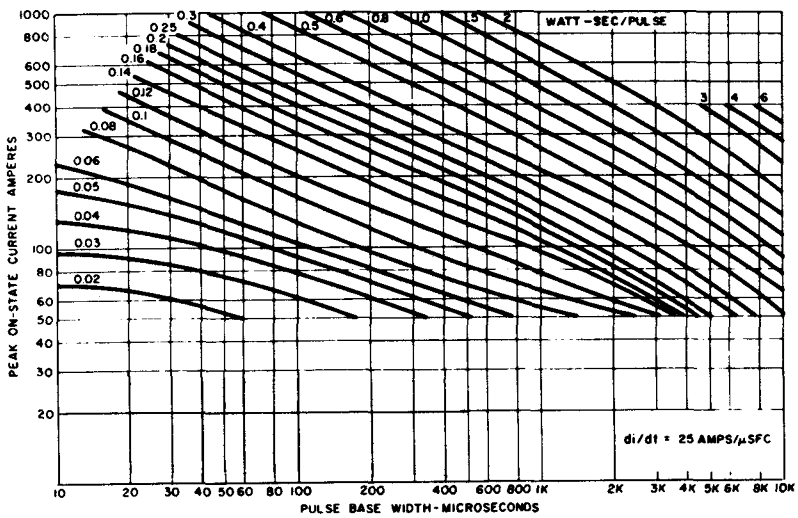
6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)



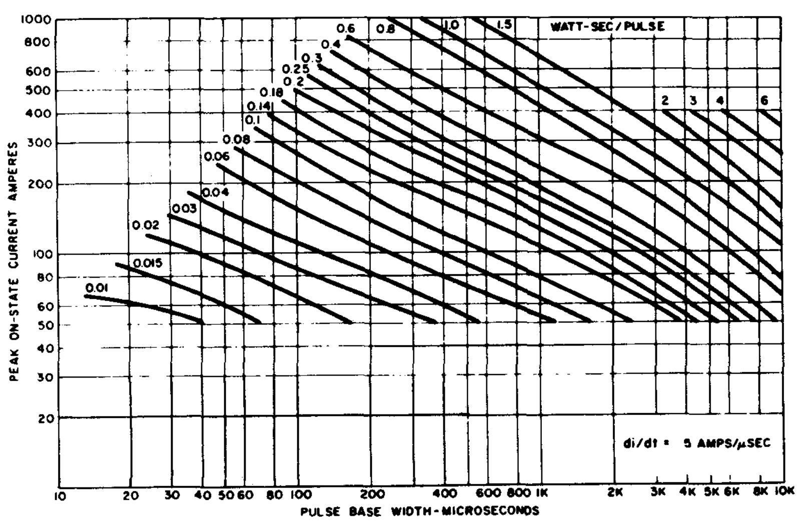
7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)



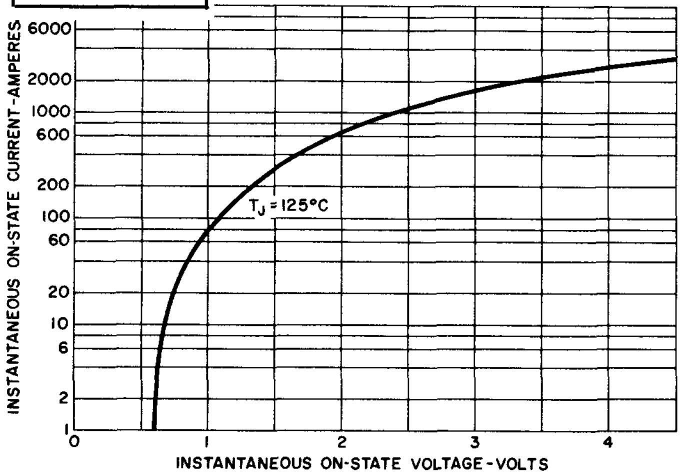
8. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec.)



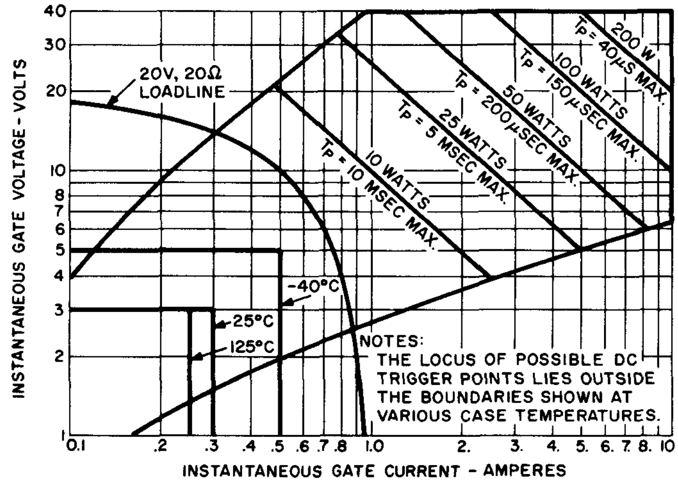
9. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec.)



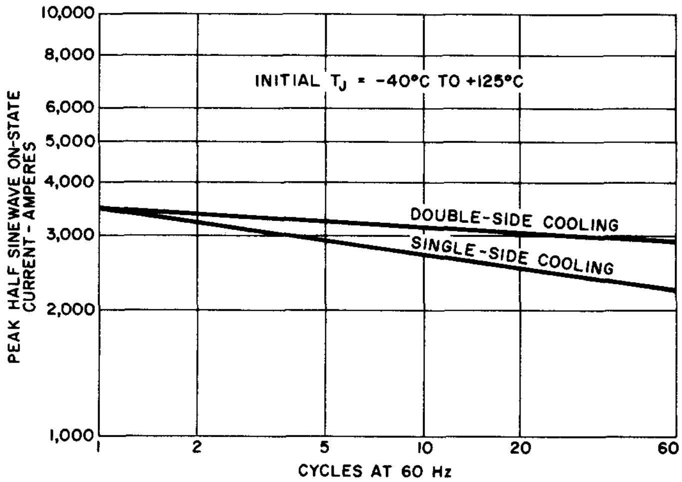
10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec.)



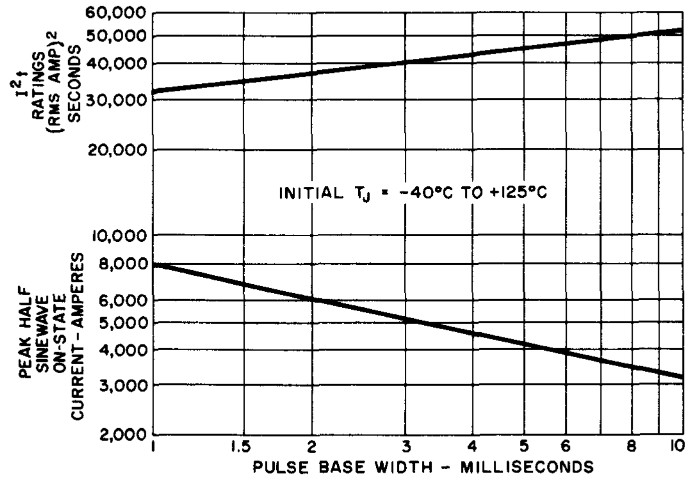
11. MAXIMUM ON-STATE CHARACTERISTICS



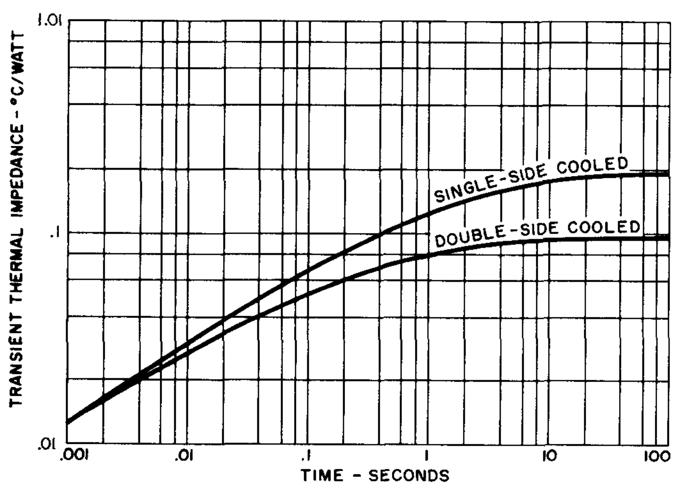
12. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS



13. SURGE (NON-REPETITIVE) ON-STATE CURRENT

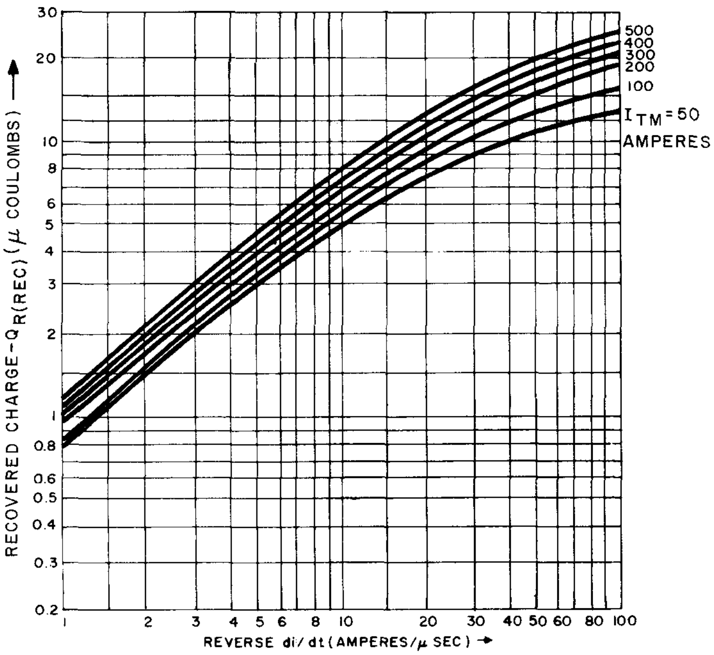


14. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING

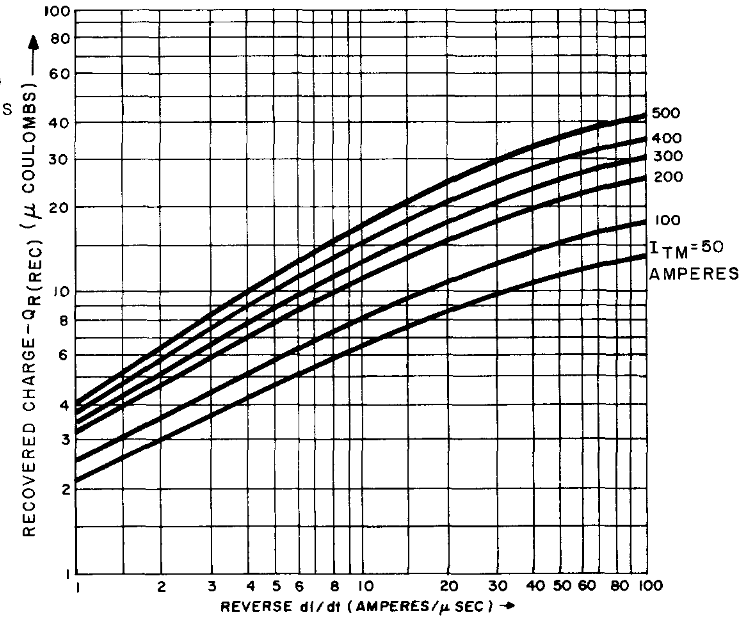


15. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

RECOVERED CHARGE DATA

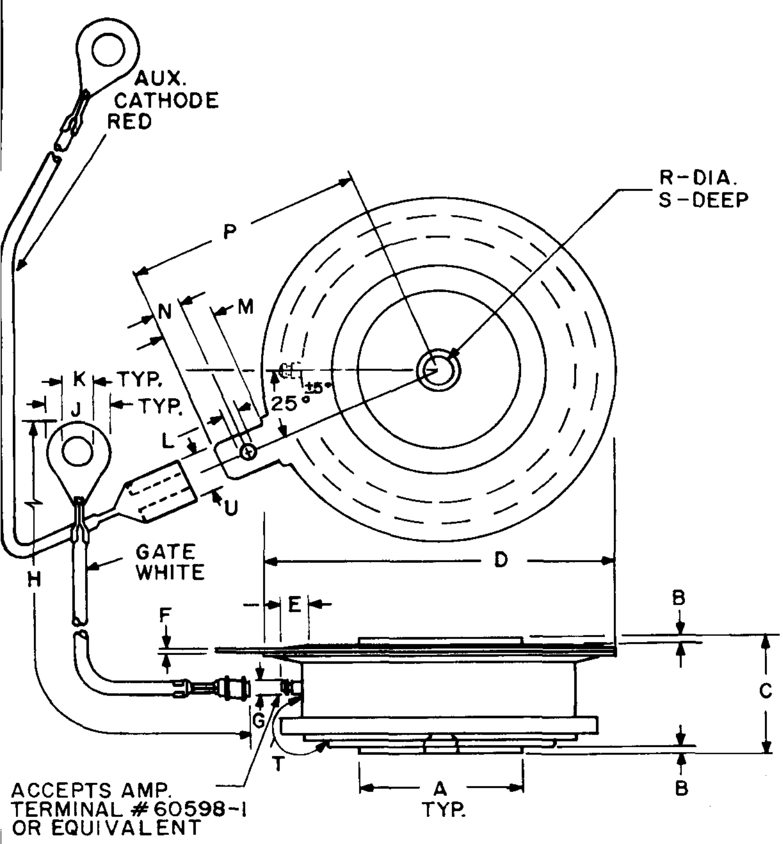


16. TYPICAL RECOVERED CHARGE AT 25°C SINEWAVE CURRENT WAVEFORM



17. TYPICAL RECOVERED CHARGE AT 125°C SINEWAVE CURRENT WAVEFORM

OUTLINE DRAWINGS



H - STRAIGHT LEAD LENGTH, TYP. 2 LEADS

T - SURFACE CREEPAGE

TABLE OF DIMENSIONS

Conversion Table

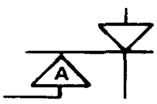
	DECIMAL INCHES		METRIC MM	
SYM	MIN	MAX.	MIN.	MAX.
A	.744	.752	18.897	19.101
B	.030	.060	.762	1.524
C	.515	.565	13.081	14.351
D	1.600	1.656	40.64	42.06
E	.110	—	2.794	—
F	.031	.017	.330	.432
G	.057	.059	1.447	1.449
H	7.980	8.115	202.70	206.11
J	—	.300	—	7.620
K	.137	.153	3.479	3.886
L	.065	.070	1.651	1.778
M	.245	.260	6.223	6.604
N	.120	.140	3.048	3.556
P	1.090	1.125	27.69	28.55
R	.135	.145	3.429	3.683
S	.067	.083	1.701	2.108
T	.340	—	8.636	—
U	.186	.189	4.724	4.801

HIGH SPEED

Silicon Controlled Rectifier

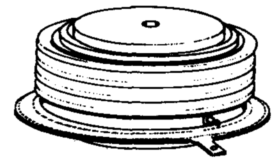
1200 Volts, 500 A RMS

C387/C388



AMPLIFYING GATE

The General Electric C387 and C388 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Press-Pak devices employing the field-proven amplifying gate.

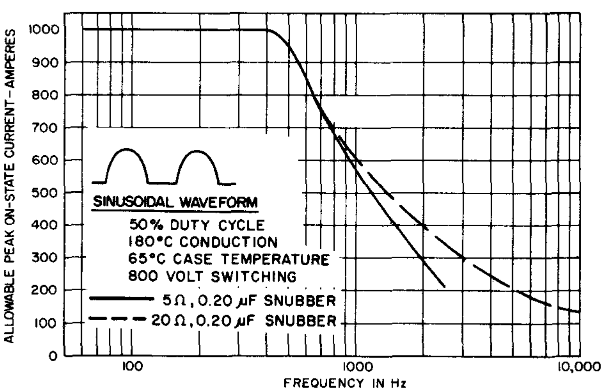


FEATURES:

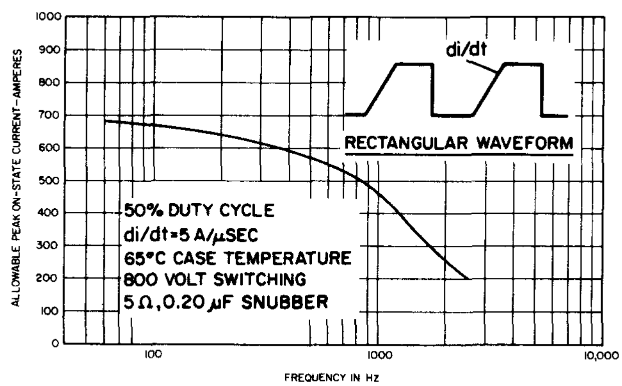
- Fully characterized for operation in inverter and chopper applications.
- High di/dt ratings.
- High dv/dt capability with selections available.
- Rugged hermetic glazed ceramic package having 1″ creepage path.

IMPORTANT: Mounting instructions on the mounting clamp specifications must be followed.

HIGH FREQUENCY CURRENT RATINGS



1. **MAXIMUM ON-STATE CHARACTERISTICS**



2. **GATE TRIGGER CHARACTERISTICS AND POWER RATINGS**

Equipment designers can use the C387/C388 SCR in demanding applications, such as:

- Choppers
- Inverters
- Regulated Power Supplies
- Sonar Transmitters
- Induction Heaters
- Radio Transmitters
- Cycloconverters
- DC to DC Converters
- High Frequency Lighting

FOR SINEWAVE OPERATION

Like the Type C140/141, C158/C159 and C359 SCR's, the C387/C388 SCR is rated for:

- Peak Current

  vs.

- Pulse Width
- Frequency
- Case Temperature

FOR RECTANGULAR WAVE OPERATION

GE now introduces a new, high-frequency rating for C387/C388 SCR, which is:

- Peak Current

  vs.

- di/dt of Leading Edge
- Frequency
- Duty Cycle
- Case Temperature

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C387/C388E	500 Volts	500 Volts	600 Volts
C387/C388M	600	600	720
C387/C388S	700	700	840
C387/C388N	800	800	960
C387/C388T	900	900	1080
C387/C388P	1000	1000	1200
C387/C388PA	1100	1100	1300
C387/C388PB	1200	1200	1400

[1] Half sinewave waveform, 10 ms max. pulse width.

Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} . . . . . 5500 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds . . . . . 50,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds . . . . . 120,000 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive . . . . . 800 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive . . . . . 500 A/μs †
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . . 2 Watts
Storage Temperature, T_{stg} . . . . . -40°C to +150°C
Operating Temperature, T_J . . . . . -40°C to +125°C
Mounting Force Required . . . . . 2000 Lb. ± 10%
8.9 KN ± 10%

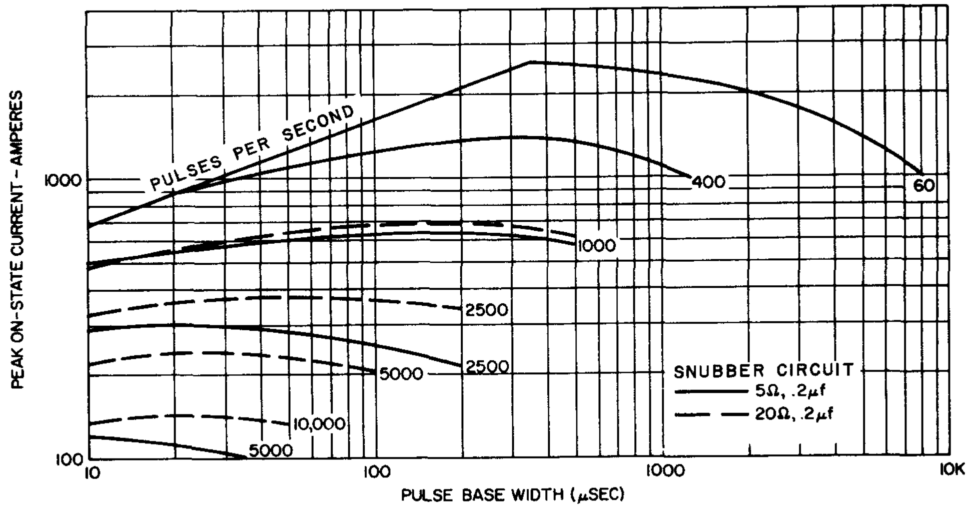
†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5 μs short circuit trigger current rise time.

CHARACTERISTICS

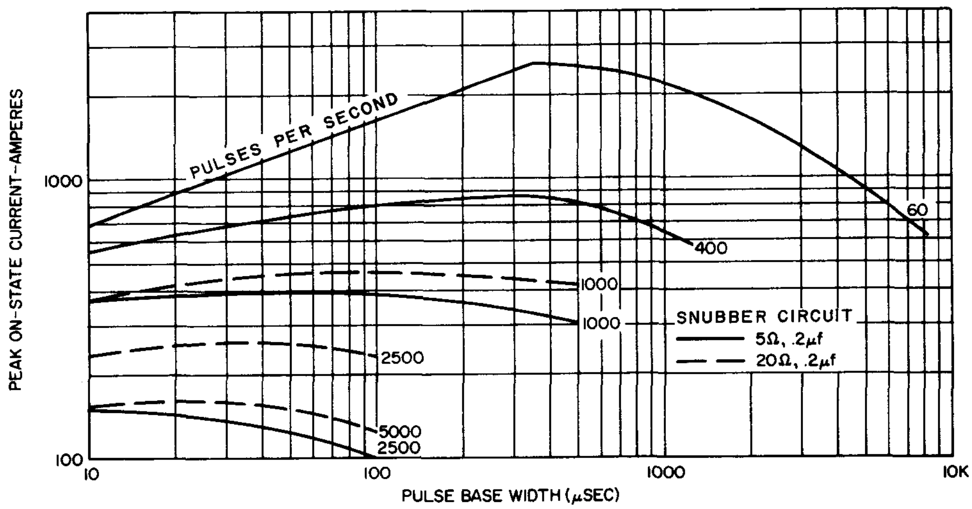
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	5	20	mA	T_J = +25°C V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	20	45	mA	T_J = 125°C V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	.05	.06	°C/Watt	Junction-to-Case (Double-Side Cooled)
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	200	500	mAdc	T_C = +25°C, Anode Supply = 24 Vdc, Initial On-State Current = 2 Amps.
DC Gate Trigger Current	I_{GT}	–	50	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	75	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	15	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	3	5	Vdc	T_C = -40°C to 0°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	1.25	3.0		T_C = 0°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = 125°C, V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	3.3	4.2	Volts	T_C = +25°C, I_{TM} = 3000 Amps Peak Duty Cycle ⩽ .01%
Turn-On Delay Time	t_d	–	0.5	–	μsec	T_C = +25°C, I_{TM} = 50 Adc, V_{DRM}. Gate Supply: 20 volt open circuit, 20 ohm, 0.1 μsec max. rise time. ††,†††
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage) C388 C387	t_q	 – –	 15 20	 † †	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20 V/μsec (linear) (6) Commutation di/dt = 25 Amps/μsec (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms.
C388 C387		– –	20 25	30 40		(1) T_C = +125°C (2) I_{TM} = 500 Amps (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (linear) (6) Commutation di/dt = 25 Amps/μsec (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode) C388 C387	$t_{q(diode)}$	 – –	 30 40	 † †	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 200 V/μsec (linear) (6) Commutation di/dt = 25 Amps/μsec (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms

†Consult factory for specified maximum turn-off time.
††Delay time may increase significantly as the gate drive approaches the I_{GT} of the Device Under Test.
†††Current risetime as measured with a current probe, or voltage risetime across a non-inductive resistor.

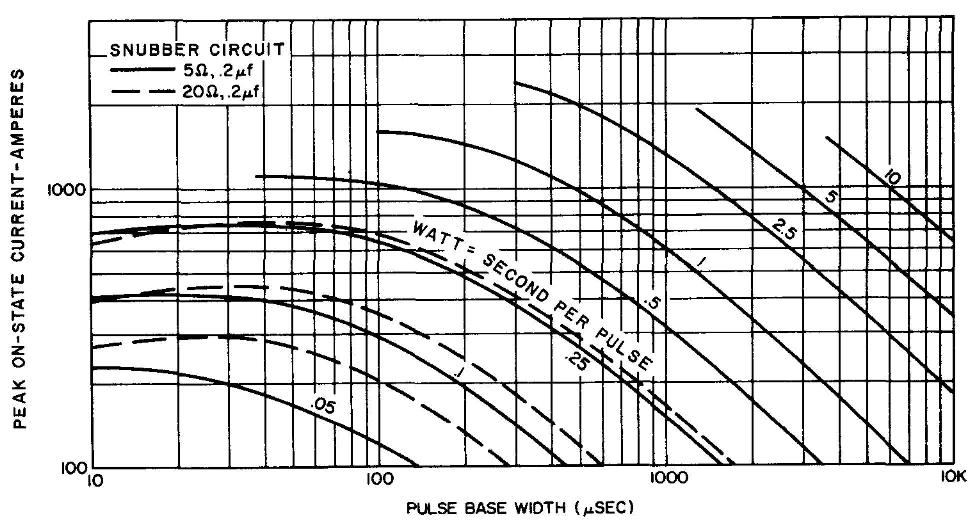
SINE WAVE CURRENT RATING DATA



3. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH ($T_C = 65°C$)



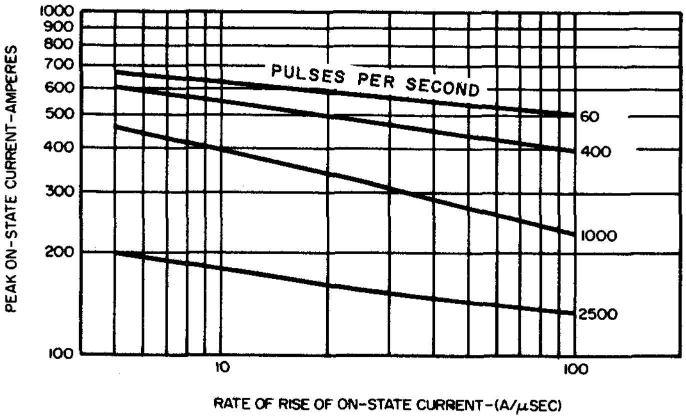
4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH ($T_C = 90°C$)



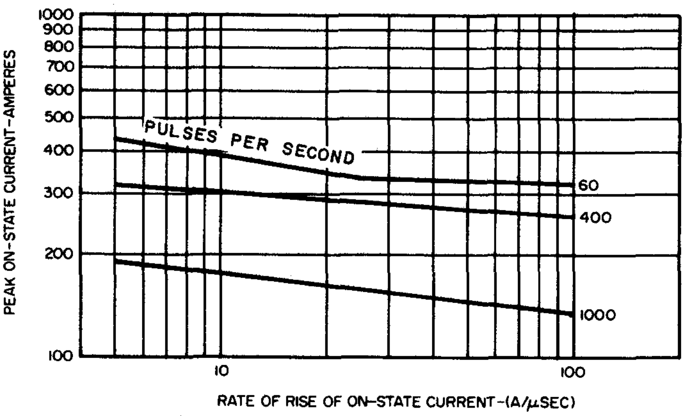
5. ENERGY PER PULSE FOR SINUSOIDAL PULSES

RECTANGULAR WAVE CURRENT RATING DATA

DUTY CYCLE – 50%

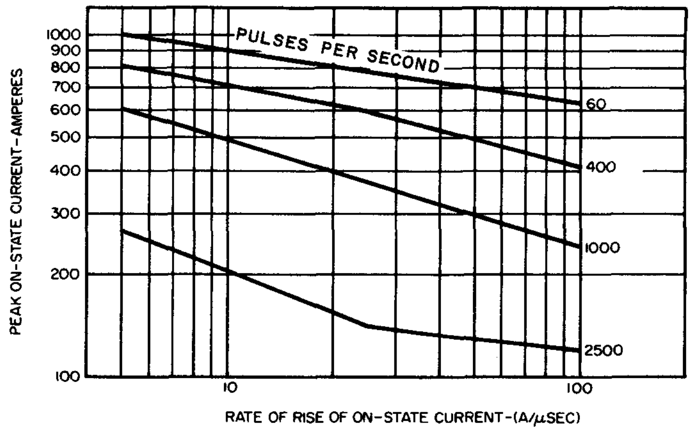


6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

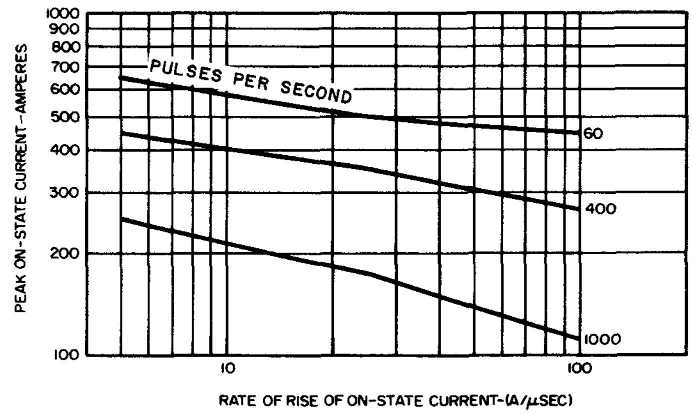


7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

DUTY CYCLE – 25%



8. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

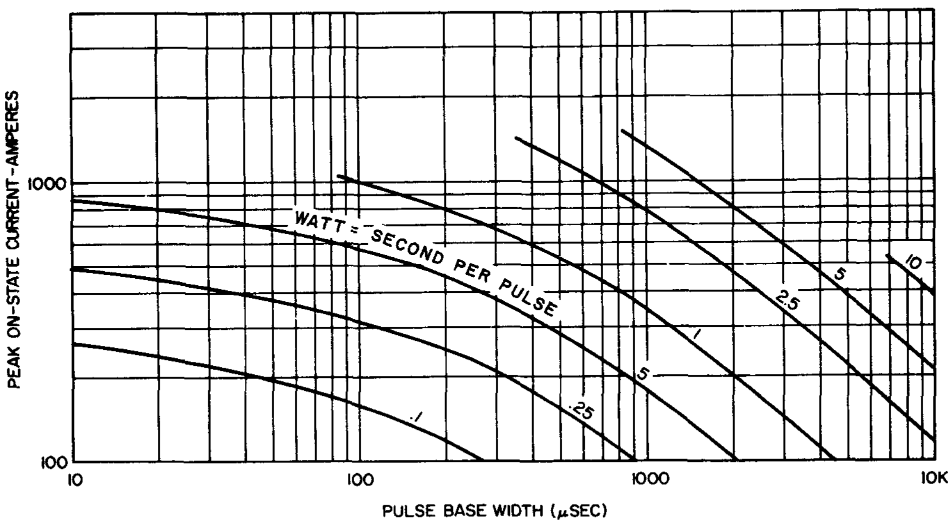


9. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

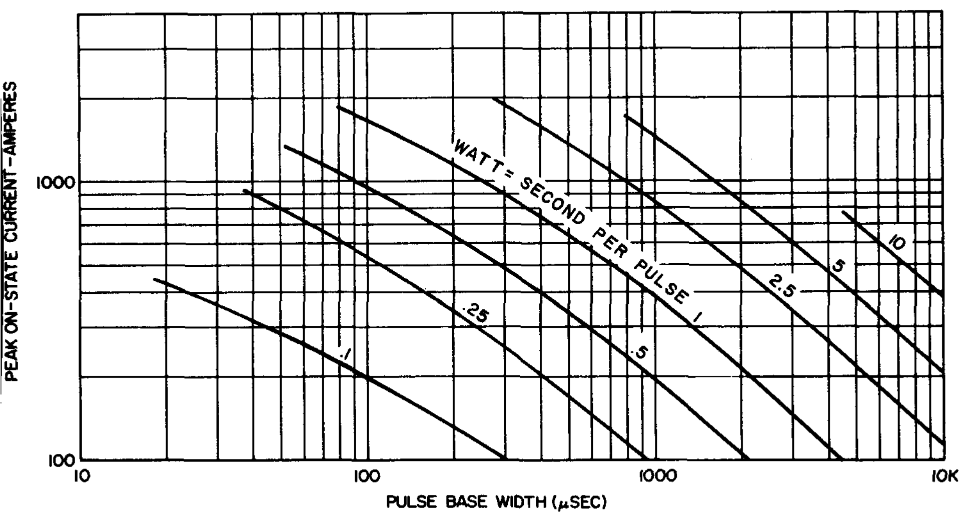
NOTES:
(Pertaining to Sine and Rectangular or Wave Current Ratings)

1. Switching voltage ⩽ 800 volts.
2. Reverse voltage applied = V_R ⩽ 800V.
3. Required gate drive:
   20 volts, 65 ohms, 1 μsec risetime for less than 100 amps/μsec.
   20 volts, 20 ohms, .5 μsec risetime for greater than 100 amps/μsec.
4. RC Snubber ckt. = .2 μf, 5Ω
5. Double-Side Cooled.
6. Max. energy dissipated during reverse recovery to be 15% of total W-S/P shown or 0.03 W-S/P whichever is least.

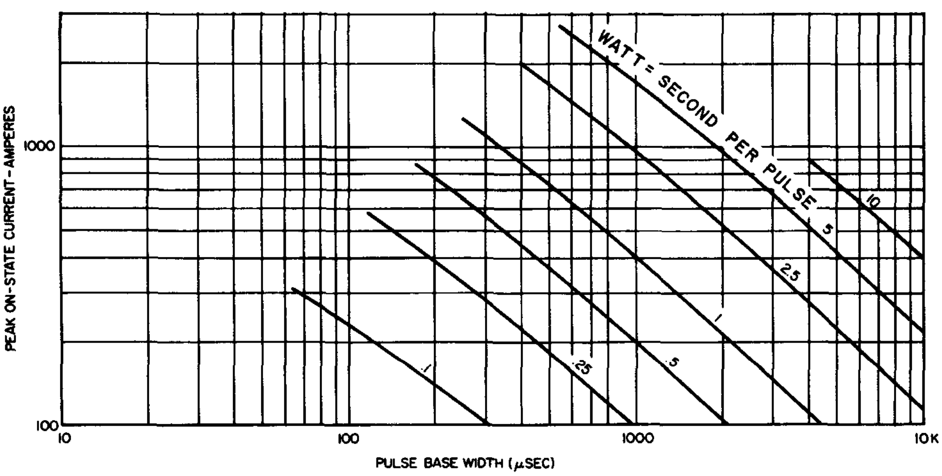
RECTANGULAR WAVE DATA
WATT-SECOND PER PULSE



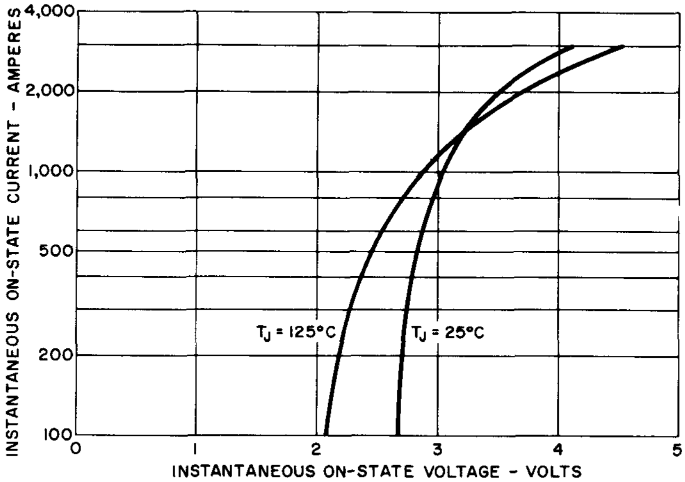
10. **ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH**
(di/dt = 100 A/μsec)



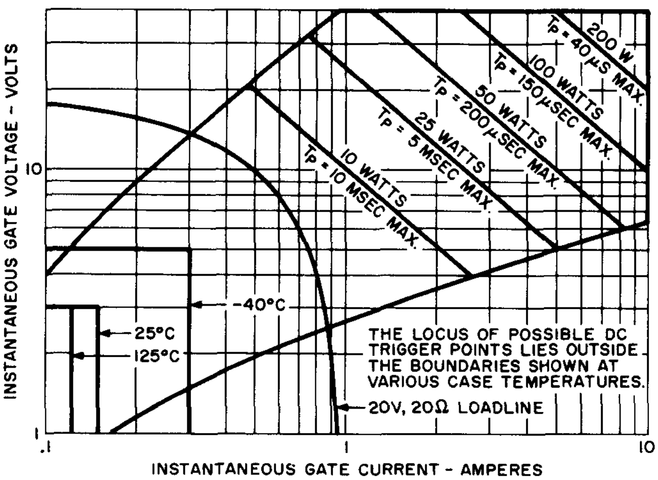
11. **ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH**
(di/dt = 25 A/μsec)



12. **ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH**
(di/dt = 5 A/μsec)



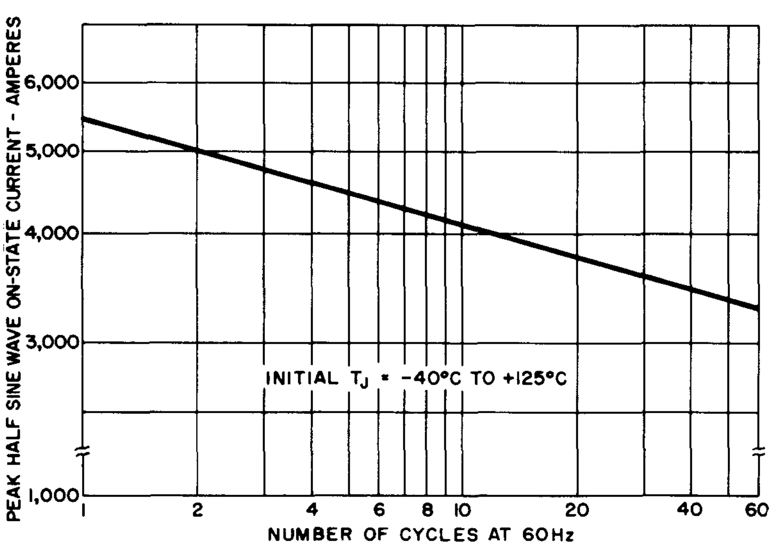
13. MAXIMUM ON-STATE CHARACTERISTICS



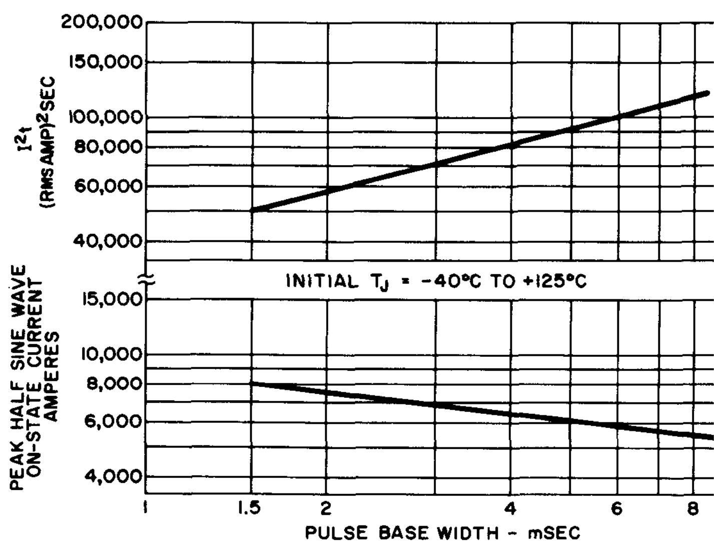
14. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

NOTES:

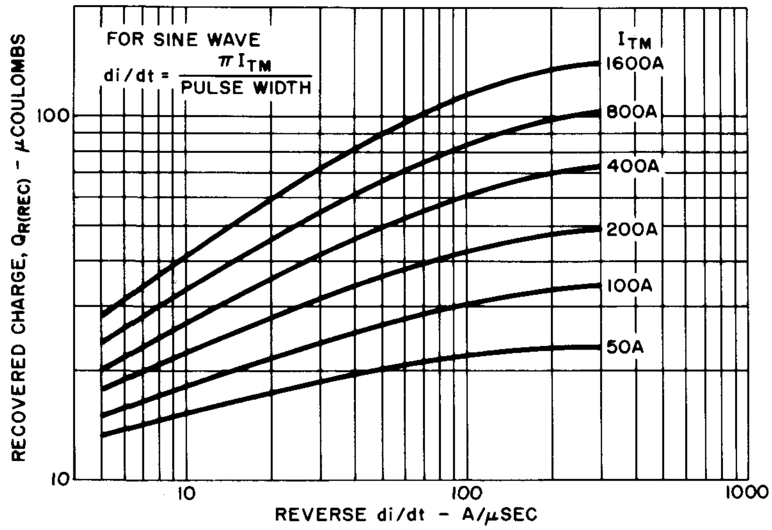
1. The locus of possible dc trigger points lie outside the boundaries shown at various case temperatures.
2. 20V – 20Ω is the minimum gate source load line when rate of circuit current rise > 100 amps/μs or anode rate of current rise > 200 amps/μs (Tp = 5 μs min., 0.5 μs max. risetime) Maximum long term repetitive anode di/dt = 500 amps/μs with 20V – 20Ω gate source.



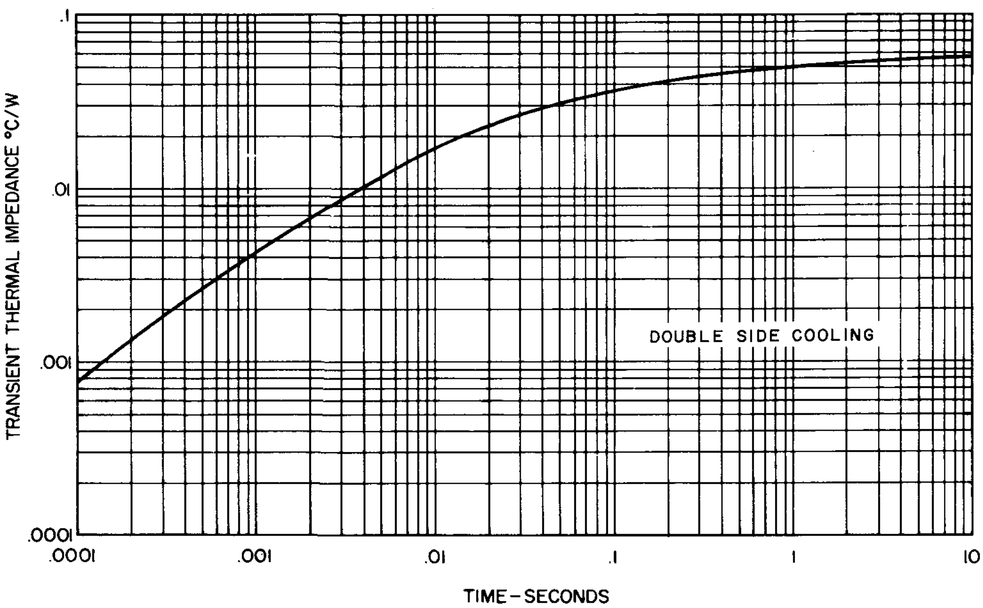
15. SURGE (NON-REPETITIVE) ON-STATE CURRENT



16. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING

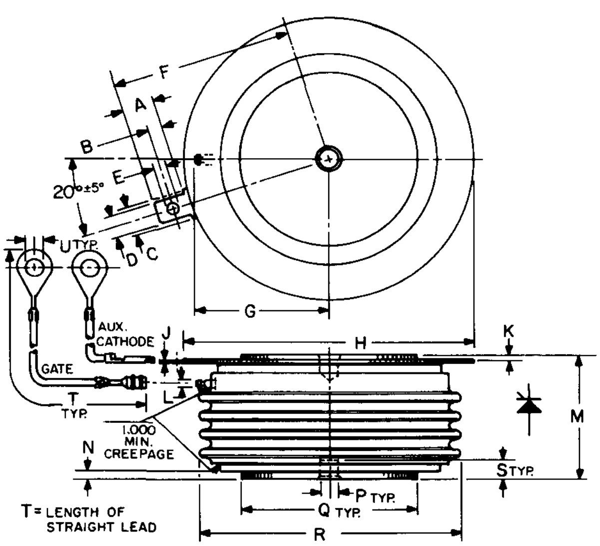


17. TYPICAL RECOVERED CHARGE (T_J = 125°C) SINEWAVE CURRENT WAVEFORM



18. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

OUTLINE DRAWING



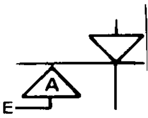
SYM	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC M.M. MIN.	METRIC M.M. MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.140	.160	3.556	4.064
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

High Power Silicon Controlled Rectifier

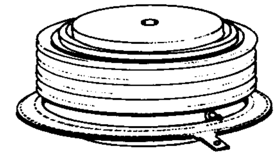
C390

1300 VOLTS 850A RMS

AMPLIFYING GATE



The General Electric C390 Silicon Controlled Rectifier is designed for phase control applications. This is an all-diffused Press-Pak device employing the field-proven amplifying gate.



FEATURES:

- High di/dt Ratings
- High dv/dt Capability with Selections Available
- Excellent Surge and I^2t Ratings Providing Easy Fusing
- Guaranteed Maximum Turn-Off Time with Selections Available
- Rugged Hermetic Glazed Ceramic Package Having 1″ Creepage Path

IMPORTANT: Mounting instructions on the last page of this specification must be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} [1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} [1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} [1] T_J = +125°C
C390E	500 Volts	500 Volts	600 Volts
C390M	600	600	700
C390S	700	700	800
C390N	800	800	900
C390T	900	900	1000
C390P	1000	1000	1150
C390PA	1100	1100	1250
C390PB	1200	1200	1400
C390PC	1300	1300	1500

[1] Half sinewave waveform, 10 msec max. pulse width.

Average On-State Current, $I_{T(AV)}$ . . . . Depends on Conduction Angle (See Charts 1 and 2)
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 8000 Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 7600 Amperes
Critical Rate-of-Rise of On-State Current (Non-Repetitive)† . . . . 800 A/μs
Critical Rate-of-Rise of On-State Current (Repetitive)† . . . . 500 A/μs
I^2t (for fusing) (for times ⩾ 1.5 milliseconds) See Figure 9 . . . . 100,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) (at 8.3 milliseconds) (See Figure 9) . . . . 265,000 (RMS Ampere)^2 Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 200 Watts @ 40 μsec Pulse
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 5 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force Required . . . . 2000 Lbs. – 2500 Lbs.
8.9 Kn – 11.1 Kn

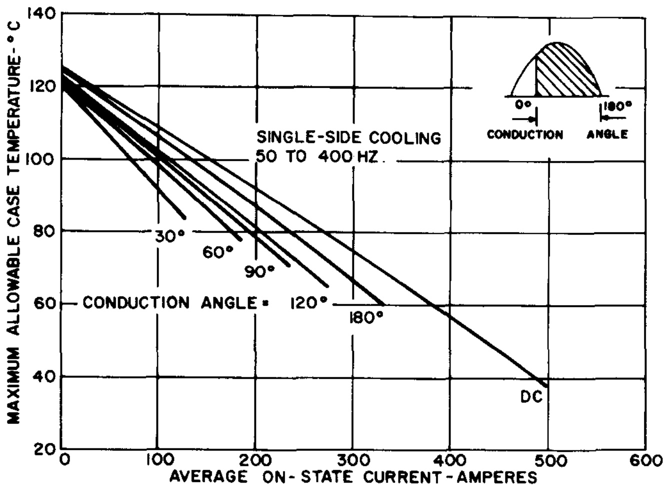
NOTE:

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of V_{DRM} ⩽ 1000V; 20 volts, 20 ohms gate trigger source with 0.5 μs short circuit trigger current rise time.

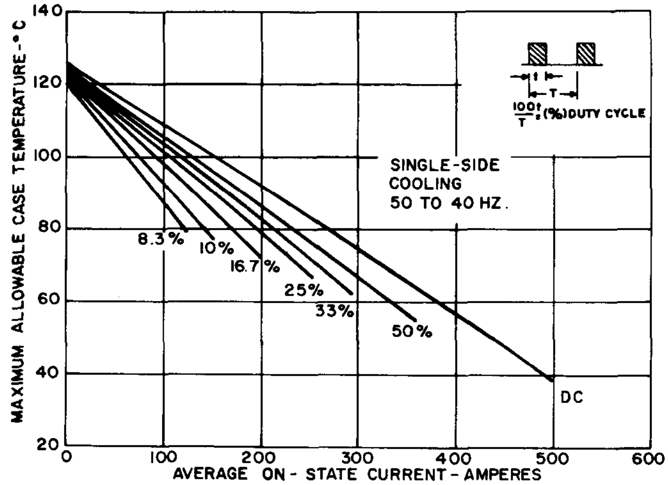
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	10	20	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	20	45	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Thermal Resistance	$R\theta_{JC}$	–	–	.06	°C/Watt	Junction-to-Case (Double-Side Cooling)
		–	–	.12		Junction-to-Case (Single-Side Cooling)
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching.)	dv/dt	200	–	–	V/μsec	T_J = +125°C, V_{DRM} = Rated, Using Linear or Exponential Rising Waveform. Gate Open. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	100	500	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial On-State Current = 2 Amps.
Latching Current	I_L	–	0.25	–	Adc	T_C = +25°C, Anode Voltage = 24 Vdc. Load Resistance 12 Ohms Max.
Turn-On Delay Time	td	–	0.7	–	μsec	T_C = +25°C, I_{TM} = 50 Adc, V_{DRM} Rated. Gate Supply: 20 Volts, 20 Ohms, 0.1 μsec Max. Rise Time
DC Gate Trigger Current See Figure 11 for Recommended Gate Drive Conditions	I_{GT}	–	–	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	15	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	5	Vdc	T_C = -40°C to +125°C, V_D = 6 Vdc. R_L = 3 Ohms
		0.25	–	–		T_C = +125°C, V_D = Rated, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	2.4	Volts	T_C = +25°C, I_{TM} = 3000 Amps Peak. Duty Cycle ⩽ 0.01%
Circuited Commutated Turn-Off Time	t_q*	–	125	–	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20V/μsec (linear) (6) Commutation di/dt = 25 Amps/μsec (7) Repetition Rate = 1 pps (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms

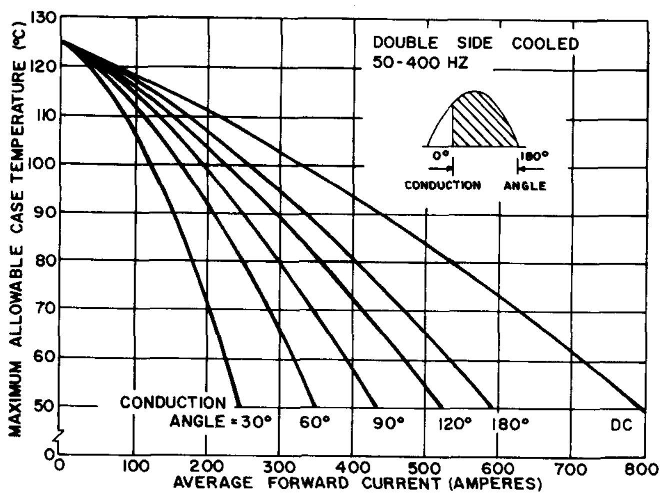
*Contact factory for maximum t_q specification.



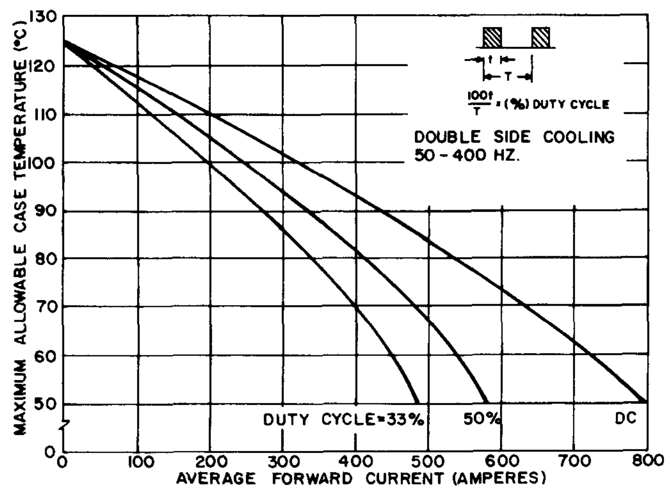
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM (SINGLE-SIDE COOLING)



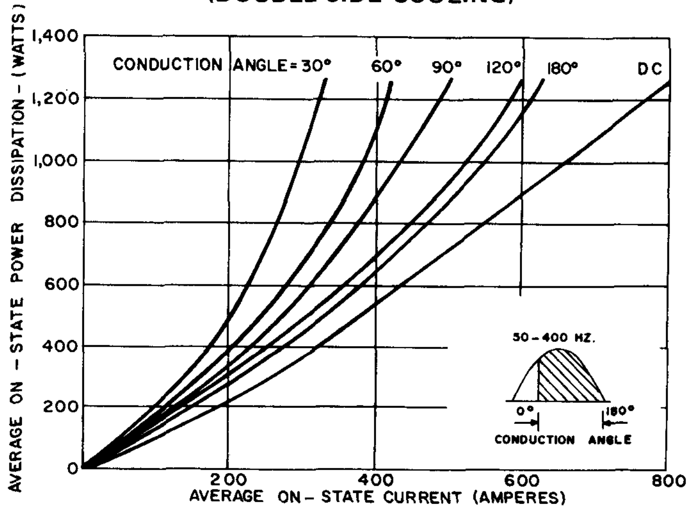
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM (SINGLE-SIDE COOLING)



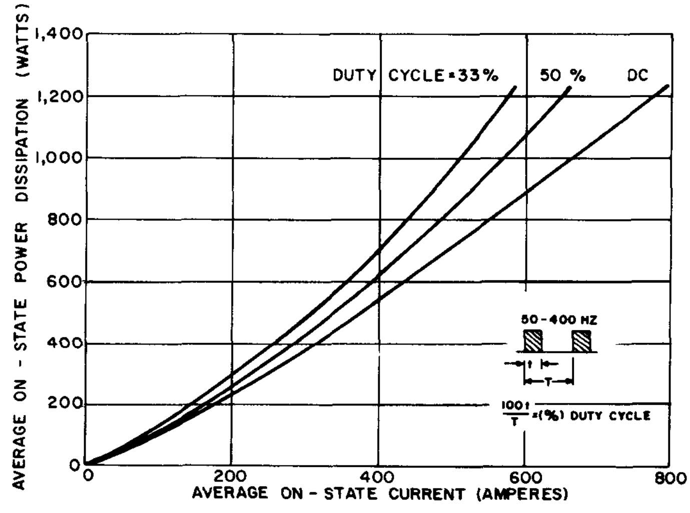
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM (DOUBLE-SIDE COOLING)



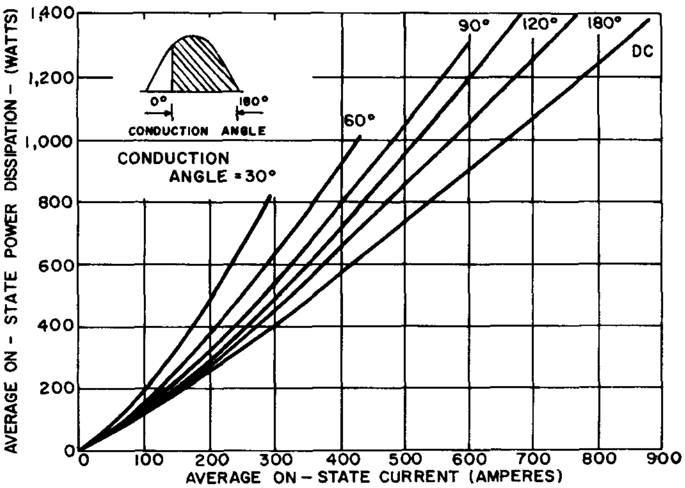
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM (DOUBLE-SIDE COOLING)



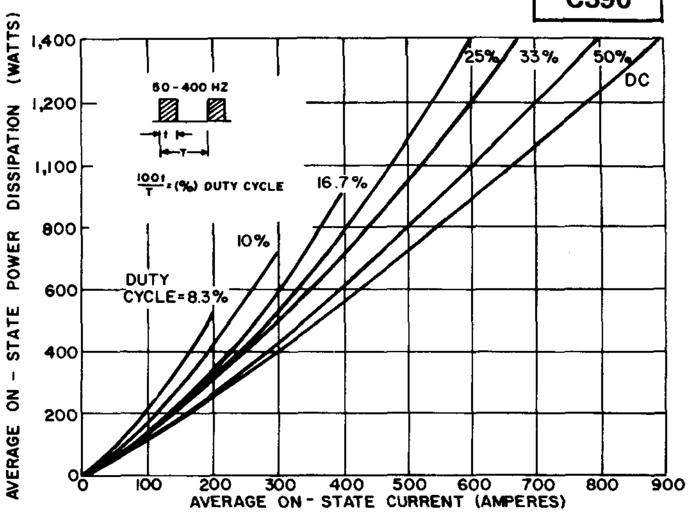
5. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



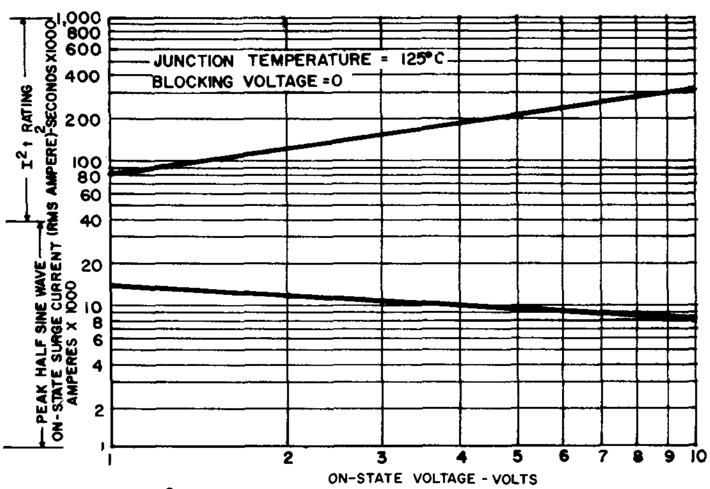
6. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



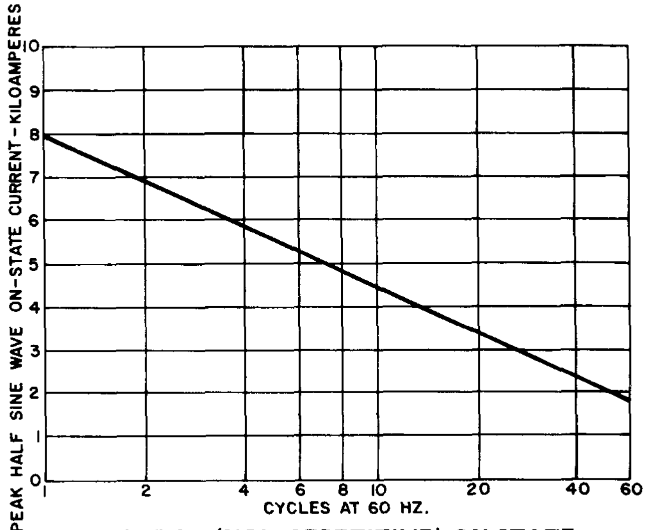
7. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM (EXTENDED RANGE)



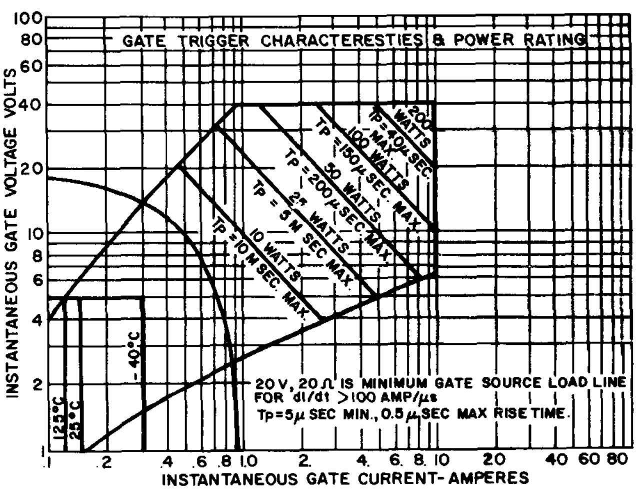
8. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM (EXTENDED RANGE)



9. I^2t RATING FOLLOWING RATED LOAD CONDITIONS



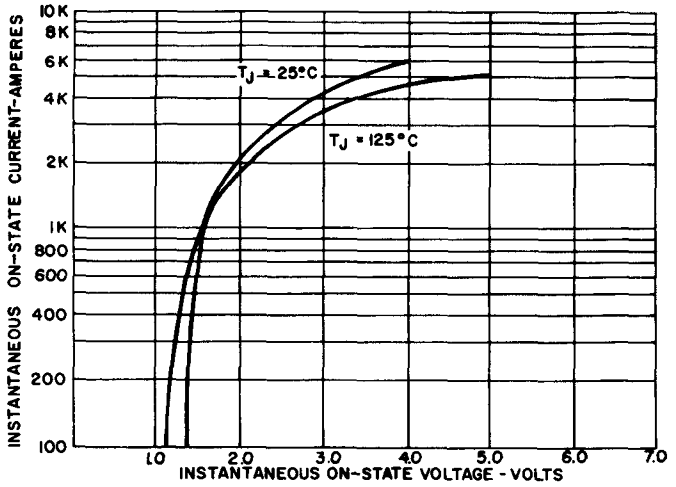
10. SURGE (NON-REPETITIVE) ON-STATE CURRENT



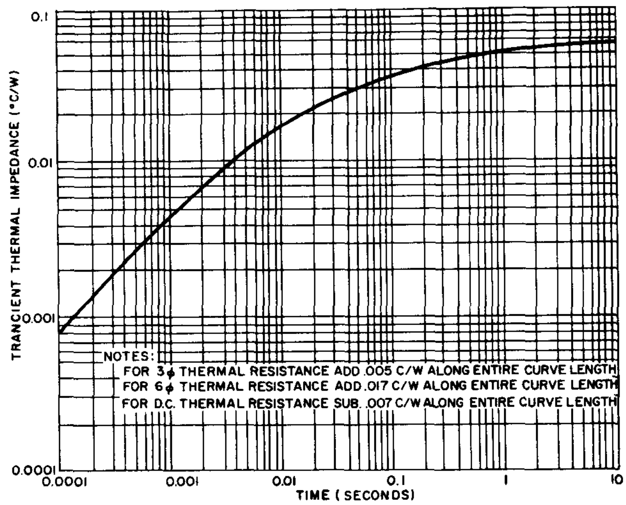
11. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

NOTES:

1. Maximum allowable gate power dissipation = 5 watts.
2. The locus of possible DC trigger points lie outside the boundaries shown at various case temperatures.
3. Tp = Rectangular Gate Current Pulse Width.

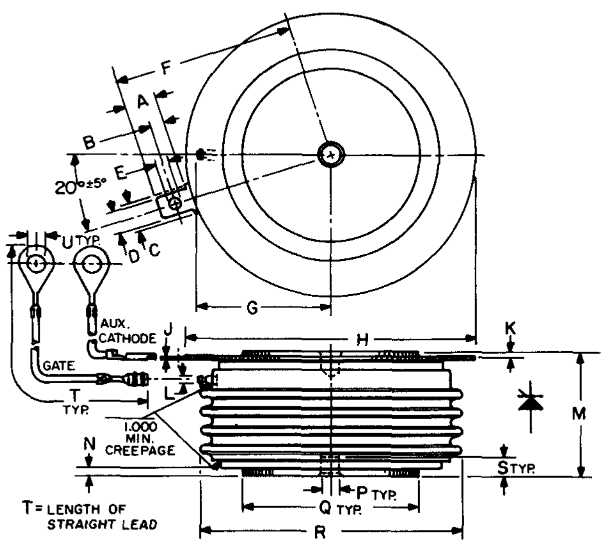


12. MAXIMUM ON-STATE CHARACTERISTICS



13. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE (DOUBLE-SIDE COOLING)

OUTLINE DRAWING



SYM	DECIMAL INCHES MIN.	MAX.	METRIC M.M. MIN.	MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.803	1.702	2.110
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

ELECTRONIC INNOVATIONS IN ACTION SEMICONDUCTORS

High Power Silicon Controlled Rectifier

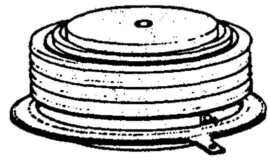
1800 VOLTS　　850A RMS

170.64 8/76

C391

AMPLIFYING GATE

The General Electric C391 Silicon Controlled Rectifier is designed for phase control applications. This is an all-diffused Press-Pak device employing the field-proven amplifying gate.



FEATURES:

- High di/dt Ratings
- High dv/dt Capability with Selections Available
- Excellent Surge and I^2t Ratings Providing Easy Fusing
- Guaranteed Maximum Turn-Off Time with Selections Available
- Rugged Hermetic Glazed Ceramic Package Having 1″ Creepage Path

IMPORTANT: Mounting instructions on the last page of this specification must be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} [1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM} [1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM} [1] T_J = +125°C
C391PC	1300 Volts	1300 Volts	1470 Volts
C391PD	1400	1400	1580
C391PE	1500	1500	1700
C391PM	1600	1600	1790
C391PS	1700	1700	1920
C391PN	1800	1800	2040

[1] Half sinewave waveform, 10 msec max. pulse width.

Average On-State Current, $I_{T(AV)}$ . . . . Depends on Conduction Angle (See Charts 1 and 3)
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 8000 Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 7000 Amperes
Critical Rate-of-Rise of On-State Current (Non-Repetitive)† . . . . 150 A/μs
Critical Rate-of-Rise of On-State Current (Repetitive)† . . . . 75 A/μs
I^2t (for fusing) (for times ⩾ 1.5 milliseconds) See Figure 11 . . . . 100,000 (RMS Ampere)² Seconds
I^2t (for fusing) (at 8.3 milliseconds) . . . . 265,000 (RMS Ampere)² Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 200 Watts @ 40 μsec Pulse
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 5 Watts
Storage Temperature, T_{STG} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force Required . . . . 2000 Lbs. – 2500 Lbs.
8.9 Kn – 11.1 Kn

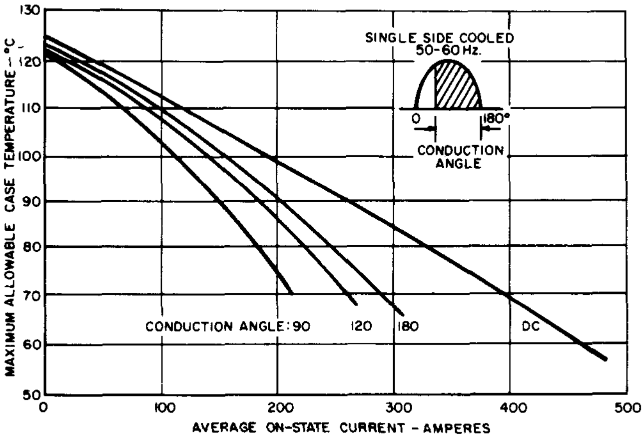
NOTE:

† di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of V_{DRM} ⩽ 1300V; 20 volts, 20 ohms gate trigger source with 0.5 μs short circuit trigger current rise time.

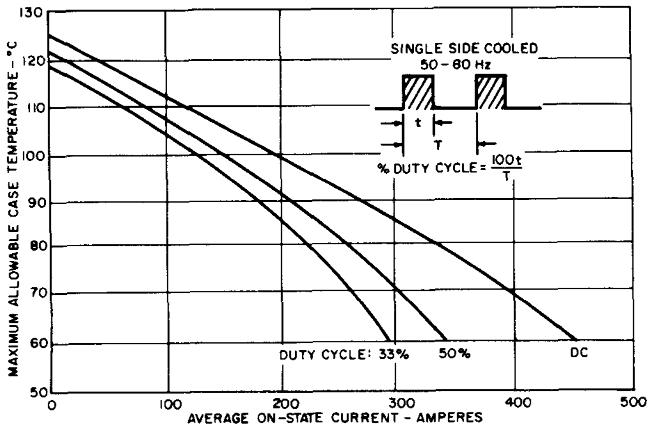
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	10	20	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	20	45	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	.06	°C/Watt	Junction-to-Case (Double-Side Cooling)
		–	–	.12		Junction-to-Case (Single-Side Cooling)
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching.)	dv/dt	200	–	–	V/μsec	T_J = +125°C, V_{DRM} 0.8 x Rated, Using Linear or Exponential Rising Waveform. Gate Open. Exponential dv/dt = $0.8 \frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
DC Gate Trigger Current See Figure 10 For Recommended Gate Drive Conditions	I_{GT}	–	–	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	–	5	Vdc	T_C = -40°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		.15	–	–		T_C = +125°C, V_{DRM} = Rated, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	2.65	Volts	T_C = +25°C, I_{TM} = 3000 Amps Peak. Duty Cycle ≤ 0.01%
Circuited Commutated Turn-Off Time	t_q*	–	200	–	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps (3) V_R = 50 Volts Min (4) .8 x V_{DRM} (Reapplied) (5) Rate-of-Rise of Reapplied Off-State Voltage = 20V/μsec (linear) (6) Commutation di/dt = 25 Amps/μsec (7) Repetition Rate = 1 pps (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms

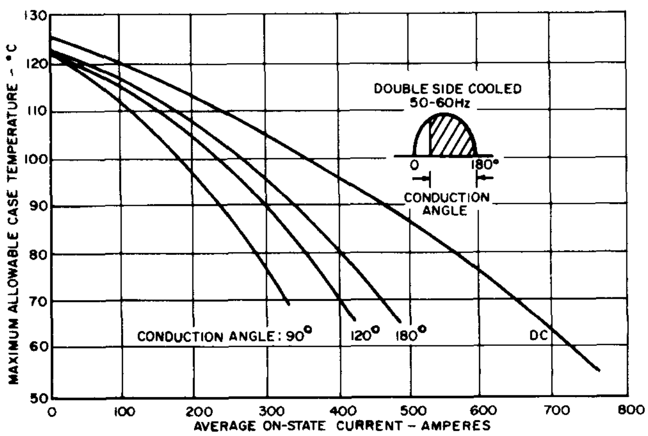
*Contact factory for maximum t_q specification.



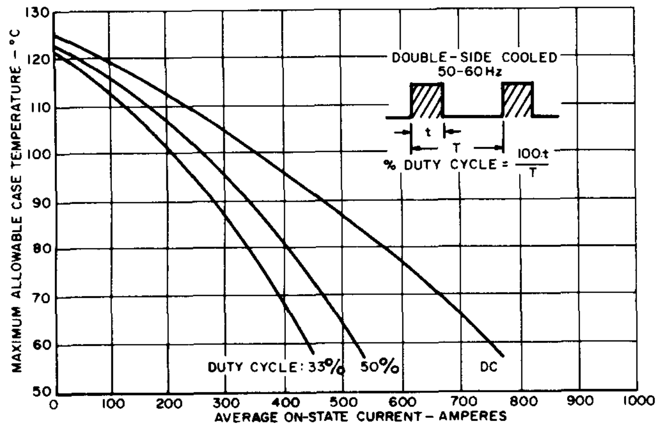
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM – SINGLE-SIDE COOLED



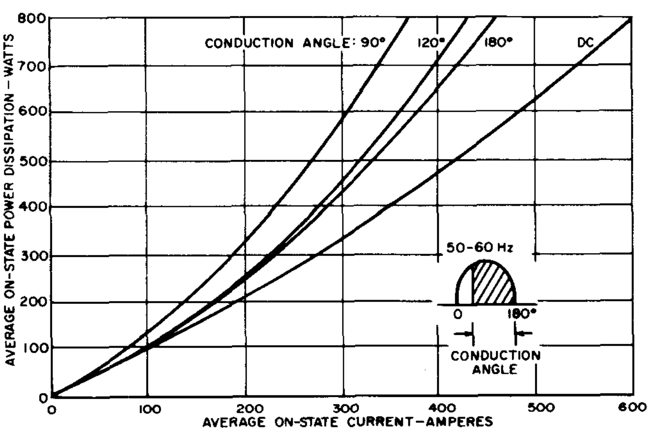
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM – SINGLE-SIDE COOLED



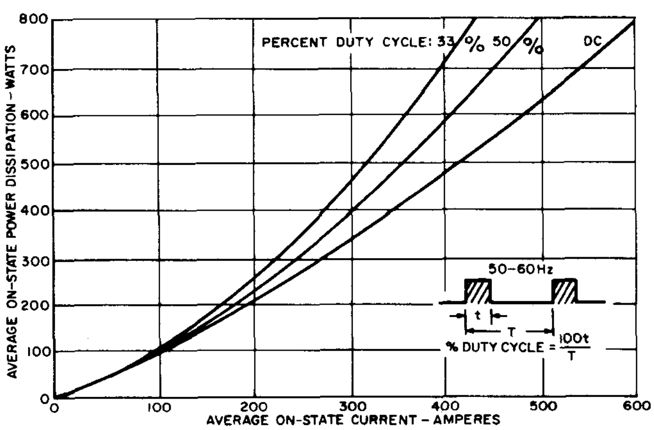
3. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM – DOUBLE-SIDE COOLED



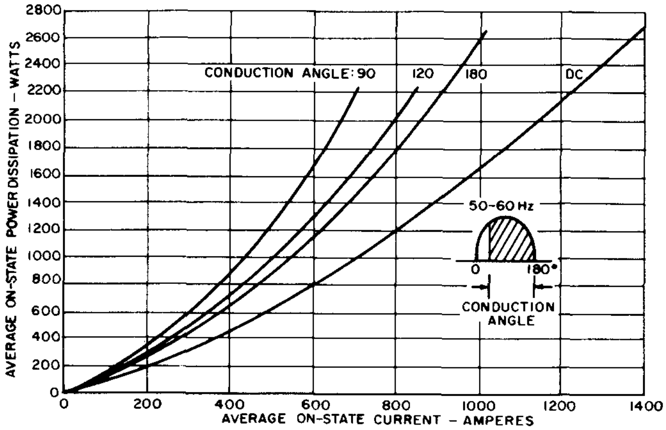
4. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM – DOUBLE-SIDE COOLED



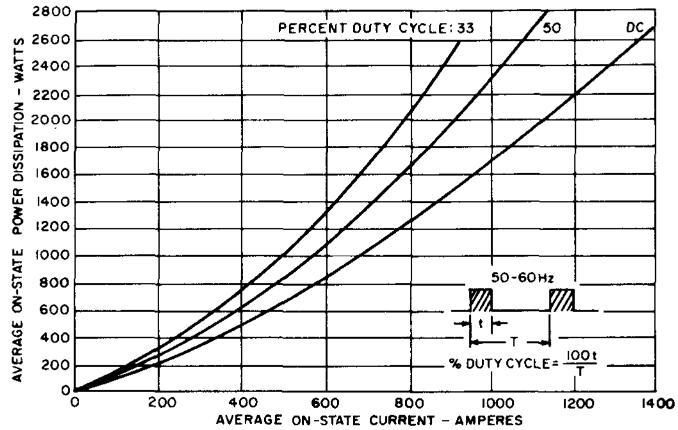
5. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



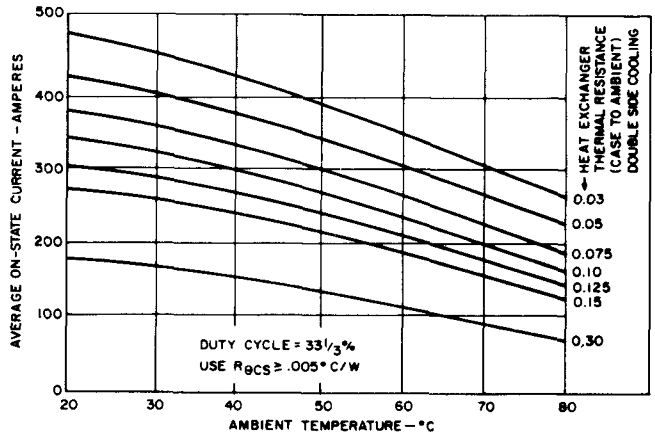
6. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



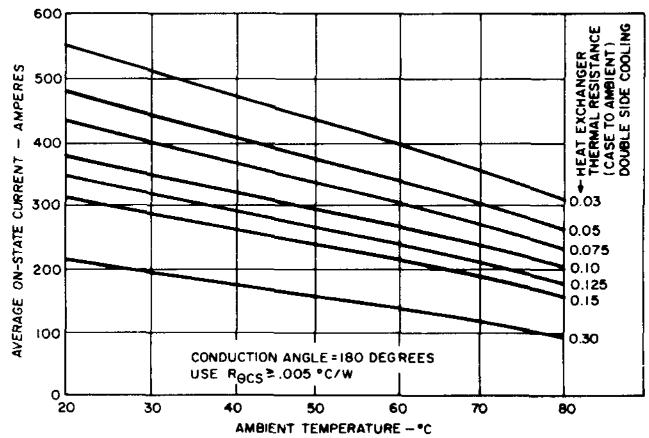
7. MAXIMUM AVERAGE ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM (EXTENDED RANGE)



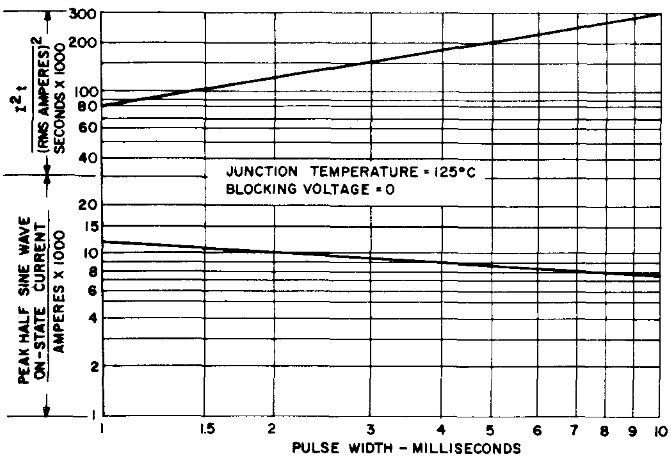
8. MAXIMUM AVERAGE ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM (EXTENDED RANGE)



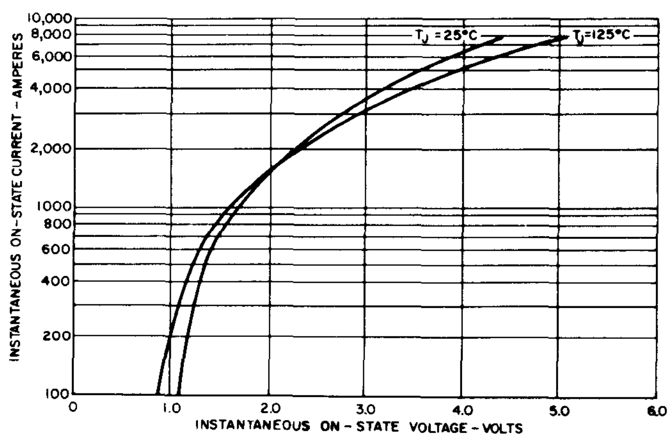
9. AVERAGE RECTANGULAR ON-STATE CURRENT VS. AMBIENT TEMPERATURE WHEN USED WITH VARIOUS HEAT EXCHANGERS



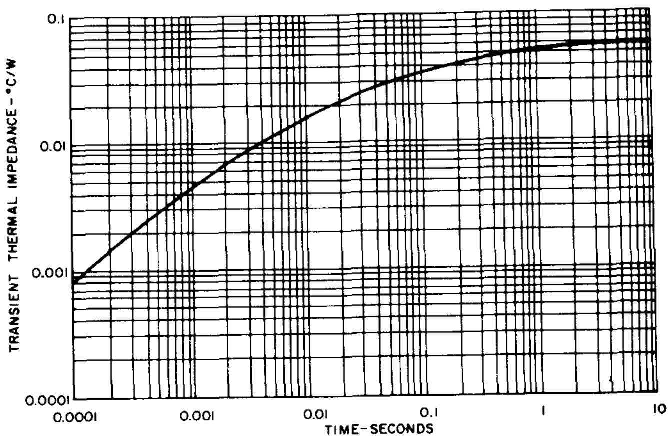
10. AVERAGE HALF SINEWAVE ON-STATE CURRENT VS. AMBIENT TEMPERATURE WHEN USED WITH VARIOUS HEAT EXCHANGERS



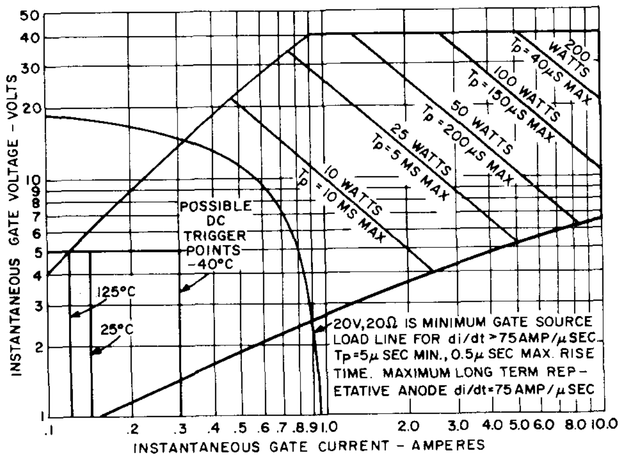
11. I^2t RATING FOLLOWING RATED LOAD CONDITIONS



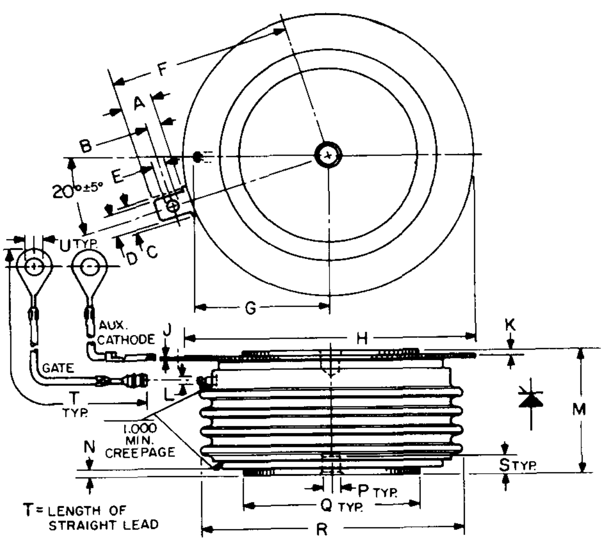
12. MAXIMUM ON-STATE CHARACTERISTICS



13. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE (DOUBLE-SIDE COOLING)



14. GATE TRIGGERING CHARACTERISTICS



SYM	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC M.M. MIN.	METRIC M.M. MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.702	2.110
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

15. OUTLINE DRAWING

SUGGESTED MOUNTING METHODS FOR PRESS-PAKS TO HEAT DISSIPATORS

When the Press-Pak is assembled to a heat sink in accordance with the following general instructions, a reliable and low thermal resistance interface will result.

1. Check each mating surface for nicks, scratches, flatness and surface finish. The heat dissipator mating surface should be flat within .0005 inches and have a surface finish of 63 micro-inches.
2. It is recommended that the heat dissipator be plated with nickel, tin, or gold iridite. Bare aluminum or copper surfaces will oxidize in time resulting in excessively high thermal resistance.
3. Sand each surface lightly with 600 grit paper just prior to assembly. Clean off and apply silicone oil (GE SF1154,200 centistoke viscosity) or silicone grease (GE G322L or Dow Corning DC 3, 4, 340 or 640). Clean off and apply again as a thin film. (A thick film will adversely affect the electrical and thermal resistances.)
4. Assemble with the specified mounting force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both top and bottom of the Press-Pak are for locating purposes only.

HEAT SINK SELECTION MADE EASY

The C391 specification sheet marks the introduction of two new characteristic curves which should greatly facilitate heat sink selection. Figures 9 and 10 plot allowable average current versus ambient temperature and case-to-ambient thermal resistance for the two most frequently encountered waveforms, 1/3 duty cycle rectangular current and 180° sinusoidal current waveforms. As soon as the average forward current and maximum ambient temperature are known, the designer can specify a heat sink thermal resistance. Note that the graphs span the range of heat sinks from water-cooled ($R_{\theta CA}$ = .03°C/W) to free-air convection ($R_{\theta CA}$ = 0.3°C/W). It is possible to linearly interpolate between the curves for $R_{\theta CS}$.

These curves have been derived from the following basic equation:

$$T_J = T_A + P_{AVG} \times R_{\theta JA}$$

where: $T_J = 125°C$

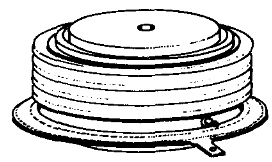
For increased reliability, the usual practice is to derate T_J 15-30 degrees. Figure 9 and 10 can perform this function by the simple expedient of raising T_A by a like amount.

HIGH SPEED
Silicon Controlled Rectifier
600 Volts (500-700) Amps RMS

C392/C393
C394/C395

AMPLIFYING GATE

The General Electric C392, C393, C394 and C395 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Press-Pak devices employing the field-proven amplifying gate.

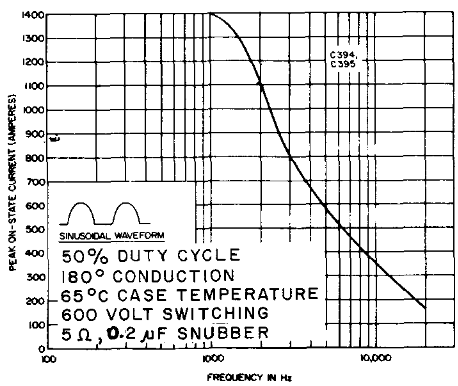


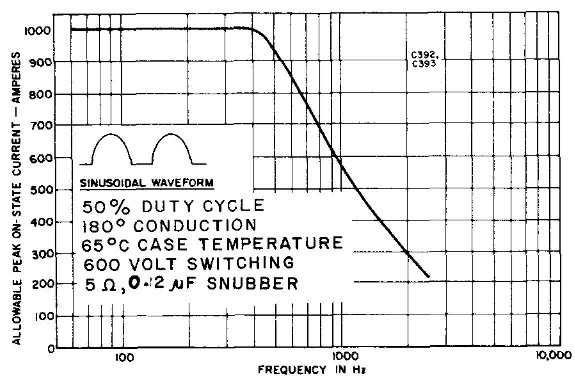
FEATURES:

- Fully characterized for operation in inverter and chopper applications.
- High di/dt ratings.
- High dv/dt capability with selections available.
- Rugged hermetic glazed ceramic package having 1″ creepage path.

IMPORTANT: Mounting instructions on the last page of specification **must** be followed.

HIGH FREQUENCY CURRENT RATINGS





Equipment designers can use the C392, C393, C394, C3 5 SCR's in demanding applications, such as:

- Choppers
- Inverters
- Regulated Power Supplies
- Cycloconverters
- DC to DC Converters
- High Frequency Lighting

FOR SINEWAVE OPERATION

Like the Type C140/141, C158/159 and C358 SCR's, the C392, C393, C394, C395 SCR's are rated for:

- Peak Current

vs.

- Pulse Width
- Frequency
- Case Temperature

FOR RECTANGULAR WAVE OPERATION

GE now introduces a new, high-frequency rating for the C392, C393, C394, C395 SCR's, which are:

- Peak Current

vs.

- di/dt of Leading Edge
- Frequency
- Duty Cycle
- Case Temperature

MAXIMUM ALLOWABLE RATINGS

TYPES	Repetitive Peak Off-State Voltage, V_{DRM} ①	Repetitive Peak Reverse Voltage, V_{RRM} ①	Non-repetitive Peak Reverse Voltage, V_{RSM} ①
	T_J = -40°C to +125°C	T_J = -40°C to +125°C	T_J = 125°C
C392, C393, C394, C395A	100 Volts	100 Volts	150 Volts
C392, C393, C394, C395B	200	200	300
C392, C393, C394, C395C	300	300	400
C392, C393, C394, C395D	400	400	500
C392, C393, C394, C395E	500	500	600
C392, C393, C394, C395M	600	600	720

① Half sinewave waveform, 10 ms max. pulse width.

Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) – C392, C393 .... 5500 Amperes
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) – C394, C395 .... 8000 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds – C392, C393 .... 50,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 1.5 milliseconds – C394, C395 .... 100,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds – C392, C393 .... 120,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds – C394, C395 .... 250,000 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive .... 800 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive.. 500 A/μs †
Average Gate Oower Dissipation, $P_{G(AV)}$ .... 2 Watts
Storage Temperature, T_{stg} .... -40°C to +150°C
Operating Temperature, T_J .... -40°C to +125°C
Mounting Force Required .... 2000 Lb. ± 10%
8.9 KN ± 10%

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5 μs short trigger current rise time.

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	5	15	mA	T_J = +25°C $V = V_{DRM} = V_{RRM}$
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	20	45	mA	T_J = 125°C $V = V_{DRM} = V_{RRM}$
Thermal Resistance	$R_{\theta JC}$	–	.05	.06	°C/Watt	Junction-to-Case (Double-Side Cooled
Critical Rate-of-Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
Holding Current	I_H	–	40	1000	mAdc	T_C = +25°C, Anode Supply = 24 Vdc, Initial On-State Current = 10 Amps.
DC Gate Trigger Current	I_{GT}	–	70	200	mAdc	T_C = +25°C, V_D = 10 Vdc, R_L = 1 Ohm
		–	100	400		T_C = -40°C, V_D = 10 Vdc, R_L = 1 Ohm
		–	25	150		T_C = +125°C, V_D = 10 Vdc, R_L = 1 Ohm

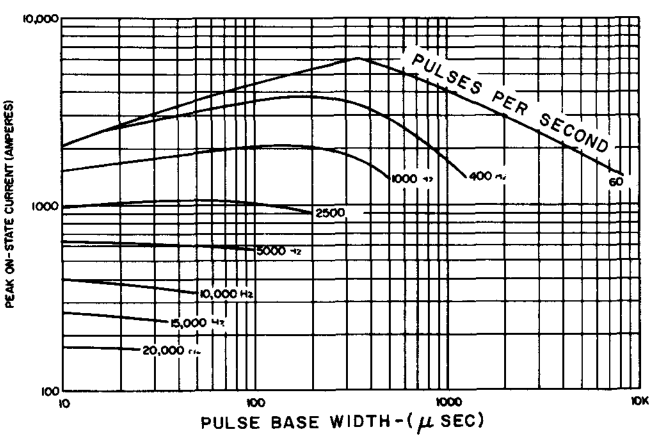
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
DC Gate Trigger Voltage	V_{GT}	–	3	5	Vdc	T_C = -40°C to 25°C, V_D = 10 Vdc, R_L = 1 Ohm
		–	1.50	3.0		T_C = 25°C to +125°C, V_D = 10 Vdc, R_L = 1 Ohm
		0.15	–	–		T_C = +125°C, V_{DRM}, R_L = 500 Ohms
Peak On-State Voltage C392, C393 C394, C395	V_{TM}	 – –	 3.3 2.3	 4.2 2.5	Volts	T_C = +25°C, I_{TM} = 3000 Amps Peak Duty Cycle ⩽ .01%. Pulse Width = 3.0 ms
Turn-On Delay Time	t_d	–	0.5	–	μsec	T_C = +25°C, I_{TM} = 50 Adc, V_{DRM}. Gate Supply: 20 Volt Open Circuit, 20 Ohms, 0.1 μsec max. rise time. ††,†††
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage) C392, C394 C393, C395	t_q	 – –	 8 12	 † †	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 20 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
C392, C394 C393, C395		– –	12 17	14 20		(1) T_C = +125°C (2) I_{TM} = 500 Amps (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 200 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode) C392, C394 C393, C395	$t_{q(diode)}$	 – –	 18 25	 † †	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 200 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms

†Consult factory for specified maximum turn-off time.
††Delay time may increase significantly as the gate drive approaches the I_{GT} of the Device Under Test.
†††Current risetime as measured with a current probe, or voltage risetime across a non-inductive resistor.

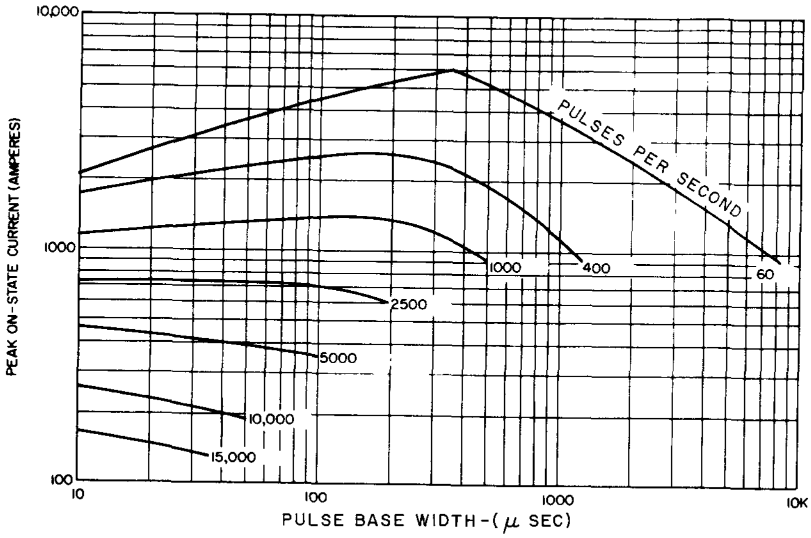
C394,C395

SINE WAVE CURRENT RATING DATA

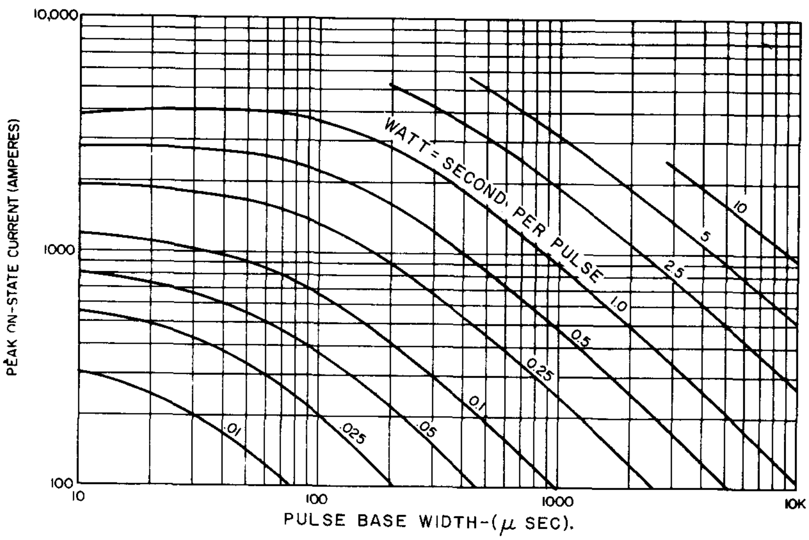


3. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)

C394,C395



4. **MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)**

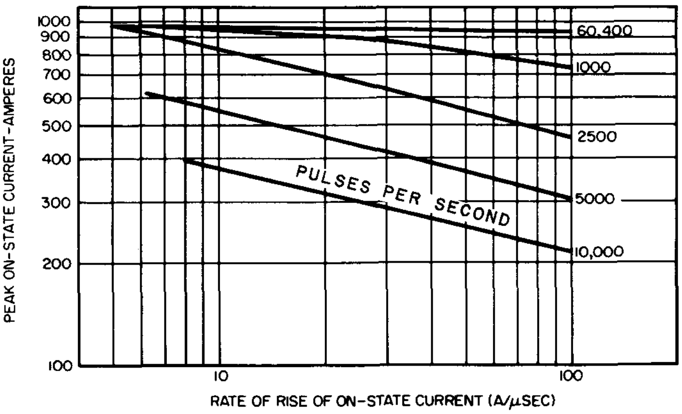


5. **ENERGY PER PULSE FOR SINUSOIDAL PULSES**

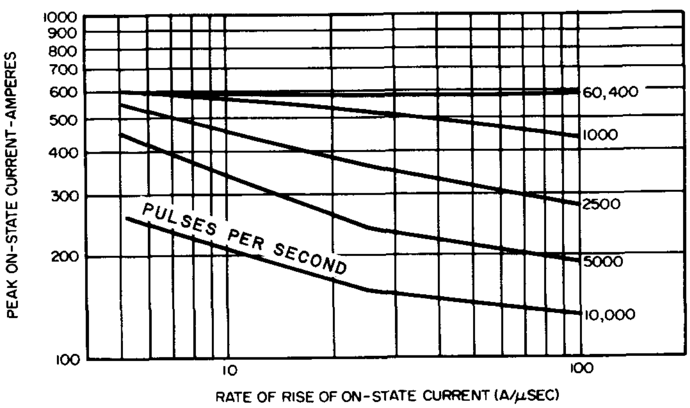
C394,C395

RECTANGULAR WAVE CURRENT RATING DATA

DUTY CYCLE — 50%

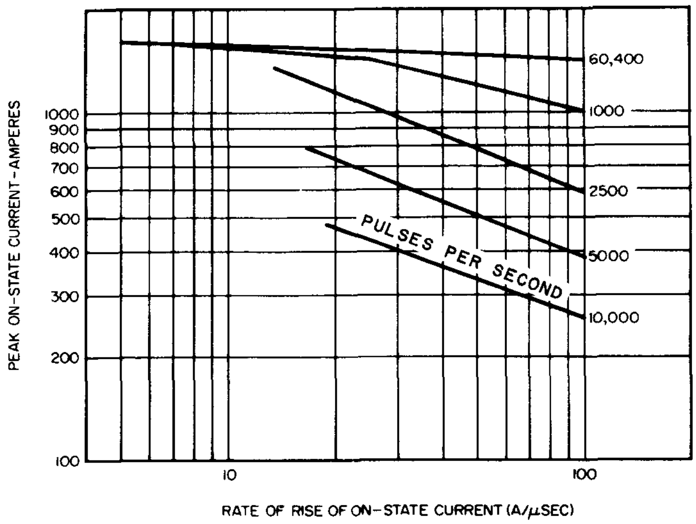


6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

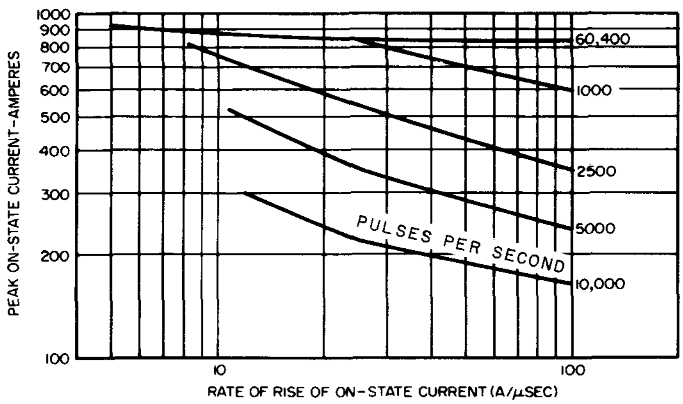


7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

DUTY CYCLE — 25%

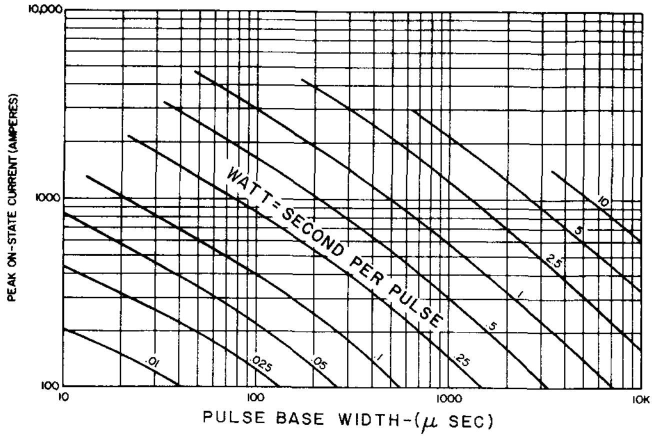


8. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

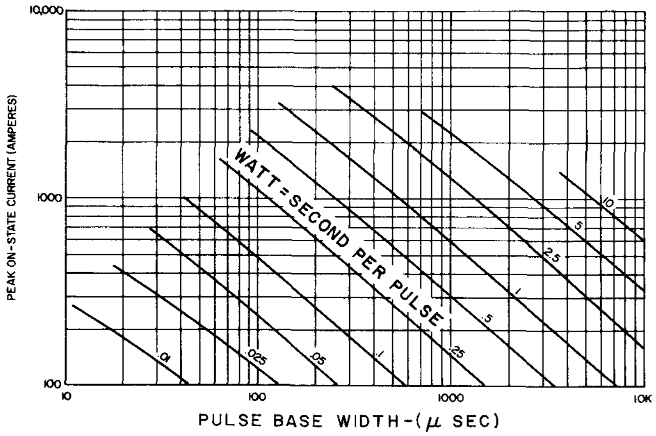


9. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

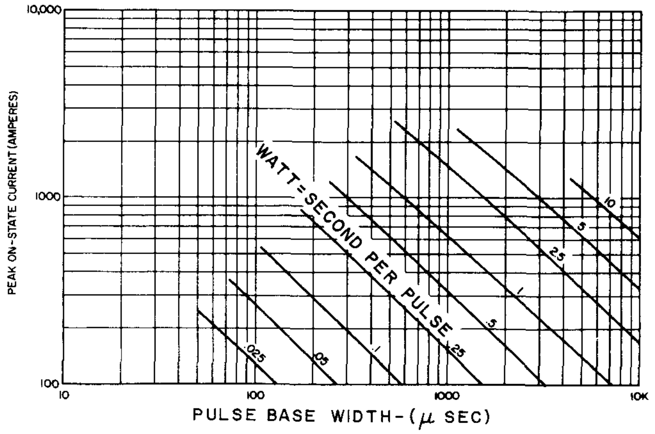
C394,C395
WATT-SECOND PER PULSE



10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec)

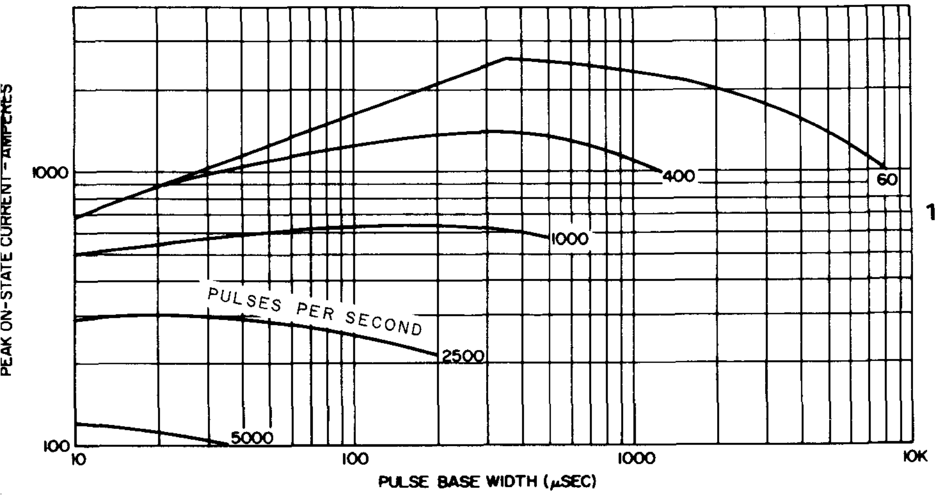


11. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec)

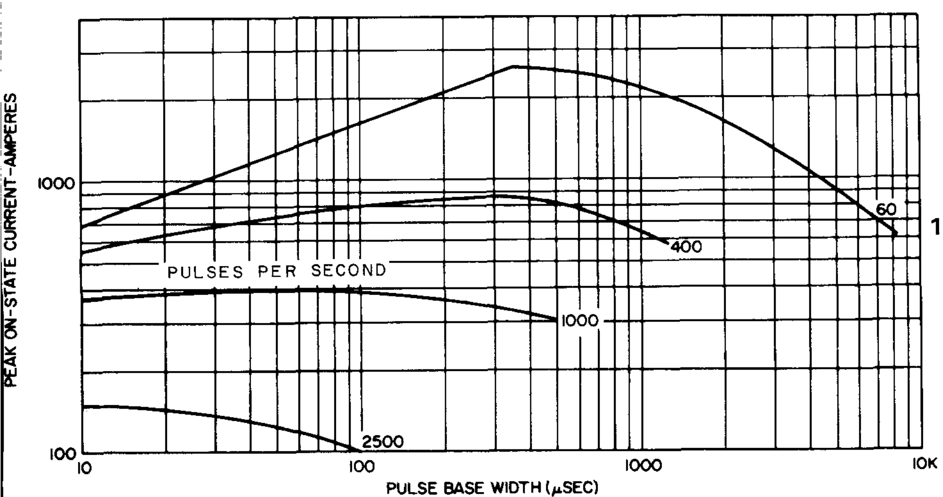


12. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec)

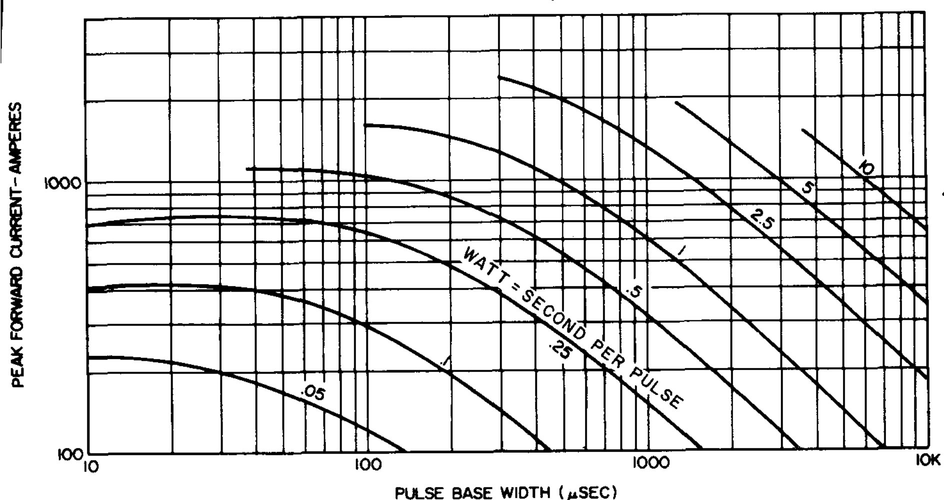
C394,C395 SINE WAVE CURRENT RATING DATA



13. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



14. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



15. ENERGY PER PULSE FOR SINUSOIDAL PULSES

NOTES:

(Pertaining to Sine and Rectangular Wave Current Ratings)

1. Switching voltage ⩽ 400 volts.
2. Reverse voltage applied = V_R ⩽ 400 volts.
3. Max. energy dissipated during reverse recovery to be 15% of total W-S/P shown or 0.03 W-S/P whichever is least. You can subtract this energy per pulse when operating with an inverse diode.
4. Required gate drive:
   20 volts, 65 ohms, 1 μsec risetime for less than 100 amps/μsec.
   20 volts, 20 ohms, .5 μsec risetime for greater than 100 amps/μsec
5. RC Snubber ckt. = .2 μf, 5Ω.
6. Double-Side Cooled
7. Values of W-S/P are for T_J = 125°C'

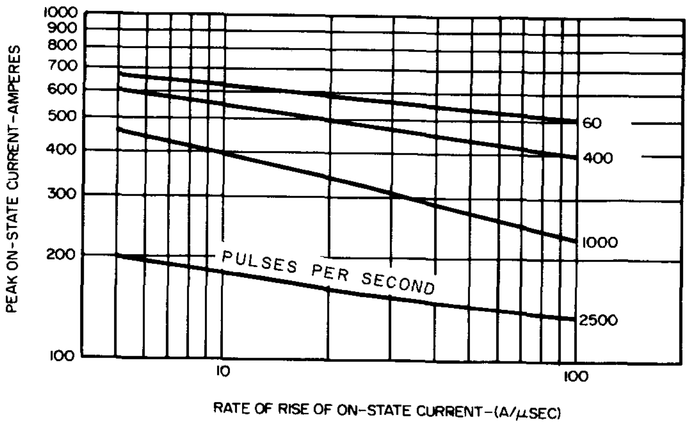
If the circuit di/dt remains below 100 amps/μs, and normally constructed snubbers using the components specified are employed, then the "soft" gate drive shown under "conditions" for each current rating curve is sufficient.

If the circuit di/dt exceeds 100 amps/μs then the stiff gate source (20V — 20Ω), t_r = .5μs, specified in Chart 27 must be used. In addition the total device di/dt must be checked to insure that it is not above the 500 amps/μs which is the long term repetitive limit noted in Chart 27 for stiff gate source.

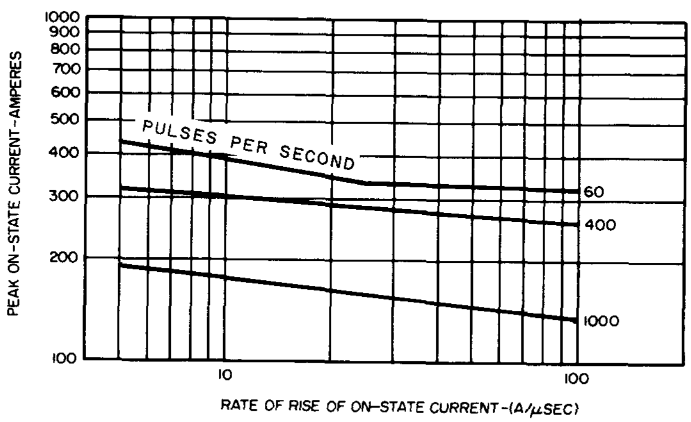
C392,C393

RECTANGULAR WAVE CURRENT RATING DATA

DUTY CYCLE – 50%

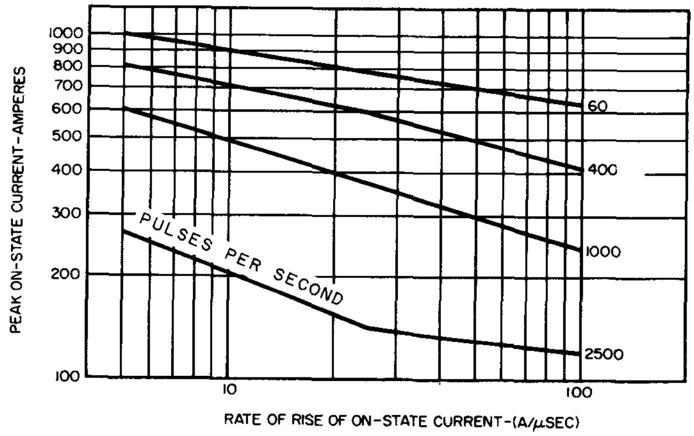


16. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS di/dt (T_C = 65°C)

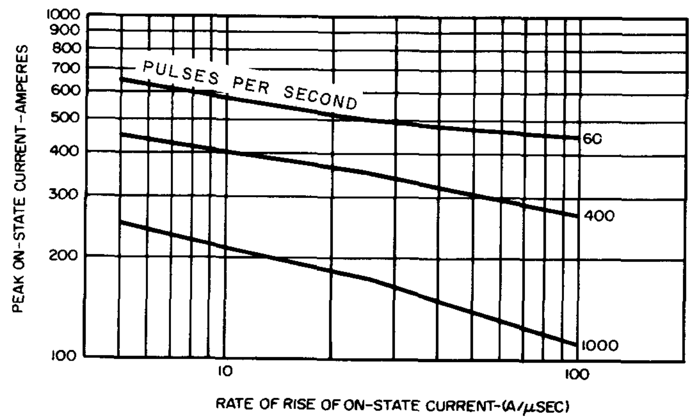


17. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

DUTY CYCLE – 25%



18. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)

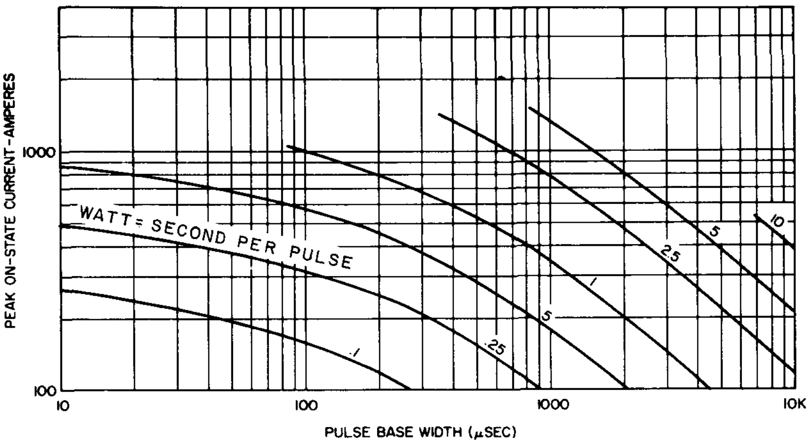


19. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

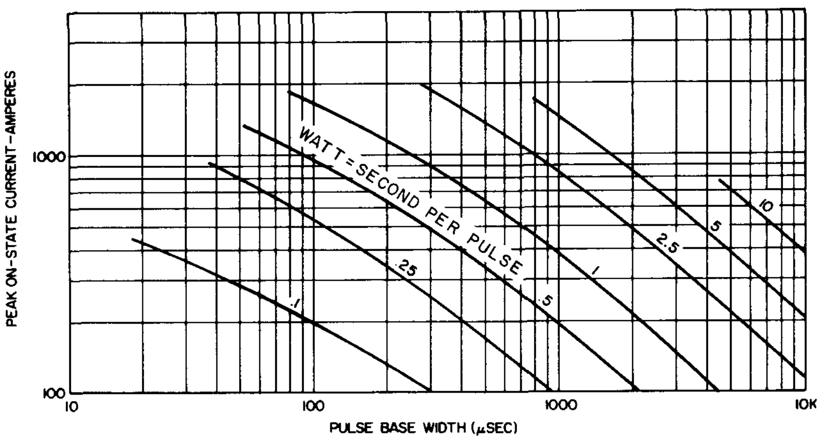
NOTES:
(Pertaining to Sine and Rectangular Wave Current Ratings)

1. RC Snubber ckt. = .25µf, 5Ω.
2. Off-State Voltage = 400 volts.
3. Reverse voltage = 50V $\leqslant V_R \leqslant$ 400 V.
4. Maximum T_J = +125°C.
5. Max. energy dissipated during reverse recovery to be 15% of total W-SYP shown or 0.03 W-S/P whichever is least. You can subtract this energy per pulse when operating with an inverse diode.
6. dv/dt (maximum) = 200 volts/µsec.
7. Required gate drive:
   20 volts, 65 ohms, 1 µsec risetime. See chart 27.
8. Double-Side Cooled.
9. Values of W-S/P are for T_J = 125°C.

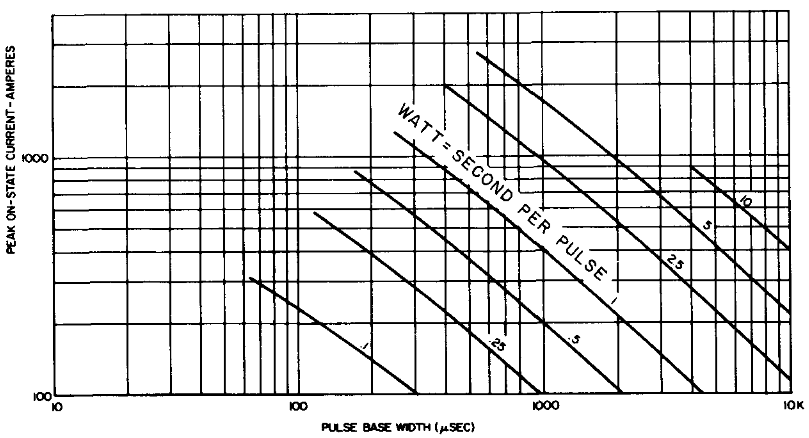
C392,C393
WATT-SECOND PER PULSE



20. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec)

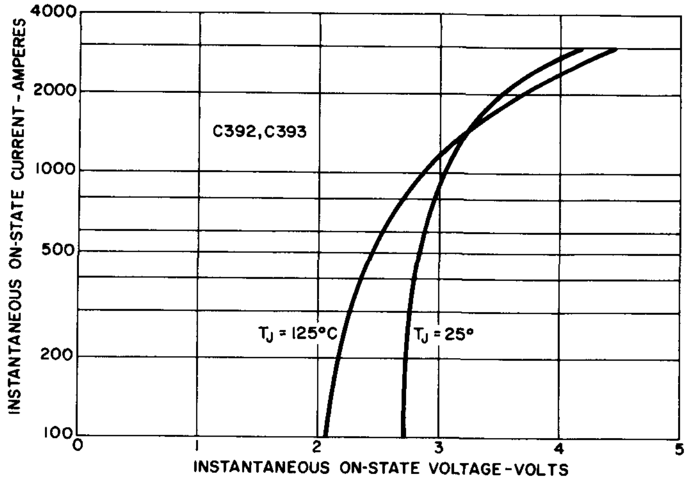


21. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec)



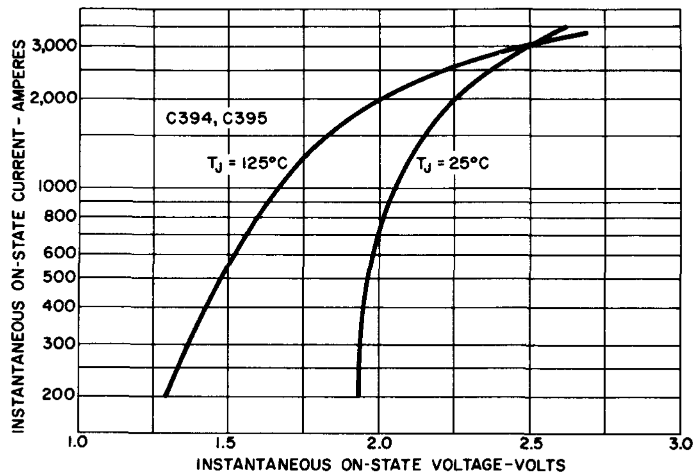
22. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec)

C392,C393

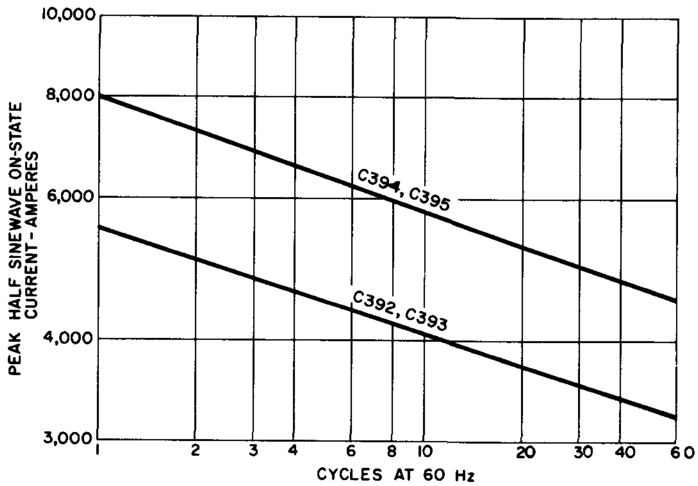


23. MAXIMUM ON-STATE CHARACTERISTICS

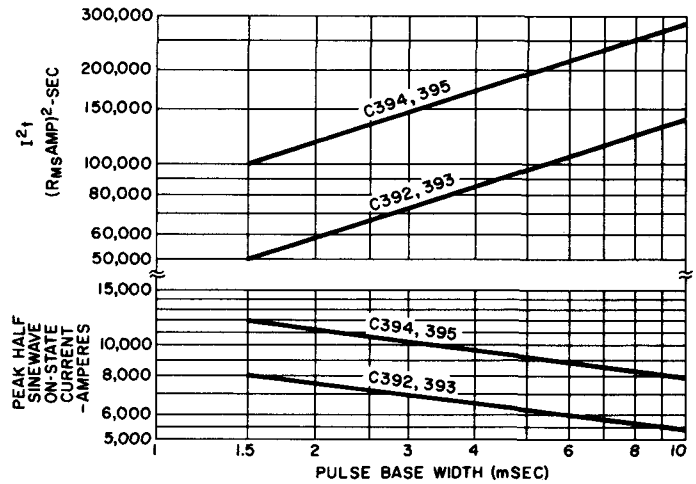
C394,C395



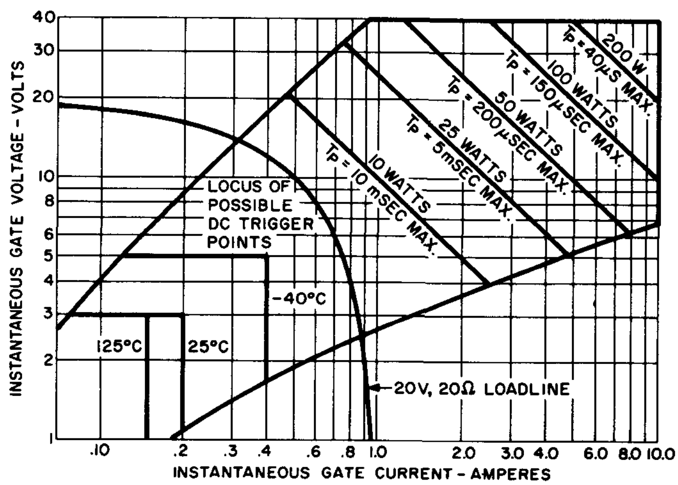
24. MAXIMUM ON-STATE CHARACTERISTICS



25. SURGE (NON-REPETITIVE) ON-STATE CURRENT



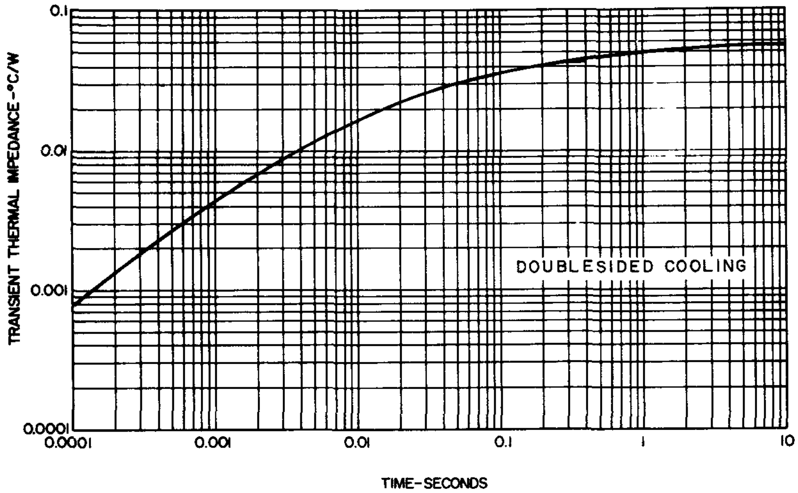
26. SUB-CYCLE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



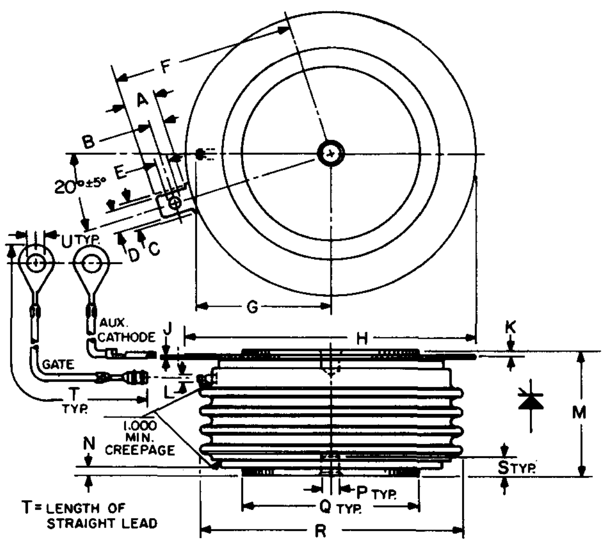
27. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

NOTES:

1. The locus of possible dc trigger points lie outside the boundaries shown at various case temperatures.
2. 20V — 20Ω is the minimum gate source load line when rate of circuit current rise > 100 amps/μs or anode rate of current rise > 200 amps/μs (Tp = 5 μs min., 0.5 μs max. risetime) Maximum long term repetitive anode di/dt = 500 amps/μs with 20V — 20Ω gate source.



28. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



SYM	DECIMAL INCHES MIN.	MAX.	METRIC M.M. MIN.	MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.70	2.11
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

OUTLINE DRAWING

SUGGESTED MOUNTING METHODS FOR PRESS-PAKS TO HEAT DISSIPATORS

When the Press-Pak is assembled to a heat sink in accordance with the following general instructions, a reliable and low thermal resistance interface with result.

1. Check each mating surface for nicks, scratches, flatness and surface finish. The heat dissipator mating surfaces should be flat within .0005 inches and have a surface finish of 63 micro-inches.

2. It is recommended that the heat dissipator be plated with nickel, tin or gold iridite. Bare aluminum or copper surfaces will oxidize in time resulting in excessively high thermal resistance.

3. Sand each surface *lightly* with 600 grit paper just prior to assembly. Clean off and apply silicone oil (GE SF1154 200. centistake viscosity) or silicone grease (GE G623 or Dow Corning DC 3, 4, 340 or 640). Clean off and apply again as a *thin* film. (A thick film will adversely affect the electrical and thermal resistances.)

4. Assemble with the specified mounting force applied through a self beveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both top and bottom of the Press-Pak are for locating purposes only.

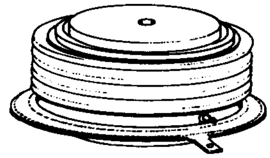
HIGH SPEED

Silicon Controlled Rectifier

1200 Volts, 650 A RMS

C397/C398

The General Electric C397 and C398 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Press-Pak devices employing the field-proven amplifying gate.

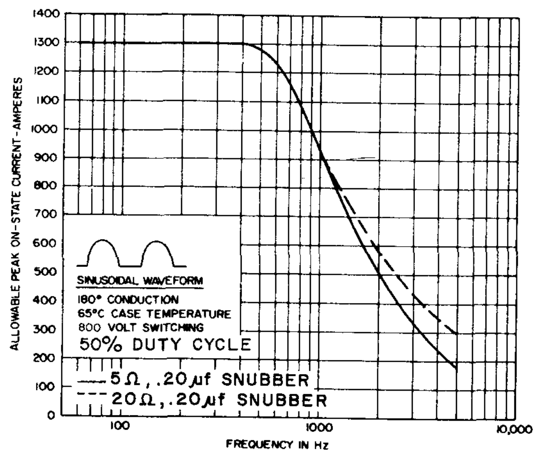


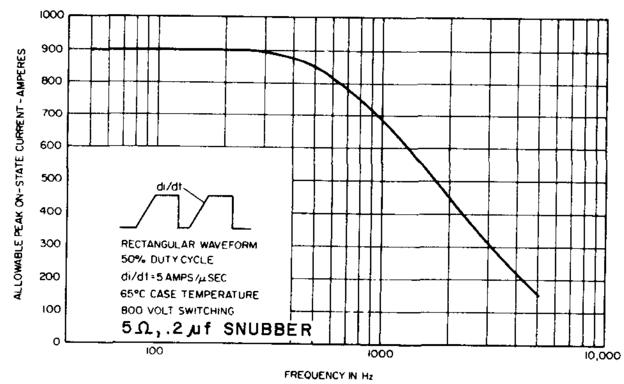
FEATURES:

- Fully characterized for operation in inverter and chopper applications.
- High di/dt ratings.
- High dv/dt capability with selections available.
- Rugged hermetic glazed ceramic package having 1″ creepage path.

IMPORTANT: Mounting instructions on the mounting clamp specifications at back of this sheet **must** be followed.

HIGH FREQUENCY CURRENT RATINGS





Equipment designers can use the C397/C398 SCR's in demanding applications, such as:

- Choppers
- Inverters
- Regulated Power Supplies
- Sonar Transmitters
- Induction Heaters
- Radio Transmitters
- Cycloconverters
- DC to DC Converters
- High Frequency Lighting

FOR SINEWAVE OPERATION

Like the Type C140/141, C158/159 and C358 SCR's, the C397/C398 SCR is rated for:

- Peak Current

  vs.

- Pulse Width
- Frequency
- Case Temperature

FOR RECTANGULAR WAVE OPERATION

GE now introduces a new, high-frequency rating for the C397/398 SCR, which is:

- Peak Current

  vs.

- di/dt of Leading Edge
- Frequency
- Duty Cycle
- Case Temperature

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = 125°C
C397/C398E	500 Volts	500 Volts	600 Volts
C397/C398M	600	600	720
C397/C398S	700	700	840
C397/C398N	800	800	960
C397/C398T	900	900	1080
C397/C398P	1000	1000	1200
C397/C398PA	1100	1100	1300
C397/C398PB	1200	1200	1400

[1] Half sinewave waveform, 10 ms max. pulse width.

Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} .... 7500 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds ....95,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds ....230,000 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive .... 800 A/μs †
Critical Rate-of-Rise of On-State Current, Repetitive.............................. 500 A/μs †
Average Gate Power Dissipation, $P_{G(AV)}$ .... 2 Watts
Storage Temperature, T_{stg} ....-40°C to +150°C
Operating Temperature, T_J ....-40°C to +125°C
Mounting Force Required.............................. 2000 Lb. ± 10%
8.9 KN ± 10%

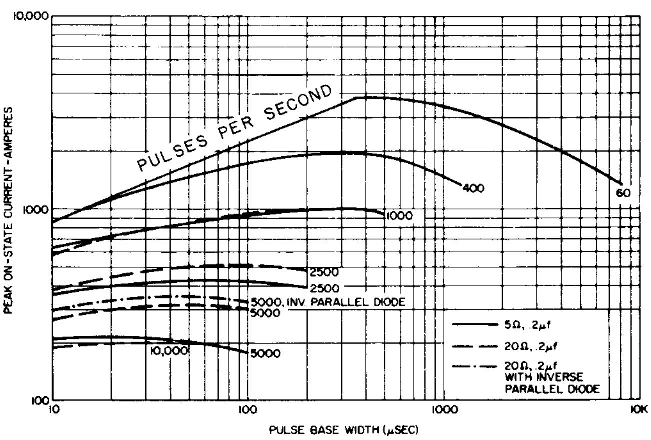
†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5 μs short circuit current rise time.

CHARACTERISTICS

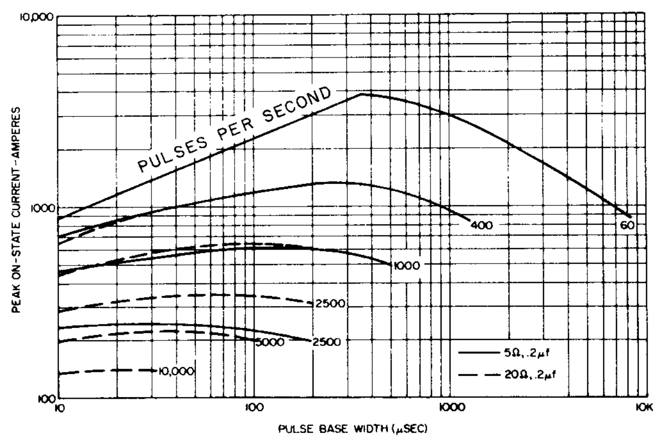
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	5	20	mA	T_J = +25°C $V = V_{DRM} = V_{RRM}$
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	20	45	mA	T_J = 125°C $V = V_{DRM} = V_{RRM}$
Thermal Resistance	$R_{\theta JC}$	–	.05	.06	°C/Watt	Junction-to-Case (DC) (Double-Side Cooled)
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = 125°C, Gate Open. V_{DRM} = Rated, Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
DC Gate Trigger Current	I_{GT}	–	50	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	75	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	15	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage	V_{GT}	–	3	5	Vdc	T_C = -40°C to 25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	1.25	3.0		T_C = 25°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.15	–	–		T_C = 125°C, V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	2.7	3.0	Volts	T_C = +25°C, I_{TM} = 3000 Amps Peak. Duty Cycle ⩽ .01%. Pulse Width = 1 ms.
Turn-On Delay Time	t_d	–	0.5	–	μsec	T_C = +25°C, I_{TM} = 50 Adc, V_{DRM}. Gate Supply: 20 volt open circuit, 20 ohms, 0.1 μsec max. rise time. ††, †††
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q				μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 20 V/μsec (linear) (6) Commutation di/dt = 25 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
C398		–	20	†		
C397		–	35	†		
C398		–	30	40		(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 50 Volts Min. (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 200 V/μsec (linear) (6) Commutation di/dt = 25 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
C397		–	45	60		
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	$t_{q(diode)}$				μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps (3) V_R = 1 Volt (4) V_{DRM} (Reapplied) (5) Rate-of-rise of reapplied off-state voltage = 200 V/μsec (linear) (6) Commutation di/dt = 25 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
C398		–	40	†		
C397		–	60	†		

†Consult factory for specified maximum turn-off time.
††Delay time may increase significantly as the gate drive approaches the I_{GT} of the Device Under Test.
†††Current risetime as measured with a current probe, or voltage risetime across a non-inductive resistor.

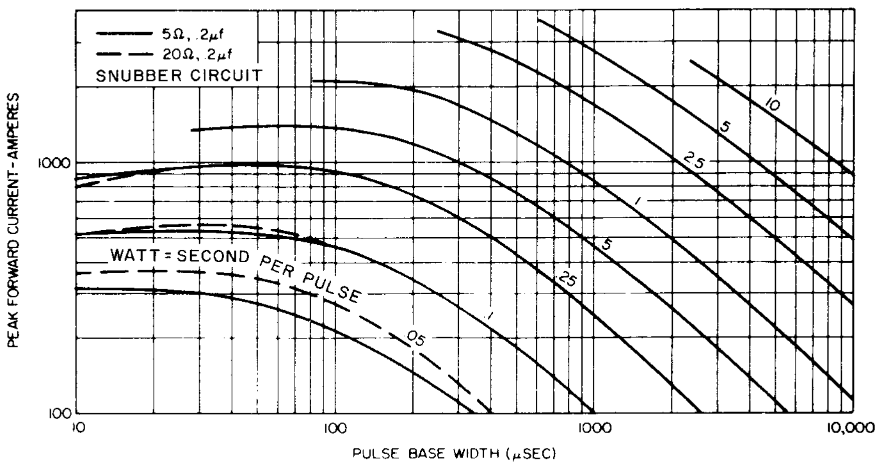
SINE WAVE CURRENT RATING DATA



1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

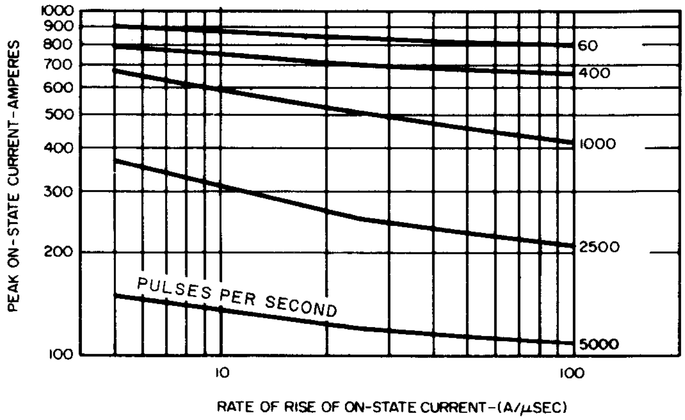
NOTES:

(Pertaining to Sine and Rectangular or Wave Current Ratings)

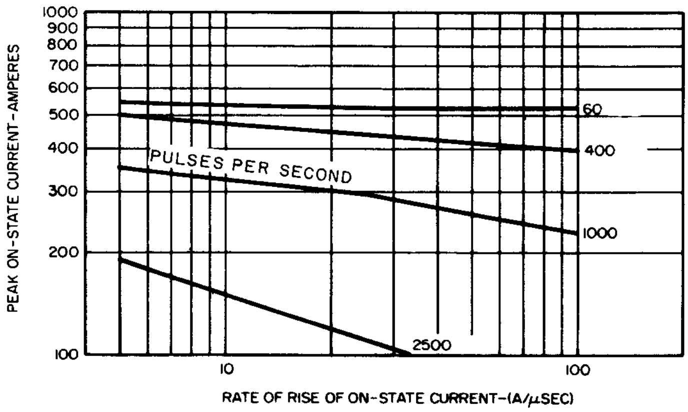
1. Switching voltage ⩽ 800 volts.
2. Reverse voltage applied = V_R ⩽ 800 V.
3. Max. energy dissipated during reverse recovery is 15% of total W-S/P shown or 0.03 W-S/P whichever is least for operation with inverse diode.
4. Required gate drive:
   20 volts, 65 ohms, 1 μsec risetime for less than 100 amps/μsec
   20 volts, 20 ohms, 5 μsec risetime for greater than 100 amps/μsec.
5. RC Snubber ckt. = .2 μf, 5Ω
6. Double-Side Cooled.
7. Values of W-S/P are for T_J = 125°C.

RECTANGULAR WAVE CURRENT RATING DATA

DUTY CYCLE — 50%

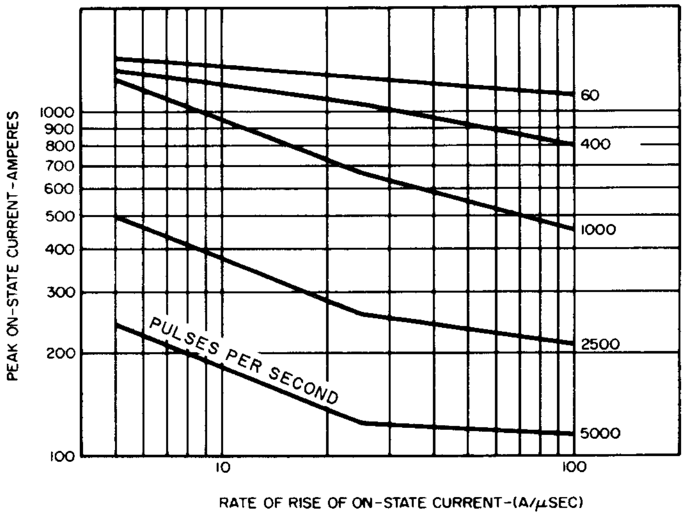


4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS di/dt (T_C = 65°C)

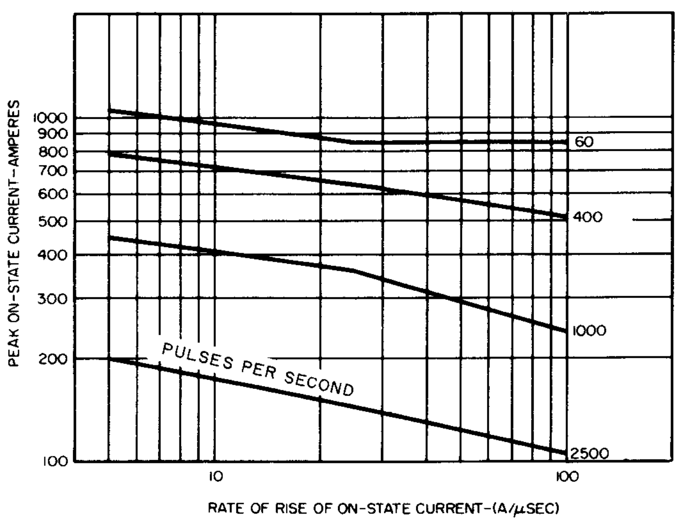


5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

DUTY CYCLE — 25%



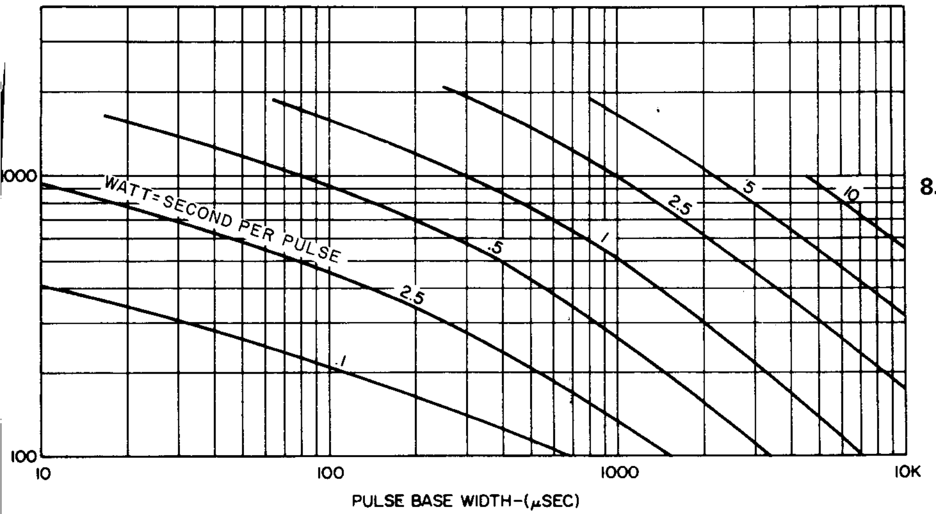
6. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 65°C)



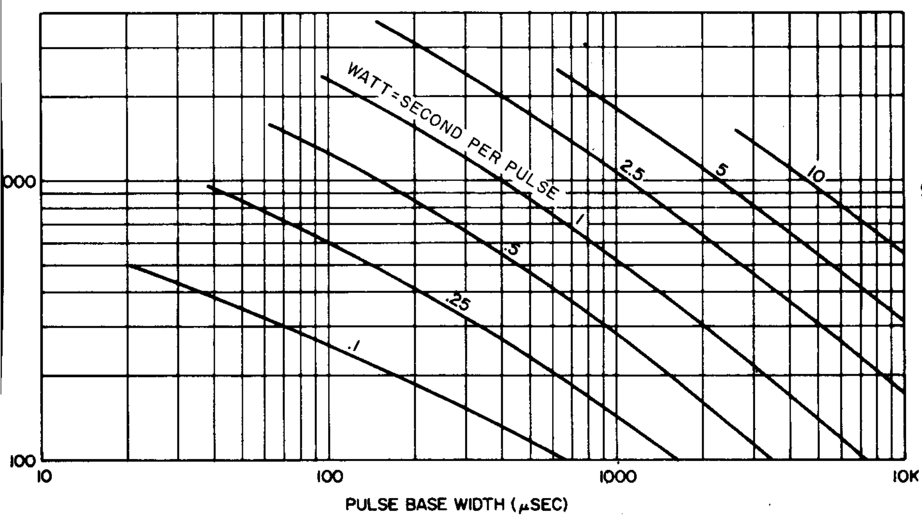
7. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. di/dt (T_C = 90°C)

NOTES: (SEE SINE WAVE DATA)

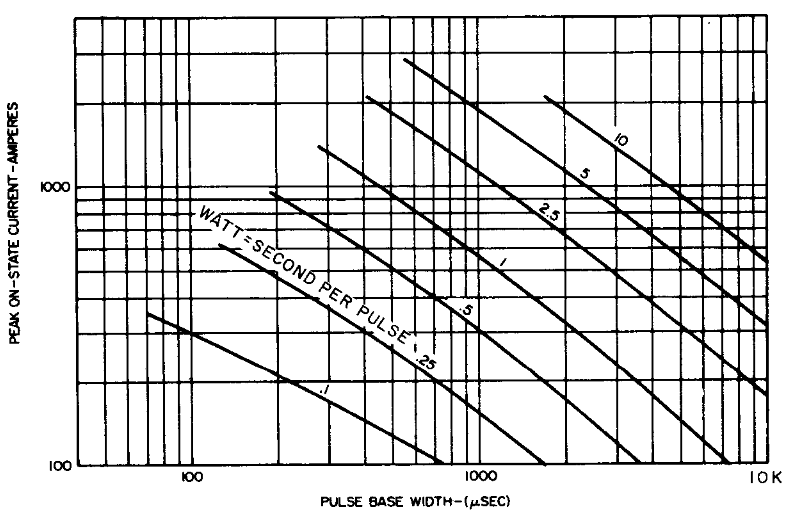
WATT—SECOND PER PULSE



8. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 100 A/μsec)

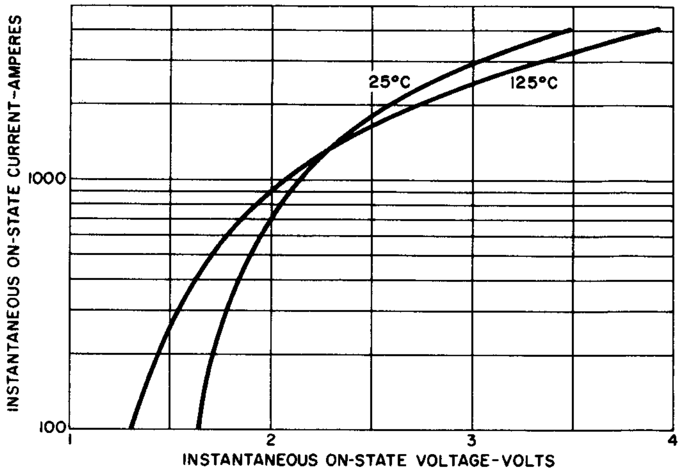


9. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 25 A/μsec)

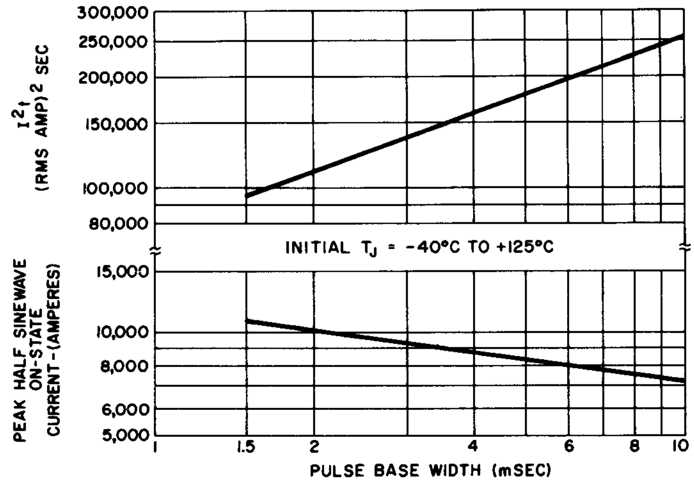


10. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 5 A/μsec)

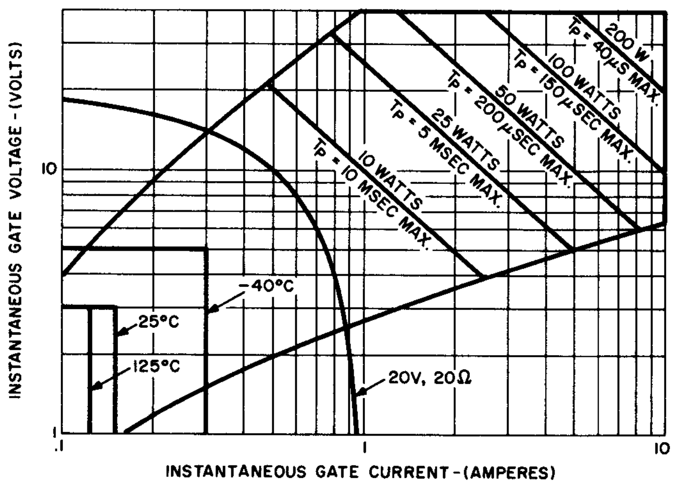
NOTES: (SEE SINE WAVE DATA)



11. MAXIMUM ON-STATE CHARACTERISTICS



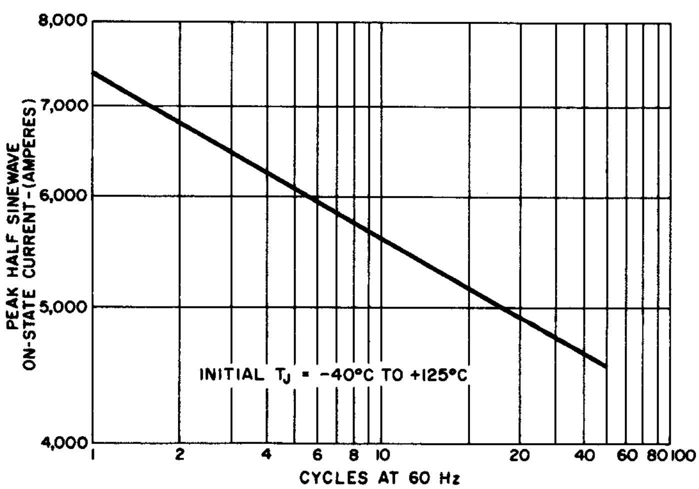
14. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



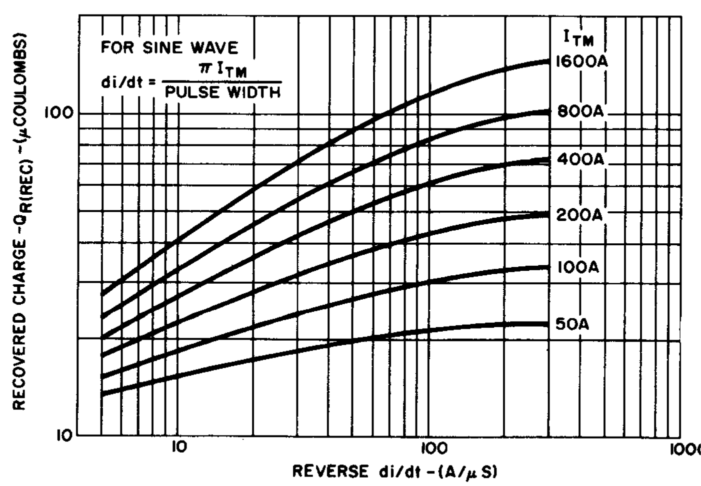
12. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

NOTES:

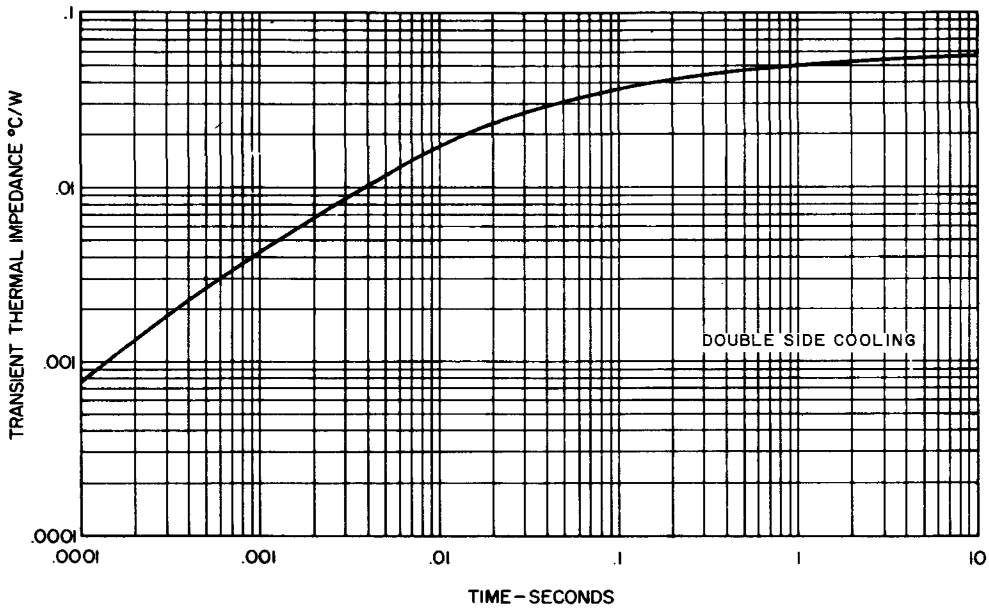
1. The locus of possible dc trigger points lies outside the boundaries shown at various case temperatures.
2. 20V — 20 is the minimum gate source load line when rate of circuit current rise > 100 amp/μs or anode rate of current rise > 200 amps/μs (Tp = 5 μs min., 0.5 μs max. rise time.)
   Maximum long term repetitive anode di/dt = 500 amps/μs with 20V — 20Ω gate source.



13. SURGE (NON-REPETITIVE) ON-STATE CURRENT

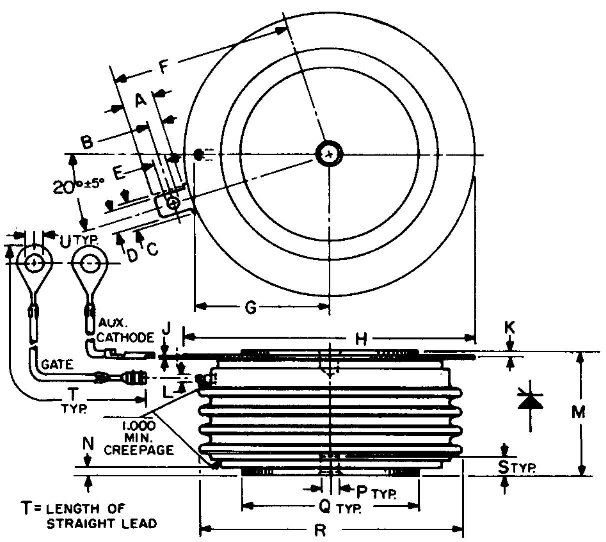


15. TYPICAL RECOVERED CHARGE (125°C) SINEWAVE CURRENT WAVEFORM



16. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE

OUTLINE DRAWING



SYM	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC M.M. MIN.	METRIC M.M. MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.061
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.70	2.11
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

High Power Silicon Controlled Rectifier

1300 Volts 900 A Avg

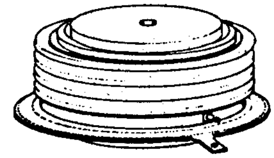
C440

AMPLIFYING GATE A

The General Electric C440 Silicon Controlled Rectifier is designed for phase control applications. This is an all-diffused Press-Pak device employing the field-proven amplifying gate.

FEATURES:

- High di/dt Ratings
- High dv/dt Capability with Selections Available
- Excellent Surge and I^2t Ratings Providing Easy Fusing
- Guaranteed Maximum Turn-Off Time with Selections Available
- Rugged Hermetic Glazed Ceramic Package Having 1″ Creepage Path



IMPORTANT: Mounting instructions on the last page of this specification must be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C440E	500 Volts	500 Volts	600 Volts
C440M	600	600	700
C440S	700	700	800
C440N	800	800	900
C440T	900	900	1000
C440P	1000	1000	1150
C440PA	1100	1100	1250
C440PB	1200	1200	1400
C440PC	1300	1300	1500

[1] Half sinewave waveform, 10 msec max. pulse width.

Average On-State Current, $I_{T(AV)}$	Depends on Conduction Angle (See Charts 1 and 2)
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz)	13,000 Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz)	12,000 Amperes
Critical Rate-of-Rise of On-State Current (Non-Repetitive)†	800 A/μs
Critical Rate-of-Rise of On-State Current (Repetitive)†	400 A/μs
I^2t (for fusing) (for times ⩾ 1.5 milliseconds) See Figure 7	340,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) (at 8.3 milliseconds)	700,000 (RMS Ampere)^2 Seconds
Peak Gate Power Dissipation P_{GM}	200 Watts @ 40 μsec Pulse
Average Gate Power Dissipation, $P_{G(AV)}$	5 Watts
Storage Temperature, T_{stg}	-40°C to +150°C
Operating Temperature, T_J	-40°C to +125°C
Mounting Force Required	3000 Lbs. + 500 Lbs. – 0 13.3 KN + 2.2 KN – 0

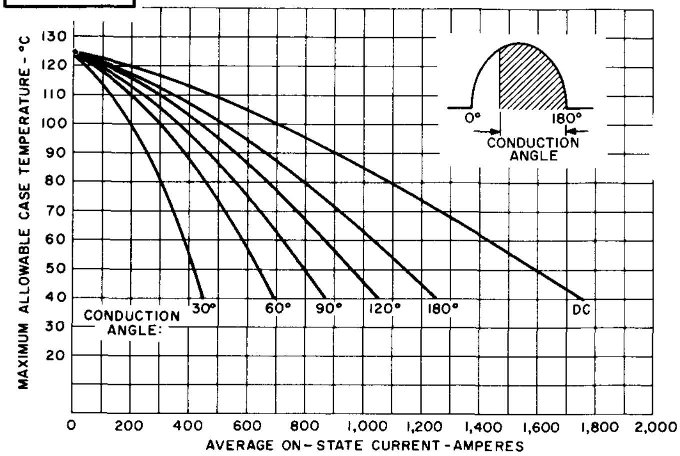
NOTES:

† di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of $V_{DRM} \leqslant$ 1000 Volts; 20 volts, 20 ohms gate trigger source with 0.5 μs short circuit trigger current rise time.

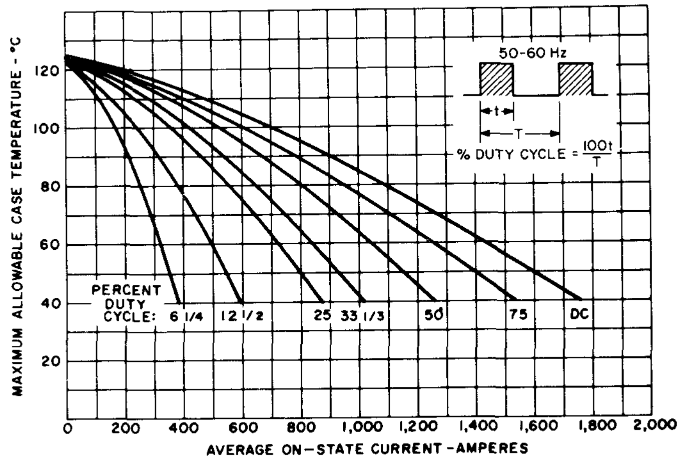
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Currents	I_{DRM} and I_{RRM}	–	10	15	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Blocking Currents	I_{DRM} and I_{RRM}	–	15	35	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	0.04	°C/Watt	Junction-to-Case – Double-Side Cooling
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching.)	dv/dt	200	–	–	V/μsec	T_J = +125°C, Rated V_{DRM} During Linear Exponential Rising Waveform. Gate Open. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
DC Holding Current	I_H	–	500	–	mAdc	T_C = +25°C, Anode Supply = 24 Vdc. Initial On-State Current = 2 Amps.
DC Latching Current	I_L	–	.25	–	Adc	T_C = +25°C, Anode Voltage = 24 Vdc. Load Resistance 12 Ohms Max.
Turn-On Delay Time	t_d	–	0.7	–	μsec	T_C = +25°C, I_T = 50 Adc, Gate Supply: 20 Volts, 20 Ohms, 0.1 μsec Max. Rise Time
Gate Pulse Width Necessary to Trigger		–	–	10	μsec	T_C = +25°C, Gate Supply: 10 Volt Open Circuit, 5 Ohms, 0.1 μsec Rise Time.
DC Gate Trigger Current See Figure 10 for Recommended Gate Drive Conditions	I_{GT}	–	–	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage See Figure 10	V_{GT}	–	–	5	Vdc	T_C = -40°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		.15	–	–		T_C = +125°C, V_D = Rated V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	1.65	Volts	T_C = +25°C, I_T = 3000 Amps Peak. Duty Cycle ≤ 0.01%
Circuit Commutated Turn-Off Time	t_q*	–	125	–	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. Peak (3) V_R = 50 Volts Min. (4) V_{DRM} Reapplied (5) Rate-of-Rise of Reapplied Off-State Voltage = 20V/μsec (linear) (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms

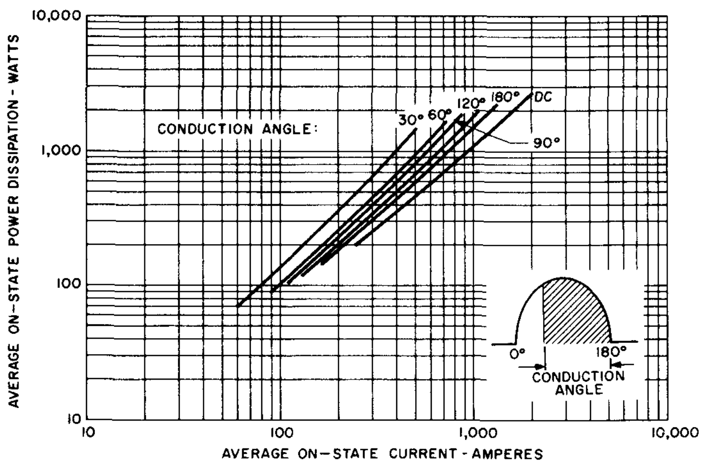
*Consult factory for maximum t_q specification.



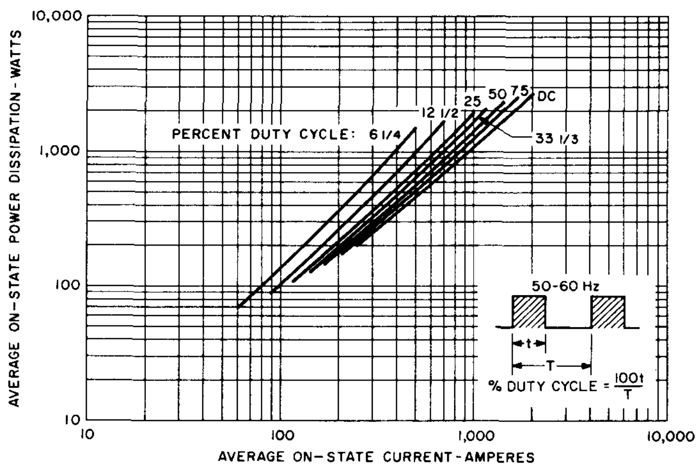
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM — DOUBLE-SIDE COOLED



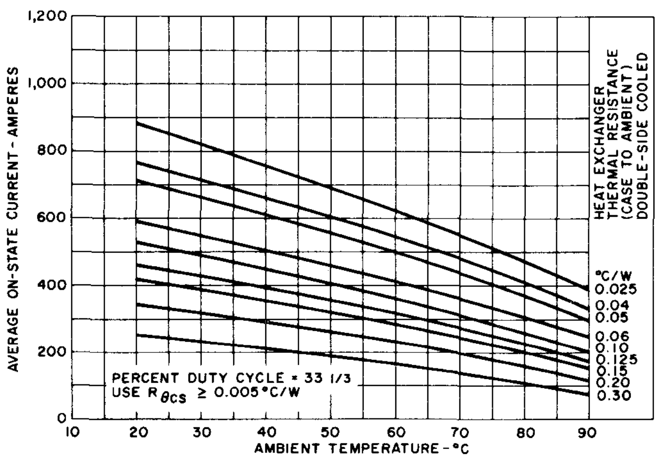
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM — DOUBLE-SIDE COOLED



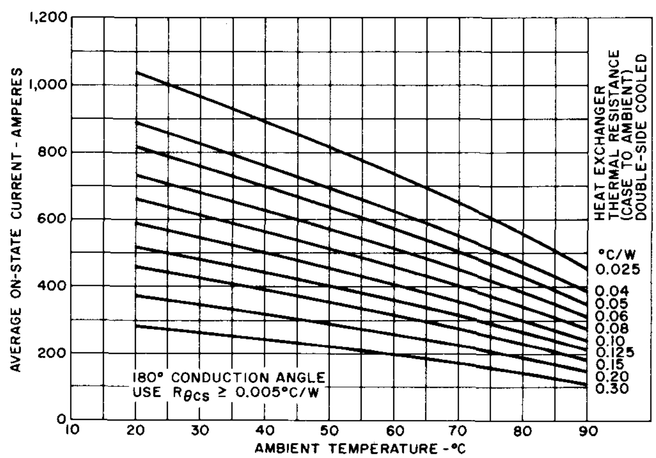
3. AVERAGE ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



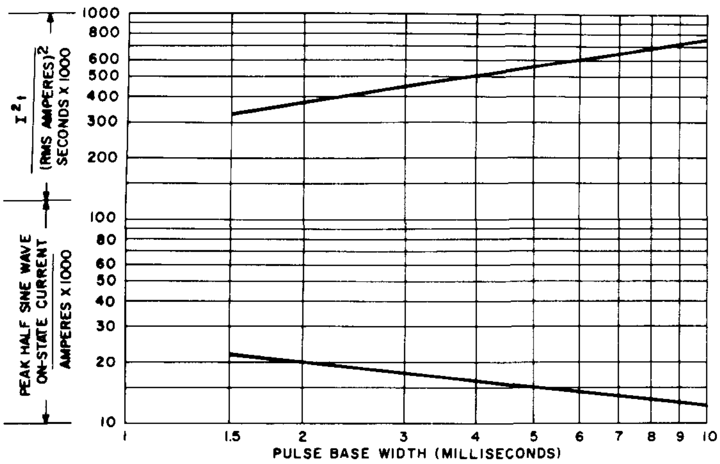
4. AVERAGE ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



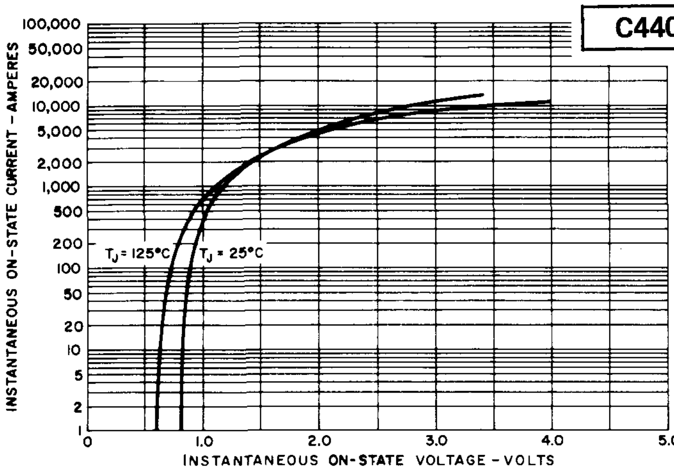
5. AVERAGE RECTANGULAR ON-STATE CURRENT VS. AMBIENT TEMPERATURE WHEN USED WITH VARIOUS HEAT EXCHANGERS



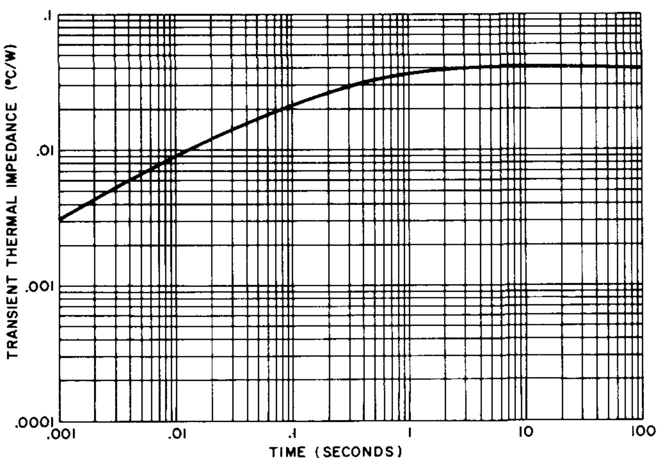
6. AVERAGE HALF SINEWAVE ON-STATE CURRENT VS. AMBIENT TEMPERATURE WHEN USED WITH VARIOUS HEAT EXCHANGERS



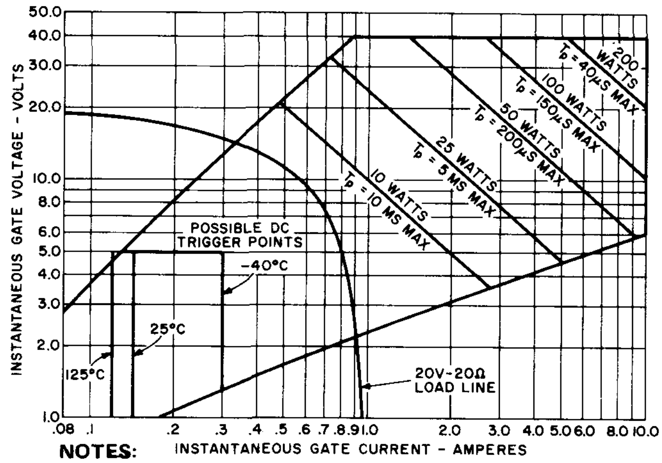
7. SUB-CYCLE SURGE (NON-REPETITIVE) AND I^2t RATINGS



8. MAXIMUM ON-STATE CHARACTERISTICS



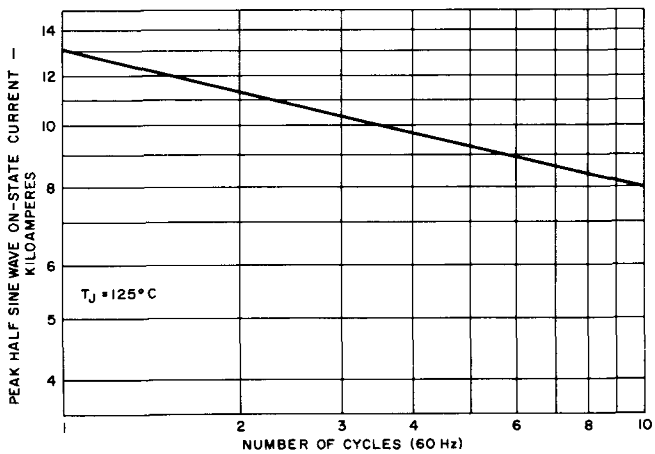
9. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE (DOUBLE-SIDE COOLED)



NOTES:

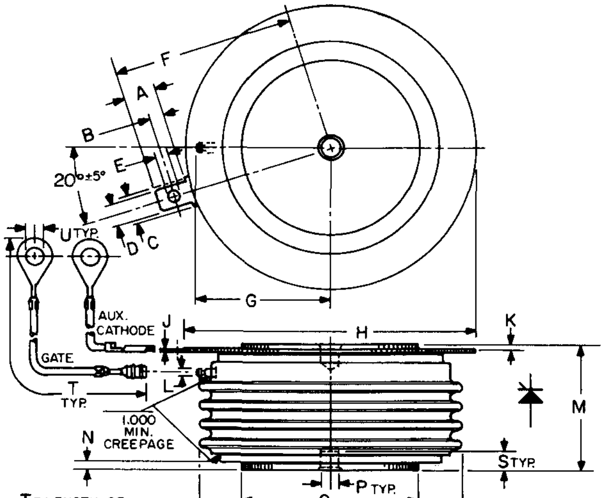
1. Maximum allowable average gate dissipation = 5 watts.
2. The locus of possible DC trigger points lies outside the boundaries shown at various case temperatures.
3. Tp = Rectangular Gate Current Pulse Width.

10. GATE TRIGGERING CHARACTERISTICS



11. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT

OUTLINE DRAWING



T = LENGTH OF STRAIGHT LEAD

SYM	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC M.M. MIN.	METRIC M.M. MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	**.067**	**.083**	**1.702**	**2.110**
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

SUGGESTED MOUNTING METHODS FOR PRESS-PAKS TO HEAT DISSIPATORS

When the Press-Pak is assembled to a heat sink in accordance with the following general instructions, a reliable and low thermal interface will result.

1. Check each mating surface for nicks, scratches, flatness and surface finish. The heat dissipator mating surface should be flat within .0005 inch/inches and have a surface finish of 63 micro-inches.

2. It is recommended that the heat dissipator mounting surfaces be plated with nickel, tin, or silver. Bare aluminum or copper surfaces will oxidize in time resulting in excessively high thermal resistance.

3. Sand each surface **lightly** with 600 grit paper just prior to assembly. Clean off and apply silicon oil (GE SF1154, 200 centistoke viscosity) or silicone grease (GE G322L or Dow Corning DC 3, 4, 340 or 640). Clean off and apply again as a **thin** film. (A thick film will adversely affect the electrical and thermal resistances.)

4. Assemble with the specified mounting force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both top and bottom of the Press-Pak are for locating purposes only.

HEAT SINK SELECTION MADE EASY

The C440 specification sheet marks the introduction of two new characteristic curves which should greatly facilitate heat sink selection. Figures 5 and 6 plot allowable average current versus ambient temperature and case-to-ambient thermal resistance for the two most frequently encountered waveforms, 1/3 duty cycle rectangular current and 180° sinusoidal current waveforms. As soon as the average forward current and maximum ambient temperature are known, the designer can specify a heat sink thermal resistance. Note that the graphs span the range of heat sinks from water-cooled ($R_{\theta CA}$ = .03°C/W) to free-air convection ($R_{\theta CA}$ = 0.3°C/W). It is possible to linearly interpolate between the curves for $R_{\theta CA}$.

These curves have been derived from the following basic equation:

$$T_J = T_A + P_{AVG} \times R_{\theta JA}$$

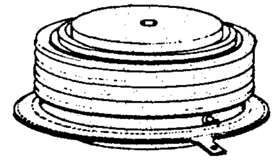
where: $T_J = 125°C$

For increased reliability, the usual practice is to derate T_J 15-30 degrees. Figures 5 and 6 can perform this function by the simple expedient of raising T_A by a like amount.

High Power
Silicon
Controlled Rectifier
1800 Volts   750A Avg.

C441

The General Electric C441 Silicon Controlled Rectifier is designed for phase control applications. This is an all-diffused Press-Pak device employing the field-proven amplifying gate.



FEATURES:

- High di/dt Ratings
- High dv/dt Capability with Selections Available
- Excellent Surge and I^2t Ratings Providing Easy Fusing
- Guaranteed Maximum Turn-Off Time with Selections Available
- Rugged Hermetic Glazed Ceramic Package Having 1″ Creepage Path

IMPORTANT: Mounting instructions on the last page of this specification **must** be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	TRANSIENT PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C441PC	1300 Volts	1300 Volts	1470 Volts
C441PD	1400	1400	1580
C441PE	1500	1500	1700
C441PM	1600	1600	1790
C441PS	1700	1700	1920
C441PN	1800	1800	2040

[1] Half sinewave waveform, 10 msec max. pulse width.

Average On-State Current, $I_{T(AV)}$ . . . . Depends on Conduction Angle (See Charts 1 and 2)
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (60 Hz) . . . . 11,000 Amperes
Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} (50 Hz) . . . . 10,000 Amperes
Critical Rate-of-Rise of On-State Current (Non-Repetitive)† . . . . 150 A/μs
Critical Rate-of-Rise of On-State Current (Repetitive)† . . . . 75 A/μs
I^2t (for fusing) (for times ⩾ 1.5 milliseconds) See Figure 7 . . . . 280,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) (at 8.3 milliseconds) . . . . 500,000 (RMS Ampere)^2 Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 200 Watts @ 40 μsec Pulse
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 5 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force Required . . . . 3000 Lbs. – 3500 Lbs.
13.3 Kn – 15.6 Kn

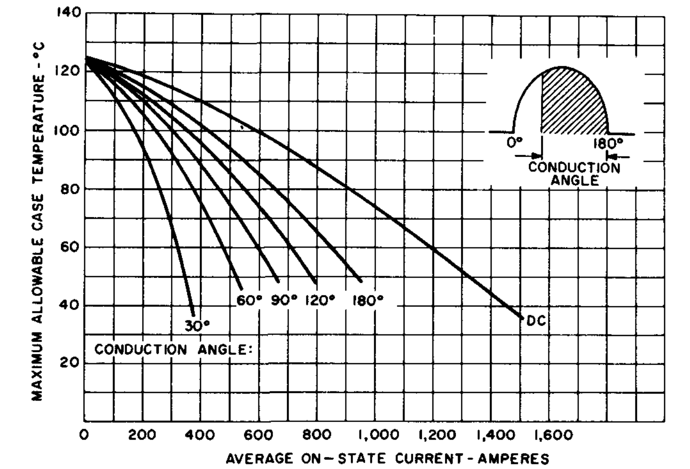
NOTE:

† di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of V_{DRM} ⩽ 1300V; 20 volts, 20 ohms gate trigger source with 0.5 μs short circuit trigger current rise time.

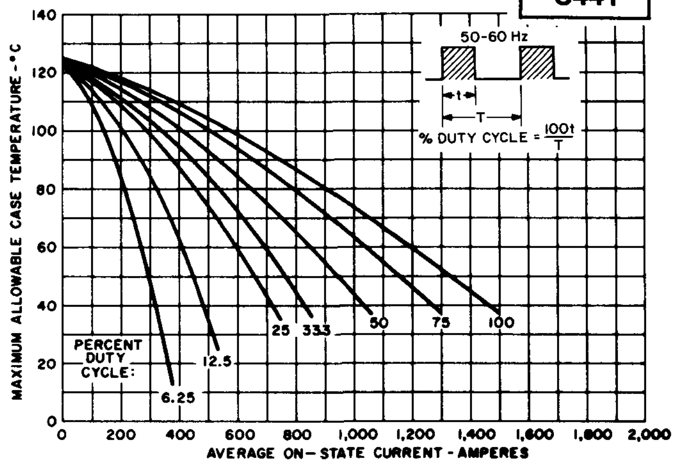
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and Off-State Currents	I_{RRM} and I_{DRM}	–	10	15	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	15	35	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	0.04	°C/Watt	Junction-to-Case (Double-Side Cooling)
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	–	–	V/μsec	T_J = +125°C, 0.8 x V_{DRM} Applied, Using Linear Exponential Rising Waveform, Gate Open. Exponential dv/dt = $0.8 \frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selection available – consult factory.						
DC Holding Current	I_H	–	500	–	mAdc	T_C = +25°C, Anode Supply = 24 Vdc, Initial On-State Current = 2 Amps.
DC Latching Current	I_L	–	.25	–	Adc	T_C = +25°C, Anode Voltage = 24 Vdc, Load Resistance 12 Ohms Max.
Turn-On Delay Time	t_d	–	0.7	–	μsec	T_C = +25°C, I_T = 50 Adc. Gate Supply: 20 Volts, 20 Ohms, 0.1 μsec max. rise time
Gate Pulse Width Necessary to Trigger		–	–	10	μsec	T_C = +25°C. Gate Supply: 10 Volt Open Circuit, 5 Ohms, 0.1 μsec rise time
DC Gate Trigger Current See Figure 10 for Recommended Gate Drive Conditions	I_{GT}	–	–	150	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	300		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	125		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger Voltage See Figure 10	V_{GT}	–	–	5	Vdc	T_C = -40°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		.15	–	–		T_C = +125°C, V_D = Rated V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	2.0	Volts	T_C = +25°C, I_T = 3000 Amps. Peak. Duty Cycle ≤ 0.01%
Circuit Commutated Turn-Off Time	t_q*	–	125	–	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps (3) V_R = 50 Volts Min. (4) 0.8 V_{DRM} Reapplied (5) Rate-of-Rise of Reapplied Off-State Voltage = 20 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec (7) Repetition Rate = 1 pps (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms

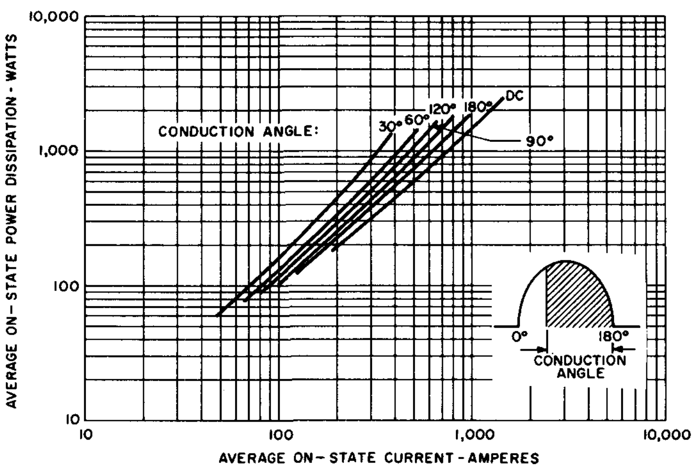
*Contact factory for maximum t_q specification.



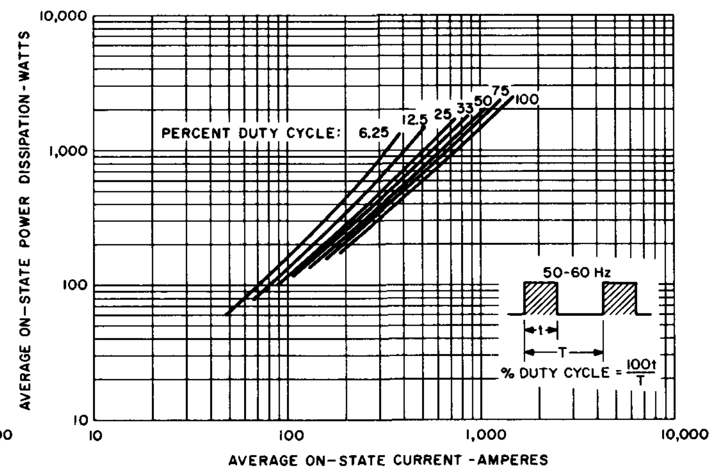
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM – DOUBLE-SIDE COOLED



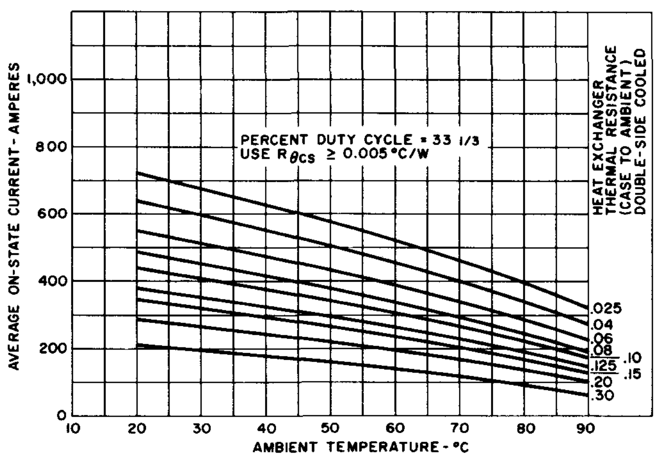
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM – DOUBLE-SIDE COOLED



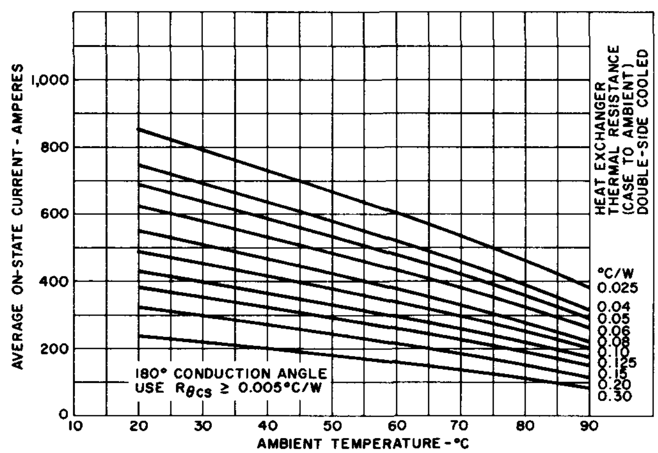
3. MAXIMUM ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



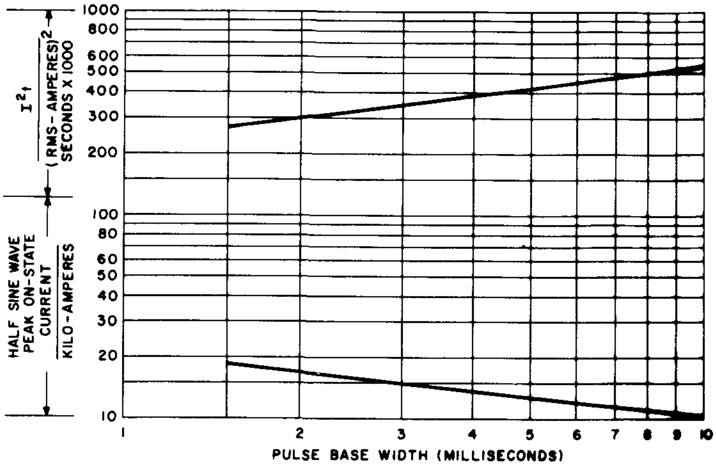
4. MAXIMUM ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



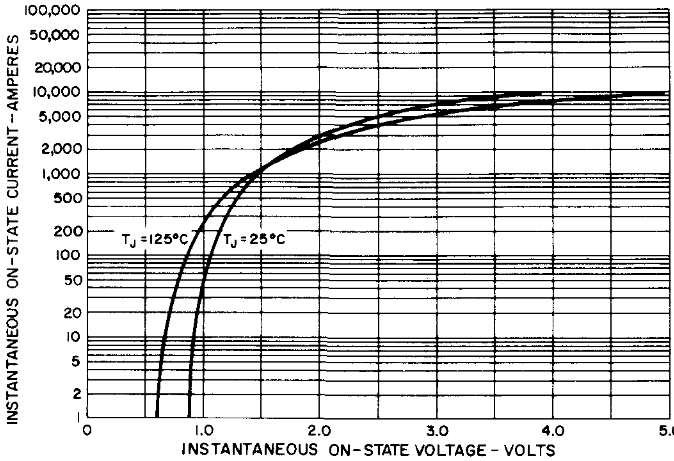
5. MAXIMUM RECTANGULAR ON-STATE CURRENT VS. AMBIENT TEMPERATURE WHEN USED WITH VARIOUS HEAT EXCHANGERS



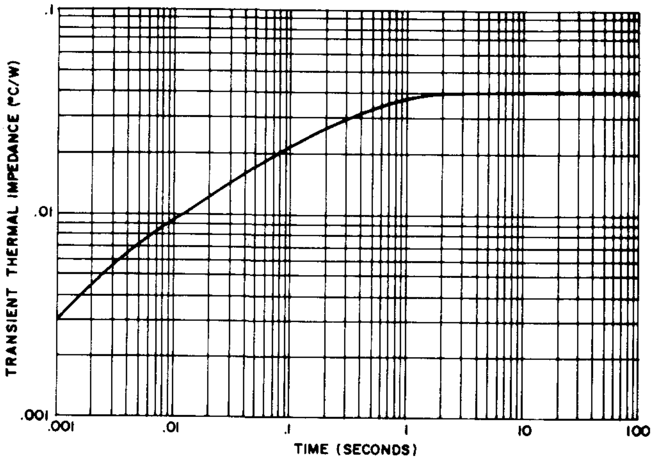
6. MAXIMUM HALF SINEWAVE ON-STATE CURRENT VS. AMBIENT TEMPERATURE WHEN USED WITH VARIOUS HEAT EXCHANGERS



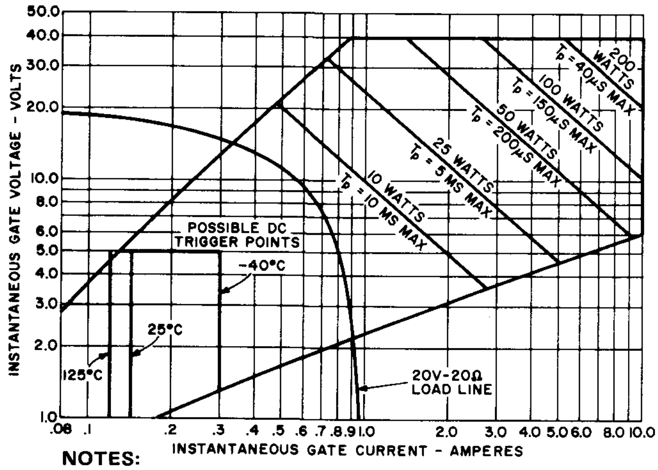
7. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE AND I^2t RATING



8. MAXIMUM ON-STATE CHARACTERISTICS



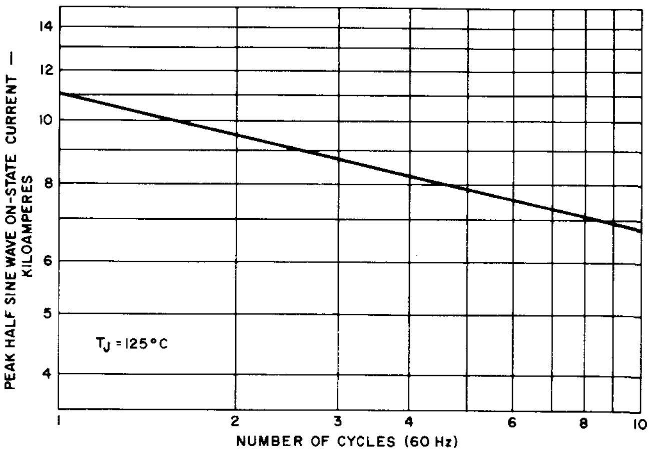
9. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE (DOUBLE-SIDE COOLED)



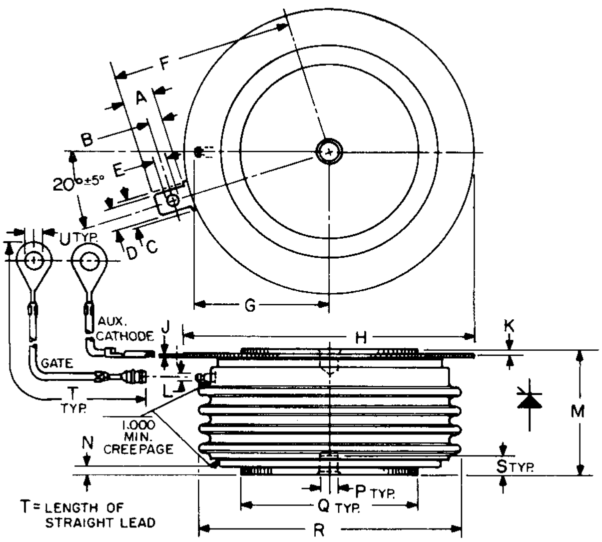
NOTES:

1. Maximum allowable average gate dissipation = 5 watts.
2. The locus of possible DC trigger points lies outside the boundaries shown at various case temperatures.
3. Tp = Rectangular Gate Current Pulse Width.

10. GATE TRIGGERING CHARACTERISTICS



11. MAXIMUM ALLOWABLE SURGE (NON-REPETITIVE) ON-STATE CURRENT



SYM	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC M.M. MIN.	METRIC M.M. MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	**.067**	**.083**	**1.702**	**2.110**
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

SUGGESTED MOUNTING METHODS FOR PRESS-PAKS TO HEAT DISSIPATORS

When the Press-Pak is assembled to a heat sink in accordance with the following general instructions, a reliable and low thermal interface will result.

1. Check each mating surface for nicks, scratches, flatness and surface finish. The heat dissipator mating surface should be flat within .0005 inch/inch and have a surface finish of 63 micro-inches.

2. It is recommended that the heat dissipator mounting surfaces be plated with nickel, tin, or silver. Bare aluminum or copper surfaces will oxidize in time resulting in excessively high thermal resistance.

3. Sand each surface **lightly** with 600 grit paper just prior to assembly. Clean off and apply silicon oil (GE SF1154, 200 centistoke viscosity) or silicone grease (GE G322L or Dow Corning DC 3, 4, 340 or 640). Clean off and apply again as a **thin** film. (A thick film will adversely affect the electrical and thermal resistances.)

4. Assemble with the specified mounting force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both top and bottom of the Press-Pak are for locating purposes only.

HEAT SINK SELECTION MADE EASY

The C441 specification sheet marks the introduction of two new characteristic curves which should greatly facilitate heat sink selection. Figures 5 and 6 plot allowable average current versus ambient temperature and case-to-ambient thermal resistance for the two most frequently encountered waveforms, 1/3 duty cycle rectangular current and 180° sinusoidal current waveforms. As soon as the average forward current and maximum ambient temperature are known, the designer can specify a heat sink thermal resistance. Note that the graphs span the range of heat sinks from water-cooled ($R_{\theta CA}$ = .03°C/W) to free-air convection ($R_{\theta CA}$ = 0.3°C/W). It is possible to linearly interpolate between the curves for $R_{\theta CA}$.

These curves have been derived from the following basic equation:

$$T_J = T_A + P_{AVG} \times R_{\theta JA}$$

where: $T_J = 125°C$

For increased reliability, the usual practice is to derate T_J 15-30 degrees. Figures 5 and 6 can perform this function by the simple expedient of raising T_A by a like amount.

ELECTRONIC INNOVATIONS IN ACTION

SEMICONDUCTORS

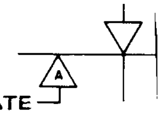
HIGH SPEED

Silicon Controlled Rectifier

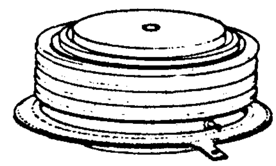
600 Volts 1100A RMS

C444 /C445

AMPLIFYING GATE

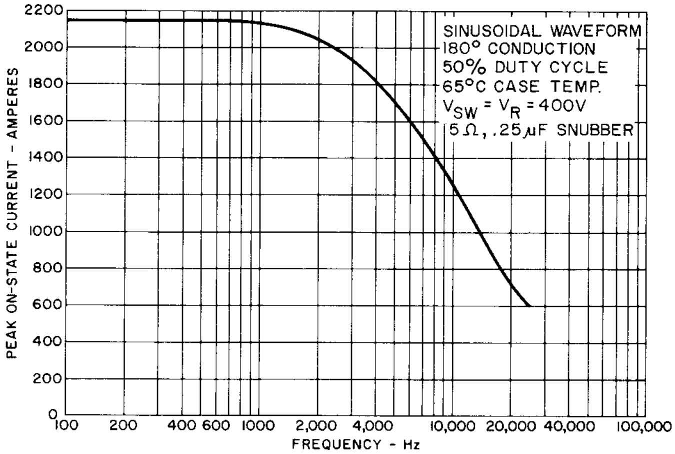


The General Electric C444 and C445 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Press-Pak devices employing the field-proven interdigitated amplifying gate system.



FEATURES:

- Interdigitated gate structure to maximize high frequency current switching capability.
- Fully characterized for operation in inverter applications.
- High di/dt ratings.
- High dv/dt capability with selections available.
- Guaranteed maximum turn-off time with selections available.
- Rugged hermetic glazed ceramic package having 1″ creepage path.



Equipment designers can use the C444/C445 SCR in demanding applications, such as:

- Choppers
- Inverters
- Regulated Power Supply
- Sonar Transmitters
- UPS
- Induction Heaters
- Cycloconverters
- DC to DC Converters
- High Frequency

FOR SINE WAVE OPERATION

Like the Types C358, C385, C388, C395 and C398, the C444/C445 SCR is Rated For:

- Peak Current
  vs.
- Pulse Width
- Frequency
- Case Temperature

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK [1] OFF-STATE VOLTAGE V_{DRM} T_J = -40°C to +125°C	REPETITIVE PEAK [1] REVERSE VOLTAGE V_{RRM} T_J = -40°C to +125°C	NON-REPETITIVE PEAK [1] REVERSE VOLTAGE V_{RSM} T_J = +125°C
C444/C445A	100 Volts	100 Volts	150 Volts
C444/C445B	200	200	300
C444/C445C	300	300	400
C444/C445D	400	400	500
C444/C445E	500	500	600
C444/C445M	600	600	720

[1] Half sinewave waveform, 10 ms max. pulse width.

Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} .... 12,000 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds .... 190,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds .... 600,000 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive† .... 800 A/μs
Critical Rate-of-Rise of On-State Current, Repetitive† .... 500 A/μs
Average Gate Power Dissipation, $P_{G(AV)}$ .... 2 Watts
Storage Temperature, T_{stg} .... -40°C to +150°C
Operating Temperature, T_J .... -40°C to +125°C
Mounting Force Required .... 3000 Lbs. + 500 Lbs. – 0 Lbs.
13.3 KN + 2.2 KN – 0 KN

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5μs short circuit trigger current rise time.

CHARACTERISTICS

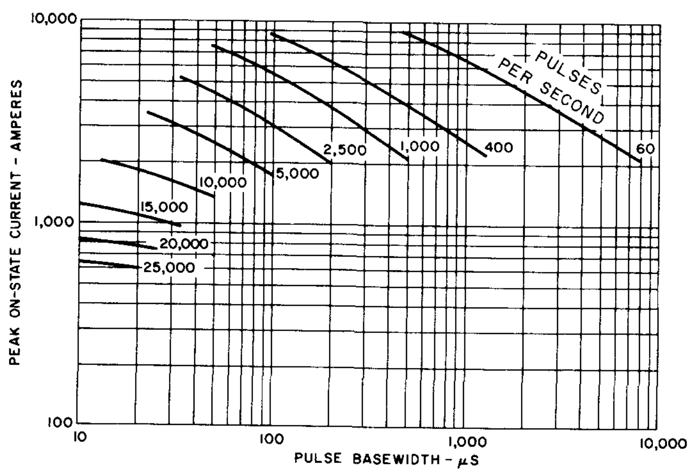
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	5	25	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{DRM} and I_{DRM}	–	20	45	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	0.04	°C/watt	Junction-to-Case – Double-Side Cooled
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	–	–	V/μsec	T_J = +125°C, Gate Open. V_{DRM} = Rated, linear or exponential waveform. Exponential dv/dt = $\frac{V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
DC Gate Trigger Current	I_{GT}	–	–	200	mAdc	T_C = +25°C, V_D = 10 Vdc, R_L = 1 ohm
		–	–	400		T_C = -40°C, V_D = 10 Vdc, R_L = 1 ohm
		–	–	150		T_C = +125°C, V_D = 10 Vdc, R_L = 1 ohm
DC Gate Trigger Voltage	V_{GT}	–	–	3.0	Vdc	T_C = +25°C to +125°C, V_D = 10 Vdc, R_L = 1 ohm
		–	–	5.0		T_C = -40°C to +25°C, V_D = 10 Vdc, R_L = 1 ohm
		0.25	–	–		T_C = 125°C, V_{DRM}, R_L = 1000 ohms

CHARACTERISTICS

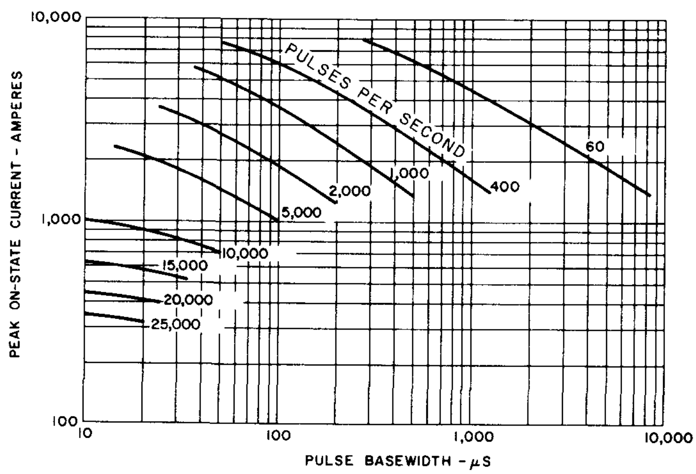
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Peak On-State Voltage	V_{TM}	–	–	2.5	Volts	T_C = +25°C, I_{TM} = 2000 Amps. peak. Duty cycle ⩽ .01%
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage) C444 C445	t_q	 – –	 – –	 10 20	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 50 Volts min. (4) V_{DRM} Reapplied (5) Rate-of-Rise of reapplied off-state voltage = 200 V/μsec (linear) (6) Communication di/dt = 25 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode) C444 C445	t_q (diode)	 – –	 15 25	 † †	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 1.5 Volts (4) V_{DRM} Reapplied (5) Rate-of-Rise of reapplied off-state voltage = 200 V/μsec (linear) (6) Commutation di/dt = 25 Amps/μsec (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms

†Consult factory for maximum turn-off time.

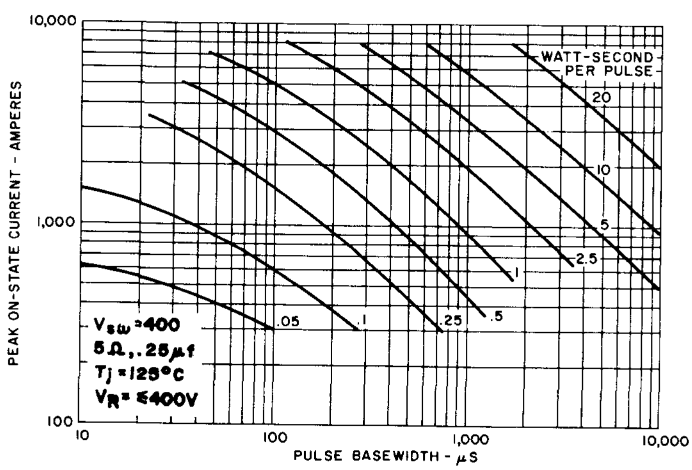
SINE WAVE CURRENT RATING DATA



1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)

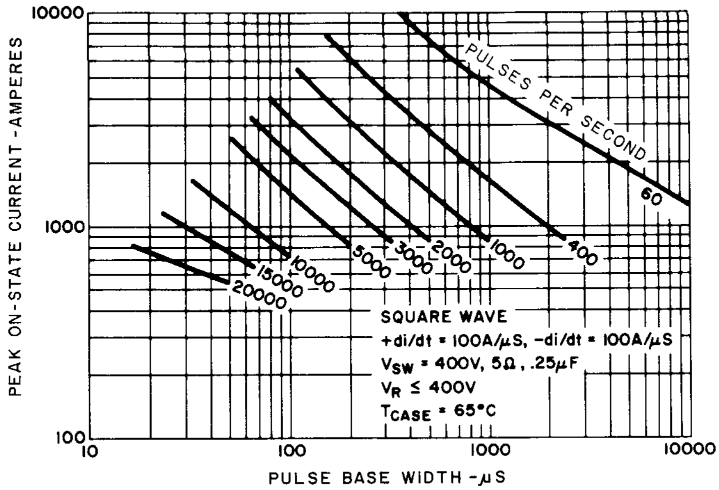


3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

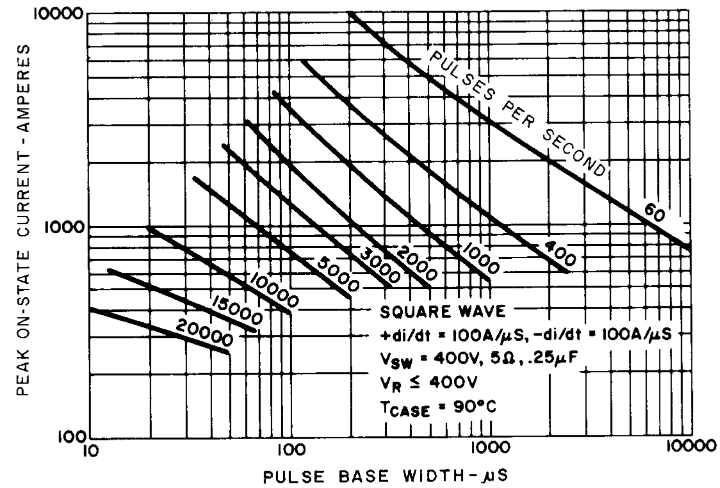
NOTES:
(Pertaining to Sine and Trapezoidal Wave Current Ratings)

1. Switching voltage ⩽ 400 volts.
2. Reverse voltage ⩽ 400 volts.
3. R-C Snubber/5Ω, .25μf
4. Double-side cooled.
5. See chart for required gate drive.

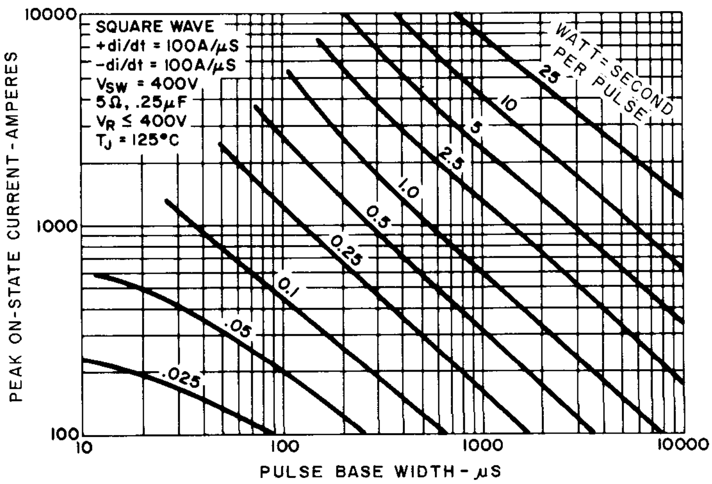
TRAPEZOIDAL WAVE CURRENT RATING



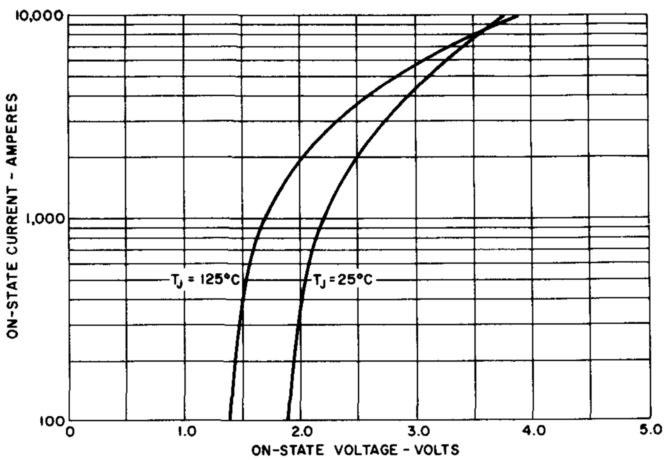
4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



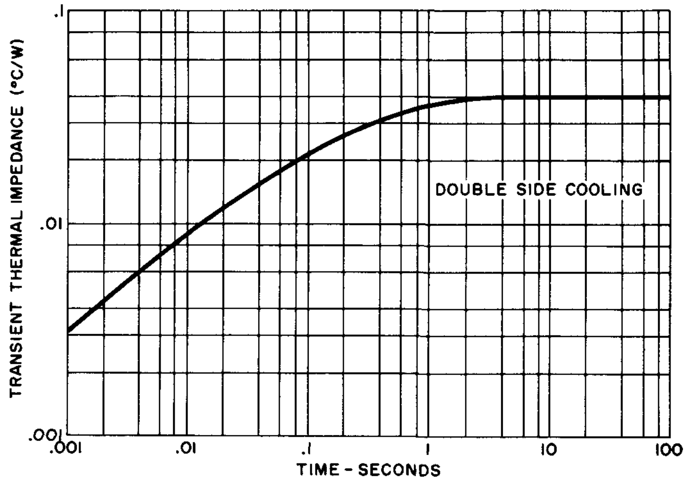
5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



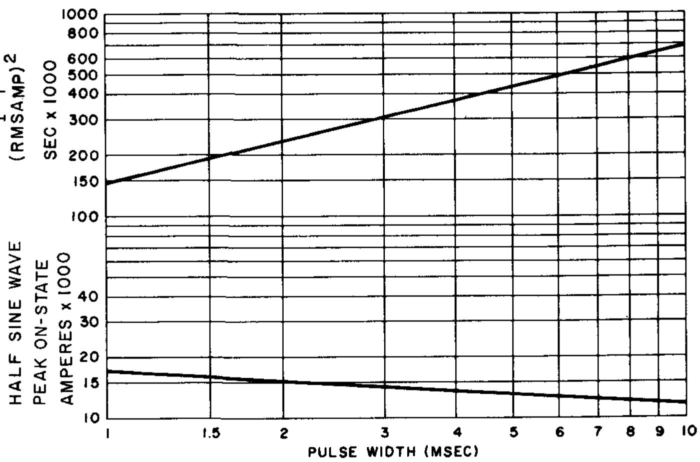
6. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH



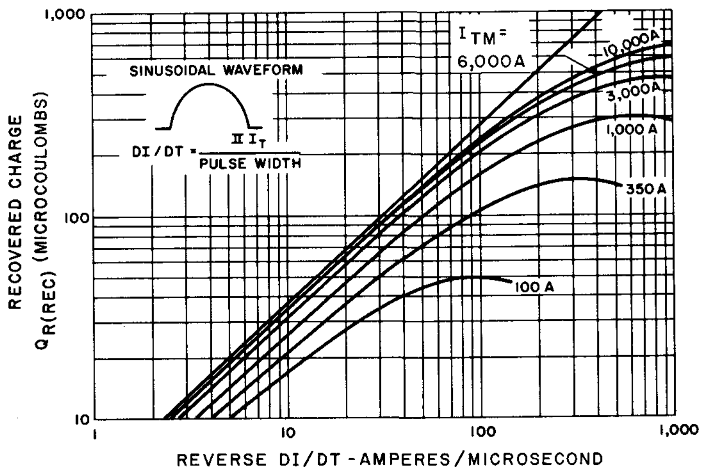
7. MAXIMUM ON-STATE CHARACTERISTICS



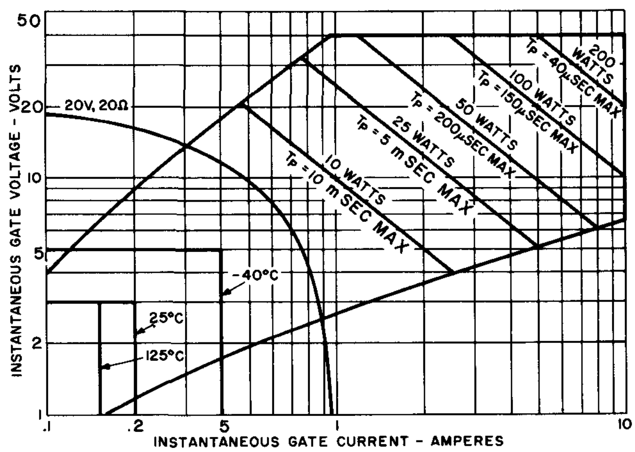
8. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



9. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



10. TYPICAL RECOVERED CHARGE (125°C)

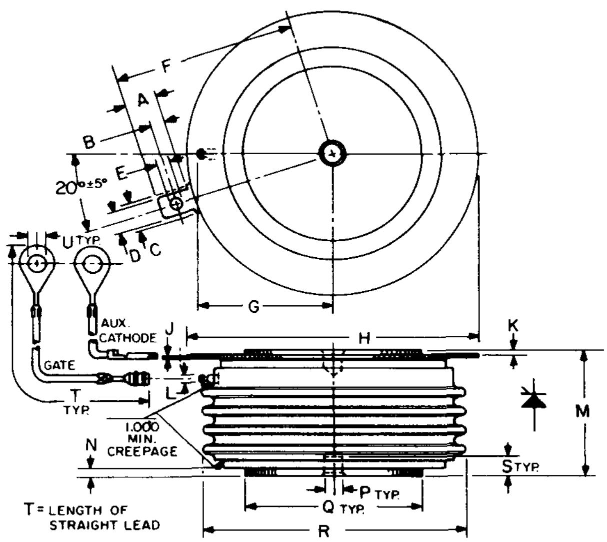


NOTES:

1. The locus of possible DC trigger points lies outside the boundaries shown at various case temperatures.
2. T_p = rectangular gate current pulse width.
3. 20V-20Ω is the minimum gate source loadline when rate of circuit current rise > 100 Amp/μsec. Maximum long-term repetitive anode di/dt = 500 Amps/μsec. with 20V-20Ω gate source.

11. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

OUTLINE DRAWING



SYM	DECIMAL INCHES MIN.	MAX.	METRIC M.M. MIN.	MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.702	2.11
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

SUGGESTED MOUNTING METHODS FOR PRESS-PAKS TO HEAT DISSIPATORS

When the Press-Pak is assembled to a heat sink in accordance with the following general instructions, a reliable and low thermal interface will result.

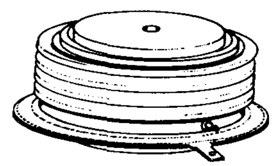
1. Check each mating surface for nicks, scratches, flatness and surface finish. The heat dissipator mating surface should be flat within .0005 inch/inches and have a surface finish of 63 micro-inches.
2. It is recommended that the heat dissipator be plated with nickel or tin. Bare aluminum or copper surfaces will oxidize in time resulting in excessively high thermal resistance.
3. Sand each surface **lightly** with 600 grit paper just prior to assembly. Clean off and apply silicon oil (GE SF1154, 200 centistoke viscosity) or silicone grease (GE G322L or Dow Corning DC 3, 4, 340 or 640). Clean off and apply again as a **thin** film. (A thick film will adversely affect the electrical and thermal resistances.)
4. Assemble with the specified mounting force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both top and bottom of the Press-Pak are for locating purposes only.

HIGH SPEED

Silicon Controlled Rectifier

1200 Volts, 1000 Amps RMS

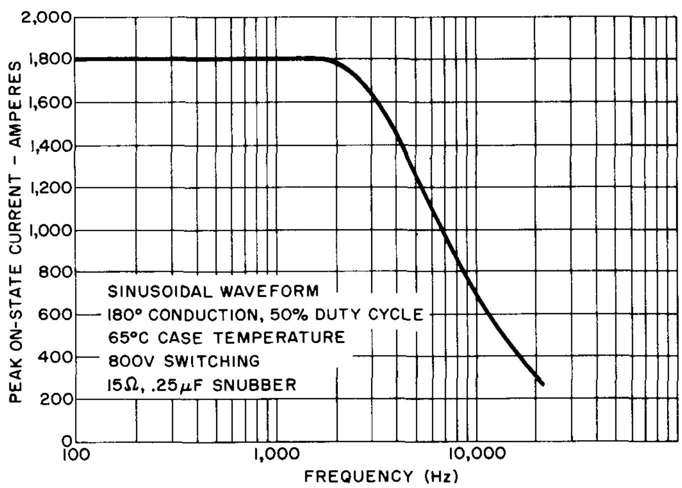
C447/C448



The General Electric C447 and C448 Silicon Controlled Rectifiers are designed for power switching at high frequencies. These are all-diffused Press-Pak devices employing the field-proven, interdigitated amplifying gate system.

FEATURES:

- Interdigitated gate structure to maximize high frequency current switching capability.
- Fully characterized for operation in inverter applications.
- High di/dt ratings.
- High dv/dt capability with selections available.
- Guaranteed maximum turn-off time with selections available.
- Rugged hermetic glazed ceramic package having 1″ creepage path.



Equipment designers can use the C447/C448 SCR in demanding applications, such as:

- Choppers
- Inverters
- Regulated Power Supplied
- Sonar Transmitters
- Induction Heaters
- Radio Transmitters
- Cycloconverters
- DC to DC Converters
- High Frequency

FOR SINE WAVE OPERATION

Like the Types C358, C385, C388, C395 and C398, the C447/C448 SCR is rated for:

- Peak Current
  vs.
- Pulse Wdith
- Frequency
- Case Temperature

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C447/C448E	500 Volts	500 Volts	600 Volts
C447/C448M	600	600	720
C447/C448S	700	700	840
C447/C448N	800	800	960
C447/C448T	900	900	1080
C447/C448P	1000	1000	1200
C447/C448PA	1100	1100	1300
C447/C448PB	1200	1200	1400

[1] Half sinewave waveform, 10 ms max. pulse width.

Peak One-Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} . . . . 10,000 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds . . . . 190,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds . . . . 415,000 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, (Non-Repetitive)† . . . . 800 A/μs
Critical Rate-of-Rise of On-State Current, (Repetitive)† . . . . 500 A/μs
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force . . . . 3000 Lb. + 500 Lb. – 0 Lb.
13.3 Kn + 2.2 Kn – 0 Kn

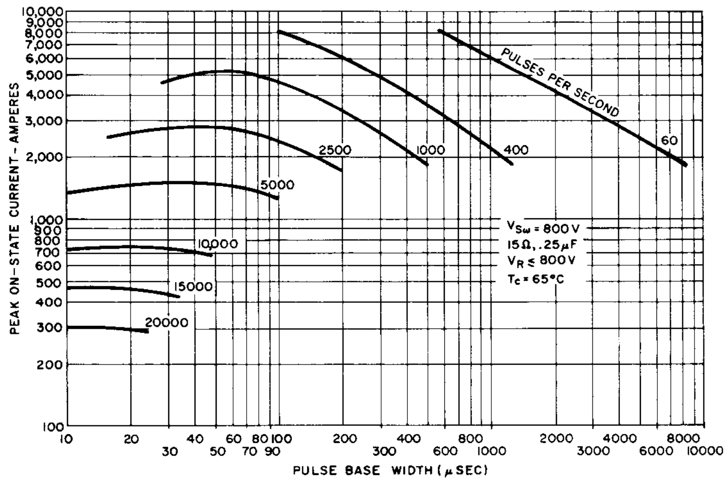
† di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms, gate trigger source with 0.5μs short circuit trigger current rise time.

CHARACTERISTICS

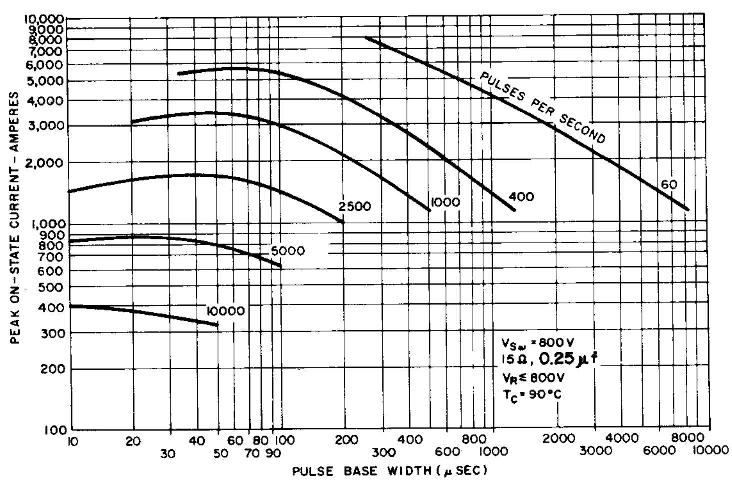
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	5	25	mA	T_C = +25°C V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	20	45	mA	T_C = +125°C V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	0.04	°C/Watt	Junction-to-Case, Double-Side Cooled
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	400	500	–	V/μsec	T_J = +125°C, Gate Open. 80% of V_{DRM} Reapplied, Linear or Exponential Rising Waveform. Exponential dv/dt = $\frac{0.8\ V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
DC Gate Trigger Current	I_{GT}	–	–	200	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	400		T_C = -40°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	150		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
DC Gate Trigger	V_{GT}	–	–	3.0	Vdc	T_C = 25°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	5.0		T_C = -40°C to 25°C, V_D = 6 Vdc, R_L = 3 Ohms
		0.25	–	–		T_C = 125°C, V_{DRM}, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	2.9	Volts	T_C = +25°C, I_{TM} = 2000 Amps. Peak. Duty Cycle ⩽ .01 %
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage) C448 C447	t_q	 – –	 – –	 25 40	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 50 Volts Min. (4) 80% of V_{DRM} Reapplied (5) Rate-of-Rise of Reapplied Off-State Voltage = 400 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms.
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode) C448 C447	$t_{q(diode)}$	 – –	 25 40	 † †	μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 1.5 Volts (4) 80% of V_{DRM} Reapplied (5) Rate-of-Rise of Reapplied Off-State Voltage = 400 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec (7) Repetition Rate = 1 pps (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms

† Consult factory for maximum turn-off time.

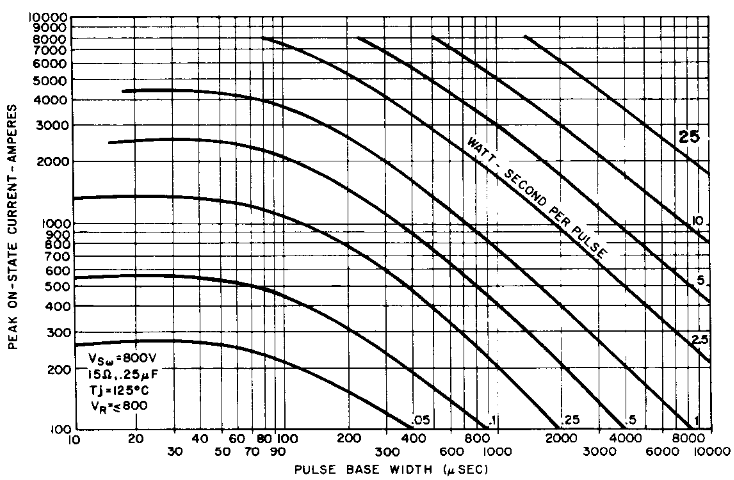
SINEWAVE CURRENT RATING DATA



1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)

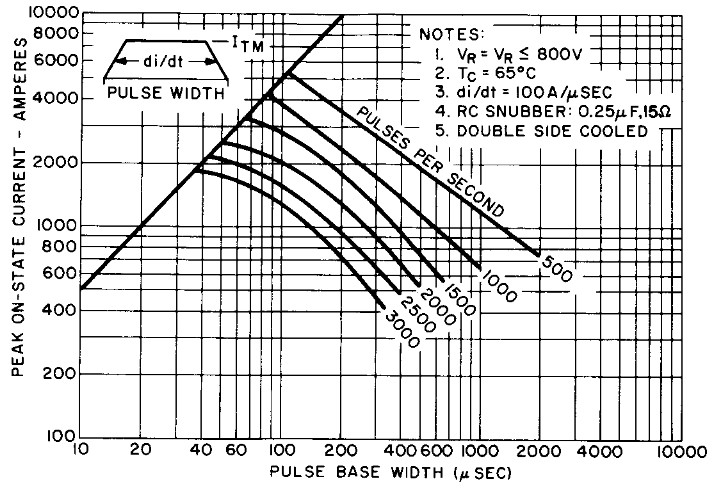


3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

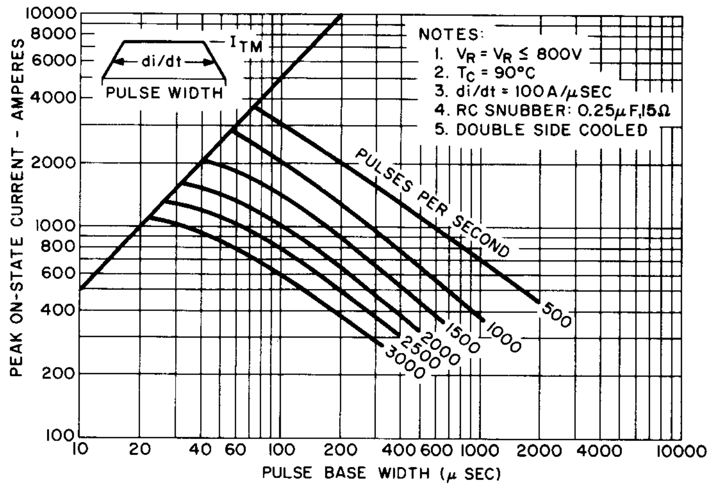
NOTES:

1. Switching Voltage ≤ 800 Volts.
2. Reverse Voltage Applied = V_R ≤ 800 Volts.
3. R-C Snubber Circuit = .25μf, 15Ω
4. Double-Side Cooled.

TRAPEZOIDAL WAVE CURRENT DATA



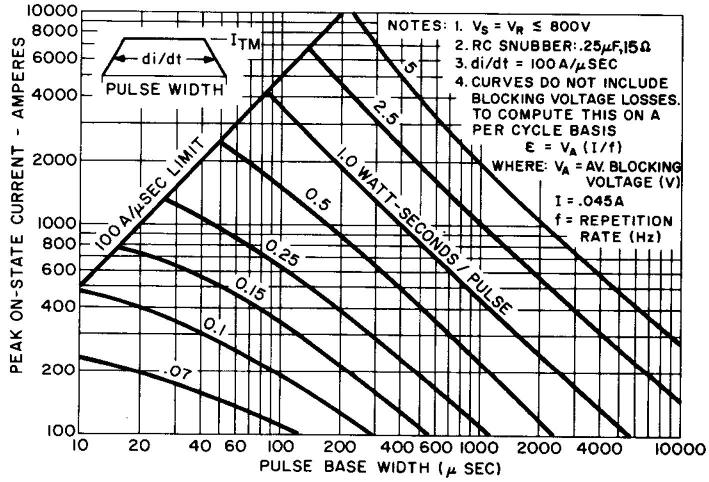
4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PEAK WIDTH (T_C = 90°C)

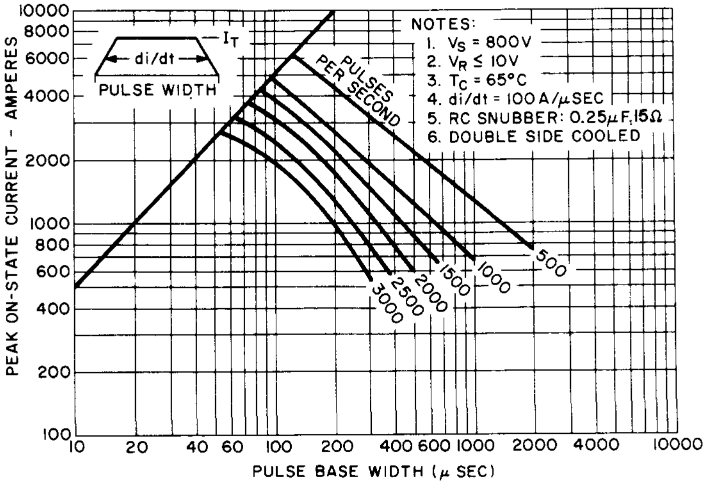
NOTES:

1. Switching Voltage ≤ 800 Volts.
2. Reverse Voltage ≤ 800 Volts.
3. R-C Snubber Circuit = 15Ω, .25
4. Double-Side Cooled

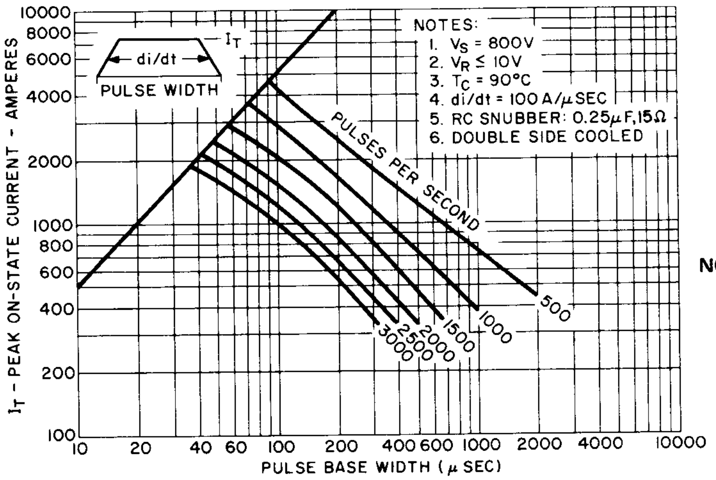


6. ENERGY PER PULSE FOR TRAPEZOIDAL PULSES

TRAPEZOIDAL WAVE CURRENT DATA



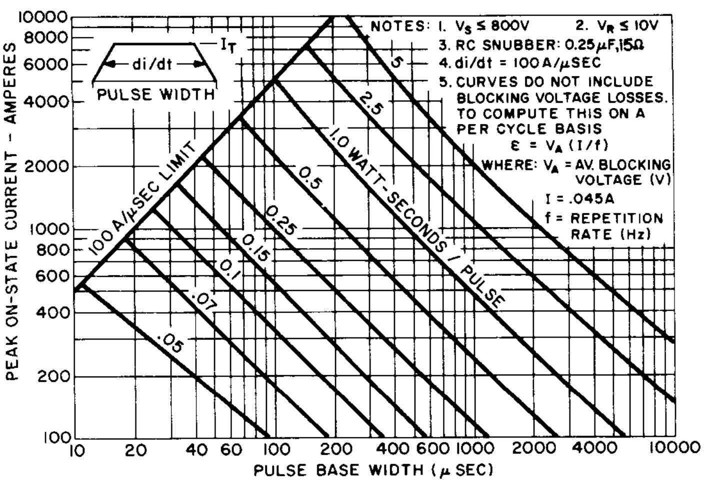
7. MAXIMUM ALLOWABLE ON-STATE CURRENT VS. PULSE WIDTH WITH ANTI-PARALLEL DIODE (T_C = 65°C)



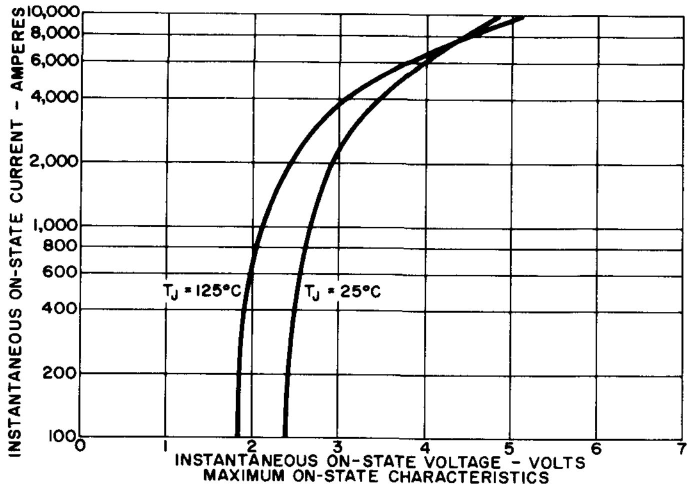
8. MAXIMUM ALLOWABLE ON-STATE CURRENT VS. PULSE WIDTH WITH ANTI-PARALLEL DIODE (T_C = 90°C)

NOTES:

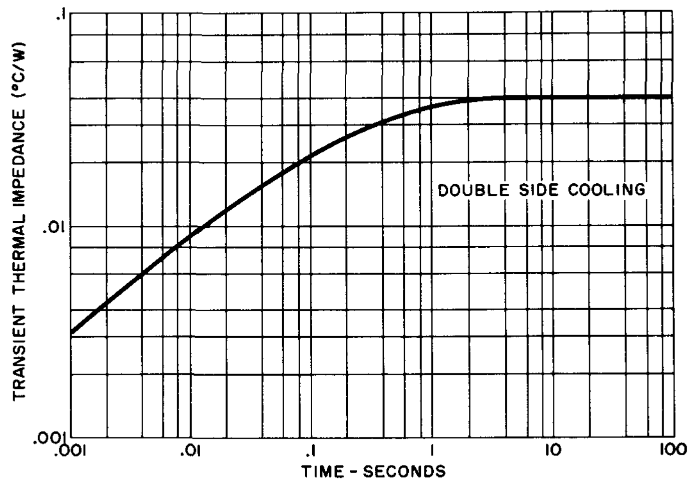
1. Switching Voltage ⩽ 800 Volts.
2. Reverse Voltage ⩽ 10Volts.
3. R-C Snubber Circuit = 15Ω, .25μf
4. Double-Side Cooled



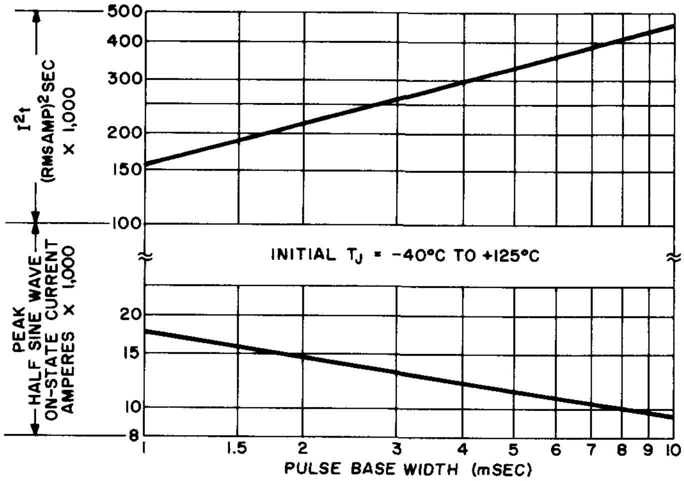
9. ENERGY PER PULSE FOR SINUSOIDAL PULSES WITH ANTI-PARALLEL DIODE



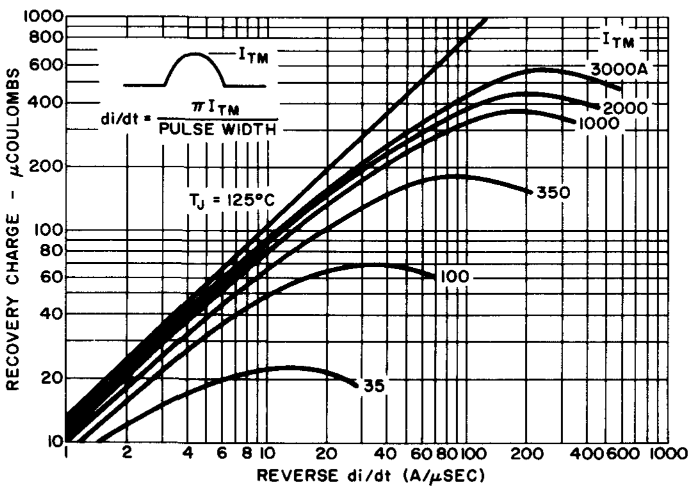
10. ON-STATE CONDUCTION CHARACTERISTIC



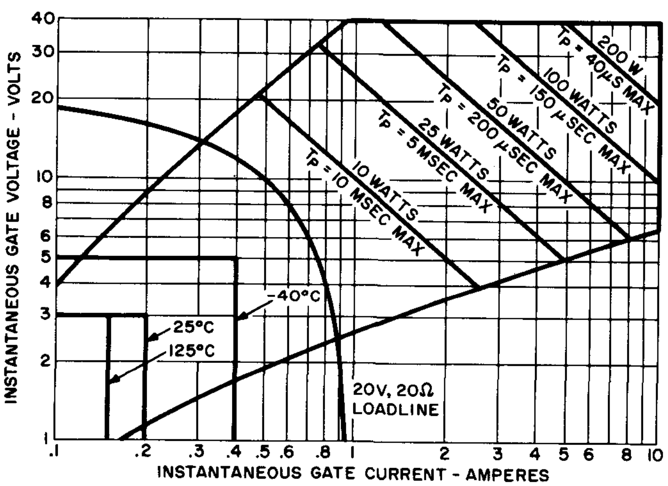
11. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



12. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



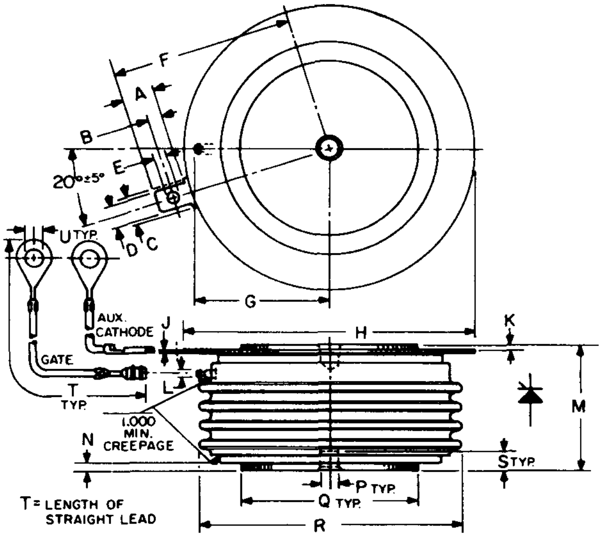
13. TYPICAL RECOVERED CHARGE (125°C)



NOTES:

1. The locus of possible dc trigger points lies outside the boundaries shown at various case temperatures.
2. T_P = rectangular gate current pulse width.
3. 20V – 20 is the minimum gate source load line when rate of circuit current rise > 100 amp/μs. Maximum long term repetitive anode di/dt = 500 amps/μs with 20V – 20Ω gate source.

14. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS



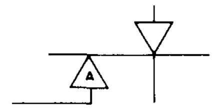
SYM	DECIMAL INCHES MIN.	MAX.	METRIC M.M. MIN.	MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.702	2.11
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

OUTLINE DRAWING

HIGH SPEED
Silicon Controlled Rectifier

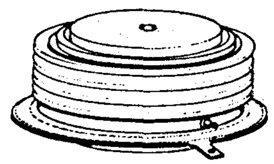
C449

1800 VOLTS 850 A RMS



AMPLIFYING GATE

The General Electric C449 Silicon Controlled Rectifier is designed for power switching at high frequencies. This is an all-diffused Press-Pak device employing the field-proven interdigitated amplifying gate system.



FEATURES:

- Interdigitated Gate Structure to Maximize High Frequency Current Switching Capability.
- Fully Characterized for Operation in Inverter Applications.
- High di/dt Ratings.
- High dv/dt Capability with Selections Available.
- Guaranteed Maximum Turn-Off Time with Selections Available.
- Rugged Hermetic Glazed Ceramic Package Having 1″ Creepage Path.

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK REVERSE VOLTAGE, V_{RRM}[1] T_J = -40°C to +125°C	NON-REPETITIVE PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = +125°C
C449PN	1800 Volts	1800 Volts	2040 Volts
C449PS	1700	1700	1920
C449PM	1600	1600	1790
C449PE	1500	1500	1700

[1] Half sinewave waveform, 10 ms max. pulse width.
Consult factory for lower rated voltage devices.

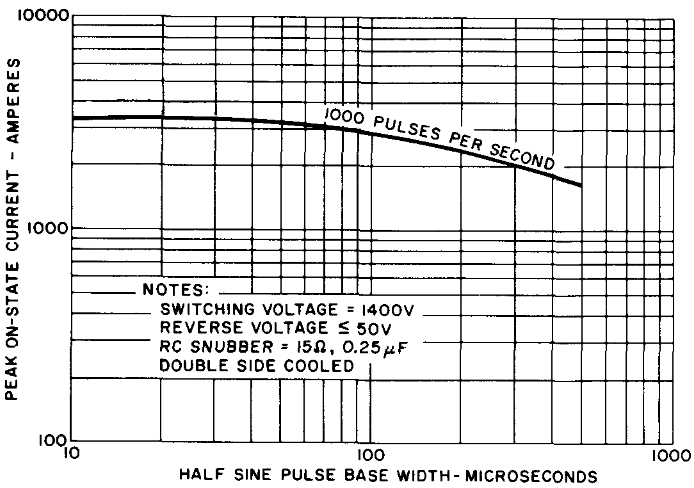
Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM}	6,500 Amperes
Critical Rate-of-Rise of On-State Current, Non-Repetitive†	500 A/μs
Critical Rate-of-Rise of On-State Current, Repetitive†	300 A/μs
Average Gate Power Dissipation, $P_{G(AV)}$	5 Watts
Storage Temperature, T_{stg}	-40°C to +150°C
Operating Temperature, T_J	-40°C to +125°C
Mounting Force Required	3000 Lb. + 500 Lb. – 0 Lb. 13.3 KN + 2.2 KN – 0 KN

†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of 80% max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5μs short circuit trigger current rise time

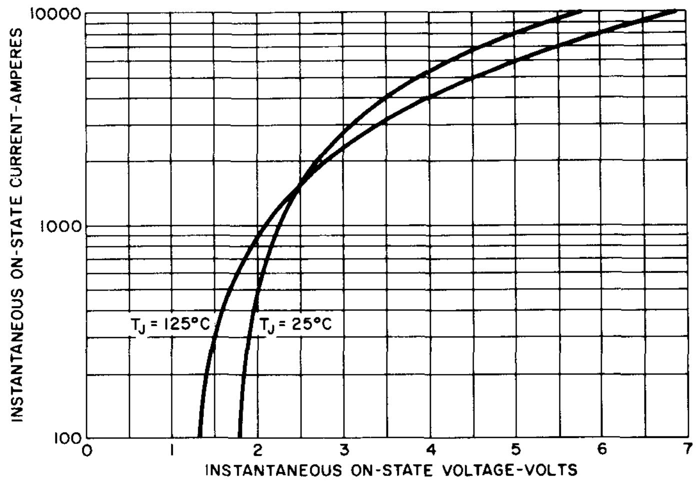
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Repetitive Peak Reverse and On-State Current	I_{RRM} and I_{DRM}	–	10	25	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Blocking Current	I_{RRM} and I_{DRM}	–	45	60	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	.04	°C/Watt	Junction-to-Case – Double-Side Cooled
Critical Linear Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	200	–	–	V/μsec	T_J = +125°C, V_{DRM} =.80 Rated, Gate Open. Exponential or linear rising waveform. Exponential di/dt = .8V_{DRM} (.632)/τ
Higher minimum dv/dt selections available – consult factory.						
Gate Trigger Current	I_{GT}	–	–	200	mAdc	T_C = +25°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	150		T_C = +125°C, V_D = 6 Vdc, R_L = 3 Ohms
Gate Trigger Voltage	V_{GT}	–	–	3	Vdc	T_C = 25°C to +125°C, V_D = 6 Vdc, R_L = 3 Ohms
		–	–	5		T_C = -40°C to 25°C, V_D = 6 Vdc, R_L = 3 Ohms
Peak On-State Voltage	V_{TM}	–	–	2.8	Volts	T_C = 25°C, I_T = 2000 Amps. Peak. Duty Cycle ⩽ 0.01%.
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q				μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R ⩾ 50 Volts (4) 80% of V_{DRM} Reapplied (5) Rate-of-Rise of Off-State Voltage = 200 V/μsec. (6) Gate Bias = Open During Turn-Off Interval, 0 Volts, 100 Ohms (7) Duty Cycle ⩽ .01%
C449 – 60		–	–	60		
C449 – 40		–	–	40		
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	t_q				μsec	(1) T_C = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 2 Volts, Minimum (4) 80% of V_{DRM} Reapplied (5) Rate-of-Rise of Off-State Voltage = 200 V/μsec. (6) Gate Bias = Open During Turn-Off Interval (7) Duty Cycle ⩽ .01%
C449 – 60		–	60	†		
C449 – 40		–	40	†		

†Consult factory for maximum turn-off time.

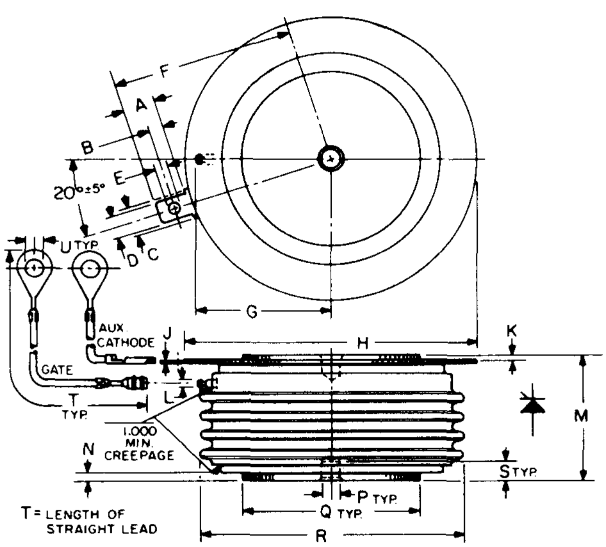


1. PEAK ON-STATE CURRENT VS. PULSE WIDTH FOR T_C = 65°C



2. MAXIMUM ON-STATE CHARACTERISTICS

OUTLINE DRAWING



SYM	DECIMAL INCHES MIN.	MAX.	METRIC M.M. MIN.	MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.702	2.11
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

SUGGESTED MOUNTING METHODS FOR PRESS-PAKS TO HEAT DISSIPATORS

When the Press-Pak is assembled to a heat sink in accordance with the following general instructions, a reliable and low thermal interface will result.

1. Check each mating surface for nicks, scratches, flatness and surface finish. The heat dissipator mating surface should be flat within .0005 inch/inches and have a surface finish of 63 micro-inches.

2. It is recommended that the heat dissipator mounting surfaces be plated with nickel, tin, or silver. Bare aluminum or copper surfaces will oxidize in time resulting in excessively high thermal resistance.

3. Sand each surface **lightly** with 600 grit paper just prior to assembly. Clean off and apply silicon oil (GE SF1154, 200 centistoke viscosity) or silicone grease (GE G322L or Dow Corning DC 3, 4, 340 or 640). Clean off and apply again as a **thin** film. (A thick film will adversely affect the electrical and thermal resistances.)

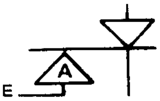
4. Assemble with the specified mounting force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both top and bottom of the Press-Pak are for locating purposes only.

SCR

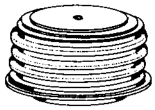
C501

550 A Avg. up to 1800 V

AMPLIFYING GATE



The C501 Series of high power devices feature the proven, multi-diffused construction in a new, larger, pressure-mounted package.



FEATURES:

- Short Delay Time
- Pressure Contacts
- Glazed Ceramic Package with 1″ Creepage Path
- Reversibility (eliminates need for special reverse polarity units)
- Hermetic Seal
- Available in Factory Assembled Heat Exchangers or Ready-to-Mount
- Higher di/dt Rating

IMPORTANT: Mounting instructions on the last page of this specification **must** be followed.

MAXIMUM ALLOWABLE RATINGS

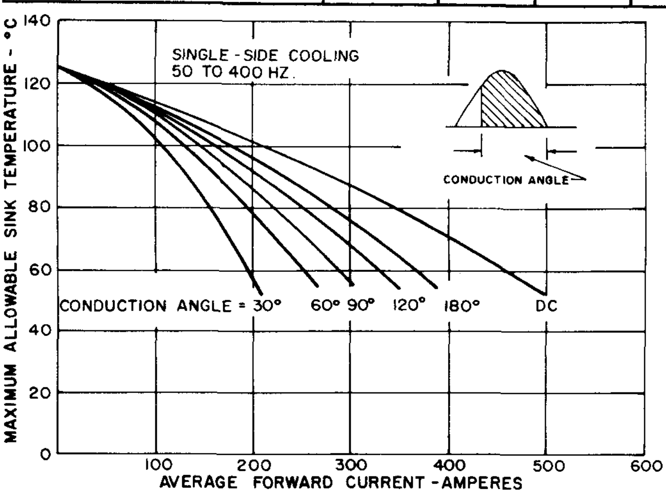
TYPE	REPETITIVE PEAK OFF-STATE AND REVERSE VOLTAGE, V_{DRM}/V_{RRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK OFF-STATE AND REVERSE VOLTAGE, V_{DRM}/V_{RRM}[1] T_J = 0°C to +125°C	TRANSIENT PEAK REVERSE VOLTAGE (NON-RECURRENT < 5 MSEC.), V_{RSM} T_J = -40°C to +125°C
C501S	700 Volts	800 Volts	800 Volts
C501N	800	900	900
C501T	900	1000	1000
C501P	1000	1100	1100
C501PA	1100	1200	1200
C501PB	1200	1300	1300
C501PC	1300	1400	1400
C501PD	1400	1500	1500
C501PE	1500	1600	1600
C501PN	1600	1700	1700
C501PS	1700	1800	1800

Average Forward Current, On-State . . . . Depends on Conduction Angle (See Charts 1 and 3)
Peak One-Cycle Surge On-State Current, I_{TSM} . . . . 8000 Amperes
Maximum Rate-of-Rise of Anode Current Turn-On Interval (See Chart 11)
(Switching Rates ≤ 60 Hz) . . . . Switch From < 500V 175A/μsec
. . . . Switch From <1000V 100A/μsec
. . . . Switch From <1300V 80A/μsec
I^2t (for fusing) (for times ≥ 1.5 milliseconds) . . . . 130,000 Ampere² Seconds
I^2t (for fusing) (at 8.3 milliseconds) . . . . 260,000 Ampere² Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 25 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 5 Watts
Peak Reverse Gate Voltage, V_{GRM} . . . . 5 Volts
Storage Temperature, T_{STG} . . . . -40°C to +125°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force Required . . . . 2200 Lbs. ± 10%
8.9 KN ± 10%

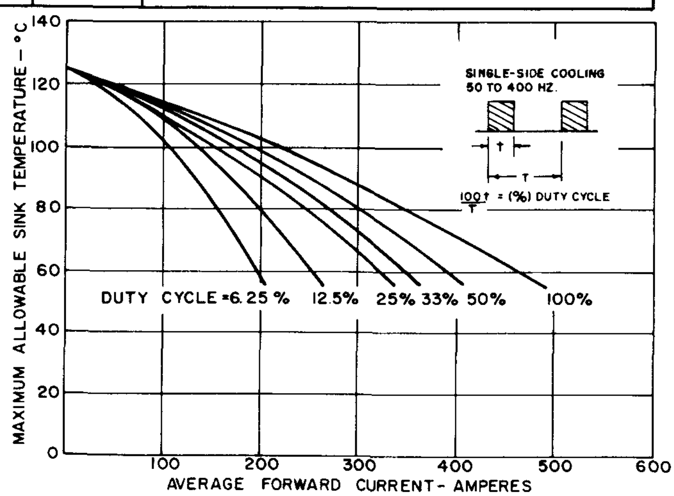
[1] Assumes heat dissipator thermal resistance less than 1°C/W.

CHARACTERISTICS

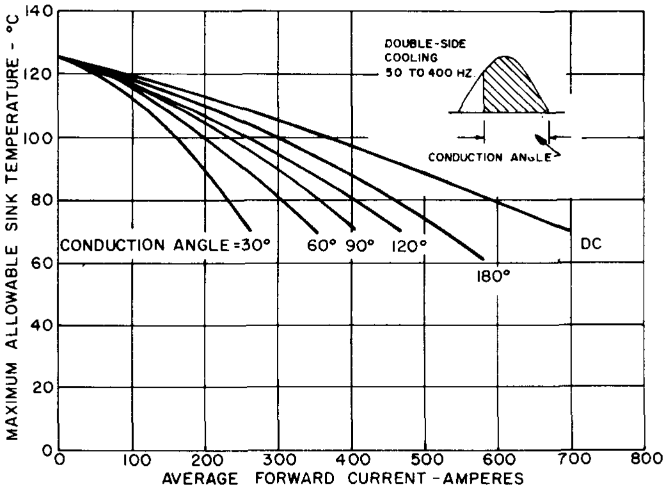
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{DRM} and I_{RRM}	–	1.0	15	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Peak Reverse and On-State Blocking Current	I_{DRM} and I_{RRM}	–	15	35	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Effective Thermal Resistance. Junction-to-Case	$R\theta_{JC}$	–	–	.05	°C/Watt	Junction-to-Case – Double Side Cooling (DC)
Critical Exponential Rate-of-Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	100	–	–	V/μsec	T_J = +125°C, V_{DRM} = 0.8 Rated, Gate Open.
Holding Current	I_H	–	100	250	mAdc	T_C = +25°C, Anode supply = 20 Vdc. Initial forward current = 500 amps.
Latching Current	I_L	–	–	1	Adc	T_C = +25°C, Anode supply = 24 Vdc, Load resistance 12 ohms max.
Delay Time	t_d	–	1.5	3	μsec	T_C = +25°C, Bias voltage = 960V, Gate supply: 20V, 10 ohms, 0.5 μsec max. rise time.
Gate Pulse Width Necessary to Trigger		–	–	10	μsec	T_C = +25°C. Gate Supply: 10 volt open circuit, 5 ohm, 0.1 μsec rise time.
Gate Trigger Current	I_{GT}	–	–	150	mAdc	T_C = +25°C, V_D = 10 Vdc, R_L = 3 ohms
		–	–	225		T_C = -40°C, V_D = 10 Vdc, R_L = 3 ohms
		–	5	75		T_C = +120°C, V_D = 10 Vdc, R_L = 3 ohms
Gate Trigger Voltage	V_{GT}	–	–	6.5	Vdc	T_C = -40°C to +125°C, V_D = 10 Vdc, R_L = 3 ohms
		0.15	–	–		T_C = +125°C, V_D = Rated, R_L = 1000 ohms
Peak On-State Voltage	V_{TM}	–	–	1.53	Volts	T_C = +25°C, I_T = 1000 amps. peak. Duty cycle ⩽ 0.01%
Circuited Commutated Turn-Off Time	t_q	–	300	200	μsec	(1) T_C = +125°C (2) I_T = 450 Amps. (3) V_R = 75 Volts min. (4) 0.5 V_{DRM} Reapplied (5) Rate-of-rise of reapplied forward blocking voltage = 25V/μsec (linear) (6) Gate bias during turn-off interval, Duty cycle ⩽ 0.01%



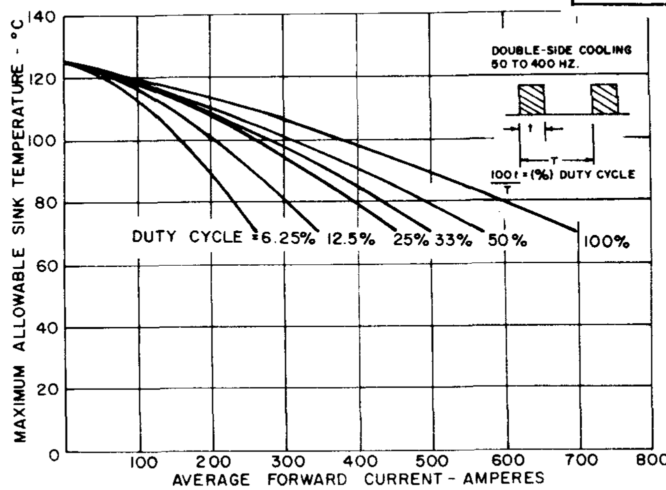
1. MAXIMUM ALLOWABLE SINK TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM (SINGLE-SIDE COOLED)



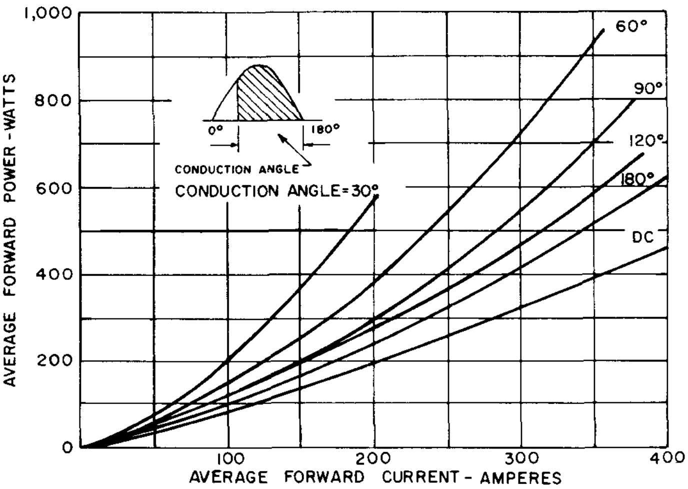
2. MAXIMUM ALLOWABLE SINK TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM (SINGLE-SIDE COOLED)



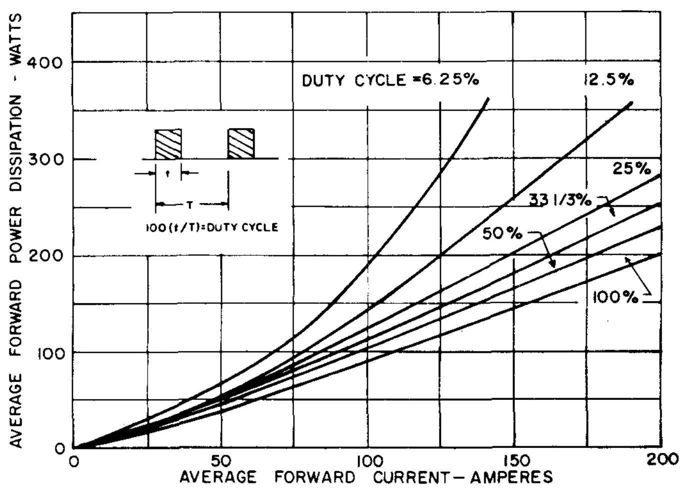
3. MAXIMUM ALLOWABLE SINK TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM (DOUBLE-SIDE COOLED)



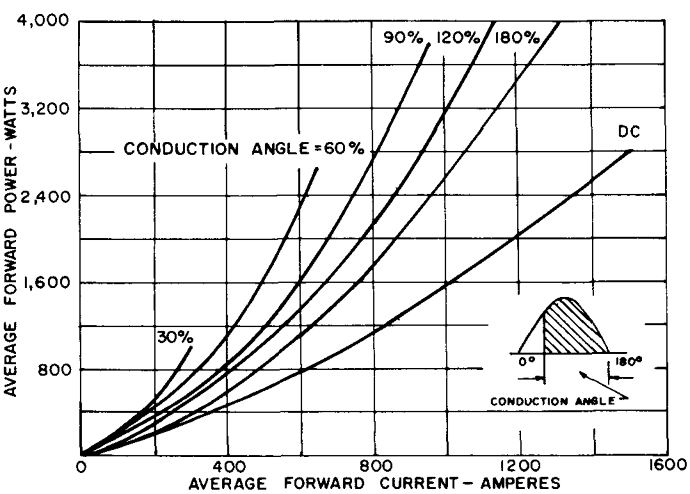
4. MAXIMUM ALLOWABLE SINK TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM (DOUBLE-SIDE COOLED)



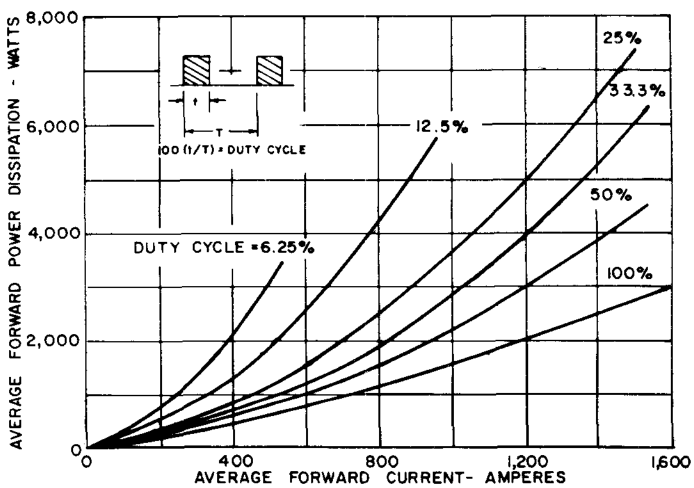
5. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



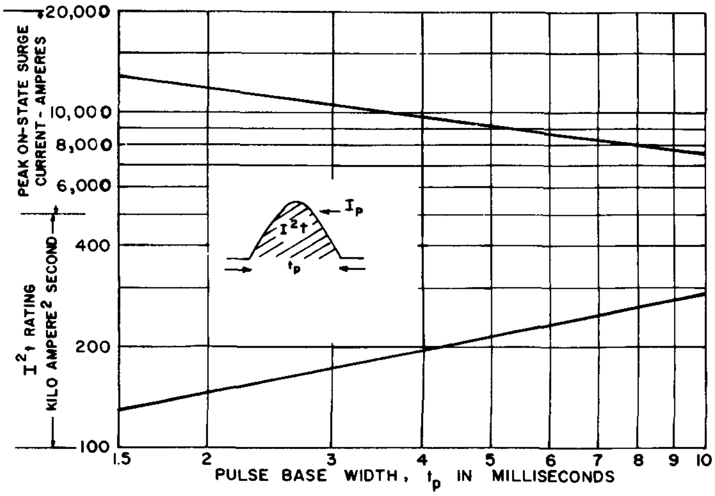
6. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



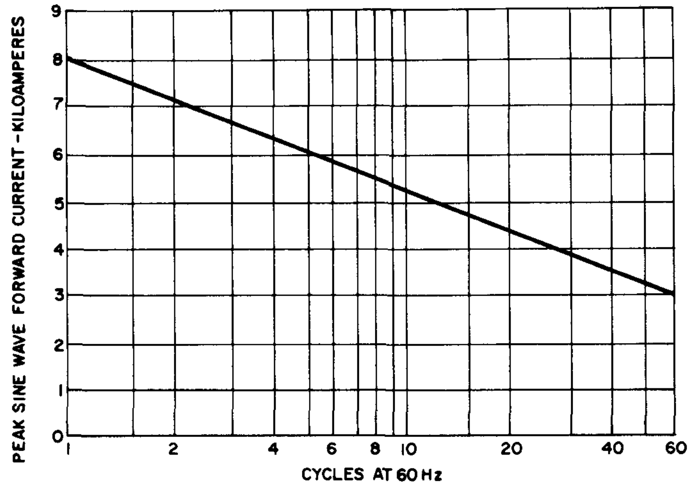
7. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



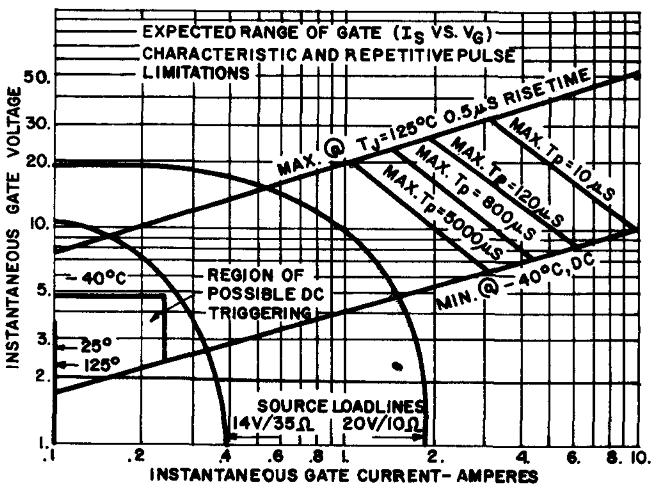
8. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



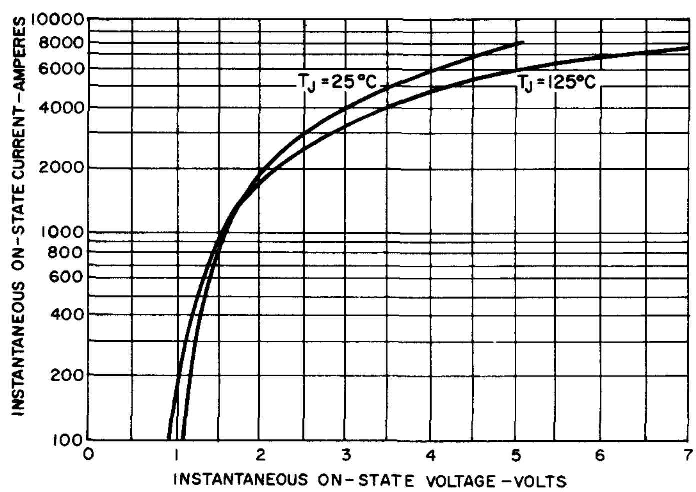
9. SUB-CYCLE SURGE AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS



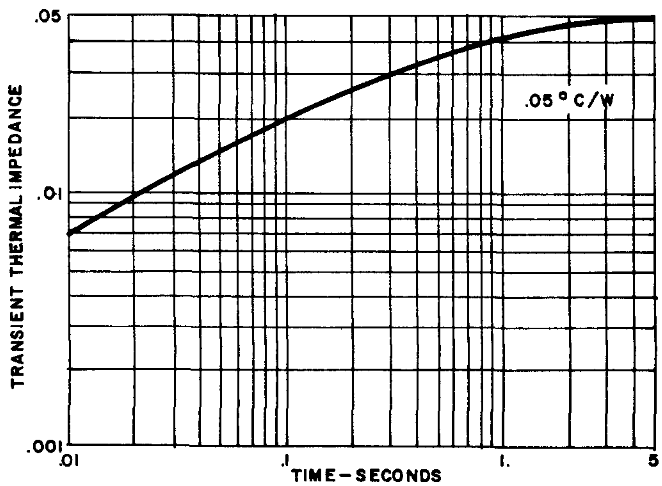
10. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



11. GATE TRIGGERING CHARACTERISTICS



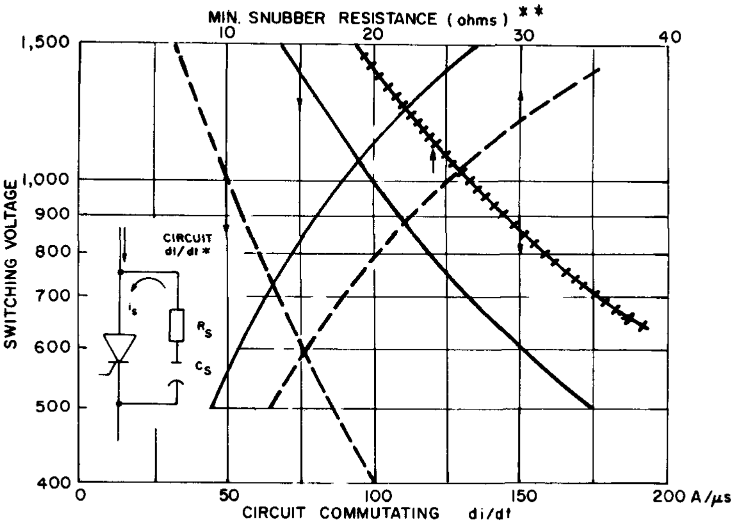
12. FORWARD CONDUCTION CHARACTERISTIC (ON-STATE)



13. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE

NOTES:

1. Add .01°C/W to account for both case to dissipator interfaces when properly mounted; e.g., $R\theta_{JS}$ = .06°C.
2. DC Thermal Impedance is based on average full cycle junction temperature. Instantaneous junction temperature may be calculated using the following modifications:
   - end of conducting portion of cycle
     – 120° sq. wave add .0065°C/W along entire curve
     – 180° sq. wave add .0047°C/W along entire curve
     – 180° sine wave add .0026° C/W along entire curve
   - end of full cycle
     – any wave, subtract .0026°C/W along entire curve



NOTES:

Code:

++++	Non-Repetitive High Gate Drive
———	Repetitive High Gate Drive
— —	Non-Repetitive Low Gate Drive
– – –	Repetitive Low Gate Drive

	Low Gate Drive	High Gate Drive
Source	14V/35 ohms	20V/10 ohms
Pulse Width, t_p	$\geqslant$ 20 µs	$\geqslant$ 10 µs
Current Rise Time, t_r	$\leqslant$ 2	$\leqslant$ 0.5 µs

*Permissible circuit di/dt excluding snubber discharge. Repetitive di/dt is recommended maximum condition to achieve most industrial requirements for service life. It meets or exceeds the JEDEC test requirements for certification set forth in NEMA Std. Sk. 516 (1972). Non-repetitive di/dt meets the JEDEC 5 sec. rating.

**Snubber discharge, i_s, is treated separately using the minimum value of snubber resistance indicated above. This applies for long industrial life (20 — 30 years) in combination with circuit di/dt.

14. ALLOWABLE REPETITIVE AND NON-REPETITIVE IN-RUSH CURRENT (DI/DT*) AND REQUIRED SNUBBER RESISTANCE FOR VARYING LEVELS OF SWITCHING VOLTAGE

OUTLINE DRAWING

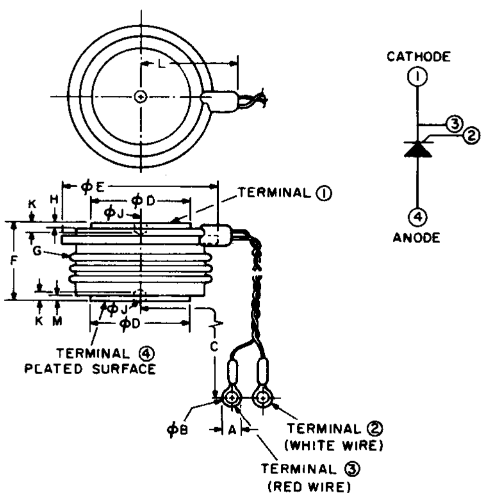


TABLE OF DIMENSIONS
Conversion Table

SYM.	DECIMAL INCHES		METRIC MM		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.200	0.240	5.08	6.10	
φ B	0.140	–	3.56	–	
C	16.000	20.000	406.40	508.00	
φ D	1.240	1.260	31.50	32.00	
φ E	–	2.000	–	50.80	
F	1.000	1.060	25.40	26.92	
G	–	–	–	–	1
H	.025	–	0.64	–	
φ J	0.136	0.146	3.45	3.71	
K	.080	–	2.03	–	
L	–	2.000	–	50.80	
M	.036	–	0.91	–	

NOTES:

1. Glazed Ceramic Insulator With 1.00 Inch Minimum Surface Creepage. (25.40 MM)

C501
ASSEMBLY OF PRESSPAKS TO HEAT DISSIPATORS

The following instruction is essential for maintaining low, stable thermal and electrical resistances associated with the Presspak to heat dissipator surfaces.

1. INSPECTION OF MATING SURFACES

Check each mating surface for nicks, scratches, flames and surface finish. The Presspak surface has a total indicator reading TIR $<$ .0005 inch and surface $\overset{32}{\vee}$ finish prior to factory electrical test in pressure fixtures. The dissipator surface should be equally as good. The TIR of a fully tested Presspak may run higher but not exceed .001 inch not including some minor nicks and scratches also associated with test fixtures. (Recommended mounting force is based upon these requirements.)

2. SURFACE DEOXIDATION AND CLEANING

Although plated surfaces are recommended for aluminum and copper heat dissipators, bare surfaces may be used if careful attention to cleaning and treating is assured. Plated surfaces and Presspaks should be *lightly sanded* with 600 grit paper, then oil or compound applied as recommended. Unplated surfaces should be vigorously abraided with a fine wire brush or 3M "Scotchbrite" coated with Alcoa #2 compound. The Alcoa #2 should be removed and the recommended compound applied.

3. FINAL SURFACE TREATMENT [a] [b]

Apply silicone oil or *thin layer* of grease or compound as indicated below. Rotate the Presspak to properly distribute the applied agent.

- bare copper – use G322L or LS2037*;
- bare aluminum – use Alcoa #2 or G322L;
- tin-plated copper or aluminum – use SF1154 preferably, or G623 or G322L;
- nickle-plated aluminum – use SF1154 or G623;
- silver-plating is not recommended.

4. MOUNTING

Assemble with specified mounting force applied through a self-leveling swivel connection. The force has to be evenly distributed over the full area. Center holes on top and bottom of the Presspak are for locating.

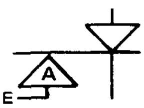
NOTES:

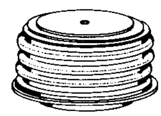
a) Silicone oil SF1154, 200 centistoke, clear silicone grease G623, and yellow compound G322L are products of the General Electric Company; compound Alcoa #2 is a product of Aluminum Company of America; and LS2037 black compound is product of Arco Company, 7301 Bessemer Avenue, Cleveland, Ohio.

b) Limit maximum joint temperature to 95°C, except for those prepared with SF1154 or G322L, which are limited to 150°C.

High Power
Silicon
Controlled Rectifier
550 A Avg. Up To 2200 Volts

C502

AMPLIFYING GATE




The General Electric C502 Silicon Controlled Rectifier feature the newly developed multi-diffusion technology to combine high blocking voltage capability with low on-state conduction losses.

The C502 is designed specifically for phase control applications like DC motor control and power supplies, cycloconverters and current regulated inverters.

FEATURES:

- High Blocking Voltage Capability
- High DV/DT with Higher Selections Available
- Excellent Surge and I^2t Current Ratings for Ease of Fusing
- Rugged Hermetic Ceramic Package with 1″ Creep and Strike
- Guaranteed Turn-Off Time Selections of 100 μsec Available
- Complementary Diodes and Mounting Hardware Available

IMPORTANT: Mounting instructions on the last page of the C501 specification **must** be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE AND REVERSE VOLTAGE V_{DRM}/V_{RRM} [2] T_J = -40°C to +125°C	REPETITIVE PEAK OFF-STATE AND REVERSE VOLTAGE V_{DRM}/V_{RRM} [2] T_J = 0°C to +125°C	TRANSIENT PEAK REVERSE VOLTAGE, V_{RSM} [1] T_J = +125°C
C502PE	1500 Volts	1600 Volts	1600 Volts
C502PM	1600	1700	1700
C502PS	1700	1800	1800
C502PN	1800	1900	1900
C502PT	1900	2000	2000
C502L	2000	2100	2100
C502LA	2100	2200	2200

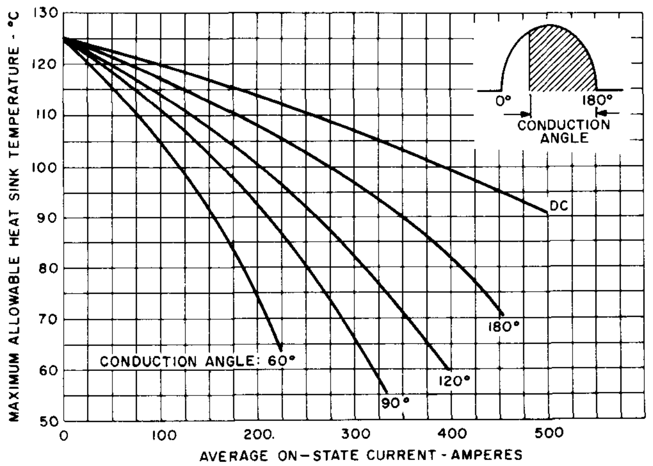
[1] Half Sine Wave Waveform, 10 msec maximum pulse width.

Average Forward Current, On-State	Depends on conduction angle (see Charts 1 and 2)
Peak One-Cycle Surge On-State Current, I_{TSM}	8,000 Amperes
Maximum Rate-of-Rise of Anode Current Switching from 1000 V (Repetitive)	100 A/μsec
I^2t (for fusing) (for times ⩾ 1.5 milliseconds) see Figure 7	130,000 Ampere² Seconds
I^2t (for fusing) (at 8.3 milliseconds)	265,000 Ampere² Seconds
Peak Gate Power Dissipation, P_{GM}	200 Watts @ 40 μsec Pulse
Average Gate Power Dissipation, $P_{G(AV)}$	5 Watts
Peak Reverse Gate Voltage, V_{GRM}	5 Volts
Storage and Operating Temperature, T_{STG} and T_J	-40°C to +125°C
Mounting Force Required	2000 Lbs. ± 10% 8.9 KN ± 10%

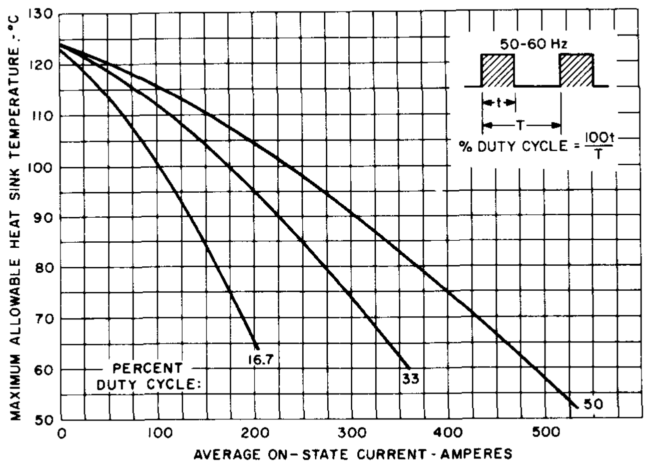
[2] Assumes heat dissipator less than 1°C/W thermal resistance.

CHARACTERISTICS

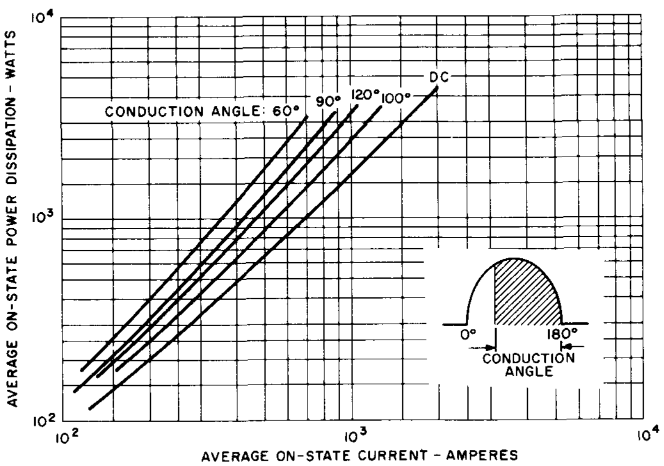
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Off-State Currents	I_{DRM} and I_{RRM}	–	1.0	15	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Peak Reverse and Off-State Blocking Current	I_{DRM} and I_{RRM}	–	15	35	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Effective Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	–	–	.05	°C/Watt	Junction-to-Case – Double Side Cooling (DC)
Critical Exponential Rate-of-Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	500	–	–	V/μsec	T_J = +125°C, V = 0.8 x V_{DRM}, Gate Open.
Holding Current	I_H	–	100	250	mAdc	T_C = +25°C, Anode supply = 24 Vdc., Initial forward current = 500 amps.
Latching Current	I_L	–	–	1	Adc	T_C = +25°C, Anode supply = 24 Vdc., Load resistance 12 ohms max.
Delay Time	t_d	–	1.5	–	μsec	T_C = +25°C, I_T = 50 Adc. Gate Supply: 20V, 20 ohms, 500mA, 0.5μsec max. rise time, 1000V switching voltage.
Gate Pulse Width Necessary to Trigger		–	–	10	μsec	T_C = +25°C. Gate Supply: 10V Open Circuit 5 ohms, 0.1 μsec rise time.
Gate Trigger Current, See Figure 10 for Recommended Gate Drive Conditions	I_{GT}	–	60	150	mAdc	T_C = +25°C, V_D = 10 Vdc, R_L = 3 ohms
		–	–	275		T_C = -40°C, V_D = 10 Vdc, R_L = 3 ohms
		2.0	15	50		T_C = +125°C, V_D = 0.5 V_{DRM}, R_L = 3 Ohms
Gate Trigger Voltage	V_{GT}	–	2.5	4.5	Vdc	T_C = 0°C to +125°C, V_D = 0.5 Vdc, R_L = 3 ohms
		0.3	–	–		T_C = +125°C, V_D = 0.5 V_{DRM}, R_L = 1000 ohms.
Peak On-State Voltage	V_{TM}	–	–	1.53	Volts	T_C = +25°C, I_T = 1000 amps. peak. Duty cycle ⩽ 0.01%
Circuited Commutated Turn-Off Time	t_q	–	125	250	μsec	(1) T_C = +125°C (2) I_T = 450 Amps. (3) V_R = 75 Volts min. (4) 0.5 V_{DRM} Reapplied (5) Rate-of-rise of reapplied forward blocking voltage = 50V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition rate = 1 pps. (8) Gate bias during turn-off interval = 0 volts, 100 ohms.
Suppressible Surge Current (Half Sinewave Peak Current, 8.3 msec Pulse Width)	$I_{TM(SUP)}$	–	6400	–	Amps	(1) T_C = 115°C (2) V_R = .67 V_{RRM} (3) .67 V_{DRM} Reapplied, 8.3 msec after surge current zero. (4) Figure 12.



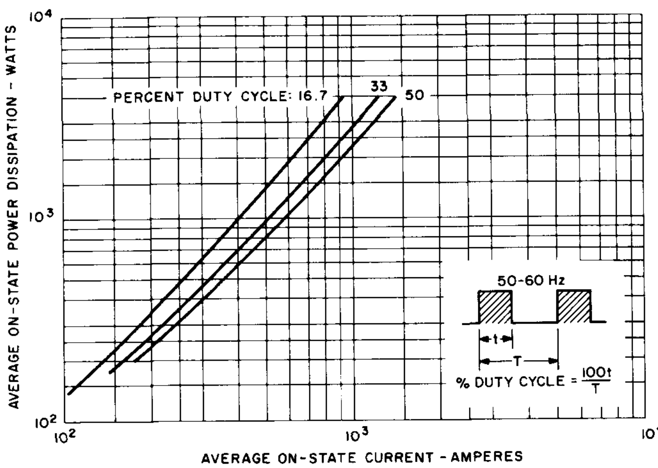
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM – DOUBLE-SIDE COOLED



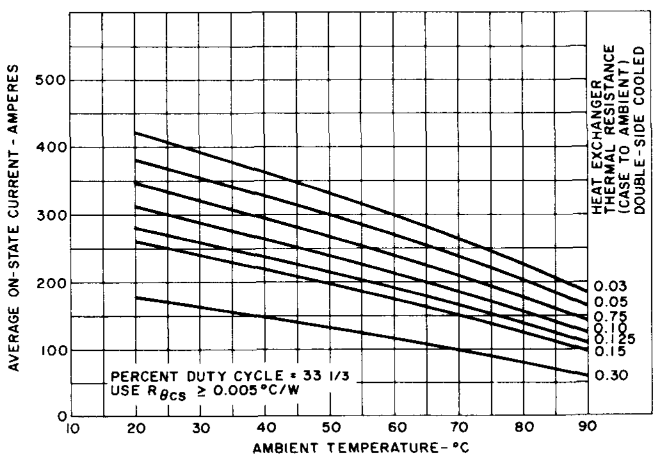
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM – DOUBLE-SIDE COOLED



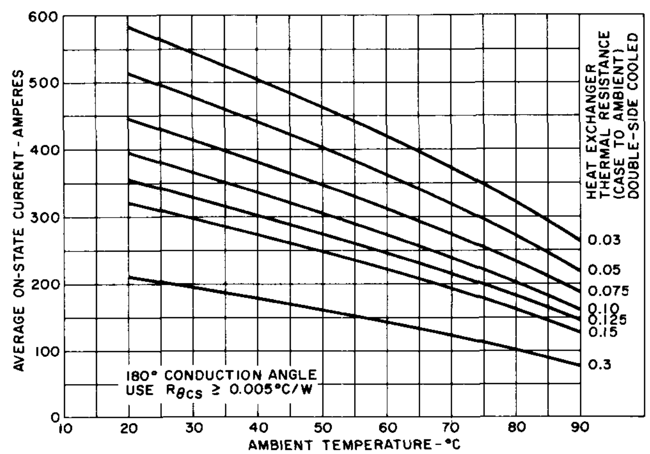
3. AVERAGE ON-STATE POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



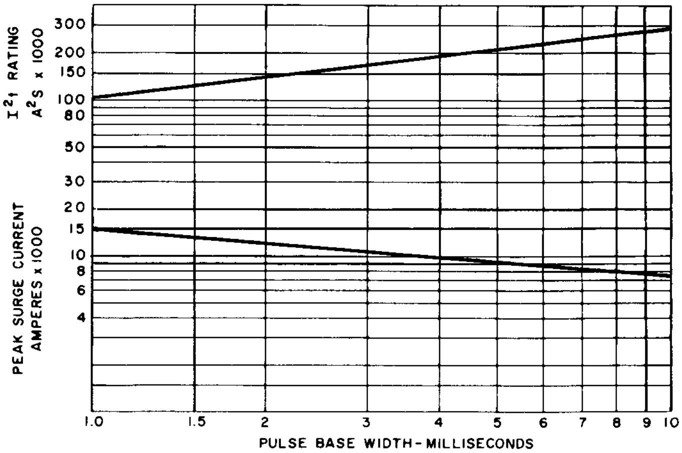
4. AVERAGE ON-STATE POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



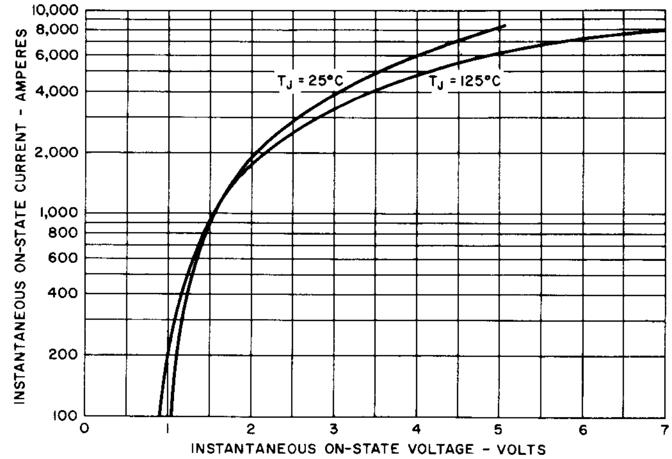
5. AVERAGE RECTANGULAR ON-STATE CURRENT VS. AMBIENT TEMPERATURE WHEN USED WITH VARIOUS HEAT EXCHANGERS



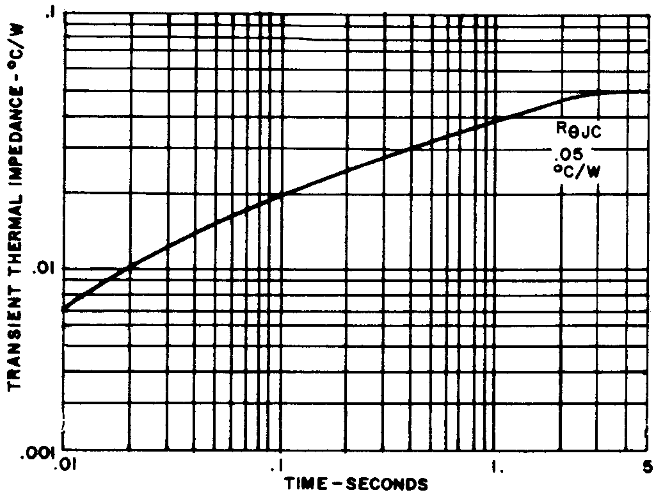
6. AVERAGE PHASE BACK ON-STATE CURRENT VS. AMBIENT TEMPERATURE WHEN USED WITH VARIOUS HEAT EXCHANGERS



7. I^2t AND I_{TSM} FOLLOWING RATED LOAD CONDITIONS



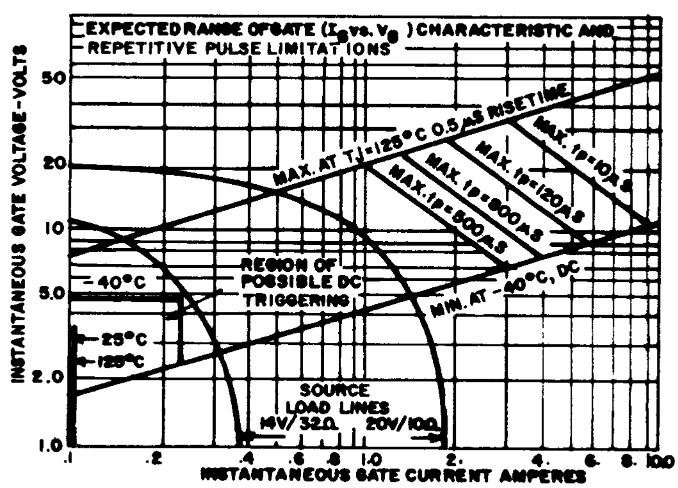
8. MAXIMUM FORWARD CONDUCTION CHARACTERISTIC ON-STATE



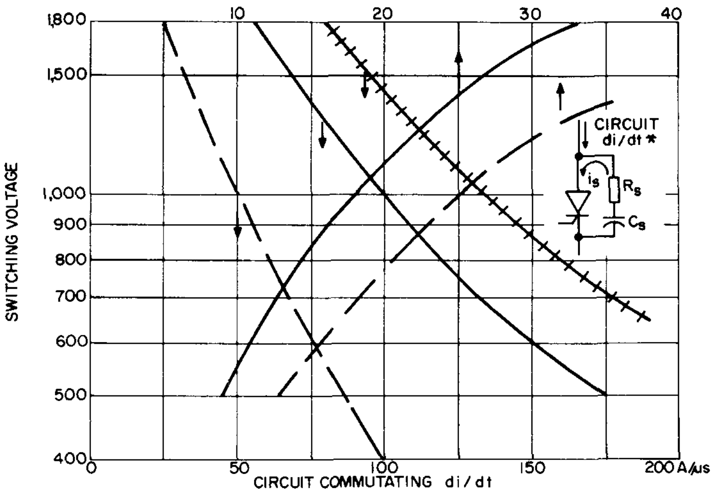
9. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE (DOUBLE-SIDE COOLED)

NOTES:

1. Power "D" adds .01°C/W to account for both case to dissipator interfaces, when properly mounted; e.g., $R_{\theta JS}$ = .06°C/W. See Mounting Instructions.
2. DC Thermal Impedance is based on average full cycle junction temperature. Instantaneous junction temperature may be calculated using the following modifications:
   - end of conducting portion of cycle
     - 120° sq. wave add .0065°C/W along entire curve
     - 180° sq. wave add .0047°C/W along entire curve
     - 180° sine wave add .0026°C/W along entire curve
   - end of full cycle
     - any wave, subtract .0026°C/W along entire curve



10. GATE TRIGGERING CHARACTERISTICS



NOTES:

Code:

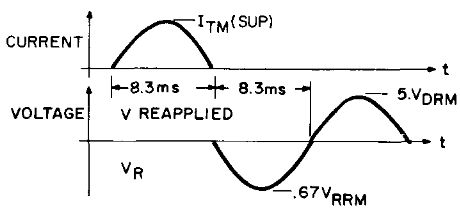
++++	Non-Repetitive High Gate Drive
——	Repetitive High Gate Drive
——	Non-Repetitive Low Gate Drive
– – –	Repetitive Low Gate Drive

	Low Gate Drive	High Gate Drive
Source	14V/35 ohms	20V/10 ohms
Pulse Width, t_p	⩾ 20 µs	⩾ 10 µs
Current Rise Time, t_r	⩽ 2	⩽ 0.5 µs

*Permissible circuit di/dt excluding snubber discharge. Repetitive di/dt is recommended maximum condition to achieve most industrial requirements for service life. It meets or exceeds the JEDEC test requirements for certification set forth in NEMA Std. Sk. 516 (1972). Non-repetitive di/dt meets the JEDEC 5 second rating.

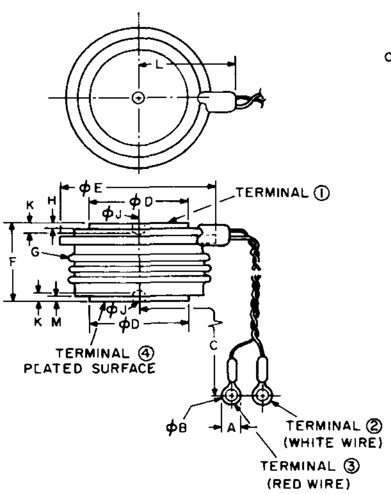
**Snubber discharge, i_s, is treated separately using the minimum value of snubber resistance indicated above. This applies for long industrial life (20 – 30 years) in combination with circuit di/dt.

11. ALLOWABLE REPETITIVE AND NON-REPETITIVE IN-RUSH CURRENT (DI/DT*) AND REQUIRED SNUBBER RESISTANCE FOR VARYING LEVELS OF SWITCHING VOLTAGE



12. SUPPRESSIBLE SURGE CURRENT TEST

OUTLINE DRAWING



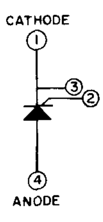


TABLE OF DIMENSIONS
Conversion Table

SYM.	DECIMAL INCHES		METRIC MM		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	0.200	0.240	5.08	6.10	
φ B	0.140	–	3.56	–	
C	16.000	20.000	406.40	508.00	
φ D	1.240	1.260	31.50	32.00	
φ E	–	2.000	–	50.80	
F	1.000	1.060	25.40	26.92	
G	–	–	–	–	1
H	.025	–	0.64	–	
φ J	0.136	0.146	3.45	3.71	
K	.080	–	2.03	–	
L	–	2.000	–	50.80	
M	.036	–	0.91	–	

NOTES:
1. Glazed Ceramic Insulator With 1.00 Inch Minimum Surface Creepage. (25.40 MM)

HEAT SINK SELECTION MADE EASY

The C502 specification sheet marks the introduction of two new characteristic curves which should greatly facilitate heat sink selection. Figures 5 and 6 plot allowable average current versus ambient temperature and case-to-ambient thermal resistance for the two most frequently encountered waveforms, 1/3 duty cycle rectangular current and 180° sinusoidal current waveforms. As soon as the average forward current and maximum ambient temperature are known, the designer can specify a heat sink thermal resistance. Note that the graphs span the range of heat sinks from water-cooled ($R_{\theta CA}$ = .03°C/W) to free-air convection ($R_{\theta CA}$ = 0.3°C/W). It is possible to linearly interpolate between the curves for $R_{\theta CA}$.

These curves have been derived from the following basic equation:

$$T_J = T_A + P_{AVG} \times R_{\theta JA}$$

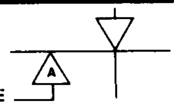
where: $T_J = 125°C$

For increased reliability, the usual practice is to derate T_J 15-30 degrees. Figures 5 and 6 can perform this function by the simple expedient of raising T_A by a like amount.

High Power
Silicon Controlled Rectifier

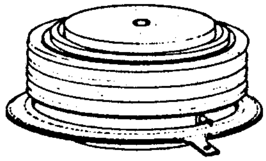
600A AVG., UP TO 2600 VOLTS

C602



AMPLIFYING GATE

The C602 Series of high power SCR's feature the proven, multi-diffused construction in a new, larger, pressure-mounted package for phase control.



FEATURES:

- 2600 Volt Blocking Voltage Capability
- Glazed Ceramic Hermetic Package with 1″ Creepage Path
- Reliability of Pressure Contacts plus Reversibility of the Package
- Available in Factory Assembled Heat Exchangers or Ready-to-Mount
- Complementary Rectifiers
- Higher dv/dt Ratings

IMPORTANT: Mounting instructions on the last page of the C501 specification **must** be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	V_{DRM}/V_{RRM} [1] REPETITIVE T_J = -40°C to +125°C	V_{DRM}/V_{RRM} [1] REPETITIVE T_J = 0°C to +125°C	TRANSIENT PEAK REVERSE VOLTAGE (NON-RECURRENT < 5 MILLISECONDS) V_{RSM} T_J = -40°C to +125°C
C602PS	1700 Volts	1800 Volts	1800 Volts
C602PN	1800	1900	1900
C602PT	1900	2000	2000
C602L	2000	2100	2100
C602LA	2100	2200	2200
C602LB	2200	2300	2300
C602LC	2300	2400	2400
C602LD	2400	2500	2500
C602LE	2500	2600	2600
C602LM	2600	2700	2700

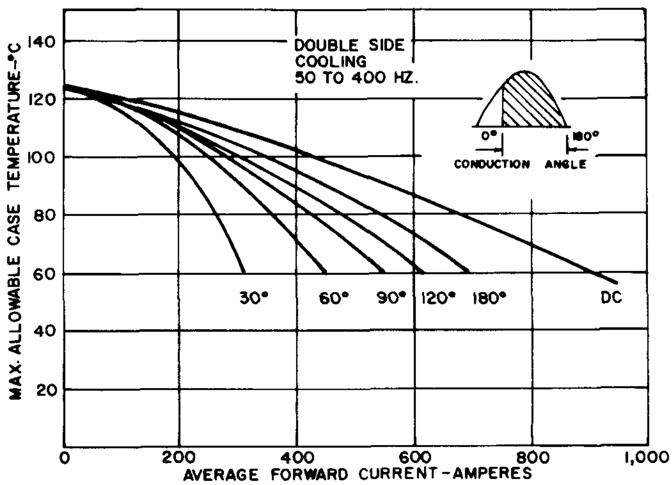
Consult factory for higher voltage grades.

Average Forward Current, On-State . . . . Depends on Conduction Angle
Peak One-Cycle Surge On-State Current, I_{TSM} . . . . 10,000 Amperes
Maximum Rate-of-Rise of Anode Current Turn-On Interval
(Switching Rates ⩽ 400 Hz) . . . . Switch From < 600V, 75A/μsec
(See Curve 9 for Recommended Load Line). . . . . Switch From < 1000V, 50A/μsec
. . . . Switch From < 1500V, 35A/μsec
I^2t (for fusing) (at 8.3 milliseconds) . . . . 415,000 Ampere² Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 40 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 5 Watts
Peak Reverse Gate Voltage, V_{GRM} . . . . 5 Volts
Storage and Operating Temperatures, T_{STG} and T_J . . . . Refer Above
Mounting Force Required . . . . 4000 Lbs. ± 10%
17.8 KN ± 10%

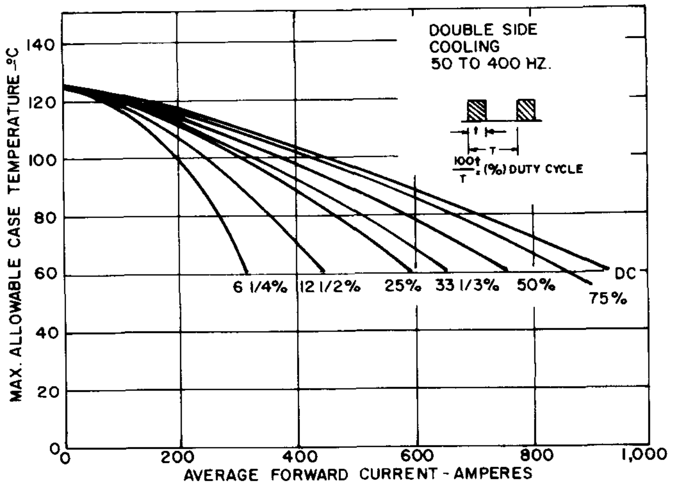
NOTES:
[1] Ratings apply for zero gate voltage. Assumes heat dissipator thermal resistance less than 0.5°C/W.

CHARACTERISTICS

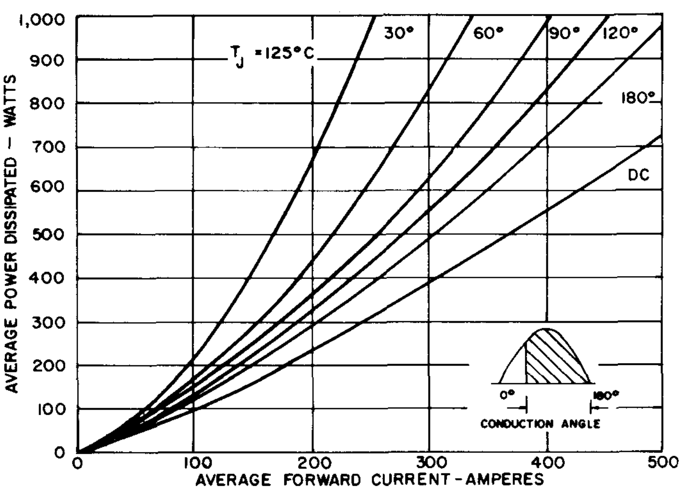
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Forward Blocking Current	I_{DRM} and I_{RRM}	–	10	15	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Peak Reverse and On-State Blocking Current	I_{DRM} and I_{RRM}	–	15	35	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Effective Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	–	–	.036	°C/Watt	Junction-to-Case, Double-Side Cooled (DC)
Critical Exponential Rate-of-Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	500	–	–	V/μsec	T_J = +125°C, V_{DRM} = .67 Rated, Gate Open.
Holding Current	I_H	–	100	250	mAdc	T_C = +25°C, Anode Supply = 20 Vdc. Initial Forward Current = 500 Amps.
Latching Current	I_L	–	–	1	Adc	T_C = +25°C, Anode Voltage = 24 Vdc. Load Resistance 12 Ohms Max.
Delay Time	t_d	–	1.8	–	μsec	Switching From 900 Volts, 20V/10Ω, .5 μsec Rise Time
Gate Pulse Width Necessary to Trigger		–	–	10	μsec	See Figure 9.
Gate Trigger Current	I_{GT}	–	80	150	mAdc	T_C = 25°C, V_D = 10 Vdc, R_L = 3 Ohms
		5.0	15	75		T_C = +125°C, V_D = .5 x Rated, R_L = 1000 Ohms
Gate Trigger Voltage	V_{GT}	–	2.6	4.5	Vdc	T_C = 0°C to +125°C, V_D = 10 Vdc, R_L = 3 Ohms
		.2	–	–		T_C = 125°C, V_D = .5 x Rated, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	1.90	Volts	T_C = +125°C, I_T = 1000 Amps. Peak, Duty Cycle ⩽ 0.01%
Circuit Commutated Turn-Off Time	t_q	–	125	250	μsec	(1) T_C = +125°C (2) I_T = 450 Amps. (3) V_R = 75 Volts Min. (4) 50% V_{DRM} Reapplied (5) Rate-of-rise of Reapplied Forward Blocking Voltage = .25V/μsec. Linear (6) Gate Bias = Open During Turn-Off Interval (7) Duty Cycle ⩽ 0.01%
Suppressible Surge Current	$I_{TM(SUP)}$	–	7500	–	Amps	(1) T_C = 115°C (2) V_R = .67 V_{RRM} (3) .67 V_{DRM}, Applied 8.3 msec. After Completion of Surge (4) Figure 13.



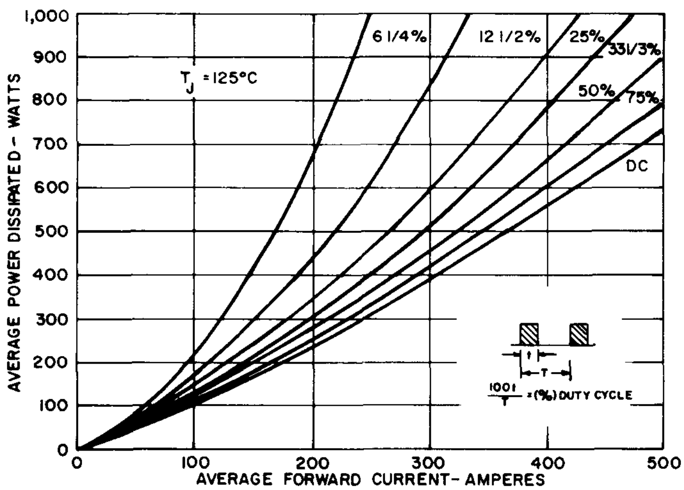
1. MAXIMUM ALLOWABLE SINK TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM (DOUBLE-SIDE COOLED)



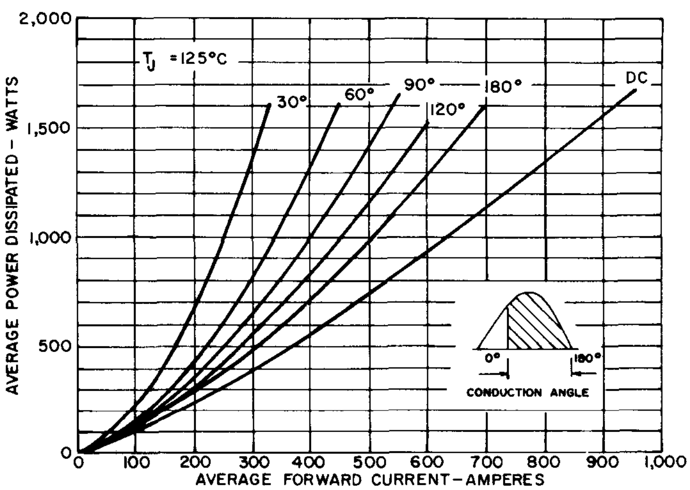
2. MAXIMUM ALLOWABLE SINK TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM (DOUBLE-SIDE COOLED)



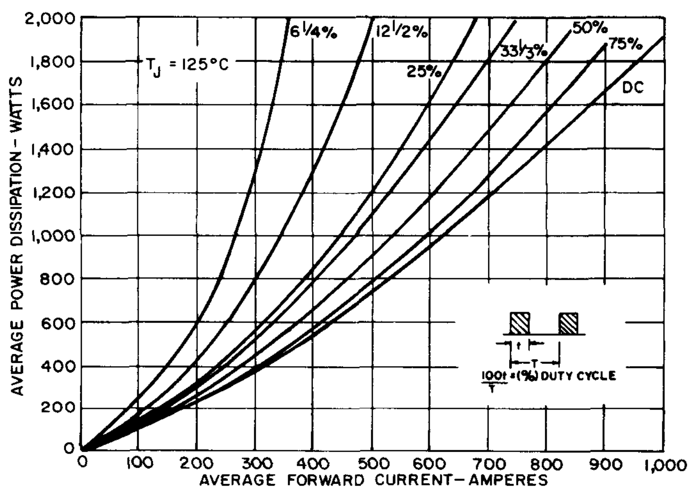
3. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



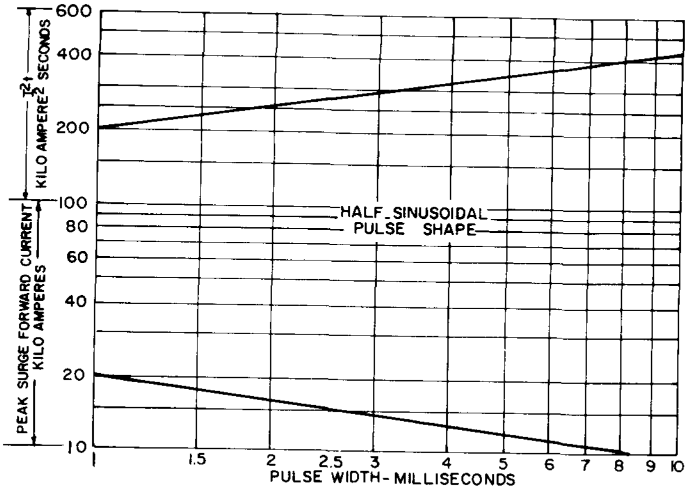
4. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



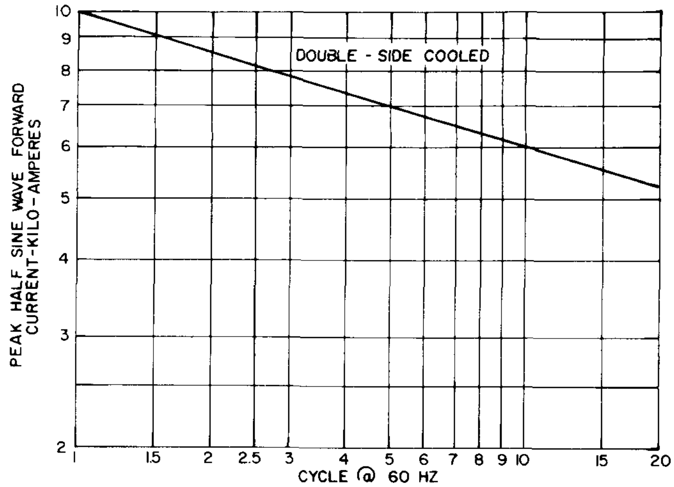
5. EXTENDED FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



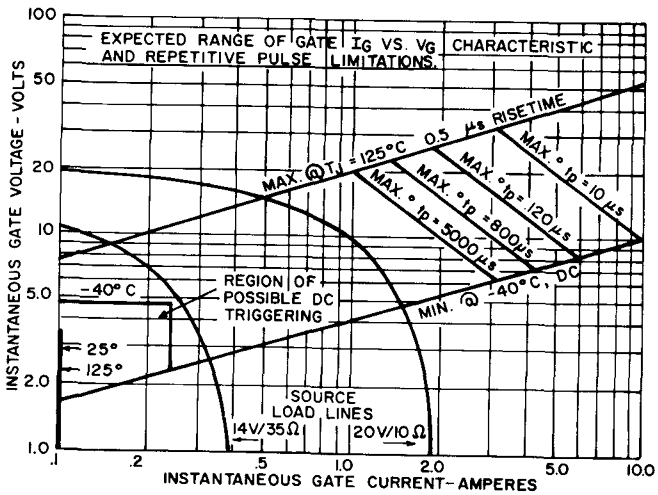
6. EXTENDED FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



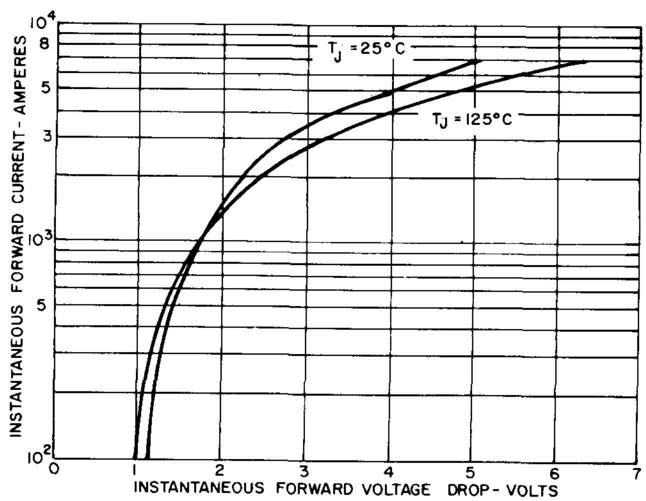
7. SUB CYCLE SURGE AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS



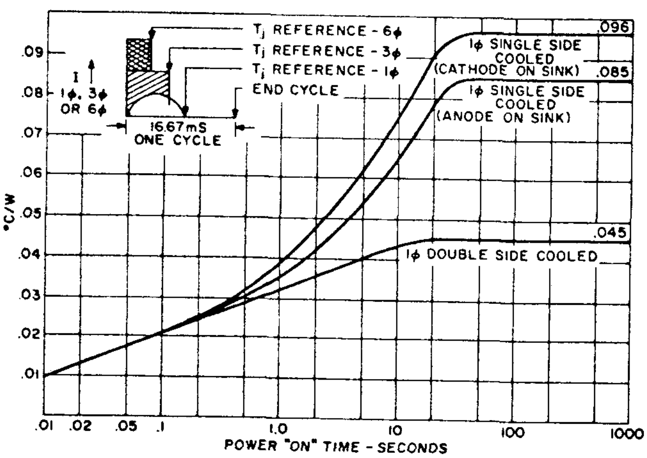
8. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



9. GATE TRIGGERING CHARACTERISTICS



10. FORWARD CONDUCTION CHARACTERISTIC, ON-STATE



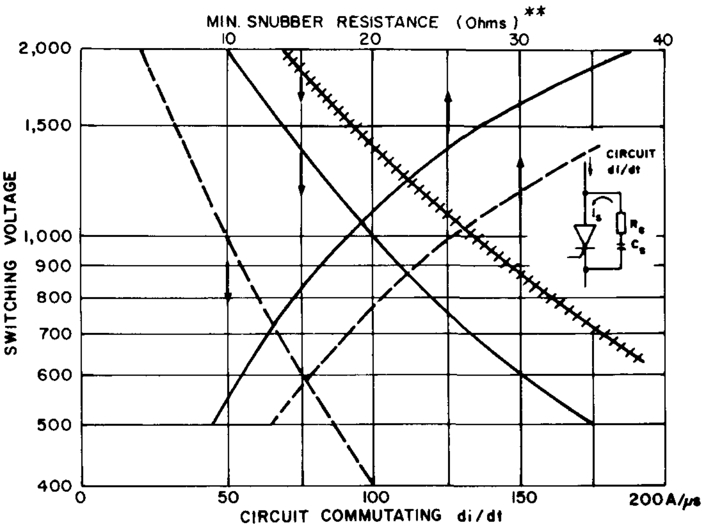
NOTES:

For 3φ thermal resistance add .0037°C/W along entire curve length.

For 6φ thermal resistance add .001°C/W along entire curve length.

For DC thermal resistance subtract .005°C/W along entire curve length.

11. TRANSIENT THERMAL IMPEDANCE – JUNCTION-TO-CASE



12. ALLOWABLE REPETITIVE AND NON-REPETITIVE IN-RUSH CURRENT (DI/DT)* AND REQUIRED SNUBBER RESISTANCE FOR VARYING LEVELS OF SWITCHING VOLTAGE

NOTES:

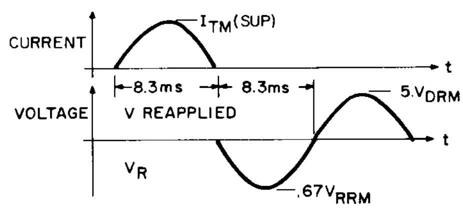
Code:

++++	Non-Repetitive High Gate Drive
——	Repetitive High Gate Drive
——	Non-Repetitive Low Gate Drive
– – –	Repetitive Low Gate Drive

	Low Gate Drive	High Gate Drive
Source	14V/35 Ohms	20V/10 Ohms
Pulse Width, t_p	≥20 μs	≥10 μs
Current Rise Time, t_r	≤2	≤0.5 μs

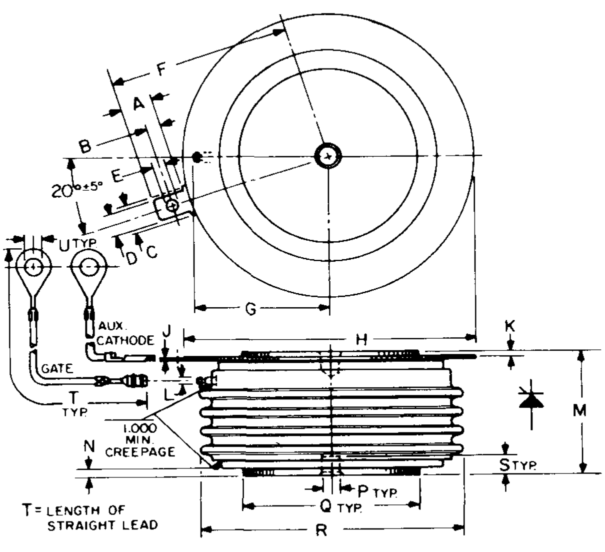
*Permissible circuit di/dt excluding snubber discharge (re: PG10.010, p. 5). Repetitive di/dt is recommended maximum condition to achieve most industrial requirements for service life. It meets or exceeds the JEDEC test requirements for certification set forth in NEMA Std., Sk. 516 (1972). Non-repetitive di/dt meets the JEDEC 5 second rating.

**Snubber discharge, i_s, is treated separately using the minimum value of snubber resistance indicated above. This applies for long industrial life (20 – 30 years) in combination with circuit di/dt.



13. SUPPRESSIBLE SURGE CURRENT

OUTLINE DRAWING

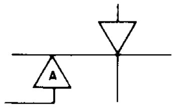


SYM	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC M.M. MIN.	METRIC M.M. MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.702	2.11
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

High Speed
Silicon
Controlled Rectifier

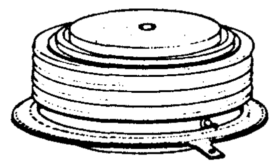
C612

2000 Volts 1150 Amps RMS



AMPLIFYING GATE

The General Electric device type C612 is a new pressure mounted, high current SCR designed for power switching at high voltage and high frequencies (up to 5 KHz). The C612 gate structure has an involute, interdigitated pattern to optimize the turn-on area for high di/dt capability and it is processed using a newly developed multi-diffusion technology.



FEATURES:

- Off-State and Reverse Blocking Capabilities to 2000 Volts.
- Very Low Switching Losses at High Frequencies.
- 60 μsec Maximum Turn-Off Time at Severe Operating Conditions with Feedback Diode. diode.
- Involute, Interdigitated Gate for High di/dt Capability.
- Narrow Pulse Capability for PWM Inverter Commutating SCR Socket.
- 1″ Creepage-Path, Glazed-Ceramic Package.

IMPORTANT: Mounting instructions on last page of this specification sheet **must** be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	V_{DRM}/V_{RRM} [1] REPETITIVE T_J = -40°C to +125°C	V_{DRM}/V_{RRM} [1] REPETITIVE T_J = 0°C to +125°C	TRANSIENT PEAK REVERSE VOLTAGE [1] V_{RSM} T_J = -40°C to +125°C
C612L	2000 Volts	2100 Volts	2100 Volts
C612PT	1900	2000	2000
C612PN	1800	1900	1900
C612PS	1700	1800	1800
C612PM	1600	1700	1700
C612PE	1500	1600	1600

Peak One-Cycle Surge On-State Current, I_{TSM} (8.3 msec) . . . . 9000 Amperes
Maximum Rate-of-Rise of Anode Current Turn-On Interval[2] . . . . Switching from 1200 Volts, 500 A/μsec
Repetitive Rate-of-Rise of Anode Current . . . . 200 A/μsec
I^2t (for fusing) (at 1.5 milliseconds) (See Figure 9) . . . . 155,000 Ampere^2 Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 100 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 5 Watts
Peak Reverse Gate Voltage, V_{GRM} . . . . 20 Volts
Storage and Operating Temperature, T_{stg} and T_J . . . . -40°C to +125°C
Mounting Force Required . . . . 3500 – 4200 Lbs.
15.6 – 18.7 Kn

NOTES:

[1] 10 msec voltage sinewave.

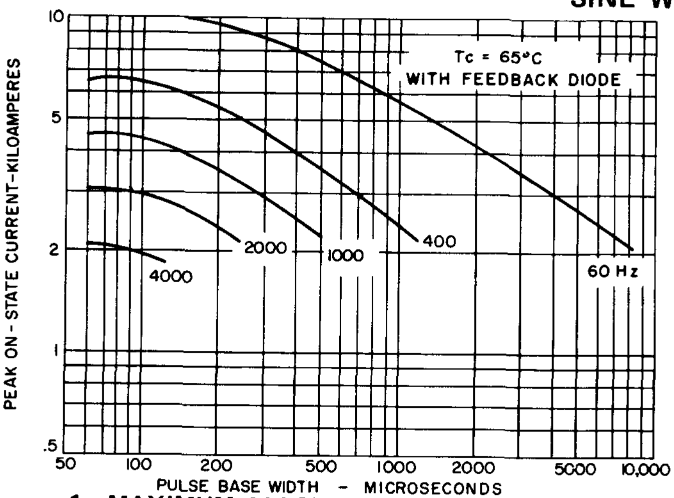
[2] di/dt rating established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5 μs short circuit trigger current rise time.

CHARACTERISTICS

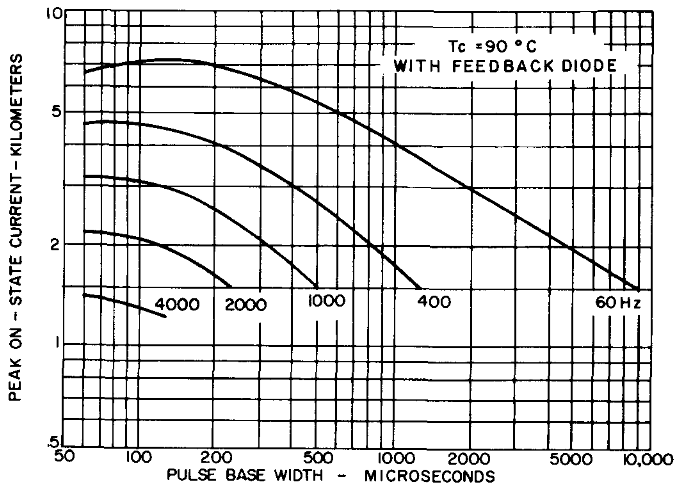
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Off-State and Reverse Currents	I_{DRM} and I_{RRM}	–	10	15	mA	$T_J = +25°C$, $V = V_{DRM} = V_{RRM}$
Peak Off-State and Reverse Currents	I_{DRM} and I_{RRM}	–	45	60	mA	$T_J = +125°C$, $V = V_{DRM} = V_{RRM}$
Effective Thermal Resistance Junction-to-Case, $R_{\theta JC}$	DC	–	–	.045	°C/watt	Double-Side Cooled
Critical Linear Rate-of-Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200	–	–	V/μsec	$T_J = +125°C$, $V_{DRM} = .80$ Rated, Gate Open[1]
Delay Time	t_d	–	1.5	3.0	μsec	Switching from 900 Volts, 20 Volt, 10 Ohm Gate 0.5 μsec Rise Time, $T_J = 25°C$
Gate Pulse Width Necessary to Trigger		–	–	10	μsec	See Figure 7.
Gate Trigger Current (See Figure 11)	I_{GT}	–	120	150	mAdc	$T_C = 25°C$, $V_D = 10$ Vdc, $R_L = 3$ Ohms
		5.0	30	–		$T_C = +125°C$, $V_D = .5$ x Rated, $R_L =$ 1000 Ohms
Gate Trigger Voltage (See Figure 11)	V_{GT}	–	3.0	4.5	Vdc	$T_C = 25°C$, $V_D = 10$ Vdc, $R_L = 3$ Ohms
		.3	–	–		$T_C = 125°C$, $V_D = .5$ x Rated, $R_L =$ 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	2.21	Volts	$T_C = +125°C$, $I_T = 2000$ Amps. Peak Duty Cycle $\leqslant 0.01\%$
Conventional Circuit Commutated Turn-Off Time (With Reverse Voltage)	t_q	–	50	55	μsec	(1) $T_C = +125°C$ (2) $I_T = 500$ Amps. (3) $V_R \geqslant 50$ Volts (4) 80% V_{DRM} reapplied[1] (5) Rate-of-rise of Forward Blocking Voltage = 200 V/μsec. (6) Gate Bias = Open During Turn-Off Interval = 0 Volts, 100 Ohms (7) Duty Cycle $\leqslant 0.01\%$
Conventional Circuit Commutated Turn-Off Time (With Feedback Diode)	t_q	–	55	60	μsec	(1) $T_C = +125°C$ (2) $I_T = 500$ Amps. (3) $V_R = 2$ Volts Min. (4) 80% V_{DRM} reapplied[1] (5) Rate-of-rise of Forward Blocking Voltage = 200 V/μsec. (6) Gate Bias = Open During Turn-Off Interval (7) Duty Cycle $\leqslant 0.01\%$

[1] 1 440 V is maximum for C613PT and C613L.

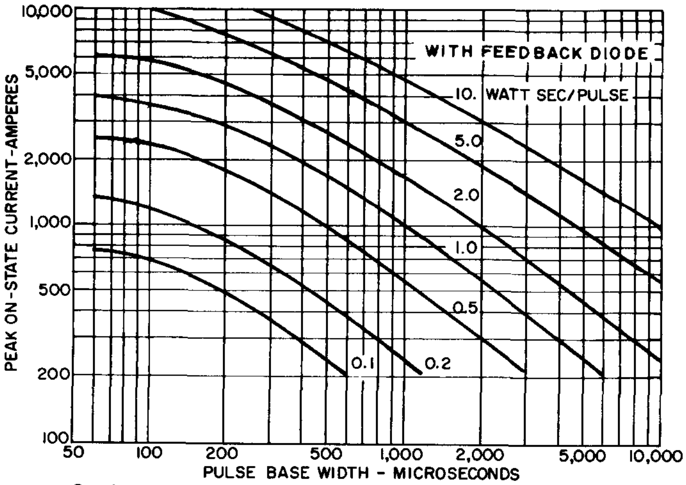
SINE WAVE DATA



1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)

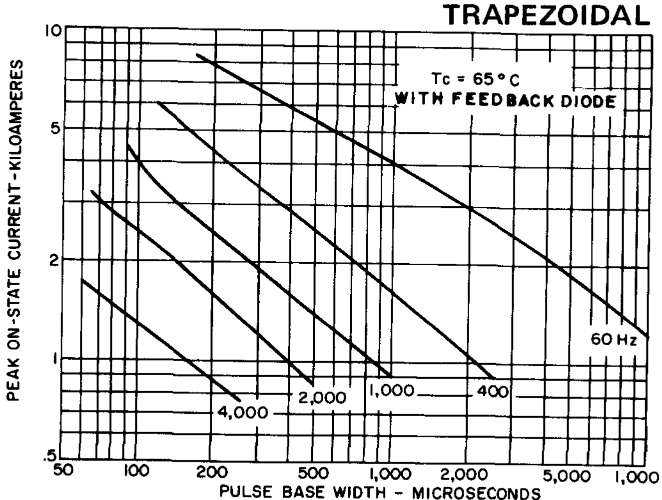


3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

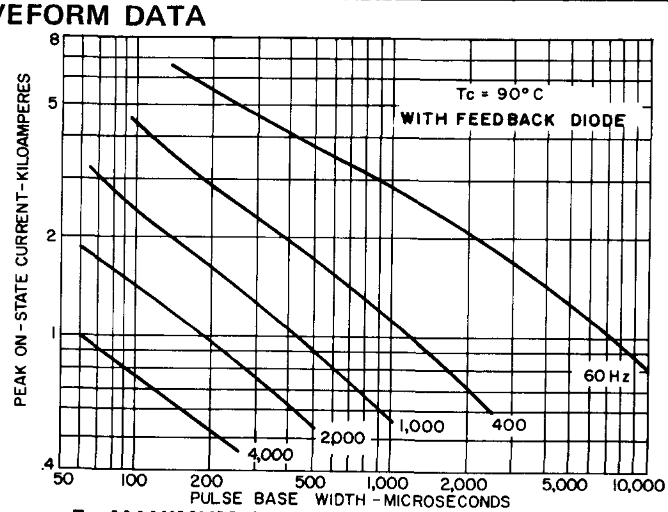
NOTES:

1. Switching voltage range: V_D = 15V − 0.8 V_{DRM}.
2. Peak snubber discharge current ⩽50A. RC ⩽10μsec.
3. High gate drive: 20V/10 Ohms, 0.5μsec. rise time.
4. Reverse voltage < 50V. If no bypass diode is used, recovery switching losses must be added.

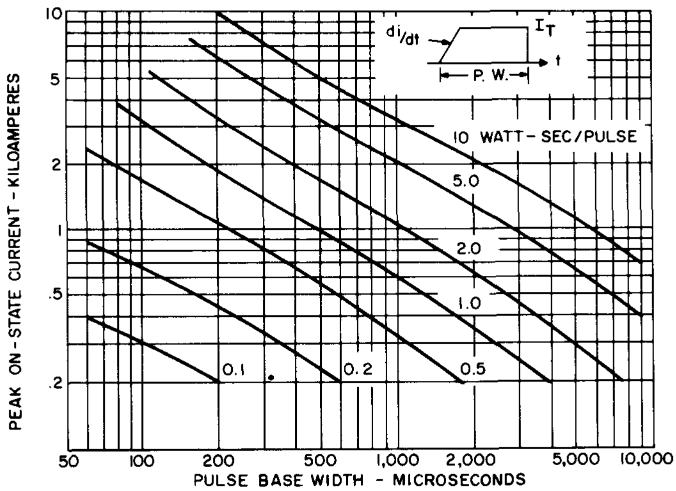
TRAPEZOIDAL WAVEFORM DATA



4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT FOR RISING DI/DT = 100 A/μSEC (T_C = 65°C)

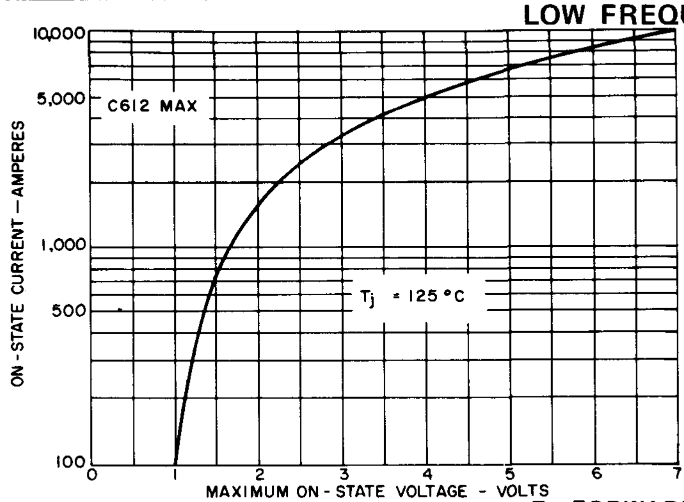


5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT FOR RISING DI/DT = 100 A/μSEC (T_C = 90°C



6. ENERGY PER PULSE FOR TRAPEZOIDAL CURRENT WAVEFORMS FOR 100 A/μSEC RISING DI/DT

NOTES:
1. Switching voltage range: V_D = 15V – 0.8 V_{DRM}.
2. Peak snubber discharge current ≤ 50A. RC ≤ 10μsec.
3. High gate drive: 20V/10 Ohms, 0.5μsec. rise time.
4. Reverse voltage ≤ 50V.

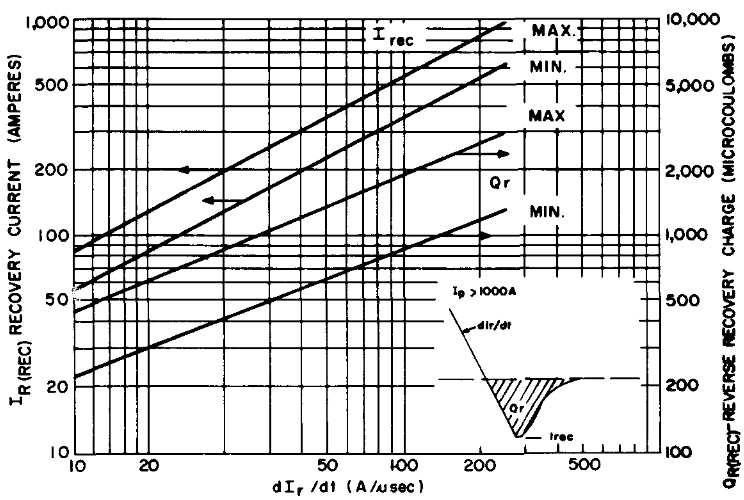


7. FORWARD CONDUCTION CHARACTERISTIC ON-STATE

LOW FREQUENCY DATA

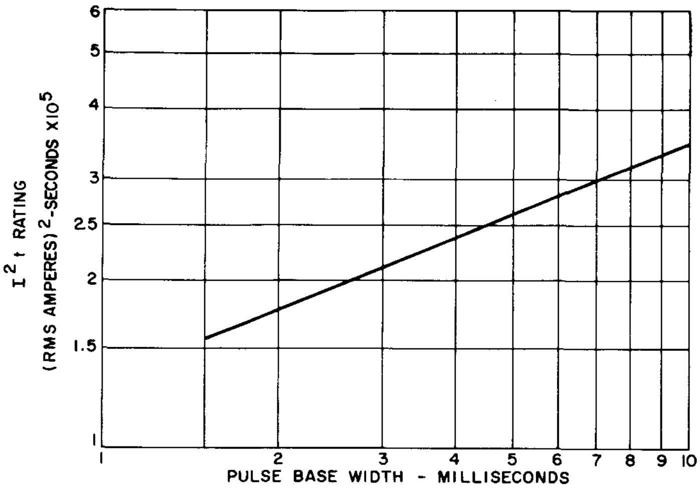
NOTES:

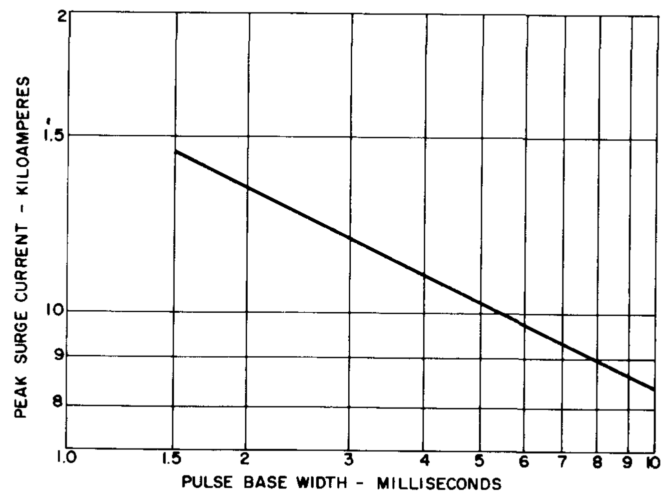
VOLTAGE (Volts)	CURRENT (Amps)
1.040	100
1.153	200
1.232	300
1.300	400
1.363	500
1.422	600
1.480	700
1.537	800
1.594	900
1.650	1000
1.706	1100
1.762	1200
1.818	1300
1.873	1400
1.929	1500
2.210	2000
2.781	3000
3.363	4000
3.954	5000
4.552	6000
5.157	7000
5.767	8000
6.382	9000
7.000	10000



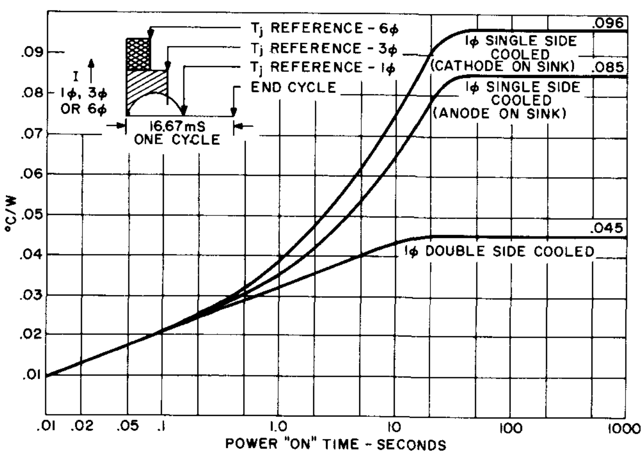
8. REVERSE RECOVERY CHARACTERISTICS (125°C)

NOTES:
Curves are based upon production tests of I_{rec}. Q_r is a close approximation based upon calculation using appropriate value of I_{rec} and an emperical formula.





9. SUB-CYCLE SURGE AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS (Sinusoidal Waveform)



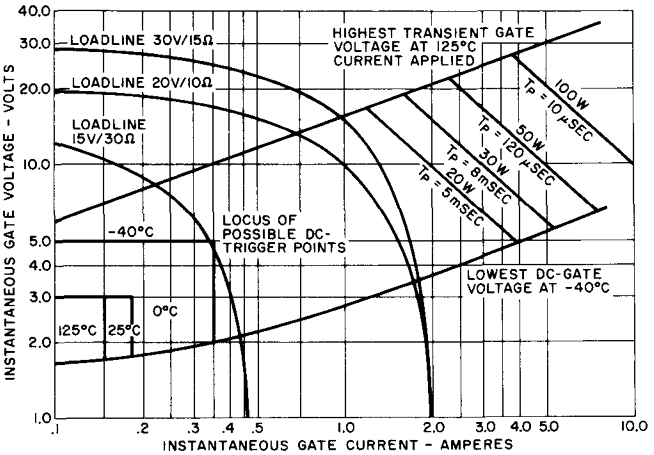
NOTES:

For 3ϕ thermal resistance add .0037°C/W along entire curve length.

For 6ϕ thermal resistance add .001°C/W along entire curve length.

For DC thermal resistance subtract .005°C/W along entire curve length.

10. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

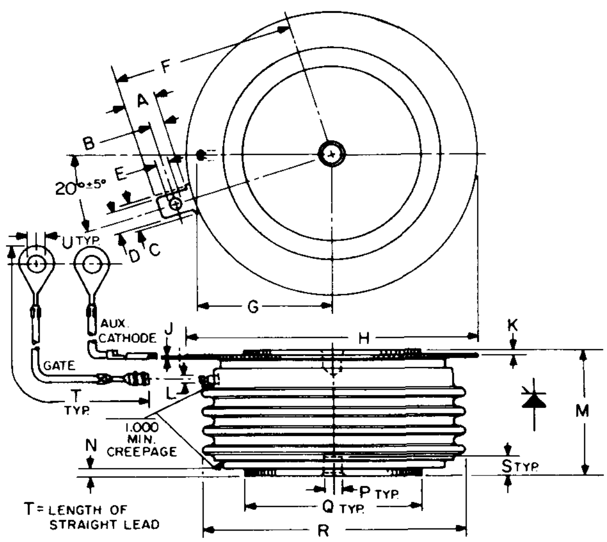


11. MAXIMUM ALLOWABLE PEAK GATE POWER VS. GATE PULSE WIDTH

NOTES:

1. Maximum allowable gate dissipation = 3 watts.
2. The locus of possible DC-trigger points lies outside the boundaries shown at various junction temperatures.
3. Loadlines 30V/15 Ω, 20V/10 Ω and similar are recommended as minimum gate drives for most inverter application: rise time ⩽ 0.5μsec; T_P ⩾ 10μsec.
4. Loadline 15V/30 Ω is the minimum usable gate drive. Snubber resistances must be > 30 Ω when turning on from ⩾ 800V bias. Delay-time may be increased. di/dt rating ⩽ 100A/μsec.

OUTLINE DRAWING



SYM	DECIMAL INCHES MIN.	MAX.	METRIC M.M. MIN.	MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.702	2.11
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

C600 SERIES SUGGESTED MOUNTING METHODS

Refer to C702 specification for mounting instructions

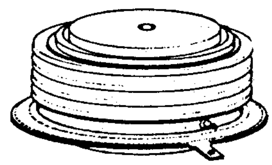
High Speed Silicon Controlled Rectifier

2000 Volts 750 Amps RMS

C613

AMPLIFYING GATE (A)

The General Electric device type C613 is a new pressure-mounted, high current SCR designed for power switching at high voltage and high frequencies (up to 5 KHz). The C613 gate structure has an involute, interdigitated pattern to optimize the turn-on area for high di/dt capability and it is processed using a newly developed multi-diffusion technology.



FEATURES:

- Off-State and Reverse Blocking Capabilities to 2000 Volts.
- Very Low Switching Losses at High Frequencies.
- 50 μsec Maximum Turn-Off Time at Severe Operating Conditions with **Bypass** diode.
- Involute, Interdigitated Gate for High di/dt Capability.
- Narrow Pulse Capability for PWM Inverter Commutating SCR Socket.
- 1″ Creepage-Path, Glazed-Ceramic Package.

IMPORTANT: Mounting instructions on last page of this specification sheet **must** be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	V_{DRM}/V_{RRM}[1] REPETITIVE T_J = -40°C to +125°C	V_{DRM}/V_{RRM}[1] REPETITIVE T_J = 0°C to +125°C	TRANSIENT PEAK REVERSE VOLTAGE[1], V_{RSM} T_J = -40°C to +125°C
C613L	2000 Volts	2100 Volts	2100 Volts
C613PT	1900	2000	2000
C613PN	1800	1900	1900
C613PS	1700	1800	1800
C613PM	1600	1700	1700
C613PE	1500	1600	1600

Consult factory for lower rated voltage devices.

Peak One-Cycle Surge On-State Current, I_{TSM} (8.3 msec) .... 6,500 Amperes
Maximum Rate-of-Rise of Anode Current Turn-On Interval[2] .... Switching from 1200 Volts, 500 A/μsec
Repetitive Rate-of-Rise of Anode Current .... Switching from 1200 Volts, 200 A/μsec
I^2t (for fusing) (at 1.5 milliseconds) (See Figure 9) .... 80,000 Ampere² Seconds
Peak Gate Power Dissipation, P_{GM} .... 50 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ .... 5 Watts
Peak Reverse Gate Voltage, V_{GRM} .... 20 Volts
Storage and Operating Temperature, T_{stg} and T_J .... Refer Above
Mounting Force Required .... 3500 – 4200 Lbs.
15.6 – 18.7 KN

NOTES:

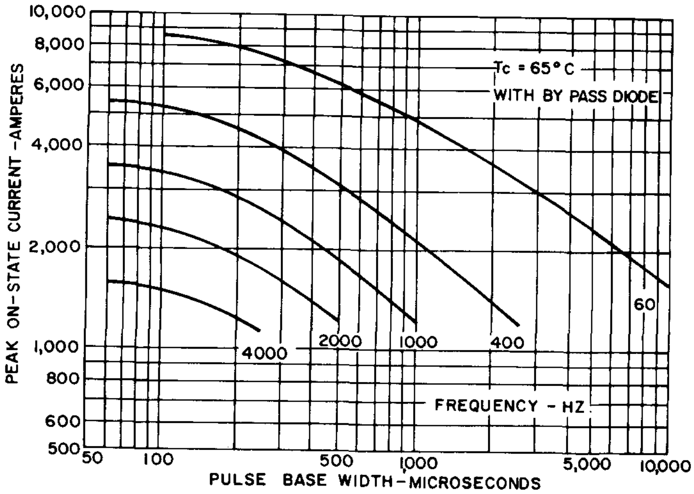
[1] 10 msec voltage sinewave.

[2] di/dt rating established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6. This di/dt is in addition to the discharge of a 0.2 μf, 20 ohm snubber circuit in parallel with the DUT. This is a non-repetitive rating.

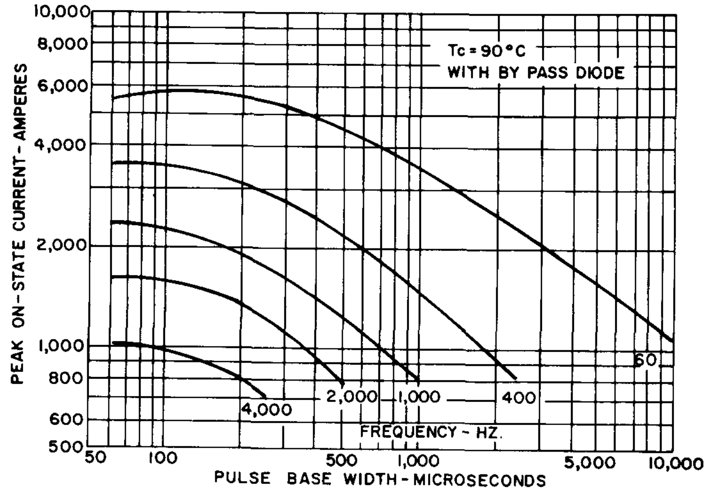
CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Off-State and Reverse Currents	I_{DRM} and I_{RRM}	–	10	15	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Peak Off-State and Reverse Currents	I_{DRM} and I_{RRM}	–	45	60	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Effective Thermal Resistance Junction-to-Case	$R_{\theta JC}$	–	–	.04	°C/Watt	Double-Side Cooled (DC)
Critical Linear Rate-of-Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	400	–	–	V/μsec	T_J = +125°C, V_{DRM} = .80 Rated Gate Open[1]
Delay Time	t_d	–	1.6	3.0	μsec	Switching from 900 Volts, 20 Volt, 10 Ohm Gate 0.5 μsec Rise Time, T_J = 25°C
Gate Pulse Width Necessary to Trigger		–	–	10	μsec	See Figure 11.
Gate Trigger Current	I_{GT}	–	120	180	mAdc	T_C = 25°C, V_D = 0 Vdc, R_L = 3 Ohms
		5.0	30	–		T_C = +125°C, V_D = .5 x Rated, R_L = 1000 Ohms
Gate Trigger Voltage	V_{GT}	–	3.5	5.0	Vdc	T_C = 25°C, V_D = 10 Vdc, R_L = 3 Ohms
		.3	–	–		T_C = 125°C, V_D = .5 x Rated, R_L = 1000 Ohms
Peak On-State Voltage	V_{TM}	–	–	2.9	Volts	T_C = +125°C, I_T = 2000 Amps. Peak Duty Cycle ⩽ 0.01%
Conventional Circuit Commutated Turn-Off Time (With Reverse Voltage)	t_q	–	40	–	μsec	(1) T_C = +125°C (2) I_T = 500 Amps. (3) V_R ⩾ 50 Volts (4) 80% V_{DRM} Reapplied[1] (5) Rate-of-rise of Forward Blocking Voltage = 400 V/μsec. (6) Gate Bias = Open During Turn-Off Interval = 0 Volts, 100 Ohms (7) Duty Cycle ⩽ 0.01%
Conventional Circuit Commutated Turn-Off Time (With Feedback Diode)	t_q	–	45	50	μsec	(1) T_C = +125°C (2) I_T = 500 Amps. (3) V_R = 2 Volts Min. (4) 80% V_{DRM} Reapplied[1] (5) Rate-of-rise of Forward Blocking Voltage = 400 V/μsec. (6) Gate Bias = Open During Turn-Off Interval (7) Duty Cycle ⩽ 0.01%

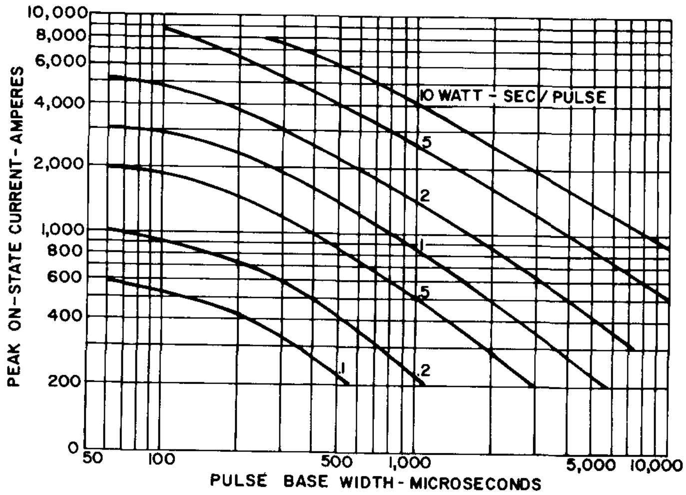
[1] 1440 V is maximum for C613PT and C613L.



1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



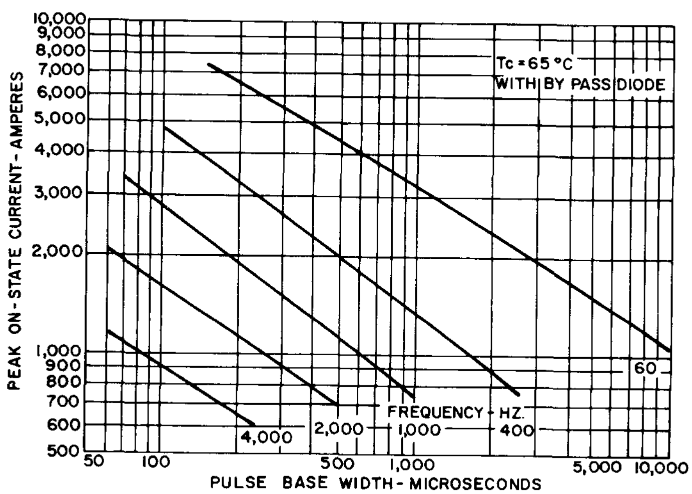
2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



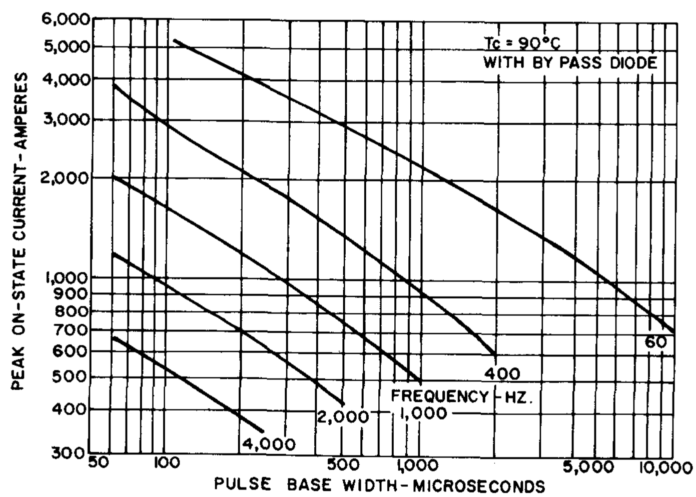
3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

NOTES:

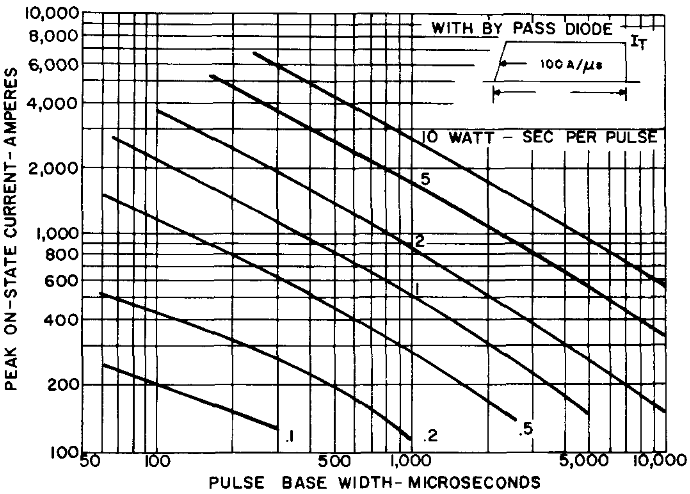
1. Switching voltage range: V_D = 15V – 0.8 V_{DRM}.
2. Peak snubber discharge current ⩽50A. RC ⩽10μsec.
3. High gate drive: 20V/10 Ohms, 0.5μsec rise time.
4. Reverse voltage < 50V. If no bypass diode is used, *reverse recovery losses must be added.*



4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT FOR RISING DI/DT = 100 A/μSEC. (T_C = 65°C)



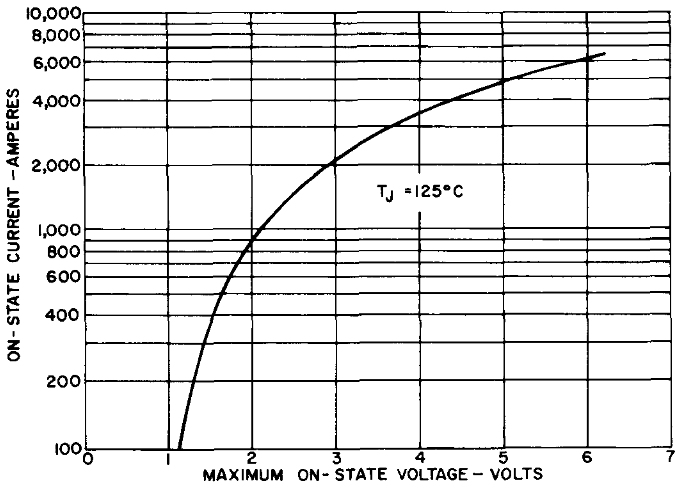
5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT FOR RISING DI/DT = 100A/μSEC. (T_C = 90°C)



6. ENERGY PER PULSE FOR TRAPEZOIDAL CURRENT WAVEFORMS FOR 100A/µSEC. RISING DI/DT

NOTES:

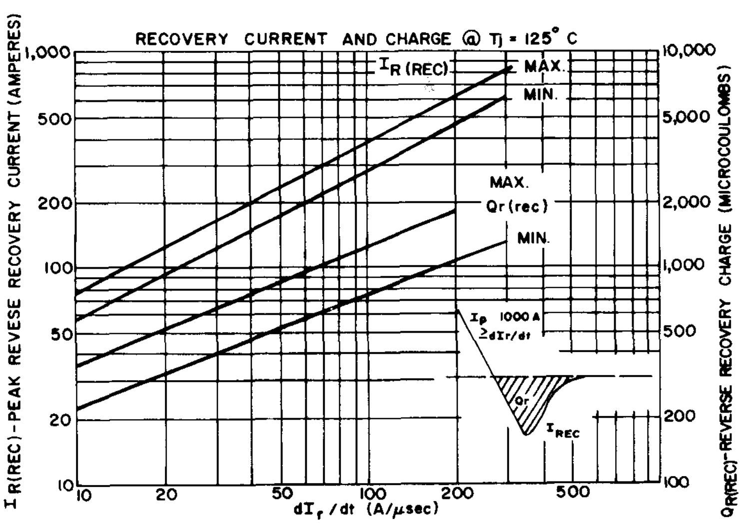
1. Switching voltage range: V_D = 15V – 0.8 V_{DRM}.
2. Peak snubber discharge current ⩽50A. RC ⩽10µsec.
3. High gate drive: 20V/10 Ohms, 0.5µsec rise time.
4. Reverse voltage ⩽50V.



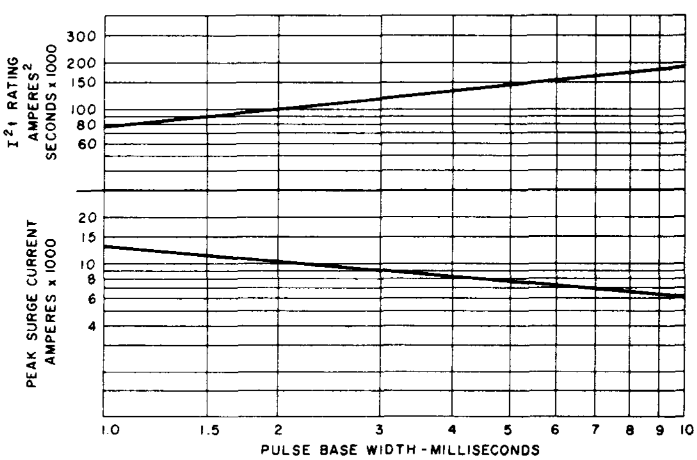
7. FORWARD CONDUCTION CHARACTERISTICS ON-STATE

NOTES:

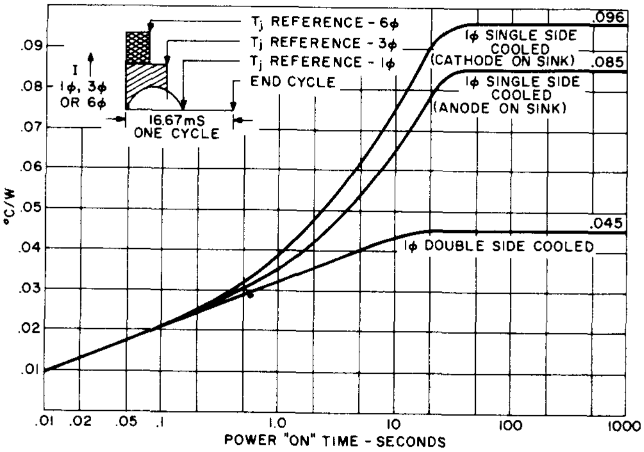
VOLTAGE (Volts)	CURRENT (Amps)
1.145	100
1.300	200
1.423	300
1.533	400
1.634	500
1.731	600
1.824	700
1.914	800
2.002	900
2.089	1000
2.174	1100
2.257	1200
2.340	1300
2.422	1400
2.503	1500
2.900	2000
3.665	3000
4.410	4000
5.142	5000
5.865	6000



8. RECOVERED CHARGE (125°C)



9. SUB-CYCLE SURGE AND I^2t RATING FOLLOWING RATED LOAD CONDITIONS (Sinusoidal Waveform)



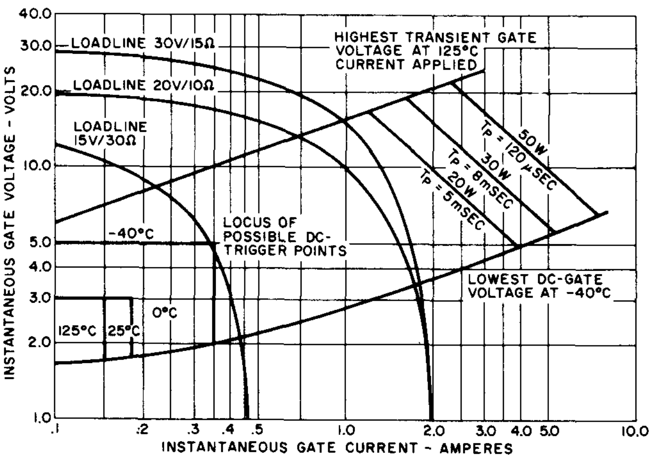
10. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE

NOTES:

For 3ϕ thermal resistance add .0037°C/W along entire curve length.

For 6ϕ thermal resistance add .001°C/W along entire curve length.

For DC thermal resistance subtract .005°C/W along entire curve length.

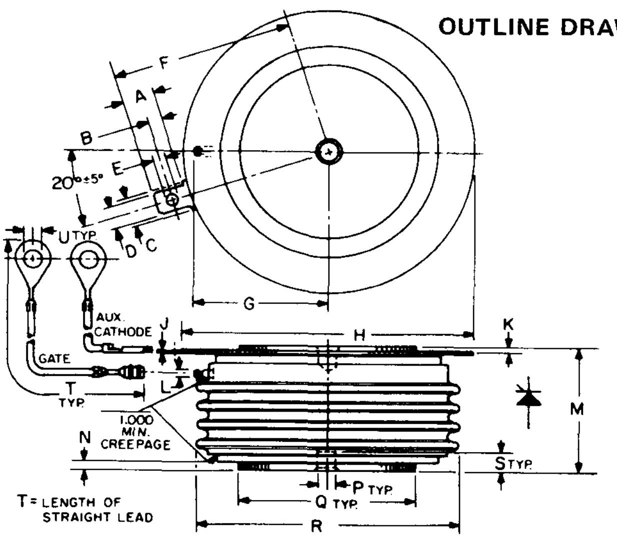


11. MAXIMUM ALLOWABLE PEAK GATE POWER VS. GATE PULSE WIDTH

NOTES:

1. Maximum allowable gate dissipation = 3 watts.
2. The locus of possible DC-trigger points lies outside the boundaries shown at various junction temperatures.
3. Loadlines 30V/15 Ω, 20V/10 Ω and similar are recommended as minimum gate drives for most inverter application; rise time ⩽0.5μsec; T_p ⩾10μsec.
4. Loadline 15V/30 Ω is the minimum usable gate drive. Snubber resistances must be > 30 Ω when turning on from ⩾800V bias. Delay-time may be increased. di/dt rating ⩽100A/μsec.

OUTLINE DRAWING



SYM	DECIMAL INCHES MIN.	MAX.	METRIC M.M. MIN.	MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.702	2.11
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

C613

ASSEMBLY OF PRESSPAKS TO HEAT DISSIPATORS

The following instruction is essential for maintaining low, stable thermal and electrical resistances associated with the Presspak to heat dissipator surfaces.

1. **INSPECTION OF MATING SURFACES**
   Check each mating surface for nicks, scratches, flames and surface finish. The Presspak surface has a total indicator reading TIR < .0005 inch and surface 32 finish prior to factory electrical test in pressure fixtures. The dissipator surface should be equally as good. The TIR of a fully tested Presspak may run higher but not exceed .001 inch not including some minor nicks and scratches also associated with test fixtures. (Recommended mounting force is based upon these requirements.)

2. **SURFACE DEOXIDATION AND CLEANING**
   Although plated surfaces are recommended for aluminum and copper heat dissipators, bare surfaces may be used if careful attention to cleaning and treating is assured. Plated surfaces and Presspaks should be *lightly sanded* with 600 grit paper, then oil or compound applied as recommended. Unplated surfaces should be vigorously abraided with a fine wire brush or 3M "Scotchbrite" coated with Alcoa #2 compound. The Alcoa #2 should be removed and the recommended compound applied.

3. **FINAL SURFACE TREATMENT** ⓐ ⓑ
   Apply silicone oil or *thin layer* of grease or compound as indicated below. Rotate the Presspak to properly distribute the applied agent.
   - bare copper – use G322L or LS2037*;
   - bare aluminum – use Alcoa #2 or G322L;
   - tin-plated copper or aluminum – use SF1154 preferably, or G623 or G322L;
   - nickel-plated aluminum – use SF1154 or G623;
   - silver-plating is not recommended.

4. **MOUNTING**
   Assemble with specified mounting force applied through a self-leveling swivel connection. The force has to be evenly distributed over the full area. Center holes on top and bottom of the Presspak are for locating.

NOTES:

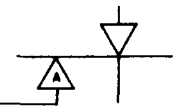
ⓐ Silicone oil SF1154, 200 centistoke, clear silicone grease G623, and yellow compound G322L are products of the General Electric Company; compound Alcoa #2 is a product of Aluminum Company of America; and LS2037 black compound is product of Arco Company, 7301 Bessemer Avenue, Cleveland, Ohio.

ⓑ Limit maximum joint temperature to 95°C, except for those prepared with SF1154 or G322L, which are limited to 150°C.

HIGH SPEED
Silicon Controlled Rectifier

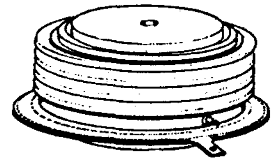
C648

1200 Volts 1150 A RMS



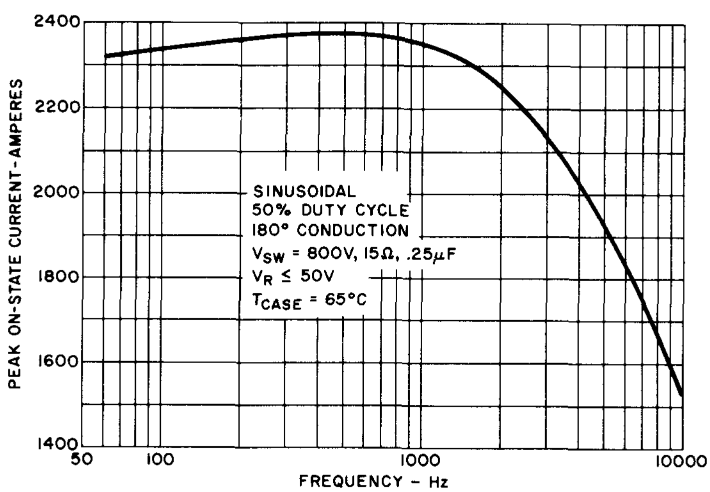
AMPLIFYING GATE

The General Electric C648 Silicon Controlled Rectifier is designed for power switching at high frequencies. This is an all-diffused Press-Pak device employing the field-proven interdigitated amplifying gate system.



FEATURES:

- Interdigitated gate structure to maximize high frequency current switching capability.
- Fully characterized for operation in inverter applications.
- High di/dt ratings.
- High dv/dt capability with selections available.
- Guaranteed maximum turn-off time with selections available.
- Rugged hermetic glazed ceramic package having 1″ creepage path.



Equipment designers can use the C648 SCR in demanding applications, such as:

- Choppers
- Inverters
- Regulated Power Supplied
- Sonar Transmitters
- Induction Heaters
- Ratio Transmitters
- Cycloconverters
- Dc to DC Converters
- High Frequency

FOR SINE WAVE OPERATION

Like the Types C358, C385, C388, C395 and C398, the C648 SCR is rated for:

- Peak Current
- Frequency

vs.

- Pulse Width
- Case Temperature

MAXIMUM ALLOWABLE RATINGS

TYPES	REPETITIVE PEAK OFF-STATE VOLTAGE V_{DRM}(1)	REPETITIVE PEAK REVERSE VOLTAGE V_{RRM}(1)	NON-REPETITIVE PEAK REVERSE VOLTAGE V_{RSM}(1)
	T_J = -40°C to +125°C	T_J = -40°C to +125°C	T_J = +125°C
C648E	500 Volts	500 Volts	600 Volts
C648M	600	600	720
C648S	700	700	840
C648N	800	800	960
C648T	900	900	1080
C648P	1000	1000	1200
C648PA	1100	1100	1300
C648PB	1200	1200	1400

1 Half sinewave waveform, 10 ms max. pulse width.

Peak One Cycle Surge (Non-Repetitive) On-State Current, I_{TSM} . . . . 10,000 Amperes
I^2t (for fusing) for times ⩾ 1.5 milliseconds . . . . 190,000 (RMS Ampere)^2 Seconds
I^2t (for fusing) for times ⩾ 8.3 milliseconds . . . . 415,000 (RMS Ampere)^2 Seconds
Critical Rate-of-Rise of On-State Current, Non-Repetitive† . . . . 800 A/μs
Critical Rate-of-Rise of On-State Current, Repetitive† . . . . 500 A/μs
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 2 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force Required . . . . 3000 Lb. + 500 Lb. – 0 Lb.
13.3 KN + 2.2 KN – 0 KN

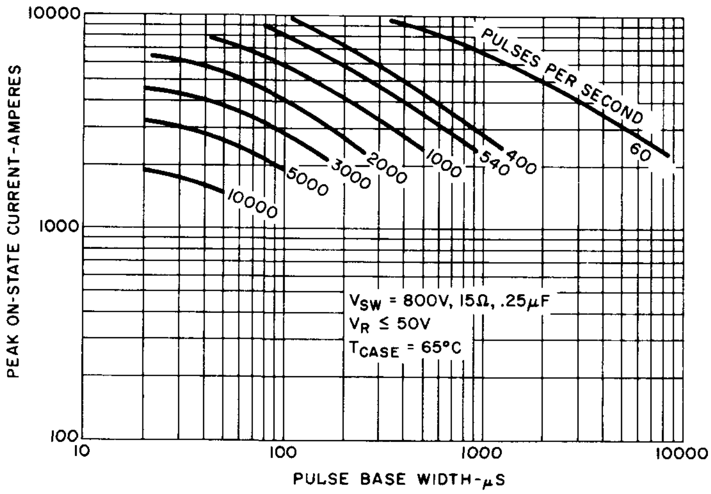
†di/dt ratings established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6 for conditions of max. rated V_{DRM}; 20 volts, 20 ohms gate trigger source with 0.5μs short circuit trigger current rise time.

CHARACTERISTICS

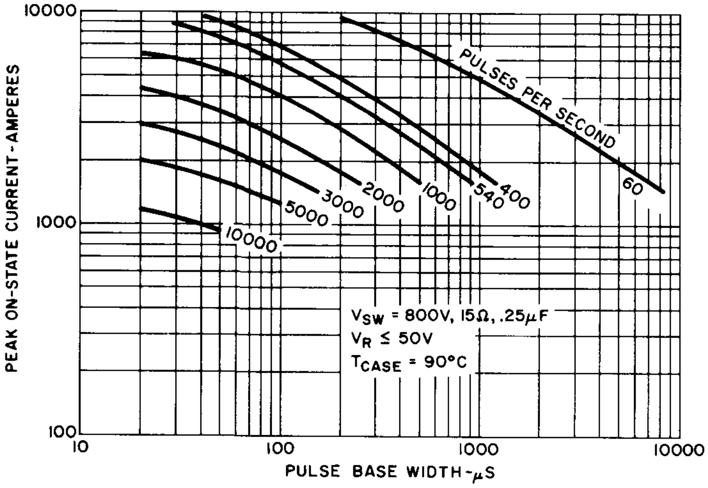
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	5	25	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Repetitive Peak Reverse and Off-State Current	I_{RRM} and I_{DRM}	–	20	45	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Thermal Resistance	$R_{\theta JC}$	–	–	0.04	°C/Watt	Junction-to-Case – Double-Side Cooled
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching.)	dv/dt	400	500	–	V/μsec	T_J = +125°C, Gate Open. 80% of V_{DRM} Reapplied, linear or exponential rising curved form. Exponential dv/dt = $\frac{0.8\ V_{DRM}}{\tau}$ (.632)
Higher minimum dv/dt selections available – consult factory.						
DC Gate Trigger Current	I_{GT}	–	–	150	mAdc	T_J = +25°C, V_D = 6 Vdc, R_L = 3 ohms.
		–	–	350		T_J = -40°C, V_D = 6 Vdc, R_L = 3 ohms.
		–	–	100		T_J = +125°C, V_D = 6 Vdc, R_L = 3 ohms.
DC Gate Trigger	V_{GT}	–	–	3	Vdc	T_J = 25°C to +125°C, V_D = 6 Vdc, R_L = 3 ohms.
		–	–	5		T_J = -40°C to 25°C, V_D = 6 Vdc, R_L = 3 ohms.
		.15	–	–		T_J = 125°C, V_{DRM}, R_L = 1000 ohms.
Peak On-State Voltage	V_{TM}	–	–	1.95	Volts	T_J = +25°C, I_{TM} = 2000 Amps peak. Duty Cycle ⩽ .01%.
Conventional Circuit Commutated Turn-Off Time (with Reverse Voltage)	t_q	–	–	40	μsec	(1) T_J = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 50 Volts Min. (4) 80% of V_{DRM} Reapplied. (5) Rate-of-Rise of Reapplied Off-State Voltage = 400 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms.
Conventional Circuit Commutated Turn-Off Time (with Feedback Diode)	$t_{q(diode)}$†	–	40	†	μsec	(1) T_J = +125°C (2) I_{TM} = 500 Amps. (3) V_R = 1.5 Volts (4) 80% of V_{DRM} Reapplied. (5) Rate-of-Rise of Reapplied Off-State Voltage = 400 V/μsec (linear). (6) Commutation di/dt = 25 Amps/μsec. (7) Repetition Rate = 1 pps. (8) Gate Bias During Turn-Off Interval = 0 Volts, 100 Ohms.

†Consult factory for maximum turn-off time.

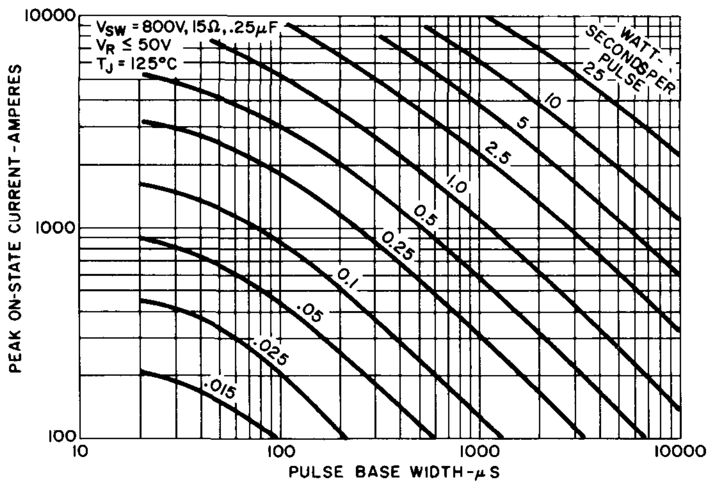
SINE WAVE CURRENT RATING DATA



1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)



3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

NOTES:

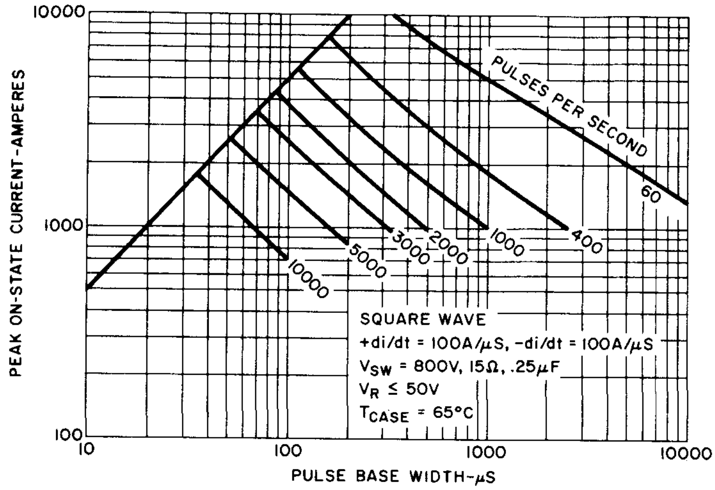
(Pertaining to Sine and Trapezoidal Wave Current Ratings)

2. Reverse voltage ⩽ 50 volts.
3. R-C snubber current, 15Ω, .25μf.
4. Energy per pulse graph includes reverse recovery losses but no blocking power. Blocking power on an energy per pulse basis is approximately:

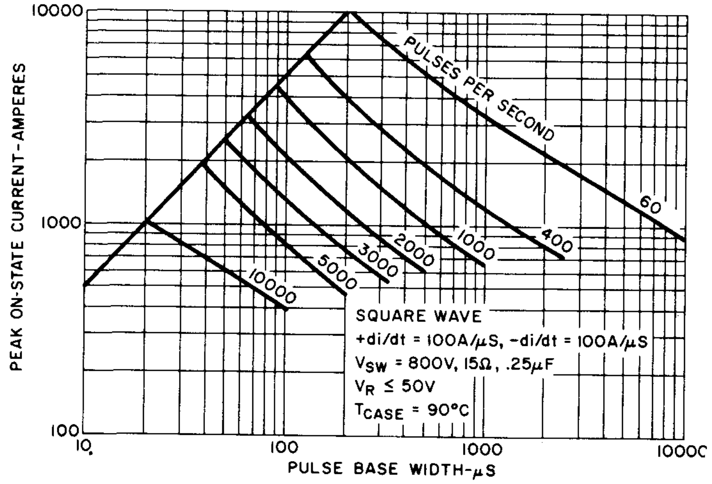
$$WS/P = (\text{RMS Value of Blocking Voltage}) \times \frac{\text{Maximum Leakage Current}}{\text{Frequency}}$$

This energy should be added to values from curves.

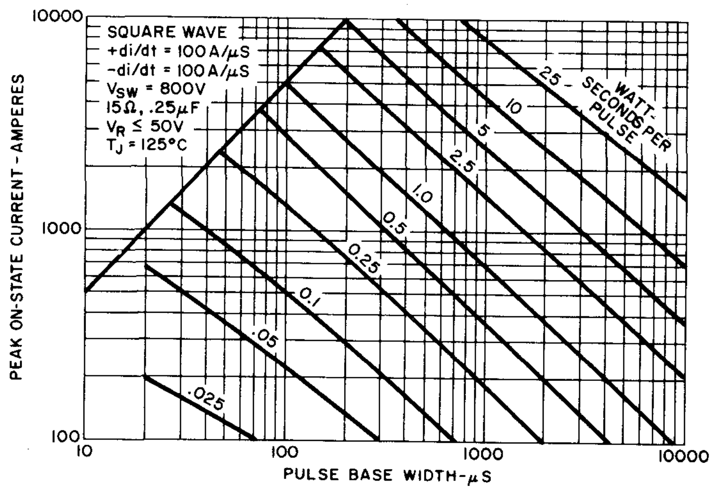
TRAPEZOIDAL WAVE CURRENT RATING DATA



4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 65°C)



5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH (T_C = 90°C)

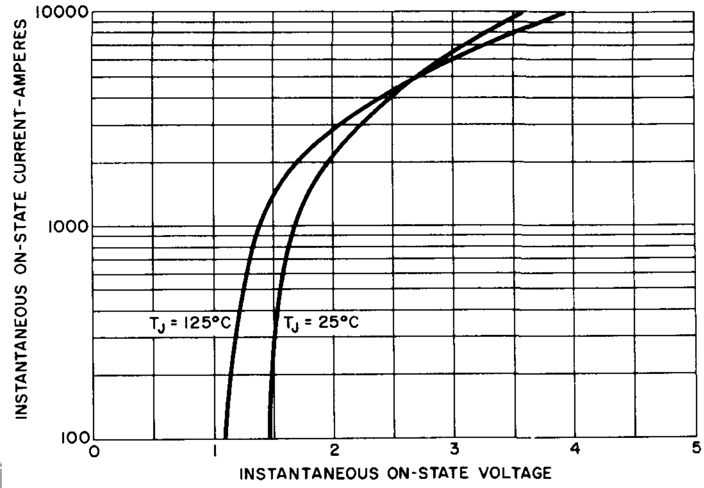


Includes reverse recovery losses but no blocking power. Blocking power on an energy per pulse basis is approximately:

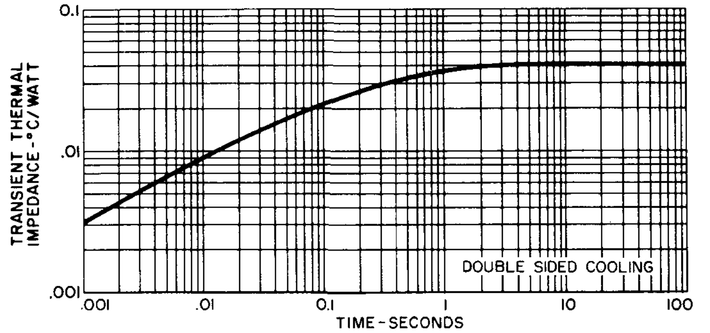
$$WS/P = (\text{RMS Value of Blocking Voltage}) \times \frac{\text{Maximum Leakage Current}}{\text{Frequency}}$$

This energy should be added to values from curves.

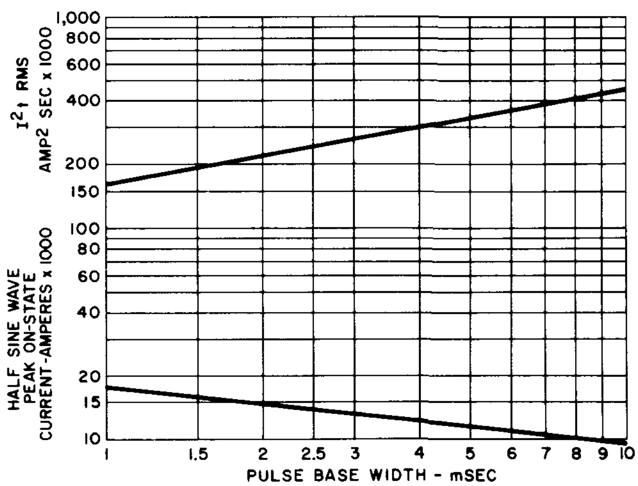
6. ENERGY PER PULSE VS. PEAK CURRENT AND PULSE WIDTH (di/dt = 10U A/μSEC)



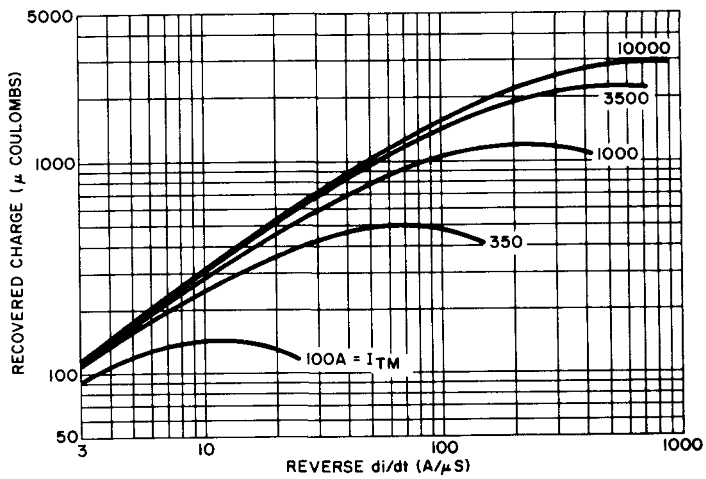
7. MAXIMUM ON-STATE CHARACTERISTICS



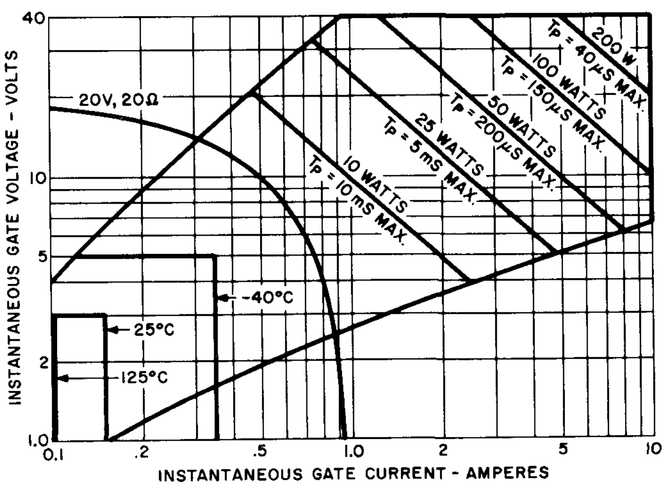
8. TRANSIENT THERMAL IMPEDANCE — JUNCTION-TO-CASE



9. SUB-CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATING



10. TYPICAL RECOVERED CHARGE (125°C) SINEWAVE CURRENT WAVEFORM

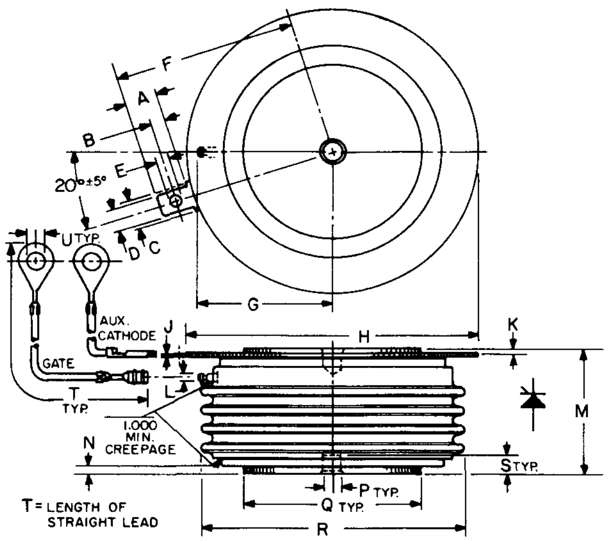


NOTES:

1. The locus of possible dc trigger points lies outside the boundaries shown at various case temperatures.
2. T_p = rectangular gate current pulse width.
3. 20V-20Ω is the minimum gate source loadline when rate of circuit current rise > 100 Amp/μs. Maximum long-term repetitive anode di/dt = 500 Amp/μs with 20V-20Ω gate source.

11. GATE TRIGGER CHARACTERISTICS AND POWER RATINGS

OUTLINE DRAWING



SYM	DECIMAL INCHES MIN.	MAX.	METRIC M.M. MIN.	MAX.
A	.240	.260	6.096	6.604
B	.110	.130	2.794	3.302
C	.245		6.223	
D	.186	.191	4.724	4.851
E	.060	.075	1.524	1.905
F		1.430		36.32
G		1.065		27.051
H	2.200	2.500	55.88	63.50
J	.011	.019	2.794	3.483
K	.030	.130	.762	3.302
L	.056	.060	1.422	1.524
M	1.000	1.065	25.40	27.05
N	.030	.096	.762	2.438
P	.130	.150	3.302	3.810
Q	1.300	1.345	33.02	34.16
R		2.150		54.61
S	.067	.083	1.702	2.110
T	12.200	12.360	309.9	313.9
U	.137	.153	3.480	3.886

SUGGESTED MOUNTING METHODS FOR PRESS-PAKS TO HEAT DISSIPATORS

When the Press-Pak is assembled to a heat sink in accordance with the following general instructions, a reliable and low thermal interface will result.

1. Check each mating surface for nicks, scratches, flatness and surface finish. The heat dissipator mating surface should be flat within .0005 inch/inches and have a surface finish of 63 micro-inches.

2. It is recommended that the heat dissipator mounting surfaces be plated with nickel, tin, or silver. Bare aluminum or copper surfaces will oxidize in time resulting in excessively high thermal resistance.

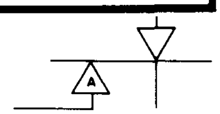
3. Sand each surface lightly with 600 grit paper just prior to assembly. Clean off and apply silicon oil (GE SF1154, 200 centistoke viscosity) or silicone grease (GE G322L or Dow Corning DC 3, 4, 340 or 640). Clean off and apply again as a thin film. (A thick film will adversely affect the electrical and thermal resistances.)

4. Assemble with the specified mounting force applied through a self-leveling, swivel connection. The force has to be evenly distributed over the full area. Center holes on both top and bottom of the Press-Pak are for locating purposes only.

High Power Silicon Controlled Rectifier

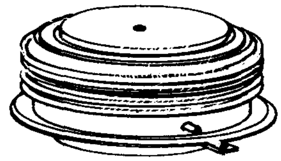
1250 A Avg., up to 2000 Volts

C701



AMPLIFYING GATE

The C701 Series of high power SCR's feature the newly developed multi-diffusion technology using 53mm diameter silicon in a new, pressure-mounted package for phase control.



FEATURES:

- 1250 Amps. Average Single Phase Current @ T_C = 60°C
- 20,000 Amps. Surge Current
- Glazed Ceramic Hermetic Package with 1" Creepage Path
- Reliability of Pressure Contacts Plus Reversibility of the Package
- Available in Factory Assembled Heat Exchanger or Ready-to-Mount
- Complementary Rectifiers

IMPORTANT: Mounting instructions on the last page of this specification **must** be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE AND REVERSE VOLTAGE, V_{DRM}/V_{RRM}[1] T_J = -40°C to +125°C	REPETITIVE PEAK OFF-STATE AND REVERSE VOLTAGE, V_{DRM}/V_{RRM}[1] T_J = 0°C to +125°C	TRANSIENT PEAK REVERSE VOLTAGE (NON-RECURRENT <5 MILLISEC.), V_{RSM} T_J = -40°C to +125°C
C701PA	1100 Volts	1200 Volts	1200 Volts
C701PB	1200	1300	1300
C701PC	1300	1400	1400
C701PD	1400	1500	1500
C701PE	1500	1600	1600
C701PM	1600	1700	1700
C701PS	1700	1800	1800
C701PN	1800	1900	1900
C701PT	1900	2000	2000
C701L	2000	2100	2100

[1] V_{DRM}/V_{RRM} ratings assume Presspak mounted to a heat dissipator of less than 0.3°C/W.

Average Forward Current, On-State . . . . Depends on Conduction Angle
Peak One-Cycle Surge On-State Current, I_{TSM} . . . . 20,000 Amperes
Maximum Rate-of-Rise of Anode Current Turn-On Interval
(Switching Rates ≤ 60 Hz) . . . . Switch From <1000V 150A/μsec
I^2t (for fusing) (at 8.3 milliseconds) . . . . 1,660,000 Ampere^2 Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 40 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 5 Watts
Peak Reverse Gate Voltage, V_{GRM} . . . . 5 Volts
Storage Temperature, T_{STG} . . . . -40°C to +125°C
Operating Temperature, T_J . . . . -40°C to +125°C
Mounting Force Required . . . . **5000 – 7000 Lbs.**
22.2 – 31.2 KN

NOTES:

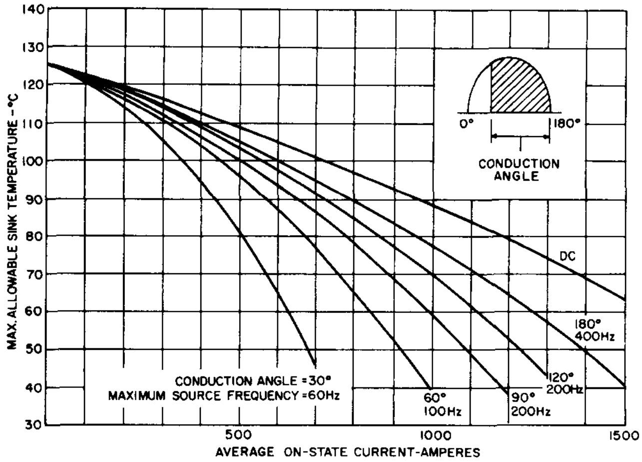
Surge current rating is established in accordance with EIA-NEMA Standard RS-397, Paragraph 5.2.2.1.

Required trigger source – 20 volts, 10 ohms; maximum switching voltage – 1000 volts; short-circuit gate supply current risetime – 0.5μsec. (This short-circuit current may be measured with a TEKTRONICS current probe): RC Snubber circuit used across SCR: 22 ohms, 0.5μf.

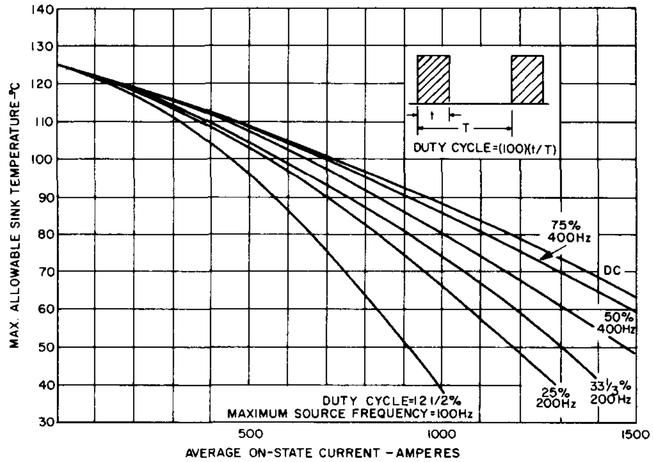
Repetitive di/dt rating is established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6.

CHARACTERISTICS

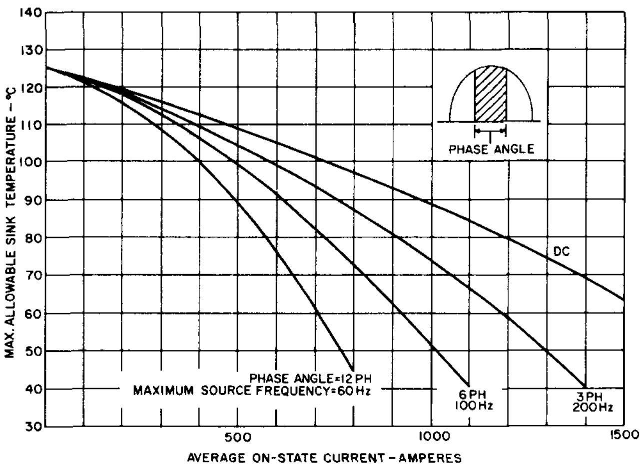
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Off-State Blocking Current	I_{DRM} and I_{RRM}	–	10	15	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Peak Reverse and Off-State Blocking Current	I_{DRM} and I_{RRM}	–	45	65	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Effective Thermal Resistance, Junction-to-Case	$R\theta_{JC}$	–	–	.023	°C/Watt	Junction-to-Case – Double Side Cooled (DC)
Critical Linear Rate-of-Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, V_{DRM} = .80 Rated, Gate Gate Open.
Holding Current	I_H	–	–	500	mAdc	T_C = +25°C, Anode supply = 20 Vdc. Initial On-State Current = 500 amps.
Latching Current	I_L	–	–	1.5	Adc	T_C = +25°C, Anode voltage = 24 Vdc. Load resistance 12 ohms max.
Delay Time	t_d	–	1.5	–	μsec	Switching From 300 Volts. 20 volt, 10 ohm Gate. 0.5 μsec Rise Time, T_J = 25°C
Gate Pulse Width Necessary to Trigger		–	–	10	μsec	See Figure 8
Gate Trigger Current	I_{GT}	–	60	150	mAdc	T_C = 25°C, V_D = 10 Vdc, R_L = 3 ohms
See Figure 8		5.0	15	50		T_C = +125° C, V_D = .5 x Rated, R_L = 1000 ohms
Gate Trigger Voltage	V_{GT}	–	2.5	4.5	Vdc	T_C = 0°C to +125°C, V_D = 10 Vdc, R_L = 1000 ohms
See Figure 8		.3	–	–		T_C = +125°C, V_D = .5 x Rated, R_L = 1000 ohms
Peak On-State Voltage	V_{TM}	–	–	1.70	Volts	T_C = -40°C to +125°C, I_T = 3000 Amps. Peak. Duty Cycle ⩽ 0.01%
Circuit Commutated Turn-Off Time	t_q	–	125	250	μsec	(1) T_C = +125°C (2) I_T = 1000 Amps. (3) V_R = 75 Volts min. (4) 0.5 V_{DRM} Reapplied (5) Rate-of-rise of reapplied forward blocking voltage = 50V/μsec. (linear) (6) Gate bias during turn-off interval, Duty cycle ⩽ 0.01%
Suppressible Surge Current	$I_{TM(SUP)}$	–	1800	–	Amps	(1) T_C = 115°C' (2) V_R = .67 V_{DRM} (3) .67 V_{RRM} Applied, 8.3 msec after completion of surge. (4) Figure 10.



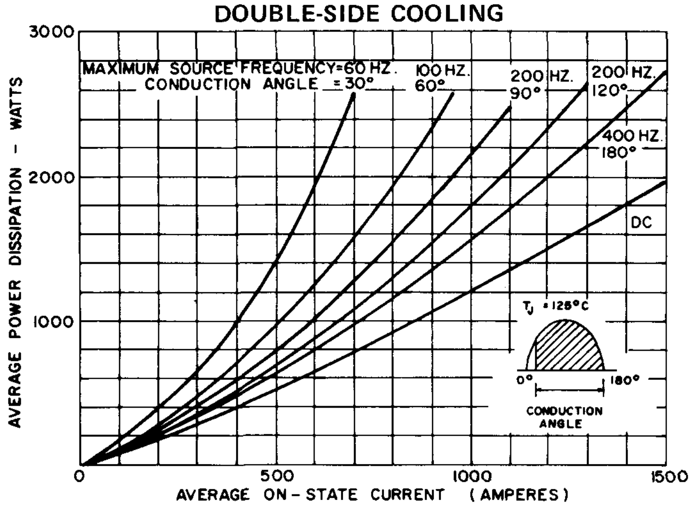
1. MAXIMUM ALLOWABLE HEATSINK TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM – DOUBLE-SIDE COOLING



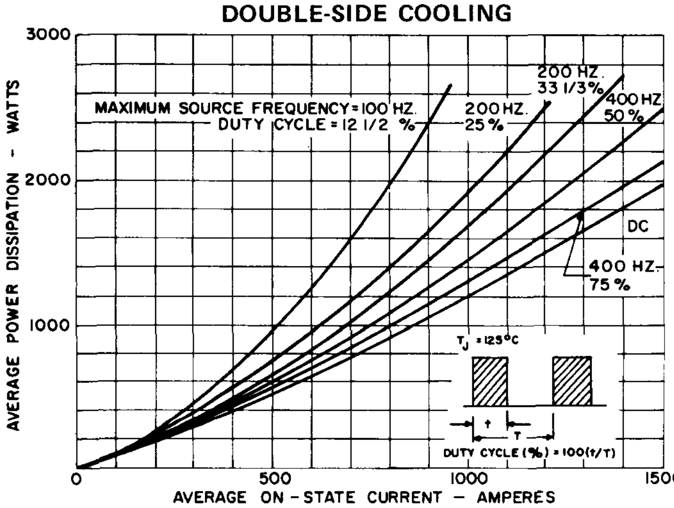
2. MAXIMUM ALLOWABLE HEATSINK TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM – DOUBLE-SIDE COOLING



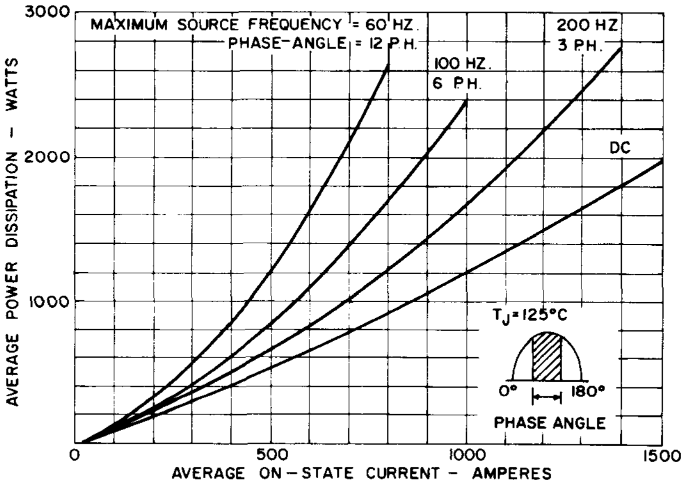
3. MAXIMUM ALLOWABLE HEATSINK HEATSINK TEMPERATURE – CIRCUIT PHASE CURRENT WAVEFORM – DOUBLE-SIDE COOLING



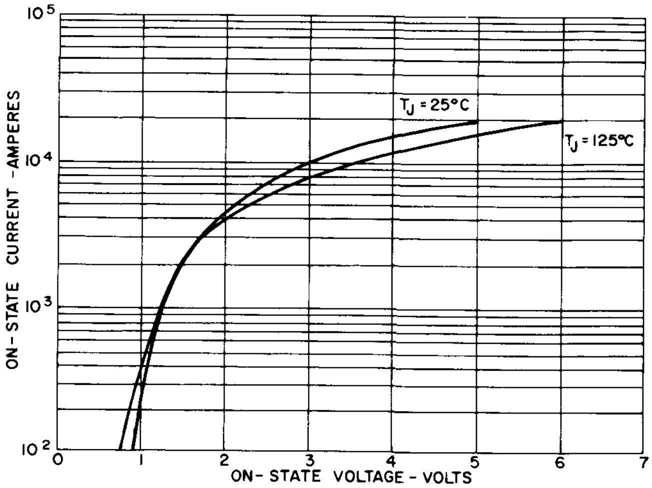
4. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



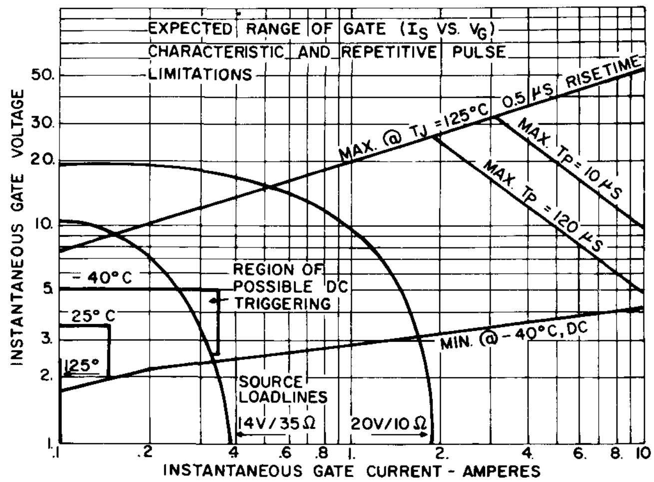
5. FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



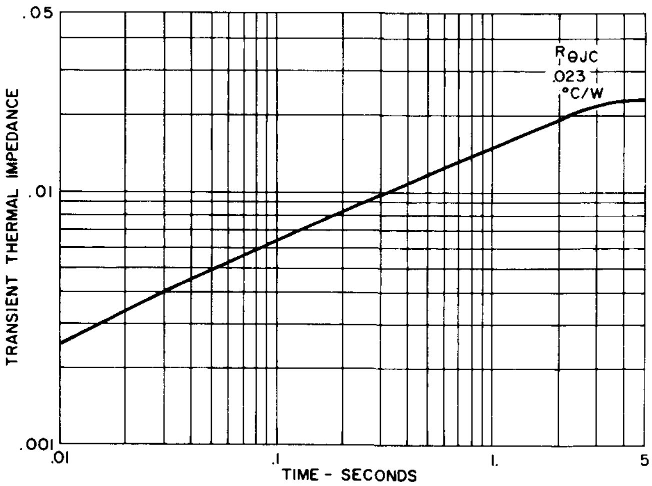
6. AVERAGE FORWARD POWER DISSIPATION



7. MAXIMUM ON-STATE CHARACTERISTICS



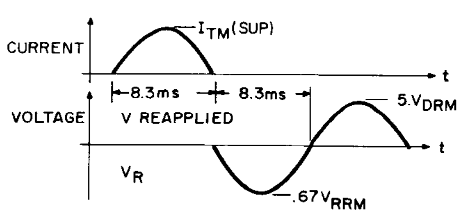
8. TRIGGERING CHARACTERISTICS



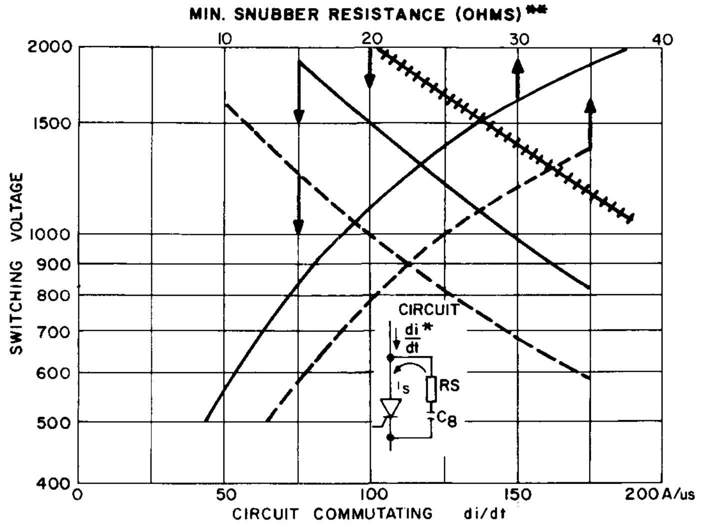
9. TRANSIENT THERMAL RESISTANCE — JUNCTION-TO-HEATSINK

NOTES:

1. Add .006°C/W to account for both case to dissipator interfaces when properly mounted; e.g., $R\theta_{JS}$ = .029° C/W. See Mounting Instructions.
2. DC Thermal Impedance is based on average full cycle junction temperature. Instantaneous junction temperature may be calculated using the following modifications:
   - end of conducting portion of cycle
     - 120° sq. wave add .0025°C/W along entire curve
     - 180° sq. wave add .0018°C/W along entire curve
     - 180° sine wave add .0010°C/W along entire curve
   - end of full cycle
     - any wave, subtract .001°C/W along entire curve.



10. SUPPRESSIBLE SURGE CURRENT TEST



NOTES:

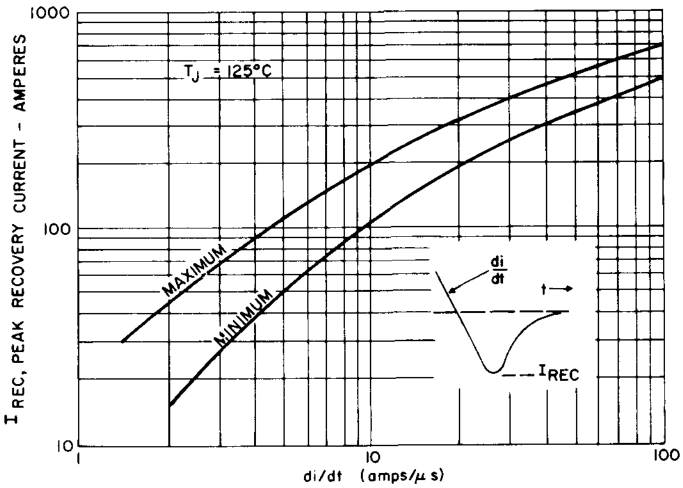
Code:
- +++++ Non-Repetitive High Gate Drive
- ——— Repetitive High Gate Drive
- — — Non-Repetitive Low Gate Drive
- - - - Repetitive Low Gate Drive

	Low Gate Drive	High Gate Drive
Source	14V/35 ohms	20V/10 ohms
Pulse Width, t_p	$\geqslant 20\ \mu s$	$\geqslant 10\ \mu s$
Current Rise Time, t_r	$\leqslant 2$	$\leqslant 0.5\ \mu s$

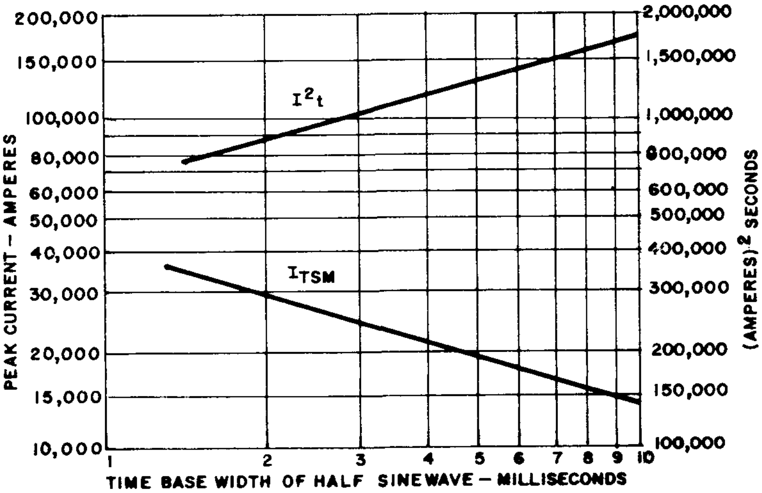
*Permissible circuit di/dt excluding snubber discharge. Repetitive di/dt is SPCO recommended maximum condition to achieve most industrial requirements for service life. It meets or exceeds the JEDEC test requirements for certification set forth in NEMA Std. Sk. 516 (1972). Non-repetitive di/dt meets the JEDEC 5 second rating.

**Snubber discharge, i_s, is treated separately using the minimum value of snubber resistance indicated above. This applies for long industrial life (20 – 30 years) in combination with circuit di/dt.

11. ALLOWABLE DI/DT AND SNUBBER RESISTANCE

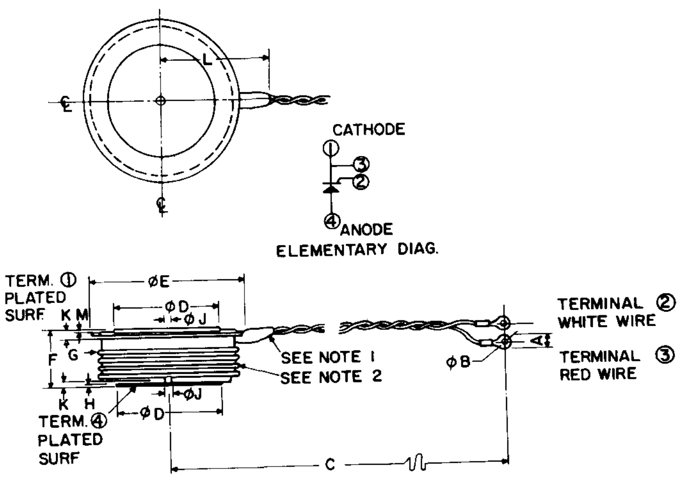


12. PEAK RECOVERY CURRENT



13. NON-REPETITIVE I_{TSM} AND I^2t CAPABILITY FOR FUSE COORDINATION

OUTLINE DRAWING



SYMBOL	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX	NOTES
A	0.200	0.240	5.08	6.10	1
Φ B	0.140		3.56		
C	16.000	20.000	406.40	508.00	
Φ D	1.700	1.900	43.18	48.26	
Φ E		2.960		75.18	
F	1.000	1.070	25.40	27.18	
G					2.
H	.005	.067	0.13	1.70	
Φ J	0.136	0.146	3.45	3.71	
K	.070		1.78		
L		2.500		63.50	
M	.030		0.76		

C701
ASSEMBLY OF PRESSPAKS TO HEAT DISSIPATORS

The following instruction is essential for maintaining low, stable thermal and electrical resistances associated with the Presspak to heat dissipator surfaces.

1. **INSPECTION OF MATING SURFACES**
   Check each mating surface for nicks, scratches, flames and surface finish. The Presspak surface has a total indicator reading TIR < .0005 inch and surface 32 finish prior to factory electrical test in pressure fixtures. The dissipator surface should be equally as good. The TIR of a fully tested Presspak may run higher but not exceed .001 inch not including some minor nicks and scratches also associated with test fixtures. (Recommended mounting force is based upon these requirements.)

2. **SURFACE DEOXIDATION AND CLEANING**
   Although plated surfaces are recommended for aluminum and copper heat dissipators, bare surfaces may be used if careful attention to cleaning and treating is assured. Plated surfaces and Presspaks should be *lightly sanded* with 600 grit paper, then oil or compound applied as recommended. Unplated surfaces should be vigorously abraided with a fine wire brush or 3M "Scotchbrite" coated with Alcoa #2 compound. The Alcoa #2 should be removed and the recommended compound applied.

3. **FINAL SURFACE TREATMENT** [a] [b]
   Apply silicone oil or *thin layer* of grease or compound as indicated below. Rotate the Presspak to properly distribute the applied agent.
   - bare copper – use G322L or LS2037*;
   - bare aluminum – use Alcoa #2 or G322L;
   - tin-plated copper or aluminum – use SF1154 preferably, or G623 or G322L;
   - nickel-plated aluminum – use SF1154 or G623;
   - silver-plating is not recommended.

4. **MOUNTING**
   Assemble with specified mounting force applied through a self-leveling swivel connection. The force has to be evenly distributed over the full area. Center holes on top and bottom of the Presspak are for locating.

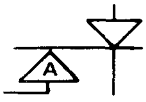
NOTES:

a) Silicone oil SF1154, 200 centistoke, clear silicone grease G623, and yellow compound G322L are products of the General Electric Company; compound Alcoa #2 is a product of Aluminum Company of America; and LS2037 black compound is product of Arco Company, 7301 Bessemer Avenue, Cleveland, Ohio.

b) Limit maximum joint temperature to 95°C, except for those prepared with SF1154 or G322L, which are limited to 150°C.

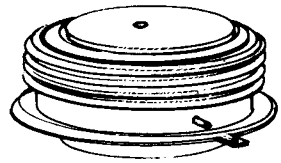
High Power
Silicon
Controlled Rectifier
1000 A Avg. Up To 2400 V

C702



AMPLIFYING GATE

The General Electric C702 Silicon Controlled Rectifier feature the newly developed multi-diffusion technology to combine high blocking voltage capability with low on-state conduction losses.



The C702 is designed specifically for phase control applications like DC motor control and power supplies, cycloconverters and current regulated inverters.

FEATURES:

- High Repetitive DI/DT
- High DV/DT with Higher Selections Available
- Excellent Surge and I^2t Current Ratings for Ease of Fusing
- Rugged Hermetic Ceramic Package with 1″ Creep
- Guaranteed Turn-Off Time Selections of 100 μsec Available
- Complementary Diodes and Mounting Hardware Available

IMPORTANT: Mounting instructions on the last page of this specification **must** be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	REPETITIVE PEAK OFF-STATE AND REVERSE VOLTAGE V_{DRM}/V_{RRM} [2] T_J = -40°C to +125°C	REPETITIVE PEAK OFF-STATE AND REVERSE VOLTAGE V_{DRM}/V_{RRM} [2] T_J = 0°C to +125°C	TRANSIENT PEAK REVERSE VOLTAGE, V_{RSM} [1] T_J = -40°C to +125°C
C702LD	2400 Volts	2500 Volts	2500 Volts
C702LC	2300	2400	2400
C702LB	2200	2300	2300
C702LA	2100	2200	2200
C702L	2000	2100	2100

[1] Half Sine Wave Waveform, 10 msec maximum pulse width.
[2] V_{DRM}/V_{RRM} ratings assume Presspak mounted to a heat dissipator of less than 0.3°C/W.

Average Forward Current, On-State . . . . Depends on Conduction Angle (See Charts 1 and 2)
Peak One-Cycle Surge On-State Current, I_{TSM} . . . . 15,000 Amperes
Maximum Repetitive Rate-of-Rise of Anode Current Turn-On Interval
(Switching Rates ⩽ 60 Hz) . . . . Switch From <1000V 125A/μsec
I^2t (for fusing) (at 8.3 milliseconds) . . . . .933,000 Ampere² Seconds
Peak Gate Power Dissipation, P_{GM} . . . . 200 Watts @ 40μsec Pulse
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 5 Watts
Peak Reverse Gate Voltage, V_{GRM} . . . . 5 Volts
Storage Temperature, T_{STG} . . . .-40°C to +125°C
Operating Temperature, T_J . . . .-40°C to +125°C
Mounting Force Required . . . . 5000 Lb. + 1000 – 0 Lb.
22.2 KN + 4.4 – 0 KN

NOTES:

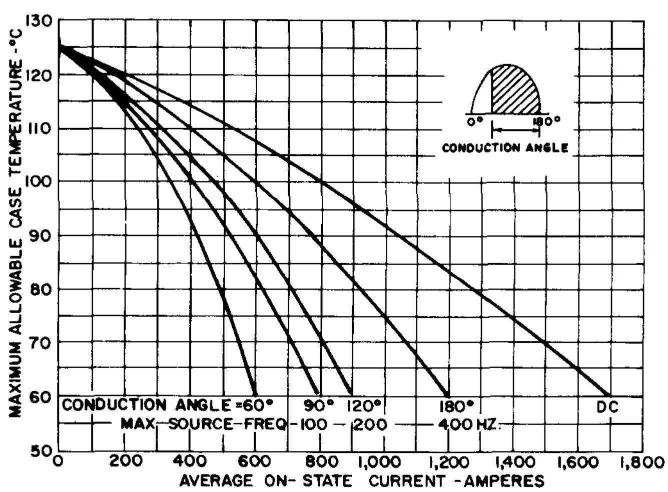
Surge current rating is established in accordance with EIA-NEMA Standard RS-397, Paragraph 5.2.2.1.

Required trigger source – 20 volts, 10 ohms; maximum switching voltage – 1000 volts; short-circuit gate supply current risetime – 0.5μsec. (This short-circuit current may be measured with a TEKTRONICS current probe): RC Snubber circuit used across SCR: 22 ohms, 0.5μf.

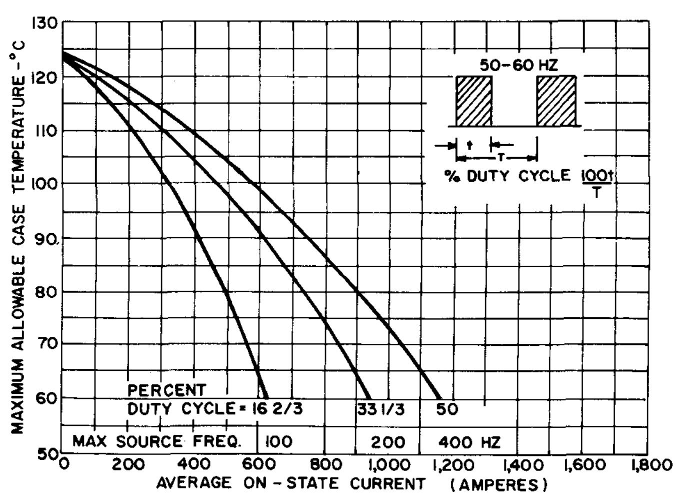
Repetitive di/dt rating is established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2.6.

CHARACTERISTICS

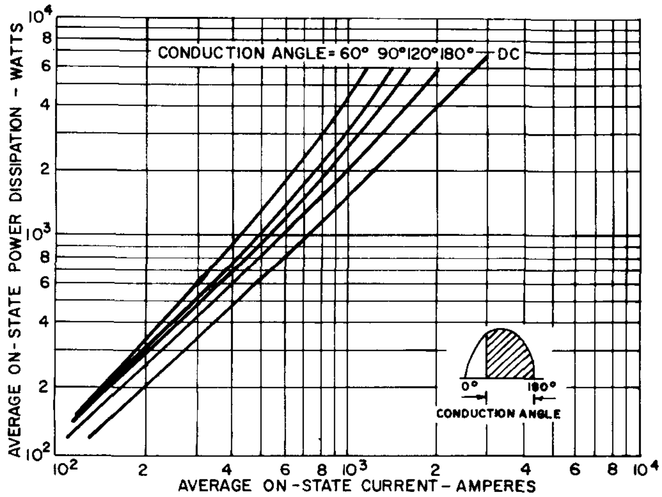
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and Off-State Blocking Current	I_{DRM} and I_{RRM}	–	10	15	mA	T_J = +25°C, V = V_{DRM} = V_{RRM}
Peak Reverse and Off-State Blocking Current	I_{DRM} and I_{RRM}	–	45	65	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Effective Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	–	–	.023	°C/Watt	Junction-to-Case – Double Side Cooled (DC) (Add .006°C/W for $R_{\theta CS}$)
Critical Exponential Rate-of-Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	200	500	–	V/μsec	T_J = +125°C, V_{DRM} = .80 Rated, Gate Open.
Delay Time See Figure 9	t_d	–	1.8	–	μsec	Switching from 300 volts, 20 volt, 10 ohm Gate. 0.5 μsec Rise Time, T_J = 25°C
Gate Pulse Width Necessary to Trigger		–	–	10	μsec	See Figure 9
Gate Trigger Current See Figure 9	I_{GT}	–	70	200	mAdc	T_C = +25°C, V_D = 10 Vdc, R_L = 3 ohms
		5.0	20	35		T_C = +125°C, V_D = .5 x Rated, R_L = 1000 ohms
Gate Trigger Voltage See Figure 9	V_{GT}	–	2.5	4.5	Vdc	T_C = 0°C to +125°C, V_D = 10 Vdc, R_L = 3 ohms
		.3	–	–		T_C = +125°C, V_D = .5 x Rated, V_{DRM}, R_L = 1000 ohms
Peak On-State Voltage	V_{TM}	–	–	2.26	Volts	T_C = 125°C, I_T = 3000 Amps. Peak. Duty Cycle ⩽ 0.01%
Circuit Commutated Turn-Off Time	t_q	–	125	250	μsec	(1) T_C = +125°C (2) I_T = 100 Amps. (3) V_R = 75 Volts min, (4) V_D Reapplied = 0.5 V_{DRM} (5) Rate-of-rise of reapplied forward blocking voltage = 50V/μsec (linear) (6) Gate bias during turn-off interval, Duty Cycle ⩽ 0.01%
Suppressible Surge Current	$I_{TM(SUP)}$	–	13,500	–	Amps	(1) T_C = 115°C (2) V_R = .67 V_{RRM} (3) .67 V_{DRM} Applied, 8.3 msec. after completion of surge. (4) Figure 14.



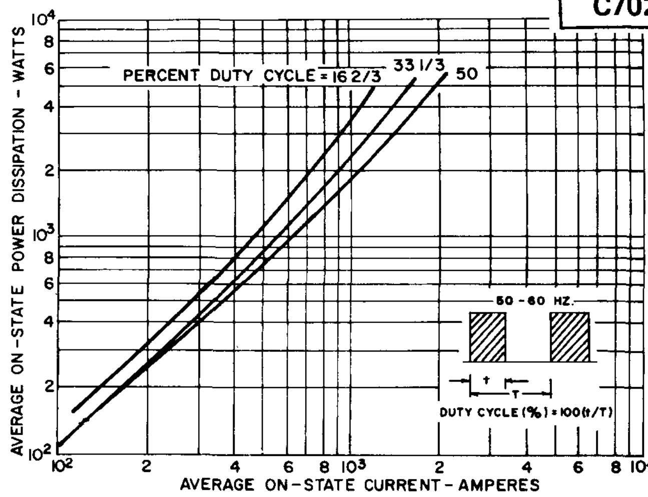
1. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR SINUSOIDAL CURRENT WAVEFORM – DOUBLE-SIDE COOLED



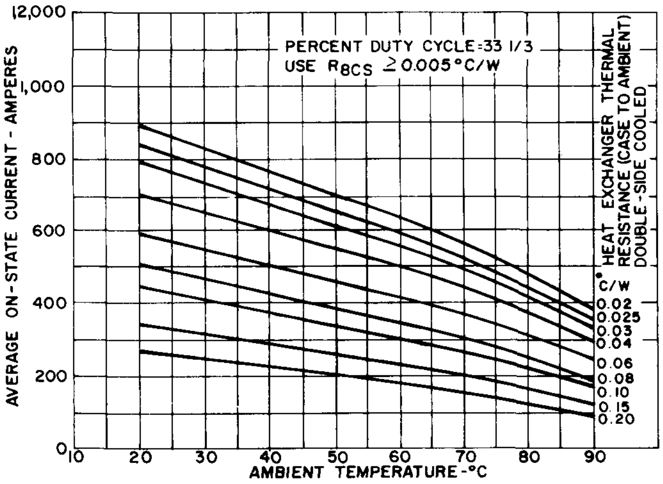
2. MAXIMUM ALLOWABLE CASE TEMPERATURE FOR RECTANGULAR CURRENT WAVEFORM – DOUBLE-SIDE COOLED



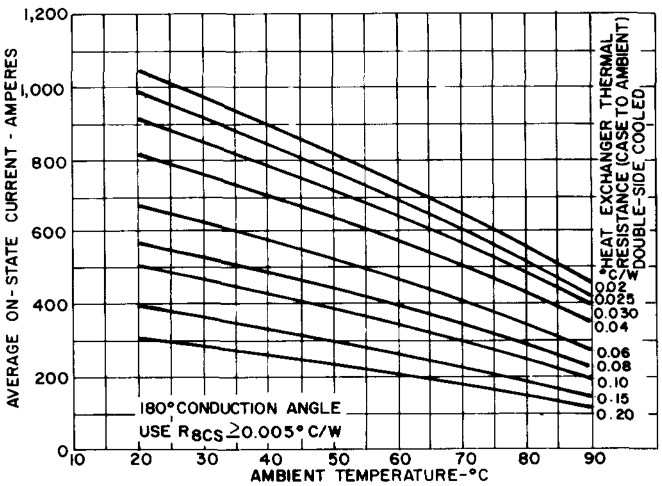
3. AVERAGE FORWARD POWER DISSIPATION FOR SINUSOIDAL CURRENT WAVEFORM



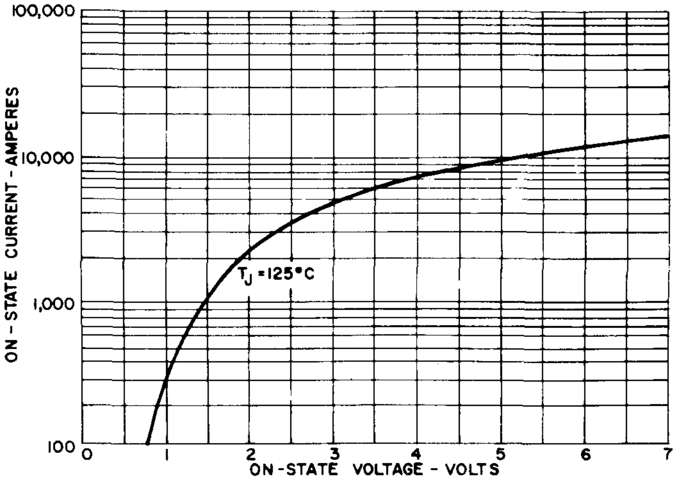
4. AVERAGE FORWARD POWER DISSIPATION FOR RECTANGULAR CURRENT WAVEFORM



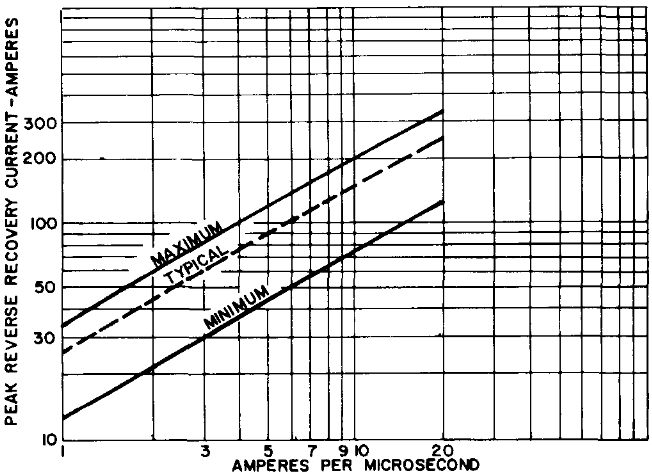
5. AVERAGE RECTANGULAR ON-STATE CURRENT VS. AMBIENT TEMPERATURE WHEN USED WITH VARIOUS HEAT EXCHANGERS



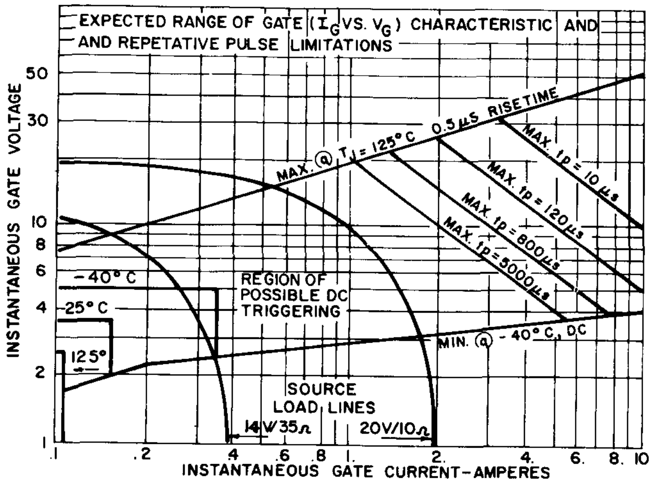
6. AVERAGE SINUSOIDAL ON-STATE CURRENT VS. AMBIENT TEMPERATURE WHEN USED WITH VARIOUS HEAT EXCHANGERS



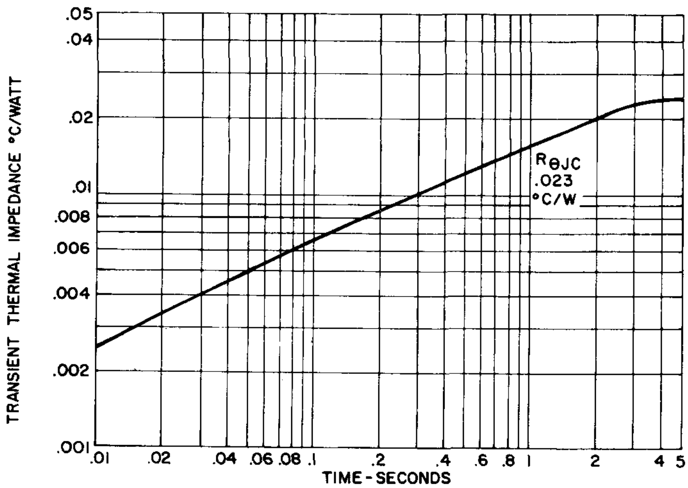
7. MAXIMUM FORWARD CONDUCTION CHARACTERISTIC ON-STATE



8. MAXIMUM REVERSE RECOVERY CURRENTS



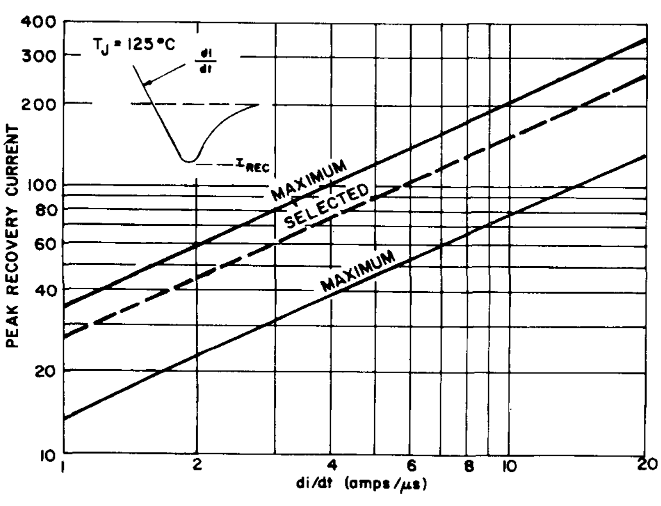
9. TRIGGERING CHARACTERISTICS



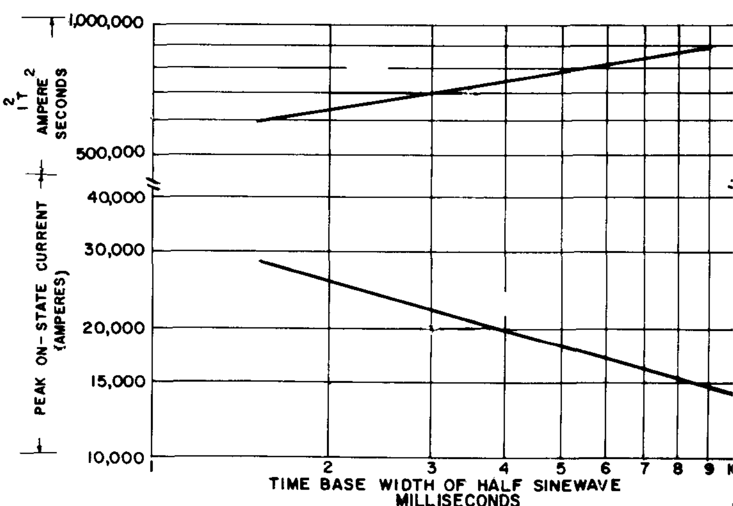
NOTES:

1. Add .006°C/W to account for both case to dissipator interfaces when properly mounted; e.g., $R\theta_{JS}$ = .029° C/W. See Mounting Instructions.
2. DC Thermal Impedance is based on average full cycle junction temperature. Instantaneous junction temperature may be calculated using the following modifications:
   - end of conducting portion of cycle
     - 120° sq. wave add .0025°C/W along entire curve
     - 180° sq. wave add .0018°C/W along entire curve
     - 180° sine wave add .0010°C/W along entire curve
   - end of full cycle
     - any wave, subtract .001°C/W along entire curve

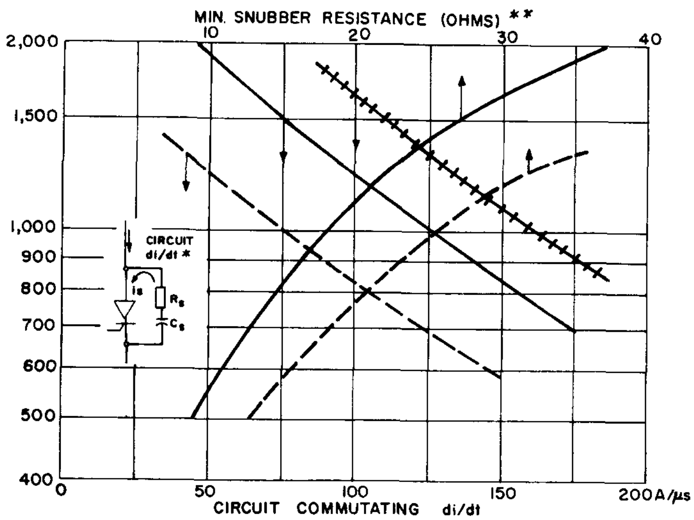
10. TRANSIENT THERMAL RESISTANCE JUNCTION-TO-HEATSINK



11. PEAK RECOVERY CURRENT VERSUS COMMUTATING CIRCUIT DI/DT



12. NON-REPETITIVE I_{TSM} AND I^2t CAPABILITY FOR FUSE COORDINATION



NOTES:

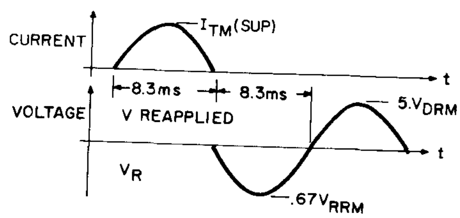
Code:	
+++++	Non-Repetitive High Gate Drive
———	Repetitive High Gate Drive
———	Non-Repetitive Low Gate Drive
— — —	Repetitive Low Gate Drive

	Low Gate Drive	High Gate Drive
Source	14V/35 ohms	20V/10 ohms
Pulse Width, t_p	⩾20 µs	⩾10 µs
Current Rise Time, t_r	⩽2	⩽0.5 µs

*Permissible circuit di/dt excluding snubber discharge. Repetitive di/dt is SPCO recommended maximum condition to achieve most industrial requirements for service life. It meets or exceeds the JEDEC test requirements for certification set forth in NEMA Std. Sk. 516 (1972). Non-repetitive di/dt meets the JEDEC 5 second rating.

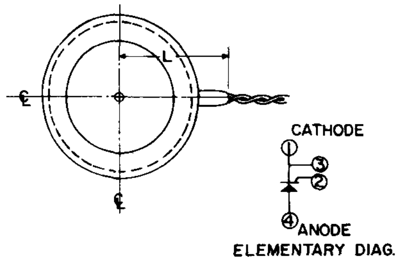
**Snubber discharge, i_s, is treated separately using the minimum value of snubber resistance indicated above. This applies for long industrial life (20 – 30 years) in combination with circuit di/dt.

13. ALLOWABLE DI/DT AND REQUIRED SNUBBER RESISTANCE FOR DIFFERENT SWITCHING VOLTAGES

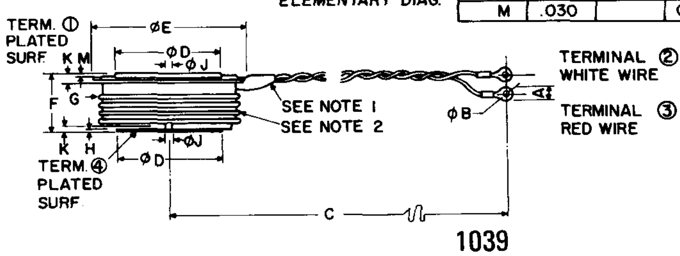


14. SUPPRESSIBLE SURGE CURRENT TEST

OUTLINE DRAWING



SYMBOL	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX	NOTES
A	0.200	0.240	5.08	6.10	1
Φ B	0.140		3.56		
C	16.000	20.000	406.40	508.00	
Φ D	1.700	1.900	43.18	48.26	
Φ E		2.960		75.18	
F	1.000	1.070	25.40	27.18	
G					2.
H	.005	.067	0.13	1.70	
Φ J	0.136	0.146	3.45	3.71	
K	.070		1.78		
L		2.500		63.50	
M	.030		0.76		



C702
ASSEMBLY OF PRESSPAKS TO HEAT DISSIPATORS

The following instruction is essential for maintaining low, stable thermal and electrical resistances associated with the Presspak to heat dissipator surfaces.

1. **INSPECTION OF MATING SURFACES**
   Check each mating surface for nicks, scratches, flames and surface finish. The Presspak surface has a total indicator reading TIR < .0005 inch and surface $\overset{32}{\vee}$ finish prior to factory electrical test in pressure fixtures. The dissipator surface should be equally as good. The TIR of a fully tested Presspak may run higher but not exceed .001 inch not including some minor nicks and scratches also associated with test fixtures. (Recommended mounting force is based upon these requirements.)

2. **SURFACE DEOXIDATION AND CLEANING**
   Although plated surfaces are recommended for aluminum and copper heat dissipators, bare surfaces may be used if careful attention to cleaning and treating is assured. Plated surfaces and Presspaks should be *lightly sanded* with 600 grit paper, then oil or compound applied as recommended. Unplated surfaces should be vigorously abraided with a fine wire brush or 3M "Scotchbrite" coated with Alcoa #2 compound. The Alcoa #2 should be removed and the recommended compound applied.

3. **FINAL SURFACE TREATMENT** ⓐ ⓑ
   Apply silicone oil or *thin layer* of grease or compound as indicated below. Rotate the Presspak to properly distribute the applied agent.
   - bare copper – use G322L or LS2037*;
   - bare aluminum – use Alcoa #2 or G322L;
   - tin-plated copper or aluminum – use SF1154 preferably, or G623 or G322L;
   - nickel-plated aluminum – use SF1154 or G623;
   - silver-plating is not recommended.

4. **MOUNTING**
   Assemble with specified mounting force applied through a self-leveling swivel connection. The force has to be evenly distributed over the full area. Center holes on top and bottom of the Presspak are for locating.

NOTES:

ⓐ Silicone oil SF1154, 200 centistoke, clear silicone grease G623, and yellow compound G322L are products of the General Electric Company; compound Alcoa #2 is a product of Aluminum Company of America; and LS2037 black compound is product of Arco Company, 7301 Bessemer Avenue, Cleveland, Ohio.

ⓑ Limit maximum joint temperature to 95°C, except for those prepared with SF1154 or G322L, which are limited to 150°C.

HEAT SINK SELECTION MADE EASY

The C702 specification sheet marks the introduction of two new characteristic curves which should greatly facilitate heat sink selection. Figures 5 and 6 plot allowable average current versus ambient temperature and case-to-ambient thermal resistance for the two most frequently encountered waveforms, 1/3 duty cycle rectangular current and 180° sinusoidal current waveforms. As soon as the average forward current and maximum ambient temperature are known, the designer can specify a heat sink thermal resistance. Note that the graphs span the range of heat sinks from water-cooled ($R\theta_{CA}$ = .03°C/W) to free-air convection ($R\theta_{CA}$ = 0.3°C/W). It is possible to linearly interpolate between the curves for $R\theta_{CA}$.

These curves have been derived from the following basic equation:

$$T_J = T_A + P_{AVG} \times R\theta_{JA}$$

where: $T_J = 125°C$

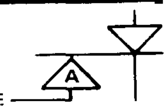
For increased reliability, the usual practice is to derate T_J 15-30 degrees. Figures 5 and 6 can perform this function by the simple expedient of raising T_A by a like amount.

High Speed Silicon Controlled Rectifier

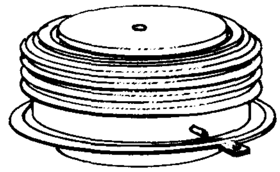
1000 A Avg. Up to 2000 Volts

C712

AMPLIFYING GATE



The General Electric device type C712 is a new pressure-mounted, high current SCR designed for power switching at high voltage and high frequencies (up to 5 KHz). The C712 gate structure has an involute, interdigitated pattern to optimize the turn-on area for high di/dt capability and it is processed using a newly developed multi-diffusion technology.



FEATURES:

- Off-State and Reverse Blocking Capabilities to 2000 Volts.
- Very Low Switching Losses at High Frequencies.
- 60 μsec Maximum Turn-Off Time at Severe Operating Conditions with **Feedback** diode.
- Involute, Interdigitated Gate for High di/dt Capability.
- Narrow Pulse Capability for PWM Inverter Commutating SCR Socket.
- 1″ Creepage-Path, Glazed-Ceramic Package.

IMPORTANT: Mounting instructions on the last page of C702 specification **must** be followed.

MAXIMUM ALLOWABLE RATINGS

TYPE	V_{DRM}/V_{RRM}[1] REPETITIVE T_J = -40°C to +125°C	V_{DRM}/V_{RRM}[1] REPETITIVE T_J = 0°C to +125°C	TRANSIENT PEAK REVERSE VOLTAGE, V_{RSM}[1] T_J = -40°C to +125°C
C712L	2000 Volts	2100 Volts	2100 Volts
C712PT	1900	2000	2000
C712PN	1800	1900	1900
C712PS	1700	1800	1800
C712PM	1600	1700	1700
C712PE	1500	1600	1600

Consult factory for lower rated voltage devices.

Peak One-Cycle Surge On-State Current, I_{TSM} (8.3 msec)	20,000 Amperes
Maximum Rate-of-Rise of Anode Current Turn-On Interval (Switching From 1200 Volts)	800 A/μsec
Repetitive di/dt Rating[2]	200 A/μsec
I^2t (for fusing) (at 8.3 milliseconds)	1,660,000 Ampere² Seconds
Peak Gate Power Dissipation, P_{GM}	100 Watts
Average Gate Power Dissipation, $P_{G(AV)}$	5 Watts
Peak Reverse Gate Voltage, V_{GRM}	20 Volts
Storage and Operating Temperature, T_{STG} and T_J	-40°C to +125°C
Mounting Force Required	5000 Lb. + 1000 – 0 Lb. 22.2 KN + 4.4 – 0 KN

NOTES:

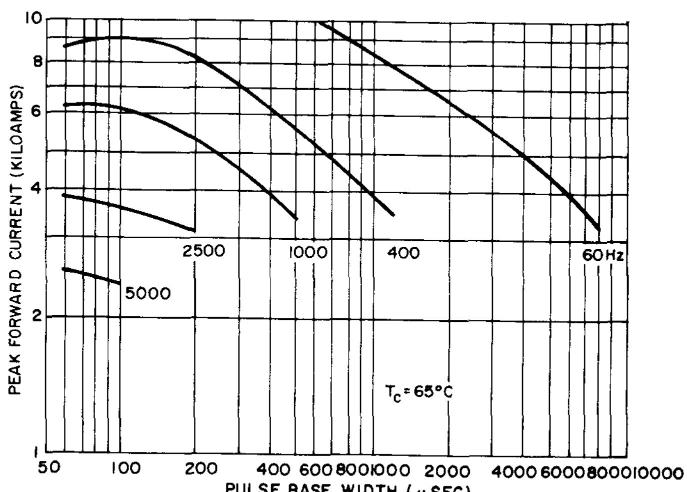
1 10 msec voltage sinewave.

2 di/dt rating established in accordance with EIA-NEMA Standard RS-397, Section 5.2.2. This di/dt is in addition to the discharge of a 0.25 μf, 20 ohm snubber circuit in parallel with the DUT.

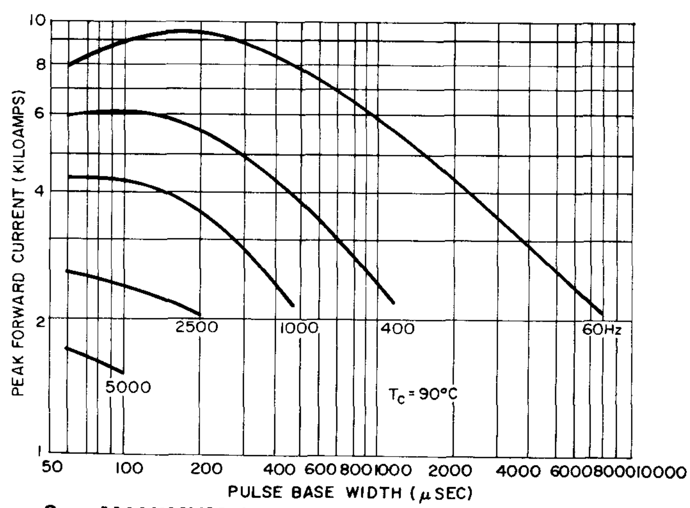
CHARACTERISTICS

C712

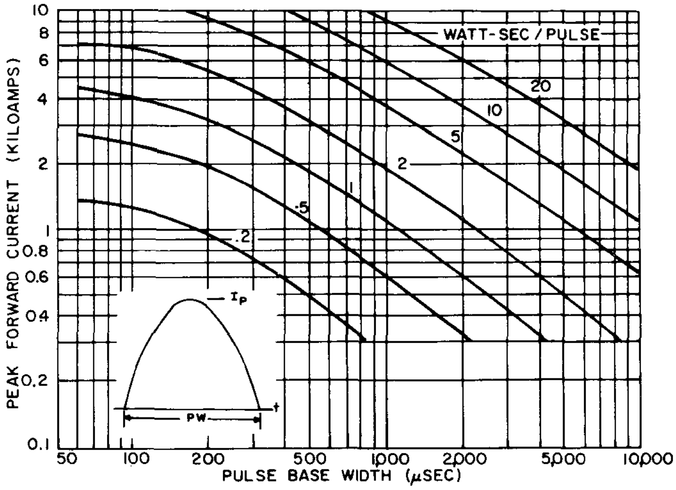
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Peak Reverse and On-State Blocking Current	I_{DRM} and I_{RRM}	–	20	60	mA	T_J = +125°C, V = V_{DRM} = V_{RRM}
Effective Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	–	–	.023	°C/Watt	Double-Side Cooled (DC)
Critical Linear Rate-of-Rise of Forward Blocking Voltage (Higher values may cause device switching)	dv/dt	500	–	–	V/μsec	T_J = +125°C, V_{DRM} = .80 Rated V_{RRM} Gate Open.
Delay Time	t_d	–	1.5	–	μsec	Switching from 140 Volts, 20 Volt, 10 Ohm Gate 0.5 μsec Rise Time, T_J = 25°C
Gate Pulse Width Necessary To Trigger		–	–	10	μsec	T_J = 25°C
Gate Trigger Current	I_{GT}	–	120	–	mAdc	T_C = 25°C, V_D = 10 Vdc, R_L = 3 Ohms
		5.0	30	–		T_C = +125°C, V_D = .5 x Rated, R_L = 1000 Ohms
Gate Trigger Voltage	V_{GT}	–	3.0	–	Vdc	T_C = 0°C to +125°C, V_D = 10 Vdc, R_L = 3 Ohms
Peak On-State Voltage	V_{TM}	–	–	1.45	Volts	T_C = +125°C, I_T = 1000 Amps. Peak Duty Cycle ⩽ 0.01%
Conventional Circuit Commutated Turn-Off Time (With Reverse Voltage)	t_q	–	–	50	μsec	(1) T_C = +125°C (2) I_T = 500 Amps. (3) V_R ⩾ 50 Volts (4) 80% V_{DRM} Reapplied (5) Rate-of-Rise of Forward Blocking Voltage = 200 V/μsec (6) Gate Bias = Open During Turn-Off Interval = 0 Volts, 100 Ohms (7) Duty Cycle ⩽ 0.01%
Conventional Circuit Commutated Turn-Off Time (With Feedback Diode)	t_q	–	55	60	μsec	(1) T_C = +125°C (2) I_T = 500 Amps. (3) V_R = 2 Volts Min. (4) 80% V_{DRM} Reapplied (5) Rate-of-Rise of Forward Blocking Voltage = 200V/μsec. (6) Gate Bias = Open During Turn-Off Interval (7) Duty Cycle ⩽ 0.01%



1. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH AT T_C = 65°C



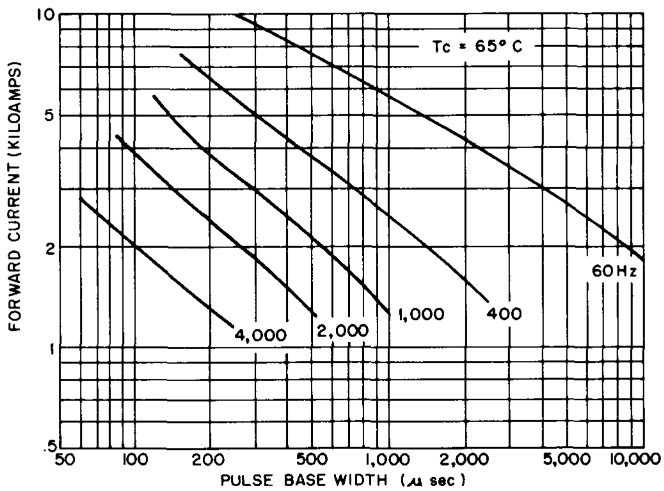
2. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT VS. PULSE WIDTH AT T_C = 90°C



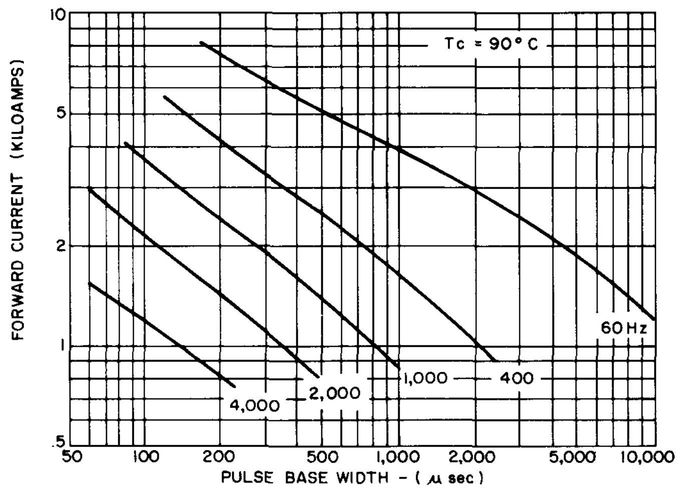
3. ENERGY PER PULSE FOR SINUSOIDAL PULSES

NOTES:

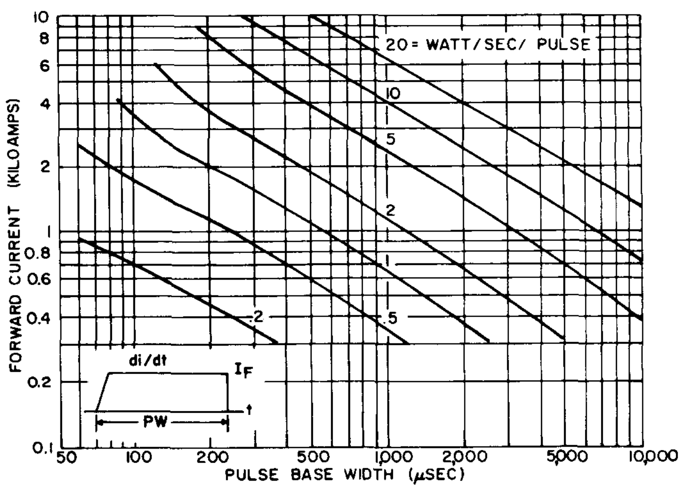
1. —— Switching capability and losses with bypass diode.
2. Switching voltage from 15 Volts to 0.8 V_{DRM}.
3. Snubber discharge < 50 Amps. RC time constant < 10 μsec.
4. High gate drive, 20V/10 Ohms, 0.5μsec rise time.



4. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT FOR TRAPEZOIDAL CURRENT WAVEFORMS FOR T_C = 65°C



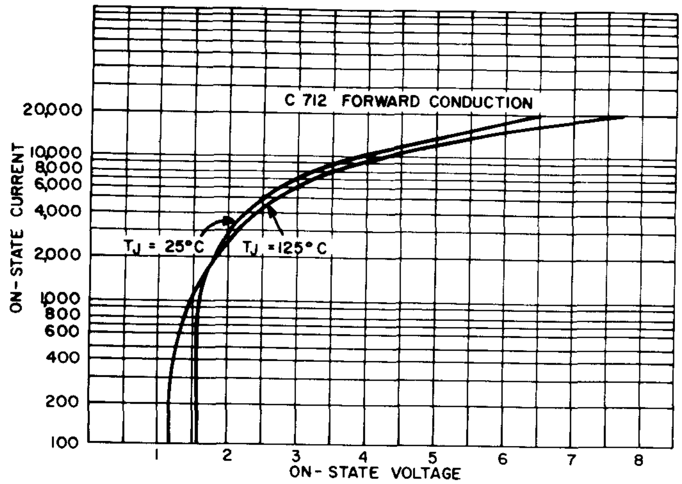
5. MAXIMUM ALLOWABLE PEAK ON-STATE CURRENT FOR TRAPEZOIDAL CURRENT WAVEFORMS FOR T_C = 90°C



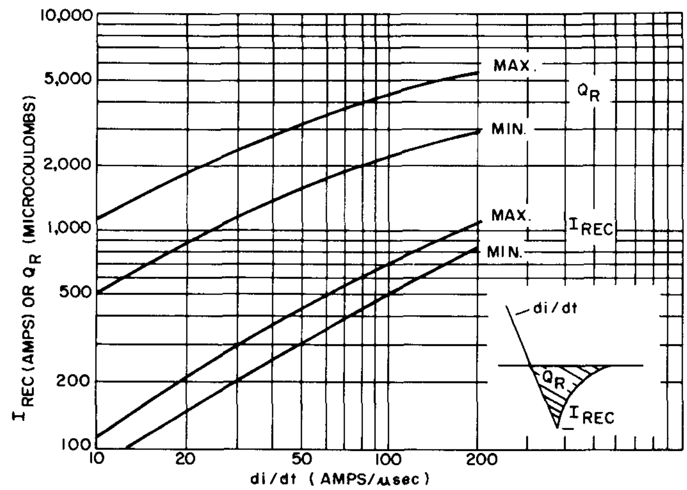
NOTES:

1. Switching voltage from 15 Volts to 0.8 V_{DRM}.
2. DI/DT during turn-on: 100A/μsec.
3. Reverse voltage < 50 Volts. If no bypass diode is used, recovery switching losses must be added.
4. RC snubber time constant < 10 μsec.
5. High gate drive: 20V/10 Ohms, 0.5μsec rise time.

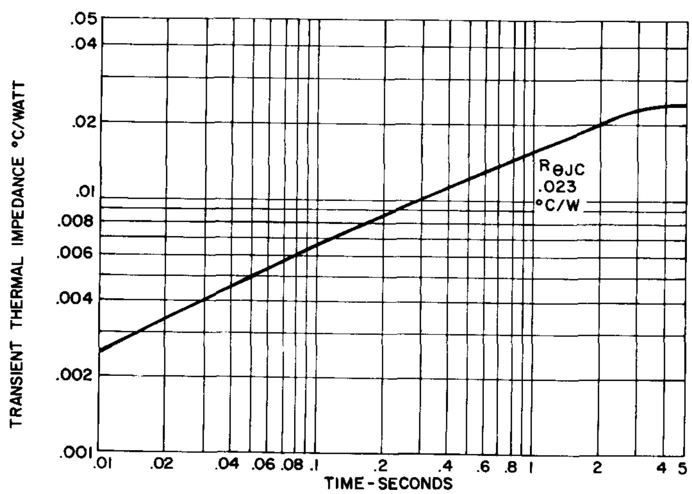
6. ENERGY PER PULSE FOR TRAPEZOIDAL CURRENT WAVEFORMS



7. FORWARD CONDUCTION CHARACTERISTIC ON-STATE



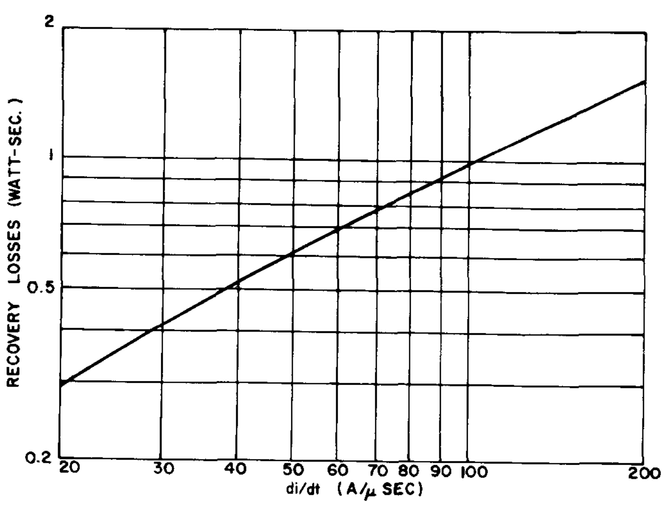
8. RECOVERED CHARGE (125°C)



NOTES:

1. Add .006°C/W to account for both case to dissipator interfaces when properly mounted; e.g., $R\theta_{JS}$ = .029° C/W. See Mounting Instructions.
2. DC Thermal Impedance is based on average full cycle junction temperature. Instantaneous junction temperature may be calculated using the following modifications:
   - end of conducting portion of cycle
     - 120° sq. wave add .0025°C/W along entire curve
     - 180° sq. wave add .0018°C/W along entire curve
     - 180° sine wave add .0010°C/W along entire curve
   - end of full cycle
     - any wave, subtract .001°C/W along entire curve

9. TRANSIENT THERMAL RESISTANCE – JUNCTION-TO-CASE



NOTES:

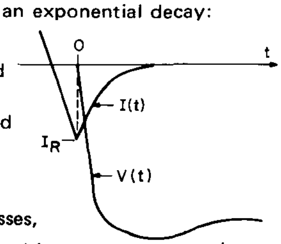
If no bypass diode is used with this thyristor, the switching losses during recovery can be significant. The actual magnitude of these losses will vary widely depending on circuit conditions and snubber design.

This curve represents typical recovery losses versus circuit di/dt. Since this curve is typical, it serves primarily to alert the equipment designer to the possible need for special design attention. The switching losses in a given circuit may be calculated with the following equation:

$$SLR = \int_o^T I(t) \,.V(t)\ dt$$

Where SLR is the recovery switching losses; I (t) is the recovery current decay; V(t) is the recovery voltage; and t = o occurs at the peak of the recovery current. I (t) may be expressed as an exponential decay:

$$I(t) = I_R e^{-(t/T)}$$



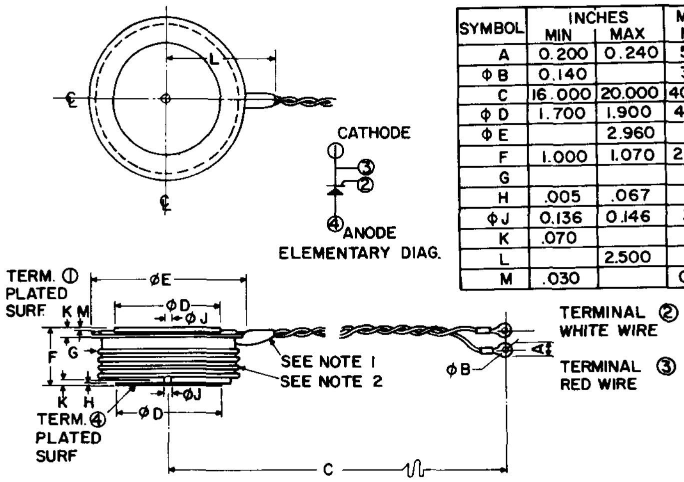
Where I_R is the peak recovery current and T = 2.5μsec. The junction temperature rise due to the recovery losses may be computed as follows:

$$\Delta T_j = F * \sigma_x * R\theta_{JA} + \alpha_x * 3.5$$

Where σ_x is the recovery losses, $R\theta_{JA}$ is the DC junction to ambient thermal impedance, and F is the operating frequency.

10. RECOVERY CURRENT SWITCHING LOSSES

OUTLINE DRAWING



SYMBOL	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX	NOTES
A	0.200	0.240	5.08	6.10	1
ΦB	0.140		3.56		
C	16.000	20.000	406.40	508.00	
ΦD	1.700	1.900	43.18	48.26	
ΦE		2.960		75.18	
F	1.000	1.070	25.40	27.18	
G					2.
H	.005	.067	0.13	1.70	
ΦJ	0.136	0.146	3.45	3.71	
K	.070		1.78		
L		2.500		63.50	
M	.030		0.76		

SCR

LOW AND MEDIUM CURRENT STACKS

C1012-13
C1112-13
C3512-13

Now, for the first time, from the originator of the Silicon Controlled Rectifier, packaged SCR building blocks, complete with SCR's, compatible rectifiers, heat sinks, interconnections, and all required hardware in one package. Requires only mounting bolts and electrical connections for power and triggering signal. Check the rest of these outstanding features:

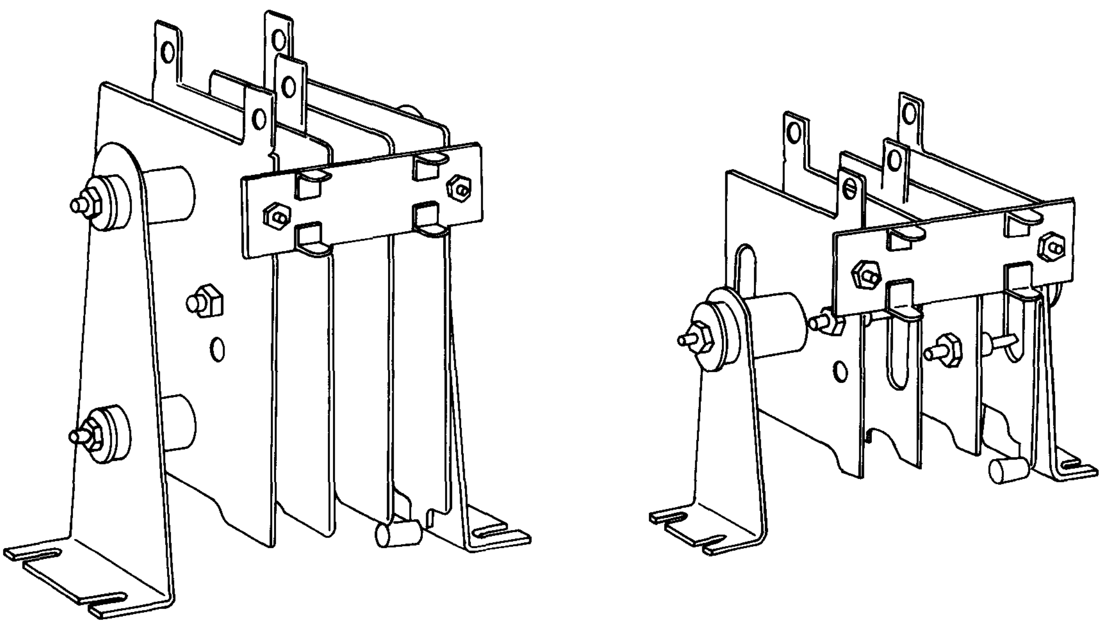
FLEXIBLE DESIGN .... Two fin sizes (3" x 3", 5" x 5") and 5 SCR types permit an optimum designed assembly for each application. Stacks can be mounted in either vertical or horizontal plane. An almost limitless number of circuit configurations possible.

WIDE RANGE OF OPERATING AND STORAGE TEMPERATURE .. Will operate from — 65°C to + 150°C Ambient.

SHIELDED TRIGGERING SIGNAL .. Coaxial shielded leads from gate/cathode terminal board to the SCR's minimize the possibility of erroneous firing caused by extraneous transients or pick up from the power leads.

PROVEN CONSTRUCTION .... General Electric's long years of experience in designing and supplying thousands of industrial rectifier stacks form the basis for this rugged construction. Painted fins yield high emissivity, providing optimum ratings without blowers or fans for forced air cooling.

DEPENDABILITY .... Backed by a General Electric one year written warranty.



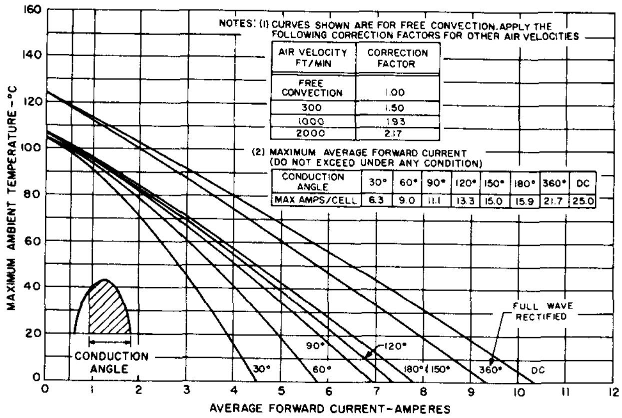
CONDENSED ELECTRICAL RATINGS SCR STACKS[1]

OPERATING TEMPERATURE RANGE	SCR TYPE	COMPATIBLE[2] RECTIFIER TYPE	MAXIMUM REPETITIVE PEAK REVERSE AND MINIMUM FORWARD BREAKOVER VOLTAGE	TRANSIENT PEAK REVERSE VOLTAGE (Non-Recurrent <5 Millisec)	MAX. AVG. FORWARD CURRENT/CELL[1] −25°C AMB. FREE CONVECTION						FOR OTHER AMBIENTS OR UNDER FORCED AIR COND., SEE CHARTS	PEAK ONE CYCLE SURGE CURRENT	MAXIMUM V_{GF} AND I_{GF} TO TRIGGER (25°C)
					3" FIN			5" FIN					
					Single Phase (180° Cond. Angle)	Three Phase (120° Cond. Angle)	D. C.	Single Phase (180° Cond. Angle)	Three Phase (120° Cond. Angle)	D. C.			
−65°C	C35U	1N2154	25V	35V	6.30A	5.80A	8.50A	10.1A	9.50A	13.65A	1 & 2	150A	3V, 40 ma
	F	1N2154	50	75									
	A	1N2155	100	150									
	G	1N2156	150	225									
	B	1N2156	200	300									
	H	1N2157	250	350									
	C	1N2157	300	400									
	D	1N2158	400	500									
	E	1N2159	500	600									
TO	C11U	1N1341A	25V	35V	3.98A	3.55A	5.80A	4.72A	4.43A	7.00A	3 & 4	60A	2V, 15 ma
	F	1N1341A	50	75									
	A	1N1342A	100	150									
	G	1N1343A	150	225									
	B	1N1344A	200	300									
	H	1N1345A	250	350									
+125°C	C	1N1345A	300	400									
	D	1N1346A	400	500									
−65°C TO +150°C	C10U	1N1341A	25V	35V	4.72A	3.95A	7.00A	4.72A	3.95A	7.00A	5 & 6	60A	2V, 15 ma
	F	1N1341A	50	75									
	A	1N1342A	100	150									
	G	1N1343A	150	225									
	B	1N1344A	200	300									
	H	1N1345A	250	350									
	C	1N1345A	300	400									
	D	1N1346A	400	500									

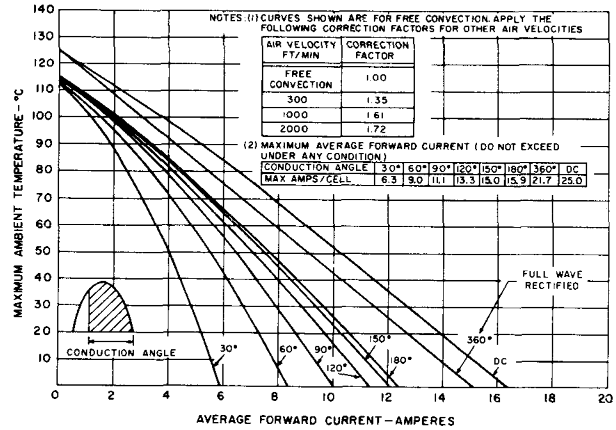
(1) For complete specifications covering both the SCR's and compatible rectifiers, see appropriate GE Spec Sheet.

(2) The compatible rectifier type, where ever used, has been chosen deliberately so that the SCR, in all cases, is the limiting component.

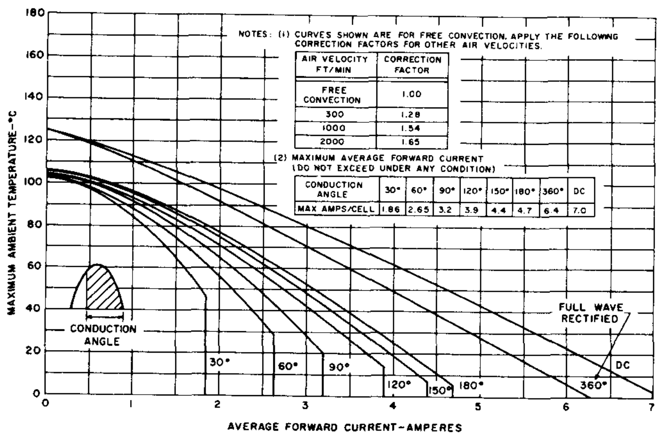
(3) SCR's can be successfully operated in series and parallel if necessary precautions are observed. Also, depending on the specific application *SCR's and rectifiers may be* subjected to transient overvoltage and overcurrent conditions for which protective steps should be taken. For further details, on these application considerations, see GE Controlled Rectifier Manual, Chapter 3.



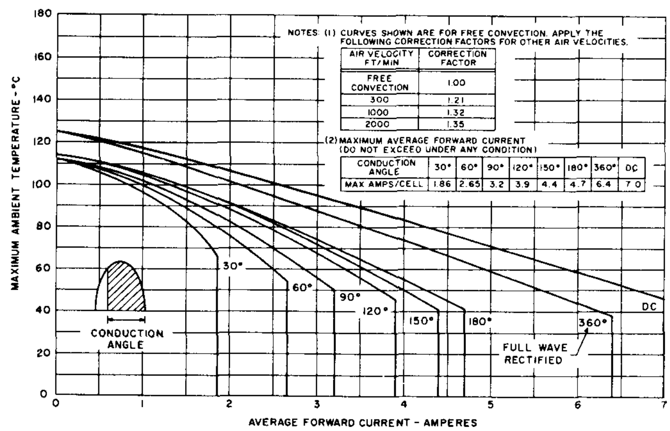
1. AMBIENT TEMP. VS. AVG. FORW. CURRENT 3" FIN-C35



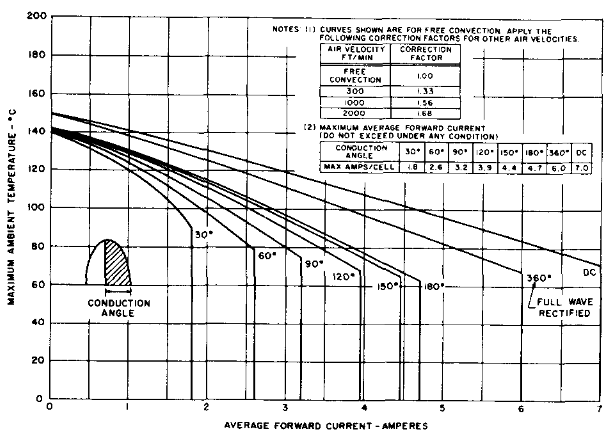
2. AMBIENT TEMP. VS. AVG. FORW. CURRENT 5" FIN-C35



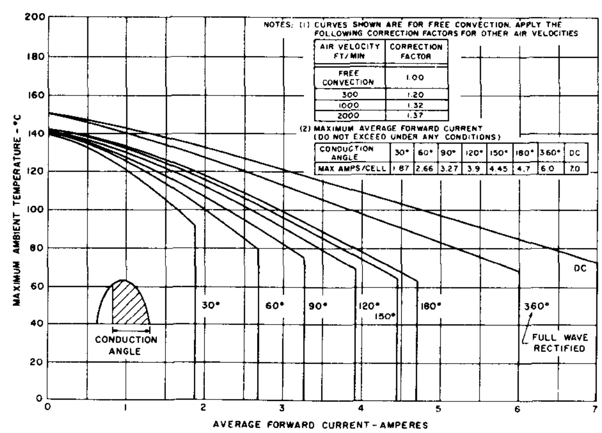
3. AMBIENT TEMP. VS. AVG. FORW. CURRENT 3" FIN-C11



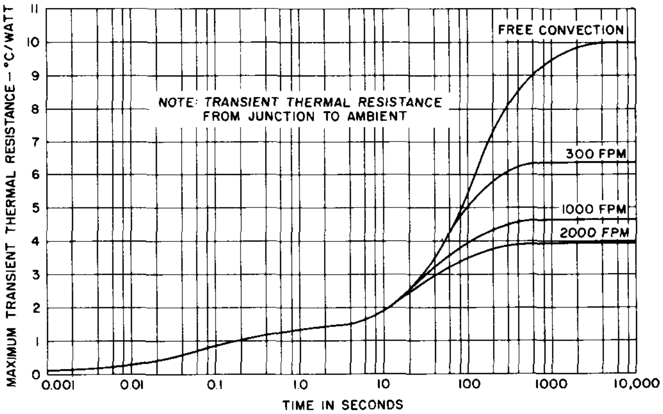
4. AMBIENT TEMP. VS. AVG. FORW. CURRENT 5" FIN-C11



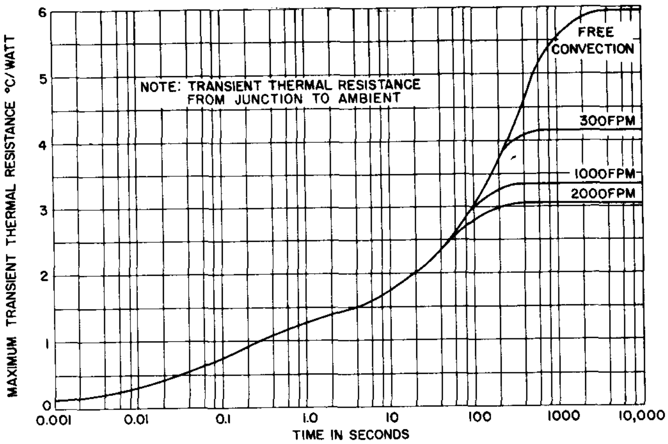
5. AMBIENT TEMP. VS. AVG. FORW. CURRENT 3" FIN-C10



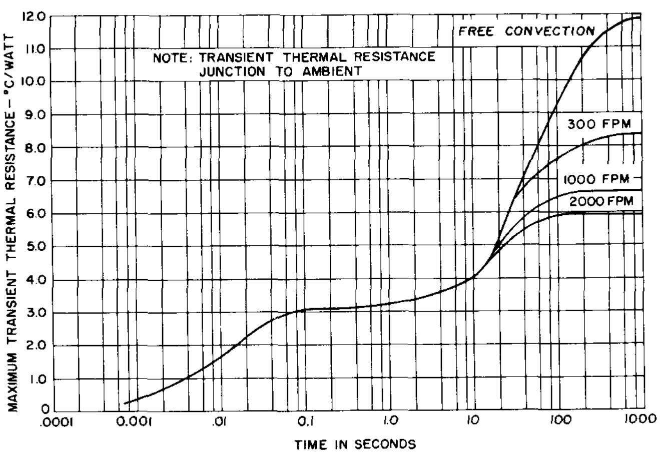
6. AMBIENT TEMP. VS. AVG. FORW. CURRENT 5" FIN-C10



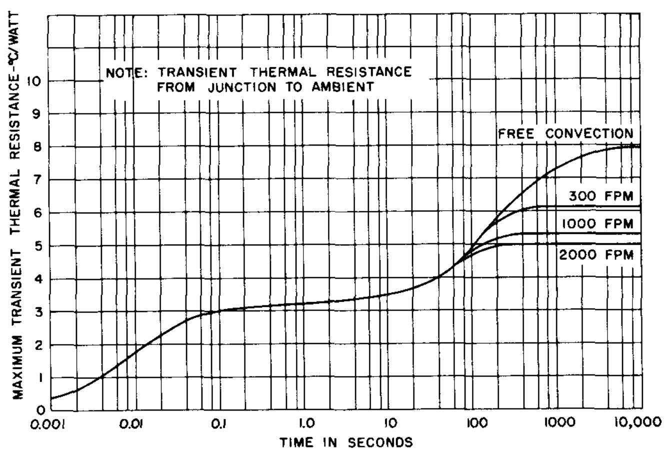
*7. **MAXIMUM TRANSIENT THERMAL RESISTANCE 3" FIN-C35**



*8. **MAXIMUM TRANSIENT THERMAL RESISTANCE 5" FIN-C35**



*9. **MAXIMUM TRANSIENT THERMAL RESISTANCE 3" FIN-C10, 11**



*10. **MAXIMUM TRANSIENT THERMAL RESISTANCE 5" FIN-C10, 11**

Note: *

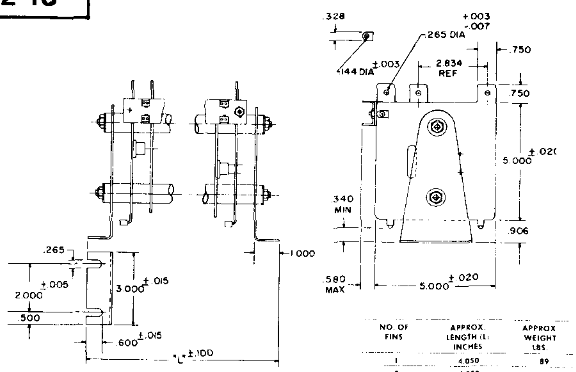
Charts 7, 8, 9, and 10 define the temperature rise of the junction above the ambient for a single load pulse of duration t. The peak allowable dissipation in the controlled rectifier for time t, if starting from ambient temperature, equals the Maximum Junction Temperature of the SCR used minus the maximum ambient temperature, divided by the transient thermal resistance:

$$P_{Peak} = \frac{T_J\ max - T_{amb.}}{r_T}$$

For optimum ratings and further information, see Publication 200.9 entitled "Power Semiconductor Ratings under Transient and Intermittent Loads."

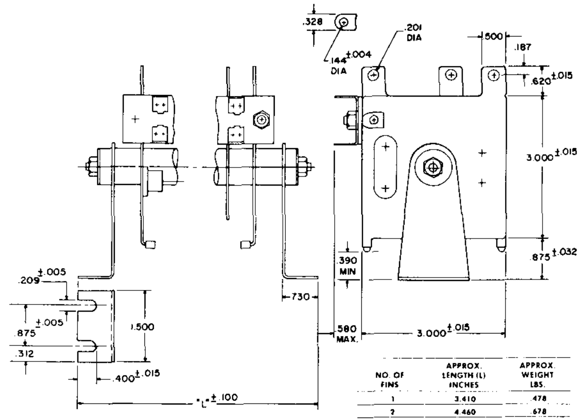
MECHANICAL SPECIFICATIONS

OUTLINE AND WEIGHT (5 INCH FINS)
C3512, C4012, C1012, C1112 SERIES



NO. OF FINS	APPROX. LENGTH (L) INCHES	APPROX WEIGHT LBS.
1	4.050	89
2	4.850	1.41
3	5.600	1.93
4	6.000	2.44
5	6.950	2.95
6	7.800	3.97
7	9.200	4.48
8	10.050	5.51
9	10.850	6.02
10	11.700	6.53
11	12.650	7.04
12	13.500	7.55

OUTLINE AND WEIGHT (3 INCH FINS)
C3513, C4013, C1013, C1113 SERIES



NO. OF FINS	APPROX. LENGTH (L) INCHES	APPROX. WEIGHT LBS.
1	3.410	.478
2	4.460	.678
3	5.260	.885
4	5.460	1.09
5	6.310	1.3
6	6.960	1.51
7	7.810	1.72
8	8.660	1.93
9	9.510	2.14
10	10.360	2.35
11	11.210	2.56
12	12.060	2.77

Maximum number of fins/stack = 12

Maximum Hi-Pot Voltage to Mounting Brackets	**2600 V. R.M.S. @ 25°C Amb., Sea Level**
Salt Spray	**MIL-STD-202A, Method 101A, 96 hrs.**
Humidity	**MIL-STD-202A, Method 103A, 240 hrs.**

SCR STACK NOMENCLATURE

C35	12	A	H	1	A	D	1

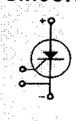
SCR CELL MODEL NUMBER
C35, C10, C11
C12

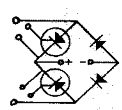
FIN SIZE:
12 — 5" sq.
13 — 3" sq.

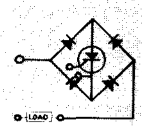
SCR PEAK REVERSE VOLTAGE RATINGS

U — 25V	B — 200
F — 50	H — 250
A — 100	C — 300
G — 150	D — 400
	M — 600

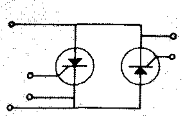
CIRCUIT CONFIGURATION: (Many Additional Variations Are Available Upon Request.)

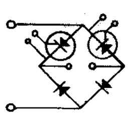

H — Single Phase Halfwave

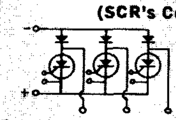

B*— Single Phase Bridge (SCR's Common Cathode)



B*— Single Phase Bridge (Fullwave Rectified)


A — Back To Back


B*— Single Phase Bridge (SCR Rect. Common Cathode)

F — Three Phase Fullwave Bridge (SCR's Common Cathode)


X — Special (Followed By Arbitrary Number)

SERIES CELLS/LEG

MINOR ELECTRICAL MODIFICATIONS
Polarity of Output, etc.

MINOR MECHANICAL MODIFICATIONS
D-Standard

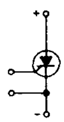
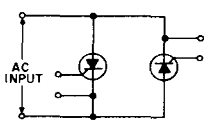
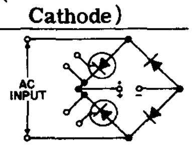
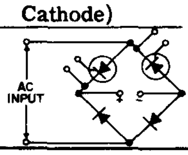
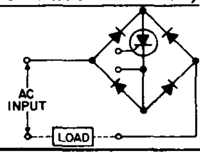
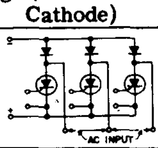
PARALLEL CELLS/LEG

*Note: Circuit description is necessary when ordering stacks to this circuit configuration.

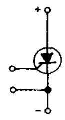
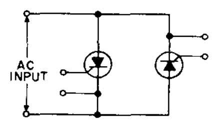
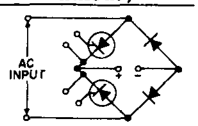
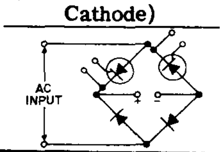
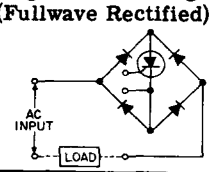
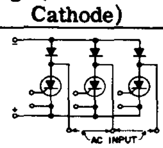
You may now quickly select and obtain the Low and Medium Current Combination SCR Stacks that fit your Controlled Rectifier applications.

* Fast Selection - Rating Tables Cover More Than 300 Stack Models
* Availability - Call Your Authorized G-E Semiconductor Distributor or Semiconductor Products District Sales Manager

C10 MOUNTED ON A 3" FIN *

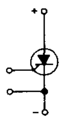
Circuit	Max Circuit Output Res. Load 25°C Amb Volts DC	Amps DC	Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Halfwave	7.0	4.72(180°)	17	25	35	1	C1013UH1AD1
	15.0		35	50	75		FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0		280	400	500		DH1AD1
Back to Back	15.0(RMS)	10.50(RMS)	17	25	35	2	C1013UA1AD1
	33.0		35	50	75		FA1AD1
	68.0		70	100	150		AA1AD1
	103.0		105	150	225		GA1AD1
	138.0		140	200	300		BA1AD1
	173.0		175	250	350		HA1AD1
	208.0		210	300	400		CA1AD1
	278.0		280	400	500		DA1AD1
Single Phase Bridge (SCR's Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1013UB1CD1
	28.5		35	50	75		FB1CD1
	60.0		70	100	150		AB1CD1
	91.5		105	150	225		GB1CD1
	123.0		140	200	300		BB1CD1
	154.5		175	250	350		HB1CD1
	186.0		210	300	400		CB1CD1
	249.0		280	400	500		DB1CD1
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1013UB1AD1
	28.5		35	50	75		FB1AD1
	60.0		70	100	150		AB1AD1
	91.5		105	150	225		GB1AD1
	123.0		140	200	300		BB1AD1
	154.5		175	250	350		HB1AD1
	186.0		210	300	400		CB1AD1
	249.0		280	400	500		DB1AD1
Single Phase Bridge (Fullwave Rectified)	12.0	6.40(360°)	17	25	35	5	C1013UB1FD1
	28.0		35	50	75		FB1FD1
	59.7		70	100	150		AB1FD1
	91.5		105	150	225		GB1FD1
	123.0		140	200	300		BB1FD1
	154.0		175	250	350		HB1FD1
	186.0		210	300	400		CB1FD1
	249.0		280	400	500		DB1FD1
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	11.85	17	25	35	6	C1013UF1AD1
	44.0		35	50	75		FF1AD1
	91.5		70	100	150		AF1AD1
	138.5		105	150	225		GF1AD1
	186.0		140	200	300		BF1AD1
	223.0		175	250	350		HF1AD1
	280.5		210	300	400		CF1AD1
	375.0		280	400	500		DF1AD1

C10 MOUNTED ON A 5" FIN *

Circuit	Max Circuit Output Res. Load 25°C Amb Volts DC	Amps DC	Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Halfwave	7.0	4.72(180°)	17	25	35	1	C1012UH1AD1
	15.0		35	50	75		FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0		280	400	500		DH1AD1
Back to Back	15.0(RMS)	10.50(RMS)	17	25	35	2	C1012UA1AD1
	33.0		35	50	75		FA1AD1
	68.0		70	100	150		AA1AD1
	103.0		105	150	225		GA1AD1
	138.0		140	200	300		BA1AD1
	173.0		175	250	350		HA1AD1
	208.0		210	300	400		CA1AD1
	278.0		280	400	500		DA1AD1
Single Phase Bridge (SCR's Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1012UB1CD1
	28.5		35	50	75		FB1CD1
	60.0		70	100	150		AB1CD1
	91.5		105	150	225		GB1CD1
	123.0		140	200	300		BB1CD1
	154.5		175	250	350		HB1CD1
	186.0		210	300	400		CB1CD1
	249.0		280	400	500		DB1CD1
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1012UB1AD1
	28.5		35	50	75		FB1AD1
	60.0		70	100	150		AB1AD1
	91.5		105	150	225		GB1AD1
	123.0		140	200	300		BB1AD1
	154.5		175	250	350		HB1AD1
	186.0		210	300	400		CB1AD1
	249.0		280	400	500		DB1AD1
Single Phase Bridge (Fullwave Rectified)	12.0	6.40(360°)	17	25	35	5	C1012UB1FD1
	28.0		35	50	75		FB1FD1
	59.7		70	100	150		AB1FD1
	91.5		105	150	225		GB1FD1
	123.0		140	200	300		BB1FD1
	154.0		175	250	350		HB1FD1
	186.0		210	300	400		CB1FD1
	249.0		280	400	500		DB1FD1
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	11.85	17	25	35	6	C1012UF1AD1
	44.0		35	50	75		FF1AD1
	91.5		70	100	150		AF1AD1
	138.5		105	150	225		GF1AD1
	186.0		140	200	300		BF1AD1
	223.0		175	250	350		HF1AD1
	280.5		210	300	400		CF1AD1
	375.0		280	400	500		DF1AD1

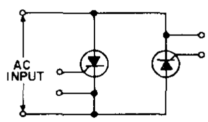
C11 MOUNTED ON A 3" FIN *

Single Phase Halfwave



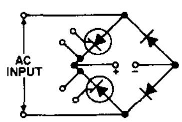
Circuit	Max Circuit Output Res. Load 25°C Amb Volts DC	Amps DC	Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Halfwave	7.0	3.98(180°)	17	25	35	1	C1113UH1AD1
	15.0		35	50	75		FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0		280	400	500		DH1AD1
	156.5		350	500	600		EH1AD1
	190.0		425	600	720		MH1AD1

Back to Back



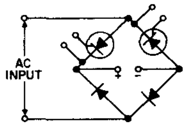
Circuit	Volts DC	Amps DC	AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Back to Back	15.0(RMS)	8.83(RMS)	17	25	35	2	C1113UA1AD1
	33.0		35	50	75		FA1AD1
	68.0		70	100	150		AA1AD1
	103.0		105	150	225		GA1AD1
	138.0		140	200	300		BA1AD1
	173.0		175	250	350		HA1AD1
	208.0		210	300	400		CA1AD1
	278.0		280	400	500		DA1AD1
	348.0		350	500	600		EA1AD1
	422.0		425	600	720		MA1AD1

Single Phase Bridge (SCR's Common Cathode)



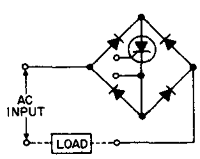
Circuit	Volts DC	Amps DC	AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Bridge (SCR's Common Cathode)	12.0	7.96(360°)	17	25	35	4	C1113U B1CD1
	28.5		35	50	75		FB1CD1
	60.0		70	100	150		AB1CD1
	91.5		105	150	225		GB1CD1
	123.0		140	200	300		BB1CD1
	154.5		175	250	350		HB1CD1
	186.0		210	300	400		CB1CD1
	249.0		280	400	500		DB1CD1
	312.0		350	500	600		EB1CD1
	376.0		425	600	720		MB1CD1

Single Phase Bridge (SCR-Rect Common Cathode)



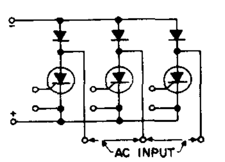
Circuit	Volts DC	Amps DC	AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	7.96(360°)	17	25	35	4	C1113UB1AD1
	28.5		35	50	75		FB1AD1
	60.0		70	100	150		AB1AD1
	91.5		105	150	225		GB1AD1
	123.0		140	200	300		BB1AD1
	154.5		175	250	350		HB1AD1
	186.0		210	300	400		CB1AD1
	249.0		280	400	500		DB1AD1
	312.0		350	500	600		EB1AD1
	376.0		425	600	720		MB1AD1

Single Phase Bridge (Fullwave Rectified)



Circuit	Volts DC	Amps DC	AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Bridge (Fullwave Rectified)	12.0	5.20(360°)	17	25	35	5	C1113UB1FD1
	28.5		35	50	75		FB1FD1
	60.0		70	100	150		AB1FD1
	91.5		105	150	225		GB1FD1
	123.0		140	200	300		BB1FD1
	154.5		175	250	350		HB1FD1
	186.0		210	300	400		CB1FD1
	249.0		280	400	500		DB1FD1
	312.0		350	500	600		EB1FD1
	376.0		425	600	720		MB1FD1

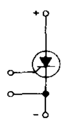
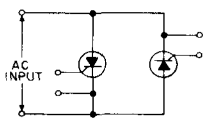
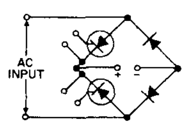
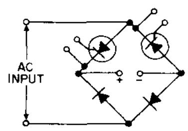
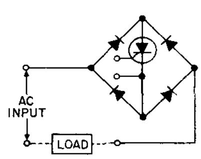
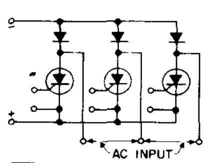
3 Phase Fullwave Bridge (SCR's Common Cathode)



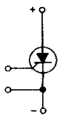
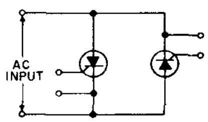
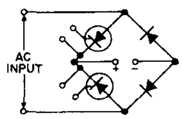
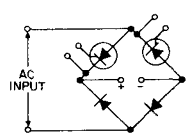
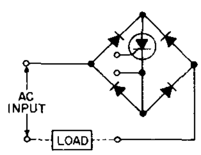
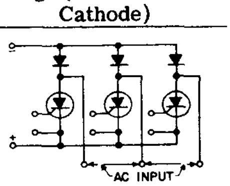
Circuit	Volts DC	Amps DC	AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	10.65	17	25	35	6	C1113UF1AD1
	44.0		35	50	75		FF1AD1
	91.5		70	100	150		AF1AD1
	138.5		105	150	225		GF1AD1
	186.0		140	200	300		BF1AD1
	223.0		175	250	350		HF1AD1
	280.5		210	300	400		CF1AD1
	375.0		280	400	500		DF1AD1
	469.5		350	500	600		EF1AD1
	565.5		425	600	720		MF1AD1

C1012-13
C1112-13
C3512-13

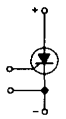
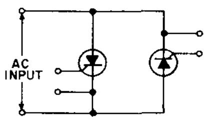
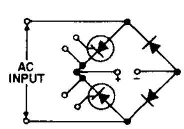
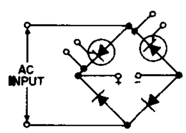
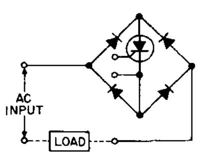
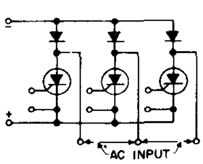
C11 MOUNTED ON A 5" FIN *

Circuit	Max Circuit Output Res. Load 25°C Amb Volts DC	Amps DC	Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Halfwave	7.0	4.72(180°)	17	25	35	1	C1112UH1AD1
	15.0	↓	35	50	75	↓	FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0		280	400	500		DH1AD1
	156.5		350	500	600		EH1AD1
	190.0		425	600	720		MH1AD1
Back to Back	15.0(RMS)	10.50(RMS)	17	25	35	2	C1112UA1AD1
	33.0	↓	35	50	75	↓	FA1AD1
	68.0		70	100	150		AA1AD1
	103.0		105	150	225		GA1AD1
	138.0		140	200	300		BA1AD1
	173.0		175	250	350		HA1AD1
	208.0		210	300	400		CA1AD1
	278.0		280	400	500		DA1AD1
	348.0		350	500	600		EA1AD1
	422.0		425	600	720		MA1AD1
Single Phase Bridge (SCR's Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1112UB1CD1
	28.5	↓	35	50	75	↓	FB1CD1
	60.0		70	100	150		AB1CD1
	91.5		105	150	225		GB1CD1
	123.0		140	200	300		BB1CD1
	154.5		175	250	350		HB1CD1
	186.0		210	300	400		CB1CD1
	249.0		280	400	500		DB1CD1
	312.0		350	500	600		EB1CD1
	376.0		425	600	720		MB1CD1
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	9.44(360°)	17	25	35	4	C1112UB1AD1
	28.5	↓	35	50	75	↓	FB1AD1
	60.0		70	100	150		AB1AD1
	91.5		105	150	225		GB1AD1
	123.0		140	200	300		BB1AD1
	154.5		175	250	350		HB1AD1
	186.0		210	300	400		CB1AD1
	249.0		280	400	500		DB1AD1
	312.0		350	500	600		EB1AD1
	376.0		425	600	720		MB1AD1
Single Phase Bridge (Fullwave Rectified)	12.0	6.40(360°)	17	25	35	5	C1112UB1FD1
	28.5	↓	35	50	75	↓	FB1FD1
	60.0		70	100	150		AB1FD1
	91.5		105	150	225		GB1FD1
	123.0		140	200	300		BB1FD1
	154.5		175	250	350		HB1FD1
	186.0		210	300	400		CB1FD1
	249.0		280	400	500		DB1FD1
	312.0		350	500	600		EB1FD1
	376.0		425	600	720		MB1FD1
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	11.85	17	25	35	6	C1112UF1AD1
	44.0	↓	35	50	75	↓	FF1AD1
	91.5		70	100	150		AF1AD1
	138.5		105	150	225		GF1AD1
	186.0		140	200	300		BF1AD1
	223.0		175	250	350		HF1AD1
	280.5		210	300	400		CF1AD1
	375.0		280	400	500		DF1AD1
	469.5		350	500	600		EF1AD1
	565.5		425	600	720		MF1AD1

C35 MOUNTED ON A 3" FIN *

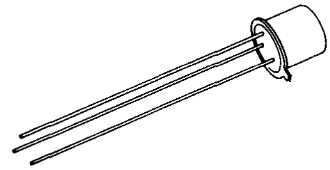
Circuit	Max Circuit Output Res. Load 25°C Amb Volts DC	Amps DC	Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Halfwave	7.0	6.3(180°)	17	25	35	1	C3513UH1AD1
	15.0		35	50	75		FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0		280	400	500		DH1AD1
	156.5		350	500	600		EH1AD1
	190.0		425	600	720		MH1AD1
Back to Back	15.0(RMS)	13.9(RMS)	17	25	35	2	C3513UA1AD1
	33.0		35	50	75		FA1AD1
	68.0		70	100	150		AA1AD1
	103.0		105	150	225		GA1AD1
	138.0		140	200	300		BA1AD1
	173.0		175	250	350		HA1AD1
	208.0		210	300	400		CA1AD1
	278.0		280	400	500		DA1AD1
	348.0		350	500	600		EA1AD1
	422.0		425	600	720		MA1AD1
Single Phase Bridge (SCR's Common Cathode)	12.0	12.6(360°)	17	25	35	4	C3513UB1CD1
	28.5		35	50	75		FB1CD1
	60.0		70	100	150		AB1CD1
	91.5		105	150	225		GB1CD1
	123.0		140	200	300		BB1CD1
	154.5		175	250	350		HB1CD1
	186.0		210	300	400		CB1CD1
	249.0		280	400	500		DB1CD1
	312.0		350	500	600		EB1CD1
	376.0		425	600	720		MB1CD1
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	12.6(360°)	17	25	35	4	C3513UB1AD1
	28.5		35	50	75		FB1AD1
	60.0		70	100	150		AB1AD1
	91.5		105	150	225		GB1AD1
	123.0		140	200	300		BB1AD1
	154.5		175	250	350		HB1AD1
	186.0		210	300	400		CB1AD1
	249.0		280	400	500		DB1AD1
	312.0		350	500	600		EB1AD1
	376.0		425	600	720		MB1AD1
Single Phase Bridge (Fullwave Rectified)	12.0	7.6(360°)	17	25	35	5	C3513UB1FD1
	28.5		35	50	75		FB1FD1
	60.0		70	100	150		AB1FD1
	91.5		105	150	225		GB1FD1
	123.0		140	200	300		BB1FD1
	154.5		175	250	350		HB1FD1
	186.0		210	300	400		CB1FD1
	249.0		280	400	500		DB1FD1
	312.0		350	500	600		EB1FD1
	376.0		425	600	720		MB1FD1
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	17.4	17	25	35	6	C3513UF1AD1
	44.0		35	50	75		FF1AD1
	91.5		70	100	150		AF1AD1
	138.5		105	150	225		GF1AD1
	186.0		140	200	300		BF1AD1
	223.0		175	250	350		HF1AD1
	280.5		210	300	400		CF1AD1
	375.0		280	400	500		DF1AD1
	469.5		350	500	600		EF1AD1
	565.5		425	600	720		MF1AD1

C35 MOUNTED ON A 5" FIN *

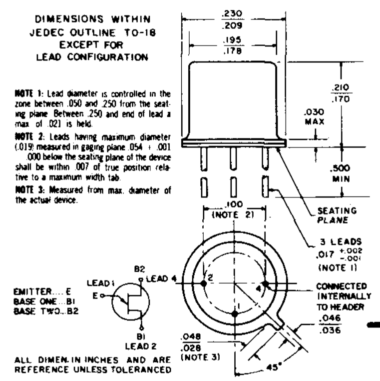
Circuit	Max Circuit Output Res. Load 25°C Amb Volts DC	Amps DC	Max Repetitive AC Input Volts "RMS"	SCR/ Cell PRV-VBO	Transient PRV (Non-recurrent)	No. of Fins/ Stack	Model Number
Single Phase Halfwave	7.0	10.1(180°)	17	25	35	1	C3512UH1AD1
	15.0		35	50	75		FH1AD1
	30.5		70	100	150		AH1AD1
	46.5		105	150	225		GH1AD1
	62.0		140	200	300		BH1AD1
	77.0		175	250	350		HH1AD1
	93.5		210	300	400		CH1AD1
	125.0		280	400	500		DH1AD1
	156.5		350	500	600		EH1AD1
	190.0		425	600	720		MH1AD1
Back to Back	15.0(RMS)	22.4(RMS)	17	25	35	2	C3512UA1AD1
	33.0		35	50	75		FA1AD1
	68.0		70	100	150		AA1AD1
	103.0		105	150	225		GA1AD1
	138.0		140	200	300		BA1AD1
	173.0		175	250	350		HA1AD1
	208.0		210	300	400		CA1AD1
	278.0		280	400	500		DA1AD1
	348.0		350	500	600		EA1AD1
	422.0		425	600	720		MA1AD1
Single Phase Bridge (SCR's Common Cathode)	12.0	20.2(360°)	17	25	35	4	C3512UB1CD1
	28.5		35	50	75		FB1CD1
	60.0		70	100	150		AB1CD1
	91.5		105	150	225		GB1CD1
	123.0		140	200	300		BB1CD1
	154.5		175	250	350		HB1CD1
	186.0		210	300	400		CB1CD1
	249.0		280	400	500		DB1CD1
	312.0		350	500	600		EB1CD1
	376.0		425	600	720		MB1CD1
Single Phase Bridge (SCR-Rect Common Cathode)	12.0	20.2(360°)	17	25	35	4	C3512UB1AD1
	28.5		35	50	75		FB1AD1
	60.0		70	100	150		AB1AD1
	91.5		105	150	225		GB1AD1
	123.0		140	200	300		BB1AD1
	154.5		175	250	350		HB1AD1
	186.0		210	300	400		CB1AD1
	249.0		280	400	500		DB1AD1
	312.0		350	500	600		EB1AD1
	376.0		425	600	720		MB1AD1
Single Phase Bridge (Fullwave Rectified)	12.0	12(360°)	17	25	35	5	C3512UB1FD1
	28.5		35	50	75		FB1FD1
	60.0		70	100	150		AB1FD1
	91.5		105	150	225		GB1FD1
	123.0		140	200	300		BB1FD1
	154.5		175	250	350		HB1FD1
	186.0		210	300	400		CB1FD1
	249.0		280	400	500		DB1FD1
	312.0		350	500	600		EB1FD1
	376.0		425	600	720		MB1FD1
3 Phase Fullwave Bridge (SCR's Common Cathode)	20.0	28.5	17	25	35	6	C3512UF1AD1
	44.0		35	50	75		FF1AD1
	91.5		70	100	150		AF1AD1
	138.5		105	150	225		GF1AD1
	186.0		140	200	300		BF1AD1
	223.0		175	250	350		HF1AD1
	280.5		210	300	400		CF1AD1
	375.0		280	400	500		DF1AD1
	469.5		350	500	600		EF1AD1
	565.5		425	600	720		MF1AD1

Silicon Unijunction Transistor

D5J37



Please refer to specification 2N2646-47 for further information on this device.



ABSOLUTE MAXIMUM RATINGS: (25°C)

Power Dissipation (Note 1)	300 mw
RMS Emitter Current	50 ma
Peak Emitter Current (Note 2)	2 amperes
Emitter Reverse Voltage	30 volts
Interbase Voltage	35 volts
Operating Temperature Range	−65°C to +125°C
Storage Temperature Range	−65°C to +150°C

ELECTRICAL CHARACTERISTICS: (25°C)

PARAMETER		D5J37 MIN.	TYP.	MAX.	
Intrinsic Standoff Ratio (V_{BB} = 10V) (Note 4)	η	.47		.85	
Interbase Resistance (V_{BB} = 3V, I_E = 0)	R_{BBO}	4.0		12.0	KΩ
Emitter Saturation Voltage (V_{BB} = 10V, I_E = .50 ma)	$V_{E(SAT)}$		2		volts
Modulated Interbase Current (V_{BB} = 10V, I_E = 50 ma)	$I_{B2(MOD)}$	4		22	ma
Emitter Reverse Current (V_{B2E} = 30V, I_{B1} = 0)	I_{EO}			12	μa
Peak Point Emitter Current (V_{BB} = 25V)	I_P			25	μa
Valley Point Current (V_{BB} = 20V, R_{B2} = 100 Ω)	I_V	4			ma
Base-One Peak Pulse Voltage (Note 3)	V_{OB1}	3			volts

NOTES:

1. Derate 3.0 MW/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.
2. Capacitor discharge — 10μfd or less, 30 volts or less.
3. The Base-One Peak Pulse Voltage is measured in the circuit below. This specification on the D5J37 is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.
4. The intrinsic standoff ratio η, is essentially constant with interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + V_D$$

Where V_P = Peak Point Emitter Voltage
V_{BB} = Interbase Voltage
V_D = Junction Diode Drop (Approx. .5V)

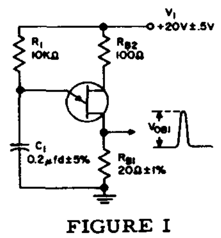
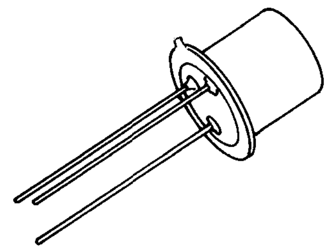


FIGURE I

Silicon Unijunction Transistor

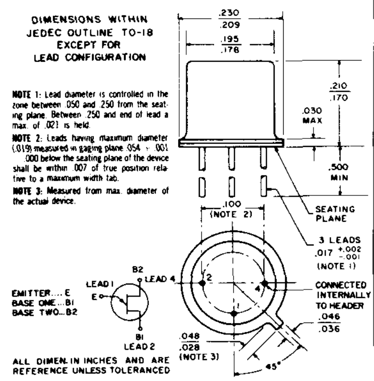
D5J43

Please refer to specification 2N2646-47 for further information on this device.



absolute maximum ratings: (25°C)

Power Dissipation (Note 1)	300 mW
RMS Emitter Current	50 mA
Peak Emitter Current (Note 2)	2 Amperes
Emitter Reverse Voltage	30 Volts
Interbase Voltage	35 Volts
Operating Temperature Range	−65°C to +125°C
Storage Temperature Range	−65°C to +150°C



electrical characteristics: (25°C)

		MIN.	TYP.	MAX.	
Intrinsic Standoff Ratio ($V_{BB} = 10V$) (Note 4)	η	.68		.82	
Interbase Resistance ($V_{BB} = 3V, I_E = 0$)	R_{BBO}	4.7		9.1	kΩ
Emitter Saturation Voltage ($V_{BB} = 10V, I_E = .50$ ma)	$V_{E(SAT)}$		2		Volts
Modulated Interbase Current ($V_{BB} = 10V, I_E = 50$ ma)	$I_{B2(MOD)}$		12		mA
Emitter Reverse Current ($V_{B2E} = 30V, I_{B1} = 0$)	I_{EO}			1.0	μA
Peak Point Emitter Current ($V_{BB} = 25V$)	I_P			2.0	μA
Valley Point Current ($V_{BB} = 20V, R_{B2} = 100\ \Omega$)	I_V	6			mA
Base-One Peak Pulse Voltage (Note 3)	V_{OB1}	5			Volts

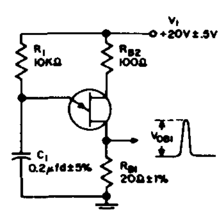
NOTES:

1. Derate 3.0 MW/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.
2. Capacitor discharge — 10μF or less, 30 volts or less.
3. The Base-One Peak Pulse Voltage is measured in the circuit below. This specification on the D5J43 is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.
4. The intrinsic standoff ratio η, is essentially constant with interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + V_D$$

Where V_P = Peak Point Emitter Voltage
V_{BB} = Interbase Voltage
V_D = Junction Diode Drop (Approx. .5V)

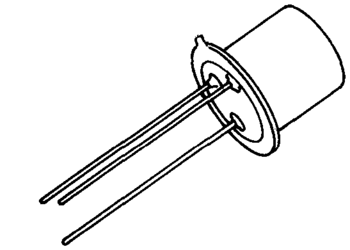
FIGURE 1



Silicon Unijunction Transistor

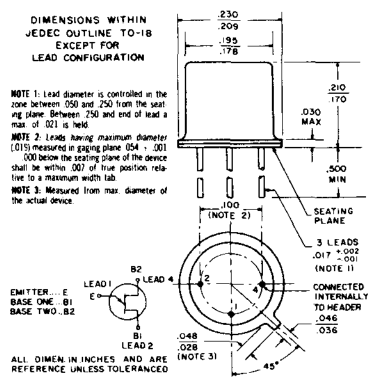
D5J44

Please refer to specification 2N2646-47 for further information on this device.



absolute maximum ratings: (25°C)

Power Dissipation (Note 1)	300 mW
RMS Emitter Current	50 mA
Peak Emitter Current (Note 2)	2Amperes
Emitter Reverse Voltage	30Volts
Interbase Voltage	35Volts
Operating Temperature Range	—65°C to +125°C
Storage Temperature Range	—65°C to +150°C



electrical characteristics: (25°C)

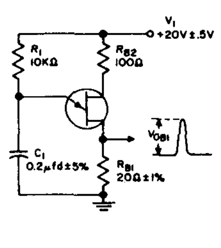
		MIN.	TYP.	MAX.	
Intrinsic Standoff Ratio (V_{BB} = 10V) (Note 4)	η	.68		.82	
Interbase Resistance (V_{BB} = 3V, I_E = 0)	R_{BBO}	4.7		9.1	kΩ
Emitter Saturation Voltage (V_{BB} = 10V, I_E = 50 ma)	$V_{E(SAT)}$		2		Volts
Modulated Interbase Current (V_{BB} = 10V, I_E = 50 ma)	$I_{B2(MOD)}$		12		mA
Emitter Reverse Current (V_{B2E} = 30V, I_{B1} = 0)	I_{EO}			12	μA
Peak Point Emitter Current (V_{BB} = 25V)	I_P			5	μA
Valley Point Current (V_{BB} = 20V, R_{B2} = 100 Ω)	I_V	4			mA
Base-One Peak Pulse Voltage (Note 3)	V_{OB1}	4			Volts

NOTES:
1. Derate 3.0 MW/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.
2. Capacitor discharge — 10μF or less, 30 volts or less.
3. The Base-One Peak Pulse Voltage is measured in the circuit below. This specification on the D5J44 is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.
4. The intrinsic standoff ratio η, is essentially constant with interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + V_D$$

Where V_P = Peak Point Emitter Voltage
V_{BB} = Interbase Voltage
V_D = Junction Diode Drop (Approx. .5V)

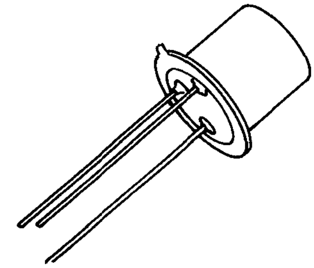
FIGURE 1



Silicon Unijunction Transistor

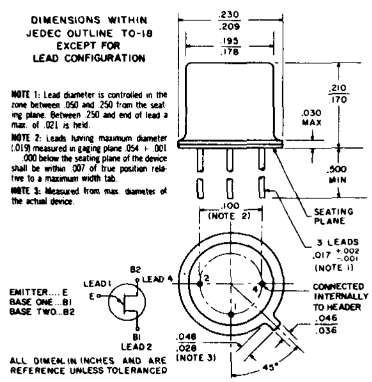
D5J45

Please refer to specification 2N2646-47 for further information on this device.



absolute maximum ratings: (25°C)

Power Dissipation (Note 1)	300 mW
RMS Emitter Current	50 mA
Peak Emitter Current (Note 2)	2 Amperes
Emitter Reverse Voltage	30 Volts
Interbase Voltage	35 Volts
Operating Temperature Range	−65°C to +125°C
Storage Temperature Range	−65°C to +150°C



electrical characteristics: (25°C)

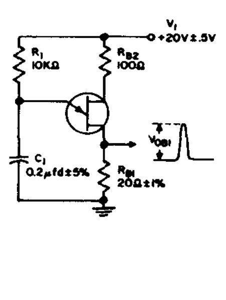
		MIN.	TYP.	MAX.	
Intrinsic Standoff Ratio ($V_{BB} = 10V$) (Note 4)	η	.68		.82	
Interbase Resistance ($V_{BB} = 3V, I_E = 0$)	R_{BBO}	4.7		9.1	kΩ
Emitter Saturation Voltage ($V_{BB} = 10V, I_E = 50$ ma)	$V_{E(SAT)}$		2		Volts
Modulated Interbase Current ($V_{BB} = 10V, I_E = 50$ ma)	$I_{B2(MOD)}$		12		mA
Emitter Reverse Current ($V_{B2E} = 30V, I_{B1} = 0$)	I_{EO}			.5	μA
Peak Point Emitter Current ($V_{BB} = 25V$)	I_P			2	μA
Valley Point Current ($V_{BB} = 20V, R_{B2} = 100\ \Omega$)	I_V	8			mA
Base-One Peak Pulse Voltage (Note 3)	V_{OB1}	6			Volts

NOTES:
1. Derate 3.0 MW/°C increase in ambient temperature. The total power dissipation (available power to Emitter and Base-Two) must be limited by the external circuitry.
2. Capacitor discharge — 10μF or less, 30 volts or less.
3. The Base-One Peak Pulse Voltage is measured in the circuit below. This specification on the D5J45 is used to ensure a minimum pulse amplitude for applications in SCR firing circuits and other types of pulse circuits.
4. The intrinsic standoff ratio η, is essentially constant with interbase voltage. η is defined by the equation:

$$V_P = \eta V_{BB} + V_D$$

Where V_P = Peak Point Emitter Voltage
V_{BB} = Interbase Voltage
V_D = Junction Diode Drop (Approx. .5V)

FIGURE 1

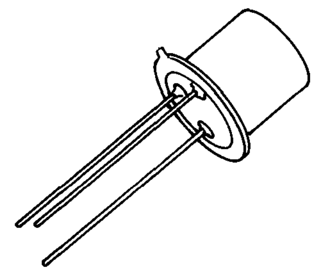


Silicon Complementary Unijunction Transistor

D5K1

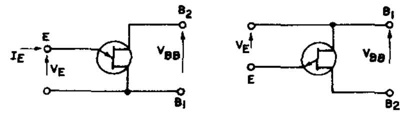
COMPLEMENTARY UNIJUNCTION

The General Electric D5K1 Complementary Unijunction Transistor is a silicon planar, monolithic integrated circuit. It has unijunction characteristics with superior stability, a much tighter intrinsic-standoff ratio distribution and lower saturation voltage.



FEATURES

- Guaranteed stability of better than .6% from −15°C to +65°C and better than 1.0% from −55°C to +150°C
- Low leakage current: less than 10nA
- Ability to temperature compensate and calibrate at room temperature
- Up to 100 kHz operation



Standard Unijunction **Complementary Unijunction**

WHAT IS A COMPLEMENTARY UNIJUNCTION TRANSISTOR?

The General Electric D5K is a silicon planar passivated semiconductor device with characteristics like those of a standard unijunction transistor except that the currents and voltages applied to it are of opposite polarity.

We have chosen to use this polarity so that standard NPN planar passivated transistor processing techniques can be used. This results in a unijunction having superior stability and better uniformity than any unijunction previously available. The much tighter spread of intrinsic-standoff ratio now available is a significant advantage. For most applications, the polarity is not important.

WHAT CAN THE D5K DO?

The General Electric D5K can be used in most applications now using standard type unijunctions. Its unique stability and uniform properties make it ideal for stable oscillators, timers, and frequency dividers.

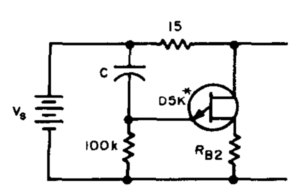
The key advantage of the D5K over conventional UJT's is its predictability over the specified temperature range. This allows an engineer to use design curves to select the correct R_{B2} compensating resistor instead of having to perform expensive temperature testing on individual devices.

The D5K1 has been characterized especially for applications requiring the best possible stability over the extreme temperature range specified. For most applications, because of the tight R_{BBO} and η spread, the D5K1 can be compensated in a given circuit with one resistor value by selecting the proper R_{B2} from Figure 2. For even better stability, a designer only has to measure the R_{BBO} of a device at room temperature, determine the proper R_{BBO}/R_{B2} ratio from Figure 3, and insert the correct R_{B2}. Using this method, oscillators and timers can be built offering 0.5% stability over most temperature ranges used.

Frequency dividers can be built with larger countdown ratios and drastically lower capacitor sizes due to the stability and low charge to trigger value (Q_t). Another product advantage, low base 1 to emitter voltage drop at high current, allows generation of high outputpulses with *low* base to base voltages.

For further application information, refer to Application Note 90.72.

FIGURE 1



TEST CIRCUIT
*CUJT ONLY SUBJECTED TO TEMPERATURE CHANGE
ALL RESISTORS 1%

FIGURE 2

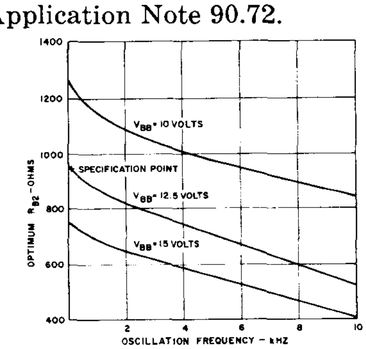
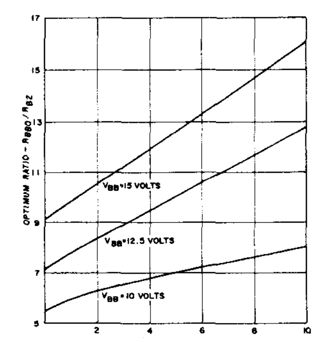
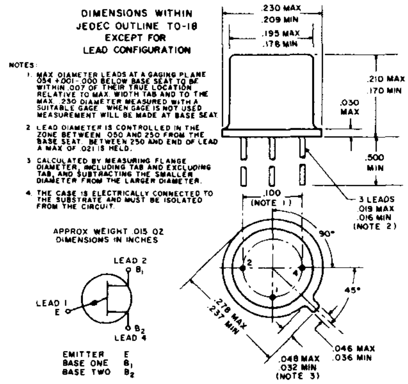


FIGURE 3



absolute maximum ratings: (25° C free air)

	D5K1	
Voltage		
Interbase Voltage	30	V
Current (Note 2)		
Average Emitter (Forward)	150	mA
Peak Emitter (Forward) (Note 1)	2	A
Peak Reverse Emitter	15	mA
Power		
Average Total (Note 2)	300	mW
Temperature		
Operating	−55 to +150	°C
Storage	−55 to +200	°C



electrical characteristics: (25° C free air)

		Min.	Typ.	Max.	
Intrinsic Standoff Ratio (Note 3)	η	0.58	0.60	0.62	
Peak Point Voltage					
(V_{BB} = 5V)	V_P	3.2	3.45	3.7	Volts
(V_{BB} = 10V)	V_P	6.1	6.45	6.8	Volts
Interbase Resistance					
(I_{BB} = 0.1mA)	R_{BBO}	5.5	6.8	8.2	kohms
Emitter Breakdown Voltage					
(I_{EB1} = 10μA)	V_{EB1O}	8.0	9.5		Volts
Peak Point Current					
(V_{BB} = 10V)	I_P			5	μA
Valley Point Current					
(V_{BB} = 10V)	I_V	1	2		mA
Emitter Reverse Current					
(V_{EB1} = 5V)	I_{EB1O}		0.1	10	nA
Emitter Saturation Voltage					
(I_E = 50mA, V_{BB} = 10V)	$V_{E(sat)}$		1.1	1.5	Volts
Modulated Interbase Current					
(I_E = 50mA, V_{BB} = 10V)	$I_{B2(mod)}$		4	10	mA
Peak Pulse Voltage					
(Note 4)	V_{OUT}	3.5	4.5		Volts
Diode Voltage Drop					
(Note 3)	V_D	.30	.45	.60	Volts
Minimum Charge to Trigger					
(V_{BB} = 10V)	Q_t		50		pC
Turn-on Time (See Figure 7)	t_{on}			1	μsec.
Recovery Time (See Figure 7)	t_{rec}			10	μsec.
Relaxation Oscillator Frequency Shift from 25°C Value (See Figure 1, C = 0.1μF, R_{B2} = 950Ω, V_S = 12.5V)					
−15°C to +65°C			0.2	0.6	%
−55°C to +150°C			0.4	1.0	%

Notes:

1. For capacitor discharge, resistor current limiting is required for capacitors greater than 5 μF and recommended for all cases. (A minimum of 15 ohms is required for good temperature stability.)
2. Derate power and currents linearly to zero at maximum operating temperature.
3. The intrinsic-standoff ratio (η) is essentially constant with temperature and interbase voltage. It and the associated diode drop of peak point voltage are defined by the equations:

$$\eta = \frac{V_{P1} - V_{P2}}{V_{BB1} - V_{BB2}} \qquad V_D = V_{P2} - \eta V_{BB2} \qquad \text{Where: } V_{BB1} = 10V \pm .001V, \quad V_{BB2} = 5V \pm .001V$$

4. The Base-One Peak Pulse Voltage is measured in the circuit shown in Figure 4. This specification is used to insure a minimum pulse amplitude for applications in SCR firing circuits and other types of firing circuits.

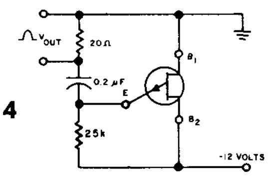


FIGURE 4

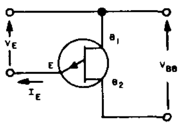


FIGURE 5

Complementary Unijunction Transistor symbol with nomenclature used for voltage and currents.

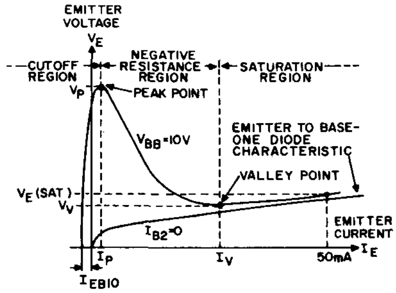


FIGURE 6

Static Emitter Characteristics curves showing important parameters and measurement points (exaggerated to show details).

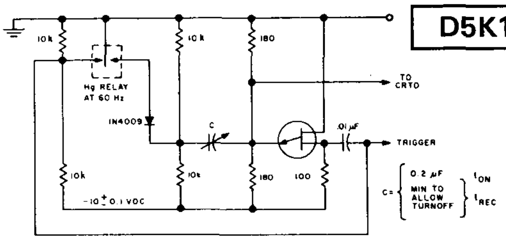
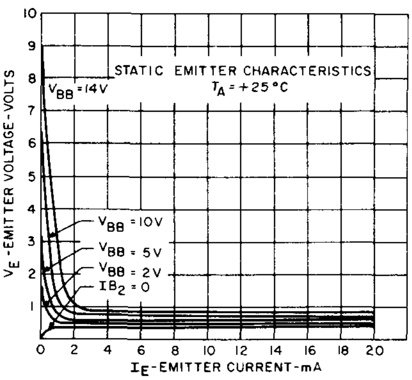
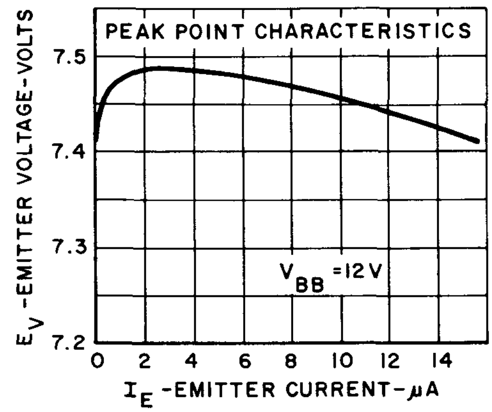
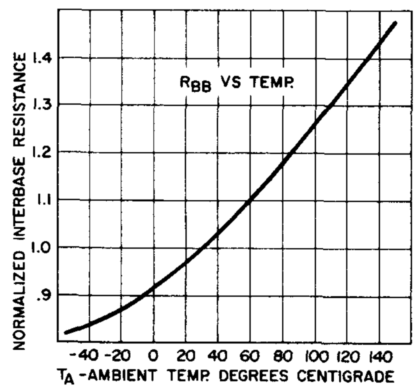


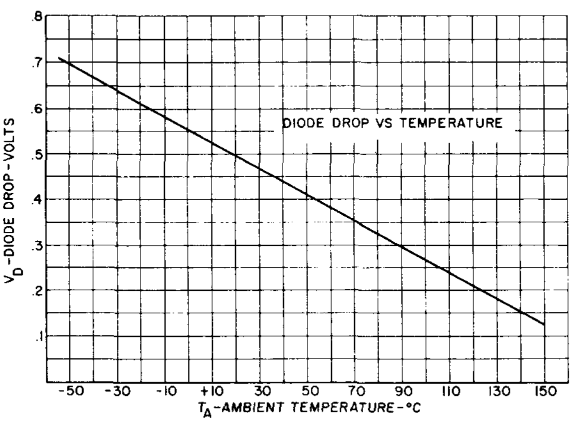
FIGURE 7

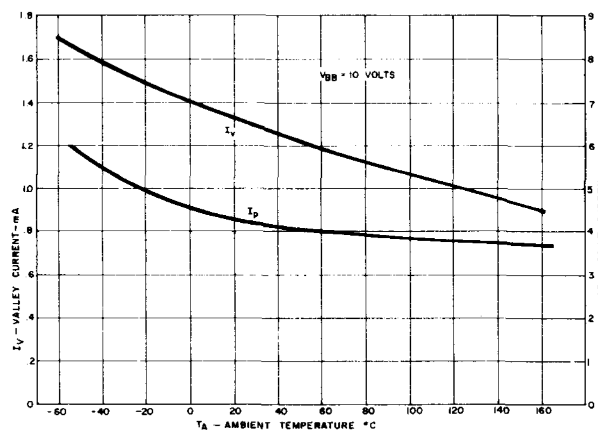
TYPICAL CHARACTERISTICS

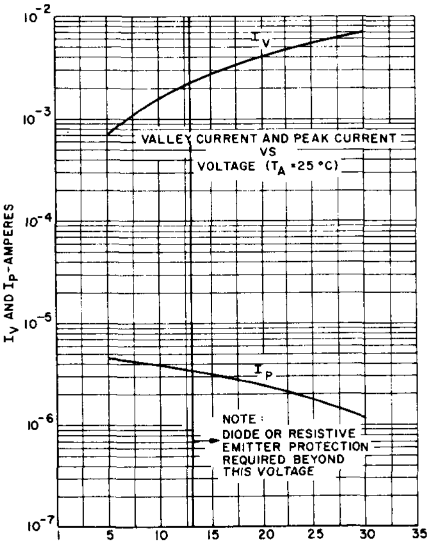


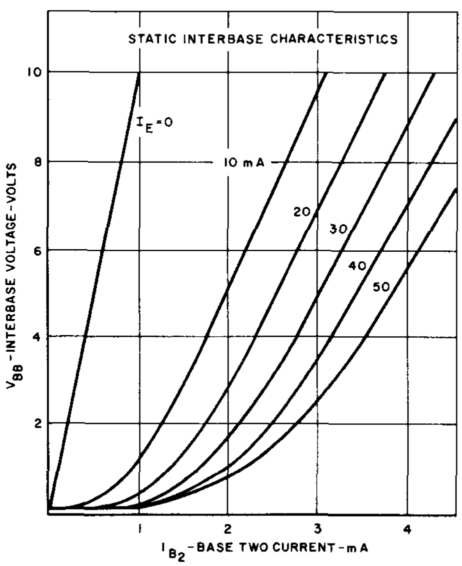


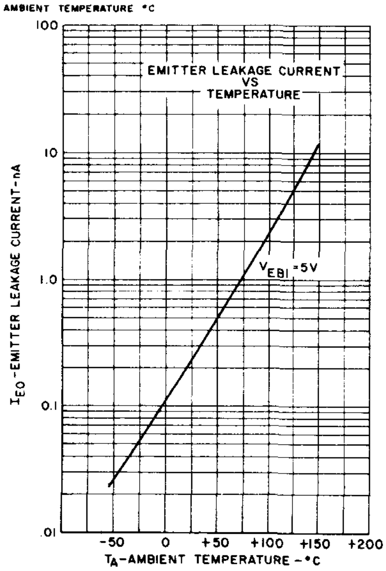








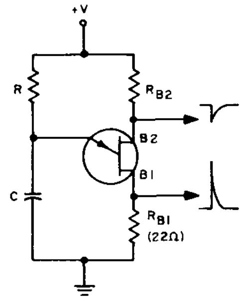




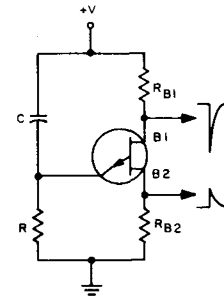
APPLICATIONS

TYPICAL CIRCUITS

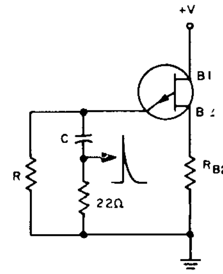
Since the CUJT has opposite polarities from standard UJT's, its oscillator circuit Figure (b) is "inverted." Figure (a) shows a positive, high energy pulse, while Figure (b) shows a negative. Circuit in Figure (c) results in positive pulses for SCR triggering.



(a)
STANDARD CIRCUIT



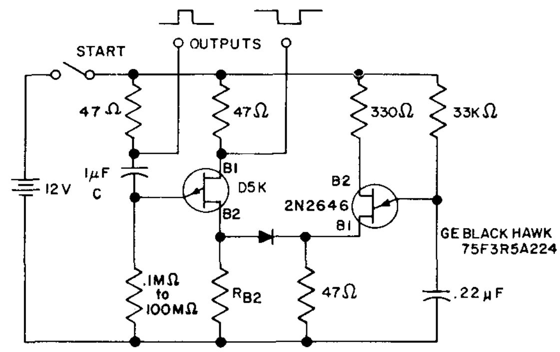
(b)
COMPLEMENTARY CIRCUIT



(c)
CUJT CIRCUIT FOR HIGH ENERGY TRIGGER PULSES

0.1 TO 90 SECOND TIMER

Timer interval starts when power is applied to circuit, terminates when voltage is applied to load. 2N2646 is used in oscillator which pulses base 2 of D5K. This reduces effective I_P of D5K and allows much larger timing resistor and smaller timing capacitor to be used than would otherwise be possible.

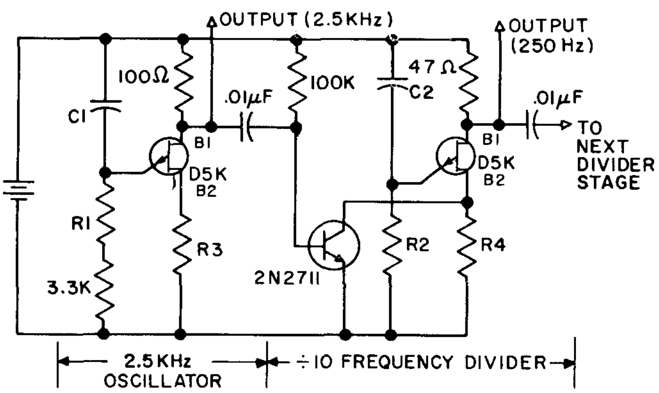


C = GE BLUE JAY AA18A105C

DECADE FREQUENCY DIVIDER

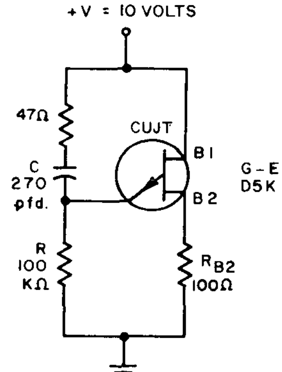
In next stage, product of R2 and C2 should be 10 × that of preceding stage (±2%). R2 should be between 27kΩ and 10 meg Ω.

C1 & C2—.0047 μF (±1%)
R1—100k Ω (±1%)
R2—1M Ω (±1%)
R3—R4—1k Ω (may need to be adjusted for variation of R_{BB} of CUJT)



50 kHz OSCILLATOR

Higher frequency (stable) oscillators are now possible. Here are typical components for a 50 kHz circuit. This is possible because of the more nearly ideal characteristics of the D5K (over conventional UJT's). One application for higher frequency is TV horizontal oscillators. Note the low R_{B2}.

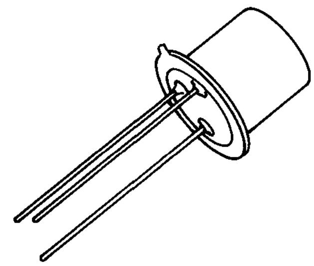


Silicon
Complementary
Unijunction Transistor

D5K2

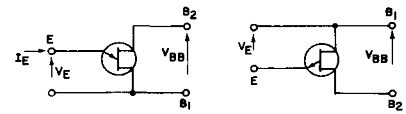
COMPLEMENTARY UNIJUNCTION

The General Electric D5K2 Complementary Unijunction Transistor is a silicon planar, monolithic integrated circuit. It has unijunction characteristics with superior stability, a much tighter intrinsic-standoff ratio distribution and lower saturation voltage.



FEATURES

- Guaranteed stability of better than 1.0% from −15°C to +65°C and better than 2.0% from −55°C to +100°C
- Low leakage current: less than 100 nA
- Ability to temperature compensate and calibrate at room temperature
- Up to 100 kHz operation



Standard Unijunction   Complementary Unijunction

WHAT IS A COMPLEMENTARY UNIJUNCTION TRANSISTOR?

The General Electric D5K is a silicon planar passivated semiconductor device with characteristics like those of a standard unijunction transistor except that the currents and voltages applied to it are of opposite polarity.

We have chosen to use this polarity so that standard NPN planar passivated transistor processing techniques can be used. This results in a unijunction having superior stability and better uniformity than any unijunction previously available. The much tighter spread of intrinsic-standoff ratio now available is a significant advantage. For most applications, the polarity is not important.

WHAT CAN THE D5K DO?

The General Electric D5K can be used in most applications now using standard type unijunctions. Its unique stability and uniform properties make it ideal for stable oscillators, timers, and frequency dividers.

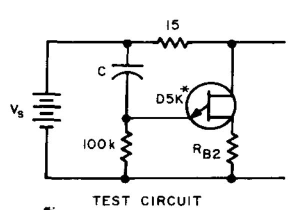
The key advantage of the D5K over conventional UJT's is its predictability over the specified temperature range. This allows an engineer to use design curves to select the correct R_{B2} compensating resistor instead of having to perform expensive temperature testing on individual devices.

For most applications now using conventional UJT's, the entire D5K2 population can be compensated in a given circuit with one resistor value by selecting the proper R_{B2} compensating resistor from Figure 2. For even better stability, a designer only has to measure the R_{BBO} of a device at room temperature, determine the proper R_{BBO}/R_{B2} ratio from Figure 3, and insert the correct R_{B2}. Using this method, oscillators and timers can be built offering 1.0% stability over most temperature ranges used.

Frequency dividers can be built with larger countdown ratios and drastically lower capacitor sizes due to the stability and low charge to trigger value (Q_t). Another product advantage, low base 1 to emitter voltage drop at high current, allows generation of high outputpulses with *low* base to base voltages.

For further application information, refer to Application Note 90.72.

FIGURE 1



TEST CIRCUIT
*CUJT ONLY SUBJECTED TO TEMPERATURE CHANGE
ALL RESISTORS 1%

FIGURE 2

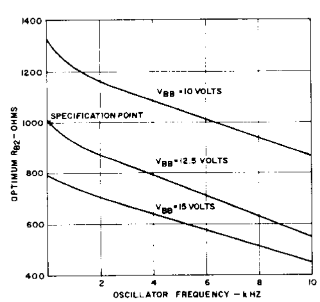
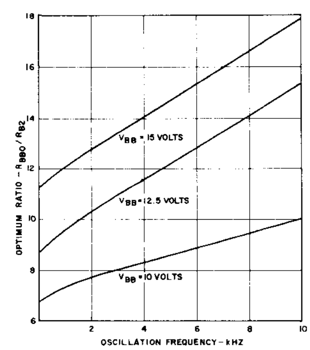


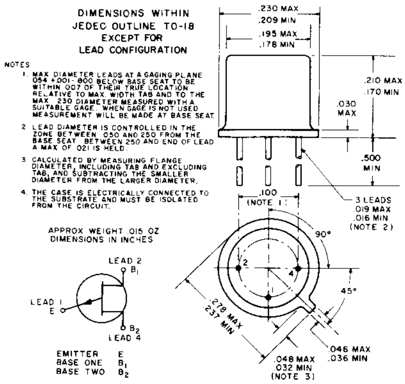
FIGURE 3



D5K2

absolute maximum ratings: (25° C free air)

	D5K2	
Voltage		
Interbase Voltage	20	V
Current (Note 2)		
Average Emitter (Forward)	150	mA
Peak Emitter (Forward) (Note 1)	2	A
Peak Reverse Emitter	15	mA
Power		
Average Total (Note 2)	200	mW
Temperature		
Operating	−55 to +100	°C
Storage	−55 to +150	°C



electrical characteristics: (25° C free air)

		Min.	Typ.	Max.	
Intrinsic Standoff Ratio (Note 3)	η	0.58	0.60	0.62	
Peak Point Voltage					
(V_{BB} = 5V)	V_P	3.2	3.45	3.7	Volts
(V_{BB} = 10V)	V_P	6.1	6.45	6.8	Volts
Interbase Resistance					
(I_{BB} = 0.1mA)	R_{BBO}	5	8	15	kohms
Emitter Breakdown Voltage					
(I_{EB1} = 10μA)	V_{EB1O}	8.0	9.5		Volts
Peak Point Current					
(V_{BB} = 10V)	I_P			15	μA
Valley Point Current					
(V_{BB} = 10V)	I_V	1	2		mA
Emitter Reverse Current					
(V_{EB1} = 5V)	I_{EB1O}		0.1	10	nA
Emitter Saturation Voltage					
(I_E = 50mA, V_{BB} = 10V)	$V_{E(sat)}$		1.1	1.5	Volts
Modulated Interbase Current					
(I_E = 50mA, V_{BB} = 10V)	$I_{B2(mod)}$		4	10	mA
Peak Pulse Voltage					
(Note 4)	V_{OUT}	3.5	4.5		Volts
Diode Voltage Drop					
(Note 3)	V_D	.30	.45	.60	Volts
Minimum Charge to Trigger					
(V_{BB} = 10V)	Q_t		50		pC
Turn-on Time (See Figure 7)	t_{on}			1	μsec.
Recovery Time (See Figure 7)	t_{rec}			10	μsec.
Relaxation Oscillator Frequency Shift from 25°C Value (See Figure 1, C = 0.1μF, R_{B2} = 1kΩ, V_S = 12.5V)					
−15°C to +65°C			0.3	1.0	%
−55°C to +100°C			0.5	2.0	%

Notes:

1. For capacitor discharge, resistor current limiting is required for capacitors greater than 5 μF and recommended for all cases. (A minimum of 15 ohms is required for good temperature stability.)
2. Derate power and currents linearly to zero at maximum operating temperature.
3. The intrinsic-standoff ratio (η) is essentially constant with temperature and interbase voltage. It and the associated diode drop of peak point voltage are defined by the equations:

$$\eta = \frac{V_{P1} - V_{P2}}{V_{BB1} - V_{BB2}} \qquad V_D = V_{P2} - \eta V_{BB2}$$

Where: $V_{BB1} = 10V \pm .001V$
$V_{BB2} = 5V \pm .001V$

4. The Base-One Peak Pulse Voltage is measured in the circuit shown in Figure 4. This specification is used to insure a minimum pulse amplitude for applications in SCR firing circuits and other types of firing circuits.

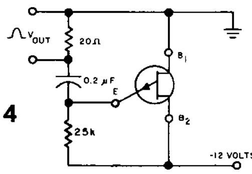


FIGURE 4

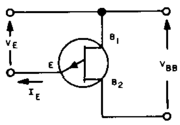


FIGURE 5

Complementary Unijunction Transistor symbol with nomenclature used for voltage and currents.

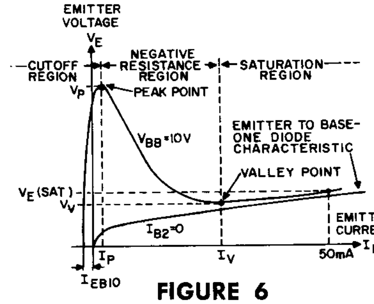


FIGURE 6

Static Emitter Characteristics curves showing important parameters and measurement points (exaggerated to show details).

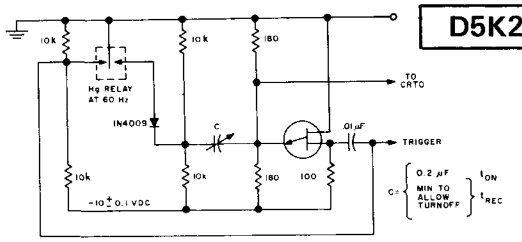
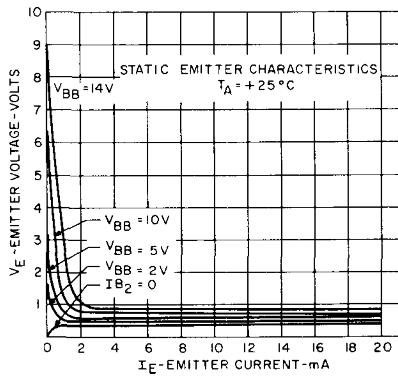
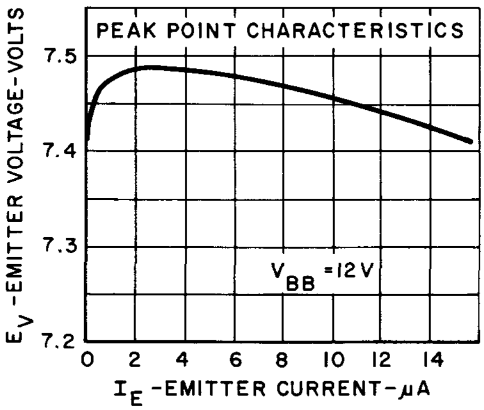
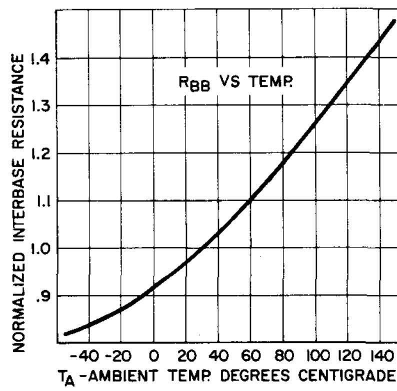


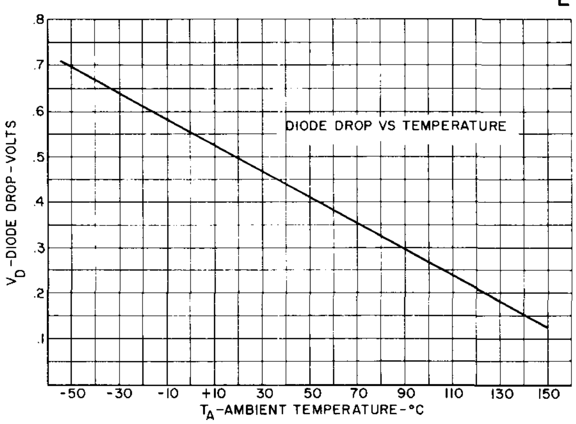
FIGURE 7

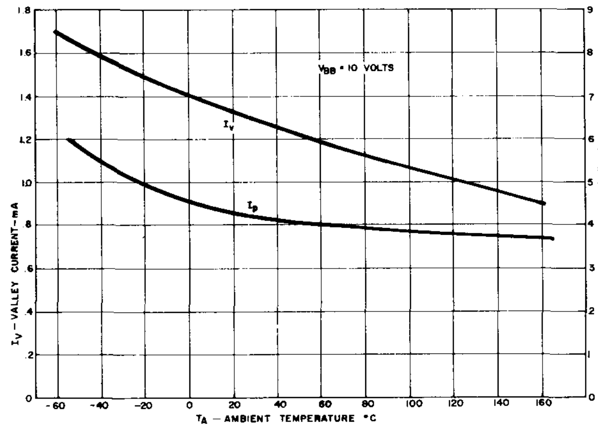
TYPICAL CHARACTERISTICS

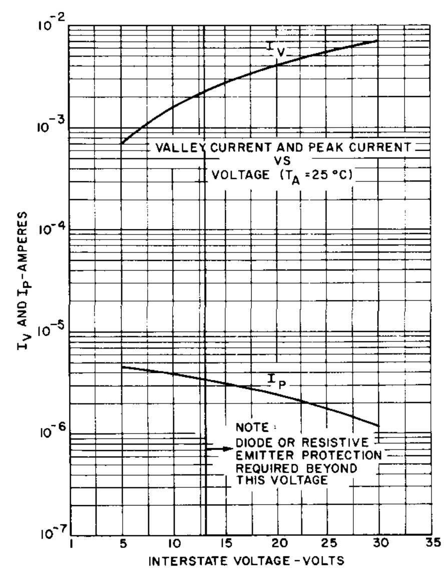


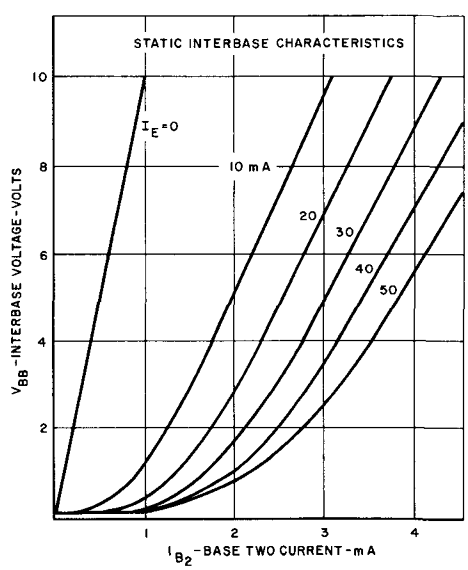


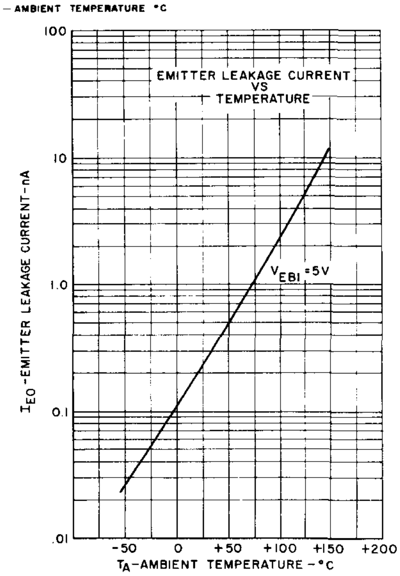








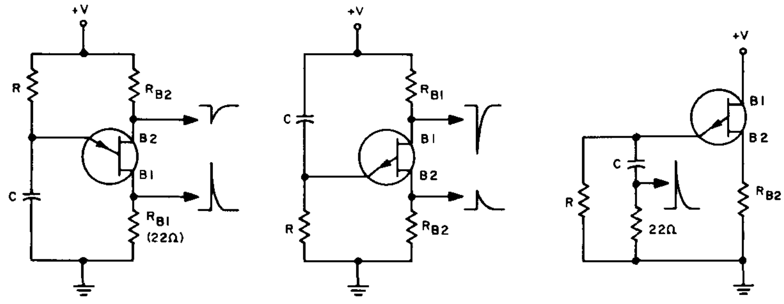




APPLICATIONS

TYPICAL CIRCUITS

Since the CUJT has opposite polarities from standard UJT's, its oscillator circuit Figure (b) is "inverted." Figure (a) shows a positive, high energy pulse, while Figure (b) shows a negative. Circuit in Figure (c) results in positive pulses for SCR triggering.



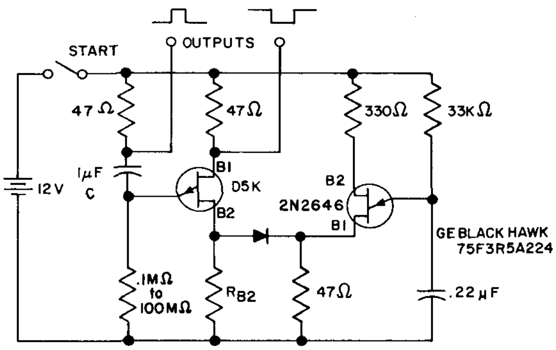
(a) STANDARD CIRCUIT

(b) COMPLEMENTARY CIRCUIT

(c) CUJT CIRCUIT FOR HIGH ENERGY TRIGGER PULSES

0.1 TO 90 SECOND TIMER

Timer interval starts when power is applied to circuit, terminates when voltage is applied to load. 2N2646 is used in oscillator which pulses base 2 of D5K. This reduces effective I_P of D5K and allows much larger timing resistor and smaller timing capacitor to be used than would otherwise be possible.

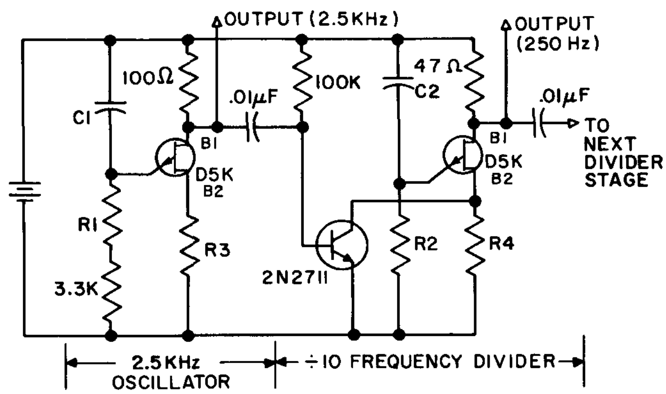


C=GE BLUE JAY AA18A105C

DECADE FREQUENCY DIVIDER

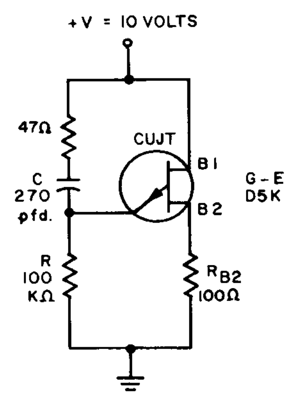
In next stage, product of R2 and C2 should be 10 × that of preceding stage (±2%). R2 should be between 27kΩ and 10 meg Ω.

C1 & C2—.0047 μF (±1%)
R1—100k Ω (±1%)
R2—1M Ω (±1%)
R3—R4—1k Ω (may need to be adjusted for variation of R_{BB} of CUJT)



50 kHz OSCILLATOR

Higher frequency (stable) oscillators are now possible. Here are typical components for a 50 kHz circuit. This is possible because of the more nearly ideal characteristics of the D5K (over conventional UJT's). One application for higher frequency is TV horizontal oscillators. Note the low R_{B2}.

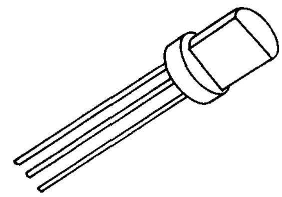


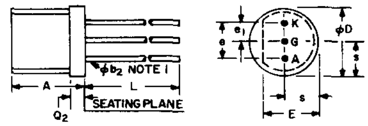
Silicon Programmable Unijunction Transistor (PUT)

D13T SERIES
D13T3
D13T4

The General Electric D13T3 and D13T4 are 100 volt versions of the popular 2N6027 and 2N6028 Programmable Unijunction Transistors (PUT). These devices offer the designer the additional advantage of using higher circuit voltages thus improving timing stability.

For PUT application information please refer to Application Note 90.70.





SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.170	.265	4.32	6.73
ϕb_2	.016	.019	.406	.483
ϕD	.165	.205	4.19	5.21
E	.110	.155	2.79	3.94
e	.095	.105	2.41	2.67
e_1	.045	.055	1.14	1.40
L	.500		12.70	
Q_2		.075		1.90
s	.080	.115	2.03	2.92

NOTE 1: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .070 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

absolute maximum ratings: (25°C)

Voltage	
Gate-Cathode Forward Voltage	+100 V
Gate-Cathode Reverse Voltage	—5 V
Gate-Anode Reverse Voltage	+100 V
Anode-Cathode Voltage	±100 V
Current	
DC Anode Current†	150 mA
Peak Anode, Recurrent Forward	
(100μsec pulse width, 1% duty cycle)	1 A
(20μsec pulse width, 1% duty cycle)	2 A
Peak Anode, Non-recurrent Forward (10μsec)	5 A
Gate Current	±20 mA
Capacitive Discharge Energy††	250μJ
Power	
Total Average Power†	300 mW
Temperature	
Operating Ambient† Temperature Range	—50°C to +100°C

†Derate currents and powers 1%/°C above 25°C

††E = ½CV² capacitor discharge energy with no current limiting-non repetative

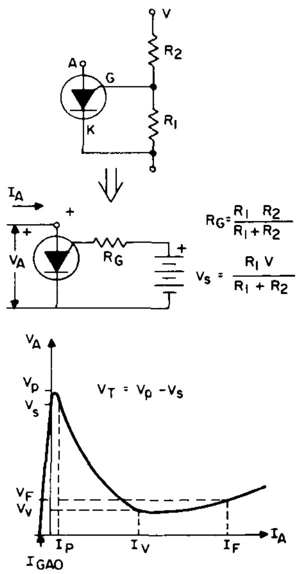


Figure 1

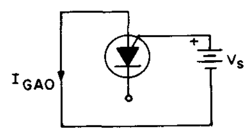


Figure 2

electrical characteristics: (25°C) (unless otherwise specified)

		Fig. No.	D13T3 Min.	D13T3 Max.	D13T4 Min.	D13T4 Max.
Peak Current						
(V_s = 10 Volts)	I_P	1				
(R_G = 1 Meg)				2		.15μA
(R_G = 10 k)				5		1.0μA
Offset Voltage						
(V_s = 10 Volts)	V_T	1				
(R_G = 1 Meg)			.2	1.6	.2	.6 Volts
(R_G = 10 k)			.2	.6	.2	.6 Volts
Valley Current						
(V_s = 10 Volts)	I_V	1				
(R_G = 1 Meg)				50		25μA
(R_G = 10 k)			70		25	μA
(R_G = 200Ω)			1.5		1.0	mA
Anode Gate-Anode Leakage Current						
(V_s = 100 Volts, T = 25°C)	I_{GAO}	2		10		10 nA
(T = 75°C)				100		100 nA
Gate to Cathode Leakage Current						
(V_s = 100 Volts, Anode-cathode short)	I_{GKS}	3		100		100 nA
Forward Voltage (I_F = 50 mA)	V_F			1.5		1.5 Volts
Pulse Output Voltage	V_O	4	6		6	Volts
Pulse Voltage Rate of Rise	t_r	4		80		80 nsecs.

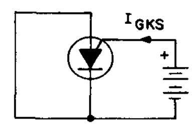


Figure 3

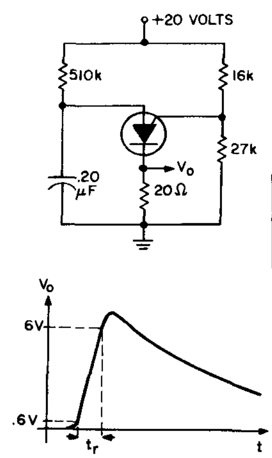
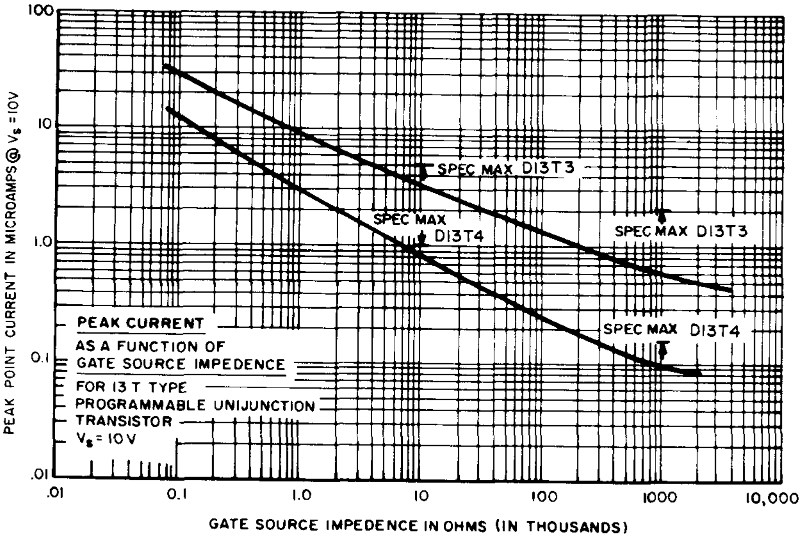
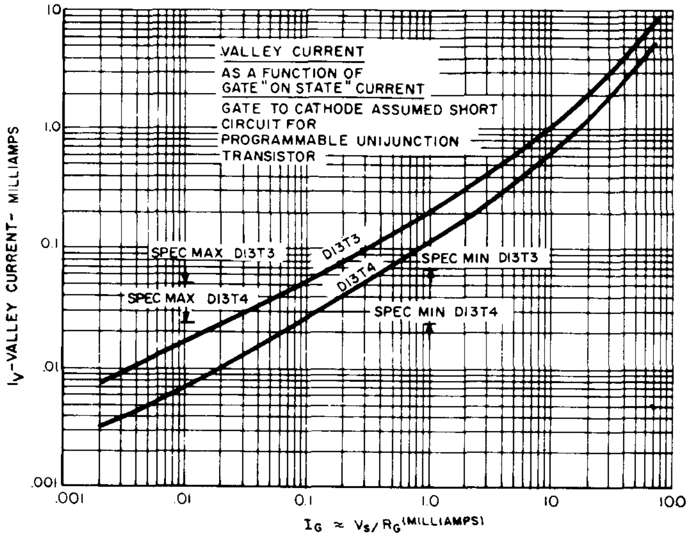


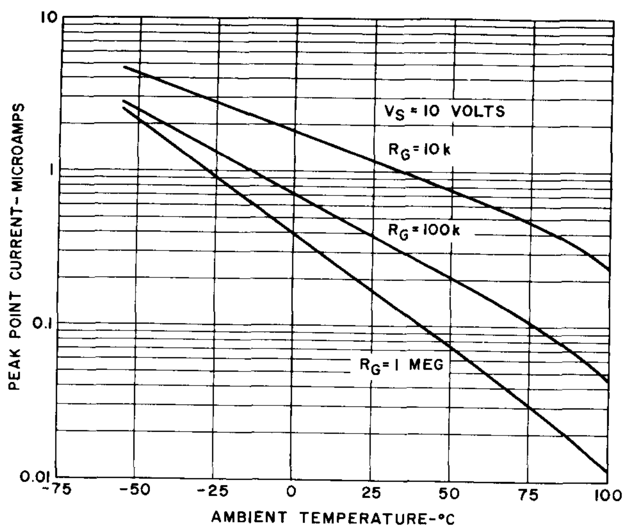
Figure 4



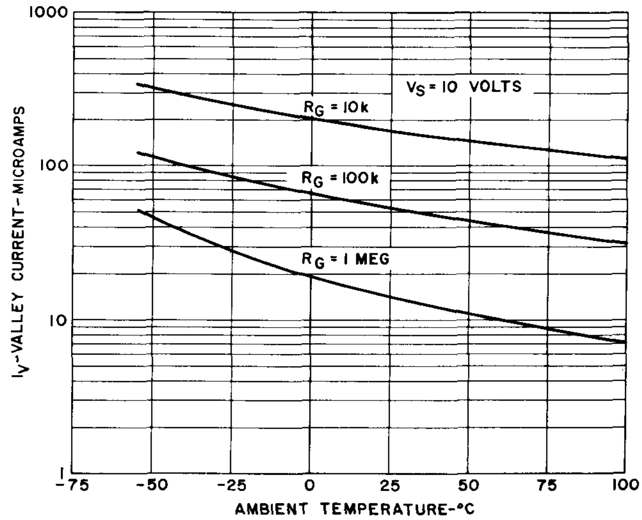
I_P vs Gate Source Impedance



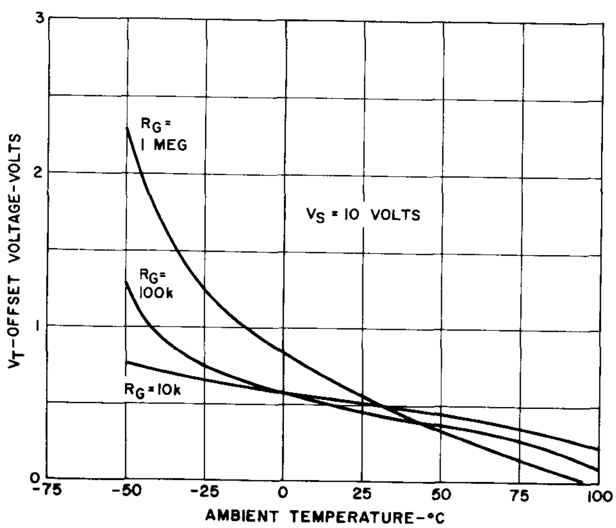
I_V vs Gate "on state" Current



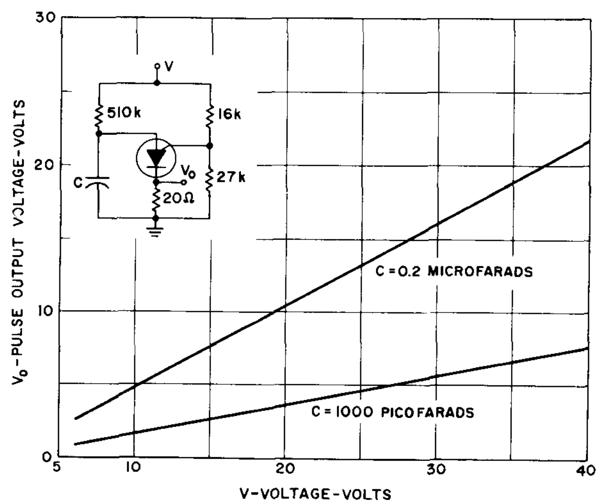
I_P vs Temperature and R_G



I_V vs Temperature and R_G



V_T vs Temperature and R_G



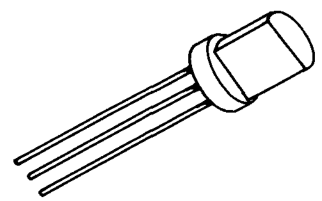
Peak Output Voltage

Silicon Transistor

NPN

D16G6

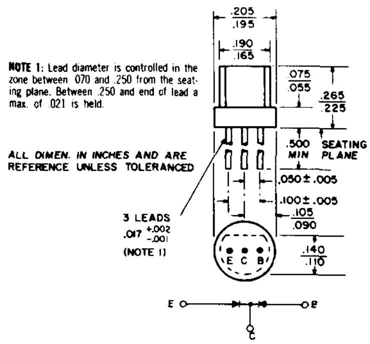
The General Electric D16G6 is an NPN silicon planar epitaxial passivated transistor designed specifically for high frequency applications. The unit is suitable for use as a UHF television tuner oscillator.



absolute maximum ratings: (25°C) (unless otherwise specified)

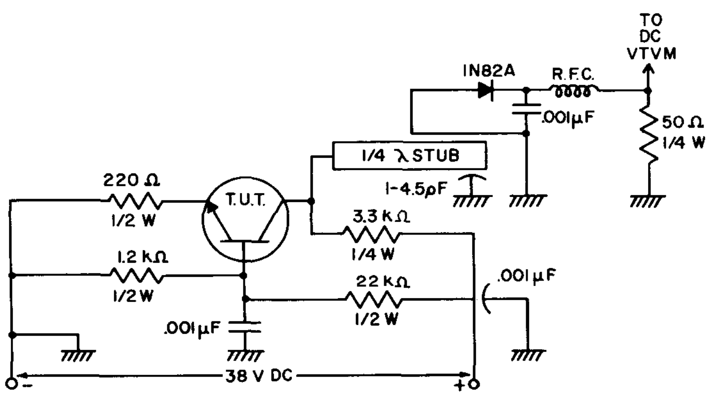
Voltages			
Collector to base	V_{CBO}	30	V
Emitter to base	V_{EBO}	3	V
Collector to emitter	V_{CEO}	12	V
Current			
Collector (steady state)*	I_C	25	mA
Dissipation			
Total Power (free air @ 25°C amb.)*	P_T	200	mW
Total Power (free air @ 55°C amb.)*	P_T	120	mW
Temperature			
Storage temperature	T_{stg}	−55 to +125	°C
Soldering temperature 10 sec. 1/16 ± 1/32″ from case		260	°C
Operating junction temperature	T_J	100	°C

* Derate 2.67 mW/°C for ambient above 25°C.



electrical characteristics: (25°C) (unless otherwise specified)

	Symbol	Min	Typ	Max	Units
Static					
Collector cutoff current ($V_{CB} = 30$ V, $I_E = 0$)	I_{CBO}			0.5	μA
Emitter cutoff current ($V_{EB} = 3$ V, $I_C = 0$)	I_{EBO}			0.5	μA
Forward current transfer ratio ($I_C = 5$ mA, $V_{CE} = 10$V)	h_{FE}	20			
Collector-base breakdown voltage ($I_E = 0$, $I_C = 100$ μA)	BV_{CBO}	30			V
Emitter-base breakdown voltage ($I_C = 0$, $I_E = 100$ μA)	BV_{EBO}	3			V
Collector-emitter breakdown voltage ($I_B = 0$, $I_C = 3$ mA)	BV_{CEO}	12		35	V
Dynamic					
Gain bandwidth product ($V_{CE} = 10$V, $I_C = 5$ mA)	f_T	500			MHz
Collector base time constant ($V_{CE} = 10$V, $I_C = 5$ mA)	$r'_b C_c$			20	psec.
Output capacitance ($V_{CB} = 10$V, $I_E = 0$, f = 1 MHz)	C_{cbo}		1.2	1.5	pF
Oscillator output ($V_{CC} = 38$V, $I_C \approx 5$ mA, f ≈ 940 MHz) (See Figure 1)	V_o	2.5			mV



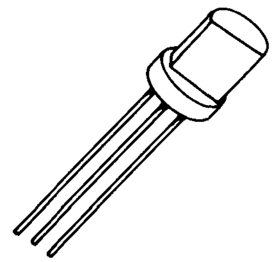
940 MHz Oscillator Test Circuit
Figure 1

Silicon Transistor

NPN

D16P1

The General Electric D16P1 is a planar epitaxial passivated NPN silicon Darlington monolithic amplifier. It is ideal for preamplifier input impedances of several megohms.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to base	V_{CBO}	18	V
Collector to emitter	V_{CEO}	12	V
Collector to emitter	V_{CES}	18	V
Emitter to base	V_{EBO}	12	V
Current			
Collector (Pulsed)*	I_C	500	mA
Collector (steady state)	I_C	200	mA
Base (steady state)	I_B	20	mA
Dissipation			
Total power (free air @ 25°C)**	P_T	400	mW
Temperature			
Storage	T_S	−65 to +150	°C
Operating	T_J	−65 to +125	°C
Lead 1/16″ ± 1/32″ from case for 10 seconds maximum	T_L	260	°C

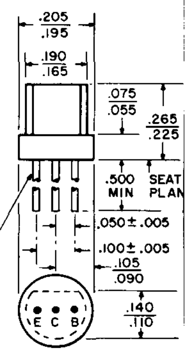
*Pulse Conditions: 300 μsec. pulse width, 2% duty cycle

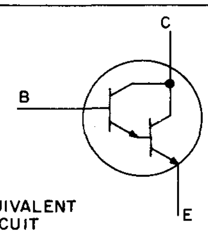
**Derate 4.0 mW/°C for increase in ambient temperature between 25 and 125°C

DIMENSIONS WITHIN JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED





EQUIVALENT CIRCUIT

electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS

		Min.	Typ.	Max.	
Collector cutoff current					
(V_{CB} = 18V, I_E = 0)	I_{CBO}			100	nA
(V_{CB} = 18V, I_E = 0, T_A = 100°C)	I_{CBO}			20	μA
Emitter cutoff current					
(V_{EB} = 12V)	I_{EBO}			100	nA

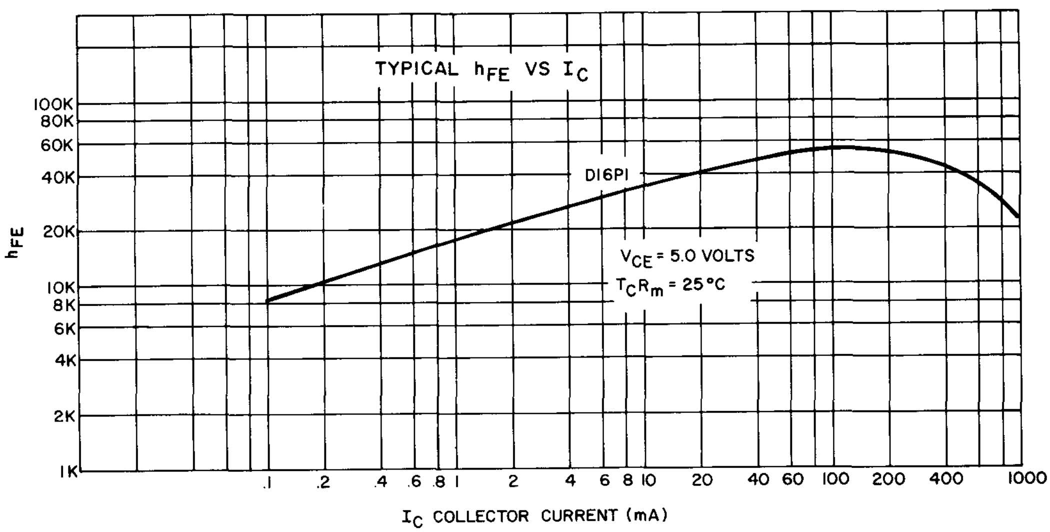
electrical characteristics: 25°C (unless otherwise specified) (cont'd)

		Min.	Typ.	Max.	
Collector emitter breakdown voltage ($I_C = 10$ mA, $I_B = 0$)	$V_{(BR)CEO}$	12			V
Forward current transfer ratio ($I_C = 2$ mA, $V_{CE} = 5V$)	h_{FE}	2,000			
($I_C = 100$ mA, $V_{CE} = 5V$)	h_{FE}†	6,000			
Collector emitter saturation voltage ($I_C = 200$ mA, $I_B = 0.2$ mA)	$V_{CE(SAT)}$†			1.4	V
Base emitter saturation voltage ($I_C = 200$ mA, $I_B = 0.2$ mA)	$V_{BE(SAT)}$†			1.6	V
Base emitter drive voltage ($I_C = 200$ mA, $V_{CE} = 5V$)	V_{BE}†			1.5	V

DYNAMIC CHARACTERISTICS

		Min.	Typ.	Max.	
Forward current transfer ratio ($I_C = 2$ mA, $V_{CE} = 5V$, f — 1 kHz)	h_{fe}	2,000			
Forward current transfer ratio ($I_C = 2$ mA, $V_{CE} = 5V$, f = 20 MHz)	$\|h_{fe}\|$	3			
Output capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{ob}		7.6	10	pF
Input capacitance ($V_{EB} = 0.5V$, f = 1 MHz)	C_{eb}		10.5		pF

†Pulsed Measurement: Pulse width ≦ 300 μsec., Duty cycle ≦ 2%



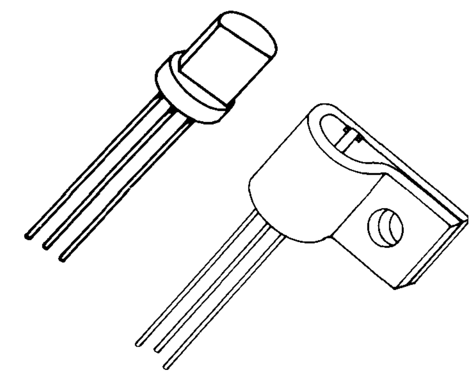
Silicon Transistors

PNP	NPN
D29E1	D33D21
D29E2	D33D22
D29E1J1	D33D21J1
D29E2J1	D33D22J1

The PNP D29E1, 2 series and the NPN D33D21, 22 series are silicon, planar, passivated, epitaxial transistors intended for general purpose applications. These complementary pairs are especially suited for the output stage of push-pull audio amplifiers, the drive stage of power amplifiers, or for control and television circuitry.

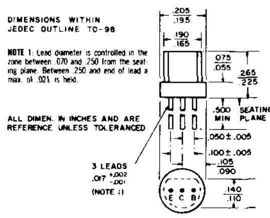
FEATURES: • Low Collector Saturation Voltage • Excellent Beta Linearity Over a Wide Current Range • Heatsinking Available on All Units

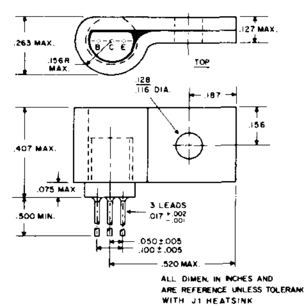
NOTE: Observe proper polarity on biases for PNP's and NPN's.



absolute maximum ratings: (25°C unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	25	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	35	Volts
Collector to Emitter	V_{CES}	35	Volts
Current			
Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec. pulse width, ≤ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
Total Power (Free Air, $T_A \leq 25°C$)*	P_T	500	mW
Total Power with J1 Heatsink (Free Air, $T_A \leq 25°C$)**	P_T	700	mW
Total Power with J1 Heatsink (Case Temp., $T_C \leq 25°C$)***	P_T	1000	mW
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +150	°C
Lead soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C





*Derate 4.0 mW/°C increase in ambient temperature above 25°C. **Derate 5.6 mW/°C increase in ambient temperature above 25°C. ***Derate 8.0 mW/°C increase in case temperature above 25°C.

electrical characteristics: (25°C unless otherwise specified)

NOTE: Characteristics apply to both heatsinked and non-heatsinked devices.

STATIC CHARACTERISTICS		Min.	Max.	
Collector Cutoff Current (V_{CE} = 25V)	I_{CES}	—	100	nA
(V_{CE} = 25V, T_A = 100°C)	I_{CES}	—	15	μA
Forward Current Transfer Ratio				
(I_C = 2 mA, V_{CE} = 2V)				
D29E1/D33D21	h_{FE}	60	200	
D29E2/D33D22	h_{FE}	150	500	
(I_C = 500 mA, V_{CE} = 2V)				
D29E1/D33D21	** h_{FE}	45	—	
D29E2/D33D22	** h_{FE}	60	—	
Collector Emitter Breakdown Voltage				
(I_C = 10 mA)	** $V_{(BR)CEO}$	25	—	Volts
(I_C = 10 μA)	$V_{(BR)CES}$	35	—	Volts
Emitter Base Breakdown Voltage				
(I_E = 10 μA)	$V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage				
(I_C = 500 mA, I_B = 50 mA)	** $V_{CE(SAT)}$	—	0.75	Volts
Base Saturation Voltage				
(I_C = 500 mA, I_B = 50 mA)	** $V_{BE(SAT)}$	—	1.2	Volts
DYNAMIC CHARACTERISTICS				
Output Capacitance, Common Base				
(V_{CB} = 10V, f = 1 MHz)	C_{cb}	—	15	pF
Input Capacitance, Common Base				
(V_{EB} = 0.5V, f = 1 MHz)	C_{eb}	—	55	pF
Gain Bandwidth Product				
(I_C = 50 mA, V_{CE} = 2V, f = 20 MHz)				
D29E1/D33D21	f_t	100	—	MHz
D29E2/D33D22	f_t	135	—	MHz

**Pulse Conditions: Pulse width ≤ 300μs Duty cycle ≤ 2%

D29E1	D33D21
D29E2	D33D22
D29E1J1	D33D21J1
D29E2J1	D33D22J1

TYPICAL h_{FE} VS. I_C

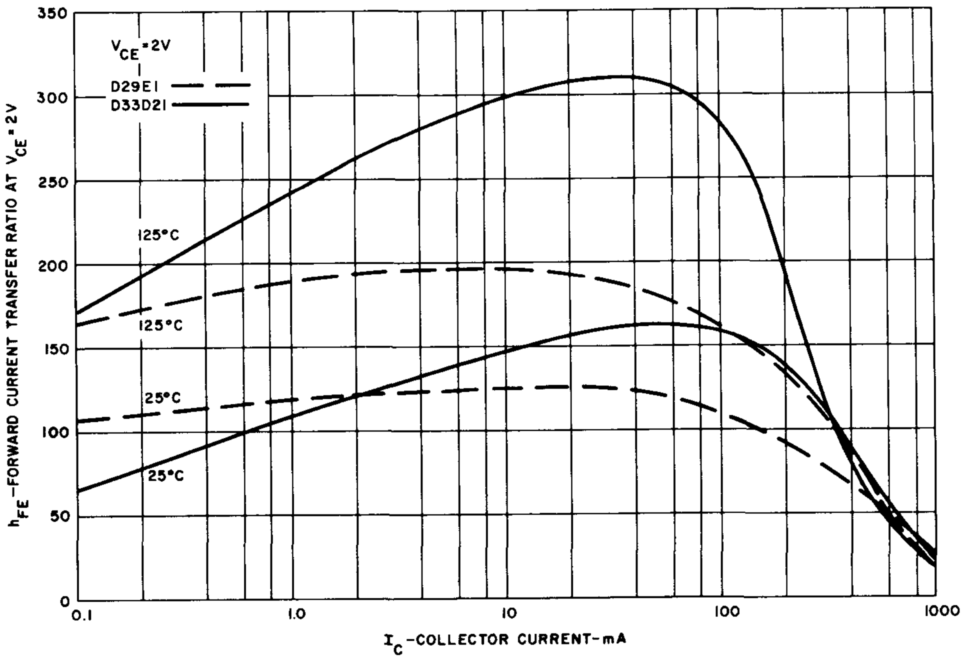


FIGURE 1

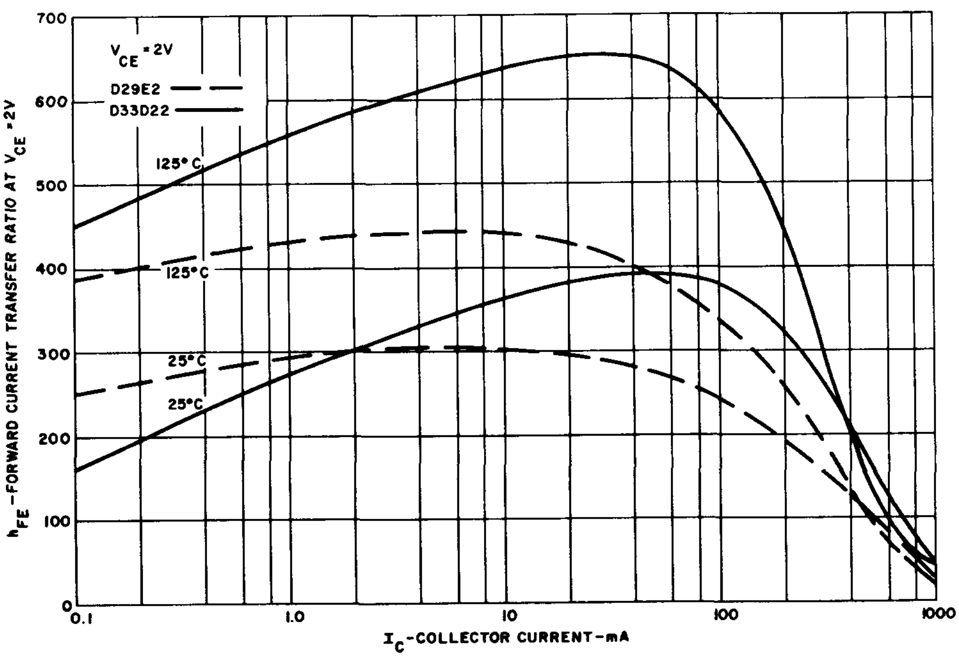


FIGURE 2

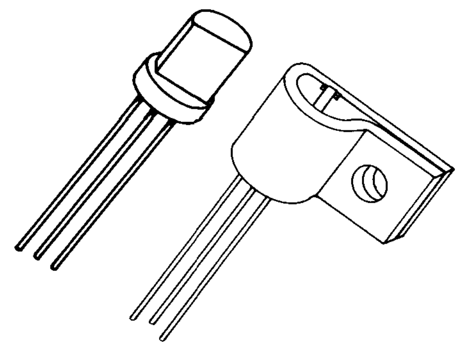
Silicon Transistors

PNP	NPN
D29E4-7	D33D24-27
D29E4J1-7J1	D33D24J1-27J1

The PNP D29E4-7 series and the NPN D33D24-27 series are silicon, planar, passivated, epitaxial transistor intended for general purpose applications. These complementary pairs are especially suited for the drive stage in high power amplifiers, and for control and television circuitry.

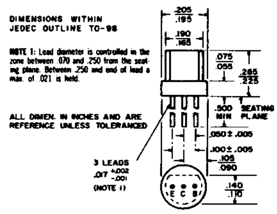
FEATURES: • Low Collector Saturation Voltage • Excellent Beta Linearity Over A Wide Current Range • Heatsinking Available On All Units

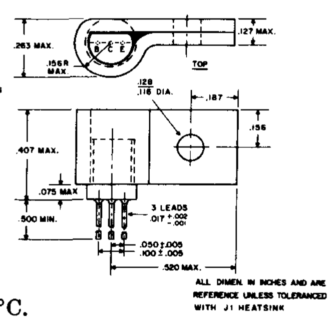
NOTE: Observe proper polarity on biases for PNP's and NPN's



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltage			
Collector to Emitter	V_{CEO}	40	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	50	Volts
Collector to Emitter	V_{CES}	50	Volts
Current			
Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec. pulse width, ≦ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
Total Power (Free Air, $T_A \leqq 25°C$) *	P_T	500	mW
Total Power with J1 Heatsink (Free Air, $T_A \leqq 25°C$) **	P_T	700	mW
Total Power with J1 Heatsink (Case Temp., $T_C \leqq 25°C$) ***	P_T	1000	mW
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +150	°C
Lead soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C





*Derate 4.0 mW/°C increase in ambient temperature above 25°C. **Derate 5.6 mW/°C increase in ambient temperature above 25°C. ***Derate 8.0 mW/°C increase in case temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

NOTE: Characteristics apply to both heatsinked and non-heatsinked devices.

		Min.	Max.	
STATIC CHARACTERISTICS				
Collector Cutoff Current (V_{CE} = 25V)	I_{CES}	—	100	nA
(V_{CE} = 25V, T_A = 100°C)	I_{CES}	—	15	μA
Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 2V)				
D29E4/D33D24	h_{FE}	60	120	
D29E5/D33D25	h_{FE}	100	200	
D29E6/D33D26	h_{FE}	150	300	
D29E7/D33D27	h_{FE}	200	500	
(I_C = 500 mA, V_{CE} = 2V)				
D29E4/D33D24	** h_{FE}	20	—	
D29E5/D33D25	** h_{FE}	25	—	
D29E6/D33D26	** h_{FE}	25	—	
D29E7/D33D27	** h_{FE}	25	—	
Collector Emitter Breakdown Voltage				
(I_C = 10 mA)	** $V_{(BR)CEO}$	40	—	Volts
(I_C = 10 μA)	$V_{(BR)CES}$	50	—	Volts
Emitter Base Breakdown Voltage (I_E = 10 μA)	$V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage (I_C = 500 mA, I_B = 50 mA)	** $V_{CE(SAT)}$	—	0.75	Volts
Base Saturation Voltage (I_C = 500 mA, I_B = 50 mA)	** $V_{BE(SAT)}$	—	1.2	Volts
DYNAMIC CHARACTERISTICS				
Output Capacitance, Common Base (V_{CB} = 10V, f = 1 MHz)	C_{cb}	—	15	pF
Input Capacitance, Common Base (V_{EB} = 0.5V, f = 1 MHz)	C_{eb}	—	55	pF
Gain Bandwidth Product (I_C = 50 mA, V_{CE} = 2V, f = 20 MHz)				
D29E4/D33D24	f_t	80	—	MHz
D29E5/D33D25	f_t	120	—	MHz
D29E6/D33D26	f_t	135	—	MHz
D29E7/D33D27	f_t	150	—	MHz

**Pulse Conditions: Pulse width ≤ 300μs Duty cycle ≤ 2%

D29E4-7	D33D24-27
D29E4J1-7J1	D33D24J1-27J1

TYPICAL h_{FE} VS. I_C

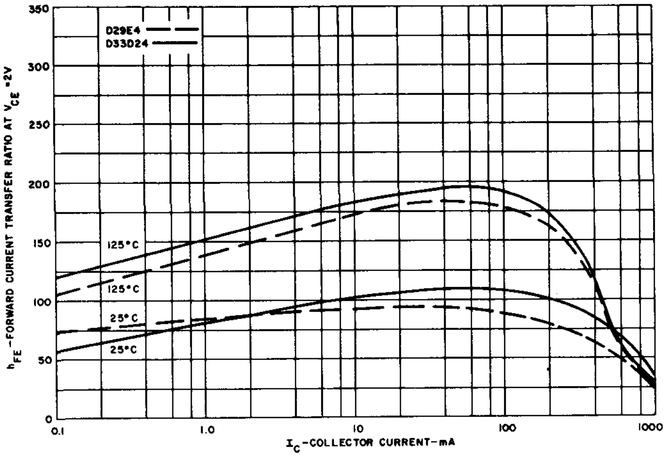


FIGURE 1

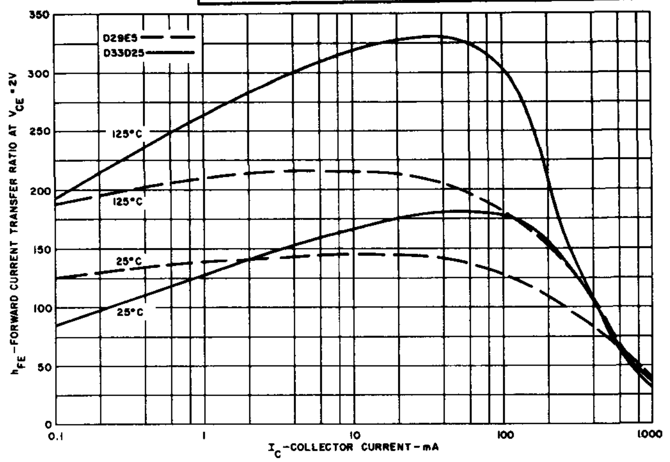


FIGURE 2

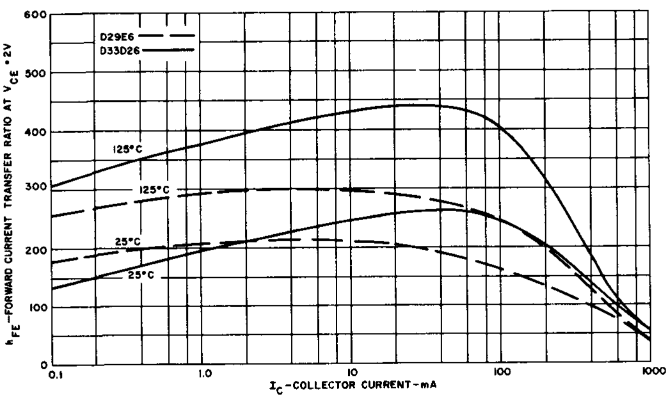


FIGURE 3

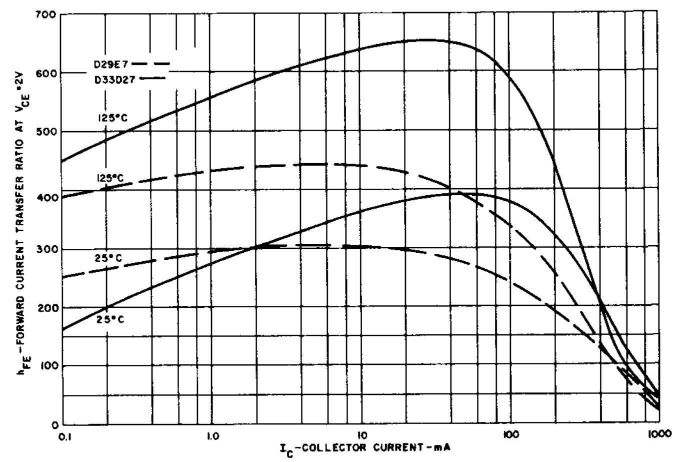


FIGURE 4

TYPICAL $V_{CE(SAT)}$ VS. I_C, $I_B = I_C/20$

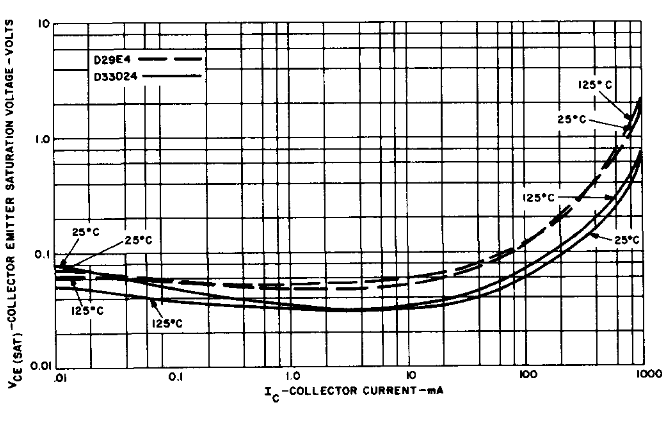


FIGURE 5

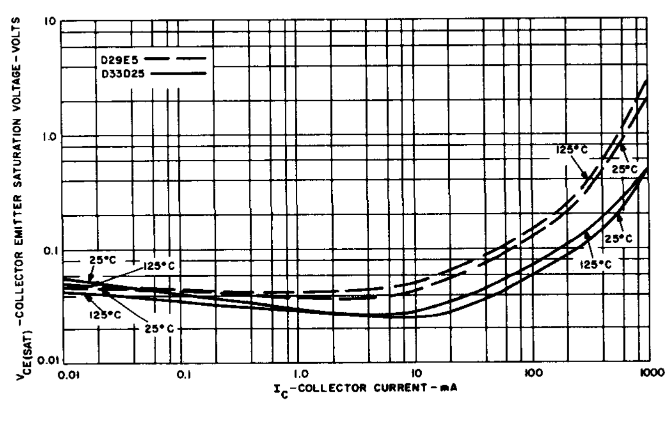


FIGURE 6

D29E4-7	D33D24-27
D29E4J1-7J1	D33D24J1-27J1

TYPICAL $V_{CE\,(SAT)}$ VS. I_C, $I_B = I_C/20$ (continued)

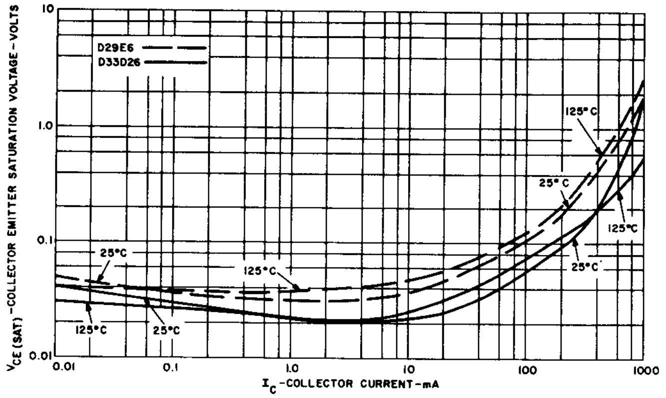


FIGURE 7

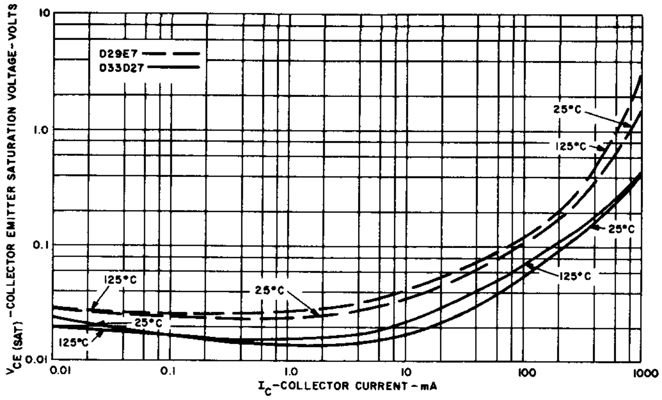


FIGURE 8

TYPICAL $V_{CE\,(SAT)}$ VS. I_C, $I_B = I_C/10$

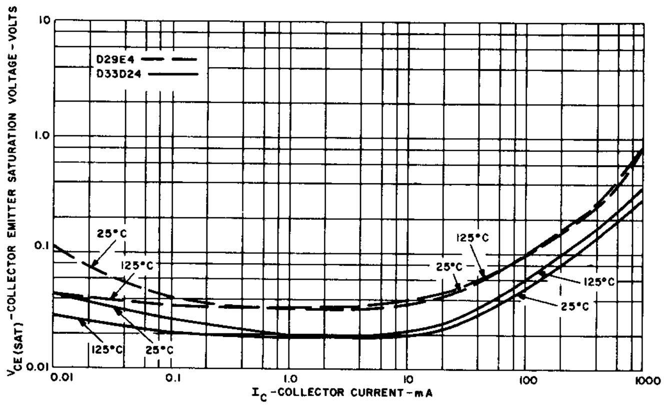


FIGURE 9

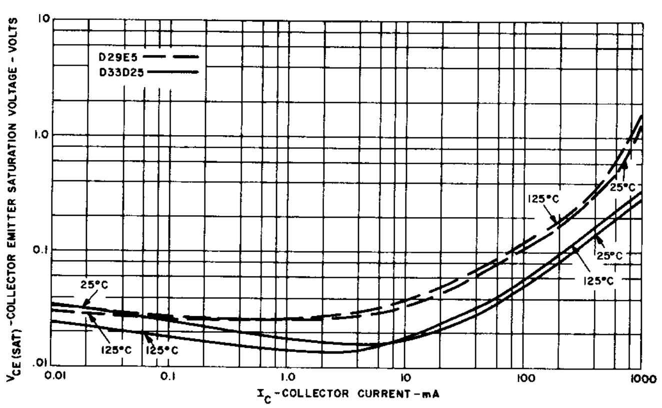


FIGURE 10

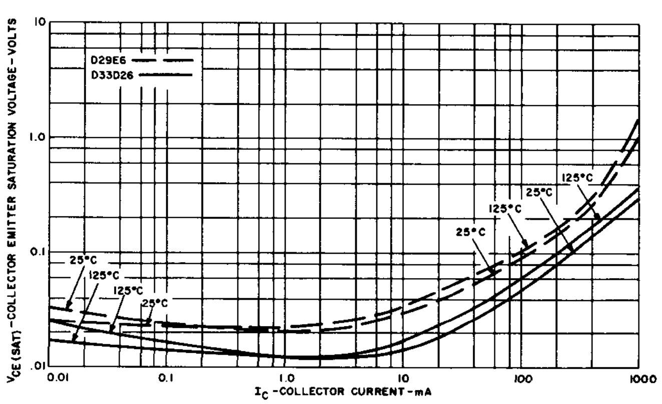


FIGURE 11

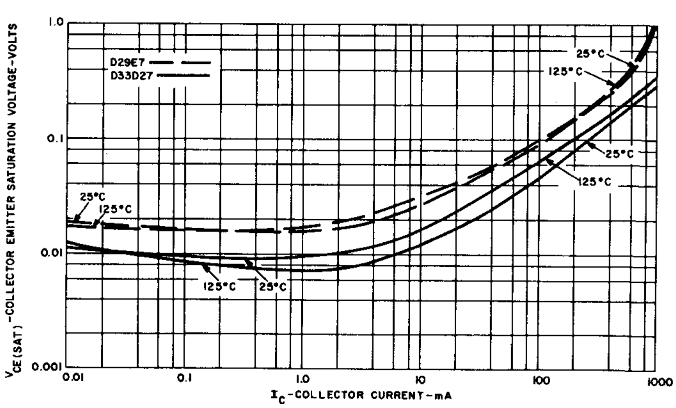


FIGURE 12

TYPICAL V_{BE} VS. I_C

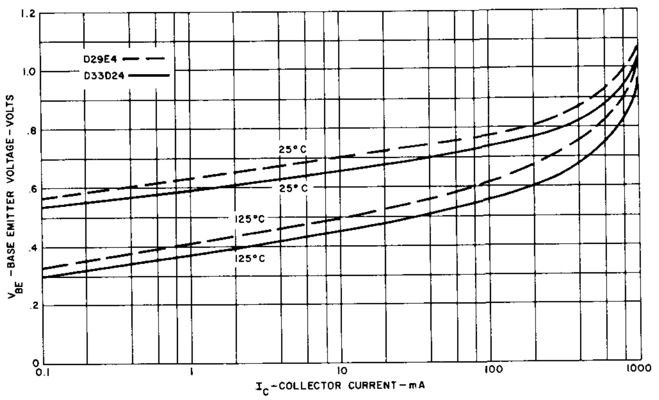


FIGURE 13

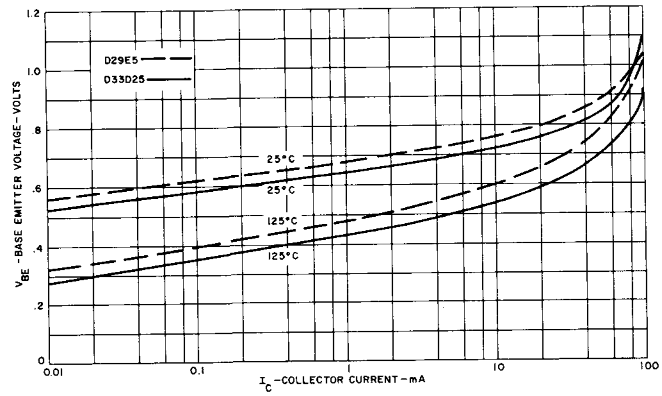


FIGURE 14

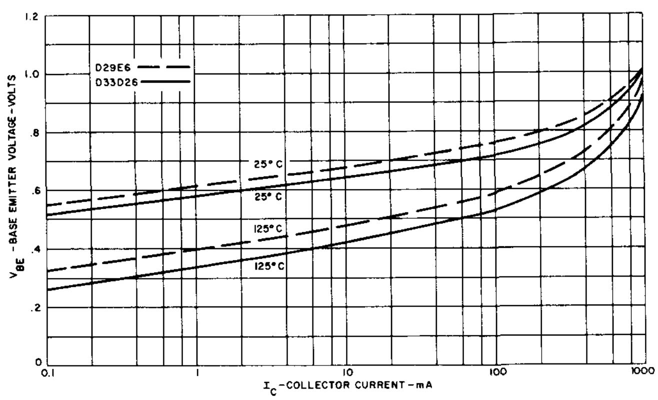


FIGURE 15

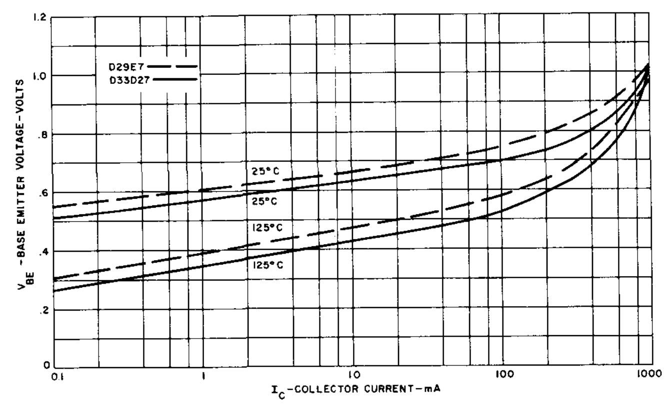
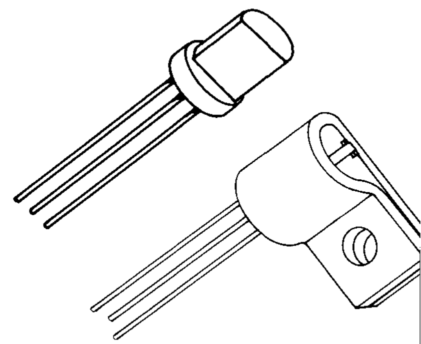


FIGURE 16

Silicon Transistors

PNP	NPN
D29E9-10	D33D29-30
D29E9J1-10J1	D33D29J1-30J1

Other D33D Series on Pages 1074–1076



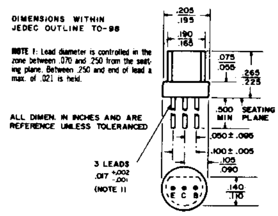
The PNP D29E9-10 series and the NPN D33D29-30 series are silicon, planar, passivated, epitaxial transistors intended for general purpose applications. These complementary pairs are especially suited for the drive stage in high power amplifiers, and for control and television circuitry.

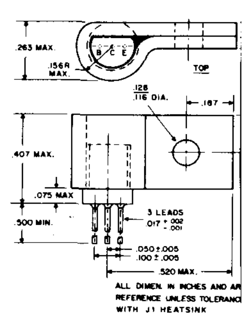
FEATURES: • Low Collector Saturation Voltage • Excellent Beta Linearity over a Wide Current Range • Heatsinking Available on All Units

NOTE: Observe proper polarity on biases for PNP's and NPN's.

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	60	Volts
Emmitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	70	Volts
Collector to Emitter	V_{CES}	70	Volts
Current			
Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec., pulse width, ≤ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
Total Power (Free Air, $T_A \leq 25°C$)*	P_T	500	mW
Total Power with J1 Heatsink (Free Air, $T_A \leq 25°C$)**	P_T	700	mW
Total Power with J1 Heatsink (Case Temp., $T_C \leq 25°C$)***	P_T	1000	mW
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +150	°C
Lead soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C





*Derate 4.0 mW/°C increase in ambient temperature above 25°C. **Derate 5.6 mW/°C increase in ambient temperature above 25°C. ***Derate 8.0 mW/°C increase in case temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

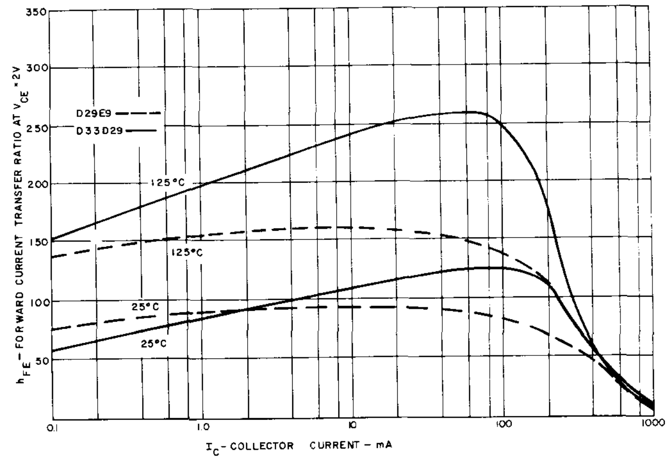
NOTE: Characteristics apply to both heatsinked and non-heatsinked devices.

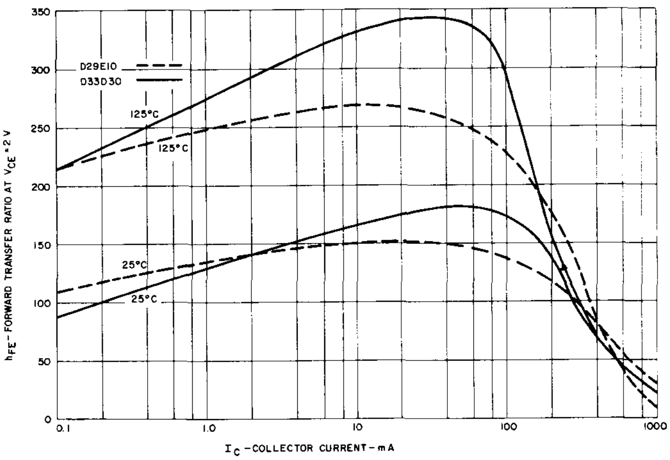
STATIC CHARACTERISTICS		Min.	Max.	
Collector Cutoff Current (V_{CE} = 25V)	I_{CES}	—	100	nA
(V_{CE} = 25V, T_A = 100°C)	I_{CES}	—	15	μA
Forward Current Transfer Ratio				
(I_C = 2 mA, V_{CE} = 2V)				
D29E9/D33D29	h_{FE}	60	120	
D29E10/D33D30	h_{FE}	100	200	
(I_C = 500 mA, V_{CE} = 2V)				
D29E9/D33D29	** h_{FE}	20	—	
D29E10/D33D30	** h_{FE}	25	—	
Collector Emitter Breakdown Voltage				
(I_C = 10 mA)	** $V_{(BR)CEO}$	60	—	Volts
(I_C = 10 μA)	$V_{(BR)CES}$	70	—	Volts
Emitter Base Breakdown Voltage				
(I_E = 10 μA)	$V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage				
(I_C = 500 mA, I_B = 50 mA)	** $V_{CE(SAT)}$	—	0.75	Volts
Base Saturation Voltage				
(I_C = 500 mA, I_B = 50 mA)	** $V_{BE(SAT)}$	—	1.2	Volts
DYNAMIC CHARACTERISTICS				
Output Capacitance, Common Base				
(V_{CB} = 10V, f = 1 MHz)	C_{cb}	—	15	pF
Input Capacitance, Common Base				
(V_{EB} = 0.5V, f = 1 MHz)	C_{eb}	—	55	pF
Gain Bandwidth Product				
(I_C = 50 mA, V_{CE} = 2V, f = 20 MHz)				
D29E9/D33D29	f_t	80	—	MHz
D29E10/D33D30	f_t	120	—	MHz

**Pulse Conditions: Pulse width ≤ 300μs Duty cycle ≤ 2%

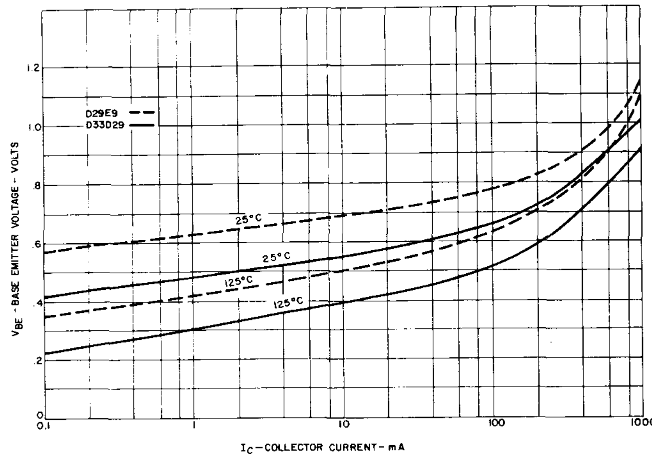
D29E9-10	D33D29-30
D29E9J1-10J1	D33D29J1-30J1

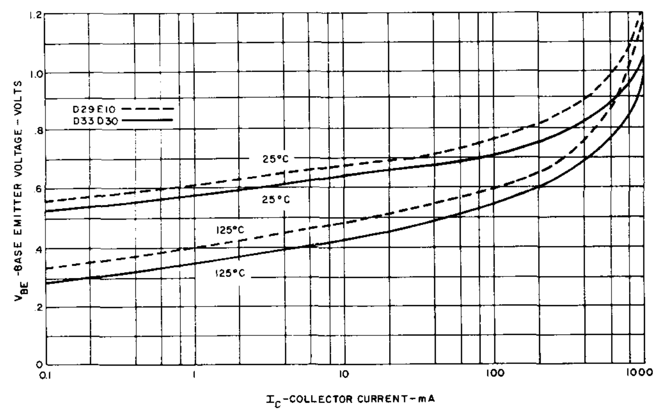
TYPICAL h_{FE} VS. I_C



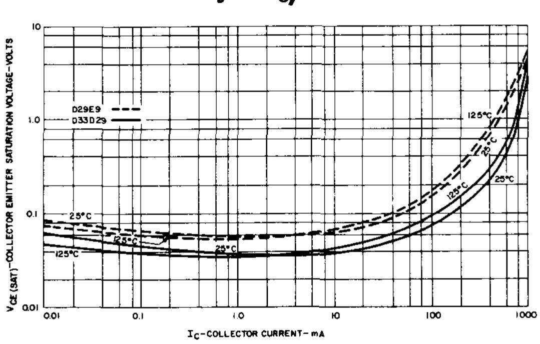


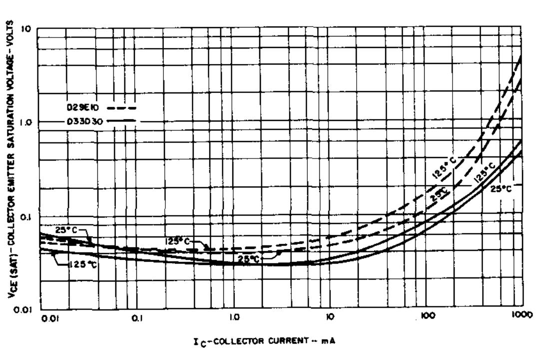
TYPICAL $V_{BE\ on}$ VS. I_C



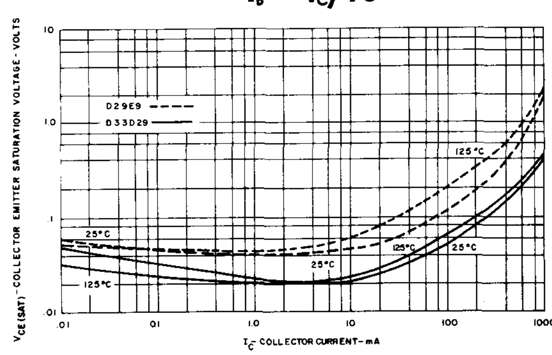


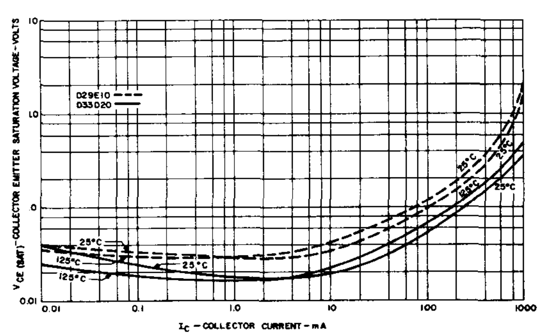
TYPICAL $V_{CE}(SAT)$ VS. I_C
$I_B = I_C/20$





TYPICAL $V_{CE}(SAT)$ VS. I_C
$I_B = I_C/10$





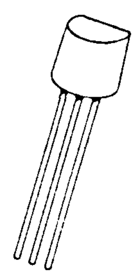
Silicon Transistors

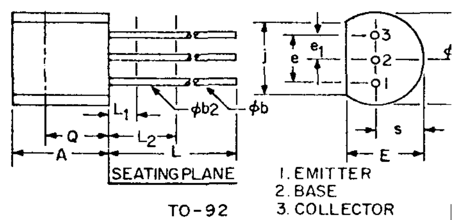
D38H1-9

The General Electric 38H series are high current, high voltage NPN Silicon Planar Transistors ideally suited for switching and amplifier applications requiring both high voltage and good high current gain and saturation characteristics. These are compliments to the D39J series.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		D38H 1,2,3	D38H 4,5,6	D38H 7,8,9	
Voltages					
Collector to Emitter	V_{CEO}	60	80	100	Volts
Collector to Base	V_{CBO}	60	80	100	Volts
Emitter to Base	V_{EBO}	60	5		Volts
Current					
Collector	I_C	–	500	–	mA
Collector (Peak Pulsed 10µs ≤ 2% duty cycle)	I_C	–	1000	–	mA
Dissipation					
Total Power $T_A \leq 25°C$	P_T	–	.500	–	Watts
Total Power $T_C \leq 25°C$	P_T	–	1.00	–	Watts
Derate Factor $T_A > 25°C$		–	4.0	–	mW/°C
Derate Factor $T_C > 25°C$		–	8.0	–	mW/°C
Temperature					
Operating	T_J		-65 to +150		°C
Storage	T_{stg}		-65 to +150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L		+260		°C





TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L_1	–	1.270	–	.050	3
L_2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

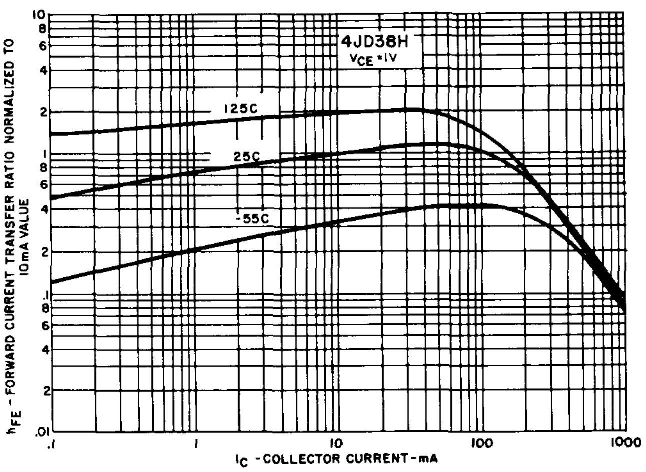
NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500 FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.5 FROM SEATING PLANE.

electrical characteristics: (T_A = 25°C unless otherwise specified)

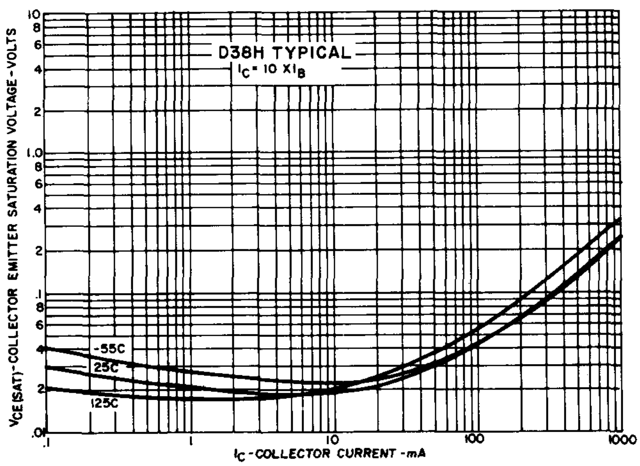
Static Characteristics		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	D38H1,2,3	$V_{(BR)CEO}$	60	–	Volts
	D38H4,5,6	$V_{(BR)CEO}$	80	–	Volts
	D38H7,8,9	$V_{(BR)CEO}$	100	–	Volts
Collector-Base Breakdown Voltage (I_C = 10µA, I_E = 0)	D38H1,2,3	$V_{(BR)CBO}$	60	–	Volts
	D38H4,5,6	$V_{(BR)CBO}$	80	–	Volts
	D38H7,8,9	$V_{(BR)CBO}$	100		Volts
Emitter-Base Breakdown Voltage (I_E = 10µA, I_C = 0)		$V_{(BR)EBO}$	5	–	Volts
Collector Cutoff Current (V_{CE} = 50V, V_{BE} = 0)		I_{CBO}	–	–	nA
Collector Cutoff Current (V_{CB} = 50V, I_E = 0)		I_{CBO}	–	25	nA
Emitter-Base Reverse Current (V_{EB} = 3V, I_C = 0)		I_{EBO}	–	25	nA
Forward Current Transfer Ratio* (V_{CE} = 1V, I_C = 10 mA)	D38H1,4,7	h_{FE}	60	150	
	D38H2,5,8	h_{FE}	100	300	
	D38H3,6,9	h_{FE}	200	500	

Static Characteristics (continued)		SYMBOL	MIN.	MAX.	UNITS
Forward Current Transfer Ratio* (continued)					
(V_{CE} = 1V, I_C = 100 mA)	D38H1,4,7	h_{FE}	55	–	
	D38H2,5,8	h_{FE}	90	–	
	D38H3,6,9	h_{FE}	150	–	
(V_{CE} = 5V, I_C = 500 mA)	D38H1,4,7	h_{FE}	30	–	
	D38H2,5,8	h_{FE}	45	–	
	D38H3,6,9	h_{FE}	75	–	
Collector-Emitter Saturation Voltage*					
(I_C = 10 mA, I_B = 1 mA)		$V_{CE(sat)}$	–	.050	Volts
(I_C = 100 mA, I_B = 10 mA)		$V_{CE(sat)}$	–	.125	Volts
(I_C = 500 mA, I_B = 50 mA)		$V_{CE(sat)}$	–	.250	Volts
Base-Emitter Saturation Voltage*					
(I_C = 100 mA, I_B = 10 mA)		$V_{BE(sat)}$	–	.83	Volts
(I_C = 500 mA, I_B = 50 mA)		$V_{BE(sat)}$	–	.95	Volts
Dynamic Characteristics					
Collector-Base Capacitance					
(V_{CB} = 10V, I_E = 0, f = 1 MHz)		C_{cb}	–	12	pF
Emitter-Base Capacitance					
(V_{EB} = .5V, I_C = 0, f = 1 MHz)		C_{eb}	–	100	pF
Gain Bandwidth Product					
(V_{CE} = 10V, I_E = 30 mA, f = 50 MHz)		f_T	80	–	MHz

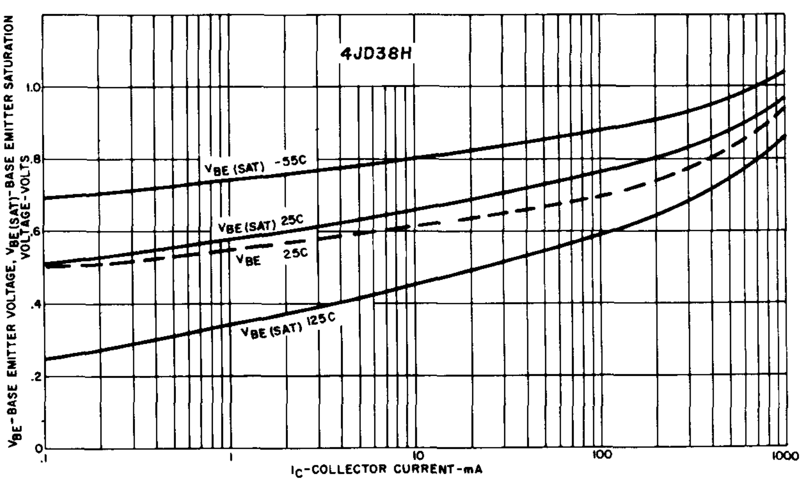
*Pulse width ⩽ 300μsec., duty cycle ⩽ 2%.



FORWARD CURRENT TRANSFER RATIO NORMALIZED TO 10mA VALUE VS COLLECTOR CURRENT



COLLECTOR EMITTER SATURATION VOLTAGE VS COLLECTOR CURRENT



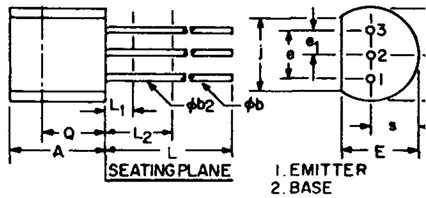
BASE EMITTER VOLTAGE (V_{CE} = 1V) AND BASE EMITTER SATURATION VOLTAGE (I_C = 10 x 1B) VS COLLECTOR CURRENT

Silicon Transistors

Complementary Darlington

D38L1-6 | **D39C1-6**

The General Electric D38L1-6 and D39C1-6 are Silicon Planar, Epitaxial, NPN-PNP complimentary Darlington amplifiers. These devices are designed for medium current-amplifier and switching applications.



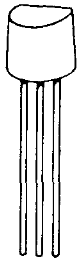
1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTS THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L φb APPLIES BETWEEN L_2 AND 12.70 MM (.5 FROM THE SEATING PLANE. DIAMETER IS CONTROLLED IN L_1 AND BEYOND 12.70 MM FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)



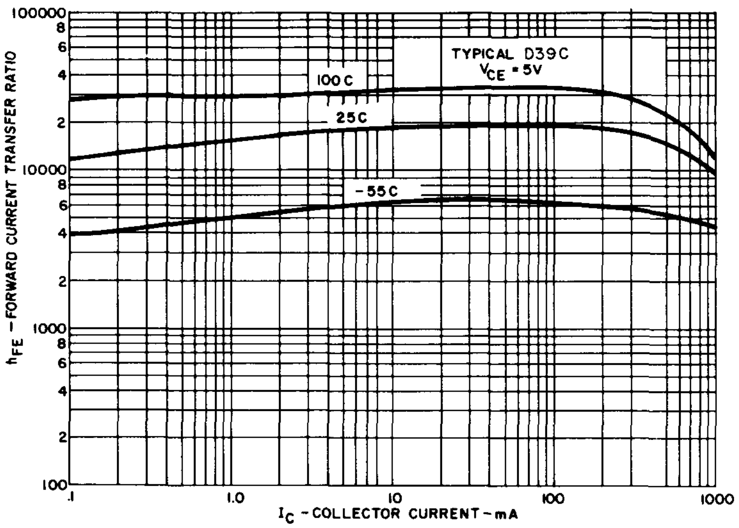
		Parts 1-3	Parts 4-6	
Voltages				
Collector to Emitter	V_{CEO}	40	25	Volts
Collector to Base	V_{CBO}	40	25	Volts
Emitter to Base	V_{EBO}	14	14	Volts
Current				
Collector	I_C	500	–	mA
Collector (Peak, Pulsed 10 μs ≤ 2% duty cycle)	I_C	1000	–	mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T	.5	–	Watts
Total Power $T_C \leq 25°C$	P_T	1.0	–	Watts
Derate Factor $T_A > 25°C$		4.0	–	mW/°C
Derate Factor $T_C > 25°C$		8.0	–	mW/°C
Temperature				
Operating	T_J	-65 to +150		°C
Storage	T_{stg}	-65 to +150		°C
Lead (1/16″ ± 1/32″ from case for 10 sec.)	T_L	+260		°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

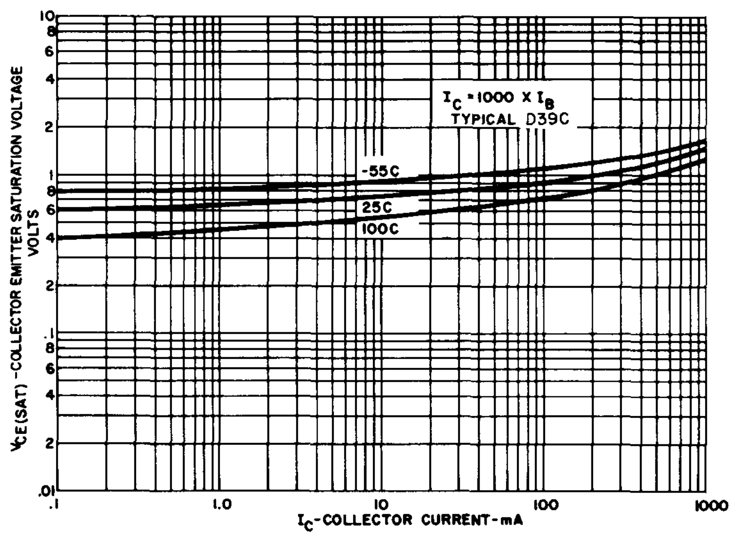
Static Characteristics		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage* (I_C = 10 mA, I_B = 0)	Parts 1-3, 4-6	$V_{(BR)CEO}$	40, 25	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)		$V_{(BR)EBO}$	14	–	Volts
Collector Cutoff Current					
(V_{CB} = 40V, I_E = 0)	Parts 1-3	I_{CBO}	–	100	nA
(V_{CB} = 25V, I_E = 0)	Parts 4-6	I_{CBO}	–	–	
(V_{CB} = 40V, I_E = 0, T_A = 100°C)	Parts 1-3	I_{CBO}	–	20	μA
(V_{CB} = 25V, I_E = 0, T_A = 100°C)	Parts 4-6	I_{CBO}	–	–	
Emitter-Base Reverse Current (V_{EB} = 8V, I_C = 0)		I_{EBO}	–	100	nA
Forward Current Transfer Ratio*					
(V_{CE} = 5V, I_C = 2 mA)	D38L1,4 D39C1,4	h_{FE}	2000	20000	
(V_{CE} = 5V, I_C = 2 mA)	D38L2,5 D39C2,5	h_{FE}	7000	70000	
(V_{CE} = 5V, I_C = 2 mA)	D38L3,6 D39C3,6	h_{FE}	50000	–	
(V_{CE} = 5V, I_C = 500 mA)	D38L1,4	h_{FE}	4000	–	
(V_{CE} = 5V, I_C = 500 mA)	D38L2,5	h_{FE}	12500	–	
(V_{CE} = 5V, I_C = 500 mA)	D38L3,6	h_{FE}	87000	–	
(V_{CE} = 5V, I_C = 500 mA)	D39C1,4	h_{FE}	1600	–	
(V_{CE} = 5V, I_C = 500 mA)	D39C2,5	h_{FE}	5600	–	
(V_{CE} = 5V, I_C = 500 mA)	D39C3,6	h_{FE}	40000	–	

Static Characteristics (continued)		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Saturation Voltage*					
(I_C = 500 mA, I_B = .5 mA)	D38L1-6	$V_{CE(sat)}$	–	1.5	Volts
(I_C = 500 mA, I_B = .5 mA)	D39C1-6	$V_{CE(sat)}$	–	1.75	Volts
Base-Emitter Saturation Voltage*					
(I_C = 500 mA, I_B = .5 mA)	D38L1-6	$V_{BE(sat)}$	–	1.75	Volts
(I_C = 500 mA, I_B = .5 mA)	D39C1-6	$V_{BE(sat)}$	–	1.9	Volts
Dynamic Characteristics					
Collector-Base Capacitance					
(V_{CE} = 10V, I_E = 0, f = 1 MHz)		C_{cb}	–	8	pF
Emitter-Base Capacitance					
(V_{EB} = .5V, I_C = 0, f = 1 MHz)		C_{eb}	–	15	pF
Gain Bandwidth Product					
(V_{CE} = 10V, I_C 30 mA, f = 20 MHz)		f_T	80	–	MHz

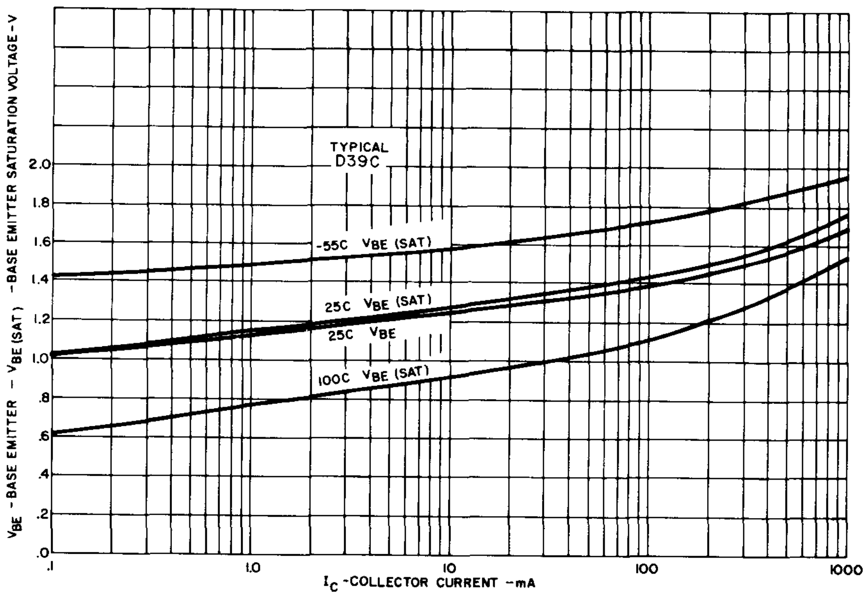
*Pulsed Conditions: Pulse width ⩽ 300 μs, Duty Cycle ⩽ 2%.



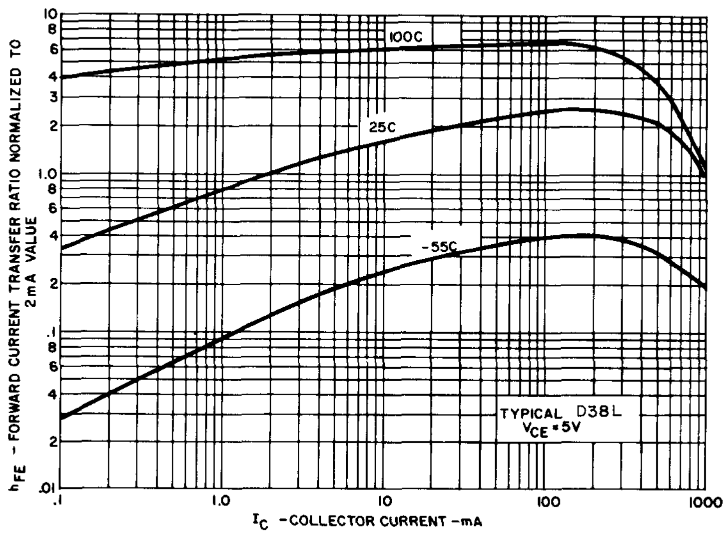
FORWARD CURRENT TRANSFER RATIO VS COLLECTOR CURRENT



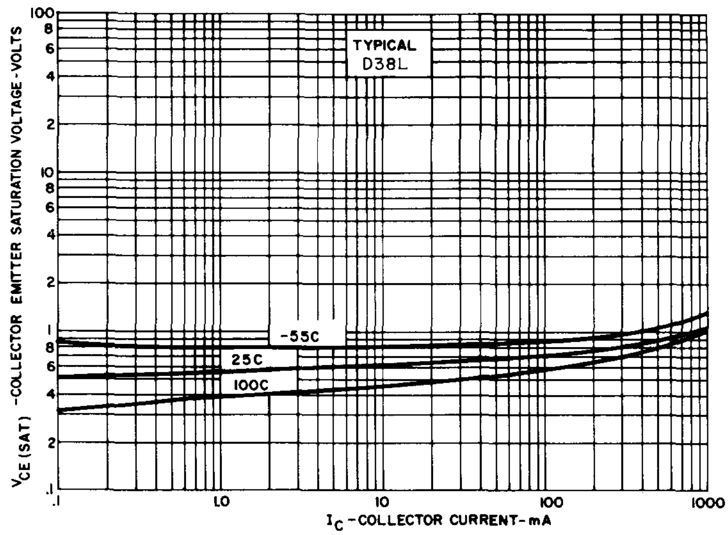
COLLECTOR EMITTER SATURATION VOLTAGE VS COLLECTOR CURRENT



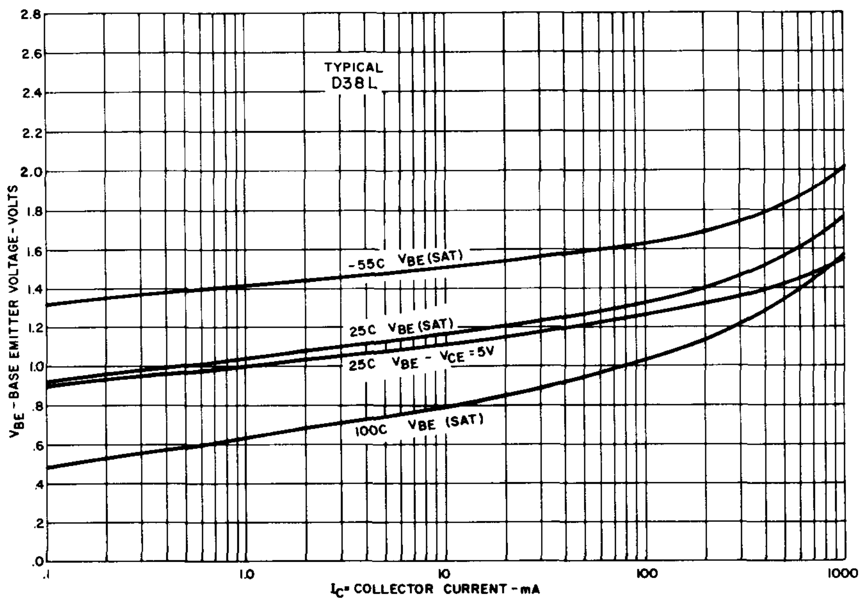
BASE EMITTER VOLTAGE (V_{CE} = 5V) AND BASE EMITTER SATURATION VOLTAGE (IC = 1000 x IB) VS COLLECTOR CURRENT



FORWARD CURRENT TRANSFER RATIO NORMALIZED TO 2mA 5V VALUE VS COLLECTOR CURRENT



COLLECTOR EMITTER SATURATION VOLTAGE
VS COLLECTOR CURRENT $I_C = I_B \times 1000$



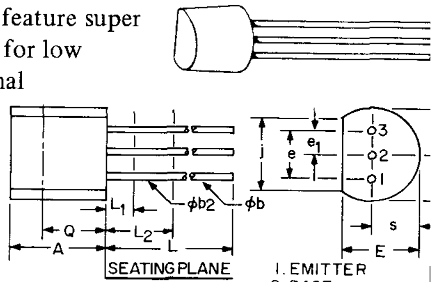
BASE EMITTER VOLTAGE V_{CE} = 5V AND BASE EMITTER SATURATION
VOLTAGE IC = IB X 1000 VS COLLECTOR CURRENT

Silicon Transistors

NPN

D38S1-10

The General Electric D38S1-10 series are NPN silicon, planar, epitaxial, transistors. They feature super high gain and low collector saturation voltage as well as a low noise figure. They are ideal for low level low noise amplifier and battery operated applications and output stages of operational amplifiers.



TO-92

1. EMITTER
2. BASE
3. COLLECTOR

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSI THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2 φb APPLIES BETWEEN L_2 AND 12.70 MM (.5 FROM THE SEATING PLANE. DIAMETER IS U CONTROLLED IN L_1 AND BEYOND 12.70 MM (. FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		D38S 1,2,3,4	D38S 5,6,7	D38S 8,9,10	
Voltages					
Collector to Emitter	V_{CEO}	30	45	60	Volts
Collector to Base	V_{CBO}	30	45	60	Volts
Emitter to Base	V_{EBO}	7	7	7	Volts
Current					
Collector	I_C	100			mA
Collector (peak, pulsed 10μS ≤ 2% duty cycle)	I_C	200			mA
Dissipation					
Total Power $T_A \leq 25°C$	P_T	.400			Watts
Derate Factor $T_A > 25°C$		4.0			mW/°C
Temperature					
Operating	T_j		-65 to +125		°C
Storage	$T_{stg.}$		-65 to +150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L		+260		°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

STATIC CHARACTERISTICS

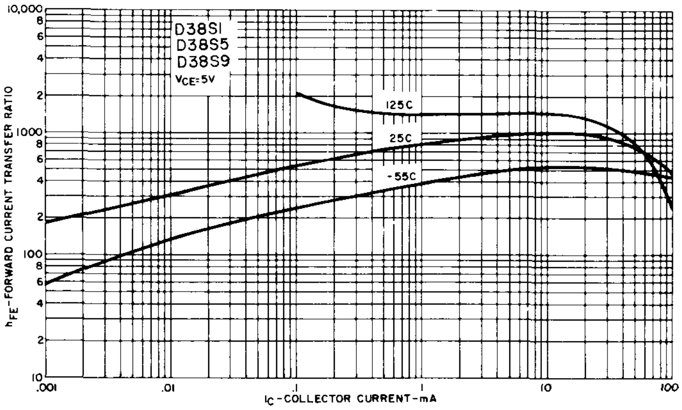
		Symbol	Min.	Max.	Units
Collector-emitter breakdown voltage (I_C = 1mA, I_B = 0)	D38S1,2,3,4	$V_{(BR)CEO}$	30		Volts
	D38S5,6,7		45		
	D38S8,9,10		60		
Collector-base breakdown voltage (I_C = 10μA, I_E = 0)	D38S1,2,3,4	$V_{(BR)CBO}$	30		Volts
	D38S5,6,7		45		
	D38S8,9,10		60		
Emitter-base breakdown voltage (I_E = 10μA, I_C = 0)		$V_{(BR)EBO}$	7		Volts
Collector cutoff current (V_{CE} = 25V, V_{BE} = o)		I_{CES}		25	nA
Emitter-base reverse current (V_{EB} = 3V, I_C = 0)		I_{EBO}		25	nA
Forward current transfer ratio (V_{CE} = 5V, I_C = .1mA)	D38S1,5,9	h_{FE}	400	800	
	D38S2,6,10	h_{FE}	600	1200	
	D38S3,7	h_{FE}	1000	2000	
	D38S4	h_{FE}	1500	3000	
	D38S8	h_{FE}	250	500	

STATIC CHARACTERISTICS Cont'd

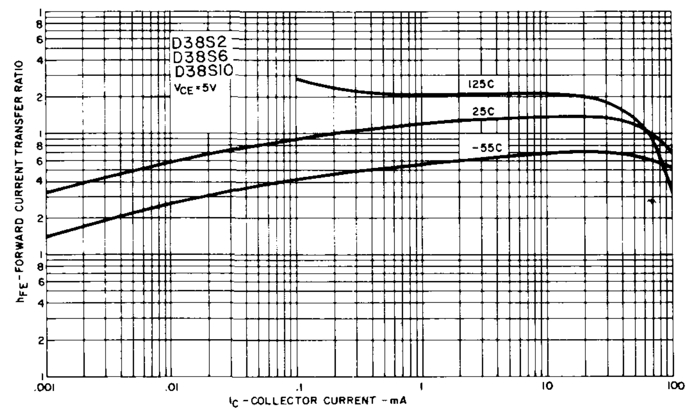
	Symbol	Min.	Max.	Units
Collector-emitter saturation voltage (I_C = 10mA, I_B = .5mA)	$V_{CE(SAT)}$		.100	Volts
Base-emitter saturation voltage (I_C = 10mA, I_B = 1mA)	$V_{BE(SAT)}$		.78	Volts

DYNAMIC CHARACTERISTICS

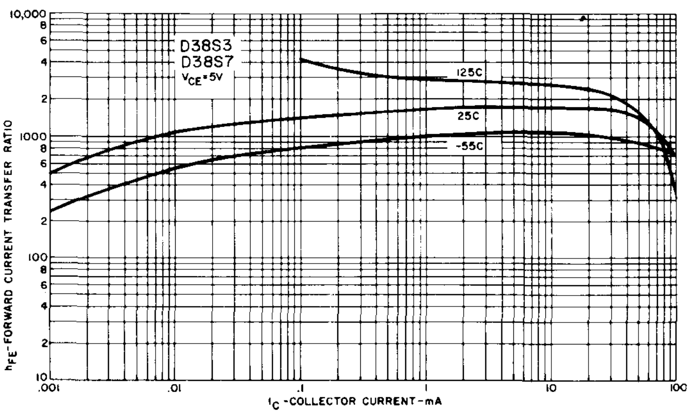
	Symbol	Min.	Max.	Units
Collector-base capacitance (V_{CB} = 5V, I_E = 0, f = 1MHz)	C_{cb}		4	pf



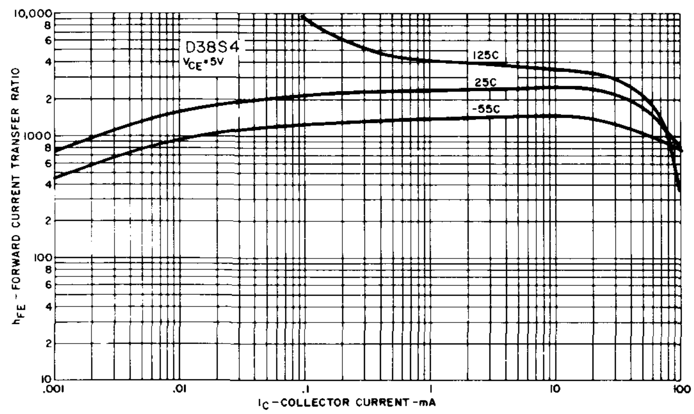
FORWARD CURRENT TRANSFER RATIO (h_{FE}) VS COLLECTOR CURRENT (I_C)



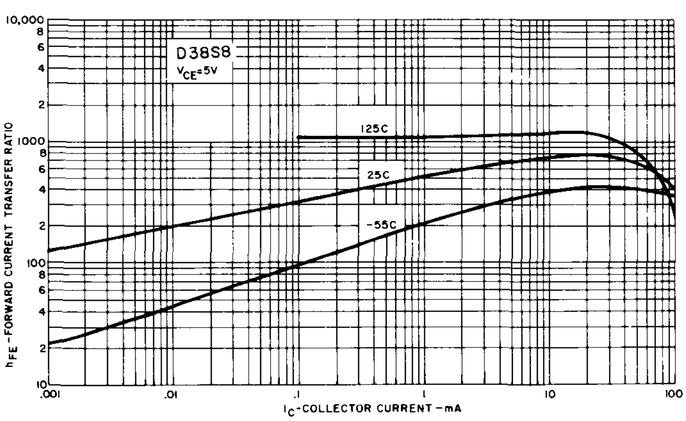
FORWARD CURRENT TRANSFER RATIO (h_{FE}) VS COLLECTOR CURRENT (I_C)



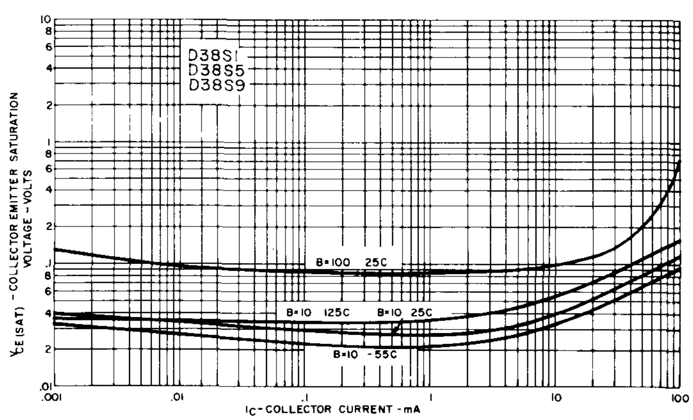
FORWARD CURRENT TRANSFER RATIO (h_{FE}) VS COLLECTOR CURRENT (I_C)



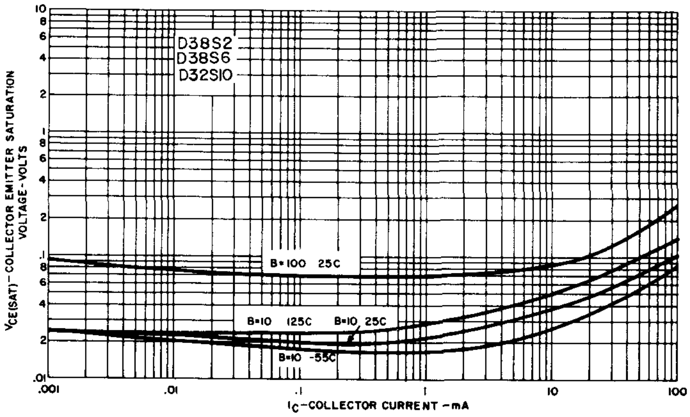
FORWARD CURRENT TRANSFER RATIO (h_{FE}) VS COLLECTOR CURRENT (I_C)



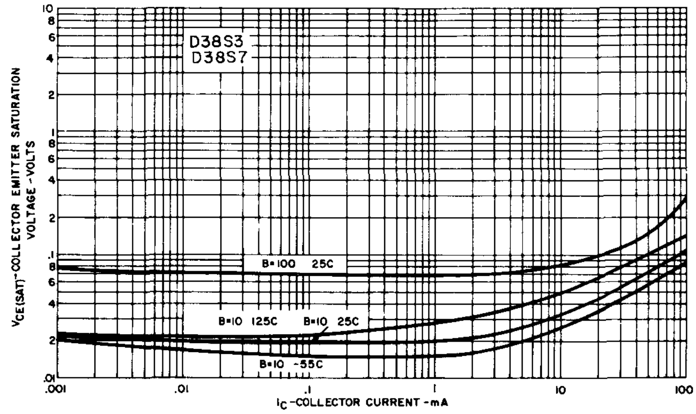
FORWARD CURRENT TRANSFER RATIO (h_{FE}) VS COLLECTOR CURRENT (I_C)



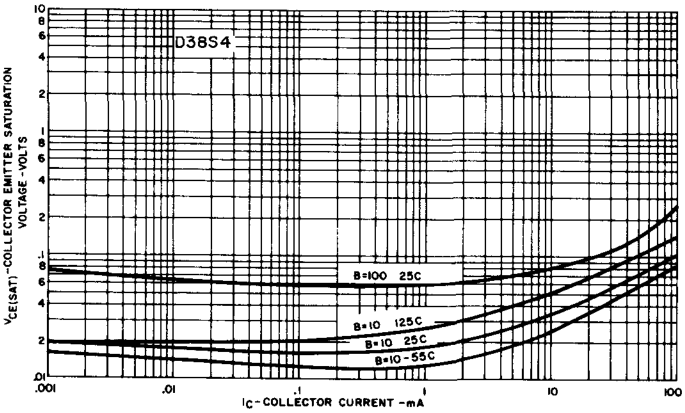
COLLECTOR EMITTER SATURATION VOLTAGE ($V_{CE(SAT)}$) VS COLLECTOR CURRENT (I_C)



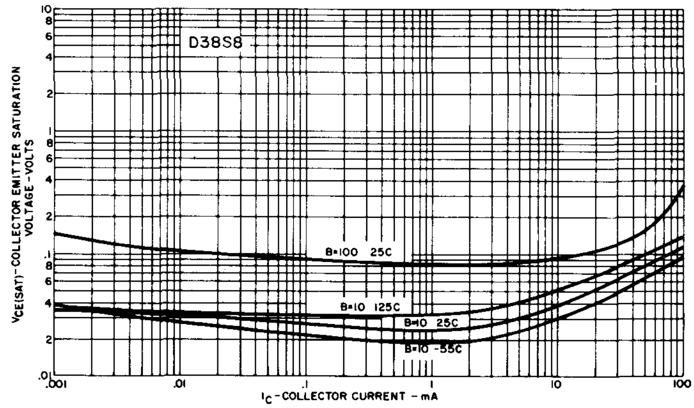
COLLECTOR EMITTER SATURATION VOLTAGE ($V_{CE(SAT)}$) VS COLLECTOR CURRENT (I_C)



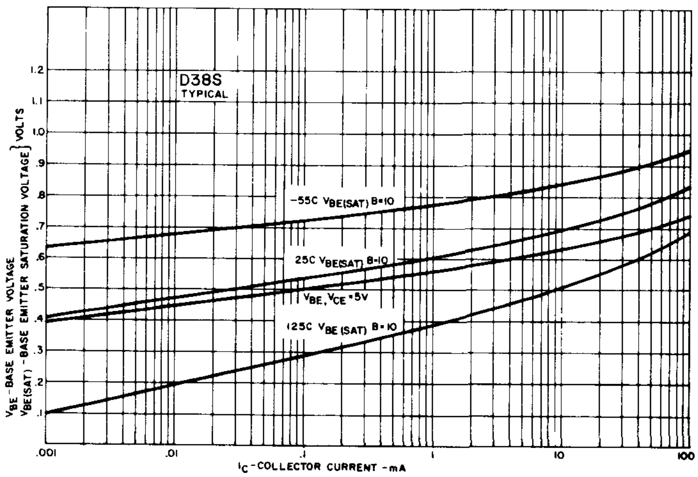
COLLECTOR EMITTER SATURATION VOLTAGE ($V_{CE(SAT)}$) VS COLLECTOR CURRENT (I_C)



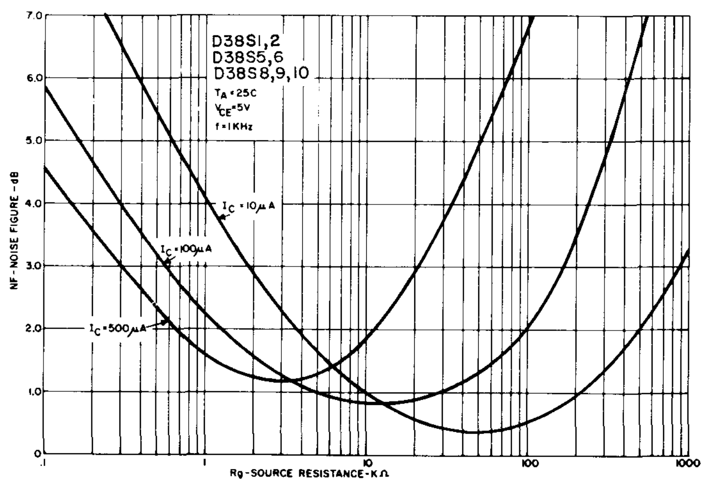
COLLECTOR EMITTER SATURATION VOLTAGE ($V_{CE(SAT)}$) VS COLLECTOR CURRENT (I_C)



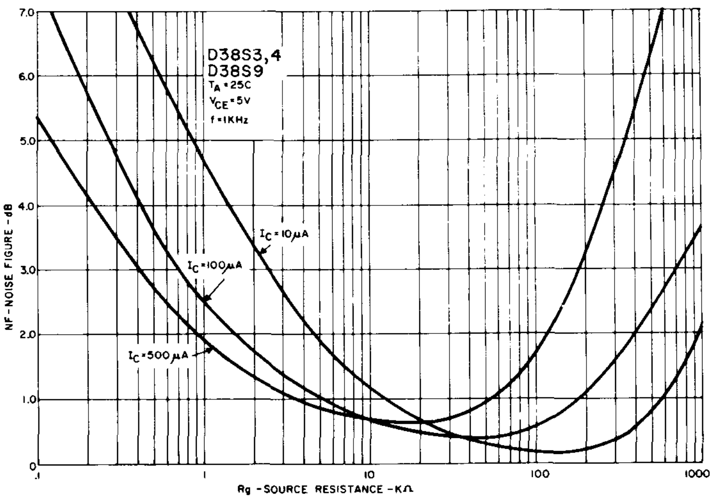
COLLECTOR EMITTER SATURATION VOLTAGE ($V_{CE(SAT)}$) VS COLLECTOR CURRENT (I_C)



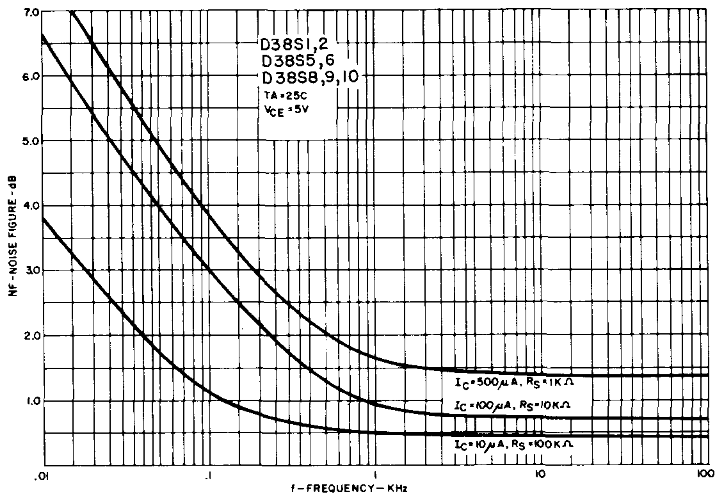
BASE EMITTER VOLTAGE V_{BE} AND BASE EMITTER SATURATION VOLTAGE ($V_{BE(SAT)}$) VS COLLECTOR CURRENT I_C



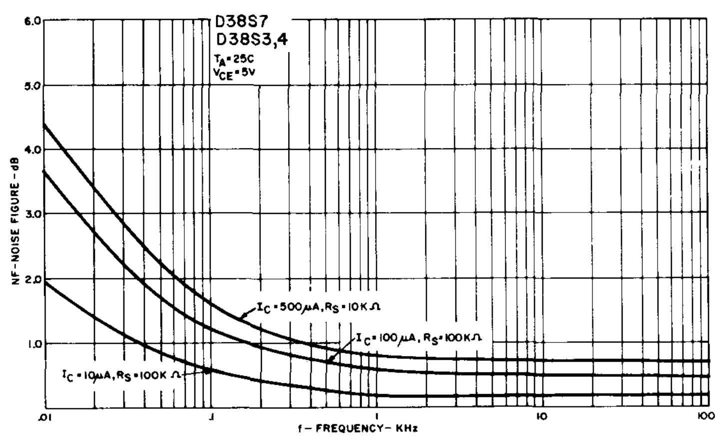
NOISE FIGURE (NF) VS SOURCE RESISTANCE (R_g)



NOISE FIGURE (NF) VS SOURCE RESISTANCE (R_g)



NOISE FIGURE (NF) VS FREQUENCY (f)



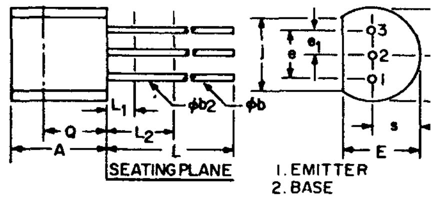
NOISE FIGURE (NF) VS FREQUENCY (f)

Silicon Transistors

High Voltage

D38V1,2,3

The General Electric D38V1,2,3 are silicon NPN planar epitaxial transistors designed for high voltage switching and amplifier applications.

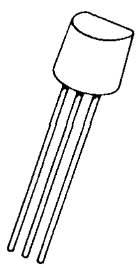


TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L1	–	1.270	–	.050	3
L2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSI THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L φb APPLIES BETWEEN L_2 AND 12.70 MM (.5 FROM THE SEATING PLANE. DIAMETER IS U CONTROLLED IN L_1 AND BEYOND 12.70 MM (FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

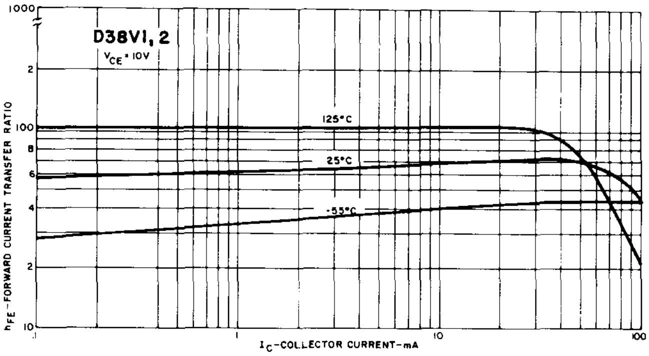


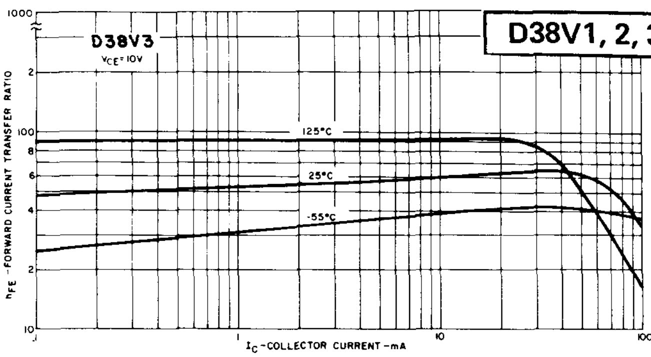
		D38V1	D38V2	D38V3	
Voltages					
Collector to Emitter	V_{CEO}	200	250	300	Volts
Collector to Base	V_{CBO}	200	250	300	Volts
Emitter to Base	V_{EBO}	6	6	6	Volts
Current					
Collector	I_C	100	100	100	mA
Dissipation					
Total Power $T_A \leq 25°C$	P_T		500		m Watts
Total Power $T_C \leq 25°C$	P_T		1000		m Watts
Derate Factor $T_A \leq 25°C$			4		mW/°C
Derate Factor $T_C \leq 25°C$			8		mW/°C
Temperature					
Operating	T_j		-65 to +150		°C
Storage	$T_{stg.}$		-65 to +150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L		+260		°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

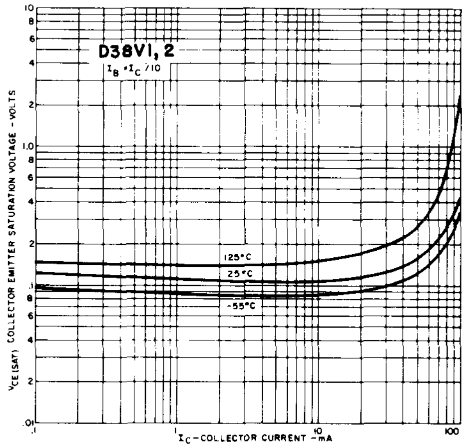
STATIC CHARACTERISTICS	SYMBOL	D38V1		D38V2		D38V3		UNITS
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Collector-emitter breakdown voltage (I_C = 1 mA, I_B = 0)	$V_{(BR)CEO}$	200	–	250	–	300	–	Volts
Collector-base breakdown voltage (I_C = 100μA, I_E = 0)	$V_{(BR)CBO}$	200	–	250	–	300	–	Volts
Emitter-base breakdown voltage (I_E = 100μA, I_C = 0)	$V_{(BR)EBO}$	6	–	6	–	6	–	Volts
Collector cutoff current (V_{CB} = 100V, I_E = 0)	I_{CBO}	–	50	–	50	–	50	nA
Collector cutoff current (V_{CB}=100V, I_E=0, T_A=125°C)	I_{CBO}	–	10	–	10	–	10	μA
Emitter-base reverse current (V_{EB} = 3V, I_C = 0)	I_{EBO}	–	50	–	50	–	50	nA
Forward Current transfer ratio								
(V_{CE} = 10V, I_C = 10mA)	$*h_{FE}$	45	–	35	–	25	–	
(V_{CE} = 10V, I_C = 20mA)	$*h_{FE}$	50	–	40	–	30	–	
(V_{CE} = 10V, I_C = 50mA)	$*h_{FE}$	50	–	40	–	30	–	
Collector-emitter saturation voltage (I_C = 40mA, I_B = 4mA)	$*V_{CE(sat)}$	–	1.0	–	1.0	–	1.0	Volts
Base-emitter saturation voltage (I_C = 20mA, I_B = 2mA)	$*V_{BE(sat)}$	.65	.85	.65	.85	.65	.85	Volts
DYNAMIC CHARACTERISTICS								
Collector-base capacitance (V_{CB}=10V, I_E=0, f=1MHz)	C_{cb}	–	5	–	5	–	5	pf
Emitter-base capacitance (V_{EB}=.5V, I_C=0, f=1MHz)	C_{eb}	–	60	–	60	–	60	pf
Gain bandwidth product (V_{CE}=10V, I_C=20mA, f=20MHz)	f_t	50	–	50	–	50	–	MHz
Turn-on Time (V_{CC}=150V, I_C=20mA, I_{B1}=I_{B2}=2.75mA)	t_{ON}	–	.5	–	.5	–	.5	μsec.
Turn-off Time (V_{CC}=150V, I_C=20mA, I_{B1}=I_{B2}=2.75mA)	t_{OFF}	–	5	–	5	–	5	μsec.

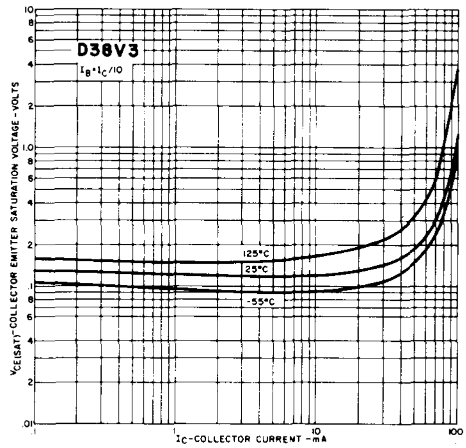
*Pulse Conditions: Pulse width ≲ 300μs, Duty Cycle ≲ 2%



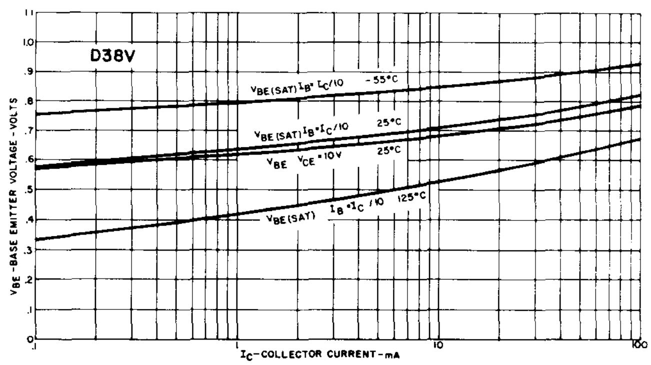


FORWARD CURRENT TRANSFER RATIO VS COLLECTOR CURRENT

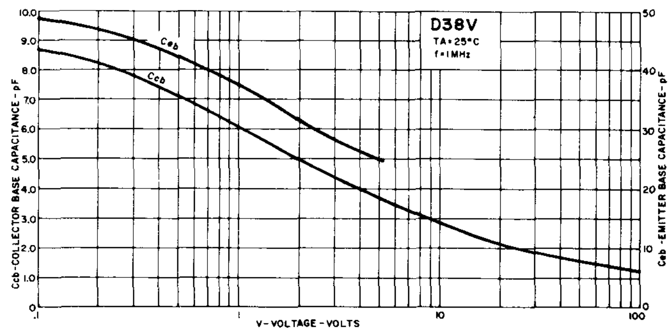




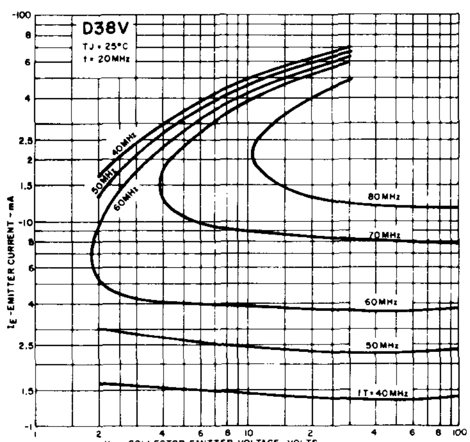
COLLECTOR EMITTER SATURATION VOLTAGE VS COLLECTOR CURRENT



BASE EMITTER VOLTAGE VS COLLECTOR CURRENT



COLLECTOR BASE AND EMITTER BASE CAPACITANCE VS REVERSE VOLTAGE

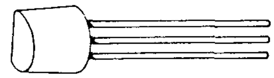


CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT

Silicon Transistors

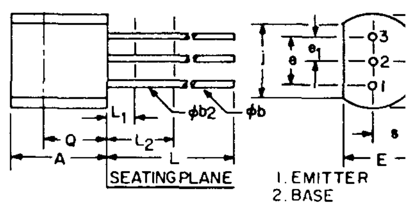
D38W7-14

The General Electric D38W7-D38W14 are NPN, silicon, planar, epitaxial transistors designed for low noise, high gain amplifier applications.



FEATURES

- Low noise figure ≤ 2db
- High voltage rating, 80V
- High forward current transfer ratio
- Low saturation voltage



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUT THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND ϕb APPLIES BETWEEN L_2 AND 12.70 MM FROM THE SEATING PLANE. DIAMETER IS CONTROLLED IN L_1 AND BEYOND 12.70 MM FROM SEATING PLANE.

absolute maximum ratings: ($T_A = 25^oC$ unless otherwise specified)

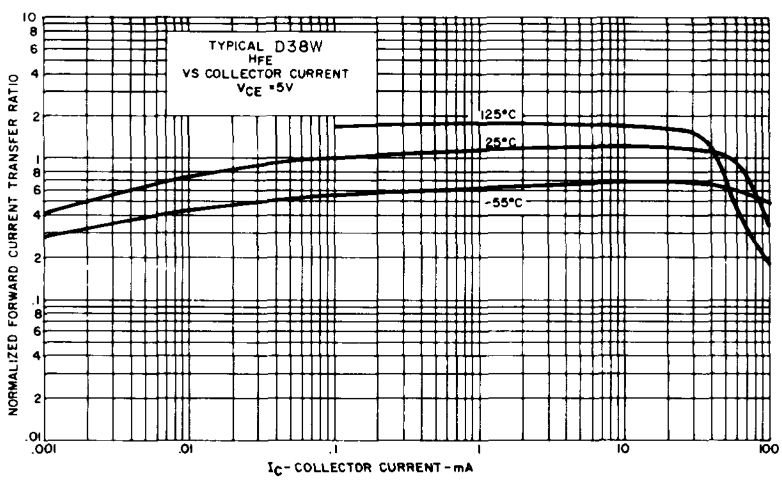
		D38W 7-10	D38W 12-14	
Voltages				
Collector to Emitter	V_{CEO}	80	100	Volts
Collector to Base	V_{CBO}	100	120	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	100		mA
Dissipation				
Total Power $T_A \leq 25^oC$	P_T	.400		Watts
Derate Factor $T_A > 25^oC$		4.0		mW/°C
Temperature				
Operating	T_j	-65 to +125		°C
Storage	$T_{stg.}$	-65 to +150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260		°C

electrical characteristics: ($T_A = 25^oC$ unless otherwise specified)

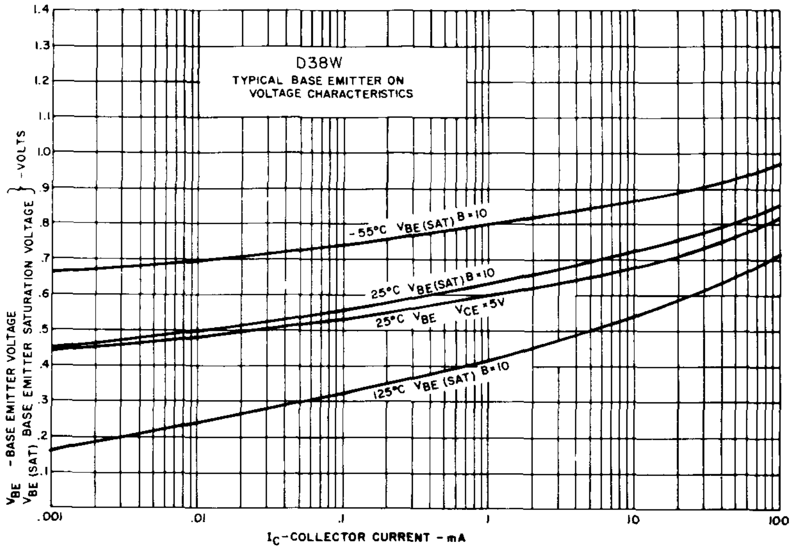
STATIC CHARACTERISTICS		Symbol	Min.	Max.	Units
Collector-emitter breakdown voltage ($I_C = 1mA$, $I_B = 0$)	D38W7, 8, 9, 10	$V_{(BR)CEO}$	80	–	Volts
	D38W12, 13, 14		100	–	Volts
Collector-base breakdown voltage ($I_C = 10\mu A$, $I_E = 0$)	D38W7, 8, 9, 10	$V_{(BR)CBO}$	100	–	Volts
	D38W12, 13, 14		120	–	Volts
Emitter-base breakdown voltage ($I_E = 10\mu A$, $I_C = 0$)		$V_{(BR)EBO}$	5	–	Volts
Collector Cutoff Current ($V_{CE} = 40V$, $V_{BE} = 0$)		I_{CES}	–	50	nA
Collector Cutoff Current ($V_{CB} = 80V$, $I_E = 0$)	D38W7, 8, 9, 10	I_{CBO}	–	100	nA
($V_{CB} = 100V$, $I_E = 0$)	D38W12, 13, 14	I_{CBO}	–	100	nA
Emitter-base reverse current ($V_{EB} = 3V$, $I_C = 0$)		I_{EBO}	–	50	nA
Forward current transfer ratio ($V_{CE} = 5V$, $I_C = .1mA$)	D38W7, 12	h_{FE}	150	300	
	D38W8, 13	h_{FE}	250	500	
	D38W9, 14	h_{FE}	400	800	
	D38W10	h_{FE}	600	1200	

STATIC CHARACTERISTICS Cont'd.

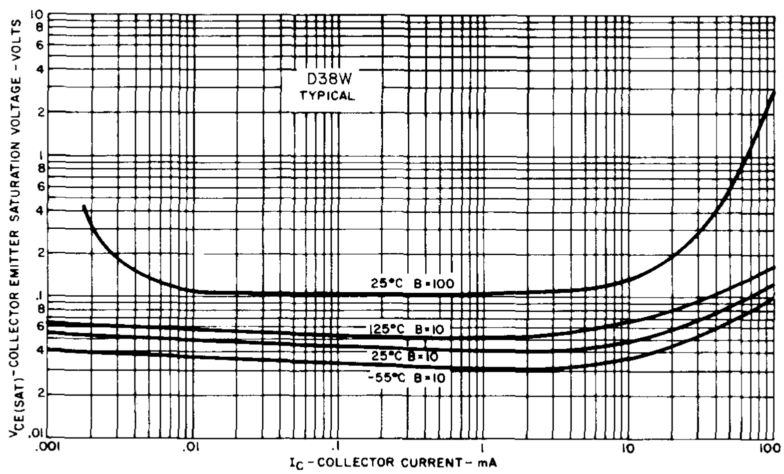
		Symbol	Min.	Max.	Units
Forward current transfer ratio					
(V_{CE} = 5V, I_C = 1mA)	D38W7, 12	h_{FE}	150		
	D38W8, 13	h_{FE}	250		
	D38W9, 14	h_{FE}	400		
	D38W10	h_{FE}	600		
Collector-emitter saturation voltage (I_C = 10mA, I_B = 1mA)		$V_{CE(sat)}$	–	0.10	Volts
Base-emitter saturation voltage (I_C = 10mA, I_B = 1mA)		$V_{BE(sat)}$	–	0.78	Volts
DYNAMIC CHARACTERISTICS					
Collector-base capacitance (V_{CB} = 5V, I_E = 0, f = 1 MHz)		C_{cb}		4.0	pf
Emitter-base capacitance (V_{EB} = .5V, I_C = 0, f = 1MHz)		C_{eb}		18	pf
Gain Bandwidth product (V_{CE} = 5V, I_C = 1mA, f = 20 MHz)		ft	75	200	MHz
Forward current transfer ratio (V_{CE} = 5V, I_C = 1mA, f = 20 MHz)		h_{fe}	11.5	20	
Noise figure (I_E = 100μA, V_{CE} = 5V, R_g = 10KΩ, f = 10Hz to 10 KHz, B.W.=15.7 KHz)	D38W8, 9, 10, 13, 14	NF		2	dB
HYBRID PARAMETERS (I_C = 1mA, V_{CE} = 5V, f = 1KHz)					
Input Resistance	D38W8, 13	hie	6	35	Kohms
	D38W9, 14	hie	10	50	Kohms
Voltage feedback ratio	D38W8, 9, 13, 14	hre	1	10	X10-4
Output Conductance	D38W8, 9, 13, 14	hoe	5	30	u-mhos
Forward Current Transfer Ratio	D32W8, 13	hfe	250	1000	
	D38W9, 14	hfe	400	1600	



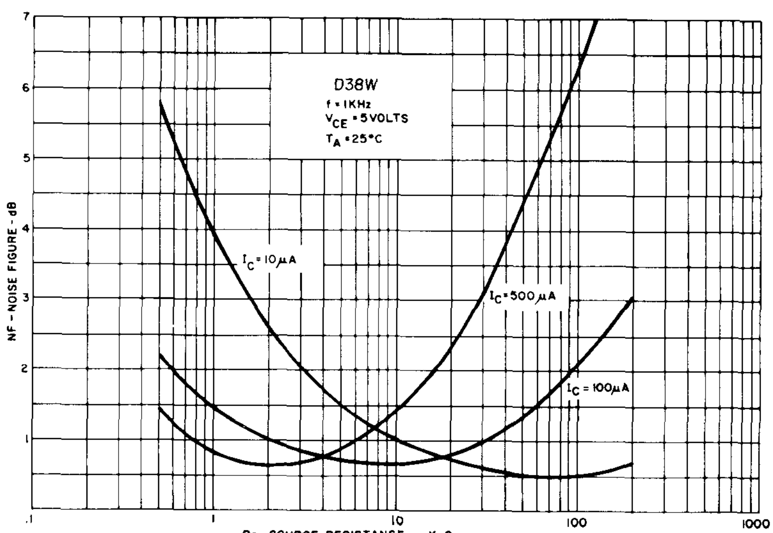
FORWARD CURRENT TRANSFER RATIO NORMALIZED TO .1mA VALUE VS COLLECTOR CURRENT



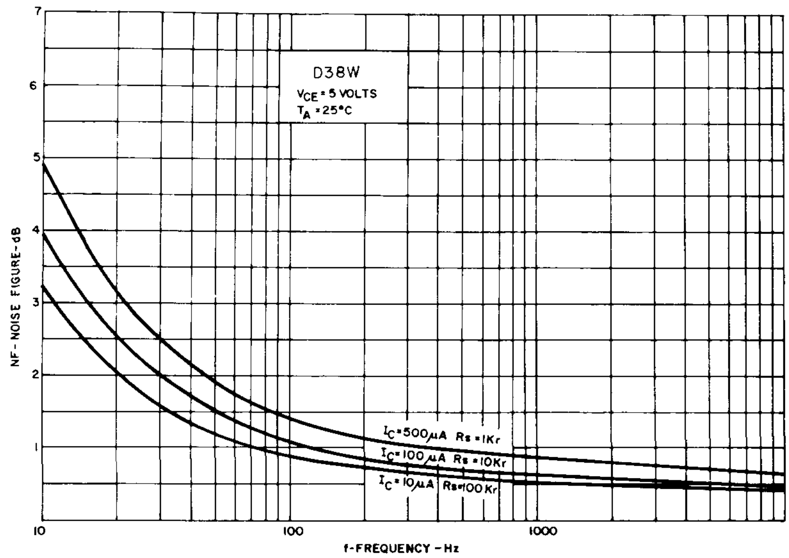
BASE EMITTER VOLTAGE AND BASE EMITTER SATURATION VOLTAGE VS COLLECTOR CURRENT



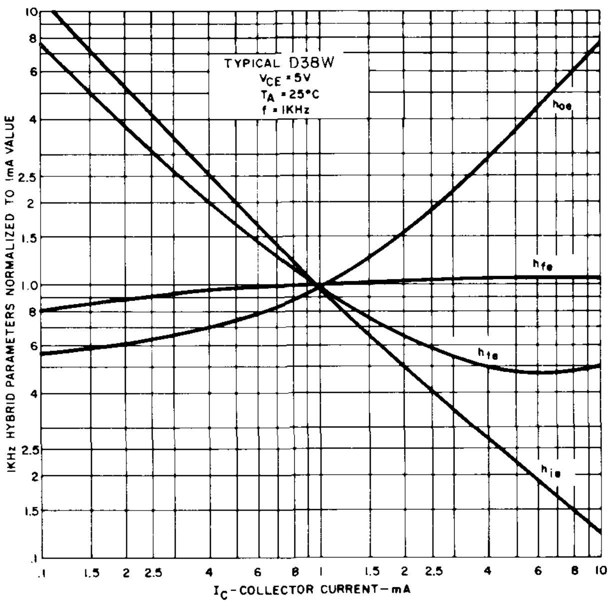
COLLECTOR EMITTER SATURATION VOLTAGE VS COLLECTOR CURRENT



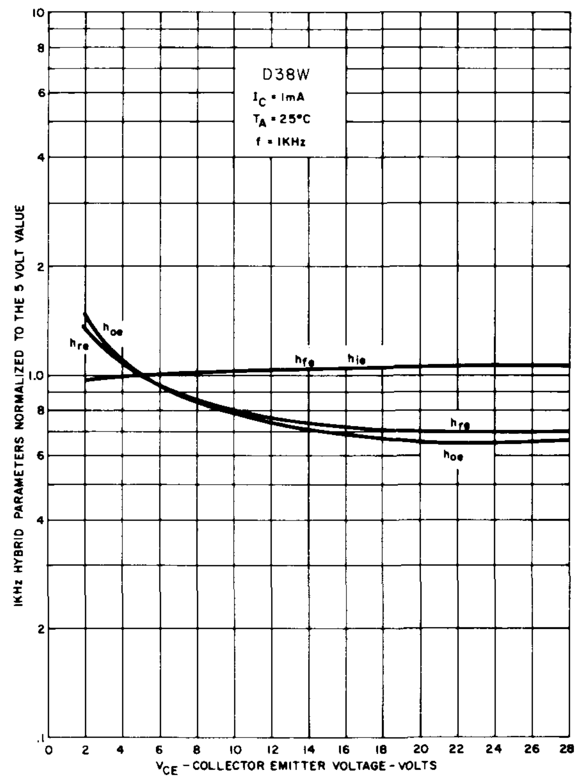
NOISE FIGURE VS SOURCE RESISTANCE



NOISE FIGURE VS FREQUENCY



1KHz HYBRID PARAMETERS VS COLLECTOR CURRENT



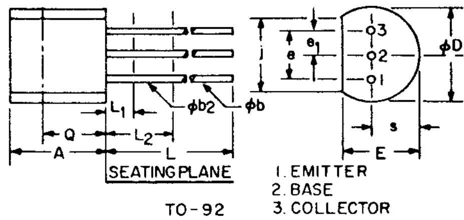
1KHz HYBRID PARAMETERS VS COLLECTOR VOLTAGE

Silicon Transistors

PNP

D39J1-9

The General Electric D39J series are high current, high voltage PNP Silicon Planar Transistors ideally suited for switching and amplifier applications requiring both high voltage and good high current gain and saturation characteristics. These are compliments to the D38H series.

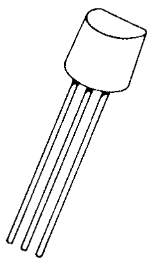


TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	–	.050	3
L2	6.350	—	.250	–	3
Q	2.920	—	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)



		D39J 1,2,3	D39J 4,5,6	D39J 7,8,9	
Voltages					
Collector to Emitter	V_{CEO}	60	80	100	Volts
Collector to Base	V_{CBO}	60	80	100	Volts
Emitter to Base	V_{EBO}	–	5	–	Volts
Current					
Collector	I_C	–	500	–	mA
Collector (Peak, pulsed 10 μs ≤ 2% duty cycle)	I_C	–	1000	–	mA
Dissipation					
Total Power T_A ≤ 25°C	P_T	–	.500	–	Watts
Total Power T_C ≤ 25°C	P_T	–	1.00	–	Watts
Derate Factor T_A > 25°C		–	4.0	–	mW/°C
Derate Factor T_C > 25°C		–	8.0	–	mW/°C
Temperature					
Operating	T_J		-65 to +150		°C
Storage	T_{stg}		-65 to +150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L		+260		°C

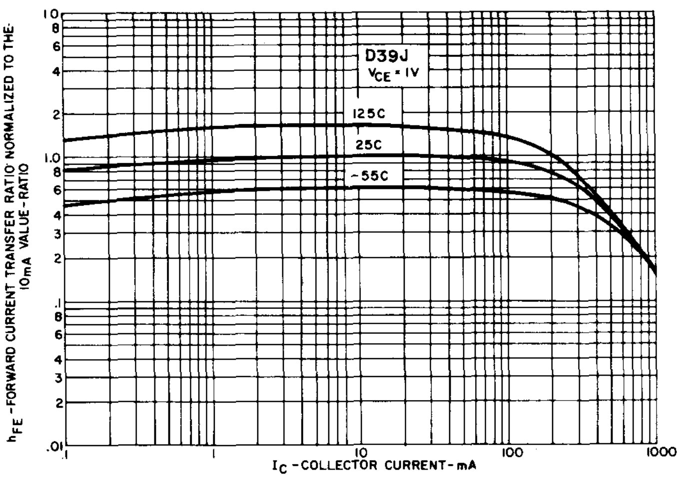
electrical characteristics: (T_A = 25°C unless otherwise specified)

Static Characteristics		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	D39J1,2,3	$V_{(BR)CEO}$	60	–	Volts
	D39J4,5,6	$V_{(BR)CEO}$	80	–	Volts
	D39J7,8,9	$V_{(BR)CEO}$	100	–	Volts
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	D39J1,2,3	$V_{(BR)CBO}$	60	–	Volts
	D39J4,5,6	$V_{(BR)CBO}$	80	–	Volts
	D39J7,8,9	$V_{(BR)CBO}$	100	–	Volts
Emitter-Base Breakdown Voltage (I_E = 10 μA, I_C = 0)		$V_{(BR)EBO}$	5	–	Volts
Collector Cutoff Current (V_{CB} = 25V, I_E = 0)		I_{CBO}	–	25	nA
Emitter-Base Reverse Current (V_{EB} = 3V, I_C = 0)		I_{EBO}	–	25	nA
Forward Current Transfer Ratio* (V_{CE} = 1V, I_C = 10 mA)	D39J1,4,7	h_{FE}	60	150	
	D39J2,5,8	h_{FE}	100	300	
	D39J3,6,9	h_{FE}	200	500	

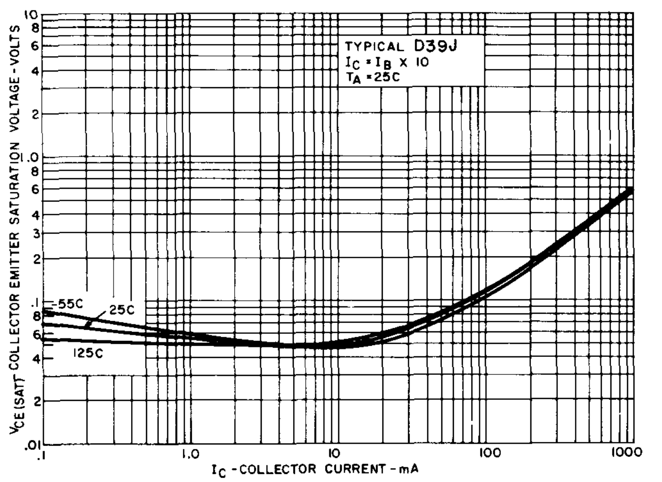
*Pulsed width ≤ 300 μsec., duty cycle ≤ 2%.

Static Characteristics (continued)		SYMBOL	MIN.	MAX.	D39J1-9 UNITS
Forward Current Transfer Ratio* (continued)					
(V_{CE} = 1V, I_C = 100 mA)	D39J1,4,7	h_{FE}	50	–	
	D39J2,5,8	h_{FE}	80	–	
	D39J3,6,9	h_{FE}	150	–	
(V_{CE} = 5V, I_C = 500 mA)	D39J1,4,7	h_{FE}	20	–	
	D39J2,5,8	h_{FE}	30	–	
	D39J3,6,9	h_{FE}	75	–	
Collector-Emitter Saturation Voltage*					
(I_C = 10 mA, I_B = 1 mA)		$V_{CE(sat)}$	–	.10	Volts
(I_C = 100 mA, I_B = 10 mA)		$V_{CE(sat)}$	–	.260	Volts
(I_C = 500 mA, I_B = 50 mA)		$V_{CE(sat)}$	–	.750	Volts
Base-Emitter Saturation Voltage*					
(I_C = 100 mA, I_B = 10 mA)		$V_{BE(sat)}$	–	8.50	Volts
(I_C = 500 mA, I_B = 50 mA)		$V_{BE(sat)}$	–	1.00	Volts
Dynamic Characteristics					
Collector-Base Capacitance					
(V_{CB} = 10V, I_E = 0, f = 1 MHz)		C_{cb}	–	20	pF
Emitter-Base Capacitance					
(V_{EB} = .5V, I_C = 0, f = 1 MHz)		C_{eb}	–	110	pF
Gain Bandwidth Product					
(V_{CE} = 10V, I_E = 30 mA, f = 50 MHz)		f_T	60	–	MHz

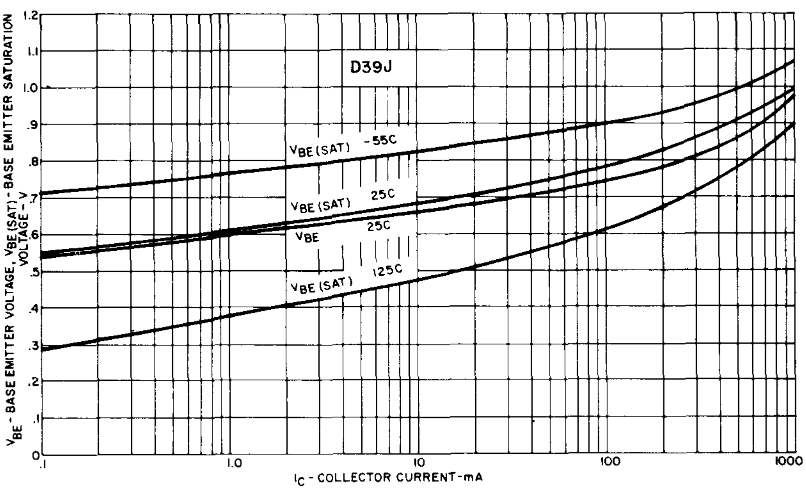
*Pulse width ≤ 300μsec., Duty Cycle ≤ 2%



FORWARD CURRENT TRANSFER RATIO NORMALIZED TO THE 10mA VALUE VS COLLECTOR CURRENT



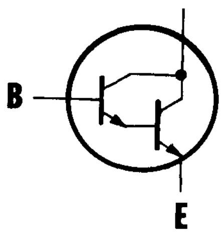
COLLECTOR EMITTER SATURATION VOLTAGE VS COLLECTOR CURRENT



BASE EMITTER VOLTAGE (V_{CE} = 1V) AND BASE EMITTER SATURATION VOLTAGE (I_C = 10 x 1B) VS COLLECTOR CURRENT

Silicon Power Tab
Monolithic Transistor
Very High Gain Darlington Amplifier
"Color Molded"

NPN
D40C

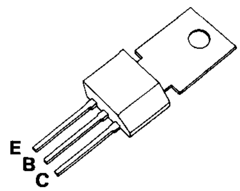


Equiv. Circuit

- h_{FE} Min.—10,000 and 40,000
- 1.33 Watt Free-Air Power Dissipation at T_A = 50°C
- Hard Solder Mountdown

TYPICAL APPLICATIONS:

Driver	Audio Output
Regulator	Relay Substitute
Touch Switch	Oscillator
I.C. Driver	Servo-Amplifier
Capacitor Multiplier	



Brown

Leads Can Be Formed To A TO-5 Pin Configuration

absolute maximum ratings: (25°C unless otherwise specified)

		D40C1(1) D40C2 D40C3	D40C4 D40C5	D40C7 D40C8	
Voltages					
Collector to Emitter	V_{CEO}	30	40	50	Volts
Emitter to Base	V_{EBO}	13	13	13	Volts
Collector to Emitter	V_{CES}	30	40	50	Volts
Current(2)					
Collector (Continuous)	I_C	←	0.5	→	Amps
Collector (Peak) (50% duty cycle, 25 msec. pulse width)		←	1.0	→	Amps
Power Dissipation(2)					
Tab at 25°C(3)	P_T	←	6.25	→	Watts
Tab at 70°C		←	4	→	Watts
Free Air at 50°C					
With Tab		←	1.33	→	Watts
Without Tab		←	1	→	Watts
Thermal Resistance(3)					
Junction to Case	$R_{\theta JC}$	←	20	→	°C/W
Junction to Ambient	$R_{\theta JA}$				
With Tab		←	75	→	°C/W
Without Tab		←	100	→	°C/W
Temperature(3)					
Operating	T_J	←	−55 to +150	→	°C
Storage	T_{STG}	←	−55 to +150	→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 sec. max.	T_L	←	+260	→	°C

NOTES:
(1) The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.
(2) Please refer to the safe region of operation curves for more information.
(3) Tab temperature is measured on center of tab, 1/16" from plastic body.

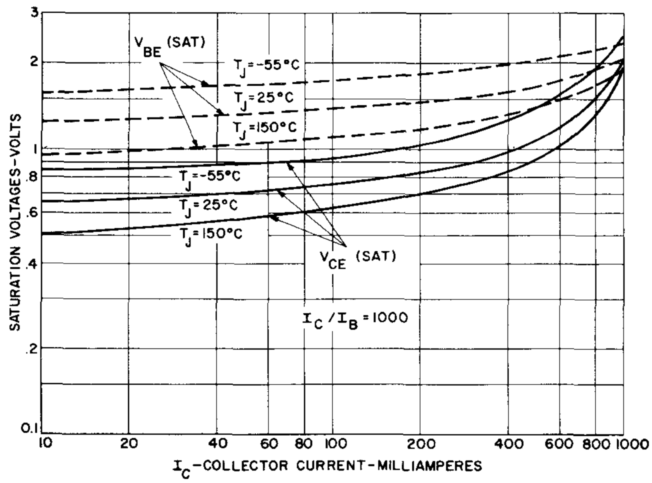
electrical characteristics: (25°C unless otherwise specified)

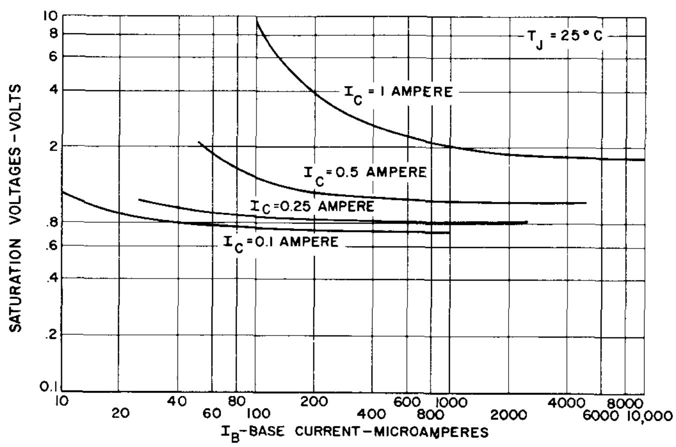
		Min.	Typ.	Max.
Forward Current Transfer Ratio				
(I_C = 200 mA, V_{CE} = 5V)	h_{FE}			
D40C1, 4, 7		10 K	–	60 K
D40C2, 5, 8		40 K	–	–
D40C3		90 K	–	–
(I_C = 20 mA, V_{CE} = 5V, f = 1 kHz)	h_{fe}			
D40C1, 4, 7		–	10 K	–
D40C2, 5, 8		–	20 K	–
D40C3		90 K	–	–

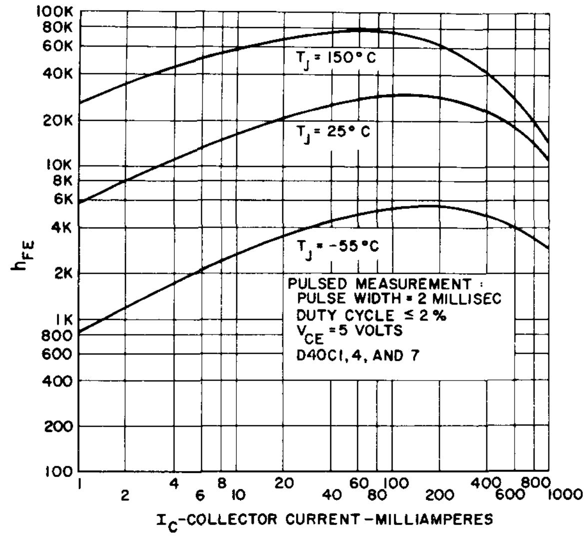
D40C

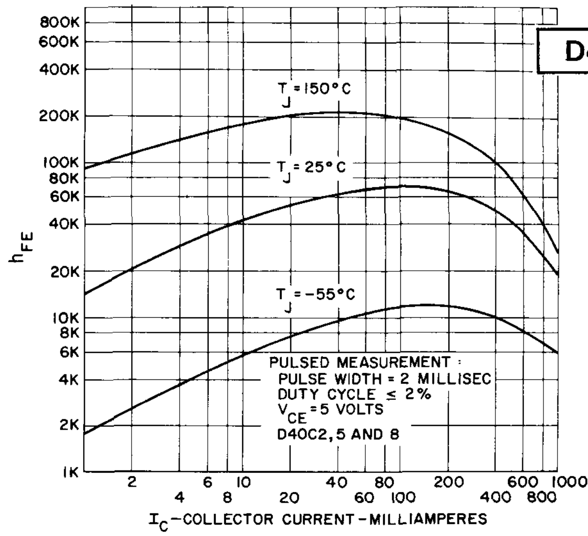
		Min.	Typ.	Max.	
Collector to Emitter Voltage					
(I_C = 10 mA)	V_{CEO}				
D40C1, 2, 3		30	–	–	Volts
D40C4, 5		40	–	–	Volts
D40C7, 8		50	–	–	Volts
Collector Saturation Voltage(4)					
(I_C = 500 mA, I_B = 0.5 mA)	$V_{CE(SAT)}$	–	–	1.5	Volts
Base Saturation Voltage(4)					
(I_C = 500 mA, I_B = 0.5 mA)	$V_{BE(SAT)}$	–	–	2.0	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CES}, T_J = 25°C)	I_{CES}	–	–	0.5	μA
(V_{CE} = Rated V_{CES}, T_J = 150°C)	I_{CBO}	–	–	20	μA
Emitter Cutoff Current					
(V_{EB} = 13V)	I_{EBO}	–	–	0.1	μA
Input Impedance					
(I_C = 20 mA, V_{CE} = 5V, f = 1 kHz)	h_{ie}	50	500	–	Ohms
Collector Capacitance					
(V_{CB} = 10V, f = 1 MHz)	C_{CBO}	–	5	10	pF
Gain Bandwidth Product					
(V_{CE} = 5V, I_C = 20 mA)	f_T	–	75	–	MHz
Switching Times					
Delay Time and Rise Time					
(I_C = 1A, I_{B1} = 1 mA)	$t_d + t_r$	–	100	–	nsec
Storage Time					
(I_C = 1A, I_{B1} = I_{B2} = 1 mA)	t_s	–	350	–	nsec
Fall Time					
(I_C = 1A, I_{B1} = I_{B2} = 1 mA)	t_f	–	800	–	nsec

NOTE:
(4) Pulsed measurement, 300 μsec pulse width, duty cycle ≦ 2%.

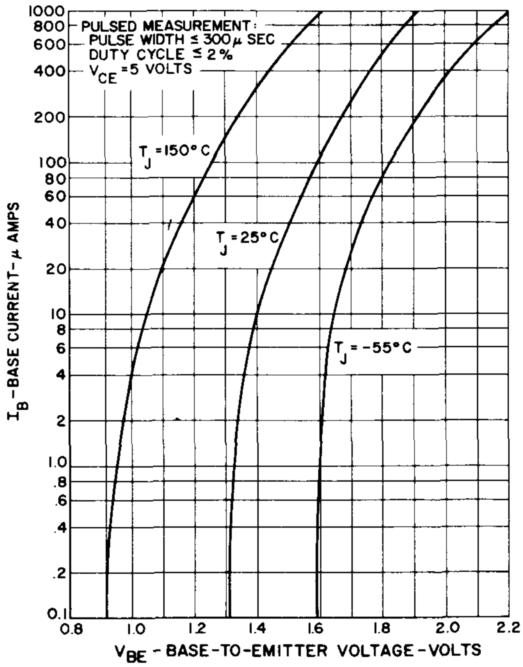




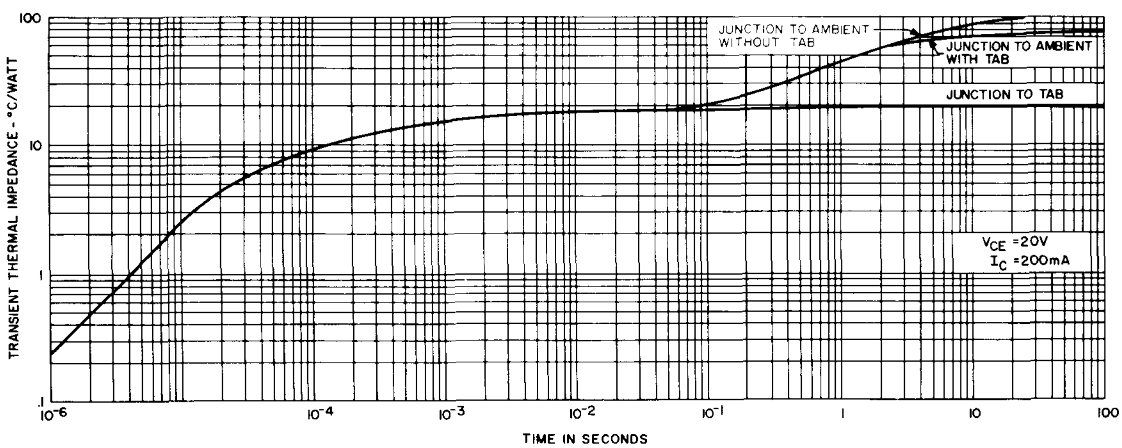




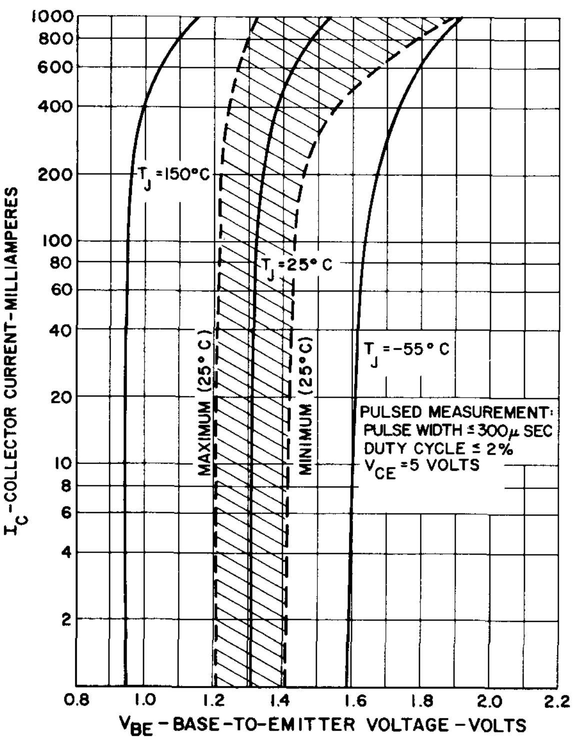
TYPICAL h_{FE} vs. I_C



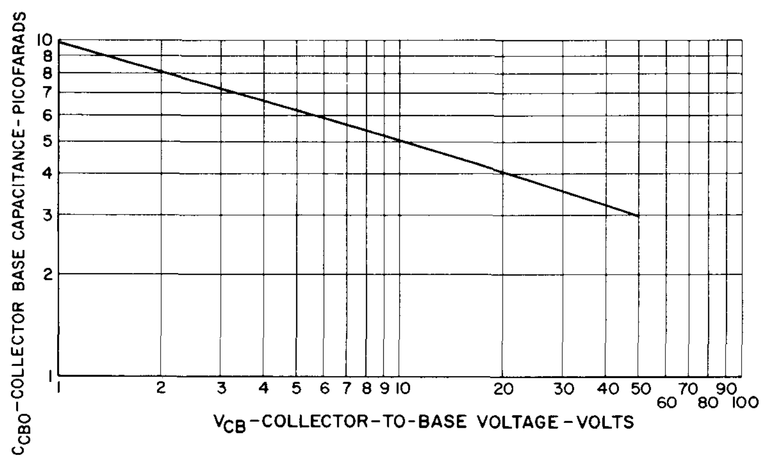
TYPICAL INPUT CHARACTERISTICS



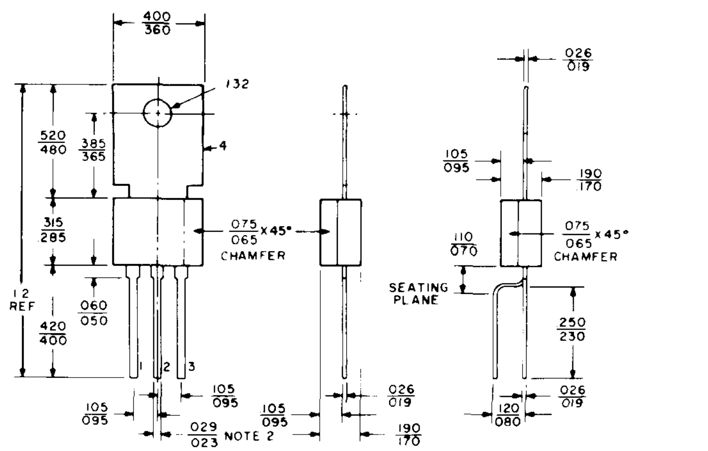
MAXIMUM TRANSIENT THERMAL IMPEDANCE



TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



TYPICAL C_{CBO} vs. VOLTAGE



TYPE U
LEAD LABELS
1 EMITTER
2 BASE
3 COLLECTOR

NOTES
1 ALL DIM ARE IN INCHES AND ARE REF UNLESS TOLERANCED
2 .043-.057 LEAD WIDTH WITHIN 0.100 OF BODY

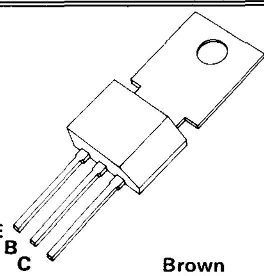
TYPE U
FITS TO-5 PRINTED CIRCUIT BOARD MOUNTING CONFIGURATION

DIMENSIONAL OUTLINES

Silicon Power Tab Transistors
"COLOR MOLDED"

NPN
D40D

The General Electric D40D is a brown, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



Brown
Leads Can Be Formed
To A TO-5 Pin Configuration

FEATURING:
- High free-air power dissipation
- NPN complement to D41D PNP
- Brown for NPN, black for PNP
- Low collector saturation voltage (0.5V typ. @ 1.0A I_C)
- Excellent linearity
- Fast switching
- Hard solder mount down

absolute maximum ratings: (25°C) (unless otherwise specified)

		D40D1[1] D40D2 D40D3	D40D4 D40D5	D40D7 D40D8	D40D10 D40D11 D40D13 D40D14	
Voltages						
Collector to Emitter	V_{CEO}	30	45	60	75	Volts
Emitter to Base	V_{EBO}	5	5	5	5	Volts
Collector to Emitter	V_{CES}	45	60	75	90	Volts
Current[2]						
Collector (Continuous)	I_C	← 1 →				Amps
Collector (Peak)		← 1.5 →				Amps
Power Dissipation[2]						
Tab at 25°C	P_T	← 6.25 →				Watts
Tab at 70°C		← 4 →				Watts
Free Air at 25°C						
With Tab		← 1.67 →				Watts
Without Tab		← 1.25 →				Watts
Free Air at 50°C						
With Tab		← 1.33 →				Watts
Without Tab		← 1.0 →				Watts
Thermal Resistance[3]						
Junction to Case	$R_{\theta JC}$	← 20 →				°C/W
Junction to Ambient	$R_{\theta JA}$					
With Tab		← 75 →				°C/W
Without Tab		← 100 →				°C/W
Temperature[3]						
Operating	T_J	← -55 to +150 →				°C
Storage	T_{STG}	← -55 to +150 →				°C
Lead Soldering, 1/16" ± 1/32" from case for 10 sec max	T_L	+260				°C

NOTES:
[1] The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.
[2] Please refer to the safe region of operation curves for more information.
[3] Tab temperature is measured on center of tab, 1/16" from plastic body.

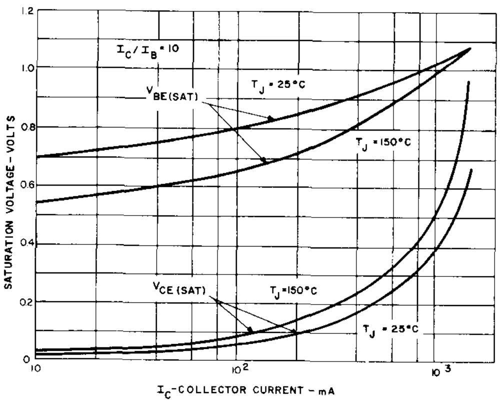
electrical characteristics: (25°C)
(unless otherwise specified)

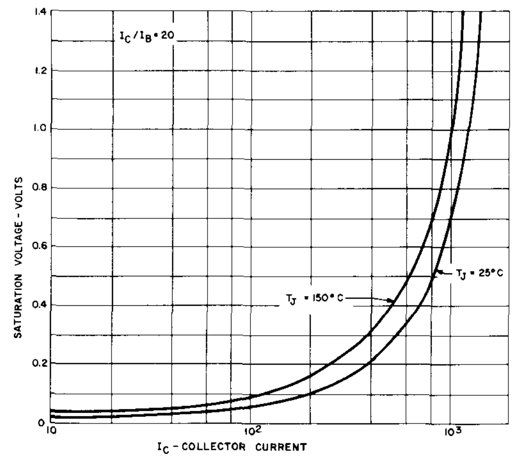
		D40D1 D40D4 D40D7 D40D10 D40D13[1] Min.	Max.	D40D2 Min.	Max.	D40D3 Min.	Max.	D40D5 D40D8 D40D11 D40D14[2] Min.	Max.
Forward Current Transfer Ratio									
(V_{CE} = 2 V, I_C = 100 mA)	h_{FE}	50	150	120	360	290	–	120	360
(V_{CE} = 2 V, I_C = 1 A)	h_{FE}	10	–	20	–	10	–	10	–
			Min.		Typ.		Max.		
Collector to Emitter Voltage									
(I_C = 10 mA) D40D1, 2, 3	V_{CEO}		30		–		–		Volts
D40D4, 5	V_{CEO}		45		–		–		Volts
D40D7, 8	V_{CEO}		60		–		–		Volts
D40D10, 11, 13, 14	V_{CEO}		75		–		–		Volts
Collector Saturation Voltage (I_C = 500 mA, I_B = 50 mA)									
D40D1, 2, 4, 5	$V_{CE(SAT)}$		–		–		0.5		Volts
D40D7, 8, 10, 11, 13, 14	$V_{CE(SAT)}$		–		–		1.0		Volts
Base Saturation Voltage									
(I_C = 500 mA, I_B = 50 mA)	$V_{BE(SAT)}$		–		–		1.5		Volts

1 h_{FE} @ 1A. not specified for D40D13.
2 h_{FE} @ 1A. not specified for D40D14.

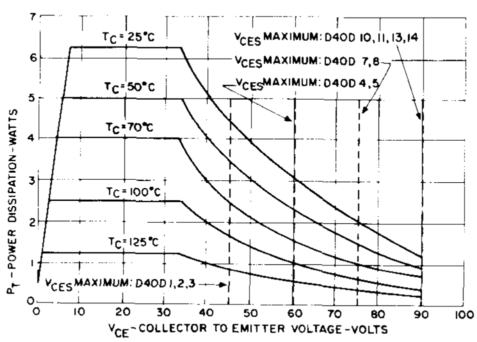
		MIN.	TYP.	MAX.	
Collector Cutoff Current					
(V_{CE} = Rated V_{CES})	I_{CES}	–	–	0.1	μA
(V_{CE} = Rated V_{CES}, T_J = 150°C)		–	1	–	μA
(V_{CE} = Rated V_{CEO})	I_{CEO}	–	1	–	μA
(V_{CE} = Rated V_{CEO}, T_J = 150°C)		–	50	–	μA
Emitter Cutoff Current					
(V_{EB} = 5 V)	I_{EBO}	–	–	0.1	μA
Collector Capacitance					
(V_{CB} = 10 V, f = 1 MHz	C_{CBO}	–	8	–	pF
Gain Bandwidth Product					
(V_{CE} = 10 V, I_c = 20 mA)	f_T	–	200	–	MHz
Switching Times					
Delay Time and Rise Time					
(I_c = 1 A, I_{B1} = 0.1 A)	$t_d + t_r$	–	25	–	nsec
Storage Time					
(I_c = 1 A, I_{B1} = I_{B2} = 0.1 A)	t_s	–	200	–	nsec
Fall Time					
(I_c = 1 A, I_{B1} = I_{B2} = 0.1 A)	t_f	–	50	–	nsec

TYPICAL SATURATION VOLTAGE CHARACTERISTICS

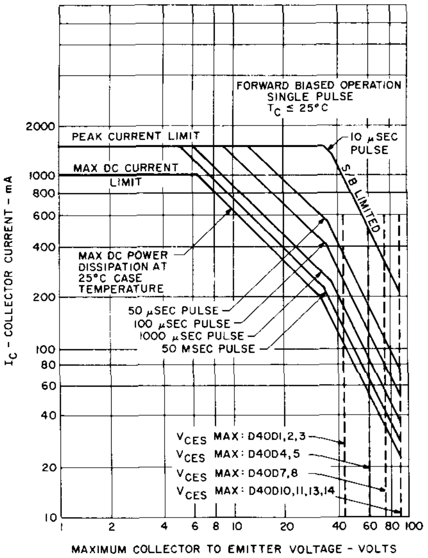


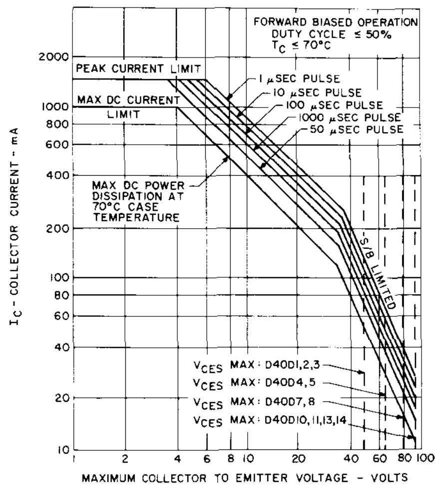


MAXIMUM PERMISSIBLE DC POWER DISSIPATION

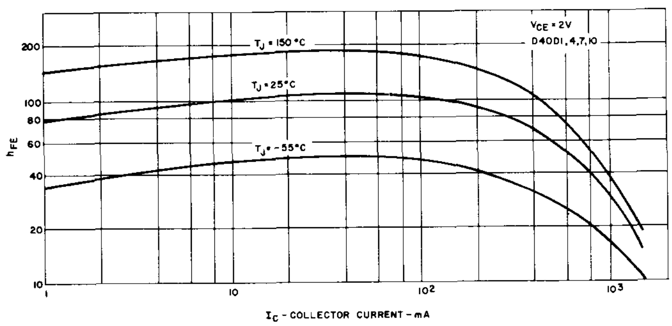


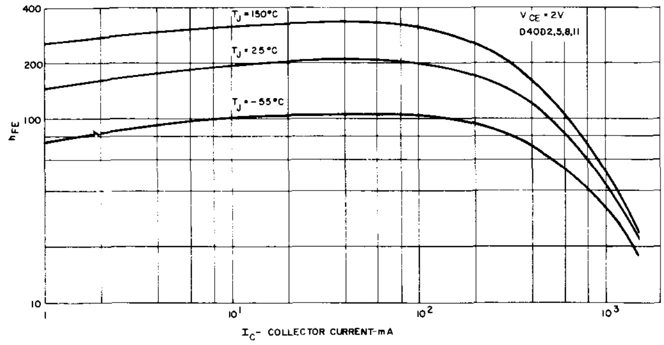
SAFE REGION OF OPERATION



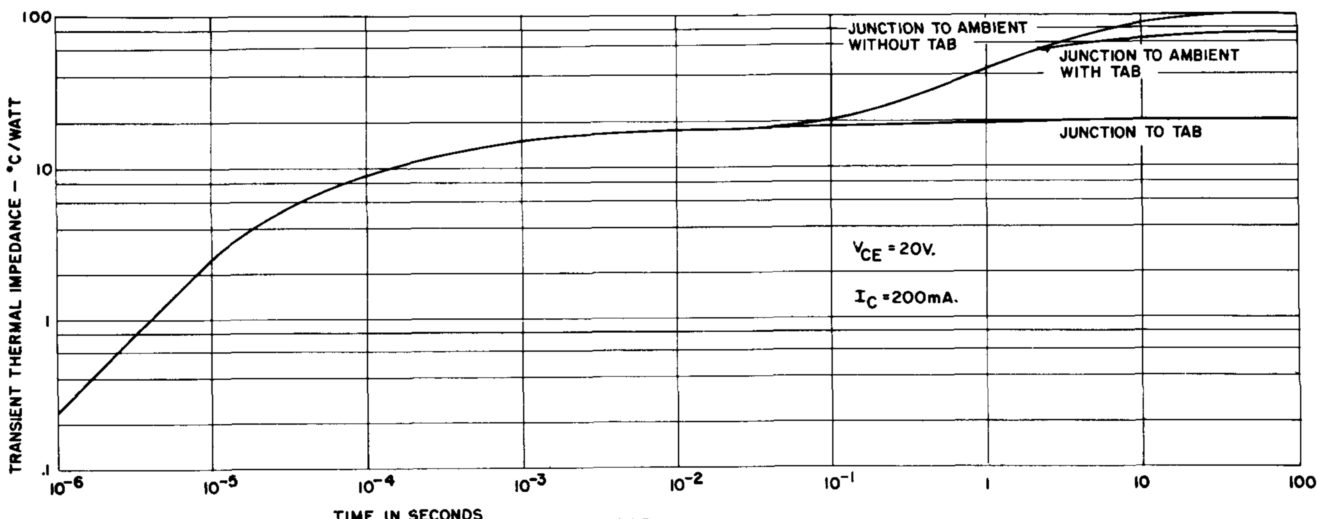


TYPICAL H_{FE} VS I_C

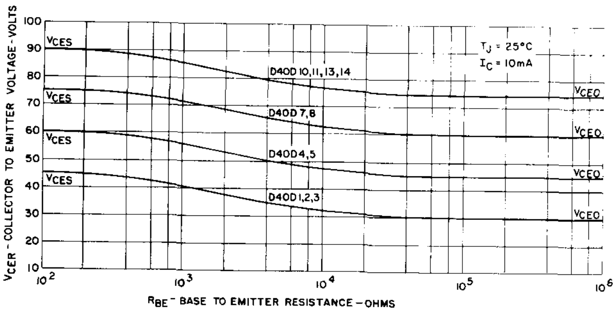




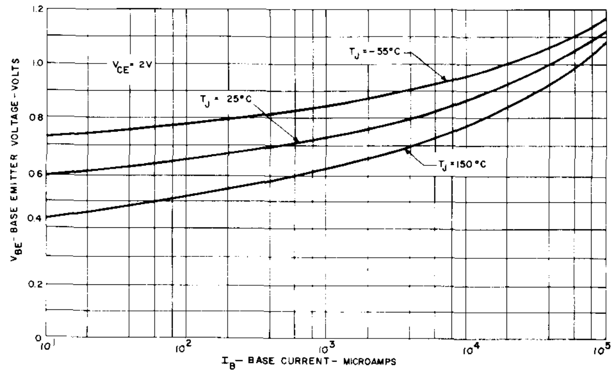
MAXIMUM TRANSIENT THERMAL IMPEDANCE



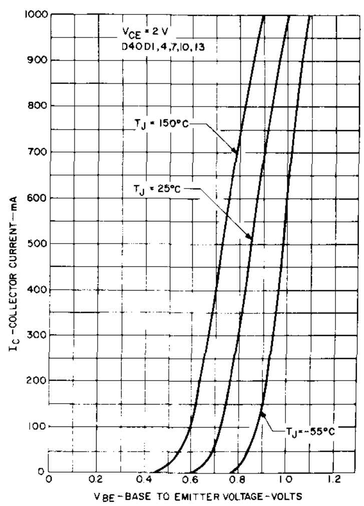
TYPICAL V_{CER}

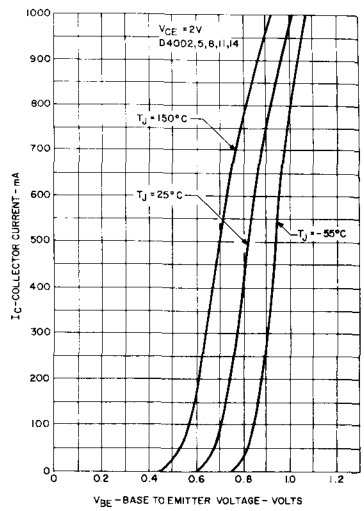


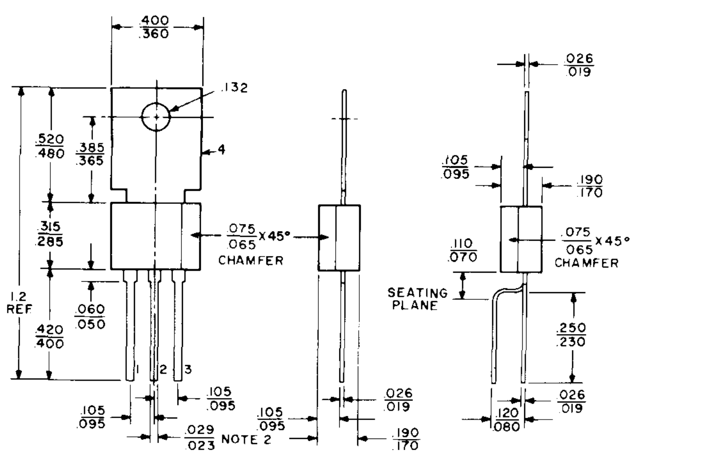
TYPICAL INPUT CHARACTERISTICS



TYPICAL TRANSCONDUCTANCE CHARACTERISTICS







TYPE U
LEAD LABELS
1 EMITTER
2 BASE
3 COLLECTOR

NOTES
1. ALL DIM. ARE IN INCHES AND ARE REF. UNLESS TOLERANCED.
2. .043-.057 LEAD WIDTH WITHIN 0.100 OF BODY.

TYPE U
FITS TO-5 PRINTED CIRCUIT BOARD MOUNTING CONFIGURATION

FOR OPTIONAL LEAD CONFIGURATIONS SEE SELECTOR GUIDE

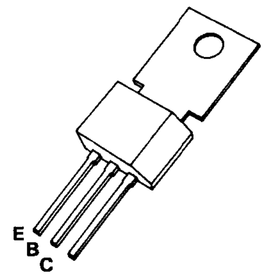
Silicon Power Tab Transistors

NPN

D40E

"Color Molded"

The General Electric D40E is a brown, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



Brown
Leads Can Be Formed
To A TO-5 Pin Configuration

FEATURING:

- High free-air power dissipation
- NPN complement to D41E PNP
- Brown for NPN, black for PNP
- Low collector saturation voltage (—0.5V typ. @—1.0A I_C)
- Excellent linearity
- Fast switching
- Hard solder mount down

absolute maximum ratings: (25°C) (unless otherwise specified)

	Symbol	D40E1	D40E5	D40E7	Units
Voltages					
Collector to Emitter	V_{CEO}	30	60	80	Volts
Emitter to Base	V_{EBO}	5	5	5	Volts
Collector to Emitter	V_{CES}	40	70	90	Volts
Current(2)					
Collector (Continuous)	I_C	←	2	→	Amps
Collector (Peak)		←	3	→	Amps
Base (Continuous)	I_B	←	0.5	→	Amps
Power Dissipation(2)(3)					
Tab at 25°C	P_T	←	8	→	Watts
Tab at 70°C		←	5.12	→	Watts
Free Air at 50°C					
With Tab		←	1.33	→	Watts
Without Tab		←	1.0	→	Watts
Thermal Resistance(3)					
Junction to Case (Tab)	$R_{\theta JC}$	←	15.6	→	°C/W
Junction to Ambient	$R_{\theta JA}$				
With Tab		←	75	→	°C/W
Without Tab		←	100	→	°C/W
Temperature					
Operating	T_J	←	—55 to +150	→	°C
Storage	T_{STG}	←	—55 to +150	→	°C
Lead Soldering, 1/16″ ± 1/32″ from case for 10 sec max	T_L		+260		°C

NOTES:
(1)The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.
(2)Please refer to the safe region of operation curves for more information.
(3)Tab temperature is measured on center of tab, 1/16″ from plastic body.

D40E electrical characteristics: (25°C) (unless otherwise specified)

Forward Current Transfer Ratio	Symbol	D40E1 Min.	D40E1 Max.	D40E5 Min.	D40E5 Max.	D40E7 Min.	D40E7 Max.
($V_{CE}=2$ V, $I_C=100$mA)	h_{FE}	50	-	50	-	50	-
($V_{CE}=2$ V, $I_C=1$A)	h_{FE}	10	-	10	-	10	-

	Symbol	Min.	Typ.	Max.	Units
Collector to Emitter Voltage					
($I_C=10$ mA) D40E1	V_{CEO}	30	—	—	Volts
D40E5	V_{CEO}	60	—	—	Volts
D40E7	V_{CEO}	80	—	—	Volts
Collector Saturation Voltage					
($I_C=1.0$A, $I_B=0.1$A) D40E1, 5, 7	$V_{CE(SAT)}$	—	—	1.0	Volts
Base Saturation Voltage					
($I_C=1.0$A, $I_B=0.1$A) D40E1, 5, 7)	$V_{BE(SAT)}$	—	—	1.3	Volts
Collector Cutoff Current					
($V_{CE}=$ Rated V_{CES})	I_{CES}	—	—	0.1	µA
Emitter Cutoff Current t					
($V_{EB}=5$ V)	I_{EBO}	—	—	0.1	µA
Collector Capacitance					
($V_{CB}=10$ V, f = 1 MHz)	C_{CBO}	—	9	—	pF
Gain Bandwidth Product					
($V_{CE}=10$ V, $I_C=100$ mA)	f_T	—	230	—	MHz
Switching Times					
Delay Time and Rise Time ($I_C=1$ A, $I_{B1}=0.1$A)	$t_d + t_r$	—	130	—	nsec
Storage Time ($I_C=1$ A, $I_{B1}=I_{B2}=0.1$A)	t_s	—	400	—	nsec
Fall Time ($I_C=1$ A, $I_{B1}=I_{B2}=0.1$ A)	t_f	—	170	—	nsec

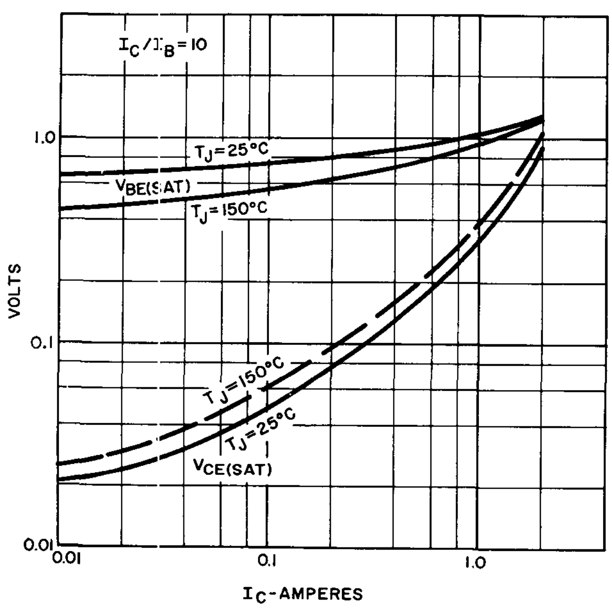


Figure 1

TYPICAL SATURATION VOLTAGE CHARACTERISTICS

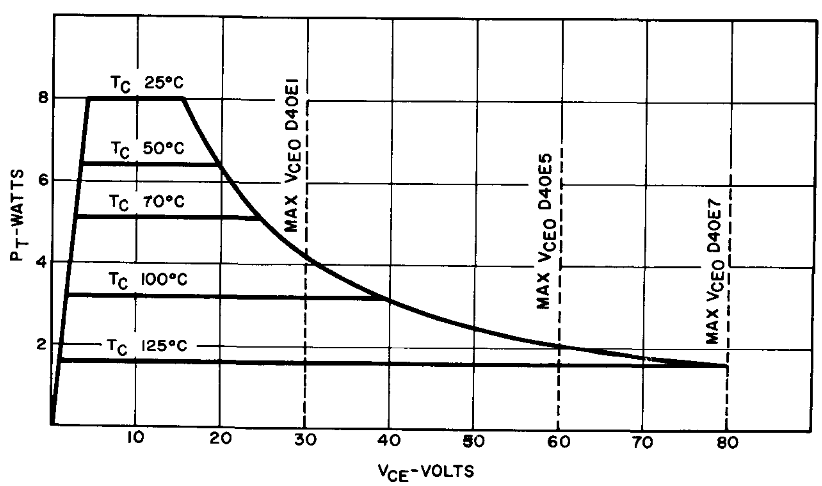


Figure 2

MAXIMUM PERMISSIBLE DC POWER DISSIPATION

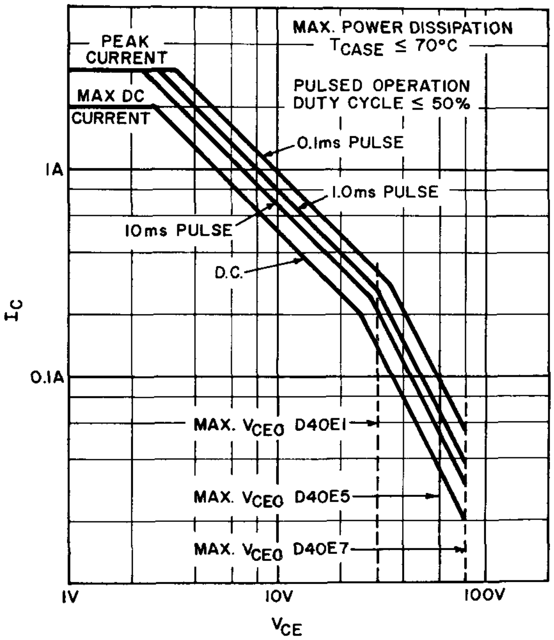


Figure 3

SAFE REGION OF OPERATION

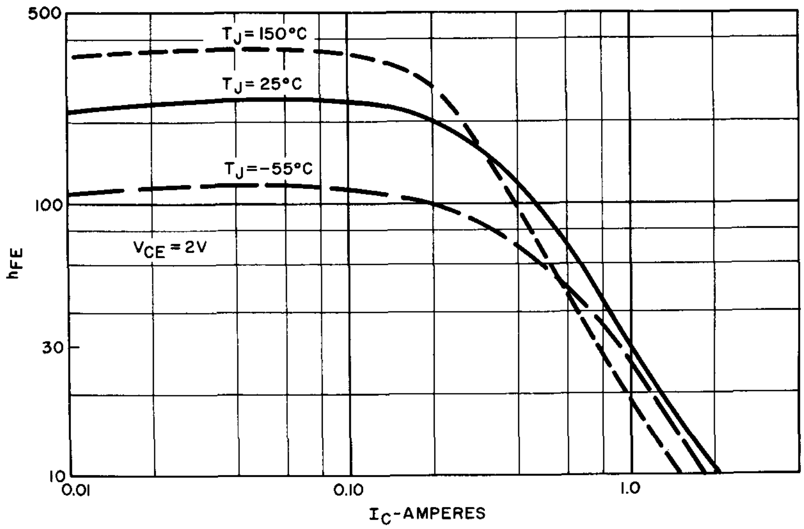


Figure 4

TYPICAL H_{FE} VS I_C

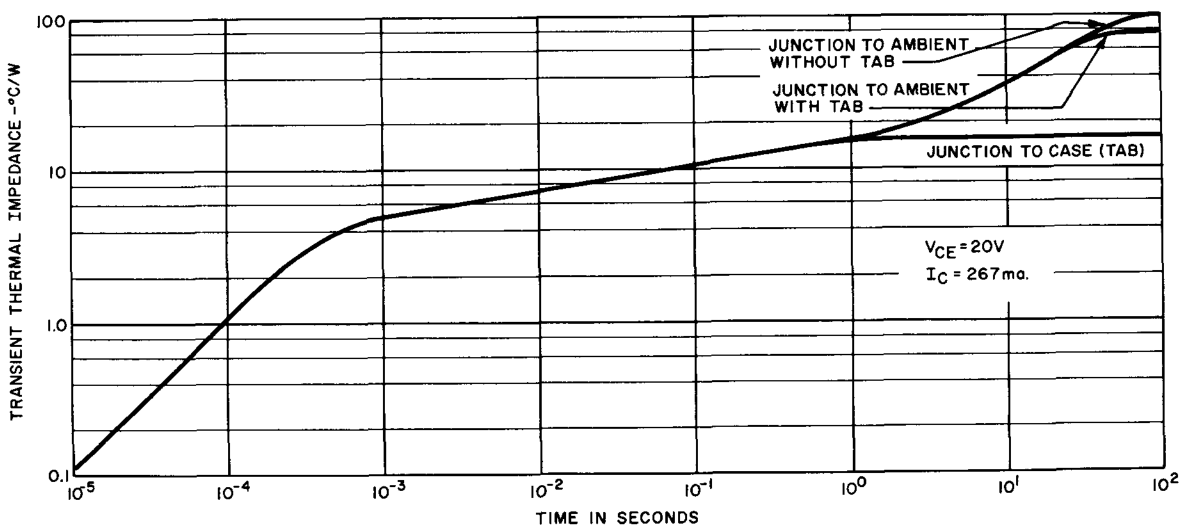


Figure 5

MAXIMUM TRANSIENT THERMAL IMPEDANCE

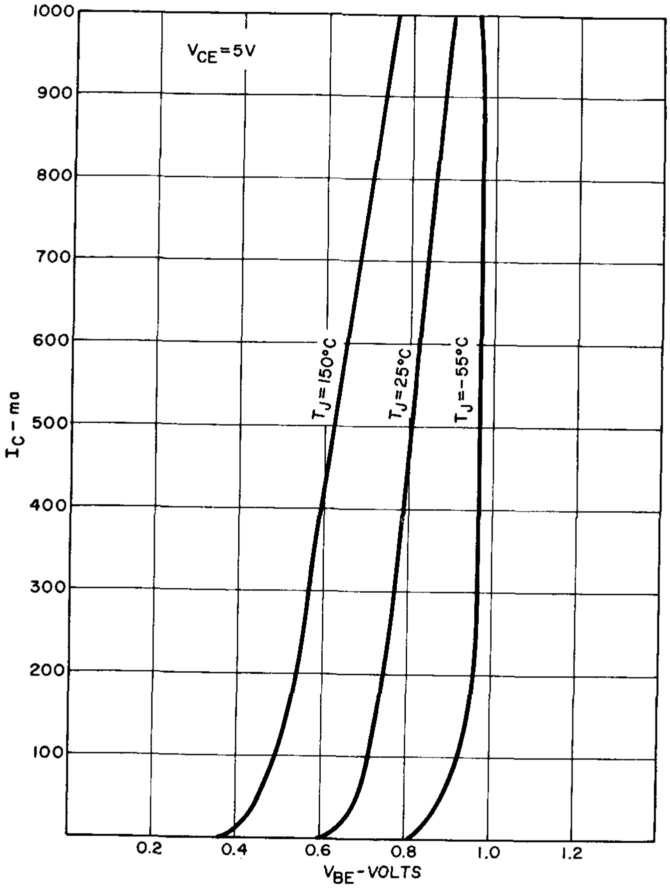
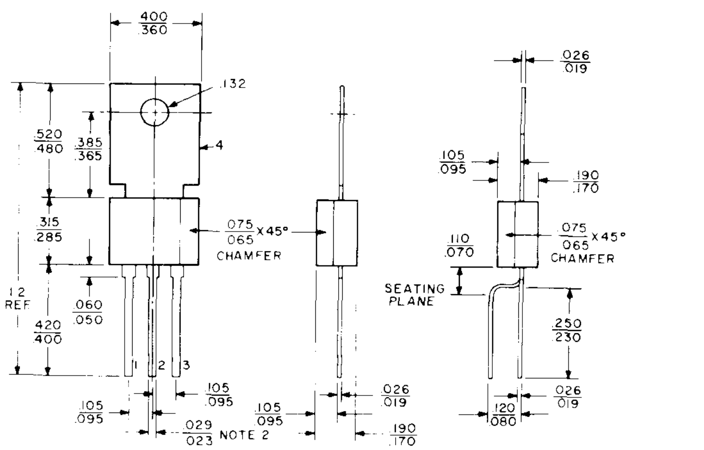


Figure 6

TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



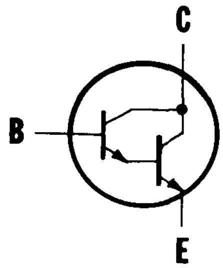
TYPE U
LEAD LABELS
1 EMITTER
2 BASE
3 COLLECTOR
4 MOUNTING TAB
(electrically common to collector)

NOTES
1 ALL DIM ARE IN INCHES AND ARE REF UNLESS TOLERANCED
2 .043-.057 LEAD WIDTH WITHIN 0.100 OF BODY

TYPE U
FITS TO-5 PRINTED CIRCUIT BOARD MOUNTING CONFIGURATION

Silicon Power Tab
Monolithic Transistor
Very High Gain Darlington Amplifier
"Color Molded"

NPN
D40K

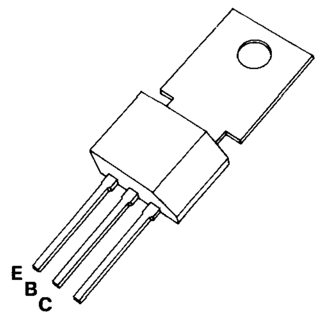


Equiv. Circuit

NPN Complement To D41K
h_{FE} Min. — 10,000
1.67 Watt Free-Air Power Dissipation

TYPICAL APPLICATIONS:

Driver	Audio Output
Regulator	Relay Substitute
Touch Switch	Oscillator
I.C. Driver	Servo-Amplifier
Capacitor Multiplier	



Leads Can Be Formed To A TO-5 Pin Configuration

absolute maximum ratings: (25°C) (unless otherwise specified)[1]

	Symbol	D40K1, 3	D40K2, 4	Units
Voltages				
Collector to Emitter	V_{CEO}	30	50	Volts
Emitter to Base	V_{EBO}	13	13	Volts
Collector to Emitter	V_{CES}	30	50	Volts
Current[2]				
Collector (Continuous)	I_C	← 2 →		Amps
Collector (Peak) (50% duty cycle, 25 msec. pulse width)		← 3 →		Amps
Power Dissipation[2]				
Tab at 25°C[3]	P_T	← 10 →		Watts
Tab at 70°C		← 6 →		Watts
Free Air at 25°C				
With Tab		← 1.67 →		Watts
Without Tab		← 1.25 →		Watts
Free Air at 50°C				
With Tab		← 1.33 →		Watts
Without Tab		← 1.0 →		Watts
Thermal Resistance[3]				
Junction to Case	$R_{\theta JC}$	← 12.5 →		°C/W
Junction to Ambient	$R_{\theta JA}$			
With Tab		← 75 →		°C/W
Without Tab		← 100 →		°C/W
Temperature[3]				
Operating	T_J	← −55 to +150 →		°C
Storage	T_{STG}	← −55 to +150 →		°C
Lead Soldering, 1/16" ± 1/32" from case for 10 sec max	T_L	← +260 →		°C

NOTES:

(1) The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.
(2) Please refer to the safe region of operation curves for more information.
(3) Tab temperature is measured on center of tab, 1/16" from plastic body.

electrical characteristics: (25°C) (unless otherwise specified)

			D40K1, 3 / D40K2, 4		
Forward Current Transfer Ratio		**Min.**			
(I_C = 200 mA, V_{CE} = 5V)	h_{FE}	10K			
(I_C = 1.5A, V_{CE} = 5V)		1K			
(I_C = 1.0A, V_{CE} = 5V)		1K			
		Min.	**Typ.**	**Max.**	
Collector to Emitter Voltage					
(I_C = 10 mA) D40K1, 3	V_{CEO}	30	—	—	Volts
D40K2, 4		50	—	—	Volts
Collector Saturation Voltage(4)					
(I_C = 1.5A, I_B = 3mA) D40K1, 2	$V_{CE(SAT)}$	—	—	1.5	Volts
(I_C = 1.0A, I_B = 2mA) D40K3, 4		–	–	1.5	Volts
Base Saturation Voltage(4)					
(I_C = 1.5A, I_B = 3mA) D40K1, 2	$V_{BE(SAT)}$	—	—	2.5	Volts
(I_C = 1.0A, I_B = 2mA) D40K3, 4		–	–	2.5	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CES}, T_J = 25°C)	I_{CES}	—	—	0.5	μA
(V_{CE} = Rated V_{CES}, T_J = 150°C)	I_{CBO}	—	—	20	μA
Emitter Cutoff Current					
(V_{EB} = 13V)	I_{EBO}	—	—	0.1	μA
Collector Capacitance					
(V_{CB} = 10V, f = 1 MHz)	C_{CBO}	—	5	10	pF
Gain Bandwidth Product					
(V_{CE} = 5V, I_C = 20 mA)	f_T	—	75	—	MHz

NOTE:

(4)Pulsed measurement, 300 μsec pulse width, duty cycle ≦2%.

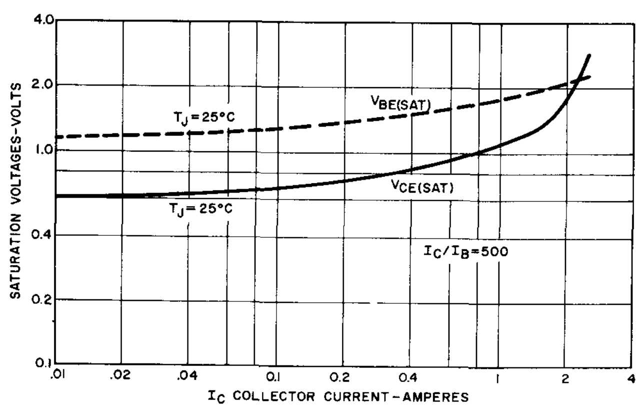


Figure 1

TYPICAL SATURATION VOLTAGE

Figure 2

TYPICAL h_{FE} vs. I_C

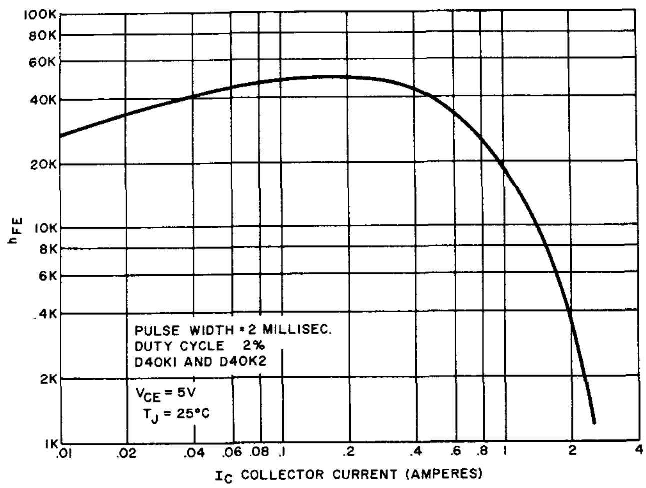
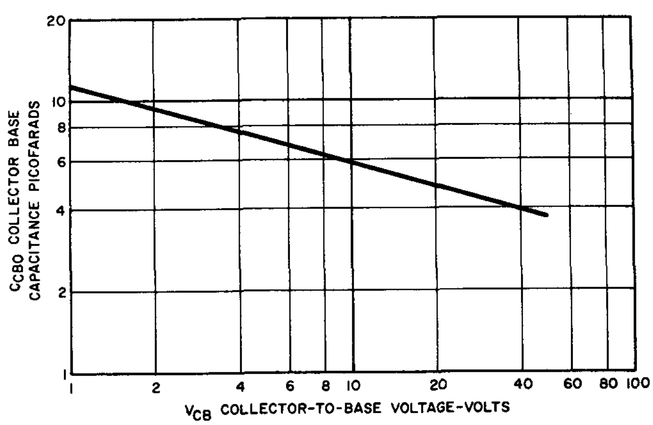
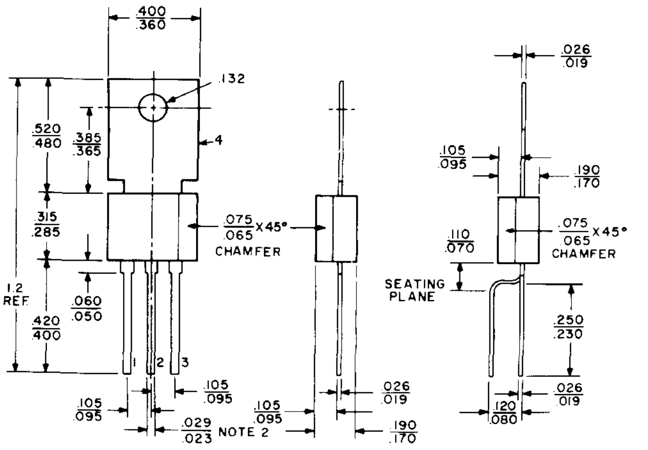


Figure 3

TYPICAL C_{CBO} vs. VOLTAGE



DIMENSIONAL OUTLINES

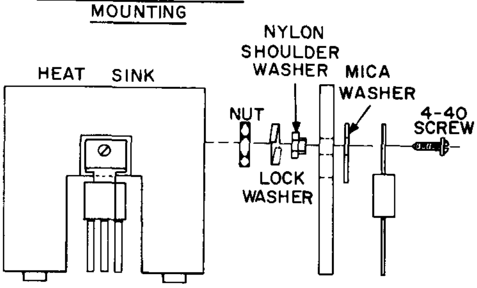


TYPE U
LEAD LABELS
1. EMITTER
2. BASE
3. COLLECTOR

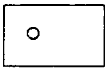
NOTES:
1. ALL DIM. ARE IN INCHES AND ARE REF. UNLESS TOLERANCED.
2. .043-.057 LEAD WIDTH WITHIN 0.100 OF BODY.

TYPE U
FITS TO-5 PRINTED CIRCUIT BOARD MOUNTING CONFIGURATION

TYPICAL INSULATING MOUNTING



INSULATING KIT



MICA WASHER (.003 THICK)

NYLON SHOULDER WASHER

THE ABOVE PARTS WILL BE AVAILABLE UPON REQUEST AS A SEPARATE KIT AT AN ADDITIONAL COST. KIT #138B8189P11

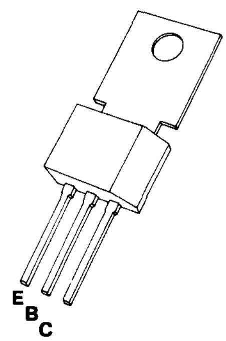
NOTE: THE THERMAL RESISTANCE TAB TO HEAT SINK WITH THE MICA WASHER IS APPROXIMATELY 7.5°C/W WITHOUT ANY THERMAL CONDUCTING COMPOUND AND ABOUT 3.75°C/W WITH A THERMAL CONDUCTING GREASE.

Silicon Power Tab Transistors

High Voltage Video Output Transistor

NPN

D40N



Brown Silicone Leads Can Be Formed To A TO-5 Pin Configuration

The D40N is a silicone plastic encapsulated power transistor for TV video and color output stages. Other TV and general applications include: (1) Drive for the TV horizontal sweep tube;. (2) Audio output stage for portable TV sets; (3) High-voltage transistor regulator; (4) Video display drivers for oscilloscopes, electroluminescent displays and desk calculators; (5) High-voltage general usage.

FEATURING:

- ***POWER-GLAS*** passivation
- Low C_{CB} (2.0 pf typ. @ V_{CB} = 20V)
- Gain rated at 3 collector currents

absolute maximum ratings: (25°C) (unless otherwise specified)

		D40N1[1] D40N2	D40N3 D40N4	D40N5	
Voltages[2] [4]					
Collector to Emitter	V_{CER}	250	300	375	Volts
Emitter to Base	V_{EBO}	5	5	5	Volts
Current					
Collector (Continuous)	I_C	←	0.1	→	Amps
Power Dissipation					
Tab at 25°C[3]	P_T	←	6.25	→	Watts
Tab at 70°C		←	4	→	Watts
Free Air at 50°C		←	1.33	→	Watts
Free Air at 50°C (Without Tab)		←	1	→	Watts
Thermal Resistance[3]					
Junction to Case	$R_{\theta JC}$	←	20	→	°C/W
Junction to Ambient	$R_{\theta JA}$				
With Tab		←	75	→	°C/W
Without Tab		←	100	→	°C/W
Temperature[3]					
Storage	T_{STG}	←	−55 to +150	→	°C
Operating	T_J	←	−55 to +150	→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	←	+260	→	°C

NOTES:

(1) The last digit is a part number which designates a voltage grade. Tab and lead forming is specified by a letter after this digit.
(2) Test conditions: I_C = 1.0 mA, R_{BE} = 10 kΩ.
(3) Tab temperature is measured on center of tab, 1/16" from plastic body.
(4) Pulsed measurement, 300 μsec pulse width, duty cycle ≤ 2%.

electrical characteristics: (25°C) (unless otherwise specified)

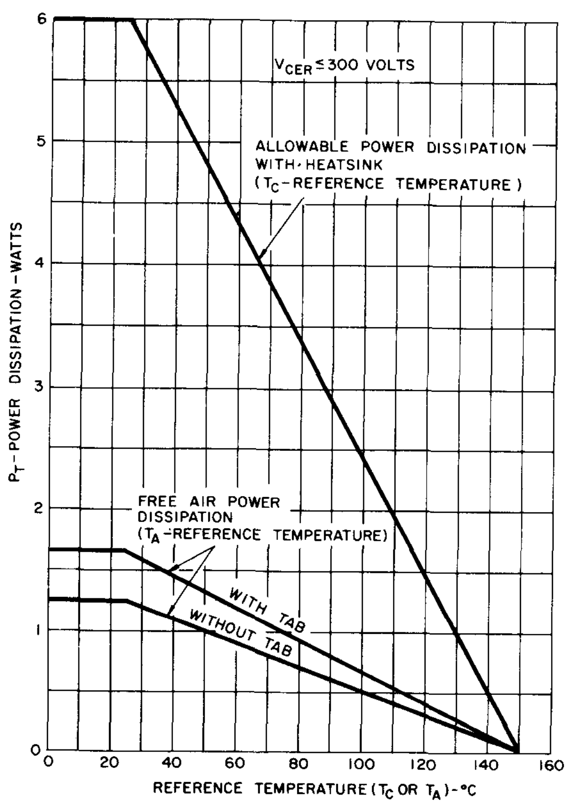
		D40N1 D40N3 Min.	D40N1 D40N3 Max.	D40N5 Min.	D40N5 Max.	D40N2 D40N4 Min.	D40N2 D40N4 Max.
Forward Current Ratio							
(V_{CE} = 10V, I_C = 4 mA)	h_{FE}	20	–	15	–	30	–
(V_{CE} = 10V, I_C = 20 mA)	h_{FE}	30	90	20	–	60	180
(V_{CE} = 10V, I_C = 40 mA)	h_{FE}	20	–	15	–	30	–

ELECTRICAL CHARACTERISTICS (Continued)

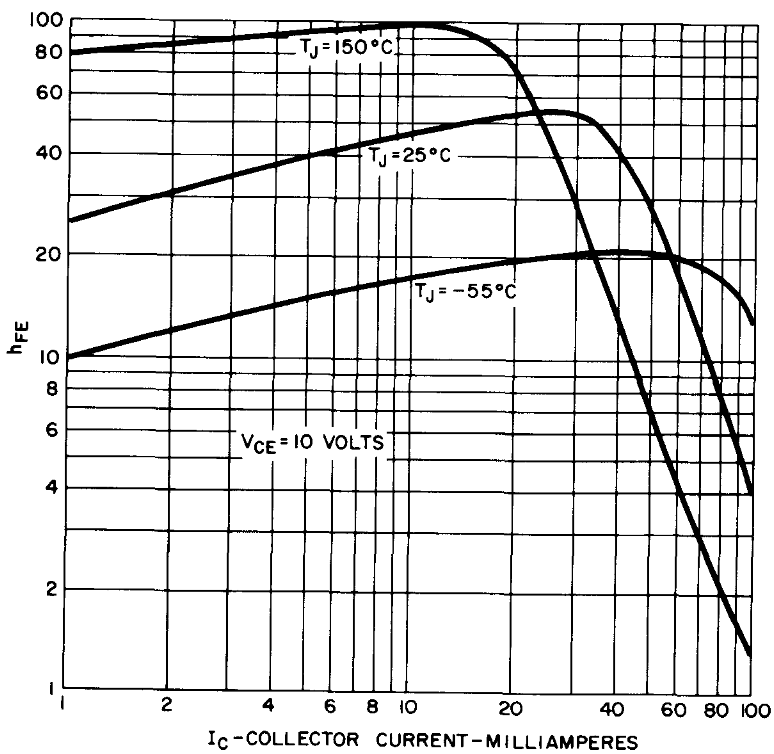
		Min.	Typ.	Max.	
Collector to Emitter Voltage(4)					
(I_{CE} = 1.0 mA, Base to Emitter R = 10 kΩ)	V_{CER}				
D40N1, 2		250	–	–	Volts
D40N3, 4		300	–	–	Volts
D40N5		375	–	–	Volts
Collector Cutoff Current					
(V_{CB} = 300V, T_J = 25°C) D40N3, 4, 5	I_{CBO}	–	0.1	10	μA
(V_{CB} = 250V, T_J = 25°C) D40N1, 2		–	0.1	10	μA
(V_{CB} = 250V, T_J = 150°C)		–	5	–	μA
Emitter Cutoff Current					
(V_{EB} = 5V)	I_{EBO}	–	–	10	μA
Collector Capacitance					
(V_{CB} = 20V, I_E = 0, f = 1MHz)	C_{CB}	–	–	3	pF
Gain Bandwidth Product					
(I_C = 20 mA, V_{CE} = 10V)	f_T	50	80	–	MHz
(I_C = 20 mA, V_{CE} = 20V)		75	95	–	MHz

NOTE:
(4) Pulsed measurement, 300 μsec pulse width, duty cycle ≤ 2%.

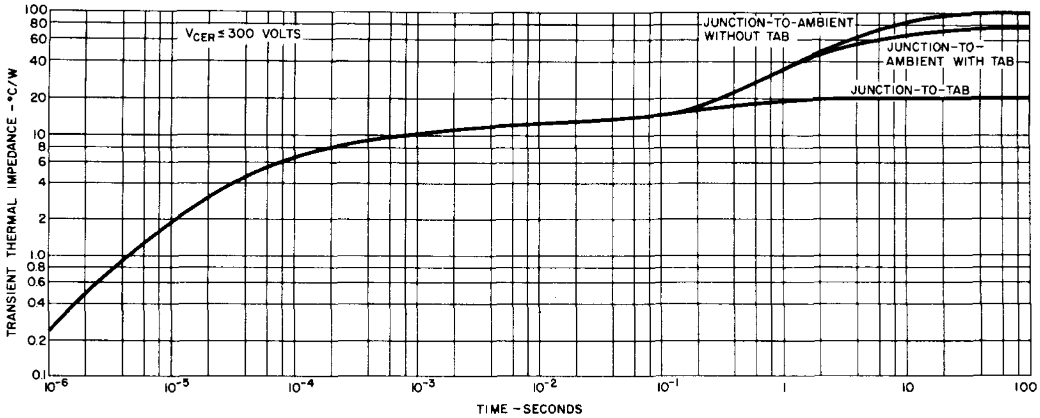
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



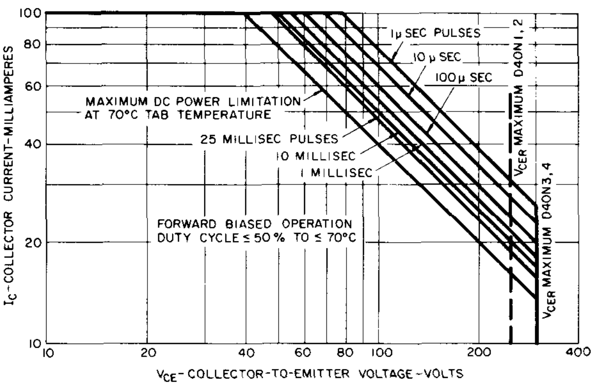
TYPICAL H_{FE} VS. I_C



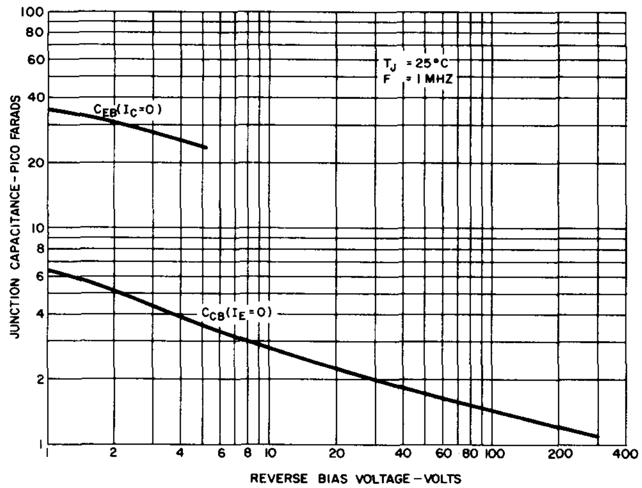
MAXIMUM TRANSIENT THERMAL IMPEDANCE



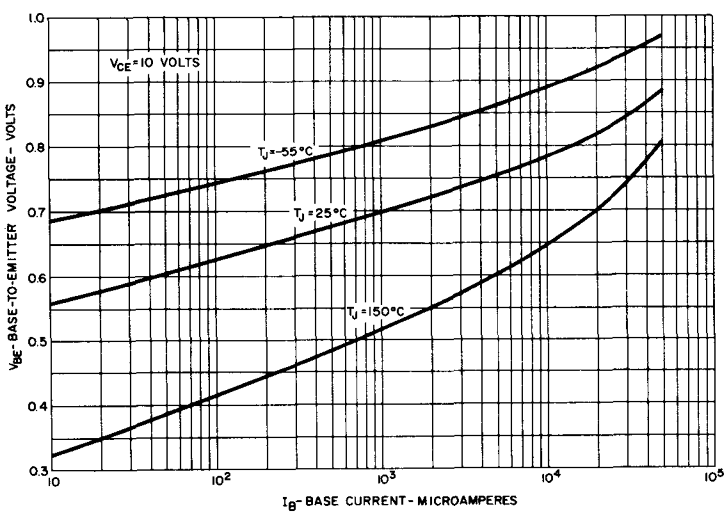
SAFE REGION OF OPERATION



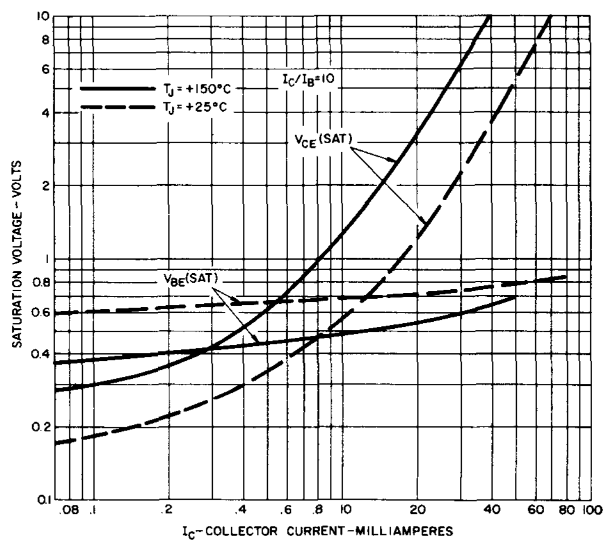
JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE



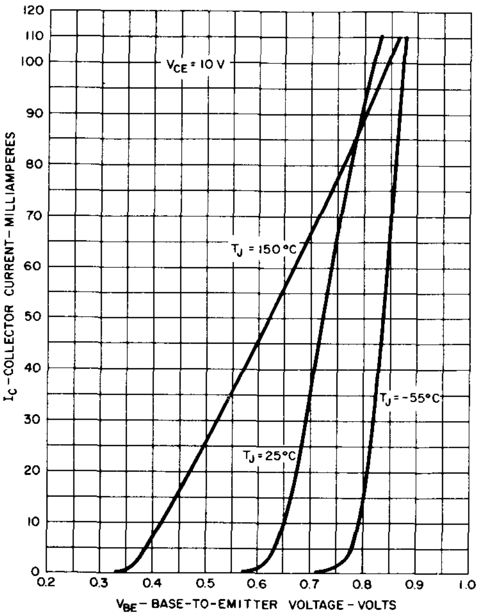
INPUT CHARACTERISTICS



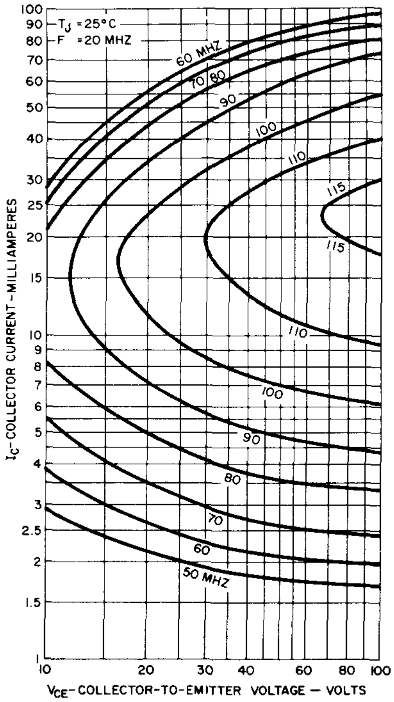
SATURATION VOLTAGE CHARACTERISTICS



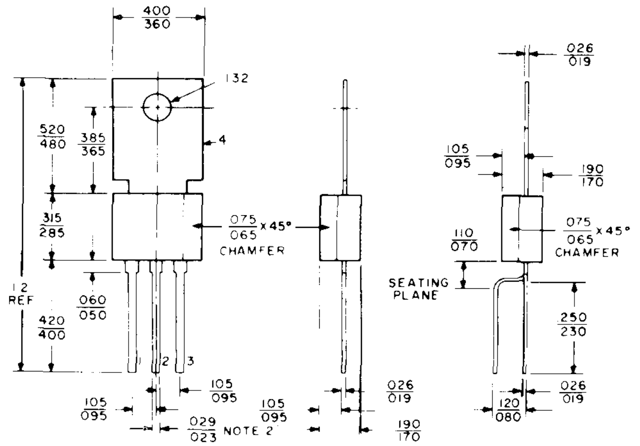
TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT



DIMENSIONAL OUTLINES



TYPE U
LEAD LABELS
1 EMITTER
2 BASE
3 COLLECTOR
4 MOUNTING TAB
(electrically common to collector)

NOTES
1 ALL DIM ARE IN INCHES AND ARE REF UNLESS TOLERANCED
2 .043-.057 LEAD WIDTH WITHIN 0.100 OF BODY

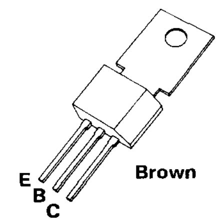
TYPE U
FITS TO-5 PRINTED CIRCUIT BOARD MOUNTING CONFIGURATION

Silicon Power Tab Transistor

NPN

D40P

The D40P is a brown silicone encapsulated glass passivated power transistor designed for various specific and general purpose applications such as: series, shunt and switching regulators, high frequency invertors, and display tube and TV deflection circuitry.

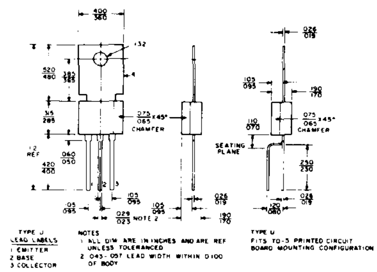


Leads can be formed to a TO-5 Pin Configuration.

FEATURING:
- ***POWER-GLAS*** Passivation
- High Free Air Power Dissipation
- Hard Solder Mountdown
- Fast Switching
- Brown for NPN

absolute maximum ratings: (25°C unless otherwise specified)

		D40P1	D40P3	D40P5	
Voltages					
Collector to Emitter	V_{CEO}	120	180	225	Volts
Emitter to Base	V_{EBO}	7	7	7	Volts
Collector to Base	V_{CBO}	200	250	300	Volts
Current					
Collector (Continous)	I_C		0.5		Amp.
Power Dissipation					
Tab at 25°C		←	6.25	→	Watts
Tab at 70°C	P_T	←	4.0	→	Watts
Free Air at 50°C		←	1.33	→	Watts
Free Air at 50°C (without tab)		←	1.0	→	Watts
Thermal Resistance					
Junction to Case	$R\theta_{JC}$	←	20	→	°C/W
Junction to Ambient	$R\theta_{JA}$				
(with tab)		←	75	→	°C/W
(without tab)		←	100	→	°C/W
Temperature					
Operating	T_j	←	–55 to +150	→	°C
Storage	T_{stg}	←	–55 to +150	→	°C
Lead Soldering, 1/16" ± 1/32" From case for 10 sec. max.	T_L	←	+260	→	°C

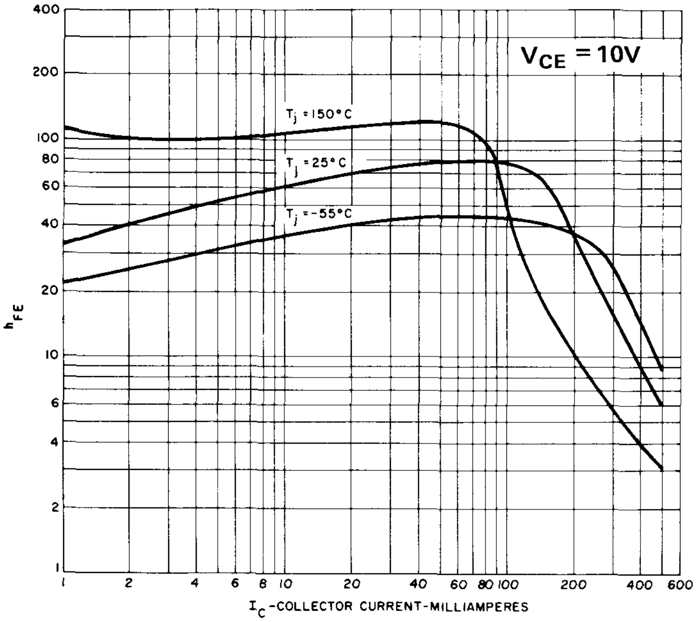


An insulating hardware kit (mica washer, nylon shoulder washer, and solder lug) is available at an additional cost upon request. Kit #138B8189P11.

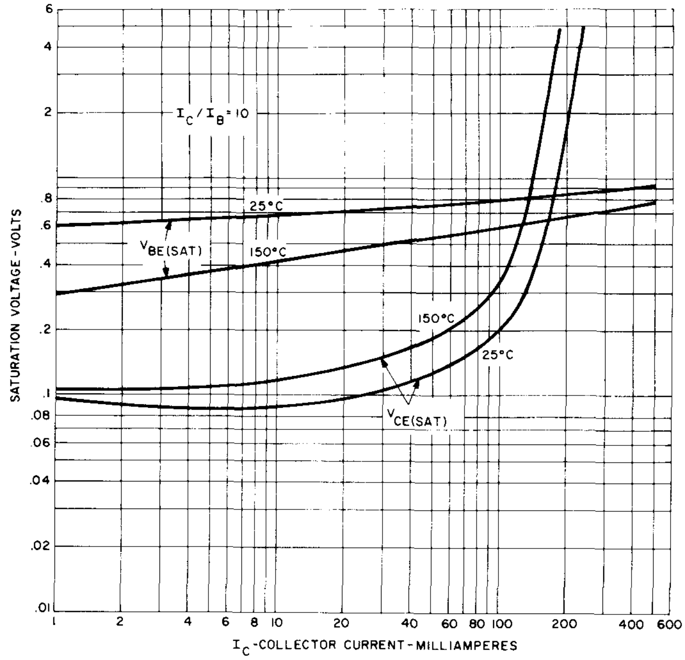
Dimensional Outlines

electrical characteristics: (25°C unless otherwise specified)

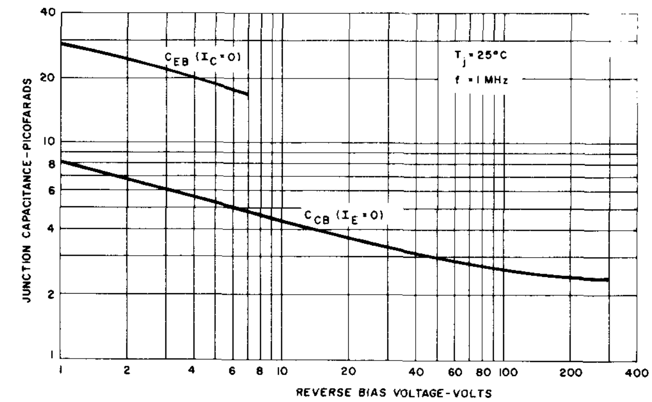
		Min.	Max.	Units
Forward Current Transfer Ratio				
(I_C = 80 mA, V_{CE} = 10V)	h_{FE}	40	—	
(I_C = 2 mA, V_{CE} = 10V)		20	—	
Collector to Emitter Voltage				
(I_C = 1.0 mA, I_b = 0)	V_{CEO}			
D40P1		120	—	Volts
D40P3		180	—	Volts
D40P5		225	—	Volts
Collector Cutoff Current				
(Rated V_{CEO})	I_{CBO}	—	10	μA
Emitter Cutoff Current				
(V_{EBO} = 7V)	I_{EBO}	—	10	μA
Collector Saturation Voltage				
(I_C = 100 mA, I_B = 10 mA)	V_{CE} (SAT)	—	1	Volt
Base Saturation Voltage				
(I_C = 100 mA, I_B = 10 mA)	V_{BE} (SAT)	—	1.5	Volt
Gain Bandwidth Product				
(I_C = 80 mA, V_{CE} = 10V)	f_T	50	—	MHz
Storage Time				
(I_C (ON) = 80 mA, I_B (ON) = 8 mA I_B (OFF) = 8 mA)	t_S	—	2.5	μsec
Collector Capacitance				
(V_{CB} = 10V, I_E = 0)	C_{CB}	—	6	pf



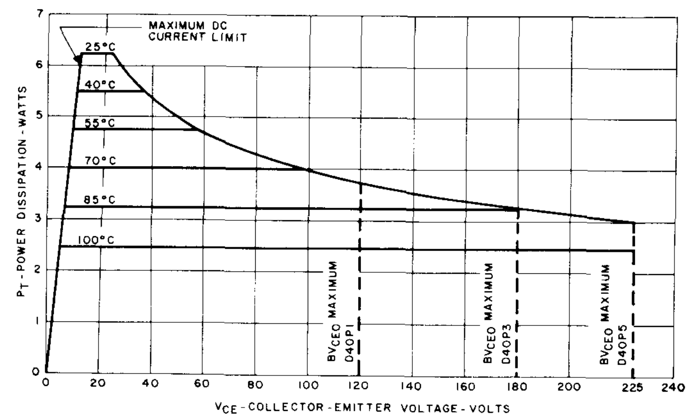
TYPICAL h_{FE} vs. I_C



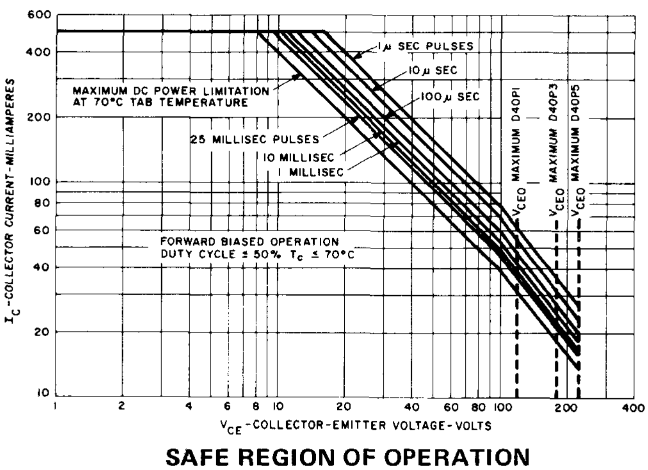
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



TYPICAL JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE



MAXIMUM PERMISSIBLE DC POWER DISSIPATION

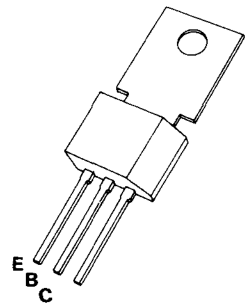


SAFE REGION OF OPERATION

Silicon Power Tab
Transistors
"Color Molded"

PNP
D41D

The General Electric D41D is a black, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 mHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



Black Silicone
Leads Can Be Formed
To A TO-5 Pin Configuration

FEATURING:

- High free-air power dissipation
- PNP complement to D40D NPN (previously D28D)
- Black for PNP, brown for NPN
- Low collector saturation voltage (−0.5V typ. @ −1.0A I_C)
- Excellent linearity
- Fast switching
- Hard solder mount down

absolute maximum ratings: (25°C) (unless otherwise specified)

		D41D1(1) D41D2	D41D4 D41D5	D41D7 D41D8	D41D14 D41D13 D41D10 D41D11	
Voltages						
Collector to Emitter	V_{CEO}	−30	−45	−60	−75	Volts
Emitter to Base	V_{EBO}	− 5	− 5	− 5	− 5	Volts
Collector to Emitter	V_{CES}	−45	−60	−75	−90	Volts
Current(2)						
Collector (Continuous)	I_C	← −1 →				Amps
Collector (Peak)		← −1.5 →				Amps
Power Dissipation(2)						
Tab at 25°C	P_T	← 6.25 →				Watts
Tab at 70°C		← 4 →				Watts
Free Air at 25°C						
With Tab		← 1.67 →				Watts
Without Tab		← 1.25 →				Watts
Free Air at 50°C						
With Tab		← 1.33 →				Watts
Without Tab		← 1.0 →				Watts
Thermal Resistance(3)						
Junction to Case	$R\theta_{JC}$	← 20 →				°C/W
Junction to Ambient	$R\theta_{JA}$					
With Tab		← 75 →				°C/W
Without Tab		← 100 →				°C/W
Temperature(3)						
Storage	T_{STG}	← −55 to +150 →				°C
Lead Soldering, 1/16" ± 1/32" from case for 10 sec max	T_L	← +260 →				°C

NOTES:

(1) The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.
(2) Please refer to the safe region of operation curves for more information.
(3) Tab temperature is measured on center of tab, 1/16" from plastic body.

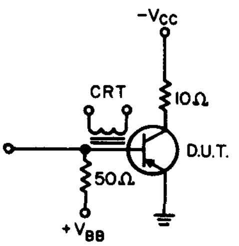
electrical characteristics: (25°C) (unless otherwise specified)

D41D

		D41D10 D41D1 D41D4 D41D7		D41D2		D41D11 D41D5 D41D8		D41D13		D4
Forward Current Transfer Ratio		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
(V_{CE} = −2V, I_C = −100 mA)	h_{FE}	50	150	120	360	120	360	50	150	120
(V_{CE} = −2V, I_C = −1A)	h_{FE}	10	–	20	–	10	–	–	–	–

		Min.	Typ.	Max.	
Collector to Emitter Voltage					
(I_C = −10 mA) D41D1, 2	V_{CEO}	−30	–	–	Volts
D41D4, 5	V_{CEO}	−45	–	–	Volts
D41D7, 8	V_{CEO}	−60	–	–	Volts
D41D10, 11, 13, 14	V_{CEO}	−75	–	–	Volts
Collector Saturation Voltage					
(I_C = −500 mA, I_B = −50 mA)					
D41D1, 2, 4, 5	$V_{CE}(SAT)$	–	–	−0.5	Volts
D41D7, 8, 10, 11, 13, 14	$V_{CE}(SAT)$	–	–	−1.0	Volts
Base Saturation Voltage					
(I_C = −500 mA, I_B = −50 mA)	$V_{BE}(SAT)$	–	–	−1.5	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CES})	I_{CES}	–	–	−0.1	μA
(V_{CE} = Rated V_{CES}, T_J = 125°C)		–	−1	–	μA
(V_{CE} = Rated V_{CEO})	I_{CEO}	–	−1	–	μA
(V_{CE} = Rated V_{CES}, T_J = 125°C)		–	−50	–	μA
Emitter Cutoff Current					
(V_{EB} = −5V)	I_{EBO}	–	–	−0.1	μA
Collector Capitance					
(V_{CB} = −10V, f = 1 mHz)	C_{CBO}	–	10	–	pF
Gain Bandwidth Product					
(V_{CE} = −10V, I_C = −20 mA)	f_T	–	150	–	mHz
Switching Times (see Figs. 1 & 2)					
Delay Time and Rise Time (I_C = −1A, I_{B1} = −0.1A)	$t_d + t_r$	–	50	–	nsec
Storage Time (I_C = −1A, I_{B1} = I_{B2} = −0.1A)	t_s	–	75	–	nsec
Fall Time (I_C = −1A, I_{B1} = I_{B2} = −0.1A)	t_f	–	40	–	nsec

SWITCHING CIRCUIT TO MEASURE SWITCHING TIMES



RISE TIME = 1 NANOSECONDS MAX
FALL TIME = 1 NANOSECONDS MAX

I_{B1}=I_{B2}=0.1 AMPS
PULSE = 10μ SEC
P.R.T. = 10m SEC
CRT = TEKTRONIX CURRENT TRANSFORMER

FIGURE 1

OSCILLOSCOPE DISPLAY OF INPUT AND OUTPUT PULSE WAVEFORM IS OF SWITCHING CIRCUIT SHOWN IN FIGURE 1

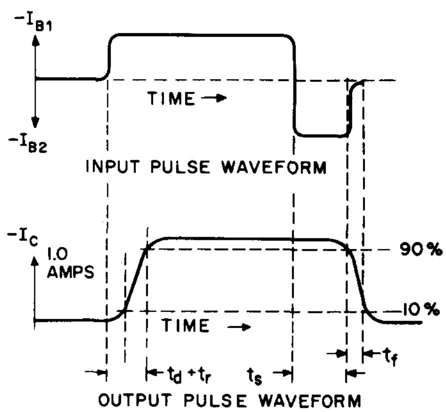
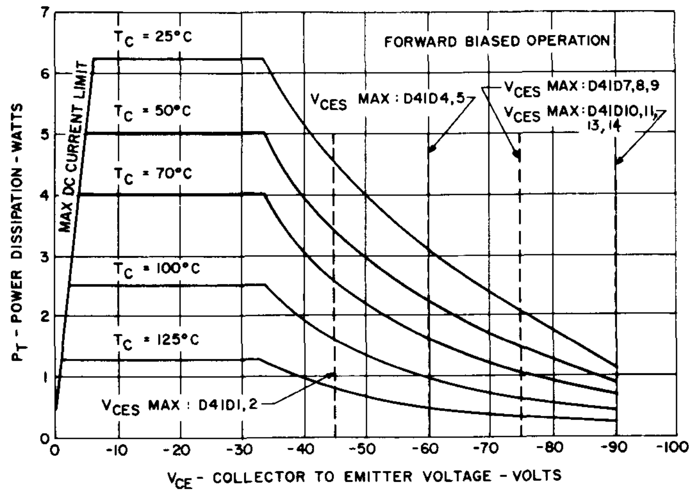
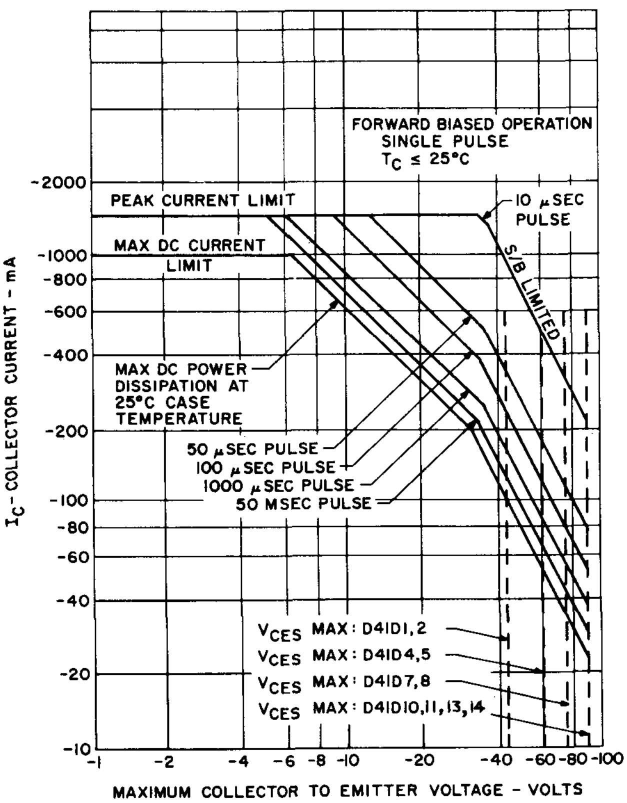


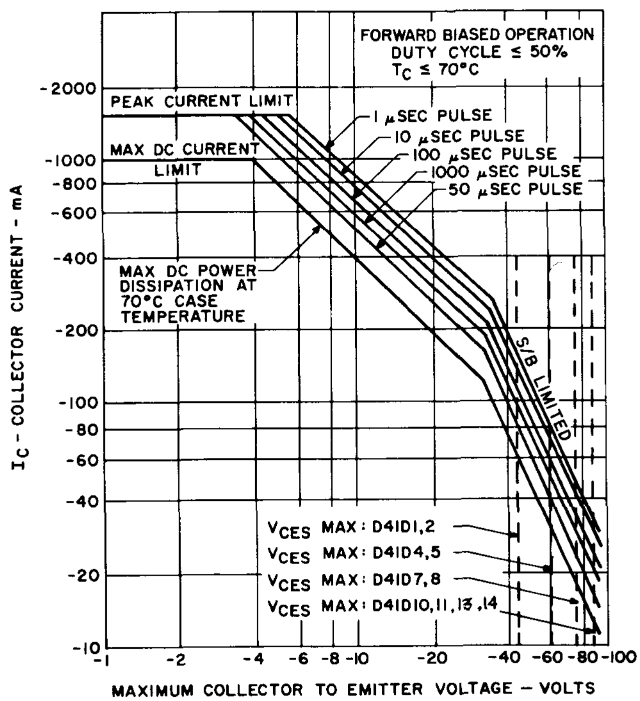
FIGURE 2

MAXIMUM PERMISSIBLE DC POWER DISSIPATION

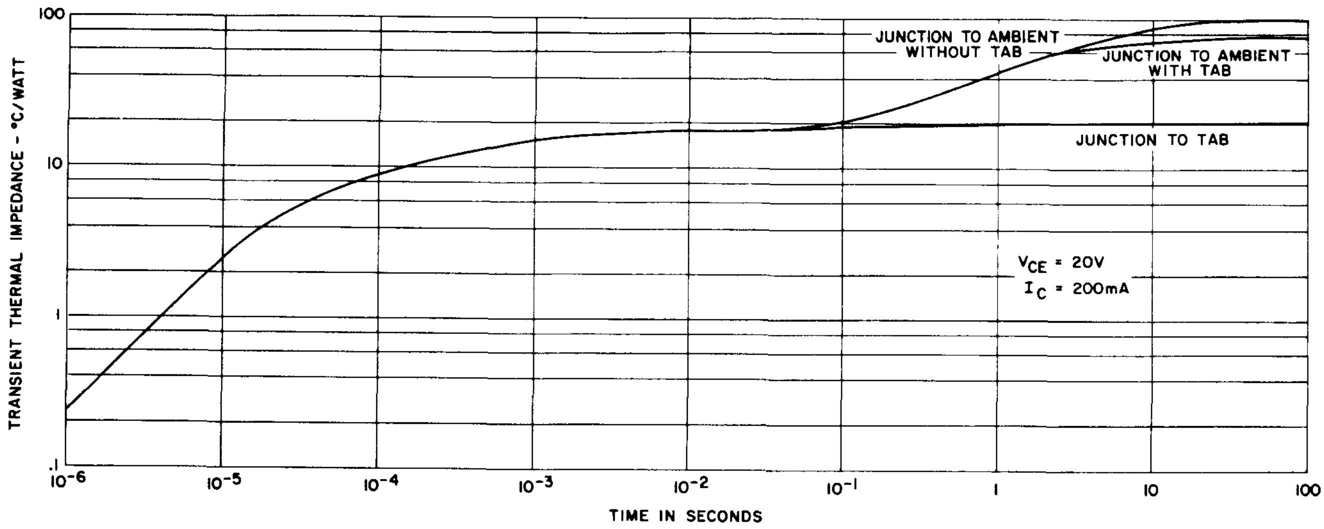


SAFE REGION OF OPERATION

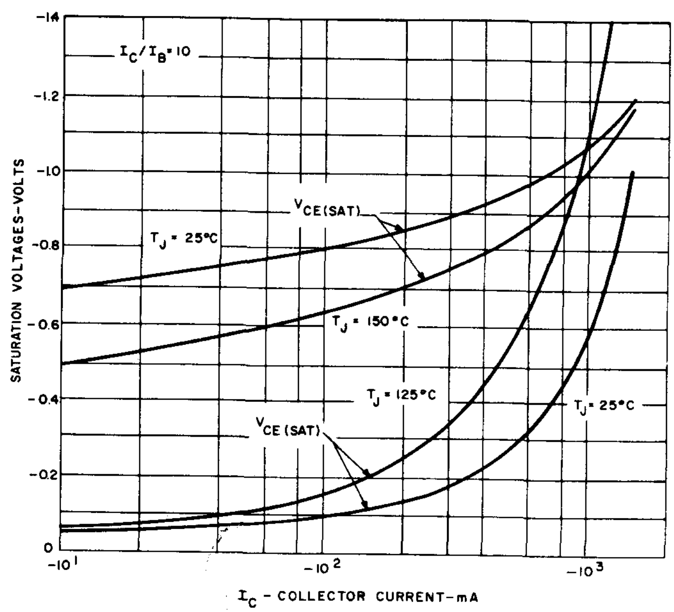


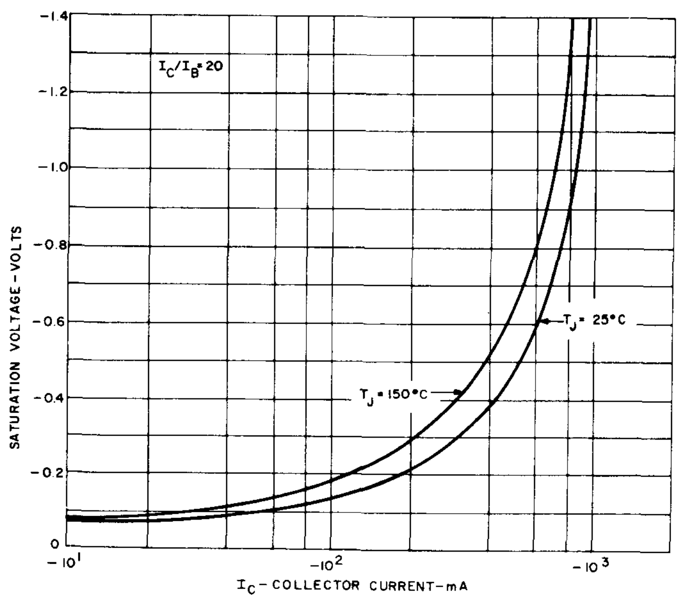


MAXIMUM TRANSIENT THERMAL IMPEDANCE

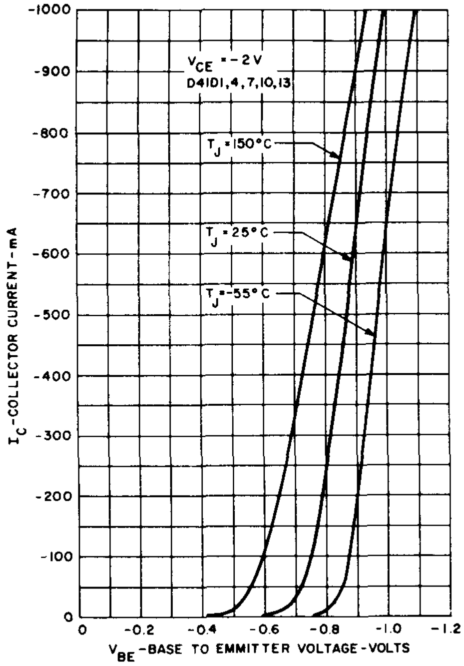


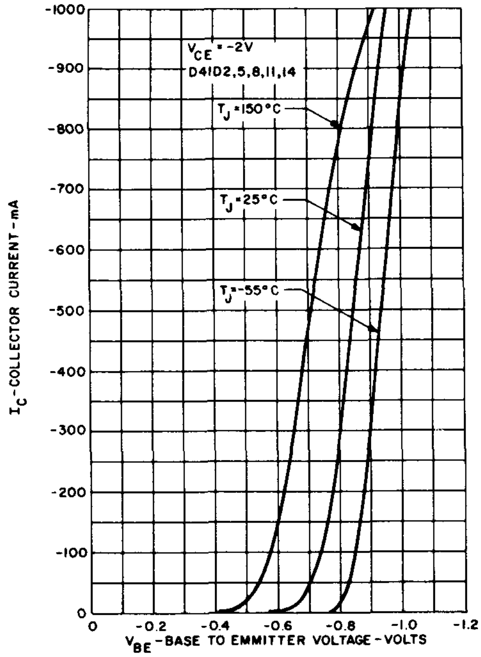
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



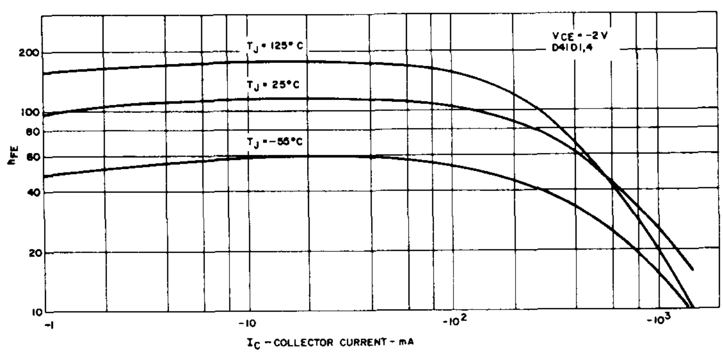


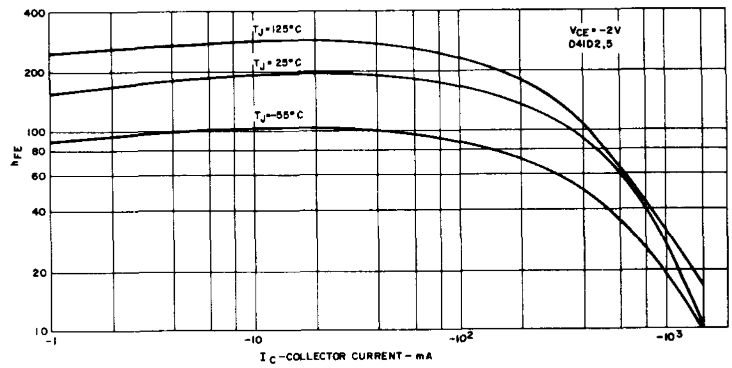
TYPICAL TRANSCONDUCTANCE CHARACTERISTICS

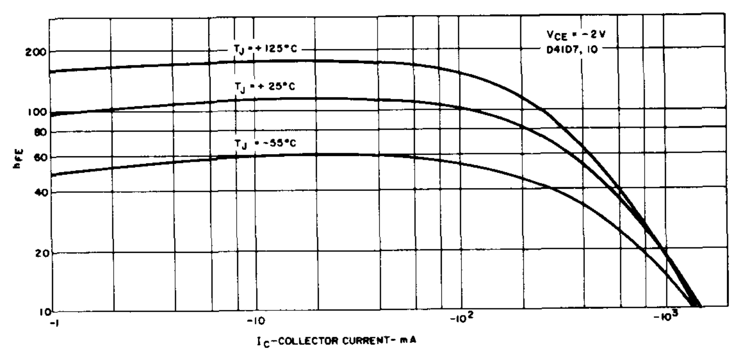


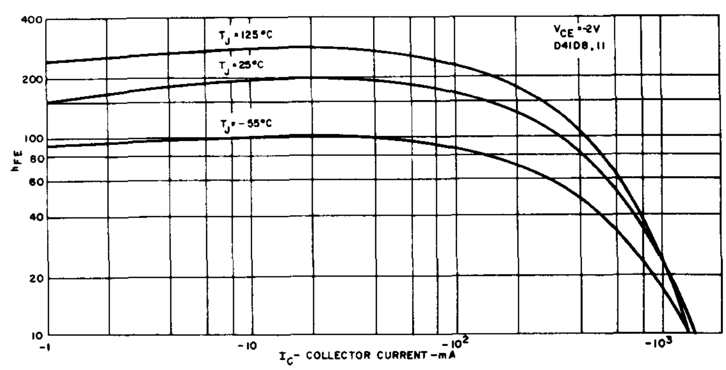


TYPICAL h_{FE} VS. I_C

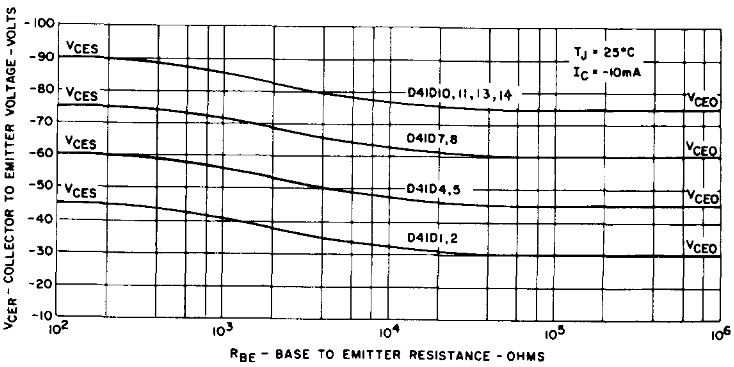




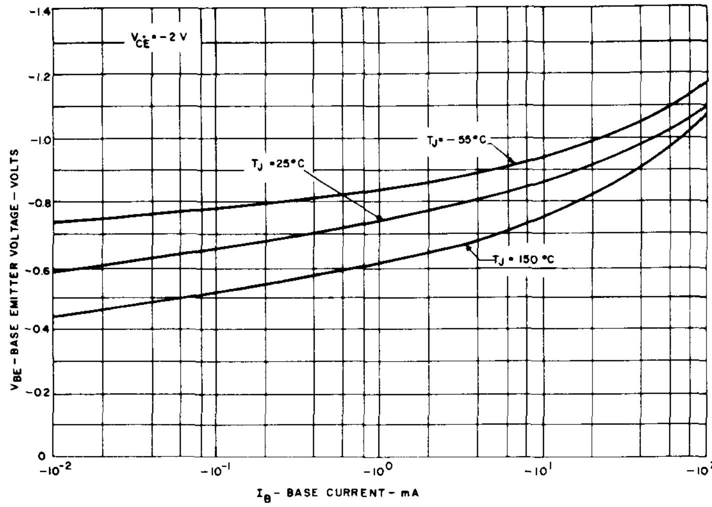




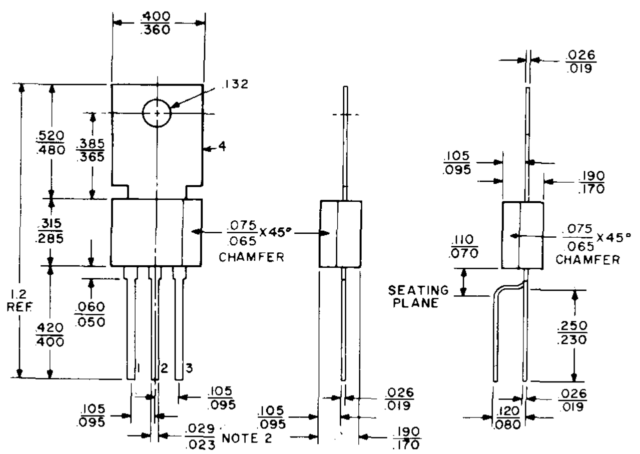
TYPICAL V_{CER}



TYPICAL INPUT CHARACTERISTICS



DIMENSIONAL OUTLINES

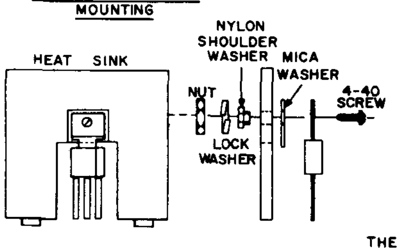


NOTES:

1. ALL DIM. ARE IN INCHES AND ARE REF. UNLESS TOLERANCED.
2. .043-.057 LEAD WIDTH WITHIN 0.100 OF BODY.

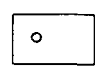
TYPE U
LEAD LABELS
1. EMITTER
2. BASE
3. COLLECTOR

TYPICAL INSULATING MOUNTING



NOTE: THE THERMAL RESISTANCE TAB TO HEAT SINK WITH THE MICA WASHER IS APPROXIMATELY 7.5°C/W WITHOUT ANY THERMAL CONDUCTING COMPOUND AND ABOUT 3.75°C/W WITH A THERMAL CONDUCTING GREASE.

INSULATING KIT



MICA WASHER (.003 THICK)

NYLON SHOULDER WASHER

THE ABOVE PARTS WILL BE AVAILABLE UPON REQUEST AS A SEPARATE KIT AT AN ADDITIONAL COST. KIT #138B8189P11

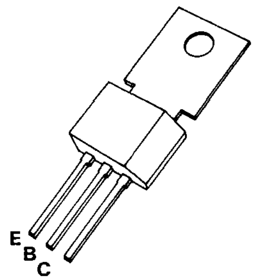
Silicon Power Tab Transistors

"COLOR MOLDED"

PNP

D41E

The General Electric D41E is a black, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 mHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



Black Silicone
Leads Can be Formed
To A TO-5 Pin Configuration

FEATURING:

- High free-air power dissipation
- PNP complement to D40E NPN
- Black for PNP, brown for NPN
- Low collector saturation voltage (—0.5V typ. @—1.0AI_C)
- Excellent linearity
- Fast switching
- Hard solder mount down

absolute maximum ratings: (25°C) (unless otherwise specified)

		D41E1[(1)]	D41E5	D41E7	
Voltage					
Collector to Emitter	V_{CEO}	—30	—60	—80	Volts
Emitter to Base	V_{EBO}	— 5	— 5	— 5	Volts
Collector to Emitter	V_{CES}	—40	—70	—90	Volts
Current[(2)]					
Collector (Continuous)	I_C	←	— 2	→	Amps
Collector (Peak)		←	— 3	→	Amps
Base (Continuous)	I_B	←	—0.5	→	Amps
Power Dissipation[(2)(3)]					
Tab at 25°C	P_T	←	8	→	Watts
Tab at 70°C		←	5.12	→	Watts
Free Air at 50°C					
With Tab		←	1.33	→	Watts
Without Tab		←	1.0	→	Watts
Thermal Resistance					
Junction to Case (Tab)	$R_{\theta JC}$	←	15.6	→	°C/W
Junction to Ambient	$R_{\theta JA}$				
With Tab		←	75	→	°C/W
Without Tab		←	100	→	°C/W
Temperature					
Operating	T_J	←	—55 to +150	→	°C
Storage	T_{STG}	←	—55 to +150	→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 sec max	T_L	←	+260	→	°C

NOTES:
(1)The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.
(2)Please refer to the safe region of operation curves for more information.
(3)Tab temperature is measured on center of tab, 1/16" from plastic body.

electrical characteristics: (25°C) (unless otherwise specified)

Forward Current Transfer Ratio	Symbol	D41E1 Min.	D41E1 Max.	D41E5 Min.	D41E5 Max.	D41E7 Min.	D41E7 Max.
(V_{CE} = —2 V, I_C = —100mA)	h_{FE}	50	—	50	—	50	—
(V_{CE} = —2 V, I_C = 1A)	h_{FE}	10	—	10	—	10	—

		Min.	Typ.	Max.	Units
Collector to Emitter Voltage					
(I_C = —10mA) D41E1	V_{CEO}	30	—	—	Volts
D41E5	V_{CEO}	60	—	—	Volts
D41E7	V_{CEO}	80	—	—	Volts
Collector Saturation Voltage (1)					
(I_C = —1.0A, I_B = —0.1A)					
D41E1, 5, 7	$V_{CE(SAT)}$	—	—	1.0	Volts
Base Saturation Voltage					
(I_C = -1.0A, I_B = —0.1A) D41E1, 5, 7	$V_{BE(SAT)}$	—	—	1.3	Volts
Collector Cutoff Current					
(V_{CE}=Rated V_{CES})	I_{CES}	—	—	—0.1	μA
Emitter Cutoff Current					
(V_{EB} = —5 V)	I_{EBO}	—	—	—0.1	μA
Collector Capacitance					
(V_{CB} = —10V, f = 1 MHz)	C_{CBO}	—	13	—	pF
Gain Bandwidth Product					
(V_{CE} = —10V, I_C = —20 mA)	f_T	—	175	—	MHz
Switching Times					
Delay Time and Rise Time					
(I_C = —1 A, I_{B1} = —0.1A)	$t_d + t_r$	—	180	—	nsec
Storage Time					
(I_C = —1A, I_{B1} = I_{B2} = —0.1A)	t_s	—	250	—	nsec
Fall Time					
(I_C = —1 A, I_{B1} = I_{B2} = —0.1A)	t_f	—	110	—	nsec

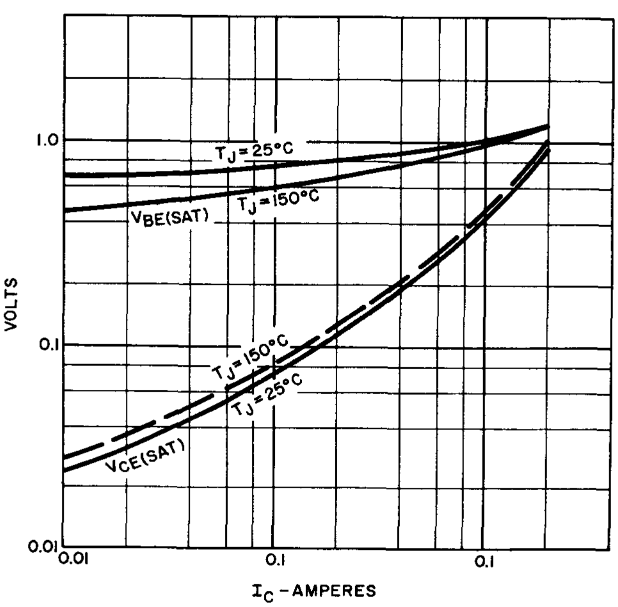


Figure 1

TYPICAL SATURATION VOLTAGE CHARACTERISTICS

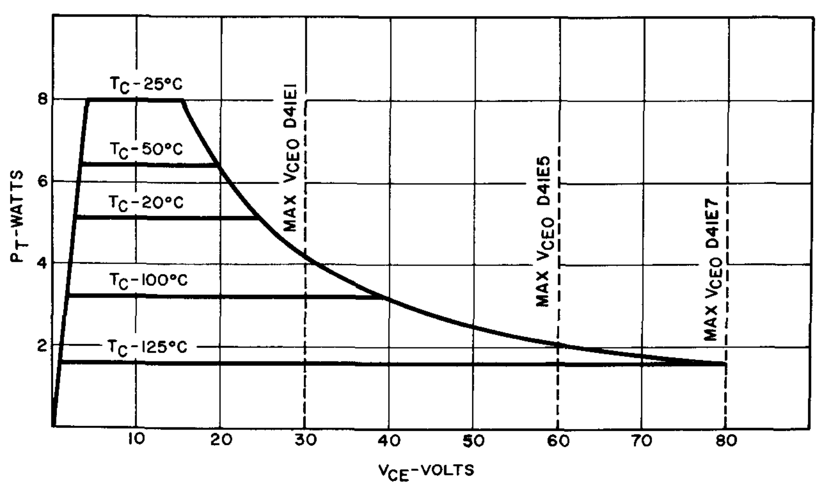


Figure 2

MAXIMUM PERMISSIBLE DC POWER DISSIPATION

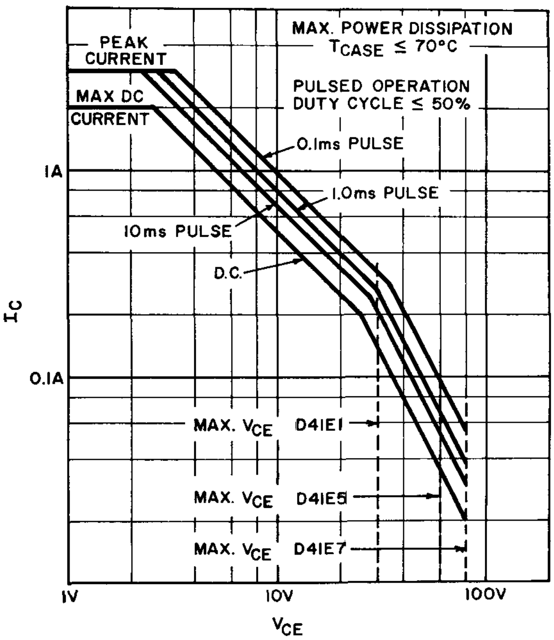


Figure 3

SAFE REGION OF OPERATION

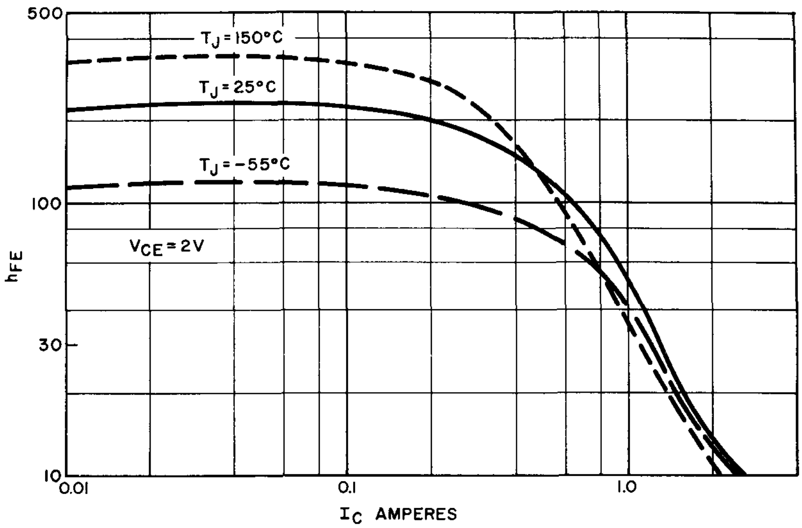


Figure 4

TYPICAL H_{FE} VS I_C

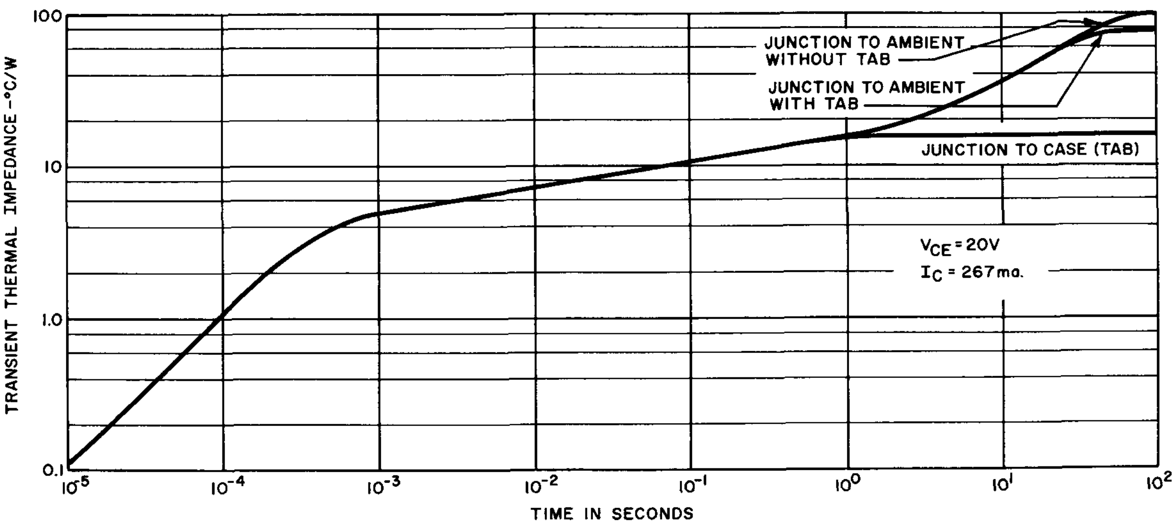


Figure 5

MAXIMUM TRANSIENT THERMAL IMPEDANCE

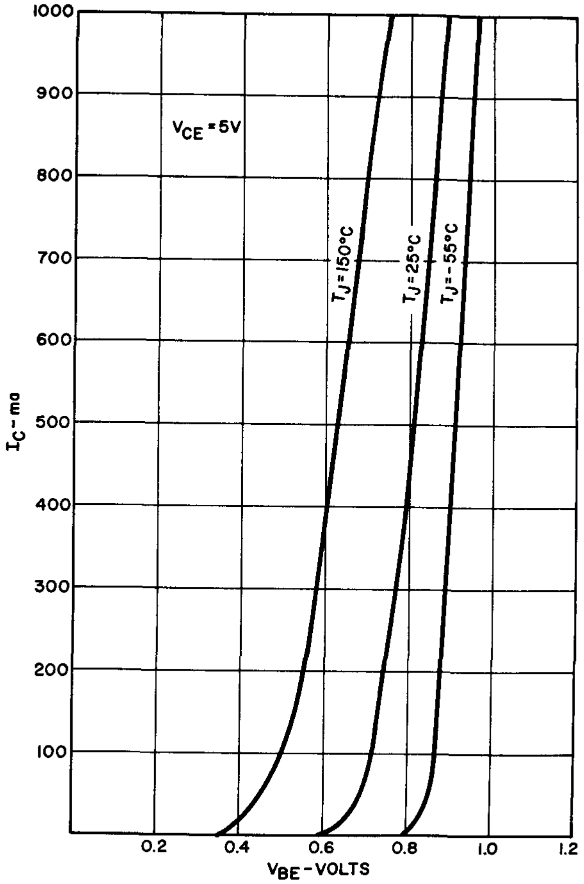
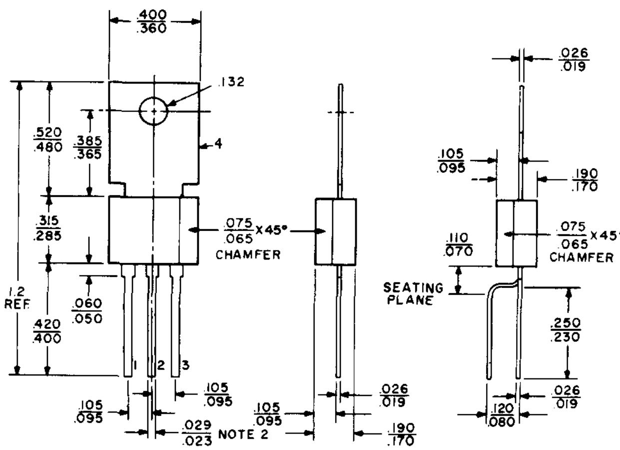


Figure 6

TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



TYPE U
LEAD LABELS
1. EMITTER
2. BASE
3. COLLECTOR
4. MOUNTING TAB (electrically common to collector)

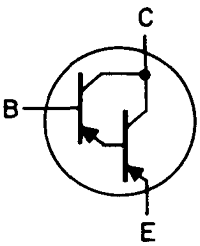
NOTES:
1. ALL DIM. ARE IN INCHES AND ARE REF. UNLESS TOLERANCED.
2. .043-.057 LEAD WIDTH WITHIN 0.100 OF BODY.

TYPE U
FITS TO-5 PRINTED CIRCUIT BOARD MOUNTING CONFIGURATION

Silicon Power Tab
Monolithic Transistor
Very High Gain Darlington Amplifier

"Color Molded"

PNP D41K



Equiv. Circuit

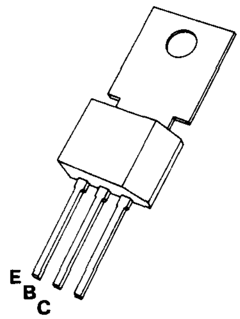
PNP Complement To D40K

h_{FE} Min. – 10,000

1.67 Watt Free-Air Power Dissipation

TYPICAL APPLICATIONS:

Driver	Audio Output
Regulator	Relay Substitute
Touch Switch	Oscillator
I.C. Driver	Servo-Amplifier
Capacitor Multiplier	



Leads Can Be Formed To A TO-5 Pin Configuration

absolute maximum ratings: (25°C) (unless otherwise specified)

	Symbol	D41K1,3		D41K2,4	Units
Voltages					
Collector to Emitter	V_{CEO}	–30		–50	Volts
Emitter to Base	V_{EBO}	–13		–13	Volts
Collector to Emitter	V_{CES}	–30		–50	Volts
Current					
Collector (Continuous)	I_C	←	2	→	Amps
Collector (Peak) (50% duty cycle, 25 msec. pulse width)		←	3	→	Amps
Power Dissipation					
Tab at 25°C[2]	P_T	←	10	→	Watts
Tab at 70°C		←	6	→	Watts
Free Air at 25°C					
With Tab		←	1.67	→	Watts
Without Tab		←	1.25	→	Watts
Free Air at 50°C					
With Tab		←	1.33	→	Watts
Without Tab		←	1	→	Watts
Thermal Resistance[2]					
Junction to Case	$R_{\theta JC}$	←	12.5	→	°C/W
Junction to Ambient	$R_{\theta JA}$				
With Tab		←	75	→	°C/W
Without Tab		←	100	→	°C/W
Temperature[2]					
Operating	T_J	←	–55 to +150	→	°C
Storage	T_{STG}	←	–55 to +150	→	°C
Lead Soldering, $^1/_{16}$" ± $^1/_{32}$" from case for 10 sec max	T_L	←	+260	→	°C

NOTES:

(1) The last digit is a part number which designates a voltage grade. Tab and lead forming is specified by a letter after this digit.

(2) Tab temperature is measured on center of tab, $^1/_{16}$" from plastic body.

electrical characteristics: (25°C) (unless otherwise specified)

		D41K1 D41K2	D41K3 D41K4		
Forward Current Transfer Ratio[3]		Min.	Typ.		
(I_C = −200 mA, V_{CE} = −5V)	h_{FE}	10K	–		
(I_C = −1.5A, V_{CE} = −5V) D41K1,2		1K			
(I_C = −1.0A, V_{CE} = −5V) D41K3,4		1K			
		Min.	Typ.	Max.	
Collector to Emitter Voltage					
(I_C = −10mA) D41K1,3	V_{CEO}	−30	–	–	Volts
D41K2,4		−50	–	–	Volts
Collector Saturation Voltage[3]					
(I_C = −1.5A, I_B = −3mA) D41K1,2	$V_{CE(SAT)}$	–	–	1.5	Volts
(I_C = −1.0A, I_B = −2mA) D41K3,4		–	–	1.5	Volts
Base Saturation Voltage[3]					
(I_C = −1.5A, I_B = −3mA) D41K1, 2	$V_{BE(SAT)}$	–	–	2.5	Volts
(I_C = −1.0A, I_B = −2mA) D41K3, 4		–	–	2.5	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CES}, T_J = 25°C)	I_{CES}	–	–	0.5	μA
(V_{CE} = Rated V_{CES}, T_J = 150°C)	I_{CBO}	–	–	20	μA
Emitter Cutoff Current					
(V_{EB} = −13V)	I_{EBO}	–	–	0.1	μA
Collector Capacitance					
(V_{CB} = −10V, f = 1 MHz)	C_{CBO}	–	9	15	pF
Gain Bandwidth Product					
(V_{CE} = −5V, I_C = −20 mA)	f_T	–	100	–	MHz

NOTE:
[3] Pulsed measurement, 2 msec pulse width, duty cycle ≦ 2%.

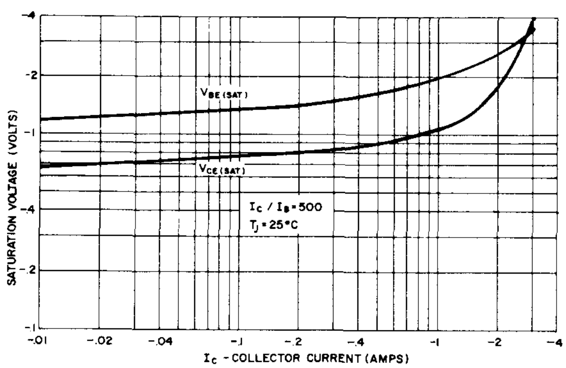


Figure 1
TYPICAL SATURATION VOLTAGE

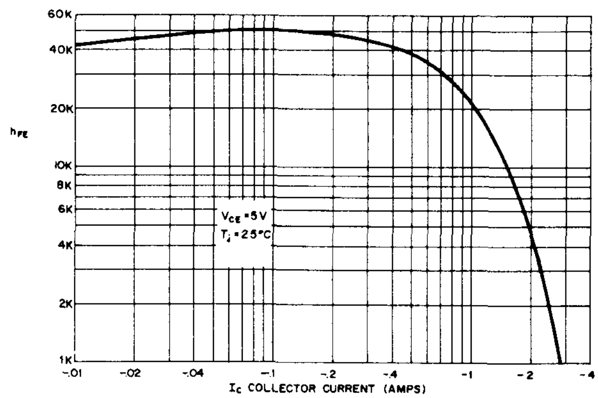


Figure 2
TYPICAL h_{FE} vs. I_C

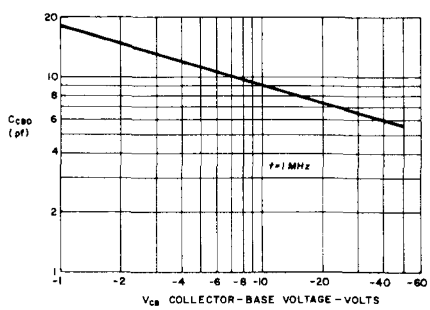


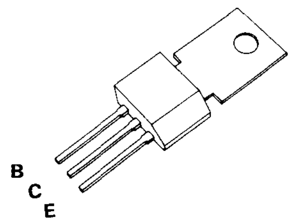
Figure 3
TYPICAL C_{CBO} vs. VOLTAGE

Silicon Power Tab Transistors

"Color Molded"

NPN D42C

The General Electric D42C is a red, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



Leads Can Be Formed To Fit TO-66 Outline

FEATURING:

- High free-air power dissipation
- NPN complement to D43C PNP
- Red for NPN, green for PNP
- Very low collector saturation voltage (0.5V typ. @ 3.0A I_C)
- Excellent linearity
- Fast switching
- Hard solder mountdown

absolute maximum ratings: (25°C) (unless otherwise specified)

		D42C1[1] D42C2 D42C3	D42C4 D42C5 D42C6	D42C7 D42C8 D42C9	D42C10 D42C11 D42C12	
Voltages						
Collector to Emitter	V_{CEO}	30	45	60	80	Volts
Emitter to Base	V_{EBO}	5	5	5	5	Volts
Collector to Emitter	V_{CES}	40	55	70	90	Volts
Current[2]						
Collector (Continuous)	I_C	←	3		→	Amps
Collector (Peak)		←	5		→	Amps
Power Dissipation[2]						
Tab at 25°C	P_T	←	12.5		→	Watts
Tab at 70°C		←	8.0		→	Watts
Free Air at 25°C		←	2.1		→	Watts
Free Air at 50°C		←	1.7		→	Watts
Thermal Resistance[3]						
Junction to Case	$R_{\theta JC}$	←	10		→	°C/W
Junction to Ambient	$R_{\theta JA}$					
With Tab		←	60		→	°C/W
Without Tab		←	80		→	°C/W
Temperature[3]						
Operating	T_J	←	−55 to +150		→	°C
Storage	T_{STG}	←	−55 to +150		→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	←	+260		→	°C

NOTES:

(1) The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.
(2) Please refer to the safe region of operation curves for more information.
(3) Tab temperature is measured on center of tab, 1/16" from plastic body.

electrical characteristics: (25°C) (unless otherwise specified)

		D42C3 D42C6 D42C9 D42C12 Min.	Max.	D42C2 D42C5 D42C8 D42C11 Min.	Max.	D42C1 D42C4 D42C7 D42C10 Min.
Forward Current Transfer Ratio						
($V_{CE} = 1V, I_C = 0.2A$)	h_{FE}	40	120	100	220	25
($V_{CE} = 1V, I_C = 2A$)	h_{FE}	20	—	20	—	—
($V_{CE} = 1V, I_C = 1A$)	h_{FE}	—	—	—	—	10

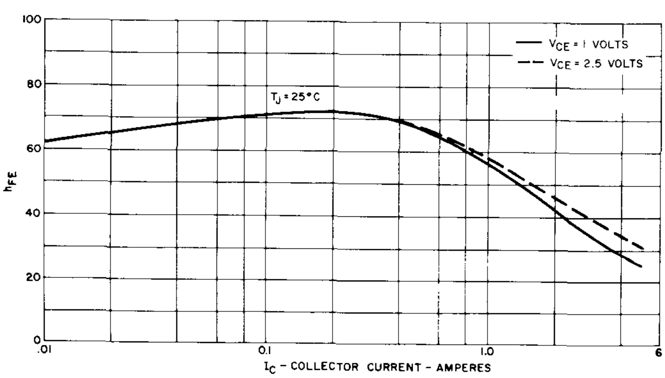
D42C

Electrical Characteristics (Continued)

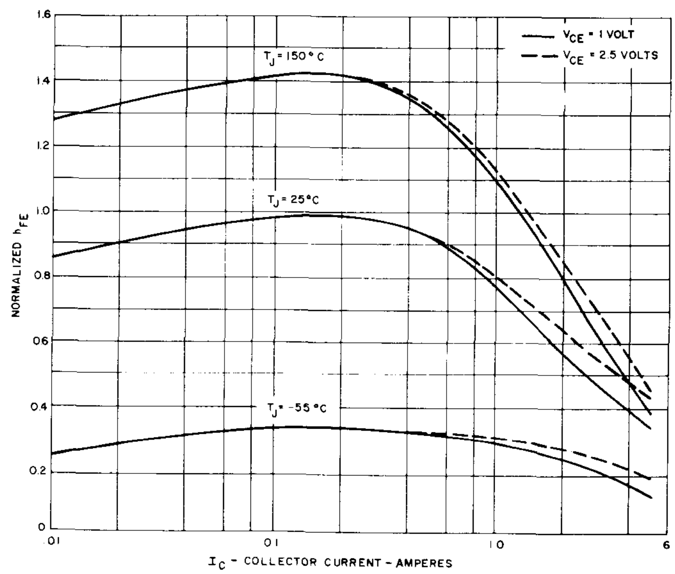
Characteristic	Symbol	Min.	Typ.	Max.	Unit
Collector to Emitter Sustaining Voltage[4]					
($I_C = 100$ mA) D42C1, 2, 3	$V_{CEO(SUS)}$	30		—	Volts
D42C4, 5, 6		45		—	Volts
D42C7,8,9		60		—	Volts
D42C10, 11, 12		80		—	Volts
Collector Saturation Voltage					
($I_C = 1$A, $I_B = 50$ mA) D42C2, 3, 5, 6, 8, 9, 11, 12	$V_{CE(SAT)}$	—		0.5	Volt
($I_C = 1$A, $I_B = 100$ mA) D42C1,4,7,10	$V_{CE(SAT)}$	—		0.5	Volt
Base Saturation Voltage					
($I_C = 1$A, $I_B = 100$ mA)	$V_{BE(SAT)}$	—		1.3	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CES}, $T_J = 25°C$)	I_{CES}	—		10	μA
Emitter Cutoff Current					
($V_{EB} = 5V$, $T_J = 25°C$)	I_{EBO}	—		100	μA
Collector Capacitance					
($V_{CB} = 10V$, f = 1 MHz)	C_{CBO}	—		100	pF
Gain Bandwidth Product					
($V_{CE} = 4V$, $I_C = 20$ mA)	f_t		50		MHz
Switching Times					
Rise Time and Delay Time ($I_C = 1$A, $I_{B1} = 0.1$A)	$t_d + t_r$		100		nsec
Storage Time ($I_C = 1$A, $I_{B1} = I_{B2} = 0.1$A)	t_s		500		nsec
Fall Time ($I_C = 1$A, $I_{B1} = I_{B2} = 0.1$A)	t_f		75		nsec

NOTE:

[4] Pulsed measurement, 300 μsec pulse width, duty cycle ≦2%.

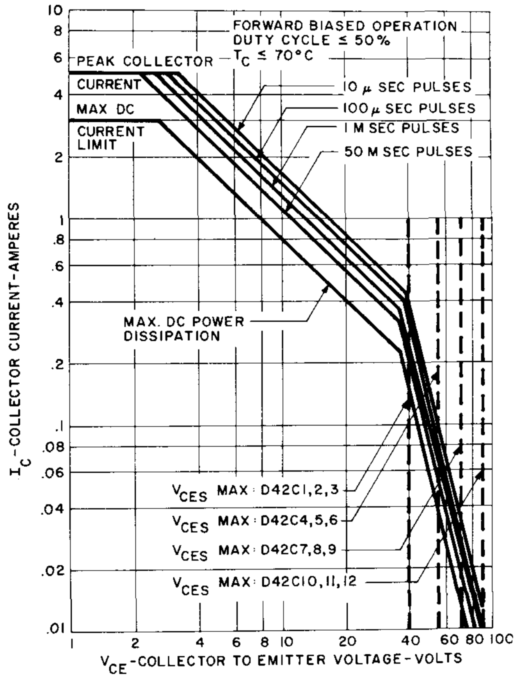


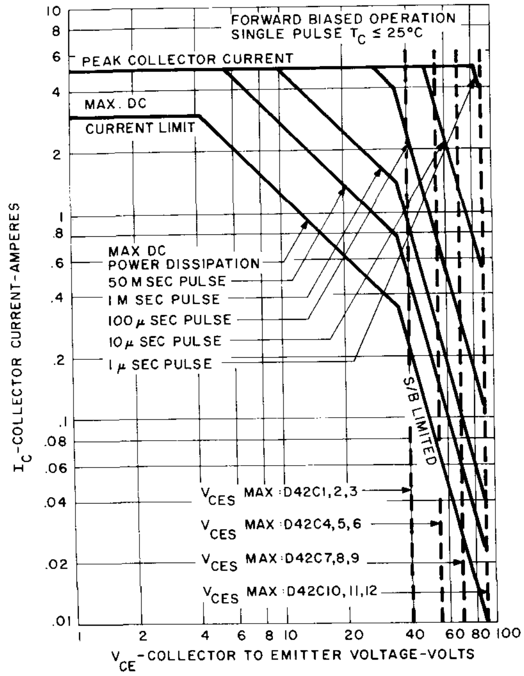
TYPICAL h_{FE} VS. I_C

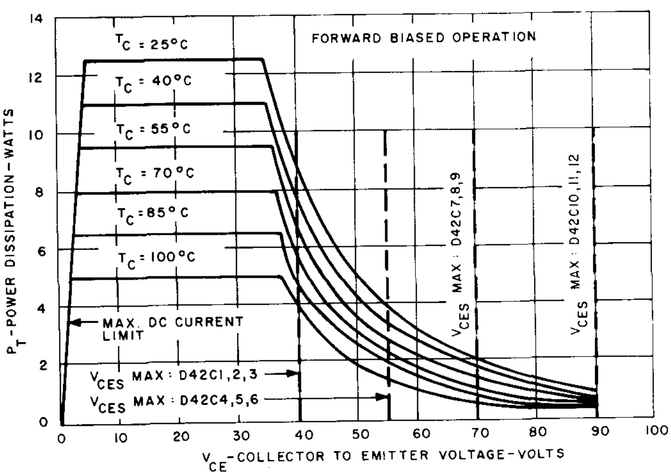


TYPICAL NORMALIZED h_{FE} VS. I_C

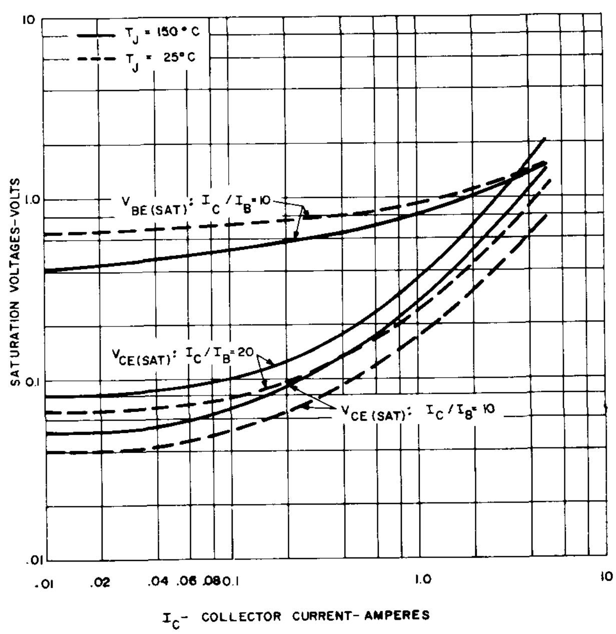
SAFE REGION OF OPERATION





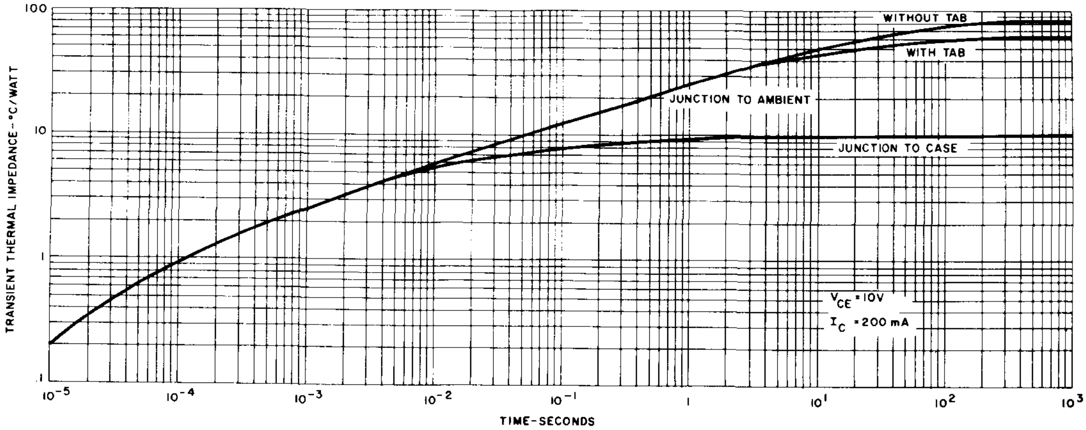


MAXIMUM PERMISSIBLE DC POWER DISSIPATION

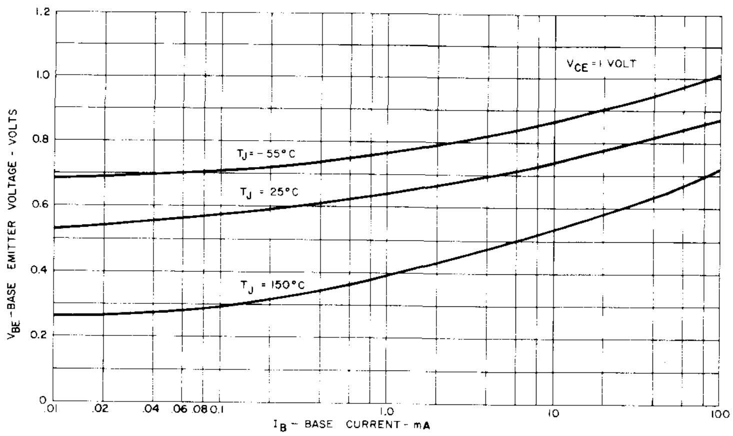


TYPICAL SATURATION VOLTAGE CHARACTERISTICS

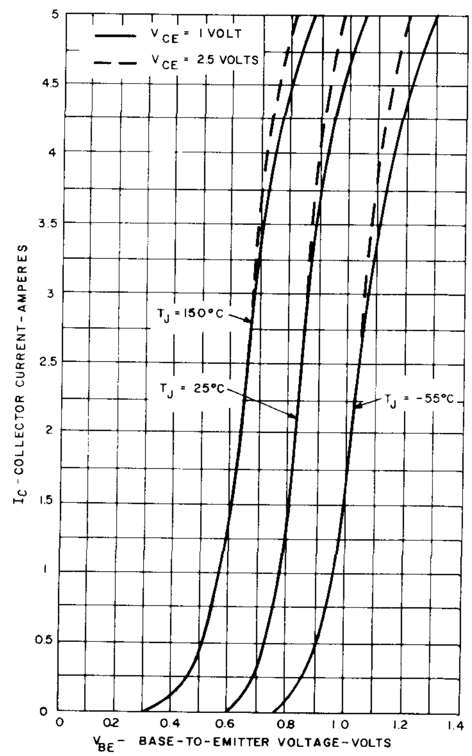
D42C



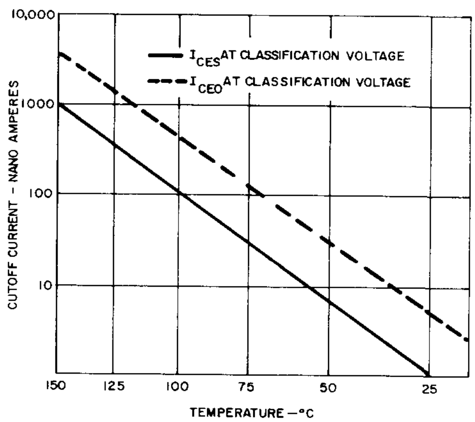
MAXIMUM TRANSIENT THERMAL IMPEDANCE



TYPICAL INPUT CHARACTERISTICS

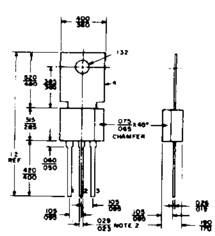


TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



TYPICAL I_{CEO}, I_{CES} VS. TEMPERATURE

DIMENSIONAL OUTLINES



Notes: (1) All dimensions are in inches and are reference unless toleranced.
(2) .043-.053 lead *width within* 0.100 of body.

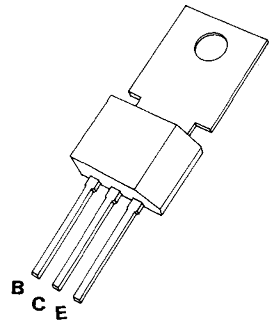
Lead Labels: (1) Base
(2) Collector (Common with tab)
(3) Emitter
(4) Mounting tab (Electrically common to collector)

Silicon Power Tab Transistors HIGH VOLTAGE

NPN

D42R

The General Electric D42R is a red, silicone encapsulated, power transistor designed for various specific and general purpose applications such as: 120 V.A.C. line operated amplifiers; series, shunt and switching regulators; low thru high frequency inverters, convertors; t-v and other display tube deflection; and many others.



RED
Leads Can be Formed To Fit TO-66 Outline

FEATURING:

- Red for NPN
- Very low collector saturation voltage
- Excellent Linearity
- Fast switching
- POWER-GLAS™ passivated mesa
- Hard solder mountdown

absolute maximum ratings: (25°C) (unless otherwise specified)

		D42R1, R3	D42R2, R4	Units
Voltages				
Collector to Emitter	V_{CEO}	250	300	Volts
Collector to Emitter	V_{CES}	400	500	Volts
Emitter to Base	V_{EBO}	← 5 →		Volts
Current				
Collector (Cont.)	I_C	← 1.0 →		Amp.
Power Dissipation				
Case @ 25°C	P_T	← 15 →		Watts
Case @ 70°C, V_{CE} = 175 V	P_T	← 9.6 →		Watts
Free Air @ 25°C	P_T	← 2.1 →		Watts
Thermal				
Operating Temperature	T_J	← 55 to + 150 →		°C
Storage	T_{STG}	← 55 to + 150 →		°C
Thermal Resistance				
Junction to Case	$R_{\theta JC}$	← 8.33 →		°C/W
Junction to Ambient	$R_{\theta JA}$			
With Tab		← 60 →		°C/W
Without Tab		← 80 →		°C/W

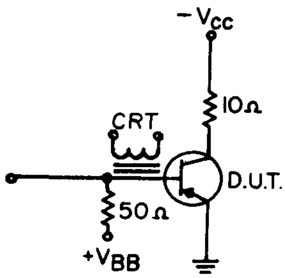
electrical characteristics: (25°C) (unless otherwise specified)

		Min.	Typ.	Max.	Units
Forward Current Transfer Ratio(1)					
@ I_C = 500 ma, V_{CE} = 10V	h_{FE}	30	75	—	—
@ I_C = 50 ma, V_{CE} = 10V	h_{FE}	20	65	—	—
Collector Cut-off Current					
V_{CES} = Max. Rating	I_{CES}	—	—	1.0	ma
Collector to Emitter Sustaining Voltage(2)					
@ I_C = 100 ma	$V_{CEO(SUS)}$				
D42R1, R3		250	—	—	Volts
D42R2, R4		300	—	—	Volts

ELECTRICAL CHARACTERISTIC (Continued)

		Min.	Typ.	Max.	Units
Collector to Emitter Saturation Voltage (1)					
@I_C = 500 mA, I_B = 50mA D42R1, R2	$V_{CE(SAT)}$	—	0.4	1.0	Volts
@I_C = 300mA, I_B = 30mA* D42R3, R4		—	0.4	1.0	Volts
Base to Emitter Saturation Voltage (1)					
@ I_C = 500 ma, I_B = 50 ma	$V_{BE(SAT)}$	—	0.85	1.2	Volts
Emitter Cutoff Current					
(V_{EB} =5V)	I_{EBO}	—	—	10	uA
Collector Capacitance					
(V_{CB} = 10V, f= 1 mHz)	C_{CBO}	—	30	—	pF
Gain Bandwidth Product					
(I_C = 50 mA, V_{CE} = 20V)	f_t	—	55	—	mHz
Switching Times (See Figures 1 and 2)					
(V_{CC} = 50V I_C = 500mA, I_{B1} = I_{B2} = 100mA)					
Rise Time and Delay Time	t_r	—	.2	.5	usec
Storage Time	t_s	—	2.5	4.5	usec
Fall Time	t_f	—	1.8	3.0	usec

NOTES:
1) Pulsed measurement, 300 usec. pulse, Duty cycle ≦2%.
2) See Sustaining Voltage Test Circuit.



RISE TIME= 1 NANOSECONDS MAX
FALL TIME= 1 NANOSECONDS MAX
I_{B1}=I_{B2}= 50mA
PULSE=10µ SEC
P.R.T. =10m SEC
CRT=TEKTRONIX CURRENT TRANSFORMER

FIGURE 1
SWITCHING CIRCUIT TO MEASURE SWITCHING TIMES

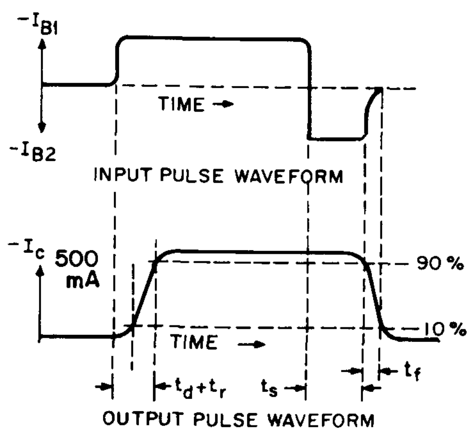


FIGURE 2
OSCILLOSCOPE DISPLAY OF INPUT AND OUTPUT PULSE WAVEFORM IS OF SWITCHING CIRCUIT SHOWN IN FIGURE 1

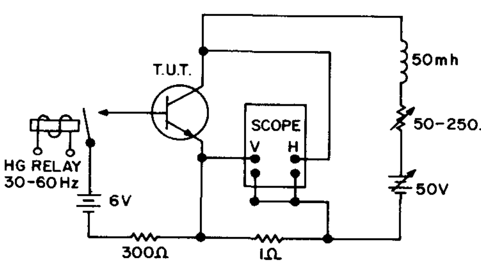


FIGURE 3
$V_{CEO(SUS)}$ TEST CIRCUIT

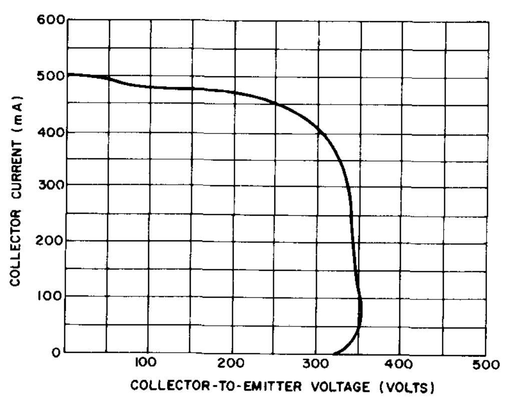
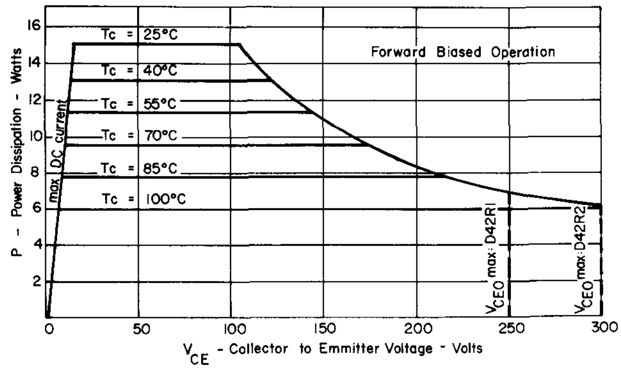
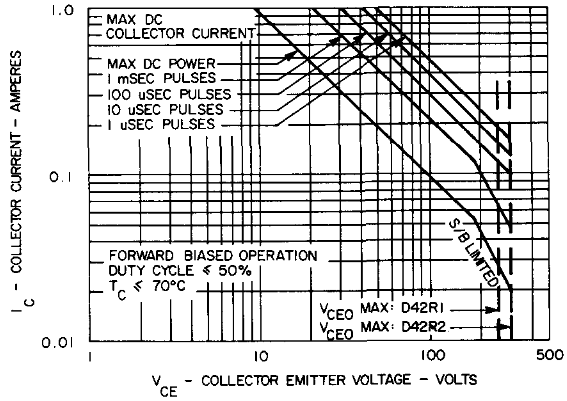


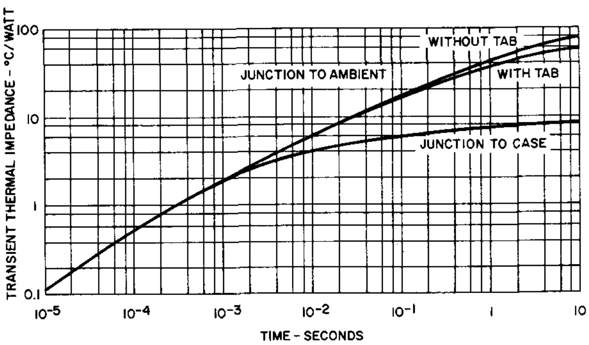
FIGURE 4
$V_{CEO(SUS)}$ OSCILLOSCOPE DISPLAY



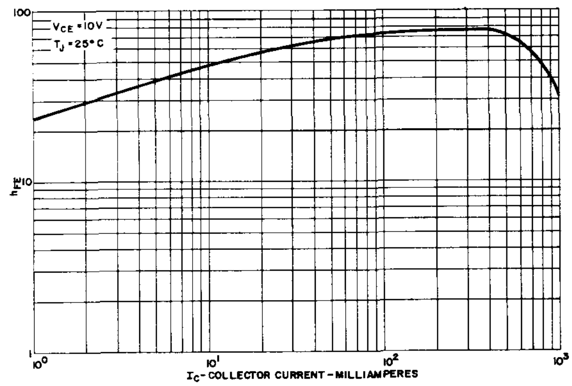
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



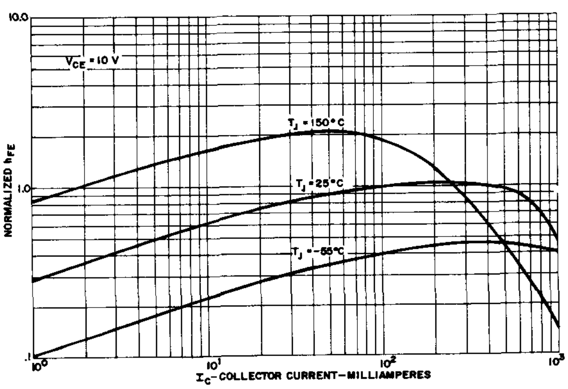
SAFE REGION OF OPERATION



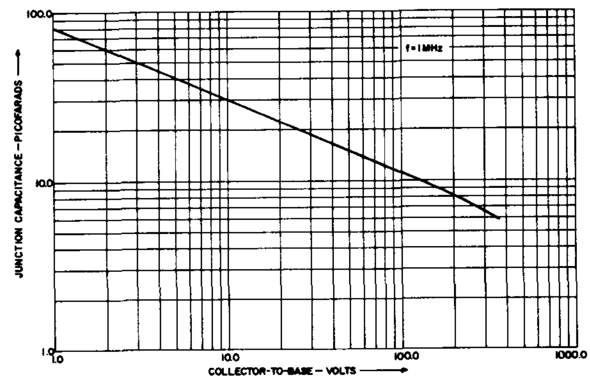
MAXIMUM TRANSIENT THERMAL IMPEDANCE



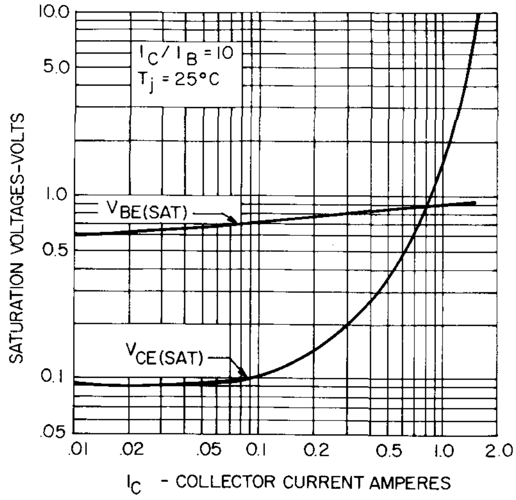
TYPICAL h_{FE} VS. I_C



NORMALIZED h_{FE} VS. I_C

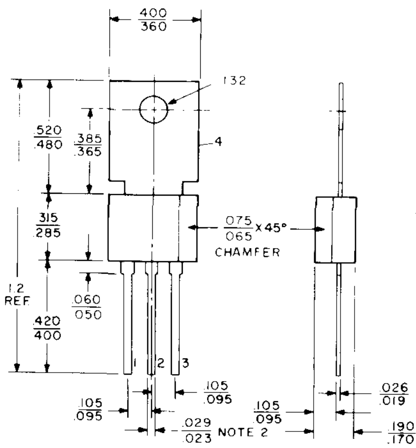


COLLECTOR-TO-BASE JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE



TYPICAL SATURATION VOLTAGE CHARACTERISTICS

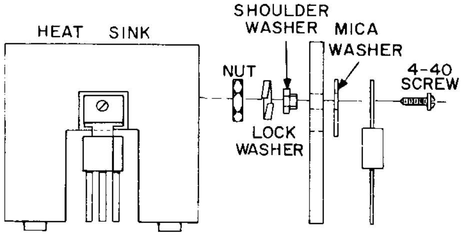
DIMENSIONAL OUTLINES



Notes: (1) All dimensions are in inches and are reference unless toleranced.
(2) .043-.053 lead width within 0.100 of body.

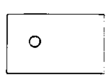
Lead Labels: (1) Base
(2) Collector (Common with tab)
(3) Emitter
(4) Mounting tab (Electrically common to collector)

TYPICAL INSULATING MOUNTING



NOTE: THE THERMAL RESISTANCE TAB TO HEAT SINK WITH THE MICA WASHER IS APPROXIMATELY 7.5°C/W WITHOUT ANY THERMAL CONDUCTING COMPOUND AND ABOUT 3.75°C/W WITH A THERMAL CONDUCTING GREASE.

INSULATING KIT



MICA WASHER (.003 THICK)

NYLON SHOULDER WASHER

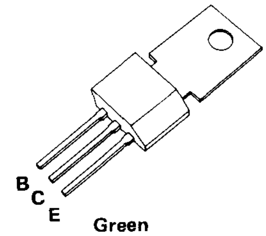
THE ABOVE PARTS WILL BE AVAILABLE UPON REQUEST AS A SEPARATE KIT AT AN ADDITIONAL COST. KIT #138B8189G11

Silicon Power Tab Transistors
"Color Molded"

PNP

D43C

The General Electric D43C is a green, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



Leads Can Be Formed To Fit TO-66 Outline

FEATURING:

- High free-air power dissipation
- PNP complement to D42C NPN
- Green for PNP, red for NPN
- Very low collector saturation voltage (—0.5V typ. @ —3.0A I_C)
- Excellent linearity
- Fast switching
- Hard solder mountdown

absolute maximum ratings: (25°C) (unless otherwise specified)

		D43C1[1] D43C2 D43C3	D43C4 D43C5 D43C6	D43C7 D43C8 D43C9	D43C10 D43C11 D43C12	
Voltages						
Collector to Emitter	V_{CEO}	—30	—45	—60	—80	Volts
Emitter to Base	V_{EBO}	— 5	— 5	— 5	— 5	Volts
Collector to Emitter	V_{CES}	—40	—55	—70	—90	Volts
Current[2]						
Collector (Continuous)	I_C	←	—3		→	Amps
Collector (Peak)		←	—5		→	Amps
Power Dissipation[2]						
Tab at 25°C	P_T	←	12.5		→	Watts
Tab at 70°C		←	8.0		→	Watts
Free Air at 25°C		←	2.1		→	Watts
Free Air at 50°C		←	1.7		→	Watts
Thermal Resistance[3]						
Junction to Case	$R_{\theta JC}$	←	10		→	°C/W
Junction to Ambient	$R_{\theta JA}$					
With Tab		←	60		→	°C/W
Without Tab		←	80		→	°C/W
Temperature[3]						
Operating	T_J	←	—55 to +150		→	°C
Storage	T_{STG}	←	—55 to +150		→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	←	+260		→	°C

NOTES:

(1) The last digit is a part number which designates a voltage grade and an h_{FE} level. Tab and lead forming is specified by a letter after this digit.

(2) Please refer to the safe region of operation curves for more information.

(3) Tab temperature is measured on center of tab, 1/16" from plastic body.

electrical characteristics: (25°C) (unless otherwise specified)

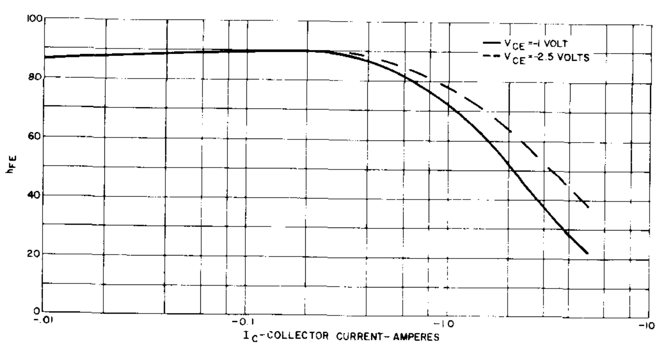
		D43C3 D43C6 D43C9 D43C12		D43C2 D43C5 D43C8 D43C11		D43C1 D43C4 D43C7 D43C10
		Min.	**Max.**	**Min.**	**Max.**	**Min.**
Forward Current Transfer Ratio						
(V_{CE} = —1V, I_C = —0.2A)	h_{FE}	40	120	40	120	25
(V_{CE} = —1V, I_C = —2A)	h_{FE}	20	—	—	—	—
(V_{CE} = —1V, I_C = —1A)	h_{FE}	—	—	20	—	10

Electrical Characteristics (Continued)

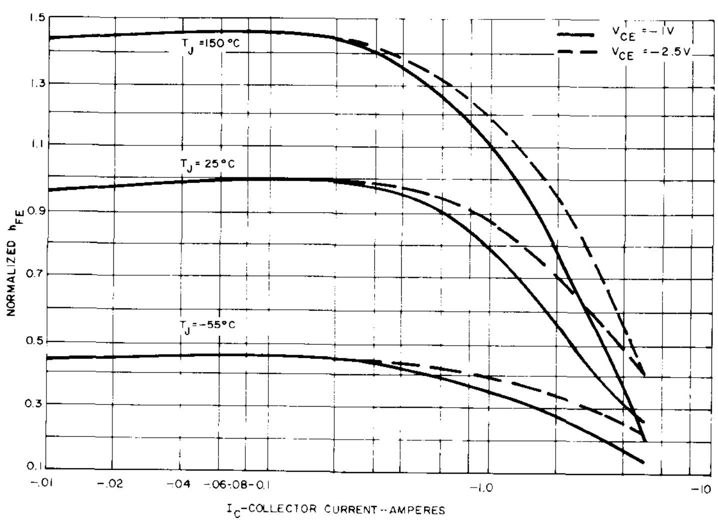
Characteristic	Symbol	Min.	Typ.	Max.	Unit
Collector to Emitter Sustaining Voltage[4]					
($I_C = -100$ mA) D43C1, 2, 3	$V_{CEO(SUS)}$	−30		—	Volts
D43C4, 5, 6		−45		—	Volts
D43C7, 8, 9		−60		—	Volts
D43C10, 11, 12		−80		—	Volts
Collector Saturation Voltage					
($I_C = -1$A, $I_B = -50$ mA) D43C2, 3, 5, 6, 8, 9, 11, 12	$V_{CE(SAT)}$	—		−0.5	Volt
($I_C = -1$A, $I_B = -100$ mA) D43C1, 4, 7, 10	$V_{CE(SAT)}$	—		−0.5	Volt
Base Saturation Voltage					
($I_C = -1$A, $I_B = -100$ mA)	$V_{BE(SAT)}$	—		−1.3	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CES}, $T_J = 25°C$)	I_{CES}	—		−10	μA
Emitter Cutoff Current					
($V_{EB} = -5V$, $T_J = 25°C$)	I_{EBO}	—		−100	μA
Collector Capacitance					
($V_{CB} = 10V$, f = 1 MHz)	C_{CBO}	—		125	pF
Gain Bandwidth Product					
($V_{CE} = -4V$, $I_C = -20$ mA)	f_t		40		MHz
Switching Times					
Rise Time and Delay Time ($I_C = -1$A, $I_{B1} = -0.1$A)	$t_d + t_r$		50		nsec
Storage Time ($I_C = -1$A, $I_{B1} = I_{B2} = -0.1$A)	t_s		500		nsec
Fall Time ($I_C = -1$A, $I_{B1} = I_{B2} = -0.1$A)	t_f		50		nsec

NOTE:

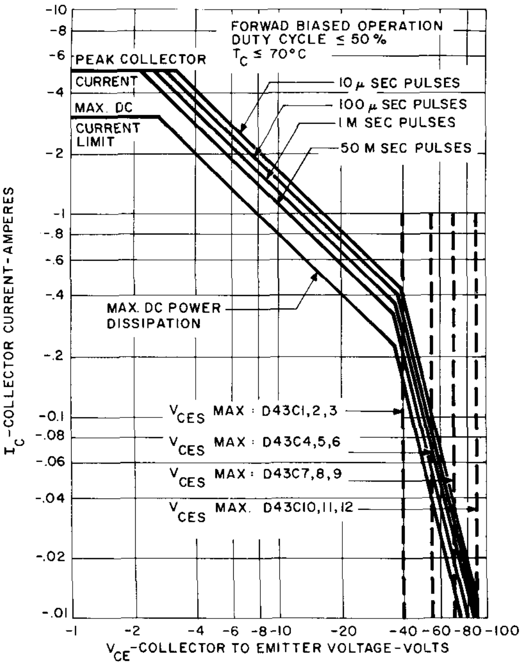
[4]Pulsed measurement, 300 μsec pulse width, duty cycle ≦2%.

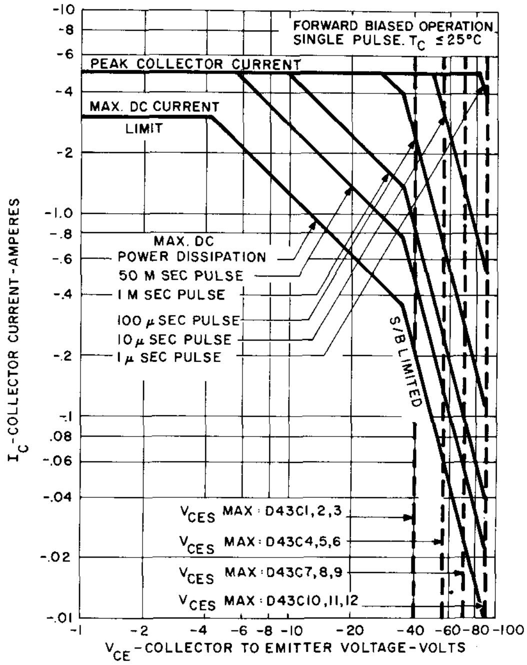


TYPICAL h_{FE} VS. I_C

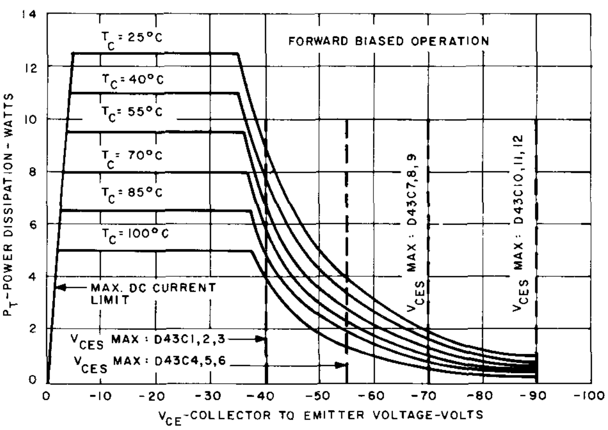


TYPICAL NORMALIZED h_{FE} VS. I_C

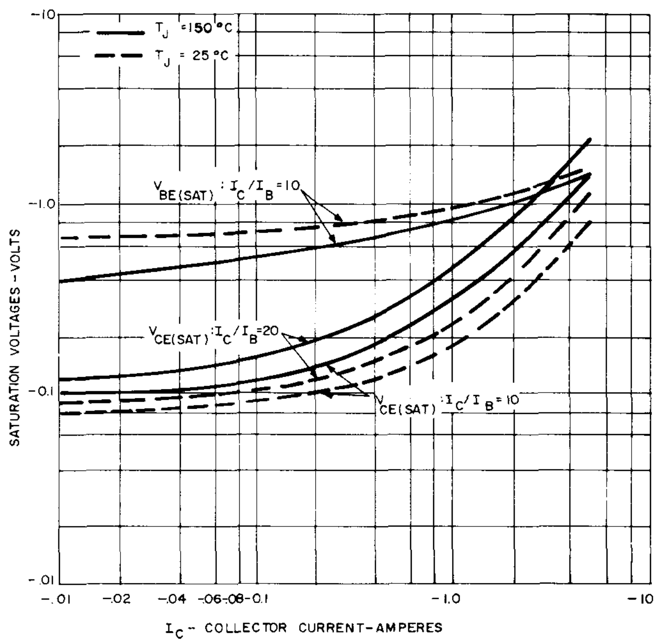




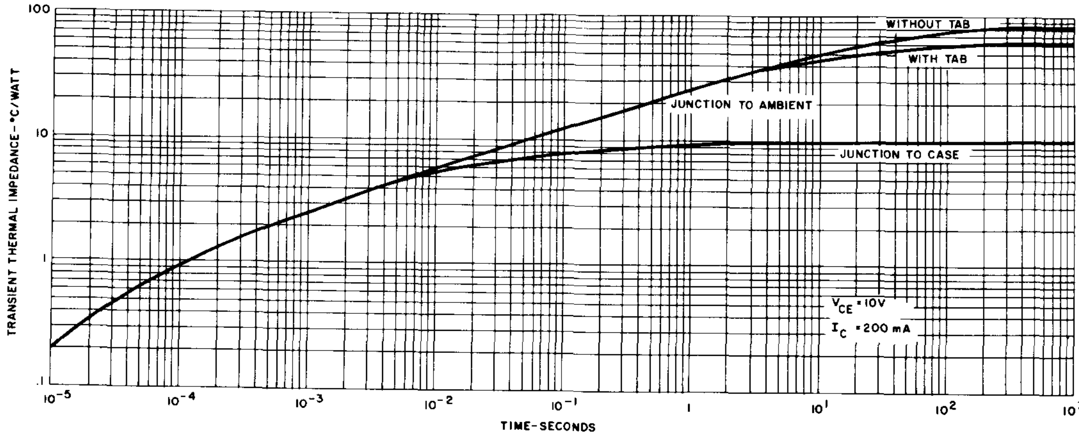
SAFE REGION OF OPERATION



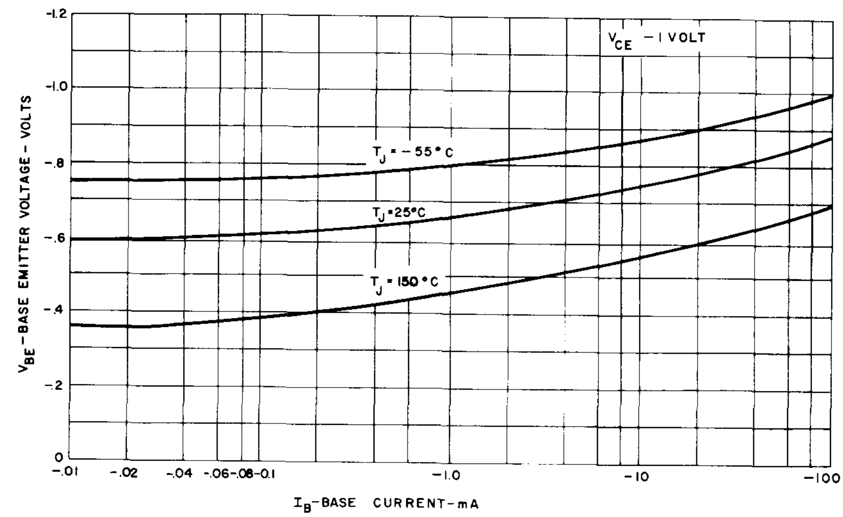
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



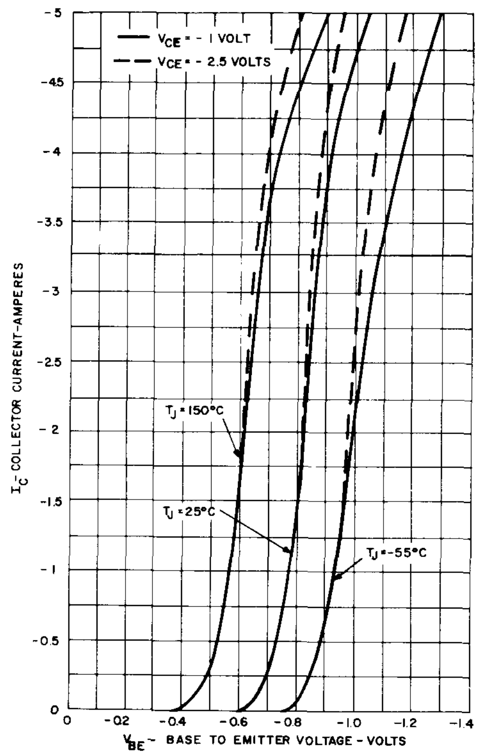
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



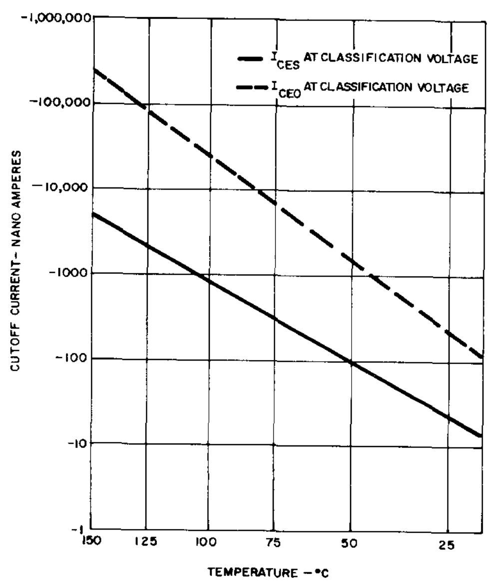
MAXIMUM TRANSIENT THERMAL IMPEDANCE



TYPICAL INPUT CHARACTERISTICS

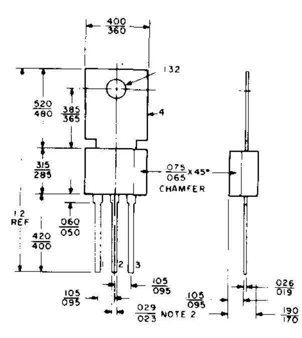


TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



TYPICAL I_{CEO}, I_{CES} VS. TEMPERATURE

DIMENSIONAL OUTLINES



Notes:
(1) All dimensions are in inches and are reference unless toleranced.
(2) .043-.053 lead width within 0.100 of body.

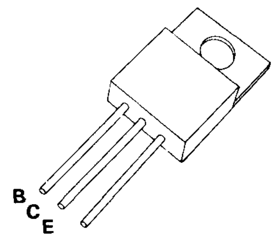
Lead Labels:
(1) Base
(2) Collector (Common with tab)
(3) Emitter
(4) Mounting tab (Electrically common to collector)

Silicon
Power Pac
Transistors
"Color Molded"

NPN

D44C

The General Electric D44C is a red, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



Red

JEDEC TO-220 A B

FEATURING:

- NPN complement to D45C PNP
- Red for NPN, green for PNP
- Very low collector saturation voltage (0.5V typ. @ 3.0A I_C)
- Excellent linearity
- Fast switching
- Round leads
- Hard solder mountdown

absolute maximum ratings: (25°C) (unless otherwise specified)

		D44C1 D44C2 D44C3	D44C4 D44C5 D44C6	D44C7 D44C8 D44C9	D44C10 D44C11 D44C12	
Voltages						
Collector to Emitter	V_{CEO}	30	45	60	80	Volts
Emitter to Base	V_{EBO}	5	5	5	5	Volts
Collector to Emitter	V_{CES}	40	55	70	90	Volts
Current(1)						
Collector (Continuous)	I_C	←	4		→	Amps
Collector (Peak)		←	6		→	Amps
Power Dissipation(1)						
Case at 25°C	P_T	←	30		→	Watts
Case at 70°C		←	19		→	Watts
Free Air at 25°C		←	1.67		→	Watts
Free Air at 50°C		←	1.33		→	Watts
Thermal Resistance(2)						
Junction to Case	$R_{\theta JC}$	←	4.2		→	°C/W
Junction to Ambient	$R_{\theta JA}$	←	75		→	°C/W
Temperature(2)						
Operating	T_J	←	−55 to +150		→	°C
Storage	T_{STG}	←	−55 to +150		→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	←	+260		→	°C

Notes:
(1) Refer to the Safe Region of Operation curve for further information.
(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

electrical characteristics: (25°C) (unless otherwise specified)

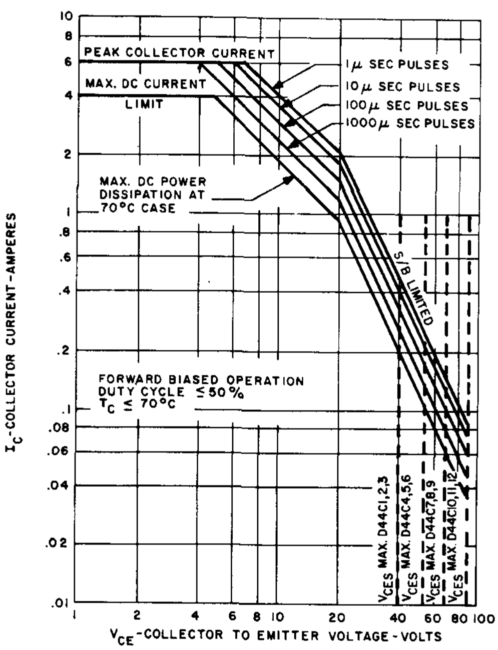
		D44C3 D44C6 D44C9 D44C12		D44C2 D44C5 D44C8 D44C11		D44C1 D44C4 D44C7 D44C10
		Min.	Max.	Min.	Max.	Min.
Forward Current Transfer Ratio						
(V_{CE} = 1V, I_C = 0.2A)	h_{FE}	40	120	100	220	25
(V_{CE} = 1V, I_C = 2A)	h_{FE}	20	—	20	—	—
(V_{CE} = 1V, I_C = 1A)	h_{FE}	—	—	—	—	10

Electrical Characteristics (Continued)

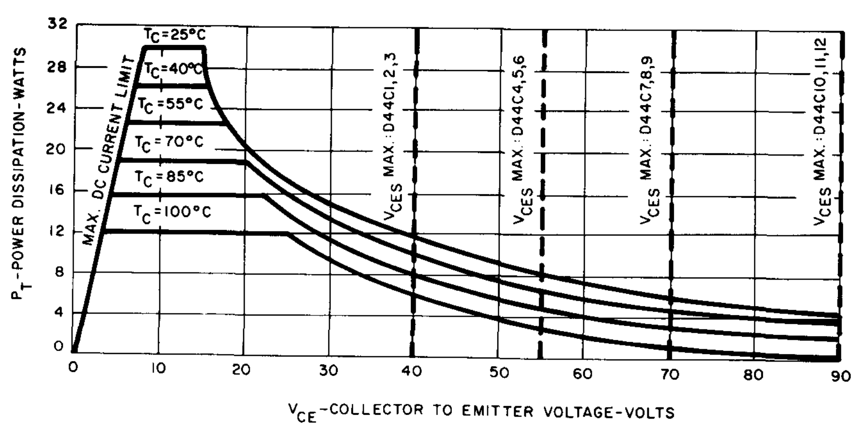
		Min.	Max.	
Collector to Emitter Sustaining Voltage(3)				
($I_C = 100$ mA) D44C1, 2, 3	$V_{CEO(SUS)}$	30	—	Volts
D44C4, 5, 6		45	—	Volts
D44C7, 8, 9		60	—	Volts
D44C10, 11, 12		80	—	Volts
Collector Saturation Voltage(3)				
($I_C = 1$A, $I_B = 50$ mA) D45C2, 3, 5, 6, 8, 9, 11, 12	$V_{CE(SAT)}$	—	0.5	Volt
($I_C = 1$A, $I_B = 100$ mA) D45C1, 4, 7, 10	$V_{CE(SAT)}$	—	0.5	Volt
Base Saturation Voltage(3)				
($I_C = 1$A, $I_B = 100$ mA)	$V_{BE(SAT)}$	—	1.3	Volts
Collector Cutoff Current				
(V_{CE} = Rated V_{CES}, $T_J = 25°C$)	I_{CES}	—	10	μA
Emitter Cutoff Current				
($V_{EB} = 5V$, $T_J = 25°C$)	I_{EBO}	—	100	μA
Collector Capacitance				
($V_{CB} = 10V$, f = 1 MHz)	C_{CBO}	—	100	pF

		Typ.	
Gain Bandwidth Product			
($V_{CE} = 4V$, $I_C = 20$ mA)	f_t	50	MHz
Switching Times			
Rise Time and Delay Time ($I_C = 1$A, $I_{B1} = 0.1$A)	$t_d + t_r$	100	nsec
Storage Time ($I_C = 1$A, $I_{B1} = I_{B2} = 0.1$A)	t_s	500	nsec
Fall Time ($I_C = 1$A, $I_{B1} = I_{B2} = 0.1$A)	t_f	75	nsec

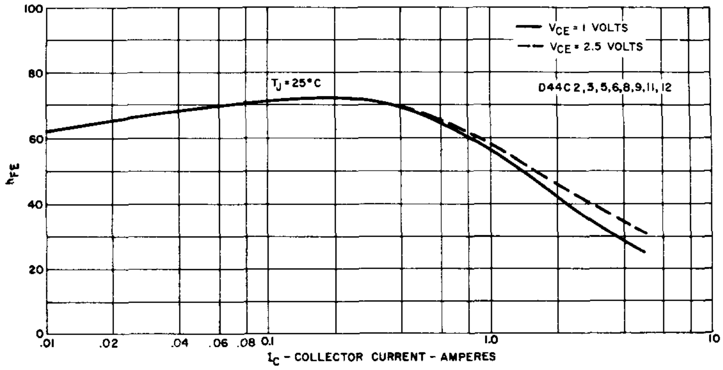
Note:
(3) Pulsed measurement, 300 μsec pulse, duty cycle ≤2%.



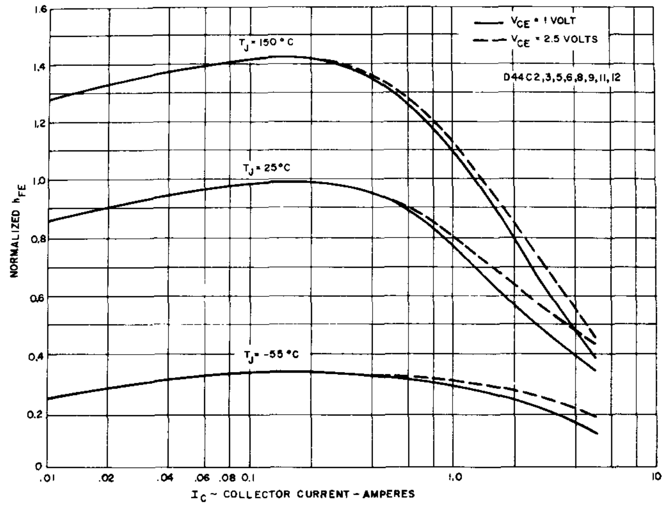
SAFE REGION OF OPERATION



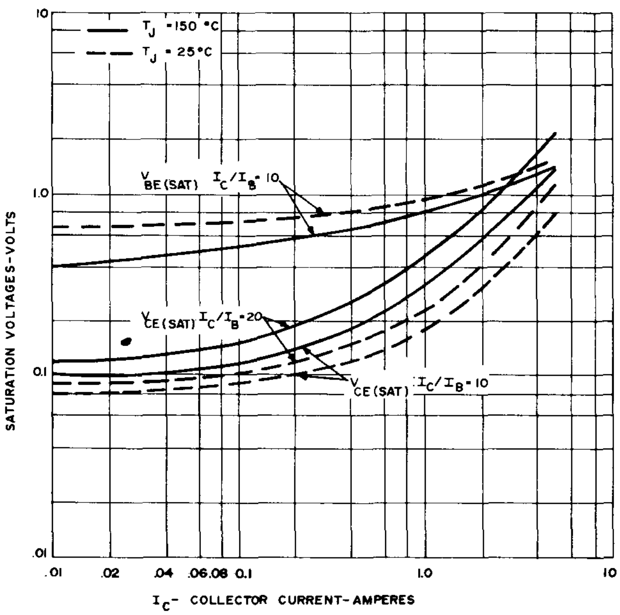
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



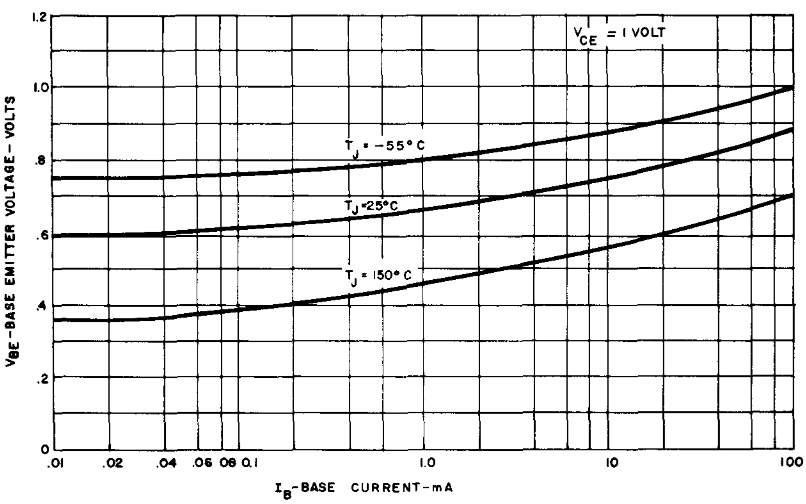
TYPICAL h_{FE} VS. I_C



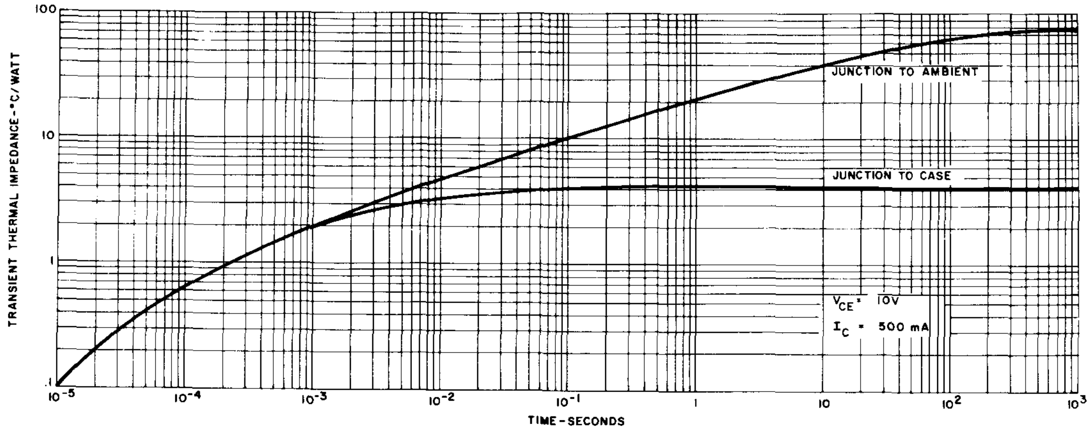
TYPICAL NORMALIZED h_{FE} VS. I_C



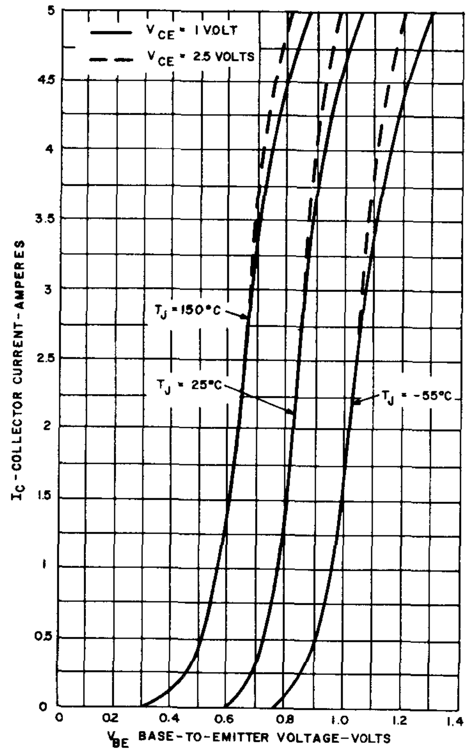
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



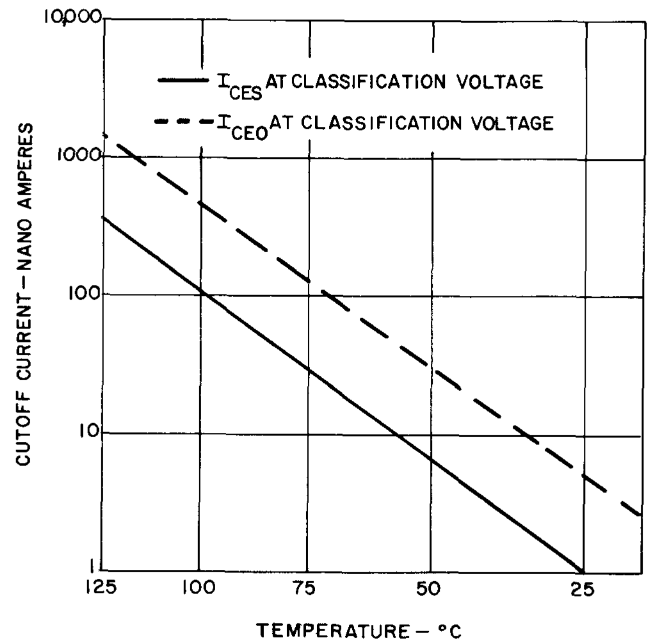
TYPICAL INPUT CHARACTERISTICS



MAXIMUM TRANSIENT THERMAL IMPEDANCE

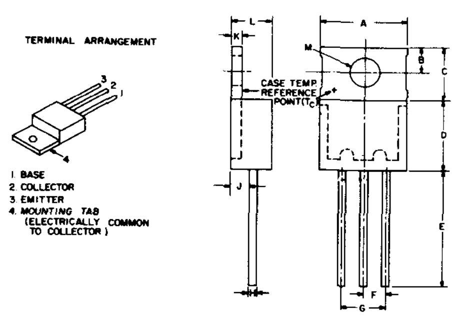


TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



TYPICAL I_{CEO}, I_{CES} VS. TEMPERATURE

DIMENSIONAL OUTLINES



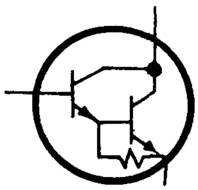
Sym.	Dec. In.		Metric MM	
	Min.	Max.	Min.	Max.
A	.390	.420	9.91	10.67
B	.110	.120	2.79	3.05
C	.240	.260	6.10	6.61
D	.325	.355	8.26	9.02
E	.500	——	12.7	——
F	.095	.105	2.41	2.67
G	.190	.210	4.82	5.34
H	.029	.035	.73	.89
J	.085	.115	2.16	2.92
K	.040	.060	1.02	1.52
L	.160	.190	4.06	4.83
M	.141	.145	3.58	3.68
N	——	.065	——	1.65

Silicon Power Pac

Monolithic Transistor
Very High Gain Darlington Amplifier
"Color Molded"

NPN

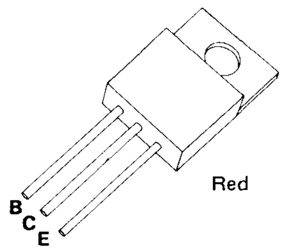
D44E



Equiv. Circuit

TYPICAL APPLICATIONS:

- Driver
- Regulator
- Capacitor Multiplier
- Solenoid Driver
- Inverter Power Supply
- Switch
- Audio Output
- Relay Substitute
- Oscillator
- Servo-Amplifier



JEDEC TO-220 AB

absolute maximum ratings: (25°C) (unless otherwise specified)

	Symbol	D44E1	D44E2	D44E3	Units
Voltages					
Collector to Emitter	V_{CEO}	40	60	80	Volts
Emitter to Base	V_{EBO}	7	7	7	Volts
Collector to Emitter	V_{CES}	40	60	80	Volts
Current(1)					
Collector (Continuous)	I_C	←	10	→	Amps
Collector (Peak) (50% duty cycle, 25 msec. pulse width)		←	20	→	Amps
Base (Continuous)	I_b	←	1	→	Amps
Power Dissipation(1)					
Case at 25°C	P_T	←	50	→	Watts
Free Air at 25°C		←	1.67	→	Watts
Thermal Resistance(2)					
Junction to Case	$R_{\theta JC}$	←	2.5	→	°C/W
Junction to Ambient	$R_{\theta JA}$	←	75	→	°C/W
Temperature(2)					
Operating	T_j	←	-55 to +150	→	°C
Storage	T_{STG}	←	-55 to +150	→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	←	+260	→	°C

NOTES:

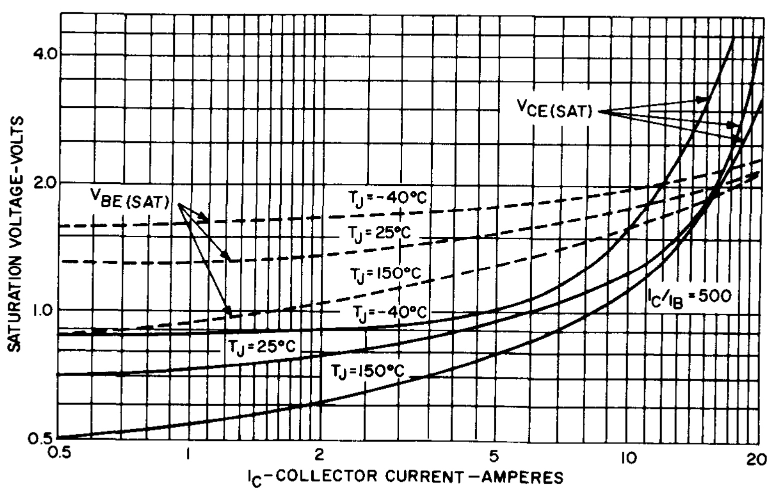
(1) Refer to the Safe Region of Operation curve for further information.

(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

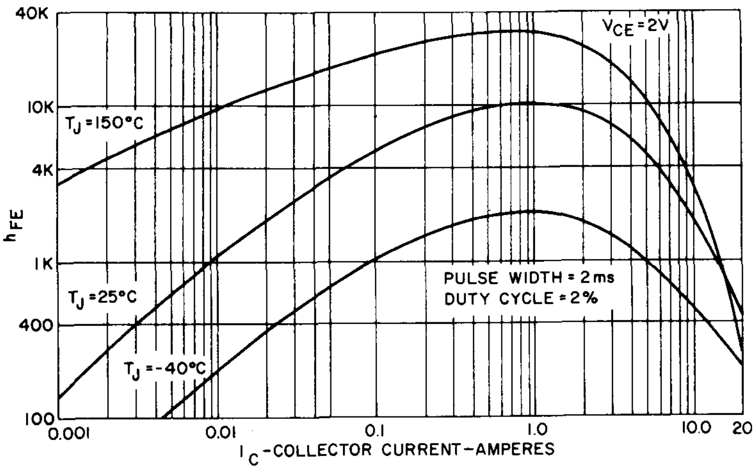
electrical characteristics: (25°C) (unless otherwise specified)

			D44E1 D44E2 D44E3		
Forward Current Transfer Ratio[3]		**Min.**			
(I_C = 5A, V_{CE} = 5V)	h_{FE}	1000			
		Min.	**Typ.**	**Max.**	
Collector to Emitter Voltage					
(I_C = 100 mA)D44E1	V_{CEO}	40	–	–	Volts
D44E2		60	–	–	Volts
D44E3		80	–	–	Volts
Collector Saturation Voltage[4]					
(I_C = 5.0A, I_B = 10mA)	$V_{CE(SAT)}$	–	–	1.5	Volts
(I_C = 10.0A, I_B = 20mA)	$V_{CE(SAT)}$	–	–	2.0	Volts
Base Saturation Voltage[3]					
(I_C = 5.0A, I_B = 10mA	$V_{BE(SAT)}$	–	–	2.5	Volts
Collector Cutoff Current					
(V_{CE} = Rated $V_{CES,}$ T_J = 25°C)	I_{CES}	–	–	10	µA
(V_{CE} = Rated $V_{CES,}$ T_J = 150°C)	I_{CES}	–	–	1.0	mA
Emitter Cutoff Current					
(V_{EB} = 7V)	I_{EBO}	–	–	1.0	µA
Collector Capacitance					
(V_{CB} = 10V, f = 1 MHz)	C_{CBO}	–	–	130	pF
Switching Times					
Delay Time and Rise Time					
(I_C = 10A, I_{B1} = 20mA)	$t_d + t_r$	–	0.6	–	µS
Storage Time					
(I_C = 10A, I_{B1} = I_{B2} = 20mA)	t_s	–	2.0	–	µS
Fall Time					
(I_C = 10A, I_{B1} = I_{B2} = 20mA)	t_f	–	0.5	–	µS

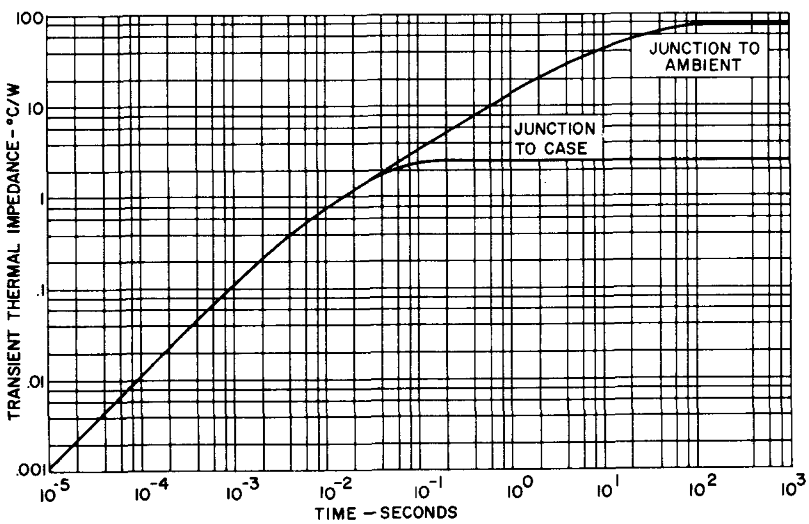
NOTE: (3) Pulsed measurement, 2m sec pulse width, duty cycle ≦ 2%.
(4) Pulsed measurement, 300µ sec pulse width, duty cycle ≦ 2%.



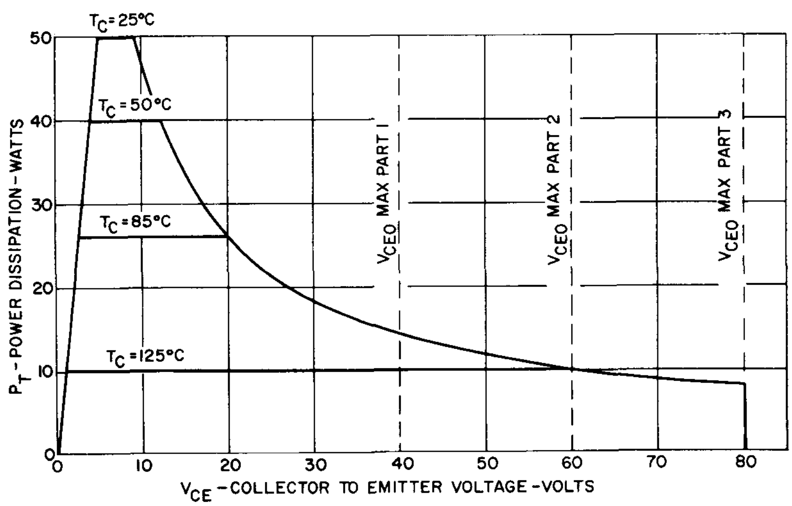
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



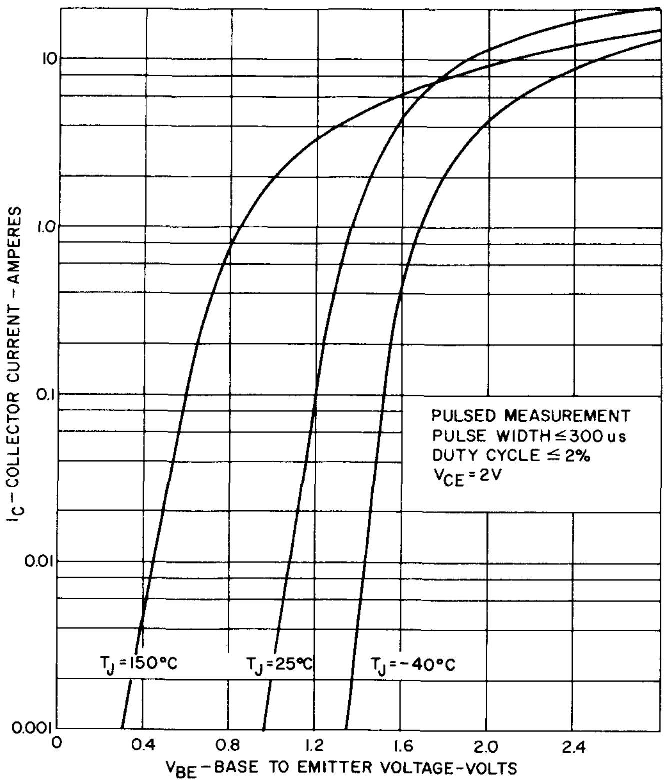
TYPICAL GAIN CHARACTERISTIC



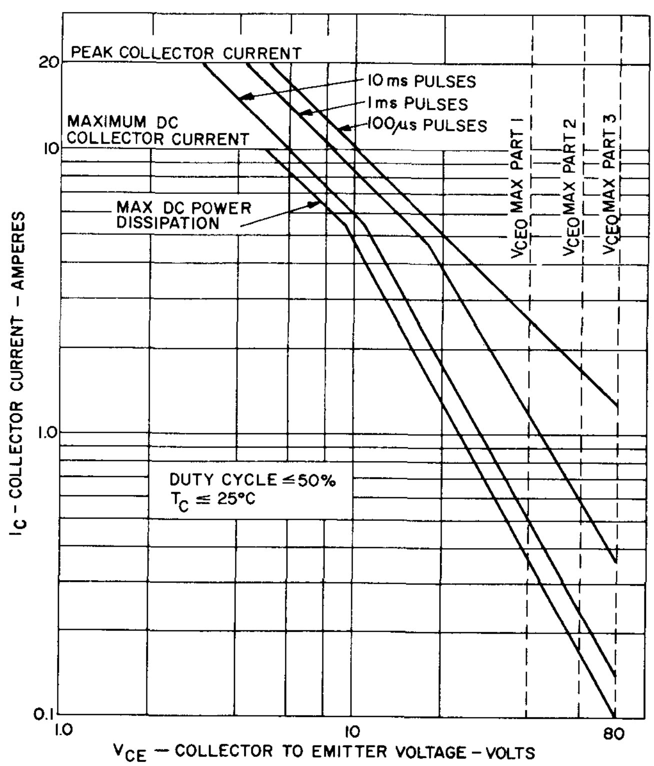
TRANSIENT THERMAL IMPEDANCE



MAXIMUM PERMISSIBLE DC POWER DISSIPATION



TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



SAFE REGION OF OPERATION

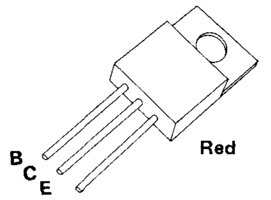
Silicon Power Pac Transistors

"Color Molded"

NPN

D44H

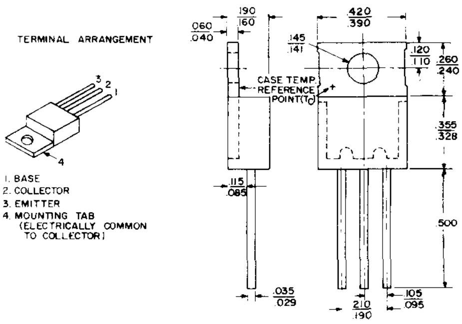
The General Electric D44H is a red, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



JEDEC TO-220 A B

FEATURING:

- NPN complement to D45H PNP
- Red for NPN, green for PNP
- Very low collector saturation voltage (0.24 V typ. @ 5.0 A I_C)
- Excellent linearity
- Fast switching
- Round leads
- Hard solder mount down



Outline Drawing

absolute maximum ratings: (25°C unless otherwise specified)

		D44H1 D44H2	D44H4 D44H5	D44H7 D44H8	D44H10 D44H11	
Voltages						
Collector to Emitter	V_{CEO}	30	45	60	80	Volts
Emitter to Base	V_{EBO}	5	5	5	5	Volts
Current (1)						
Collector (Continuous)	I_C	← 10 →				Amps
Collector (Peak)		← 20 →				Amps
Power Dissipation (1)						
Case at 25° C	P_T	← 50 →				Watts
Case at 70° C		← 32 →				Watts
Free Air at 25° C		← 1.67 →				Watts
Free Air at 50° C		← 1.33 →				Watts
Thermal Resistance (2)						
Junction to Case	$R_{\theta JC}$	← 2.5 →				°C/W
Junction to Ambient	$R_{\theta JA}$	← 75 →				°C/W
Temperature (2)						
Operating	T_J	← −55 to +150 →				°C
Storage	T_{STG}	← −55 to +150 →				°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	← +260 →				°C

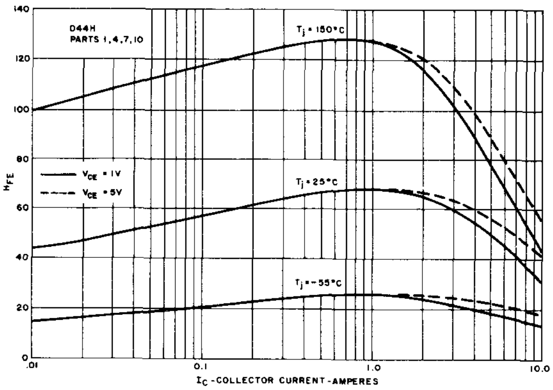
NOTES:
(1) Refer to the Safe Region of Operation curve for further information.
(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

electrical characteristics: (25°C unless otherwise specified)

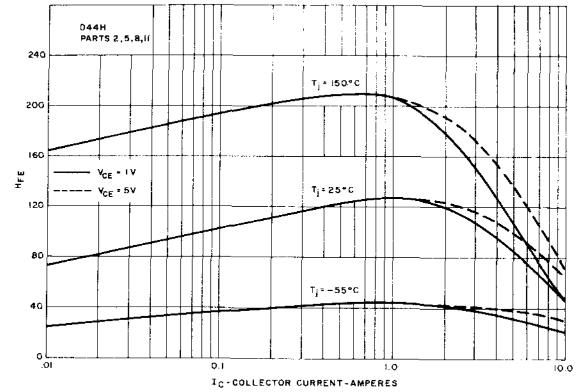
			Min.	Max.	
Forward Current Transfer Ratio					
(V_{CE} = 1V, I_C = 2A)	D44H1, 4, 7, 10	h_{FE}	35	–	
	D44H2, 5, 8, 11	h_{FE}	60	–	
(V_{CE} = 1V, I_C = 4A)	D44H1, 4, 7, 10	h_{FE}	20	–	
	D44H2, 5, 8, 11	h_{FE}	40	–	
Collector to Emitter Sustaining Voltage (3)					
(I_C = 100 mA)	D44H1, 2	$V_{CEO}(SUS)$	30	–	Volts
	D44H4, 5		45	–	Volts
	D44H7, 8		60	–	Volts
	D44H10, 11		80	–	Volts
Collector Saturation Voltage (3)					
(I_C = 8A, I_B = 0.4A)	D44H2, 5, 8, 11	$V_{CE}(SAT)$	–	1.0	Volt
(I_C = 8A, I_B = 0.8A)	D44H1, 4, 7, 10	$V_{CE}(SAT)$	–	1.0	Volt
Base Saturation Voltage (3)					
(I_C = 8A, I_B = 0.8A)		$V_{BE}(SAT)$	–	1.5	Volts
On-Voltage					
(I_C = 10 mA, V_{CE} = 2V)		$V_{BE(on)}$	0.52	0.62	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CEO}, T_J = 25°C)		I_{CBO}	–	10	μA
Emitter Cutoff Current					
(V_{EB} = 5V, T_J = 25°C)		I_{EBO}	–	100	μA

	Symbol	Min.	Typ.	Max.	Unit
Collector Capacitance (V_{CB} = 10V, f = 1 MHz)	C_{CBO}	–	130	–	pF
Gain Bandwidth Product (V_{CE} = 10V, I_C = 500 mA)	f_t	–	50	–	MHz
Switching Times					
Rise Time and Delay Time (I_C = 5A, I_{B1} = 0.5A)	$t_d + t_r$		300		nsec
Storage Time (I_C = 5A, I_{B1} = I_{B2} = 0.5A)	t_s		500		nsec
Fall Time (I_C = 5A, I_{B1} = I_{B2} = 0.5A)	t_f		140		nsec

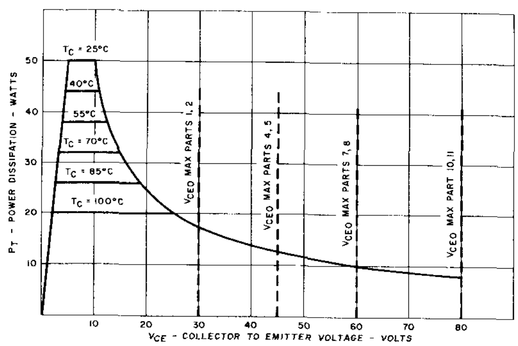
NOTE:
(3) Pulsed measurement, 300 μsec pulse, duty cycle ≤ 2%.



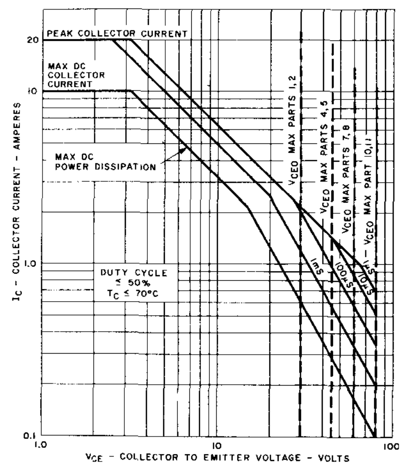
TYPICAL GAIN CHARACTERISTICS



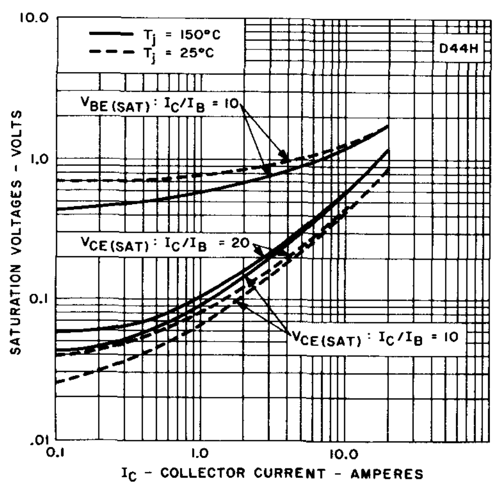
TYPICAL GAIN CHARACTERISTICS



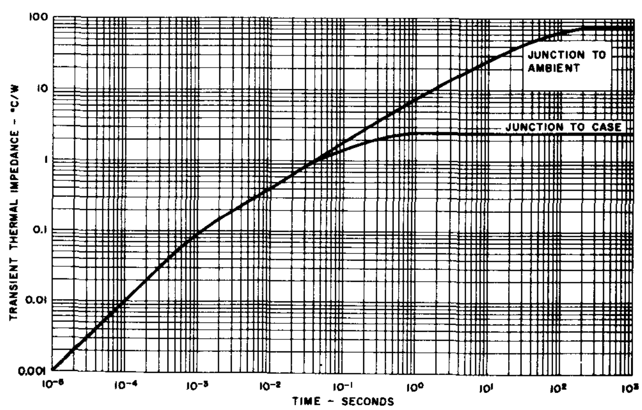
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



SAFE REGION OF OPERATION



TYPICAL SATURATION VOLTAGE CHARACTERISTICS



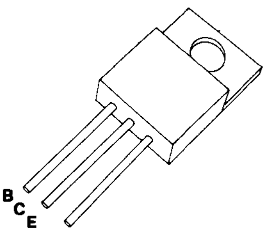
TRANSIENT THERMAL IMPEDANCE

Silicon Power Pac Transistors HIGH VOLTAGE

NPN

D44Q

The General Electric D44Q is a red, silicone encapsulated, power transistor designed for various specific and general purpose applications such as: 120 V.A.C. line operated amplifiers; series, shunt and switching regulators; low thru high frequency inverters/convertors; t-v and other display tube deflection; and many others.



Compatible with JEDEC TO–66 mounting registration

FEATURING:

- Red for NPN
- Very low collector stauration voltage
- Excellent linearity
- Fast switching
- Round leads
- Glass passivated mesa construction

absolute maximum ratings: (25°C) (unless otherwise specified)

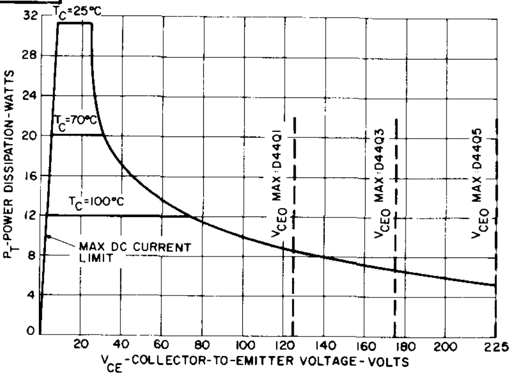
		D44Q1	D44Q3	D44Q5	
Voltages					
Collector to Emitter	V_{CEO}	125	175	225	Volts
Emitter to Base	V_{EBO}	7	7	7	Volts
Collector to Base	V_{CBO}	200	250	300	Volts
Current					
Collector (Continuous)	I_C	←	4.0	→	Amps
Power Dissipation(1)					
Tab at 25°C	P_T	←	31.25	→	Watts
Tab at 70°C		←	20.0	→	Watts
Free Air at 25°C		←	1.67	→	Watts
Free Air at 50°C		←	1.33	→	Watts
Thermal Resistance					
Junction to Case	$R\theta_{JC}$	←	4.0	→	°C/W
Junction to Ambient	$R\theta_{JA}$	←	75	→	°C/W
Temperature(2)					
Operating	T_J	←	−55 to +150	→	°C
Storage	T_{STG}	←	−55 to +150	→	°C
Lead Soldering, 1/16" ± 1/32" From Case for 10 sec. max.	T_L	←	+260	→	°C

Notes: (1) Refer to the safe region of operation curve for further information.
(2) Case temperature reference point is indicated on the dimensional outline drawing.

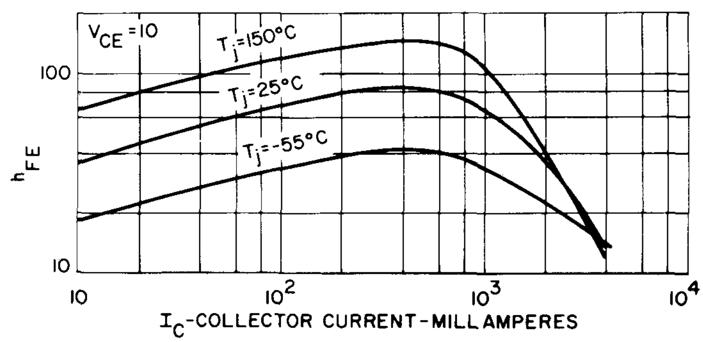
electrical characteristics: (25°C) (unless otherwise specified)

		MIN.	TYP.	MAX.	UNITS
Forward Current Transfer Ratio					
@ I_C = 2.0A, V_{CE} = 10V	h_{FE}	20	–	–	–
@ I_C = 200 MA, V_{CE} = 10V	h_{FE}	30	80	–	–
Collector to Emitter Voltage	V_{CEO}				
(I_C = 10 MA)					
D44Q1		125	–	–	Volts
D44Q3		175	–	–	Volts
D44Q5		225	–	–	Volts
Collector Cutoff Current(1) (Rated V_{CEO})	I_{CBO}	–	–	10	μA
Collector Saturation Voltage(1) (I_C = 2A, I_B = 200MA)	$V_{CE(SAT)}$	–	–	1	Volts
Base Saturation Voltage (1) (I_C = 2A, I_B = 200MA)	$V_{BE(SAT)}$	–	–	1.3	Volts
Gain Bandwidth Product (I_C = 100 MA, V_{CE} = 10V)	f_T	–	50	–	MHZ
Storage Time (V_{CC} = 50V I_C = 1.0A, I_B = I_{B2} = 100mA)	t_s	–	1.3	2	μs
Rise Time	t_r	–	.12	.2	μs
Fall Time	t_f	–	.6	1.7	μs
Collector Capacitance (V_{CB} = 10V, 1 MHz)	C_{CBO}	–	40	–	pf

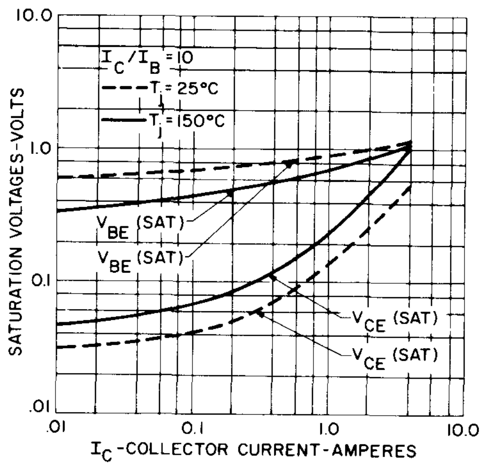
Note: (1) Pulsed Measurement, 300μsec. Pulse, Duty Cycle ≦ 2%.



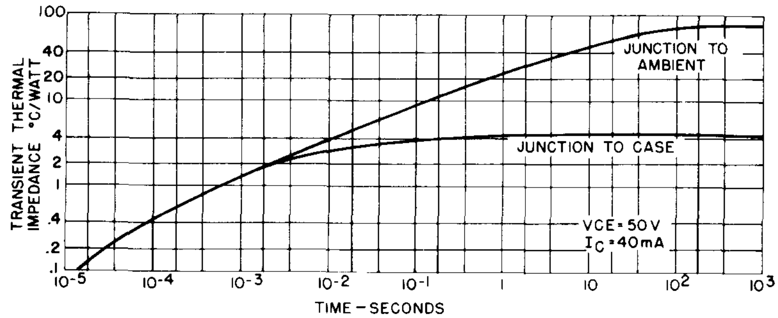
Maximum Permissible DC Power Dissipation



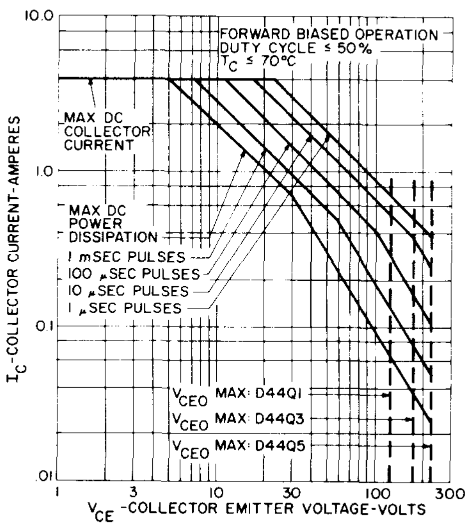
Typical h_{FE} vs I_C



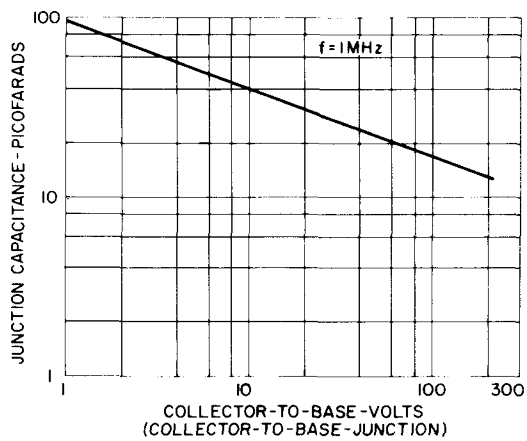
Typical Saturation Voltage Characteristics



Maximum Transient Thermal Impedance



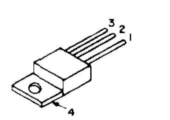
Safe Region of Operation



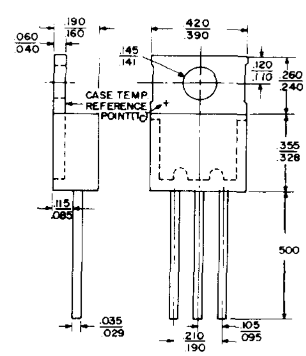
Capacitance vs Reverse Bias Voltage

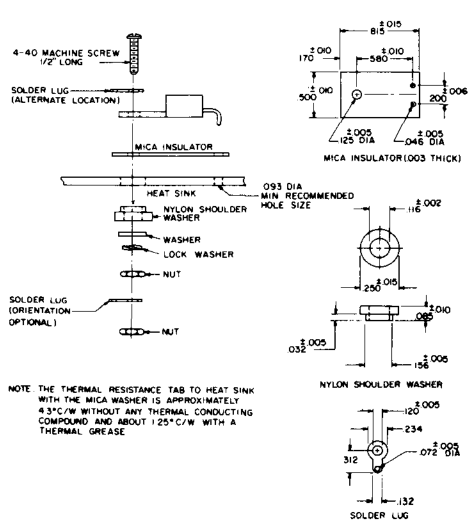
DIMENSIONAL OUTLINES

TERMINAL ARRANGEMENT



1. BASE
2. COLLECTOR
3. EMITTER
4. MOUNTING TAB (ELECTRICALLY COMMON TO COLLECTOR)





NOTE: THE THERMAL RESISTANCE TAB TO HEAT SINK WITH THE MICA WASHER IS APPROXIMATELY 4.3°C/W WITHOUT ANY THERMAL CONDUCTING COMPOUND AND ABOUT 1.25°C/W WITH A THERMAL GREASE

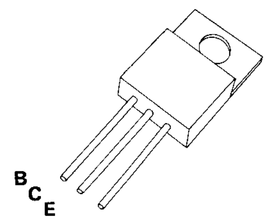
THE ABOVE PARTS WILL BE AVAILABLE UPON REQUEST AS A SEPARATE KIT AT AN ADDITIONAL COST. KIT # 138818 9P3

Silicon Power Pac Transistors

HIGH VOLTAGE

D44R (NPN)

The General Electric D44R is a red, silicone encapsulated, power transistor designed for various specific and general purpose applications such as: 120 V.A.C. line operated amplifiers; series, shunt and switching regulators; low thru high frequency inverters/converters; t-v and other display tube deflection; and many others.



Compatible with JEDEC TO-220 AB mounting registration

FEATURING:

- Red for NPN
- Very low collector saturation voltage
- Excellent linearity
- Fast switching
- Round leads
- ***POWER-GLAS*** passivated mesa
- Hard solder mountdown

absolute maximum ratings:

(25°C unless otherwise specified)

		D44R1 D44R2 D44R5 D44R7	D44R3 D44R4 D44R6 D44R8	Units
Voltages				
Collector to Emitter	V_{CEO}	250	300	Volts
Emitter to Base	V_{CES}	400	500	Volts
	V_{EBO}	← 5 →		Volts
Current				
Collector (Cont.)	I_C	← 1.0 →		Amp.
Power Dissipation(1)				
Tab at 25°C	P_T	← 31.25 →		Watts
Tab at 70°C		← 20.0 →		Watts
Free Air at 25°C		← 1.67 →		Watts
Free Air at 50°C		← 1.33 →		Watts
Thermal Resistance				
Junction to Case	$R_{\theta JC}$	← 4.0 →		°C/W
Junction to Ambient	$R_{\theta JA}$	← 75 →		°C/W
Temperature (2)				
Operating	T_J	← −55 to +150 →		°C
Storage	T_{STG}	← −55 to +150 →		°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	← +260 →		°C

NOTES:

(1) Refer to the Safe Region of Operation curve for further information.

(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

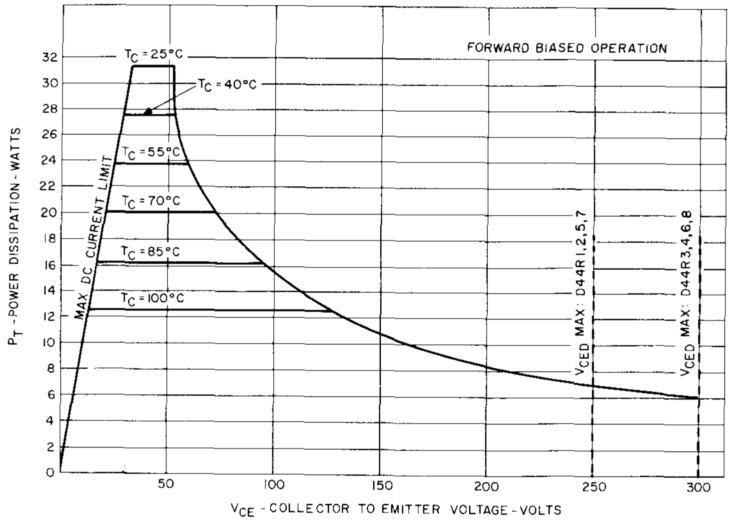
electrical characteristics: (25°C unless otherwise specified)

		Min.	Typ.	Max.	Units
Forward Current Transfer Ratio					
@ I_C = 500 ma, V_{CE} = 10V	h_{FE}				
D44R1, 3		30	75	90	
D44R2, 4		75	–	175	
D44R5, 6		30	–	–	
D44R7, 8		150		300	
@ I_C = 50 ma, V_{CE} = 10V	h_{FE}				
D44R1, 3, 5, 6		20	65	–	
D44R2, 4		40	–	–	
D44R7, 8		60	–	–	
Collector to Emitter Sustaining Voltage(2)					
@ I_C = 100 ma	$V_{CEO(SUS)}$				
D44R1, 2, 5, 7		250	–	–	Volts
D44R3, 4, 6, 8		300	–	–	Volts
Collector to Emitter Saturation Voltage(1)					
@ I_C = 300mA, I_B = 30mA Pt. 5 & 6	$V_{CE(SAT)}$	–	0.4	1.0	Volts
I_C = 500mA, I_B = 50mA Pt. 1,2,3,4,7,8	$V_{CE(SAT)}$	–	0.4	1.0	Volts

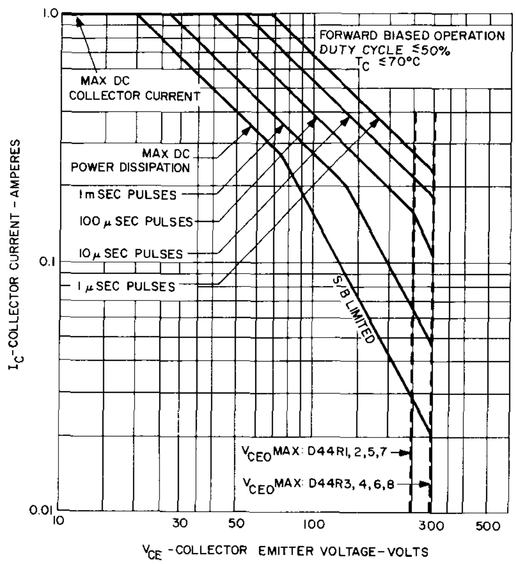
D44R	Electrical Characteristics (Continued)		Min.	Typ.	Max.	Units
	Base to Emitter Saturation Voltage(1) @ I_C = 500 ma, I_B = 50 ma	$V_{BE(SAT)}$	–	–	1.2	Volts
	Collector Cut-off Current(1) V_{CES} = Max. Rating	I_{CES}	–	–	1.0	ma
	Emitter Cut-off Current (V_{EB} = 5V, T_J = 25°C)	I_{EBO}	–	–	10	μA
	Collector Capacitance (V_{CB} = 10V, f = 1MHz)	C_{CBO}	–	30	–	pF
	Gain Bandwidth Product (V_{CE} = 10V, I_C = 100 mA)	f_t	20	40	–	MHz
	Switching Times					
	Rise Time (V_{CC} = 50V, I_C = 500mA, I_{B1} = I_{B2} = 100mA)	t_r	–	.2	.5	μsec
	Storage Time (V_{CC} = 50V, I_C = 500mA, I_{B1} = I_{B2} = 100mA)	t_s	–	2.5	4.5	μsec
	Fall Time (V_{CC} = 50V, I_C = 500mA, I_{B1} = I_{B2} = 100mA)	t_f	–	1.8	3.0	μsec

NOTES:

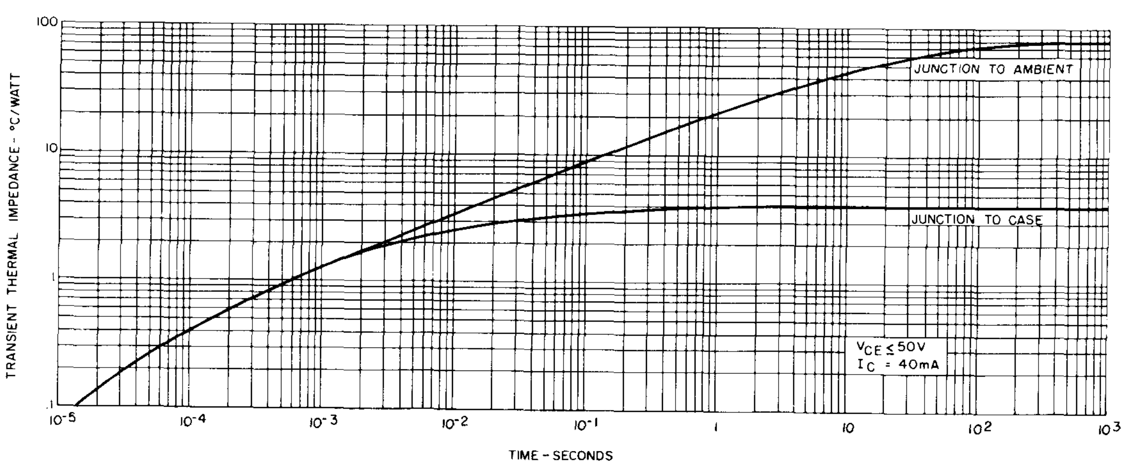
(1) Pulsed measurement, 300 μsec. pulse, Duty cycle ≦ 2%.



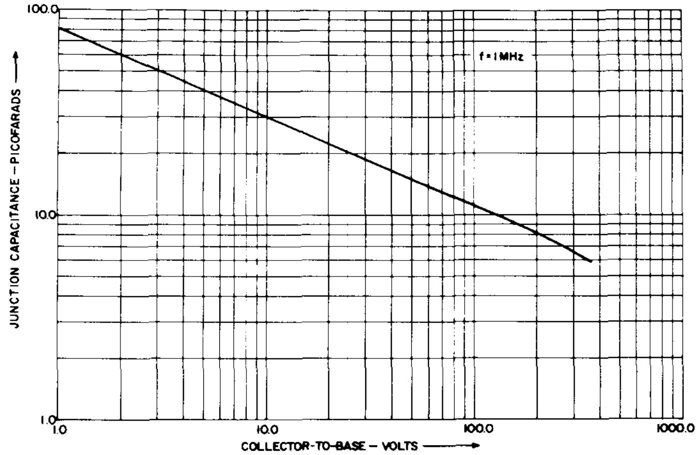
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



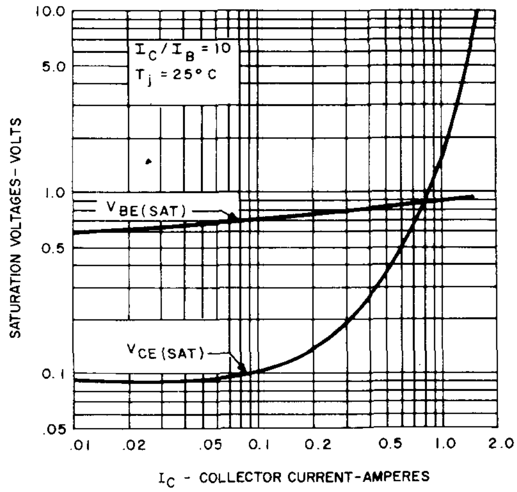
SAFE REGION OF OPERATION



MAXIMUM TRANSIENT THERMAL IMPEDANCE

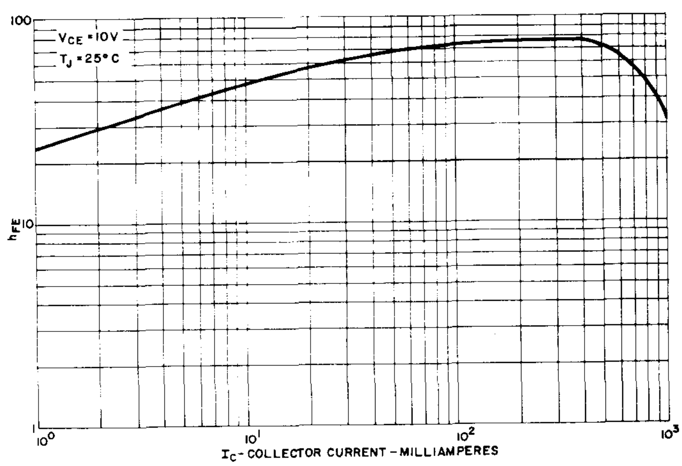


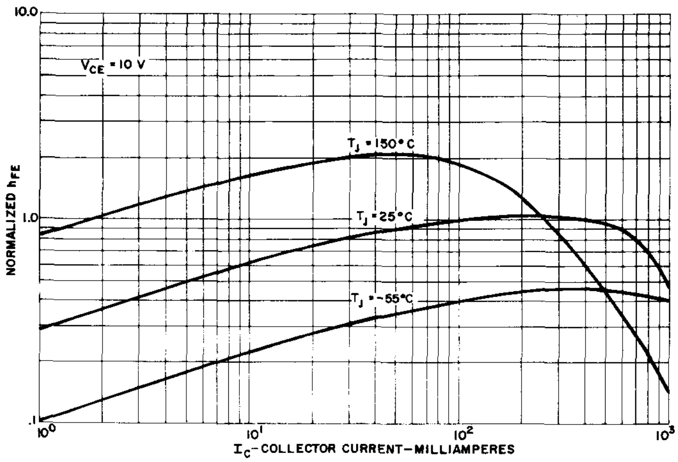
COLLECTOR-TO-BASE JUNCTION CAPACITANCE VS. REVERSE BIAS VOLTAGE



TYPICAL SATURATION VOLTAGE CHARACTERISTICS

TYPICAL h_{FE} VS. I_C

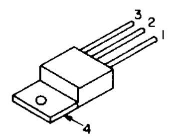




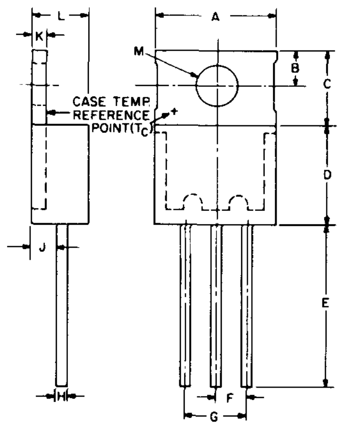
TYPICAL NORMALIZED h_{FE} VS. I_C

Sym.	Dec. In.		Metric MM	
	Min.	Max.	Min.	Max.
A	.390	.420	9.91	10.67
B	.110	.120	2.79	3.05
C	.240	.260	6.10	6.61
D	.325	.355	8.26	9.02
E	.500	——	12.7	——
F	.095	.105	2.41	2.67
G	.190	.210	4.82	5.34
H	.029	.035	.73	.89
J	.085	.115	2.16	2.92
K	.040	.060	1.02	1.52
L	.160	.190	4.06	4.83
M	.141	.145	3.58	3.68
N	——	.065	——	1.65

TERMINAL ARRANGEMENT



1. BASE
2. COLLECTOR
3. EMITTER
4. MOUNTING TAB (ELECTRICALLY COMMON TO COLLECTOR)



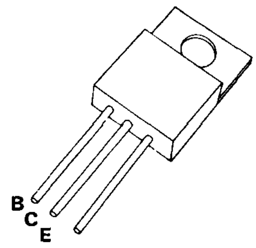
POWER PAC POWER TRANSISTOR DIMENSIONAL OUTLINES

ELECTRONIC INNOVATIONS IN ACTION
SEMICONDUCTORS

Silicon Power Pac Transistors
"Color Molded"

PNP
D45C

The General Electric D45C is a green, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



Green
JEDEC TO-220 A B

FEATURING:

- PNP complement to D44C NPN
- Green for PNP, red for NPN
- Very low collector saturation voltage (—0.5V typ. @ —3.0A I_C)
- Excellent linearity
- Fast switching
- Round leads
- Hard solder mountdown

absolute maximum ratings: (25°C) (unless otherwise specified)

		D45C1 D45C2 D45C3	D45C4 D45C5 D45C6	D45C7 D45C8 D45C9	D45C10 D45C11 D45C12	
Voltages						
Collector to Emitter	V_{CEO}	—30	—45	—60	—80	Volts
Emitter to Base	V_{EBO}	— 5	— 5	— 5	— 5	Volts
Collector to Emitter	V_{CES}	—40	—55	—70	—90	Volts
Current(1)						
Collector (Continuous)	I_C	←	—4		→	Amps
Collector (Peak)		←	—6		→	Amps
Power Dissipation(1)						
Tab at 25°C	P_T	←	30		→	Watts
Tab at 70°C		←	19		→	Watts
Free Air at 25°C		←	1.67		→	Watts
Free Air at 50°C		←	1.33		→	Watts
Thermal Resistance(2)						
Junction to Case	$R_{\theta JC}$	←	4.2		→	°C/W
Junction to Ambient	$R_{\theta JA}$	←	75		→	°C/W
Temperature(2)						
Operating	T_J	←	—55 to +150		→	°C
Storage	T_{STG}	←	—55 to +150		→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	←	+260		→	°C

Notes:
(1) Refer to the Safe Region of Operation curve for further information.
(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

electrical characteristics: (25°C) (unless otherwise specified)

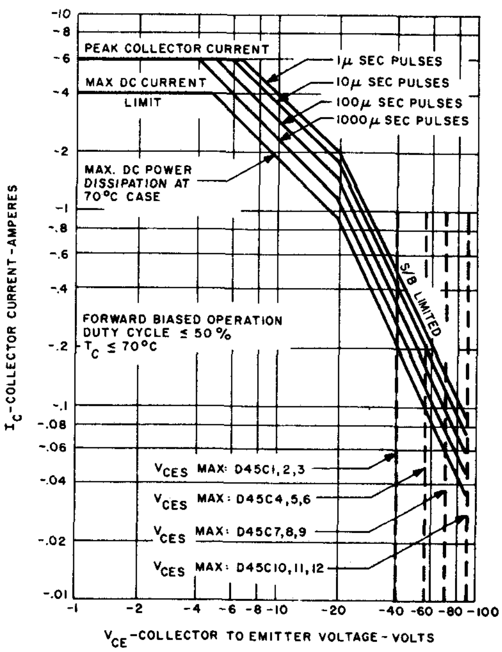
		D45C3 D45C6 D45C9 D45C12		D45C2 D45C5 D45C8 D45C11		D45C1 D45C4 D45C7 D45C10
		Min.	**Max.**	**Min.**	**Max.**	**Min.**
Forward Current Transfer Ratio						
(V_{CE} = —1V, I_C = —0.2A)	h_{FE}	40	120	40	120	25
(V_{CE} = —1V, I_C = —2A)	h_{FE}	20	—	—	—	—
(V_{CE} = —1V, I_C = —1A)	h_{FE}	—	—	20	—	10

Electrical Characteristics (Continued)

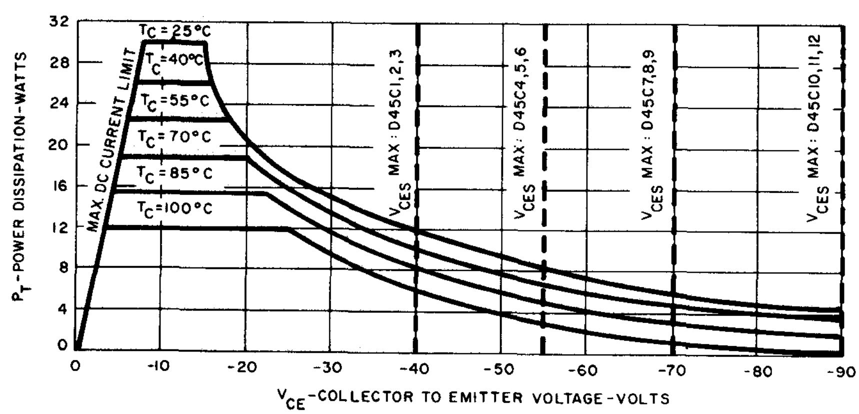
Characteristic	Symbol	Min.	Max.	Unit
Collector to Emitter Sustaining Voltage(3)				
($I_C = -100$ mA) D45C1, 2, 3	$V_{CEO(SUS)}$	−30	—	Volts
D45C4, 5, 6		−45	—	Volts
D45C7, 8, 9		−60	—	Volts
D45C10, 11, 12		−80	—	Volts
Collector Saturation Voltage(3)				
($I_C = -1$A, $I_B = -50$ mA) D45C2, 3, 5, 6, 8, 9, 11, 12	$V_{CE(SAT)}$	—	−0.5	Volt
($I_C = -1$A, $I_B = -100$ mA) D45C1, 4, 7, 10	$V_{CE(SAT)}$	—	−0.5	Volt
Base Saturation Voltage(3)				
($I_C = -1$A, $I_B = -100$ mA)	$V_{BE(SAT)}$	—	−1.3	Volts
Collector Cutoff Current				
(V_{CE} = Rated V_{CES}, $T_J = 25°C$)	I_{CES}	—	−10	μA
Emitter Cutoff Current				
($V_{EB} = -5V$, $T_J = 25°C$)	I_{EBO}	—	−100	μA
Collector Capacitance				
($V_{CB} = 10V$, f = 1 MHz)	C_{CBO}	—	125	pF

Characteristic	Symbol	Typ.	Unit
Gain Bandwidth Product			
($V_{CE} = -4V$, $I_C = -20$ mA)	f_t	40	MHz
Switching Times			
Rise Time and Delay Time ($I_C = -1A$, $I_{B1} = -0.1A$)	$t_d + t_r$	50	nsec
Storage Time ($I_C = -1A$, $I_{B1} = I_{B2} = -0.1A$)	t_s	500	nsec
Fall Time ($I_C = -1A$, $I_{B1} = I_{B2} = -0.1A$)	t_f	50	nsec

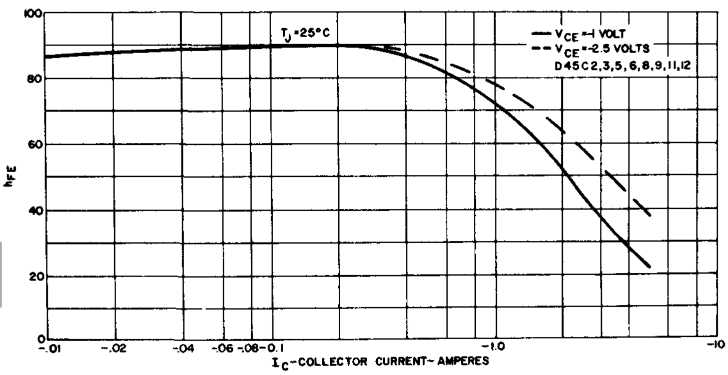
Note:
(3) Pulsed measurement, 300 μsec pulse, duty cycle ≤2%.



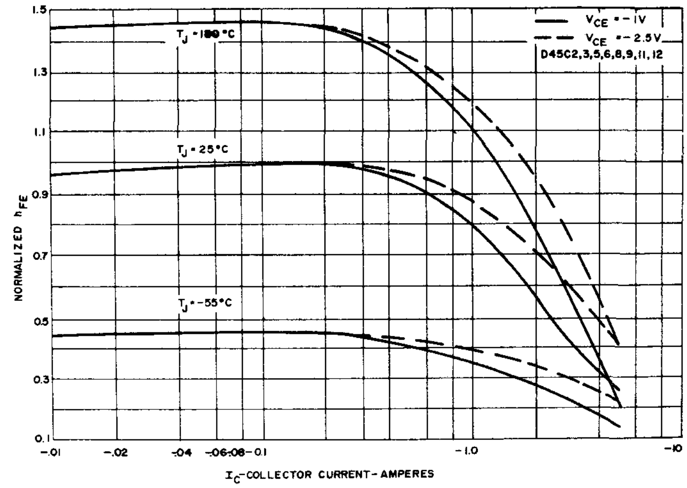
SAFE REGION OF OPERATION



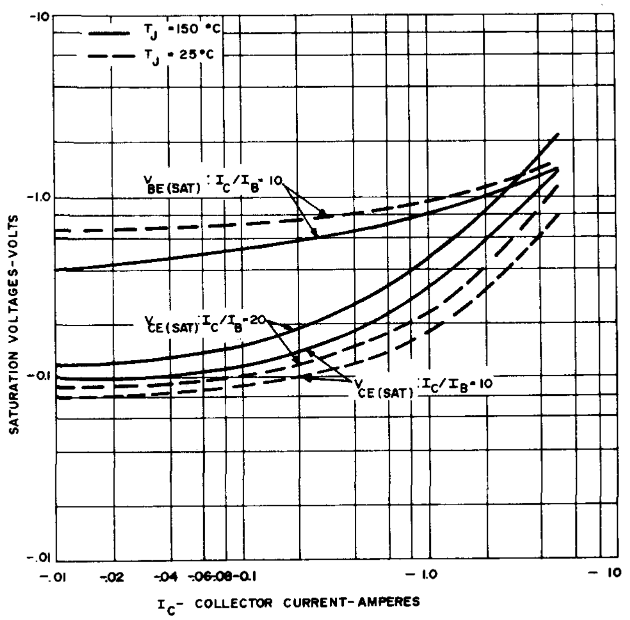
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



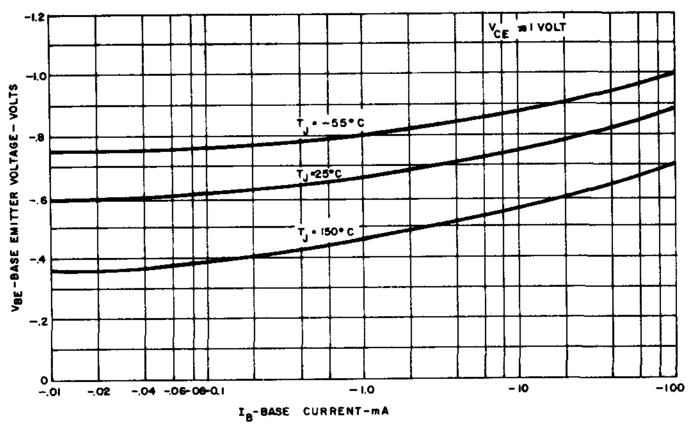
TYPICAL h_{FE} VS. I_C



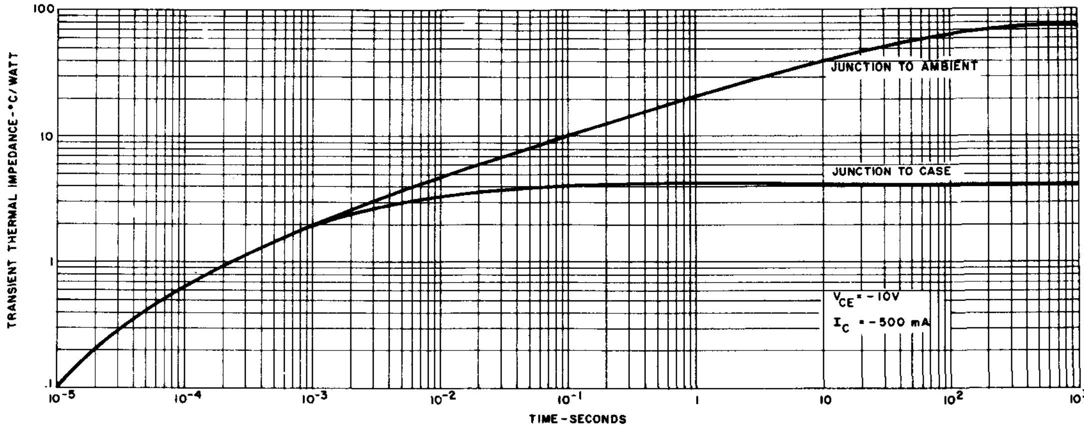
TYPICAL NORMALIZED h_{FE} VS. I_C



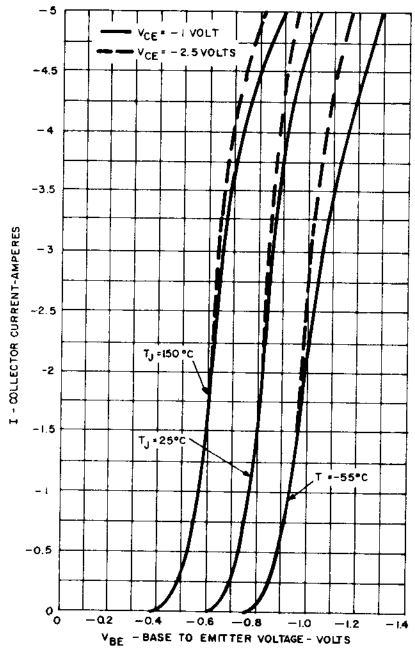
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



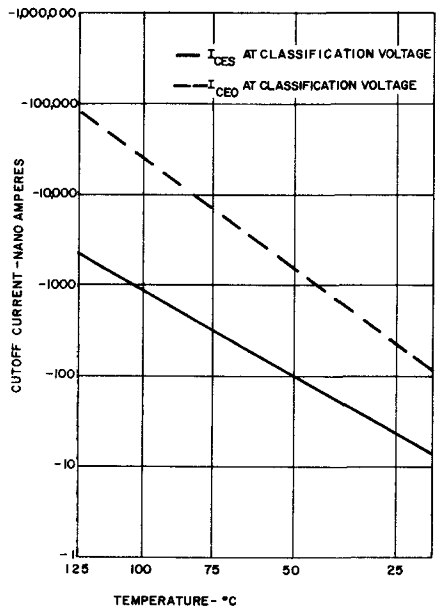
TYPICAL INPUT CHARACTERISTICS



MAXIMUM TRANSIENT THERMAL IMPEDANCE

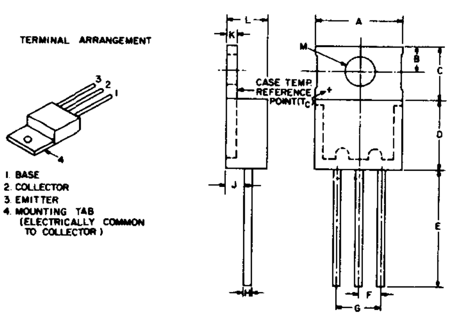


TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



TYPICAL I_{CEO}, I_{CES} VS. TEMPERATURE

DIMENSIONAL OUTLINES



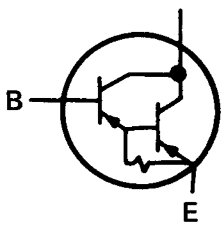
Sym.	Dec. In.		Metric MM	
	Min.	Max.	Min.	Max.
A	.390	.420	9.91	10.67
B	.110	.120	2.79	3.05
C	.240	.260	6.10	6.61
D	.325	.355	8.26	9.02
E	.500	——	12.7	——
F	.095	.105	2.41	2.67
G	.190	.210	4.82	5.34
H	.029	.035	.73	.89
J	.085	.115	2.16	2.92
K	.040	.060	1.02	1.52
L	.160	.190	4.06	4.83
M	.141	.145	3.58	3.68
N	——	.065	——	1.65

Silicon Power Pac
Monolithic Transistor
Very High Gain Darlington Amplifier
"Color Molded"

PNP

D45E

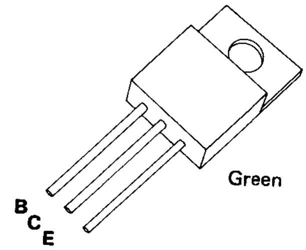
COMPLEMENT TO D44E



Equiv. Circuit

TYPICAL APPLICATIONS:

Driver	Switch
Regulator	Audio Output
Capacitor Multiplier	Relay Substitute
Solenoid Driver	Oscillator
Inverter Power Supply	Servo-Amplifier



JEDEC TO-220 AB

absolute maximum ratings: (25°C) (unless otherwise specified)

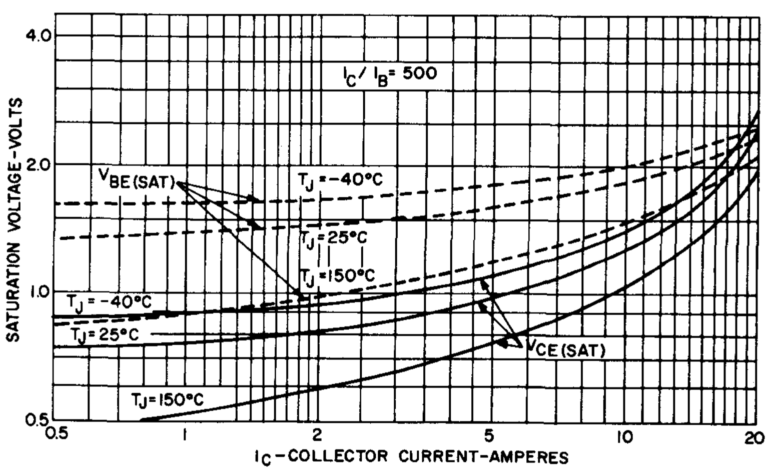
	Symbol	D45E1	D45E2	D45E3	Units
Voltages					
Collector to Emitter	V_{CEO}	-40	-60	-80	Volts
Emitter to Base	V_{EBO}	- 7	- 7	- 7	Volts
Collector to Emitter	V_{CES}	-40	-60	-80	Volts
Current(1)					
Collector (Continuous)	I_C	←	-10	→	Amps
Collector (Peak) (50% duty cycle, 25 msec. pulse width)		←	-20	→	Amps
Base (Continuous)	I_b	←	- 1	→	Amps
Power Dissipation(1)					
Tab at 25°C	P_T	←	50	→	Watts
Free Air at 25°C		←	1.67	→	Watts
Thermal Resistance(2)					
Junction to Case	$R_{\theta JC}$	←	2.5	→	°C/W
Junction to Ambient	$R_{\theta JA}$	←	75	→	°C/W
Temperature(2)					
Operating	T_j	←	-55 to +150	→	°C
Storage	T_{STG}	←	-55 to +150	→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	←	+260	→	°C

NOTES:
(1) Refer to the Safe Region of Operation curve for further information.
(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

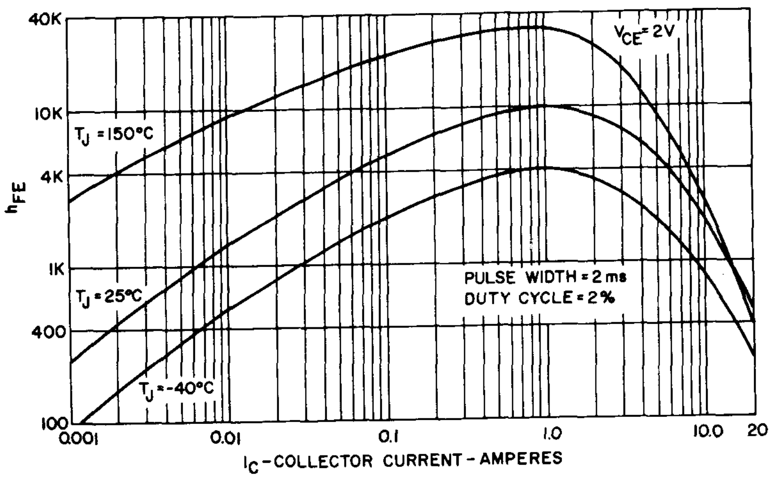
electrical characteristics: (25°C) (unless otherwise specified)

		D45E1 D45E2 D45E3			
Forward Current Transfer Ratio(3)		**Min.**	**Typ.**		
(I_C = 5A, V_{CE} = 5V)	h_{FE}	1000			
		Min.	**Typ.**	**Max.**	
Collector to Emitter Voltage					
(I_C = 100 mA) D45E1	V_{CEO}	-40	–	–	Volts
D45E2		-60	–	–	Volts
D45E3		-80	–	–	Volts
Collector Saturation Voltage(4)					
(I_C = -5.0A, I_B = -10mA)	$V_{CE(SAT)}$	–	–	-1.5	Volts
(I_C = -10.0A, I_B = -20mA)	$V_{CE(SAT)}$	–	–	-2.0	Volts
Base Saturation Voltage(3)					
(I_C = -5.0A, I_B = -10mA	$V_{BE(SAT)}$	–	–	-2.5	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CES}, T_J = 25°C)	I_{CES}	–	–	-10	μA
(V_{CE} = Rated V_{CES}, T_J = 150°C)	I_{CES}	–	–	-1.0	mA
Emitter Cutoff Current					
(V_{EB} = -7V)	I_{EBO}	–	–	-1.0	μA
Collector Capacitance					
(V_{CB} = 10V, f = 1 MHz)	C_{CBO}	–	–	220	pF
Switching Times					
Delay Time and Rise Time					
(I_C = -10A, I_{B1} = -20mA)	$t_d + t_r$	–	0.6	–	μS
Storage Time					
(I_C = -10A, I_{B1} = I_{B2} = -20mA)	t_s	–	2.0	–	μS
Fall Time					
(I_C = -10A, I_{B1} = I_{B2} = -20mA)	t_f	–	0.5	–	μS

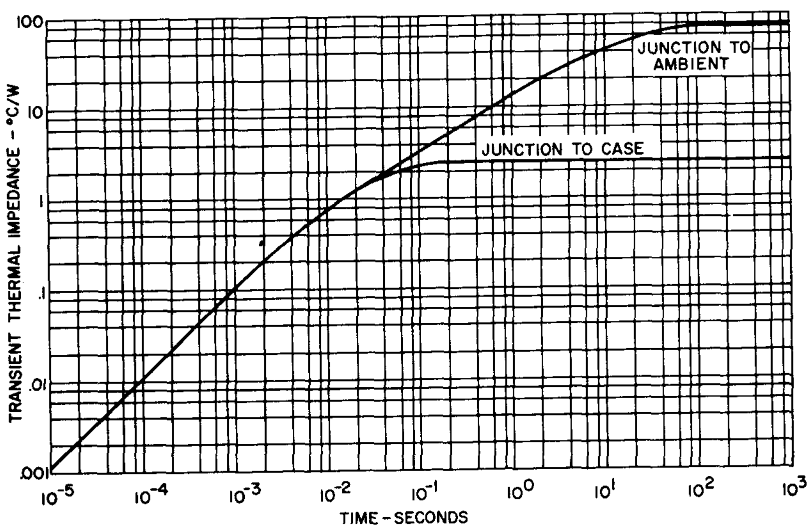
NOTE: (3) Pulsed measurement, 2m sec pulse width, duty cycle ≦ 2%.
(4) Pulsed measurement, 300μ sec pulse width, duty cycle ≦ 2%.



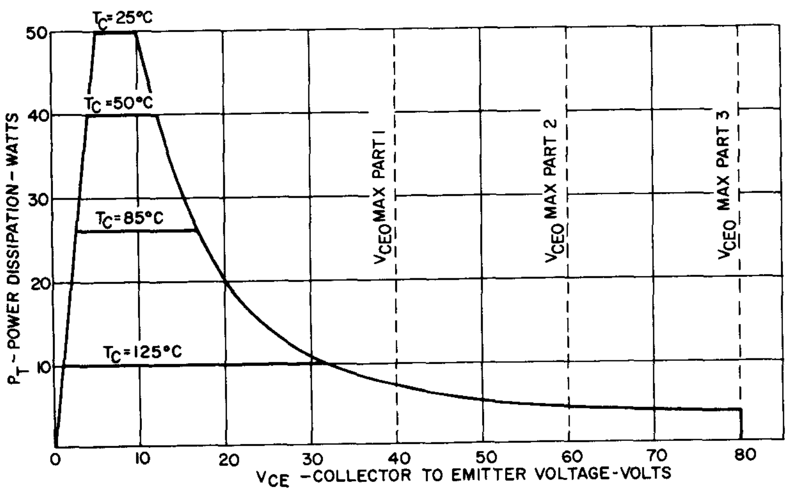
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



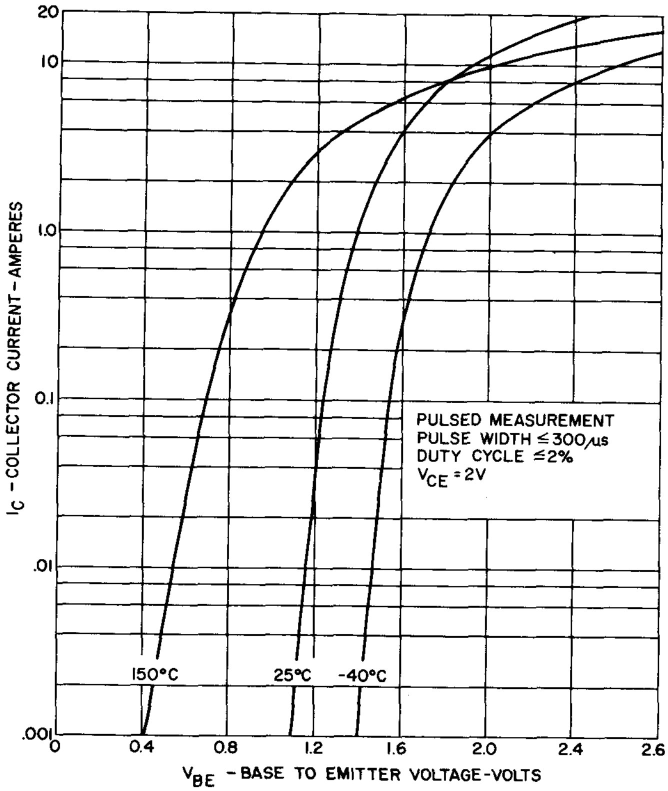
TYPICAL GAIN CHARACTERISTIC



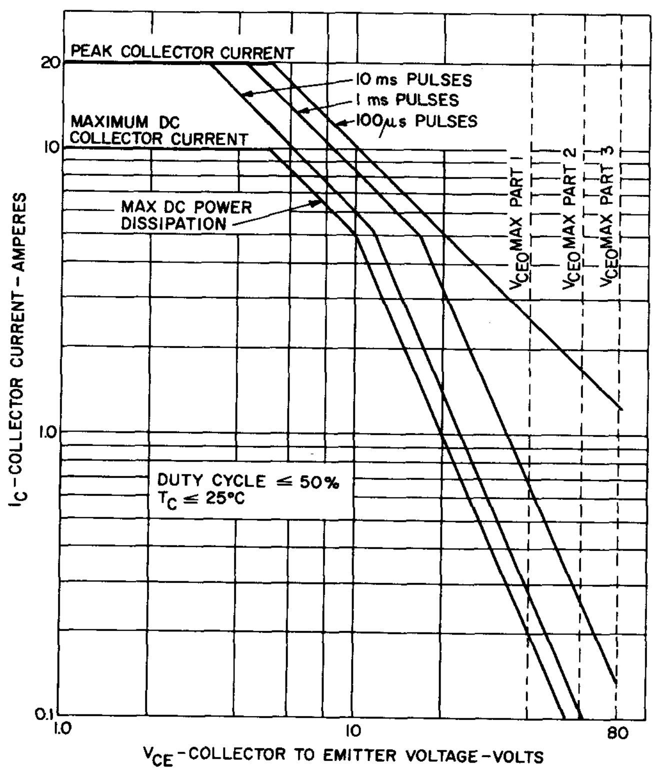
TRANSIENT THERMAL IMPEDANCE



MAXIMUM PERMISSIBLE DC POWER DISSIPATION



TYPICAL TRANSCONDUCTANCE CHARACTERISTICS



SAFE REGION OF OPERATION

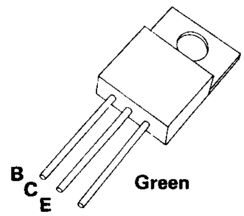
Silicon Power Pac Transistors

"Color Molded"

PNP

D45H

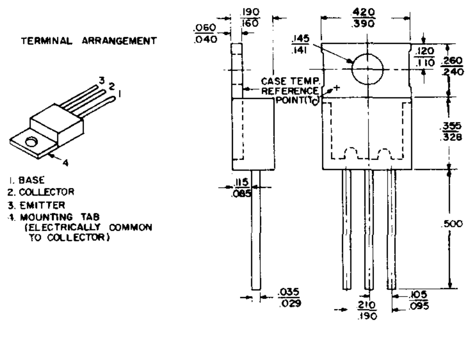
The General Electric D45H is a green, silicone plastic encapsulated, power transistor designed for various specific and general purpose applications, such as: output and driver stages of amplifiers operating at frequencies from DC to greater than 1.0 MHz; series, shunt and switching regulators; low and high frequency inverters/converters; and many others.



JEDEC TO-220 A B

FEATURING:

- PNP complement to D44H NPN
- Green for PNP, red for NPN
- Very low collector saturation voltage (-0.37 V typ. @ -5.0 A I_C)
- Excellent linearity
- Fast switching
- Round leads
- Hard solder mount down



Dimensional Outlines

absolute maximum ratings: (25°C unless otherwise specified)

		D45H1 D45H2	D45H4 D45H5	D45H7 D45H8 D45H9	D45H10 D45H11 D45H12	
Voltages						
Collector to Emitter	V_{CEO}	−30	−45	−60	−80	Volts
Emitter to Base	V_{EBO}	− 5	− 5	− 5	− 5	Volts
Current (1)						
Collector (Continuous)	I_C	←	−10		→	Amps
Collector (Peak)		←	− 20		→	Amps
Power Dissipation (1)						
Tab at 25°C	P_T	←	50		→	Watts
Tab at 70°C		←	32		→	Watts
Free Air at 25°C		←	1.67		→	Watts
Free Air at 50°C		←	1.33		→	Watts
Thermal Resistance (2)						
Junction to Case	$R_{\theta JC}$	←	2.5		→	°C/W
Junction to Ambient	$R_{\theta JA}$	←	75		→	°C/W
Temperature (2)						
Operating	T_J	←	−55 to +150		→	°C
Storage	T_{STG}	←	−55 to +150		→	°C
Lead Soldering, 1/16" ± 1/32" from case for 10 seconds max.	T_L	←	+260		→	°C

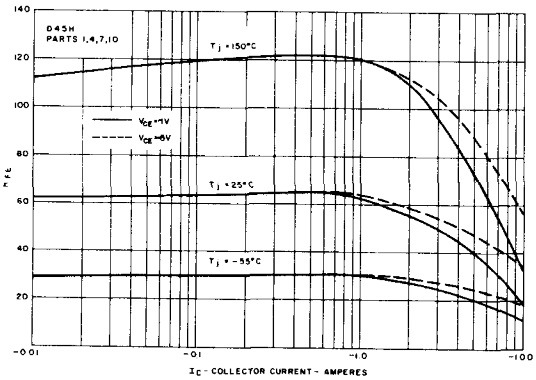
NOTES:
(1) Refer to the Safe Region of Operation curve for further information
(2) Case temperature reference point is indicated on the Dimensional Outline Drawing.

electrical characteristics: (25°C unless otherwise specified)

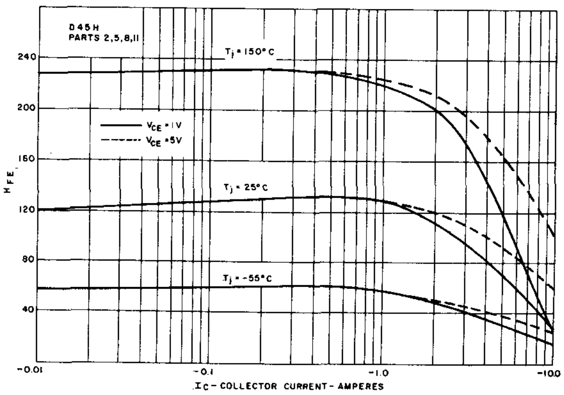
			Min.	Max.	
Forward Current Transfer Ratio					
($V_{CE} = -1V$, $I_C = -2A$)	D45H1, 4, 7, 10	h_{FE}	35	–	
	D45H2, 5, 8, 11, 9, 12	h_{FE}	60	–	
($V_{CE} = -1V$, $I_C = -4A$)	D45H1, 4, 7, 10	h_{FE}	20	–	
	D45H2, 5, 8, 11, 9, 12	h_{FE}	40	–	
Collector to Emitter Sustaining Voltage (3)					
($I_C = -100$ mA)	D45H1, 2		−30	–	Volts
	D45H4, 5	$V_{CEO}(SUS)$	−45	–	Volts
	D45H7, 8, 9		−60	–	Volts
	D45H10, 11, 12		−80	–	Volts
Collector Saturation Voltage (3)					
($I_C = -8A$, $I_B = -0.4A$)	D45H2, 5, 8, 11	$V_{CE}(SAT)$	–	−1.0	Volt
($I_C = -8A$, $I_B = -0.8A$)	D45H1, 4, 7, 10, 9, 12	$V_{CE}(SAT)$	–	−1.0	Volt
Base Saturation Voltage (3)					
($I_C = -8A$, $I_B = -0.8A$)		$V_{BE}(SAT)$	–	−1.5	Volts
On-Voltage					
($I_C = 10$ mA, $V_{CE} = 2V$)		$V_{BE(on)}$	0.54	0.64	Volts
Collector Cutoff Current					
(V_{CE} = Rated V_{CEO}, $T_J = 25°C$)		I_{CBO}	–	−10	μA
Emitter Cutoff Current					
($V_{EB} = -5V$, $T_J = 25°C$)		I_{EBO}	–	−100	μA

		Typ.	
Collector Capacitance			
(V_{CB} = 10V, f = 1 MHz)	C_{CBO}	230	pF
Gain Bandwidth Product			
(V_{CE} = −10V, I_C = −500 mA)	f_t	40	MHz
Switching Times			
Rise Time and Delay Time			
(I_C = −5A, I_{B1} = −0.5A)	$t_d + t_r$	135	nsec
Storage Time			
(I_C = −5A, I_{B1} = I_{B2} = −0.5A)	t_s	500	nsec
Fall Time			
(I_C = −5A, I_{B1} = I_{B2} = −0.5A)	t_f	100	nsec

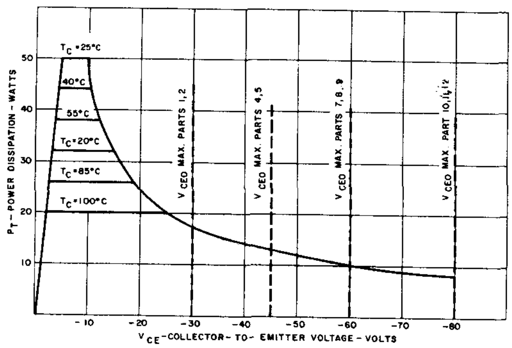
NOTE:
(3) Pulsed measurement, 300 μsec pulse, duty cycle ≤ 2%.



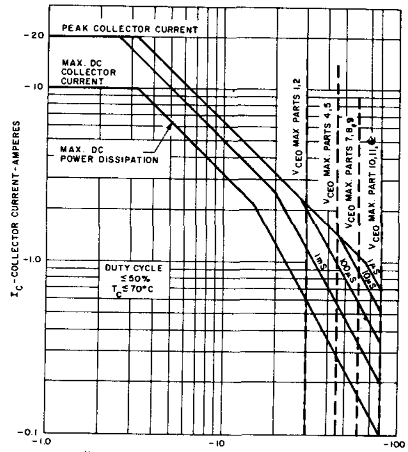
TYPICAL GAIN CHARACTERISTICS



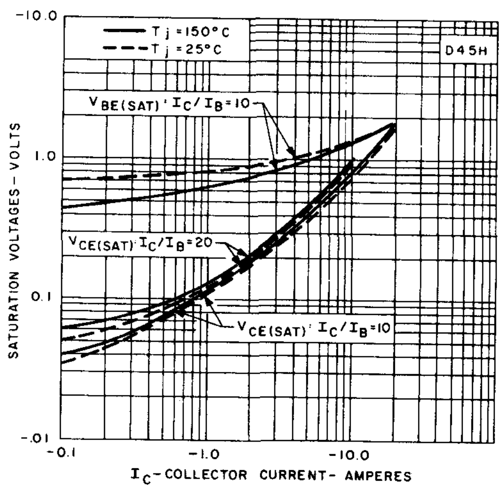
TYPICAL GAIN CHARACTERISTICS



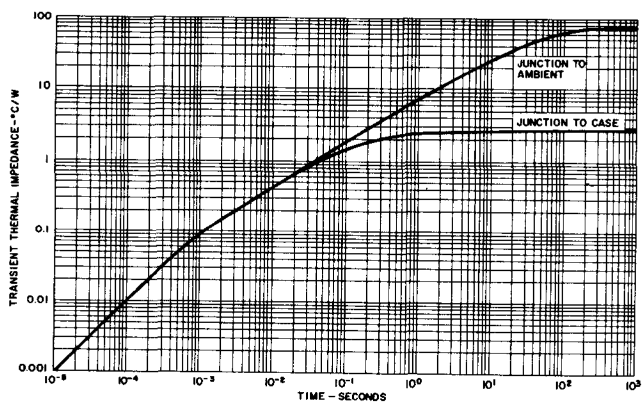
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



SAFE REGION OF OPERATION



TYPICAL SATURATION VOLTAGE CHARACTERISTICS



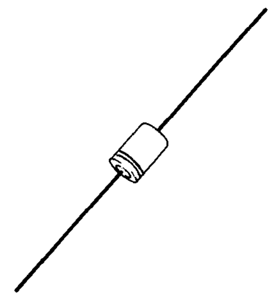
TRANSIENT THERMAL IMPEDANCE

Silicon
Diodes

DA1701-4

This family of General Electric Double Heatsink Diodes are very high speed switching diodes for computer circuits and general purpose applications. These diodes incorporate an oxide passivated epitaxial pellet with a raised solid silicon anode contact.

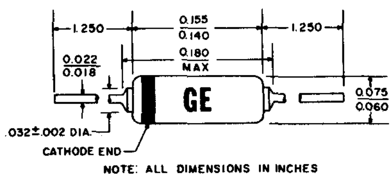
These DA-series diodes *exceed* the electrical and mechanical requirements of the following JEDEC devices:



DA1701		DA1702	DA1703
1N914	1N4153	1N4151	1N4152
1N914A	1N4154	1N4152	1N4154
1N916	1N4446	1N4153	1N4727
1N916A	1N4447	1N4154	
1N4148	1N4448	1N4454	
1N4149	1N4454	1N4727	
1N4151	1N4727		
1N4152			

Standard Cathode Band and Body Marking Colors:

DA1701 — Violet
DA1702 — Yellow
DA1703 — Green
DA1704 — Black
Body marking will consist *only* of the GE symbol



absolute maximum ratings: (25°C)

		DA1701	DA1702	DA1703	DA1704	
Voltage						
Reverse		100	75	40	25	Volts
Current						
Average Rectified	I_o	←	← 200 →		→	mA
Recurrent Peak Forward	I_F peak	←	← 600 →		→	mA
Forward Steady State D-C		←	← 150 →		→	mA
Peak Forward Surge (1μ sec)		←	← 4 →		→	Amps
Derate above 25°C		←	← 1.1 →		→	mA/°C
Temperature						
Operating		←	← −65 to +175 →		→	°C
Storage		←	← −65 to +200 →		→	°C

Power Dissipation

Heatsink Spacing From End of Diode Body	Power Dissipation at 25°C (mW) (Note 1)	Steady State Thermal Resistance (°C/mW)
0.125 inches	700	0.250
0.250 inches	550	0.319
0.500 inches	460	0.380

Note 1: The maximum power dissipation is defined as the heat dissipating capability of the diode when operated at 25°C as an A-C signal device within the absolute maximum voltage and current ratings specified above. The power rating is based on a maximum junction temperature of 200°C. The steady state thermal resistance (°C/mW) can be used to calculate the power dissipating capabilities, within the maximum voltage and current ratings, at temperatures other than 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

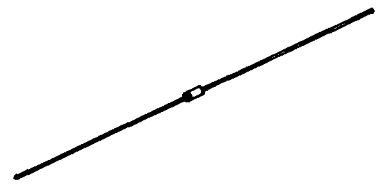
		DA1701		DA1702		DA1703		DA1704		
Forward Voltage	V_F	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	
(I_F = 0.100mA)		0.490	0.550	0.490	0.550	0.490	0.550	0.460	0.570	Volts
(I_F = 1.0 mA)		0.590	0.650	0.590	0.650	0.590	0.650	0.570	0.680	Volts
(I_F = 10 mA)		0.700	0.810	0.700	0.810	0.700	0.810	0.680	0.850	Volts
(I_F = 30 mA, Note 2)		0.780	0.930	0.780	0.930	0.780	0.930	0.740	1.00	Volts
(I_F = 50 mA, Note 2)		0.830	1.00	0.830	1.00	0.830	1.00	0.770	1.10	Volts
(I_F = 100 mA, Note 2)		0.935	1.10	0.935	1.10	0.935	1.10	0.820	1.30	Volts
Reverse Current	I_R									
(V_R = 15 Volts)									50	nA
(V_R = 20 Volts)									100	nA
(V_R = 30 Volts)			30		30		50			nA
(V_R = 30 Volts, T_A = 150°C)			30		30		50			μA
(V_R = 50 Volts)			50		50					nA
(V_R = 50 Volts, T_A = 150°C)			50		50					μA
(V_R = 75 Volts)			5							μA
Breakdown Voltage	B_V									
(I_R = 5μA)				75		40		25		Volts
(I_R = 100μA)		100								Volts
Stored Charge	Q_S									
(I_F = 10mA, Note 3)			40		40		40		40	pC
Peak Forward Voltage	V_P									
(I_F = 50mA, tr = 10nS, Note 4)			3.0		2.75		1.75		1.75	Volts
Capacitance	C_O									
(V_R = 0V, f = 1MHz, Signal Level = 50mV, Note 5)			1.0		1.0		2.0		3.0	pF

Note 2: Pulsed measurement with pulse width ≤350μ Sec, duty cycle ≤2%.
Note 3: Test method per JEDEC suggested standard number for direct measurement of diode stored charge, B-Line Electronics Corporation stored charge meter Model QS-3 or equivalent.
Note 4: Measured per EIA Standard RS-286.
Note 5: Capacitance as measured on Boonton Electronics Model 75A Capacitance Bridge (or equivalent).

Silicon Signal Diode

DE104

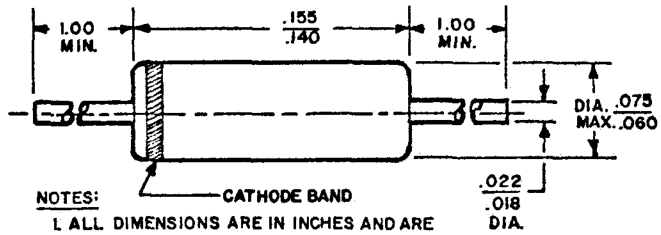
The General Electric type DE104 is a very low leakage diode for general application. This diode incorporates an oxide passivated planar structure built in a high resistivity epitaxial layer grown on a low resistivity silicon substrate. This structure makes possible a diode having high conductance, low leakage and low capacitance, combined with improved uniformity and reliability. Type DE104 is housed in a standard glass diode D110 package.



absolute maximum ratings: (25 °C) (unless otherwise specified)

Current	
Average Rectified	75 mA
Forward Steady-State DC	50 mA
Recurrent Peak Forward	225 mA
Peak Forward Surge (1.0 μsec pulse)	2000 mA
Power	
Dissipation (25°C)	250 mW
Temperature	
Operating	−65 to +175°C
Storage	−65 to +200°C

*Derate 1.43 mW/°C above 25°C based on T_J = 200°C.



NOTES:
1. ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.
2. LEAD DIAMETER NOT CONTROLLED WITHIN .050" OF THE BODY.

electrical characteristics (25 °C) (unless otherwise specified)

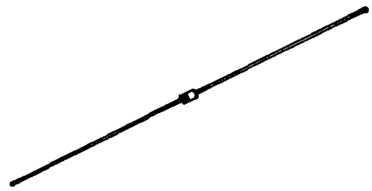
	SYMBOL	MIN.	MAX.	UNITS
Forward Voltages				
I_F = 10 μA	V_F	0.520	0.620	Volts
I_F = 100 μA		0.610	0.700	Volts
I_F = 1.0 mA		0.700	0.790	Volts
I_F = 10 mA		0.790	0.890	Volts
I_F = 50 mA		0.875	1.000	Volts
I_F = 100 mA (Note 1)		0.930	1.100	Volts
Reverse Current				
V_R = 20 Volts	I_R	–	20	pA
V_R = 20 Volts, T_A = 150°C		–	100	nA
Breakdown Voltage				
I_R = 5 μA	B_V	40	–	Volts
Capacitance				
V_R = 0 Volts (Note 2)	C_o	–	4	pF

NOTES:
1. Pulsed measurement (pulse width ≤ 300μsec, duty cycle ≤ 2%).
2. Capacitance as measured on Boonton Model 75A, capacitance bridge at a signal level of 50 mV and a frequency of 1 MHz.

Silicon Signal Diodes

DE110, DE111, DE112, DE113, DE114, DE115

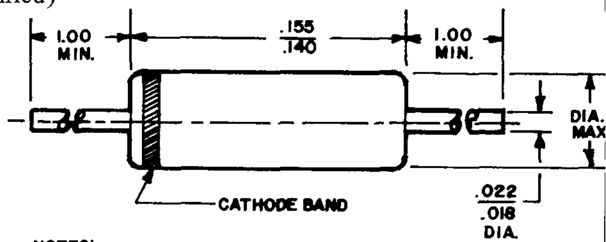
These General Electric Signal Diodes are very low leakage diodes for general application. They incorporate an oxide passivated planar structure built in a high resistivity epitaxial layer grown on a low resistivity silicon substrate. This structure makes possible a diode having high conductance, low leakage and low capacitance, combined with improved uniformity and reliability. They are housed in a standard D HD glass diode package.



absolute maximum ratings: (25°C) (unless otherwise specified)

Current	
Average Rectified	75 mA
Forward Steady-State DC	50 mA
Recurrent Peak Forward	225 mA
Peak Forward Surge (1.0 µsec pulse)	2000 mA
Power	
Dissipation (25°C)	250 mW
Temperature	
Operating	−65 to +175°C
Storage	−65 to +200°C

*Derate 1.43 mW/°C temperature above 25°C based on T_J max. = 200°C



NOTES:
1. ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.
2. LEAD DIAMETER NOT CONTROLLED WITHIN .050" OF THE BOD

electrical characteristics (25°C) (unless otherwise specified)

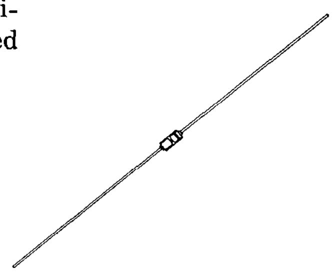
	DE110		DE111		DE112		DE113		DE114		DE115		
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	UNITS
Forward Voltage (V_F)													
(I_F = 10 µA)	0.500	0.600	0.500	0.600	–	–	–	–	0.500	0.600	0.500	0.600	Volts
(I_F = 100 µA)	0.590	0.690	0.590	0.690	–	–	–	–	0.590	0.690	0.590	0.690	Volts
(I_F = 1.0 mA)	0.680	0.780	0.680	0.780	–	–	–	–	0.680	0.780	0.680	0.780	Volts
(I_F = 10 mA)	0.780	0.880	0.780	0.880	–	–	–	–	0.780	0.880	0.780	0.880	Volts
(I_F = 50 mA)	–	–	–	–	–	1.0	–	1.0	–	–	–	–	Volts
(I_F = 100 mA) (Note 1)	0.880	1.200	0.880	1.200	–	–	–	–	0.880	1.200	0.880	1.200	Volts
Reverse Current (I_R)													
(V_R = 20 Volts)	–	–	–	200	–	100	–	250	–	–	–	–	pA
(V_R = 20 Volts, T_A = 150°C)	–	–	–	0.500	–	0.250	–	0.500	–	–	–	–	µA
(V_R = 30 Volts)	–	2.0	–	–	–	–	–	1.0	–	–	–	–	nA
(V_R = 30 Volts, T_A = 150°C)	–	4.0	–	–	–	–	–	2.0	–	–	–	–	µA
(V_R = 50 Volts)	–	–	–	5.0	–	–	–	–	–	–	–	2.0	nA
(V_R = 50 Volts, T_A = 150°C)	–	–	–	10.0	–	–	–	–	–	–	–	4.0	µA
Breakdown Voltage (B_v)													
(I_R = 5 µA)	40	–	–	–	–	–	–	–	40	–	–	–	Volts
Capacitance (C_o)													
(V_R = 0) (Note 2)	–	4	–	4	–	6	–	6	–	4	–	4	pF

NOTES:
1. Pulsed measurement (pulse width ≤ 300 µsec, duty cycle ≤ 2%).
2. Capacitance as measured on Boonton model 75A capacitance bridge at a signal level of 50 mV and a frequency of 1 mE.

Low Current Rectifier

DT230 SERIES

The General Electric DT230 250 milliampere rectifier is a planar epitaxial passivated rectifier sealed in the DO35 double heatsink package. The DT230 is designed primarily for the industrial and consumer markets.

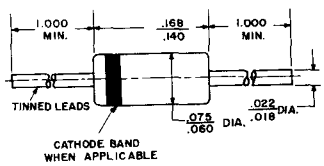


Features

Glass Package
Hermetic Seal
Capable of 15 lb. Lead Pull
Proved Design—GE innovated DHD package
Silicon Anode Contact Pellet
Eutectic Bond Between Pellet and Slugs

Typical Applications

Color Television Difference Amplifier Clamp
Arc Protection Color Television Video Output
Low Current Power Supply Rectification
Operational Amplifiers
Measurement Systems
Arc Suppression
DC to DC Converters
Free Wheeling Rectifiers
Telephone Equipment Switching

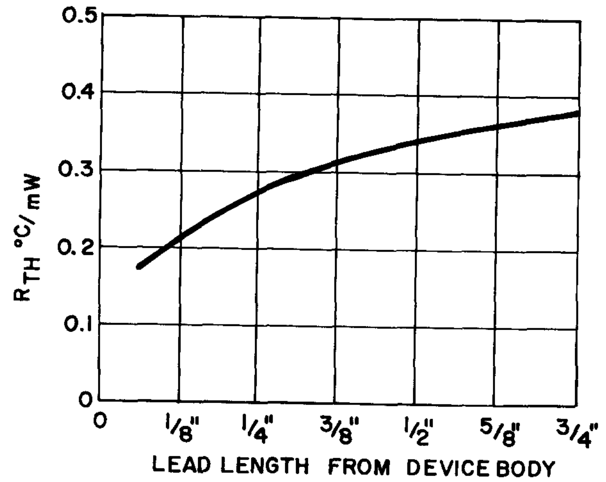


maximum ratings (25°C) (unless otherwise specified)

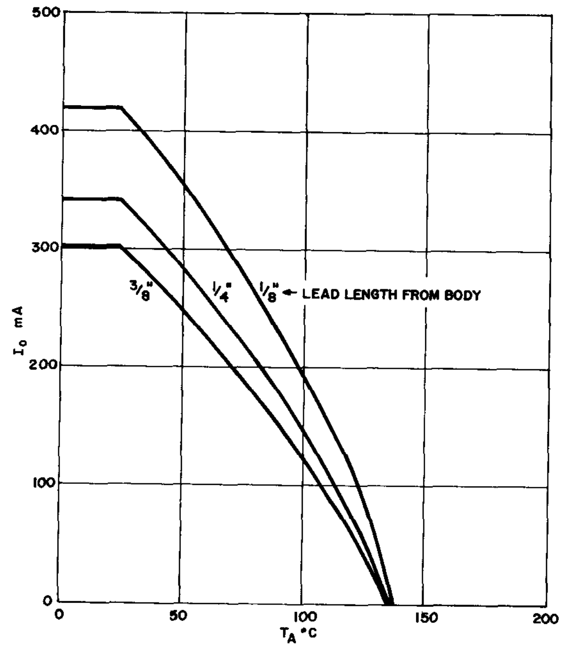
DT230	H	HI	B	G	A	F
Reverse Voltage Working	250	250	200	150	100	50 Volts
Peak, V_{RM}, DC, V_R	250	250	200	150	100	50 Volts
Average Forward Current I_O @ 50°C	← 250 → mA					
Peak Forward Surge I_{FSM} Non-Repetitive .0083 sec. half sine wave	← 5 → A					
Maximum Average Power	← 350 → mW					
Junction Temperature Storage Tstg	← −65 to 200 → °C					
Temperature Operating Junction T_J	← −65 to 150 → °C					

characteristics

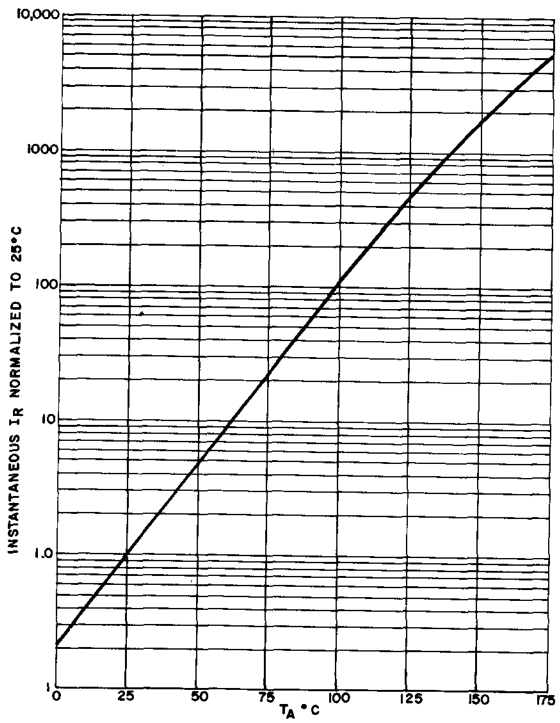
DT230 Part No.	H	HI	B	G	A	F
Maximum Forward Voltage Drop V_F @ 25°C I_F = 250 ma	—	1.1	1.1	1.1	1.1	1.1 Volts
I_F 200 ma	1.0	—	—	—	—	— Volts
Maximum Reverse Current @ V_{RM} I_R 25°C	← 1 → μA					
I_R 100°C	← 300 → μA					
Reverse Recovery Time, trr Typical	← 30 → ηsec					
Maximum	← 300 → ηsec					
Capacitance V_R = 0 C_O Typical	← 2 → pF					
Maximum	← 5 → pF					



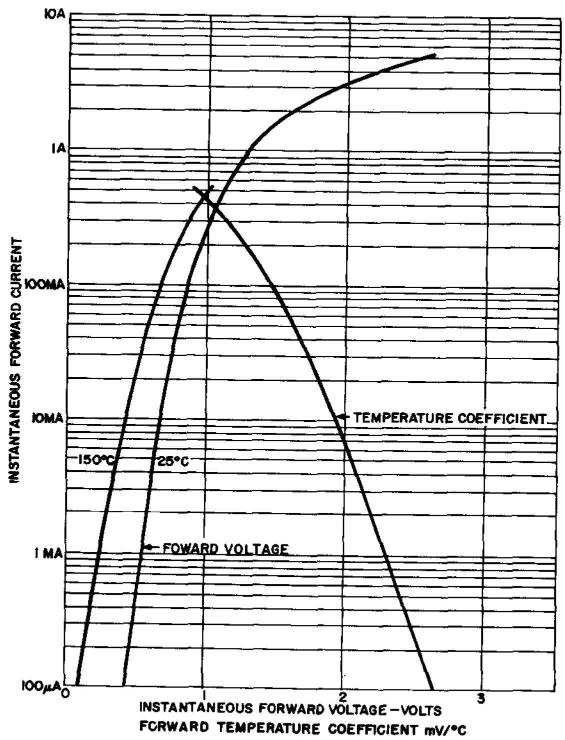
TYPICAL THERMAL IMPEDANCE VS. LEAD LENGTH



AVERAGE FORWARD CURRENT VS. AMBIENT TEMPERATURE SINGLE PHASE OPERATION



TYPICAL REVERSE CURRENT VS. TEMPERATURE AT V_{RM}

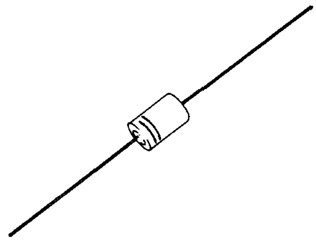


TYPICAL I_F VS. V_F AT T_A
TYPICAL I_F VS. T. C.

Silicon Diodes

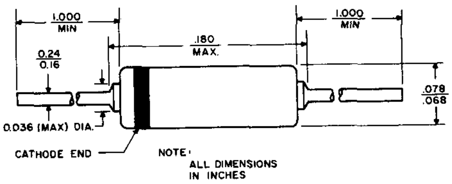
DZ800, 5, 6

General Electric types DZ800, DZ805 and DZ806 are high-speed, silicon signal diodes intended for general purpose applications. The DZ800 series has controlled conductance characteristics for stabistor applications.



absolute maximum ratings: (25°C) (unless otherwise specified)

Voltage		
Reverse DZ800	2	Volts
DZ805	15	Volts
DZ806	25	Volts
Current		
Forward Steady State DC	70	mA
Recurrent Peak Forward	135	mA
Power		
Dissipation	150	mW
Temperature		
Operating	−55 to 125°C	



electrical characteristics: (25°C) (unless otherwise specified)

		Min.	Typ.	Max.	
Forward Voltage					
($I_F = 0.100$ mA)	V_{F1}	0.430		0.550	Volts
($I_F = 1.0$ mA)	V_{F1}	0.530		0.690	Volts
($I_F = 2.0$ mA)	V_{F1}	0.560		0.720	Volts
($I_F = 10$ mA)	V_{F1}	0.640		0.800	Volts
($I_F = 100$ mA, Pulsed)	V_{F1}	0.800		1.300	Volts
Reverse Current					
DHD800 ($V_R = 2V$)	I_R			2.0	μA
DHD805 ($V_R = 12V$)	I_R			2.0	μA
DHD806 ($V_R = 22V$)	I_R			2.0	μA
Breakdown Voltages					
DHD805 ($I_R = 5$ μA)	B_V	15			Volts
DHD806 ($I_R = 5$ μA)	B_V	25			Volts
Stored Charge					
($I_F = 10$ mA)	Q_s		40		pC
Capacitance					
($V_R = 0V$)*	C_o		4		pF

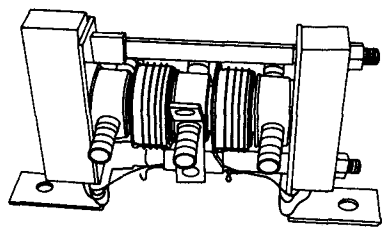
*Capacitance as measured on Boonton Model 75A capacitance bridge at a signal level of 50 mV and a frequency of 1 MHz.

WATER-COOLED

Heat Exchanger

G6 SERIES

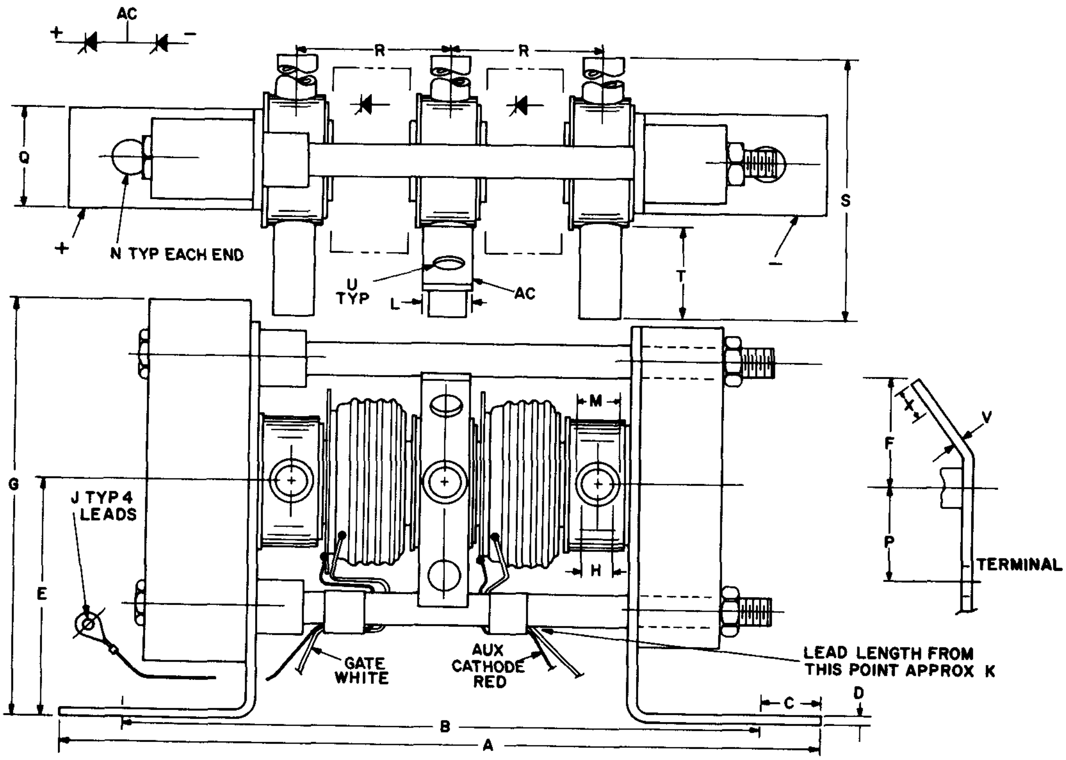
The General Electric Type G 6 water-cooled heat exchangers are designed for the efficient cooling of high power silicon controlled rectifiers



Special features of this heatsink are:

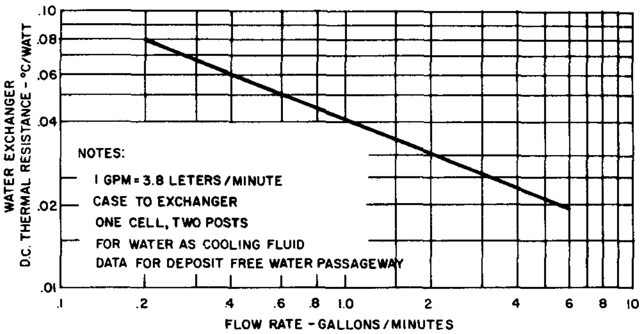
- Light weight, compact design.
- High efficiency at low coolant flow rates
- Double-side cooling of cell for maximum current capability.
- Factory assembled and tested for high reliability.

OUTLINE USING G6 TO COOL TWO 1" PRESS PAKS IN VOLTAGE DOUBLER CONNECTION

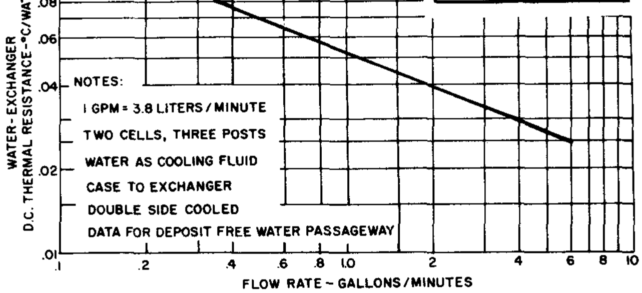


SYM	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.
A	9.100	9.400	231.14	238.76
B	7.620	7.880	193.55	200.15
C	.740	.760	18.80	19.30
D	.120	.130	3.05	3.30
E	2.950	REF.	74.93	REF.
F	1.350	REF.	34.29	REF.
G	5.075	5.325	128.95	135.26
H	.375	REF.	9.53	REF.
J	.137	.153	3.48	3.89
K	9.000	REF.	228.60	REF.
L	.615	.635	15.62	16.13
M	.490	.510	12.45	12.95
N	.432	.442	10.97	11.23

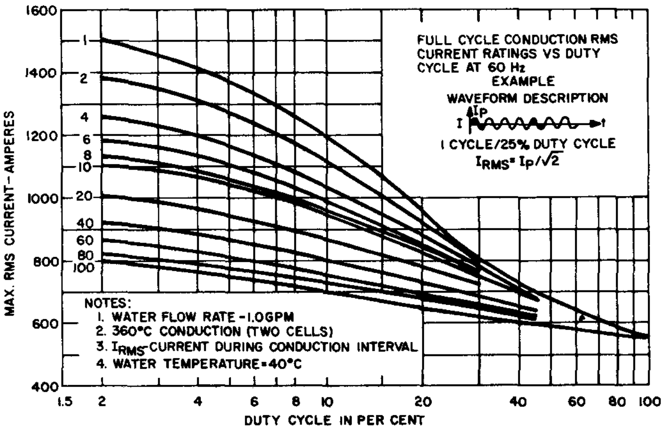
SYM	DECIMAL INCHES MIN.	DECIMAL INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.
P	1.540	1.585	39.12	40.26
Q	1.235	1.285	31.37	32.64
R	1.845	REF.	46.86	REF.
S	3.665	3.985	93.09	101.22
T	1.030	1.160	26.16	29.46
U	.380	.395	9.65	10.03
V	.115	.135	2.92	3.43
W				
X	.406	REF.	10.31	REF.



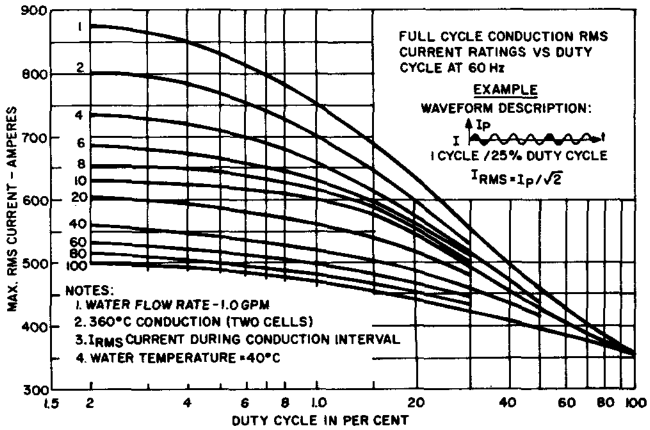
1. THERMAL RESISTANCE VS. FLOW RATE (ONE CELL, TWO POSTS)



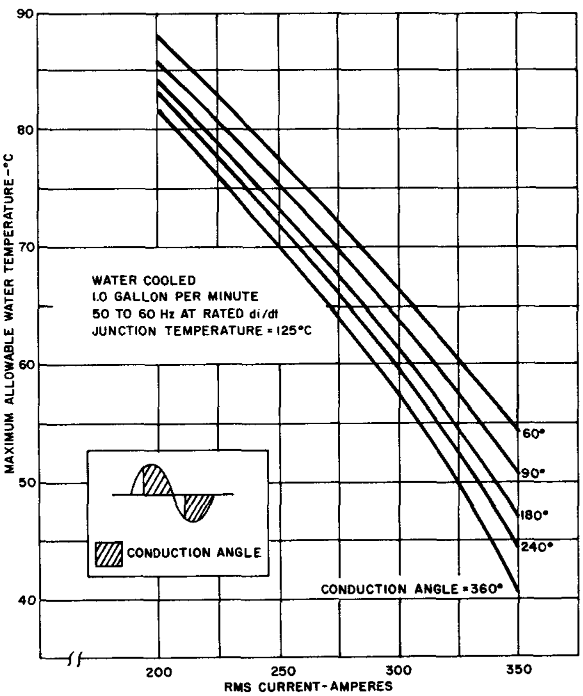
2. THERMAL RESISTANCE VS. FLOW RATE (TWO CELLS, THREE POSTS)



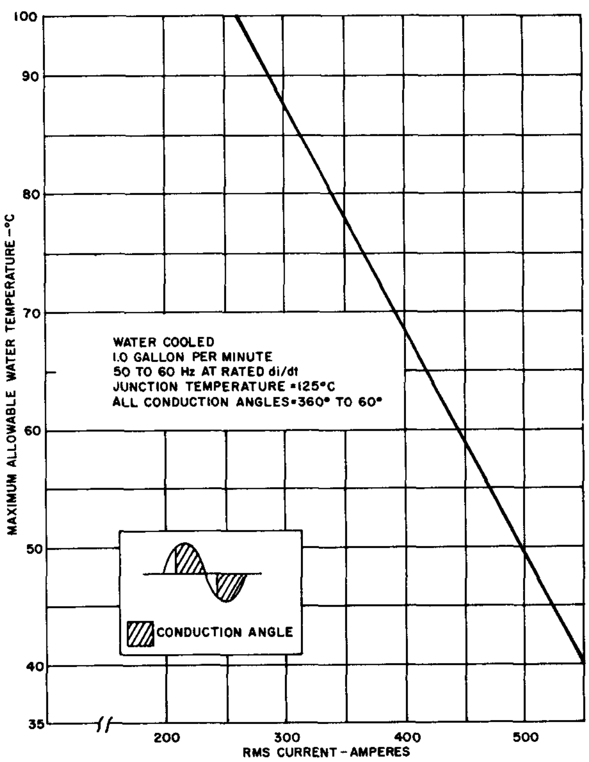
3. WELDING RATINGS - SCR TYPE C380 (TWO CELLS)



4. WELDING RATINGS - SCR TYPE C350 (TWO CELLS)



5. PHASE CONTROL RATINGS - SCR TYPE C350 (TWO CELLS)



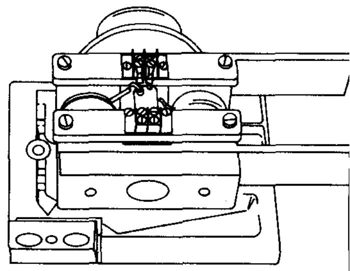
6. PHASE CONTROL RATING - SCR TYPE C380 (TWO CELLS)

WATER-COOLED

Heat Exchanger

G9/G10

The G9/G10 water cooled switches are designed for the efficient cooling of two (2) type C500 series power thyristors connected as an AC switch.



Features:

1) Insulating mounting base containing built-in cooling fluid passageways.
2) Screw-on connections for metallic water piping.
3) Nickel-plated power connection tangs.

Maximum Allowable Ratings

Maximum Allowable Peak Volts Off-State (PFV, PRV) . .	Depends on Choice of Particular C500 Series Thyristor
Switch RMS Current (Sinusoidal Waveform)	
Peak One-Cycle Surge, 60 Cycles	
Junction Operation Temperature	
Storage Temperature	-40°C to 65°C
Maximum Ambient Temperature	65°C
Maximum Water Pressure	60 psig
Maximum Water Temperature	50°C

Environmental Capabilities

Water Quality	Tap Water With No Additives (See Note 1)
Salt Spray	Test Condition A of Methods 101 of Standard MIL-STD-202
Moisture Resistance . . .	Method 106 of MIL-STD-202 (See Note 2)
Flammability	Materials are UL Rated, Flam. Class S.E. (Self Extinguishing)

Characteristics

Maximum On-State Voltage	Refer To Particular C5__ Specifications
On-State Losses (Per Device)	
Steady State Thermal Resistance	See Figure 1
Transient Thermal Impedance	See Figure 2
Pressure Drop Vs Water Flow	See Figure 3
Weight	17 Pounds

Note 1: Quality of Water - Water shall have:

(a) A neutral or slightly alkaline reaction, i.e., a pH between 7.0 and 9.0

(b) A chloride content of not more than 20 parts per million; a nitrate content of not more than 10 parts per million; and a sulphate content of not more than 100 parts per million.

(c) A total solids content of not more than 250 parts per million.

(d) A total hardness, as calcium carbonate, of not more than 250 parts per million.

No additives are to be used without prior approval from the switch manufacturer's Application Engineering department.

Note 2: This test simulates a realistic condition which may occur when equipment is stored or is inoperative under high humidity conditions. When the switch is to be placed in operation, all surface moisture must be eliminated before power is applied, otherwise catastrophic electrochemical failure can be induced.

Coordination between cooling water and the prevailing humidity is necessary to avoid condensation on the water jackets and electrical insulation. Ordinarily this is no problem with 40°C cooling water. In some cases with lower temperature water, humidity control has been necessary to stop condensation completely.

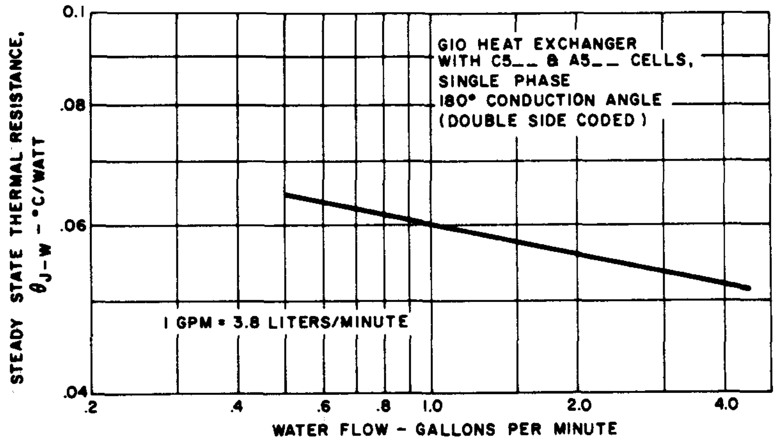


Figure 1: Steady State Thermal Resistance

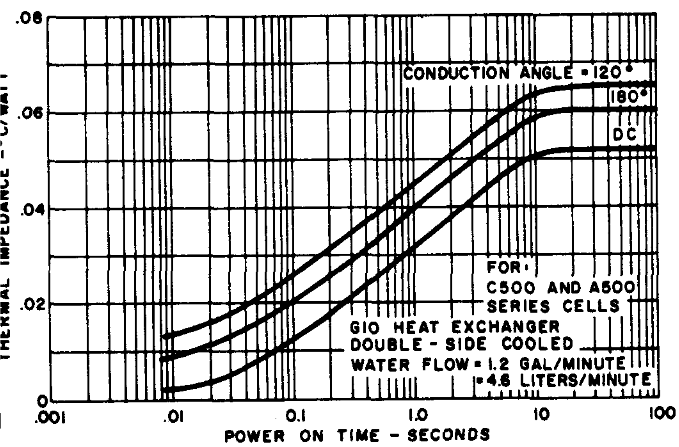


Figure 2: Transient Thermal Impedance

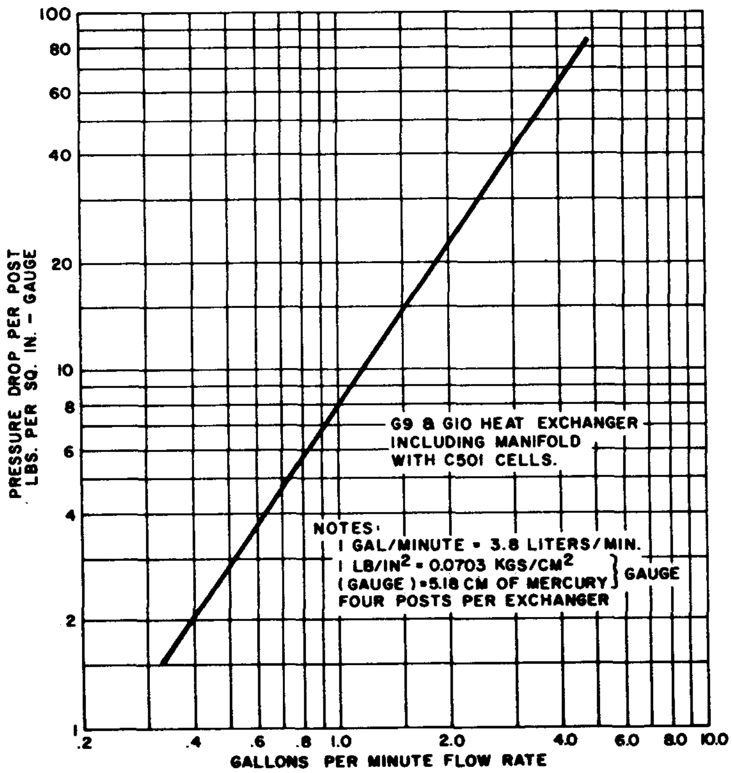
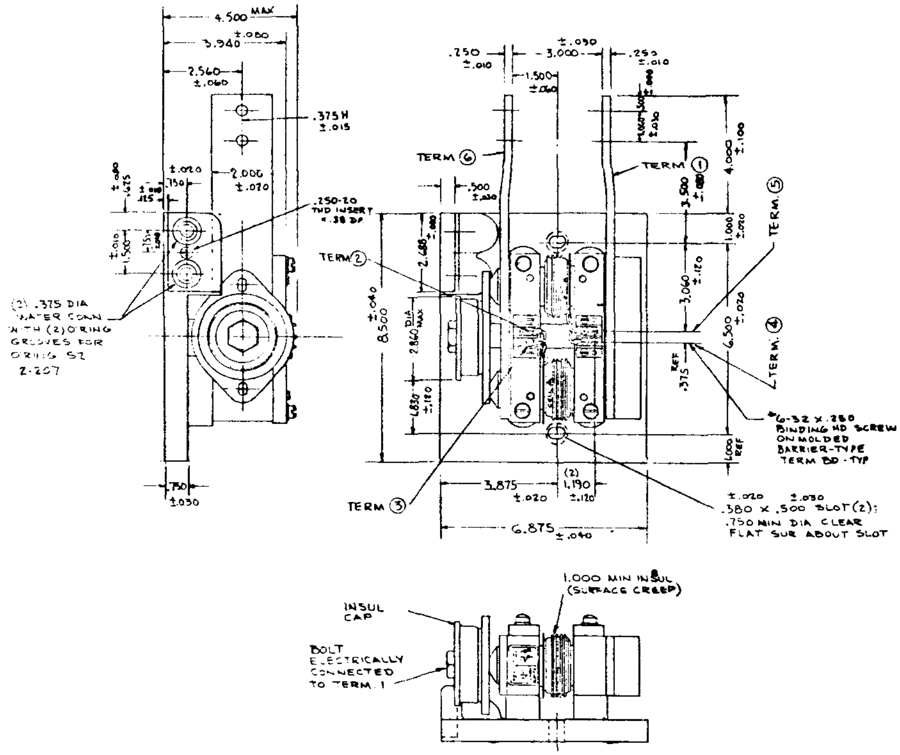
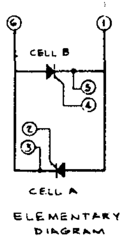


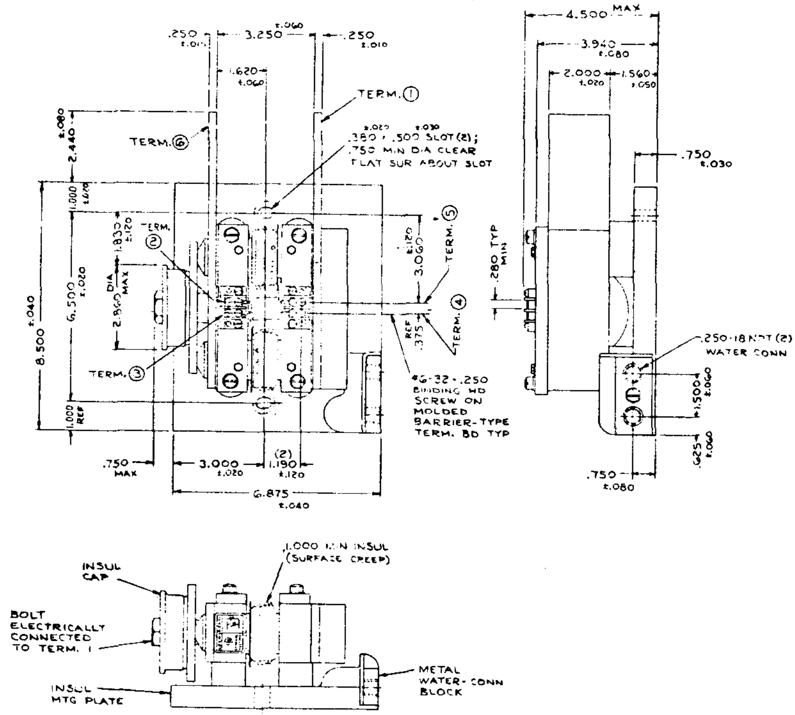
Figure 3: Pressure Drop For Water Flow

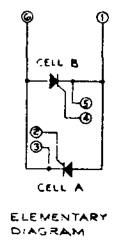
OUTLINE DRAWING: G9 AC CONTACTOR





OUTLINE DRAWING: G10AC CONTACTOR





MOUNTING & HANDLING

1) Visually examine the switch before it is mounted to see that it has not been damaged during shipping or handling.

2) A low-resistance electrical connection must be made to the power connections in order to avoid feeding heat back into the SCR's. The power terminals may be lightly abraded with #400 grit emery paper, wiped clean and contact grease added to reduce oxidation. (Power terminals are nickel-plated.)

3) When mounting the insulating base, the following precautions should be taken to avoid distorting the plastic part.

   a) The mounting surface is to be flat within 0.030".

   b) Bolts or nuts which are used to hold the switch into the equipment shall be used with a flat washer against the plastic base. Torque values shall not be exceeded. (8 ft-lbs max for 1/4" screw) (15 ft-lbs max for 5/16" screw) Flat washer should be 0.7" to 0.9" OD.

4) For pipe connections, a sealing agent such as teflon joint compound shall be used in order to limit the torque needed in order to get a water-tight joint.

5) Prior to shipment or exposure of switch to freezing temperatures, the water is to be purged from the switch and cooling base to avoid freeze-up with its likely damage to the parts in the assembly. The water may be removed by blowing it out with dry air. Care should be exercised to limit the applied air pressure to less than 60 psig (rated pressure for the assembly). If hoses are connected to the switch assembly, it is recommended that they be removed before purging to avoid water backfill.

Water-cooled Heat Exchanger

G11 SERIES

The General Electric Type G11 water-cooled heat exchangers are designed for the efficient cooling of C300 series high power silicon controlled rectifiers and rectifier diodes.

FEATURES:

- Basic exchanger suitable for use in AC switches and parallel applications of diodes and SCR's.
- Unique large surface area coolant passage provides high thermal conduction at low flow rates.
- Light weight, compact design factory assembled and tested.
- Double-side cooling of cell for maximum current capability.

ratings and characteristics:

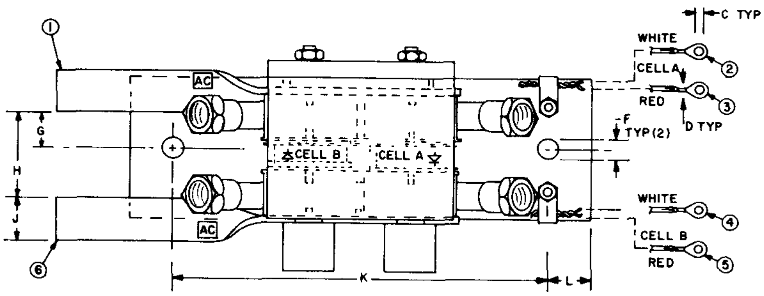
Steady State Thermal Resistance . . . . See Figure 1
Pressure Drop Vs Water Flow . . . . See Figure 2
Storage Temperature . . . . -40°C to 100°C
Maximum Ambient Temperature . . . . 100°C
Maximum Water Pressure . . . . 75 psig
Maximum Water Temperature . . . . 75°C
Weight . . . . 5 Pounds

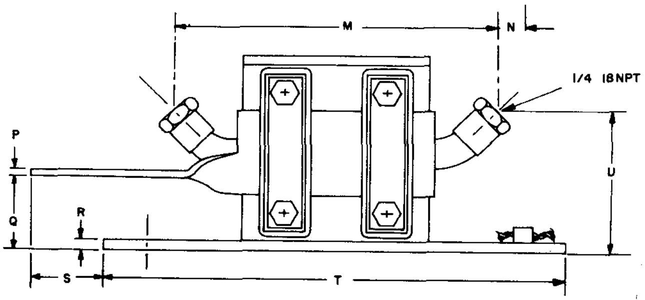
QUALITY OF WATER – WATER SHALL HAVE:

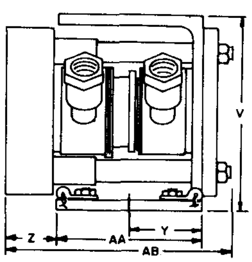
1) A neutral or slightly alkaline reaction, ie. a pH between 7.0 and 9.0
2) A chloride content of not more than 20 ppm; a nitrate content of not more than 10 ppm; and a sulphate content of not more than 100 ppm.
3) A total solids content of not more than 250 ppm.
4) A total hardness, as calcium carbonate, of not more than 250 ppm.

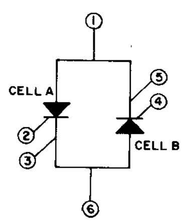
No additives are to be used without prior approval from the switch manufacturer's Application Engineering Department.

OUTLINE DRAWING









SYM	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
C	.137	.153	3.479	3.886
D	–	.300	–	7.62
F	.385	.395	9.78	10.02
G	.550	.670	13.98	17.01
H	1.400	1.600	35.57	40.63
J	.740	.760	18.80	19.29
K	6.460	6.540	164.09	166.11
L	.720	.780	18.29	19.80
M	5.500	5.750	139.71	146.04
N	.312	.562	7.93	14.26
P	.115	.135	2.93	3.42
Q	1.047	1.177	26.60	29.89

SYM	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
R	.180	.215	4.58	5.45
S	1.160	1.600	29.47	40.63
T	7.950	8.050	201.94	204.46
U	2.50	REF.	63.5	REF.
V	–	4.000	–	101.59
W	.660	.790	16.77	20.06
X	1.250	1.410	31.76	35.80
Y	1.240	1.260	31.50	31.99
Z	.800	1.000	20.33	25.39
AA	3.485	2.580	63.12	65.52
AB	–	4.180	–	106.16

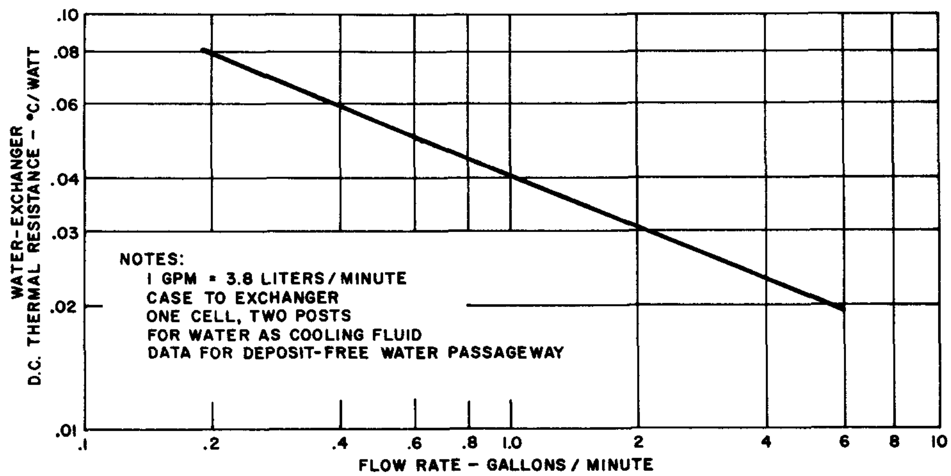


FIGURE 1: THERMAL RESISTANCE VS FLOW RATE (ONE CELL, TWO POSTS)

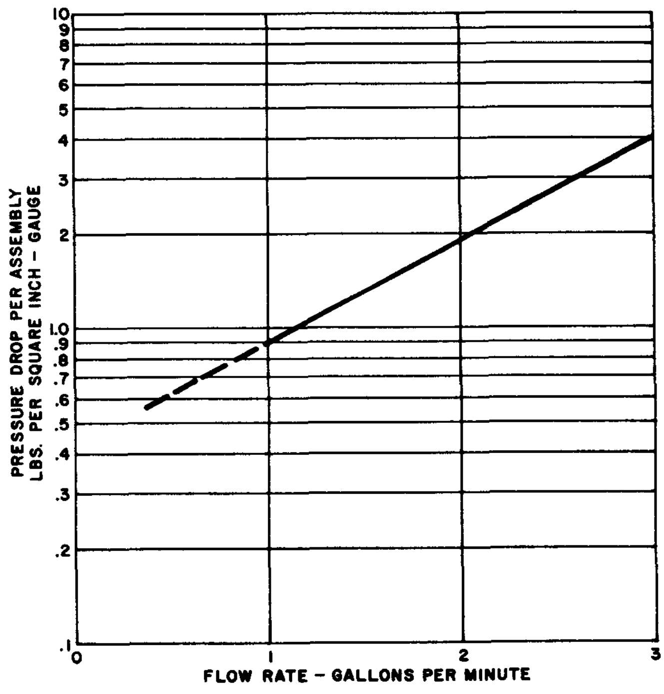


FIGURE 2: PRESSURE DROP PER G11 ASSEMBLY
(FOUR COOLING POSTS IN SERIES EXCLUDING PRESSURE DROPS OF CONNECTING HOSING)

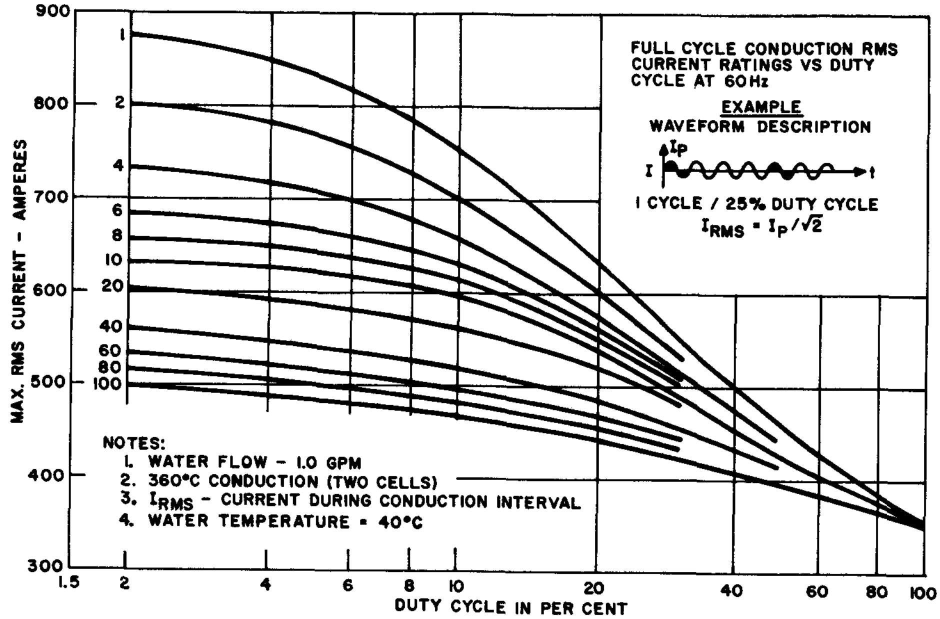


FIGURE 3: WELDING RATINGS - SCR TYPE C350 (TWO CELLS)

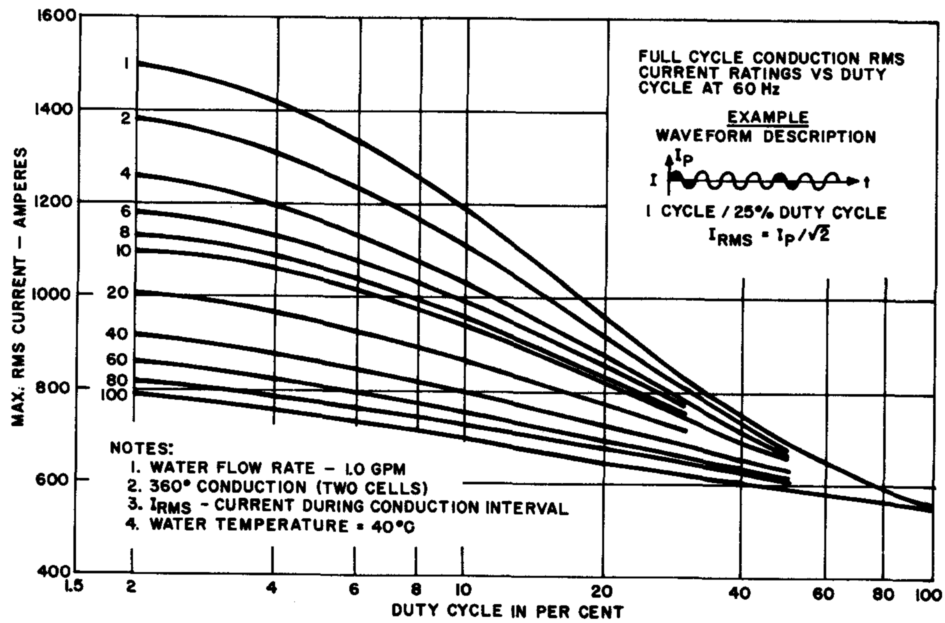


FIGURE 4: WELDING RATINGS - SCR TYPE C380 (TWO CELLS)

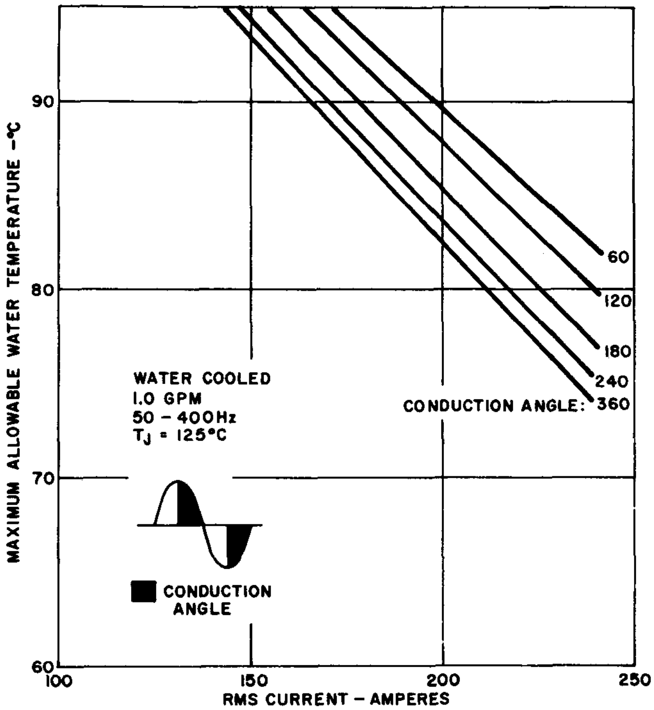


FIGURE 5: PHASE CONTROL CHARACTERISTICS TWO C350 SCR'S

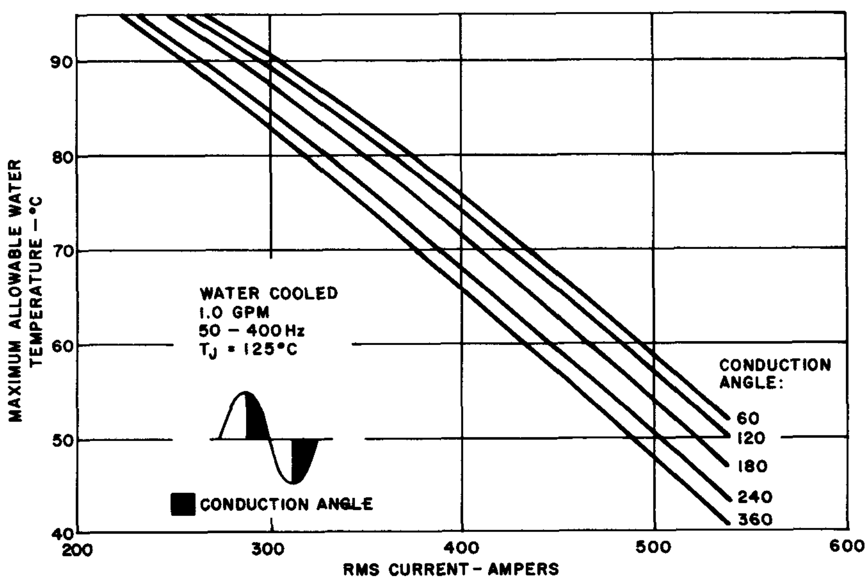


FIGURE 6: PHASE CONTROL CHARACTERISTICS TWO C380 SCR'S

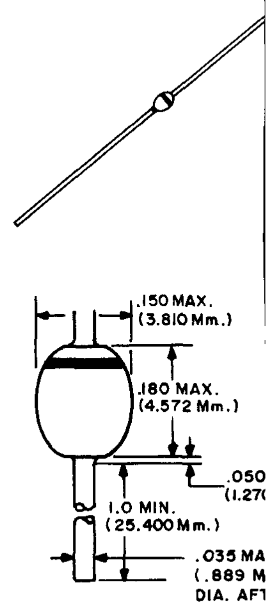
Passivated Rectifier

REPLACEMENT FOR 1N4001-4007

GER SERIES

GER4001
GER4002
GER4003
GER4004
GER4005
GER4006
GER4007

THE GENERAL ELECTRIC GER SERIES IS A 2 AMPERE RATED, AXIAL LEADED GENERAL PURPOSE RECTIFIER. DUAL HEATSINK CONSTRUCTION PROVIDES RIGID MECHANICAL SUPPORT FOR THE PELLET AND EXCELLENT THERMAL CHARACTERISTICS. PASSIVATION AND PROTECTION OF THE SILICON PELLETS PN JUNCTION ARE PROVIDED BY SOLID GLASS; NO ORGANIC MATERIALS ARE PRESENT WITHIN THE HERMETICALLY SEALED PACKAGE.



ALL DIMENTIONS ARE IN
AND (METRIC)
*WELD AND SOLDER FLASH
CONTROLLED IN THIS A

absolute maximum ratings: (25°C unless otherwise specified)

Ratings	*Symbol*	GER 4001	GER 4002	GER 4003	GER 4004	GER 4005	GER 4006	GER 4007
Reverse Volt Working Peak, DC, V_R	$V_{RM(wkg)}$	50	100	200	400	600	800	1000
Ave Half Wave 75°C	I_O • mA	1000	1000	1000	1000	1000	1000	1000
Rectified Forward Current 25°C	mA	2000	2000	2000	2000	2000	2000	2000
Peak Forward Current 25°C	I_{FM} (surge A)	30	30	30	30	30	30	30
½ Cycle Surge 60 Hz	I_{FM} (Rep)	10	10	10	10	10	10	10
Max. Junction Temperature	T_j	175°C	175°C	175°C	175°C	175°C	175°C	175°C

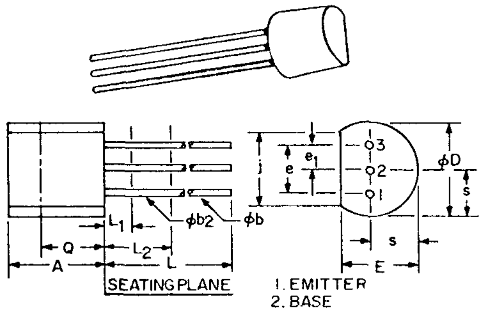
electrical characteristics:

Max. Forward Volt Drop 1 Amp Continuous DC 25°C	V_F	← 1.1 Volts →	
Max. Full Cycle Average Forward Voltage Drop (Rated Current @ 25°C)	$V_{F(av)}$	← .8 Volts →	
Maximum Reverse Current @ Rated V_R (25°C)	I_R	.01	mA
(100°C)	I_R	.05	mA
Maximum Full Cycle Average Reverse Current	I_R(av)	.03	mA
Operating & Storage Temperature Range	Tj, Tstg	−65 to +175	°C

Silicon
Transistors

NPN
GES929,30

Electrical replacements for 2N929 and 2N930



TO-92

1. EMITTER
2. BASE
3. COLLECTOR

The General Electric GES929 and GES930 are NPN, silicon, planar, epitaxial, passivated transistors. These devices feature very high gain at extremely low collector currents, low leakage currents and inherent low noise characteristics. These transistors are ideally suited for low level amplifier applications and, with leads in a TO-92 pin configuration, are epoxy replacements for the 2N929 and 2N930 type devices.

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) $\phi b2$ APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	50	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	70	Volts
Current			
Collector (Steady State)	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C)†	P_T	360	mW
Total Power (Free Air @ 55°C)†	P_T	250	mW
Temperature			
Storage	T_{STG}		−65 to +150°C
Operating	T_J		+125°C
Lead Soldering, 1/16" ± 1/32" from case for 10 sec. max.	T_L		+260°C

†Derate 3.6 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics

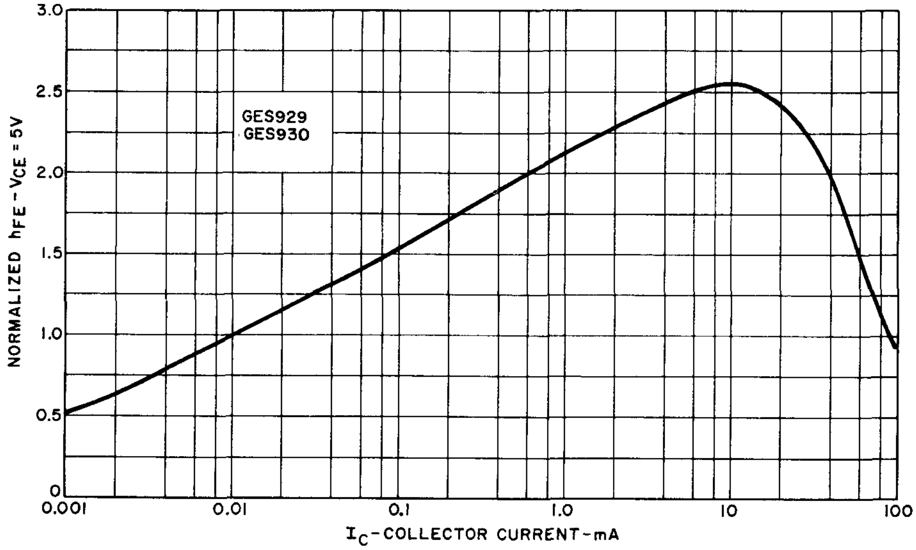
				Min.	Max.	
Collector Cutoff Current (V_{CB} = 50V)			I_{CBO}		10	nA
(V_{CB} = 50V, TA = 100°C)			I_{CBO}		10	μA
(V_{CB} = 50V)			I_{CES}'		10	nA
Emitter Cutoff Current (V_{EB} = 5V)			I_{EBO}		50	nA
Forward Current Transfer Ratio	(V_{CE} = 5V, I_C = 10 μA)	GES929	h_{FE}	60	120	
		GES930	h_{FE}	100	300	
	(V_{CE} = 5V, I_C = 0.5 mA)	GES929	h_{FE}	90	—	
		GES930	h_{FE}	150	—	
	(V_{CE} = 5V, I_C = 10 mA)	GES929	h_{FE}	—	350	
		GES930	h_{FE}	—	600	
Collector Emitter Breakdown Voltage (I_C = 10 mA)‡			$V_{(BR)CEO}$	50		Volts
Collector Base Breakdown Voltage (I_C = 10 μA)			$V_{(BR)CBO}$	70		Volts
Emitter Base Breakdown Voltage (I_E = 10 μA)			$V_{(BR)EBO}$	5		Volts
Collector Saturation Voltage (I_C = 10 mA, I_B = 1 mA)‡			$V_{CE(sat)}$		.125	Volts
Base Saturation Voltage (I_C = 10 mA, I_B = 1 mA)‡			$V_{BE(sat)}$		.78	Volts
Base Emitter Voltage (V_{CE} = 10V, I_C = 2 mA)			V_{BE}	.5	.9	Volts

‡Pulse conditions 300 μsec. 2% duty cycle.

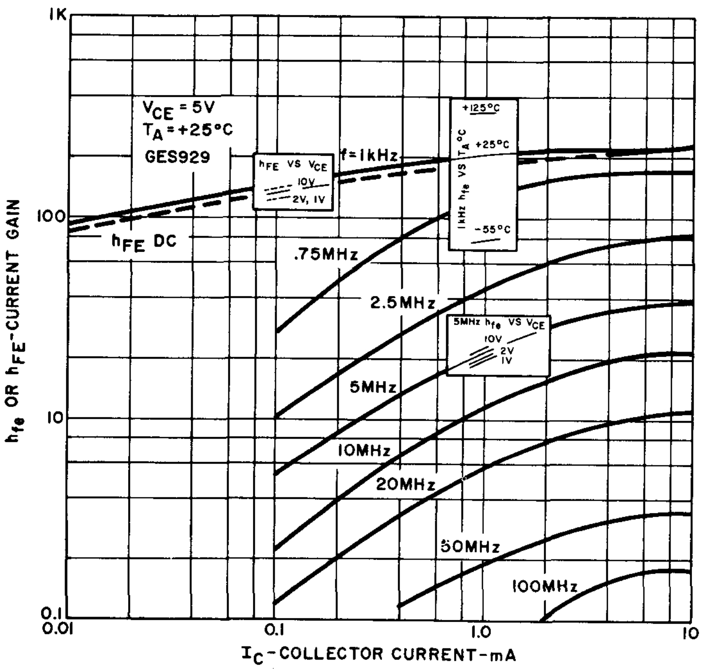
Dynamic Characteristics

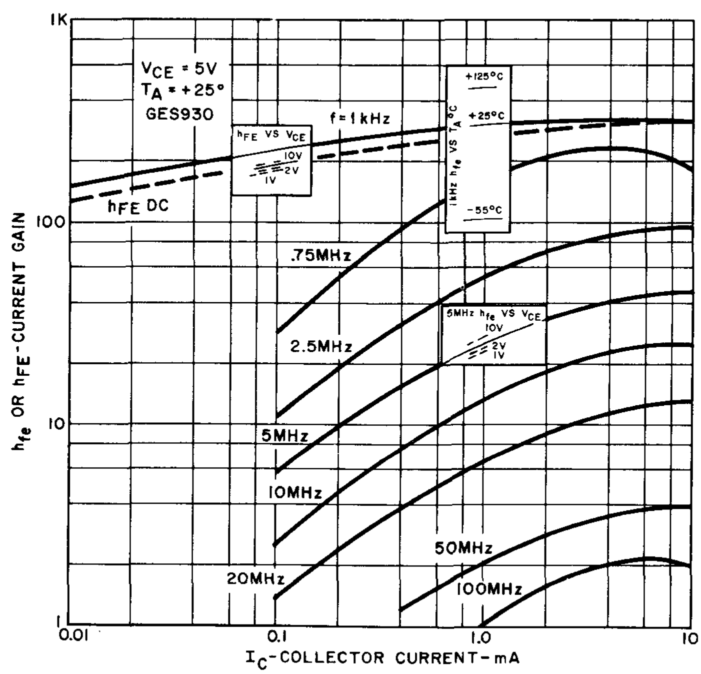
Characteristic	Conditions	Device	Symbol	Min.	Max.	Unit
Gain Bandwidth Product	($V_{CE} = 10V$, $I_C = 2$ mA, f = 10 mHz)		f_T	90	350	mHz
Noise Figure	($V_{CE} = 5V$, $I_C = 10\,\mu A$, $R_s = 10$ k, BW = 15.7 kHz)	GES929	NF		4	dB
		GES930	NF		3	dB
Output Capacitance, Common Base	($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)		C_{cb}	1.0	4.0	pF

Normalized h_{FE} vs. I_C

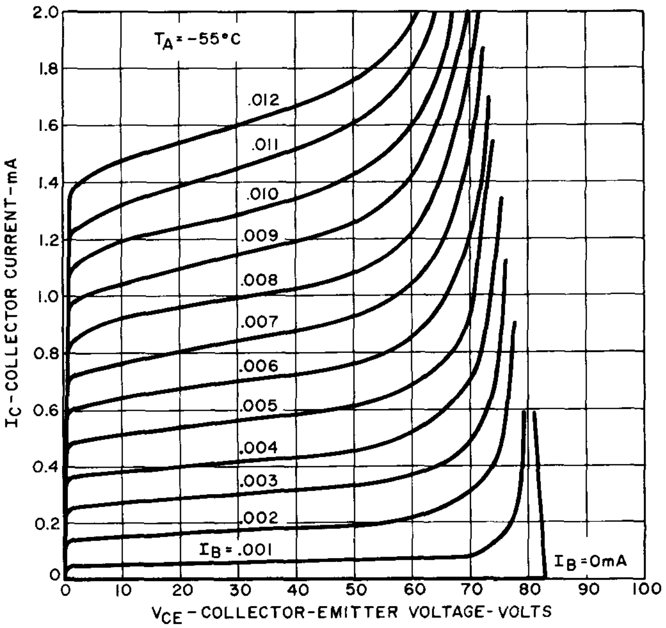


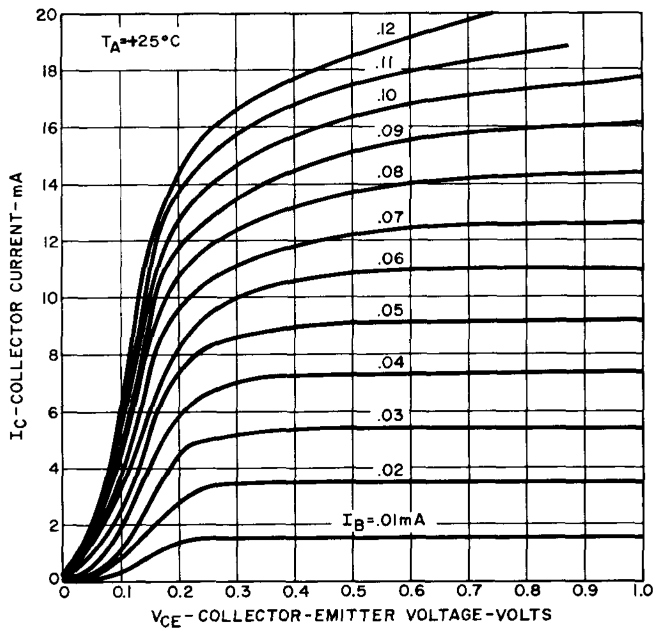
Small Signal Current Gain vs. Collector Current

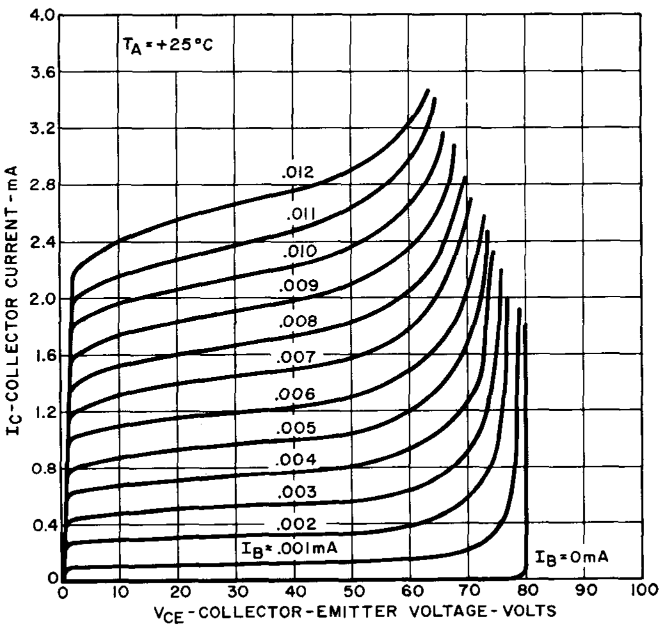


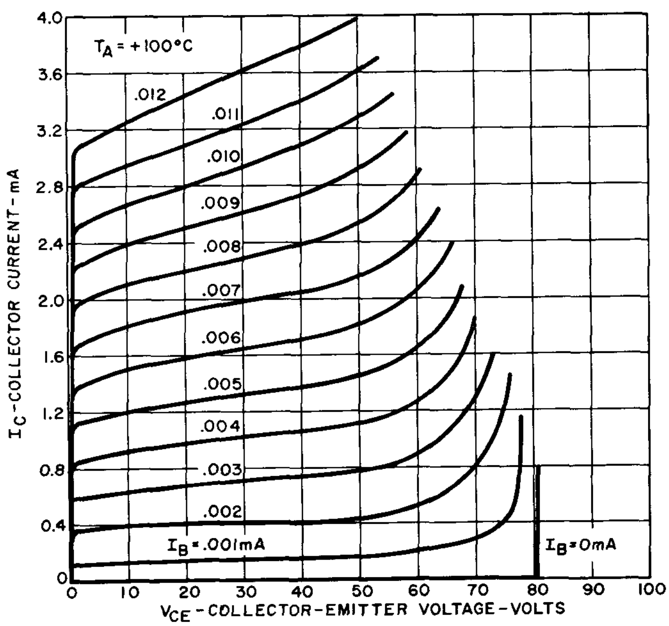


Typical Collector Characteristics
GES929

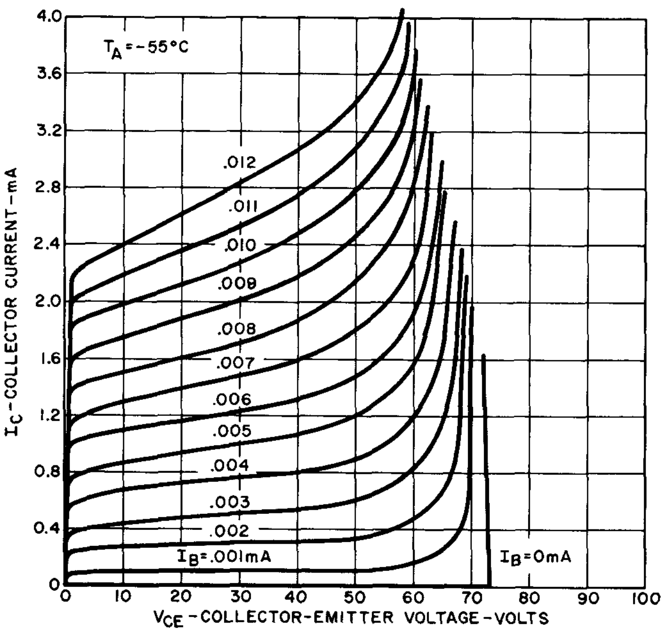


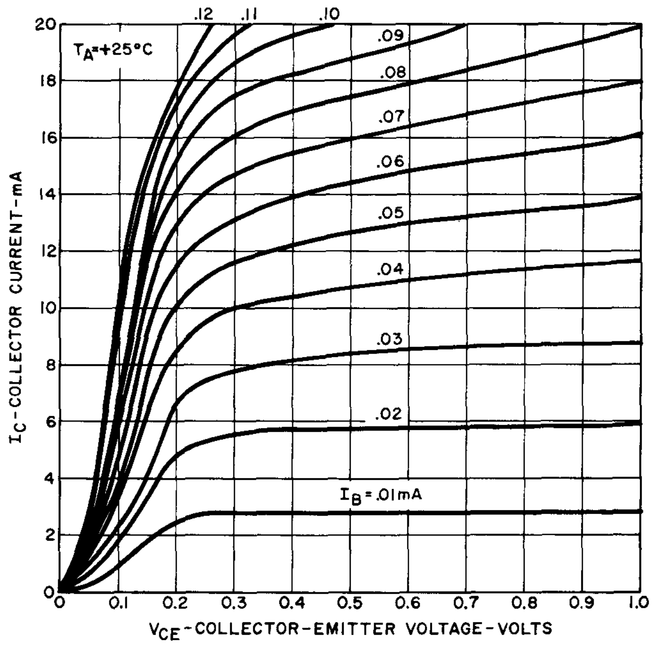


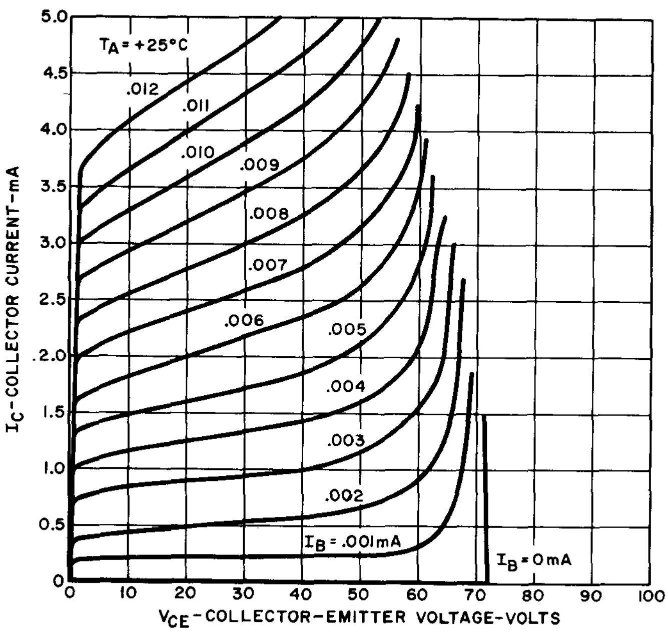


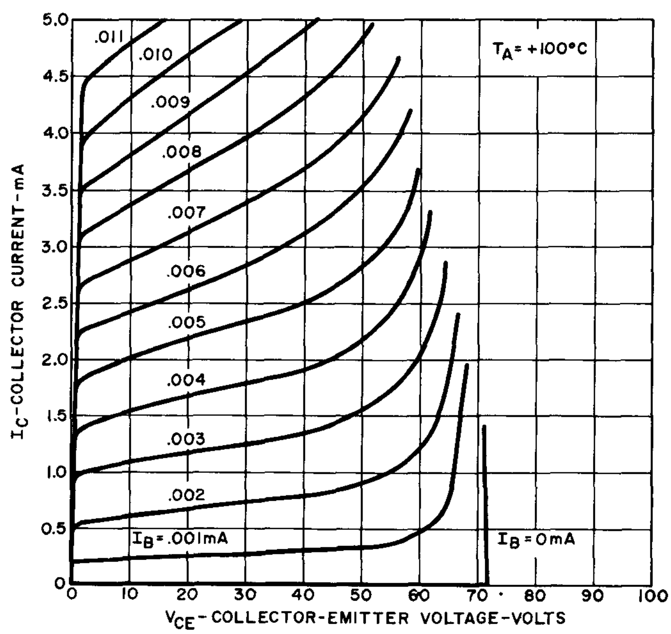


Typical Collector Characteristics
GES930







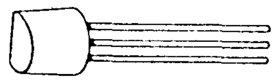


Silicon Transistors

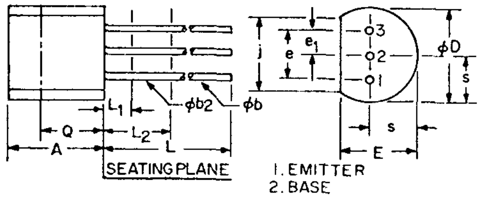
NPN

GES2221,2

Features:
- Performance comparable to hermetic units
- High Gain
- Medium Voltage
- Low $V_{CE(SAT)}$
- High Frequency



The General Electric GES2221 and GES2222 units are silicon, NPN, planar passivated, epitaxial devices specifically developed for high speed switching, amplifier and core driver applications.



TO-92

1. EMITTER
2. BASE
3. COLLECTOR

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) $\phi b2$ APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A=25°C,unless otherwise specified)

		GES2221	GES2222	
Voltages				
Collector to Emitter	V_{CEO}	30	30	Volts
Collector to Emitter	V_{CES}	40	40	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	60	60	Volts
Current				
Collector	I_C	400	400	mA
Collector (peak, pulsed 10 μsec, ≤2% duty cycle)	I_C	800	800	mA
Dissipation				
Total Power (T_C≦25°C)	P_T	1.0	1.0	Watts
Total Power (T_A≦25°C)	P_T	0.360	0.360	Watts
Derate Factor (T_C≧25°C)		10.0	10.0	mW/°C
Derate Factor (T_A≧25°C)		3.6	3.6	mW/°C
Temperature				
Storage	T_{stg}	← −65 to +150 →		°C
Operating	T_J	← −65 to +125 →		°C
Lead (1/16"±1/32" from case for 10 sec.)	T_L	← +260 →		°C

electrical characteristics: (T_A = 25°C,unless otherwise specified)

STATIC CHARACTERISTICS	**Symbol**	**GES2221 Min.**	**GES2221 Max.**	**GES2222 Min.**	**GES2222 Max.**	
Collector-Emitter Breakdown Voltage						
(I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$*	30		30		Volts
Emitter-Base Breakdown Voltage						
(I_E = 10μA, I_C = 0)	$V_{(BR)EBO}$	5		5		Volts
Collector-Base Breakdown Voltage						
(I_C = 10μA, I_E = 0)	$V_{(BR)CBO}$	60		60		Volts
Collector-Emitter Breakdown Voltage						
(I_C = 10μA, V_{BE} = 0)	$V_{(BR)CES}$	40		40		Volts
Collector-Emitter Saturation Voltage						
(I_C = 150mA, I_B = 15mA)	$V_{CE(SAT)}$*		.3		.3	Volts
(I_C = 500mA, I_B = 50mA)	$V_{CE(SAT)}$*		1.2		1.2	Volts
Base-Emitter Saturation Voltage						
(I_C = 150mA, I_B = 15mA)	$V_{BE(SAT)}$*		1.1		1.1	Volts
(I_C = 500mA, I_B = 50mA)	$V_{BE(SAT)}$*		2.4		2.4	Volts

STATIC CHARACTERISTICS (Continued)	Symbol	GES2221 Min.	GES2221 Max.	GES2222 Min.	GES2222 Max.	
Forward Current Transfer Ratio						
($V_{CE} = 1.0V$, $I_C = 150mA$)	h_{FE}*	20		50		
($V_{CE} = 10V$, $I_C = 0.1mA$)	h_{FE}	20		35		
($V_{CE} = 10V$, $I_C = 1.0mA$)	h_{FE}	25		50		
($V_{CE} = 10V$, $I_C = 10mA$)	h_{FE}*	35		75		
($V_{CE} = 10V$, $I_C = 150mA$)	h_{FE}*	40	120	100	300	
($V_{CE} = 10V$, $I_C = 500mA$)	h_{FE}*	20		30		
Collector Cutoff Current						
($V_{CB} = 50V$, $I_E = 0$)	I_{CBO}		10		10	nA
($V_{CB} = 50V$, $I_E = 0$, $T_A = 100°C$)	I_{CBO}		10		10	μA
Emitter-Base Reverse Current						
($V_{EB} = 3.0V$, $I_C = 0$)	I_{EBO}		50		50	nA

DYNAMIC CHARACTERISTICS

	Symbol	GES2221 Min.	GES2221 Max.	GES2222 Min.	GES2222 Max.	
Gain Bandwidth Product						
($V_{CE} = 20V$, $I_C = 20mA$, $f = 100MHz$)	f_t	250		250		MHz
Collector-Base Capacitance						
($V_{CB} = 10V$, $I_E = 0$, $f = 1MHz$)	C_{cb}		8.0		8.0	pF
Emitter-Base Capacitance						
($V_{EB} = 0.5V$, $I_C = 0$, $f = 1MHz$)	C_{eb}		25		25	pF

*Pulse width ≤ 300μsec., Duty Cycle ≤ 2%

Silicon Transistors

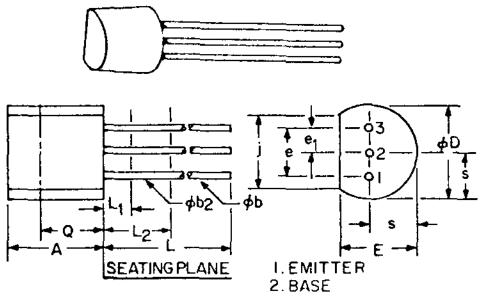
NPN

GES2221A,2A

The General Electric GES2221A and GES2222A units are silicon, NPN, planar passivated, epitaxial devices specifically developed for high speed switching, amplifier and core driver applications.

FEATURES:

- Performance comparable to hermetic units
- High gain
- Medium voltage
- Excellent switching speeds
- Low saturation voltages
- High frequency



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		GES2221A GES2222A	
Voltages			
Collector to Emitter	V_{CEO}	40	Volts
Collector to Emitter	V_{CES}	40	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	75	Volts
Current			
Collector	I_C	400	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	800	mA
Dissipation			
Total Power ($T_C \leqq 25°C$)	P_T	1.0	Watts
Total Power ($T_A \leqq 25°C$)	P_T	0.360	Watts
Derate Factor ($T_C \geqq 25°C$)		10.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		3.6	mW/°C
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +125	°C
Lead (1⁄16" ± 1⁄32" from case for 10 sec.)	T_L	+260	°C

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	GES2222A GES2221A Min.	Max.	
Collector-Emitter Breakdown Voltage				
($I_C = 10mA$, $I_B = 0$)	$V_{(BR)CEO}$*	40	—	Volts
Emitter-Base Breakdown Voltage				
($I_E = 10\mu A$, $I_C = 0$)	$V_{(BR)EBO}$	5	—	Volts
Collector-Base Breakdown Voltage				
($I_C = 10\mu A$, $I_E = 0$)	$V_{(BR)CBO}$	75	—	Volts
Collector-Emitter Breakdown Voltage				
($I_C = 10\mu A$, $V_{BE} = 0$)	$V_{(BR)CES}$	40	—	Volts
Collector-Emitter Saturation Votage				
($I_C = 150mA$, $I_B = 15mA$)	$V_{CE(SAT)}$*	—	0.3	Volts
($I_C = 500mA$, $I_B = 50mA$)	$V_{CE(SAT)}$*	—	1.0	Volts
Base-Emitter Saturation Voltage				
($I_C = 150mA$, $I_B = 15mA$)	$V_{BE(SAT)}$*	0.6	1.1	Volts
($I_C = 500mA$, $I_B = 50mA$)	$V_{BE(SAT)}$*	—	2.0	Volts

STATIC CHARACTERISTICS (Continued)	Symbol	GES2221A Min.	GES2221A Max.	GES2222A Min.	GES2222A Max.	
Forward Current Transfer Ratio						
($V_{CE} = 1.0V$, $I_C = 150mA$)	h_{FE}*	20	—	50	—	
($V_{CE} = 10V$, $I_C = 0.1mA$)	h_{FE}	20	—	35	—	
($V_{CE} = 10V$, $I_C = 1.0mA$)	h_{FE}	25	—	50	—	
($V_{CE} = 10V$, $I_C = 10mA$)	h_{FE}*	35	—	75	—	
($V_{CE} = 10V$, $I_C = 150mA$)	h_{FE}*	40	120	100	300	
($V_{CE} = 10V$, $I_C = 500mA$)	h_{FE}*	20	—	30	—	
Collector Cutoff Current						
($V_{CB} = 60V$, $I_E = 0$)	I_{CBO}	—	10	—	10	nA
($V_{CB} = 60V$, $I_E = 0$, $T_A = 100°C$)	I_{CBO}	—	10	—	10	μA
Emitter-Base Reverse Current						
($V_{EB} = 3.0V$, $I_C = 0$)	I_{EBO}	—	50	—	50	nA

*Pulsed, 300 μsec, ≦ 2% duty cycle

DYNAMIC CHARACTERISTICS	Symbol	GES2221A Min.	GES2221A Max.	GES2222A Min.	GES2222A Max.	
Gain Bandwidth Product						
($V_{CE} = 20V$, $I_C = 20mA$, $f = 100$ MHz)	f_t	250	—	300	—	MHz
Collector-Base Capacitance						
($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	8.0	—	8.0	pF
Emitter-Base Capacitance						
($V_{EB} = 0.5V$, $I_C = 0$, $f = 1$ MHz)	C_{eb}	—	25	—	25	pF
Collector-Base Time Constant						
($V_{CE} = 20V$, $I_C = 20mA$, $f = 31.9$ MHz)	$r_b'C_c$	—	150	—	150	psec
Input Admittance						
($I_C = 20mA$, $V_{CE} = 20V$, $f = 300$ MHz)	h_{ie}	—	60	—	60	ohms
SWITCHING CHARACTERISTICS						
Turn-On Time						
($I_C = 150mA$, $V_{CC} = 30V$, $I_{B1} = 15mA$, Figure 1)	t_{on}	—	35	—	35	nsec
Turn-Off Time						
($I_C = 150mA$, $V_{CC} = 30V$, $I_{B1} = -I_{B2} = 15mA$, Figure 2)	t_{off}	—	285	—	285	nsec

*Pulse width ≦ 300μ sec., duty cycle ≦ 2%

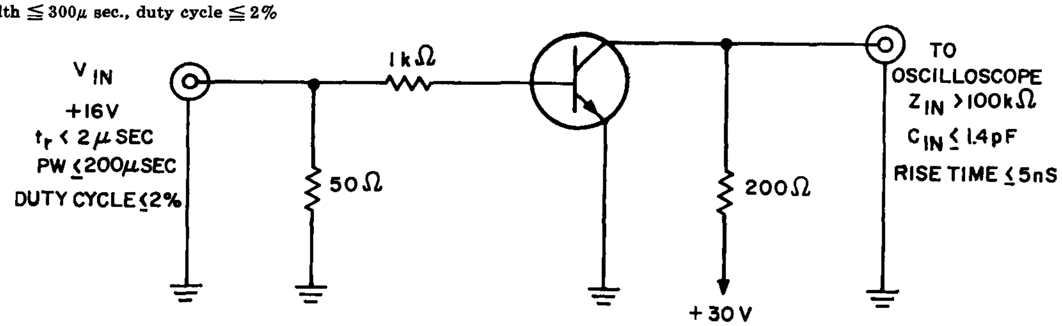


FIGURE 1. TEST CIRCUIT FOR DETERMINING TURN-ON TIME

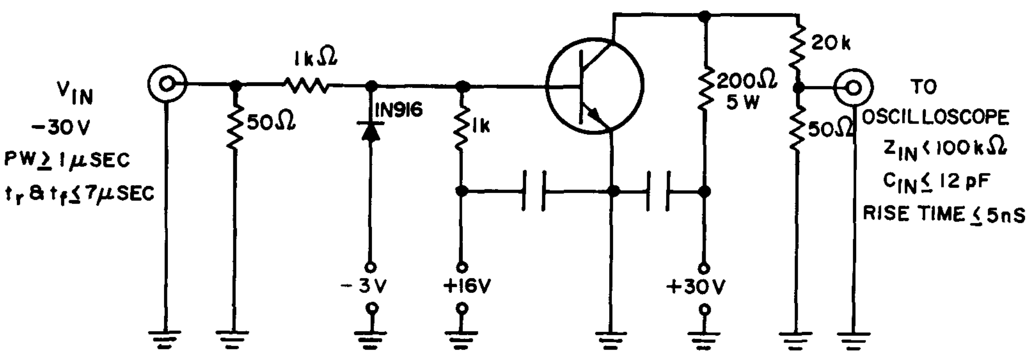


FIGURE 2. TEST CIRCUIT FOR DETERMINING TURN-OFF TIME

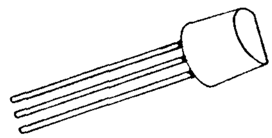
Silicon Signal Transistor

Electrical replacement for 2N2483

NPN

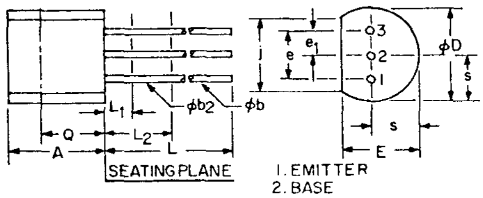
GES2483

The General Electric GES2483 is a silicon, NPN, planar, epitaxial, passivated transistor. This transistor is ideally suited for low-level amplifier applications. This device is an epoxy replacement for the 2N2483.



FEATURES:

- Very high gain at extremely low collector currents
- Low leakage currents
- Inherent low noise characteristics
- Epoxy encapsulation with proved reliability – excellent characteristic stability under environmental stresses, 85°C–85% RH



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L_1	–	1.270	–	.050	3
L_2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	60	Volts
Emitter to Base	V_{EBO}	6	Volts
Collector to Base	V_{CBO}	60	Volts
Current			
Collector (continuous)	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C)(1)	P_T	360	mW
Total Power (Free Air @ 55°C)	P_T	250	mW
Temperature			
Storage	T_{STG}	–65 to +150	°C
Operating	T_J	–65 to +125	°C
Lead soldering, 1/16" ± 1/32" from case for 10 secs. max.	T_L	+ 260	°C

(1)Derate 3.60 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	Units
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO*}$	60	—	Volts
Emitter-Base Breakdown Voltage (I_E = 10μA, I_C = 0)	$V_{(BR)EBO}$	6	—	Volts
Collector-Base Breakdown Voltage (I_C = 10μA, I_E = 0)	$V_{(BR)CBO}$	60	—	Volts
Collector-Base Cutoff Current (V_{CB} = 45V, I_E = 0)	I_{CBO}	—	50	nA
(V_{CB} = 45V, I_E = 0, T_A = 100°C)	I_{CBO}	—	10	μA
Emitter-Base Cutoff Current (V_{EB} = 5.0V, I_C = 0)	I_{EBO}	—	50	nA
Base-Emitter Voltage (I_C = 100μA, V_{CE} = 5V)	$V_{BE(ON)}$	0.50	0.70	Volts

STATIC CHARACTERISTICS (Continued)	Symbol	Min.	Max.	Units
Collector-Emitter Saturation Voltage				
(I_C = 1mA, I_B = 0.1mA)	$V_{CE(SAT)}$	—	0.350	Volts
Forward Current Transfer Ratio				
(V_{CE} = 5V, I_C = 10μA)	h_{FE}	40	—	
(V_{CE} = 5V, I_C = 100μA)	h_{FE}	75	—	
(V_{CE} = 5V, I_C = 500μA)	h_{FE}	100	—	
(V_{CE} = 5V, I_C = 1mA)	h_{FE}	175	—	
(V_{CE} = 5V, I_C = 10mA)	h_{FE}*	—	500	

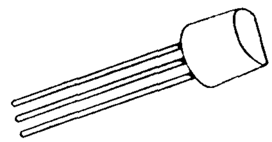
DYNAMIC CHARACTERISTICS	Symbol	Min.	Max.	Units
Forward Current Transfer Ratio				
(I_C = 1mA, V_{CE} = 5V, f=1KHz)	h_{fe}	80	450	
Wide Band Noise Figure				
(I_C = 10μA, V_{CE} = 5V, R_g=10KΩ, f = 10Hz to 10KHz, B.W.=15.7 KHz)	NF	—	4	dB
Spot Noise Figure				
(I_C = 10μA, V_{CE} = 5V, R_g = 10KΩ, f = 1KHz)	NF	—	4	dB
(I_C = 10μA, V_{CE} = 5V, R_g = 10KΩ, f = 10KHz)	NF	—	3	dB
(I_C = 10μA, V_{CE} = 5V, R_g = 10KΩ, f = 100 Hz)	NF	—	15	dB
Forward Current Transfer Ratio				
(I_C = 50μA, V_{CE} = 5V, f=5MHz)	$\|h_{fe}\|$	2.0	—	
(I_C = 500μA, V_{CE} =5V, f=30MHz)	$\|h_{fe}\|$	2.0	—	
Output Capacitance				
(V_{CB} = 10V, f = 1MHz, Emitter connected to Guard Terminal on 3-Terminal Bridge)	C_{cb}	1.0	4.0	pF
Input Capacitance				
(V_{EB} = 0.5V, f = 1MHz, Collector connected to Guard Terminal on 3-Terminal Bridge)	C_{eb}	—	12	pF

*Pulsed Test – Pulse width $\leq$ 300 μsec., duty cycle $\leq$ 2%.

Silicon Transistor

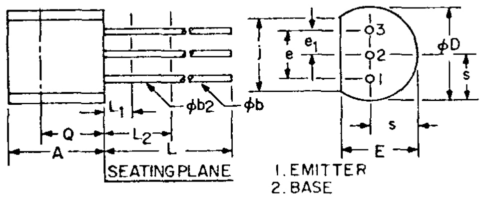
PNP GES2906

The GES2906 is a planar, epitaxial, passivated, PNP, silicon transistor intended for general purpose, amplifier, saturated switching, and core driver applications.



Features:

- Low leakage currents
- Low collector saturation voltages
- High speed switching
- Epoxy encapsulation with proved reliability—excellent characteristic stability under environmental stresses, 85°C @ 85% RH



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	−40	Volts
Emitter to Base	V_{EBO}	−5	Volts
Collector to Base	V_{CBO}	−60	Volts
Current			
Collector	I_C	−350	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	−700	mA
Dissipation			
Total Power ($T_C \leqq 25°C$)	P_T	0.700	Watts
Total Power ($T_A \leqq 25°C$)	P_T	0.360	Watts
Derate Factor ($T_C \geqq 25°C$)		7.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		3.6	mW/°C
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +125	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260	°C

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	
Collector-Emitter Breakdown Voltage				
($I_C = -10MA, I_B = 0$)	$V_{(BR)CEO}$*	−40	—	Volts
Emitter-Base Breakdown Voltage				
($I_E = -10\mu A, I_C = 0$)	$V_{(BR)EBO}$	−5	—	Volts

electrical characteristics: (cont.)

	Symbol	Min.	Max.	
Collector-Base Breakdown Voltage				
($I_C = -10\mu A$, $I_E = 0$)	$V_{(BR)CBO}$	−60	—	Volts
Collector-Base Cutoff Current				
($V_{CB} = -50V$, $I_E = 0$)	I_{CBO}	—	−20	nA
($V_{CB} = -50V$, $I_E = 0$, $T_A = +100°C$)	I_{CBO}	—	−20	μA
Collector-Emitter Cutoff Current				
($V_{CE} = -30V$, $I_B = 0$)	I_{CES}	—	−50	nA
Collector-Emitter Saturation Voltage				
($I_C = -150mA$, $I_B = -15mA$)	$V_{CE(SAT)}$*	—	−0.4	Volts
($I_C = -500mA$, $I_B = -50mA$)	$V_{CE(SAT)}$*	—	−1.6	Volts
Base-Emitter Saturation Voltage				
($I_C = -150mA$, $I_B = -15mA$)	$V_{BE(SAT)}$*	—	−1.3	Volts
($I_C = -500mA$, $I_B = -50mA$)	$V_{BE(SAT)}$*	—	−2.6	Volts
Forward Current Transfer Ratio				
($V_{CE} = -10V$, $I_C = -0.1mA$)	h_{FE}	20	—	
($V_{CE} = -10V$, $I_C = -1.0mA$)	h_{FE}	25	—	
($V_{CE} = -10V$, $I_C = -10mA$)	h_{FE}	35	—	
($V_{CE} = -10V$, $I_C = -150mA$)	h_{FE}*	40	120	
($V_{CE} = -10V$, $I_C = -500mA$)	h_{FE}*	20	—	
DYNAMIC CHARACTERISTICS				
Output Capacitance, common base				
($V_{CB} = -10V$, f = 1 MHz, Emitter connected to Guard Terminal on 3-Terminal Bridge)	C_{cb}	—	8	pF
Input Capacitance, common base				
($V_{EB} = -0.5V$, f = 1MHz, Collector connected to Guard Terminal on 3-Terminal Bridge)	C_{eb}	—	30	pF
High Frequency Current Gain				
($I_C = -50mA$, $V_{CE} = -20V$, f = 100MHz)	$\|h_{fe}\|$	2.0	—	
Delay Time				
($I_{CS} = -150mA$, $I_{B1} = -15mA$, see Fig. 1)	t_d	—	10	nsec
Rise Time				
($I_{CS} = -150mA$, $I_{B1} = -15mA$, see Fig. 1)	t_r	—	40	nsec
Storage Time				
($I_{CS} = -150mA$, $I_{B1} = I_{B2} = -15mA$, see Fig. 2)	t_s	—	80	nsec
Fall Time				
($I_{CS} = -150mA$, $I_{B1} = I_{B2} = -15mA$, see Fig. 2)	t_f	—	30	nsec

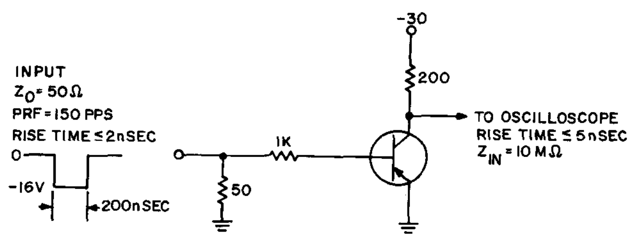


Figure 1 Test Circuit For Determining Delay Time and Rise Time

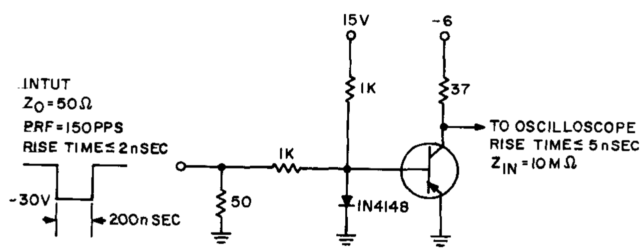


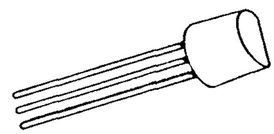
Figure 2 Test Circuit For Determining Storage Time and Fall Time

*Pulse conditions of 300 μsec duration, 2% duty cycle.

Silicon Transistor

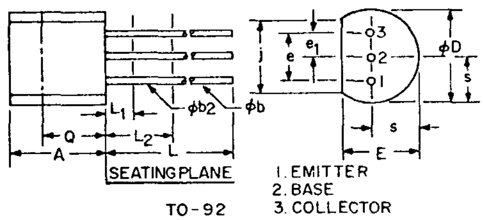
PNP GES2907

The GES2907 is a planar, epitaxial, passivated, PNP, silicon, transistors intended for general purpose, amplifiers, saturated switching, and core driver applications.



Features:

- Low leakage currents
- Low collector saturation voltages
- High speed switching
- Epoxy encapsulation with proved reliability—excellent characteristic stability under environmental stresses, 85°C @ 85% RH



SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

Voltages

Collector to Emitter	V_{CEO}	−40	Volts
Emitter to Base	V_{EBO}	−5	Volts
Collector to Base	V_{CBO}	−60	Volts

Current

Collector	I_C	−350	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	−700	mA

Dissipation

Total Power ($T_C \leqq 25°C$)	P_T	0.700	Watts
Total Power ($T_A \leqq 25°C$)	P_T	0.360	Watts
Derate Factor ($T_C \geqq 25°C$)		7.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		3.6	mW/°C

Temperature

Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +125	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260	°C

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	
Collector-Emitter Breakdown Voltage				
($I_C = -10mA, I_B = 0$)	$V_{(BR)CEO}$*	−40	—	Volts
Emitter-Base Breakdown Voltage				
($I_E = -10\mu A, I_C = 0$)	$V_{(BR)EBO}$	−5	—	Volts

electrical characteristics: (cont.)

	Symbol	Min.	Max.	
Collector-Base Breakdown Voltage				
($I_C = -10\mu A$, $I_E = 0$)	$V_{(BR)CBO}$	−60	—	Volts
Collector-Base Cutoff Current				
($V_{CB} = -50V$, $I_E = 0$)	I_{CBO}	—	−50	nA
($V_{CB} = -50V$, $I_E = 0$, $T_A = +100°C$)	I_{CBO}	—	−20	μA
Collector-Emitter Cutoff Current				
($V_{CE} = -30V$, $I_B = 0$)	I_{CES}	—	−50	nA
Collector-Emitter Saturation Voltage				
($I_C = -150mA$, $I_B = -15mA$)	$V_{CE(SAT)}$*	—	−0.4	Volts
($I_C = -500mA$, $I_B = -50mA$)	$V_{CE(SAT)}$*	—	−1.6	Volts
Base-Emitter Saturation Voltage				
($I_C = -150mA$, $I_B = -15mA$)	$V_{BE(SAT)}$*	—	−1.3	Volts
($I_C = -500mA$, $I_B = -50mA$)	$V_{BE(SAT)}$*	—	−2.6	Volts
Forward Current Transfer Ratio				
($V_{CE} = -10V$, $I_C = -0.1mA$)	h_{FE}	35	—	
($V_{CE} = -10V$, $I_C = -1.0mA$)	h_{FE}	50	—	
($V_{CE} = -10V$, $I_C = -10mA$)	h_{FE}	75	—	
($V_{CE} = -10V$, $I_C = -150mA$)	h_{FE}*	100	300	
($V_{CE} = -10V$, $I_C = -500mA$)	h_{FE}*	30	—	
DYNAMIC CHARACTERISTICS				
Output Capacitance, common base				
($V_{CB} = -10V$, $f = 1MHz$, Emitter connected to Guard Terminal on 3-Terminal Bridge)	C_{cb}	—	8	pF
Input Capacitance, common base				
($V_{EB} = -0.5V$, $f = 1MHz$, Collector connected to Guard Terminal on 3-Terminal Bridge)	C_{eb}	—	30	pF
High Frequency Current Gain				
($I_C = -50mA$, $V_{CE} = -20V$, $f = 100$ MHz)	$\lvert h_{fe} \rvert$	2.0	—	
Delay Time				
($I_{CS} = -150mA$, $I_{B1} = -15mA$, see Fig. 1)	t_d	—	10	nsec
Rise Time				
($I_{CS} = -150mA$, $I_{B1} = -15mA$, see Fig. 1)	t_r	—	40	nsec
Storage Time				
($I_{CS} = -150mA$, $I_{B1} = I_{B2} = -15mA$, see Fig. 2)	t_s	—	80	nsec
Fall Time				
($I_{CS} = -150mA$, $I_{B1} = I_{B2} = -15mA$, see Fig. 2)	t_f	—	30	nsec

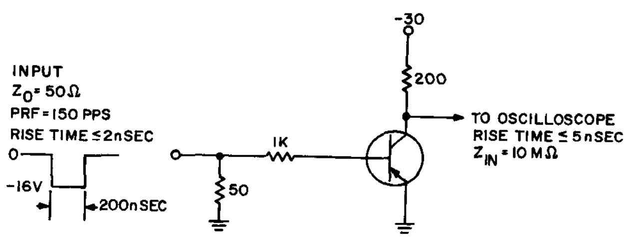


Figure 1 Test Circuit For Determining Delay Time and Rise Time

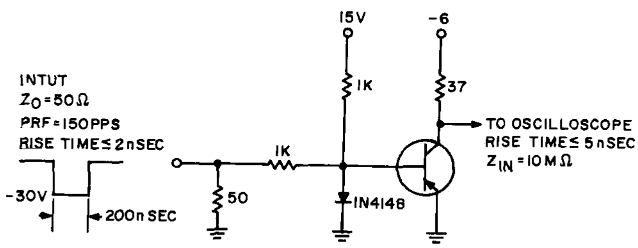


Figure 2 Test Circuit For Determining Storage Time and Fall Time

*Pulse conditions of 300 μsec duration, 2% duty cycle.

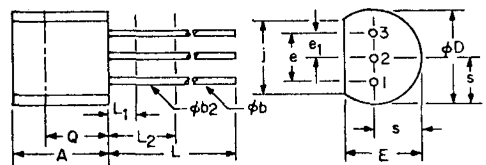
Silicon Monolithic
Darlington Amplifiers

CONSUMER-INDUSTRIAL

NPN

GES5305, GES5307
GES5306, GES5308
GES5306A, GES5308A

The General Electric GES5305, 6, 6A, 7, 8, 8A are NPN, silicon, planar, epitaxial, passivated Darlington monolithic amplifiers. These devices are especially suited for preamplifier input stages requiring input impedances of several megohms or extremely low level, high gain, low noise amplifier applications. Additional applications include medium speed switching circuits in consumer and industrial control applications.



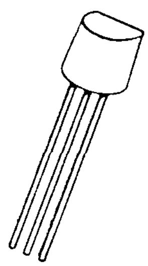
1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

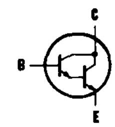
NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (25°C) (unless otherwise specified)



		GES5305 GES5306 GES5306A	GES5307 GES5308 GES5308A	
Voltages				
Collector to Base	V_{CBO}	25	40	Volts
Collector to Emitter	V_{CEO}	25	40	Volts
Emitter to Base	V_{EBO}	12	12	Volts
Current				
Collector (Steady State)	I_C	300		mA
Collector (Pulsed)*	I_C	500		mA
Base (Steady State)	I_B	50		mA
Dissipation				
Total Power ($T_A \leqq 25°C$)†	P_T	400		mW
Total Power with Heatsink ($T_A \leqq 25°C$)††	P_T	600		mW
Total Power with Heatsink ($T_C \leqq 25°C$)†††	P_T	900		mW
Temperature				
Storage	T_{stg}	−65 to +150°C		
Operating	T_j	−65 to +125°C		
Lead, 1/16" ± 1/32" from case for 10 sec. max.	T_L	+260°C		

*Pulse conditions: 300 μsec. pulse width, 2% duty cycle.
†Derate 4.0 mW/°C for increase in ambient temperature above 25°C.
††Derate 6.0 mW/°C for increase in ambient temperature above 25°C.
†††Derate 9.0 mW/°C for increase in case temperature above 25°C.



Equiv. Circuit

electrical characteristics: (25°) (unless otherwise specified)

STATIC CHARACTERISTICS		MIN.	MAX.	
Collector to Base Breakdown Voltage (I_C = 0.1 μA, I_C = 0) GES5305, 6, 6A	$V_{(BR)CBO}$	25		Volts
Collector to Emitter Breakdown Voltage (I_C = 10mA, I_B = 0) GES5305, 6, 6A	$V_{(BR)CEO}$	25		Volts
Collector to Base Breakdown Voltage (I_C = 0.1 μA, I_C = 0) GES5307, 8, 8A	$V_{(BR)CBO}$	40		Volts
Collector to Emitter Breakdown Voltage (I_C = 10mA, I_B = 0) GES5307, 8, 8A	$V_{(BR)CEO}$	40		Volts
Emitter to Base Breakdown Voltage (I_E = 0.1 μA, I_E = 0)	$V_{(BR)EBO}$	12		Volts
Forward Current Transfer Ratio				
(V_{CE} = 5V, I_C = 2mA) GES5305, 7	h_{FE}	2000	20000	
(V_{CE} = 5V, I_C = 100mA) GES5305, 7	h_{FE}	6000		
(V_{CE} = 5V, I_C = 2mA) GES5306, 6A, 8, 8A	h_{FE}	7000	70000	
(V_{CE} = 5V, I_C = 100mA) GES5306, 6A, 8, 8A	h_{FE}	20000		
Collector Cutoff-Current				
(V_{CB} = 25V, I_E = 0)	I_{CBO}		100	nA
(V_{CB} = 25V, I_E = 0, T_A = 100°C)	I_{CBO}		20	μA
(V_{CB} = 40V, I_E = 0)	I_{CBO}		100	nA
(V_{CB} = 40V, I_E = 0, T_A = 100°C)	I_{CBO}		20	μA
Emitter Cutoff Current (V_{EB} = 12V, I_C = 0)	I_{EBO}		100	nA
Collector Emitter Saturation Voltage				
(I_C = 200mA, I_B = 0.2mA)	$V_{BE(SAT)}$		1.4	Volts
Base Emitter Saturation Voltage				
(I_C = 200mA, I_B = 0.2mA)	$V_{CE(SAT)}$		1.6	Volts
Base Emitter Voltage (V_{CE} = 5V, I_C = 200mA)	V_{BE}		1.5	Volts

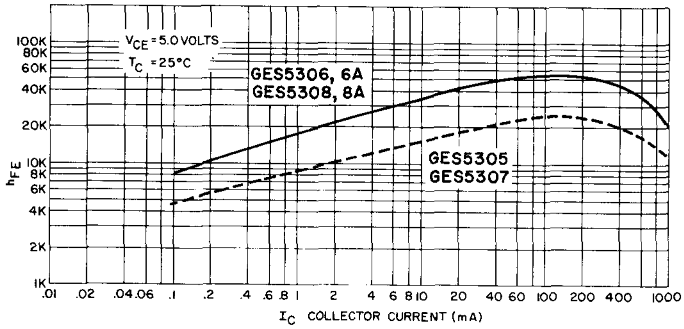
DYNAMIC CHARACTERISTICS		MIN.	TYP.	MAX.	
Forward Current Transfer Ratio					
(V_{CE} = 5V, I_C = 2mA, f = 1kHz) GES5305, 7	h_{fe}	2000			
(V_{CE} = 5V, I_C = 2mA, f = 1kHz) GES5306, 6A, 8, 8A	h_{fe}	7000			
(V_{CE} = 5V, I_C = 2mA, f = 1kHz)	$\lvert h_{fe} \rvert$	15.6			dB
Gain Bandwidth Product (V_{CE} = 5V, I_C = 2mA, f = 10 MHz)	f_T	30			MHz
Input Impedance (V_{CE} = 5V, I_C = 2mA, f = 1 kHz)	h_{ie}		650		kohms
Collector Base Capacitance (V_{CB} = 10V, f = 1 MHz)	C_{cb}		7.6	10	pF
Emitter Capacitance (V_{EB} = 0.5V, f = 1 MHz)	C_{eb}		10.5		pF
GES5306A, 8A only:					
Noise Voltage (I_C = 0.6 mA, V_{CE} = 5V, R_G = 160kΩ, f = 10 Hz to 10kHz, B.W. = 15.7 kHz)	e_n		195	230	nV/$\sqrt{Hz}$

NOTE: As measured on a Quan-Tech Model 2283/2181M test set with 10 Hz filter modified by Quan-Tech to a wideband (f = 10 Hz to 10 kHz, B.W. = 15.7 kHz) filter.

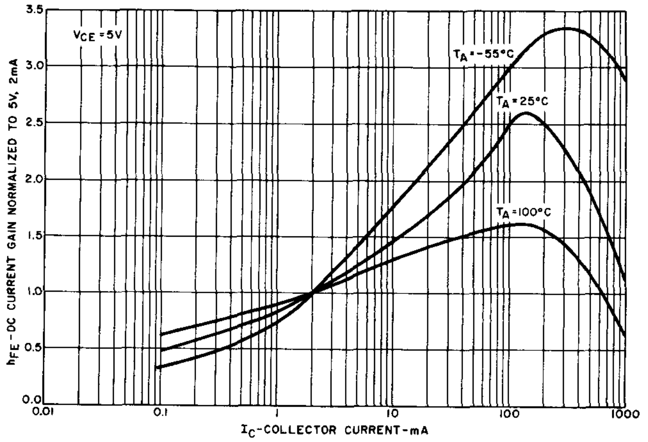
GES5305, GES5307
GES5306, GES5308
GES5306A, GES5308A

Typical Curves

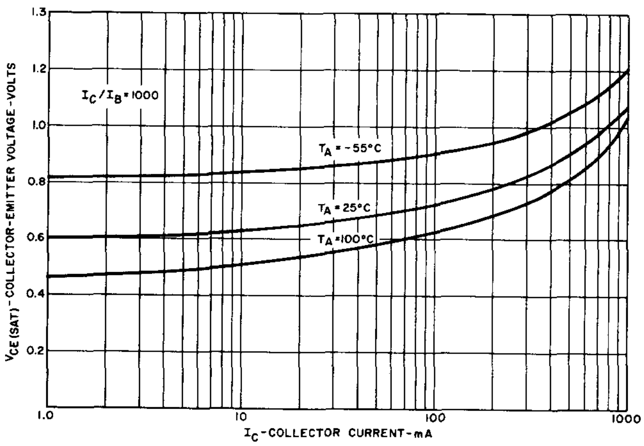
Typical h_{FE} vs. I_C



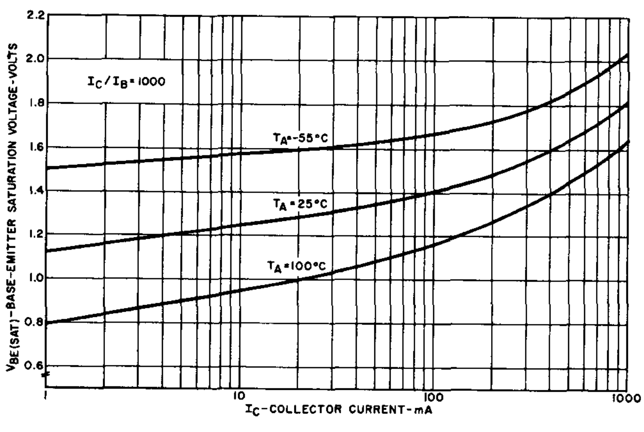
Normalized h_{FE} vs. I_C



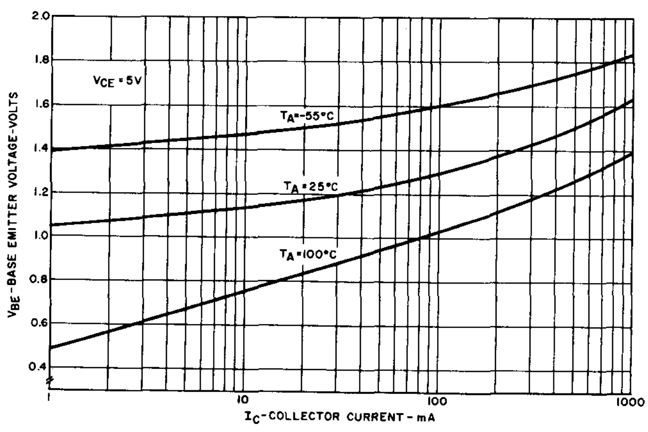
V_{CE} vs. I_C



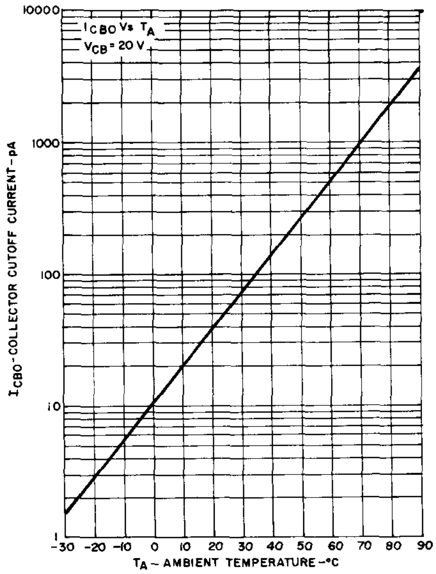
$V_{BE(SAT)}$ vs. I_C



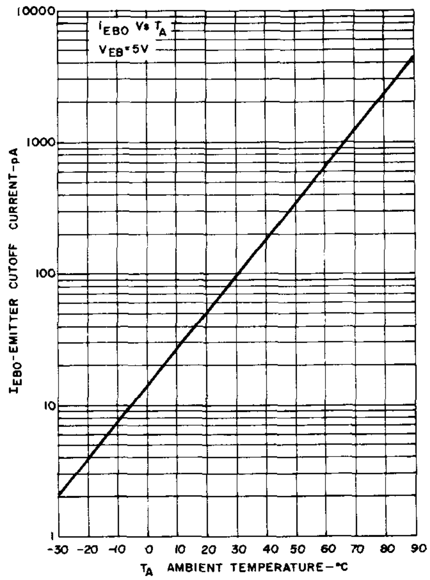
Transconductance Characteristic, V_{BE} vs. I_C



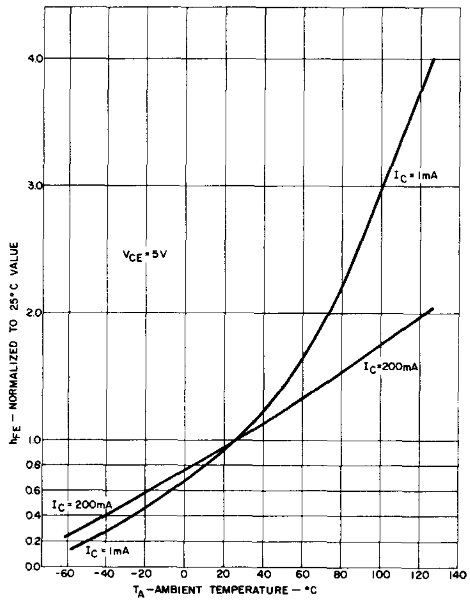
I_{CBO} vs. T_A



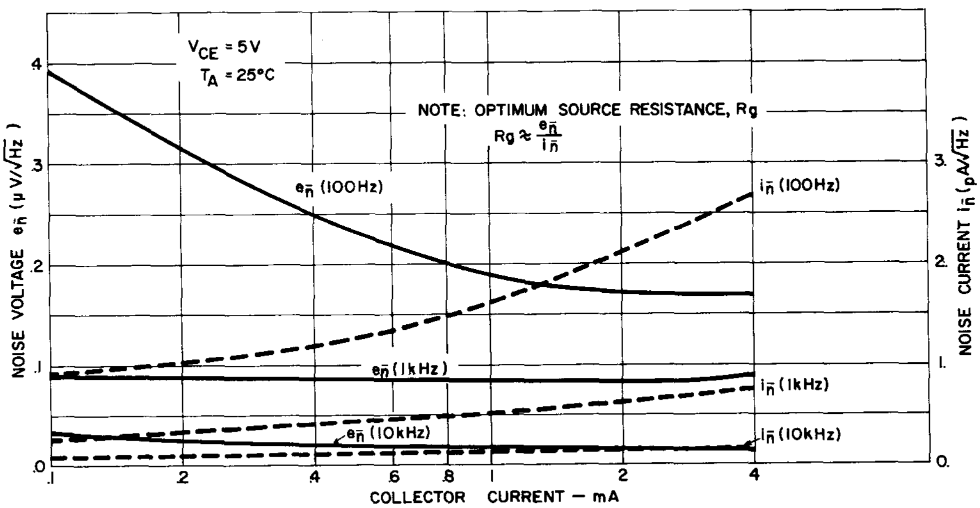
I_{EBO} vs. T_A



h_{FE} vs. T_A



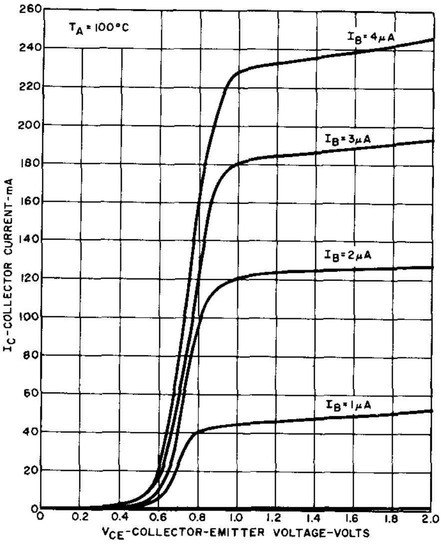
Equivalent Input Noise Voltage and Current vs. Bias Current

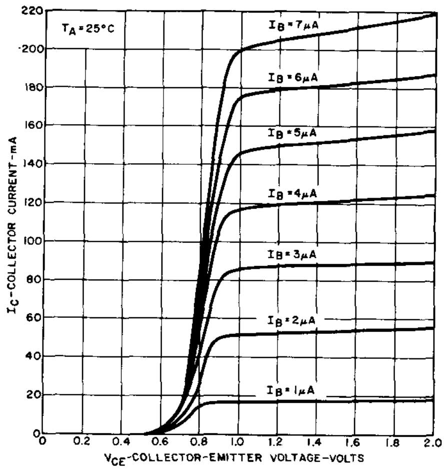


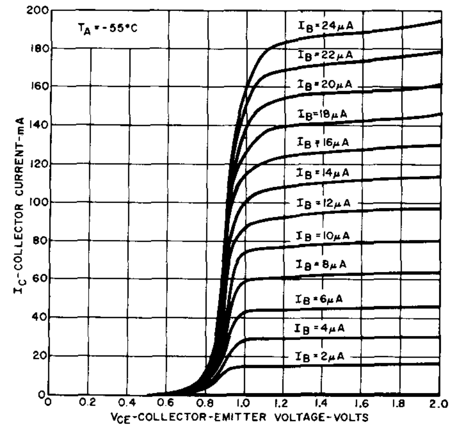
NOTE: Due to the noise characteristics of this device versus frequency, calculation of noise figure (N.F.) from $e_{\bar{n}}$, $i_{\bar{n}}$ values is not accurate [as is the case with field effect transistors (F.E.T.'s)].

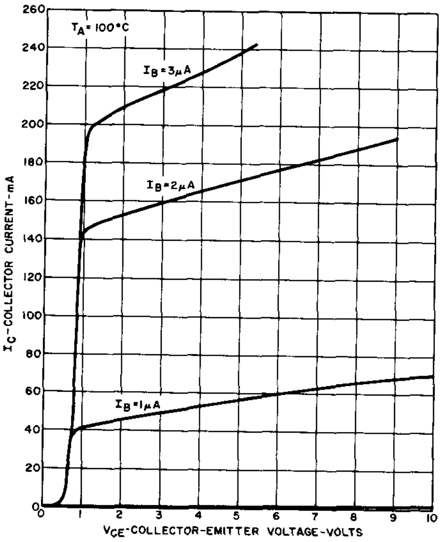
GES5305, GES5307
GES5306, GES5308
GES5306, GES5308A

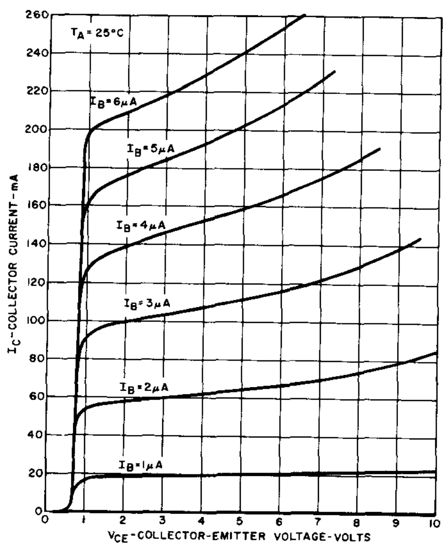
Typical Collector Characteristics

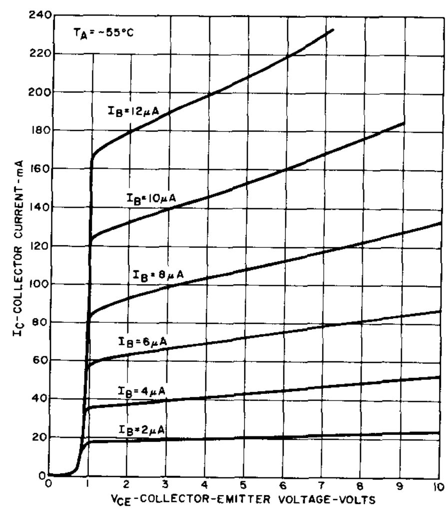










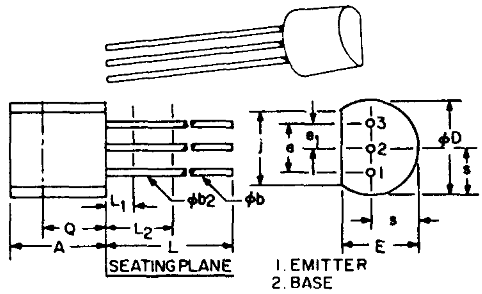


Silicon Transistors

NPN

GES5368, 69
GES5370, 71

The General Electric GES5368 — GES6371 are planar, epitaxial, passivated NPN silicon transistors designed as a medium current switch and for general purpose amplifier applications. For complimentary PNP types see GES5372 — GES5375 specifications.



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		GES5368 GES5369 GES5370	GES5371	
Voltages				
Collector to Emitter	V_{CEO}	30	30	Volts
Collector to Base	V_{CBO}	60	40	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	← 500 →		mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T	← 360 →		Watts
Derate Factor $T_A > 25°C$		← 2.87 →		mW/°C
Temperature				
Operating	T_J	-65 to + 150		°C
Storage	T_{STG}	-65 to + 150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260		°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	Units
Collector-Emitter Breakdown Voltage				
(I_C = 10mA, I_B = 0)	$V_{(BR)CEO^*}$	30		Volts
Collector-Base Breakdown Voltage				
(I_C = 10uA, V_{BE} = 0) GES5368, GES5369, GES5370	$V_{(BR)CBO}$	60		Volts
Collector-Base Breakdown Voltage				
(I_C = 10uA, I_E = 0) GES5371	$V_{(BR)CBO}$	40		Volts
Emitter-Base Breakdown Voltage				
(I_E = 10uA, I_C = 0)	$V_{(BR)EBO}$	5		Volts
Collector Cutoff Current				
(V_{CB} = 40V, I_E = 0) GES5368, GES5369, GES5370	I_{CBO}		50	nA
Collector Cutoff Current				
(V_{CB} = 30V, I_E = 0) GES5371	I_{CBO}		50	nA
Emitter-Base Reverse Current				
(V_{EB} = 3 V, I_C = 0)	I_{EBO}		50	nA
Forward Current Transfer Ratio				
(V_{CE} = 10V, I_C = 1mA) GES5368	h_{FE}	20		
(V_{CE} = 10V, I_C = 1mA) GES5369	h_{FE}	50		
(V_{CE} = 10V, I_C = 1mA) GES5370	h_{FE}	75		
(V_{CE} = 10V, I_C = 1mA) GES5371	h_{FE}	20		
Forward Current Transfer Ratio				
(V_{CE} = 10V, I_C = 10mA) GES5368	h_{FE^*}	40		
(V_{CE} = 10V, I_C = 10mA) GES5369	h_{FE^*}	75		
(V_{CE} = 10V, I_C = 10mA) GES5370	h_{FE^*}	150		
(V_{CE} = 10V, I_C = 10mA) GES5371	h_{FE^*}	40		
Forward Current Transfer Ratio				
(V_{CE} = 10V, I_C = 150mA) GES5368	h_{FE^*}	60	200	
(V_{CE} = 10V, I_C = 150mA) GES5369	h_{FE^*}	100	300	
(V_{CE} = 10V, I_C = 150mA) GES5370	h_{FE^*}	200	600	
(V_{CE} = 10V, I_C = 150mA) GES5371	h_{FE^*}	60	600	

GES5368, 69

GES5370, 71

ELECTRICAL CHARACTERISTICS (CONTINUED)

	Symbol	Min.	Max.	Units
Collector-Emitter Saturation Voltage (I_C = 150mA, I_B = 15mA)	$V_{CE(SAT)}$*		.3	Volts
Base-Emitter Saturation Voltage (I_C = 150mA, I_B = 15mA)	$V_{BE(SAT)}$*		1.3	Volts
Base-Emitter Voltage (V_{CE} = 10V, I_C = 150mA)	$V_{BE(ON)}$*		1.2	Volts
DYNAMIC CHARACTERISTICS				
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 1MHz)	C_{CB}		8	pf
Forward Current Transfer Ratio (V_{CE} = 10V, I_C = 20mA, f = 100MHz)	h_{FE}	2.5		
SWITCHING CHARACTERISTICS				
Turn-on Time, Figure 1 (I_C = 150mA, I_{B1} = 15mA V_{CC} = 30V)	t_{ON}		40	nsec
Turn-off Time, Figure 2 (I_C = 150mA, I_{B1} = I_{B2} = 15mA V_{CC} = 30V)				
GES5368, GES5369	t_{OFF}		350	nsec
GES5370, GES5371	t_{OFF}		400	nsec

*Pulse Width ≦ 300 μsec., duty cycle ≦ 2%

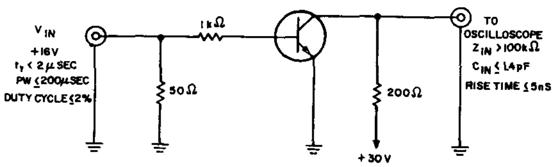


FIGURE 1. TEST CIRCUIT FOR DETERMINING TURN-ON TIME

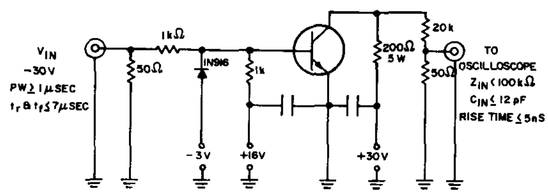
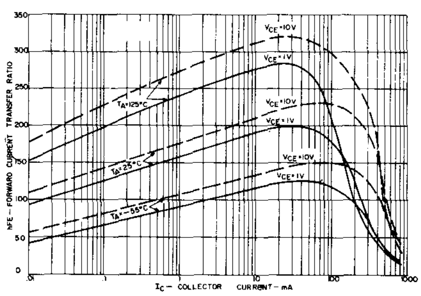
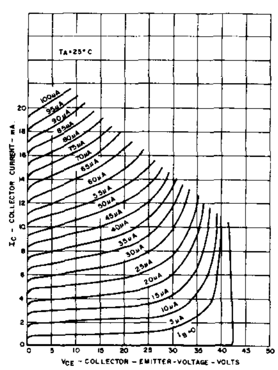


FIGURE 2. TEST CIRCUIT FOR DETERMINING TURN-OFF TIME

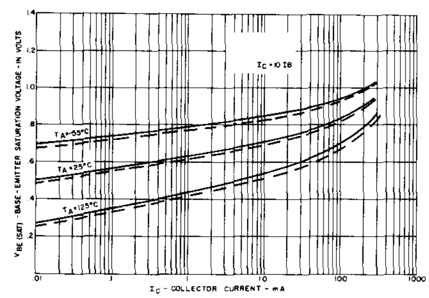
TYPICAL CHARACTERISTIC CURVES



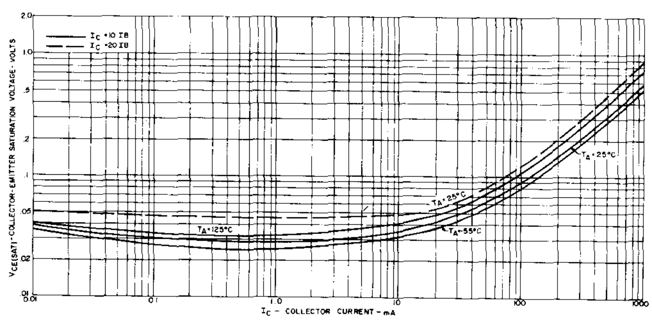
BETA VS. COLLECTOR CURRENT



COLLECTOR CHARACTERISTICS



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

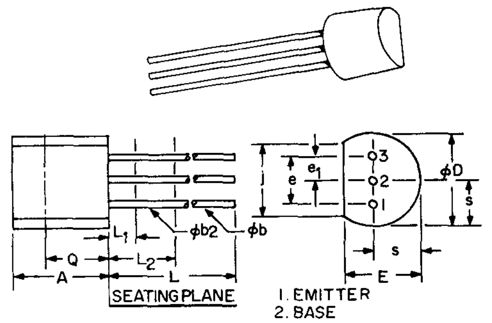
Silicon
Transistors

PNP

GES5372, 73
GES5374, 75

The General Electric GES5372 — GES5375 are planar, epitaxial, passivated PNP silicon transistors designed as a medium current switch and for general purpose amplifier applications. For complimentary NPN types see GES5368 — GES5371 specifications.

Voltage and current values for PNP are negative: Observe proper bias polarity.



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		GES5372 GES5373 GES5374	GES5375	
Voltages				
Collector to Emitter	V_{CEO}	30	30	Volts
Collector to Base	V_{CBO}	50	40	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	← 500 →		mA
Dissipation				
Total Power TA ≤ 25°C	P_T	← 360 →		Watts
Derate Factor TA > 25°C		← 2.87 →		mW/°C
Temperature				
Operating	T_J	-65 to + 150		°C
Storage	T_{STG}	-65 to + 150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260		°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	Min.	Max.	Units
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$	30		Volts
Collector-Base Breakdown Voltage (I_C = 10 μA, V_{BE} = 0) GES5372, GES5373, GES5374	$V_{(BR)CBO}$	50		Volts
Collector-Base Breakdown Voltage (I_C = 10uA, I_E = 0) GES5375	$V_{(BR)CBO}$	40		Volts
Emitter-Base Breakdown Voltage (I_E = 10uA, I_C = 0)	$V_{(BR)EBO}$	5		Volts
Collector Cutoff Current (V_{CB} = 40V, I_E = 0) GES5372, GES5373, GES5374	I_{CBO}		50	nA
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0) GES5375	I_{CBO}		50	nA
Emitter-Base Reverse Current (V_{EB} = 3 V, Ic = 0)	I_{EBO}		50	nA
Forward Current Transfer Ratio				
(V_{CE} = 10 V, I_C = 1mA) GES5372	h_{FE}	20		
(V_{CE} = 10 V, I_C = 1mA) GES5373	h_{FE}	50		
(V_{CE} = 10 V, I_C = 1mA) GES5374	h_{FE}	100		
(V_{CE} = 10 V, I_C = 1mA) GES5375	h_{FE}	20		
Forward Current Transfer Ratio				
(V_{CE} = 10 V, I_C = 10mA) GES5372	h_{FE}*	30		
(V_{CE} = 10 V, I_C = 10mA) GES5373	h_{FE}*	75		
(V_{CE} = 10 V, I_C = 10mA) GES5374	h_{FE}*	150		
(V_{CE} = 10 V, I_C = 10mA) GES5375	h_{FE}*	30		

ELECTRICAL CHARACTERISTICS (CONTINUED)

	Symbol	Min.	Max.	Units
Forward Current Transfer Ratio				
(V_{CE} = 10 V, I_C = 150mA) GES5372	h_{FE}*	60	200	
(V_{CE} = 10 V, I_C = 150mA) GES5373	h_{FE}*	100	300	
(V_{CE} = 10 V, I_C = 150mA) GES5374	h_{FE}*	150	400	
(V_{CE} = 10 V, I_C = 150mA) GES5375	h_{FE}*	40	400	
Collector-Emitter Saturation Voltage				
(I_C = 150mA, I_B = 15mA)	$V_{CE(SAT)}$*		.3	Volts
Base-Emitter Saturation Voltage				
(I_C = 150mA, I_B = 15mA)	$V_{BE(SAT)}$*		1.3	Volts
Base-Emitter Voltage				
(V_{CE} = 10 V, I_C = 150mA)	$V_{BE(ON)}$*		1.2	Volts
DYNAMIC CHARACTERISTICS				
Collector-Base Capacitance				
(V_{CB} = 10V, I_E = 0, f = 1MHz)	C_{CB}		10	pf
Forward Current Transfer Ratio				
(V_{CE} = 10V, I_C = 20mA, F = 100MHz)	h_{FE}	1.5		
SWITCHING CHARACTERISTICS				
Turn-on Time, Figure 1				
(I_C = 150mA, I_{B1}, = 15mA V_{CC} = 30V)	t_{ON}		50	nsec.
Turn-off Time, Figure 2				
(I_C = 150mA, I_{B1}, = I_{B2} = 15mA, V_{CC} = 6V) GES5372, GES5373,	t_{OFF}		150	nsec.
GES5374, GES5375	t_{OFF}		175	nsec.

*Pulse Conditions of 300 μs duration, 2% Duty Cycle.

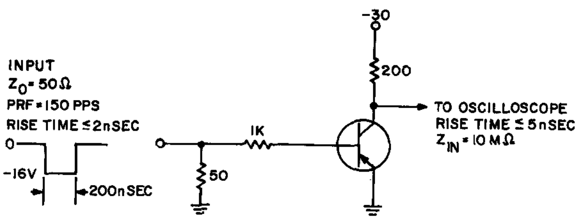


FIGURE 1. TEST CIRCUIT FOR DETERMINING DELAY TIME AND RISE TIME

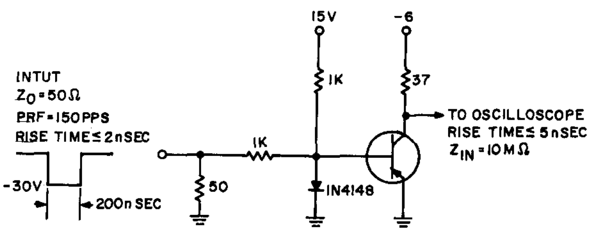
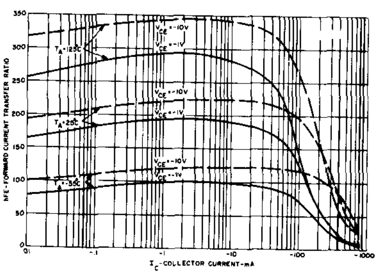
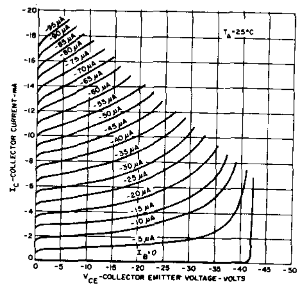


FIGURE 2. TEST CIRCUIT FOR DETERMINING STORAGE TIME AND FALL TIME

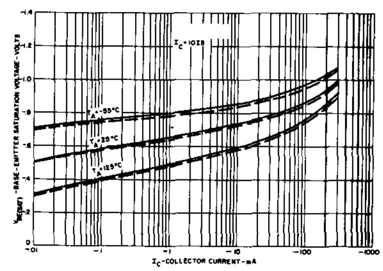
TYPICAL CHARACTERISTIC CURVES



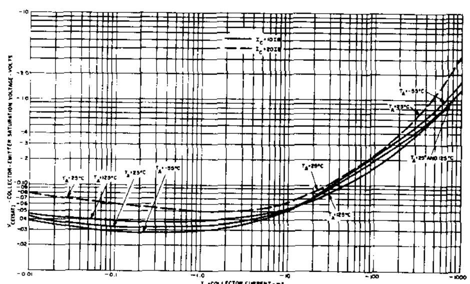
BETA VS. COLLECTOR CURRENT



COLLECTOR CHARACTERISTICS



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



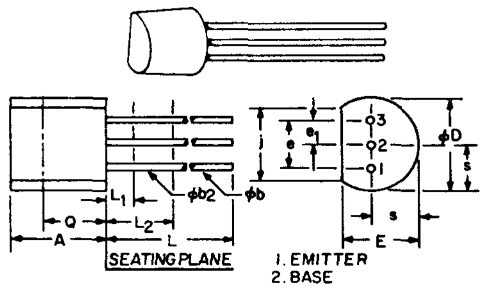
COLLECTER-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

Silicon Transistors

PNP

GES5447,8

The General Electric GES5447 and GES5448 are silicon, PNP planar, epitaxial, passivated transistors, designed for general audio frequency applications and linear amplifiers. For complimentary NPN types see GES5449, GES5450 and GES5451 specification. Voltage and current valves for PNP are negative, observe proper bias polarity.



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A =25°C unless otherwise specified)

		GES5447	GES5448	
Voltages				
Collector to Emitter	V_{CEO}	25	30	Volts
Collector to Base	V_{CBO}	40	50	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	← 200 →		mA
Dissipation				
Total Power $T_A \leqq 25°C$	P_T	← 360 →		Watts
Total Power $T_C \leqq 25°C$	P_T	← 500 →		Watts
Derate Factor T_A > 25°C		← 2.88 →		mW/°C
Derate Factor T_C >25°C		← 4 →		mW/°C
Temperature				
Storage	$T_{STG.}$	-65 to + 150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260		°C

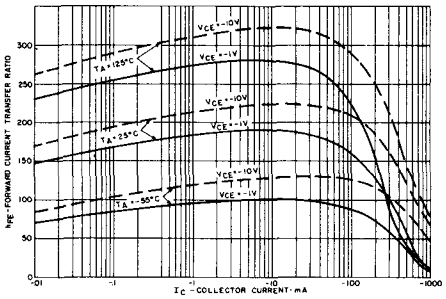
electrical characteristics: (T_A =25°C unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	GES5447 Min.	GES5447 Max.	GES5448 Min.	GES5448 Max.	Units
Collector-emitter breakdown voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$*	25		30		Volts
Collector-base breakdown voltage (I_C = 100uA, I_E = 0)	$V_{(BR)CBO}$	40		50		Volts
Emitter-base breakdown voltage (I_E = 100uA, I_C = 0)	$V_{(BR)EBO}$	5		5		Volts
Collector cutoff current (V_{CB} = 20V, I_E = 0)	I_{CBO}		100		100	nA
Emitter-base reverse current (V_{EB} = 3V, I_C = 0)	I_{EBO}		100		100	nA
Forward current transfer ratio (V_{CE} = 5V, I_C = 50mA)	h_{FE}*	60	300	30	150	
Collector-emitter saturation voltage (I_C = 50mA, I_B = 5mA)	$V_{CE(sat)}$*		.25		.25	Volts
Base-emitter voltage (V_{CE} = 5V, I_C = 50mA)	$V_{BE(on)}$*	.6	1	.6	1	Volts

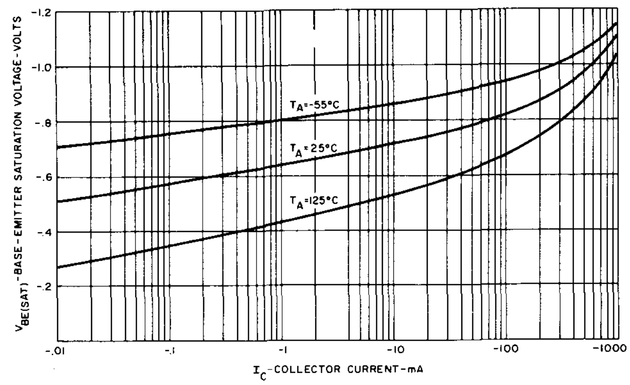
DYNAMIC CHARACTERISTICS	Symbol	GES5447 Min.	GES5447 Max.	GES5448 Min.	GES5448 Max.	Units
Collector-base capacitance (V_{CB} = 10V, I_E = 0, f = 1MHz)	C_{cb}		12		12	pf
Forward current transfer ratio (V_{CE} = 5V, I_C = 50mA, f = 20MHz)	h_{FE}	5		5		

*Pulse Conditions: Pulse Width $\leqq$ 300 μs and duty cycle $\leqq$ 2%

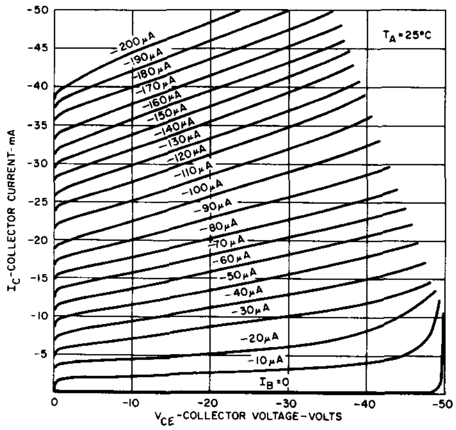
TYPICAL CHARACTERISTIC CURVES



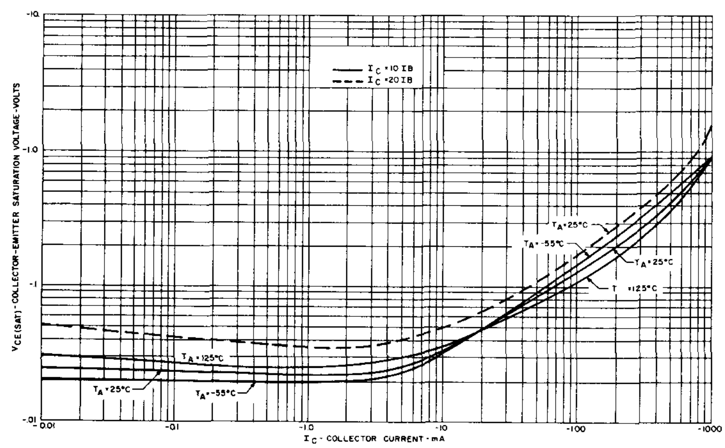
BETA VS. COLLECTOR CURRENT



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



COLLECTOR CHARACTERISTICS



COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

Silicon

Transistors

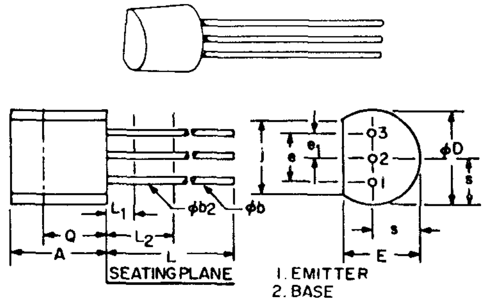
NPN

GES5449,50,51

The General Electric GES5449, GES5450 and GES5451 are silicon NPN planar, epitaxial, passivated transistors designed for general audio frequency applications and linear amplifiers. For complimentary PNP types see GES5447 and GES5448 specifications.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		GES5449 GES5450	GES5451	
Voltages				
Collector to Emitter	V_{CEO}	30	20	Volts
Collector to Base	V_{CBO}	50	40	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	← 800 →		mA
Dissipation				
Total Power $T_A \leqq 25°C$	P_T	← .360 →		Watts
Total Power $T_C \leqq 25°C$	P_T	← .500 →		Watts
Derate Factor $T_A > 25°C$		← 2.88 →		mW/°C
Derate Factor $T_C > 25°C$		← 4 →		mW/°C
Temperature				
Storage	T_{STG}	-65 to + 150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260		°C



TO-92

1. EMITTER
2. BASE
3. COLLECTOR

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L1	–	1.270	–	.050	3
L2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

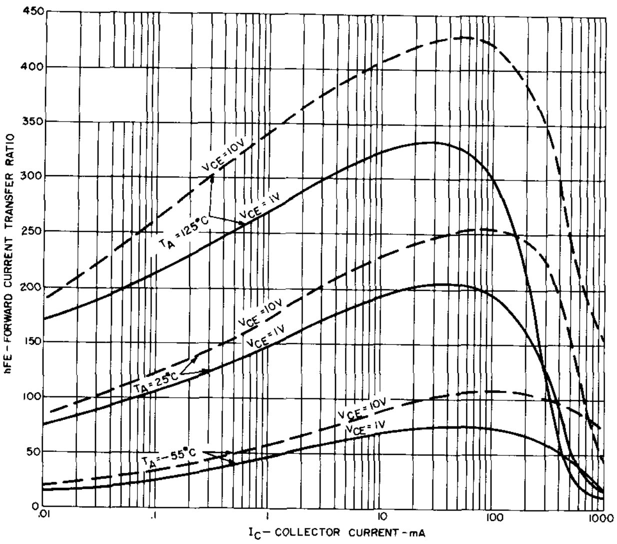
NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

electrical characteristics: (T_A = 25°C unless otherwise specified)

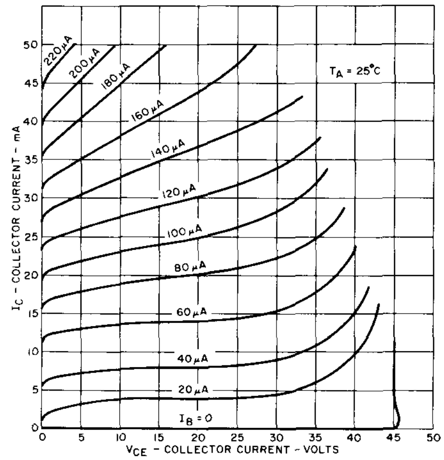
STATIC CHARACTERISTICS	Symbol	GES5449 Min.	GES5449 Max.	GES5450 Min.	GES5450 Max.	GES5451 Min.	GES5451 Max.	Units
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO*}$	30		30		20		Volts
Collector-Base Breakdown Voltage (I_C = 100 uA, I_E = 0)	$V_{(BR)CBO}$	50		50		40		Volts
Emitter-Base Breakdown Voltage (I_E = 100uA, I_C = 0)	$V_{(BR)EBO}$	5		5		5		Volts
Collector Cutoff Current (V_{CB} = 20 V, I_E = 0)	I_{CBO}		100		100		100	nA
Emitter-Base Reverse Current (V_{EB} = 3 V, I_C = 0)	I_{EBO}		100		100		100	nA
Forward Current Transfer Ratio (V_{CE} = 2 V, I_C = 50mA)	h_{FE*}	100	300	50	150	30	600	
Collector-Emitter Saturation Voltage (I_C = 100mA, I_B = 5mA)	$V_{CE(SAT)*}$		.6		.8		1	Volts
Base-Emitter Voltage (V_{CE} = 2 V, I_C = 100mA)	$V_{BE(ON)*}$	.5	1	.5	1	.5	1	Volts
DYNAMIC CHARACTERISTICS								
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1MHz)	C_{CB}		12		12		12	pf
Forward Current Transfer Ratio (V_{CE} = 2 V, I_C = 50mA, f = 20MHz)	h_{FE}	5		5		5		

*Pulse Conditions: Pulse Width ≦ 300 μs and duty cycle ≦ 2%

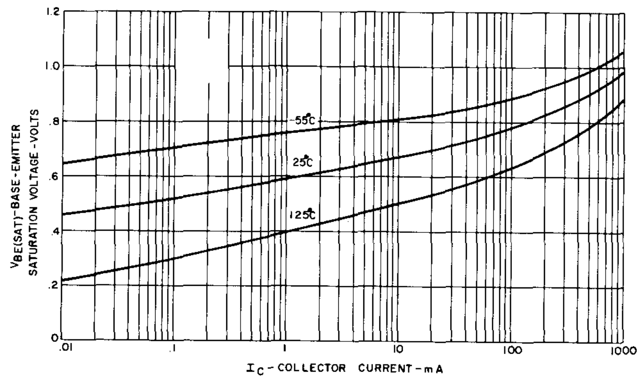
TYPICAL CHARACTERISTIC CURVES



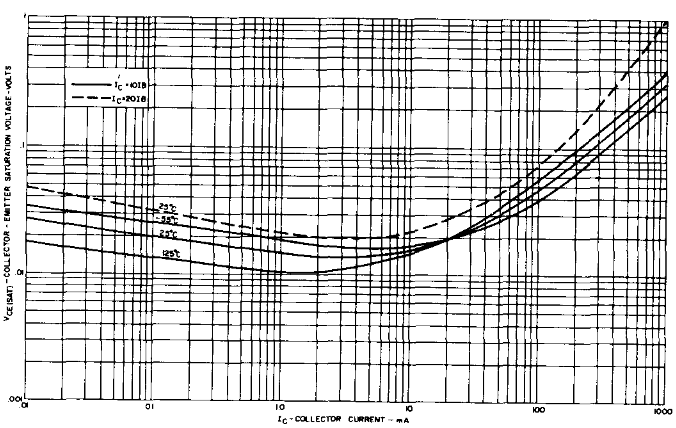
BETA VS. COLLECTOR CURRENT



COLLECTOR CHARACTERISTICS



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

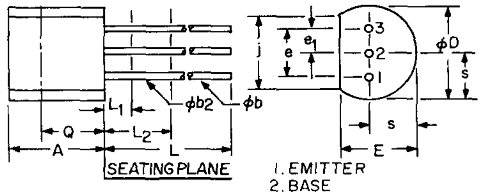


COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

Silicon Transistors

NPN	PNP
GES5810	GES5811
GES5812	GES5813

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a wide range of general purpose applications at audio and intermediate frequencies.



TO-92

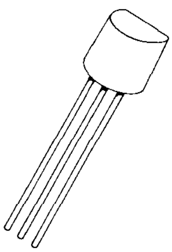
SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

Features:

- Excellent Gain Linearity over Wide Range of Collector Currents to 500mA and Beyond.
- High Collector Current Ratings: 1000 mA.
- Integral Heat Sinks Available. Order as GES5810-J1 etc.
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.

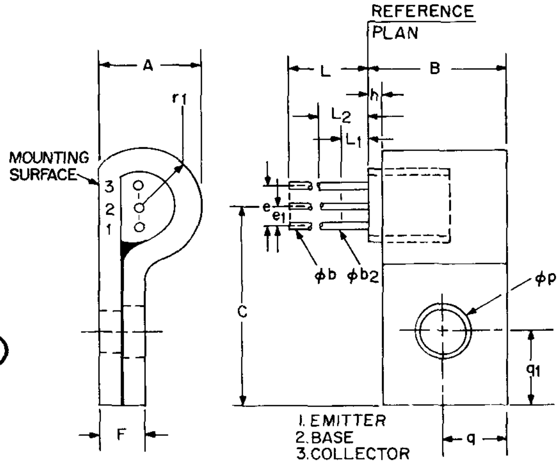
Voltage and current values for PNP devices are negative; observe bias polarity.

absolute maximum ratings: (25°C unless otherwise specified)



Voltages			
Collector to Emitter	V_{CEO}	25	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	35	Volts
Collector to Emitter	V_{CES}	35	Volts
Current			
Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec. pulse width, ≤ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
Total Power (Free Air, $T_A = 25°C$)[1]	P_T	500	mW
Total Power with Heatsink (Free Air, $T_A \leq 25°C$)[2]	P_T	700	mW
Total Power with Heatsink (Case Temp., $T_C \leq 25°C$)[3]	P_T	1000	mW
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +135	°C
Lead soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C

[1]Derate 4.55 mW/°C increase in ambient temperature above 25°C. [2]Derate 6.36 mW/°C increase in ambient temperature above 25°C. [3]Derate 9.09 mW/°C increase in case temperature above 25°C.



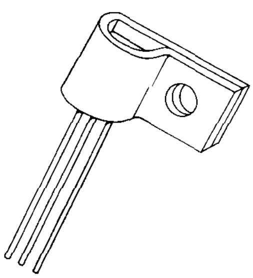
TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	6.680	—	.263	
B	—	10.160	—	.400	
ϕb	.407	.533	.016	.021	1
ϕb2	.407	.482	.016	.019	1
C	—	13.200	—	.520	
e	2.420	2.660	.095	.105	
e1	1.150	1.395	.045	.055	
F	—	3.550	—	.140	
h	1.570 REF.		.062 REF.		
L	12.700	—	.500	—	1
L1	—	1.270	—	.050	1
L2	6.350	—	.250	—	1
ϕp	—	3.630	—	.145	2
q	3.960 REF.		.156 REF.		
q1	2.210 REF.		.187 REF.		
r1	—	3.960	—	.156	

electrical characteristics: (25°C unless otherwise specified)

NOTE: Characteristics apply to both heatsinked and non-heatsinked devices.

STATIC CHARACTERISTICS		Min.	Max.	
Collector Cutoff Current (V_{CB}=25V)	I_{CBO}	—	100	nA
(V_{CB}=25V, T_A=100°C)	I_{CBO}	—	15	μA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	10	μA
Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 2V)				
GES5810, GES5811	h_{FE}	60	200	
GES5812, GES5813	h_{FE}	150	500	
(I_C = 500 mA, V_{CE} = 2V)				
GES5810, GES5811	* h_{FE}	45	—	
GES5812, GES5813	* h_{FE}	60	—	
Collector-Emitter Breakdown Voltage (I_C = 10 mA)	* $V_{(BR)CEO}$	25	—	Volts
(I_C = 10 μA)	$V_{(BR)CES}$	35	—	Volts
Emitter-Base Breakdown Voltage (I_E = 10 μA)	$V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage (I_C = 500 mA, I_B = 50 mA)	* $V_{CE(SAT)}$	—	0.75	Volts
Base-Saturation Voltage (I_C = 500 mA, I_B = 50 mA)	* $V_{BE(SAT)}$	—	1.2	Volts
Base-Emitter Voltage (I_C = 500 mA, V_{CE} = 2V)	* V_{BE}	.60	1.1	Volts
DYNAMIC CHARACTERISTICS				
Collector-Base Capacitance (V_{CB} = 10V, f = 1 MHz)	C_{cb}	—	15	pF



*Pulse Conditions: Pulse width ≤ 300μs Duty cycle ≤ 2%

NOTES:
1. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 & .5"(12.70MM) FROM REFERENCE PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND .5"(12.70MM) FROM REFERENCE PLANE.
2. MOUNTING HOLE IS FOR #4 SCREW. HOLE WILL ACCEPT A .113" (2.87MM) DIAMETER PIN INSERTED PERPENDICULAR TO THE MOUNTING SURFACE.

		Min.	Max.	
Input Capacitance, Common Base ($V_{EB} = 0.5V$, f = 1 MHz)	C_{eb}	—	55	pF
Gain Bandwidth Product ($I_C = 50$ mA, $V_{CE} = 2V$, f = 20 MHz)				
GES5810, GES5811	f_T	100	—	MHz
GES5812, GES5813	f_T	135	—	MH:

Typical h_{FE} vs. I_C

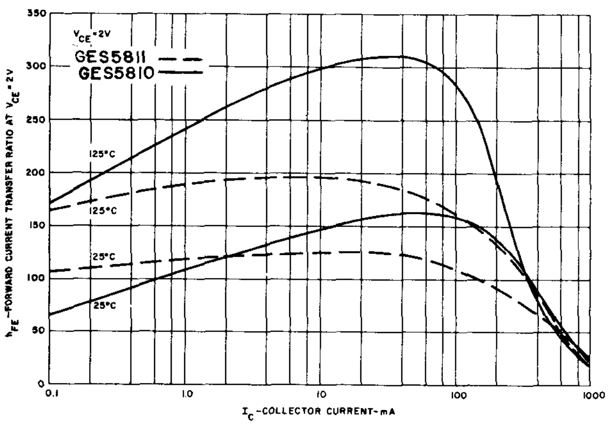


Figure 1

Typical h_{FE} vs. I_C

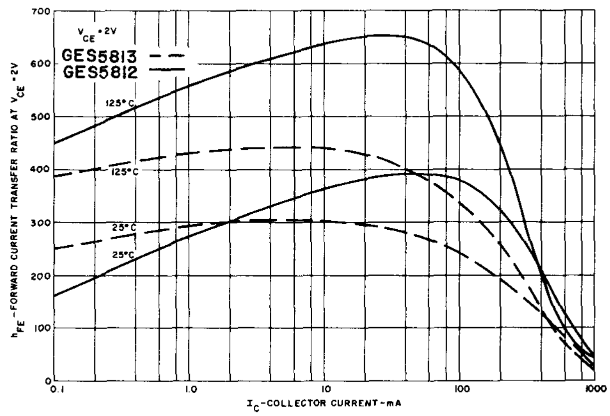


Figure 2

Typical I_{CBO} vs. Ambient Temperature

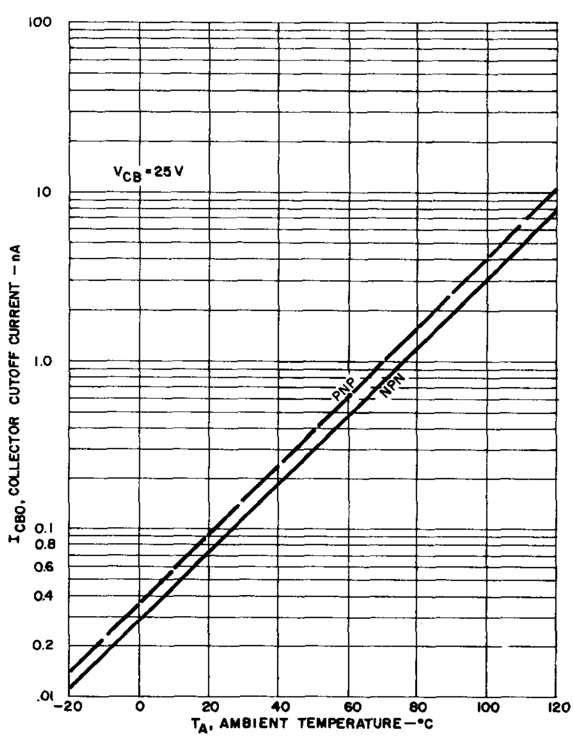


Figure 3

Power vs. Ambient Temperature Derating

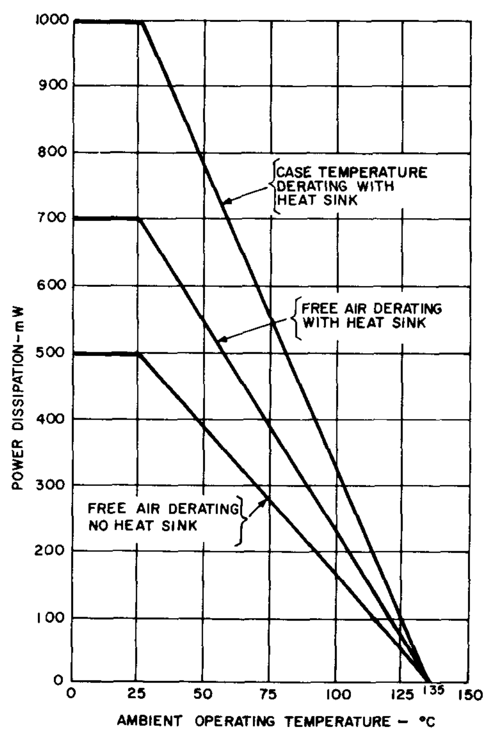


Figure 4

Silicon Transistors

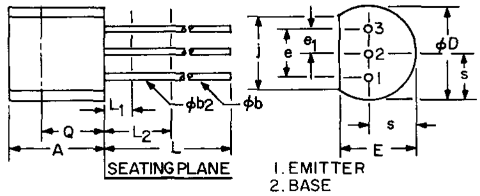
NPN	PNP
GES5814	GES5815
GES5816	GES5817
GES5818	GES5819

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a wide range of general purpose applications at audio and intermediate frequencies.

Features:

- Excellent Gain Linearity over Wide Range of Collector Currents to 500mA and Beyond.
- High Collector Current Ratings: 1000 mA.
- Integral Heat Sinks Available. Order H.S. as GES5814-J1 etc.
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.

Voltage and current values for PNP devices are negative; observe proper bias polarity



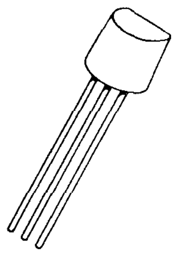
1. EMITTER
2. BASE
3. COLLECTOR

TO-92

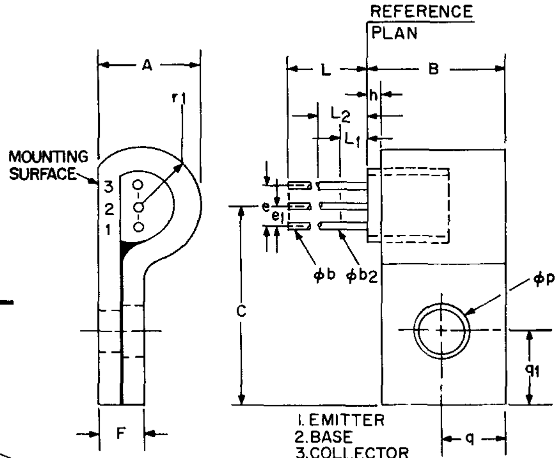
SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltage			
Collector to Emitter	V_{CEO}	40	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	50	Volts
Collector to Emitter	V_{CES}	50	Volts
Current			
Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec. pulse width, ≦ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
Total Power (Free Air, $T_A \leqq 25°C$) (1)	P_T	500	mW
Total Power with Heatsink (Free Air, $T_A \leqq 25°C$) (2)	P_T	700	mW
Total Power with Heatsink (Case Temp., $T_C \leqq 25°C$) (3)	P_T	1000	mW
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +135	°C
Leading soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C



(1) Derate 4.55 mW/°C increase in ambient temperature above 25°C. (2) Derate 6.36 mW/°C increase in ambient temperature above 25°C. (3) Derate 0.09 mW/°C increase in case temperature above 25°C.



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	6.680	—	.263	
B	—	10.160	—	.400	
ϕb	.407	.533	.016	.021	1
ϕb2	.407	.482	.016	.019	1
C	—	13.200	—	.520	
e	2.420	2.660	.095	.105	
e1	1.150	1.395	.045	.055	
F	—	3.550	—	.140	
h	1.570	REF.	.062	REF.	
L	12.700	—	.500	—	1
L1	—	1.270	—	.050	1
L2	6.350	—	.250	—	1
ϕp	—	3.630	—	.145	2
q	3.960	REF.	.156	REF.	
q1	2.210	REF.	.187	REF.	
r1	—	3.960	—	.156	

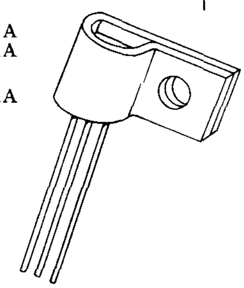
NOTES:
1. (THREE LEADS) ϕb2 APPLIES BETWEEN L1 AND L2. ϕb APPLIES BETWEEN L2 & .5"(12.70MM) FROM REFERENCE PLANE. DIAMETER IS UNCONTROLLED IN L1 AND BEYOND .5"(12.70MM) FROM REFERENCE PLANE.
2. MOUNTING HOLE IS FOR #4 SCREW. HOLE WILL ACCEPT A .113"(2.87MM) DIAMETER PIN INSERTED PERPENDICULAR TO THE MOUNTING SURFACE.

electrical characteristics: (25°C) (unless otherwise specified)

NOTE: Characteristics apply to both heatsinked and non-heatsinked devices.

STATIC CHARACTERISTICS		Min.	Max.	
Collector Cutoff Current				
(V_{CB}=25V)	I_{CBO}	—	100	nA
(V_{CB}=25V, T_A=100°C)	I_{CBO}	—	15	μA
Emitter Cutoff Current				
(V_{EB} = 5V)	I_{EBO}	—	10	μA
Forward Current Transfer Ratio				
(I_C = 2 mA, V_{CE} = 2V)				
GES5814, GES5815	h_{FE}	60	160	
GES5816, GES5817	h_{FE}	100	200	
GES5818, GES5819	h_{FE}	150	300	
(I_C = 500 mA, V_{CE} = 2 V)				
GES5814, GES5815	* h_{FE}	20	—	
GES5816, GES5817	* h_{FE}	25	—	
GES5818, GES5819	* h_{FE}	25	—	
Collector Emitter Breakdown Voltage				
(I_C = 10 mA)	* $V_{(BR)CEO}$	40	—	Volts
(I_C = 10 μA)	$V_{(BR)CES}$	50	—	Volts
Emitter Base Breakdown Voltage				
(I_E = 10 μA)	$V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage				
(I_C = 500 mA, I_B = 50 mA)	* $V_{CE(SAT)}$	—	0.75	Volts
Base Saturation Voltage				
(I_C = 500 mA, I_B = 50 mA)	* $V_{BE(SAT)}$	—	1.2	Volts
Base Emitter Voltage				
(I_C = 500 mA, V_{CE} = 2V)	* V_{BE}	.60	1.1	Volts

*Pulse Conditions: Pulse width ≤ 300μs Duty cycle ≤ 2%



GES5814, 15
GES5816, 17
GES5818, 19

electrical characteristics: (25°C) (unless otherwise specified)

DYNAMIC CHARACTERISTICS		Min.	Max.	
Collector-Base Capacitance				
*($V_{CB} = 10V$, f = 1 MHz)	C_{cb}	—	15	pF
Input Capacitance, Common Base				
($V_{EB} = 0.5V$, f = 1 MHz)	C_{eb}	—	55	pF
Gain Bandwidth Product				
($I_C = 50$ mA, $V_{CE} = 2V$, f = 20 MHz)				
GES5814, GES5815	f_T	100	—	MHz
GES5816, GES5817	f_T	120	—	MHz
GES5818, GES5819	f_T	135	—	MHz

*Indicates JEDEC Registered values.

Typical h_{FE} vs. I_C

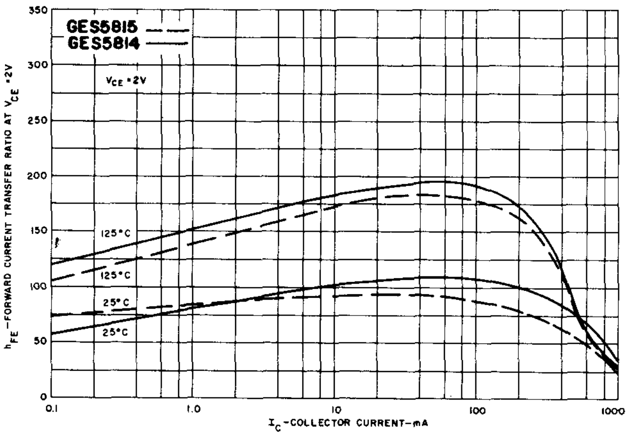


Figure 1

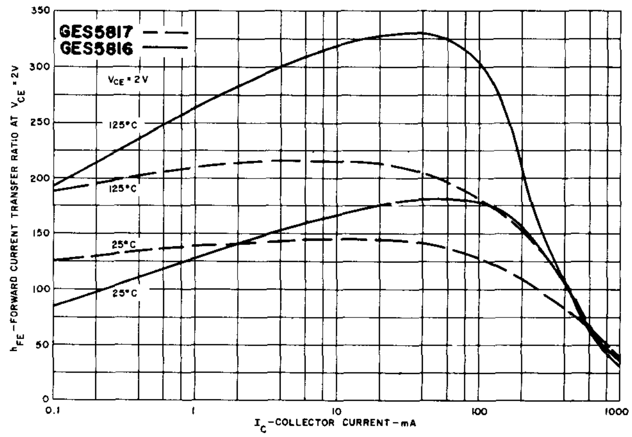


Figure 2

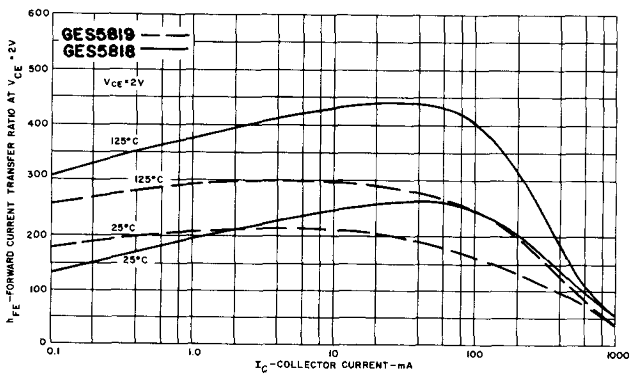


Figure 3

Typical $V_{CE(SAT)}$ vs. I_C, ($I_B = I_C/20$)

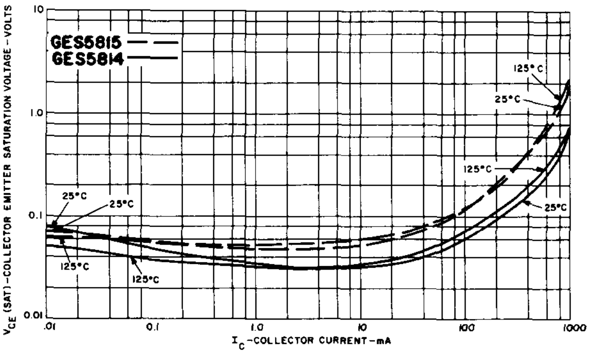


Figure 4

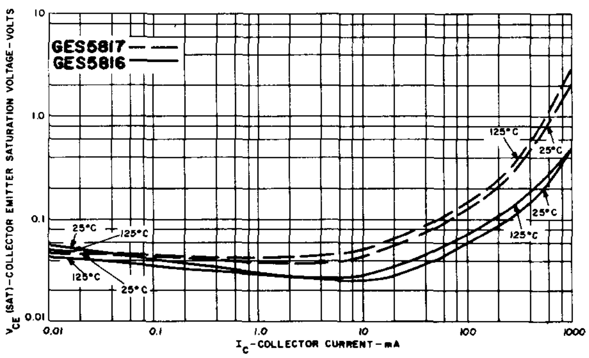


Figure 5

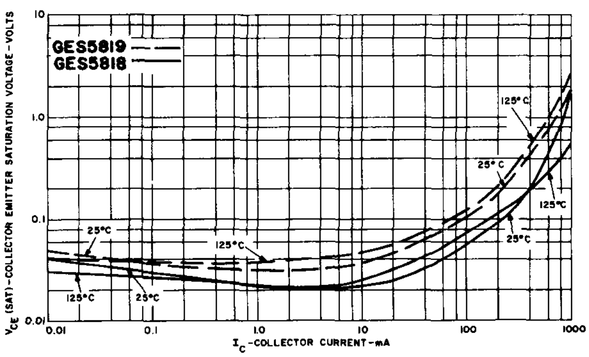


Figure 6

Typical $V_{CE(SAT)}$ vs. ($I_B = I_C/10$)

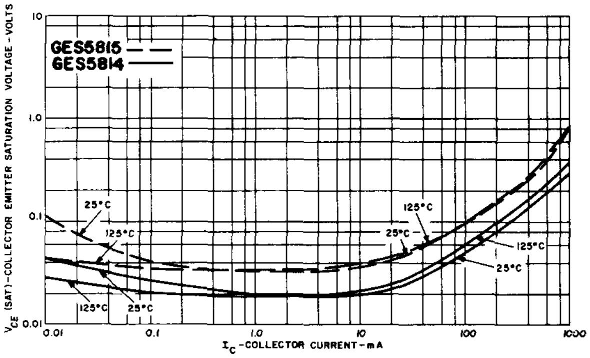


Figure 7

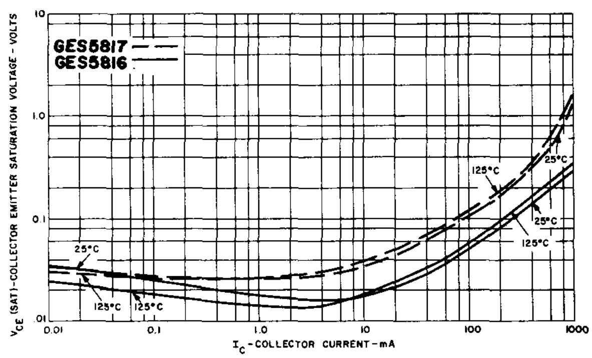


Figure 8

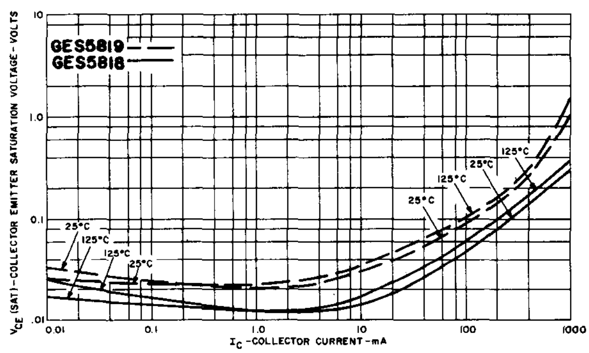


Figure 9

Typical $V_{BE\ on}$ vs. I_C

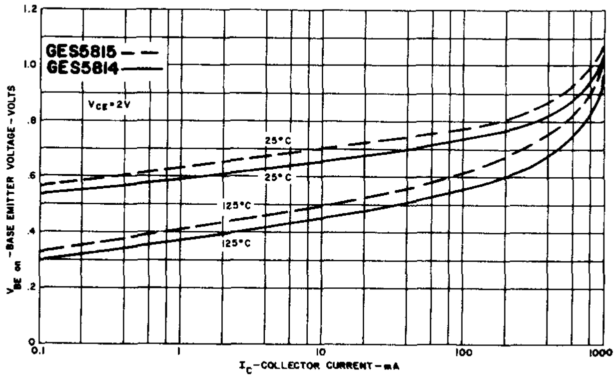


Figure 10

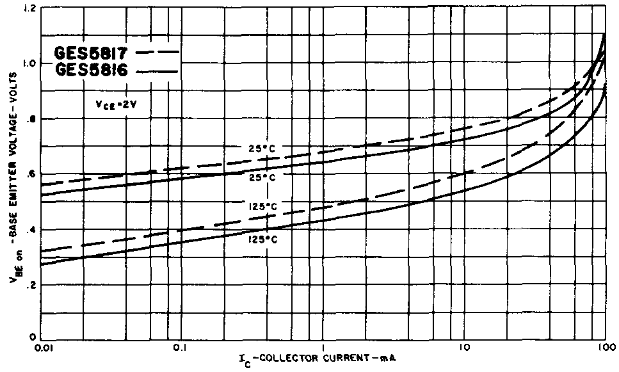


Figure 11

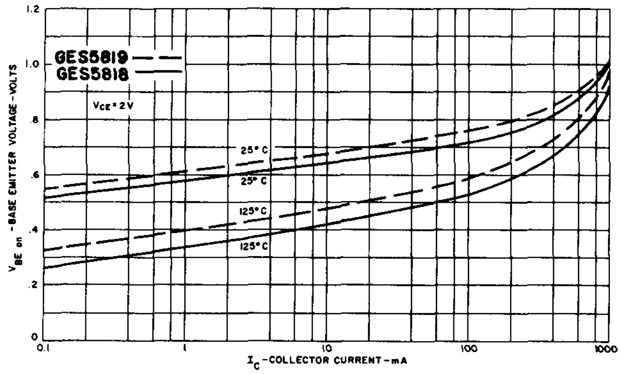


Figure 12

Typical I_{CBO} vs. Ambient Temperature

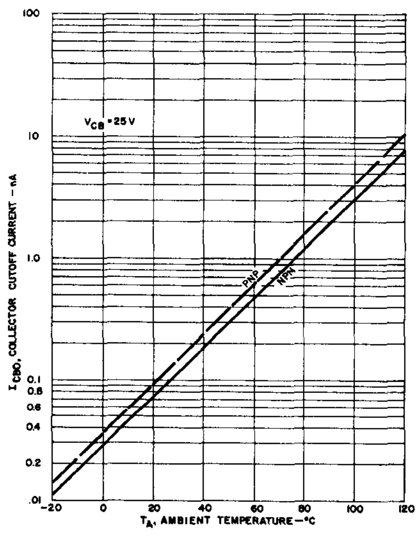


Figure 13

Power vs. Ambient Temperature Derating

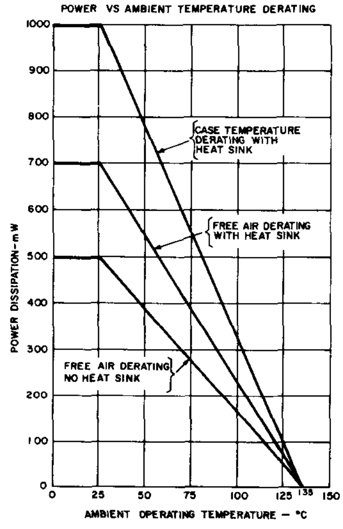
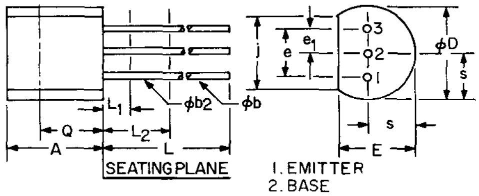


Figure 14

Silicon Transistors

NPN	PNP
GES5820	GES5821
GES5822	GES5823

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a wide range of general purpose applications at audio low and intermediate frequencies.



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

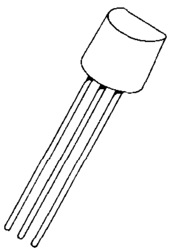
Features:

- Excellent Gain Linearity over Wide Range of Collector Currents to 500mA and Beyond
- High Collector Current Ratings: 1000 mA.
- Integral Heat Sinks Available. Order as GES5820-J1 etc.
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.

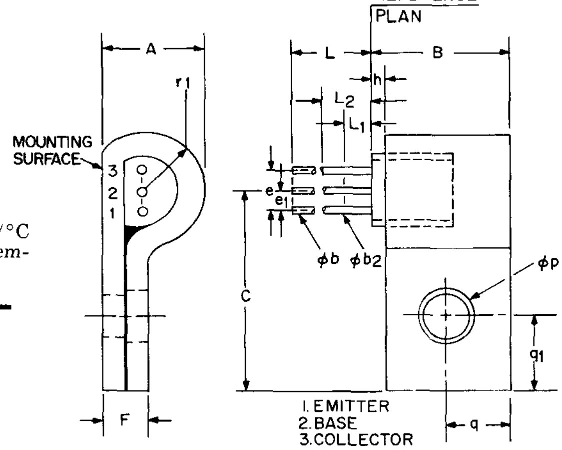
Voltage and current values for PNP devices are negative; observe proper bias polarity

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	60	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	70	Volts
Collector to Emitter	V_{CES}	70	Volts
Current			
Collector (Continuous)	I_C	750	mA
Collector (Pulsed, 300 μsec. pulse width, ≤ 2% duty cycle)	I_{CM}	1000	mA
Dissipation			
Total Power (Free Air, $T_A \leq 25°C$)[1]	P_T	500	mW
Total Power with Heatsink (Free Air, $T_A \leq 25°C$)[2]	P_T	700	mW
Total Power with Heatsink (Case Temp., $T_C \leq 25°C$)[3]	P_T	1000	mW
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +135	°C
Lead soldering (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C



[1]Derate 4.55 mW/°C increase in ambient temperature above 25°C. [2]Derate 6.36 mW/°C increase in ambient temperature above 25°C. [3]Derate 9.09 mW/°C increase in case temperature above 25°C.



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	–	6.680	–	.263	
B	–	10.160	–	.400	
φb	.407	.533	.016	.021	1
φb2	.407	.482	.016	.019	1
C	–	13.200	–	.520	
e	2.420	2.660	.095	.105	
e1	1.150	1.395	.045	.055	
F	–	3.550	–	.140	
h	1.570	REF.	.062	REF.	
L	12.700	–	.500	–	1
L_1	–	1.270	–	.050	1
L_2	6.350	–	.250	–	1
φp	–	3.630	–	.145	2
q	3.960	REF.	.156	REF.	
q_1	2.210	REF.	.187	REF.	
r_1	–	3.960	–	.156	

NOTES:
1. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 & .5" (12.70MM) FROM REFERENCE PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND .5" (12.70MM) FROM REFERENCE PLANE.
2. MOUNTING HOLE IS FOR #4 SCREW. HOLE WILL ACCEPT A .113" (2.87MM) DIAMETER PIN INSERTED PERPENDICULAR TO THE MOUNTING SURFACE.

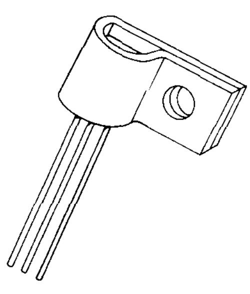
electrical characteristics: (25°C) (unless otherwise specified)

NOTE: Characteristics apply to both heatsinked and non-heatsinked devices.

STATIC CHARACTERISTICS

		Min.	Max.	
Collector Cutoff Current (V_{CB}=25V)	I_{CBO}	—	100	nA
(V_{CB}=25V, T_A=100°C)	I_{CBO}	—	15	μA
Emitter Cutoff Current (V_{EB} = 5V)	I_{EBO}	—	10	μA
Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 2V)				
GES5820, GES5821	h_{FE}	60	160	
GES5822, GES5823	h_{FE}	100	200	
(I_C = 500 mA, V_{CE} = 2V)				
GES5820, GES5821	* h_{FE}	20	—	
GES5822, GES5823	* h_{FE}	25	—	
Collector-Emitter Breakdown Voltage				
(I_C = 10 mA)	* $V_{(BR)CEO}$	60	—	Volts
(I_C = 10 μA)	$V_{(BR)CES}$	70	—	Volts
Emitter-Base Breakdown Voltage (I_E = 10 μA)	* $V_{(BR)EBO}$	5	—	Volts
Collector Saturation Voltage (I_C = 500 mA, I_B = 50 mA)	* $V_{CE(SAT)}$	—	0.75	Volts
Base Saturation Voltage (I_C = 500 mA, I_B = 50 mA)	* $V_{BE(SAT)}$	—	1.2	Volts
Base-Emitter Voltage (I_C = 500 mA, V_{CE} = 2V)	V_{BE}	.60	1.1	Volts

*Pulse Conditions: Pulse width ≤ 300μs Duty cycle ≤ 2%



DYNAMIC CHARACTERISTICS

		Min.	Max.	
Collector-Base Capacitance				
(V_{CB} = 10V, f = 1 MHz)	C_{cb}	—	15	pF
Input Capacitance, Common Base				
(V_{EB} = 0.5V, f = 1 MHz)	C_{eb}	—	55	pF
Gain Bandwidth Product				
(I_C = 50 mA, V_{CE} = 2V, f = 20 MHz)				
GES5820, GES5821	f_T	100	—	MHz
GES5822, GES5823	f_T	120	—	MHz

Typical h_{FE} vs. I_C

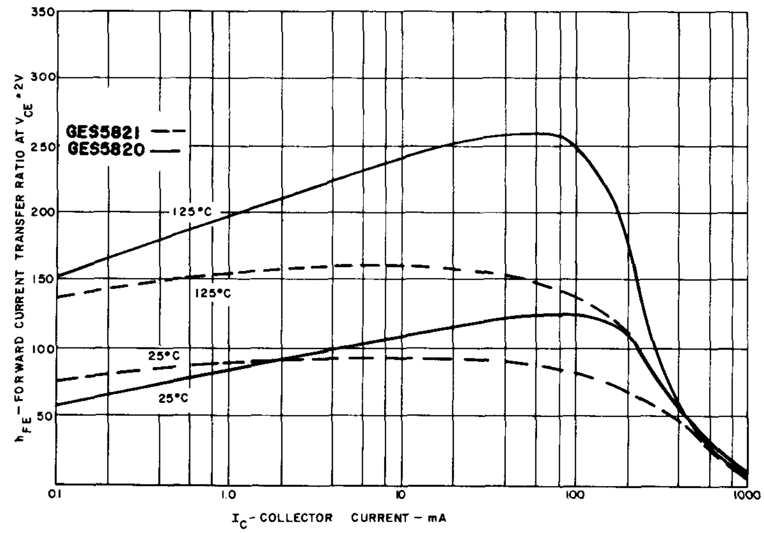


Figure 1

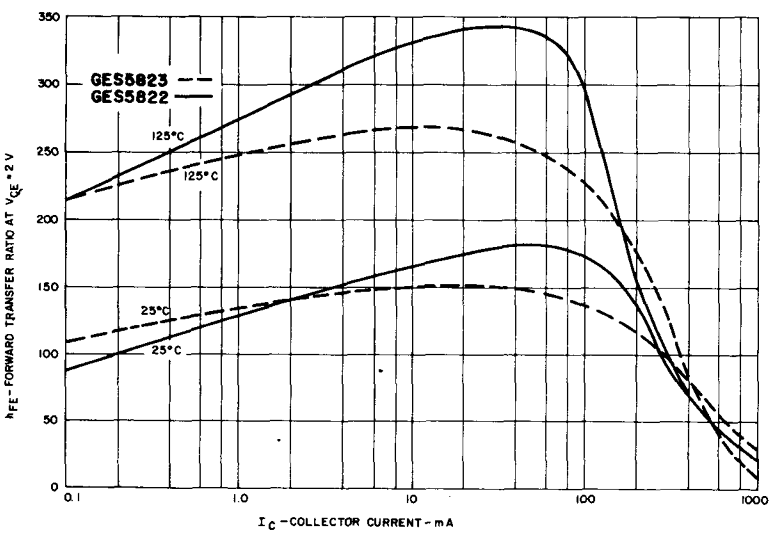


Figure 2

Typical $V_{CE(SAT)}$ vs. I_C
($I_B = I_C/20$)

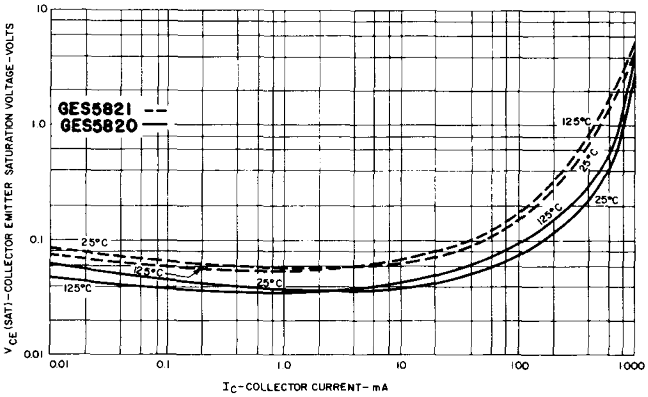


Figure 3

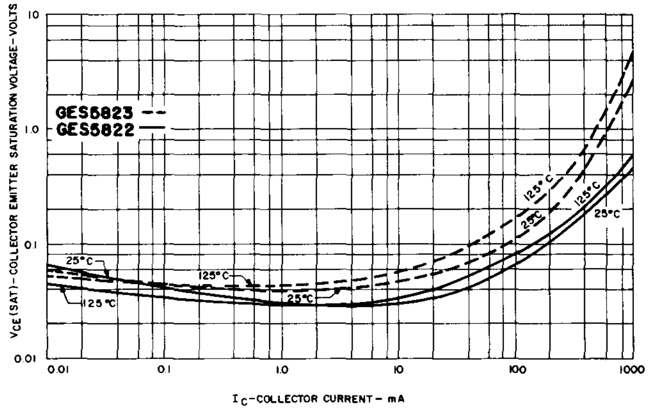


Figure 4

Typical $V_{CE(SAT)}$ vs. I_C
($I_B = I_C/10$)

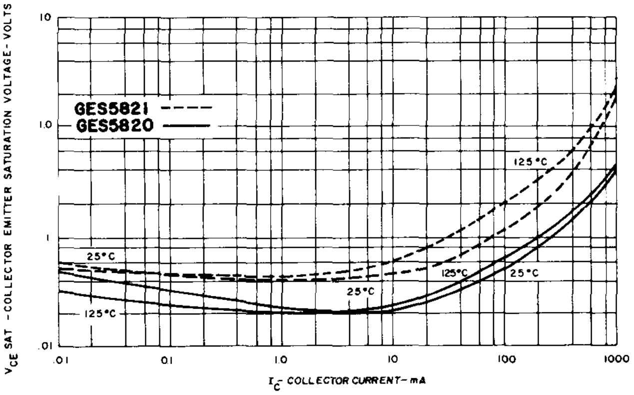


Figure 5

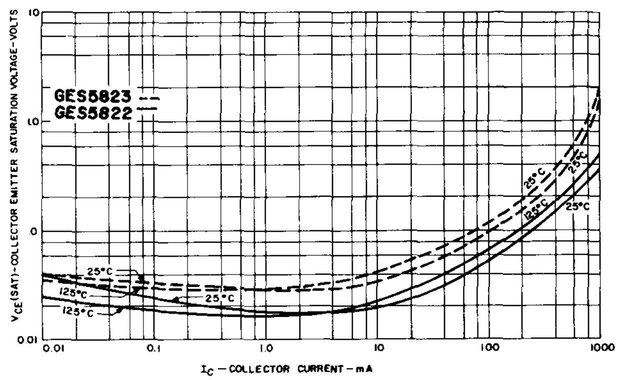


Figure 6

Typical $V_{BE\ on}$ vs. I_C

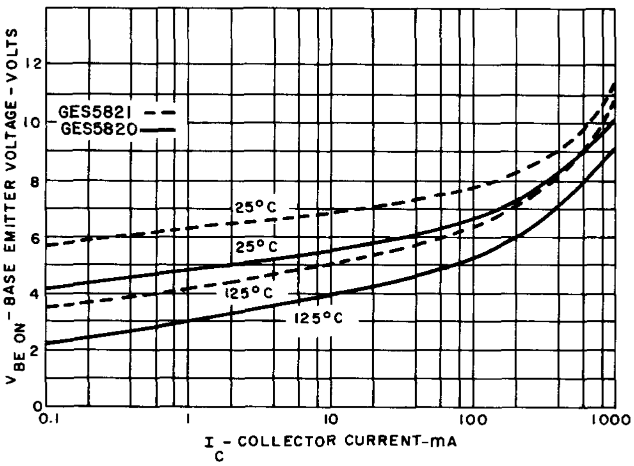


Figure 7

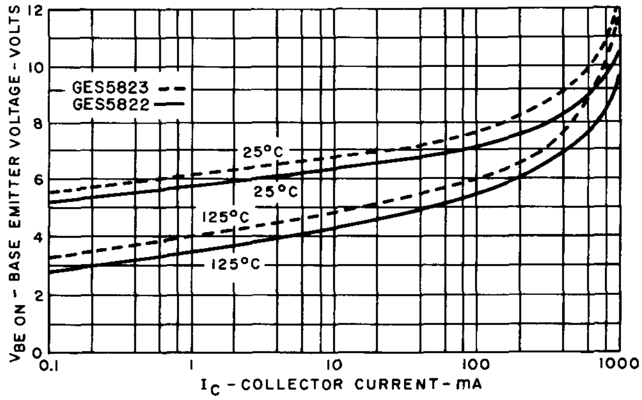


Figure 8

Typical I_{CBO} vs. Ambient Temperature

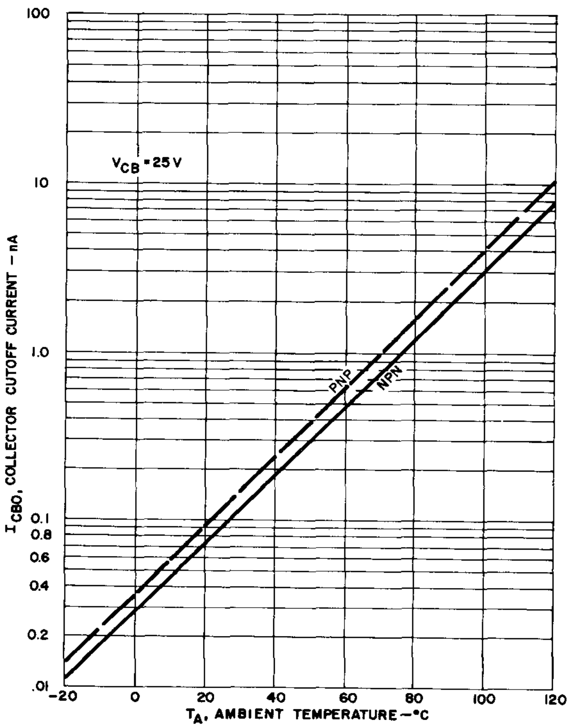


Figure 9

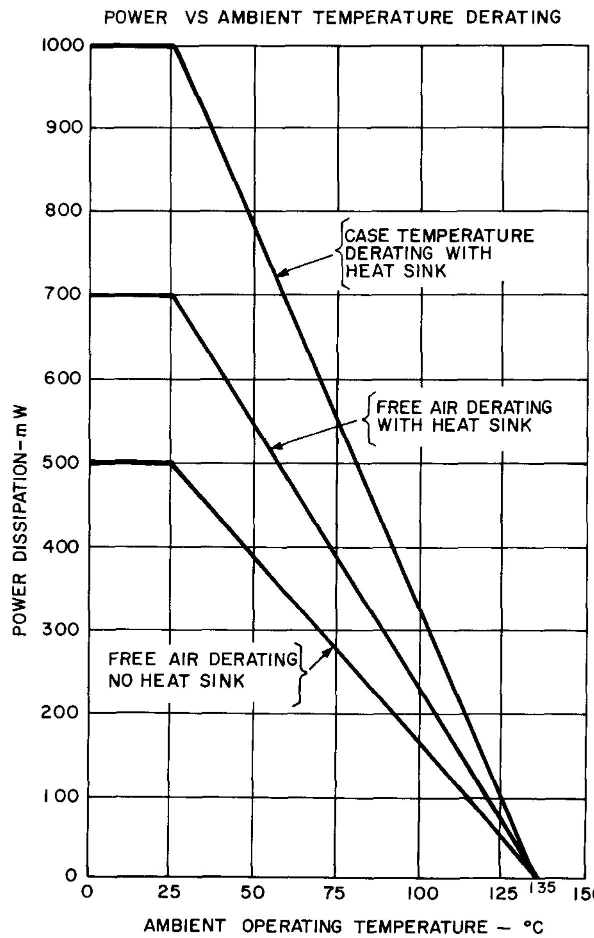


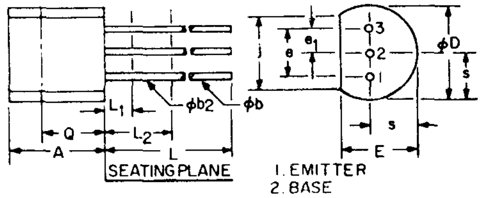
Figure 10

Silicon Transistors

NPN

GES5824
GES5825
GES5826

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a broad range of general purpose signal level applications at audio and intermediate frequencies.



TO-92

1. EMITTER
2. BASE
3. COLLECTOR

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	–	.050	3
L_2	6.350	–	.250	–	3
Q	2.920	—	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) $\phi b2$ APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

Features:

- Excellent Gain Linearity—particularly designed for operation in the 10 microampere to 20 milliampere range.
- 2:1 DC gain ratio per group.
- Low Collector Saturation Voltage
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	40	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	50	Volts
Current			
Collector (Continuous)	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C)[1]	P_T	360	mW
Total Power (Free Air @ 55°C)	P_T	260	mW
Temperature			
Storage	T_{STG}	−65 to 150°C	
Operating	T_J	−65 to 125°C	
Lead Soldering, 1/16" ± 1/32" from case for 10 secs. max.	T_L	260°C	

[1]Derate 3.60 mW/°C increase in ambient temperature above 25°C.

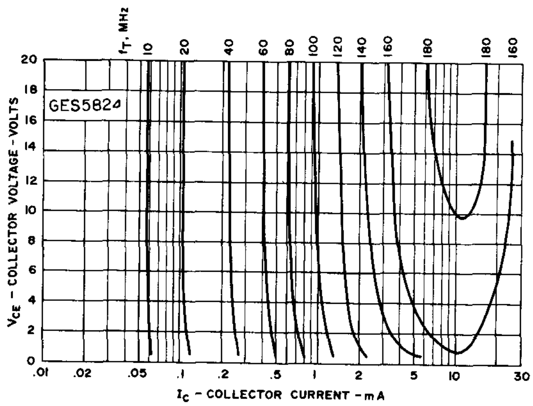
electrical characteristics: (25°C) (unless otherwise specified)

Static Characteristics		**Min.**	**Typ.**	**Max.**	**Units**
Collector Current,					
V_{CB} = 40 Volts	I_{CBO}			50	nA
V_{CB} = 40 Volts, T_A = 100°C	I_{CBO}			10	μA
Emitter Cutoff Current,					
V_{EB} = 5 Volts	I_{EBO}			50	nA
Collector-Emitter Breakdown Voltage, I_C = 10 mA	$V_{(BR)CEO}$	40			Volts
Collector Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{CE(SAT)}$			.125	Volts
Base-Emitter Saturation Voltage (I_C = 10mA, I_B = 1 mA)	$V_{BE(SAT)}$			.78	Volts
Base-Emitter Voltage (I_C = 2 mA, V_{CE} = 10V)	V_{BE}	.5		.9	Volts
Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 5V)					
GES5824	h_{FE}	60		150	
GES5825	h_{FE}	100		200	
GES5826	h_{FE}	150		300	
Dynamic Characteristics					
Gain Bandwidth Product (I_C = 2 mA, V_{CE} = 10V, f = 10 MHz)	f_T	90		250	MHz
Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 5V, f = 1 KHz)					
GES5824	h_{fe}	60		225	
GES5825	h_{fe}	100		300	
GES5826	h_{fe}	150		450	
Collector-Base Capacitance (V_{CB} = 10V, f = 1 MHz)	C_{cb}		1.9	4.0	pF
Collector—Base Time Constant (V_{CE}=10V, I_C=2mA, f=31.9 MHz)	$r_b'C_c$		65		p sec.

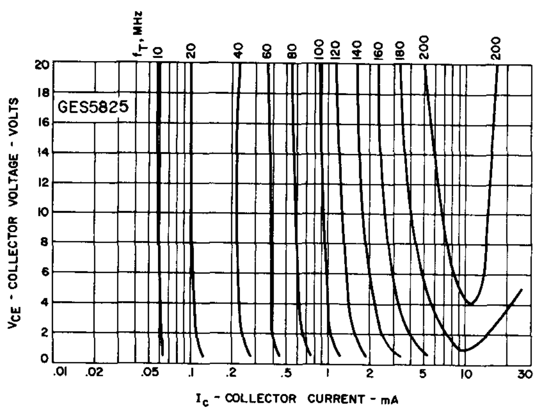
Registered values.

GAIN BAND-WIDTH PRODUCT vs. COLLECTOR CURRENT

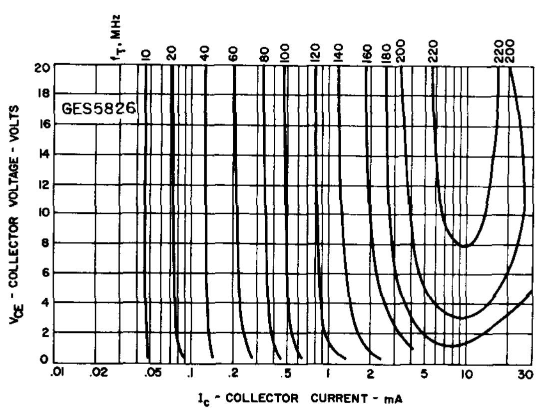
GES5824



GES5825

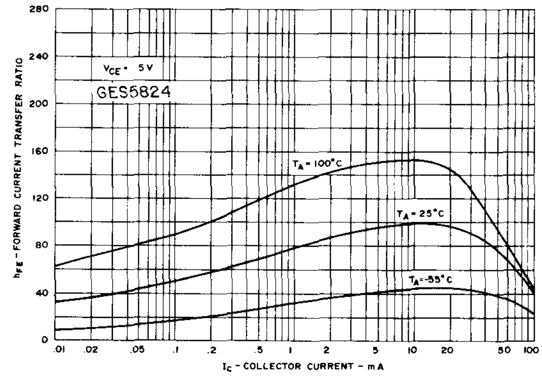


GES5826

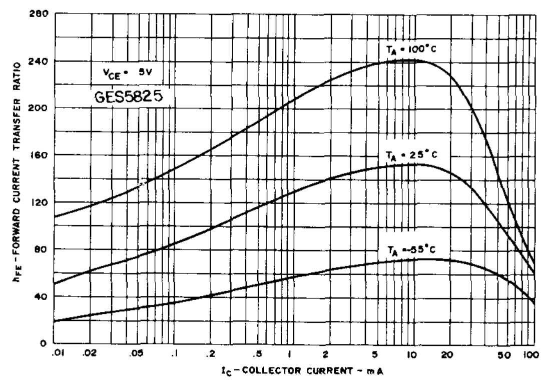


FORWARD CURRENT TRANSFER RATIO vs. COLLECTOR CURRENT

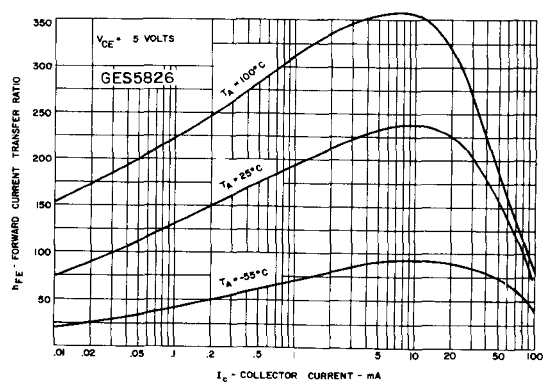
GES5824



GES5825

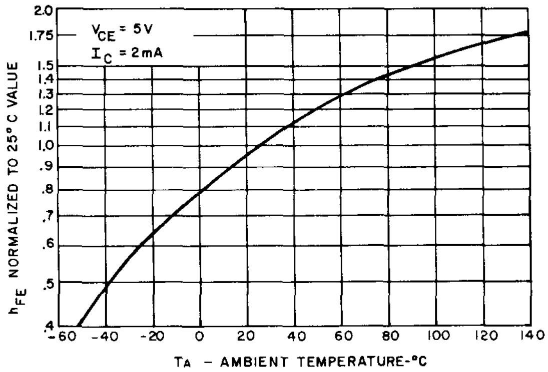


GES5826

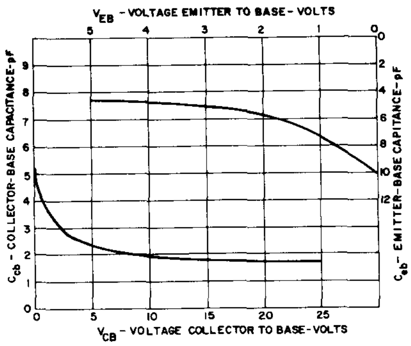


TYPICAL ELECTRICAL CHARACTERISTICS

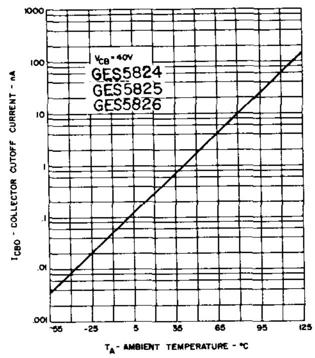
h_{FE} vs. TEMPERATURE



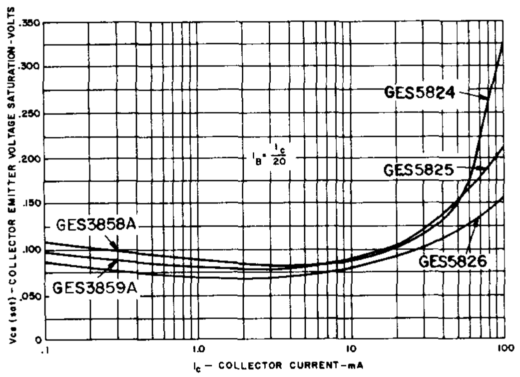
Capacitance vs. VOLTAGE



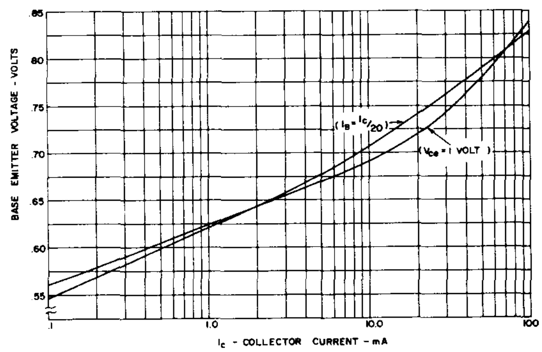
I_{CBO} vs. TEMPERATURE



$V_{CE(SAT)}$ vs. Collector Current



$V_{BE(SAT)}$, $V_{BE(DRIVE)}$ vs. Collector Current

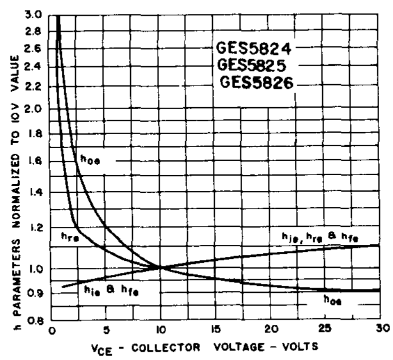


TYPICAL SMALL SIGNAL CHARACTERISTICS

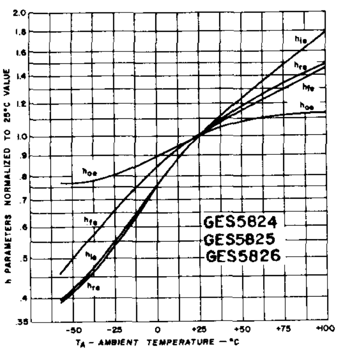
f = 1 KHz, V_{CE} = 10V, I_C = 2mA, T_A = 25°C

Symbol	Characteristics	GES5824	GES5825	GES5826	Units
h_{ie}	Input Resistance	1680	2480	3660	ohms
h_{oe}	Output Conductance	8.2	11	17	μmhos
h_{fe}	Forward Current Transfer Ratio	110	175	275	
h_{re}	Voltage Feedback Ratio	8.2	10.5	14.6	$X10^{-5}$

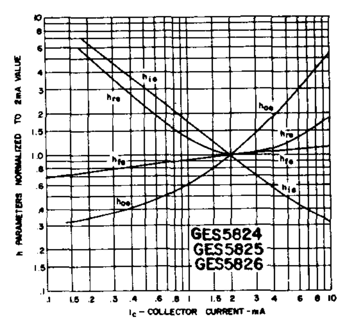
h PARAMETERS vs. V_{CE}



h PARAMETERS vs. TEMPERATURE



h PARAMETERS vs. I_C

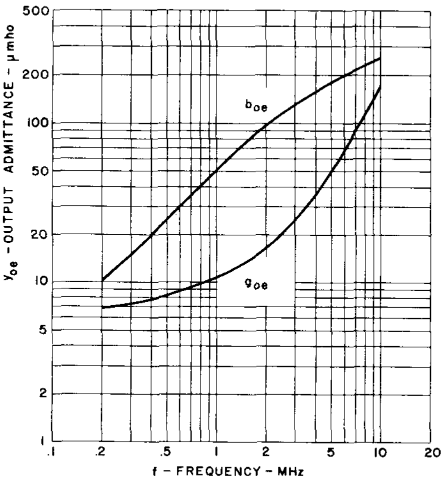


TYPICAL COMMON EMITTER "y" PARAMETERS

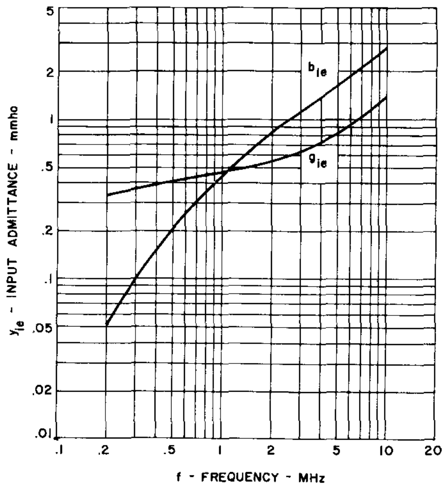
$V_{CE} = 10V$

$I_C = 2mA$

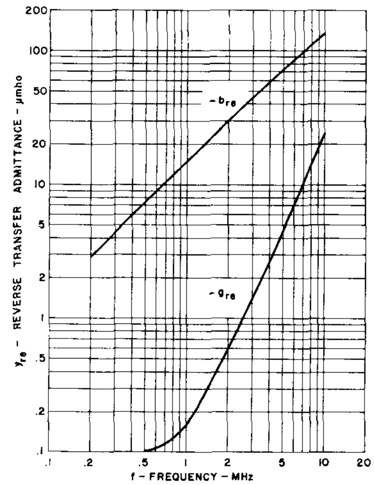
y_{oe}
Output Admittance vs. Frequency (INPUT SHORT CIRCUIT)



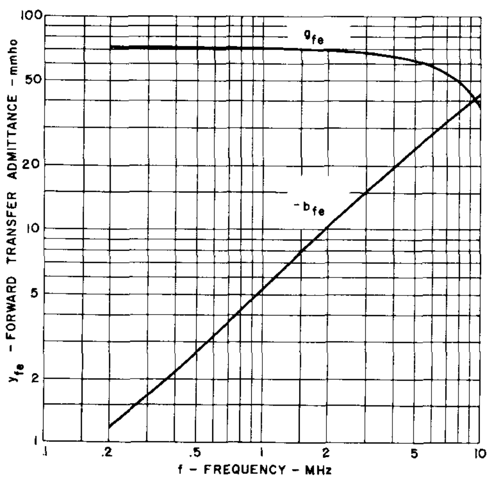
y_{ie}
Input Admittance vs. Frequency (OUTPUT SHORT CIRCUIT)



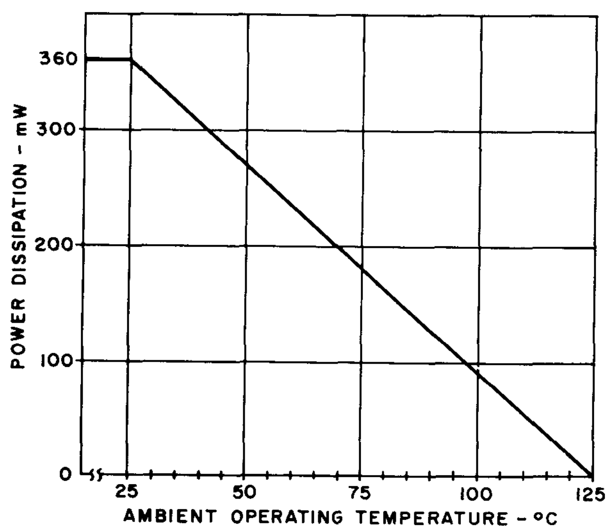
y_{re}
Reverse Transfer Admittance vs. Frequency (INPUT SHORT CIRCUIT)



y_{fe}
Forward Transfer Admittance vs. Frequency (OUTPUT SHORT CIRCUIT)



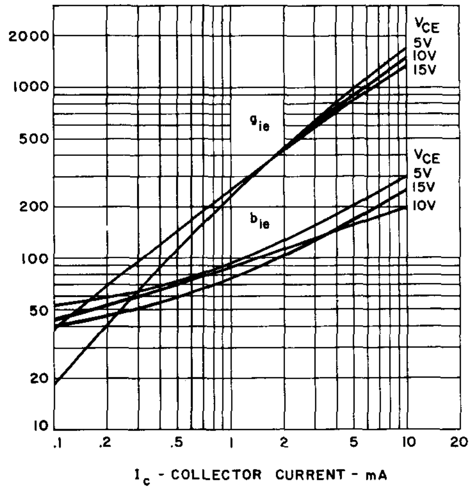
Power vs. Ambient Temp. Derating



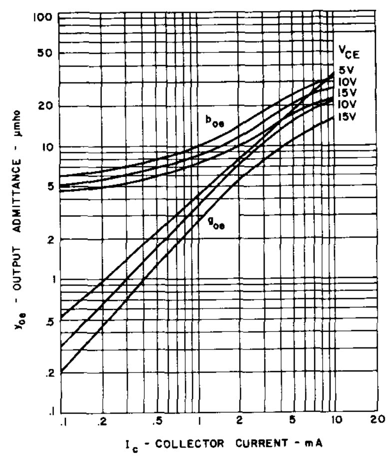
TYPICAL COMMON EMITTER "y" PARAMETERS

f=250 KHz

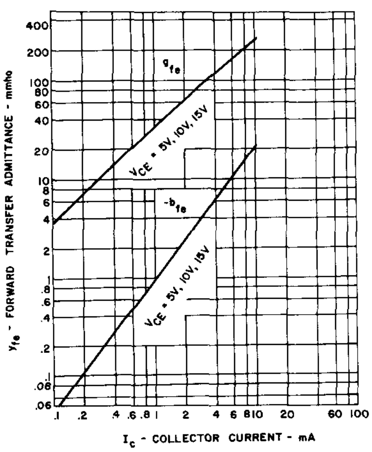
y_{ie}
Input Admittance vs. Collector Current (OUTPUT SHORT CIRCUIT)



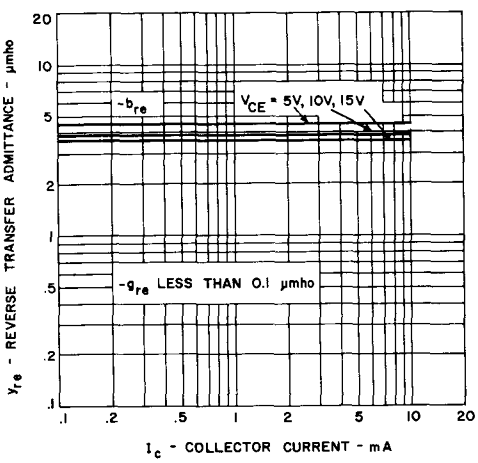
y_{oe}
Output Admittance vs. Collector Current (INPUT SHORT CIRCUIT)



y_{fe}
Forward Transfer Admittance vs. Collector Current (OUTPUT SHORT CIRCUIT)

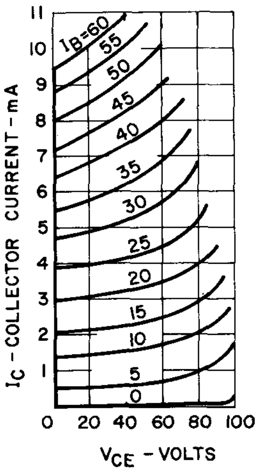


y_{re}
Reverse Transfer Admittance vs. Collector Current (INPUT SHORT CIRCUIT)

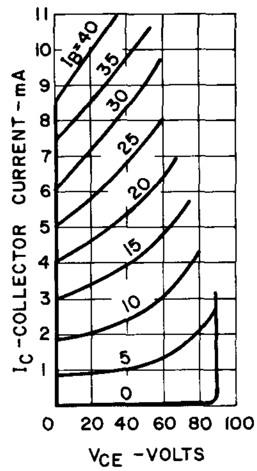


COLLECTOR CHARACTERISTICS

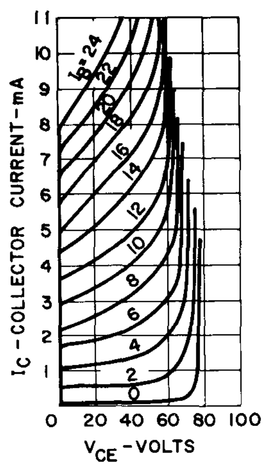
GES5824



GES5825



GES5826

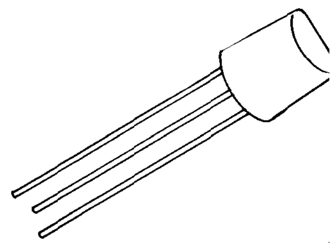


Silicon Transistor

NPN

GES5827

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a broad range of general purpose signal level applications at audio and intermediate frequencies.



Features:

- Excellent Gain Linearity—particularly designed for operation in the 10 microampere to 20 milliampere range.
- 2:1 DC gain ratio per group.
- Low Collector Saturation Voltage
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.

absolute maximum ratings: (25°C) (unless otherwise specified)

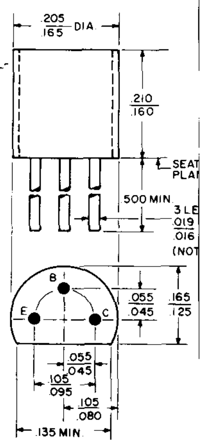
Voltages			
*Collector to Emitter	V_{CEO}	40	Volts
*Emitter to Base	V_{EBO}	5	Volts
*Collector to Base	V_{CBO}	50	Volts
Current			
*Collector (continuous)	I_C	100	mA
Dissipation			
*Total Power (Free Air @ 25°C)[1]	P_T	360	mW
Total Power (Free Air @ 55°C)	P_T	260	mW
Temperature			
*Storage	T_{STG}	−65 to +150	°C
*Operating	T_J	−65 to +125	°C
*Lead soldering, 1/16" ± 1/32" from case for 10 secs. max.	T_L	+260	°C

*[1]Derate 3.60 mW/°C increase in ambient temperature above 25°C.

NOTE 1: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED.

TO-18 LEAD SPACING

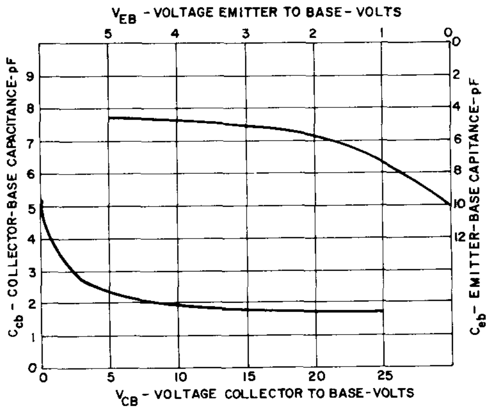


electrical characteristics: (25°C) (unless otherwise specified)

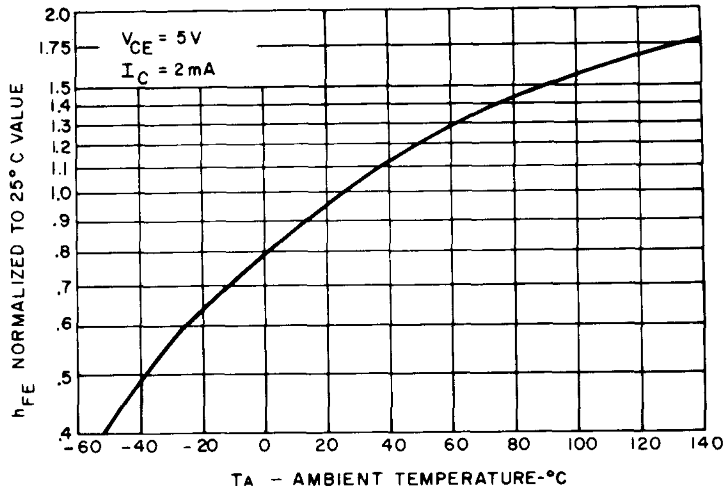
		Min.	Typ.	Max.	Units
STATIC CHARACTERISTICS					
*Collector Current ($V_{CB} = 40V$)	I_{CBO}			50	nA
($V_{CB} = 40V, T_A = 100°C$)	I_{CBO}			10	μA
*Emitter Cutoff Current ($V_{EB} = 5$ Volts)	I_{EBO}			50	nA
*Collector-Emitter Breakdown Voltage ($I_C = 10$ mA)	$V_{(BR)CEO}$	40			Volts
*Collector Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(SAT)}$			.125	Volts
Base-Emitter Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{BE(SAT)}$			.78	Volts
*Base-Emitter Voltage ($I_C = 2$ mA, $V_{CE} = 10$ V)	V_{BE}	.5		.9	Volts
*Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$)	h_{FE}	250		500	
DYNAMIC CHARACTERISTICS					
Gain Bandwidth Product ($I_C = 2$ mA, $V_{CE} = 10V$, f = 10 MHz)	f_T	90		350	MHz
*Forward Current Transfer Ratio ($I_C = 2$ mA, $V_{CE} = 5V$, f = 1 KHz)	h_{fe}	250		750	
*Collector-Base Capacitance ($V_{CB} = 10V$, f = 1 MHz)	C_{cb}		1.9	4.0	pF
Collector—Base Time Constant (V_{CE}=10V, I_C=2mA, f=31.9 MHz)	$r_b'C_c$		65		p sec.

*indicates JEDEC registered values.

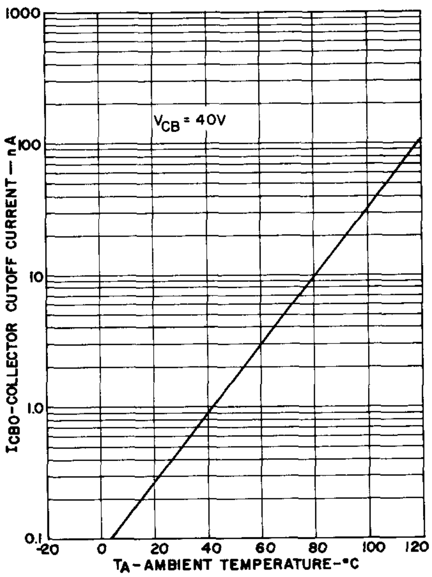
Capacitance vs. Voltage



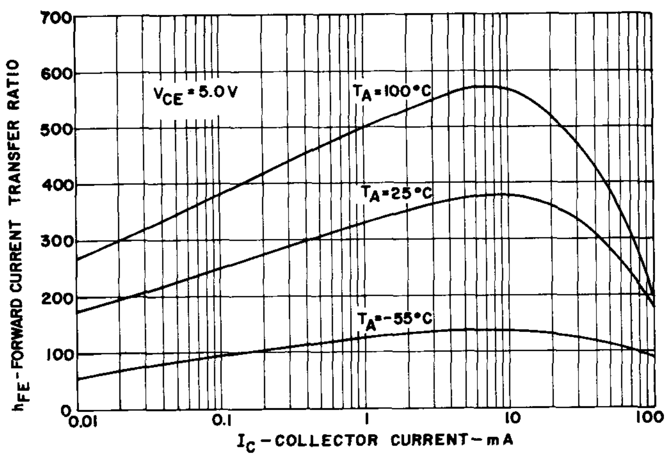
hFE vs. Ambient Temperature



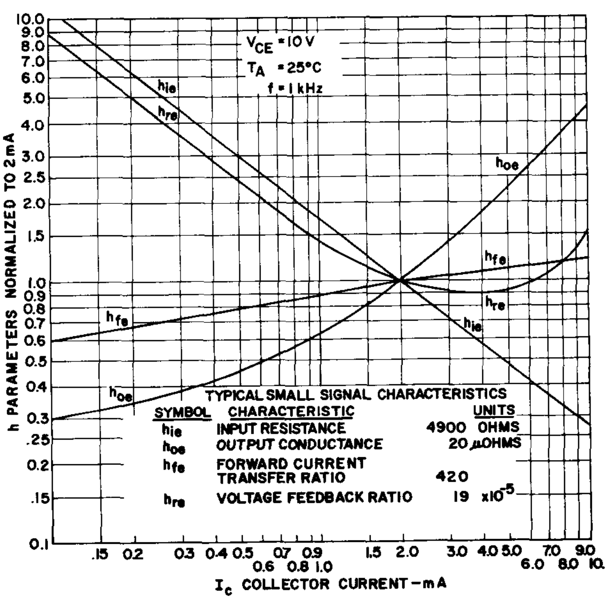
ICBO vs. Ambient Temperature



Forward Current Transfer Ratio vs. Collector Current



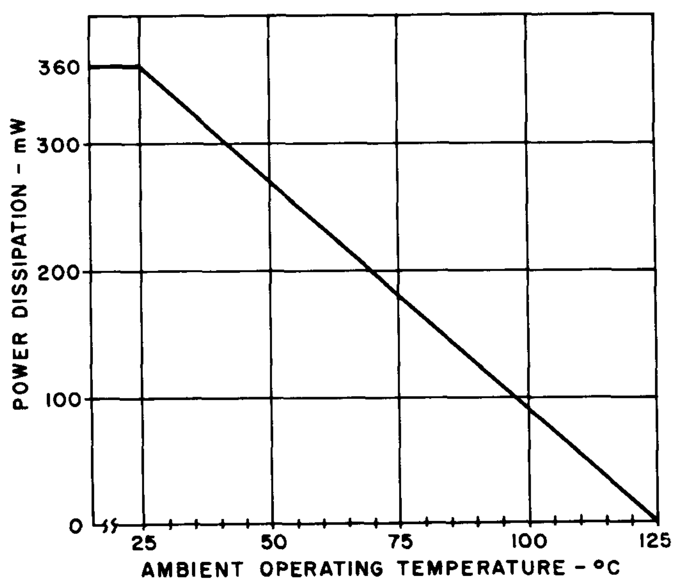
Normalized h Parameters vs. IC



TYPICAL SMALL SIGNAL CHARACTERISTICS

SYMBOL	CHARACTERISTIC		UNITS
hie	INPUT RESISTANCE	4900	OHMS
hoe	OUTPUT CONDUCTANCE	20	μOHMS
hfe	FORWARD CURRENT TRANSFER RATIO	420	
hre	VOLTAGE FEEDBACK RATIO	19	$\times 10^{-5}$

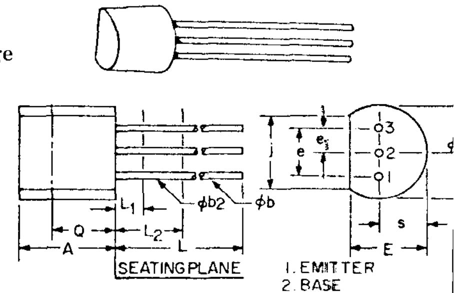
Power vs. Ambient Temperature Derating



Silicon Transistor

NPN GES5828

These silicon, planar, passivated, epitaxial transistors are intended to satisfy a broad range of general purpose signal level applications at audio and intermediate frequencies.



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSID THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.50 FROM THE SEATING PLANE. DIAMETER IS UN CONTROLLED IN L_1 AND BEYOND 12.70 MM (.5 FROM SEATING PLANE.

Features:

- Excellent Gain Linearity—particularly designed for operation in the 10 microampere to 20 milliampere range.
- 2:1 DC gain ratio per group.
- Low Collector Saturation Voltage
- Epoxy Encapsulation with Proved Reliability—excellent characteristic stability under environmental stresses, 85°C—85% RH.

absolute maximum ratings: (25°C) (unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	40	Volts
Emitter to Base	V_{EBO}	5	Volts
Collector to Base	V_{CBO}	50	Volts
Current			
Collector (continuous)	I_C	100	mA
Dissipation			
Total Power (Free Air @ 25°C)[1]	P_T	360	mW
Total Power (Free Air @ 55°C)	P_T	260	mW
Temperature			
Storage	T_{STG}	−65 to +150	°C
Operating	T_J	−65 to +125	°C
Lead soldering, 1/16″ ± 1/32″ from case for 10 secs. max.	T_L	+260	°C

[1]Derate 3.60 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

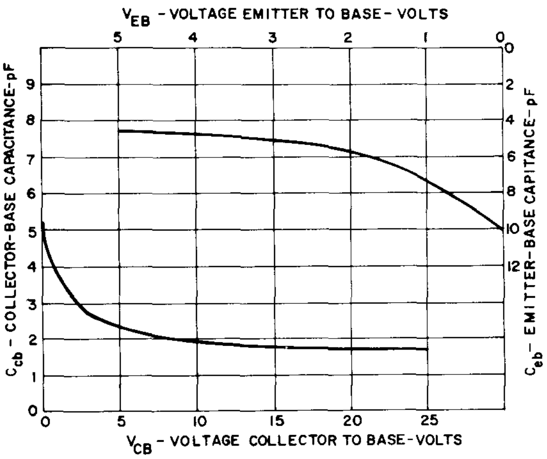
STATIC CHARACTERISTICS

		Min.	Typ.	Max.	Units
Collector Current (V_{CB} = 40 Volts)	I_{CBO}			50	nA
(V_{CB} = 40 Volts, T_A = 100°C)	I_{CBO}			10	μA
Emitter Cutoff Current (V_{EB} = 5 Volts)	I_{EBO}			50	nA
Collector-Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$	40			Volt
Collector Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{CE(SAT)}$			.125	Volt
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{BE(SAT)}$			.78	Volt
Base-Emitter Voltage (I_C = 2 mA, V_{CE} = 10V)	V_{BE}	.5		.9	Volt
Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 5V)	h_{FE}	400		800	

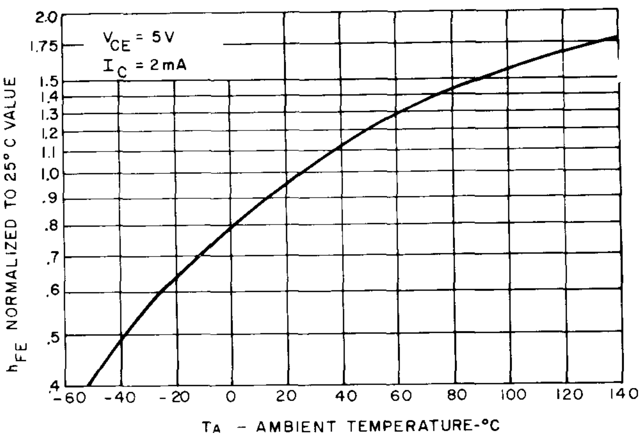
DYNAMIC CHARACTERISTICS

		Min.	Typ.	Max.	Units
Gain Bandwidth Product (I_C = 2 mA, V_{CE} = 10V, f = 10 MHz)	f_T	90		350	MH
Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 5V, f = 1 KHz)	h_{fe}	400		1200	
Collector-Base Capacitance (V_{CB} = 10V, f = 1 MHz)	C_{cb}		1.9	4.0	pF
Collector—Base Time Constant (V_{CE}=10V, I_C=2mA, f=31.9 MHz)	$r_b'C_c$		65		p se

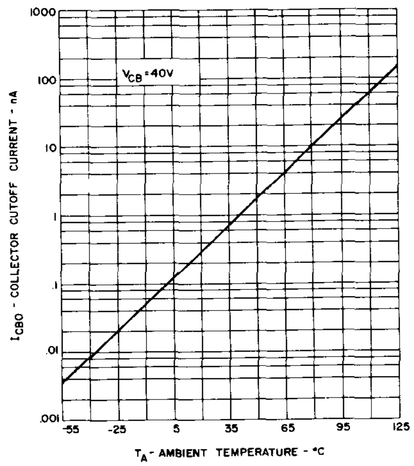
Capacitance vs. Voltage



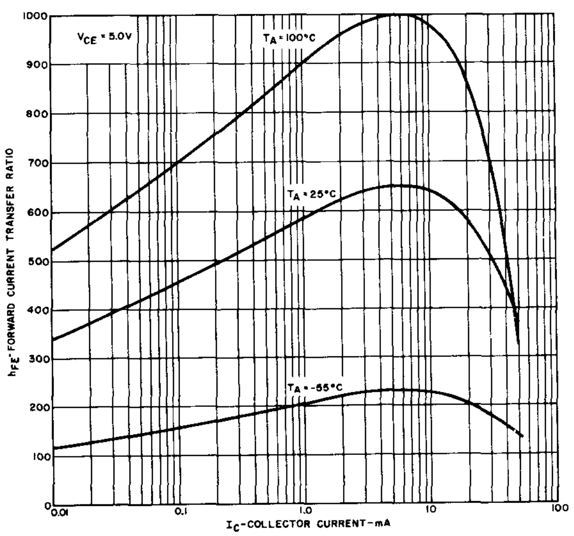
hFE vs. Ambient Temperature



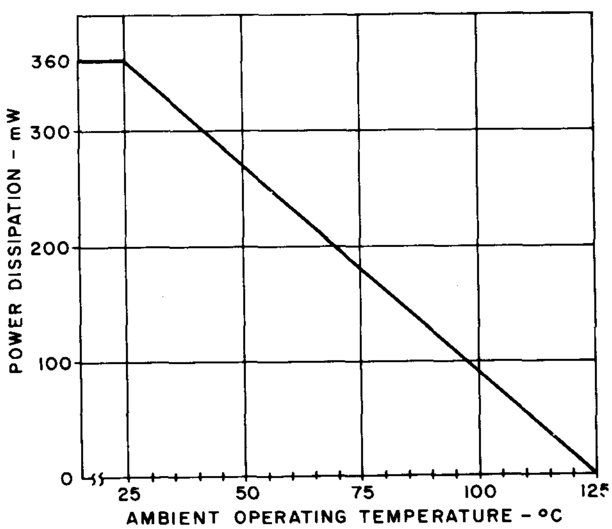
ICBO vs. Ambient Temperature



Forward Current Transfer Ratio vs. Collector Current



Power vs. Ambient Temperature Derating



Silicon Transistors

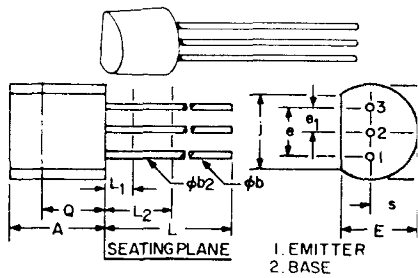
NPN

GES6000
GES6002

The General Electric GES6000 and GES6002 units are silicon NPN planar passivated, epitaxial devices designed primarily for high speed switching, low noise amplifier and core driver applications. Complementary PNP versions of these units are available and are designated as GES6001 and GES6003 respectively.

Features

- Epoxy encapsulation with proved reliability.
- Performance comparable to hermetic units—excellent characteristic stability under environmental stresses—85°C—85% Relative Humidity.
- Low $V_{CE(SAT)}$
- Characterized for Industrial Service.*
- Low Noise Figure.



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTS THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.5 FROM THE SEATING PLANE. DIAMETER IS CONTROLLED IN L_1 AND BEYOND 12.70 MM FROM SEATING PLANE.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		GES6000	GES6002	
Voltages				
Collector to Emitter	V_{CEO}	25	25	Volts
Collector to Emitter	V_{CES}	35	35	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	35	35	Volts
Current				
Collector	I_C	500	500	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	800	800	mA
Dissipation				
Total Power ($T_C \leqq 25°C$)	P_T	.800	.800	Watts
Total Power ($T_A \leqq 25°C$)	P_T	.400	.400	Watts
Derate Factor ($T_C \geqq 25°C$)		8.0	8.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		4.0	4.0	mW/°C
Temperature				
Storage	T_{STG}	←— −65 to +150 —→		°C
Operating	T_J	←— −65 to +125 —→		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	←— +260 —→		°C

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	GES6000 Min.	GES6000 Max.	GES6002 Min.	GES6002 Max.	
Collector-Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)†	$V_{(BR)CEO}$	25		25		Volts
Emitter-Base Breakdown Voltage ($I_E = 100\mu A, I_C = 0$)	$V_{(BR)EBO}$	5		5		Volts
Collector-Base Breakdown Voltage ($I_C = 100\mu A, I_E = 0$)	$V_{(BR)CBO}$	35		35		Volts
Collector-Emitter Breakdown Voltage ($I_C = 100\mu A, V_{BE} = 0$)	$V_{(BR)CES}$	35		35		Volts
Collector-Emitter Saturation Voltage ($I_C = 100mA, I_B = 10mA$)†	$V_{CE(SAT)}$		.200		.200	Volts
Base-Emitter Saturation Voltage ($I_C = 100mA, I_B = 10mA$)†	$V_{BE(SAT)}$	.70	.95	.70	.95	Volts
Base-Emitter Voltage ($V_{CE} = 5V, I_C = 10mA$)†	V_{BE}	.55	.78	.55	.78	Volts
Forward Current Transfer Ratio ($V_{CE} = 1V, I_C = 100\mu A$)	h_{FE}	40		80		
($V_{CE} = 1V, I_C = 10mA$)†	h_{FE}	100	300	200	500	
($V_{CE} = 1V, I_C = 100mA$)†	h_{FE}	80		150		
Collector Cutoff Current ($V_{CB} = 25V, I_E = 0$)	I_{CBO}		10		10	nA
($V_{CB} = 25V, I_E = 0, T_A = 100°C$)	I_{CBO}		10		10	μA
Emitter-Base Reverse Current ($V_{EB} = 3.0V, I_C = 0$)	I_{EBO}		20		20	nA

† Pulsed, 300μsec, ≦ 2% duty cycle

DYNAMIC CHARACTERISTICS

Characteristic	Symbol	GES6000 Min.	GES6000 Typ.	GES6000 Max.	GES6002 Min.	GES6002 Typ.	GES6002 Max.	Units
Forward Current Transfer Ratio (I_E = 1mA, V_{CE} = 10V, f = 1KHz)	h_{fe}	60		450	130		750	
Input Impedance (I_E = 1mA, V_{CE} = 10V, f = 1KHz)	h_{ie}	1.2	4	13	2.5	9	20	Kohms
Output Conductance (I_E = 1mA, V_{CE} = 10V, f = 1KHz)	h_{oe}		10	50		15	70	umhos
Voltage Feedback Ratio (I_E = 1mA, V_{CE} = 10V, f = 1KHz)	h_{re}		9			20		$x10^{-4}$
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 1 MHz)	C_{cb}		3.9	6.0		3.9	6.0	pF
Emitter-Base Capacitance (V_{EB} = 0.5V, I_C = 0, f = 1 MHz)	C_{eb}		15	20		13	18	pF
Gain-Bandwidth Product (V_{CE} = 10V, I_E = −10mA, f = 100 MHz)	f_T	125	250	500	140	260	560	MHz
Noise Figure (V_{CE} = 5V, I_E = 100μA, BW = 15.7KHz, R_S = 5K Ω, f = 10 Hz to 10KHz)	NF			3			2	dB
Delay Time—See Figure 1 (V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, V_{BE}(off) = 0V)	t_d		7			7		nsec
Rise Time—See Figure 1 (V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, V_{BE}(off) = 0V)	t_r		12			12		nsec
Storage Time—See Figure 2 (V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, I_{B2} = 15mA)	t_s		170			200		nsec
Fall Time—See Figure 2 (V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, I_{B2} = 15mA)	t_f		35			50		nsec

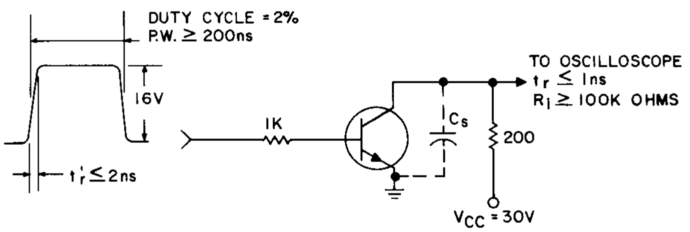
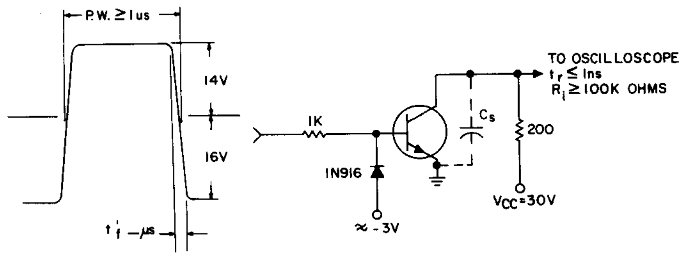
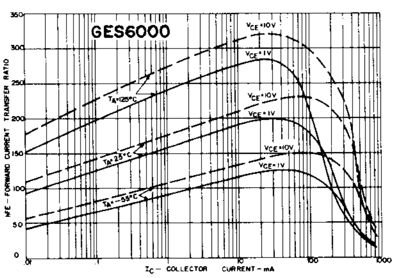


FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

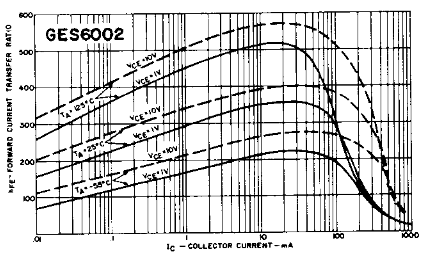


C_s = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS AND PROBE = 10pF

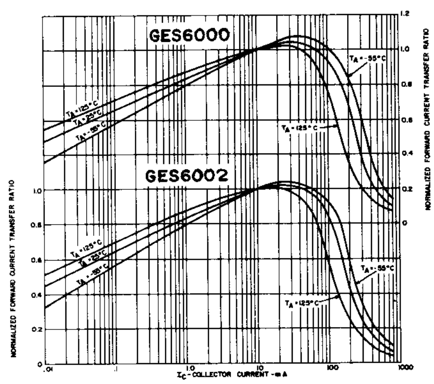
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



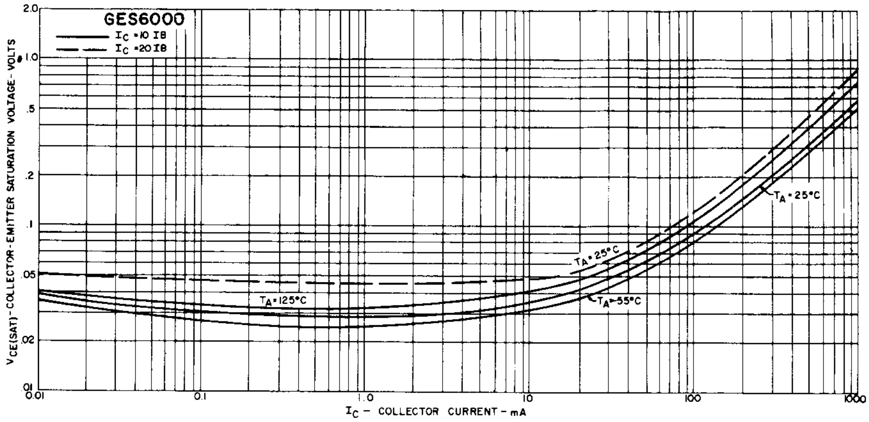
BETA VS. COLLECTOR CURRENT

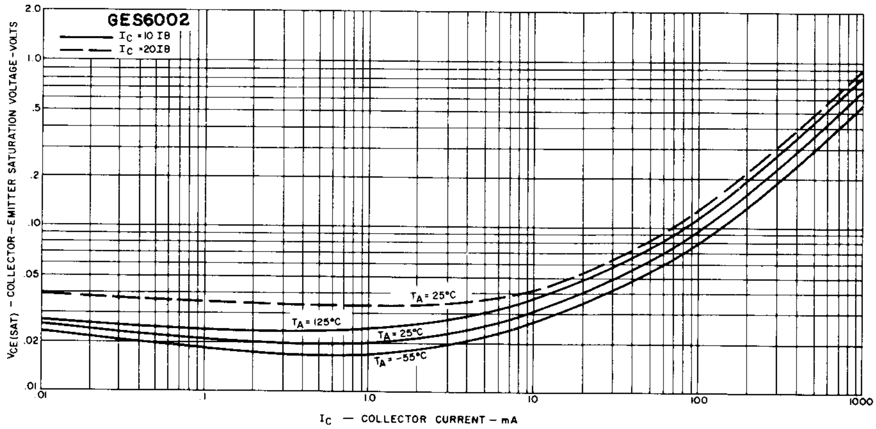


BETA VS. COLLECTOR CURRENT

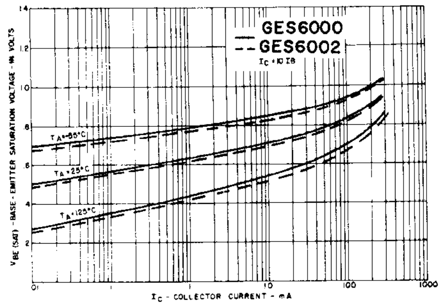


NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

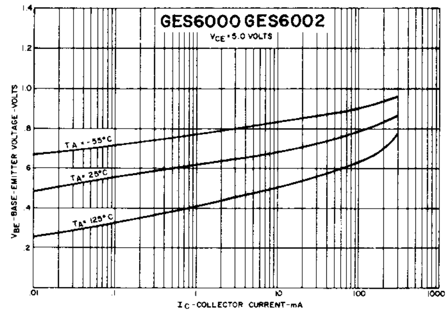




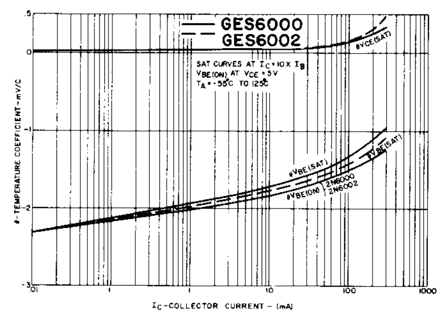
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



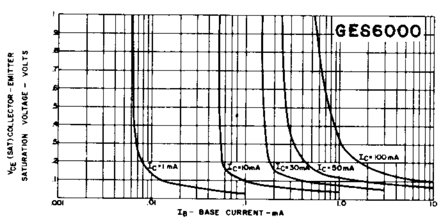
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



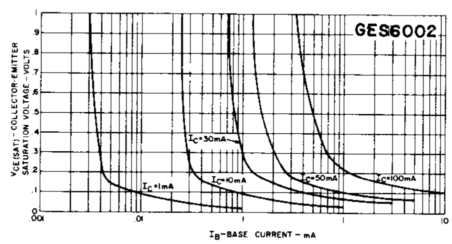
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT

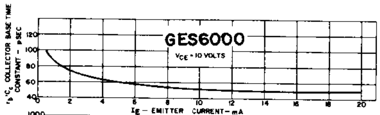


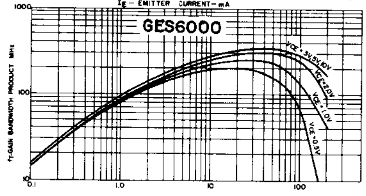
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT

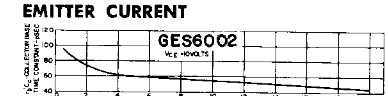
COLLECTOR-BASE TIME CONSTANT VS. EMITTER CURRENT

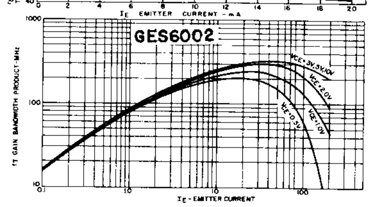




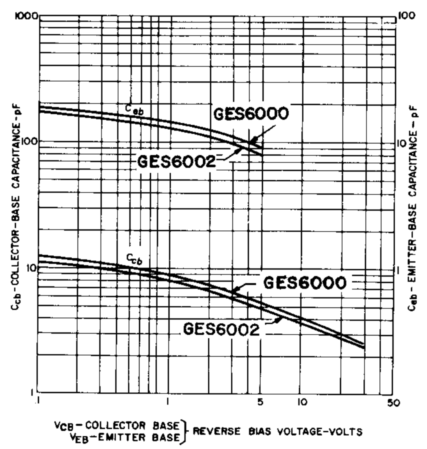
GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

COLLECTOR BASE TIME CONSTANT VS. EMITTER CURRENT

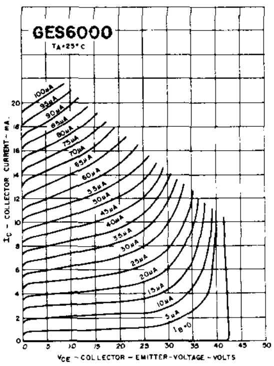


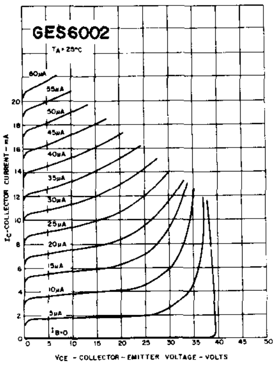


GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

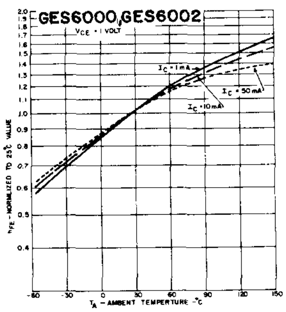


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

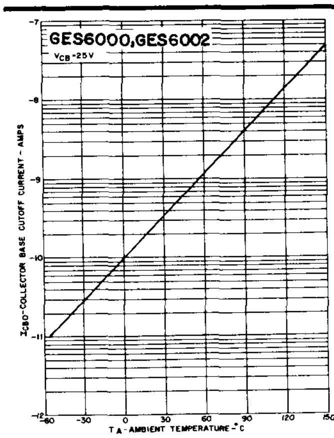




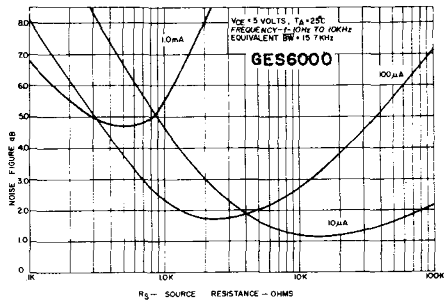
COLLECTOR CHARACTERISTICS



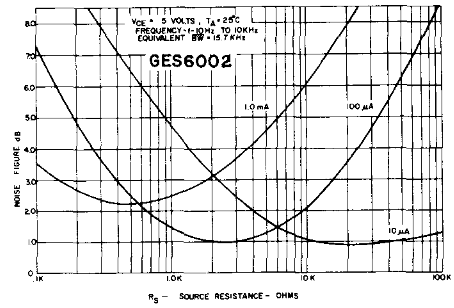
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



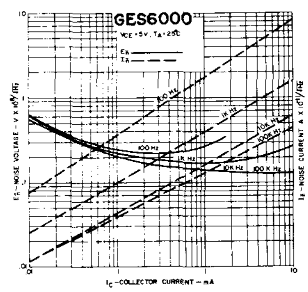
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



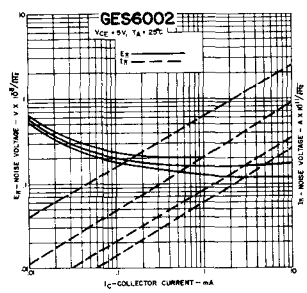
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



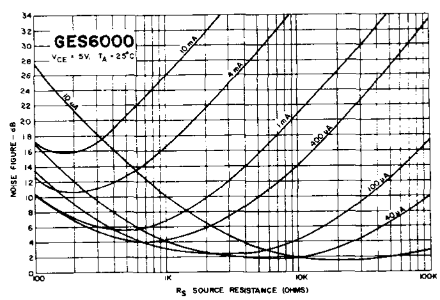
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



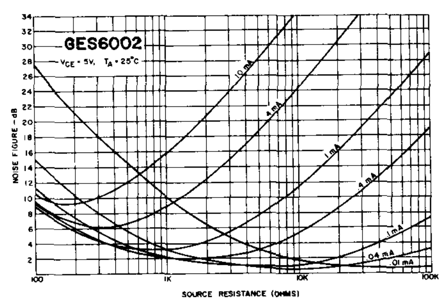
E_n & I_n VS. COLLECTOR CURRENT



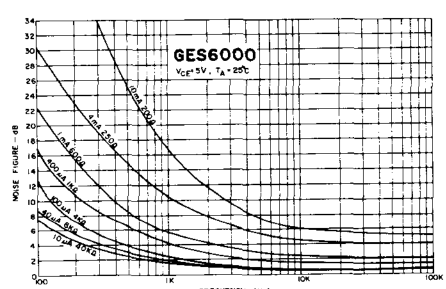
E_n & I_n VS. COLLECTOR CURRENT



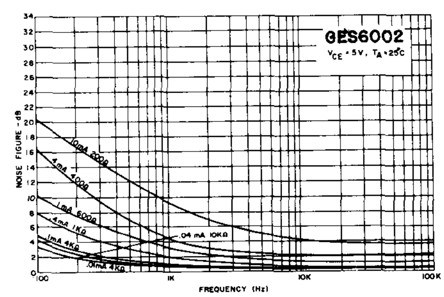
NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY



NOISE FIGURE VS. FREQUENCY

Silicon Transistors

PNP

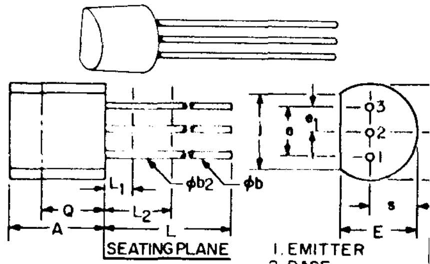
GES6001
GES6003

The General Electric GES6001 and GES6003 units are silicon PNP planar passivated epitaxial devices developed primarily for high speed switching and general purpose amplifier applications where ultra low noise characteristics are desirable. Complementary NPN versions of these types are available and are designated as GES6000 and GES6002 respectively.

Features

- Epoxy encapsulation with proved reliability
- Performance comparable to hermetic units — excellent characteristic stability under environmental stresses — 85°C — 85% Relative Humidity.
- Low $V_{CE\ (SAT)}$
- Characterized for Industrial Service*
- Low Noise Figure.

*Voltage and Current Values for PNP are negative: Observe Proper Bias Polarity.



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	407	550	016	022	1,3
ϕb2	407	482	016	.019	3
ϕD	4450	5200	175	.205	
E	3180	4190	.125	.165	
e	2410	2.670	.095	105	
e_1	1.150	1.395	.045	.055	
J	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSI THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2 ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.5 FROM THE SEATING PLANE. DIAMETER IS U CONTROLLED IN L_1 AND BEYOND 12.70 MM (FROM SEATING PLANE.

absolute maximum ratings: ($T_A = 25°$, unless otherwise specified)

	Symbol	GES6001	GES6003	
Voltages				
Collector to Emitter	V_{CEO}	25	25	Volts
Collector to Emitter	V_{CES}	35	35	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	35	35	Volts
Current				
Collector	I_C	500	500	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	800	800	mA
Dissipation				
Total Power ($T_C \leqq 25°C$)	P_T	.800	.800	Watts
Total Power ($T_A \leqq 25°C$)	P_T	.400	.400	Watts
Derate Factor ($T_C \geqq 25°C$)		8.0	8.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		4.0	4.0	mW/°C
Temperature				
Storage	T_{STG}	←— −65 to +150 —→		°C
Operating	T_J	←— −65 to +125 —→		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	←— +260 —→		°C

electrical characteristics: ($T_A = 25°$, unless otherwise specified)

STATIC CHARACTERISTICS

	Symbol	GES6001 Min.	GES6001 Max.	GES6003 Min.	GES6003 Max.	
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)†	$V_{(BR)CEO}$	25		25		Volts
Emitter-Base Breakdown Voltage (I_E = 100μA, I_C = 0)	$V_{(BR)EBO}$	5		5		Volts
Collector-Base Breakdown Voltage (I_C = 100μA, I_E = 0)	$V_{(BR)CBO}$	35		35		Volts
Collector-Emitter Breakdown Voltage (I_C = 100μA, V_{BE} = 0)	$V_{(BR)CES}$	35		35		Volts
Collector-Emitter Saturation Voltage (I_C = 100mA, I_B = 10mA)†	$V_{CE(SAT)}$		.400		.400	Volts
Base-Emitter Saturation Voltage (I_C = 100mA, I_B = 10mA)†	$V_{BE(SAT)}$	.75	1.0	.75	1.0	Volts
Base-Emitter Voltage (V_{CE} = 5V, I_C = 10mA)†	V_{BE}	.55	.80	.55	.80	Volts
Forward Current Transfer Ratio (V_{CE} = 1V, I_C = 100μA)	h_{FE}	50		100		
(V_{CE} = 1V, I_C = 10mA)†	h_{FE}	100	300	200	500	
(V_{CE} = 1V, I_C = 100mA)†	h_{FE}	60		110		
Collector Cutoff Current (V_{CB} = 25V, I_E = 0)	I_{CBO}		10		10	nA
(V_{CB} = 25V, I_E = 0, T_A = 100°C)	I_{CBO}		10		10	μA
Emitter-Base Reverse Current (V_{EB} = 3.0V, I_C = 0)	I_{EBO}		20		20	nA

†—Pulsed, 300μsec. ≦ 2% duty cycle

DYNAMIC CHARACTERISTICS

		GES6001 Min.	GES6001 Typ.	GES6001 Max.	GES6003 Min.	GES6003 Typ.	GES6003 Max.	
Forward Current Transfer Ratio ($I_E = 1mA, V_{CE} = 10V, f = 1KHz$)	h_{fe}	75		450	235		750	
Input Impedance ($I_E = 1mA, V_{CE} = 10V, f = 1KHz$)	h_{ie}	1.5	7	17	3	10	25	Kohms
Output Conductance ($I_E = 1mA, V_{CE} = 10V, f = 1KHz$)	h_{oe}		45	100		75	150	μmhos
Voltage Feedback Ratio ($I_E = 1mA, V_{CE} = 10V, f = 1KHz$)	h_{re}		10			20		$x10^{-4}$
Collector-Base Capacitance ($V_{CB} = 10V, I_E = 0, f = 1$ MHz)	C_{cb}		4.5	8.0		4.5	8.0	pF
Emitter-Base Capacitance ($V_{EB} = 0.5V, I_C = 0, f = 1$ MHz)	C_{eb}		17	25		15	20	pF
Gain-Bandwidth Product ($V_{CE} = 10V, I_E = 10mA, f = 100$ MHz)	f_T	225	340	500	240	400	560	MHz
Noise Figure ($V_{CE} = 5V, I_E = 100\mu A$, BW = 15.7KHz, $R_S = 5K\Omega$, f = 10 Hz to 10KHz)	NF			3			1.5	dB
Delay Time see figure 1 ($V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, V_{BE}(off) = 0V$)	t_d		3			3		nsec
Rise Time — see figure 1 ($V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, V_{BE}(off) = 0V$)	t_r		13			13		nsec
Storage Time — see figure 2 ($V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, I_{B2} = 15mA$)	t_s		130			150		nsec
Fall Time — see figure 2 ($V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, I_{B2} = 15mA$)	t_f		25			50		nsec

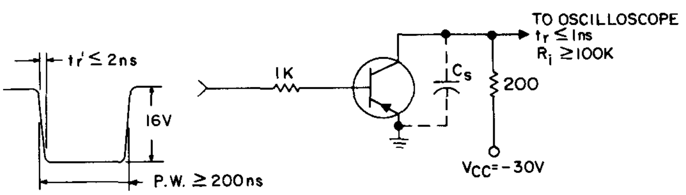
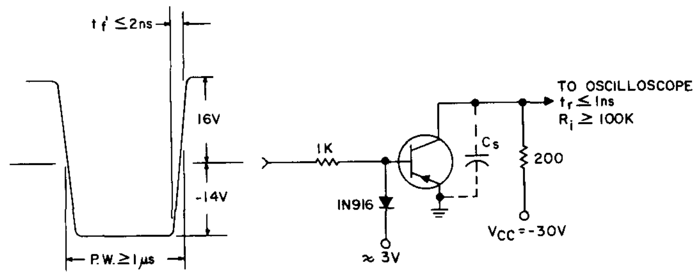
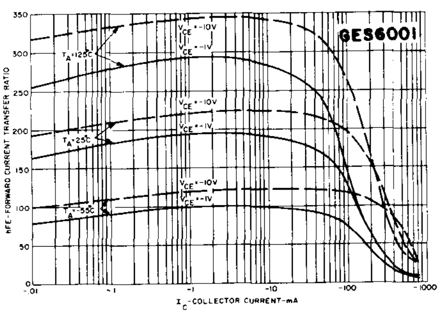


FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

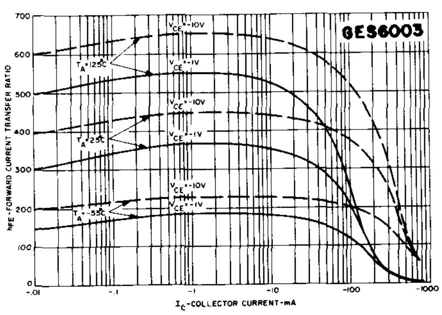


Cs = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS, AND PROBE = 10pF

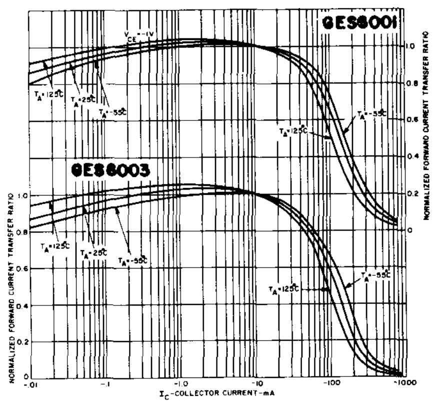
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



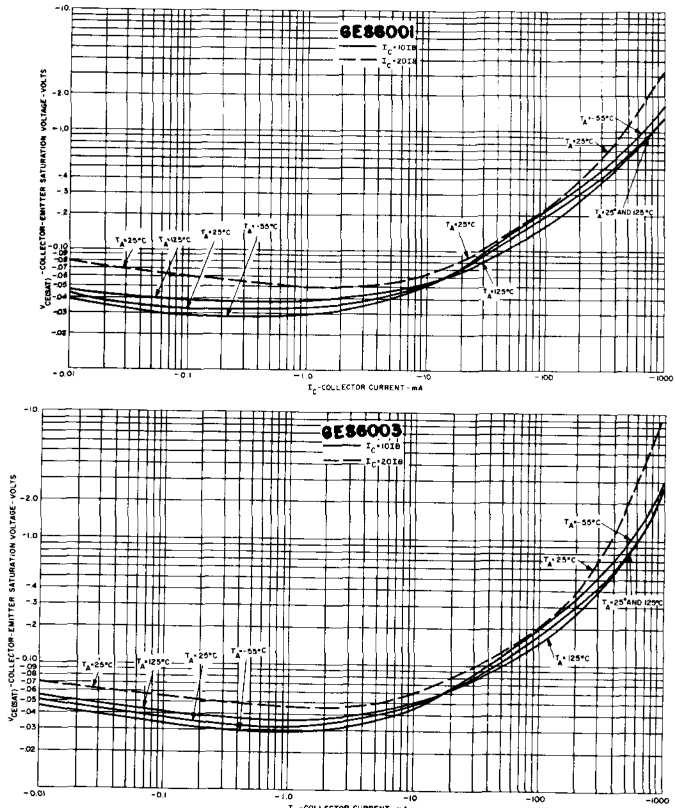
BETA VS. COLLECTOR CURRENT



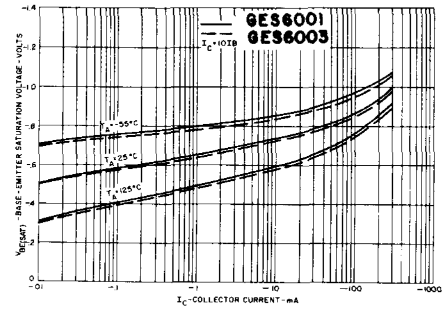
BETA VS. COLLECTOR CURRENT



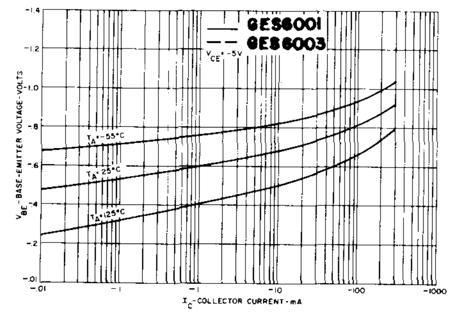
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



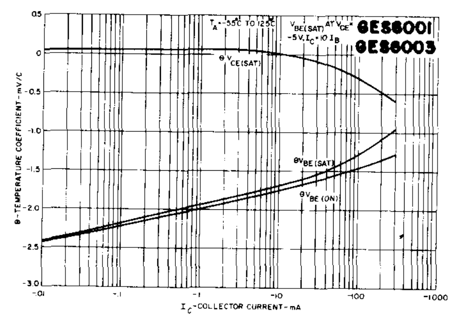
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



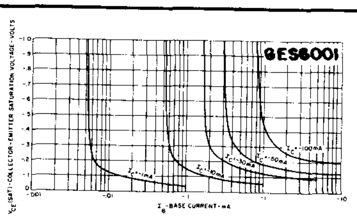
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



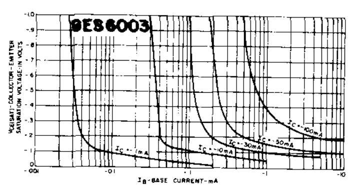
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT

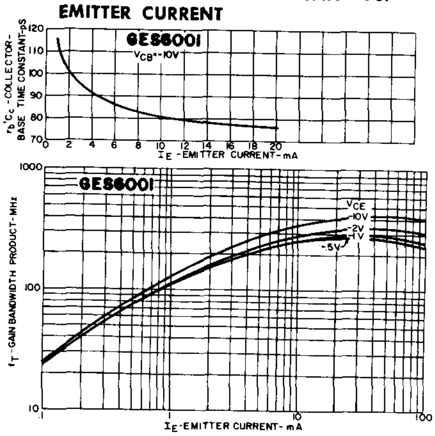


COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



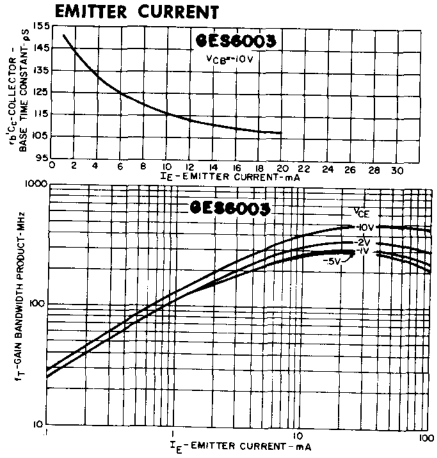
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT

EMITTER-BASE TIME CONSTANT VS. EMITTER CURRENT

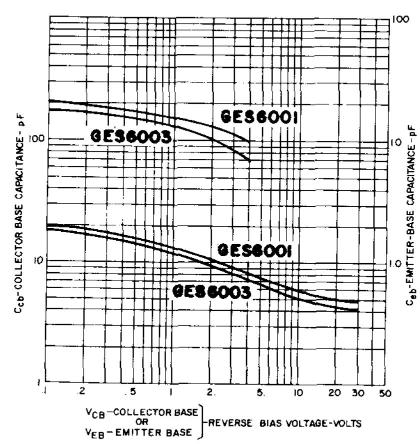


GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

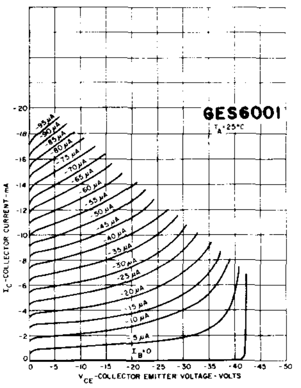
COLLECTOR BASE TIME CURRENT VS. EMITTER CURRENT

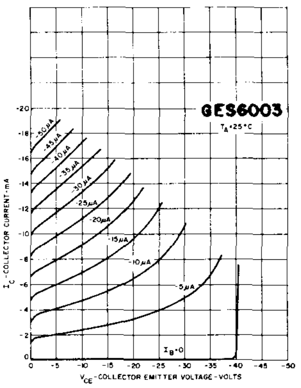


GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

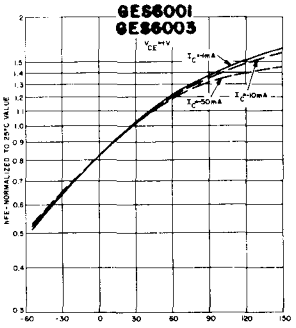


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

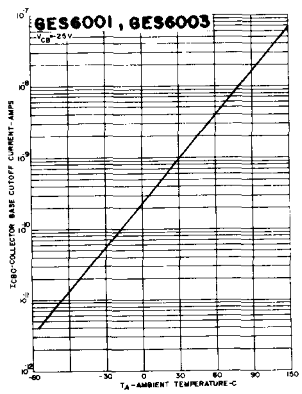




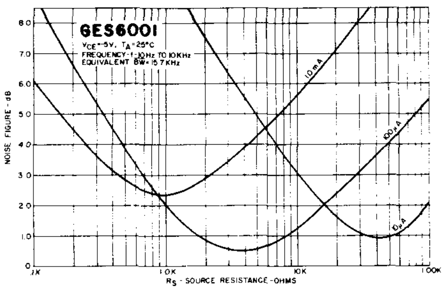
COLLECTOR CHARACTERISTICS



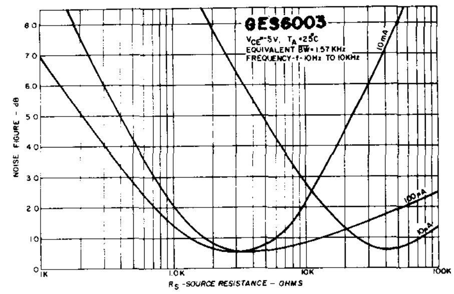
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



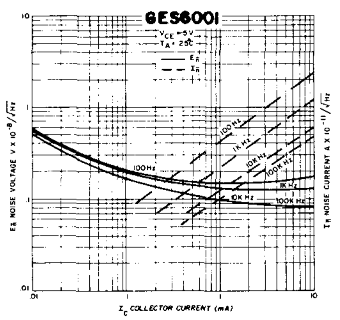
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



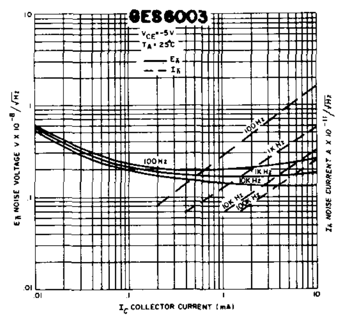
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



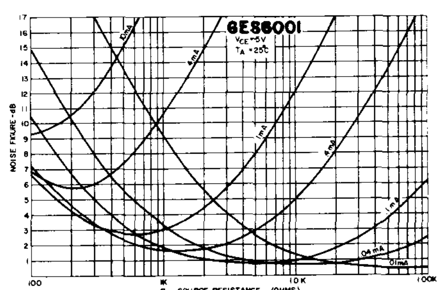
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



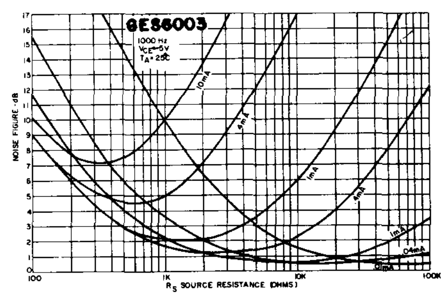
E_n & I_n VS. COLLECTOR CURRENT



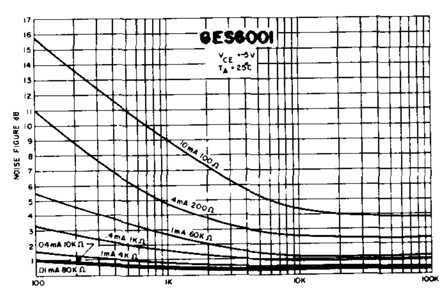
E_n & I_n VS. COLLECTOR CURRENT



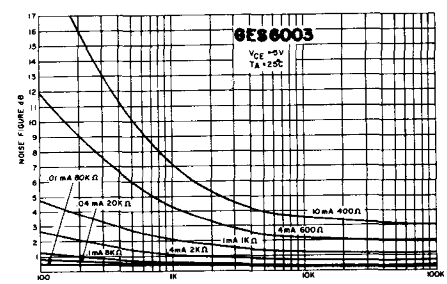
NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY

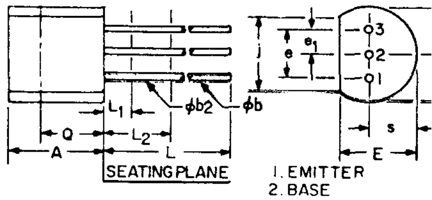


NOISE FIGURE VS. FREQUENCY

Silicon Transistors

NPN GES6004 GES6006

The General Electric GES6004 and GES6006 units are NPN silicon, planar passivated, epitaxial devices specifically developed for higher voltage general purpose amplifier and switch applications in industrial applications. PNP versions of these units are available and are designated GES6005 and GES6007 respectively.



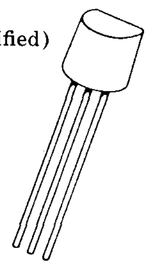
TO-92

1. EMITTER
2. BASE
3. COLLECTOR

Features

- Epoxy encapsulation with proved reliability.
- Performance comparable to hermetic units—excellent characteristic stability under environmental stresses—85°C—85% Relative Humidity.
- Low $V_{CE(SAT)}$
- Characterized for Industrial Service.
- Low Noise Figure.
- 40V $_{(BR)CEO}$—Maximum voltage rating.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)



		GES6004	GES6006	
Voltages				
Collector to Emitter	V_{CEO}	40	40	Volts
Collector to Emitter	V_{CES}	50	50	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	50	50	Volts
Current				
Collector	I_C	500	500	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	800	800	mA
Dissipation				
Total Power ($T_C \leqq 25°C$)	P_T	.800	.800	Watts
Total Power ($T_A \leqq 25°C$)	P_T	.400	.400	Watts
Derate Factor ($T_C \geqq 25°C$)		8.0	8.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		4.0	4.0	mW/°C
Temperature				
Storage	T_{STG}	←—— −65 to +150 ——→		°C
Operating	T_J	←—— −65 to +125 ——→		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	←—— +260 ——→		°C

SYMBOL	MILLIMETERS		INCHES		NO
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1
φb2	.407	.482	.016	.019	
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1
L1	—	1.270	—	.050	
L2	6.350	—	.250	—	
Q	2.920	—	.115	—	
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS

	Symbol	GES6004 Min.	GES6004 Max.	GES6006 Min.	GES6006 Max.	
Collector-Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)†	$V_{(BR)CEO}$	40		40		Volts
Emitter-Base Breakdown Voltage ($I_E = 100\mu A, I_C = 0$)	$V_{(BR)EBO}$	5		5		Volts
Collector-Base Breakdown Voltage ($I_C = 100\mu A, I_E = 0$)	$V_{(BR)CBO}$	50		50		Volts
Collector-Emitter Breakdown Voltage ($I_C = 100\mu A, V_{BE} = 0$)	$V_{(BR)CES}$	50		50		Volts
Collector-Emitter Saturation Voltage ($I_C = 100mA, I_B = 10mA$)†	$V_{CE(SAT)}$		.200		.200	Volts
Base-Emitter Saturation Voltage ($I_C = 100mA, I_B = 10mA$)†	$V_{BE(SAT)}$	.70	.95	.70	.95	Volts
Base-Emitter Voltage ($V_{CE} = 5V, I_C = 10mA$)†	V_{BE}	.55	.78	.55	.78	Volts
Forward Current Transfer Ratio ($V_{CE} = 1V, I_C = 100\mu A$)	h_{FE}	40		80		
($V_{CE} = 1V, I_C = 10mA$)†	h_{FE}	100	300	200	500	
($V_{CE} = 1V, I_C = 100mA$)†	h_{FE}	80		150		
Collector Cutoff Current ($V_{CB} = 25V, I_E = 0$)	I_{CBO}		10		10	nA
($V_{CB} = 25V, I_E = 0, T_A = 100°C$)	I_{CBO}		10		10	μA
Emitter-Base Reverse Current ($V_{EB} = 3.0V, I_C = 0$)	I_{EBO}		20		20	nA

† Pulsed, 300μsec, ≦ 2% duty cycle

DYNAMIC CHARACTERISTICS

Characteristic	Symbol	GES6004 Min.	GES6004 Typ.	GES6004 Max.	GES6006 Min.	GES6006 Typ.	GES6006 Max.	Unit
Forward Current Transfer Ratio (I_E = 1mA, V_{CE} = 10V, f = 1KHz)	h_{fe}	60		450	130		750	
Input Impedance (I_E = 1mA, V_{CE} = 10V, f = 1KHz)	h_{ie}	1.2	4	13	2.5	9	20	Kohms
Output Conductance (I_E = 1mA, V_{CE} = 10V, f = 1KHz)	h_{oe}		10	50		15	70	umhos
Voltage Feedback Ratio (I_E = 1mA, V_{CE} = 10V, f = 1KHz)	h_{re}		9			20		$x10^{-4}$
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 1 MHz)	C_{cb}		4.2	6.0		4.2	6.0	pF
Emitter-Base Capacitance (V_{EB} = 0.5V, I_C = 0, f = 1 MHz)	C_{eb}		15	20		14	18	pF
Gain-Bandwidth Product (V_{CE} = 10V, I_E = 10mA, f = 100 MHz)	f_T	125	250	500	140	260	560	MHz
Noise Figure (V_{CE} = 5V, I_E = 100μA, BW = 15.7KHz, R_S = 5KΩ, f = 10 Hz to 10KHz)	NF			3			2	dB
Delay Time—See Figure 1 (V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, V_{BE}(off) = 0V)	t_d		7			7		nsec
Rise Time—See Figure 1 (V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, V_{BE}(off) = 0V)	t_r		12			12		nsec
Storage Time—See Figure 2 (V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, I_{B2} = 15mA)	t_s		150			190		nsec
Fall Time—See Figure 2 (V_{CC} = 30V, I_C(on) = 150mA, I_{B1} = 15mA, I_{B2} = 15mA)	t_f		30			50		nsec

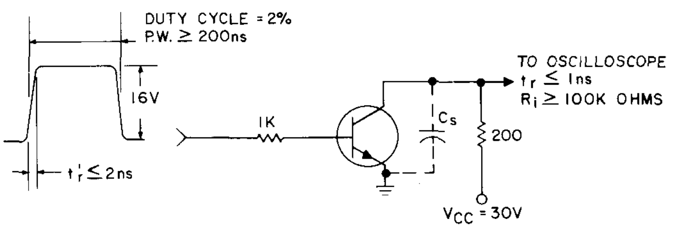
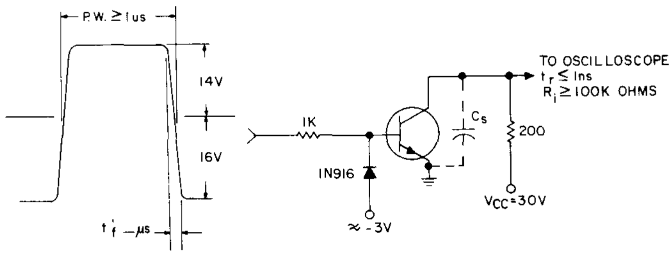
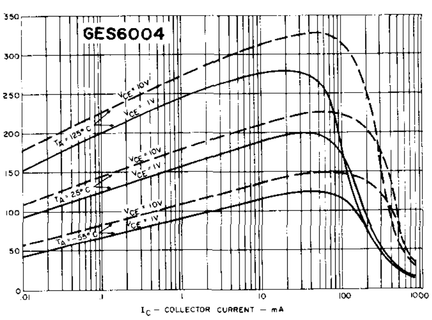


FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

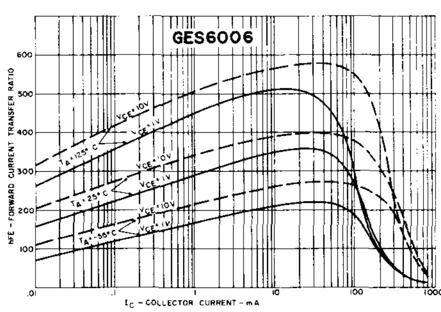


C_S = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS AND PROBE = 10pF

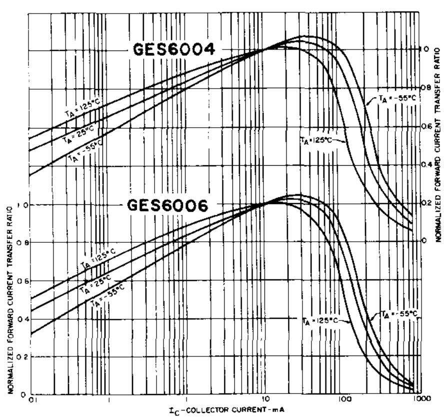
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



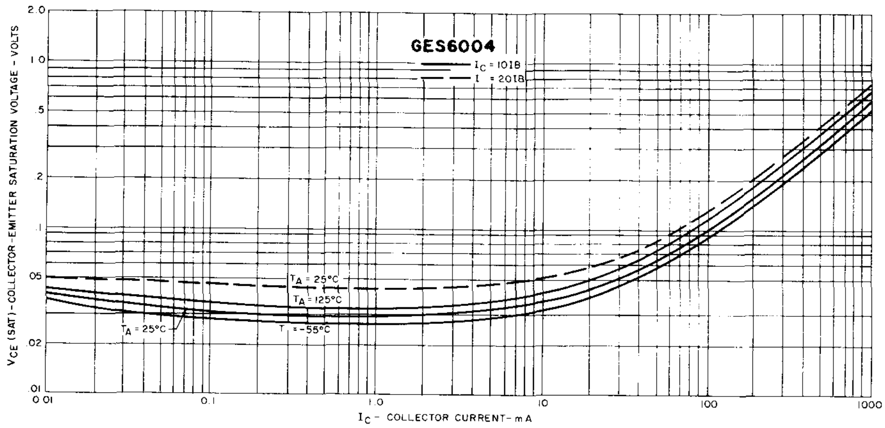
BETA VS. COLLECTOR CURRENT

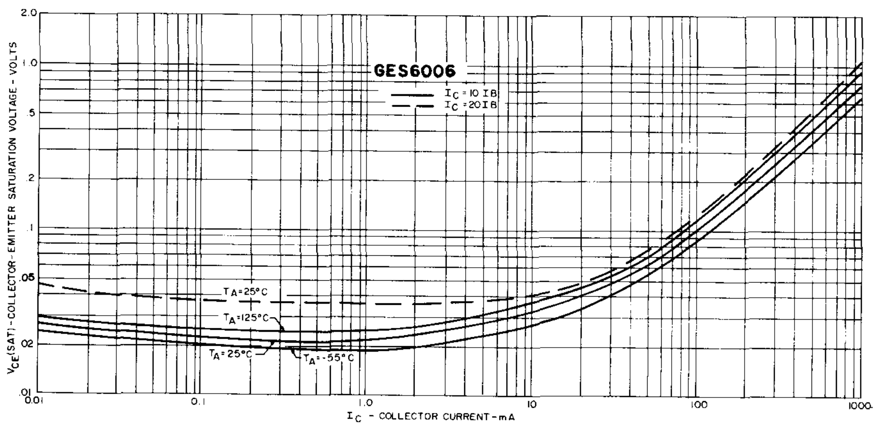


BETA VS. COLLECTOR CURRENT

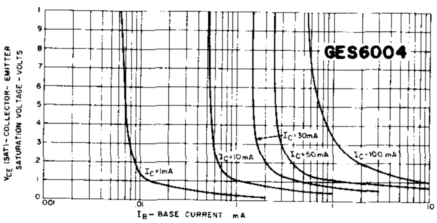


NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

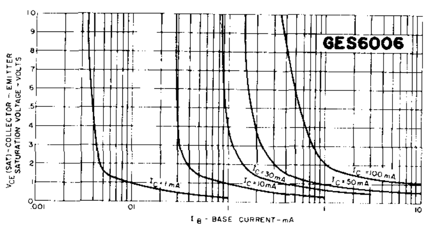




COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

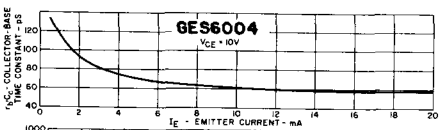


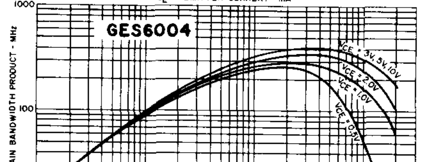
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT

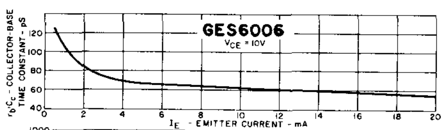
COLLECTOR-BASE TIME CONSTANT VS. EMITTER CURRENT

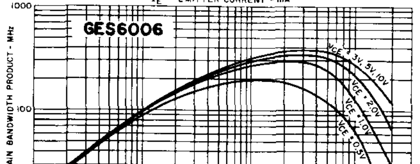




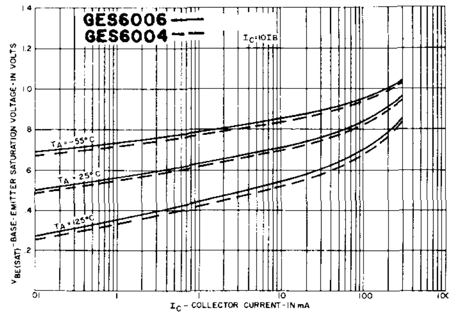
GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

COLLECTOR BASE TIME CONSTANT VS. EMITTER CURRENT

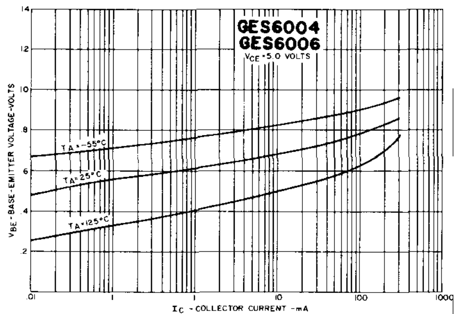




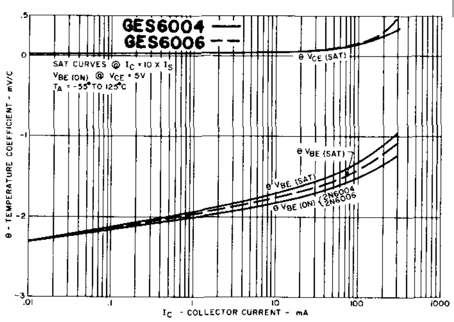
GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT



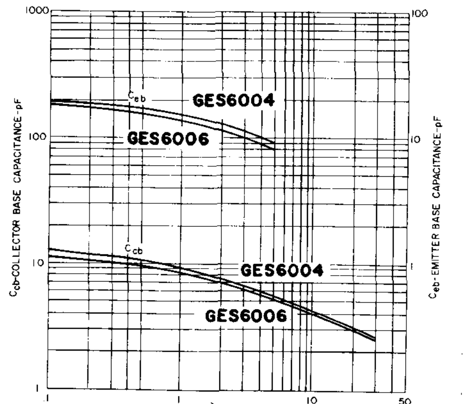
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



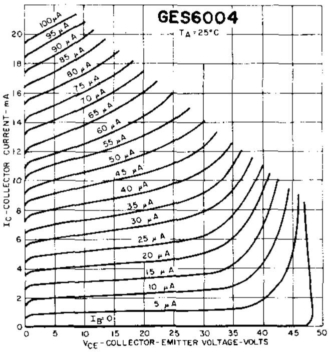
TRANSCONDUCTANCE VS. COLLECTOR CURRENT

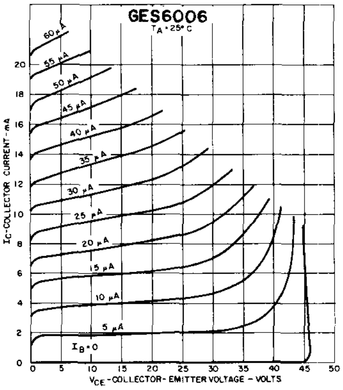


TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT

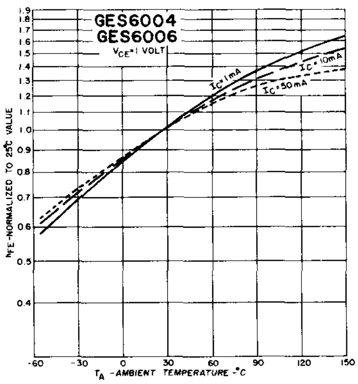


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

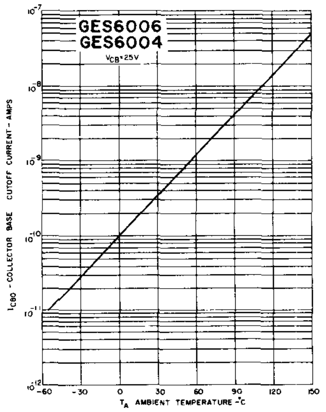




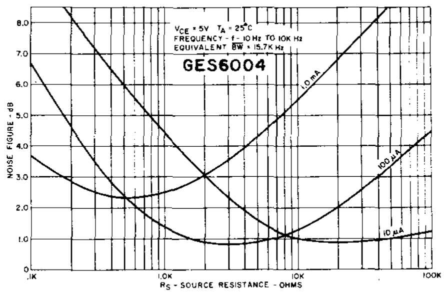
COLLECTOR CHARACTERISTICS



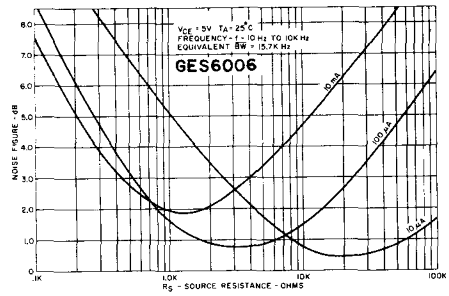
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



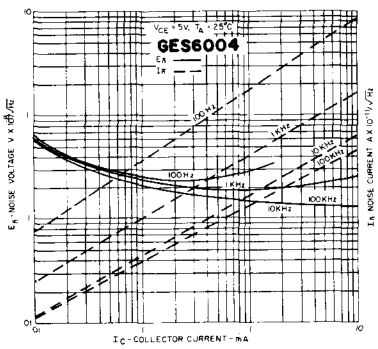
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



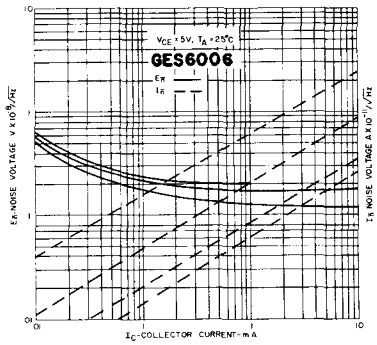
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



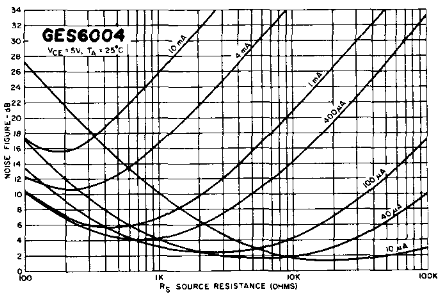
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



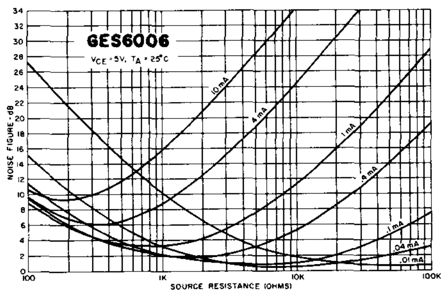
E_n & I_n VS. COLLECTOR CURRENT



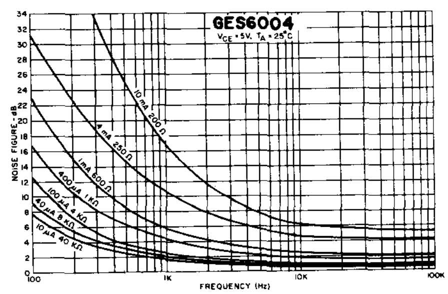
E_n & I_n VS. COLLECTOR CURRENT



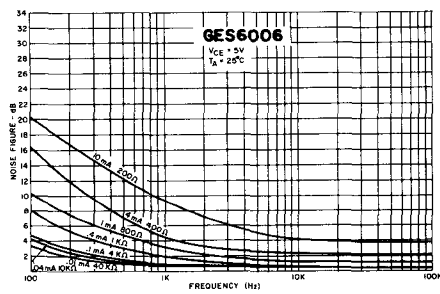
NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY



NOISE FIGURE VS. FREQUENCY

Silicon Transistors

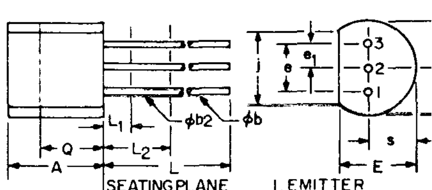
GES6005
GES6007

The General Electric GES6005 and GES6007 units are silicon PNP planar passivated epitaxial devices developed specifically for high speed switching and general purpose amplifier applications where ultra low noise characteristics are desirable. Complementary NPN versions of these units are available and are designated as GES6004 and GES6006 respectively.

Features

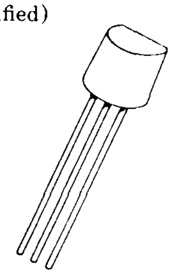
- Epoxy encapsulation with proved reliability
- Performance comparable to hermetic units — excellent characteristic stability under environmental stresses — 85°C — 85% Relative Humidity.
- Low $V_{CE\,(SAT)}$
- Characterized for Industrial Service*
- Low Noise Figure.
- $40V_{(BR)CEO}$ — Maximum voltage rating.

*Voltage and Current Values for PNP are negative: Observe Proper Bias Polarity.



TO-92

1. EMITTER
2. BASE
3. COLLECTOR



SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: ($T_A = 25°$, unless otherwise specified)

		GES6005	GES6007	
Voltages				
Collector to Emitter	V_{CEO}	40	40	Volts
Collector to Emitter	V_{CES}	50	50	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	50	50	Volts
Current				
Collector	I_C	500	500	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	800	800	mA
Dissipation				
Total Power ($T_C \leqq 25°C$)	P_T	.800	.800	Watts
Total Power ($T_A \leqq 25°C$)	P_T	.400	.400	Watts
Derate Factor ($T_C \geqq 25°C$)		8.0	8.0	mW/°C
Derate Factor ($T_A \geqq 25°C$)		4.0	4.0	mW/°C
Temperature				
Storage	T_{STG}	← −65 to +150 →		°C
Operating	T_J	← −65 to +125 →		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	← +260 →		°C

electrical characteristics: ($T_A = 25°$, unless otherwise specified)

STATIC CHARACTERISTICS

	Symbol	GES6005 Min.	GES6005 Max.	GES6007 Min.	GES6007 Max.	
Collector-Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)†	$V_{(BR)CEO}$	40		40		Volts
Emitter-Base Breakdown Voltage ($I_E = 100\mu A, I_C = 0$)	$V_{(BR)EBO}$	5		5		Volts
Collector-Base Breakdown Voltage ($I_C = 100\mu A, I_E = 0$)	$V_{(BR)CBO}$	50		50		Volts
Collector-Emitter Breakdown Voltage ($I_C = 100\mu A, V_{BE} = 0$)	$V_{(BR)CES}$	50		50		Volts
Collector-Emitter Saturation Voltage ($I_C = 100mA, I_B = 10mA$)†	$V_{CE(SAT)}$		.400		.400	Volts
Base-Emitter Saturation Voltage ($I_C = 100mA, I_B = 10mA$)†	$V_{BE(SAT)}$	.75	1.0	.75	1.0	Volts
Base-Emitter Voltage ($V_{CE} = 5V, I_C = 10mA$)†	V_{BE}	.55	.80	.55	.80	Volts
Forward Current Transfer Ratio ($V_{CE} = 1V, I_C = 100\mu A$)	h_{FE}	50		100		
($V_{CE} = 1V, I_C = 10mA$)†	h_{FE}	100	300	200	500	
($V_{CE} = 1V, I_C = 100mA$)†	h_{FE}	60		110		
Collector Cutoff Current ($V_{CB} = 25V, I_E = 0$)	I_{CBO}		10		10	nA
($V_{CB} = 25V, I_E = 0, T_A = 100°C$)	I_{CBO}		10		10	μA
Emitter-Base Reverse Current ($V_{EB} = .3.0V, I_C = 0$)	I_{EBO}		20		20	nA

†—Pulsed, 300μsec. ≦ 2% duty cycle

DYNAMIC CHARACTERISTICS

	Symbol	GES6005 Min.	GES6005 Typ.	GES6005 Max.	GES6007 Min.	GES6007 Typ.	GES6007 Max.	
Forward Current Transfer Ratio ($I_E = 1mA$, $V_{CE} = 10V$, f = 1KHz)	h_{fe}	75		450	150		750	
Input Impedance ($I_E = 1mA$, $V_{CE} = 10V$, f = 1KHz)	h_{ie}	1.5	7	17	3	10	25	Kohms
Output Conductance ($I_E = 1mA$, $V_{CE} = 10V$, f = 1KHz)	h_{oe}		45	60		75	150	μmhos
Voltage Feedback Ratio ($I_E = 1mA$, $V_{CE} = 10V$, f = 1KHz)	h_{re}		12			24		$x10^{-4}$
Collector-Base Capacitance ($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)	C_{cb}		4.5	8		4.5	8	pF
Emitter-Base Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, f = 1 MHz)	C_{eb}		17	25		15	20	pF
Gain-Bandwidth Product ($V_{CE} = 10V$, $I_E = 10mA$, f = 100 MHz)	f_T	225	340	500	240	400	560	MHz
Noise Figure ($V_{CE} = 5V$, $I_E = +100\mu A$, BW = 15.7 KHz, $R_s = 5K\Omega$, f = 10 Hz to 10 KHz)	NF			3			1.5	dB
Delay Time — see figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_d		3			3		nsec
Rise Time — see figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_r		13			13		nsec
Storage Time — see figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = +15mA$)	t_s		130			150		nsec
Fall Time — see figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = +15mA$)	t_f		25			50		nsec

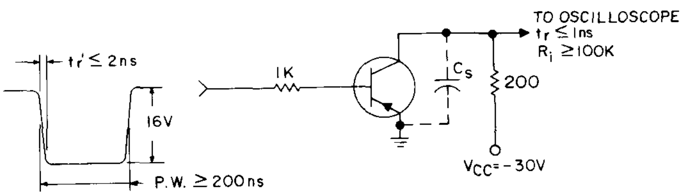
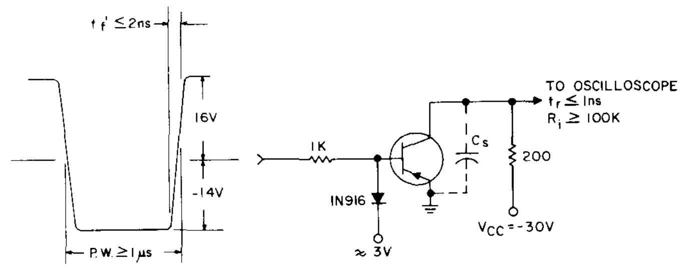
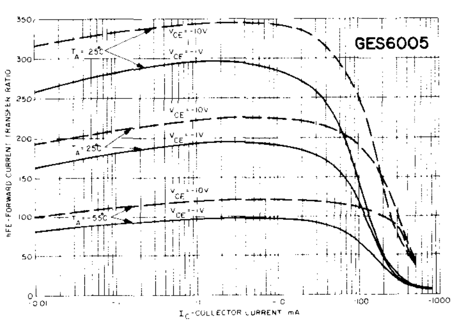


FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

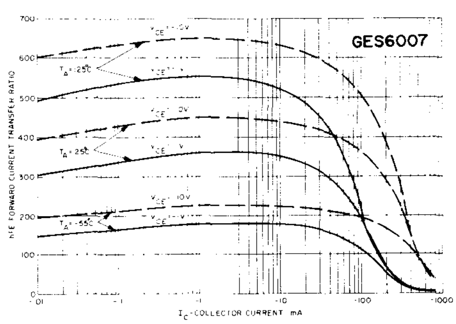


C_S = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS, AND PROBE ≈ 10pF

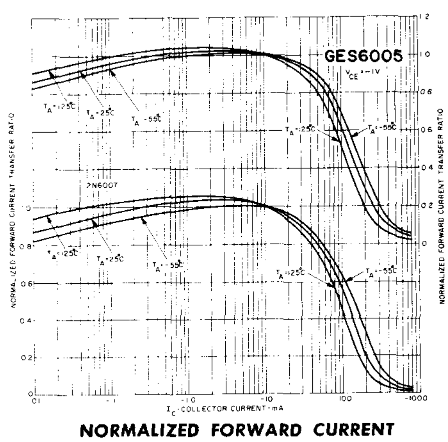
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



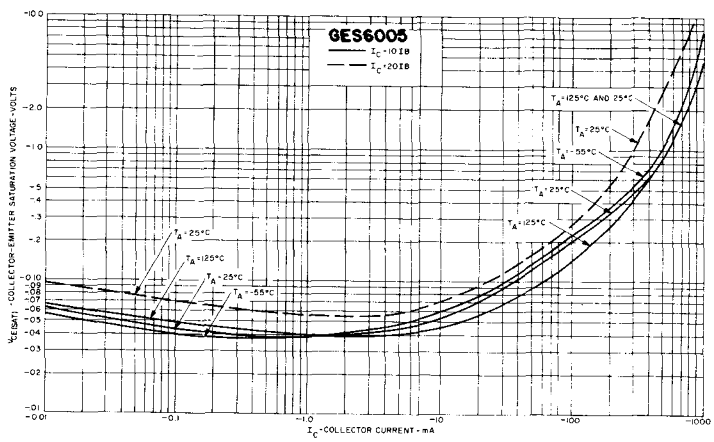
BETA VS. COLLECTOR CURRENT

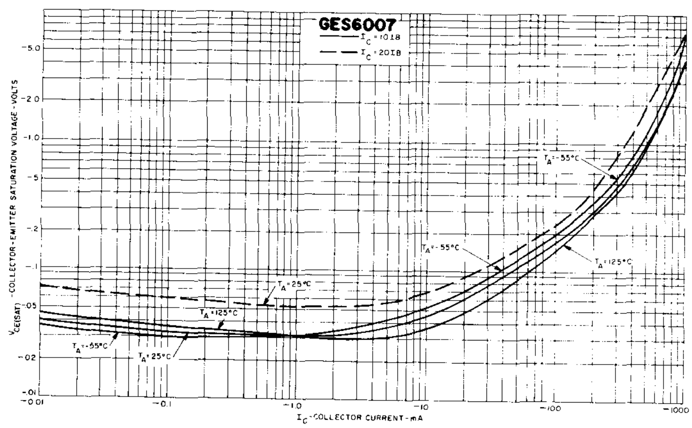


BETA VS. COLLECTOR CURRENT

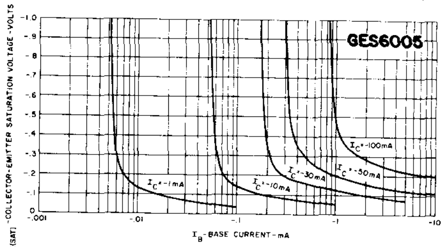


NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

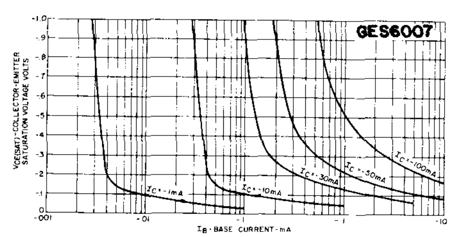




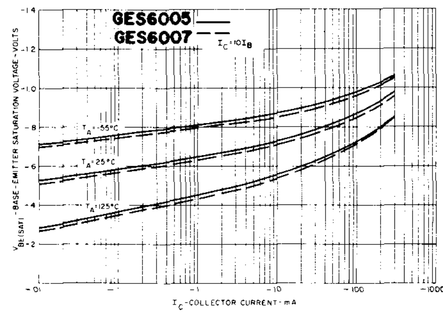
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



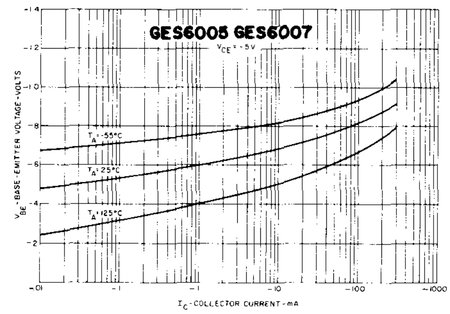
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



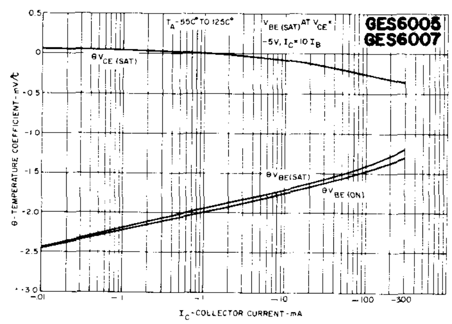
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

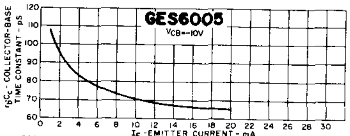


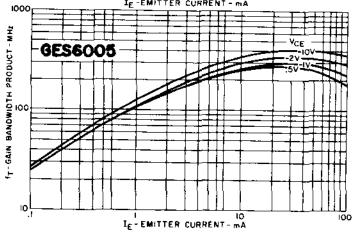
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT

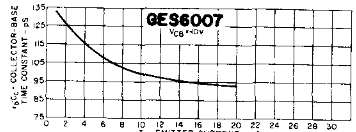
COLLECTOR-BASE TIME CONSTANT VS. EMITTER CURRENT

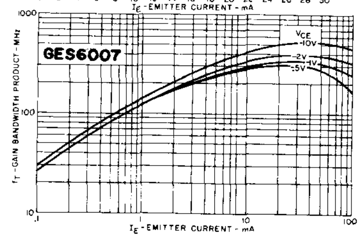




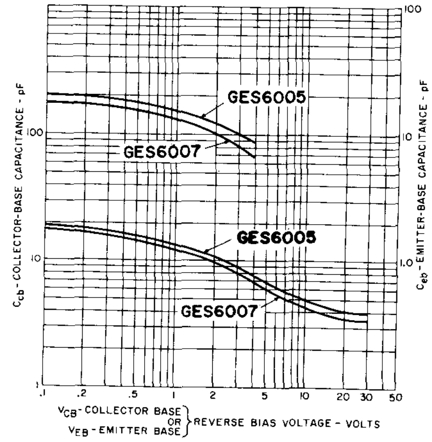
GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

COLLECTOR BASE TIME CONSTANT VS. EMITTER CURRENT

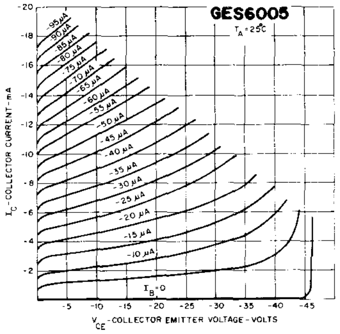


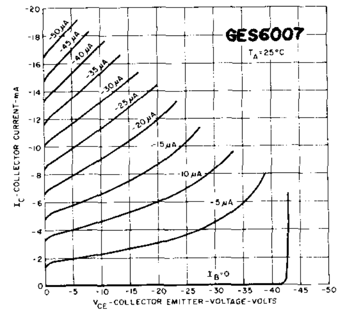


GAINBANDWIDTH PRODUCT VS. EMITTER CURRENT

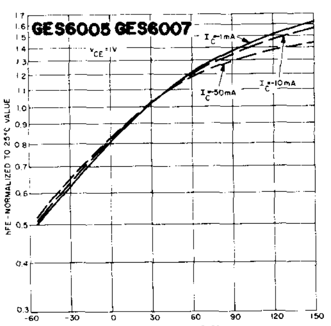


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

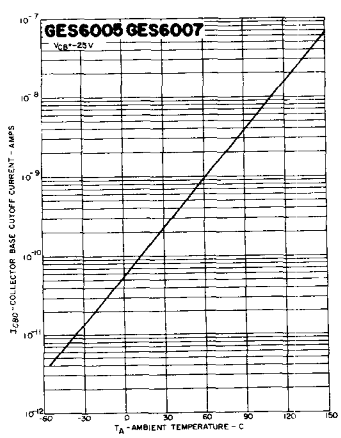




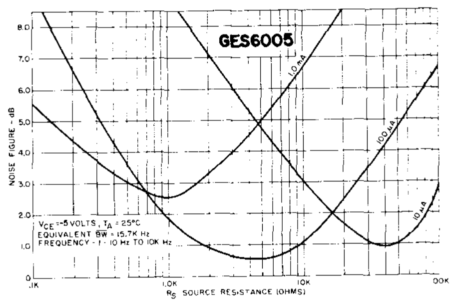
COLLECTOR CHARACTERISTICS



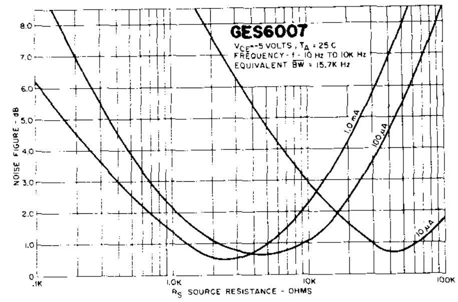
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



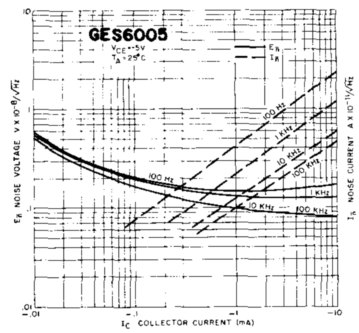
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



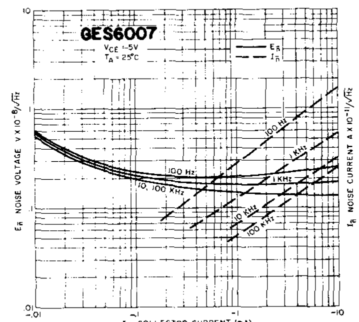
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



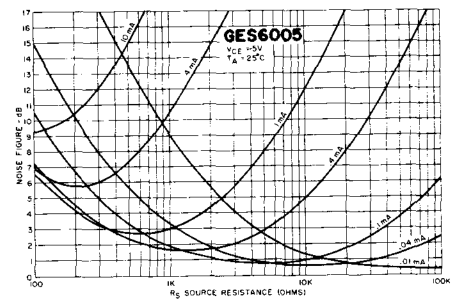
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



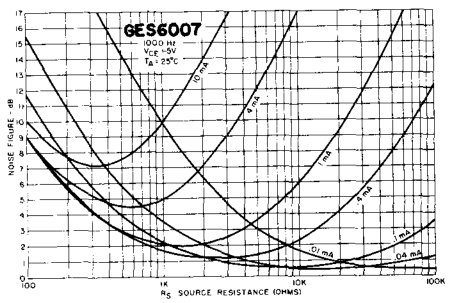
E_n & I_n VS. COLLECTOR CURRENT



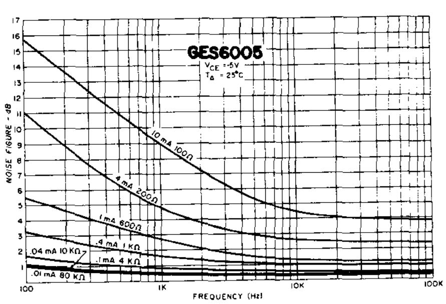
E_n & I_n VS. COLLECTOR CURRENT



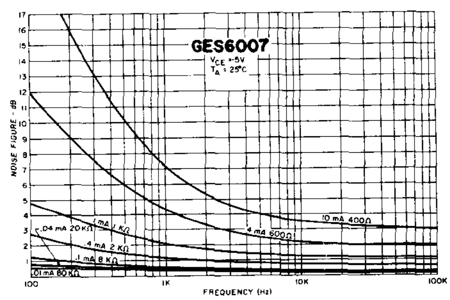
NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY



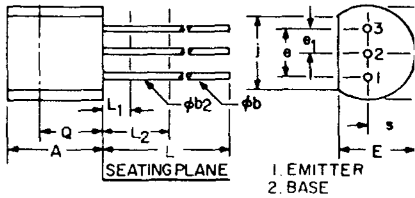
NOISE FIGURE VS. FREQUENCY

Silicon Transistors

NPN

GES6010
GES6012

The General Electric GES6010 and GES6012 devices are silicon, NPN, planar epitaxial passivated transistors designed primarily for high level linear amplifiers or medium speed switching circuits and are especially suited for industrial control applications. Complementary PNP versions of these types are available and are designated as GES6011 and GES6013 respectively.



1. EMITTER
2. BASE
3. COLLECTOR

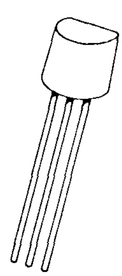
TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L1	–	1.270	–	.050	3
L2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

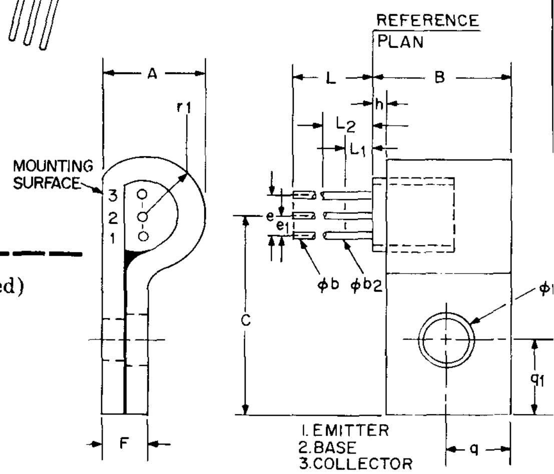
Features

- Epoxy encapsulation with proved reliability.
- Performance comparable to hermetic units—excellent characteristic stability under environmental stresses—85°C—85% Relative Humidity.
- 500 mw Power Dissipation.
- Integral Heat Sinks available—Up to 1 W Power Dissipation. Order as GES6010-J1etc.
- Beta hold-up out to 800 mA.
- 40 Volt BV_{CEO} ratings.
- Integral Heat Sinks available—Up to 1 W Power Dissipation.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)



		GES6010	GES6012	
Voltages				
Collector to Emitter	V_{CEO}	40	40	Volts
Collector to Emitter	V_{CES}	50	50	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	50	50	Volts
Current				
Collector	I_C	800	800	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	1500	1500	mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T	.500	.500	Watts
Derating Factor $T_A \geq 25°C$		4	4	mW/°C
Total Power $T_A \leq 25°C$ Heatsink	P_T	.625	.625	Watts
Total Power $T_C \leq 25°C$ Heatsink	P_T	1.0	1.0	Watts
Derating Factor $T_A \geq 25°C$ Heatsink		5	5	mW/°C
Derating Factor $T_C \geq 25°C$ Heatsink		8	8	mW/°C
Temperature				
Storage	T_{STG}	←— −65 to +150 —→		°C
Operating	T_J	←— −65 to +150 —→		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	←— +260 —→		°C



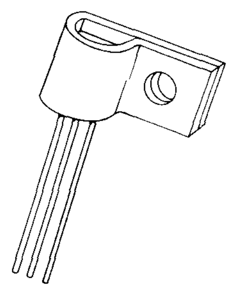
1. EMITTER
2. BASE
3. COLLECTOR

TO-92.

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	GES6010 Min.	GES6010 Max.	GES6012 Min.	GES6012 Max.	
Collector-Emitter Breakdown Voltage ($I_C = 10mA$, $I_B = 0$)†	$V_{(BR)CEO}$	40		40		Volts
Emitter-Base Breakdown Voltage ($I_E = 100\mu A$, $I_C = 0$)	$V_{(BR)EBO}$	5		5		Volts
Collector-Base Breakdown Voltage ($I_C = 100\mu A$, $I_E = 0$)	$V_{(BR)CBO}$	50		50		Volts
Collector-Emitter Breakdown Voltage ($I_C = 100\mu A$, $V_{BE} = 0$)	$V_{(BR)CES}$	50		50		Volts
Collector-Emitter Saturation Voltage ($I_C = 100mA$, $I_B = 10mA$)†	$V_{CE(SAT)}$		.130		.130	Volts
($I_C = 500mA$, $I_B = 50mA$)†	$V_{CE(SAT)}$		.500		.500	Volts
Base-Emitter Saturation Voltage ($I_C = 100mA$, $I_B = 10mA$)†	$V_{BE(SAT)}$	.70	.88	.70	.88	Volts
($I_C = 500mA$, $I_B = 50mA$)†	$V_{BE(SAT)}$	.80	1.0	.80	1.0	Volts
Base-Emitter Voltage ($V_{CE} = 5V$, $I_C = 10mA$)†	V_{BE}	.55	.75	.55	.75	Volts
Forward Current Transfer Ratio ($V_{CE} = 1V$, $I_C = 100\mu A$)	h_{FE}	45		70		
($V_{CE} = 1V$, $I_C = 10mA$)†	h_{FE}	100	300	200	500	
($V_{CE} = 1V$, $I_C = 100mA$)†	h_{FE}	85		170		
($V_{CE} = 2V$, $I_C = 500mA$)†	h_{FE}	25		40		
Collector Cutoff Current ($V_{CB} = 25V$, $I_E = 0$)	I_{CBO}		10		10	nA
Emitter-Base Reverse Current ($V_{EB} = 3.0V$, $I_C = 0$)	I_{EBO}		20		20	nA

† Pulsed, 300μsec, ≦ 2% duty cycle



SYMBOL	MILLIMETERS		INCHES		NOTE
	MIN.	MAX.	MIN.	MAX.	
A	–	6.680	–	.263	
B	–	10.160	–	.400	
φb	.407	.533	.016	.021	1
φb2	.407	.482	.016	.019	1
C	–	13.200	–	.520	
e	2.420	2.660	.095	.105	
e1	1.150	1.395	.045	.055	
F	–	3.550	–	.140	
h	1.570	REF.	.062	REF.	
L	12.700	–	.500	–	1
L1	–	1.270	–	.050	1
L2	6.350	–	.250	–	1
φp	–	3.630	–	.145	2
q	3.960	REF.	.156	REF.	
q1	2.210	REF.	.187	REF.	
r1	–	3.960	–	.156	

NOTES:
1. (THREE LEADS) φb2 APPLIES BETWEEN L1 AND L2. φb APPLI BETWEEN L2 & .5" (12.70MM) FROM REFERENCE PLANE. DIAMETER IS UNCONTROLLED IN L1 AND BEYOND .5" (12.70MM FROM REFERENCE PLANE.
2. MOUNTING HOLE IS FOR #4 SCREW. HOLE WILL ACCEPT A .113" (2.87MM) DIAMETER PIN INSERTED PERPENDICULAR TO THE MOUNTING SURFACE.

DYNAMIC CHARACTERISTICS

Characteristic	Symbol	GES6010 Min.	GES6010 Typ.	GES6010 Max.	GES6012 Min.	GES6012 Typ.	GES6012 Max.	Units
Forward Current Transfer Ratio ($I_E =$ 1mA, $V_{CE} = 10V$, f = 1KHz)	h_{fe}	65		450	130		750	
Input Impedance ($I_E =$ 1mA, $V_{CE} = 10V$, f = 1KHz)	h_{ie}	1.5		12	2.5		20	Kohms
Output Conductance ($I_E =$ 1mA, $V_{CE} = 10V$, f = 1KHz)	h_{oe}			45			70	umhos
Collector-Base Capacitance ($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)	C_{cb}			10			10	pF
Emitter-Base Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, f = 1 MHz)	C_{eb}			50			45	pF
Gain Bandwidth Product ($V_{CE} = 10V$, $I_E =$ 10mA, f = 100 MHz)	f_T	105		335	135		425	MHz
Noise Figure ($V_{CE} = 5V$, $I_E =$ 100μA, BW = 15.7KHz, $R_S = 5K\Omega$, f = 10 Hz to 10KHz)	NF			5			3	dB
Delay Time—See Figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_d		12			12		nsec
Rise Time—See Figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_r		25			25		nsec
Storage Time—See Figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} =$ 15mA)	t_s		300			350		nsec
Fall Time—See Figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} =$ 15mA)	t_f		100			150		nsec

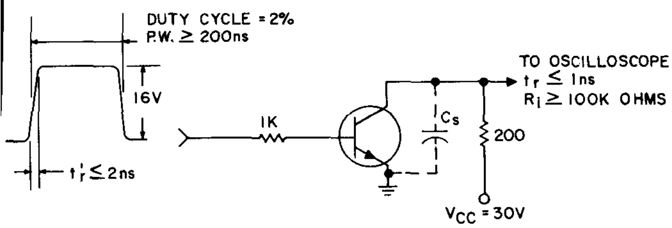
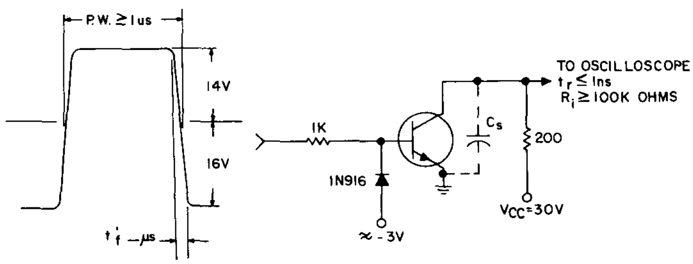
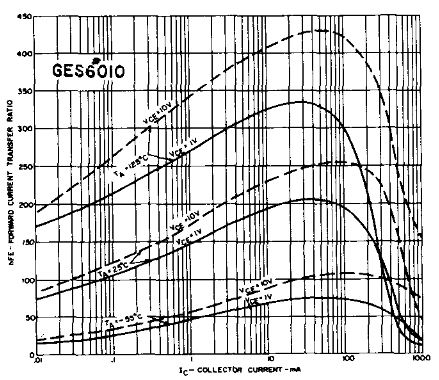


FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

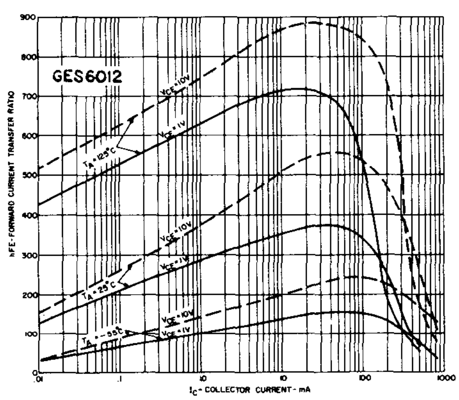


C_s = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS AND PROBE = 10pF

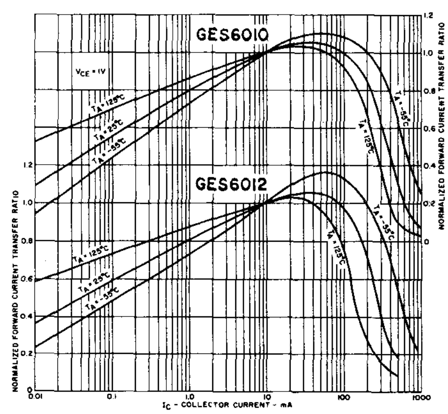
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



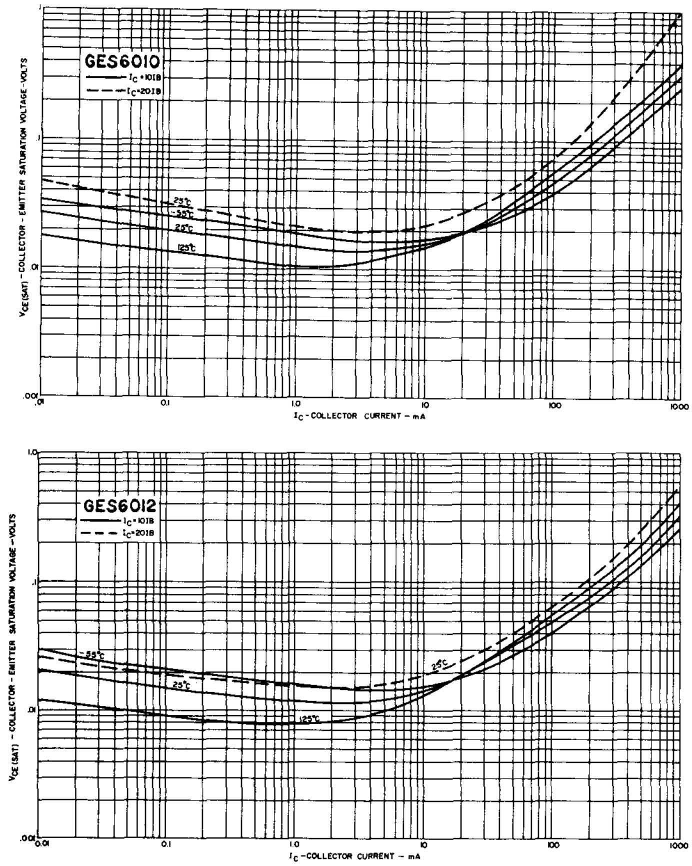
BETA VS. COLLECTOR CURRENT



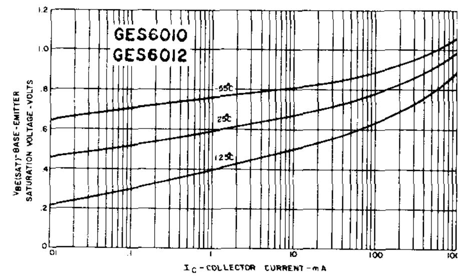
BETA VS. COLLECTOR CURRENT



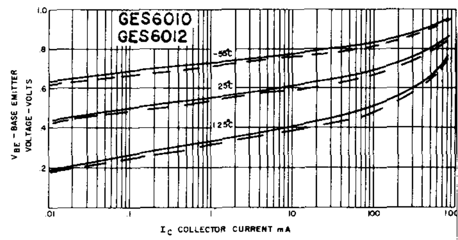
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



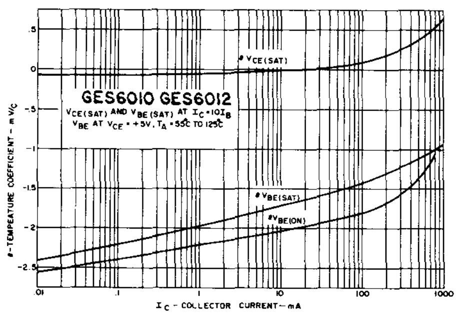
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



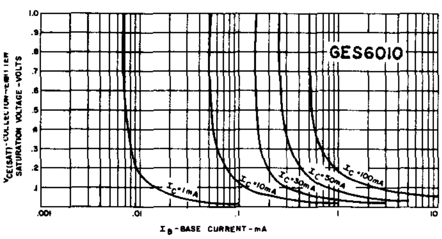
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



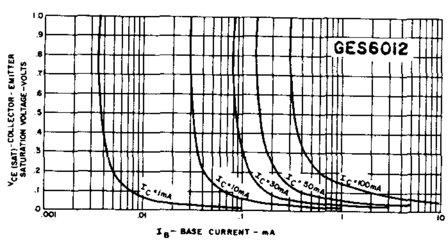
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



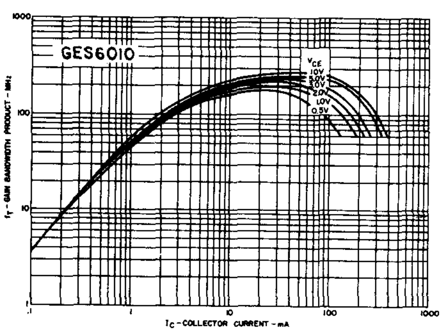
TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT



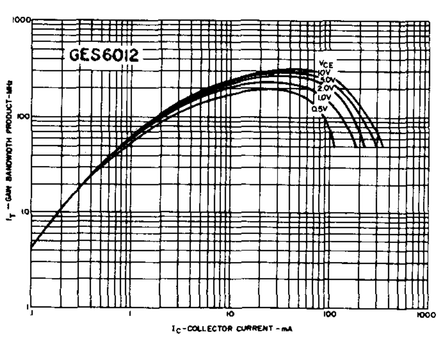
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



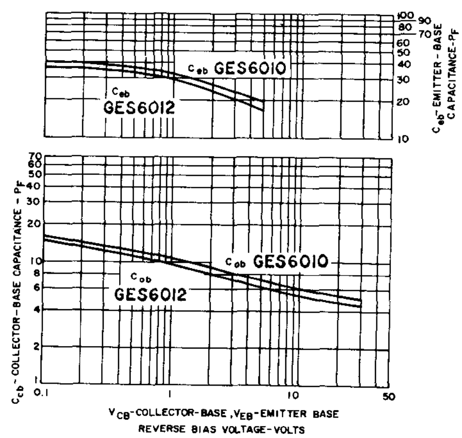
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



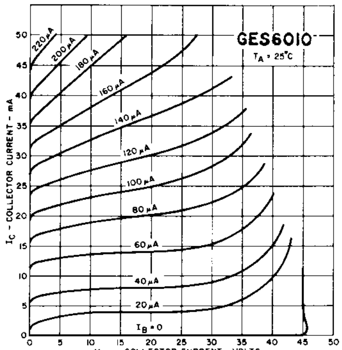
GAINBANDWIDTH PRODUCT VS. COLLECTOR CURRENT

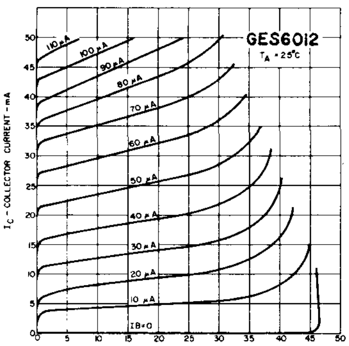


GAINBANDWIDTH PRODUCT VS. COLLECTOR CURRENT

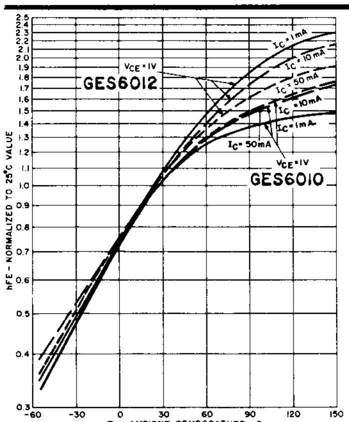


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

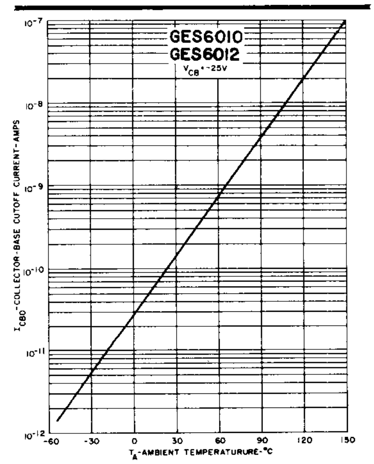




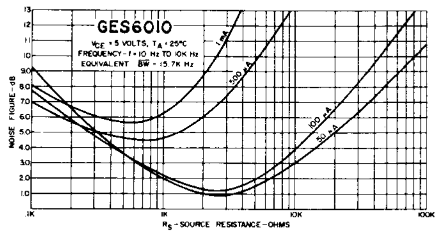
COLLECTOR CHARACTERISTICS



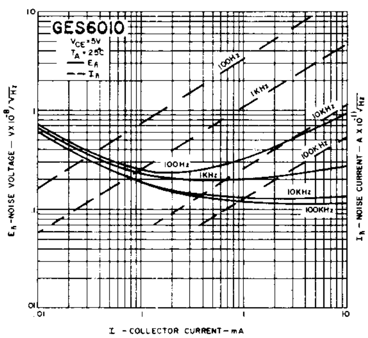
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



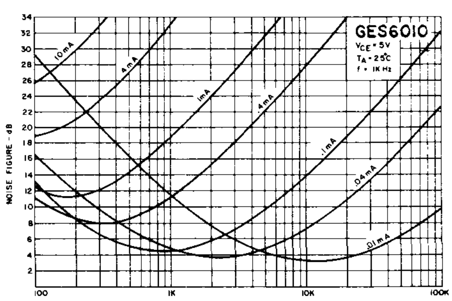
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



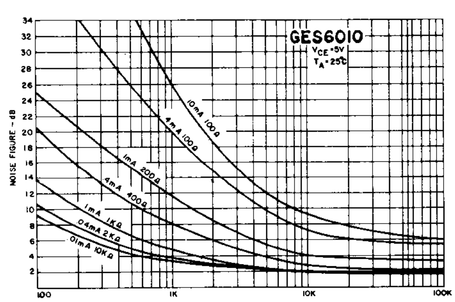
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



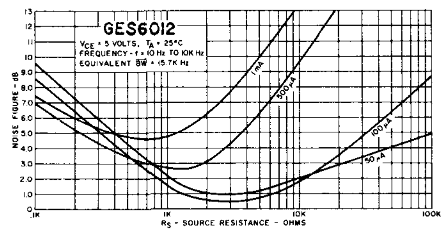
E_n & I_n VS. COLLECTOR CURRENT



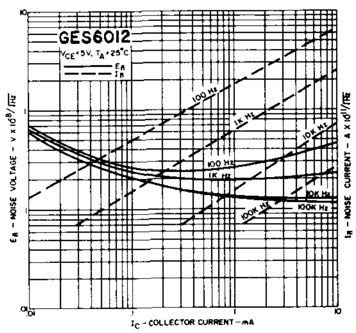
NOISE FIGURE VS. SOURCE RESISTANCE



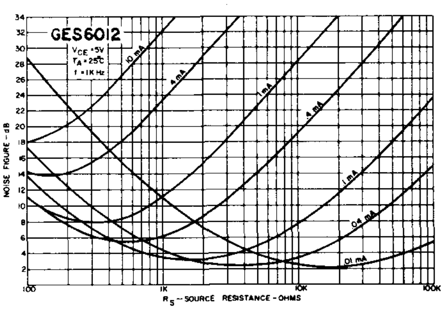
NOISE FIGURE VS. FREQUENCY



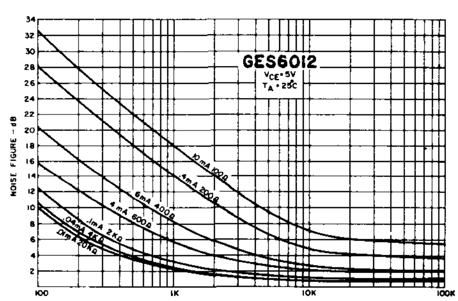
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



E_n & I_n VS. COLLECTOR CURRENT



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY

Silicon Transistors

PNP

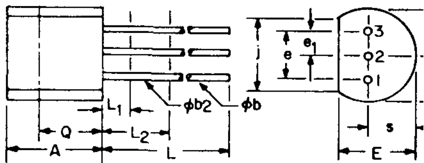
GES6011
GES6013

The General Electric GES6011 and GES6013 devices are silicon PNP, planar epitaxial passivated transistors specifically designed for high level linear amplifiers or medium speed switching circuits, and are especially suited for industrial control applications. Complementary NPN versions are available and are designated as GES6010 and GES6012 respectively.

*Voltage and Current Values for PNP are negative: Observe Proper Bias Polarity.

Features

- Epoxy encapsulation with proved reliability
- Performance comparable to hermetic units — excellent charactistic stability under environmental stresses—85°C—85% Relative Humidity.
- 500 mw Power Dissipation
- Excellent Beta Linearity over extremely wide current ranges
- Beta hold-up out to 800 mA
- 40 Volt — $V_{(BR)CEO}$ ratings
- Integral Heat Sinks available—Up to 1 W Power Dissipation. Order as GES6011-J1 etc.



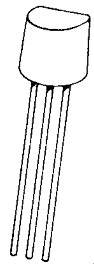
1. EMITTER
2. BASE
3. COLLECTOR

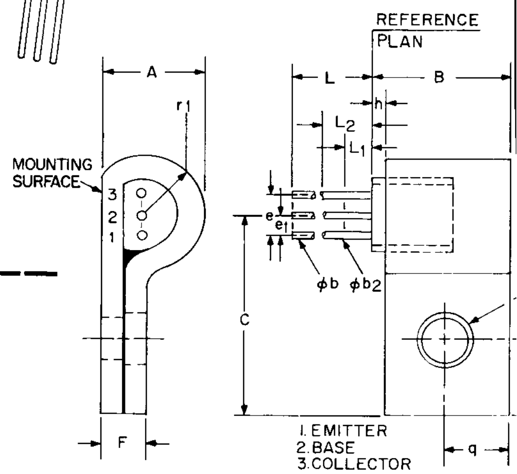
TO-92

SYMBOL	MILLIMETERS		INCHES		NOT[ES]
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1
φb2	.407	.482	.016	.019	
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		GES6011	GES6013	
Voltages				
Collector to Emitter	V_{CEO}	40	40	Volts
Collector to Emitter	V_{CES}	50	50	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	50	50	Volts
Current				
Collector	I_C	800	800	mA
Collector (peak, pulsed 10 μsec, ≤ 2% duty cycle)	I_C	1500	1500	mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T	.500	.500	Watts
Derating Factor $T_A \geq 25°C$		4	4	mW/°C
Total Power $T_A \leq 25°C$ Heatsink	P_T	.625	.625	Watts
Total Power $T_C \leq 25°C$ Heatsink	P_T	1.0	1.0	Watts
Derating Factor $T_A \geq 25°C$ Heatsink		5	5	mW/°C
Derating Factor $T_C \geq 25°C$ Heatsink		8	8	mW/°C
Temperature				
Storage	T_{STG}	←—— −65 to +150 ——→		°C
Operating	T_J	←—— −65 to +150 ——→		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	←—— +260 ——→		°C



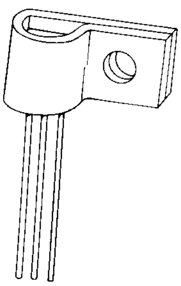


TO-92

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	GES6011 Min.	GES6011 Max.	GES6013 Min.	GES6013 Max.	
Collector-Emitter Breakdown Voltage ($I_C = 10mA, I_B = 0$)†	$V_{(BR)CEO}$	40		40		Volts
Emitter-Base Breakdown Voltage ($I_E = 100\mu A, I_C = 0$)	$V_{(BR)EBO}$	5		5		Volts
Collector-Base Breakdown Voltage ($I_C = 100\mu A, I_E = 0$)	$V_{(BR)CBO}$	50		50		Volts
Collector-Emitter Breakdown Voltage ($I_C = 100\mu A, V_{BE} = 0$)	$V_{(BR)CES}$	50		50		Volts
Collector-Emitter Saturation Voltage ($I_C = 100mA, I_B = 10mA$)†	$V_{CE(SAT)}$		.300		.300	Volts
($I_C = 500mA, I_B = 50mA$)†	$V_{CE(SAT)}$		.750		.750	Volts
Base-Emitter Saturation Voltage ($I_C = 100mA, I_B = 10mA$)†	$V_{BE(SAT)}$	.70	.95	.70	.95	Volts
($I_C = 500mA, I_B = 50mA$)†	$V_{BE(SAT)}$	.80	1.10	.80	1.10	Volts
Base-Emitter Voltage ($V_{CE} = 5V, I_C = 10mA$)†	V_{BE}	.55	.77	.55	.77	Volts
Forward Current Transfer Ratio ($V_{CE} = 1V, I_C = 100\mu A$)	h_{FE}	60		120		
($V_{CE} = 1V, I_C = 10mA$)†	h_{FE}	100	300	200	500	
($V_{CE} = 1V, I_C = 100mA$)†	h_{FE}	75		150		
($V_{CE} = 2V, I_C = 500mA$)†	h_{FE}	45		80		
Collector Cutoff Current ($V_{CB} = 25V, I_E = 0$)	I_{CBO}		10		10	nA
Emitter-Base Reverse Current ($V_{EB} = 3.0V, I_C = 0$)	I_{EBO}		20		20	nA

†Pulsed, 300 μsec, ≤ 2% duty cycle



SYMBOL	MILLIMETERS		INCHES		NO[TES]
	MIN.	MAX.	MIN.	MAX.	
A	—	6.680	—	.263	
B	—	10.160	—	.400	
φb	.407	.533	.016	.021	
φb2	.407	.482	.016	.019	
C	—	13.200	—	.520	
e	2.420	2.660	.095	.105	
e1	1.150	1.395	.045	.055	
F	—	3.550	—	.140	
h	1.570	REF.	.062	REF.	
L	12.700	—	.500	—	1
L1	—	1.270	—	.050	1
L2	6.350	—	.250	—	1
φp	—	3.630	—	.145	2
q	3.960	REF.	.156	REF.	
q1	2.210	REF.	.187	REF.	
r1	—	3.960	—	.156	

NOTES:
1. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APP[LIES] BETWEEN L_2 & .5" (12.70MM) FROM REFERENCE PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND .5" (12.70[MM]) FROM REFERENCE PLANE.
2. MOUNTING HOLE IS FOR #4 SCREW. HOLE WILL ACCEP[T] .113" (2.87MM) DIAMETER PIN INSERTED PERPENDICUL[A][R] TO THE MOUNTING SURFACE.

DYNAMIC CHARACTERISTICS

		GES6011			GES6013			
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Forward Current Transfer Ratio ($I_E = 1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{fe}	80		450	160		750	
Input Impedance ($I_E = 1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{ie}	1.5		15	2.5		30	Kohms
Output Conductance ($I_E = 1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{oe}			50			150	μmhos
Collector-Base Capacitance ($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{cb}			15			15	pF
Emitter-Base Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, $f = 1$ MHz)	C_{eb}			55			55	pF
Gain Bandwidth Product ($V_{CE} = 10V$, $I_E = 10mA$, $f = 30$ MHz)	f_T	75		250	100		300	MHz
Noise Figure $V_{CE} = 5V$, $I_E = 100\mu A$, BW = 15.7 KHz, $R_s = 5K\Omega$, f = 10 Hz to 10 KHz)	NF			3			2	dB
Delay Time — see figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_d		10			10		nsec
Rise Time — see figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_r		35			35		nsec
Storage Time — see figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = 15mA$)	t_s		375			450		nsec
Fall Time — see figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = 15mA$)	t_f		50			75		nsec

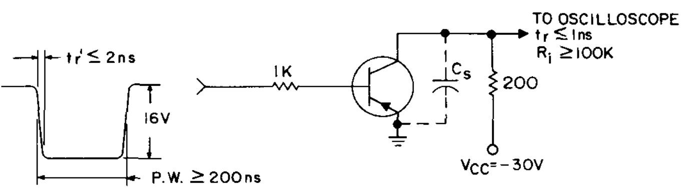
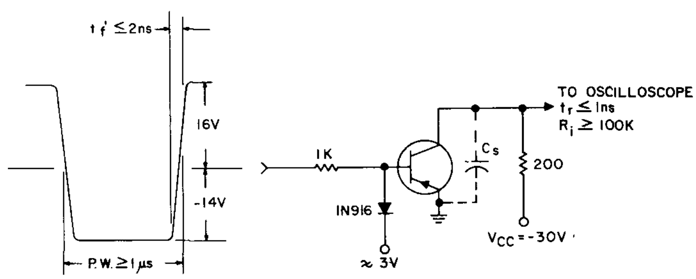
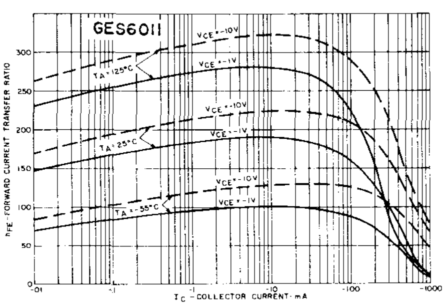


FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

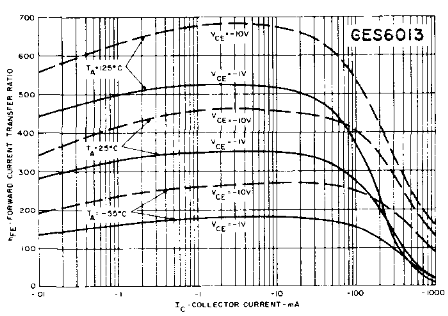


C_s = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS, AND PROBE = 10pF

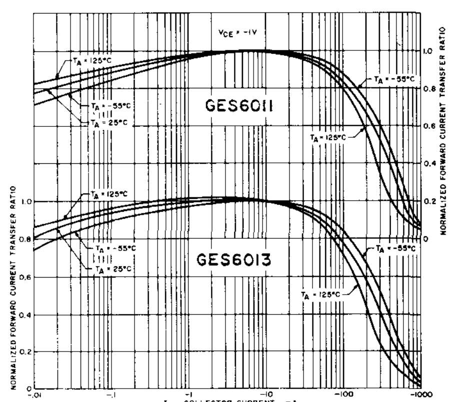
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



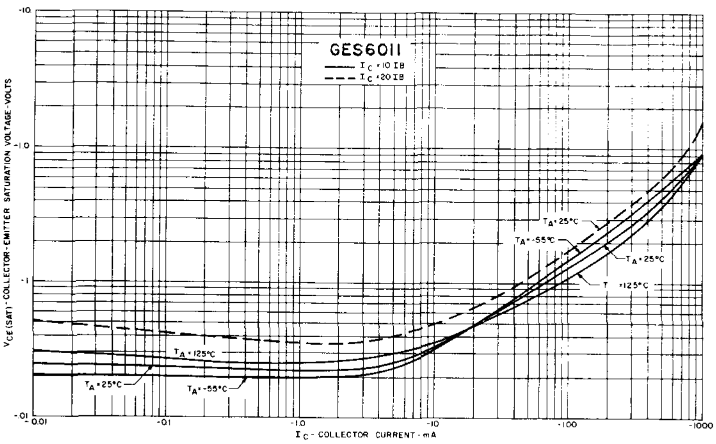
BETA VS. COLLECTOR CURRENT

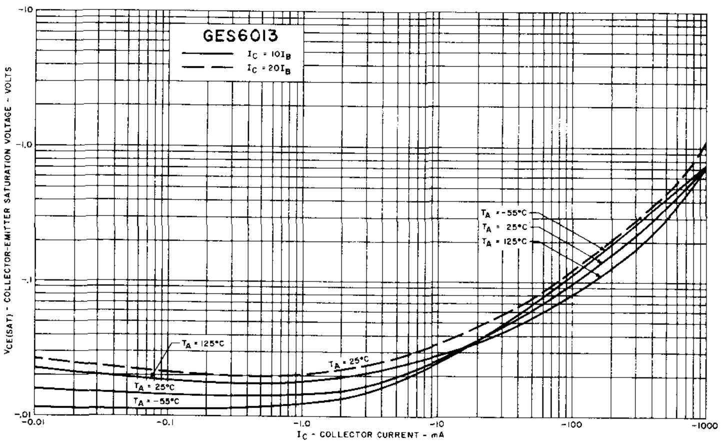


BETA VS. COLLECTOR CURRENT

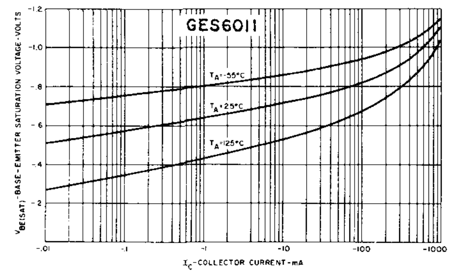


NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

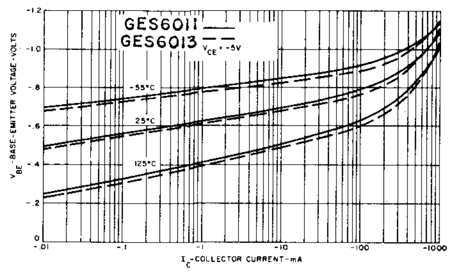




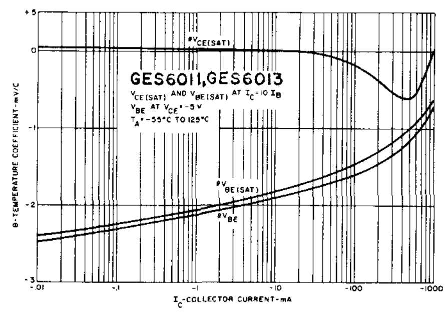
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



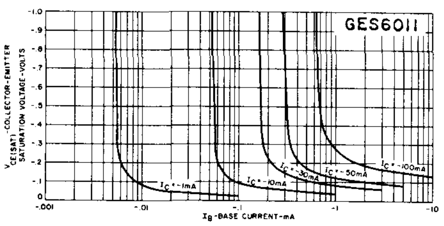
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



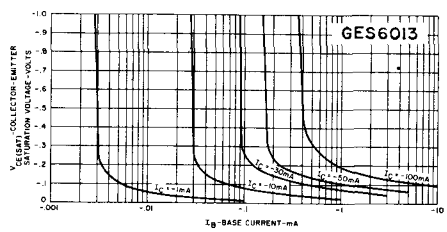
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



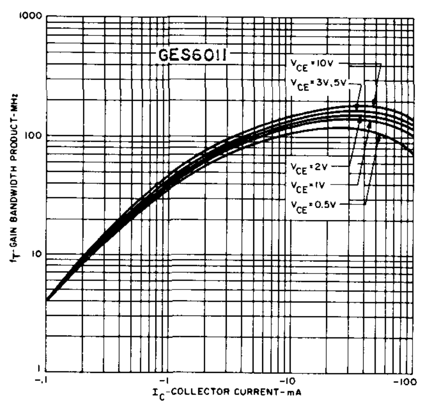
TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT



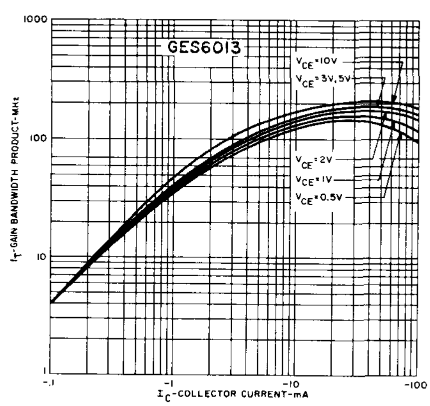
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



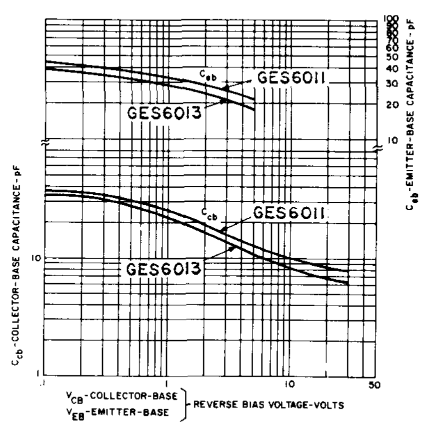
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



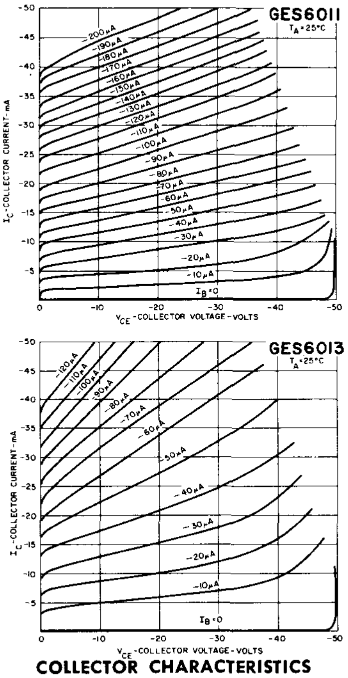
GAIN BAND WIDTH PRODUCT VS. COLLECTOR CURRENT



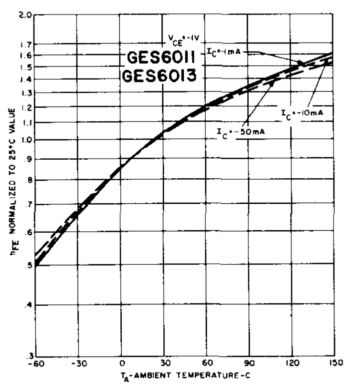
GAIN BAND WIDTH PRODUCT VS. COLLECTOR CURRENT



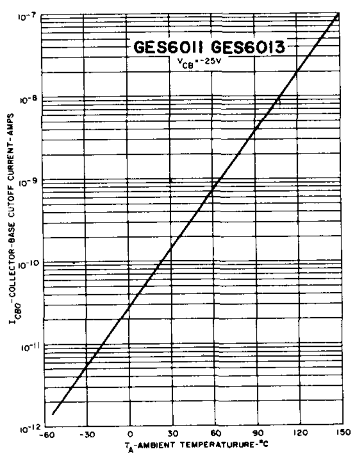
COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE



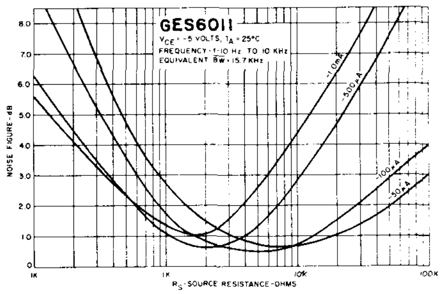
COLLECTOR CHARACTERISTICS



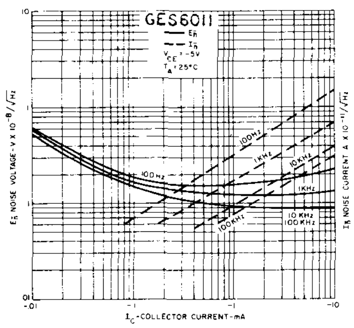
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



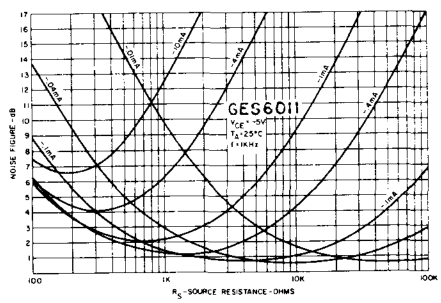
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



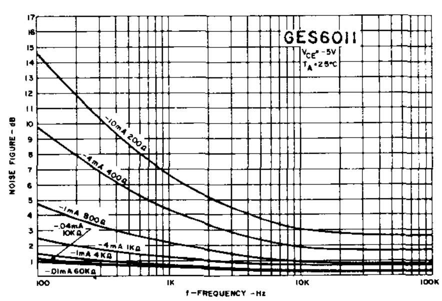
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



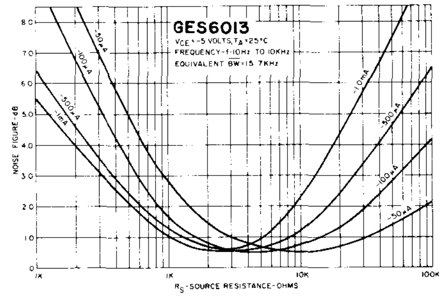
E_n & I_n VS. COLLECTOR CURRENT



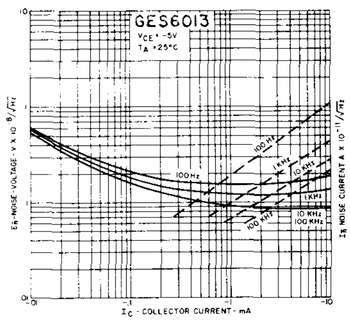
NOISE FIGURE VS. SOURCE RESISTANCE



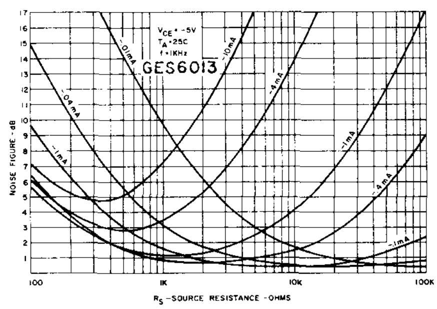
NOISE FIGURE VS. FREQUENCY



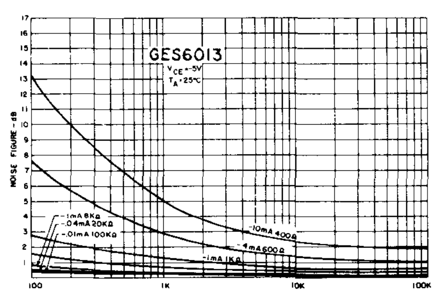
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



E_n & I_n VS. COLLECTOR CURRENT



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY

Silicon Transistors

PNP

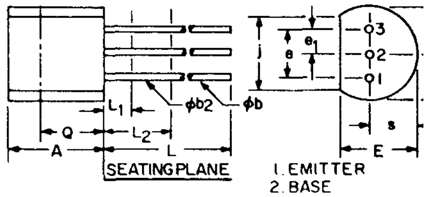
GES6015
GES6017

The General Electric GES6015 and GES6017 devices are silicon PNP, planar epitaxial passivated transistors specially designed for high level linear amplifiers or medium speed switching circuits, and are especially suited for industrial control applications. Complementary NPN versions are available and are designated as GES6014 and GES6016 respectively.

Features

- Epoxy encapsulation with proved reliability
- Performance comparable to hermetic units — excellent charactistic stability under environmental stresses—85°C—85% Relative Humidity.
- 500 mw Power Dissipation
- Excellent Beta Linearity over extremely wide current ranges
- Beta hold-up out to 800 mA
- 60 Volt — $V_{(BR)CEO}$ ratings
- Integral Heat Sinks available—Up to 1 W Power Dissipation. Order as GES6015-J1 etc.

*Voltage and Current Values for PNP are negative: Observe Proper Bias Polarity.

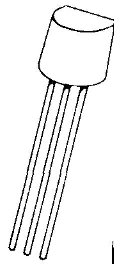


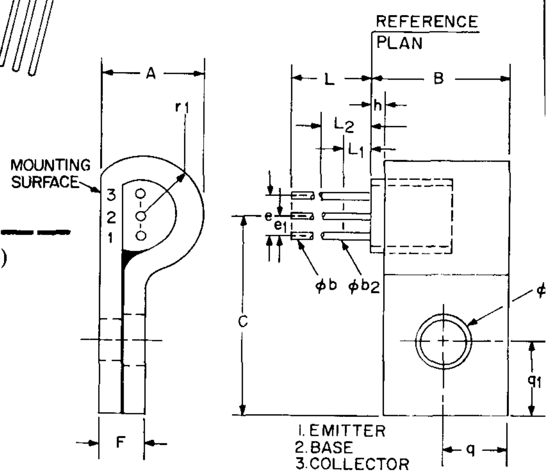
TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

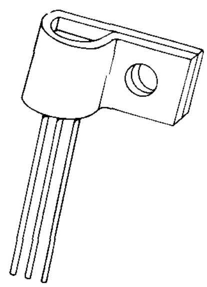
absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

		GES6015	GES6017	
Voltages				
Collector to Emitter	V_{CEO}	60	60	Volts
Collector to Emitter	V_{CES}	70	70	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	70	70	Volts
Current				
Collector	I_C	800	800	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	1500	1500	mA
Dissipation				
Total Power ($T_A \leqq 25°C$)	P_T	.500	.500	Watts
Total Power ($T_A \leqq 25°C$) Heatsink	P_T	.700	.700	Watts
Total Power ($T_C \leqq 25°C$)	P_T	1	1	Watts
Derate Factor ($T_A \geqq 25°C$)		4	4	mW/°C
Derate Factor ($T_C \geqq 25°C$) Heatsink		8	8	mW/°C
Temperature				
Storage	T_{STG}	←— −65 to +150 —→		°C
Operating	T_J	←— −65 to +150 —→		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	←—— +260 ——→		°C





TO-92



SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	—	6.680	—	.263	
B	—	10.160	—	.400	
φb	.407	.533	.016	.021	1
φb2	.407	.482	.016	.019	1
C	—	13.200	—	.520	
e	2.420	2.660	.095	.105	
e1	1.150	1.395	.045	.055	
F	—	3.550	—	.140	
h	1.570	REF.	.062	REF.	
L	12.700	—	.500	—	1
L1	—	1.270	—	.050	1
L2	6.350	—	.250	—	1
φp	—	3.630	—	.145	2
q	3.960	REF.	.156	REF.	
q1	2.210	REF.	.187	REF.	
r1	—	3.960	—	.156	

NOTES:
1. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 & .5"(12.70MM) FROM REFERENCE PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND .5"(12.70MM) FROM REFERENCE PLANE.
2. MOUNTING HOLE IS FOR #4 SCREW. HOLE WILL ACCEPT A .113" (2.87MM) DIAMETER PIN INSERTED PERPENDICULAR TO THE MOUNTING SURFACE.

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	GES6015 Min.	GES6015 Max.	GES6017 Min.	GES6017 Max.	
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)†	$V_{(BR)CEO}$	60		60		Volts
Emitter-Base Breakdown Voltage (I_E = 100μA, I_C = 0)	$V_{(BR)EBO}$	5		5		Volts
Collector-Base Breakdown Voltage (I_C = 100μA, I_E = 0)	$V_{(BR)CBO}$	70		70		Volts
Collector-Emitter Breakdown Voltage (I_C = 100μA, V_{BE} = 0)	$V_{(BR)CES}$	70		70		Volts
Collector-Emitter Saturation Voltage (I_C = 100mA, I_B = 10mA)†	$V_{CE(SAT)}$		.300		.300	Volts
(I_C = 500mA, I_B = 50mA)†	$V_{CE(SAT)}$		.750		.750	Volts
Base-Emitter Saturation Voltage (I_C = 100mA, I_B = 10mA)†	$V_{BE(SAT)}$	.70	.95	.70	.95	Volts
(I_C = 500mA, I_B = 50mA)†	$V_{BE(SAT)}$	.80	1.10	.80	1.10	Volts
Base-Emitter Voltage (V_{CE} = 5V, I_C = 10mA)†	V_{BE}	.55	.77	.55	.77	Volts
Forward Current Transfer Ratio (V_{CE} = 1V, I_C = 100μA)	h_{FE}	60		120		
(V_{CE} = 1V, I_C = 10mA)†	h_{FE}	100	300	200	500	
(V_{CE} = 1V, I_C = 100mA)†	h_{FE}	75		150		
(V_{CE} = 2V, I_C = 500mA)†	h_{FE}	40		75		
Collector Cutoff Current (V_{CB} = 25V, I_E = 0)	I_{CBO}		10		10	nA
Emitter-Base Reverse Current (V_{EB} = 3.0V, I_C = 0)	I_{EBO}		20		20	nA

†Pulsed, 300 μsec, ≦ 2% duty cycle

DYNAMIC CHARACTERISTICS

		GES6015 Min.	GES6015 Typ.	GES6015 Max.	GES6017 Min.	GES6017 Typ.	GES6017 Max.	
Forward Current Transfer Ratio ($I_E = 1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{fe}	80		450	160		750	
Input Impedance ($I_E = 1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{ie}	1.5		15	2.5		30	Kohms
Output Conductance ($I_E = 1mA$, $V_{CE} = 10V$, $f = 1KHz$)	h_{oe}			50			150	μmhos
Collector-Base Capacitance ($V_{CB} = 10V$, $I_E = 0$, $f = 1$ MHz)	C_{cb}			15			15	pF
Emitter-Base Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, $f = 1$ MHz)	C_{eb}			55			55	pF
Gain Bandwidth Product ($V_{CE} = 10V$, $I_E = 10mA$, $f = 30$ MHz)	f_T	75		250	100		300	MHz
Noise Figure $V_{CE} = 5V$, $I_E = 100\mu A$, BW = 15.7KHz, $R_s = 5K\Omega$, f = 10 Hz to 10 KHz)	NF			3			2	dB
Delay Time — see figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_d		10			10		nsec
Rise Time — see figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_r		35			35		nsec
Storage Time — see figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = 15mA$)	t_s		375			450		nsec
Fall Time — see figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} = 15mA$)	t_f		50			75		nsec

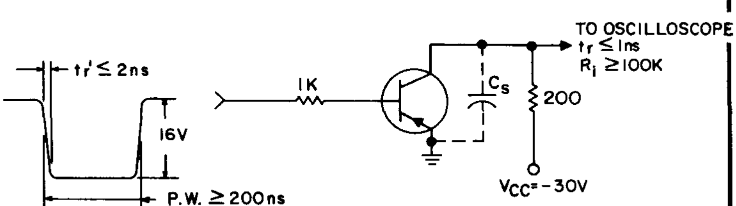
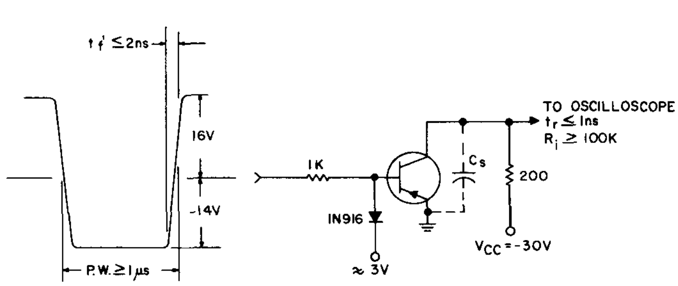
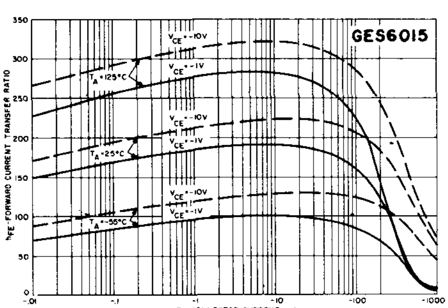


FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

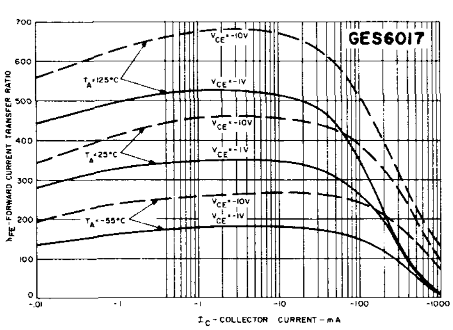


C_s = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS, AND PROBE = 10pF

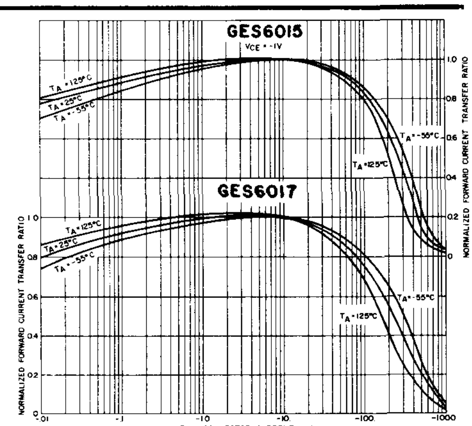
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



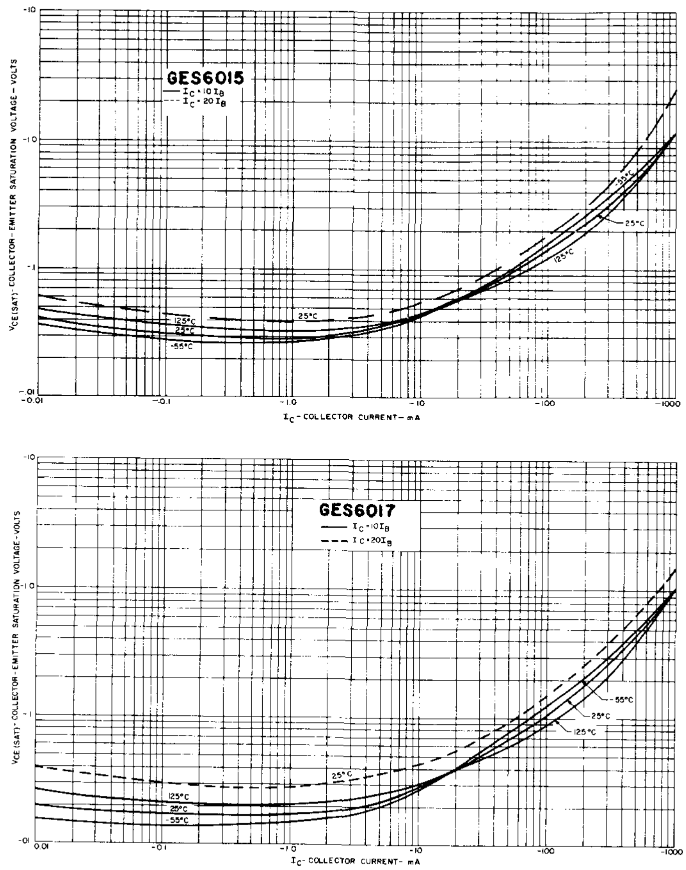
BETA VS. COLLECTOR CURRENT



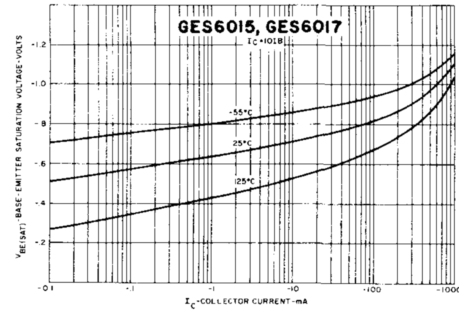
BETA VS. COLLECTOR CURRENT



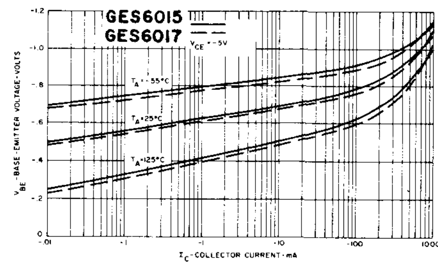
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



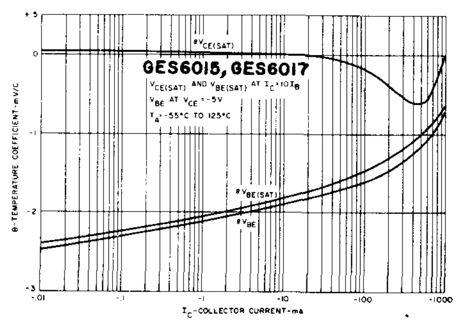
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



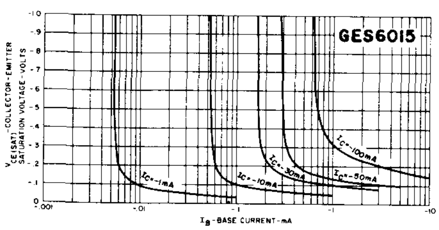
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



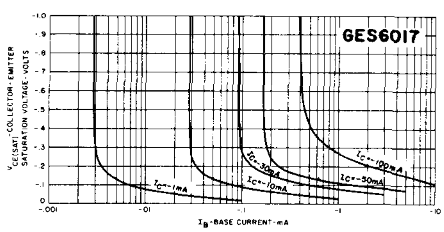
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



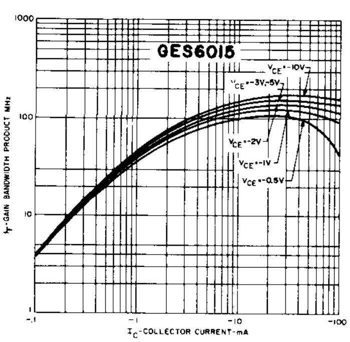
TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT



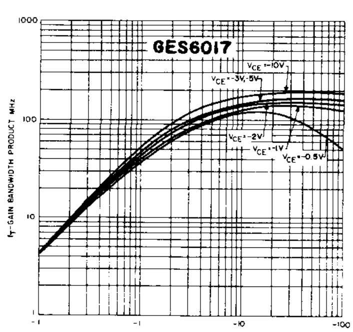
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



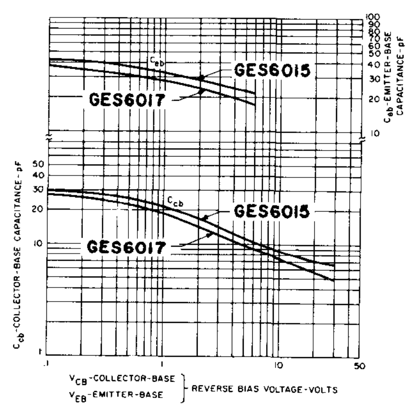
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



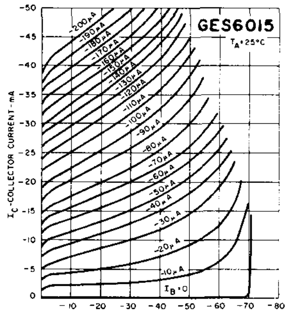
GAIN BAND WIDTH PRODUCT VS. COLLECTOR CURRENT

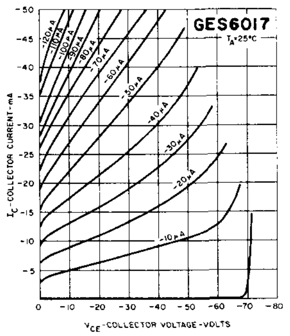


GAIN BAND WIDTH PRODUCT VS. CURRENT CURRENT

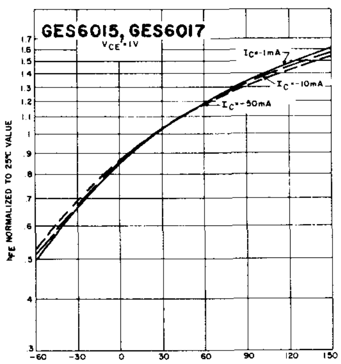


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

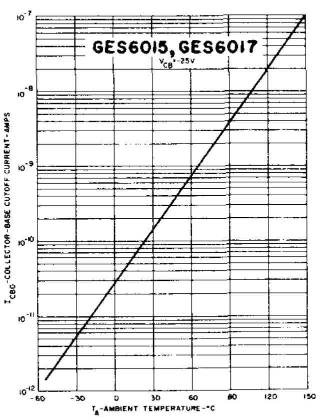




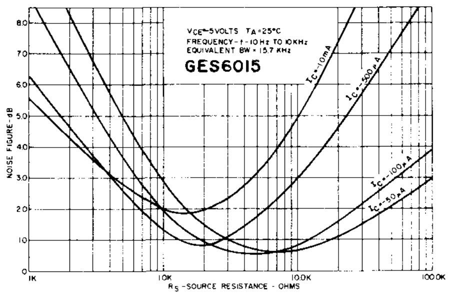
COLLECTOR CHARACTERISTICS



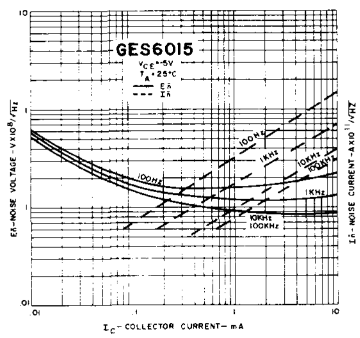
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



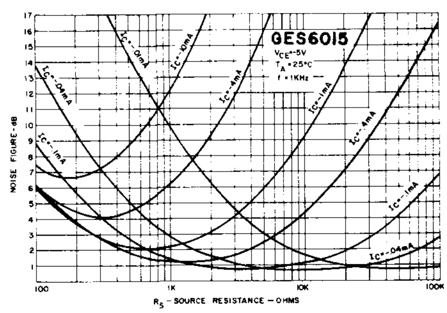
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



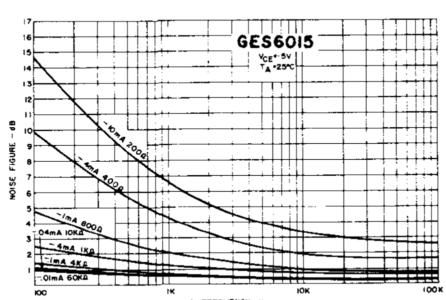
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



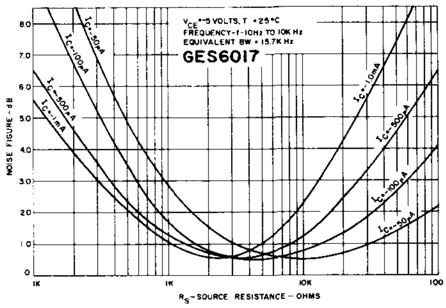
E_n & I_n VS. COLLECTOR CURRENT



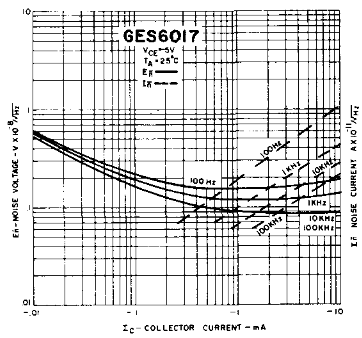
NOISE FIGURE VS. SOURCE RESISTANCE



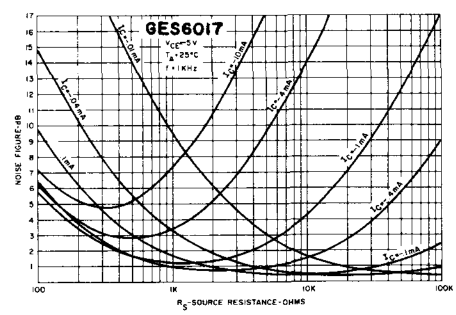
NOISE FIGURE VS. FREQUENCY



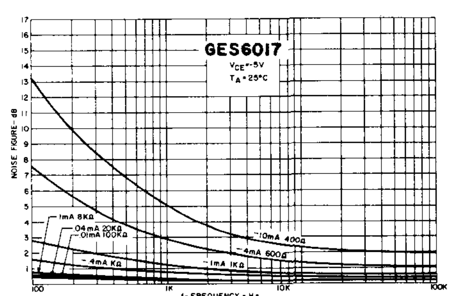
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



E_n & I_n VS. COLLECTOR CURRENT



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY

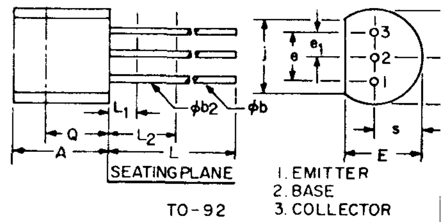
Silicon Transistors

NPN

GES6014

GES6016

The General Electric GES6014 and GES6016 devices are silicon, NPN, planar epitaxial passivated transistors designed primarily for high current linear amplifiers or medium speed switching circuits and are especially suited for industrial control applications. Complementary PNP versions of these types are available and are designated as GES6015 and GES6017 respectively.

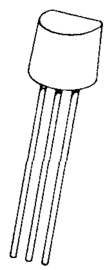


Features

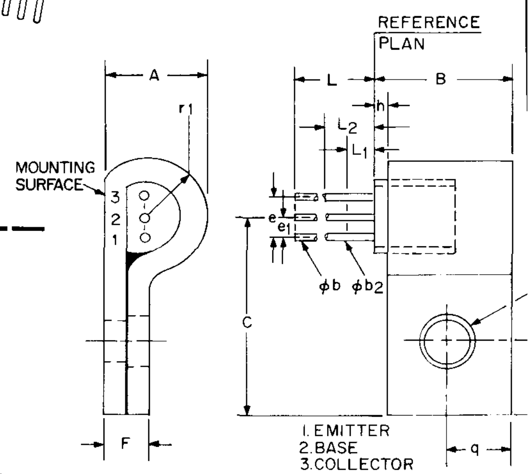
- Epoxy encapsulation with proved reliability.
- Performance comparable to hermetic units—excellent characteristic stability under environmental stresses—85°C—85% Relative Humidity.
- 500 mw Power Dissipation.
- Excellent Beta Linearity over extremely wide current ranges.
- Beta hold-up out to 800 mA.
- 60 Volt $V_{(BR)CEO}$ ratings.
- Integral Heat Sinks available—Up to 1 W Power Dissipation. Order as GES6014-J1 etc.

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)



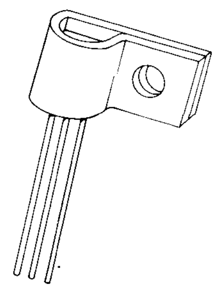
		GES6014	GES6016	
Voltages				
Collector to Emitter	V_{CEO}	60	60	Volts
Collector to Emitter	V_{CES}	70	70	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Collector to Base	V_{CBO}	70	70	Volts
Current				
Collector	I_C	800	800	mA
Collector (peak, pulsed 10 μsec, ≦ 2% duty cycle)	I_C	1500	1500	mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T	.500	.500	Watts
Derating Factor $T_A \geq 25°C$		4	4	mW/°C
Total Power $T_A \leq 25°C$ Heatsink	P_T	.625	.625	Watts
Total Power $T_C \leq 25°C$ Heatsink	P_T	1.0	1.0	Watts
Derating Factor $T_A \geq 25°C$ Heatsink		5	5	mW/°C
Derating Factor $T_C \geq 25°C$ Heatsink		8	8	mW/°C
Temperature				
Storage	T_{STG}	←— −65 to +150 —→		°C
Operating	T_J	←— −65 to +150 —→		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	←— +260 —→		°C



electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol	GES6014 Min.	GES6014 Max.	GES6016 Min.	GES6016 Max.	
Collector-Emitter Breakdown Voltage ($I_C = 10mA$, $I_B = 0$)†	$V_{(BR)CEO}$	60		60		Volts
Emitter-Base Breakdown Voltage ($I_E = 100\mu A$, $I_C = 0$)	$V_{(BR)EBO}$	5		5		Volts
Collector-Base Breakdown Voltage ($I_C = 100\mu A$, $I_E = 0$)	$V_{(BR)CBO}$	70		70		Volts
Collector-Emitter Breakdown Voltage ($I_C = 100\mu A$, $V_{BE} = 0$)	$V_{(BR)CES}$	70		70		Volts
Collector-Emitter Saturation Voltage ($I_C = 100mA$, $I_B = 10mA$)†	$V_{CE(SAT)}$		.150		.150	Volts
($I_C = 500mA$, $I_B = 50mA$)†	$V_{CE(SAT)}$		.500		.500	Volts
Base-Emitter Saturation Voltage ($I_C = 100mA$, $I_B = 10mA$)†	$V_{BE(SAT)}$	.70	.88	.70	.88	Volts
($I_C = 500mA$, $I_B = 50mA$)†	$V_{BE(SAT)}$	.80	1.0	.80	1.0	Volts
Base-Emitter Voltage ($V_{CE} = 5V$, $I_C = 10mA$)†	V_{BE}	.55	.75	.55	0.75	Volts
Forward Current Transfer Ratio ($V_{CE} = 1V$, $I_C = 100\mu A$)	h_{FE}	45		70		
($V_{CE} = 1V$, $I_C = 10mA$)†	h_{FE}	100	300	200	500	
($V_{CE} = 1V$, $I_C = 100mA$)†	h_{FE}	85		170		
($V_{CE} = 2V$, $I_C = 500mA$)†	h_{FE}	20		20		
Collector Cutoff Current ($V_{CB} = 25V$, $I_E = 0$)	I_{CBO}		10		10	nA
Emitter-Base Reverse Current ($V_{EB} = 3.0V$, $I_C = 0$)	I_{EBO}		20		20	nA

† Pulsed, 300μsec, ≦ 2% duty cycle



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	6.680	—	.263	
B	—	10.160	—	.400	
ϕb	.407	.533	.016	.021	1
ϕb2	.407	.482	.016	.019	1
C	—	13.200	—	.520	
e	2.420	2.660	.095	.105	
e1	1.150	1.395	.045	.055	
F	—	3.550	—	.140	
h	1.570	REF.	.062	REF.	
L	12.700	—	.500	—	1
L1	—	1.270	—	.050	1
L2	6.350	—	.250	—	1
ϕp	—	3.630	—	.145	2
q	3.960	REF.	.156	REF.	
q1	2.210	REF.	.187	REF.	
r1	—	3.960	—	.156	

NOTES:

1. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 & .5" (12.70MM) FROM REFERENCE PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND .5" (12.70MM) FROM REFERENCE PLANE.
2. MOUNTING HOLE IS FOR #4 SCREW. HOLE WILL ACCEPT A .113" (2.87MM) DIAMETER PIN INSERTED PERPENDICULAR TO THE MOUNTING SURFACE.

DYNAMIC CHARACTERISTICS

Characteristic	Symbol	GES6014 Min.	GES6014 Typ.	GES6014 Max.	GES6016 Min.	GES6016 Typ.	GES6016 Max.	Units
Forward Current Transfer Ratio ($I_E =$ 1mA, $V_{CE} = 10V$, f = 1KHz)	h_{fe}	65		450	130		750	
Input Impedance ($I_E =$ 1mA, $V_{CE} = 10V$, f = 1KHz)	h_{ie}	1.5		12	2.5		20	Kohms
Output Conductance ($I_E =$ 1mA, $V_{CE} = 10V$, f = 1KHz)	h_{oe}			45			170	umhos
Collector-Base Capacitance ($V_{CB} = 10V$, $I_E = 0$, f = 1 MHz)	C_{cb}			10			10	pF
Emitter-Base Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, f = 1 MHz)	C_{eb}			50			45	pF
Gain Bandwidth Product ($V_{CE} = 10V$, $I_E =$ 10mA, f = 30 MHz)	f_T	105		335	135		425	MHz
Noise Figure ($V_{CE} = 5V$, $I_E =$ 100μA, BW = 15.7KHz, $R_S = 5K\Omega$, f = 10 Hz to 10KHz)	NF			5			3	dB
Delay Time—See Figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_d		12			12		nsec
Rise Time—See Figure 1 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $V_{BE}(off) = 0V$)	t_r		25			25		nsec
Storage Time—See Figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} =$ 15mA)	t_s		300			350		nsec
Fall Time—See Figure 2 ($V_{CC} = 30V$, $I_C(on) = 150mA$, $I_{B1} = 15mA$, $I_{B2} =$ 15mA)	t_f		100			150		nsec

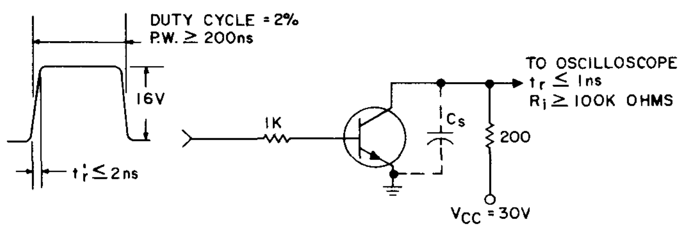
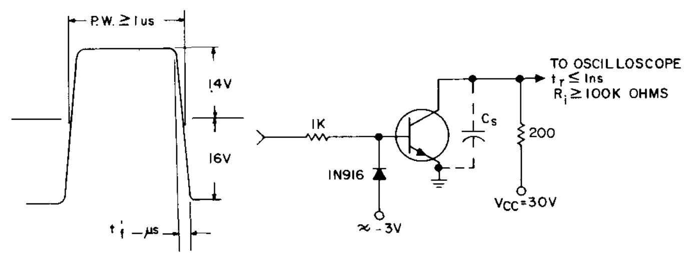
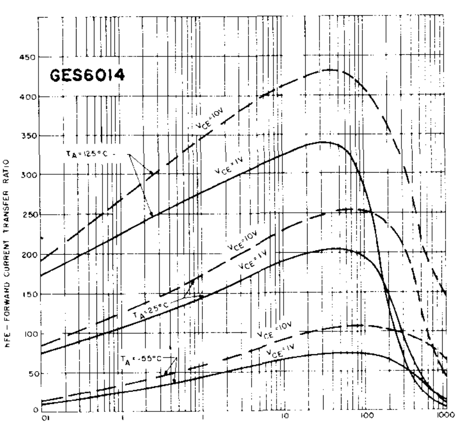


FIGURE 1. DELAY AND RISE TIME EQUIVALENT CIRCUIT

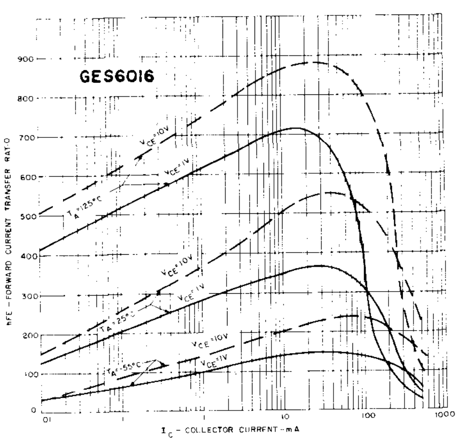


C_S = TOTAL SHUNT CAPACITANCE FIXTURE, CONNECTORS AND PROBE = 10pF

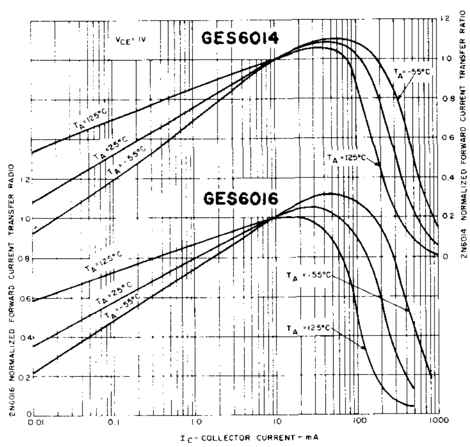
FIGURE 2. STORAGE AND FALL TIME EQUIVALENT CIRCUIT



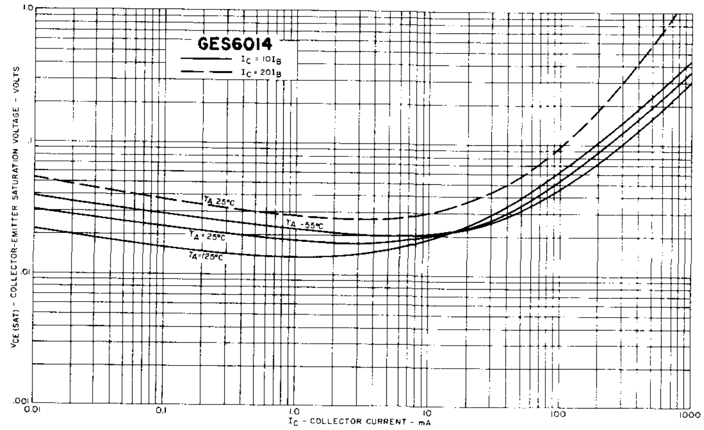
BETA VS. COLLECTOR CURRENT

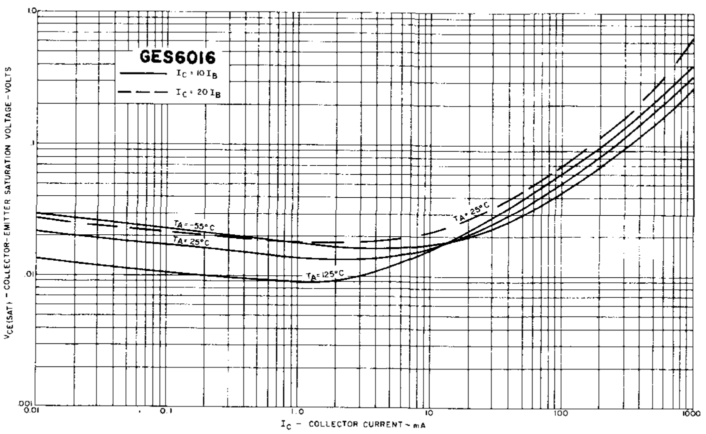


BETA VS. COLLECTOR CURRENT

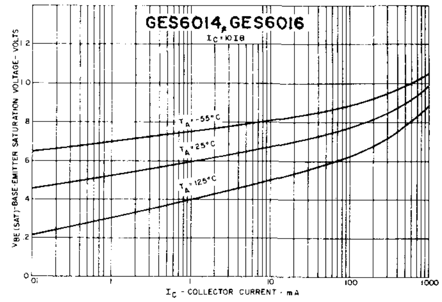


NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT

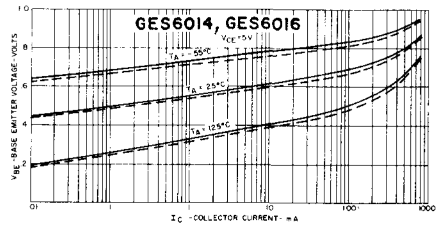




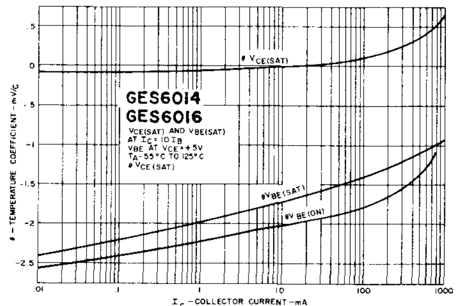
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



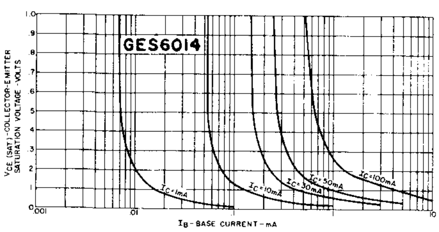
BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



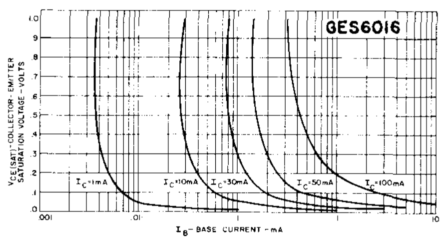
TRANSCONDUCTANCE VS. COLLECTOR CURRENT



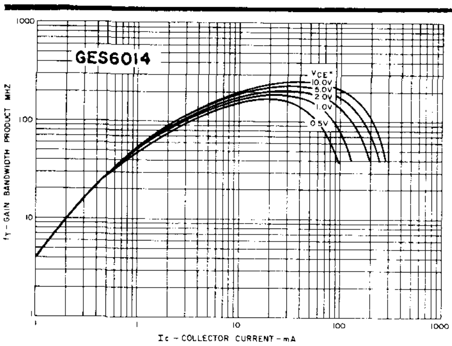
TEMPERATURE COEFFICIENTS VS. COLLECTOR CURRENT



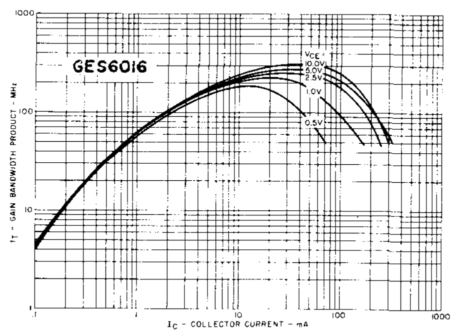
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



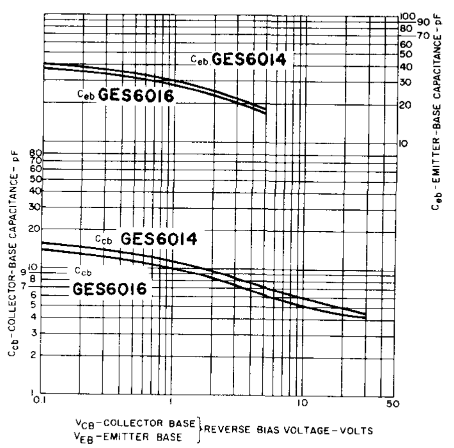
COLLECTOR-EMITTER SATURATION VOLTAGE VS. BASE CURRENT



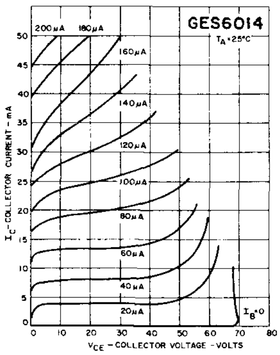
GAINBANDWIDTH PRODUCT VS. COLLECTOR CURRENT

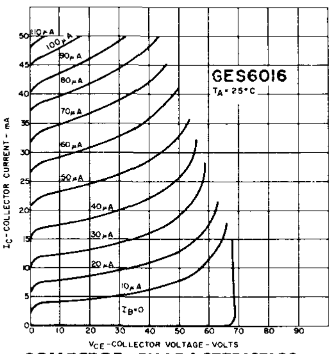


COLLECTOR BASE TIME CONSTANT VS. COLLECTOR CURRENT

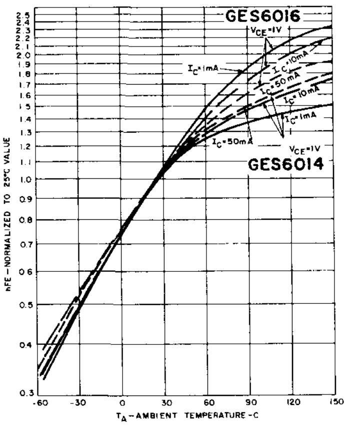


COLLECTOR-BASE & EMITTER-BASE CAPACITANCE VS. REVERSE BIAS VOLTAGE

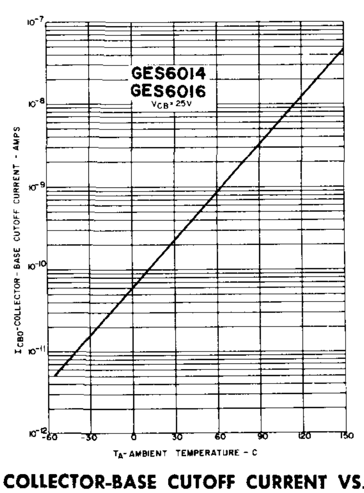




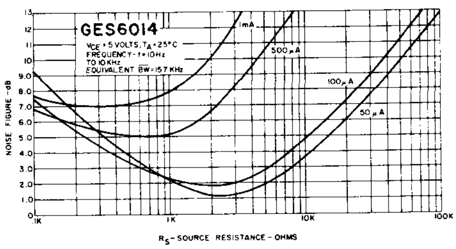
COLLECTOR CHARACTERISTICS



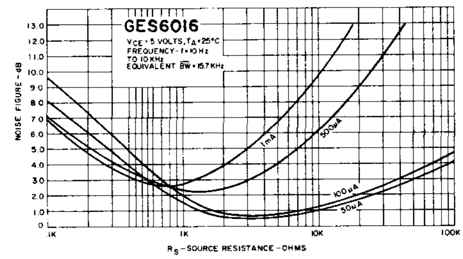
NORMALIZED FORWARD CURRENT TRANSFER RATIO VS. AMBIENT TEMPERATURE



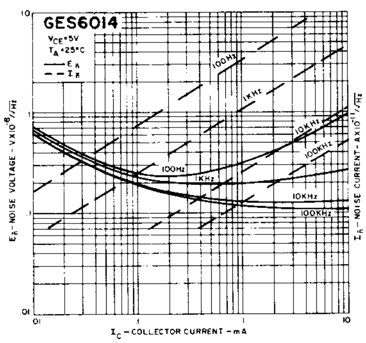
COLLECTOR-BASE CUTOFF CURRENT VS. AMBIENT TEMPERATURE



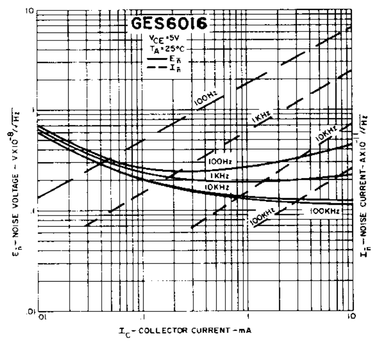
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



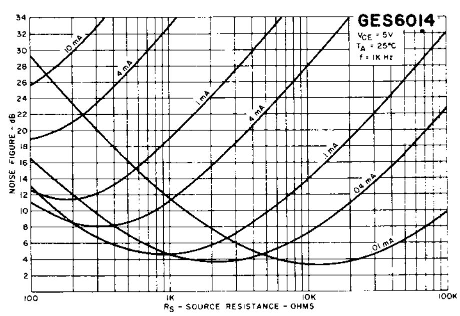
NOISE FIGURE-WIDEBAND VS. SOURCE RESISTANCE



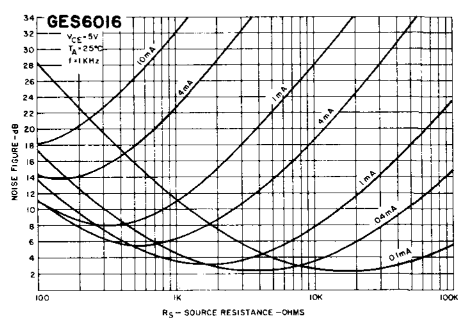
E_n & I_n VS. COLLECTOR CURRENT



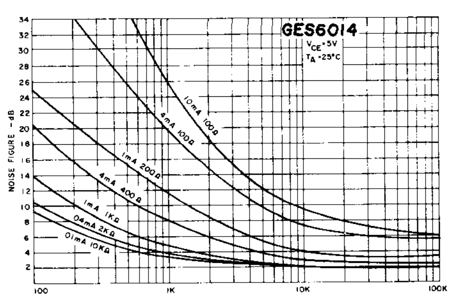
E_n & I_n VS. COLLECTOR CURRENT



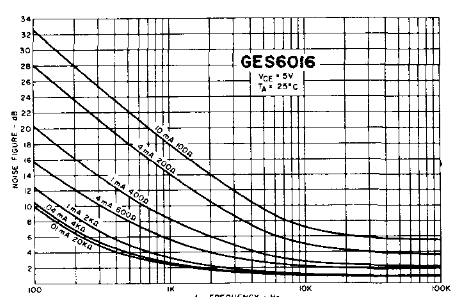
NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. SOURCE RESISTANCE



NOISE FIGURE VS. FREQUENCY

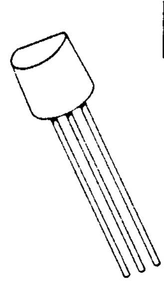


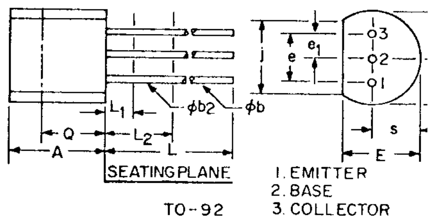
NOISE FIGURE VS. FREQUENCY

Silicon
Signal Transistor

GES6218,19
GES6220,21

The General Electric GES6218, GES6219, GES6220 and GES6221 are NPN Epoxy Encapsulated Transistors. The device is intended primarily for use in television, nixie-neon tube and other general high voltage applications.





TO-92

SYMBOL	MILLIMETERS		INCHES		NO
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	
ϕb2	.407	.482	.016	.019	
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1
L_1	—	1.270	—	.050	
L2	6.350	—	.250	—	
Q	2.920	—	.115	—	
s	2.030	2.670	.080	.105	

NOTES:
1. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb AP BETWEEN L_2 & .5"(12.70MM) FROM REFERENCE PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND .5"(12.70 FROM REFERENCE PLANE.
2. MOUNTING HOLE IS FOR #4 SCREW. HOLE WILL ACCEP .113" (2.87MM) DIAMETER PIN INSERTED PERPENDICUL TO THE MOUNTING SURFACE.

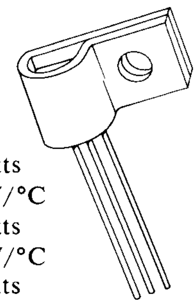
FEATURES:

- Epoxy encapsulation with proved reliability.
- Performance comparable to hermetic units — excellent characteristics stability under environmental stresses — 85°C-85% relative humidity.
- 500 mW power dissipation.
- Excellent beta linearity over extremely wide current ranges.
- 300 V BV_{CEO} ratings available.
- Integral heat sinks available — up to 625 mW power dissipation.

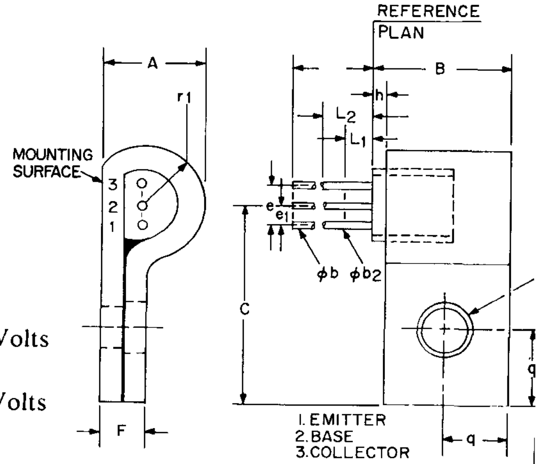
absolute maximum ratings: (25°C unless otherwise specified)

		GES6218	GES6219	GES6220	GES6221	
Voltages						
Collector to emitter	V_{CEO}	300	250	200	150	Volts
Emitter to base	V_{EBO}	5	5	5	5	Volts
Collector to base	V_{CBO}	300	250	200	150	Volts
Current						
Collector	I_c	50	50	50	50	mA
Dissipation						
Total Power $T_A \leq 25°C$	P_T	.500	.500	.500	.500	Watts
Derating Factor $T_A > 25°C$		4	4	4	4	mW/°C
Total Power $T_A \leq 25°C$*	P_T	.625	.625	.625	.625	Watts
Derating Factor $T_A > 25°C$*		5	5	5	5	mW/°C
Total Power $T_C \leq 25°C$*	P_T	1.0	1.0	1.0	1.0	Watts
Derating Factor $T_C > 25°C$*		8	8	8	8	mW/°C
Temperature						
Storage	T_{stg}	-65 to +150				°C
Operating	T_j	-65 to +150				°C
Lead (1/16" ±1/32" from case for 10 sec.)	T_L	+260				°C

*Heatsink



SYMBOL	MILLIMETERS		INCHES		NOT
	MIN.	MAX.	MIN.	MAX.	
A	—	6.680	—	.263	
B	—	10.160	—	.400	
ϕb	.407	.533	.016	.021	1
ϕb2	.407	.482	.016	.019	1
C	—	13.200	—	.520	
e	2.420	2.660	.095	.105	
e1	1.150	1.395	.045	.055	
F	—	3.550	—	.140	
h	1.570 REF.		.062 REF.		
L	12.700	—	.500	—	1
L_1	—	1.270	—	.050	1
L2	6.350	—	.250	—	1
ϕp	—	3.630	—	.145	2
q	3.960 REF.		.156 REF.		
q1	2.210 REF.		.187 REF.		
r1	—	3.960	—	.156	



TO-92

electrical characteristics: (25°C unless otherwise specified)

		GES6218	GES6219	GES6220	GES6221	
		Min.	Min.	Min.	Min.	
STATIC CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C= 1mA, I_B=0)	$V_{(BR)CEO}$*	300	250	200	150	Volts
Emitter-Base Breakdown Voltage (I_E=100uA, I_C=0)	$V_{(BR)EBO}$	5	5	5	5	Volts

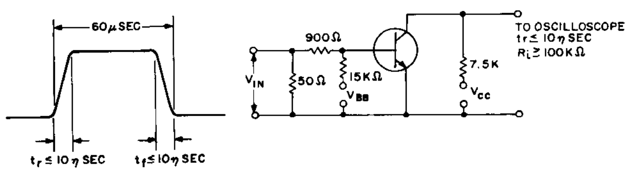
STATIC CHARACTERISTICS CONT'D.

	Symbol	GES6218 Min.	GES6218 Max.	GES6219 Min.	GES6219 Max.	GES6220 Min.	GES6220 Max.	GES6221 Min.	GES6221 Max.	
Collector-Base Breakdown Voltage ($I_C = 100uA$, $I_E = 0$)	$V_{(BR)CBO}$	300		250		200		150		Volts
Collector Cutoff Current										
($V_{CB} = 250V$, $I_E = 0$)	I_{CBO}		0.50							uA
($V_{CB} = 200V$, $I_E = 0$)	I_{CBO}				1.0					uA
($V_{CB} = 150V$, $I_E = 0$)	I_{CBO}						1.0			uA
($V_{CB} = 100V$, $I_E = 0$)	I_{CBO}								10	uA
Forward Current Transfer Ratio										
($V_{CE} = 10V$, $I_C = 2mA$)	h_{FE}	10		10		10		10		
($V_{CE} = 10V$, $I_C = 20mA$)	h_{FE}†	20		20		20		20		
Base-Emitter Voltage										
($V_{CE} = 10V$, $I_C = 20mA$)	V_{BE}	0.55	0.75	0.55	0.75	0.55	0.75	0.55	0.75	Volts
Collector-Emitter Saturation Voltage										
($I_C = 10mA$, $I_B = 1mA$)	$V_{CE(sat)}$†	0.3	1.0							Volts
($I_C = 10mA$, $I_B = 1mA$)	$V_{CE(sat)}$†			0.3	1.0					Volts
($I_C = 20mA$, $I_B = 2mA$)	$V_{CE(sat)}$†					0.3	2.0			Volts
($I_C = 20mA$, $I_B = 2mA$)	$V_{CE(sat)}$†							0.3	2.3	Volts
Base-Emitter Saturation Voltage										
($I_C = 10mA$, $I_B = 1mA$)	$V_{BE(sat)}$†	0.60	0.75							Volts
($I_C = 10mA$, $I_B = 1mA$)	$V_{BE(sat)}$†			0.60	0.75					Volts
($I_C = 20mA$, $I_B = 2mA$)	$V_{BE(sat)}$†					0.65	0.86			Volts
($I_C = 20mA$, $I_B = 2mA$)	$V_{BE(sat)}$†							0.65	0.85	Volts

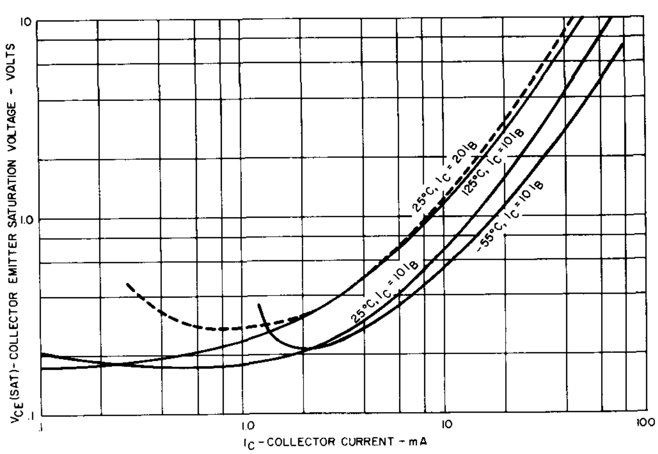
DYNAMIC CHARACTERISTICS ($T_A = 25°C$ unless otherwise specified)

	Symbol	Min.	Max.	
Forward Current Transfer Ratio ($V_{CE} = 10V$, $I_C = 20mA$, f=1KHz)	h_{fe}	20	300	
Collector Base Capacitance ($V_{CB} = 10V$, $I_E = 0$, f=1MHz)	C_{cb}		5	pF
Emitter Base Capacitance ($V_{EB} = 0.5V$, $I_C = 0$, f=1MHz)	C_{eb}		70	pF
Magnitude of Forward Current Transfer Ratio ($V_{CE} = 10V$, $I_C = 10mA$, f=20MHz)	h_{fe}	8		dB
Gain Bandwidth Product ($I_C = 10mA$, $V_{CE} = 10V$, f=20MHz)	f_T	50		MHz
Turn On Time (See Figure 1) ($V_{CC} = 150V$, $V_{BB} = 30V$, $V_{IN} = 5V$. $I_C = 20mA$, $I_{B1} = I_{B2} = 2.75mA$)	t_{ON}		0.5	usec.
Turn Off Time (See Figure 1) ($V_{CC} = 150V$, $V_{BB} = 30V$, $V_{IN} = 5V$, $I_C = 20mA$, $I_{B1} = I_{B2} = 2.75mA$)	t_{OFF}		5.0	usec.

†Pulse Width ⩽ 300 μs, Duty Cycle ⩽ 2%.

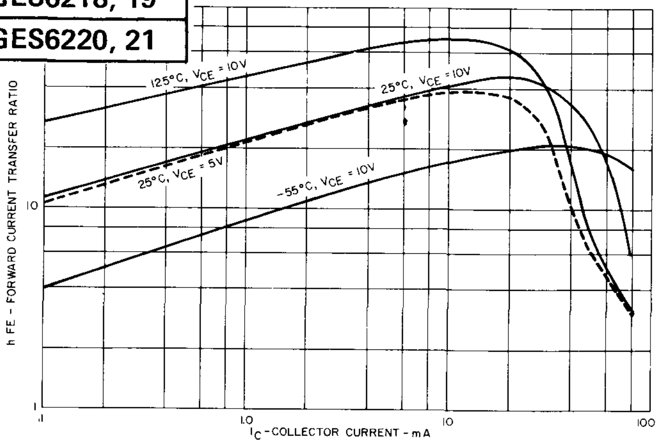


SWITCHING-ON AND OFF TIME EQUIVALENT CIRCUIT

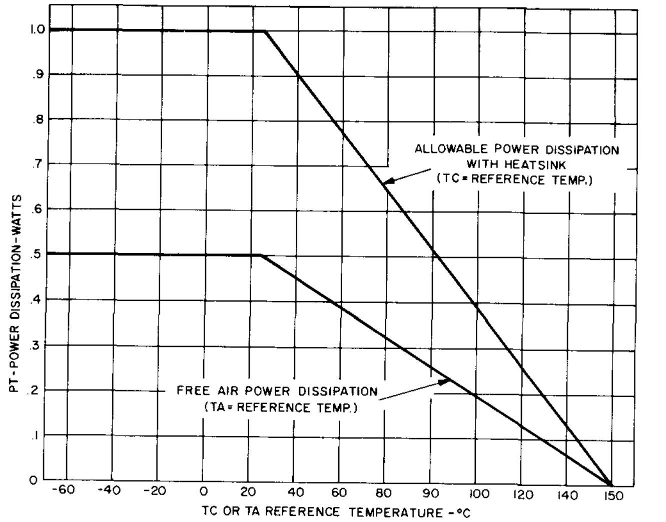


COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

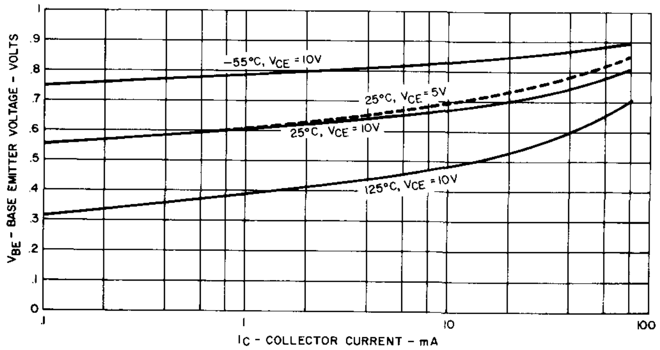
GES6218, 19
GES6220, 21



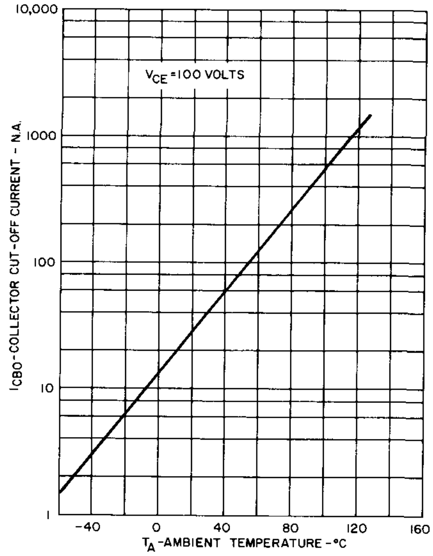
FORWARD CURRENT TRANSFER VS. COLLECTOR CURRENT



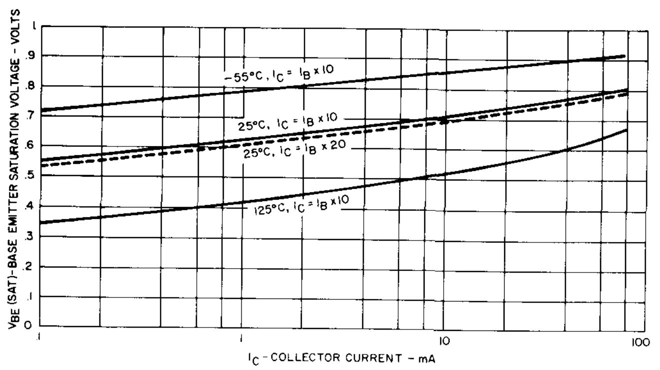
MAXIMUM PERMISSIBLE DC POWER DISSIPATION



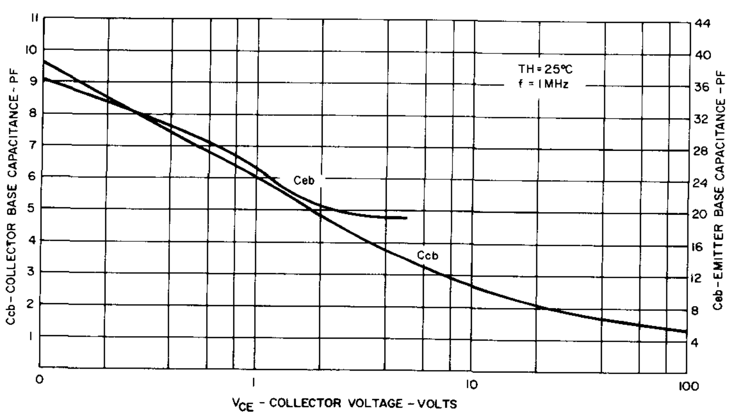
BASE-EMITTER VOLTAGE VS. COLLECTOR CURRENT



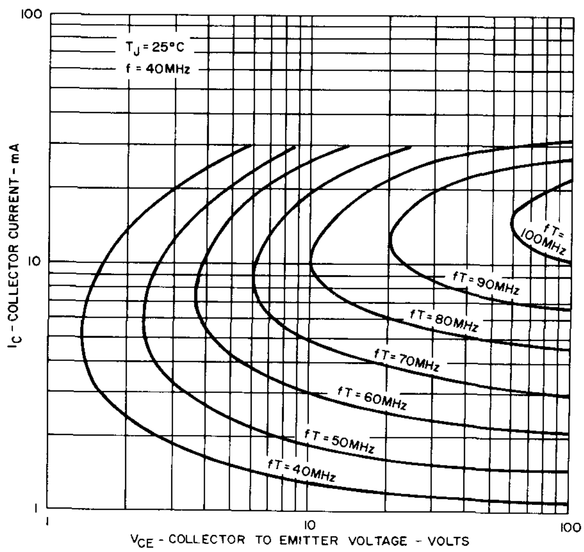
COLLECTOR CUT-OFF CURRENT VS. TEMPERATURE



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



COLLECTOR-BASE CAPACITANCE AND EMITTER-BASE CAPACITANCE VS. REVERSE VOLTAGE



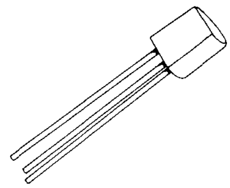
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT

GET Series See GES____ Equivalent

NPN

GES6222
GES6224

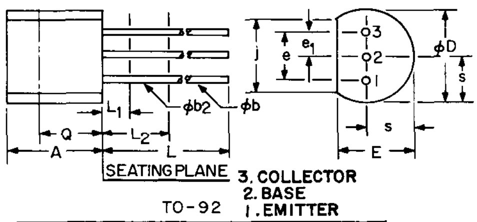
Silicon
Signal Transistors



These Silicon Planar Passivated Epitaxial Transistors are intended to satisfy a broad range of general purpose signal level applications at audio and intermediate frequencies.

FEATURES:

- Excellent gain linearity – particularly designed for operation in the 10 μA to 20 mA range.
- Low collector saturation voltage.
- 60 volt $V_{BR(CEO)}$ rating.
- Epoxy encapsulation with proven reliability – excellent characteristic stability under environmental stresses – 85°C – 85% RH.
- Low capacitance.



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L_1	–	1.270	–	.050	3
L_2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

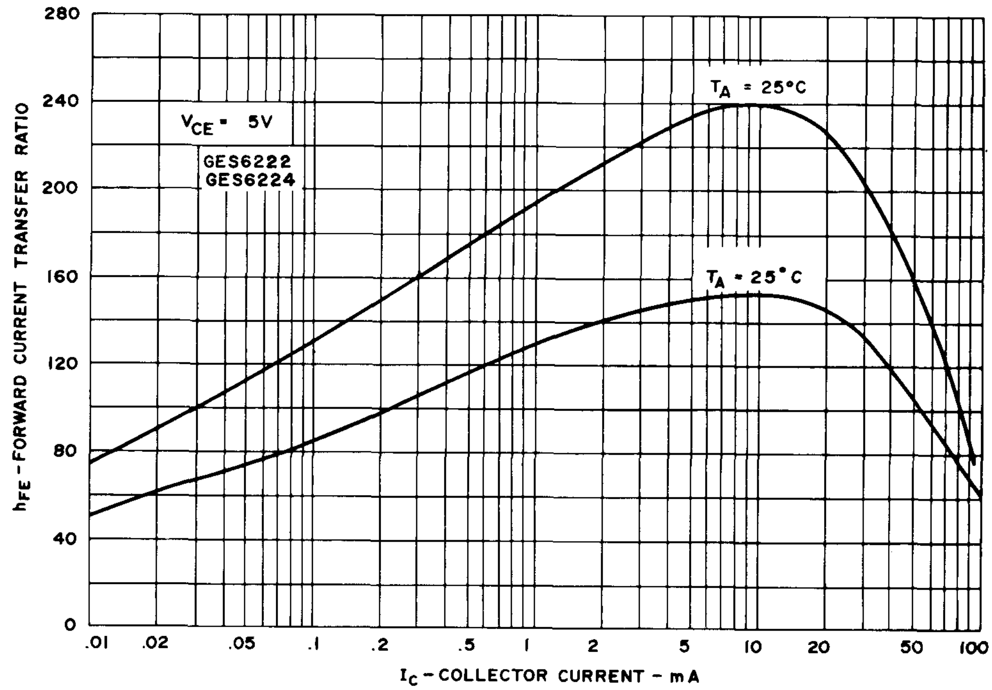
absolute maximum ratings: (T_A = 25°C unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	60	Volts
Collector to Base	V_{CBO}	60	Volts
Emitter to Base	V_{EBO}	5	Volts
Current			
Collector (Continuous)	I_C	100	mA
Dissipation			
Total Power $T_A \leq 25$°C	P_T	360	mW
Derating Factor $T_A > 25$°C	P_T	2.88	mW/°C
Temperature			
Storage	T	-65 to +150	°C
Operating	T	-65 to +150	°C
Lead Soldering (1/16" ± 1/32" from case for 10 sec max.)	T	+260	°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

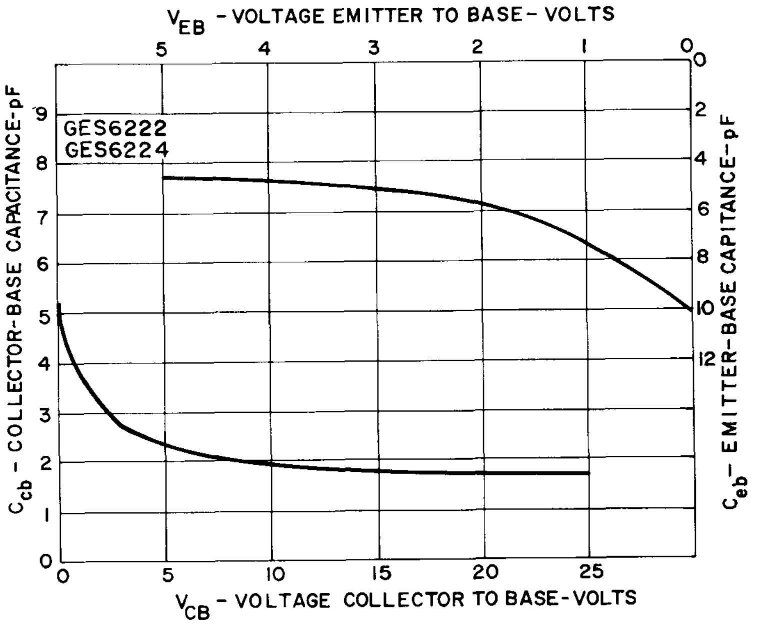
Static Characteristics			SYMBOL	MIN.	MAX.	UNITS
Collector Base Leadage Current (V_{CB} = 60V, I_E = 0)			I_{CBO}	–	50	nA
Emitter Base Leadage Current (V_{EB} = 5V, I_C = 0)			I_{EBO}	–	50	nA
Forward Current Transfer Ratio (I_C = 10 μA, V_{CE} = 5V)	–	GES6222	h_{FE}	20	–	
	–	GES6224	h_{FE}	40	–	
(I_C = 2 mA, V_{CE} = 5V)	–	GES6222	h_{FE}	75	200	
	–	GES6224	h_{FE}	150	300	
(I_C = 100 mA, V_{CE} = 5V)	–	GES6222	h_{FE}	20	–	
	–	GES6224	h_{FE}	40	–	
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)			$V_{(BR)CEO}$	60	–	Volts
Collector-Base Breakdown Voltage. (I_C = 100 μA, I_E = 0)			$V_{(BR)CBO}$	60	–	Volts

Static Characteristics (continued)		SYMBOL	MIN.	MAX.	UNITS
Emitter-Base Breakdown Voltage (I_C = 100 μA, I_C = 0)		$V_{(BR)EBO}$	5	–	Volts
Base-Emitter Voltage (I_C = 2 mA, V_{CE} = 5V)		$V_{BE(on)}$	0.5	0.9	Volts
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	– GES6222, GES6224	$V_{CE(sat)}$	0.020	0.125	Volts
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	– GES6222, GES6224	$V_{BE(sat)}$	–	.78	Volts
Dynamic Characteristics					
Forward Current Transfer Ratio (I_C = 2 mA, V_{CE} = 5V, f = 1 kHz)	– GES6222	h_{fe}	75	300	
	– GES6224	h_{fe}	150	400	
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 1 MHz)		C_{cb}	–	4	pF

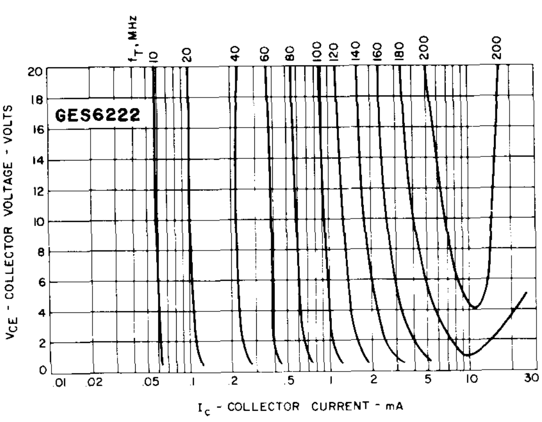


FORWARD CURRENT TRANSFER
RATIO VS. COLLECTOR CURRENT

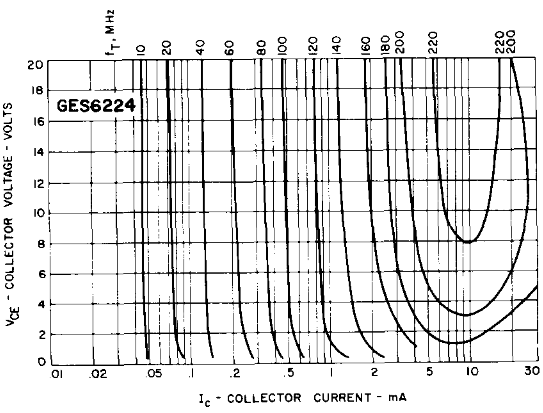
TYPICAL ELECTRICAL CHARACTERISTICS



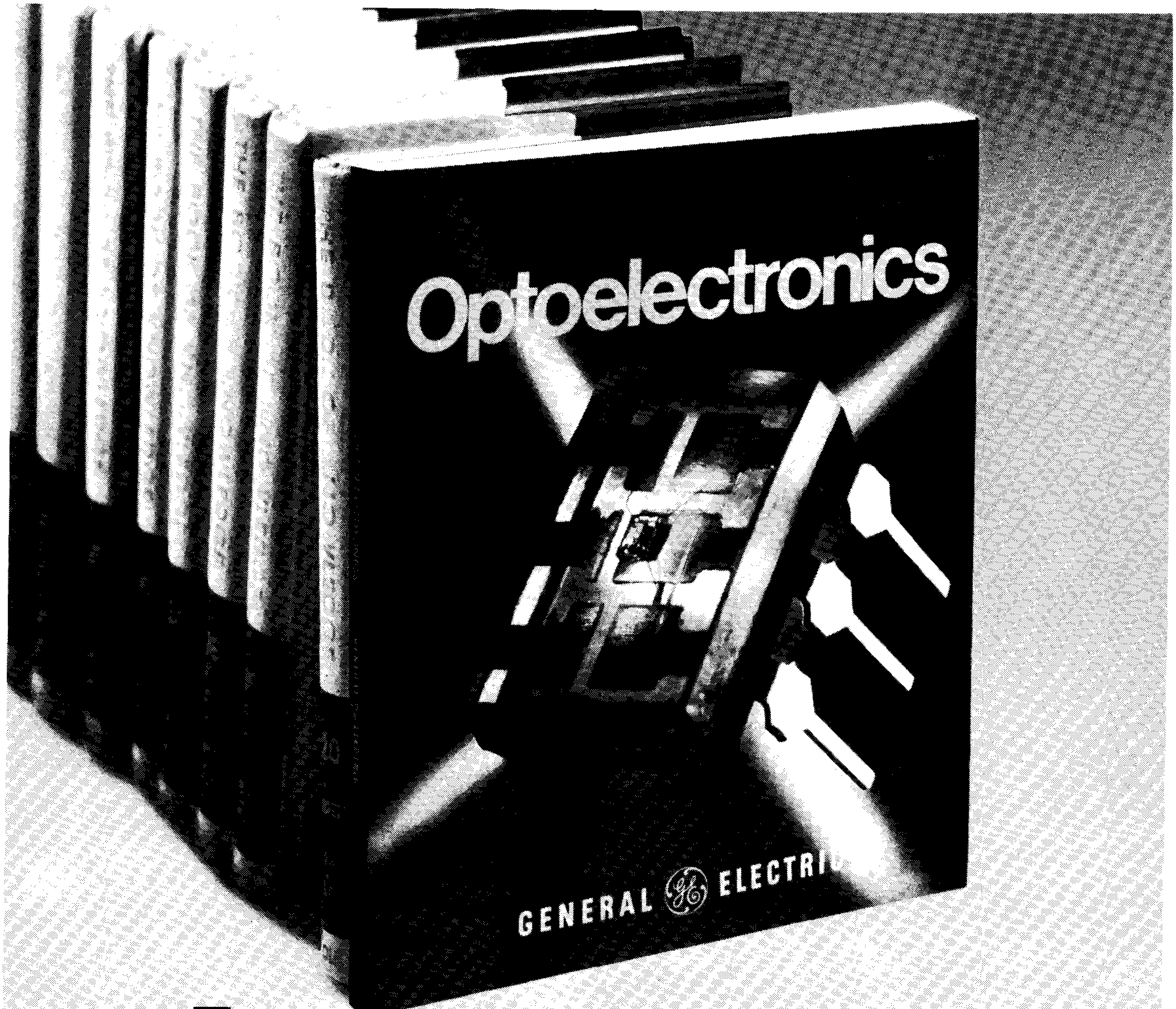
CAPACITANCE VS. VOLTAGE



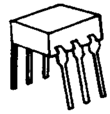
GES6222



GES6224

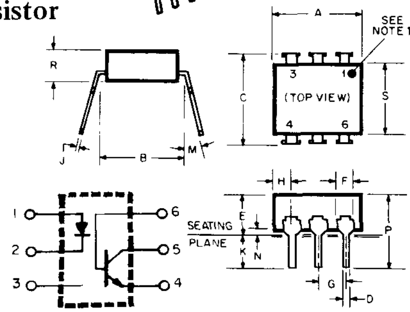

Optoelectronics
GENERAL

Photon Coupled Isolator H11A1-H11A2



Ga As Infrared Emitting Diode & NPN Silicon Photo-Transistor

The General Electric H11A1 and H11A2 are gallium arsenide infrared emitting diodes coupled with a silicon photo-transistor in a dual in-line package.



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF.	7.62	REF.	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C)

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak) (Pulse width 1 μsec 300 P Ps)	3	ampere
Reverse Voltage	3	volts

*Derate 1.33mW/°C above 25°C ambient

PHOTO-TRANSISTOR		
Power Dissipation	**150	milliwatts
V_{CEO}	30	volts
V_{CBO}	70	volts
V_{ECO}	7	volts
Collector Current (Continuous)	100	milliamps

**Derate 2.0mW/°C above 25°C ambient

TOTAL DEVICE

Storage Temperature -55 to 150°C
Operating Temperature -55 to 100°C
Lead Soldering Time (at 260°C) 10 seconds
Surge Isolation Voltage (Input to Output).

H11A1	$2500V_{(peak)}$	$1770V_{(RMS)}$
H11A2	$1500V_{(peak)}$	$1060V_{(RMS)}$

Steady-State Isolation Voltage (Input to Output).

H11A1	$1500V_{(peak)}$	$1060V_{(RMS)}$
H11A2	$950V_{(peak)}$	$660V_{(RMS)}$

individual electrical characteristics (25°C)

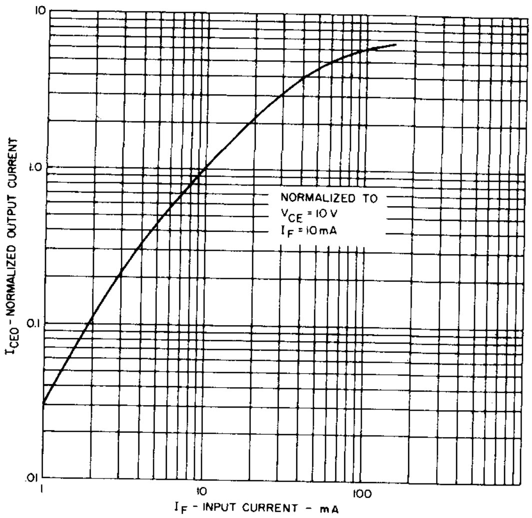
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10 mA)	1.1	1.5	volts
Reverse Current (V_R = 3 V)	–	10	microamps
Capacitance (V = O,f = 1 MHz)	50	–	picofarads

PHOTO-TRANSISTOR	MIN.	TYP.	MAX.	UNITS
Breakdown Voltage–$V_{(BR)CEO}$ (I_C = 10mA, I_F = O)	30	–	–	volts
Breakdown Voltage–$V_{(BR)CBO}$ (I_C = 100μA, I_F = O)	70	–	–	volts
Breakdown Voltage–$V_{(BR)ECO}$ (I_E = 100μA, I_F = O)	7	–	–	volts
Collector Dark Current–I_{CEO} (V_{CE} = 10V, I_F = O)	–	5	50	nanoamps
Capacitance (V_{CE} = 10V,f = 1MHz)	–	2	–	picofarads

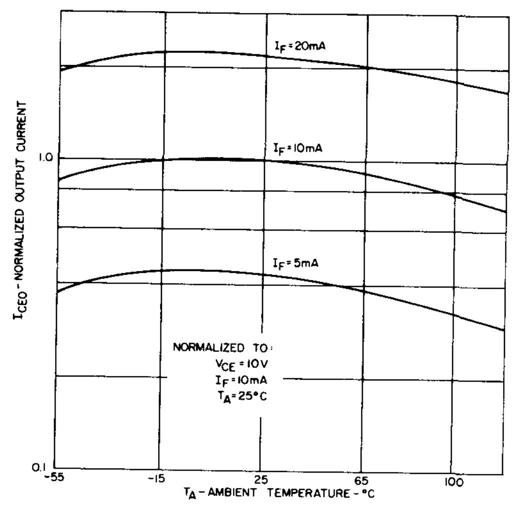
coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V)	H11A1	50	–	–	%
	H11A2	20	–	–	%
Saturation Voltage – Collector to Emitter (I_F = 10mA, I_C = 0.5mA)		–	0.1	0.4	volts
Isolation Resistance (Input to Output Voltage = $500V_{DC}$)		100	–	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = O,f = 1MHz)		–	–	2	picofarads
Switching Speeds:					
Rise/Fall Time (V_{CE} = 10V, I_{CE} = 2mA, R_L = 100Ω)		–	2	–	microseconds
Rise/Fall Time (V_{CB} = 10V, I_{CB} = 50μA, R_L = 100Ω)		–	300	–	nanoseconds

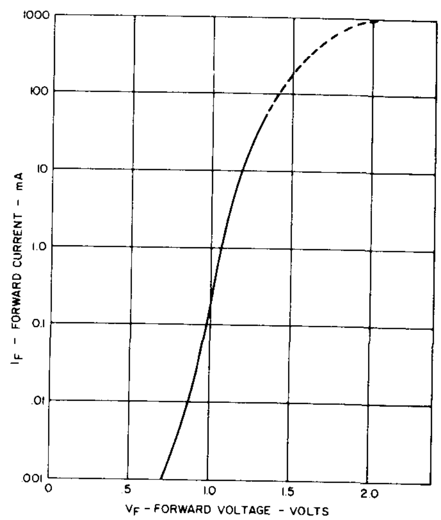
TYPICAL CHARACTERISTICS



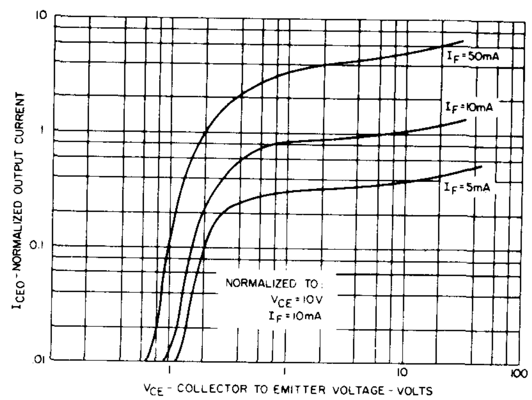
OUTPUT CURRENT VS INPUT CURRENT



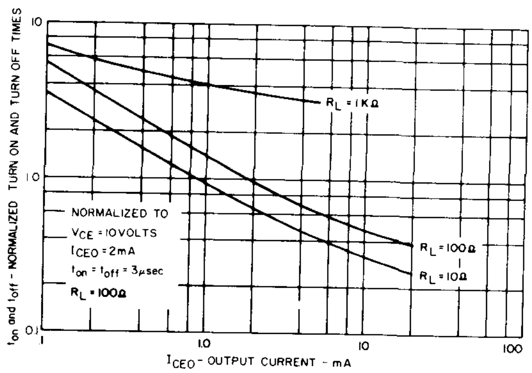
OUTPUT CURRENT VS TEMPERATURE



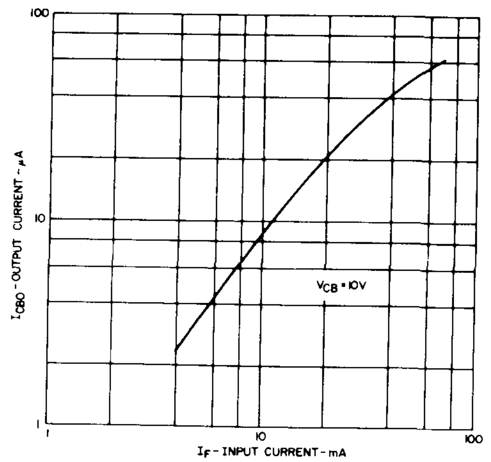
INPUT CHARACTERISTICS



OUTPUT CHARACTERISTICS

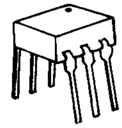


SWITCHING TIMES VS OUTPUT CURRENT



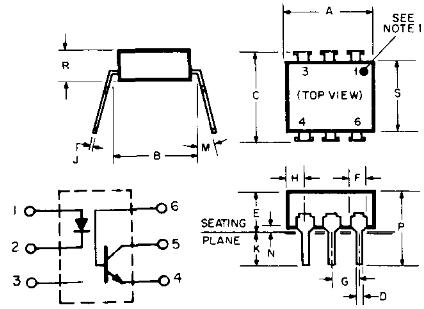
OUTPUT CURRENT (I_{CBO}) VS INPUT CURRENT

Photon Coupled Isolator H11A3 - H11A4



Ga As Infrared Emitting Diode & NPN Silicon Photo-Transistor

The General Electric H11A3 and H11A4 are gallium arsenide, infrared emitting diodes coupled with a silicon photo-transistor in a dual in-line package.



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF.	7.62	REF.	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C)

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak)	3	ampere
(Pulse width 1μsec 300 P Ps)		
Reverse Voltage	3	volts

*Derate 1.33mW/°C above 25°C ambient.

PHOTO-TRANSISTOR		
Power Dissipation	**150	milliwatts
V_{CEO}	30	volts
V_{CBO}	70	volts
V_{ECO}	7	volts
Collector Current (Continuous)	100	milliamps

**Derate 2.0mW/°C above 25°C ambient.

TOTAL DEVICE

Storage Temperature -55 to 150°C
Operating Temperature -55 to 100°C
Lead Soldering Time (at 260°C) 10 seconds
Surge Isolation Voltage (Input to Output).

H11A3	$2500V_{(peak)}$	$1770V_{(RMS)}$
H11A4	$1500V_{(peak)}$	$1060V_{(RMS)}$

Steady-State Isolation Voltage (Input to Output).

H11A3	$1500V_{(peak)}$	$1060V_{(RMS)}$
H11A4	$950V_{(peak)}$	$660V_{(RMS)}$

individual electrical characteristics (25°C)

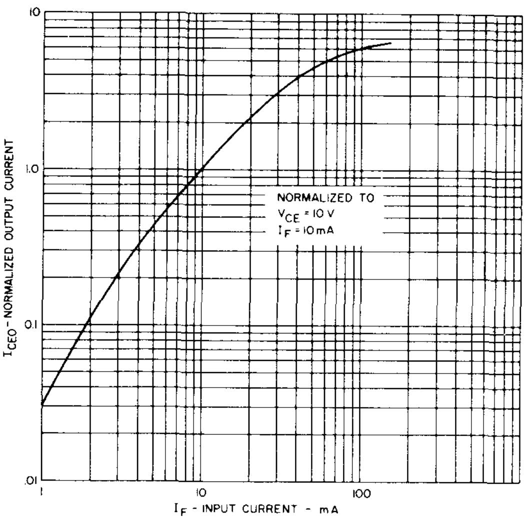
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	1.1	1.5	volts
Reverse Current (V_R = 3V)	–	10	microamps
Capacitance (V = 0, f = 1MHz)	50	–	picofarads

PHOTO-TRANSISTOR	MIN.	TYP.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 10mA, I_F = 0)	30	–	–	volts
Breakdown Voltage – $V_{(BR)CBO}$ (I_C = 100μA, I_F = 0)	70	–	–	volts
Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100μA, I_F = 0)	7	–	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = 0)	–	5	50	nanoamps
Capacitance (V_{CE} = 10V, f = 1MHz)	–	2	–	picofarads

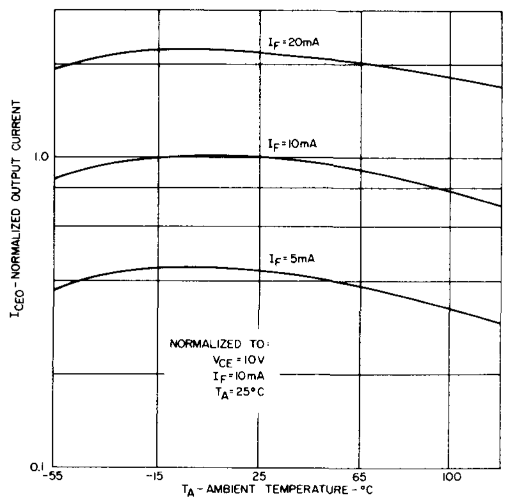
coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V)	H11A3	20	–	–	%
	H11A4	10	–	–	%
Saturation Voltage — Collector to Emitter (I_F = 10mA, I_C = 0.5mA)		–	0.1	0.4	volts
Isolation Resistance (Input to Output Voltage = $500V_{DC}$)		100	–	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = 0, f = 1MHz)		–	–	2	picofarads
Switching Speeds: Rise/Fall Time (V_{CE} = 10V, I_{CE} = 2mA, R_L = 100Ω)		–	2	–	microseconds
Rise/Fall Time (V_{CB} = 10V, I_{CB} = 50μA, R_L = 100Ω)		–	300	–	nanoseconds

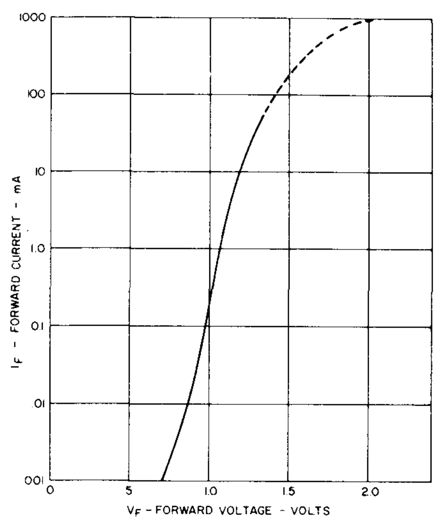
TYPICAL CHARACTERISTICS



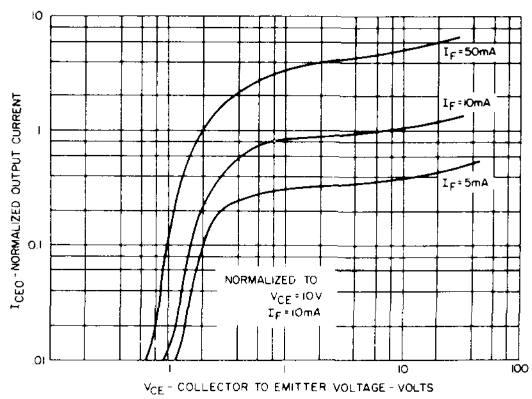
OUTPUT CURRENT VS INPUT CURRENT



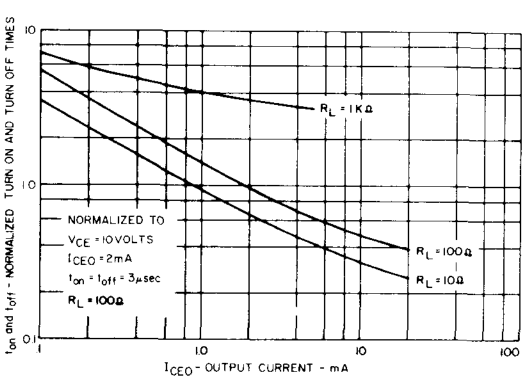
OUTPUT CURRENT VS TEMPERATURE



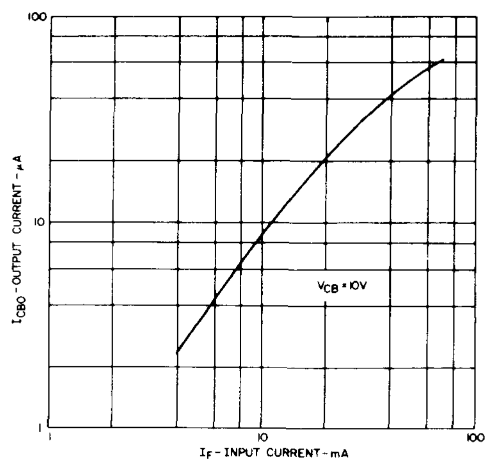
INPUT CHARACTERISTICS



OUTPUT CHARACTERISTICS



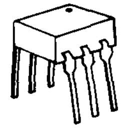
SWITCHING TIMES VS OUTPUT CURRENT



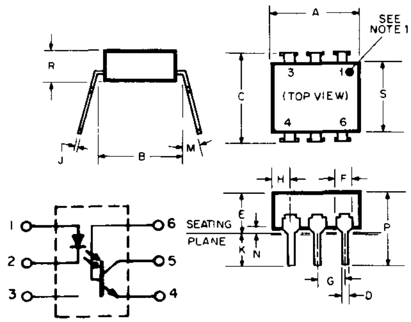
OUTPUT CURRENT (I_{CBO}) VS INPUT CURRENT

Photon Coupled Isolator H11A5

Ga As Infrared Emitting Diode & NPN Silicon Photo-Transistor



The General Electric H11A5 is a gallium arsenide, infrared emitting diode coupled with a silicon photo-transistor in a dual in-line package.



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF.	7.62	REF.	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:

1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C)

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak)	3	ampere
(Pulse width 1μsec 300 P Ps)		
Reverse Voltage	3	volts

*Derate 1.33mW/°C above 25°C ambient.

PHOTO-TRANSISTOR		
Power Dissipation	**150	milliwatts
V_{CEO}	30	volts
V_{CBO}	70	volts
V_{ECO}	7	volts
Collector Current (Continuous)	100	milliamps

**Derate 2.0mW/°C above 25°C ambient.

TOTAL DEVICE

Storage Temperature -55 to 150°C
Operating Temperature -55 to 100°C
Lead Soldering Time (at 260°C) 10 seconds
Surge Isolation Voltage (Input to Output).
1500$V_{(peak)}$ 1060$V_{(RMS)}$
Steady-State Isolation Voltage (Input to Output).
950$V_{(peak)}$ 660$V_{(RMS)}$

individual electrical characteristics (25°C)

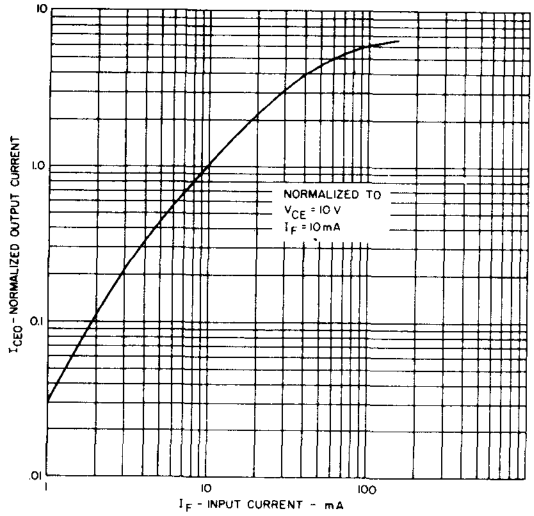
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	1.1	1.7	volts
Reverse Current (V_R = 3V)	–	10	microamps
Capacitance (V = O,f = 1MHz)	50	–	picofarads

PHOTO-TRANSISTOR	MIN.	TYP.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 10mA, I_F = O)	30	–	–	volts
Breakdown Voltage – $V_{(BR)CBO}$ (I_C = 100μA, I_F = O)	70	–	–	volts
Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100μA, I_F = O)	7	–	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = O)	–	5	100	nanoamps
Capacitance (V_{CE} = 10V,f = 1MHz)	–	2	–	picofarads

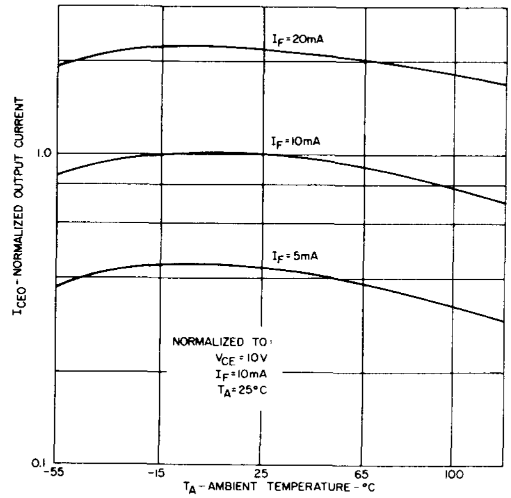
coupled electrical characteristics (25°C)

	MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ration (I_F = 10mA, V_{CE} = 10V)	30	–	–	%
Saturation Voltage – Collector to Emitter (I_F = 10mA, I_C = 0.5mA)	–	0.1	0.4	volts
Isolation Resistance (Input to Output Voltage = 500V_{DC})	100	–	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = O,f = 1MHz)	–	–	2	picofarads
Switching Speeds: Rise/Fall Time (V_{CE} = 10V, I_{CE} = 2mA, R_L = 100Ω)	–	2	–	microseconds
Rise/Fall Time (V_{CB} = 10V, I_{CB} = 50μA, R_L = 100Ω)	–	300	–	nanoseconds

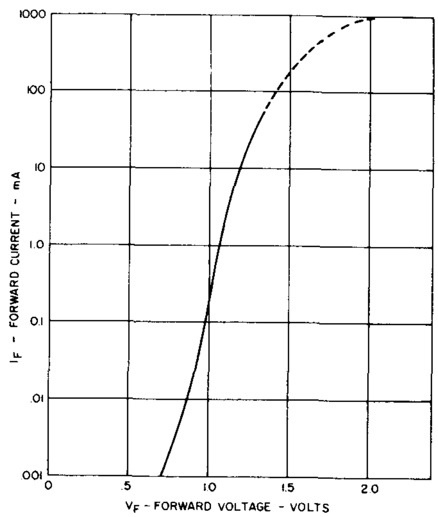
TYPICAL CHARACTERISTICS



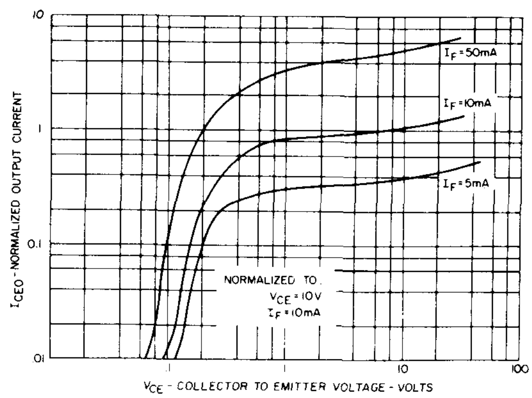
OUTPUT CURRENT VS INPUT CURRENT



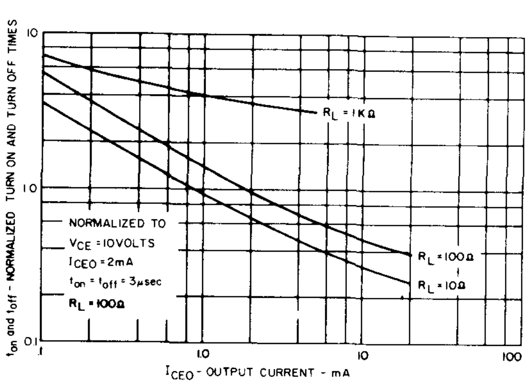
OUTPUT CURRENT VS TEMPERATURE



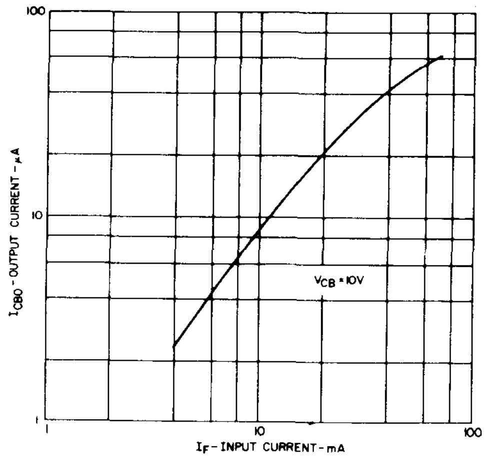
INPUT CHARACTERISTICS



OUTPUT CHARACTERISTICS



SWITCHING TIMES VS OUTPUT CURRENT

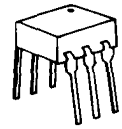


OUTPUT CURRENT (I_{CBO}) VS INPUT CURRENT

PHOTON COUPLED CURRENT THRESHOLD SWITCH H11A10

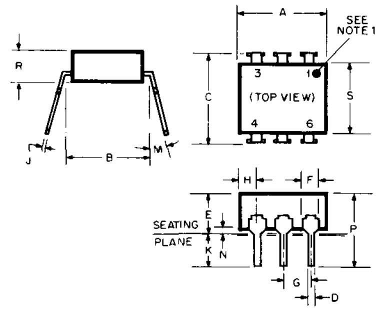
Ga As Infrared Emitting Diode & NPN Silicon Photo-Transistor

The General Electric H11A10 is a gallium arsenide infrared emitting diode coupled with a silicon photo transistor in a dual in-line package. It is characterized and specified with two resistors, one on the input and one on the output. This configuration provides a circuit which will detect a doubling of the input current level by registering more than a twenty to one difference in the output current over a wide temperature range.



FEATURES:

- Programmable Threshold - "off" to "on" with a 2/1 change in input current
- Glass Dielectric Isolation
- Fast Switching Speeds
- Operation over wide temperature range
- High Noise Immunity
- Covered under U.L. Component Recognition Program, reference file E51868



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF.	7.62	REF.	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C) (unless otherwise specified)

INFRARED EMITTING DIODE

Power Dissipation	$T_A = 25°C$	*100	milliwatts
Power Dissipation	$T_C = 25°C$	*100	milliwatts
Forward Current (Continuous)		50	milliamps
Forward Current (Peak) (Pulse width 1 μsec, 300 pps)		3	ampere
Reverse Voltage		6	volts

*Derate 1.33mW/°C above 25°C

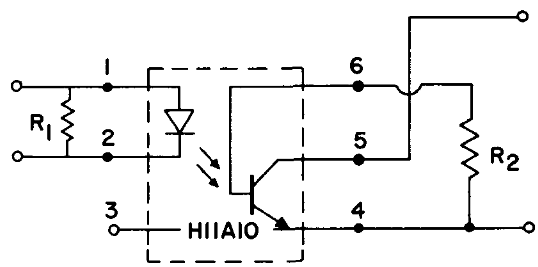
PHOTO-TRANSISTOR

Power Dissipation	$T_A = 25°C$	**300	milliwatts
Power Dissipation	$T_C = 25°C$	***500	milliwatts
(T_C indicates collector lead temperature 1/32" from case)			
V_{CEO}		30	volts
V_{CBO}		70	volts
V_{EBO}		7	volts
Collector Current (Continuous)		100	milliamps

**Derate 4.0mW/°C above 25°C
***Derate 6.7mW/°C above 25°C

TOTAL DEVICE

Storage Temperature -55 to 150°C
Operating Temperature -55 to 100°C
Lead Soldering Time (at 260°C) 10 seconds
Input to Output Isolation Voltage 1500V(peak)
Surge Isolation (Input to Output)
1500V(peak) 1060V(RMS)
Steady-State Isolation Voltage (Input to Output)
950V(peak) 660V(RMS)



THRESHOLD SWITCH BIAS CIRCUIT ILLUSTRATION

individual electrical characteristics (25°C) (unless otherwise specified)

INFRARED EMITTING DIODE	SYMBOL	MIN.	MAX.	UNITS	PHOTO-TRANSISTOR	SYMBOL	MIN.	TYP.	MAX.	UNITS
Forward Voltage (I_F=10mA)	V_F		1.5	volts	Breakdown Voltage (I_C=10mA, I_F=0)	$V_{(BR)CEO}$	30	–	–	volts
Reverse Current (V_R=6V)	I_R	–	10	microamps	Breakdown Voltage (I_C=100μA, I_F=0)	$V_{(BR)CBO}$	70	–	–	volts
Capacitance (V=0, f=1 MHz)	C_J		100	picofarads	Breakdown Voltage (I_E=100μA, I_F=0)	$V_{(BR)EBO}$	7	–	–	volts

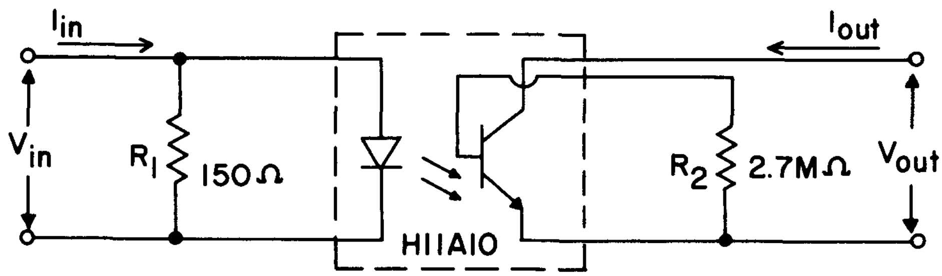


FIGURE 1

THRESHOLD CIRCUIT CHARACTERISTICS - BIAS PER FIGURE 1
(-55°C to 100°C Unless Otherwise Specified)

SYMBOL	PARAMETER/CONDITIONS	MIN.	TYP.	MAX.	UNITS
I_{out}	Output Current (V_{out}=10V, $I_{in} \leq$ 5mA, T_A=25°C)		1	50	nanoamperes
I_{out}	Output Current (V_{out}=10V, $I_{in} \leq$ 5mA, T_A=100°C)		1	50	microamperes
I_{out}/I_{in}	D.C. Current Transfer Ratio (V_{out}=10V, $I_{in} \geq$ 10mA)	10	30		percent
V_{out}	Output Saturation Voltage (I_{in}=10mA, I_{out}=0.5mA)		0.2	0.4	volts
R_{io}	Input to Output Resistance (V_{io}=500V) Note 1	100			gigaohms
t_{on}	Turn-On Time (Vcc = 10V, I_{in}=20 mA, R_L=100Ω) Figure 2		5		microseconds
t_{off}	Turn-Off Time (Vcc = 10V, I_{in}=20mA, R_L=100Ω) Figure 2		5		microseconds

Note 1: Tests of input to output isolation current resistance, and capacitance are performed with the input terminals (diode) shorted together and the output terminals (transistor) shorted together

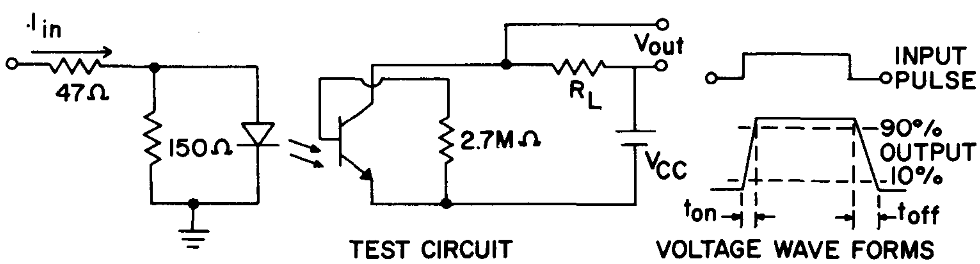
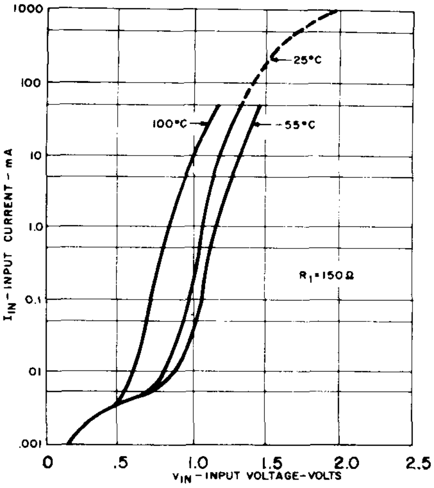
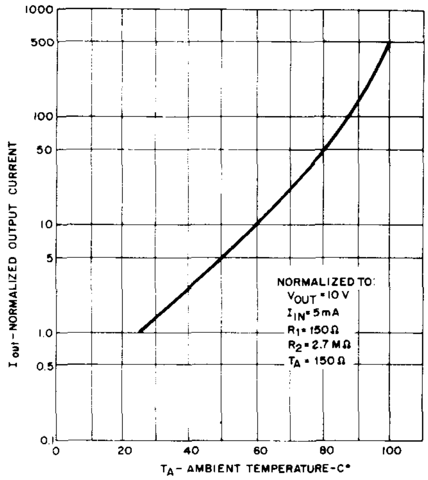


FIGURE 2

TYPICAL CHARACTERISTICS BIASED PER FIGURE 1

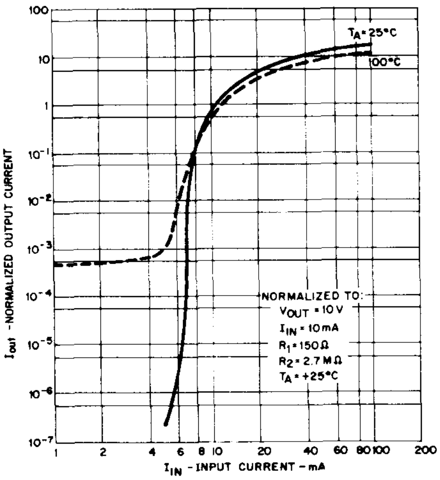


1. INPUT

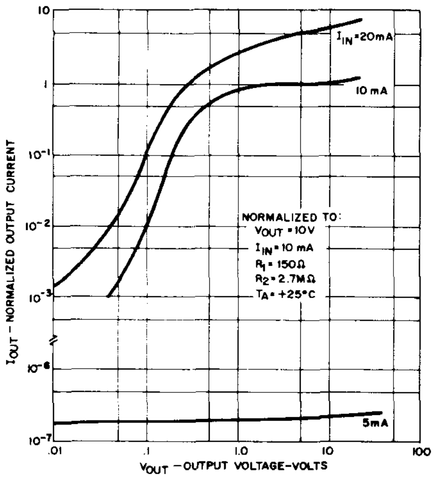


2. LEAKAGE

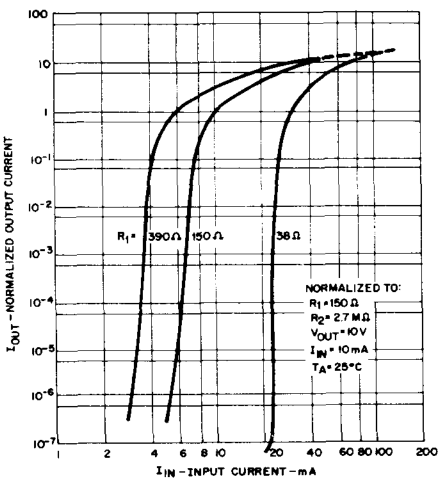
PROGRAMMING AND TRANSFER CHARACTERISTICS



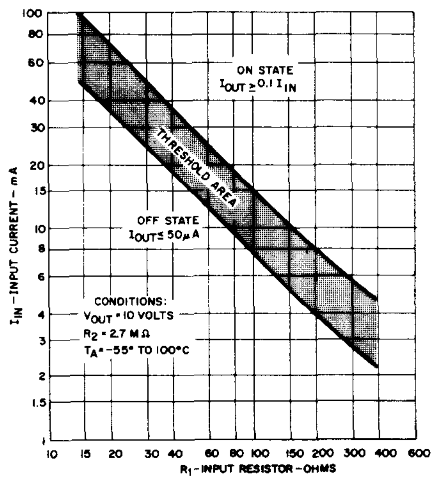
3. TEMPERATURE



4. INPUT CURRENT

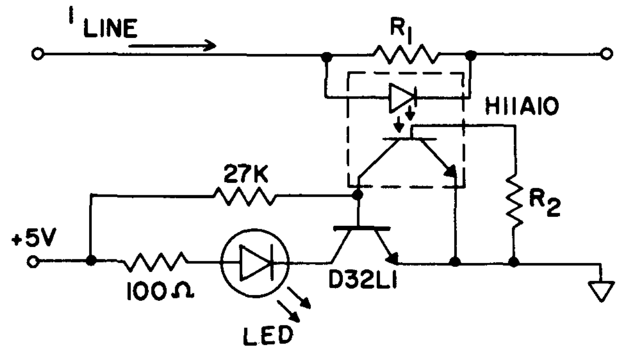


5. THRESHOLDING



6. PROGRAMMING

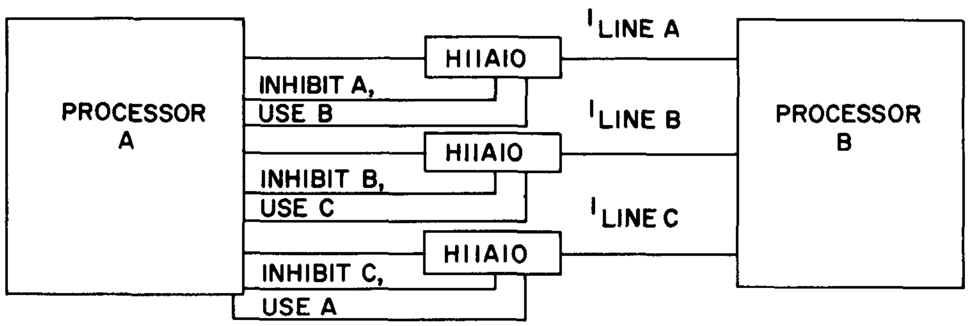
LINE CURRENT MONITORS
LINE DROPOUT ALARM LIGHT

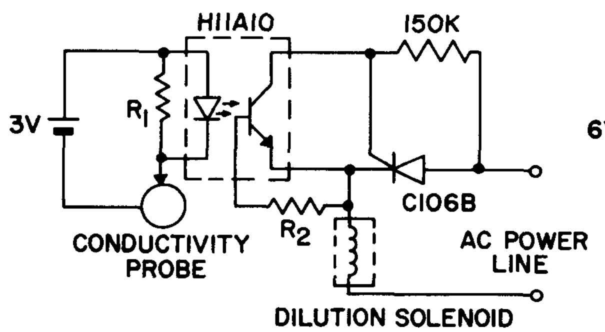


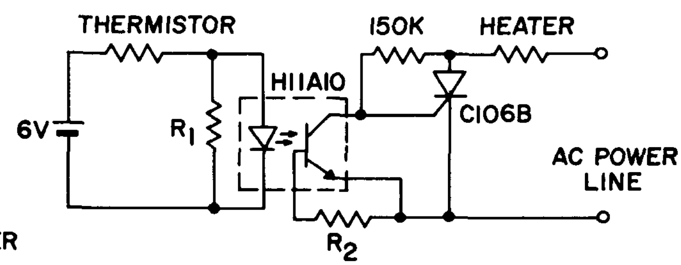
When remote line current (I_{LINE}) falls below the programmed threshold value the LED turns on, indicating loss of power to critical, isolated circuit function. Phase inversion, accomplished by replacing the D32L1 with a D34C1 PNP and interchanging the collector and emitter connections, provides an over-current alarm light.

INFORMATION FLOW DIRECTOR

To minimize lines needed to communicate between A and B, a queue system is set up using H11A10's to monitor line use and set up the queue procedures.





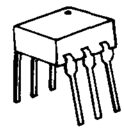


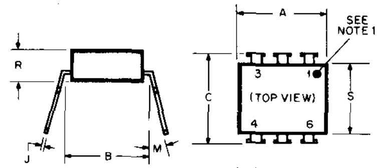
In many process control applications such as solution mixing, resistor trimming, light control and temperature control, it is advantageous to monitor conductivity with isolated low voltages and transmit this information to a power control or logic system. Low voltages are often preferred for safety, convenience or self heating considerations or to prevent ground loops and provide noise immunity. Until the advent of the H11A10 such systems were complex and costly. Using the H11A10 allows the use of simple low power circuits such as illustrated here to provide these functions. In battery operated systems, the low current thresholds of the H11A10 can considerably enhance battery life.

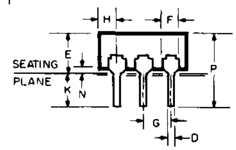
Photon Coupled Isolator H11A520-H11A550-H11A5100

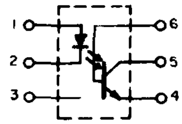
Ga As Infrared Emitting Diode & NPN Silicon Photo-Transistor

The General Electric H11A520, H11A550 and H11A5100 consist of a gallium arsenide, infrared emitting diode coupled with a silicon photo-transistor in a dual in-line package.









FEATURES:

- High isolation voltage, 5000V minimum.
- General Electric unique patented glass isolation construction.
- High efficiency liquid epitaxial IRED.
- High humidiy resistant silicone encapsulation.
- Fast switching speeds.

SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF.	7.62	REF.	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C) (unless otherwise specified)

INFRARED EMITTING DIODE		
Power Dissipation – T_A = 25°C	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak) (Pulse width 1 μsec, 300 pps)	3	amperes
Reverse Voltage	6	volts

*Derate 1.33mW/°C above 25°C.

PHOTO-TRANSISTOR		
Power Dissipation – T_A = 25°C	**300	milliwatts
V_{CEO}	30	volts
V_{CBO}	70	volts
V_{EBO}	7	volts
Collector Current (Continuous)	100	milliamps

**Derate 4.0mW/°C above 25°C.

TOTAL DEVICE

Storage Temperature -55 to 150°C.
Operating Temperature -55 to 100°C.
Lead Soldering Time (at 260°C) 10 seconds.
Surge Isolation Voltage (Input to Output). See Note 2.
5656$V_{(peak)}$ 4000$V_{(RMS)}$
Steady-State Isolation Voltage (Input to Output). See Note 2.
5000$V_{(DC)}$ 3000$V_{(RMS)}$

individual electrical characteristics (25°C) (unless otherwise specified)

INFRARED EMITTING DIODE	MIN.	MAX.	UNITS
Forward Voltage – V_F (I_F = 10mA)	.8	1.5	volts
Forward Voltage – V_F (I_F = 10mA) T_A = -55°C	.9	1.7	volts
Forward Voltage – V_F (I_F = 10mA) T_A = +100°C	.7	1.4	volts
Reverse Current – I_R (V_R = 6V)	–	10	microamps
Capacitance – C_J (V = 0, f = 1 MHz)	–	100	picofarads

PHOTO-TRANSISTOR	MIN.	TYP.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 10mA, I_F = 0)	30	–	–	volts
Breakdown Voltage – $V_{(BR)CBO}$ (I_C = 100μA, I_F = 0)	70	–	–	volts
Breakdown Voltage – $V_{(BR)EBO}$ (I_E = 100μA, I_F = 0)	7	–	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = 0)	–	5	50	nano-amps
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = 0) T_A = 100°C	–	–	500	micro-amps
Capacitance – C_{CE} (V_{CE} = 10V, f = 1MHz)	–	2	–	pico-farads

coupled electrical characteristics (25°C) (unless otherwise specified)

		MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V)	H11A5100	100	–	–	%
	H11A550	50	–	–	%
	H11A520	20	–	–	%
Saturation Voltage – Collector to Emitter (I_F = 20mA, I_C = 2mA)		–	–	0.4	volts
Isolation Resistance (Input to Output Voltage = $500V_{DC}$. See Note 1)		100	–	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = 0, f = 1 MHz. See Note 1)		–	–	2.0	picofarads
Turn-On Time – t_{on} (V_{CC} = 10V, I_C = 2mA, R_L = 100Ω). (See Figure 1)		–	5	10	microseconds
Turn-Off Time – t_{off} (V_{CC} = 10V, I_C = 2mA, R_L = 100Ω). (See Figure 1)		–	5	10	microseconds

NOTE 1:

Tests of input to output isolation current resistance, and capacitance are performed with the input terminals (diode) shorted together and the output terminals (transistor) shorted together.

NOTE 2:

Surge Isolation Voltage

a. *Definition:*
This rating is used to protect against transient over-voltages generated from switching and lightning-induced surges. Devices shall be capable of withstanding this stress, a minimum of 100 times during its useful life. Ratings shall apply over entire device operating temperature range.

b. *Specification Format:*
Specification, in terms of peak and/or RMS, 60 Hz voltage, of specified duration (e.g., $5656V_{peak}/4000V_{RMS}$ for one second).

c. *Test Conditions:*
Application of full rated 60 Hz sinusoidal voltage for one second, with initial application restricted to zero voltage (i.e., zero phase), from a supply capable of sourcing 5mA at rated voltage.

Steady-State Isolation Voltage

a. *Definition:*
This rating is used to protect against a steady-state voltage which will appear across the device isolation from an electrical source during its useful life. Ratings shall apply over the entire device operating temperature range and shall be verified by a 1000 hour life test.

b. *Specification Format:*
Specified in terms of D.C. and/or RMS 60 Hz sinusoidal waveform.

c. *Test Conditions:*
Application of the full rated 60 Hz sinusoidal voltage, with initial application restricted to zero voltage (i.e., zero phase), from a supply capable of sourcing 5mA at rated voltage, for the duration of the test.

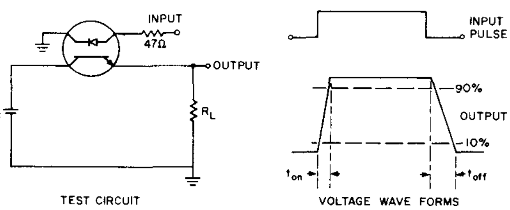
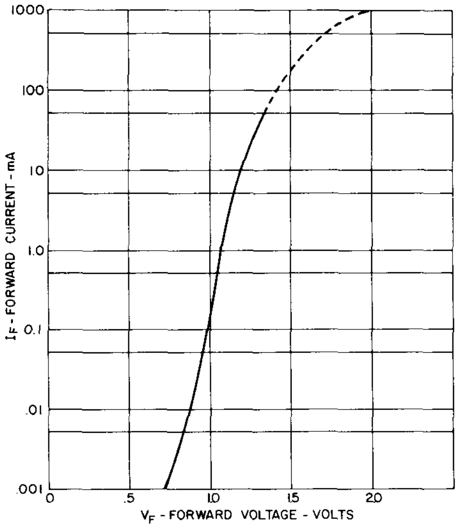
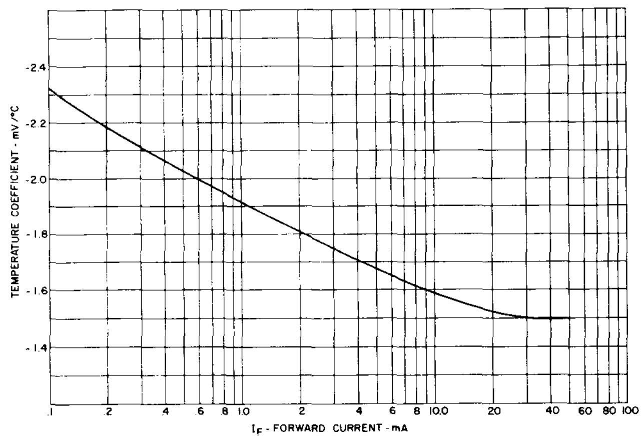


FIGURE 1: Adjust Amplitude of Input Pulse for Output (I_C) of 2mA

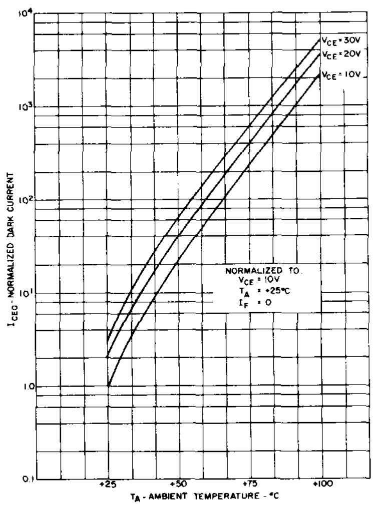
TYPICAL CHARACTERISTICS



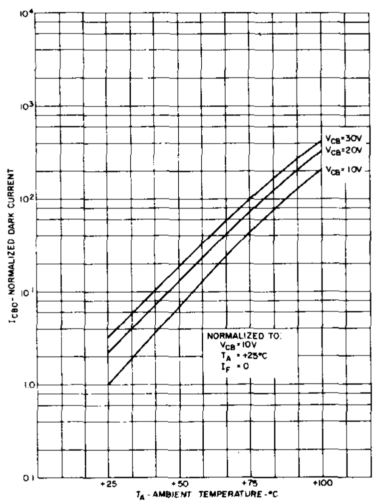
1. INPUT CHARACTERISTICS



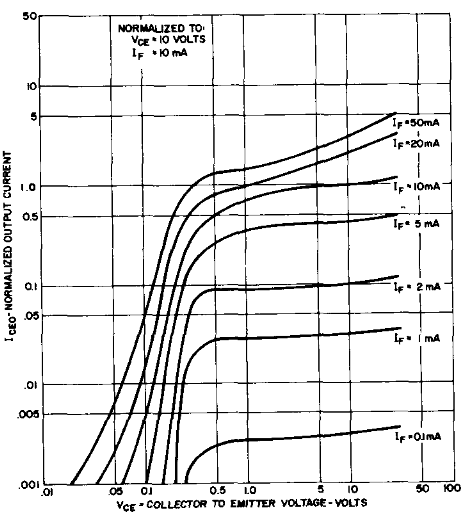
2. FORWARD CURRENT TEMPERATURE COEFFICIENT



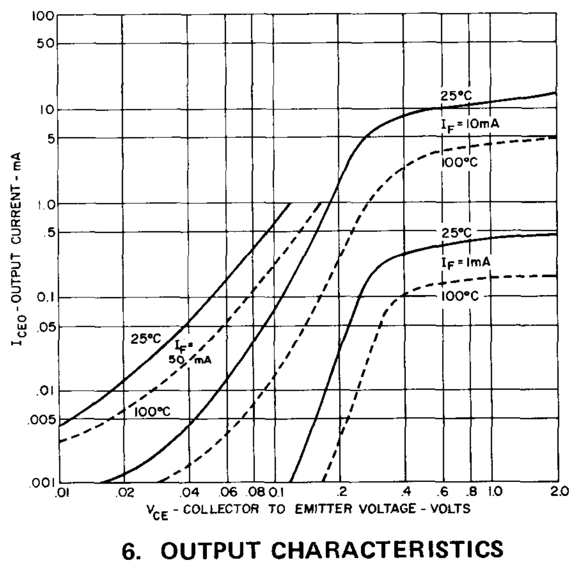
3. DARK I_{CEO} CURRENT VS. TEMPERATURE



4. I_{CBO} VS. TEMPERATURE

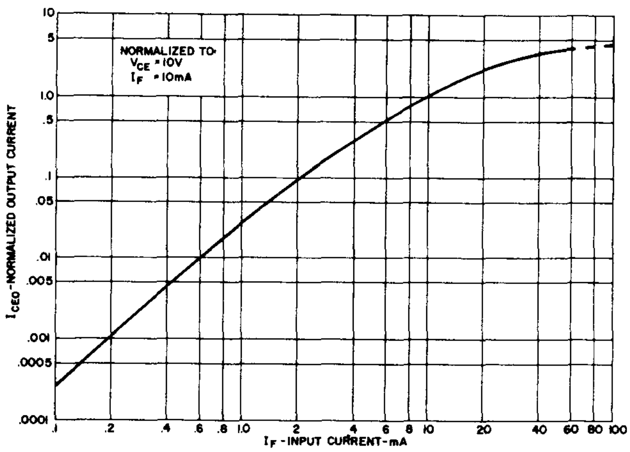


5. OUTPUT CHARACTERISTICS

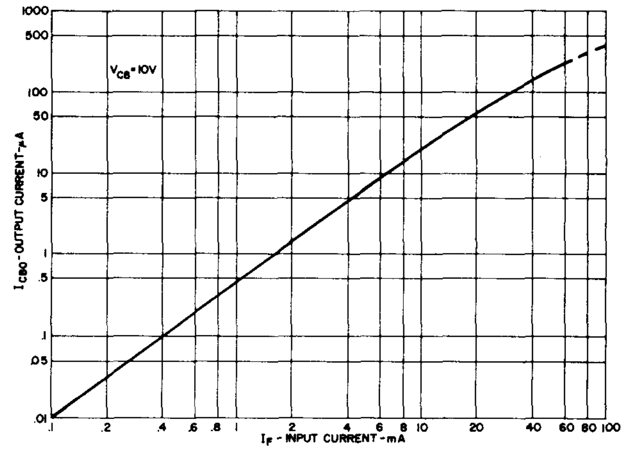


6. OUTPUT CHARACTERISTICS

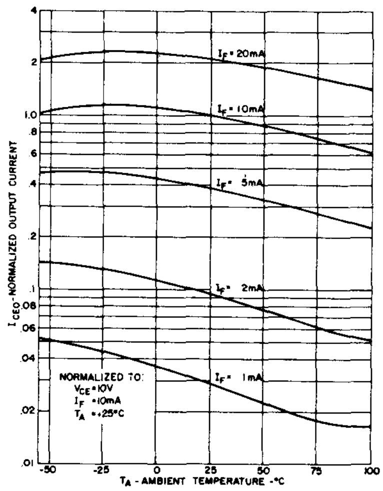
TYPICAL CHARACTERISTICS



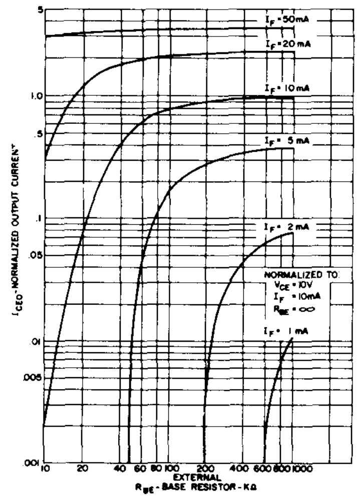
7. OUTPUT CURRENT VS. INPUT CURRENT



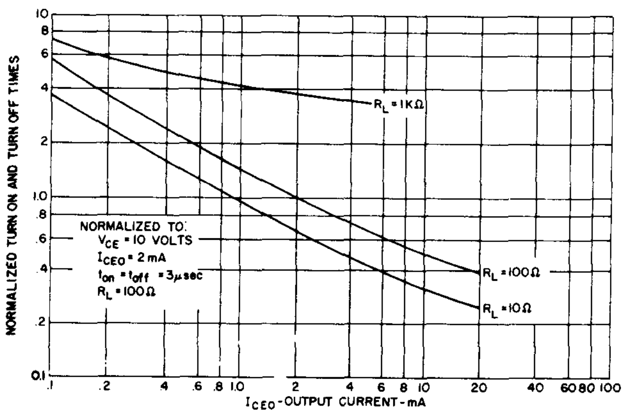
8. OUTPUT CURRENT – COLLECTOR-TO-BASE VS. INPUT CURRENT



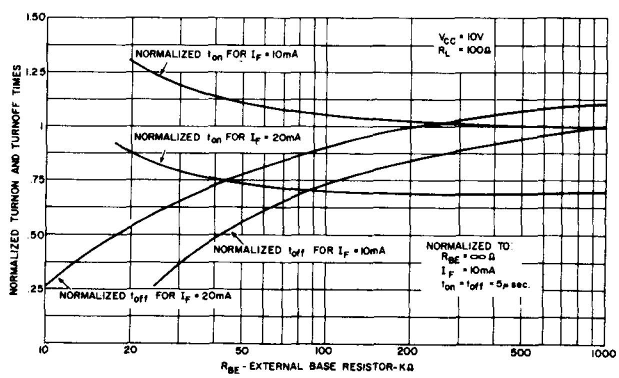
9. OUTPUT CURRENT VS. TEMPERATURE



10. OUTPUT CURRENT VS. BASE EMITTER RESISTANCE



11. SWITCHING TIMES VS. OUTPUT CURRENT

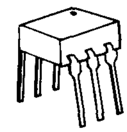


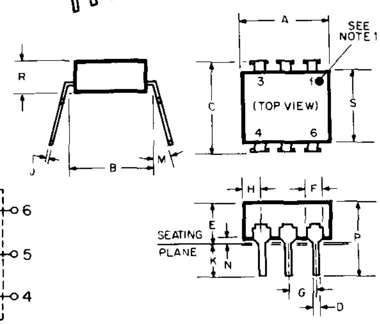
12. SWITCHING TIME VS. R_{BE}

AC INPUT PHOTON COUPLED ISOLATOR H11AA1-H11AA2

Ga As Infrared Emitting Diodes & NPN Silicon Photo-Transistor

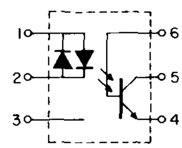
The General Electric H11AA1 and H11AA2 consist of two gallium arsenide infrared emitting diodes connected in inverse parallel and coupled with a silicon photo-transistor in a dual in-line package.





FEATURES:

- AC or polarity insensitive inputs
- Fast switching speeds
- Built-in reverse polarity input protection
- High isolation voltage
- High isolation resistance
- I/O compatible with integrated circuits



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF	7.62	REF	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:

1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C) (unless otherwise specified)

INFRARED EMITTING DIODE

Power Dissipation	$T_A = 25°C$	*100	milliwatts
Power Dissipation	$T_C = 25°C$	*100	milliwatts
(T_C indicates collector lead temperature 1/32" from case)			
Input Current (RMS)		60	milliamps
Input Current (Peak) (Pulse width 1μsec, 300 pps)		± 1	ampere

*Derate 1.33mW/°C above 25°C

PHOTO-TRANSISTOR

Power Dissipation	$T_A = 25°C$	**300	milliwatts
Power Dissipation	$T_C = 25°C$	***500	milliwatts
(T_C indicates collector lead temperature 1/32" from case)			
V_{CEO}		30	volts
V_{CBO}		70	volts
V_{EBO}		5	volts
Collector Current (Continuous)		100	milliamps

**Derate 4.0mW/°C above 25°C
***Derate 6.7mW/°C above 25°C

TOTAL DEVICE

Storage Temperature -55 to 150°C
Operating Temperature -55 to 100°C
Lead Soldering Time (at 260°C) 10 seconds
Surge Isolation Voltage (Input to Output)
1500V(peak) 1060V(RMS)
Steady-State Isolation Voltage (Input to Output)
950V(peak) 660V(RMS)

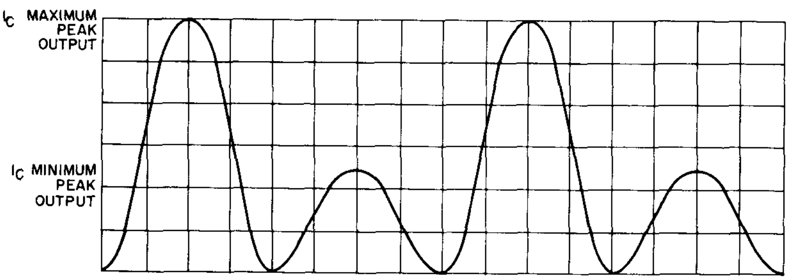
individual electrical characteristics (25°C) (unless otherwise specified)

INFRARED EMITTING DIODE	SYMBOL	MAX.	UNITS	PHOTO-TRANSISTOR	SYMBOL	MIN.	MAX.	UNITS
Input Voltage (I_F = ± 10 mA)	V_F			Breakdown Voltage (I_C = 10mA, I_F = 0)	$V_{(BR)CEO}$	30		volts
H11AA1		1.5	volts					
H11AA2		1.8	volts	Breakdown Voltage (I_C = 100μA, I_F = 0)	$V_{(BR)CBO}$	70		volts
Capacitance (V = 0, F = 1 MHz)	C_J	100	picofarads	Breakdown Voltage (I_E = 100μA, I_F = 0)	$V_{(BR)EBO}$	5		volts
				Collector Dark Current (V_{CE} = 10V, I_F = 0)	I_{CEO}			
				H11AA1			100	nanoamps
				H11AA2			200	nanoamps

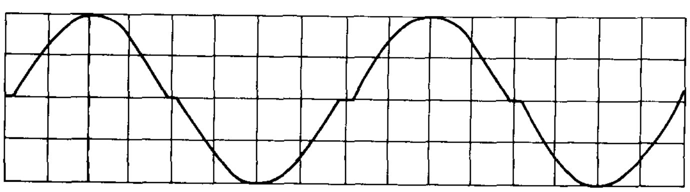
coupled electrical characteristics (25°C) (unless otherwise specified)

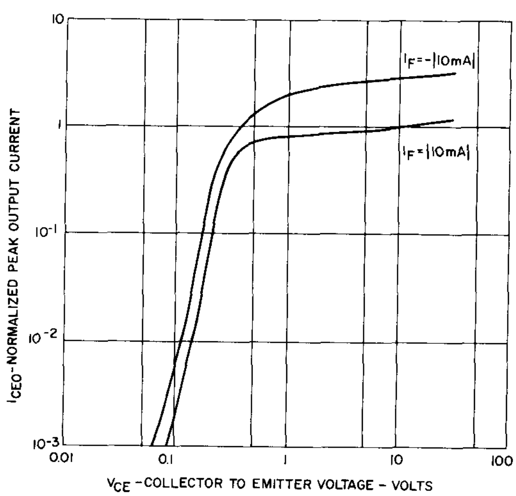
	MIN.	MAX.	UNITS
Current Transfer Ratio (V_{CE} = 10V, I_F = ± 10mA)			
H11AA1	20		percent
H11AA2	10		percent
Saturation Voltage - Collector to Emitter (I_{CEO}=0.5mA, I_F= ±10mA)		0.4	volts
Current Transfer Ratio Symmetry: $\frac{I_{CEO}(V_{CE}=10V, I_F=10mA)}{I_{CEO}(V_{CE}=10V, I_F=-10mA)}$ Note 2			
H11AA1	0.33	3.0	
Isolation Resistance (Input to Output Voltage = $500V_{DC}$. See Note 1)	100		gigaohms

Note 1: Tests of input to output isolation current resistance, and capacitance are performed with the input terminals (diode) shorted together and the output terminals (transistor) shorted together

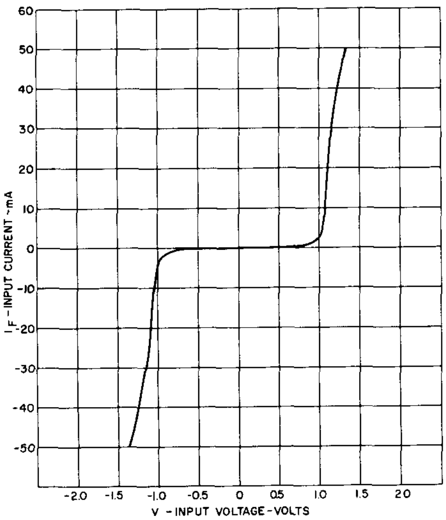


$I_{(CEO)}$ OUTPUT WAVE FORM (SEE NOTE 2) AT V_{CE}=5V

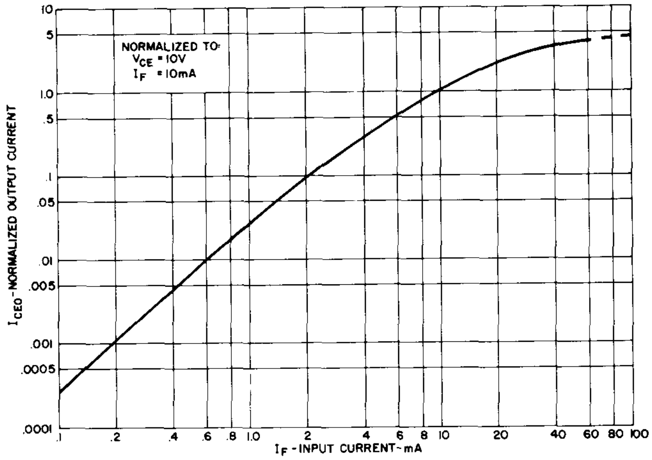

I_F INPUT WAVE FORM



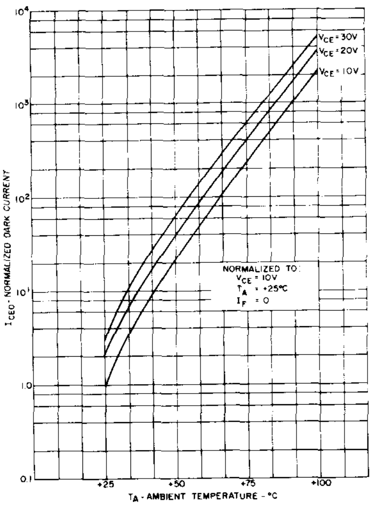
Note 2: The H11AA1 specification guarantees the maximum peak output current will be no more than three times the minimum peak output current at I_F = 10 mA



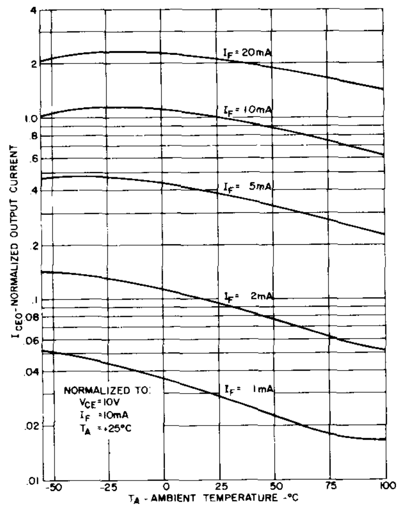
1. INPUT CHARACTERISTICS



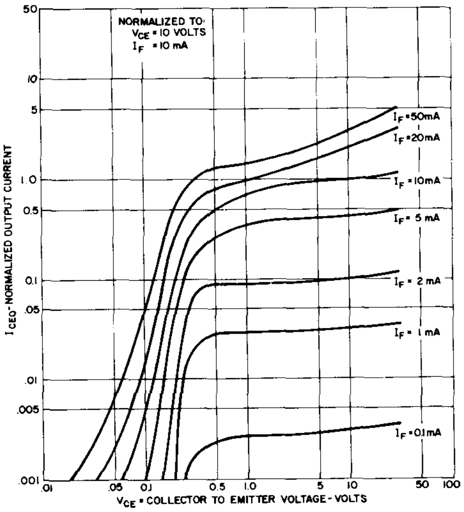
2. OUTPUT CURRENT VS INPUT CURRENT



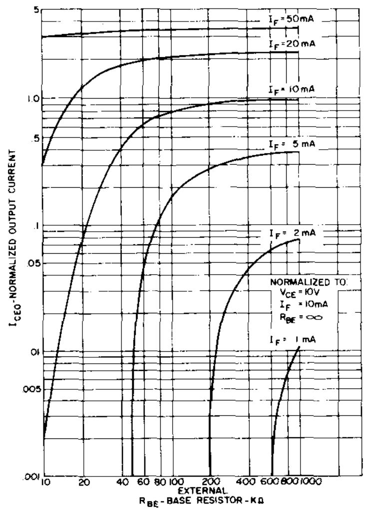
3. DARK I_{CEO} CURRENT VS TEMPERATURE



4. OUTPUT CURRENT VS TEMPERATURE

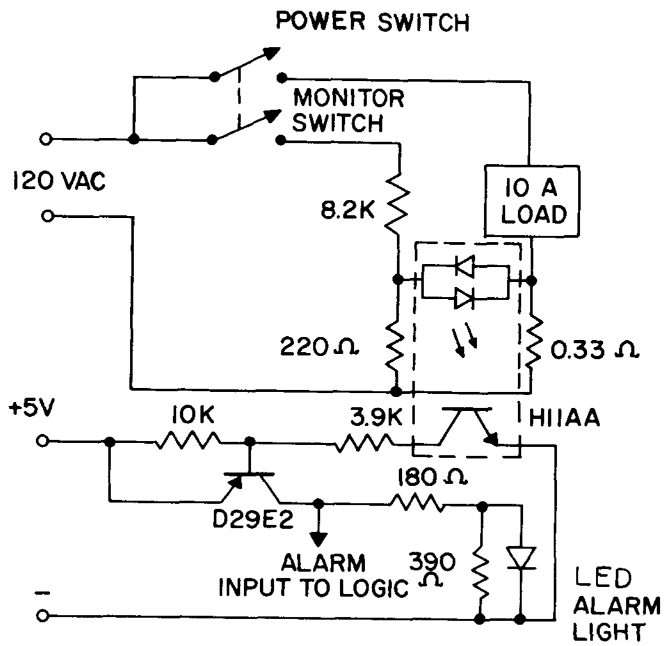


5. OUTPUT CHARACTERISTICS



6. OUTPUT CURRENT VS BASE EMITTER RESISTANCE

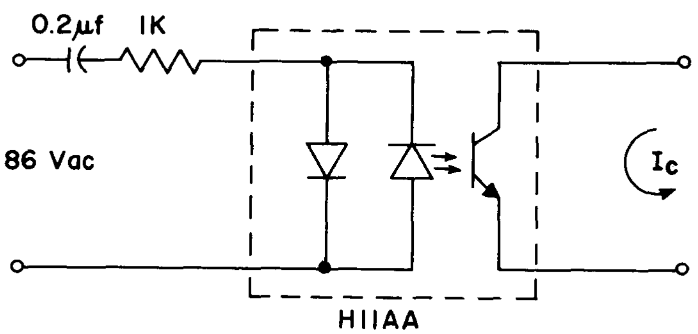
LOAD MONITOR AND ALARM



In many computer controlled systems where AC power is controlled, load dropout due to filament burnout, fusing, etc. or the opposite situation - load power when uncalled for due to switch failure can cause serious systems or safety problems. This circuit provides a simple AC power monitor which lights an alarm lamp and provides a "1" input to the computer control in either of these situations while maintaining complete electrical isolation between the logic and the power system.

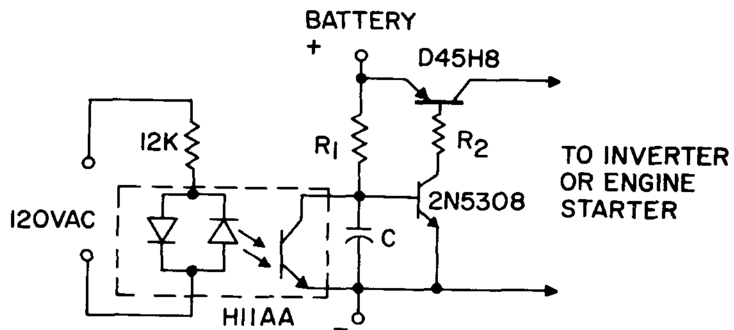
Note that for other than resistive loads, phase angle correction of the monitoring voltage divider is required.

RING DETECTOR



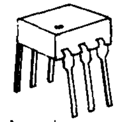
In many telecommunications applications it is desirable to detect the presence of a ring signal in a system without any direct electrical contact with the system. When the 86 Vac ring signal is applied, the output transistor of the H11AA is turned on indicating the presence of a ring signal in the isolated telecommunications system.

UPS SOLID STATE TURN-ON SWITCH



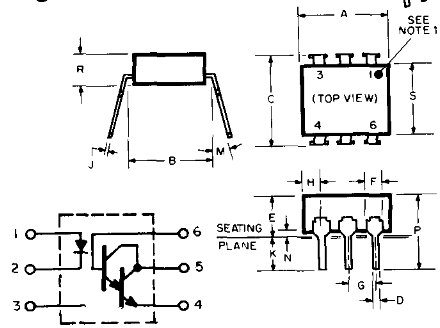
Interruption of the 120 VAC power line turns off the H11AA, allowing C to charge and turn on the 2N5308-D45H8 combination which activates the auxiliary power supply. This system features low standby drain, isolation to prevent ground loop problems and the capability of ignoring a fixed number of "dropped cycles" by choice of the value of C.

Photon Coupled Isolator H11B1-H11B2-H11B3



Ga As Infrared Emitting Diode & NPN Silicon Photo-Darlington Amplifier

The General Electric H11B1, H11B2 and H11B3 are gallium arsenide, infrared emitting diodes coupled with a silicon photo-darlington amplifier in a dual in-line package.



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF	7.62	REF	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal I.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C)

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak)	3	ampere
(Pulse width 1 μsec 300 P Ps)		
Reverse Voltage	3	volts

*Derate 1.33mW/°C above 25°C ambient.

PHOTO-DARLINGTON		
Power Dissipation	**150	milliwatts
V_{CEO}	25	volts
V_{CBO}	30	volts
V_{ECO}	7	volts
Collector Current (Continuous)	100	milliamps

**Derate 2.0mW/°C above 25°C ambient.

TOTAL DEVICE

Storage Temperature -55 to 150°C
Operating Temperature -55 to 100°C
Lead Soldering Time (at 260°C) 10 seconds

Surge Isolation Voltage (Input to Output).

H11B1	$2500V_{(peak)}$	$1770V_{(RMS)}$
H11B2, B3	$1500V_{(peak)}$	$1060V_{(RMS)}$

Steady-State Isolation Voltage (Input to Output).

H11B1	$1500V_{(peak)}$	$1060V_{(RMS)}$
H11B2, B3	$950V_{(peak)}$	$660V_{(RMS)}$

individual electrical characteristics (25°C)

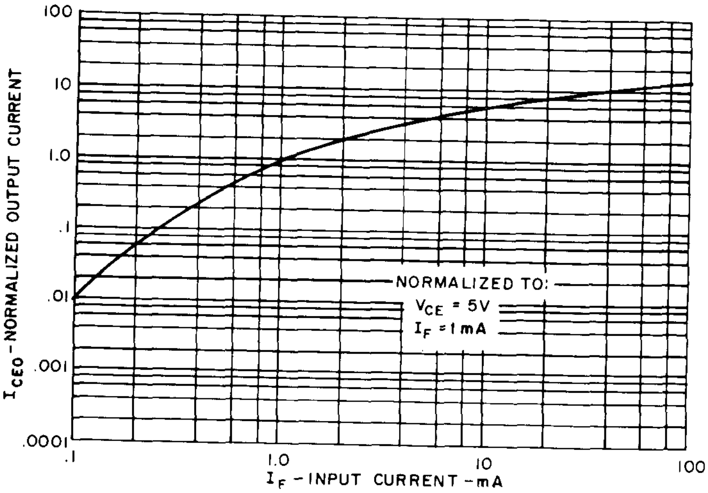
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage			
H11B1, B2 (I_F = 10mA)	1.1	1.5	volts
H11B3 (I_F = 50mA)	1.1	1.5	volts
Reverse Current (V_R = 3V)	–	10	microamps
Capacitance (V = O,f = 1MHz)	50	–	picofarads

PHOTO-TRANSISTOR	MIN.	TYP.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 10mA, I_F = O)	25	–	–	volts
Breakdown Voltage – $V_{(BR)CBO}$ (I_C = 100μA, I_F = O)	30	–	–	volts
Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100μA, I_F = O)	7	–	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = O)	–	5	100	nanoamps
Capacitance (V_{CE} = 10V,f = 1MHz)	–	6	–	picofarads

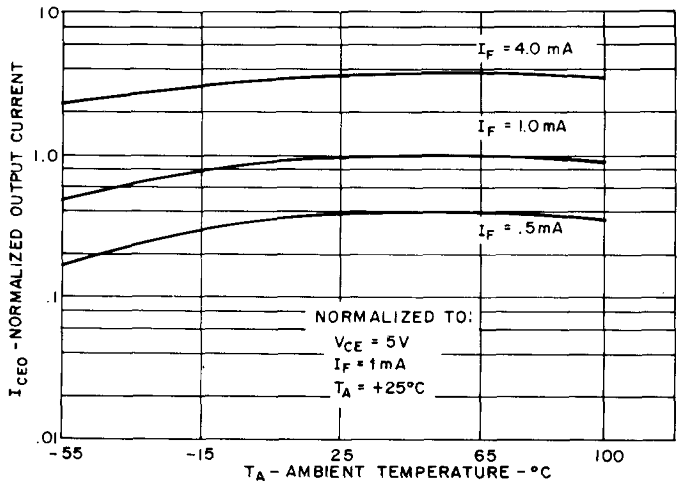
coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 1mA, V_{CE} = 5V)	H11B1	500	–	–	%
	H11B2	200	–	–	%
	H11B3	100	–	–	%
Saturation Voltage – Collector to Emitter (I_F = 1mA, I_C = 1mA)		–	0.7	1.0	volts
Isolation Resistance (Input to Output Voltage = $500V_{DC}$)		100	–	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = O,f = 1MHz)		–	–	2	picofarads
Switching Speeds: (V_{CE} = 10V, I_C = 10mA, R_L = 100Ω)	On-Time	–	125	–	microseconds
	Off-Time	–	100	–	microseconds

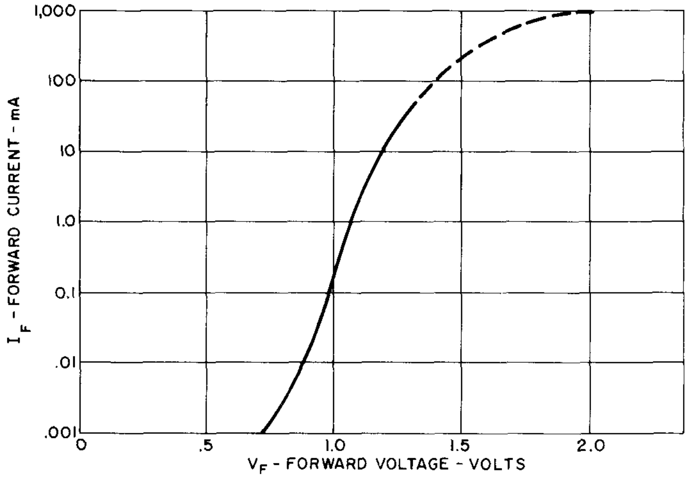
TYPICAL CHARACTERISTICS



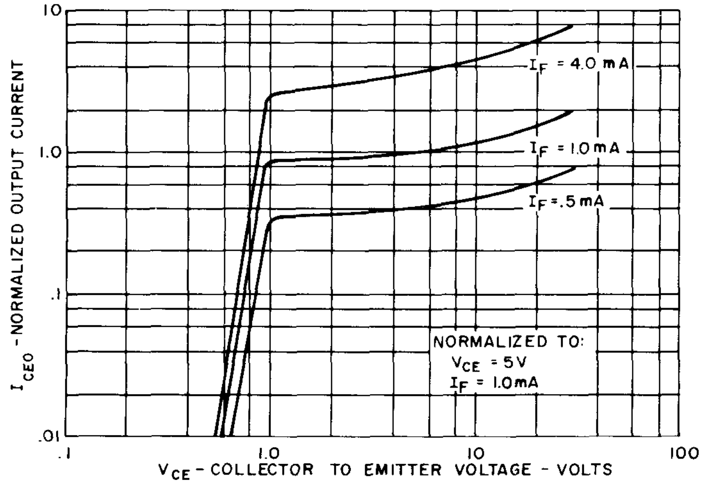
OUTPUT CURRENT VS INPUT CURRENT



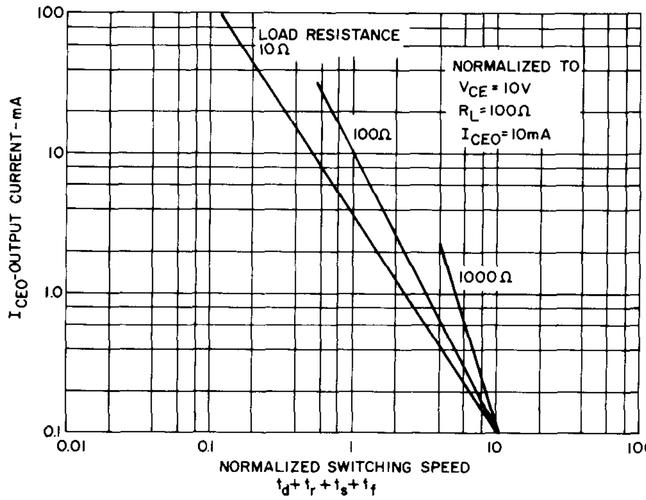
OUTPUT CURRENT VS TEMPERATURE



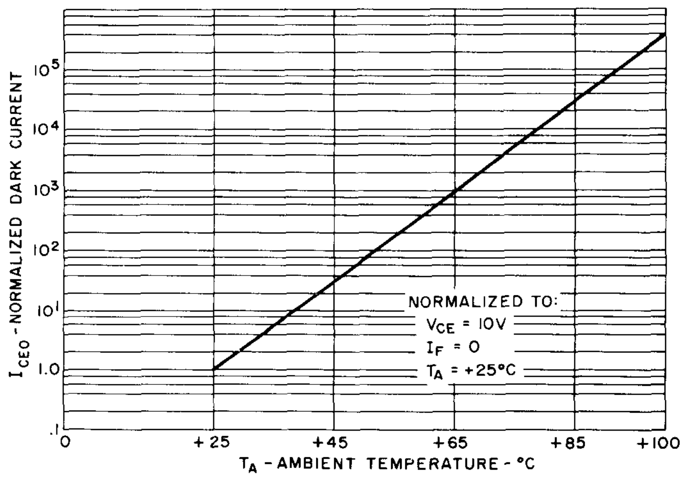
INPUT CHARACTERISTICS



OUTPUT CHARACTERISTICS



SWITCHING SPEED VS OUTPUT CURRENT

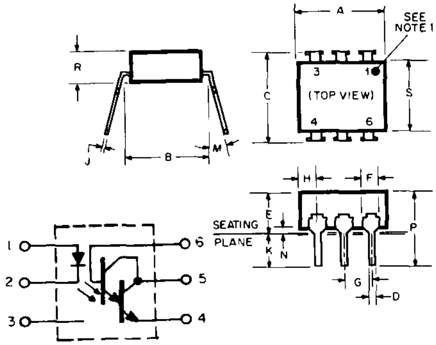


NORMALIZED DARK CURRENT VS TEMPERATURE

Photon Coupled Isolator H11B255

Ga As Infrared Emitting Diode & NPN Silicon Photo-Darlington Amplifier

The General Electric H11B255 consists of a gallium arsenide infrared emitting diode coupled with a silicon photo-darlington amplifier in a dual in-line package.



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF.	7.62	REF.	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C)

INFRARED EMITTING DIODES		
Power Dissipation	*90	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak)	3	ampere
(Pulse width 1μsec. 300 P Ps)		
Reverse Voltage	3	volts

*Derate 1.2mW/°C above 25°C ambient.

PHOTO-TRANSISTOR		
Power Dissipation	**210	milliwatts
V_{CEO}	55	volts
V_{CBO}	55	volts
V_{EBO}	8	volts
Collector Current (Continuous)	100	milliamps

**Derate 2.8mW/°C above 25°C ambient.

TOTAL DEVICE

Storage Temperature -55 to 150°C
Operating Temperature -55 to 100°C
Lead Soldering Time (at 260°C) 10 seconds.
Surge Isolation Voltage (Input to Output).
$1500V_{(peak)}$ $1060V_{(RMS)}$
Steady-State Isolation Voltage (Input to Output).
$950V_{(peak)}$ $660V_{(RMS)}$

individual electrical characteristics (25°C)

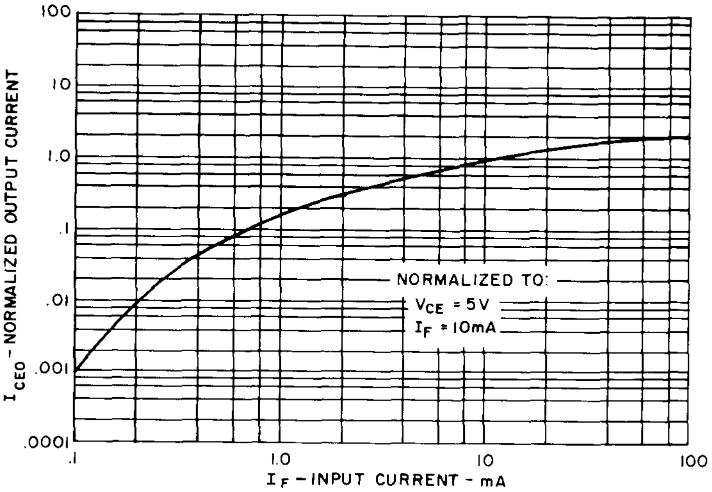
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 20mA)	1.1	1.5	volts
Reverse Current (V_R = 3V)	–	10	microamps
Capacitance (V = O,f = 1 MHz)	50	–	picofarads

PHOTO-TRANSISTOR	MIN.	TYP.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 100μA, I_F = O)	55	–	–	volts
Breakdown Voltage – $V_{(BR)CBO}$ (I_C = 100μA, I_F = O)	55	–	–	volts
Breakdown Voltage – $V_{(BR)EBO}$ (I_E = 100μA, I_F = O)	8	–	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = O)	–	–	100	nanoamps
Capacitance (V_{CE} = 10V,f = 1 MHz)	–	2	–	picofarads

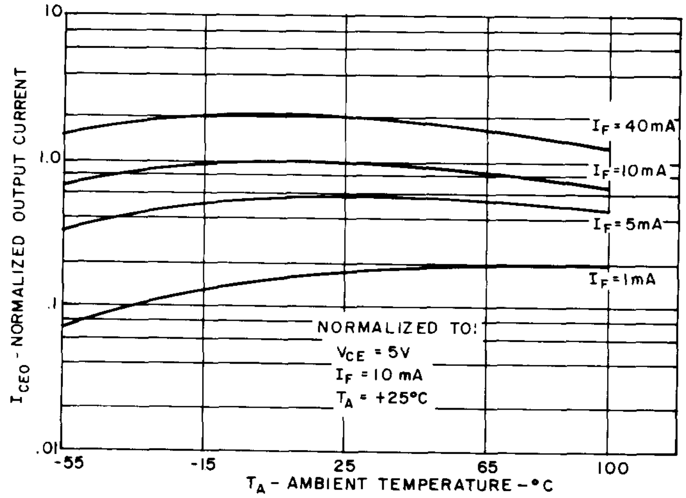
coupled electrical characteristics (25°C)

	MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 5V)	100	–	–	%
Saturation Voltage – Collector to Emitter (I_F = 50mA, I_C = 50mA)	–	–	1.0	volts
Isolation Resistance (Input to Output Voltage = 500V_{DC})	100	–	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = O,f = 1 MHz)	–	–	2	picofarads
Switching Speeds: On-Time – (V_{CE} = 10V, I_C = 10mA, R_L = 100Ω)	–	125	–	microseconds
Off-Time – (V_{CE} = 10V, I_C = 10mA, R_L = 100Ω)	–	100	–	microseconds

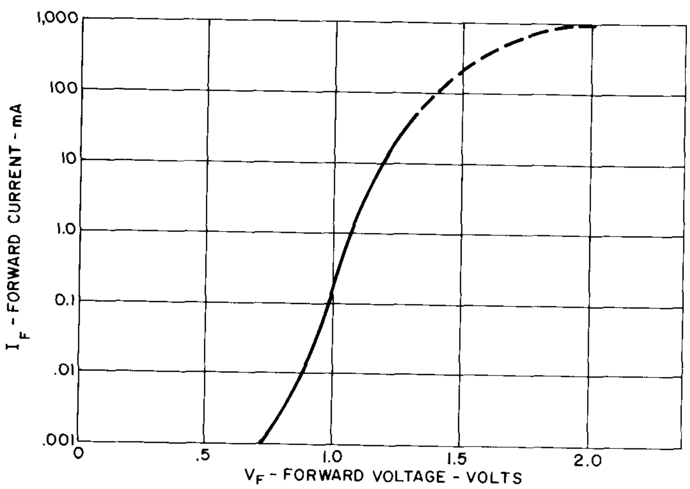
TYPICAL CHARACTERISTICS



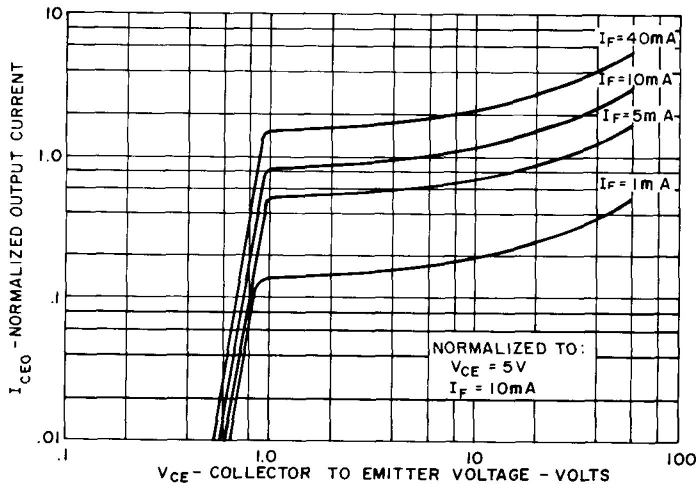
1. OUTPUT CURRENT VS. INPUT CURRENT



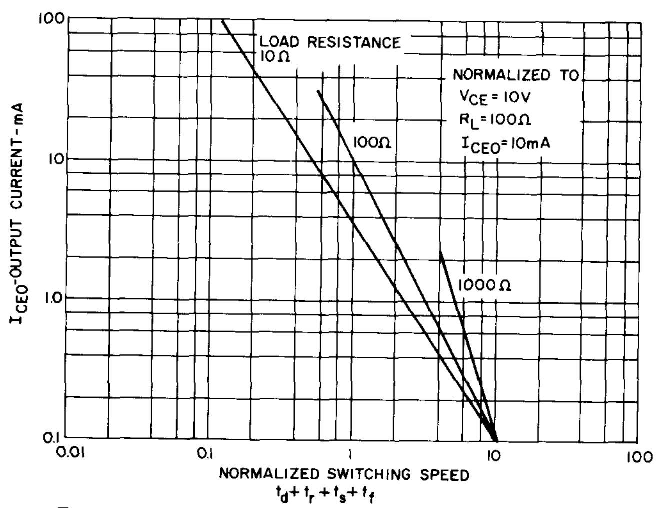
2. OUTPUT CURRENT VS. TEMPERATURE



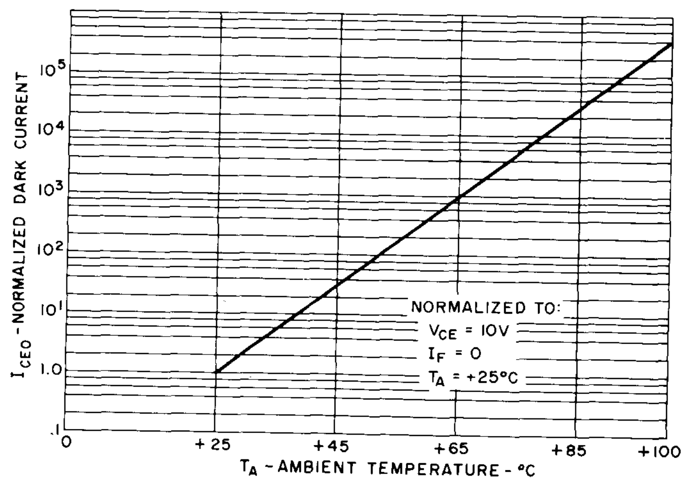
3. INPUT CHARACTERISTICS



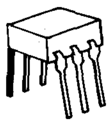
4. OUTPUT CHARACTERISTICS



5. SWITCHING SPEED VS. OUTPUT CURRENT



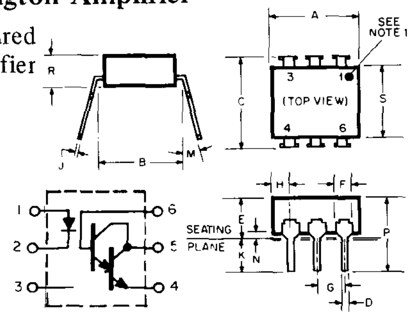
6. NORMALIZED DARK CURRENT VS. TEMPERATURE



Photon Coupled Isolator H11BX522

Ga As Solid State Lamp & NPN Silicon Photo-Darlington Amplifier

The General Electric H11BX522 is a gallium arsenide, infrared emitting diode coupled with a silicon photo-darlington amplifier in a dual in-line package.



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF	7.62	REF	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C)

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak) (Pulse width 1 μsec 300 P Ps)	3	amperes
Reverse Voltage	3	Volts

*Derate 1.33mW/° above 25°C ambient.

PHOTO-TRANSISTOR		
Power Dissipation	**150	milliwatts
V_{CEO}	25	volts
V_{CBO}	30	volts
V_{EBO}	7	volts
Collector Current (Continuous)	100	milliamps

**Derate 2.0mW/°C above 25°C ambient.

TOTAL DEVICE

Storage Temperature -55 to 150°C
Operating Temperature -55 to 100°C
Lead Soldering Time (at 260°C) 10 Seconds
Surge Isolation Voltage (Input to Output).
$2500V_{(peak)}$ $1700V_{(RMS)}$
Steady-State Isolation Voltage (Input to Output)
$1500V_{(peak)}$ $1060V_{(RMS)}$

individual electrical characteristics (25°C)

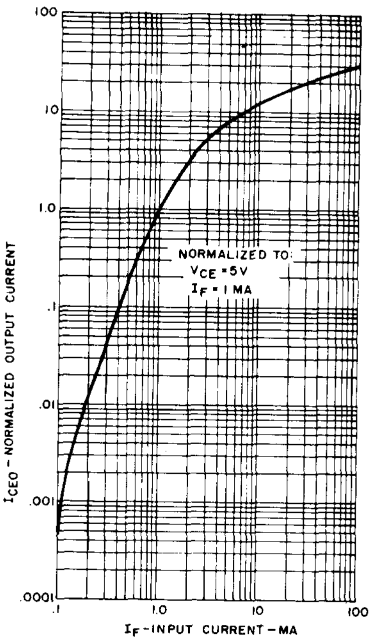
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 0.5mA)	1.0	1.15	volts
Reverse Current (V_R = 3V)	–	10	microamps
Capacitance (V = 0, f = 1 MHz)	50	–	picofarads

PHOTO-DARLINGTON	MIN.	TYP.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 10mA, I_F = 0)	25	–	–	volts
Breakdown Voltage – $V_{(BR)CBO}$ (I_C = 100μA, I_F = 0)	30	–	–	volts
Breakdown Voltage – $V_{(BR)EBO}$ (I_E = 100μA, I_F = 0)	7	–	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 12V, R_{BE} = 7.5 MΩ, T_A = 50°C)	–	–	10	micro-amps
Capacitance Collector-Emitter – C_{CE} (V_{CE} = 10V, f = 1 MHz)	–	6	–	pico-farads

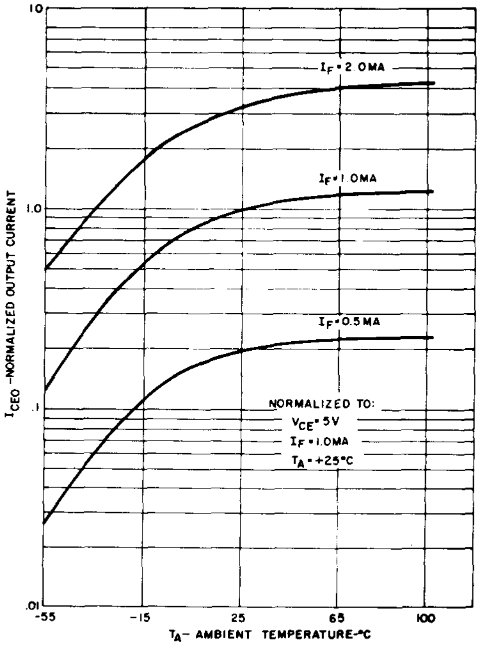
coupled electrical characteristics (25°C)

	MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 0.5mA, V_{CE} = 6V, R_{BE} = 7.5MΩ) -25°C → +50°C	200	–	–	%
Saturation Voltage – Collector-Emitter (I_F = 5mA, I_C = 2mA, R_{BE} = 7.5 MΩ)	–	–	1.0	Volts
Isolation Resistance (Input to Output Voltage = $500V_{DC}$)	–	100	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = 0, f = 1 MHz)	–	2	–	picofarads
Switching Speeds: (I_F = 5mA, See Figure 1) t_{pr}	1	–	3	milliseconds

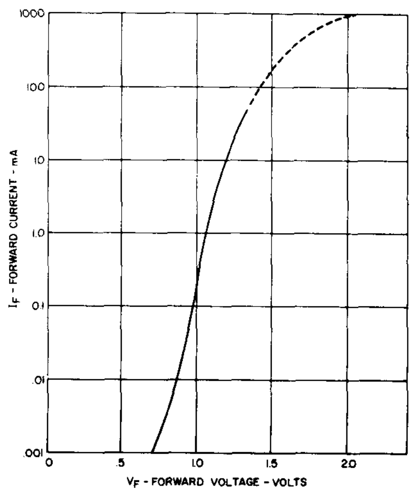
TYPICAL CHARACTERISTICS



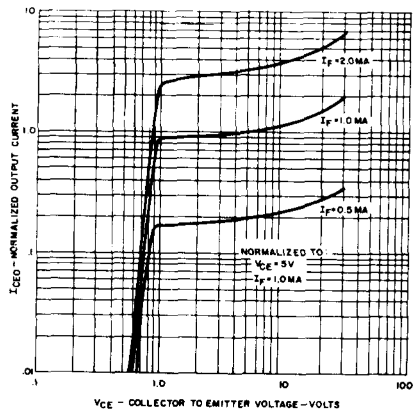
OUTPUT CURRENT VS INPUT CURRENT



OUTPUT CURRENT VS TEMPERATURE



INPUT CHARACTERISTICS



OUTPUT CHARACTERISTICS

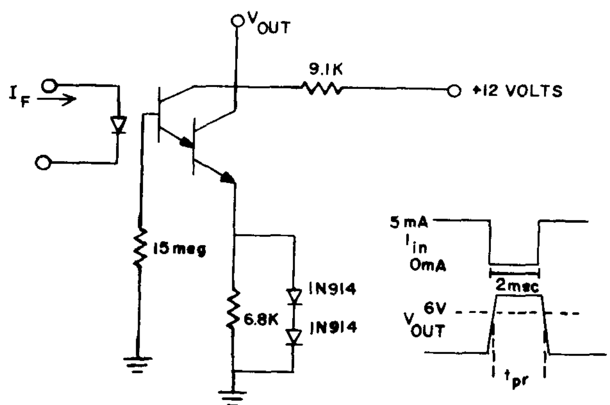
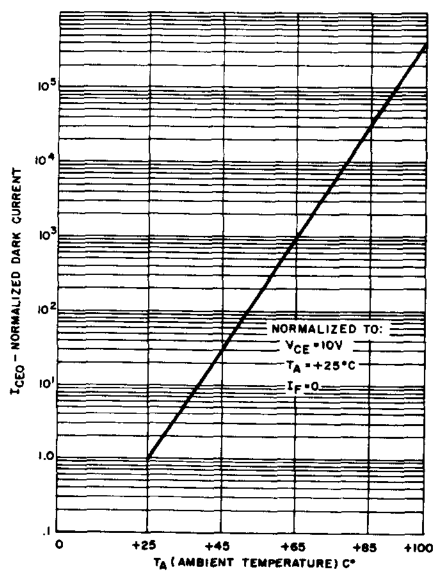
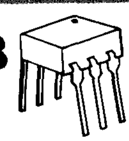


FIGURE 1.



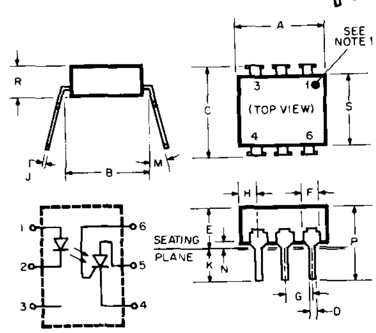
NORMALIZED
DARK CURRENT VS TEMPERATURE

Photon Coupled Isolator H11C1-H11C2-H11C3



Ga As Infrared Emitting Diode & Light Activated SCR

The General Electric H11C1, H11C2 and H11C3 are gallium arsenide, infrared emitting diodes coupled with light activated silicon controlled rectifiers in a dual in-line package.



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF.	7.62	REF.	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C)

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak)	3	ampere
(Pulse width 1 μsec 300 P Ps)		
Reverse Voltage	6	volts

*Derate 1.33 mW/°C above 25°C ambient.

PHOTO-SCR		
Peak Forward Voltage	200	volts
RMS Forward Current	300	milliamps
Forward Current (Peak)	10	amperes
(100μsec 1% duty cycle)		
Surge Current (10m sec)	5	amperes
Reverse Gate Voltage	6	volts
Power Dissipation (25°C Ambient)	** 400	milliwatts
Power Dissipation (25°C Case)	***1000	milliwatts

**Derate 5.3mW/°C above 25°C ambient.
***Derate 13.3mW/°C above 25°C case.

TOTAL DEVICE		
Storage Temperature -55 to 150°C		
Operating Temperature -55 to 100°C		
Lead Soldering Time (at 260°C) 10 seconds		
Surge Isolation Voltage (Input to Output).		
H11C1	$2500V_{(peak)}$	$1770V_{(RMS)}$
H11C2	$2100V_{(peak)}$	$1480V_{(RMS)}$
H11C3	$1500V_{(peak)}$	$1060V_{(RMS)}$
Steady-State Isolation Voltage (Input to Output).		
H11C1	$1500V_{(peak)}$	$1060V_{(RMS)}$
H11C2	$1260V_{(peak)}$	$890V_{(RMS)}$
H11C3	$950V_{(peak)}$	$660V_{(RMS)}$

individual electrical characteristics (25°C)

INFRARED EMITTING DIODE		TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	V_F	1.2	1.5	volts
Reverse Current (V_R = 3V)	I_R	–	10	microamps
Capacitance (V = 0,f = 1MHz)	C_J	50	–	picofarads

PHOTO-SCR	MIN.	TYP.	MAX.	UNITS
Peak Off-State Voltage – V_{DM} (R_{GK} = 10KΩ, 100°C)	200	–	–	volts
Peak Reverse Voltage – V_{RM} (R_{GK} = 10KΩ, 100°C)	200	–	–	volts
On-State Voltage – V_{TM} (I_{TM} = .3 amp)	–	1.1	1.3	volts
Off-State Current – I_{DM} (V_{DM} = 200V, T_A = 100°C)	–	–	50	microamps
Reverse Current – I_{RM} (V_{RM} = 200V, T_A = 100°C)	–	–	50	microamps
Capacitance (Anode-Gate)	–	20	–	picofarads
V=0V,f=1MHz(Gate-Cathode)	–	350	–	picofarads

coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
Input Current to Trigger (V_{AK} = 50V, R_{GK} = 10KΩ)	H11C1, C2	–	–	20	milliamps
	H11C3	–	–	30	milliamps
Input Current to Trigger (V_{AK} = 100V, R_{GK} = 27KΩ)	H11C1, C2	–	–	11	milliamps
	H11C3	–	–	14	milliamps
Isolation Resistance (Input to Output Voltage = 500V_{DC})		100	–	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = 0,f = 1MHz)		–	–	2	picofarads
Coupled dV/dt, Input to Output (See Figure 13)		500	–	–	volts/μsec

TYPICAL CHARACTERISTICS

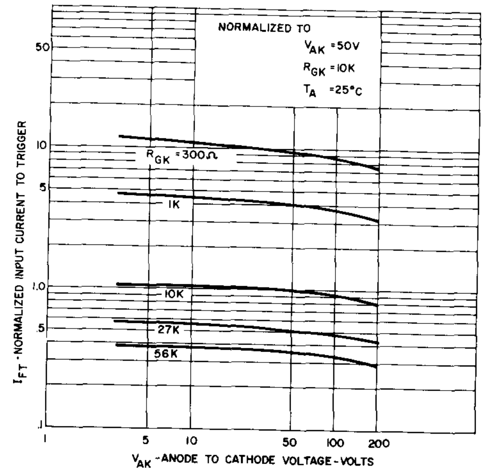


FIGURE 1. INPUT CURRENT TO TRIGGER VS ANODE-CATHODE VOLTAGE

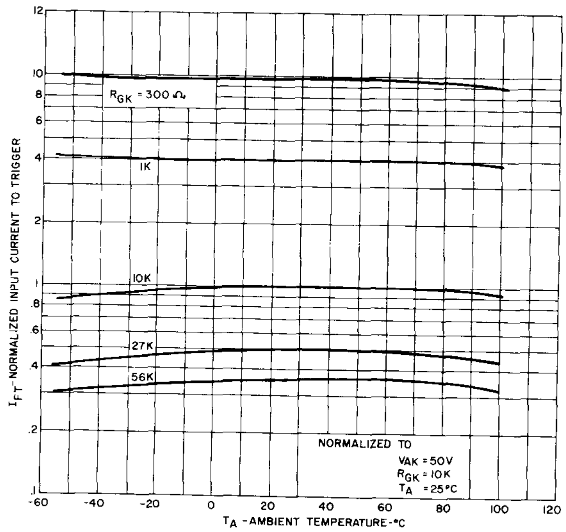


FIGURE 2. INPUT CURRENT TO TRIGGER VS TEMPERATURE

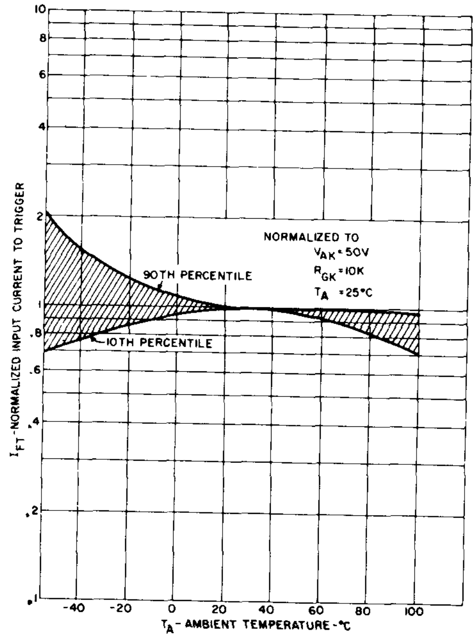


FIGURE 3. INPUT CURRENT TO TRIGGER DISTRIBUTION VS TEMPERATURE

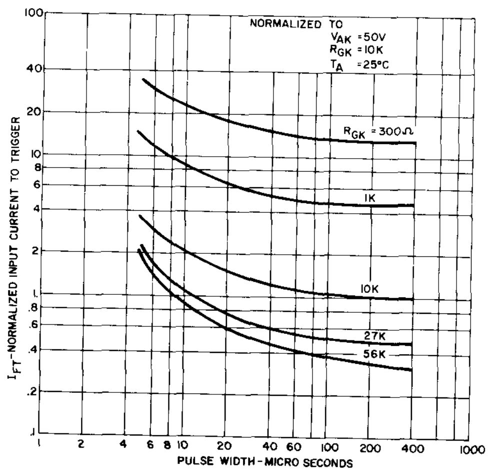


FIGURE 4. INPUT CURRENT TO TRIGGER VS PULSE WIDTH

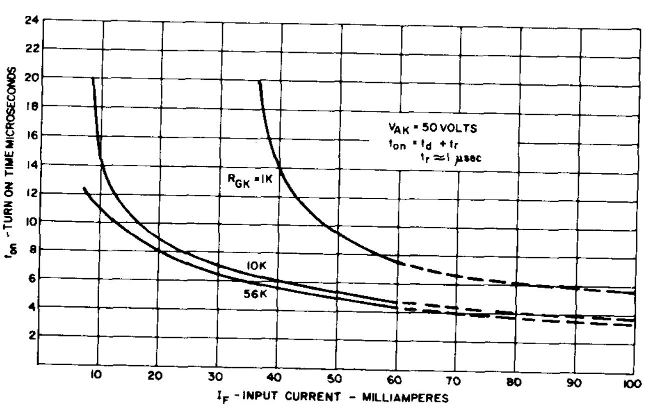


FIGURE 5. TURN ON TIME VS INPUT CURRENT

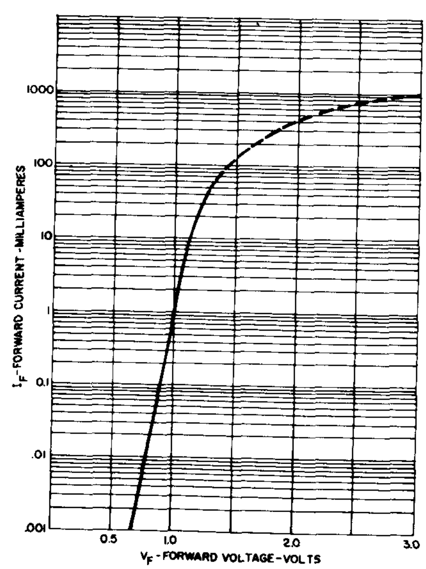


FIGURE 6. INPUT CHARACTERISTICS I_F VS V_F

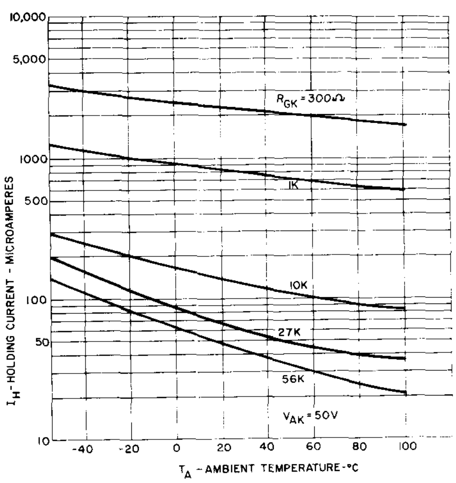


FIGURE 7. HOLDING CURRENT VS TEMPERATURE

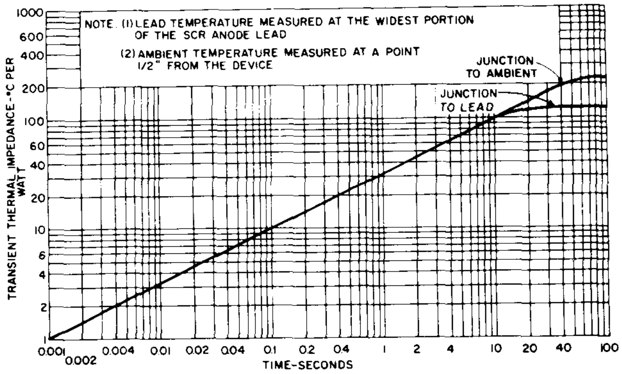


FIGURE 8. MAXIMUM TRANSIENT THERMAL IMPEDANCE

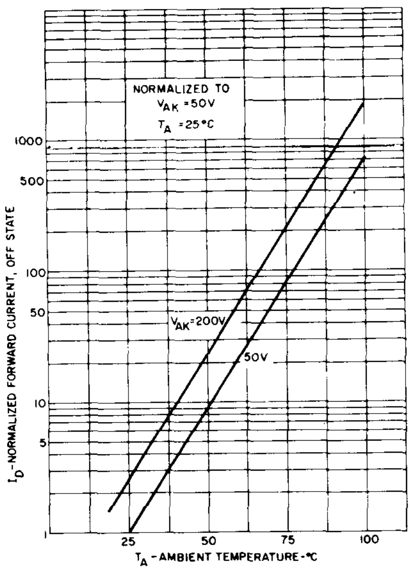


FIGURE 9. OFF STATE FORWARD CURRENT VS TEMPERATURE

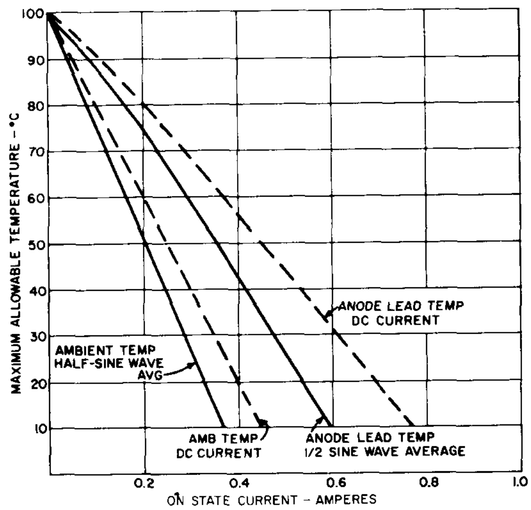


FIGURE 10. ON STATE CURRENT VS MAXIMUM ALLOWABLE TEMPERATURE

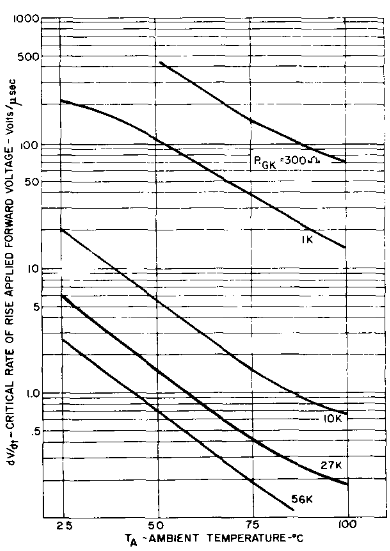


FIGURE 11. dV/dt VS TEMPERATURE

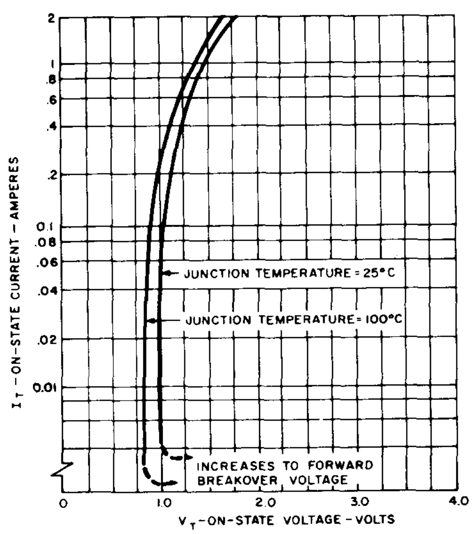
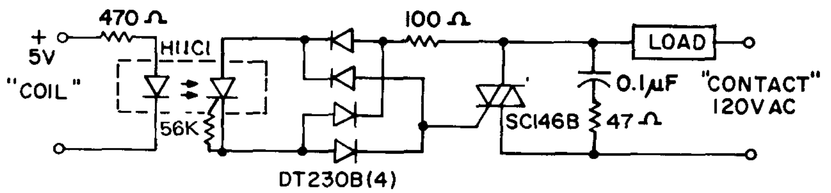


FIGURE 12. ON-STATE CHARACTERISTICS

TYPICAL APPLICATIONS

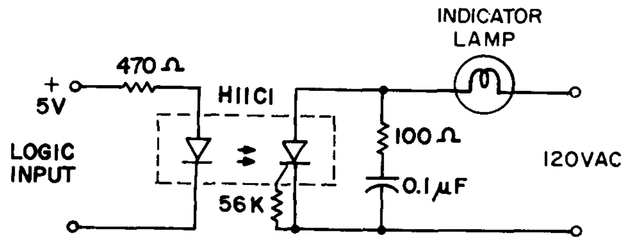
10A, T^2L COMPATABLE, SOLID STATE RELAY

Use of the H11C1 for high sensitivity, 2500 v isolation capability, provides this highly reliable solid state relay design. This design is compatable with 74, 74S and 74H series T^2L logic systems inputs and 120VAC loads up to 10 A.



25W LOGIC INDICATOR LAMP DRIVER

The high surge capability and non-reactive input characteristics of the H11C allow it to directly couple, without buffers, T^2L and DTL logic to indicator and alarm devices, without danger of introducing noise and logic glitches.



200V SYMMETRICAL TRANSISTOR COUPLER

Use of the high voltage PNP portion of the H11C provides a 200V transistor capable of conducting positive and negative signals with current transfer ratios of over 1%. This function is useful in remote instrumentation, high voltage power supplys and test equipment. Care should be taken not to exceed the H11C 400 mW power dissipation rating when used at high voltages.

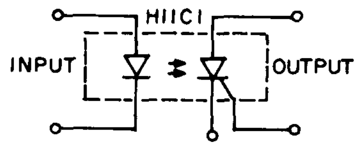
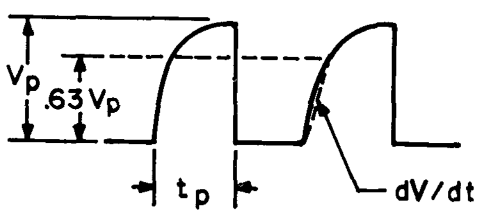
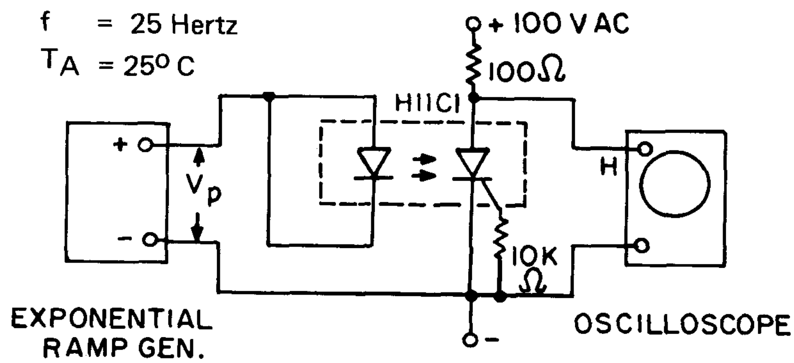


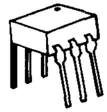
FIGURE 13
COUPLED dV/dt – TEST CIRCUIT

V_p = 800 Volts
t_p =.010 Seconds
f = 25 Hertz
T_A = 25° C



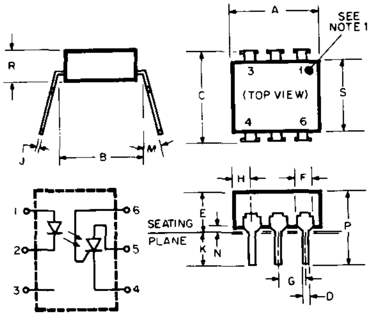


Photon Coupled Isolator H11C4 – H11C5 – H11C6



Ga As Infrared Emitting Diode & Light Activated SCR

The General Electric H11C4, H11C5 and H11C6 are gallium arsenide, infrared emitting diodes coupled with light activated silicon controlled rectifiers in a dual in-line package.



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF	7.62	REF	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C)

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak)	3	ampere
(Pulse width 1μsec 300 P Ps)		
Reverse Voltage	6	volts

*Derate 1.33mW/°C above 25°C ambient.

PHOTO – SCR		
Peak Forward Voltage	400	volts
RMS Forward Current	300	milliamps
Forward Current (Peak)	10	amperes
(100μsec 1% duty cycle)		
Surge Current (10m sec)	5	amperes
Reverse Gate Voltage	6	volts
Power Dissipation (25°C Ambient)	** 400	milliwatts
Power Dissipation (25°C Case)	***1000	milliwatts

**Derate 5.3mW/°C above 25°C ambient.
***Derate 13.3mW/°C above 25°C case.

TOTAL DEVICE

Storage Temperature -55 to 150°C
Operating Temperature -55 to 100°C
Lead Soldering Time (at 260°C) 10 seconds

Surge Isolation Voltage (Input to Output).		
H11C4	2500V(peak)	1770V(RMS)
H11C5	2100V(peak)	1480V(RMS)
H11C6	1500V(peak)	1060V(RMS)
Steady-State Isolation Voltage (Input to Output).		
H11C4	1500V(peak)	1060V(RMS)
H11C5	1260V(peak)	890V(RMS)
H11C6	950V(peak)	660V(RMS)

individual electrical characteristics (25°C)

INFRARED EMITTING DIODE		TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	V_F	1.2	1.5	volts
Reverse Current (V_R = 3V)	I_R	–	10	microamps
Capacitance (V = 0,f = 1MHz)	C_J	50	–	picofarads

PHOTO – SCR	MIN.	TYP.	MAX.	UNITS
Peak Off-State Voltage – V_{DM} (R_{GK} = 10KΩ, 100°C)	400	–	–	volts
Peak Reverse Voltage – V_{RM} (R_{GK} = 10KΩ, 100°C)	400	–	–	volts
On-State Voltage – V_{TM} (I_{TM} = .3 amp)	–	1.1	1.3	volts
Off-State Current – I_{DM} (V_{DM} = 400V, T_A = 100°C)	–	–	150	microamps
Reverse Current – I_{RM} (V_{RM} = 400V, T_A = 100°C)	–	–	150	microamps
Capacitance (Anode-Gate)	–	20	–	picofarads
V=0V,f=1MHz (Gate-Cathode)	–	350	–	picofarads

coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
Input Current to Trigger (V_{AK} = 50V, R_{GK} = 10KΩ)	H11C4, C5	–	–	20	milliamps
	H11C6	–	–	30	milliamps
Input Current to Trigger (V_{AK} = 100V, R_{GK} = 27KΩ)	H11C4, C5	–	–	11	milliamps
	H11C6	–	–	14	milliamps
Isolation Resistance (Input to Output Voltage = 500V_{DC})		100	–	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = 0,f = 1MHz)		–	–	2	picofarads
Coupled dv/dt, Input to Output (See Figure 13)		500	–	–	volts/μsec

TYPICAL CHARACTERISTICS

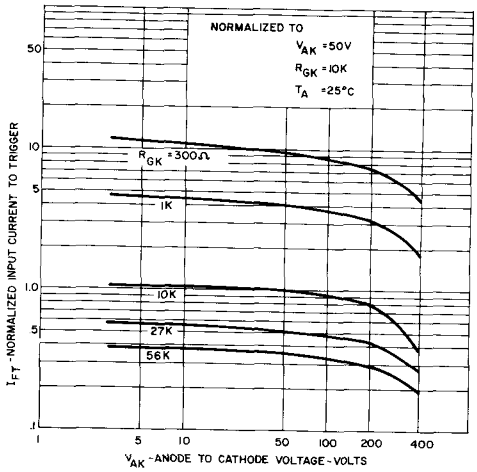


FIGURE 1. INPUT CURRENT TO TRIGGER VS. ANODE-CATHODE VOLTAGE

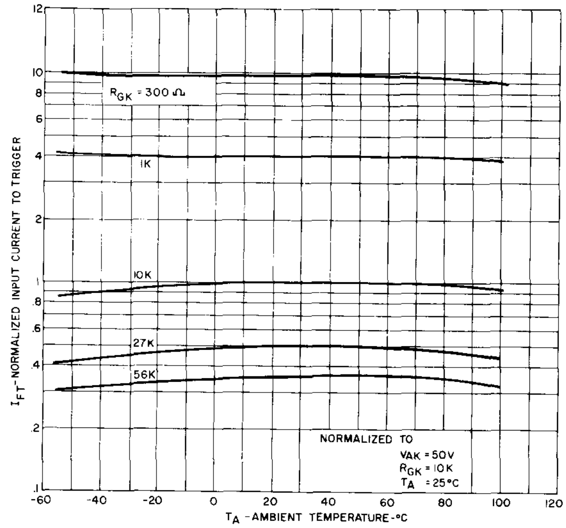


FIGURE 2. INPUT CURRENT TO TRIGGER VS. TEMPERATURE

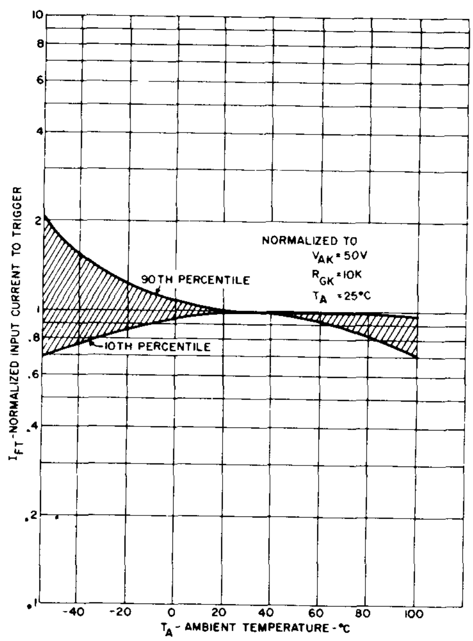


FIGURE 3. INPUT CURRENT TO TRIGGER DISTRIBUTION VS. TEMPERATURE

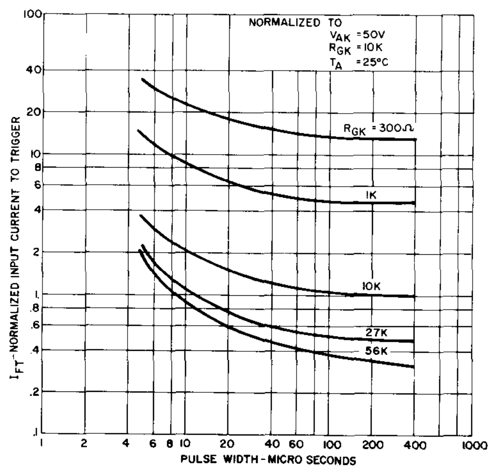


FIGURE 4. INPUT CURRENT TO TRIGGER VS. PULSE WIDTH

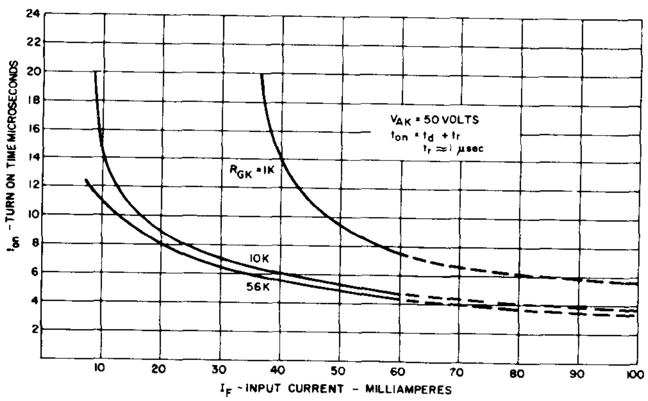


FIGURE 5. TURN-ON TIME VS. INPUT CURRENT

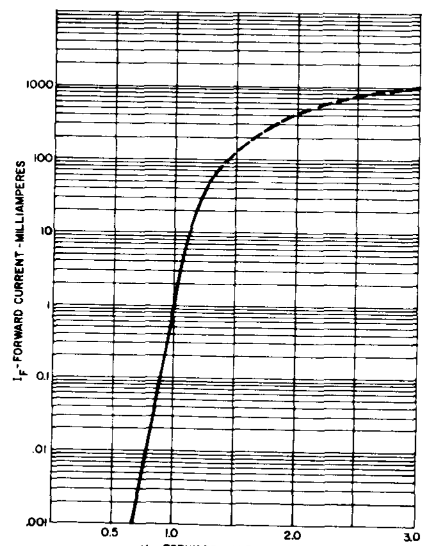


FIGURE 6. INPUT CHARACTERISTICS I_F VS. V_F

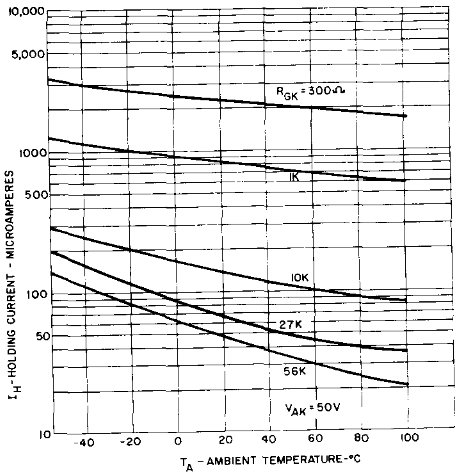


FIGURE 7. HOLDING CURRENT VS. TEMPERATURE

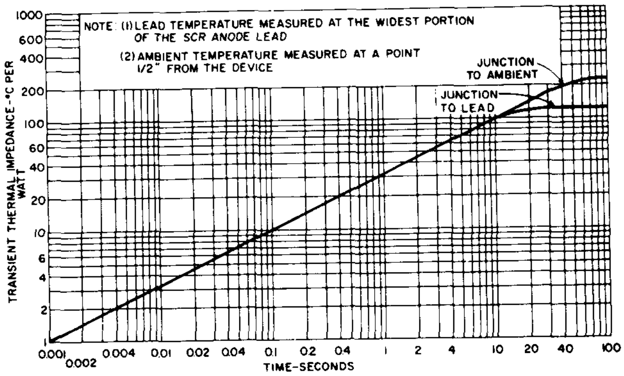


FIGURE 8. MAXIMUM TRANSIENT THERMAL IMPEDANCE

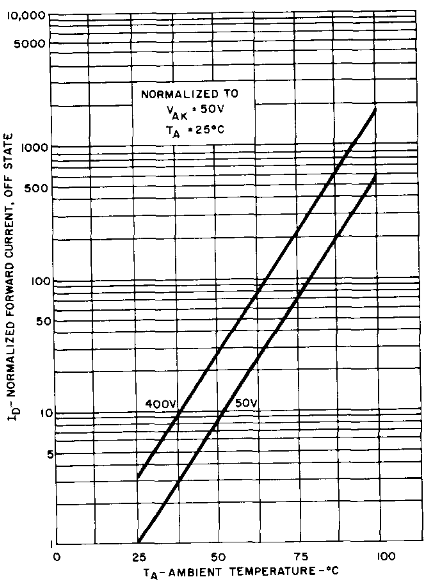


FIGURE 9. OFF-STATE FORWARD CURRENT VS. TEMPERATURE

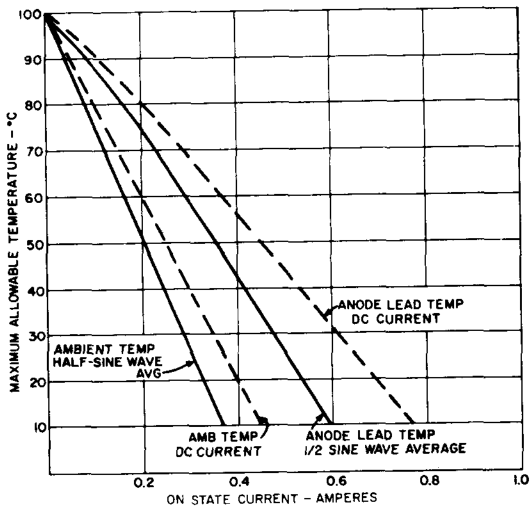


FIGURE 10. ON-STATE CURRENT VS. MAXIMUM ALLOWABLE TEMPERATURE

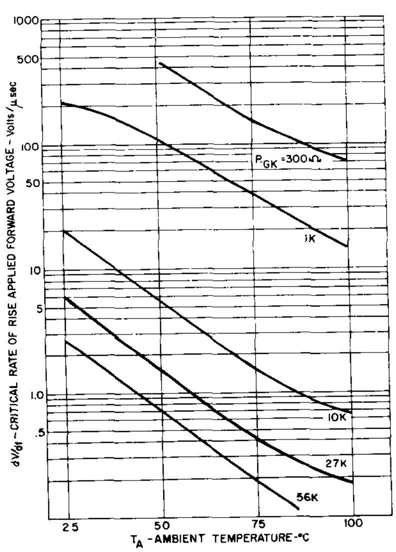


FIGURE 11. dv/dt VS. TEMPERATURE

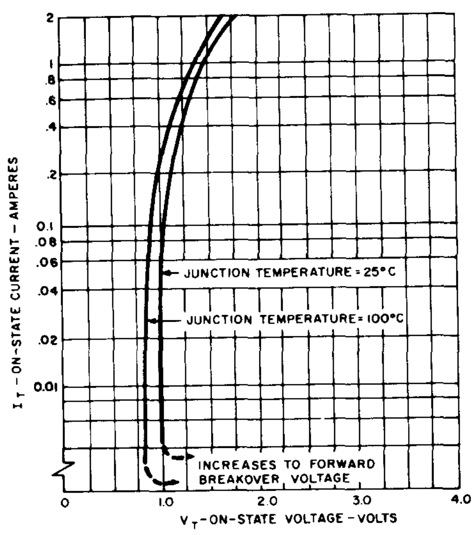
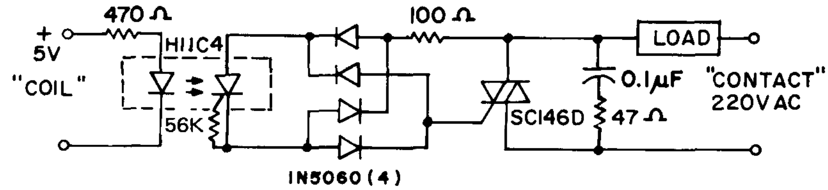


FIGURE 12. ON-STATE CHARACTERISTICS

TYPICAL APPLICATIONS

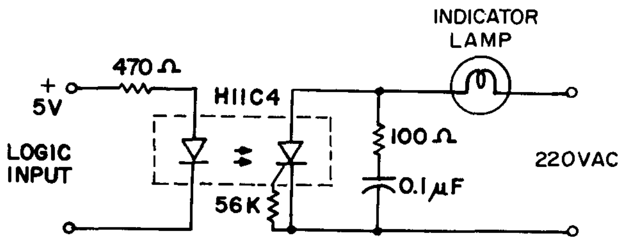
10A, T^2L COMPATIBLE, SOLID STATE RELAY

Use of the H11C4 for high sensitivity, 2500V isolation capability, provides this highly reliable solid state relay design. This design is compatible with 74, 74S and 74H series T^2L logic systems inputs and 220V AC loads up to 10A.



25W LOGIC INDICATOR LAMP DRIVER

The high surge capability and non-reactive input characteristics of the H11C allow it to directly couple, without buffers, T^2L and DTL logic to indicator and alarm devices, without danger of introducing noise and logic glitches.



400V SYMMETRICAL TRANSISTOR COUPLER

Use of the high voltage PNP portion of the H11C provides a 400V transistor capable of conducting positive and negative signals with current transfer ratios of over 1%. This function is useful in remote instrumentation, high voltage power supplies and test equipment. Care should be taken not to exceed the H11C 400 mW power dissipation rating when used at high voltages.

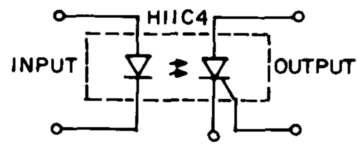
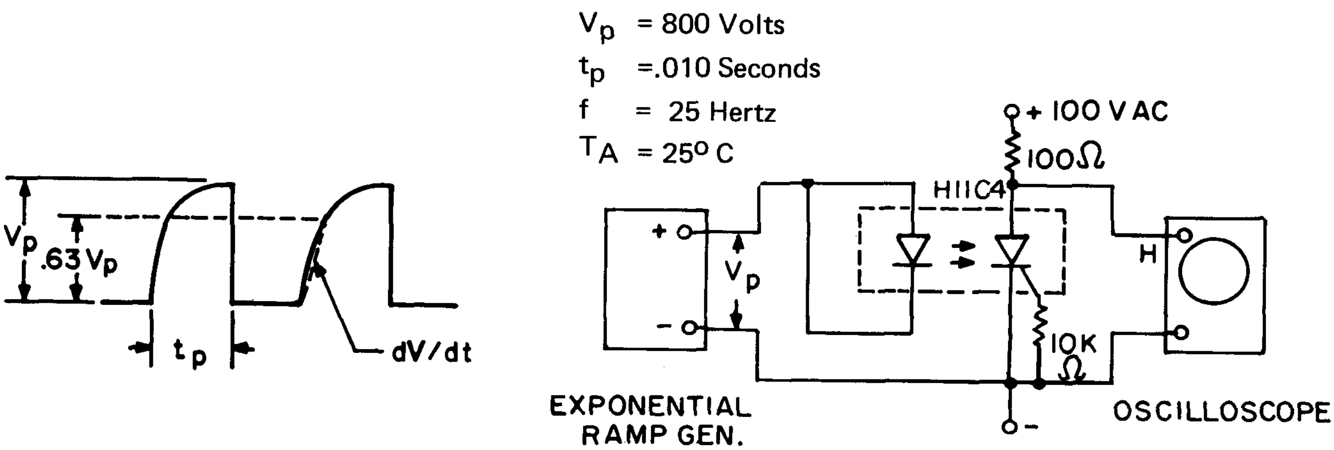
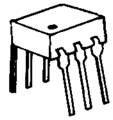


FIGURE 13
COUPLED dv/dt – TEST CIRCUIT

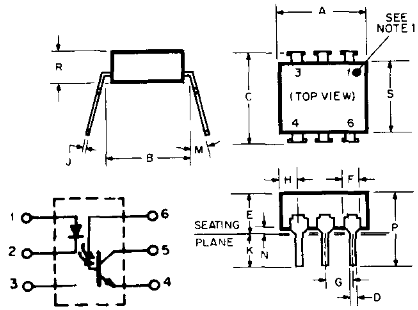


Photon Coupled Isolator H11D1-H11D4



Ga As Infrared Emitting Diode & NPN Silicon High Voltage Photo-Transistor

The General Electric H11D1-H11D4 are gallium arsenide, infrared emitting diodes coupled with silicon high voltage photo-transistors in a dual in-line package.



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF	7.62	REF	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

absolute maximum ratings: (25°C)

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak) (Pulse width 1μsec 300 P Ps)	3	ampere
Reverse Voltage	6	volts

*Derate 1.33mW/°C above 25°C ambient.

PHOTO-TRANSISTOR	H11D1-D2	H11D3-D4	
Power Dissipation	**300	**300	milliwatts
V_{CEO}	300	200	volts
V_{CBO}	300	200	volts
V_{ECO}	7	7	volts
Collector Current (Continuous)	100	100	milliamps

**Derate 4.0mW/°C above 25°C ambient.

TOTAL DEVICE

Storage Temperature -55 to 150°C
Operating Temperature -55 to 100°C
Lead Soldering Time (at 260°C) 10 seconds.
Surge Isolation Voltage (Input to Output).

H11D1	$2500V_{(peak)}$	$1770V_{(RMS)}$
H11D2, D3, D4	$1500V_{(peak)}$	$1060V_{(RMS)}$

Steady-State Isolation Voltage (Input to Output).

H11D1	$1500V_{(peak)}$	$1060V_{(RMS)}$
H11D2, D3, D4	$950V_{(peak)}$	$660V_{(RMS)}$

individual electrical characteristics (25°C)

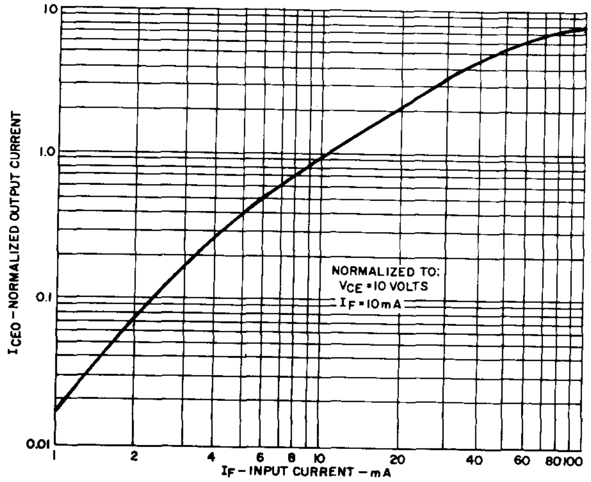
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	1.1	1.5	volts
Reverse Current (V_R = 6V)	–	10	microamps
Capacitance (V = 0,f = 1MHz)	50	–	picofarads

PHOTO-TRANSISTOR		MIN.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$	D1,2	300	–	volts
(I_C = 1mA; I_F = 0)	D3,4	200	–	volts
Breakdown Voltage – $V_{(BR)CBO}$	D1,2	300	–	volts
(I_C = 100μA; I_F = 0)	D3,4	200	–	volts
Breakdown Voltage – $V_{(BR)EBO}$ (I_E = 100μA; I_F = 0)		7	–	volts
Collector Dark Current – I_{CEO}				
(V_{CE}=200V; I_F=0; T_A= 25°C)	D1,2	–	100	nanoamps
(V_{CE}=200V; I_F=0; T_A=100°C)	D1,2	–	250	microamps
(V_{CE}=100V; I_F=0; T_A= 25°C)	D3,4	–	100	nanoamps
(V_{CE}=100V; I_F=0; T_A=100°C)	D3,4	–	250	microamps

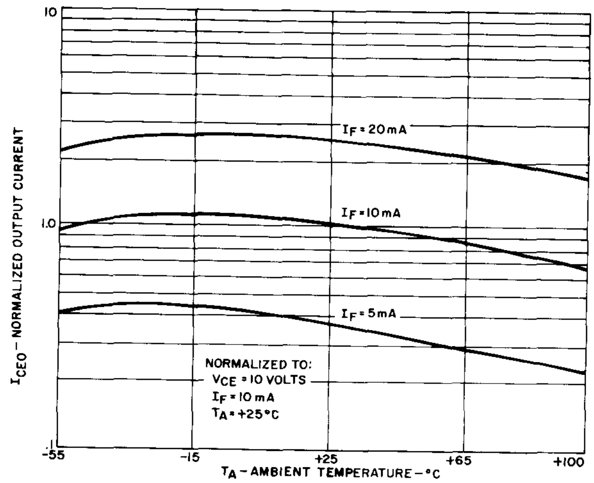
coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V)	H11D1, D2, D3	20	–	–	%
	H11D4	10	–	–	%
Saturation Voltage – Collector to Emitter (I_F = 10mA, I_C = 0.5mA)		–	0.1	0.4	volts
Isolation Resistance (Input to Output Voltage = $500V_{DC}$)		100	–	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = 0,f = 1MHz)		–	–	2	picofarads
Switching Speeds: Turn-On Time – (V_{CE} = 10V, I_{CE} = 2mA, R_L = 100Ω)		–	5	–	microseconds
Turn-Off Time – (V_{CB} = 10V, I_{CE} = 2mA, R_L = 100Ω)		–	5	–	microseconds

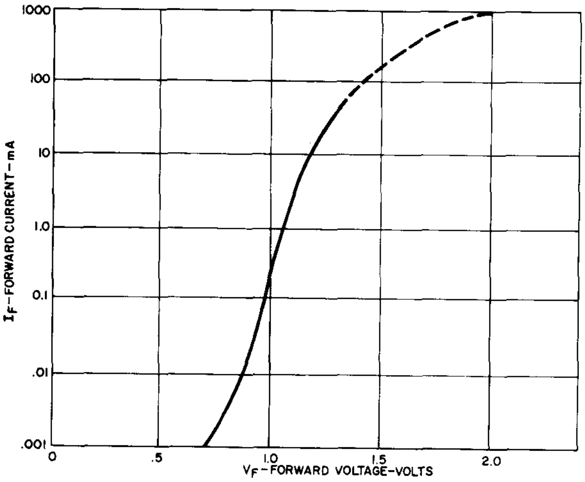
TYPICAL CHARACTERISTICS



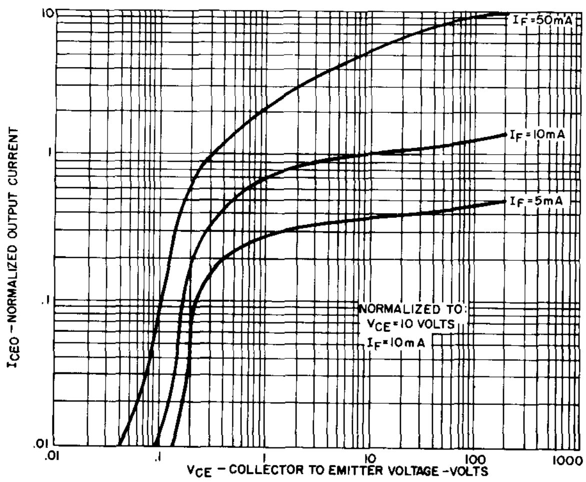
1. OUTPUT CURRENT VS INPUT CURRENT



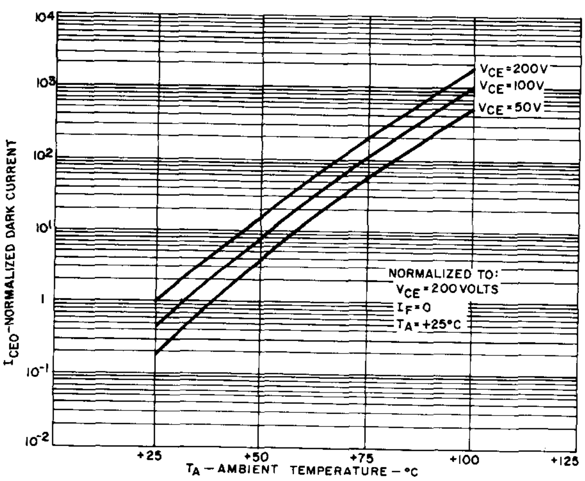
2. OUTPUT CURRENT VS. TEMPERATURE



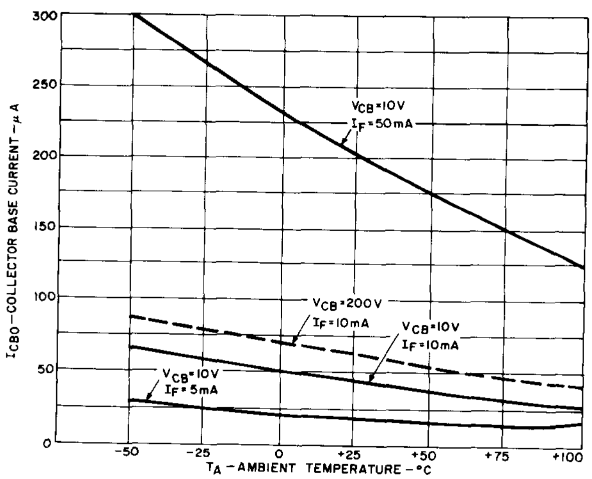
3. INPUT CHARACTERISTICS



4. OUTPUT CHARACTERISTICS

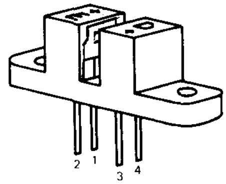


5. NORMALIZED DARK CURRENT VS. TEMPERATURE



6. COLLECTOR BASE CURRENT VS. TEMPERATURE

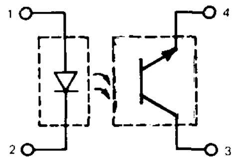
Photon Coupled Interrupter Module H13A1-H13A2

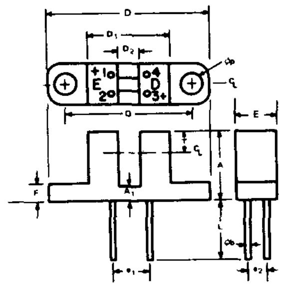


The General Electric H13A1 and H13A2 are gallium arsenide infrared emitting diodes coupled with a silicon photo-transistor in a plastic housing. The gap in the housing provides a means of interrupting the signal with tape, cards, shaft encoders, or other opaque material, switching the output transistor from an "ON" into an "OFF" state.

FEATURES:

- Low cost, plastic module
- Non-contact switching
- Fast switching speeds
- Solid state reliability
- I/O compatible with integrated circuits





SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.390	.400	9.91	10.16	
A_1	.075	.085	1.91	2.15	
ϕb	.016	.019	.407	.482	1
D	.954	.984	24.24	24.99	
D_1	.475	.495	12.07	12.57	
D_2	.120	.130	3.05	3.30	
e_1	.205	.235	5.21	5.96	
e_2	.090	.110	2.29	2.79	
E		.250		6.35	
F	.095	.105	2.42	2.66	
L	.300		7.62		1
ϕp	.120	.130	3.05	3.30	
Q	.745	.755	18.93	19.17	
T	.110 NOM.		2.79 NOM.		2

NOTES:
1. Four leads. Lead diameter controlled between .050" (1.27 MM) *from the seating plane and the end of the leads.*
2. The sensing area falls within a .060" (1.52 MM) square on this centerline.

absolute maximum ratings: (25 °C) (unless otherwise specified)

Storage and Operating Temperature -55° to 85°C. Lead Soldering Time (at 260°C) 10 seconds.

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (peak, 100μs, 1% duty cycle)	1	amp
Reverse Voltage	3	volts

*Derate 1.67mW/°C above 25°C ambient

PHOTO-TRANSISTOR		
Power Dissipation	**150	milliwatts
Collector Current (Continuous)	100	milliamps
V_{CEO}	30	volts
V_{ECO}	5	volts

**Derate 2.5mW/°C above 25°C ambient

individual electrical characteristics (25 °C)

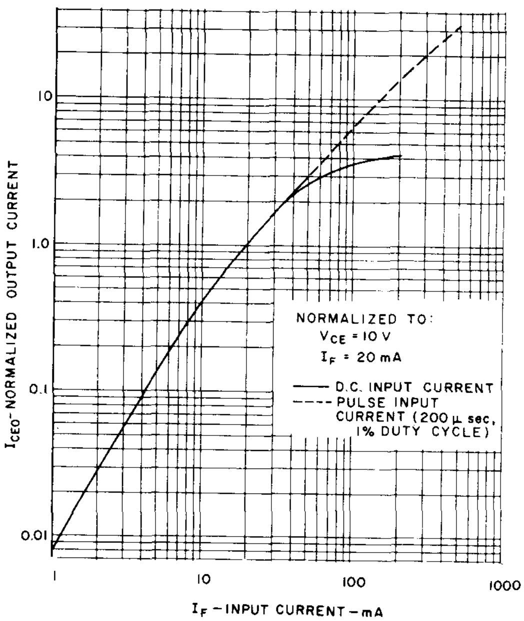
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10 mA)	1.2	1.7	volts
Reverse Current (V_R = 2V)	–	10	μamps
Capacitance (V = O, f = 1MHz)	150	–	pf

PHOTO-TRANSISTOR	MIN.	MAX.	UNITS
Breakdown Voltage $V_{(BR)CEO}$ (I_C = 10 mA)	30	–	volts
Breakdown Voltage $V_{(BR)ECO}$ (I_E = 100μA)	5	–	volts
Collector Dark Current I_{CEO} (V_{CE} = 10V, I_F =O, H=O)	–	100	nA

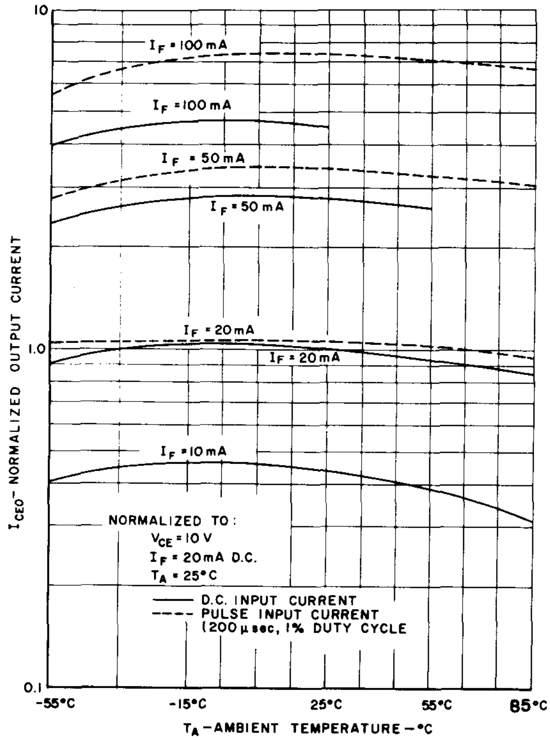
coupled electrical characteristics (25 °C)

		MIN.	TYP.	MAX.	UNITS
Output Current (I_F = 20 mA, V_{CE} = 10V)	H13A1	200	400	–	μamps
	H13A2	50	–	–	μamps
Saturation Voltage (I_F = 20 mA, I_C = 25μA)		–	0.2	0.4	volts
Switching Speeds (V_{CE} = 10V, I_C = 2 mA, R_L = 100Ω)					
On Time ($t_d + t_r$)		–	5	–	μsecs
Off Time ($t_s + t_f$)		–	5	–	μsecs

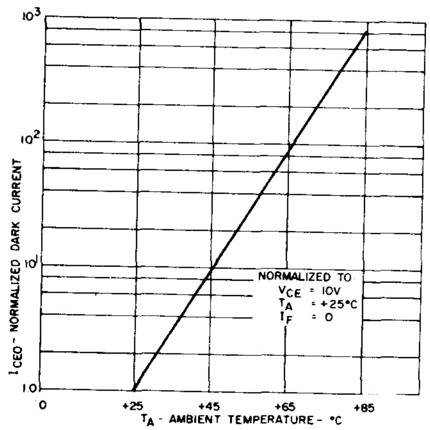
TYPICAL CHARACTERISTICS



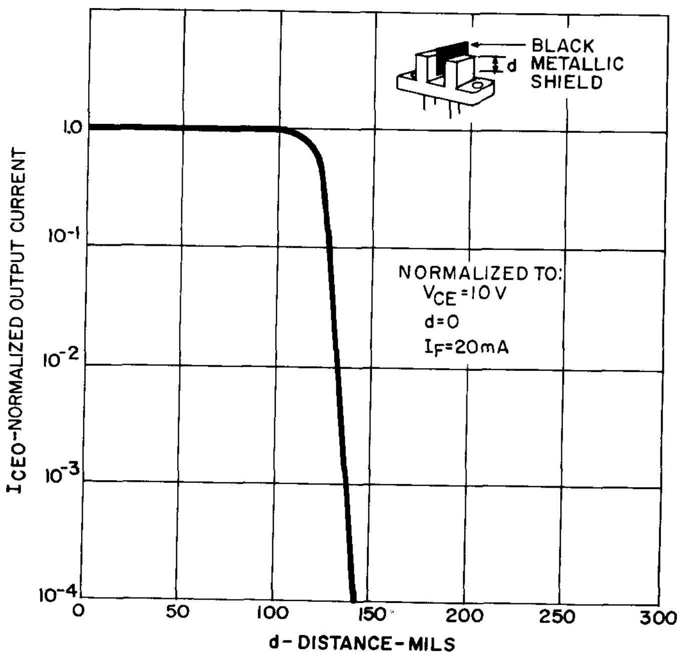
OUTPUT CURRENT VS INPUT CURRENT



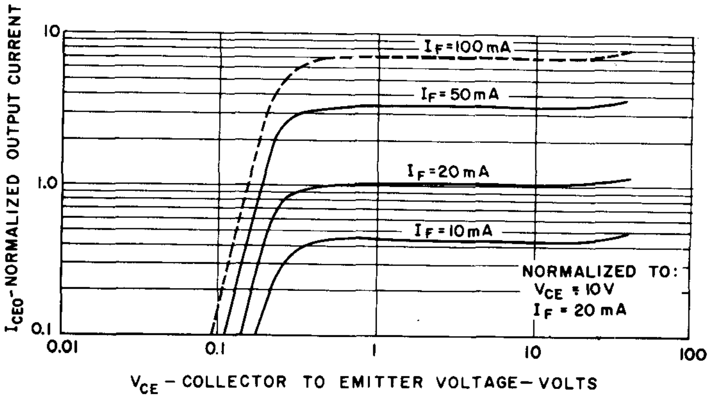
OUTPUT CURRENT VS TEMPERATURE



NORMALIZED DARK CURRENT VS TEMPERATURE

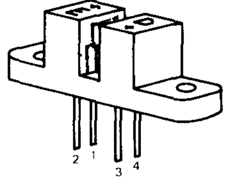


OUTPUT CURRENT VS SHIELD DISTANCE



OUTPUT CHARACTERISTICS

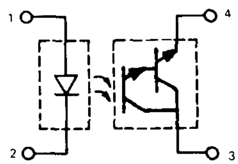
Photon Coupled Interrupter Module H13B1-H13B2

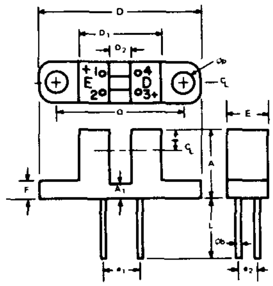


The General Electric H13B1 and H13B2 are gallium arsenide infrared emitting diodes coupled with a silicon photo-darlington in a plastic housing. The gap in the housing provides a means of interrupting the signal with tape, cards, shaft encoders, or other opaque material, switching the output transistor from an "ON" into an "OFF" state.

FEATURES:

- Low cost, plastic module
- Non-contact switching
- Solid state reliability
- I/O compatible with integrated circuits





SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.390	.400	9.91	10.16	
A_1	.075	.085	1.91	2.15	
ϕb	.016	.019	.407	.482	1
D	.954	.984	24.24	24.99	
D_1	.475	.495	12.07	12.57	
D_2	.120	.130	3.05	3.30	
e_1	.205	.235	5.21	5.96	
e_2	.090	.110	2.29	2.79	
E		.250		6.35	
F	.095	.105	2.42	2.66	
L	.300		7.62		1
ϕp	.120	.130	3.05	3.30	
Q	.745	.755	18.93	19.17	
T	.110 NOM.		2.79 NOM.		2

NOTES:

1. Four leads. Lead diameter controlled between .060" (1.27 MM) from the seating plane and the end of the leads.
2. The sensing area falls within a .060" (1.52 MM) square on this centerline.

absolute maximum ratings: (25°C) (unless otherwise specified)

Storage and Operating Temperature -55° to 85°C. Lead Soldering Time (at 260°C) 10 seconds.

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (peak, 100 μs, 1% duty cycle)	1	amp
Reverse Voltage	3	volts

*Derate 1.67mW/°C above 25°C ambient

PHOTO-DARLINGTON		
Power Dissipation	**150	milliwatts
Collector Current (Continuous)	100	milliamps
V_{CEO}	25	volts
V_{ECO}	7	volts

**Derate 2.5mW/°C above 25°C ambient

individual electrical characteristics (25°C)

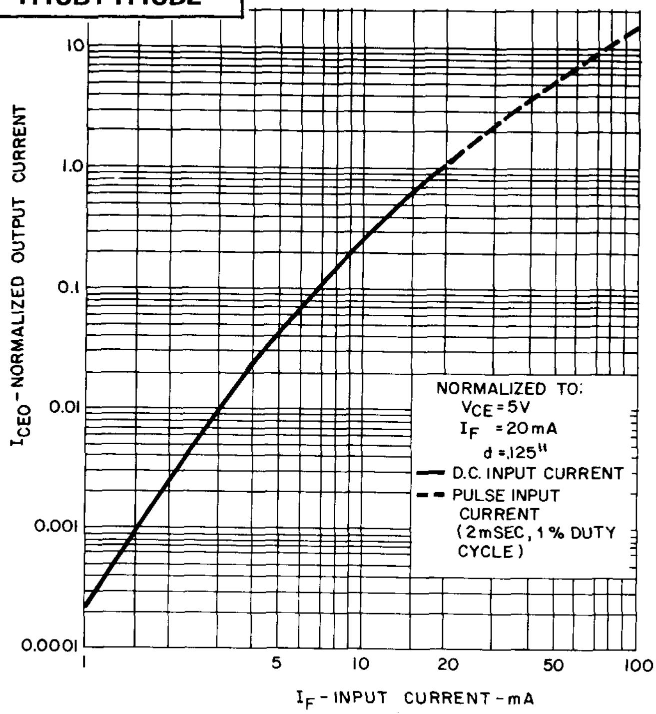
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10 mA)	1.2	1.7	volts
Reverse Current (V_R = 2V)	–	10	μamps
Capacitance (V = O, f = 1MHz)	150	–	pf

PHOTO-DARLINGTON	MIN.	MAX.	UNITS
Breakdown Voltage $V_{(BR)CEO}$ (I_C = 10 mA)	25	–	volts
Breakdown Voltage $V_{(BR)ECO}$ (I_E = 100μA)	7	–	volts
Collector Dark Current I_{CEO} (V_{CE} = 10V, I_F= O, H = O)	–	100	nA

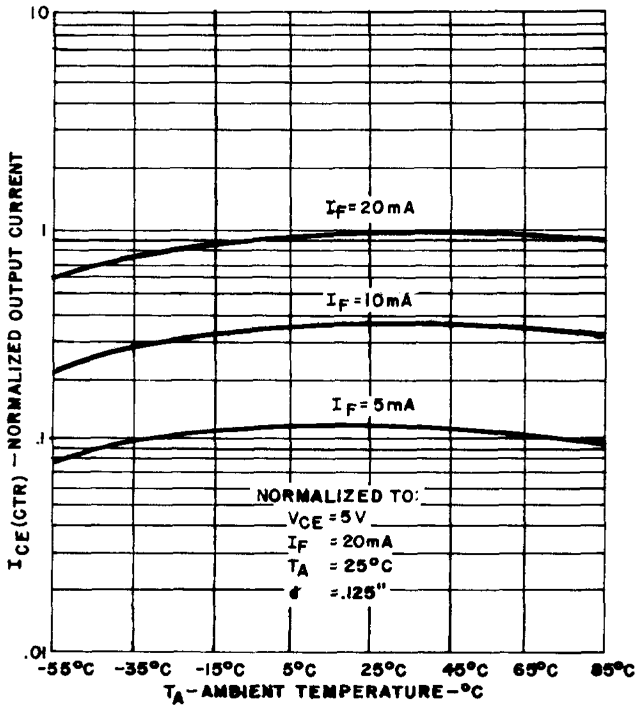
coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
Output Current (I_F = 20 mA, V_{CE} = 5V)	H13B1	2500	–	–	μamps
	H13B2	1000	–	–	μamps
Saturation Voltage (I_F = 20 mA, I_C = 0.5 mA)		–	–	1.2	volts
Switching Speeds (V_{CE} = 10V, I_C = 2 mA, R_L = 100Ω)					
On Time ($t_d + t_r$)		–	150	–	μsecs
Off Time ($t_s + t_f$)		–	150	–	μsecs

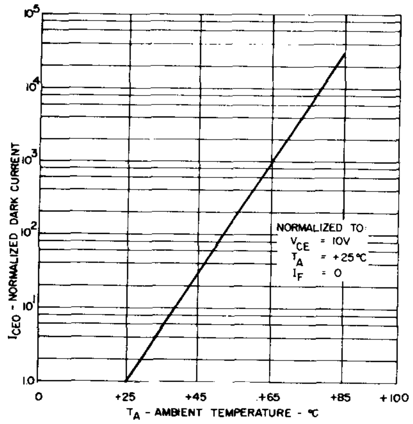
TYPICAL CHARACTERISTICS



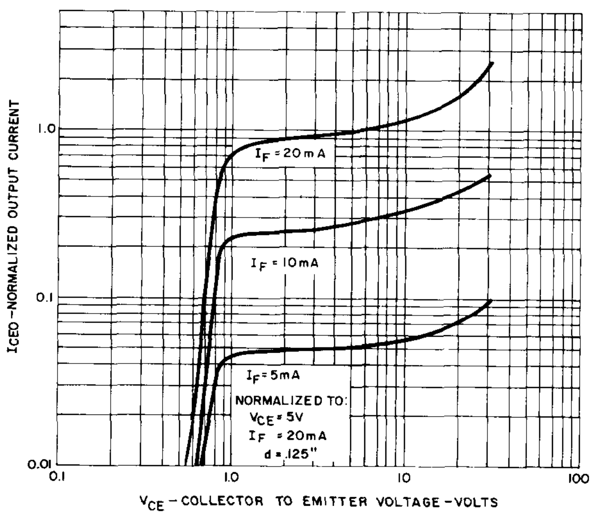
OUTPUT CURRENT VS INPUT CURRENT



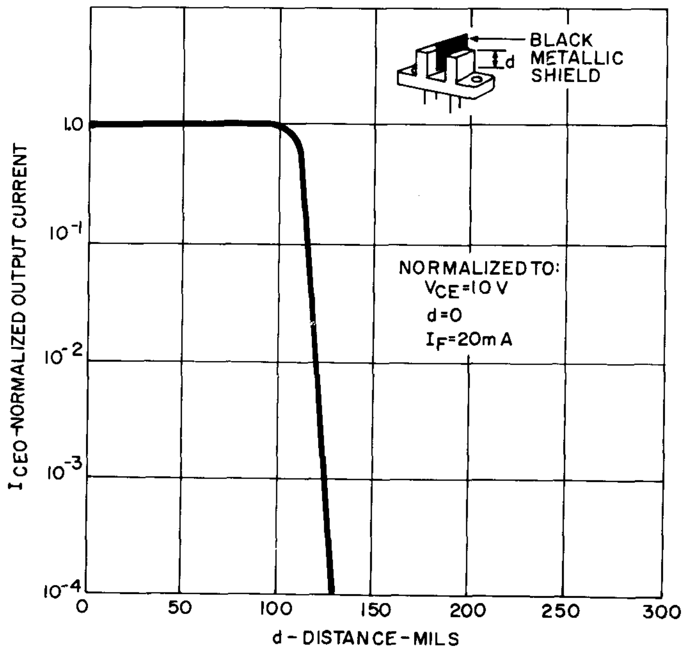
OUTPUT CURRENT VS TEMPERATURE



NORMALIZED DARK CURRENT VS TEMPERATURE



OUTPUT CHARACTERISTICS

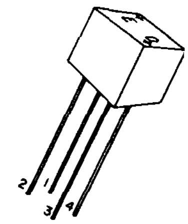


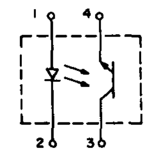
OUTPUT CURRENT VS SHIELD DISTANCE

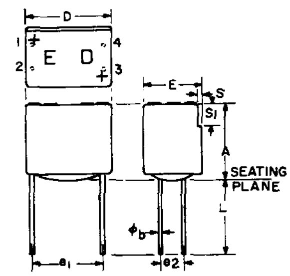
Photon Coupled Isolator H15A1-H15A2

Ga As Infrared Emitting Diodes & NPN Silicon Photo-Transistors

The General Electric H15A1 and H15A2 are gallium arsenide, infrared emitting diodes coupled with silicon photo transistors in a low cost plastic package with lead spacing, compatible to dual in-line package.







SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.350		8.89	
ϕb	.016	.019	.407	.482	1
D		.375		9.52	
e_1	.285	.315	7.24	8.00	
e_2	.090	.110	2.29	2.79	
E		.250		6.35	
L	.300		7.62		1
S	.010	.020	.26	.50	
S_1	.085	.105	2.16	2.66	

NOTES:

1. FOUR LEADS. LEAD DIAMETER CONTROLLED BETWEEN .050" (1.27MM) FROM THE SEATING PLANE AND THE END OF THE LEADS.

absolute maximum ratings: (25°C)

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak)	3	ampere
(Pulse width 1 μsec 300 P Ps)		
Reverse Voltage	3	volts

*Derate 1.67m/W°C above 25°C ambient.

PHOTO-TRANSISTOR		
Power Dissipation	**150	milliwatts
V_{CEO}	30	volts
V_{ECO}	5	volts
Collector Current (Continuous)	100	milliamps

**Derate 2.5m/W°C above 25°C ambient.

TOTAL DEVICE

Storage Temperature -55 to 85°C

Operating Temperature -55 to 85°C

Lead Soldering Time (at 260°C) 10 seconds

Surge Isolation Voltage (Input to Output).
$5650V_{(peak)}$ $4000V_{(RMS)}$

Steady-State Isolation Voltage (Input to Output).
$3500V_{(peak)}$ $2500V_{(RMS)}$

individual electrical characteristics (25°C)

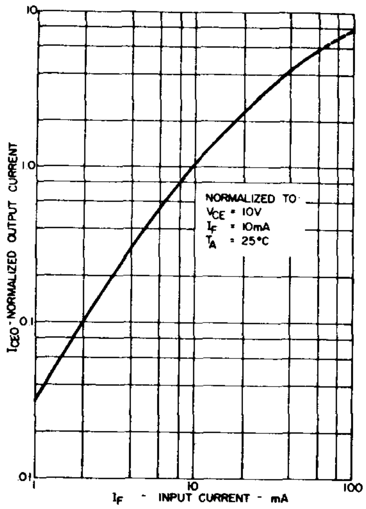
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	1.1	1.7	volts
Reverse Current (V_R = 3V)	–	10	microamps
Capacitance (V = O, f = 1MHz)	50	–	picofarads

PHOTO-TRANSISTOR	MIN.	TYP.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 10mA, I_F = O)	30	–	–	volts
Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100μA, I_F = O)	5	–	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = O)	–	5	100	nanoamps
Capacitance (V_{CE} = 10V, f = 1MHz)	–	3.5	–	picofarads

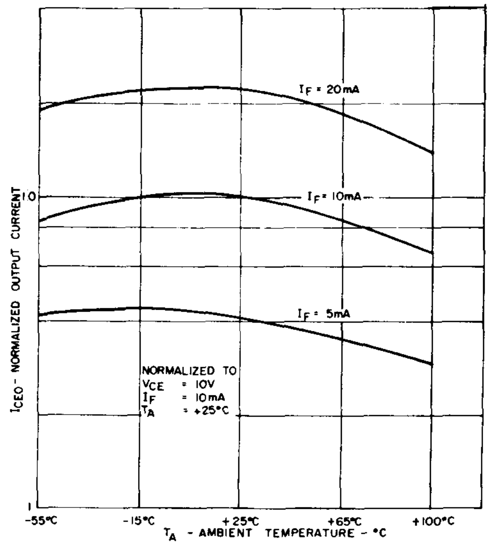
coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 10mA, V_{CE} = 10V)	H15A1	20	–	–	%
	H15A2	10	–	–	%
Saturation Voltage – Collector to Emitter (I_F = 10mA, I_C = 0.5mA)		–	0.2	0.4	volts
Isolation Resistance (Input to Output Voltage = 500V_{DC})		100	–	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = O, f = 1MHz)		–	–	2	picofarads
Switching Speeds: Turn-On Time – (V_{CE} = 10V, I_{CE} = 2mA, R_L = 100Ω)		–	3	–	microseconds
Turn-Off Time – (V_{CE} = 10V, I_{CE} = 2mA, R_L = 100Ω)		–	3	–	microseconds

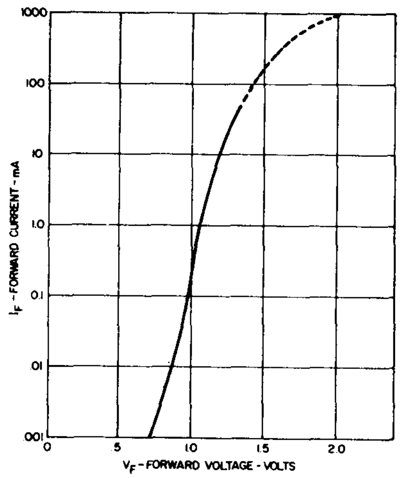
TYPICAL CHARACTERISTICS



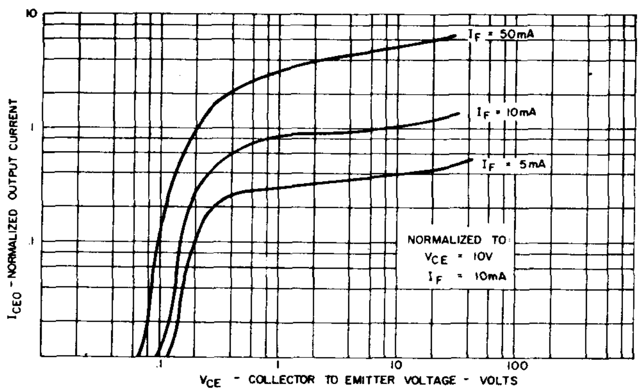
1. OUTPUT CURRENT VS. INPUT CURRENT



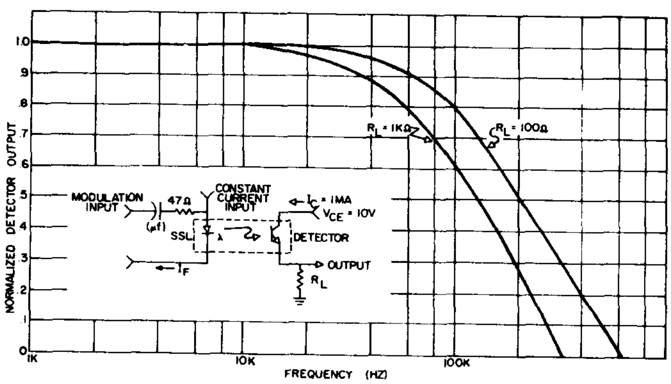
2. OUTPUT CURRENT VS. TEMPERATURE



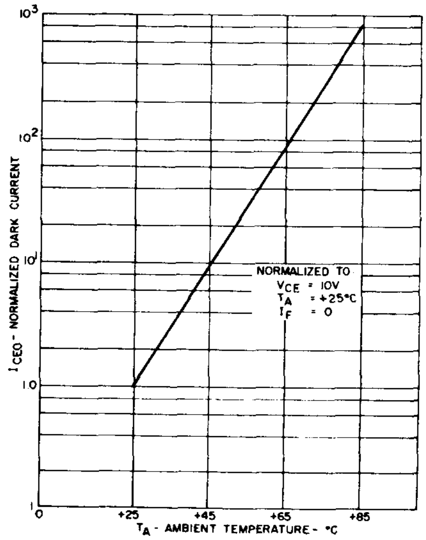
3. INPUT CHARACTERISTICS



4. OUTPUT CHARACTERISTICS



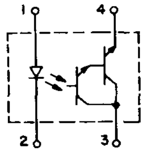
5. FREQUENCY VS. DETECTOR OUTPUT

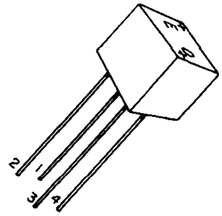


6. NORMALIZED DARK CURRENT VS. TEMPERATURE

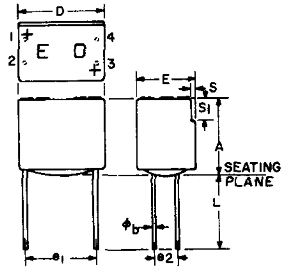
Photon Coupled Isolator H15B1-H15B2

Ga As Infrared Emitting Diode & NPN Silicon Photo-Darlington Amplifier





The General Electric H15B1 and H15B2 are gallium arsenide, infrared emitting diodes coupled with silicon photo-darlington amplifiers in a low cost plastic package with lead spacing, compatible to dual in-line package.



SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A		.350		8.89	
φb	.016	.019	.407	.482	1
D		.375		9.52	
e_1	.285	.315	7.24	8.00	
e_2	.090	.110	2.29	2.79	
E		.250		6.35	
L	.300		7.62		1
S	.010	.020	.26	.50	
S_1	.085	.105	2.16	2.66	

NOTES:

1. FOUR LEADS. LEAD DIAMETER CONTROLLED BETWEEN .050" (1.27MM) FROM THE SEATING PLANE AND THE END OF THE LEADS.

absolute maximum ratings: (25°C)

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak) (Pulse width 1 μsec 300 P Ps)	3	ampere
Reverse Voltage	3	volts

*Derate 1.67mW/°C above 25°C ambient.

PHOTO-DARLINGTON		
Power Dissipation	**150	milliwatts
V_{CEO}	30	volts
V_{CBO}	70	volts
V_{ECO}	7	volts
Collector Current (Continuous)	100	milliamps

**Derate 2.5mW/°C above 25°C ambient.

TOTAL DEVICE

Storage Temperature -55 to 85°C
Operating Temperature -55 to 85°C
Lead Soldering Time (at 260°C) 10 seconds
Surge Isolation Voltage (Input to Output).
5650V$_{(peak)}$ 4000V$_{(RMS)}$
Steady-State Isolation Voltage (Input to Output).
3500V$_{(peak)}$ 2500V$_{(RMS)}$

individual electrical characteristics (25°C)

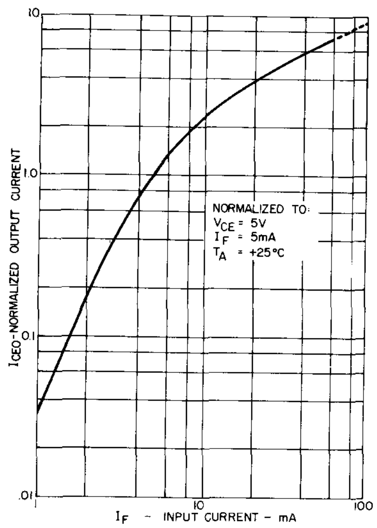
INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	1.1	1.7	volts
Reverse Current (V_R = 3V)	–	10	microamps
Capacitance (V = 0,f = 1MHz)	50	–	picofarads

PHOTO-DARLINGTON	MIN.	TYP.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 10mA, I_F = 0)	30	–	–	volts
Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100μA, I_F = 0)	7	–	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = 0)	–	5	100	nanoamps
Capacitance (V_{CE} = 10V, f = 1MHz)	–	6	–	picofarads

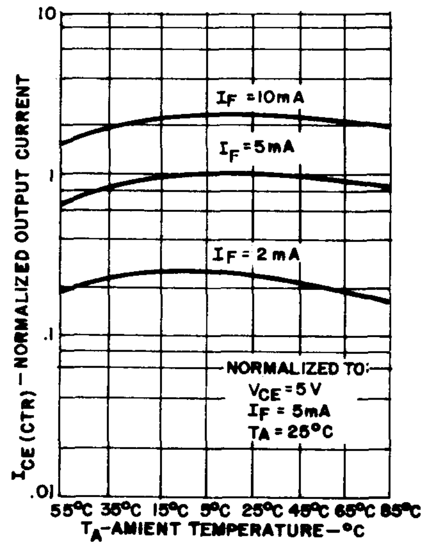
coupled electrical characteristics (25°C)

		MIN.	TYP.	MAX.	UNITS
DC Current Transfer Ratio (I_F = 5mA, V_{CE} = 5V)	H15B1	400	–	–	%
	H15B2	200	–	–	%
Saturation Voltage – Collector to Emitter (I_F = 5mA, I_C = 2mA)		–	0.8	1.4	volts
Isolation Resistance (Input to Output Voltage = 500V_{DC})		100	–	–	gigaohms
Input to Output Capacitance (Input to Output Voltage = 0,f = 1MHz)		–	–	2	picofarads
Switching Speeds: Turn-On Time – (V_{CE} = 10V, I_C = 10mA, R_L = 100Ω)		–	125	–	microseconds
Turn-Off Time – (V_{CE} = 10V, I_C = 10mA, R_L = 100Ω)		–	100	–	microseconds

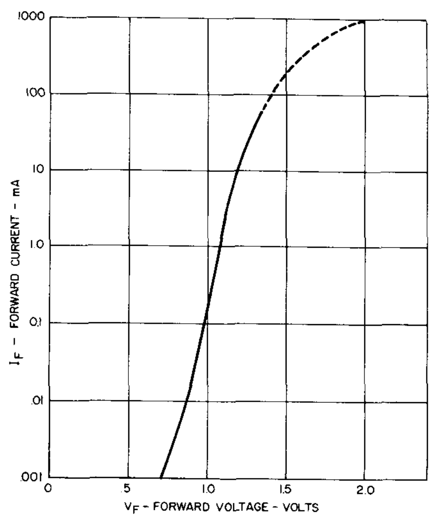
TYPICAL CHARACTERISTICS



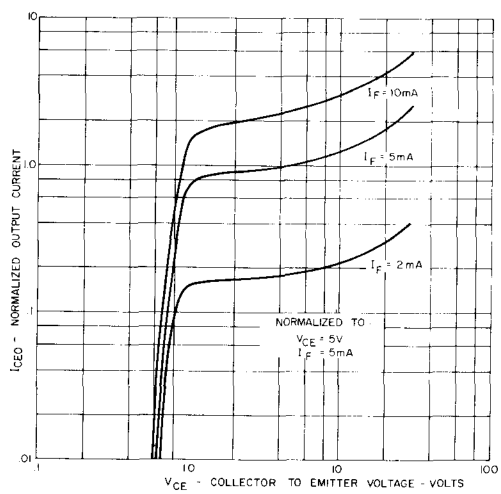
1. OUTPUT CURRENT VS. INPUT CURRENT



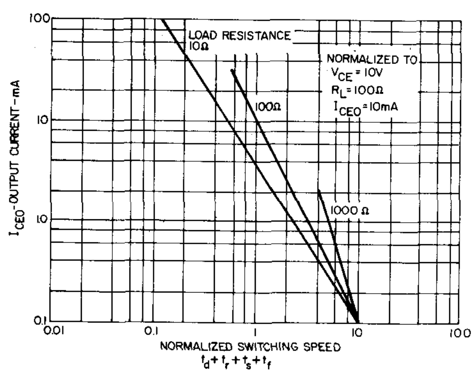
2. OUTPUT CURRENT VS. TEMPERATURE



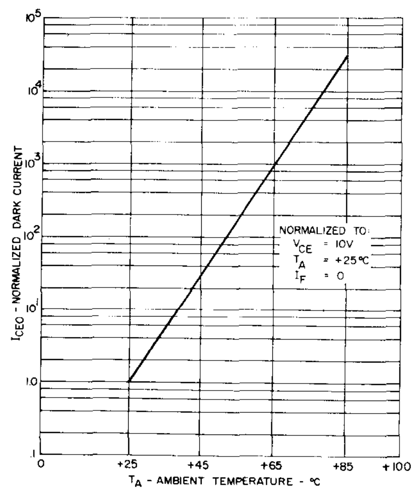
3. INPUT CHARACTERISTICS



4. OUTPUT CHARACTERISTICS

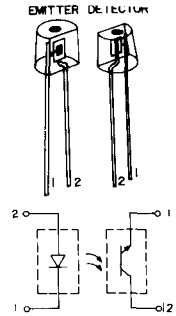


5. SWITCHING SPEED VS. OUTPUT CURRENT



6. NORMALIZED DARK CURRENT VS. TEMPERATURE

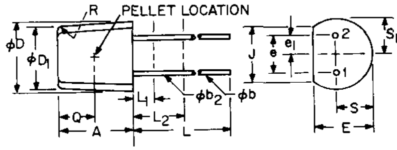
Matched Emitter – Detector Pair H17A1



The General Electric H17A1 is a matched emitter-detector pair which consists of a gallium arsenide, infrared emitting diode in a clear epoxy TO-92 type package and a silicon photo-transistor also in a clear epoxy TO-92 type package.

Each emitter and detector is marked with a color coded dot on the top of the unit (see package illustration). Emitter and detector must be paired as follows:

- Emitter — Detector
- BLACK matched to — BLUE
- ORANGE matched to — RED
- WHITE matched to — VIOLET



NOTES:
1. (TWO LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND .5" (12.70MM) FROM SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND. .5" (12.70MM) FROM SEATING PLANE.
2. THE CENTER LINE OF THE ACTIVE ELEMENT IS LOCATED WITHIN ±.020" (.51 MM) OF THE POSITION SHOWN.
3. AS MEASURED WITHIN .050" (1.27MM) OF THE SEATING PLANE.

SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.170	.210	4.31	5.34	
ϕb	.016	.021	.406	.534	1
ϕb_2	.016	.019	.406	.483	1
ϕD	.170	.200	4.31	5.08	
ϕD_1	.160	.190	4.06	4.83	
E	.125	.155	3.17	3.94	
e	.095	.105	2.41	2.67	3
e_1	.045	.055	1.14	1.40	3
J	.135	.170	3.42	4.32	
L	.500		12.70		1
L_1		.050		1.27	1
L_2	.250		6.35		1
Q	.095	REF.	2.29	REF.	2
R	.055		.12		
S	.080	.105	2.03	2.67	
S_1	.090	REF.	2.29	REF.	

FEATURES:

- Low Cost
- Side Looking
- I/O Compatible with Integrated Circuits

absolute maximum ratings: (25°C) (unless otherwise specified)

Storage and Operating Temperature -55°C to 100°C. Lead Soldering Time (at 260°C) 10 Seconds.

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak) (100 μs, 1% Duty Cycle)	1	ampere
Reverse Voltage	3	volts

*Derate 1.3mW/°C above 25°C ambient.

PHOTO-TRANSISTOR		
Power Dissipation	**150	milliwatts
Collector Current (Continuous)	100	milliamps
V_{CEO}	30	volts
V_{ECO}	5	volts

**Derate 2.0mW/°C above 25°C ambient.

individual electrical characteristics (25°C)

INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	1.2	1.7	volts
Reverse Current (V_R = 2V)	–	10	μamps
Capacitance (V = 0, f = 1MHz)	50	–	pf

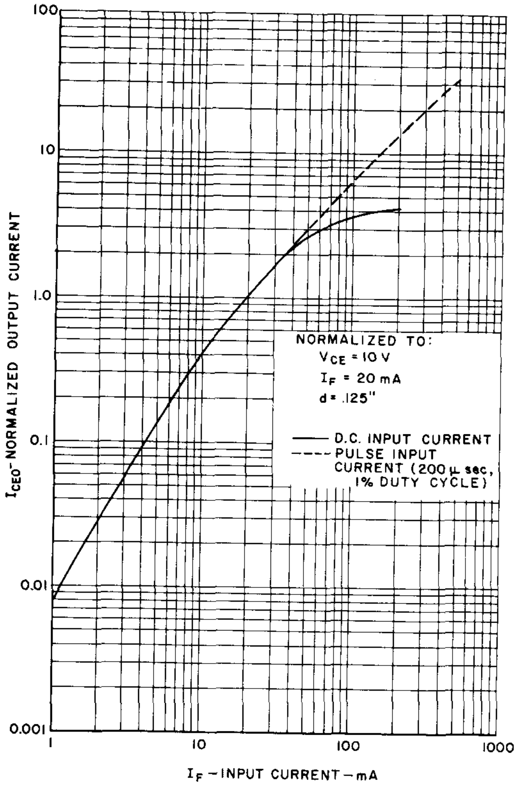
PHOTO-TRANSISTOR	MIN.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 1mA)	30	–	volts
Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100 μA)	5	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = 0, H ≈ 0)	–	100	nA

coupled electrical characteristics (25°C)

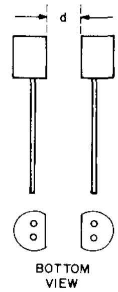
Note: Coupled electrical characteristics are measured at a separation distance of .125" with the faces of the emitter and detector parallel within 3°.

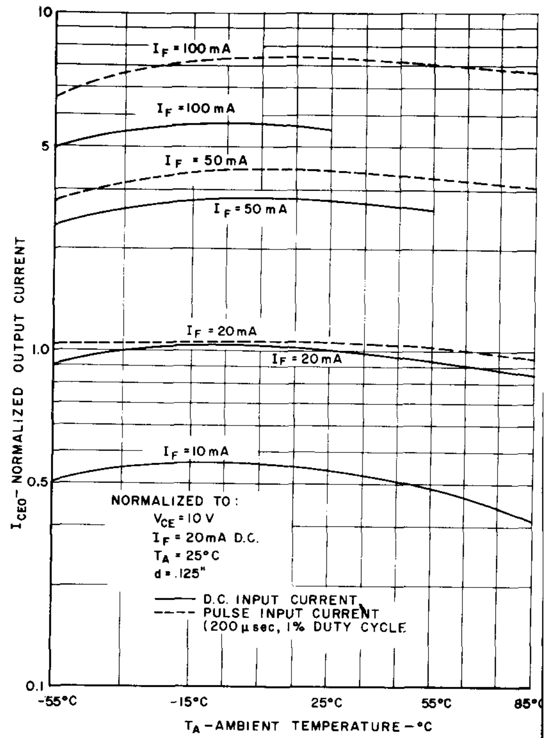
	MIN.	TYP.	MAX.	UNITS
Output Current (I_F = 20mA, V_{CE} = 10V)	50	–	–	μamps
Saturation Voltage (I_F = 20mA, I_C = 25μA)	–	0.2	0.4	volts
Switching Speeds: Turn-On Time ($t_d + t_r$) (V_{CE} = 10V, I_C = 2mA, R_L = 100Ω)	–	5	–	μsecs
Turn-Off Time ($t_s + t_f$) (V_{CE} = 10V, I_C = 2mA, R_L = 100Ω)	–	5	–	μsecs

TYPICAL CHARACTERISTICS

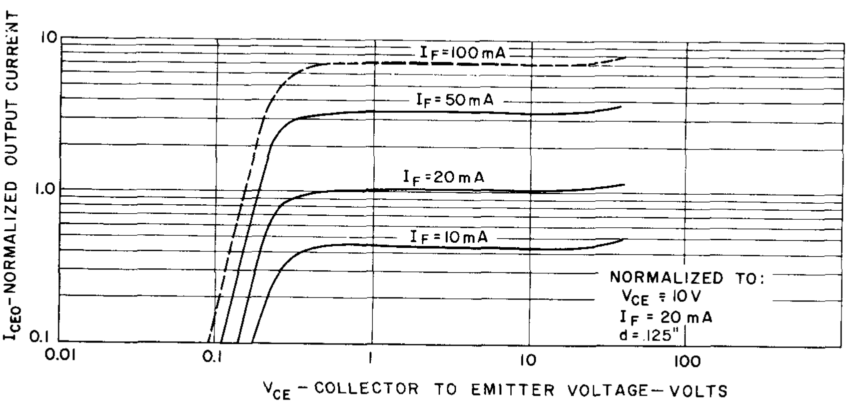


1. OUTPUT CURRENT VS. INPUT CURRENT

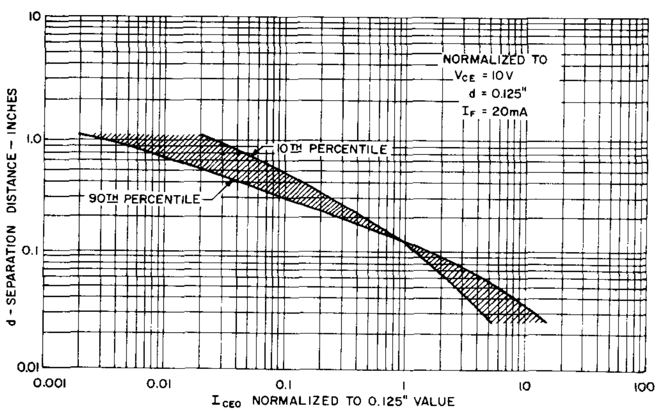




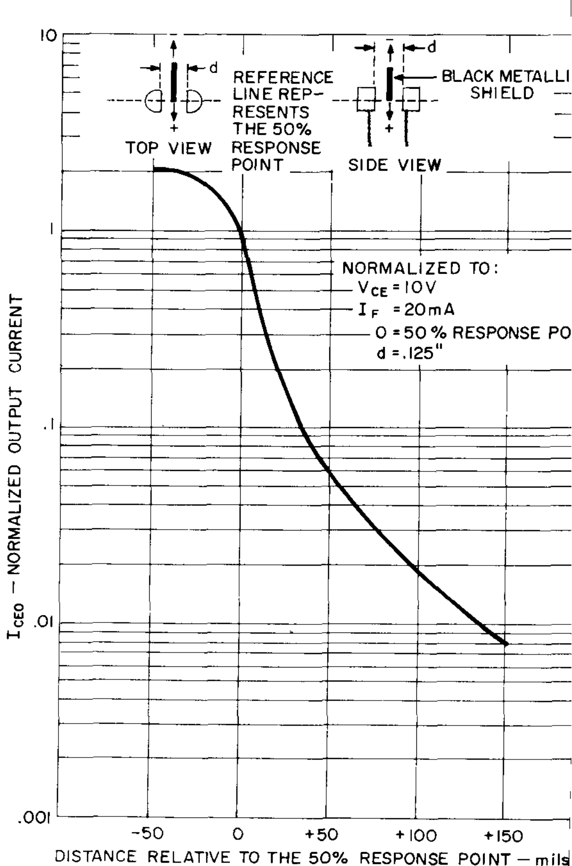
2. OUTPUT CURRENT VS. TEMPERATURE



3. OUTPUT CHARACTERISTICS

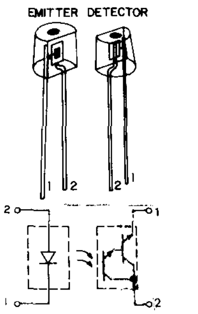


4. OUTPUT VS. DISTANCE DISTRIBUTION



5. OUTPUT CURRENT VS. SHIELD LOCATIO

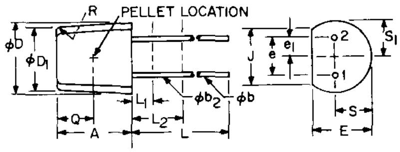
Matched Emitter – Detector Pair H17B1



The General Electric H17B1 is a matched emitter-detector pair which consists of a gallium arsenide, infrared emitting diode in a clear epoxy TO-92 type package and a silicon photo-darlington also in a clear epoxy TO-92 type package.

Each emitter and detector is marked with a color coded dot on the top of the unit (see package illustration). Emitter and detector must be paired as follows:

- Emitter — Detector
- BLACK matched — BROWN
- ORANGE matched to — YELLOW
- WHITE matched to — GREEN



NOTES:
1. (TWO LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND .5" (12.70MM) FROM SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND .5" (12.70MM) FROM SEATING PLANE.
2. THE CENTER LINE OF THE ACTIVE ELEMENT IS LOCATED WITHIN ±.020" (.51 MM) OF THE POSITION SHOWN.
3. AS MEASURED WITHIN .050" (1.27MM) OF THE SEATING PLANE.

SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.170	.210	4.31	5.34	
ϕb	.016	.021	.406	.534	1
ϕb_2	.016	.019	.406	.483	1
ϕD	.170	.200	4.31	5.08	
ϕD_1	.160	.190	4.06	4.83	
E	.125	.155	3.17	3.94	
e	.095	.105	2.41	2.67	3
e_1	.045	.055	1.14	1.40	3
J	.135	.170	3.42	4.32	
L	.500		12.70		1
L_1		.050		1.27	1
L_2	.250		6.35		1
Q	.095	REF.	2.29	REF.	2
R	.055		.12		
S	.080	.105	2.03	2.67	
S_1	.090	REF.	2.29	REF.	

FEATURES:

- Low Cost
- Side Looking
- I/O Compatible with Integrated Circuits

absolute maximum ratings: (25°C) (unless otherwise specified)

Storage and Operating Temperature -55°C to 100°C. Lead Soldering Time (at 260°C) 10 Seconds.

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak) (100 µs, 1% Duty Cycle)	1	ampere
Reverse Voltage	3	volts

*Derate 1.33mW/°C above 25°C ambient.

PHOTO-TRANSISTOR		
Power Dissipation	**150	milliwatts
Collector Current (Continuous)	100	milliamps
V_{CEO}	25	volts
V_{ECO}	7	volts

**Derate 2.0mW/°C above 25°C ambient.

individual electrical characteristics (25°C)

INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	1.2	1.7	volts
Reverse Current (V_R = 2V)	–	10	µamps
Capacitance (V = 0, f = 1MHz)	50	–	pf

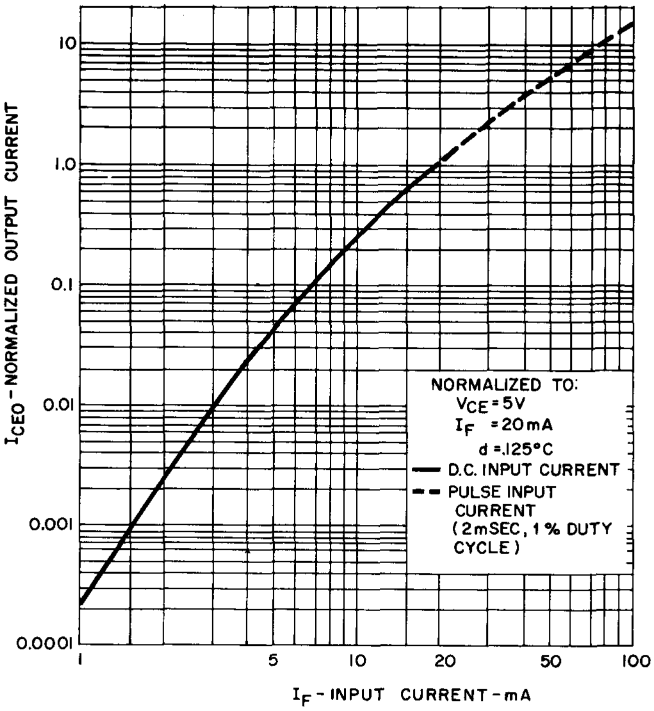
PHOTO-DARLINGTON	MIN.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 1mA)	25	–	volts
Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100µA)	7	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = 0, H ≈ 0)		100	**nA**

coupled electrical characteristics (25°C)

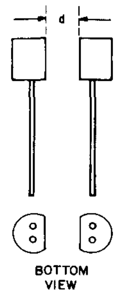
Note: Coupled electrical characteristics are measured at a separation distance of .125" with the faces of the emitter and detector parallel within 3°.

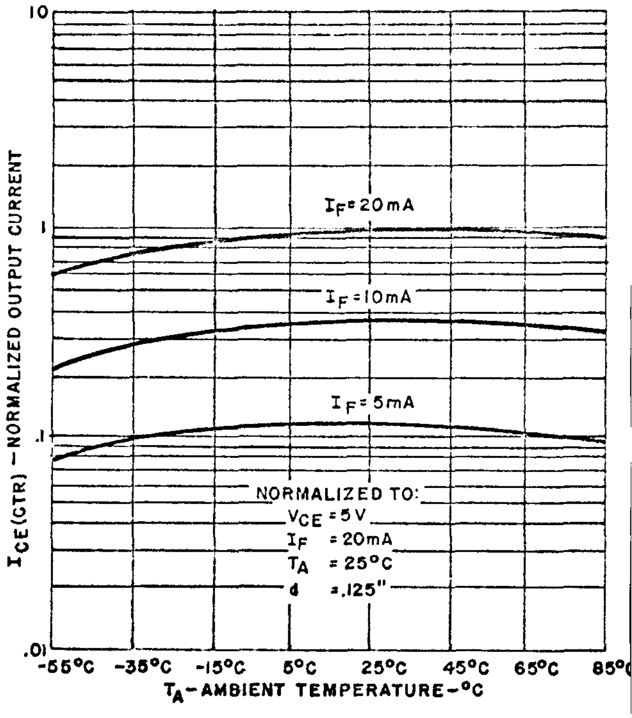
	MIN.	TYP.	MAX.	UNITS
Output Current (I_F = 20mA, V_{CE} = 5V)	1000	–	–	µamps
Saturation Voltage (I_F = 20mA, I_C = 0.5mA)	–	–	1.2	volts
Switching Speeds: Turn-On Time ($t_d + t_r$) (V_{CE} = 10V, I_C = 2mA, R_L = 100Ω)	–	150	–	µsecs
Turn-Off Time ($t_s + t_f$) (V_{CE} = 10V, I_C = 2mA, R_L = 100Ω)	–	150	–	µsecs

TYPICAL CHARACTERISTICS

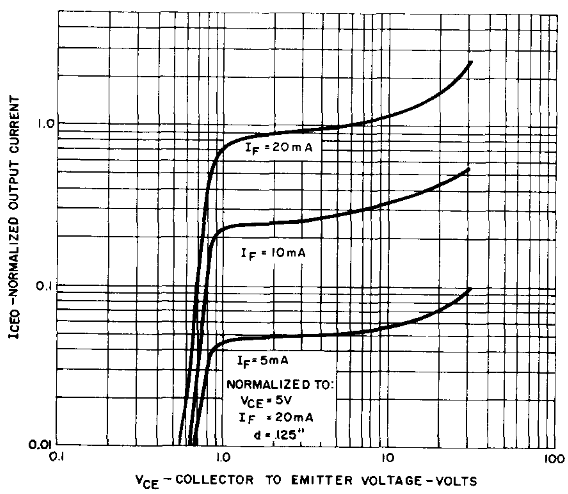


1. OUTPUT CURRENT VS. INPUT CURRENT

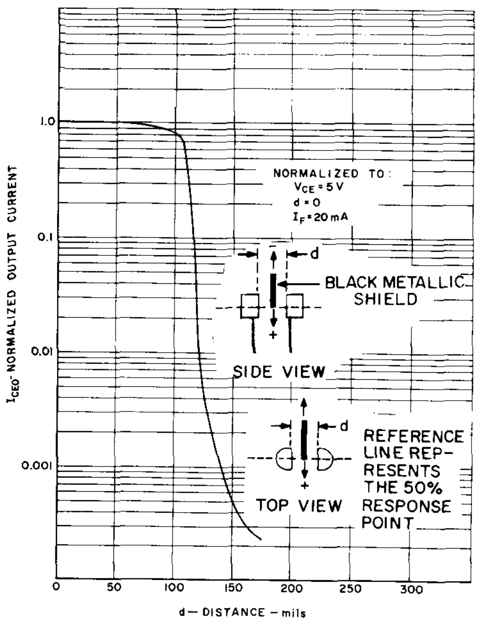




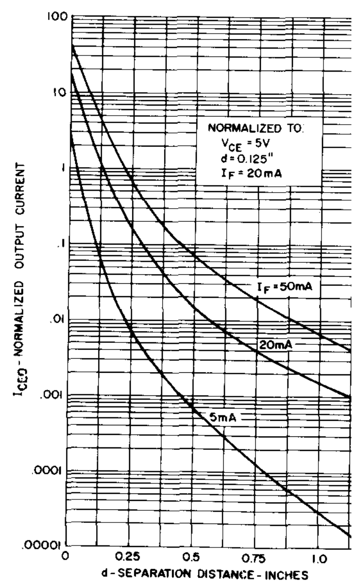
2. OUTPUT CURRENT VS. TEMPERATURE



3. OUTPUT CHARACTERISTICS



4. OUTPUT CURRENT VS. SHIELD LOCATION



5. OUTPUT VS. DISTANC

Matched Emitter – Detector Pair H19A1

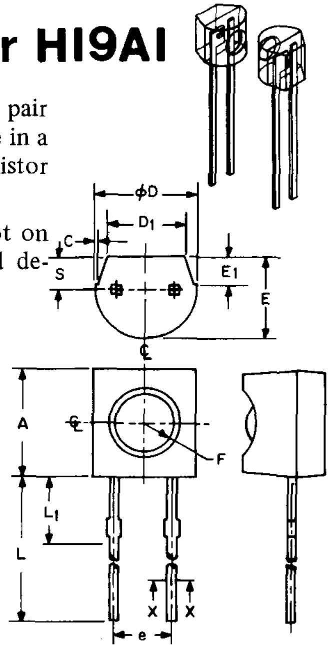
The General Electric H19A1 is a matched emitter-detector pair which consists of a gallium arsenide, infrared emitting diode in a clear epoxy TO-92 type package and a silicon photo-transistor also in a clear epoxy TO-92 type package.

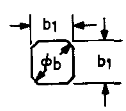
Each emitter and detector is marked with a color coded dot on the top of the unit (see package illustration). Emitter and detector must be paired as follows:

- Emitter — Detector
- BLACK matched to – BLUE
- ORANGE matched to – RED
- WHITE matched to – VIOLET

FEATURES:

- Low Cost
- Side Looking
- I/O Compatible with Integrated Circuits





SECTION X-X
LEAD PROFILE

SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.170	.210	4.32	5.33	1
φb	.016	.019	.407	.482	2
b1	.015 NOM.		.381	NOM.	
C	–	.005	–	.127	
φD	.165	.195	4.20	4.95	1
D1	.135	–	3.43	–	
e	.095	.105	2.42	2.66	3
E	.125	.165	3.18	4.19	
E1	.040	.060	1.02	1.52	
F	.050	NOM.	1.26	NOM.	
L	.500	–	12.70	–	
L1	–	.120	–	3.04	2
S	.047	.067	1.20	1.70	

NOTES:
1. CENTER LINE OF ACTIVE ELEMENT LOCATED WITHIN ±.020"(.50mm) OF CENTER POINT OF UNIT.
2. TWO LEADS. LEAD DIAMETER UNCONTROLLED IN L1.
3. AS MEASURED WITHIN .050"(1.27mm) OF THE BODY OF UNIT.

absolute maximum ratings: (25°C) (unless otherwise specified)

Storage and Operating Temperature -55°C to 100°C. Lead soldering Time (at 260°C) 10 Seconds.

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak) (100 μs, 1% Duty Cycle)	1	ampere
Reverse Voltage	3	volts

*Derate 1.3mW/°C above 25°C ambient.

PHOTO-TRANSISTOR		
Power Dissipation	**150	milliwatts
Collector Current (Continuous)	100	milliamps
V_{CEO}	30	volts
V_{ECO}	5	volts

**Derate 2.0mW/°C above 25°C ambient.

individual electrical characteristics (25°C)

INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	1.2	1.7	volts
Reverse Current (V_R = 2V)	–	10	μ amps
Capacitance (V = 0,f = 1 MHz)	50	–	pf

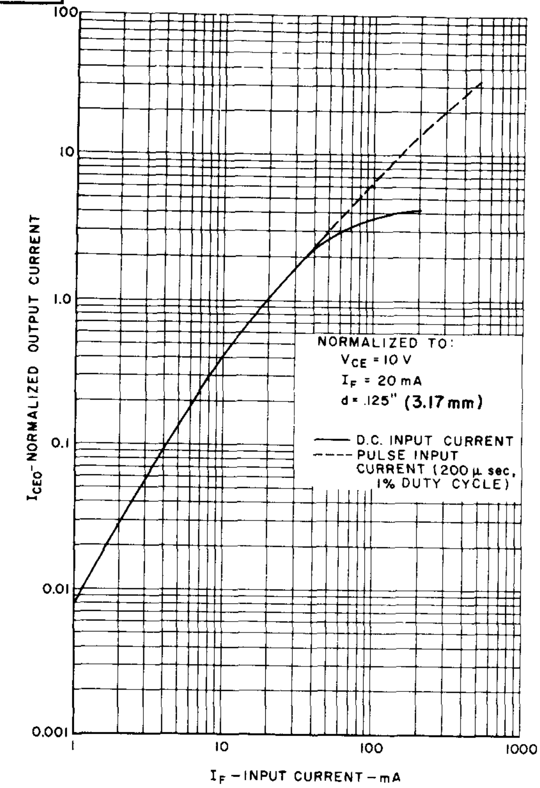
PHOTO-TRANSISTOR	MIN.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 1mA)	30	–	volts
Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100 μA)	5	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = 0,H ≈ 0)	–	100	nA

coupled electrical characteristics (25°C)

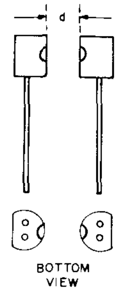
Note: Coupled electrical characteristics are measured at a separation distance of .125″ (3.17 mm) with the faces of the emitter and detector parallel within 3°.

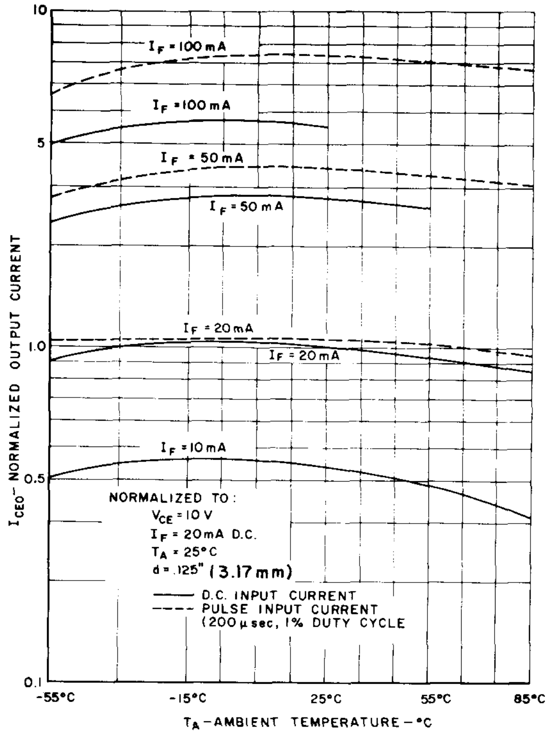
	MIN.	TYP.	MAX.	UNITS
Output Current (I_F = 20mA, V_{CE} = 10V)	100	–	–	μ amps
Saturation Voltage (I_F = 20mA, I_C = 25 μA)	–	0.2	0.4	volts
Switching Speeds: Turn-On Time ($t_d + t_r$) (V_{CE} = 10V, I_C = 2mA, R_L = 100Ω)	–	5	–	μ secs
Turn-Off Time ($t_s + t_f$) (V_{CE} = 10V, I_C = 2mA, R_L = 100Ω)	–	5	–	μ secs

TYPICAL CHARACTERISTICS

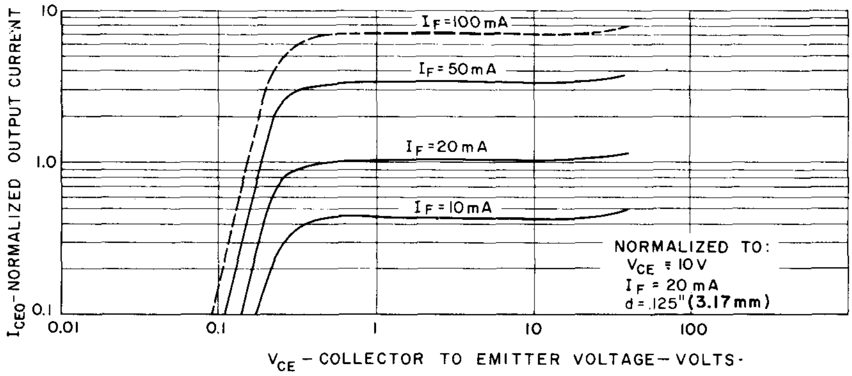


1. OUTPUT CURRENT VS. INPUT CURRENT

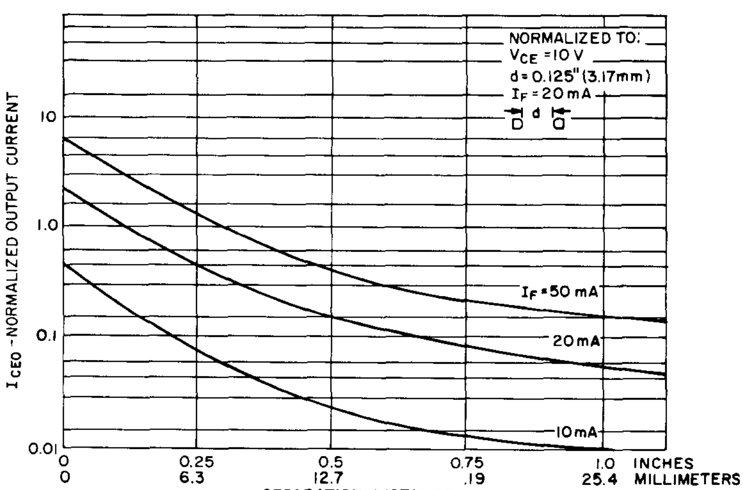




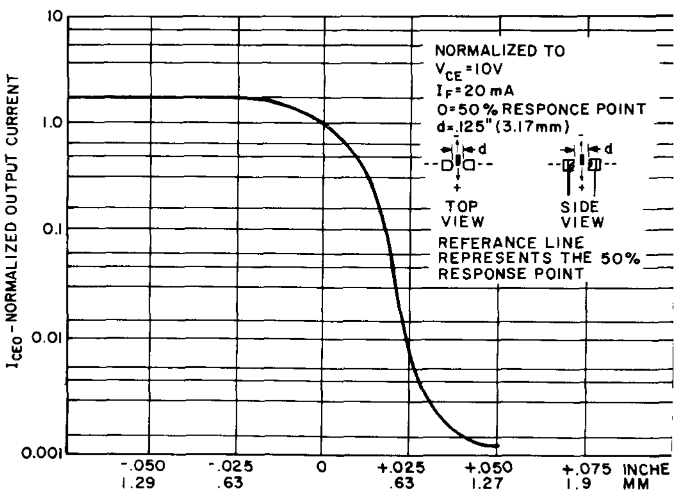
2. OUTPUT CURRENT VS. TEMPERATURE



3. OUTPUT CHARACTERISTICS



4. OUTPUT VS. DISTANCE DISTRIBUTION



5. OUTPUT CURRENT VS. SHIELD LOCATION

Matched Emitter – Detector Pair H19B1

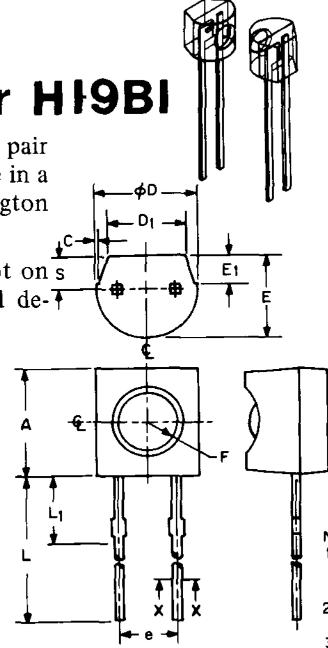
The General Electric H19B1 is a matched emitter-detector pair which consists of a gallium arsenide, infrared emitting diode in a clear epoxy TO-92 type package and a silicon photo-darlington also in a clear epoxy TO-92 type package.

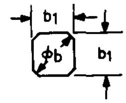
Each emitter and detector is marked with a color coded dot on the top of the unit (see package illustration). Emitter and detector must be paired as follows:

- Emitter – Detector
- BLACK matched to – BROWN
- ORANGE matched to – YELLOW
- WHITE matched to – GREEN

FEATURES:

- Low Cost
- Side Looking
- I/O Compatible with Integrated Circuits





SECTION X-X
LEAD PROFILE

SYMBOL	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
A	.170	.210	4.32	5.33	1
ϕb	.016	.019	.407	.482	2
b1	.015 NOM.		.381	NOM.	
C	–	.005	–	.127	
ϕD	.165	.195	4.20	4.95	1
D1	.135	–	3.43	–	
e	.095	.105	2.42	2.66	3
E	.125	.165	3.18	4.19	
E1	.040	.060	1.02	1.52	
F	.050	NOM.	1.26	NOM.	
L	.500	–	12.70	–	
L1	–	.120	–	3.04	2
S	.047	.067	1.20	1.70	

NOTES:
1. CENTER LINE OF ACTIVE ELEMENT LOCATED WITHIN ±.020"(.50mm) OF CENTER POINT OF UNIT.
2. TWO LEADS. LEAD DIAMETER UNCONTROLLED IN L_1.
3. AS MEASURED WITHIN .050"(1.27mm) OF THE BODY OF UNIT.

absolute maximum ratings: (25°C) (unless otherwise specified)

Storage and Operating Temperature -55°C to 100°C. Lead Soldering Time (at 260°C) 10 Seconds.

INFRARED EMITTING DIODE		
Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak) (100μs, 1% Duty Cycle)	1	ampere
Reverse Voltage		

*Derate 1.33mW/°C above 25°C ambient.

PHOTO-TRANSISTOR		
Power Dissipation	**150	milliwatts
Collector Current (Continuous)	100	milliamps
V_{CEO}	25	volts
V_{ECO}	7	volts

** Derate 2.0mW/°C above 25°C ambient.

individual electrical characteristics (25°C)

INFRARED EMITTING DIODE	TYP.	MAX.	UNITS
Forward Voltage (I_F = 10mA)	1.2	1.7	volts
Reverse Current (V_R = 2V)	–	10	μ amps
Capacitance (V = 0,f = 1 MHz)	50	–	pf

PHOTO-DARLINGTON	MIN.	MAX.	UNITS
Breakdown Voltage – $V_{(BR)CEO}$ (I_C = 1mA)	25	–	volts
Breakdown Voltage – $V_{(BR)ECO}$ (I_E = 100μA)	7	–	volts
Collector Dark Current – I_{CEO} (V_{CE} = 10V, I_F = 0,H ≈ 0)	–	100	nA

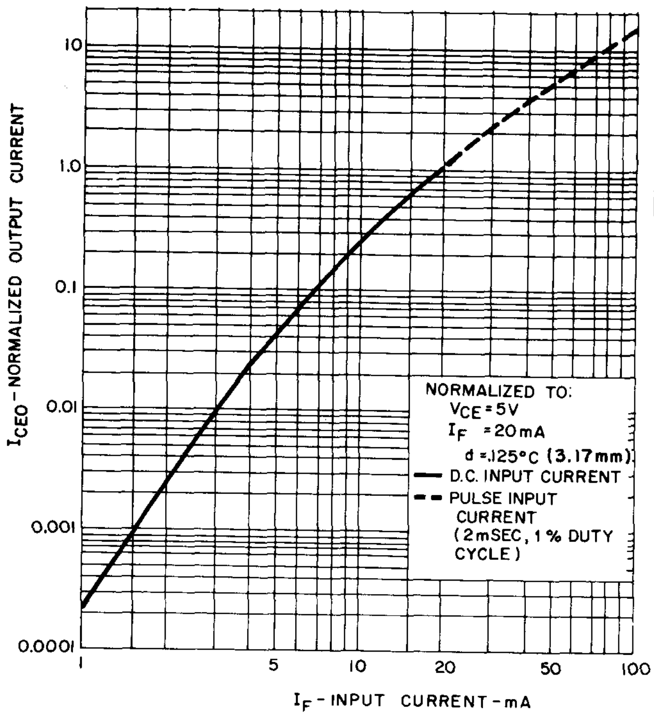
coupled electrical characteristics (25°C)

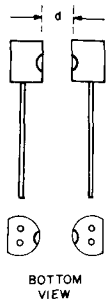
Note: Coupled electrical characteristics are measured at a separation distance of .125" (3.17 mm) with the faces of the emitter and detector parallel within 3°.

	MIN.	TYP.	MAX.	UNITS
Output Current (I_F = 20mA, V_{CE} = 5V)	2000	–	–	μ amps
Saturation Voltage (I_F = 20mA, I_C = 0.5mA)	–	–	1.2	volts
Switching Speeds: Turn-On Time ($t_d + t_r$) (V_{CE} = 10V, I_C = 2mA, R_L = 100Ω)	–	150	–	μ secs
Turn-Off Time ($t_s + t_f$) (V_{CE} = 10V, I_C = 2mA, R_L = 100Ω)	–	150	–	μ secs

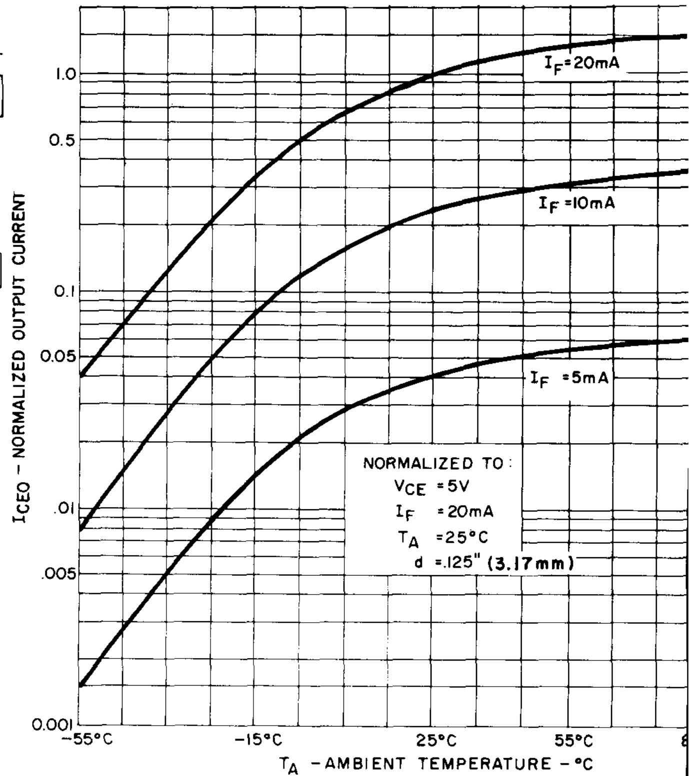
TYPICAL CHARACTERISTICS

H19B1

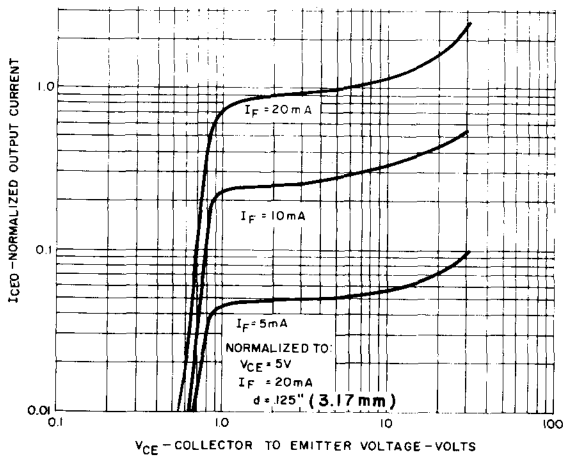




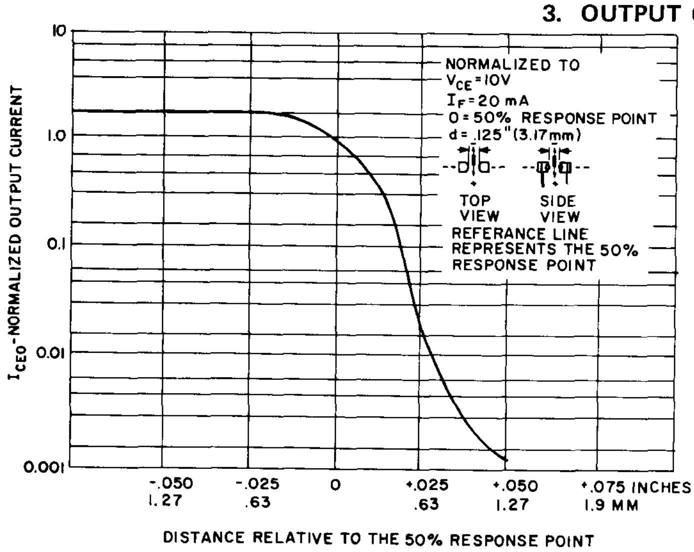
1. OUTPUT CURRENT VS. INPUT CURRENT



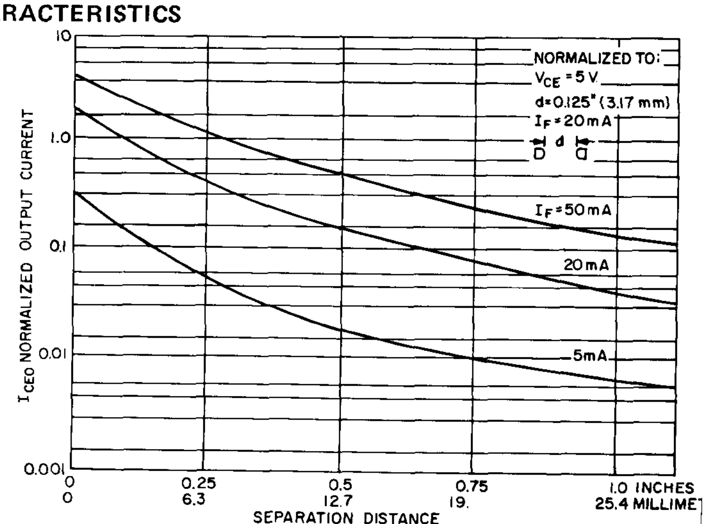
2. OUTPUT CURRENT VS. TEMPERATURE



3. OUTPUT CHARACTERISTICS



4. OUTPUT CURRENT VS. SHIELD LOCATION

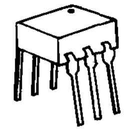


5. OUTPUT VS. DISTANCE DISTRIBUTION

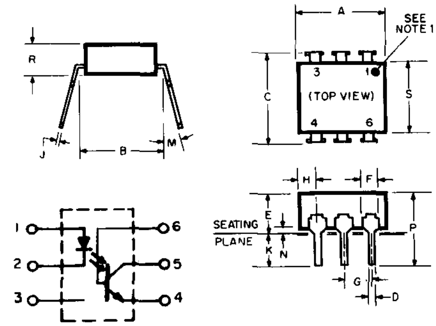
Photon Coupled Isolator H74A1

Ga As Infrared Emitting Diode & NPN Silicon Photo-Transistor

TTL Interface



The General Electric H74A1 provides logic to logic optical interfacing of TTL gates with *guaranteed* level compatibility in practical *specified* circuits. The H74A1 is a transistor output photo-coupled isolator specifically designed to eliminate ground loop cross talk and reflection problems when two distinct logic systems are coupled. It is guaranteed to couple 7400, 74H00 and 74S00 logic gates over the full TTL temperature and voltage ranges.



absolute maximum ratings: (25°C) (unless otherwise specified)

INFRARED EMITTING DIODE

Power Dissipation	$T_A = 25°C$	*100	milliwatts
Power Dissipation	$T_C = 25°C$	*100	milliwatts
(T_C indicates collector lead temperature 1/32″ from case)			
Forward Current (Continuous)		60	milliamps
Forward Current (Peak)		3	ampere
(Pulse width 1μsec 300 pps)			
Reverse Voltage		6	volts

*Derate 2.2mW/°C above 25°C.

PHOTO-TRANSISTOR

Power Dissipation	$T_A = 25°C$	**300	milliwatts
Power Dissipation	$T_C = 25°C$	***500	milliwatts
(T_C indicates collector lead temperature 1/32″ from case)			
V_{CEO}		15	volts
V_{CBO}		15	volts
V_{ECO}		5.5	volts
Collector Current (Continuous)		50	milliamps

**Derate 6.7mW/°C above 25°C.
***Derate 11.1mW/°C above 25°C.

TOTAL DEVICE

Storage Temperature -55 to 150°C
Operating Temperature 0 to 70°C
Lead Soldering Time (at 260°C) 10 seconds
Surge Isolation Voltage (Input to Output)
1500$V_{(peak)}$ 1060$V_{(RMS)}$
Steady-State Isolation Voltage (Input to Output)
950$V_{(peak)}$ 660$V_{(RMS)}$

SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF.	7.62	REF.	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to terminal 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

Electrical Characteristics of H74A1*

*All specifications refer to the following bias configuration (Figure 1) over the full operating temperature (0°C to 70°C) and logic supply voltage range (4.5 to 5.5V_{DC}) unless otherwise noted.

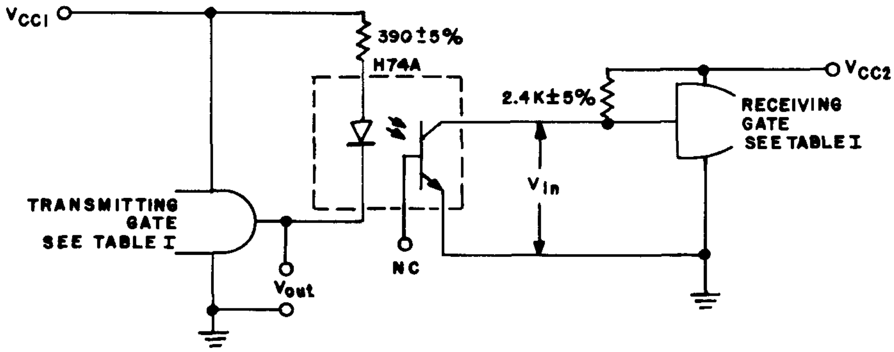


Figure 1. H74A1 BIAS CIRCUIT

V_{in} (0), Receiving Gate For $V_{OUT(0)}$ from Transmitting Gate – . . . . . . 0.8 V Max.
V_{in} (1), Receiving Gate for $V_{OUT(1)}$ from Transmitting Gate – . . . . . . 2.4 V Min.
t_p (0), Transmitting Gate to Receiving Gate Propagation Time – . . . . . . 20 μsec. Typ.
t_p (1), Transmitting Gate to Receiving Gate Propagation Time – . . . . . . 4 μsec. Typ.
Isolation Resistance (Input to Output = 500V_{DC}). . . . . . 100 gigaohms Min.
Input to Output Capacitance (Input to Output Voltage = O, f = 1 MHz) . . . . . . 2.5 pF Max.

TABLE I.

CHARACTERISTICS REQUIRED OF TTL GATES WHICH ARE TO BE INTERFACED BY H74A1

PARAMETER	TEST CONDITIONS, FIGURE 2						LIMITS		
	V_{CC}		I_{IN}		I_{SINK}		Min.	Max.	Units
	Min.	Max.	Min.	Max.	Min.	Max.			
V_{OUT} (1)	4.5V					-0.4mA	2.4		Volts
V_{OUT} (0)	4.5V				12.0mA			0.4	Volts
V_{IN} (1)		5.5V		1.0mA			2.0		Volts
V_{IN} (0)		5.5V	-1.6mA					0.8	Volts

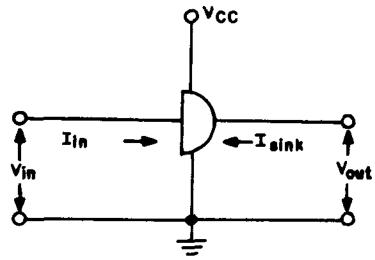
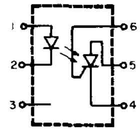


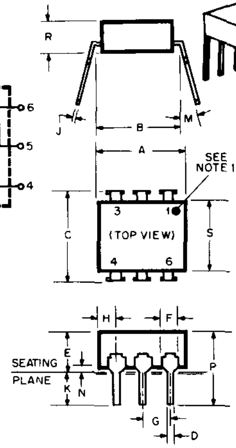
Figure 2.

Photon Coupled Isolator H74C1, H74C2

Ga As Infrared Emitting Diode & Light Activated SCR



TTL Interface



SYMBOL	INCH MIN.	INCH MAX.	MILLIMETER MIN.	MILLIMETER MAX.	NOTES
A	.330	.350	8.38	8.89	
B	.300	REF.	7.62	REF.	2
C		.340		8.64	3
D	.016	.020	.406	.508	
E		.200		5.08	4
F	.040	.070	1.01	1.78	
G	.090	.110	2.28	2.79	
H		.085		2.16	5
J	.008	.012	.203	.305	
K	.100		2.54		3
M		15°		15°	
N	.015		.381		3
P		.375		9.53	
R	.100	.185	2.54	.470	
S	.225	.280	5.71	7.12	

NOTES:
1. There shall be a permanent indication of terminal orientation in the quadrant adjacent to *terminal* 1.
2. Installed position lead centers.
3. Overall installed dimension.
4. These measurements are made from the seating plane.
5. Four places.

The General Electric H74C1 and H74C2 are gallium arsenide infrared emitting diodes coupled with light activated silicon controlled rectifiers in a dual in-line package. They are specifically designed to operate from TTL logic inputs and allow control of 120 or $240V_{AC}$ power with 7400, 74H00 and 74S00 series logic gates. It can also control up to $400V_{DC}$ power circuits. They are guaranteed and specified to operate over TTL voltage and temperature ranges using standard tolerance components.

absolute maximum ratings: (25°C) (unless otherwise specified)

INFRARED EMITTING DIODE

Power Dissipation	*100	milliwatts
Forward Current (Continuous)	60	milliamps
Forward Current (Peak 100μsec 1% duty cycle)	1	ampere
Reverse Voltage	6	volts

*Derate 1.33 mW/°C above 25°C ambient.

PHOTO – SCR

Peak Forward Voltage		
H74C1	200	volts
H74C2	400	volts
RMS Forward Current	300	milliamps
Forward Current (Peak, 100μsec 1% duty cycle)	10	amperes
Surge Current (10 msec)	5	amperes
Reverse Gate Voltage	6	volts
Power Dissipation (25°C Ambient)	** 400	milliwatts
Power Dissipation (25°C Case)	***1000	milliwatts

**Derate 5.3 mW/°C above 25°C ambient.
***Derate 13.3 mW/°C above 25°C case.

electrical characteristics of H74C*

*All specifications refer to the following bias configuration (Figure 1) over the full operating temperature (0°C to 70°C) and logic supply voltage range (4.5 to $5.5V_{DC}$) unless otherwise noted.

SCR Leakage, Logic Gate $V_{OUT(1)}$, Both Directions	50	μA Max.
SCR Drop, Anode Positive, Logic Gate $V_{OUT(0)}$, I_{TM} = 250mA	1.3	V Max.
Coupled dv/dt to Trigger, V_{DC} to V_{AC} (25°)	500	V/μsec. Min.
Capacitance (Input to Output Voltage = 0, f = 1 MHz)	2	pF Max.
Isolation Resistance (Input to Output Voltage = $500V_{DC}$)	100	Gigaohms Min
Turn-On Time of SCR; $V_{OUT(0)}$, Input to Output (25°C)	200	μsec. Max.

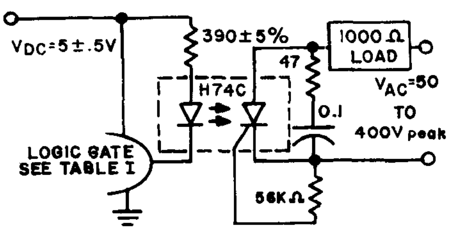


Figure 1. H74C BIAS CIRCUIT

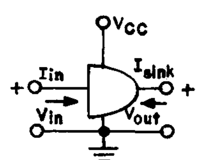


Figure 2.

H74C1, H74C2 absolute maximum ratings – total device

SCR Current	See Figure 4
Operating Temperature Range	0°C to 70°C
Operating Voltage Range, V_{DC}	4.5 to 5.5V_{DC}
Operating Voltage Range, H74C1	50 to 200 V_{pk}
Operating Voltage Range, H74C2	50 to 400 V_{pk}
Storage Temperature Range	-55°C to 150°C
Lead Soldering Time (at 260°C)	10 sec. Max.
Surge Isolation Voltage (Input to Output)	1500 $V_{(peak)}$ 1060V_{RMS}
Steady-State Isolation Voltage (Input to Output)	950 $V_{(peak)}$ 660V_{RMS}

TABLE 1. Characteristics required of TTL gate which is to be interfaced with H74

PARAMETER	TEST CONDITIONS, FIGURE 2						LIMITS		
	V_{CC}		I_{IN}		I_{SINK}		MIN.	MAX.	UNITS
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.			
V_{OUT} (1)	4.5V					-0.4mA	2.4		Volts
V_{OUT} (0)	4.5V				12.0mA			0.4	Volts

TYPICAL CHARACTERISTICS OF OUTPUT (SCR)

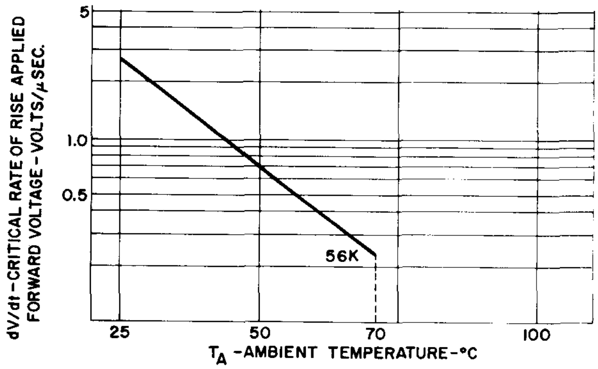


FIGURE 1. dv/dt VS. TEMPERATURE

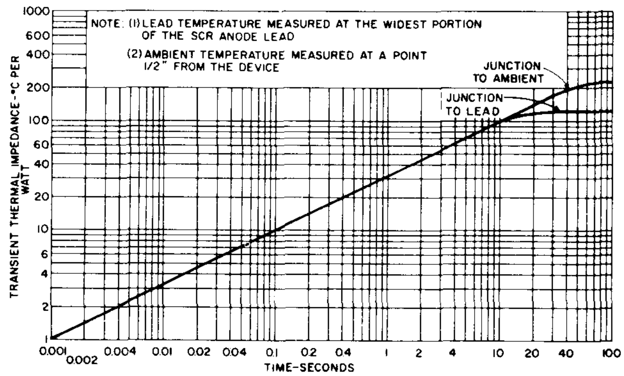


FIGURE 2. MAXIMUM TRANSIENT THERMAL IMPEDANCE

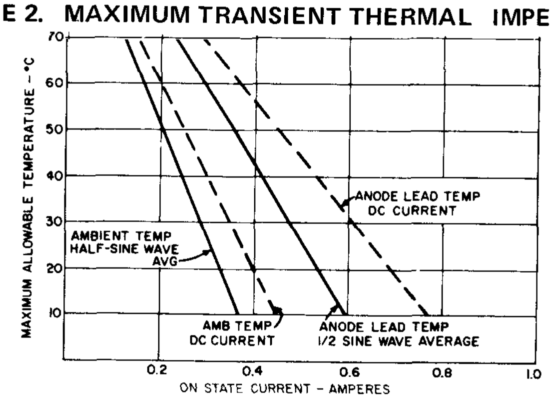


FIGURE 4. ON-STATE CURRENT VS. MAXIMUM ALLOWABLE TEMPERATURE

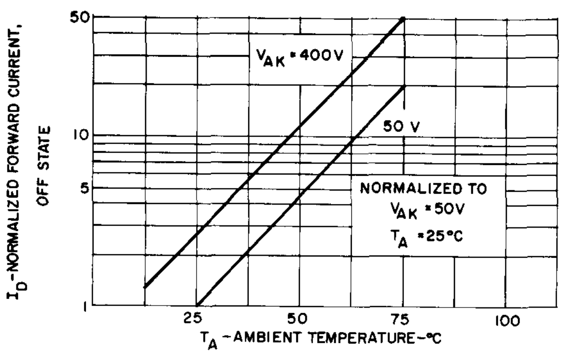


FIGURE 3. OFF-STATE FORWARD CURRENT VS. TEMPERATURE

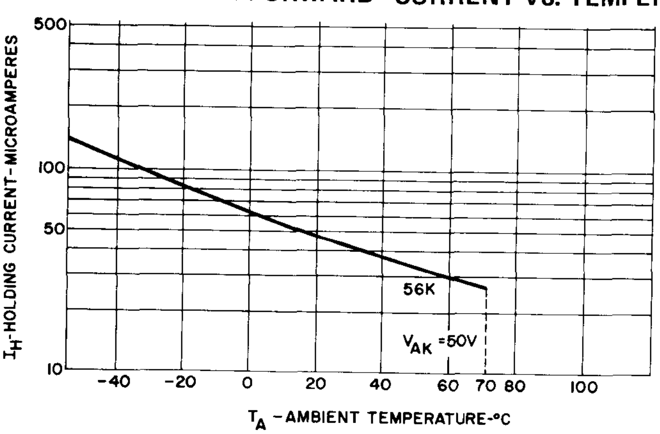


FIGURE 5. HOLDING CURRENT VS. TEMPERATURE

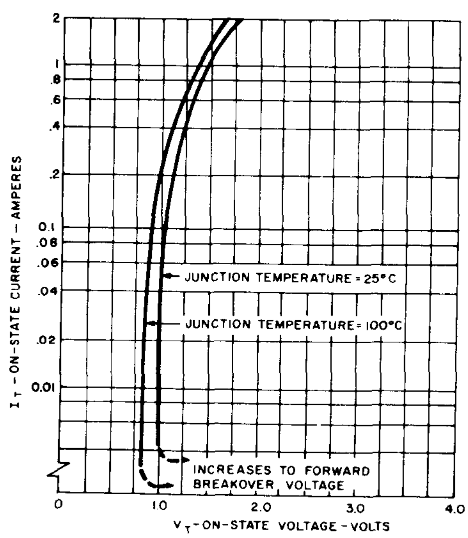


FIGURE 6. ON-STATE CHARACTERISTICS

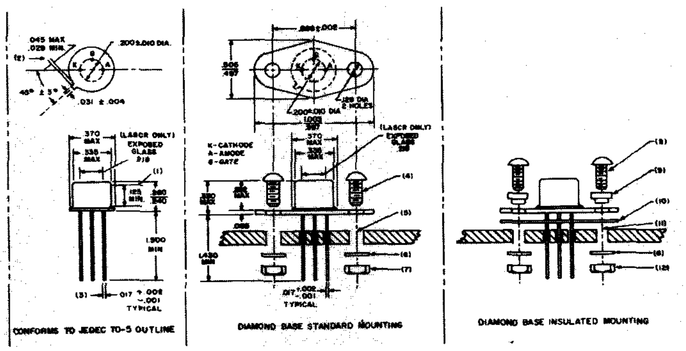
SCR L8,9 L811,L911 (Diamond Base*)

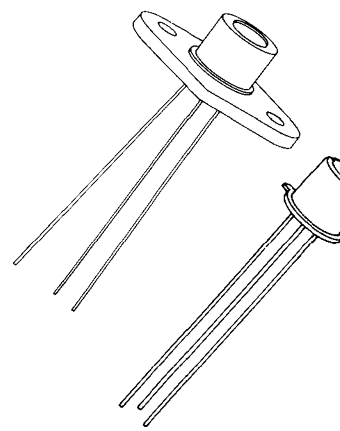
The L8, L9 Light Activated SCR's are basically Silicon Controlled Rectifiers with incident light taking the place of (or adding to) an electrical gate current. Thus it is a photo-operated device that is truly a switch. It features optional gate triggering inputs; i.e., from either an isolated light source or direct electrical supply. The former trigger technique offers a range of light trigger intensity with varying gate bias. The L8, L9 is expected to be particularly useful in such applications as:

- **Optical logic control**
- **Counting**
- **Sorting**
- **Precision Indexing**
- **Explosion proff isolated switches**
- **Static Relays**
- **Meter Relays**

OUTLINE DRAWING

(1) This zone is controlled for automatic handling. The variation in actual diameter within this zone shall not exceed .010.
(2) Measured from max. diameter of the actual device.
(3) The specified lead diameter applies in the zone between .050 and .250 from the base seal. Between .250 and 1.5 maximum of .021 diameter is held. Outside of these the lead diameter is not controlled. Leads may be inserted, without damage in .031 holes while device enters .371 hole concentric with lead hole circle.
(4) #4-40 screw, st'n steel ⁷⁄₁₆" long
(5) .120 hole (#31 drill)
(6) Int tooth lockwasher, st'n steel
(7) #4-40 nut, st'n steel
(8) #2-56 screw, st'n steel ⅜" long
(9) Shoulder washer, teflon
(10) Mica insulator, .003 thick
(11) .0935 hole (#42 drill)
(12) #2-56 nut, st'n steel
All dimensions in inches





Type†	Peak Forward Blocking Voltage, V_{FXM}. $T_J = -65°C$ to $+100°C$ $R_{GK} = 56{,}000$ Ohms Maximum	Working and Repetitive Peak Reverse Voltage, V_{ROM} (wkg) and V_{ROM} (rep). $T_J = -65°C$ to $+100°C$	Non-Repetitive Peak Reverse Voltage, V_{ROM} (non-rep) (< 5 Millisec.) $T_J = -65°C$ to $+100°C$
L8U, L9U	25 Volts	25 Volts	40 Volts
L8F, L9F	50 Volts	50 Volts	75 Volts
L8A, L9A	100 Volts	100 Volts	150 Volts
L8G, L9G	150 Volts	150 Volts	225 Volts
L8B, L9B	200 Volts	200 Volts	300 Volts

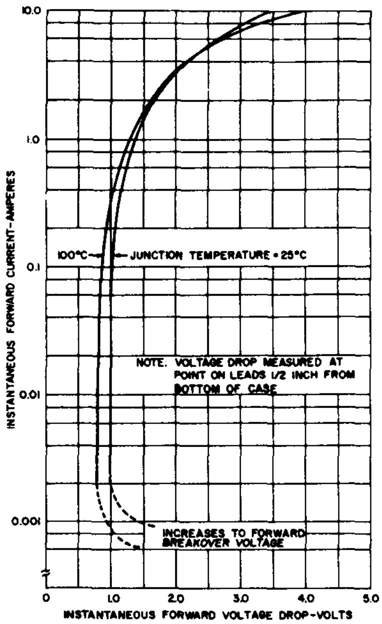
†When ordering the Diamond Base versions, be sure to include the proper voltage letter symbol. For example: The 25 volt, Diamond Base version of the L8U is type number L811U.

Peak Forward Voltage, PFV	300	Volts
RMS Forward Current, On-state	1.6	Amperes
Average Forward Current, On-state	Depends on conduction angle (see charts 11, 12, 15, & 16)	
Peak One Cycle Surge Forward Current (Non-repetitive), I_{FM} (surge)	15	Amperes
I^2t (for fusing)	0.5	Ampere² seconds (for times < 1.5 milliseconds)
Peak Forward Gate Power Dissipation, P_{GM}	0.1	Watt
Average Forward Gate Power Dissipation, P_G (AV)	0.01	Watt
Peak Gate Voltage, Forward & Reverse, V_{GFM} & V_{GRM}	6	Volts
Storage Temperature, T_{stg}	−65°C to +150°C	
Operating Temperature	−65°C to +100°C	
Peak Non-recurrent Surge Forward Current During Turn-on Time Interval (Current Rise Time < 5 Microseconds)	40	Amperes

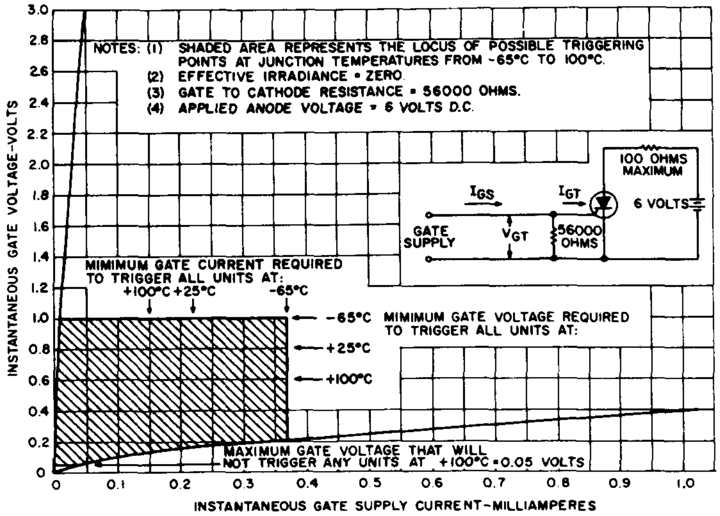
*The L811 and L911 series are identical to the L8 and L9 respectively except that they are soldered to a diamond base heat sink. See charts 14, 15, & 16 for Transient Thermal Resistance and Current Curves, and Page 4 for Outline Drawings.

CHARACTERISTICS

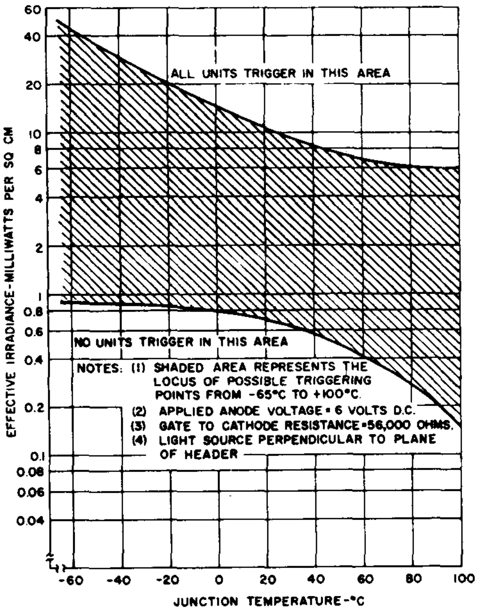
Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Forward Breakover Voltage	$V_{(BR)FX}$				Volts	$T_J = -65°C$ to $+100°C$ $R_{GK} = 56,000$ Ohms Sinusoidal Waveform, 60 CPS. $H_e < 0.02$ MW/CM² for L9 types $H_e < 0.08$ MW/CM² for L8 types
L8U, L9U		25	—	—		
L8F, L9F		50	—	—		
L8A, L9A		100	—	—		
L8G, L9G		150	—	—		
L8B, L9B		200	—	—		
Forward Blocking Current	I_{FX}	—	2.0	10	μamperes	V_{FX} = Rated V_{FXM}, $R_{GK} = 56,000$ Ohms $T_J = +25°C$, $H_e < 0.02$ or 0.08 MW/CM²
		—	40	100	μamperes	V_{FX} = Rated V_{FXM}, $R_{GK} = 56,000$ Ohms $T_J = +100°C$, $H_e < 0.02$ or 0.08 MW/CM²
Reverse Blocking Current	I_{RX}	—	2.0	10	μamperes	V_{RX} = Rated $V_{ROM(rep)}$, $R_{GK} = 56,000$ Ohms $T_J = +25°C$, $H_e < 0.02$ or 0.08 MW/CM²
		—	40	100	μamperes	V_{RX} = Rated $V_{ROM(rep)}$, $R_{GK} = 56,000$ Ohms $T_J = +100°C$, $H_e < 0.02$ or 0.08 MW/CM²
Gate Supply Trigger Current	I_{GS}	—	20	220	μamperes	$V_{FX} = 6$ Vdc, $R_{GK} = 56,000$ Ohms, $R_L = 100$ Ohms, $T_J = +25°C$, $H_e = 0$
		—	10	150	μamperes	$V_{FX} = 6$ Vdc, $R_{GK} = 56,000$ Ohms, $R_L = 100$ Ohms, $T_J = +100°C$, $H_e = 0$
		—	30	370	μamperes	$V_{FX} = 6$ Vdc, $R_{GK} = 56,000$ Ohms, $R_L = 100$ Ohms, $T_J = -65°C$, $H_e = 0$
Gate Trigger Voltage	V_{GT}	0.3	0.5	0.8	Vdc	$V_{FX} = 6$ Vdc, $R_{GK} = 56,000$ Ohms, $R_L = 100$ Ohms, $T_J = +25°C$, $H_e = 0$
		—	0.2	0.6	Vdc	$V_{FX} = 6$ Vdc, $R_{GK} = 56,000$ Ohms, $R_L = 100$ Ohms, $T_J = +100°C$, $H_e = 0$
		—	0.7	1.0	Vdc	$V_{FX} = 6$ Vdc, $R_{GK} = 56,000$ Ohms, $R_L = 100$ Ohms, $T_J = -65°C$, $H_e = 0$
		0.05	0.15	—	Vdc	V_{FX} = Rated V_{FXM}, $R_{GK} = 56,000$ Ohms, $R_L = 100$ Ohms, $T_J = +100°C$, $H_e = 0$
Peak On-Voltage	V_{FM}	—	1.2	1.4	Volts	$T_J = +25°C$, $I_{FM} = 1$ ampere Single half sine wave pulse, 2.0 milliseconds wide.
Holding Current	I_{HX}	20	75	560	μamperes	$T_J = +25°C$, $V_{FX} = 5$ Vdc, $H_e = 0$ $R_{GK} = 56,000$ Ohms
		10	40	450	μamperes	$T_J = +100°C$, $V_{FX} = 5$ Vdc, $H_e = 0$ $R_{GK} = 56,000$ Ohms
		30	180	750	μamperes	$T_J = -65°C$, $V_{FX} = 5$ Vdc, $H_e = 0$ $R_{GK} = 56,000$ Ohms
Effective Irradiance to Trigger	H_{ET}				Milliwatts/CM²	$V_{FX} = 6$ Vdc, $R_L = 100$ Ohms $R_{GK} = 56,000$ Ohms. Light Source Perpendicular to Plane of Header.
L8		0.68	5.0	10.0		$T_J = +25°C$
L9		0.68	2.0	4.2		
L8		0.15	2.0	6.0		$T_J = +100°C$
L9		0.15	0.7	2.5		
L8		0.9	15.0	50.0		$T_J = -65°C$
L9		0.9	4.0	20.0		
L8		0.02	—	—		$T_J = +100°C$, $R_{GK} = 56,000$ Ohms, V_{FX} = Rated V_{FXM}, $R_L = 500$ Ohms, Light Source Perpendicular to Plane of Header.
L9		0.02	—	—		
Rate of Rise of Applied Forward Voltage	dv/dt				Volts/μsec	$T_J = +100°C$, $R_{GK} = 56,000$ Ohms
L8U, L9U		0.01	0.02	—		$V_{FXM} = 25$ Volts
L8F, L9F		0.02	0.04	—		$V_{FXM} = 50$ Volts
L8A, L9A		0.05	0.07	—		$V_{FXM} = 100$ Volts
L8G, L9G		0.07	0.10	—		$V_{FXM} = 150$ Volts
L8B, L9B		0.09	0.12	—		$V_{FXM} = 200$ Volts
Delay Time	t_d	—	1 to 100	—	μsec	See Application Note 200.34
Rise Time	t_r	—	0.6	—	μsec	$T_J = +25°C$, $I_F = 1.0$ Ampere, V_{FX} = Rated V_{FXM}
Circuit-Commutated Turn-off Time	t_{off}	—	40	—	μsec	$T_J = +100°C$, $I_{FM} = 1.0$ Ampere, I_R (recovery) = 1.0 Ampere, Reapplied V_{FXM}=Rated V_{FXM}, Rate of Rise of Reapplied. $V_{FXM} = 20$ Volts Per μsec, $R_{GK} = 100$ Ohms, $H_e = 0$



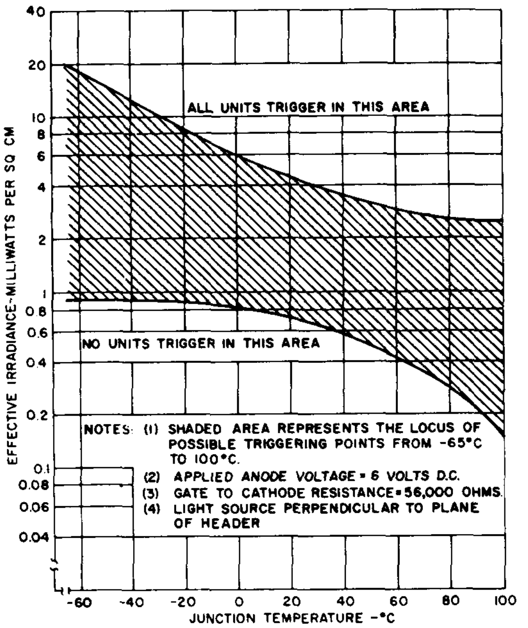
1. MAXIMUM FORWARD CHARACTERISTICS, ON-STATE



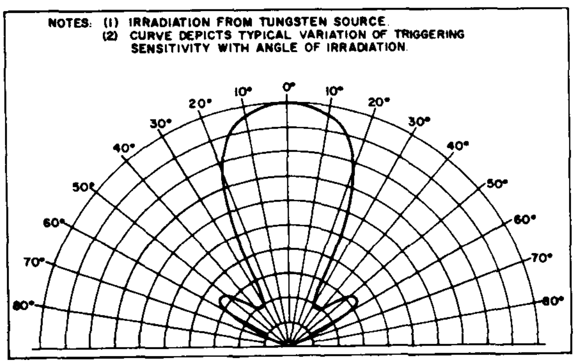
2. ELECTRICAL GATE TRIGGERING CHARACTERISTICS



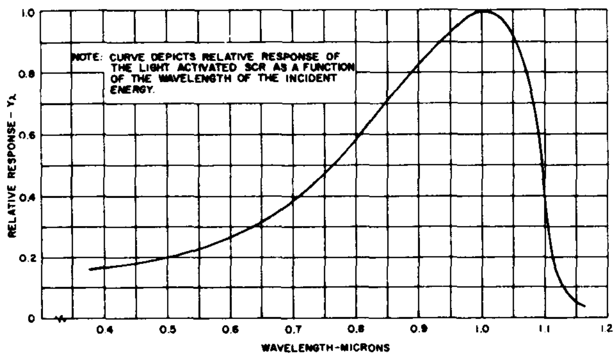
3. L8 LIGHT TRIGGERING CHARACTERISTICS



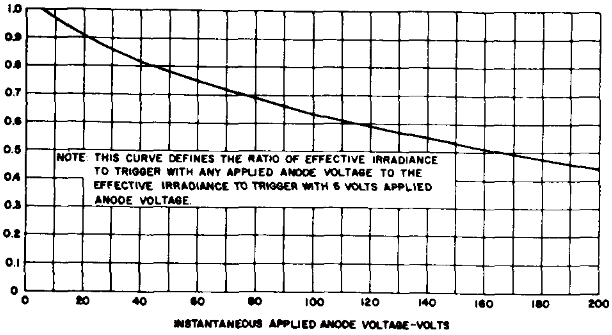
4. L9 LIGHT TRIGGERING CHARACTERISTICS



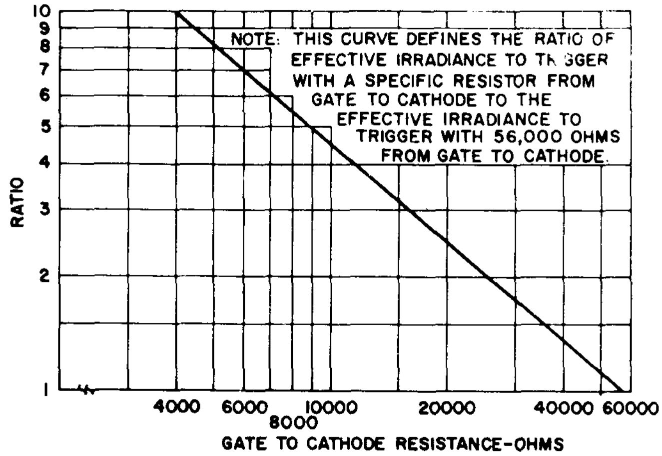
5. TYPICAL ANGULAR RESPONSE



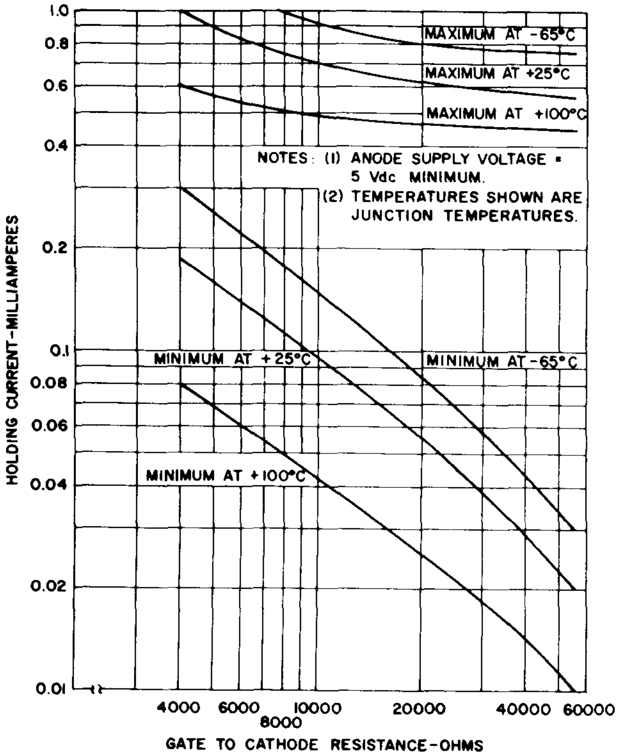
6. TYPICAL SPECTRAL RESPONSE



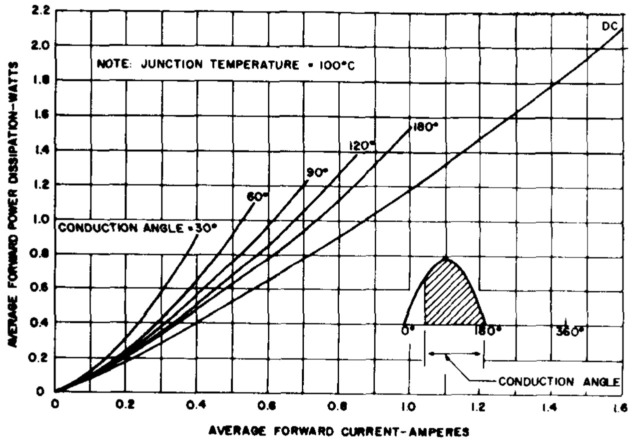
7. TYPICAL VARIATION OF LIGHT SENSITIVITY WITH ANODE VOLTAGE



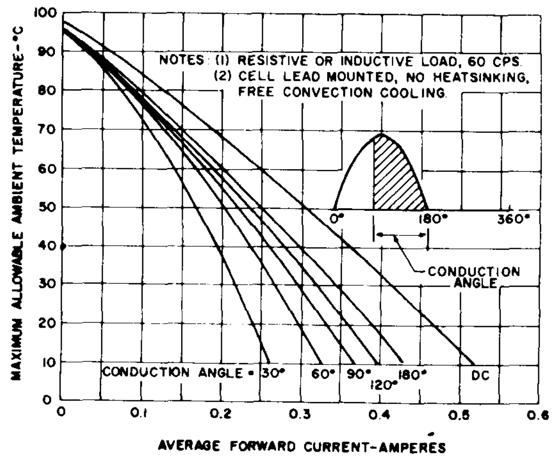
8. TYPICAL VARIATION OF LIGHT SENSITIVITY WITH GATE TO CATHODE RESISTANCE



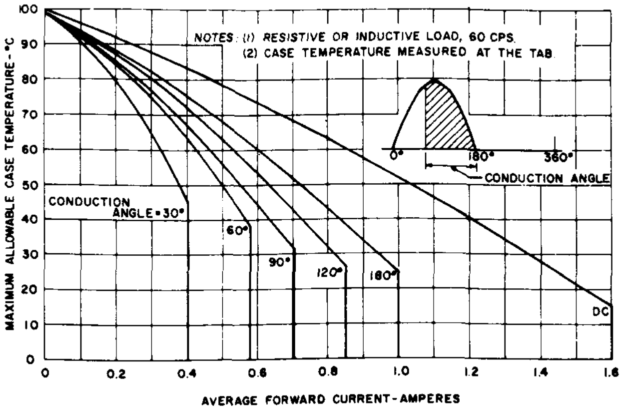
9. VARIATION OF HOLDING CURRENT WITH GATE TO CATHODE RESISTANCE



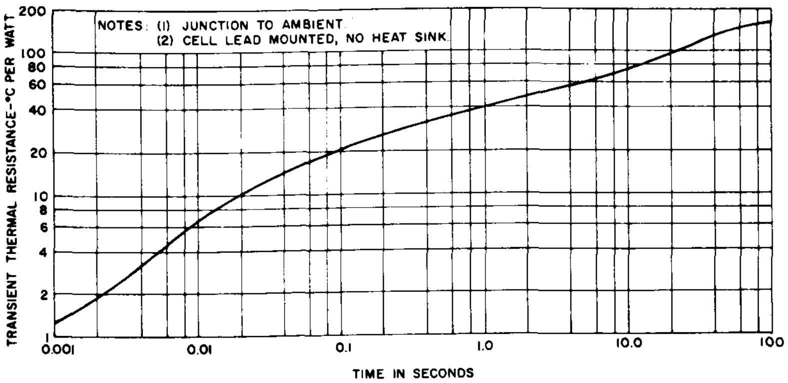
10. FORWARD POWER DISSIPATION FOR HALF WAVE RECTIFIED SINE WAVE



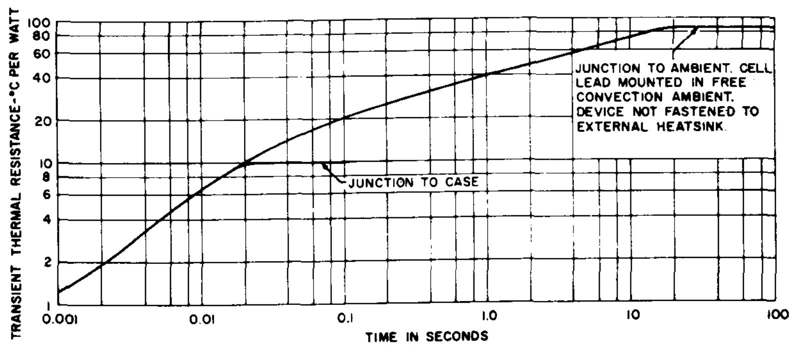
11. MAXIMUM AMBIENT TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE



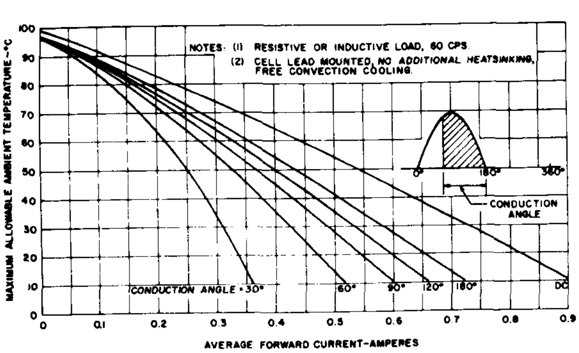
12. MAXIMUM CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE



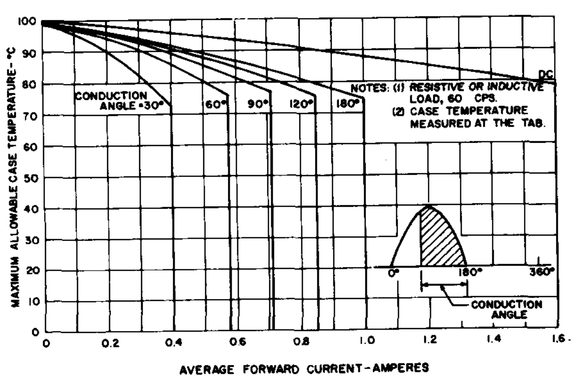
13. MAXIMUM TRANSIENT THERMAL RESISTANCE



14. MAXIMUM TRANSIENT THERMAL RESISTANCE (Diamond Base)



15. MAXIMUM AMBIENT TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE (Diamond Base)



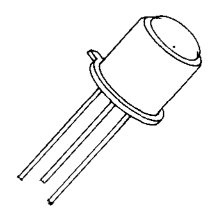
16. MAXIMUM CASE TEMPERATURE FOR HALF WAVE RECTIFIED SINE WAVE (Diamond Base)

SYMBOLS AND DEFINITION OF TERMS

Symbol	*Definition*
$V_{(BR)FX}$	**Forward Breakover Voltage, Gate Terminal Returned to the Cathode Terminal Through An Impedance and/or Bias Voltage.** The forward breakover voltage is the maximum positive voltage from anode-to-cathode for which the small-signal resistance is zero.
V_{FXM}	**Peak Forward Blocking Voltage Rating, Gate Terminal Returned to the Cathode Terminal Through An Impedance and/or Bias Voltage.** The peak forward blocking voltage rating is the maximum allowable instantaneous value of forward blocking voltage including transient voltages which will not switch the SCR to the on-state.
V_{FXM}	**Peak Forward Blocking Voltage, Gate Terminal Returned to the Cathode Terminal Through An Impedance and/or Bias Voltage.** The peak forward blocking voltage is the peak forward voltage when the SCR is in the off-state.
V_{FX}	**DC Forward Blocking Voltage, Gate Terminal Returned to the Cathode Terminal Through An Impedance and/or Bias Voltage.** The DC forward blocking voltage is the DC forward voltage when the SCR is in the off-state.
V_{FM}	**Peak On-Voltage.** The peak on-voltage is the peak forward voltage for a stated forward current when the SCR is in the on-state.
I_{RX}	**DC Reverse Blocking Current, Gate Terminal Returned to the Cathode Terminal Through An Impedance and/or Bias Voltage.** The DC reverse blocking current is the DC current through the collector junction when the SCR is in the reverse blocking state for a stated anode-to-cathode voltage.
V_{ROM} (wkg)	**Working Peak Reverse Voltage Rating, Gate Open.** The working peak reverse voltage rating is the maximum allowable instantaneous value of the reverse voltage, excluding all repetitive and non-repetitive transient voltages which occur across the SCR.
V_{ROM} (rep)	**Repetitive Peak Reverse Voltage Rating, Gate Open.** The repetitive peak reverse voltage rating is the maximum allowable instantaneous value of the reverse voltage, including all repetitive transient voltages, but excluding all non-repetitive transient voltages, which occur across the SCR.
PFV	**Peak Forward Voltage Rating.** The peak forward voltage rating is the maximum allowable instantaneous value of forward voltage which may be applied anode-to-cathode. It may cause switching to the on-state. If switching occurs at a voltage lower than the PFV value, no damage to the device will result. If the PFV value is exceeded, and if switching occurs, the device may be permanently damaged.
I_R (recovery)	**Peak Reverse Recovery Current.** The peak reverse recovery current is the peak reverse current obtained when instantaneously switching from a forward current condition to a reverse voltage in a given circuit.
I_{FX}	**DC Forward Blocking Current, Gate Terminal Returned to the Cathode Terminal Through An Impedance and/or Bias Voltage.** The DC forward blocking current is the DC current through the collector junction when the SCR is in the off-state for a stated anode-to-cathode voltage.
I_{FM}	**Peak Forward Current, On-State.** The peak forward current is the peak current through the collector junction for a positive anode-to-cathode voltage.
I_{HX}	**Holding Current, Gate Terminal Returned to the Cathode Terminal Through An Impedance and/or Bias Voltage.** The holding current is the minimum current through the collector junction required to maintain the SCR in the on-state for stated conditions and load.
P_{GM}	**Peak Gate Power Dissipation Rating.** The peak gate power dissipation rating is the maximum allowable instantaneous value of gate power dissipation between gate and cathode.
t_r	**Pulse Rise Time.** The rise time of a pulse is the time interval durirg which the amplitude of its leading edge is increasing from 10 to 90 percent of the maximum amplitude.
t_{off}	**Circuit-Commutated Turn-Off Time.** The circuit-commutated turn-off time is the time interval between the time when the forward current decreases to zero and the time when the device voltage reaches zero and is rising to a stated value of forward blocking voltage at a stated rate of rise without turning on during switching in the external anode circuit from the on-state to the off-state under stated conditions.
T_{stg}	**Storage Temperature.**
T_J	**Junction Temperature.**
R_L	**Load Resistor.**
R_{GK}	**Gate-To-Cathode Resistance.** External resistance connected between gate and cathode leads.
I_F	**Forward Current, On State.** The forward current is the current through the collector junction for a positive anode-to-cathode voltage.
I_{FM} (surge)	**Peak Rectangular Surge Forward Current, On State.** The peak rectangular surge forward current is the maximum forward current of 5 milliseconds duration in a resistive load system. The surge may be preceded and followed by maximum rated voltage, current, and junction temperature conditions, and maximum allowable gate power may be concurrently dissipated.
V_{RX}	**DC Reverse Voltage, Gate Terminal Returned to the Cathode Terminal Through An Impedance and/or Bias Voltage.** The DC reverse voltage is the DC negative anode-to-cathode voltage.
dv/dt	**Rate of Rise of Applied Forward Voltage.** As specified for the SCR, this value will not trigger the SCR below rated voltage under stated conditions. This rate of rise is defined as the slope of a straight line starting at zero anode voltage and extending through the one time constant (τ) point on an exponentially rising voltage. $\tau = \frac{0.632 \times \text{rated voltage}}{dv/dt}$
I^2t	**I squared t Rating.** This is the maximum allowable forward non-recurring overcurrent capability for pulse durations of greater than 1.5 milliseconds. I is in RMS amperes, and t is pulse duration in seconds. The same conditions as listed above for I_{FM} (surge) apply.
V_{ROM} (non-rep)	**Non-Repetitive Peak Reverse Voltage Rating, Gate Open.** The non-repetitive peak reverse voltage rating is the maximum allowable instantaneous value of the reverse voltage, including all non-repetitive transient voltages, but excluding all repetitive transient voltages, which occur across the SCR.
V_{GRM}	**Peak Reverse Gate Voltage Rating.** The peak reverse gate voltage rating is the maximum allowable peak voltage between the gate terminal and the cathode terminal when the junction between the gate region and the adjacent cathode region is reverse biased.
V_{GFM}	**Peak Forward Gate Voltage Rating.** The peak forward gate voltage rating is the maximum allowable peak voltage between the gate terminal and the cathode terminal resulting from the flow of forward gate current.
V_{GT}	**Gate Trigger Voltage, DC.** The DC gate trigger voltage is the DC voltage between the gate and the cathode required to produce the DC gate trigger current.
I_{GT}	**Gate Trigger Current, DC.** The DC gate trigger current is the minimum DC gate current required to cause switching from the off-state to the on-state for a stated anode-to-cathode voltage.
I_{GS}	**Gate Supply Current to Trigger, DC.** The gate supply current to trigger is the sum of the gate trigger current (I_{GT}) and the external gate-to-cathode shunt resistor current which the gate supply must supply to trigger the SCR.
$P_{G(AV)}$	**Average Gate Power Dissipation Rating.** The average gate power dissipation rating is the maximum allowable gate power dissipation, averaged over a full cycle, between gate and cathode.
t_d	**Pulse Delay Time.** The delay time of a pulse is the time interval from a point at which the leading edge of the input pulse has risen to 10 percent of its maximum amplitude to a point at which the leading edge of the output pulse has risen to 10 percent of its maximum amplitude.
H_E	**Effective Irradiance.** The amount of incident radiant flux density which has an effect on the device. This is the integral of the product of the spectral response curve of the cell and the spectral distribution of the energy source, expressed in watts per square centimeter.
H_{ET}	**Effective Irradiance to Trigger.** The amount of incident radiant flux density which is effective in causing the device to switch to the conducting state. This is the integral of the product of the spectral response, curve of the cell and the spectral distribution of the energy source, expressed in watts per square centimeter, which causes the device to switch.
Y_λ	**Relative Response:** The ratio of the response of the device at any one wavelength to the maximum response.

Light Detector Planar Silicon Photo-Darlington Amplifier

NPN L14F1 - L14F2

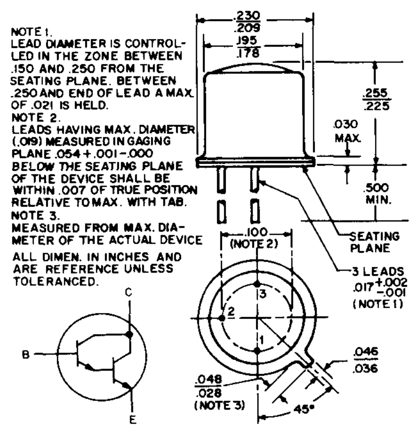


The General Electric L14F1 and L14F2 are supersensitive NPN Planar Silicon Photodarlington Amplifiers. For many applications, only the collector and emitter leads are used; however, a base lead is provided to control sensitivity and the gain of the device. The L14F1 – L14F2 are a TO-18 Style hermetically sealed packages with lens cap and are designed to be used in opto-electronic sensing applications requiring very high sensitivity.

absolute maximum ratings: (25°C) (unless otherwise specified)

VOLTAGES – DARK CHARACTERISTICS			
Collector to Emitter Voltage	V_{CEO}	25	volts
Collector to Base Voltage	V_{CBO}	25	volts
Emitter to Base Voltage	V_{EBO}	12	volts
CURRENTS			
Light Current	I_L	200	mA
DISSIPATIONS			
Power Dissipation (T_A = 25°C)*	P_T	300	mW
Power Dissipation (T_C = 25°C)**	P_T	600	mW
TEMPERATURES			
Junction Temperature	T_J	150	°C
Storage Temperature	T_{STG}	-65 to 150	°C

*Derate 2.4 mW/°C above 25°C ambient.
**Derate 4.8 mW/°C above 25°C case.



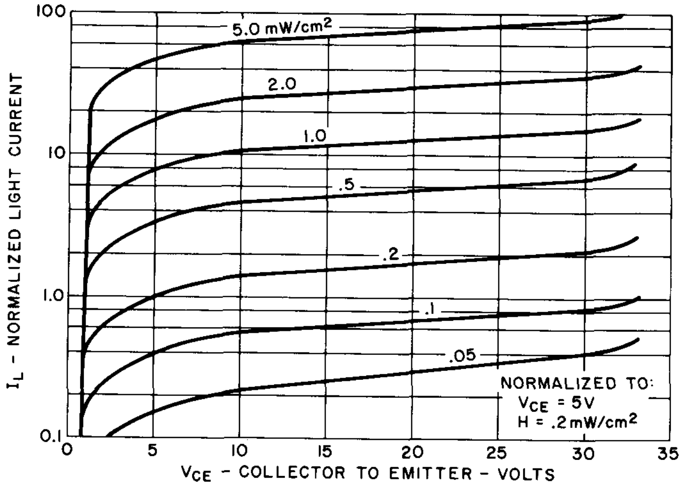
electrical characteristics: (25°C) (unless otherwise specified)

STATIC CHARACTERISTICS		L14F1 MIN.	L14F1 MAX.	L14F2 MIN.	L14F2 MAX.	
LIGHT CURRENT (V_{CE} = 5V, H† = 0.2 mW/cm²)	I_L	3	–	1	–	mA
DARK CURRENT (V_{CE} = 12V, I_B = 0)	I_D	–	100	–	100	nA
EMITTER-BASE BREAKDOWN VOLTAGE (I_E = 100 μA)	$V_{(BR)EBO}$	12	–	12	–	V
COLLECTOR-BASE BREAKDOWN VOLTAGE (I_C = 100 μA)	$V_{(BR)CBO}$	25	–	25	–	V
COLLECTOR-EMITTER BREAKDOWN VOLTAGE (I_C = 10 mA)	$V_{(BR)CEO}$	25	–	25	–	V
SWITCHING CHARACTERISTICS (see Switching Circuit)						
SWITCHING SPEEDS (V_{CC} = 10V, I_L = 10 mA, R_L = 100 Ω)						
DELAY TIME	t_d	–	50	–	50	μsec
RISE TIME	t_r	–	300	–	300	μsec
STORAGE TIME	t_s	–	10	–	10	μsec
FALL TIME	t_f	–	250	–	250	μsec

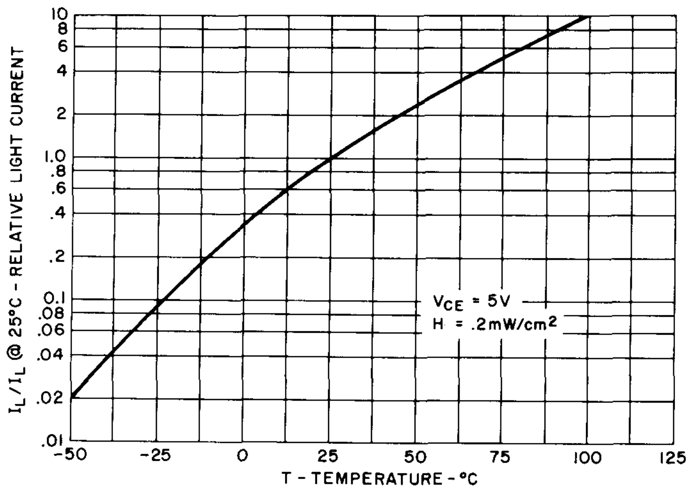
†H = Radiation Flux Density. Radiation source is an unfiltered tungsten filament bulb at 2870°K color temperature.

NOTE: The 2870°K radiation is 25% effective on the photodarlington; i.e., a GaAs source of 0.05 mW/cm² is equivalent to this 0.2 mW/cm² tungsten source.

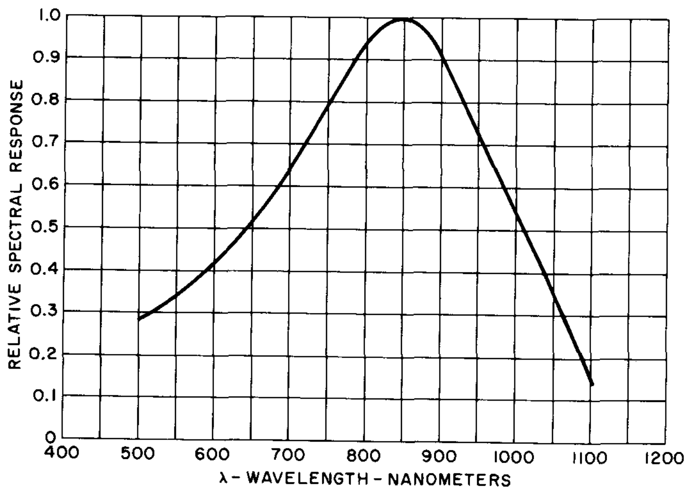
TYPICAL ELECTRICAL CHARACTERISTICS



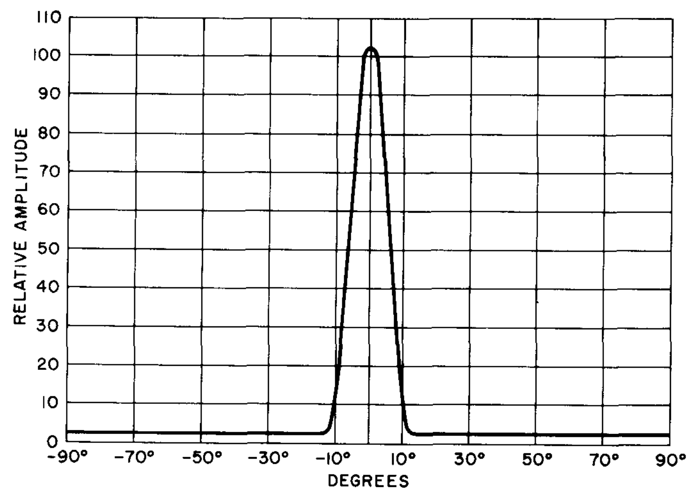
1. LIGHT CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



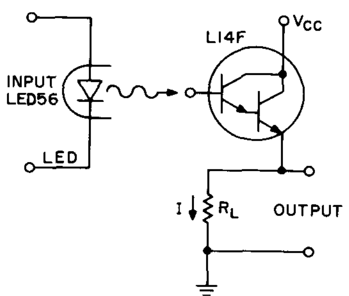
2. RELATIVE LIGHT CURRENT VS. AMBIENT TEMPERATURE



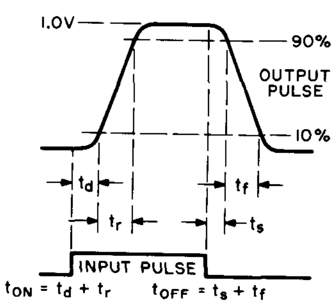
3. SPECTRAL RESPONSE CURVE



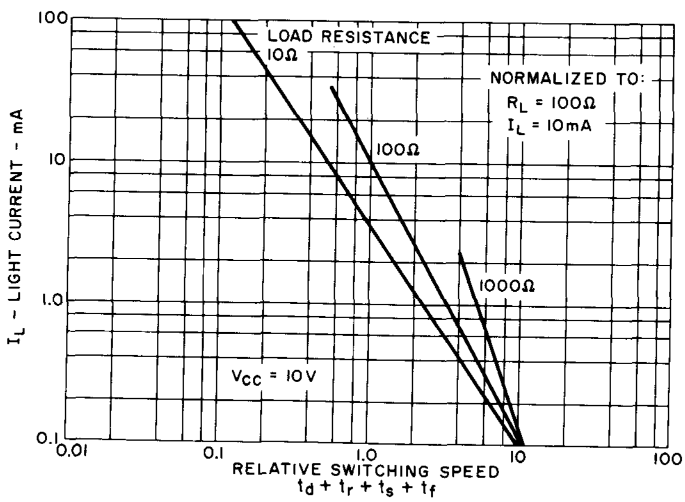
4. ANGULAR RESPONSE



5. TEST CIRCUIT



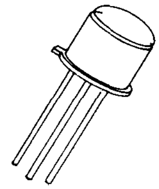
6. WAVE FORMS



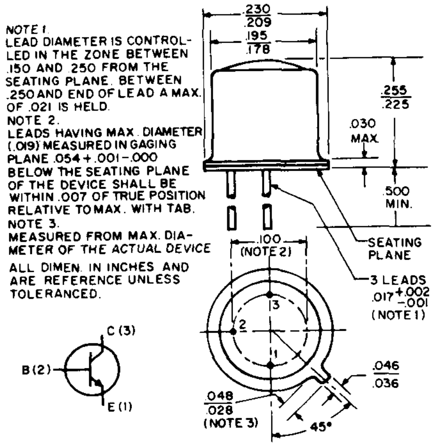
7. LIGHT CURRENT VS. RELATIVE SWITCHING SPEED

Light Detector Planar Silicon Photo Transistor

NPN L14G1-L14G2-L14G3



The General Electric L14G1 thru L14G3 are highly sensitive NPN Planar Silicon Phototransistors. They are housed in a TO-18 style hermetically sealed package with lens cap. The L14G series is ideal for use in optoelectronic sensing applications where both high sensitivity and fast switching speeds are important parameters. Generally only the collector and emitter leads are used; a base lead is provided, however, to control sensitivity and gain of the device.



absolute maximum ratings: (25°C unless otherwise specified)

Voltages — Dark Characteristics			
Collector to Emitter Voltage	V_{CEO}	45	volts
Collector to Base Voltage	V_{CBO}	45	volts
Emitter to Base Voltage	V_{EBO}	5	volts
Currents			
Light Current	I_L	50	mA
Dissipations			
Power Dissipation (T_A = 25°C)*	P_T	300	mW
Power Dissipation (T_C = 25°C)**	P_T	600	mW
Temperatures			
Junction Temperature	T_J	+ 150	°C
Storage Temperature	T_{STG}	− 65 to + 150	°C

*Derate 2.4 mW/°C above 25°C ambient
**Derate 4.8 mW/°C above 25°C case

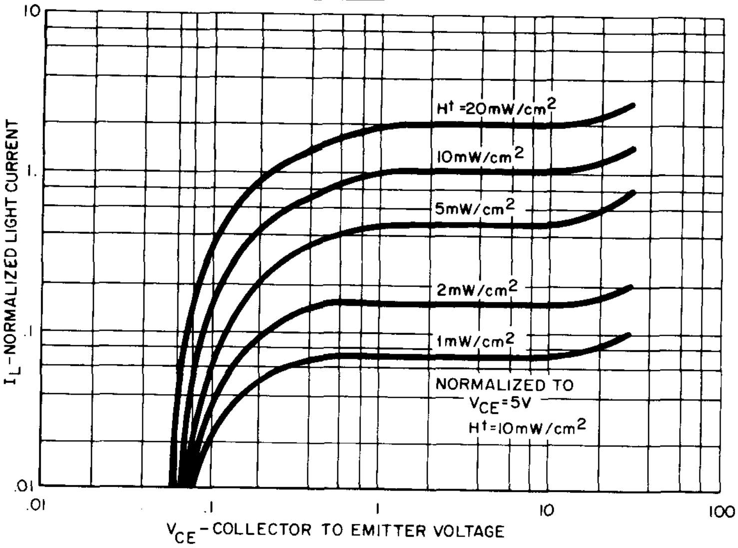
electrical characteristics: (25°C unless otherwise specified)

STATIC CHARACTERISTICS		L14G1 MIN.	L14G1 MAX.	L14G2 MIN.	L14G2 MAX.	L14G3 MIN.	L14G3 MAX.	
Light Current (V_{CE} = 5V, H† = 10mW/cm²)	I_L	6		3		12		mA
Dark Current (V_{CE} = 10V, H ≈ 0)	I_D		100		100		100	nA
Emitter-Base Breakdown Voltage (I_E = 100μA, I_C = 0, H ≈ 0)	$V_{(BR)EBO}$	5		5		5		V
Collector-Base Breakdown Voltage (I_C = 100μA, I_E = 0, H ≈ 0)	$V_{(BR)CBO}$	45		45		45		V
Collector-Emitter Breakdown Voltage (I_C = 10mA, H ≈ 0	$V_{(BR)CEO}$	45		45		45		V
Saturation Voltage (I_C = 10mA, I_B = 1mA)	$V_{CE(SAT)}$		0.4		0.4		0.4	V
Turn-On Time (V_{CE} = 10V, I_C = 2mA,	t_{on}		8		8		8	μsec
Turn-Off Time R_L = 100Ω)	t_{off}		7		7		7	μsec

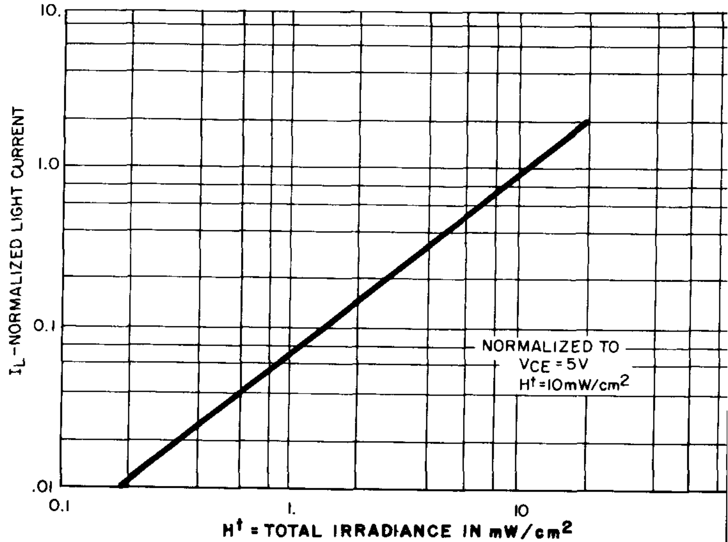
†H = Radiation Flux Density. Radiation source is on unfiltered tungsten filament bulb at 2870°K color temperature.

NOTE: A GaAs source of 3.0 mW/cm² is approximately equivalent to a tungsten source, at 2870°K, of 10 mW/cm²

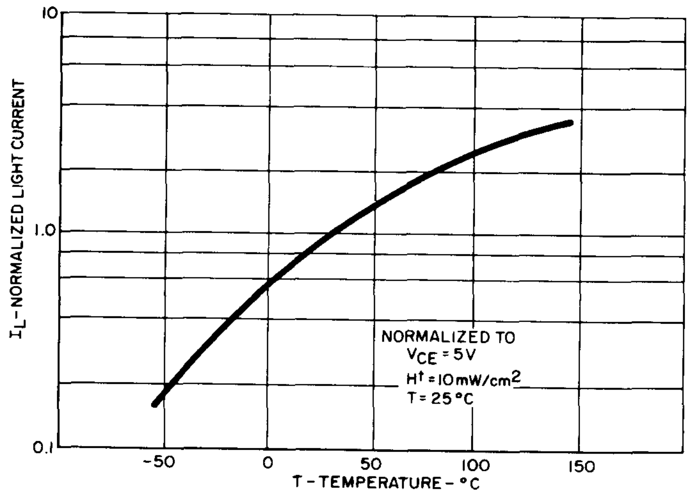
TYPICAL ELECTRICAL CHARACTERISTICS



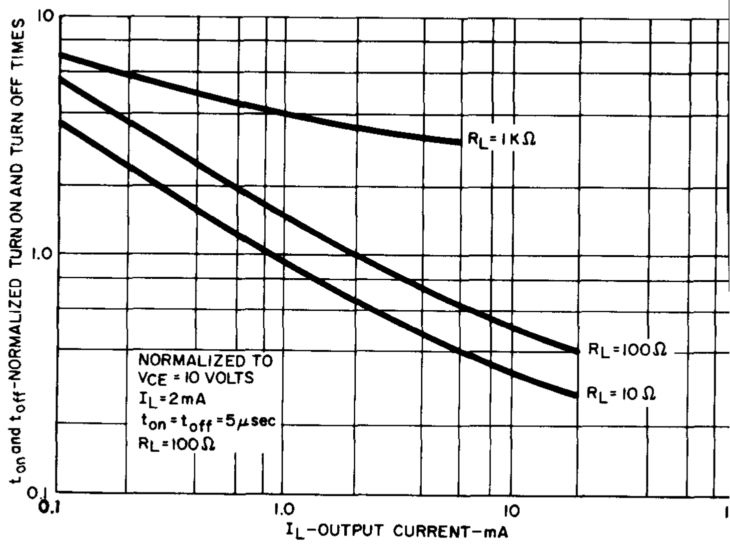
Light Current vs Collector to Emitter Voltage



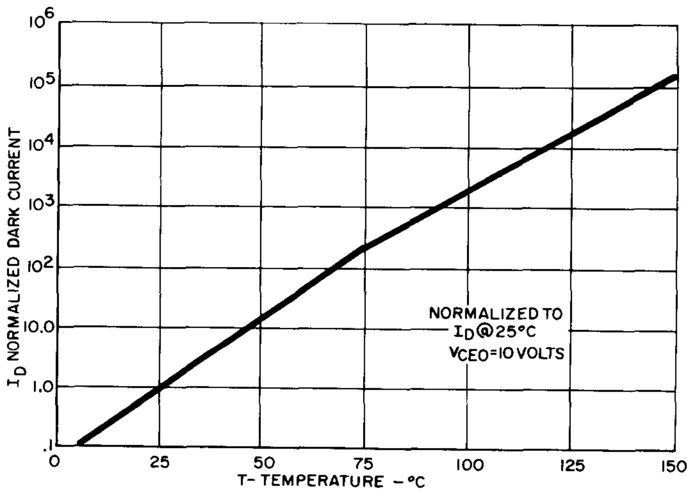
Normalized Light Current vs Radiation



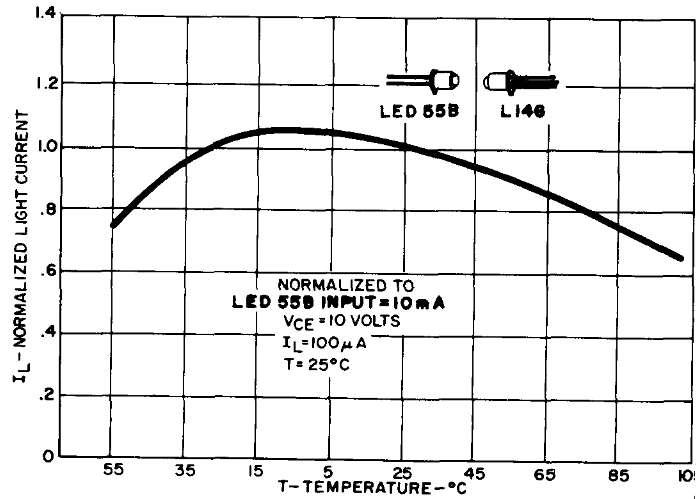
Normalized Light Current vs Temperature



Switching Times vs Output Current



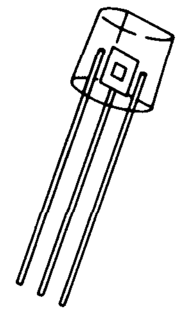
Dark Current vs Temperature



Normalized Light Current vs Temperature
Both Emitter (LED55B) and Detector (L14G) at Same Temperature

Light Detector Planar Silicon Photo Transistor

NPN L14 H1-4

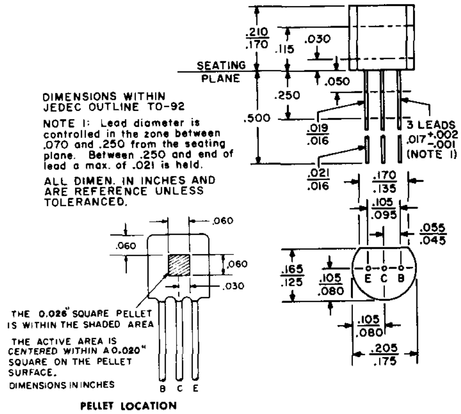


The General Electric Light Sensor Series are NPN Planar Silicon Phototransistors in a clear epoxy TO-92 package. They can be used in industrial and commercial applications requiring a low cost, general purpose, photosensitive device. Generally only the collector and emitter leads are used; a base lead is provided, however, to control sensitivity and gain of the device.

absolute maximum ratings: (25°C) (unless otherwise specified)

		L14H2, H4	L14H1, H3	
Voltages — Dark Characteristics				
Collector to Emitter Voltage	V_{CEO}	30V	60V	volts
Collector to Base Voltage	V_{CBO}	30V	60V	volts
Emitter to Base Voltage	V_{EBO}	5		volts
Currents				
Light Current	I_L	100		mA
Dissipations				
Power Dissipation (T_A = 25°C)*	P_T	200		mW
Temperatures				
Junction Temperature	T_J	100		°C
Storage Temperature	T_{STG}	−65 to 100		°C

*Derate 2.67 mW/°C above 25°C ambient

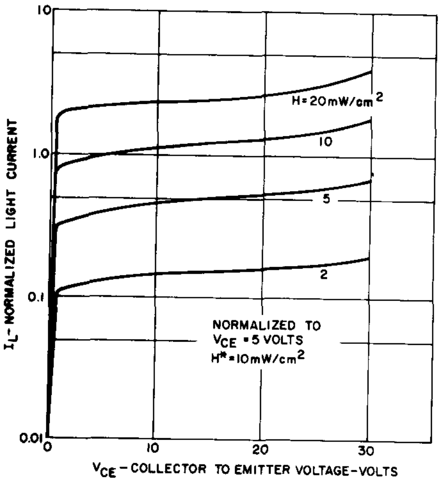


electrical characteristics: (25°C) (unless otherwise specified)

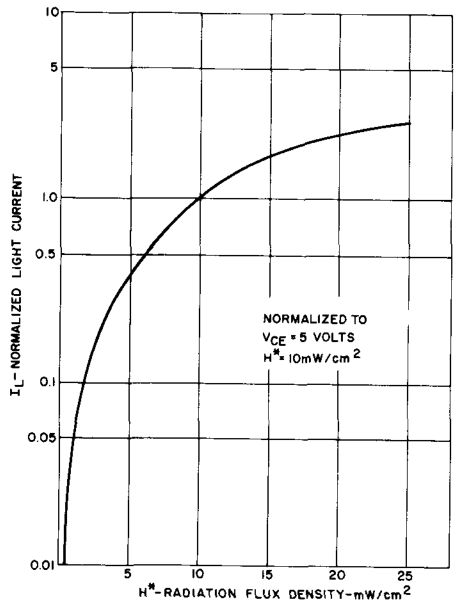
STATIC CHARACTERSITICS		L14H1 Min.	L14H1 Max.	L14H2 Min.	L14H2 Max.	L14H3 Min.	L14H3 Max.	L14H4 Min.	L14H4 Max.	Units
Light Current (V_{CE} = 5V, H† = 10mW/cm²)	I_L	.5		2.0		2.0		.5		mA
Dark Current (V_{CE} = 10V, H ≈ 0, I_B = 0)	I_D		100		100		100		100	nA
Emitter-Base Breakdown Voltage (I_E = 100μA, I_C = 0, H ≈ 0)	$V_{(BR)EBO}$	5		5		5		5		volts
Collector-Base Breakdown Voltage (I_C = 100μA, I_E = 0, H ≈ 0)	$V_{(BR)CBO}$	60		30		60		30		volts
Collector-Emitter Breakdown Voltage (I_C = 10mA, H ≈ 0) (Pulse Width≤300μsec, Duty cycle≤1%)	$V_{(BR)CEO}$	60		30		60		30		volts
Saturation Voltage (I_C = 10mA, I_B = 1mA)	$V_{CE(SAT)}$		0.4		0.4		0.4		0.4	volts
Switching Speeds (V_{CE} = 30V, I_L = 800 μA, R_L = 1kΩ)**										
On Time ($t_d + t_r$)	t_{on}		8		8		8		8	μsec
Off Time ($t_s + t_f$)	t_{off}		7		7		7		7	μsec

†H = Radiation Flux Density. Radiation source is an unfiltered tungsten filament bulb at 2870°K color temperature.
**Radiant source is a gallium arsenide light emitting diode.

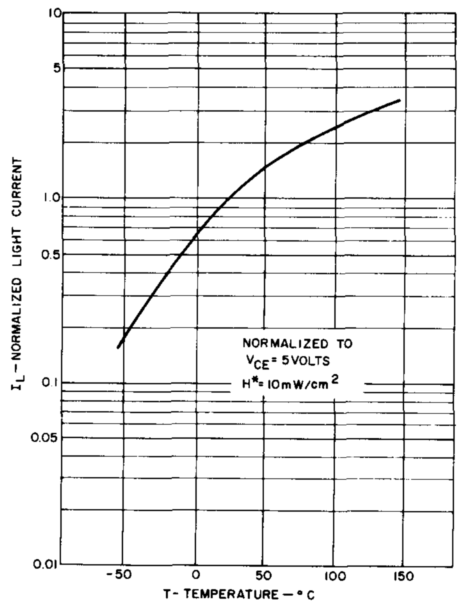
TYPICAL ELECTRICAL CHARACTERISTICS



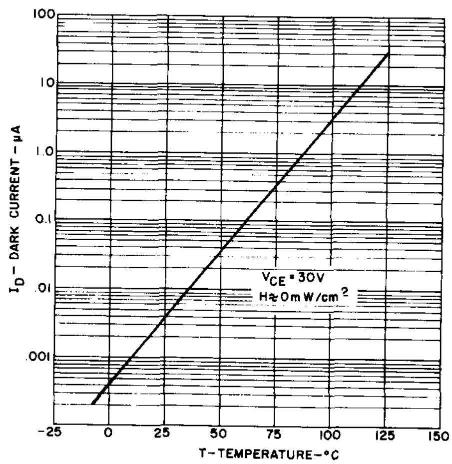
1. NORMALIZED LIGHT CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



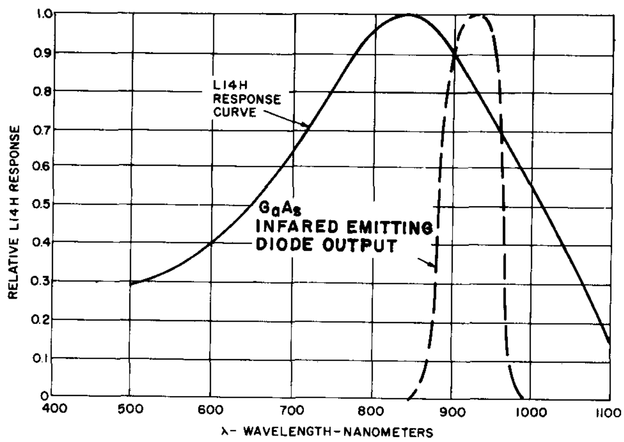
2. NORMALIZED LIGHT CURRENT VS. RADIATION



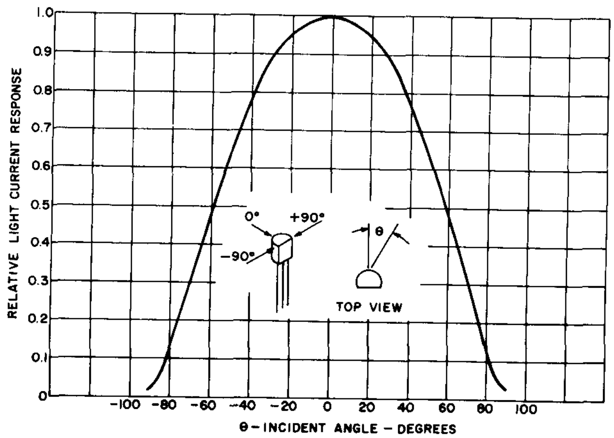
3. NORMALIZED LIGHT CURRENT VS. TEMPERATURE



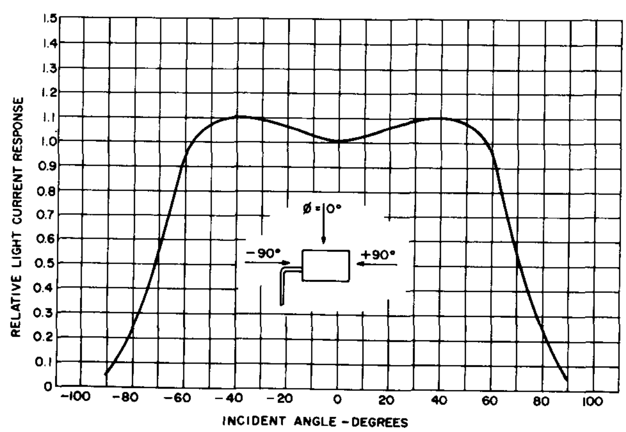
4. DARK CURRENT VS. TEMPERATURE



5. SPECTRAL CURVES



6. RELATIVE RESPONSE VS. INCIDENT ANGLE



7. RELATIVE RESPONSE VS. INCIDENT ANGLE

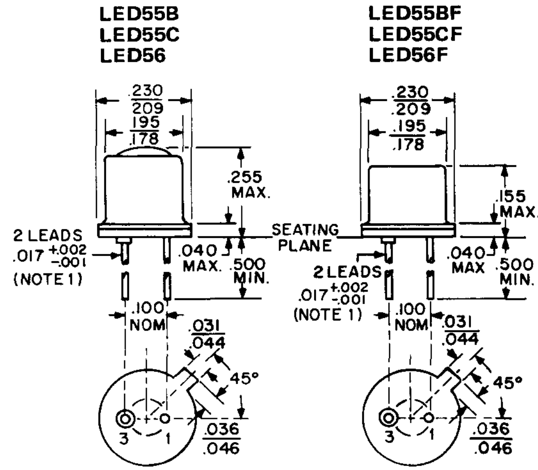
Direct replacement for SSL55B, SSL55C, SSL56, SSL55BF, SSL55CF, SSL56F

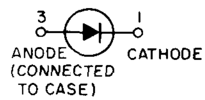
Infrared Emitter

LED55B, LED55C, LED56, LED55BF, LED55CF, LED56F

Gallium Arsenide Infrared–Emitting Diode

The General Electric LED55B-LED55C-LED56 Series are gallium arsenide, light emitting diodes which emit non-coherent, infrared energy with a peak wave length of 940 nanometers. They are ideally suited for use with silicon detectors. The "F" versions of these devices have flat lens caps.





NOTE 1:
LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .050 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX. OF .021 IS HELD.

absolute maximum ratings: (25°C unless otherwise specified)

Voltage:			
Reverse Voltage	V_R	3	volts
Currents:			
Forward Current Continuous	I_F	100	mA
Forward Current (pw 1 μsec 200 Hz)	I_F	10	A
Dissipations:			
Power Dissipation (T_A = 25°C)*	P_T	170	mW
Power Dissipation (T_C = 25°C)**	P_T	1.3	W
Temperatures:			
Junction Temperature	T_J	-65°C to +150°C	
Storage Temperature	T_{STG}	-65°C to +150°C	
Lead Soldering Time		10 seconds at 260°C	

*Derate 1.36 mW/°C above 25°C ambient.
**Derate 10.4 mW/°C above 25°C case.

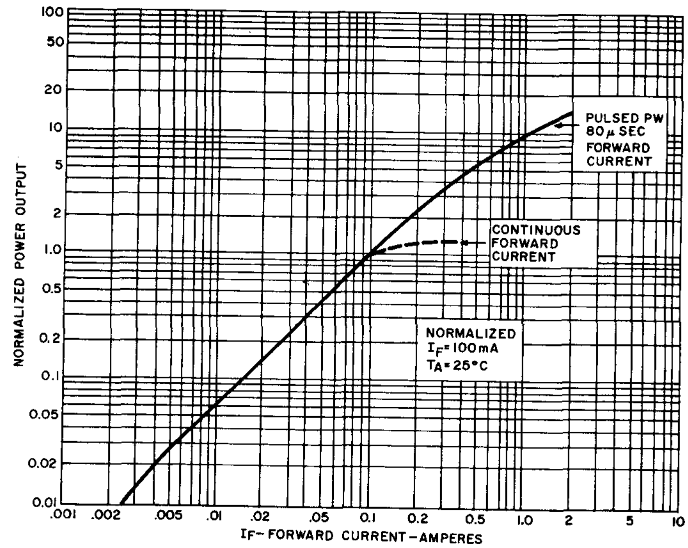
electrical characteristics: (25°C unless otherwise specified)

		MIN.	TYP.	MAX.	UNITS
Reverse Leakage Current (V_R = 3V)	I_R			10	μA
Forward Voltage (I_F = 100mA)	V_F		1.4	1.7	V

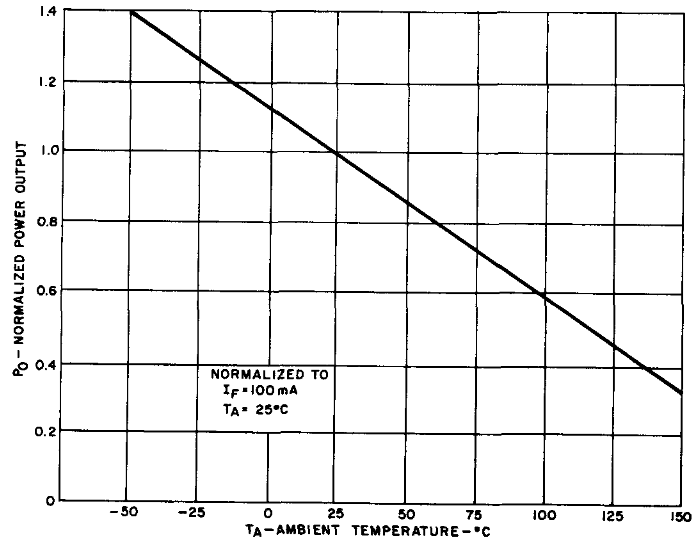
optical characteristics: (25°C unless otherwise specified)

		MIN.	TYP.	MAX.	UNITS
Total Power Output (note 1) (I_F = 100mA)					
LED55B-LED55BF	P_O	3.5			mW
LED55C-LED55CF		5.4			mW
LED56 -LED56F		1.5			mW
Peak Emission Wavelength (I_F = 100mA)			940		nm
Spectral Shift with Temperature			.28		nm/°C
Spectral Bandwidth 50%			60		nm
Rise Time 0-90% of Output			300		nsec
Fall Time 100-10% of Output			200		nsec

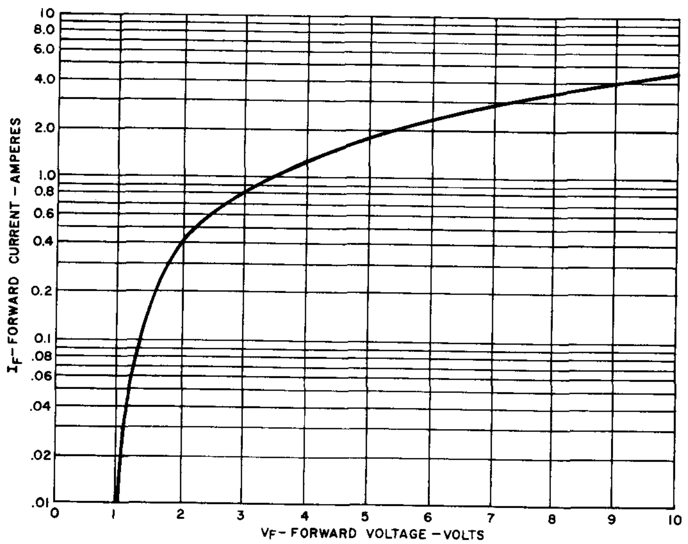
Note 1: Total power output, P_O, is the total power radiated by the device into a solid angle of 2π steradians.



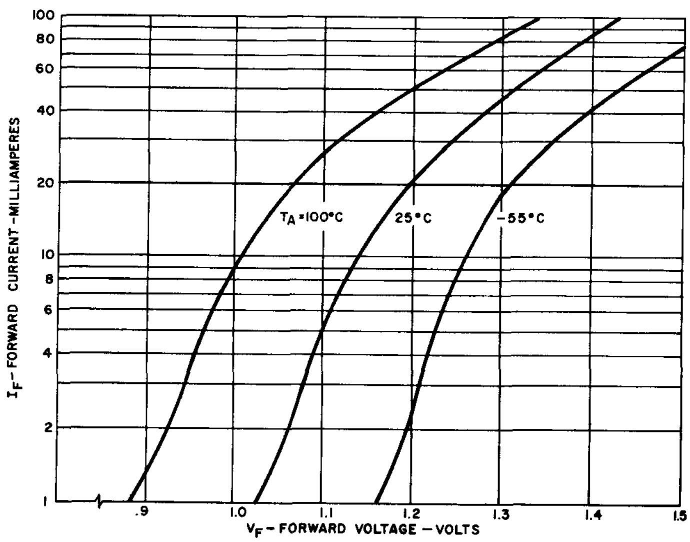
1. POWER OUTPUT VS. INPUT CURRENT



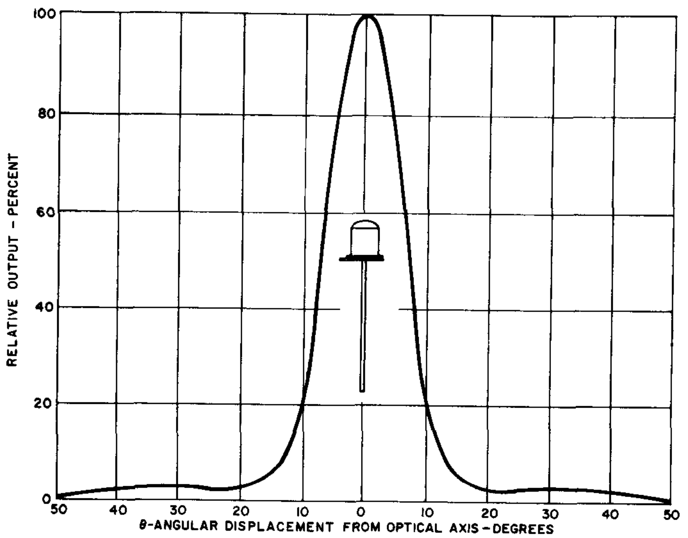
2. POWER OUTPUT VS. TEMPERATURE



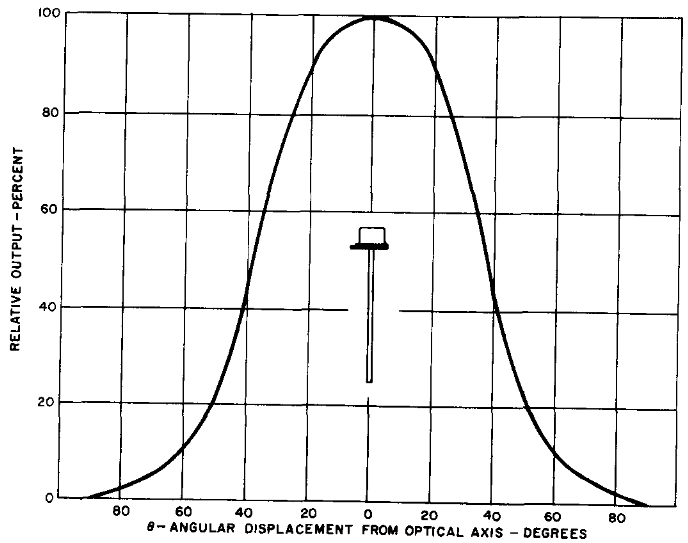
3. LED 55B, 55C, 56, 55BF, 55CF, 56F FORWARD VOLTAGE VS. FORWARD CURRENT



4. FORWARD VOLTAGE VS. FORWARD CURRENT



5. LED 55B, 55C, 56 TYPICAL RADIATION PATTERN



6. LED 55BF, 55CF, 56F TYPICAL RADIATION PATTERN

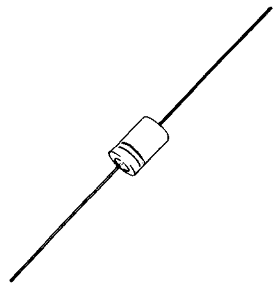
Silicon Diodes

MA1701,2,3,4

MPA, MPS SERIES SEE SELECTOR GUIDE

This family of General Electric Milli-Heatsink Diodes are very high speed switching diodes for computer circuits and general purpose applications. These diodes incorporate an oxide passivated epitaxial pellet with a raised solid silicon anode contact.

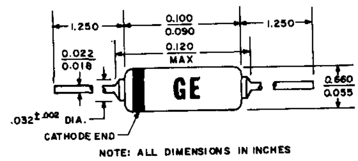
These MA-series diodes *exceed* the electrical and mechanical requirements of the following JEDEC devices:



MA1701		MA1702	MA1703
1N914	1N4153	1N4151	1N4152
1N914A	1N4154	1N4152	1N4154
1N916	1N4446	1N4153	1N4727
1N916A	1N4447	1N4154	
1N4148	1N4448	1N4454	
1N4149	1N4454	1N4727	
1N4151	1N4727		
1N4152			

Standard Cathode Band and Body Marking Colors:

MA1701 — Violet
MA1702 — Yellow
MA1703 — Green
MA1704 — Black
Body marking will consist *only* of the GE symbol



absolute maximum ratings: (25°C)

		MA1701	MA1702	MA1703	MA1704	
Voltage						
Reverse	V_R	100	75	40	25	Volts
Current						
Average Rectified	I_o	←	200	→		mA
Recurrent Peak Forward	I_{FRM}	←	600	→		mA
Forward Steady State D-C	I_F	←	150	→		mA
Peak Forward Surge (1μsec)	I_{FSM}	←	4	→		Amps
Derate above 25°C		←	1.1	→		mA/°C
Temperature						
Operating	T_J	←	−65 to +175	→		°C
Storage	T_{STG}	←	−65 to +200	→		°C

Power Dissipation

Heatsink Spacing From End of Diode Body	Power Dissipation at 25°C/mW [1]	Steady State Thermal Resistance (°C/mW)
0.125 inches	700	0.230
0.250 inches	550	0.319
0.500 inches	460	0.438

Note 1: The maximum power dissipation is defined as the heat dissipating capability of the diode when operated at 25°C as an AC signal device within the absolute maximum voltage and current ratings specified above. The power rating is based on a maximum junction temperature of 200°C. The steady state thermal resistance (°C/mW) can be used to calculate the power dissipating capabilities, within the maximum voltage and current ratings, at temperatures other than 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

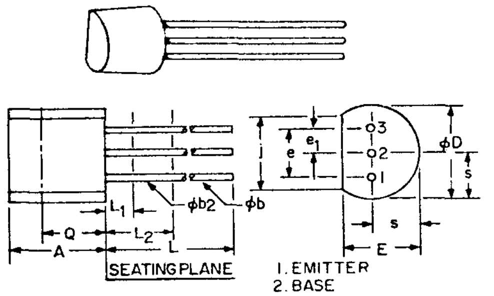
		MA1701		MA1702		MA1703		MA1704		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Forward Voltage	V_F									
($I_F = 0.100$mA)		0.490	0.550	0.490	0.550	0.490	0.550	0.460	0.570	Volts
($I_F = 1.0$ mA)		0.590	0.650	0.590	0.650	0.590	0.650	0.570	0.680	Volts
($I_F = 10$ mA)		0.700	0.810	0.700	0.810	0.700	0.810	0.680	0.850	Volts
($I_F = 30$ mA) (2)		0.780	0.930	0.780	0.930	0.780	0.930	0.740	1.00	Volts
($I_F = 50$ mA) (2)		0.830	1.00	0.830	1.00	0.830	1.00	0.770	1.10	Volts
($I_F = 100$ mA) (2)		0.935	1.10	0.935	1.10	0.935	1.10	0.820	1.30	Volts
Reverse Current	I_R									
($V_R = 15$ Volts)									50	nA
($V_R = 20$ Volts)									100	nA
($V_R = 30$ Volts)			30		30		50			nA
($V_R = 30$ Volts, $T_A = 150°C$)			30		30		50			µA
($V_R = 50$ Volts)			50		50					nA
($V_R = 50$ Volts, $T_A = 150°C$)			50		50					µA
($V_R = 75$ Volts)			5							µA
Breakdown Voltage	$V_{(BR)R}$									
($I_R = 5\mu A$)				75		40		25		Volts
($I_R = 100\mu A$)		100								Volts
Stored Charge	Q_S									
($I_F = 10$mA) (3)			40		40		40		40	pC
Peak Forward Voltage	V_{FM}									
($I_F = 50$mA, $t_r = 10$nsec) (4)			3.0		2.75		1.75		1.75	Volts
Capacitance	C_O									
($V_R = 0$V, f = 1MHz, Signal Level = 50mV) (5)			1.0		1.0		2.0		3.0	pF

Note 2: Pulsed measurement with pulse width ≤350µsec, duty cycle ≤2%.
Note 3: Test method per JEDEC suggested standard number for direct measurement of diode stored charge, B-Line Electronics Corporation stored charge meter Model QS-3 or equivalent.
Note 4: Measured per EIA Standard RS-286.
Note 5: Capacitance as measured on Boonton Electronics Model 75A Capacitance Bridge (or equivalent).

Silicon Transistors

NPN

MPS-A05
MPS-A06



TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

The MPS-A05 and MPS-A06 are silicon planar epitaxial passivated NPN transistors designed for general purpose audio amplifier applications.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

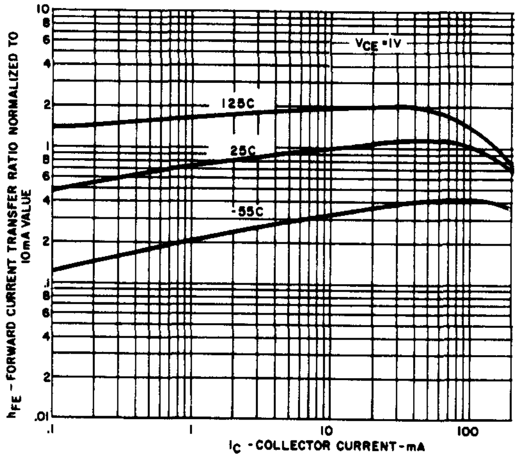
		MPS-A05	MPS-A06	
Voltages				
Collector to Emitter	V_{CEO}	60	80	Volts
Collector to Base	V_{CBO}	60	80	Volts
Emitter to Base	V_{EBO}	4	4	Volts
Current				
Collector	I_C	500	500	mA
Dissipation				
Total Power $T_A \leqslant 25°C$	P_T	625	625	m Watts
Total Power $T_C \leqslant 25°C$	P_T	1.5	1.5	Watts
Derate Factor $T_A > 25°C$		5	5	mW/°C
Derate Factor $T_C > 25°C$		12	12	mW/°C
Temperature				
Operating	T_J	-55°C to +150°C		°C
Storage	T_{STG}	-55°C to +150°C		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230°C		°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

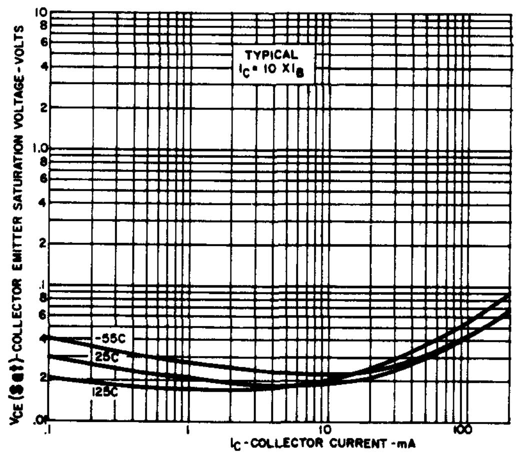
Static Characteristics	SYMBOL	MPS-A05 MIN.	MPS-A05 MAX.	MPS-A06 MIN.	MPS-A06 MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1mA, I_B = 0)	$V_{(BR)CEO}$	60	–	80	–	Volts
Collector-Base Breakdown Voltage (I_C = 100µA, I_E = 0)	$V_{(BR)CBO}$	60	–	80	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100µA, I_C = 0)	$V_{(BR)EBO}$	4	–	4	–	Volts
Collector Cutoff Current						
(V_{CB} = 60V, I_E = 0) – MPS-A05	I_{CBO}	–	100	–	–	nA
(V_{CB} = 80V, I_E = 0) – MPS-A06	I_{CBO}	–	–	–	100	nA
Collector Cutoff Current (V_{CE} = 60V, I_B = 0)	I_{CEO}	–	100	–	100	nA
Forward Current Transfer Ratio						
(V_{CE} = 1V, I_C = 10mA)	h_{FE}	50	–	50	–	
(V_{CE} = 1V, I_C = 100mA)	†h_{FE}	50	–	50	–	

Static Characteristics (continued)	SYMBOL	MPS-A05 MIN.	MPS-A05 MAX.	MPS-A06 MIN.	MPS-A06 MAX.	UNITS
Collector-Emitter Saturation Voltage (I_C = 100mA, I_B = 10mA)	†$V_{CE(sat)}$	–	.25	–	.25	Volts
Base-Emitter Saturation Voltage (I_C = 100mA, I_B = 10mA)	†$V_{BE(sat)}$	–	1.0	–	1.0	Volts
Base-Emitter Voltage (V_{CE} = 1V, I_C = 100mA)	†$V_{BE(ON)}$	–	1.0	–	1.0	Volts
Dynamic Characteristics						
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0,f = 1 MHz)	C_{cb}	–	12	–	12	pF
Gain bandwidth (V_{CE} = 5V, I_C = 30mA, f = 50MHz)	f_T	80	–	80	–	MHz

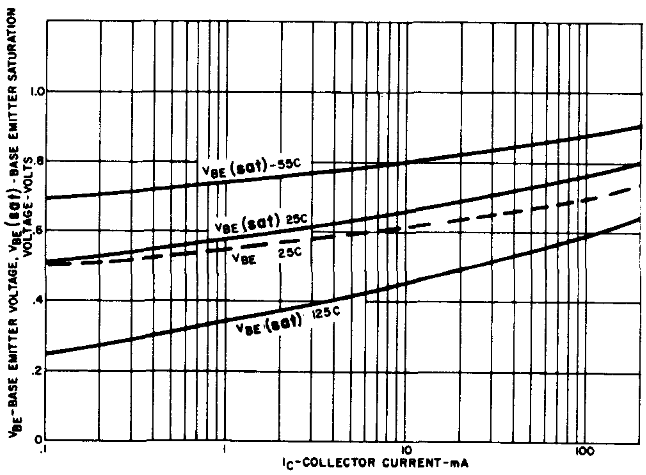
†Pulse width ≤ 300 μsec., Duty Cycle ≤ 2%.



FORWARD CURRENT TRANSFER RATIO NORMALIZED TO 10mA VALUE VS COLLECTOR CURRENT



COLLECTOR EMITTER SATURATION VOLTAGE VS COLLECTOR CURRENT



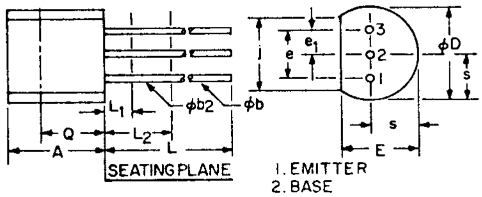
BASE EMITTER VOLTAGE (V_{CE} = 1V) AND BASE EMITTER SATURATION VOLTAGE (I_C = 10 x I_B) VS COLLECTOR CURRENT

Silicon Darlington Transistor

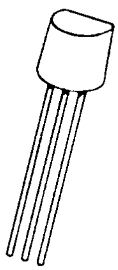
NPN

MPS-A12

The General Electric MPS-A12 is a Silicon Planar Epitaxial Passivated NPN Darlington Transistor is designed for preamplifier input applications where high impedance is a requirement.



TO-92



SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L_1	–	1.270	–	.050	3
L2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

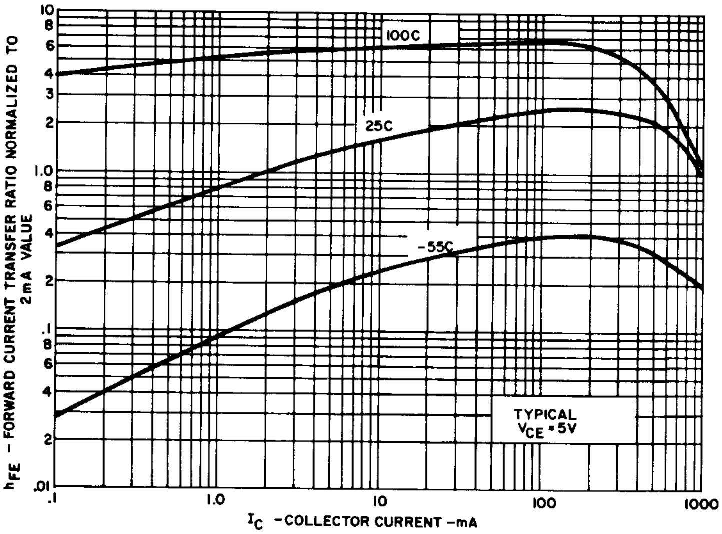
NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

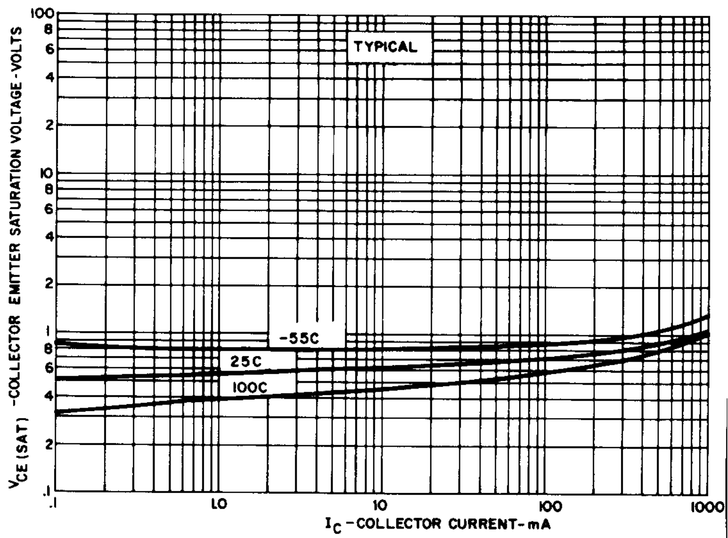
Voltages			
Collector to Emitter	V_{CES}	20	Volts
Collector to Base	V_{CBO}	20	Volts
Emitter to Base	V_{EBO}	4	Volts
Current			
Collector	I_C	500	mA
Dissipation			
Total Power $T_A \leqslant 25°C$	P_T	626	mW
Derating Factor $T_A > 25°C$	P_T	5.0	mW/°C
Temperature			
Storage	T_{stg}	-55 to +150	°C
Operating	T_J	-55 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+230	°C

electrical characteristics: (T_A unless otherwise specified)

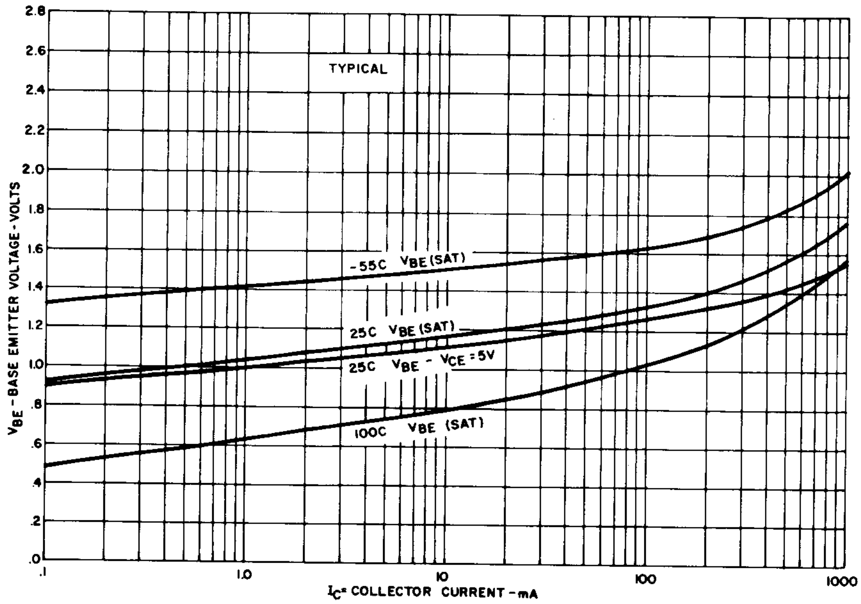
Static Characteristics	SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, I_B = 0)	BV_{CES}	20	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0)	I_{CES}	–	100	nAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	100	nAdc
Emitter Cutoff Current (V_{EB} = 10 Vdc, I_C = 0)	I_{EBO}	–	100	nAdc
DC Current Gain (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20,000	–	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.01 mAdc)	$V_{CE(sat)}$	–	1.0	Vdc
Base-Emitter On-Voltage (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	–	1.4	Vdc
Dynamic Characteristics				
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{cb}	–	8	pF
Small-Signal Current Gain (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{fe}	20,000	–	



FORWARD CURRENT TRANSFER RATIO NORMALIZED TO 2mA 5V VALUE VS. COLLECTOR CURRENT



COLLECTOR EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT $I_C = I_B \times 1000$

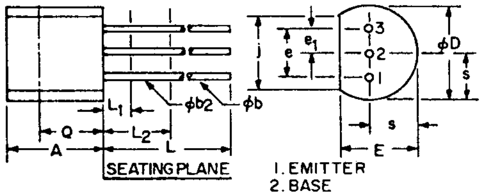


BASE EMITTER VOLTAGE V_{CE} = 5V AND BASE EMITTER SATURATION VOLTAGE IC = IB X 1000 VS. COLLECTOR CURRENT

Silicon Darlington Transistor

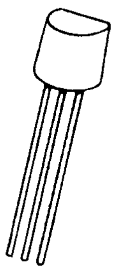
MPS-A13
MPS-A14

The General Electric MPS-A13, A14 are Silicon Planar Epitaxial Passivated NPN Darlington Transistors designed for preamplifier input applications where high impedance is a requirement.



1. EMITTER
2. BASE
3. COLLECTOR

TO-92



SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L_1	–	1.270	–	.050	3
L_2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

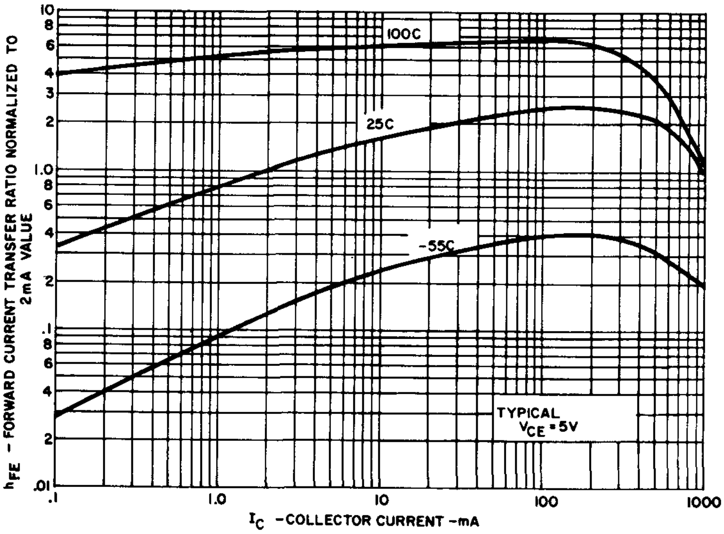
Voltages			
Collector to Emitter	V_{CES}	30	Volts
Collector to Base	V_{CB}	30	Volts
Emitter to Base	V_{EB}	10	Volts
Current			
Collector	I_C	500	mA
Dissipation			
Total Power $T_A \leq 25°C$	P_T	625	mWatts
Total Power $T_C \leq 25°C$	P_T	1.5	Watts
Derate Factor $T_A > 25°C$	P_T	5.0	mW/°C
Derate Factor $T_C > 25°C$	P_T	12	mW/°C
Temperature			
Storage	T_{stg}	-55 to +150	°C
Operating	T_J	-55 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+230	°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

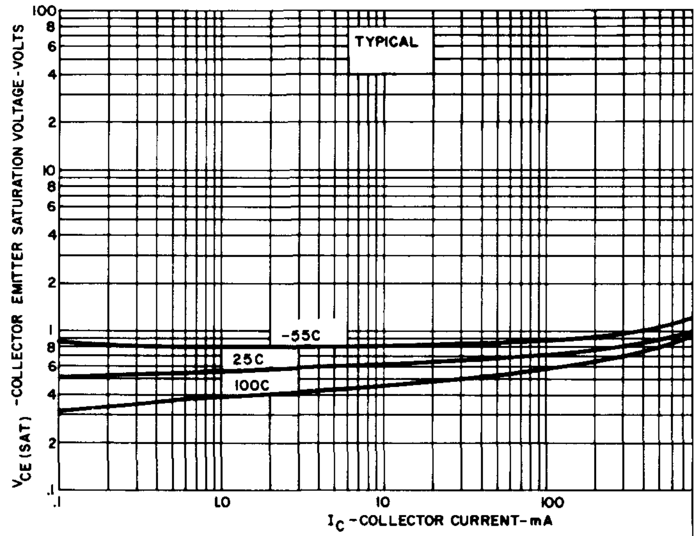
Static Characteristics		SYMBOL	MIN.	TYP.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, I_B = 0)		BV_{CES}	30	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	–	–	100	nAdc
Emitter Cutoff Current (V_{BE} = 10 Vdc, I_C = 0)		I_{EBO}	–	–	100	nAdc
DC Current Gain (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	– MPS-A13	*h_{FE}	5,000	–	–	
	– MPS-A14	*h_{FE}	10,000	–	–	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	– MPS-A13	*h_{FE}	10,000	–	–	
	– MPS-A14	*h_{FE}	20,000	–	–	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 0.1 mAdc)		*$V_{CE(sat)}$	–	0.75	1.5	Vdc
Base-Emitter On-Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		*$V_{BE(on)}$	–	1.29	2.0	Vdc
Dynamic Characteristics						
High Frequency Current Gain (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)		h_{FE}	4	–	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{cb}	–	5.4	8	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_S = 100K ohms, f = 1.0 kHz)		NF	–	2.0	–	dB

*Pulse Test: Pulse Width $\leq$ 300 μs, duty cycle $\leq$ 2.0%.

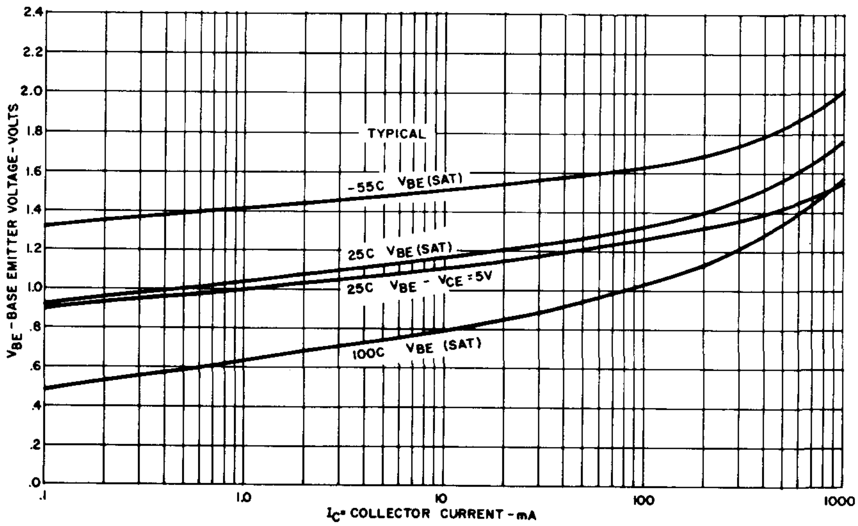
MPS-A13
MPS-A14



FORWARD CURRENT TRANSFER RATIO NORMALIZED TO 2mA 5V VALUE VS. COLLECTOR CURRENT



COLLECTOR EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT $I_C = I_B \times 1000$

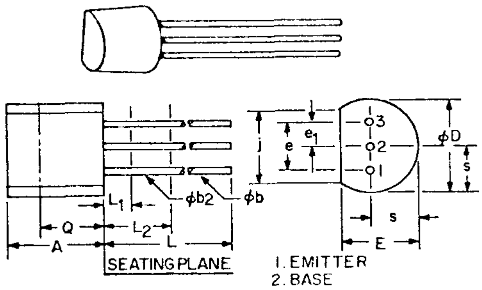


BASE EMITTER VOLTAGE V_{CE} = 5V AND BASE EMITTER SATURATION VOLTAGE IC = IB 1000 VS. COLLECTOR CURRENT

Silicon Transistors

NPN

MPS-A20



TO-92

1. EMITTER
2. BASE
3. COLLECTOR

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L_1	–	1.270	–	.050	3
L2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

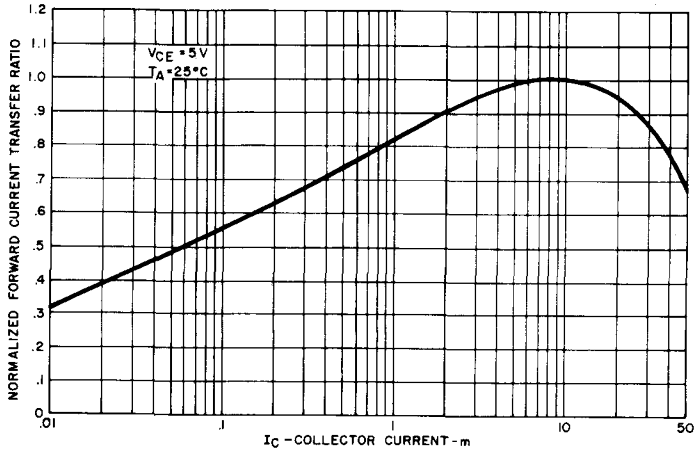
The MPS-A20 is a silicon planar epitaxial passivated NPN transistor, designed for general purpose amplifier applications.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

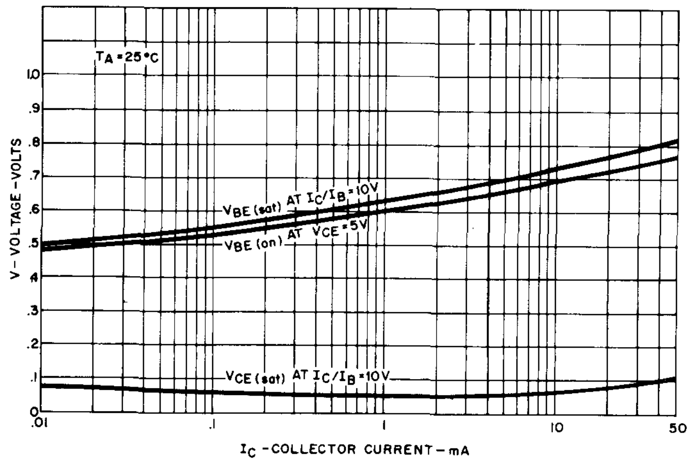
Voltages			
Collector to Emitter	V_{CEO}	40	Volts
Collector to Base	V_{CBO}	50	Volts
Emitter to Base	V_{EBO}	4	Volts
Current			
Collector	I_C	100	mA
Dissipation			
Total Power $T_A \leq 25°C$	P_T	350	m Watts
Total Power $T_C \leq 25°C$	P_T	1.0	Watts
Derate Factor $T_A > 25°C$		2.8	mW/°C
Derate Factor $T_C > 25°C$		8.0	mW/°C
Temperature			
Operating	T_J	-55°C to +150°C	°C
Storage	T_{STG}	-55°C to +150°C	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230°C	°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

Static Characteristics	SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 1mA, I_B = 0)	$V_{(BR)CEO}$	40	–	Volts
Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)	$V_{(BR)CBO}$	50	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	$V_{(BR)EBO}$	4	–	Volts
Collector Cutoff Current (V_{CB} = 30V, I_E = 0)	I_{CBO}	–	100	nA
Forward Current Transfer Ratio (V_{CE} = 10V, I_C = 5mA)	h_{FE}	40	400	
Collector-Emitter Saturation Voltage (I_C = 10mA, I_B = 1mA)	$V_{CE(sat)}$	–	.25	Volts
Dynamic Characteristics				
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 1 MHz)	C_{cb}	–	4	pF
Gain Bandwidth Product (V_{CE} = 10V, I_C = 5mA, f = 100 MHz)	f_t	125	–	MHz



NORMALIZED DC CURRENT GAIN



"SATURATION" AND "ON" VOLTAGES

ELECTRONIC INNOVATIONS IN ACTION

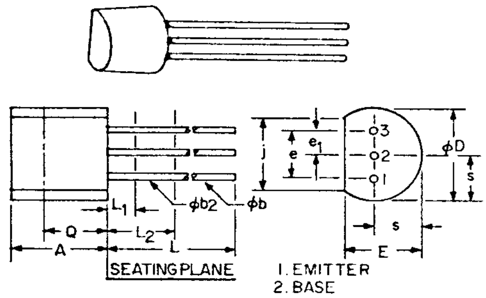
SEMICONDUCTORS

Silicon Transistors

PNP

MPS-A55
MPS-A56

The MPS-A55 and MPS-A56 are silicon planar epitaxial passivated PNP transistors designed for medium current general purpose amplifier applications. Voltage and current values for PNP are negative: observe proper polarity.



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

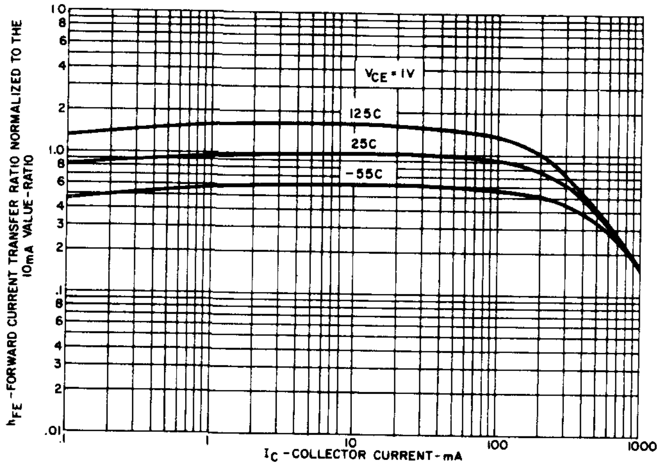
		MPS-A55	MPS-A56	
Voltages				
Collector to Emitter	V_{CEO}	60	80	Volts
Collector to Base	V_{CBO}	60	80	Volts
Emitter to Base	V_{EBO}	4	4	Volts
Current				
Collector	I_C	500	500	mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T	625	625	m Watts
Total Power $T_C \leq 25°C$	P_T	1.5	1.5	Watts
Derate Factor $T_A > 25°C$		5	5	mW/°C
Derate Factor $T_C > 25°C$		12	12	mW/°C
Temperature				
Operating	T_J	-55°C to +150°C		°C
Storage	T_{STG}	-55°C to +150°C		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230°C		°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

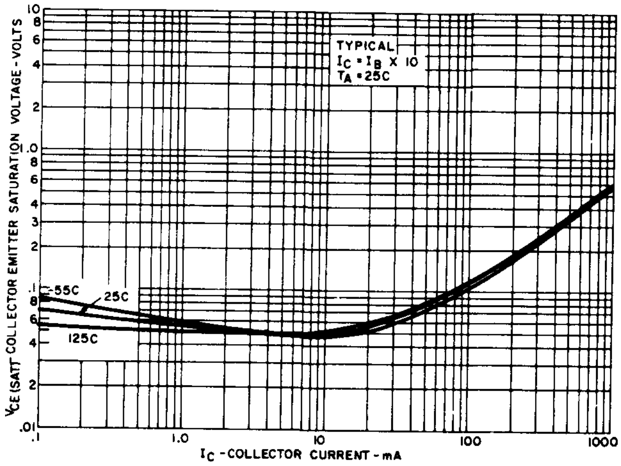
		MPS-A55		MPS-A56		
Static Characteristics	**SYMBOL**	**MIN.**	**MAX.**	**MIN.**	**MAX.**	**UNITS**
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	$V_{(BR)CEO}$	60	–	80	–	Volts
Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)	$V_{(BR)CBO}$	60	–	80	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	$V_{(BR)EBO}$	4	–	4	–	Volts
Collector Cutoff Current (V_{CB} = 60V, I_E = 0) – MPS-A55	I_{CBO}	–	100	–	100	nA
(V_{CB} = 80V, I_E = 0) – MPS-A56	I_{CBO}	–	100	–	100	nA
Collector Cutoff Current (V_{CE} = 60V, I_B = 0)	I_{CEO}	–	100	–	100	nA
Forward Current Transfer Ratio (V_{CE} = 1V, I_C = 10mA)	h_{FE}	50	–	50	–	
(V_{CE} = 1V, I_C = 100mA)	†h_{FE}	50	–	50	–	

Static Characteristics (continued)	SYMBOL	MPS-A55 MIN.	MPS-A55 MAX.	MPS-A56 MIN.	MPS-A56 MAX.	UNITS
Collector-Emitter Saturation Voltage (I_C = 100mA, I_B = 10mA)	†$V_{CE(sat)}$	–	.25	–	.25	Volts
Base-Emitter Saturation Voltage (I_C = 100mA, I_B = 10mA)	†$V_{BE(sat)}$	–	1.0	–	1.0	Volts
Base-Emitter Voltage (V_{CE} = 1V, I_C = 100mA)	†$V_{BE(on)}$	–	1.0	–	1.0	Volts
Dynamic Characteristics						
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0,f = 1 MHz)	C_{cb}	–	20	–	20	pF
Gain Bandwidth Product (V_{CE} = 5V, I_C = 30mA, f = 50MHz)	f_T	50	–	50	–	MHz

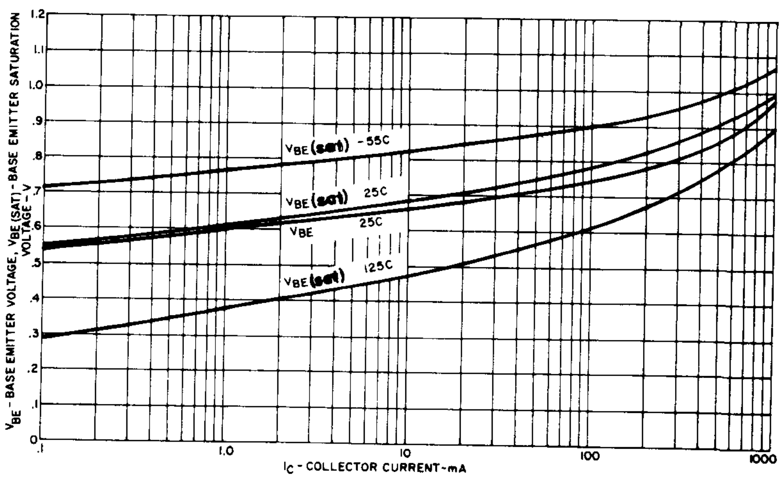
†Pulse width ⩽ 300 μsec., Duty Cycle ⩽ 2%.



FORWARD CURRENT TRANSFER RATIO NORMALIZED TO THE 10mA VALUE VS COLLECTOR CURRENT



COLLECTOR EMITTER SATURATION VOLTAGE VS COLLECTOR CURRENT



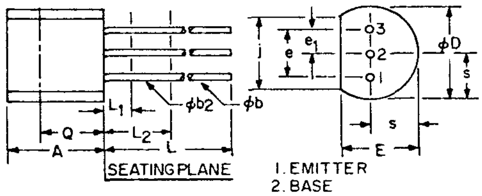
BASE EMITTER VOLTAGE (V_{CE} = 1V) AND BASE EMITTER SATURATION VOLTAGE (I_C = 10 x 1B) VS COLLECTOR CURRENT

Silicon Darlington Transistor

PNP

MPS-A65
MPS-A66

The General Electric MPS-A65, A66 are Silicon Planar Epitaxial Passivated PNP Darlington Transistors designed for preamplifier input applications where high impedance is a requirement.

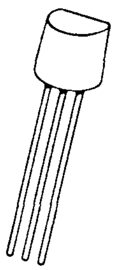


1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.



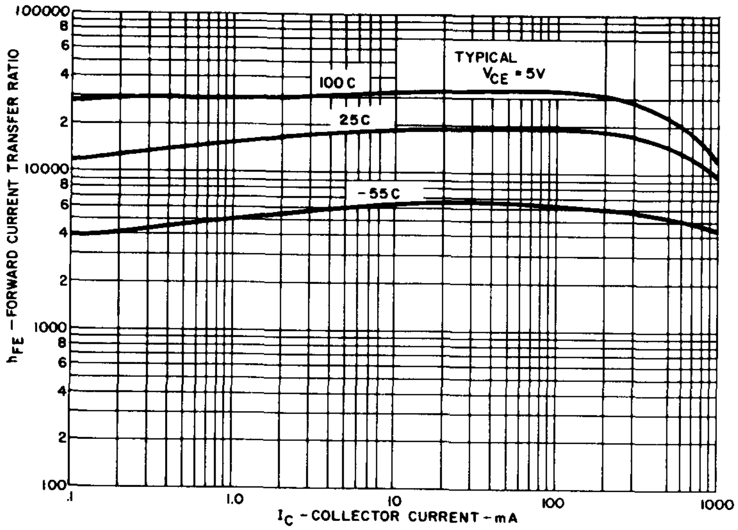
absolute maximum ratings: (T_A = 25°C unless otherwise specified)

Voltages			
Collector to Emitter	V_{CES}	30	Volts
Collector to Base	V_{CB}	30	Volts
Emitter to Base	V_{EB}	8	Volts
Current			
Collector	I_C	300	mA
Dissipation			
Total Power $T_A \leq 25°C$	P_T	625	mWatts
Total Power $T_C \leq 25°C$	P_T	1.5	Watts
Derate Factor $T_A > 25°C$	P_T	5.0	mW/°C
Derate Factor $T_C > 25°C$	P_T	12	mW/°C
Temperature			
Storage	T_{stg}	-55 to +150	°C
Operating	T_J	-55 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+230	°C

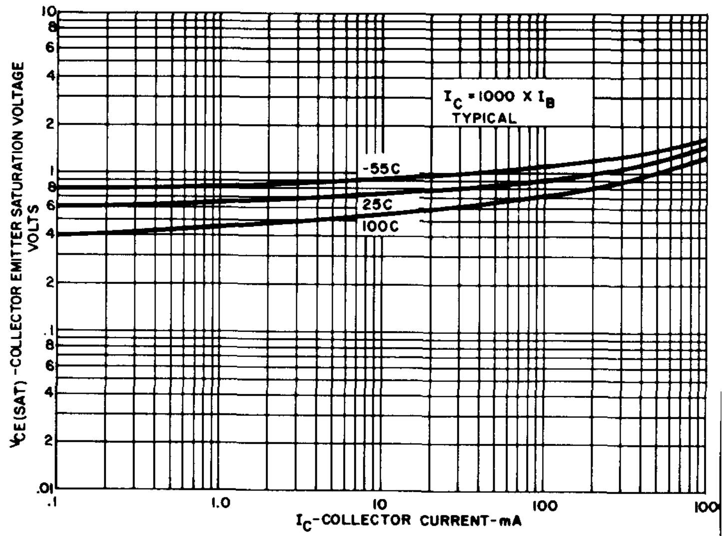
electrical characteristics: (T_A = 25°C unless otherwise specified)

Static Characteristics		SYMBOL	MIN.	TYP.	MAX.	UNITS
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, I_B = 0)		BV_{CES}	30	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	–	–	100	nAdc
Emitter Cutoff Current (V_{BE} = 8.0 Vdc, I_C = 0)		I_{EBO}	–	–	100	nAdc
DC Current Gain (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	– MPS-A65	*h_{FE}	50,000	–	–	
	– MPS-A66	*h_{FE}	75,000	–	–	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	– MPS-A65	*h_{FE}	20,000	–	–	
	– MPS-A66	*h_{FE}	40,000	–	–	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 0.1 mAdc)		*$V_{CE(sat)}$	–	0.9	1.5	Vdc
Base-Emitter On-Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		*$V_{BE(on)}$	–	1.45	2.0	Vdc
Dynamic Characteristics						
Current-Gain – Bandwidth Product (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 50 MHz)		f_T	100	125	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{cb}	–	2.5	–	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_S = 100k ohms, f = 1.0 kHz)		NF	–	2.0	–	dB

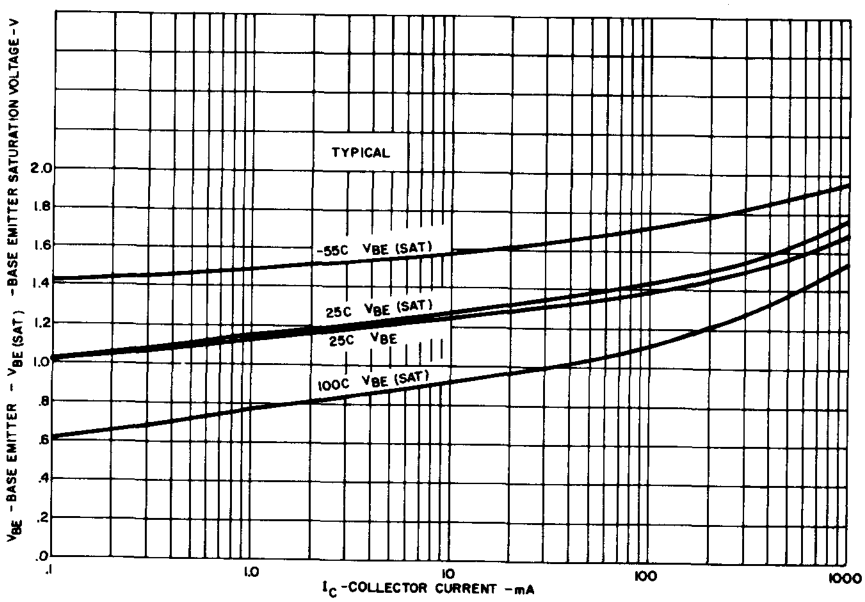
*Pulse Test: Pulse Width ≤ 300 μs, duty cycle ≤ 2.0%.



FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



COLLECTOR EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



BASE EMITTER VOLTAGE (V_{CE} = 5V) AND BASE EMITTER SATURATION VOLTAGE (IC = 1000 x IB) VS. COLLECTOR CURRENT

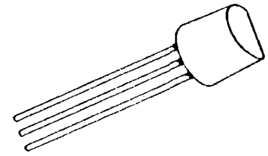
Silicon Transistors

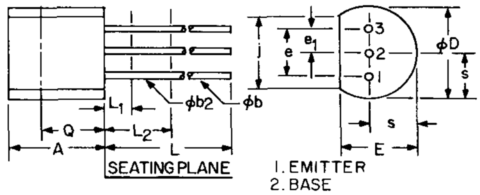
PNP

MPS-A70

The MPS-A70 is a Planar Epitaxial PNP Transistor designed for general purpose amplifier applications.

PNP Valves Are Negative: Observe Proper Polarity.





TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
ϕb_2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) ϕb_2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: ($T_A = 25°C$, unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	40	Volts
Collector to Base	V_{CBO}	40	Volts
Emitter to Base	V_{EBO}	4	Volts
Current			
Collector	I_C	100	mA
Dissipation			
Total Power $T_A \leq 25°C$	P_T	350	mW
Total Power $T_C \leq 25°C$	P_T	1.0	Watt
Derate Factor $T_A > 25°C$		2.8	mW/°C
Derate Factor $T_C > 25°C$		8.0	mW/°C
Temperature			
Operating	T_J	-55 to +150	°C
Junction	T_{stg}	-55 to +150	°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+230	°C

electrical characteristics: ($T_A = 25°C$, unless otherwise specified)

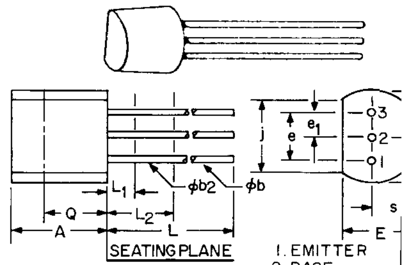
Static Characteristics	SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	BV_{CEO}	40	–	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\,\mu$Adc, $I_C = 0$)	BV_{CEO}	4.0	–	Vdc
Collector-Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	–	100	nAdc
DC Current Gain ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	40	400	–
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	–	0.25	Vdc
Dynamic Characteristics				
Current-Gain-Bandwidth Product ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	125	–	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{ob}	–	4.0	pF

Silicon Transistors

PNP

MPS3638,A

The MPS3638 and MPS3638A are planar, epitaxial, passivated PNP silicon transistors intended for general purpose applications. The units feature low collector saturation voltage, controlled current gain and excellent frequency response.



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OU THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AN φb APPLIES BETWEEN L_2 AND 12.70 MM FROM THE SEATING PLANE. DIAMETER I CONTROLLED IN L_1 AND BEYOND 12.70 M FROM SEATING PLANE.

absolute maximum ratings: (T_A=25°C, unless otherwise specified)

Voltages		
Collector to Emitter	V_{CEO}	−25V
Emitter to Base	V_{EBO}	−4V
Collector to Base	V_{CBO}	−25V
Collector to Emitter	V_{CES}	−25V
Current		
Collector (steady state)	I_C	−350mA
Collector (peak, pulsed 10 μusec, 2% Duty Cycle)	I_C	−700mA
Dissipation		
Total Power ($T_C \leqq 25$°C)	P_T	0.700 Watts
Total Power ($T_A \leqq 25$°C)	P_T	0.360 Watts
Derate Factor ($T_C \geqq 25$°C)		7.0 mW/°C
Derate Factor ($T_A \geqq 25$°C)		3.6 mW/°C
Temperature		
Storage	T_{STG}	−65 to +150°C
Operating	T_J	−65 to +125°C
Lead Soldering, 1/16″ ± 1/32″ from case for 10 seconds max.	T_L	+260°C

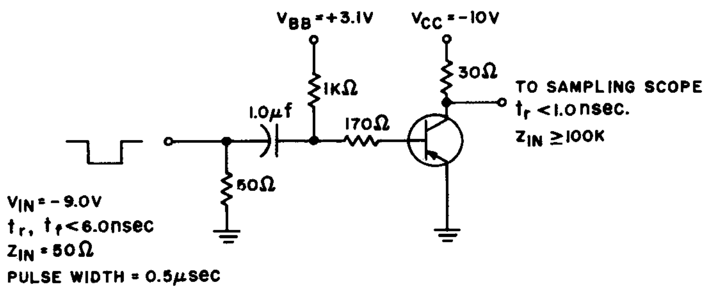
electrical characteristics: (T_A=25°C, unless otherwise specified)

STATIC CHARACTERISTICS	Symbol		Min.	Max.	Units
Collector-Base Breakdown Voltage					
($I_C = -100\mu A$, $I_E = 0$)	$V_{(BR)CBO}$		−25		Volts
Collector-Emitter Breakdown Voltage					
($I_C = 10mA$, $I_B = 0$)	$V_{(BR)CEO}$*		−25		Volts
($I_C = 100\mu A$, $V_{BE} = 0$)	$V_{(BR)CES}$		−25		Volts
Emitter-Base Breakdown Voltage					
($I_E = 10\mu A$, $I_C = 0$)	$V_{(BR)EBO}$		−4		Volts
Forward Current Transfer Ratio					
($I_C = -1mA$, $V_{CE} = -10V$)	h_{FE}	MPS3638A	80		
($I_C = -10mA$, $V_{CE} = -10V$)	h_{FE}*	MPS3638	20		
		MPS3638A	100		
($I_C = -50mA$, $V_{CE} = -1V$)	h_{FE}*	MPS3638	30	70 (Typ.)	
		MPS3638A	100		
($I_C = -300mA$, $V_{CE} = -2V$)	h_{FE}*	MPS3638	20	40 (Typ.)	
		MPS3638A	20	50 (Typ.)	
Collector Saturation Voltage					
($I_C = -50mA$, $I_B = -2.5mA$)	$V_{CE(SAT)}$ *			−.250	Volts
($I_C = -300mA$, $I_B = -30mA$)	$V_{CE(SAT)}$ *			−1.0	Volts
Base Saturation Voltage					
($I_C = -50mA$, $I_B = -2.5mA$)	$V_{BE(SAT)}$ *			−1.1	Volts
($I_C = -300mA$, $I_B = -30mA$)	$V_{BE(SAT)}$ *		−.80	−2.0	Volts

STATIC CHARACTERISTICS (Continued)	Symbol		Min.	Max.	Units
Collector Cutoff Current					
($V_{CE} = -15V, V_{BE} = 0$	I_{CES}			-35	nA
($V_{CB} = -15V$, $V_{BE} = 0$, $T_A = 100°C$)	I_{CES}			-10	μA

*Pulse conditions of 300 μsec duration, 2% duty cycle

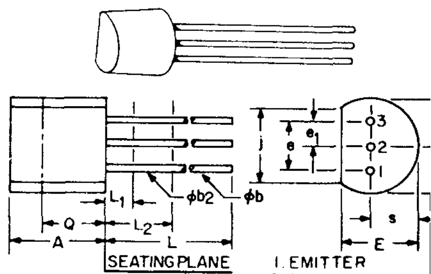
DYNAMIC CHARACTERISTICS	Symbol		Min.	Max.	Units
Forward Current Transfer Ratio					
($I_C = -10mA$, $V_{CE} = -10V$, f = 1kHz)	h_{fe}	MPS3638 MPS3638A	25 100		
Input Impedance					
($I_C = -10mA$, $V_{CE} = -10V$, f = 1kHz)	h_{ie}	MPS3638 MPS3638A	480 (Typ.)	2000	ohms
Output Admittance					
($I_C = -10mA$, $V_{CE} = -10V$, f = 1kHz)	h_{oe}	MPS3638 MPS3638A	80 (Typ.)	1200	umhos
Reverse Voltage Transfer Ratio					
($I_C = -10mA$, $V_{CE} = -10V$, f = 1kHz)	h_{re}	MPS3638 MPS3638A	162 (Typ.)	2600 1500	10^{-6} 10^{-6}
Output Capacitance, common base					
($V_{CB} = -10V$, f = 1MHz)	C_{cb}			10	pF
Input Capacitance, common base					
($V_{EB} = -0.5V$, f = 1MHz)	C_{eb}			35	pF
Gain bandwidth product					
($V_{CE} = -3V$, $I_C = -50mA$)	f_t		100 (Typ.)		MHz
Delay Time					
($V_{CC} = -10V$, $I_C = -300mA$, $I_{B1} = -30mA$, $V_{BB(off)} = +3.1V$) (See Test Circuit)	t_d			20	nsec
Rise Time					
($V_{CC} = -10V$, $I_C = -300mA$, $I_{B1} = -30mA$, $V_{BB(off)} = +3.1V$) (See Test Circuit)	t_r			70	nsec
Turn-on Time					
($I_C = -300mA$, $I_{B1} = -30mA$) (See Test Circuit)	t_{on}			75	nsec
Storage Time					
($V_{CC} = -10V$, $I_C = -300mA$, $I_{B1} = -30mA$, $I_{B2} = 30mA$) (See Test Circuit)	t_s			140	nsec
Fall Time					
($V_{CC} = -10V$, $I_C = -300mA$, $I_{B1} = -30mA$, $I_{B2} = 30mA$) (See Test Circuit)	t_f			70	nsec
Turn-off Time					
($I_C = -300mA$, $I_{B1} = -30mA$, $I_{B2} = 30mA$) (See Test Circuit)	t_{off}			170	nsec



Silicon Transistors

PNP MPS3702,3

The General Electric MPS3702 and MPS3703 are silicon, PNP planar, epitaxial, passivated transistors, designed for general audio frequency applications and linear amplifiers. For complimentary NPN types see MPS3704, MPS3705 and MPS3706 specification. Voltage and current valves for PNP are negative, observe proper bias polarity.



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSI[illegible] THIS SIDE.
3. (THREE LEADS) φb_2 APPLIES BETWEEN L_1 AND L_2 φb APPLIES BETWEEN L_2 AND 12.70 MM (.5[illegible] FROM THE SEATING PLANE. DIAMETER IS U[illegible] CONTROLLED IN L_1 AND BEYOND 12.70 MM ([illegible] FROM SEATING PLANE.

absolute maximum ratings: (T_A =25°C unless otherwise specified)

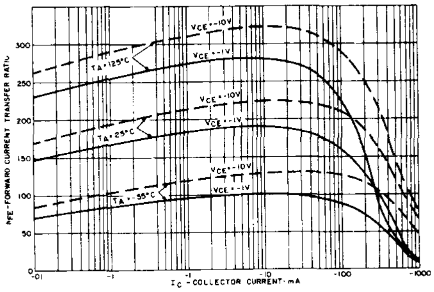
		MPS3702	MPS3703	
Voltages				
Collector to Emitter	V_{CEO}	25	30	Volts
Collector to Base	V_{CBO}	40	50	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	← 200 →		mA
Dissipation				
Total Power T_A ≦ 25°C	P_T	← 350 →		Watts
Total Power T_C ≦ 25°C	P_T	← 1.0 →		Watts
Derate Factor T_A > 25°C		← 2.8 →		mW/°C
Derate Factor T_C >25°C		← 8 →		mW/°C
Temperature				
Storage and Operating	T_{STG}, T_J	-55 to + 150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260		°C

electrical characteristics: (T_A =25°C unless otherwise specified)

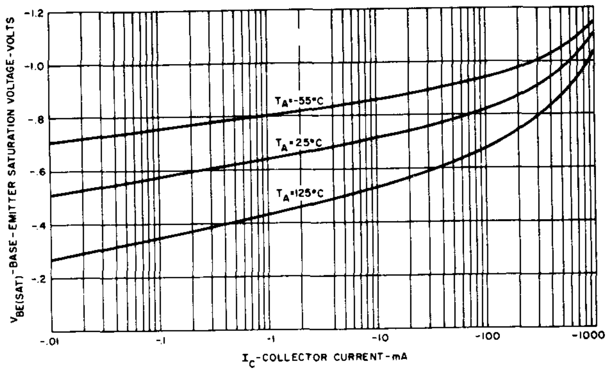
STATIC CHARACTERISTICS	Symbol	MPS3702 Min.	MPS3702 Max.	MPS3703 Min.	MPS3703 Max.	Units
Collector-emitter breakdown voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$*	25		30		Volts
Collector-base breakdown voltage (I_C = 100uA, I_E = 0)	$V_{(BR)CBO}$	40		50		Volts
Emitter-base breakdown voltage (I_E = 100uA, I_C = 0)	$V_{(BR)EBO}$	5		5		Volts
Collector cutoff current (V_{CB} = 20V, I_E = 0)	I_{CBO}		100		100	nA
Emitter-base reverse current (V_{EB} = 3V, I_C = 0)	I_{EBO}		100		100	nA
Forward current transfer ratio (V_{CE} = 5V, I_C = 50mA)	h_{FE}*	60	300	30	150	
Collector-emitter saturation voltage (I_C = 50mA, I_B = 5mA)	$V_{CE(sat)}$*		.25		.25	Volts
Base-emitter voltage (V_{CE} = 5V, I_C = 50mA)	$V_{BE(on)}$*	.6	1	.6	1	Volts
DYNAMIC CHARACTERISTICS						
Collector-base capacitance (V_{CB} = 10V, I_E = 0, f = 1MHz)	C_{ob}		12		12	pf
Current Gain-Bandwidth Product (V_{CE} = 5V, I_C = 50mA, f = 20MHz)	f_T	100		100		MHz

*Pulse Conditions: Pulse Width ≦ 300 μs and duty cycle ≦ 2%

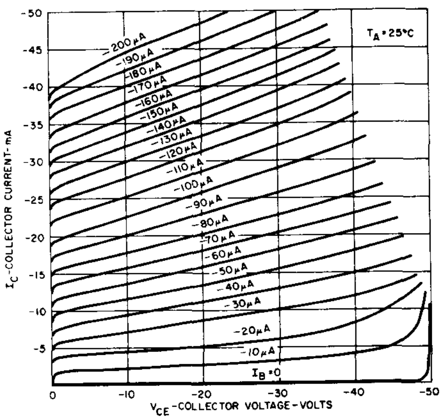
TYPICAL CHARACTERISTIC CURVES



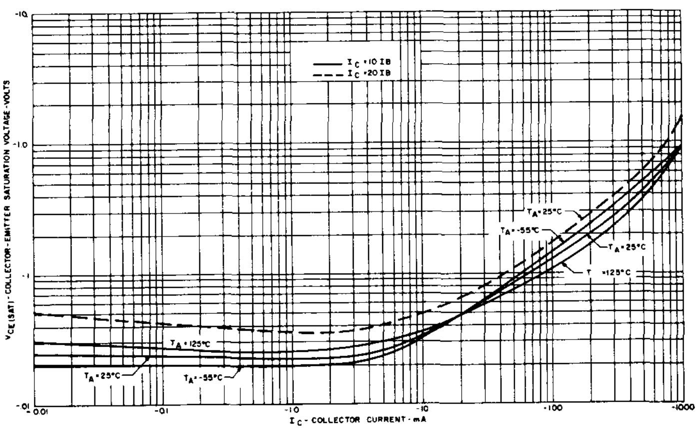
BETA VS. COLLECTOR CURRENT



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



COLLECTOR CHARACTERISTICS



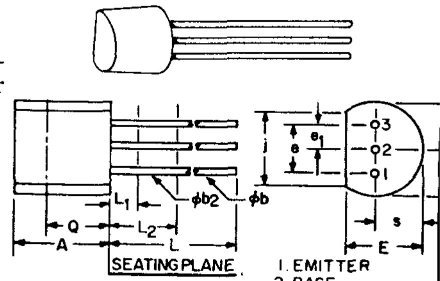
COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

Silicon Transistors

NPN

MPS3704,05,06

The General Electric MPS3704, MPS3705 and MPS3706 are silicon NPN planar, epitaxial, passivated transistors designed for general audio frequency applications and linear amplifiers. For complimentary PNP types see MPS3702 and MPS3703 specifications.



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSID THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L_2. ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.50 FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.5 FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

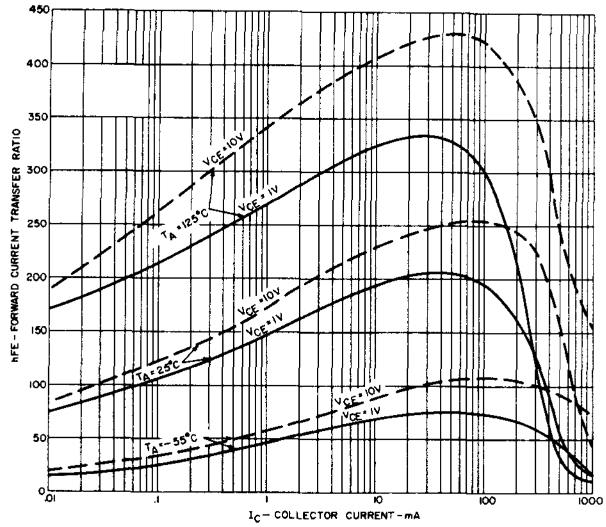
		MPS3704 MPS3705	MPS3706	
Voltages				
Collector to Emitter	V_{CEO}	30	20	Volts
Collector to Base	V_{CBO}	50	40	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	← 600 →		mA
Dissipation				
Total Power $T_A \leqq 25°C$	P_T	← .350 →		Watts
Total Power $T_C \leqq 25°C$	P_T	← 1.0 →		Watts
Derate Factor $T_A > 25°C$		← 2.8 →		mW/°C
Derate Factor $T_C > 25°C$		← 8.0 →		mW/°C
Temperature				
Storage and Operating	T_{STG}, T_J	-55 to + 150		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	+260		°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

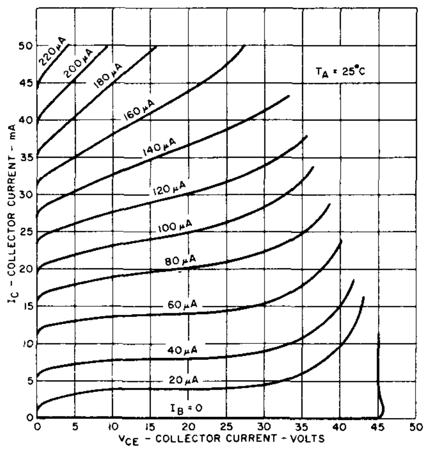
STATIC CHARACTERISTICS	Symbol	MPS3704 Min.	MPS3704 Max.	MPS3705 Min.	MPS3705 Max.	MPS3706 Min.	MPS3706 Max.	Units
Collector-Emitter Breakdown Voltage (I_C = 10mA, I_B = 0)	$V_{(BR)CEO}$*	30		30		20		Volts
Collector-Base Breakdown Voltage (I_C = 100 uA, I_E = 0)	$V_{(BR)CBO}$	50		50		40		Volts
Emitter-Base Breakdown Voltage (I_E = 100uA, I_C = 0)	$V_{(BR)EBO}$	5		5		5		Volts
Collector Cutoff Current (V_{CB} = 20 V, I_E = 0)	I_{CBO}		100		100		100	nA
Emitter-Base Reverse Current (V_{EB} = 3 V, I_C = 0)	I_{EBO}		100		100		100	nA
Forward Current Transfer Ratio (V_{CE} = 2 V, I_C = 50mA)	h_{FE}*	100	300	50	150	30	600	
Collector-Emitter Saturation Voltage (I_C = 100mA, I_B = 5mA)	$V_{CE(SAT)}$*		.6		.8		1	Volts
Base-Emitter Voltage (V_{CE} = 2 V, I_C = 100mA)	$V_{BE(ON)}$*	.5	1	.5	1	.5	1	Volts
DYNAMIC CHARACTERISTICS								
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1MHz)	C_{OB}		12		12		12	pf
Current Gain-Bandwidth Product (V_{CE} = 2 V, I_C = 50mA, f = 20MHz)	f_T	100		100		100		MHz

*Pulse Conditions: Pulse Width $\leqq$ 300 μs and duty cycle $\leqq$ 2%

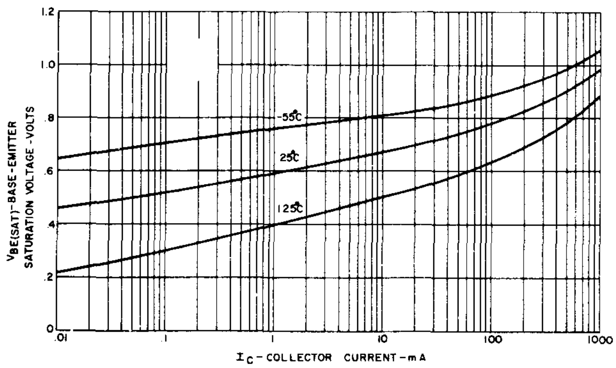
TYPICAL CHARACTERISTIC CURVES



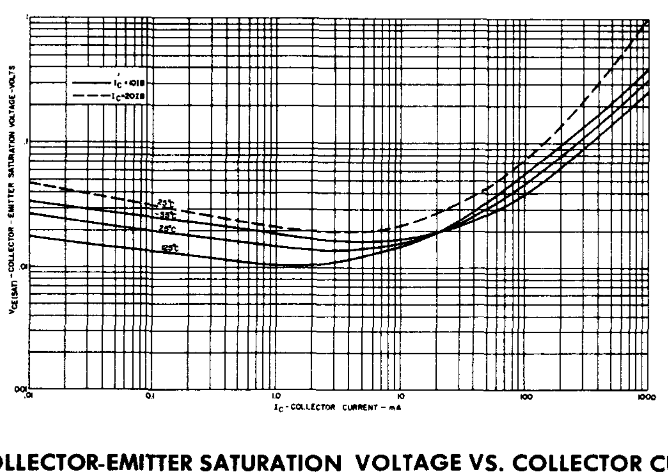
BETA VS. COLLECTOR CURRENT



COLLECTOR CHARACTERISTICS



BASE-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

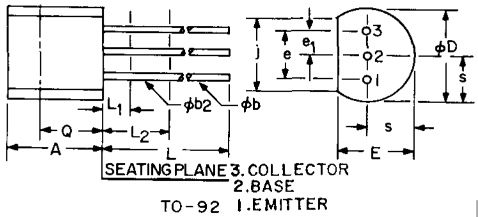


COLLECTOR-EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

Silicon Transistors

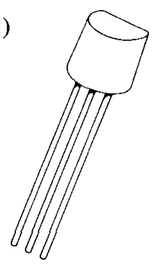
NPN MPS5172 | PNP MPS6076

The General Electric MPS5172 and MPS6076 transistors are designed for general purpose applications. The planar, passivated construction assures excellent device stability and life. This high performance and high value is made possible by advanced manufacturing techniques, epoxy encapsulation and utilization of full line beta distribution. Significant savings may be realized by designing equipment utilizing these "full line distribution" type transistors.



SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.



absolute maximum ratings: (T_A = 25°C unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	25	Volts
Collector to Base	V_{CBO}	25	Volts
Emitter to Base	V_{EBO}	5	Volts
Current			
Collector (Steady-State)†	I_C	100	mA
Dissipation			
Total Power $T_A \leqslant 25°C$††	P_T	360	mW
Temperature			
Storage	T_{stg}	-55 to +150	°C
Operating	T_J	+125	°C
Lead (1/16" ± 1/32" from case for 10 sec. max.)	T_L	+260	°C

†Determined from power limitations due to saturation voltage at this current.
††Derate 3.6 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (T_A = 25°C unless otherwise specified)

	SYMBOL	MIN.	MAX.	UNITS
Static Characteristics				
Collector Cutoff Current				
(V_{CB} = 25V)	I_{CBO}	–	100	nA
(V_{CB} = 25V; T_A = 100°C)	I_{CBO}	–	10	μA
(V_{CB} = 25V)	I_{CES}	–	100	nA
Emitter Cutoff Current				
(V_{EB} = 5V) – MPS5172	I_{EBO}	–	100	nA
(V_{EB} = 3V) – MPS6076	I_{EBO}	–	100	nA
Forward Current Transfer Ratio (V_{CE} = 10V, I_C = 10 mA)	‡h_{FE}	100	500	
Collector-Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$	25	–	Volts
Collector Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{CE(sat)}$	–	.25	Volts
Base Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{BE(sat)}$	–	.80	Volts
Base Emitter Voltage) (V_{CE} = 10V, I_C = 10 mA)	V_{BE}	0.5	1.2	Volts
Dynamic Characteristics				
Forward Current Transfer Ratio (V_{CE} = 10V, I_C = 10 mA, f = 1 kHz)	h_{fe}	100	750	
Output Capacitance, Common Base (V_{CB} = 10V, I_E = 0, f = 1 MHz)	C_{cb}	1.0	13	pF
Gain Bandwidth Product (V_{CB} = 5V, I_C = 2 mA)	f_T	(Typical 200)		MHz

‡Typically a minimum of 50% of the distribution will have $h_{FE} > 150$ at stated conditions.

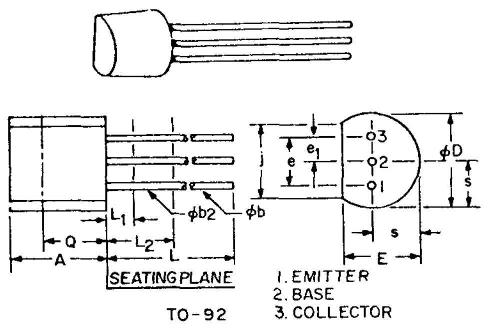
Note: Polarities are Absolute.

ELECTRONIC INNOVATIONS IN ACTION
SEMICONDUCTORS

Silicon Transistors

NPN
MPS6512-MPS6515
PNP
MPS6516-MPS6519

These Silicon Planar Epitaxial Passivated Complementary Transistors are designed for general purpose amplifier applications. Polarities are absolute, observe PNP/NPN polarity.



TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L_1	–	1.270	–	.050	3
L_2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		NPN	PNP	UNITS
Voltages				
Collector to Emitter				
MPS6512, 13	V_{CEO}	30	–	Volts
MPS6514, 15	V_{CEO}	25	–	Volts
MPS6516, 17, 18	V_{CEO}	–	40	Volts
MPS6519	V_{CEO}	–	25	Volts
Collector to Base				
MPS6512, 13, 14, 15	V_{CBO}	40	–	Volts
MPS6516, 17, 18	V_{CBO}	–	40	Volts
MPS6519	V_{CBO}	–	25	Volts
Emitter to Base	V_{EBO}	4	4	Volts
Current				
Collector	I_C	100	100	mA
Dissipation				
Total Power $T_A \leq 25°C$	P_T	350	350	mW
Total Power $T_C \leq 25°C$	P_T	1	1	Watt
Derating Factor $T_A > 25°C$		2.8	2.8	mW/°C
Derating Factor $T_C > 25°C$		8	8	mW/°C
Temperature				
Operating	T_J	-55°C to +150°C		°C
Storage	T_{STG}	-55°C to +150°C		°C
Lead (1/16" ± 1/32" from case for 10 sec.)	T_L	260°C		°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

MPS6512 Thru MPS6515 (NPN)

	SYMBOL	MIN.	MAX.	UNITS
Static Characteristics				
Collector-Emitter Breakdown Voltage				
(I_C = .5mA, I_B = 0) MPS6512, 13	$V_{(BR)CEO}$	30	–	Volts
MPS6514, 15	$V_{(BR)CEO}$	25	–	Volts
Emitter-Base Breakdown Voltage (I_E = 10μA, I_C = 0)	$V_{(BR)EBO}$	4	–	Volts
Collector Cutoff Current				
(V_{CB} = 30V, I_E = 0)	I_{CBO}	–	50	ηA
(V_{CB} = 30V, I_E = 0, T_A = 60°C)	I_{CBO}		1	μA

MPS6512 Thru MPS6515 (NPN)

	SYMBOL	MIN.	TYP.	MAX.	UNITS
Static Characteristics (continued)					
Forward Current Transfer Ratio					
(I_C = 2mA, V_{CE} = 10V)					
MPS6512	h_{FE}	50	–	100	
MPS6513	h_{FE}	90	–	180	
MPS6514	h_{FE}	150	–	300	
MPS6515	h_{FE}	250	–	500	
(I_C = 100mA, V_{CE} = 10V)					
MPS6512	†h_{FE}	30	–		
MPS6513	†h_{FE}	60	–		
MPS6514	†h_{FE}	90	–		
MPS6515	†h_{FE}	150	–		
Collector-Emitter Saturation Voltage (I_C = 50mA, I_B = 5mA)	†$V_{CE(sat)}$	–	–	.5	Volts
Dynamic Characteristics					
Current Gain, Bandwidth Product					
(I_C = 2mA, V_{CE} = 10V, f = 100 MHz)					
MPS6512, 13	f_T	–	250	–	MHz
MPS6514, 15	f_T	–	390	–	
(I_C = 10mA, V_{CE} = 10V, f = 100 MHz)					
MPS6512, 13	f_T	–	330	–	
MPS6514, 15	f_T	–	480	–	
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 100 kHz)	C_{ob}	–	–	3.5	pF
Noise Figure (I_C = 10μA, V_{CE} = 5V, Rs = 10K Ohms, BW = 15.7 kHz, f = 10 Hz to 10 kHz)	NF	–	2	–	dB

MPS6515 Thru MPS6519 (PNP)

		SYMBOL	MIN.	TYP.	MAX.	UNITS
Static Characteristics						
Collector-Emitter Breakdown Voltage (I_C = .5mA, I_B = 0)						
	MPS6516, 17, 18	$V_{(BR)CEO}$	40	–	–	Volts
	MPS6519	$V_{(BR)CEO}$	25	–	–	Volts
Emitter-Base Breakdown Voltage (I_E = 10μA, I_C = 0)		$V_{(BR)EBO}$	4	–	–	Volts
Collector Cutoff Current						
(V_{CB} = 30V, I_E = 0)	MPS6516, 17, 18	I_{CBO}	–	–	50	ηA
(V_{CB} = 20V, I_E = 0)	MPS6519	I_{CBO}	–	–	50	ηA
(V_{CB} = 30V, I_E = 0, T_A = 60°C)	MPS6516, 17, 18	I_{CBO}	–	–	1	μA
(V_{CB} = 20V, I_E = 0, T_A = 60°C)	MPS6519	I_{CBO}	–	–	1	μA
Forward Current Transfer Ratio						
(I_C = 2mA, V_{CE} = 10V)	MPS6516	h_{FE}	50	–	100	
	MPS6517	h_{FE}	90	–	180	
	MPS6518	h_{FE}	150	–	300	
	MPS6519	h_{FE}	250	–	500	
(I_C = 100mA, V_{CE} = 10V)	MPS6516	†h_{FE}	30	–	–	
	MPS6517	†h_{FE}	60	–	–	
	MPS6518	†h_{FE}	90	–	–	
	MPS6519	†h_{FE}	150	–	–	
Collector-Emitter Saturation Voltage (I_C = 50mA, I_B = 5 mA)		†$V_{CE(sat)}$	–	–	.5	Volts
Dynamic Characteristics						
Current Gain Bandwidth Product						
(I_C = 2mA, V_{CE} = 10V, f = 100 MHz)	MPS6516, 17	f_T	–	200	–	MHz
	MPS6518, 19	f_T	–	340	–	
(I_C = 10mA, V_{CE} = 10V, f = 100 MHz)	MPS6516, 17	f_T	–	270	–	
	MPS6518, 19	f_T	–	420	–	
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 100 KHz)		C_{ob}	–	–	4	pF
Noise Figure (I_C = 10μA, V_{CE} = 5V, Rs = 10KΩ BW = 15.7 kHz, f = 10Hz to 10kHz)			–	2	–	dB

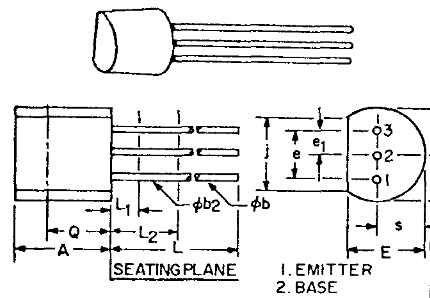
†Pulse Width ⩽ 300μs, Duty Cycle ⩽ 2%.

Silicon Transistors

NPN

MPS6530
MPS6531
MPS6532

The MPS6530, MPS6531 and MPS6532 are silicon planar epitaxial passivated NPN transistors designed for general purpose switching and amplifier applications.



1. EMITTER
2. BASE
3. COLLECTOR

TO-92

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
ϕb	.407	.550	.016	.022	1,3
ϕb2	.407	.482	.016	.019	3
ϕD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L1	—	1.270	—	.050	3
L2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSI THIS SIDE.
3. (THREE LEADS) ϕb2 APPLIES BETWEEN L_1 AND L ϕb APPLIES BETWEEN L_2 AND 12.70 MM (.5 FROM THE SEATING PLANE. DIAMETER IS U CONTROLLED IN L_1 AND BEYOND 12.70 MM (FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		MPS6530 & 31	MPS6532	
Voltages				
Collector to Emitter	V_{CEO}	40	30	Volts
Collector to Base	V_{CBO}	60	50	Volts
Emitter to Base	V_{EBO}	5	5	Volts
Current				
Collector	I_C	600	600	mA
Dissipation				
Total Power $T_A \leqslant 25°C$	P_T	350	350	m Watts
Total Power $T_C \leqslant 25°C$	P_T	1.0	1.0	Watts
Derate Factor $T_A > 25°C$		2.80	2.80	mW/°C
Derate Factor $T_C > 25°C$		8.0	8.0	mW/°C
Temperature				
Operating	T_J	-55°C to +150°C		°C
Storage	T_{STG}	-55°C to +150°C		°C
Lead (1/16″ ± 1/32″ from case for 10 sec.)	T_L	+230°C		°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

Static Characteristics		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage					
(I_C = 10mA, I_B = 0)	– MPS6530, MPS6531	$V_{(BR)CEO}$	40	–	Volts
(I_C = 10mA, V_{BE} = 0)	– MPS6532	$V_{(BR)CEO}$	30	–	Volts
Collector-Base Breakdown Voltage					
(I_C = 10μA, I_E = 0)	– MPS6530, MPS6531	$V_{(BR)CBO}$	60	–	Volts
(I_C = 10μA, I_E = 0)	– GPS6532	$V_{(BR)CBO}$	50	–	Volts
Emitter-Base Breakdown Voltage					
(I_E = 10μA, I_C = 0)		$V_{(BR)EBO}$	5	–	Volts
Collector Cutoff Current					
(V_{CB} = 40V, I_E = 0)	– MPS6530, MPS6531	I_{CBO}	–	50	nA
(V_{CB} = 30V, I_E = 0)	– MPS6532	I_{CBO}	–	100	nA
(V_{CB} = 40V, I_E = 0, T_A = 60°C)	– MPS6530, MPS6531	I_{CBO}	–	2	μA
(V_{CB} = 30V, I_E = 0 T_A = 60°C)	– MPS6532	I_{CBO}	–	5	μA
Emitter-Base Reverse Current					
(V_{EB} = 4V, I_C = 0)		I_{EBO}	–	100	nA
Forward Current Transfer Ratio					
(V_{CE} = 1V, I_C = 10mA)	– MPS6530	h_{FE}	30	–	
(V_{CE} = 1V, I_C = 10mA)	– MPS6531	h_{FE}	60	–	
(V_{CE} = 1V, I_C = 100mA)	– MPS6530	†h_{FE}	40	120	

Static Characteristics (continued)		SYMBOL	MIN.	MAX.	UNITS
Forward Current Transfer Ratio (continued)					
(V_{CE} = 1V, I_C = 100mA)	– MPS6531	†h_{FE}	90	270	
(V_{CE} = 1V, I_C = 100mA)	– MPS6532	†h_{FE}	30	–	
(V_{CE} = 10V, I_C = 500mA)	– MPS6530	†h_{FE}	25	–	
(V_{CE} = 10V, I_C = 500mA)	– MPS6531	†h_{FE}	50	–	
Collector-Emitter Saturation Voltage					
(I_C = 100mA, I_B = 10mA)	– MPS6530, MPS6532	$V_{CE(sat)}$	–	.5	Volts
(I_C = 100mA, I_B = 10mA)	– MPS6531	$V_{CE(sat)}$	–	.3	Volts
Base-Emitter Saturation Voltage					
(I_C = 100mA, I_B = 10mA)	– MPS6530, MPS6531	$V_{CE(sat)}$	–	1	Volts
(I_C = 100mA, I_B = 10mA)	– MPS6532	$V_{CE(sat)}$	–	1.2	Volts
Dynamic Characteristics					
Collector-Base Capacitance					
(V_{CB} = 10V, I_E = O,f = 1 MHz)		C_{cb}	–	5	pF

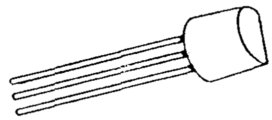
†Pulse width ⩽ 300 μsec., Duty Cycle ⩽ 2%.

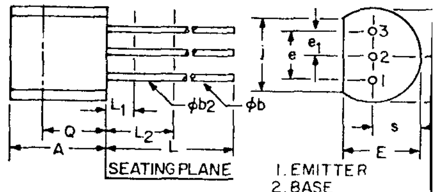
Silicon Transistors

MPS6533 MPS6534 MPS6535

PNP

The MPS6533, MPS6534 and MPS6535 are silicon planar epitaxial passivated PNP transistors designed for general purpose switching and amplifier applications. Voltage and current values for PNP are negative: observe proper bias polarity.





TO-92

SYMBOL	MILLIMETERS MIN.	MILLIMETERS MAX.	INCHES MIN.	INCHES MAX.	NOTES
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	–	.500	–	1,3
L_1	–	1.270	–	.050	3
L_2	6.350	–	.250	–	3
Q	2.920	–	.115	–	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSID THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2 φb APPLIES BETWEEN L_2 AND 12.70 MM (.50 FROM THE SEATING PLANE. DIAMETER IS UN CONTROLLED IN L_1 AND BEYOND 12.70 MM (. FROM SEATING PLANE.

absolute maximum ratings: (T_A = 25°C unless otherwise specified)

		MPS6533 & 34	MPS6535	
Voltages				
Collector to Emitter	V_{CEO}	40	30	Volts
Collector to Base	V_{CBO}	40	30	Volts
Emitter to Base	V_{EBO}	4	4	Volts
Current				
Collector	I_C	600	600	mA
Dissipation				
Total Power $T_A \leqslant 25°C$	P_T	350	350	m Watts
Total Power $T_C \leqslant 25°C$	P_T	1.0	1.0	Watts
Derate Factor $T_A > 25°C$		2.8	2.8	mW/°C
Derate Factor $T_C > 25°C$		8.0	8.0	mW/°C
Temperature				
Operating	T_J	-55°C to +150°C		°C
Storage	T_{STG}	-55°C to +150°C		°C
Lead (1/16″ ± 1/32″ from case for 10 sec.)	T_L	+230°C		°C

electrical characteristics: (T_A = 25°C unless otherwise specified)

Static Characteristics		SYMBOL	MIN.	MAX.	UNITS
Collector-Emitter Breakdown Voltage					
(I_C = 10mA, I_B = 0)	– MPS6533, MPS6534	$V_{(BR)CEO}$	40	–	Volts
(I_C = 10mA, V_{BE} = 0)	– MPS6535	$V_{(BR)CEO}$	30	–	Volts
Collector-Base Breakdown Voltage					
(I_C = 10μA, I_E = 0)	– MPS6533, MPS6534	$V_{(BR)CBO}$	40	–	Volts
(I_C = 10μA, I_E = 0)	– MPS6535	$V_{(BR)CBO}$	30	–	Volts
Emitter-Base Breakdown Voltage					
(I_E = 10μA, I_C = 0)		$V_{(BR)EBO}$	4	–	Volts
Collector Cutoff Current					
(V_{CB} = 30V, I_E = 0)	– MPS6533, MPS6534	I_{CBO}	–	50	nA
(V_{CB} = 20V, I_E = 0)	– MPS6535	I_{CBO}	–	100	nA
(V_{CB} = 30V, I_E = 0, T_A = 60°C)	– MPS6533, MPS6534	I_{CBO}	–	2	μA
(V_{CB} = 20V, I_E = 0, T_A = 60°C)	– MPS6535	I_{CBO}	–	5	μA
Emitter-Base Reverse Current					
(V_{EB} = 3V, I_C = 0)		I_{EBO}	–	100	nA
Forward Current Transfer Ratio					
(V_{CE} = 1V, I_C = 10mA)	– MPS6533	h_{FE}	30	–	
(V_{CE} = 1V, I_C = 10mA)	– MPS6534	h_{FE}	60	–	
(V_{CE} = 1V, I_C = 100mA)	– MPS6533	†h_{FE}	40	120	

Static Characteristics (continued)		SYMBOL	MIN.	MAX.	UNITS
Forward Current Transfer Ratio (continued)					
(V_{CE} = 1V, I_C = 100mA)	– MPS6534	†h_{FE}	90	270	
(V_{CE} = 1V, I_C = 100mA)	– MPS6535	†h_{FE}	30	–	
(V_{CE} = 10V, I_C = 500mA)	– MPS6533	†h_{FE}	25	–	
(V_{CE} = 10V, I_C = 500mA)	– MPS6534	†h_{FE}	50	–	
Collector-Emitter Saturation Voltage					
(I_C = 100mA, I_B = 10mA)	– MPS6533, MPS6535	†$V_{CE(sat)}$	–	.5	Volts
(I_C = 100mA, I_B = 10mA)	– MPS6534	†$V_{CE(sat)}$	–	.3	
Base-Emitter Saturation Voltage					
(I_C = 100mA, I_B = 10mA)	– MPS, MPS6533, MPS6534	†$V_{BE(sat)}$	–	1	Volts
(I_C = 100mA, I_B = 10mA)	– MPS6535	†$V_{BE(sat)}$	–	1.2	Volts
Dynamic Characteristics					
Collector-Base Capacitance					
(V_{CE} = 10V, I_E = O,f = 1 MHz)		C_{cb}	–	6	pF

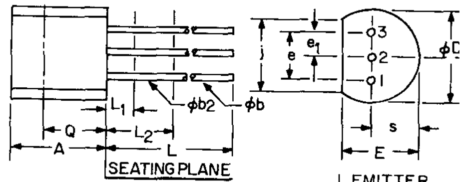
†Pulse width ⩽ 300 μsec., Duty Cycle ⩽ 2%.

Silicon Transistors

NPN

MPS6565
MPS6566

The General Electric MPS6565 and MPS6566 are Silicon Planar Epitaxial Passivated NPN Transistors designed for general purpose amplifier applications.

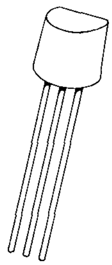


TO-92

1. EMITTER
2. BASE
3. COLLECTOR

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.320	5.330	.170	.210	
φb	.407	.550	.016	.022	1,3
φb2	.407	.482	.016	.019	3
φD	4.450	5.200	.175	.205	
E	3.180	4.190	.125	.165	
e	2.410	2.670	.095	.105	
e_1	1.150	1.395	.045	.055	
j	3.430	4.320	.135	.170	
L	12.700	—	.500	—	1,3
L_1	—	1.270	—	.050	3
L_2	6.350	—	.250	—	3
Q	2.920	—	.115	—	2
s	2.030	2.670	.080	.105	

NOTES:
1. THREE LEADS
2. CONTOUR OF PACKAGE UNCONTROLLED OUTSIDE THIS SIDE.
3. (THREE LEADS) φb2 APPLIES BETWEEN L_1 AND L_2. φb APPLIES BETWEEN L_2 AND 12.70 MM (.500") FROM THE SEATING PLANE. DIAMETER IS UNCONTROLLED IN L_1 AND BEYOND 12.70 MM (.500") FROM SEATING PLANE.



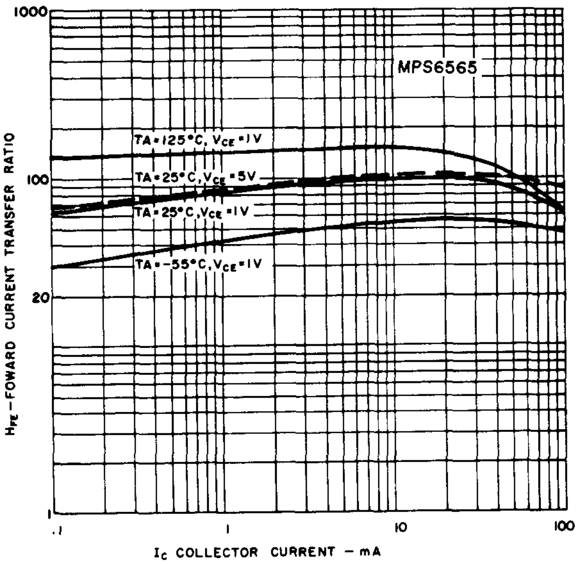
absolute maximum ratings: (T_A = 25°C unless otherwise specified)

Voltages			
Collector to Emitter	V_{CEO}	45	Volts
Collector to Base	V_{CBO}	60	Volts
Emitter to Base	V_{EBO}	4.0	Volts
Current			
Collector	I_C	200	mA
Dissipation			
Total Power $T_A \leqslant 25°C$	P_T	350	mW
Derating Factor $T_A > 25°C$	P_T	2.8	mW/°C
Total Power $T_C \leqslant 25°C$	P_T	1.0	Watt
Derating Factor $T_C > 25°C$	P_T	8.0	mW/°C
Temperature			
Operating	T_J	-55 to +150	°C
Storage	T_{stg}	-55 to +150	°C
Lead (1/16" ± 1/32" from Case for 10 Sec.)	T_L	260	°C

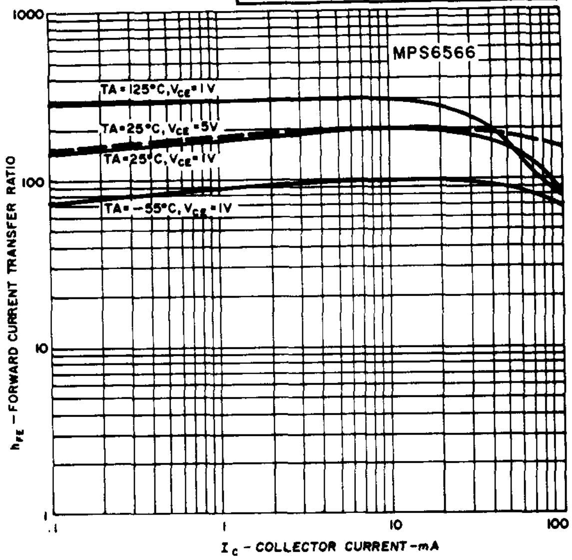
electrical characteristics: (T_A = 25°C unless otherwise specified)

	SYMBOL	MIN.	MAX.	UNITS
Static Characteristics				
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	†$V_{(BR)CEO}$	45	–	Volts
Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)	$V_{(BR)CBO}$	60	–	Volts
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	$V_{(BR)EBO}$	4	–	Volts
Collector Cutoff Current (V_{CB} = 30V, I_E = 0)	I_{CBO}	–	100	nA
Forward Current Transfer Ratio (I_C = 10 mA, V_{CE} = 10V) – MPS6565	†h_{FE}	40	160	
– MPS6566	†h_{FE}	100	400	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	†$V_{CE(sat)}$	–	.4	Volts
Dynamic Characteristics				
Collector-Base Capacitance (V_{CB} = 10V, I_E = 0, f = 100 KHz)	C_{ob}	–	3.5	pF
Emitter-Base Capacitance (V_{BE} = .5V, I_C = 0, f = 100 KHz)	C_{ib}	3.7 Typ.	–	pF
Magnitude of Forward Current Transfer Ratio (I_C = 10 mA, V_{CE} = 10V, f = 100 MHz)	h_{fe}	2	–	
Hybrid Parameters (I_C = 10 mA, V_{CE} = 10V, f = 1 KHz)	h_{oe}	60 (Typical)	–	μmhos
	h_{ie}	500 (Typical)	–	Ohms
	h_{re}	2.5 (Typical)	–	$X10^{-4}$
Noise Figure (I_C = 100 μA, V_{CE} = 5V, R_s = 1K Ohms, f = 10 Hz to 15.7 KHz)	NF	4 (Typical)	–	dB

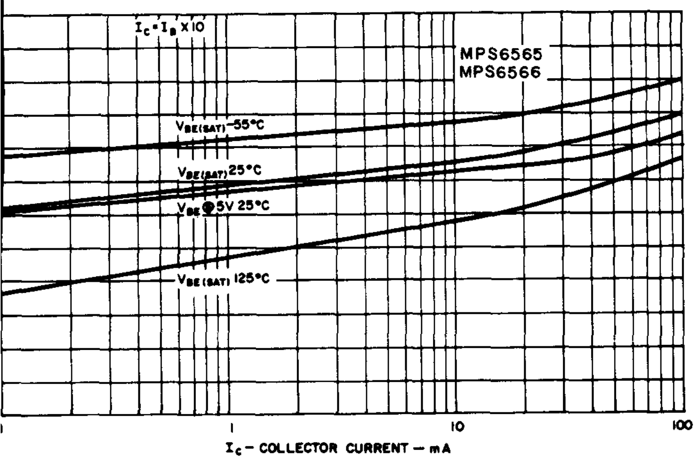
†Pulse width ≤ 300 μs, duty cycle ≤ 2%.



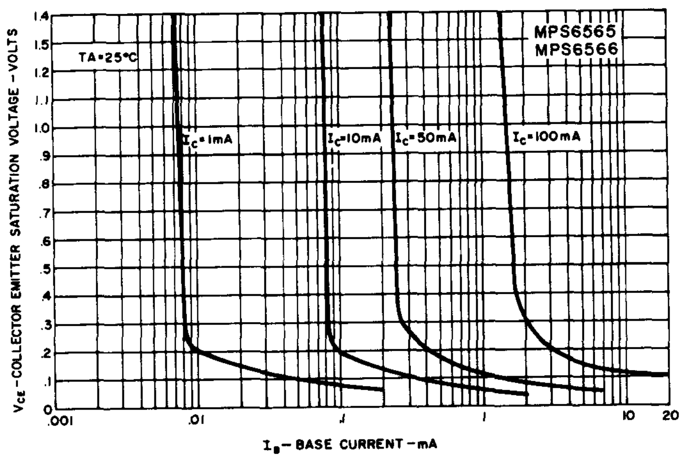
FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



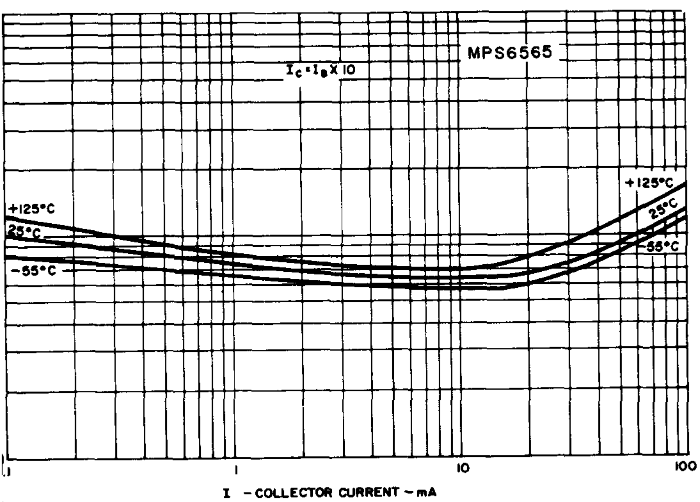
FORWARD CURRENT TRANSFER RATIO VS. COLLECTOR CURRENT



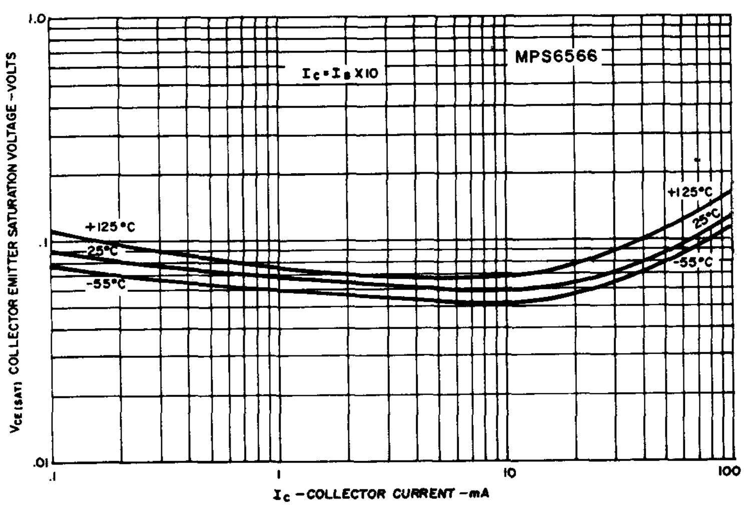
BASE EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



COLLECTOR EMITTER SATURATION VOLTAGE VS. BASE CURRENT



COLLECTOR EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT



COLLECTOR EMITTER SATURATION VOLTAGE VS. COLLECTOR CURRENT

POWER-TAB™

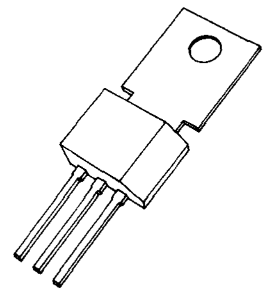
TRIAC

Bi-Directional Triode Thyristor

8 RMS Up to 600 Volts

SC116

The triac is a silicon AC switch which may be gate triggered from an Off-State to an On-State from either polarity of applied voltage. The SC116 is a POWER-TAB™ Molded Silicone Encapsulated Triac. It incorporates General Electric's patented POWER GLAS™ process that improves upon normal passivation techniques. It provides an intimate bond between the silicon chip and the glass coating. The resulting stable, low-level leakage current provides excellent performance and demonstrated reliability.



JEDEC TO-202AB

FEATURES:

- 100 Ampere Peak, one cycle surge rating with the economy of a TO-202 package.
- POWER GLAS™ passivated silicon chip for maximum reliability.
- Very low Off-State (leakage) current at room and elevated temperatures.
- Inherent immunity from non-repetitive transient voltage damage (maximum critical rate-of-rise of On-State current subsequent to voltage breakdown triggering, di/dt = 10 A/μsec.).
- Low On-State Voltage at high current level.
- Excellent surge current capability.
- Special selection for non-standard gate requirements available upon request.
- Rugged, industry-proven POWER-TAB™ packaging.
- Various lead forming configurations available upon request.

MAXIMUM ALLOWABLE RATINGS

TYPE	RMS ON-STATE CURRENT, $I_{T(RMS)}$ (1)	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} (2)				PEAK ONE FULL CYCLE SURGE (NON-REP) ON-STATE CURRENT I_{TSM} AMPERES		I^2t FOR FUSING FOR TIMES AT (3)	
	AMPERES	B	D	E	M	50 Hz	60 Hz	(RMS AMPERE)^2 SECONDS, 1.0 MILLISECOND	(RMS AMPERE)^2 SECONDS, 8.3 MILLISECONDS
		VOLTS	VOLTS	VOLTS	VOLTS	AMPERES	AMPERES		
SC116	8	200	400	500	600	90	100	20	42

Peak Gate Power Dissipation, P_{GM} (4) . . . . 10 Watts for 10 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 0.5 Watts
Storage Temperature, T_{stg} . . . . -40°C to +150°C
Operating Temperature, T_J . . . . -40°C to +100°C

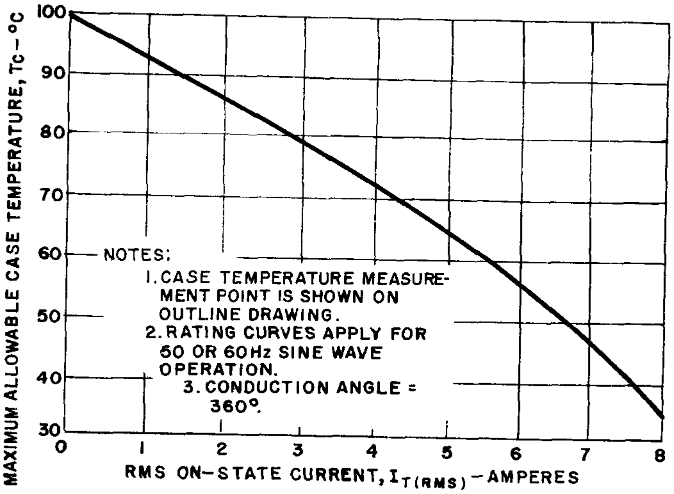
NOTES:

1. At case temperature reference point temperature of 35°C maximum and 360°C conduction.
2. Ratings apply for zero gate voltage only. Ratings apply for either polarity of main terminal 2 voltage referenced to main terminal 1.
3. Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.
4. Ratings apply for either polarity of gate terminal referenced to main terminal 1.

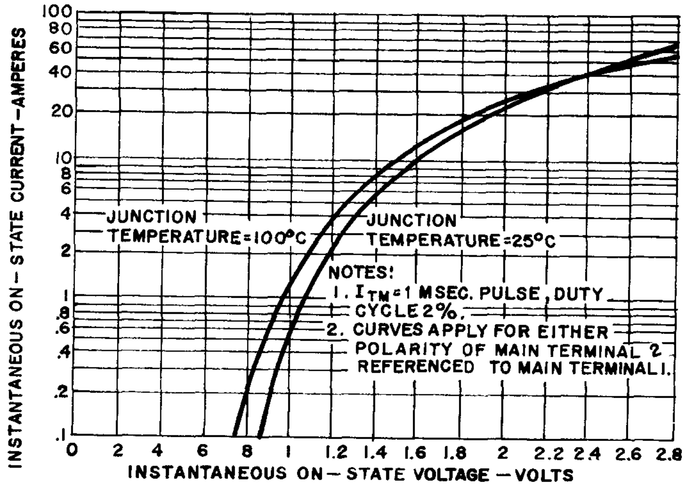
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	REF. NOTE
Repetitive Peak Off-State Current	I_{DRM}				mA	V_{DRM} = Max. Allowable Repetitive Peak Off-State Voltage Rating Gate Open Circuited.	1
		–	–	0.1		T_C = + 25°C	
		–	–	0.5		T_C = +100°C	
Peak On-State Voltage	V_{TM}	–	–	1.63	Volts	T_C = +25°C, I_{TM} = 1 msec. Wide pulse, duty cycle ≤ 2%. I_{TM} = 11.5 A peak.	1
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching.)	dv/dt	50	150	–	Volts/μsec	T_C = +100°C, Rated V_{DRM}. Gate Open Circuited. Exponential Voltage Waveform.	1
Critical Rate-of-Rise of Commutating Off-State Voltage (Commutating dv/dt)	$dv/dt_{(c)}$	4	–	–	Volts/μsec	T_C = 35°C, $I_{T(RMS)}$ = Rated Max. Allowable RMS On-State Current V_{DRM} = Max. Rated Peak Off-State Voltage. Gate Open Circuited. Commutating di/dt = 4.3 A/msec.	1
DC Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc	2
						TRIGGER MODE / R_L / T_C	
		–	–	50		MT2+ Gate+ / 100 Ohms / +25°C	
		–	–	50		MT2– Gate– / 100 Ohms / +25°C	
		–	–	80		MT2+ Gate– / 50 Ohms / +25°C	
		–	–	80		MT2+ Gate+ / 50 Ohms / -40°C	
		–	–	80		MT2– Gate– / 50 Ohms / -40°C	
		–	–	130		MT2+ Gate– / 25 Ohms / -40°C	
DC Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc	2
						TRIGGER MODE / R_L / T_C	
		–	–	2.5		MT2+ Gate+ / 100 Ohms / +25°C	
		–	–	2.5		MT2– Gate– / 100 Ohms / +25°C	
		–	–	2.5		MT2+ Gate– / 50 Ohms / +25°C	
		–	–	3.5		MT2+ Gate+ / 50 Ohms / -40°C	
		–	–	3.5		MT2– Gate– / 50 Ohms / -40°C	
		–	–	3.5		MT2+ Gate– / 25 Ohms / -40°C	
DC Gate Non-Trigger Voltage	V_{GD}	0.20	–	–		All Trigger Modes / 1000 Ohms / +100°C	2,3
DC Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc, Peak initiating on-state current = 0.5A, 0.1 milliseconds to 10 milliseconds wide pulse. Gate trigger source = 7 Volts, 20 Ohms	1
		–	–	50		T_C = +25°C	
		–	–	100		T_C = -40°C	
DC Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger source = 15 volts, 100 Ohms, 50 μsec pulse width, 5 μsec rise and fall times max.	2
						TRIGGER MODE / T_C	
		–	–	100		MT2+ Gate+ / +25°C	
		–	–	100		MT2– Gate– / +25°C	
		–	–	200		MT2+ Gate– / +25°C	
		–	–	200		MT2+ Gate+ / -40°C	
		–	–	200		MT2– Gate– / -40°C	
		–	–	400		MT2+ Gate– / -40°C	
Apparent Thermal Resistance	$R_{\theta JC}$	–	–	6.2	°C/Watt	Junction-to-Case	4

NOTES:

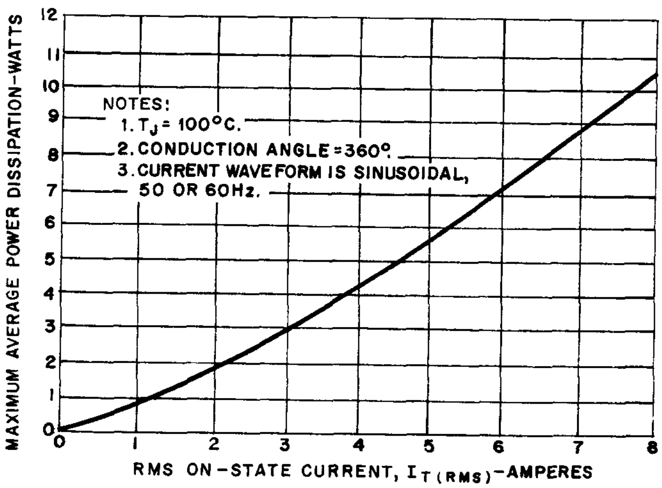
1. Values apply for either polarity of main terminal 2 characteristics referenced to main terminal 1.
2. Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.
3. With V_D equal to maximum allowable off-state voltage.
4. Apparent thermal resistance applies for a 50 or 60 Hz full sine wave of current.



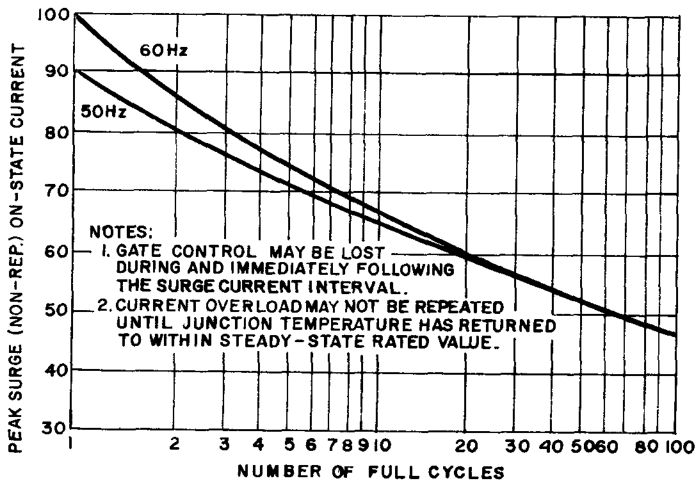
1. MAXIMUM RMS ON-STATE CURRENT
MAXIMUM ALLOWABLE CASE TEMPERATURE



2. MAXIMUM ON-STATE VOLTAGE
VS. ON-STATE CURRENT



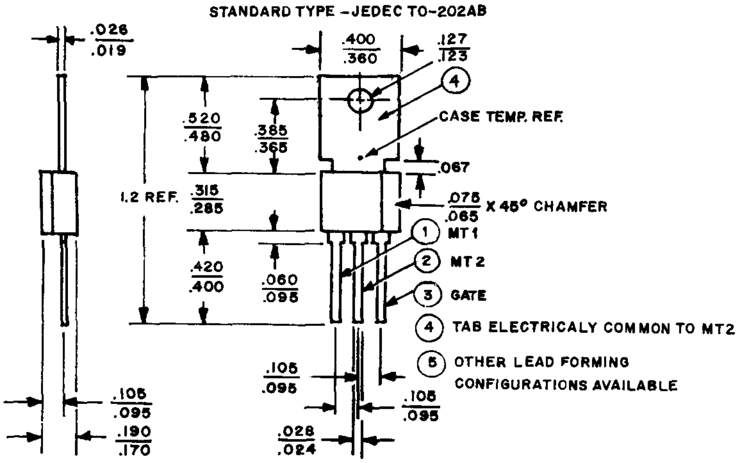
3. MAXIMUM AVERAGE POWER DISSIPATION
VS. RMS ON-STATE CURRENT



4. MAXIMUM ALLOWABLE FULL CYCLE
SURGE CURRENT FOLLOWING RATED
LOAD CONDITIONS

OUTLINE DRAWING

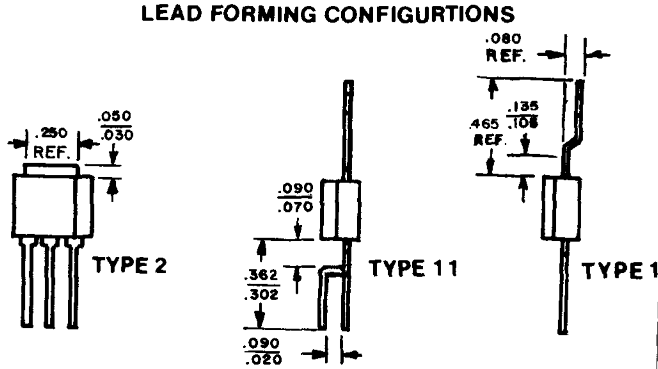
STANDARD TYPE – JEDEC TO-202AB



PART NUMBER DESIGNATION

SC116	B	1
POWER-TAB™ TRIAC	VOLTAGE	LEAD FORMING CONFIGURATIONS
8A RMS NON-ISOLATED	B = 200 VOLTS	1 = STANDARD TYPE
	D = 400 VOLTS	2 = Type 2
	E = 500 VOLTS	11 = Type 11
	M = 600 VOLTS	12 = Type 12
		# = OTHER VARIATIONS

LEAD FORMING CONFIGURTIONS



Triac

Bi-Directional Triode Thyristor

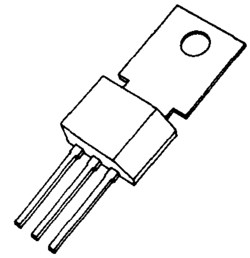
SC136

3A RMS   Up to 400 Volts

General Electric's Triac is a bi-directional triode thyristor which may be gate triggered from blocking to a conducting state for either polarity of applied voltage. This device will perform most of the functions of two SCR's (silicon controlled rectifiers) connected in inverse parallel.

The GE SC136 series Triac is designed for 120 and 240 volt, 50 and 60 Hz AC switching and control applications such as lamp dimming, motor speed and temperature controlling, and static switching. The device is able to withstand the inrush surge of any parallel combination of tungsten lamp loads totaling 150 watts on a 120-volt line or 300 watts on a 240-volt line.

An important feature of the SC136 is its ability to switch into the conducting state should a breakover voltage in either polarity be exceeded, thus providing inherent immunity from transient voltage damage which generally eliminates the need for auxiliary protective devices.



Blue Silicone Leads Can Be Formed To A TO-5 Pin Configuration

Features:

- Inherent immunity from transient voltage damage (can be broken over safely in either direction)
- Improved commutating dv/dt (5V/μs min)
- No maximum torque limit on mounting screw
- Narrow leads greatly simplifies customer assembly
- Four standard lead forming configurations available from factory (including TO-5 compatability)
- Special selections for non-standard gate requirements available upon request

TYPICAL TRIAC APPLICATIONS

	GENERAL FUNCTIONS				
TYPES OF EQUIPMENT	Heat Control	Motor Speed Control	Light Control	Solid State Contractors and Relays	Power Regulation
Photographic Dev. Equip	X	X	X		
Process Control	X	X	X	X	X
Reproduction Equipment	X	X	X	X	
Blenders, Mixers		X			
Computer Tape Decks		X			
Fans		X			
Hand Tools		X			
Machine Tools/Misc. Mfg.		X		X	
Sewing Machines		X			
Laundry				X	
Farm Equipment	X	X	X	X	
Light Dimmers			X		
Photographic Equipment	X		X	X	
Outdoor Signs			X	X	
Clutches/Brakes				X	
Industrial Timers				X	
Vending Machines	X	X		X	
Computer Power Supplies					X
Home Entertainment	X	X	X	X	X

MAXIMUM ALLOWABLE RATINGS

TYPE	RMS On-State Current 360° Conduction, T_{TAB} = 65°C $I_{T\ (RMS)}$	Repetitive Peak Off-State Voltage T_j = -40°C to + 110°C V_{DRM} Notes 1, 2	Peak One Full Cycle Surge (Non-rep) On-State Current T_j = -40°C to + 110°C I_{TSM}
	Amperes	Volts	Amps
SC136B	3.0	200	30
SC136D	3.0	400	30

Critical Rate-Of-Rise of On-State Current, di/dt: (2) (4)
Breakover voltage triggered operation 5A/μS
Peak Gate Power Dissipation, P_{GM} (3). . . . . 5.0 Watts
Average Gate Power Dissipation, $P_{G(AV)}$ (3) . . . . 0.1 Watts
Storage Temperature, T_{stg} . . . . –40°C to +150°C
Operating Temperature, T_J . . . . –40°C to +110° C

NOTES:
1. Ratings apply for zero gate voltage only.
2. Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.
3. Ratings apply for either polarity of gate terminal referenced to main terminal 1.
4. di/dt rating is established in accordance with EIA Standard RS397, Recommended Standards for Thyristors, Section 5.2.2.6.

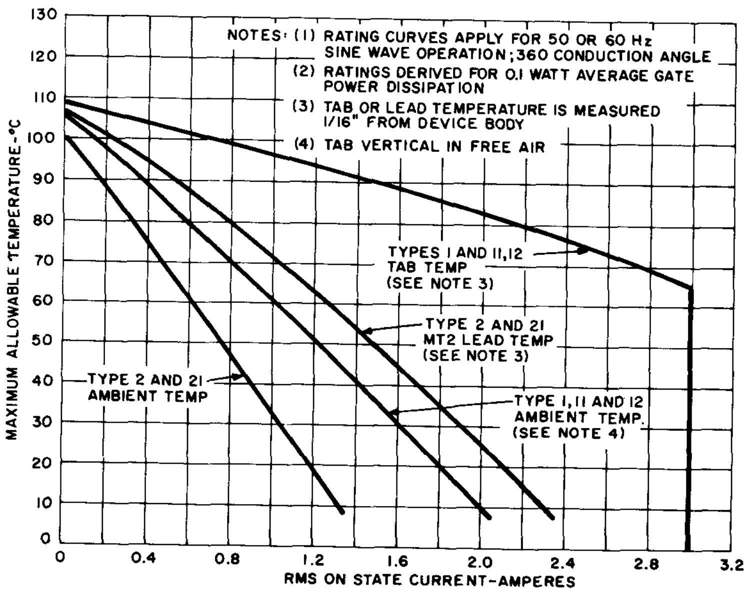


FIGURE 1:
MAXIMUM ALLOWABLE TEMPERATURES VS. RMS ON-STATE CURRENT

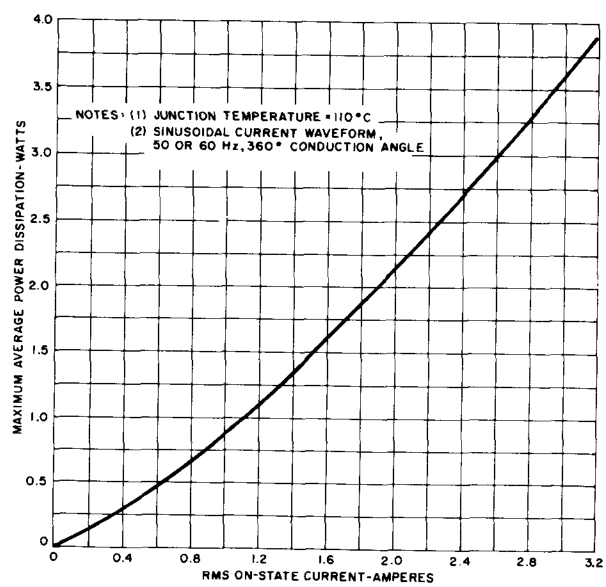


FIGURE 2:
MAXIMUM AVERAGE POWER DISSIPATION VS. RMS ON-STATE CURRENT

CHARACTERISTICS

Test	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Reference Note
Peak Off-State Current	I_{DRM}				μA	V_{DRM} = Maximum Allowable Peak Off-State Voltage, Gate Open Circuited	1, 5
		–	–	10		T_L = +25°C	
		–	–	500		T_L = +110°C	
Peak On-State Voltage	V_{TM}	–	–	1.8	Volts	T_L = +25°C, I_{TM} = 5A peak, 1 msec Wide pulse, duty cycle ≦ 2%	1, 5
Critical Rate of Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt	10	–	–	Volts/μsec	T_L = +110°C, Rated V_{DRM} Gate Open Circuited, Exponential Waveform	1, 5
Critical Rate of Rise of Commutating Off-State Voltage (Commutating dv/dt)	$dv/dt_{(c)}$	5	–	–	Volts/μsec	T_L = +65°C, $I_{T(RMS)}$ = 3.0 A V_{DRM} = Rated Max. Allowable Peak Off-State Voltage. Gate Open Circuited Commutating di/dt = 1.6A/msec	1, 5
DC Gate Trigger Current	I_{GT}				mAdc	R_L = 50 ohms; Trigger Mode / V_D / T_L	2, 4, 5
		–	–	25		MT2+ Gate+ / 6 V_{dc} / +25°C	
		–	–	25		MT2– Gate– / 6 V_{dc} / +25°C	
		–	–	25		MT2+ Gate– / 6 V_{dc} / +25°C	
		–	–	50		MT2+ Gate + / 12 V_{dc} / –40°C	
		–	–	50		MT2– Gate– / 12 V_{dc} / –40°C	
		–	–	50		MT2+ Gate– / 12 V_{dc} / –40°C	
DC Gate Trigger Voltage	V_{GT}				Vdc	Trigger Mode / V_D / R_L / T_L	2, 5
		–	–	2.0		MT2+ Gate+ / 6 Vdc / 50 ohms / +25°C	
		–	–	2.0		MT2– Gate– / 6 Vdc / 50 ohms / +25°C	
		–	–	2.0		MT2+ Gate – / 6 Vdc / 50 ohms / +25°C	
		–	–	3.0		MT2+ Gate+ / 12 Vdc / 50 ohms / –40°C	
		–	–	3.0		MT2– Gate– / 12 Vdc / 50 ohms / –40°C	
		–	–	3.0		MT2+ Gate – / 12 Vdc / 50 ohms / –40°C	
		0.20	–	–		MT2+ Gate+, MT2– Gate–, MT2+ Gate–, MT2– Gate+ / Rated V_{DRM} / 1000 ohms / +110°C	
DC Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc, Peak initiating on-state current = 0.1A 0.1 milliseconds to 10 milliseconds wide pulse, Gate trigger pulse width = 100 μsec	1, 5
		–	–	50		T_L = +25°C, Gate trigger source = 5V, 50Ω	
		–	–	100		T_L = –40°C, Gate trigger source = 10V,50Ω	
DC Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc, Gate trigger pulse width = 100 μsec; Trigger Mode / Trigger Source / T_L	2, 5
		–	–	50		MT2+ Gate+ / 5V, 50Ω / +25°C	
		–	–	50		MT2– Gate– / 5V, 50Ω / +25°C	
		–	–	100		MT2+ Gate– / 5V, 50Ω / +25°C	
		–	–	100		MT2+ Gate+ / 10V, 50Ω / –40°C	
		–	–	100		MT2– Gate– / 10V, 50Ω / –40°C	
		–	–	200		MT2+ Gate– / 10V, 50Ω / –40°C	
Steady-State Thermal Resistance	$R_{\theta JA}$	–	–	75	°C/Watt	Junction to Ambient, tab types 1, 11, 12	3, 5
	$R_{\theta JA}$	–	–	100		Junction to Ambient, no tab types 2, 21	
	$R_{\theta J\text{-}TAB}$	–	–	10		Junction to tab, types 1, 11, 12	
	$R_{\theta JL}$	–	–	35		Junction to MT2 lead, no tab types 2, 21	

NOTES:
1. Values apply for either polarity of main terminal 2 characteristics referenced to main terminal 1.
2. Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.
3. Junction to case values tested in accordance with JEDEC Semiconductor device registration #JC-22 (RDF-2), VA, Note 6, which states, "Thermal characteristics are to be measured with the device operating in only one direction. The values registered are to be the limiting value for either direction." The junction to ambient value is with the device inserted in a socket (unsoldered) and natural convection. See outline drawing for tab and lead temperature measurement points.
4. Special selections for non-standard gate requirements available upon request.
5. The lead temperature (T_L) is measured in the center of the tab, 1/16 inch from the body on Type 1, 11 and 12 devices, and in the center of the MT_2 lead, 1/16 inch from the body on Type 2 and 21 devices.

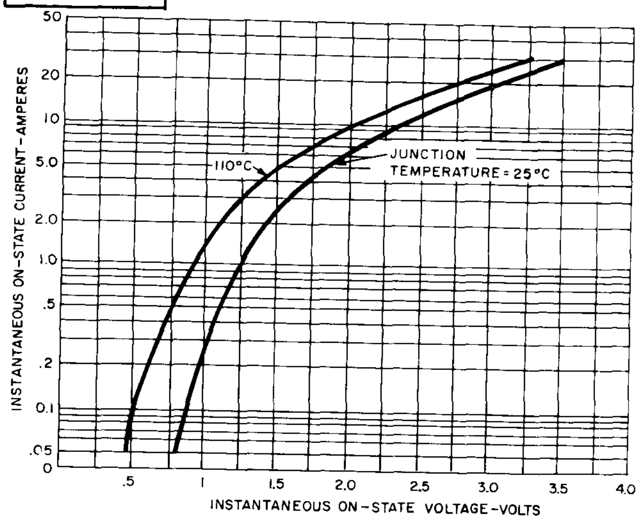


FIGURE 3: MAXIMUM ON-STATE CHARACTERISTICS

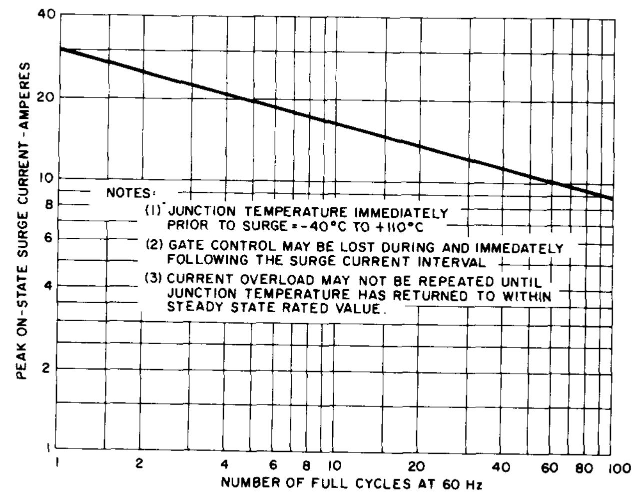
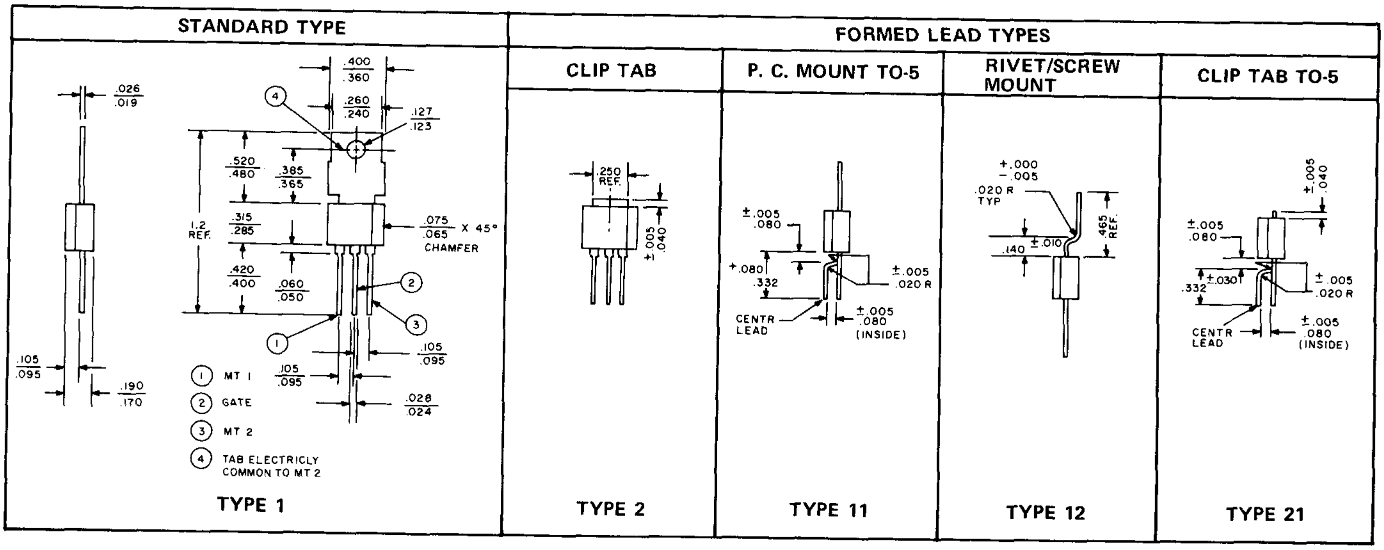


FIGURE 4: MAXIMUM ALLOWABLE FULL CYCLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS

OUTLINE DRAWINGS



OTHER TRIAC AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

Publication Number	Specification Sheets	
175.13	SC136	(3 Amp in plastic package)
175.14	SC142	(8 Amp in plastic package with isolated tab)
175.15	SC141/146	(6, 10 Amp in plastic package)
175.16	SC240/241	(6 Amp)
175.17	SC245/246	(10 Amp)
175.18	SC250/251	(15 Amp)
175.29	SC260/261	(25 Amp)
175.30	ST2	(Diac)
175.32	ST4	(Asymmetrical A.C. Switch)

Publication Number	Application Notes
200.35	Using the Triac for Control of AC Power
200.51	Better Room Conditioning Via Solid State Controls
200.53	Solid State Incandescent Lighting Controls
200.61	A Zero Voltage Switching Temperature Control
200.70	Low Resistance Sensor–Zero Voltage Switching Temperature Control
201.12	500 Watt AC Line Voltage and Power Regulator
201.19	RF Filter Considerations for Triac & SCR Circuits
200.55	Handling and Thermal Considerations for General Electric Plastic Power Devices
201.24	Thyristor Selection for Incandescent Lamp Loads

All of these referred to may be ordered by publication number from General Electric Company, Distribution Services, Bldg. 6-208, Schenectady, New York 12305.

Bi-Directional Triode Thyristor

Power Pac™ Triacs

6A to 15A RMS Up to 600 Volts

Isolated and Non-Isolated Tab

ISOLATED TAB
SC140
SC142
SC147
NON-ISOLATED TAB
SC141
SC143
SC146
SC149
SC151

A triac is a solid state silicon AC switch which may be gate triggered from an OFF-State to an ON-State for either polarity of applied voltage.

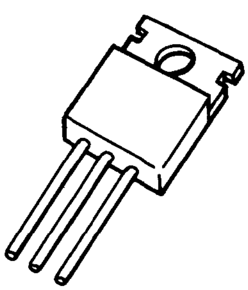
POWER PAC™ triacs are molded silicone encapsulated devices which incorporate General Electric's patented POWER GLAS™ glassivation process. This process provides an intimate bond between the silicon chip and the glass coating, significantly improving device performance and reliability. The copper mounting surface on the isolated tab types is electrically insulated from the silicon chip and the three electrical terminal leads.

FEATURES:

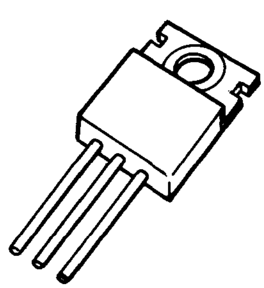
- POWER-GLAS™ passivated silicon chip for maximum reliability.
- Very low off-state (leakage) current at room and elevated temperatures.
- Inherent immunity from non-repetitive transient voltage damage (max. critical rate-of-rise of on-state current subsequent to voltage breakover triggering, di/dt = 10 A/μsec.).
- Low on-state voltage at high current levels.
- Excellent surge current capability.
- 1600 volts RMS Surge Isolation Voltage on Isolated Triacs.
- Selected types available from factory for use where circuit requires operation:
  - with popular zero voltage triggering IC's
  - at 400 Hz
  - with low gate trigger current
  - at higher voltage levels
  - at higher commutating dv/dt levels

POWER PAC PACKAGE

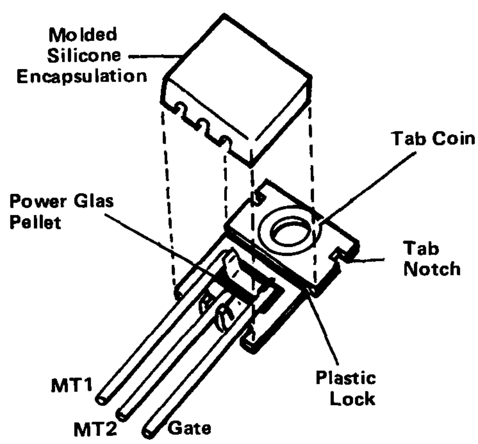
- Meets JEDEC TO-220AB specifications.
- Round leads – greatly simplifies assembly.
- Six standard lead forming configurations available from factory (including TO-66 compatibility.)
- Rugged, industry-proven packaging.



ISOLATED (RED)



NON-ISOLATED (BLUE)



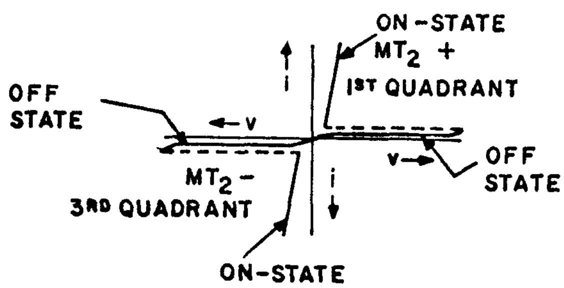
PICTORIAL ASSEMBLY

ISOLATED TAB	NON-ISOLATED TAB
SC140, 2, 7	SC141, 3, 6, 9, SC151

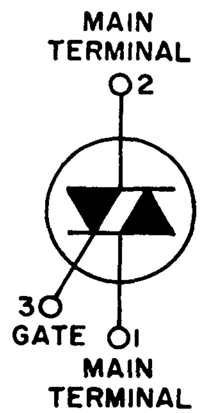
MAXIMUM ALLOWABLE RATINGS

TYPE	RMS ON-STATE CURRENT, $I_{T(RMS)}$ (1)	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} (2)				PEAK ONE FULL CYCLE SURGE (NON-REP) ON-STATE CURRENT, I_{TSM} AMPERES		I^2t FOR FUSING FOR TIMES AT (3)	
	AMPERES	B	D	E	M	50 Hz	60 Hz	(RMS AMPERE)^2 SECONDS 1.0 MILLISECOND	(RMS AMPERE)^2 SECONDS, 8.3 MILLISECONDS
		VOLTS	VOLTS	VOLTS	VOLTS	AMPERES	AMPERES		
ISOLATED TAB									
SC140	6.5	200	400	500	600	74	80	18	26.5
SC142	8	200	400	500	600	104	110	20	50
SC147	10	200	400	500	600	104	110	20	50
NON-ISOLATED TAB									
SC141	6	200	400	500	600	74	80	18	26.5
SC143	8	200	400	500	600	110	120	20	60
SC146	10	200	400	500	600	110	120	20	60
SC149	12	200	400	500	600	110	120	20	60
SC151	15	200	400	500	600	110	120	20	60

Peak Gate Power Dissipation, P_{GM} (4) . . . . 10 Watts for 10 Microseconds (See Chart 4)
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 0.5 Watts
Peak Gate Current, I_{GM} (4) . . . . See Chart 4
Peak Gate Voltage, V_{GM} (4) . . . . See Chart 4
Storage Temperature, T_{stg} . . . . -40°C to +125°C
Operating Temperature, T_J . . . . -40 °C to +100 °C
Surge Isolation Voltage (5) . . . . 1600 Volts RMS



TYPICAL CHARACTERISTICS
VOLT-AMPERES



TERMINAL ARRANGEMENT

NOTES:
1. At the case reference point (see outline drawing) temperature of 80°C maximum (except 75°C maximum for SC142 and SC149) and 360° conduction.
2. Ratings apply for zero gate voltage only. Ratings apply for either polarity of main terminal 2 voltage referenced to main terminal 1.
3. Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.
4. Ratings apply for either polarity of gate terminal referenced to main terminal 1.
5. Isolated tab triacs only. Rating applies from main terminals 1 and 2 and gate terminal to device mounting surface. Test voltage is 50 or 60 Hz sinusoidal wave form applied for one minute. Rating applies over the entire device operating temperature range.

ISOLATED TAB	NON-ISOLATED TAB
SC140, 2, 7	SC141, 3, 6, 9, SC151

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	REF. NOTE
Repetitive Peak Off-State Current	I_{DRM}				mA	V_{DRM} = Maximum Allowable Repetitive Off-State Voltage Rating Gate Open Circuited	1
		–	–	0.1		T_C = +25°C	
		–	–	0.5		T_C = +100°C	
Peak On-State Voltage	V_{TM}				Volts	T_C = +25°C, I_{TM} = 1 msec., Wide Pulse, Duty Cycle ≤ 2%	1
SC140		–	–	1.85		I_{TM} = 9.2 A Peak	
SC141		–	–	1.83		I_{TM} = 8.5 A Peak	
SC142		–	–	1.75		I_{TM} = 11.5 A Peak	
SC143		–	–	1.55		I_{TM} = 11.5 A Peak	
SC146		–	–	1.65		I_{TM} = 14 A Peak	
SC147		–	–	1.50		I_{TM} = 14 A Peak	
SC149		–	–	1.65		I_{TM} = 17 A Peak	
SC151		–	–	1.52		I_{TM} = 21 A Peak	
Critical Rate-of-Rise of Off-State Voltage (Higher values may cause device switching)	dv/dt				Volts/μsec	T_C = +100°C, Rated V_{DRM} Gate Open Circuited Exponential Voltage Waveform	1
SC140, SC141		30	100	–			
SC142, SC143		50	150	–			
SC146, SC147		100	150	–			
SC149		100	200	–			
SC151		100	250	–			
Critical Rate-of-Rise of Commutating Off-State Voltage (Commutating dv/dt)	$dv/dt_{(c)}$	4	–	–	Volts/μsec	$I_{T(RMS)}$ = Rated Maximum Allowable RMS On-State Current, V_{DRM} = Maximum Rated Peak Off-State Voltage, Gate Open Circuited.	1, 4
DC Gate Trigger Current	I_{GT}				mAdc	V_D = 12 Vdc; TRIGGER MODE, R_L, T_C	2
		–	–	50		MT2+ Gate +, 100 Ohms, +25°C	
		–	–	50		MT2– Gate –, 100 Ohms, +25°C	
		–	–	50		MT2+ Gate –, 50 Ohms, +25°C	
		–	–	80		MT2+ Gate +, 50 Ohms, -40°C	
		–	–	80		MT2– Gate –, 50 Ohms, -40°C	
		–	–	80		MT2+ Gate –, 25 Ohms, -40°C	
DC Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc; TRIGGER MODE, R_L, T_C	2
		–	–	2.5		MT2+ Gate +, 100 Ohms, +25°C	
		–	–	2.5		MT2– Gate –, 100 Ohms, +25°C	
		–	–	2.5		MT2+ Gate –, 50 Ohms, +25°C	
		–	–	3.5		MT2+ Gate +, 50 Ohms, -40°C	
		–	–	3.5		MT2– Gate –, 50 Ohms, -40°C	
		–	–	3.5		MT2+ Gate –, 25 Ohms, -40°C	
DC Gate Non-Trigger Voltage	V_{GD}	0.2	–	–	Vdc	TRIGGER MODE: MT2+ Gate +, MT2– Gate –, MT2+ Gate –, MT2– Gate +; R_L = 1000 Ohms; T_C = +100°C	2, 3

ISOLATED TAB	NON-ISOLATED TAB
SC140, 2, 7	SC141, 3, 6, 9, SC151

CHARACTERISTICS (Continued)

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS		REF. NOTE
DC Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc Peak Initiating On-State Current = 0.5A, 0.1 milliseconds to 10 milliseconds wide pulse, Gate Trigger Source = 7V, 20 Ohms.		1
		–	–	50		T_C = +25°C		
		–	–	100		T_C = -40°C		
DC Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc Gate Trigger Source = 15V, 100 Ohms, 50μsec pulse width, 5 μsec rise and fall times maximum		2
						TRIGGER MODE	Tc	
		–	–	100		MT2 + Gate +	+25°C	
		–	–	100		MT2 – Gate –		
		–	–	200		MT2 + Gate –		
		–	–	200		MT2 + Gate +	-40°C	
		–	–	200		MT2 – Gate –		
		–	–	400		MT2 + Gate –		
Steady State Thermal Resistance	$R\theta_{JA}$	–	–	75	°C/Watt	Junction-to-Ambient		1, 5
Steady State Thermal Resistance	$R\theta_{JC}$				°C/Watt	Junction-to-Case This characteristic is useful as an acceptance test at an incoming inspection station.		1, 6
SC140		–	–	3.1				
SC141		–	–	3.0				
SC142		–	–	3.3				
SC143		–	–	3.2				
SC146		–	–	2.2				
SC147		–	–	2.5				
SC149		–	–	2.0				
SC151		–	–	2.0				
Apparent Thermal Resistance	$R\theta_{JC(ac)}$				°C/Watt	Junction-to-Case This characteristic is useful in the calculation of junction temperature rise above case temperature for AC current conduction.		7
SC140		–	–	2.04				
SC141		–	–	2.22				
SC142		–	–	2.31				
SC143		–	–	1.97				
SC146		–	–	1.50				
SC147		–	–	1.69				
SC149		–	–	1.52				
SC151		–	–	1.10				

NOTES:

1. Characteristic values apply for either polarity of main terminal 2 referenced to main terminal 1.
2. Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.
3. With V_D equal to maximum allowable off-state voltage.
4. Values for these test conditions are:

Device	Commutating di/dt	Tc
SC140	3.5 A/msec	+80°C
SC141	3.2 A/msec	+80°C
SC142	4.3 A/msec	+75°C
SC143	4.3 A/msec	+80°C
SC146 / SC147	5.4 A/msec	+80°C
SC149	6.4 A/msec	+75°C
SC151	8.1 A/msec	+80°C

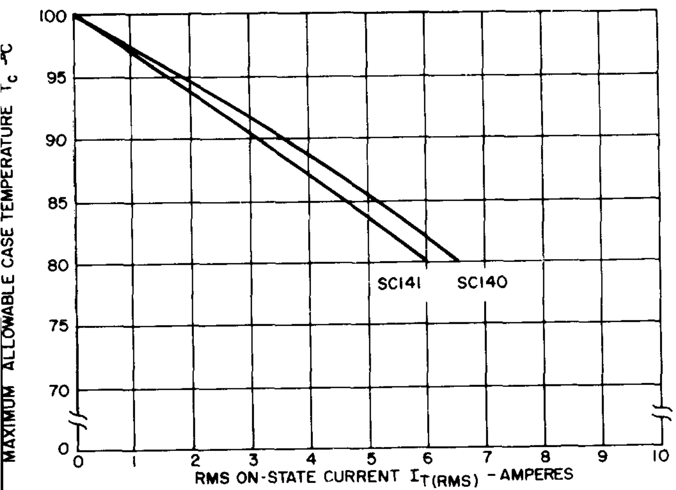
5. The junction-to-ambient value is under worst case conditions; i.e., with No. 22 copper wire used for electrical contact to the terminals and natural convection cooling.
6. Junction-to-case steady-state thermal resistance ($R\theta_{JC}$) is tested in accordance with EIA-NEMA Standard RS-397, Section 3.3.2, which states: *"Thermal characteristics are to be measured with the device operating in only one direction."* The values listed are the limiting value for either direction. For non-isolated devices, the MT2 lead temperature reference point is approximately equal to the case temperature reference point (see outline drawing).
7. Apparent thermal resistance applies for a 50 or 60 Hz full sine wave of current. It can be calculated with the following formula:

$$\text{Apparent thermal resistance} = \frac{T_{J(max)} - T_C}{P_{T(AV)}}$$

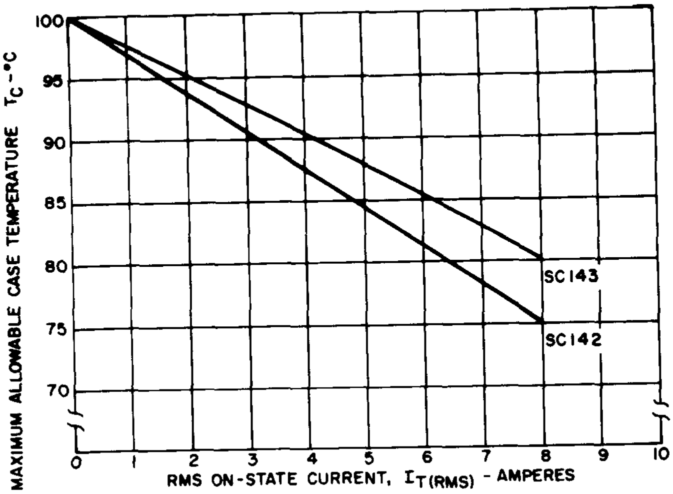
where: $T_{J(max)}$ = maximum junction temperature
T_C = case temperature
$P_{T(AV)}$ = average on-state power

See Reference Chart 12.

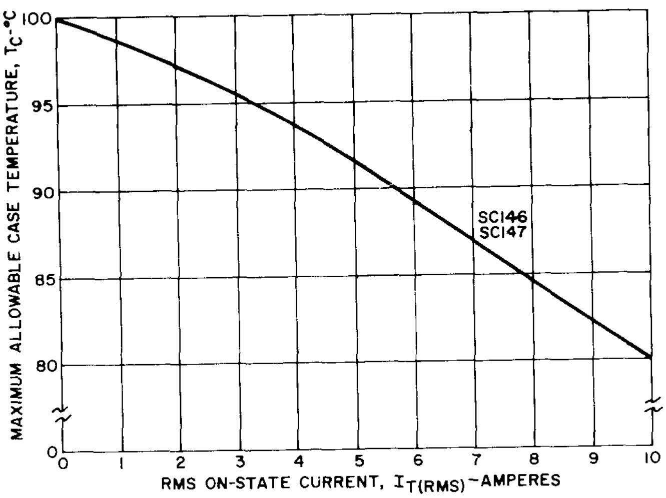
ISOLATED TAB	NON-ISOLATED TAB
SC140, 2, 7	SC141, 3, 6, 9, SC151



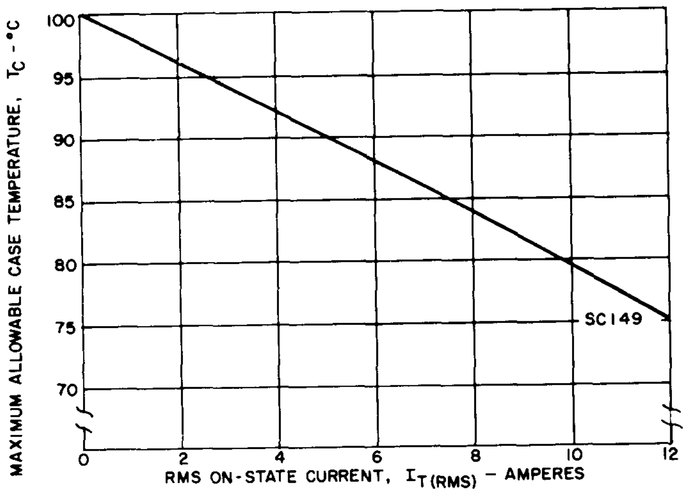
SC140 / SC141



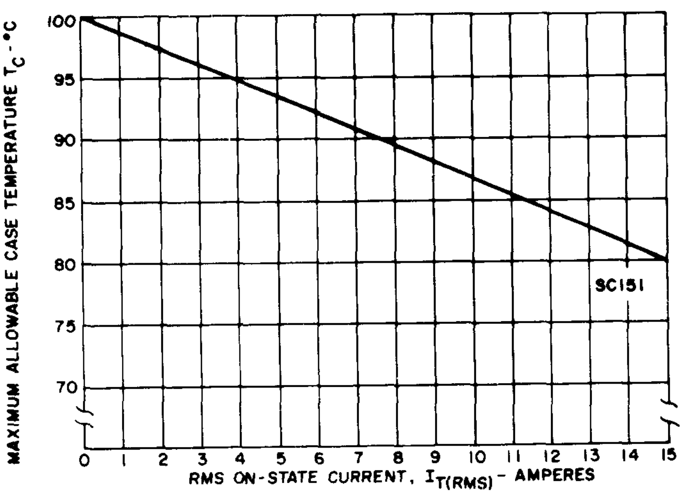
SC142 / SC143



SC146 / SC147



SC149



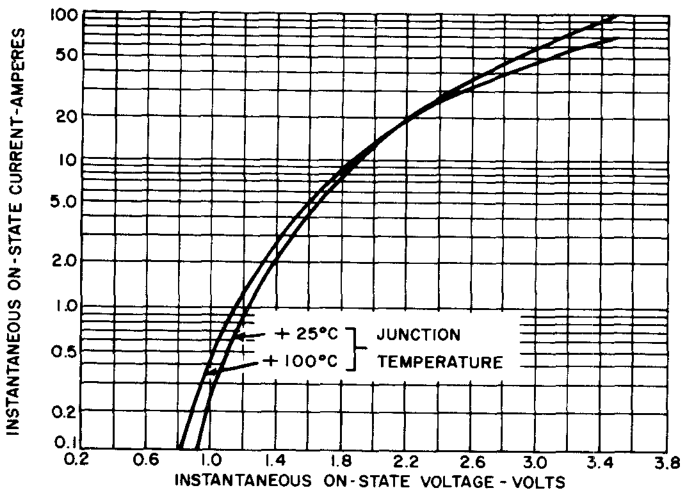
SC151

NOTES:

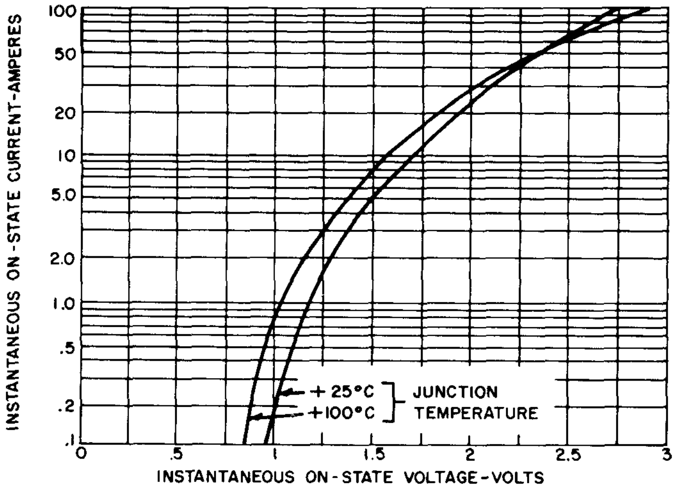
1. Case temperature measurement point is shown on outline drawings.
2. Rating curves apply for 50 or 60 Hz sine wave operation.
3. Conduction angle = 360°.

1. MAXIMUM CURRENT RATINGS

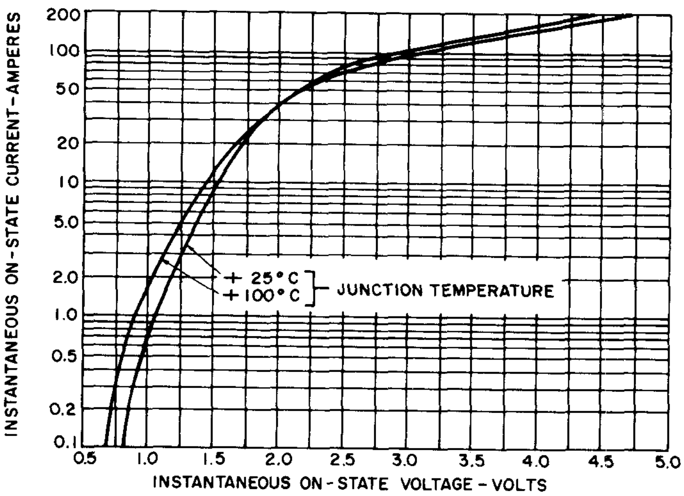
ISOLATED TAB	NON-ISOLATED TAB
SC140, 2, 7	SC141, 3, 6, 9, SC151



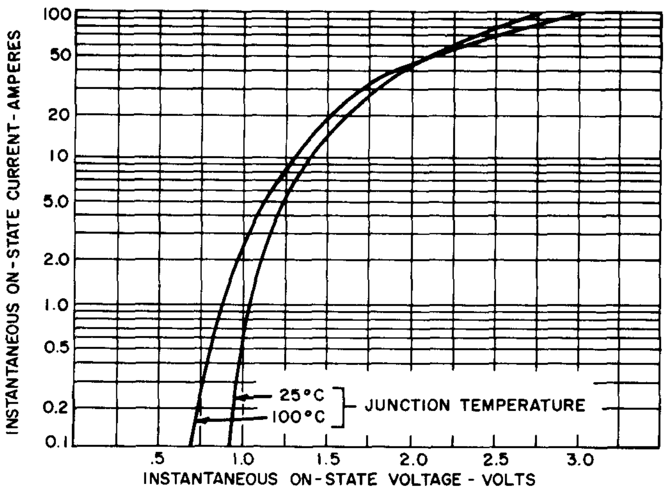
SC140 / SC141



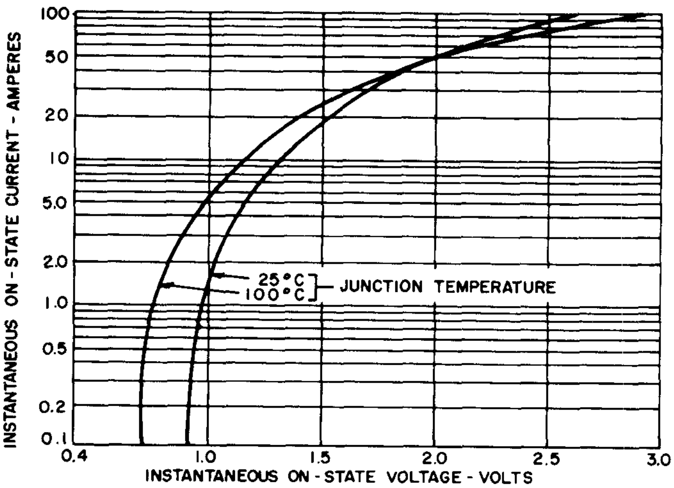
SC142



SC143 / SC146 / SC149



SC147



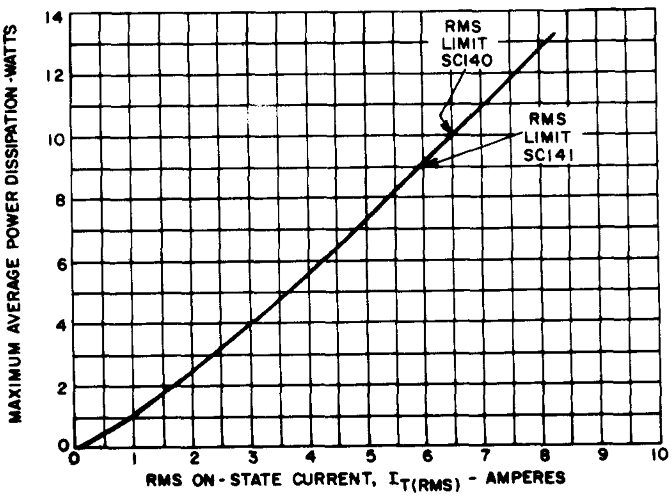
SC151

NOTES:

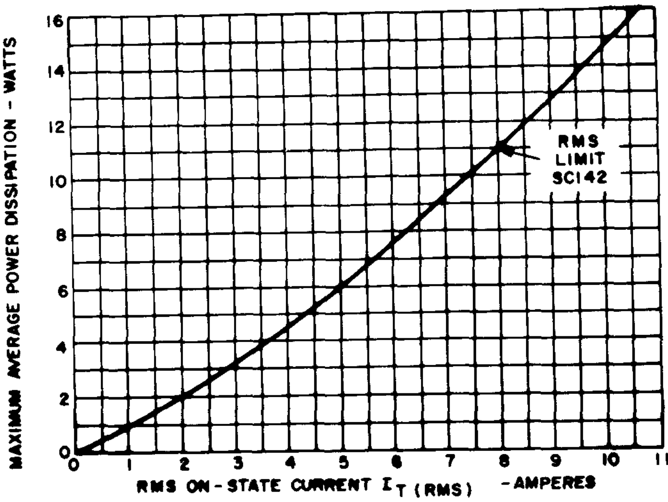
1. I_{TM} = 1 msec. pulse, duty cycle 2%.
2. Curves apply for either polarity of main terminal 2 referenced to main terminal 1.

2. MAXIMUM ON-STATE CHARACTERISTICS

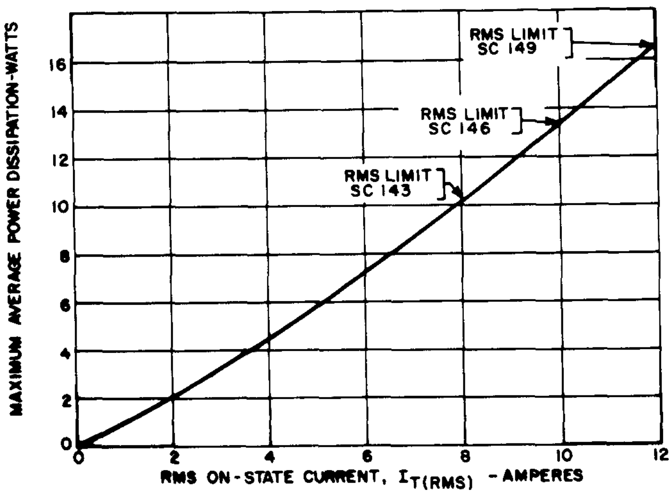
ISOLATED TAB	NON-ISOLATED TAB
SC140, 2, 7	SC141, 3, 6, 9, SC151



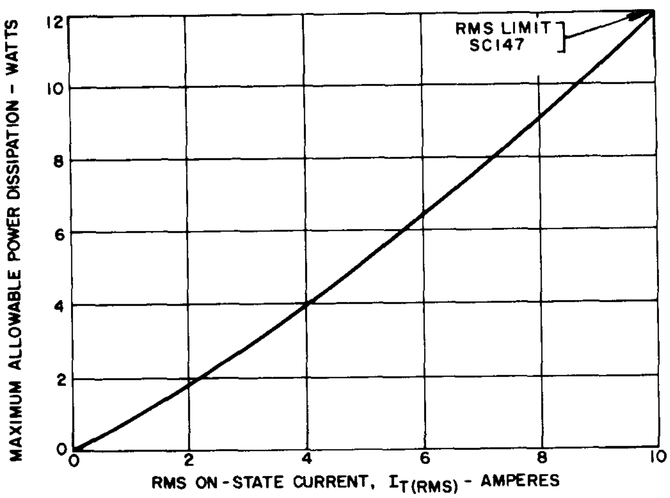
SC140 / SC141



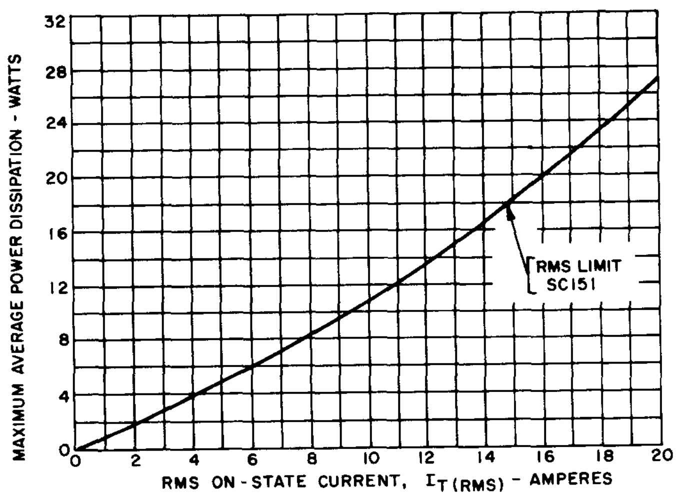
SC142



SC143 / SC146 / SC149



SC147



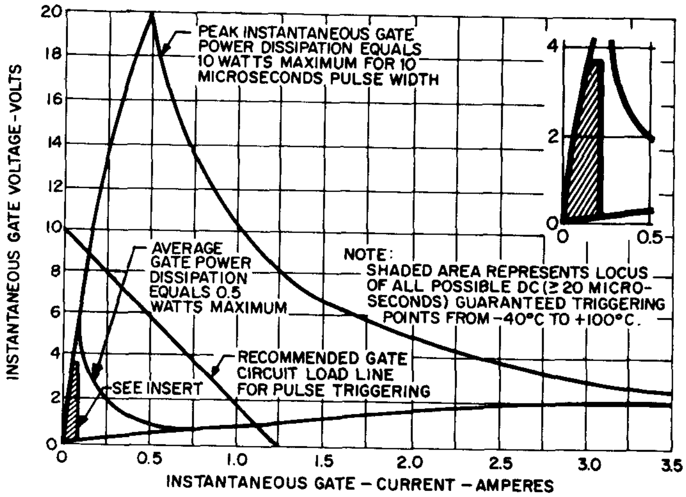
SC151

NOTES:

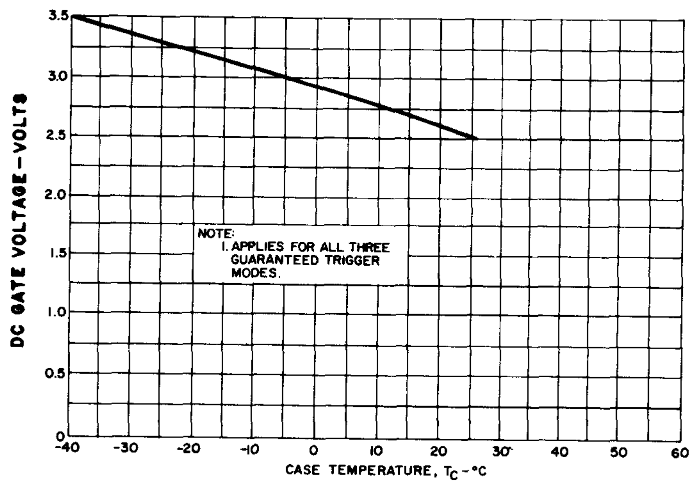
1. T_J = 100°C.
2. Conduction angle = 360°.
3. Current waveform is sinusoidal, 50 or 60 Hz.

3. MAXIMUM POWER DISSIPATION

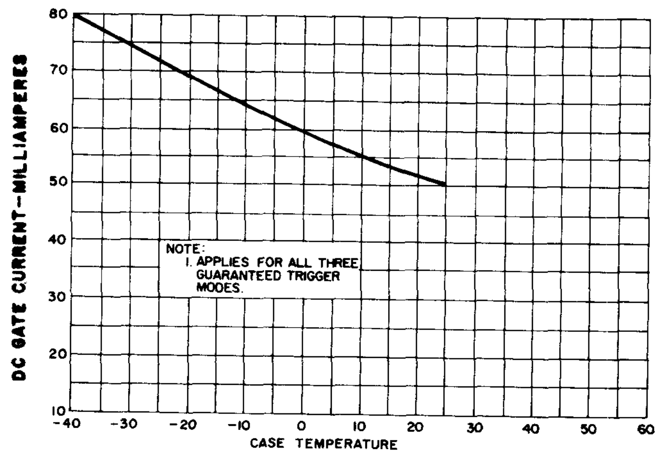
ISOLATED TAB	NON-ISOLATED TAB
SC140, 2, 7	SC141, 3, 6, 9, SC151



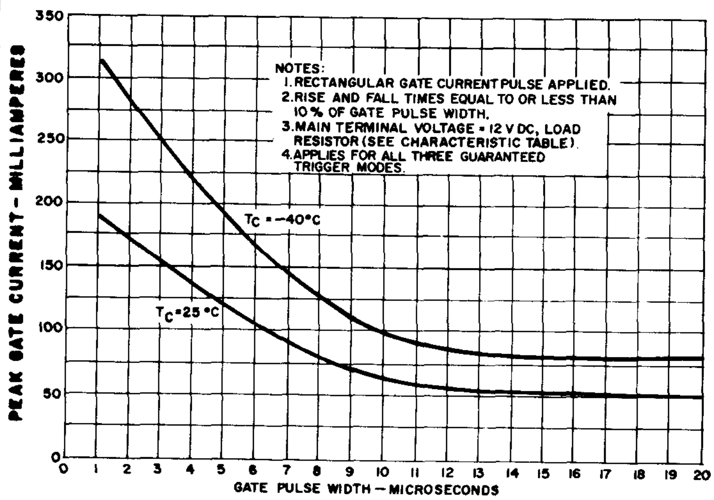
4. GATE CHARACTERISTICS AND RATINGS



5. MAXIMUM DC GATE VOLTAGE TO TRIGGER VERSUS CASE TEMPERATURE

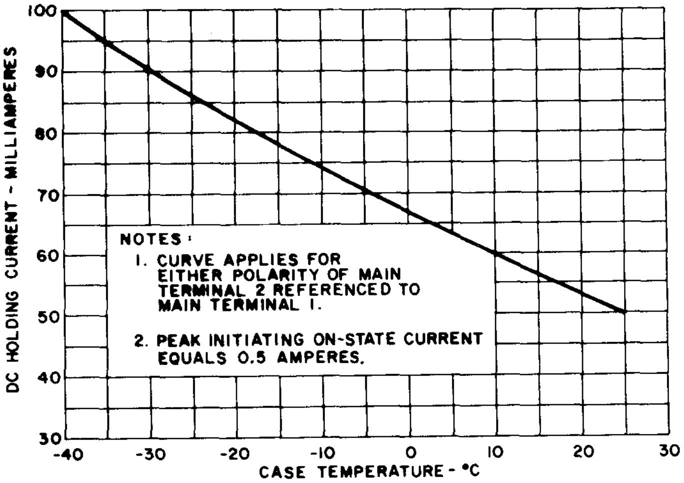


6. MAXIMUM DC GATE CURRENT TO TRIGGER VERSUS CASE TEMPERATURE

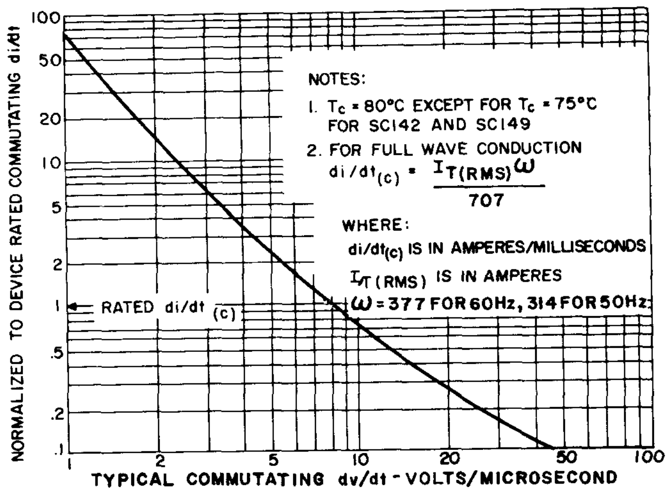


7. MAXIMUM GATE CURRENT TO TRIGGER VERSUS GATE PULSE WIDTH

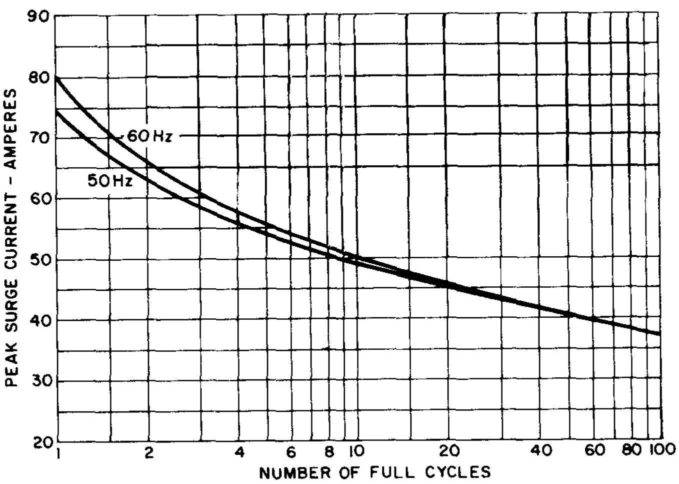
ISOLATED TAB	NON-ISOLATED TAB
SC140, 2, 7	SC141, 3, 6, 9, SC151



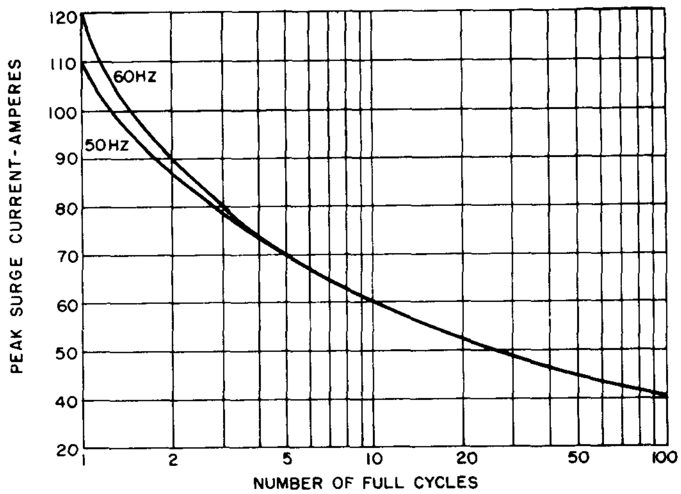
8. MAXIMUM DC HOLDING CURRENT VERSUS CASE TEMPERATURE



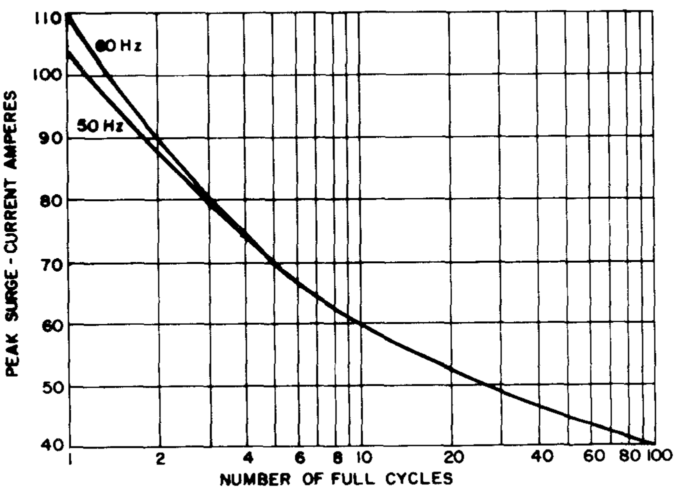
9. NORMALIZED DEVICE RATED COMMUTATING DI/DT VERSUS COMMUTATING DV/DT



SC140 / SC141



SC143 / SC146 / SC149 / SC151

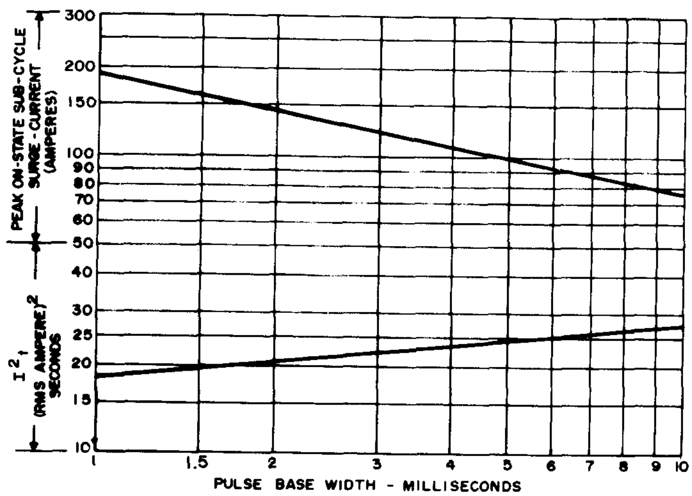


SC142 / SC147

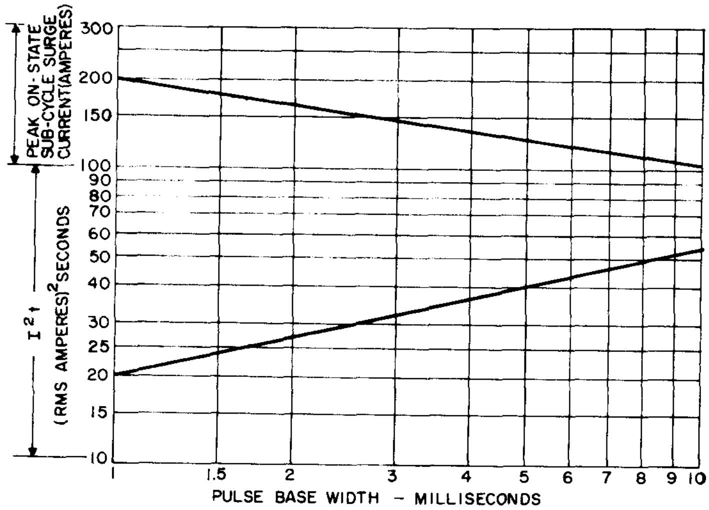
NOTES:
1. Gate control may be lost during and immediately following the surge current interval.
2. Current surge may not be repeated until junction temperature has returned to within steady-state rated value.
3. Junction temperature immediately prior to surge = 40°C to 100°C.

10. MAXIMUM ALLOWABLE PEAK FULL CYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT

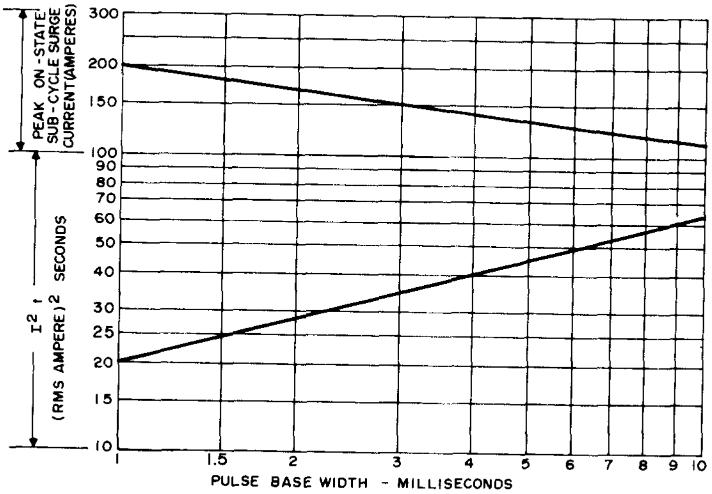
ISOLATED TAB	NON-ISOLATED TAB
SC140, 2, 7	SC141, 3, 6, 9, SC151



SC140 / SC141



SC142 / SC147

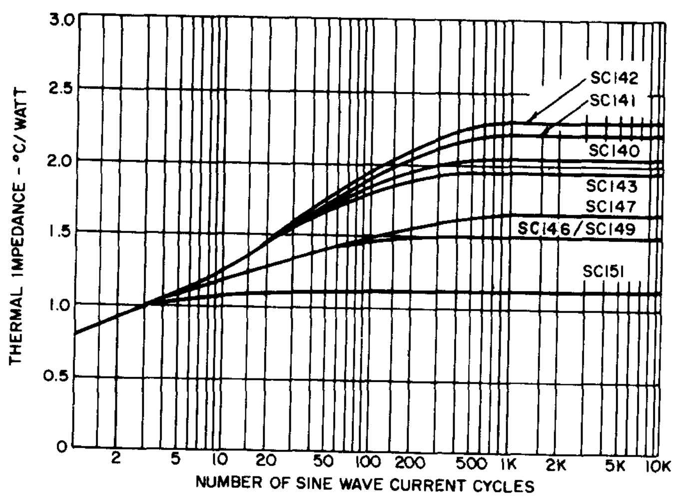


SC143 / SC146 / SC149 / SC151

NOTES:

1. Curves apply for either polarity of main terminal 2 referenced to main terminal 1.
2. Curves for half sine wave current waveform.
3. Gate control may be lost during and immediately following the surge current interval.
4. Current surge may not be repeated until junction temperature has returned to within steady-state rated value.
5. Junction temperature immediately prior to surge = -40°C to 100°C.

11. SUBCYCLE SURGE (NON-REPETITIVE) ON-STATE CURRENT AND I^2t RATINGS



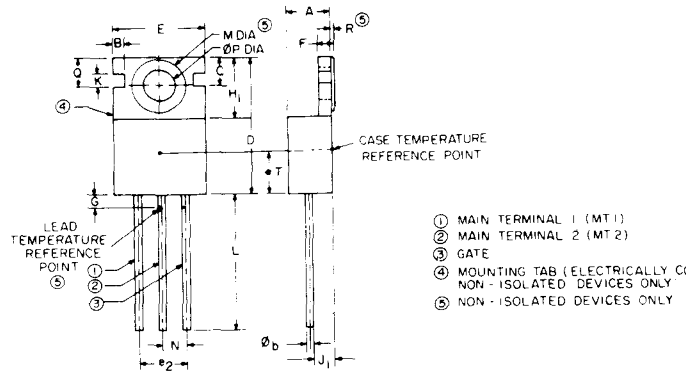
NOTES:

1. Curve defines temperature rise of either junction above case temperature for equal amplitudes symmetrical sine wave current at 50 and 60 Hz.
2. Curve considers junction temperature measured immediately after the final cycle of current.
3. Gate will regain control if temperature is maintained below rated value and load current is reduced or maintained at RMS value.
4. For more than 100 cycles of current the case temperature rise must be observed and used in calculating the total junction temperature.
5. Junction temperature rise above case is defined as apparent transient thermal impedance times average conduction power dissipated during full cycle conduction.
6. Apparent steady-state value is not the same as JEDEC value listed as steady-state in characteristics table.

12. MAXIMUM APPARENT TRANSIENT THERMAL IMPEDANCE (50 AND 60 Hz SINE WAVE OPERATION)

ISOLATED TAB	NON-ISOLATED TAB
SC140, 2, 7	SC141, 3, 6, 9, SC151

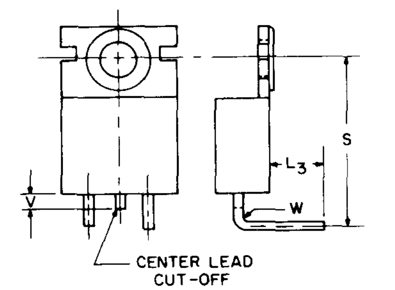
STANDARD TYPE



TYPE I - JEDEC TO-220-AB

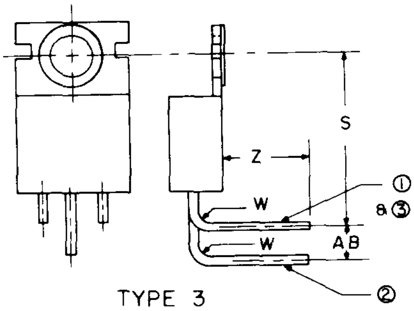
SYMBOL	INCHES		METRIC MM		SYMBOL	INCHES		METRIC MM	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	.160	.190	4.06	4.83	N	.095	.105	2.41	2.67
B	.054 TYP.		1.37 TYP.		Ø P	.141	.145	3.58	3.68
Ø b	.029	.035	.73	.89	Q	.118 REF.		3.00 REF.	
C	.110	.120	2.79	3.05	R	.0015	.004	—	.10
D	.560	.650	14.23	16.51	S	.570	.590	14.47	14.99
E	.390	.420	9.90	10.67	T	—	.220	—	5.59
e_2	.190	.210	4.82	5.33	V	.040	.070	1.01	1.78
F	.040	.055	1.01	1.39	W	.020	.030	.50	.76
G	—	.065	—	1.65	Z	.172	.202	4.36	5.13
H_1	.240	.260	6.09	6.60	AA	.087	.097	2.20	2.46
J_1	.085	.115	2.15	2.92	AB	.120	.130	3.04	3.30
K	.054 REF.		1.37 REF.		AC	.025	.035	.63	.89
L	.500	–	12.70	—	AD	.045	.055	1.14	1.40
L_3	.360	–	9.14	—	AE	.353	.433	8.96	11.00
M	.232	.236	5.89	5.99					

TO-66 EQUIVALENT
(NON-ISOLATED DEVICES ONLY)



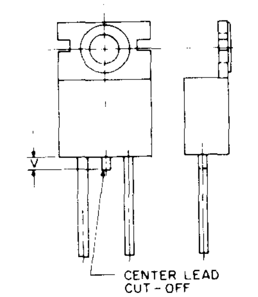
TYPE 2

FLAT MOUNTING
CHASSIS HEATSINK



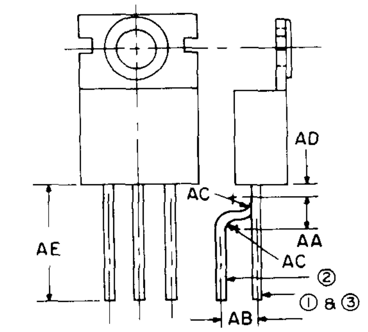
TYPE 3

CENTER LEAD CUT
(NON-ISOLATED DEVICES ONLY)



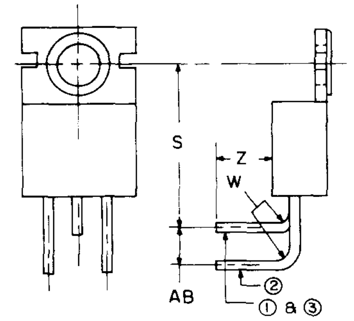
TYPE 4

UPRIGHT MOUNTING



TYPE 5

FLAT MOUNTING
RADIATOR HEATSINK



TYPE 6

ISOLATED TAB	NON-ISOLATED TAB
SC140, 2, 7	SC141, 3, 6, 9, SC151

POWER PAC TRIAC PART NUMBER DESIGNATION

SC1 40 B 2

- SC1 — POWER PAC TRIAC
- 40 — CURRENT RATING & ISOLATION
- B — VOLTAGE RATING
- 2 — LEAD FORMING CONFIGURATIONS

CURRENT RATING & ISOLATION

40 = 6.5 A RMS Isolated
41 = 6 A RMS Non-Isolated
42 = 8 A RMS Isolated
43 = 8 A RMS Non-Isolated
46 = 10 A RMS Non-Isolated
47 = 10 A RMS Isolated
49 = 12 A RMS Non-Isolated
51 = 15 A RMS Non-Isolated

VOLTAGE RATING

B = 200 Volts
D = 400 Volts
E = 500 Volts
M = 600 Volts

LEAD FORMING CONFIGURATIONS

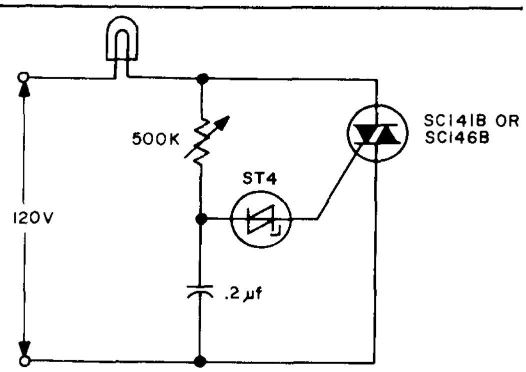
None = Standard Type 1
2 = Type 2
3 = Type 3
4 = Type 4
5 = Type 5
6 = Type 6

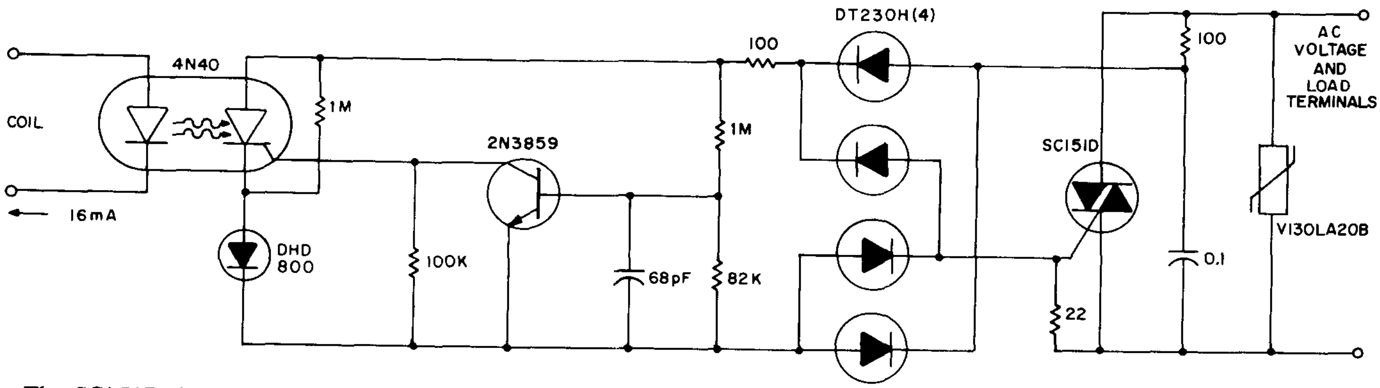
NOTE: See Outline Drawing.

TYPICAL CIRCUITS

Triacs are especially useful in AC lamp dimming because of their ability to conduct in both directions.

The circuit shown here incorporates General Electric's ST4 asymmetrical AC trigger integrated circuit. This device greatly reduces the snap-on effects that are present in symmetrical trigger circuits and minimizes control circuit hysteresis. This performance is possible with a single RC time constant, whereas a symmetrical circuit of comparable performance would require at least three additional passive components.





The SC151D, in combination with an optically-isolated SCR (4N40), allows this highly transient immune, TTL compatible, zero voltage switching design for a normally open 15 ampere solid-state relay. Zero voltage crossing is sensed via the base emitter diode drop of the 2N3859 which then allows the 4N40 SCR portion to be triggered and apply gate signal to the SC151 triac. The transient immunity is designed in through use of the GE-MOV®, the snubber network and the choice of 400 volt semiconductors.

OTHER TRIAC, TRIGGER AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

PUBLICATION NUMBER	TRIAC SPECIFICATION SHEETS	
175.13	SC136	
175.34	Hermetic Triacs	
	TRIGGER SPECIFICATION SHEETS	
175.30	ST2	(Diac)
175.32	ST4	(Asymmetrical AC Trigger)
65.32	2N4992	(Silicon Bilateral Switch)
	RELIABILITY REPORT	
95.29	Glassivated Triac Reliability Report	

PUBLICATION NUMBER	APPLICATION NOTES
200.35	Using the Triac for Control of AC Power
200.53	Solid State Incandescent Lighting Controls
201.12	500 Watt AC Line Voltage and Power Regulator
201.19	RF Filter Considerations for Triac & SCR Circuits
201.24	Thyristor Selection for Incandescent Lamp Loads
200.55	Thermal Mounting Considerations for Plastic Power Semiconductor Packages

Bi-Directional Triode Thyristor

Hermetic Triacs

6A to 40A RMS   Up to 600 Volts

STUD/TO-3 FLANGE
SC240
SC245
SC250
SC260
SC265
PRESS-FIT
SC241
SC246
SC251
SC261
SC266

The triac is a silicon AC switch which may be gate triggered from an OFF-State to an ON-State for either polarity of applied voltage. These triacs are hermetically sealed devices which incorporate General Electric's patented POWER-GLAS™ process that improves upon normal passivation techniques. It provides an intimate bond between the silicon chip and the glass coating. The resulting stable, low-level leakage current provides excellent performance and demonstrated reliability.

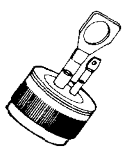
FEATURES:

- POWER-GLAS™ passivated silicon chip for maximum reliability.
- Very low off-state (leakage) current at room and elevated temperatures.
- Inherent immunity from non-repetitive transient voltage damage (max. critical rate-of-rise of on-state current subsequent to voltage breakover triggering, di/dt = 10 A/μsec.)
- Low on-state voltage at high current levels.
- Excellent surge current capability.
- 1800 volts RMS Surge Isolation Voltage on Isolated Triacs.
- Selected types available from factory for use where circuit requires operation:
  - with popular zero voltage triggering IC's
  - at 400 Hz
  - with low gate trigger current
  - at higher voltage levels
  - at higher commutating dv/dt levels.

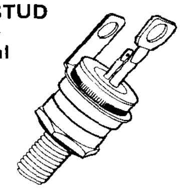
SIX BASIC PACKAGES

- Other packages available upon request.

PRESS-FIT

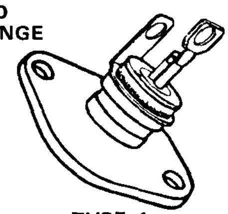


ISOLATED STUD With Press-on MT2 Terminal



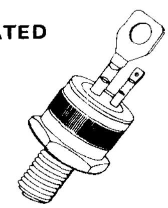
TYPE 2

ISOLATED TO-3 FLANGE



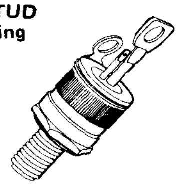
TYPE 4

NON-ISOLATED STUD



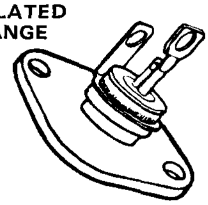
TYPE 1

ISOLATED STUD With Solder Ring MT2 Terminal



TYPE 3

NON-ISOLATED TO-3 FLANGE



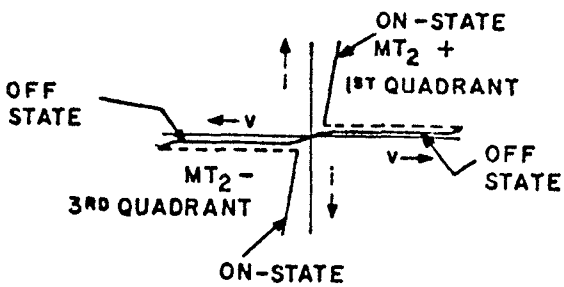
TYPE 5

STUD/TO-3 FLANGE	PRESS-FIT
SC240, 45, 50, 60, 65	SC241, 46, 51, 61, 66

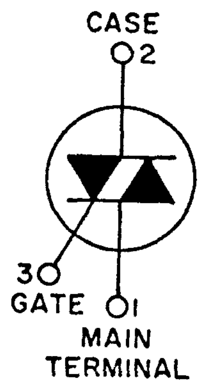
MAXIMUM ALLOWABLE RATINGS

TYPE	RMS ON-STATE CURRENT $I_{T(RMS)}$ (1)	REPETITIVE PEAK OFF-STATE VOLTAGE, V_{DRM} (2)				PEAK ONE FULL CYCLE SURGE (NON-REP) ON-STATE CURRENT, I_{TSM} AMPERES		I^2t FOR FUSING FOR TIMES AT(3)	
	AMPERES	B	D	E	M	50 Hz	60 Hz	(RMS AMPERE)^2 SECONDS, 1.0 MILLISECONDS	(RMS AMPERE)^2 SECONDS, 8.3 MILLISECONDS
		VOLTS	VOLTS	VOLTS	VOLTS	AMPERES	AMPERES		
SC240/241	6	200	400	500	600	74	80	18	26.5
SC245/246	10	200	400	500	600	90	100	20	41.5
SC250/251	15	200	400	500	600	90	100	20	41.5
SC260/261	25	200	400	500	600	230	250	150	260.0
SC265/266	40	200	400	500	600	275	300	300	375.0

Peak Gate Power Dissipation, P_{GM} (4)
SC240/SC241, SC245/SC246, SC250/SC251, SC260/SC261 . . . . 10 Watts for 10 Microseconds (See Figure 5A)
SC265/SC266 . . . . 10 Watts for 20 Microseconds (See Figure 5B)
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . 0.5 Watts
Peak Gate Current, I_{GM} (4) . . . . (See Figures 6A, 6B, 6C)
Peak Gate Voltage, V_{GM} (4) . . . . (See Figures 6A, 6B, 6C)
Storage Temperature, T_{stg} . . . . -40°C to +125°C
Operating Temperature, T_J
SC240/SC241, SC245/SC246. . . . . -40°C to +100°C
SC250/SC251, SC260/SC261, SC265/SC266 . . . . -40°C to +115°C
Stud Torque (Isolated and Non-Isolated Stud Types). . . . . 25 Lb.-In. (29 Kg-Cm) (2.8 N-M)
Insertion Pressure (Press-Fit Types). . . . . ($3.56 N \times 10^3$) 800 Lbs. (364 Kg)
Surge Isolation Voltage (5) . . . . 1800 Volts RMS



TYPICAL CHARACTERISTICS
VOLT-AMPERES



TERMINAL ARRANGEMENT

NOTES:

1. $I_{T(RMS)}$ ratings apply for 50 and 60 Hz with 360° conduction and at case reference point (see outline drawings) temperature as indicated in the following chart:

CASE REFERENCE POINT TEMPERATURE CHART

Device	A RMS	Stud/ Press-Fit	Isolated Stud	Non-Isolated TO-3 Flange	Isolated TO-3 Flange
SC240/SC241	6	82°C	80°C	80°C	79°C
SC245/SC246	10	80°C	78°C	78°C	76°C
SC250/SC251	15	86°C	83°C	83°C	80°C
SC260/SC261	25	80°C	75°C	75°C	71°C
SC265/SC266	40	81°C	74°C	74°C	68°C

2. V_{DRM} ratings apply for zero gate voltage only. Ratings apply for either polarity of main terminal 2 referenced to main terminal 1.
3. I^2t ratings apply for either polarity of main terminal 2 referenced to main terminal 1.
4. Ratings apply for either polarity of gate terminal referenced to main terminal 1.
5. Surge isolation voltage rating applies to isolated triacs only. Rating applies from main terminals 1, 2 and gate terminal to device mounting surface. Test voltage is 50 or 60 Hz sinusoidal waveform applied for one minute. Rating applies over the entire device operating temperature range.

STUD/TO-3 FLANGE	PRESS-FIT
SC240, 45, 50, 60, 65	SC241, 46, 51, 61, 66

CHARACTERISTICS

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS			REF. NOTE
Repetitive Peak Off-State Current	I_{DRM}				mA	V_{DRM} = Maximum Allowable Repetitive Peak Off-State Voltage Rating. Gate Open Circuited.			1
SC240/SC241 SC245/SC246 SC250/SC251		– –	– –	0.1 0.5		T_C = +25°C T_C = T_J (Max.)			
SC260/SC261 SC265/SC266		– –	– –	0.2 1.0		T_C = +25°C T_C = T_J (Max.)			
Peak On-State Voltage	V_{TM}	–	–	–	Volts	T_C = +25°C, I_{TM} = 1 msec., Wide Pulse. Duty Cycle ⩽ 2%.			1
SC240/SC241		–	–	1.83		I_{TM} = 8.5 A Peak			
SC245/SC246		–	–	1.65		I_{TM} = 14 A Peak			
SC250/SC251		–	–	1.65		I_{TM} = 21 A Peak			
SC260/SC261		–	–	1.58		I_{TM} = 35 A Peak			
SC265/SC266		–	–	1.38		I_{TM} = 56 A Peak			
Critical Rate-of-Rise of Off-State Voltage (Higher Values May Cause Device Switching.)	dv/dt				Volts/μsec	T_C = T_J Max. Rated V_{DRM}. Gate Open Circuited. Exponential Voltage Waveform.			1
SC240/SC241		30	100	–					
SC245/SC246		100	150	–					
SC250/SC251		100	250	–					
SC260/SC261		50	150	–					
SC265/SC266		50	150	–					
Critical Rate-of-Rise of Commutating Off-State Voltage (Commutating dv/dt)	$dv/dt_{(c)}$				Volts/μsec	$I_{T(RMS)}$ = Rated Maximum Allowable RMS On-State Current, V_{DRM} = Maximum Rated Peak Off-State Voltage. Gate Open Circuited.			1,7
SC240/SC241		4	–	–					
SC245/SC246		4	–	–					
SC250/SC251		4	–	–					
SC260/SC261		5	–	–					
SC265/SC266		5	–	–					
DC Gate Trigger Current	I_{GT}				mAdc	V_D = 12Vdc			2
						TRIGGER MODE	R_L	T_C	
SC240/SC241 SC245/SC246 SC250/SC251 SC260/SC261		–	–	50		MT2+ Gate+	100 Ohms	+25°C	
		–	–	50		MT2– Gate–	100 Ohms		
		–	–	50		MT2+ Gate–	50 Ohms		
		–	–	80		MT2+ Gate+	50 Ohms	-40°C	
		–	–	80		MT2– Gate–	50 Ohms		
		–	–	80		MT2+ Gate–	25 Ohms		
SC265/SC266		–	–	80		MT2+ Gate+	100 Ohms	+25°C	
		–	–	80		MT2– Gate–	100 Ohms		
		–	–	80		MT2+ Gate–	50 Ohms		
		–	–	120		MT2+ Gate+	50 Ohms	-40°C	
		–	–	120		MT2– Gate–	50 Ohms		
		–	–	120		MT2+ Gate–	25 Ohms		

CONTINUED:

STUD/TO-3 FLANGE	PRESS-FIT
SC240, 45, 50, 60, 65	SC241, 46, 51, 61, 66

CHARACTERISTICS (Continued)

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS			REF. NOTE
DC Gate Trigger Voltage	V_{GT}				Vdc	V_D = 12 Vdc			2
						TRIGGER MODE	R_L	T_C	
		–	–	2.5		MT2+ Gate+	100 Ohms	+25°C	
		–	–	2.5		MT2– Gate–	100 Ohms		
		–	–	2.5		MT2+ Gate–	50 Ohms		
		–	–	3.5		MT2+ Gate+	50 Ohms	-40°C	
		–	–	3.5		MT2– Gate–	50 Ohms		
		–	–	3.5		MT2+ Gate–	25 Ohms		
DC Gate Non-Trigger Voltage	V_{GD}				Vdc				2, 3
						TRIGGER MODE	R_L	T_C	
		0.2	–	–		MT2+ Gate+	1000 Ohms	Max. T_J	
		0.2	–	–		MT2– Gate–			
		0.2	–	–		MT2+ Gate–			
		0.2	–	–		MT2– Gate+			
DC Holding Current	I_H				mAdc	Main Terminal Source Voltage = 24 Vdc. Peak Initiating On-State Current = 0.5Amps, 0.1 milliseconds to 10 milliseconds wide pulse. Gate Trigger Source = 7 Volts, 20 Ohms			1
SC240/SC241 SC245/SC246 SC250/SC251		– –	– –	50 100		T_C = +25°C T_C = -40°C			
SC260/SC261 SC265/SC266		– –	– –	75 150		T_C = +25°C T_C = -40°C			
DC Latching Current	I_L				mAdc	Main Terminal Source Voltage = 24 Vdc. Gate Trigger Source = 15 Volts, 100 Ohms, 50 µsec pulse width, 5 µsec rise and fall times maximum.			2
						TRIGGER MODE		T_C	
		–	–	100		MT2+ Gate–		+25°C	
		–	–	100		MT2– Gate–			
		–	–	200		MT2+ Gate–			
		–	–	200		MT2+ Gate+		-40°C	
		–	–	200		MT2– Gate–			
		–	–	400		MT2+ Gate–			
Steady State Thermal Resistance	$R_{\theta JA}$	–	–	45	°C/Watt	Junction-to-Ambient			1, 4
Steady State Thermal Resistance	$R_{\theta JC}$				°C/Watt	Junction-to-Case. This characteristic is useful as an acceptance test at an incoming inspection station.			1, 5
SC240/SC241		–	–	2.80		Non-Isolated Stud/Press-Fit			
		–	–	2.95		Isolated Stud			
		–	–	2.95		Non-Isolated TO-3 Flange			
		–	–	3.10		Isolated TO-3 Flange			
SC245/SC246		–	–	2.00		Non-Isolated Stud/Press-Fit			
		–	–	2.15		Isolated Stud			
		–	–	2.15		Non-Isolated TO-3 Flange			
		–	–	2.30		Isolated TO-3 Flange			
SC250/SC251		–	–	2.00		Non-Isolated Stud/Press-Fit			
		–	–	2.15		Isolated Stud			
		–	–	2.15		Non-Isolated TO-3 Flange			
		–	–	2.30		Isolated TO-3 Flange			

CONTINUED:

STUD/TO-3 FLANGE	PRESS-FIT
SC240, 45, 50, 60, 65	SC241, 46, 51, 61, 66

CHARACTERISTICS (Continued)

TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	REF. NOTE
SC260/SC261	$R_{\theta JC}$	–	–	1.80	°C/Watt	Non-Isolated Stud/Press-Fit	1,5
		–	–	1.95		Isolated Stud	
		–	–	1.95		Non-Isolated TO-3 Flange	
		–	–	2.10		Isolated TO-3 Flange	
SC265/SC266		–	–	1.00		Non-Isolated Stud/Press-Fit	
		–	–	1.15		Isolated Stud	
		–	–	1.15		Non-Isolated TO-3 Flange	
		–	–	1.30		Isolated TO-3 Flange	
Apparent Thermal Resistance	$R_{\theta JC(AC)}$				°C/Watt	Junction-to-Case. This characteristic is useful in the calculation of junction temperature rise above case temperature for AC current conduction.	6
SC240/SC241		–	–	2.00		Non-Isolated Stud/Press-Fit	
		–	–	2.20		Isolated Stud	
		–	–	2.20		Non-Isolated TO-3 Flange	
		–	–	2.40		Isolated TO-3 Flange	
SC245/SC246		–	–	1.50		Non-Isolated Stud/Press-Fit	
		–	–	1.65		Isolated Stud	
		–	–	1.65		Non-Isolated TO-3 Flange	
		–	–	1.80		Isolated TO-3 Flange	
SC250/SC251		–	–	1.45		Non-Isolated Stud/Press-Fit	
		–	–	1.60		Isolated Stud	
		–	–	1.60		Non-Isolated TO-3 Flange	
		–	–	1.75		Isolated TO-3 Flange	
SC260/SC261		–	–	1.25		Non-Isolated Stud/Press-Fit	
		–	–	1.40		Isolated Stud	
		–	–	1.40		Non-Isolated TO-3 Flange	
		–	–	1.55		Isolated TO-3 Flange	
SC265/SC266		–	–	0.80		Non-Isolated Stud/Press-Fit	
		–	–	0.95		Isolated Stud	
		–	–	0.95		Non-Isolated TO-3 Flange	
		–	–	1.10		Isolated TO-3 Flange	

NOTES:

1. Characteristic values apply for either polarity of main terminal 2 referenced to main terminal 1.
2. Main terminal 1 is the reference terminal for main terminal 2 and gate terminal.
3. With V_D equal to maximum allowable off-state voltage.
4. The junction-to-ambient value is under worst case conditions; i.e., with No. 22 copper wire used for electrical contact to the terminals and natural convection cooling.
5. Junction-to-case steady-state thermal resistance ($R_{\theta JC}$) is tested in accordance with EIA-NEMA Standard RS-397, Section 3.3.2, which states: *"Thermal characteristics are to be measured with the device operating in only one direction."* The values listed are the limiting value for either direction.
6. Apparent thermal resistance applies for a 50 or 60 Hz full sine wave of current. It can be calculated with the following formula:

$$\text{Apparent thermal resistance} = \frac{T_{J(max)} - T_C}{P_{T(AV)}}$$

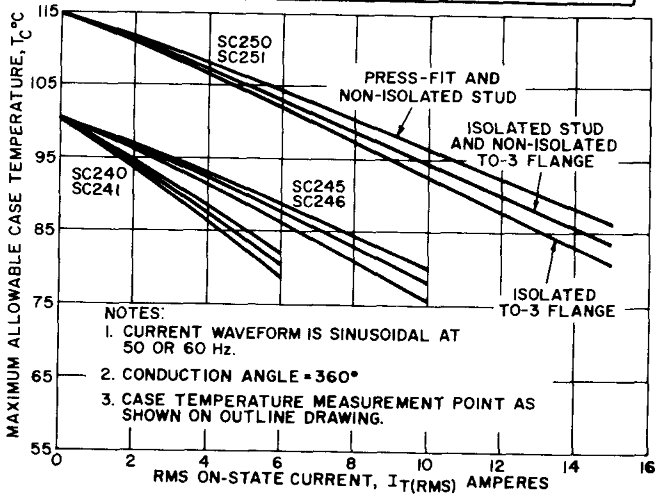
where: $T_{J(max)}$ = maximum junction temperature
T_C = case temperature
$P_{T(AV)}$ = average on-state power

See Figure 7 for Maximum Apparent Transient Thermal Impedance.

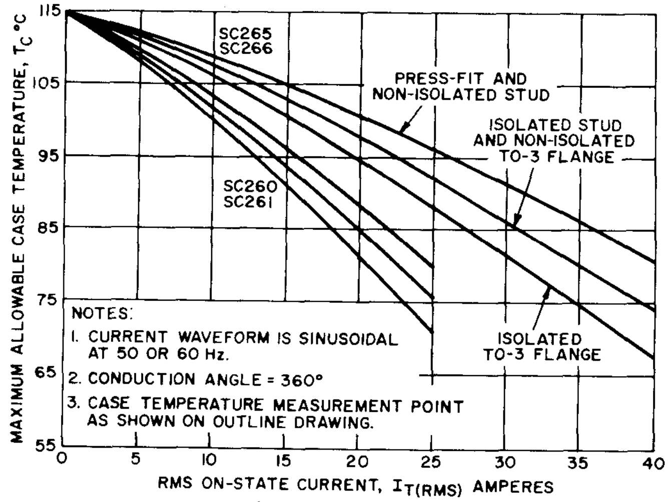
7. Values for these test conditions are:

Device	Package	Commutating di/dt	T_C (°C)
SC240/SC241	Non-Isolated Stud/Press-Fit	3.2 A/msec.	82
	Isolated Stud		80
	Non-Isolated TO-3 Flange		80
	Isolated TO-3 Flange		79
SC245/SC246	Non-Isolated Stud/Press-Fit	5.4 A/msec.	80
	Isolated Stud		78
	Non-Isolated TO-3 Flange		78
	Isolated TO-3 Flange		76
SC250/SC251	Non-Isolated Stud/Press-Fit	8.0 A/msec.	86
	Isolated Stud		83
	Non-Isolated TO-3 Flange		83
	Isolated TO-3 Flange		80
SC260/SC261	Non-Isolated Stud/Press Fit	13.5 A/msec.	80
	Isolated Stud		75
	Non-Isolated TO-3 Flange		75
	Isolated TO-3 Flange		71
SC265/SC266	Non-Isolated Stud/Press-Fit	21.5 A/msec.	81
	Isolated Stud		74
	Non-Isolated TO-3 Flange		74
	Isolated TO-3 Flange		68

STUD/TO-3 FLANGE	PRESS-FIT
SC240, 45, 50, 60, 65	SC241, 46, 51, 61, 66

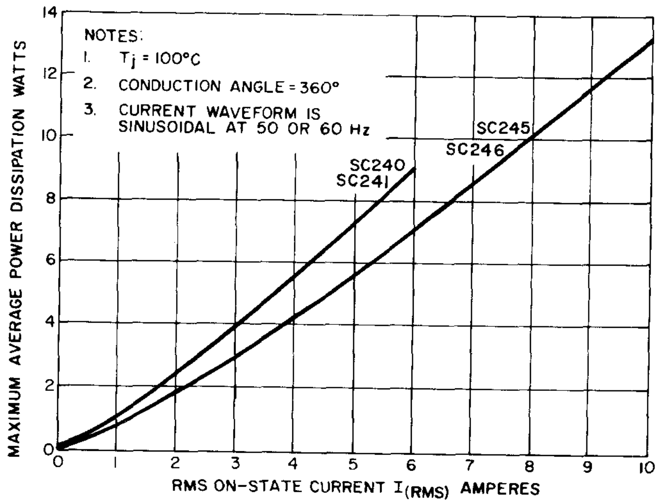


SC240/SC241, SC245/SC246, SC250/SC251

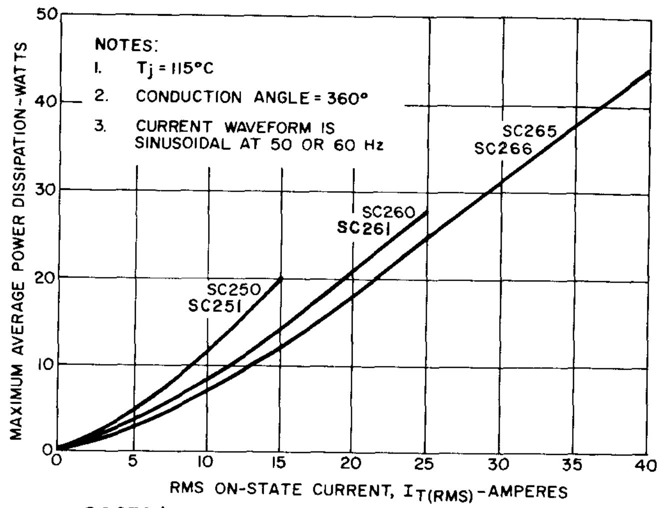


SC260/SC261, SC265/SC266

1. MAXIMUM ALLOWABLE CASE TEMPERATURE VS. RMS ON-STATE CURRENT

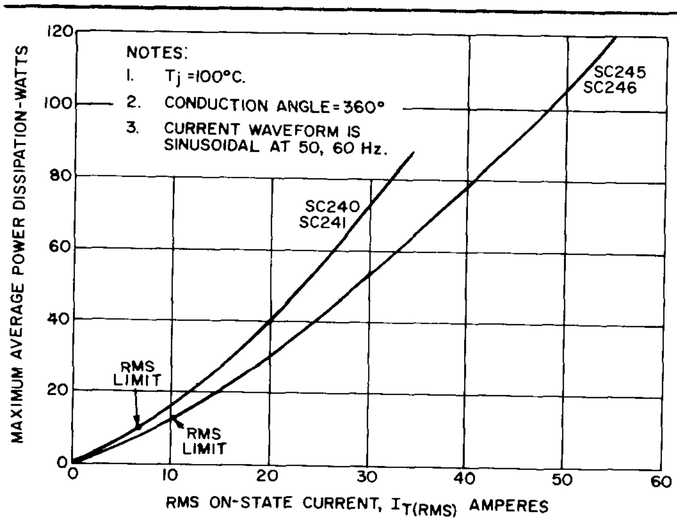


SC240/SC241, SC245/SC246

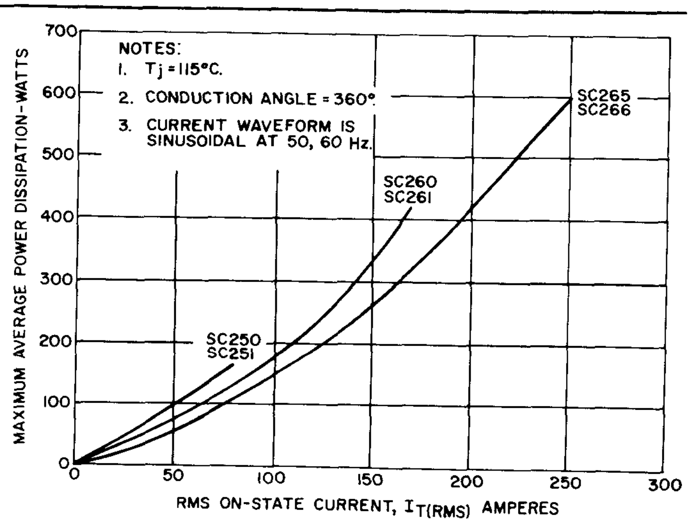


SC250/SC251, SC260/SC261, SC265/SC266

2. MAXIMUM AVERAGE POWER DISSIPATION VS. RMS ON-STATE CURRENT



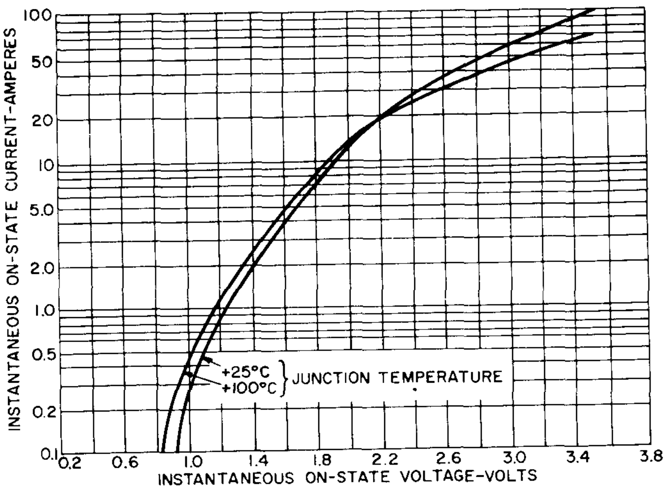
SC240/SC241, SC245/SC246



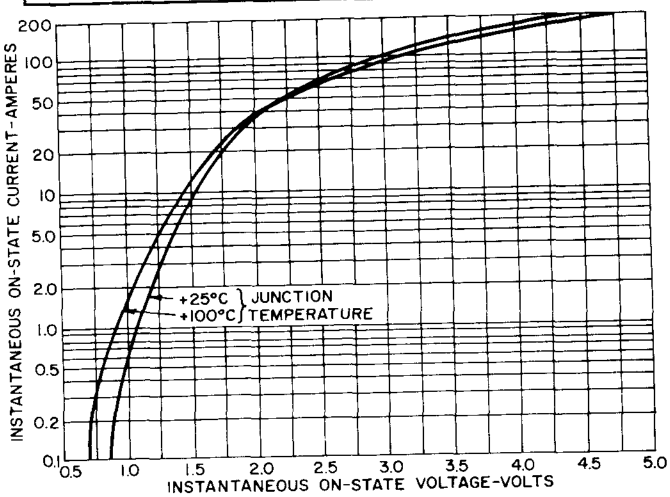
SC250/SC251, SC260/SC261, SC265/SC266

3. MAXIMUM AVERAGE POWER DISSIPATION VS. RMS ON-STATE CURRENT (HIGH LEVEL)

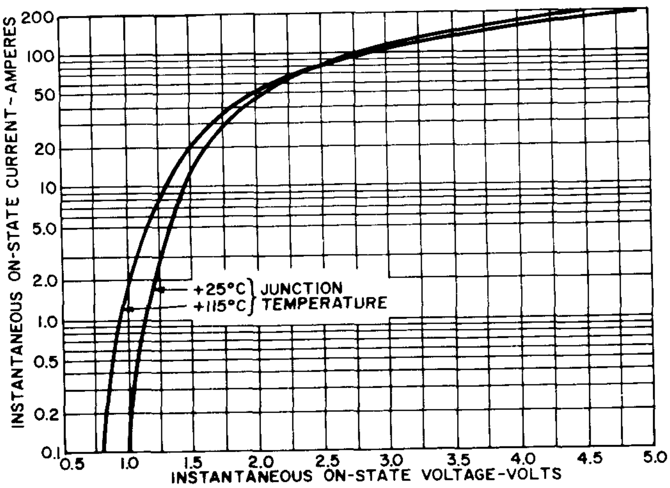
STUD/TO-3 FLANGE	PRESS-FIT
SC240, 45, 50, 60, 65	SC241, 46, 51, 61, 66



SC240/SC241



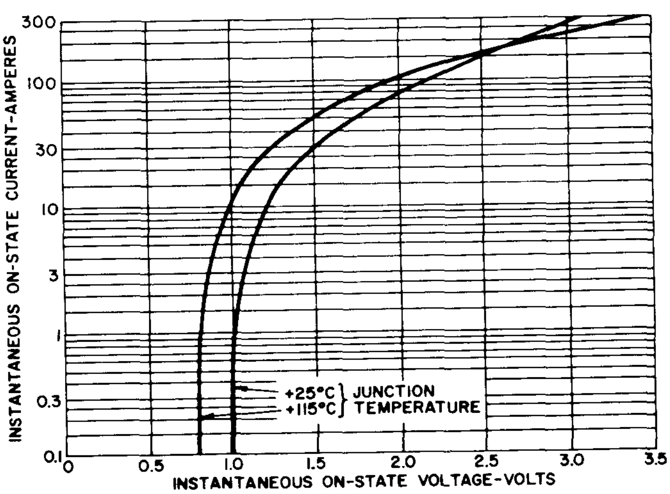
SC245/SC246



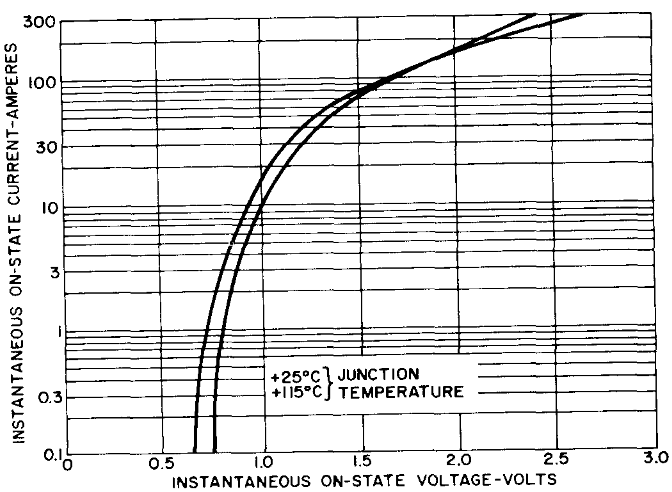
SC250/SC251

NOTES:

1. I_{TM} = 1 msec. wide pulse, duty cycle ⩽ 2%.
2. Curves apply for either polarity of main terminal 2 referenced to main terminal 1.



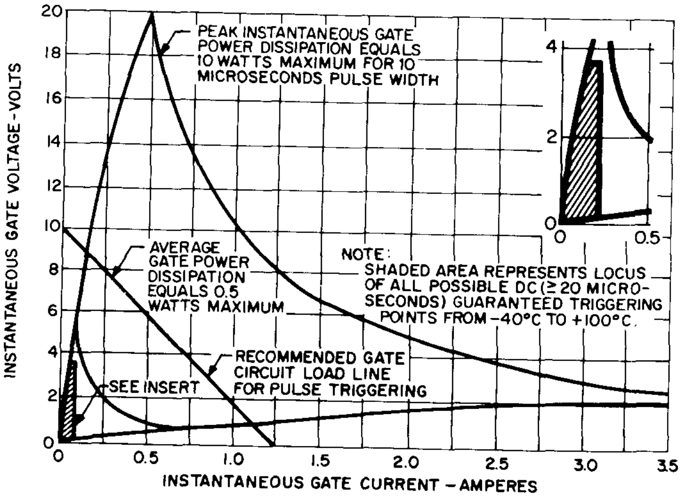
SC260/SC261



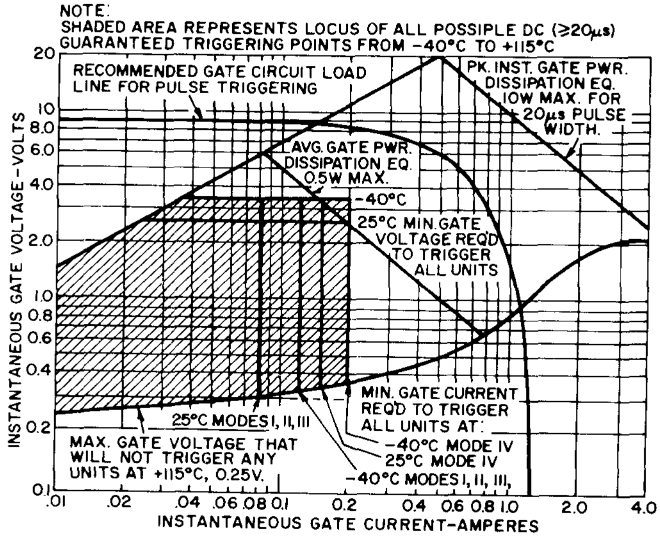
SC265/SC266

4. MAXIMUM ON-STATE VOLTAGE VS. ON-STATE CURRENT

STUD/TO-3 FLANGE	PRESS-FIT
SC240, 45, 50, 60, 65	SC241, 46, 51, 61, 66

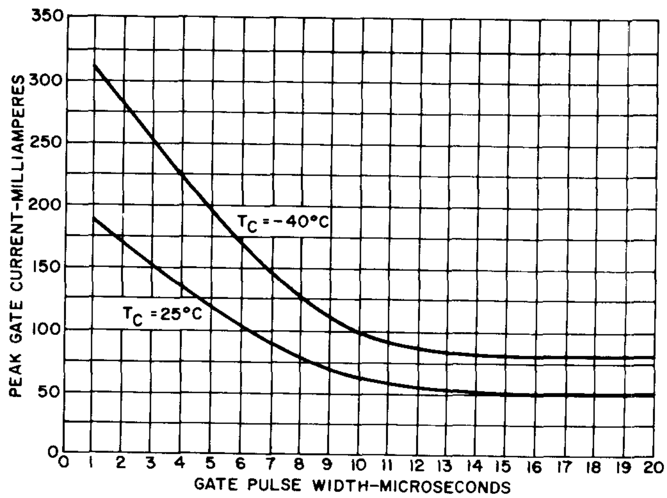


SC240/SC241, SC245/SC246, SC250/SC251, SC260/SC261

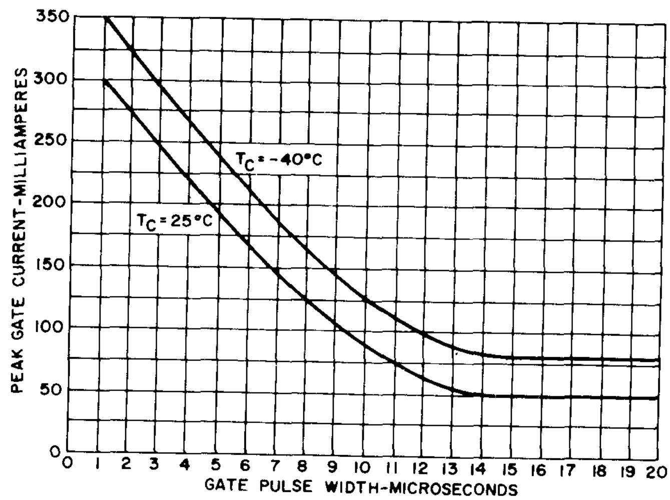


SC265/SC266

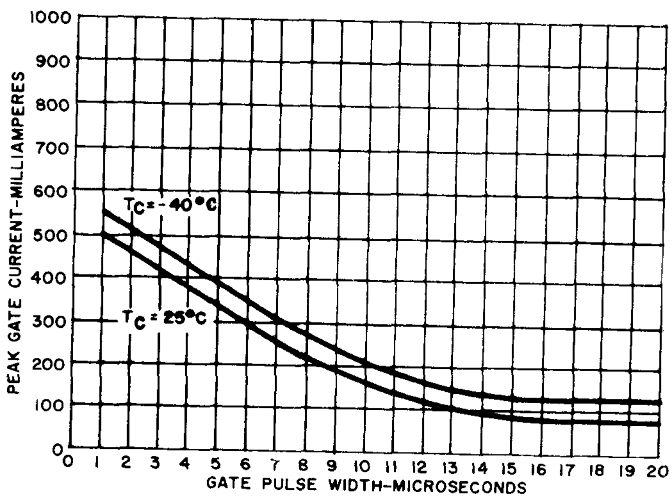
5. GATE CHARACTERISTICS AND RATINGS



SC240/SC241, SC245/SC246, SC250/SC251



SC260/SC261



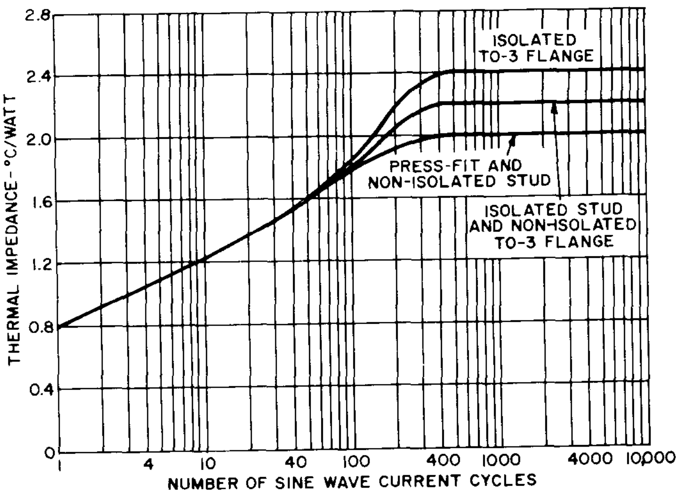
SC265/SC266

NOTES:

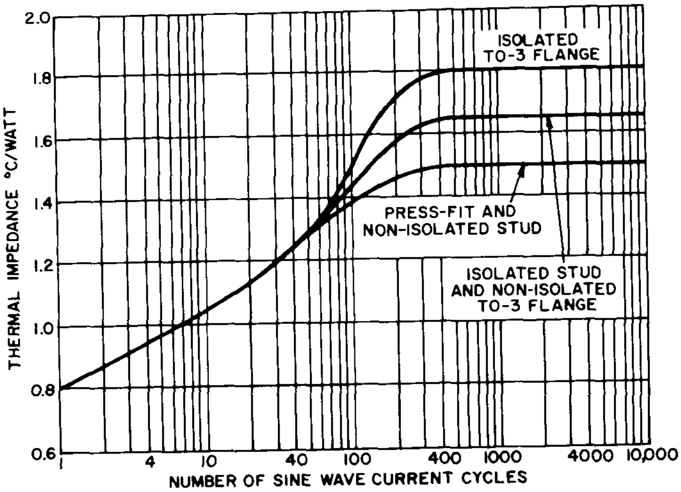
1. Rectangular gate current pulse applied.
2. Rise and fall times equal to or less than 10% of gate pulse width.
3. Main terminal voltage ≈ 12 vdc, load resistor (see characteristic table).
4. Applies for all three guaranteed trigger modes.

6. MAXIMUM GATE TRIGGER CURRENT VS. GATE PULSE WIDTH

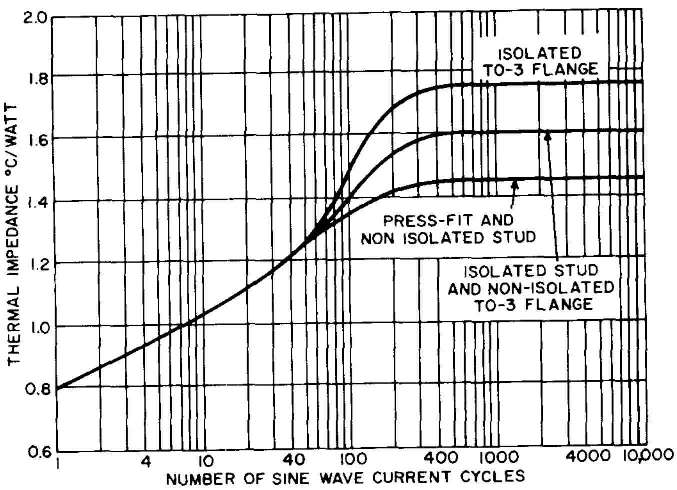
STUD/TO-3 FLANGE	PRESS-FIT
SC240, 45, 50, 60, 65	SC241, 46, 51, 61, 66



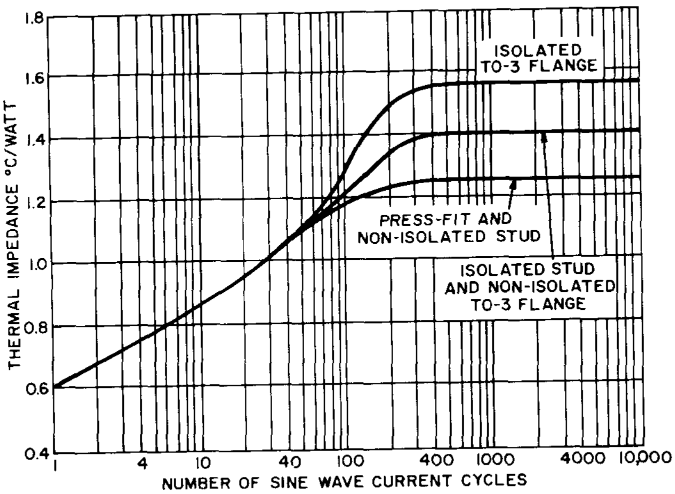
SC240/SC241



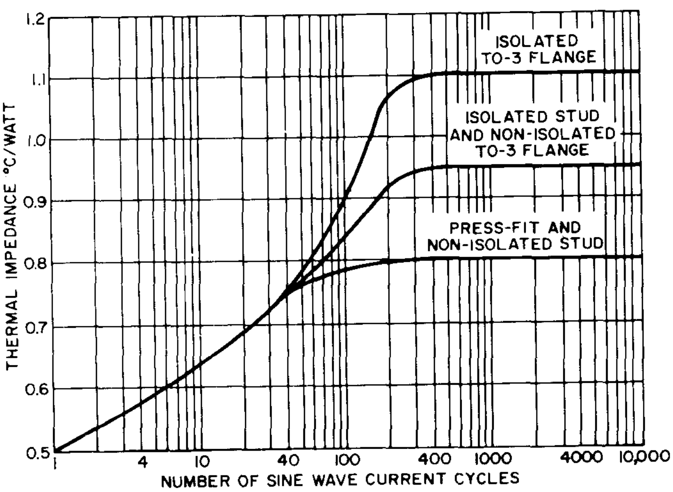
SC245/SC246



SC250/SC251



SC260/SC261



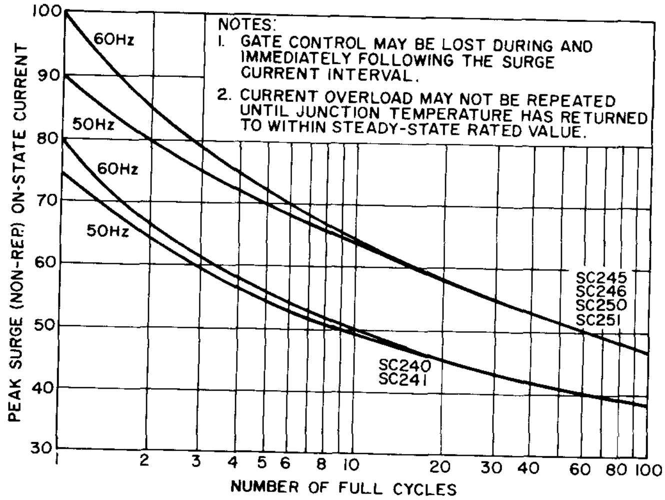
SC265/SC266

NOTES:

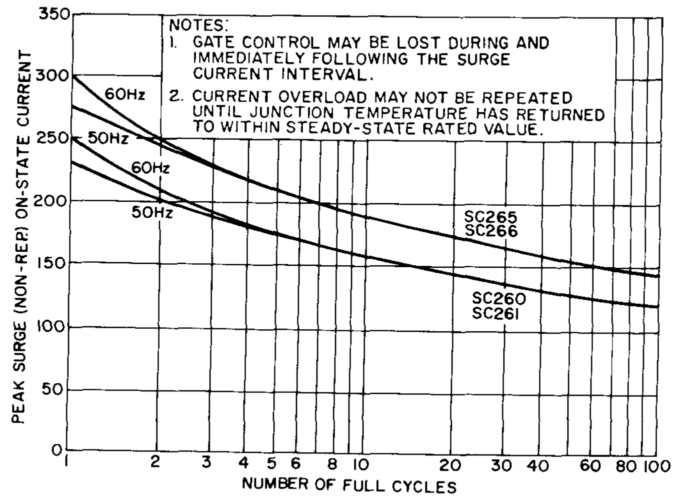
1. Curves define temperature rise of either junction above case temperature for equal amplitudes symmetrical sine wave current at 50 and 60 Hz.
2. Curve considers junction temperature measured immediately after the final cycle of current.
3. Gate will regain control if temperature is maintained below rated value and load current is reduced or maintained at RMS value.
4. For more than 100 cycles of current the case temperature rise must be observed and used in calculating the total junction temperature.
5. Junction temperature rise above case is defined as apparent transient thermal impedance times average conduction power dissipated during full cycle conduction.
6. Apparent steady-state value is not the same as JEDEC value listed as steady-state in characteristics table.

7. MAXIMUM APPARENT TRANSIENT THERMAL IMPEDANCE

STUD/TO-3 FLANGE	PRESS-FIT
SC240, 45, 50, 60, 65	SC241, 46, 51, 61, 66

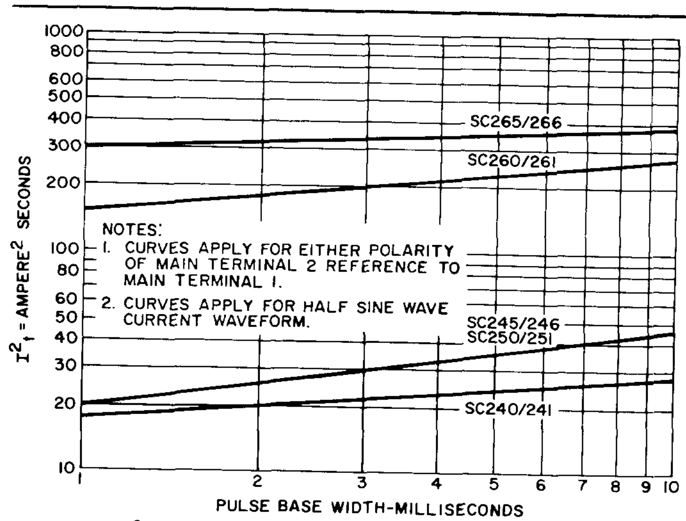


SC240/SC241, SC245/SC246, SC250/SC251

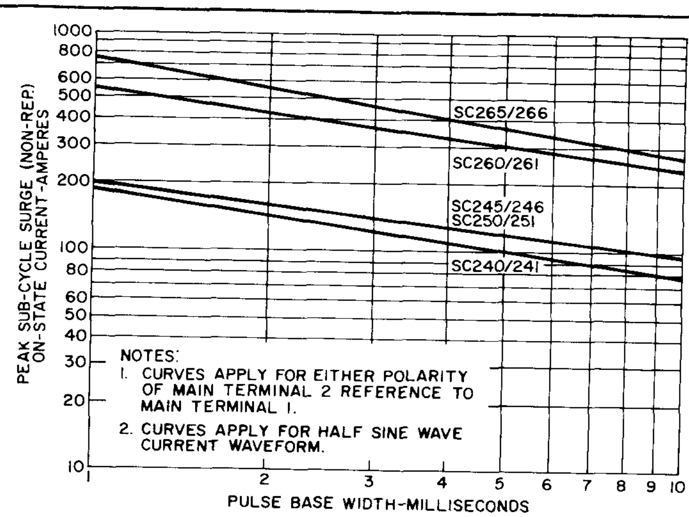


SC260/SC261, SC265/SC266

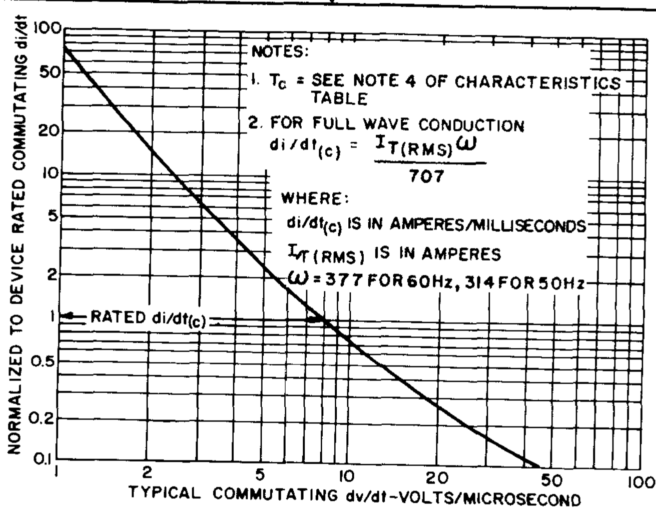
8. MAXIMUM ALLOWABLE FULL CYCLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



9. I^2t RATING FOLLOWING RATED LOAD CONDITIONS



10. SUB-CYCLE SURGE FOLLOWING RATED LOAD CONDITIONS



11. NORMALIZED DEVICE RATED COMMUTATING di/dt VS. COMMUTATING dv/dt (Typical Values)

STUD/TO-3 FLANGE	PRESS-FIT
SC240, 45, 50, 60, 65	SC241, 46, 51, 61, 66

OUTLINE DRAWINGS

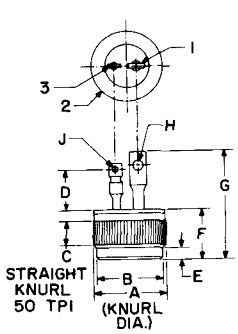


FIGURE A
(Pierced MT1 Terminal)

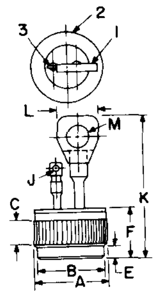
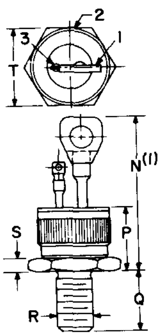


FIGURE B
(Flag MT1 Terminal)

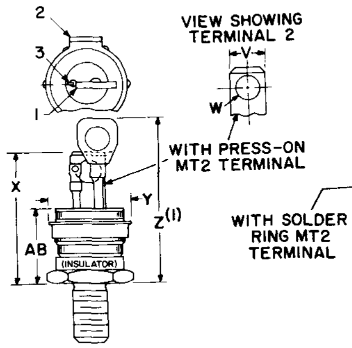
MT1 TERMINAL SPECIFICATION

Device	Amperes RMS	MT1 Terminal
SC240/SC241	6	See Figure A
SC245/SC246	10	See Figure A
SC250/SC251	15	See Figure A
SC260/SC261	25	See Figure B
SC265/SC266	40	See Figure B

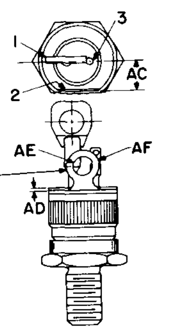
Device current rating determines the standard MT1 terminal supplied on all hermetic triac package variations. Devices rated less than 25 Amperes RMS will be supplied with a pierced terminal as shown in Figure A. Devices rated 25 Amperes RMS and above will be supplied with a flag terminal as shown in Figure B (1).



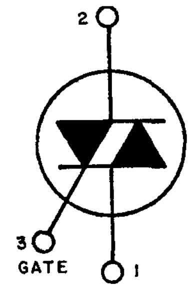
STUD
TYPE 1



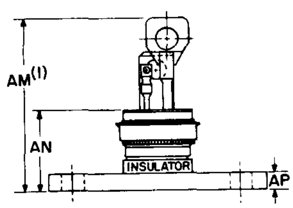
ISOLATED STUD
TYPE 2



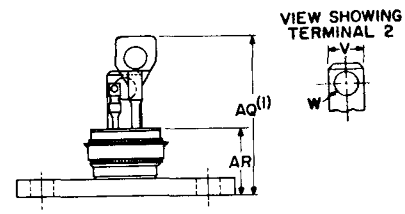
ISOLATED STUD
TYPE 3



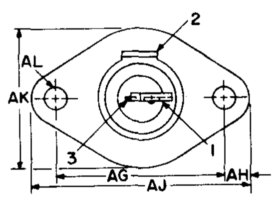
TERMINAL ARRANGEMENT



ISOLATED TO-3 FLANGE
TYPE 4



NON-ISOLATED TO-3 FLANGE
TYPE 5



SYMBOL	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.
A	.501	.505	12.73	12.82
B	.467	.475	11.87	12.06
C	.177 REF.		4.50 REF.	
D	.260	.301	6.60	7.65
E	.083	.097	2.11	2.46
F	.340	.376	8.64	9.55
G	—	.782	—	19.86
H	.081	.089	2.06	2.26
J	.060	.069	1.53	1.75
K	—	1.064	—	27.02
L	.284	.302	7.22	7.67
M	.146	.160	3.71	4.06
N(1)	—	1.150	—	29.21
P	—	.475	—	12.06
Q	.432	.442	10.98	11.22
R(6)	1/4-28, UNF2A		—	—
S	.086	.098	2.19	2.48
T	.552	.562	14.03	14.27
V	.240	.260	6.10	6.60
W	.145	.160	3.68	4.06

SYMBOL	INCHES		METRIC MM	
	MIN.	MAX.	MIN.	MAX.
X	—	.975	—	24.76
Y	.580	.610	14.74	15.49
Z(1)	—	1.260	—	32.00
AB		.585	—	14.85
AC	.220 REF.		5.59 REF.	
AD	.012	.023	.31	.58
AE	.140	.150	3.56	3.81
AF	.229	.251	5.82	6.37
AG	1.182	1.192	30.03	30.27
AH	.160	—	4.07	—
AJ	1.507	1.567	38.28	39.80
AK	.975	1.025	24.77	26.03
AL	.150	.161	3.81	4.08
AM(1)	—	1.300	—	33.02
AN	—	.630	—	16.00
AP	.119	.131	3.03	3.32
AQ(1)	—	1.195	—	30.35
AR	—	.515	—	13.08

NOTES:

1. Outline drawings and table dimensions are given for devices with the MT1 flag terminal (Fig. B). To calculate the height of devices with the MT1 pierced terminal (Fig. A), subtract 0.282 inches (7.100 mm) from table data.
2. Case temperature is measured for press-fit devices at the center of the base; for stud types 1, 2 and 3 at the center of any hex flat; for TO-3 *outline* mounting flange types 4 and 5 at the center of the bottom of the flange.
3. One external tooth lock washer and one nut (both steel, cadmium plated) are supplied with each stud and isolated stud unit.
4. Insulation hardware for stud devices consisting of solder terminal, mica washers and one nylon bushing are available at extra cost upon request.
5. Other standard package variations are available upon request.
6. Metric stud 8mm x 1.25 (.315 in. x .049 in.) is available upon request.

WARNING
Isolated products described in this specification sheet should be handled with care. The ceramic portion of these thyristors contains BERYLLIUM OXIDE as a major ingredient.
Do not crush, grind, or abrade these portions of the thyristors because the dust resulting from such action may be hazardous if inhaled.

STUD/TO-3 FLANGE	PRESS-FIT
SC240, 45, 50, 60, 65	SC241, 46, 51, 61, 66

HERMETIC TRIAC PART NUMBER DESIGNATION

SC2 40 B 2

- SC2 — HERMETIC TRIAC WITH POWER-GLAS™ CHIP
- 40 — CURRENT RATING & PACKAGE STYLE
- B — VOLTAGE RATINGS
- 2 — STUD/TO-3 FLANGE PACKAGE VARIATIONS

CURRENT RATING & PACKAGE STYLE

40 = 6 A RMS Stud/TO-3 Flange
41 = 6 A RMS Press-Fit
45 = 10 A RMS Stud/TO-3 Flange
46 = 10 A RMS Press-Fit
50 = 15 A RMS Stud/TO-3 Flange
51 = 15 A RMS Press-Fit
60 = 25 A RMS Stud/TO-3 Flange
61 = 25 A RMS Press-Fit
65 = 40 A RMS Stud/TO-3 Flange
66 = 40 A RMS Press-Fit

VOLTAGE RATINGS

B = 200 Volts
D = 400 Volts
E = 500 Volts
M = 600 Volts

STUD/TO-3 FLANGE PACKAGE VARIATIONS

None = Non-Isolated Stud Mount
2 = Isolated Stud Mount with Press on MT2 Terminal
3 = Isolated Stud Mount with Solder Ring MT2 Terminal
4 = Isolated on TO-3 Outline Mounting Flange
5 = Non-Isolated on TO-3 Outline Mounting Flange
6 – 9 = Other Standard Variations

MOUNTING CONSIDERATIONS

Installation of Press-Fit Device in Heat Sink

When press fitting a Triac into a heatsink, the following specifications and recommendations apply:

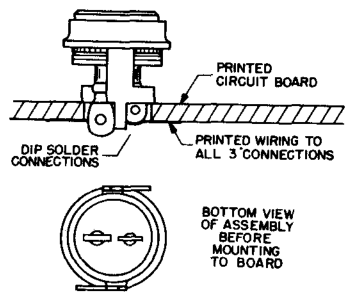
1. Heatsink materials may be copper, aluminum, or steel. For maximum heat transfer and minimum corrosion problems, copper is recommended. The heatsink thickness, or amount of heatsink wall, in contact with the Triac should be 1/8 inch.
2. The hole diameter into which the Triac is pressed must be 0.4975 ± .001 inch. A slight chamfer on the hole should be used. This hole may be punched in a flat plate and reamed, or extruded and sized in sheet metal.
3. The entire knurled section of the Triac should be in contact with the heatsink to insure maximum heat transfer. The Triac must not be inserted into a heatsink deeper than the knurl height.
4. The Triac insertion force must not exceed 800 pounds. If the insertion force approaches this value before complete insertion, either the Triac is misaligned with the hole or the Triac-to-hole interference is excessive. The insertion force must be uniformly applied to the top face (terminal end) of the Triac within an annular ring which has an inside diameter of not less than 0.370 inch and not larger than 0.390 inch; the outside diameter of the insertion force must not be less than 0.500 inch.
5. The thermal resistance between the Triac case and a copper heatsink will not exceed 0.5°C/W, if the Triac is inserted in the manner described.

Soldering of Press-Fit Package to Heat Sink

The press-fit package may be soldered directly to a heatsink using 60/40 (Pb-Sn) solder at a temperature of about 200°C.

Attachment of Press-Fit Device to Printed Circuit Board

For certain light load applications, the Triac can be inverted and, using a special brass bracket (A7149451), dip-soldered into a printed circuit board. The feet on the bracket act both as a mechanical support and Main Terminal 2 (case) electrical connection. For Triacs preassembled into the bracket, add –X24 to the type number, for example, SC251BX24.



Attachment of the Stud & Isolated Stud Device To a Heat Sink

These devices require certain precautions in order to insure good thermal transfer. The chassis hole must be drilled and deburred, and should be between .005 and .015 inches larger than the stud outside diameter. The use of a Torque wrench is highly recommended and must be used within the torque limits indicated on page 2. A good grade of silicone grease will minimize contact thermal resistance.

OTHER TRIAC, TRIGGER AND APPLICATION INFORMATION AVAILABLE FROM GENERAL ELECTRIC

PUBLICATION NUMBER	TRIAC SPECIFICATION SHEETS
175.13	SC136 (Power Tab Triac)
175.35	Power Pac Triacs
	TRIGGER SPECIFICATION SHEETS
175.30	ST2 (Diac)
175.32	ST4 (Asymmetrical AC Trigger)
65.32	2N4992 (Silicon Bilateral Switch)
	RELIABILITY REPORT
95.29	Glassivated Triac Reliability Report

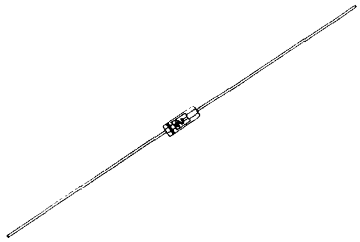
PUBLICATION NUMBER	APPLICATION NOTES
200.32	A Variety of Mounting Techniques for Press Fit Devices
200.35	Using the Triac for Control of AC Power
200.51	Better Room Conditioning Via Solid State Controls
200.53	Solid State Incandescent Lighting Controls
201.12	500 Watt AC Line Voltage and Power
201.19	RF Filter Consideration for Triac & SCR Circuits
201.24	Thyristor Selection for Incandescent Lamp Loads

Diac

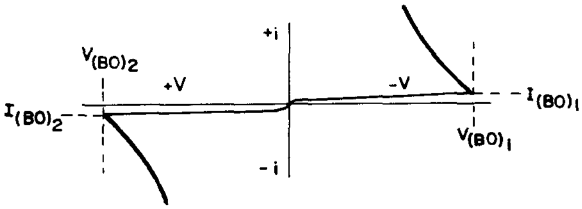
ST2

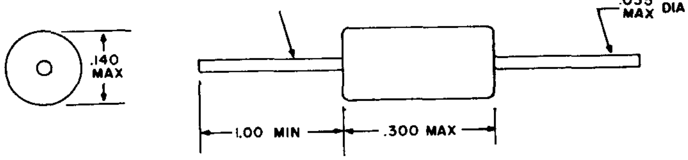
Silicon Bidirectional Trigger

The DIAC is a diffused silicon bi-directional trigger diode which may be used to trigger the G-E TRIAC or Silicon Controlled Rectifiers. This device has a three-layer structure having negative resistance switching characteristics for both directions of applied voltage.



VOLT – AMPERE CHARACTERISTICS



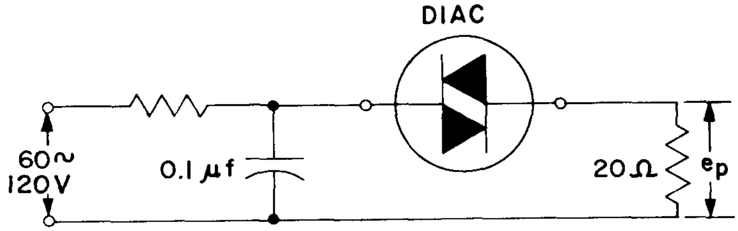


Storage Temperature . . . . T_{STG} –40°C to +150°C
Operating Temperature . . . . T_J –40°C to +100°C

MAXIMUM RATINGS at 50°C Ambient

Peak Current (10 μsec duration, 120 cycle repetition rate) . . . . I_p ± 2 Amperes Max.
Peak Output Voltage* . . . . e_p ± 3 Volts Min.

*CIRCUIT FOR PEAK OUTPUT VOLTAGE TEST



CHARACTERISTICS at 25°C Ambient

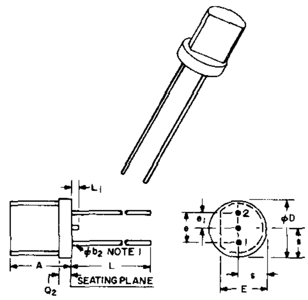
Test	Symbols	Min.	Typ.	Max.	Units
Breakover Voltage	$V_{(BR)1}$ and $V_{(BR)2}$	28	32	36	Volts
Breakover Voltage Temp. Coefficient		–	0.1	–	%/°C
Breakover Currents	$I_{(BR)1}$ and $I_{(BR)2}$	–	–	200	μamp
Breakover Voltage Symmetry	$\lvert V_{(BR)1}\rvert - \lvert V_{(BR)2}\rvert$	–	–	3.8	Volts

Silicon Asymmetrical AC Trigger

ST4

The ST4 is an asymmetrical AC trigger integrated circuit for use in triac phase controls. This device greatly reduces the snap-on effects that are present in symmetrical trigger circuits and minimizes control circuit hysteresis. This performance is possible with a single RC time constant, whereas a symmetrical circuit of comparable performance would require at least three additional passive components.

The ST4 is available in a two leaded TO98 type in-line epoxy package.



SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.170	.265	4.32	6.73
ϕb2	.016	.019	.406	.483
ϕD	.165	.205	4.19	5.21
E	.110	.155	2.79	3.94
e	.095	.105	2.41	2.67
e1	.045	.055	1.14	1.40
L	.500		12.70	
Q2	.055	.075	1.40	1.90
s	.080	.115	2.03	2.92
L1	.031	.094	.794	2.38

NOTE 1: LEAD DIAMETER IS CONTROLLED IN THE ZONE BETWEEN .070 AND .250 FROM THE SEATING PLANE. BETWEEN .250 AND END OF LEAD A MAX OF .021 IS HELD.

FEATURES

- Reduces Circuit Complexity (Minimum Parts Count)
- Hysteresis–Free Control
- Low Switching Current (80μA)
- Wide Range of Control
- Low Cost Packaging

PERFORMANCE

A typical triac phase-control circuit is shown in figure 1 along with the symmetrical trigger characteristics.

Its main disadvantage is the snap-on hysteresis exhibited in figure 2.

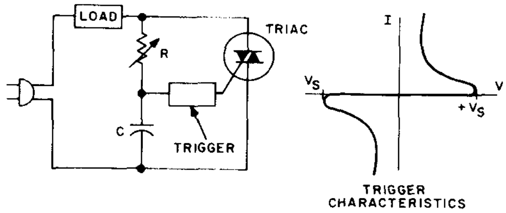


Figure 1. Typical triac phase-control circuit with hysteresis.

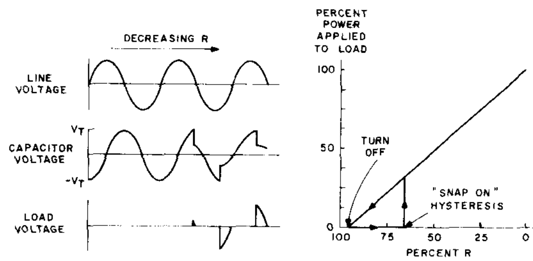


Figure 2. Typical waveforms illustrating hysteresis effect.

Using a lamp dimmer as an example, the light "snaps on" to moderate brightness, although a gradual increase in brightness is both expected and desired. During each half-cycle of AC voltage, the capacitor C is charged through the resistor R and while the trigger is not firing, the capacitor voltage lags line voltage by approximately 90°. However, once the trigger device fires, the capacitor voltage drops as it is discharged into the triac gate. During the next half-cycle, the capacitor voltage will now exceed the breakover voltage sooner since it started charging from a lower voltage. This action results in a large step in the transfer function of figure 2. This snap-on effect can be eliminated with additional circuit components, usually 2 resistors and a capacitor.

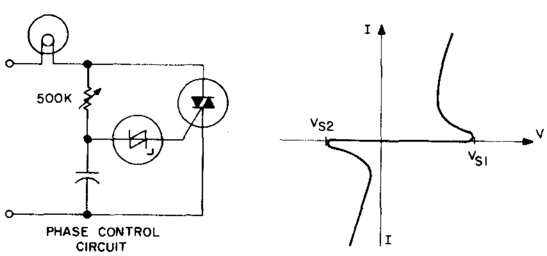


Figure 3. Typical triac phase-control circuit with an asymmetrical switch.

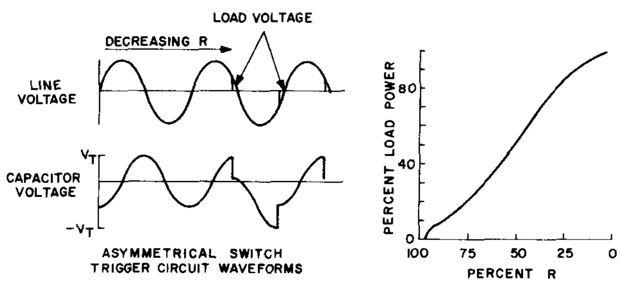


Figure 4. Hysteresis-free, cost-optimized, circuit performance.

A superior and more economical way to eliminate this hysteresis is to use the ST4 trigger device. The ST4 is constructed such that when the device triggers for the first time, the triggering voltage on the next half-cycle is equal to the original breakover voltage plus the voltage decrease due to the capacitor discharge into the triac gate. This allows the capacitor voltage to maintain the same time relationship with line voltage and thus the same firing angle. These concepts are shown graphically in figures 3 and 4.

Further discussion of hysteresis, device operation, and light dimming can be found in:

1. *GE SCR Manual,* chapters 7 & 9. **2.** 200.35 *Using the Triac for the Control of AC Power.* **3.** 200.53 *Solid State Incandescent Lighting Control.*

absolute maximum ratings: (25°C)

CURRENT

I_{21} Continuous . . . . 200 ma

I_{21} Pulsed (PW = 2μs, Duty Cycle ≤ 10%). . . . . 500 ma

I_{12} Pulsed (PW = 2μs, Duty Cycle ≤ 10%). . . . . 175 ma

POWER

Total Average*. . . . . 350 mW

*Derate power 3.5 mW/°C above 25°C

TEMPERATURE

ST4

Operating junction temperature range . . . . −55°C to +125°C

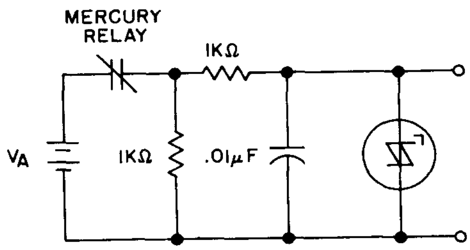
Storage temperature range . . . . −55°C to +150°C

Lead temperature (during soldering) at distance ≥ 1/16 ins. (1.59 mm) from case for 10 sec. max. . . . . 260°C

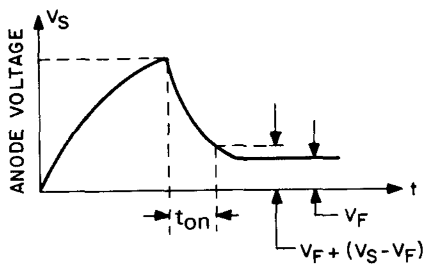
electrical characteristics: (25°C)

Test	Symbol	Min.	Max.	Units	Test Conditions
Switching Voltage	V_{S1}	14	18	Volts	
	V_{S2}	7	9	Volts	
Switching Current	I_{S1}, I_{S2}	–	80	μA	
	I_{S1}, I_{S2}	–	160	μA	$T_A = -55°C$
Voltage Drop	V_{F1}	7	10	Volts	$I_{12} = 100$ mA
	V_{F2}	–	1.6	Volts	$I_{21} = 100$ mA
Off-State Current	I_{12}	–	100	nA	$V_{12} = 10$ Volts
	I_{21}	–	100	nA	$V_{21} = 5$ Volts
Switching Voltage Temperature Coefficient	T.C.	–	.05	%/°C	$T_J = -55°C$ to +125°C
Turn-on Time	t_{on}	–	1	μsec	See Circuit 1
Turn-off Time	t_{off}	–	30	μsec	See Circuit 2
Output Pulse	V_o	3.5	–	Volts	See Circuit 3

Circuit 1
Turn-on Time, t_{on}

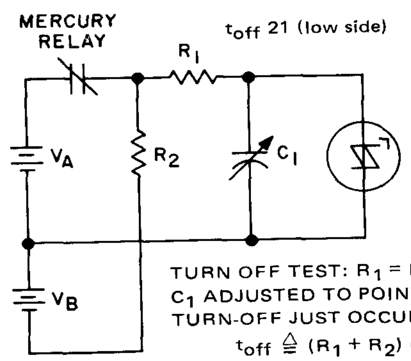


t_{on} 12 (high side) $V_A = 20V$
t_{on} 21 (low side) $V_A = -12V$



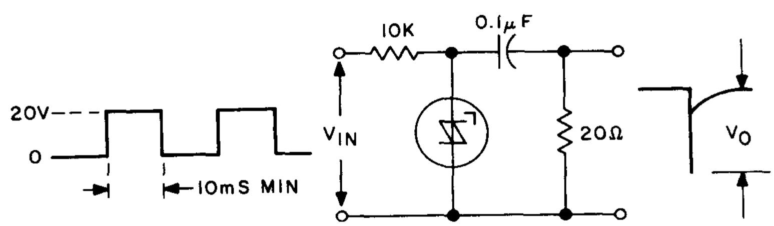
Circuit 2
Turn-off Time, t_{off}

t_{off} 12 (high side) $V_A = 20V$, $V_B = 5V$
t_{off} 21 (low side) $V_A = -12V$, $V_B = -12V$



TURN OFF TEST: $R_1 = R_2 = 500\Omega$
C_1 ADJUSTED TO POINT WHERE TURN-OFF JUST OCCURS
$t_{off} \triangleq (R_1 + R_2)\,C_1$

Circuit 3
Peak Pulse Amplitude, V_o (Both Directions)



ST4

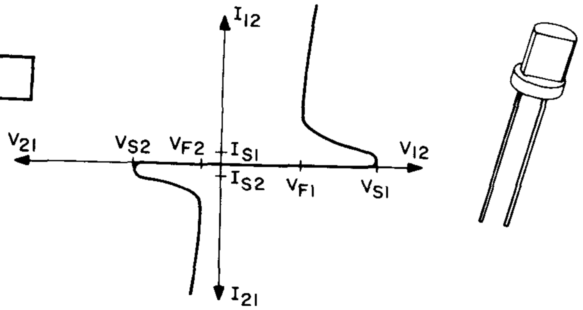


FIGURE 5. ST4 ELECTRICAL CHARACTERISTICS

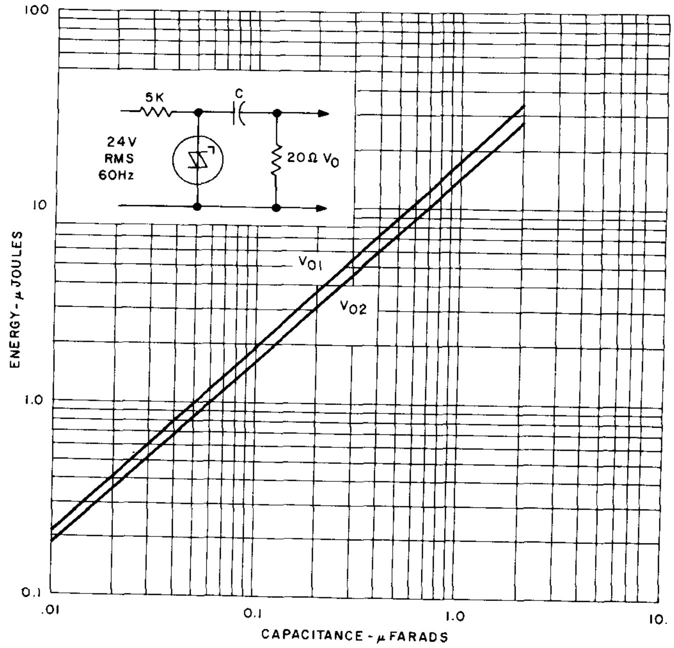


FIGURE 6. CAPACITIVE DISCHARGE ENERGY (PER PULSE) VS. CAPACITANCE (TYPICAL)

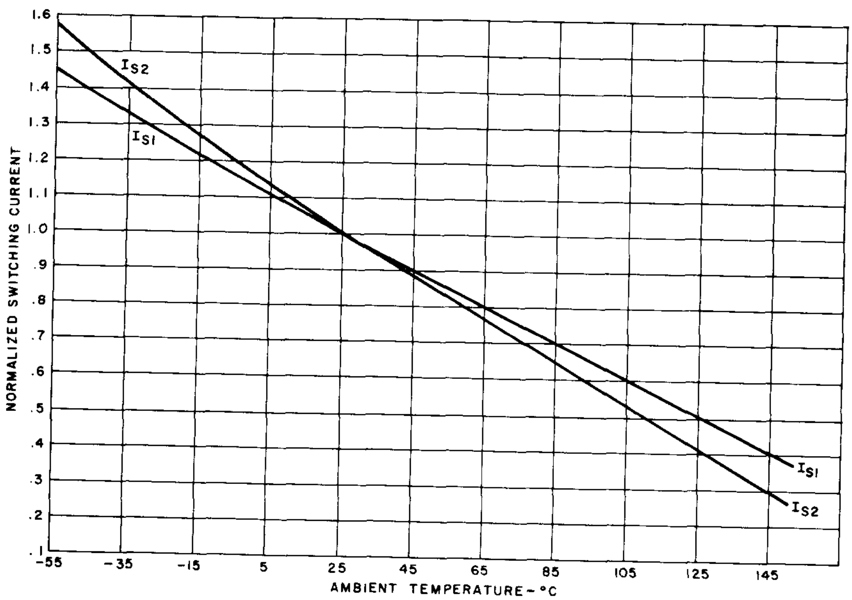


FIGURE 7. SWITCHING CURRENT VARIATION WITH TEMPERATURE (TYPICAL)

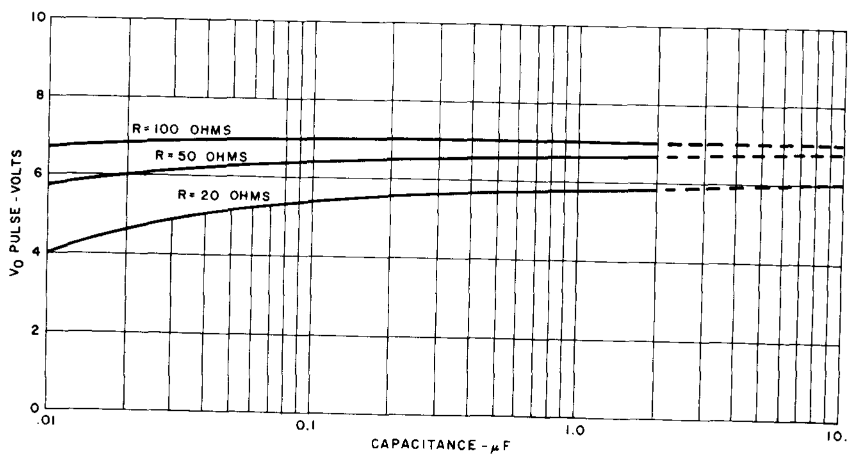


FIGURE 8. OUTPUT PULSE (EITHER DIRECTION) AS A FUNCTION OF LOAD RESISTANCE AND CHARGING CAPACITANCE (TYPICAL)

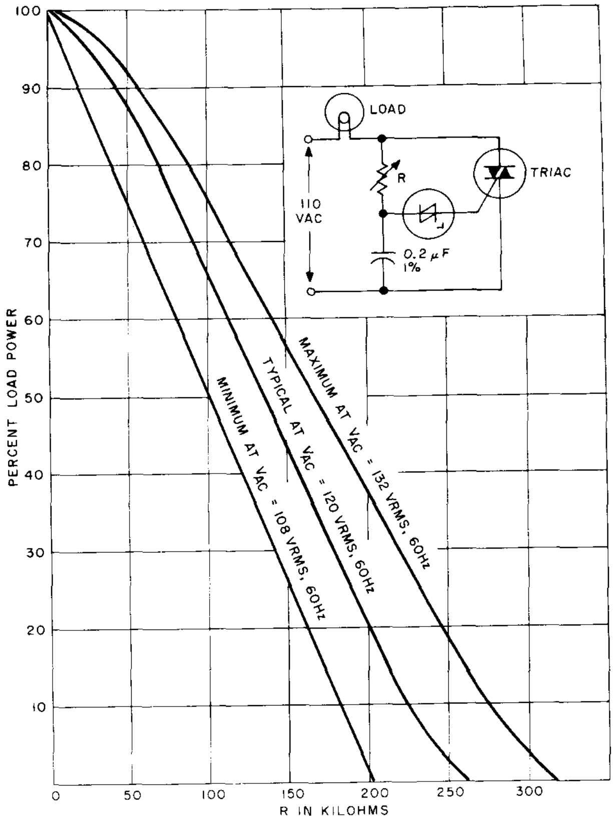


FIGURE 9. OUTPUT POWER TO LOAD VS. CONTROL RESISTOR VALUE (25°C)

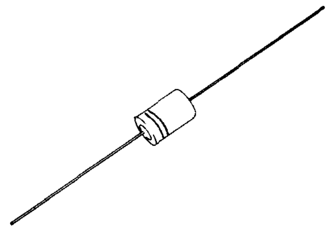
USE THE ST4 ASYMMETRICAL AC TRIGGER WITH A TRIAC SELECTED FROM GE'S COMPREHENSIVE LINE.		
Current Rating	**GE Type**	**Specification Sheet No.**
3A	SC35/36	175.24
6A	SC40/41	175.25
6A	SC240/241	175.16
6/10A	SC141/146	175.15
10A	SC45/46	175.26
10A	SC245/246	175.17
15A	SC50/51	175.27
15A	SC250/251	175.18
25A	SC60/61	175.21

Silicon Diodes

STB567, 8, 9

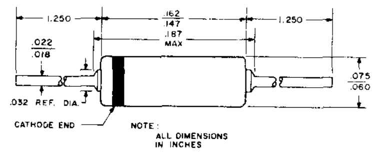
STABISTORS

These low-cost General Electric Stabistors are multi-pellet diodes which have a tightly controlled conductance at $I_F = 10mA$. They consist of 2, 3, or 4 planar passivated epitaxial diode pellets in series, mounted in a subminiature double-heatsink package. The STB567, STB568, and STB569 are examples of such diodes with 2, 3, and 4 pellets respectively. These diodes can be used as low voltage regulator diodes or to maintain a bias on the output transistor of push-pull amplifiers. Multi-Pellet Stabistors maintain LINEAR temperature response (in millivolts per degree C) over the ambient temperature range of −55°C to +175°C. Nominal change in voltage for the STB567, STB568, and STB569 is 4mV, 6mV, and 8mV respectively for each degree C change in ambient temperature.

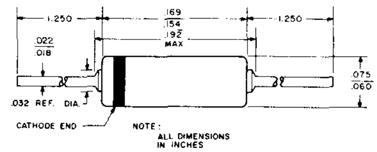


absolute maximum ratings: (25°C) (unless otherwise specified)

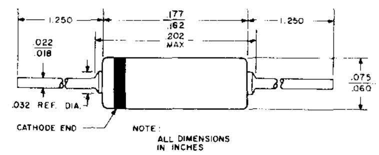
Voltage		
Reverse (continuous)	12	volts
Power		
Dissipation	400	mW
(Derate: 2.67 mW/°C for Ambient Temperature above 25°C)		
Temperature		
Operating	−65 to +175	°C
Storage	−65 to +200	°C
Lead (1/16 ± 1/32 inch from case for 10 sec)	300	°C



STB567



STB568



STB569

NOTES

1. ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

electrical characteristics: (25°C) (unless otherwise specified)

	STB567 Min.	STB567 Max.	STB568 Min.	STB568 Max.	STB569 Min.	STB569 Max.	
Forward Voltage* $I_F = 10mA$	1.31	1.61	2.09	2.31	2.72	3.01	Volts
Breakdown Voltage $I_R = 5\mu A$	12		12		12		Volts

***Forward Voltage Tolerances:**

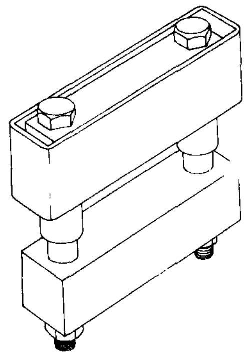
STB567	1.46 ± 10%
STB568	2.20 ± 5%
STB569	2.87 ± 5%

Press Pak Mounting Clamp

SERIES 1000

800 LBS. / 3.52 KN } CLAMP FORCE

The General Electric Company now offers the Series 1000, Press Pak, Mounting Clamp designed to facilitate single or double-side cooling of the ½" GE Press Pak's.

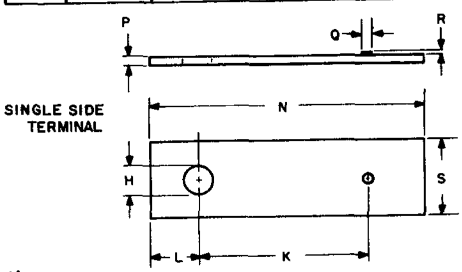


Special features of this clamp:

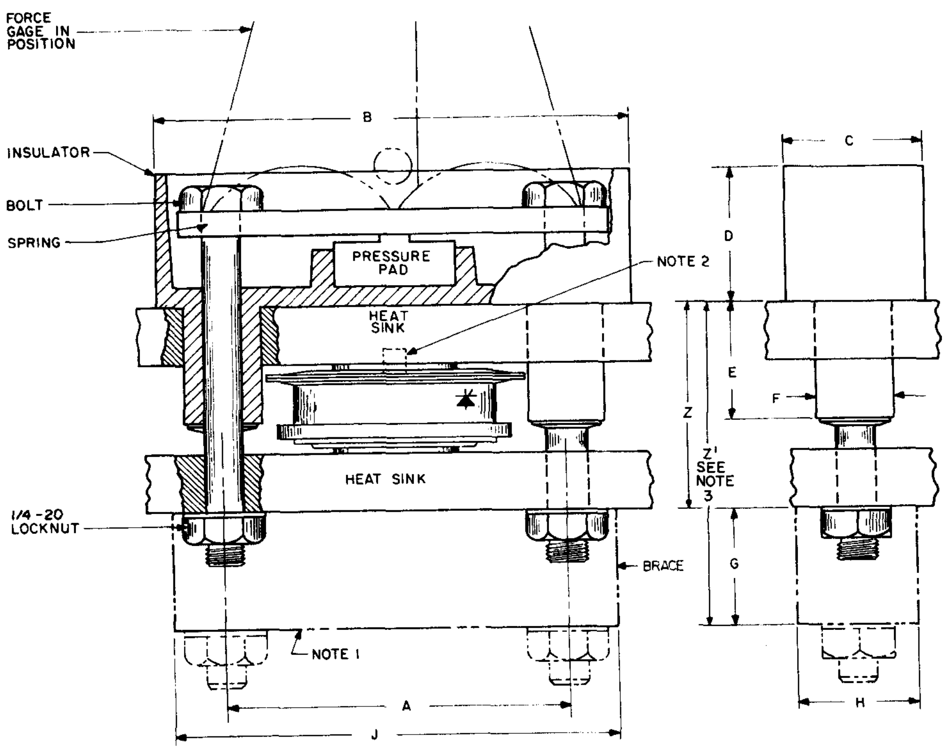
- *Hardened Steel pivot* insuring *constant pressure* in rugged applications over long periods.
- One-piece phenolic insulator gives added 1/2" creep distance.
- Use of special *Force Indicator Gauge eliminates* need for torque wrenches, inaccurate "flex" gauges, and *guesswork.*
- Various bolt lengths available to accommodate most mounting situations.
- No loose parts to complicate assembly.
- Stiffening *brace* to reinforce heat sink available upon request.
- Single-side cooling terminal available upon request.
- Positive, non-binding swivel action.

TABLE I DIMENSIONS

	INCHES		MM	
DIM.	MIN.	MAX.	MIN.	MAX.
A	2.115	2.135	53.72	54.23
B	2.935	2.965	74.54	75.31
C	.865	.885	21.97	22.48
D	.825	.855	20.95	21.72
E	.730	.770	18.54	19.56
F	.460	.480	11.68	12.19
G	.735	.765	18.66	19.43
H	.735	.765	18.66	19.43
J	2.710	2.790	68.83	70.87
K	2.177	2.197	55.30	55.79
L	.605	.645	15.37	16.37
M	.380	.392	9.66	9.95
N	3.480	3.520	88.40	89.40
P	.090	.095	2.29	2.40
Q	.125	.135	3.18	3.42
R	.025	.035	.64	.88
S	.980	1.020	24.90	25.90



OUTLINE DRAWING



Notes:

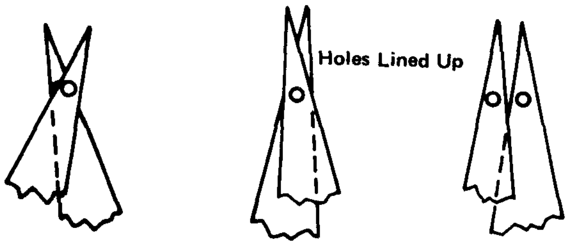
1. The back up brace should be used when the mounting web of the heatsink is not sufficiently thick to prevent the heatsink from bending when the clamp is tightened. Extruded aluminum heatsinks with mounting webs less than 1/4 require this brace.
2. The semiconductor device to be mounted must be positively located in the center of the clamp. A 1/8 diameter by 1/4 long grooved or spring pin is recommended for locating the device. Use a #30 drill (.1285 diameter) for the hole in the heatsink.
3. When using brace add 3/4" to required "Z" dimension to accommodate brace thickness.
4. Minimum heatsink web thickness should be 5/16" to insure positive pressure.

MOUNTING PROCEDURE

With the semiconductor positively located in place on the heatsink(s) (refer to Note 1 of Table I), place the clamp in position with the bolts through the holes in the heatsink(s), and proceed as follows:

1. Refer to Device Specification Sheet for Preparation of Mounting Surface.
2. Tighten the nuts evenly until finger tight.
3. Tighten each bolt ½ turn, using a 7/16 socket wrench on the bolt heads.
4. Place the Force Indicator Gauge firmly against the springs, as shown on the Outline Drawing, so that both ends and the middle are in solid contact with the springs. The holes of the gauge will then indicate the spring deflection, or force; correct mounting force is indicated when the holes coincide.

Examples:



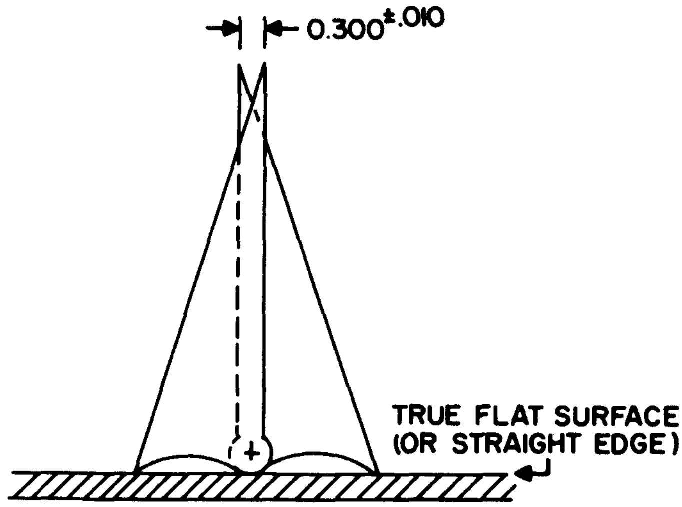
Less then rated force. Tighten nuts alternately ¼ turn at a time until points coincide.

Correct force.

Excessive force. Loosen nuts and start over. *NEVER* try to adjust spring force by backing off the nuts, spring friction will produce false readings. Always start at Step 1.

To Calibrate Force Gauge:

If the gauge is suspected of being out of calibration due to wear or damage, check it on a flat surface as shown below.



If the points are not 0.300 ± .010 apart, calibrate the gauge by filing the bottom contact points.

ORDERING INSTRUCTIONS

In order to select the proper clamp for a given application, it is necessary to know three mounting parameters:

- The correct force necessary to mount the semiconductor device.
- The length of the bolts necessary to span dimension "Z".
- The capability of the sink to withstand the mounting force without bending (refer to Note 1 of Table I)

Knowing these parameters, the proper clamp may be selected from Table II.

TABLE II – CLAMP SELECTION CHART

GE Device Type[4]	# Springs	Recommended Mounting Force	Clamp Force	Allowable "Z"[1] Dimension (inches)	Bolt Length (inches)	Order Number[2,3]
C350, C354 C355, C358 C380, C385 A390, A396	1	700-900 (Lb.) 3.1-4.0 (KN)	700-900 (Lb.) 3.1-4.0 (KN)	.800-1.175	2.00	HW1000G101
				.900-1.425	2.25	HW1000G102
				1.150-1.675	2.50	HW1000G103
				1.250-1.925	2.75	HW1000G104
				1.500-2.175	3.00	HW1000G105

Phenolic temperature beyond 125°C and spring temperature above 110°C is not permissible.
Minimum heatsink web thickness should be 5/16" to insure positive pressure.

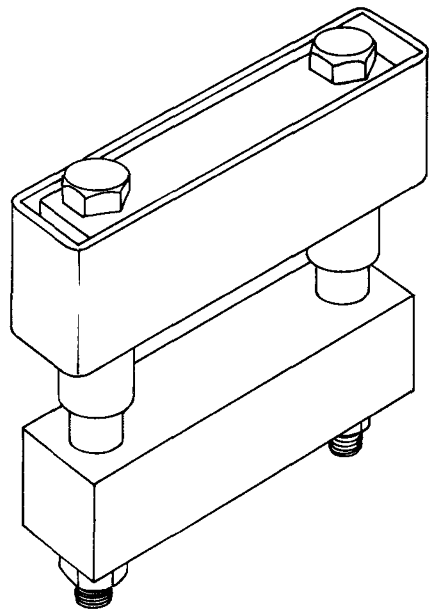
1. Refer to Outline Drawing and to Note 3 of Table I for determination of "Z" dimension.
2. If a brace is required, add suffix "B" to the order number, e.g. HW1000G101B.
3. If a terminal is required (used with single side cooling), add the letter "T" to the order number, e.g. HW1000G101BT.
4. All group numbers or bolt lengths can be used with any device types.

Press Pak
Mounting Clamp

SERIES 2500

2500 LBS. / 11 KN } CLAMP FORCE

The General Electric Company now offers the Series 2500, Press Pak, mounting clamp designed to facilitate single-, or double-side cooling of all GE Press Pak's.

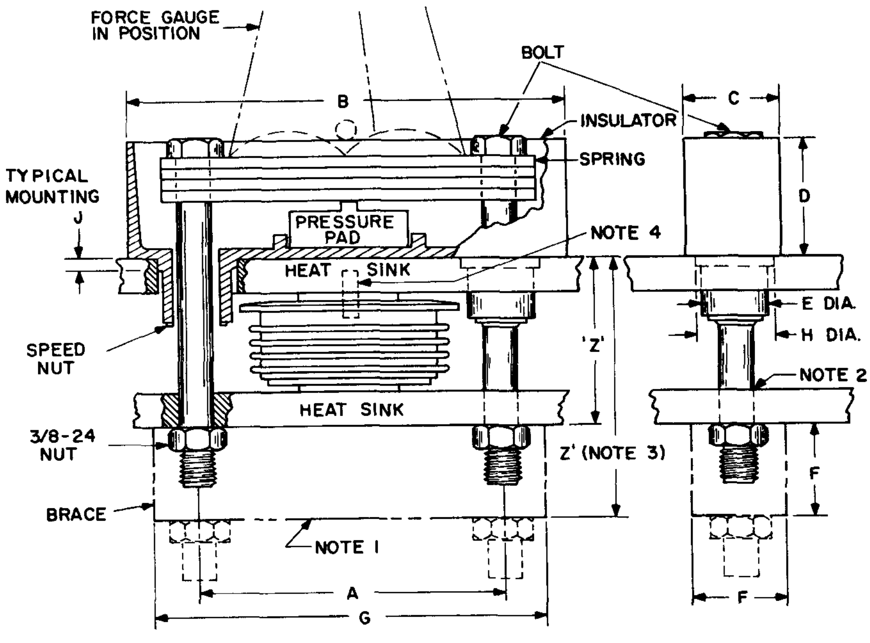


Special features of this clamp:

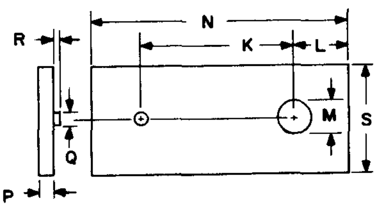
- Metal pivot insuring constant pressure in rugged applications over long periods.
- One-piece phenolic insulator gives 1" nominal creep distance.
- Use of special *Force Indicator Gauge* eliminates need for torque wrenches, inaccurate "flex" gauges, and *guesswork*.
- Various bolt lengths available to accommodate most mounting situations.
- No loose parts to complicate assembly.
- Stiffening *brace* to reinforce heat sink *available upon request.*
- *Single-side cooling terminal available upon request.*
- Positive, non-binding swivel action.

OUTLINE DRAWING

	INCHES		MM	
DIM.	MIN.	MAX.	MIN.	MAX.
A	3.095	3.105	78.6	79.0
B	—	4.520	—	114.5
C	—	1.000	—	25.4
D	1.230	1.270	31.2	32.2
E	.680	.700	17.28	17.77
F	—	1.000	—	25.4
G	3.940	4.060	100.0	103.1
H	.850	.860	21.60	21.83
J	.110	.140	2.80	3.55
K	2.177	2.197	55.30	55.79
L	.605	.645	15.37	16.37
M	.380	.392	9.66	9.95
N	3.480	3.520	88.40	89.40
P	.090	.095	2.29	2.40
Q	.125	.135	3.18	3.42
R	.025	.035	.64	.88
S	1.230	1.270	31.25	32.25



SINGLE SIDE TERMINAL



NOTES:

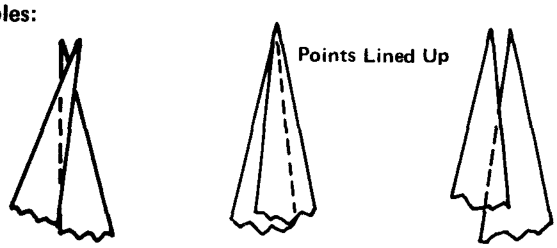
1. The backup brace should be used when the mounting web of the heatsink is not sufficiently thick to prevent the heatsink from behding when the clamp is tightened. Extruded aluminum heatsinks with mounting webs less than 3/8" thick require this brace in order to withstand the full 2500 lbs. mounting force. Refer to **MOUNTING PROCEDURE** for complete mounting instructions.
2. **Heatsink A:** Drill .890, + .020, – .000 holes on 3.1" ± .010 centers.·Countersink holes approx. .015 x 45° on clamp insulator side.
   Heatsink B: Drill .437 ± .005 holes on 3.100 ± .010 centers.
3. When a brace is used, the "Z" dimension includes the one inch thickness of the brace. Refer to Table 11 for selection of the proper bolt length.
4. The semiconductor device to be mounted must be positively located in the center of the clamp. A 1/8" diameter by 1/4" long grooved or spring pin is recommended for locating the device: Use a No. 30 drill (0.1285" diameter) for the hole in the heatsink.

MOUNTING PROCEDURE

With the semiconductor positively located in place on the heatsink(s) (refer to Note 4 of Table 1), place the clamp in position with the bolts through the holes in the heatsink(s), and proceed as follows:

1. Refer to Device Specification Sheet for Preparation of Mounting Surface.
2. Tighten the nuts evenly until finger tight.
3. Tighten bolts 2½ turns each, using a 9/16 socket wrench on the bolt heads.
4. Place the Force Indicator Gauge firmly against the springs, as shown on the Outline Drawing, so that both ends and the middle are in solid contact with the springs. The upper points of the gauge will then indicate the spring deflection, or force; correct mounting force is indicated when the points coincide.

Examples:



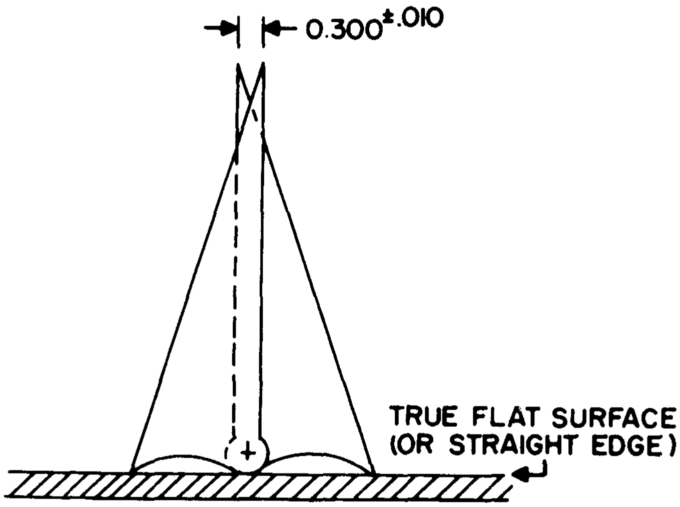
Less than rated force. Tighten nuts alternately 1/4 turn at a time until points coincide.

Correct force.

Excessive force. Loosen nuts and start over. *NEVER* try to adjust spring force by backing off the nuts, spring friction will produce false readings. Always start at Step. 1.

To Calibrate Force Gauge:

If the gauge is suspected of being out of calibration due to wear or damage, check it on a flat surface as shown below.



If the points are not 0.300 ± .010 apart, calibrate the gauge by filing the bottom contact points.

ORDERING INSTRUCTIONS

In order to select the proper clamp for a given application, it is necessary to know three mounting parameters:

- The correct force necessary to mount the semiconductor device.
- The length of the bolts necessary to span dimension "Z".
- The capability of the sink to withstand the mounting force without bending (refer to Note 1 of Table I).

Knowing these parameters, the proper clamp may be selected from Table II.

TABLE II – CLAMP SELECTION CHART

GE Device Type(4)	Recommended Mounting Force	Clamp Force	Allowable "Z"(1) Dimension (inches)	Bolt Length (inches)	Order Number(2,3)
C387, C388			1.375-2.125	3.50	HW2500G77
C397, C398			1.875-2.625	4.00	HW2500G78
C395	2000-2500 (Lbs.) 8.9 – 11.0 (KN)	2200-2400 (Lbs.) 9.8 – 10.6 (KN)	2.375-3.125	4.50	HW2500G79
C500 Family			3.375-4.125	5.50	HW2500G82
A500 Family			5.375-6.125	7.50	HW2500G83

Phenolic temperature beyond 125°C and spring temperature above 110°C is not permissable.

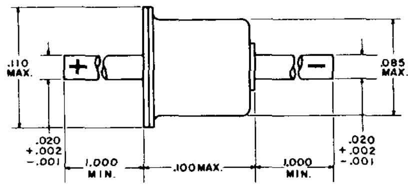
1. Refer to Outline Drawing and to Note 3 of Table I for determination of "Z" dimension.
2. If a brace is required, add suffix "B" to the order number, e.g. HW2500G72B.
3. If a terminal is required (used with a single side cooling), add the letter "T" to the order number, e.g. HW2500G72BT.
4. All group numbers or bolt lengths can be used with any device types.

Germanium
Tunnel Diodes

TYPE TD-9

The General Electric TD-9 is a Germanium Tunnel Diode offering a peak current of 500 μa. This device, which makes use of the quantum mechanical tunneling phenomenon to obtain a negative conductance characteristic, is designed for converter, small signal, low level switching and logic applications. This device is housed in General Electrics new hermetically sealed subminiature axial package.

AXIAL DIODE OUTLINE



ALL DIMENSIONS IN INCHES.
DIMENSIONS ARE REFERENCE UNLESS TOLERANCED.

ABSOLUTE MAXIMUM RATINGS

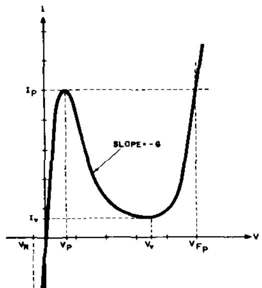
Forward Current* I_F	2.5 ma
Reverse Current* I_R	5 ma
Storage Temperature T_{STG}	-55^oC to $+100^oC$
Lead Temperature	
1/16" ± 1/32" from case for 10 sec	260^oC

* Derate maximum currents 1%/°C above 25°C

ELECTRICAL CHARACTERISTICS: (25°C)

Static Characteristics:

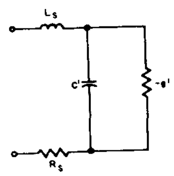
		Min	Typ	Max	Units
Peak Point Current	I_P	450	500	550	μa
Valley Point Current	I_V		60	100	μa
Peak Point Voltage	V_P		65		mv
Valley Point Voltage	V_V		350		mv
Forward Voltage (I_F=I_P Typ)	V_{FP}		500		mv
Reverse Voltage (I_R=I_P Typ)	V_{RP}		20	40	mv



TYPICAL STATIC CHARACTERISTIC CURVE

Dynamic Characteristics:

		Typ	Max	Units
Total Series Inductance	L_S	0.5		nh
Total Series Resistance	R_S	2.5	6.0	ohm
Valley Point Capacitance	C	2.5	5.0	pf
Max. Terminal Neg. Cond.	-G	4		$x10^{-3}$mho
Resistive Cutoff Freq.	f_{ro}	2.5		kmc
Self Resonant Freq.	f_{ro}	4.5		kmc
Frequency of Oscillation	f_{osc}	4.5		kmc



EQUIVALENT CIRCUIT (BIASED IN NEGATIVE CONDUCTANCE REGION)

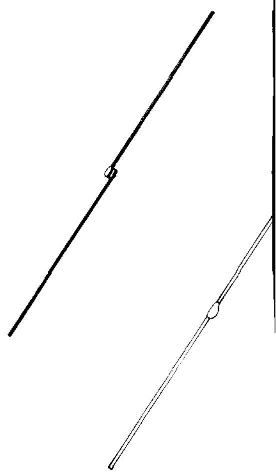
TUNNEL DIODE SYMBOL

$$fro = \frac{|g'|}{2\pi C'}\sqrt{\frac{1}{Rs\,|g'|} - 1} \qquad fxo = \frac{1}{2}\sqrt{\frac{1}{LsC'} - \left(\frac{|g'|}{C}\right)^2} \qquad fosc = \frac{1}{2\pi}\sqrt{\frac{1}{LsC} - \left(\frac{Rt}{L-}\right)^2}$$

Germanium Diodes

TYPE	
TD261,A	TD271,A
TD262,A	TD272,A
TD263,A,B	TD273,A,B
TD264,A	TD274,A
TD265,A	TD275,A
TD266,A	TD276,A

The General Electric TD261,A through TD266A series of tunnel diodes are extremely fast, P-Type germanium devices with peak currents of 2.2, 4.7, 10, 22, 50 and 100 ma. Among the unusual features offered by these tunnel diodes are high I_P/I_V ratios and C/I_P ratios as low as 0.025 pf/ma. New manufacturing techniques provide a high temperature tunnel diode capable of 100°C storage and operation resulting in high reliability performance. Types TD271,A through TD276,A are built in a special microwave package which has electrical characteristics of the TD260 line with a series inductance of .15 mh. Specially selected units offering parameter variations or tighter control are also available.



absolute maximum ratings: (25°C)

	TD261 TD261A TD271 TD271A	TD262 TD262A TD272 TD272A	TD263 TD263A TD263B TD273 TD273A TD273B	TD264 TD264A TD274 TD274A	TD265 TD265A TD275 TD275A	TD266 TD266A TD276 TD276A	
Maximum Power Dissipation	1.5	3.5	7	7.5	18	35	mw
Operating and Storage Temperature	←		−55 to +100°C			→	°C
Lead Temperature 1/16" ± 1/32" from case for 10 seconds	←		230			→	°C

*Derate maximum forward current 1% per °C for ambients in excess of 25°C.

electrical characteristics: (25°C)

COLOR DOT**		BROWN TD261 TD271 Min.	Typ.	Max.	BROWN/GRAY TD261A TD271A Min.	Typ.	Max.	RED TD262 TD272 Min.	Typ.	Max.	RED/GRAY TD262A TD272A Min.	Typ.	Max.	
Peak Point Current	I_P	2.0	2.2	2.4	2.0	2.2	2.4	4.2	4.7	5.2	4.2	4.7	5.2	ma
Valley Point Current	I_V		.20	.31		.22	.31		.45	.60		.45	.60	ma
Peak Point Voltage	V_P		70	100		80	110		80	110		90	120	mv
Valley Point Voltage	V_V		390			390			390			400		mv
Forward Voltage														
($I_F = I_P$)	V_{FP}*	500	540	650	500	580	650	500	560	650	500	575	650	mv
($I_F = .25\ I_P$)	V_{FS}	420	500		420	500		435	510		435	530		mv
Total Series Inductance														
TD260	L_S		1.5			1.5			1.5			1.5		nh
TD270	L_S		.15			.15			.15			.15		nh
Total Series Resistance	R_S		5			7			3.5			4.0		ohm
Valley Point Terminal Capacitance	C_V		1.8	3.0		0.65	1.0		2.8	6.0		0.65	1.0	pf
Rise Time	t_r***		430			160			320			74		Psec

*Max V_{FP} on TD270 devices is 675 mv

**TD270 series marked with white cathode dot only

***Switching speed with constant current drive, $t_r \approx \frac{V_{FP} - V_P}{I_P - I_V} C_V$

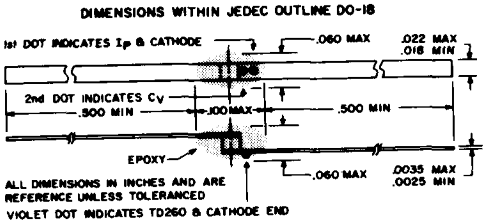
TD261,A – 66,A	TD271,A – 76,A
TD263,B	TD273,B

electrical characteristics: (25°C)

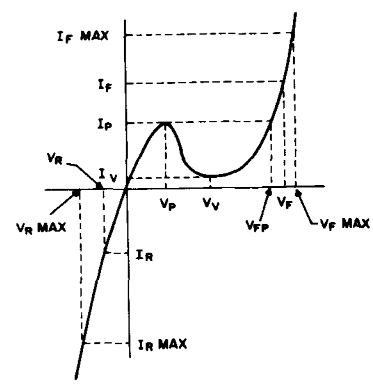
COLOR DOT**		ORANGE TD263 TD273			ORANGE/GRAY TD263A TD273A			ORANGE/WHITE TD263B TD273B			YELLOW TD264 TD274			YELLOW/GRAY TD264A TD274A			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Point Current	I_P	9.0	10	11	9.0	10	11	9.0	10	11	20	22	24	20	22	24	ma
Valley Point Current	I_V		0.9	1.4		0.9	1.4		0.9	1.4		2.7	3.1		2.7	3.1	ma
Peak Point Voltage	V_P		75	100		80	110		90	120		90	115		100	130	mv
Valley Point Voltage	V_V		400			410			420			425			425		mv
Forward Voltage																	
($I_F = I_P$)	V_{FP}*	500	560	650	520	570	650	550	600	670	500	580	650	550	610	680	mv
($I_F = .25\ I_P$)	V_{FS}	450	510		450	530		450	540			520		460	540		mv
Total Series Inductance																	
TD260	L_S		1.5			1.5			1.5			1.5			1.5		nh
TD270	L_S		.15			.15			.15			.15			.15		nh
Total Series Resistance	R_S		1.7			2.0			2.5			1.8			2.0		ohms
Valley Point Terminal Capacitance	C_V		6.5	9.0		3.5	5.0		1.2	2.0		7.0	18		2.5	4.0	pf
Rise Time	t_r***		350			190			68			185			64		Psec

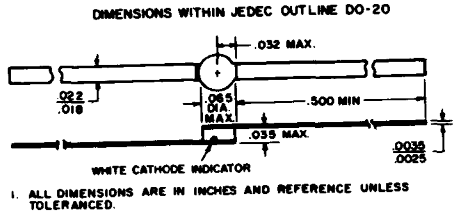
electrical characteristics: (25°C)

COLOR DOT**		GREEN TD265 TD275			GREEN/GRAY TD265A TD275A			BLUE TD266 TD276			BLUE/GRAY TD266A TD276A			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Peak Point Current	I_P	45	50	55	45	50	55	90	100	110	90	100	110	ma
Valley Point Current	I_V		6.0	8.5		6.0	8.5		12.0	17.5		12.0	17.5	ma
Peak Point Voltage	V_P		110	180		130	200		150	210		180	260	mv
Valley Point Voltage	V_V		425			425			450			450		mv
Forward Voltage														
($I_F = I_P$)	V_{FP}	520	625	700	550	640	750	520	650	720	550	680	800	mv
($I_F = .25\ I_P$)	V_{FS}		530		480	550			530		500	550		mv
Total Series Inductance														
TD260	L_S		1.5			1.5			1.5			1.5		nh
TD270	L_S		.15			.15			.15			.15		nh
Total Series Resistance	R_S		1.4			1.5			1.1			1.2		ohms
Valley Point Terminal Capacitance	C_V		8.5	25		3.0	5.0		10.0	35		4.0	6.0	pf
Rise Time	t_r***		100			35			57			22		Psec



TD260 SERIES





TD270 SERIES

GE-MOV®

Metal Oxide Varistors

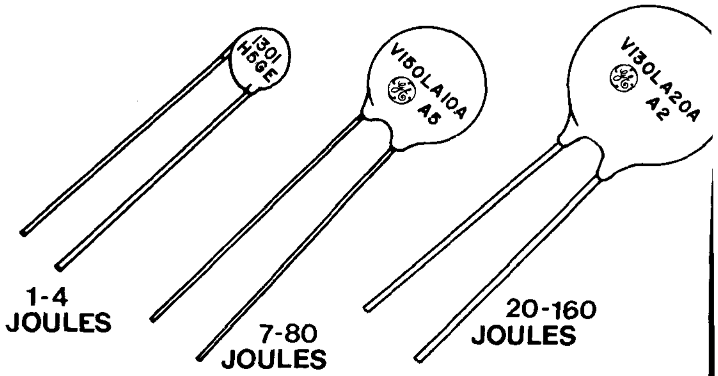
RATINGS OF 130-1200 VOLTS D.C., 95-1000 VOLTS RMS, 1-160 JOULES

SERIES L

Description:

GE-MOV® zinc oxide varistors are voltage dependent, symmetrical resistors which perform in a manner similar to back-to-back zener diodes in circuit protective functions and offer advantages in performance and economics.

When exposed to high energy voltage transients, the varistor impedance changes from a very high standby value to a very low conducting value thus clamping the transient voltage to a safe level. The dangerous energy of the incoming high voltage pulse is absorbed by the GE-MOV® varistor, thus protecting your voltage sensitive circuit components.

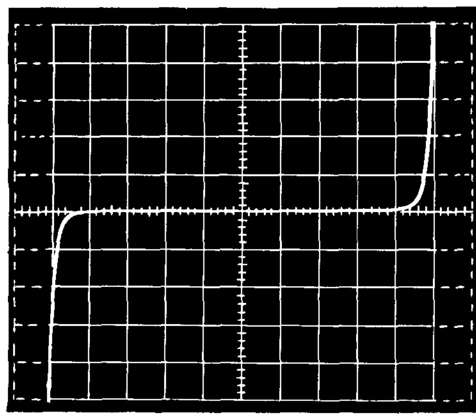


Replacement For:

- Zener Diodes
- Silicon Carbide
- Selenium Thyrectors
- R-C Networks (non dv/dt)

Features:

- Excellent Clamping
- High Transient Current Capability (4000 Amperes)
- Nanosecond Response
- High Energy Capability
- Wide Operating Temperature Range
- Low Temperature Coefficient
- Low Standby Drain
- Compact and Lightweight



I-V Oscillograph
(Actual Photo)

Model Number Nomenclature:

V 130 LA 10 A

- V — GENERAL ELECTRIC GE-MOV® VARISTOR
- 130 — RMS APPLIED VOLTAGE
- LA — PRODUCT **SERIES**
- 10 — PULSE ENERGY RATING (JOULES)
- A — SELECTION **(A or B)**

Benefits:

- Improves Circuit, Component and System Reliability
- Extends Contact Life
- Reduction of Lightning Effects
- Promotes System Cost Reduction
- Reduces System Size and Weight Requirements
- Increases Product Safety
- No Follow-On Current

Maximum Electrical Ratings:

Maximum Energy, Power and Peak Current	See Rating Table
Storage Temperature, T_{STG}	-40°C to +125°C
Operating Surface Temperature, T_S	115°C
Operating Ambient Temperature (Without Derating)	85°C
Maximum Voltage Temperature Coefficient	-0.05%/°C

Mechanical Ratings:

Insulation Resistance — Megohms	>1000
Hipot Encapsulation — Volts D.C. for 1 Minute	2500
Solderability	Per Mil Std 202E Method 208C

MODEL NUMBER(6)	MODEL SIZE (2)	MAXIMUM RATINGS — STEADY STATE (1): RMS (3) APPLIED VOLTAGE	RECURRENT (3) PEAK IDLE VOLTAGE	DC APPLIED VOLTAGE	TRANSIENT: ENERGY	AVERAGE POWER DISSIPATION	PEAK(4) PULSE CURRENT	CHARACTERISTICS — VARISTOR PEAK (5) VOLTAGE @ 1mA AC PEAK: MIN	MAX	TYPICAL CAPACITANCE f = .1 – 1MHz
		VOLTS	VOLTS	VOLTS	JOULES	WATTS	AMPS	VOLTS	VOLTS	PICOFARADS
V95LA7_	2	95	134	130	7	0.45	2000	134	191	1250
V130LA1 V130LA2	1	130	184	175	1 2	0.24	400	184	273	250
V130LA10_ V130LA20_	2 3	130	184	175	10 20	0.5 0.85	2000 4000	184	254	1000 1900
V150LA1 V150LA2	1	150	212	200	1 2	0.24	400	212	301	150
V150LA10_ V150LA20_	2 3	150	212	200	10 20	0.5 0.85	2000 4000	212	282	800 1600
V250LA2 V250LA4	1	250	354	330	2 4	0.28	400	354	509	110
V250LA15A V250LA20_ V250LA40_	2 2 3	250	354	330	15 20 40	0.6 0.9	2000 2000 4000	354	472	500 500 1000
V275LA2 V275LA4	1	275	389	375	2 4	0.28	400	389	579	100
V275LA15A V275LA20_ V275LA40_	2 2 3	275	389	369	15 20 40	0.6 0.6 0.9	2000 2000 4000	389	522	450 450 900
V300LA2 V300LA4	1	300	424	405	2 4	0.28	400	420	607	90
V320LA15A V320LA20_ V320LA40_	2 2 3	320	452	420	15 20 40	0.6 0.6 0.9	2000 2000 4000	462	635	380 380 750
V420LB20_ V420LB40_	2 3	420	595	560	20 40	0.6 0.9	2000 4000	610	800	300 600
V460LB20_ V460LB40_	2 3	460	650	615	20 40	0.6 0.9	2000 4000	640	878	270 540
V480LB20A V480LB40_ V480LB80_	2 2 3	480	679	640	20 40 80	0.6 0.7 1.0	2000 2000 4000	670	914	260 260 520
V510LB20A V510LB40_ V510LB80_	2 2 3	510	721	675	20 40 80	0.6 0.7 1.0	2000 2000 4000	735	970	240 240 470
V550LB20A V550LB40_ V550LB80_	2 2 3	550	778	700	20 40 80	0.6 0.7 1.0	2000 2000 4000	775	1060	230 230 450
V575LB20A V575LB40_ V575LB80_	2 2 3	575	813	730	20 40 80	0.7 0.8 1.1	2000 2000 4000	805	1115	215 215 425
V1000LB80_ V1000LB160_	2 3	1000	1414	1200	80 160	0.9 1.3	2000 4000	1425	1900	130 260

(1) Steady State defined as the normal input conditions existing when no transients are present.
(2) Relative size only (See "Dimensions Table").
(3) Sinusoidal voltage assumed as normal input conditions. If nonsinusoidal wave input is present, peak voltage input values should be used to select model.
(4) See Figure 18, 19, 20.
(5) 1mA standby current based upon 60Hz sinusoidal input.
(6) (–) indicates (A or B) selection. See Figure 1-15.

MAXIMUM VOLT-AMPERE CHARACTERISTICS

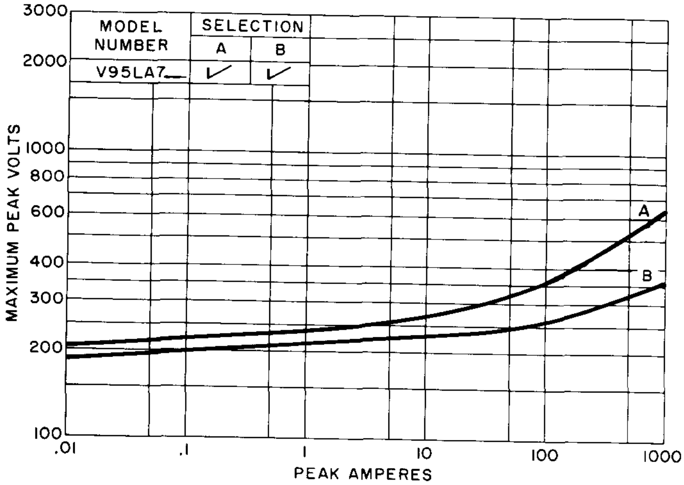


FIGURE 1

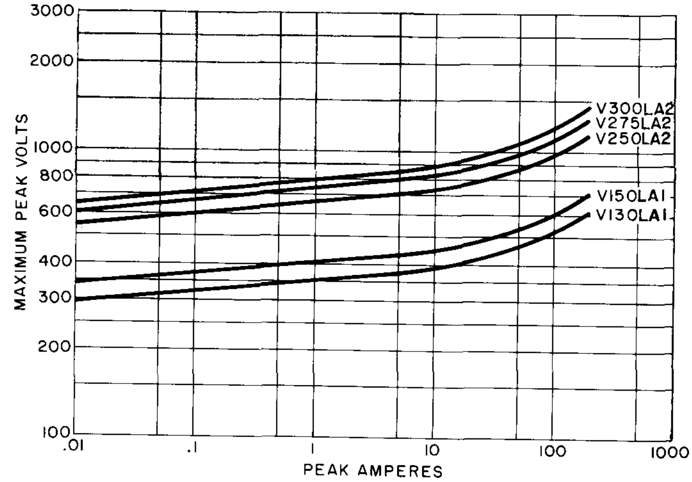


FIGURE 2

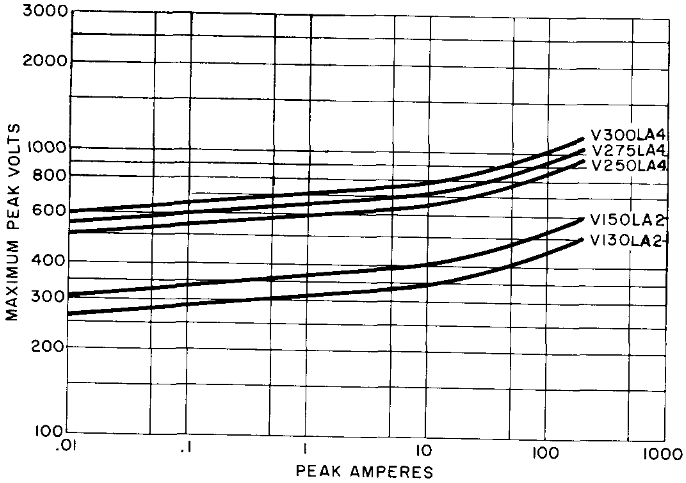


FIGURE 3

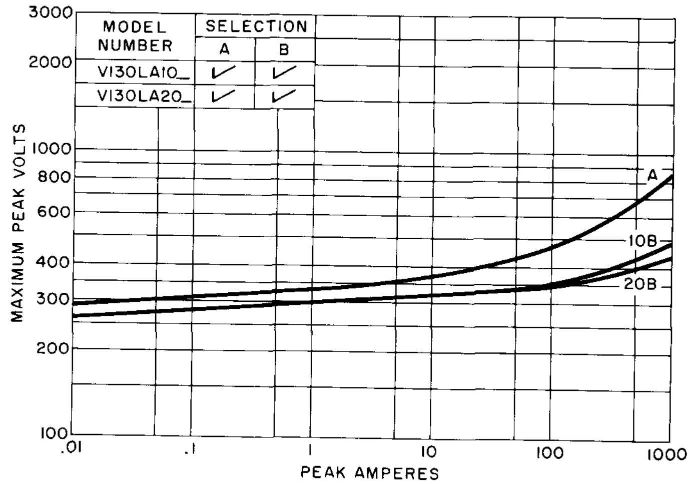


FIGURE 4

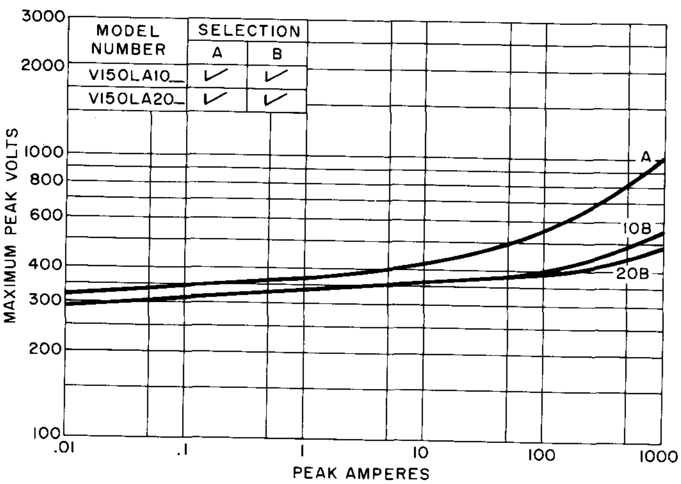


FIGURE 5

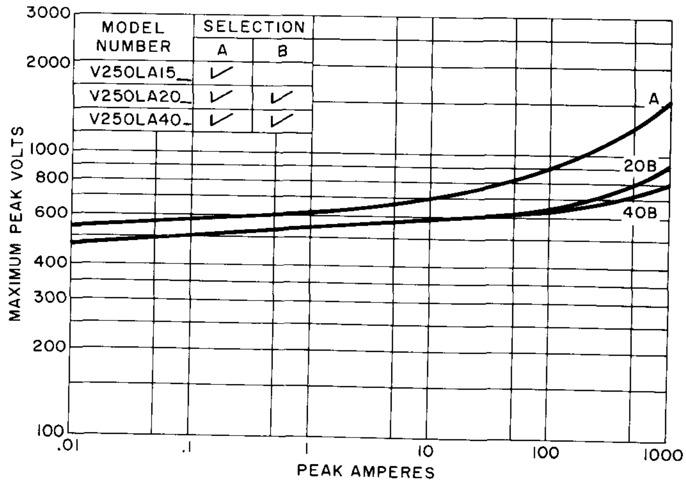
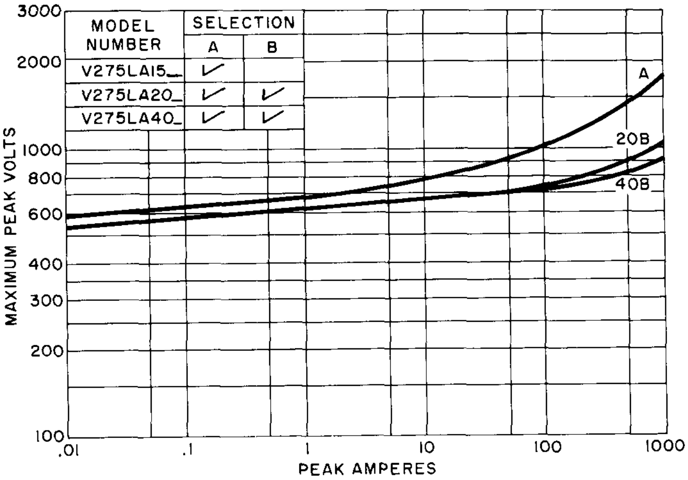


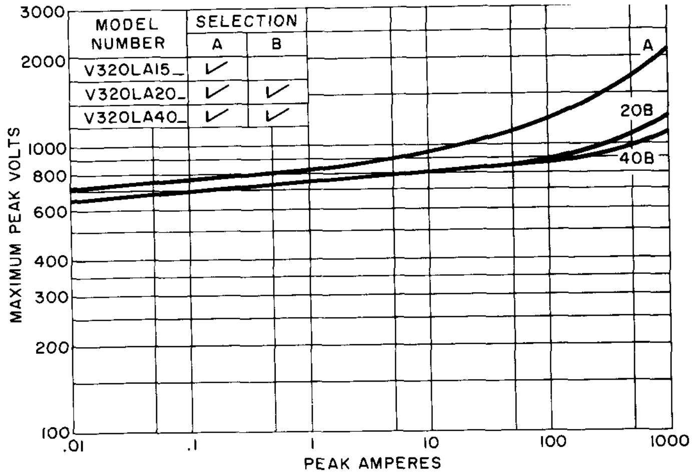
FIGURE 6

MAXIMUM VOLT-AMPERE CHARACTERISTICS



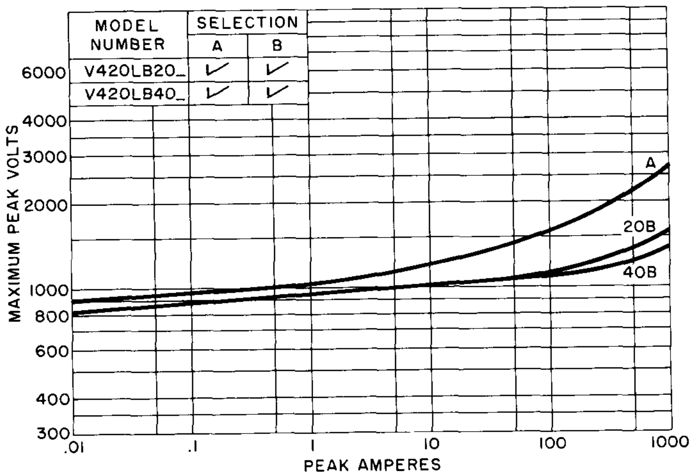
MODEL NUMBER	SELECTION A	SELECTION B
V275LA15_	✓	
V275LA20_	✓	✓
V275LA40_	✓	✓

FIGURE 7



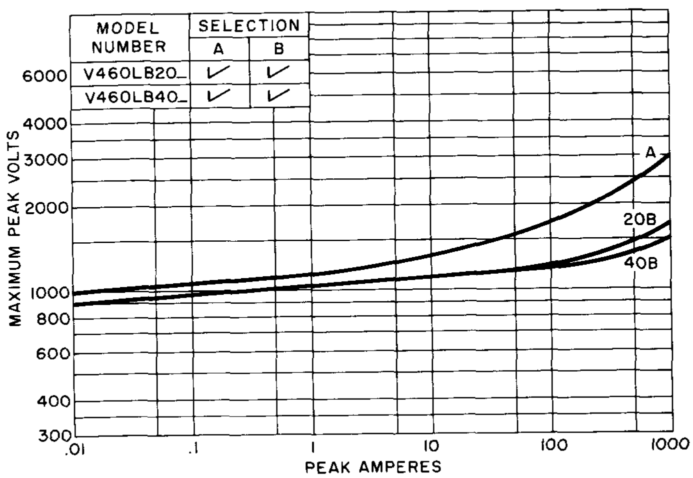
MODEL NUMBER	SELECTION A	SELECTION B
V320LA15_	✓	
V320LA20_	✓	✓
V320LA40_	✓	✓

FIGURE 8



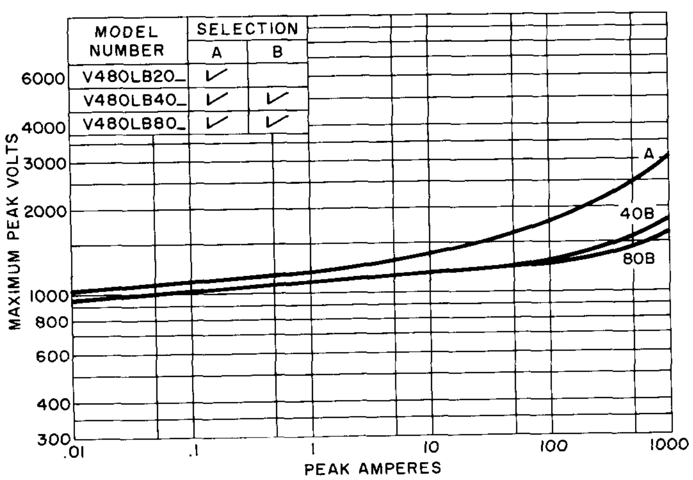
MODEL NUMBER	SELECTION A	SELECTION B
V420LB20_	✓	✓
V420LB40_	✓	✓

FIGURE 9



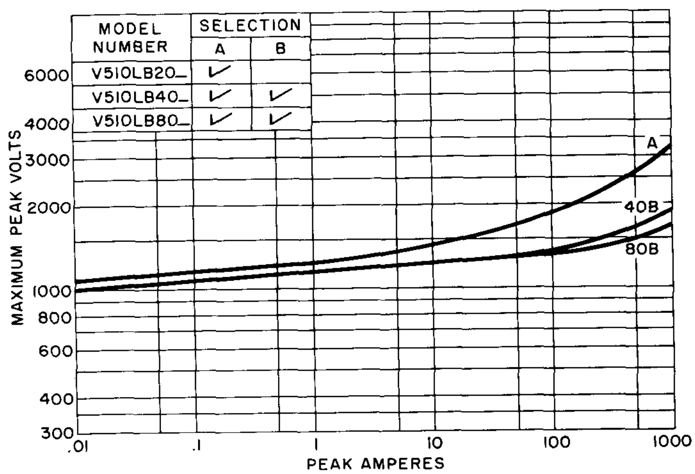
MODEL NUMBER	SELECTION A	SELECTION B
V460LB20_	✓	✓
V460LB40_	✓	✓

FIGURE 10



MODEL NUMBER	SELECTION A	SELECTION B
V480LB20_	✓	
V480LB40_	✓	✓
V480LB80_	✓	✓

FIGURE 11



MODEL NUMBER	SELECTION A	SELECTION B
V510LB20_	✓	
V510LB40_	✓	✓
V510LB80_	✓	✓

FIGURE 12

MAXIMUM VOLT-AMPERE CHARACTERISTICS

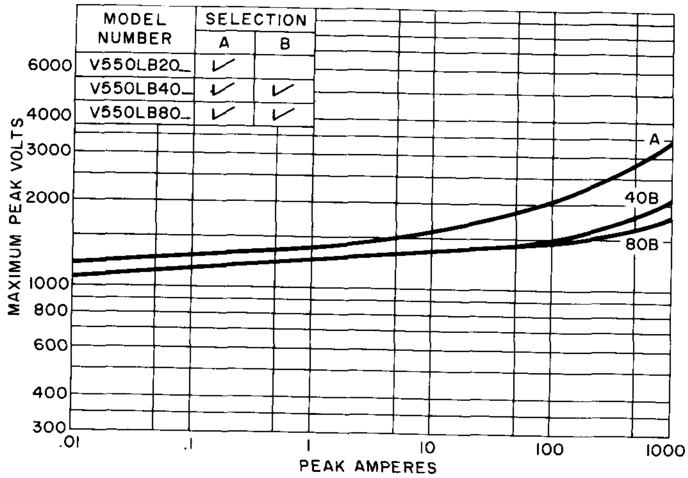


FIGURE 13

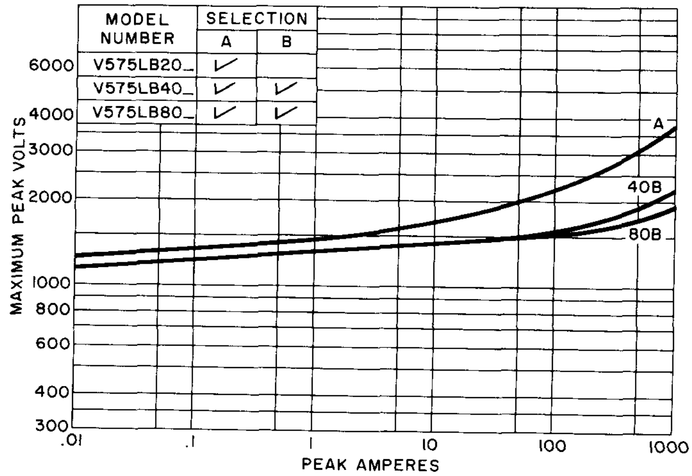


FIGURE 14

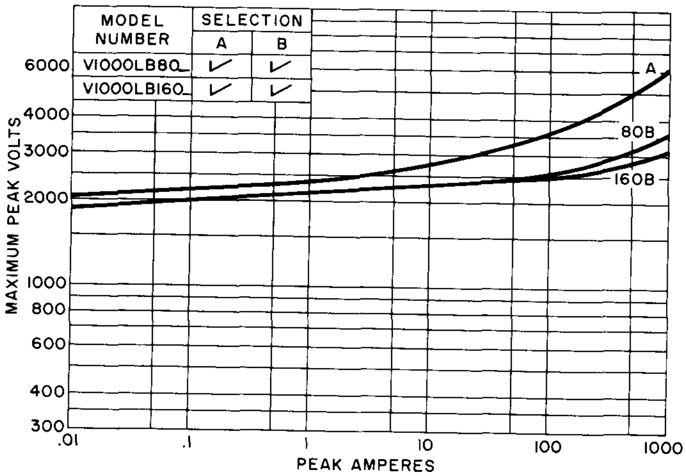


FIGURE 15

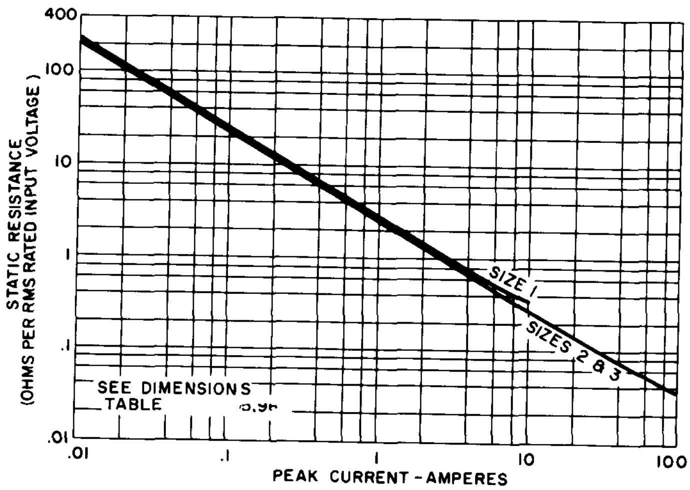


FIGURE 16 TYPICAL STATIC RESISTANCE VS. PEAK CURRENT

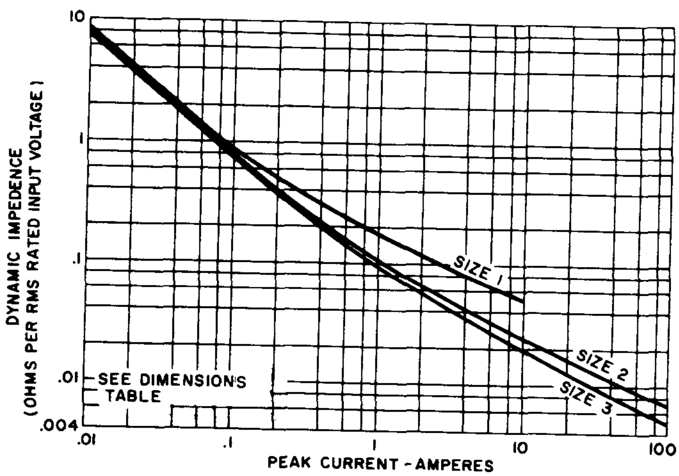


FIGURE 17 TYPICAL DYNAMIC IMPEDANCE VS. PEAK CURRENT

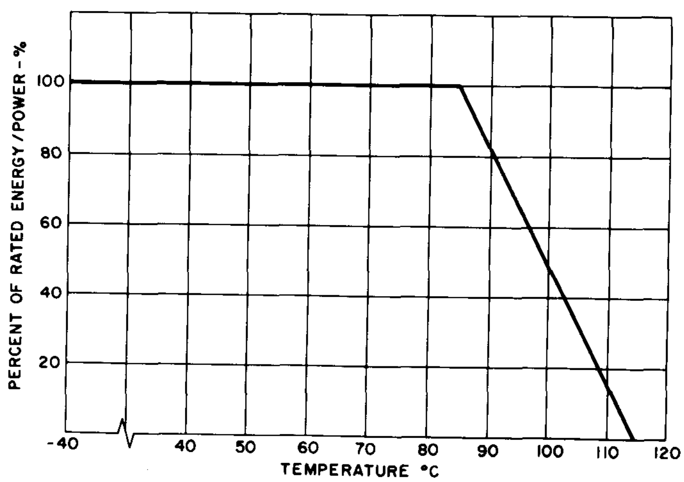


FIGURE 18 POWER AND ENERGY RATING VS. TEMPERATURE

PULSE LIFETIME RATINGS

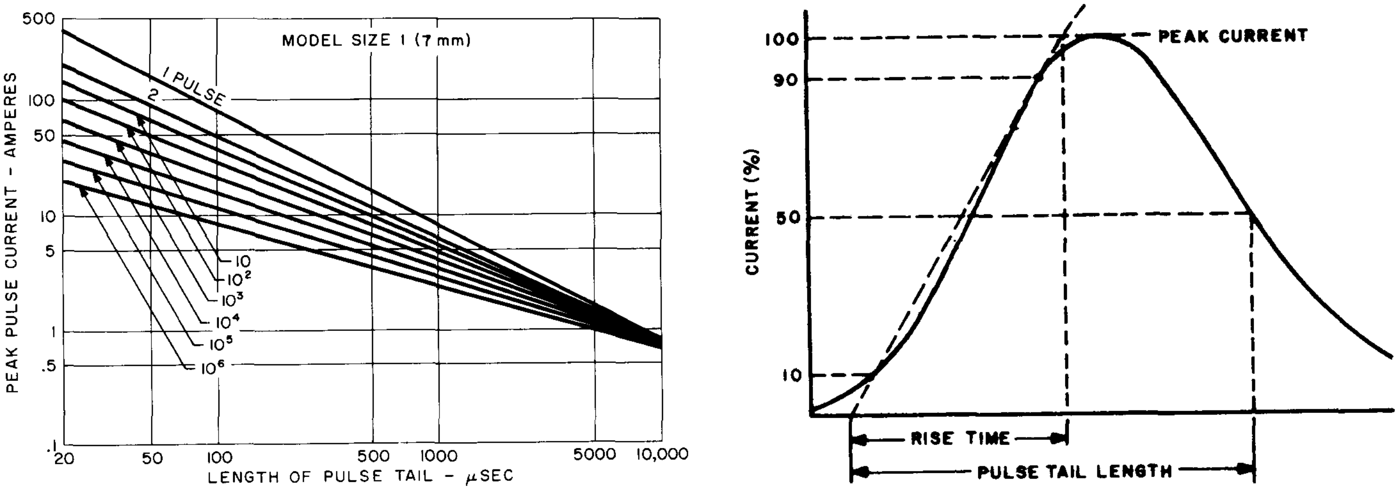


FIGURE 19

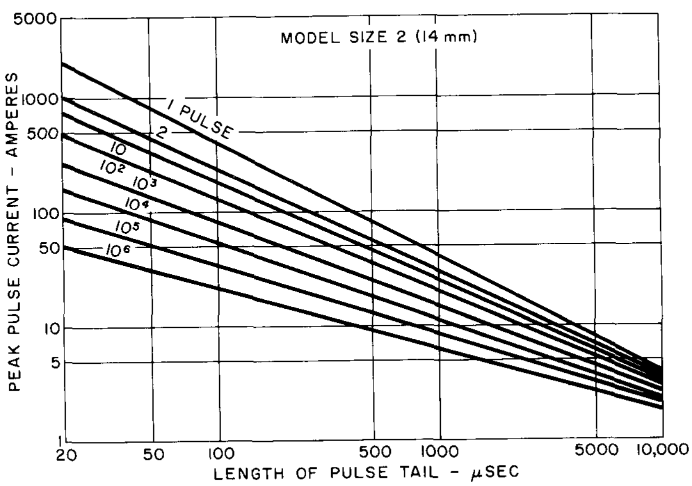


FIGURE 20

NOTES:

1. End of lifetime is defined as a degradation failure which occurs when the device exhibits a shift in the varistor voltage at one (1) milliampere in excess of ± 10% of the initial value. This type of failure is normally a result of a decreasing V_1 value, but does not prevent the device from continuing to function. However, the varistor will no longer meet the original specifications.

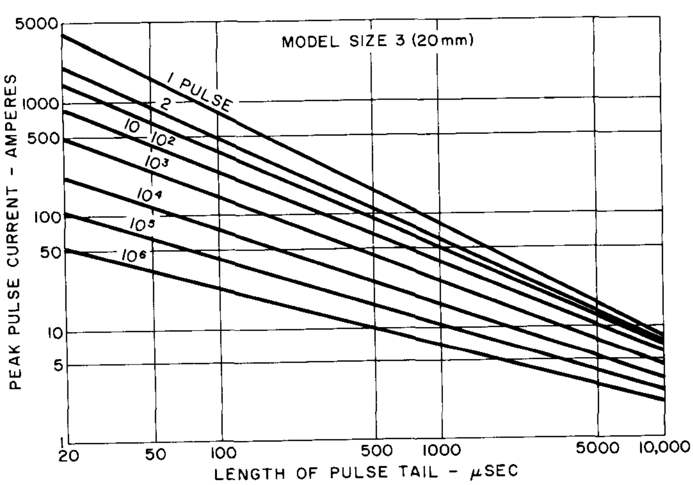


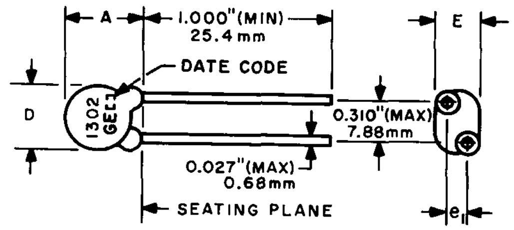
FIGURE 21

SERIES L

DIMENSIONS TABLE

MODEL NUMBER	MARKING (1, 2)	A MAXIMUM INCHES	A MAXIMUM MM	D MAXIMUM INCHES	D MAXIMUM MM	E MAXIMUM INCHES	E MAXIMUM MM	e_1 MINIMUM INCHES	e_1 MINIMUM MM	e_1 MAXIMUM INCHES	e_1 MAXIMUM MM
V130LA1 V130LA2	1301 1302	.46	11.7	.34	8.7	.20	5.0	.07	1.9	.12	3.1
V150LA1 V150LA2	1501 1502					.21	5.3	.08	2.1	.13	3.3
V250LA2 V250LA4	2502 2504					.27	6.9	.12	3.2	.19	4.9
V275LA2 V275LA4	2752 2754					.29	7.4	.14	3.5	.22	5.5
V300LA2 V300LA4	3002 3004					.30	7.7	.15	3.8	.23	5.7

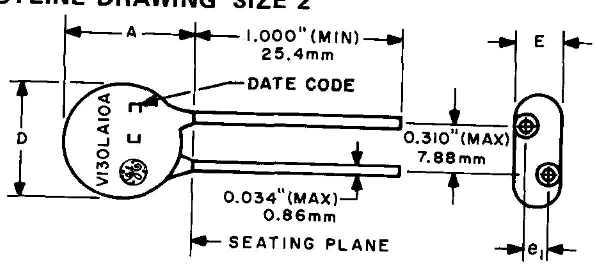
OUTLINE DRAWING SIZE 1



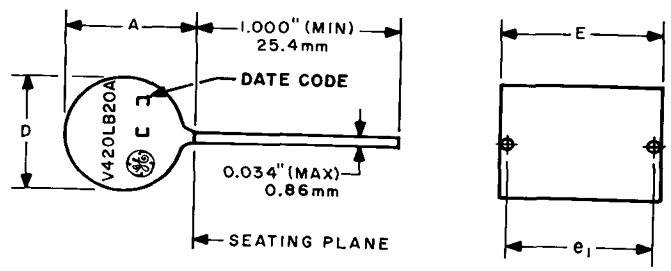
DIMENSIONS TABLE

MODEL NUMBER	MARKING (1, 2)	A MAXIMUM INCHES	A MAXIMUM MM	D MAXIMUM INCHES	D MAXIMUM MM	E MAXIMUM INCHES	E MAXIMUM MM	e_1 MINIMUM INCHES	e_1 MINIMUM MM	e_1 MAXIMUM INCHES	e_1 MAXIMUM MM
V95LA7	V95LA7 _	.74	18.9	.65	16.4	.17	4.4	.07	1.7	.11	2.7
V130LA10 V150LA10	V130LA10 _ V150LA10 _					.21	5.3	.08	2.1	.14	3.5
V250LA15 V250LA20	V250LA15 _ V250LA20 _					.26	6.7	.13	3.4	.20	5.0
V275LA15 V275LA20	V275LA15 _ V275LA20 _					.29	7.3	.14	3.7	.22	5.5
V320LA15 V320LA20	V320LA15 _ V320LA20 _					.32	8.2	.16	4.2	.25	6.4
V420LB20 V460LB20	V420LB20 _ V460LB20 _					.41	10.3	.21	5.4	.33	8.5
V480LB20 V480LB40	V480LB20 _ V480LB40 _					.475	10.7	.23	5.9	.35	8.8
V510LB20 V510LB40	V510LB20 _ V510LB40 _					.44	11.1	.25	6.4	.36	9.2
V550LB20 V550LB40	V550LB20 _ V550LB40 _					.46	11.6	.26	6.7	.38	9.6
V575LB20 V575LB40	V575LB20 _ V575LB40 _					.49	12.4	.27	6.9	.41	10.5
V1000LB80	V1000LB80 _					.72	18.4	.46	11.7	.65	16.5

OUTLINE DRAWING SIZE 2



"LA" CONFIGURATION



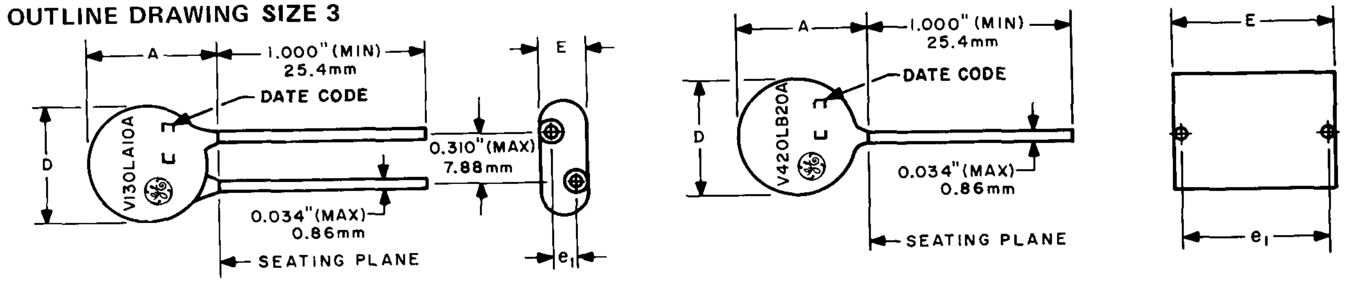
"LB" CONFIGURATION

(1) (–) A or B selection.
(2) All devices to be marked with part designation as indicated plus 2 digit date code and either the General Electric monogram or the initials GE.
(3) Drawings are not to scale.
(4) Lead dimensions as measured within 0.05 inches (1.3mm) of seating plane.

DIMENSIONS TABLE

MODEL NUMBER	MARKING (1, 2)	A MAXIMUM INCHES	A MAXIMUM MM	D MAXIMUM INCHES	D MAXIMUM MM	E MAXIMUM INCHES	E MAXIMUM MM	e_1 MINIMUM INCHES	e_1 MINIMUM MM	e_1 MAXIMUM INCHES	e_1 MAXIMUM MM
V130LA20 V150LA20	V130LA20 _ V150LA20 _	1.00	25.5	.89	22.5	.21	5.3	.08	2.1	.14	3.5
V250LA40 V275LA40	V250LA40 _ V275LA40 _	↓	↓	↓	↓	.29	7.3	.14	3.5	.22	5.6
V320LA40	V320LA40 _	↓	↓	↓	↓	.32	8.2	.17	4.4	.26	6.5
V420LB40 V460LB40	V420LB40 _ V460LB40 _	1.10	27.9	0.95	24.1	.41	10.4	.22	5.5	.34	8.7
V480LB80 V510LB80	V480LB80 _ V510LB80_	↓	↓	↓	↓	.44	11.1	.24	6.0	.37	9.4
V550LB80 V575LB80	V550LB80 _ V575LB80 _	↓	↓	↓	↓	.49	12.4	.27	6.8	.42	10.7
V1000LB160	V1000LB160 _	↓	↓	↓	↓	.73	18.6	.47	12.0	.67	16.9

OUTLINE DRAWING SIZE 3



"LA" CONFIGURATION

"LB" CONFIGURATION

(1) (–) indicates A or B selection.
(2) All devices are to be marked with part designation as indicated, plus a 2-digit date code and either the General Electric Monogram or the initials GE.
(3) Drawings are not to scale.
(4) Lead dimensions as measured within 0.05 inches (1.3mm) of seating plane.

GE-MOV®

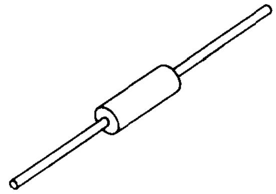
Metal Oxide Varistors

33-430 VOLTS D.C. NOMINAL VARISTOR VOLTAGE
RATINGS OF 23-365 VOLTS D.C., 18-264 VOLTS RMS, 1-.7 JOULES

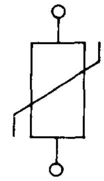
SERIES MA

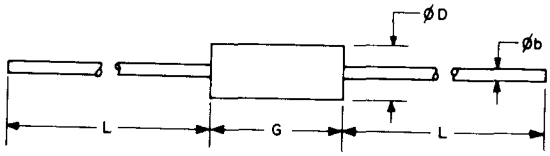
Description:

GE-MOV® zinc oxide varistors are voltage dependent, symmetrical resistors which perform in a manner similar to back-to-back zener diodes in circuit protective functions and offer advantages in performance and economics. The MA (molded axial) series is characterized at the 1mADC varistor voltage following ±10% EIA values as are zener diodes and other varistors used as transient suppressors. When exposed to high energy voltage transients, the varistor impedance changes from a very high standby value to a very low conducting value thus clamping the transient voltage to a safe level. The dangerous energy of the incoming high voltage pulse is absorbed by the GE-MOV® varistor, thus protecting your voltage sensitive circuit components.



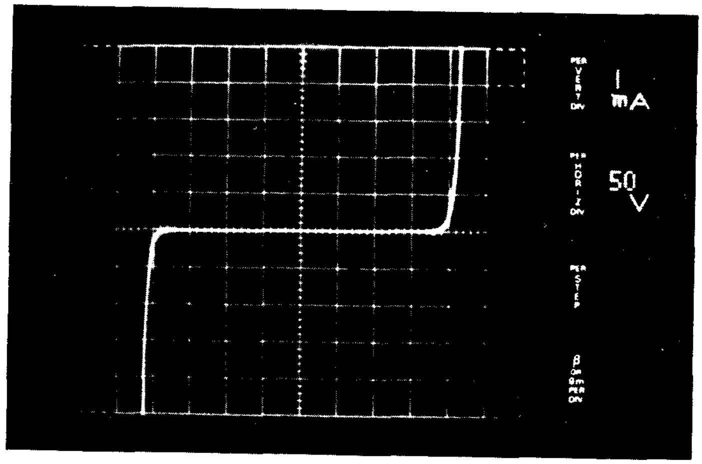
SYMBOL	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
ϕb	.79	.83	.031	.033
ϕD	3.43	3.68	.135	.145
G	8.01	8.50	.315	.335
L	26.0	29.0	1.03	1.14





Features:

- Excellent Clamping
- Peak Transient Current Capability Up To 20 Amps
- Wide Operating Temperature Range (-40°C to 125°C)
- Low Temperature Coefficient (-.03%/°C)
- Low Capacitance
- Low Standby Drain
- Compact and Lightweight
- Compatible With Automatic Insertion



I-V Oscillograph
(Actual Photo)

Benefits:

- Improves Circuit, Component and System Reliability
- Extends Contact Life
- Reduction of Secondary Lightning Effects
- Promotes System Cost Reduction
- Reduces System Size and Weight Requirements
- Increases Product Safety
- No Follow-On Current
- Reduces Electrical "Spike" Noise

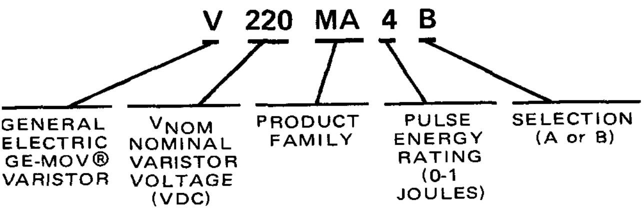
Replacement For The Following When Used As Transient Suppressors:

- Zener Diodes
- Silicon Carbide
- Selenium Thyrectors
- R-C Networks (non dv/dt)
- Neon Bulbs
- Miniature Electronic Crowbars

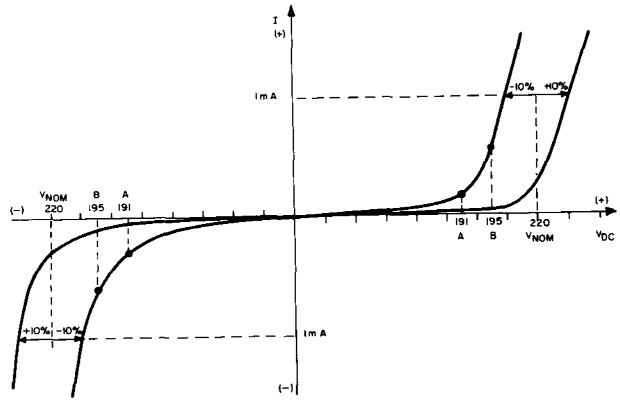
Applications:

- Telephone Relays
- Telephone Solid State Circuits
- Communication Equipment
- Relay Coils
- Traffic Controllers
- Computer Equipment
- Railroad Circuitry
- Numerical Control
- Test Equipment
- Instrumentation
- Solid State Motor Control
- Television
- Copier Machines
- Calculators
- Contact Arc Suppression
- Solid State Relays/Timers
- Automobiles
- Solid State Security Systems
- Medical Equipment
- Fire Alarms

Model Number Nomenclature:



Example:
V220MA4B V-1 Characteristics:



A – Maximum allowable steady state DC applied voltage.
See Ratings Table.

B – Maximum allowable steady state recurrent peak applied voltage.
See Ratings Table.

V_{NOM} – Nominal Varistor voltage at 1mADC.
See Characteristics Table.

The MA series GE-MOV® varistors are characterized at the 1mADC varistor voltage according to EIA values.

For example – V220MA4B; the nominal varistor voltage is 220VDC, ±10%, at 1mADC. The maximum allowable steady state applied voltages, 191 VDC and 195 VAC (peak) fall below the low side nominal varistor voltage of 198 VDC (220 – 10%) to insure the maximum idle power dissipation characteristics (See V-I curve to the right).

ABSOLUTE MAXIMUM RATINGS

Maximum Electrical Ratings:

Maximum Energy, Power and Peak Current	See Rating Table
Storage Temperature, T_{STG}	-55°C to +125°C
Operating Ambient Temperature (Without Derating)	75°C
Maximum Voltage Temperature Coefficient	-.03%/°C

Mechanical Ratings:

Insulation Resistance – Megohms	> 1000
Hipot Encapsulation – Volts D.C. for 1 Minute	1000
Solderability	Per Mil Std 202E Method 208C

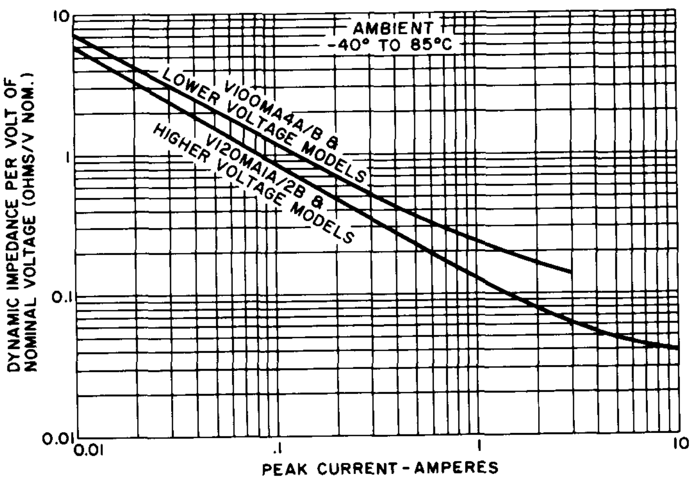


FIGURE 1 TYPICAL CHARACTERISTIC OF DYNAMIC IMPEDANCE VS. PEAK CURRENT

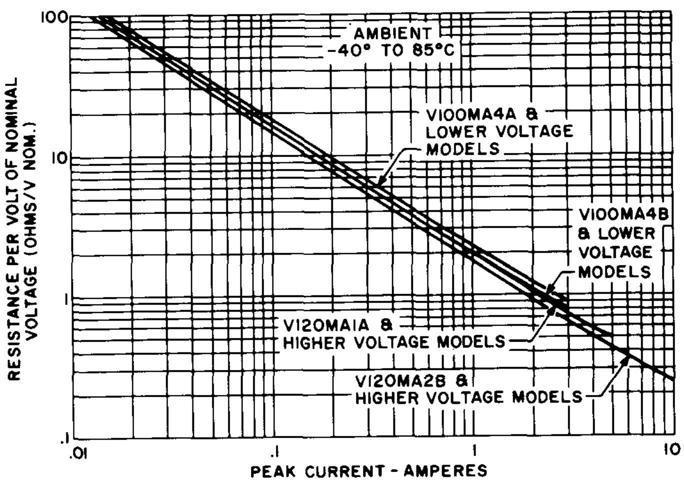


FIGURE 2 MAXIMUM STATIC RESISTANCE VS. PEAK CURRENT

MAXIMUM RATINGS TABLE

MODEL NUMBER	STEADY STATE (1)			TRANSIENT		
	DC APPLIED VOLTAGE (2,4)	RMS (2,3,4) APPLIED VOLTAGE 50-60 Hz AC	RECURRENT PEAK APPLIED VOLTAGE (2,3,4)	ENERGY (4)	AVERAGE POWER DISSIPATION (4)	NON-RECURRENT PEAK PULSE CURRENT (4, 5)
	VOLTS	VOLTS	VOLTS	JOULES (WATT-SECS)	MILLIWATTS (FREE AIR)	AMPERES
V33MA1A V33MA1B	23 26	18 20	26 28	.13 .15	200	10
V39MA2A V39MA2B	28 31	22 25	31 35	.16 .18	200	10
V47MA2A V47MA2B	34 38	27 30	38 42	.19 .21	200	10
V56MA2A V56MA2B	40 45	32 35	45 49	.23 .25	200	10
V68MA3A V68MA3B	48 56	38 40	54 57	.26 .30	200	10
V82MA3A V82MA3B	60 66	45 50	65 71	.33 .37	200	10
V100MA4A V100MA4B	72 81	57 60	80 85	.40 .45	200	10
V120MA1A V120MA2B	97 101	72 75	102 106	.10 .20	200	10 20
V150MA1A V150MA2B	121 127	88 92	124 130	.10 .20	200	10 20
V180MA1A V180MA3B	144 152	105 110	148 156	.15 .30	200	10 20
V220MA2A V220MA4B	181 191	132 138	187 195	.20 .40	200	10 20
V270MA2A V270MA4B	224 235	163 171	230 242	.20 .40	200	10 20
V330MA2A V330MA5B	257 274	188 200	266 283	.25 .50	200	10 20
V390MA3A V390MA6B	322 334	234 242	331 342	.30 .60	200	10 20
V430MA3A V430MA7B	349 365	253 264	358 373	.35 .70	200	10 20

(1) Steady State defined as the normal input conditions existing when no transients are present.

(2) Applied Voltage is that voltage which appears across the varistor terminals when no transient is present. High line voltage conditions should be included in the value for Applied Voltage used to select the correct model. (i.e., applications for 117 V_{RMS} should use ratings of 129 V_{RMS} or more.)

(3) For AC applications a sinusoidal Applied Voltage is assumed to be the normal input condition. If Applied Voltage is non-sinusoidal, Recurrent Peak Applied Voltage values should be used to select correct model.

(4) See Figure 3.

(5) See Figure 8.

CHARACTERISTICS TABLE

MODEL NUMBER	CHARACTERISTICS AT 25°C									
	V_{NOM} VARISTOR VOLTAGE @ 1.0mA DC CURRENT (6)		LEAKAGE CURRENT @ MAX. RATED DC VOLTAGE		ALPHA (7) I_2 = 1mA, I_1 = 0.1mA			MAXIMUM AC IDLE POWER	MAXIMUM THERMAL RESISTANCE BODY TO AIR	TYPICAL CAPACITANCE
			TYP.	MAX.	MIN.	TYP.	MAX.			
	VOLTS	± TOL. %	MICROAMPERES					MILLIWATTS	°C/W	PICOFARADS
V33MA1A V33MA1B	33	20 10	10	250	12	20	55	8	250	300
V39MA2A V39MA2B	39	20 10						9		250
V47MA2A V47MA2B	47	20 10			↓	↓		11		210
V56MA2A V56MA2B	56	20 10			16	25		13		180
V68MA3A V68MA3B	68	20 10						15		150
V82MA3A V82MA3B	82	20 10						18		120
V100MA4A V100MA4B	100	20 10			↓	↓		20		100
V120MA1A V120MA2B	120	15 10			25	32		22		40
V150MA1A V150MA2B	150	15 10						25		32
V180MA1A V180MA3B	180	15 10						30		27
V220MA2A V220MA4B	220	15 10						40		21
V270MA2A V270MA4B	270	15 10						45		17
V330MA2A V330MA5B	330	15 10						55		14
V390MA3A V390MA6B	390	15 10						65		12
V430MA3A V430MA7B	430	15 10	↓	↓	↓	↓	↓	70	↓	11

(6) 1mA DC current pulse, 10-50 msec.

(7) $I = KV^{\alpha}$, Where $\alpha = \frac{\text{Log } I_2/I_1}{\text{Log } V_2/V_2}$

NOTE:

The GE-MOV® varistor may be operated at maximum energy, power, peak pulse current, and applied voltage (AC or DC) ratings up to 75°C ambient. Above 75°C ambient these values must be derated in order to remain below a limit of 125°C average surface temperature. The magnitude of total average power dissipation is determined by averaging the energy of repetitive transients over their time base (0.1 Watt = 0.1 Joules/Sec) and then adding the idle power dissipation of the varistor.

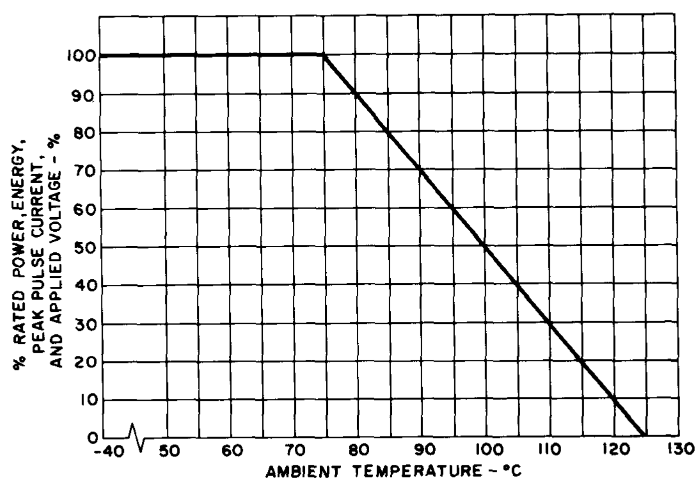


FIGURE 3 % RATED POWER, ENERGY, PEAK PULSE CURRENT AND APPLIED VOLTAGE (AC OR DC) VS T_A

MAXIMUM VOLT – AMPERE CHARACTERISTICS (T_A = 25°C)

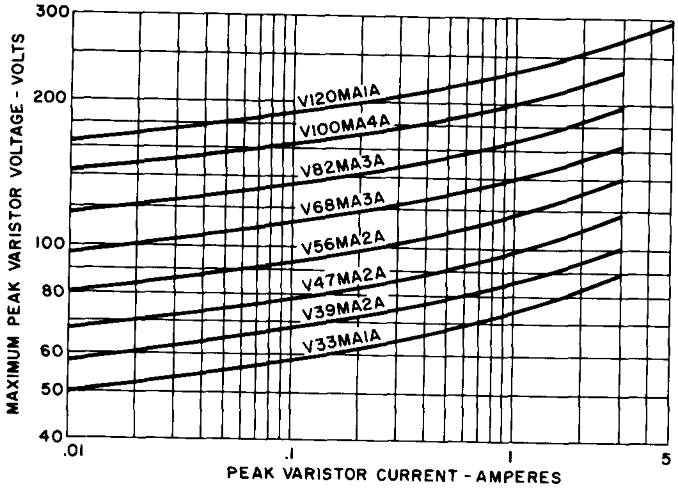


FIGURE 4 PEAK VARISTOR CURRENT – AMPERES

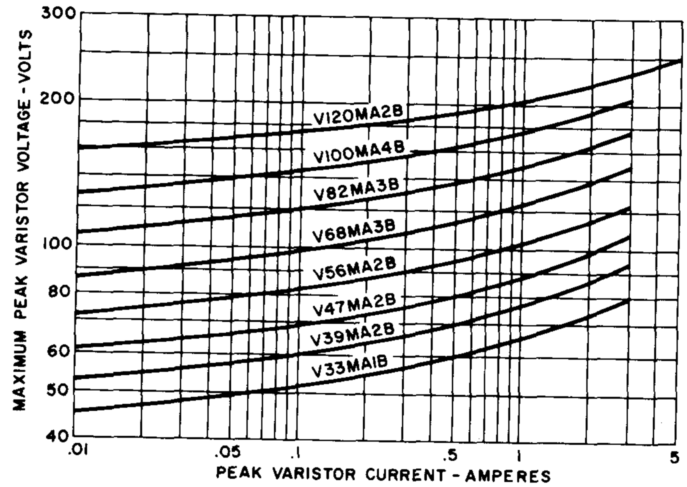


FIGURE 5 PEAK VARISTOR CURRENT – AMPERES

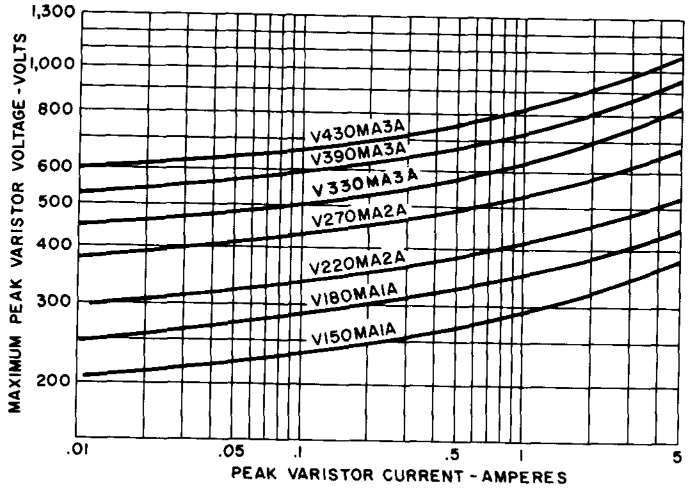


FIGURE 6 PEAK VARISTOR CURRENT – AMPERES

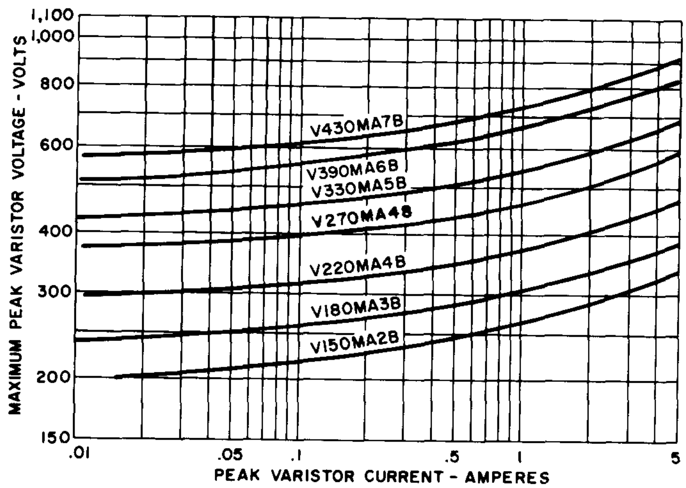


FIGURE 7 PEAK VARISTOR CURRENT – AMPERES

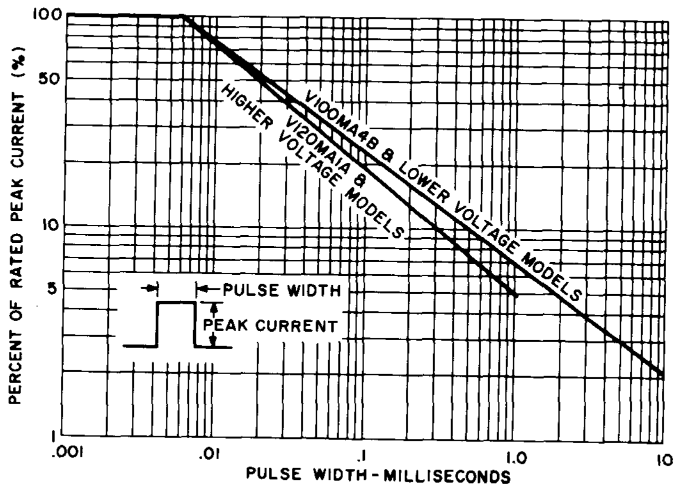
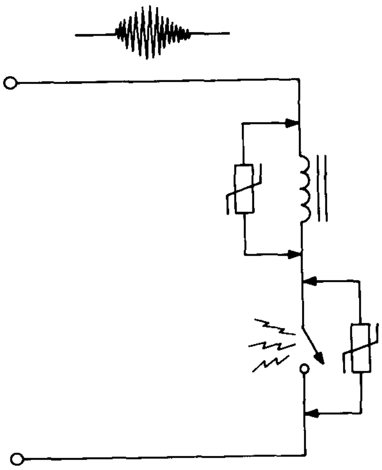


FIGURE 8 % RATED NON-RECURRENT PEAK PULSE CURRENT VS. PULSE WIDTH (T_A = 25°C)

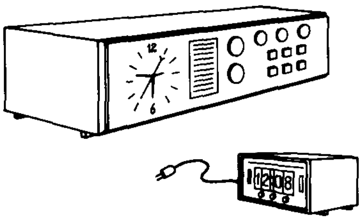
GE-MOV® VARISTOR APPLICATIONS



CONTACT ARCING / NOISE

Switch contacts interrupting an inductive load current will arc causing deterioration of the contacts and noise-generating "spikes" on the power line.

Placing an MA Series GE-MOV® varistor across the load or contacts is a low-cost method to suppress high voltage spikes, and (particularly at lower currents or voltages) to reduce contact damage due to arcing. Their bi-directional characteristic makes them useful for AC or DC applications without affecting load operation or suffering voltage damage themselves, as diodes or capacitors may do.



RESIDENTIAL POWER LINE TRANSIENT VOLTAGES

About 2% of all homes experience repeated transient voltages (over 1200 volts) of a level potentially damaging to home appliances. GE-MOV® axial-leaded varistors provide a reliable, cost-effective way to reduce these voltages to acceptable levels.

GE-MOV® VARISTOR APPLICATION NOTES AND SPECIFICATION SHEETS

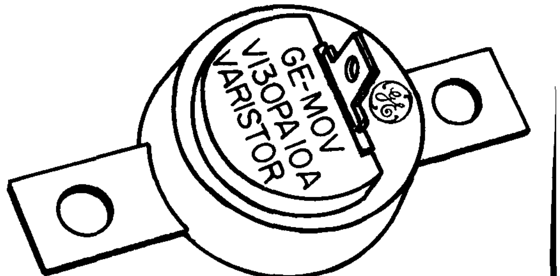
PUB. NO.	TITLE
200.60	GE-MOV® Varistors Voltage Transient Suppressors
200.72	Using GE-MOV® Varistors To Extend Contact Life
200.73	Testing GE-MOV® Varistors
200.77	Detecting And Suppressing Nanosecond Wide Spikes With GE-MOV® Varistors
201.28	Energy Dissipation In GE-MOV® Varistors For Various Pulse Shapes
660.30	Six Ways To Control Voltage Transients, Reprint From *Electronic Design*
660.32	Transient Suppression . . . Don't Make The Cure Worse Than The Disease, Reprint From *Machine Design*
451.133	Transient Voltage Suppression Manual

GE-MOV®

Metal Oxide Varistors

RATINGS OF 170-750 VOLTS D.C., 130-575 VOLTS RMS.

SERIES PA

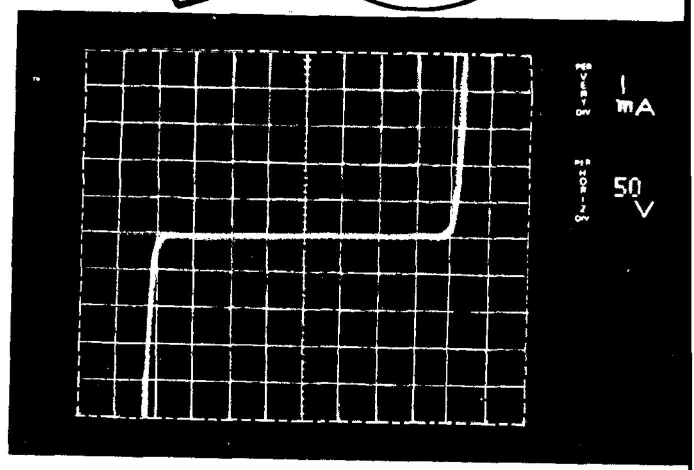


Description:

GE-MOV® zinc oxide varistors are voltage dependent, symmetrical resistors which perform in a manner similar to back-to-back zener diodes in circuit protective functions and offers advantages in performance and economics. When exposed to high energy voltage transients, the varistor impedence changes from a very high standby valve to a very low conducting valve thus clamping the transient voltage to a safe level. The energy of the incoming high voltage pulse is absorbed by the GE-MOV® varistor, thus protecting sensitive circuit components.

Replacement For:

- Zener Diodes
- Silicon Carbide
- Selenium Thyrectors
- R-C Networks (non dv/dt)



I-V Oscillograph (Actual Photo)

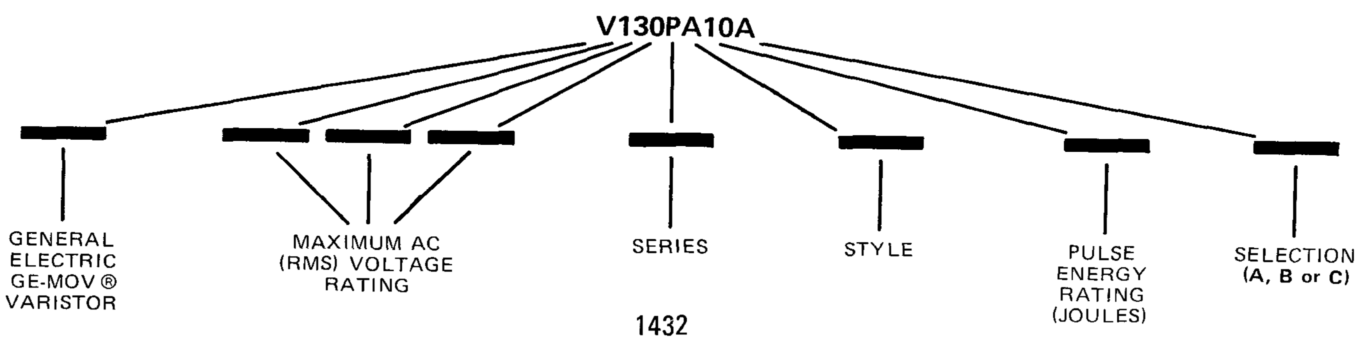
Features:

- Up to 15 Watt Average Power Dissipation
- NEMA Creep and Strike Distances
- Excellent Clamping (as low as 1.7 @ 200 amps.)
- Discharge Current Capability as high as 4000 amps.
- Energy Dissipation up to 80 watt-seconds
- Nanosecond Response
- Low Standby Power Dissipation
- Quick Connect Terminal

Benefits:

- Improves Circuit, Component and System Reliability
- Extends Contact Life
- Reduction of Lightning Effects
- Promotes System Cost Reduction
- Reduces System Size and Weight Requirements
- Increases Product Safety
- No Follow-On Current

Model Number Nomenclature:



Ratings:

Maximum Energy, Power and Peak Current . . . . See Rating Table
Storage Temperature, T_{STG} . . . . -40°C to +125°C
Maximum Hot Spot Temperature, T_{HS} . . . . 125°C
Operating Case Temperature (without derating) . . . . 70°C
Maximum Thermal Impedance Case to Ambient for Maximum Recurrent Peak AC Voltage . . . . . ≤ 8°C/Watt
Maximum Thermal Impedance Case to Ambient for Maximum DC Input . . . . ≤ 5°C/Watt
Maximum Voltage Temperature Coefficient . . . . -0.05%/°C

Mechanical:

Insulating Resistance – Megohms . . . . > 1000
Hipot Encapsulation – Volts DC for 1 Minute 2500
Maximum Weight . . . . 45 Grams

MAXIMUM RATINGS AND CHARACTERISTICS

MODEL NUMBER [5]	RATINGS						CHARACTERISTICS		
	RMS [1,2] APPLIED VOLTAGE 50-60 HZ	RECURRENT PEAK APPLIED VOLTAGE	DC [1] APPLIED VOLTAGE	ENERGY [3]	AVERAGE [3] POWER DISSIPATION	PEAK [4] CURRENT	VARISTOR PEAK VOLTAGE @1MA AC MIN.	VARISTOR PEAK VOLTAGE @1MA AC MAX.	THERMAL RESISTANCE HOT SPOT TO CASE
	VOLTS	VOLTS	VOLTS	JOULES	WATTS	AMPERES	VOLTS	VOLTS	°C/WATT
V130PA10 (–) 20 (–)	130	184	170	10 20	8 15	4000 4000	185	255	6.8 3.6
V150PA10 (–) 20 (–)	150	212	195	10 20	8 15	4000 4000	214	298	6.8 3.6
V250PA10 (–) 20 (–) 40 (–)	250	354	330	10 20 40	4 7 13	4000 4000 4000	358	480	13.7 7.8 4.2
V275PA10 (–) 20 (–) 40 (–)	275	389	360	10 20 40	4 7 13	4000 4000 4000	390	523	13.7 7.8 4.2
V320PA40 (–)	320	452	415	40	12	4000	448	601	4.5
V420PA20 (–) 40 (–)	420	595	540	20 40	5 10	4000 4000	585	802	11.0 5.5
V460PA20 (–) 40 (–)	460	650	600	20 40	5 10	4000 4000	648	880	11.0 5.5
V480PA20 (–) 40 (–) 80 (–)	480	679	625	20 40 80	3 5 10	4000 4000 4000	680	918	18.3 11.0 5.5
V510PA20 (–) 40 (–) 80 (–)	510	721	655	20 40 80	3 5 10	4000 4000	713	962	18.3 11.0 5.5
V550PA20 (–) 40 (–) 80 (–)	550	778	720	20 40 80	3 5 9	4000 4000 4000	782	1072	18.3 11.0 6.1
V575PA20 (–) 40 (–) 80 (–)	575	813	750	20 40 80	3 5 9	4000 4000 4000	816	1119	18.3 11.0 6.1

1. Applied voltage is that voltage which appears across the varistor terminals when no transient is present. High line voltage conditions must be included in the value for applied voltage used to select the correct model.
2. For AC applications, a sinusoidal applied voltage is assumed to be the normal input condition. If applied voltage is non-sinusoidal, recurrent peak applied voltage values should be used to select correct model.
3. See Figure 12.
4. See Figure 13. Peak currents apply for full rated bias.
5. (–) indicates A, B or C selection. See Figures 1-11.

MAXIMUM VOLT-AMPERE CHARACTERISTICS

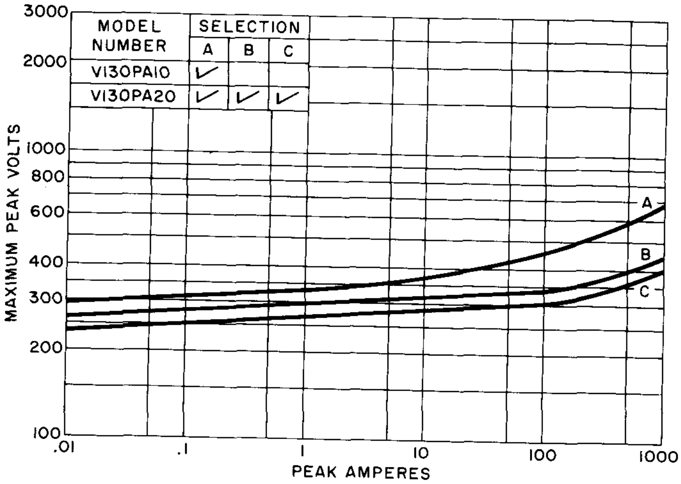


FIGURE 1

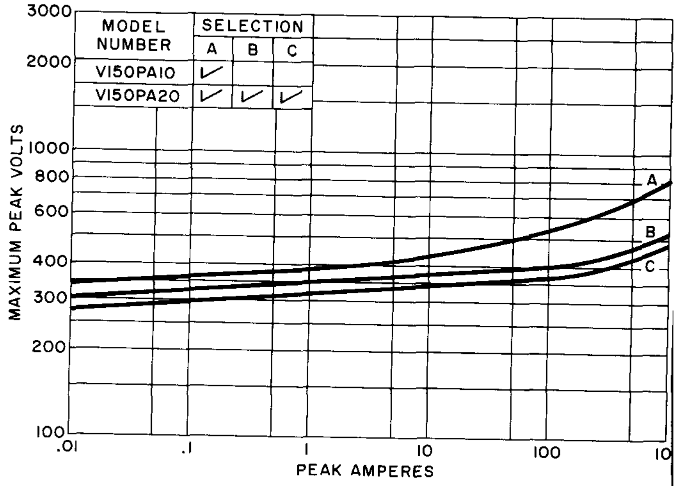


FIGURE 2

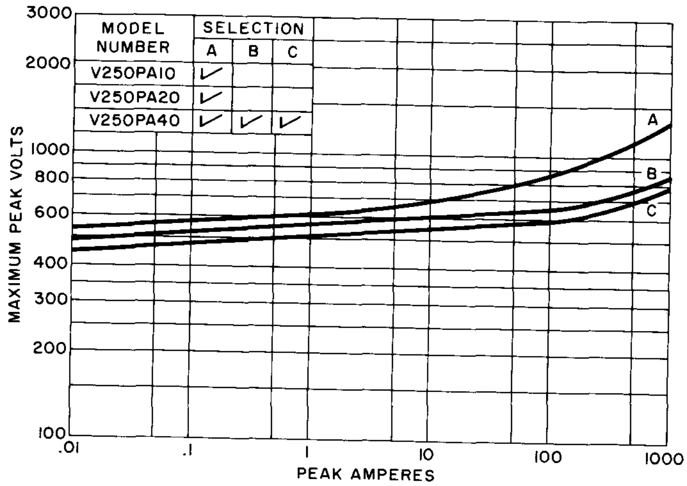


FIGURE 3

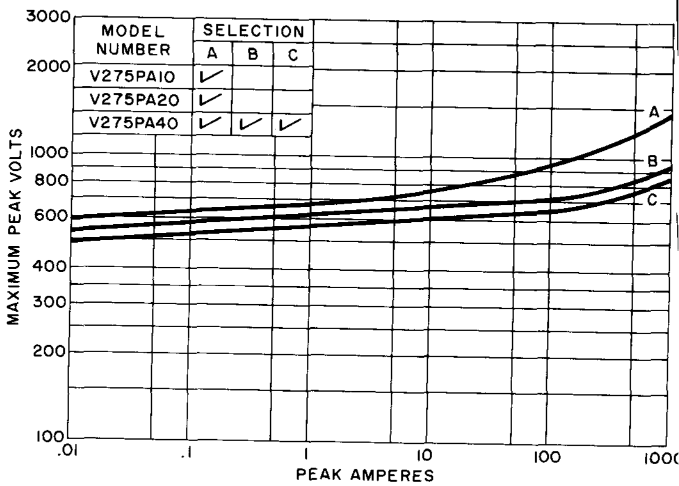


FIGURE 4

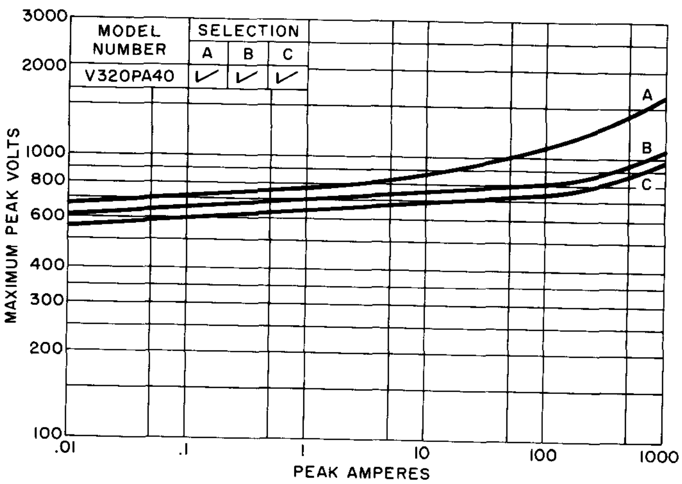


FIGURE 5

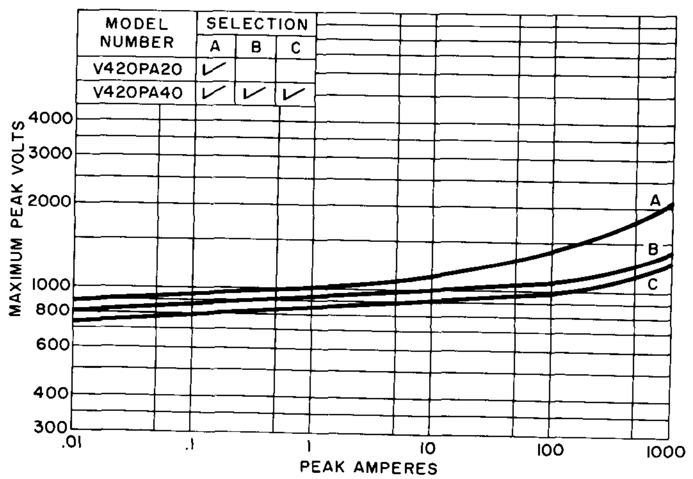
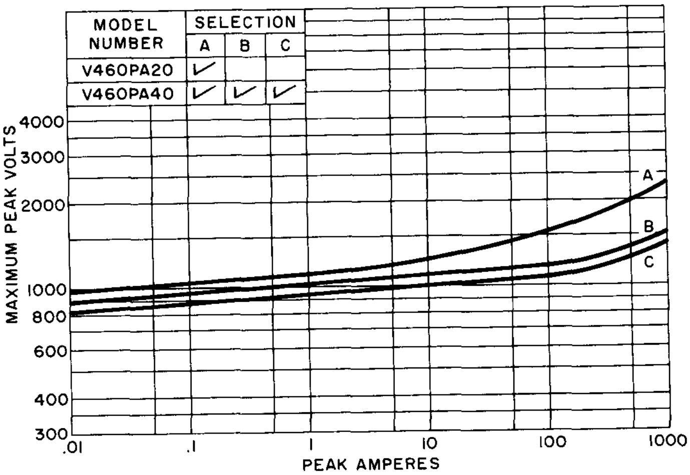
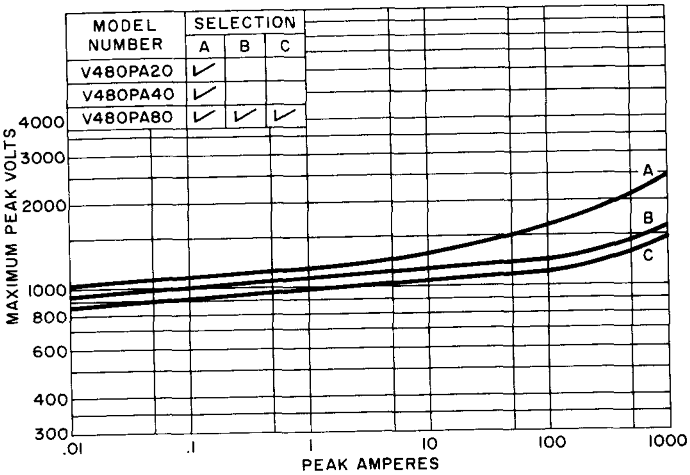


FIGURE 6



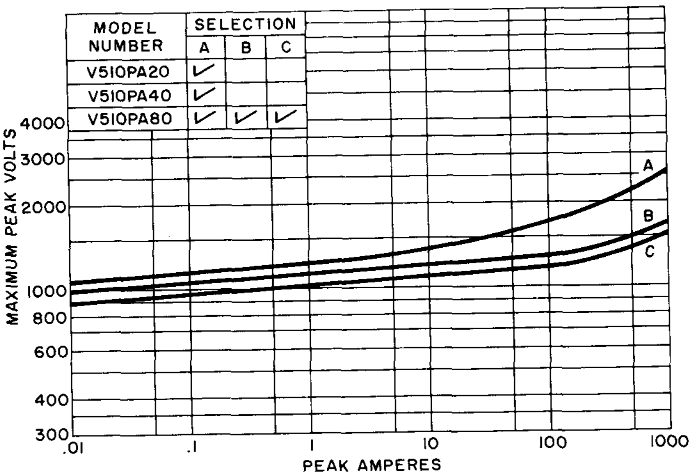
MODEL NUMBER	SELECTION A	B	C
V460PA20	✓		
V460PA40	✓	✓	✓

FIGURE 7



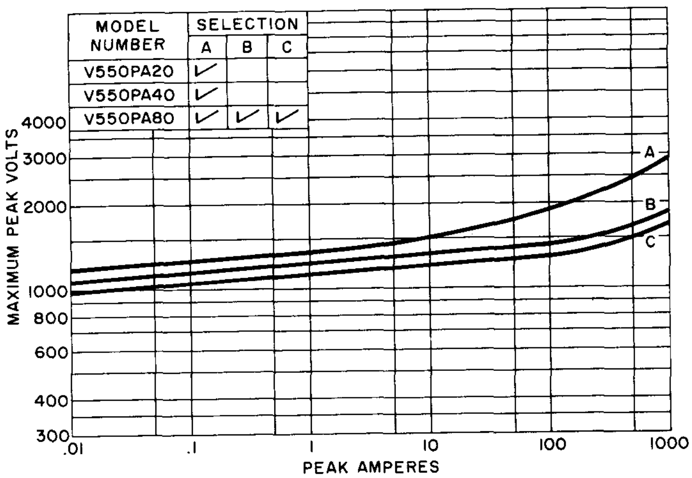
MODEL NUMBER	SELECTION A	B	C
V480PA20	✓		
V480PA40	✓		
V480PA80	✓	✓	✓

FIGURE 8



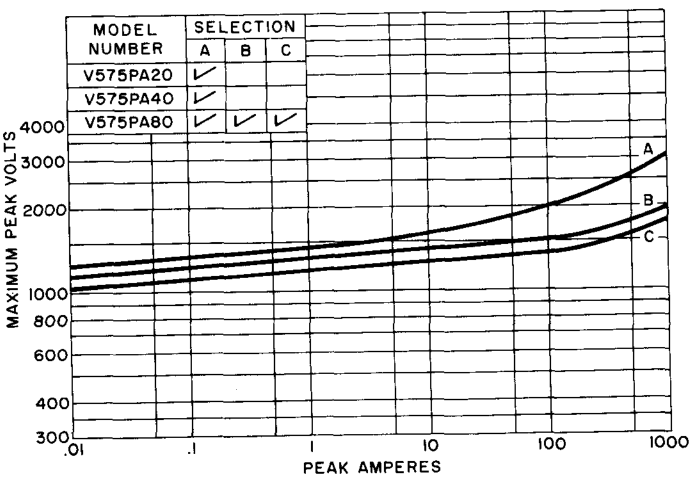
MODEL NUMBER	SELECTION A	B	C
V510PA20	✓		
V510PA40	✓		
V510PA80	✓	✓	✓

FIGURE 9



MODEL NUMBER	SELECTION A	B	C
V550PA20	✓		
V550PA40	✓		
V550PA80	✓	✓	✓

FIGURE 10



MODEL NUMBER	SELECTION A	B	C
V575PA20	✓		
V575PA40	✓		
V575PA80	✓	✓	✓

FIGURE 11

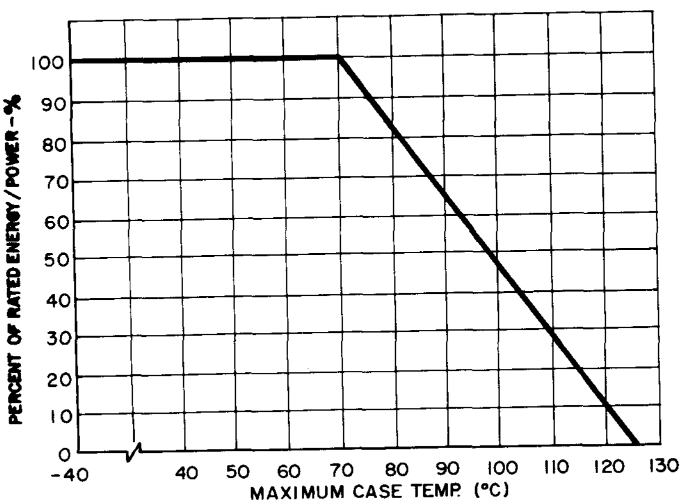


FIGURE 12

ENERGY AND POWER RATING VS. CASE TEMPERATURE

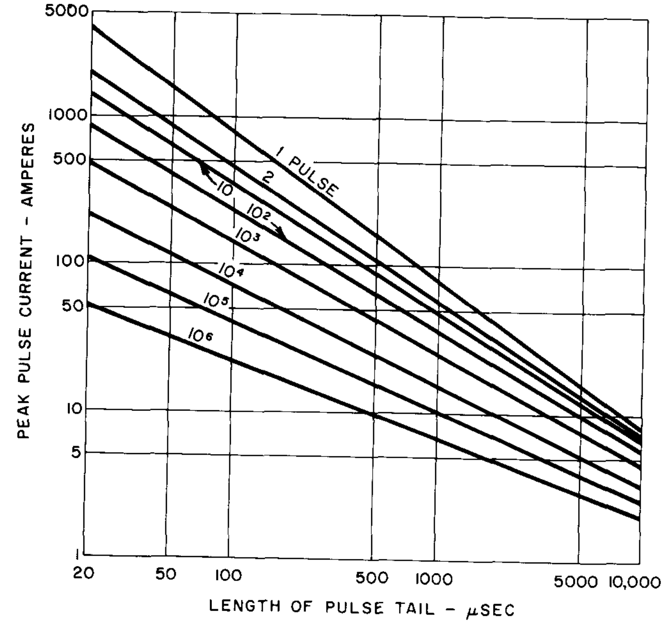


FIGURE 13

PULSE LIFE DERATING CURVE

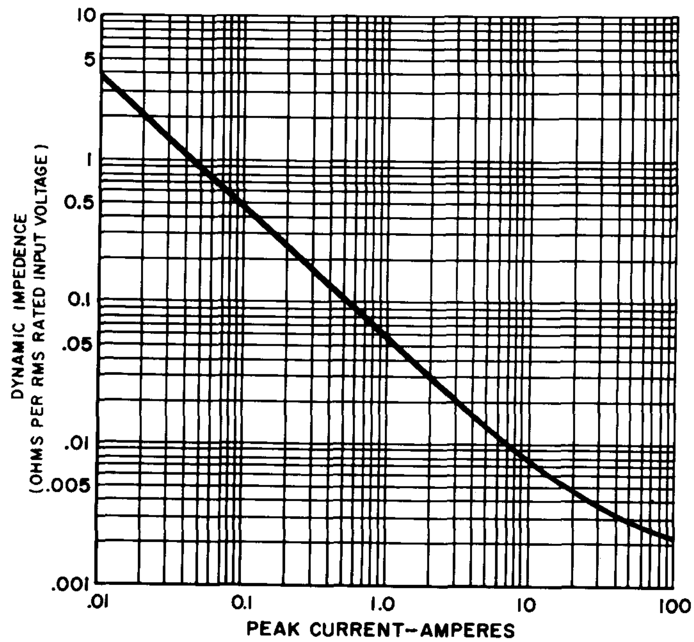


FIGURE 14

DYNAMIC IMPEDANCE VS. PEAK CURRENT

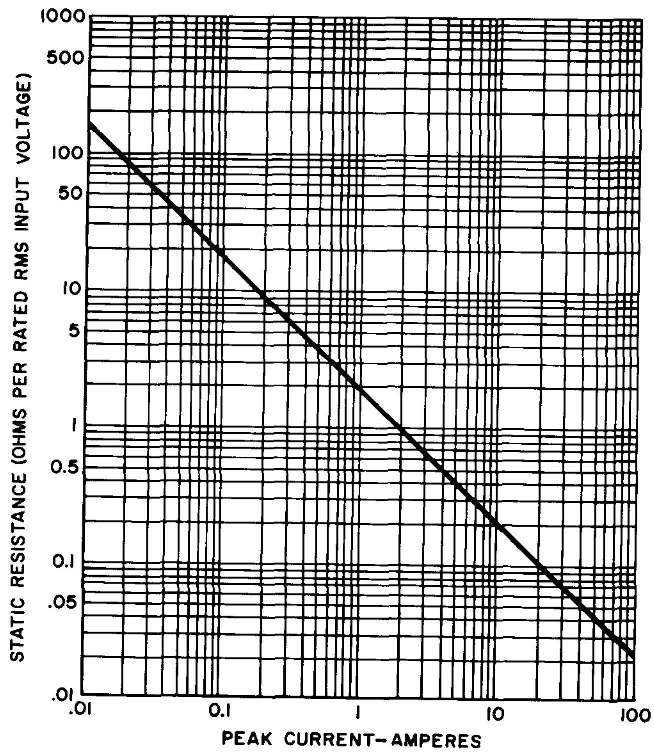
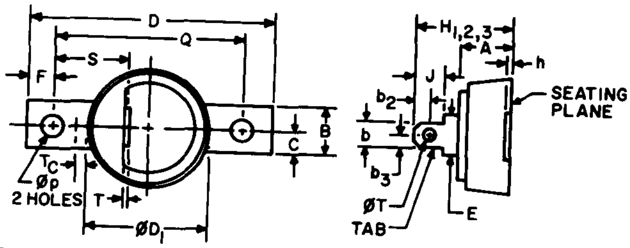


FIGURE 15

TYPICAL RESISTANCE VS. PEAK CURRENT



SYMBOL	INCHES MIN.	INCHES NOM.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS NOM.	MILLIMETERS MAX.	NOTES
A			.57			14.3	
b			.26			6.6	1
b_2		.16			4.1		
b_3		.13			3.2		
B			.51			12.9	
C			.26			6.5	
D			2.61			66.2	
ϕD_1			1.32			33.5	
E		.44			11.2		
F		.30			7.7		
h		.03	.04		.8	.9	
H_1	.91		1.01	23.2		25.5	3
H_2	.96		1.12	24.6		28.3	3
H_3	1.03		1.29	26.3		32.6	3
J			.32			8.1	
ϕp	.22		.24	5.8		6.0	
Q	1.99	2.00	2.01	50.6	50.8	51.0	
S		.76			19.2		
T			.04			1.0	1
ϕT	.11			2.8			
T_c		.13			3.2		2

NOTES:

1. Tab is designed to fit 1/4" quick connect terminal.
2. Case temperature is measured at T_C on top surface of base plate.
3. H_1 (130-150 V_{RMS} devices)
   H_2 (250-320 V_{RMS} devices)
   H_3 (420-575 V_{RMS} devices)
4. Electrical connection: top terminal and base plate.

FIGURE 16

DIMENSION TABLE

PROPER MOUNTING OF THE "PA" SERIES VARISTOR

When applying the varistor in a manner which requires high power dissipation capability, the possibility of necessary heat sinking should be taken into consideration. Figure 12 allows one to determine the maximum power dissipation for a given case temperature. To determine if a varistor has been properly heat sinked, a measurement of strap temperature, T_C, (see outline drawing) should be made under required worst case power and thermal conditions.

To describe the proper heat sink for any application, a fundamental knowledge of heat transference is required. Heat generated by power dissipated in the varistor, will flow through the mounting junction, to the heat sink, and finally to the surrounding ambient. The varistor case temperature (T_C) is a function of both the heat sink temperature (T_S) and the ambient temperature (T_A) which are directly proportional to the amount of heat flow (P) from the junction and the thermal resistances of the mounting ($R\theta_{CS}$) and the heat sink ($R\theta_{SA}$). Figure 17 shows a thermal schematic of a mounted varistor.

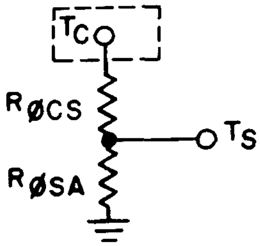


FIGURE 17
EQUIVALENT THERMAL RESISTANCE NETWORK FOR A POWER VARISTOR

The relationship between power dissipated (P), or heat flow, and temperature may be expressed as:

$$\frac{T_C - T_A}{P} = R\theta_{CS} + R\theta_{SA}$$

Table I lists some typical values for $R\theta_{CS}$ for various mounting methods.[1]

TABLE I

EXPECTED $R\theta_{CS}$ FOR
FOR GE-MOV® VARISTOR POWER PACKAGE

MOUNTING DESCRIPTION	TYPICAL $R\theta_{CS}$*
Screws (a)	0.9 °C/Watt
Screws (a) With Thermal Grease	0.3 °C/Watt
Screws (b) With Insulation Kit	2.0 °C/Watt
Screws (b) With Insulation Kit and Thermal Grease Both Faces	1.0 °C/Watt

(a) 10-32 Screw Torqued to 12-15 in lbs.
(b) 6-32 Screw Torqued to 405 in lbs.

*Values given in the table are for devices mounted on a clean, flat heatsink. The surface under the varistor contact surface should be flat to within .001 in. per inch with a surface finish of 63 micro-inches or smoother. Surfaces must be free of burrs, holes, paint or other foreign material and should be cleaned just prior to varistor mounting. Rough, curved or bent heatsink surfaces will cause increased thermal resistance and may result in premature device failure.

[1] For further information on heatsinking and values of $R\theta_{SA}$, refer to Application Note #200.55 *Handling and Thermal Considerations for General Electric Power Devices.*

TYPICAL NON-ISOLATED MOUNTING

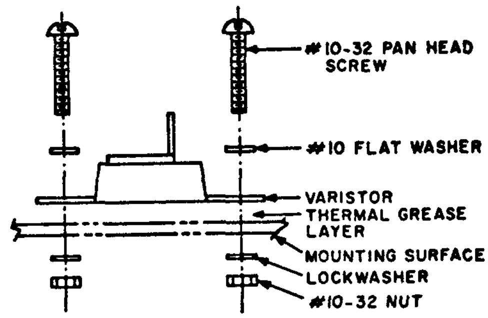


FIGURE 18

TYPICAL ISOLATED MOUNTING

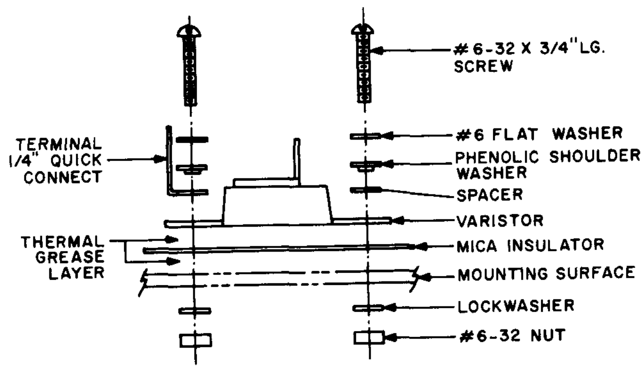


FIGURE 19

NOTE:

[1] GE G623, Dow Corning, DC3, 4, 340, or 640 Thermal Grease is recommended.

[2] Isolation kits containing the following parts can be ordered by part #A7811055.

(1) MICA insulation 1" x 3.1" x .005" thick.
(2) #6-32 x 3/4" screw.
(2) #6 flat washer.
(2) Phenolic shoulder washer.
(2) #6 internal tooth lock washer.
(2) #6-32 nut.
(1) 1/4" quick connect terminal.
(1) Spacer

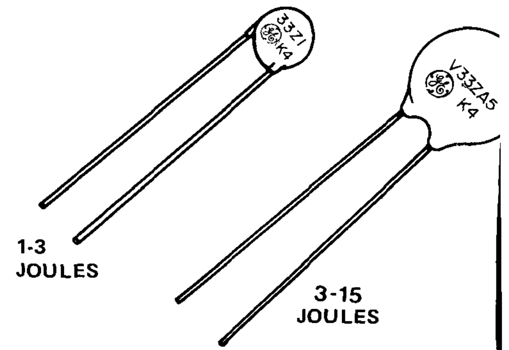
GE-MOV®

Metal Oxide Varistors

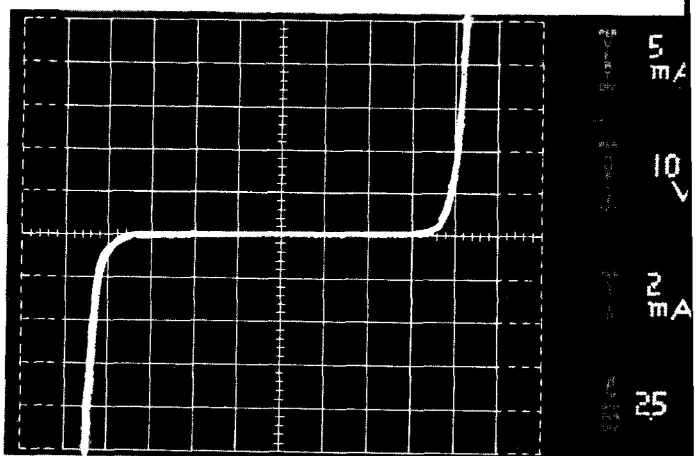
18-180 VOLTS D.C. NOMINAL VARISTOR VOLTAGE
RATINGS OF 14-153 VOLTS D.C., 20-115 VOLTS RMS, 1-15 JOULES

SERIES ZA

Description:
GE-MOV® zinc oxide varistors are voltage dependent, symmetrical resistors which perform in a manner similar to back-to-back zener diodes in circuit protective functions and offer advantages in performance and economics. The ZA series is characterized at the 1mADC varistor voltage following ±10% EIA values as are zener diodes and other varistors used as transient suppressors. When exposed to high energy voltage transients, the varistor impedance changes from a very high standby value to a very low conducting value thus clamping the transient voltage to a safe level. The dangerous energy of the incoming high voltage pulse is absorbed by the GE-MOV® varistor, thus protecting your voltage sensitive circuit components.



Replacement For:
- Zener Diodes
- Silicon Carbide
- Selenium Thyrectors
- R-C Networks (non dv/dt)



I-V Oscillograph
(Actual Photo)

Features:
- Low Voltage Design
- Excellent Clamping
- High Transient Current Capability (2000 Amps)
- Nanosecond Response
- High Energy Capability
- Wide Operating Temperature Range
- Low Temperature Coefficient
- Low Standby Drain
- Compact and Lightweight

Benefits:
- Improves Circuit, Component and System Reliability
- Extends Contact Life
- Reduction of Lightning Effects
- Promotes System Cost Reduction
- Reduces System Size and Weight Requirements
- Increases Product Safety
- No Follow-On Current

Applications:
- Telephone Relays
- Telephone Solid State Circuits
- Communication Equipment
- Relay Coils
- Traffic Controllers
- Computer Equipment
- Railroad Circuitry
- Numerical Control
- Test Equipment
- Instrumentation
- Solid State Motor Control
- Television
- Copier Machines
- Calculators
- Contact Arc Suppression
- Solid State Relays/Timers
- Power Supplies
- Solid State Security Systems
- Medical Equipment
- Fire Alarms

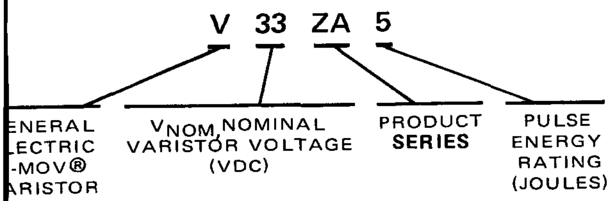
ıximum Electrical Ratings:

ıximum Energy, Power and Peak Current . . . . See Rating Table
ɔrage Temperature, T_{STG} . . . . -40°C to +125°C
ɔerating Surface Temperature, T_S . . . . 115°C
ɔerating Ambient Temperature (without derating) . . . . 85°C
ıximum Voltage Temperature Coefficient . . . . -0.05%/°C

echanical Ratings:

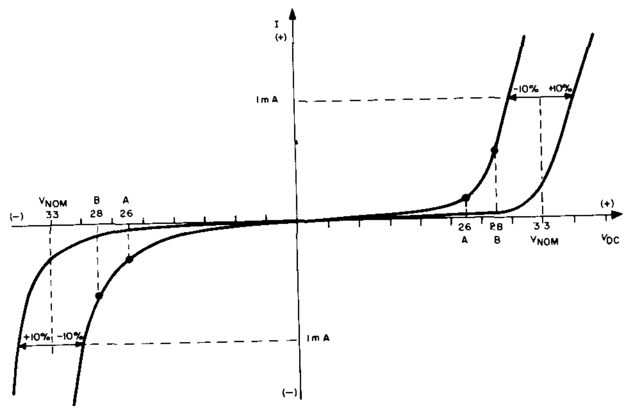
sulation Resistance–Megohms . . . . > 1000
.pot Encapsulation–Volts D.C. for 1 Minute 2500
ɔlderability . . . . Per Mil Std 202C Method 208C

odel Number Nomenclature:



e ZA series GE-MOV ® varistors are characterized at e 1mADC varistor voltage according to RETMA values. r example–V33ZA5: The nominal varistor voltage is VDC, ±10%, at 1mADC. The maximum allowable steady ate applied voltages, 26VDC and 28VAC (peak) fall below e low side nominal varistor voltage of 29.7VDC (33VDC– 0%) to insure the maximum idle power dissipation aracteristics are not exceeded.

V33ZA5 Typical V-I Characteristics:



A–Maximum allowable steady state DC applied voltage.
See Ratings Table.

B–Maximum allowable steady state recurrent peak applied voltage.
See Ratings Table.

VNOM–Nominal Varistor voltage at 1mADC. *See Characteristics Table.*

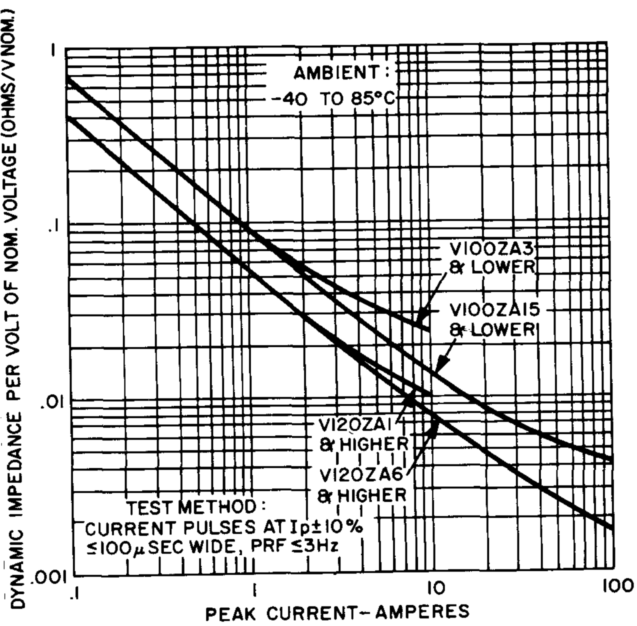


FIGURE 1 TYPICAL CHARACTERISTIC OF DYNAMIC IMPEDANCE VS. PEAK CURRENT

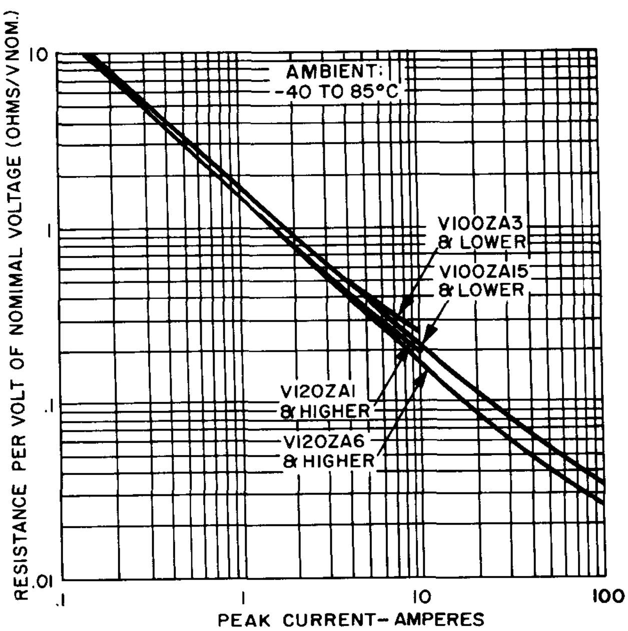


FIGURE 2 MAXIMUM RESISTANCE VS. PEAK CURRENT

SERIES ZA	MAXIMUM RATINGS						CHARACTERISTICS		
MODEL NUMBER	STEADY STATE (1)			TRANSIENT			VNOM VARISTOR VOLTAGE @ 1.0 mA DC CURRENT (5)		TYPICAL CAPACITANCE
	DC APPLIED VOLTAGE (1,2,4)	RMS (2,3,4) APPLIED VOLTAGE 50-60 Hz AC	RECURRENT PEAK APPLIED VOLTAGE (2,3,4)	ENERGY (4)	AVERAGE POWER DISSIPATION (4)	PEAK PULSE CURRENT (6)			
	VOLTS	VOLTS	VOLTS	JOULES (WATT-SECS)	WATTS	AMPS	VOLTS	TOL.	PICOFARADS
V18ZA1	14	10	14	0.5	.18	250	18	± 20%	2500
V18ZA3	14	10	14	3.0	.40	1000	18	± 20%	12000
V22ZA1	18	14	19	0.6	.18	250	22	± 15%	2000
V22ZA3	18	14	19	3.0	.40	1000	22	± 15%	10000
V24ZA1	20	15	21	0.8	.18	250	24	± 10%	1700
V24ZA4	20	15	21	4.0	.40	1000	24	± 10%	8500
V27ZA1	22	17	24	0.8	.18	250	27	± 15%	1700
V27ZA4	22	17	24	4.0	.40	1000	27	± 15%	8500
V33ZA1	26	20	28	1.0	.19	250	33	± 10%	1400
V33ZA5	26	20	28	5.0	.40	1000	33	± 10%	7000
V39ZA1	31	25	35	1.2	.20	250	39	± 10%	1200
V39ZA6	31	25	35	6.0	.45	1000	39	± 10%	6000
V47ZA1	38	30	42	1.4	.21	250	47	± 10%	1000
V47ZA7	38	30	42	7.0	.45	1000	47	± 10%	5000
V56ZA2	45	35	49	1.7	.22	250	56	± 10%	800
V56ZA8	45	35	49	8.0	.45	1000	56	± 10%	4000
V68ZA2	56	40	57	2.0	.24	250	68	± 10%	700
V68ZA10	56	40	57	10.0	.50	1000	68	± 10%	3500
V82ZA2	66	50	71	2.5	.25	250	82	± 10%	600
V82ZA12	66	50	71	12.0	.50	1000	82	± 10%	3000
V100ZA3	81	60	85	3.0	.26	250	100	± 10%	500
V100ZA15	81	60	85	15.0	.55	1000	100	± 10%	2500
V120ZA1	102	75	106	1.0	.20	500	120	± 10%	200
V120ZA6	102	75	106	6.0	.45	2000	120	± 10%	1200
V150ZA1	127	95	134	1.2	.20	500	150	± 10%	170
V150ZA8	127	95	134	8.0	.45	2000	150	± 10%	1000
V180ZA1	153	115	163	1.5	.20	500	180	± 10%	140
V180ZA10	153	115	163	10.0	.45	2000	180	± 10%	800

1. Leakage curren
@ max DC rated voltage = 20 μA typical 200 μA max.
2. Applied Voltag
is that voltage across the varisto
terminals when n
transient is prese
Include high line conditions on selection.
3. For AC applications a sinusoidal Applie
Voltage is assume
assumed to be the normal input condition. If Applied Voltage is non-sinusoidal, Recurrent Peak Applied Voltage values should be used to select the correct model.
4. See Figure 11.
5. 1mA DC current pulse, 20 msec min.
6. See Figures 7 thru 10.

MAXIMUM VOLT-AMPERE CHARACTERISTICS

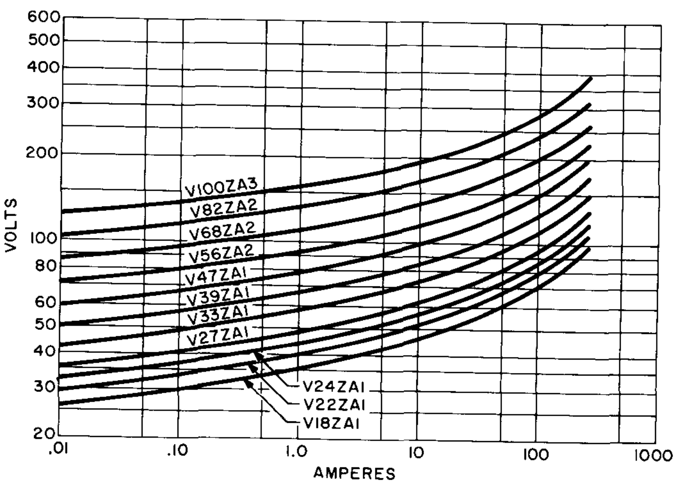


FIGURE 3

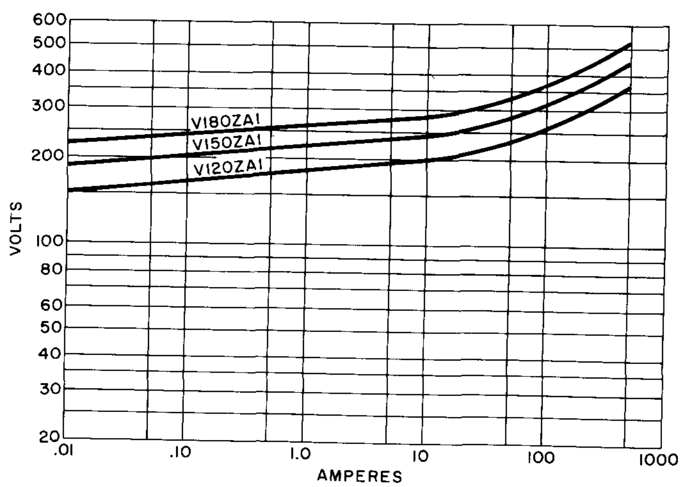


FIGURE 4

MAXIMUM VOLT-AMPERE CHARACTERISTICS

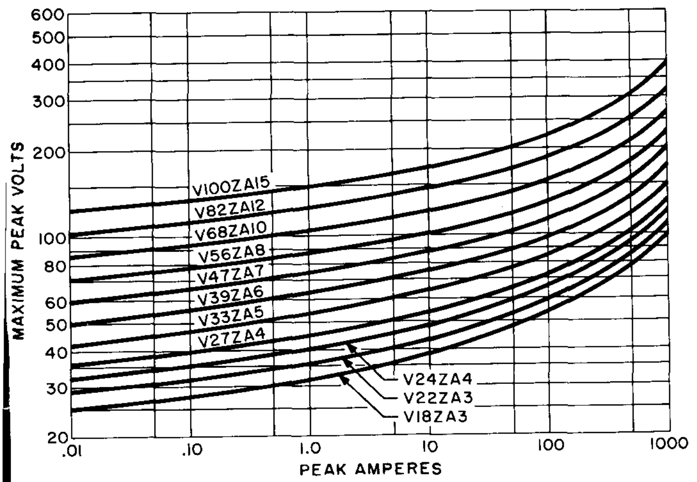


FIGURE 5

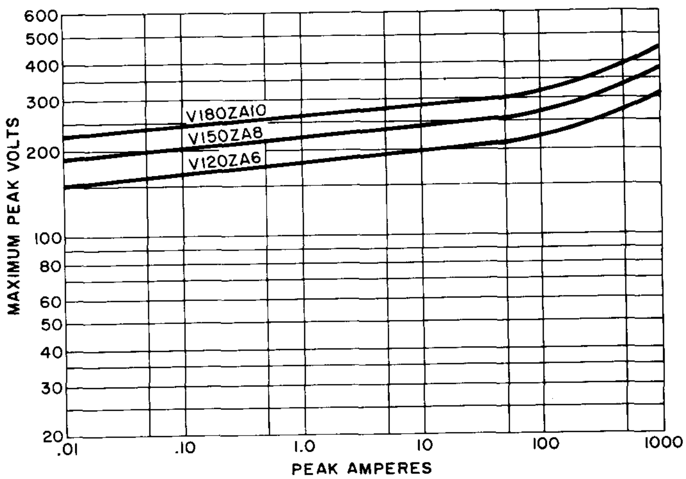


FIGURE 6

PULSE LIFETIME RATINGS

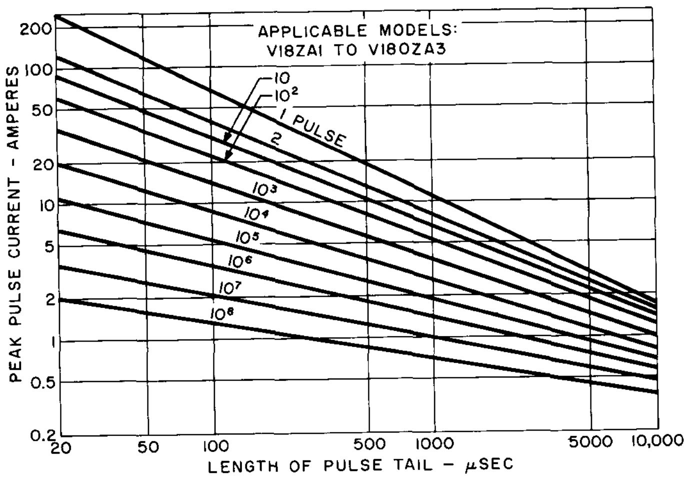


FIGURE 7

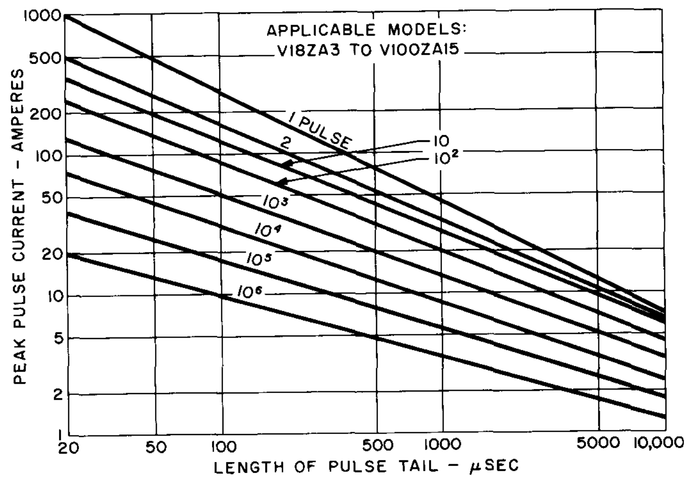


FIGURE 8

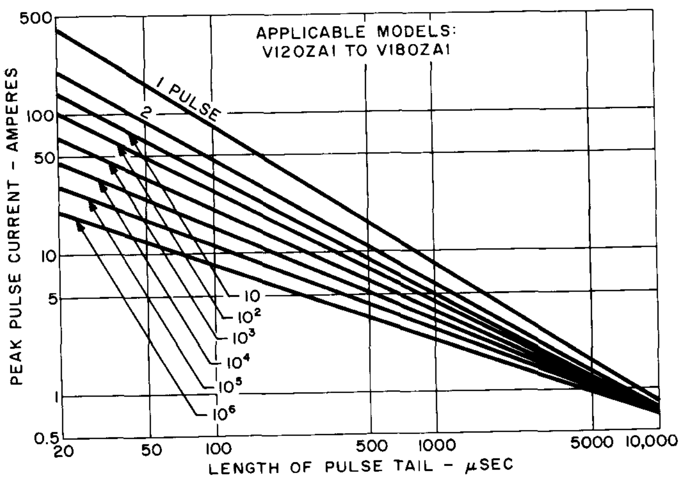


FIGURE 9

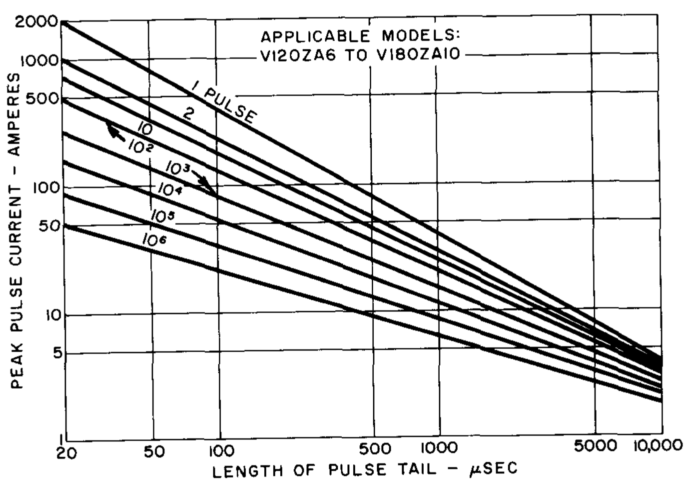
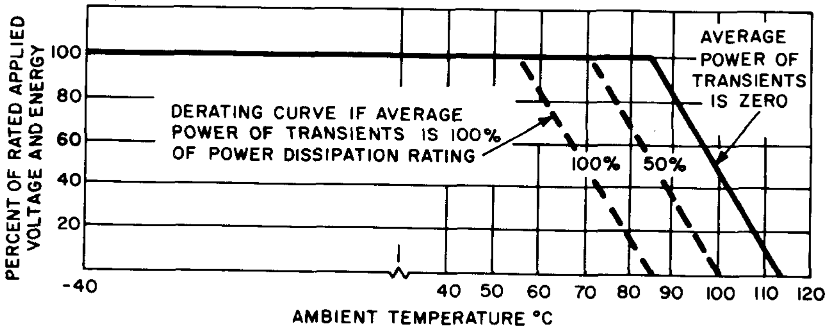


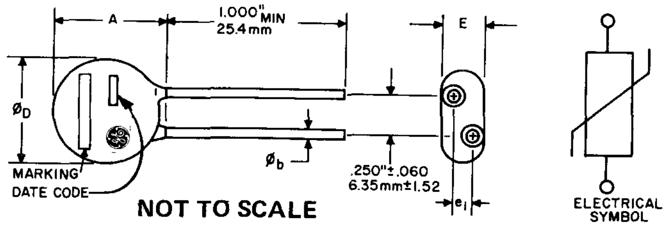
FIGURE 10



The maximum allowable operating ambient temperature without derating is 85°C if the average power of the input transients is zero. This condition is satisfied if the voltage transients are random and non repetitive. Above 85°C the applied voltage and energy ratings both are reduced.

If the voltage transients are repetitive the allowable ambient is reduced according to the level of the average power input. For example, if the average power of the transients is 50% of the dissipation rating the maximum allowable ambient temperature without derating is 70°C. Then, for operation above 70°C the applied voltage and energy ratings are linearly reduced to zero at 100°C.

Figure 11. VOLTAGE AND ENERGY RATINGS VS. AMBIENT TEMPERATURE AND AVERAGE POWER OF INPUT TRANSIENTS

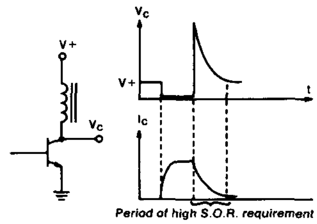


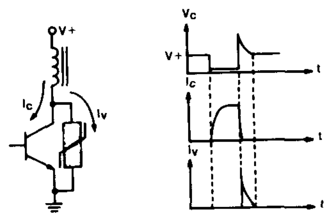
MODEL NUMBER	MARKING	A MAX.		ØD MAX.		E MAX.		e1 MIN.		e1 MAX.		Øb MIN.		Øb MAX.	
		IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM
V18ZA1	18Z1	.461	11.7	.335	8.51	.158	4.0	.038	0.98	.079	2.0	.023	.59	.027	.68
V18ZA3	V18ZA3	.745	16.9	.636	16.15	.173	4.4	.043	1.09	.079	2.0	.030	.77	.034	.86
V22ZA1	22Z1	.461	11.7	.335	8.51	.158	4.0	.038	0.98	.079	2.0	.023	.59	.027	.68
V22ZA3	V22ZA3	.745	16.9	.636	16.15	.173	4.4	.043	1.09	.079	2.0	.030	.77	.034	.86
V24ZA1	24Z1	.461	11.7	.315	8.51	.158	4.0	.038	0.98	.079	2.0	.023	.59	.027	.68
V24ZA4	V24ZA4	.745	18.9	.636	16.15	.173	4.4	.043	1.09	.079	2.0	.030	.77	.034	.86
V27ZA1	27Z1	.461	11.7	.335	8.51	.158	4.0	.038	0.98	.079	2.0	.023	.59	.027	.68
V27ZA4	V27ZA4	.745	18.9	.636	16.15	.197	5.0	.054	1.36	.099	2.5	.030	.77	.034	.86
V33ZA1	33Z1	.461	11.7	.335	8.51	.158	4.0	.038	0.98	.079	2.0	.023	.59	.027	.68
V33ZA5	V33ZA5	.745	18.9	.636	16.15	.197	5.0	.054	1.36	.099	2.5	.030	.77	.034	.86
V39ZA1	39Z1	.461	11.7	.335	8.51	.178	4.5	.048	1.24	.099	2.5	.023	.59	.027	.68
V39ZA6	V39ZA6	.745	18.9	.636	16.15	.197	5.0	.054	1.36	.099	2.5	.030	.77	.034	.86
V47ZA1	47Z1	.461	11.7	.335	8.51	.197	5.0	.059	1.50	.119	3.0	.023	.59	.027	.68
V47ZA7	V47ZA7	.745	18.9	.636	16.15	.212	5.4	.065	1.63	.119	3.0	.030	.77	.034	.86
V56ZA2	56Z2	.461	11.7	.335	8.51	.197	5.0	.059	1.50	.119	3.0	.023	.59	.027	.68
V56ZA8	V56ZA8	.745	18.9	.636	16.15	.237	6.0	.075	1.90	.138	3.5	.030	.77	.024	.68
V68ZA2	68Z2	.461	11.7	.335	8.51	.217	5.5	.068	1.75	.138	3.5	.023	.59	.027	.68
V68ZA10	V68ZA10	.745	18.9	.636	16.15	.251	6.4	.086	2.17	.158	4.0	.030	.77	.034	.86
V82ZA2	82Z2	.461	11.7	.335	8.51	.237	6.0	.079	2.01	.158	4.0	.023	.59	.027	.68
V82ZA12	V82ZA12	.745	18.9	.636	16.15	.275	7.0	.097	2.44	.178	4.5	.030	.77	.034	.86
V100ZA3	100Z	.461	11.7	.335	8.51	.256	6.5	.089	2.27	.178	4.5	.023	.59	.027	.68
V100ZA15	V100ZA15	.745	18.9	.636	16.15	.291	7.4	.107	2.71	.197	5.0	.030	.77	.034	.86
V120ZA1	120Z	.461	11.7	.335	8.51	.158	4.0	.038	0.98	.079	2.0	.023	.59	.027	.68
V120ZA6	V120ZA6	.745	18.9	.636	16.15	.197	5.0	.059	1.36	.099	2.5	.030	.77	.034	.86
V150ZA1	150Z	.461	11.7	.335	8.51	.178	4.5	.048	1.24	.099	2.5	.023	.59	.027	.68
V150ZA8	V150ZA8	.745	18.9	.636	16.15	.197	5.0	.054	1.36	.099	2.5	.030	.77	.034	.86
V180ZA1	180Z	.461	11.7	.335	8.51	.178	4.5	.048	1.24	.099	2.5	.023	.59	.027	.68
V180ZA10	V180ZA10	.745	18.9	.636	16.15	.212	5.4	.065	1.63	.119	3.0	.030	.77	.034	.86

GE-MOV® VARISTOR APPLICATIONS

ELECTRONIC SWITCHING OF INDUCTIVE LOADS

When an inductive load is switched off by a transistor, a high S.O.R. (Safe Operation Region) is required of the transistor to prevent reverse-biased second breakdown. If a GE-MOV® Varistor is connected from collector to emitter, the energy stored in the inductor is no longer forced through the transistor but instead is transferred to the Varistor. This results in a significant decrease in transistor stress and a much more reliable circuit operation.

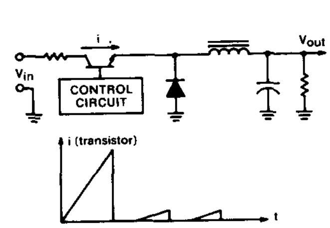


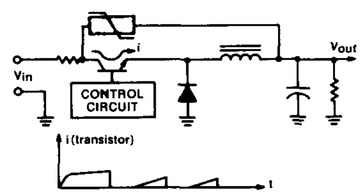


ELECTRONIC SWITCHING FOR REGULATION

Sudden application of supply voltage (or initial turn-on) can damage a switch mode regulator switching device by subjecting it to the heavy current surge required to charge the uncharged filter capacitor.

A GE-MOV® Varistor can be used to shunt the initial surge around the switching device, precharging the capacitor to a safe value. The Varistor will not affect circuit operation at times other than at initial turn-on because it draws extremely little current at a voltage of $V_{IN} - V_{OUT}$. Applied in this manner, the GE-MOV® Varistor can offer important protection for a line operated power supply.





GE-MOV® VARISTOR APPLICATION NOTES

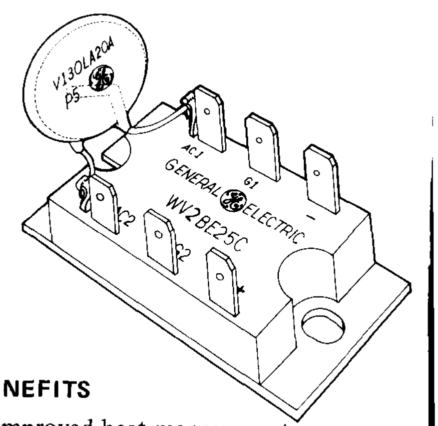
PUB. NO.	TITLE
200.60	GE-MOV Varistors Voltage Transient Suppressors
200.72	Using GE-MOV Varistors to Extend Contact Life
200.73	Testing GE-MOV Varistors
200.77	Detecting & Suppressing Nanosecond Wide Spikes with GE-MOV® Varistors
201.28	Energy Dissipation in GE-MOV® Varistors for Various Pulse Shapes
660.30	Six Ways to Control Voltage Transients, Reprint from *Electronic Design*
660.32	Transient Suppression . . . Don't Make The Cure Worse Than The Disease, Reprint from *Machine Design*
451.133	Transient Voltage Suppression Manual

Phase Control Power Modules

AC-DC Conversion

120 OR 240V AC RMS
LINE OPERATION

PHASE CONTROL 25 AMP SERIES



DESCRIPTION

The General Electric Power Module is a new concept of packaging individual power semiconductor pellets in an electrically isolated, epoxy encapsulated package to perform phase controlled circuit functions, controlling resistive or inductive loads.

FEATURES

- Direct bonded copper mountdown for low thermal resistance and mechanical integrity.
- Strike and creep distances meet proposed NEMA Standard (1/16/1972) and U.L. 508 for 240V AC RMS Operation.
- Power-Glas™ passivated silicon pellets for high reliability.
- GE-MOV® Varistor transient over-voltage protection on all base circuits.
- Electrically isolated package (2500V Peak) terminals to base.
- 120V or 240V RMS line operation.
- Maximum rated output of 25 amperes $I_{T(AV)}$ at 85°C base plate temperature $T_{(BP)}$.
- Epoxy encapsulated to provide resistance from mechanical shock and moisture.
- Standard fast-on terminals.

BENEFITS

- Improved heat management.
- Reduced circuit design costs.
- Lower initial costs achieved by reduc packaging costs.
- Reduced inventory costs.
- Lower test cost achieved by testing functional assembly.
- Ease of Installation: Customer provides gating circuit and standard wiring.
- Ease of maintenance.

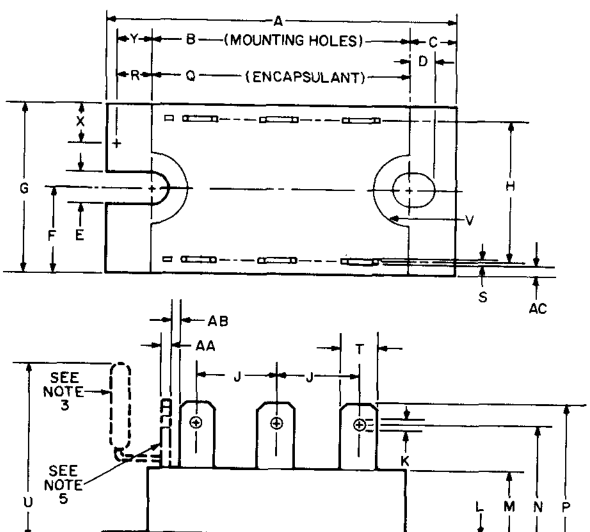
APPLICATIONS

- DC Motor Power Supplies
- Permanent Magnet Motor Controls
- Magnetic Clutches and Brakes
- Industrial Heating
- SCR Phase Controlled Power Supplies
- Battery Charger Power Supplies

MARKETS

- Industrial Control
- Machine Tool
- Business Machine
- Computer
- Communication

OUTLINE DRAWING



SYM	INCHES MIN.	INCHES MAX.	METRIC MM MIN.	METRIC MM MAX.	NOTES
A	2,485	2.515	63.12	63.88	
B	1.890	1.910	48.01	48.51	
C	.290	.310	7.37	7.87	
D	.155	–	3.94	–	
E	.200	.215	5.08	5.46	
F	.620	.630	15.75	16.00	
G	1.240	1.260	30.50	32.00	
H	1.07	REF.	27.18	REF.	
J	.630	.660	15.87	16.76	
K	.057	.067	1.45	1.70	
L	.055	.070	1.40	1.78	
M	.523	.550	13.28	13.97	
N	.800	.850	20.32	21.59	
P	.965	1.025	24.51	26.04	
Q	–	1.915	–	48.64	
R	.285	–	7.23	–	
S	.027	.037	.69	.94	
T	.245	.255	6.22	6.48	1 & 2
U	–	1.550	–	39.37	3
V	.230	–	5.84	–	
X	–	.310	–	7.37	4
Y	–	.235	–	5.97	4
AA	.065	.085	1.65	2.16	
AB	.040	–	1.02	–	

NOTES:

1. TERMINALS WILL ACCEPT .250 SERIES FAST-ON CONNECTORS.
2. VIEW SHOWS TYPICAL LOCATIONS. SEE CIRCUIT SCHEMATICS AND TERMINAL POSITIONS FOR NUMBER OF TERMINALS AND THEIR LOCATIONS FOR SPECIFIC MODEL.
3. U DIMENSION SHOW MAXIMUM HEIGHT OF VARISTOR. VIEW ONLY SHOWS TYPICAL LOCATION. VARISTOR APPEARS ONLY ON MODELS BEGINNING WITH LETTERS WV.
4. POINTS (X-Y) ARE FOR THERMOCOUPLE PLACEMENT FOR BASE PLATE TEMPERATURE MEASUEMENT.
5. TABS SHOWN ATTACHED TO A.C. TERMINALS ARE INTENDED FOR GE-MOV® VARISTOR ATTACHMENT.

Power Module Nomenclature:

W V 2 BE 25 E

W	V	2	BE	25	E
GENERAL ELECTRIC POWER MODULE SERIES	GENERAL ELECTRIC GE-MOV® VARISTOR PROTECTED INPUT	BASE PLATE DIMENSION	CIRCUIT TYPE	MAX. CURRENT AT MAX. BASE PLATE TEMP.	VOLTAGE

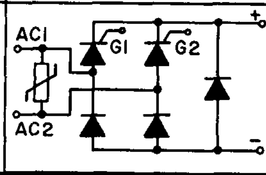
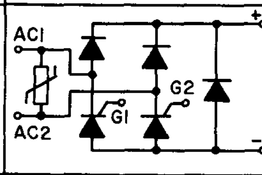
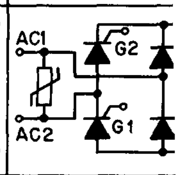
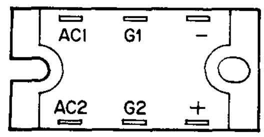
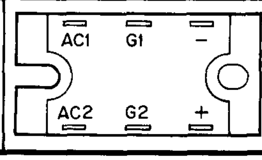
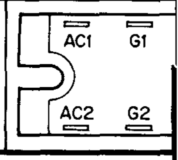
Maximum Average Output Current (Total Bridge, T_{BP} = 85°C) . . . . . 25 Amperes
DC Output Current $I_{T(AV)}$ (Total Bridge) . . . . . Depends on Conduction Angle (See Chart 1,3,4,5)
Critical Rate-Of-Rise of On-State Current, di/dt:[1] . . . . . (See Chart 13)
Gate Triggered Operation-Switching from 500 Volts . . . . . 100 Amperes Per Microsecond
Peak One Cycle Surge (Non-Rep) On-State Current, I_{TSM} 60Hz . . . . . 300 Amperes
I^2t (for fusing), For Times at 8.3 milliseconds. . . (See Chart) . . . . . 370 Ampere² Seconds
1.0 milliseconds . . . . . 260 Ampere² Seconds
Peak Gate Power Dissipation, P_{GM} . . . . . 5 Watts for 10 Microseconds
Average Gate Power Dissipation, $P_{G(AV)}$ . . . . . 0.5 Watts
Peak Positive Gate Current, I_{GM} . . . . . (See Chart 12)
Peak Positive Gate Voltage, V_{GM} . . . . . (See Chart 12)
Peak Negative Gate Voltage, V_{GM} . . . . . 5 Volts
Storage Temperature, T_{STG} . . . . . -40°C to 125°C
Operating Temperature, T_J . . . . . -40°C to 125°C
Isolation Breakdown Voltage Between Any Terminal and Base Plate[2] . . . . . 2500 Volts (Peak)
Minimum Strike and Creep Distance:
Terminal to Terminal . . . . . 0.375 Inch
Terminal to Terminal . . . . . (0.95 CM)
Minimum Strike and Creep Distance:
Terminal to Base Plate . . . . . 0.500 Inch
Terminal to Base Plate . . . . . (1.27 CM)
Maximum Weight . . . . . 2.65 Ounces
Maximum Weight . . . . . (75 Grams)

[1] di/dt rating is established in accordance with EIA NEMA Standard RS 397, Section 5.2.2.6. Off-State (blocking) voltage capability may be temporarily lost after each current pulse for duration less than the period of the applied pulse repetition rate. The pulse repetition rate for this test is 400 Hz. The duration of the di/dt test condition is 5 seconds (minimum).

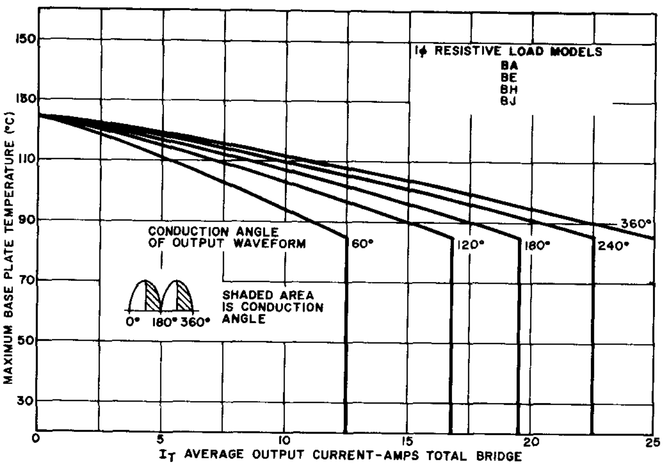
[2] Rating applies for 50, 60 and 400 Hz Sinusoidsl Wave Form.

CHARACTERISTICS

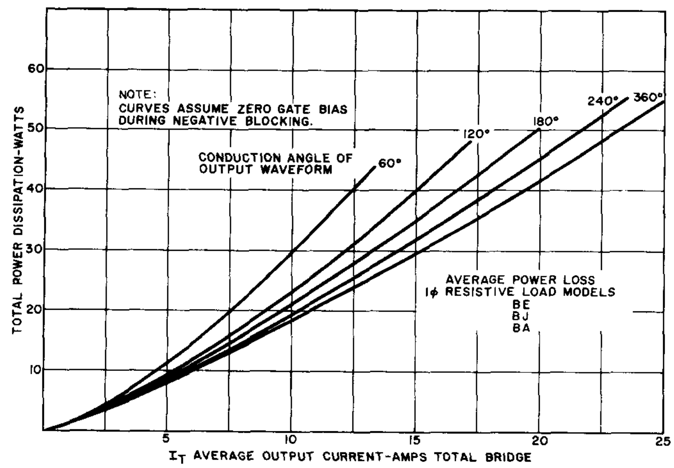
TEST	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Critical Rate-Of-Rise of Off-State Voltage (Higher Values May Cause Device Switching)	dv/dt	20	–	–	Volts/μsec	T_{BP} = 125°C, Rated V_{DRM} Gate Open Circuited, Linear Wave Form
DC Gate Trigger Current	I_{GT}	–	–	40	mAdc	T_{BP} = 25°C, V_D = 12Vdc, R_L = 80Ω
		–	–	80		T_{BP} = -40°C, V_D = 12Vdc, R_L = 50Ω
DC Gate Trigger Voltage	V_{GT}	–	–	2.5	Vdc	T_{BP} = 25°C, V_D = 12Vdc, R_L = 80Ω
		–	–	3.0		T_{BP} = -40°C, V_D = 12Vdc, R_L = 50Ω
		0.20	–	–		T_{BP} = 125°C, V_{DRM} = Rated, R_L = 1KΩ
Holding Current	I_H	–	–	75	mAdc	Anode Source Voltage = 24Vdc, Peak Initiating On-State Current = 0.5A, 0.1 msec to 10 msec Wide Pulse. Gate Trigger Source = 7V, 20 ohms. T_{BP} = 25°C.
		–	–	150		T_{BP} = -40°C.
Latching Current	I_L	–	–	150	mAdc	Main Terminal Source Voltage = 24Vdc, Gate trigger source = 15V, 100 ohms, 50μsec pulse width, 5μsec rise and fall times max. T_{BP} = 25°C.
		–	–	300		T_{BP} = -40°C.
Steady-State Thermal Resistance, Base Plate to Heat Sink	$R_{\Theta BP-HS}$	–	–	0.1	°C/Watt	NOTE: Assumes a 2.0 square inch surface area with thermal grease, GE-G-640, or equivalent on smooth contact surface.

CIRCUIT FAMILY		BE		BJ		BA	
BASIC CIRCUIT SCHEMATIC							
AVERAGE OUTPUT CURRENT @ T_{BP}=85°C AMPS		25		25		25	
VOLTAGE INPUT $(V_{AC})_{RMS}$		120	240	120	240	120	
CIRCUIT* TYPES	BASIC CIRCUIT	WV2BE25C	WV2BE25E	WV2BJ25C	WV2BJ25E	WV2BA25C	WV
	WITHOUT FREE WHEELING DIODE	WV2BC25C	WV2BC25E	WV2BK25C	WV2BK25E		
	WITHOUT GE-MOV® VARISTOR PROTECTION	W2BE25C	W2BE25E	W2BJ25C	W2BJ25E	W2BA25C	W
	WITHOUT FREE WHEELING DIODE AND GE-MOV® VARISTOR PROTECTION	W2BC25C	W2BC25E	W2BK25C	W2BK25E		
TERMINAL POSITION							

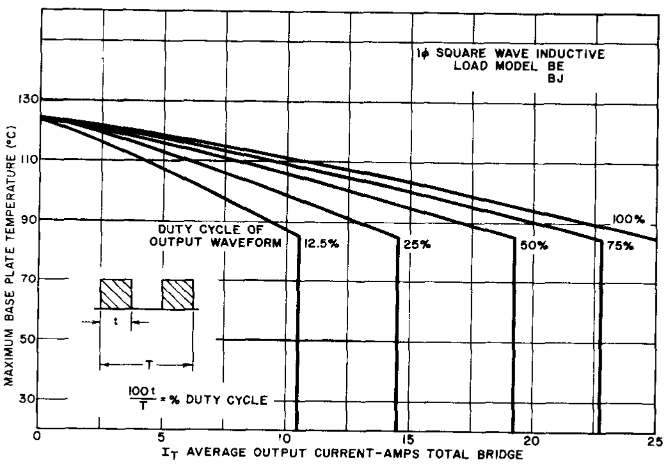
*OTHER CIRCUIT TYPES AVAILABLE, CONTACT FACTORY.
†CONTACT FACTORY FOR CURRENT RATINGS FOR APPLICABLE CIRCUIT.



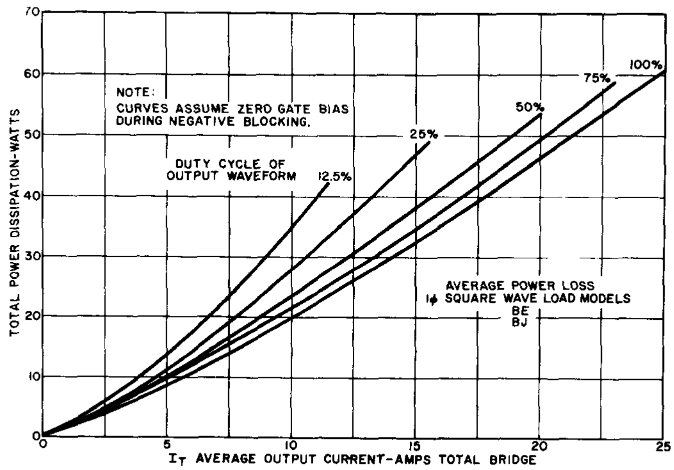
1. MAX. ALLOWABLE BASE PLATE TEMPERATURE VS. AVERAGE OUTPUT CURRENT (SINE WAVE)



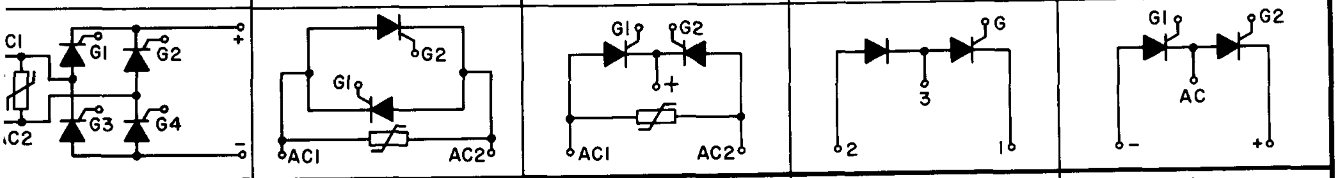
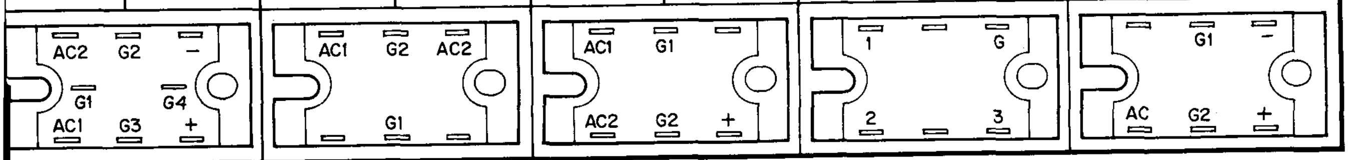
2. MAX. OUTPUT POWER DISSIPATION VS. AVERAGE OUTPUT CURRENT (SINE WAVE)

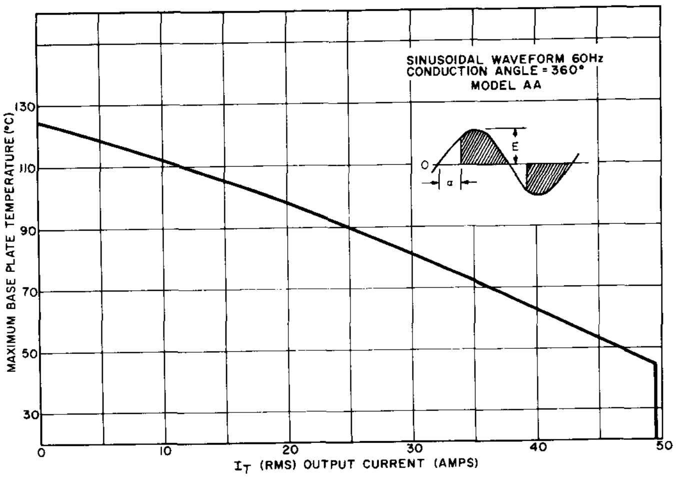


5. MAX. ALLOWABLE BASE PLATE TEMPERATURE VS. AVERAGE OUTPUT CURRENT (SQUARE WAVE)

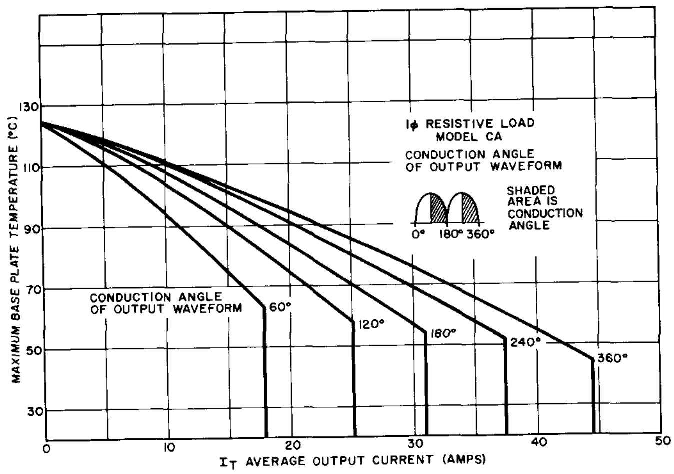


6. MAX. OUTPUT POWER DISSIPATION VS. AVERAGE OUTPUT CURRENT (SQUARE WAVE

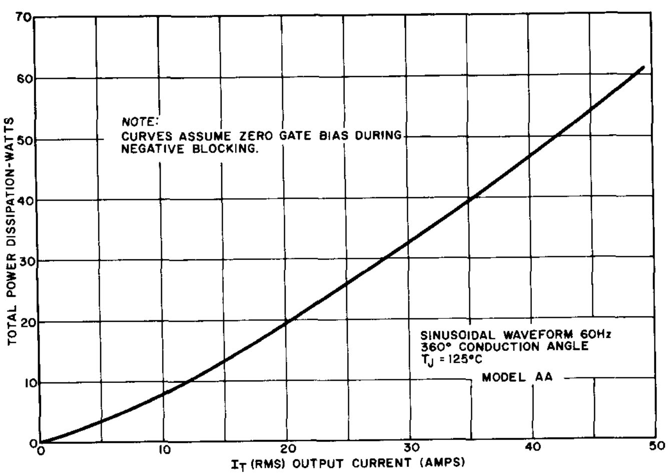
BH		AA		CA		DA		DC	
									
25		50(ARMS)		25		†		†	
120	240	120	240	120	240	120	240	120	240
WV2BH25C	WV2BH25E	WV2AA50C	WV2AA50E	WV2CA25C	WV2CA25E	WV2DA__C	WV2DA__E	WV2DC__C	WV2DC__E
W2BH25C	W2BH25E	W2AA50C	W2AA50E	W2CA25C	W2CA25E	W2DA__C	W2DA__E	W2DC__C	W2DC__E
									



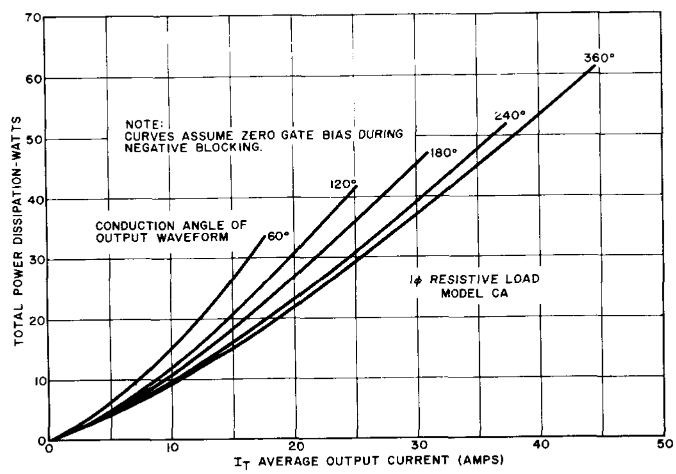
3. MAX. ALLOWABLE BASE PLATE TEMPERATURE VS. RMS OUTPUT CURRENT



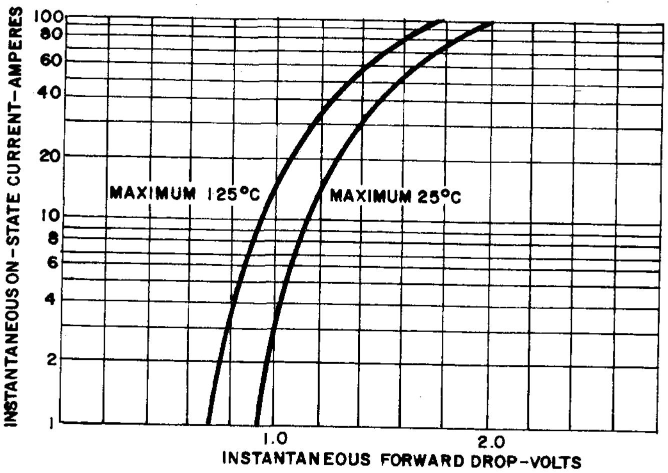
4. MAX. ALLOWABLE BASE PLATE TEMPERATURE VS. AVERAGE OUTPUT CURRENT (SINE WAVE)



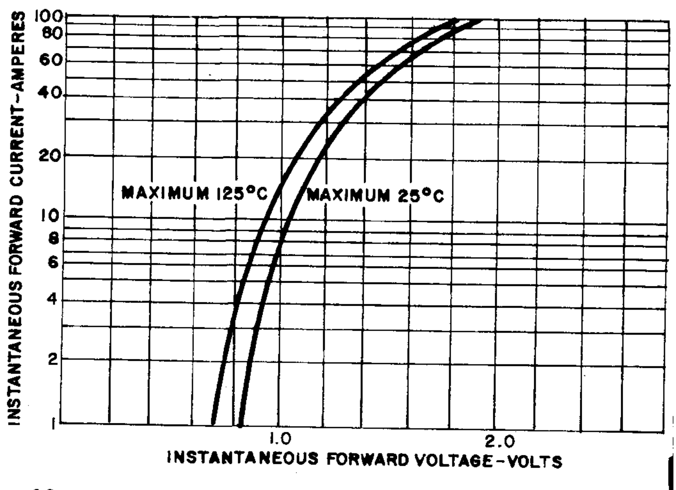
7. MAX. POWER DISSIPATION VS. RMS OUTPUT CURRENT



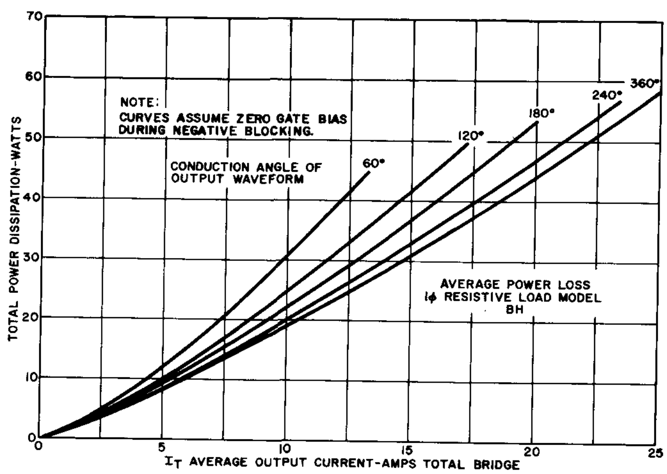
8. MAX. OUTPUT POWER DISSIPATION VS. AVERAGE OUTPUT CURRENT (SINE WAVE)



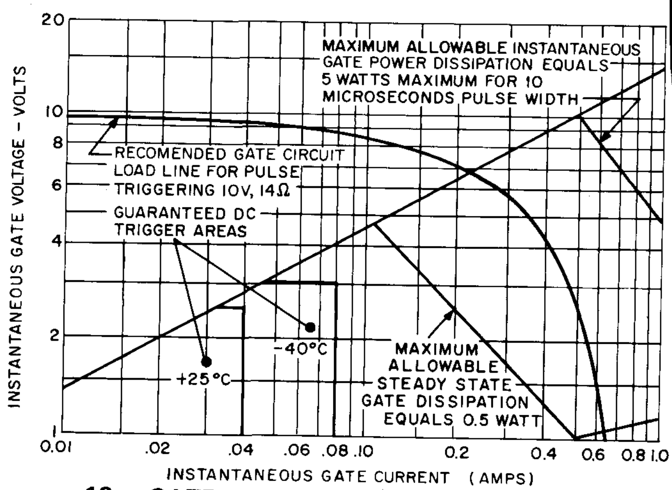
9. INSTANTANEOUS ON-STATE VOLTAGE VS. INSTANTANEOUS ON-STATE CURRENT (SCR)



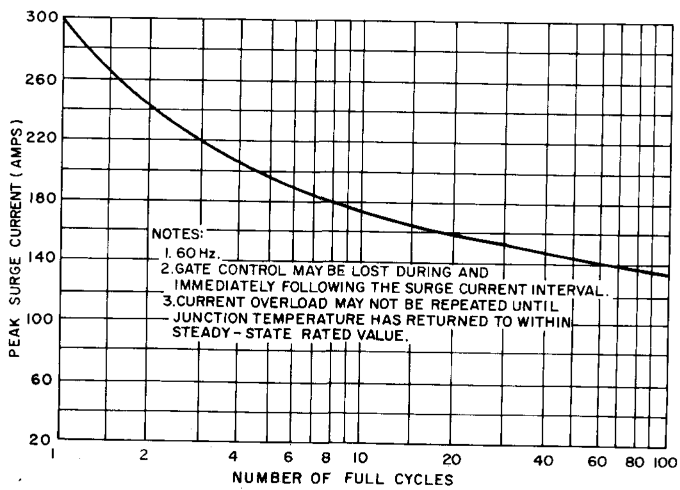
10. INSTANTANEOUS FORWARD VOLTAGE VS. INSTANTANEOUS FORWARD CURRENT (DIODE)



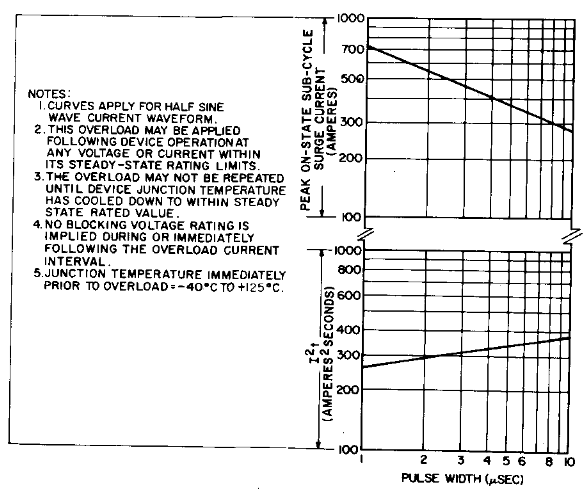
11. MAX. OUTPUT POWER DISSIPATION VS. AVERAGE OUTPUT CURRENT (SINE WAVE)



12. GATE TRIGGER CHARACTERISTICS



13. MAXIMUM ALLOWABLE SURGE CURRENT FOLLOWING RATED LOAD CONDITIONS



14. SUB-CYCLE SURGE AND I^2T RATING FOLLOWING RATED LOAD CONDITIONS

GENERAL ELECTRIC WORLDWIDE ELECTRONIC COMPONENTS SALES OFFICES

2/77

ALABAMA
Huntsville 35801
3322 S. Memorial Pkwy.
Suite 4
Area Code: 205
883-9220

ARIZONA
Phoenix 85016
5320 North 16th St.
Area Code: 602
264-1751

CALIFORNIA
Los Angeles 90064
11840 W. Olympic Blvd.
Area Code: 213
479-7763

Palo Alto 94304
1801 Page Mill Rd.
Suite 223
Area Code: 415
493-2600

COLORADO
Denver 80201
201 University Blvd.
Mailing Address:
P.O. Box 2331, 80201
Area Code: 303
320-3031

CONNECTICUT
Bridgeport 06602
1285 Boston Ave.
Building 28-CE
Area Code: 203
334-1012

DISTRICT OF COLUMBIA
(Washington)
Falls Church, Va. 22043
7777 Leesburg Pike
Area Code: 703
790-1700

FLORIDA
North Palm Beach 33408
321 Northlake Blvd.
Suite 101
Area Code: 305
844-5202

ILLINOIS
Chicago 60641
3800 N. Milwaukee Ave.
Area Code: 312
777-1600

INDIANA
Ft. Wayne 46805
2109 E. State Blvd.
Area Code: 219
482-4557

Indianapolis 46208
3750 N. Meridian St.
Area Code: 317
923-7221

MASSACHUSETTS
Wellesley 02181
1 Washington St.
Area Code: 617
237-2050

MICHIGAN
Southfield 48075
24681 Northwestern
Area Code: 313
355-3552

MINNESOTA
Minneapolis 55435
4900 Viking Dr.
Room 108
Area Code: 612
835-2550

MISSOURI
Kansas City 64105
911 Main St.
Suite 518
Area Code: 816
221-4033

St. Louis 63132
1530 Fairview St.
Area Code: 314
429-6941

NEW JERSEY
Fairfield 07006
420 Route 46
Area Code: 201
227-6050

NEW YORK
Albany 12205
11 Computer Dr., W.
Area Code: 518
458-7755

New York City — call:
Jericho 11753
400 Jericho Tnpk.
Area Code: 516
681-0900

Rochester 14623
3000 Winton Rd., S.
Area Code: 716
461-5400

Syracuse 13201
Bldg. 1, Room 227
Electronics Pk.
Area Code: 315
456-2196

NORTH CAROLINA
Greensboro 27408
1828 Banking St.
P.O. Box 9476
Area Code: 919
273-6981

OHIO
Cleveland 44132
26250 Euclid Ave.
Area Code: 216
266-2900

Dayton 45439
3430 S. Dixie Highway
Mailing Address:
P.O. Box 2143
Kettering Branch 45429
Area Code: 513
298-0311

OKLAHOMA
Oklahoma City 73112
3022 Northwest Expressway
May-Ex Building
Room 412
Area Code: 405
943-9015

PENNSYLVANIA
Erie 16531
Building 63-2
1100 Lawrence Pkwy.
Area Code: 814
455-5466

(Philadelphia)
Wayne 19087
999 Old Eagle School Rd.
Area Code: 215
962-1500

Pittsburgh 15220
3 Parkway Center
Room 304
Area Code: 412
921-4134

TEXAS
Dallas 75240
6530 LBJ Freeway
Suite 119-B
Area Code: 214
661-8582

Houston 77036
7011 S.W. Freeway
Suite 106
Area Code: 713
777-3443

VIRGINIA
Waynesboro 22980
Suites 19 and 20
Skyline Motor Court
Rt. 250 East
Area Code: 703
943-1151

Portsmouth 23707
808 Loudon Ave.
Area Code: 804
397-8752

WASHINGTON
Seattle 98188
112 Andover Park, E.
P.O. Box 88850, 98188
Area Code: 206
575-2866

WISCONSIN
Milwaukee 53202
615 E. Michigan St.
Area Code: 414
271-5000

AFRICA
S.A. General Electric (Pty) Ltd.
P.O. Box 24
Maitland 7405
R.S.A.
Tel: 511251

S.A. General Electric Ltd.
P.O. Box 1482
Capetown, R.S.A.
Tel: 51-1251

AUSTRALIA
Australian General Electric Ltd.
86-90 Bay St.
Ultimo, N.S.W., 2007
Tel: 212-3711

AUSTRIA
General Electric Technical
Service Company, Inc.
East Central Europe Liaison
Peter Jordan Strasse 99
A-1180 Vienna, Austria

BELGIUM
General Electric Company (USA)
Chaussee De La Hulpe 150
B-1170 Brussels
Tel: 660 20 10

CANADA
Canadian General Electric Co.
189 Dufferin St.
Toronto, Ontario, Canada
Area Code: 416
Tel: 537-4481

ENGLAND
International General Electric
Company of New York, Ltd.
Park Lorne,
111 Park Rd.
London NW87 JL
Tel: 01-402-4100

FRANCE
General Electric Technical Service
Company Inc., France
42 Avenue Montaigne
Paris-8e
Tel: 225-52-32

GERMANY
General Electric Germany
Postfach 2963
Eschersheimer Landstrasse 60-62
6000 Frankfurt/Ma 1
Tel: (0611)-15641

INDIA
Elpro International Ltd.
Producer Goods Dept.
Nirmal, 17th Floor
Nariman Point, Bombay 400 021
Tel: 292471

IRELAND
Electronic Trading Co.
The Demesne
County Louth
Dundalk
Tel: (042) 32371

ITALY
Compagnia Generale Di
Elettricita S.P.A.
Via Pergolesi 25
20124 Milan
Tel: 202808-203208

JAPAN
General Electric Japan, Ltd.
Tonichi Bldg., 5th Floor
2-31, Roppongi, 6-Chome,
Minato-Ku
Tokyo, 106 Japan
Tel: 03-405-2920

MEXICO
General Electric De Mexico, S.A.
Apartado 53-983
Marina Nacional No. 365
Mexico 17 D.F.
Tel: 545-63-60

SINGAPORE
General Electric (USA) Asia Co.
Cathay Building, Suite 104
Orchard Road
Singapore, 9

SPAIN
International General Electric
Company of Spain, S.A.
Edificio Espana Apartado 700
Avenida Jose Antonio 88
Madrid
Tel: 247.16.05

SWEDEN
International General Electric AB
Fack, Tritonvagen 27
17120 Solna
Sweden
Tel: 081730 07 40

VENEZUELA
General Electric De Venezuela S.A.
Sabana Grande
Caracas

451.138

PRINTED IN U.S.A.