

PHILIPS

Data handbook



Electronic
components
and materials

Semiconductors and integrated circuits

Part 2 June 1979

Low-frequency power transistors

Low-frequency power hybrid modules

SEMICONDUCTORS AND INTEGRATED CIRCUITS

PART 2 - JUNE 1979

LOW-FREQUENCY POWER TRANSISTORS

DATA HANDBOOK SYSTEM
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MAINTENANCE TYPE LIST

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GENERAL

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ACCESSORIES

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DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, sub-assemblies and materials; it is made up of three series of handbooks each comprising several parts.

ELECTRON TUBES

BLUE

SEMICONDUCTORS AND INTEGRATED CIRCUITS

RED

COMPONENTS AND MATERIALS

GREEN



The several parts contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

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October 1977

ELECTRON TUBES (BLUE SERIES)

Part 1a	December 1975	ET1a 12-75	Transmitting tubes for communication, tubes for r.f. heating Types PE05/25 to TBW15/25
Part 1b	August 1977	ET1b 08-77	Transmitting tubes for communication, tubes for r.f. heating, amplifier circuit assemblies
Part 2a	November 1977	ET2a 11-77	Microwave tubes Communication magnetrons, magnetrons for microwave heating, klystrons, travelling-wave tubes, diodes, triodes T-R switches
Part 2b	May 1978	ET2b 05-78	Microwave semiconductors and components Gunn, Impatt and noise diodes, mixer and detector diodes, backward diodes, varactor diodes, Gunn oscillators, sub- assemblies, circulators and isolators
Part 3	January 1975	ET3 01-75	Special Quality tubes, miscellaneous devices
Part 4	March 1975	ET4 03-75	Receiving tubes
Part 5a	March 1978	ET5a 03-78	Cathode-ray tubes Instrument tubes, monitor and display tubes, C.R. tubes for special applications
Part 5b	December 1978	ET5b 12-78	Camera tubes and accessories, image intensifiers
Part 6	January 1977	ET6 01-77	Products for nuclear technology Channel electron multipliers, neutron tubes, Geiger-Müller tubes
Part 7a	March 1977	ET7a 03-77	Gas-filled tubes Thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes
Part 7b	May 1979	ET7b 05-79	Gas-filled tubes Segment indicator tubes, indicator tubes, switching diodes, dry reed contact units
Part 8	May 1977	ET8 05-77	TV picture tubes
Part 9	March 1978	ET9 03-78	Photomultiplier tubes; phototubes

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

Part 1a	August 1978	SC1a 08-78	Rectifier diodes, thyristors, triacs Rectifier diodes, voltage regulator diodes ($> 1,5$ W), transient suppressor diodes, rectifier stacks, thyristors, triacs
Part 1b	May 1977	SC1b 05-77	Diodes Small signal germanium diodes, small signal silicon diodes, special diodes, voltage regulator diodes ($< 1,5$ W), voltage reference diodes, tuner diodes
Part 2	November 1977	SC2 11-77	Low-frequency and dual transistors*
Part 2	June 1979	SC2 06-79	Low-frequency power transistors
Part 3	January 1978	SC3 01-78	High-frequency, switching and field-effect transistors
Part 4a	December 1978	SC4a 12-78	Transmitting transistors and modules
Part 4b	September 1978	SC4b 09-78	Devices for optoelectronics Photosensitive diodes and transistors, light emitting diodes, photocouplers, infrared sensitive devices, photoconductive devices
Part 4c	July 1978	SC4c 07-78	Discrete semiconductors for hybrid thick and thin-film circuits
Part 5a	November 1978	SC5a 11-76	Professional analogue integrated circuits
Part 5b	March 1977	SC5b 03-77	Consumer integrated circuits Radio-audio, television
Part 6	October 1977	SC6 10-77	Digital integrated circuits LOCMOS HE4000B family
Signetics integrated circuits 1978			Bipolar and MOS memories Bipolar and MOS microprocessors Analogue circuits Logic - TTL

* Low-frequency general purpose transistors will be transferred to SC3 later in 1979. The old book SC2 11-77 should be kept until then.

COMPONENTS AND MATERIALS (GREEN SERIES)

Part 1	June 1977	CM1 06-77	Assemblies for industrial use High noise immunity logic FZ/30-series, counter modules 50-series, NORbits 60-series, 61-series, circuit blocks 90-series, circuit block CSA70(L), PLC modules, input/output devices, hybrid circuits, peripheral devices, ferrite core memory products
Part 2a	October 1977	CM2a 10-77	Resistors Fixed resistors, variable resistors, voltage dependent resistors (VDR), light dependent resistors (LDR), negative temperature coefficient thermistors (NTC), positive temperature coefficient thermistors (PTC), test switches
Part 2b	February 1978	CM2b 02-78	Capacitors Electrolytic and solid capacitors, film capacitors, ceramic capacitors, variable capacitors
Part 3	January 1977	CM3 01-77	Radio, audio, television Components for black and white television, components for colour television
Part 3a	September 1978	CM3a 09-78	FM tuners, television tuners, surface acoustic wave filters
Part 3b	October 1978	CM3b 10-78	Loudspeakers
Part 4a	November 1978	CM4a 11-78	Soft ferrites Ferrites for radio, audio and television, beads and chokes, Ferroxcube potcores and square cores, Ferroxcube transformer cores
Part 4b	February 1979	CM4b 02-79	Piezoelectric ceramics, permanent magnet materials
Part 6	April 1977	CM6 04-77	Electric motors and accessories Small synchronous motors, stepper motors, miniature direct current motors
Part 7	September 1971	CM7 09-71	Circuit blocks Circuit blocks 100 kHz-series, circuit blocks 1-series, circuit blocks 10-series, circuit blocks for ferrite core memory drive
Part 7a	January 1979	CM7a 01-79	Assemblies Circuit blocks 40-series and CSA70 (L), counter modules 50-series, input/output devices
Part 8	June 1979	CM8 06-79	Variable mains transformers
Part 9	March 1976	CM9 03-76	Piezoelectric quartz devices
Part 10	April 1978	CM10 04-78	Connectors



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INDEX OF TYPE NUMBERS

Data Handbooks SC1a to SC4c

The inclusion of a type number in this publication does not necessarily imply its availability.

type no.	part	section	type no.	part	section	type no.	part	section
AA119	1b	PC	BA243	1b	T	BAX15	1b	WD
AAZ15	1b	GB	BA244	1b	T	BAX16	1b	WD
AAZ17	1b	GB	BA280	1b	T	BAX17	1b	WD
AAZ18	1b	GB	BA314	1b	Vrg	BAX18	1b	WD
AC125	2	LF	BA314A	1b	Vrg	BAX18A	1b	WD
AC126	2	LF	BA315	1b	Vrg	BB105A	1b	T
AC127	2	LF	BA316	1b	WD	BB105B	1b	T
AC128	2	LF	BA317	1b	WD	BB105G	1b	T
AC128/01	2	LF	BA318	1b	WD	BB106	1b	T
AC132	2	LF	BA379	1b	T	BB110B	1b	T
AC187	2	LF	BAS16	4c	Mm	BB110G	1b	T
AC187/01	2	LF	BAT17	4c	Mm	BB117	1b	T
AC188	2	LF	BAT18	4c	Mm	BB119	1b	T
AC188/01	2	LF	BAV10	1b	WD	BB204B	1b	T
AF367	3	HFSW	BAV18	1b	WD	BB204G	1b	T
BA100	1b	AD	BAV19	1b	WD	BB205A	1b	T
BA102	1b	T	BAV20	1b	WD	BB205B	1b	T
BA145	1a	R	BAV21	1b	WD	BB205G	1b	T
BA148	1a	R	BAV45	1b	Sp	BBY31	4c	Mm
BA157	1a	R	BAV70	4c	Mm	BC107	2	LF
BA158	1a	R	BAV99	4c	Mm	BC108	2	LF
BA159	1a	R	BAW21A	1b	WD	BC109	2	LF
BA182	1b	T	BAW21B	1b	WD	BC140	2	LF
BA216	1b	WD	BAW56	4c	Mm	BC141	2	LF
BA217	1b	WD	BAW62	1b	WD	BC146	2	LF
BA218	1b	WD	BAX12	1b	WD	BC147	2	LF
BA219	1b	WD	BAX12A	1b	WD	BC148	2	LF
BA220	1b	WD	BAX13	1b	WD	BC149	2	LF
BA221	1b	WD	BAX14	1b	WD	BC157	2	LF
BA222	1b	WD	BAX14A	1b	WD	BC158	2	LF

AD = Silicon alloyed diodes
 GB = Germanium gold bonded diodes
 HFSW = High-frequency and switching transistors
 LF = Low-frequency transistors (SC2 11-77)
 Mm = Discrete semiconductors for hybrid
 thick and thin-film circuits

PC = Germanium point contact diodes
 R = Rectifier diodes
 Sp = Special diodes
 T = Tuner diodes
 Vrg = Voltage regulator diodes
 WD = Silicon whiskerless diodes

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type no.	part	section	type no.	part	section	type no.	part	section
BC159	2	LF	BCW71;R	4c	Mm	BD182	2	P
BC160	2	LF	BCW72;R	4c	Mm	BD183	2	P
BC161	2	LF	BCX17;R	4c	Mm	BD201	2	P
BC177	2	LF	BCX18;R	4c	Mm	BD202	2	P
BC178	2	LF	BCX19;R	4c	Mm	BD203	2	P
BC179	2	LF	BCX20;R	4c	Mm	BD204	2	P
BC200	2	LF	BCX51	4c	Mm	BD226	2	P
BC264A	3	FET	BCX52	4c	Mm	BD227	2	P
BC264B	3	FET	BCX53	4c	Mm	BD228	2	P
BC264C	3	FET	BCX54	4c	Mm	BD229	2	P
BC264D	3	FET	BCX55	4c	Mm	BD230	2	P
BC327	2	LF	BCX56	4c	Mm	BD231	2	P
BC328	2	LF	BCY30A	2	LF	BD232	2	P
BC337	2	LF	BCY31A	2	LF	BD233	2	P
BC338	2	LF	BCY32A	2	LF	BD234	2	P
BC368	2	LF	BCY33A	2	LF	BD235	2	P
BC369	2	LF	BCY34A	2	LF	BD236	2	P
BC546	2	LF	BCY55	2	DT	BD237	2	P
BC547	2	LF	BCY56	2	LF	BD238	2	P
BC548	2	LF	BCY57	2	LF	BD291	2	P
BC549	2	LF	BCY58	2	LF	BD292	2	P
BC550	2	LF	BCY59	2	LF	BD293	2	P
BC556	2	LF	BCY70	2	LF	BD294	2	P
BC557	2	LF	BCY71	2	LF	BD295	2	P
BC558	2	LF	BCY72	2	LF	BD296	2	P
BC559	2	LF	BCY78	2	LF	BD329	2	P
BC560	2	LF	BCY79	2	LF	BD330	2	P
BC635	2	LF	BCY87	2	DT	BD331	2	P
BC636	2	LF	BCY88	2	DT	BD332	2	P
BC637	2	LF	BCY89	2	DT	BD333	2	P
BC638	2	LF	BD131	2	P	BD334	2	P
BC639	2	LF	BD132	2	P	BD335	2	P
BC640	2	LF	BD133	2	P	BD336	2	P
BCW29;R	4c	Mm	BD135	2	P	BD337	2	P
BCW30;R	4c	Mm	BD136	2	P	BD338	2	P
BCW31;R	4c	Mm	BD137	2	P	BD433	2	P
BCW32;R	4c	Mm	BD138	2	P	BD434	2	P
BCW33;R	4c	Mm	BD139	2	P	BD435	2	P
BCW69;R	4c	Mm	BD140	2	P	BD436	2	P
BCW70;R	4c	Mm	BD181	2	P	BD437	2	P

DT = Dual transistors (SC2 11-77)

FET = Field-effect transistors

LF = Low-frequency transistors (SC2 11-77)

Mm = Discrete semiconductors for hybrid thick and thin-film circuits

P = Low-frequency power transistors (SC2 06-79)

type no.	part	section	type no.	part	section	type no.	part	section
BD438	2	P	BD954	2	P	BDX64	2	P
BD645	2	P	BD955	2	P	BDX64A	2	P
BD646	2	P	BD956	2	P	BDX64B	2	P
BD647	2	P	BDT62	2	P	BDX64C	2	P
BD648	2	P	BDT62A	2	P	BDX65	2	P
BD649	2	P	BDT62B	2	P	BDX65A	2	P
BD650	2	P	BDT62C	2	P	BDX65B	2	P
BD651	2	P	BDT63	2	P	BDX65C	2	P
BD652	2	P	BDT63A	2	P	BDX66	2	P
BD675	2	P	BDT63B	2	P	BDX66A	2	P
BD676	2	P	BDT63C	2	P	BDX66B	2	P
BD677	2	P	BDT91	2	P	BDX66C	2	P
BD678	2	P	BDT92	2	P	BDX67	2	P
BD679	2	P	BDT93	2	P	BDX67A	2	P
BD680	2	P	BDT94	2	P	BDX67B	2	P
BD681	2	P	BDT95	2	P	BDX67C	2	P
BD682	2	P	BDT96	2	P	BDX77	2	P
BD683	2	P	BDV64	2	P	BDX78	2	P
BD684	2	P	BDV64A	2	P	BDX91	2	P
BD933	2	P	BDV64B	2	P	BDX92	2	P
BD934	2	P	BDV65	2	P	BDX93	2	P
BD935	2	P	BDV65A	2	P	BDX94	2	P
BD936	2	P	BDV65B	2	P	BDX95	2	P
BD937	2	P	BDX35	2	P	BDX96	2	P
BD938	2	P	BDX36	2	P	BDY20	2	P
BD939	2	P	BDX37	2	P	BDY90	2	P
BD940	2	P	BDX42	2	P	BDY91	2	P
BD941	2	P	BDX43	2	P	BDY92	2	P
BD942	2	P	BDX44	2	P	BDY93	2	P
BD943	2	P	BDX45	2	P	BDY94	2	P
BD944	2	P	BDX46	2	P	BDY96	2	P
BD945	2	P	BDX47	2	P	BDY97	2	P
BD946	2	P	BDX62	2	P	BF115	3	HFSW
BD947	2	P	BDX62A	2	P	BF167	3	HFSW
BD948	2	P	BDX62B	2	P	BF173	3	HFSW
BD949	2	P	BDX62C	2	P	BF177	3	HFSW
BD950	2	P	BDX63	2	P	BF178	3	HFSW
BD951	2	P	BDX63A	2	P	BF179	3	HFSW
BD952	2	P	BDX63B	2	P	BF180	3	HFSW
BD953	2	P	BDX63C	2	P	BF181	3	HFSW

HFSW = High-frequency and switching transistors
P = Low-frequency power transistors (SC2 06-79)

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type no.	part	section	type no.	part	section	type no.	part	section
BF182	3	HFSW	BF495	3	HFSW	BFS21A	3	FET
BF183	3	HFSW	BF550;R	4c	Mm	BFS22A	4a	Tra
BF184	3	HFSW	BF622	4c	Mm	BFS23A	4a	Tra
BF185	3	HFSW	BF623	4c	Mm	BFS28	3	FET
BF194	3	HFSW	BFQ10	3	FET	BFT24	3	HFSW
BF195	3	HFSW	BFQ11	3	FET	BFT25;R	4c	Mm
BF196	3	HFSW	BFQ12	3	FET	BFT44	3	HFSW
BF197	3	HFSW	BFQ13	3	FET	BFT45	3	HFSW
BF198	3	HFSW	BFQ14	3	FET	BFT46	4c	Mm
BF199	3	HFSW	BFQ15	3	FET	BFT92;R	4c	Mm
BF200	3	HFSW	BFQ16	3	FET	BFT93;R	4c	Mm
BF240	3	HFSW	BFQ17	4c	Mm	BFW10	3	FET
BF241	3	HFSW	BFQ18A	4c	Mm	BFW11	3	FET
BF245A	3	FET	BFQ19	4c	Mm	BFW12	3	FET
BF245B	3	FET	BFQ23	3	HFSW	BFW13	3	FET
BF245C	3	FET	BFQ24	3	HFSW	BFW16A	3	HFSW
BF256A	3	FET	BFQ32	3	HFSW	BFW17A	3	HFSW
BF256B	3	FET	BFQ34	3	HFSW	BFW30	3	HFSW
BF256C	3	FET	BFQ42	4a	Tra	BFW45	3	HFSW
BF324	3	HFSW	BFQ43	4a	Tra	BFW61	3	FET
BF327	3	FET	BFR29	3	FET	BFW92	3	HFSW
BF336	3	HFSW	BFR30	4c	Mm	BFW93	3	HFSW
BF337	3	HFSW	BFR31	4c	Mm	BFX34	3	HFSW
BF338	3	HFSW	BFR49	3	HFSW	BFX89	3	HFSW
BF362	3	HFSW	BFR53;R	4c	Mm	BFY50	3	HFSW
BF363	3	HFSW	BFR64	3	HFSW	BFY51	3	HFSW
BF419	2	P	BFR65	3	HFSW	BFY52	3	HFSW
BF422	3	HFSW	BFR84	3	FET	BFY55	3	HFSW
BF423	3	HFSW	BFR90	3	HFSW	BFY90	3	HFSW
BF450	3	HFSW	BFR91	3	HFSW	BG1895		
BF451	3	HFSW	BFR92;R	4c	Mm	-541	1a	R
BF457	2	P	BFR93;R	4c	Mm	-641	1a	R
BF458	2	P	BFR94	3	HFSW	BG1897		
BF459	2	P	BFR95	3	HFSW	-541	1a	R
BF469	2	P	BFR96	3	HFSW	-542	1a	R
BF470	2	P	BFS17;R	4c	Mm	-641	1a	R
BF471	2	P	BFS18;R	4c	Mm	-642	1a	R
BF472	2	P	BFS19;R	4c	Mm	BG1898		
BF480	3	HFSW	BFS20;R	4c	Mm	-541	1a	R
BF494	3	HFSW	BFS21	3	FET	-641	1a	R

FET = Field-effect transistors

HFSW = High-frequency and switching transistors

Mm = Discrete semiconductors for hybrid thick and thin-film circuits

P = Low-frequency power transistors (SC2 06-79)

R = Rectifier diodes

Tra = Transmitting transistors and modules

type no.	part	section	type no.	part	section	type no.	part	section
BGY22	4a	Tra	BLX39	4a	Tra	BPX95B	4b	PDT
BGY22A	4a	Tra	BLX65	4a	Tra	BR100	1a	Th
BGY23	4a	Tra	BLX66	4a	Tra	BR101	3	HFSW
BGY23A	4a	Tra	BLX67	4a	Tra	BRY39(Th)	1a	Th
BGY32	4a	Tra	BLX68	4a	Tra	(SCS)	3	HFSW
						(PUT)	3	HFSW
BGY33	4a	Tra	BLX69A	4a	Tra	BRY61	4c	Mm
BGY35	4a	Tra	BLX91A	4a	Tra	BSR12;R	4c	Mm
BGY36	4a	Tra	BLX92A	4a	Tra	BSR30	4c	Mm
BGY37	3	HFSW	BLX93A	4a	Tra	BSR31	4c	Mm
BLV10	4a	Tra	BLX94A	4a	Tra			
						BSR32	4c	Mm
BLV11	4a	Tra	BLX95	4a	Tra	BSR33	4c	Mm
BLV20	4a	Tra	BLX96	4a	Tra	BSR40	4c	Mm
BLV21	4a	Tra	BLX97	4a	Tra	BSR41	4c	Mm
BLW29	4a	Tra	BLX98	4a	Tra	BSR42	4c	Mm
BLW31	4a	Tra	BLY87A	4a	Tra			
						BSR43	4c	Mm
BLW32	4a	Tra	BLY87C	4a	Tra	BSR56	4c	Mm
BLW33	4a	Tra	BLY88A	4a	Tra	BSR57	4c	Mm
BLW34	4a	Tra	BLY88C	4a	Tra	BSR58	4c	Mm
BLW60	4a	Tra	BLY89A	4a	Tra	BSS38	3	HFSW
BLW60C	4a	Tra	BLY89C	4a	Tra			
						BSS50	3	HFSW
BLW64	4a	Tra	BLY90	4a	Tra	BSS51	3	HFSW
BLW75	4a	Tra	BLY91A	4a	Tra	BSS52	3	HFSW
BLW76	4a	Tra	BLY91C	4a	Tra	BSS60	3	HFSW
BLW77	4a	Tra	BLY92A	4a	Tra	BSS61	3	HFSW
BLW78	4a	Tra	BLY92C	4a	Tra			
						BSS63;R	4c	Mm
BLW79	4a	Tra	BLY93A	4a	Tra	BSS64;R	4c	Mm
BLW80	4a	Tra	BLY93C	4a	Tra	BSS68	3	HFSW
BLW81	4a	Tra	BLY94	4a	Tra	BSV15	3	HFSW
BLW82	4a	Tra	BPW22	4b	PDT	BSV16	3	HFSW
BLW83	4a	Tra	BPW34	4b	PDT			
						BSV17	3	HFSW
BLW84	4a	Tra	BPX25	4b	PDT	BSV52;R	4c	Mm
BLW85	4a	Tra	BPX29	4b	PDT	BSV64	3	HFSW
BLW86	4a	Tra	BPX40	4b	PDT	BSV78	3	FET
BLW87	4a	Tra	BPX41	4b	PDT	BSV79	3	FET
BLW95	4a	Tra	BPX42	4b	PDT			
						BSV80	3	FET
BLW98	4a	Tra	BPX47A	4b	PDT	BSV81	3	FET
BLX13	4a	Tra	BPX70	4b	PDT	BSW41A	3	HFSW
BLX13C	4a	Tra	BPX71	4b	PDT	BSW66	3	HFSW
BLX14	4a	Tra	BPX72	4b	PDT	BSW67	3	HFSW
BLX15	4a	Tra	BPX94	4b	PDT			

FET = Field-effect transistors
HFSW = High-frequency and switching transistors
Mm = Discrete semiconductors for hybrid thick and thin-film circuits

PDT = Photodiodes or transistors
Th = Thyristors
Tra = Transmitting transistors and modules

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type no.	part	section	type no.	part	section	type no.	part	section
BSW68	3	HFSW	BU206	2	P	BY409	1a	R
BSX19	3	HFSW	BU207A	2	P	BY409A	1a	R
BSX20	3	HFSW	BU208A	2	P	BY476	1a	R
BSX21	3	HFSW	BU209A	2	P	BY476A	1a	R
BSX45	3	HFSW	BU326	2	P	BY477	1a	R
BSX46	3	HFSW	BU326A	2	P	BY478	1a	R
BSX47	3	HFSW	BU426	2	P	BYW19 *	1a	R
BSX59	3	HFSW	BU426A	2	P	BYW29 *	1a	R
BSX60	3	HFSW	BU433	2	P	BYW30 *	1a	R
BSX61	3	HFSW	BUW84	2	P	BYW31 *	1a	R
BT126	1a	Th	BUW85	2	P	BYW54	1a	R
BT128 *	1a	Th	BUX80	2	P	BYW55	1a	R
BT129 *	1a	Th	BUX81	2	P	BYW56	1a	R
BT137 *	1a	Tri	BUX82	2	P	BYW92 *	1a	R
BT138 *	1a	Tri	BUX83	2	P	BYX10	1a	R
BT139 *	1a	Tri	BUX84	2	P	BYX22 *	1a	R
BT151 *	1a	Th	BUX85	2	P	BYX25 *	1a	R
BTW23 *	1a	Th	BUX86	2	P	BYX29 *	1a	R
BTW24 *	1a	Th	BUX87	2	P	BYX30 *	1a	R
BTW30 *	1a	Th	BY126	1a	R	BYX32 *	1a	R
BTW31 *	1a	Th	BY127	1a	R	BYX35	1a	R
BTW33 *	1a	Th	BY164	1a	R	BYX36 *	1a	R
BTW34 *	1a	Tri	BY176	1a	R	BYX38 *	1a	R
BTW38 *	1a	Th	BY179	1a	R	BYX39 *	1a	R
BTW40 *	1a	Th	BY184	1a	R	BYX42 *	1a	R
BTW41 *	1a	Tri	BY187	1a	R	BYX45 *	1a	R
BTW42 *	1a	Th	BY188 *	1a	R	BYX46 *	1a	R
BTW43 *	1a	Tri	BY206	1a	R	BYX49 *	1a	R
BTW45 *	1a	Th	BY207	1a	R	BYX50 *	1a	R
BTW47 *	1a	Th	BY208 *	1a	R	BYX52 *	1a	R
BTW92 *	1a	Th	BY209	1a	R	BYX55 *	1a	R
BTX18 *	1a	Th	BY223	1a	R	BYX56 *	1a	R
BTX94 *	1a	Tri	BY224 *	1a	R	BYX71 *	1a	R
BTY79 *	1a	Th	BY225 *	1a	R	BYX90	1a	R
BTY87 *	1a	Th	BY226	1a	R	BYX91 *	1a	R
BTY91 *	1a	Th	BY227	1a	R	BYX96 *	1a	R
BU126	2	P	BY228	1a	R	BYX97 *	1a	R
BU133	2	P	BY277 *	1a	R	BYX98 *	1a	R
BU204	2	P	BY406	1a	R	BYX99 *	1a	R
BU205	2	P	BY407	1a	R	BZV10	1b	Vrf

HFSW = High-frequency and switching transistors
 P = Low-frequency power transistors (SC2 06-79)
 R = Rectifier diodes

Th = Thyristors
 Tri = Triacs
 Vrf = Voltage reference diodes

type no.	part	section	type no.	part	section	type no.	part	section
BZV11	1b	Vrf	BZZ24	1a	Vrg	ORP10	4b	I
BZV12	1b	Vrf	BZZ25	1a	Vrg	ORP13	4b	I
BZV13	1b	Vrf	BZZ26	1a	Vrg	ORP23	4b	Ph
BZV14	1b	Vrf	BZZ27	1a	Vrg	ORP52	4b	Ph
BZV15 *	1a	Vrg	BZZ28	1a	Vrg	ORP60	4b	Ph
BZV38	1b	Vrf	BZZ29	1a	Vrg	ORP61	4b	Ph
BZW10	1a	TS	CNY22	4b	PhC	ORP62	4b	Ph
BZW70 *	1a	TS	CNY23	4b	PhC	ORP66	4b	Ph
BZW86 *	1a	TS	CNY42	4b	PhC	ORP68	4b	Ph
BZW91 *	1a	TS	CNY43	4b	PhC	ORP69	4b	Ph
BZW93 *	1a	TS	CNY44	4b	PhC	OSB9110	1a	St
BZW95 *	1a	TS	CNY46	4b	PhC	OSB9210	1a	St
BZW96 *	1a	TS	CNY47	4b	PhC	OSB9310	1a	St
BZX55 *	1b	Vrg	CNY47A	4b	PhC	OSB9410	1a	St
BZX61 *	1b	Vrg	CNY48	4b	PhC	OSM9110	1a	St
BZX70 *	1a	Vrg	CQY11B	4b	LED	OSM9210	1a	St
BZX75 *	1b	Vrg	CQY11C	4b	LED	OSM9310	1a	St
BZX79 *	1b	Vrg	CQY24A	4b	LED	OSM9410	1a	St
BZX84 *	4c	Mm	CQY46A	4b	LED	OSS9110	1a	St
BZX87 *	1b	Vrg	CQY47A	4b	LED	OSS9210	1a	St
BZX90	1b	Vrf	CQY49B	4b	LED	OSS9310	1a	St
BZX91	1b	Vrf	CQY49C	4b	LED	OSS9410	1a	St
BZX92	1b	Vrf	CQY50	4b	LED	RPY58A	4b	Ph
BZX93	1b	Vrf	CQY52	4b	LED	RPY71	4b	Ph
BZY78	1b	Vrf	CQY54	4b	LED	RPY76A	4b	I
BZY88 *	1b	Vrg	CQY58	4b	LED	RPY82	4b	Ph
BZY91 *	1a	Vrg	CQY88	4b	LED	RPY84	4b	Ph
BZY93 *	1a	Vrg	CQY89	4b	LED	RPY85	4b	Ph
BZY95 *	1a	Vrg	CQY94	4b	LED	RPY86	4b	I
BZY96 *	1a	Vrg	CQY95	4b	LED	RPY87	4b	I
BZZ14	1a	Vrg	CQY96	4b	LED	RPY88	4b	I
BZZ15	1a	Vrg	CQY97	4b	LED	RPY89	4b	I
BZZ16	1a	Vrg	OA47	1b	GB	1N821	1b	Vrf
BZZ17	1a	Vrg	OA90	1b	PC	1N823	1b	Vrf
BZZ18	1a	Vrg	OA91	1b	PC	1N825	1b	Vrf
BZZ19	1a	Vrg	OA95	1b	PC	1N827	1b	Vrf
BZZ20	1a	Vrg	OA200	1b	AD	1N829	1b	Vrf
BZZ21	1a	Vrg	OA202	1b	AD	1N914	1b	WD
BZZ22	1a	Vrg	OM931	2	P	1N914A	1b	WD
BZZ23	1a	Vrg	OM961	2	P	1N916	1b	WD

AD = Silicon alloyed diodes

GB = Germanium gold bonded diodes

I = Infrared devices

LED = Light-emitting diodes

Mm = Discrete semiconductors for hybrid
thick and thin-film circuits

P = Low-frequency power transistors (SC2 06-79)

PC = Germanium point contact diodes

Ph = Photoconductive devices

PhC = Photocouplers

St = Rectifier stacks

TS = Transient suppressor diodes

Vrf = Voltage reference diodes

Vrg = Voltage regulator diodes

WD = Silicon whiskerless diodes

INDEX

type no.	part	section	type no.	part	section	type no.	part	section
1N916A	1b	WD	1N5749B	1b	Vrg	2N3020	3	HFSW
1N916B	1b	WD	1N5750B	1b	Vrg	2N3055	2	P
1N3879	1a	R	1N5751B	1b	Vrg	2N3375	4a	Tra
1N3880	1a	R	1N5752B	1b	Vrg	2N3442	2	P
1N3881	1a	R	1N5753B	1b	Vrg	2N3553	4a	Tra
1N3882	1a	R	1N5754B	1b	Vrg	2N3632	4a	Tra
1N3889	1a	R	1N5755B	1b	Vrg	2N3823	3	FET
1N3890	1a	R	1N5756B	1b	Vrg	2N3866	4a	Tra
1N3891	1a	R	1N5757B	1b	Vrg	2N3924	4a	Tra
1N3892	1a	R	2N918	3	HFSW	2N3926	4a	Tra
1N4009	1b	WD	2N929	2	LF	2N3927	4a	Tra
1N4148	1b	WD	2N930	2	LF	2N3966	3	FET
1N4150	1b	WD	2N1613	3	HFSW	2N4030	3	HFSW
1N4151	1b	WD	2N1711	3	HFSW	2N4031	3	HFSW
1N4154	1b	WD	2N1893	3	HFSW	2N4032	3	HFSW
1N4446	1b	WD	2N2218	3	HFSW	2N4033	3	HFSW
1N4448	1b	WD	2N2218A	3	HFSW	2N4036	3	HFSW
1N5060	1a	R	2N2219	3	HFSW	2N4091	3	FET
1N5061	1a	R	2N2219A	3	HFSW	2N4092	3	FET
1N5062	1a	R	2N2221	3	HFSW	2N4093	3	FET
1N5729B	1b	Vrg	2N2221A	3	HFSW	2N4347	2	P
1N5730B	1b	Vrg	2N2222	3	HFSW	2N4391	3	FET
1N5731B	1b	Vrg	2N2222A	3	HFSW	2N4392	3	FET
1N5732B	1b	Vrg	2N2297	3	HFSW	2N4393	3	FET
1N5733B	1b	Vrg	2N2368	3	HFSW	2N4427	4a	Tra
1N5734B	1b	Vrg	2N2369	3	HFSW	2N4856	3	FET
1N5735B	1b	Vrg	2N2369A	3	HFSW	2N4857	3	FET
1N5736B	1b	Vrg	2N2483	2	LF	2N4858	3	FET
1N5737B	1b	Vrg	2N2484	2	LF	2N4859	3	FET
1N5738B	1b	Vrg	2N2894	3	HFSW	2N4860	3	FET
1N5739B	1b	Vrg	2N2894A	3	HFSW	2N4861	3	FET
1N5740B	1b	Vrg	2N2904	3	HFSW	2N5415	3	HFSW
1N5741B	1b	Vrg	2N2904A	3	HFSW	2N5416	3	HFSW
1N5742B	1b	Vrg	2N2905	3	HFSW	61SV	4b	I
1N5743B	1b	Vrg	2N2905A	3	HFSW	40820	3	HFSW
1N5744B	1b	Vrg	2N2906	3	HFSW	40835	3	HFSW
1N5745B	1b	Vrg	2N2906A	3	HFSW	40838	3	HFSW
1N5746B	1b	Vrg	2N2907	3	HFSW	56200	3,4a	A
1N5747B	1b	Vrg	2N2907A	3	HFSW	56201c	2	A
1N5748B	1b	Vrg	2N3019	3	HFSW	56201d	2	A

A = Accessories

FET = Field-effect transistors

HFSW = High-frequency and switching transistors

I = Infrared devices

LF = Low-frequency transistors (SC2 11-77)

P = Low-frequency power transistors (SC2 06-79)

R = Rectifier diodes

Tra = Transmitting transistors and modules

Vrg = Voltage regulator diodes

WD = Silicon whiskerless diodes

type no.	part	section	type no.	part	section	type no.	part	section
56201j	2	A	56290	1a	HE	56350	1a	DH
56218	3,4a	A	56293	1a	HE	56352	2	A
56230	1a	HE	56295	1a	A	56353	2	A
56231	1a	HE	56299	1a	A	56354	2	A
56233	1a	A	56309B	1a	A	56356	3	A
56234	1a	A	56309R	1a	A	56358	1a	A
56245	3,4a	A	56312	1a	DH	56359b	2	A
56246	1a to		56313	1a	DH	56359c	2	A
	4a	A	56314	1a	DH	56359d	2	A
56253	1a	DH	56315	1a	DH	56360a	2	A
56256	1a	DH	56316	1a	A	56363	1a,2	A
56261a	2	A	56318	1a	DH	56364	1a,2	A
56262A	1a	A	56319	1a	DH	56366	1a	A
56263	1a to		56326	2,3	A	56367	2	A
	4a	A	56333	2,3	A	56368a	2	A
56264A	1a	A	56334	1a	DH	56368b	2	A
56268	1a	DH	56337	1a	A	56369	2	A
56271	1a	DH	56339	2	A	56378	2	A
56278	1a	DH	56348	1a	DH	56379	2	A
56280	1a	DH	56349	1a	DH			

A = Accessories
 DH = Diecast heatsinks
 HE = Heatsink extrusions

MAINTENANCE TYPE LIST

The types listed below are included in this handbook only for the first page of the publication.
Detailed information will be supplied on request.

BD133	BD232	BU133
BD181	BDY93/94	2N3055
BD182	BDY96/97	2N3442
BD183	BU126	2N4347



TYPE NUMBER SURVEY
SELECTION GUIDE



In this alphanumeric list we present all low-frequency power transistors mentioned in this handbook.

type number		envelope	P _{tot} W	type number		envelope	P _{tot} W
NPN	PNP			NPN	PNP		
BD131		TO-126	15	BD681	BD682	TO-126	40
BD133		TO-126	15	BD683	BD684	TO-126	40
BD135	BD136	TO-126	8	BD933	BD934	TO-220	30
BD137	BD138	TO-126	8	BD935	BD936	TO-220	30
BD139	BD140	TO-126	8	BD937	BD938	TO-220	30
BD181		TO-3	78	BD939	BD940	TO-220	30
BD182		TO-3	117	BD941	BD942	TO-220	30
BD183		TO-3	117	BD943	BD944	TO-220	40
BD201	BD202	TO-220	60	BD945	BD946	TO-220	40
BD203	BD204	TO-220	60	BD947	BD948	TO-220	40
BD226	BD227	TO-126	12,5	BD949	BD950	TO-220	40
BD228	BD229	TO-126	12,5	BD951	BD952	TO-220	40
BD230	BD231	TO-126	12,5	BD953	BD954	TO-220	40
BD232		TO-126	15	BD955	BD956	TO-220	40
BD233	BD234	TO-126	25	BDT63	BDT62	TO-220	90
BD235	BD236	TO-126	25	BDT63A	BDT62A	TO-220	90
BD237	BD238	TO-126	25	BDT63B	BDT62B	TO-220	90
BD291	BD292	SOT-82	60	BDT63C	BDT62C	TO-220	90
BD293	BD294	SOT-82	60	BDT91	BDT92	TO-220	90
BD295	BD296	SOT-82	60	BDT93	BDT94	TO-220	90
BD329	BD330	TO-126	15	BDT95	BDT96	TO-220	90
BD331	BD332	SOT-82	60	BDV65	BDV64	SOT-93	125
BD333	BD334	SOT-82	60	BDV65A	BDV64A	SOT-93	125
BD335	BD336	SOT-82	60	BDV65B	BDV64B	SOT-93	125
BD337	BD338	SOT-82	60	BDX35		TO-126	15
BD433	BD434	TO-126	36	BDX36		TO-126	15
BD435	BD436	TO-126	36	BDX37		TO-126	15
BD437	BD438	TO-126	36	BDX42	BDX45	TO-126	5
BD645	BD646	TO-220	62,5	BDX43	BDX46	TO-126	5
BD647	BD648	TO-220	62,5	BDX44	BDX47	TO-126	5
BD649	BD650	TO-220	62,5	BDX63	BDX62	TO-3	90
BD651	BD652	TO-220	62,5	BDX63A	BDX62A	TO-3	90
BD675	BD676	TO-126	40	BDX63B	BDX62B	TO-3	90
BD677	BD678	TO-126	40	BDX63C	BDX62C	TO-3	90
BD679	BD680	TO-126	40	BDX65	BDX64	TO-3	117

IIIIII

TYPE NUMBER SURVEY

type number		envelope	P _{tot} W	type number		envelope	P _{tot} W
NPN	PNP			NPN	PNP		
BDX65A	BDX64A	TO-3	117	BU207A		TO-3	12,5
BDX65B	BDX64B	TO-3	117	BU208A		TO-3	80
BDX65C	BDX64C	TO-3	117	BU209A		TO-3	12,5
BDX67	BDX66	TO-3	150	BU326		TO-3	60
BDX67A	BDX66A	TO-3	150	BU326A		TO-3	60
BDX67B	BDX66B	TO-3	150	BU426		SOT-93	70
BDX67C	BDX66C	TO-3	150	BU426A		SOT-93	70
BDX77	BDX78	TO-220	60	BU433		SOT-93	70
BDX91	BDX92	TO-3	90	BUW84		SOT-82	50
BDX93	BDX94	TO-3	90	BUW85		SOT-82	50
BDX95	BDX96	TO-3	90	BUX80		TO-3	100
BDY20		TO-3	115	BUX81		TO-3	100
BDY90		TO-3	40	BUX82		TO-3	60
BDY91		TO-3	40	BUX83		TO-3	60
BDY92		TO-3	40	BUX84		TO-220	40
BDY93		TO-3	30	BUX85		TO-220	40
BDY94		TO-3	30	BUX86		TO-126	20
BDY96		TO-3	40	BUX87		TO-126	20
BDY97		TO-3	40	2N3055		TO-3	115
BF419		TO-126	6	2N3442		TO-3	117
BF457		TO-126	6	2N4347		TO-3	117
BF458		TO-126	6				
BF459		TO-126	6				
BF469	BF470	TO-126	1,8				
BF471	BF472	TO-126	1,8				
BU126		TO-3	30				
BU133		TO-3	30				
BU204		TO-3	10				
BU205		TO-3	10				
BU206		TO-3	10				

HIGH-VOLTAGE TRANSISTORS

video output - deflection - SMPS

IC	case	pol.	collector-emitter voltage (open base) = V _{CEO} (V)										
			160	250	300	375	400	450	600	700	800		
A													
10	TO-3	N						BUX80	BUX81				
6	TO-3	N				BU326	BU326A	BU326A					
	SOT-93	N				BU426	BU426A						
	SOT-93	N				BU433							
	TO-3	N					BUX82	BUX83					
5	TO-3	N									BU207A	BU208A	BU209A
4	TO-3	N										BU205	BU206
2,5	TO-3	N											
2	SOT-82	N											
	TO-220	N						BUW84	BUW85	BUW85			
		N						BUX84	BUX85				
0,5	TO-126	N						BUX86	BUX87				
0,1	TO-126	N											
	TO-126	N	BF457	BF419	BF458	BF459							
0,05	TO-126	N		BF469	BF471*	BF472*							
	TO-126	P		BF470									

* VCER.



LOW-VOLTAGE TRANSISTORS

audio - general purpose - switching

IC	case	pol.	collector-emitter voltage (open base) V _{CEO} (V)							remarks			
			20	22	32	45	60	80	100		120 V		
A													
16	TO-3	N						BDX67	BDX67A	BDX67B	BDX67C	BDX67C	Darlington
12	SOT-93	N						BDX66	BDX66A	BDX66B	BDX66C	BDX66C	Darlington
		P						BDV65	BDV65A	BDV65B	BDV65C	BDV65C	Darlington
10	TO-3	N						BDV64	BDV64A	BDV64B	BDV64C	BDV64C	Darlington
		P						BDX65	BDX65A	BDX65B	BDX65C	BDX65C	Darlington
10	TO-220	N						BDX64	BDX64A	BDX64B	BDX64C	BDX64C	Darlington
		P						BDT63	BDT63A	BDT63B	BDT63C	BDT63C	Darlington
8	TO-220	N						BDT62	BDT62A	BDT62B	BDT62C	BDT62C	Darlington
		P						BDT91	BDT93	BDT95	BDT95	BDT95	Darlington
8	TO-3	N						BDT92	BDT94	BDT96	BDT96	BDT96	Darlington
		P						BDY92	BDY91	BDY90	BDY90	BDY90	Darlington
6	SOT-82	N				BD201		BD203	BDX77	BD649	BD651	BD651	Darlington
		P				BD202		BD204	BDX78	BD650	BD652	BD652	Darlington
6	SOT-82	N						BDX63	BDX63A	BDX63B	BDX63C	BDX63C	Darlington
		P						BDX62	BDX62A	BDX62B	BDX62C	BDX62C	Darlington
6	SOT-82	N						BDX91	BDX93	BDX95	BDX95	BDX95	Darlington
		P						BDX92	BDX94	BDX96	BDX96	BDX96	Darlington
6	SOT-82	N				BD291		BD293	BD295	BD335	BD337	BD337	Darlington
		P				BD292		BD294	BD296	BD336	BD338	BD338	Darlington
6	SOT-82	N						BD331	BD333	BD335	BD337	BD337	Darlington
		P						BD332	BD334	BD336	BD338	BD338	Darlington

LOW-VOLTAGE TRANSISTORS

audio - general purpose - switching

I _C	case	pol.	collector-emitter voltage (open base) V _{CEO} (V)								remarks
			20	22	32	45	60	80	100	120 V	
5	TO-220	N		BD943	BD945	BD947	BD949	BD951	BD953	BD955	
				BD944	BD946	BD948	BD950	BD952	BD954	BD956	
4	TO-126	N					BDX35	BDX37			
				BD433	BD435	BD437	BD438	BD436	BDX36		
3	TO-126	P				BD675	BD677	BD679	BD681	BD683	Darlington
						BD676	BD678	BD680	BD682	BD684	
	TO-126	P				BD131					
						BD132					
	TO-126	N									
						BD329					
	TO-220	N				BD933	BD935	BD937	BD939	BD941	
						BD934	BD936	BD938	BD940	BD942	
2	TO-126	N				BD233	BD235	BD237			
						BD234	BD236	BD238			
1.5	TO-126	N				BD226	BD228	BD230			
						BD227	BD229	BD231			
1	TO-126	P				BD135	BD137	BD139			
						BD136	BD138	BD140			
	TO-126	N				BDX42	BDX43	BDX44			
						BDX45	BDX46	BDX47			



TO-126 (SOT-32)

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BF469	BF470	1,8	250
BF471	BF472		300
BDX42	BDX45	5	45
BDX43	BDX46		60
BDX45	BDX47		80
BF457		6	160
BF458			250
BF459			300
BD135	BD136	8	45
BD137	BD138		60
BD139	BD140		80
BD226	BD227	12,5	45
BD228	BD229		60
BD230	BD231		80
BD131	BD132	15	45
BD329	BD330		20
BDX35			60
BDX36			60
BDX37			80
BUX86			20
BUX87			450
BD233	BD234	25	45
BD235	BD236		60
BD237	BD238		80
BD433	BD434	36	22
BD435	BD436		32
BD437	BD438		45
BD675	BD676	40	45
BD677	BD678		60
BD679	BD680		80
BD681	BD682		100
BD683	BD684		120

SOT-82

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BUW84		50	400
BUW85			450
BD291	BD292	60	45
BD293	BD294		60
BD295	BD296		80
BD331	BD332	60	60
BD333	BD334		80
BD335	BD336		100
BD337	BD338		120

TO-220 (SOT-78)

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BD933	BD934	30	45
BD935	BD936		60
BD937	BD938		80
BD939	BD940		100
BD943	BD944	40	22
BD945	BD946		32
BD947	BD948		45
BD949	BD950		60
BD951	BD952		80
BD953	BD954		100
BUX84		40	400
BUX85			450
BD201	BD202	60	45
BD203	BD204		60
BDX77	BDX78		80
BD645	BD646	62,5	60
BD647	BD648		80
BD649	BD650		100
BD651	BD652		120

TO-220 (SOT-78) continued

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BDT91	BDT92	90	60
BDT93	BDT94		80
BDT95	BDT96		100
BDT63	BDT62	90	60
BDT63A	BDT62A		80
BDT63B	BDT62B		100
BDT63C	BDT62C		120

SOT-93

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BU426		70	375
BU426A			400
BU433			375
BDV65	BDV64	125	60
BDV65A	BDV64A		80
BDV65B	BDV64B		100
BDV65C	BDV64C		120

TO-3 (SOT-3)

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BU204		10	600
BU205			700
BU206			800
BU207A		12,5	600
BU209A			800
BDY90		40	100
BDY91			80
BDY92			60
BU326		60	375
BU326A			400
BUX82		60	400
BUX83			450
BU208A		80	700
BDX63	BDX62	90	60
BDX63A	BDX62A		80
BDX63B	BDX62B		100
BDX63C	BDX62C		120
BUX80		100	400
BUX81			450
BDX65	BDX64	117	60
BDX65A	BDX64A		80
BDX65B	BDX64B		100
BDX65C	BDX64C		120
BDX67	BDX66	150	60
BDX67A	BDX66A		80
BDX67B	BDX66B		100
BDX67C	BDX66C		120

TYPE NUMBER SURVEY ACCESSORIES

type number	description	envelope
56201c	insulating bushes (up to 500 V)	TO-3
56201d	mica washer (up to 500 V)	TO-3
56201j	insulating bushes (up to 500 V)	TO-3
56261a	insulating bushes (up to 500 V)	TO-3
56326	metal washer	SOT-32
56333	metal washer mica washer insulating bush	SOT-32
56339	mica washer (500 to 2000 V)	TO-3
56352	insulating mounting support	
56353	spring clip	SOT-32/SOT-82
56354	mica insulator	SOT-32/SOT-82
56359b	mica washer (up to 800 V)	TO-220
56359c	insulating bush (up to 800 V)	TO-220
56359d	rectangular insulating washer (up to 1000 V)	TO-220
56360a	rectangular washer (brass)	TO-220
56363	spring clip (direct mounting)	TO-220
56364	spring clip (insulated mounting)	TO-220
56367	alumina insulator	TO-220
56368a	mica insulator	SOT-93
56368b	insulating bush	SOT-93
56369	mica insulator (up to 2 kV)	TO-220
56378	mica insulator	SOT-93
56379	spring clip	SOT-93

CLIP MOUNTING

envelope	direct mounting		insulated mounting			
	clip		mica	clip		
TO-126 (SOT-32)	56353		56354	56353		
SOT-82	56353		56354	56353		
TO-220 (SOT-78)	56363		56369	56364		
SOT-93	56379		56378	56379		

SCREW MOUNTING

envelope	direct mounting		insulated mounting			
	metal washer	mounting material	mica washer	insul. bush	metal washer	mounting material
TO-126 (SOT-32)	56326	M3	←	56333	→	M2,5
TO-220 (SOT-78) up to 800 V up to 1000 V	56360a	M3	56359b 56359b	56359c 56359d	56360a 56360a	M3 M3
SOT-93	—	M4	56368a	56368b		M3
TO-3 (SOT-3) up to 500 V up to 2000 V	—	M4	56201d 56339	56201c; 56201j or 56261a 56352		M3 M3

The accessories mentioned can be supplied on request.

See also chapter Mounting Instructions.

GENERAL

Type designation
Rating systems
Transistor ratings
Letter symbols
SOAR curves



PRO ELECTRON TYPE DESIGNATION CODE
FOR SEMICONDUCTOR DEVICES

This type designation code applies to discrete semiconductor devices — as opposed to integrated circuits —, multiples of such devices and semiconductor chips.

A basic type number consists of:

TWO LETTERS FOLLOWED BY A SERIAL NUMBER

FIRST LETTER

The first letter gives information about the material used for the active part of the devices.

- A. GERMANIUM or other material with band gap of 0,6 to 1,0 eV.
- B. SILICON or other material with band gap of 1,0 to 1,3 eV.
- C. GALLIUM-ARSENIDE or other material with band gap of 1,3 eV or more.
- R. COMPOUND MATERIALS (e.g. Cadmium-Sulphide).

SECOND LETTER

The second letter indicates the function for which the device is primarily designed.

- A. DIODE; signal, low power
- B. DIODE; variable capacitance
- C. TRANSISTOR; low power, audio frequency ($R_{th j-mb} > 15 \text{ }^{\circ}\text{C/W}$)
- D. TRANSISTOR; power, audio frequency ($R_{th j-mb} \leq 15 \text{ }^{\circ}\text{C/W}$)
- E. DIODE; tunnel
- F. TRANSISTOR; low power, high frequency ($R_{th j-mb} > 15 \text{ }^{\circ}\text{C/W}$)
- G. MULTIPLE OF DISSIMILAR DEVICES — MISCELLANEOUS; e.g. oscillator
- H. DIODE; magnetic sensitive
- L. TRANSISTOR; power, high frequency ($R_{th j-mb} \leq 15 \text{ }^{\circ}\text{C/W}$)
- N. PHOTO-COUPLER
- P. RADIATION DETECTOR; e.g. high sensitivity phototransistor
- Q. RADIATION GENERATOR; e.g. light-emitting diode (LED)
- R. CONTROL AND SWITCHING DEVICE; e.g. thyristor, low power ($R_{th j-mb} > 15 \text{ }^{\circ}\text{C/W}$)
- S. TRANSISTOR; low power, switching ($R_{th j-mb} > 15 \text{ }^{\circ}\text{C/W}$)
- T. CONTROL AND SWITCHING DEVICE; e.g. thyristor, power ($R_{th j-mb} \leq 15 \text{ }^{\circ}\text{C/W}$)
- U. TRANSISTOR; power, switching ($R_{th j-mb} \leq 15 \text{ }^{\circ}\text{C/W}$)
- X. DIODE: multiplier, e.g. varactor, step recovery
- Y. DIODE; rectifying, booster
- Z. DIODE; voltage reference or regulator (transient suppressor diode, with third letter W)

SERIAL NUMBER

Three figures, running from 100 to 999, for devices primarily intended for consumer equipment. One letter (Z, Y, X, etc.) and two figures, running from 10 to 99, for devices primarily intended for industrial/professional equipment.

This letter has no fixed meaning except W, which is used for transient suppressor diodes.

VERSION LETTER

It indicates a minor variant of the basic type either electrically or mechanically. The letter never has a fixed meaning, except letter R, indicating reverse voltage, e.g. collector to case or anode to stud.

SUFFIX

Sub-classification can be used for devices supplied in a wide range of variants called associated types. Following sub-coding suffixes are in use:

1. VOLTAGE REFERENCE and VOLTAGE REGULATOR DIODES: *ONE LETTER and ONE NUMBER*

The LETTER indicates the nominal tolerance of the Zener (regulation, working or reference) voltage

- A. 1% (according to IEC 63: series E96)
- B. 2% (according to IEC 63: series E48)
- C. 5% (according to IEC 63: series E24)
- D. 10% (according to IEC 63: series E12)
- E. 20% (according to IEC 63: series E6)

The number denotes the typical operating (Zener) voltage related to the nominal current rating for the whole range.

The letter 'V' is used instead of the decimal point.

2. TRANSIENT SUPPRESSOR DIODES: *ONE NUMBER*

The NUMBER indicates the maximum recommended continuous reversed (stand-off) voltage V_R . The letter 'V' is used as above.

3. CONVENTIONAL and CONTROLLED AVALANCHE RECTIFIER DIODES and THYRISTORS: *ONE NUMBER*

The NUMBER indicates the rated maximum repetitive peak reverse voltage (V_{RRM}) or the rated repetitive peak off-state voltage (V_{DRM}), whichever is the lower. Reversed polarity is indicated by letter R, immediately after the number.

4. RADIATION DETECTORS: *ONE NUMBER*, preceded by a hyphen (-)

The NUMBER indicates the depletion layer in μm . The resolution is indicated by a version LETTER.

5. ARRAY OF RADIATION DETECTORS and GENERATORS: *ONE NUMBER*, preceded by a stroke (/).

The NUMBER indicates how many basic devices are assembled into the array.

TRANSISTOR RATINGS

The ratings are presented as voltage, current, power and temperature ratings. The list of these ratings and their definitions is given as follows:

Transistor voltage ratings

Collector to base voltage ratings

- V_{CBmax} The maximum permissible instantaneous voltage between collector and base terminals. The collector voltage is negative with respect to base in PNP transistors and positive with respect to base in NPN types.
- $V_{CBmax} (I_E = 0)$ The maximum permissible instantaneous voltage between collector and base terminals, when the emitter terminal is open circuited.

Emitter to base voltage ratings

- V_{EBmax} The maximum permissible instantaneous reverse voltage between emitter and base terminal. The emitter voltage is negative with respect to base for PNP transistor and positive with respect to base for NPN types.
- $V_{EBmax} (I_C = 0)$ The maximum permissible instantaneous reverse voltage between emitter and base terminals when the collector terminal is open circuited.

Collector to emitter voltage ratings

- V_{CEmax} The maximum permissible instantaneous voltage between collector and emitter terminals. The collector voltage is negative with respect to emitter in PNP transistors and positive with respect to emitter in NPN types. This rating is very dependent on circuit conditions and collector current and it is necessary to refer to the curve of V_{CE} versus I_C for the appropriate circuit condition in order to obtain the correct rating.
- V_{CEmax} (Cut-off) The maximum permissible instantaneous voltage between collector and emitter terminals when the emitter current is reduced to zero by means of a reverse emitter base voltage, i.e. the base voltage is normally positive with respect to emitter for PNP transistor and negative with respect to emitter for NPN types.

NOTE: The term "cut-off" is sometimes replaced by $V_{BE} > x$ volts, or $\frac{R_B}{R_E} \leq y$, which are equivalent conditions under which the device may be cut-off.

- $V_{CEmax} (I_C = x \text{ mA})$ The maximum permissible instantaneous voltage between collector and emitter terminals when the collector current is at a high value, often the max. rated value.
- $V_{CEmax} (I_B = 0)$ The maximum permissible instantaneous voltage between collector and emitter terminals when the base terminal is open circuited or when a very high resistance is in series with the base terminal. Special care must be taken to ensure that thermal runaway due to excessive collector leakage current does not occur in this condition.

Due to the current dependency of V_{CE} it is usual to present this information as a voltage rating chart which is a curve of collector current versus collector to emitter voltage (see Fig. 1).

TRANSISTOR RATINGS

This curve is divided into two areas:

A permissible area of operation under all conditions of base drive provided the dissipation rating is not exceeded (area 1) and an area where operation is allowable under certain specified conditions (area 2). To assist in determining the rating in this second area, further curves are provided relating the voltage rating to external circuit conditions, for example:

$$\frac{R_B}{R_E}, R_B, Z_{Bg}, V_{BE}, I_B \text{ or } \frac{V_{BB}}{R_B}$$

An example of this type of curve is given in Fig. 2 as V_{CE} versus $\frac{R_B}{R_E}$ for two different values of collector current.

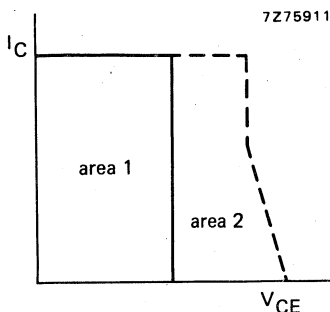


Fig. 1.

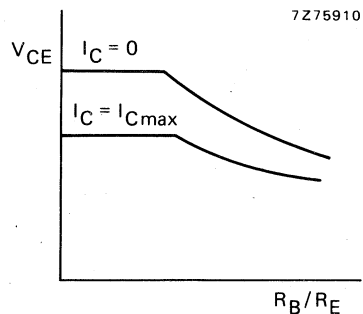


Fig. 2.

It should be noted that when R_E is shunted by a capacitor, the collector voltage V_{CE} during switching must be restricted to a value which does not rely on the effect of R_E . In the case of an inductive load and when an energy rating is given, it may be permissible to operate outside the rated area provided the specified energy rating is not exceeded.

Transistor current ratings

Collector current ratings

- I_{Cmax} The maximum permissible collector current. Without further qualification, the d.c. value is implied.
- $I_C(AV)_{max}$ The maximum permissible average value of the total collector current
- I_{CM} The maximum permissible instantaneous value of the total collector current.

Emitter current ratings

- I_{Emax} The maximum permissible emitter current. Without further qualification, the d.c. value is implied.
- $I_E(AV)_{max}$ The maximum permissible average value of the total emitter current.
- $I_{ER(AV)_{max}}$ The maximum permissible average value of the total emitter current when operating in the reverse emitter-base breakdown region.
- I_{EM} The maximum permissible instantaneous value of the total emitter current.
- I_{ERM} The maximum permissible instantaneous value of the total reverse emitter current allowable in the reverse breakdown region.

Base current ratings

I_{Bmax}	The maximum permissible base current. Without further qualification, the d.c. value is implied.
$I_{B(AV)max}$	The maximum permissible average value of the total base current.
$I_{BR(AV)max}$	The maximum permissible average value of the total reverse base current allowable in the reverse breakdown region.
I_{BM}	The maximum permissible instantaneous value of the total base current. The rating also includes the switch off current.
I_{BRM}	The maximum permissible instantaneous value of the total reverse current allowable in the reverse breakdown region.

Transistor power ratings

P_{tot} max: The total maximum permissible continuous power dissipation in the transistor and includes both the collector-base dissipation and the emitter-base dissipation. Under steady state conditions the total power is given by the expression:

$$P_{tot} = V_{CE} \times I_C + V_{BE} \times I_B.$$

In order to distinguish between "steady state" and "pulse" conditions the terms "steady state power (P_S)" and "pulse power (P_p)" are often used. The permissible total power dissipation is dependent upon temperature and its relationship is shown by means of a chart as shown in Fig. 3.

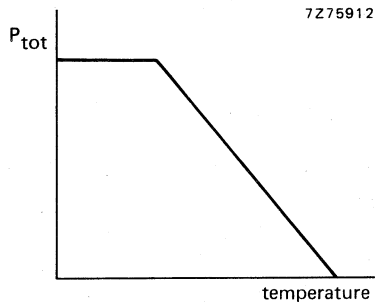


Fig. 3.

The temperature may be ambient, case or mounting base temperatures. Where a cooling clip or a heatsink is attached to the device, the allowable power dissipation is also dependent on the efficiency of the heatsink.

The efficiency of this clip or heatsink is measured in terms of its thermal resistance (R_{th}) normally expressed in degrees centigrade per watt ($^{\circ}C/W$). For mounting base rated device, the added effect of the contact resistance (R_{thi}) must be taken into account.

The effect of heatsinks of various thermal resistance and contact resistance is often included in the above chart.

TRANSISTOR RATINGS

Thus for any heatsink of known thermal resistance and any given ambient temperature, the maximum permissible power dissipation can be established. Alternatively, knowing the power dissipation which will occur and the ambient temperature, the necessary heatsink thermal resistance can be calculated.

A general expression from which the total permissible steady state power dissipation can be calculated is:

$$P_{\text{tot}} = \frac{T_j - T_{\text{amb}}}{R_{\text{th } j-a}}$$

where $R_{\text{th } j-a}$ is the thermal resistance from the transistor junction to the ambient. For case rated or mounting base rated devices, the thermal resistance $R_{\text{th } j-a}$ is made up of the thermal resistance junction to case or mounting base ($R_{\text{th } j-mb}$), the contact thermal resistance ($R_{\text{th } i}$) and the heatsink thermal resistance $R_{\text{th } h}$.

For the calculation of pulse power operation P_p , the maximum pulse power is obtained by the aid of a chart as shown in Fig. 4.

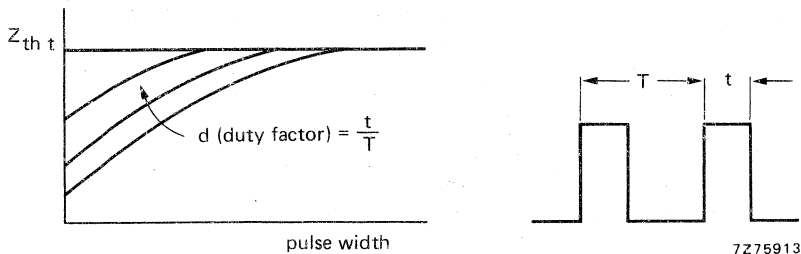


Fig. 4.

The general expression from which the maximum pulse power dissipation can be calculated is:

$$P_p = \frac{T_j - T_{\text{amb}} - P_s \times R_{\text{th } j-a}}{Z_{\text{th } t} + d (R_{\text{th } c-a})}$$

where $Z_{\text{th } t}$ and d are given in the above chart and $R_{\text{th } c-a}$ is the thermal resistance between case and ambient for case rated device. For mounting base rated device, it is equal to $R_{\text{th } h} + R_{\text{th } i}$ and is zero for free air rated device because the effect of the temperature rise of the case over the ambient for a pulse train is already included in $Z_{\text{th } t}$.

Temperature ratings

$T_{j\text{max}}$	The maximum permissible junction temperature which is used as the basis for the calculation of power ratings. Unless otherwise stated, the continuous value is implied.
$T_{j\text{max}}$ (continuous operation)	The maximum permissible continuous value.
$T_{j\text{max}}$ (intermittent operation)	The maximum permissible instantaneous junction temperature usually allowed for a total duration of 200 hours.
T_{mb}	The temperature of the surface making contact with a heatsink. This is confined to devices where a flange or stud for fixing onto a heatsink forms an integral part of the envelope.
T_{case}	The temperature of the envelope. This is confined to devices to which may be attached a clip-on cooling fin.

RATING SYSTEMS

The rating systems described are those recommended by the International Electrotechnical Commission (IEC) in its Publication 134.

DEFINITIONS OF TERMS USED

Electronic device. An electronic tube or valve, transistor or other semiconductor device.

Note

This definition excludes inductors, capacitors, resistors and similar components.

Characteristic. A characteristic is an inherent and measurable property of a device. Such a property may be electrical, mechanical, thermal, hydraulic, electro-magnetic, or nuclear, and can be expressed as a value for stated or recognized conditions. A characteristic may also be a set of related values, usually shown in graphical form.

Bogey electronic device. An electronic device whose characteristics have the published nominal values for the type. A bogey electronic device for any particular application can be obtained by considering only those characteristics which are directly related to the application.

Rating. A value which establishes either a limiting capability or a limiting condition for an electronic device. It is determined for specified values of environment and operation, and may be stated in any suitable terms.

Note

Limiting conditions may be either maxima or minima.

Rating system. The set of principles upon which ratings are established and which determine their interpretation.

Note

The rating system indicates the division of responsibility between the device manufacturer and the circuit designer, with the object of ensuring that the working conditions do not exceed the ratings.

ABSOLUTE MAXIMUM RATING SYSTEM

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, which should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.

The equipment manufacturer should design so that, initially and throughout life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variations, signal variation, environmental conditions, and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

DESIGN MAXIMUM RATING SYSTEM

Design maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the electronic device under consideration.

The equipment manufacturer should design so that, initially and throughout life, no design maximum value for the intended service is exceeded with a bogey device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, variation in characteristics of all other devices in the equipment, equipment control adjustment, load variation, signal variation and environmental conditions.

DESIGN CENTRE RATING SYSTEM

Design centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under normal conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device in average applications, taking responsibility for normal changes in operating conditions due to rated supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all electronic devices.

The equipment manufacturer should design so that, initially, no design centre value for the intended service is exceeded with a bogey electronic device in equipment operating at the stated normal supply voltage.



LETTER SYMBOLS FOR TRANSISTORS AND SIGNAL DIODES

based on IEC Publication 148

LETTER SYMBOLS FOR CURRENTS, VOLTAGES AND POWERS

Basic letters

The basic letters to be used are:

I, i = current
V, v = voltage
P, p = power.

Lower-case basic letters shall be used for the representation of instantaneous values which vary with time.

In all other instances upper-case basic letters shall be used.

Subscripts

A, a	Anode terminal
(AV), (av)	Average value
B, b	Base terminal, for MOS devices; Substrate
(BR)	Breakdown
C, c	Collector terminal
D, d	Drain terminal
E, e	Emitter terminal
F, f	Forward
G, g	Gate terminal
K, k	Cathode terminal
M, m	Peak value
O, o	As third subscript: The terminal not mentioned is open circuited
R, r	As first subscript: Reverse. As second subscript: Repetitive. As third subscript: With a specified resistance between the terminal not mentioned and the reference terminal.
(RMS), (rms)	R. M. S. value
S, s	As first or second subscript: Source terminal (for FETS only)
	As second subscript: Non-repetitive (not for FETS)
	As third subscript: Short circuit between the terminal not mentioned and the reference terminal
X, x	Specified circuit
Z, z	Replaces R to indicate the actual working voltage, current or power of voltage reference and voltage regulator diodes.

Note: No additional subscript is used for d. c. values.

Upper-case subscripts shall be used for the indication of:

- a) continuous (d. c.) values (without signal)
Example I_B
- b) instantaneous total values
Example i_B
- c) average total values
Example $I_{B(AV)}$
- d) peak total values
Example I_{BM}
- e) root-mean-square total values
Example $I_{B(RMS)}$

Lower-case subscripts shall be used for the indication of values applying to the varying component alone:

- a) instantaneous values
Example i_b
- b) root-mean-square values
Example $I_b(rms)$
- c) peak values
Example I_{bm}
- d) average values
Example $I_{b(av)}$

Note: If more than one subscript is used, subscript for which both styles exist shall either be all upper-case or all lower-case.

Additional rules for subscripts

Subscripts for currents

Transistors: If it is necessary to indicate the terminal carrying the current, this should be done by the first subscript (conventional current flow from the external circuit into the terminal is positive).

Examples: I_B, i_B, i_b, I_{bm}

Diodes: To indicate a forward current (conventional current flow into the anode terminal) the subscript F or f should be used; for a reverse current (conventional current flow out of the anode terminal) the subscript R or r should be used.

Examples: $I_F, I_R, i_F, I_f(rms)$

Subscripts for voltages

Transistors: If it is necessary to indicate the points between which a voltage is measured, this should be done by the first two subscripts. The first subscript indicates the terminal at which the voltage is measured and the second the reference terminal or the circuit node. Where there is no possibility of confusion, the second subscript may be omitted.

Examples: V_{BE} , v_{BE} , v_{be} , V_{bem}

Diodes: To indicate a forward voltage (anode positive with respect to cathode), the subscript F or f should be used; for a reverse voltage (anode negative with respect to cathode) the subscript R or r should be used.

Examples: V_F , V_R , v_F , V_{rm}

Subscripts for supply voltages or supply currents

Supply voltages or supply currents shall be indicated by repeating the appropriate terminal subscript.

Examples: V_{CC} , I_{EE}

Note: If it is necessary to indicate a reference terminal, this should be done by a third subscript

Example: V_{CCE}

Subscripts for devices having more than one terminal of the same kind

If a device has more than one terminal of the same kind, the subscript is formed by the appropriate letter for the terminal followed by a number; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

Examples: I_{B2} = continuous (d. c.) current flowing into the second base terminal

V_{B2-E} = continuous (d. c.) voltage between the terminals of second base and emitter

Subscripts for multiple devices

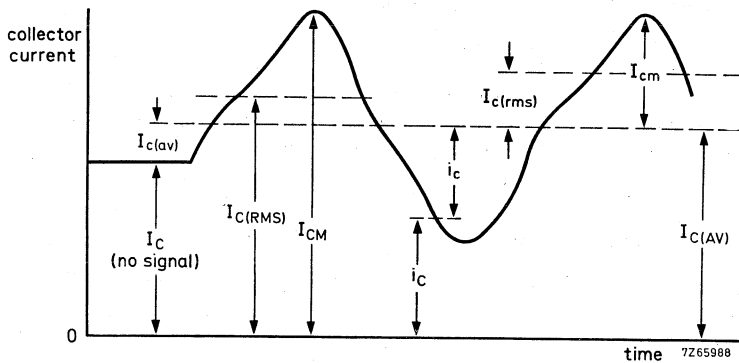
For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

Examples: I_{2C} = continuous (d. c.) current flowing into the collector terminal of the second unit

V_{1C-2C} = continuous (d. c.) voltage between the collector terminals of the first and the second unit.

Application of the rules

The figure below represents a transistor collector current as a function of time. It consists of a continuous (d.c.) current and a varying component.



LETTER SYMBOLS FOR ELECTRICAL PARAMETERS

Definition

For the purpose of this Publication, the term "electrical parameter" applies to four-pole matrix parameters, elements of electrical equivalent circuits, electrical impedances and admittances, inductances and capacitances.

Basic letters

The following is a list of the most important basic letters used for electrical parameters of semiconductor devices.

- B, b = susceptance; imaginary part of an admittance
- C = capacitance
- G, g = conductance; real part of an admittance
- H, h = hybrid parameter
- L = inductance
- R, r = resistance; real part of an impedance
- X, x = reactance; imaginary part of an impedance
- Y, y = admittance;
- Z, z = impedance;

Upper-case letters shall be used for the representation of:

- a) electrical parameters of external circuits and of circuits in which the device forms only a part;
- b) all inductances and capacitances.

Lower-case letters shall be used for the representation of electrical parameters inherent in the device (with the exception of inductances and capacitances).

Subscripts

General subscripts

The following is a list of the most important general subscripts used for electrical parameters of semiconductor devices:

F, f	= forward; forward transfer
I, i (or 1)	= input
L, l	= load
O, o (or 2)	= output
R, r	= reverse; reverse transfer
S, s	= source

Examples: Z_S , h_F , h_F

The upper-case variant of a subscript shall be used for the designation of static (d. c.) values.

Examples: h_{FE} = static value of forward current transfer ratio in common-emitter configuration (d. c. current gain)
 R_E = d. c. value of the external emitter resistance.

Note: The static value is the slope of the line from the origin to the operating point on the appropriate characteristic curve, i. e. the quotient of the appropriate electrical quantities at the operating point.

The lower-case variant of a subscript shall be used for the designation of small-signal values.

Examples: h_{fe} = small-signal value of the short-circuit forward current transfer ratio in common-emitter configuration

$Z_e = R_e + jX_e$ = small-signal value of the external impedance

Note: If more than one subscript is used, subscripts for which both styles exist shall either be all upper-case or all lower-case

Examples: h_{FE} , y_{RE} , h_{fe}

Subscripts for four-pole matrix parameters

The first letter subscript (or double numeric subscript) indicates input, output, forward transfer or reverse transfer

$$\begin{array}{l} \text{Examples: } h_i \text{ (or } h_{11}) \\ h_o \text{ (or } h_{22}) \\ h_f \text{ (or } h_{21}) \\ h_r \text{ (or } h_{12}) \end{array}$$

A further subscript is used for the identification of the circuit configuration. When no confusion is possible, this further subscript may be omitted.

$$\text{Examples: } h_{fe} \text{ (or } h_{21e}), h_{FE} \text{ (or } h_{21E})$$

Distinction between real and imaginary parts

If it is necessary to distinguish between real and imaginary parts of electrical parameters, no additional subscripts should be used. If basic symbols for the real and imaginary parts exist, these may be used.

$$\begin{array}{l} \text{Examples: } Z_i = R_i + jX_i \\ y_{fe} = g_{fe} + jb_{fe} \end{array}$$

If such symbols do not exist or if they are not suitable, the following notation shall be used:

$$\begin{array}{l} \text{Examples: } \text{Re}(h_{ib}) \text{ etc. for the real part of } h_{ib} \\ \text{Im}(h_{ib}) \text{ etc. for the imaginary part of } h_{ib} \end{array}$$

SAFE OPERATING AREA CURVES

1. D.C. SOAR

The d.c. safe operating area (SOAR) of a transistor is limited on the current axis by $I_{C \max}$ and on the voltage axis by $V_{CE0 \max}$. Intersecting these two is a third limit defined by $P_{\text{tot} \max}$. These limits can be superimposed on the normal $I_C - V_{CE}$ curve as in Fig. 1, but are better shown on a double logarithmic scale as in Fig. 2; the $P_{\text{tot} \max}$ limit then appears as a straight line at 45° to the axes.

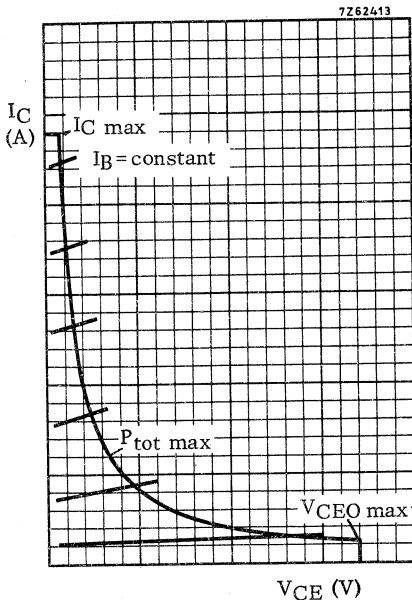


Fig. 1

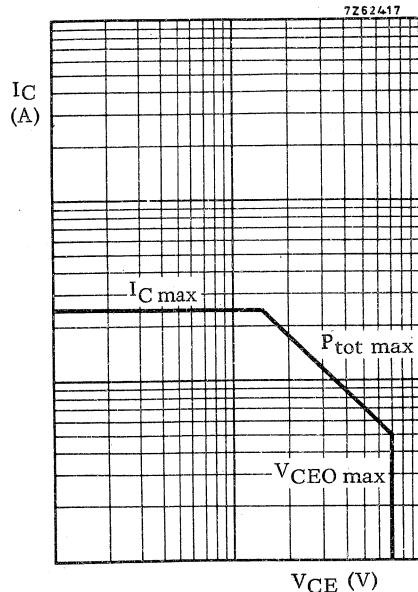


Fig. 2: D.C. SOAR curve

For steady state conditions there is a linear relation between the power dissipated at the junction and the temperature difference between junction and mounting base:

$$T_j - T_{mb} = C \cdot P_{\text{tot}}$$

where $C = R_{\text{th} j-mb}$, i.e. the thermal resistance from junction to mounting base.

$$T_j - T_{mb} = P_{\text{tot}} \cdot R_{\text{th} j-mb} \tag{1}$$

In terms of maximum allowable junction temperature eq. (1) can be written as:

$$T_{j \max} - T_{mb} = P_{\text{tot} \max} \cdot R_{\text{th} j-mb} \tag{1a}$$

The data sheets give an upper limit for $P_{tot\ max}$ which applies up to a temperature T_1 . These relations are shown in Fig. 3 where the upper limit for $P_{tot\ max}$ has been chosen as 100%.

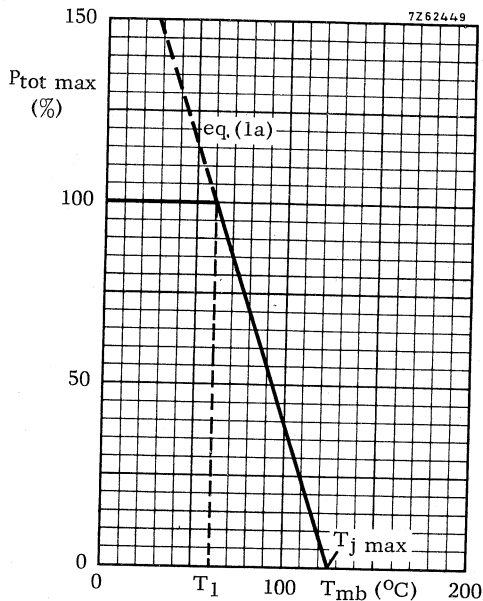


Fig. 3

So far we have discussed only d.c. conditions; it will be obvious that under pulse conditions a higher $P_{tot\ max}$ can be permitted.

2. Extension of the SOAR for pulse power

When pulse power is applied to a transistor the junction temperature will rise in a series of steps until a steady state condition is reached. See Fig. 4.

For this steady state, eq. (1) can be modified to:

$$T_{j\ peak} - T_{mb} = P_{peak} \cdot Z_{th\ j-mb} \tag{2}$$

where $Z_{th\ j-mb}$ is the transient thermal impedance from junction to mounting base and is dependent not only on $R_{th\ j-mb}$, but also on pulse width (t_p) and period (T). $Z_{th\ j-mb}$ is generally published in the form of Fig. 5.

In terms of maximum allowable junction temperature eq. (2) can be written as:

$$T_{j\ max} - T_{mb} = P_{peak\ max} \cdot Z_{th\ j-mb} \tag{2a}$$

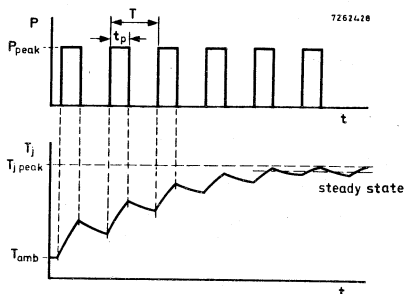


Fig. 4

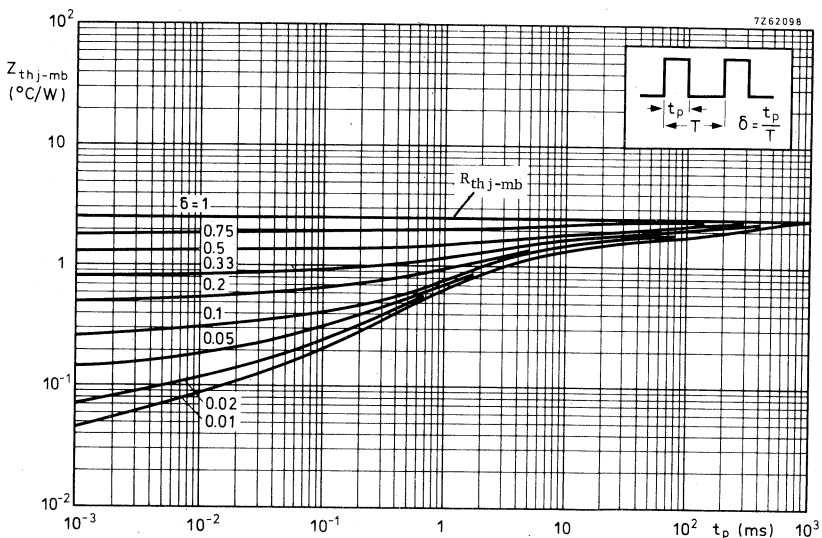


Fig. 5

Dividing eq. (2a) by eq. (1a), leads to:

$$P_{\text{peak max}} = P_{\text{tot max}} \frac{R_{\text{th j-mb}}}{Z_{\text{th j-mb}}} = P_{\text{tot max}} \cdot M_p \tag{3}$$

This means that the $P_{\text{tot max}}$ curve can be shifted by the factor M_p , see the sloping part of the thick dashed line of Fig. 6. M_p is known as the 'power multiplying factor'. The horizontal part of the dashed line of Fig. 6 is the rating I_{CMmax} ; it is the upper limit of the SOAR for pulse conditions.

In addition to the limits set by the SOAR the average current $I_{\text{C(AV)}}$ with an averaging time t_{av} of 50 ms should not exceed the maximum permissible d.c. current I_{Cmax} . Averaging is not necessary when SOAR limits lower than the rated I_{CMmax} are indicated for different pulse durations.

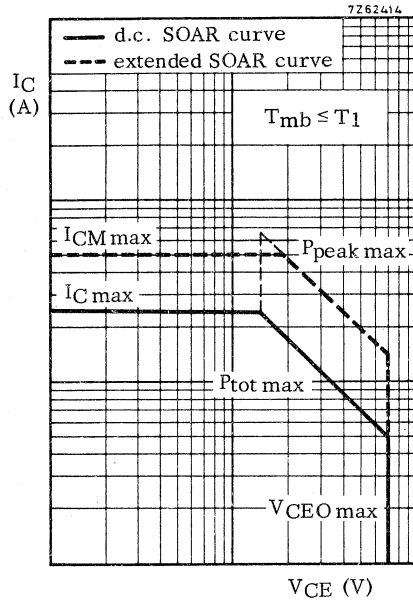


Fig. 6

3. Second Breakdown

3.1 The phenomenon

Primary breakdown is a sudden increase in I_C as a result of avalanche action within the crystal. If the collector current is increased further a critical condition can be reached at which the voltage across the crystal drops to a very low level. This phenomenon is known as second breakdown. It is initiated by a current concentration that leads to local heating within the crystal. The higher the voltage (before second breakdown) the lower the power at which the concentration occurs. If a single point on the crystal exceeds $T_{j\ max}$, the transistor characteristics may be permanently affected; further current concentration will lead to increased temperature and consequent second breakdown, which will destroy the transistor.

The SOAR curve must define an area that only precludes second breakdown but also the current concentration that precedes it.

3.2 Second breakdown and the d.c. SOAR

A transistor's susceptibility to second breakdown is investigated by d.c. loading up to current concentration. With different combinations of I_C and V_{CE} , points are plotted at which current concentration is observed. A limit is then defined that precludes current concentration. This line lowers the original SOAR curve (see Fig. 7). The final d.c. SOAR curve is that shown in Fig. 8. In general the second breakdown limit is independent of the mounting base temperature

The thermal resistance $R_{th\ j-mb}$ is guaranteed for all I_C - V_{CE} combinations within the d.c. SOAR.

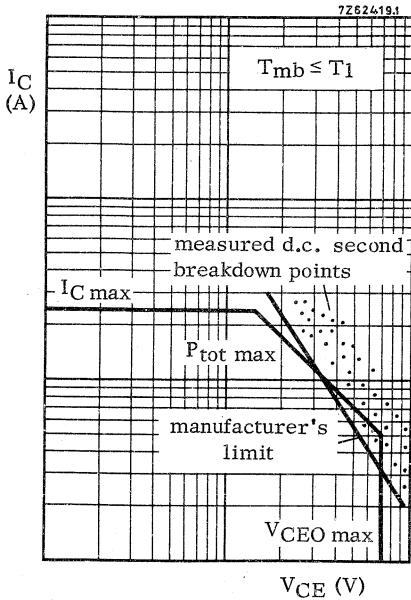


Fig. 7

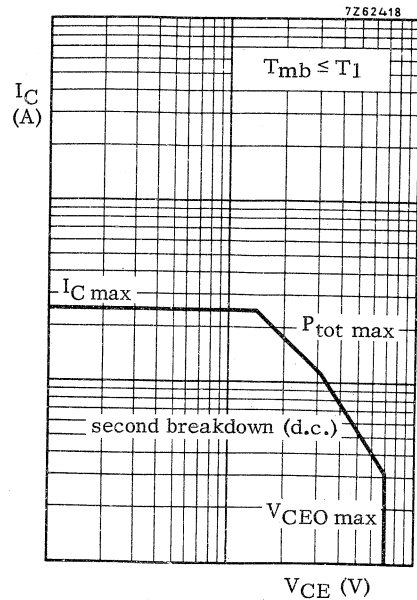


Fig. 8

3.3 Fixing the second breakdown line for pulses, in the SOAR curve

In section 3.1 it was suggested that second breakdown occurs when a single point of the junction (crystal) reaches a critical temperature. It is really the thermal conditions in the crystal itself that determine the point of second breakdown - the thermal resistance ($R_{th \text{ crystal}}$) and the thermal impedance ($Z_{th \text{ crystal}}$) between the hottest part of the crystal and the rest. $Z_{th \text{ crystal}}$ is dependent on $R_{th \text{ crystal}}$, δ , t_p , and the relation $I_C - V_{CE}$.

As with M_p , a multiplying factor M can be derived to fix the second breakdown line for pulse conditions. However, for second breakdown two multiplying factors are given; M_V is the voltage multiplying factor at the $I_{C \max}$ level; M_I is the current multiplying factor at the $V_{CE \max}$ level.*

Knowing δ and t_p , one can find M_V and M_I from two curves published in the data sheets, Figs 9a and 9b being examples. The voltage value at which the d.c. second breakdown line intersects the $I_{C \max}$ line is then multiplied by M_V . In Fig. 10 the d.c. intersection is shown as point C, and a new intersection for specific pulse conditions as point C'. In the same way M_I is used to find D' from D, which is the point at which the d.c. second breakdown line intersects the $V_{CE \max}$ line. The line that passes through C' and D' defines the second breakdown limit for given values of δ and t_p .

* As decided in 1973, $M_{SB(V)}$ is now replaced by M_I and $M_{SB(I)}$ by M_V . The definitions are unaltered. Most of the graphs in the book have been changed, the remainder will be corrected at the first opportunity.

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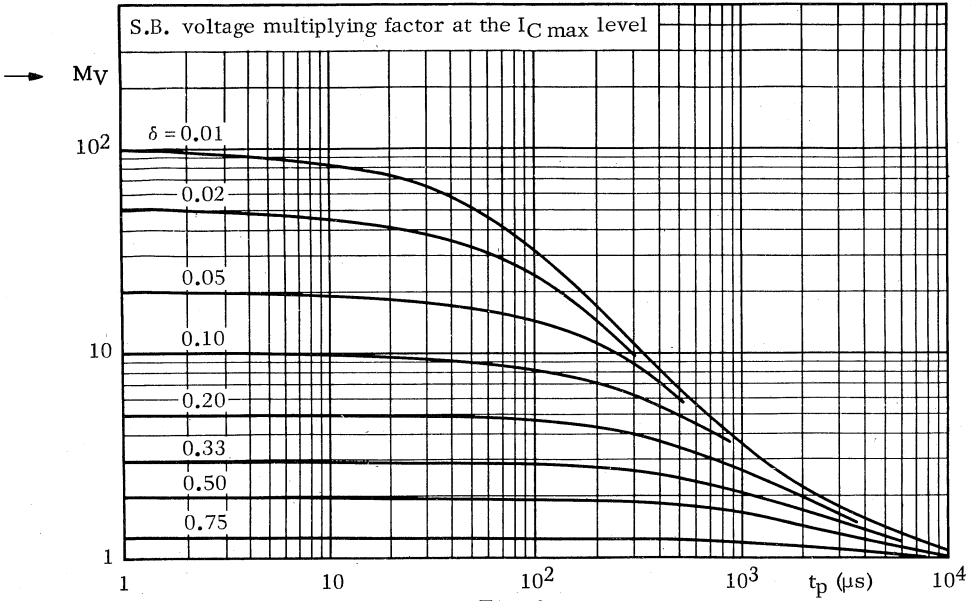


Fig. 9a

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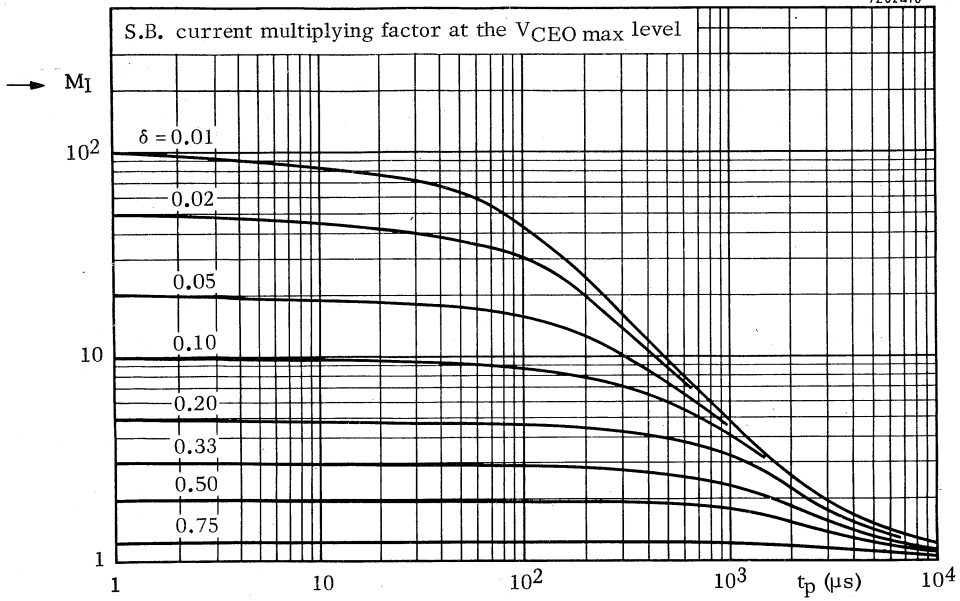


Fig. 9b

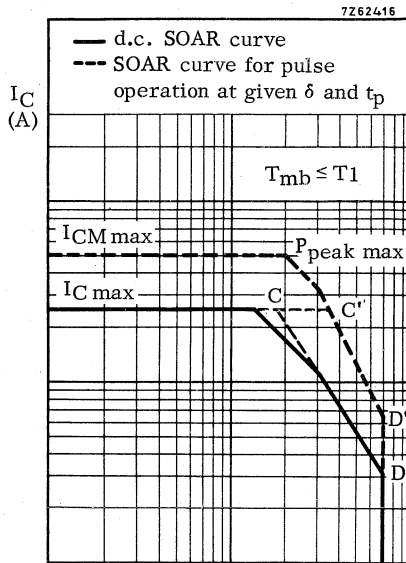


Fig. 10

A transistor can be safely operated under pulse conditions within the area bounded by $I_{CM\ max}$, $P_{peak\ max}$, pulse SB limit, and $V_{CEO\ max}$, provided the mounting base temperature does not exceed T_1 . If the mounting base temperature does exceed T_1 , M_p must be reduced by a factor derived from Fig. 3 (see section 1) but M need not be changed.

The SOAR curve for one specific duty cycle (δ) is given in the data sheets, but with the aid of curves Z_{th} , M_V , M_I and the d.c. SOAR, a pulse condition SOAR can be constructed for any duty factor.

4. Example of how to use the published SOAR information

4.1 Statement of the problem

The driver- and output-stage of an audio amplifier are given in Fig. 11. We shall investigate whether the driver transistor TR3 operates safely under worst case conditions.

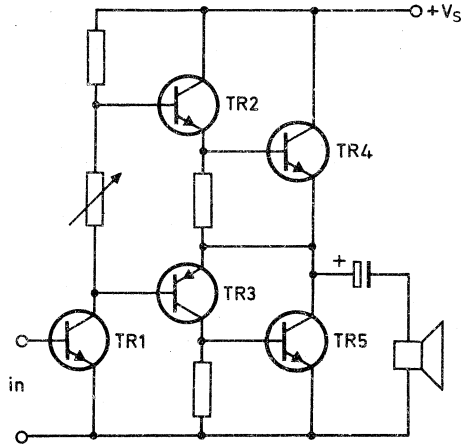


Fig. 11

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The loudspeaker impedance is such that worst case conditions occur when the amplifier is overdriven by about 20 times the input signal necessary for full output power at a frequency of 750 Hz. Fig. 12 gives V_{CE} and I_C of TR3 under these conditions. The mounting base temperature of TR3 under these conditions is found to be 85 °C.

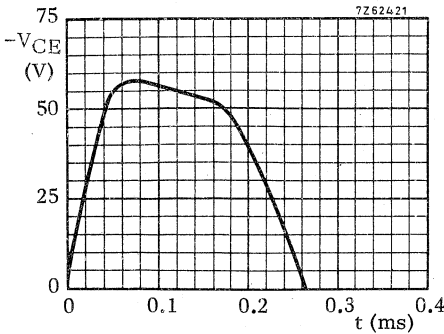


Fig. 12a

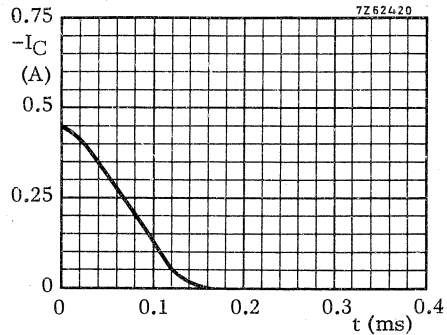


Fig. 12b

4.2 Information obtained from the published data of TR3

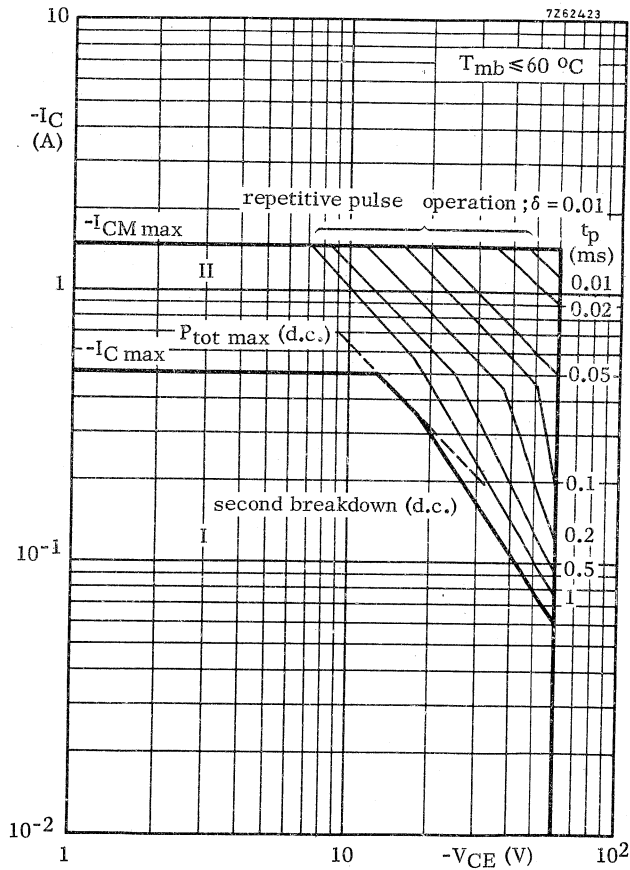
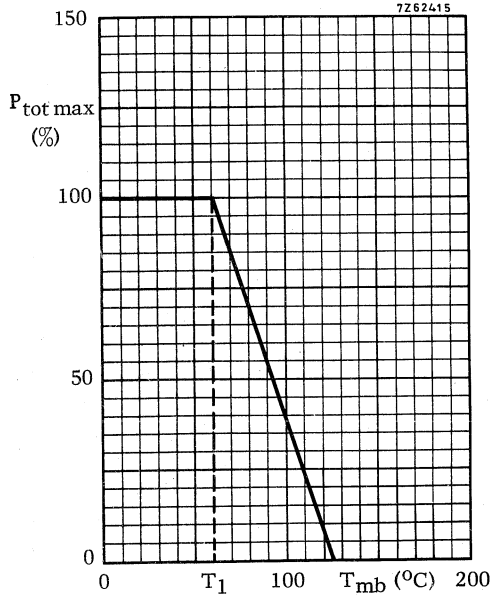


Fig. 13. Safe Operating Area with the transistor forward biased
 I Region of permissible d.c. operation
 II Permissible extension for repetitive pulse operation.



$T_{j\ max} = 125\ ^\circ C$

$R_{th\ j-mb} = 10\ ^\circ C/W$

Fig. 14

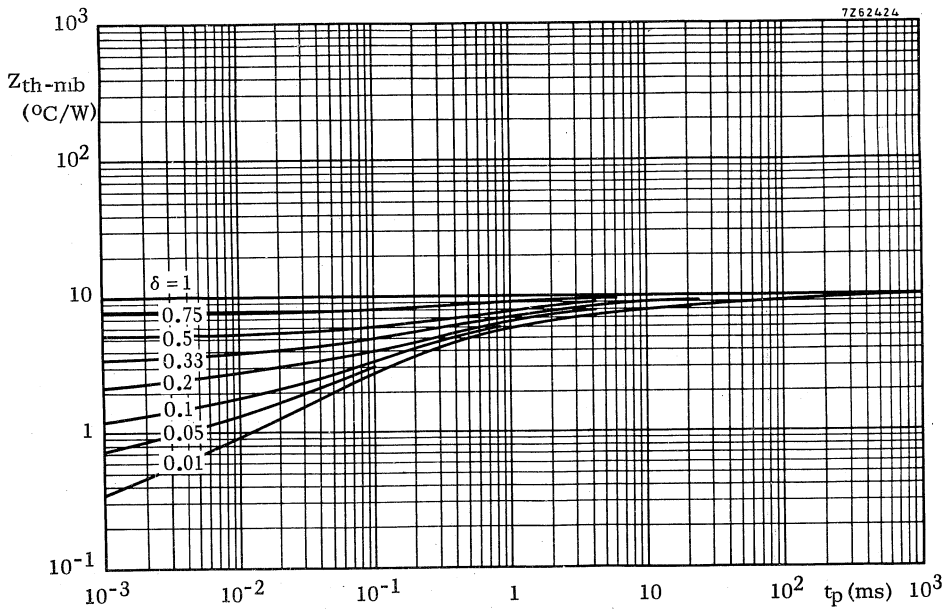


Fig. 15

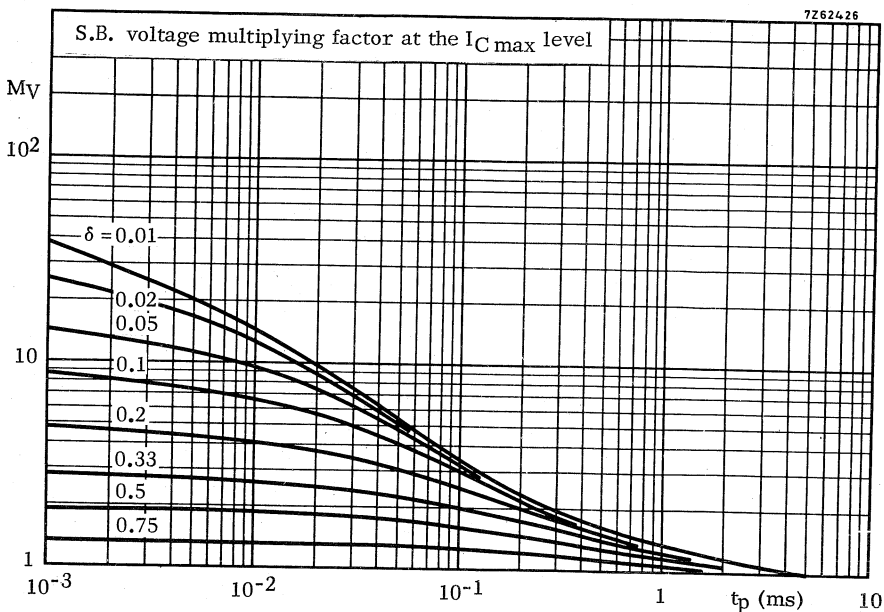


Fig. 16

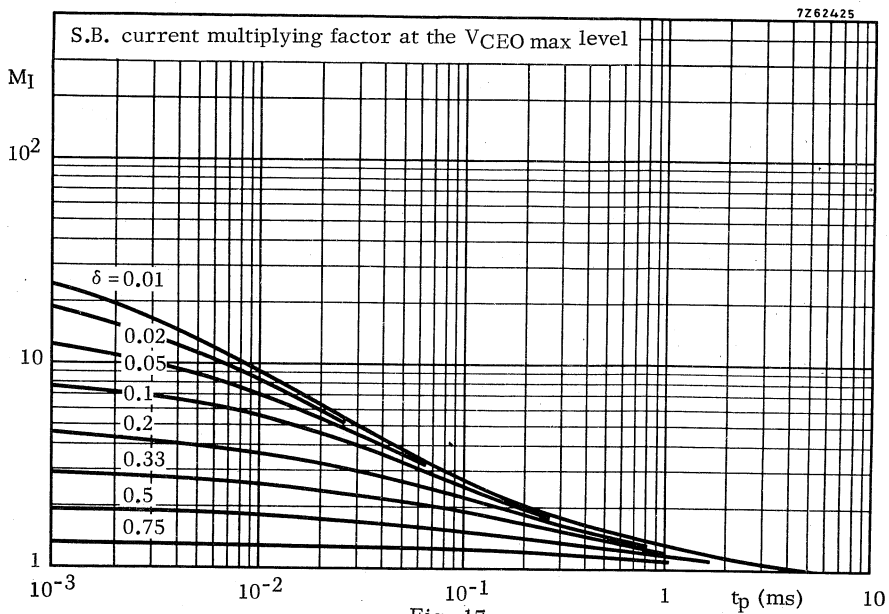


Fig. 17

4.3 Construction of the pulse SOAR of TR3 in this application

4.3.1

Plot the power curve obtained by multiplying the two curves of Fig. 12 and construct an equivalent rectangular power pulse with the same peak value and area as the original pulse. The result is given in Fig. 18.

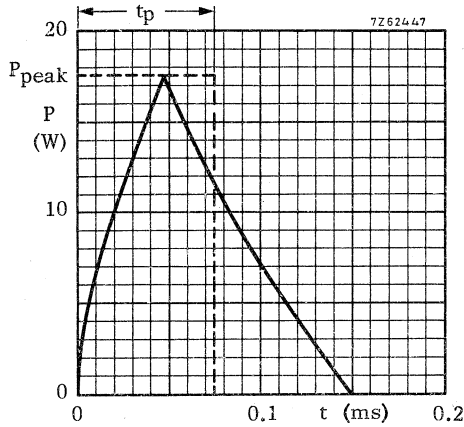


Fig. 18

4.3.2

Ascertain t_p , T , $\delta = t_p/T$ and P_{peak} . The results are:

$$t_p = 75 \mu s$$

$$T = \frac{1}{750} = 1.33 \text{ ms}$$

$$\delta = 0.056$$

$$P_{peak} = 17.5 \text{ W}$$

4.3.3

Refer to Fig. 14 and determine the derating factor for $P_{tot \text{ max}}$ at 85 °C. The result is 0.6.

Refer to Fig. 15 and determine $M_p = \frac{R_{th \text{ j-mb}}}{Z_{th \text{ j-mb}}}$ for $t_p = 75 \mu s$ and $\delta = 0.056$.

$$R_{th \text{ j-mb}} = 10 \text{ } ^\circ\text{C/W}$$

$$Z_{th \text{ j-mb}} = 2.75 \text{ } ^\circ\text{C/W}$$

$$M_p = \frac{10}{2.75} = 3.64$$

4.3.4

Refer to Fig. 16. and 17. and ascertain the M_{SB} factors for $t_p = 75 \mu s$ and $\delta = 0.056$. The results are:

$$M_V = 3.6$$

$$M_I = 2.8$$

4.3.5

Refer to Fig. 13. and construct the pulse extension of the d.c. SOAR for $t_p = 75 \mu s$ and $\delta = 0.056$ according to the following rules (see Fig. 19).

- Multiply the value of the voltage at point A by the derating factor obtained from Fig. 14 (0.6) and by $M_P = 3.64$ to obtain A'.

$$V_A = 13 \text{ V}$$

$$V_{A'} = 13 \text{ V} \times 0.6 \times 3.64 = 28.4 \text{ V}$$

- Through point A' construct a line of constant power (45°)

$$P_{\text{peak max}} = 28.4 \times I_{C \text{ max}} = 14.2 \text{ W.}$$

- Multiply the value of V_{CE} at point C by $M_V = 3.6$ (see 4.3.4), to obtain C'.

- Multiply the value of I_C at point D by $M_I = 2.8$ (see 4.3.4), to obtain D'.

- Construct a new limit for second breakdown by drawing a line through point C' and D'.

- The SOAR for this particular case is formed by the $I_{CM \text{ max}}$ line, the maximum peak dissipation line through A', the second breakdown limit line C'-D' and the V_{CEO} line.

4.3.6

Plot the $I_C - V_{CE}$ excursion as found from Fig. 12a and b in Fig. 19 and check if every point of this excursion is inside the SOAR.

In this particular example the $P_{\text{peak max}}$ limit is exceeded, while the SB-limit is not exceeded. A solution for this case is to decrease the mounting base temperature, T_{mb} , by enlarging the heatsink.

4.3.7

The new permissible mounting base temperature, $T_{mb \text{ max}}$, can be calculated as follows

$$T_{mb \text{ max}} = T_{j \text{ max}} - P_{\text{peak}} \cdot Z_{th \text{ j-mb}}$$

$$P_{\text{peak}} = 17.5 \text{ W (see 4.3.2)}$$

$$Z_{th \text{ j-mb}} = 2.75 \text{ }^\circ\text{C/W}$$

Therefore:

$$T_{mb \text{ max}} = 125 - 17.5 \times 2.75 = 77 \text{ }^\circ\text{C}$$

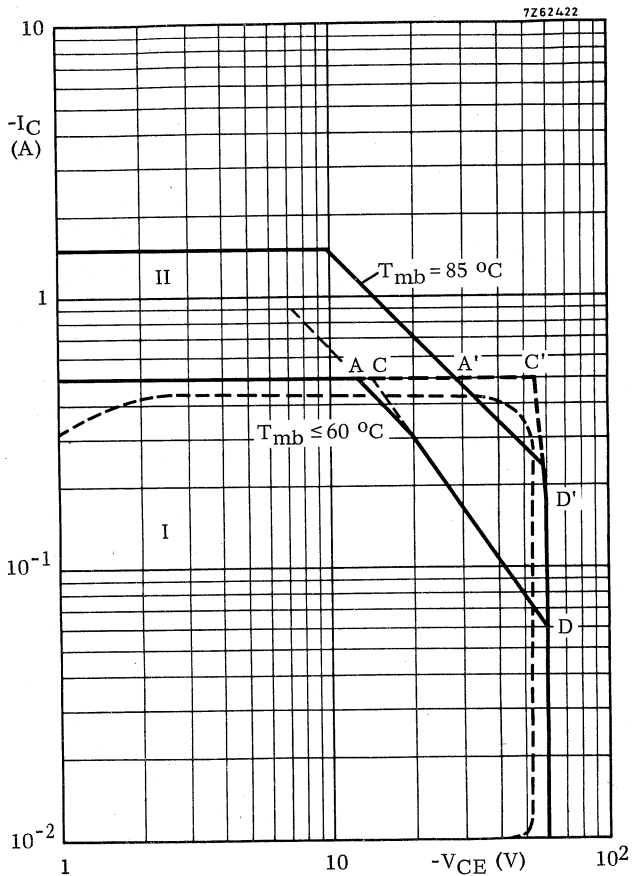


Fig. 19

- I Region of permissible operation up to $T_{mb} = 60\text{ }^{\circ}\text{C}$
- II Permissible extension for $t_p = 75\text{ }\mu\text{s}$, $\delta = 0.056$ and $T_{mb} = 85\text{ }^{\circ}\text{C}$

4.3.8

.....

For calculation of the heatsink the power may be averaged provided the period T does not exceed the thermal time constant of the transistor.

$$\text{Then } T_{mb} - T_{amb} = \delta \cdot P_{peak} \cdot R_{th\ mb-a}$$

If $T_{mb\ max}$ and P_{peak} are known, the max. allowable $R_{th\ mb-a}$ may be calculated with

$$R_{th\ mb-a\ max} = \frac{T_{mb\ max} - T_{amb}}{\delta \cdot P_{peak}}$$

$$\text{In our example } R_{th\ mb-a\ max} = \frac{77 - 25}{0.056 \times 17.5} = 53\ ^\circ\text{C/W}$$



TRANSISTOR DATA



SILICON PLANAR EPITAXIAL POWER TRANSISTOR

N-P-N transistor in a SOT-32 plastic envelope for general purpose, medium power applications. P-N-P complement is BD132.

QUICK REFERENCE DATA

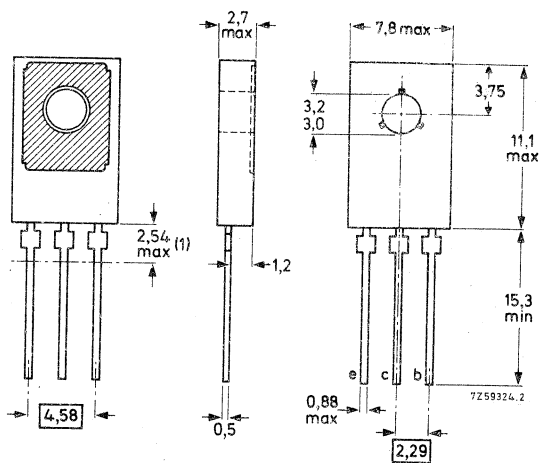
Collector-base voltage (open emitter)	V_{CB0}	max.	70 V
Collector-emitter voltage (open base)	V_{CEO}	max.	45 V
Collector current (peak value)	I_{CM}	max.	6 A
Total power dissipation up to $T_{mb} = 60\text{ }^{\circ}\text{C}$	P_{tot}	max.	15 W
Junction temperature	T_j	max.	150 $^{\circ}\text{C}$
D.C. current gain	h_{FE}	>	40
$I_C = 0,5\text{ A}; V_{CE} = 12\text{ V}$			
Transition frequency at $f = 35\text{ MHz}$	f_T	>	60 MHz
$I_C = 0,25\text{ A}; V_{CE} = 5\text{ V}$			

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126 (SOT-32).

Collector connected to metal part of mounting surface.



See also chapters Mounting instructions and Accessories.

(1) Within this region the cross-section of the leads is uncontrolled.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	V_{CBO}	max.	70 V
Collector-emitter voltage (open base)	V_{CEO}	max.	45 V
Emitter-base voltage (open collector)	V_{EBO}	max.	6 V
Collector current (d.c.)	I_C	max.	3 A
Collector current (peak value)	I_{CM}	max.	6 A
Base current (peak value)	I_{BM}	max.	0,5 A
Reverse base current (peak value)	$-I_{BM}$	max.	0,5 A
Total power dissipation up to $T_{mb} = 60\text{ }^\circ\text{C}$	P_{tot}	max.	15 W
Storage temperature	T_{stg}		-65 to + 150 $^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base

$$R_{th\ j-mb} = 6\text{ }^\circ\text{C/W}$$



CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$$I_E = 0; V_{CB} = 50\text{ V}$$

$$I_{CBO} < 5\text{ }\mu\text{A}$$

$$I_E = 0; V_{CB} = 50\text{ V}; T_j = 150\text{ }^\circ\text{C}$$

$$I_{CBO} < 500\text{ }\mu\text{A}$$

Emitter cut-off current

$$I_C = 0; V_{EB} = 5\text{ V}$$

$$I_{EBO} < 5\text{ }\mu\text{A}$$

Saturation voltages

$$I_C = 0,5\text{ A}; I_B = 50\text{ mA}$$

$$V_{CEsat} < 0,3\text{ V}$$

$$V_{BEsat} < 1,2\text{ V}$$

$$I_C = 2\text{ A}; I_B = 200\text{ mA}$$

$$V_{CEsat} < 0,7\text{ V}$$

$$V_{BEsat} < 1,5\text{ V}$$

D.C. current gain

$$I_C = 0,5\text{ A}; V_{CE} = 12\text{ V}$$

$$h_{FE} > 40$$

$$I_C = 2\text{ A}; V_{CE} = 1\text{ V}$$

$$h_{FE} > 20$$

Collector capacitance at $f = 1\text{ MHz}$

$$I_E = I_e = 0; V_{CB} = 5\text{ V}$$

$$C_c < 60\text{ pF}$$

Transition frequency at $f = 35\text{ MHz}$

$$I_C = 0,25\text{ A}; V_{CE} = 5\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$$

$$f_T > 60\text{ MHz}$$

D.C. current gain ratio of the complementary pairs

$$I_C = 0,5\text{ A}; V_{CE} = 12\text{ V}$$

$$h_{FE1}/h_{FE2} < 1,2$$



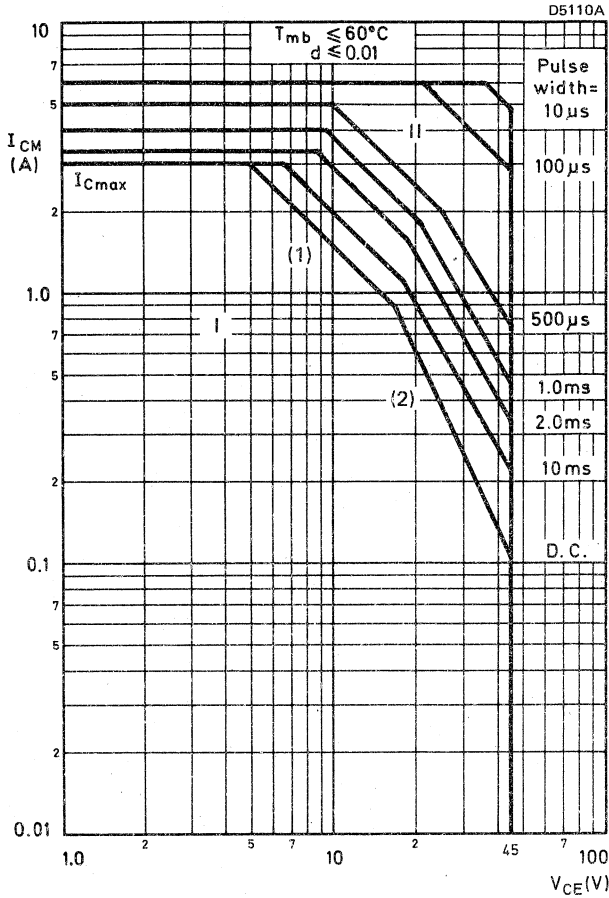


Fig. 2 Safe Operating Area with the transistor forward biased.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) P_{tot} max and P_{peak} max lines.
- (2) Second breakdown limits (independent of temperature).

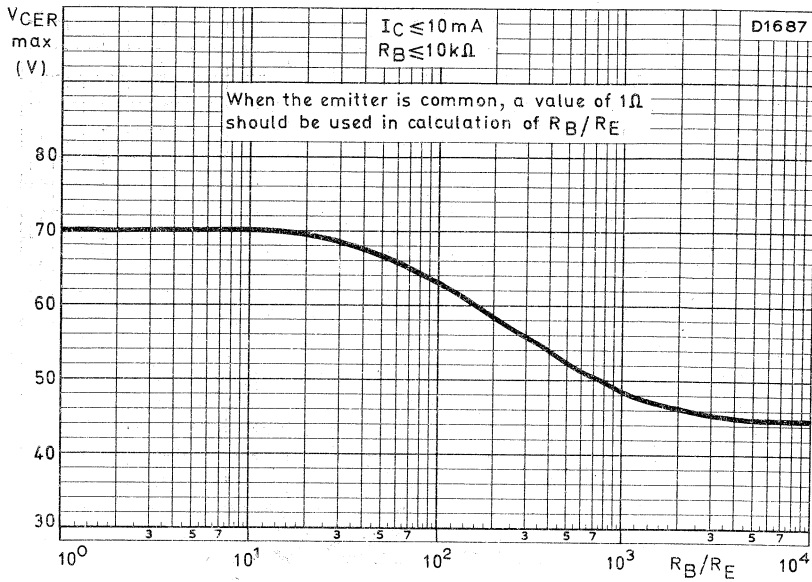


Fig. 3 Maximum allowable collector-emitter voltage as a function of base-emitter resistance.

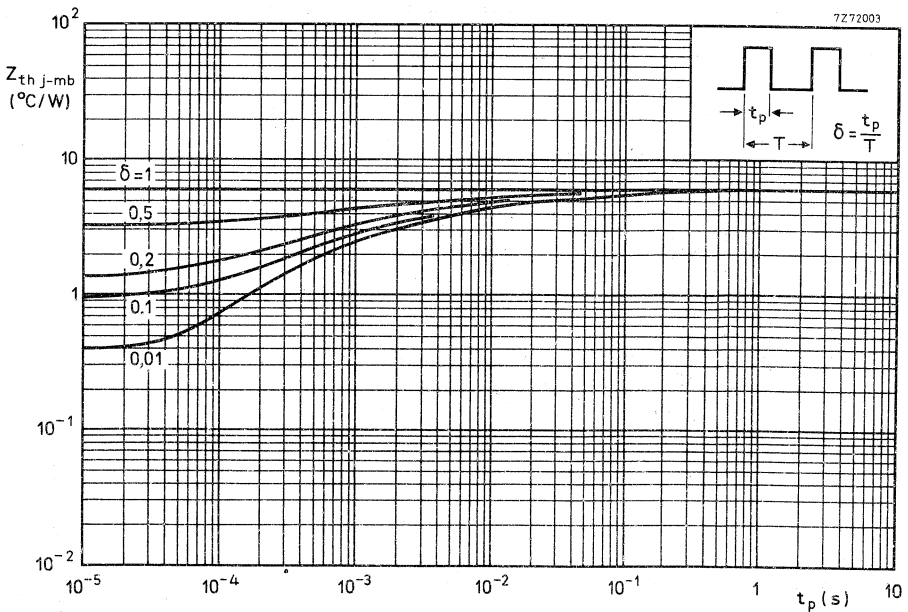


Fig. 4 Pulse power rating chart.

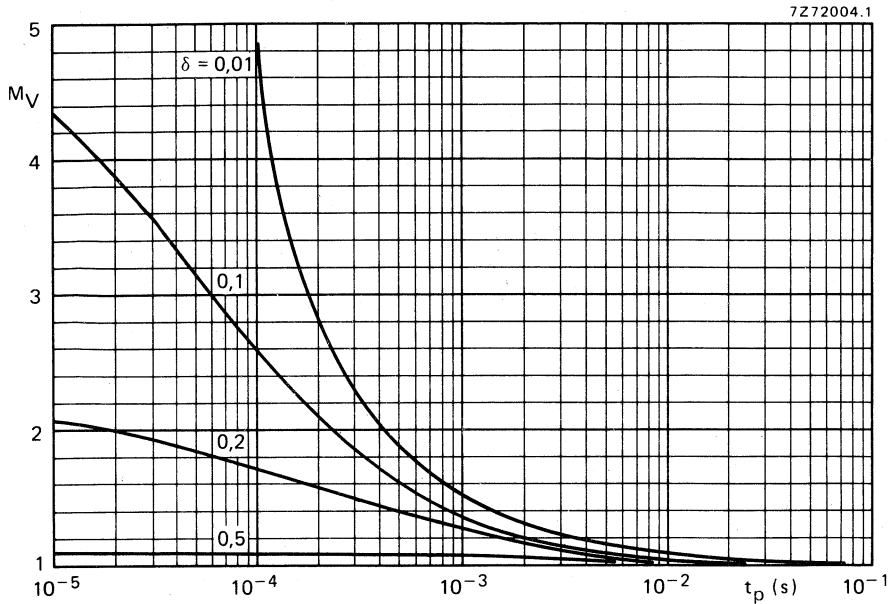


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

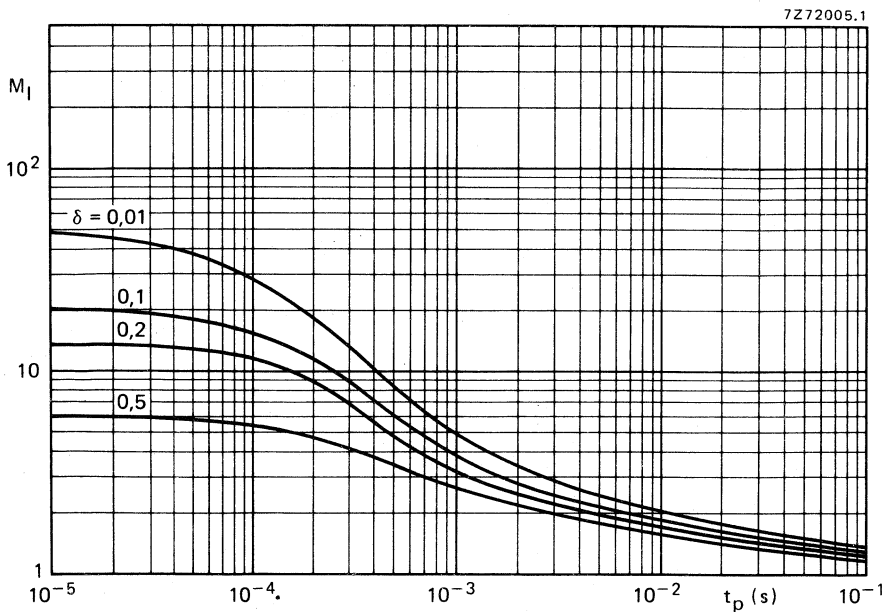


Fig. 6 S.B. current multiplying factor at the V_{CE0max} level.

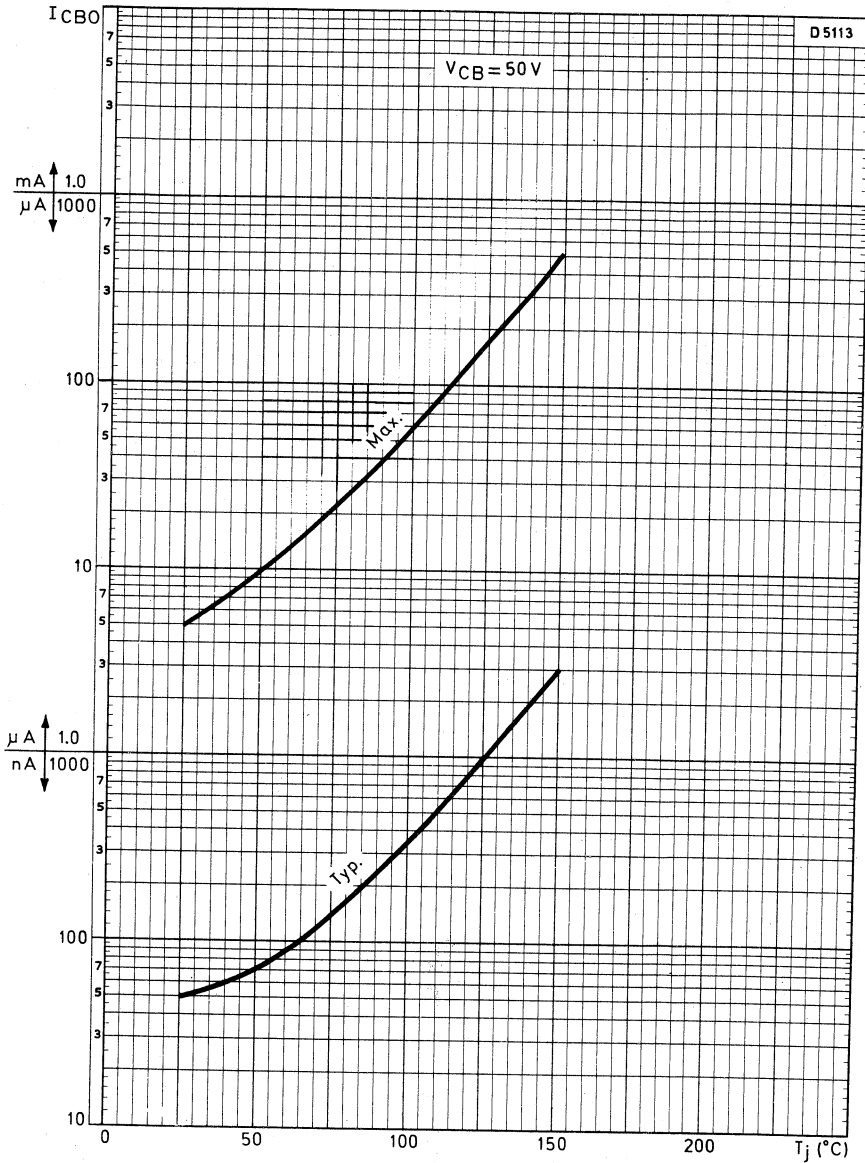


Fig. 7 Collector-base current (open emitter) as a function of the junction temperature.

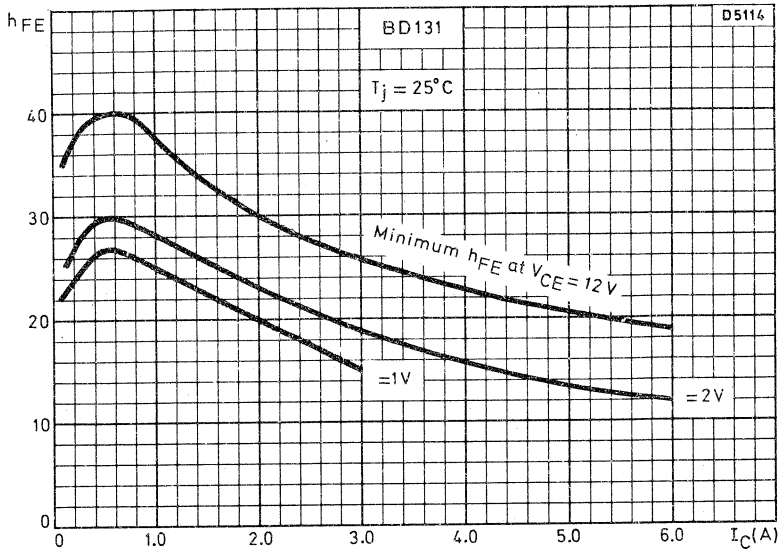


Fig. 8.

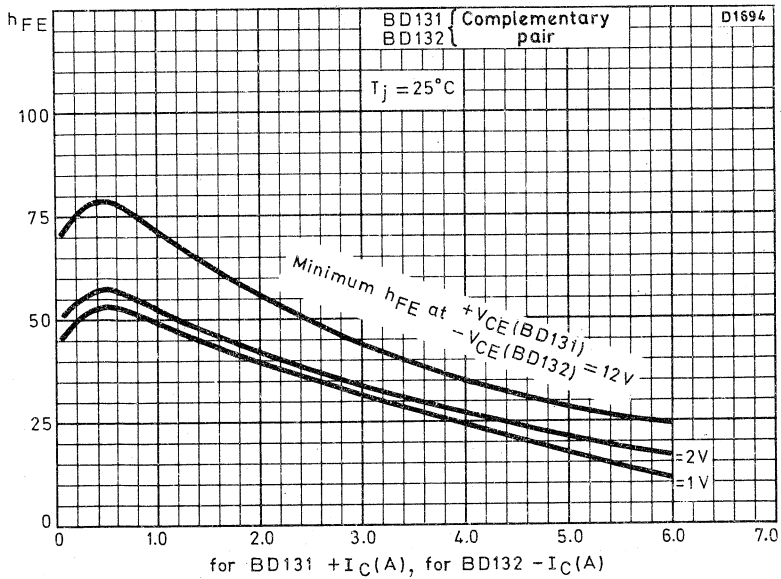


Fig. 9.

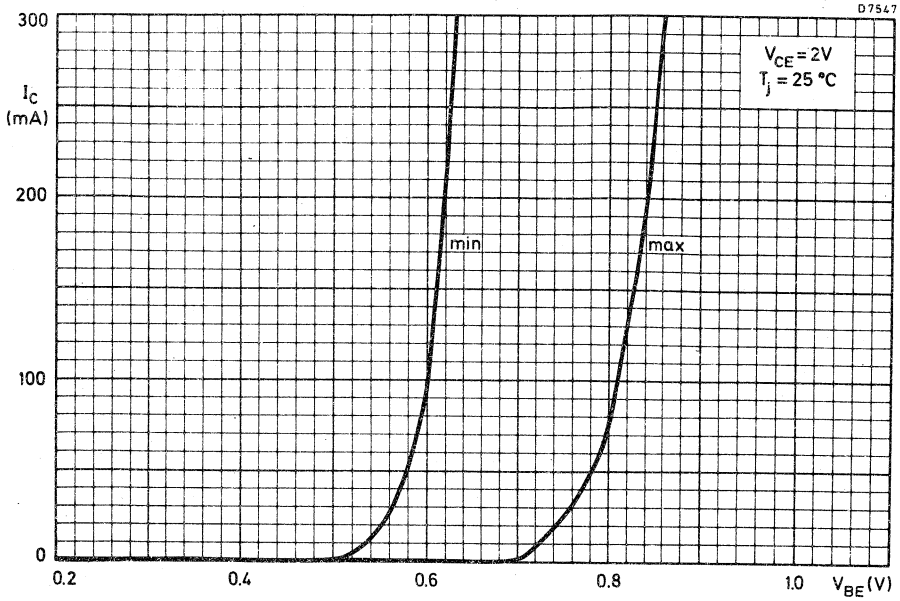


Fig. 10.

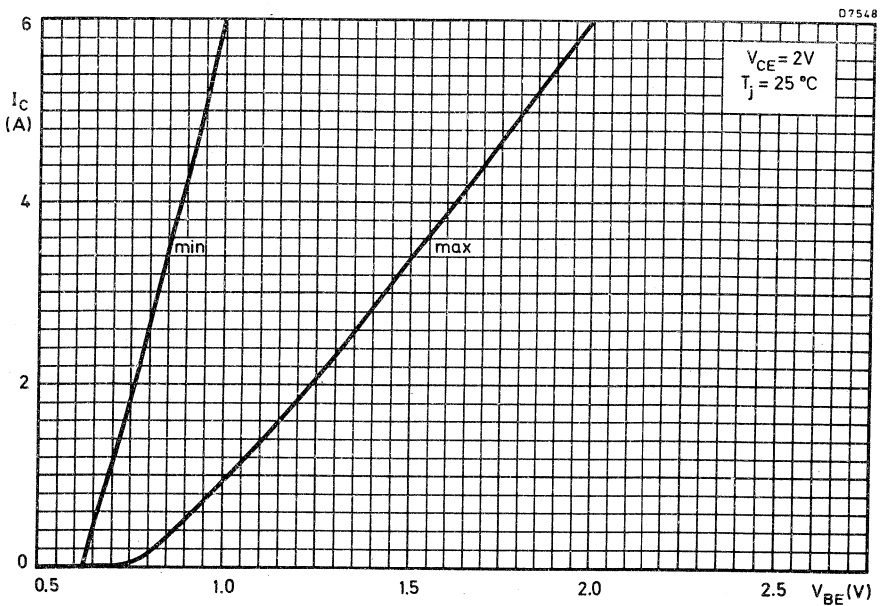


Fig. 11.

SILICON PLANAR EPITAXIAL POWER TRANSISTOR

P-N-P transistor in a SOT-32 plastic envelope for general purpose, medium power applications. N-P-N complement is BD131.

QUICK REFERENCE DATA

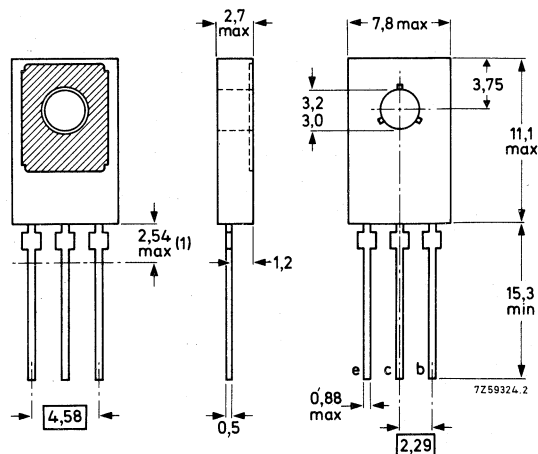
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	45 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	45 V
Collector current (peak value)	$-I_{CM}$ max.	6 A
Total power dissipation up to $T_{mb} = 60\text{ }^{\circ}\text{C}$	P_{tot} max.	15 W
Junction temperature	T_j max.	150 $^{\circ}\text{C}$
D.C. current gain	h_{FE}	> 40
$-I_C = 0,5\text{ A}; -V_{CE} = 12\text{ V}$		
Transition frequency at $f = 35\text{ MHz}$	f_T	> 60 MHz
$-I_C = 0,25\text{ A}; -V_{CE} = 5\text{ V}$		

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126 (SOT-32)

Collector connected to metal part of mounting surface.



See also chapters Mounting instructions and Accessories.

(1) Within this region the cross-section of the leads is uncontrolled.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	4 V
Collector current (d.c.)	$-I_C$	max.	3 A
Collector current (peak value)	$-I_{CM}$	max.	6 A
Base current (peak value)	$-I_{BM}$	max.	0,5 A
Reverse base current (peak value)	$+I_{BM}$	max.	0,5 A
Total power dissipation up to $T_{mb} = 60\text{ }^\circ\text{C}$	P_{tot}	max.	15 W
Storage temperature	T_{stg}		-65 to $+150\text{ }^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	6 $^\circ\text{C/W}$
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CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 40\text{ V}$

$-I_{CBO} < 5\text{ }\mu\text{A}$

$I_E = 0; -V_{CB} = 40\text{ V}; T_j = 150\text{ }^\circ\text{C}$

$-I_{CBO} < 500\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 3\text{ V}$

$-I_{EBO} < 5\text{ }\mu\text{A}$

Saturation voltages

$-I_C = 0,5\text{ A}; -I_B = 50\text{ mA}$

$-V_{CEsat} < 0,3\text{ V}$

$-V_{BEsat} < 1,2\text{ V}$

$-I_C = 2\text{ A}; -I_B = 200\text{ mA}$

$-V_{CEsat} < 0,7\text{ V}$

$-V_{BEsat} < 1,5\text{ V}$

D.C. current gain

$-I_C = 0,5\text{ A}; -V_{CE} = 12\text{ V}$

$h_{FE} > 40$

$-I_C = 2\text{ A}; -V_{CE} = 1\text{ V}$

$h_{FE} > 20$

Transition frequency at $f = 35\text{ MHz}$

$-I_C = 0,25\text{ A}; -V_{CE} = 5\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$

$f_T > 60\text{ MHz}$

D.C. current gain ratio

of the complementary pairs

$-I_C = 500\text{ mA}; -V_{CE} = 12\text{ V}$

$h_{FE1}/h_{FE2} < 1,2$

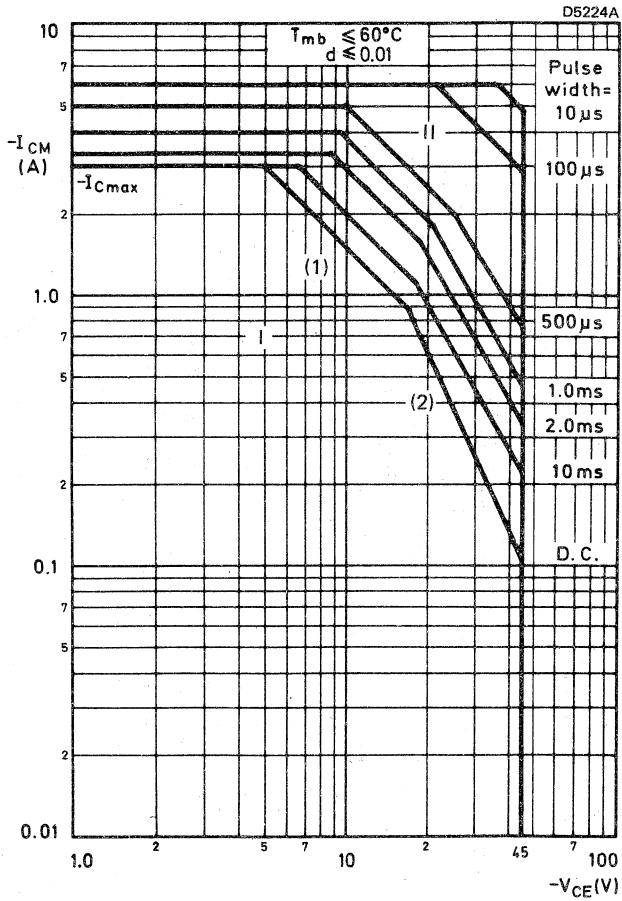


Fig. 2 Safe Operating Area with the transistor forward biased.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
- (2) Second breakdown limits (independent of temperature).

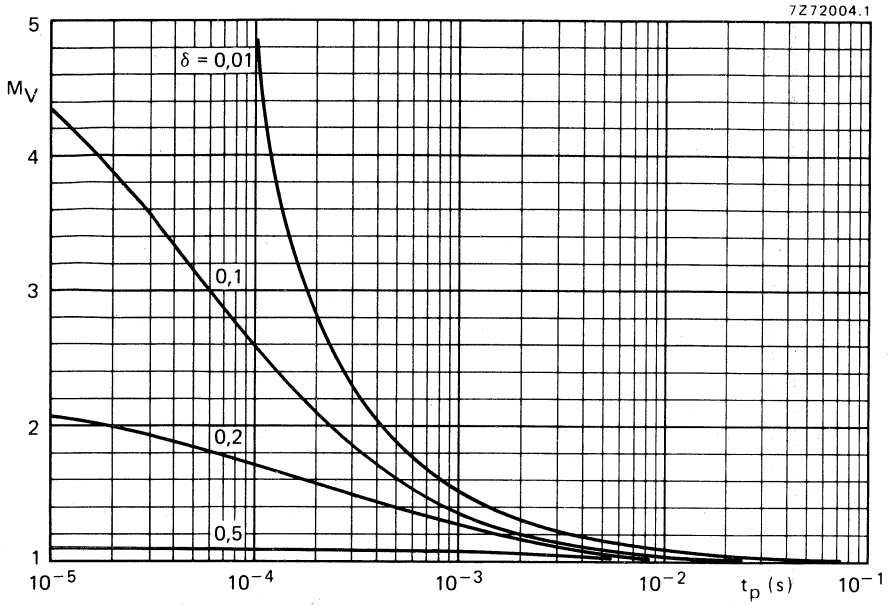


Fig. 3 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

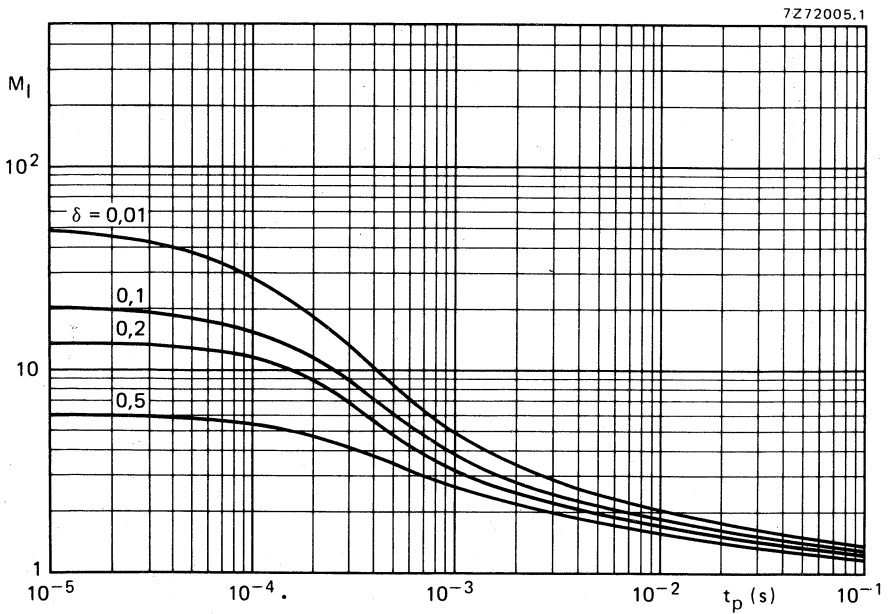


Fig. 4 S.B. current multiplying factor at the $-V_{CEOmax}$ level.

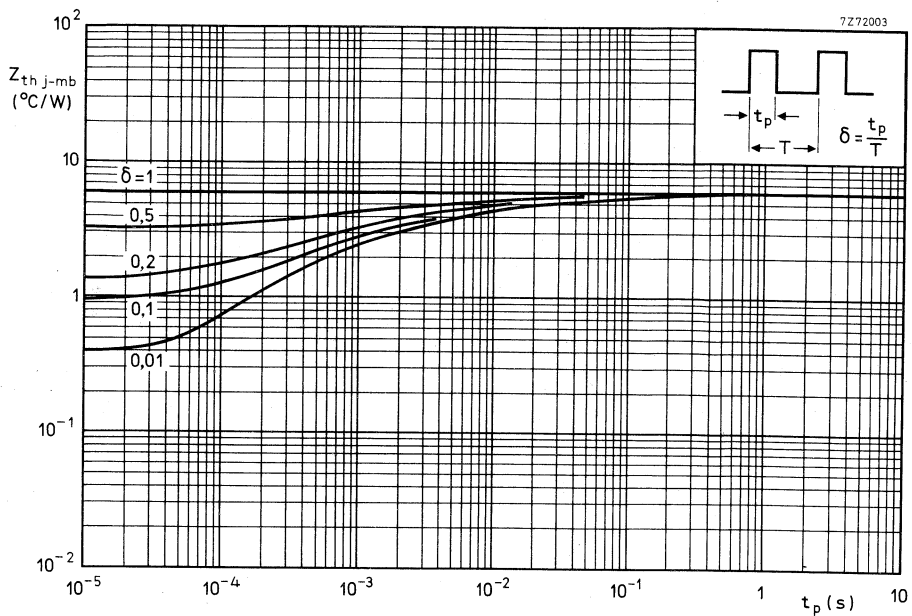


Fig. 5 Pulse power rating chart.



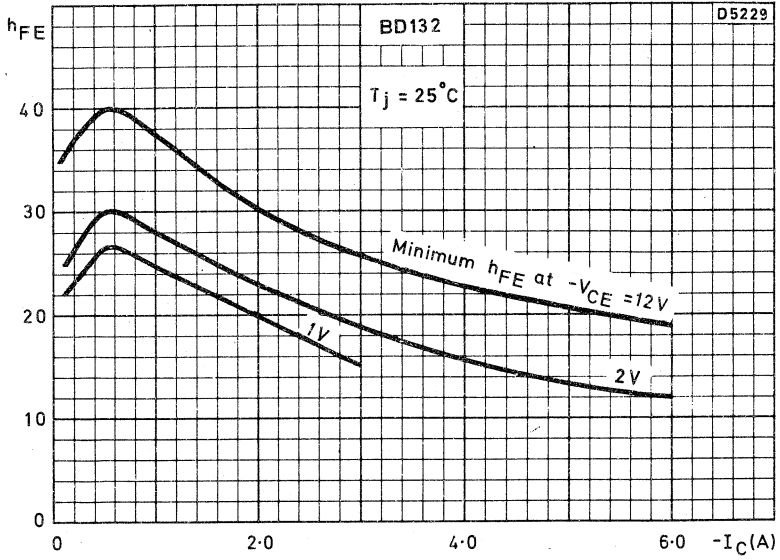


Fig. 6 D.C. current gain.

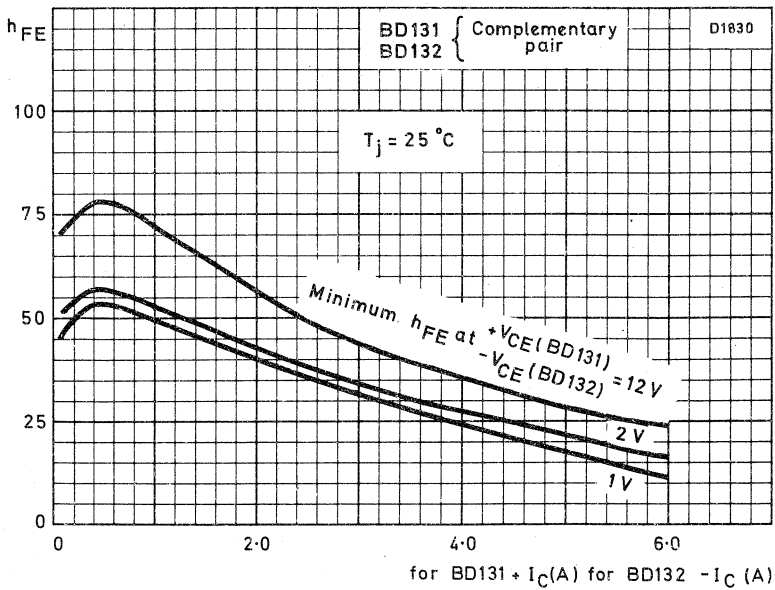


Fig. 7 D.C. current gain ratio.

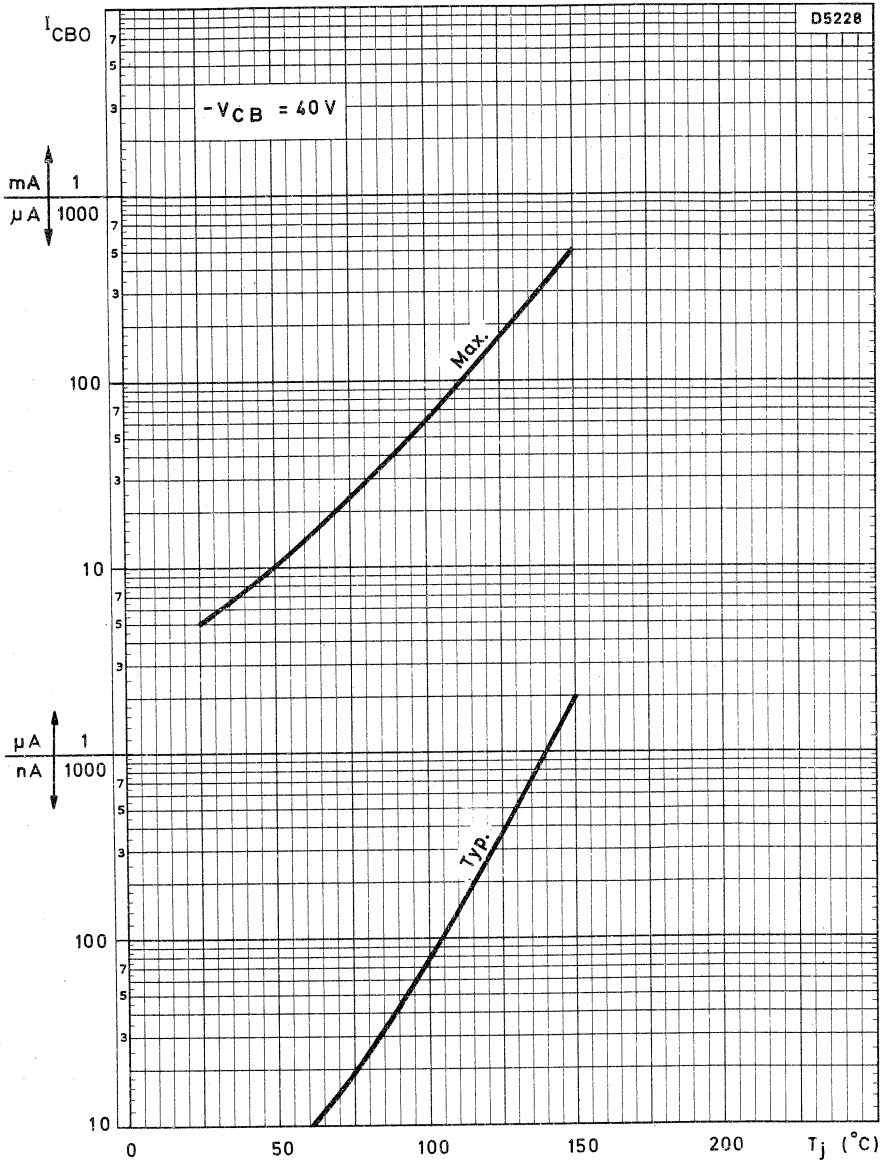
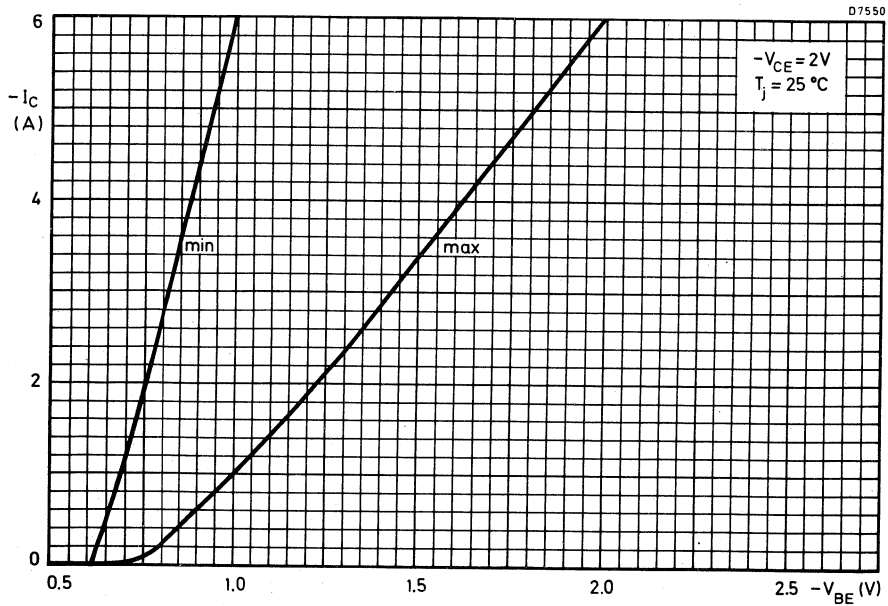
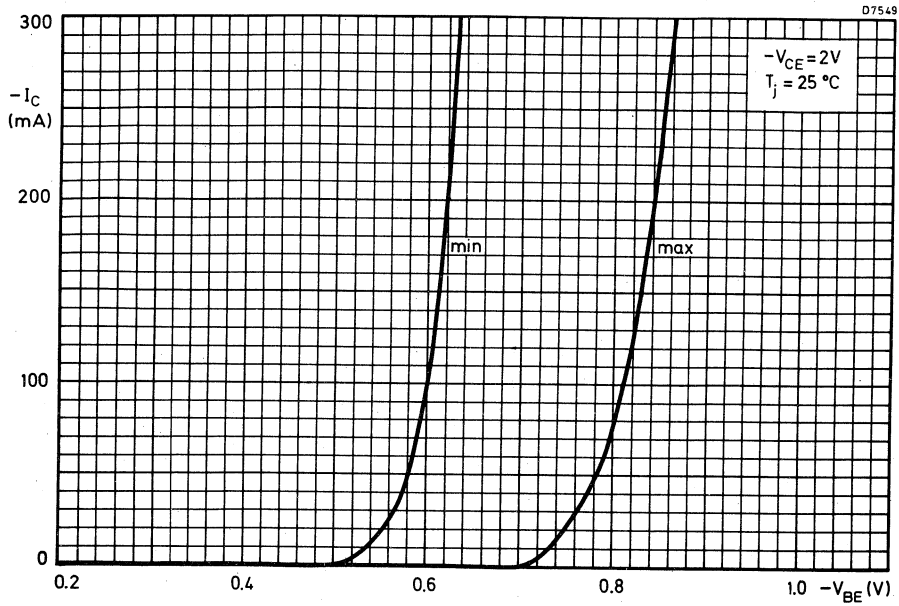


Fig. 8 Collector-base current (open emitter) as a function of the junction temperature.



SILICON PLANAR EPITAXIAL POWER TRANSISTOR

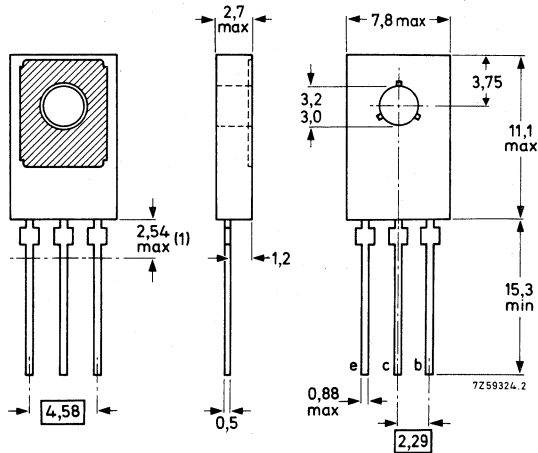
N-P-N transistor in a SOT-32 plastic envelope for general purpose, medium power applications.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max.	90 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60 V
Collector current (peak value)	I_{CM}	max.	6 A
Total power dissipation up to $T_{mb} = 60\text{ }^{\circ}\text{C}$	P_{tot}	max.	15 W
Junction temperature	T_j	max.	150 $^{\circ}\text{C}$
D. C. current gain			
$I_C = 0,5\text{ A}; V_{CE} = 12\text{ V}$	h_{FE}	>	40
Transition frequency at $f = 35\text{ MHz}$			
$I_C = 0,25\text{ A}; V_{CE} = 5\text{ V}$	f_T	>	60 MHz

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)
Collector connected
to metal part of
mounting surface



For mounting instructions see section Accessories type 56326 for non-insulated mounting and set 56333 for insulated mounting.

1) Within this region the cross-section of the leads is uncontrolled.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

General purpose n-p-n transistors in SOT-32 plastic envelope, recommended for driver stages in hi-fi amplifiers and television circuits.

The BD136, BD138 and BD140 are complementary to the BD135, BD137 and BD139 respectively.

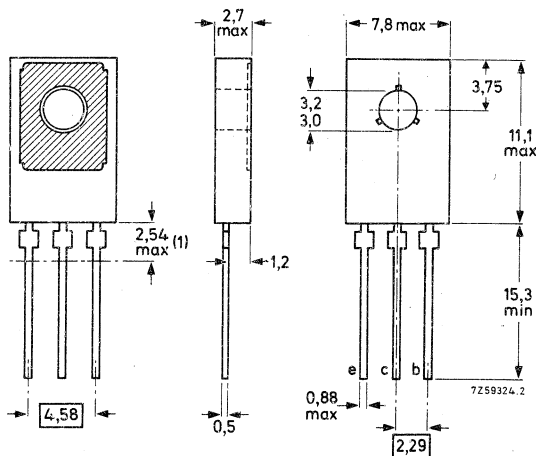
QUICK REFERENCE DATA		BD135	BD137	BD139
Collector-base voltage (open emitter)	V_{CBO}	max. 45	60	100 V
Collector-emitter voltage (open base)	V_{CEO}	max. 45	60	80 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	V_{CER}	max. 45	60	100 V
Collector current (peak value)	I_{CM}	max. 1,5	1,5	1,5 A
Total power dissipation up to $T_{mb} = 70 \text{ }^\circ\text{C}$	P_{tot}	max. 8	8	8 W
Junction temperature	T_j	max. 150	150	150 $^\circ\text{C}$
D.C. current gain	h_{FE}	> 40	40	40
$I_C = 150 \text{ mA}; V_{CE} = 2 \text{ V}$		< 250	250	250
Transition frequency	f_T	typ. 250	250	250 MHz
$I_C = 50 \text{ mA}; V_{CE} = 5 \text{ V}$				

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected to metal part of mounting surface



For mounting instructions see section Accessories type 56326 for non-insulated mounting and set 56333 for insulated mounting.

¹⁾ Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

			BD135	BD137	BD139
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100 V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	V_{CER}	max.	45	60	100 V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5 V

Currents

Collector current (d. c.)	I_C	max.	1,0	1,0	1,0 A
Collector current (peak value)	I_{CM}	max.	1,5	1,5	1,5 A

Power dissipation

Total power dissipation up to $T_{mb} = 70 \text{ }^\circ\text{C}$	P_{tot}	max.	8	W
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Temperatures

Storage temperature	T_{stg}	-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max. 150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	100	$^\circ\text{C/W}$
From junction to mounting base	$R_{th \text{ j-mb}}$	10	$^\circ\text{C/W}$

CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

 $I_E = 0; V_{CB} = 30\text{ V}$ $I_{CBO} < 100\text{ nA}$ $I_E = 0; V_{CB} = 30\text{ V}; T_j = 125\text{ }^\circ\text{C}$ $I_{CBO} < 10\text{ }\mu\text{A}$

Emitter cut-off current

 $I_C = 0; V_{EB} = 5\text{ V}$ $I_{EBO} < 10\text{ }\mu\text{A}$

Base-emitter voltage

 $I_C = 500\text{ mA}; V_{CE} = 2\text{ V}$ $V_{BE} < 1\text{ V}$

Saturation voltage

 $I_C = 500\text{ mA}; I_B = 50\text{ mA}$ $V_{CEsat} < 0,5\text{ V}$

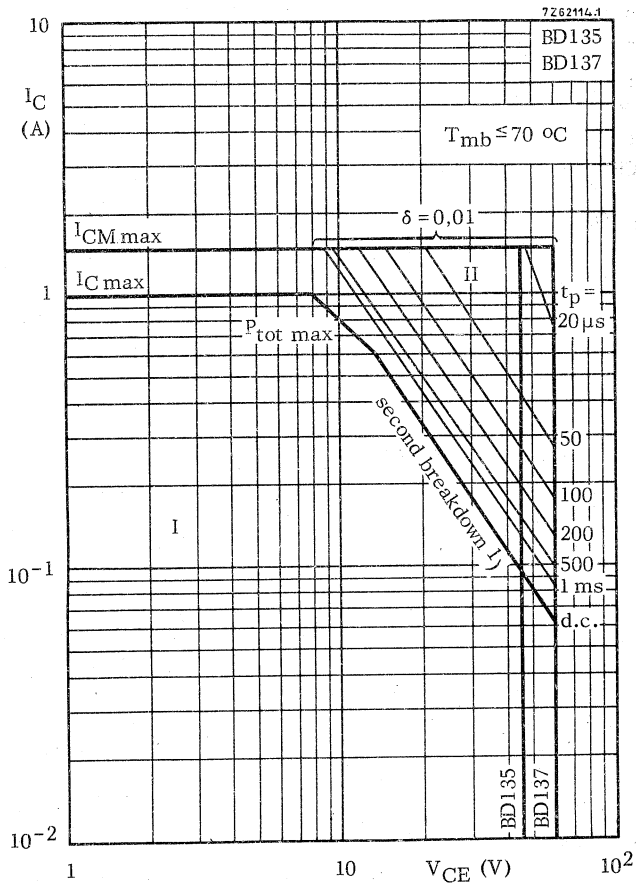
D.C. current gain

 $I_C = 5\text{ mA}; V_{CE} = 2\text{ V}$ $h_{FE} > 25$ $I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$ $h_{FE} 40\text{ to }250$ $I_C = 500\text{ mA}; V_{CE} = 2\text{ V}$ $h_{FE} > 25$ Transition frequency at $f = 35\text{ MHz}$ $I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$ $f_T \text{ typ } 250\text{ MHz}$

D.C. current gain ratio of matched pairs

BD135/BD136; BD137/BD138; BD139/BD140

 $|I_C| = 150\text{ mA}; |V_{CE}| = 2\text{ V}$ $h_{FE1}/h_{FE2} \text{ typ } 1,3$
 $< 1,6$ 

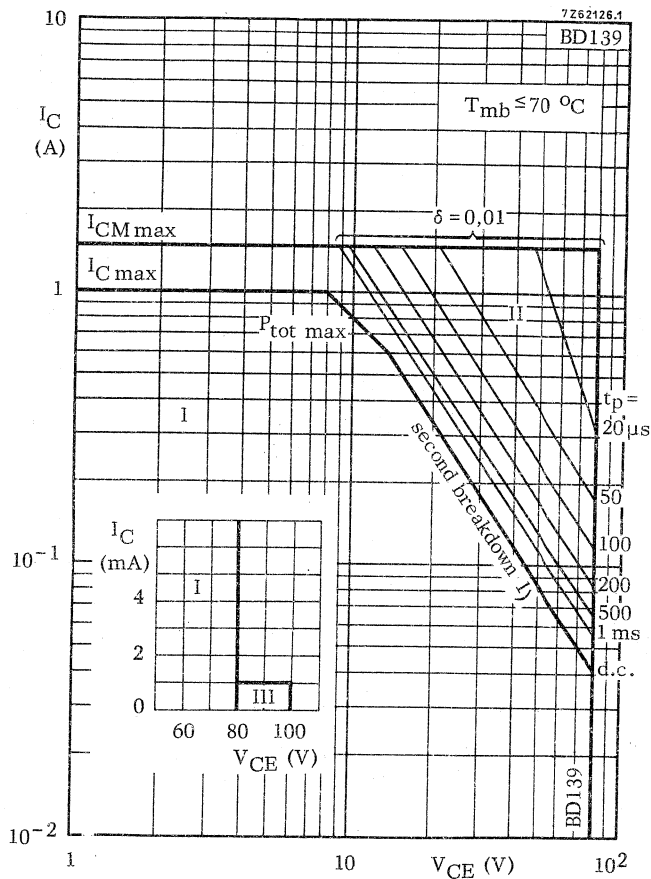


Safe Operating Area with the transistor forward biased

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

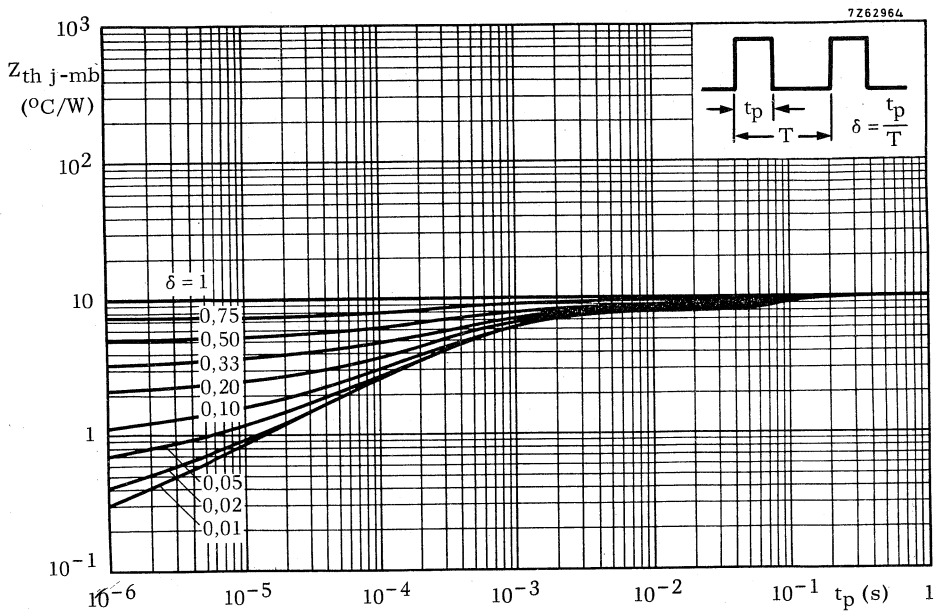
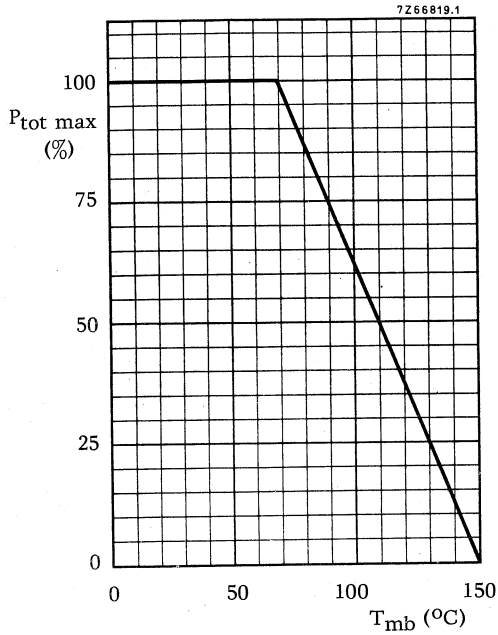
¹⁾ Independent of temperature

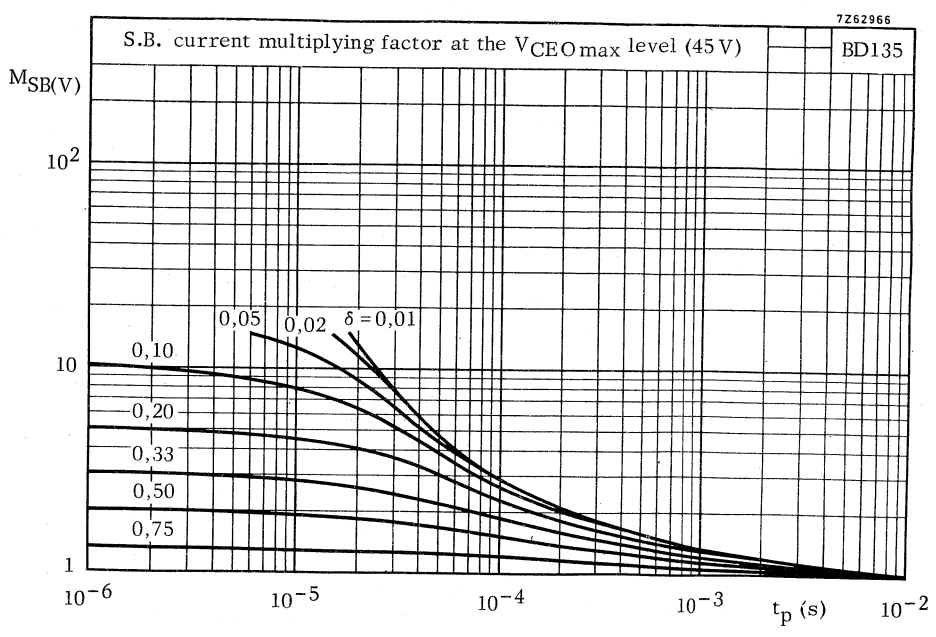
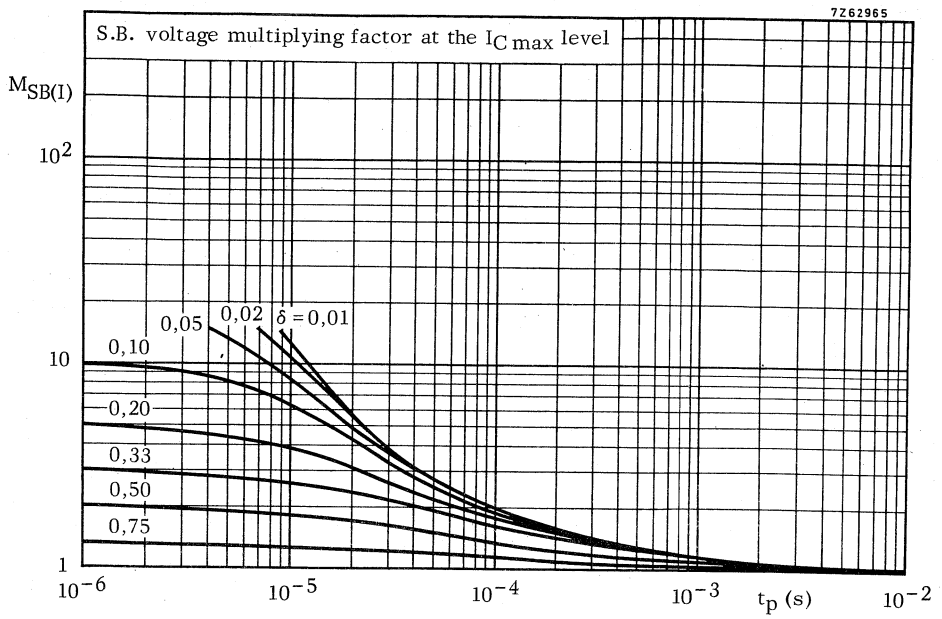


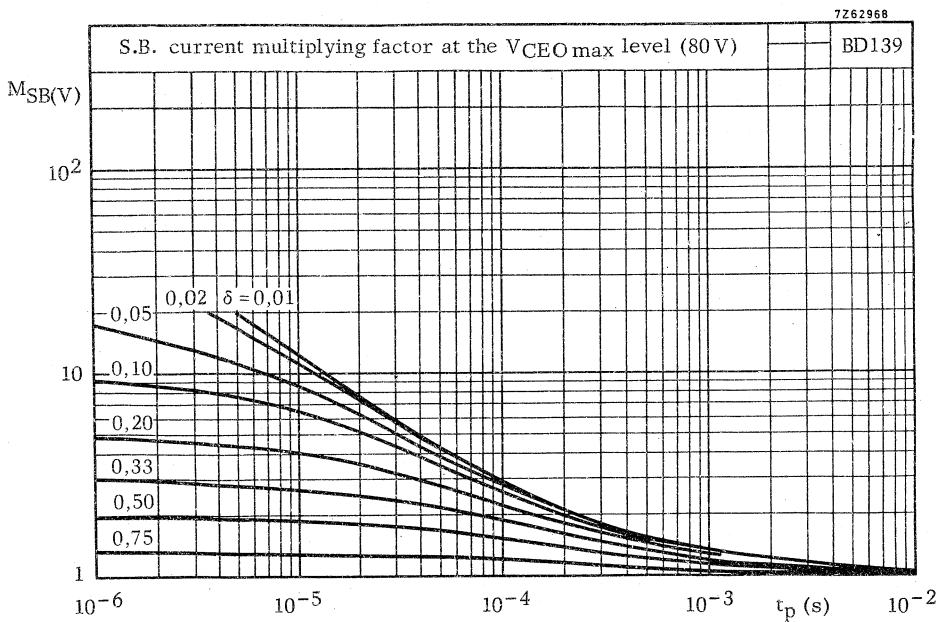
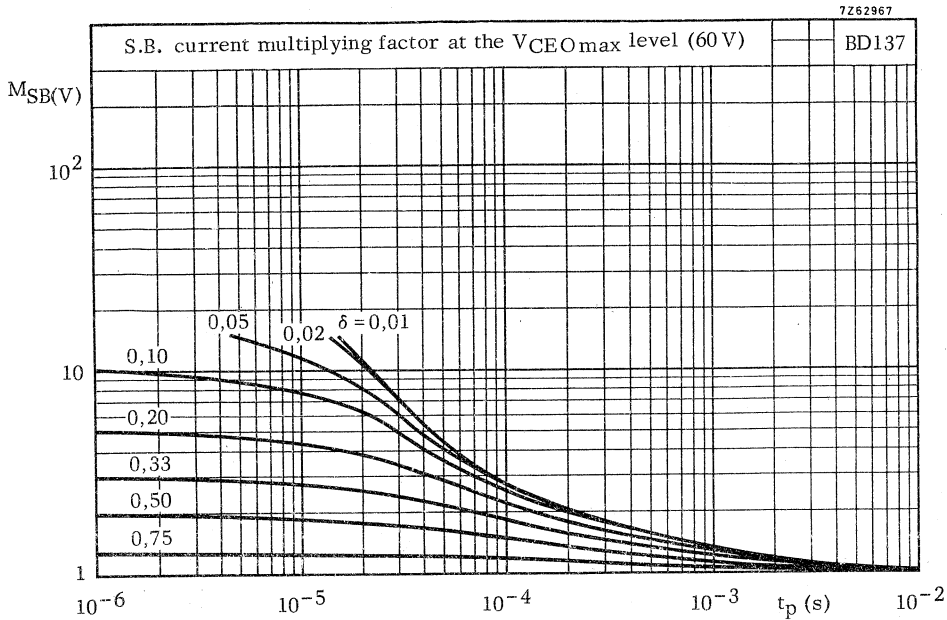
Safe Operating Area with the transistor forward biased

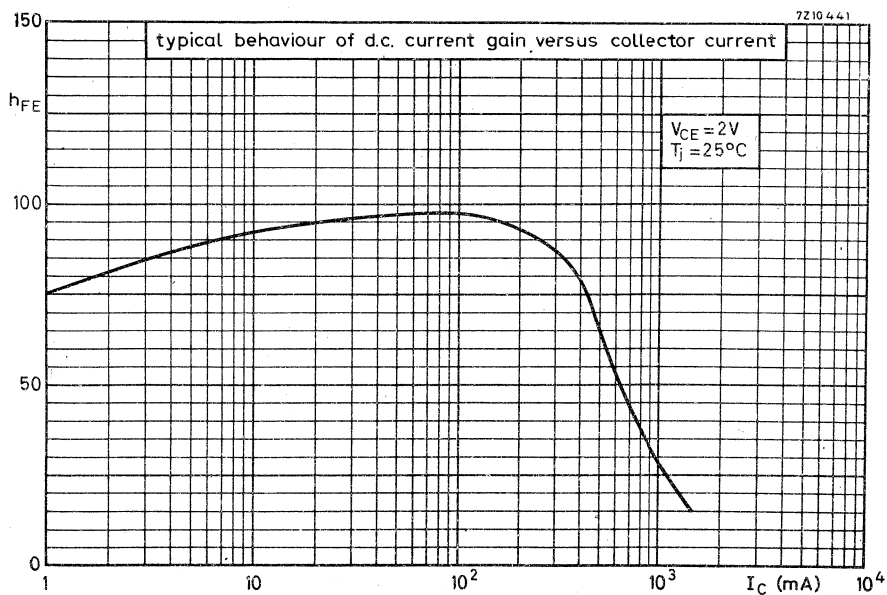
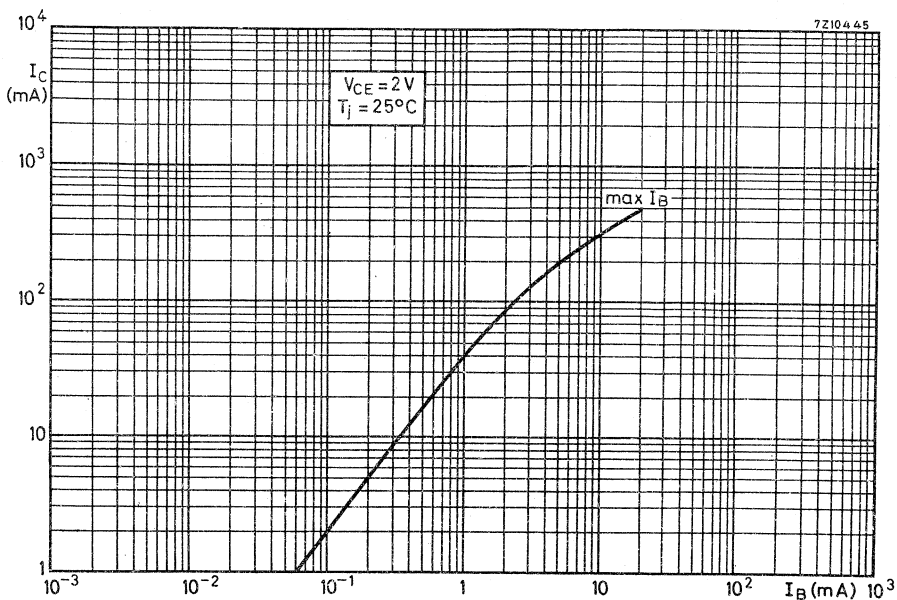
- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulsed operation
- III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 1 \text{ k}\Omega$

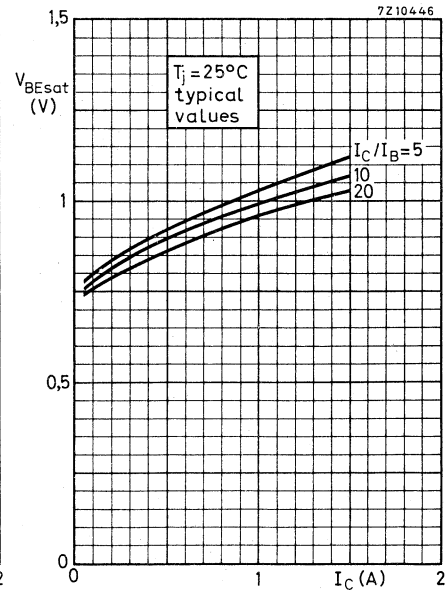
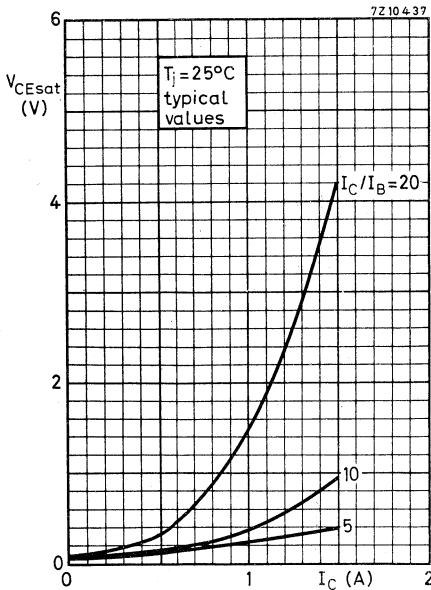
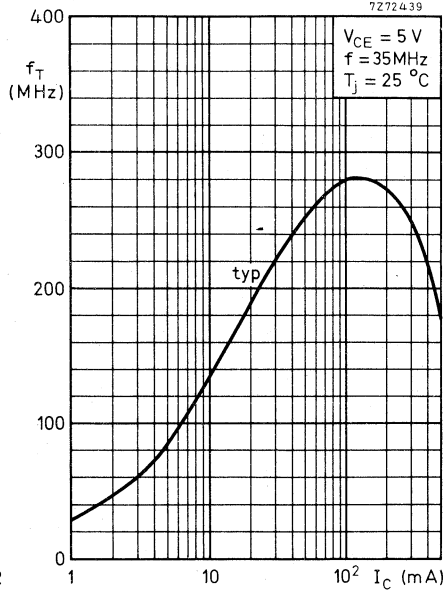
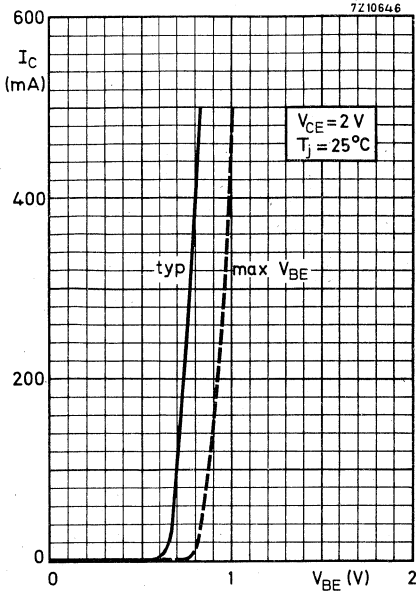
1) Independent of temperature











SILICON PLANAR EPITAXIAL POWER TRANSISTORS

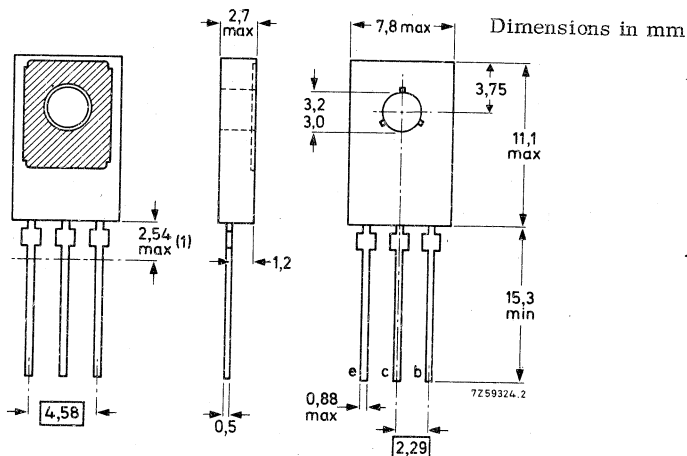
General purpose p-n-p transistors in SOT-32 plastic envelope, recommended for driver stages in hi-fi amplifiers and television circuits.
The BD135, BD137 and BD139 are complementary to the BD136, BD138 and BD140 respectively.

		QUICK REFERENCE DATA			
			BD136	BD138	BD140
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	$-V_{CER}$	max.	45	60	100 V
Collector current (peak value)	$-I_{CM}$	max.	1,5	1,5	1,5 A
Total power dissipation up to $T_{mb} = 70^\circ\text{C}$	P_{tot}	max.	8	8	8 W
Junction temperature	T_j	max.	150	150	150 $^\circ\text{C}$
D.C. current gain					
$-I_C = 150 \text{ mA}; -V_{CE} = 2 \text{ V}$	h_{FE}	>	40	40	40
		<	250	250	250
Transition frequency					
$-I_C = 50 \text{ mA}; -V_{CE} = 5 \text{ V}$	f_T	typ.	75	75	75 MHz

MECHANICAL DATA

TO-126 (SOT-32)

Collector connected to metal part of mounting surface



For mounting instructions see section Accessories type 56326 for non-insulated mounting and set 56333 for insulated mounting.

1) Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BD136	BD138	BD140	
<u>Voltages</u>					
Collector-base voltage (open emitter)	$-V_{CB0}$	max. 45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 45	60	80	V
Collector-emitter voltage ($R_{BE} = 1\text{ k}\Omega$)	$-V_{CER}$	max. 45	60	100	V
Emitter-base voltage (open collector)	$-V_{EB0}$	max. 5	5	5	V
<u>Currents</u>					
Collector current (d. c.)	$-I_C$	max. 1,0	1,0	1,0	A
Collector current (peak value)	$-I_{CM}$	max. 1,5	1,5	1,5	A
<u>Power dissipation</u>					
Total power dissipation up to $T_{mb} = 70\text{ }^\circ\text{C}$	P_{tot}		max. 8		W
<u>Temperatures</u>					
Storage temperature	T_{stg}		-65 to +150		$^\circ\text{C}$
Junction temperature	T_j		max. 150		$^\circ\text{C}$
THERMAL RESISTANCE					
From junction to ambient in free air	$R_{th\ j-a}$			100	$^\circ\text{C}/\text{W}$
From junction to mounting base	$R_{th\ j-mb}$			10	$^\circ\text{C}/\text{W}$

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 30\text{ V}$

$-I_{CBO} < 100\text{ nA}$

$I_E = 0; -V_{CB} = 30\text{ V}; T_j = 125\text{ }^\circ\text{C}$

$-I_{CBO} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$

$-I_{EBO} < 10\text{ }\mu\text{A}$

Base-emitter voltage

$-I_C = 500\text{ mA}; -V_{CE} = 2\text{ V}$

$-V_{EB} < 1\text{ V}$

Saturation voltage

$-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$

$-V_{CEsat} < 0,5\text{ V}$

D.C. current gain

$-I_C = 5\text{ mA}; -V_{CE} = 2\text{ V}$

$h_{FE} > 25$

$-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$

$h_{FE} 40\text{ to }250$

$-I_C = 500\text{ mA}; -V_{CE} = 2\text{ V}$

$h_{FE} > 25$

Transition frequency at $f = 35\text{ MHz}$

$-I_C = 50\text{ mA}; -V_{CE} = 5\text{ V}$

$f_T \text{ typ } 75\text{ MHz}$

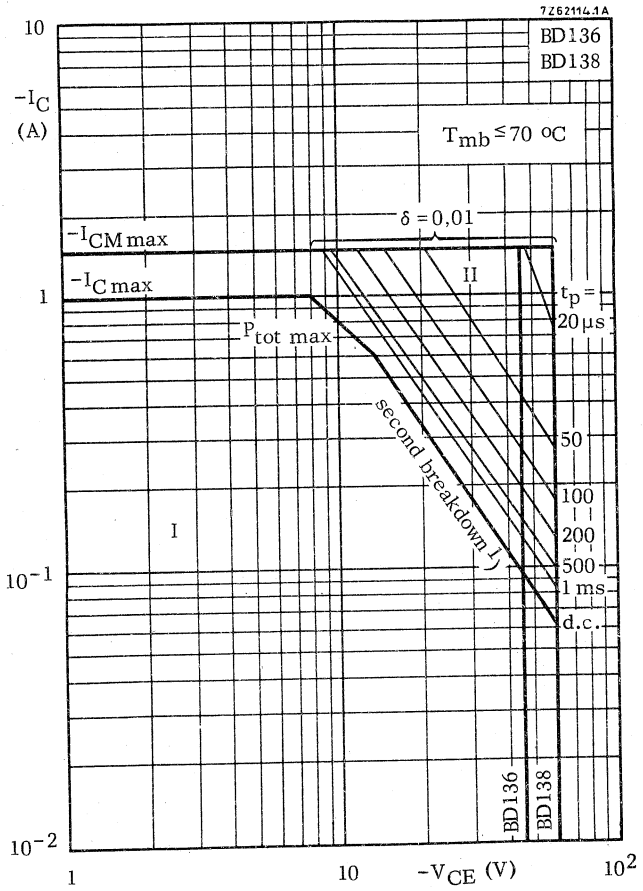
D.C. current gain ratio of matched pairs

BD135/BD136; BD137/BD138; BD139/BD140

$|I_C| = 150\text{ mA}; |V_{CE}| = 2\text{ V}$

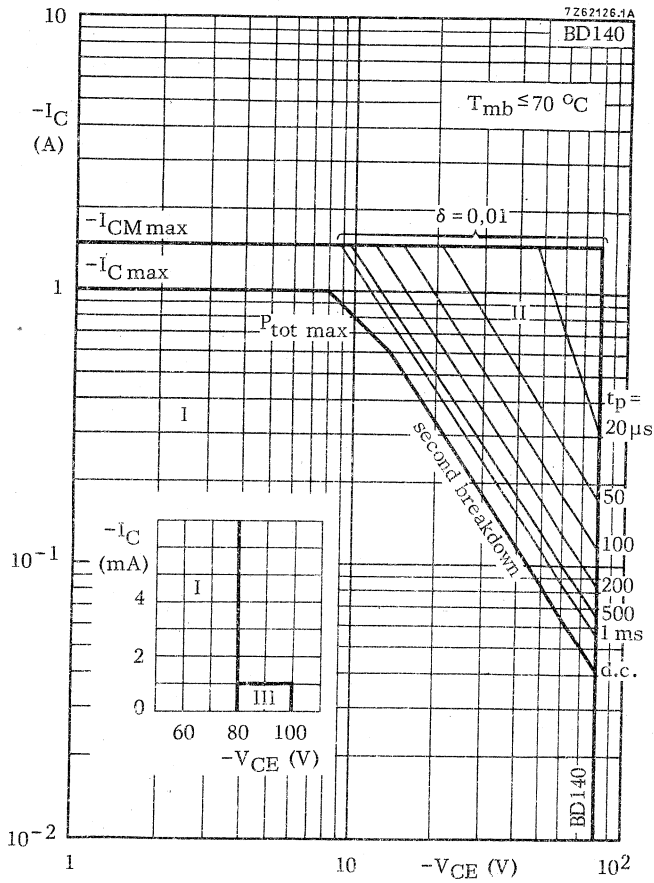
$h_{FE1}/h_{FE2} \text{ typ } 1,3$
 $< 1,6$





Safe Operating Area with the transistor forward biased
 I Region of permissible d.c. operation
 II Permissible extension for repetitive pulse operation

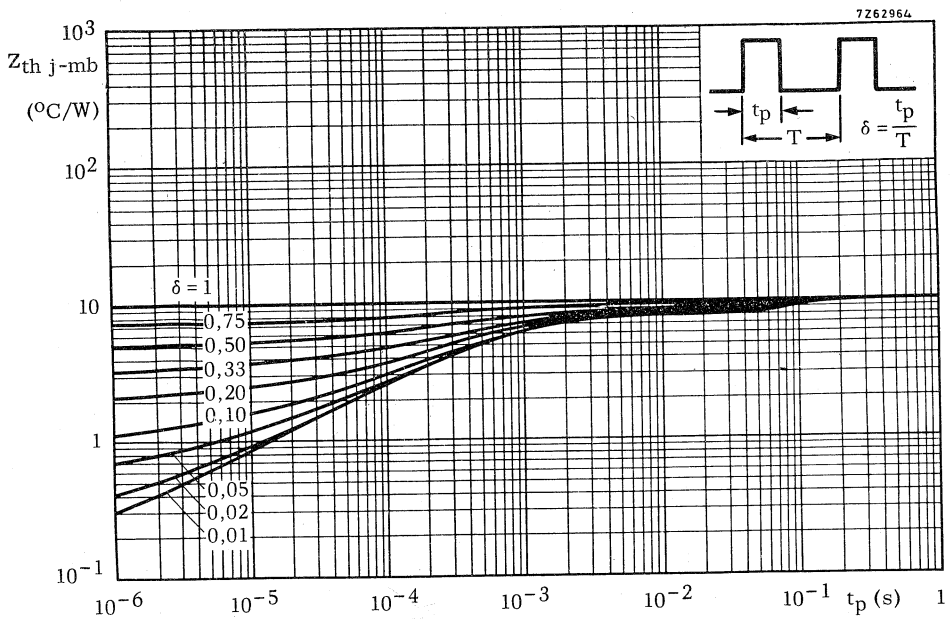
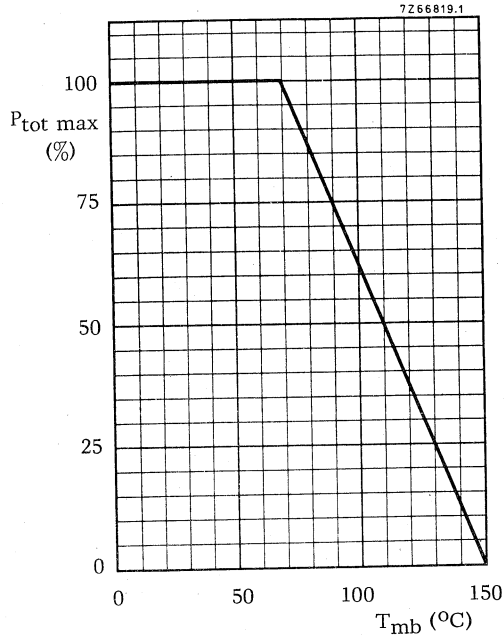
1) Independent of temperature

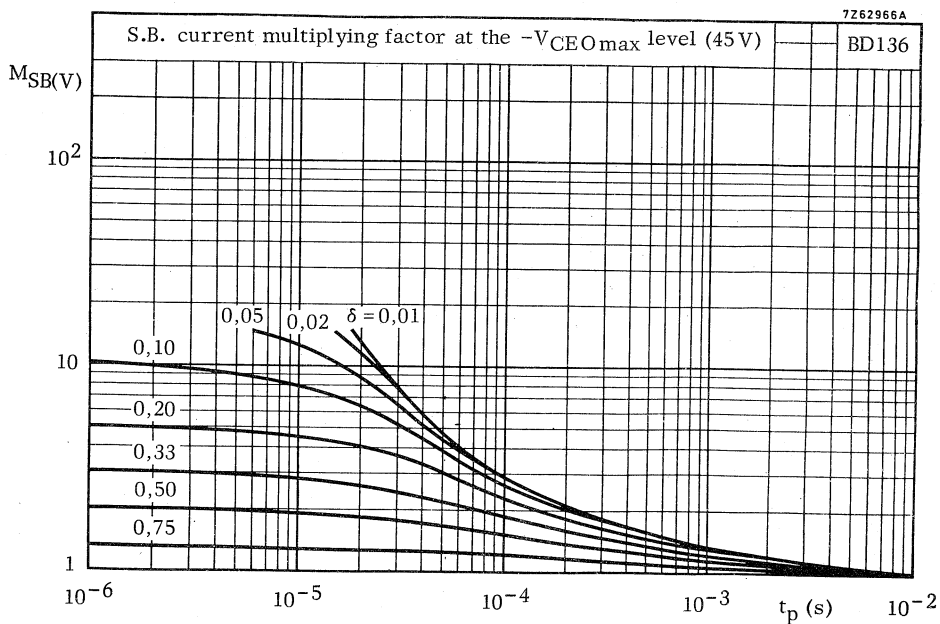
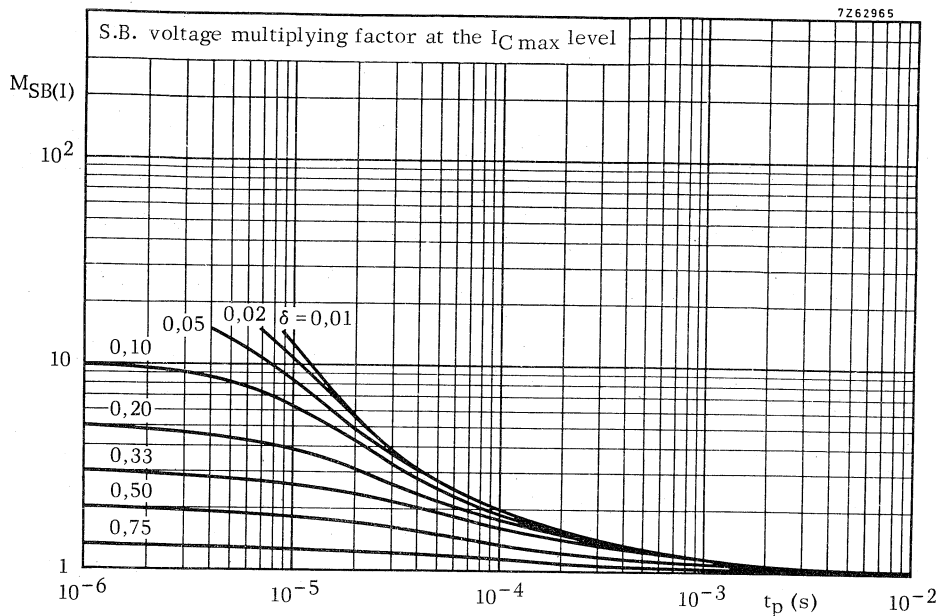


Safe Operating Area with the transistor forward biased

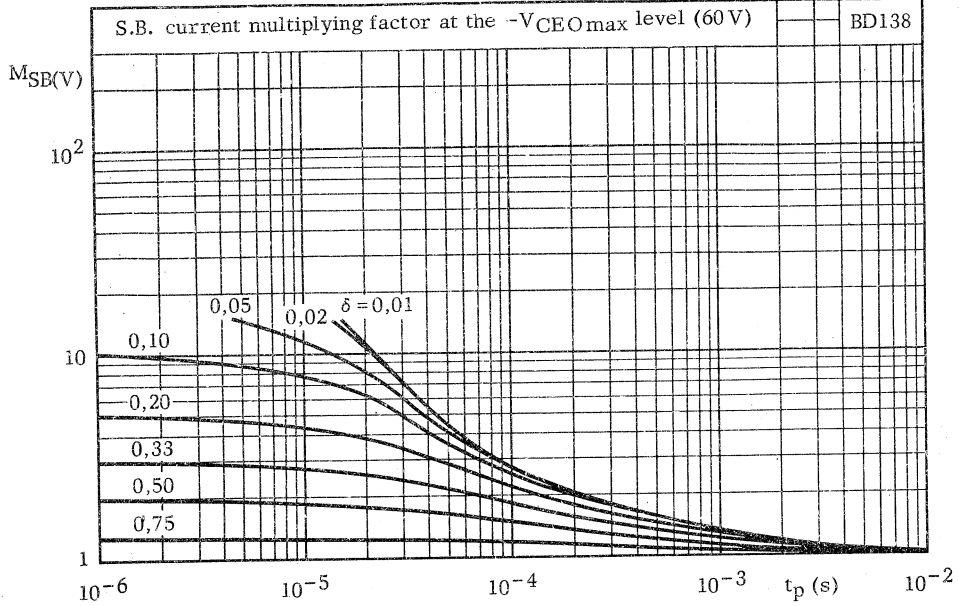
- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse¹⁾ operation
- III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 1 \text{ k}\Omega$.

¹⁾ Independent of temperature

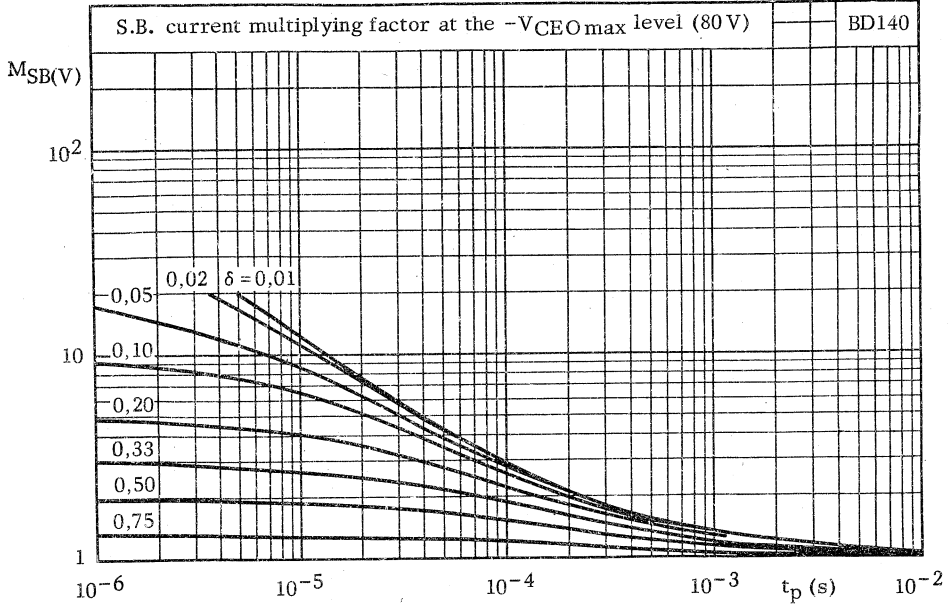


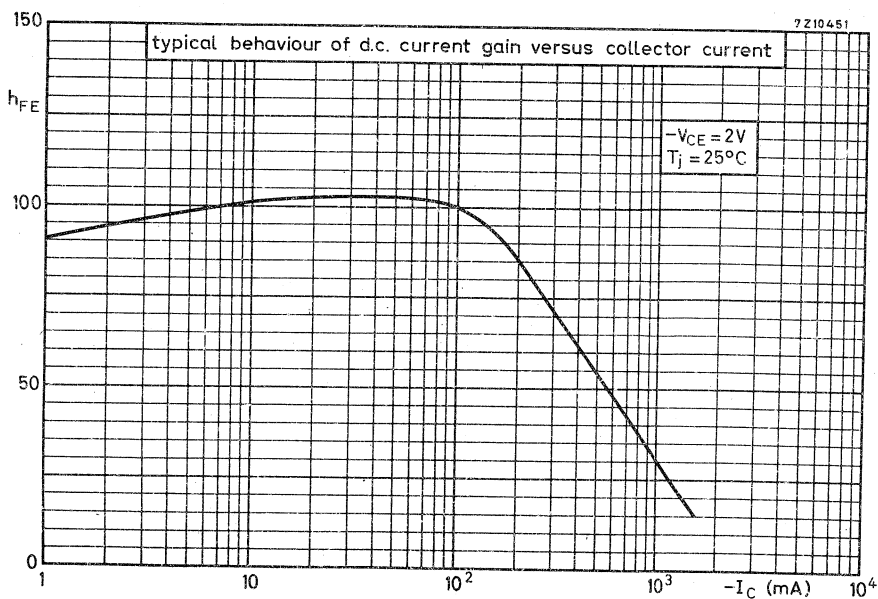
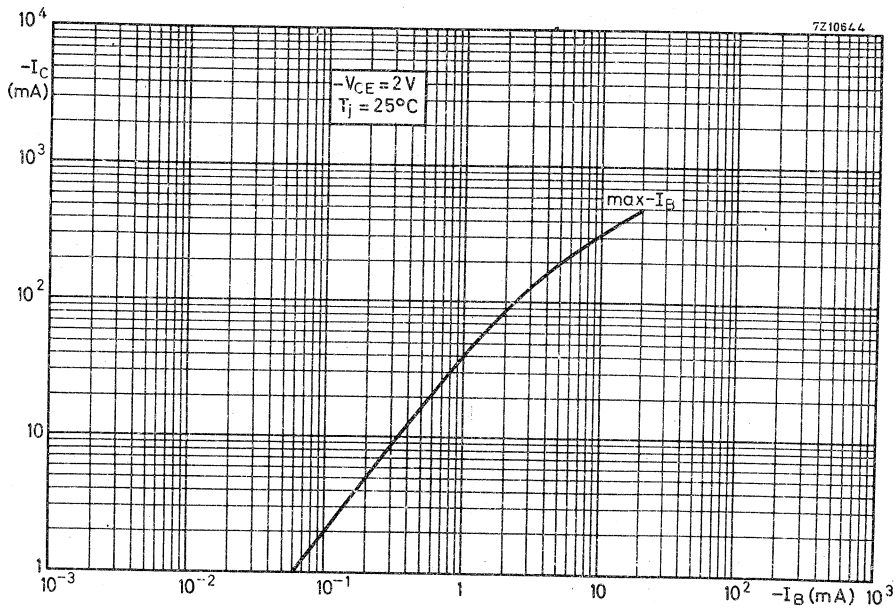


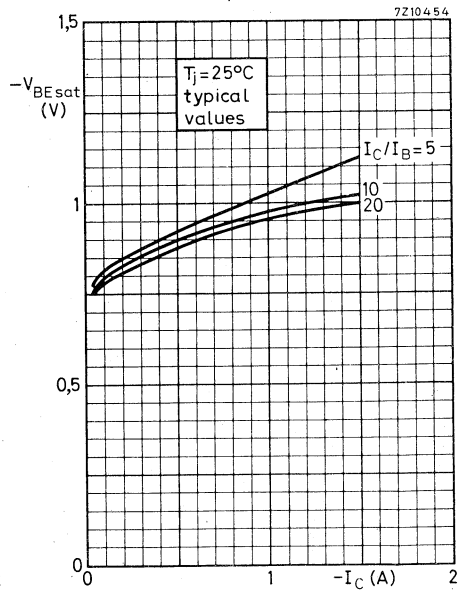
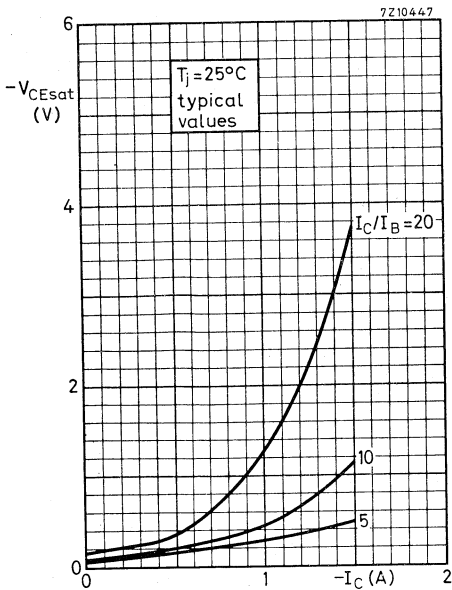
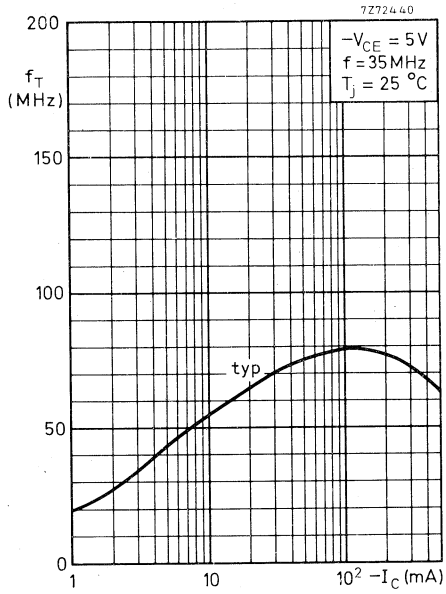
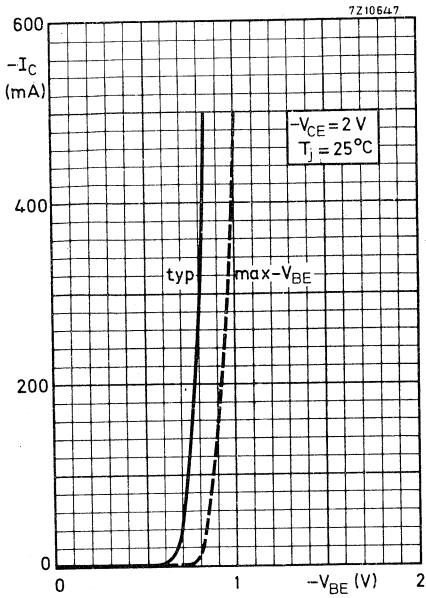
7Z62967A



7Z62968A







SILICON DIFFUSED POWER TRANSISTORS

N-P-N transistors in a TO-3 metal envelope for use in hi-fi audio equipment.

The BD181 is intended for 20 W into 4 Ω as well as 15 W into 8 Ω.

The BD182 is intended for 40 W into 4 Ω.

The BD183 is intended for 40 W into 8 Ω.

The transistors are also available as matched pairs under the type numbers 2-BD181, 2-BD182 and 2-BD183.

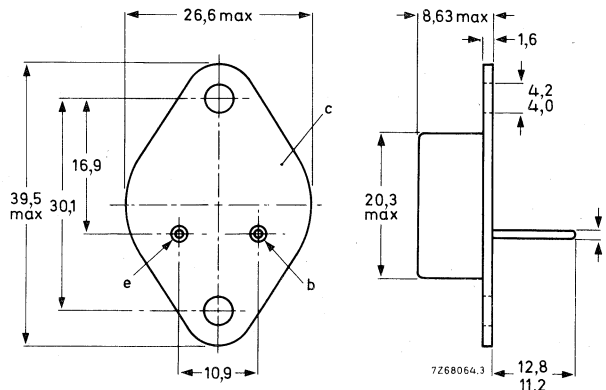
QUICK REFERENCE DATA					
			BD181	BD182	BD183
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	V_{CER}	max.	55	70	85 V
Collector current (peak value)	I_{CM}	max.	15	15	15 A
Total power dissipation					
up to $T_{mb} = 25^\circ C$	P_{tot}	max.	-	117	117 W
up to $T_{mb} = 83^\circ C$	P_{tot}	max.	78	-	- W
Junction temperature	T_j	max.	200	200	200 °C
D. C. current gain					
$I_C = 3 A; V_{CE} = 4 V$	h_{FE}		20 to 70	-	20 to 70
$I_C = 4 A; V_{CE} = 4 V$	h_{FE}		-	20 to 70	-
Cut-off frequency					
$I_C = 0,3 A; V_{CE} = 4 V$	f_{hfe}	>	15	15	15 kHz

MECHANICAL DATA

Dimensions in mm

Collector connected to envelope

TO-3



For mounting instructions and accessories, see section Accessories.

SILICON EPITAXIAL-BASE POWER TRANSISTORS

N-P-N transistors in a plastic envelope. With their p-n-p complements BD202 and BD204 they are primarily intended for use in hi-fi equipment delivering an output of 15 to 25 W into a 4 Ω or 8 Ω load.

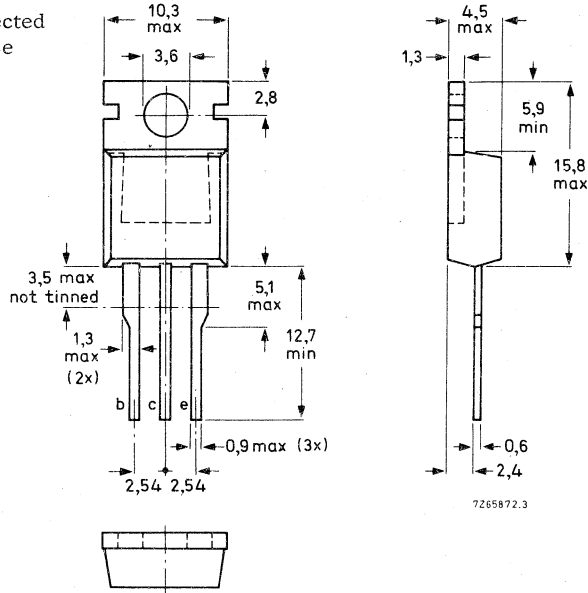
QUICK REFERENCE DATA					
			BD201	BD203	
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	V
Collector current (d. c.)	I_C	max.	8	8	A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.	60	60	W
Cut-off frequency $I_C = 0,3 A; V_{CE} = 3 V$	f_{hfe}	>	25	25	kHz

MECHANICAL DATA

Dimensions in mm

TO-220

Collector connected to mounting base



For mounting instructions and accessories see section Accessories.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

			BD201	BD203	
Collector-base voltage (open emitter)	V _{CBO}	max.	60	60	V
Collector-emitter voltage (open base)	V _{CEO}	max.	45	60	V
Emitter-base voltage (open collector)	V _{EBO}	max.	5	5	V

Currents

Collector current (d. c.)	I _C	max.	8	A
Collector current (peak value, t _p ≤ 10 ms)	I _{CM}	max.	12	A
Collector current (non-repetitive peak value, t _p ≤ 2 ms)	I _{CSM}	max.	25	A

Power dissipation

Total power dissipation up to T _{mb} = 25 °C	P _{tot}	max.	60	W
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Temperatures

Storage temperature	T _{stg}	-65 to +150	°C
Junction temperature	T _j	max. 150	°C

THERMAL RESISTANCE

From junction to mounting base	R _{th j-mb}	=	2,08	°C/W
From junction to ambient in free air	R _{th j-a}	=	70	°C/W

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_B = 0; V_{CE} = 30\text{ V}$ $I_{CEO} < 1\text{ mA}$

$I_E = 0; V_{CB} = 40\text{ V}; T_j = 150\text{ }^\circ\text{C}$ $I_{CBO} < 1\text{ mA}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$ $I_{EBO} < 5\text{ mA}$

Base-emitter voltage ¹⁾

$I_C = 3\text{ A}; V_{CE} = 2\text{ V}$ $V_{BE} < 1,5\text{ V}$

Knee voltage ¹⁾

$I_C = 3\text{ A}; I_B = \text{value for which}$

$I_C = 3,3\text{ A at } V_{CE} = 2\text{ V}$ $V_{CEK} \text{ typ. } 1\text{ V}$

Saturation voltage ¹⁾

$I_C = 3\text{ A}; I_B = 0,3\text{ A}$ $V_{CEsat} < 1\text{ V}$

D. C. current gain ¹⁾

BD201; $I_C = 3\text{ A}; V_{CE} = 2\text{ V}$ $h_{FE} > 30$

BD203; $I_C = 2\text{ A}; V_{CE} = 2\text{ V}$ $h_{FE} > 30$

$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$ $h_{FE} > 30$

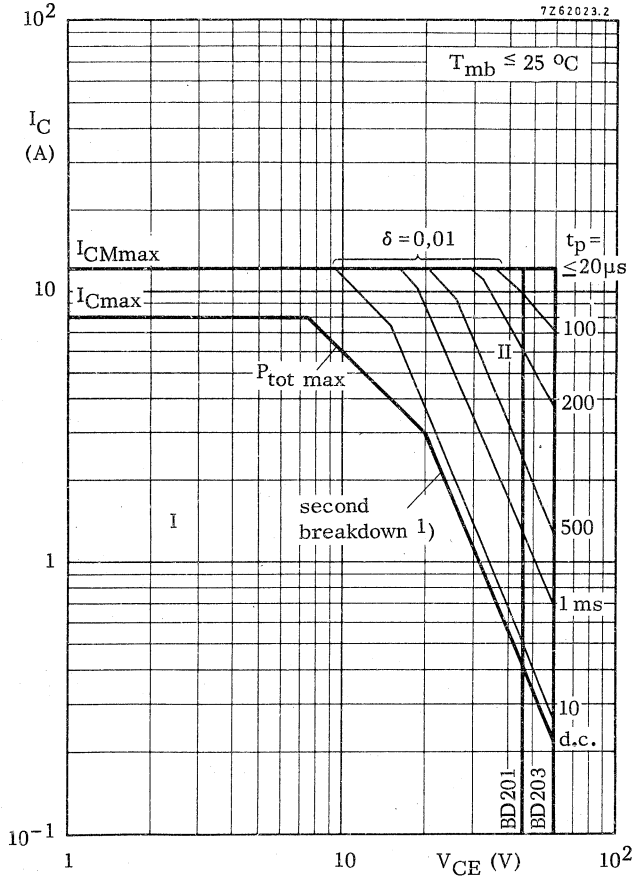
Cut-off frequency

$I_C = 0,3\text{ A}; V_{CE} = 3\text{ V}$ $f_{hfe} > 25\text{ kHz}$

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,3\text{ A}; V_{CE} = 3\text{ V}$ $f_T > 3\text{ MHz}$

¹⁾ Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.

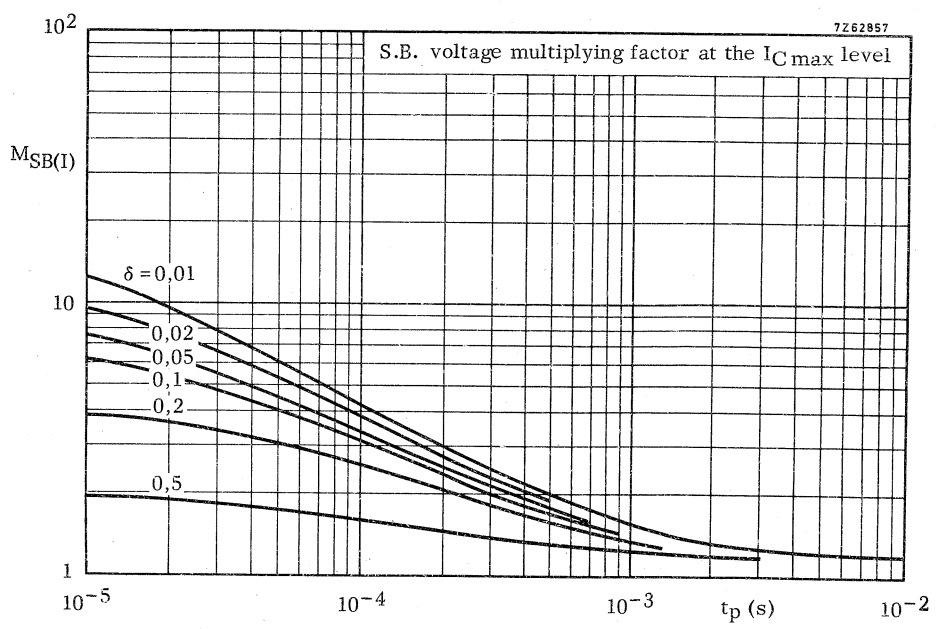
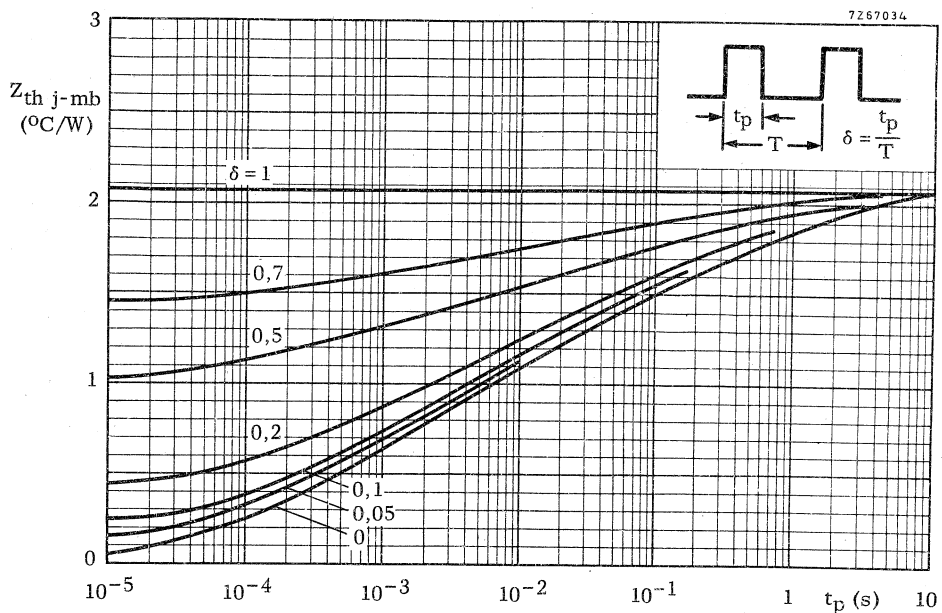


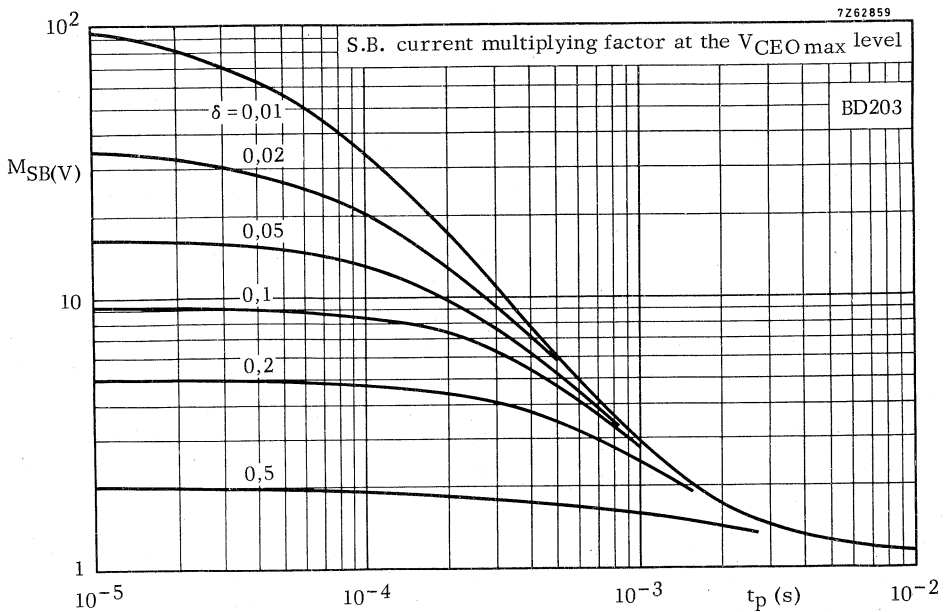
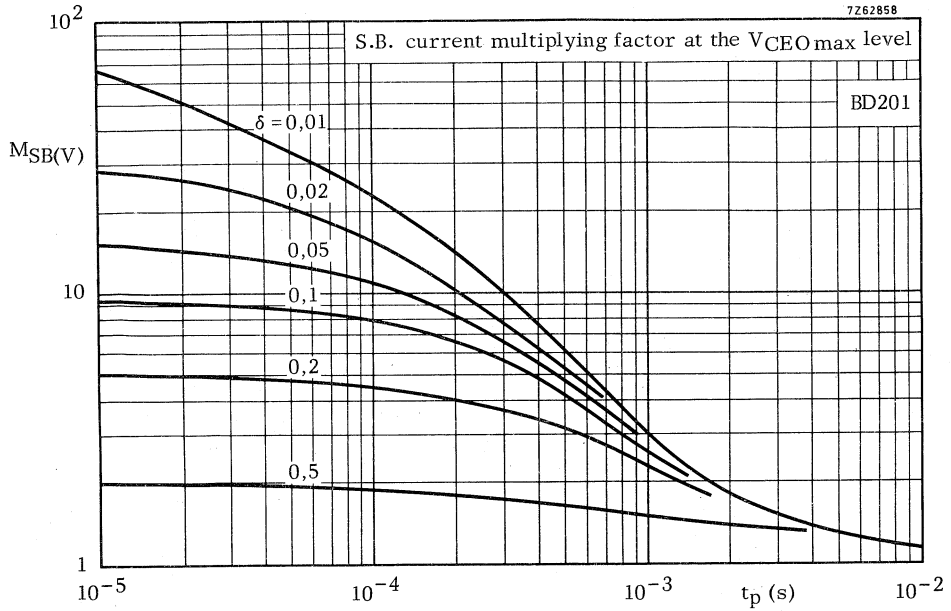
Safe Operating Area with the transistor forward biased

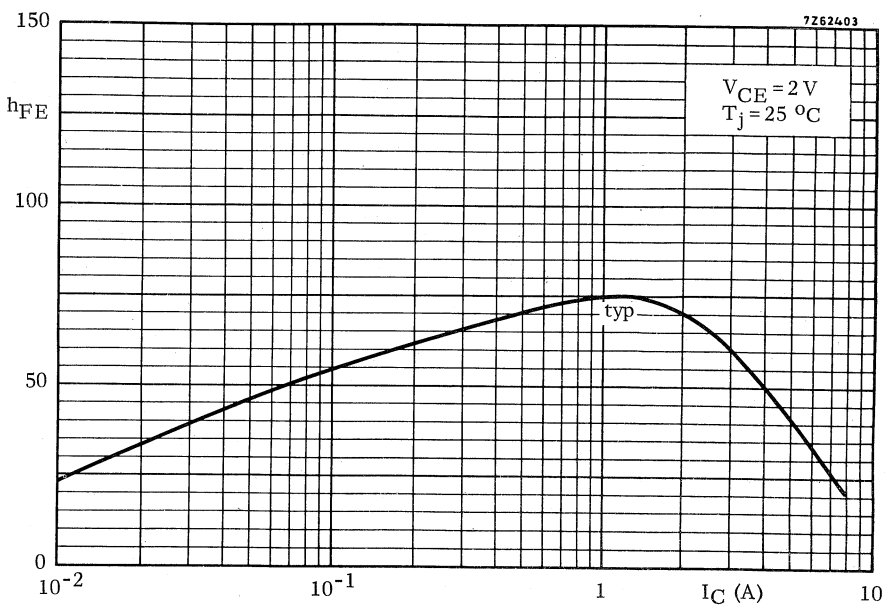
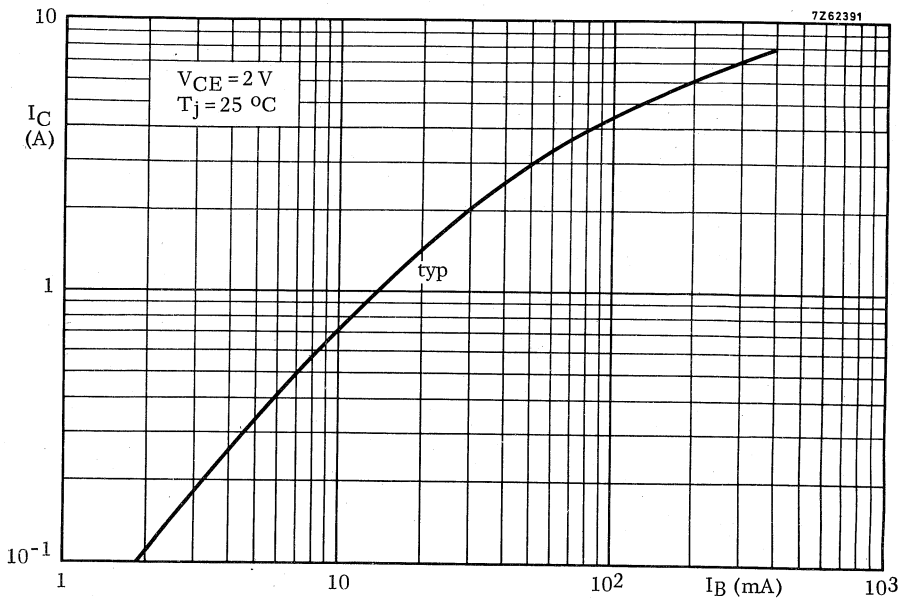
- I Region of permissible d. c. operation
- II Permissible extension for repetitive pulse operation

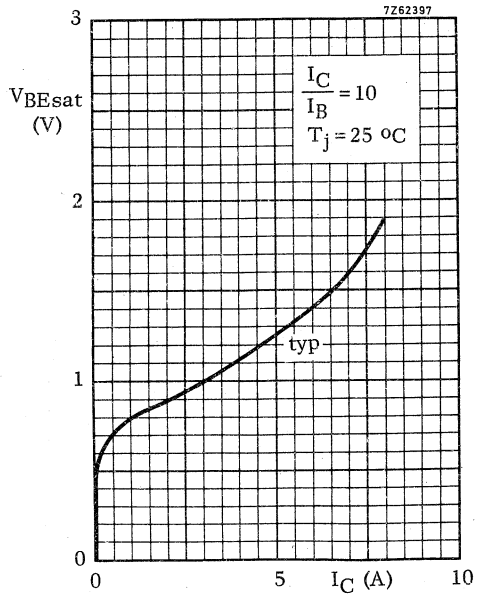
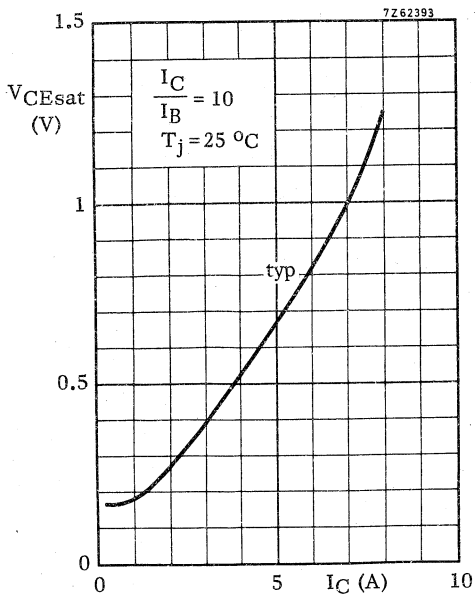
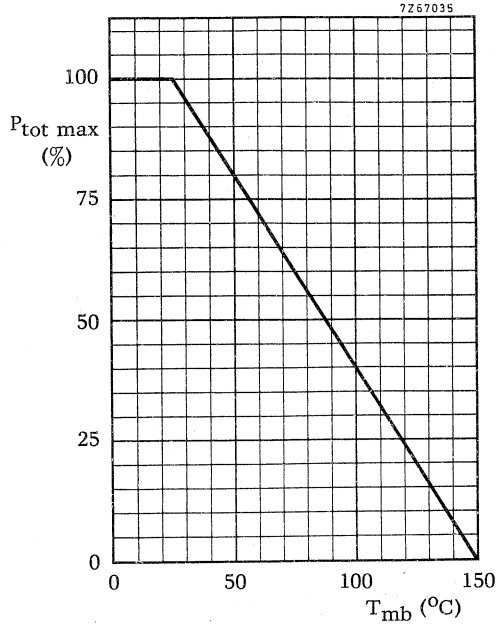
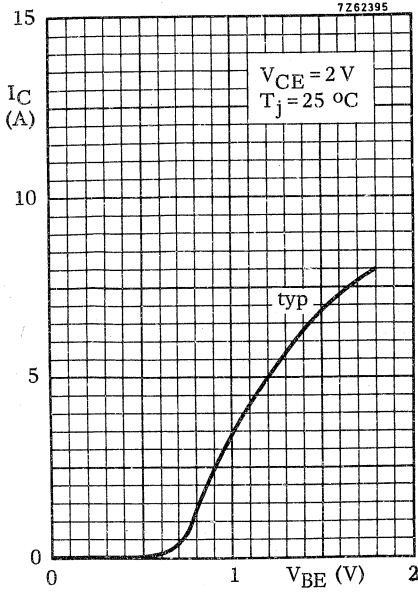
For $P_{tot \text{ max}}$ versus T_{mb} see page 8.

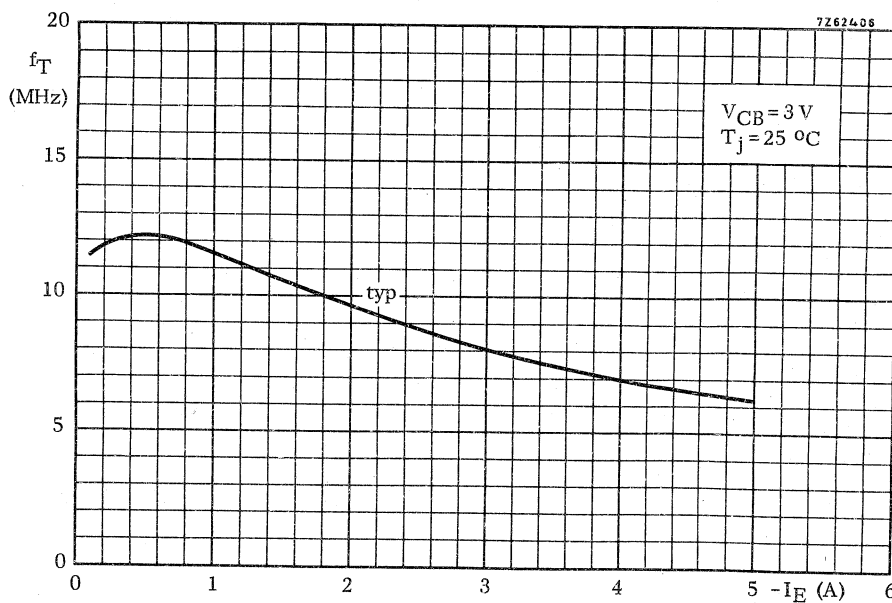
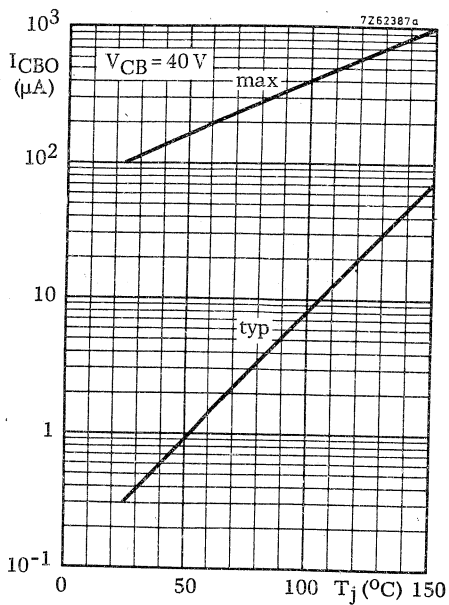
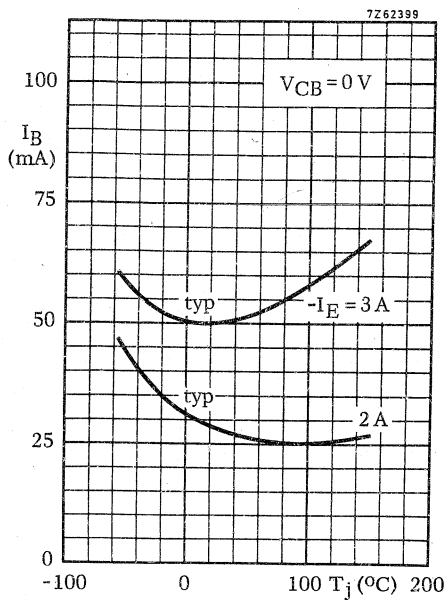
1) Independent of temperature.











SILICON EPITAXIAL-BASE POWER TRANSISTORS

P-N-P transistors in a plastic envelope. With their n-p-n complements BD201 and BD203 they are primarily intended for use in hi-fi equipment delivering an output of 15 to 25 W into a 4 Ω or 8 Ω load.

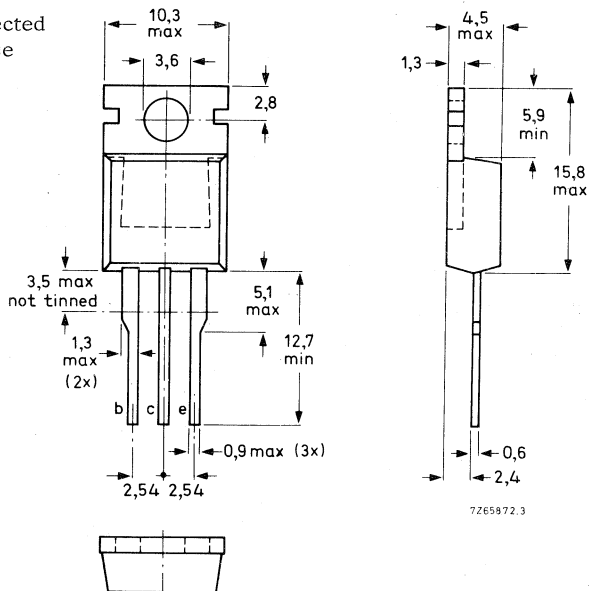
QUICK REFERENCE DATA				
		BD202		BD204
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60 V
Collector current (d. c.)	$-I_C$	max.	8	8 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	60	60 W
Cut-off frequency	f_{hfe}	>	25	25 kHz
$-I_C = 0,3\text{ A}; -V_{CE} = 3\text{ V}$				

MECHANICAL DATA

Dimensions in mm

TO-220

Collector connected to mounting base



For mounting instructions and accessories see section Accessories.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

<u>Voltages</u>			BD202	BD204	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	60	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	V

<u>Currents</u>					
Collector current (d. c.)	$-I_C$	max.		8	A
Collector current (peak value, $t_p \leq 10$ ms)	$-I_{CM}$	max.		12	A
Collector current (non-repetitive peak value, $t_p \leq 2$ ms)	$-I_{CSM}$	max.		25	A

<u>Power dissipation</u>					
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.		60	W

<u>Temperatures</u>					
Storage temperature	T_{stg}			-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.		150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=		2,08	$^\circ\text{C/W}$
From junction to ambient in free air	$R_{th\ j-a}$	=		70	$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_B = 0; -V_{CE} = 30\text{ V}$

$-I_{CEO} < 1\text{ mA}$

$I_E = 0; -V_{CB} = 40\text{ V}; T_j = 150\text{ }^\circ\text{C}$

$-I_{CBO} < 1\text{ mA}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$

$-I_{EBO} < 5\text{ mA}$

Base-emitter voltage ¹⁾

$-I_C = 3\text{ A}; -V_{CE} = 2\text{ V}$

$-V_{BE} < 1,5\text{ V}$

Knee voltage ¹⁾

$-I_C = 3\text{ A}; -I_B = \text{value at which}$

$-I_C = 3,3\text{ A at } -V_{CE} = 2\text{ V}$

$-V_{CEK} \text{ typ. } 1\text{ V}$

Saturation voltage ¹⁾

$-I_C = 3\text{ A}; -I_B = 0,3\text{ A}$

$-V_{CEsat} < 1\text{ V}$

D. C. current gain ¹⁾

BD202; $-I_C = 3\text{ A}; -V_{CE} = 2\text{ V}$

$h_{FE} > 30$

BD204; $-I_C = 2\text{ A}; -V_{CE} = 2\text{ V}$

$h_{FE} > 30$

$-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$

$h_{FE} > 30$

Cut-off frequency

$-I_C = 0,3\text{ A}; -V_{CE} = 3\text{ V}$

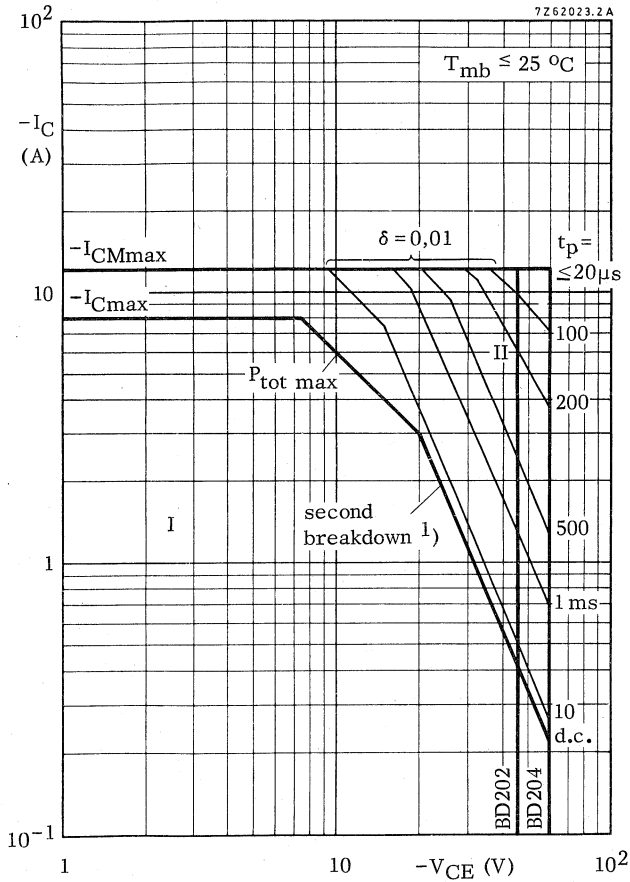
$f_{hfe} > 25\text{ kHz}$

Transition frequency at $f = 1\text{ MHz}$

$-I_C = 0,3\text{ A}; -V_{CE} = 3\text{ V}$

$f_T > 3\text{ MHz}$

¹⁾ Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.



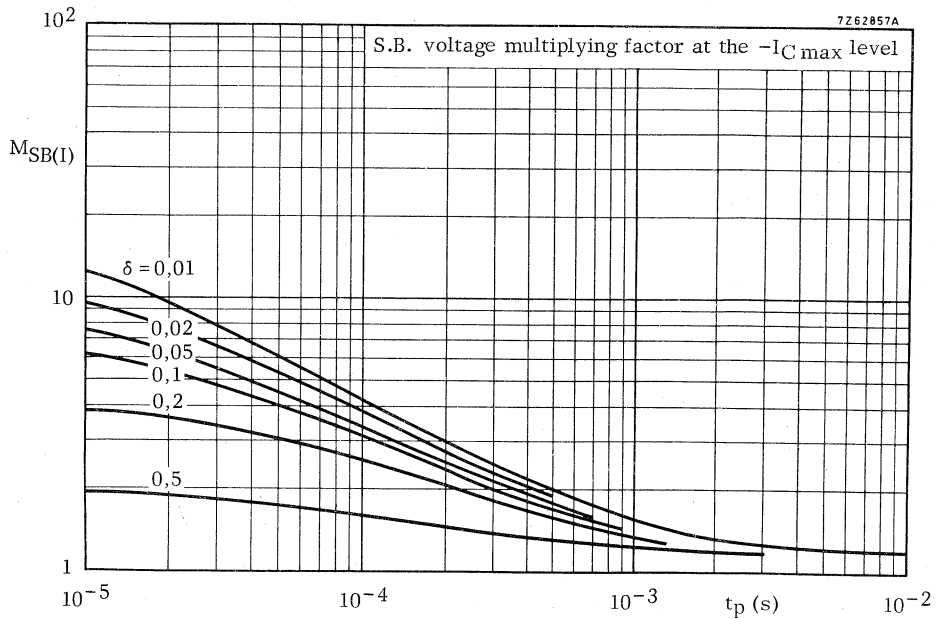
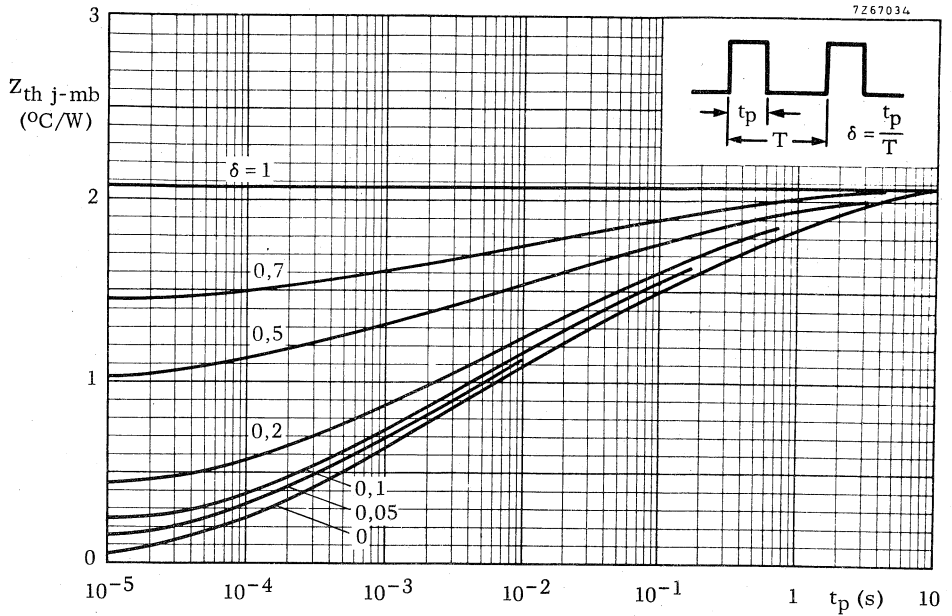
Safe Operating Area with the transistor forward biased

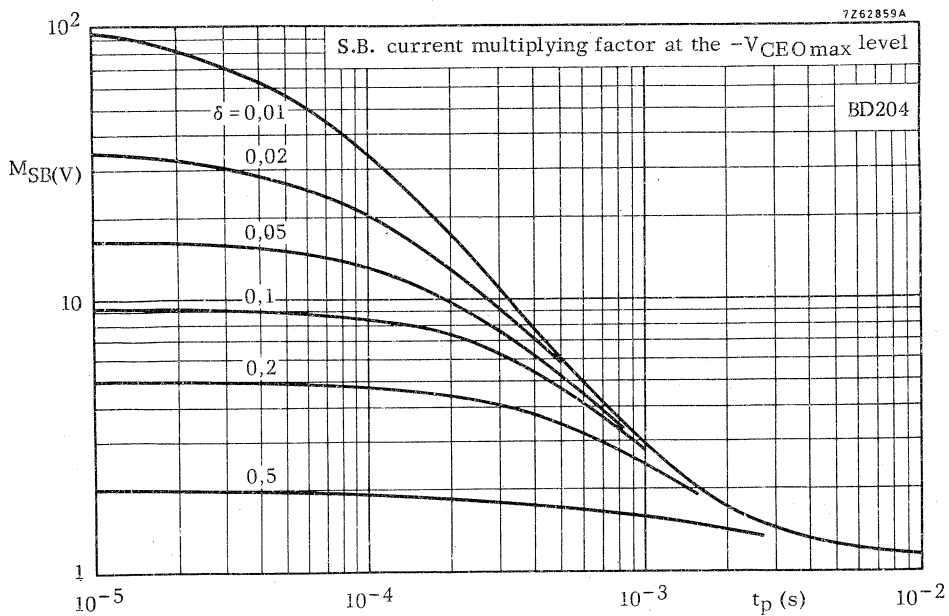
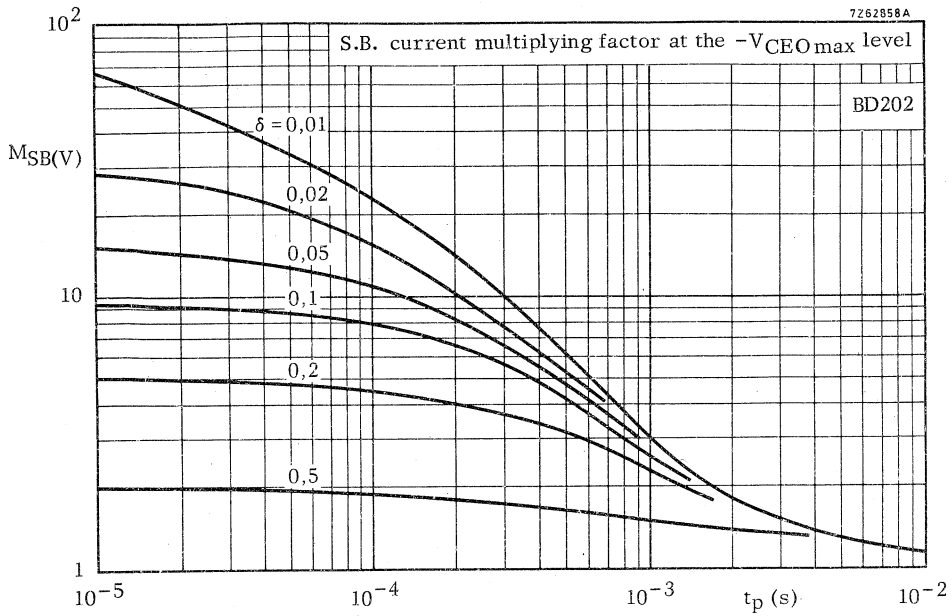
I Region of permissible d.c. operation

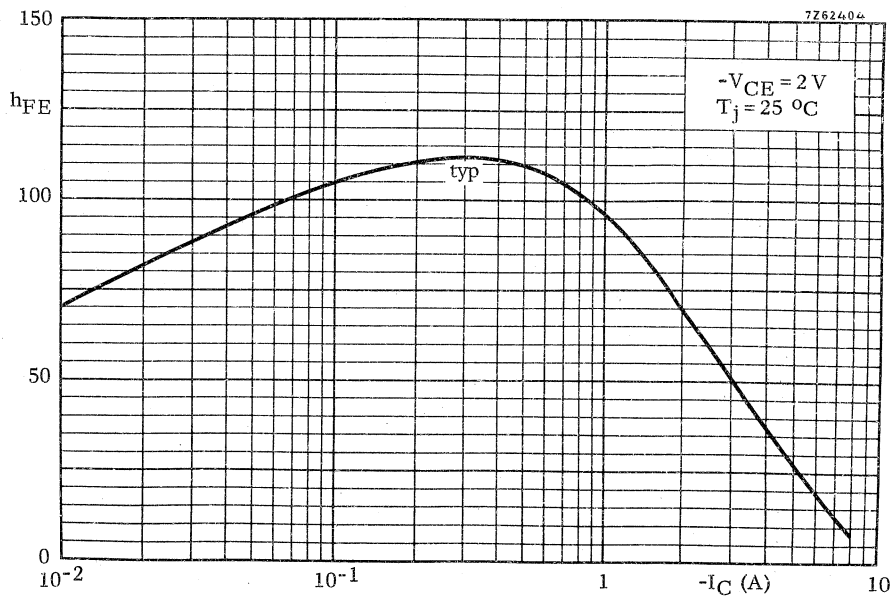
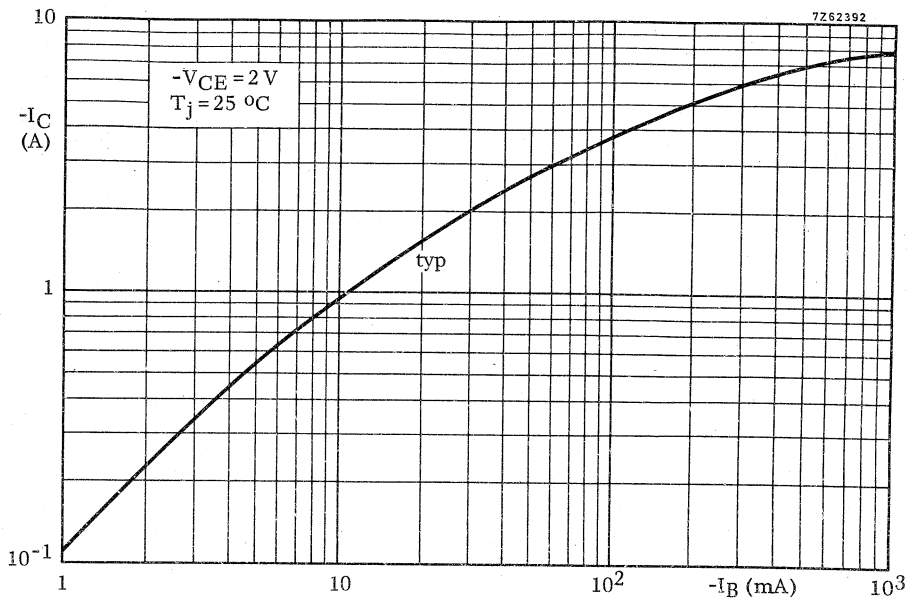
II Permissible extension for repetitive pulse operation

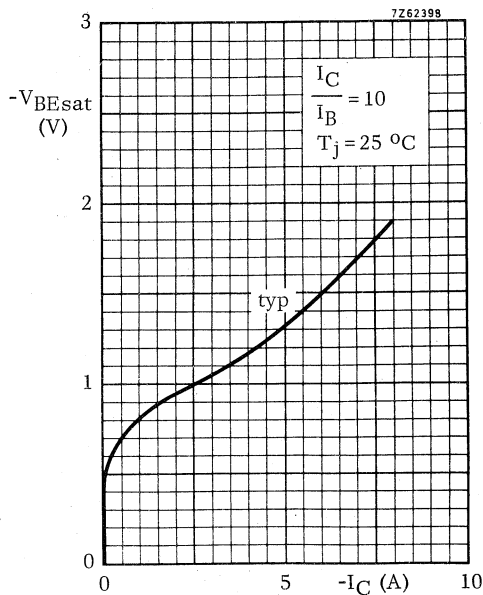
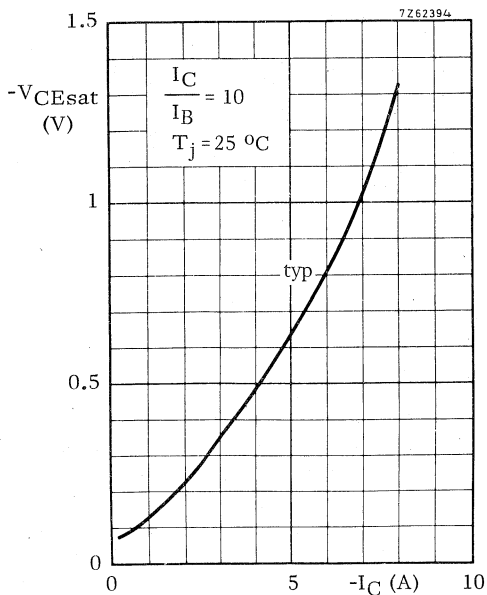
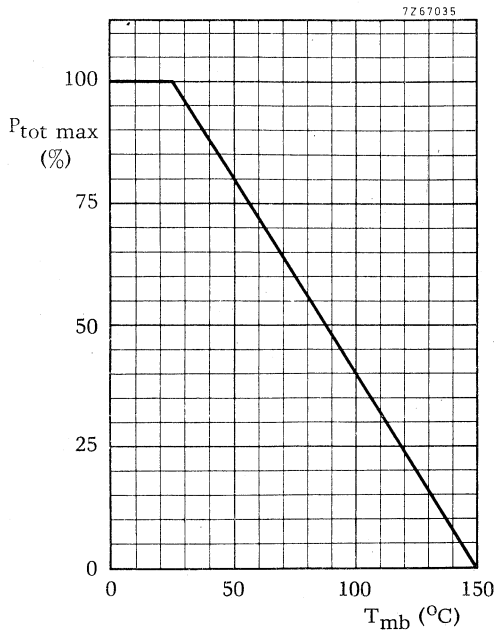
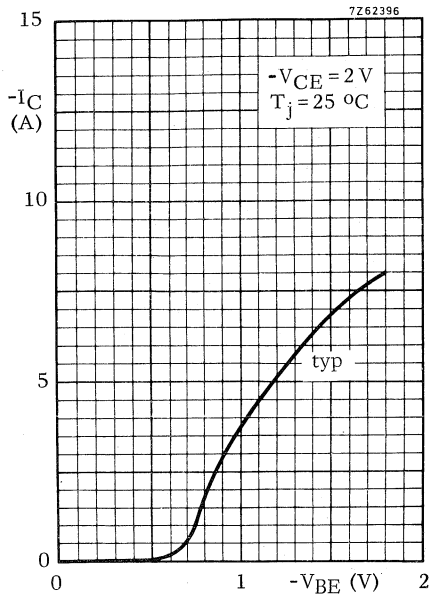
For $P_{tot max}$ versus T_{mb} see page 8.

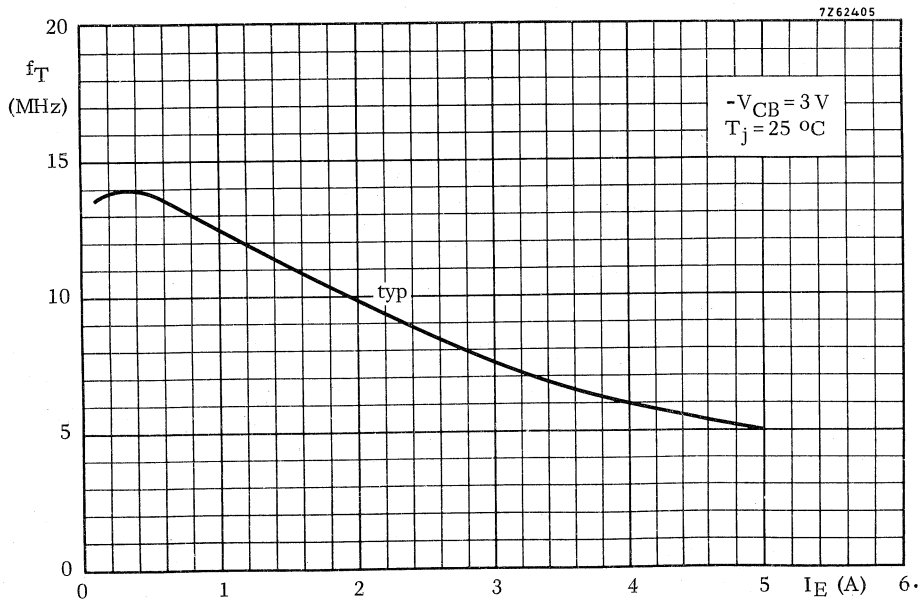
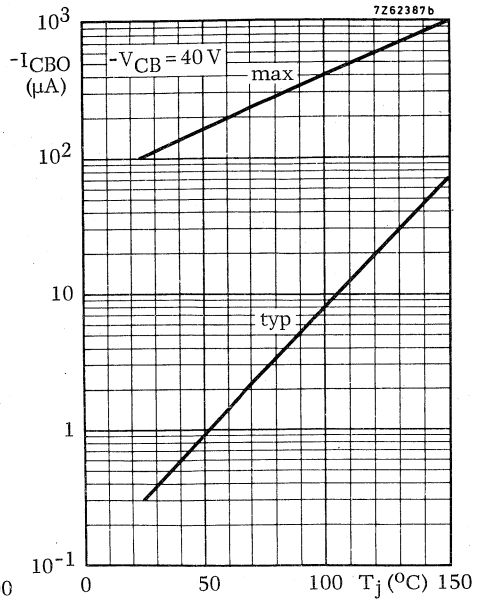
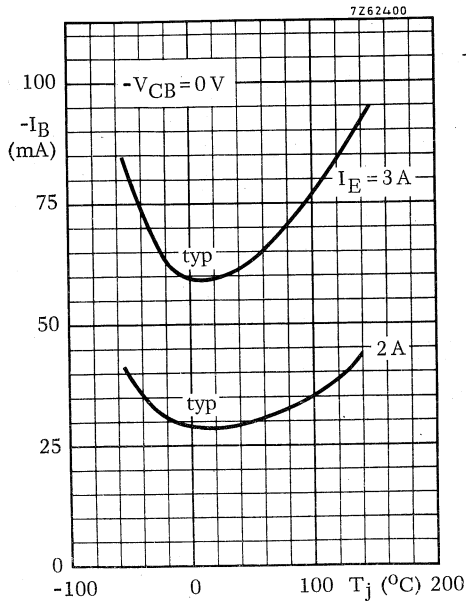
1) Independent of temperature.











SILICON PLANAR EPITAXIAL POWER TRANSISTORS

General purpose n-p-n transistors in a SOT-32 plastic envelope especially recommended for television circuits. Their complements are BD227, BD229 and BD231.

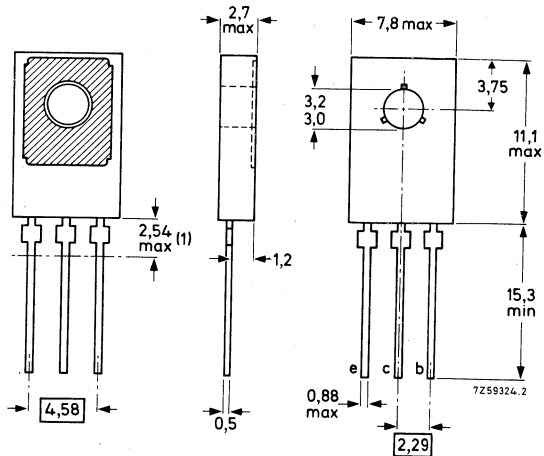
QUICK REFERENCE DATA				
		BD226	BD228	BD230
Collector-base voltage (open emitter)	V_{CB0}	max. 45	60	100 V
Collector-emitter voltage (open base)	V_{CEO}	max. 45	60	80 V
Collector-emitter voltage ($R_{BE} = 1\text{ k}\Omega$)	V_{CER}	max. 45	60	100 V
Collector current (peak value)	I_{CM}	max. 3	3	3 A
Total power dissipation up to $T_{mb} = 62\text{ }^\circ\text{C}$	P_{tot}	max. 12,5	12,5	12,5 W
Junction temperature	T_j	max. 150	150	150 $^\circ\text{C}$
D.C. current gain				
$I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$	h_{FE}	> 40	40	40
$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	> 250	160	160
Transition frequency	h_{FE}	> 25	25	25
$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$	f_T	typ. 125	125	125 MHz

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected to metal part of mounting surface



For mounting instructions see section Accessories, type 56326 for non-insulated mounting and type 56333 for insulated mounting.

1) Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

<u>Voltages</u>		BD226	BD228	BD230	
Collector-base voltage (open emitter)	V _{CBO}	max. 45	60	100	V
Collector-emitter voltage (open base)	V _{CEO}	max. 45	60	80	V
Collector-emitter voltage (R _{BE} = 1 kΩ)	V _{CER}	max. 45	60	100	V
Emitter-base voltage (open collector)	V _{EBO}	max. 5	5	5	V

Currents

Collector current (d. c.)	I _C	max.	1,5	A
Collector current (peak value)	I _{CM}	max.	3	A

Power dissipation

Total power dissipation up to T _{mb} = 62 °C	P _{tot}	max.	12,5	W
---	------------------	------	------	---

Temperatures

Storage temperature	T _{stg}	-65 to +150	°C
Junction temperature	T _j	max. 150	°C

THERMAL RESISTANCE

From junction to ambient in free air	R _{th j-a}	=	100	°C/W
From junction to mounting base	R _{th j-mb}	=	7	°C/W

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = 30\text{ V}$

$I_{CBO} < 100\text{ nA}$

$I_E = 0; V_{CB} = 30\text{ V}; T_j = 125\text{ }^\circ\text{C}$

$I_{CBO} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 10\text{ }\mu\text{A}$

Base-emitter voltage ¹⁾

$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$

$V_{BE} < 1,3\text{ V}$

Saturation voltage

$I_C = 1\text{ A}; I_B = 0,1\text{ A}$

$V_{CEsat} < 0,8\text{ V}$

D. C. current gain

$I_C = 5\text{ mA}; V_{CE} = 2\text{ V}$

	BD226	BD228	BD230
$h_{FE} >$	25	25	25
$h_{FE} >$	40	40	40
$h_{FE} <$	250	160	160
$h_{FE} >$	25	25	25

$I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$

$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$

Transition frequency at $f = 35\text{ MHz}$

$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$

f_T typ. 125 MHz

D. C. current gain ratio of matched pairs

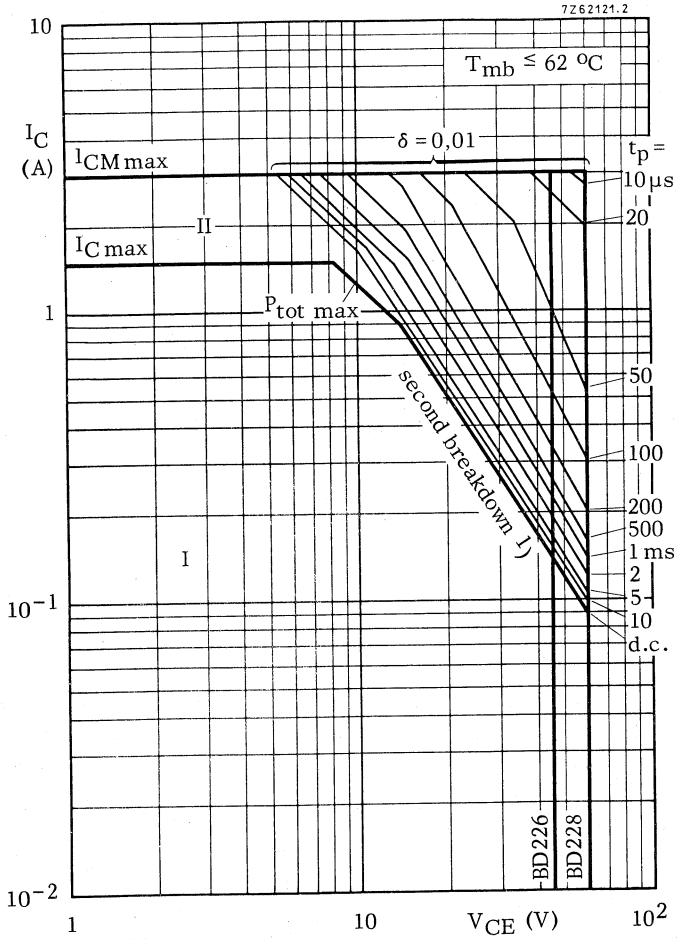
BD226/BD227; BD228/BD229;

BD230/BD231

$|I_C| = 150\text{ mA}; |V_{CE}| = 2\text{ V}$

h_{FE1}/h_{FE2} typ. $< 1,3$
 $< 1,6$

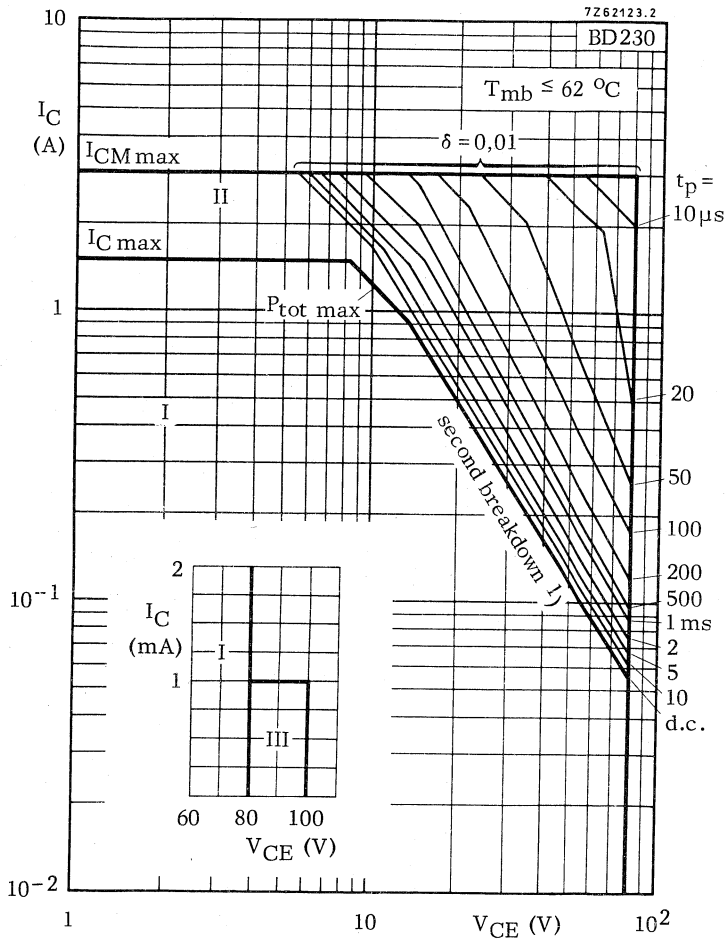
¹⁾ V_{BE} decreases by about $2,3\text{ mV}/^\circ\text{C}$ with increasing temperature.



Safe Operating Area with the transistor forward biased

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation

1) Independent of temperature

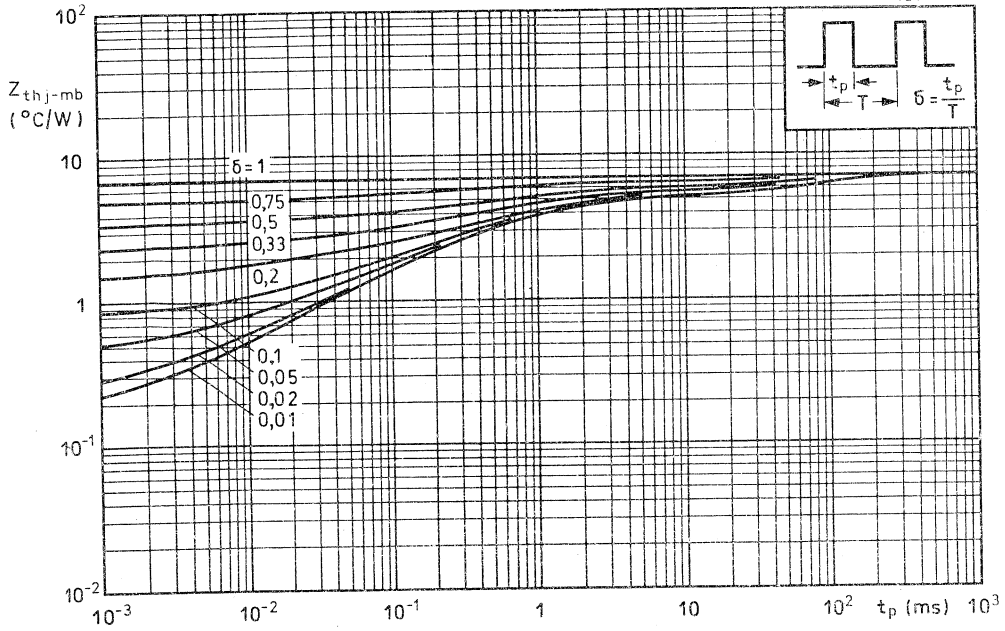


Safe Operating Area with the transistor forward biased

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse. operation
- III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 1 \text{ k}\Omega$

1) Independent of temperature

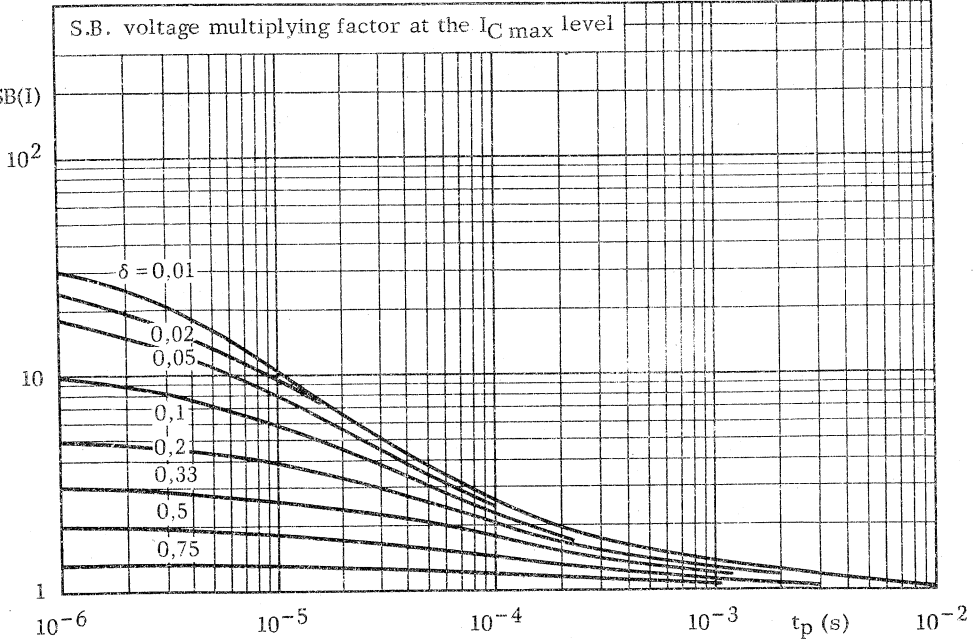
7Z62125



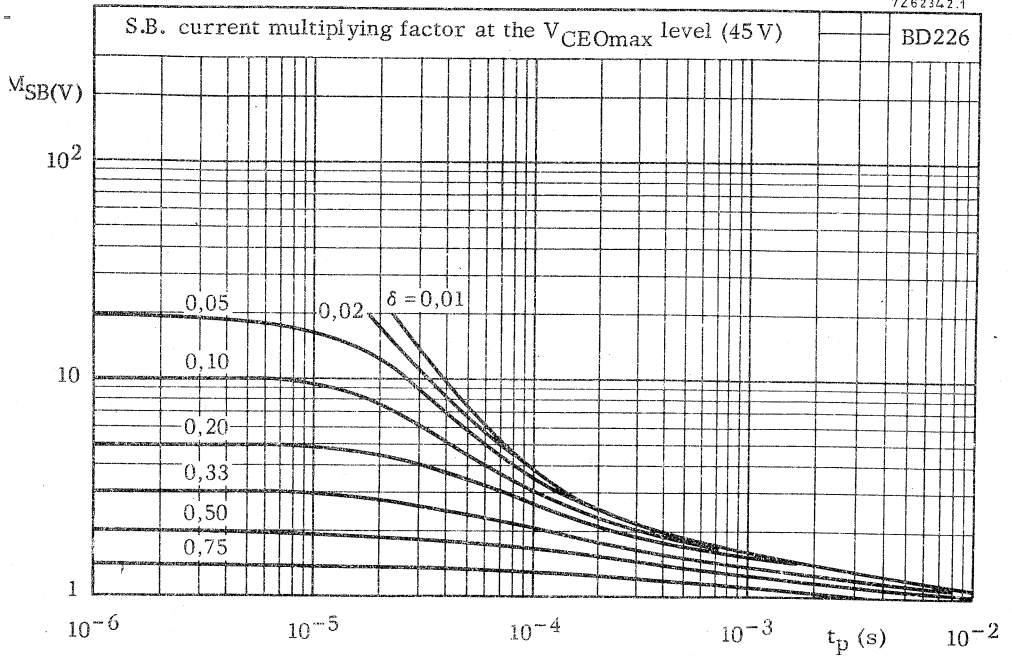
7Z62106.2

S.B. voltage multiplying factor at the I_C max level

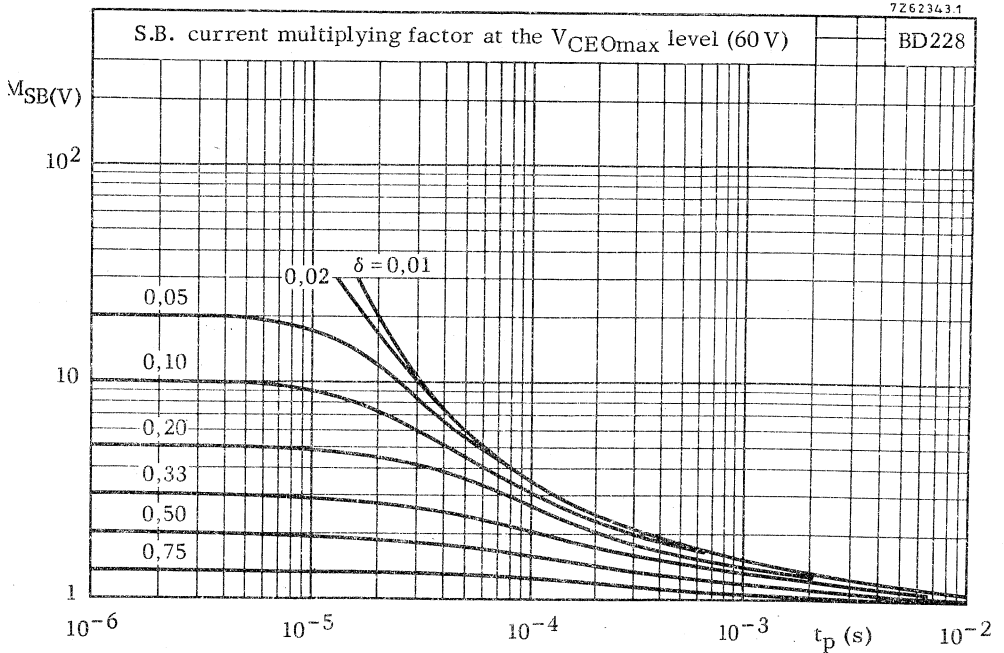
$M_{SB(1)}$



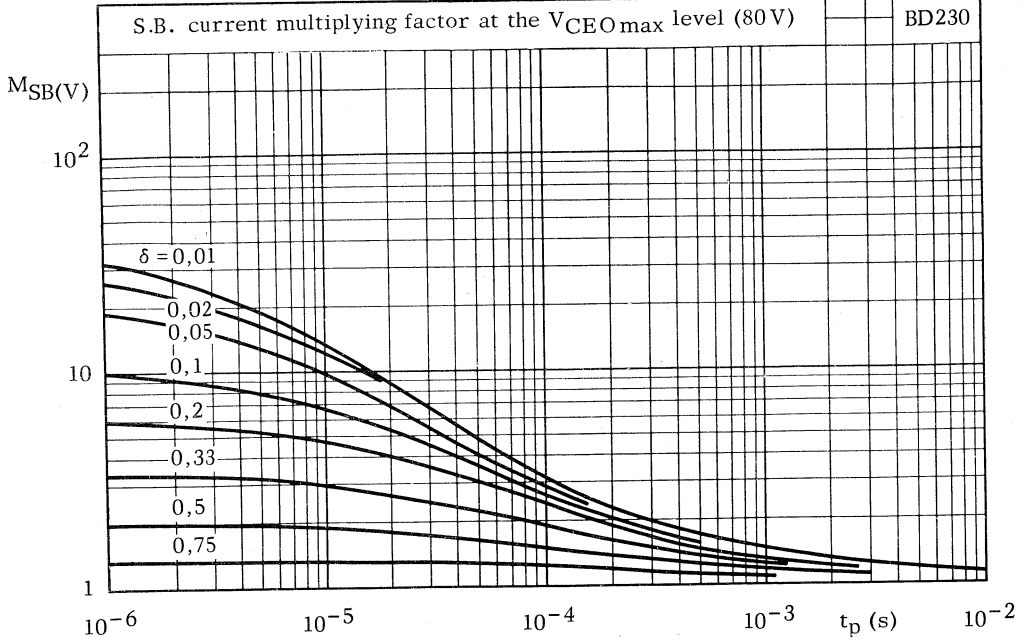
7Z6234.2.1



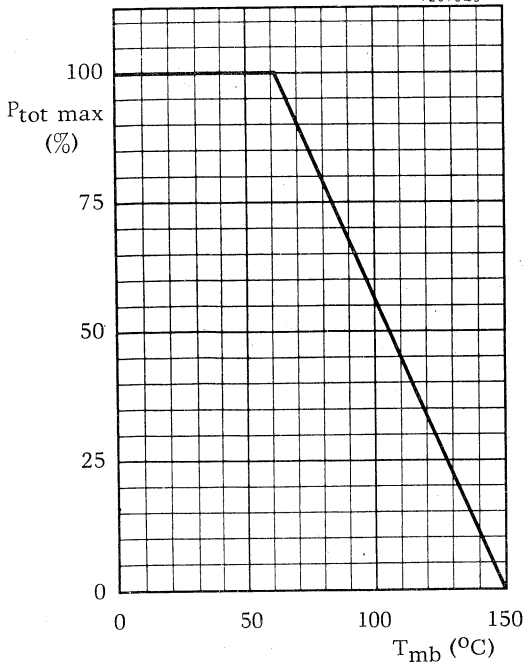
7Z6234.3.1



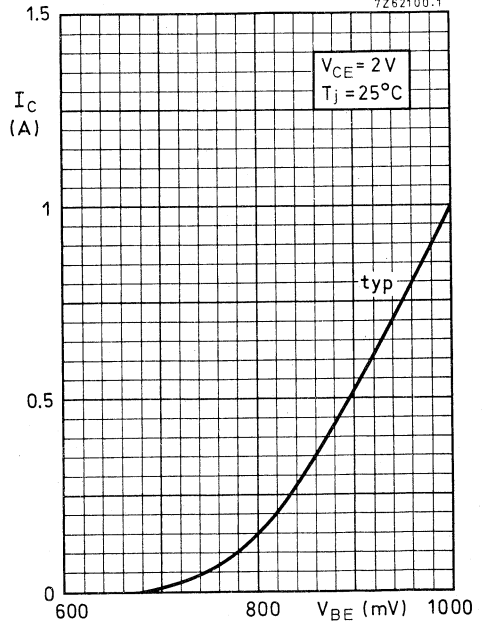
7262107.2

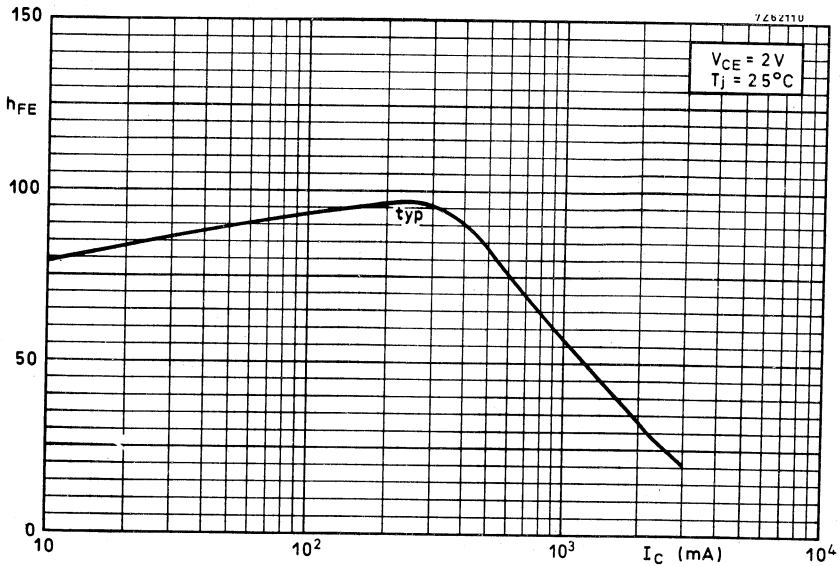
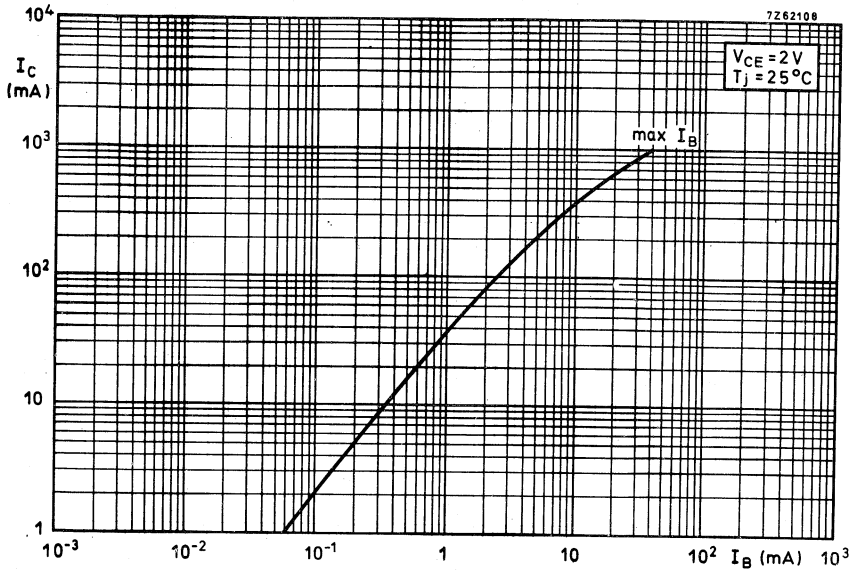


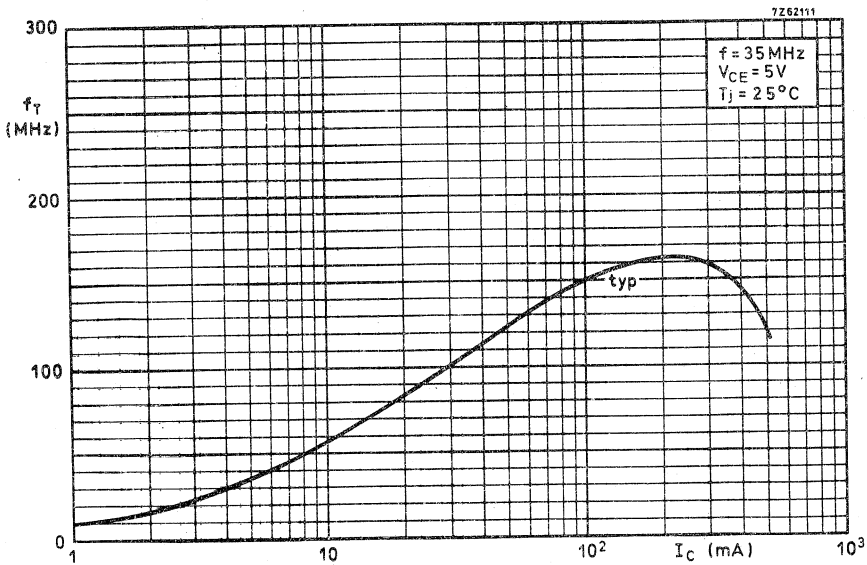
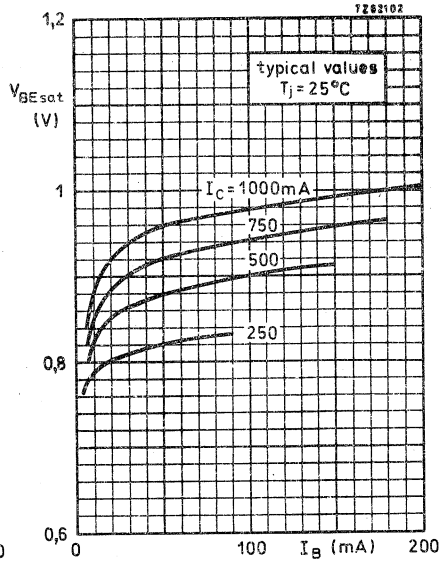
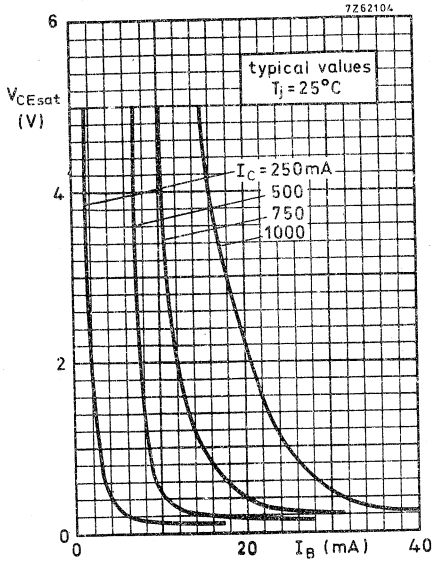
7267045



7262100.1







SILICON PLANAR EPITAXIAL POWER TRANSISTORS

General purpose p-n-p transistors in a SOT-32 plastic envelope especially recommended for television circuits. Their complements are BD226, BD228 and BD230.

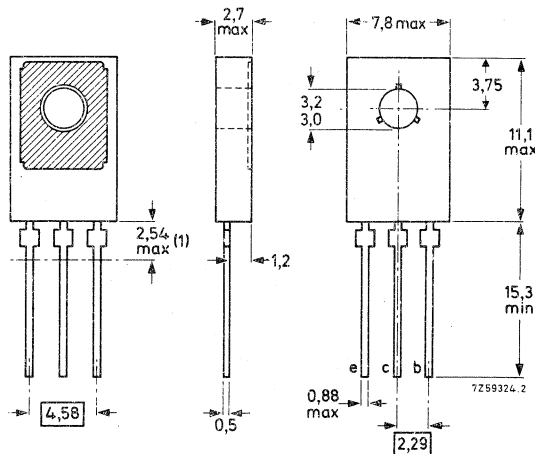
		QUICK REFERENCE DATA		
		BD227	BD229	BD231
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 45	60	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 45	60	80 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	$-V_{CER}$	max. 45	60	100 V
Collector current (peak value)	$-I_{CM}$	max. 3	3	3 A
Total power dissipation up to $T_{mb} = 62 \text{ }^\circ\text{C}$	P_{tot}	max. 12,5	12,5	12,5 W
Junction temperature	T_j	max. 150	150	150 $^\circ\text{C}$
D.C. current gain				
$-I_C = 150 \text{ mA}; -V_{CE} = 2 \text{ V}$	h_{FE}	> 40	40	40
$-I_C = 1 \text{ A}; -V_{CE} = 2 \text{ V}$	h_{FE}	< 250	160	160
Transition frequency				
$-I_C = 50 \text{ mA}; -V_{CE} = 5 \text{ V}$	f_T	typ. 50	50	50 MHz

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected to metal part of mounting surface



For mounting instructions see section Accessories, type 56326 for non-insulated mounting and type 56333 for insulated mounting.

1) Within this region the cross-section of the leads is uncontrolled.

**BD227 BD229
BD231**

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

			BD227	BD229	BD231
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	$-V_{CER}$	max.	45	60	100 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5 V

Currents

Collector current (d. c.)	$-I_C$	max.		1,5	A
Collector current (peak value)	$-I_{CM}$	max.		3	A

Power dissipation

Total power dissipation up to $T_{mb} = 62 \text{ }^\circ\text{C}$	P_{tot}	max.	12,5	W
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Temperatures

Storage temperature	T_{stg}		-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	=	100	$^\circ\text{C/W}$
From junction to mounting base	$R_{th \text{ j-mb}}$	=	7	$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 30\text{ V}$	$-I_{CBO} <$	100	nA
$I_E = 0; -V_{CB} = 30\text{ V}; T_j = 125\text{ }^\circ\text{C}$	$-I_{CBO} <$	10	μA

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO} <$	10	μA
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Base-emitter voltage ¹⁾

$-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$	$-V_{BE} <$	1,3	V
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Saturation voltage

$-I_C = 1\text{ A}; -I_B = 0,1\text{ A}$	$-V_{CEsat} <$	0,8	V
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D. C. current gain

		BD227	BD229	BD231
$-I_C = 5\text{ mA}; -V_{CE} = 2\text{ V}$	$h_{FE} >$	25	25	25
$-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$	$h_{FE} >$	40	40	40
$-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$	$h_{FE} <$	250	160	160
	$h_{FE} >$	25	25	25

Transition frequency at $f = 35\text{ MHz}$

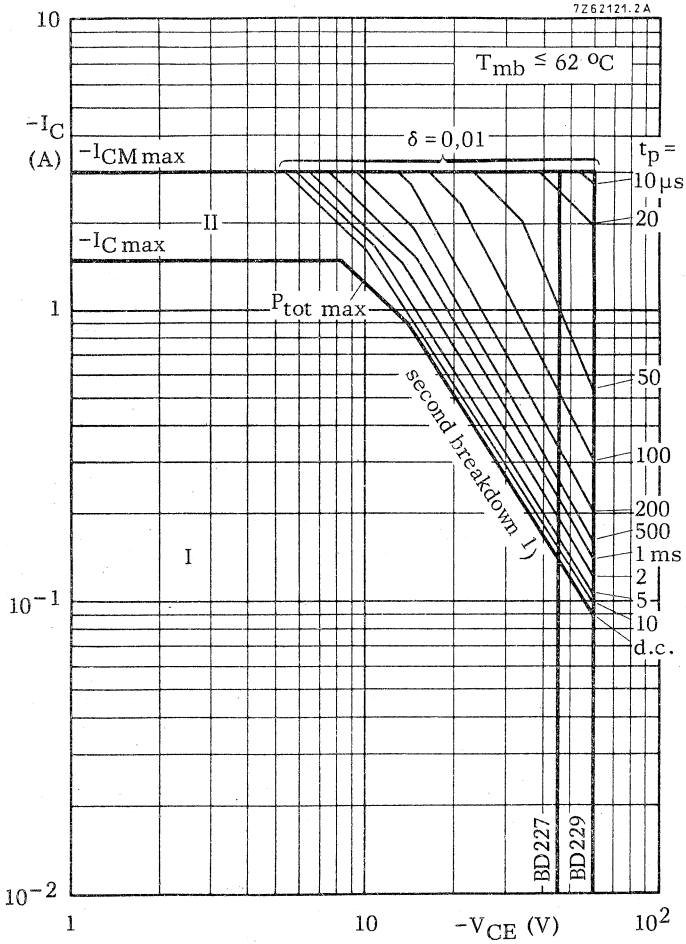
$-I_C = 50\text{ mA}; -V_{CE} = 5\text{ V}$	f_T	typ.	50	MHz
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D. C. current gain ratio of matched pairs

BD226/BD227; BD228/BD229;
BD230/BD231

$ I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$	$h_{FE1}/h_{FE2} <$	typ.	1,3 1,6
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¹⁾ $-V_{BE}$ decreases by about $2,3\text{ mV}/^\circ\text{C}$ with increasing temperature.

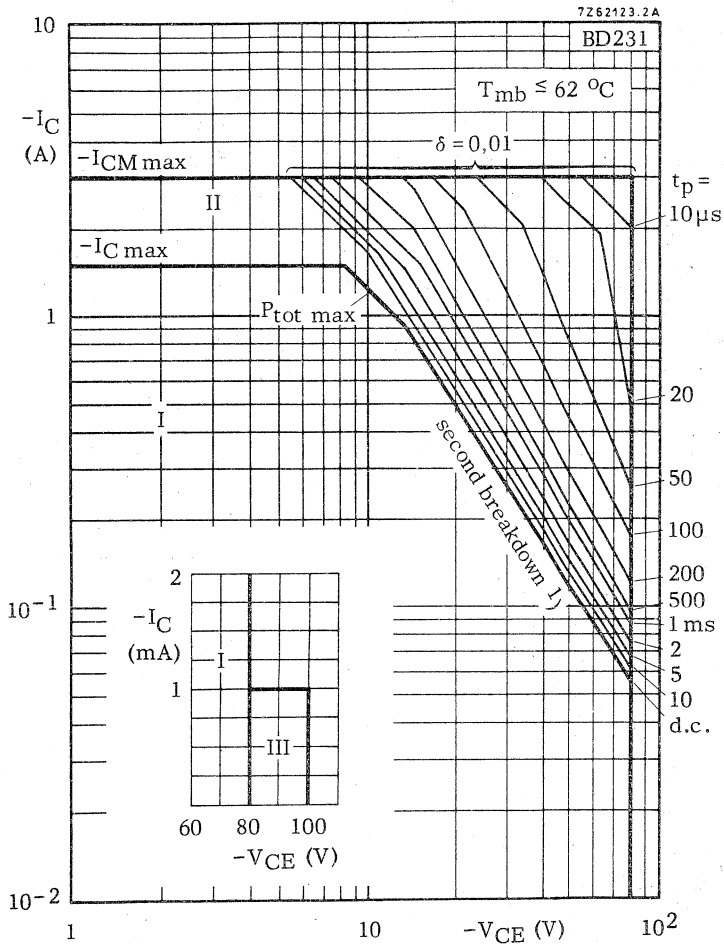


Safe Operating Area with the transistor forward biased

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

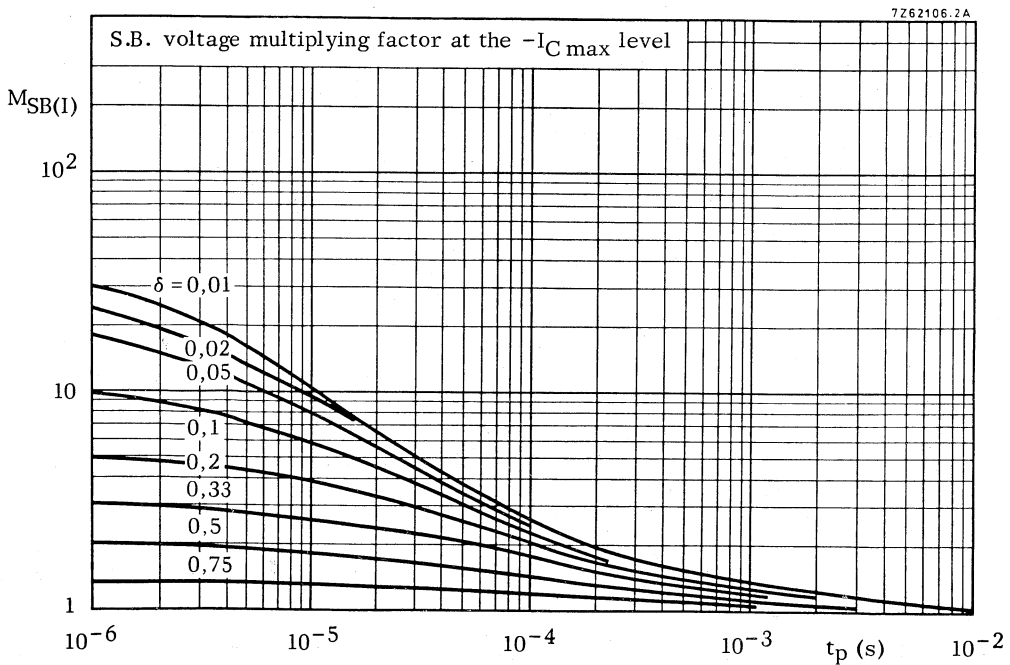
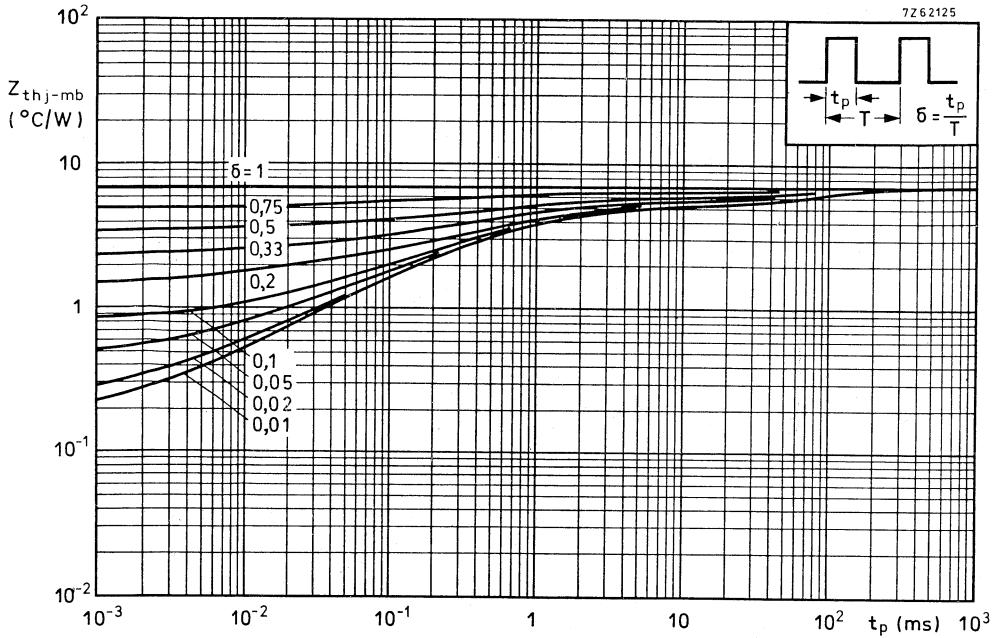
1) Independent of temperature



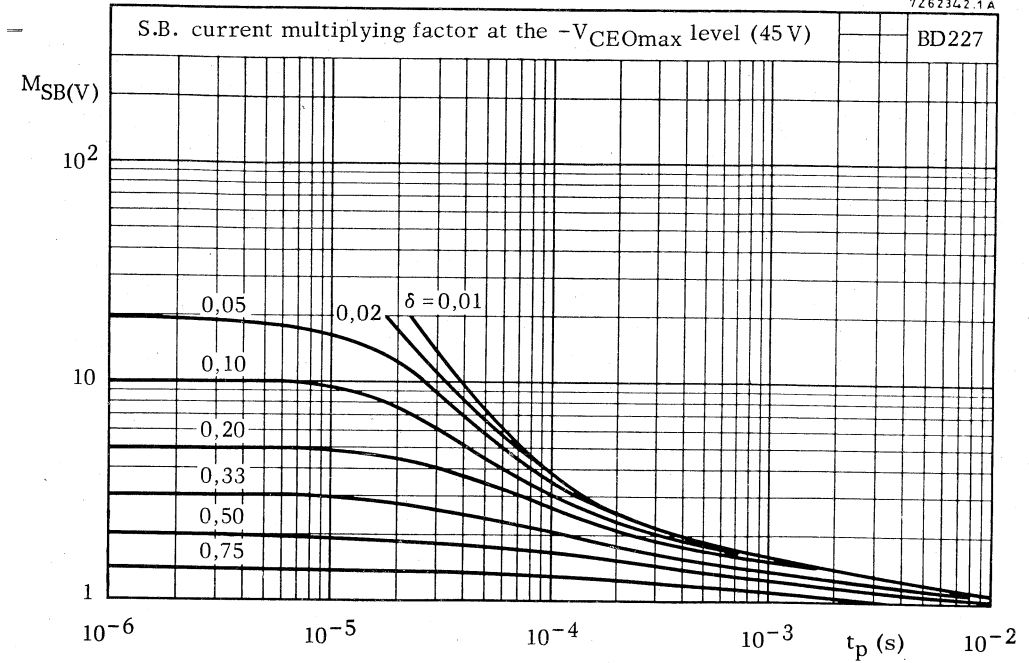
Safe Operating Area with the transistor forward biased

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 1\ \text{k}\Omega$

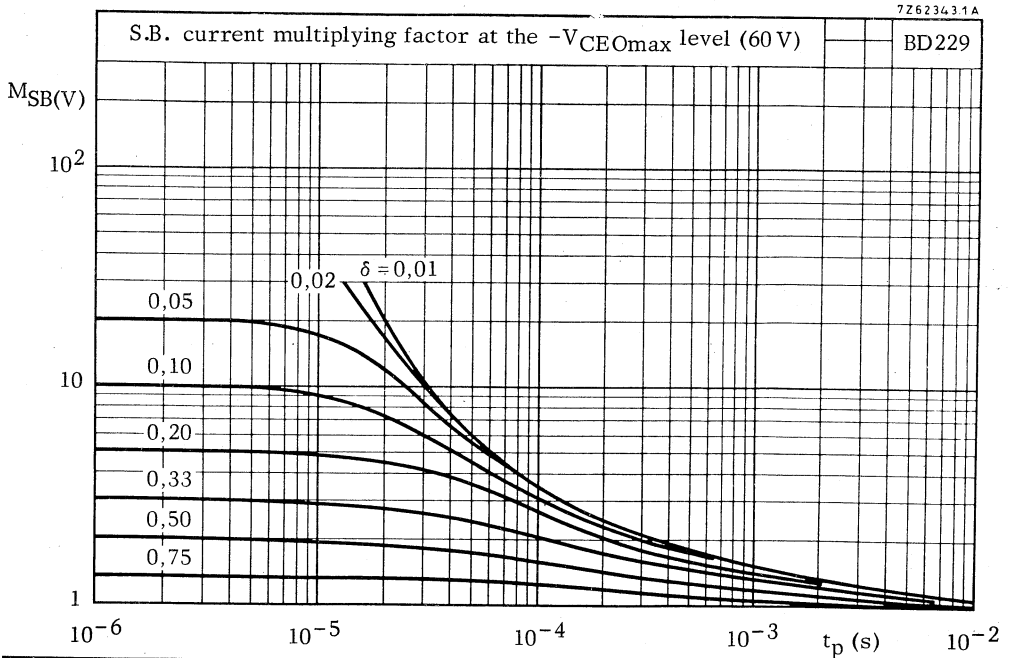
1) Independent of temperature



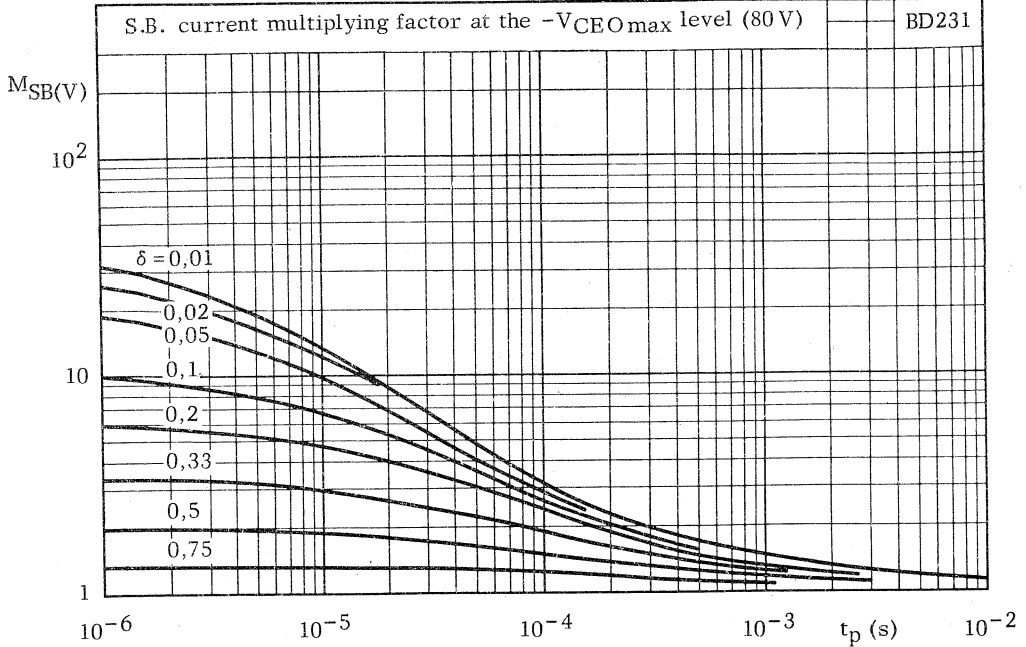
7262342.1A



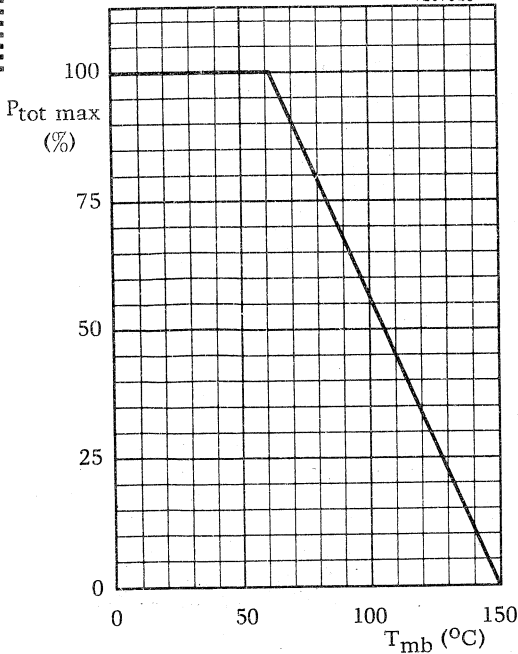
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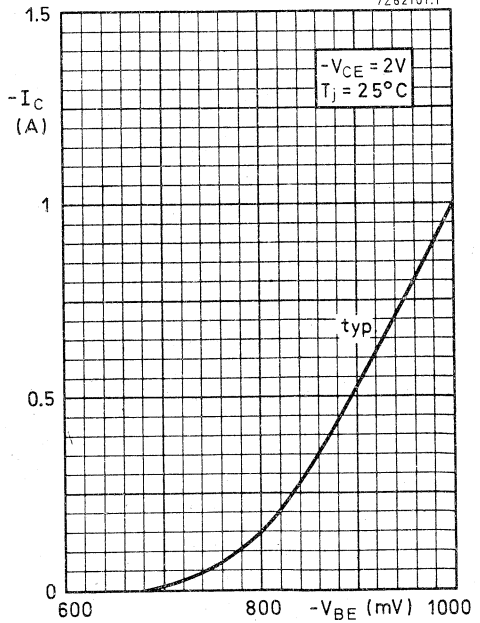
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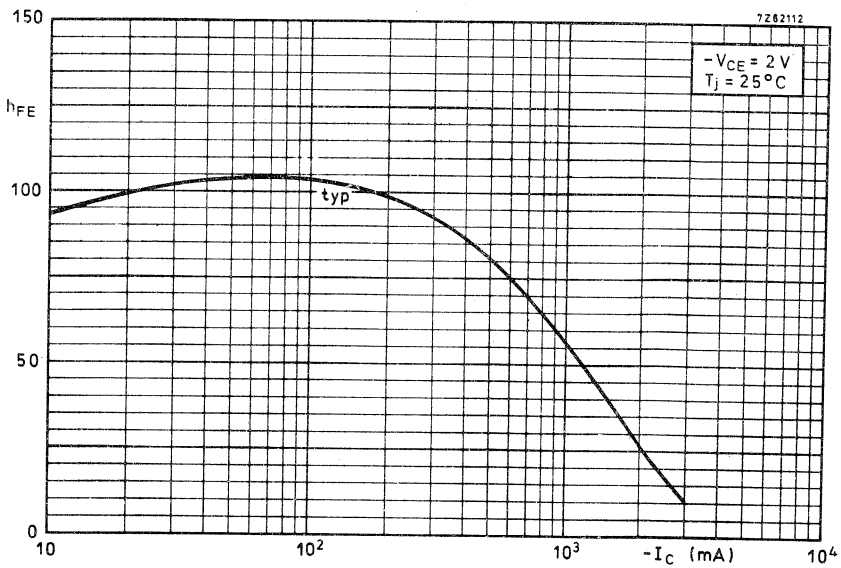
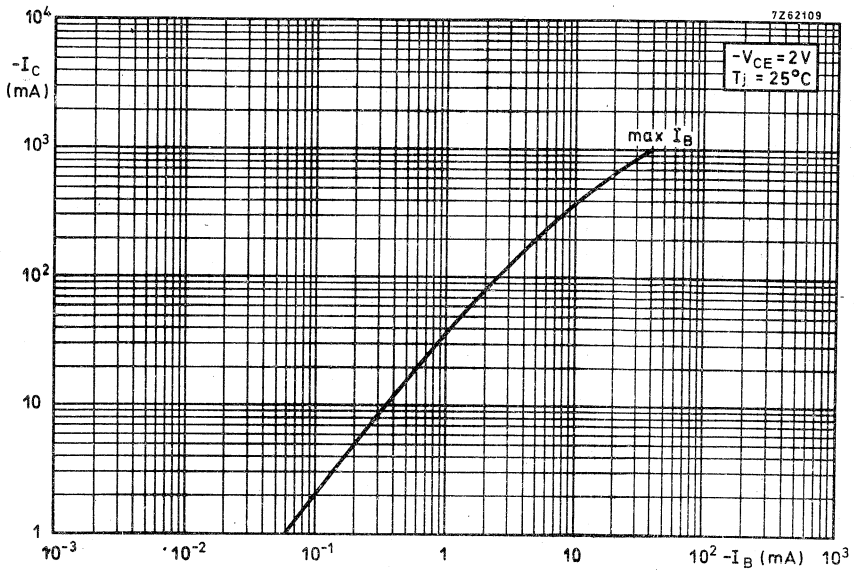


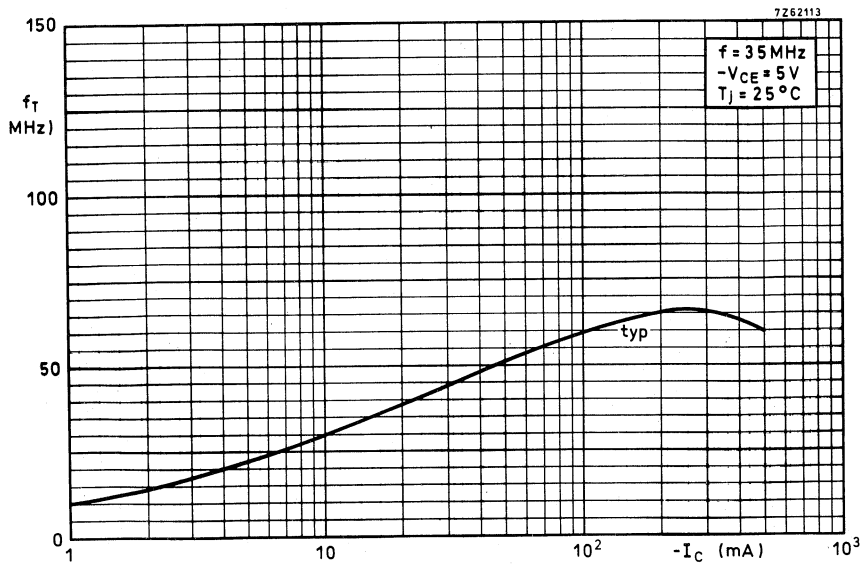
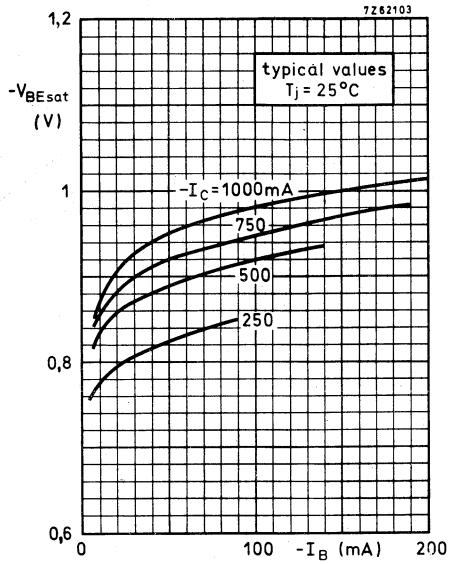
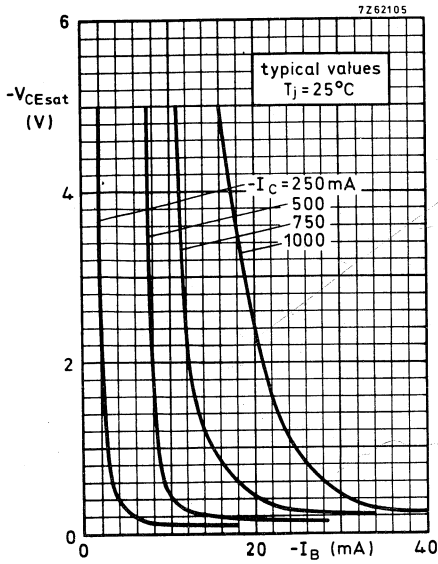
7Z67045



7Z62101.1







SILICON DIFFUSED POWER TRANSISTOR

High-voltage n-p-n transistor in a SOT-32 plastic envelope intended for use as line driver in television receivers.

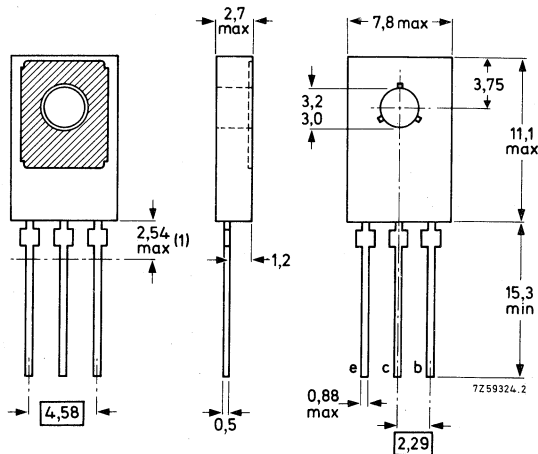
QUICK REFERENCE DATA			
Collector-emitter voltage ($R_{BE} \leq 1 \text{ k}\Omega$) peak value	V_{CERM}	max.	500 V
Collector-emitter voltage (open base)	V_{CEO}	max.	300 V
Collector current (d. c.)	I_C	max.	0,25 A
Collector current (peak value, $t_p \leq 1 \text{ ms}$)	I_{CM}	max.	1 A
Total power dissipation up to $T_{mb} = 57,5 \text{ }^\circ\text{C}$	P_{tot}	max.	15 W
Junction temperature	T_j	max.	125 $^\circ\text{C}$
D. C. current gain	h_{FE}	>	20
$I_C = 150 \text{ mA}; V_{CE} = 5 \text{ V}$			
Transition frequency	f_T	typ.	20 MHz
$I_C = 50 \text{ mA}; V_{CE} = 10 \text{ V}$			

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected to metal part of mounting surface



For mounting instructions see section Accessories in handbook SC2, set 56333 for insulated mounting and type 56326 for non-insulated mounting.

1) Within this region the cross-section of the leads is uncontrolled.

SILICON EPITAXIAL-BASE POWER TRANSISTORS

N-P-N transistors in a SOT-32 plastic envelope intended for use in television and audio amplifier circuits where high peak powers can occur. P-N-P complements are BD234, BD236 and BD238. Matched pairs can be supplied.

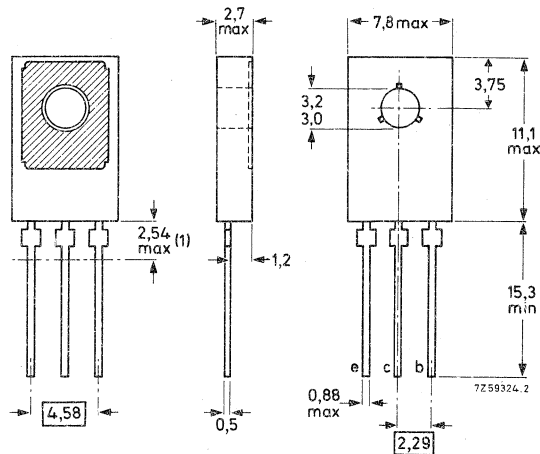
		QUICK REFERENCE DATA				
			BD233	BD235	BD237	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.		6		A
Total power dissipation up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.		25		W
Junction temperature	T_j	max.		150		$^\circ\text{C}$
D.C. current gain $I_C = 1 \text{ A}; V_{CE} = 2 \text{ V}$	h_{FE}	>		25		
Transition frequency $I_C = 250 \text{ mA}; V_{CE} = 10 \text{ V}$	f_T	>		3		MHz

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected
to metal part of
mounting surface



For mounting instructions see section Accessories, type 56326 for direct mounting and set 56333 for insulated mounting.

1) Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

<u>Voltages</u>		BD233	BD235	BD237	
Collector-base voltage (open emitter)	V_{CBO} max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO} max.	45	60	80	V
Collector-emitter voltage ($R_{BE} = 1\text{ k}\Omega$)	V_{CER} max.	45	60	100	V
Emitter-base voltage (open collector)	V_{EBO} max.	5	5	5	V

Currents

Collector current (d. c.)	I_C	max.	2	A
Collector current (peak value)	I_{CM}	max.	6	A

Power dissipation

Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	25	W
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Temperatures

Storage temperature	T_{stg}	-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max. 150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	100	$^\circ\text{C}/\text{W}$
From junction to mounting base	$R_{th\ j-mb}$	=	5	$^\circ\text{C}/\text{W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = V_{CBOmax}$	I_{CBO}	<	100	μA
$I_E = 0; V_{CB} = V_{CBOmax}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<	3	mA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<	1	mA
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CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$

Base-emitter voltage

$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$

$V_{BE} < 1,3\text{ V}$

Saturation voltage

$I_C = 1\text{ A}; I_B = 0,1\text{ A}$

$V_{CEsat} < 0,6\text{ V}$

D.C. current gain

$I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$

$h_{FE} \quad 40\text{ to }250$

$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$

$h_{FE} > 25$

Transition frequency at $f = 1\text{ MHz}$

$I_C = 250\text{ mA}; V_{CE} = 10\text{ V}$

$f_T > 3\text{ MHz}$

D.C. current gain ratio of matched pairs

BD233/BD234; BD235/BD236; BD237/BD238

$|I_C| = 150\text{ mA}; |V_{CE}| = 2\text{ V}$

$h_{FE1}/h_{FE2} < 1,6$

Switching times

$I_{Con} = 1\text{ A}; I_{Bon} = -I_{Boff} = 0,1\text{ A}$

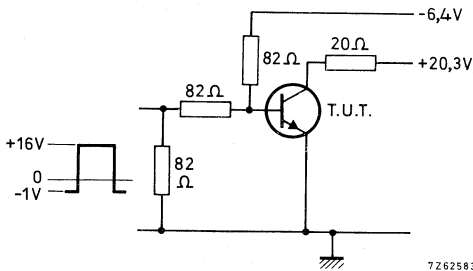
turn-on time

$t_{on} \quad \text{typ} \quad 0,3\text{ }\mu\text{s}$

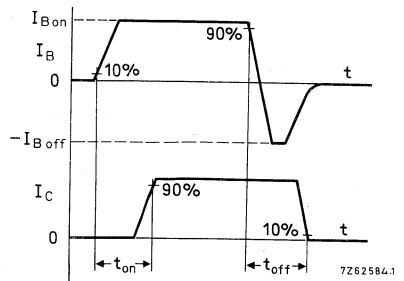
turn-off time

$t_{off} \quad \text{typ} \quad 1,1\text{ }\mu\text{s}$

Test circuit



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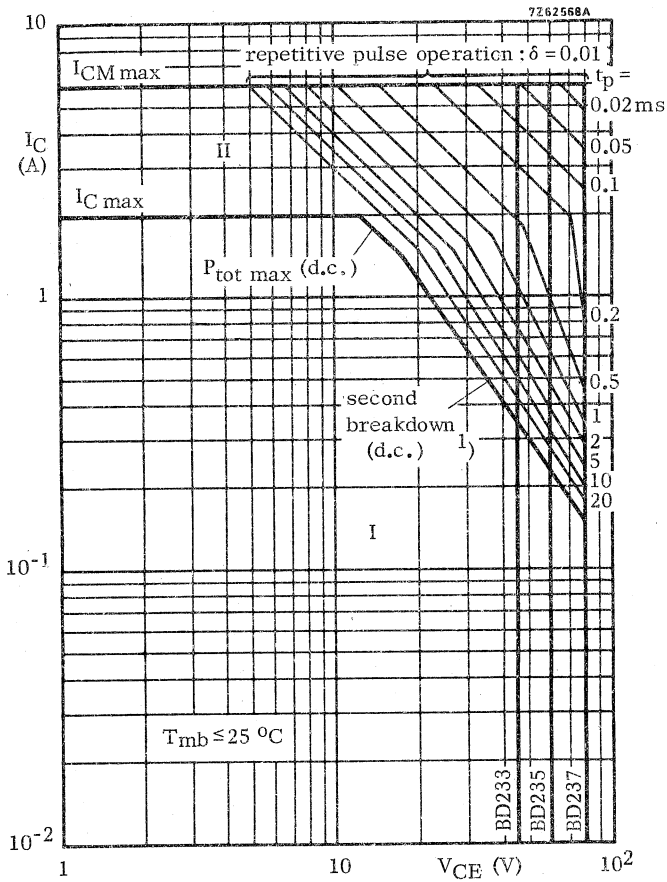
7262584.1

Input pulse:

$t_r = t_f = 15\text{ ns}$

$t_D = 10\text{ }\mu\text{s}$

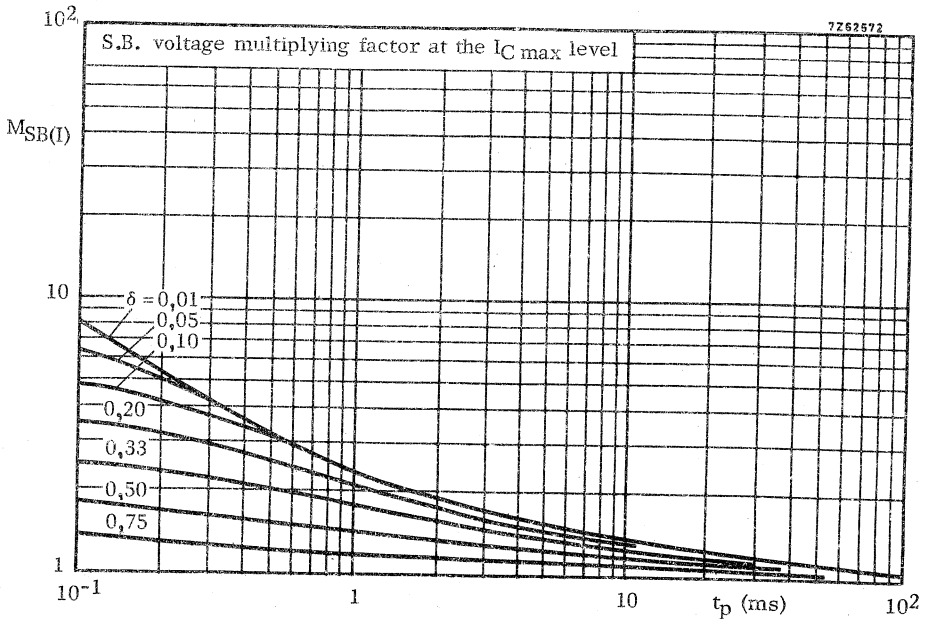
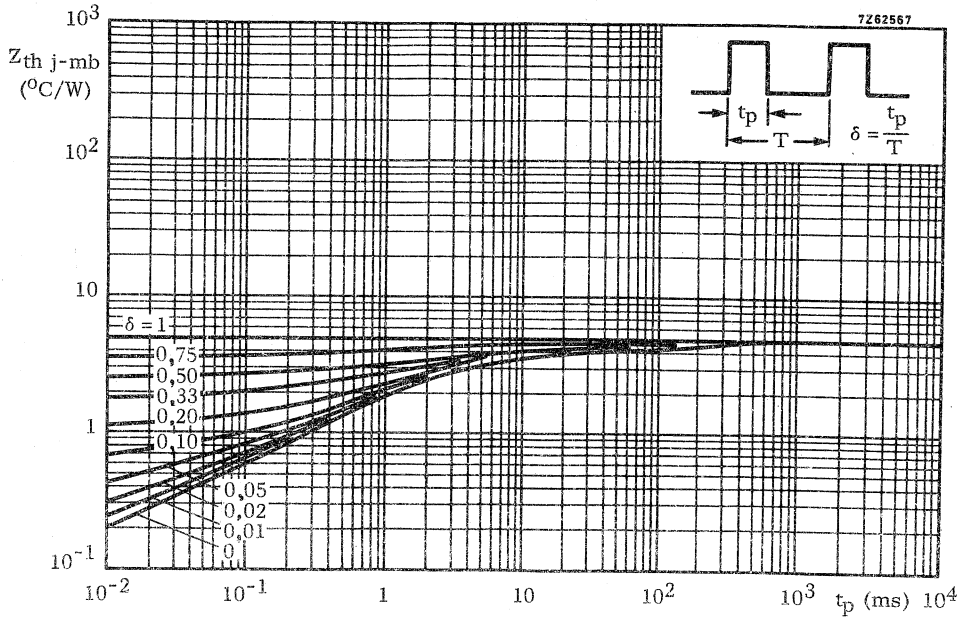
$T = 500\text{ }\mu\text{s}$

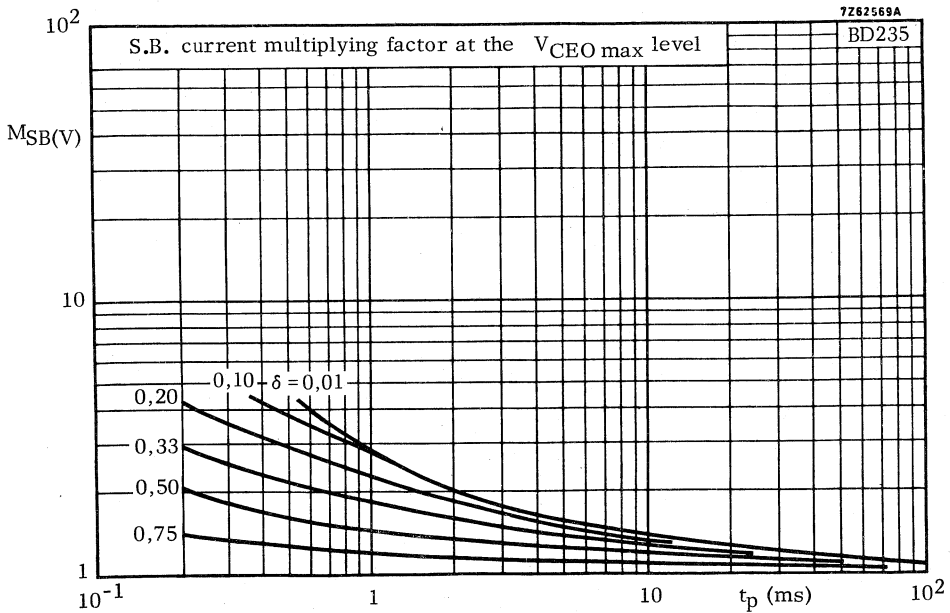
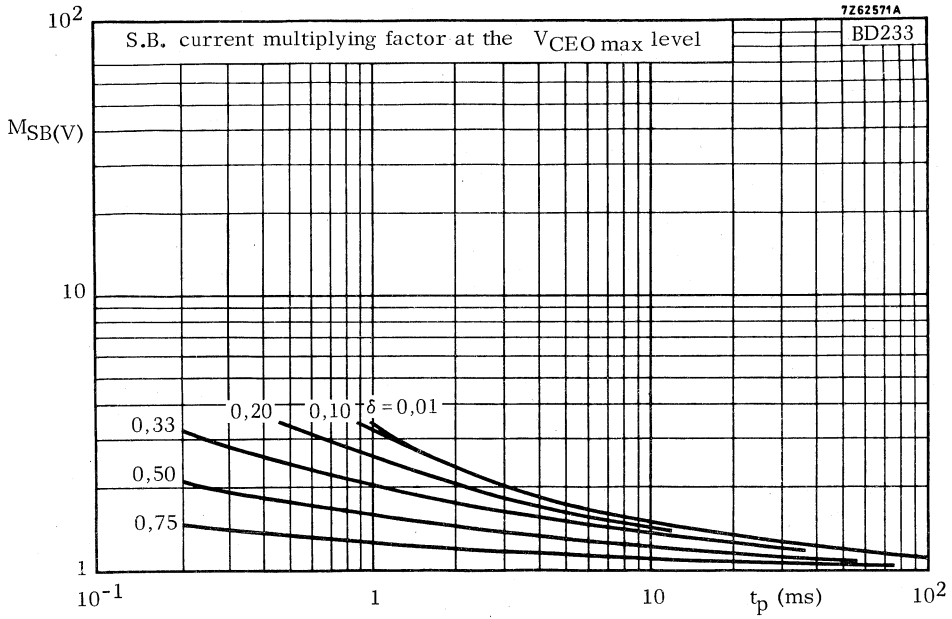


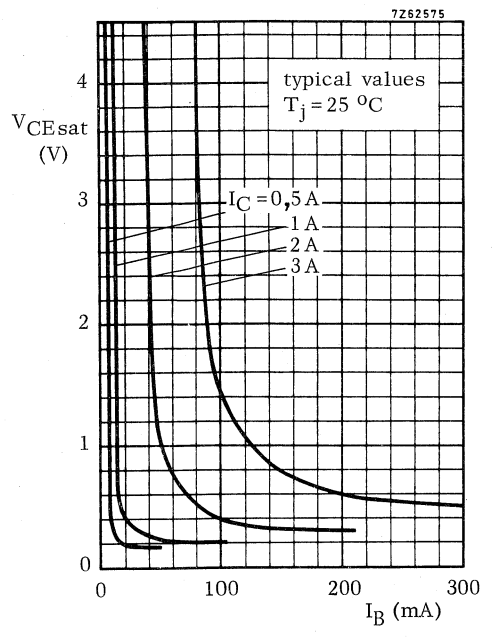
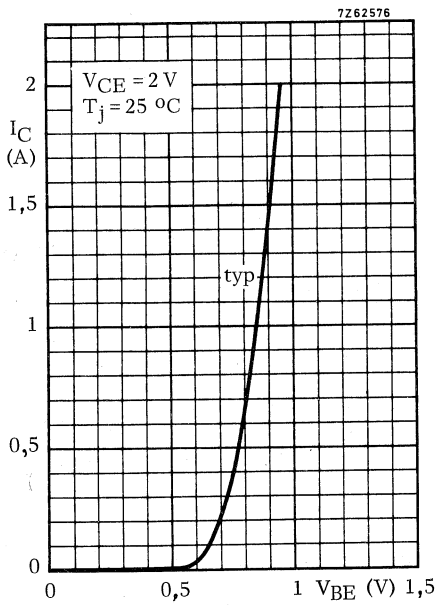
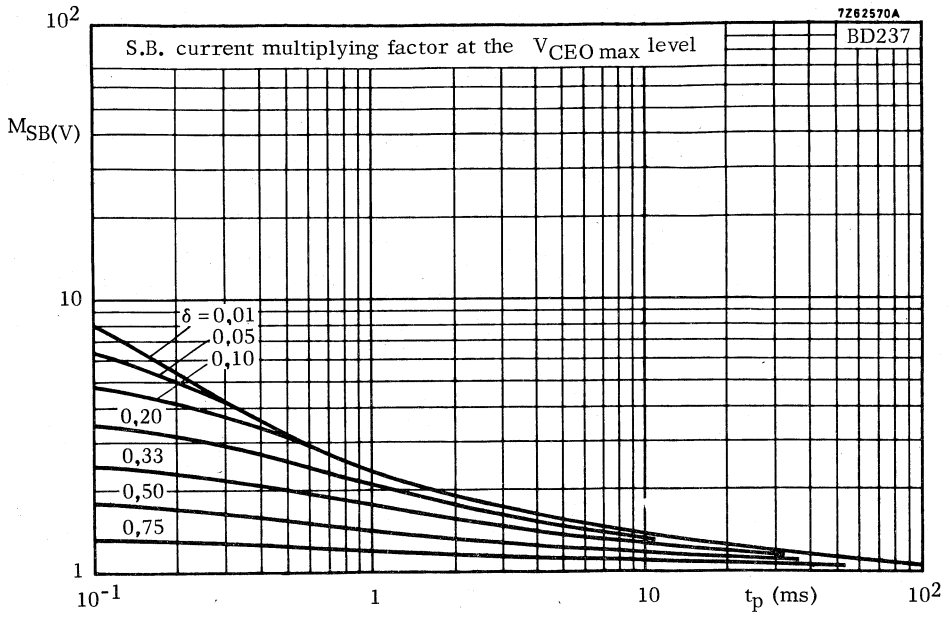
Safe Operating Area with the transistor forward biased

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation

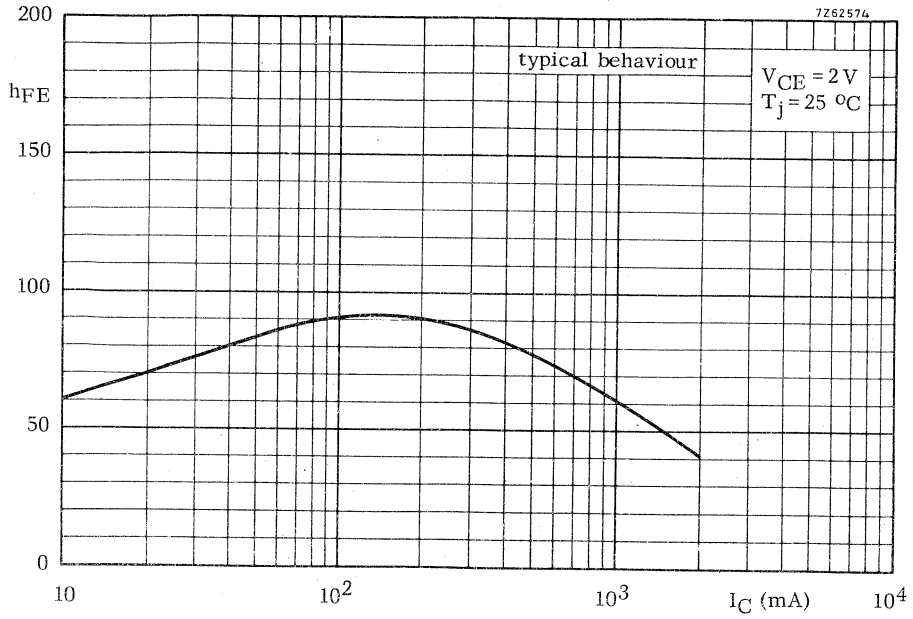
¹⁾ Independent of temperature







7262574



SILICON EPITAXIAL-BASE POWER TRANSISTORS

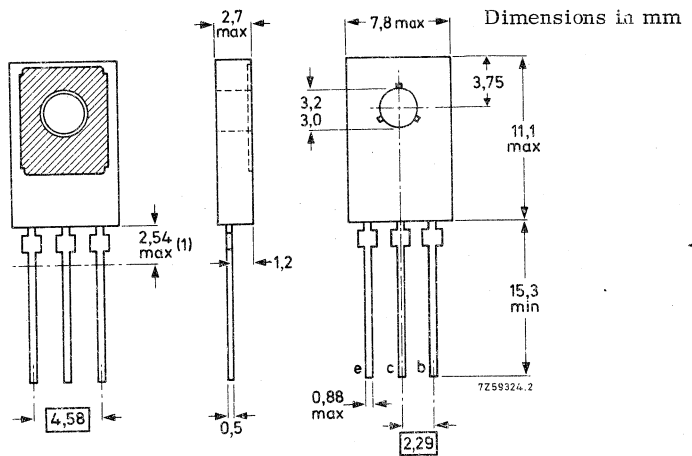
P-N-P transistors in a SOT-32 plastic envelope intended for use in television and audio amplifier circuits where high peak powers can occur. N-P-N complements are BD233, BD235 and BD237. Matched pairs can be supplied.

QUICK REFERENCE DATA						
			BD234	BD236	BD238	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage ($R_{BE} = 1\text{ k}\Omega$)	$-V_{CER}$	max.	45	60	100	V
Collector current (peak value)	$-I_{CM}$	max.		6		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		25		W
Junction temperature	T_j	max.		150		$^\circ\text{C}$
D.C. current gain $-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$	h_{FE}	>		25		
Transition frequency $-I_C = 250\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	>		3		MHz

MECHANICAL DATA

TO-126 (SOT-32)

Collector connected to metal part of mounting surface



For mounting instructions see section Accessories, type 56326 for direct mounting and set 56333 for insulated mounting.

1) Within this region the cross-section of the leads is uncontrolled.

BD234; BD236; BD238

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

			BD234	BD236	BD238	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	$-V_{CER}$	max.	45	60	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V

Currents

Collector current (d. c.)	$-I_C$	max.	2			A
Collector current (peak value)	$-I_{CM}$	max.	6			A

Power dissipation

Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	25			W
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Temperatures

Storage temperature	T_{stg}		-65 to +150			$^\circ\text{C}$
Junction temperature	T_j	max.	150			$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th \text{ j-a}}$	=	100			$^\circ\text{C/W}$
From junction to mounting base	$R_{th \text{ j-mb}}$	=	5			$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	100			μA
$I_E = 0; -V_{CB} = -V_{CBOmax}; T_j = 150^\circ\text{C}$	$-I_{CBO}$	<	3			mA

Emitter cut-off current

$I_C = 0; -V_{EB} = 5 \text{ V}$	$-I_{EBO}$	<	1			mA
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CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$

Base-emitter voltage

$-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$

$-V_{BE} < 1,3\text{ V}$

Saturation voltage

$-I_C = 1\text{ A}; -I_B = 0,1\text{ A}$

$-V_{CEsat} < 0,6\text{ V}$

D.C. current gain

$-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$

$h_{FE} 40\text{ to }250$

$-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$

$h_{FE} > 25$

Transition frequency at $f = 1\text{ MHz}$

$-I_C = 250\text{ mA}; -V_{CE} = 10\text{ V}$

$f_T > 3\text{ MHz}$

D.C. current gain ratio of matched pairs

BD233/BD234; BD235/BD236; BD237/BD238

$|I_C| = 150\text{ mA}; |V_{CE}| = 2\text{ V}$

$h_{FE1}/h_{FE2} < 1,6$

Switching times

$-I_{Con} = 1\text{ A}; -I_{Bon} = I_{Boff} = 0,1\text{ A}$

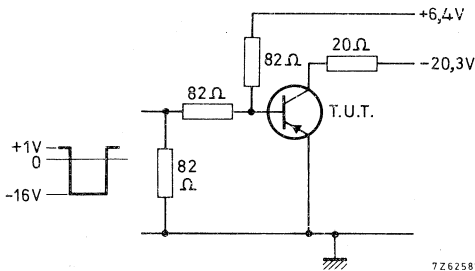
turn-on time

$t_{on} \text{ typ } 0,3\text{ }\mu\text{s}$

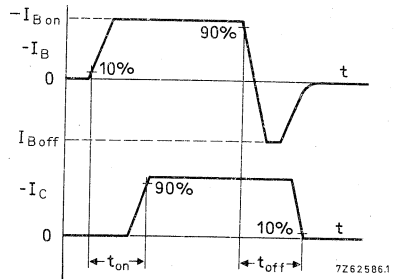
turn-off time

$t_{off} \text{ typ } 0,7\text{ }\mu\text{s}$

Test circuit



7262585



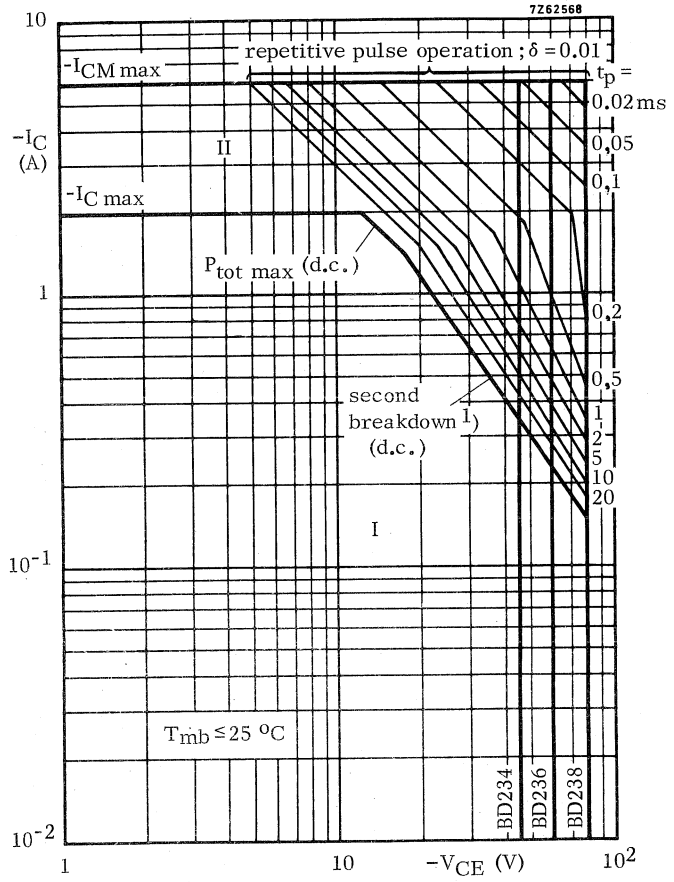
7262586.1

Input pulse:

$t_r = t_f = 15\text{ ns}$

$t_p = 10\text{ }\mu\text{s}$

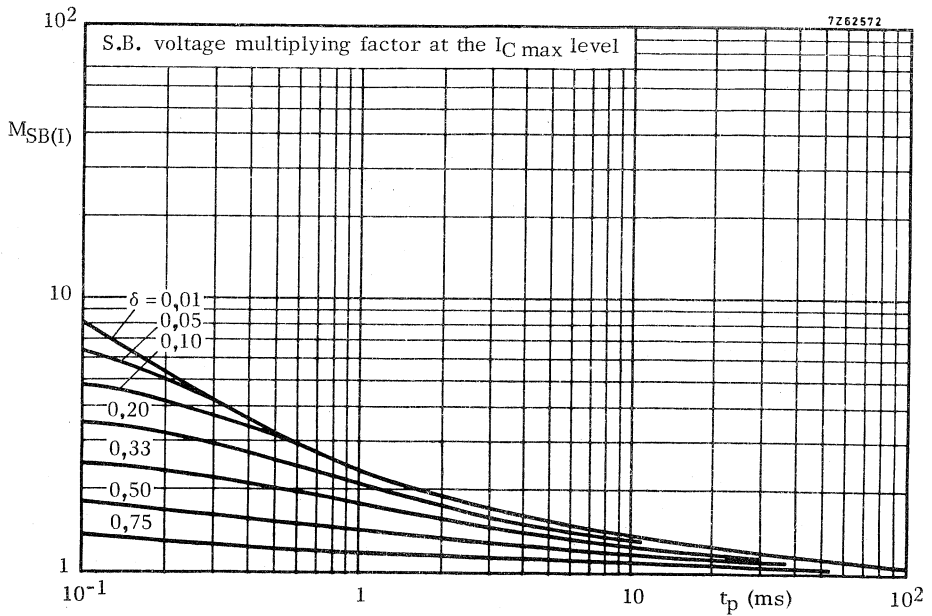
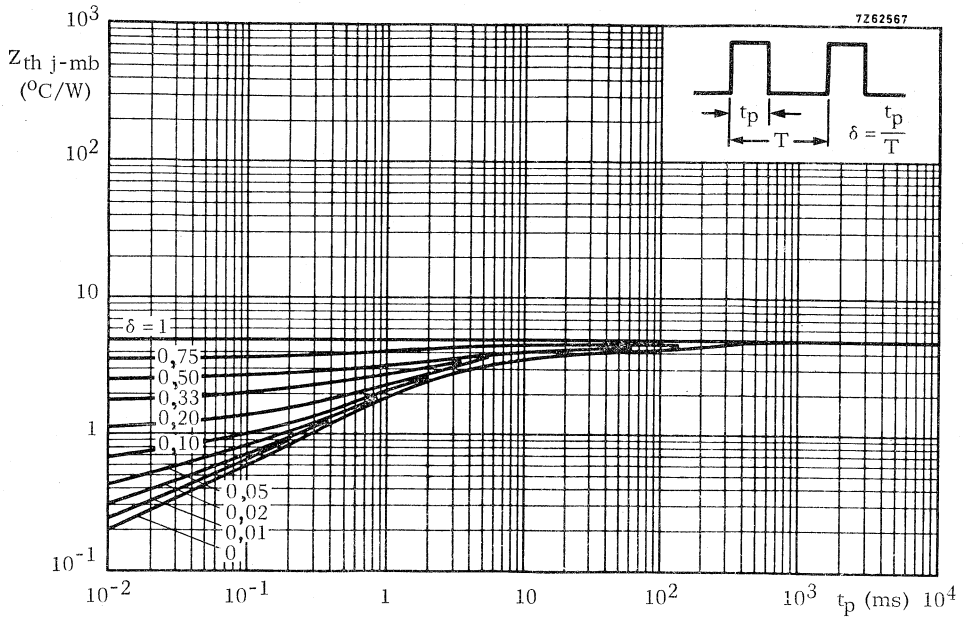
$T = 500\text{ }\mu\text{s}$



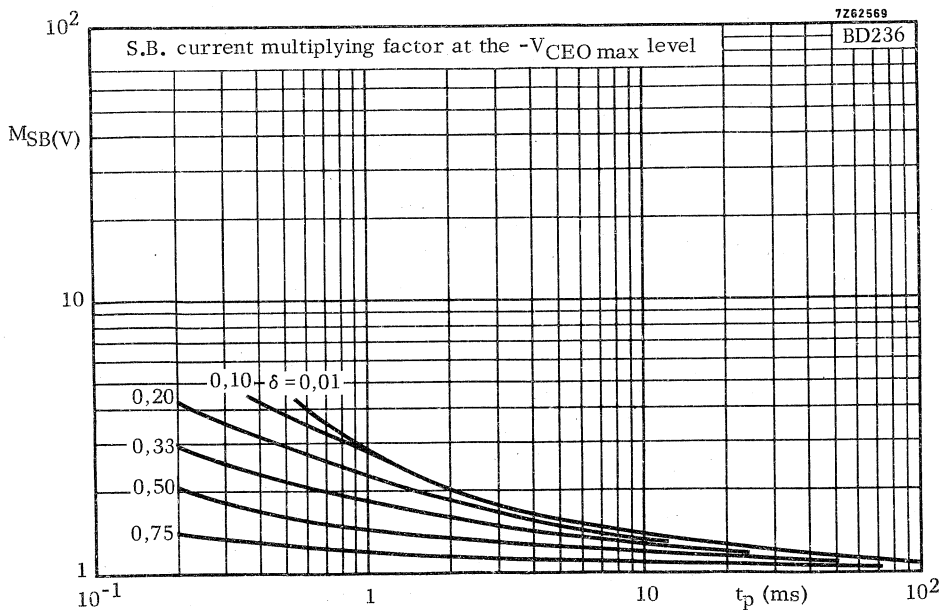
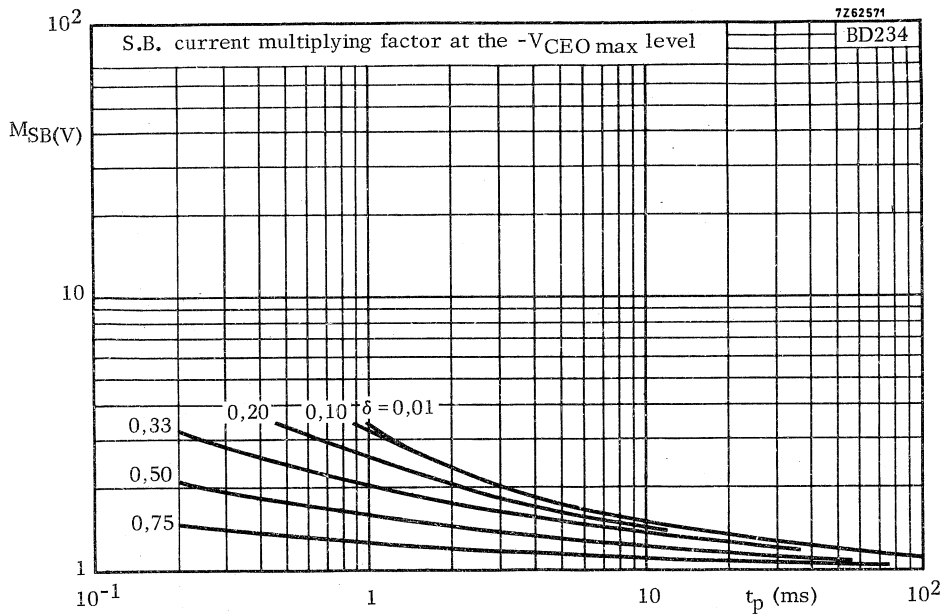
Safe Operating Area with the transistor forward biased

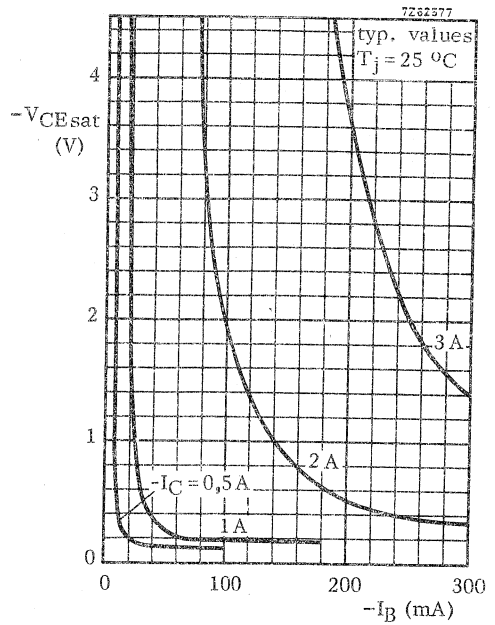
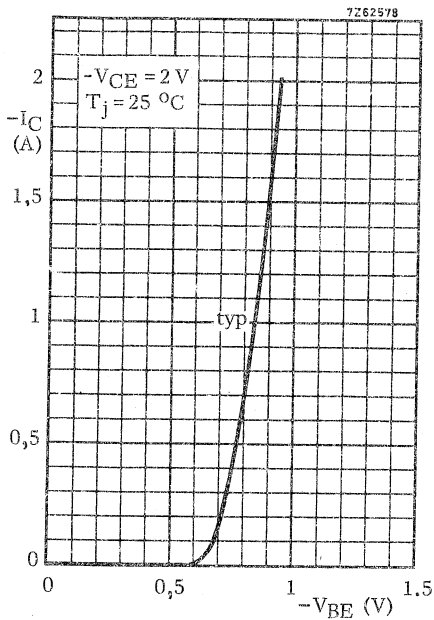
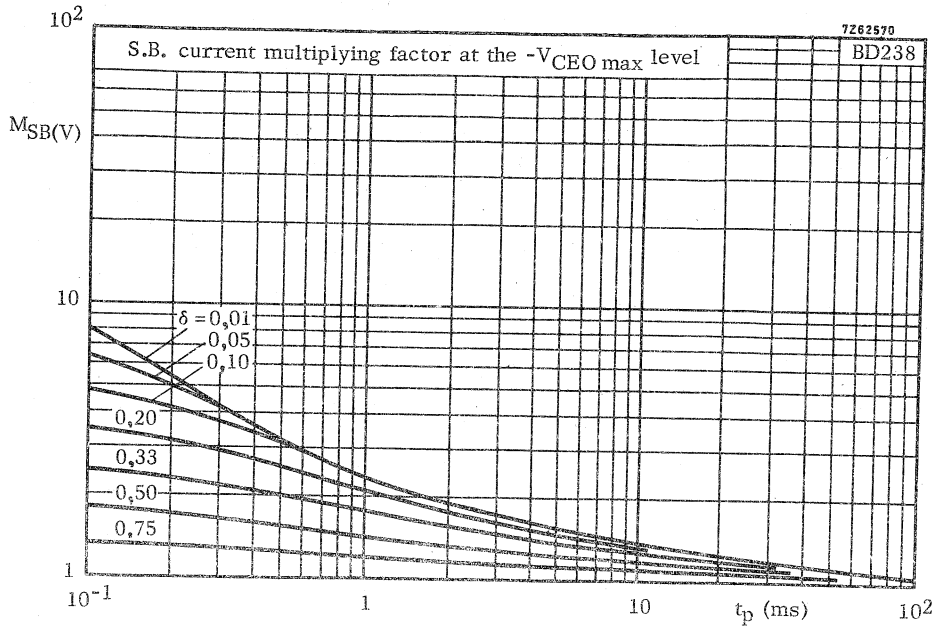
- I Region of permissible d. c. operation
- II Permissible extension for repetitive pulse operation

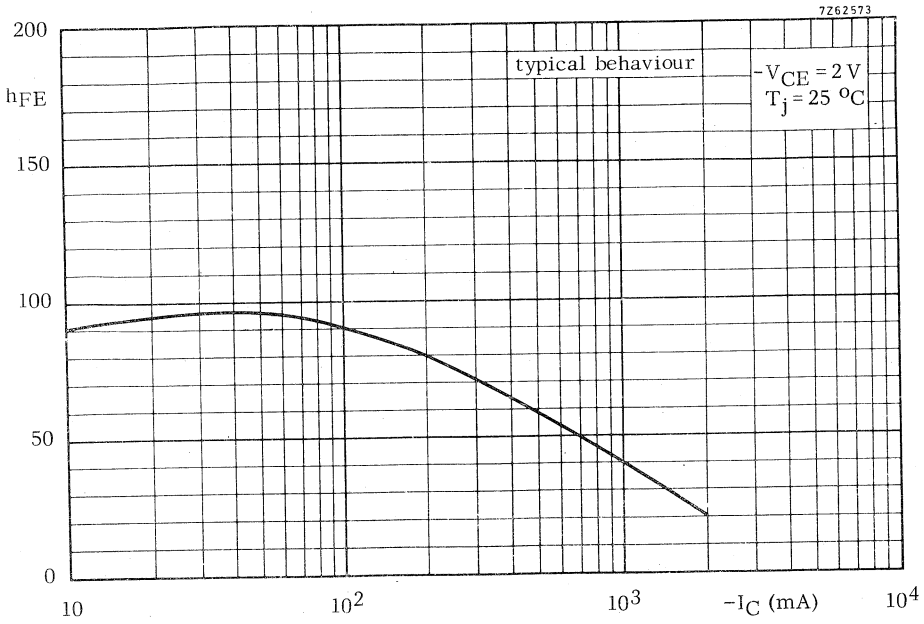
1) Independent of temperature.



BD234; BD236;
BD238







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SILICON EPITAXIAL-BASE POWER TRANSISTORS

General purpose n-p-n transistors in plastic SOT-82 envelopes for clip mounting; can also be soldered or adhesive mounted into a hybrid circuit. Recommended for use with p-n-p complements BD292, 294 and 296 in class-B output stages. In a hi-fi circuit the combinations can deliver 20 W into 4 Ω or 8 Ω load. Matched pairs can be supplied.

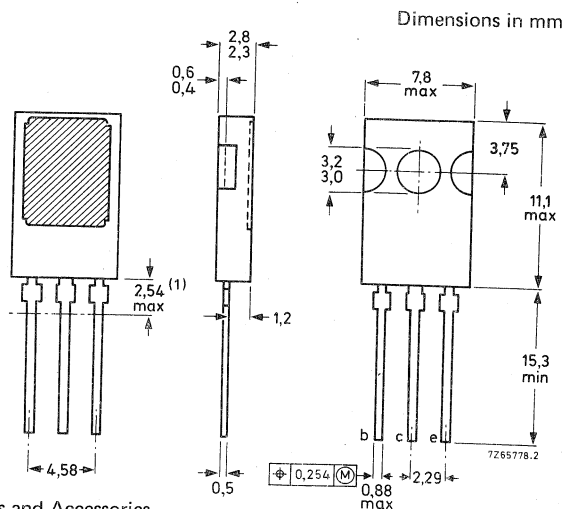
QUICK REFERENCE DATA

		BD291	BD293	BD295	
Collector-base voltage (open emitter)	V_{CBO} max.	45	60	80	V
Collector-emitter voltage (open base)	V_{CEO} max.	45	60	80	V
Collector-current (d.c.)	I_C max.	6		A	
Collector-current (peak) $t_p < 10$ ms; $\delta < 0,1$	I_{CM} max.	10		A	
Base current (d.c.)	I_B max.	2,5		A	
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot} max.	60		W	
D.C. current gain $I_C = 1$ A; $V_{CE} = 2$ V	h_{FE} >	30			
Transition frequency $I_C = 300$ mA; $V_{CE} = 3$ V	f_T >	3		MHz	

MECHANICAL DATA

Fig. 1 SOT-82.

Collector connected to metal part of mounting surface



See also chapters Mounting instructions and Accessories.

(1) Within this region the cross-section of the leads is uncontrolled.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BD291	BD293	BD295	
Collector-base voltage (open emitter)	V _{CBO}	max. 45	60	80	V
Collector-emitter voltage (open base)	V _{CEO}	max. 45	60	80	V
Emitter-base voltage	V _{EBO}	max. 5	5	5	V
Collector current (d.c.)	I _C	max.	6		A
Collector current (peak value) $t_p < 10 \text{ ms}; \delta < 0,1$	I _{CM}	max.	10		A
Base current (d.c.)	I _B	max.	2,5		A
Emitter current (d.c.)	-I _E	max.	6		A
Total power dissipation up to T _{mb} = 25 °C	P _{tot}	max.	60		W
Storage temperature	T _{stg}		-65 to + 150		°C
Junction temperature	T _j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient in free air	R _{th j-a}	=	100	°C/W
From junction to mounting base	R _{th j-mb}	=	2,08	°C/W

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

 $I_E = 0; V_{CB} = 40\text{ V}; T_j = 150\text{ }^\circ\text{C}$ $I_B = 0; V_{CE} = 30\text{ V}$ $I_{CBO} < 1\text{ mA}$
 $I_{CEO} < 1\text{ mA}$

Emitter cut-off current

 $I_C = 0; V_{EB} = 5\text{ V}$ $I_{EBO} < 5\text{ mA}$

Collector-emitter saturation voltage

 $I_C = 3\text{ A}; I_B = 0,3\text{ A}$ $V_{CEsat} < 1\text{ V}$

Base-emitter voltage*

 $I_C = 3\text{ A}; V_{CE} = 3\text{ V}$ $V_{BE} < 1,5\text{ V}$

D.C. current gain**

 $I_C = 1\text{ A}; V_{CE} = 2\text{ V}$ $I_C = 2\text{ A}; V_{CE} = 2\text{ V} : \text{BD293} : \text{BD295}$ $I_C = 3\text{ A}; V_{CE} = 2\text{ V} : \text{BD291}$ $h_{FE} > 30$ Transition frequency at $f = 1\text{ MHz}$ $I_C = 300\text{ mA}; V_{CE} = 3\text{ V}$ $f_T > 3\text{ MHz}$ D.C. current gain ratio of
matched complementary pairs $I_C = 1\text{ A}; V_{CE} = 2\text{ V}$ h_{FE1}/h_{FE2} typ. 1,3
< 2,5* V_{BE} decreases by about $1,8\text{ mV}/^\circ\text{C}$ with increasing temperature.** Measured under pulse conditions ; $t_p < 300\text{ }\mu\text{s}$; $\delta < 2\%$.

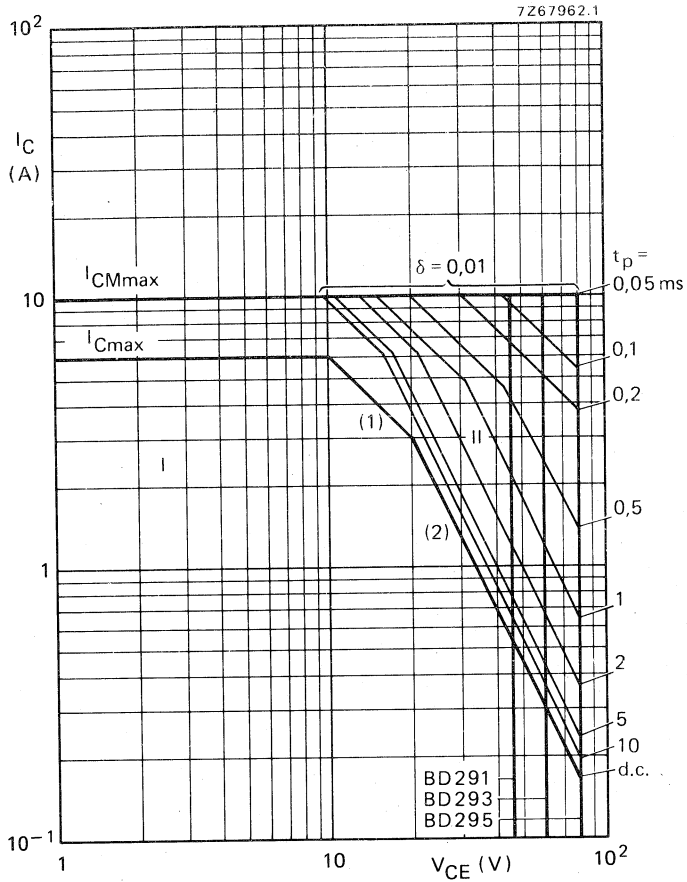


Fig. 2 Safe Operating Area with the transistor forward biased, $T_{mb} \leq 25^\circ C$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot max}$ and $P_{peak max}$ lines.
- (2) Second breakdown limits (independent of temperature).

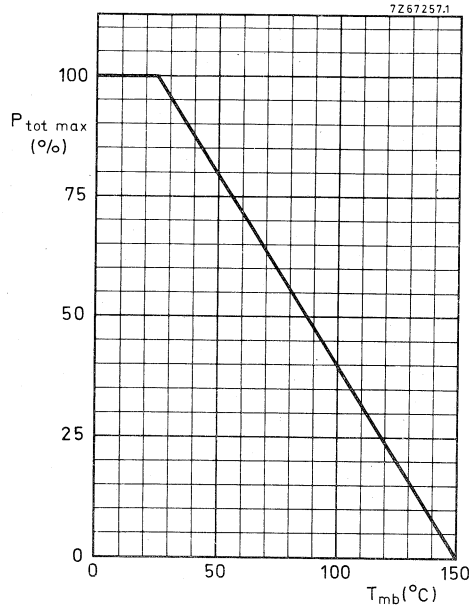


Fig. 3 Power derating curve.

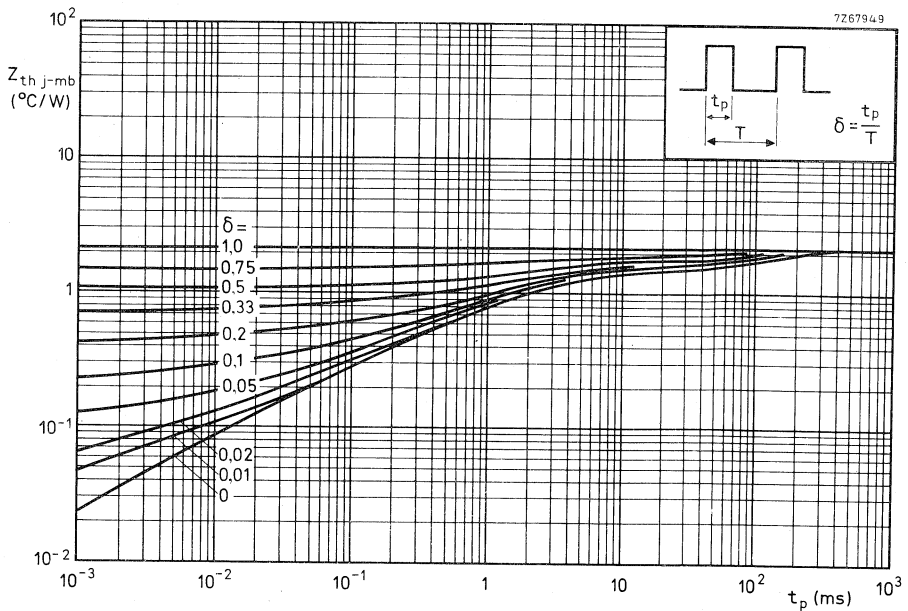


Fig. 4 Pulse power rating chart.

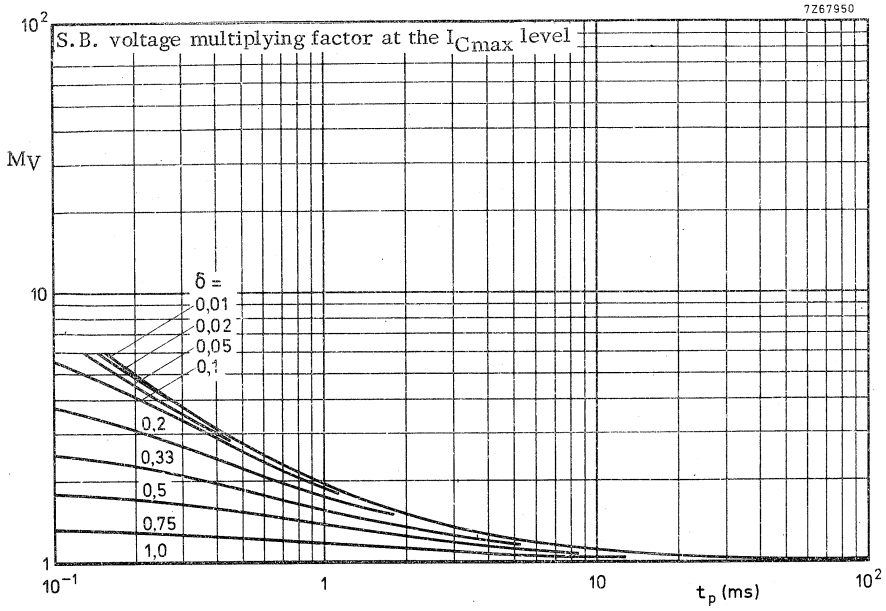


Fig. 5 Second breakdown voltage multiplying factor at the I_{Cmax} level.

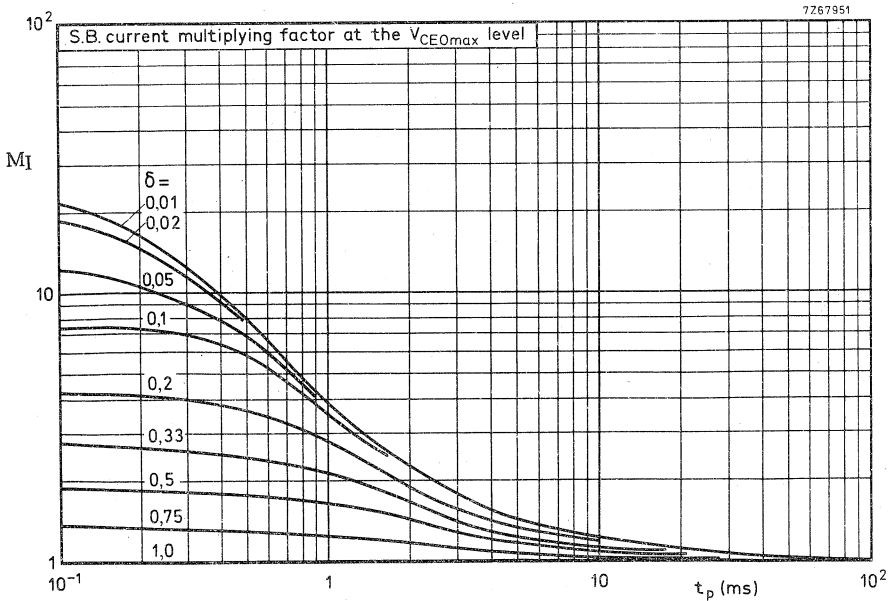


Fig. 6 Second breakdown current multiplying factor at the V_{CE0max} level.

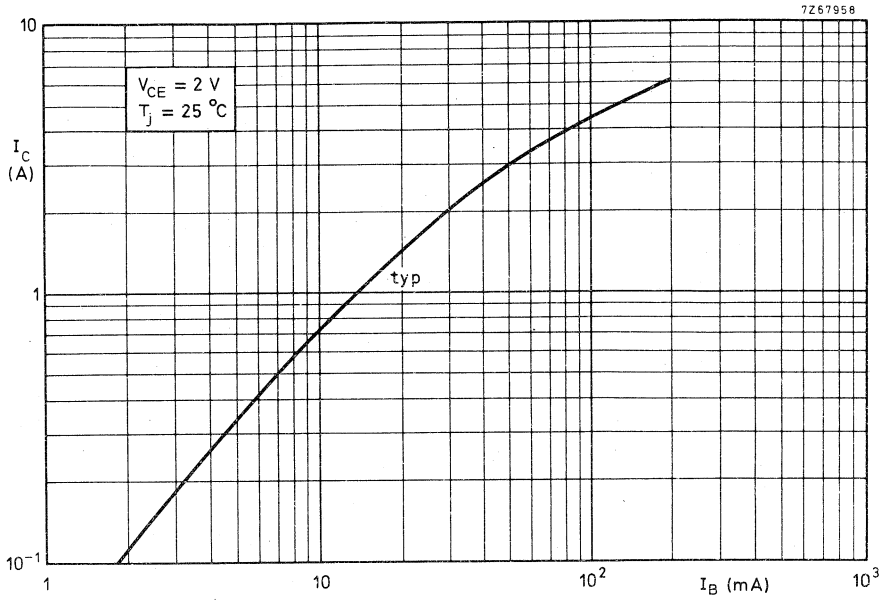


Fig. 7 Typical collector current.

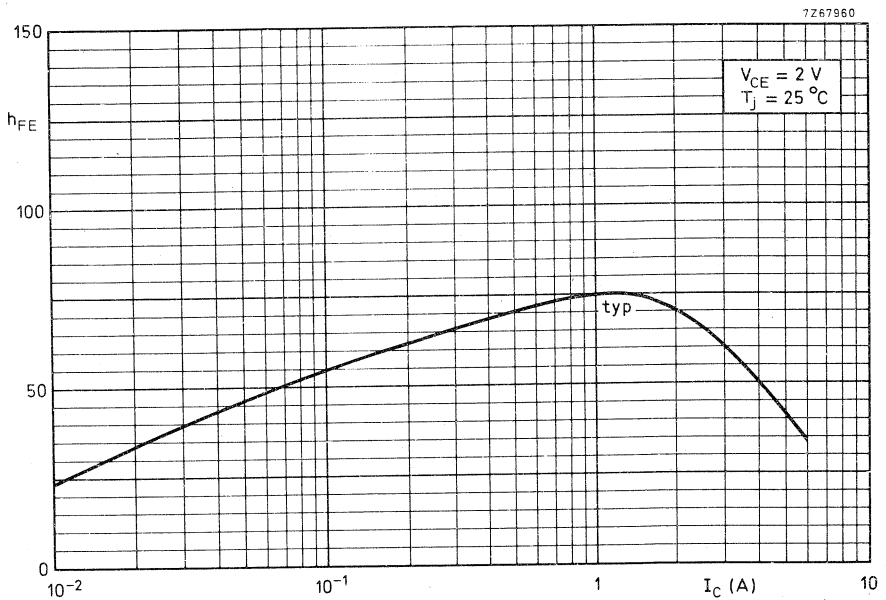


Fig. 8 Typical d.c. current gain.

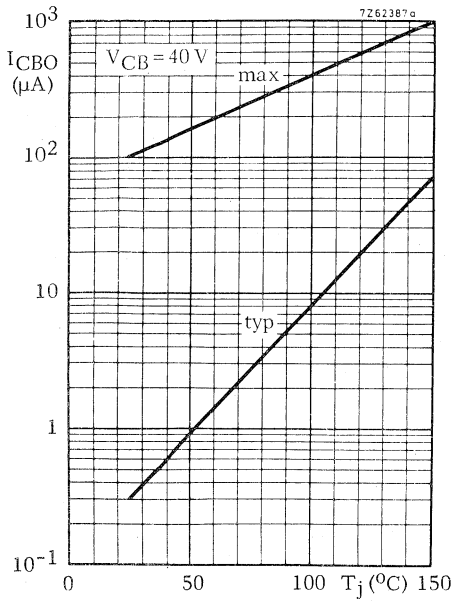


Fig. 9 Collector-base current.

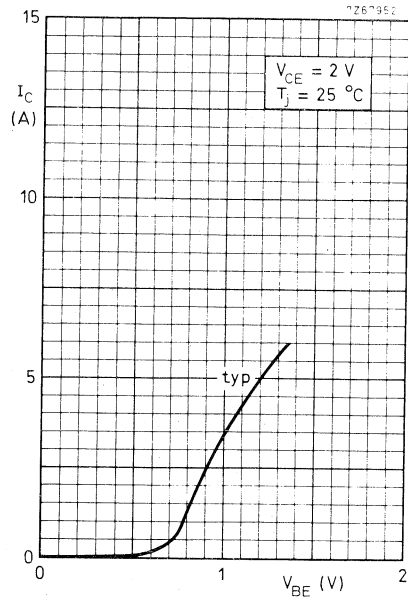


Fig. 10 Collector current.

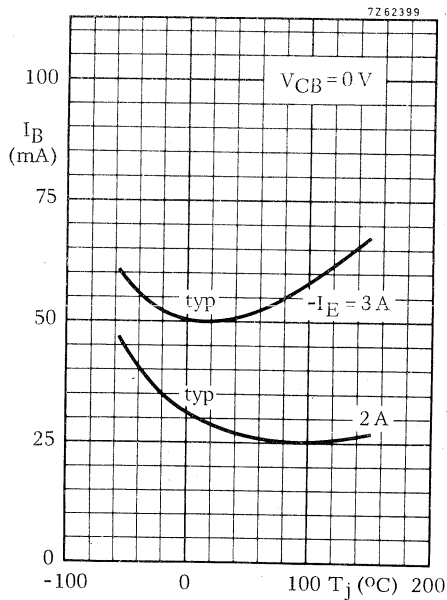


Fig. 11 Base current.

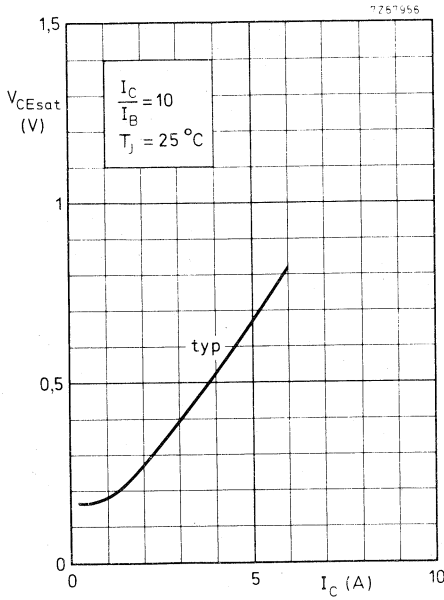


Fig. 12 Collector-emitter saturation voltage.

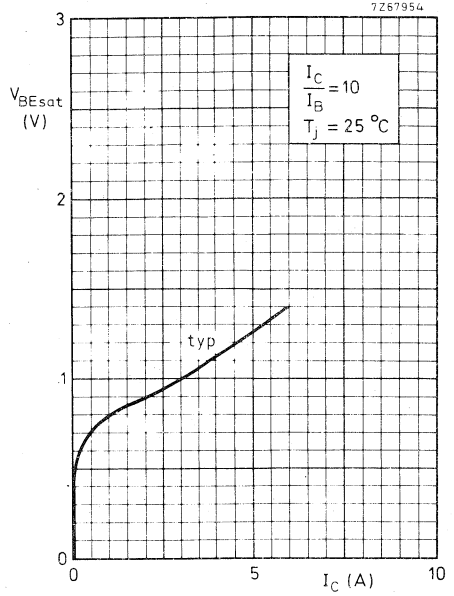


Fig. 13 Base-emitter saturation voltage.

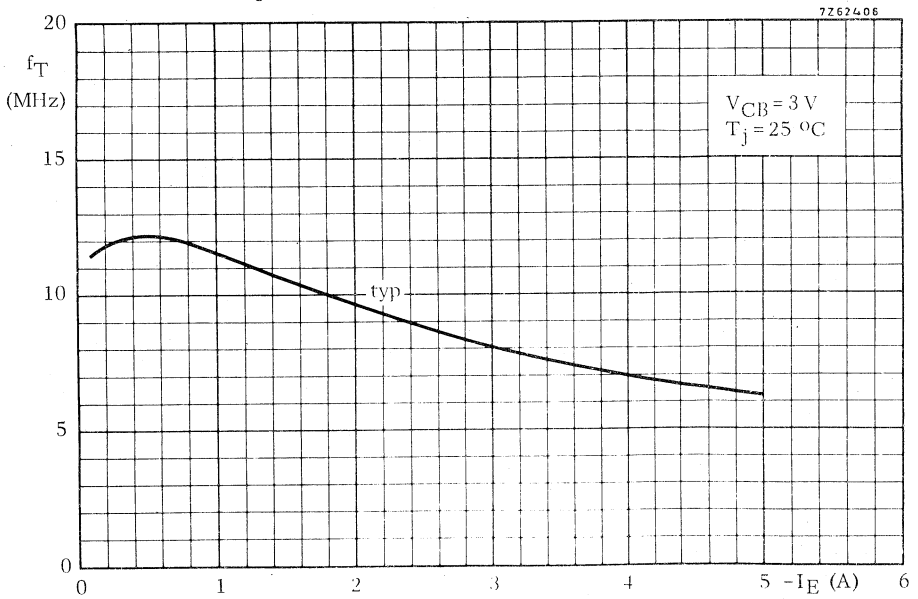


Fig. 14 Transition frequency.

APPLICATION INFORMATION

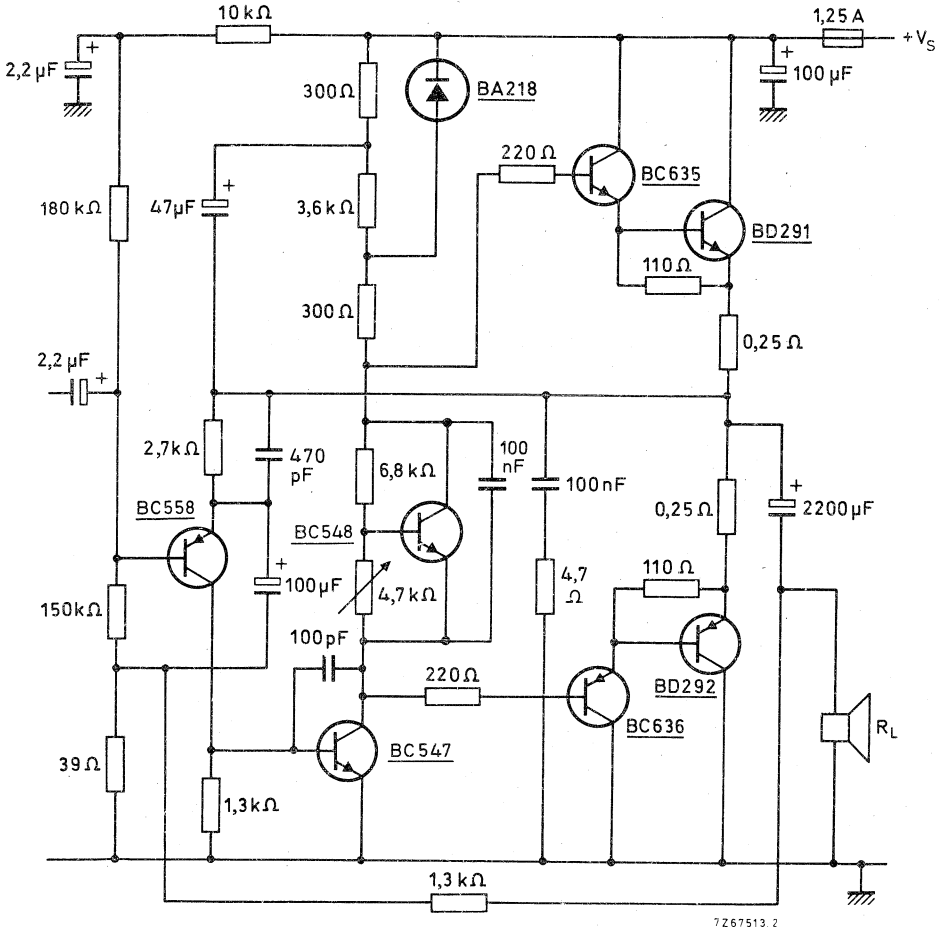


Fig. 15 Basic circuit diagram of a 20 W hi-fi amplifier.

Performance at $V_S = 32,4 \text{ V}$; $R_L = 4 \Omega$ (unloaded supply voltage = 38 V)

Collector quiescent current of BD291 and BD292

$|I_{CQ}|$ typ. 20 mA

Total current drain at $P_O = 20 \text{ W}$; $f = 1 \text{ kHz}$

I_S typ. 1 A

Input impedance

z_i typ. 175 kΩ

Output impedance

z_o typ. 50 mΩ

Output power at $f = 1 \text{ kHz}$; $d_{tot} = 1\%$

P_O typ. 24 W

Input voltage for $P_O = 20 \text{ W}$; $f = 1 \text{ kHz}$

$V_{i(rms)}$ typ. 375 mV

Total harmonic distortion at $P_O = 20\text{ W}$	d_{tot}	typ.	0,06 %
Intermodulation distortion at $P_O = 20\text{ W}$	d_{im}	typ.	0,5 %
Voltage feedback factor		typ.	52 dB
Unweighted signal to noise ratio, (ref. to $P_O = 50\text{ mW}$)		typ.	75 dB
Frequency response (-1 dB)		typ.	20 Hz to 75 kHz
Thermal resistance required per output transistor	$R_{\text{th j-a}}$	\leq	8,65 °C/W

Stable continuous operation is ensured up to an ambient temperature of 50 °C.

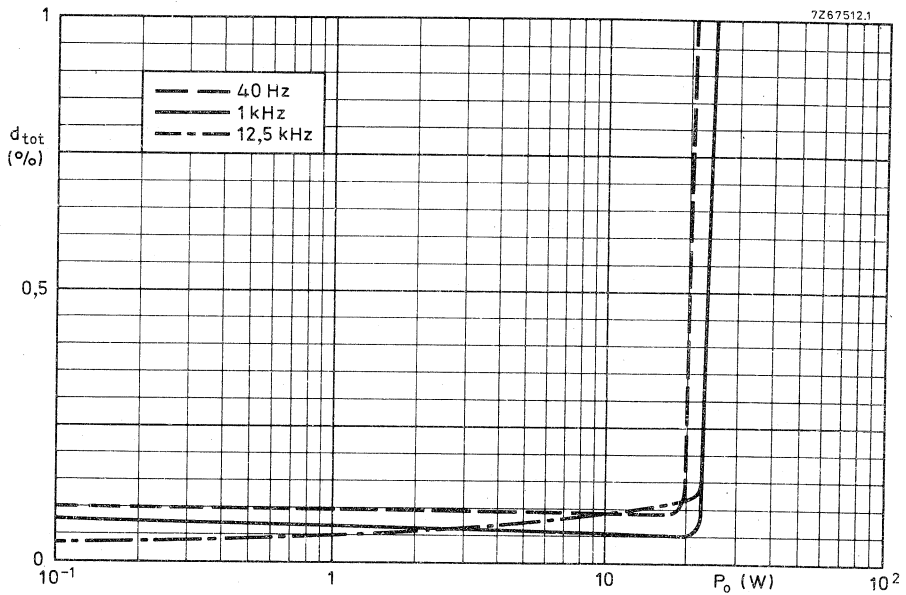


Fig. 16 Total harmonic distortion.

APPLICATION INFORMATION (continued)

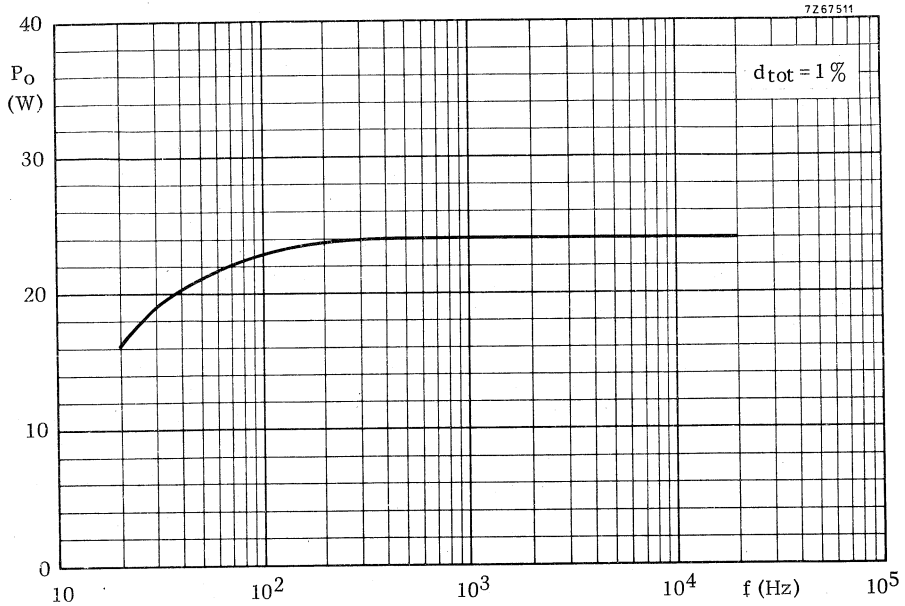


Fig. 17 Typical value of output power as a function of the frequency.

SILICON EPITAXIAL-BASE POWER TRANSISTORS

General purpose p-n-p transistors in plastic SOT-82 envelopes for clip mounting; can also be soldered or adhesive mounted into a hybrid circuit. Recommended for use with n-p-n complements BD291, 293 and 295 in class-B output stages. In a hi-fi circuit the combinations can deliver 20 W into 4 Ω or 8 Ω load. Matched pairs can be supplied.

QUICK REFERENCE DATA

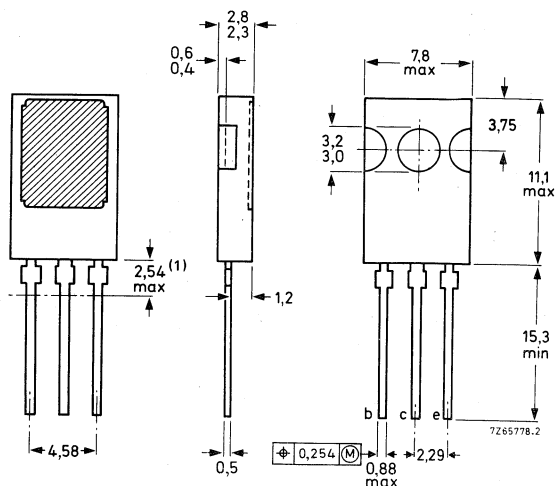
		BD292	BD294	BD296
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	45	60	80 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	45	60	80 V
Collector-current (d.c.)	$-I_C$ max.	6		A
Collector-current (peak) $t_p < 10$ ms; $\delta < 0,1$	$-I_{CM}$ max.	10		A
Base current (d.c.)	$-I_B$ max.	2,5		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot} max.	60		W
D.C. current gain $-I_C = 1$ A; $-V_{CE} = 2$ V	$h_{FE} >$	30		
Transition frequency $-I_C = 300$ mA; $-V_{CE} = 3$ V	$f_T >$	3		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-82.

Collector connected to metal part of mounting surface.



See also chapters Mounting instructions and Accessories.

(1) Within this region the cross-section of the leads is uncontrolled.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BD292	BD294	BD296
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	45	60	80 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	45	60	80 V
Emitter-base voltage	$-V_{EBO}$ max.	5	5	5 V
Collector current (d.c.)	$-I_C$ max.		6	A
Collector current (peak value) $t_p < 10$ ms; $\delta < 0,1$	$-I_{CM}$ max.		10	A
Base current (d.c.)	$-I_B$ max.		2,5	A
Emitter current (d.c.)	I_E max.		6	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot} max.		60	W
Storage temperature	T_{stg}		-65 to + 150	°C
Junction temperature	T_j max.		150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$ =	100	°C/W
From junction to mounting base	$R_{th\ j-mb}$ =	2,08	°C/W

0180000001
0180000002
0180000003
0180000004
0180000005
0180000006
0180000007
0180000008
0180000009
0180000010

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

 $I_E = 0; -V_{CB} = 40\text{ V}; T_j = 150\text{ }^\circ\text{C}$ $-I_{CBO} < 1\text{ mA}$ $I_B = 0; -V_{CE} = 30\text{ V}$ $-I_{CEO} < 1\text{ mA}$

Emitter cut-off current

 $I_C = 0; -V_{EB} = 5\text{ V}$ $-I_{EBO} < 5\text{ mA}$

Collector-emitter saturation voltage

 $-I_C = 3\text{ A}; -I_B = 0,3\text{ A}$ $-V_{CEsat} < 1\text{ V}$

Base-emitter voltage *

 $-I_C = 3\text{ A}; -V_{CE} = 2\text{ V}$ $-V_{BE} < 1,5\text{ V}$

D.C. current gain **

 $-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$ $h_{FE} > 30$ $-I_C = 2\text{ A}; -V_{CE} = 2\text{ V}; \text{BD294}; \text{BD296}$ $h_{FE} > 30$ $-I_C = 3\text{ A}; -V_{CE} = 2\text{ V}; \text{BD292}$ $h_{FE} > 30$ Transition frequency at $f = 1\text{ MHz}$ $-I_C = 300\text{ mA}; -V_{CE} = 3\text{ V}$ $f_T > 3\text{ MHz}$ D.C. current gain ratio of
matched complementary pairs $-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$ $h_{FE1}/h_{FE2} \text{ typ. } 1,3$
 $< 2,5$ * V_{BE} decreases by about $1,8\text{ mV}/^\circ\text{C}$ with increasing temperature.** Measured under pulse conditions; $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.

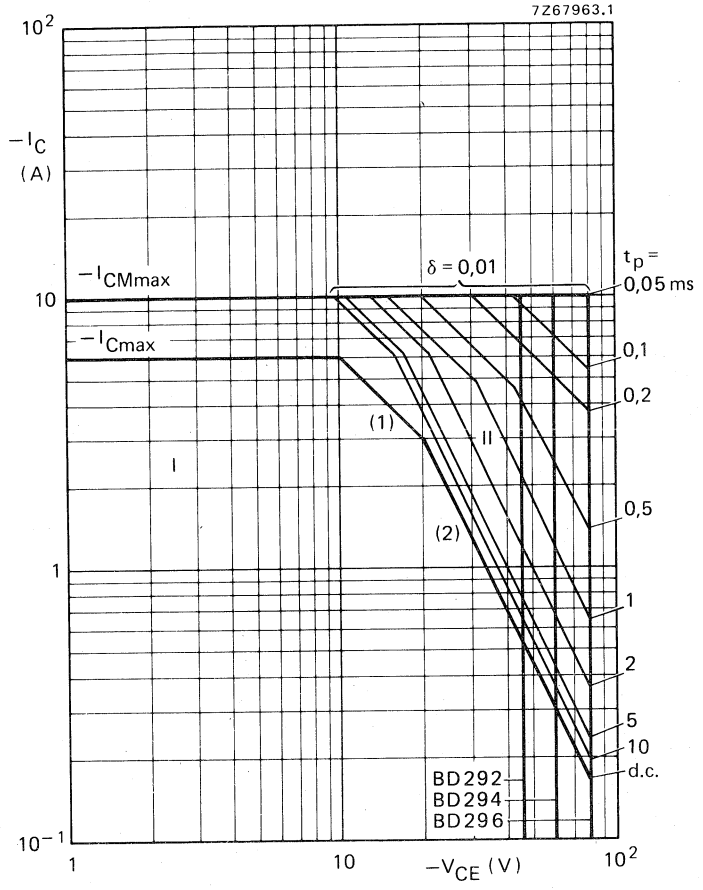


Fig. 2 Safe Operating Area with the transistor forward biased; $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
- (2) Second breakdown limits (independent of temperature).

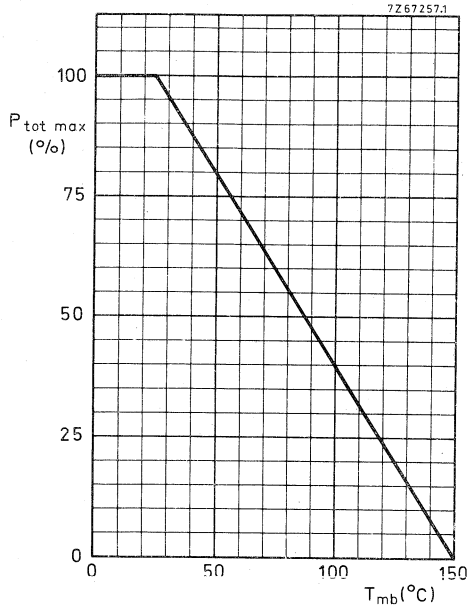


Fig. 3 Power derating curve.

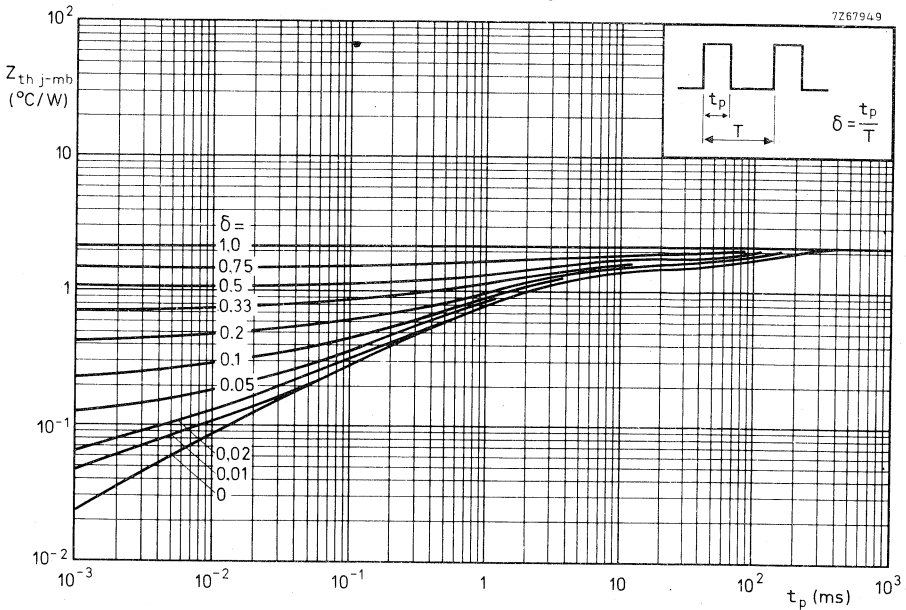


Fig. 4 Pulse power rating chart.

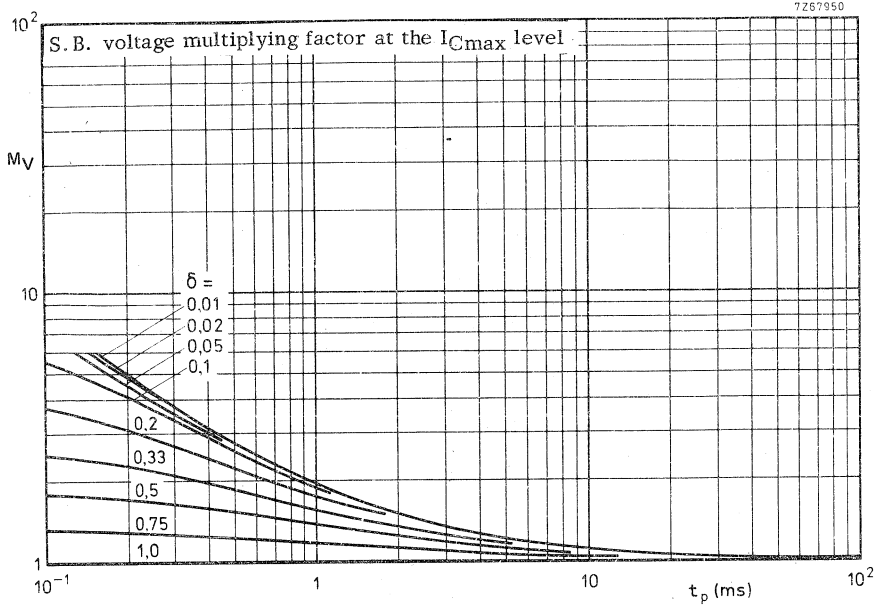


Fig. 5 Second breakdown voltage multiplying factor at the I_{Cmax} level.

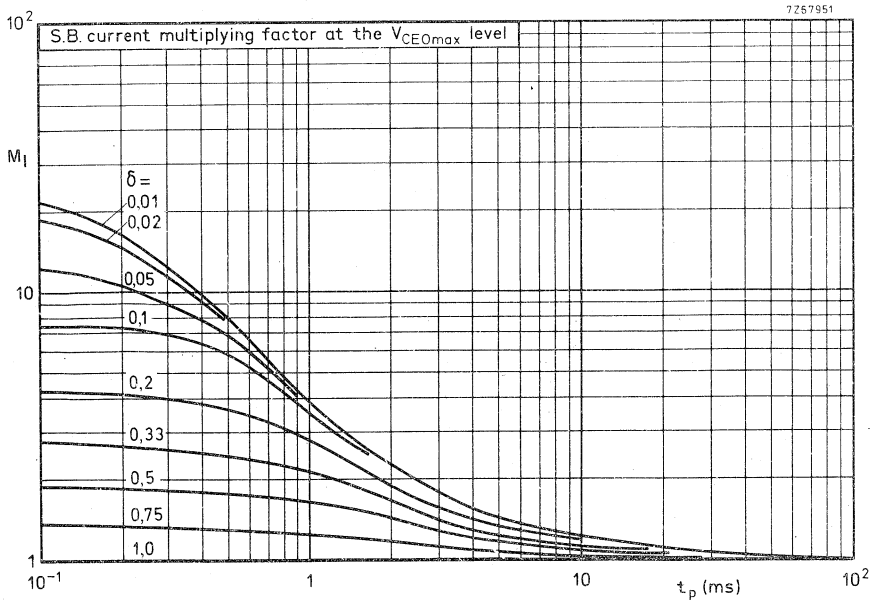


Fig. 6 Second breakdown current multiplying factor at the V_{CE0max} level.

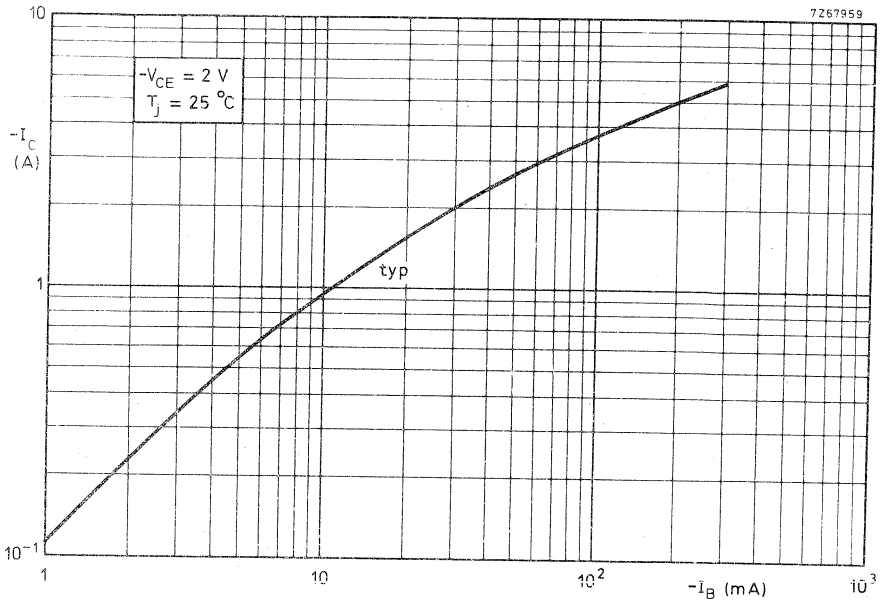


Fig. 7 Typical collector current.

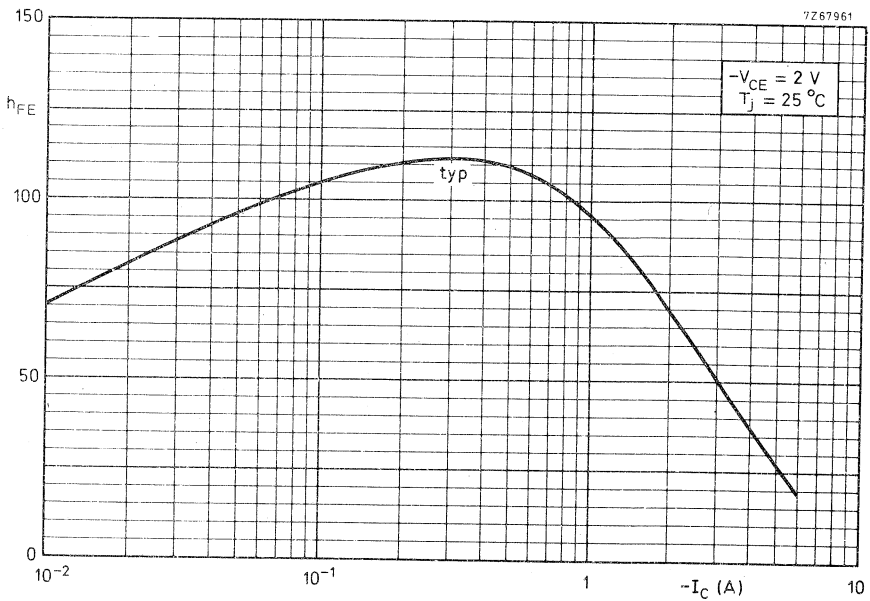


Fig. 8 Typical d.c. current gain.

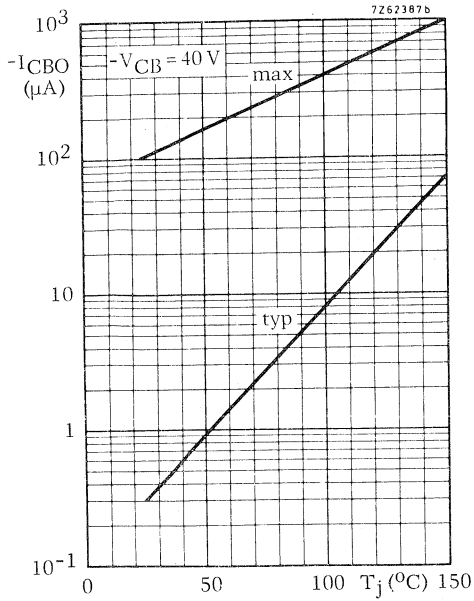


Fig. 9 Collector-base current.

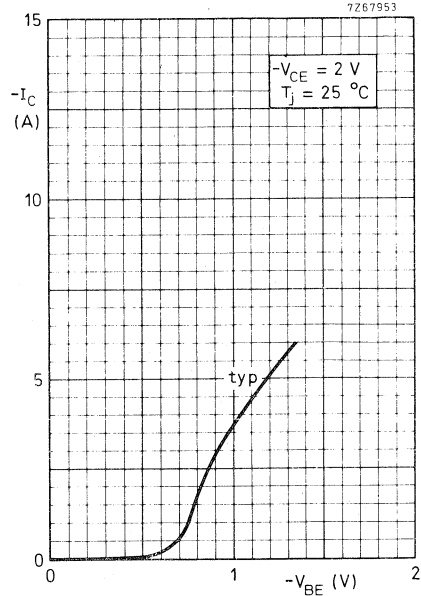


Fig. 10 Collector current.

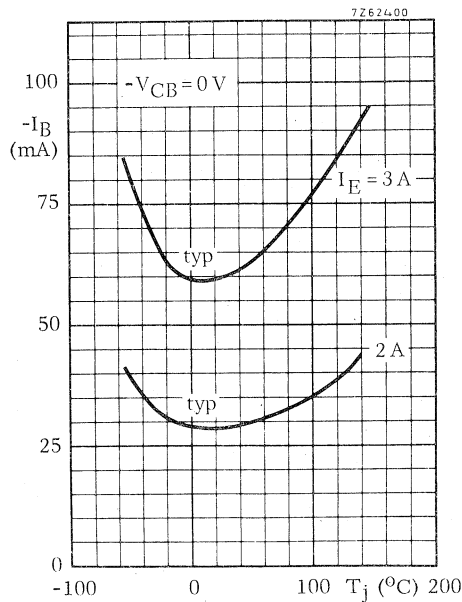


Fig. 11 Base current.

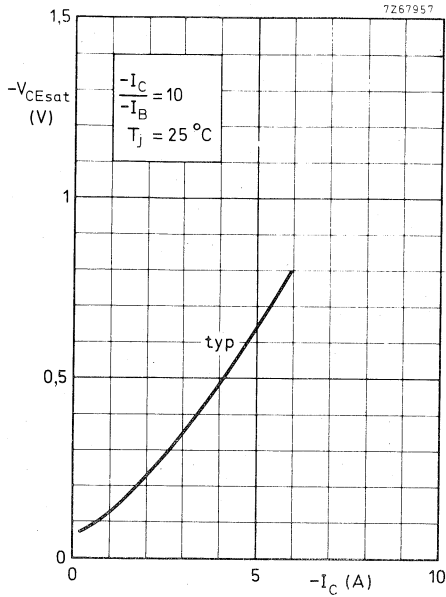


Fig. 12 Collector-emitter saturation voltage.

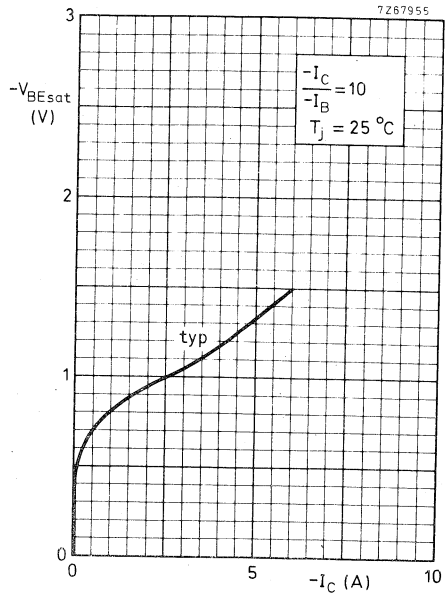


Fig. 13 Base-emitter saturation voltage.

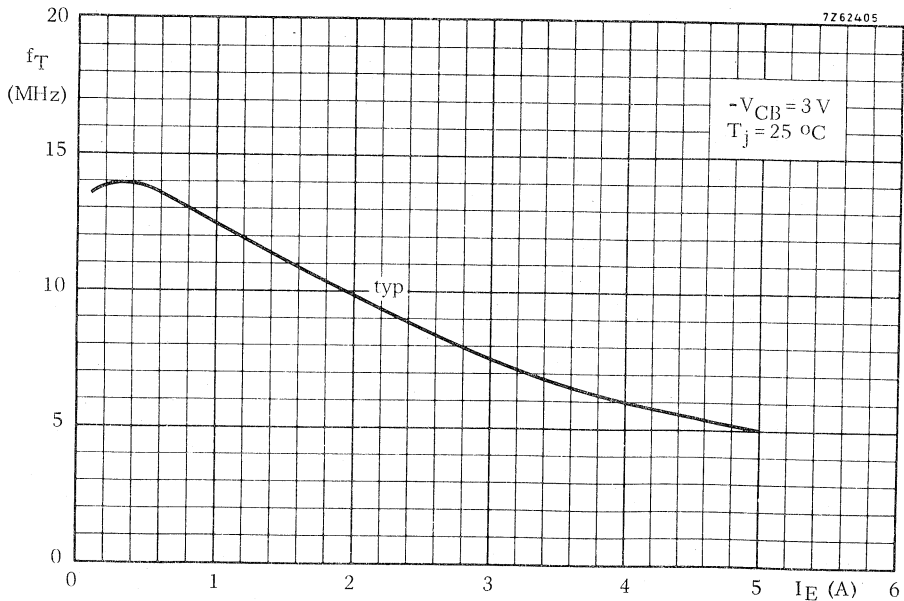


Fig. 14 Transition frequency as a function of emitter current.

FOR APPLICATION INFORMATION SEE BD291, BD293 AND BD295.

SILICON PLANAR EPITAXIAL POWER TRANSISTOR

N-P-N transistor in a SOT-32 plastic envelope intended for car-radio output stages.
 P-N-P complement is BD330. Matched pairs can be supplied.

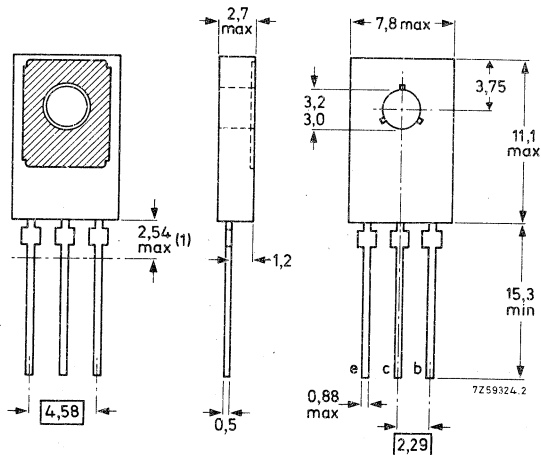
QUICK REFERENCE DATA			
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	32 V
Collector-emitter voltage (open base)	V_{CEO}	max.	20 V
Collector current (peak value)	I_{CM}	max.	3 A
Total power dissipation up to $T_{mb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	15 W
Junction temperature	T_j	max.	150 $^{\circ}\text{C}$
D.C. current gain $I_C = 0,5\text{ A}; V_{CE} = 1\text{ V}$	h_{FE}		85 to 375
Transition frequency $I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$	f_T	typ.	130 MHz

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected
to metal part of
mounting surface



For mounting instructions see section Accessories, type 56326 for non-insulated mounting and set 56333 for insulated mounting.

¹⁾ Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	32 V
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	32 V
Collector-emitter voltage (open base)	V_{CEO}	max.	20 V
Emitter-base voltage (open collector)	V_{EBO}	max.	5 V

Currents

Collector current (d. c.)	I_C	max.	3 A
Collector current (peak value)	I_{CM}	max.	3 A
Base current (d. c.)	I_B	max.	1 A
Emitter current (d. c.)	$-I_E$	max.	3 A

Power dissipation

Total power dissipation up to $T_{mb} = 45\text{ }^\circ\text{C}$	P_{tot}	max.	15 W
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Temperatures

Storage temperature	T_{stg}	- 65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	7 $^\circ\text{C}/\text{W}$
From junction to ambient in free air	$R_{th\ j-a}$	=	100 $^\circ\text{C}/\text{W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = 32\text{ V}$

$I_{CBO} < 10\text{ }\mu\text{A}$

$I_E = 0; V_{CB} = 32\text{ V}; T_j = 150\text{ }^\circ\text{C}$

$I_{CBO} < 1\text{ mA}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 10\text{ }\mu\text{A}$

Base-emitter voltage

$I_C = 5\text{ mA}; V_{CE} = 10\text{ V}$

$V_{BE} \text{ typ. } 0,6\text{ V}$

$I_C = 2\text{ A}; V_{CE} = 1\text{ V}$

$V_{BE} < 1,2\text{ V}$

Collector-emitter saturation voltage

$I_C = 2\text{ A}; I_B = 0,2\text{ A}$

$V_{CEsat} < 0,5\text{ V}$

D. C. current gain

$I_C = 5\text{ mA}; V_{CE} = 10\text{ V}$

$h_{FE} > 50$

$I_C = 0,5\text{ A}; V_{CE} = 1\text{ V}$

$h_{FE} \text{ 85 to 375}$

$I_C = 2\text{ A}; V_{CE} = 1\text{ V}$

$h_{FE} > 40$

Transition frequency at $f = 35\text{ MHz}$

$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$

$f_T \text{ typ. } 130\text{ MHz}$

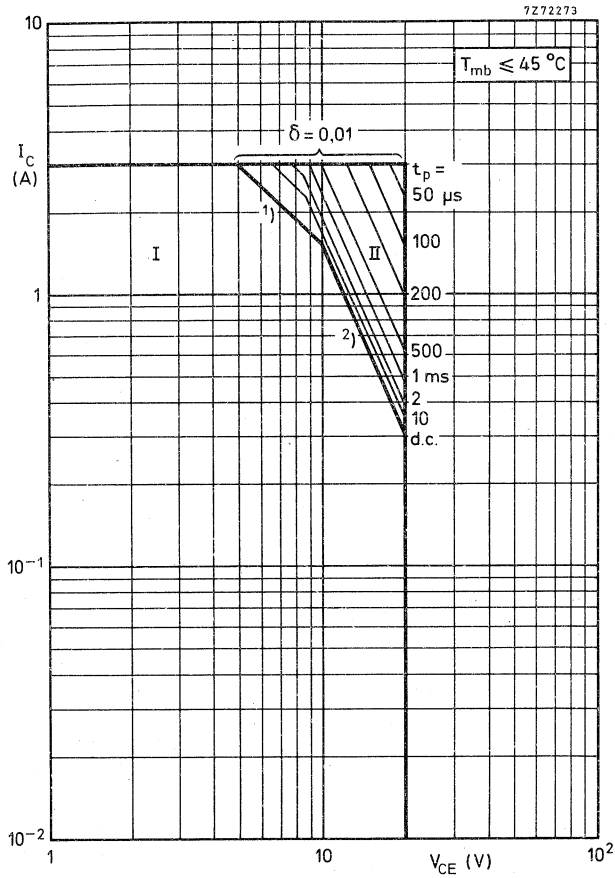
D. C. current gain ratio of
matched pairs

BD329/BD330

$|I_{C1}| = 0,5\text{ A}; |V_{CE1}| = 1\text{ V}$

$h_{FE1}/h_{FE2} < 1,6$





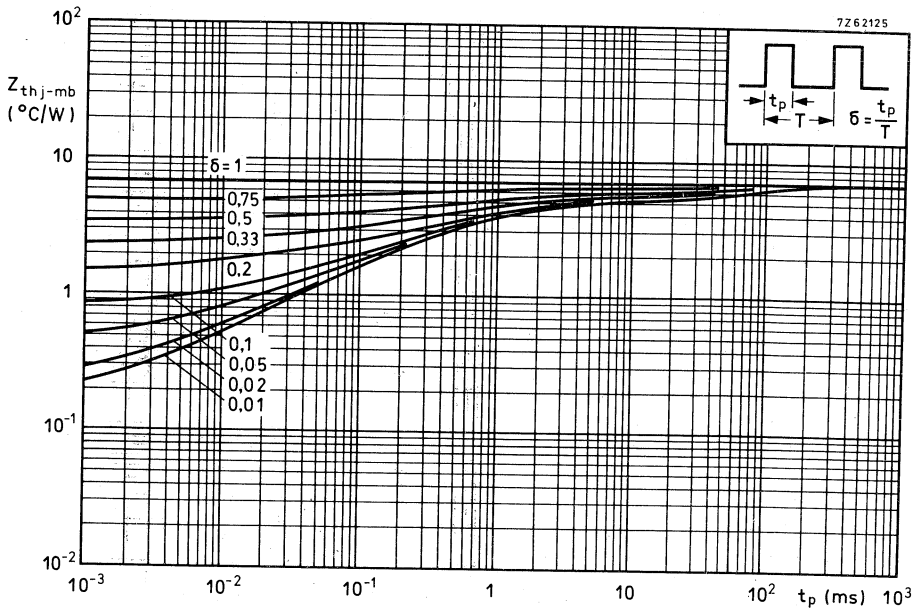
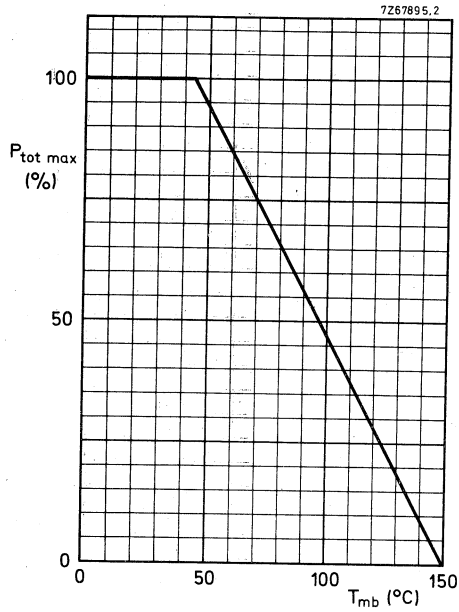
Safe Operating Area with the transistor forward biased

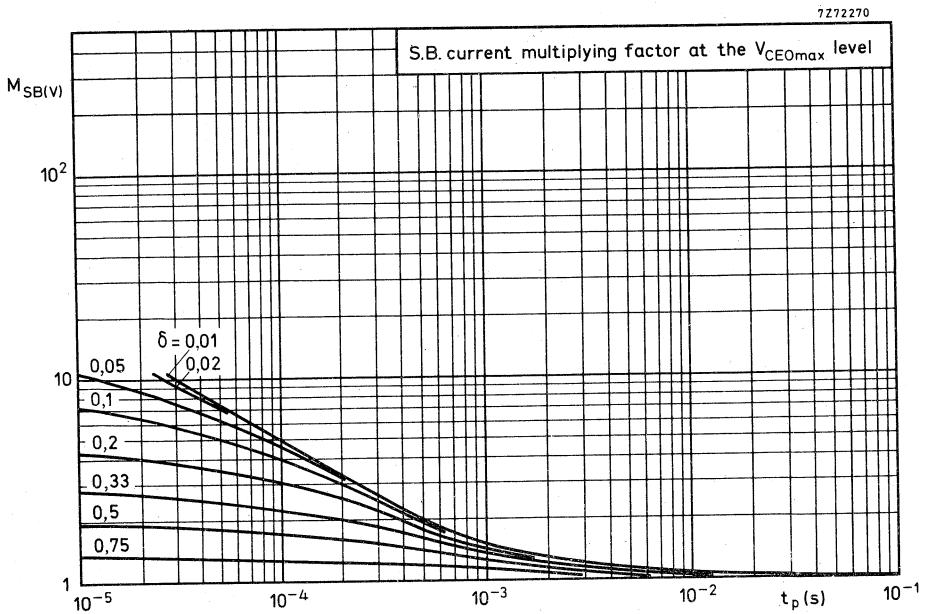
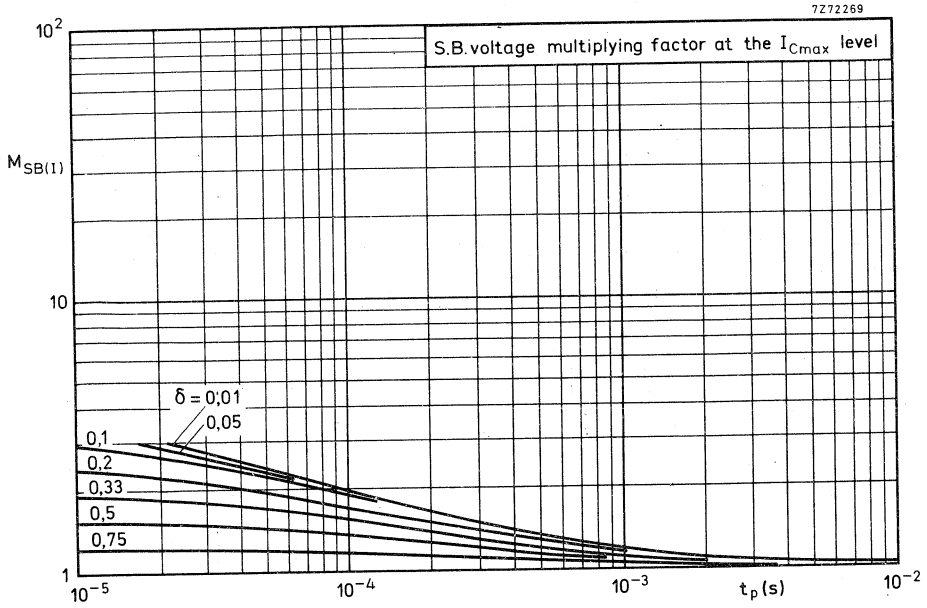
I Region of permissible d.c. operation

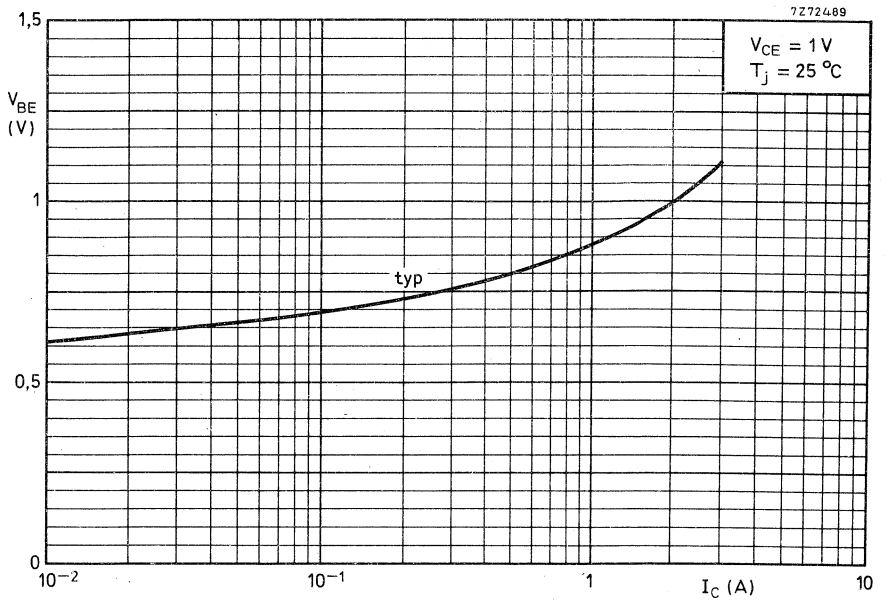
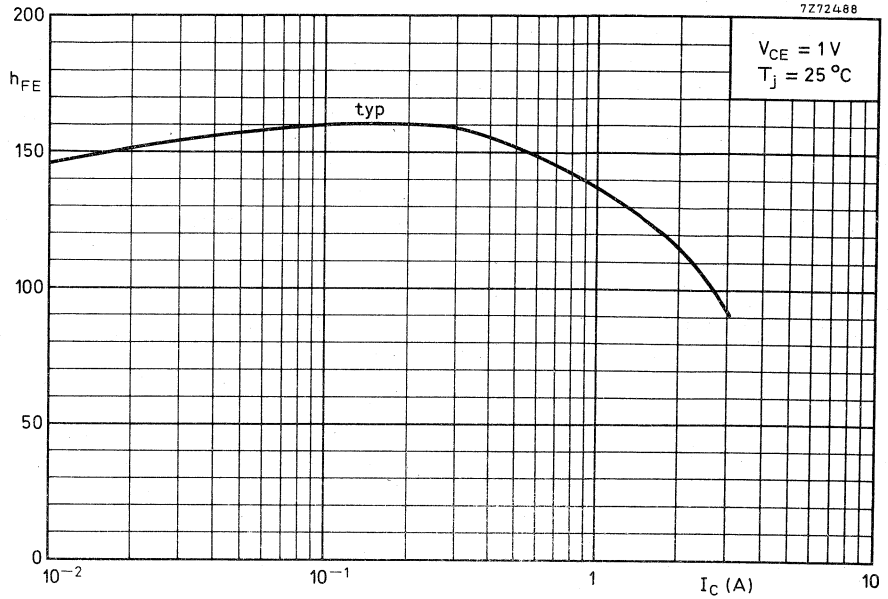
II Permissible extension for repetitive pulse operation

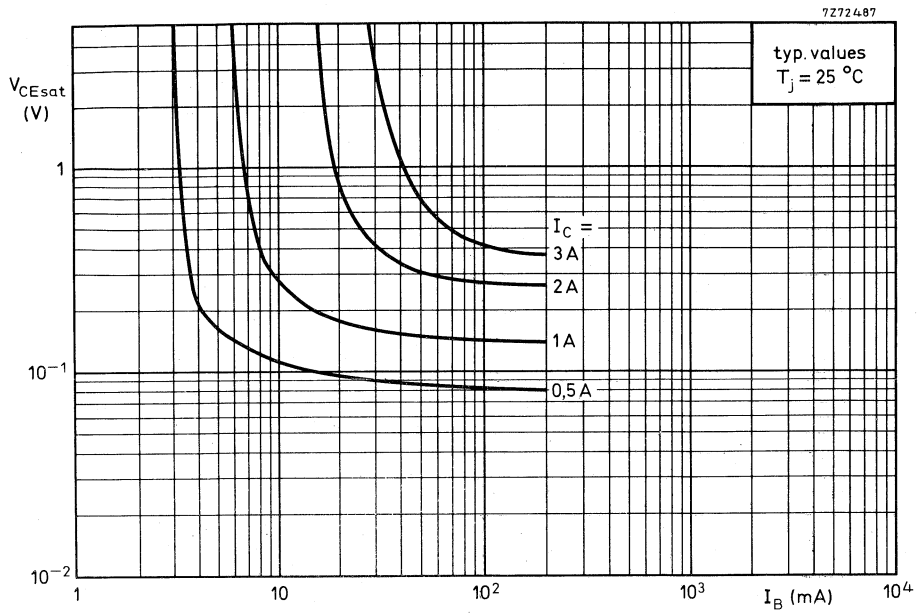
1) $P_{tot \max}$ and $P_{peak \max}$ lines.

2) Second-breakdown limits (independent of temperature).





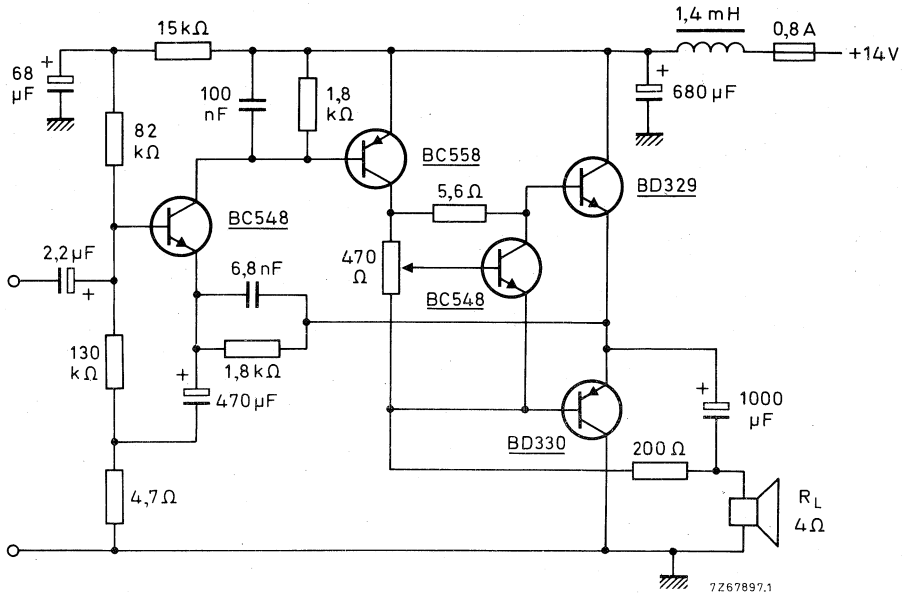




APPLICATION INFORMATION See next page.

APPLICATION INFORMATION

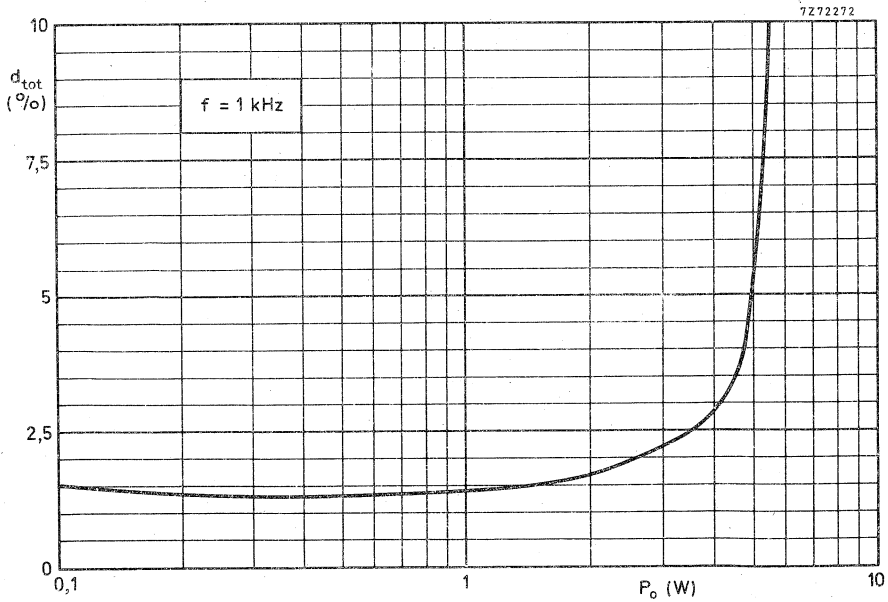
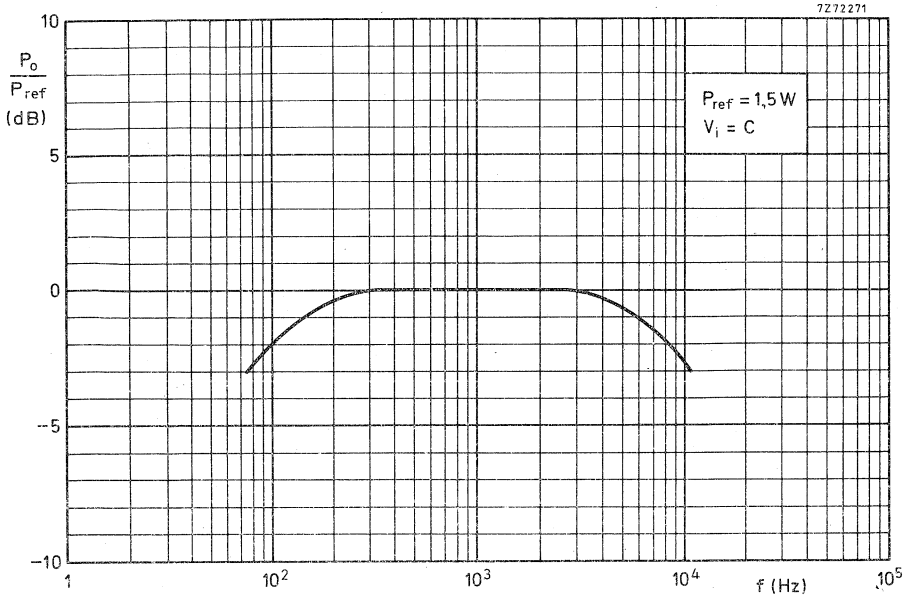
Basic circuit diagram of a 5,5 W car-radio audio amplifier.



Performance at $f = 1$ kHz unless otherwise specified

Output power at $d_{tot} = 10\%$	P_o	typ.	5,5 W
Input voltage for $P_o = 5,5$ W	$V_{i(rms)}$	typ.	20 mV
Input impedance	z_i	typ.	20 kΩ
Collector quiescent current of output transistors	$ I_{CQ} $	typ.	10 mA
Collector current of BC558	$-I_C$	typ.	28 mA
Collector current of BC548 (pre-amplifier)	I_C	typ.	0,5 mA
Total current drain at $P_o = 5,5$ W	I_B	typ.	540 mA
Frequency range (-3 dB)	f		75 Hz to 11 kHz

With a heatsink thermal resistance for each output transistor of $40^\circ\text{C}/\text{W}$ the maximum permissible ambient temperature is 60°C .



SILICON PLANAR EPITAXIAL POWER TRANSISTOR

P-N-P transistor in a SOT-32 plastic envelope intended for car-radio output stages. N-P-N complement is BD329. Matched pairs can be supplied.

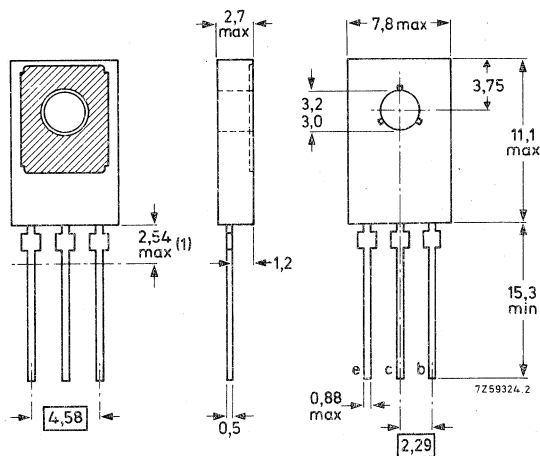
QUICK REFERENCE DATA			
Collector-emitter voltage ($V_{BE} = 0$)	$-V_{CES}$	max.	32 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20 V
Collector current (peak value)	$-I_{CM}$	max.	3 A
Total power dissipation up to $T_{mb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	15 W
Junction temperature	T_j	max.	150 $^{\circ}\text{C}$
D. C. current gain $-I_C = 0,5\text{ A}; -V_{CE} = 1\text{ V}$	h_{FE}		85 to 375
Transition frequency $-I_C = 50\text{ mA}; -V_{CE} = 5\text{ V}$	f_T	typ.	100 MHz

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected to metal part of mounting surface



For mounting instructions see section Accessories, type 56326 for non-insulated mounting and set 56333 for insulated mounting.

¹⁾ Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32 V
Collector-emitter voltage ($V_{BE} = 0$)	$-V_{CES}$	max.	32 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V

Currents

Collector current (d.c.)	$-I_C$	max.	3 A
Collector current (peak value)	$-I_{CM}$	max.	3 A
Base current (d.c.)	$-I_B$	max.	1 A
Emitter current (d.c.)	I_E	max.	3 A

Power dissipation

Total power dissipation up to $T_{mb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	15 W
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Temperatures

Storage temperature	T_{stg}	- 65 to +150	$^{\circ}\text{C}$
Junction temperature	T_j	max.	150 $^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	7 $^{\circ}\text{C}/\text{W}$
From junction to ambient in free air	$R_{th\ j-a}$	=	100 $^{\circ}\text{C}/\text{W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 32\text{ V}$	$-I_{CBO}$	<	10	μA
$I_E = 0; -V_{CB} = 32\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$	<	1	mA

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO}$	<	10	μA
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Base-emitter voltage

$-I_C = 5\text{ mA}; -V_{CE} = 10\text{ V}$	$-V_{BE}$	typ.	0,6	V
$-I_C = 2\text{ A}; -V_{CE} = 1\text{ V}$	$-V_{BE}$	<	1,2	V

Collector-emitter saturation voltage

$-I_C = 2\text{ A}; -I_B = 0,2\text{ A}$	$-V_{CEsat}$	<	0,5	V
--	--------------	---	-----	------------

D. C. current gain

$-I_C = 5\text{ mA}; -V_{CE} = 10\text{ V}$	h_{FE}	>	50
$-I_C = 0,5\text{ A}; -V_{CE} = 1\text{ V}$	h_{FE}		85 to 375
$-I_C = 2\text{ A}; -V_{CE} = 1\text{ V}$	h_{FE}	>	40

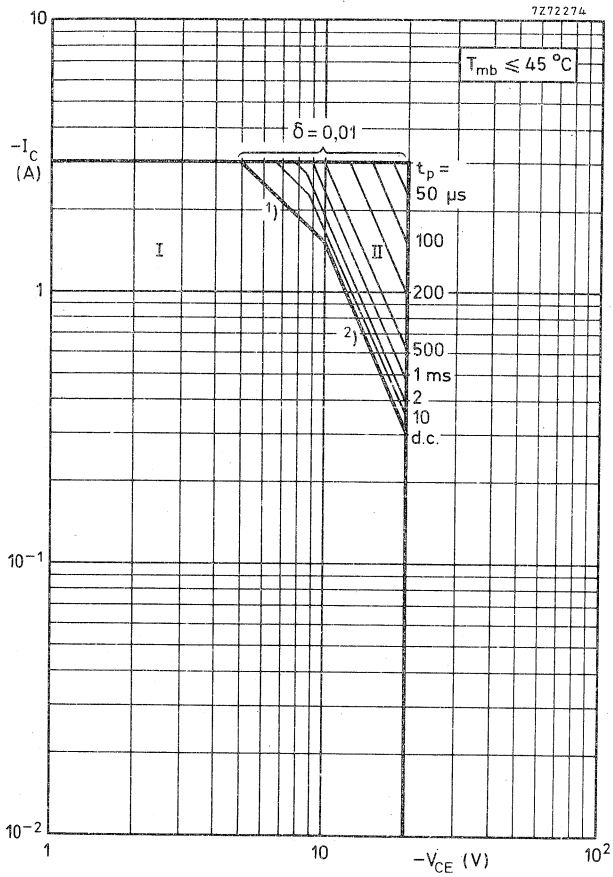
Transition frequency at $f = 35\text{ MHz}$

$-I_C = 50\text{ mA}; -V_{CE} = 5\text{ V}$	f_T	typ.	100	MHz
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D. C. current gain ratio of matched pairs

BD329/BD330

$ I_C = 0,5\text{ A}; V_{CE} = 1\text{ V}$	h_{FE1}/h_{FE2}	<	1,6
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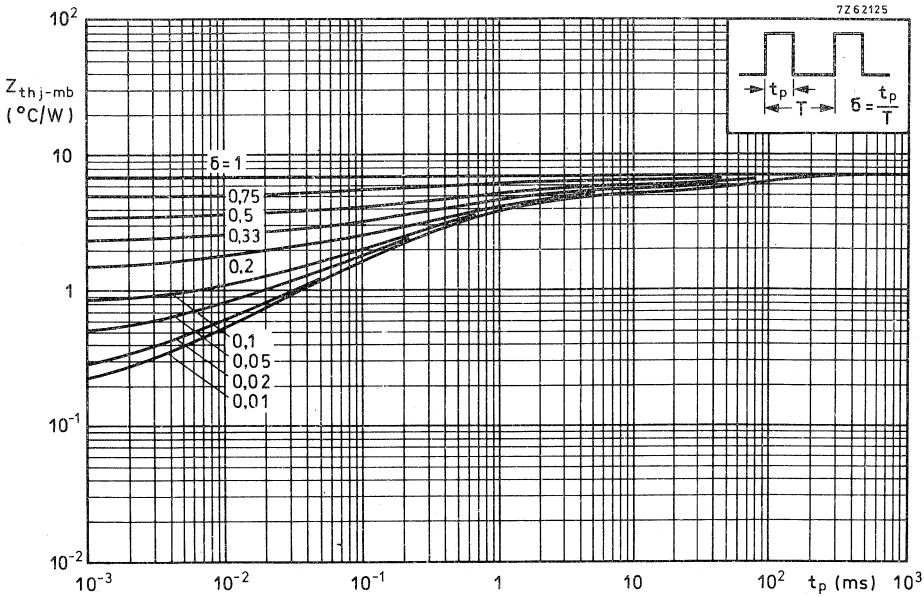
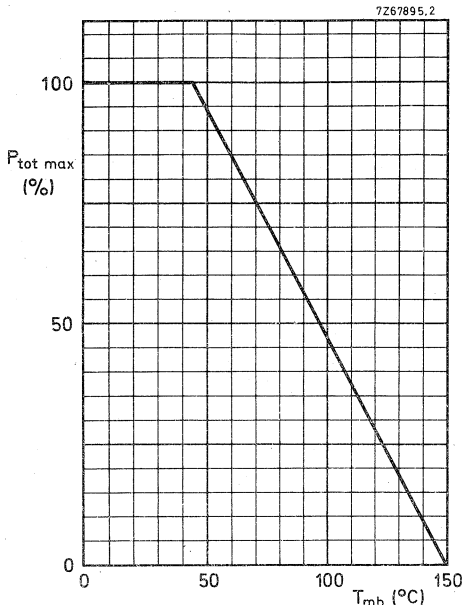


Safe Operating Area with the transistor forward biased

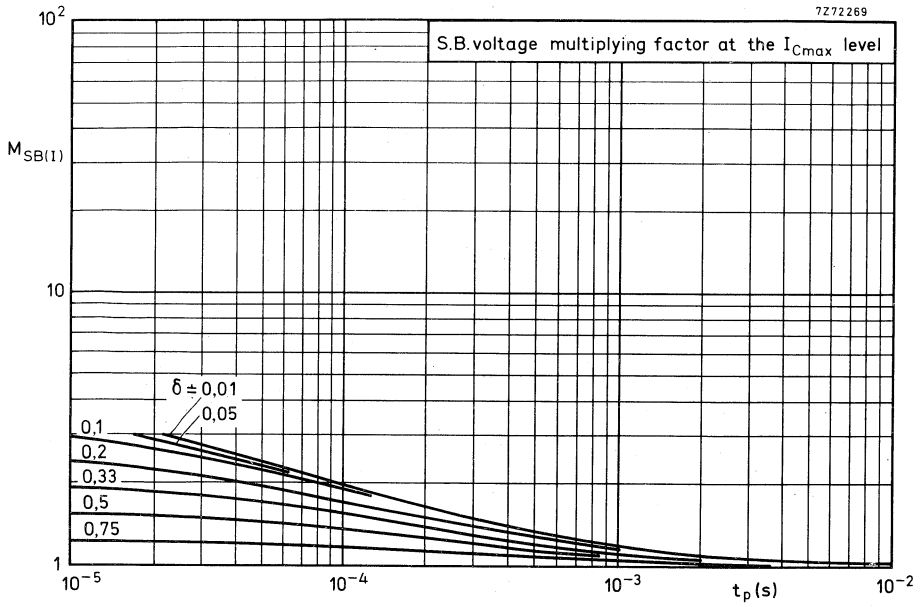
- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation

1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

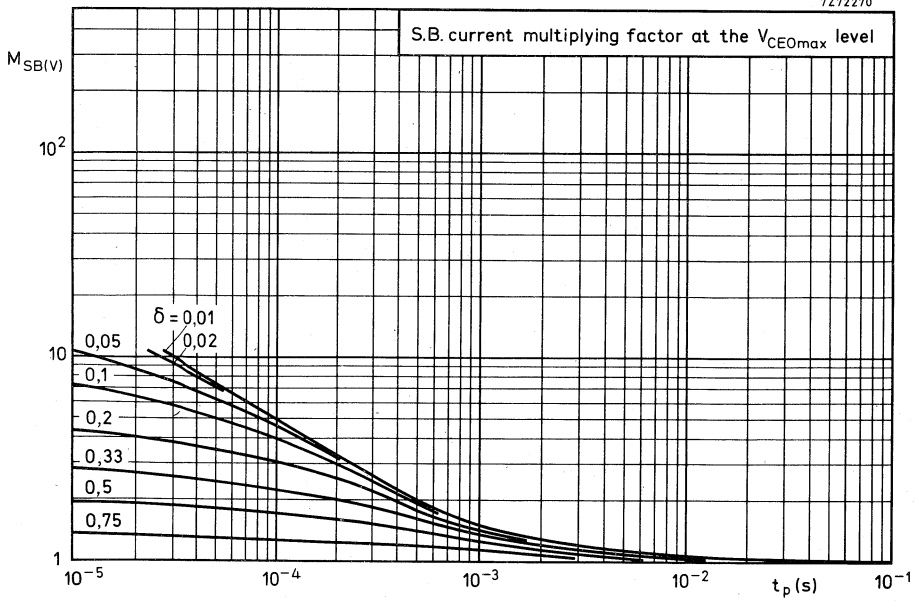
2) Second-breakdown limits (independent of temperature).

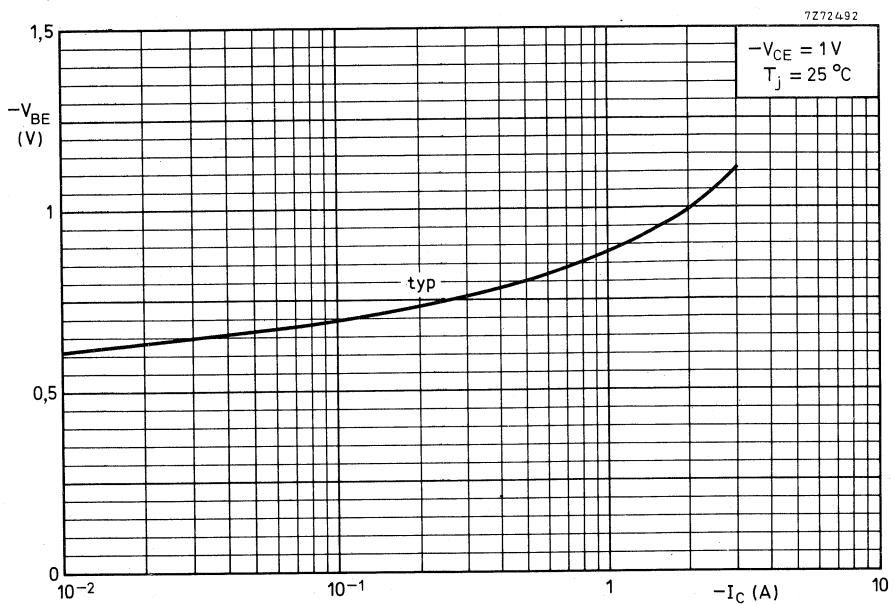
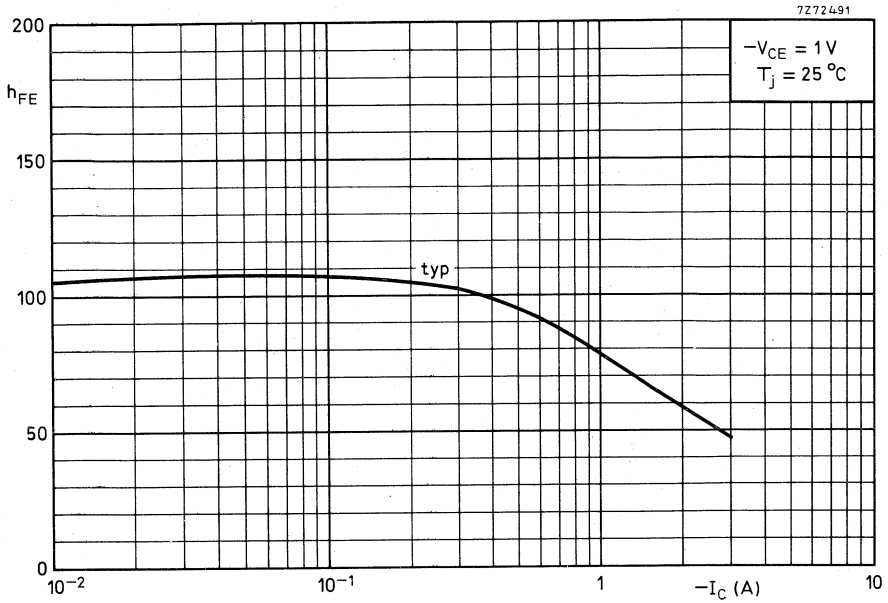


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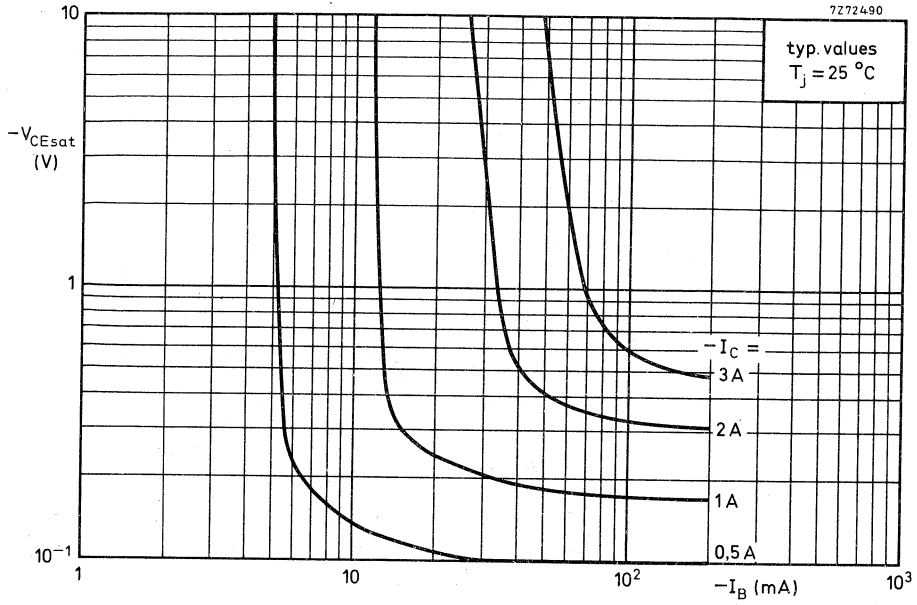


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FOR APPLICATION INFORMATION SEE BD329.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; plastic SOT-82 envelope for clip mounting; can also be soldered or adhesive mounted into a hybrid circuit. P-N-P complements are BD332, BD334, BD336 and BD338.

QUICK REFERENCE DATA

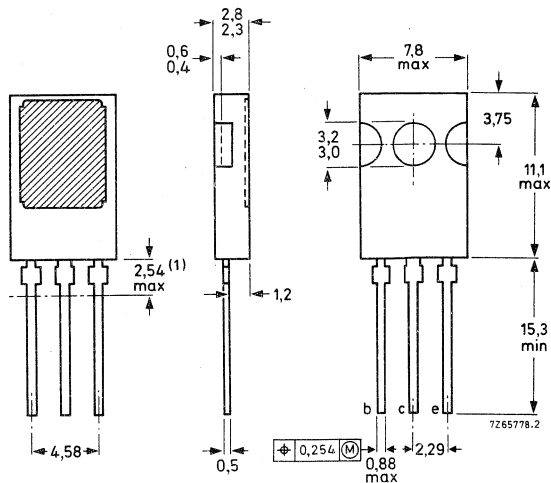
			BD331	333	335	337
Collector-base voltage (open emitter)	V_{CB0}	max.	60	80	100	120 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120 V
Collector-current (d.c.)	I_C	max.	6			A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	60			W
Junction temperature	T_j	max.	150			$^\circ\text{C}$
D.C. current gain						
$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	typ.	1500			
$I_C = 3,0\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	>	750			
Transition frequency	f_T	typ.	7			MHz
$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$						

MECHANICAL DATA

Dimensions in mm

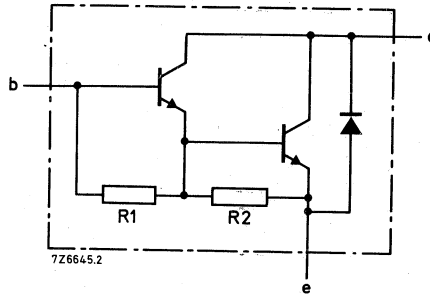
Fig. 1 SOT-82.

Collector connected to metal part of mounting surface



See also chapters Mounting instructions and Accessories.

(1) Within this region the cross-section of the leads is uncontrolled.



R₁ typ. 4 kΩ
R₂ typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BD331	333	335	337
Collector-base voltage (open emitter)	V _{CB0}	max. 60	80	100	120 V
Collector-emitter voltage (open base)	V _{CE0}	max. 60	80	100	120 V
Emitter-base voltage (open collector)	V _{EB0}	max. 5	5	5	5 V
Collector current (d.c.)	I _C	max. 6			A
Collector current (peak value) t _p ≤ 10 ms; δ ≤ 0,1	I _{CM}	max. 10			A
Base current (d.c.)	I _B	max. 150			mA
Total power dissipation up to T _{mb} = 25 °C	P _{tot}	max. 60			W
Storage temperature	T _{stg}	-65 to + 150			°C
Junction temperature *	T _j	max. 150			°C

THERMAL RESISTANCE *

From junction to mounting base	R _{th j-mb}	=	2,08	°C/W
From junction to ambient in free air	R _{th j-a}	=	100	°C/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = V_{CB0max}$

$I_{CBO} < 0,2\text{ mA}$

$I_E = 0; V_{CB} = V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$

$I_{CBO} < 2\text{ mA}$

$I_B = 0; V_{CE} = \frac{1}{2} V_{CE0max}$

$I_{CEO} < 0,5\text{ mA}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 5\text{ mA}$

D.C. current gain *

$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 1500$

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} > 750$

$I_C = 6\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 1500$

Base-emitter voltage **

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$V_{BE} < 2,5\text{ V}$

Collector-emitter saturation voltage

$I_C = 3\text{ A}; I_B = 12\text{ mA}$

$V_{CEsat} < 2\text{ V}$

Transition frequency

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$f_T \text{ typ. } 7\text{ MHz}$

Cut-off frequency

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$f_{hfe} \text{ typ. } 60\text{ kHz}$

Turn-off breakdown energy with inductive load (see Fig. 12)

$-I_{Boff} = 0; I_{Con} = 4,5\text{ A}$

$E_{(BR)} > 50\text{ mJ}$

Diode forward voltage

$I_F = 3\text{ A}$

$V_F \text{ typ. } 1,8\text{ V}$

D.C. current gain ratio of complementary
matched pairs

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE1}/h_{FE2} < 2,5$

* Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.** V_{BE} decreases by about $3,8\text{ mV}/^\circ\text{C}$ with increasing temperature.

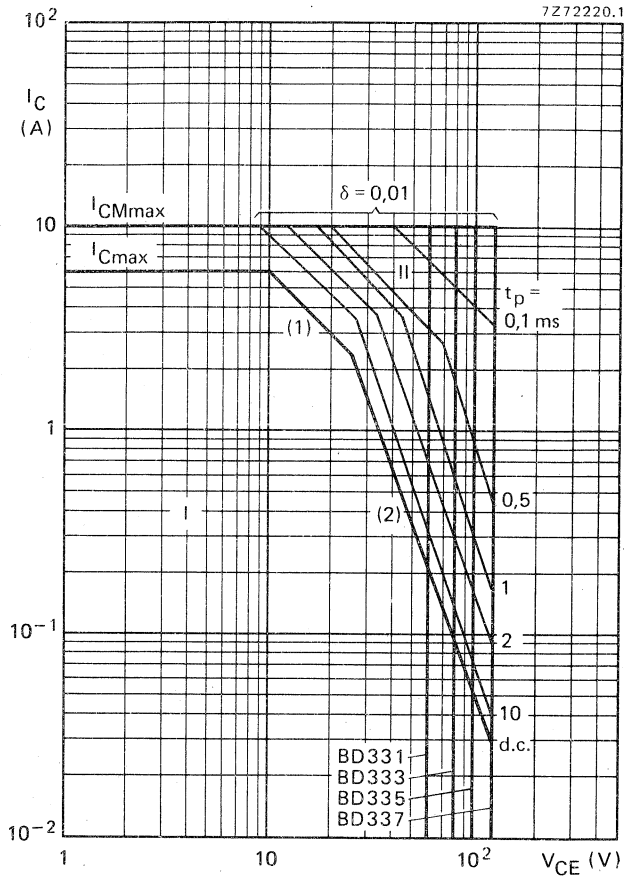


Fig. 3 Safe Operating Area with the transistor forward biased; $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
- (2) Second breakdown limits (independent of temperature).

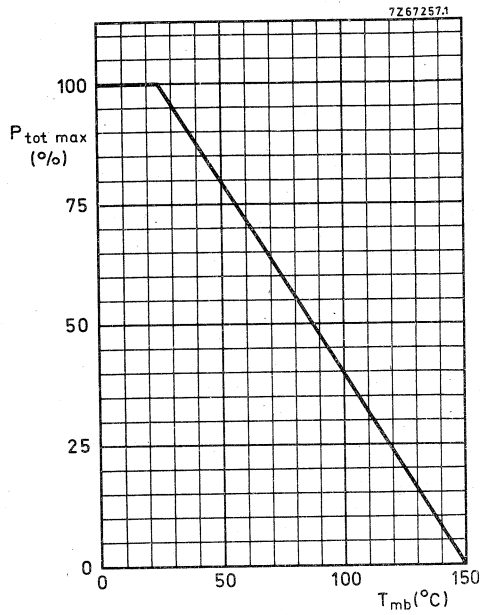


Fig. 4 Power derating curve.

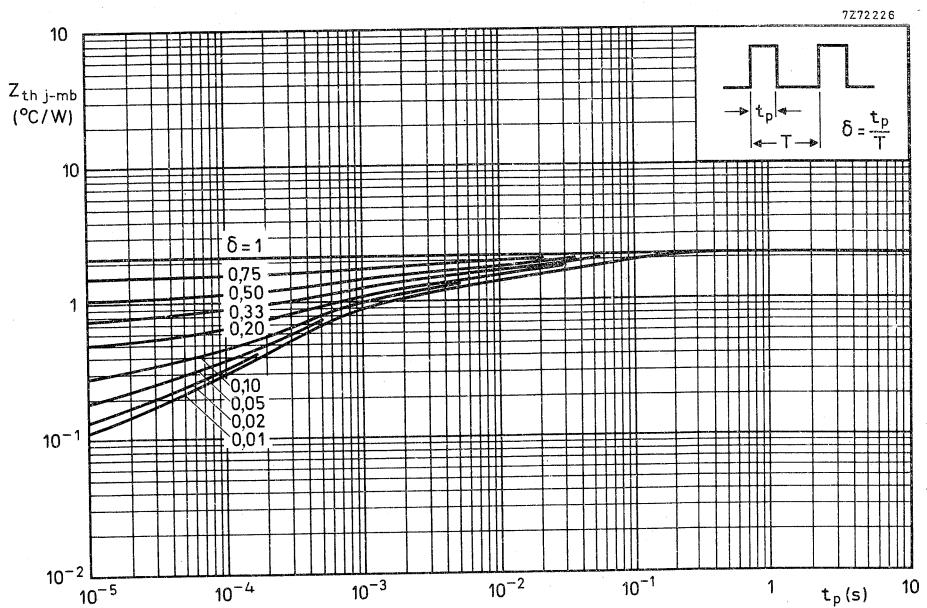


Fig. 5 Pulse power rating chart.

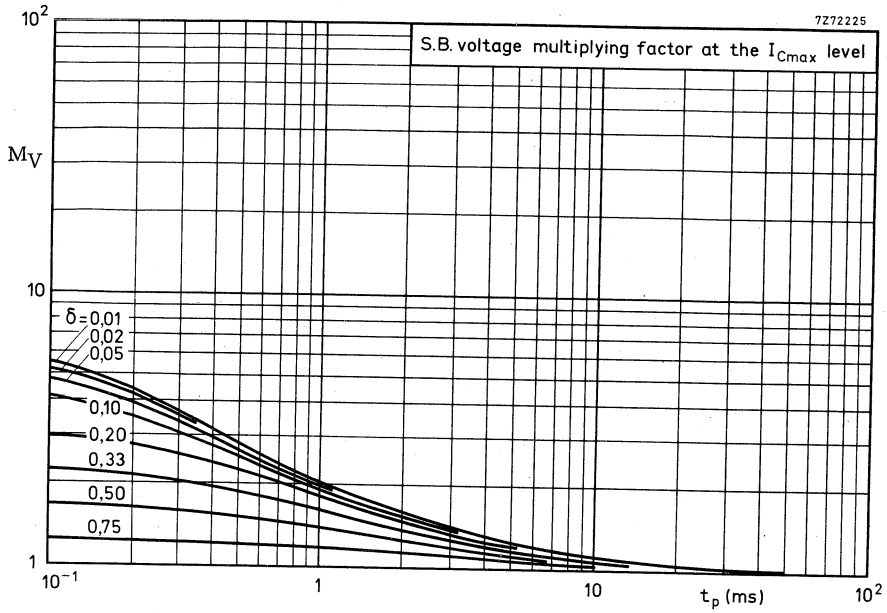


Fig. 6 Second breakdown voltage multiplying factor at I_{Cmax} level.

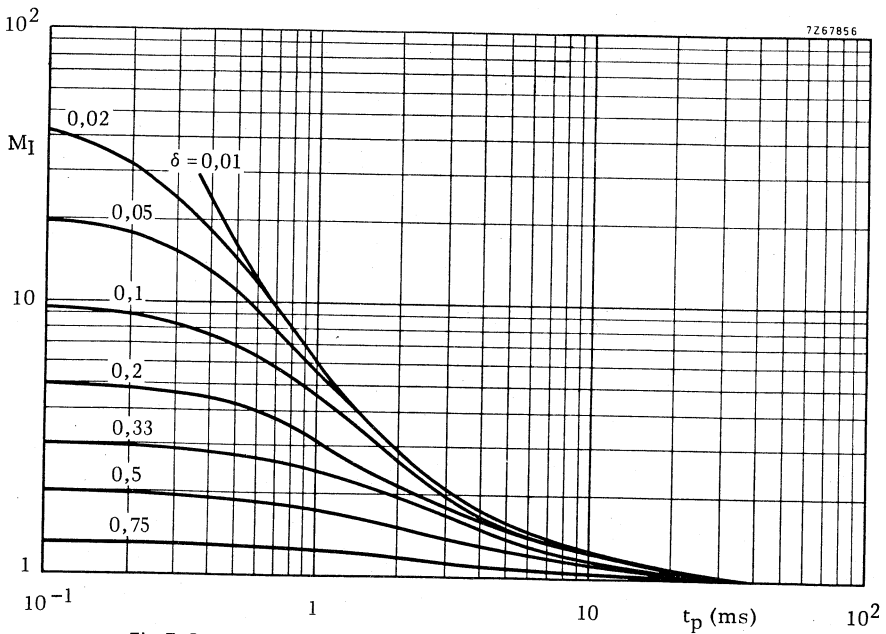


Fig. 7 Second breakdown current multiplying factor at V_{CE0max} level.

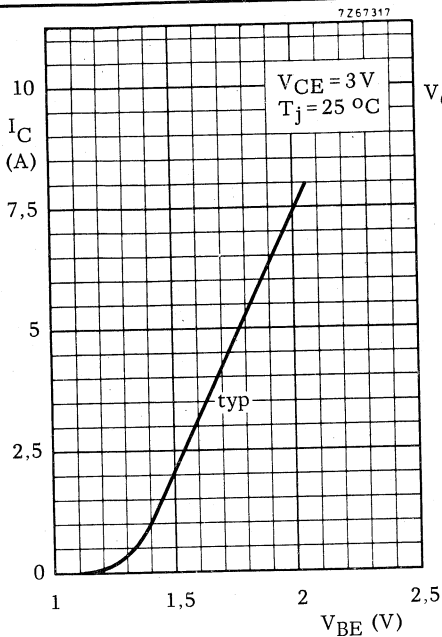


Fig. 8 Collector current.

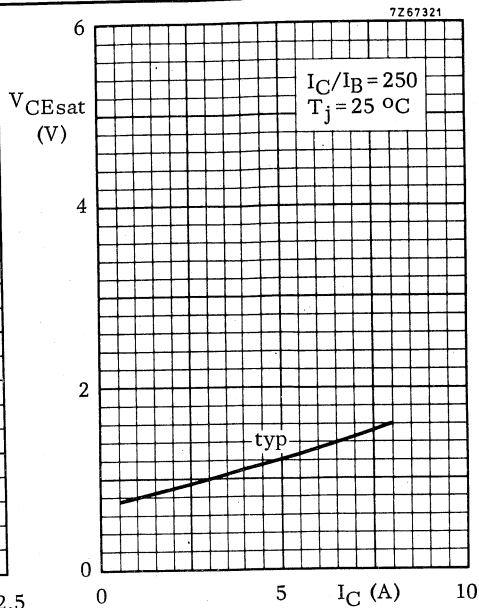


Fig. 9 Collector-emitter saturation voltage.

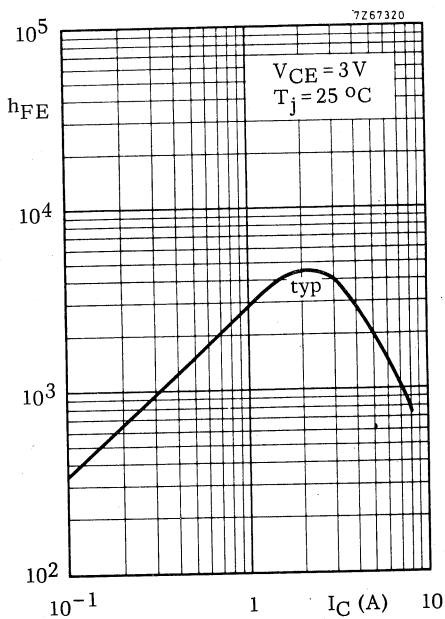


Fig. 10 D.C. current gain.

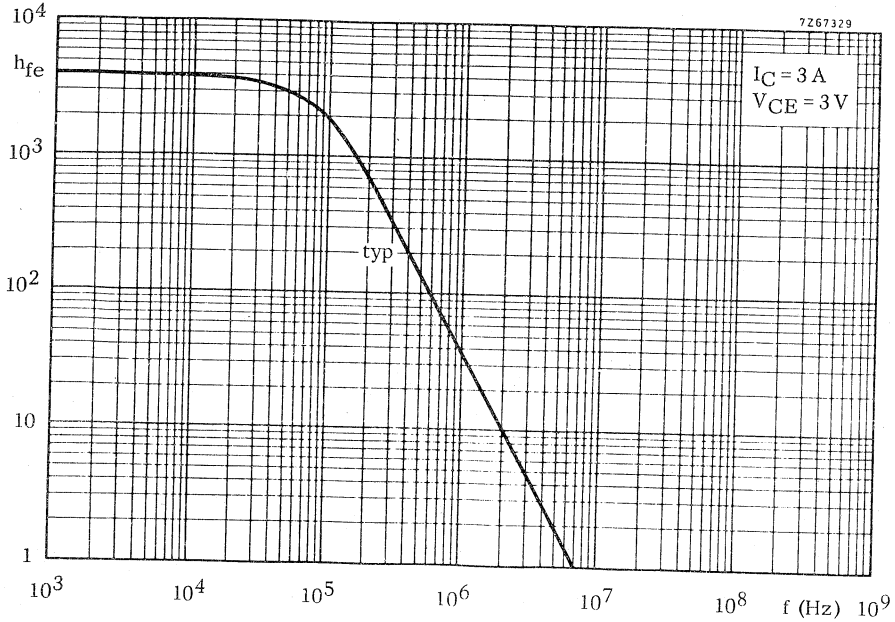


Fig. 11 Small signal current gain at $I_C = 3 \text{ A}$; $V_{CE} = 3 \text{ V}$.

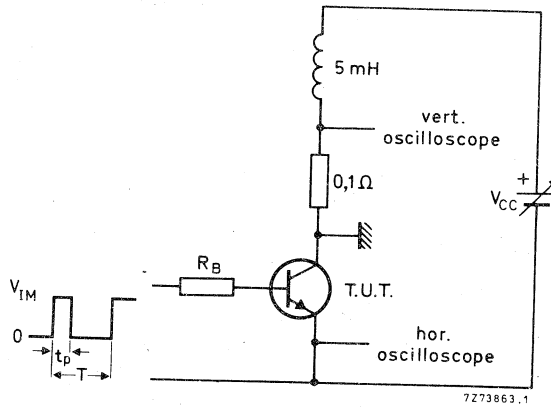


Fig. 12 Test circuit for turn-off breakdown energy. $V_{IM} = 12 \text{ V}$; $R_B = 270 \Omega$.

APPLICATION INFORMATION

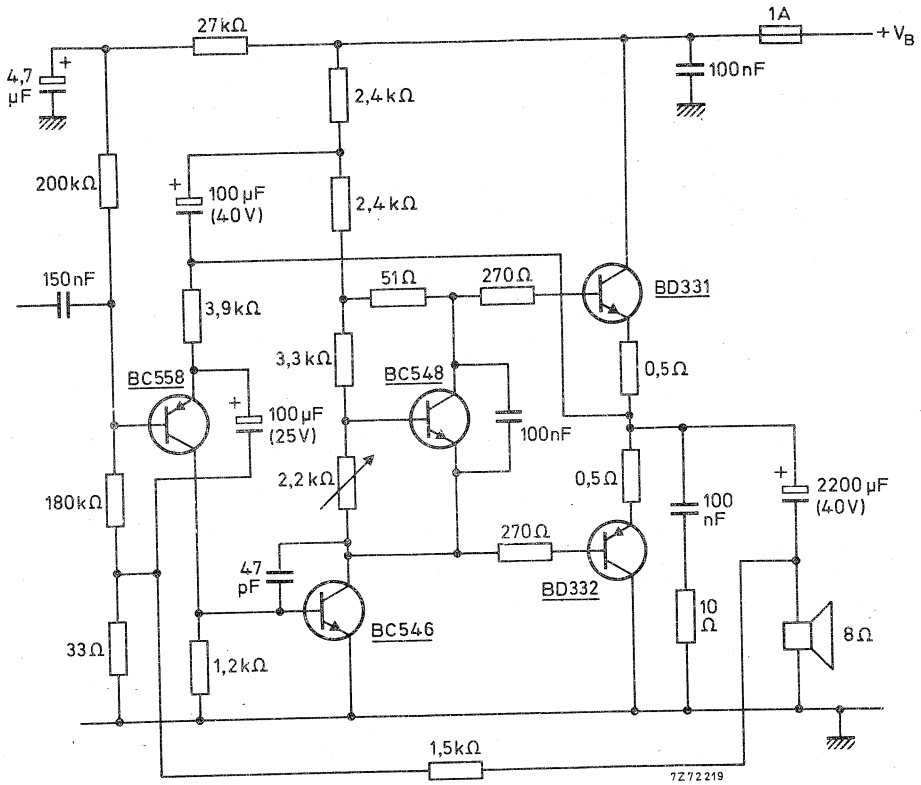


Fig. 13 Basic circuit diagram of a 20 W hi-fi amplifier.

Performance at $V_B = 43 \text{ V}$ (unloaded supply voltage = 51 V):

Collector quiescent current of BD331 and BD332

Total current drain at $P_O = 20 \text{ W}$; $f = 1 \text{ kHz}$

Input impedance

Output impedance

Output power at $f = 1 \text{ kHz}$; $d_{\text{tot}} = 1\%$

Input voltage for $P_O = 20 \text{ W}$; $f = 1 \text{ kHz}$

Total harmonic distortion at $P_O = 20 \text{ W}$

Intermodulation distortion at $P_O = 20 \text{ W}$

Heatsink thermal resistance per output transistor

Stable continuous operation is ensured up to an ambient temperature of $50 \text{ }^\circ\text{C}$.

$ I_{CQ} $	typ.	20 mA
I_B	typ.	710 mA
z_i	typ.	180 k Ω
z_o	typ.	80 m Ω
P_O	typ.	24 W
$V_{i(\text{rms})}$	typ.	375 mV
d_{tot}	typ.	0,08 %
d_{im}	typ.	0,2 %
$R_{\text{th h-a}}$	\leq	6,4 $^\circ\text{C}/\text{W}$

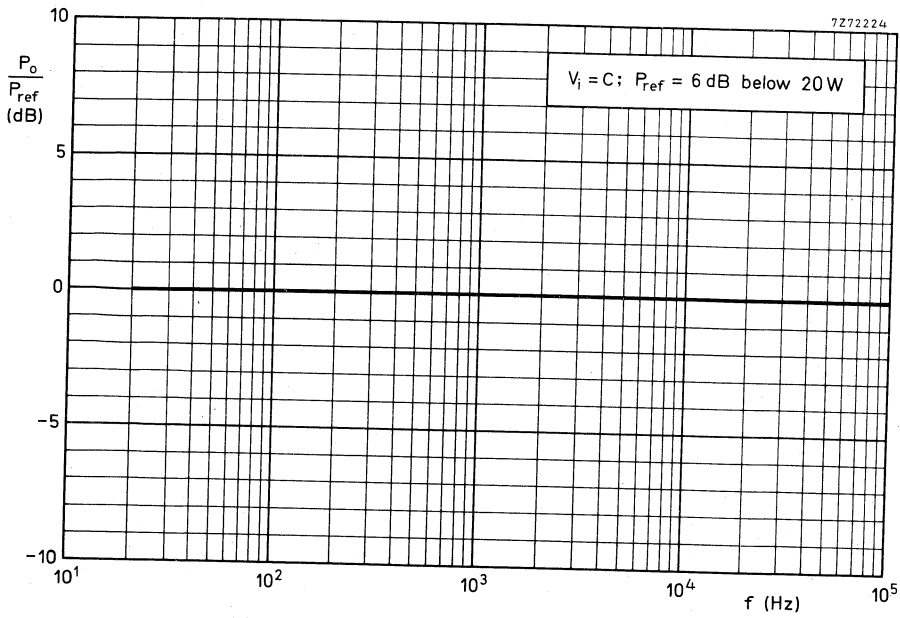


Fig. 14 Output power in relation to reference power.

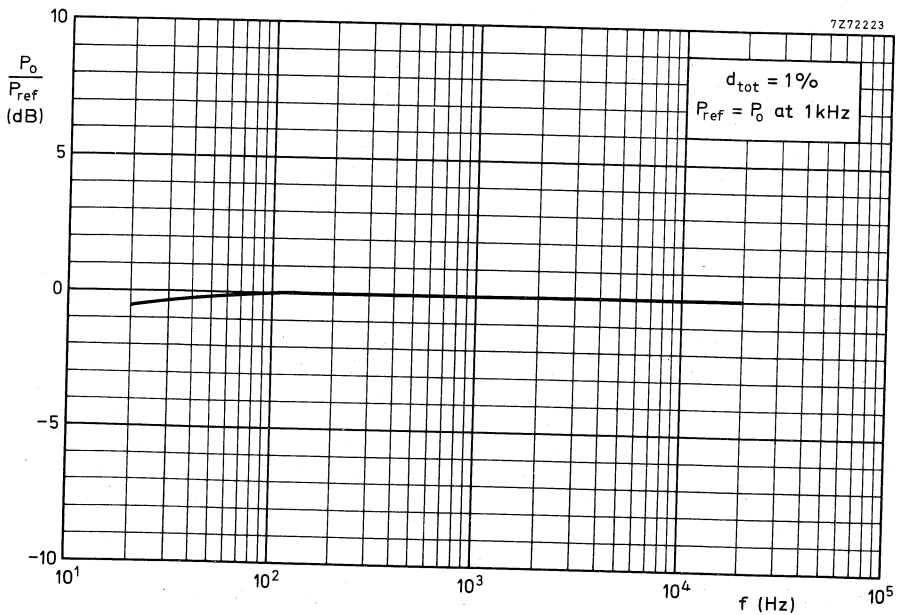


Fig. 15 Output power in relation to reference power.

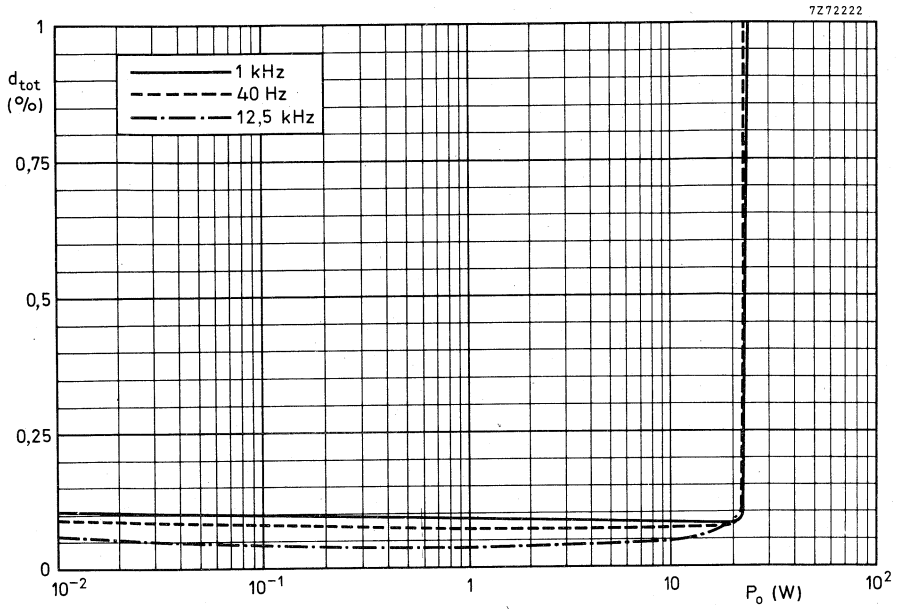


Fig. 16 Total harmonic distortion.



SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; plastic SOT-82 envelope for clip mounting; can also be soldered or adhesive mounted into a hybrid circuit. N-P-N complements are BD331, BD333, BD335 and BD337.

QUICK REFERENCE DATA

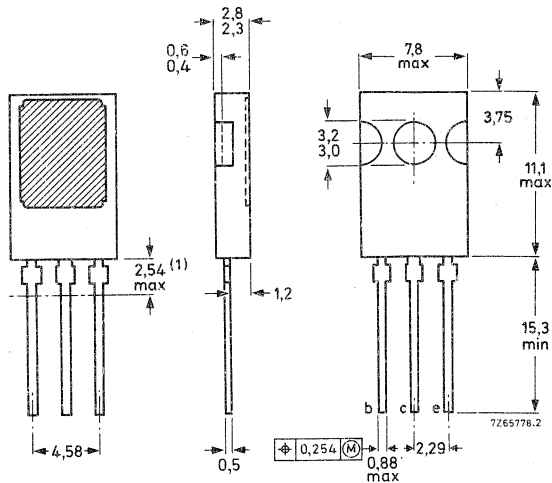
			BD332	334	336	338
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120 V
Collector-current (d.c.)	$-I_C$	max.	6		A	
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	60		W	
Junction temperature	T_j	max.	150		$^\circ\text{C}$	
D.C. current gain			1500			
$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}	typ.	750			
$-I_C = 3,0\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}	>				
Transition frequency	f_T	typ.	7		MHz	
$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$						

MECHANICAL DATA

Dimensions in mm

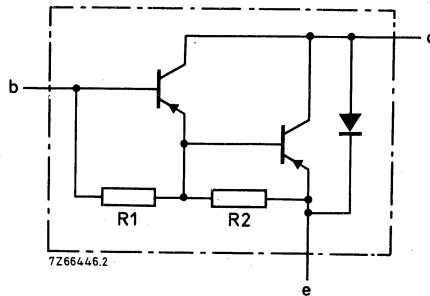
Fig. 1 SOT-82.

Collector connected to metal part of mounting surface.



See also chapters Mounting instructions and Accessories.

(1) Within this region the cross-section of the leads is uncontrolled.



R₁ typ. 4 kΩ
R₂ typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD332	334	336	338
Collector-base voltage (open emitter)	-V _{CB0}	max.	60	80	100	120 V
Collector-emitter voltage (open base)	-V _{CEO}	max.	60	80	100	120 V
Emitter-base voltage (open collector)	-V _{EBO}	max.	5	5	5	5 V
Collector current (d.c.)	-I _C	max.	6			A
Collector current (peak value) t _p ≤ 10 ms; δ ≤ 0,1	-I _{CM}	max.	10			A
Base current (d.c.)	-I _B	max.	150			mA
Total power dissipation up to T _{mb} = 25 °C	P _{tot}	max.	60			W
Storage temperature	T _{stg}		-65 to + 150			°C
Junction temperature *	T _j	max.	150			°C

THERMAL RESISTANCE *

From junction to mounting base	R _{th j-mb}	=	2,08	°C/W
From junction to ambient in free air	R _{th j-a}	=	100	°C/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CB0\max}$

$-I_{CBO} < 0,2\text{ mA}$

$I_E = 0; -V_{CB} = -V_{CB0\max}; T_j = 150\text{ }^\circ\text{C}$

$-I_{CBO} < 2\text{ mA}$

$I_B = 0; -V_{CE} = -\frac{1}{2} V_{CEO}$

$-I_{CEO} < 0,5\text{ mA}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$

$-I_{EBO} < 5\text{ mA}$

D.C. current gain *

$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 1500$

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} > 750$

$-I_C = 6\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 1500$

Base-emitter voltage **

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$-V_{BE} < 2,5\text{ V}$

Collector-emitter saturation voltage

$-I_C = 3\text{ A}; -I_B = 12\text{ mA}$

$-V_{CEsat} < 2\text{ V}$

Transition frequency

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$f_T \text{ typ. } 7\text{ MHz}$

Cut-off frequency

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$f_{hfe} \text{ typ. } 60\text{ kHz}$

Diode, forward voltage

$I_F = 3\text{ A}$

$V_F \text{ typ. } 1,8\text{ V}$

D.C. current gain ratio of
complementary matched pairs

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE1}/h_{FE2} < 2,5$

* Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.** V_{BE} decreases by about $3,8\text{ mV}/^\circ\text{C}$ with increasing temperature.

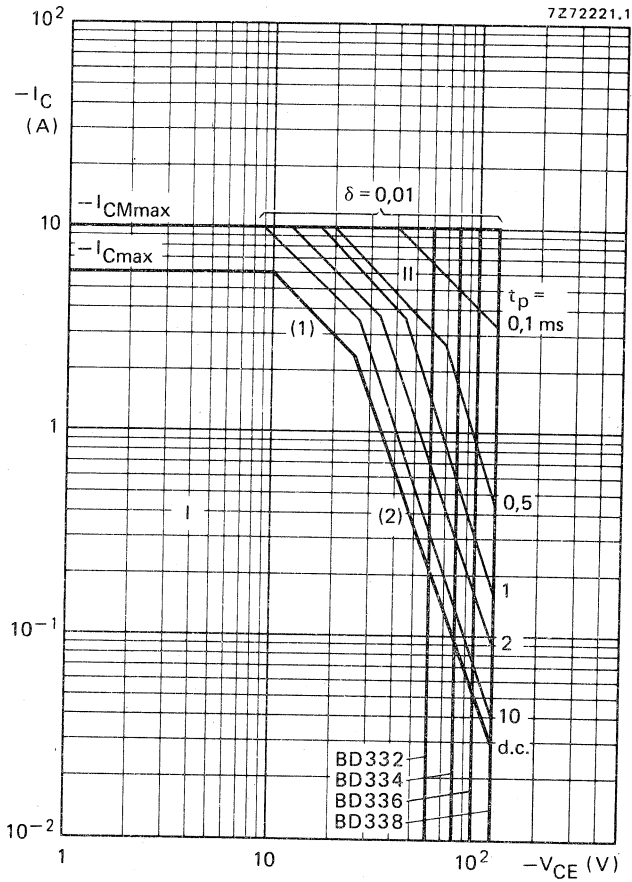


Fig. 3 Safe Operating Area with the transistor forward biased; $T_{mb} = 25 \text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
- (2) Second breakdown limits (independent of temperature).

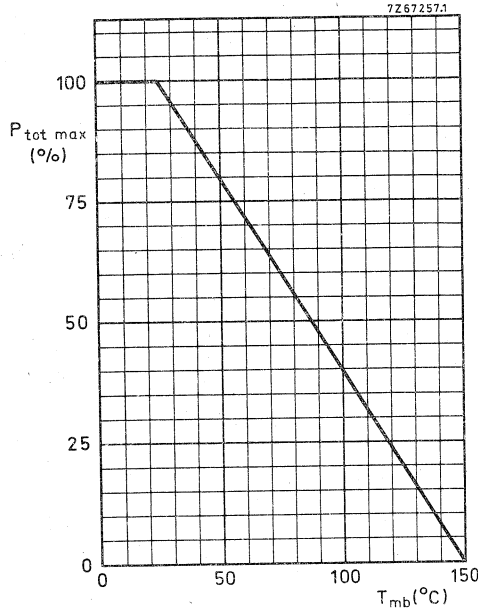


Fig. 4 Power derating curve.

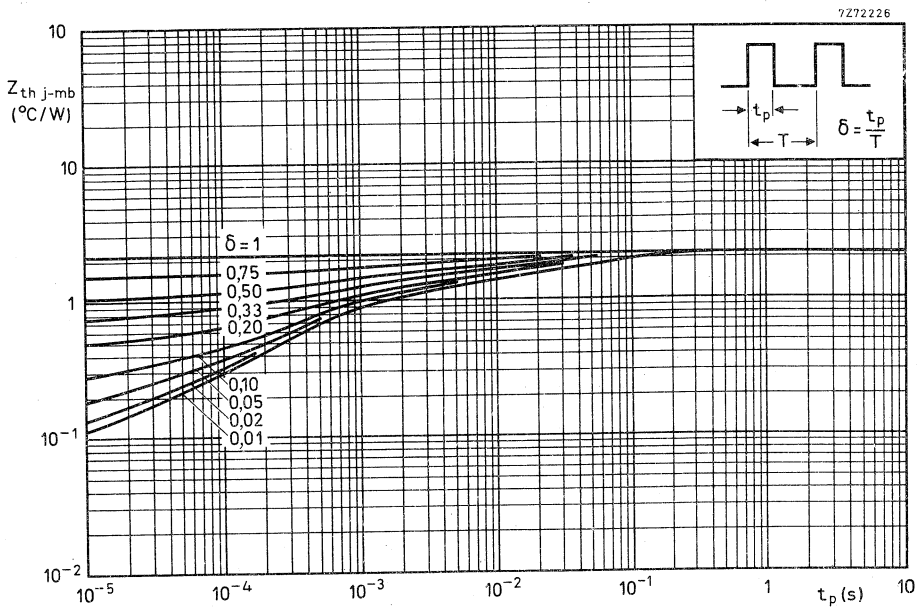


Fig. 5 Pulse power rating chart.

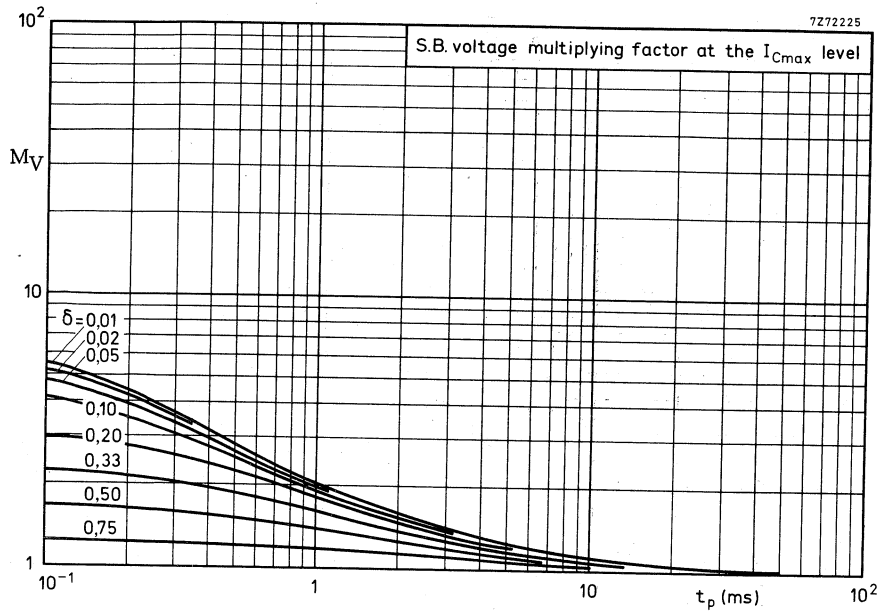


Fig. 6 Second breakdown voltage multiplying factor at the I_{Cmax} level.

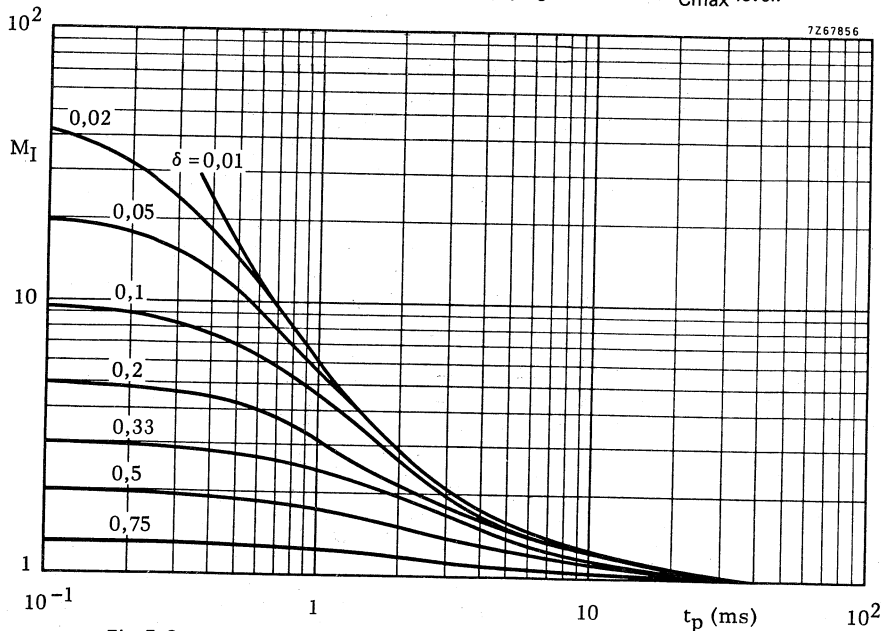


Fig. 7 Second breakdown current multiplying factor at the V_{CE0max} level.

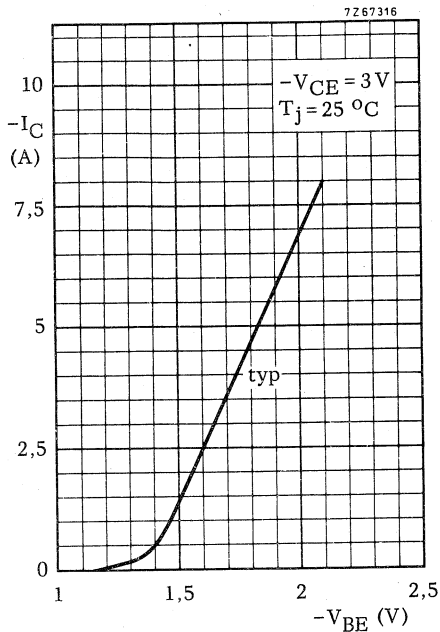


Fig. 8 Collector current.

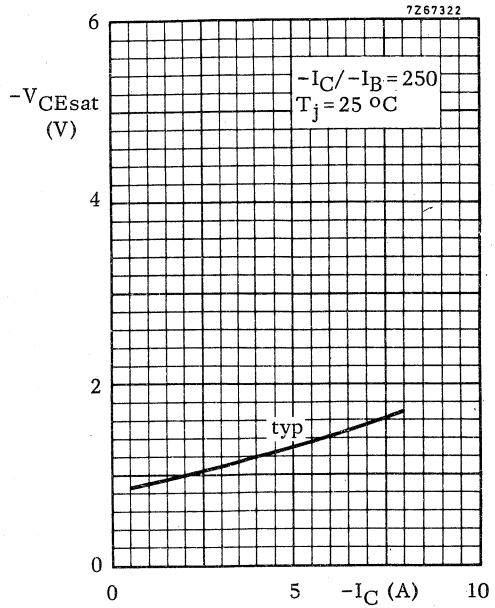


Fig. 9 Collector-emitter saturation voltage.

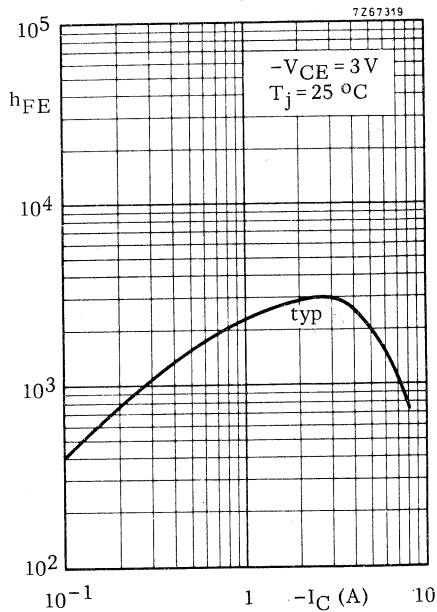


Fig. 10 D.C. current gain.

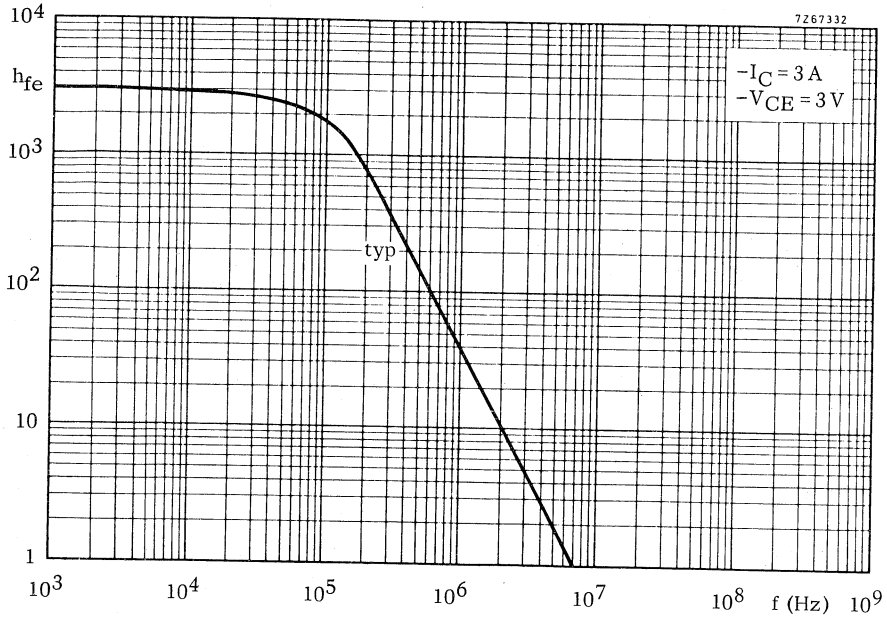


Fig. 11 Small signal current gain.

FOR APPLICATION INFORMATION SEE BD331, BD333, BD335 AND BD337.

SILICON EPITAXIAL-BASE POWER TRANSISTORS

N-P-N transistors in a SOT-32 plastic envelope, intended for use in complementary output stages of audio amplifiers up to 15 W.

The complementary pairs are BD433/BD434, BD435/BD436 and BD437/BD438.

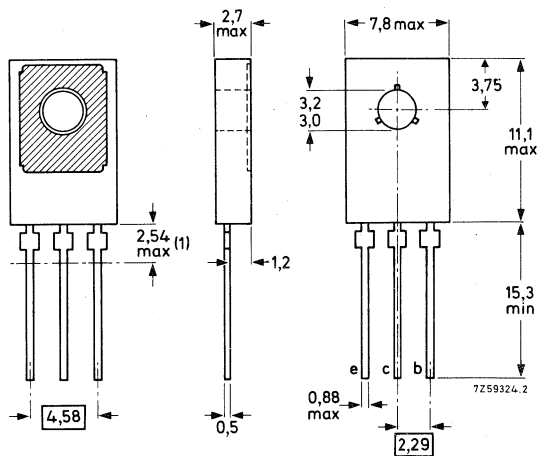
QUICK REFERENCE DATA					
			BD433	BD435	BD437
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	22	32	45 V
Collector-emitter voltage (open base)	V_{CEO}	max.	22	32	45 V
Collector current (peak value)	I_{CM}	max.	7	7	7 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	36	36	36 W
D. C. current gain $I_C = 2\text{ A}; V_{CE} = 1\text{ V}$	h_{FE}	>	50	50	40
Transition frequency $I_C = 250\text{ mA}; V_{CE} = 1\text{ V}$	f_T	>	3	3	3 MHz

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected
to metal part of
mounting surface



For mounting instructions see section Accessories, set 56333 for insulated mounting and type 56326 for non-insulated mounting.

¹⁾ Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

			BD433	BD435	BD437	
Collector-base voltage (open emitter)	V_{CBO}	max.	22	32	45	V
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	22	32	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	22	32	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V

Currents

Collector current (d. c.)	I_C	max.	4			A
Collector current (peak value)	I_{CM}	max.	7			A
Base current (d. c.)	I_B	max.	1			A

Power dissipation

Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.	36			W
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Temperatures

Storage temperature	T_{stg}		-65 to +150			$^\circ C$
Junction temperature	T_j	max.	150			$^\circ C$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	3,5			$^\circ C/W$
From junction to ambient in free air	$R_{th\ j-a}$	=	100			$^\circ C/W$

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

CHARACTERISTICS

Collector cut-off current

$I_E = 0; V_{CB} = V_{CB0max}$	I_{CBO}	<	100	μA
$I_E = 0; V_{CB} = 10\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<	1	mA
$I_E = 0; V_{CB} = V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<	3	mA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<	1	mA
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Knee voltage

			BD433	BD435	BD437	
$I_C = 2\text{ A}; I_B = \text{value for which}$ $I_C = 2,2\text{ A at } V_{CE} = 1\text{ V}$	V_{CEK}	<	0,8	-	-	V

Base-emitter voltage ¹⁾

$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$	V_{BE}	typ.	580	580	580	mV
$I_C = 2\text{ A}; V_{CE} = 1\text{ V}$	V_{BE}	<	1,1	1,1	-	V
$I_C = 3\text{ A}; V_{CE} = 1\text{ V}$	V_{BE}	<	-	-	1,3	V

Collector-emitter saturation voltage

$I_C = 2\text{ A}; I_B = 0,2\text{ A}$	V_{CEsat}	<	0,5	0,5	-	V
$I_C = 3\text{ A}; I_B = 0,3\text{ A}$	V_{CEsat}	<	-	-	0,7	V

D. C. current gain

$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$	h_{FE}	>	25	25	25	
$I_C = 500\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	>	85	85	85	
$I_C = 2\text{ A}; V_{CE} = 1\text{ V}$	h_{FE}	<	475	475	375	
$I_C = 2\text{ A}; V_{CE} = 1\text{ V}$	h_{FE}	>	50	50	40	
$I_C = 3\text{ A}; V_{CE} = 1\text{ V}$	h_{FE}	>	-	-	30	

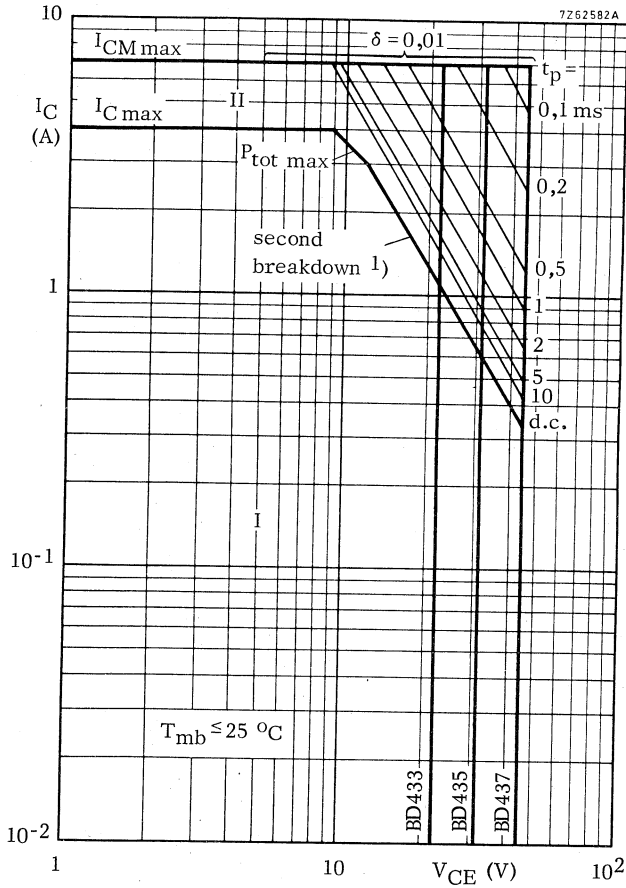
Transition frequency at $f = 1\text{ MHz}$

$I_C = 250\text{ mA}; V_{CE} = 1\text{ V}$	f_T	>		3		MHz
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D. C. current gain ratio of the complementary pairs

$ I_C = 500\text{ mA}; V_{CE} = 1\text{ V}$						
BD433/BD434 and BD435/BD436	h_{FE1}/h_{FE2}	<		1,4		
BD437/BD438	h_{FE1}/h_{FE2}	<		1,8		

¹⁾ V_{BE} decreases by typ. 2,3 mV/ $^\circ\text{C}$ with increasing temperature.

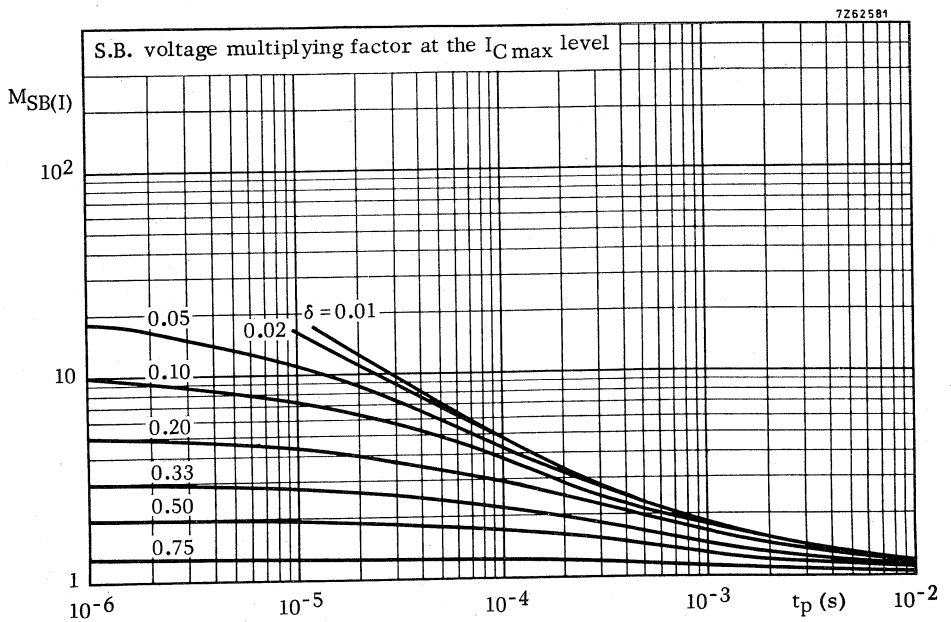
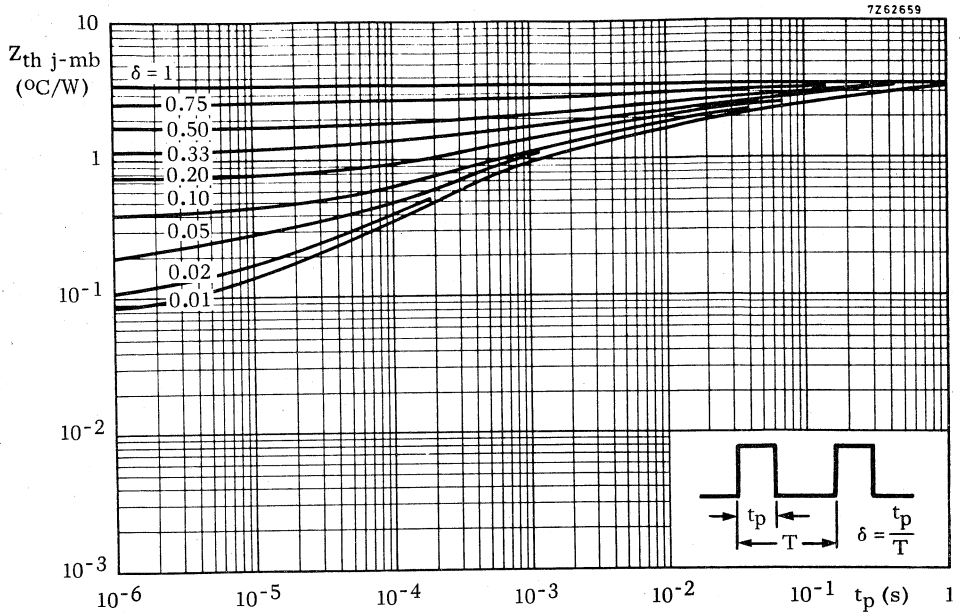


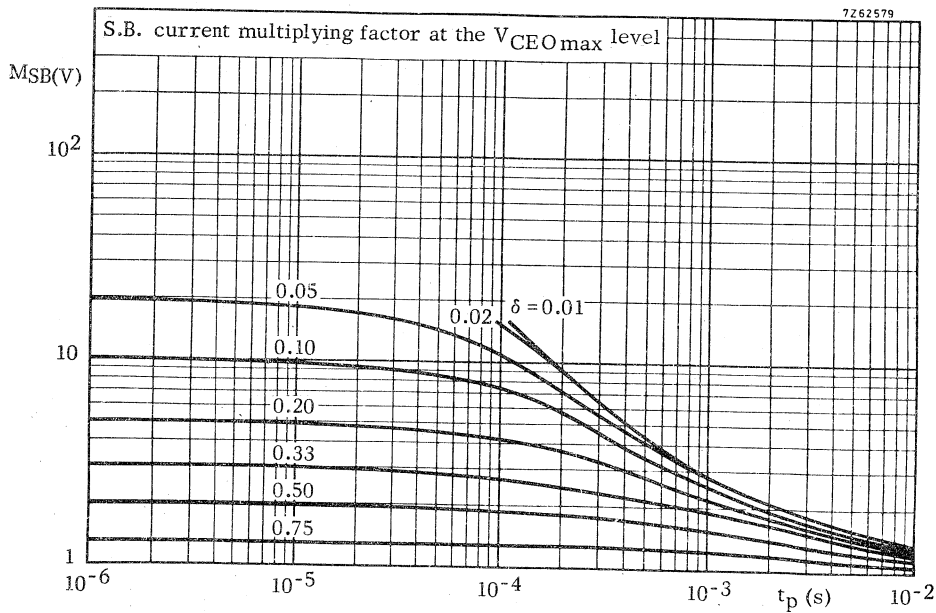
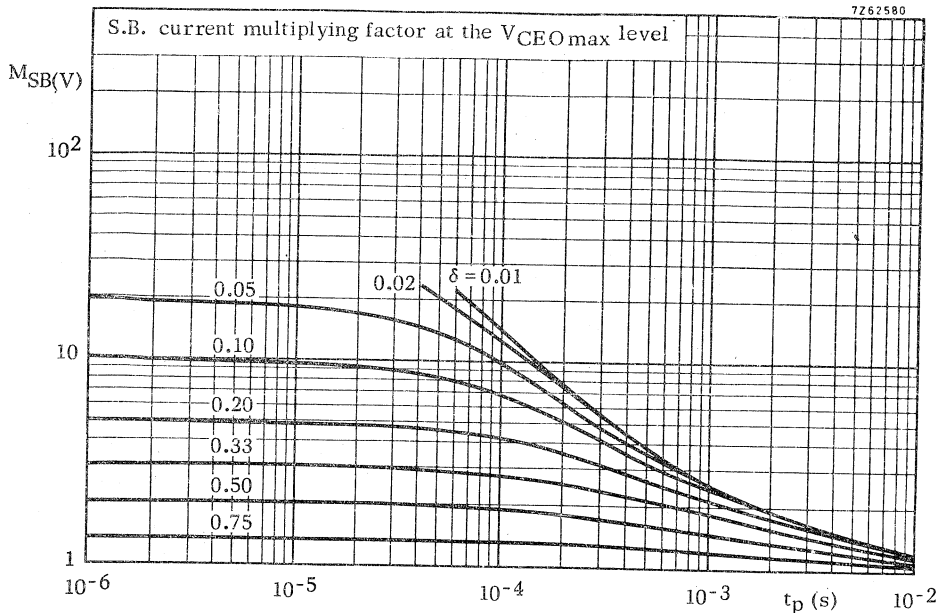
Safe Operating Area with the transistor forward biased

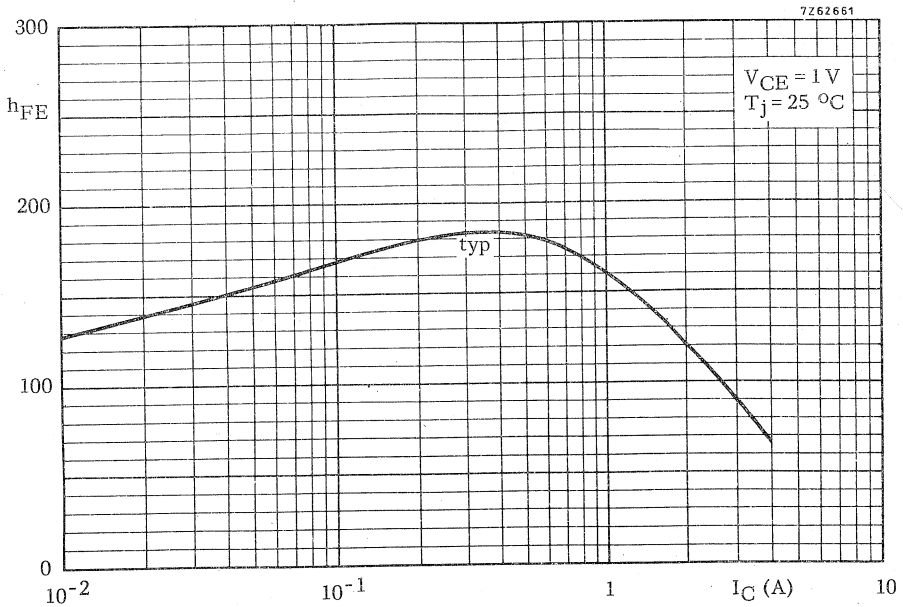
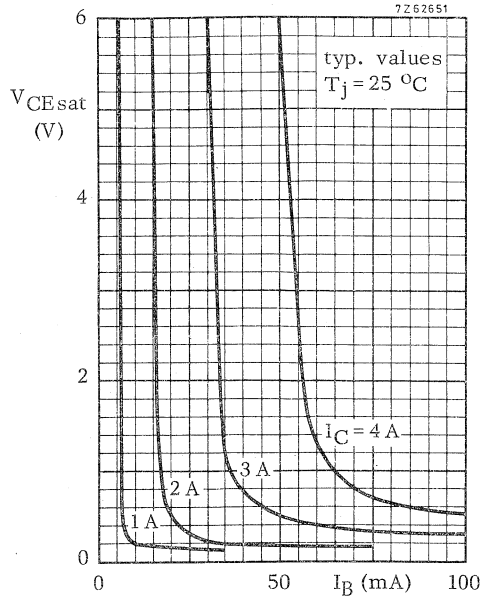
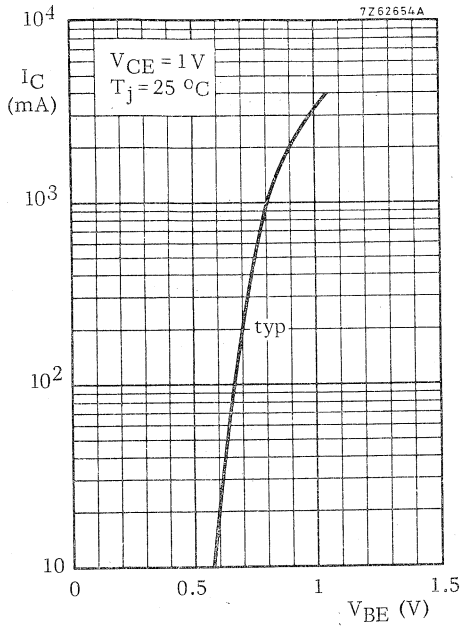
I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

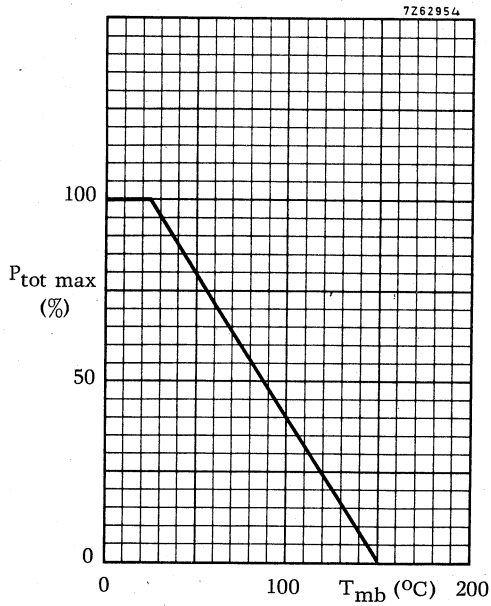
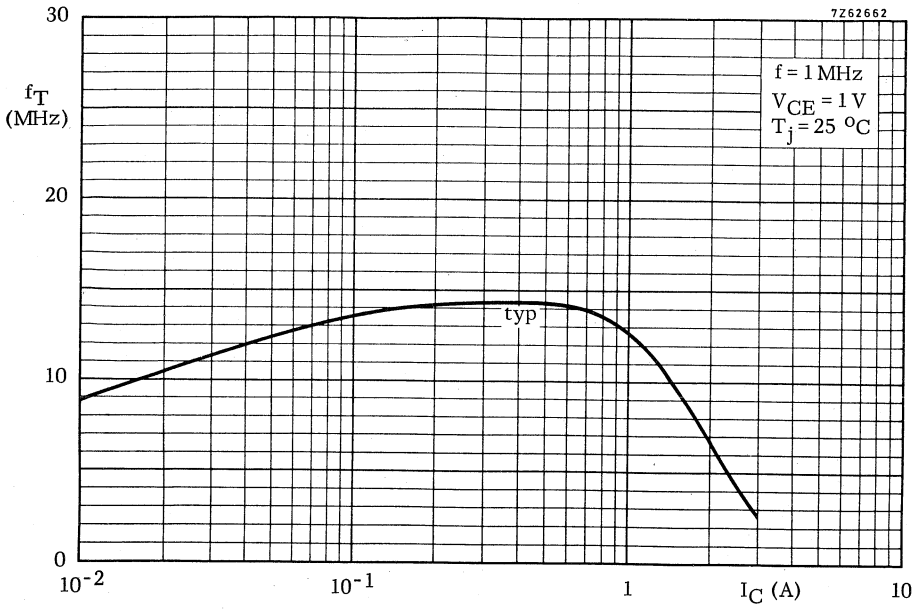
¹⁾ Independent of temperature.





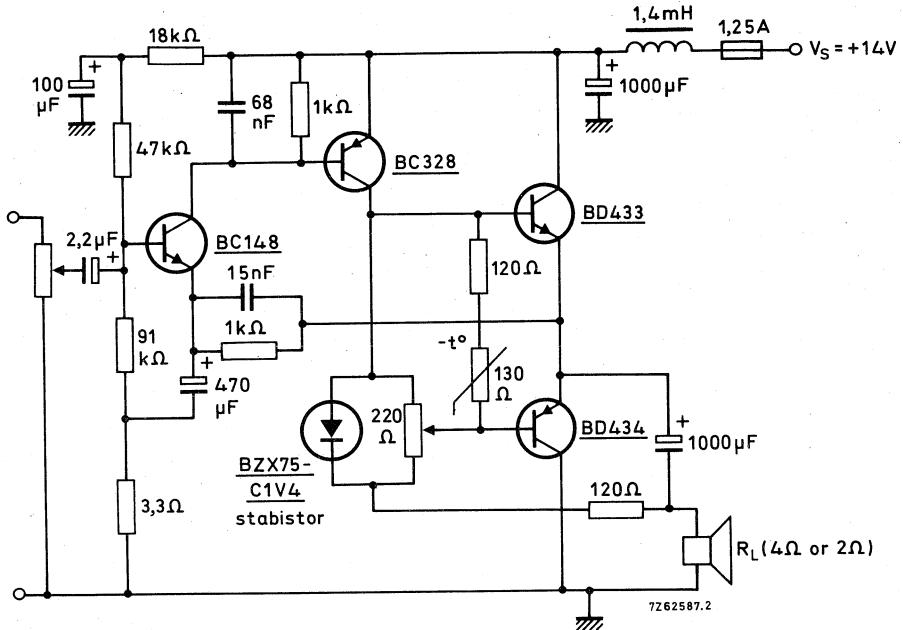


**BD433; BD435;
BD437**



APPLICATION INFORMATION

Basic circuit diagram of a 6 W car-radio audio amplifier.



Typical performance:

Output power at $d_{tot} = 10\%$ and $R_L = 4 \Omega$

Output power at $d_{tot} = 10\%$ and $R_L = 2 \Omega$

Input voltage for $P_o = 5 \text{ W}$; $R_L = 4 \Omega$
 $P_o = 5 \text{ W}$; $R_L = 2 \Omega$

Input impedance

Collector quiescent current of output transistors

Collector current of BC328 ¹⁾

Total current consumption at $P_o = 6 \text{ W}$

Frequency response (-3 dB)

Total thermal resistance per output transistor

Stable continuous operation is ensured up to an ambient temperature of $60 \text{ }^\circ\text{C}$

The amplifier is overdrive proof and short circuit proof.

$P_o \geq 6 \text{ W}$

$P_o 8 \text{ W}$

$V_{i(rms)} 20 \text{ mV}$

$V_{i(rms)} 15 \text{ mV}$

$z_i 20 \text{ k}\Omega$

$|I_{CQ}| 10 \text{ mA}$

$-I_C 50 \text{ mA}$

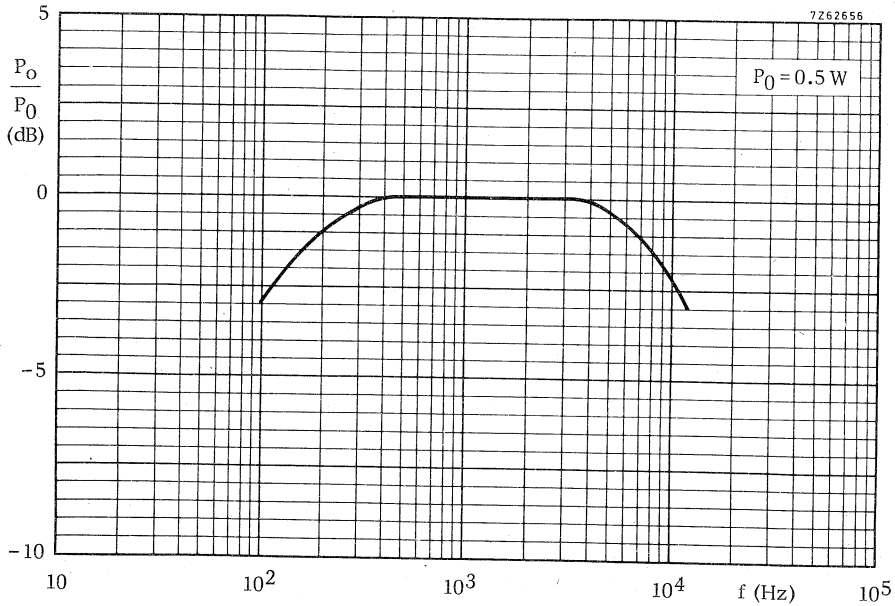
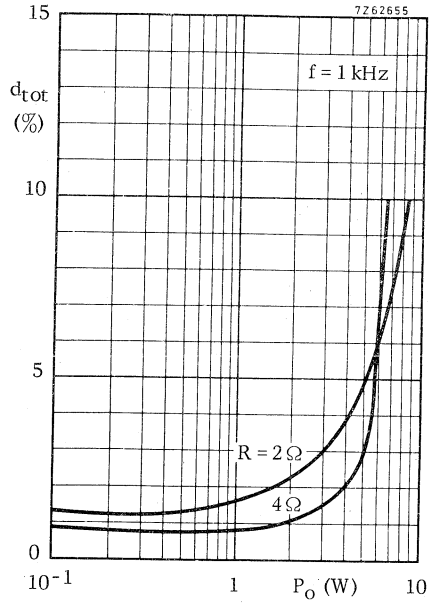
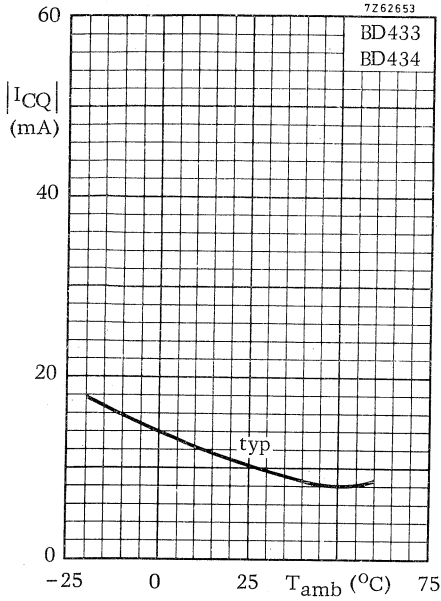
$I_{tot} 580 \text{ mA}$

0,1 to 12 kHz

$R_{th j-a} \text{ max. } 26,5 \text{ }^\circ\text{C/W}$

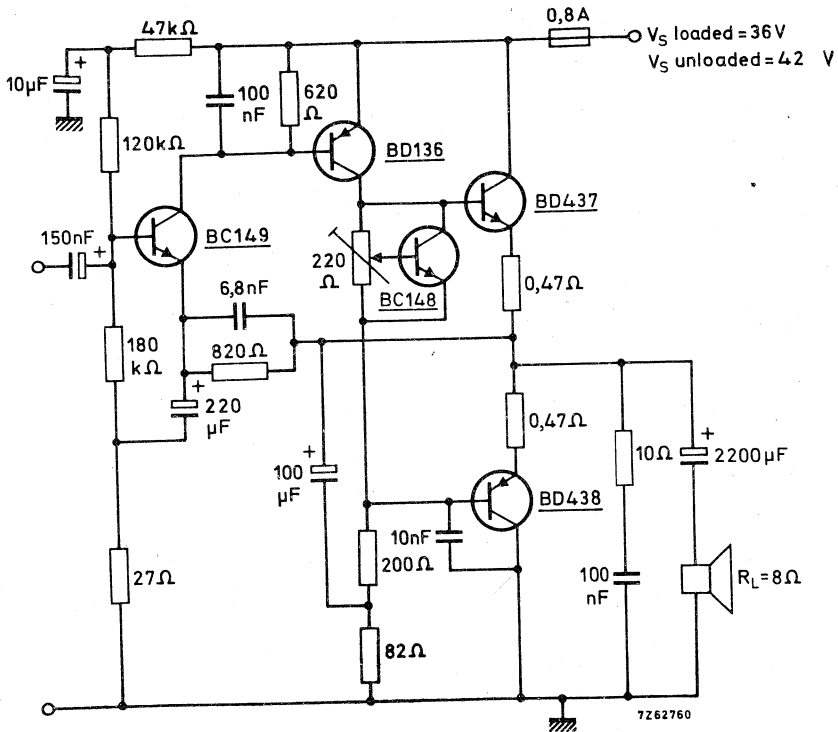
¹⁾ Area of printed wiring copper around collector lead $\approx 1 \text{ cm}^2$.

APPLICATION INFORMATION (continued)



APPLICATION INFORMATION (continued)

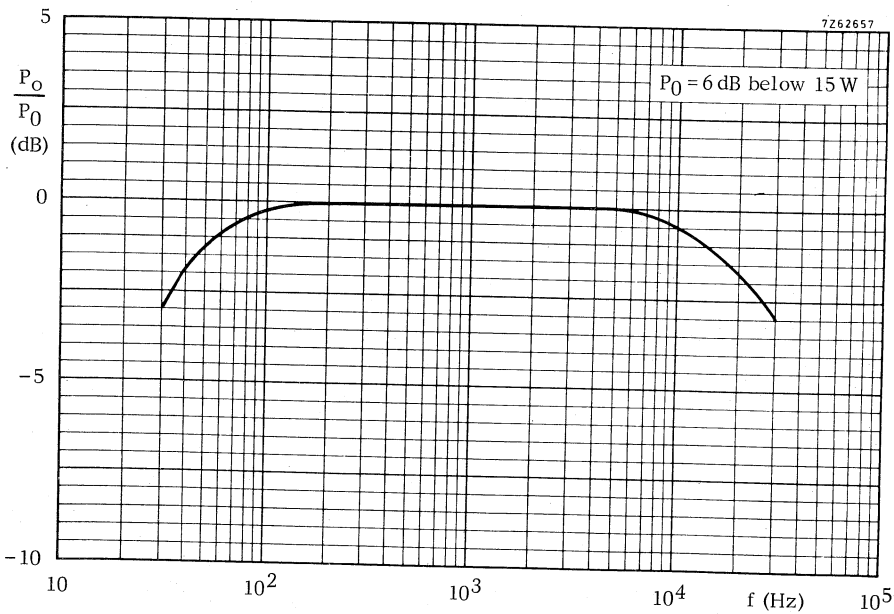
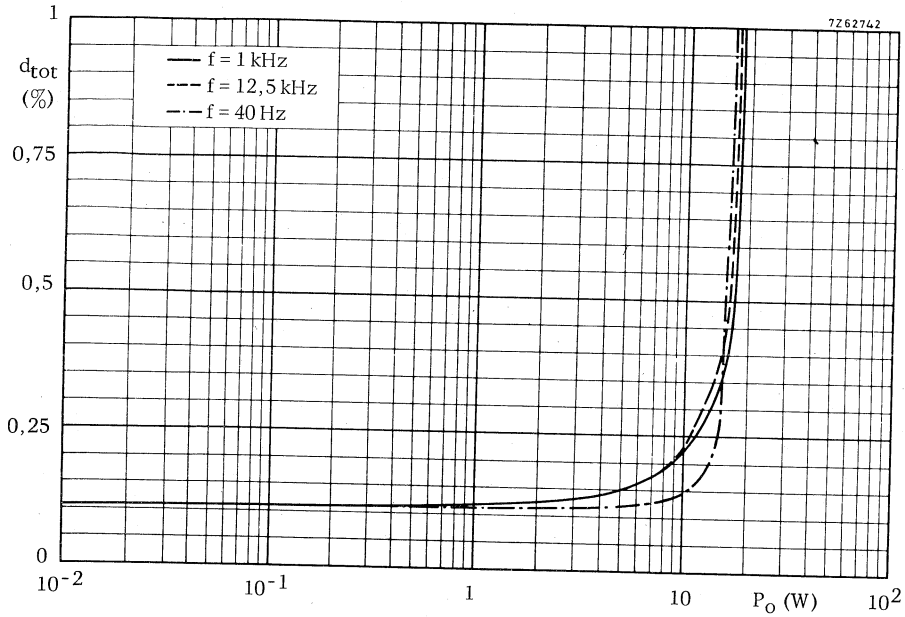
Basic circuit diagram of a 15 W high quality amplifier.



Typical performance:

Output power at $d_{tot} = 1\%$	P_o	\geq	15	W
Input voltage for $P_o = 10$ W	$V_{i(rms)}$		360	mV
Input impedance	z_i		100	k Ω
Output impedance	z_o		0,15	Ω
Collector quiescent current of output transistors	$ I_{CQ} $		10	mA
Collector current of BD136	$-I_C$		72	mA
Collector current of BC149	I_C		1,6	mA
Total current consumption at $P_o = 15$ W	I_{tot}		710	mA
Frequency response (-3 dB)			30 Hz to 30	kHz
Total thermal resistance per output transistor	$R_{th j-a}$	max.	18	$^{\circ}C/W$
Total thermal resistance of the BD136	$R_{th j-a}$	max.	44	$^{\circ}C/W$
Stable continuous operation is ensured up to an ambient temperature of 45 $^{\circ}C$.				

APPLICATION INFORMATION (continued)



SILICON EPITAXIAL-BASE POWER TRANSISTORS

P-N-P transistors in a SOT-32 plastic envelope, intended for use in complementary output stages of audio amplifiers up to 15 W.
The complementary pairs are BD433/BD434, BD435/BD436 and BD437/BD438.

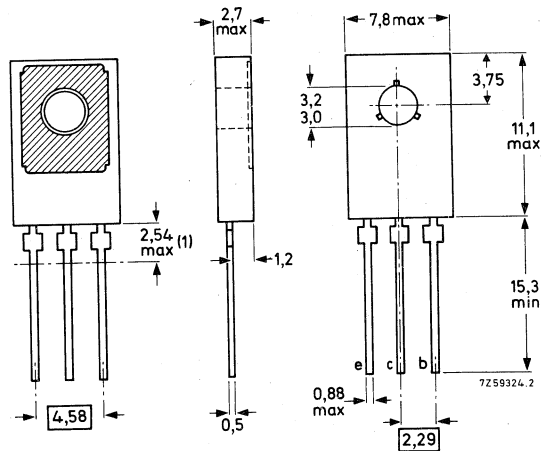
		QUICK REFERENCE DATA				
			BD434	BD436	BD438	
Collector-emitter voltage ($-V_{BE} = 0$)	$-V_{CES}$	max.	22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	22	32	45	V
Collector current (peak value)	$-I_{CM}$	max.	7	7	7	A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	36	36	36	W
D.C. current gain	h_{FE}	>	50	50	40	
$-I_C = 2\text{ A}; -V_{CE} = 1\text{ V}$						
Transition frequency	f_T	>	3	3	3	MHz
$-I_C = 250\text{ mA}; -V_{CE} = 1\text{ V}$						

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected to metal part of mounting surface



For mounting instructions see section Accessories, set 56333 for insulated mounting and 56326 for non-insulated mounting.

1) Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

		BD434	BD436	BD438	
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 22	32	45	V
Collector-emitter voltage ($-V_{BE} = 0$)	$-V_{CES}$	max. 22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 22	32	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max. 5	5	5	V

Currents

Collector current (d. c.)	$-I_C$	max.	4	A
Collector current (peak value)	$-I_{CM}$	max.	7	A
Base current (d. c.)	$-I_B$	max.	1	A

Power dissipation

Total power dissipation upto $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	36	W
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Temperatures

Storage temperature	T_{stg}		-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	3,5	$^\circ\text{C}/\text{W}$
From junction to ambient in free air	$R_{th\ j-a}$	=	100	$^\circ\text{C}/\text{W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CB0max}$	$-I_{CBO}$	<	100	μA
$I_E = 0; -V_{CB} = 10\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$	<	1	mA
$I_E = 0; -V_{CB} = -V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$	<	3	mA

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO}$	<	1	mA
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Knee voltage

			BD434	BD436	BD438	
$-I_C = 2\text{ A}; -I_B = \text{value for which}$ $-I_C = 2,2\text{ A at } -V_{CE} = 1\text{ V}$	$-V_{CEK}$	<	0,8	-	-	V

Base-emitter voltage ¹⁾

$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	$-V_{BE}$	typ.	580	580	580	mV
$-I_C = 2\text{ A}; -V_{CE} = 1\text{ V}$	$-V_{BE}$	<	1,1	1,1	-	V
$-I_C = 3\text{ A}; -V_{CE} = 1\text{ V}$	$-V_{BE}$	<	-	-	1,3	V

Collector-emitter saturation voltage

$-I_C = 2\text{ A}; -I_B = 0,2\text{ A}$	$-V_{CEsat}$	<	0,5	0,5	-	V
$-I_C = 3\text{ A}; -I_B = 0,3\text{ A}$	$-V_{CEsat}$	<	-	-	0,7	V

D. C. current gain

$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	h_{FE}	>	25	25	25	
$-I_C = 500\text{ mA}; -V_{CE} = 1\text{ V}$	h_{FE}	>	85	85	85	
	h_{FE}	<	475	475	375	
$-I_C = 2\text{ A}; -V_{CE} = 1\text{ V}$	h_{FE}	>	50	50	40	
$-I_C = 3\text{ A}; -V_{CE} = 1\text{ V}$	h_{FE}	>	-	-	30	

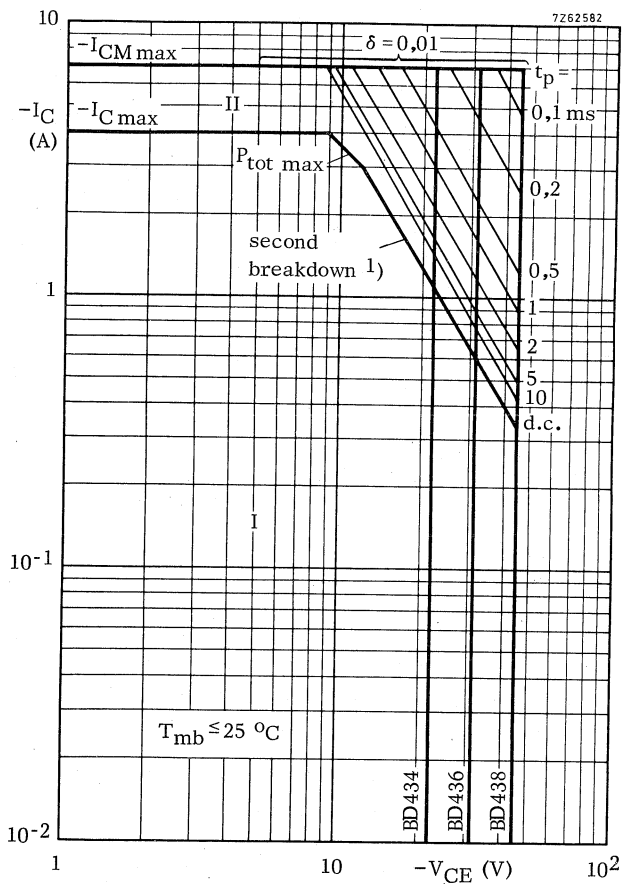
Transition frequency at $f = 1\text{ MHz}$

$-I_C = 250\text{ mA}; -V_{CE} = 1\text{ V}$	f_T	>		3		MHz
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D. C. current gain ratio of the complementary pairs

$ I_C = 500\text{ mA}; V_{CE} = 1\text{ V}$						
BD433/BD434 and BD435/BD436	h_{FE1}/h_{FE2}	<		1,4		
BD437/BD438	h_{FE1}/h_{FE2}	<		1,8		

¹⁾ $-V_{BE}$ decreases by typ. 2,3 $\text{mV}/^\circ\text{C}$ with increasing temperature.

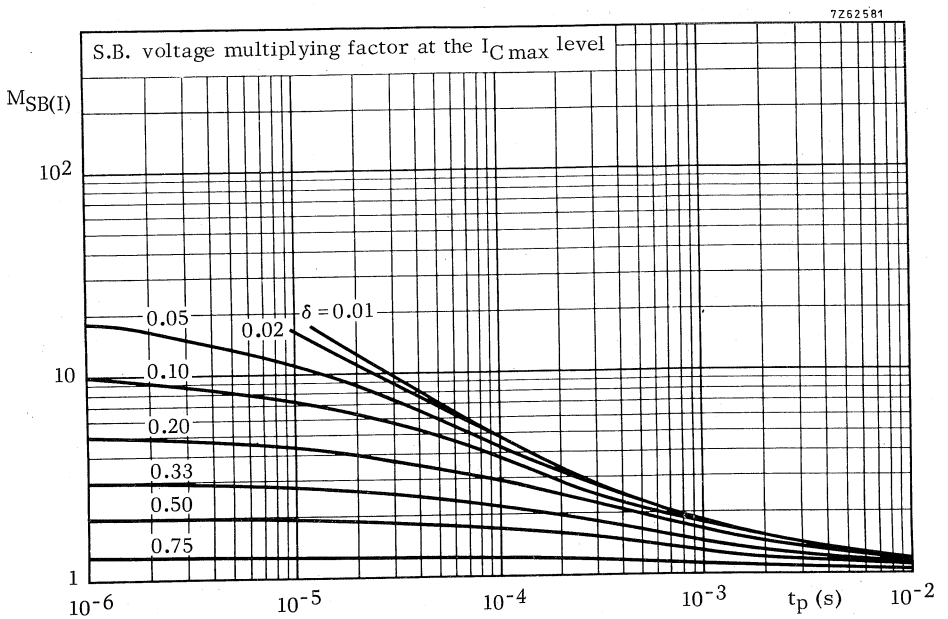
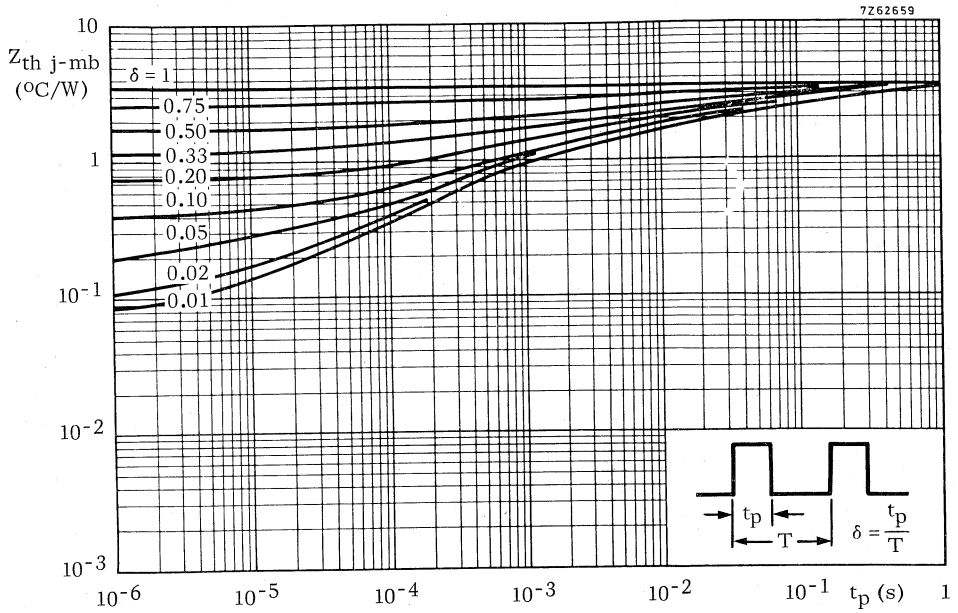


Safe Operating Area with the transistor forward biased

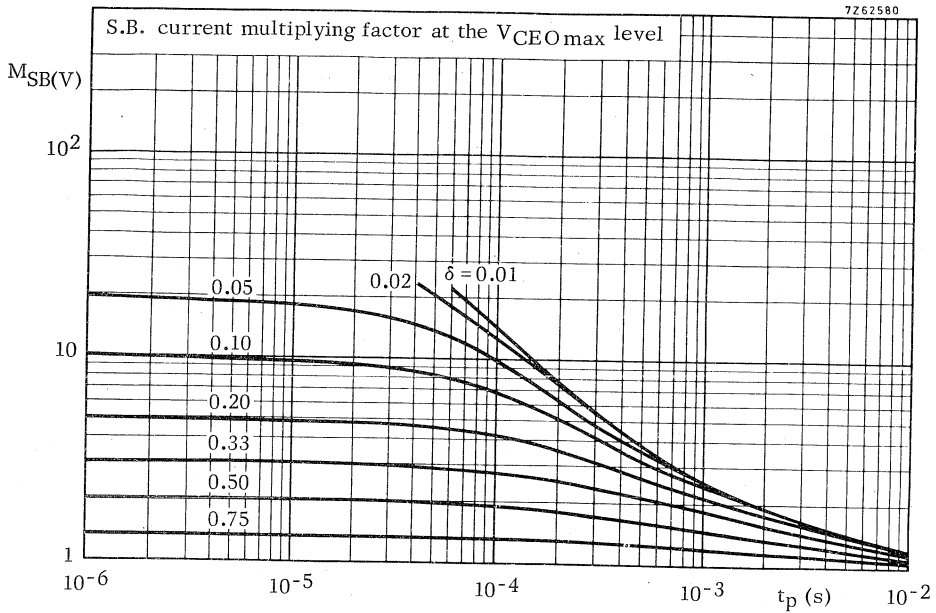
I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

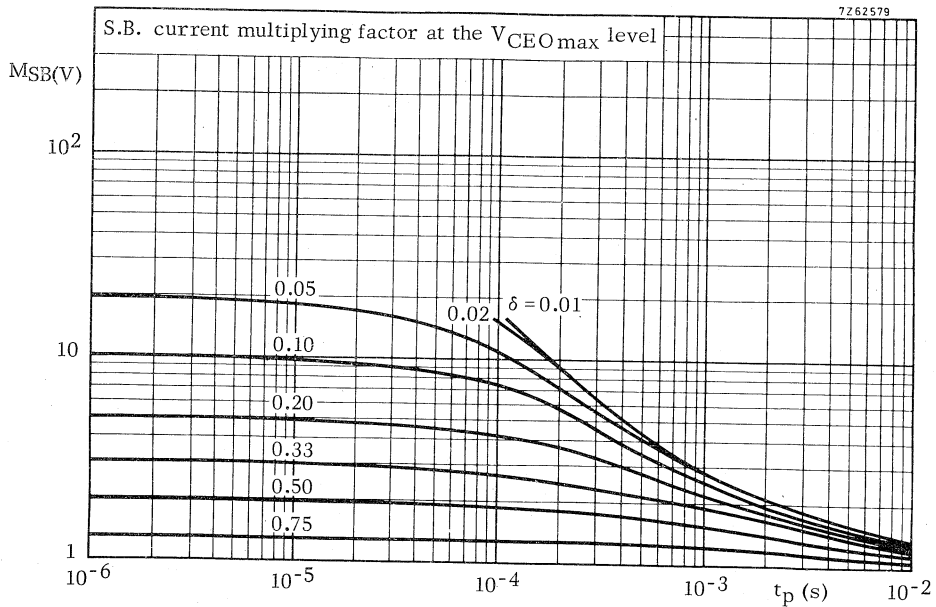
1) Independent of temperature.

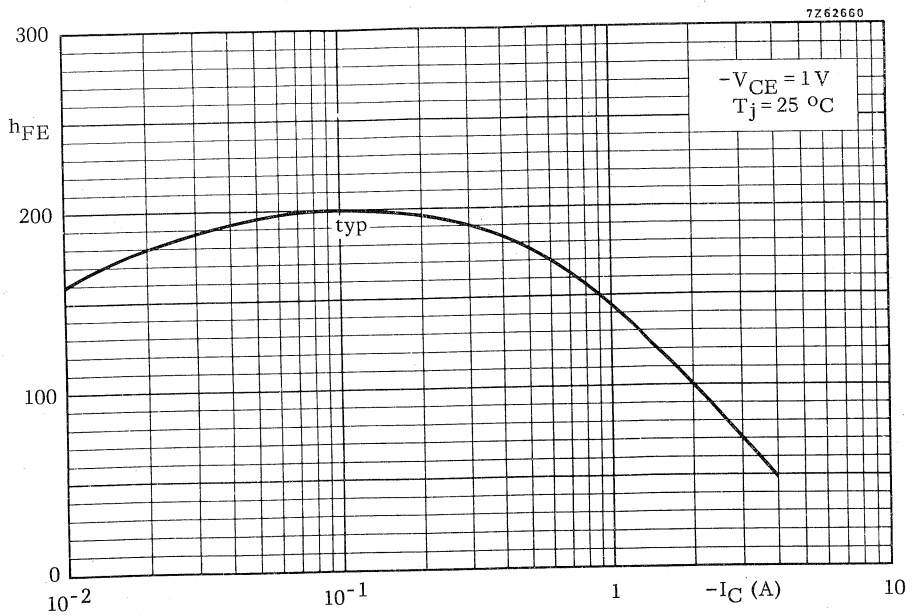
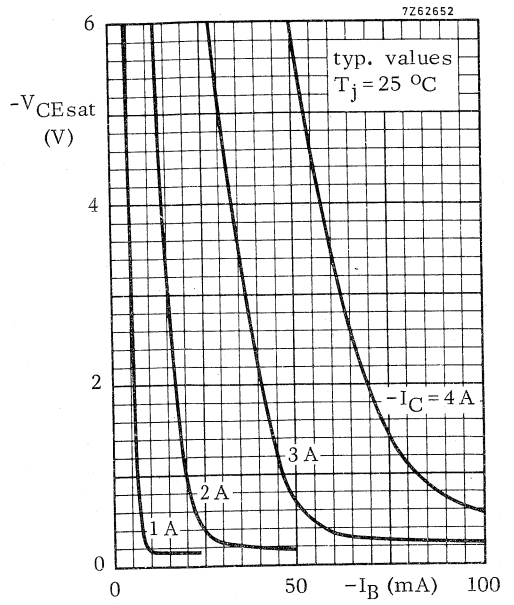
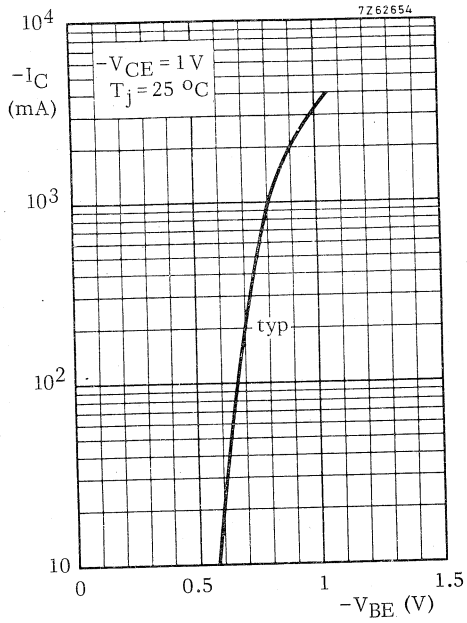


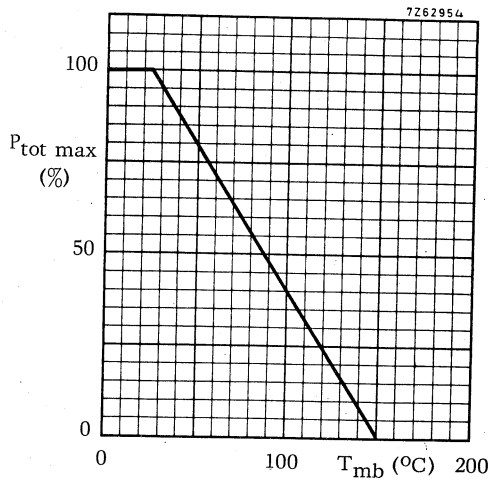
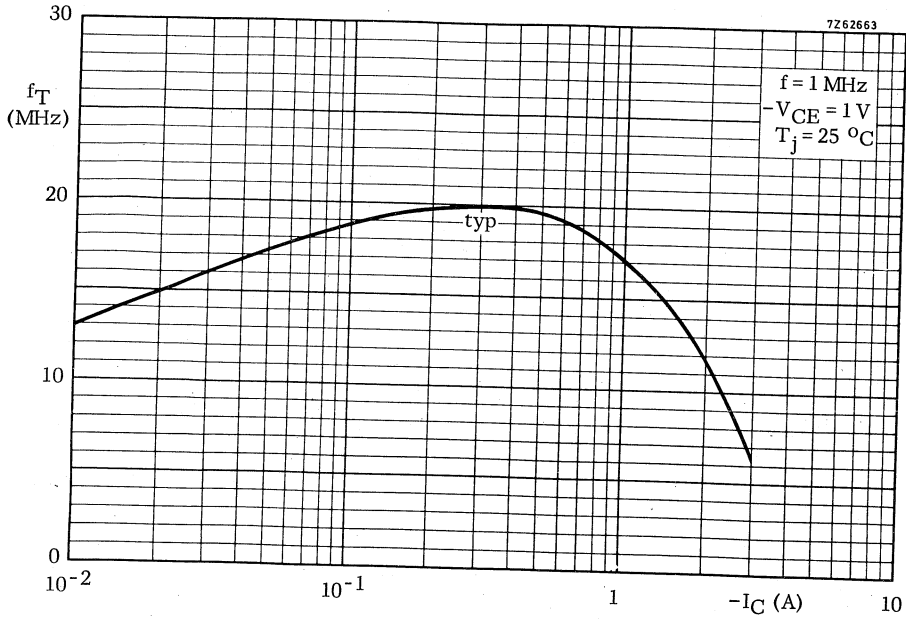
BD434; BD436



BD438







APPLICATION INFORMATION

For information on a 6 W car-radio amplifier and on a 15 W high quality amplifier see BD433; BD435; BD437.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-220 plastic envelope. P-N-P complements are BD646, BD648, BD650 and BD652. Matched complementary pairs can be supplied.

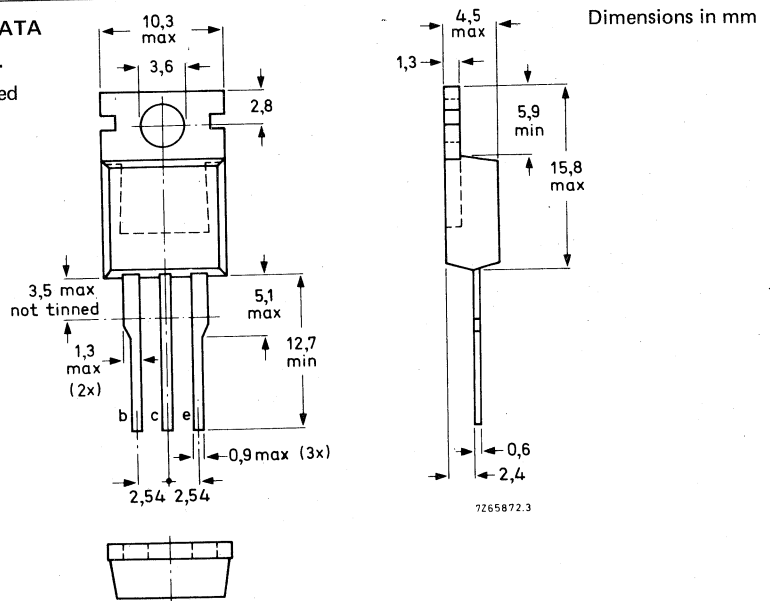
QUICK REFERENCE DATA

			BD645	647	649	651
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120 V
Collector current (peak value)	I_{CM}	max.		12		A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.		62,5		W
Junction temperature	T_j	max.		150		$^{\circ}\text{C}$
D.C. current gain:				1500		
$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	typ.		750		
$I_C = 3,0\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	>				
Cut-off frequency: $I_C = 3\text{ A}; V_{CE} = 3\text{ V}$	f_{hfe}	typ.		50		kHz

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting Instructions and Accessories.

CIRCUIT DIAGRAM

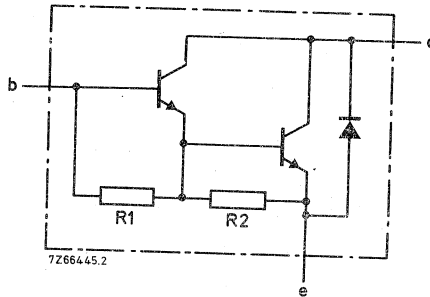


Fig. 2
R₁ typ. 4 kΩ
R₂ typ. 100 Ω

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BD645	647	649	651
Collector-base voltage (open emitter)	V _{CBO} max.	80	100	120	140 V
Collector-emitter voltage (open base)	V _{CEO} max.	60	80	100	120 V
Emitter-base voltage (open collector)	V _{EBO} max.	5	5	5	5 V
Collector current (d.c.)	I _C max.		8		A
Collector current (peak value)	I _{CM} max.		12		A
Base current (d.c.)	I _B max.		150		mA
Total power dissipation up to T _{mb} = 25 °C	P _{tot} max.		62,5		W
Storage temperature	T _{stg}	-65 to + 150			°C
Junction temperature *	T _j max.		150		°C

THERMAL RESISTANCE *

From junction to mounting base	R _{th j-mb} =	2	°C/W
From junction to ambient in free air	R _{th j-a} =	70	°C/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CBO} = V_{CEOmax}$

$I_{CBO} < 0,2\text{ mA}$

$I_E = 0; V_{CB} = \frac{1}{2} V_{CBOmax}; T_j = 150\text{ }^\circ\text{C}$

$I_{CBO} < 2\text{ mA}$

$I_B = 0; V_{CE} = \frac{1}{2} V_{CEOmax}$

$I_{CEO} < 0,5\text{ mA}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 5\text{ mA}$

D.C. current gain (note 1)

$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 1500$

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} > 750$

$I_C = 8\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 500$

Base-emitter voltage (notes 1 and 2)

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$V_{BE} < 2,5\text{ V}$

Collector-emitter saturation voltage (note 1)

$I_C = 3\text{ A}; I_B = 12\text{ mA}$

$V_{CEsat} < 2\text{ V}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_c \text{ typ. } 75\text{ pF}$

Cut-off frequency

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$f_{hfe} \text{ typ. } 50\text{ kHz}$

Turn-off breakdown energy with inductive load

$-I_{Boff} = 0; I_{CM} = 4,5\text{ A}; t_p = 1\text{ ms};$

$T = 100\text{ ms}; \text{ see Fig. 4}$

$E_{(BR)} > 50\text{ mJ}$

D.C. current gain ratio of matched complementary pairs

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE1}/h_{FE2} < 2,5$

Small signal current gain

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}; f = 1\text{ MHz}$

$|h_{fe}| \text{ typ. } 50$

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.
2. V_{BE} decreases by about $3,6\text{ mV}/^\circ\text{C}$ with increasing temperature.

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Switching times (between 10% and 90% levels)

$I_{Con} = 3\text{ A}$; $I_{Bon} = -I_{Boff} = 12\text{ mA}$; $V_{CC} = 10\text{ V}$

Turn-on time

t_{on} typ. $0,5\text{ }\mu\text{s}$

Turn-off time

t_{off} typ. $2,5\text{ }\mu\text{s}$

$V_{IM} = 10\text{ V}$

$t_r = t_f = 15\text{ ns}$

$t_p = 10\text{ }\mu\text{s}$

$T = 500\text{ }\mu\text{s}$

$R1 = 56\text{ }\Omega$

$R2 = 410\text{ }\Omega$

$R3 = 560\text{ }\Omega$

$R4 = 3\text{ }\Omega$

$-V_{BB} = 4\text{ V}$

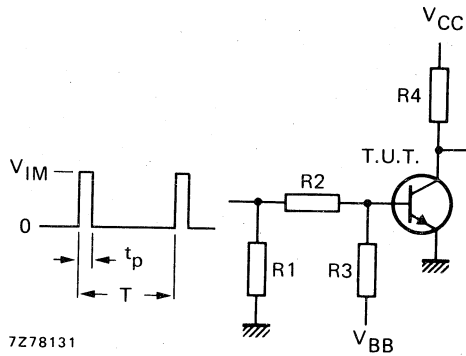


Fig. 3 Test circuit switching times.

Diode, forward voltage
 $I_F = 3\text{ A}$

V_F typ. $1,2\text{ V}$

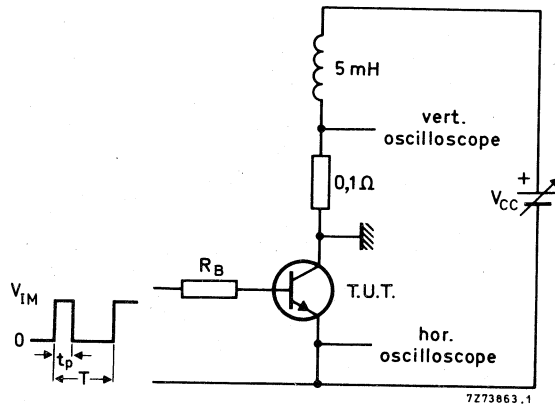


Fig. 4 Test circuit for turn-off breakdown energy. $V_{IM} = 12\text{ V}$; $R_B = 270\text{ }\Omega$; $T = 100\text{ ms}$; $t_p = 1\text{ ms}$.

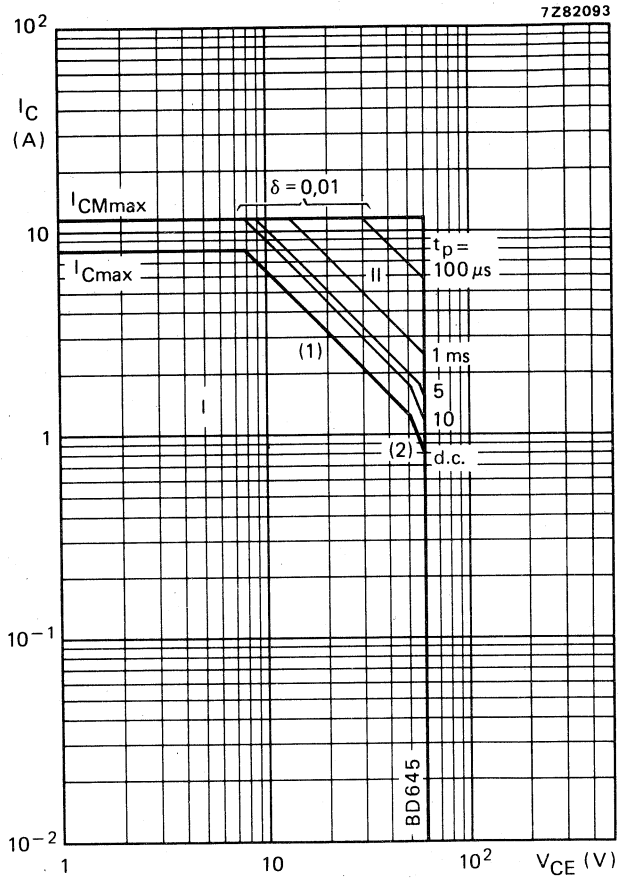


Fig. 5 Safe Operating Area; $T_{mb} = 25^{\circ}\text{C}$

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
- (2) Second-breakdown limits (independent of temperature).

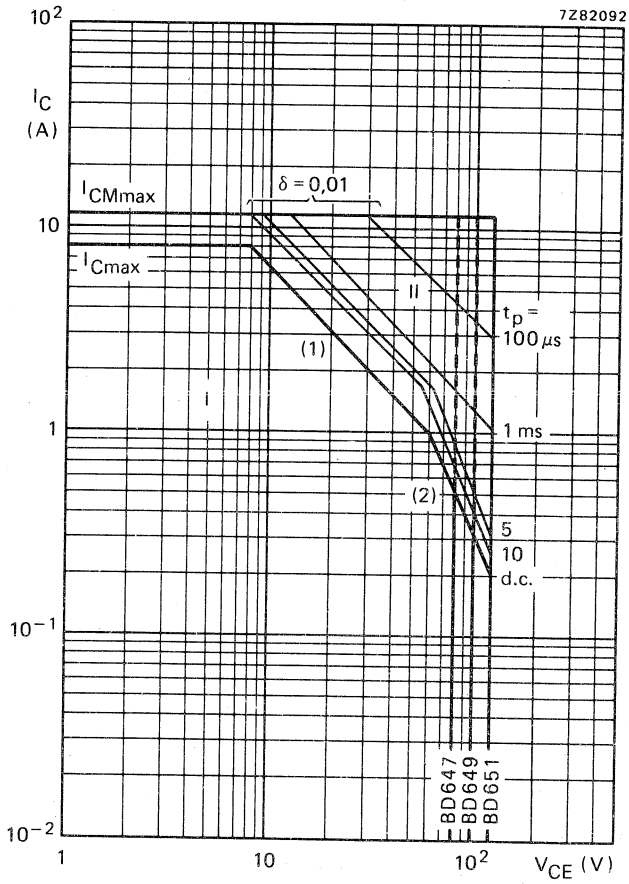


Fig. 6 Safe Operating Area; $T_{mb} = 25 \text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.

- (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
- (2) Second-breakdown limits (independent of temperature).

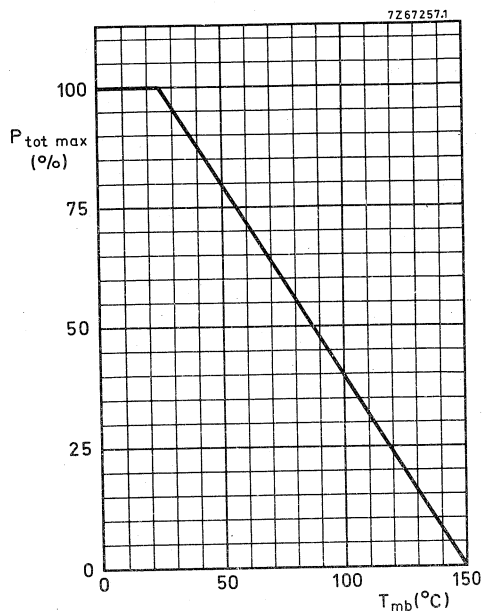


Fig. 7.

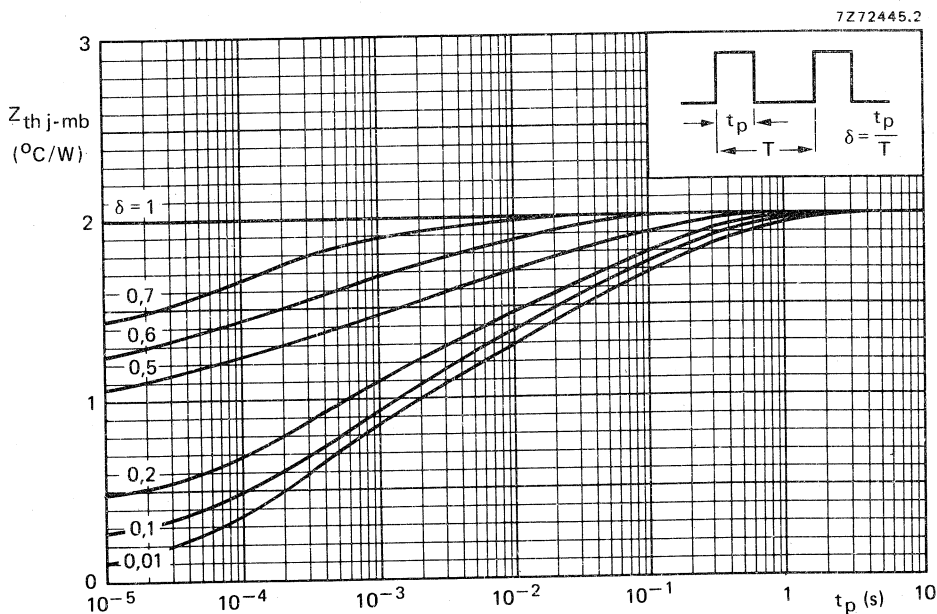


Fig. 8 Pulse power rating chart.

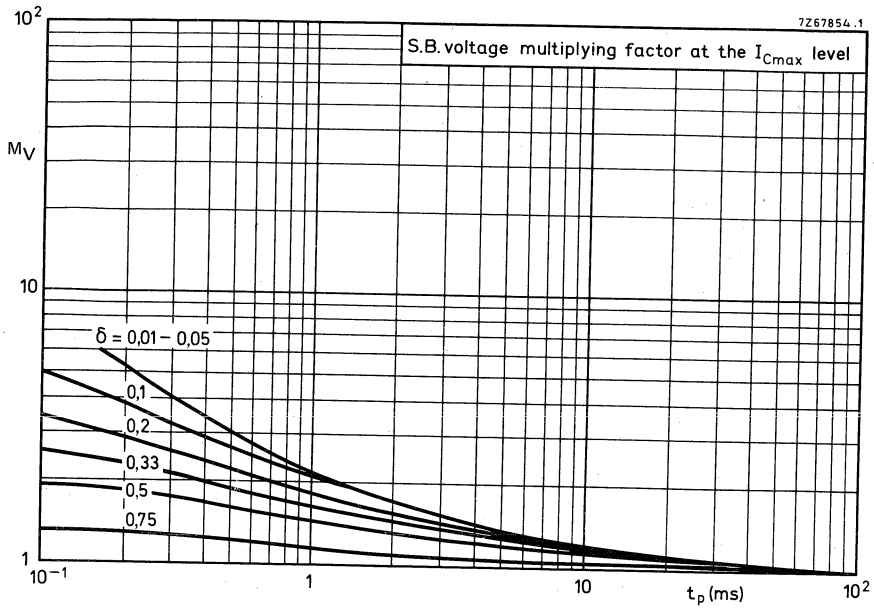


Fig. 9.

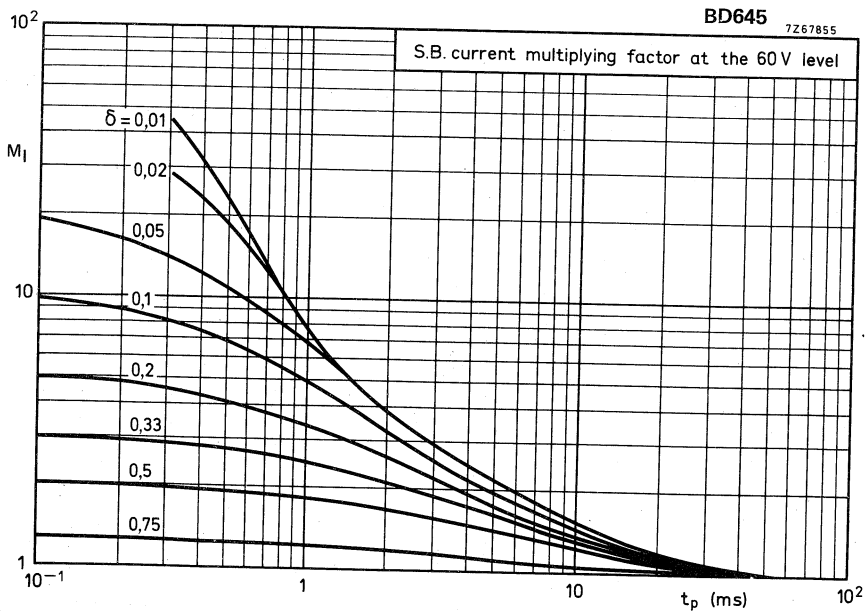


Fig. 10.

BD647; BD649

7267856

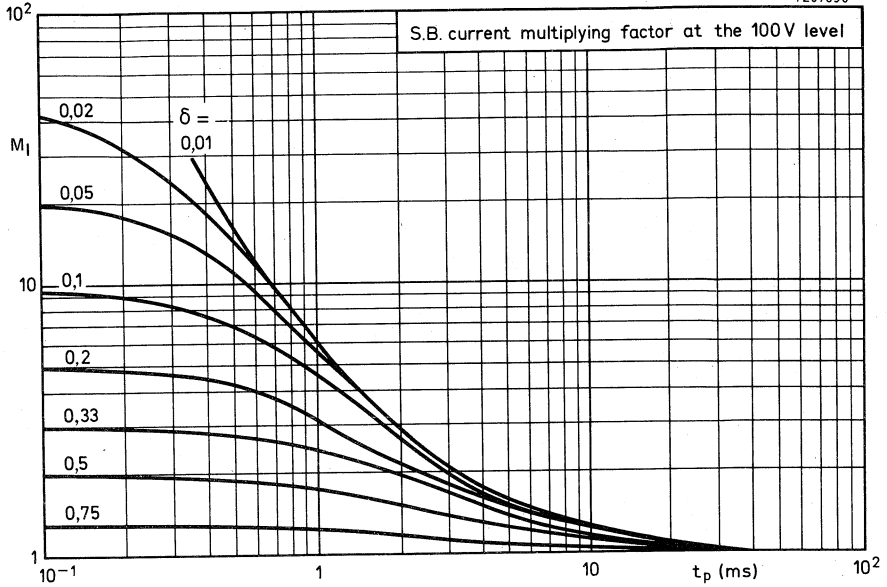


Fig. 11 Second breakdown current multiplying factor at the 100 V level.

BD651

7277026.1

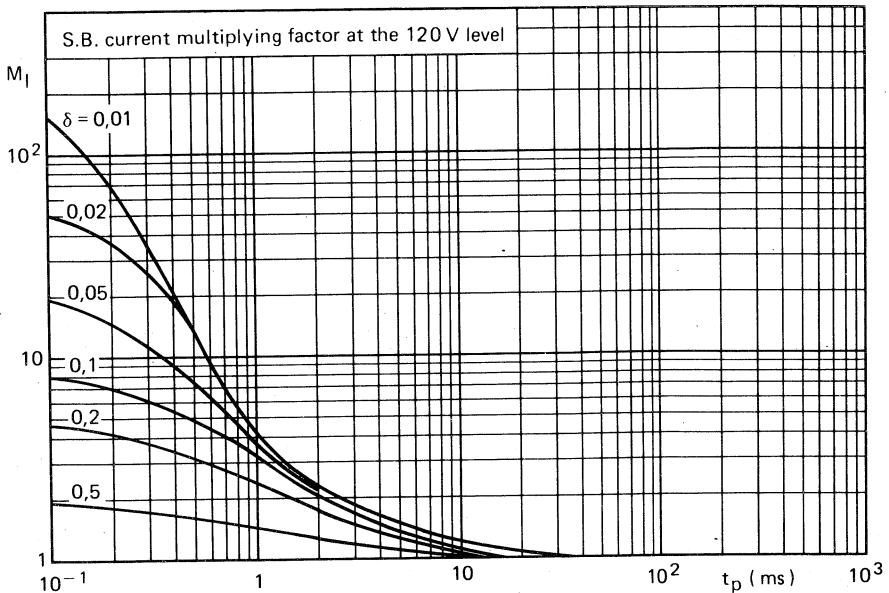


Fig. 12 Second breakdown current multiplying factor at the 120 V level.

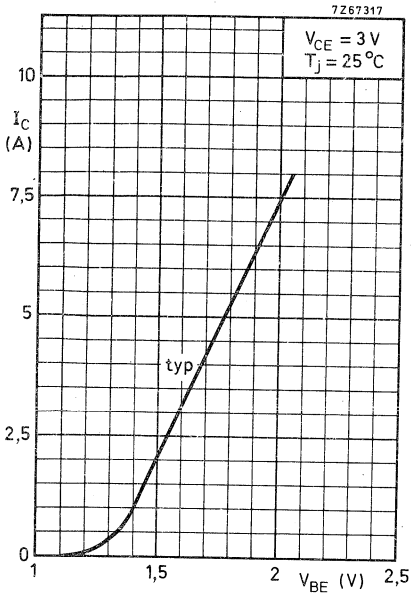


Fig. 13.

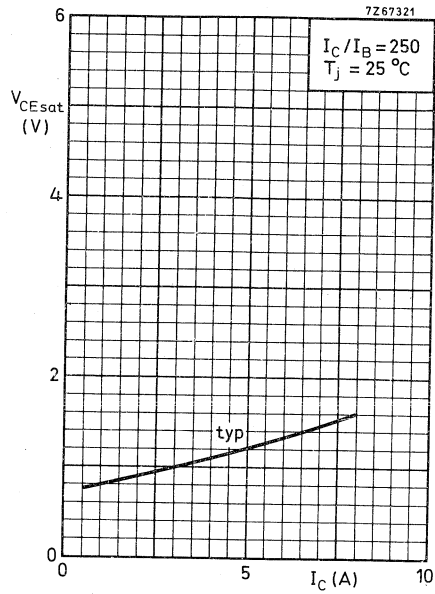


Fig. 14.

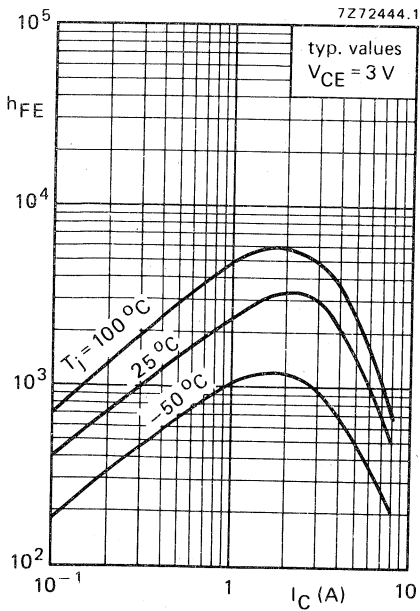


Fig. 15.

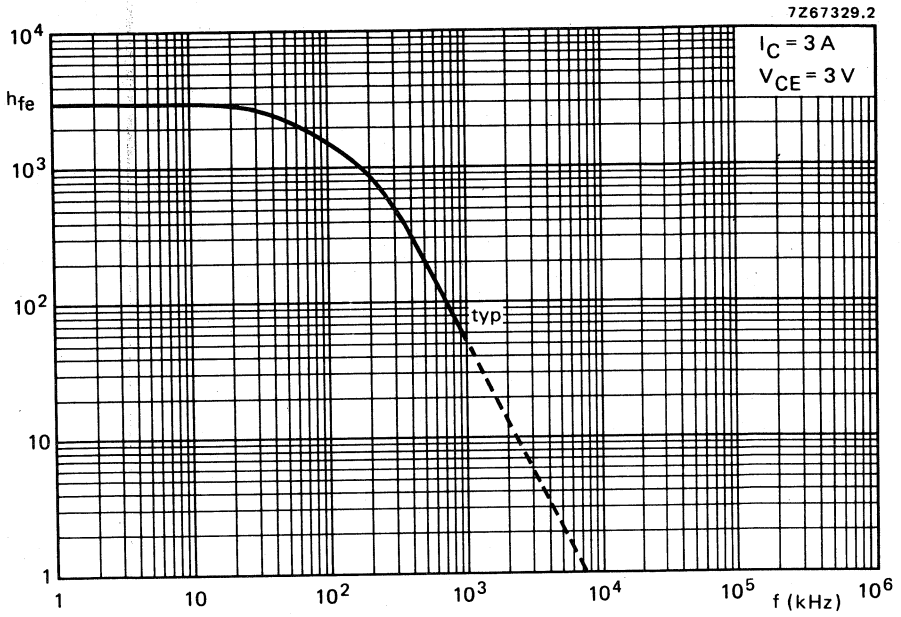


Fig. 16.



SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-220 plastic envelope. N-P-N complements are BD645, BD647, BD649 and BD651. Matched complementary pairs can be supplied.

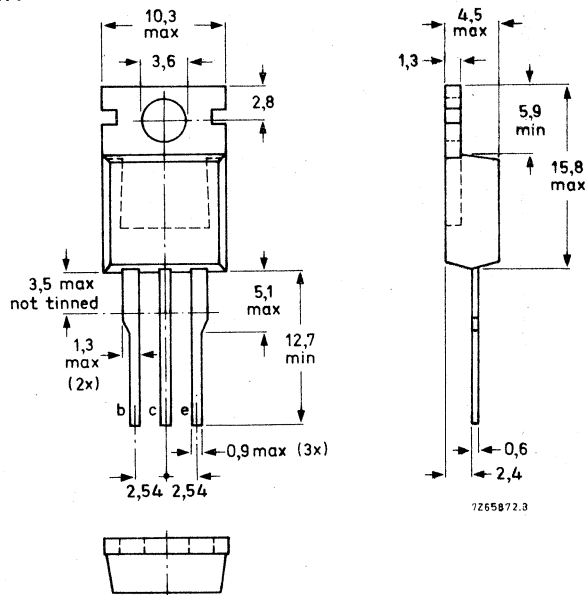
QUICK REFERENCE DATA

		BD646	648	650	652
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100	120 V
Collector current (peak value)	$-I_{CM}$ max.			12	A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.			62,5	W
Junction temperature	T_j max.			150	$^{\circ}\text{C}$
D.C. current gain:					
$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE} typ.			1500	
$-I_C = 3,0\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE} >			750	
Cut-off frequency:					
$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe} typ.			100	kHz

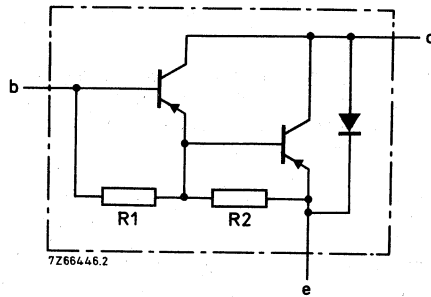
MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting Instructions and Accessories.



R₁ typ. 4 kΩ
R₂ typ. 80 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BD646	648	650	652
Collector-base voltage (open emitter)	-V _{CBO} max.	60	80	100	120 V
Collector-emitter voltage (open base)	-V _{CEO} max.	60	80	100	120 V
Emitter-base voltage (open collector)	-V _{EBO} max.	5	5	5	5 V
Collector current (d.c.)	-I _C max.	8			A
Collector current (peak value)	-I _{CM} max.	12			A
Base current (d.c.)	-I _B max.	150			mA
Total power dissipation up to T _{mb} = 25 °C	P _{tot} max.	62,5			W
Storage temperature	T _{stg}	-65 to + 150			°C
Junction temperature *	T _j	150			°C

THERMAL RESISTANCE *

From junction to mounting base	R _{th j-mb} =	2	°C/W
From junction to ambient in free air	R _{th j-a} =	70	°C/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CB0max}$

$-I_{CBO} < 0,2\text{ mA}$

BD646: $-V_{CB} = 40\text{ V}$

$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 150\text{ }^\circ\text{C}$

$-I_{CBO} < 2\text{ mA}$

BD650: $-V_{CB} = 60\text{ V}$

BD652: $-V_{CB} = 70\text{ V}$

$I_B = 0; -V_{CE} = \frac{1}{2} V_{CE0max}$

$-I_{CEO} < 0,5\text{ mA}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$

$-I_{EBO} < 5\text{ mA}$

D.C. current gain (note 1)

$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 1500$

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} > 750$

$-I_C = 8\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 500$

Base-emitter voltage (notes 1 and 2)

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$-V_{BE} < 2,5\text{ V}$

Collector-emitter saturation voltage (note 1)

$-I_C = 3\text{ A}; -I_B = 12\text{ mA}$

$-V_{CEsat} < 2\text{ V}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$

$C_c \text{ typ. } 75\text{ pF}$

Cut-off frequency

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$f_{hfe} \text{ typ. } 100\text{ kHz}$

Small-signal current gain

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz}$

$|h_{fe}| \text{ typ. } 150$

D.C. current gain ratio of matched complementary pairs

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE1}/h_{FE2} \text{ max. } 2,5$

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.2. $-V_{BE}$ decreases by about $3,6\text{ mV}/^\circ\text{C}$ with increasing temperature.

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Switching times (between 10% and 90% levels)

$-I_{Con} = 3\text{ A}; -I_{Bon} = I_{Boff} = 12\text{ mA}; V_{CC} = -10\text{ V}$

Turn-on time

t_{on} typ. $0,2\text{ }\mu\text{s}$

Turn-off time

t_{off} typ. $1,5\text{ }\mu\text{s}$

$-V_{IM} = 10\text{ V}$

$t_r = t_f = 15\text{ ns}$

$t_p = 10\text{ }\mu\text{s}$

$T = 500\text{ }\mu\text{s}$

$R1 = 56\text{ }\Omega$

$R2 = 410\text{ }\Omega$

$R3 = 560\text{ }\Omega$

$R4 = 3\text{ }\Omega$

$V_{BB} = 4\text{ V}$

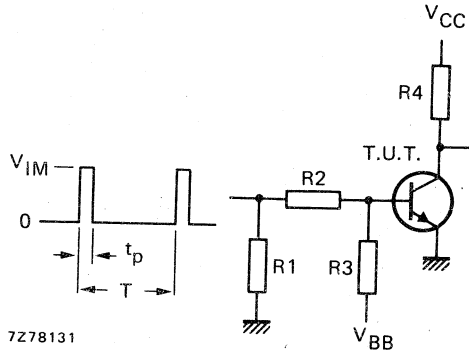


Fig. 3 Test circuit.

Diode, forward voltage
 $I_F = 3\text{ A}$

V_F typ. $1,8\text{ V}$

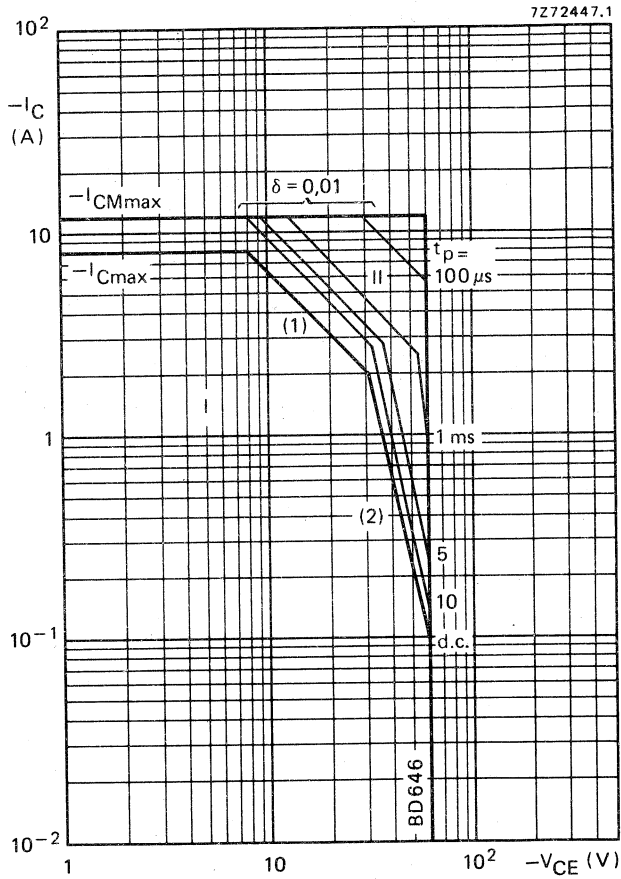


Fig. 4 Safe Operating Area. $T_{mb} = 25^\circ C$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot max}$ and $P_{peak max}$ lines.
- (2) Second-breakdown limits (independent of temperature).

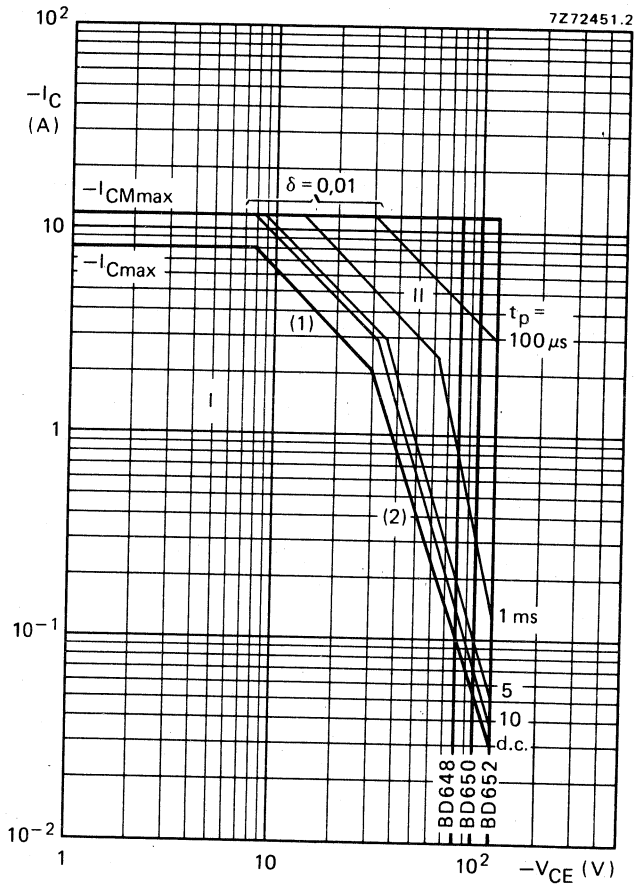


Fig. 5 Safe Operating Area. $T_{mb} = 25\text{ }^{\circ}\text{C}$

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits (independent of temperature).

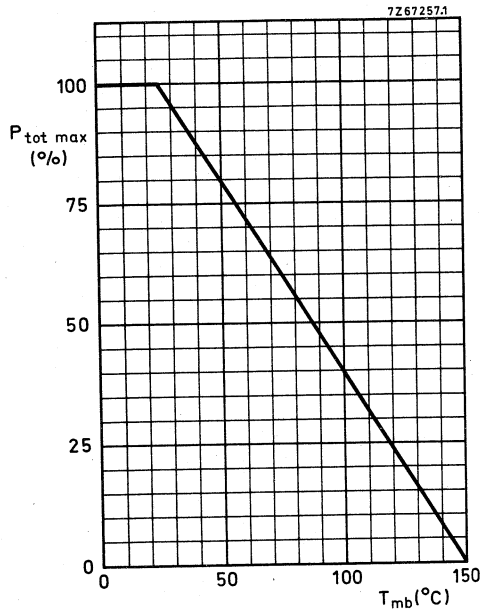


Fig. 6.

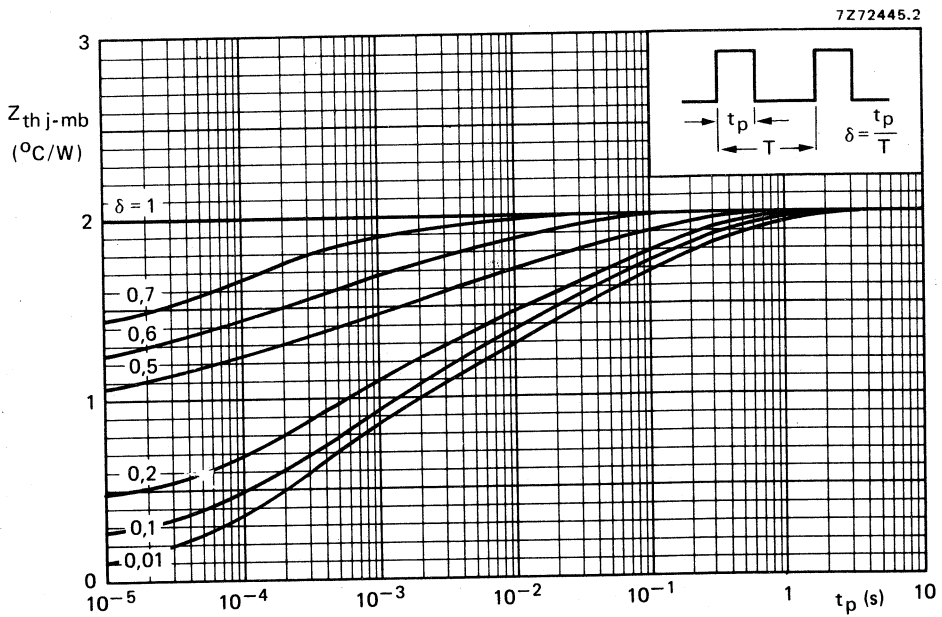


Fig. 7 Pulse power rating chart.

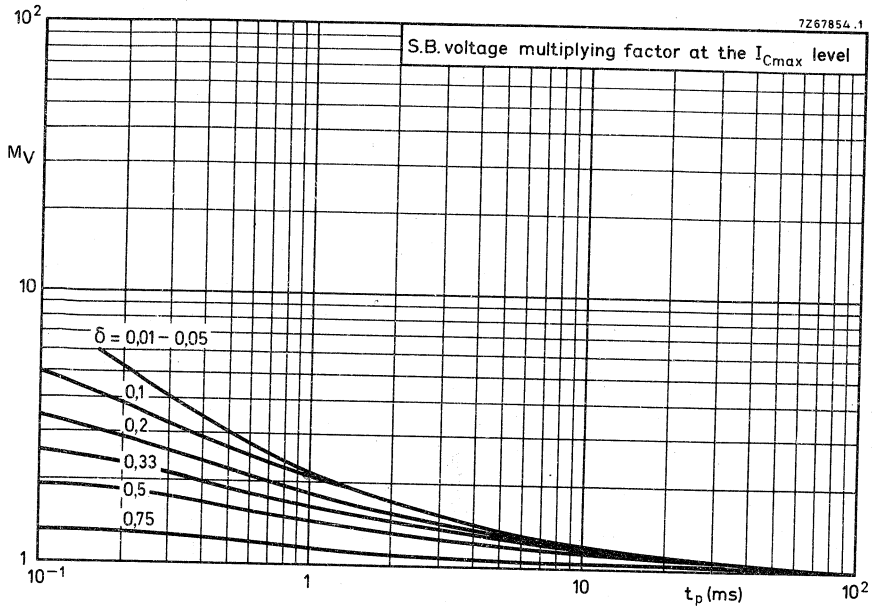


Fig. 8.

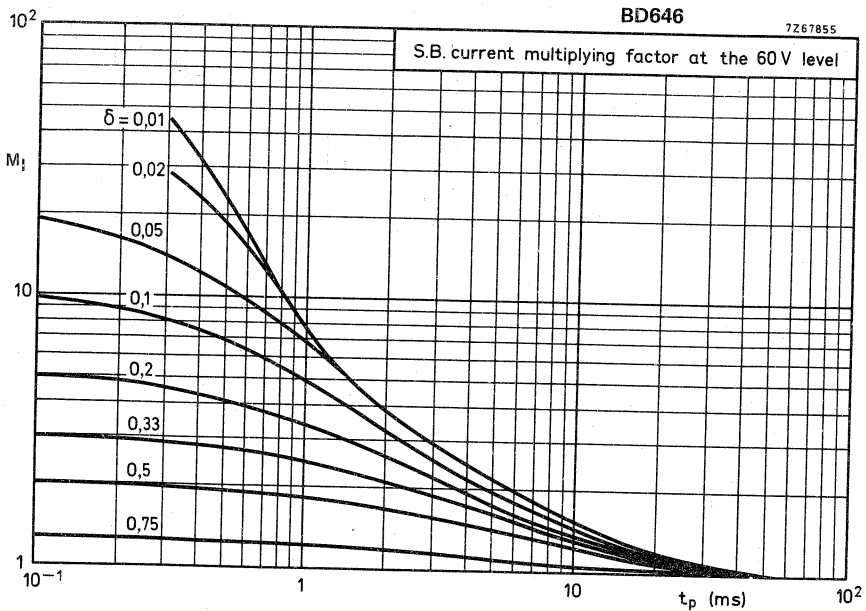
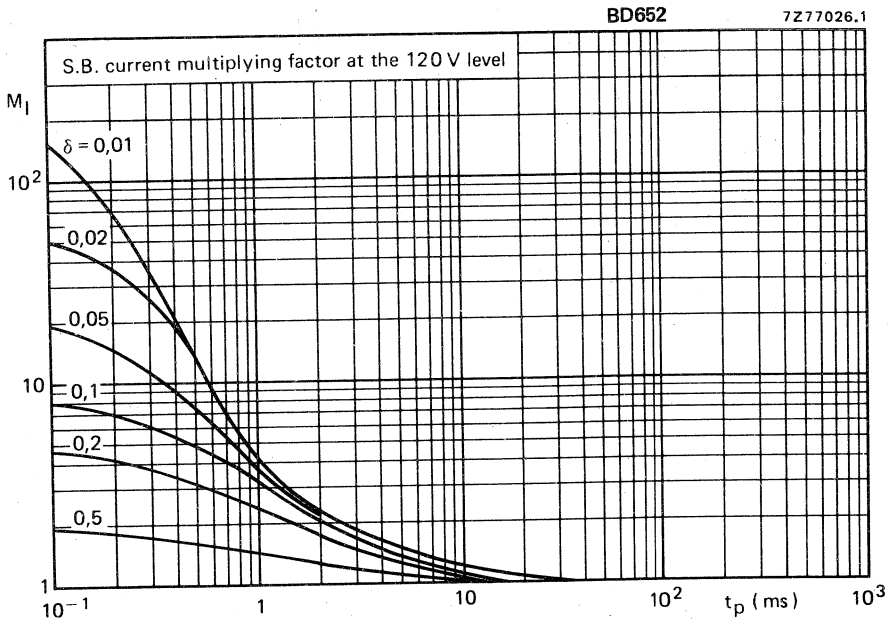
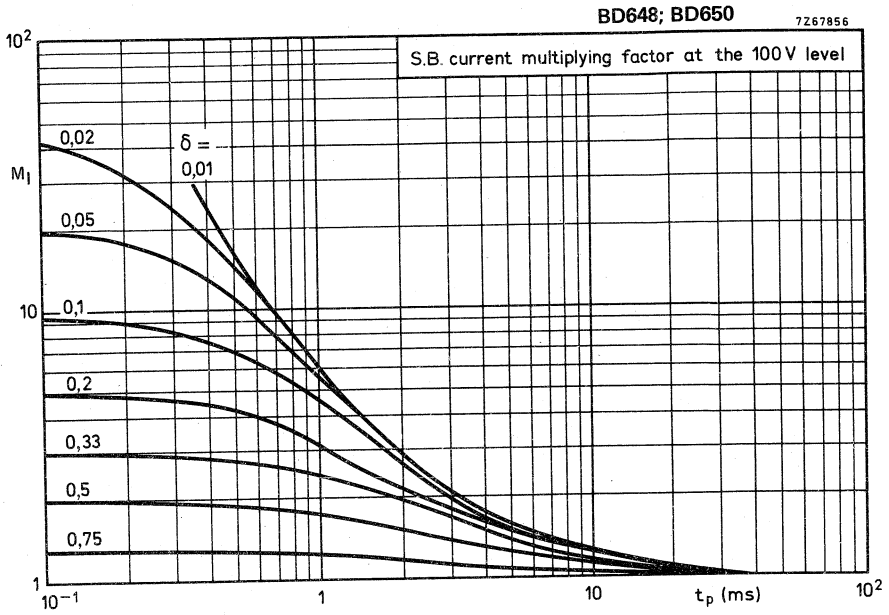


Fig. 9.



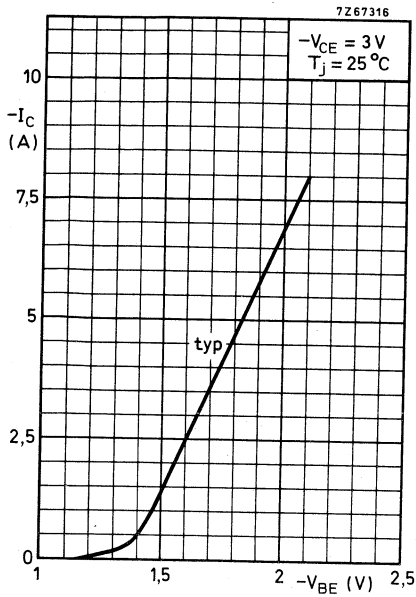


Fig. 12.

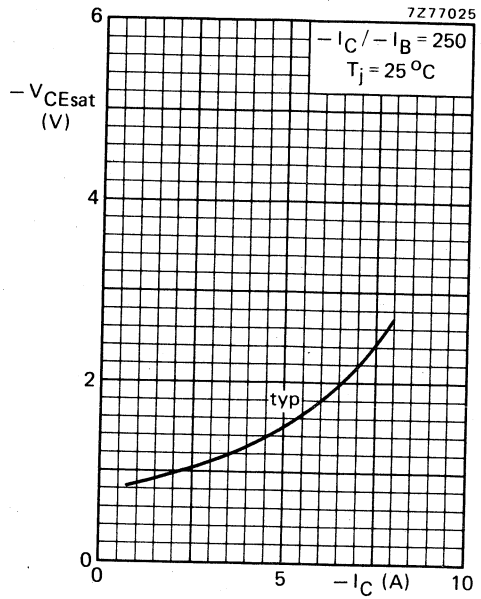


Fig. 13.

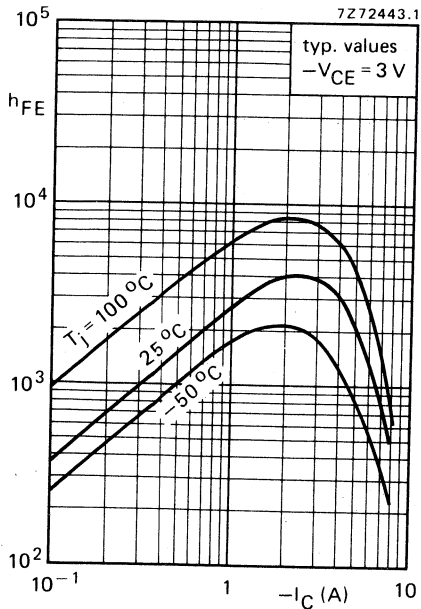


Fig. 14.

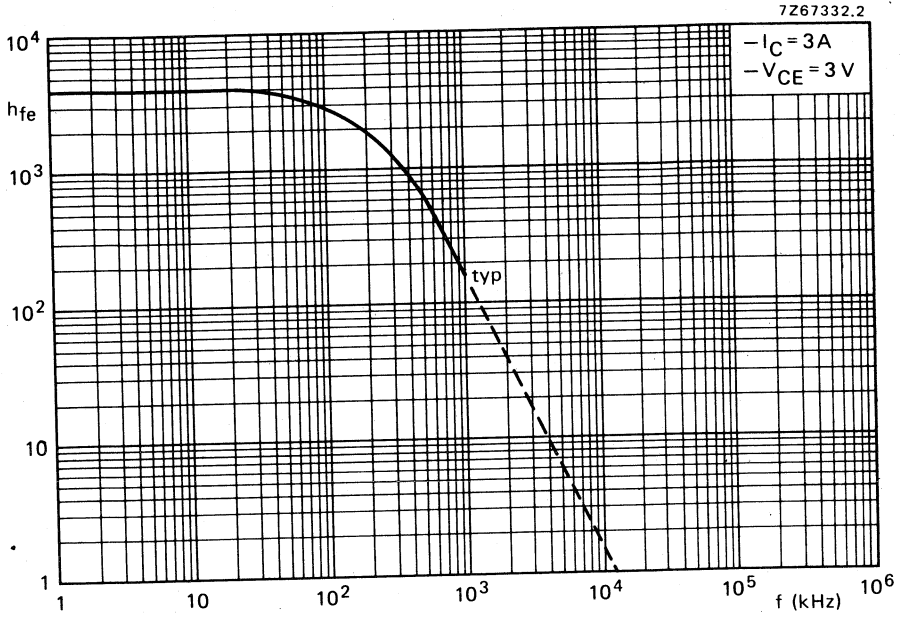


Fig. 15.



SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial-base transistors in monolithic Darlington circuit for audio and video applications; SOT-32 plastic envelope. P-N-P complements are BD676, BD678, BD680, BD682 and BD684.

QUICK REFERENCE DATA

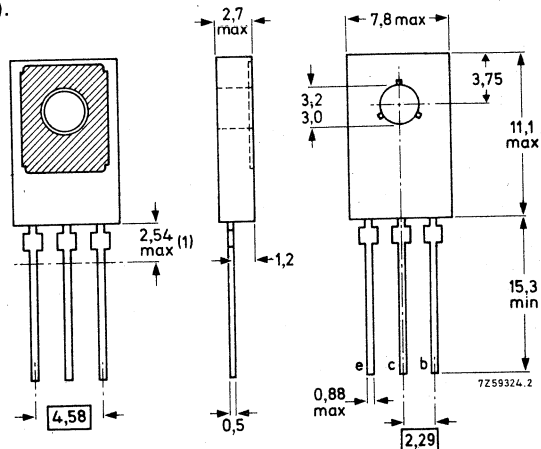
		BD675	677	679	681	683	
Collector-base voltage (open emitter)	V_{CBO} max.	60	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO} max.	45	60	80	100	120	V
Collector current (peak value)	I_{CM} max.					6	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot} max.					40	W
Junction temperature	T_j max.					150	$^\circ\text{C}$
D.C. current gain	h_{FE} typ.					1000	
$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$	$h_{FE} >$					750	
$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}						
Cut-off frequency	f_{hfe} typ.					60	kHz
$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V}$							

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126 (SOT-32).

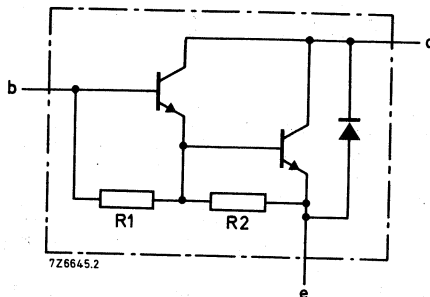
Collector connected to mounting base.



(1) Within this region the cross-section of the leads is uncontrolled.

Accessories: 56326 (washer) or 56353 (clip) for direct mounting.
56333 (washer + mica) or 56353 + 56354 (clip + mica) for insulated mounting.

CIRCUIT DIAGRAM



R₁ typ. 3 kΩ
R₂ typ. 120 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD675	677	679	681	683
Collector-base voltage (open emitter)	V _{CBO}	max.	60	80	100	120	140 V
Collector-emitter voltage (open base)	V _{CEO}	max.	45	60	80	100	120 V
Emitter-base voltage (open collector)	V _{EBO}	max.	5	5	5	5	5 V
Collector current (d.c.)	I _C	max.			4		A
Collector current (peak value)	I _{CM}	max.			6		A
Base current (d.c.)	I _B	max.			100		mA
Total power dissipation up to T _{mb} = 25 °C	P _{tot}	max.			40		W
Storage temperature	T _{stg}				-65 to + 150		°C
Junction temperature	T _j	max.			150		°C

THERMAL RESISTANCE

From junction to mounting base	R _{th j-mb}	=			3,12		°C/W
From junction to ambient in free air	R _{th j-a}	=			100		°C/W

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$, unless otherwise specified; where $I_C = 1,5\text{ A}$ for BD675 read $I_C = 2\text{ A}$.

Collector cut-off current

$$I_E = 0; V_{CB} = V_{CE0\text{max}}$$

$$I_{CBO} < 0,2\text{ mA}$$

$$I_E = 0; V_{CB} = \frac{1}{2} V_{CB0\text{max}}; T_{mb} = 150\text{ }^\circ\text{C}$$

$$I_{CBO} < 2\text{ mA}$$

$$I_B = 0; V_{CE} = \frac{1}{2} V_{CE0\text{max}}$$

$$I_{CEO} < 0,5\text{ mA}$$

Emitter cut-off current

$$I_C = 0; V_{EB} = 5\text{ V}$$

$$I_{EBO} < 5\text{ mA}$$

D.C. current gain (note 1)

$$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$$

$$h_{FE} \text{ typ. } 1000$$

$$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V}$$

$$h_{FE} > 750$$

$$I_C = 4\text{ A}; V_{CE} = 3\text{ V}$$

$$h_{FE} \text{ typ. } 500$$

Base-emitter voltage (notes 1 and 2)

$$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V}$$

$$V_{BE} < 2,5\text{ V}$$

Collector-emitter saturation voltage (note 1)

$$I_C = 1,5\text{ A}; I_B = 6\text{ mA}$$

$$V_{CEsat} < 2,5\text{ V}$$

Small signal current gain

$$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V}; f = 1\text{ MHz}$$

$$|h_{fe}| \text{ typ. } 50 \leftarrow$$

Cut-off frequency

$$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V}$$

$$f_{hfe} \text{ typ. } 60\text{ kHz} \leftarrow$$

Turn-off breakdown energy with inductive load

$$-I_{Boff} = 0; I_{CM} = 3,5\text{ A};$$

$$L = 5\text{ mH}; \text{ see Fig. 3}$$

$$E(BR) > 30\text{ mJ} \leftarrow$$

D.C. current gain ratio of matched complementary pairs

$$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V}$$

$$h_{FE1}/h_{FE2} < 2,5 \leftarrow$$

Diode forward voltage

$$I_F = 1,5\text{ A}$$

$$V_F \text{ typ. } 1,5\text{ V} \leftarrow$$

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$; $\delta < 2\%$.
2. V_{BE} decreases by about $3,6\text{ mV}/^\circ\text{C}$ with increasing temperature.

CHARACTERISTICS (continued)

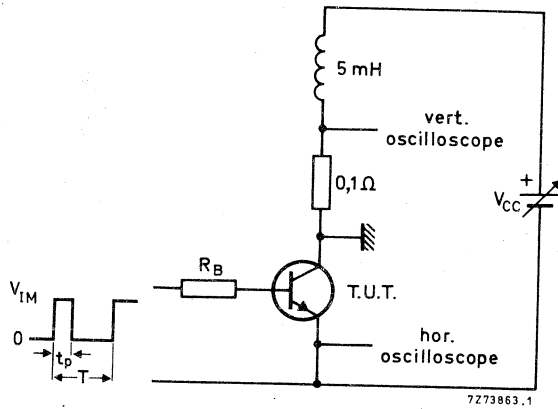


Fig. 3 Test circuit for turn-off breakdown energy. $V_{IM} = 12 \text{ V}$; $R_B = 270 \Omega$.

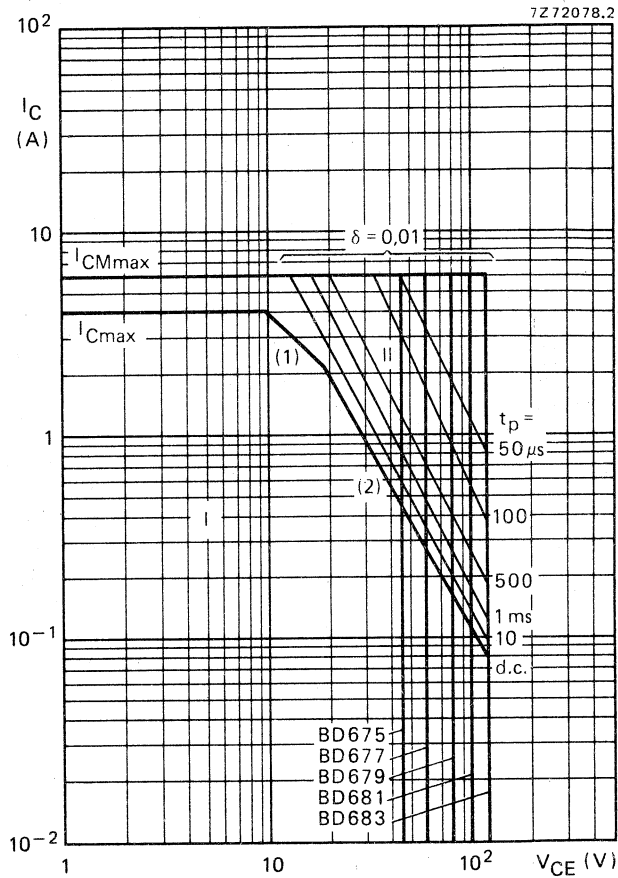


Fig. 4 Safe Operating Area. $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ line.
- (2) Second-breakdown limits (independent of temperature).

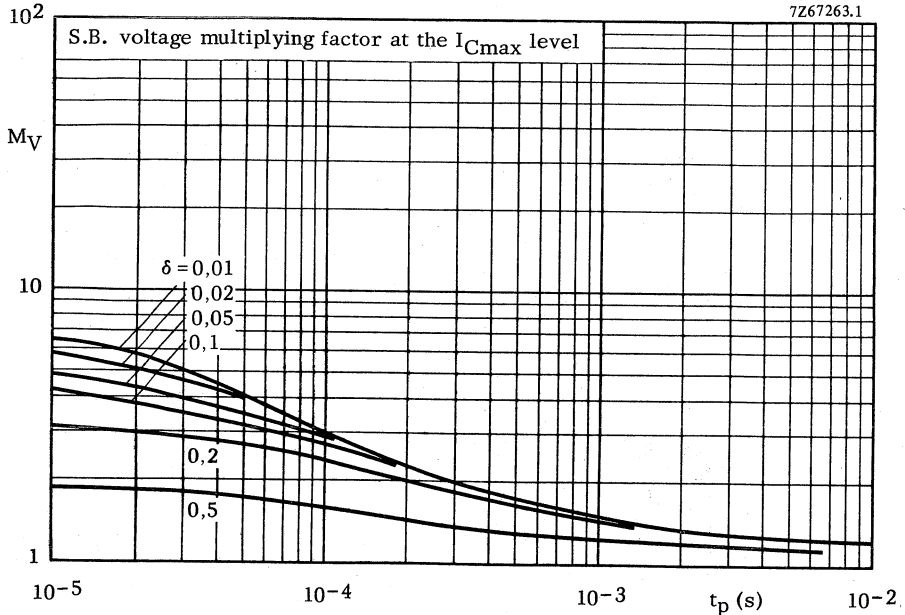


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

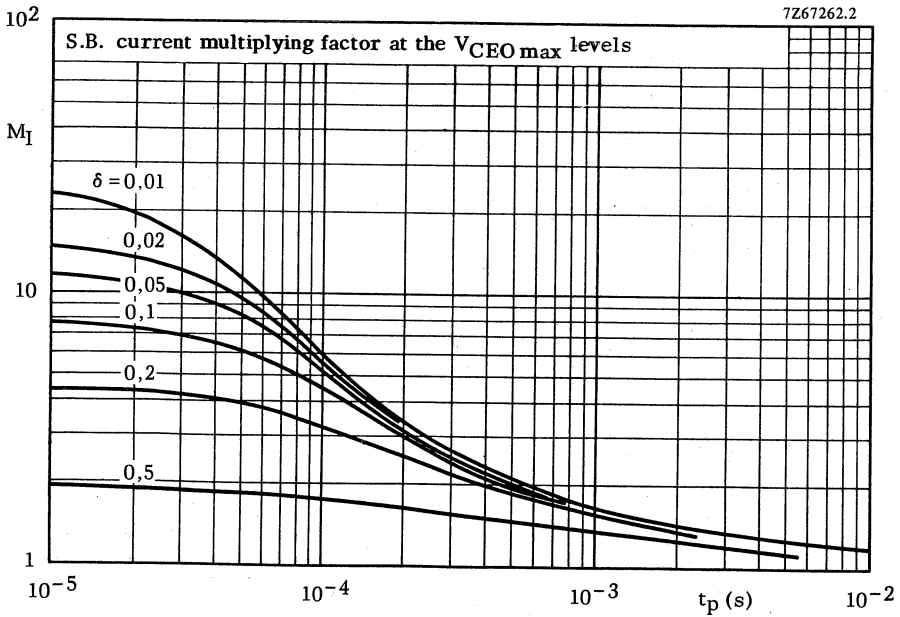


Fig. 6 S.B. current multiplying factor at the V_{CE0max} levels.

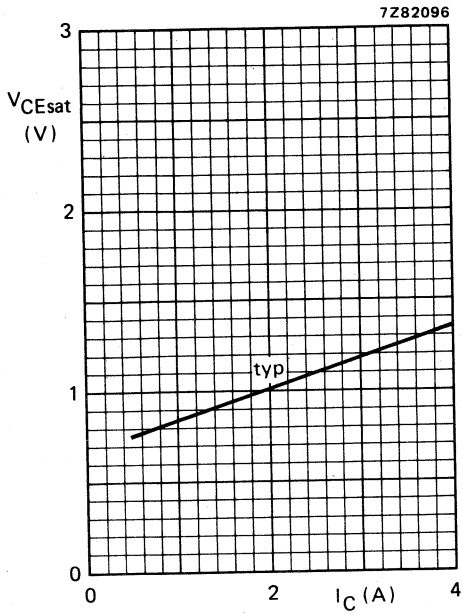


Fig. 7.

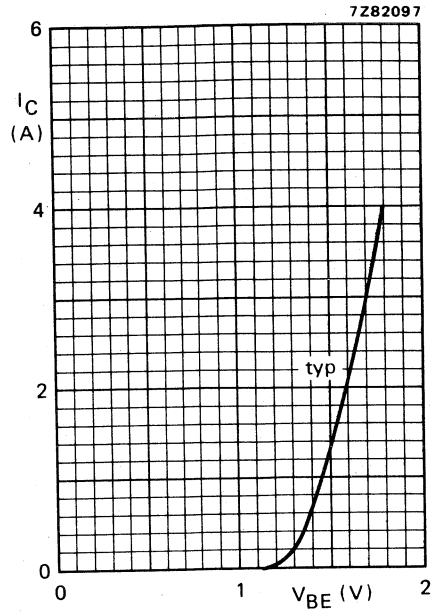


Fig. 8.

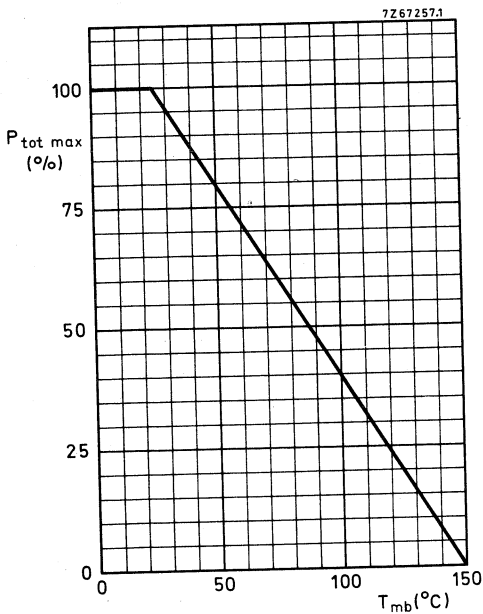


Fig. 9.

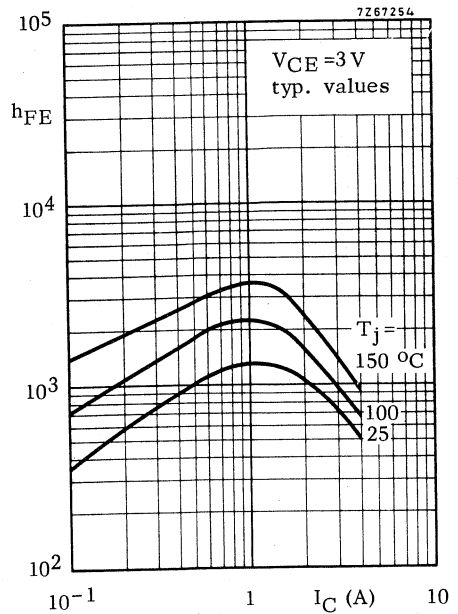


Fig. 10.

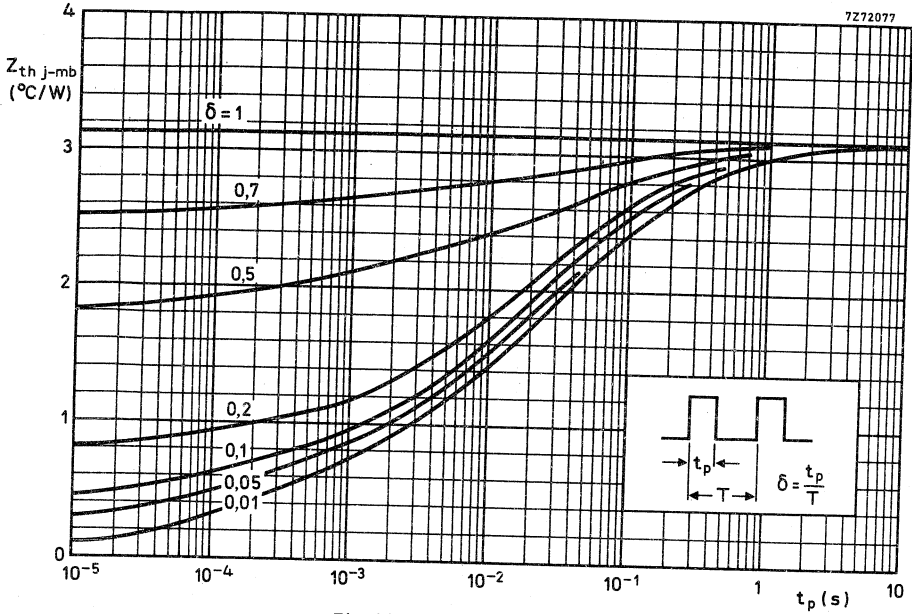


Fig. 11 Pulse power rating chart.

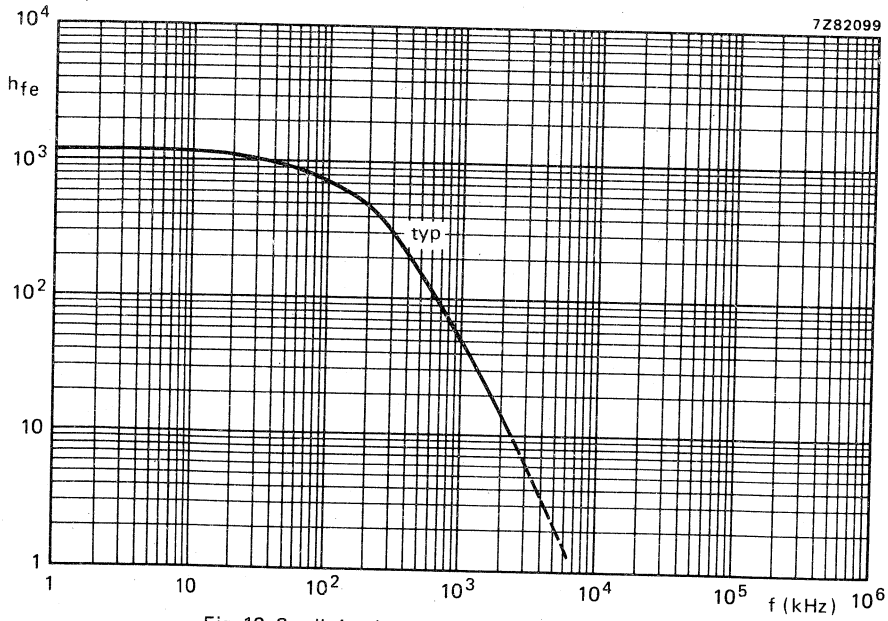


Fig. 12 Small signal current gain. $I_C = 1,5\ A$; $V_{CE} = 3\ V$.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial-base transistors in monolithic Darlington circuit for audio and video applications; SOT-32 plastic envelope. N-P-N complements are BD675, BD677, BD679, BD681 and BD683.

QUICK REFERENCE DATA

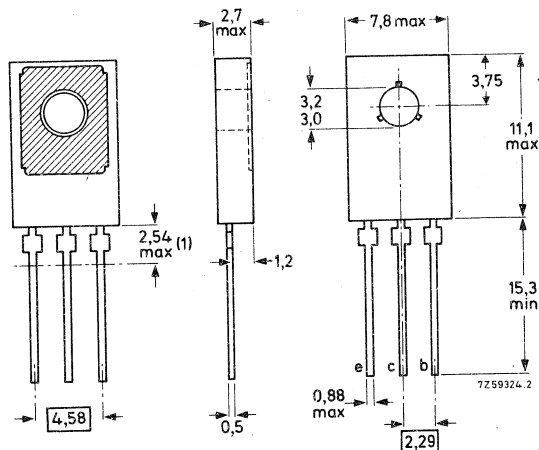
			BD676	678	680	682	684	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Collector-current (peak value)	$-I_{CM}$	max.			6			A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.			40			W
Junction temperature	T_j	max.			150			$^{\circ}\text{C}$
D.C. current gain						1000		
$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}	typ.				750		
$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}	>						
Cut-off frequency						60		kHz
$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe}	typ.						

MECHANICAL DATA

Dimensions in mm

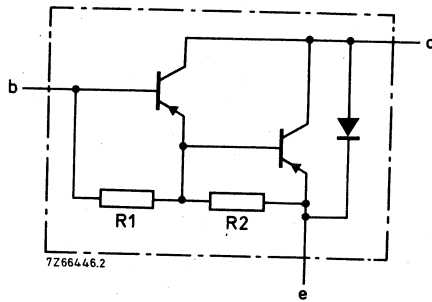
Fig. 1 TO-126 (SOT-32).

Collector connected to mounting base.



(1) Within this region the cross-section of the leads is uncontrolled.

See also chapters Mounting Instructions and Accessories.



R1 typ. 3 k Ω
R2 typ. 80 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD676	678	680	682	684	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	5	V
Collector current (d.c.)	$-I_C$	max.			4			A
Collector current (peak value)	$-I_{CM}$	max.			6			A
Base current (d.c.)	$-I_B$	max.			100			mA
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.			40			W
Storage temperature	T_{stg}				-65 to +150			$^\circ\text{C}$
Junction temperature	T_j	max.			150			$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=			3,12			$^\circ\text{C/W}$
From junction to ambient in free air	$R_{th\ j-a}$	=			100			$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified; where $-I_C = 1,5\text{ A}$ for BD676 read $-I_C = 2\text{ A}$.

Collector cut-off current

$$I_E = 0; -V_{CB} = -V_{CB0\max} \quad -I_{CBO} < 0,2\text{ mA}$$

$$I_E = 0; -V_{CB} = -\frac{1}{2} V_{CB0\max}; T_{mb} = 150\text{ }^\circ\text{C} \quad -I_{CBO} < 2\text{ mA}$$

$$I_B = 0; -V_{CE} = -\frac{1}{2} V_{CE0\max} \quad -I_{CEO} < 0,5\text{ mA}$$

Emitter cut-off current

$$I_C = 0; -V_{EB} = 5\text{ V} \quad -I_{EBO} < 5\text{ mA}$$

D.C. current gain (note 1)

$$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 1000$$

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} > 750$$

$$-I_C = 4\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 500$$

Base-emitter voltage (notes 1 and 2)

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V} \quad -V_{BE} < 2,5\text{ V}$$

Collector-emitter saturation voltage (note 1)

$$-I_C = 1,5\text{ A}; -I_B = 6\text{ mA} \quad -V_{CEsat} < 2,5\text{ V}$$

Small-signal current gain

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz} \quad |h_{fe}| \text{ typ. } 50 \quad \leftarrow$$

Cut-off frequency

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V} \quad f_{hfe} \text{ typ. } 60\text{ kHz} \quad \leftarrow$$

D.C. current gain ratio of matched complementary pairs

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE1}/h_{FE2} < 2,5 \quad \leftarrow$$

Diode, forward voltage

$$I_F = 1,5\text{ A} \quad V_F \text{ typ. } 1,5\text{ V}$$

Notes

1. Measured under pulse conditions: $t_D < 300\text{ }\mu\text{s}$, $\delta < 2\%$.
2. V_{BE} decreases by about $3,6\text{ mV}/^\circ\text{C}$ with increasing temperature.

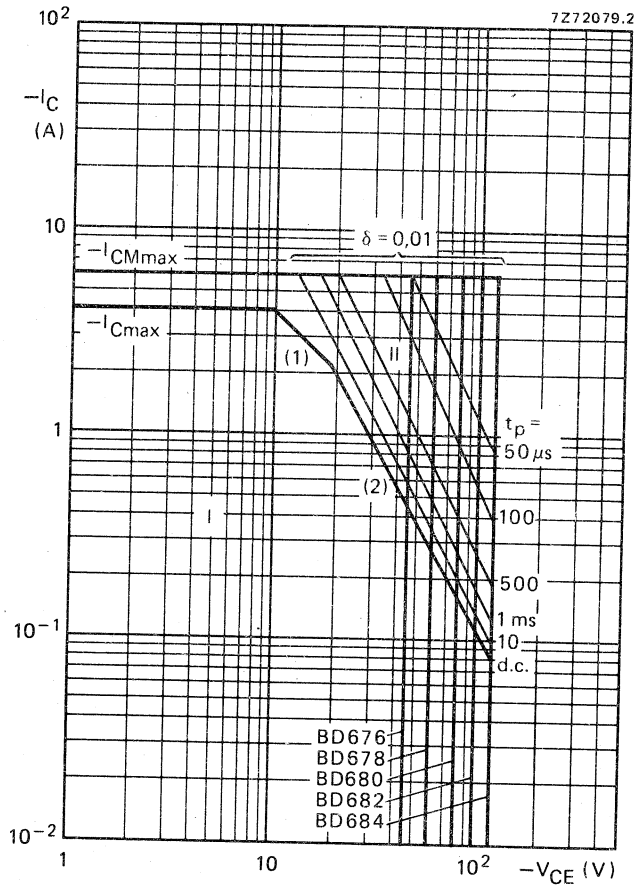


Fig. 3 Safe Operating Area. $T_{mb} = 25^\circ C$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) P_{tot} max line.

(2) Second-breakdown limits (independent of temperature).

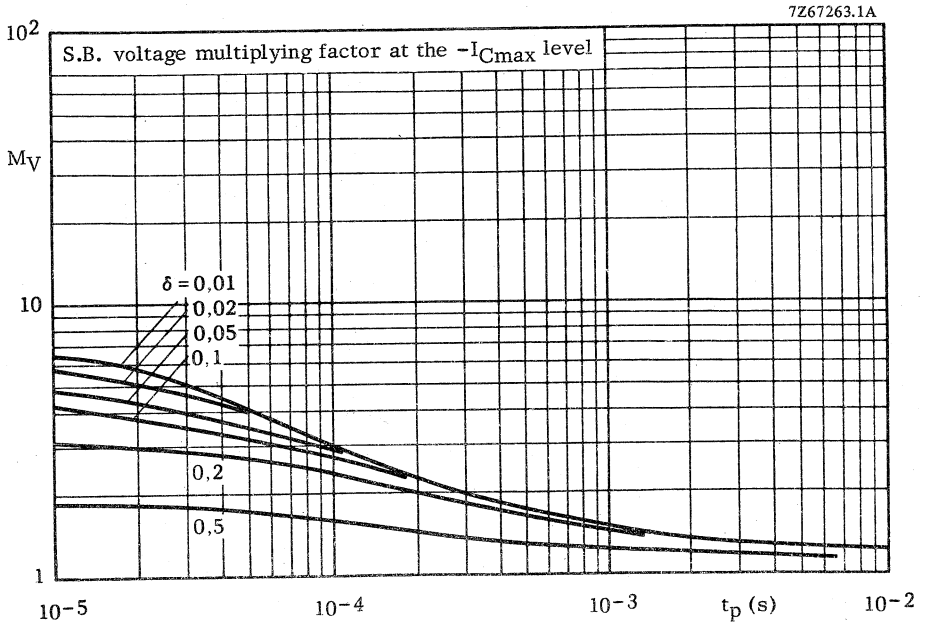


Fig. 4 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

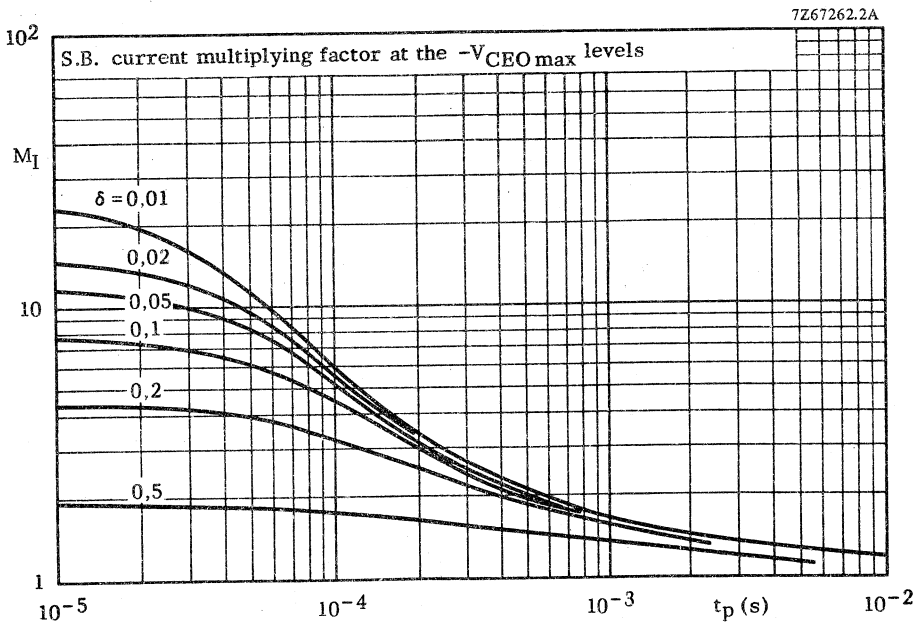


Fig. 5 S.B. current multiplying factor at the $-V_{CEOmax}$ levels.

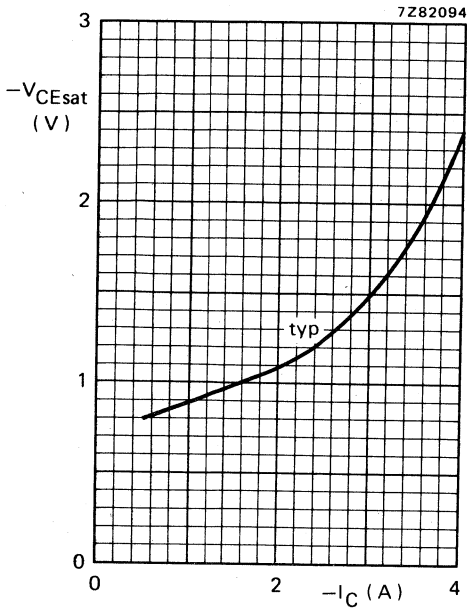


Fig. 6.

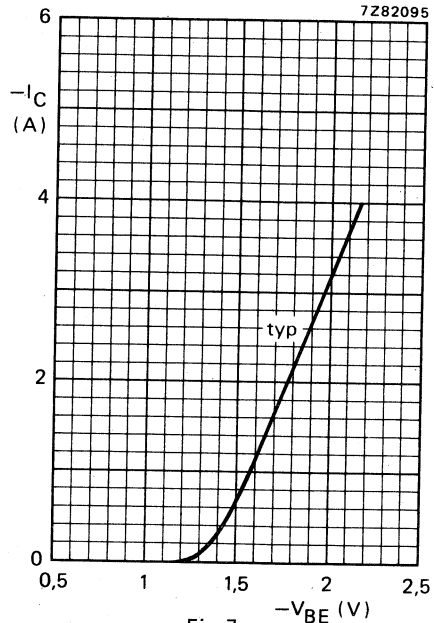


Fig. 7.

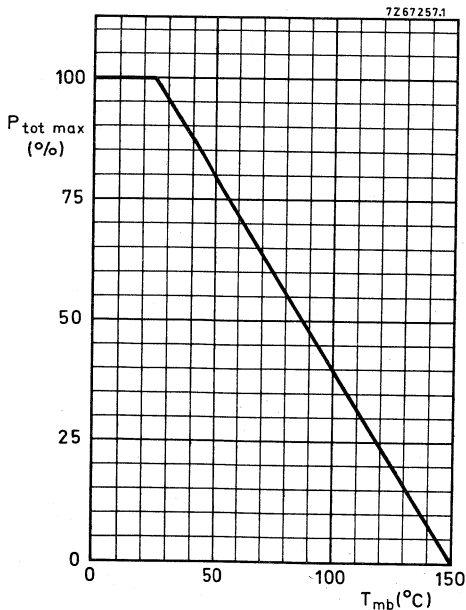


Fig. 8.

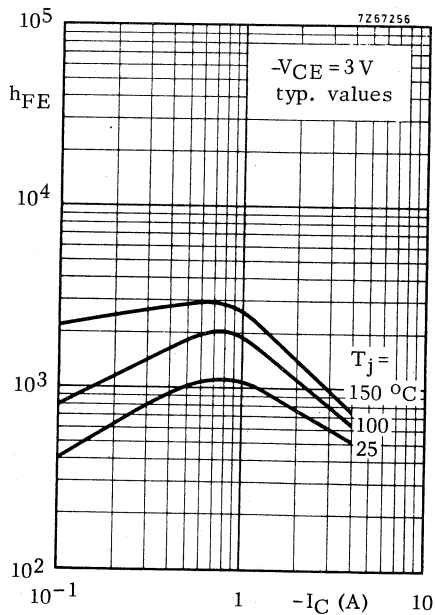


Fig. 9.

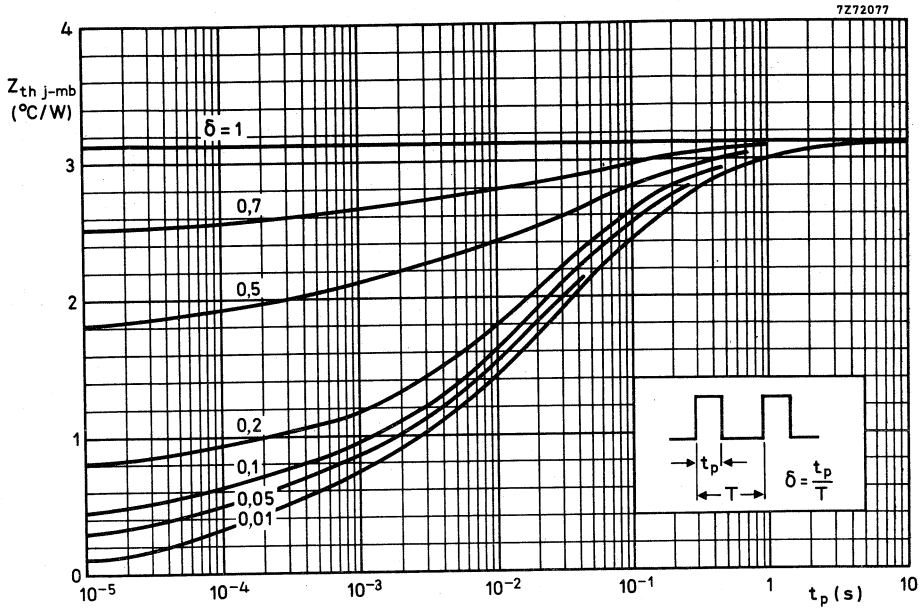


Fig. 10 Pulse power rating chart.

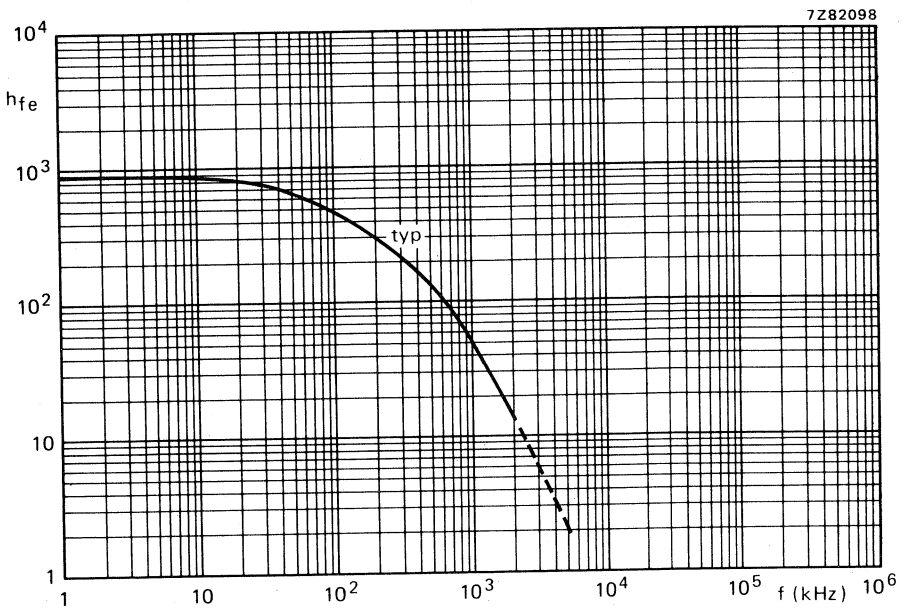


Fig. 11 Small signal current gain. $-I_C = 1,5\ A$; $-V_{CE} = 3\ V$.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in output stages of audio and television amplifier circuits where high peak powers can occur.

P-N-P complements are BD934; 936; 938; 940 and 942.

QUICK REFERENCE DATA

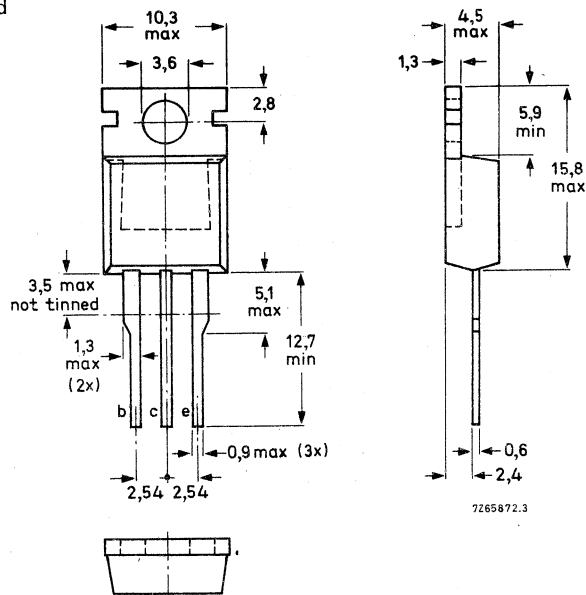
			BD933	935	937	939	941	
Collector-base voltage	V_{CBO}	max.	45	60	100	120	140	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	100	120	V
Collector current (d.c.)	I_C	max.			3			A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.			30			W
Junction temperature	T_j	max.			150			$^\circ\text{C}$
D.C. current gain					40 to 250			
$I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$	h_{FE}				25			
$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	>						
Transition frequency					3			MHz
$I_C = 250\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>						

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD933	935	937	939	941	
Collector-base voltage (open emitter)	V_{CB0}	max.	45	60	100	120	140	V
Collector-emitter voltage (open base)	V_{CE0}	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.			5			V
Collector current (d.c.)	I_C	max.			3			A
Collector current (peak value)	I_{CM}	max.			7			A
Base current (d.c.)	I_B	max.			0,5			A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.			30			W
Storage temperature	T_{stg}		-65 to + 150					$^\circ\text{C}$
→ Junction temperature	T_j	max.	150					$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=		4,17			$^\circ\text{C/W}$
From junction to ambient in free air	$R_{th\ j-a}$	=		70			$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = V_{CB0max}$	I_{CBO}	<		0,1			mA
$I_E = 0; V_{CB} = V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<		3			mA
$I_E = 0; V_{CE} = V_{CE0max}$	I_{CEO}	<		0,5			mA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<		1			mA
--------------------------------	-----------	---	--	---	--	--	----

D.C. current gain *

$I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$	h_{FE}			40 to 250			
$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	>		25			

Base-emitter voltage **

$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$	V_{BE}	<		1,3			V
---	----------	---	--	-----	--	--	---

Collector-emitter saturation voltage *

$I_C = 1\text{ A}; I_B = 0,1\text{ A}$	V_{CEsat}	<		0,6			V
--	-------------	---	--	-----	--	--	---

Transition frequency at $f = 1\text{ MHz}$

$I_C = 250\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>		3			MHz
---	-------	---	--	---	--	--	-----

Switching times

$I_{Con} = 1\text{ A}; I_{Bon} = -I_{Boff} = 0,1\text{ A}$							
turn-on time	t_{on}	typ.		0,3			μs
Turn-off time	t_{off}	typ.		1			μs

* Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}; \delta < 2\%$.

** V_{BE} decreases by about 2,3 mV/ $^\circ\text{C}$ with increasing temperature.

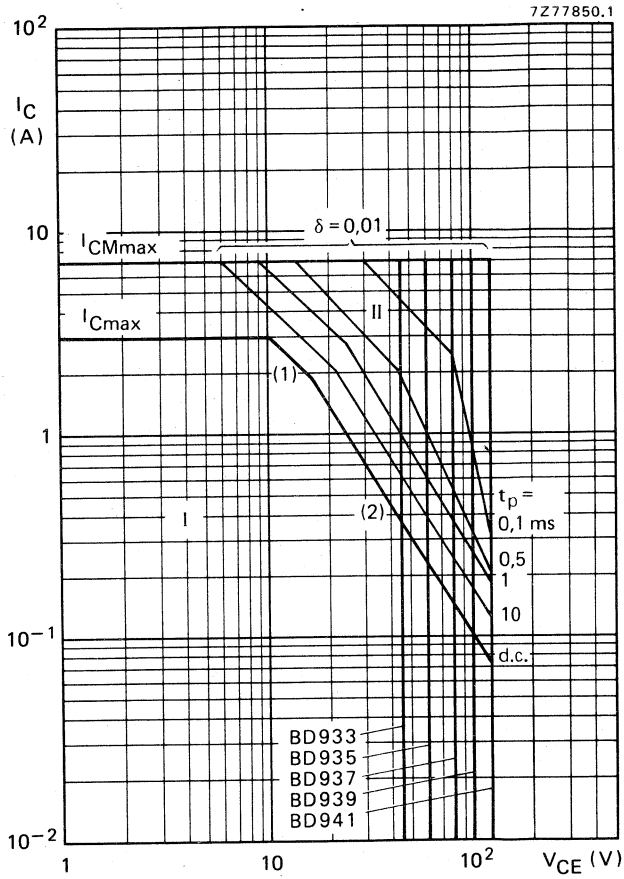


Fig. 2 Safe Operating Area; $T_{mb} = 25 \text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
- (2) Second breakdown limits, independent of temperature.

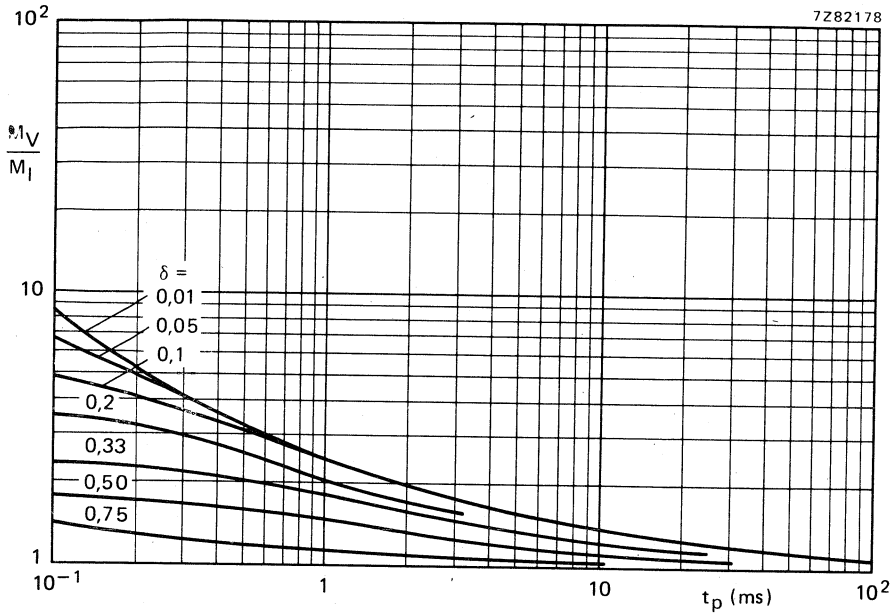


Fig. 3 Second breakdown voltage multiplying factor at the I_{Cmax} level and second breakdown current multiplying factor at the V_{CE0max} level.

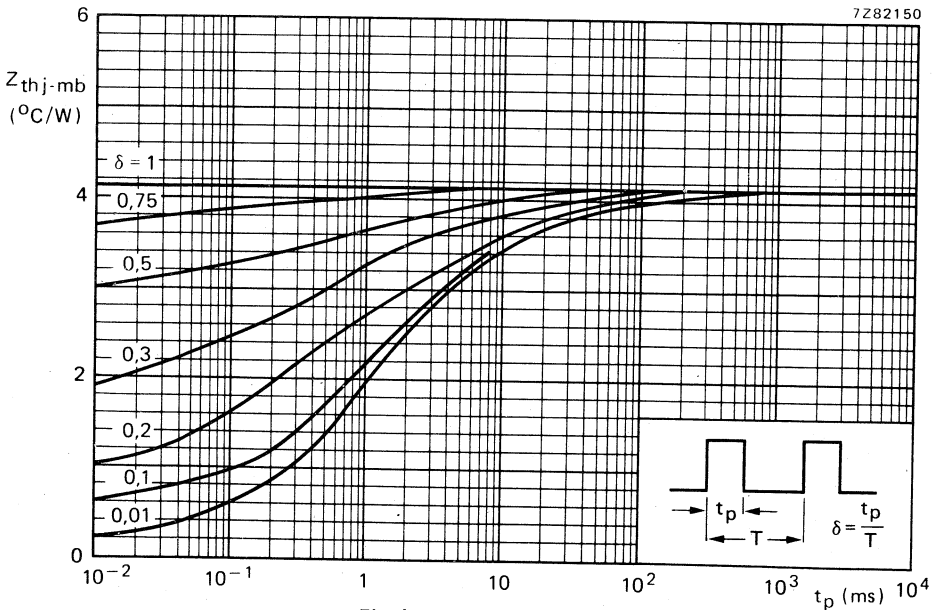


Fig. 4 Pulse power rating chart.

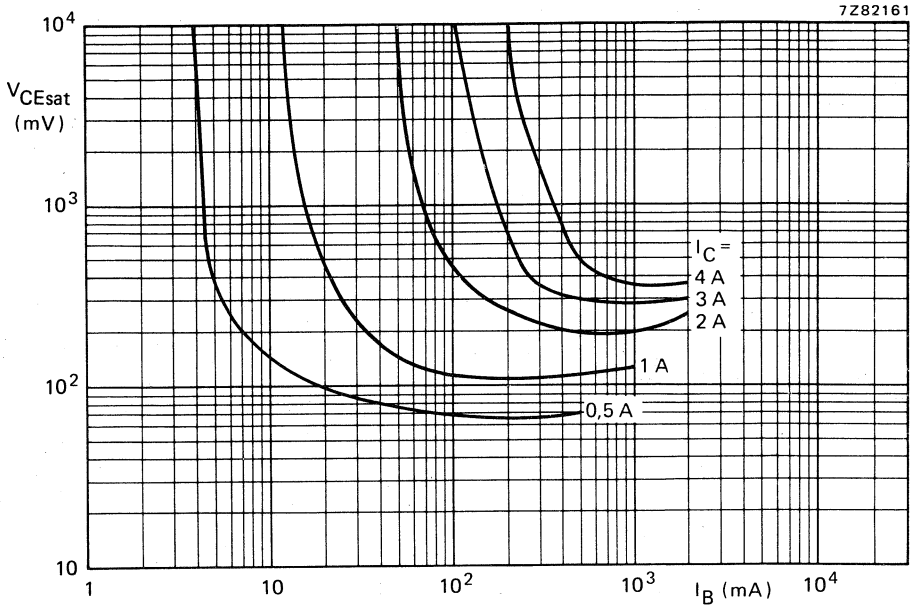


Fig. 5 Typical collector-emitter saturation voltage as a function of base current with collector current as a parameter.

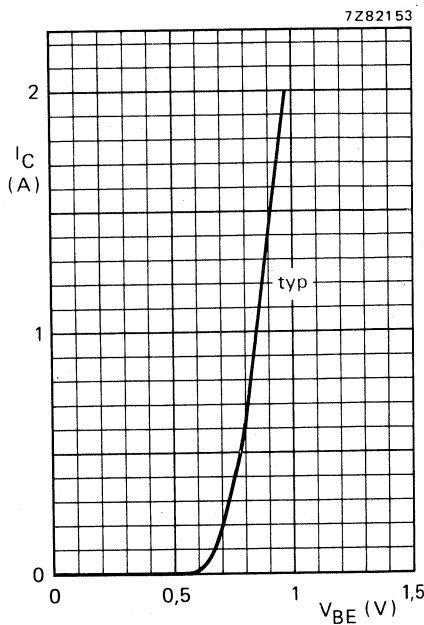


Fig. 6 Typical collector current as a function of base-emitter voltage. $V_{CE} = 2$ V; $T_j = 25$ °C.

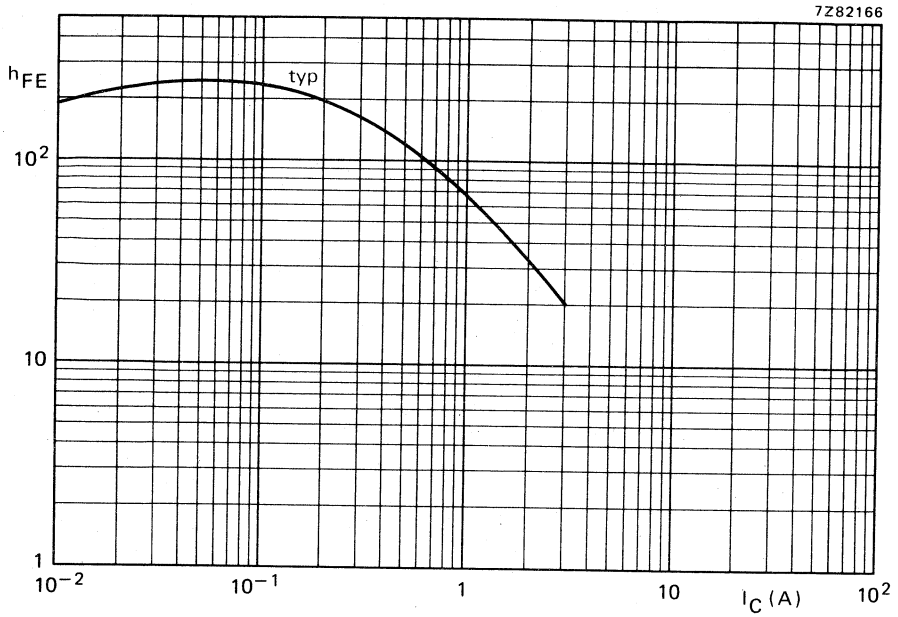


Fig. 7 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 2$ V;
 $T_j = 25$ °C.



SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in output stages of audio and television amplifier circuits where high peak powers can occur.
 N-P-N complements are BD933; 935; 937; 939 and 941.

QUICK REFERENCE DATA

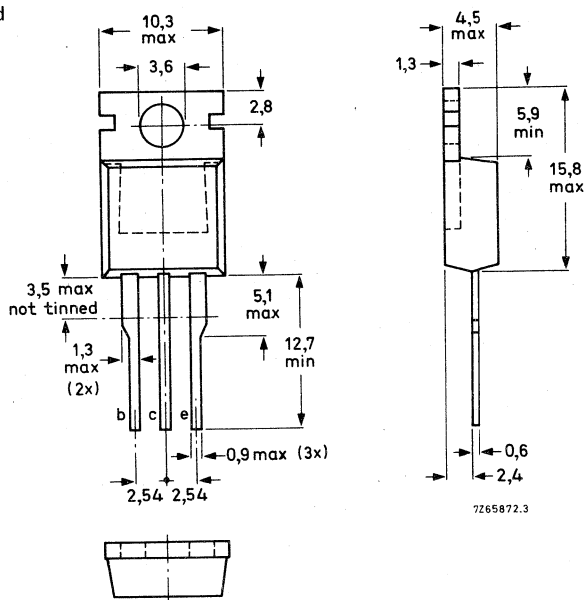
		BD934	936	938	940	942
Collector-base voltage	$-V_{CB0}$	max. 45	60	100	120	140 V
Collector-emitter voltage	$-V_{CEO}$	max. 45	60	80	100	120 V
Collector current (d.c.)	$-I_C$	max.		3		A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.		30		W
Junction temperature	T_j	max.		150		$^\circ\text{C}$
D.C. current gain				40 to 250		
$-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$	h_{FE}			> 25		
$-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$	h_{FE}					
Transition frequency	f_T			> 3		MHz
$-I_C = 250\text{ mA}; -V_{CE} = 10\text{ V}$						

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BD934	936	938	940	942	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.			5			V
Collector current (d.c.)	$-I_C$	max.			3			A
Collector current (peak value)	$-I_{CM}$	max.			7			A
Base current (d.c.)	$-I_B$	max.			0,5			A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.			30			W
Storage temperature	T_{stg}				-65 to + 150			$^\circ\text{C}$
→ Junction temperature	T_j	max.			150			$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=		4,17			$^\circ\text{C/W}$
From junction to ambient in free air	$R_{th\ j-a}$	=		70			$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$-I_E = 0; -V_{CB} = -V_{CB0max}$	$-I_{CBO}$	<		0,1			mA
$-I_E = 0; -V_{CB} = -V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$	<		3			mA
$I_B = 0; -V_{CE} = -V_{CE0max}$	$-I_{CEO}$	<		0,5			mA

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO}$	<		1			mA
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D.C. current gain (note 1)

$-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$	h_{FE}			40 to 250			
$-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$	h_{FE}	>		25			

Base-emitter voltage (notes 1 and 2)

$-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$	$-V_{BE}$	<		1,3			V
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Collector-emitter saturation voltage (note 1)

$-I_C = 1\text{ A}; -I_B = 0,1\text{ A}$	$-V_{CEsat}$	<		0,6			V
--	--------------	---	--	-----	--	--	---

Transition frequency at $f = 1\text{ MHz}$

$-I_C = 250\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	>		3			MHz
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Switching times

$-I_{Con} = 1\text{ A}; -I_{Bon} = I_{Boff} = 0,1\text{ A}$							
turn-on time	t_{on}	typ.		0,3			μs
turn-off time	t_{off}	typ.		0,7			μs

Notes

1. Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}$; $\delta < 2\%$.
2. $-V_{BE}$ decreases by about $2,3\text{ mV}/^\circ\text{C}$ with increasing temperature.

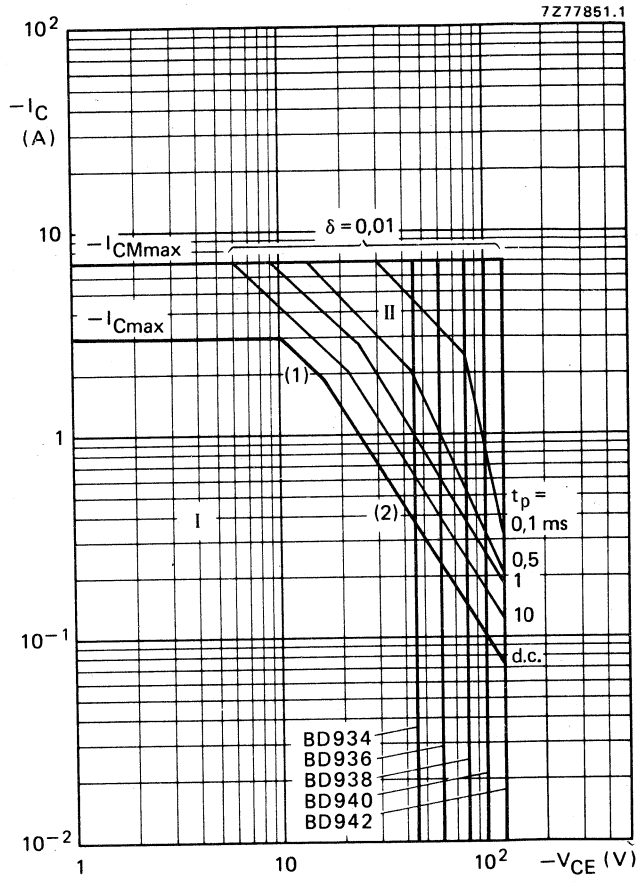


Fig. 2 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
- (2) Second breakdown limits independent of temperature.

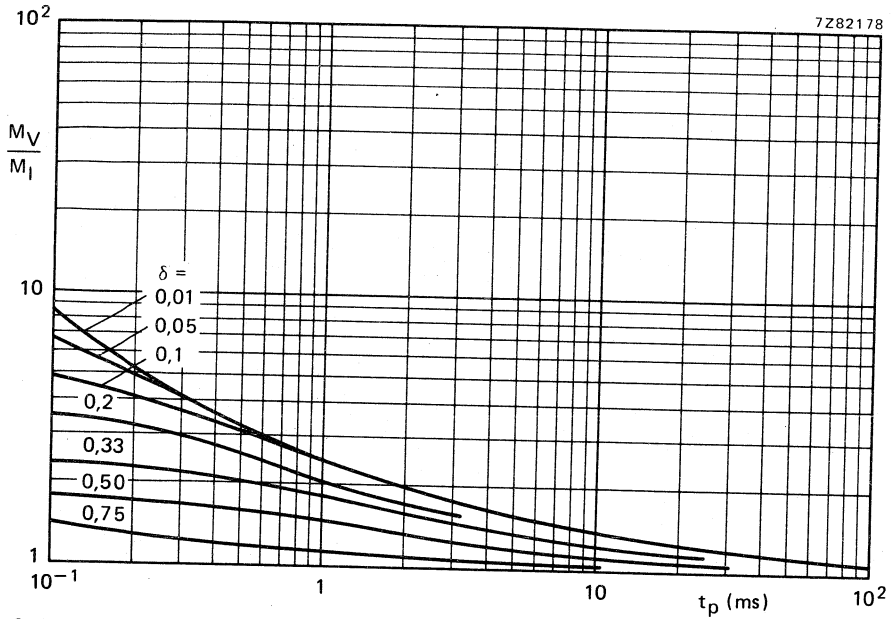


Fig. 3 Second breakdown voltage multiplying factor at the I_{Cmax} level and second breakdown current multiplying factor at the V_{CE0max} level.

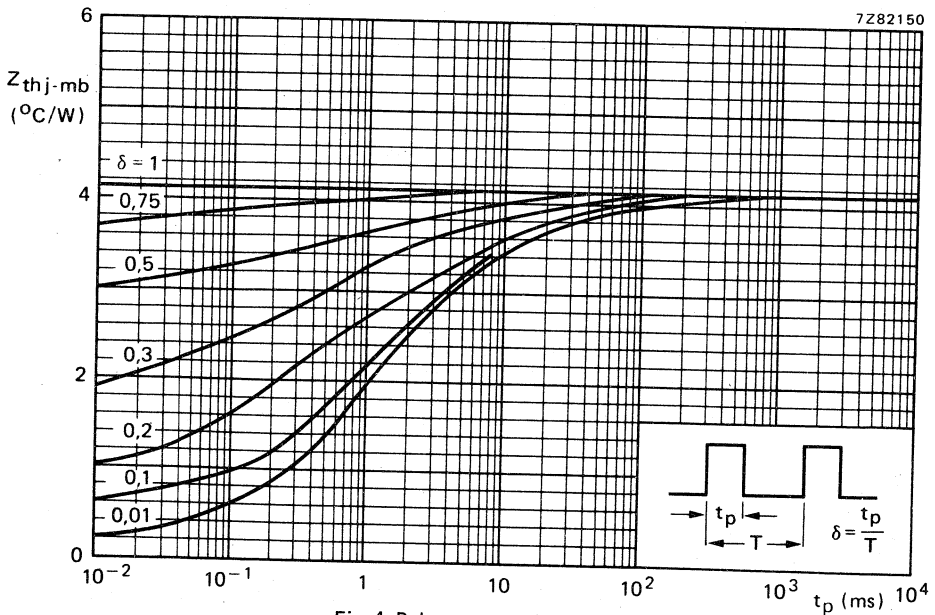


Fig. 4 Pulse power rating chart.

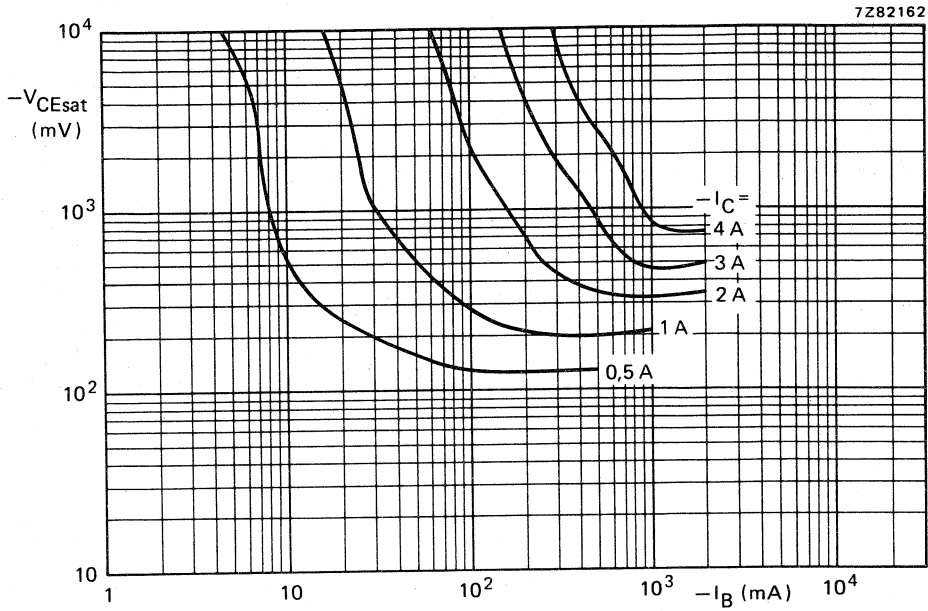


Fig. 5 Typical collector-emitter saturation voltage as a function of base current with collector current as a parameter.

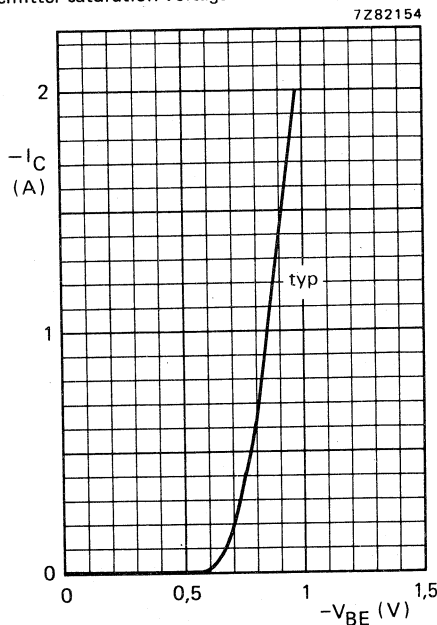


Fig. 6 Typical collector current as a function of base-emitter voltage. $-V_{CE} = 2$ V; $T_j = 25$ °C.

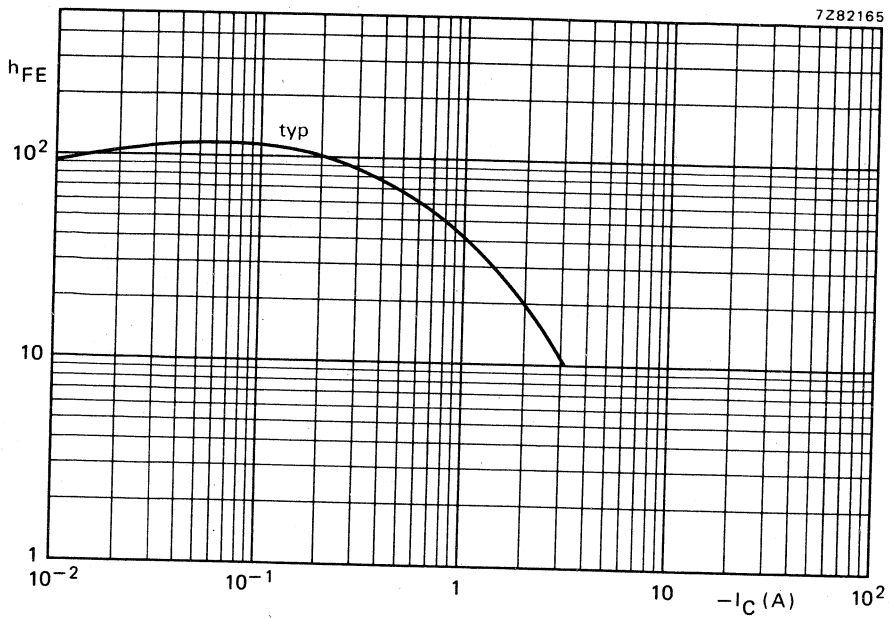


Fig. 7 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 2$ V;
 $T_j \leq 25$ °C.



SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in audio output stages and general purpose amplifier applications. P-N-P complements are BD944; 946 and 948.

QUICK REFERENCE DATA

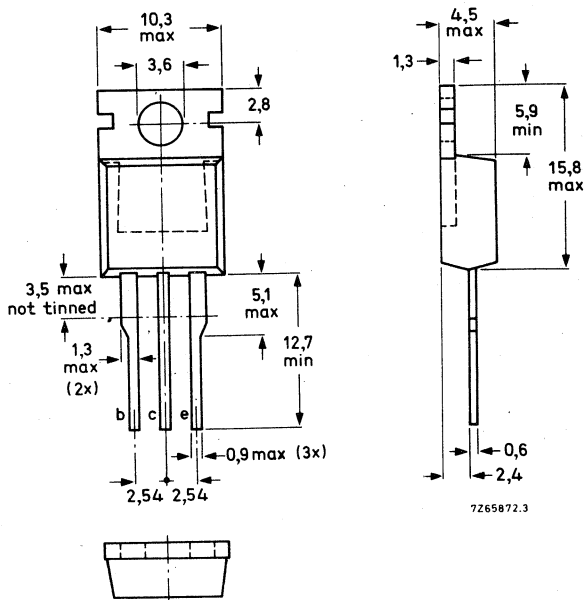
		BD943	945	947
Collector-base voltage (open emitter)	V_{CB0}	max. 22	32	45 V
Collector-emitter voltage (open base)	V_{CEO}	max. 22	32	45 V
Collector current (d.c.)	I_C	max. 5		A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max. 40		W
Junction temperature	T_j	max. 150		$^\circ\text{C}$
D.C. current gain			25	
$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$	h_{FE}	>	85 to 475	
$I_C = 500\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}	>	50 50 40	
$I_C = 2\text{ A}; V_{CE} = 1\text{ V}$	h_{FE}	>		
Transition frequency at $f = 1\text{ MHz}$	f_T	>	3	MHz
$I_C = 250\text{ mA}; V_{CE} = 1\text{ V}$				

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BD943	945	947
Collector-base voltage (open emitter)	V_{CBO} max.	22	32	45 V
Collector-emitter voltage (open base)	V_{CEO} max.	22	32	45 V
Emitter-base voltage (open collector)	V_{EBO} max.		5	V
Collector current (d.c.)	I_C max.		5	A
Collector current (peak value)	I_{CM} max.		8	A
Base current (d.c.)	I_B max.		1	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.		40	W
Storage temperature	T_{stg}	-65 to +150		$^\circ\text{C}$
Junction temperature	T_j max.		150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$ =		3,12	$^\circ\text{C/W}$
From junction to ambient in free air	$R_{th\ j-a}$ =		70	$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = V_{CBOmax}$	I_{CBO} <		0,1	mA
$I_E = 0; V_{CB} = V_{CBOmax}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO} <		3	mA
$I_B = 0; V_{CE} = 20\text{ V}; \text{BD945}$ $25\text{ V}; \text{BD947}$	I_{CEO} <		0,5	mA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO} <		1	mA
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D.C. current gain (note 1)

$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$	h_{FE} >		25	
$I_C = 500\text{ mA}; V_{CE} = 1\text{ V}$	h_{FE}		85 to 475	
$I_C = 2\text{ A}; V_{CE} = 1\text{ V}$	h_{FE} >	50	50	40
$I_C = 3\text{ A}; V_{CE} = 1\text{ V}$	h_{FE} >	-	-	30

Base-emitter voltage (notes 1 and 2)

$I_C = 2\text{ A}; V_{CE} = 1\text{ V}$	V_{BE} <	1,1	1,1	- V
$I_C = 3\text{ A}; V_{CE} = 1\text{ V}$	V_{BE} <	-	-	1,3 V

Collector-emitter saturation voltage (note 1)

$I_C = 2\text{ A}; I_B = 0,2\text{ A}$	V_{CEsat} <	0,5	0,5	- V
$I_C = 3\text{ A}; I_B = 0,3\text{ A}$	V_{CEsat} <	-	-	0,7 V

Notes

1. Measured under pulse conditions; $t_p \leq 300\text{ }\mu\text{s}$; $\delta < 2\%$.
2. V_{BE} decreases by about 2,3 mV/ $^\circ\text{C}$ with increasing temperature.

Knee voltage *

$I_C = 2 \text{ A}$; I_B value for which

$I_C = 2,2 \text{ A}$ and $V_{CE} = 1 \text{ V}$

Transition frequency at $f = 1 \text{ MHz}$

$I_C = 250 \text{ mA}$; $V_{CE} = 1 \text{ V}$

		BD943	945	947
V_{CEK}	<	0,8	—	— V
f_T	>	3	3	3 MHz

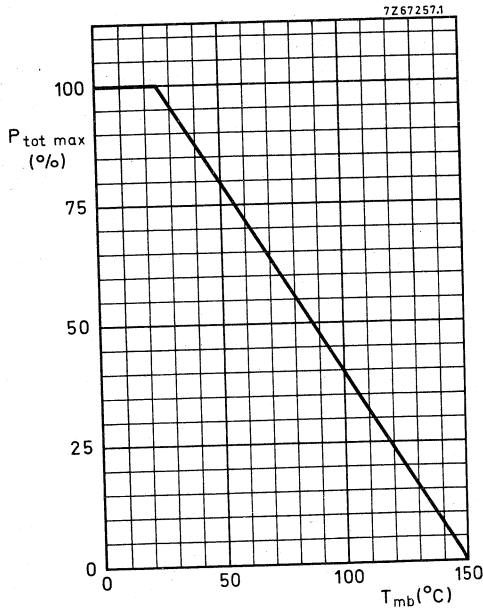


Fig. 2 Power derating curve.

* Measured under pulse conditions; $t_p \leq 300 \mu\text{s}$; $\delta < 2\%$.

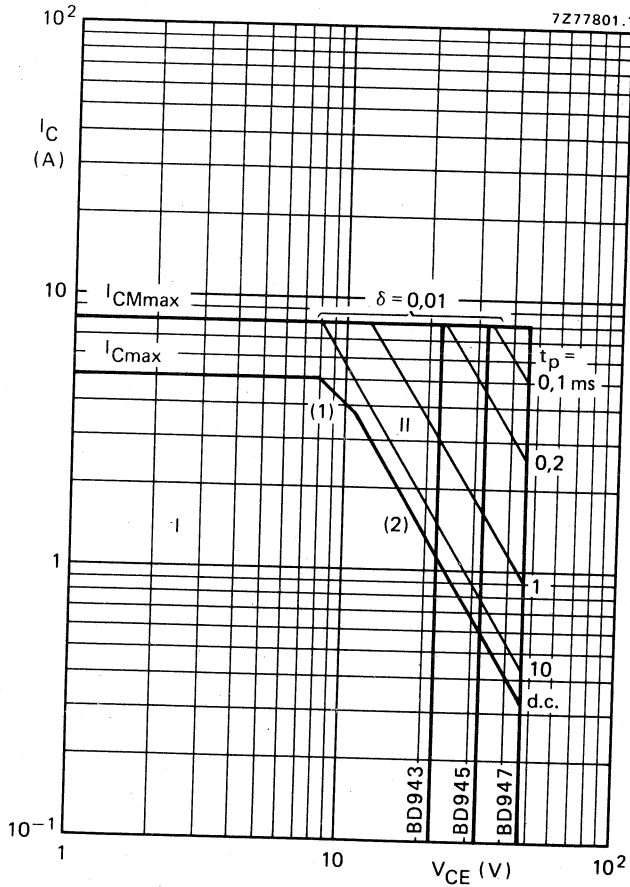


Fig. 3 Safe Operating Area, $T_{mb} = 25\text{ }^{\circ}\text{C}$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits (independent of temperature).

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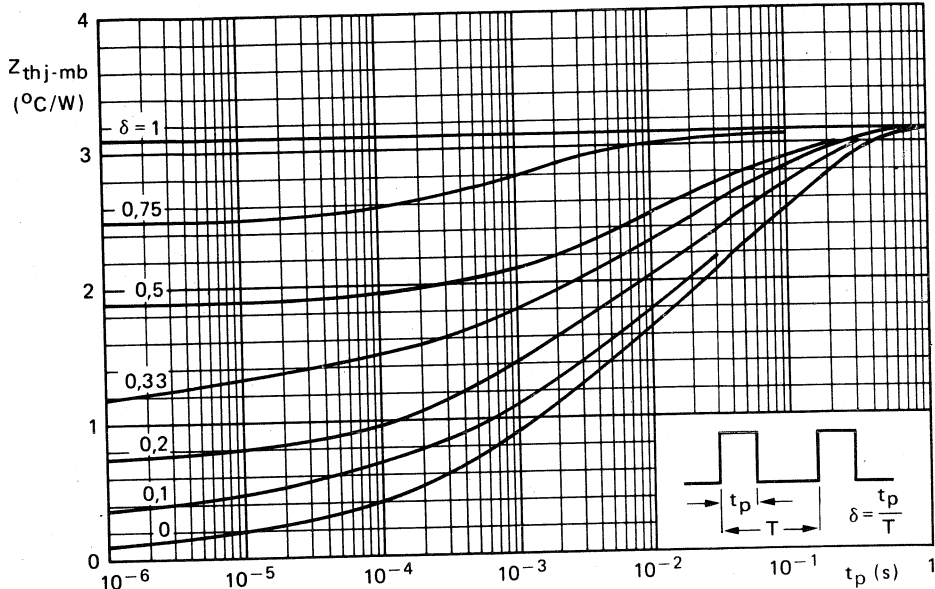


Fig. 4 Pulse power rating chart.

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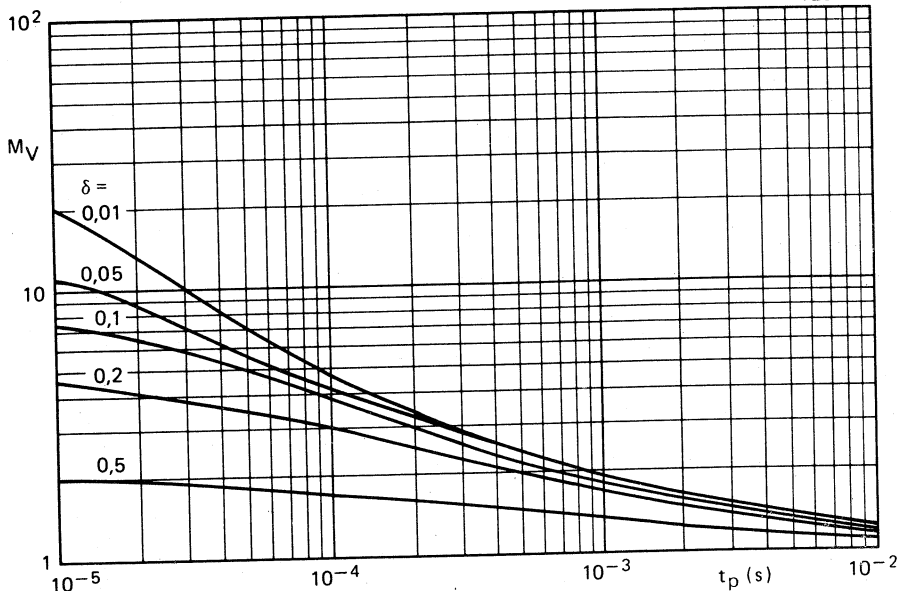


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

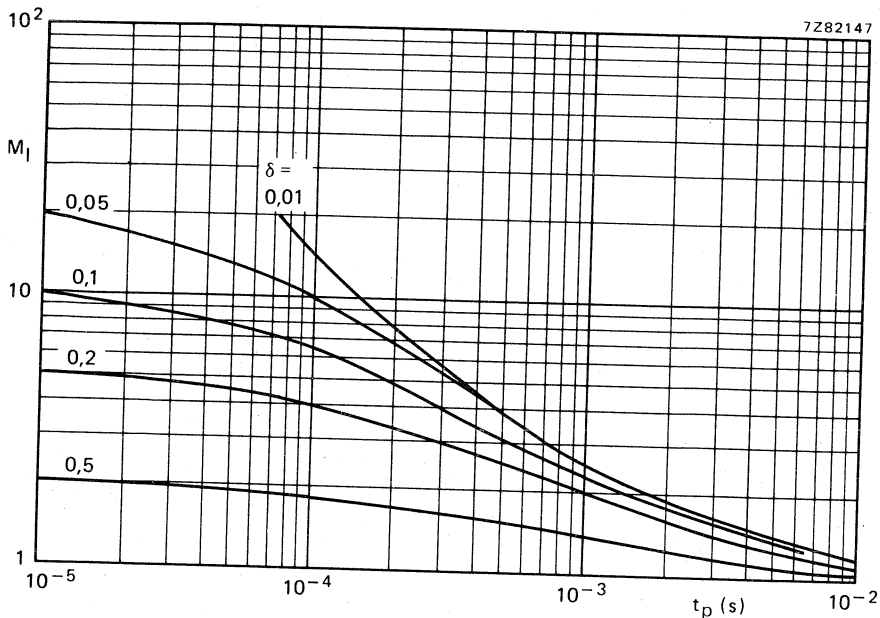


Fig. 6 S.B. current multiplying factor at the V_{CE0max} level for BD943 and BD945.

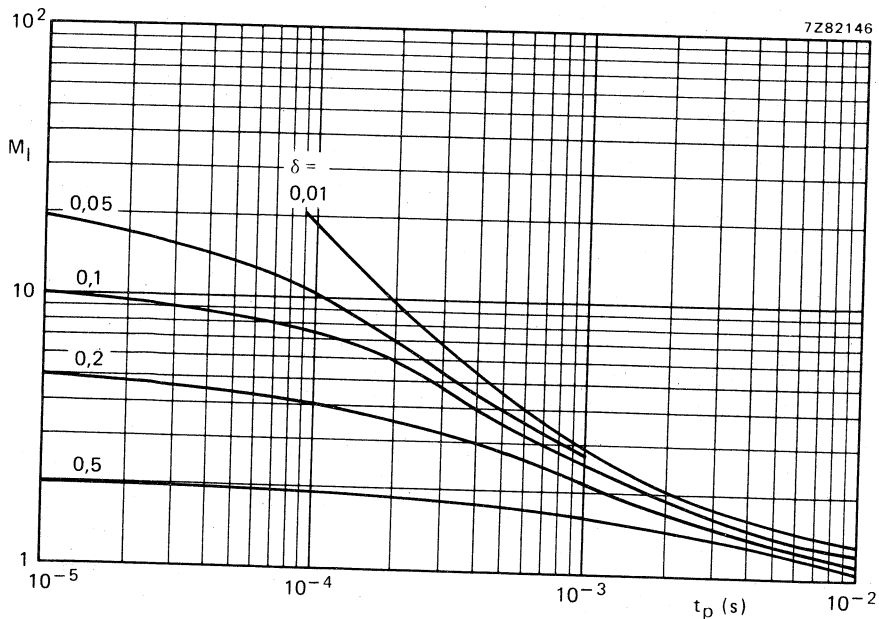


Fig. 7 S.B. current multiplying factor at the V_{CE0max} level for BD947.

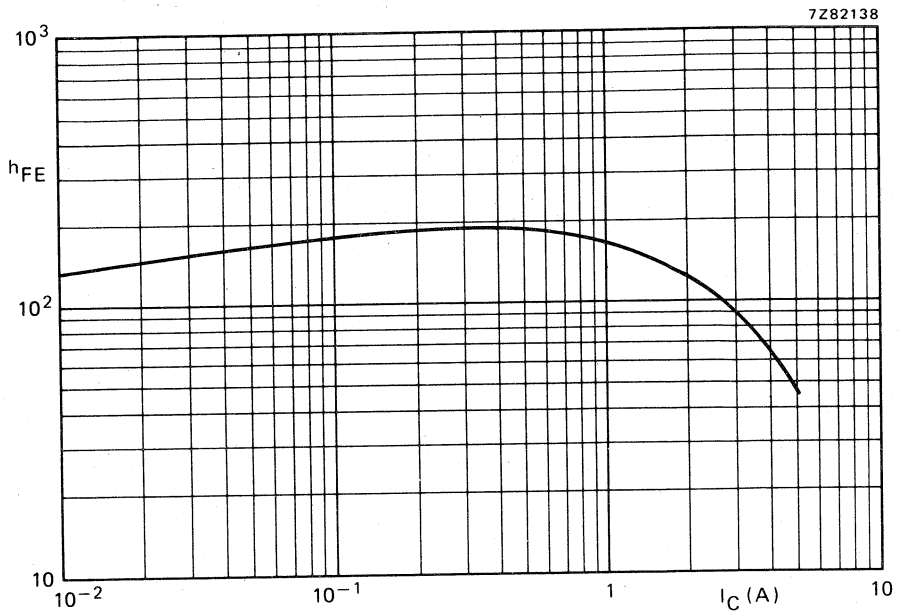


Fig. 8 Typical d.c. current gain at $V_{CE} = 1$ V; $T_j = 25$ °C.



SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in audio output stages and general purpose amplifiers. N-P-N complements are BD943; 945 and 947.

QUICK REFERENCE DATA

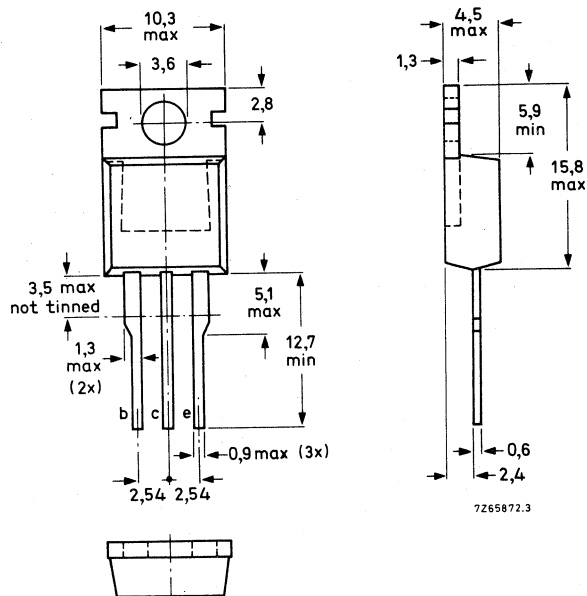
			BD944	946	948
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	22	32	45 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	22	32	45 V
Collector current (d.c.)	$-I_C$	max.		5	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		40	W
Junction temperature	T_j	max.		150	$^\circ\text{C}$
D.C. current gain				25	
$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	h_{FE}	>		85 to 475	
$-I_C = 500\text{ mA}; -V_{CE} = 1\text{ V}$	h_{FE}	>		50 50 40	
$-I_C = 2\text{ A}; -V_{CE} = 1\text{ V}$	h_{FE}	>			
Transition frequency at $f = 1\text{ MHz}$	f_T	>		3	MHz
$-I_C = 250\text{ mA}; -V_{CE} = 1\text{ V}$					

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BD944	946	948
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	22	32	45 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	22	32	45 V
Emitter-base voltage (open collector)	$-V_{EBO}$ max.		5	V
Collector current (d.c.)	$-I_C$ max.		5	A
Collector current (peak value)	$-I_{CM}$ max.		8	A
Base current (d.c.)	$-I_B$ max.		1	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot} max.		40	W
Storage temperature	T_{stg}	-65 to +150		$^\circ\text{C}$
Junction temperature	T_j max.		150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$ =	3,12	$^\circ\text{C/W}$
From junction to ambient (in free air)	$R_{th\ j-a}$ =	70	$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO} <$	0,1	mA
$I_E = 0; -V_{CB} = -V_{CBOmax}; T_j = 150^\circ\text{C}$	$-I_{CBO} <$	3	mA
$I_B = 0; -V_{CE} = 15\text{ V}; \text{BD944}$ $-V_{CE} = 20\text{ V}; \text{BD946}$ $-V_{CE} = 25\text{ V}; \text{BD948}$	$-I_{CEO} <$	0,5	mA

Emitter cut-off current

$-I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO} <$	1	mA
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D.C. current gain (note 1)

$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	$h_{FE} >$	25		
$-I_C = 500\text{ mA}; -V_{CE} = 1\text{ V}$	h_{FE}	85 to 475		
$-I_C = 2\text{ A}; -V_{CE} = 1\text{ V}$	$h_{FE} >$	50	50	40
$-I_C = 3\text{ A}; -V_{CE} = 1\text{ V}$	$h_{FE} >$	-	-	30

Base-emitter voltage (notes 1 and 2)

$-I_C = 2\text{ A}; -V_{CE} = 1\text{ V}$	$-V_{BE} <$	1,1	1,1	- V
$-I_C = 3\text{ A}; -V_{CE} = 1\text{ V}$	$-V_{BE} <$	-	-	1,3 V

Collector-emitter saturation voltage (note 1)

$-I_C = 2\text{ A}; -I_B = 0,2\text{ A}$	$-V_{CEsat} <$	0,5	0,5	- V
$-I_C = 3\text{ A}; -I_B = 0,3\text{ V}$	$-V_{CEsat} <$	-	-	0,7 V

Notes

1. Measured under pulse conditions; $t_p \leq 300\ \mu\text{s}$; $\delta < 2\%$.
2. V_{BE} decreases by about 2,3 mV/ $^\circ\text{C}$ with increasing temperature.

Knee voltage *

$-I_C = 2 \text{ A}; -I_B = \text{value for which}$
 $-I_C = 2,2 \text{ A and } -V_{CE} = 1 \text{ V}$

Transition frequency at $f = 1 \text{ MHz}$

$-I_C = 250 \text{ mA}; -V_{CE} = 1 \text{ V}$

		BD944	946	948
$-V_{CEK}$	<	0,8	—	— V
f_T	>	3	3	3 MHz

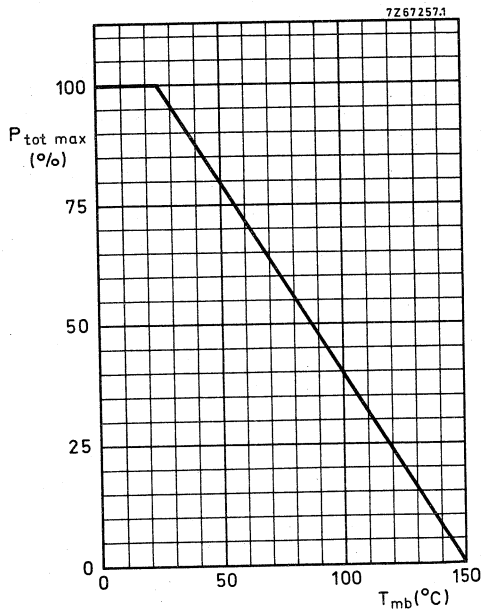


Fig. 2 Power derating curve.

* Measured under pulse conditions; $t_p \leq 300 \mu s; \delta < 2\%$.

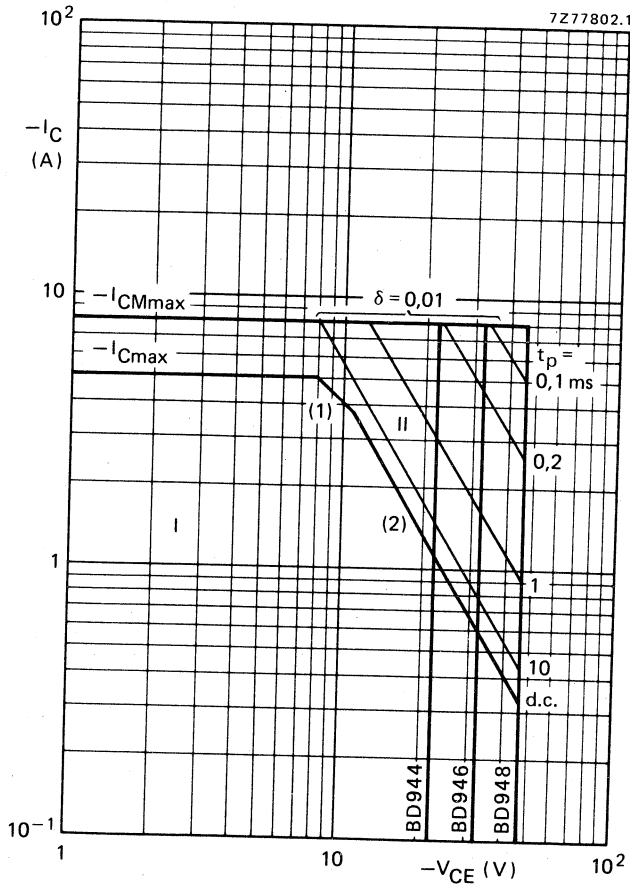


Fig. 3 Safe Operating Area, $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
- (2) Second-breakdown limits (independent of temperature).

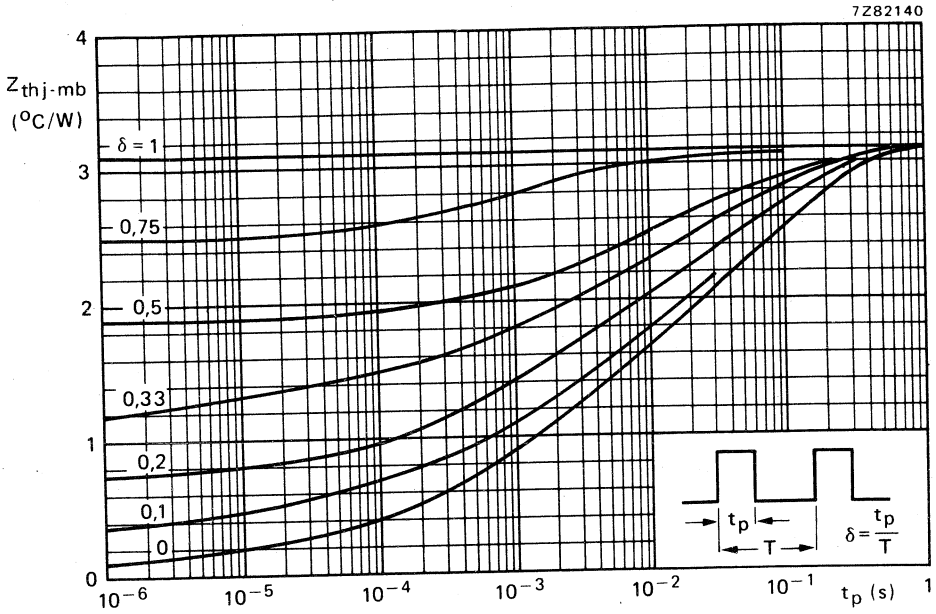


Fig. 4 Pulse power rating chart.

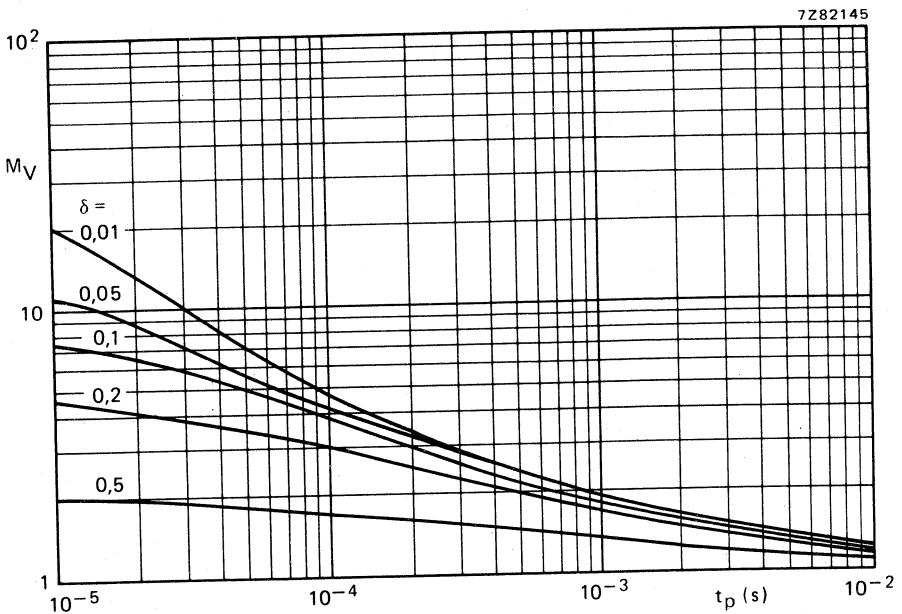


Fig. 5 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

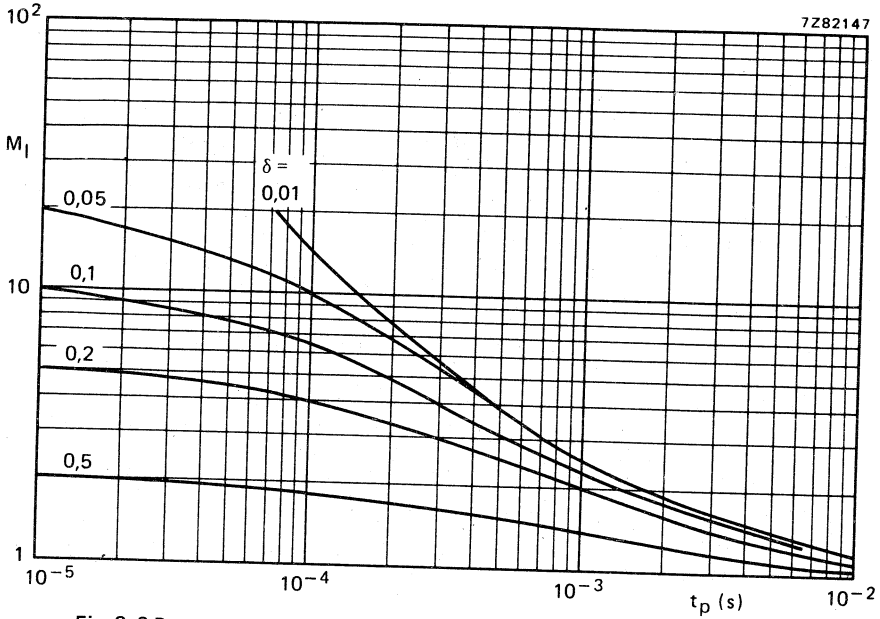


Fig. 6 S.B. current multiplying factor at the $-V_{CE0max}$ level for BD944/946.

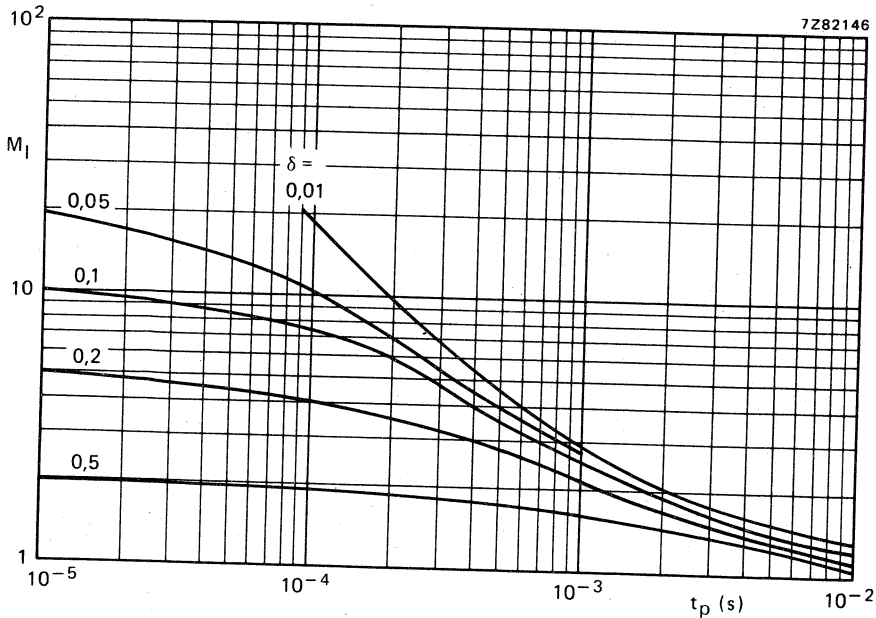


Fig. 7 S.B. current multiplying factor at the $-V_{CE0max}$ level for BD948.

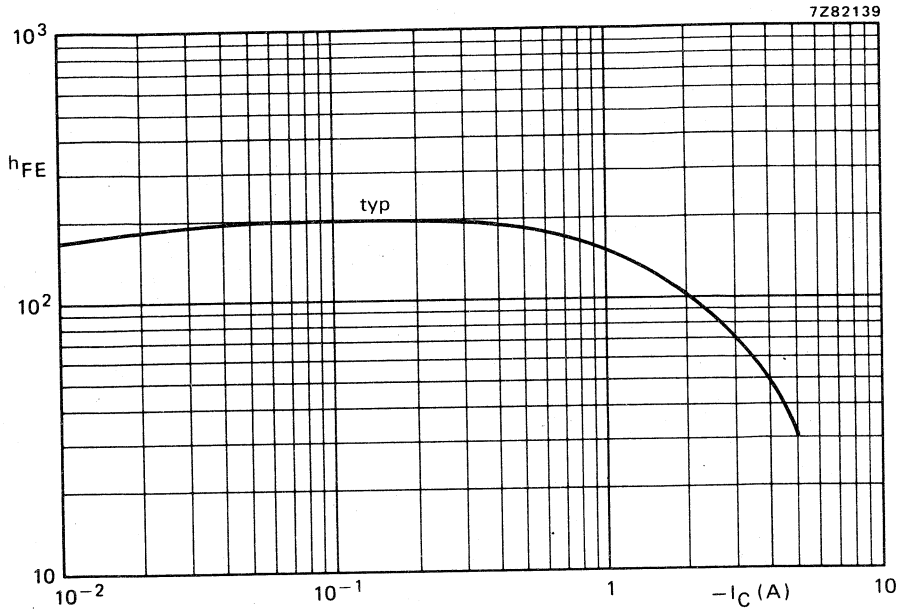


Fig. 8 Typical d.c. current gain at $-V_{CE} = 1$ V; $T_j = 25$ °C.



SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N transistors in a plastic TO-220 envelope. With their p-n-p complements BD950; 952; 954 and 956 they are intended for use in a wide range of power amplifiers and for switching applications.

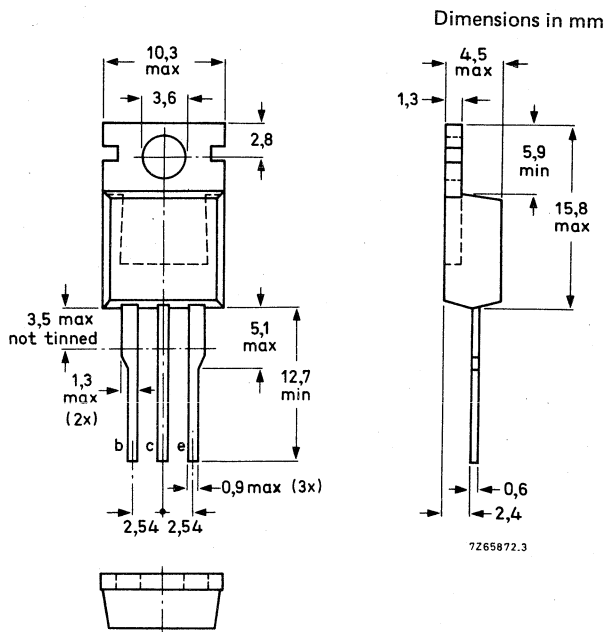
QUICK REFERENCE DATA

		BD949	BD951	BD953	BD955
Collector-base voltage (open emitter)	V_{CBO}	max. 60	80	100	120 V
Collector-emitter voltage (open base)	V_{CEO}	max. 60	80	100	120 V
Collector current (d.c.)	I_C	max.	5		A
Collector current (peak value)	I_{CM}	max.	8		A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	40		W
Junction temperature	T_j	max.	150		$^\circ\text{C}$
D.C. current gain					
$I_C = 0,5 \text{ A}; V_{CE} = 4 \text{ V}$	h_{FE}	>	40		
$I_C = 2 \text{ A}; V_{CE} = 4 \text{ V}$	h_{FE}	>	20		

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters
Mounting instructions
and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BD949	951	953	955
Collector-base voltage (open emitter)	V_{CB0} max.	60	80	100	120 V
Collector-emitter voltage (open base)	V_{CE0} max.	60	80	100	120 V
Emitter-base voltage (open collector)	V_{EBO} max.			5	V
Collector current (d.c.)	I_C max.			5	A
Collector current (peak value)	I_{CM} max.			8	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.			40	W
Storage temperature	T_{stg}			-65 to 150	$^\circ\text{C}$
Junction temperature	T_j max.			150	$^\circ\text{C}$

THERMAL RESISTANCE

from junction to mounting base	$R_{thj-mb} =$		3,12		$^\circ\text{C/W}$
from junction to ambient (in free air)	$R_{thj-a} =$		70		$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = V_{CB0} \text{ max}$

$I_E = 0; V_{CB} = \frac{1}{2} V_{CB0} \text{ max}; T_j = 150\text{ }^\circ\text{C}$

$I_B = 0; V_{CE} = \frac{1}{2} V_{CE0} \text{ max}$

$I_{CB0} <$ 0,1 mA

$I_{CB0} <$ 2 mA

$I_{CE0} <$ 0,5 mA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} <$ 1 mA

D.C. current gain (note 1)

$I_C = 0,5\text{ A}; V_{CE} = 4\text{ V}$

$I_C = 2\text{ A}; V_{CE} = 4\text{ V}$

$h_{FE} >$ 40

$h_{FE} >$ 20

Base-emitter voltage (notes 1 and 2)

$I_C = 2\text{ A}; V_{CE} = 4\text{ V}$

$V_{BE} <$ 1,4 V

Collector-emitter saturation voltage (note 1)

$I_C = 2\text{ A}; I_B = 0,2\text{ A}$

$V_{CEsat} <$ 1 V

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,5\text{ A}; V_{CE} = 4\text{ V}$

$f_T >$ 3 MHz

(1) Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}$, $\delta < 2\%$.

(2) V_{EB} decreases by about 2,3 mV/ $^\circ\text{C}$ with increasing temperature.

CHARACTERISTICS (continued)

Switching times

(between 10% and 90% levels)

$I_{Con} = 1 \text{ A}; I_{Bon} = -I_{Boff} = 0,1 \text{ A}$

Turn-on time

Turn-off time

t_{on}	typ.	0,3 μs
t_{off}	typ.	1,5 μs

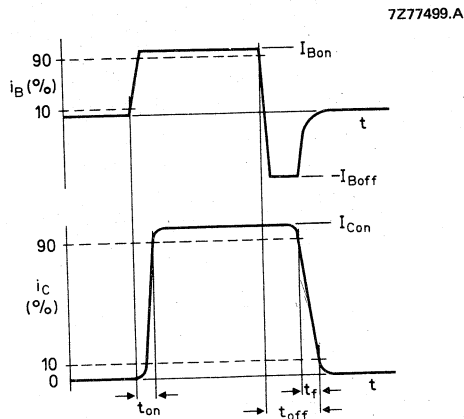
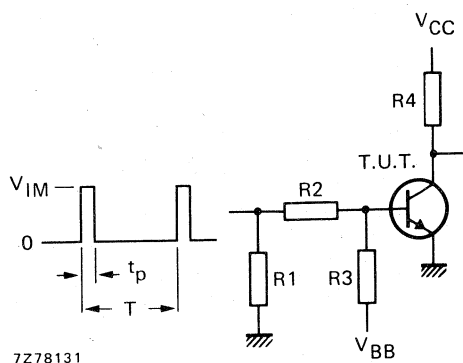


Fig. 2 Switching times waveforms.



V_{IM}	=	30 V
V_{CC}	=	20 V
V_{BB}	=	-3,5 V
R1	=	82 Ω
R2	=	150 Ω
R3	=	39 Ω
R4	=	20 Ω
$t_r = t_f$	\leq	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

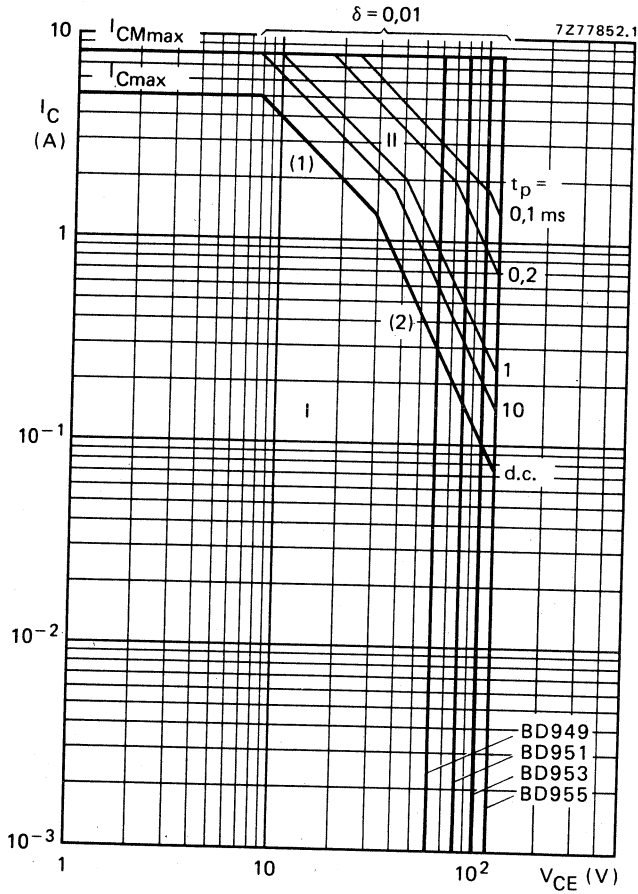


Fig. 4 Safe Operating Area; $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
 - (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
 - (2) Second-breakdown limit (independent of temperature).

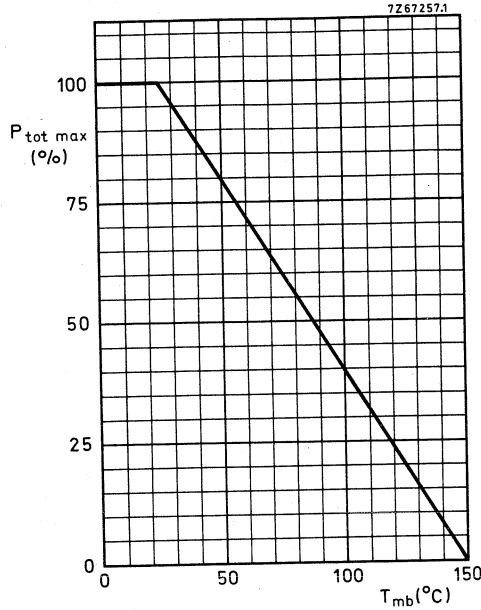


Fig. 5 Power derating curve.

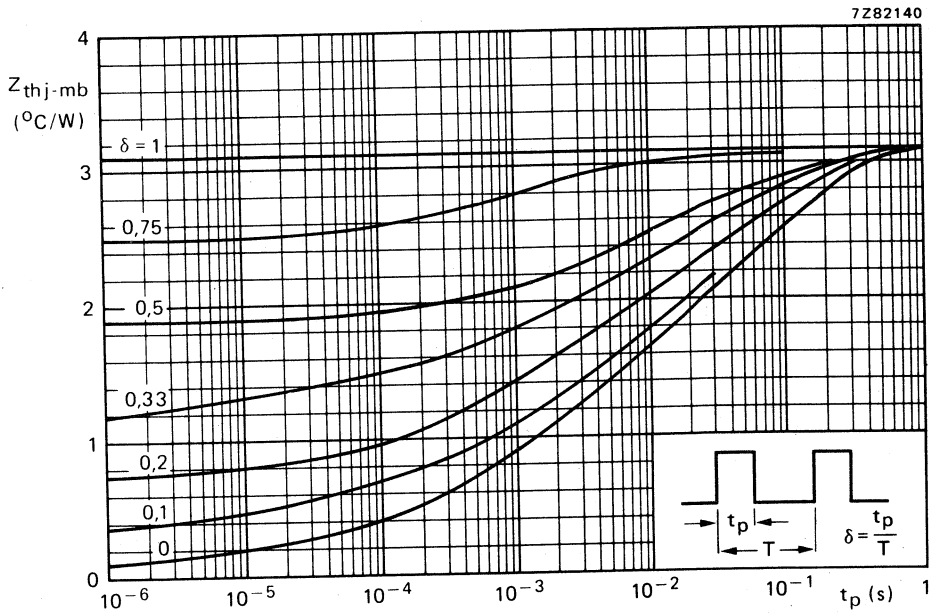


Fig. 6 Pulse power rating chart.

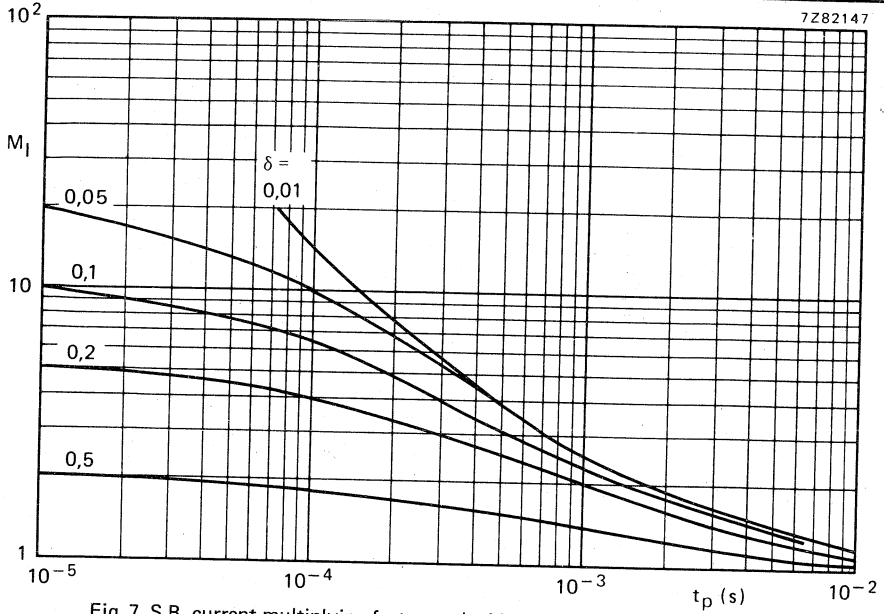


Fig. 7 S.B. current multiplying factor at the V_{CEO} max level for BD949/951.

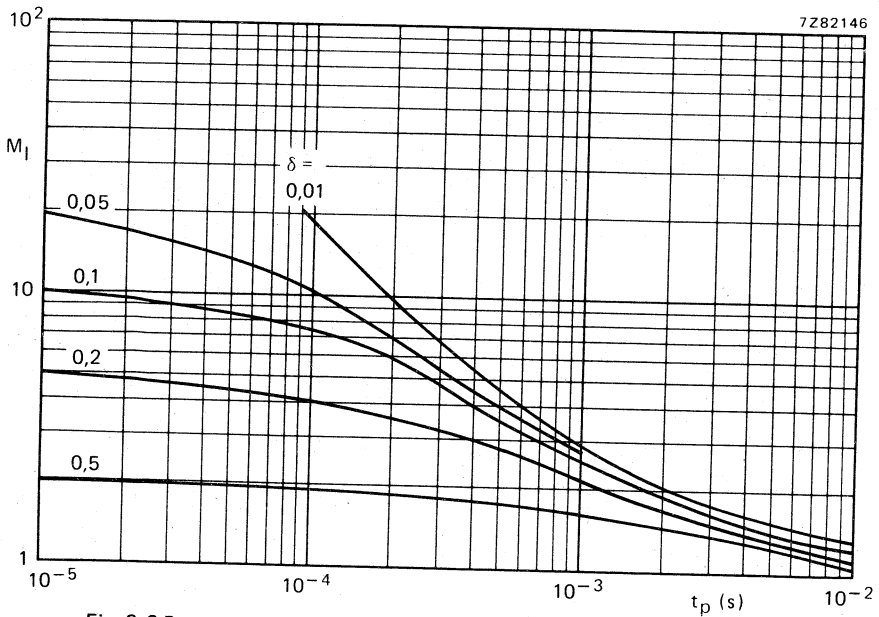


Fig. 8 S.B. current multiplying factor at the V_{CEO} max level for BD953/955.

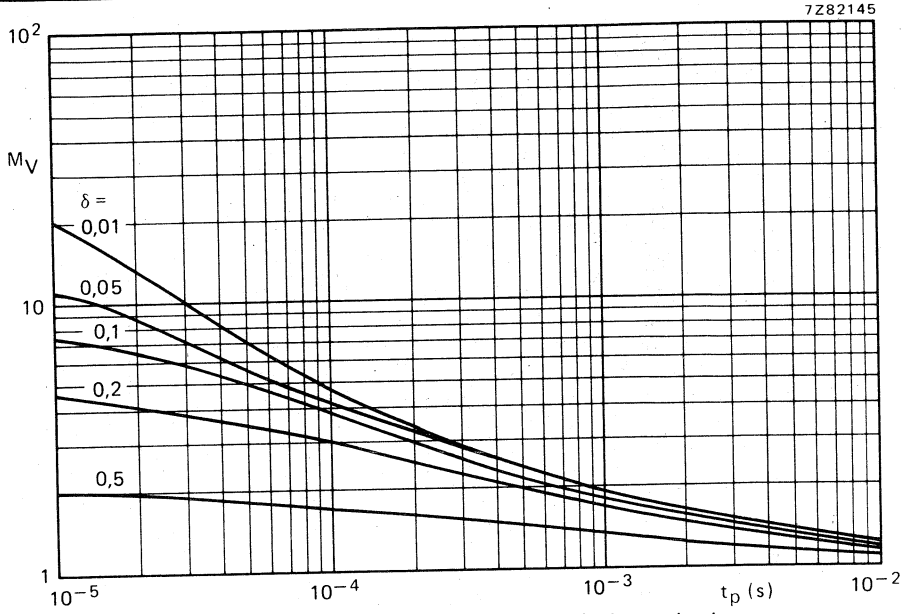


Fig. 9 S.B. voltage multiplying factor at the I_C max level.

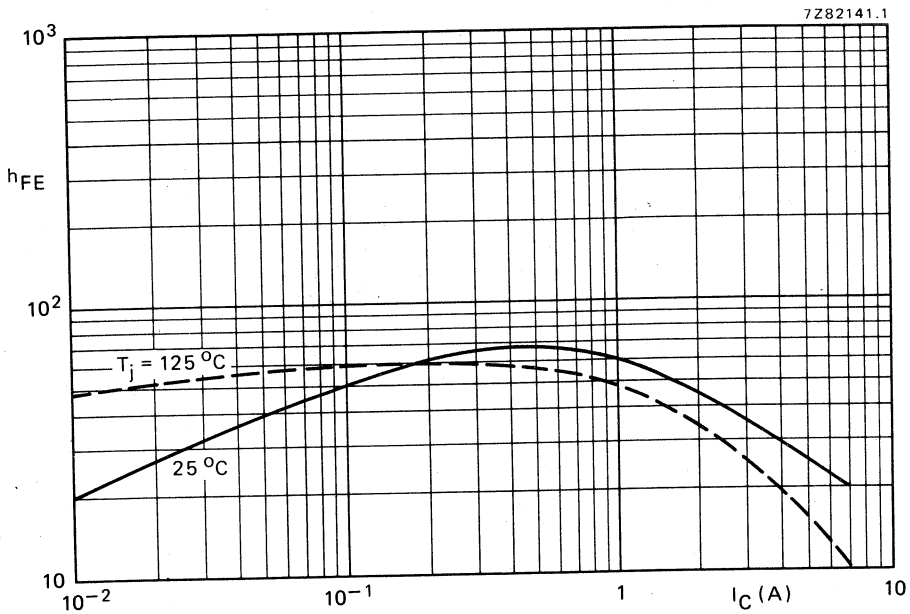


Fig. 10 Typical d.c. current gain at $V_{CE} = 4$ V.

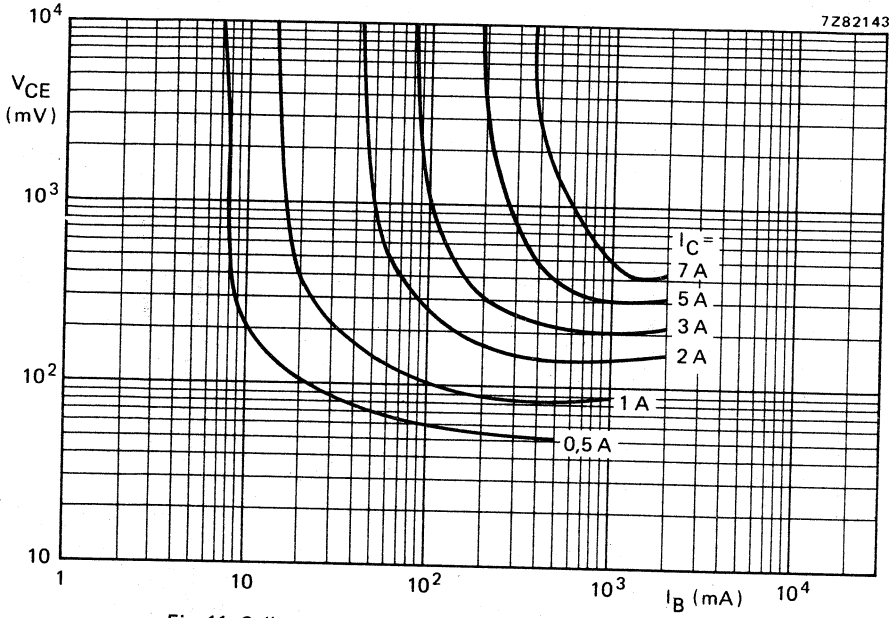


Fig. 11 Collector-emitter voltage as a function of base current.



SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P transistors in a plastic TO-220 envelope. With their n-p-n complements BD949; 951; 953 and 955 they are intended for use in a wide range of power amplifiers and for switching applications.

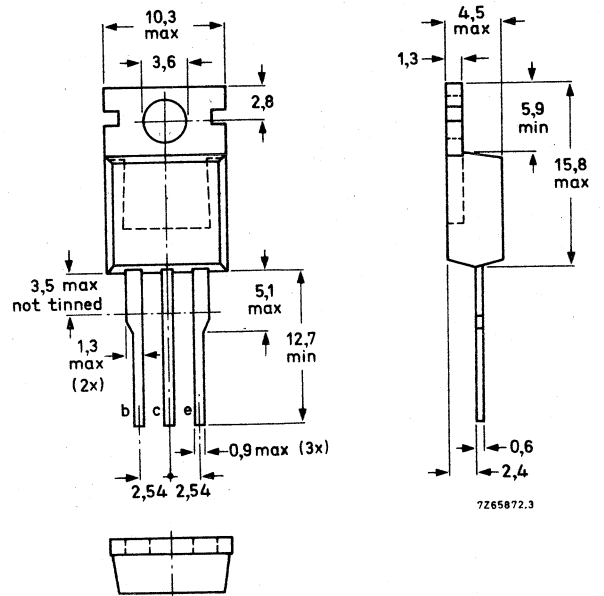
QUICK REFERENCE DATA

		BD950	952	954	956
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 60	80	100	120 V
Collector current (d.c.)	$-I_C$			5	A
Collector current (peak value)	$-I_{CM}$			8	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}			40	W
Junction temperature	T_j			150	$^\circ\text{C}$
D.C. current gain				40	
$-I_C = 0,5\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	$>$		20	
$-I_C = 2\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	$>$			

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters
Mounting instructions
and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BD950	952	954	956
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 60	80	100	120 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current (d.c.)	$-I_C$	max.	5		A
Collector current (peak value)	$-I_{CM}$	max.	8		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	40		W
Storage temperature	T_{stg}		-65 to 150		$^\circ\text{C}$
Junction temperature	T_j	max.	150		$^\circ\text{C}$

THERMAL RESISTANCE

from junction to mounting base	$R_{th\ j-mb}$	=	3,12		$^\circ\text{C/W}$
from junction to ambient (in free air)	$R_{th\ j-a}$	=	70		$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CBO\ max}$	$-I_{CBO}$	<	0,1		mA
$I_E = 0; -V_{CB} = -\frac{1}{2} V_{CBO\ max}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$	<	2		mA
$I_B = 0; -V_{CE} = -\frac{1}{2} V_{CEO\ max}$	$-I_{CEO}$	<	0,5		mA

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO}$	<	1		mA
---------------------------------	------------	---	---	--	----

D.C. current gain (note 1)

$-I_C = 0,5\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	>	40		
$-I_C = 2\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	>	20		

Base-emitter voltage (notes 1 and 2)

$-I_C = 2\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE}$	<	1,4		V
---	-----------	---	-----	--	---

Collector-emitter saturation voltage (note 1)

$-I_C = 2\text{ A}; -I_B = 0,2\text{ A}$	$-V_{CEsat}$	<	1		V
--	--------------	---	---	--	---

Transition frequency at $f = 1\text{ MHz}$

$-I_C = 0,5\text{ A}; -V_{CE} = 4\text{ V}$	f_T	>	3		MHz
---	-------	---	---	--	-----

(1) Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}$, $\delta < 2\%$.

(2) V_{EB} decreases by about $2,3\text{ mV}/^\circ\text{C}$ with increasing temperature.

CHARACTERISTICS (continued)

Switching times

(between 10% and 90% levels)

$I_{Con} = 1 \text{ A}; -I_{Bon} = I_{Boff} = 0,1 \text{ A}$

Turn-on time

Turn-off time

t_{on}	typ.	0,1 μs
t_{off}	typ.	0,4 μs

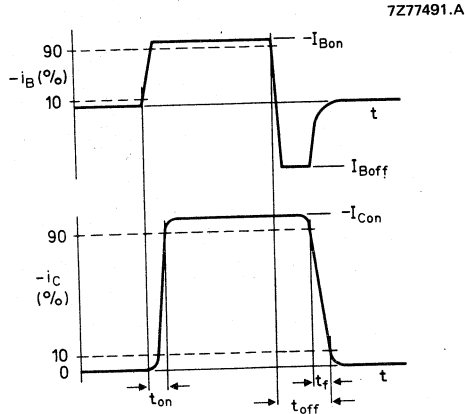
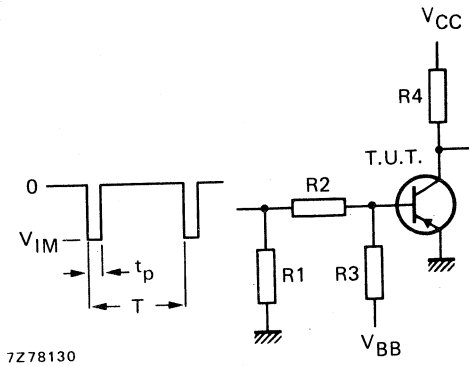


Fig. 2 Switching times waveforms.



$-V_{IM}$	=	30 V
$-V_{CC}$	=	20 V
V_{BB}	=	3,5 V
$R1$	=	82 Ω
$R2$	=	150 Ω
$R3$	=	39 Ω
$R4$	=	20 Ω
$t_r = t_f$	\leq	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

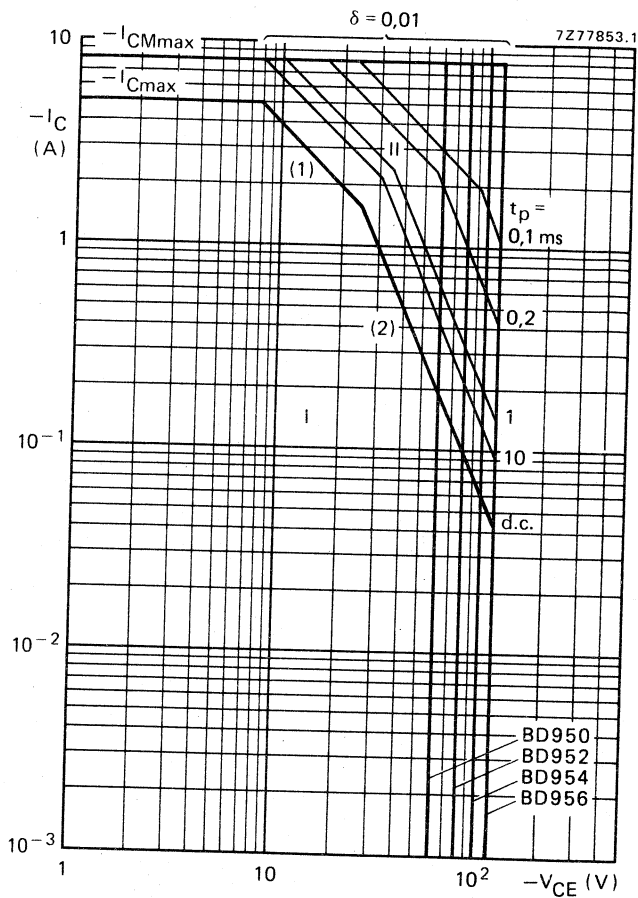


Fig. 4 Safe Operating Area; $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
- (2) Second-breakdown limit (independent of temperature).

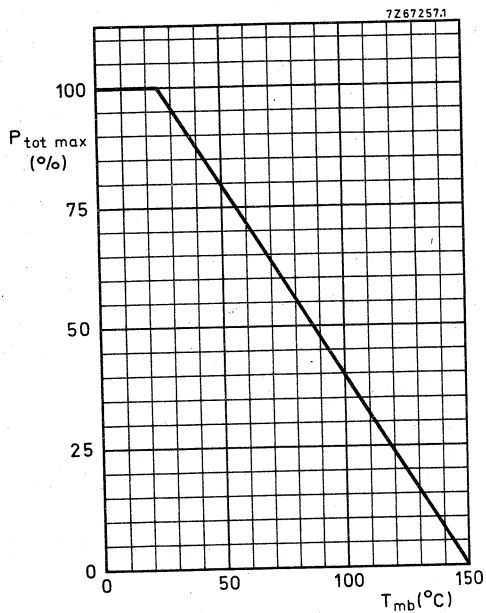


Fig. 5 Power derating curve.

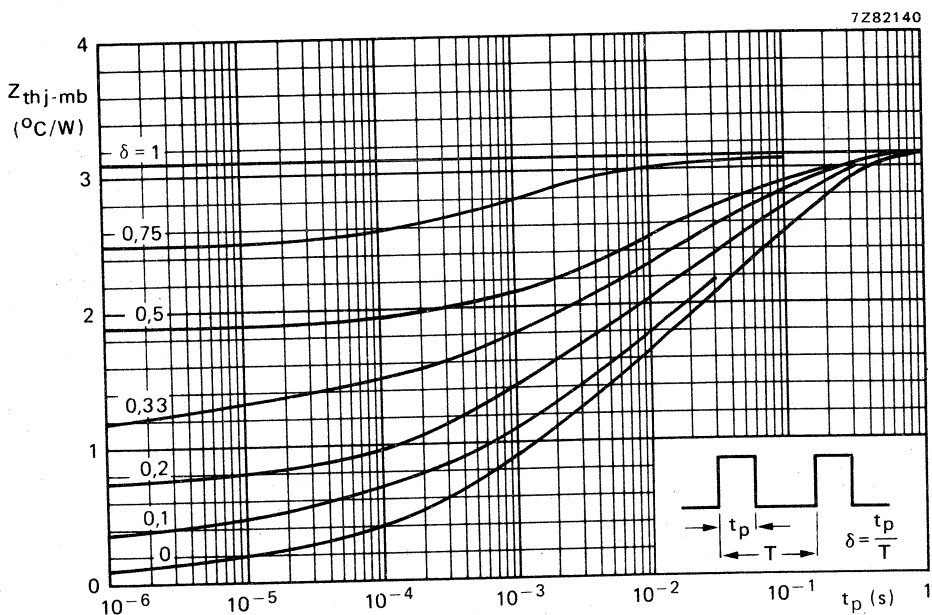


Fig. 6 Pulse power rating chart.

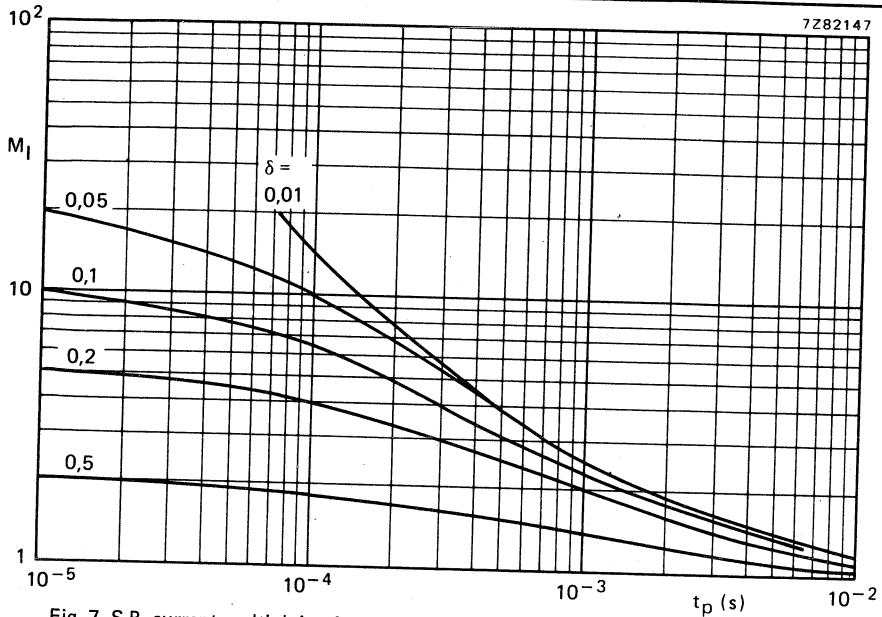


Fig. 7 S.B. current multiplying factor at the $-V_{CEO}$ max level for BD950 and BD952.

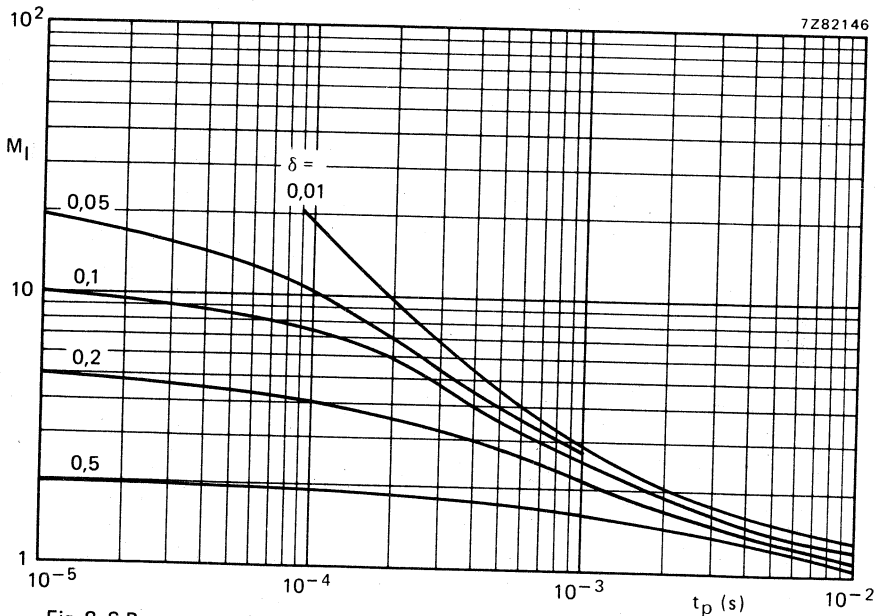


Fig. 8 S.B. current multiplying factor at the $-V_{CEO}$ max level for BD954 and BD956.

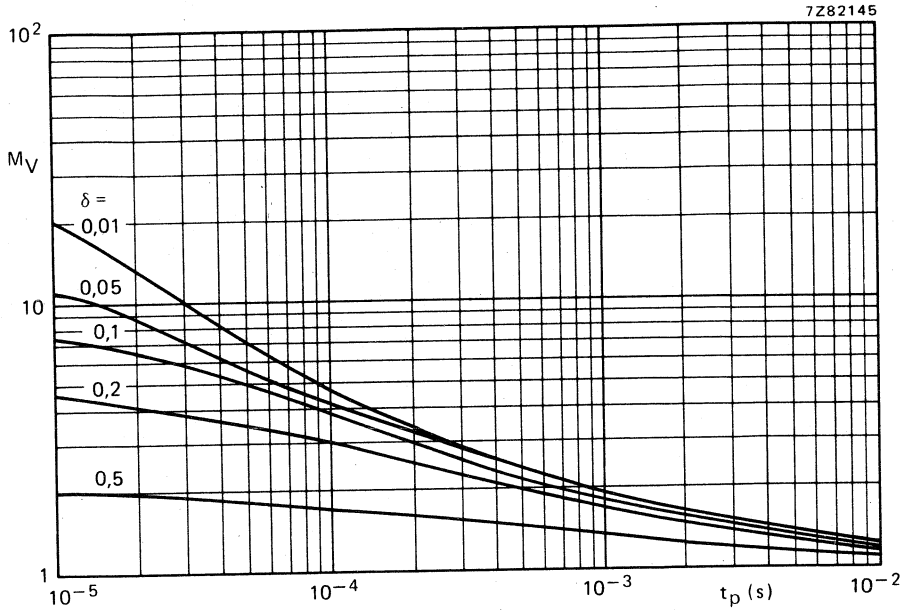


Fig. 9 S.B. voltage multiplying factor at the $-I_C$ max level.

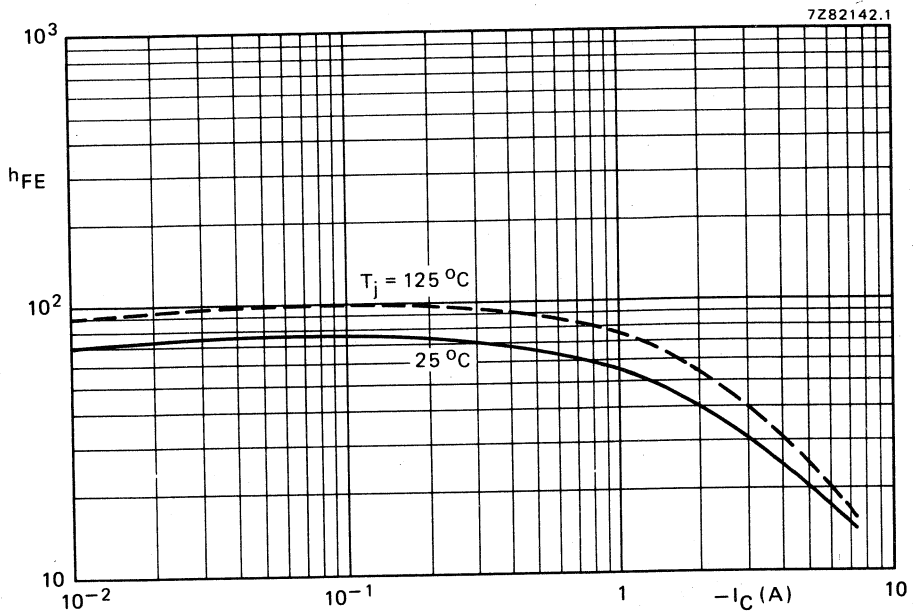


Fig. 10 Typical d.c. current gain at $-V_{CE} = 4$ V.

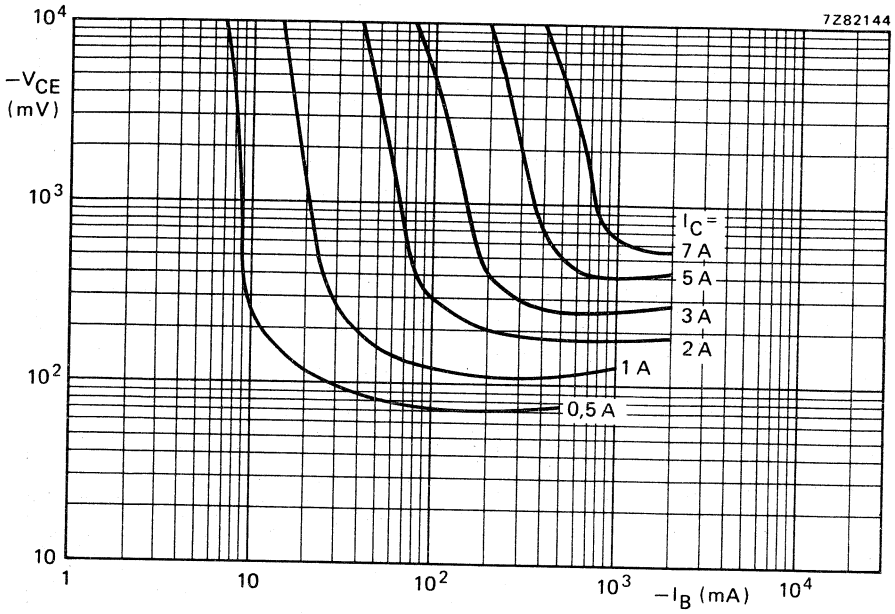


Fig. 11 Collector-emitter voltage as a function of base current.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. TO-220 plastic envelope. N-P-N complements are BDT63, BDT63A, BDT63B and BDT63C.

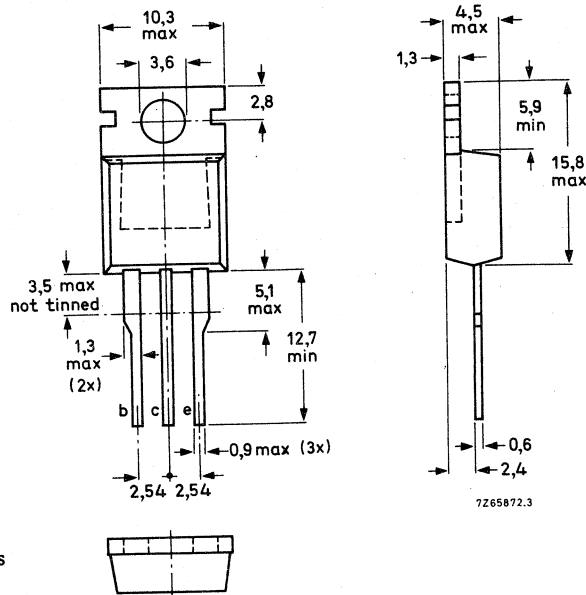
QUICK REFERENCE DATA

		BDT62	A	B	C
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100	120 V
Collector current (d.c.)	$-I_C$ max.			10	A
Collector current (peak value) $t_p = 0,3$ ms; $\delta = 10\%$	$-I_{CM}$ max.			15	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot} max.			90	W
Junction temperature	T_j max.			150	°C
D.C. current gain $-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE}	>		1000	

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters
Mounting instructions
and Accessories.

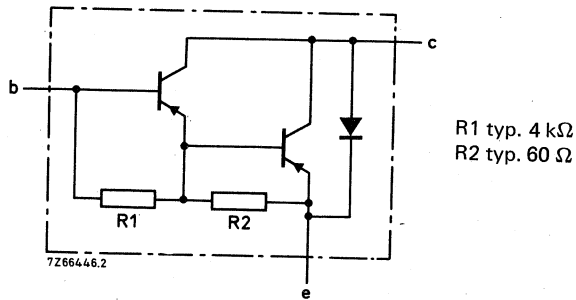


Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BDT62	A	B	C
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100	120 V
Emitter-base voltage (open collector)	$-V_{EBO}$ max.		5		V
Collector current (d.c.)	$-I_C$ max.		10		A
Collector current (peak value) $t_p = 0,3$ ms; $\delta = 10\%$	$-I_{CM}$ max.		15		A
Base current (d.c.)	$-I_B$ max.		250		mA
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot} max.		90		W
Storage temperature	T_{stg}		-65 to +150		°C
Junction temperature*	T_j max.		150		°C

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j-mb} =$	1,39	°C/W
From junction to ambient (in free air)	$R_{th\ j-a} =$	70	°C/W

* Base on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CB0max}$

$I_E = 0; -V_{CB} = -\frac{1}{2}V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$

$I_B = 0; -V_{CE} = -\frac{1}{2}V_{CE0max}$

$-I_{CBO} < 0,2\text{ mA}$

$-I_{CBO} < 2\text{ mA}$

$-I_{CEO} < 0,5\text{ mA}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$

$-I_{EBO} < 5\text{ mA}$

Forward bias second-breakdown collector current

$-V_{CE} = 40\text{ V}; t = 0,1\text{ s}; \text{non-repetitive}$

(without heatsink)

BDT62

BDT62A, B and C

$I_{(SB)} > 0,45\text{ A}$

$I_{(SB)} > 1,4\text{ A}$

D.C. current gain*

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$-I_C = 10\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} > 1000$

$h_{FE} \text{ typ. } 200$

Base-emitter voltage*

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$-V_{BE} < 2,5\text{ V}$

Collector-emitter saturation voltage*

$-I_C = 3\text{ A}; -I_B = 12\text{ mA}$

$-I_C = 8\text{ A}; -I_B = 80\text{ mA}$

$-V_{CEsat} < 2\text{ V}$

$-V_{CEsat} < 2,5\text{ V}$

Cut-off frequency

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$f_{hfe} \text{ typ. } 100\text{ kHz}$

Collector capacitance

$-V_{CB} = 10\text{ V}; f = 1\text{ MHz}$

$C_{ob} \text{ typ. } 100\text{ pF}$

D.C. current gain ratio of matched complementary pairs

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE1}/h_{FE2} < 2,5$

Small-signal current gain at $f = 1\text{ MHz}$

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$h_{fe} > 25$

* Measured under pulse conditions; $t_p < 300\text{ }\mu\text{s}$; $\delta < 2\%$.

CHARACTERISTICS (continued)

Diode, forward voltage

$I_F = 3 \text{ A}$

$V_F < 2 \text{ V}$

Switching times

(between 10% and 90% levels)

$-I_{Con} = 3 \text{ A}; -I_{Bon} = I_{Boff} = 12 \text{ mA}$

turn-on time

t_{on} typ. $0,5 \mu\text{s}$

turn-off time

t_{off} typ. $2,5 \mu\text{s}$

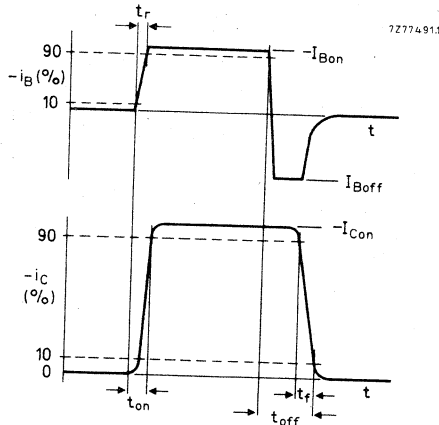
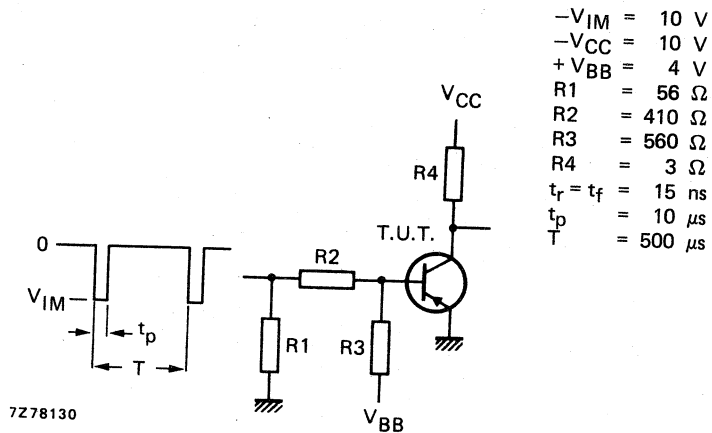


Fig. 3 Switching times waveforms.



- $-V_{IM} = 10 \text{ V}$
- $-V_{CC} = 10 \text{ V}$
- $+V_{BB} = 4 \text{ V}$
- $R1 = 56 \Omega$
- $R2 = 410 \Omega$
- $R3 = 560 \Omega$
- $R4 = 3 \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 10 \mu\text{s}$
- $T = 500 \mu\text{s}$

Fig. 4 Switching times test circuit.

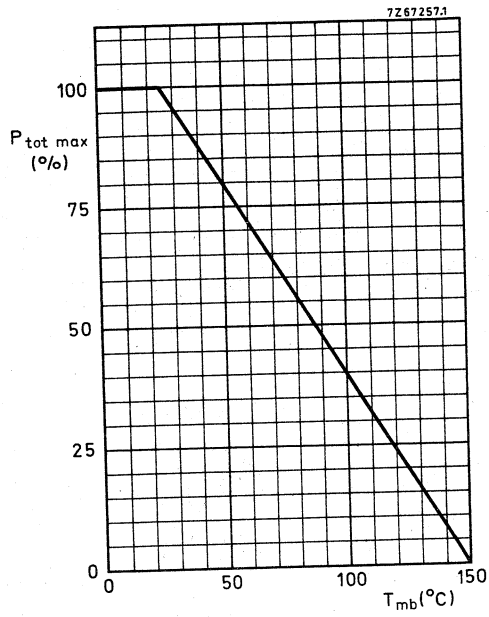


Fig. 5 Power derating curve.



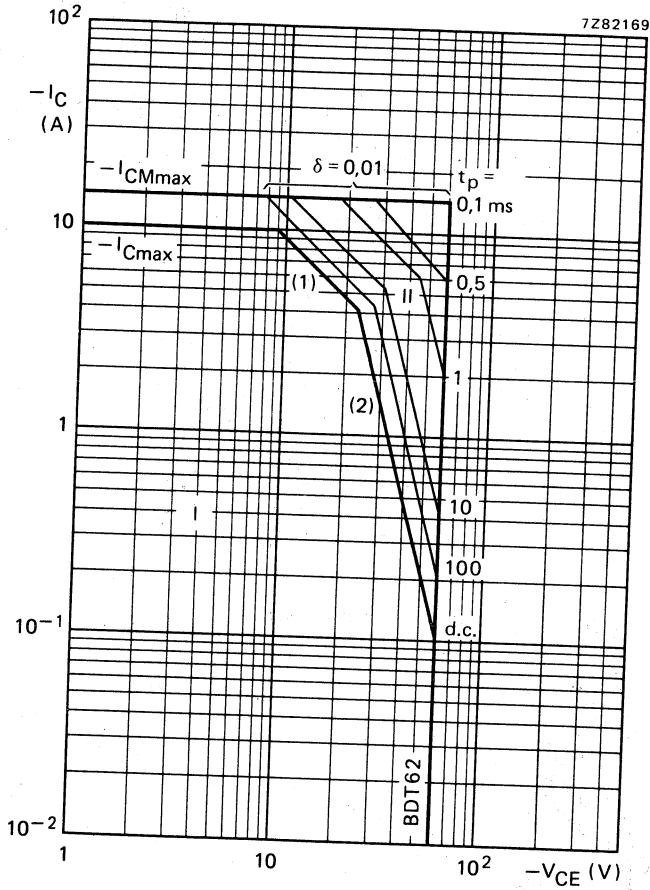


Fig. 6 Safe Operating Area BDT62; $T_{mb} = 25 \text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
- (2) Second-breakdown limits (independent of temperature).

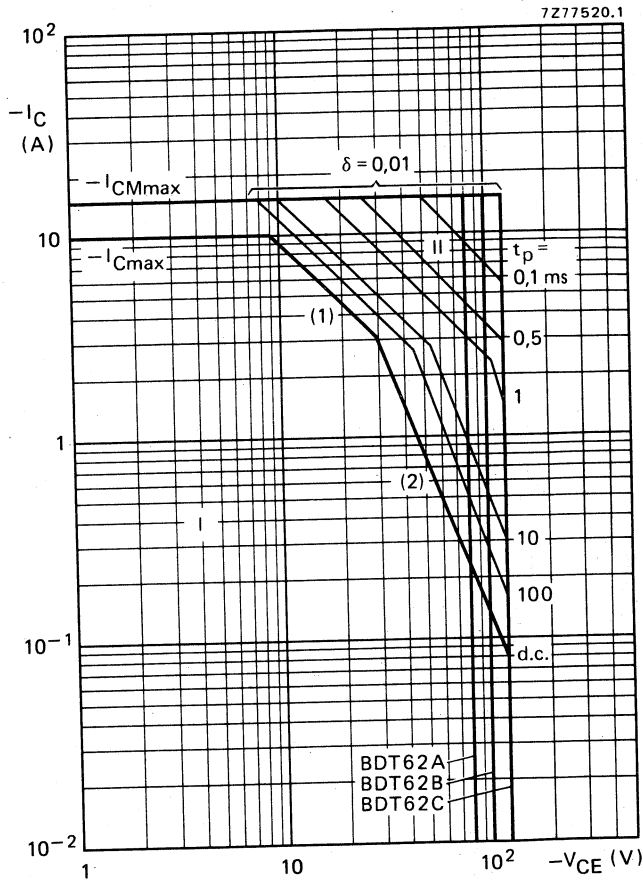


Fig. 7 Safe Operating Area BDT62A; 62B and 62C; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
- (2) Second-breakdown limits (independent of temperature).

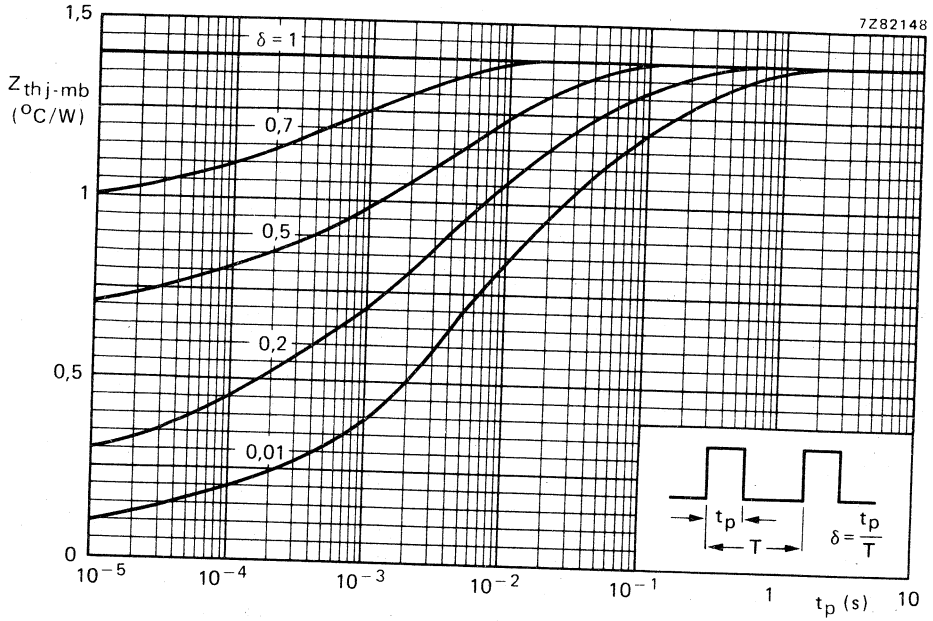


Fig. 8 Pulse power rating chart.

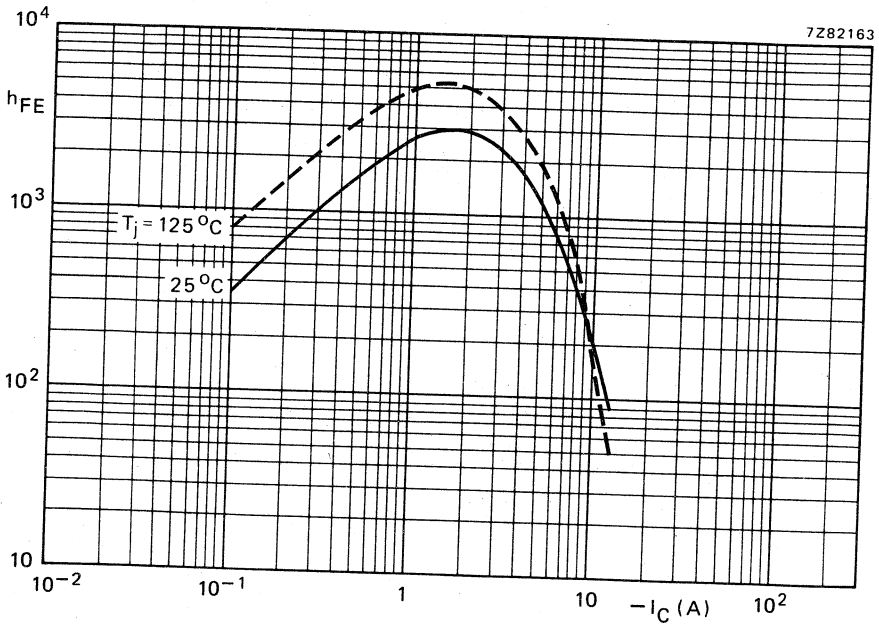


Fig. 9 Typical d.c. current gain at $-V_{CE} = 3$ V.

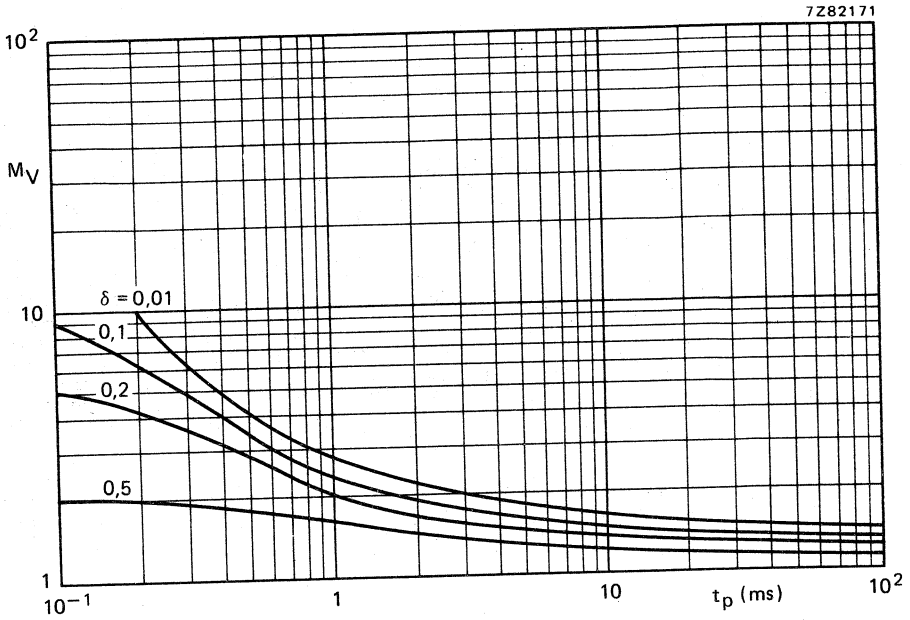


Fig. 10 S.B. voltage multiplying factor at the $I_{C \max}$ level.

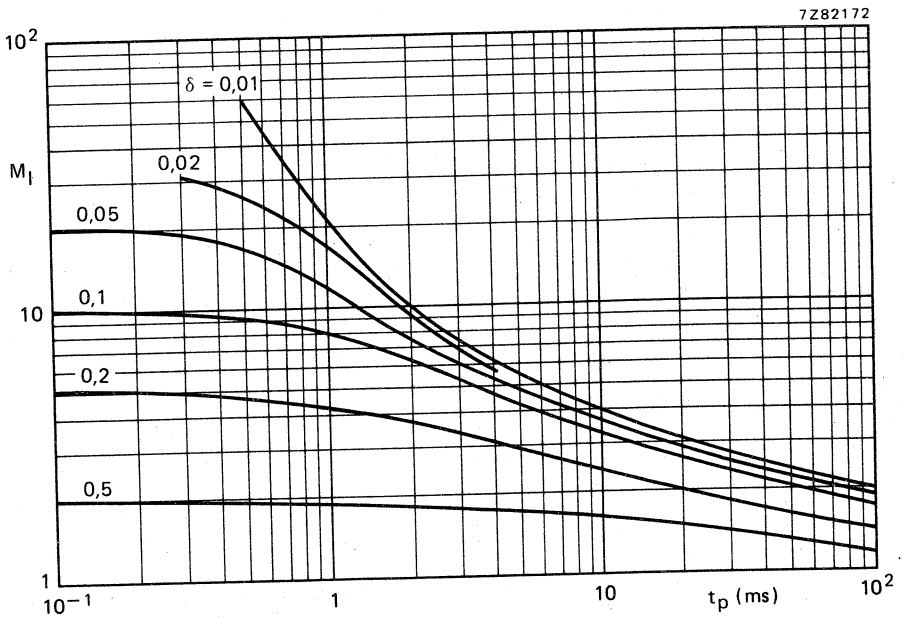


Fig. 11 S.B. current multiplying factor at the $V_{CE0 \max}$ level.

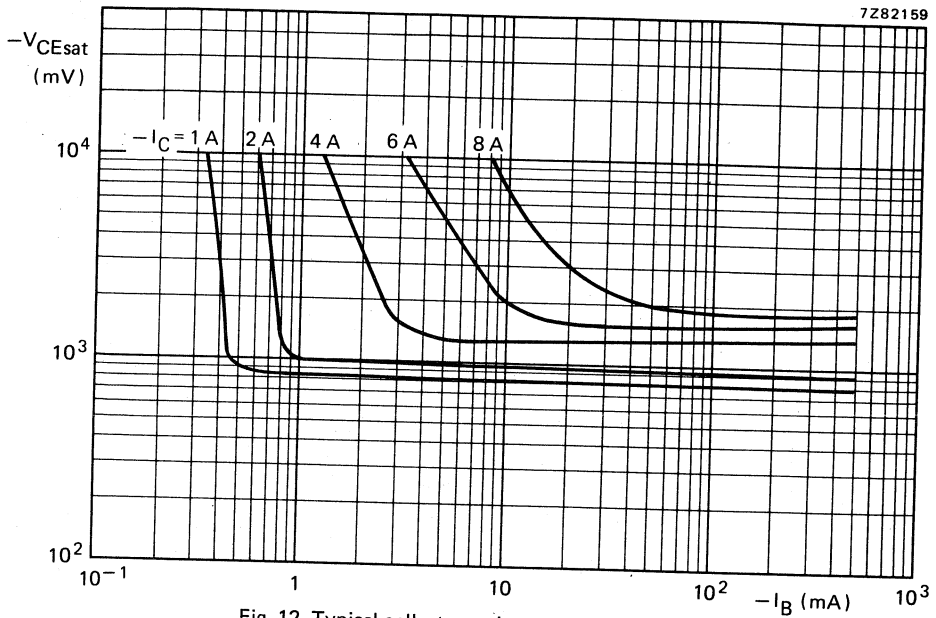


Fig. 12 Typical collector-emitter saturation voltage.

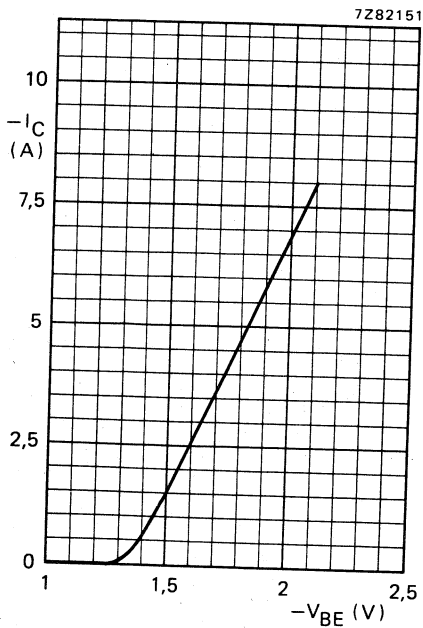


Fig. 13 Typical base emitter voltage as a function of the collector current.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-220 plastic envelope. P-N-P complements are BDT62, BDT62A; BDT62B and BDT62C.

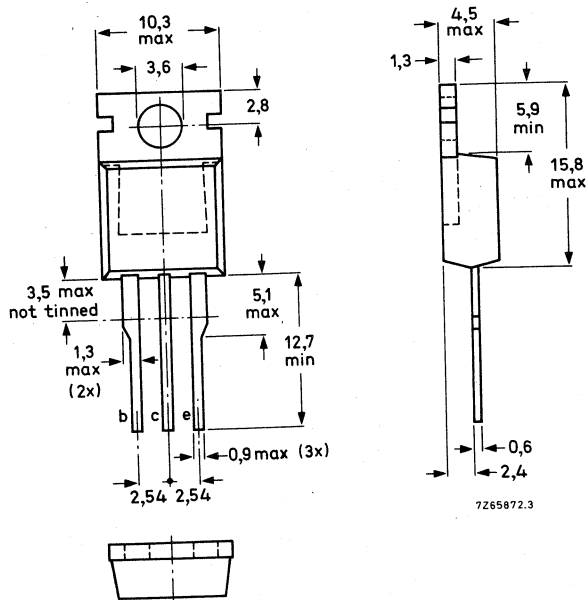
QUICK REFERENCE DATA

		BDT63	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max. 60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max. 60	80	100	120	V
Collector current (d.c.)	I_C			10		A
Collector current (peak value) $t_p = 0,3 \text{ ms}; \delta = 10\%$	I_{CM}			15		A
Total power dissipation up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}			90		W
Junction temperature	T_j			150		$^\circ\text{C}$
D.C. current gain $I_C = 3 \text{ A}; V_{CE} = 3 \text{ V}$	h_{FE}			> 1000		

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters
Mounting instructions
and Accessories.

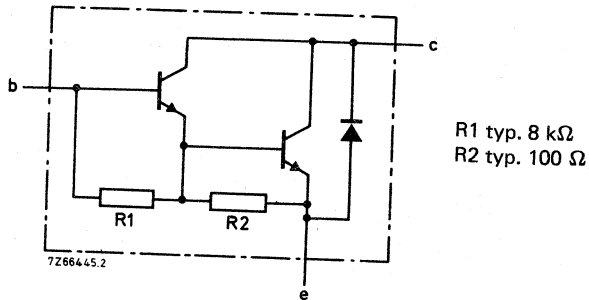


Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BDT63	A	B	C	
Collector-base voltage (open emitter)	V_{CBO} max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO} max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO} max.	5				V
Collector current (d.c.)	I_C max.	10				A
Collector current (peak value) $t_p = 0,3 \text{ ms}; \delta = 10\%$	I_{CM} max.	15				A
Base current (d.c.)	I_B max.	250				mA
Total power dissipation up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot} max.	90				W
Storage temperature	T_{stg}	-65 to + 150				$^\circ\text{C}$
Junction temperature*	T_j max.	150				$^\circ\text{C}$

THERMAL RESISTANCE *

From junction to mounting base	$R_{th j-mb} =$	1,39	$^\circ\text{C/W}$
From junction to ambient (in free air)	$R_{th j-a} =$	70	$^\circ\text{C/W}$

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Collector cut-off current

$I_E = 0; V_{CB} = V_{CB0max}$

$I_E = 0; V_{CB} = \frac{1}{2}V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$

$I_B = 0; V_{CE} = \frac{1}{2}V_{CE0max}$

I_{CBO}	<	0,2 mA
I_{CBO}	<	2 mA
I_{CEO}	<	0,5 mA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

I_{EBO}	<	5 mA
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Forward-bias second-breakdown collector current

$V_{CE} = 40\text{ V}; t = 0,1\text{ s}; \text{non-repetitive}$
(without heatsink)

$I_{(SB)}$	>	2,25 A
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D.C. current gain*

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$I_C = 10\text{ A}; V_{CE} = 3\text{ V}$

h_{FE}	>	1000
h_{FE}	typ.	3000

Base-emitter voltage*

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

V_{BE}	<	2,5 V
----------	---	-------

Collector-emitter saturation voltage*

$I_C = 3\text{ A}; I_B = 12\text{ mA}$

$I_C = 8\text{ A}; I_B = 80\text{ mA}$

V_{CEsat}	<	2 V
V_{CEsat}	<	2,5 V

Diode, forward voltage

$I_F = 3\text{ A}$

V_F	<	2 V
-------	---	-----

Turn-off breakdown energy with inductive load (Fig. 6)

$-I_{Boff} = 0; L = 5\text{ mH}$

$E_{(BR)}$	>	100 mJ
------------	---	--------

Small-signal current gain at $f = 1\text{ MHz}$

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

h_{fe}	>	25
----------	---	----

Cut-off frequency

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

f_{hfe}	typ.	50 kHz
-----------	------	--------

Collector capacitance

$V_{CB} = 10\text{ V}; f = 1\text{ MHz}$

C_{ob}	typ.	100 pF
----------	------	--------

D.C. current gain ratio of matched complementary pairs

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

h_{FE1}/h_{FE2}	<	2,5
-------------------	---	-----

* Measured under pulse conditions; $t_p < 300\text{ }\mu\text{s}$; $\delta < 2\%$.

CHARACTERISTICS (continued)

Switching times

(between 10% and 90% levels)

$I_{Con} = 3 \text{ A}$; $I_{Bon} = -I_{Boff} = 12 \text{ mA}$

turn-on time

turn-off time

t_{on}	typ.	0,5 μs
t_{off}	typ.	2,5 μs

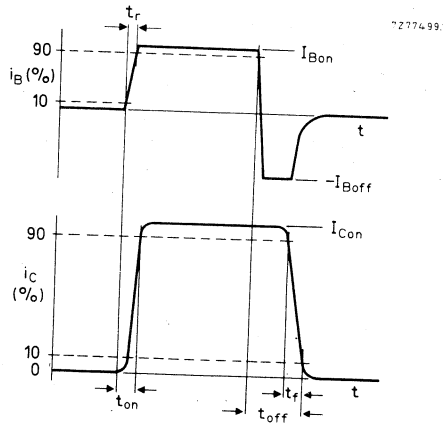
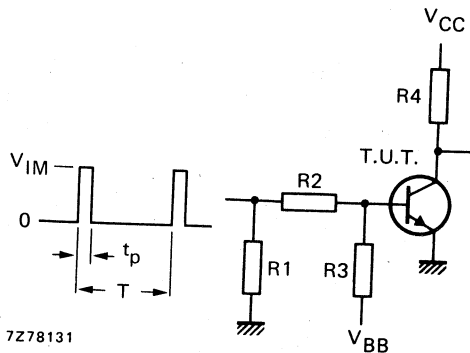


Fig. 3 Switching times waveforms.



V_{IM}	=	10 V
V_{CC}	=	10 V
$-V_{BB}$	=	4 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	3 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

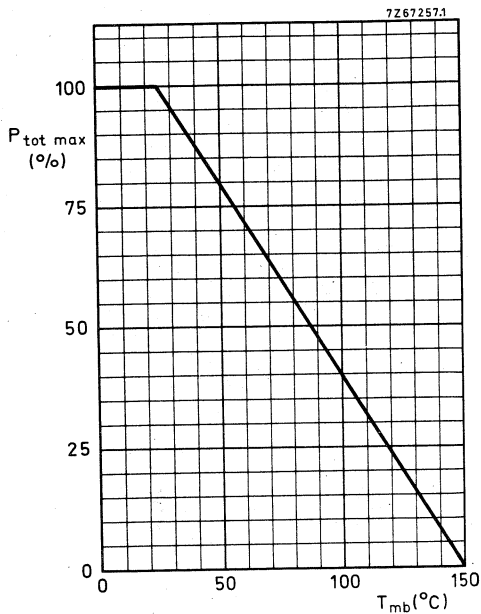


Fig. 5 Power derating curve.

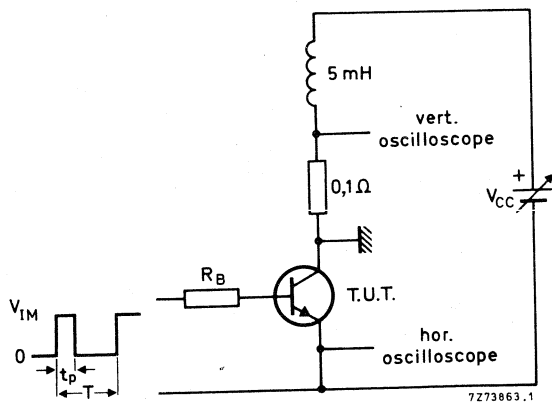


Fig. 6 Turn-off breakdown energy with inductive load.
 $V_{IM} = 12\text{ V}$; $R_B = 270\ \Omega$; $\delta = \frac{t_p}{T} \times 100\% = 1\%$; $I_{CC} = 6,3\text{ A}$.

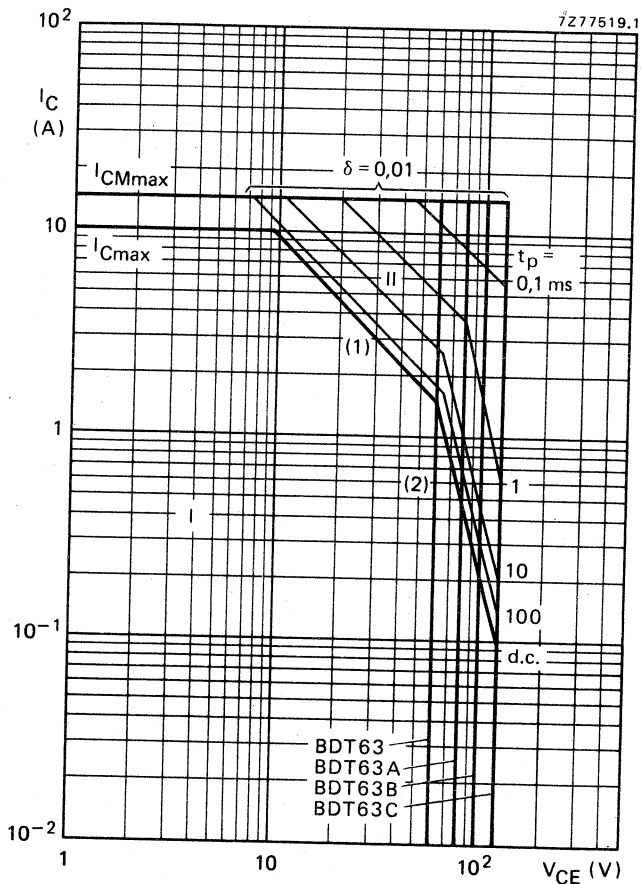


Fig. 7 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
- (2) Second-breakdown limits (independent of temperature).

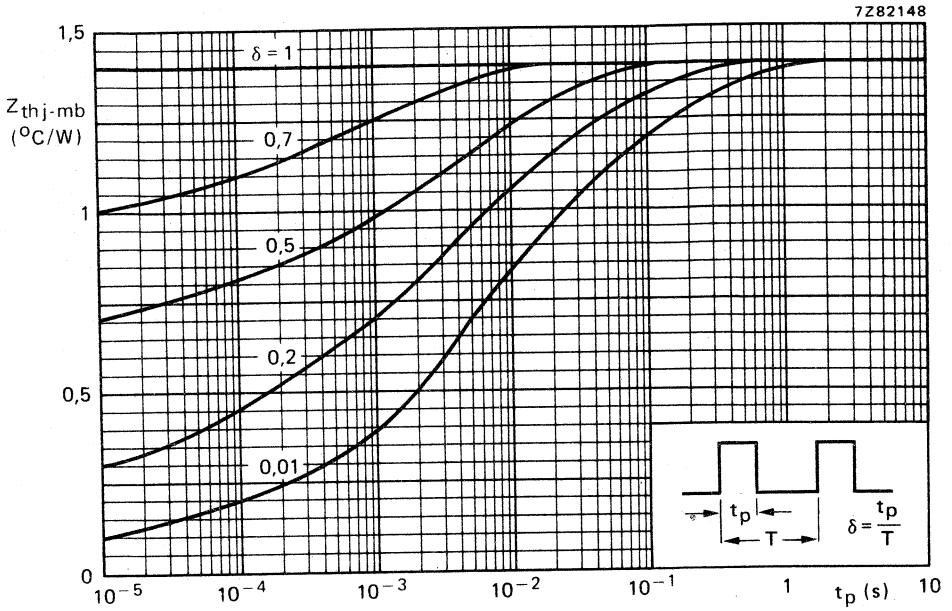


Fig. 8 Pulse power rating chart.

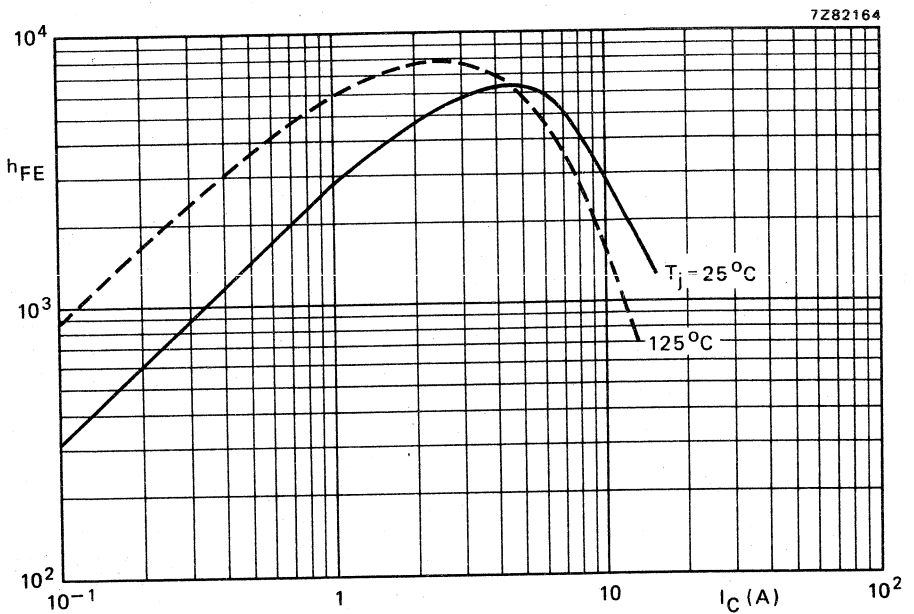


Fig. 9 Typical d.c. current gain at $V_{CE} = 3\text{ V}$.

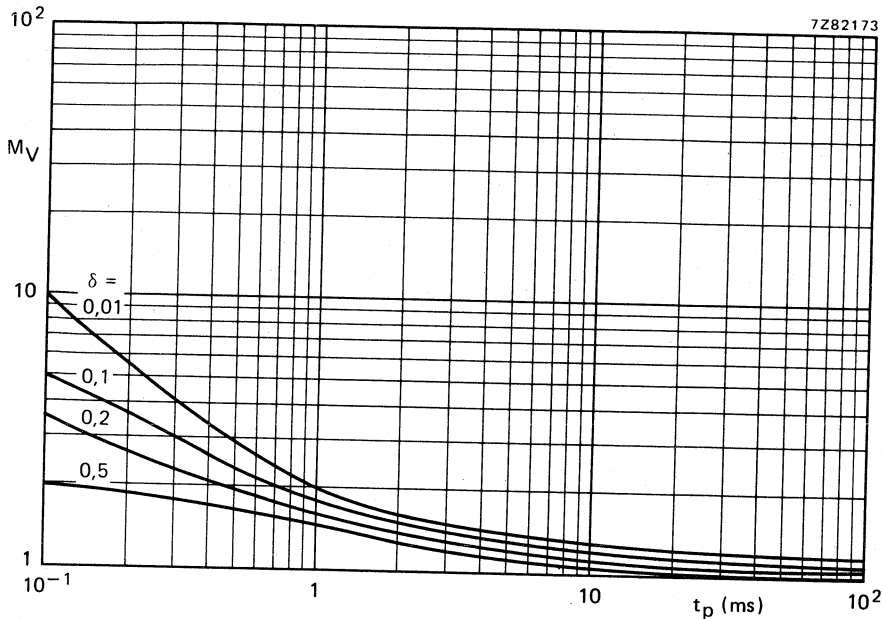


Fig. 10 S.B. voltage multiplying factor at the $I_{C \max}$ level.

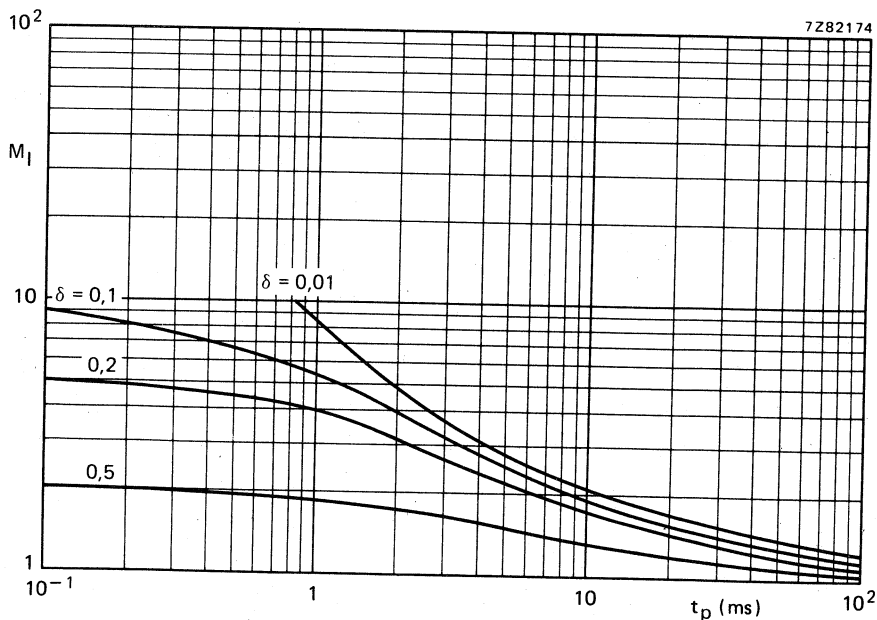


Fig. 11 S.B. current multiplying factor at V_{CE0} level = 60 V and 100 V.

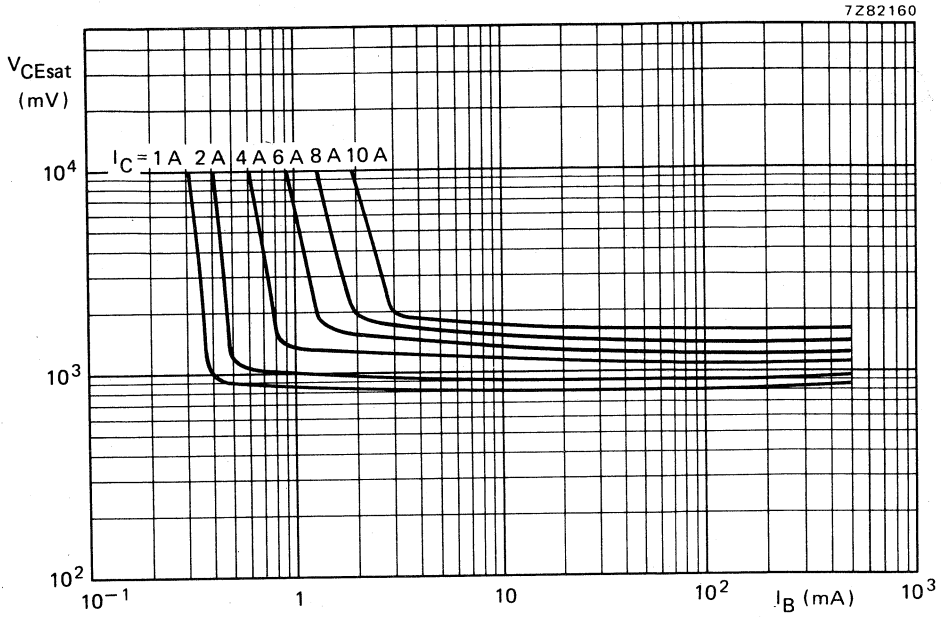


Fig. 12 Typical collector-emitter saturation voltage.

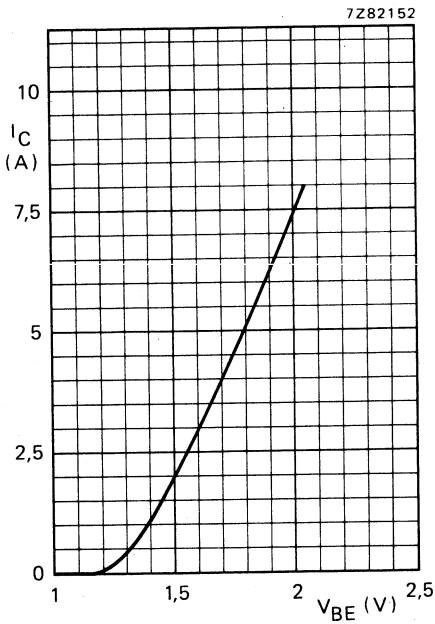


Fig. 13 Typical base-emitter voltage as a function of the collector current.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N transistors in a plastic envelope intended for use in audio output stages and general amplifier and switching applications.

P-N-P complements are BDT92, BDT94 and BDT96.

QUICK REFERENCE DATA

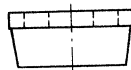
		BDT91	BDT93	BDT95
Collector-base voltage (open emitter)	V_{CB0}	max. 60	80	100 V
Collector-emitter voltage (open base)	V_{CE0}	max. 60	80	100 V
Collector current (d.c.)	I_C	max.	10	A
Collector current (peak value)	I_{CM}	max.	20	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	90	W
Junction temperature	T_j	max.	150	$^\circ\text{C}$
D.C. current gain			20 to 200	
$I_C = 4\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}		5	
$I_C = 10\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>		
Transition frequency	f_T	>	4	MHz
$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$				

MECHANICAL DATA

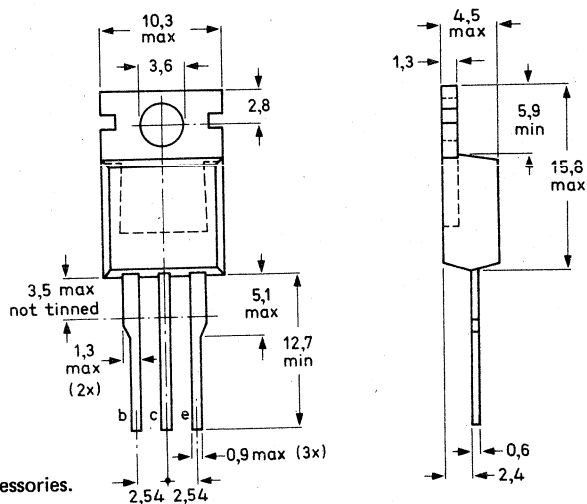
Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



top view



See also chapters
Mounting instructions and Accessories.

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RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BDT91	BDT93	BDT95
Collector-base voltage (open emitter)	V_{CBO}	max. 60	80	100 V
Collector-emitter voltage (open base)	V_{CEO}	max. 60	80	100 V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V
Collector current (d.c.)	I_C	max.	10	A
Collector current (peak value)	I_{CM}	max.	20	A
Base current (d.c.)	I_B	max.	4	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	90	W
Storage temperature	T_{stg}		-65 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1,39	$^\circ\text{C/W}$
From junction to ambient (in free air)	$R_{th\ j-a}$	=	70	$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = V_{CBOmax}$

$I_E = 0; V_{CB} = \frac{1}{2}V_{CBOmax}; T_j = 150\text{ }^\circ\text{V}$

$I_B = 0; V_{CE} = V_{CEOmax}$

I_{CBO}	<	0,1	mA
I_{CBO}	<	5	mA
I_{CEO}	<	1	mA

Emitter cut-off current

$I_C = 0; V_{EB} = 7\text{ V}$

I_{EBO}	<	1	mA
-----------	---	---	----

D.C. current gain (note 1)

$I_C = 4\text{ A}; V_{CE} = 4\text{ V}$

$I_C = 10\text{ A}; V_{CE} = 4\text{ V}$

h_{FE}		20 to 200	
h_{FE}	>	5	

Base-emitter voltage (notes 1 and 2)

$I_C = 4\text{ A}; V_{CE} = 4\text{ V}$

V_{BE}	<	1,6	V
----------	---	-----	---

Collector-emitter saturation voltage (note 1)

$I_C = 4\text{ A}; I_B = 0,4\text{ A}$

$I_C = 10\text{ A}; I_B = 3,3\text{ A}$

V_{CEsat}	<	1	V
V_{CEsat}	<	3	V

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$

f_T	>	4	MHz
-------	---	---	-----

Cut-off frequency

$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$

f_{hfe}	>	20	kHz
-----------	---	----	-----

Notes

1. Measured under pulse conditions: $t_D \leq 300\text{ }\mu\text{s}; \delta \leq 2\%$.
2. V_{BE} decreases by about 2,3 mV/ $^\circ\text{C}$ with increasing temperature.

Second-breakdown collector current
 $V_{CE} = 60 \text{ V}; t_p = 0,1 \text{ s}$

$I_{(SB)} < 1,5 \text{ A}$

Switching times
(between 10% and 90% levels)
 $I_{Con} = 4 \text{ A}; I_{Bon} = -I_{Boff} = 0,4 \text{ A}$
Turn-on time
Turn-off time

t_{on} typ. $0,3 \mu\text{s}$
 t_{off} typ. $1,5 \mu\text{s}$

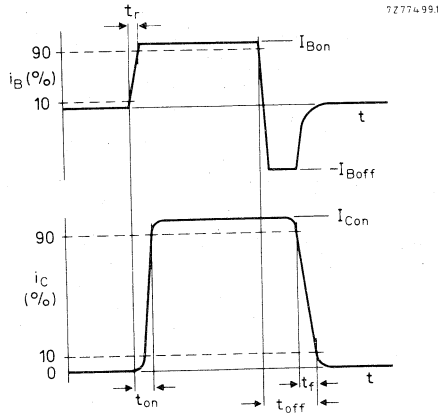


Fig. 2 Switching times waveforms.

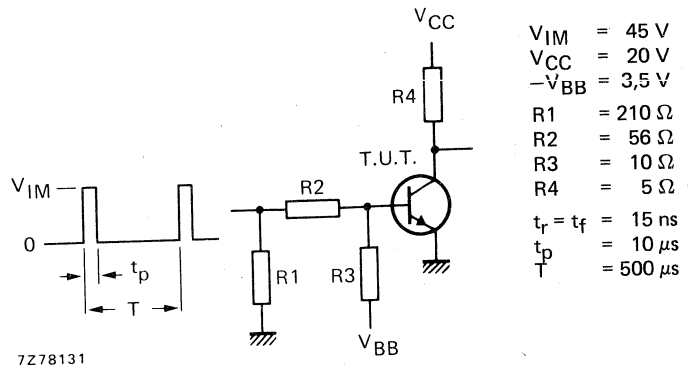


Fig. 3 Switching times test circuit.

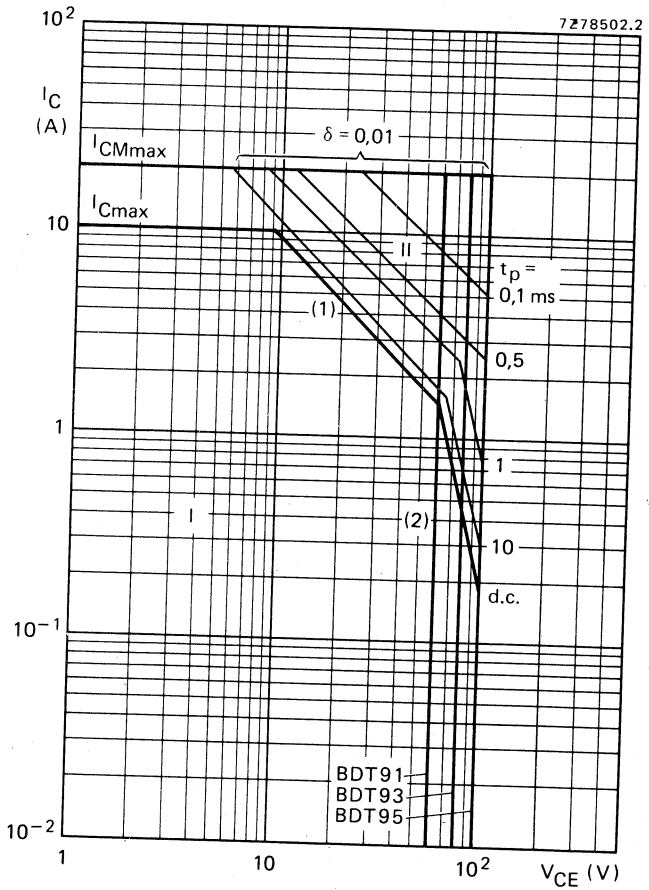


Fig. 4 Safe Operating Area; $T_{mb} = 25 \text{ }^\circ\text{C}$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.

(2) Second-breakdown limits (independent of temperature).

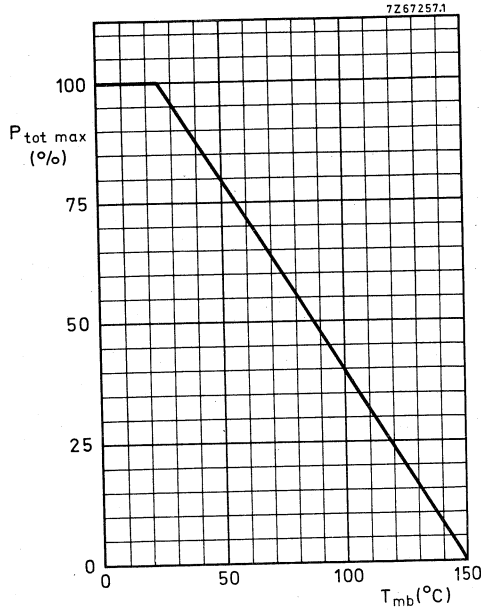


Fig. 5 Power derating curve.

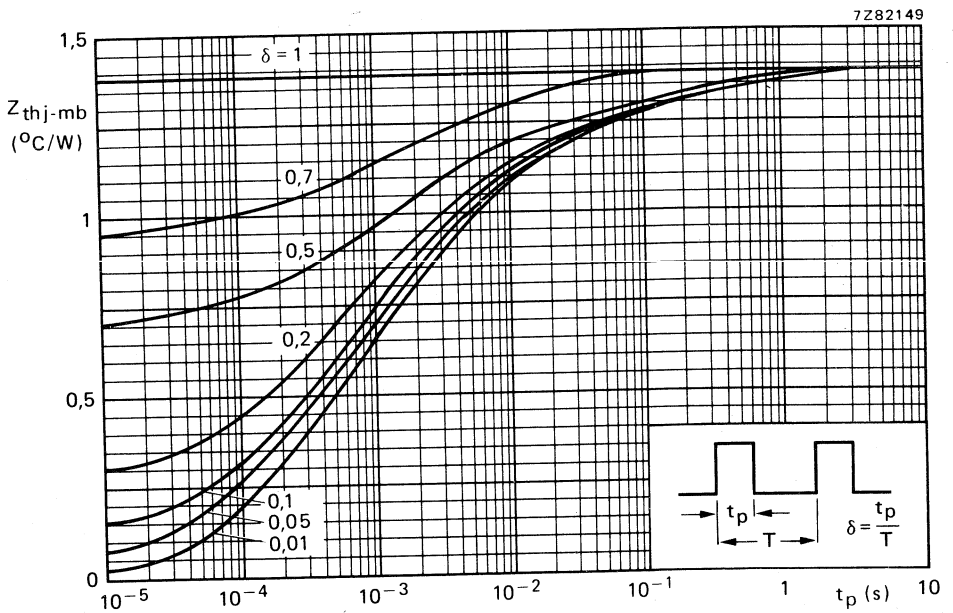


Fig. 6 Pulse power rating chart.

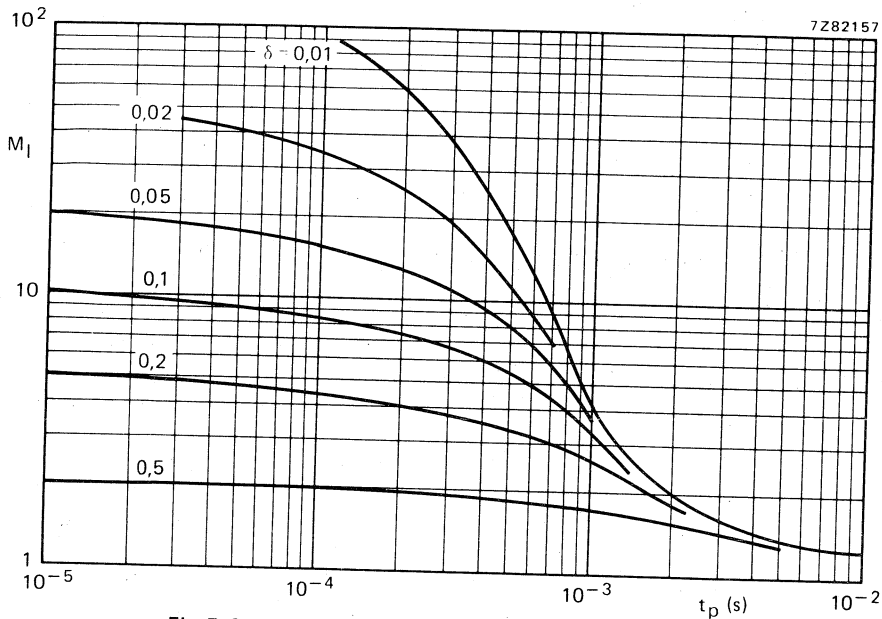


Fig. 7 S.B. current multiplying factor at the V_{CE0max} level.

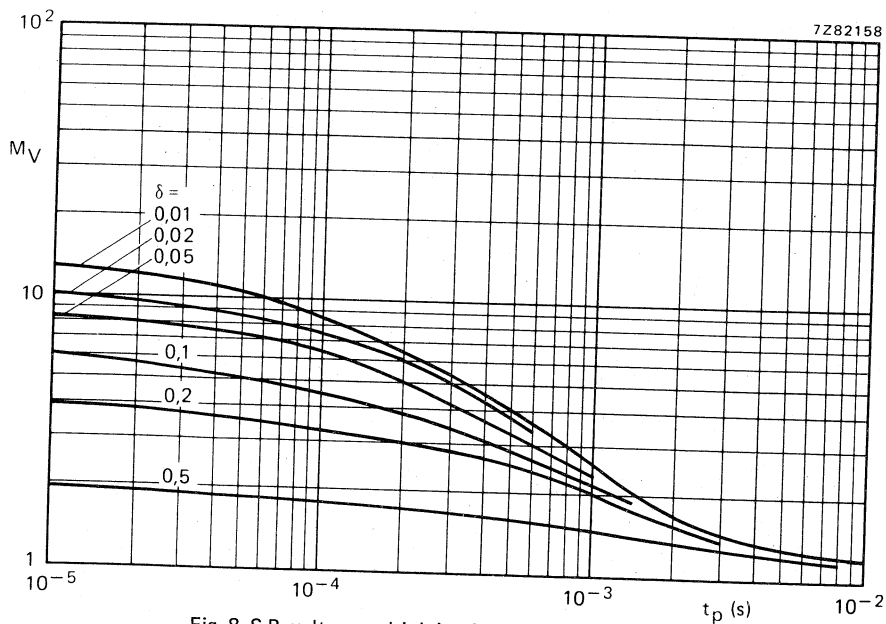


Fig. 8 S.B. voltage multiplying factor at the I_{Cmax} level.

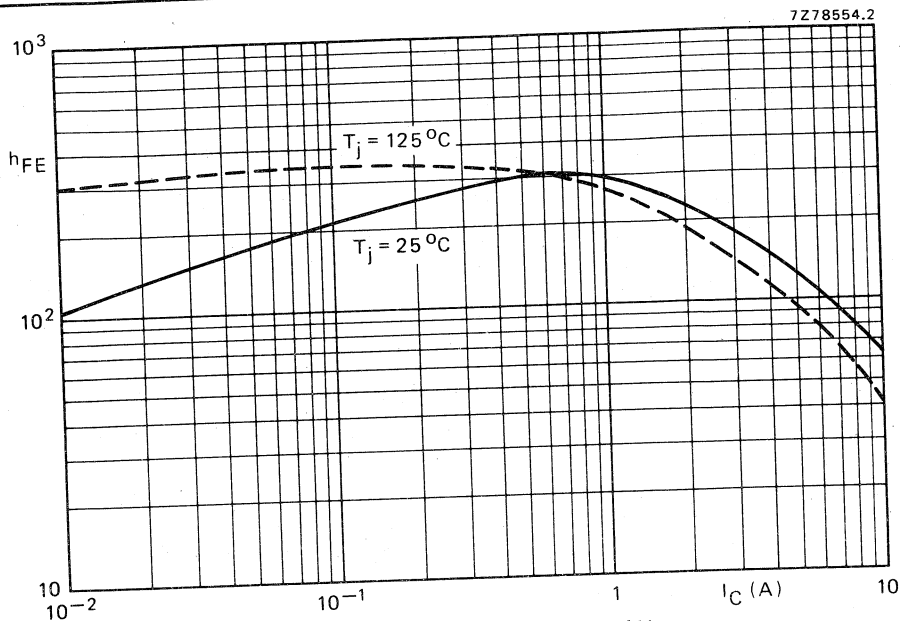


Fig. 9 Typical d.c. current gain at $V_{CE} = 4$ V.

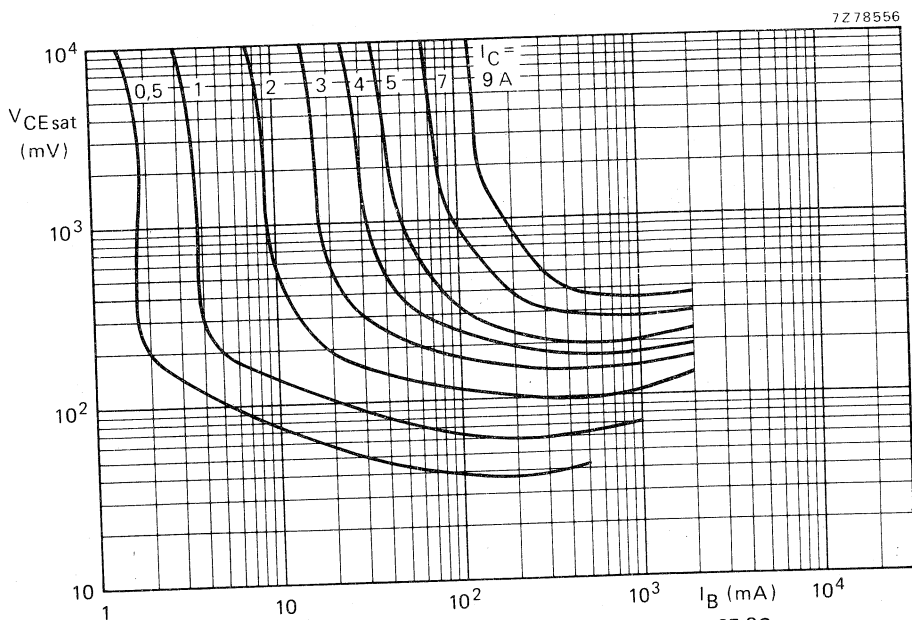


Fig. 10 Typical collector-emitter saturation voltage. $T_{mb} = 25^\circ\text{C}$.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P transistors in a plastic envelope intended for use in audio output stages and general amplifier and switching applications.

N-P-N complements are BDT91, BDT93 and BDT95.

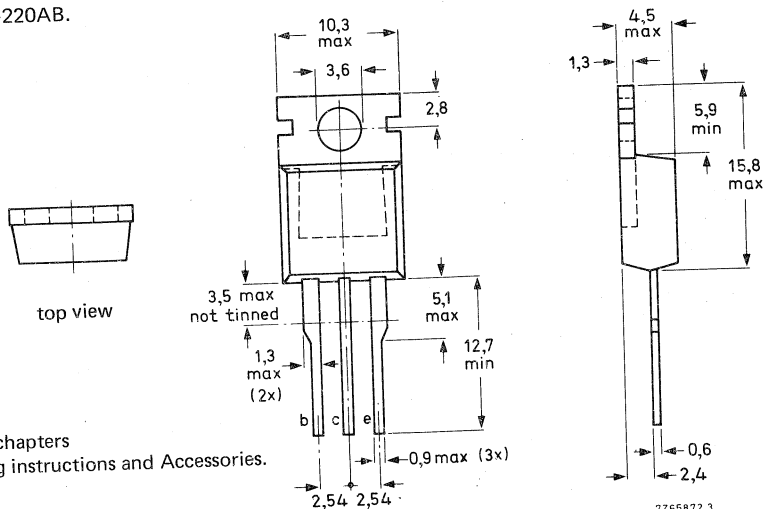
QUICK REFERENCE DATA

			BDT92	BDT94	BDT96
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100 V
Collector current (d.c.)	$-I_C$	max.		10	A
Collector current (peak value)	$-I_{CM}$	max.		20	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.		90	W
Junction temperature	T_j	max.		150	$^\circ\text{C}$
D.C. current gain				20 to 200	
$-I_C = 4\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}			5	
$-I_C = 10\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	>			
Transition frequency	f_T	>		4	MHz
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}$					

MECHANICAL DATA

Fig. 1 TO-220AB.

Dimensions in mm



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BDT92	BDT94	BDT96
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100 V
Emitter-base voltage (open collector)	$-V_{EBO}$ max.		7	V
Collector current (d.c.)	$-I_C$ max.		10	A
Collector current (peak value)	$-I_{CM}$ max.		20	A
Base current (d.c.)	$-I_B$ max.		4	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.		90	W
Storage temperature	T_{stg}		-65 to +150	$^\circ\text{C}$
Junction temperature	T_j max.		150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$ =		1,39	$^\circ\text{C/W}$
From junction to ambient (in free air)	$R_{th\ j-a}$ =		70	$^\circ\text{C/W}$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current				
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$ <		0,1	mA
$I_E = 0; -V_{CB} = -\frac{1}{2}V_{CBOmax}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$ <		5	mA
$I_B = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CEO}$ <		1	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 7\text{ V}$	$-I_{EBO}$ <		1	mA
D.C. current gain (note 1)				
$-I_C = 4\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}		20 to 200	
$-I_C = 10\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE} >		5	
Base-emitter voltage (notes 1 and 2)				
$-I_C = 4\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE}$ <		1,6	V
Collector-emitter saturation voltage (note 1)				
$-I_C = 4\text{ A}; -I_B = 0,4\text{ A}$	$-V_{CEsat}$ <		1	V
$-I_C = 10\text{ A}; -I_B = 3,3\text{ A}$	$-V_{CEsat}$ <		3	V
Transition frequency at $f = 1\text{ MHz}$				
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}$	f_T >		4	MHz
Cut-off frequency				
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}$	f_{hfe} >		20	kHz

Notes

1. Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 2\%$.
2. V_{BE} decreases by about $2,3\text{ mV}/^\circ\text{C}$ with increasing temperature.

Second-breakdown collector current

$-V_{CE} = 60 \text{ V}; t_p = 0,1 \text{ s}$

$-I_{(SB)} < 0,6 \text{ A}$

Switching times

(between 10% and 90% levels)

$-I_{Con} = 4 \text{ A}; -I_{Bon} = +I_{Boff} = 0,4 \text{ A}$

Turn-on time

Turn-off time

t_{on}	typ.	0,3 μs
t_{off}	typ.	1,5 μs

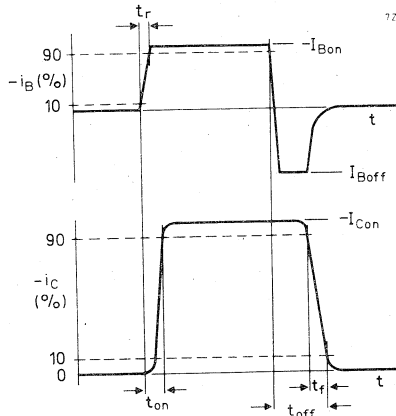


Fig. 2 Switching times waveforms.

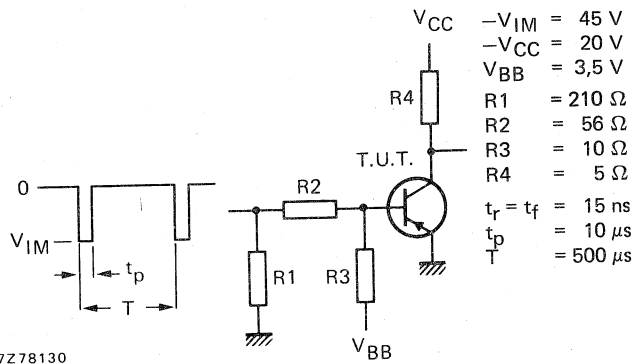


Fig. 3 Switching times test circuit.

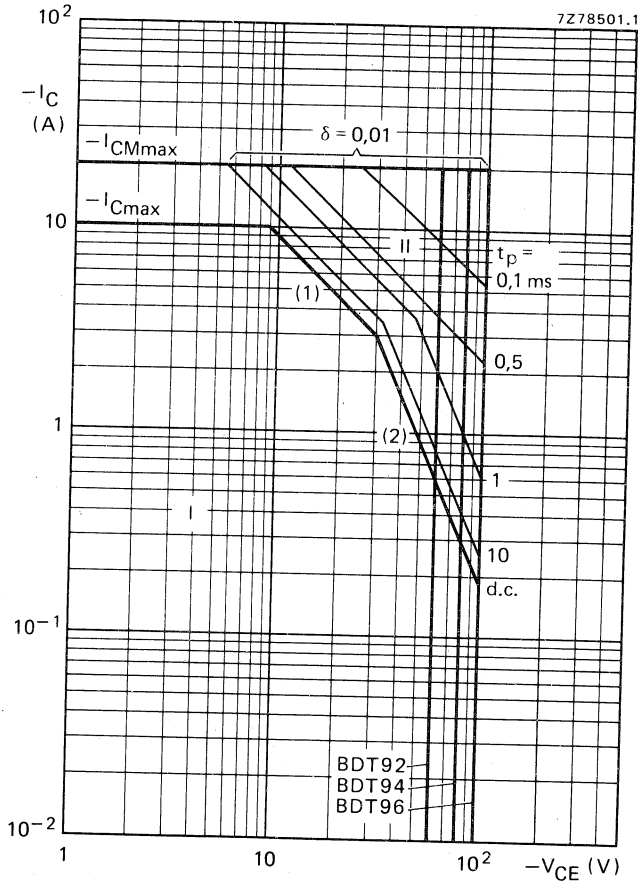


Fig. 4 Safe Operating Area; $T_{mb} = 25 \text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
- (2) Second-breakdown limits (independent of temperature).

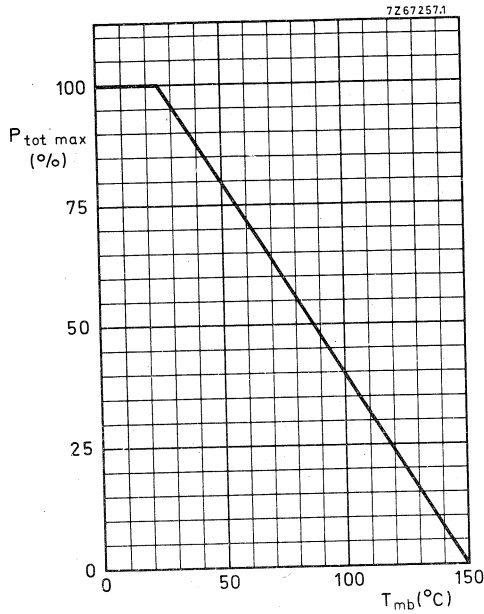


Fig. 5 Power derating curve.

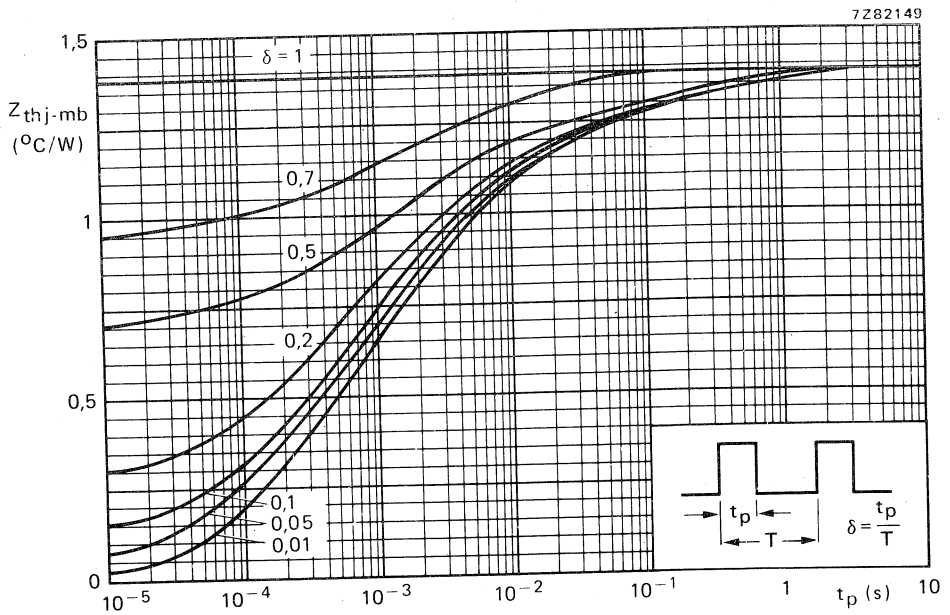


Fig. 6 Pulse power rating chart.

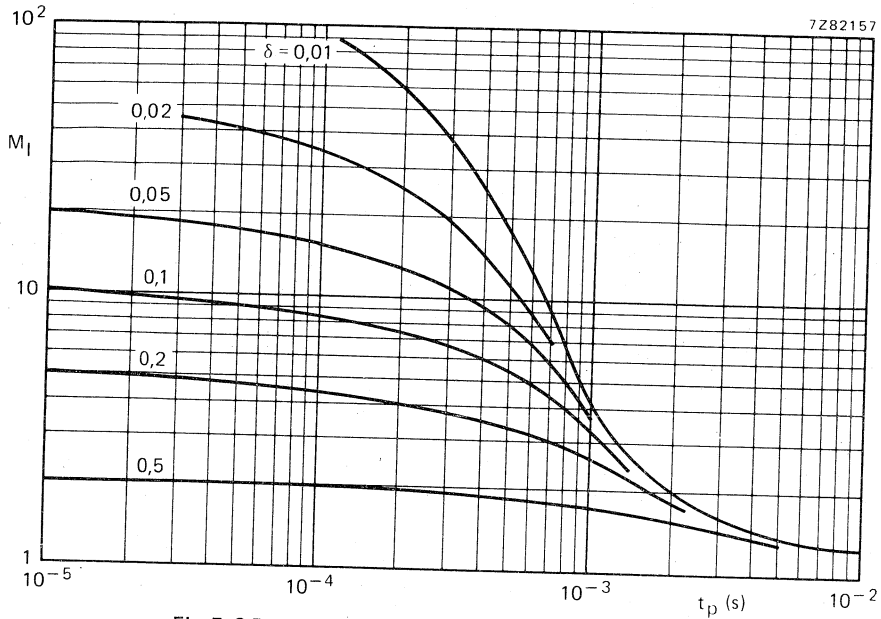


Fig. 7 S.B. current multiplying factor at the V_{CE0max} level.

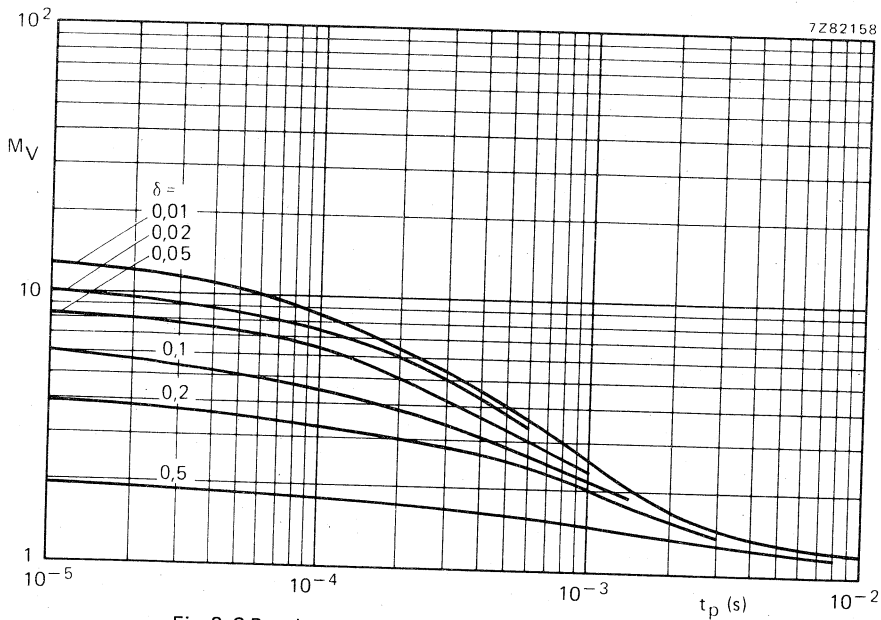


Fig. 8 S.B. voltage multiplying factor at the I_{Cmax} level.

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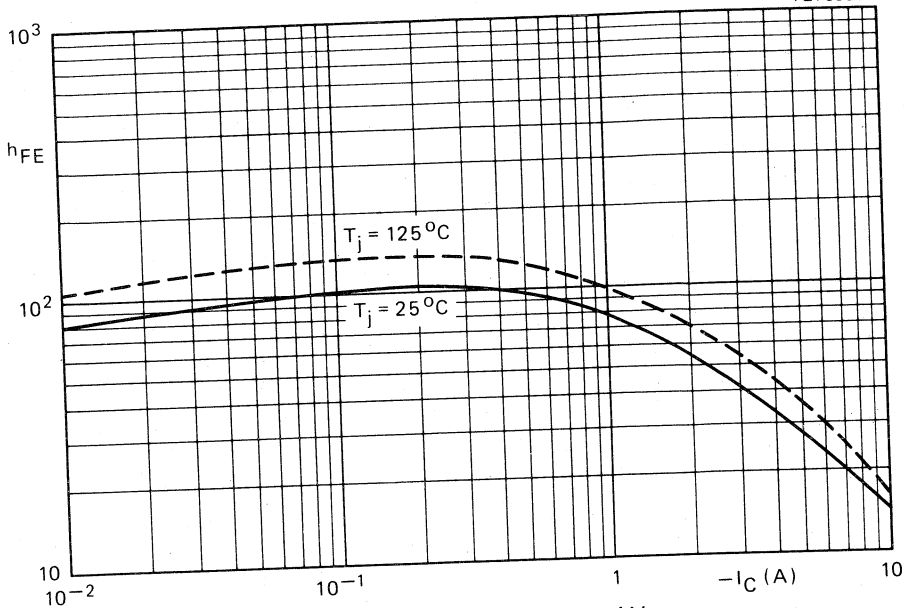


Fig. 9 Typical d.c. current gain at $-V_{CE} = 4$ V.

7278558.1

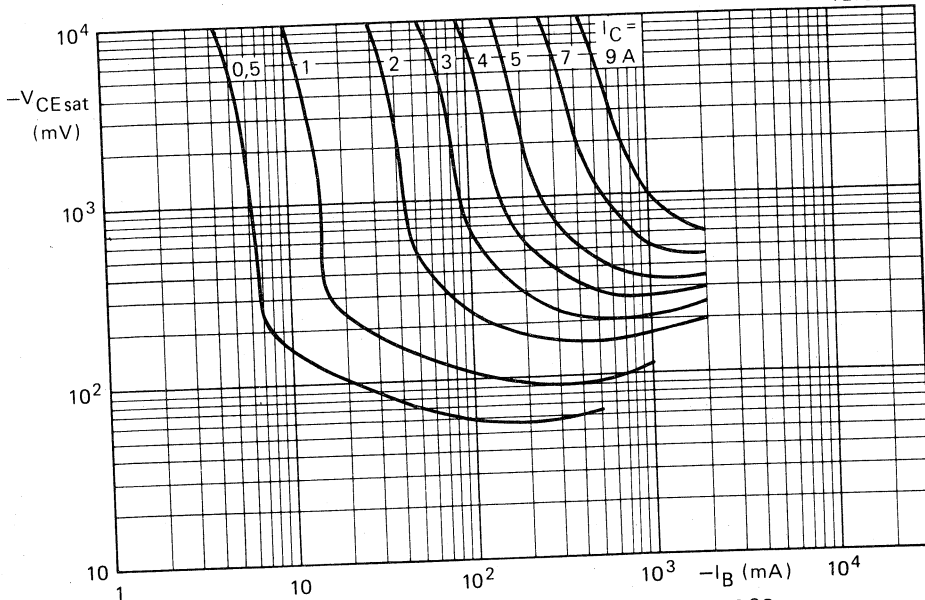


Fig. 10 Typical collector-emitter saturation voltage. $T_{mb} = 25^\circ\text{C}$.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. N-P-N complements are BDV65, BDV65A and BDV65B. Matched complementary pairs can be supplied.

QUICK REFERENCE DATA

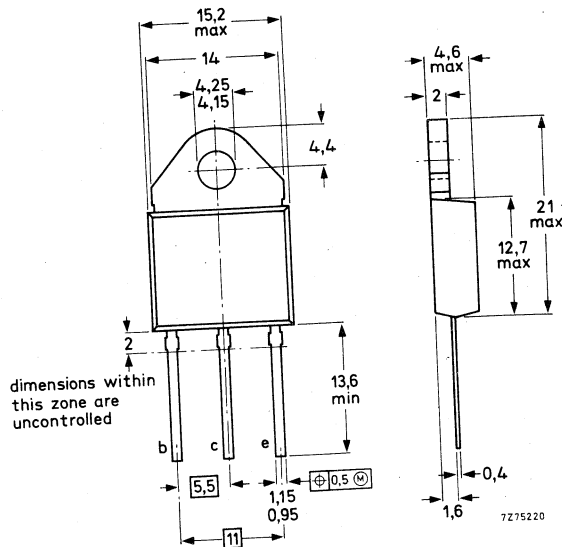
		BDV64	BDV64A	BDV64B	
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100	V
Collector current (peak value)	$-I_{CM}$ max.		20		A ←
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.		125		W
Junction temperature	T_j max.		150		$^{\circ}\text{C}$
D.C. current gain	h_{FE} typ.		1500		
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	$h_{FE} >$		1000		
$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$					
Cut-off frequency	f_{hfe} typ.		100		kHz
$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$					

Dimensions in mm

MECHANICAL DATA

Fig. 1 SOT-93.

Collector connected to mounting base.



Accessories supplied on request: 56368 (see also data sheet *Mounting instructions SOT-93*).

CIRCUIT DIAGRAM

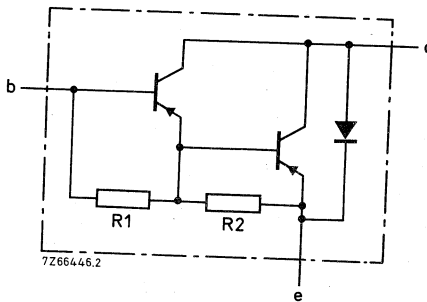


Fig. 2
R1 typical 5 kΩ
R2 typical 80 Ω.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

	BDV64	BDV64A	BDV64B
Collector-base voltage (open emitter)	-V _{CBO} max. 60	80	100 V
Collector-emitter voltage (open base)	-V _{CEO} max. 60	80	100 V
Emitter-base voltage (open collector)	-V _{EBO} max. 5	5	5 V
→ Collector current (d.c.)	-I _C max.	12	A
→ Collector current (peak value)	-I _{CM} max.	20	A
Base current (d.c.)	-I _B max.	0,5	A
Total power dissipation up to T _{mb} = 25 °C	P _{tot} max.	125	W
Storage temperature	T _{stg}	- 65 to + 150	°C
Junction temperature	T _j max.	150	°C*

THERMAL RESISTANCE

From junction to mounting base	R _{th j-mb} =	1	°C/W*
--------------------------------	------------------------	---	-------

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Collector cut-off currents

$I_E = 0; -V_{CB} = -V_{CBOmax}$
 $I_E = 0; -V_{CB} = -\frac{1}{2} V_{CBOmax}; T_j = 150\text{ }^\circ\text{C}$
 $I_B = 0; -V_{CE} = -\frac{1}{2} V_{CEOmax}$

$-I_{CBO}$	<	400 μA
$-I_{CBO}$	<	2 mA
$-I_{CEO}$	<	1 mA

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$

$-I_{EBO}$	<	5 mA
------------	---	------

D.C. current gain*

$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$
 $-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$
 $-I_C = 10\text{ A}; -V_{CE} = 4\text{ V}$

h_{FE}	typ.	1500
h_{FE}	>	1000
h_{FE}	typ.	1000

Base-emitter voltage*

$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$

$-V_{BE}$	<	2,5 V**
-----------	---	---------

Collector-emitter saturation voltage*

$-I_C = 5\text{ A}; -I_B = 20\text{ mA}$

$-V_{CEsat}$	<	2 V
--------------	---	-----

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_B = 0; -V_{CB} = 10\text{ V}$

C_C	typ.	200 pF
-------	------	--------

Cut-off frequency

$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$

f_{hfe}	typ.	100 kHz
-----------	------	---------

Diode, forward voltage

$I_F = 5\text{ A}$

V_F	typ.	1,8 V
-------	------	-------

Switching times (see also Fig. 4)

$-I_{Con} = 5\text{ A}; -I_{Bon} = I_{Boff} = 20\text{ mA}; V_{CC} = -16\text{ V}$

Turn-on time

Fall time

Turn-off time

t_{on}	typ.	0,5 μs
t_f	typ.	1,0 μs
t_{off}	typ.	2,0 μs

* Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}; \delta < 2\%$.
 ** $-V_{BE}$ decreases by about 3,6 mV/ $^\circ\text{C}$ with increasing temperature.

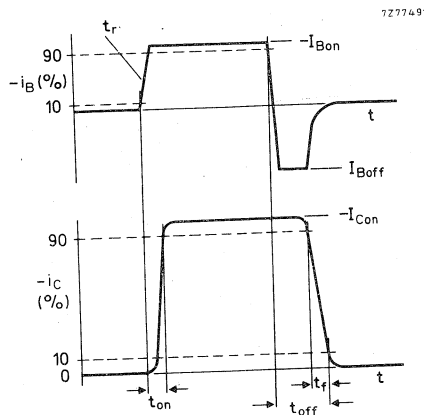


Fig. 3 Waveforms showing $t_{on}; t_s + t_f = t_{off}$.

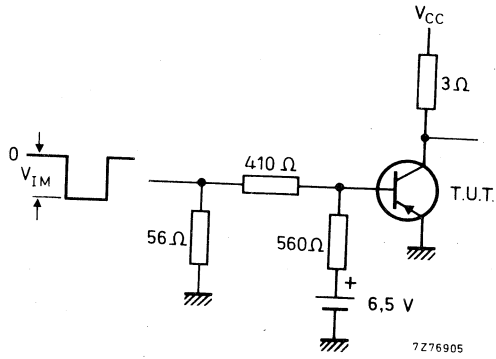


Fig. 4 Switching times test circuit; $V_{CC} = -16$ V;
 $V_{IM} = 16,5$ V; $t_r = t_f = 15$ ns; $t_p = 10$ μ s; $T = 500$ μ s.

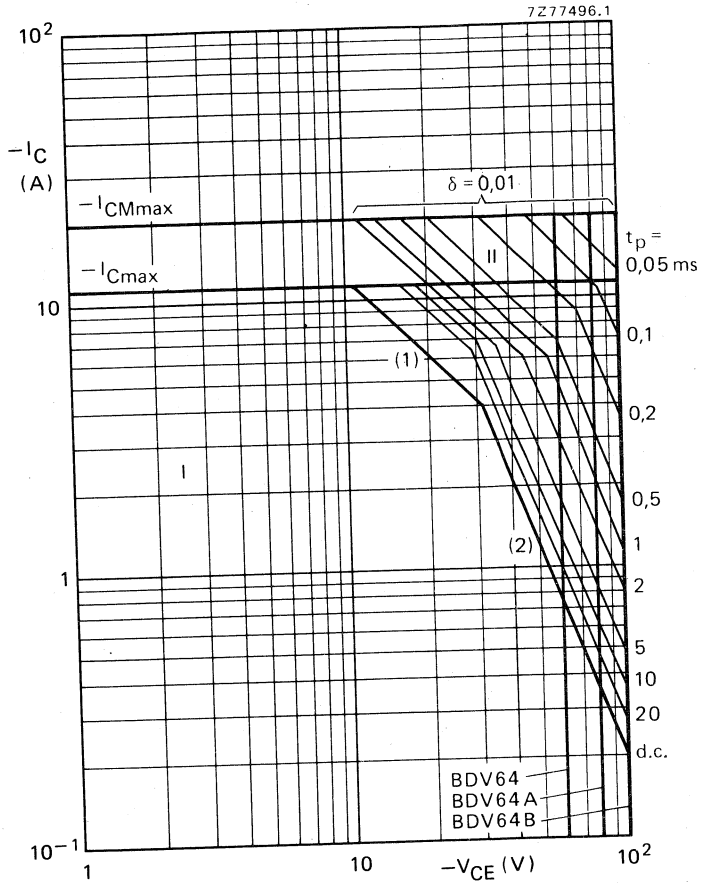


Fig. 5 Safe Operating Area; $T_{mb} \leq 25^\circ\text{C}$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.

(2) Second breakdown limits (independent of temperature).

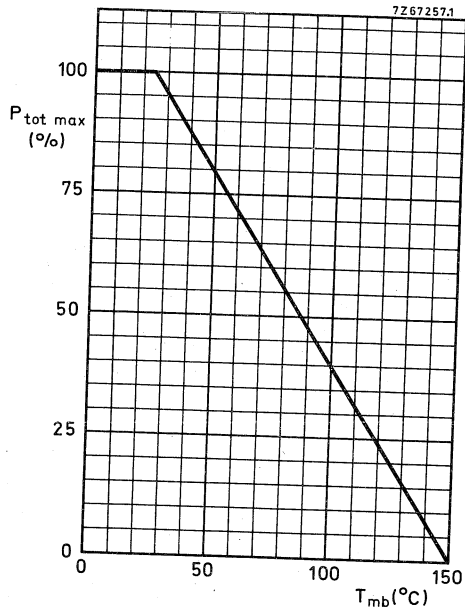


Fig. 6.

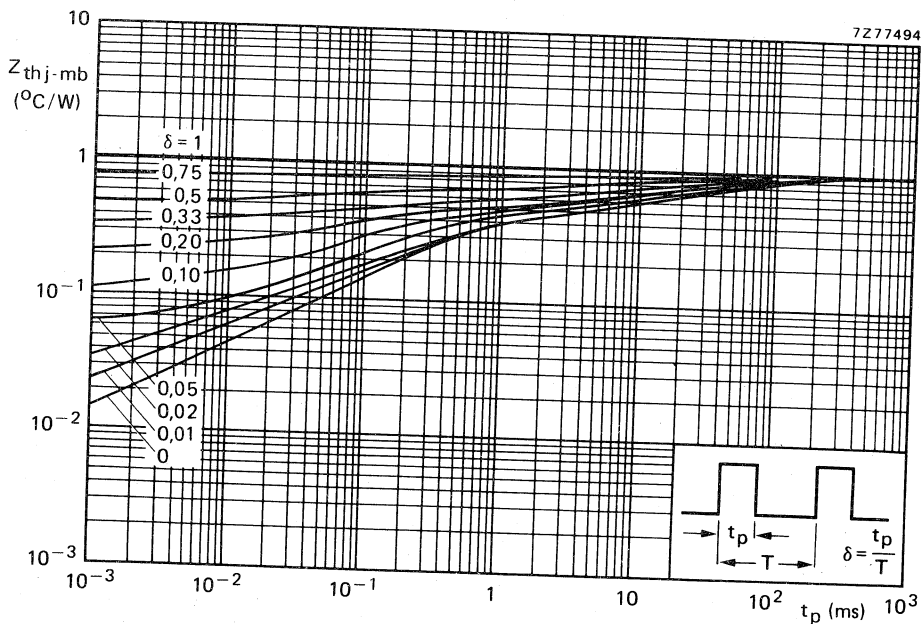


Fig. 7 Heating-up curve.

7277493

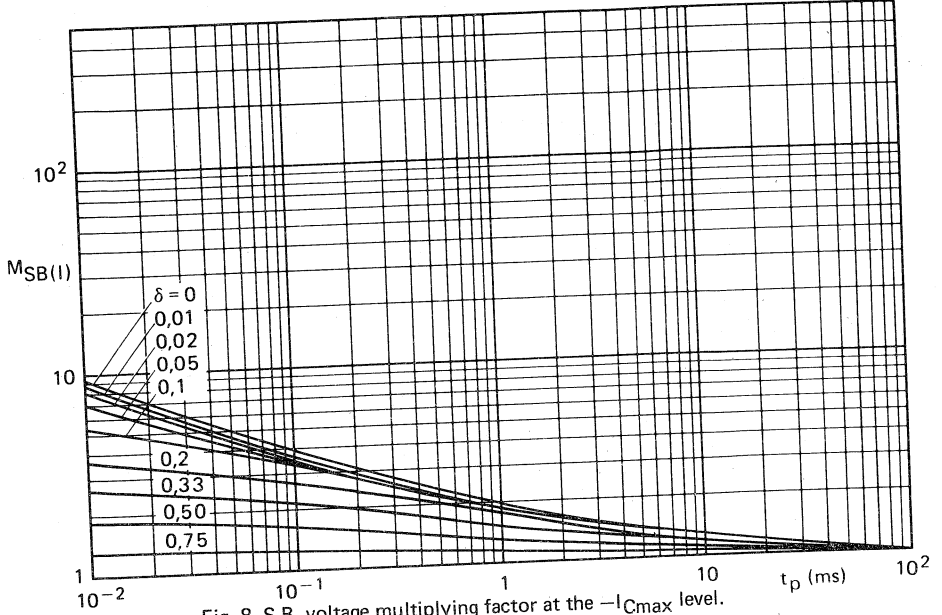


Fig. 8 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

7277495

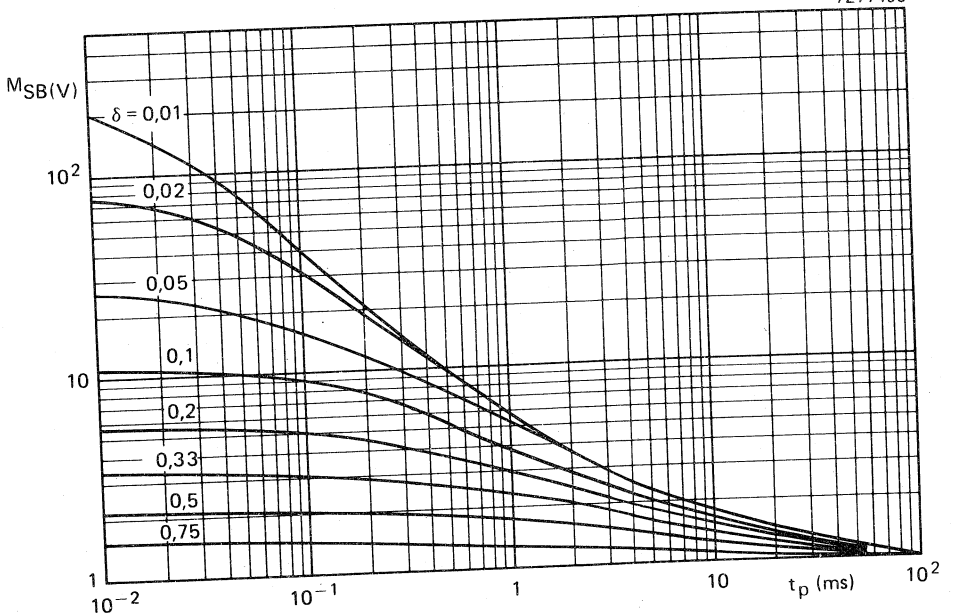


Fig. 9 S.B. current multiplying factor at the $-V_{CE0max}$ level (100 V).

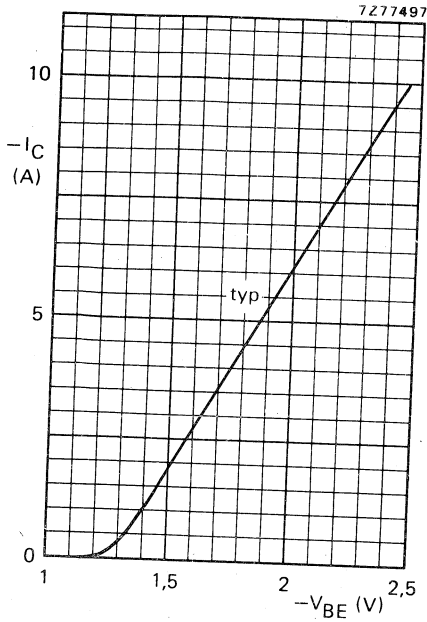


Fig. 10 $-V_{CE} = 4$ V; $T_j = 25$ °C.

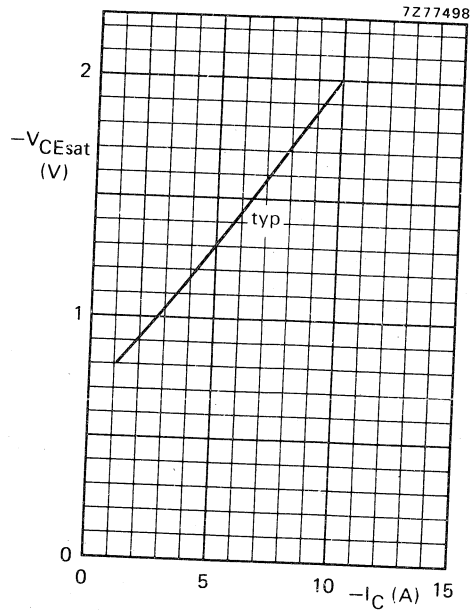


Fig. 11 $-I_C / -I_B = 250$; $T_j = 25$ °C.

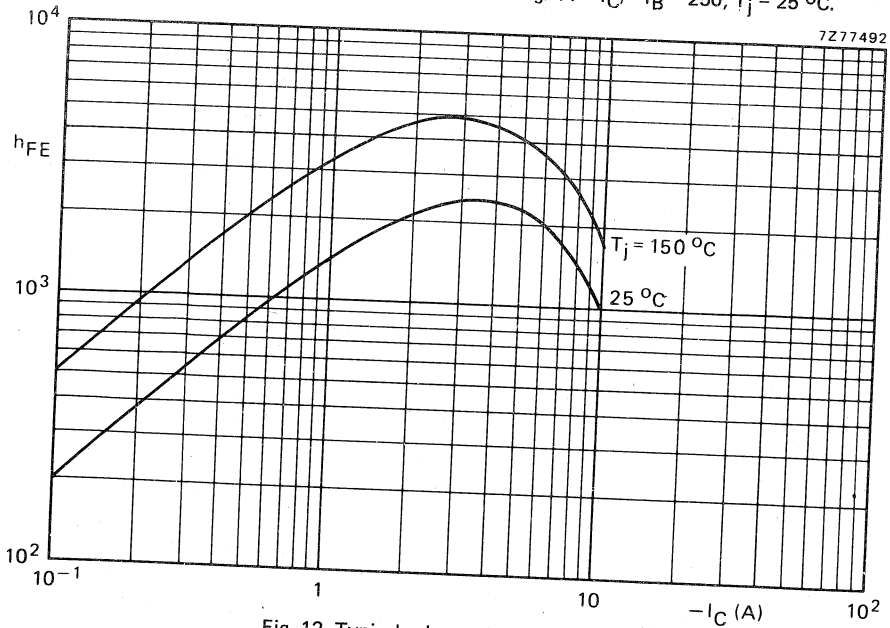


Fig. 12 Typical values; $-V_{CE} = 4$ V.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. P-N-P complements are BDV64, BDV64A and BDV64B. Matched complementary pairs can be supplied.

QUICK REFERENCE DATA

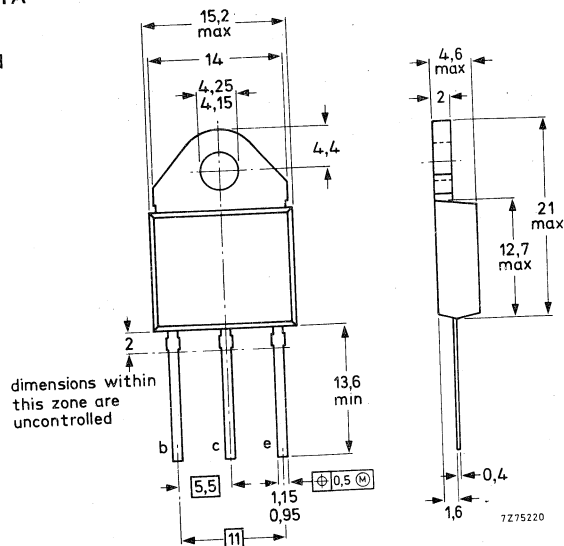
		BDV65	BDV65A	BDV65B
Collector-base voltage (open emitter)	V_{CB0}	max. 60	80	100 V
Collector-emitter voltage (open base)	V_{CE0}	max. 60	80	100 V
Collector current (peak value)	I_{CM}		20	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}		125	W
Junction temperature	T_j		150	$^\circ\text{C}$
D.C. current gain	h_{FE}	typ.	1500	
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>	1000	
$I_C = 5\text{ A}; V_{CE} = 4\text{ V}$				
Cut-off frequency	f_{hfe}	typ.	70	kHz
$I_C = 5\text{ A}; V_{CE} = 4\text{ V}$				

Dimensions in mm

MECHANICAL DATA

Fig. 1 SOT-93.

Collector connected to mounting-base.



Accessories supplied on request: 56368 (see also data sheet *Mounting instructions SOT-93*).

CIRCUIT DIAGRAM

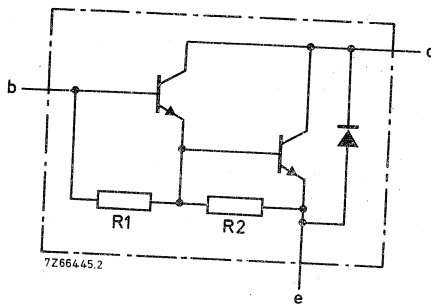


Fig. 2.
R1 typical 5 k Ω
R2 typical 80 Ω .

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

- Collector-base voltage (open emitter)
- Collector-emitter voltage (open base)
- Emitter-base voltage (open collector)
- Collector current (d.c.)
- Collector current (peak value)
- Base current (d.c.)
- Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$
- Storage temperature
- Junction temperature

		BDV65	BDV65A	BDV65B
V_{CBO}	max.	60	80	100 V
V_{CEO}	max.	60	80	100 V
V_{EBO}	max.	5	5	5 V
I_C	max.		12	A
I_{CM}	max.		20	A
I_B	max.		0,5	A
P_{tot}	max.		125	W
T_{stg}			- 65 to + 150	$^{\circ}\text{C}$
T_j	max.		150	$^{\circ}\text{C}^*$
$R_{th\ j-mb}$	=		1	$^{\circ}\text{C}/\text{W}^*$

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Collector cut-off currents

$I_E = 0; V_{CB} = V_{CB0max}$
 $I_E = 0; V_{CB} = \frac{1}{2}V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$
 $I_B = 0; V_{CE} = \frac{1}{2}V_{CE0max}$

$I_{CBO} < 400\text{ }\mu\text{A}$
 $I_{CBO} < 2\text{ mA}$
 $I_{CEO} < 1\text{ mA}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 5\text{ mA}$

D.C. current gain*

$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$
 $I_C = 5\text{ A}; V_{CE} = 4\text{ V}$
 $I_C = 10\text{ A}; V_{CE} = 4\text{ V}$

h_{FE} typ. 1500
 $h_{FE} > 1000$
 h_{FE} typ. 1750

Base-emitter voltage*

$I_C = 5\text{ A}; V_{CE} = 4\text{ V}$

$V_{BE} < 2,5\text{ V}^{**}$

Collector-emitter saturation voltage*

$I_C = 5\text{ A}; I_B = 20\text{ mA}$

$V_{CEsat} < 2\text{ V}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

C_c typ. 150 pF

Cut-off frequency

$I_C = 5\text{ A}; V_{CE} = 4\text{ V}$

f_{hfe} typ. 70 kHz

Diode, forward voltage

$I_F = 5\text{ A}$

V_F typ. 1,2 V

Switching times (see also Fig. 4)

$I_{Con} = 5\text{ A}; I_{Bon} = -I_{Boff} = 20\text{ mA}; V_{CC} = 16\text{ V}$

Turn-on time

Fall time

Turn-off time

t_{on} typ. 0,5 μs
 t_f typ. 1,5 μs
 t_{off} typ. 2,5 μs

* Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}; \delta < 2\%$.

** V_{BE} decreases by about 3,6 mV/ $^\circ\text{C}$ with increasing temperature.

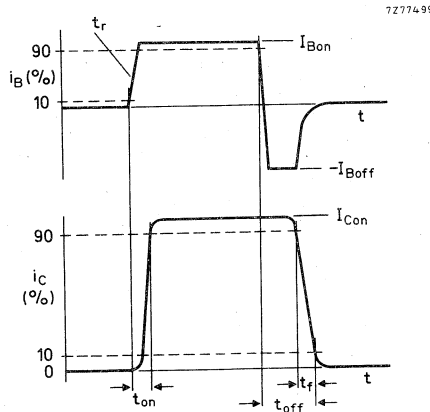


Fig. 3 Waveforms showing $t_{on}; t_s + t_f = t_{off}$.

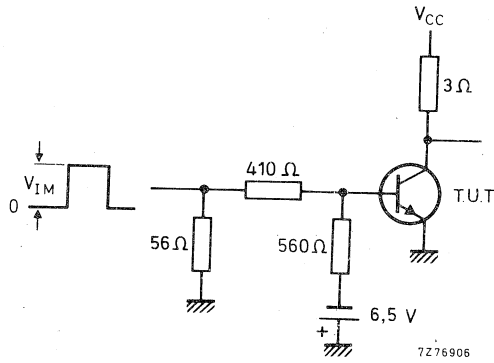


Fig. 4 Switching times test circuit; $V_{CC} = 16\text{ V}$;
 $V_{1M} = 16,5\text{ V}$; $t_r = t_f = 15\text{ ns}$; $t_p = 10\text{ }\mu\text{s}$; $T = 500\text{ }\mu\text{s}$.

Turn-off breakdown energy with inductive load (see also Fig. 5).

$I_{Con} = 6,3\text{ A}$; $-I_{Boff} = 0$; $t_p = 1\text{ ms}$; $T = 100\text{ ms}$

$E(BR) > 100\text{ mJ}$

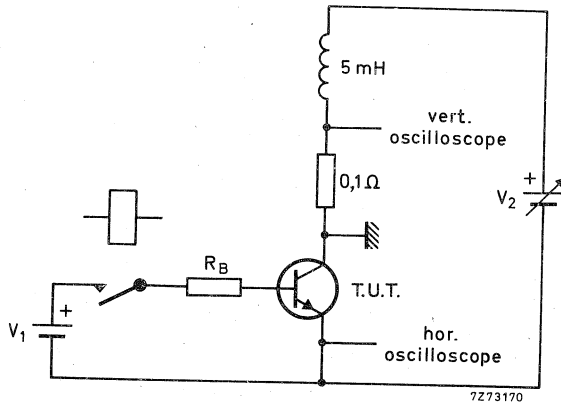


Fig. 5 Test circuit; $V_1 = 12\text{ V}$; $R_B = 270\text{ }\Omega$.

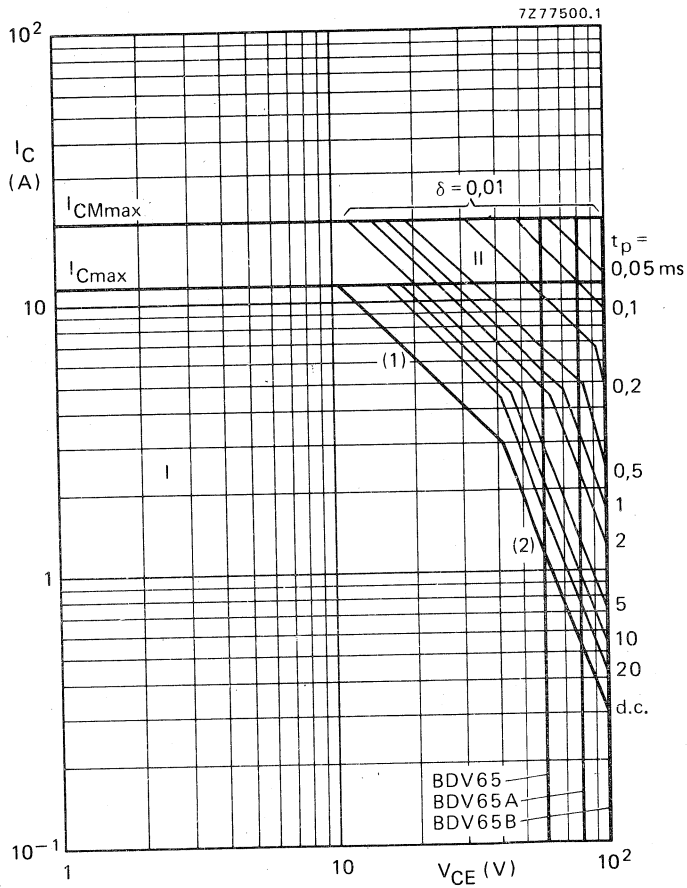


Fig. 6 Safe Operating Area; $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation

(1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.

(2) Second breakdown limits (independent of temperature).

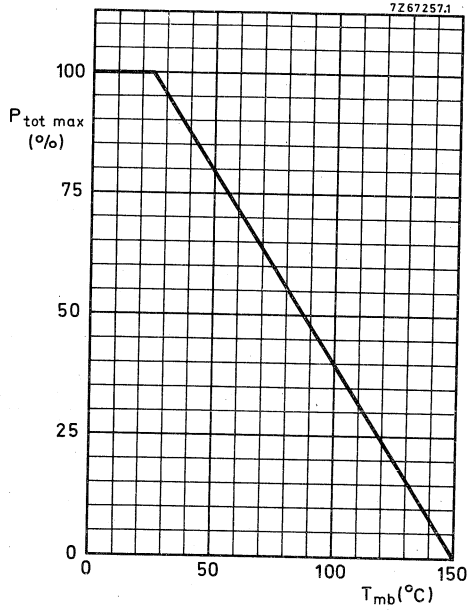


Fig. 7.

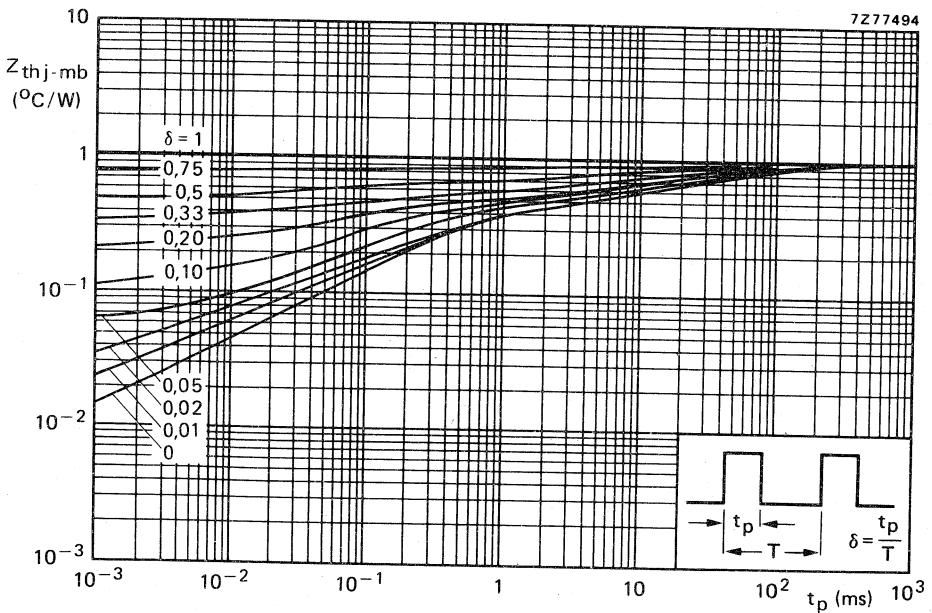
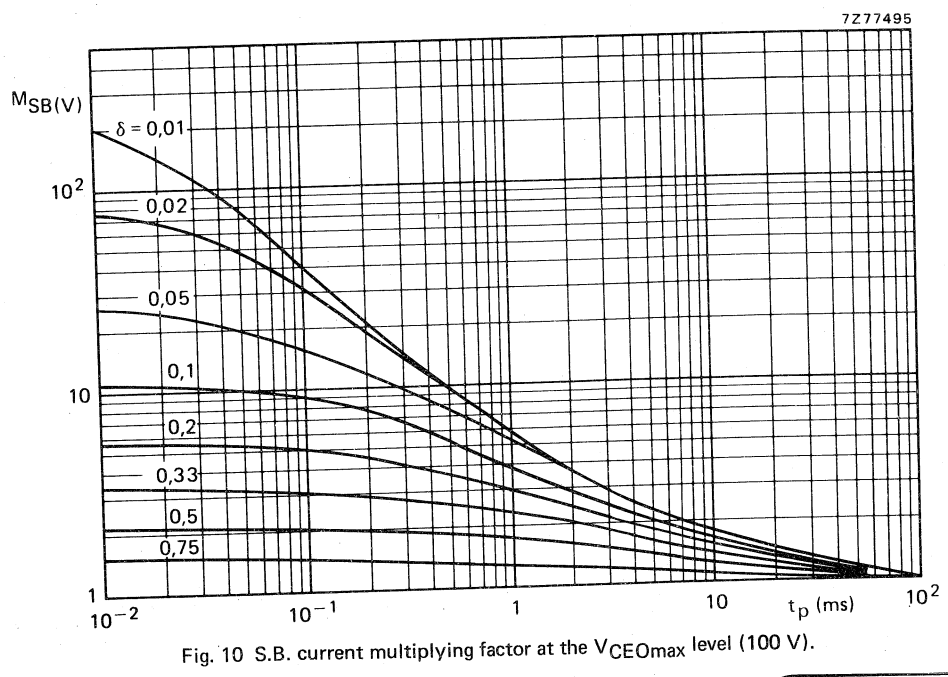
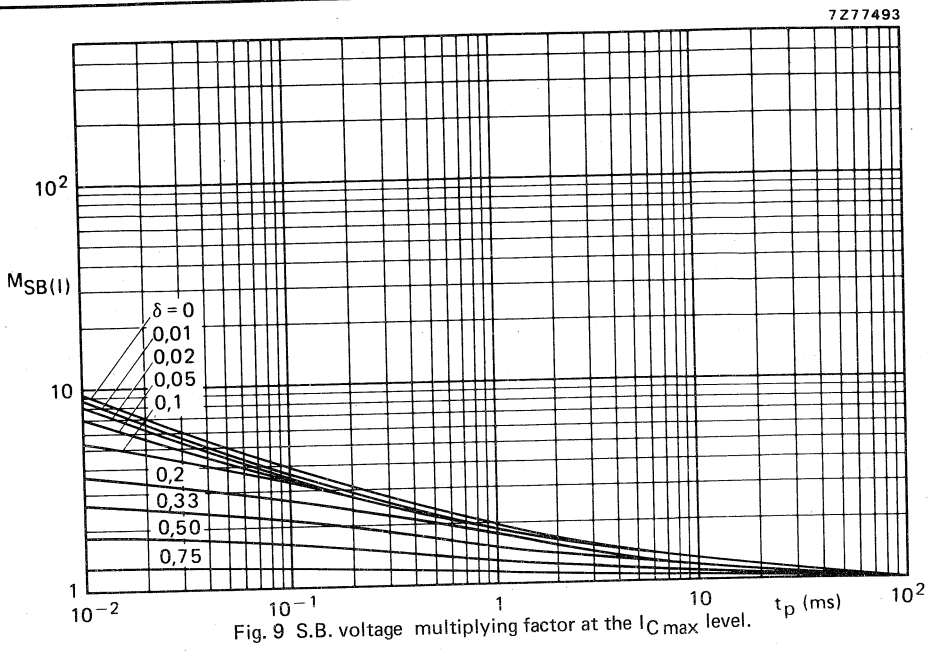


Fig. 8 Heating-up curve.



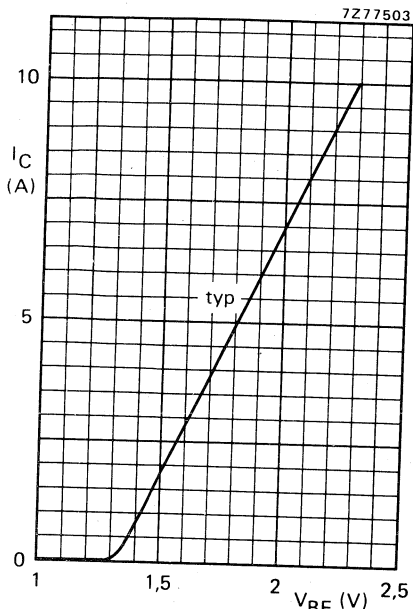


Fig. 11 $V_{CE} = 4$ V; $T_j = 25$ °C.

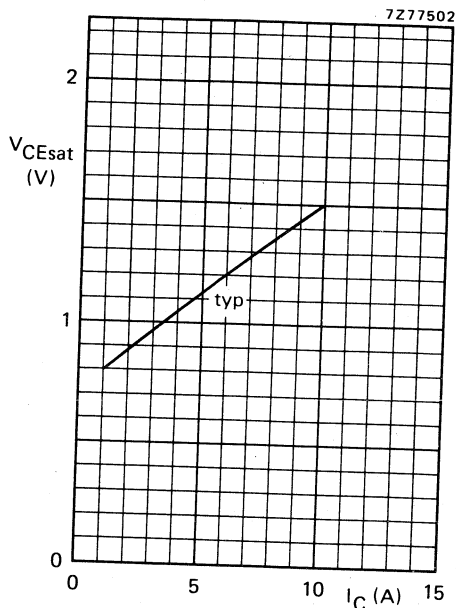


Fig. 12 $I_C/I_B = 250$; $T_j = 25$ °C.

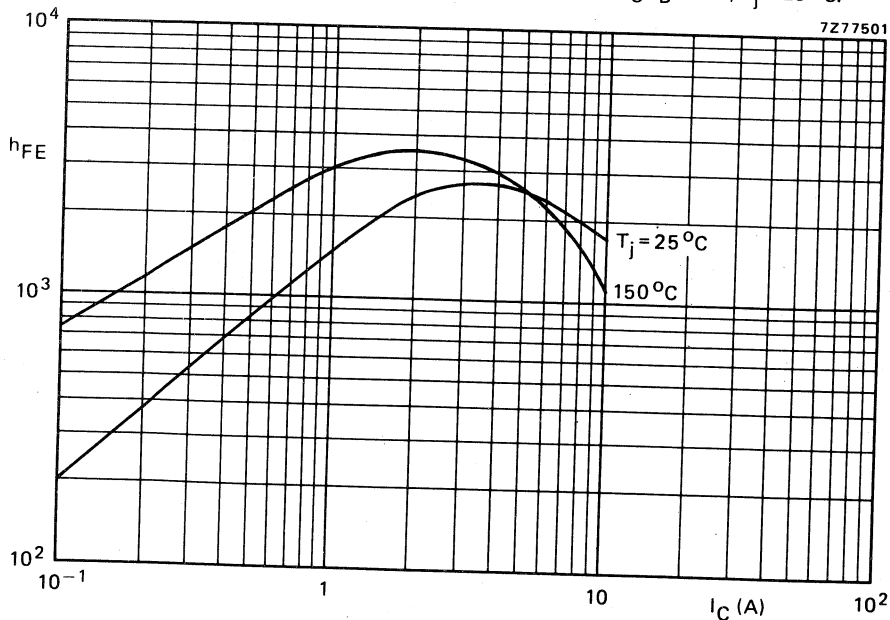


Fig. 13 Typical values; $V_{CE} = 4$ V.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

N-P-N transistors in TO-126 plastic envelopes intended for high current switching applications, e.g. inverters, and switching regulator circuits.

QUICK REFERENCE DATA

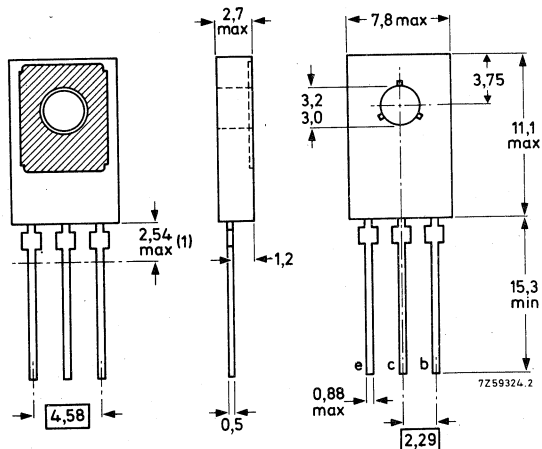
		BDX35	BDX36	BDX37
Collector-base voltage (open emitter)	V_{CBO}	max. 100	120	120 V
Collector-emitter voltage (open base)	V_{CEO}	max. 60	60	80 V
Collector current (peak value)	I_{CM}	max. 10	10	10 A
Total power dissipation up to $T_{mb} = 75\text{ }^{\circ}\text{C}$	P_{tot}	max. 15	15	15 W
D.C. current gain $I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$	h_{FE}	> 45	45	45
Collector-emitter saturation voltage $I_C = 5\text{ A}; I_B = 0,5\text{ A}$	V_{CEsat}	< 0,9	0,7	0,9 V
Turn-off time $I_{Con} = 5\text{ A}; I_{Bon} = -I_{Boff} = 0,5\text{ A}$	t_{off}	typ. 350	350	350 ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126 (SOT-32)

Collector connected to the metal part of the mounting surface



(1) Within this region the cross-section of the leads is uncontrolled. See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

		BDX35	BDX36	BDX37
Collector-base voltage (open emitter)	V_{CBO} max.	100	120	120 V
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES} max.	100	120	120 V
Collector-emitter voltage (open base)	V_{CEO} max.	60	60	80 V
Emitter-base voltage (open collector)	V_{EBO} max.		5	V
Collector current (d.c.)	I_C max.		5	A
Collector current (peak value)	I_{CM} max.		10	A
Base current (d.c.)	I_B max.		1	A
Base current (peak value)	I_{BM} max.		2	A
Reverse base current (peak value)	$-I_{BM}$ max.		2	A
Total power dissipation up to $T_{mb} = 75\text{ }^\circ\text{C}$	P_{tot} max.		15	W
up to $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot} max.		1,25	W
Storage temperature	T_{stg}		-65 to + 150	$^\circ\text{C}$
Junction temperature	T_j max.		150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$ =		5	$^\circ\text{C/W}$
From junction to ambient in free air	$R_{th\ j-a}$ =		100	$^\circ\text{C/W}$

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

 $I_E = 0; V_{CB} = 80\text{ V}$ $I_E = 0; V_{CB} = 80\text{ V}; T_j = 100\text{ }^\circ\text{C}$ $I_E = 0; V_{CB} = 100\text{ V}$ $I_E = 0; V_{CB} = 100\text{ V}; T_j = 100\text{ }^\circ\text{C}$

Emitter cut-off current

 $I_C = 0; V_{EB} = 4\text{ V}$ $I_C = 0; V_{EB} = 5\text{ V}$

D.C. current gain

 $I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$

Collector-emitter saturation voltage

 $I_C = 5\text{ A}; I_B = 0,5\text{ A}$ $I_C = 7\text{ A}; I_B = 0,7\text{ A}$ $I_C = 10\text{ A}; I_B = 1\text{ A}$

Base-emitter saturation voltage

 $I_C = 5\text{ A}; I_B = 0,5\text{ A}$ $I_C = 7\text{ A}; I_B = 0,7\text{ A}$ $I_C = 10\text{ A}; I_B = 1\text{ A}$ Collector capacitance at $f = 1\text{ MHz}$ $I_E = I_e = 0; V_{CB} = 10\text{ V}$ Transition frequency at $f = 35\text{ MHz}$ $I_C = 0,5\text{ A}; V_{CE} = 5\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$

Turn-off time

 $I_C = 5\text{ A}; I_{Bon} = -I_{Boff} = 0,5\text{ A}$

BDX35	I_{CBO}	<	10 μA
BDX35	I_{CBO}	<	50 μA
BDX36/37	I_{CBO}	<	10 μA
BDX36/37	I_{CBO}	<	50 μA
		typ.	5 nA
	I_{EBO}	<	10 μA
		<	1 mA
	h_{FE}		45 to 450
BDX35/36	h_{FE}	typ.	130
BDX37	h_{FE}	typ.	80
BDX35/37	V_{CEsat}	<	0,9 V
BDX36	V_{CEsat}	<	0,7 V
BDX35/37	V_{CEsat}	<	1,2 V
BDX36	V_{CEsat}	<	1,5 V
		<	1,6 V
BDX35/37	V_{BEsat}	<	1,8 V
BDX36	V_{BEsat}	<	2,2 V
		typ.	40 pF
	C_c	<	60 pF
		typ.	100 MHz
	f_T		
		typ.	350 ns
	t_{off}	<	800 ns



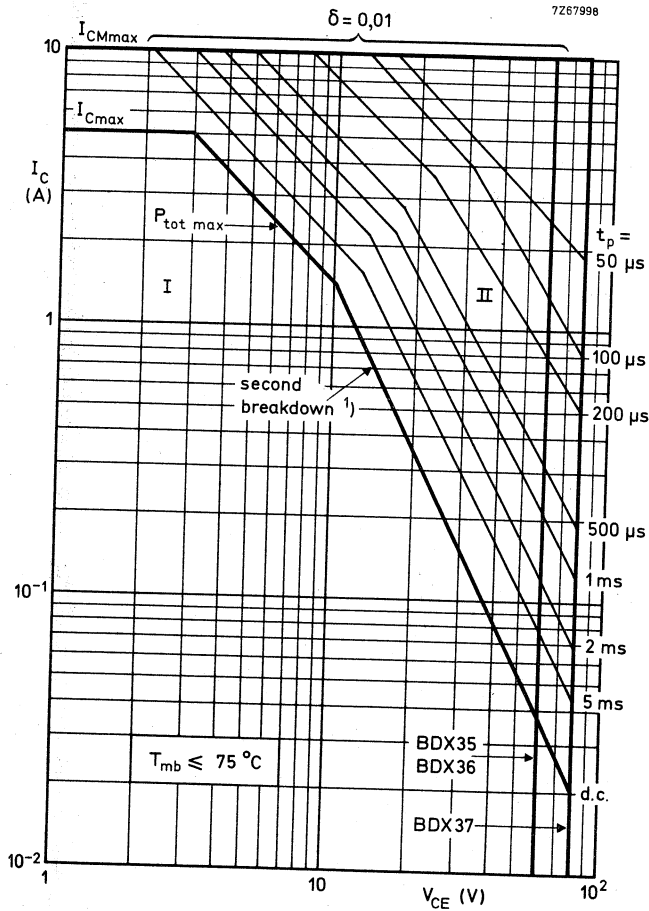


Fig. 2 Safe Operating Area with the transistor forward biased.

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation.

1) Independent of temperature.

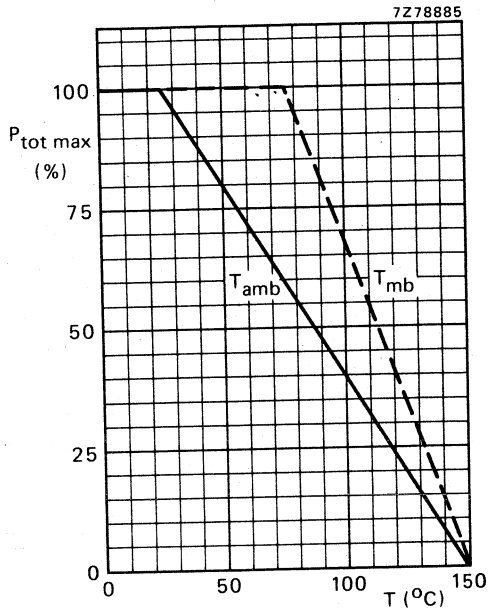


Fig. 3 Power derating curve.

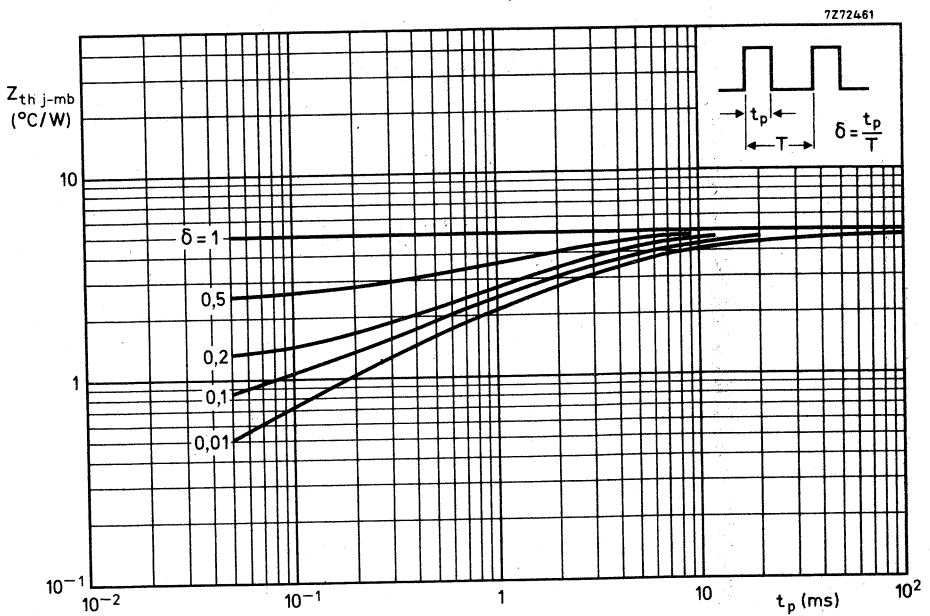


Fig. 4 Pulse power rating chart.

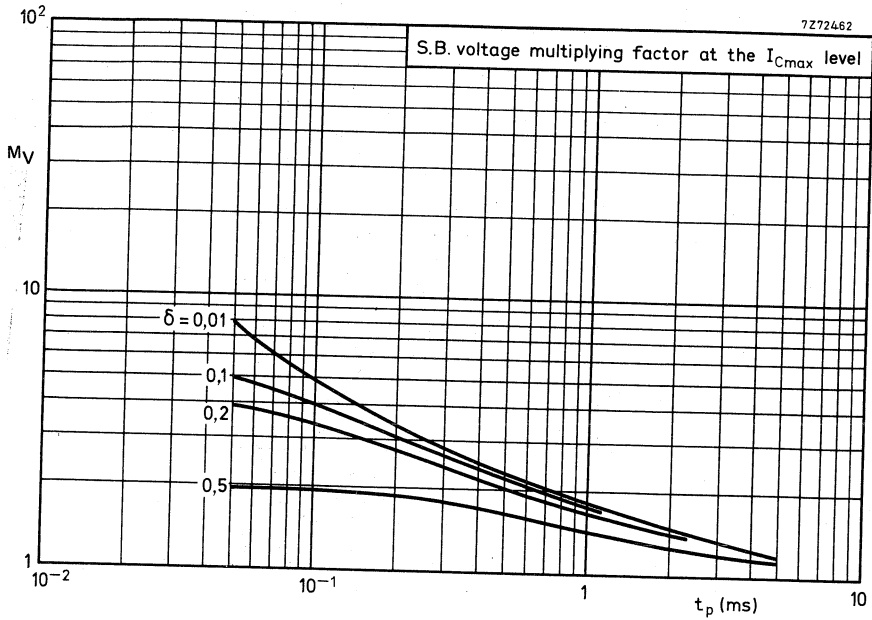


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

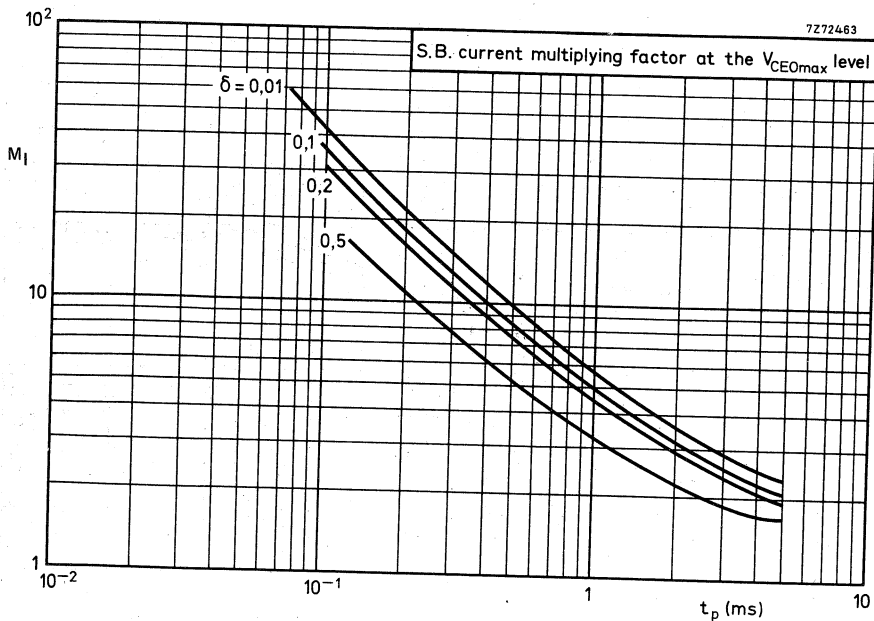


Fig. 6 S.B. current multiplying factor at the V_{CE0max} level.

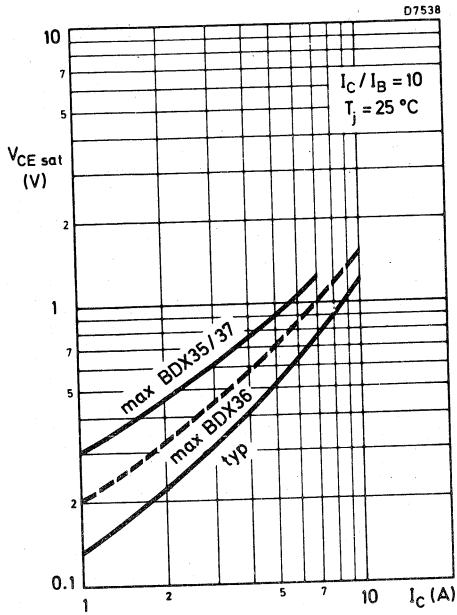


Fig. 7 Collector-emitter saturation voltage as a function of the collector current.

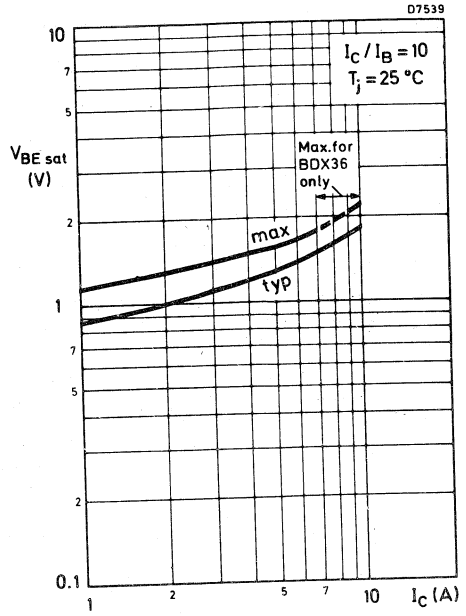


Fig. 8 Base-emitter saturation voltage as a function of the collector current.

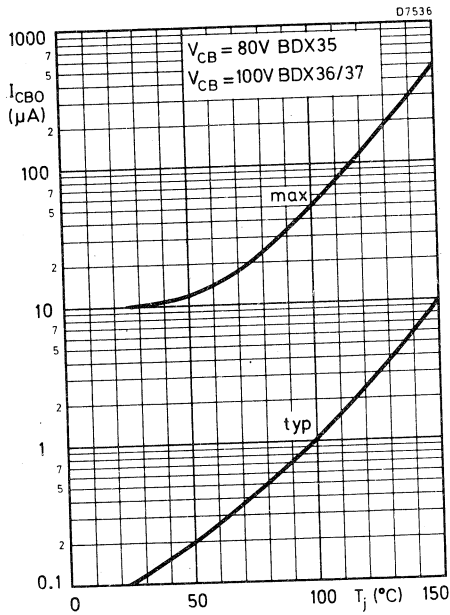


Fig. 9 Collector-base current with an open emitter as a function of junction temperature.

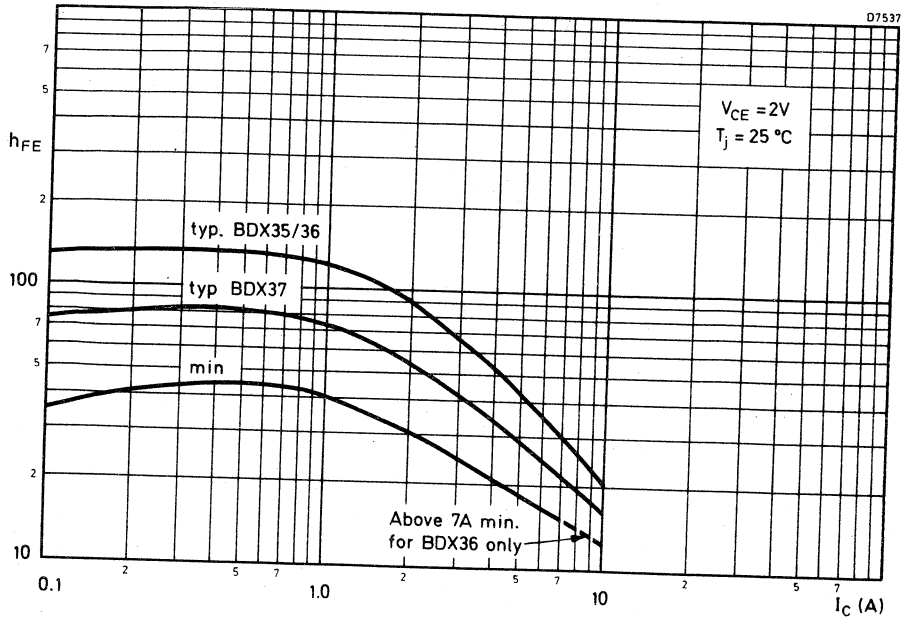


Fig. 10 D.C. current gain as a function of collector current.

N-P-N SILICON PLANAR DARLINGTON TRANSISTORS

Silicon n-p-n planar Darlington transistors for industrial switching applications, e.g. print hammer, solenoid, relay and lamp driving. Encapsulated in a TO-126 plastic envelope with collector connected to the heatsink.

P-N-P complements are BDX45, BDX46 and BDX47 respectively.

QUICK REFERENCE DATA

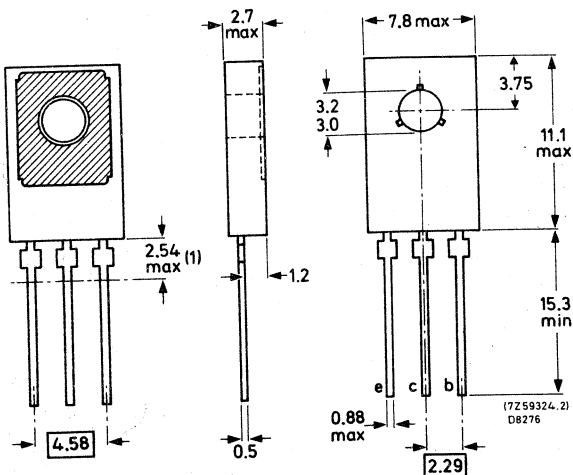
		BDX42	BDX43	BDX44
Collector-base voltage (open emitter)	V_{CB0} max.	60	80	100 V
Collector-emitter voltage	V_{CER} max.	45	60	80 V
Collector current	I_C max.	1	1	1 A
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$ up to $T_{mb} = 100\text{ }^\circ\text{C}$	P_{tot} max.	1,25	1,25	1,25 W
	P_{tot} max.	5	5	5 W
D.C. current gain $I_C = 500\text{ mA}$; $V_{CE} = 10\text{ V}$	h_{FE}	> 2000	2000	2000
	Collector-emitter saturation voltage $I_C = 1\text{ A}$; $I_B = 1\text{ mA}$	V_{CEsat}	—	1,6
Turn-off time $I_C = 500\text{ mA}$; $I_{Bon} = -I_{Boff} = 0,5\text{ mA}$	V_{CEsat}	1,6	—	1,6 V
	t_{off} typ.	1500	1500	1500 ns

Dimensions in mm

MECHANICAL DATA

Fig. 1 TO-126.

Collector connected to the metal part of mounting surface.



(1) Dimensions within this zone are uncontrolled.

See also chapters Mounting Instructions and Accessories.

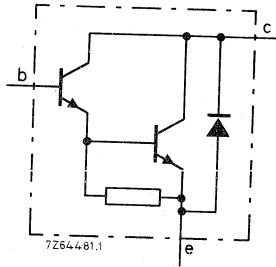


Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX42	BDX43	BDX44
Collector-base voltage (open emitter)	V_{CB0}	max.	60	80	100 V
Collector-emitter voltage *	V_{CER}	max.	45	60	80 V
Emitter-base voltage (open collector)	V_{EBO}	max.		5	V
Collector current (d.c.)	I_C	max.		1	A
Collector current (peak)	I_{CM}	max.		2	A
Base current (d.c.)	I_B	max.		0,1	A
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$ up to $T_{mb} = 100\text{ }^\circ\text{C}$	P_{tot}	max.		1,25	W
Storage temperature	T_{stg}			5	W
Junction temperature **	T_j	max.		-65 to + 150	$^\circ\text{C}$
				150	$^\circ\text{C}$

THERMAL RESISTANCE **

From junction to ambient	$R_{th\ j-a}$	=		100	$^\circ\text{C/W}$
From junction to mounting base	$R_{th\ j-mb}$	=		10	$^\circ\text{C/W}$

* External R_{BE} not to exceed value shown in Fig. 12.

** Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current				
$V_{BE} = 0; V_{CE} = 45\text{ V}$	BDX42	I_{CES}	<	10 μA
$V_{BE} = 0; V_{CE} = 60\text{ V}$	BDX43	I_{CES}	<	10 μA
$V_{BE} = 0; V_{CE} = 80\text{ V}$	BDX44	I_{CES}	<	10 μA
Emitter cut-off current				
$I_C = 0; V_{EB} = 4\text{ V}$		I_{EBO}	<	10 μA
D.C. current gain				
$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$		h_{FE}	>	1000
$I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$		h_{FE}	>	2000
Collector-emitter saturation voltage				
$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}$		V_{CEsat}	<	1,3 V
$I_C = 1\text{ A}; I_B = 1\text{ mA}$	BDX43	V_{CEsat}	<	1,6 V
$I_C = 1\text{ A}; I_B = 4\text{ mA}$	BDX42, 44	V_{CEsat}	<	1,6 V
$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}; T_j = 150\text{ }^\circ\text{C}$		V_{CEsat}	<	1,3 V
$I_C = 1\text{ A}; I_B = 1\text{ mA}; T_j = 150\text{ }^\circ\text{C}$	BDX43	V_{CEsat}	<	1,8 V
$I_C = 1\text{ A}; I_B = 4\text{ mA}; T_j = 150\text{ }^\circ\text{C}$	BDX42, 44	V_{CEsat}	<	1,6 V
Base-emitter saturation voltage				
$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}$		V_{BEsat}	<	1,9 V
$I_C = 1\text{ A}; I_B = 1\text{ mA}$	BDX43	V_{BEsat}	<	2,2 V
$I_C = 1\text{ A}; I_B = 4\text{ mA}$	BDX42, 44	V_{BEsat}	<	2,2 V
Small signal current gain				
$I_C = 500\text{ mA}; V_{CE} = 5\text{ V}; f = 35\text{ MHz}$		h_{fe}	typ.	10
Switching times (see also Fig. 3 and Fig. 4)				
$I_C = 500\text{ mA}; I_{Bon} = -I_{Boff} = 0,5\text{ mA}$				
Turn-on time		t_{on}	typ.	400 ns
Turn-off time		t_{off}	typ.	1500 ns
$I_C = 1\text{ A}; I_{Bon} = -I_{Boff} = 1\text{ mA}$				
Turn-on time		t_{on}	typ.	400 ns
Turn-off time		t_{off}	typ.	1500 ns



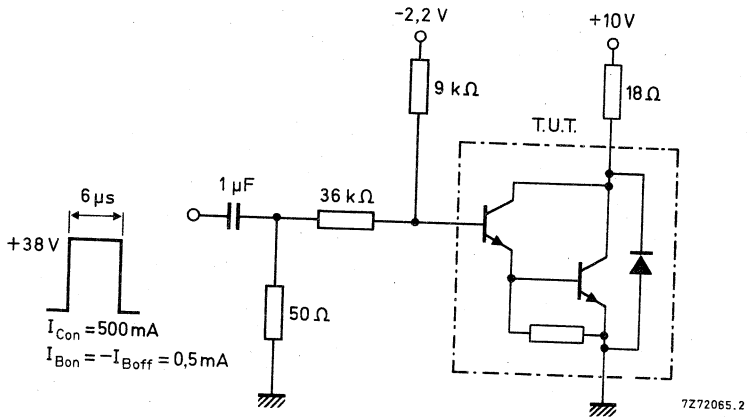


Fig. 3 Test circuit for 500 mA switching.

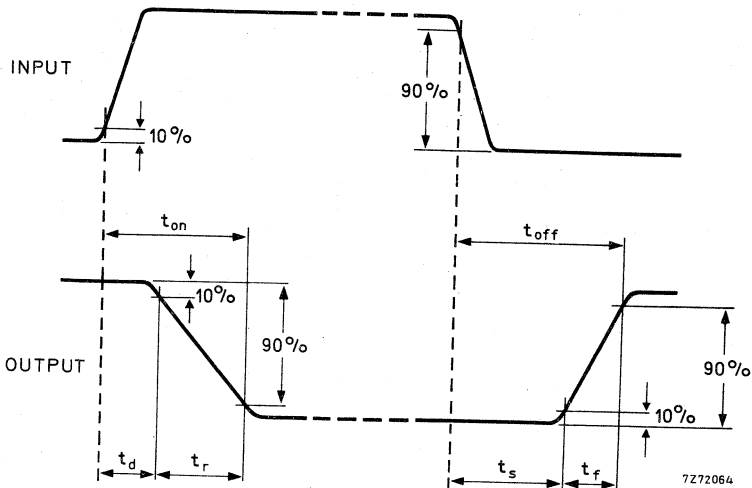


Fig. 4 Switching waveforms.

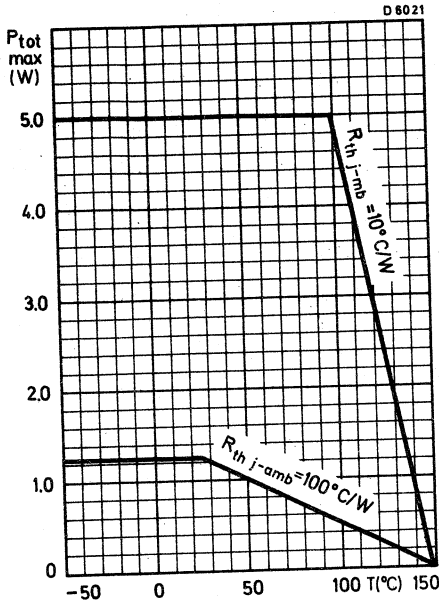


Fig. 5.

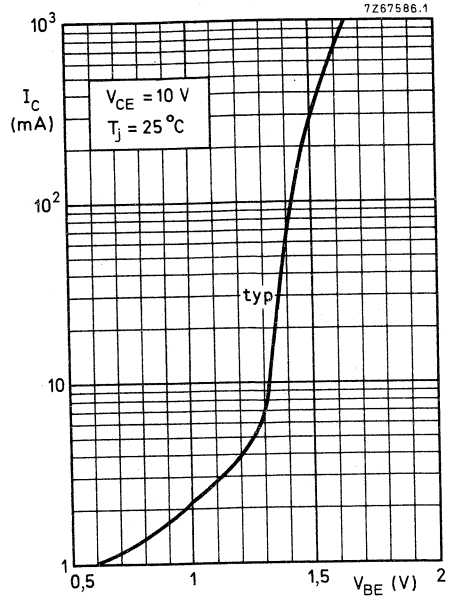


Fig. 6.

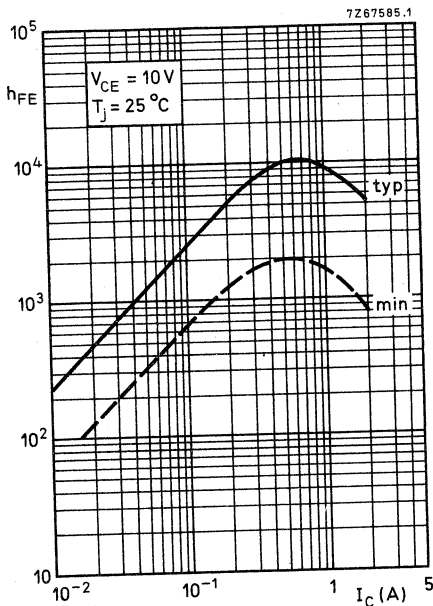


Fig. 7.

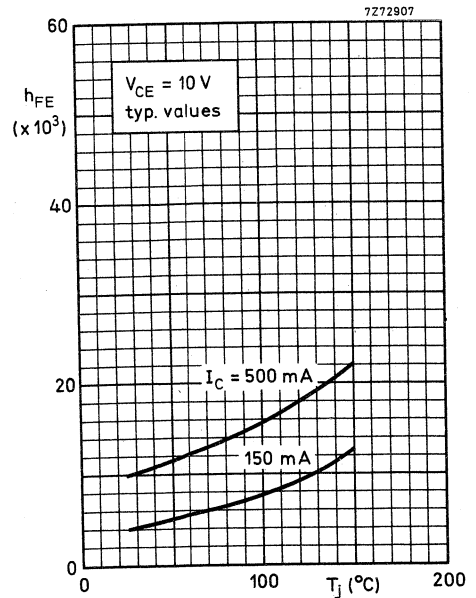


Fig. 8.

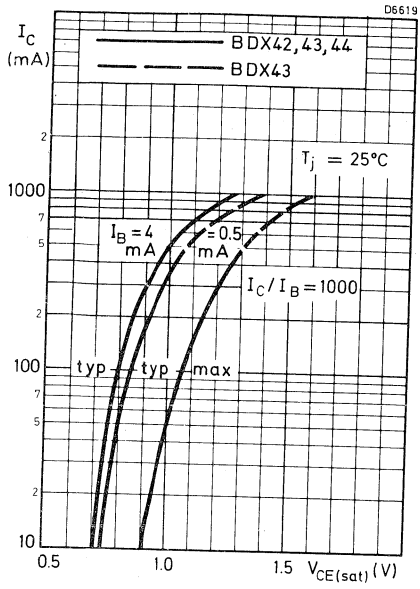


Fig. 9.

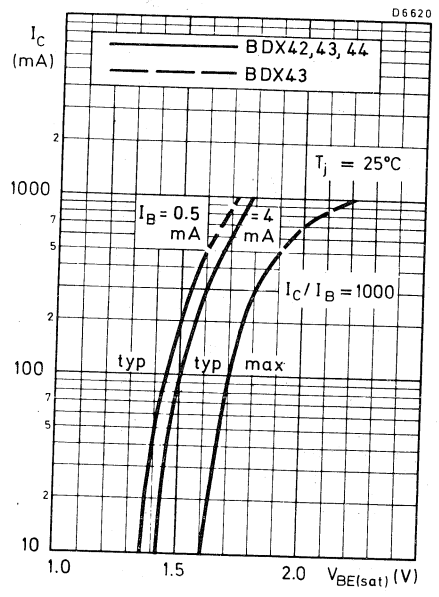


Fig. 10.

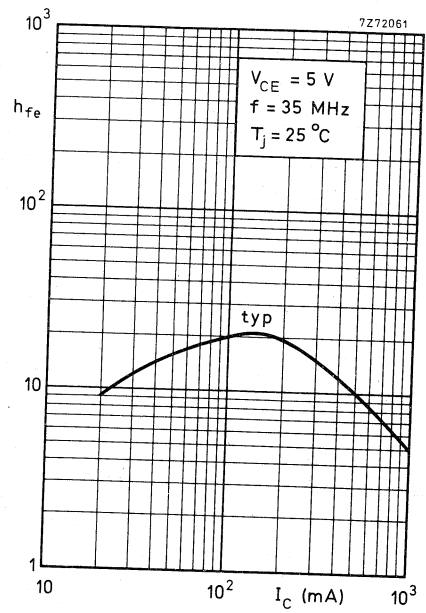


Fig. 11.

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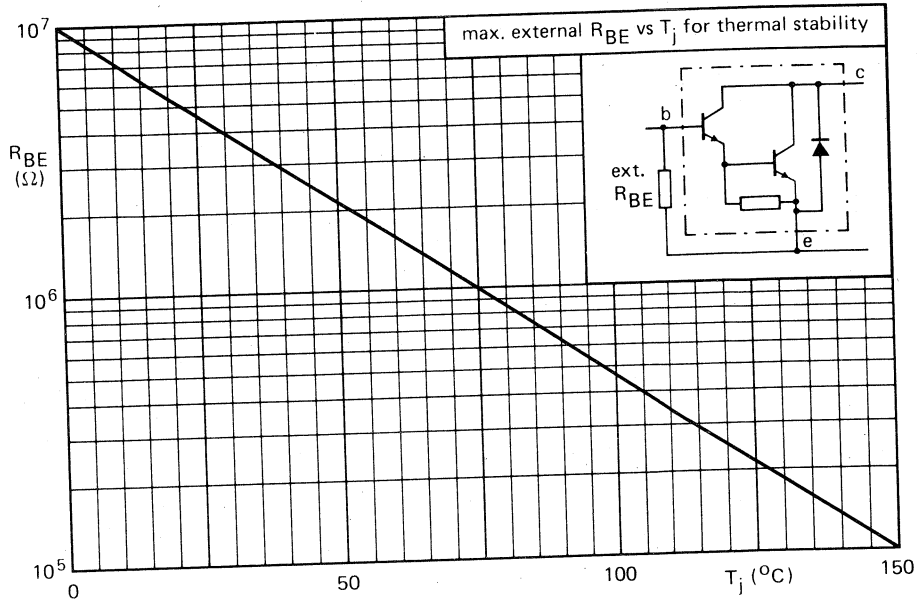


Fig. 12.



P-N-P SILICON PLANAR DARLINGTON TRANSISTORS

Silicon p-n-p planar Darlington transistors for industrial switching applications, e.g. print hammer, solenoid, relay and lamp driving. Encapsulated in a TO-126 plastic envelope with collector connected to the heatsink.

N-P-N complements are BDX42, BDX43 and BDX44 respectively.

QUICK REFERENCE DATA

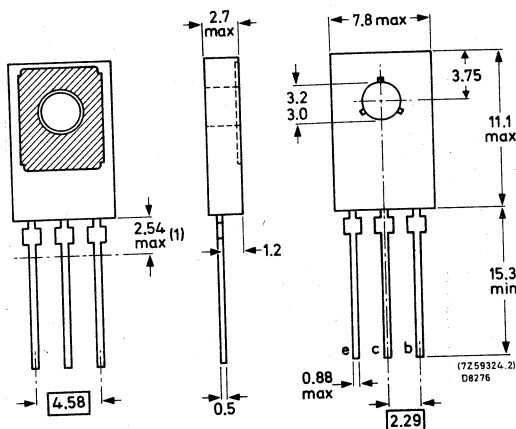
		BDX45	BDX46	BDX47
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100 V
Collector-emitter voltage	$-V_{CER}$ max.	45	60	80 V
Collector current	$-I_C$ max.	1	1	1 A
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$ up to $T_{mb} = 100\text{ }^\circ\text{C}$	P_{tot} max.	1,25	1,25	1,25 W
	P_{tot} max.	5	5	5 W
D.C. current gain	h_{FE} >	2000	2000	2000
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$				
Collector-emitter saturation voltage	$-V_{CEsat}$ <	—	1,6	— V
	$-V_{CEsat}$ <	1,6	—	1,6 V
$-I_C = 1\text{ A}; -I_B = 1\text{ mA}$ $-I_C = 1\text{ A}; -I_B = 4\text{ mA}$				
Turn-off time	t_{off} typ.	1500	1500	1500 ns
$-I_C = 500\text{ mA}; -I_{B(on)} = I_{B(off)} = 0,5\text{ mA}$				

Dimensions in mm

MECHANICAL DATA

Fig. 1 TO-126.

Collector connected to the metal part of mounting surface.



(1) Dimensions within this zone are uncontrolled

See also chapters Mounting Instructions and Accessories.

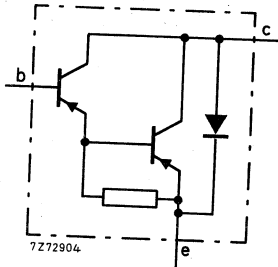


Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BDX45	BDX46	BDX47
Collector-base voltage (open emitter)	$-V_{CB0}$ max.	60	80	100 V
Collector-emitter voltage *	$-V_{CER}$ max.	45	60	80 V
Emitter-base voltage (open collector)	$-V_{EBO}$ max.		5	V
Collector current (d.c.)	$-I_C$ max.		1	A
Collector current (peak)	$-I_{CM}$ max.		2	A
Base current (d.c.)	$-I_B$ max.		0,1	A
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$ up to $T_{mb} = 100\text{ }^\circ\text{C}$	P_{tot} max.		1,25	W
Storage temperature	P_{tot} max.		5	W
Junction temperature**	T_{stg}	-65 to +150		$^\circ\text{C}$
	T_j max.		150	$^\circ\text{C}$
THERMAL RESISTANCE **				
From junction to ambient	$R_{th\ j-a}$ =		100	$^\circ\text{C/W}$
From junction to mounting base	$R_{th\ j-mb}$ =		10	$^\circ\text{C/W}$

* External RBE not to exceed value shown in Fig. 12.

** Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current
 $V_{BE} = 0; -V_{CE} = 45\text{ V}$
 $V_{BE} = 0; -V_{CE} = 60\text{ V}$
 $V_{BE} = 0; -V_{CE} = 80\text{ V}$

BDX45	$-I_{CES}$	<	10 μA
BDX46	$-I_{CES}$	<	10 μA
BDX47	$-I_{CES}$	<	10 μA

Emitter cut-off current
 $I_C = 0; V_{EB} = 4\text{ V}$

	$-I_{EBO}$	<	10 μA
--	------------	---	------------------

D.C. current gain
 $-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$
 $-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$

	h_{FE}	>	1000
	h_{FE}	>	2000

Collector-emitter saturation voltage
 $-I_C = 500\text{ mA}; -I_B = 0,5\text{ mA}$
 $-I_C = 1\text{ A}; -I_B = 1\text{ mA}$
 $-I_C = 1\text{ A}; -I_B = 4\text{ mA}$
 $-I_C = 500\text{ mA}; -I_B = 0,5\text{ mA}; T_j = 150\text{ }^\circ\text{C}$
 $-I_C = 1\text{ A}; -I_B = 1\text{ mA}; T_j = 150\text{ }^\circ\text{C}$
 $-I_C = 1\text{ A}; -I_B = 4\text{ mA}; T_j = 150\text{ }^\circ\text{C}$

	$-V_{CEsat}$	<	1,3 V
BDX46	$-V_{CEsat}$	<	1,6 V
BDX45, 47	$-V_{CEsat}$	<	1,6 V
	$-V_{CEsat}$	<	1,3 V
BDX46	$-V_{CEsat}$	<	1,8 V
BDX45, 47	$-V_{CEsat}$	<	1,6 V

Base-emitter saturation voltage
 $-I_C = 500\text{ mA}; -I_B = 0,5\text{ mA}$
 $-I_C = 1\text{ A}; -I_B = 1\text{ mA}$
 $-I_C = 1\text{ A}; -I_B = 4\text{ mA}$

	$-V_{BEsat}$	<	1,9 V
BDX46	$-V_{BEsat}$	<	2,2 V
BDX45, 47	$-V_{BEsat}$	<	2,2 V

Small signal current gain
 $-I_C = 500\text{ mA}; -V_{CE} = 5\text{ V}, f = 35\text{ MHz}$

	h_{fe}	typ.	10
--	----------	------	----

Switching times (see also Fig. 3 and Fig. 4)
 $-I_C = 500\text{ mA}; -I_{Bon} = I_{Boff} = 0,5\text{ mA}$

Turn-on time
 Turn-off time

	t_{on}	typ.	400 ns
	t_{off}	typ.	1500 ns

$-I_C = 1\text{ A}; -I_{Bon} = I_{Boff} = 1\text{ mA}$

Turn-on time
 Turn-off time

	t_{on}	typ.	400 ns
	t_{off}	typ.	1500 ns



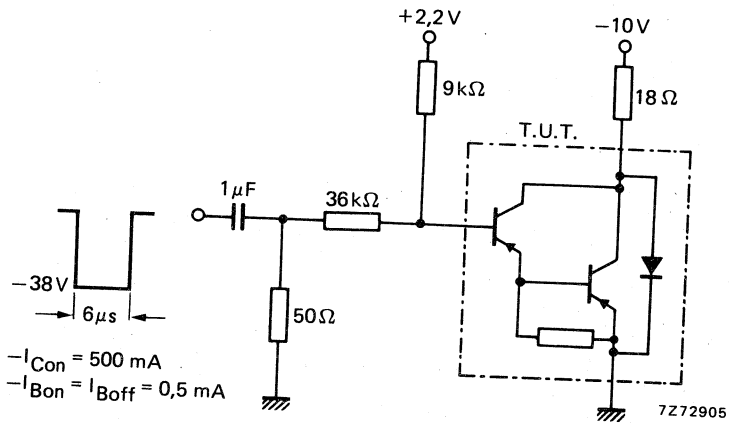


Fig. 3 Test circuit for 500 mA switching.

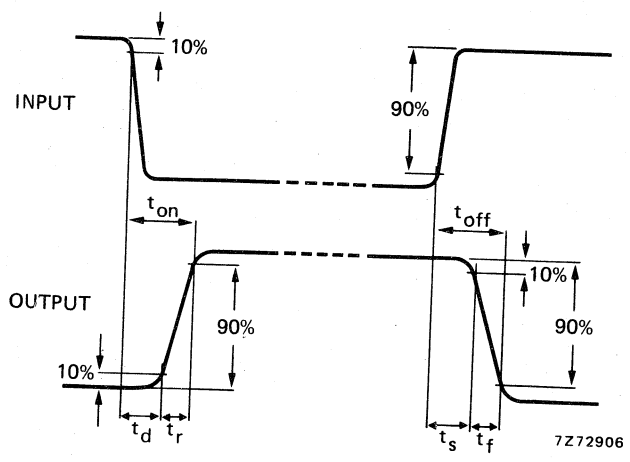


Fig. 4 Switching waveforms.

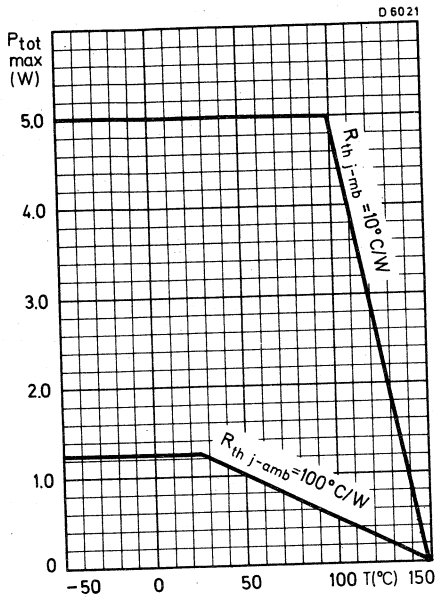


Fig. 5.

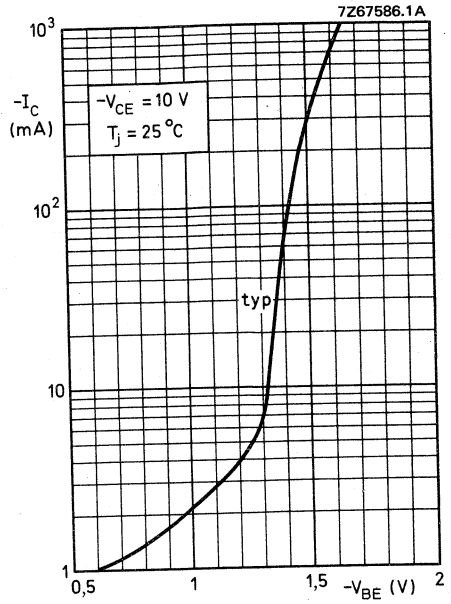


Fig. 6.

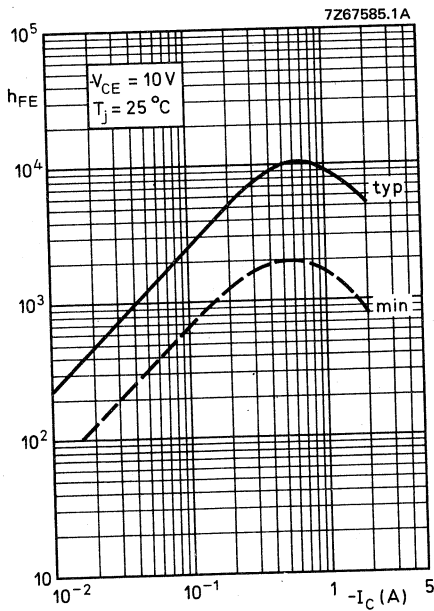


Fig. 7.

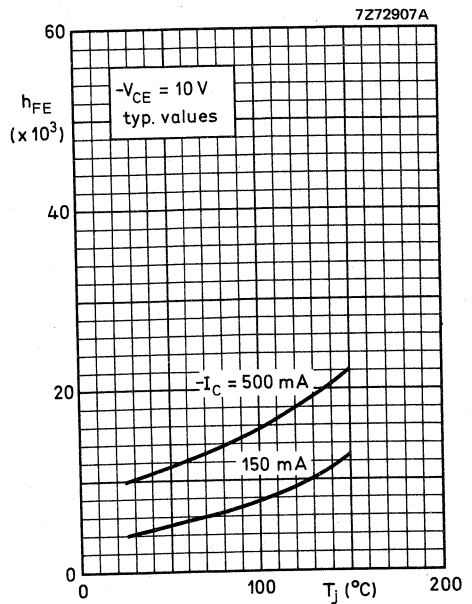


Fig. 8.

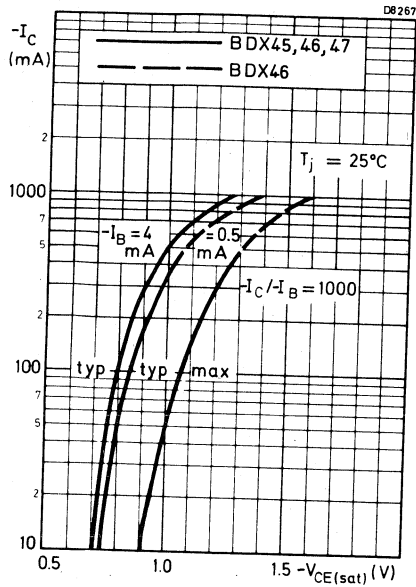


Fig. 9.

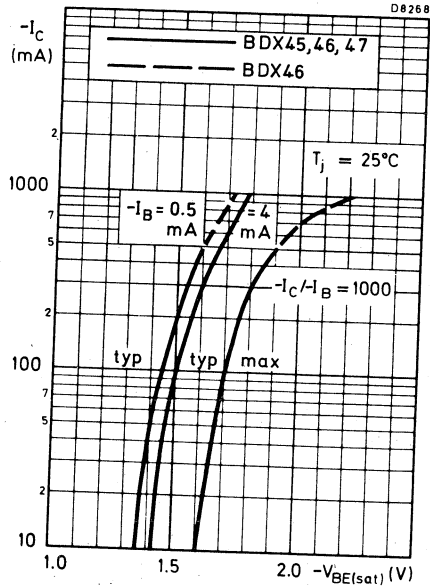


Fig. 10.

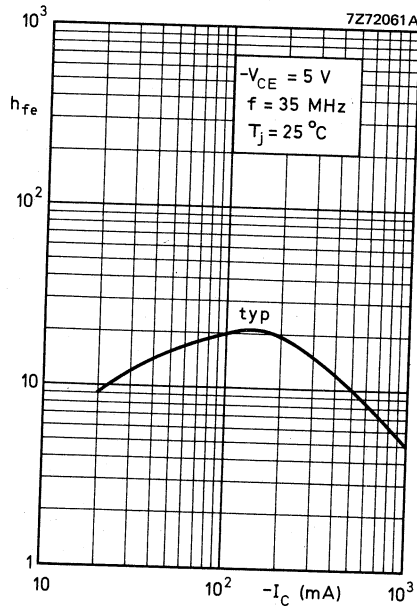


Fig. 11.

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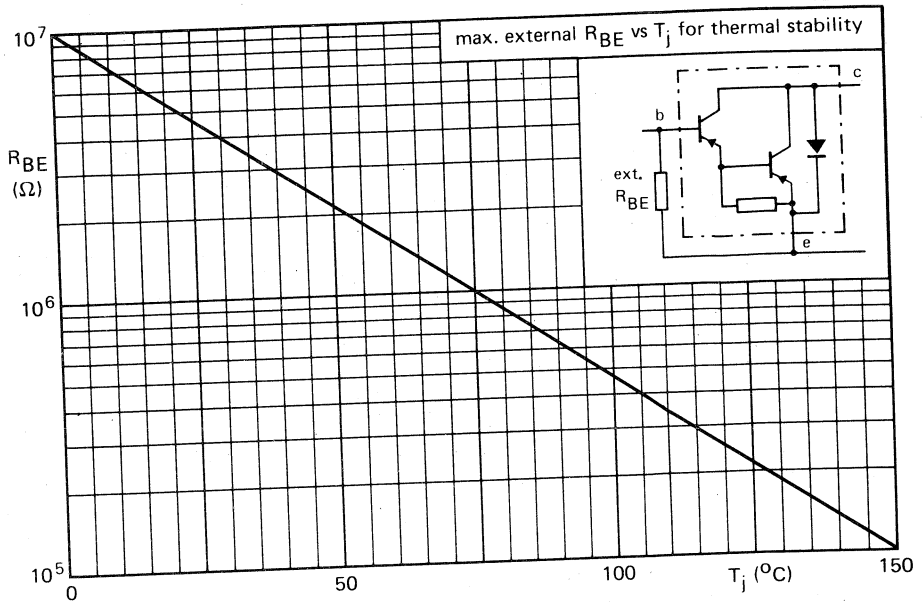


Fig. 12.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications: TO-3 envelope, N-P-N complements are BDX63, BDX63A, BDX63B and BDX63C. Matched complementary pairs can be supplied.

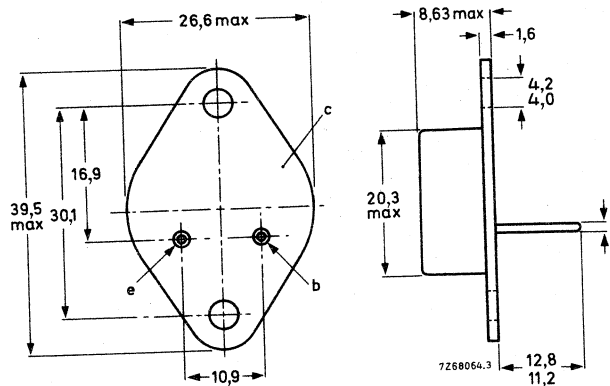
QUICK REFERENCE DATA

		BDX62	62A	62B	62C
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100	120 V
Collector current (peak value)	$-I_{CM}$ max.	12			A
Total power dissipation up to $T_{mb} = 25^{\circ}\text{C}$	P_{tot} max.	90			W
Junction temperature	T_j max.	200			$^{\circ}\text{C}$
D.C. current gain	h_{FE} typ.	1500			
$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}	1000			
$-I_C = 3,0\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}				
Cut-off frequency	f_{hfe} typ.	100			kHz
$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$					

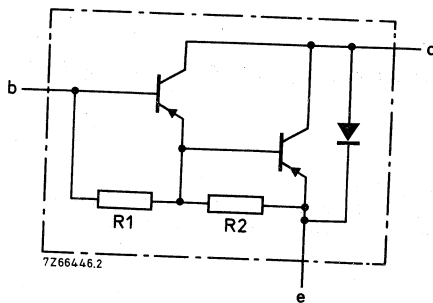
Dimensions in mm

MECHANICAL DATA

Fig. 1 TO-3.
Collector connected to case.



See also chapters Mounting instructions and Accessories.



R₁ typ. 6 kΩ
R₂ typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BDX62	62A	62B	62C
Collector-base voltage (open emitter)	-V _{CBO} max.	60	80	100	120 V
Collector-emitter voltage (open base)	-V _{CEO} max.	60	80	100	120 V
Emitter-base voltage (open collector)	-V _{EBO} max.	5	5	5	5 V
Collector current (d.c.)	-I _C max.	8			A
Collector current (peak value)	-I _{CM} max.	12			A
Base current (d.c.)	-I _B max.	150			mA
Total power dissipation up to T _{mb} = 25 °C	P _{tot} max.	90			W
Storage temperature	T _{stg}	-65 to +200			°C
Junction temperature*	T _j max.	200			°C
From junction to mounting base	R _{th j-mb} =	1,94			°C/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CBOmax}$

$I_E = 0; -V_{CB} = 40\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX62}$

$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX62A}$

$I_E = 0; -V_{CB} = 60\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX62B}$

$I_E = 0; -V_{CB} = 70\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX62C}$

$I_B = 0; -V_{CE} = -\frac{1}{2}V_{CEO}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$

D.C. current gain (note 1)

$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V}$

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$-I_C = 8\text{ A}; -V_{CE} = 3\text{ V}$

Base-emitter voltage (notes 1 and 2)

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

Collector-emitter saturation voltage (note 1)

$-I_C = 3\text{ A}; -I_B = 12\text{ mA}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$

Cut-off frequency

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

Small-signal current gain

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz}$

D.C. current gain ratio of complementary matched pairs

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$

$-I_{CBO} < 0,2\text{ mA}$

$-I_{CBO} < 2\text{ mA}$

$-I_{CEO} < 0,5\text{ mA}$

$-I_{EBO} < 5\text{ mA}$

$h_{FE} \text{ typ. } 1500$

$h_{FE} > 1000$

$h_{FE} \text{ typ. } 750$

$-V_{BE} < 2,5\text{ V}$

$-V_{CEsat} < 2\text{ V}$

$C_c \text{ typ. } 100\text{ pF}$

$f_{hfe} \text{ typ. } 100\text{ kHz}$

$h_{fe} \text{ typ. } 100$

$h_{FE1}/h_{FE2} < 2,5$

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.

2. $-V_{BE}$ decreases by about $3,6\text{ mV}/^\circ\text{C}$ with increasing temperature.

CHARACTERISTICS (continued)

Switching times

(between 10% and 90% levels)

$-I_{Con} = 3 \text{ A}; -I_{Boff} = I_{Boff} = 12 \text{ mA}$

turn-on time

turn-off time

t_{on} typ. $0,5 \mu\text{s}$
 t_{off} typ. $2,5 \mu\text{s}$

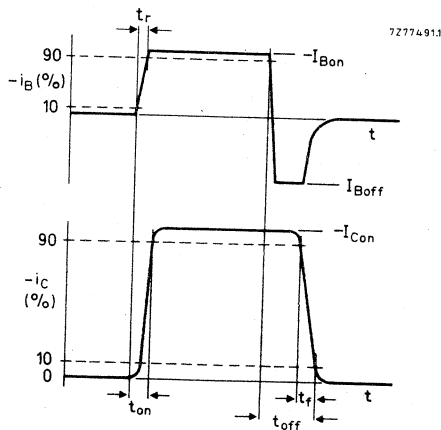


Fig. 3 Switching times waveforms.

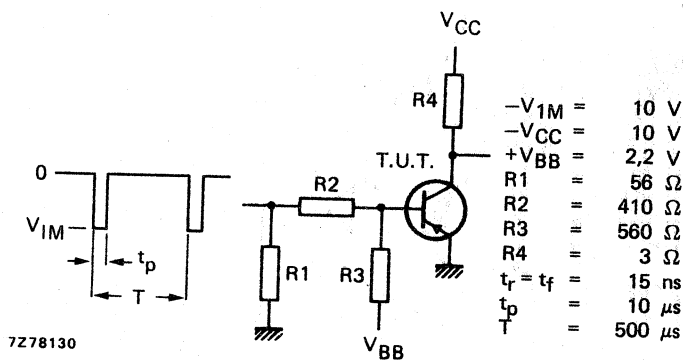


Fig. 4 Switching times test circuit.

Diode forward voltage
 $I_F = 3 \text{ A}$

V_F typ. $1,8 \text{ V}$

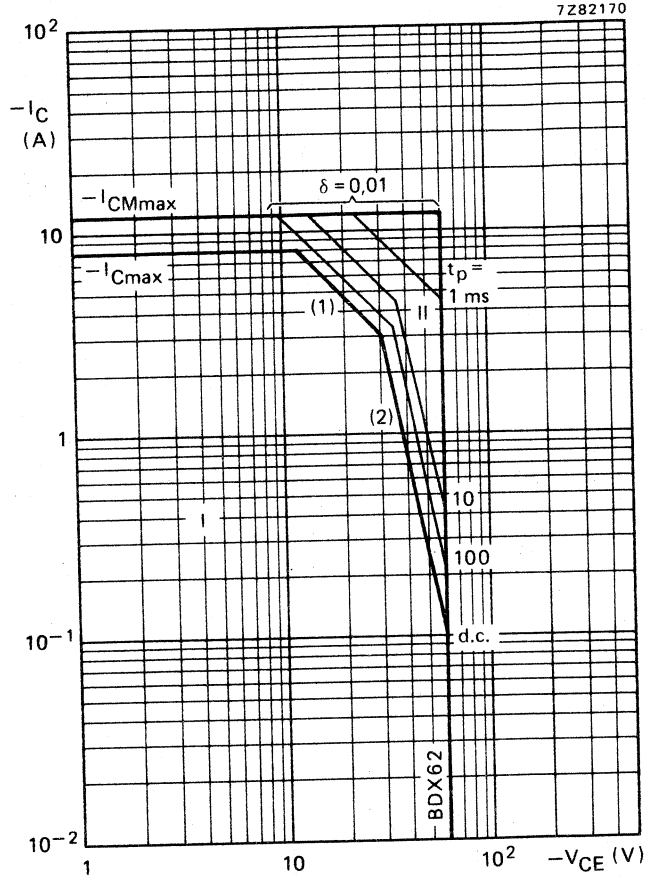


Fig. 5 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
- (2) Second-breakdown limits (independent of temperature).

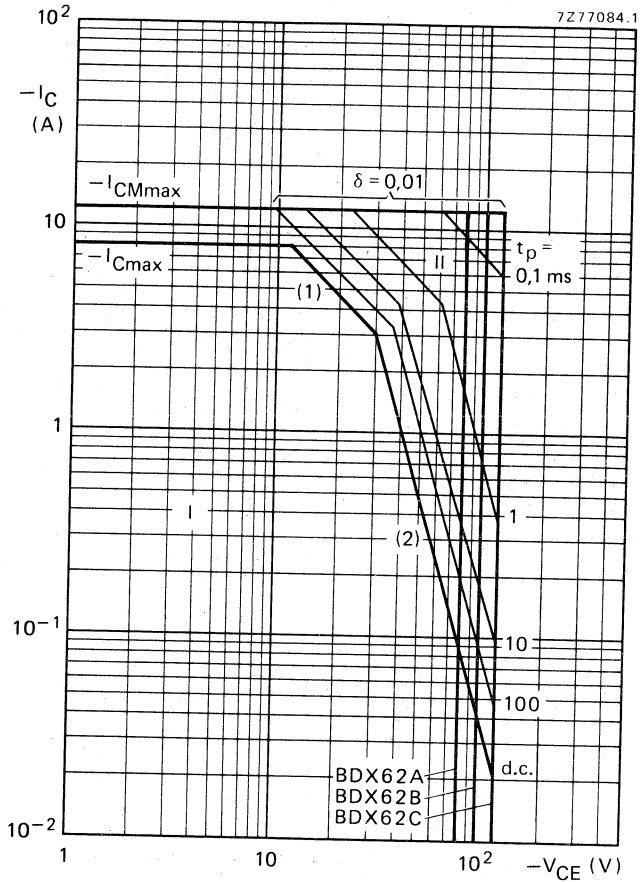


Fig. 6 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

(2) Second-breakdown limits (independent of temperature).

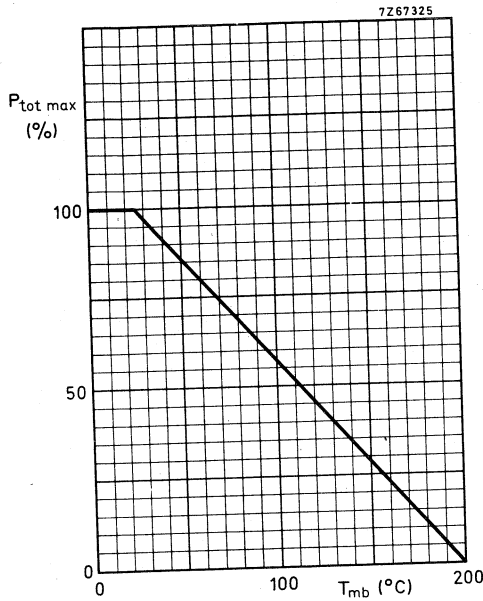


Fig. 7 Power derating curve.

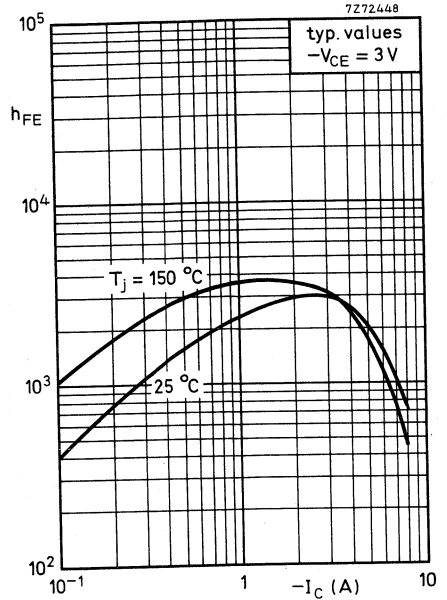


Fig. 8 D.C. current gain.

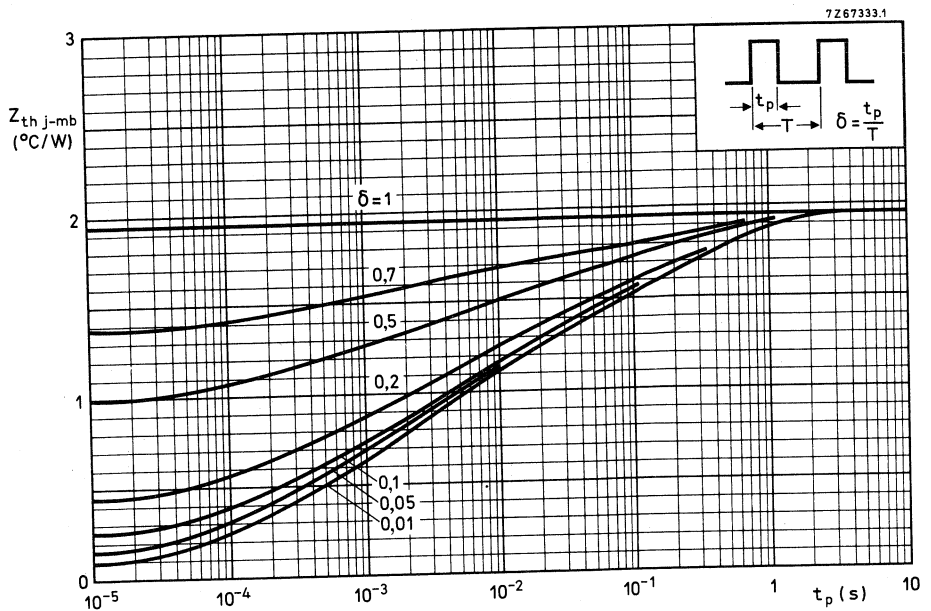


Fig. 9 Pulse power rating chart.

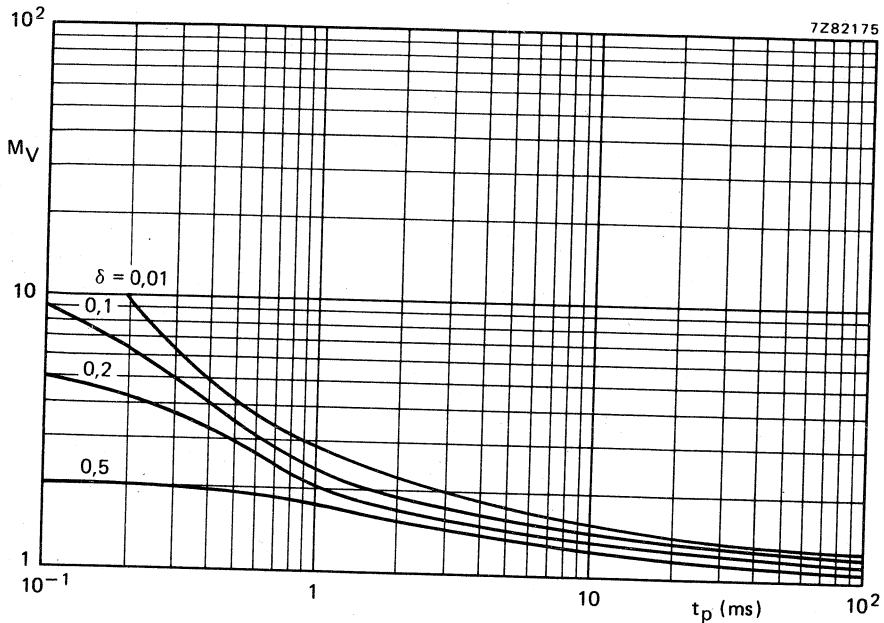


Fig. 10 S.B. voltage multiplying factor at the I_{Cmax} level.

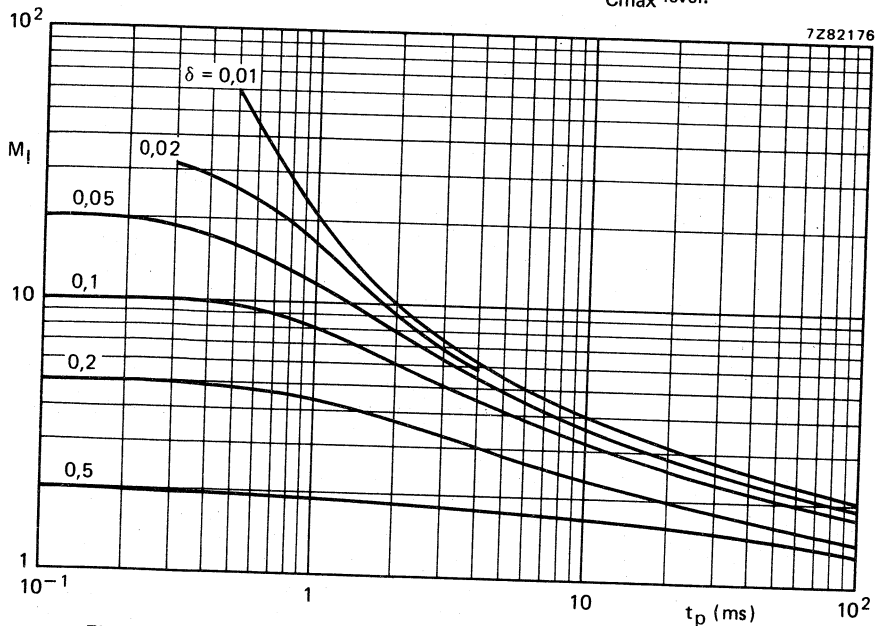


Fig. 11 S.B. current multiplying factor at the V_{CE0} 100 V and 60 V level.

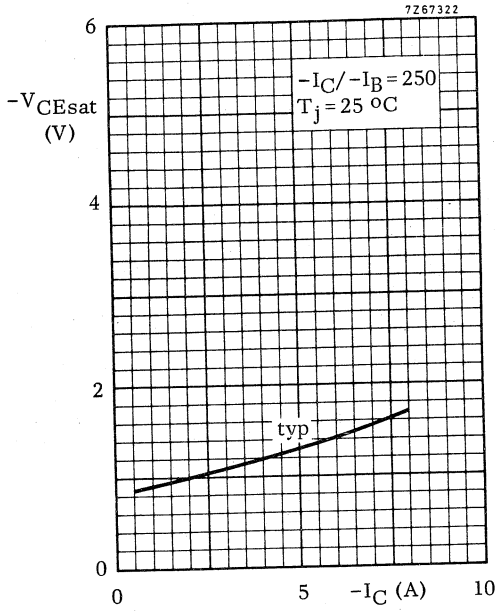


Fig. 12.

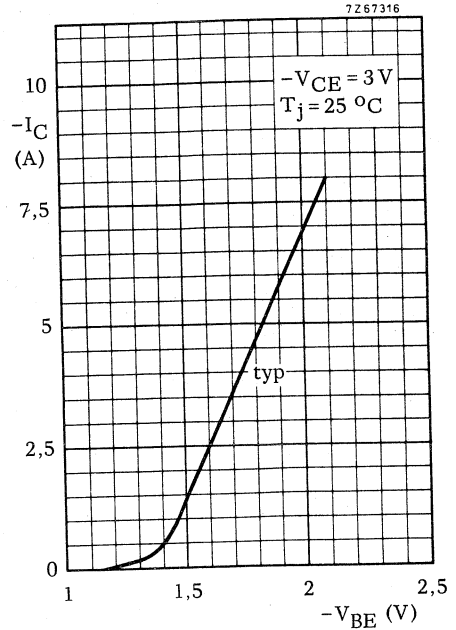


Fig. 13.

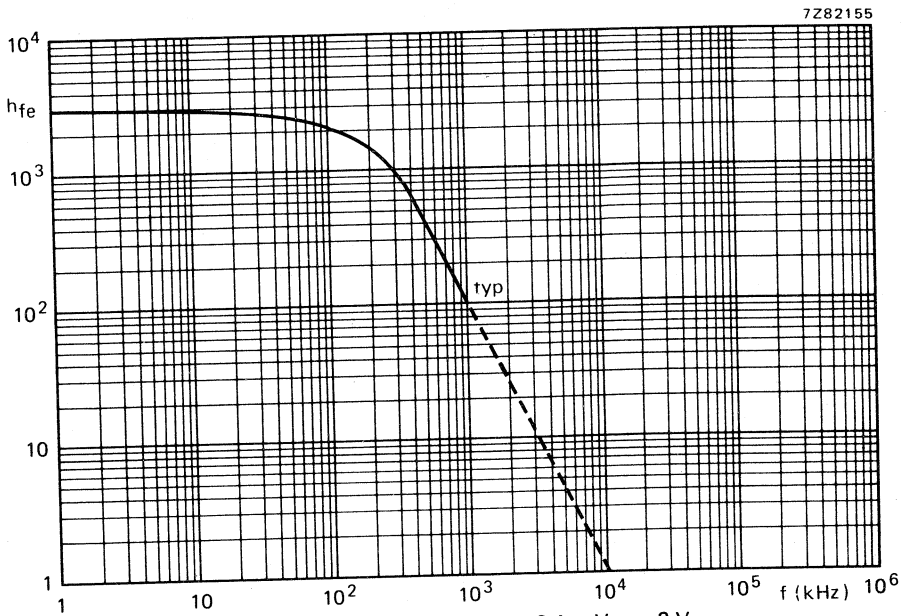


Fig. 14 Small signal current gain at $-I_C = 3\text{ A}$; $-V_{CE} = 3\text{ V}$.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope, P-N-P complements are BDX62, BDX62A, BDX62B and BDX62C. Matched complementary pairs can be supplied.

QUICK REFERENCE DATA

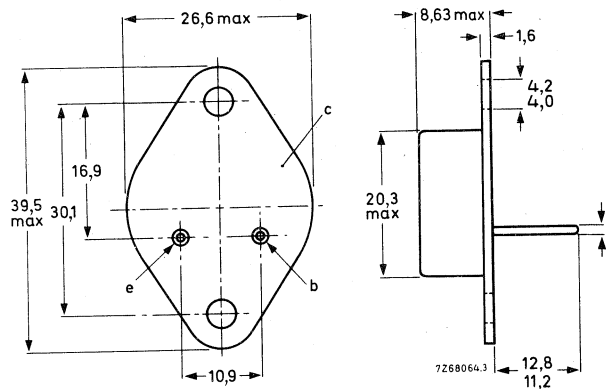
		BDX63	63A	63B	63C
Collector-base voltage (open emitter)	V_{CBO} max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO} max.	60	80	100	120 V
Collector current (peak value)	I_{CM} max.	12			A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.	90			W
Junction temperature	T_j max.	200			$^{\circ}\text{C}$
D.C. current gain	h_{FE} typ.	1500			
$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$	$h_{FE} >$	1000			
$I_C = 3,0\text{ A}; V_{CE} = 3\text{ V}$	f_{hfe} typ.	100			kHz
Cut-off frequency					
$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$					

MECHANICAL DATA

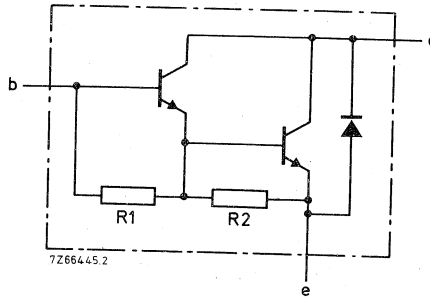
Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting instructions and Accessories.



R1 typ. 8 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BDX63	63A	63B	63C
Collector-base voltage (open emitter)	V_{CBO} max.	80	100	120	140 V
Collector-emitter voltage (open-base)	V_{CEO} max.	60	80	100	120 V
Emitter-base voltage (open collector)	V_{EBO} max.	5	5	5	5 V
Collector current (d.c.)	I_C max.		8		A
Collector current (peak value)	I_{CM} max.		12		A
Base current (d.c.)	I_B max.		150		mA
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.		90		W
Storage temperature	T_{stg}		-65 to +200		$^\circ\text{C}$
Junction temperature*	T_j max.		200		$^\circ\text{C}$

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j-mb} =$	1,94	$^\circ\text{C/W}$
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* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = V_{CE0max}$

$I_{CBO} < 0,2\text{ mA}$

$I_E = 0; V_{CB} = \frac{1}{2}V_{CB0max}; T_j = 200\text{ }^\circ\text{C}$

$I_{CBO} < 2\text{ mA}$

$I_B = 0; V_{CE} = \frac{1}{2}V_{CE0max}$

$I_{CEO} < 0,5\text{ mA}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 5\text{ mA}$

D.C. current gain (note 1)

$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 1500$

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} > 1000$

$I_C = 8\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 2000$

Base-emitter voltage (notes 1 and 2)

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$V_{BE} < 2,5\text{ V}$

Collector-emitter saturation voltage (note 1)

$I_C = 3\text{ A}; I_B = 12\text{ mA}$

$V_{CEsat} < 2\text{ V}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_c \text{ typ. } 100\text{ pF}$

Cut-off frequency

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$f_{hfe} \text{ typ. } 100\text{ kHz}$

Turn-off breakdown energy with inductive load (Fig. 4)

$-I_{Boff} = 0; I_{Con} = 4,5\text{ A}; t_p = 1\text{ ms};$

$T = 100\text{ ms}$

$E_{(BR)} > 50\text{ mJ}$

D.C. current gain ratio of complementary
matched pairs

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE1}/h_{FE2} < 2,5$

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.
2. V_{BE} decreases by about $3,6\text{ mV}/^\circ\text{C}$ with increasing temperature.

CHARACTERISTICS (continued)

Switching times

(between 10% and 90% levels)

$I_{Con} = 3 \text{ A}$; $I_{Bon} = -I_{Boff} = 12 \text{ mA}$

turn-on time

turn-off time

t_{on} typ. $0,5 \mu\text{s}$
 t_{off} typ. $2,5 \mu\text{s}$

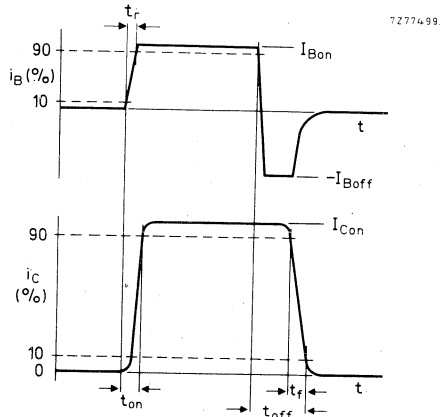


Fig. 3 Switching time waveforms.

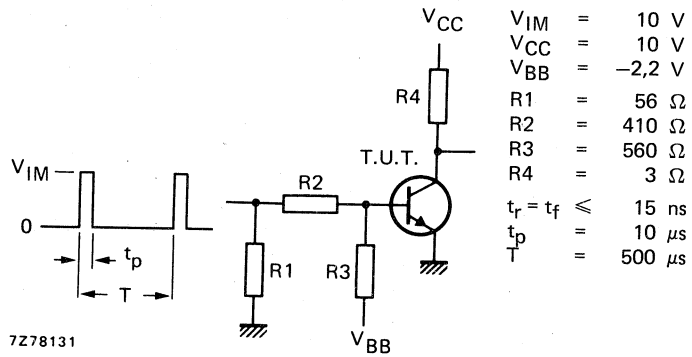


Fig. 4 Switching times test circuit.

Diode, forward voltage
 $I_F = 3 \text{ A}$

V_F typ. 1,2 V

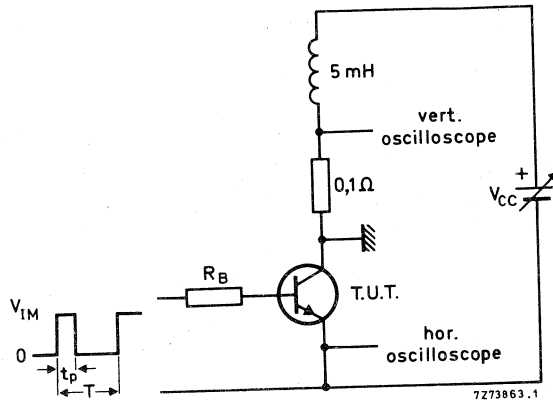


Fig. 5 Test circuit for turn-off breakdown energy.
 $V_{IM} = 12 \text{ V}$; $R_B = 270 \Omega$; $I_C = 4,5 \text{ A}$; $t_p = 1 \text{ ms}$; $\delta = 1\%$.



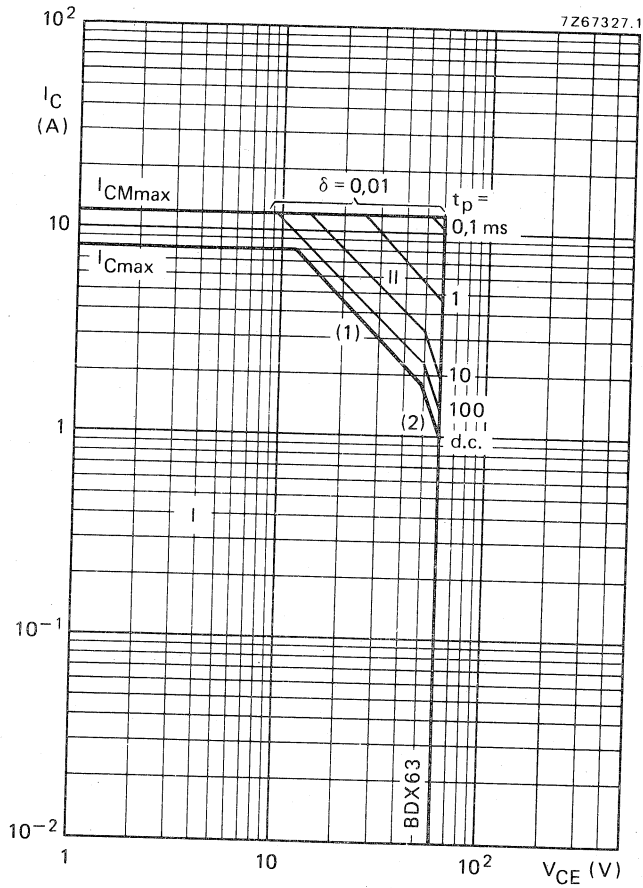


Fig. 6 Safe Operating Area, $T_{mb} \leq 25^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
- (2) Second-breakdown limits (independent of temperature).

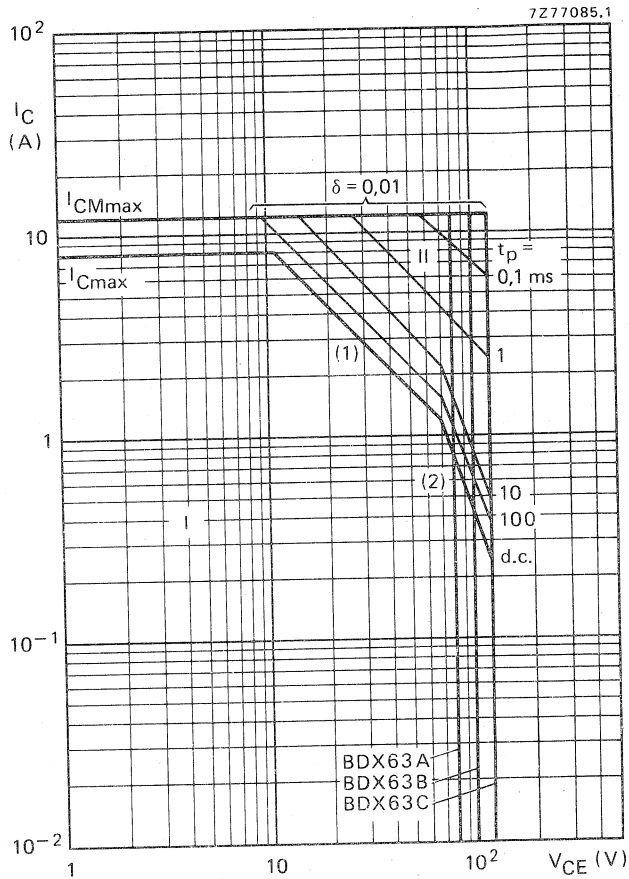


Fig. 7 Safe Operating Area, $T_{mb} \leq 25\ ^\circ C$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
- (2) Second-breakdown limits (independent of temperature).

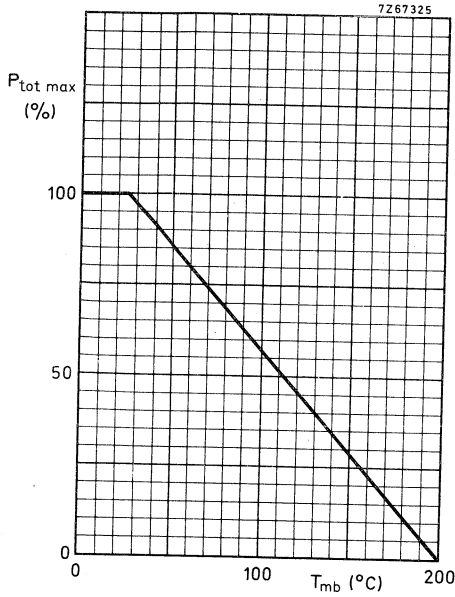


Fig. 8 Power derating curve.

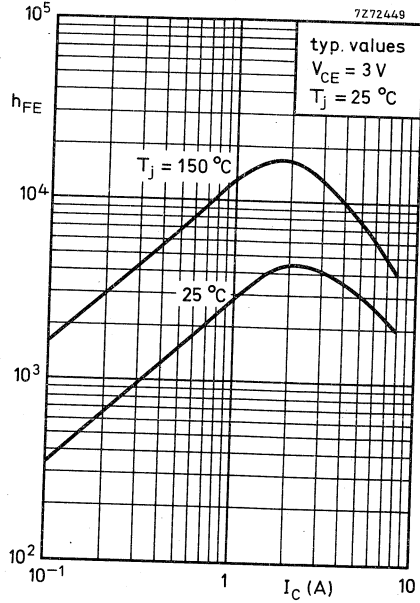


Fig. 9 D.C. current gain.

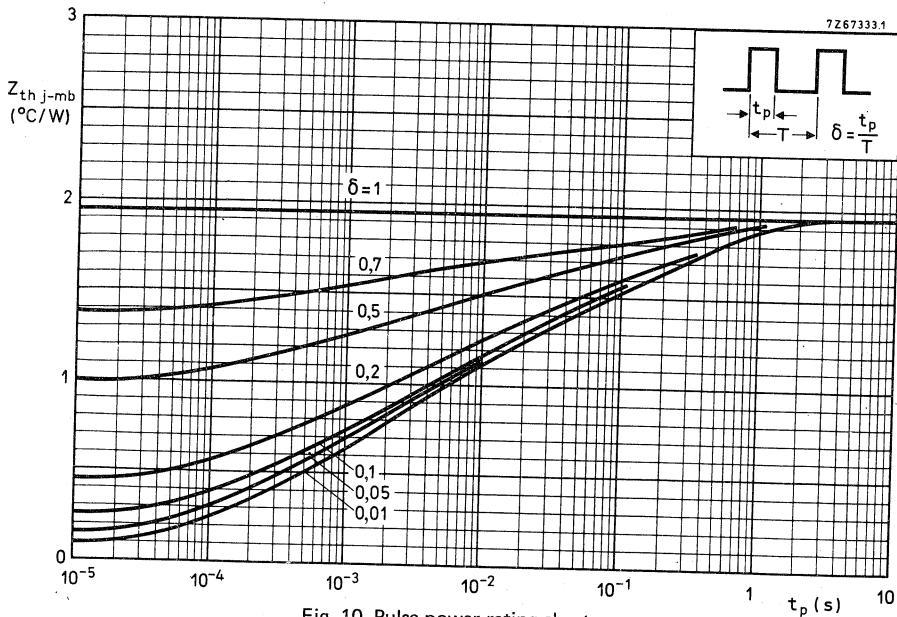


Fig. 10 Pulse power rating chart.

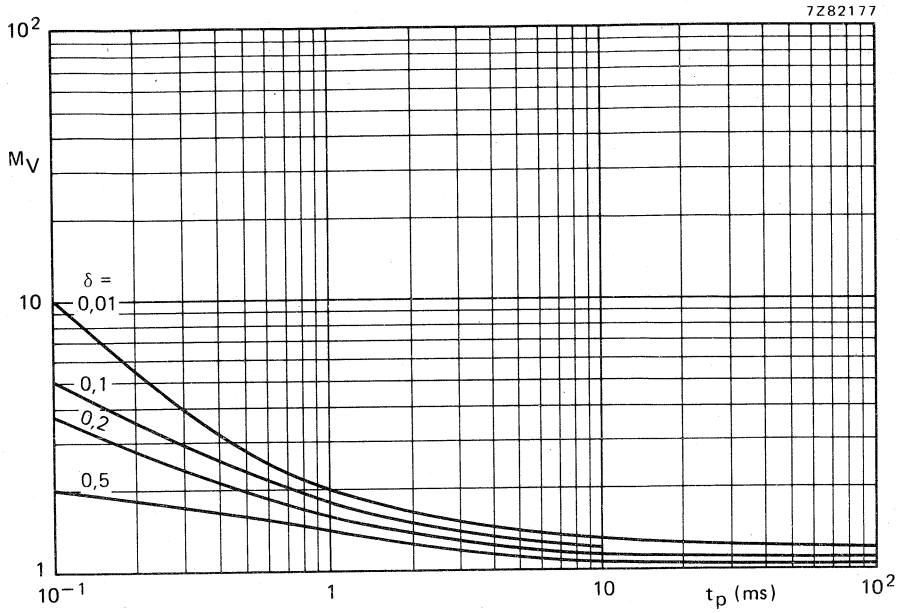


Fig. 11 S.B. voltage multiplying factor at the I_{Cmax} level.

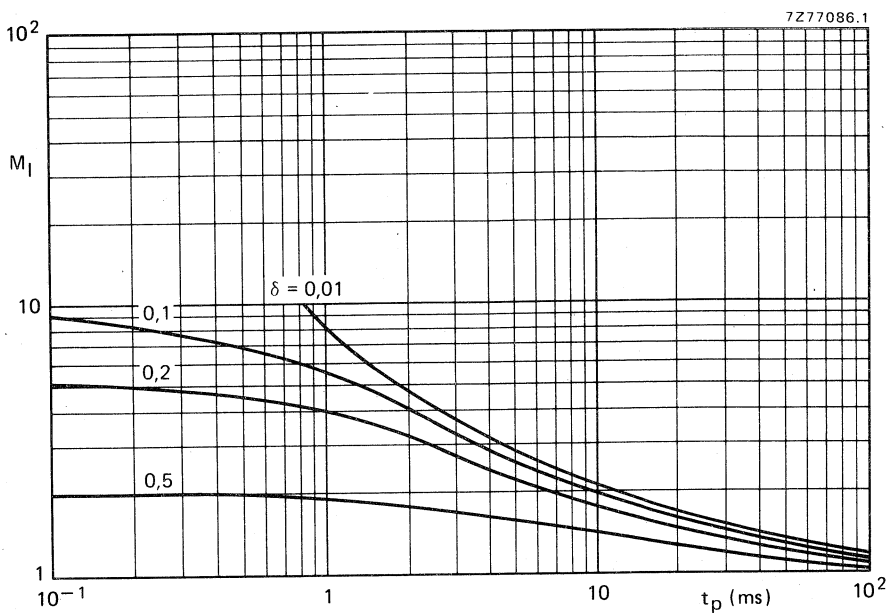
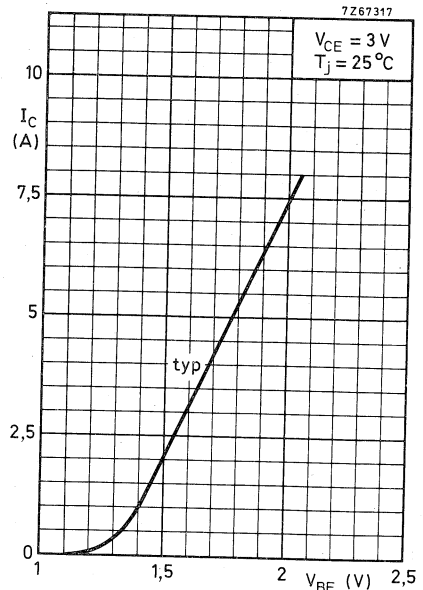
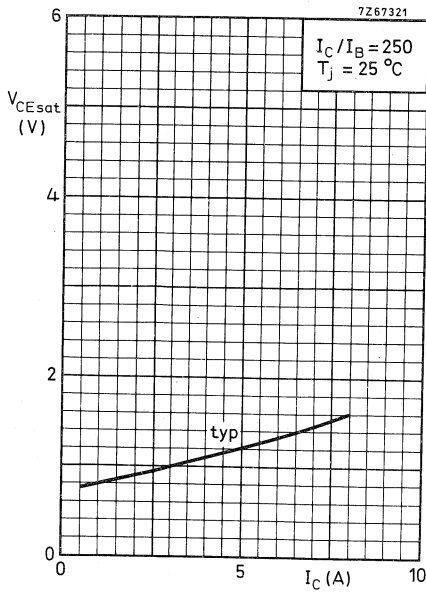
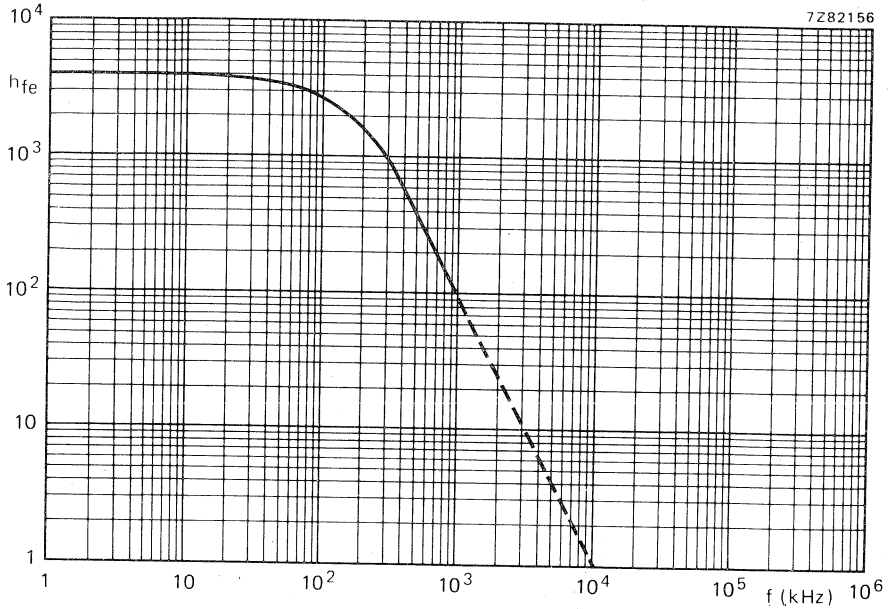


Fig. 12 S.B. current multiplying factor at the V_{CEO} 100 V and 60 V level.



SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope. N-P-N complements are BDX65, BDX65A, BDX65B and BDX65C. Matched complementary pairs can be supplied.

QUICK REFERENCE DATA

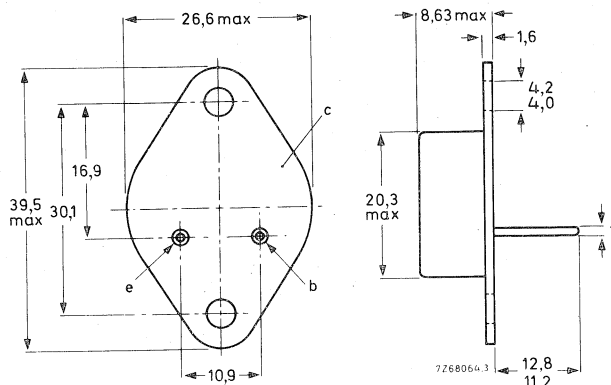
			BDX64	64A	64B	64C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (peak value)	$-I_{CM}$	max.	16			A	
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	117			W	
Junction temperature	T_j	max.	200			$^{\circ}\text{C}$	
D.C. current gain							
$-I_C = 1\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}	typ.	1500				
$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}	>	1000				
Cut-off frequency							
$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe}	typ.	80			kHz	

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting instructions and Accessories.

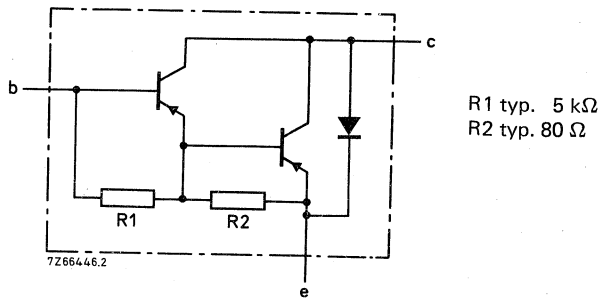


Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX64	64A	64B	64C
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5 V
Collector current (d.c.)	$-I_C$	max.		12		A
Collector current (peak value)	$-I_{CM}$	max.		16		A
Base current (d.c.)	$-I_B$	max.		200		mA
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		117		W
Storage temperature	T_{stg}			-65 to +200		$^\circ\text{C}$
Junction temperature*	T_j	max.		200		$^\circ\text{C}$

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j-mb}$	=		1,5		$^\circ\text{C/W}$
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* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CB0max}$

$-I_{CBO} < 0,4\text{ mA}$

$I_E = 0; -V_{CB} = 40\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX64}$

$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX64A}$

$I_E = 0; -V_{CB} = 60\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX64B}$

$I_E = 0; -V_{CB} = 70\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX64C}$

$-I_{CBO} < 3\text{ mA}$

$I_B = 0; -V_{CE} = -\frac{1}{2} V_{CEOmax}$

$-I_{CEO} < 1\text{ mA}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$

$-I_{EBO} < 5\text{ mA}$

D.C. current gain (note 1)

$-I_C = 1\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 1500$

$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} > 1000$

$-I_C = 12\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 750$

Base-emitter voltage (notes 1 and 2)

$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}$

$-V_{BE} < 2,5\text{ V}$

Collector-emitter saturation voltage (note 1)

$-I_C = 5\text{ A}; -I_B = 20\text{ mA}$

$-V_{CEsat} < 2\text{ V}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$

$C_c \text{ typ. } 200\text{ pF}$

Cut-off frequency

$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}$

$f_{hfe} \text{ typ. } 80\text{ kHz}$

Small-signal current gain

$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz}$

$h_{fe} \text{ typ. } 30$

D.C. current gain ratio of complementary matched pairs

$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE1}/h_{FE2} < 2,5$

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.
2. $-V_{BE}$ decreases by about $3,6\text{ mV}/^\circ\text{C}$ with increasing temperature.

CHARACTERISTICS (continued)

Diode, forward voltage

$I_F = 5 \text{ A}$

$V_F < 1,8 \text{ V}$

Switching times

(between 10% and 90% levels)

$-I_{Con} = 5 \text{ A}; -I_{Bon} = I_{Boff} = 20 \text{ mA}$

turn-on time

turn-off time

t_{on} typ. $1 \mu\text{s}$
 t_{off} typ. $2,5 \mu\text{s}$

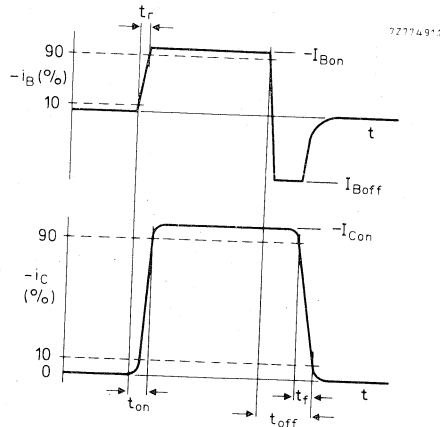
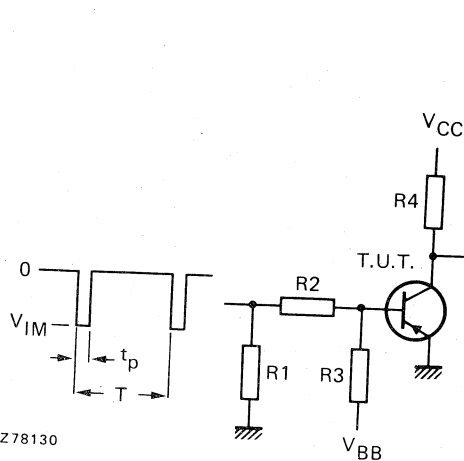


Fig. 3 Switching times waveforms.



- $-V_{IM} = 16,5 \text{ V}$
- $-V_{CC} = 16 \text{ V}$
- $+V_{BB} = 6,5 \text{ V}$
- $R1 = 56 \Omega$
- $R2 = 410 \Omega$
- $R3 = 560 \Omega$
- $R4 = 3 \Omega$
- $t_r = t_f \leq 15 \text{ ns}$
- $t_p = 10 \mu\text{s}$
- $T = 500 \mu\text{s}$

Fig. 4 Switching times test circuit.

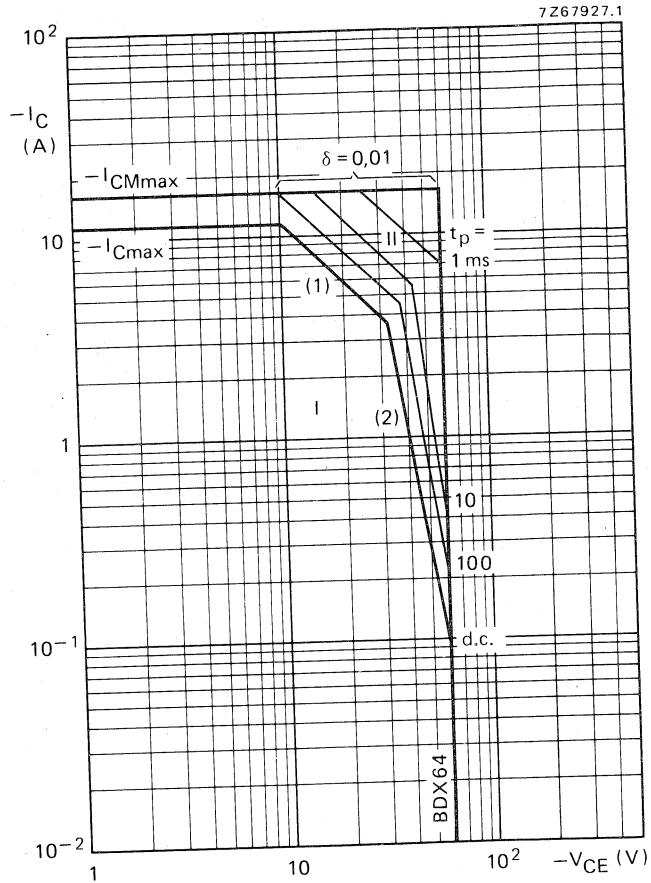


Fig. 5 Safe Operating Area; $T_{mb} \leq 25^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
- (2) Second-breakdown limits (independent of temperature).

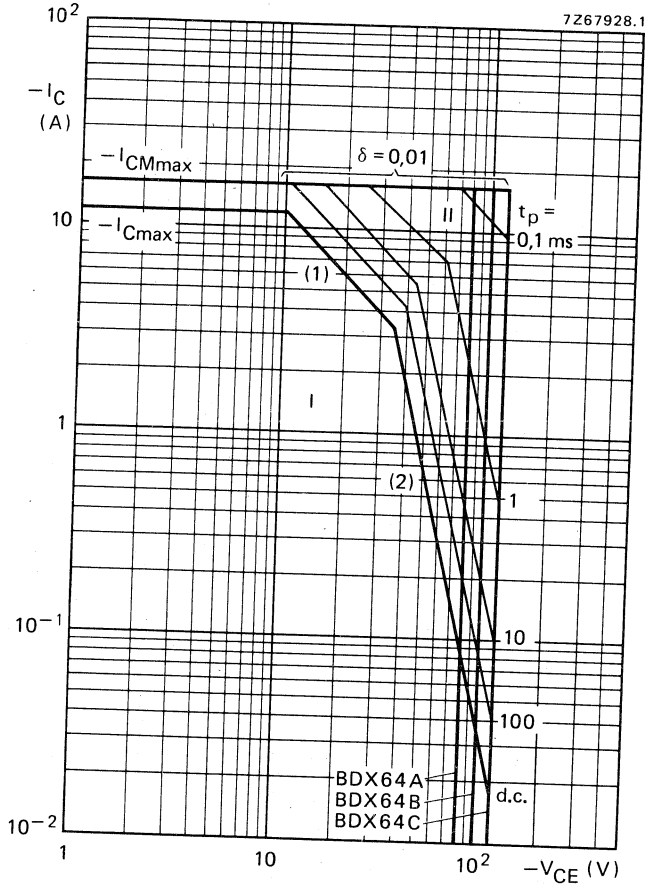


Fig. 6 Safe Operating Area; $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
- (2) Second-breakdown limits (independent of temperature).

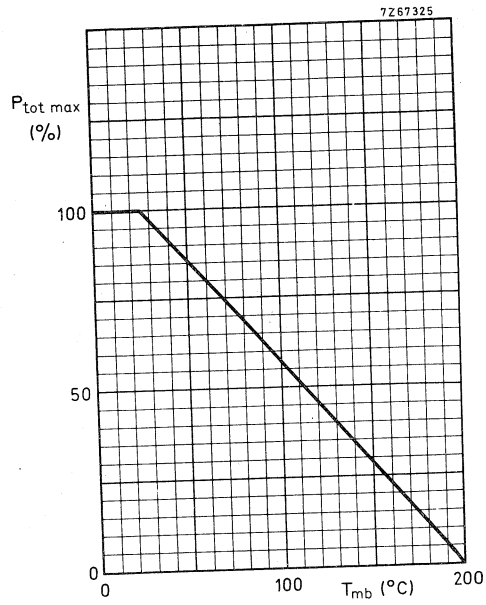


Fig. 7 Power derating curve.

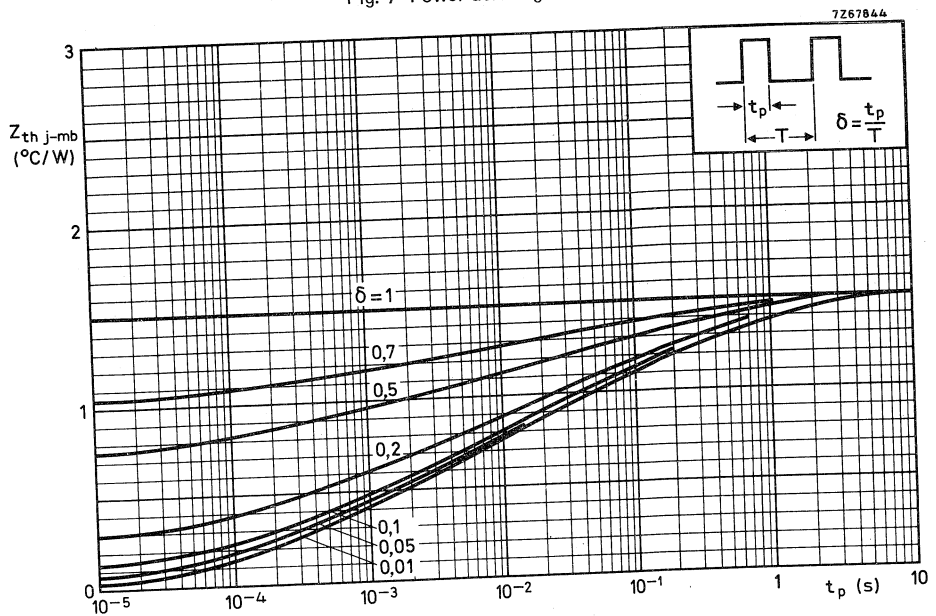


Fig. 8 Pulse power rating chart.

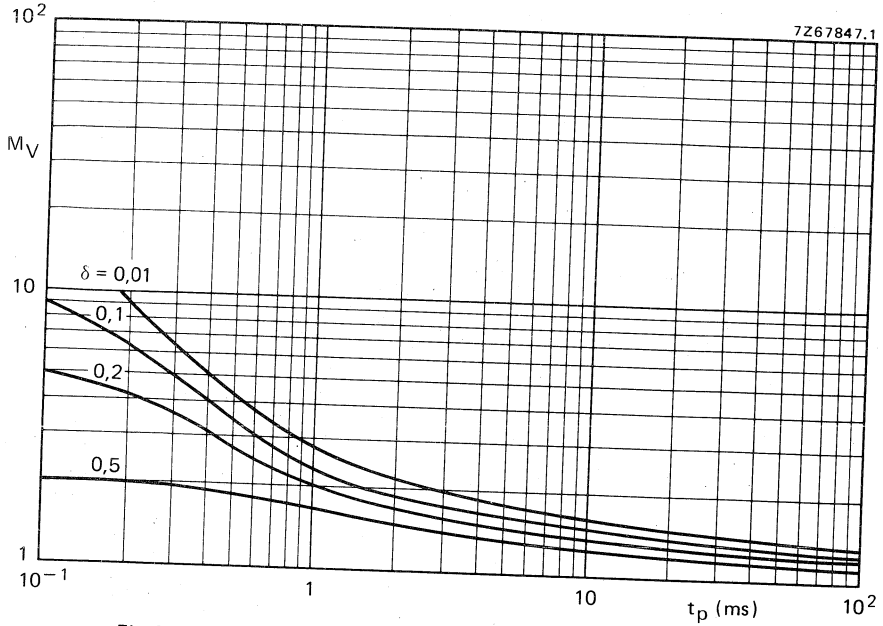


Fig. 9 S.B. voltage multiplying factor at the $-I_{C\max}$ level.

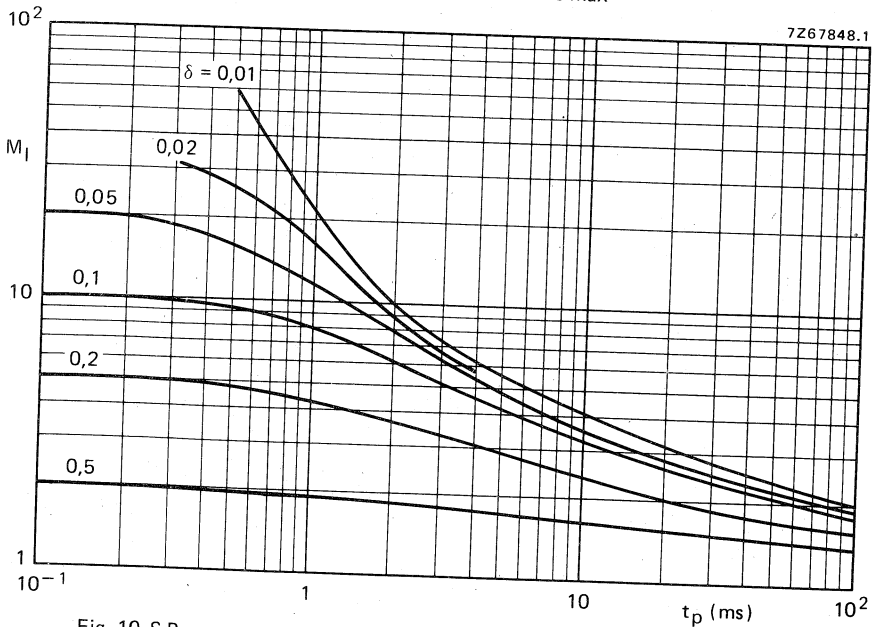


Fig. 10 S.B. current multiplying factor at $-V_{CE0}$ 100 V and 60 V level.

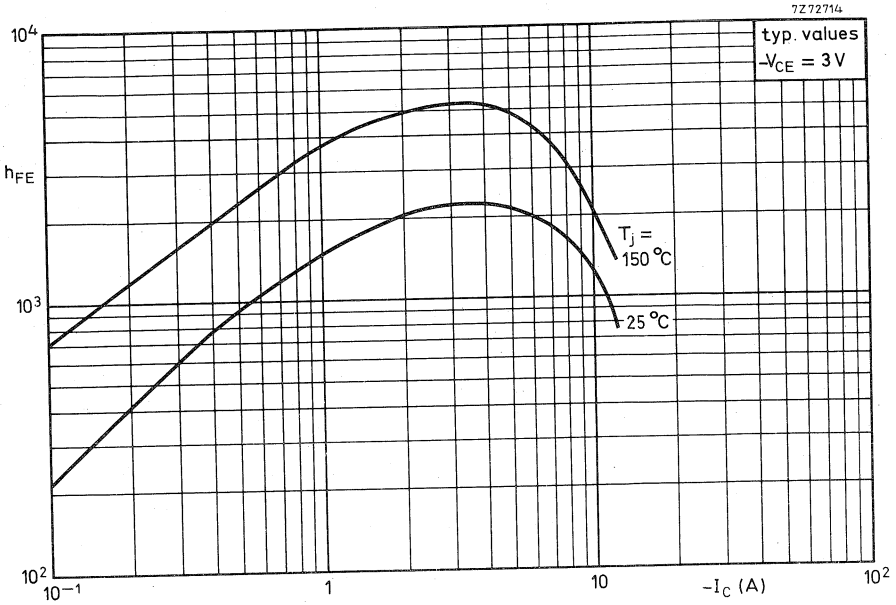


Fig. 11 D.C. current gain.

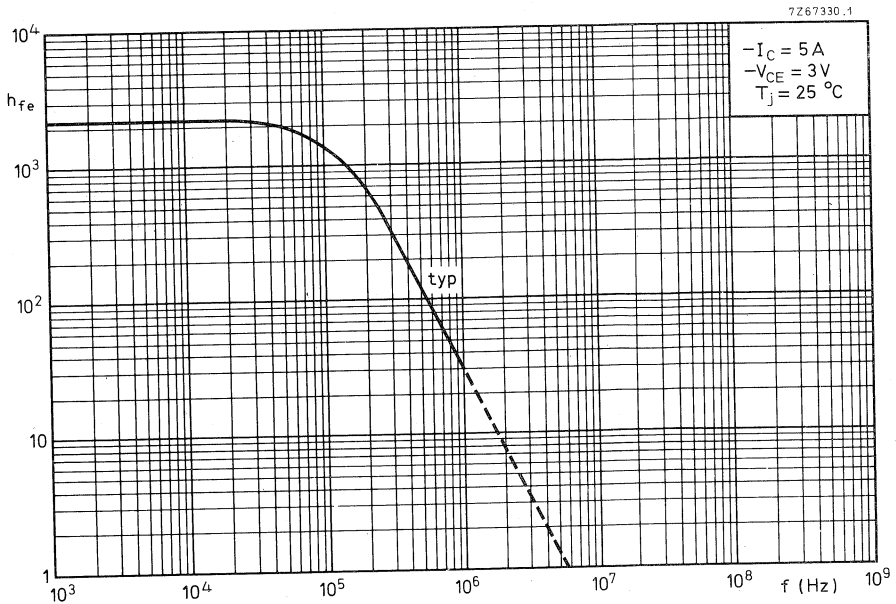


Fig. 12 Small-signal current gain.

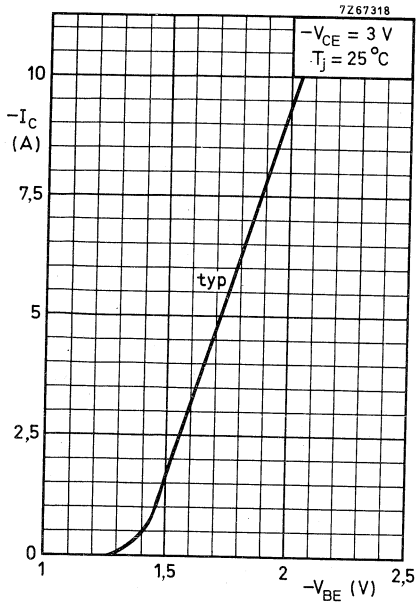


Fig. 13 Typical collector current.

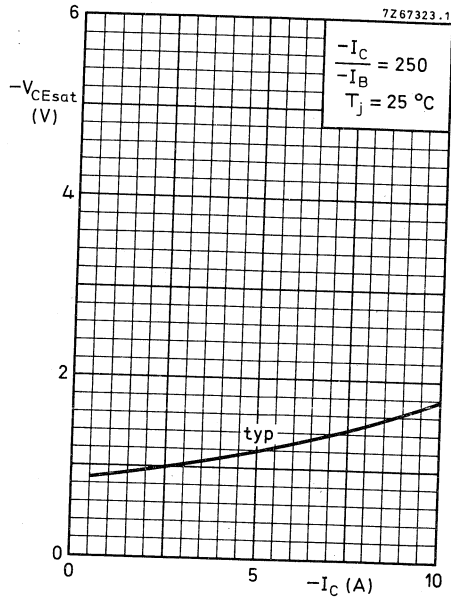


Fig. 14 Typical collector-emitter saturation voltage.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope. P-N-P complements are BDX64, BDX64A, BDX64B and BDX64C. Matched complementary pairs can be supplied.

QUICK REFERENCE DATA

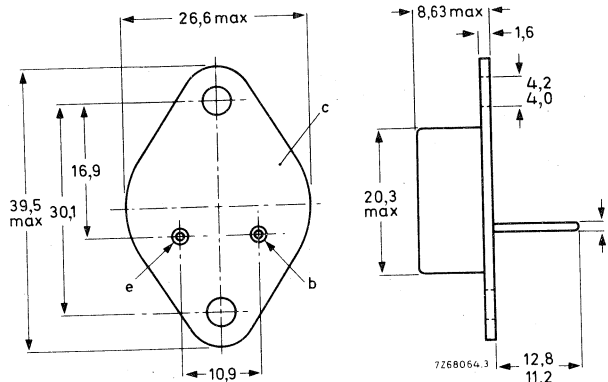
		BDX65	65A	65B	65C
Collector-base voltage (open emitter)	V_{CB0} max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CE0} max.	60	80	100	120 V
Collector current (peak value)	I_{CM} max.	16			A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.	117			W
Junction temperature	T_j max.	200			$^{\circ}\text{C}$
D.C. current gain	h_{FE} typ.	1500			
$I_C = 1\text{ A}; V_{CE} = 3\text{ V}$	$h_{FE} >$	1000			
$I_C = 5\text{ A}; V_{CE} = 3\text{ V}$	f_{hfe} typ.	50			kHz
Cut-off frequency					
$I_C = 5\text{ A}; V_{CE} = 3\text{ V}$					

Dimensions in mm

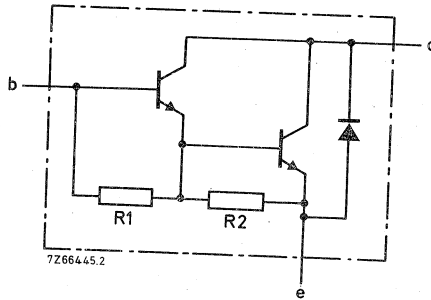
MECHANICAL DATA

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting instructions and Accessories.



R1 typ. 5 kΩ
R2 typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX65	65A	65B	65C
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120 V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5 V
Collector current (d.c.)	I_C	max.		12		A
Collector current (peak value)	I_{CM}	max.		16		A
Base current (d.c.)	I_B	max.		200		mA
Total power dissipation up to $T_{mb} = 25\text{ °C}$	P_{tot}	max.		117		W
Storage temperature	T_{stg}			-65 to +200		°C
Junction temperature*	T_j	max.		200		°C

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j-mb}$	=	1,5	°C/W
--------------------------------	----------------	---	-----	------

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = V_{CE0max}$

$I_E = 0; V_{CB} = \frac{1}{2} V_{CB0max}; T_j = 200\text{ }^\circ\text{C}$

$I_B = 0; V_{CE} = \frac{1}{2} V_{CE0max}$

I_{CBO}	<	0,4 mA
I_{CBO}	<	3 mA
I_{CEO}	<	1 mA

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

I_{EBO}	<	5 mA
-----------	---	------

D.C. current gain (note 1)

$I_C = 1\text{ A}; V_{CE} = 3\text{ V}$ BDX65; 65A; 65B
BDX65C

$I_C = 5\text{ A}; V_{CE} = 3\text{ V}$

$I_C = 12\text{ A}; V_{CE} = 3\text{ V}$ BDX65; 65A; 65B
BDX65C

h_{FE}	typ.	1500
h_{FE}	typ.	1250
h_{FE}	>	1000
h_{FE}	typ.	1250
h_{FE}	typ.	600

Base-emitter voltage (notes 1 and 2)

$I_C = 5\text{ A}; V_{CE} = 3\text{ V}$

V_{BE}	<	2,5 V
----------	---	-------

Collector-emitter saturation voltage (note 1)

$I_C = 5\text{ A}; I_B = 20\text{ mA}$

V_{CEsat}	<	2 V
-------------	---	-----

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

C_c	typ.	200 pF
-------	------	--------

Cut-off frequency

$I_C = 5\text{ A}; V_{CE} = 3\text{ V}$

f_{hfe}	typ.	50 kHz
-----------	------	--------

Turn-off breakdown energy with inductive load (Fig. 5)

$-I_{Boff} = 0; I_{Con} = 6,3\text{ A}$

$E_{(BR)}$	>	100 mJ
------------	---	--------

D.C. current gain ratio of complementary matched pairs

$I_C = 5\text{ A}; V_{CE} = 3\text{ V}$

h_{FE1}/h_{FE2}	<	2,5
-------------------	---	-----

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.
2. V_{BE} decreases by about $3,6\text{ mV}/^\circ\text{C}$ with increasing temperature.

CHARACTERISTICS (continued)

Diode, forward voltage

$I_F = 5 \text{ A}$

V_F typ. 1,2 V

Switching times

(between 10% and 90% levels)

$I_{Con} = 5 \text{ A}; I_{Boff} = -I_{Boff} = 20 \text{ mA}$

Turn-on time

t_{on} typ. 1 μs

Turn-off time

t_{off} typ. 2,5 μs

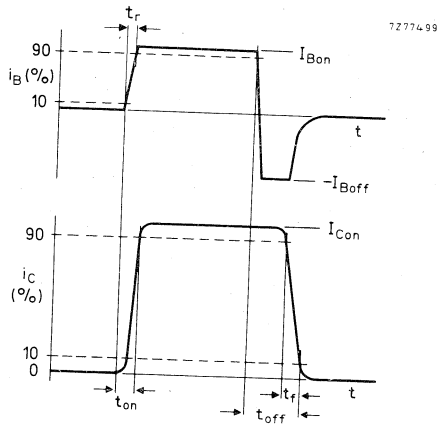


Fig. 3 Switching times waveforms.

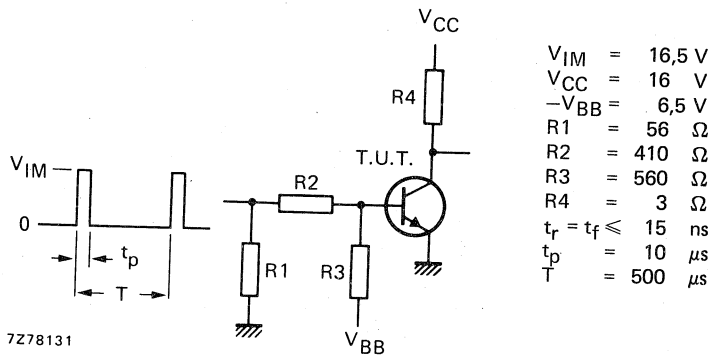


Fig. 4 Switching times test circuit.

CHARACTERISTICS (continued)

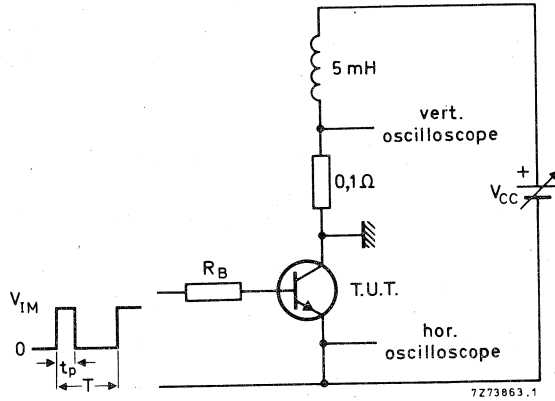


Fig. 5 Test circuit for turn-off breakdown energy. $V_{IM} = 12 \text{ V}$; $R_B = 270 \Omega$; $I_C = 6,3 \text{ A}$; $\delta = 1\%$.

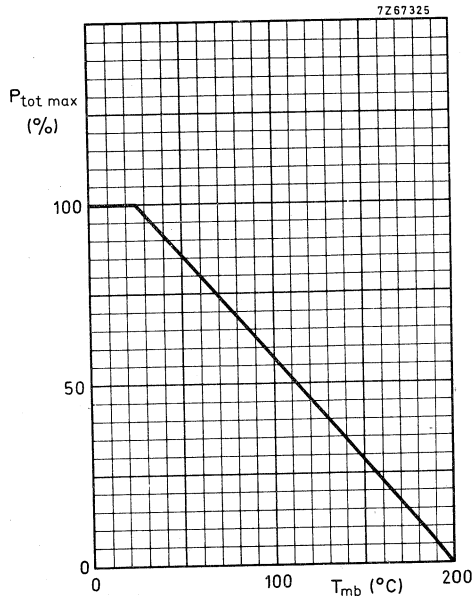


Fig. 6 Power derating curve.

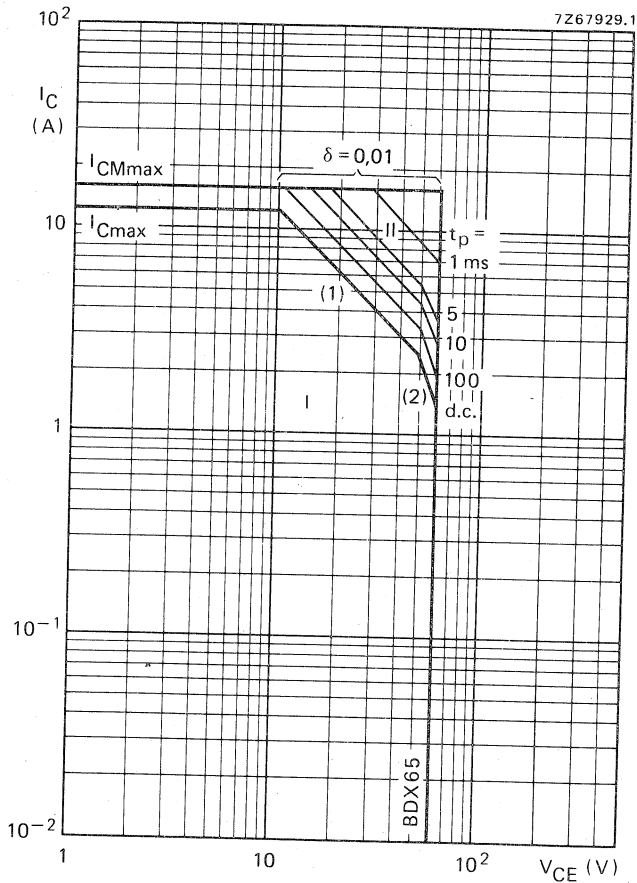


Fig. 7 Safe Operating Area at $T_{mb} \leq 25^\circ\text{C}$ of BDX65.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot \text{ max}}$ and $P_{tot \text{ peak max}}$ lines.

(2) Second-breakdown limits (independent of temperature).

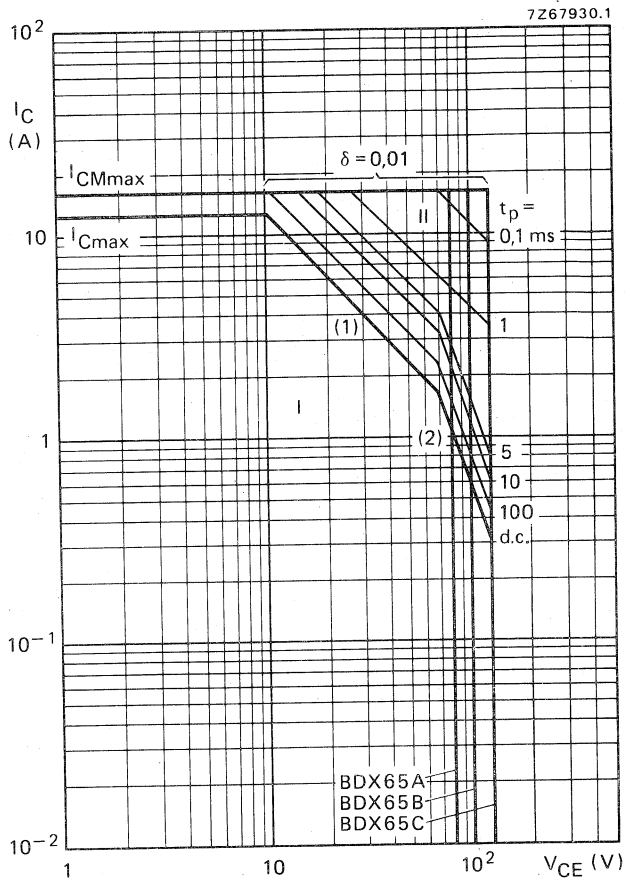


Fig. 8 Safe Operating Area at $T_{mb} \leq 25^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ and $P_{tot\ peak\ max}$ lines.
- (2) Second-breakdown limits (independent of temperature).

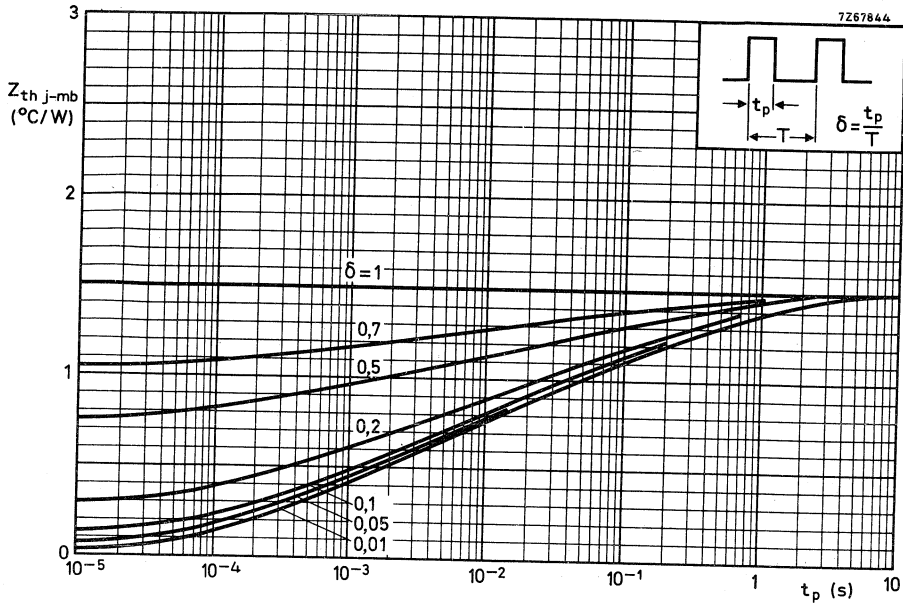


Fig. 9 Pulse power rating chart.

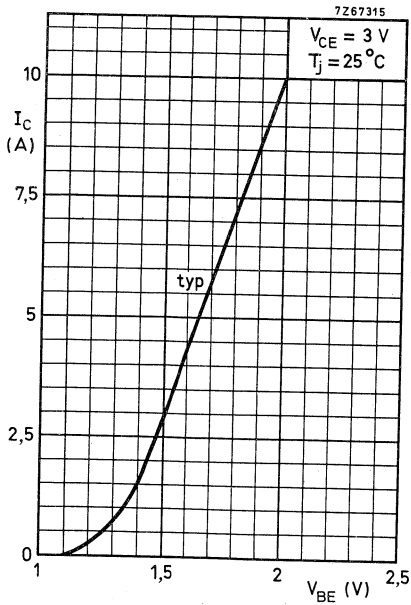


Fig. 10 Typical collector current.

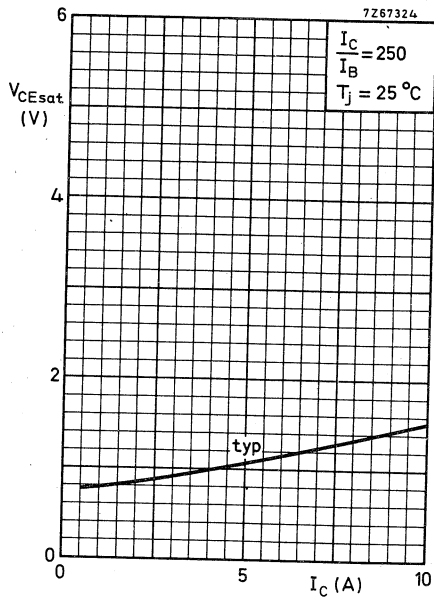


Fig. 11 Typical collector-emitter saturation voltage.

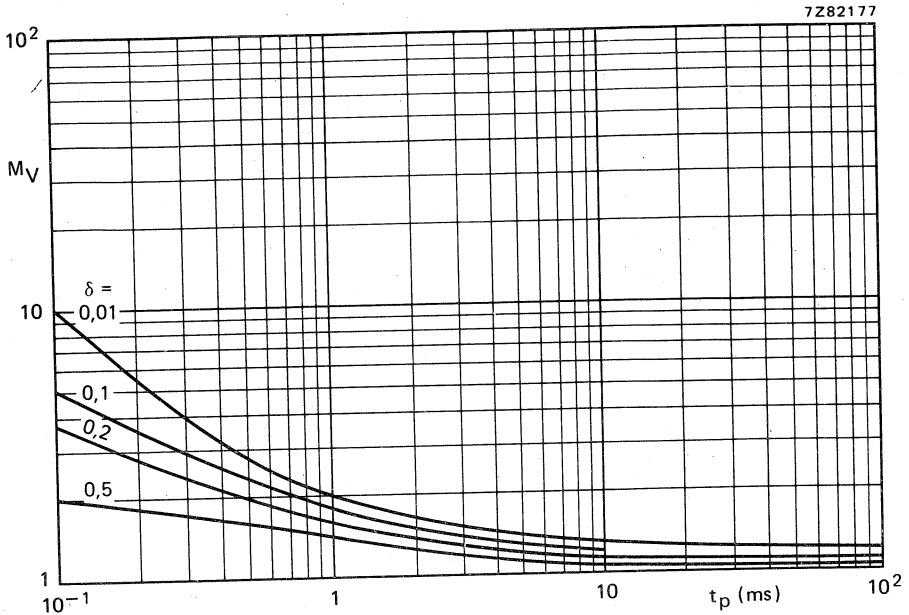


Fig. 12 S.B. voltage multiplying factor at the I_{Cmax} level.

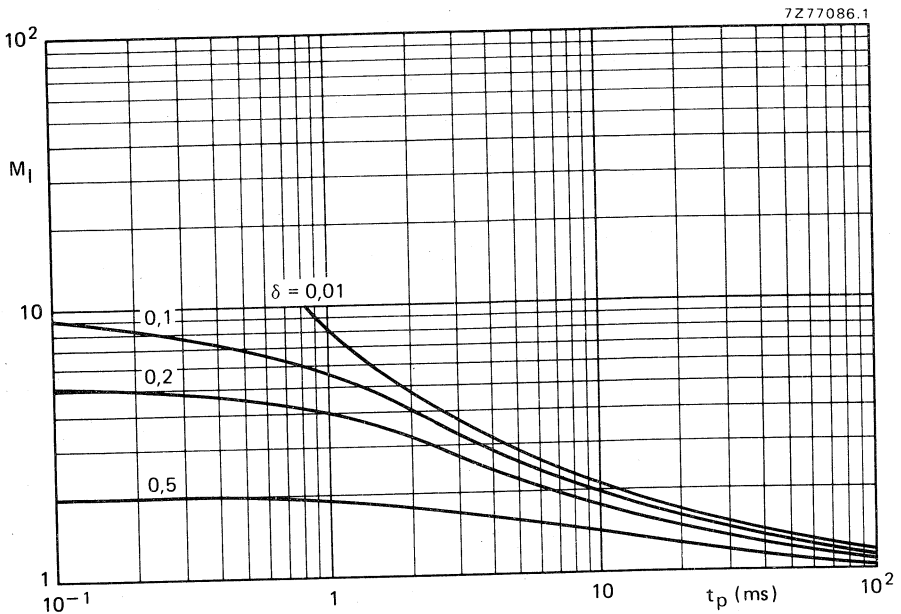


Fig. 13 S.B. current multiplying factor at V_{CE0} 100 V and 60 V level.

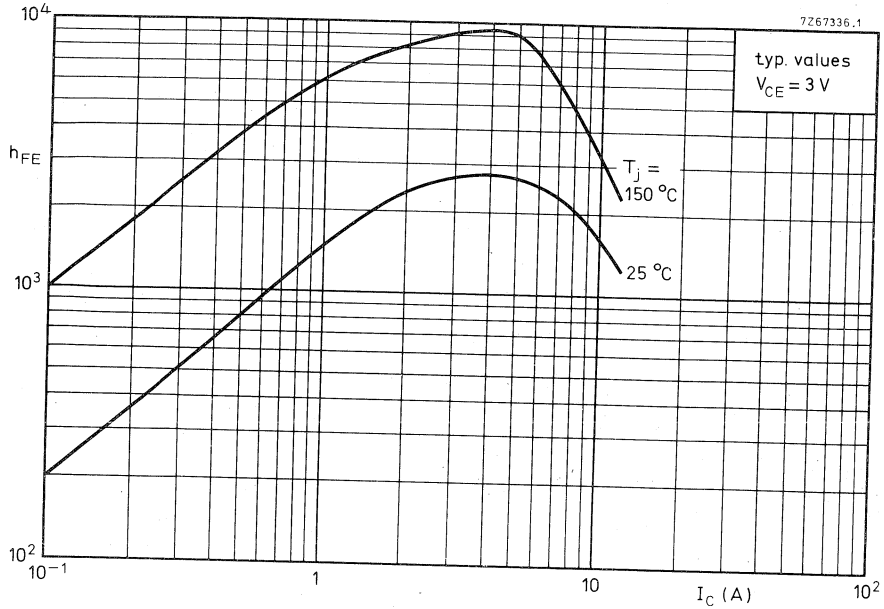


Fig. 14 Typical d.c. current gain BDX65; 65A and 65B.

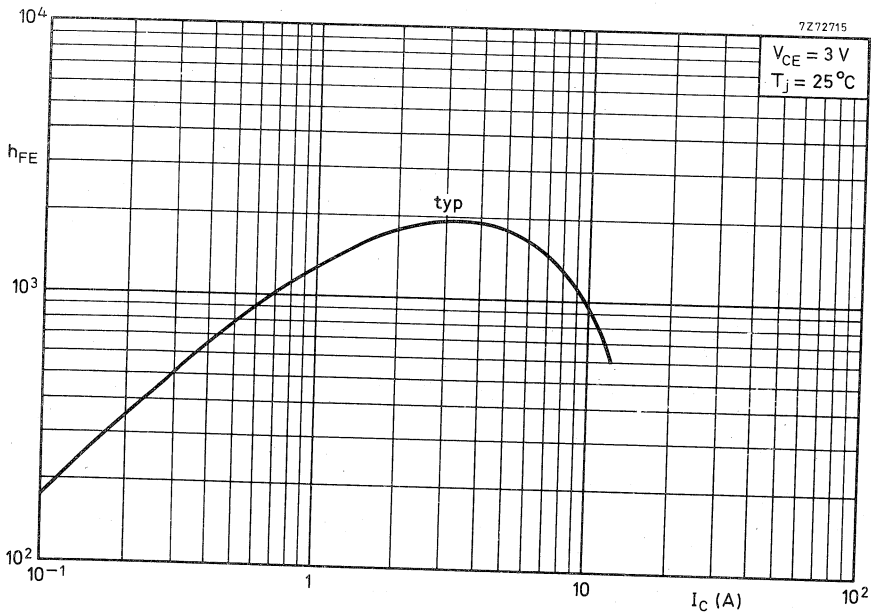


Fig. 15 Typical d.c. current gain for BDX65C.

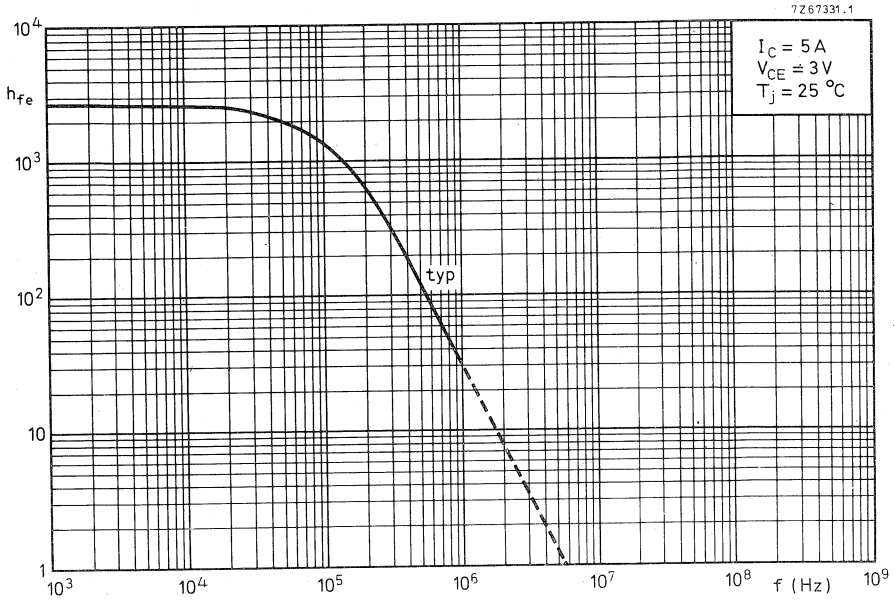


Fig. 16 Typical small-signal current gain for BDX65; 65A and 65B.

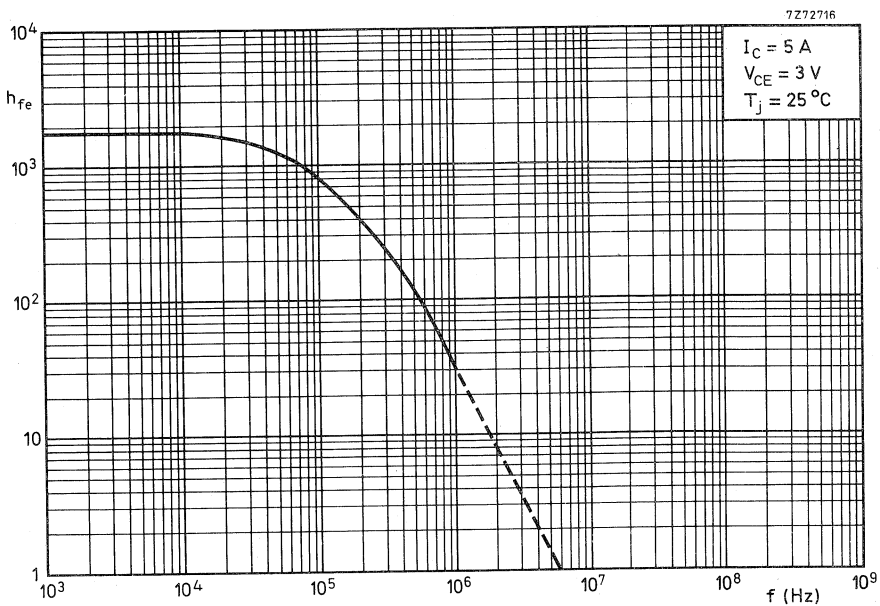


Fig. 17 Typical small-signal current gain for BDX65C.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope. N-P-N complements are BDX67, BDX67A, BDX67B and BDX67C. Matched complementary pairs can be supplied.

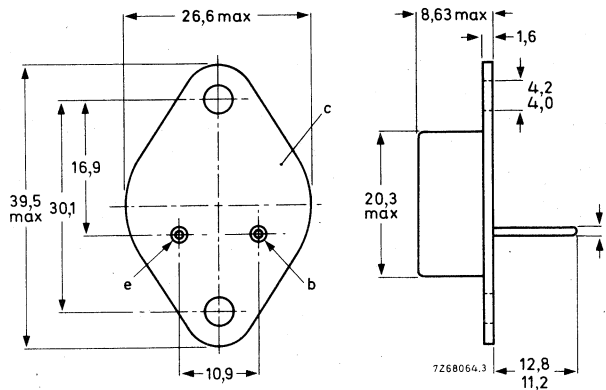
QUICK REFERENCE DATA

		BDX66	66A	66B	66C
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 60	80	100	120 V
Collector current (peak value)	$-I_{CM}$	max.	20		A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	150		W
Junction temperature	T_j	max.	200		$^{\circ}\text{C}$
D.C. current gain					
$-I_C = 1\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}	typ.	2000		
$-I_C = 10\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}	>	1000		
Cut-off frequency					
$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe}	typ.	60		kHz

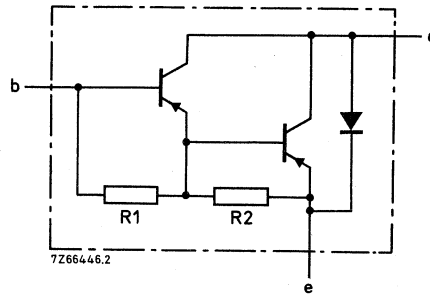
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



See also chapters Mounting instructions and Accessories.



R1 typ. 3 kΩ
R2 typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BDX66	66A	66B	66C
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 60	80	100	120 V
Collector-emitter voltage (open-base)	$-V_{CEO}$	max. 60	80	100	120 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max. 5	5	5	5 V
Collector current (d.c.)	$-I_C$		16		A
Collector current (peak value)	$-I_{CM}$		20		A
Base current	$-I_B$		250		mA
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}		150		W
Storage temperature	T_{stg}		-65 to +200		$^\circ\text{C}$
Junction temperature*	T_j		200		$^\circ\text{C}$

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j-mb}$	=	1,17	$^\circ\text{C/W}$
--------------------------------	----------------	---	------	--------------------

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CB0\max}$

$-I_{CBO} < 1\text{ mA}$

$I_E = 0; -V_{CB} = 40\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX66}$

$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX66A}$

$I_E = 0; -V_{CB} = 60\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX66B}$

$I_E = 0; -V_{CB} = 70\text{ V}; T_j = 20\text{ }^\circ\text{C}; \text{BDX66C}$

$-I_{CBO} < 5\text{ mA}$

$I_B = 0; -V_{CE} = -\frac{1}{2}V_{CE0\max}$

$-I_{CEO} < 3\text{ mA}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$

$-I_{EBO} < 5\text{ mA}$

D.C. current gain *

$-I_C = 1\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 2000$

$-I_C = 10\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} > 1000$

$-I_C = 16\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 1000$

Base-emitter voltage *

$-I_C = 10\text{ A}; -V_{CE} = 3\text{ V}$

$-V_{BE} < 2,5\text{ V}$

Collector-emitter saturation voltage *

$-I_C = 10\text{ A}; -I_B = 40\text{ mA}$

$-V_{CE\text{sat}} < 2\text{ V}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$

$C_C \text{ typ. } 300\text{ pF}$

Cut-off frequency

$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}$

$f_{hfe} \text{ typ. } 60\text{ kHz}$

Small-signal current gain

$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz}$

$h_{fe} \text{ typ. } 50$

D.C. current gain ratio of complementary matched pairs

$-I_C = 10\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE1}/h_{FE2} < 2,5$

Diode, forward voltage

$I_F = 10\text{ A}$

$V_F \text{ typ. } 2\text{ V}$

* Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.

CHARACTERISTICS (continued)

$T_j = 25^\circ\text{C}$ unless otherwise specified
(between 10% and 90% levels)

$-I_{Con} = 10\text{ A}$; $-I_{Bon} = I_{Boff} = 40\text{ mA}$;
turn-on time
turn-off time

t_{on}	typ.	1 μs
t_{off}	typ.	3,5 μs

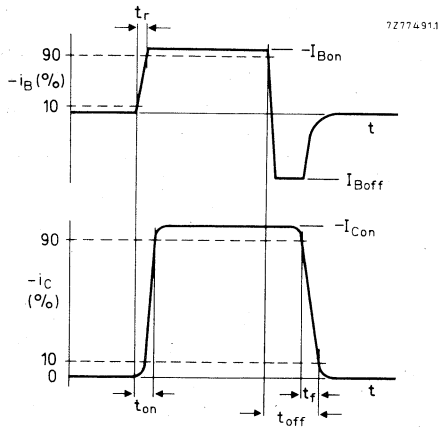


Fig. 3 Switching times waveforms.

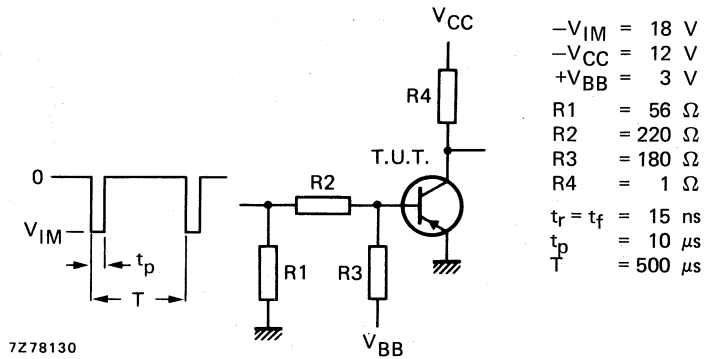


Fig. 4 Switching times test circuit.

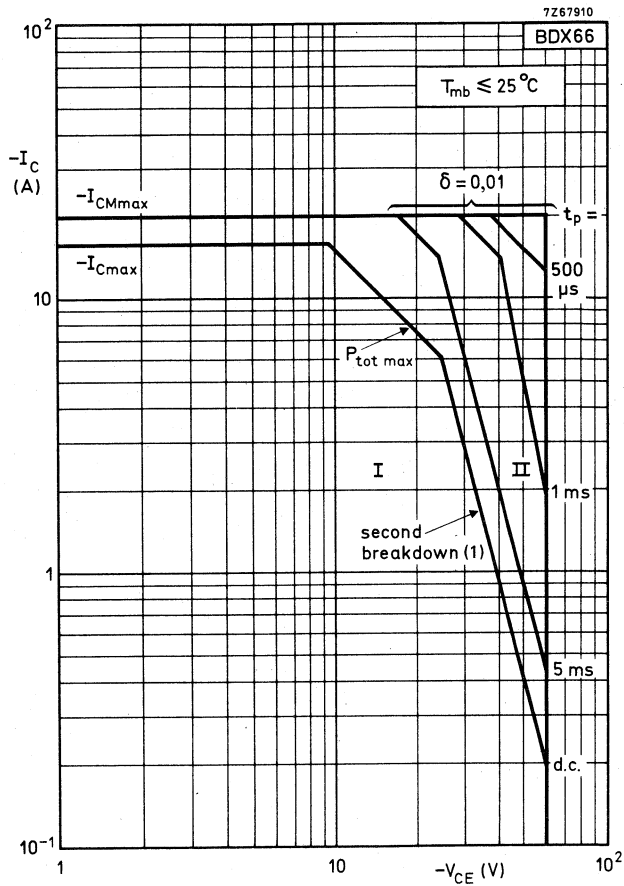


Fig. 5 Safe Operating Area with the transistor forward biased.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) Independent of temperature.

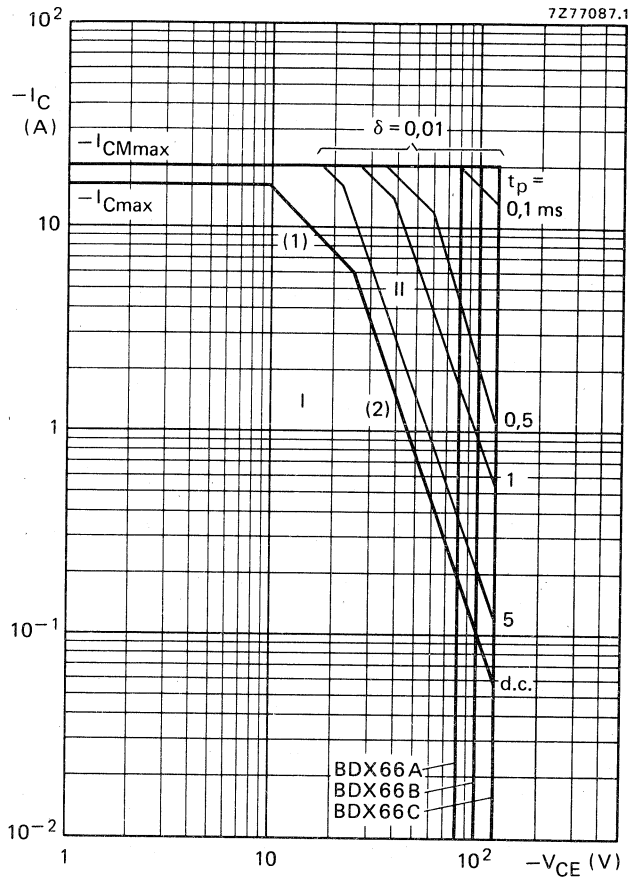


Fig. 6 Safe Operating Area.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot \text{ max}}$ and $P_{tot \text{ peak max}}$ lines.

(2) Second breakdown limits (independent of temperature).

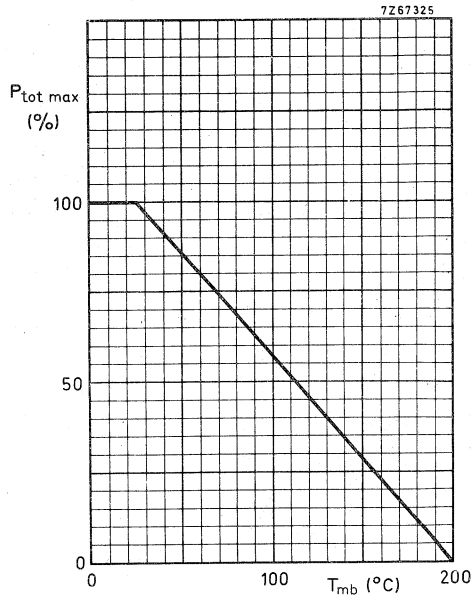


Fig. 7 Power derating curve.

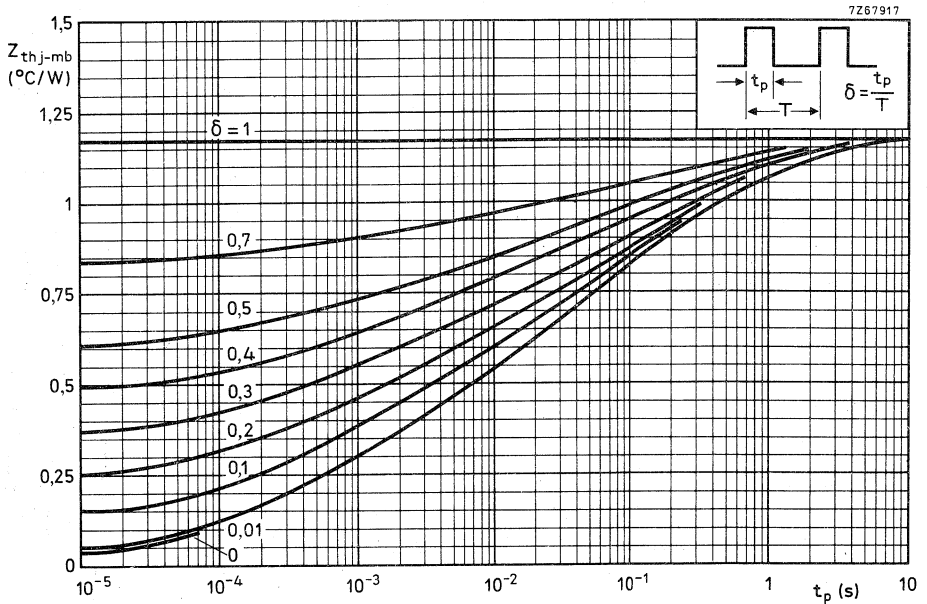


Fig. 8 Pulse power rating chart.

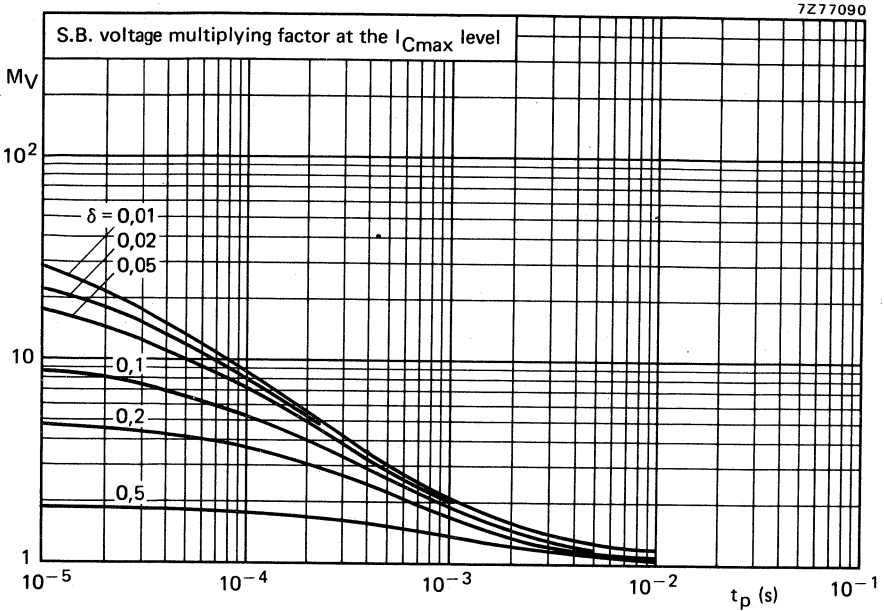


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

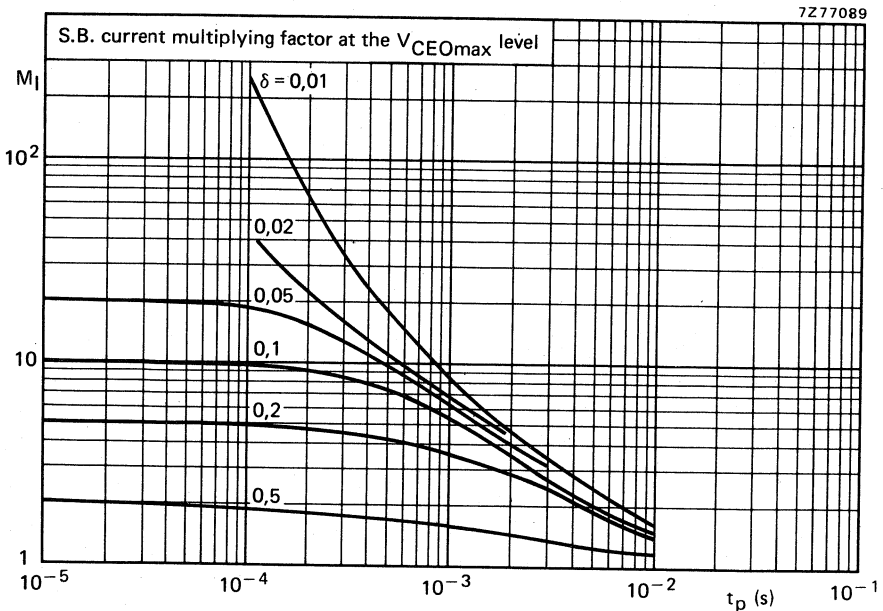


Fig. 10 S.B. current multiplying factor at the V_{CE0max} level.

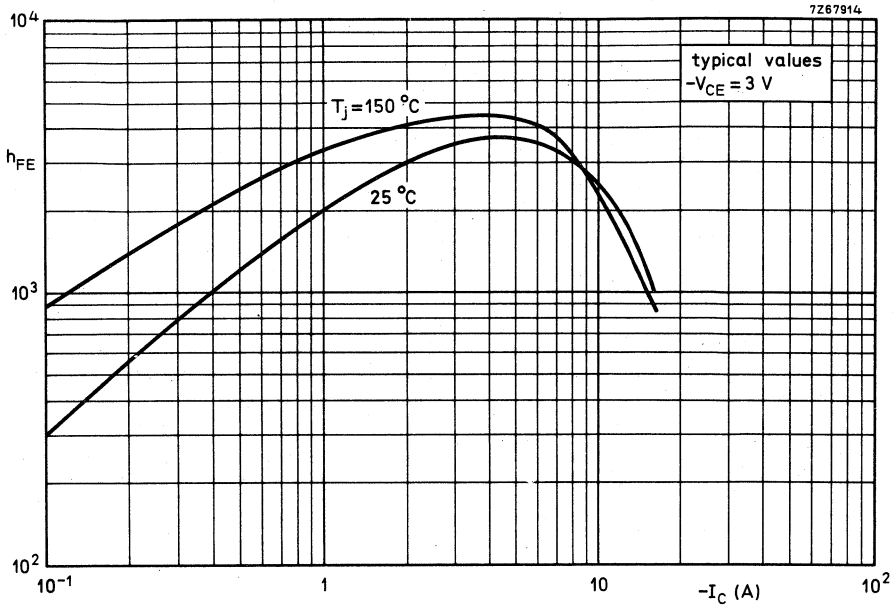


Fig. 11 D.C. current gain.

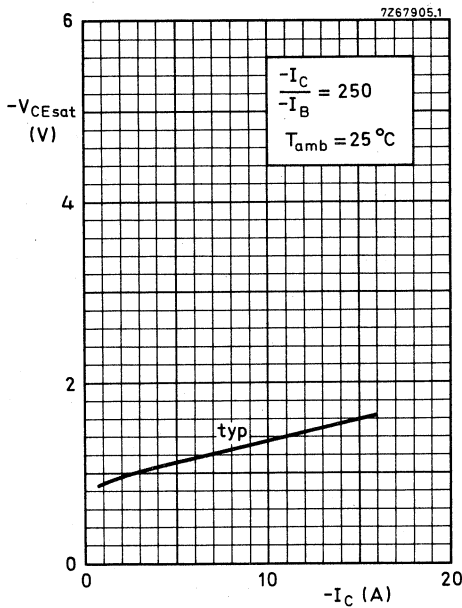


Fig. 12 Collector-emitter saturation voltage.

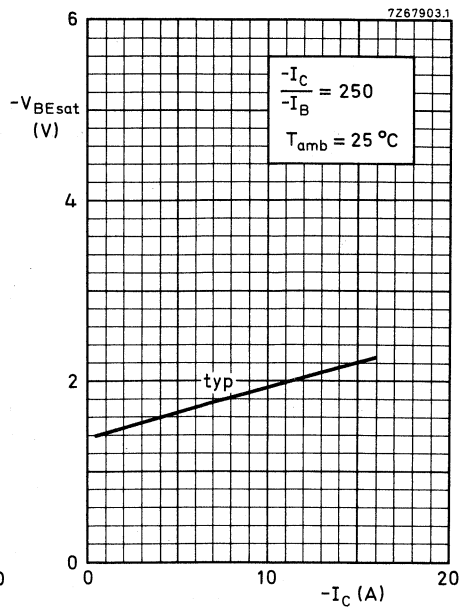


Fig. 13 Base-emitter saturation voltage.

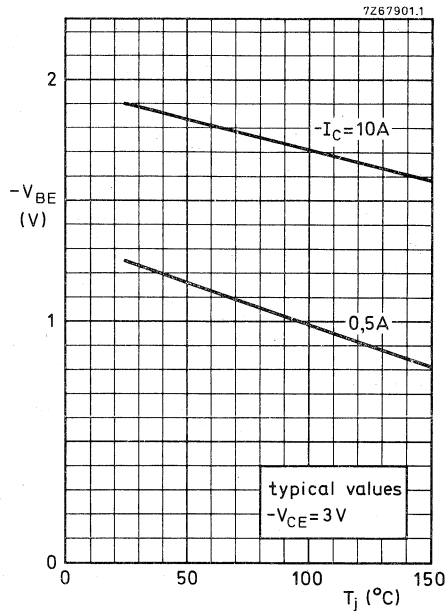


Fig. 14 Typical base-emitter voltage.

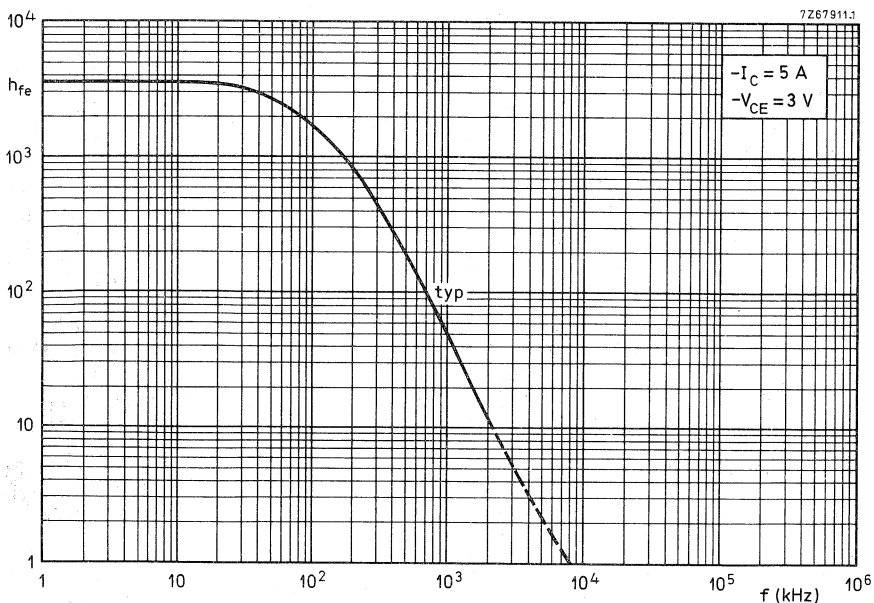


Fig. 15 Small-signal current gain.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope. P-N-P complements are BDX66, BDX66A, BDX66B and BDX66C. Matched complementary pairs can be supplied.

QUICK REFERENCE DATA

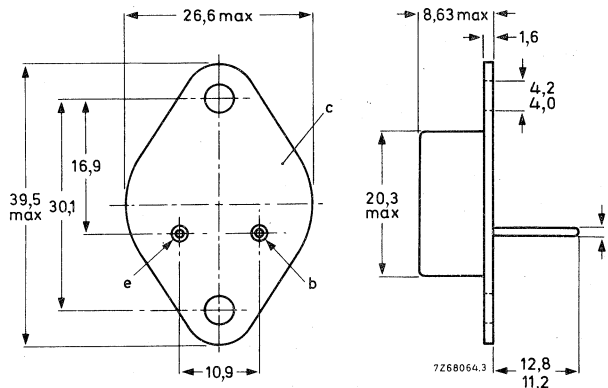
			BDX67	67A	67B	67C
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120 V
Collector current (peak value)	I_{CM}	max.			20	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.			150	W
Junction temperature	T_j	max.			200	$^\circ\text{C}$
D.C. current gain						
$I_C = 1\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	typ.			1350	
$I_C = 10\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	>			1000	
Cut-off frequency						
$I_C = 5\text{ A}; V_{CE} = 3\text{ V}$	f_{hfe}	typ.			50	kHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting instructions and Accessories.

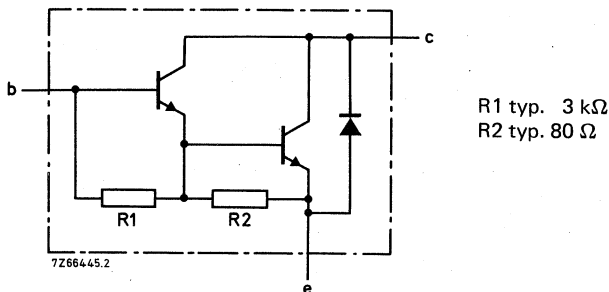


Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BDX67	67A	67B	67C
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120 V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5 V
Collector current (d.c.)	I_C	max.		16		A
Collector current (peak value)	I_{CM}	max.		20		A
Base current (d.c.)	I_B	max.		250		mA
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.		150		W
Storage temperature	T_{stg}			-65 to +200		$^\circ\text{C}$
Junction temperature *	T_j	max.		200		$^\circ\text{C}$

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j-mb}$	=		1,17		$^\circ\text{C/W}$
--------------------------------	----------------	---	--	------	--	--------------------

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = V_{CEOmax}$

$I_{CBO} < 1\text{ mA}$

$I_E = 0; V_{CB} = \frac{1}{2} V_{CBOmax}; T_j = 200\text{ }^\circ\text{C}$

$I_{CBO} < 5\text{ mA}$

$I_B = 0; V_{CE} = \frac{1}{2} V_{CEOmax}$

$I_{CEO} < 3\text{ mA}$

Emitter-cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 5\text{ mA}$

D.C. current gain *

$I_C = 1\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 1350$

$I_C = 10\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} > 1000$

$I_C = 16\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 850$

Base-emitter voltage *

$I_C = 10\text{ A}; V_{CE} = 3\text{ V}$

$V_{BE} < 2,5\text{ V}$

Collector-emitter saturation voltage *

$I_C = 10\text{ A}; I_B = 40\text{ mA}$

$V_{CEsat} < 2\text{ V}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_c \text{ typ. } 300\text{ pF}$

Cut-off frequency

$I_C = 5\text{ A}; V_{CE} = 3\text{ V}$

$f_{hfe} \text{ typ. } 50\text{ kHz}$

Turn-off breakdown energy with inductive load

$-I_{Boff} = 0; I_{Con} = 7,8\text{ A}; \text{ see Fig. 5}$

$E_{(BR)} > 150\text{ mJ}$

Small-signal current gain

$I_C = 5\text{ A}; V_{CE} = 3\text{ V}; f = 1\text{ MHz}$

$h_{fe} \text{ typ. } 20$

D.C. current gain ratio of
complementary matched pairs

$I_C = 10\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE1}/h_{FE2} < 2,5$

Diode, forward voltage

$I_F = 10\text{ A}$

$V_F \text{ typ. } 2,5\text{ V}$

* Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Switching times

(between 10% and 90% levels)

$I_{Con} = 10\text{ A}$; $I_{Bon} = -I_{Boff} = 40\text{ mA}$;

turn-on time

turn-off time

t_{on} typ. $1\text{ }\mu\text{s}$

t_{off} typ. $3,5\text{ }\mu\text{s}$

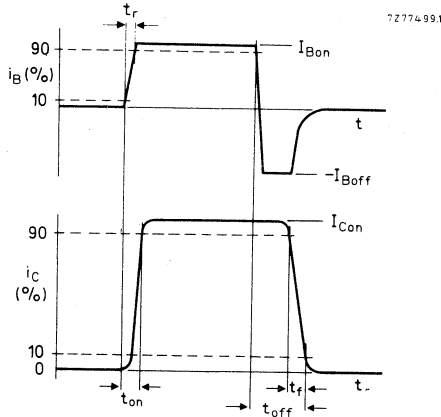


Fig. 3 Switching times waveforms.

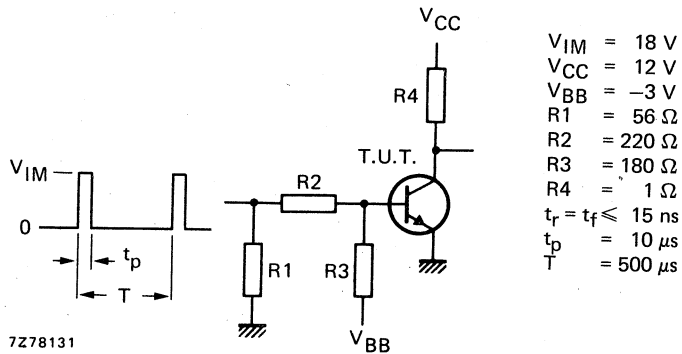


Fig. 4 Switching times test circuit.

CHARACTERISTICS (continued)

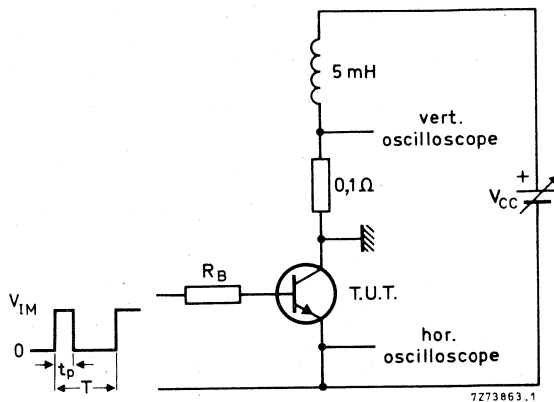


Fig. 5 Test circuit for turn-off breakdown energy. $V_{IM} = 12$ V; $R_B = 270$ Ω ; $I_C = 7,8$ A; $t_p = 1$ ms; $\delta = 1\%$.

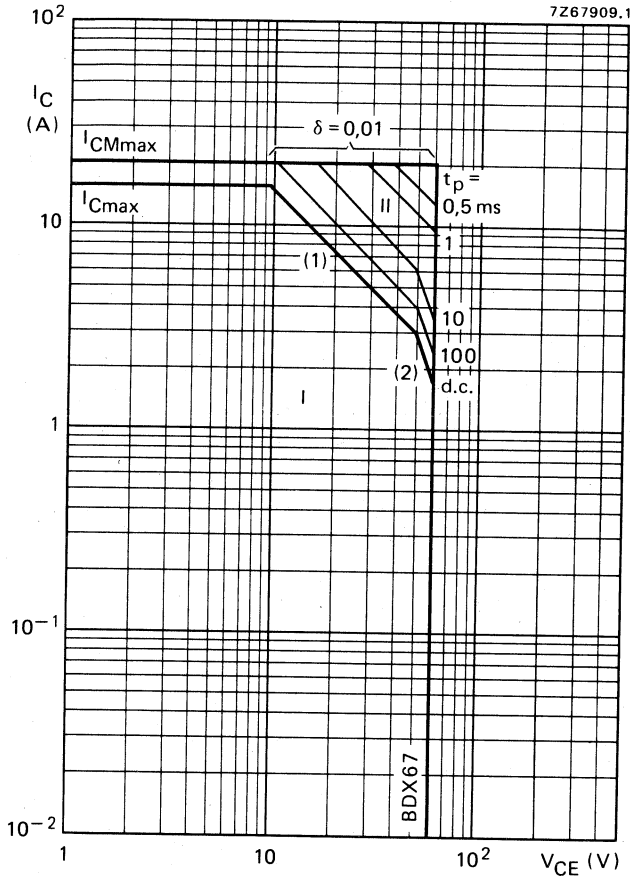


Fig. 6 Safe Operating Area at $T_{mb} = 25^\circ\text{C}$ of BDX67.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) $P_{tot \text{ max}}$ and $P_{tot \text{ peak max}}$ lines.

(2) Second breakdown limits (independent of temperature).

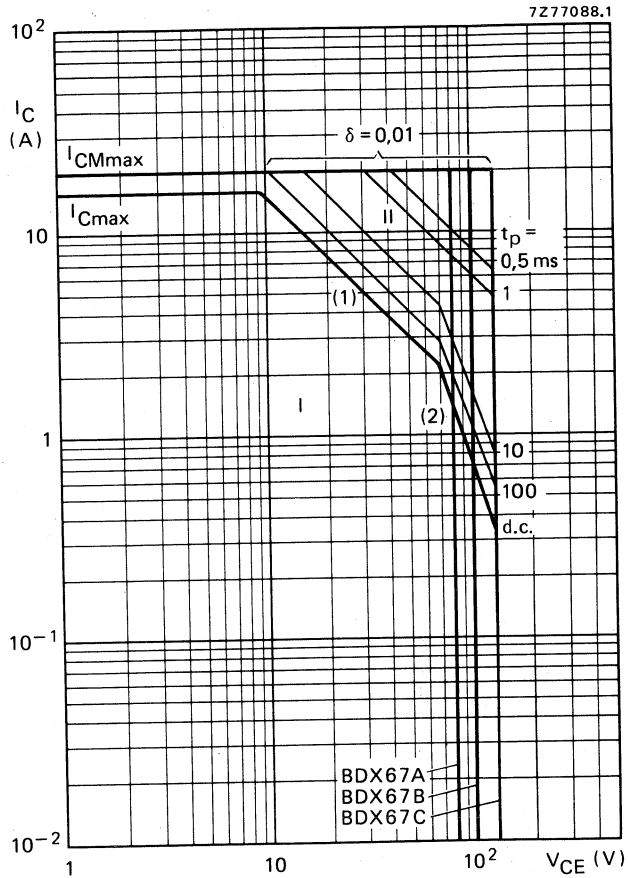


Fig. 7 Safe Operating Area at $T_{mb} = 25^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot \text{ max}}$ and $P_{tot \text{ peak max}}$ lines.
- (2) Second breakdown limits (independent of temperature).

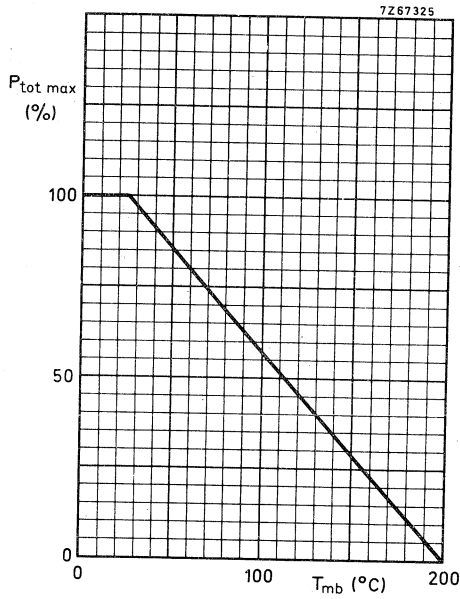


Fig. 8 Power derating curve.

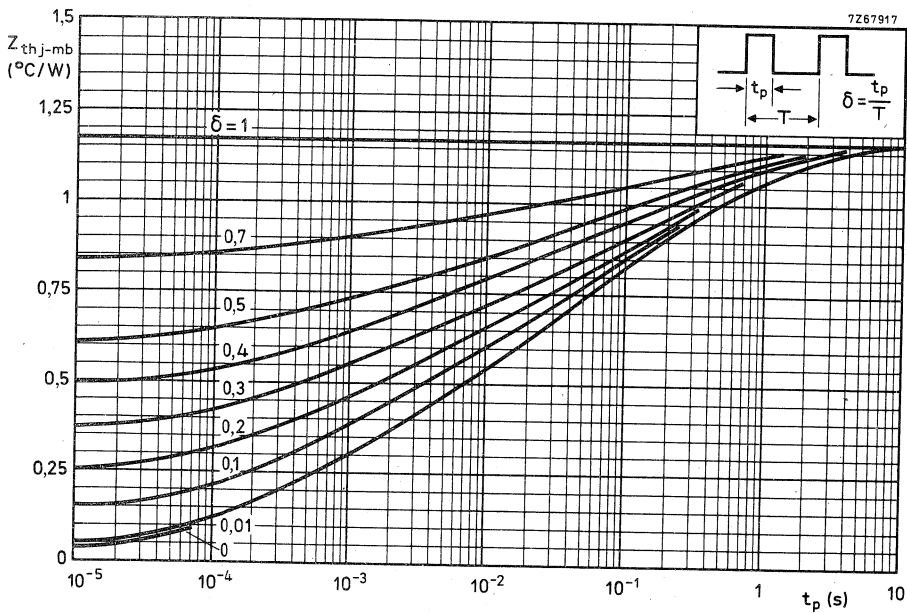


Fig. 9 Pulse power rating chart.

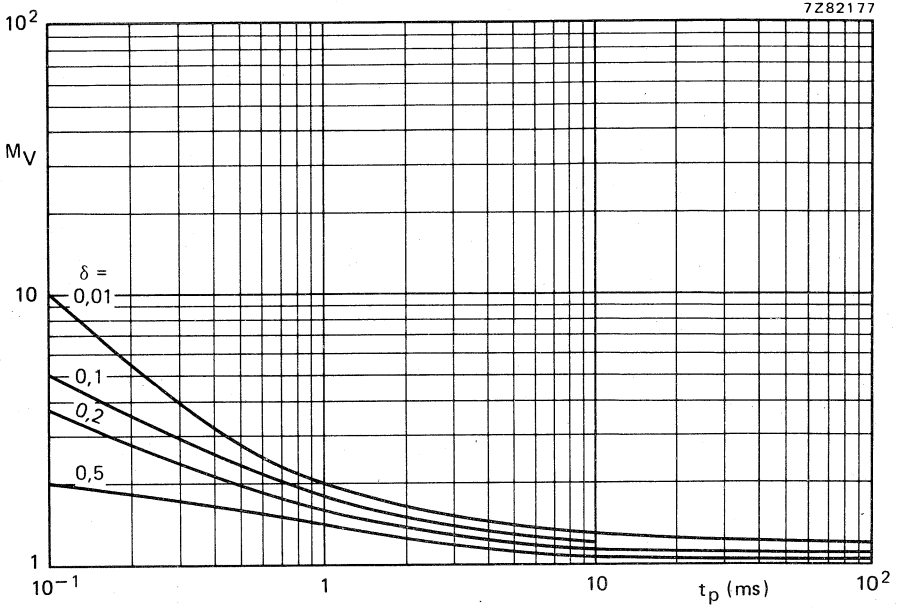


Fig. 10 S.B. voltage multiplying factor at the I_{Cmax} level.

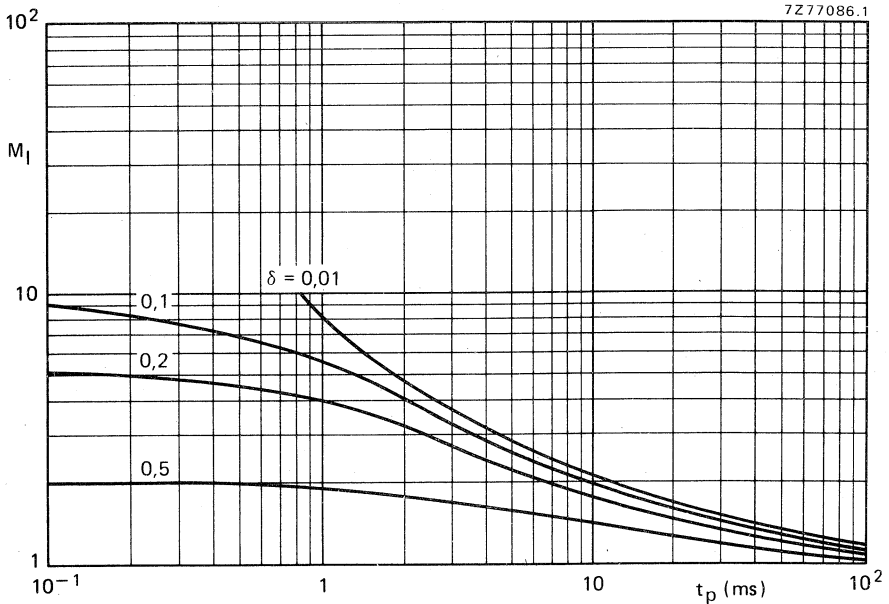


Fig. 11 S.B. current multiplying factor at the V_{CE0max} level.

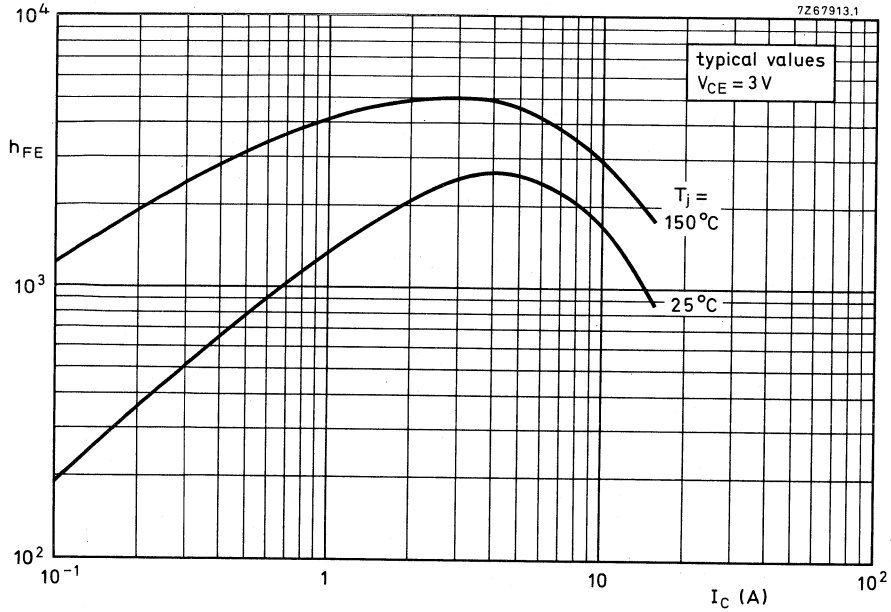


Fig. 12 D.C. current gain.

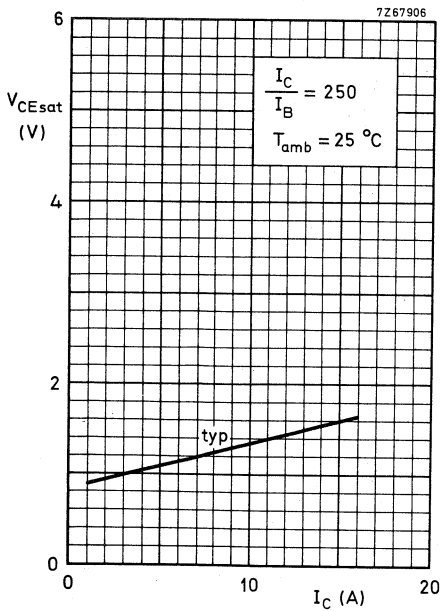


Fig. 13 Collector-emitter saturation voltage.

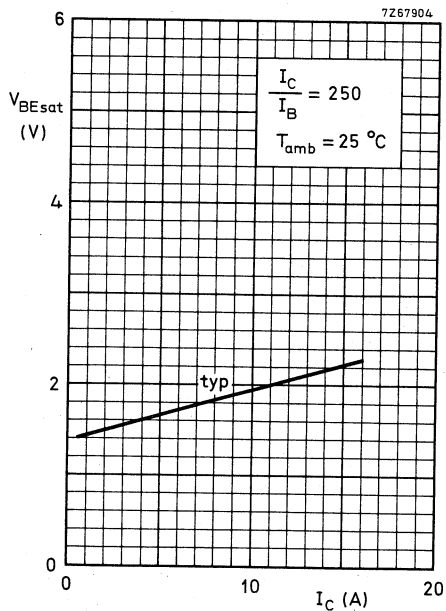


Fig. 14 Base-emitter saturation voltage.

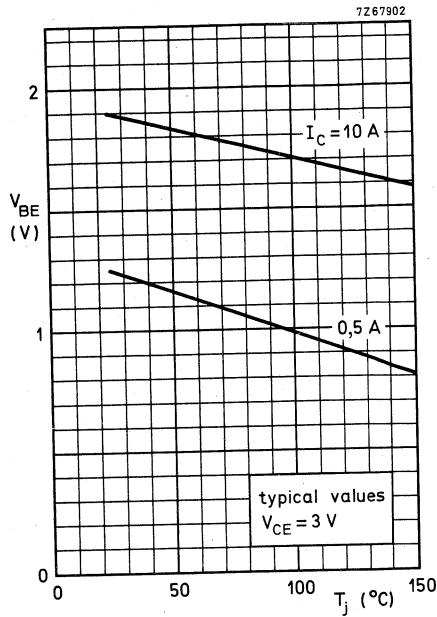


Fig. 15 Typical base-emitter voltage at $I_C = 10\text{ A}$ and $I_C = 0,5\text{ A}$.

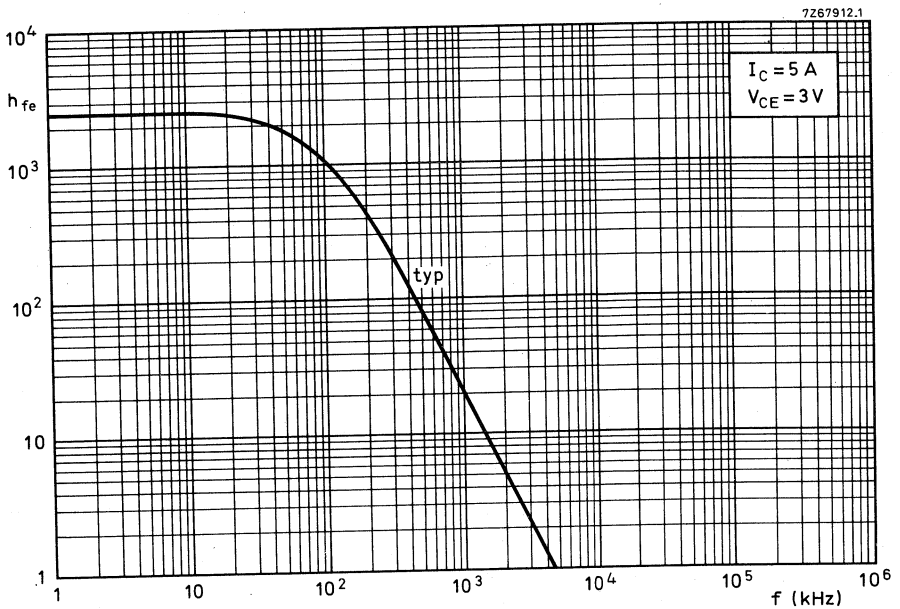


Fig. 16 Small-signal current gain.

SILICON EPITAXIAL-BASE POWER TRANSISTOR

N-P-N transistor in a plastic envelope, intended for industrial amplifier and switching applications. P-N-P complement is BDX78.

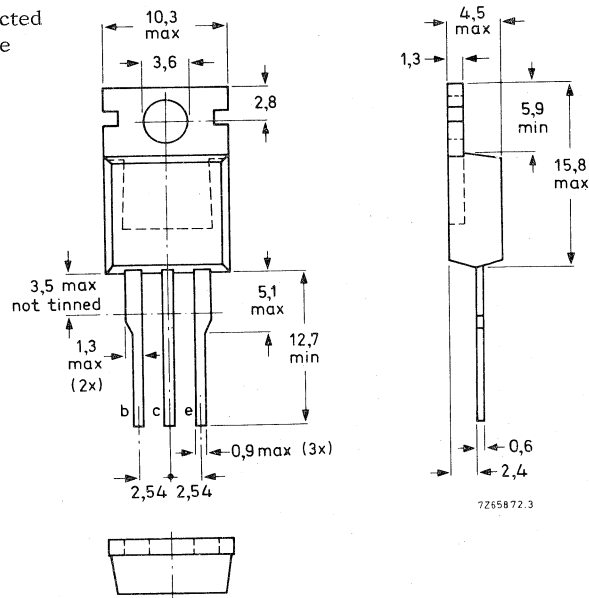
QUICK REFERENCE DATA			
Collector-emitter voltage (open base)	V_{CEO}	max.	80 V
Collector current (d. c.)	I_C	max.	8 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	60 W
D.C. current gain $I_C = 2\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	>	30
Cut-off frequency $I_C = 0,3\text{ A}; V_{CE} = 3\text{ V}$	f_{hfe}	>	25 kHz

MECHANICAL DATA

Dimensions in mm

TO-220

Collector connected
to mounting base



For mounting instructions and accessories see section Accessories.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltage

Collector-base voltage (open emitter)	V_{CBO}	max.	100 V
Collector-emitter voltage (open base)	V_{CEO}	max.	80 V
Emitter-base voltage (open collector)	V_{EBO}	max.	5 V

Current

Collector current (d. c.)	I_C	max.	8 A
Collector current (peak value, $t_p \leq 10$ ms)	I_{CM}	max.	12 A
Collector current (non-repetitive peak value, $t_p \leq 2$ ms)	I_{CSM}	max.	25 A

Temperature

Storage temperature	T_{stg}	-65 to +150	$^{\circ}C$
Junction temperature	T_j	max.	150 $^{\circ}C$

Power dissipation

Total power dissipation up to $T_{mb} = 25$ $^{\circ}C$	P_{tot}	max.	60 W
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THERMAL RESISTANCE

From junction to mounting base	$R_{th j-mb}$	=	2,08 $^{\circ}C/W$
From junction to ambient in free air	$R_{th j-a}$	=	70 $^{\circ}C/W$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_B = 0; V_{CE} = 30\text{ V}$

$I_{CEO} < 1\text{ mA}$

$I_E = 0; V_{CB} = 40\text{ V}; T_j = 150\text{ }^\circ\text{C}$

$I_{CBO} < 1\text{ mA}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 5\text{ mA}$

Base-emitter voltage ¹⁾

$I_C = 3\text{ A}; V_{CE} = 2\text{ V}$

$V_{BE} < 1,5\text{ V}$

Knee voltage ¹⁾

$I_C = 3\text{ A}; I_B = \text{value for which}$

$I_C = 3,3\text{ A at } V_{CE} = 2\text{ V}$

$V_{CEK} \text{ typ. } 1\text{ V}$

Saturation voltage ¹⁾

$I_C = 3\text{ A}; I_B = 0,3\text{ A}$

$V_{CEsat} < 1\text{ V}$

D.C. current gain ¹⁾

$I_C = 2\text{ A}; V_{CE} = 2\text{ V}$

$h_{FE} > 30$

Cut-off frequency

$I_C = 0,3\text{ A}; V_{CE} = 3\text{ V}$

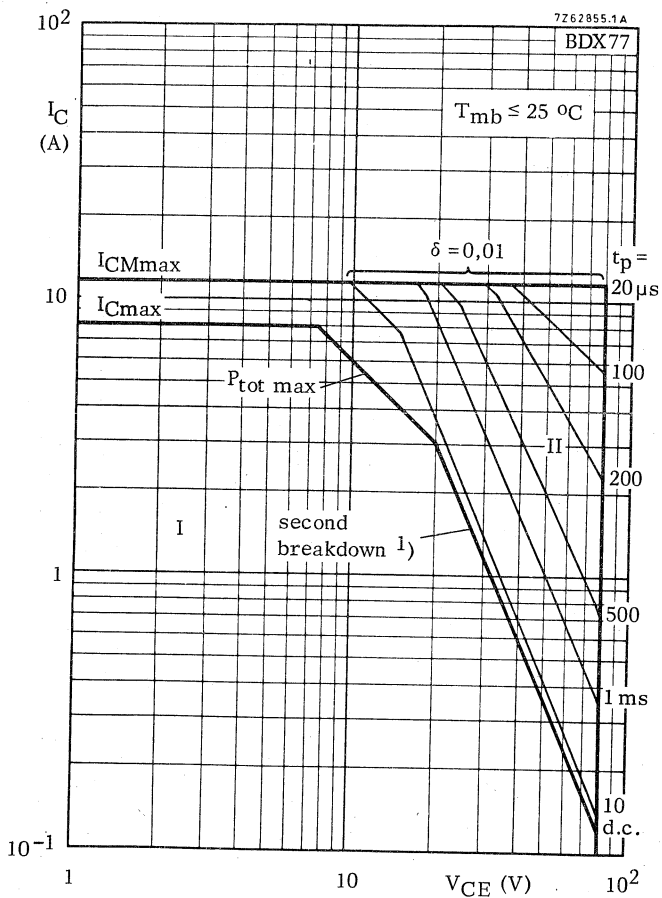
$f_{hfe} > 25\text{ kHz}$

Transition frequency at $f = 1\text{ MHz}$

$-I_E = 0,3\text{ A}; V_{CB} = 3\text{ V}$

$f_T > 3\text{ MHz}$

¹⁾ Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.

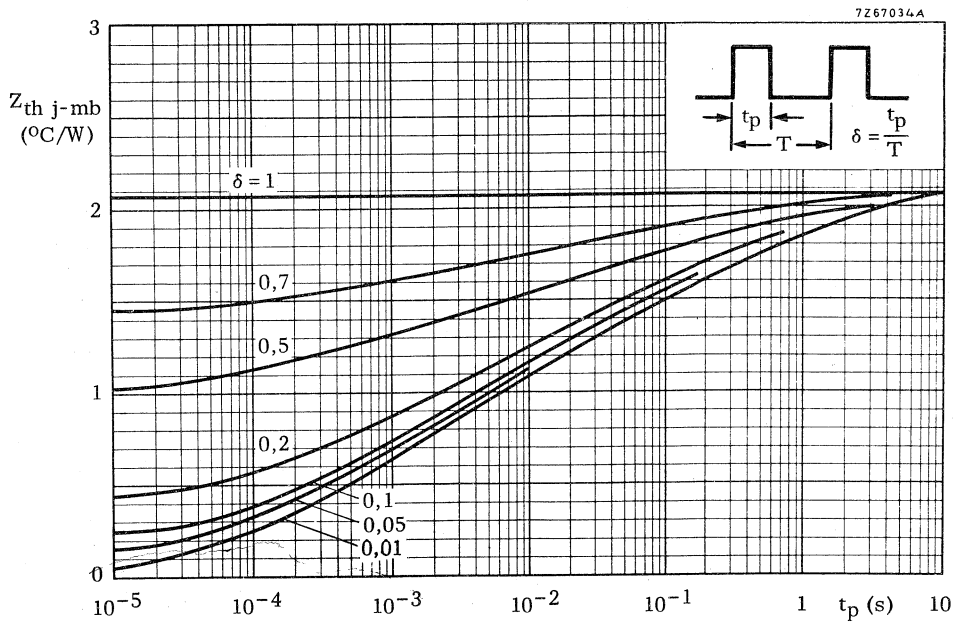
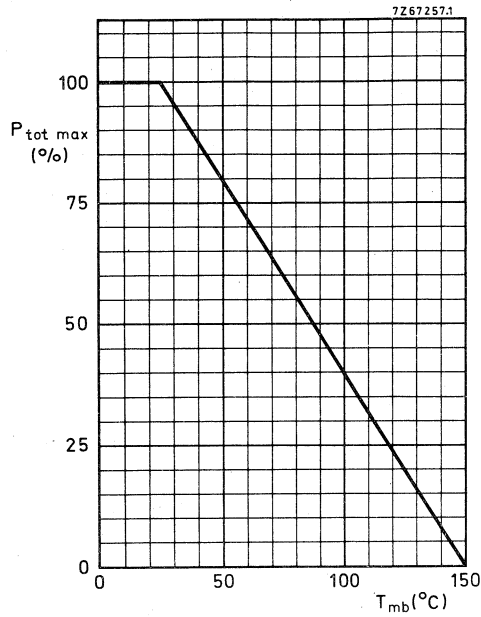


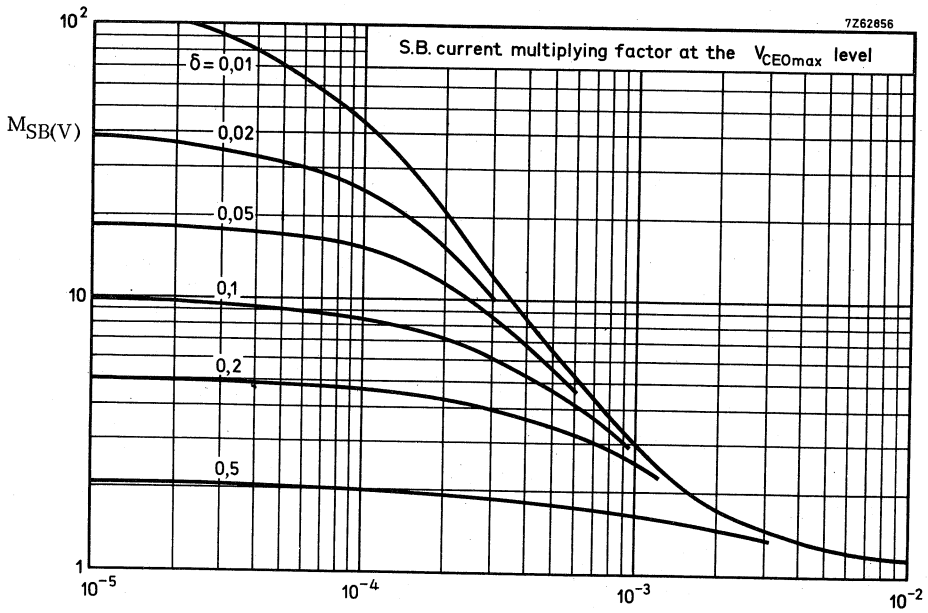
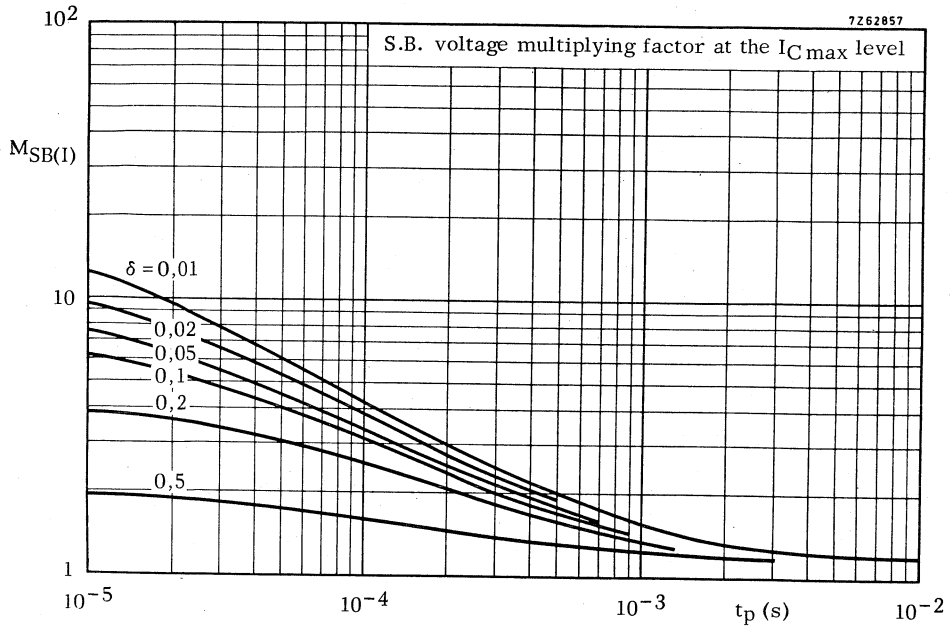
Safe Operating Area with the transistor forward biased

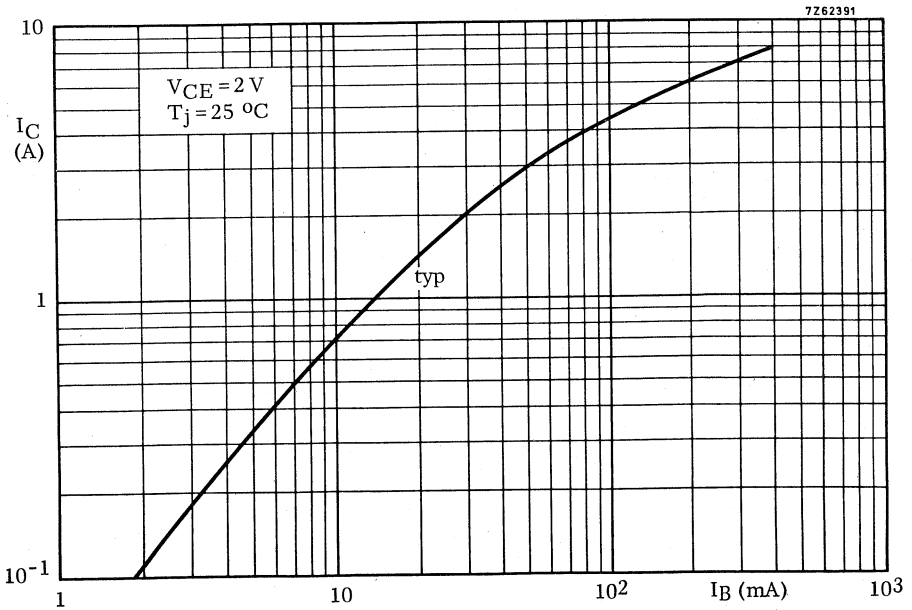
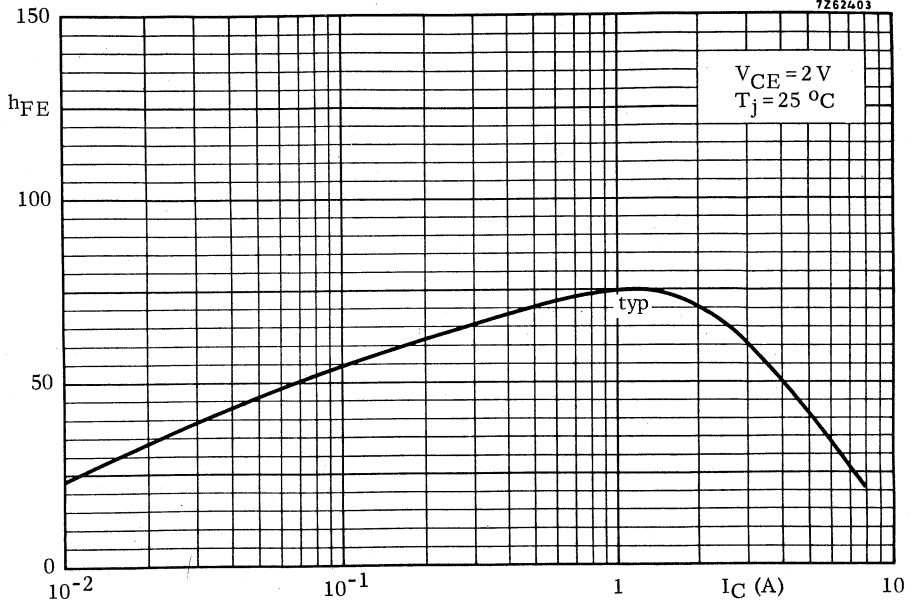
I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

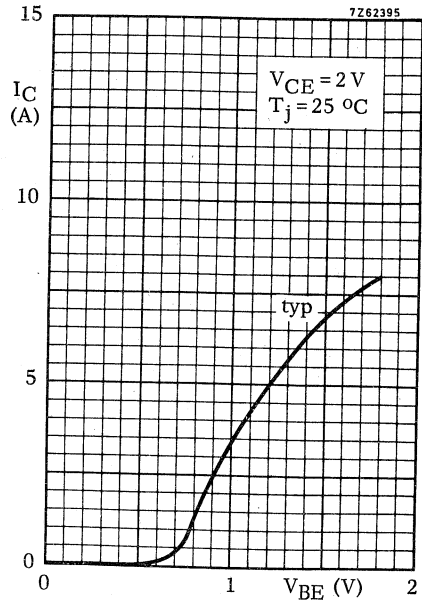
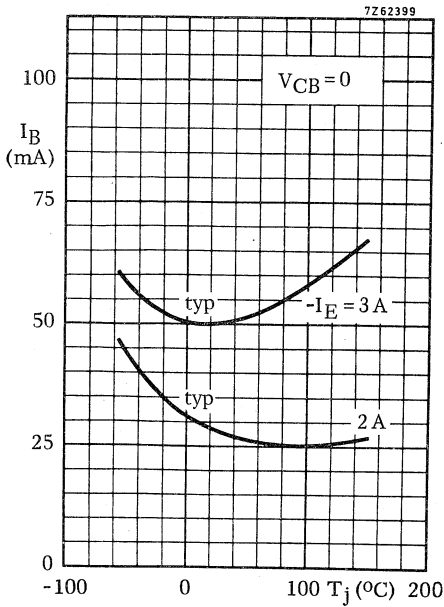
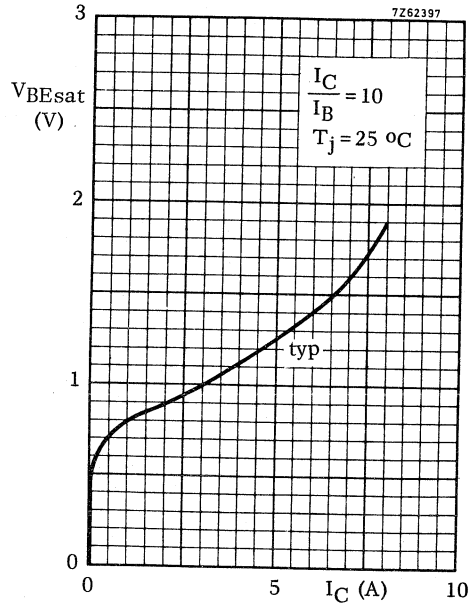
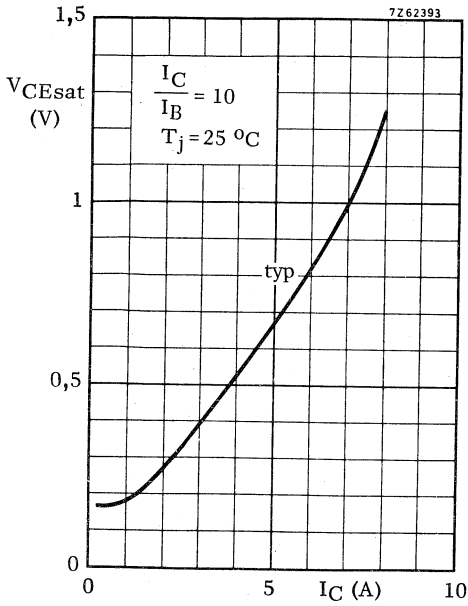
¹⁾ Independent of temperature.

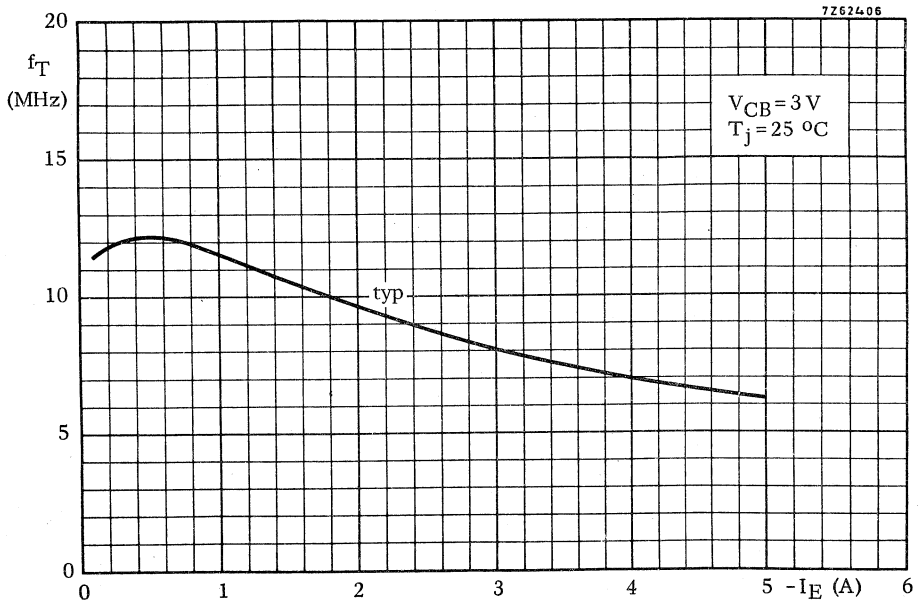
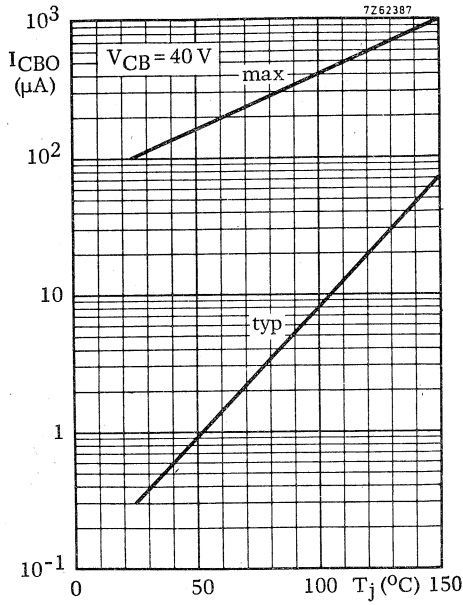






BDX77





SILICON EPITAXIAL-BASE POWER TRANSISTOR

P-N-P transistor in a plastic envelope, intended for industrial amplifier and switching applications. N-P-N complement BDX77.

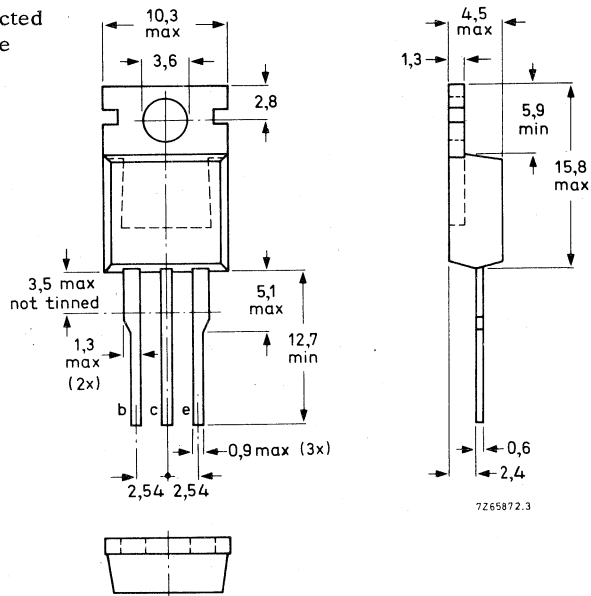
QUICK REFERENCE DATA			
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	80 V
Collector current (d. c.)	$-I_C$	max.	8 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	60 W
D. C. current gain $-I_C = 2\text{ A}; -V_{CE} = 2\text{ V}$	h_{FE}	>	30
Cut-off frequency $-I_C = 0,3\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe}	>	25 kHz

MECHANICAL DATA

Dimensions in mm

TO-220

Collector connected to mounting base



For mounting instructions and accessories see section Accessories.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltage

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	80 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V

Current

Collector current (d. c.)	$-I_C$	max.	8 A
Collector current (peak value, $t_p \leq 10$ ms)	$-I_{CM}$	max.	12 A
Collector current (non-repetitive peak value, $t_p \leq 2$ ms)	$-I_{CSM}$	max.	25 A

Temperature

Storage temperature	T_{stg}	-65 to +150	$^{\circ}C$
Junction temperature	T_j	max.	150 $^{\circ}C$

Power dissipation

Total power dissipation up to $T_{mb} = 25$ $^{\circ}C$	P_{tot}	max.	60 W
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THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	2,08 $^{\circ}C/W$
From junction to mounting base in free air	$R_{th\ j-a}$	=	70 $^{\circ}C/W$

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$I_B = 0; -V_{CE} = 30\text{ V}$

$-I_{CEO} < 1\text{ mA}$

$I_E = 0; -V_{CB} = 40\text{ V}; T_j = 150\text{ }^\circ\text{C}$

$-I_{CBO} < 1\text{ mA}$

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$

$-I_{EBO} < 5\text{ mA}$

Base-emitter voltage ¹⁾

$-I_C = 3\text{ A}; -V_{CE} = 2\text{ V}$

$-V_{BE} < 1,5\text{ V}$

Knee voltage ¹⁾

$-I_C = 3\text{ A}; -I_B = \text{value at which}$

$-I_C = 3,3\text{ A at } -V_{CE} = 2\text{ V}$

$-V_{CEK} \text{ typ. } 1\text{ V}$

Saturation voltage ¹⁾

$-I_C = 3\text{ A}; -I_B = 0,3\text{ A}$

$-V_{CEsat} < 1\text{ V}$

D.C. current gain ¹⁾

$-I_C = 2\text{ A}; -V_{CE} = 2\text{ V}$

$h_{FE} > 30$

Cut-off frequency

$-I_C = 0,3\text{ A}; -V_{CE} = 3\text{ V}$

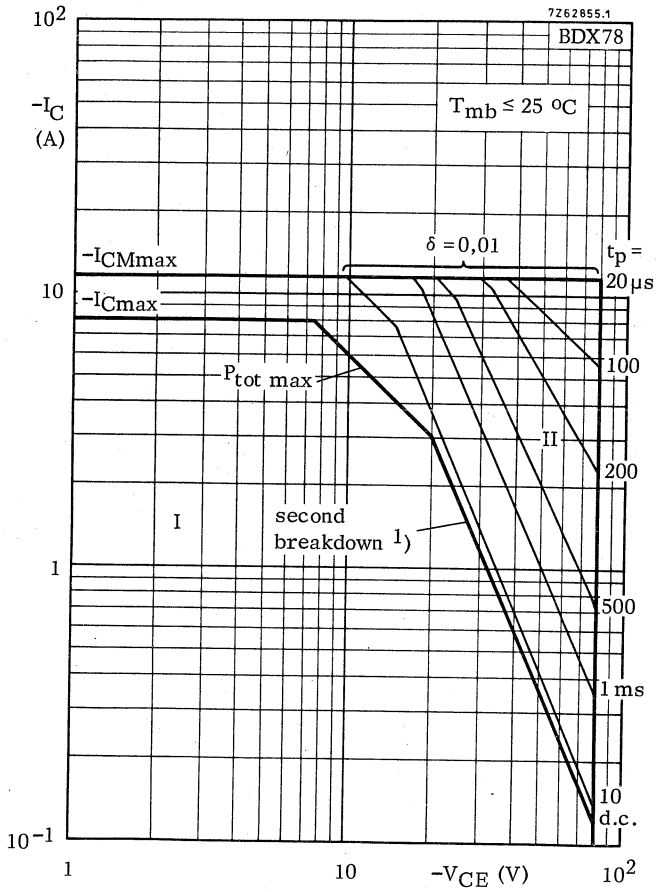
$f_{hfe} > 25\text{ kHz}$

Transition frequency at $f = 1\text{ MHz}$

$I_E = 0,3\text{ A}; -V_{CB} = 3\text{ V}$

$f_T > 3\text{ MHz}$

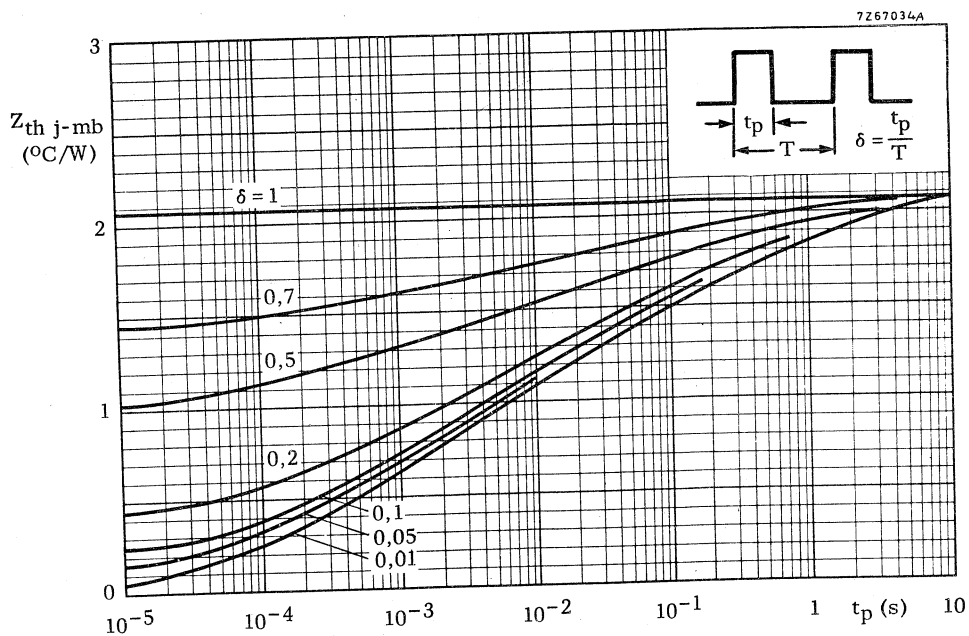
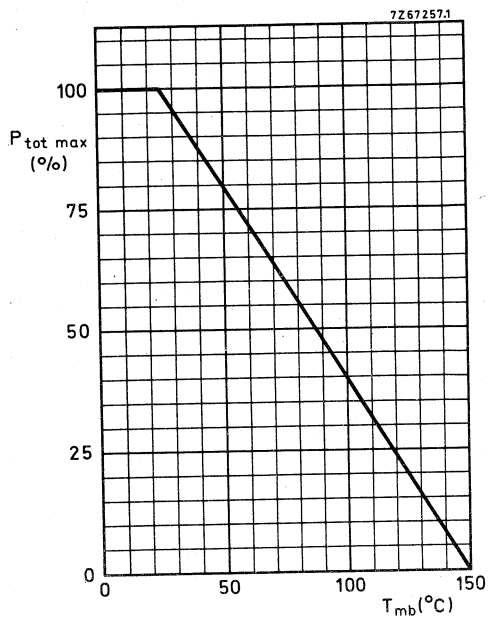
¹⁾ Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.

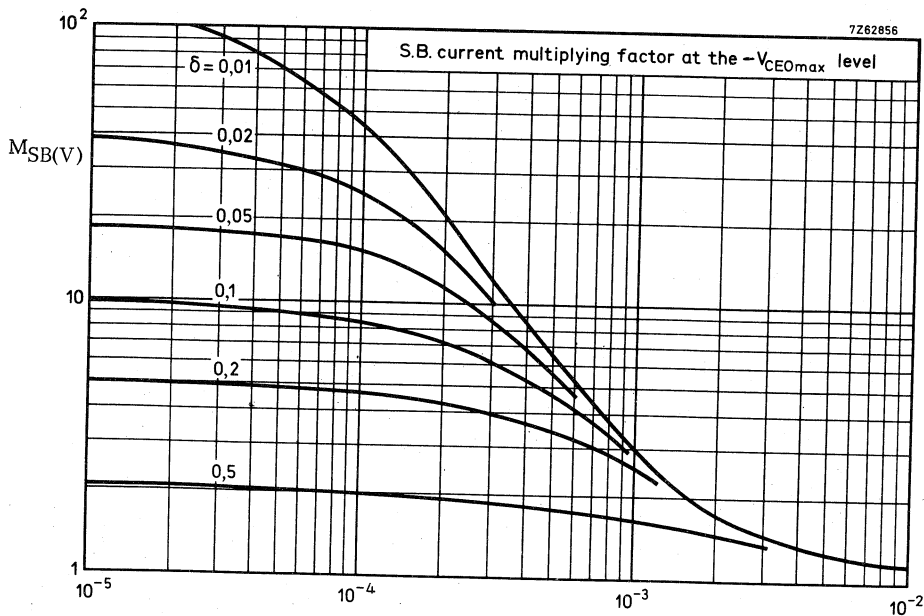
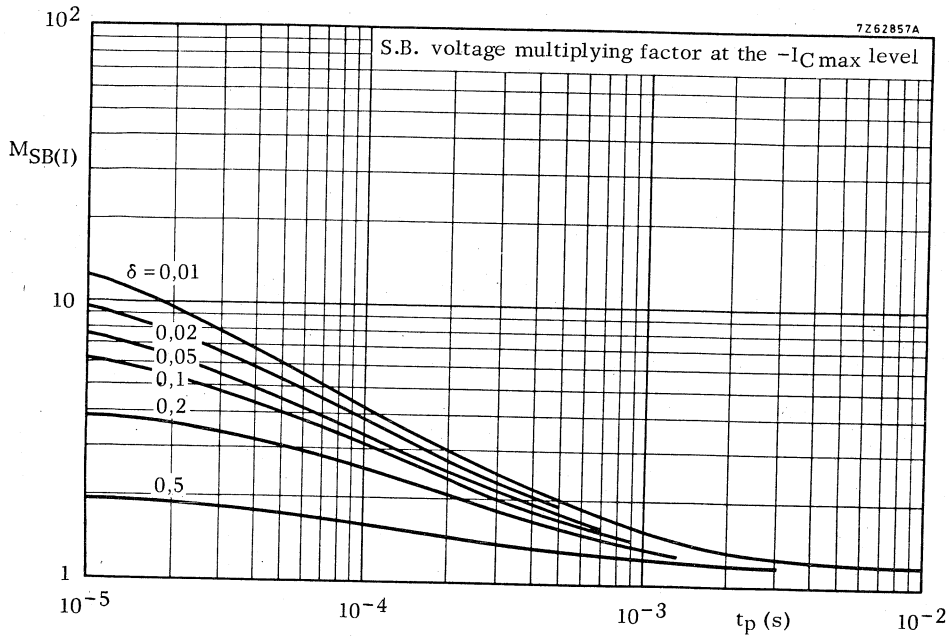


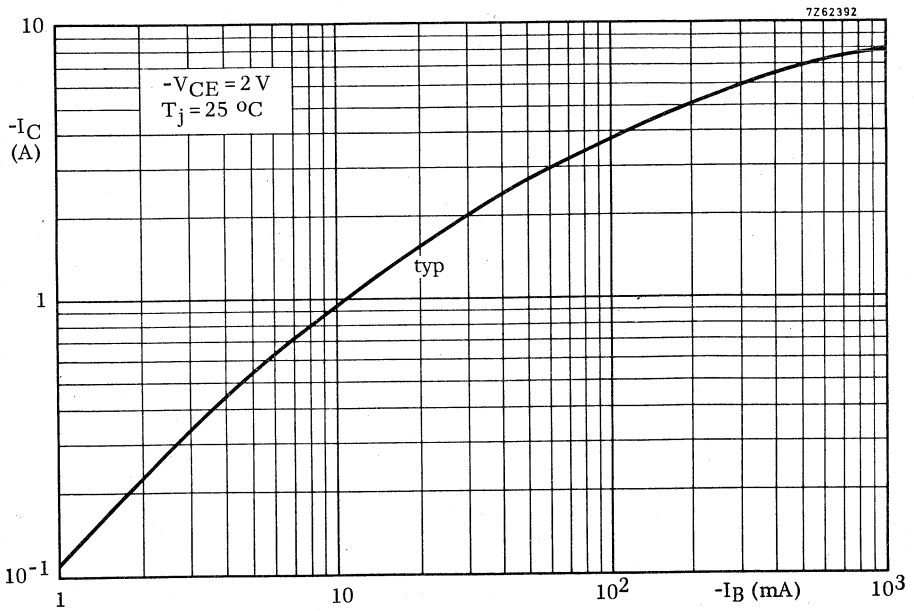
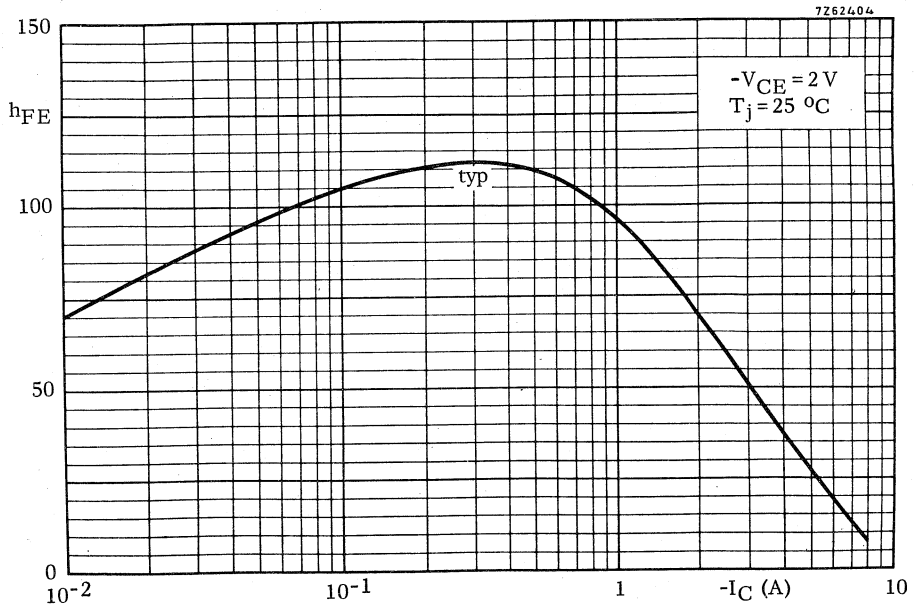
Safe Operating Area with the transistor forward biased

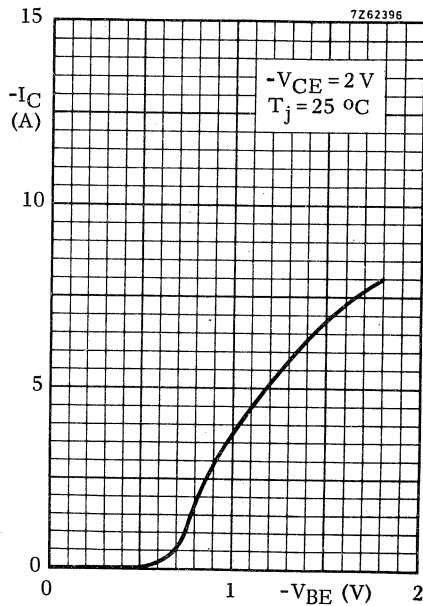
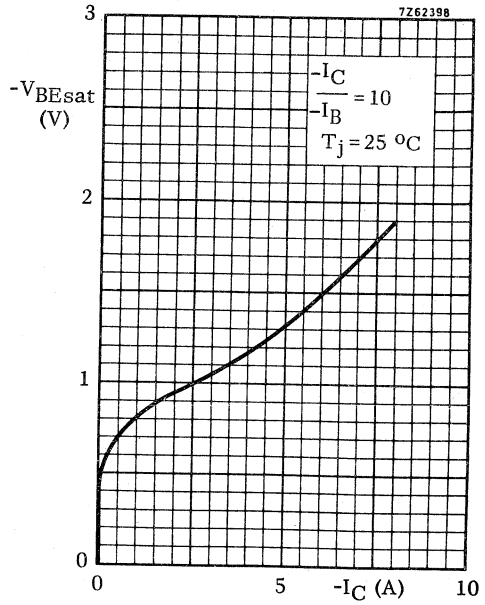
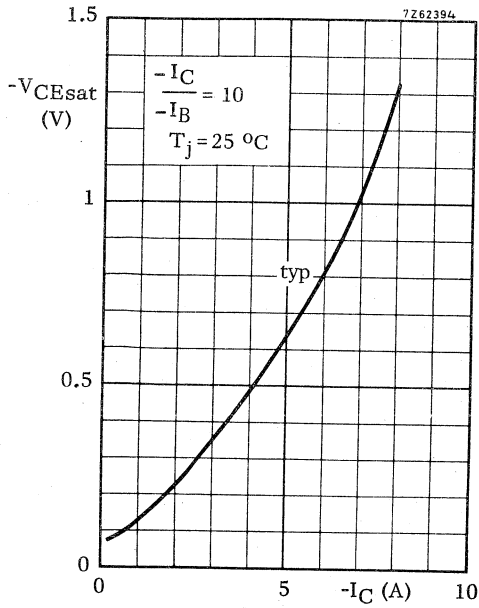
- I Region of permissible d. c. operation
- II Permissible extension for repetitive pulse operation

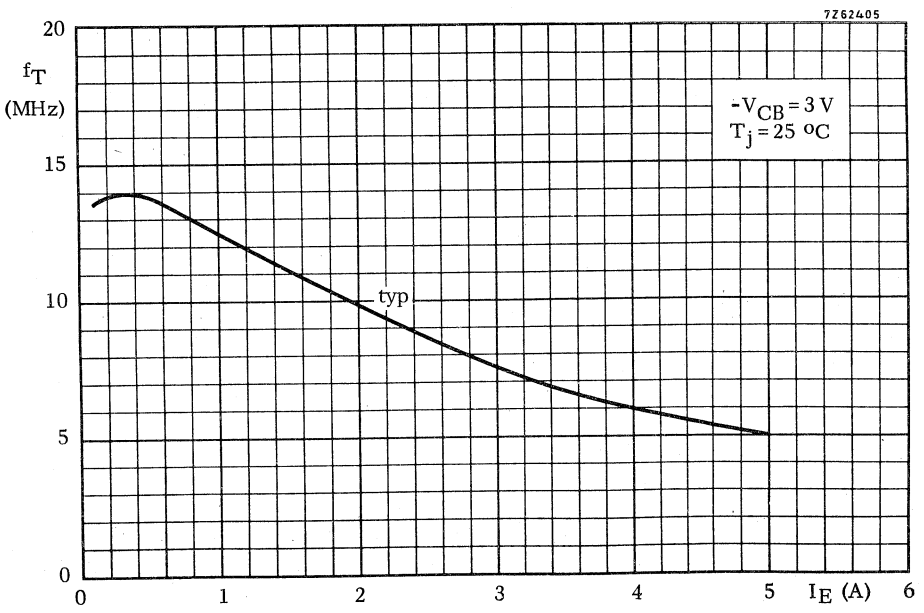
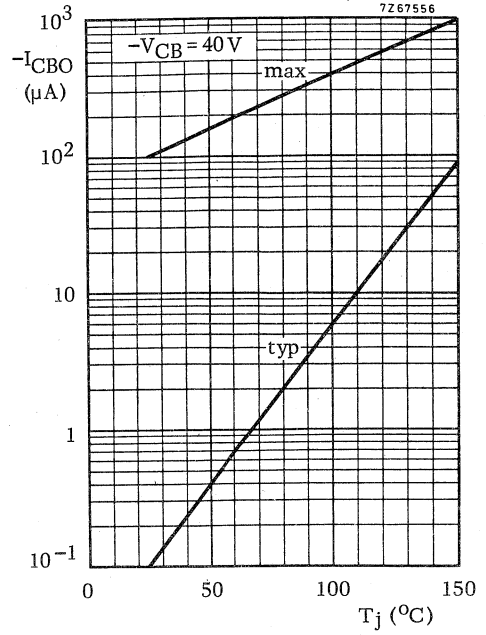
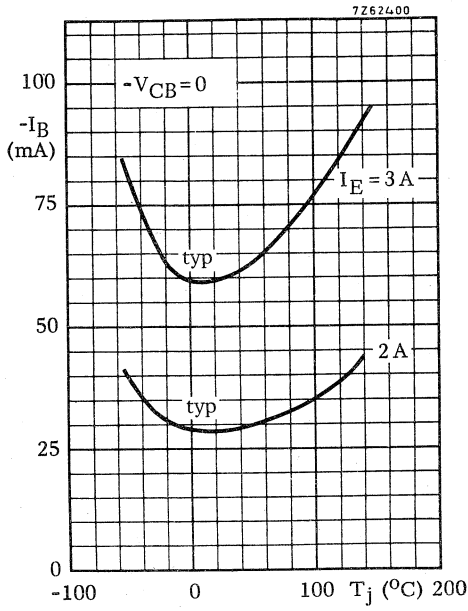
1) Independent of temperature.











SILICON POWER TRANSISTORS

N-P-N transistors in TO-3 envelope for audio output stages and general amplifier and switching applications. P-N-P complements are BDX92, BDX94 and BDX96.

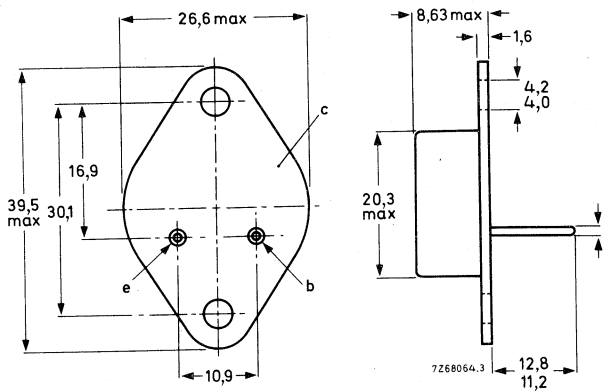
QUICK REFERENCE DATA						
			BDX91	BDX93	BDX95	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (peak value)	I_{CM}	max.	12			A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	90			W
Junction temperature	T_j	max.	200			$^{\circ}\text{C}$
D.C. current gain $I_C = 3\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	>	20			
Transition frequency $I_C = 1\text{ A}; V_{CE} = 10\text{ V}$	f_T	>	4			MHz

MECHANICAL DATA

Dimensions in mm

TO-3

Collector connected to envelope



For mounting instructions and accessories see section Accessories.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

		BDX91	BDX93	BDX95	
Collector-base voltage (open emitter)	V_{CBO} max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO} max.	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO} max.	5	5	5	V

Currents

Collector current (d.c.)	I_C max.		8		A
Collector current (peak value)	I_{CM} max.		12		A

Power dissipation

Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.		90		W
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Temperatures

Storage temperature	T_{stg}		-65 to +200		$^\circ\text{C}$
Junction temperature	T_j max.		200		$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb} =$		1,94		$^\circ\text{C/W}$
--------------------------------	------------------	--	------	--	--------------------

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

CHARACTERISTICS

Collector cut-off current

$I_E = 0; V_{CB} = V_{CB0max}$

$I_{CBO} < 0,1\text{ mA}$

$I_E = 0; V_{CB} = 30\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX91}$

$I_E = 0; V_{CB} = 40\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX93}$

$I_E = 0; V_{CB} = 50\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX95}$

$I_{CBO} < 2\text{ mA}$

$I_B = 0; V_{CE} = V_{CEOmax}$

$I_{CEO} < 1\text{ mA}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 1\text{ mA}$

D.C. current gain ¹⁾

$I_C = 3\text{ A}; V_{CE} = 2\text{ V}$

$h_{FE} > 20$

$I_C = 5\text{ A}; V_{CE} = 2\text{ V}$

$h_{FE} > 10$

Base-emitter voltage ¹⁾

$I_C = 3\text{ A}; V_{CE} = 2\text{ V}$

$V_{BE} < 1,4\text{ V}$

Collector-emitter saturation voltage ¹⁾

$I_C = 3\text{ A}; I_B = 0,3\text{ A}$

$V_{CEsat} < 0,8\text{ V}$

$I_C = 5\text{ A}; I_B = 1\text{ A}$

$V_{CEsat} < 1\text{ V}$

Base-emitter saturation voltage ¹⁾

$I_C = 3\text{ A}; I_B = 0,3\text{ A}$

$V_{BEsat} < 1,5\text{ V}$

$I_C = 5\text{ A}; I_B = 1\text{ A}$

$V_{BEsat} < 2\text{ V}$

Small-signal current gain at $f = 1\text{ kHz}$

$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$

$h_{fe} > 40$

Transition frequency

$I_C = 1\text{ A}; V_{CE} = 10\text{ V}$

$f_T > 4\text{ MHz}$

¹⁾ Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Switching times (between 10% and 90% levels)

$I_{Con} = 3\text{ A}; I_{Bon} = -I_{Boff} = 0,3\text{ A}; V_{CC} = 30\text{ V}$

→ Turn-on time

t_{on} typ. 0,2 μs
 < 1 μs

→ Turn-off time

t_{off} typ. 1,2 μs
 < 2 μs

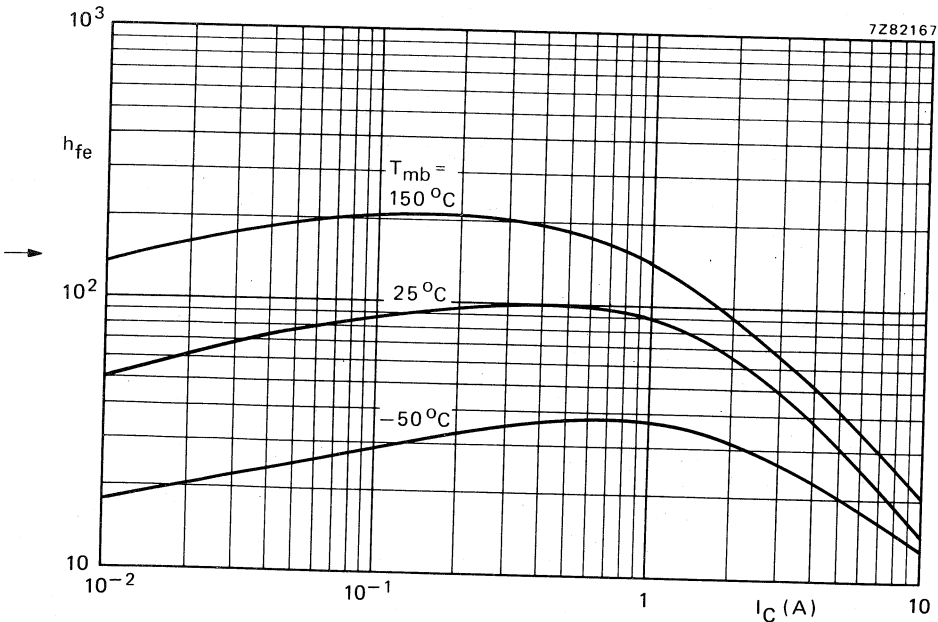
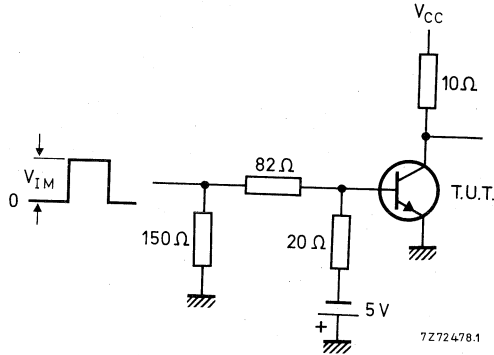
Test circuit

$V_{IM} = 55\text{ V}$

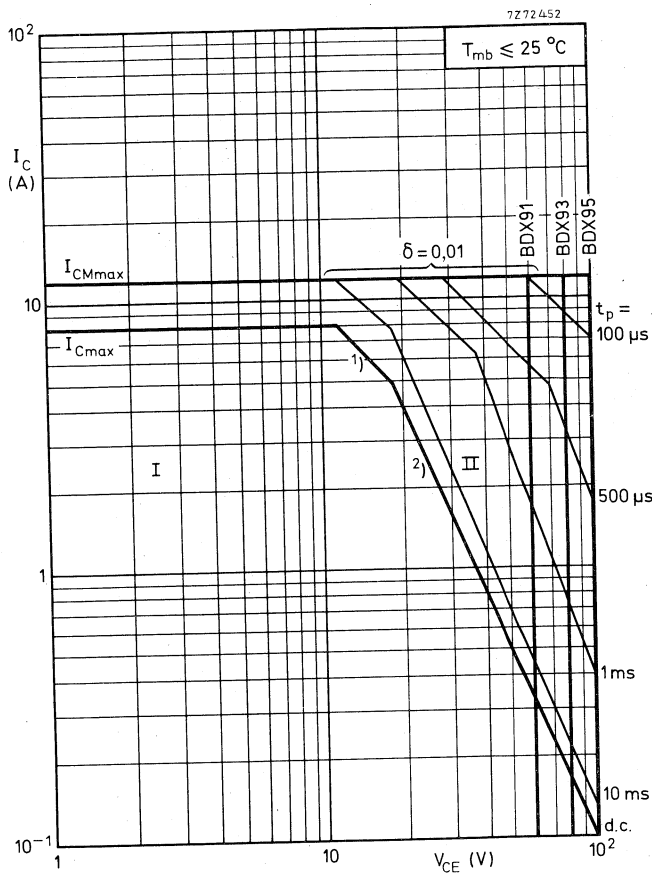
$t_r = t_f = 15\text{ ns}$

$t_p = 10\text{ } \mu\text{s}$

$T = 500\text{ } \mu\text{s}$



Typical small-signal current gain as a function of collector current; $V_{CE} = 2\text{ V}$.



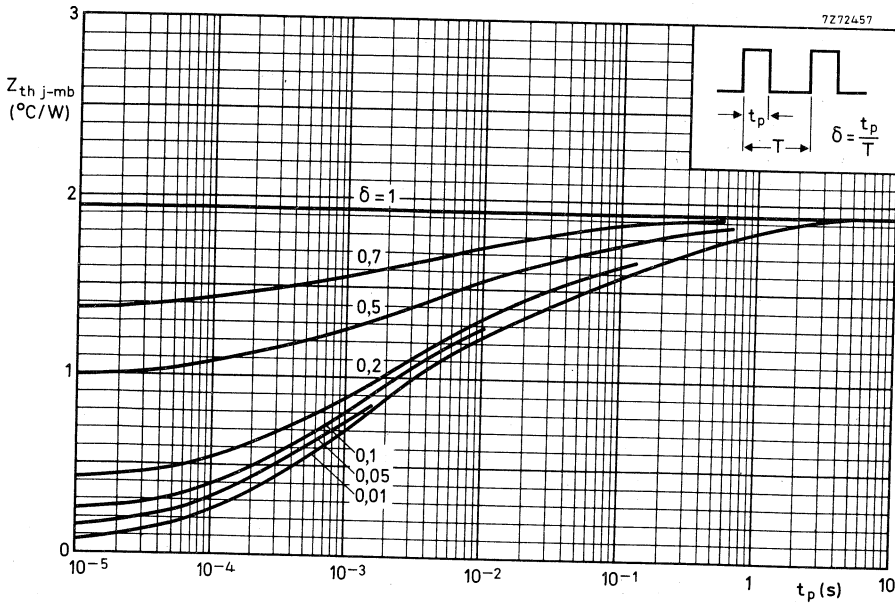
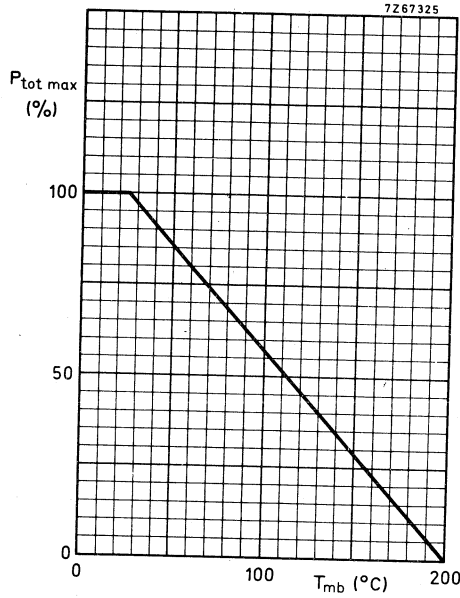
Safe Operating ARea with the transistor forward biased

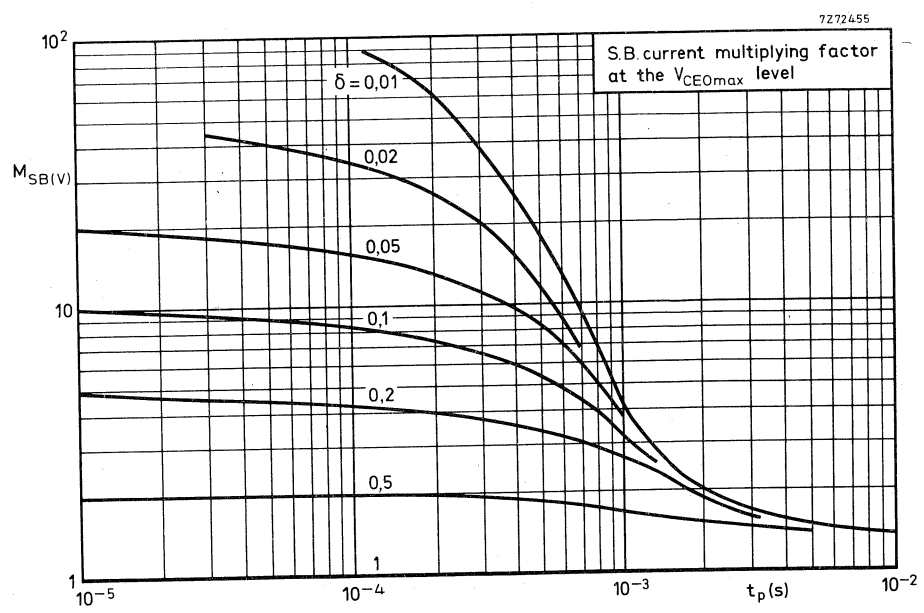
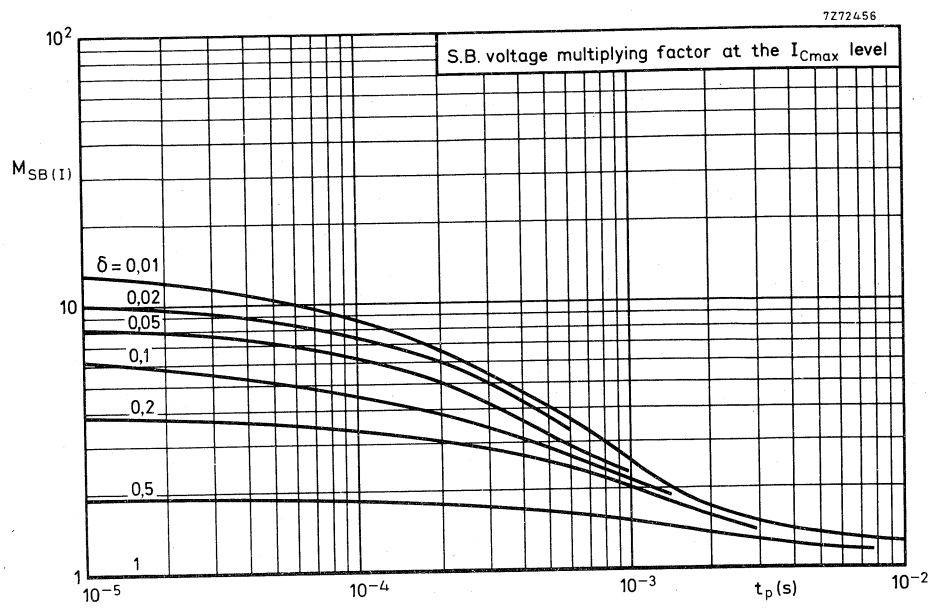
I Region of permissible d.c. operation

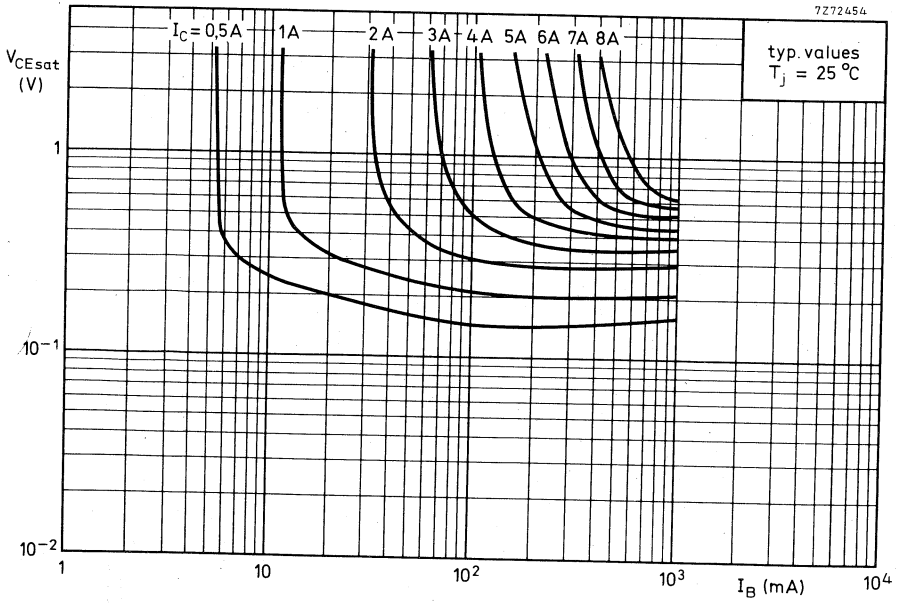
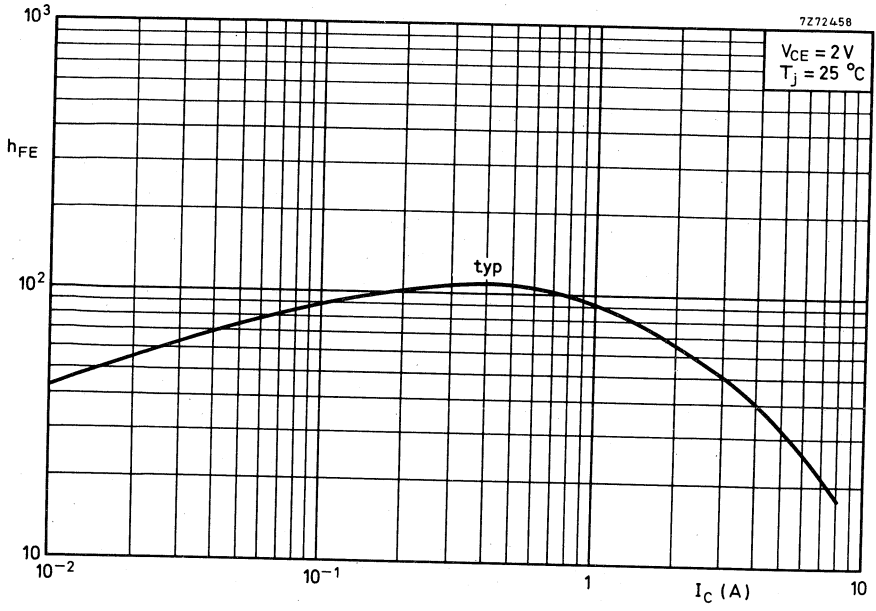
II Permissible extension for repetitive pulse operation

¹⁾ P_{tot} max and P_{peak} max lines.

²⁾ Second-breakdown limits (independent of temperature).







SILICON POWER TRANSISTORS

P-N-P transistors in TO-3 envelope for audio output stages and general amplifier and switching applications. N-P-N complements are BDX91, BDX93 and BDX95.

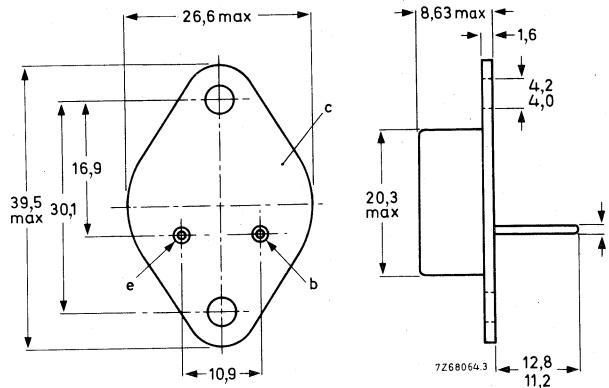
QUICK REFERENCE DATA					
		BDX92	BDX94	BDX96	
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100	V
Collector current (peak value)	$-I_{CM}$ max.	12			A
Total power dissipation up to $T_{mb} = 25^{\circ}\text{C}$	P_{tot} max.	90			W
Junction temperature	T_j max.	200			$^{\circ}\text{C}$
D. C. current gain $-I_C = 3 \text{ A}; -V_{CE} = 2 \text{ V}$	h_{FE}	>			20
Transition frequency $-I_C = 1 \text{ A}; -V_{CE} = 10 \text{ V}$	f_T	>			4 MHz

MECHANICAL DATA

Dimensions in mm

TO-3

Collector connected to envelope



For mounting instructions and accessories see section Accessories.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

		BDX92	BDX94	BDX96	
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$ max.	5	5	5	V

Currents

Collector current (d. c.)	$-I_C$ max.		8		A
Collector current (peak value)	$-I_{CM}$ max.		12		A

Power dissipation

Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot} max.		90		W
--	----------------	--	----	--	---

Temperatures

Storage temperature	T_{stg}		-65 to +200		$^\circ\text{C}$
Junction temperature	T_j max.		200		$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$		1,94		$^\circ\text{C/W}$
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$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

CHARACTERISTICS

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CB0max}$	$-I_{CBO}$	<	0,1	mA
$I_E = 0; -V_{CB} = 30\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX92}$	$-I_{CBO}$	<	2	mA
$I_E = 0; -V_{CB} = 40\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX94}$				
$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX96}$				
$I_B = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CEO}$	<	1	mA

Emitter cut-off current

$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO}$	<	1	mA
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D.C. current gain ¹⁾

$-I_C = 3\text{ A}; -V_{CE} = 2\text{ V}$	h_{FE}	>	20	
$-I_C = 5\text{ A}; -V_{CE} = 2\text{ V}$	h_{FE}	>	10	

Base-emitter voltage ¹⁾

$-I_C = 3\text{ A}; -V_{CE} = 2\text{ V}$	$-V_{BE}$	<	1,4	V
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Collector-emitter saturation voltage ¹⁾

$-I_C = 3\text{ A}; -I_B = 0,3\text{ A}$	$-V_{CEsat}$	<	0,8	V
$-I_C = 5\text{ A}; -I_B = 1\text{ A}$	$-V_{CEsat}$	<	1	V

Base-emitter saturation voltage ¹⁾

$-I_C = 3\text{ A}; -I_B = 0,3\text{ A}$	$-V_{BEsat}$	<	1,5	V
$-I_C = 5\text{ A}; -I_B = 1\text{ A}$	$-V_{BEsat}$	<	2	V

Small-signal current gain at $f = 1\text{ kHz}$

$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}$	h_{fe}	>	40	
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Transition frequency

$-I_C = 1\text{ A}; -V_{CE} = 10\text{ V}$	f_T	>	4	MHz
--	-------	---	---	-----

¹⁾ Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.

CHARACTERISTICS (continued)

$T_j = 25^\circ\text{C}$ unless otherwise specified

Switching times (between 10% and 90% levels)

$-I_{\text{Con}} = 3\text{ A}$; $-I_{\text{Bon}} = I_{\text{Boff}} = 0,3\text{ A}$; $V_{\text{CC}} = -30\text{ V}$

→ Turn-on time

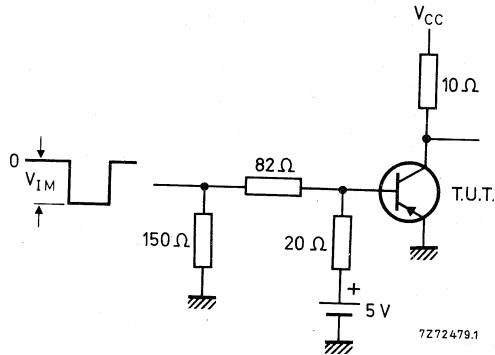
t_{on} typ. $0,2\ \mu\text{s}$
 $< 1\ \mu\text{s}$

→ Turn-off time

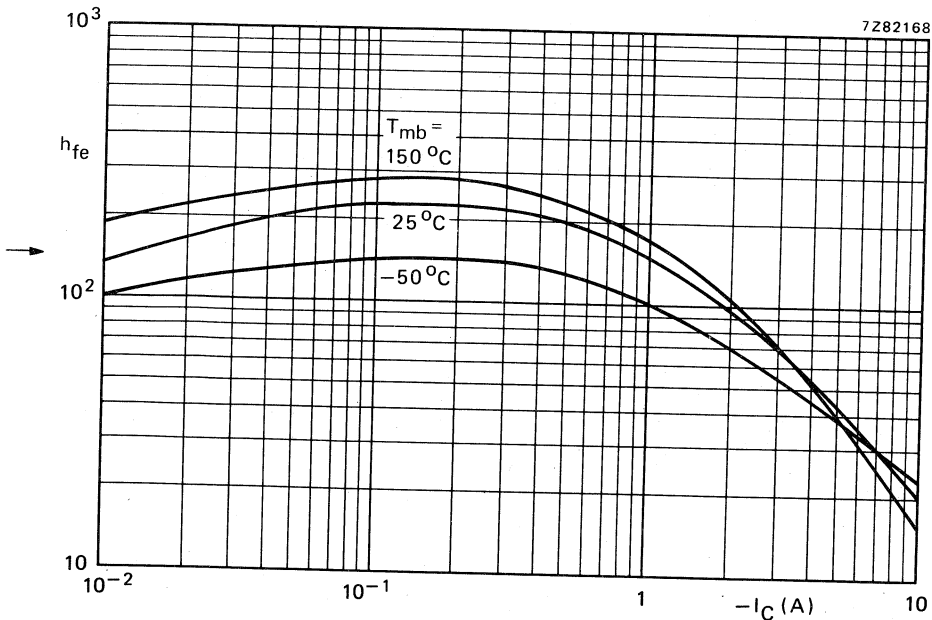
t_{off} typ. $1\ \mu\text{s}$
 $< 2\ \mu\text{s}$

Test circuit

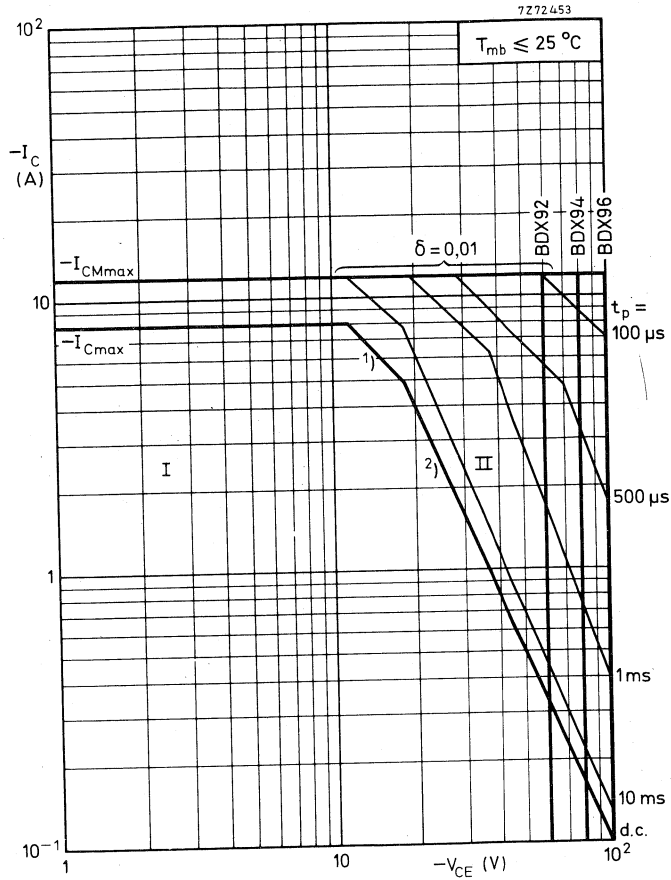
$V_{\text{IM}} = 55\text{ V}$
 $t_r = t_f = 15\text{ ns}$
 $t_p = 10\ \mu\text{s}$
 $T = 500\ \mu\text{s}$



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Typical small-signal current gain as a function of collector current; $-V_{\text{CE}} = 2\text{ V}$.

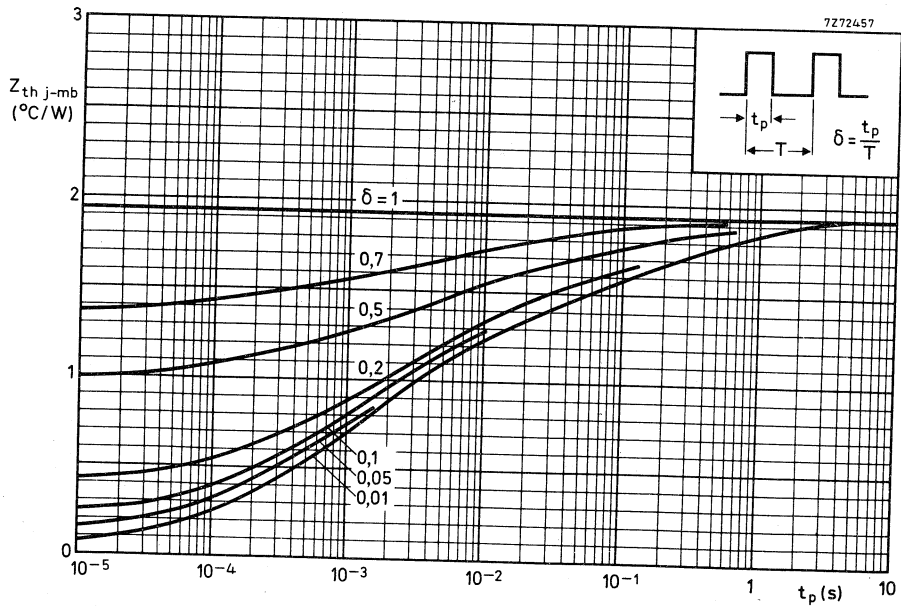
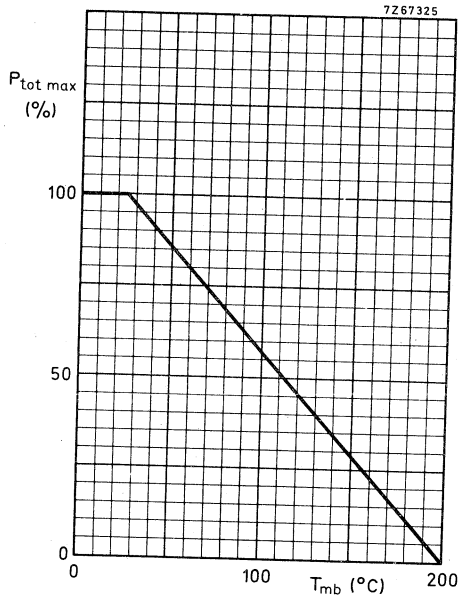


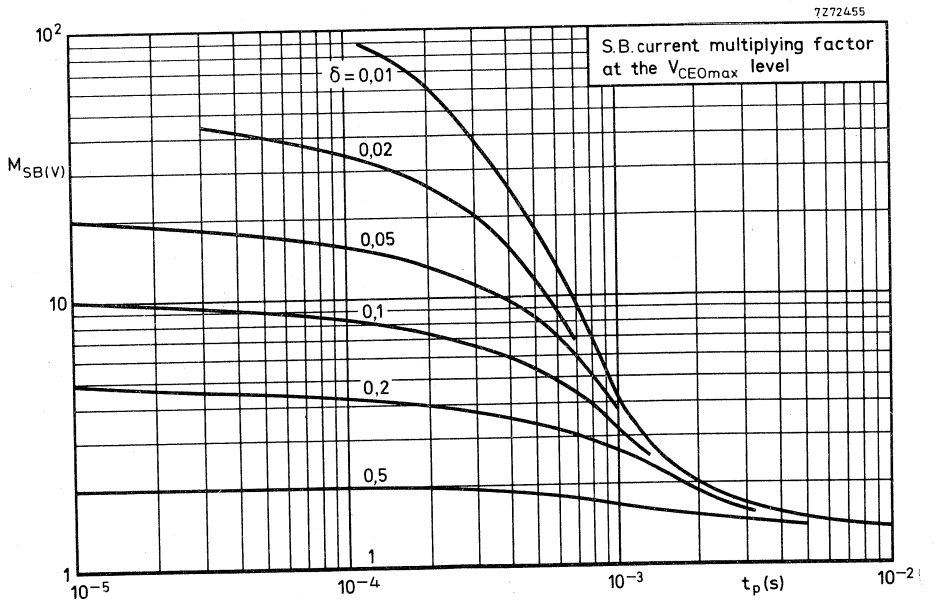
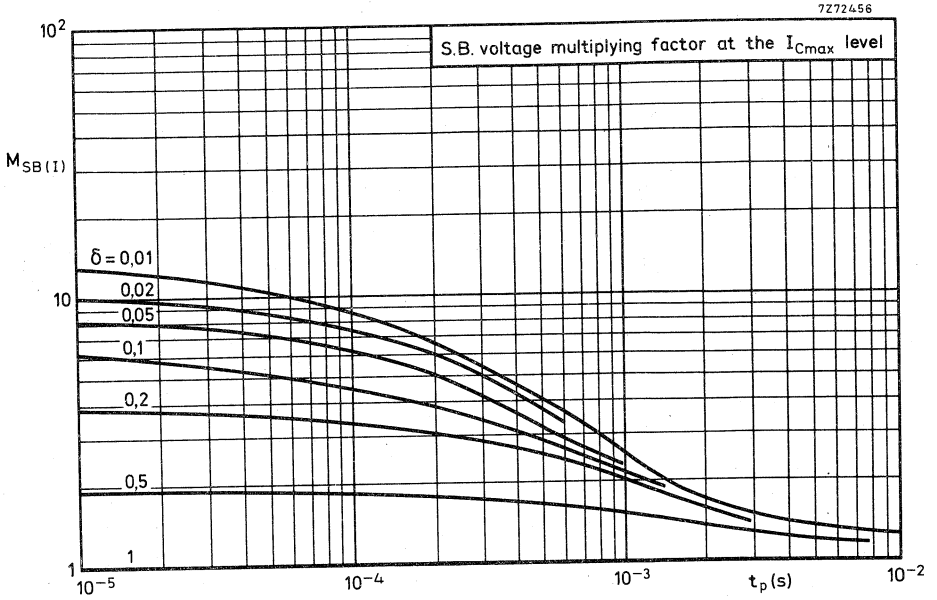
Safe Operating Area with the transistor forward biased

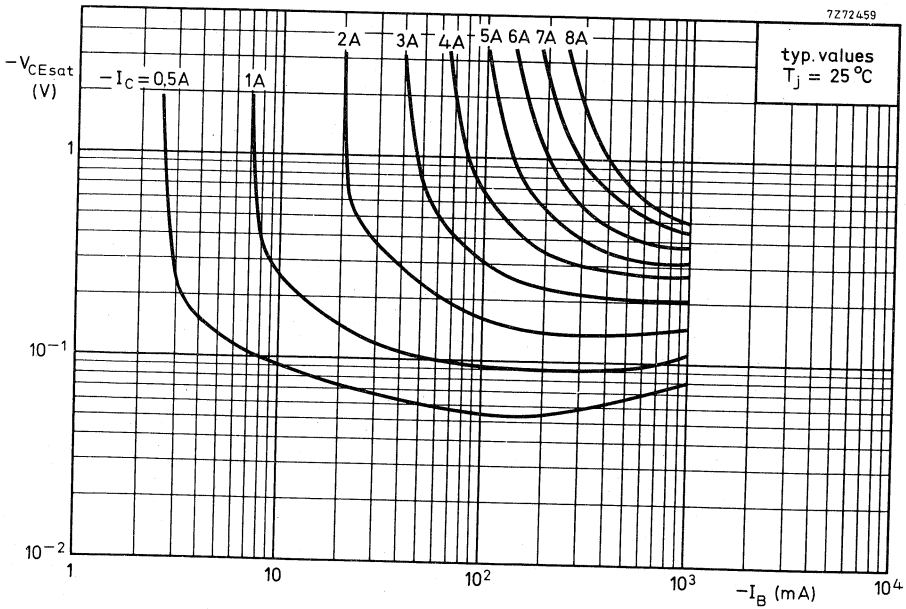
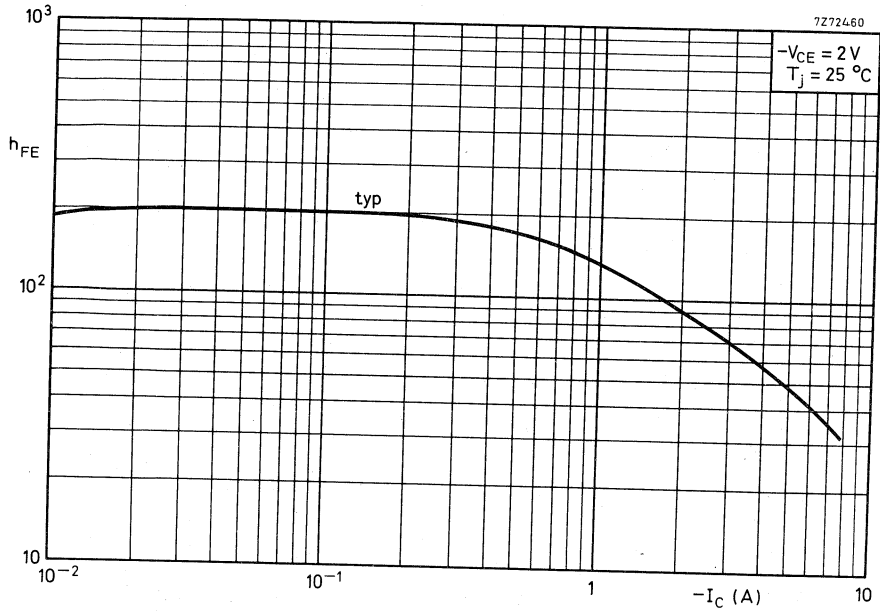
I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

- 1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
- 2) Second-breakdown limits (independent of temperature).







SILICON DIFFUSED POWER TRANSISTORS

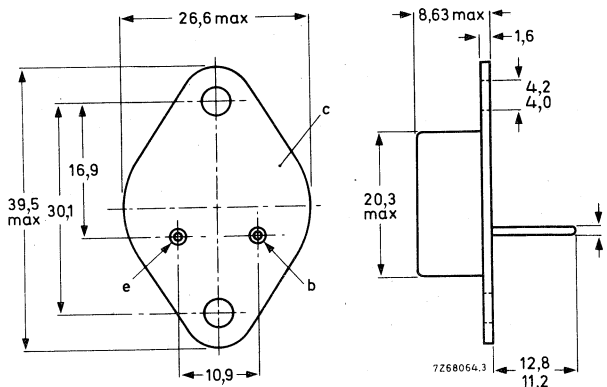
N-P-N transistor in a TO-3 metal envelope, intended for use in linear applications such as hi-fi amplifiers and signal processing circuits.

QUICK REFERENCE DATA		
Collector-base voltage (open emitter)	V_{CBO}	max. 100 V
Collector-emitter voltage (open base)	V_{CEO}	max. 60 V
Collector current (peak value)	I_{CM}	max. 15 A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max. 115 W
Junction temperature	T_j	max. 200 $^{\circ}\text{C}$
D. C. current gain	h_{FE}	20 to 70
$I_C = 4\text{ A}; V_{CE} = 4\text{ V}$		
Transition frequency at $f = 1\text{ MHz}$	f_T	typ. 1 MHz
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$		

MECHANICAL DATA

Dimensions in mm

Collector connected to envelope
TO-3



For mounting instructions and accessories, see section Accessories.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	100 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60 V ¹⁾
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	V_{CER}	max.	70 V ¹⁾
Emitter-base voltage (open collector)	V_{EBO}	max.	7 V

Currents

Collector current (d. c.)	I_C	max.	15 A
Collector current (peak value)	I_{CM}	max.	15 A
Emitter current (peak value)	$-I_{EM}$	max.	15 A

Power dissipation

Total power dissipation up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	115 W
--	-----------	------	-------

Temperatures

Storage temperature	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction temperature	T_j	max.	200 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th, j-a}$	=	40 $^\circ\text{C/W}$
From junction to mounting base	$R_{th, j-mb}$	=	1,5 $^\circ\text{C/W}$

¹⁾ $I_C = 0.2 \text{ A}$



CHARACTERISTICS

$T_j = 25^\circ\text{C}$ unless otherwise specified

Collector cut-off currents

$I_E = 0; V_{CB} = 100\text{ V}$

I_{CBO} typ. 3 μA
< 5 mA

$-V_{BE} = 1.5\text{ V}; V_{CE} = 100\text{ V}$

I_{CEX} typ. 4 μA
< 5 mA

$-V_{BE} = 1.5\text{ V}; V_{CE} = 100\text{ V}; T_j = 150^\circ\text{C}$

I_{CEX} typ. 0.3 mA
< 10 mA

Emitter cut-off current

$I_C = 0; V_{EB} = 7\text{ V}$

I_{EBO} typ. 1 nA
< 5 mA

Base-emitter voltage

$I_C = 4\text{ A}; V_{CE} = 4\text{ V}$

V_{BE} typ. 1.1 V
< 1.8 V

Collector-emitter saturation voltage

$I_C = 4\text{ A}; I_B = 0.4\text{ A}$

V_{CEsat} typ. 0.4 V
< 1.1 V

Knee voltage

$I_C = 10\text{ A}; I_B = \text{value for which}$
 $I_C = 11\text{ A at } V_{CE} = 5\text{ V}$

V_{CEK} < 3.0 V

D.C. current gain

$I_C = 4\text{ A}; V_{CE} = 4\text{ V}$

h_{FE} 20 to 70

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 20\text{ V}$

C_c typ. 250 pF

Transition frequency at $f = 1\text{ MHz}$

$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$

f_T typ. 1 MHz

Cut-off frequency

$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$

f_{hfe} typ. 9 kHz



CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Switching times

$I_C = 4\text{ A}$; $I_B = -I_{BM} = 400\text{ mA}$

Delay time

t_d typ. $0.4\text{ }\mu\text{s}$

Rise time

t_r typ. $2\text{ }\mu\text{s}$

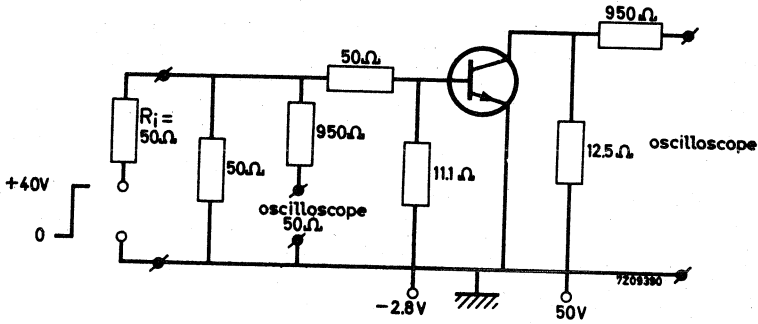
Storage time

t_s typ. $2\text{ }\mu\text{s}$

Fall time

t_f typ. $2.5\text{ }\mu\text{s}$

Test circuit:



Pulse generator:

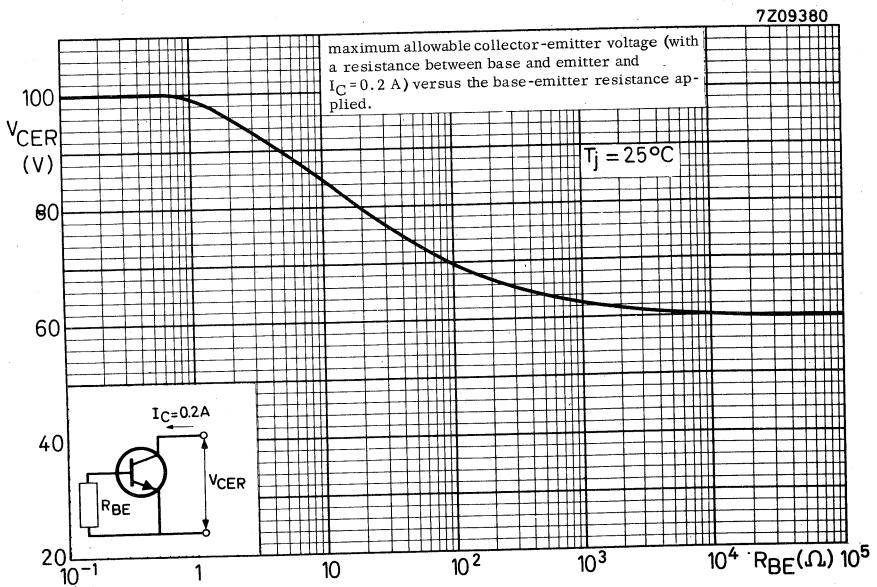
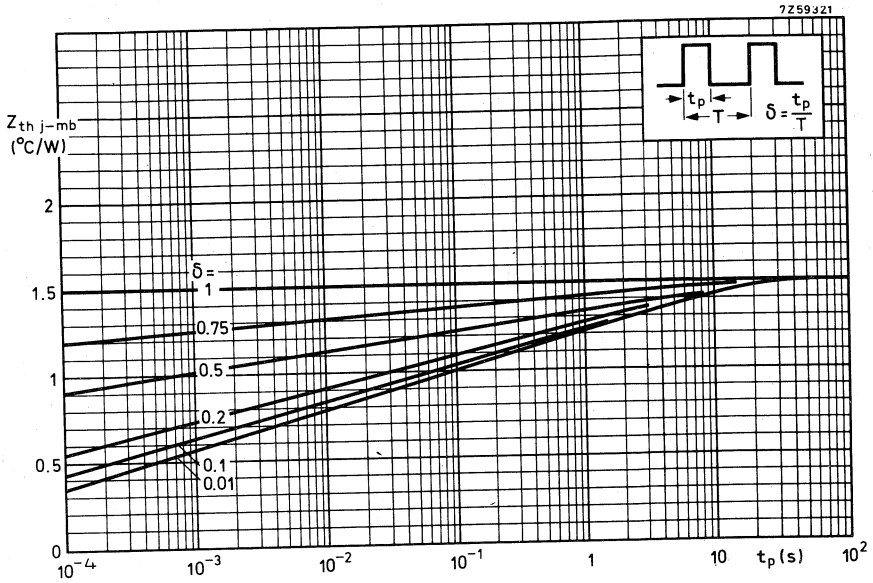
Pulse duration $t > 10\text{ }\mu\text{s}$

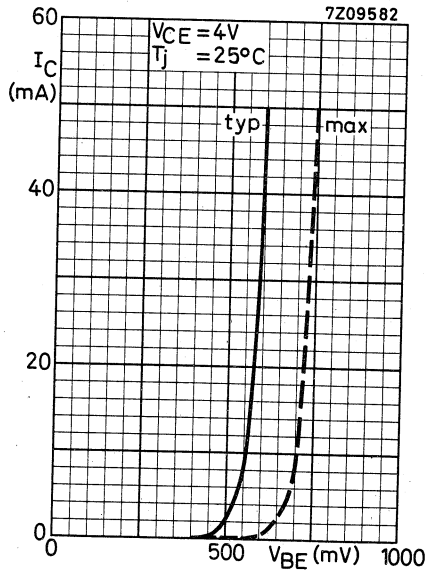
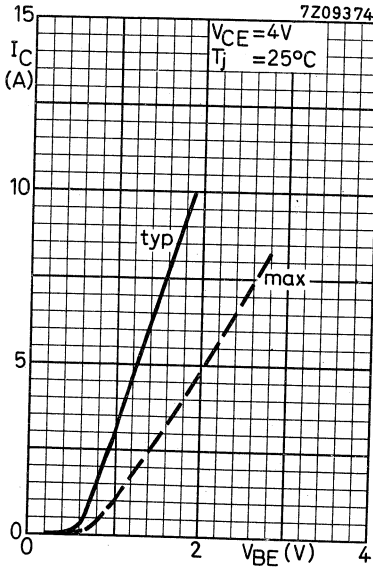
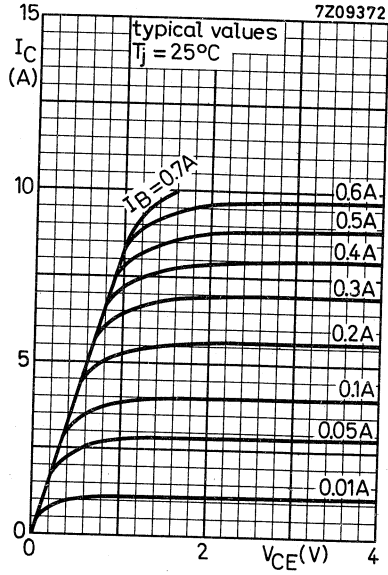
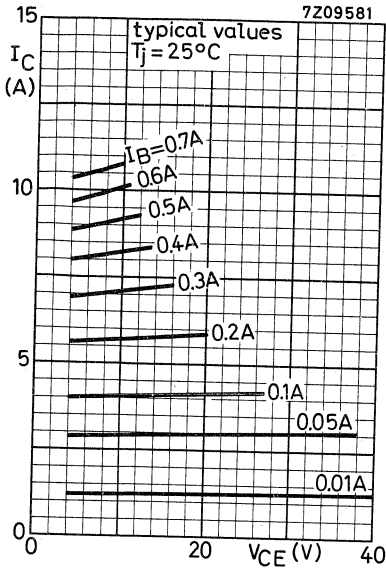
Rise time $t_r \leq 10\text{ ns}$

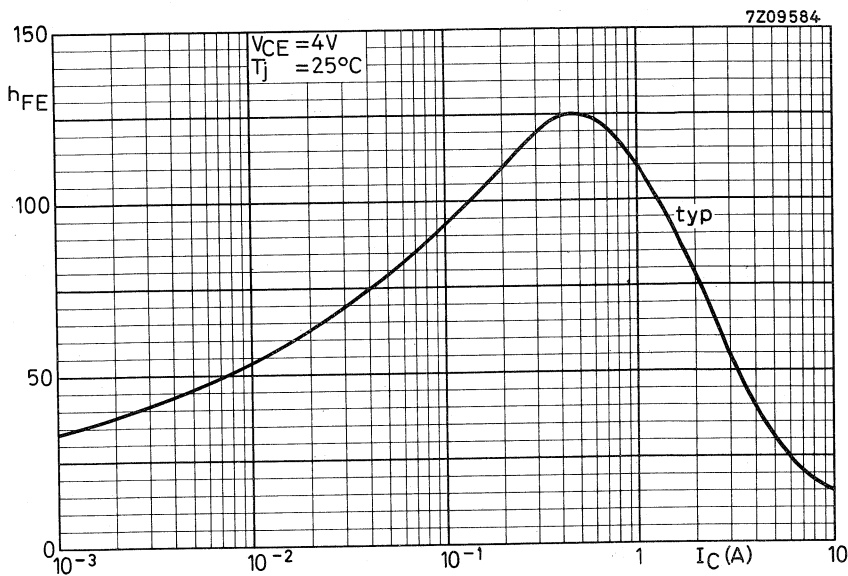
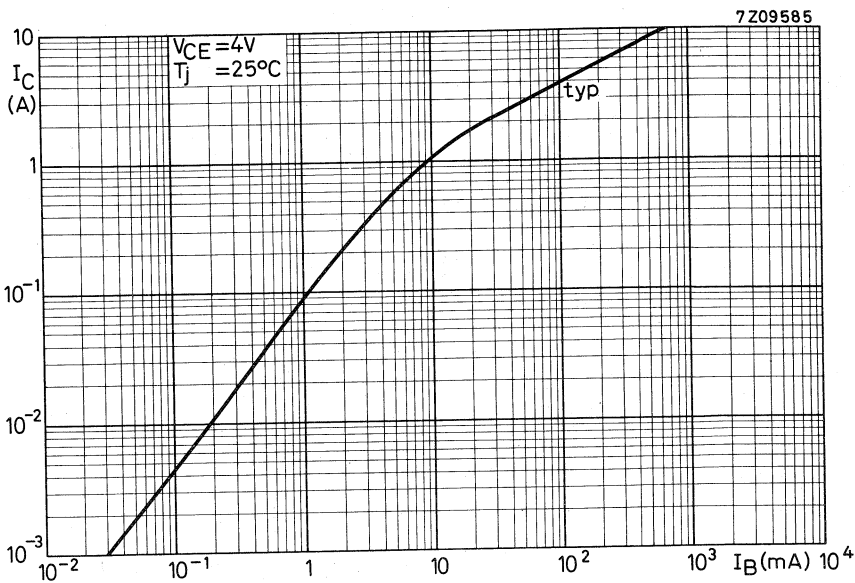
Oscilloscope:

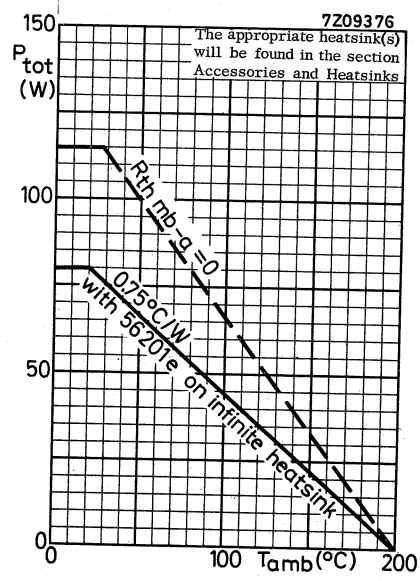
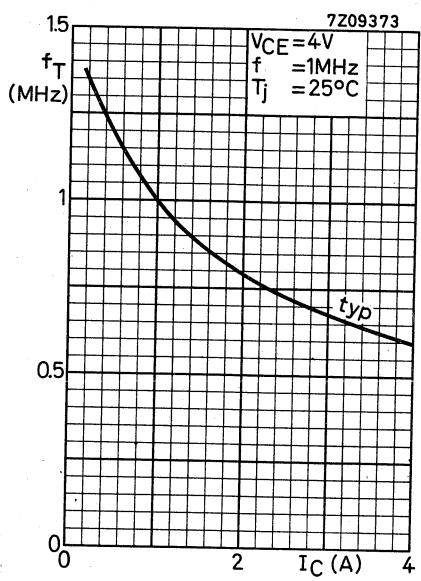
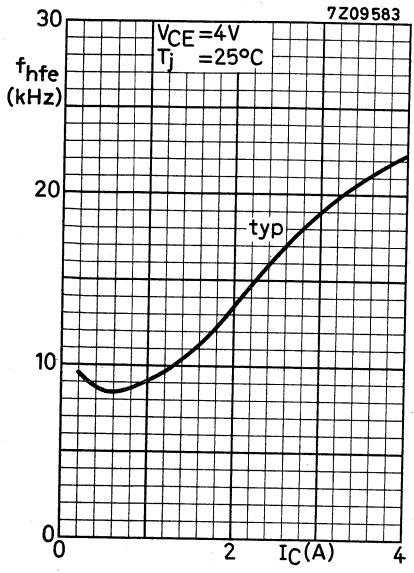
Rise time $t_r \leq 10\text{ ns}$

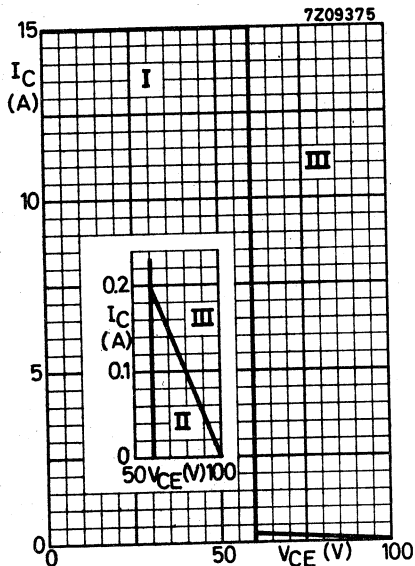
Input resistance $R_i = 50\text{ }\Omega$



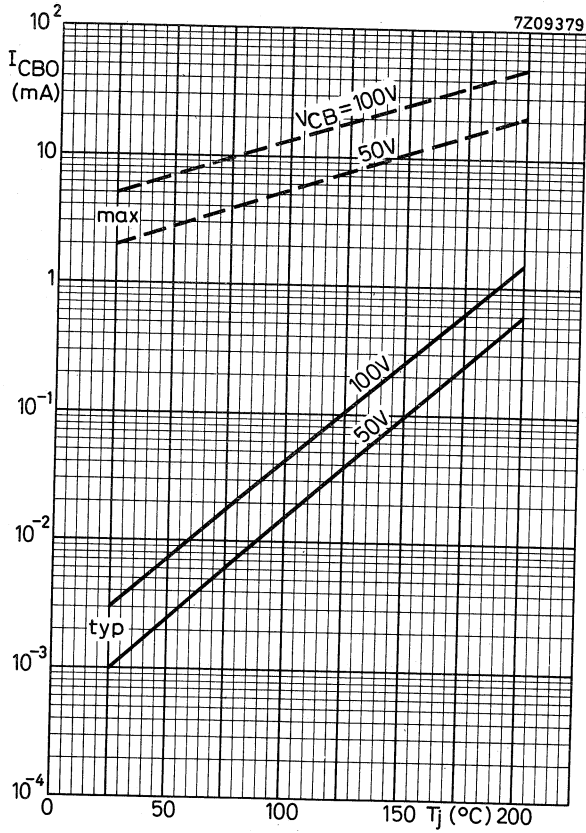








- I Region of permissible operation under all base-emitter conditions provided no limiting values are exceeded.
- II Additional region of operation when the transistor is cut-off with $-V_{BE} \leq 1.5$ V.
- III Operation during switching off is allowed, provided the transistor is cut-off with $-V_{BE} \leq 1.5$ V and the transient energy does not exceed 75 mWs.



SILICON DIFFUSED POWER TRANSISTORS

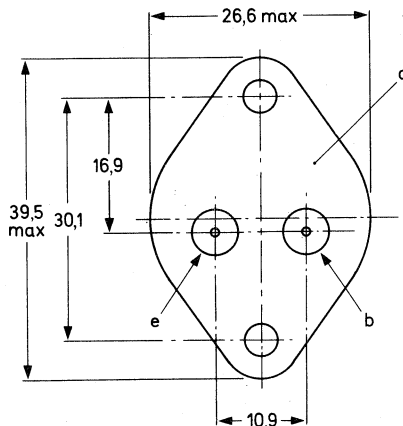
High-speed switching n-p-n transistors in a metal envelope intended for use in converters, inverters, switching regulators and switching control amplifiers.

		QUICK REFERENCE DATA			
			BDY90	BDY91	BDY92
Collector-base voltage (open emitter)	V_{CB0}	max.	120	100	80 V
Collector-emitter voltage (open base)	V_{CEO}	max.	100	80	60 V
Collector current (peak value)	I_{CM}	max.	15	15	15 A
Total power dissipation up to $T_{mb}=75^{\circ}\text{C}$	P_{tot}	max.	40	40	40 W
Collector-emitter saturation voltage $I_C = 10 \text{ A}; I_B = 1 \text{ A}$	V_{CEsat}	<	1.5	1.5	1.0 V
Fall time $I_C = 5.0 \text{ A}; I_B = -I_{BM} = 0.5 \text{ A}$ $V_{CC} = 30 \text{ V}$	t_f	<	0.2	0.2	0.2 μs
Transition frequency at $f = 5 \text{ MHz}$ $I_C = 0.5 \text{ A}; V_{CE} = 5 \text{ V}$	f_T	typ.	70	70	70 MHz

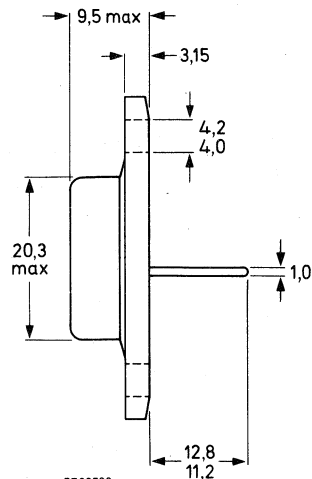
MECHANICAL DATA

Collector connected to case

TO-3



Dimensions in mm



7269700

For mounting instructions and accessories, see section Accessories.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

<u>Voltages</u> (See also pages 4, 5 and 6)		BDY90	BDY91	BDY92
Collector-base voltage (open emitter)	V_{CBO}	max. 120	100	80 V
Collector-emitter voltage ($V_{EB} = 1.5$ V)	V_{CEX}	max. 120	100	80 V
Collector-emitter voltage (open base)	V_{CEO}	max. 100	80	60 V
Emitter-base voltage (open collector)	V_{EBO}	max. 6	6	6 V

Currents

Collector current (d.c.)	I_C	max.	10 A
Collector current (peak value)	I_{CM}	max.	15 A
Base current (d.c.)	I_B	max.	2 A
Base current (peak value)	I_{BM}	max.	3 A
Emitter current (d.c.)	$-I_E$	max.	11 A
Emitter current (peak value)	$-I_{EM}$	max.	15 A

Power dissipation

Total power dissipation up to $T_{mb}=75^{\circ}\text{C}$	P_{tot}	max.	40 W
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Temperatures

Storage temperature	T_{stg}	-65 to + 175 $^{\circ}\text{C}$
Junction temperature	T_j	max. 175 $^{\circ}\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	2.5 $^{\circ}\text{C}/\text{W}$
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CHARACTERISTICS

$T_j = 25^{\circ}\text{C}$ unless otherwise specified

Collector cut-off current

$V_{EB} = 1.5$ V; $V_{CE} = V_{CEXmax}$;
 $T_{mb} = 150^{\circ}\text{C}$

I_{CEX}	<	3 mA
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Saturation voltages

$I_C = 5$ A; $I_B = 0.5$ A

V_{CEsat}	<	0.5 V
V_{BEsat}	<	1.2 V

$I_C = 10$ A; $I_B = 1$ A

BDY90

BDY91

V_{CEsat}	<	1.5 V
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BDY92

BDY90 to 92

V_{CEsat}	<	1.0 V
V_{BEsat}	<	1.5 V

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

D. C. current gain

$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$

$h_{FE} > 35$

$I_C = 5\text{ A}; V_{CE} = 5\text{ V}$

$h_{FE} 30\text{ to }120$

$I_C = 10\text{ A}; V_{CE} = 5\text{ V}$

$h_{FE} > 20$

Transition frequency at $f = 5\text{ MHz}$

$I_C = 0.5\text{ A}; V_{CE} = 5\text{ V}$

f_T typ. 70 MHz

Switching times

Turn on time

$I_C = 5\text{ A}; I_B = -I_{BM} = 0.5\text{ A}$

$V_{CC} = 30\text{ V}$

$t_{on} < 0.35\text{ }\mu\text{s}$

Turn off time

$I_C = 5\text{ A}; I_B = -I_{BM} = 0.5\text{ A}$

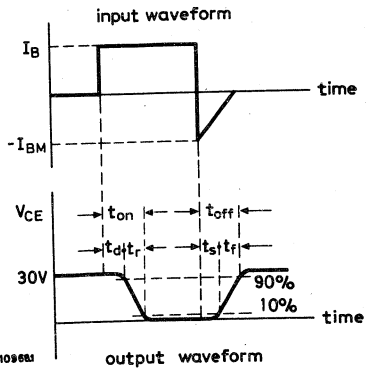
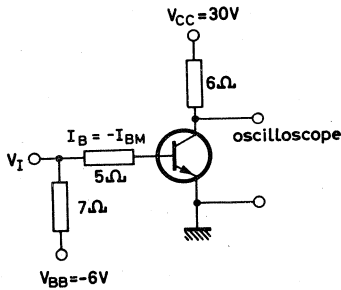
$V_{CC} = 30\text{ V}$ storage time

$t_s < 1.3\text{ }\mu\text{s}$

fall time

$t_f < 0.2\text{ }\mu\text{s}$

Test circuit



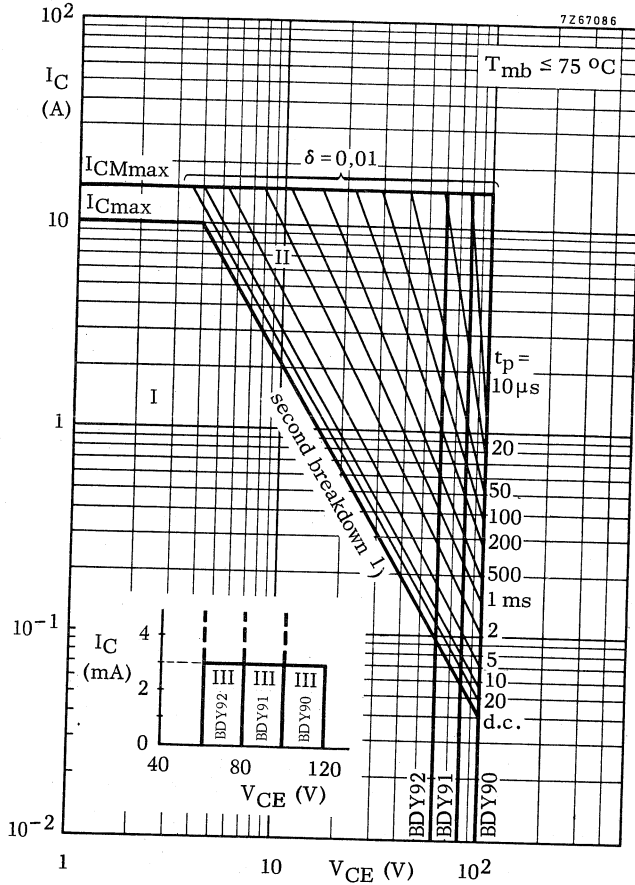
Pulse generator:

Rise time $t_R < 50\text{ ns}$

Fall time $t_f < 50\text{ ns}$

Pulse duration $t_p = 20\text{ }\mu\text{s}$

Duty cycle $\delta = 0.02$

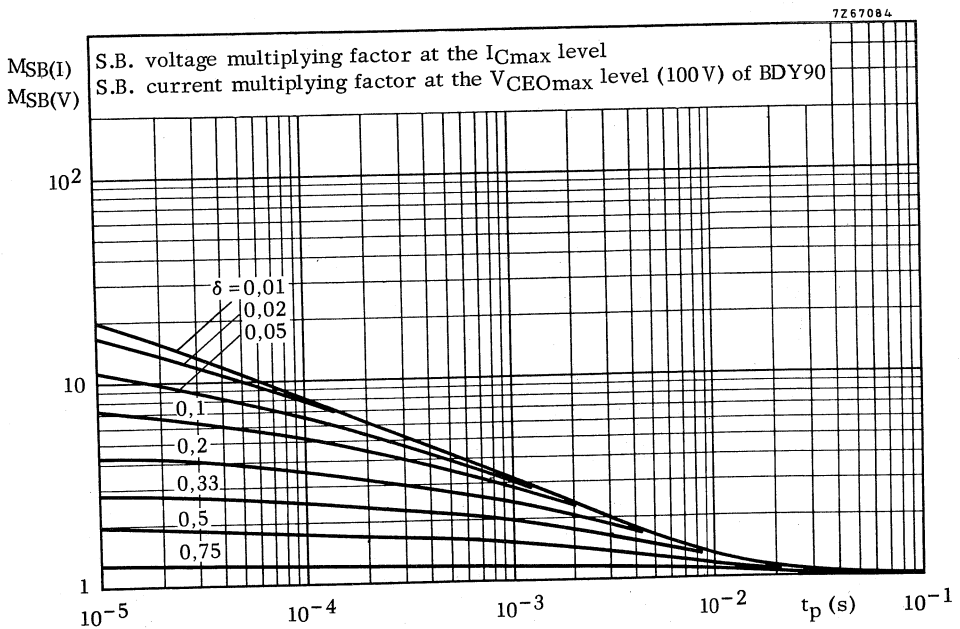
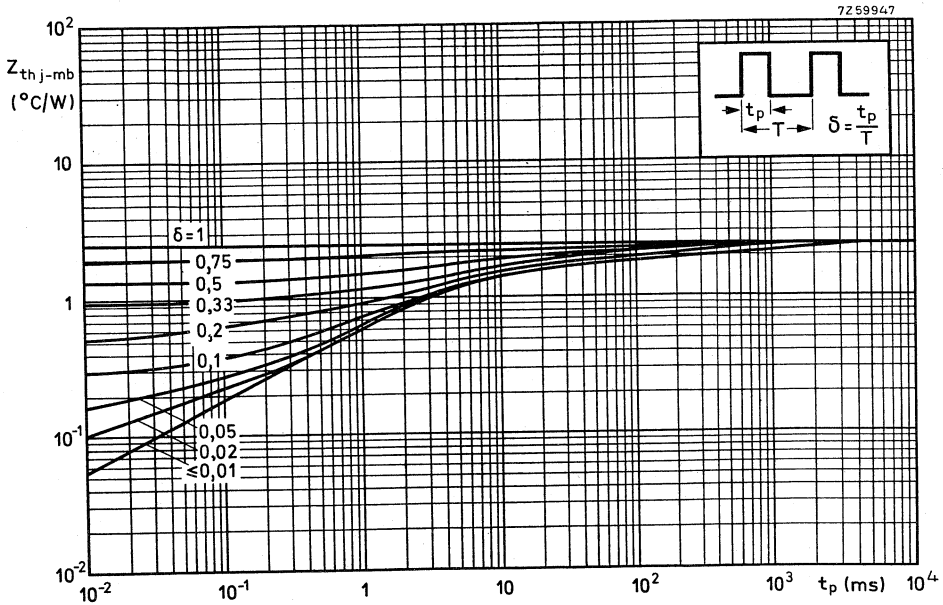


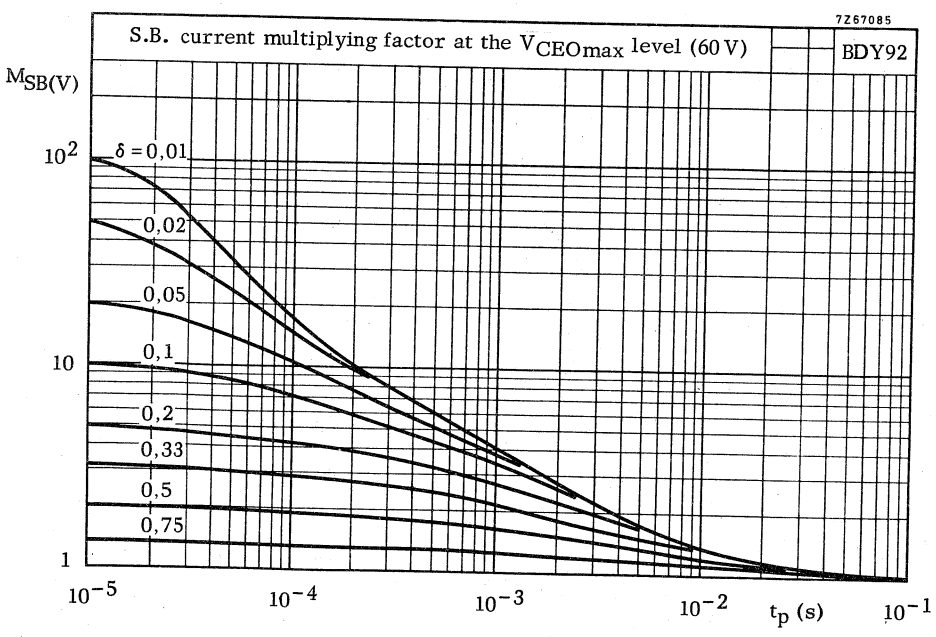
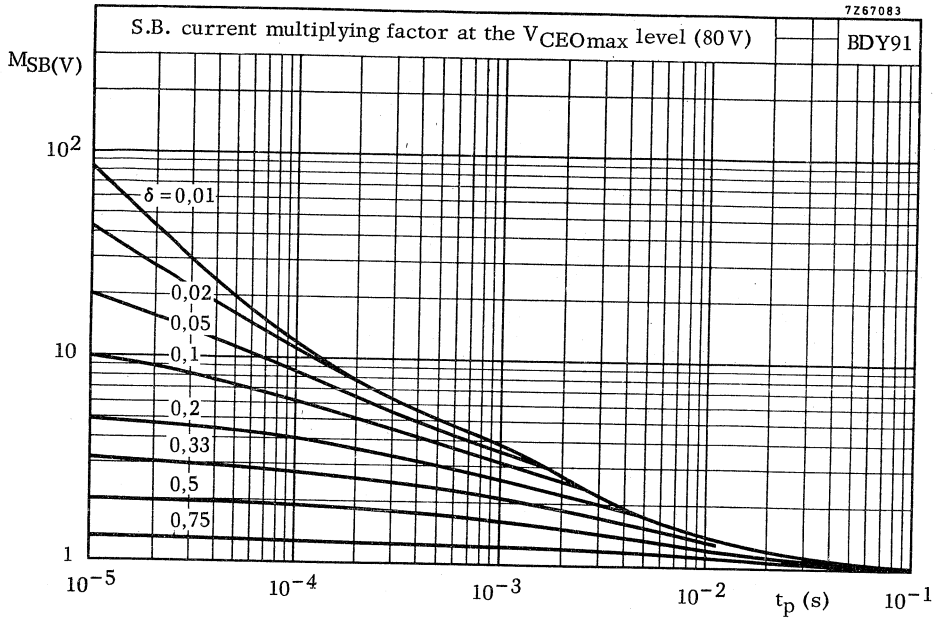
Safe Operating Area (Regions I and II forward biased)

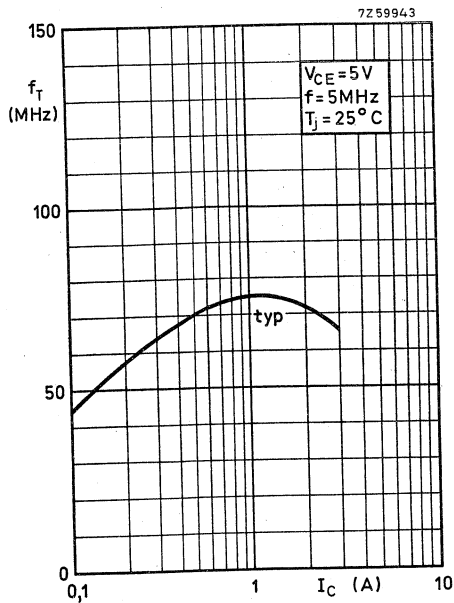
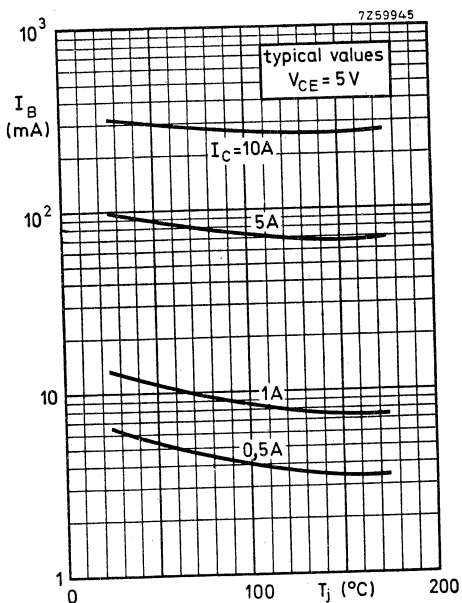
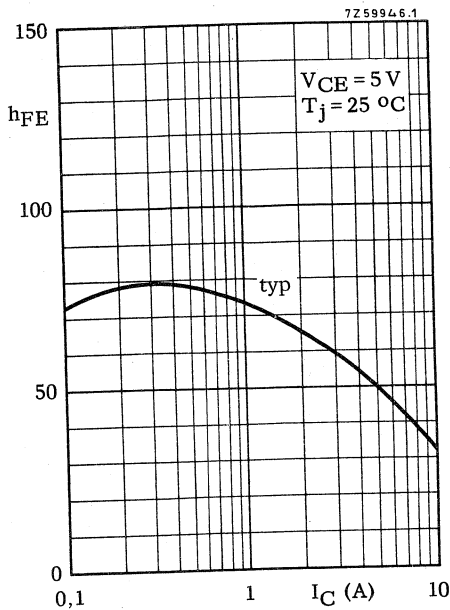
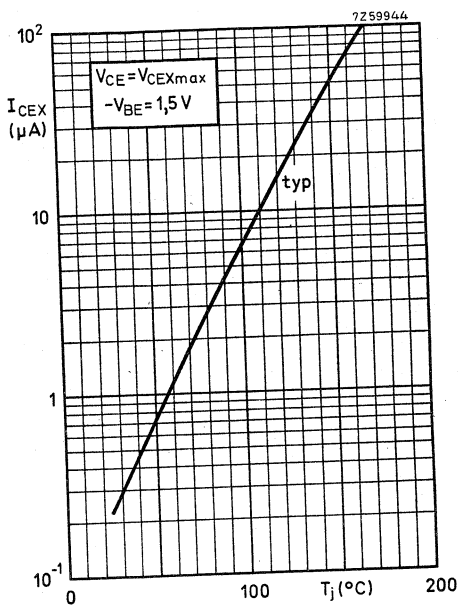
- I Region of permissible d. c. operation
- II Permissible extension for repetitive pulse operation
- III Repetitive pulse operation in this region is allowable, provided $-V_{BE} \geq 1,5 \text{ V}$

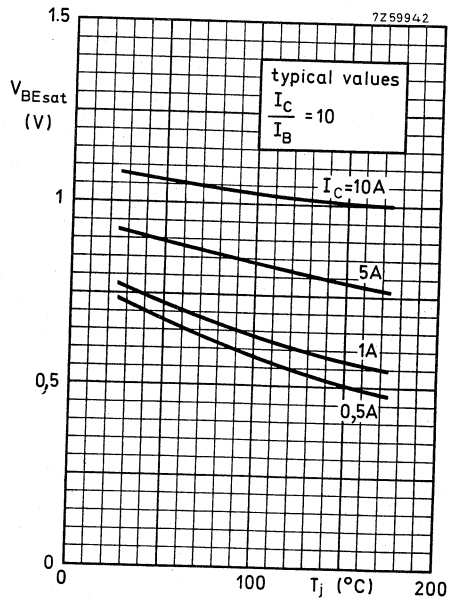
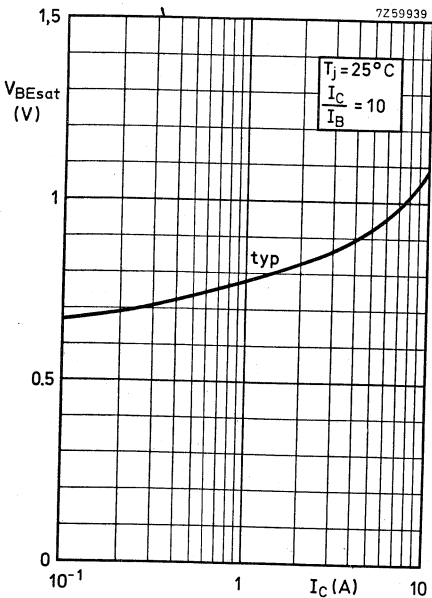
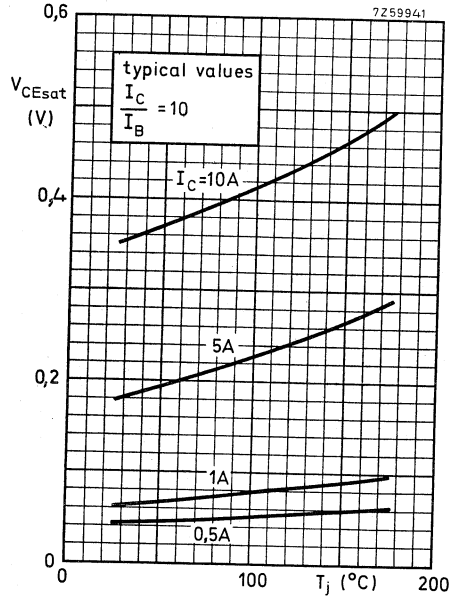
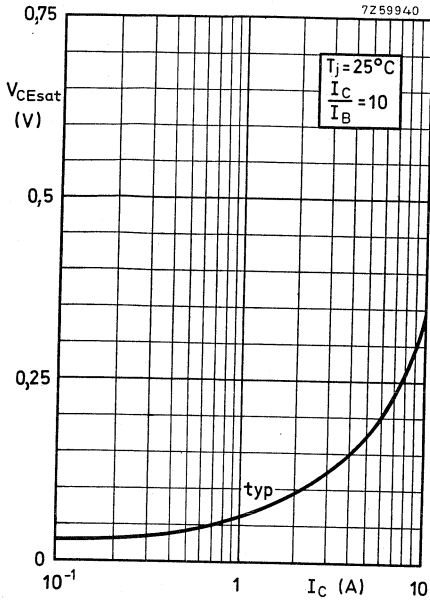
For $P_{tot \text{ max}}$ versus T_{mb} see page 10.

1) Independent of temperature



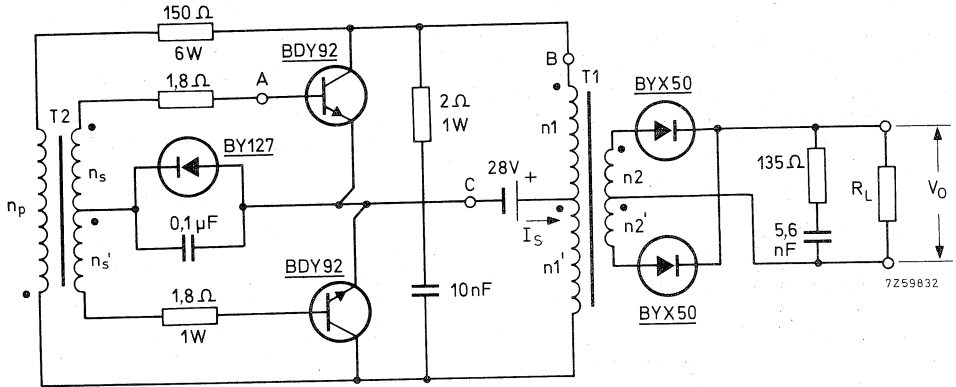






APPLICATION INFORMATION

Typical operation in a 250 W d. c. to d. c. converter with two BDY92 transistors



Each transistor is mounted on a heatsink of $R_{th\ h-a} = 15\text{ }^{\circ}\text{C/W}$

Performance at $T_{amb} = 55\text{ }^{\circ}\text{C}$

- $I_S = 10,5\text{ A}$
- $V_O = 240\text{ V}$
- $P_O = 250\text{ W}$
- $\eta = 84\%$
- $f = 28,5\text{ kHz}$

Losses at $P_O = 250\text{ W}$

In transistors	2 x 6 W
In diodes	2 x 2 W
In transformers	8 W
Circuit losses	14 W

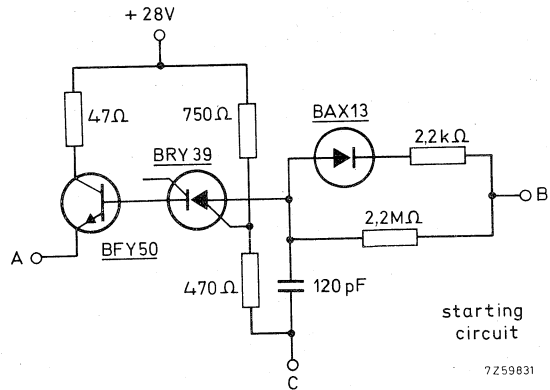
Transformer data

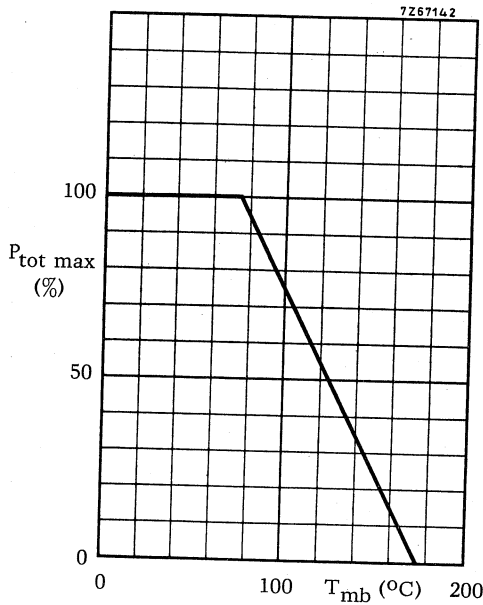
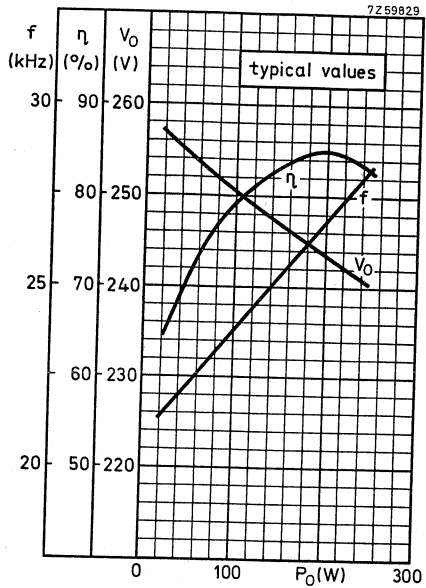
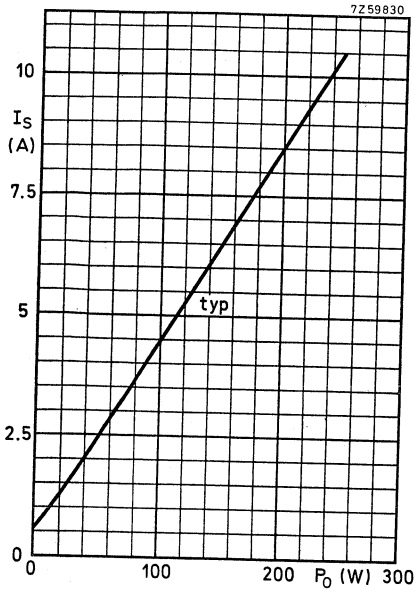
T_1 = Ferroxcube core E55 material 3E1
Cat. No. 4332 020 34900

- $n_1 + n_1'$ is bifilarly wound
- $n_1 = n_1' = 9$ turns, $\phi\ 1,4\text{ mm}$
- $n_2 = n_2' = 85$ turns, $\phi\ 0,5\text{ mm}$

T_2 = Ferroxcube core H16 material 3E2
Cat. No. 4322 020 33030

- $n_S + n_S'$ is bifilarly wound
- $n_S = n_S' = 4$ turns, $\phi\ 0,7\text{ mm}$
- $n_P = 24$ turns, $\phi\ 0,3\text{ mm}$





SILICON DIFFUSED POWER TRANSISTORS

High voltage, high speed switching n-p-n power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators and motor control systems.

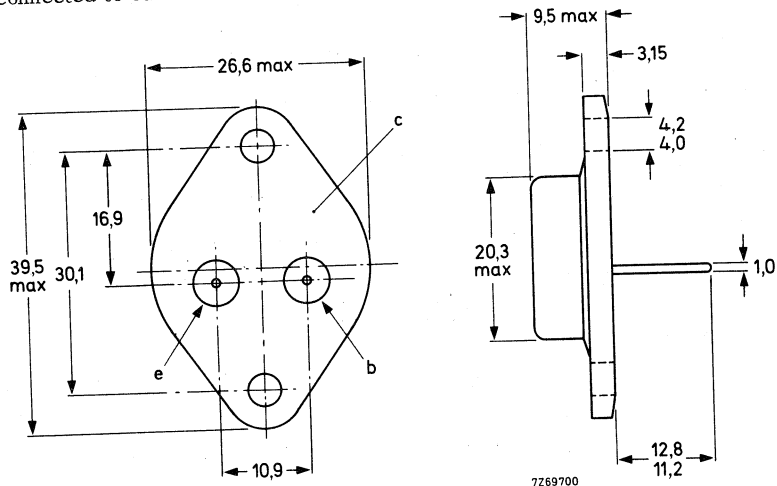
QUICK REFERENCE DATA			BDY93	BDY94
Collector-emitter peak voltage ($V_{BE} = 0$)	V_{CESM}	max.	750	750 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	V_{CER}	max.	450	400 V
Collector-emitter voltage (open base)	V_{CEO}	max.	350	300 V
Collector current (d. c.)	I_C	max.	4	4 A
Collector current (peak value)	I_{CM}	max.	7	7 A
Total power dissipation up to $T_{mb} = 75 \text{ }^\circ\text{C}$	P_{tot}	max.	30	30 W
Collector-emitter saturation voltage $I_C = 2,5 \text{ A}; I_B = 0,5 \text{ A}$	V_{CEsat}	<	1,5	1,5 V
Fall time $I_C = 2,5 \text{ A}; I_{B1} = 0,5 \text{ A}; -I_{B2} = 1 \text{ A}$	t_f	typ.	0,4	0,5 μs

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-3



For mounting instructions and accessories, see section Accessories.

SILICON DIFFUSED POWER TRANSISTORS

High voltage, high speed switching n-p-n power transistors in a TO-3 envelope, intended for use in converters, inverters, switching regulators and motor control systems.

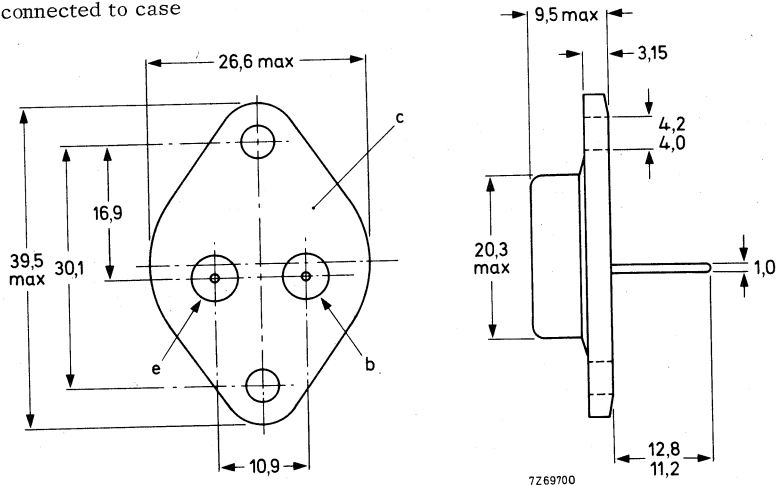
QUICK REFERENCE DATA		BDY96	BDY97
Collector-emitter peak voltage ($V_{BE} = 0$)	V_{CESM} max.	750	750 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	V_{CER} max.	450	400 V
Collector-emitter voltage (open base)	V_{CEO} max.	350	300 V
Collector current (d. c.)	I_C max.	10	10 A
Collector current (peak value)	I_{CM} max.	15	15 A
Total power dissipation up to $T_{mb} = 90^\circ C$	P_{tot} max.	40	40 W
Collector-emitter saturation voltage $I_C = 5 A; I_B = 1 A$	$V_{CEsat} <$	1,5	1,5 V
Fall time $I_C = 5 A; I_{B1} = 1 A; -I_{B2} = 2 A$	t_f typ.	0,3	0,4 μs

MECHANICAL DATA

Dimensions in mm

TO-3

Collector connected to case



For mounting instructions and accessories, see section Accessories

HIGH-VOLTAGE TRANSISTOR

Silicon n-p-n transistor in TO-126 plastic envelope intended for use as a driver for line output transistors in colour tv receivers.

QUICK REFERENCE DATA

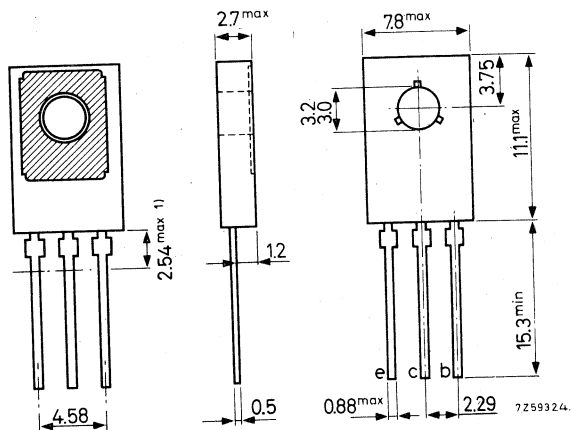
Collector-base voltage (open emitter)	V_{CBO}	max.	300	V
Collector-emitter voltage (open base)	V_{CEO}	max.	250	V
Collector current (peak value)	I_{CM}	max.	300	mA
Total power dissipation up to $T_{mb} = 90\text{ }^{\circ}\text{C}$	P_{tot}	max.	6	W
Junction temperature	T_j	max.	150	$^{\circ}\text{C}$
D.C. current gain	h_{FE}	typ.	45	
$I_C = 20\text{ mA}; V_{CE} = 10\text{ V}$	t_s	typ.	0.5	μs
Storage time				

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-126 (SOT-32)

Collector connected to mounting base



(1) Within this region the cross-section of the leads is uncontrolled

See also chapters Mounting Instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter)	V_{CB0}	max.	300	V
Collector-emitter voltage ($R_{BE} \leq 1 \text{ k}\Omega$)	V_{CER}	max.	300	V
Collector-emitter voltage (open base)	V_{CEO}	max.	250	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (continuous)	I_C	max.	100	mA
Collector current (peak value) *	I_{CM}	max.	300	mA
Total power dissipation up to $T_{mb} = 90 \text{ }^\circ\text{C}$ up to $T_{amb} = 70 \text{ }^\circ\text{C}$	P_{tot}	max.	6	W
	P_{tot}	max.	0.8	W
Storage temperature	T_{stg}		-65 to +150	$^\circ\text{C}$
Operating junction temperature	T_j	max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th \text{ j-mb}}$	=	10	$^\circ\text{C/W}$
From junction to ambient	$R_{th \text{ j-a}}$	=	100	$^\circ\text{C/W}$

* Precautions should be taken during switch-on of the BF419 where an overshoot of current is likely to occur. The amplitude of the overshoot depends on the relative magnitude of stray external capacities to the transistor collector capacity. It is desirable to keep the stray capacities to a minimum by short lead lengths etc. so as to minimise the area of the switching path.

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$

Collector cut-off current

$I_E = 0; V_{CB} = 250\text{ V}$

$I_{CBO} < 50\text{ nA}$

Emitter cut-off current

$I_C = 0; V_{EB} = 3\text{ V}$

$I_{EBO} < 50\text{ nA}$

D.C. current gain

$I_C = 20\text{ mA}; V_{CE} = 10\text{ V}$

$h_{FE} \text{ typ. } 45$

Collector-emitter saturation voltage

$I_C = 200\text{ mA}; I_B = 20\text{ mA}^*$

$V_{CEsat} < 11\text{ V}$

Collector output capacitance at $f = 1\text{ MHz}$

$I_E = 0; V_{CB} = 30\text{ V}$

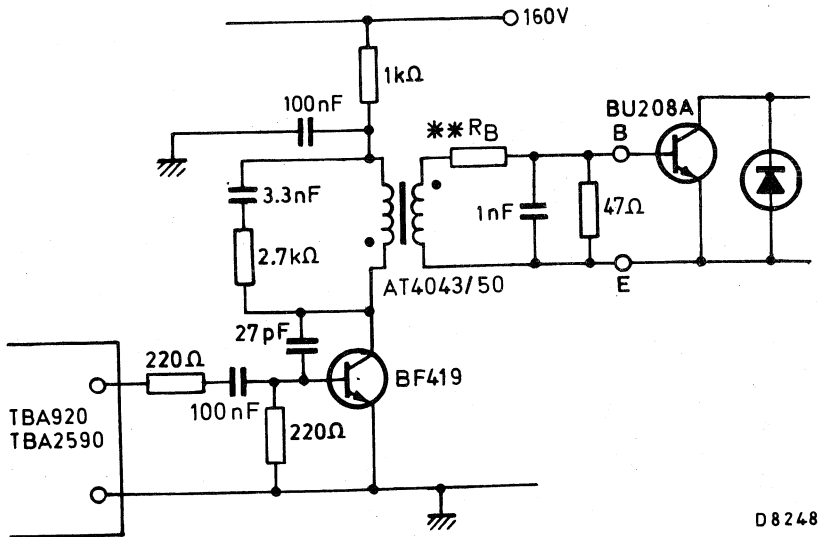
$C_{Tc} < 4.5\text{ pF}$

Storage time

(in the typical circuit below)

$t_s \text{ typ. } 0.5\text{ }\mu\text{s}$

* The BF419 is controlled to V_{CEsat} max. 11.0 V and is thermally stable under all operating conditions where T_j max of $150\text{ }^\circ\text{C}$ is not exceeded. For the typical circuit shown below, a heatsink is not required for operation with $T_{amb} \leq 70\text{ }^\circ\text{C}$.



D 8 2 4 8

Fig.2 Typical circuit.

** R_B is chosen so that the end-of-scan base current for the BU208A is 1.4 A under nominal conditions. Typical value of R_B is $0.5\text{ }\Omega$ plus $0.1\text{ }\Omega$ lead resistance.

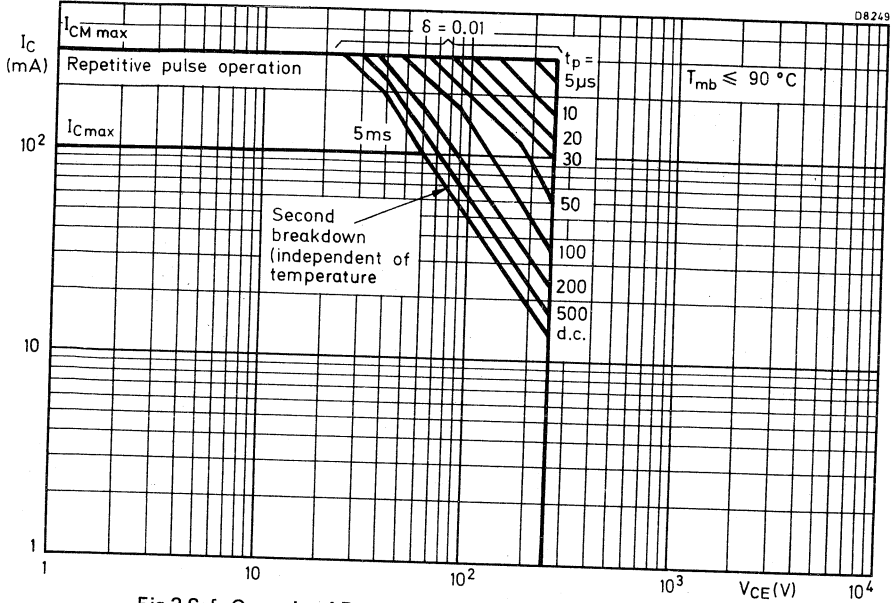


Fig.3 Safe Operating Areas with the transistor forward biased.

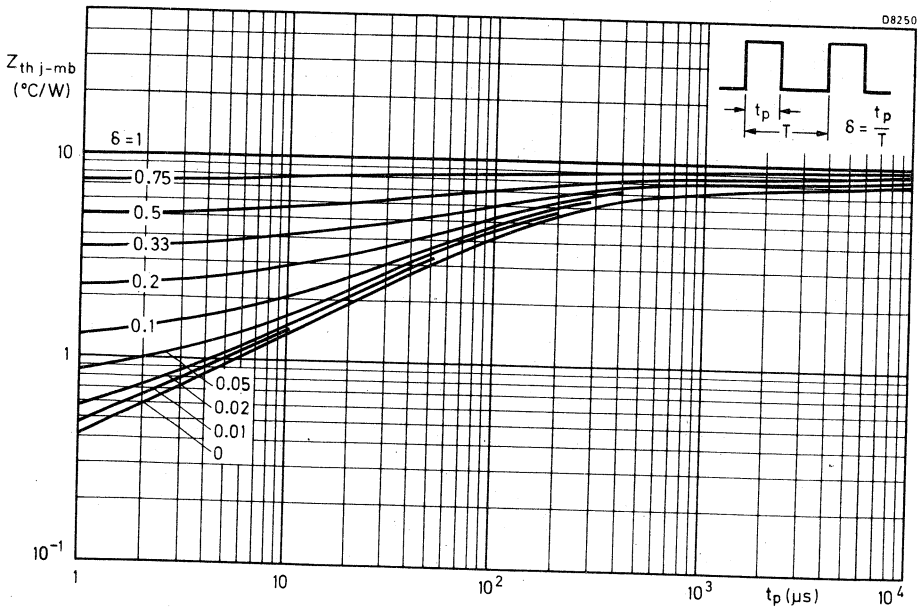


Fig. 4.

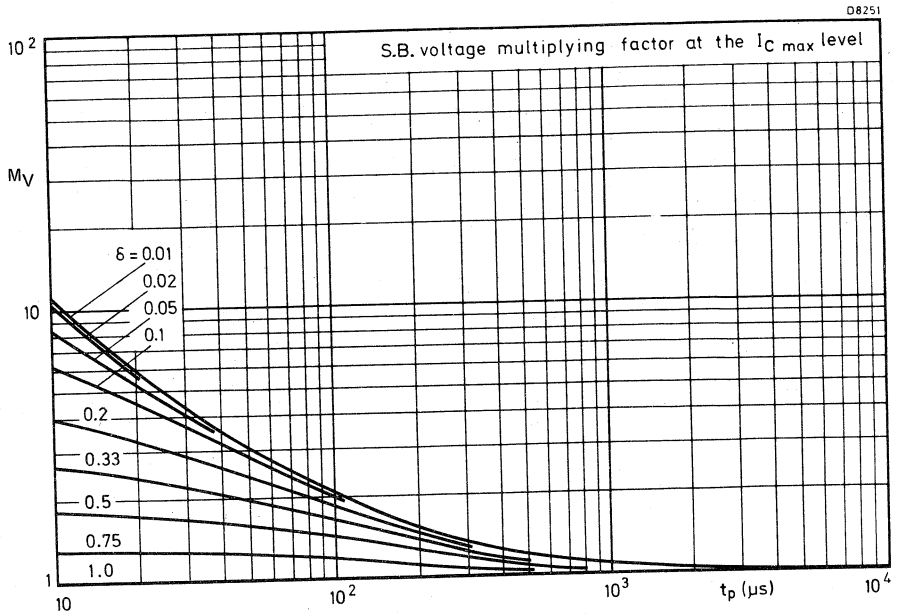


Fig. 5.

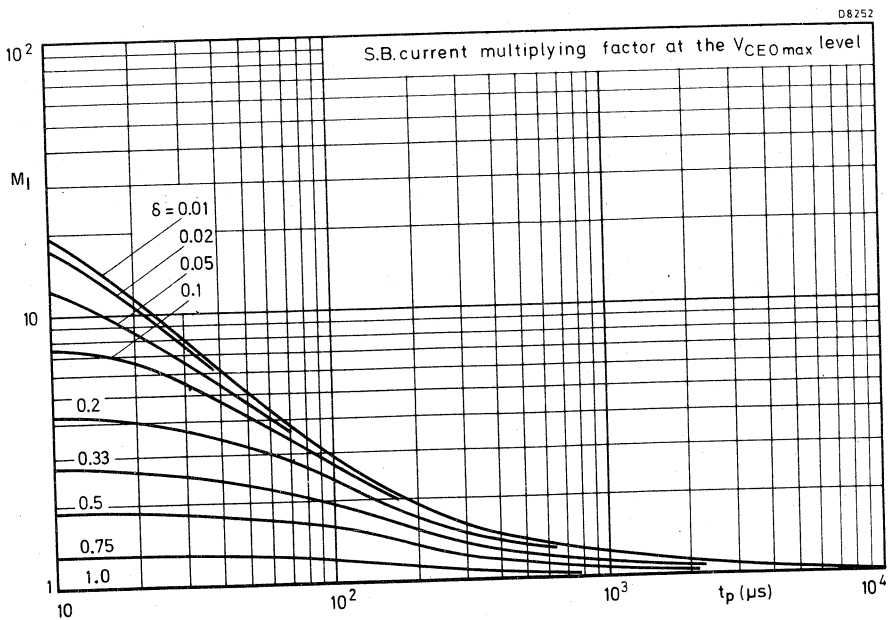


Fig. 6.

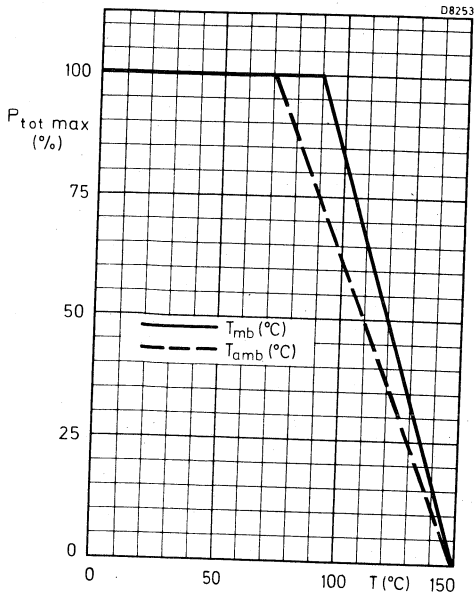


Fig. 7.

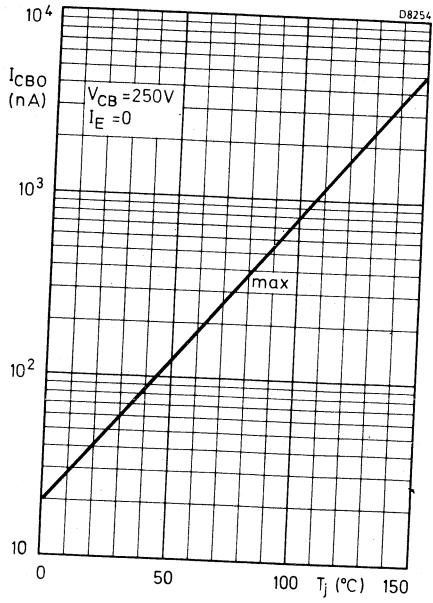


Fig. 8.

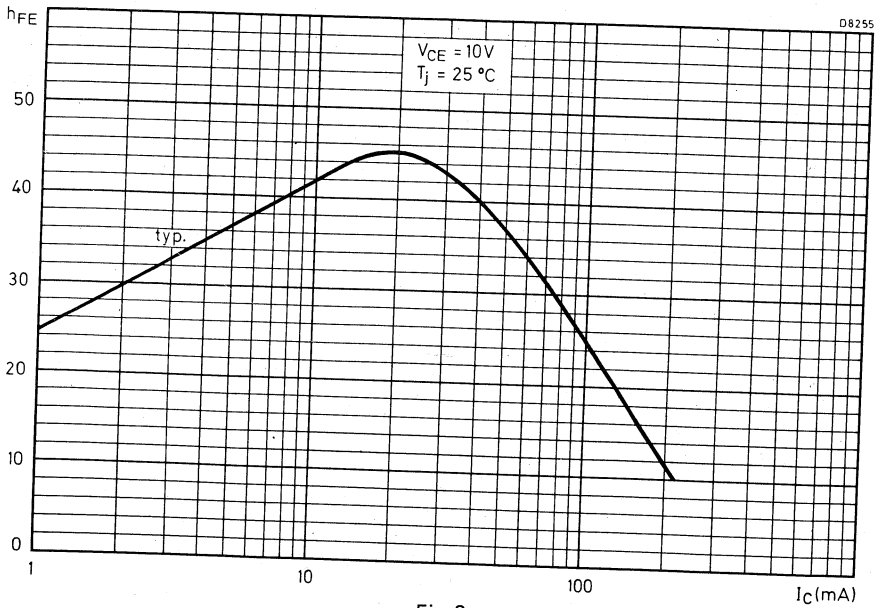


Fig. 9.

SILICON PLANAR TRANSISTORS

for video output stages

N-P-N transistors in a SOT-32 plastic envelope intended for video output stages in black-and-white and in colour television receivers.

QUICK REFERENCE DATA

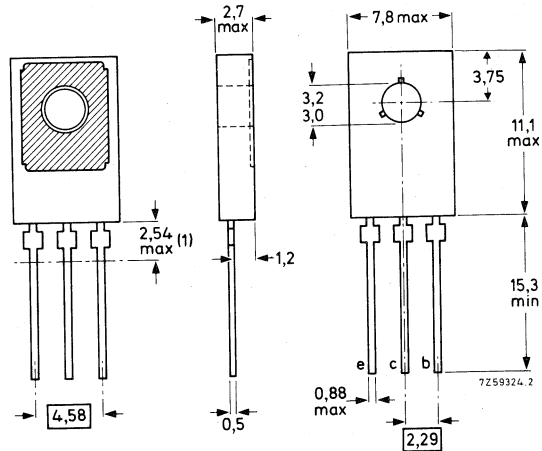
			BF457	BF458	BF459	
Collector-base voltage (open emitter)	V_{CB0}	max.	160	250	300	V
Collector-emitter voltage (open base)	V_{CEO}	max.	160	250	300	V
Collector current (peak value)	I_{CM}	max.	300			mA
Total power dissipation up to $T_{mb} = 90\text{ }^{\circ}\text{C}$	P_{tot}	max.	6			W
Junction temperature	T_j	max.	150			$^{\circ}\text{C}$
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$ $I_C = 30\text{ mA}; V_{CE} = 10\text{ V}$	h_{FE}	>	26			
Transition frequency $I_C = 15\text{ mA}; V_{CE} = 10\text{ V}$	f_T	typ.	90			MHz
Feedback capacitance at $f = 1\text{ MHz}$ $I_E = 0; V_{CB} = 30\text{ V}$	C_{re}	<	3,5			pF

MECHANICAL DATA

Dimensions in mm

Collector connected to metal part of mounting surface

TO-126 (SOT-32)



(1) Within this region the cross-section of the leads is uncontrolled.

For mounting instructions see section Accessories type 56326 for non-insulated mounting and type 56333 for insulated mounting.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltage

			BF457	BF458	BF459	
Collector-base voltage (open emitter)	V_{CBO}	max.	160	250	300	V
Collector-emitter voltage (open base)	V_{CEO}	max.	160	250	300	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V

Current

Collector current (d. c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	300	mA
Base current (d. c.)	I_B	max.	50	mA

Power dissipation

Total power dissipation up to $T_{mb} = 90\text{ }^\circ\text{C}$	P_{tot}	max.	6	W
---	-----------	------	---	---

Temperature

Storage temperature	T_{stg}	-55 to +150	$^\circ\text{C}$
Junction temperature	T_j	max.	150 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	104	$^\circ\text{C}/\text{W}$
From junction to mounting base	$R_{th\ j-mb}$	=	10	$^\circ\text{C}/\text{W}$

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

CHARACTERISTICS

Collector cut-off current

$I_E = 0; V_{CB} = 100\text{ V}$ for BF457

$I_E = 0; V_{CB} = 200\text{ V}$ for BF458

$I_E = 0; V_{CB} = 250\text{ V}$ for BF459

$I_{CBO} < 50\text{ nA}$

Emitter cut-off current

$I_C = 0; V_{EB} = 3\text{ V}$

$I_{EBO} < 50\text{ nA}$

D. C. current gain

$I_C = 30\text{ mA}; V_{CE} = 10\text{ V}$

$h_{FE} > 26$

Collector-emitter saturation voltage

$I_C = 30\text{ mA}; I_B = 6\text{ mA}$

$V_{CEsat} < 1\text{ V}$

High frequency knee voltage at $T_j = 150\text{ }^\circ\text{C}$

$I_C = 50\text{ mA}$

V_{CEK} typ. 15 V

The high frequency knee voltage of a transistor is that value of the collector-emitter voltage at which the small signal gain, measured in a practical circuit, has dropped to 80% of the gain at $V_{CE} = 50\text{ V}$. A further reduction of the collector-emitter voltage results in a rapid increase of the distortion of the signal.

Transition frequency at $f = 100\text{ MHz}$

$I_C = 15\text{ mA}; V_{CE} = 10\text{ V}$

f_T typ. 90 MHz

Feedback capacitance at $f = 1\text{ MHz}$

$I_E = 0; V_{CB} = 30\text{ V}$

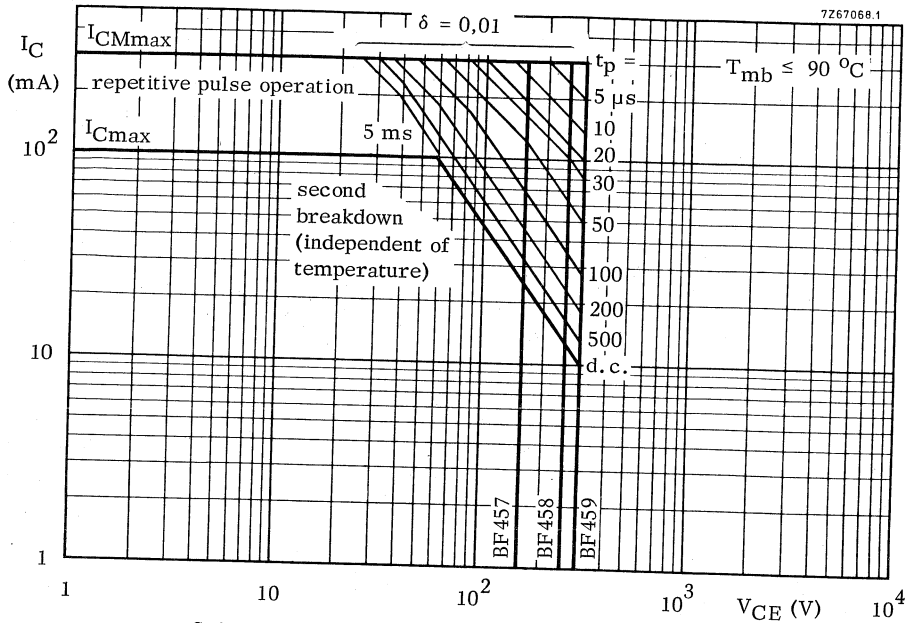
$C_{re} < 3.5\text{ pF}$

Output capacitance at $f = 1\text{ MHz}$

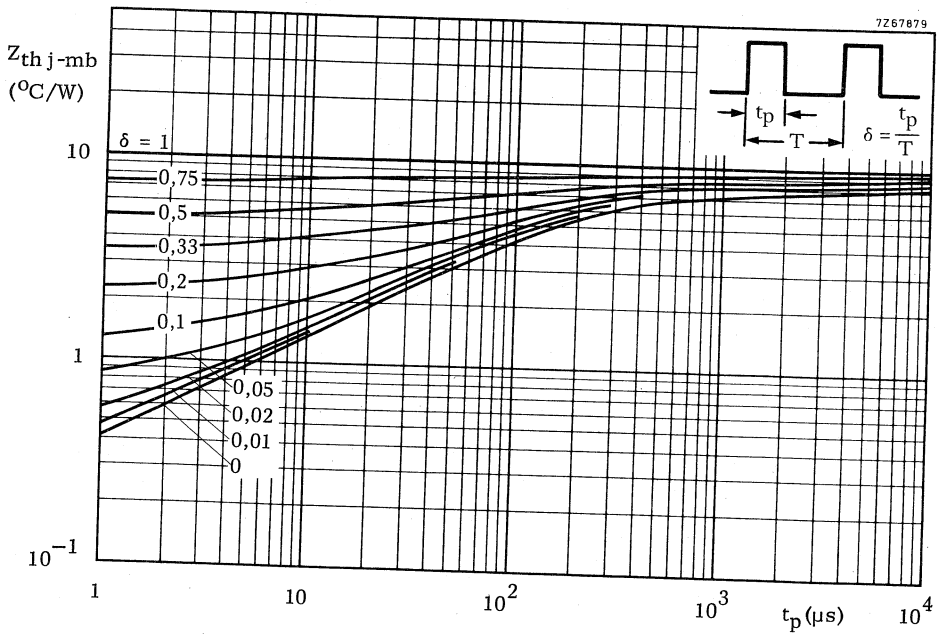
$I_E = 0; V_{CB} = 30\text{ V}$

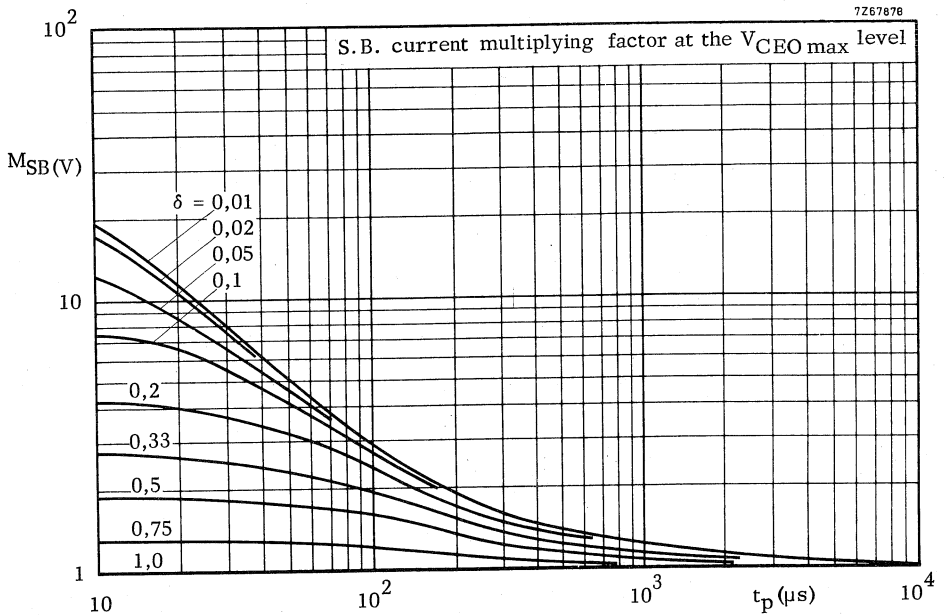
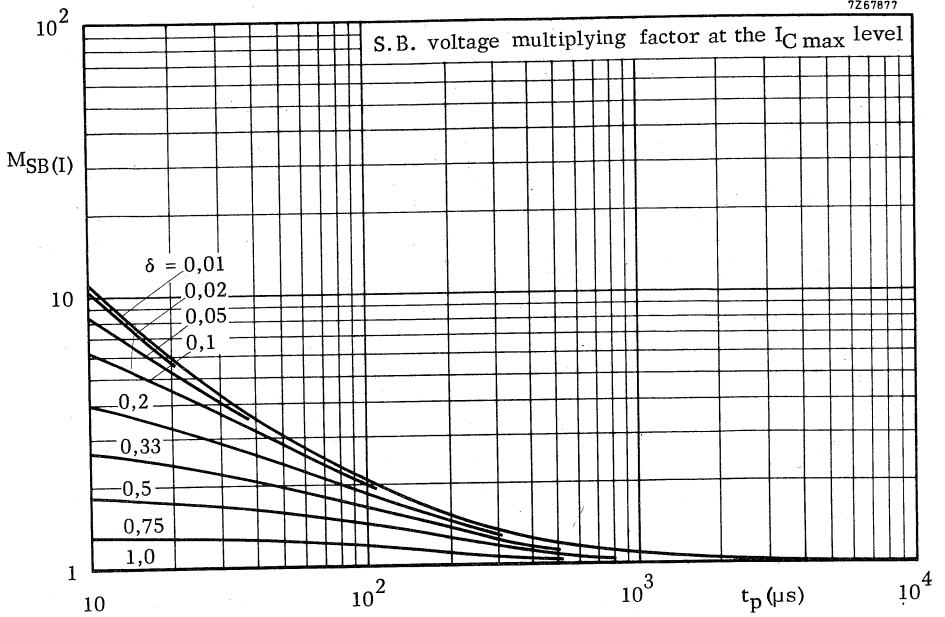
$C_{oe} < 4.5\text{ pF}$

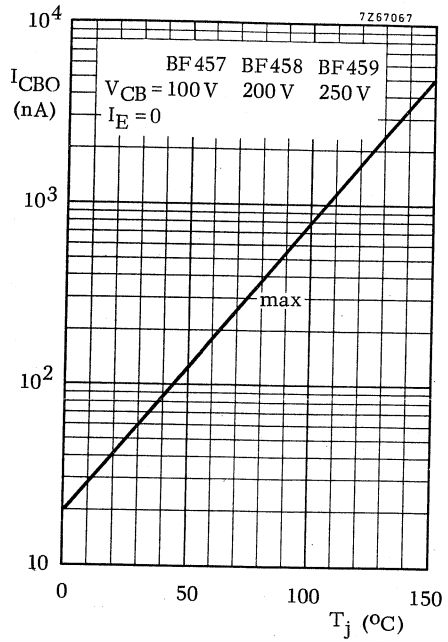
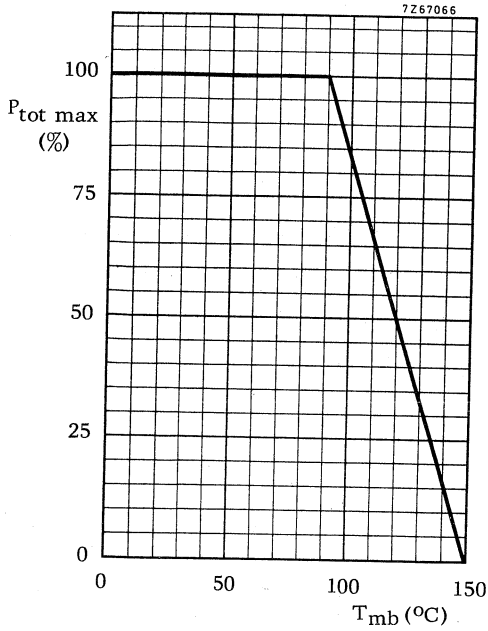




Safe Operating Area with the transistor forward biased







SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in plastic envelope intended for class-B video output stages in television receivers and for high-voltage i.f. output stages.
P-N-P complements are BF470 and BF472 respectively.

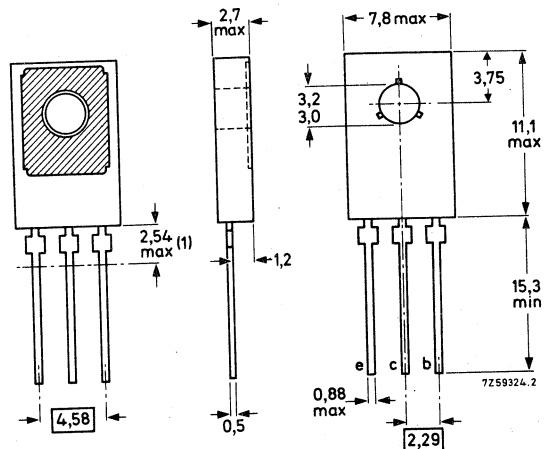
QUICK REFERENCE DATA

		BF469	BF471
Collector-base voltage (open emitter)	V_{CBO}	max. 250	300 V
Collector-emitter voltage open base	V_{CEO}	max. 250	— V
$R_{BE} = 2,7 \text{ k}\Omega$	V_{CER}	max. —	300 V
Collector current (peak value)	I_{CM}	max. 100	mA
Total power dissipation up to $T_{mb} \leq 114 \text{ }^\circ\text{C}$	P_{tot}	max. 1,8	W
Junction temperature	T_j	max. 150	$^\circ\text{C}$
D.C. current gain $I_C = 25 \text{ mA}; V_{CE} = 20 \text{ V}$	h_{FE}	>	50
Transition frequency $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$	f_T	>	60 MHz
Feedback capacitance at $f = 0,5 \text{ MHz}$ $I_E = 0; V_{CB} = 30 \text{ V}$	C_{re}	<	1,8 pF

MECHANICAL DATA

Fig. 1 TO-126 (SOT-32).

Collector connected
to mounting base



For mounting instructions
see Handbook section Accessories
type 56326 for direct mounting
type 56333 for insulated mounting
types 56353 and 56354 for direct and insulated clip mounting.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BF469	BF471
Collector-base voltage (open emitter)	V_{CBO}	max. 250	300 V
Collector-emitter voltage $R_{BE} = 2,7 \text{ k}\Omega$ open base	V_{CER}	max. —	300 V
	V_{CEO}	max. 250	— V
Emitter-base voltage (open collector)	V_{EBO}	max. 5	V
Collector current (d.c.)	I_C	max. 50	mA
Collector current (peak value)	I_{CM}	max. 100	mA
Total power dissipation up to $T_{mb} = 114 \text{ }^\circ\text{C}$ *	P_{tot}	max. 1,8	W
Storage temperature	T_{stg}	-65 to + 150 $^\circ\text{C}$	
Junction temperature	T_j	max. 150	$^\circ\text{C}$
THERMAL RESISTANCE			
From junction to mounting base	$R_{th \text{ j-mb}}$	= 20	$^\circ\text{C/W}$
From junction to ambient in free air *	$R_{th \text{ j-a}}$	= 100	$^\circ\text{C/W}$

* Transistor mounted on a printed-circuit board, maximum lead length 4 mm, mounting pad for collector lead minimum 10 mm x 10 mm.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

 $I_E = 0; V_{CB} = 200\text{ V}$ $R_{BE} = 2,7\text{ k}\Omega; V_{CE} = 200\text{ V}; T_j = 150\text{ }^\circ\text{C}$

I_{CBO}	<	10	nA
I_{CER}	<	10	μA

Emitter cut-off current

 $I_C = 0; V_{EB} = 5\text{ V}$

I_{EBO}	<	10	μA
-----------	---	----	---------------

D.C. current gain

 $I_C = 25\text{ mA}; V_{CE} = 20\text{ V}$

h_{FE}	>	50	
----------	---	----	--

High-frequency knee voltage at $T_j = 150\text{ }^\circ\text{C}^*$ $I_C = 25\text{ mA}$

V_{CEK}	typ.	20	V
-----------	------	----	---

Transition frequency

 $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$

f_T	>	60	MHz
-------	---	----	-----

Feedback capacitance at $f = 0,5\text{ MHz}$ $I_E = 0; V_{CB} = 30\text{ V}$

C_{re}	<	1,8	pF
----------	---	-----	----

Feedback time constant at $f = 10,7\text{ MHz}^{**}$ $-I_E = 10\text{ mA}; V_{CB} = 20\text{ V}$

$r_{bb'}C_{b'c}$	<	90	ps
------------------	---	----	----

* The high-frequency knee voltage of a transistor is that value of the collector-emitter voltage at which the small-signal gain, measured in a practical circuit, has dropped to 80% of the gain at $V_{CE} = 50\text{ V}$.
A further reduction of the collector-emitter voltage results in a rapid increase of the distortion of the signal.

** $r_{bb'}C_{b'c} = \frac{|h_{rb}|}{\omega}$.

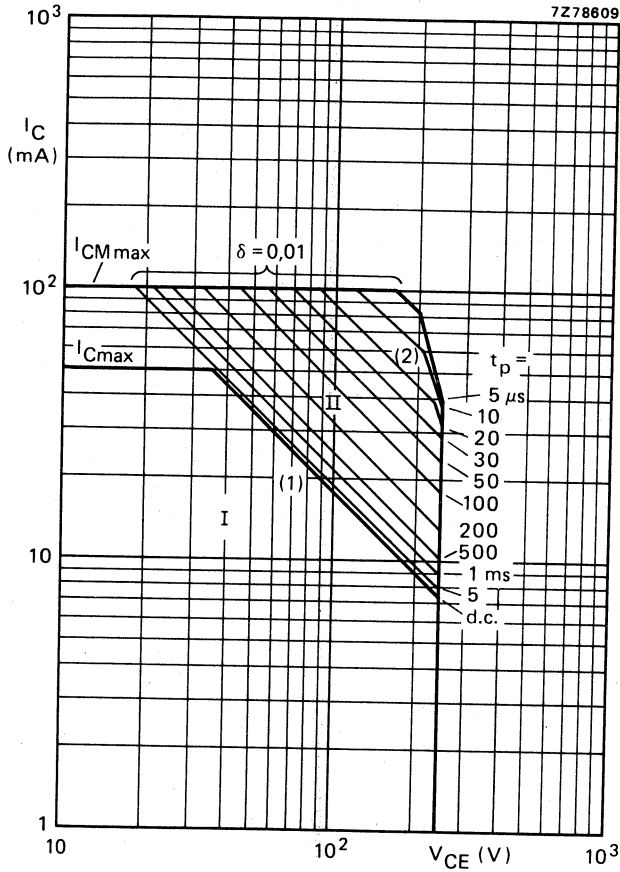


Fig. 2 Safe Operating Area at $T_{mb} = 114\text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\max}$ and $P_{peak\max}$ lines.
- (2) Second breakdown limits (independent of temperature).

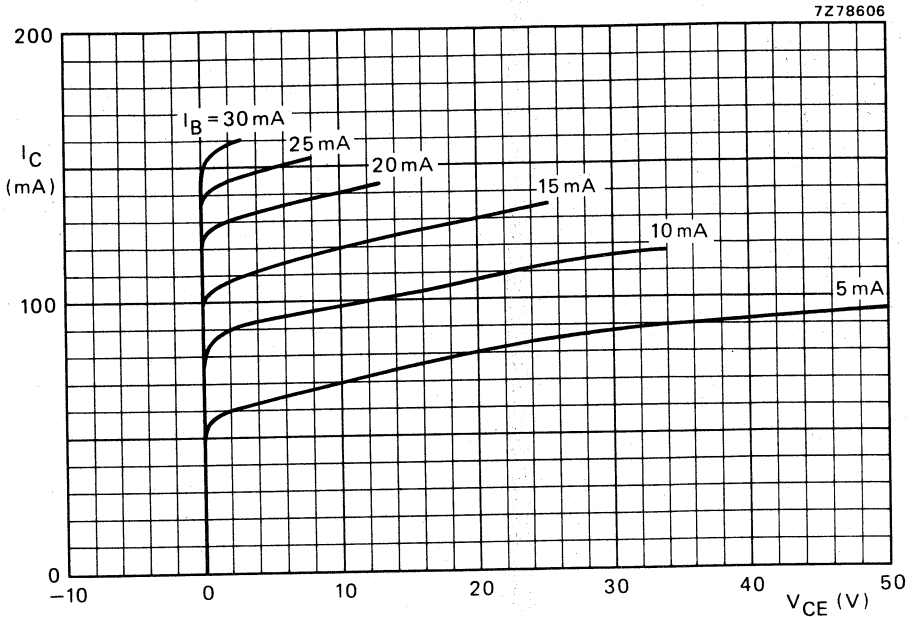


Fig. 3 $T_j = 25\text{ }^\circ\text{C}$.

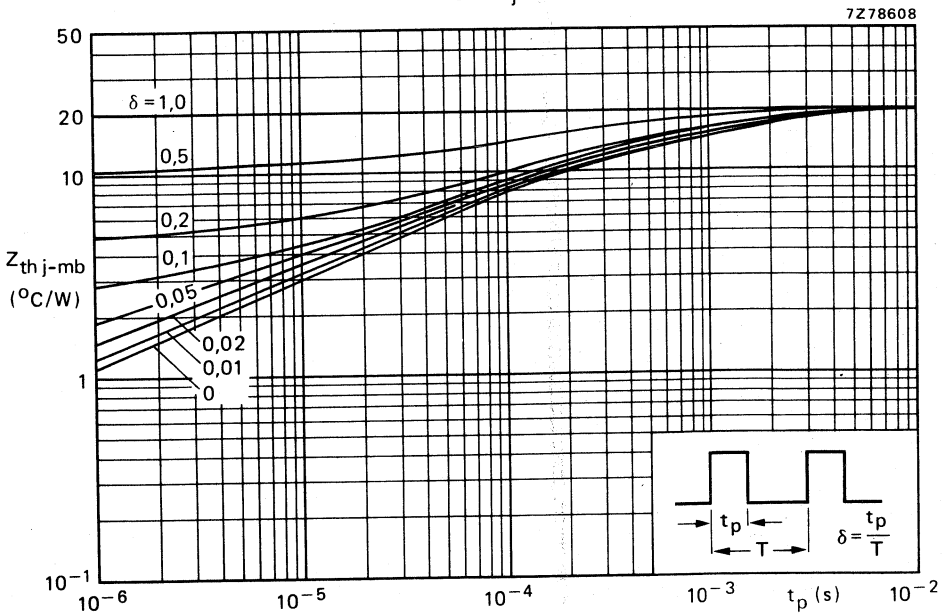


Fig. 4.

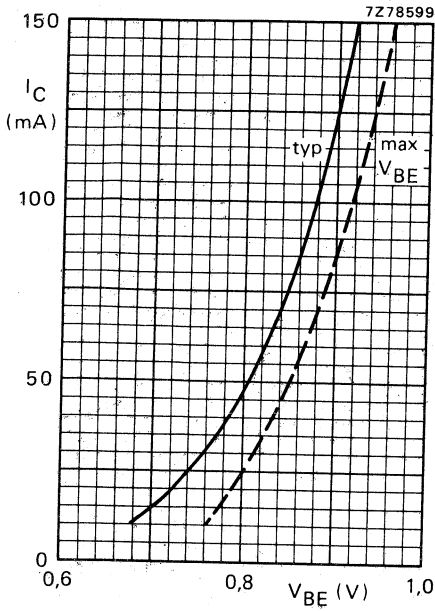


Fig. 5 $V_{CE} = 20$ V; $T_j = 25$ °C.

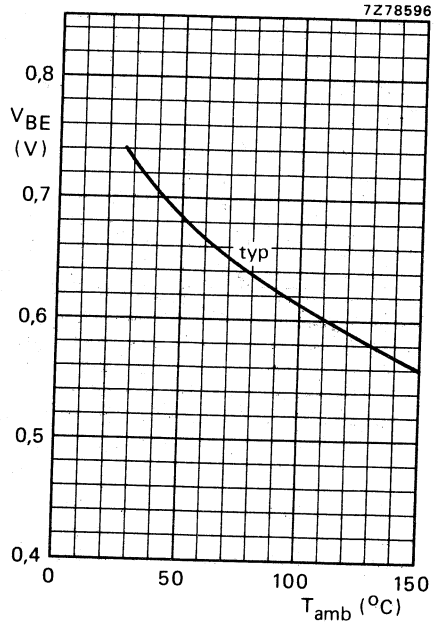


Fig. 6 $I_C = 25$ mA; $V_{CE} = 20$ V.

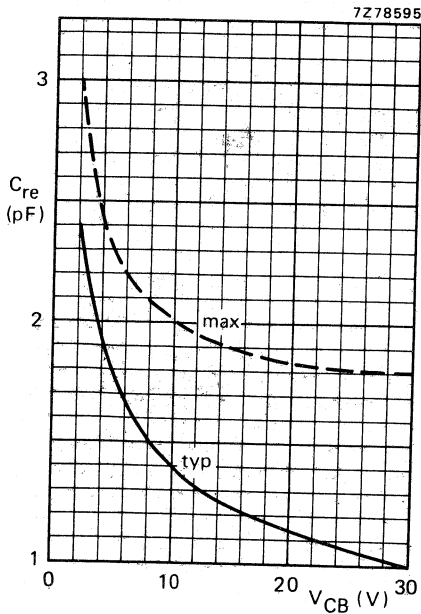


Fig. 7 $I_E = 0$; $f = 1$ MHz; $T_j = 25$ °C.

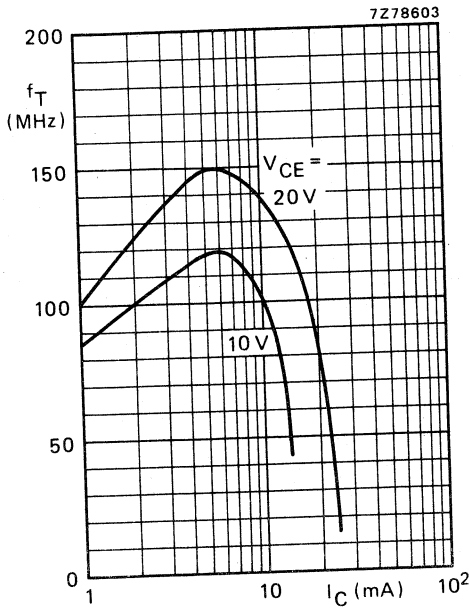


Fig. 8 $f_M = 35$ MHz; $T_{amb} = 25$ °C.

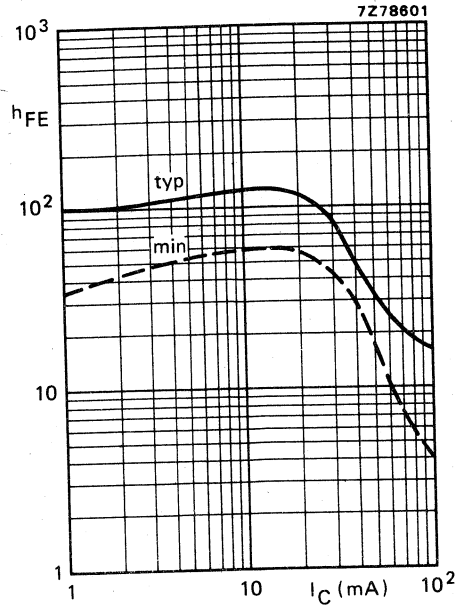


Fig. 9 $V_{CE} = 20$ V; $T_{amb} = 25$ °C.

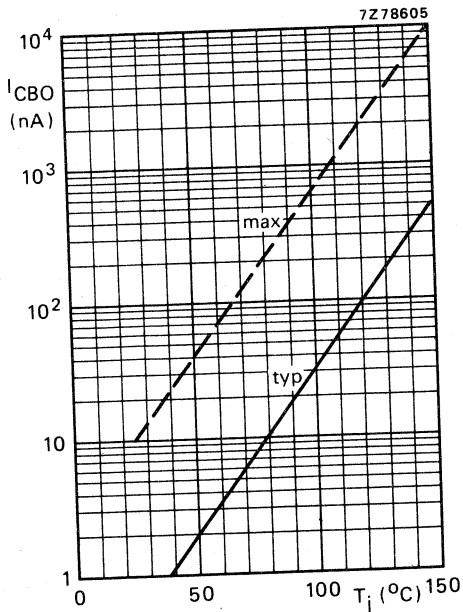


Fig. 10 $V_{CB} = 200$ V.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in a plastic envelope intended for class-B video output stages in television receivers and for high-voltage i.f. output stages.
N-P-N complements are BF469 and BF471 respectively.

QUICK REFERENCE DATA

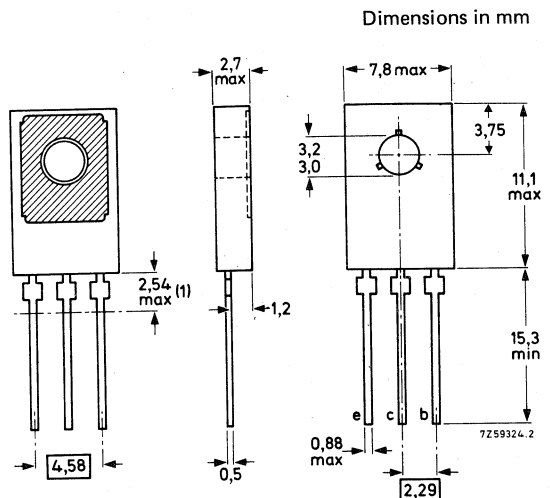
		BF470	BF472
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 250	300 V
Collector-emitter voltage open base	$-V_{CEO}$	max. 250	— V
	$-V_{CER}$	max. —	300 V
$R_{BE} = 2,7 \text{ k}\Omega$			
Collector current (peak value)	$-I_{CM}$	max. 100	mA
Total power dissipation up to $T_{mb} = 114 \text{ }^\circ\text{C}$	P_{tot}	max. 1,8	W
Junction temperature	T_j	max. 150	$^\circ\text{C}$
D.C. current gain	h_{FE}	>	50
$-I_C = 25 \text{ mA}; -V_{CE} = 20 \text{ V}$			
Transition frequency	f_T	>	60 MHz
$-I_C = 10 \text{ mA}; -V_{CE} = 10 \text{ V}$			
Feedback capacitance at $f = 0,5 \text{ MHz}$	C_{re}	<	1,8 pF
$I_E = 0; -V_{CB} = 30 \text{ V}$			

MECHANICAL DATA

Fig. 1 TO-126 (SOT-32).

Collector connected to mounting base.

For mounting instructions see Handbook section Accessories type 56326 for direct mounting type 56333 for insulated mounting types 56353 and 56354 for direct and insulated clip mounting.



RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BF470	BF472
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 250	300 V
Collector-emitter voltage	$-V_{CER}$	max. —	300 V
$R_{BE} = 2,7 \text{ k}\Omega$ open base	$-V_{CEO}$	max. 250	— V
Emitter-base voltage (open collector)	$-V_{EBO}$	max. 5	V
Collector current (d.c.)	$-I_C$	max. 50	mA
Collector current (peak value)	$-I_{CM}$	max. 100	mA
Total power dissipation up to $T_{mb} = 114 \text{ }^\circ\text{C}$ *	P_{tot}	max. 1,8	W
Storage temperature	T_{stg}	-65 to + 150 $^\circ\text{C}$	
Junction temperature	T_j	max. 150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th \text{ j-mb}}$	=	20	$^\circ\text{C/W}$
From junction to ambient in free air *	$R_{th \text{ j-a}}$	=	100	$^\circ\text{C/W}$

* Transistor mounted on a printed-circuit board, maximum lead length 4 mm; mounting pad for collector lead minimum 10 mm x 10 mm.

CHARACTERISTICS

 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current $I_E = 0; -V_{CB} = 200\text{ V}$ $R_{BE} = 2,7\text{ k}\Omega; -V_{CE} = 200\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$	<	10	nA
	$-I_{CER}$	<	10	μA
Emitter cut-off current $I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO}$	<	10	μA
D.C. current gain $-I_C = 25\text{ mA}; -V_{CE} = 20\text{ V}$	h_{FE}	>	50	
High-frequency knee voltage at $T_j = 150\text{ }^\circ\text{C}^*$ $-I_C = 25\text{ mA}$	$-V_{CEK}$	typ.	20	V
Transition frequency $-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	>	60	MHz
Feedback capacitance at $f = 0,5\text{ MHz}$ $I_E = 0; -V_{CB} = 30\text{ V}$	C_{re}	<	1,8	pF
Feedback time constant at $f = 10,7\text{ MHz}^{**}$ $I_E = 10\text{ mA}; -V_{CB} = 20\text{ V}$	$r_{bb} \cdot C_{b'c}$	<	90	ps

* The high-frequency knee voltage of a transistor is that value of the collector-emitter voltage at which the small-signal gain, measured in a practical circuit, has dropped to 80% of the gain at $-V_{CE} = 50\text{ V}$. A further reduction of the collector-emitter voltage results in a rapid increase of the distortion of the signal.

$$** r_{bb} \cdot C_{b'c} = \frac{|h_{rb}|}{\omega}$$

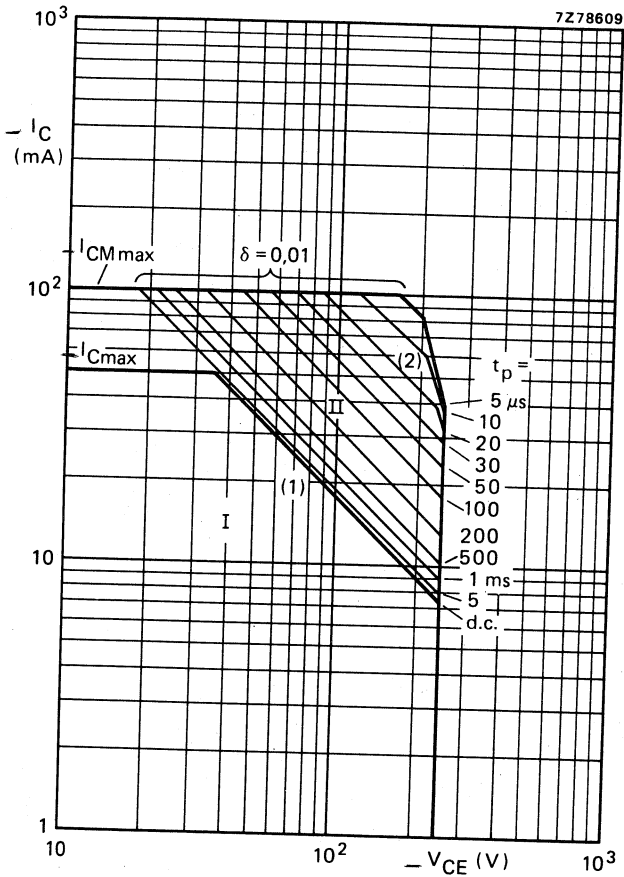
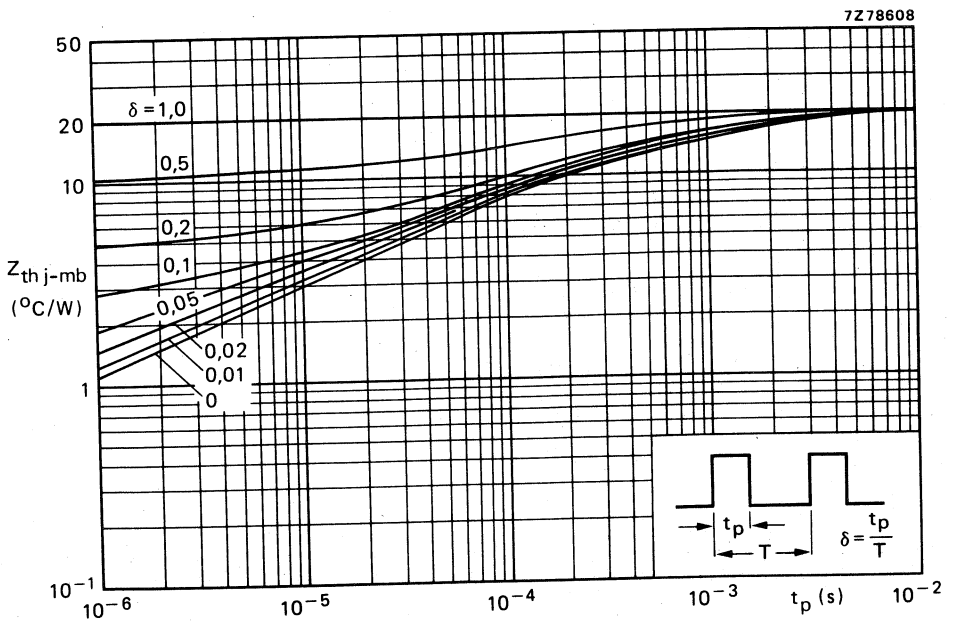
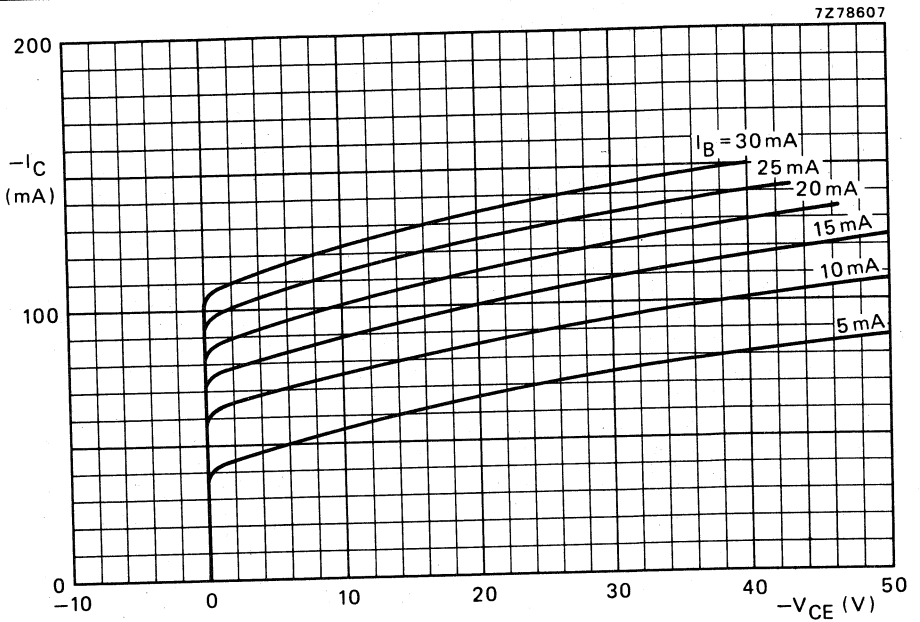


Fig. 2 Safe Operating Area at $T_{mb} = 114 \text{ }^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot \text{ max}}$ and $P_{tot \text{ peak max}}$ lines.
- (2) Second breakdown limits (independent of temperature).



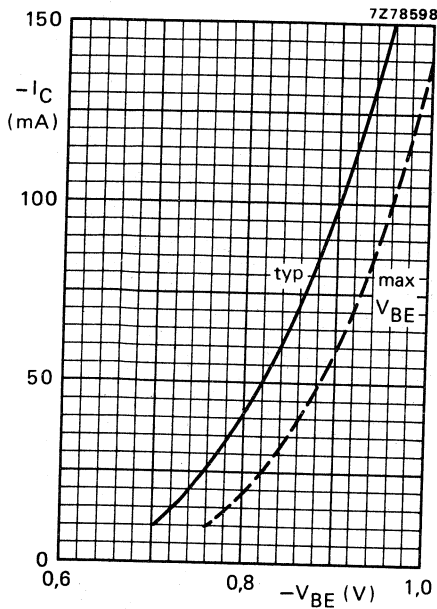


Fig. 5 $-V_{CE} = 20$ V; $T_j = 25$ °C.

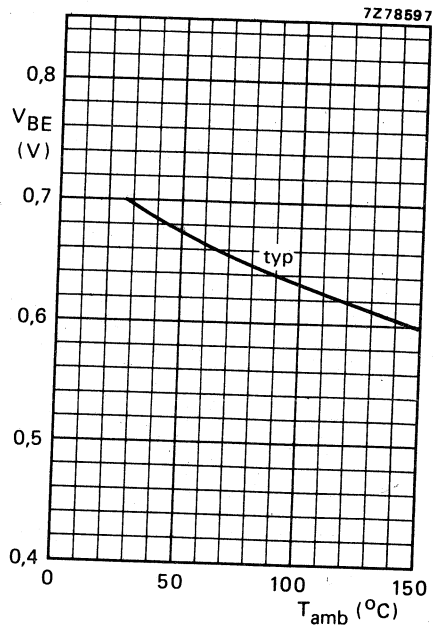


Fig. 6 $-V_{CE} = 20$ V; $-I_C = 25$ mA.

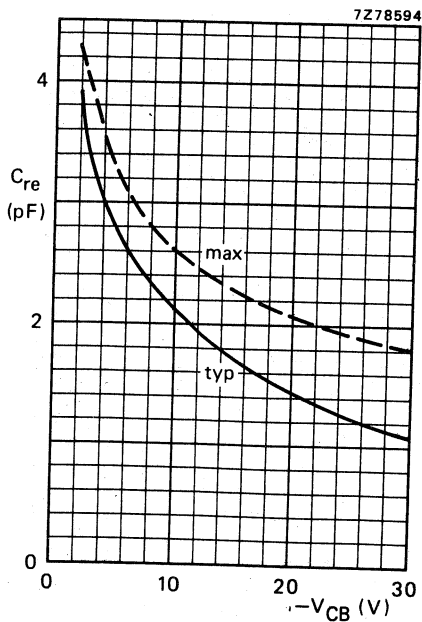


Fig. 7 $I_E = 0$; $f = 1$ MHz; $T_j = 25$ °C.

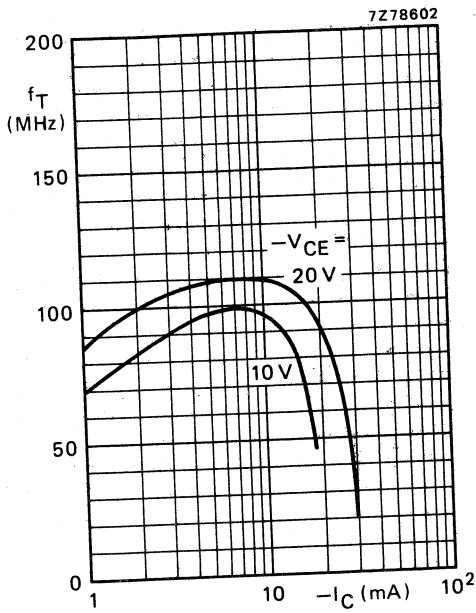


Fig. 8 $f_M = 35\text{ MHz}$; $T_{amb} = 25\text{ }^\circ\text{C}$.

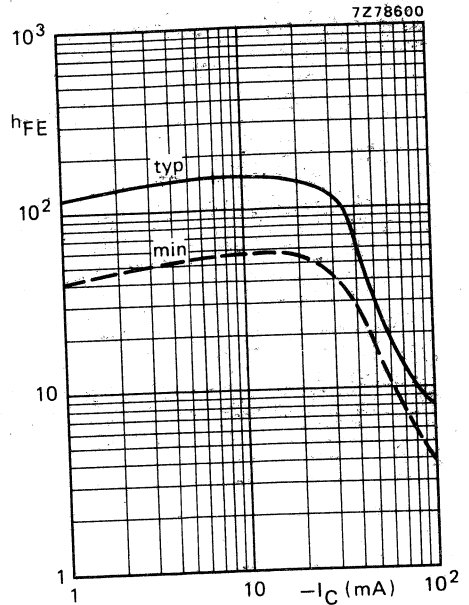


Fig. 9 $-V_{CE} = 20\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$.

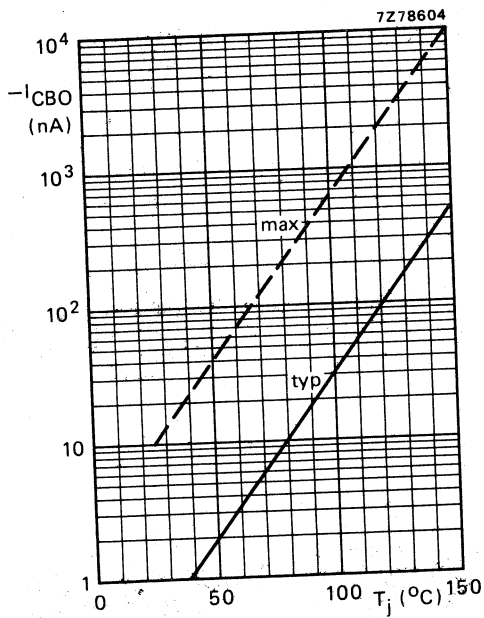


Fig. 10 $-V_{CB} = 200\text{ V}$.

SILICON DIFFUSED POWER TRANSISTOR

High voltage, high speed switching n-p-n power transistor intended for use in the switched mode power supply of 90° and 110° colour television receivers.

QUICK REFERENCE DATA

Collector-emitter voltage ($V_{BE} = 0$) (peak value)

V_{CESM} max. 750 V

Collector current (peak value)

I_{CM} max. 6 A

Total power dissipation up to
 $T_{mb} = 50^\circ C$

P_{tot} max. 30 W

Collector-emitter saturation voltage
 $I_C = 2,5 A; I_B = 0,25 A$

V_{CEsat} < 10 V

Fall time

t_f typ. 0,15 μs

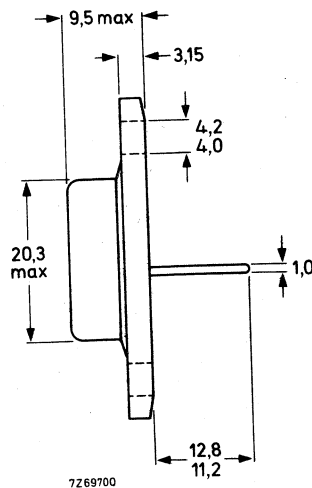
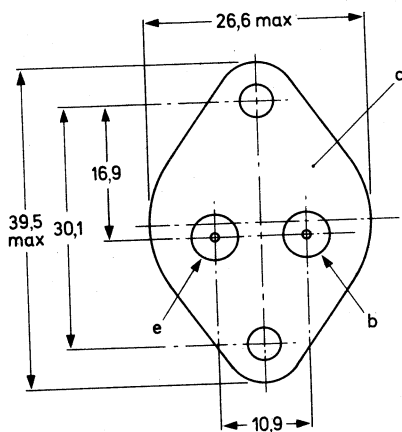
$I_{CM} = 2,5 A; I_{B(end)} = 0,25 A$

Dimensions in mm

MECHANICAL DATA

Collector connected to case.

TO-3



For mounting instructions and accessories, see section Accessories.

SILICON DIFFUSED POWER TRANSISTOR

High voltage n-p-n power transistor intended for general purpose applications.

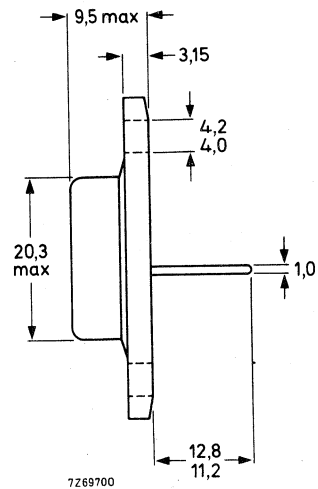
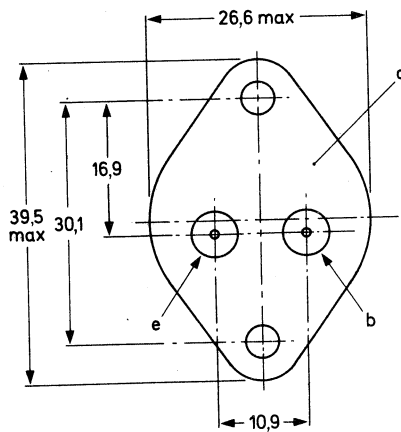
QUICK REFERENCE DATA			
Collector-emitter voltage ($V_{BE} = 0$) (peak value)	V_{CESM}	max.	750 V
Collector current (peak value)	I_{CM}	max.	6 A
Total power dissipation up to $T_{mb} = 50\text{ }^{\circ}\text{C}$	P_{tot}	max.	30 W
Collector-emitter saturation voltage $I_C = 2.5\text{ A}; I_B = 0.25\text{ A}$	$V_{CE\text{ sat}}$	<	10 V
Fall time $I_{CM} = 2.5\text{ A}; I_{B1} = -I_{B2} = 0.5\text{ A}; V_{CC} = 125\text{ V}$	t_f	typ.	0.5 μs

MECHANICAL DATA

Dimensions in mm

Collector connected to case

TO-3



For mounting instructions and accessories, see section Accessories.

SILICON DIFFUSED POWER TRANSISTORS

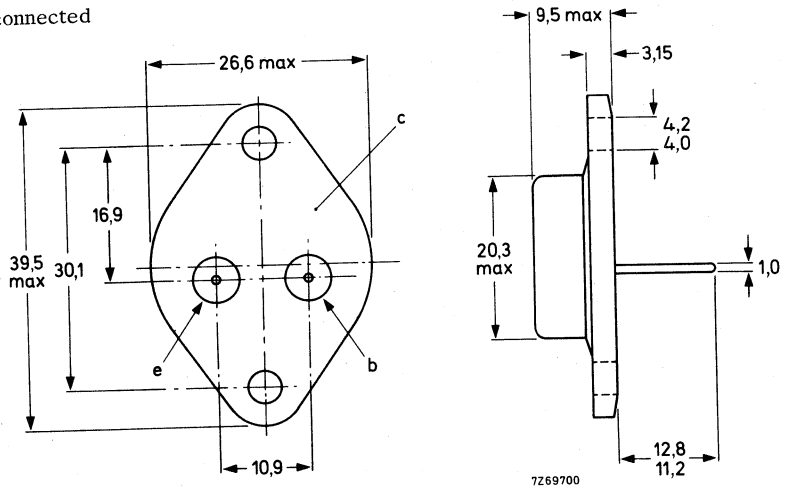
High-voltage, high-speed switching n-p-n transistors in a metal envelope intended for use in horizontal deflection circuits of television receivers.

QUICK REFERENCE DATA		BU204	BU205	BU206
Collector-emitter voltage ($V_{BE}=0$, peak value)	V_{CESM} max.	1300	1500	1700 V
Collector current (d. c.)	I_C max.	2,5	2,5	2,5 A
Total power dissipation up to $T_{mb} = 90\text{ }^\circ\text{C}$	P_{tot} max.	10	10	10 W
D. C. current gain $I_C = 2\text{ A}; V_{CE} = 5\text{ V}$	$h_{FE} >$	2	2	1,8
Fall time $I_{CM} = 2\text{ A}; I_{B(end)} = 1\text{ A}$	t_f typ.	0,75	0,75	0,75 μs

MECHANICAL DATA

TO-3

Collector connected to case



For mounting instructions and accessories see section Accessories.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltage

			BU204	BU205	BU206
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM}	max.	1300	1500	1700 V
Collector-emitter voltage ($R_{BE} \leq 100 \Omega$, peak value)	V_{CERM}	max.	1300	1500	1700 V
Collector-emitter voltage (open base)	V_{CEO}	max.	600	700	800 V

Current

Collector current (d.c.)	I_C	max.		2,5	A
Collector current (peak value)	I_{CM}	max.		3	A
Base current (peak value)	I_{BM}	max.		2,5	A
Reverse base current (d.c. or average over any 20 ms period)	$-I_{B(AV)}$	max.		100	mA
Reverse base current (peak value) ¹⁾	$-I_{BM}$	max.		1,5	A

Power dissipation

Total power dissipation up to $T_{mb} = 90 \text{ }^\circ\text{C}$	P_{tot}	max.		10	W
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Temperature

Storage temperature	T_{stg}			-65 to +115	$^\circ\text{C}$
Junction temperature	T_j	max.		115	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th j-mb}$	max.		2,5	$^\circ\text{C/W}$
--------------------------------	---------------	------	--	-----	--------------------

1) Turn-off current.

$T_j = 25^\circ\text{C}$ unless otherwise specified

CHARACTERISTICS

Collector cut-off current

$$V_{BE} = 0; V_{CE} = V_{CESMmax}$$

$$I_{CES} < \begin{matrix} 1 \\ \text{mA} \end{matrix}$$

D.C. current gain

$$I_C = 2 \text{ A}; V_{CE} = 5 \text{ V}$$

$$h_{FE} > \begin{matrix} \text{BU204} & \text{BU205} & \text{BU206} \\ 2 & 2 & 1, 8 \end{matrix}$$

Emitter-base voltage

$$I_C = 0; I_E = 10 \text{ mA}$$

$$+V_{EBO} > \begin{matrix} 5 & 5 & 5 \text{ V} \end{matrix}$$

$$I_C = 0; I_E = 100 \text{ mA}$$

$$+V_{EBO} \text{ typ.} \begin{matrix} 7 & 7 & 7 \text{ V} \end{matrix}$$

Saturation voltage

$$I_C = 2 \text{ A}; I_B = 1 \text{ A}$$

$$V_{CESat} < \begin{matrix} 5 & 5 & - \text{ V} \end{matrix}$$

$$I_C = 2 \text{ A}; I_B = 1, 1 \text{ A}$$

$$V_{CESat} < \begin{matrix} - & - & 5 \text{ V} \end{matrix}$$

$$I_C = 2 \text{ A}; I_B = 1 \text{ A}$$

$$V_{BESat} < \begin{matrix} 1, 5 & 1, 5 & - \end{matrix}$$

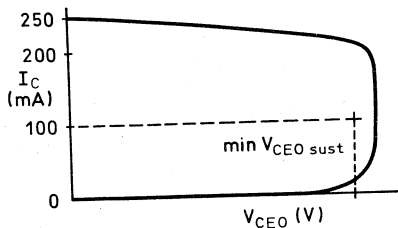
$$I_C = 2 \text{ A}; I_B = 1, 1 \text{ A}$$

$$V_{BESat} < \begin{matrix} - & - & 1, 5 \text{ V} \end{matrix}$$

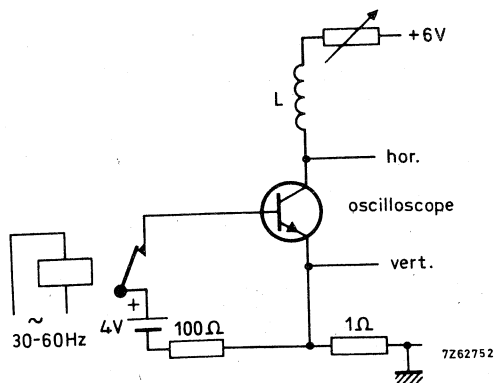
Collector-emitter sustaining voltage

$$I_B = 0; I_C = 100 \text{ mA}; L = 25 \text{ mH}$$

$$V_{CEOsust} > \begin{matrix} 600 & 700 & 800 \text{ V} \end{matrix}$$



Oscilloscope display for $V_{CEOsust}$



Test circuit for $V_{CEOsust}$

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Transition frequency at $f = 5\text{ MHz}$

$I_C = 0,1\text{ A}; V_{CE} = 5\text{ V}$

f_T typ. 7,5 MHz

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

C_c typ. 65 pF

Switching times (in horizontal deflection circuit)

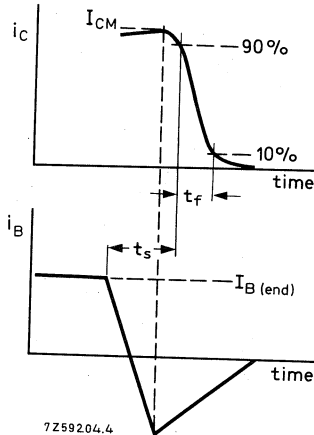
$I_{CM} = 2\text{ A}; I_{B(end)} = 1\text{ A}; L_B = 25\text{ }\mu\text{H}$

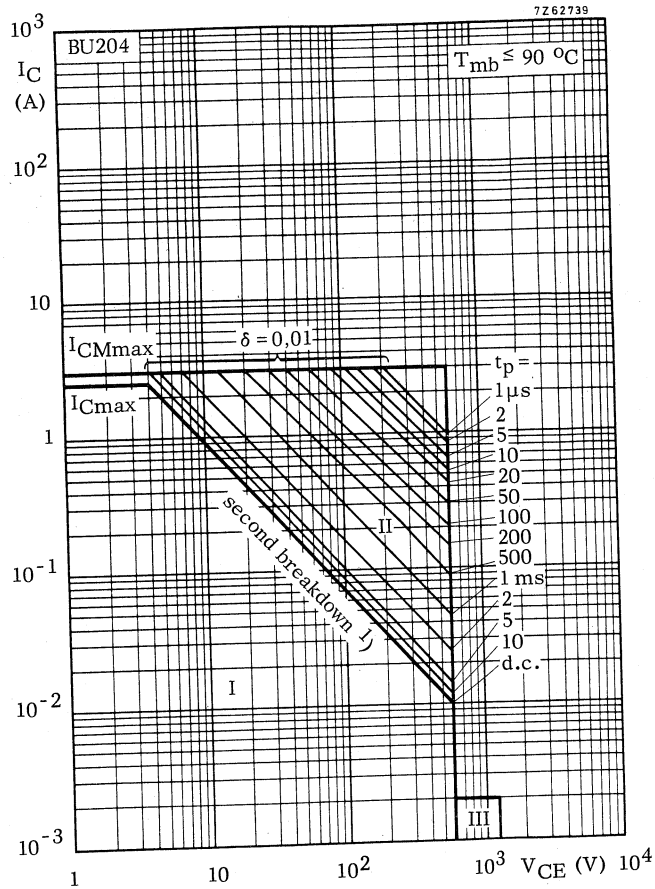
Fall time

t_f typ. 0,75 μs

Storage time

t_s typ. 10 μs





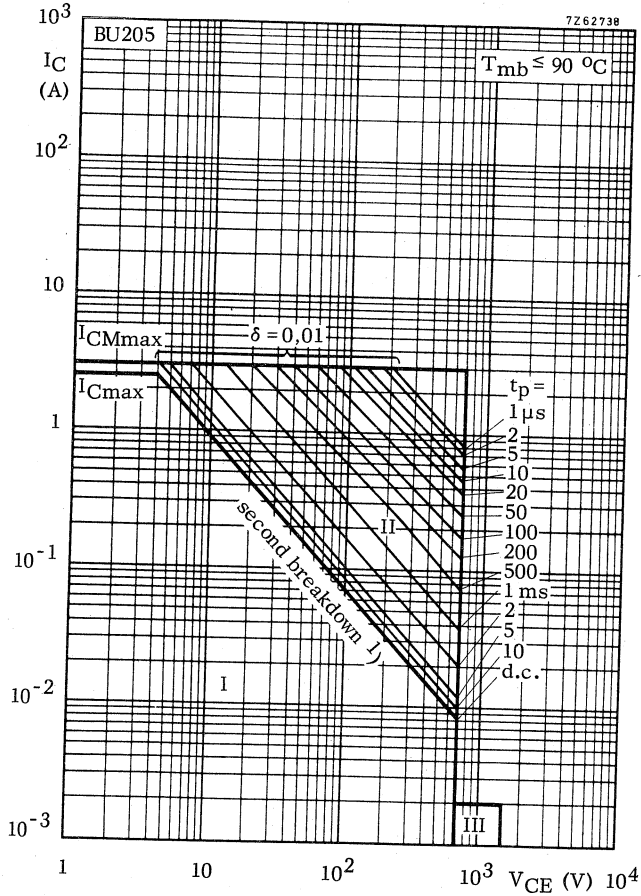
Safe Operation Area with the transistor forward biased.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 100 \Omega$; $t_p \leq 20 \mu s$; $\delta \leq 0,25$.

Note

Information on picture tube arcing is available.

1) Independent of temperature.



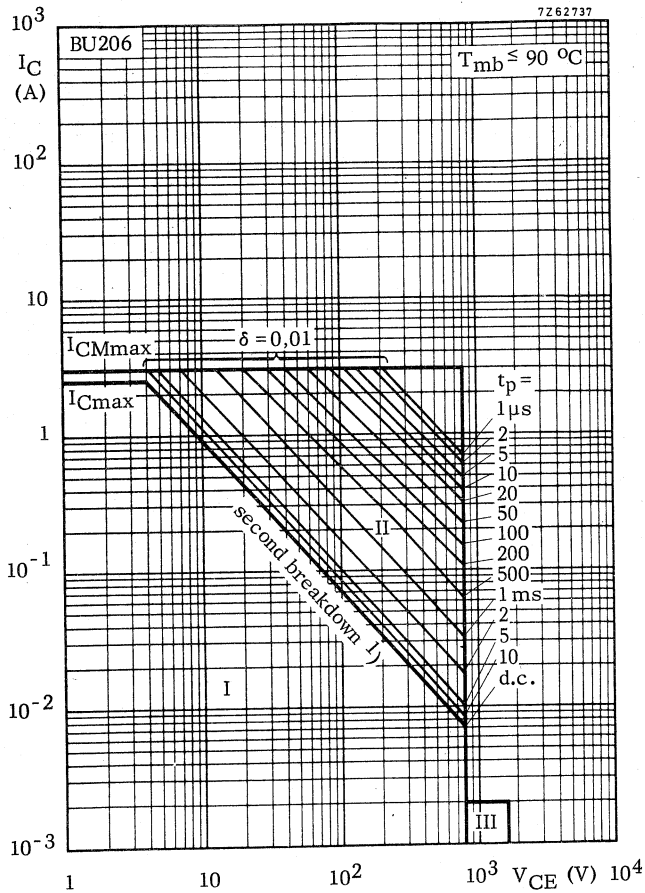
Safe Operation Area with the transistor forward biased.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 100 \Omega$; $t_p \leq 20 \mu\text{s}$; $\delta \leq 0, 25$.

Note

Information on picture tube arcing is available.

1) Independent of temperature.



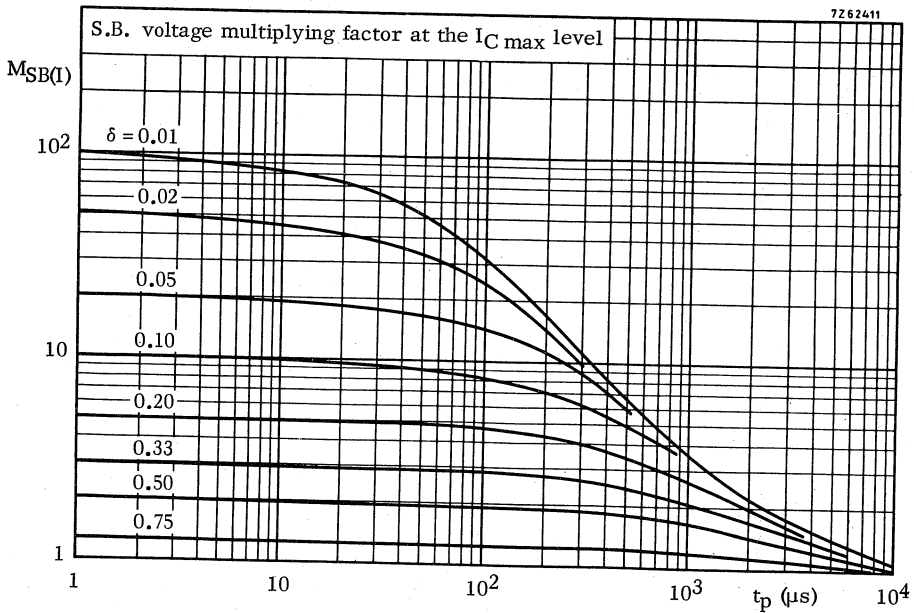
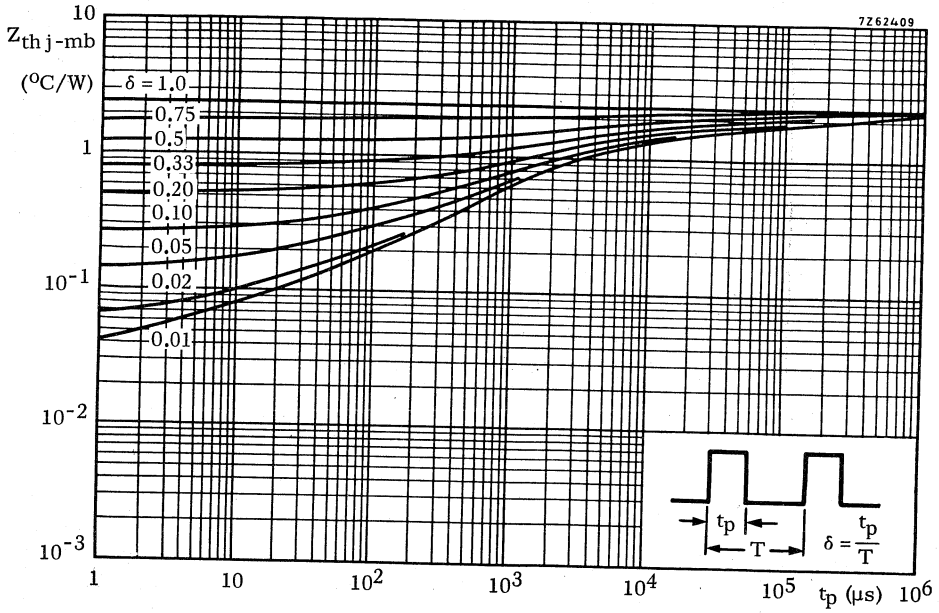
Safe Operating Area with the transistor forward biased.

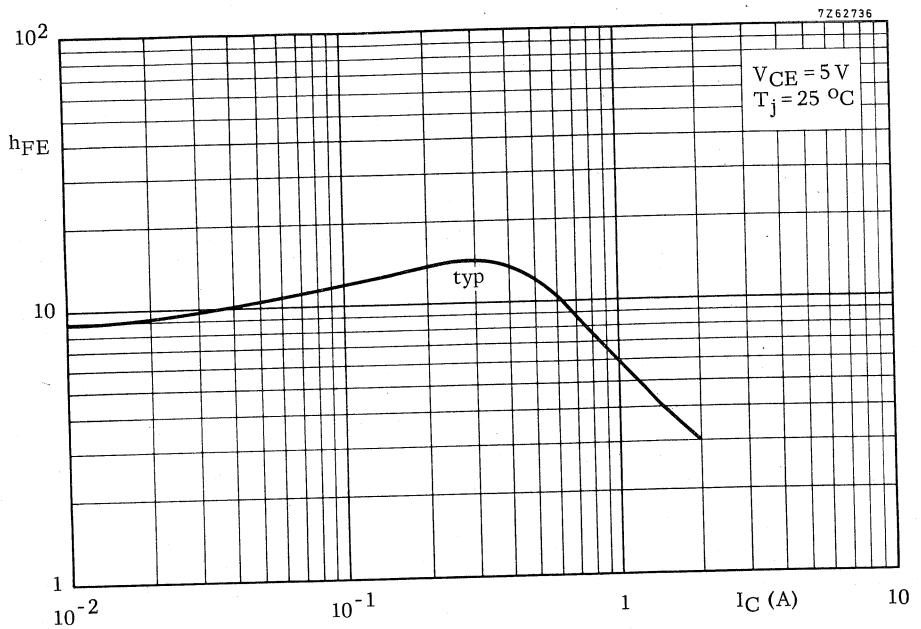
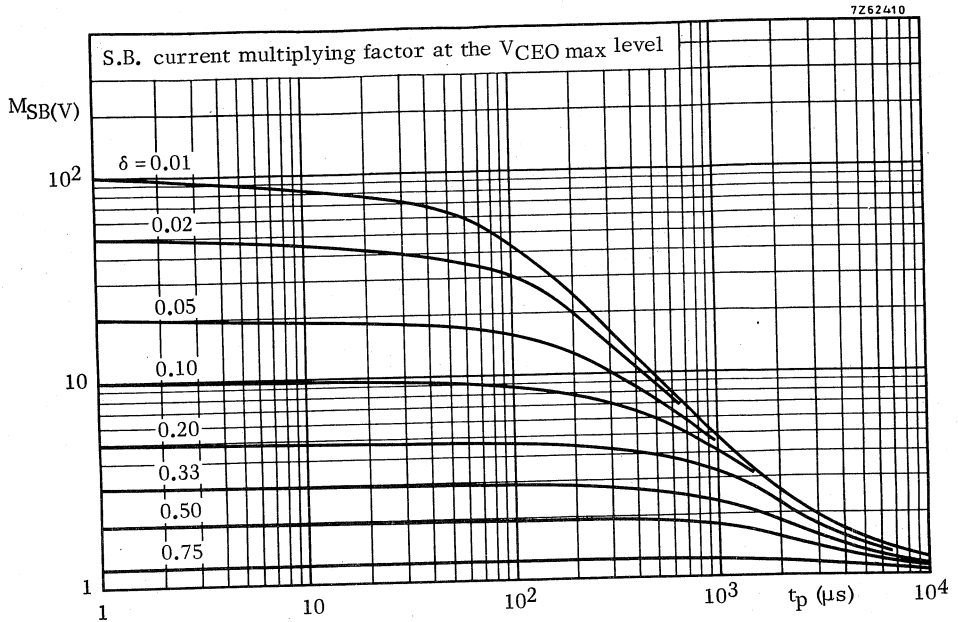
- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation;
- III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 100 \Omega$; $t_p \leq 20 \mu s$; $\delta \leq 0,25$.

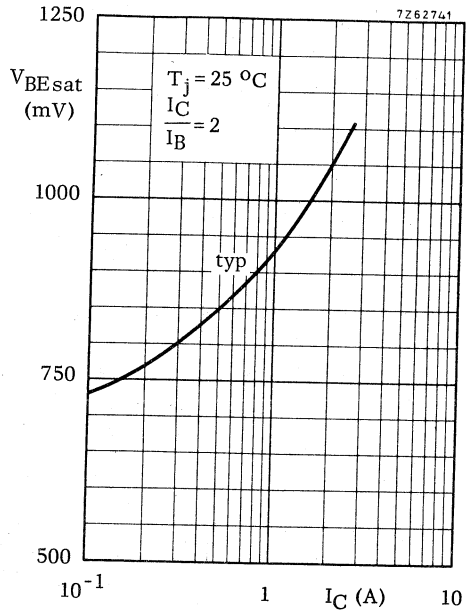
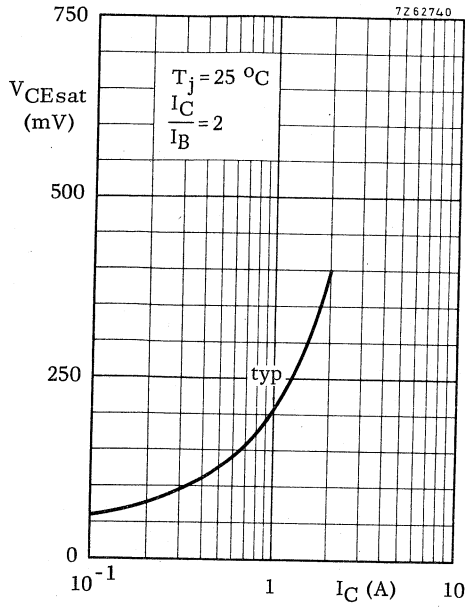
Note

Information on picture tube arcing is available.

1) Independent of temperature.







SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed switching n-p-n transistors in a metal envelope intended for use in horizontal deflection circuits of colour television receivers.

QUICK REFERENCE DATA

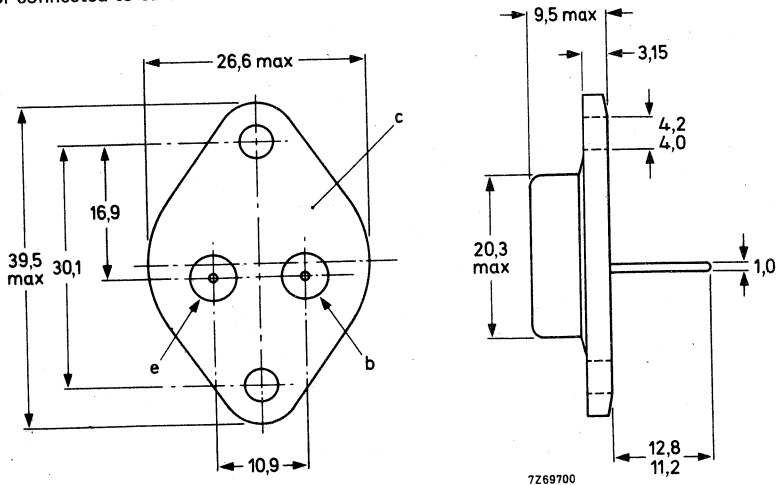
		BU207A	BU209A	
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM} max.	1500	1700	V
Collector current (d.c.)	I_C max.	5	4	A
Total power dissipation up to $T_{mb} = 95^\circ\text{C}$	P_{tot} max.	12,5	12,5	W
Collector-emitter saturation voltage $I_C = 4,5\text{ A}; I_B = 2\text{ A}$	$V_{CEsat} <$	5	—	V
$I_C = 3\text{ A}; I_B = 1,3\text{ A}$	$V_{CEsat} <$	—	5	V
Fall time $I_{CM} = 4,5\text{ A}; I_{B(end)} = 1,8\text{ A}$	t_f typ.	0,9	—	μs
$I_{CM} = 3\text{ A}; I_{B(end)} = 1,3\text{ A}$	t_f typ.	—	0,7	μs

MECHANICAL DATA

Dimensions in mm

TO-3

Collector connected to case.



See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BU207A	BU209A
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM} max.	1500	1700 V
Collector-emitter voltage ($R_{BE} \leq 100 \Omega$, peak value)	V_{CERM} max.	1500	1700 V
Collector-emitter voltage (open base)	V_{CEO} max.	600	800 V
Collector current (d.c.)	I_C max.	5	4 A
Collector current (peak value)	I_{CM} max.	7,5	6 A
Base current (peak value)	I_{BM} max.	4	4 A
Reverse base current (d.c. or average over any 20 ms period)	$-I_{B(AV)}$ max.	100	mA
Reverse base current (peak value)*	$-I_{BM}$ max.	3,5	A
Total power dissipation up to $T_{mb} = 95 \text{ }^\circ\text{C}$	P_{tot} max.	12,5	W
Storage temperature	T_{stg}	-65 to + 115	$^\circ\text{C}$
Junction temperature	T_j max.	115	$^\circ\text{C}$
THERMAL RESISTANCE			
From junction to mounting base	$R_{th j-mb}$ =	1,6	$^\circ\text{C/W}$

* Turn-off current.

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$V_{BE} = 0; V_{CE} = V_{CESMmax}$

D.C. current gain

$I_C = 4,5\text{ A}; V_{CE} = 5\text{ V}$

$I_C = 3,0\text{ A}; V_{CE} = 5\text{ V}$

Emitter-base voltage

$I_C = 0; I_E = 10\text{ mA}$

$I_C = 0; I_E = 100\text{ mA}$

Saturation voltage

$I_C = 4,5\text{ A}; I_B = 2\text{ A}$

$I_C = 3,0\text{ A}; I_B = 1,3\text{ A}$

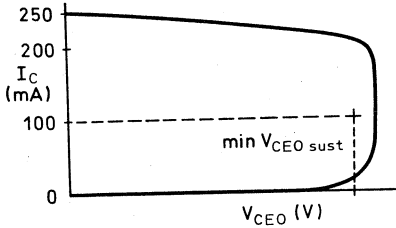
$I_C = 4,5\text{ A}; I_B = 2\text{ A}$

$I_C = 3,0\text{ A}; I_B = 1,3\text{ A}$

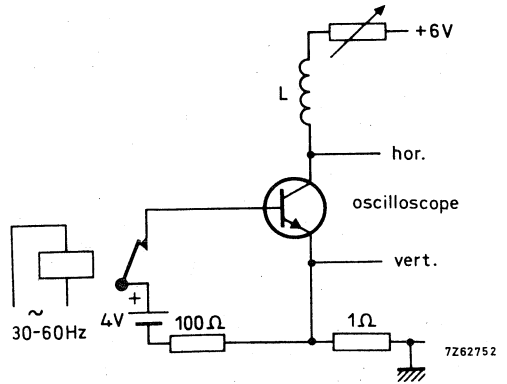
Collector-emitter sustaining voltage

$I_B = 0; I_C = 100\text{ mA}; L = 25\text{ mH}$

		1,0 mA	
		BU207A	BU209A
I_{CES}	<		
h_{FE}	>	2,25	—
h_{FE}	>	—	2,25
$+V_{EBO}$	>	5	5 V
$+V_{EBO}$	typ.	7	7 V
V_{CEsat}	<	5	— V
V_{CEsat}	<	—	5 V
V_{BEsat}	<	1,5	—
V_{BEsat}	<	—	1,5 V
$V_{CEO sust}$	>	600	800 V



Oscilloscope display for $V_{CEO sust}$.



Test circuit for $V_{CEO sust}$.

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Transition frequency at $f = 5\text{ MHz}$

$I_C = 0,1\text{ A}$; $V_{CE} = 5\text{ V}$

f_T typ. 7 MHz

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0$; $V_{CB} = 10\text{ V}$

C_c typ. 125 pF

Switching times (in line deflection circuit)

$L_B = 10\text{ }\mu\text{H}$

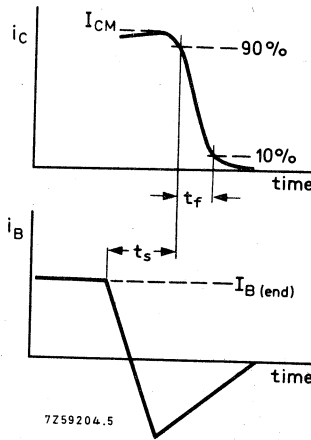
$I_{CM} = 4,5\text{ A}$; $I_{B(\text{end})} = 1,8\text{ A}$

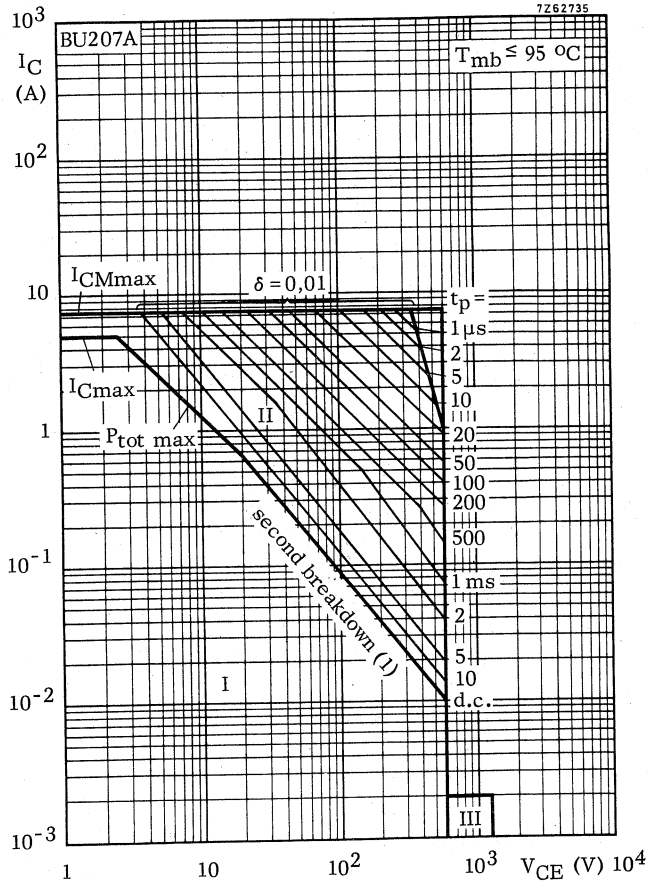
		BU207A	BU209A
t_f	typ.	0,9	— μs
t_f	typ.	—	0,7 μs
t_s	typ.	10	— μs
t_s	typ.	—	10 μs

$I_{CM} = 3,0\text{ A}$; $I_{B(\text{end})} = 1,3\text{ A}$

$I_{CM} = 4,5\text{ A}$; $I_{B(\text{end})} = 1,8\text{ A}$

$I_{CM} = 3,0\text{ A}$; $I_{B(\text{end})} = 1,3\text{ A}$





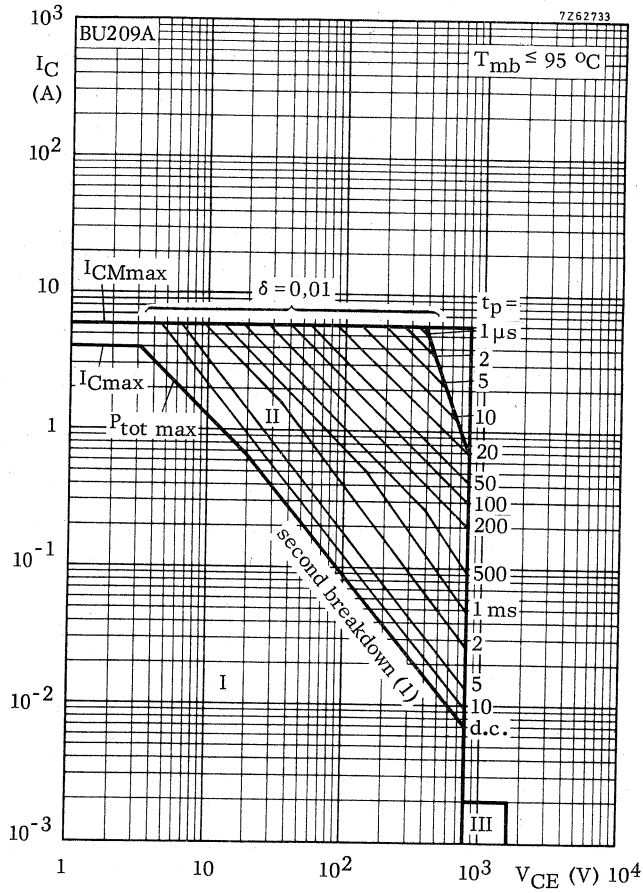
Safe Operating Area with the transistor forward biased.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- III Repetitive pulse operation in this region is permissible, provided $R_{BE} \leq 100 \text{ } \Omega$; $t_p \leq 20 \text{ } \mu\text{s}$; $\delta \leq 0,25$.

Notes

Information on picture tube arcing is available.

(1) Independent of temperature.



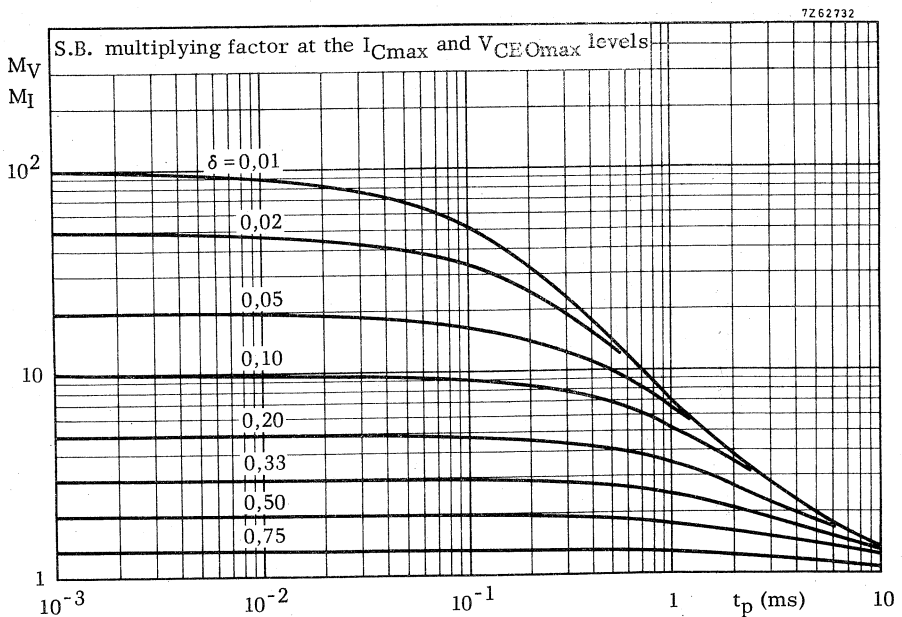
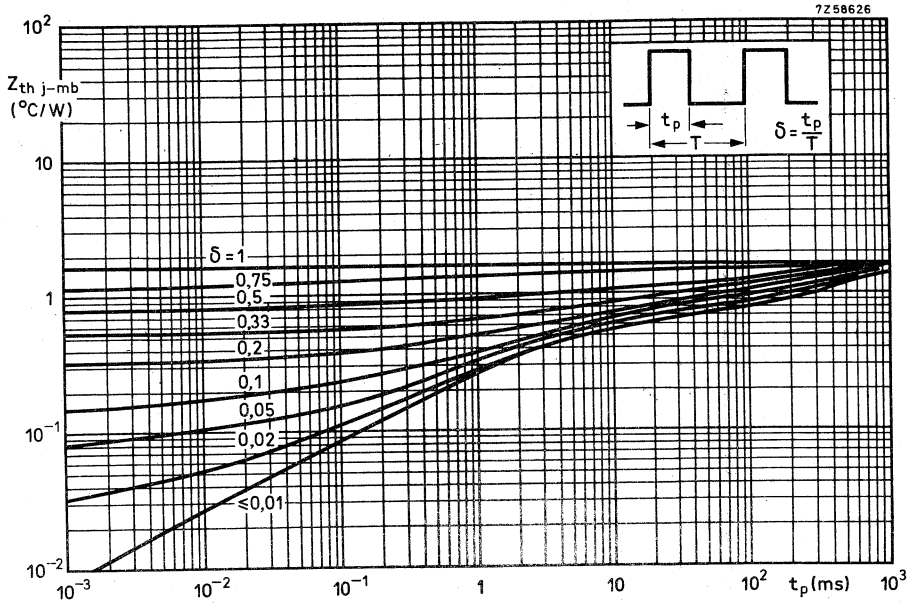
Safe Operating Area with the transistor forward biased.

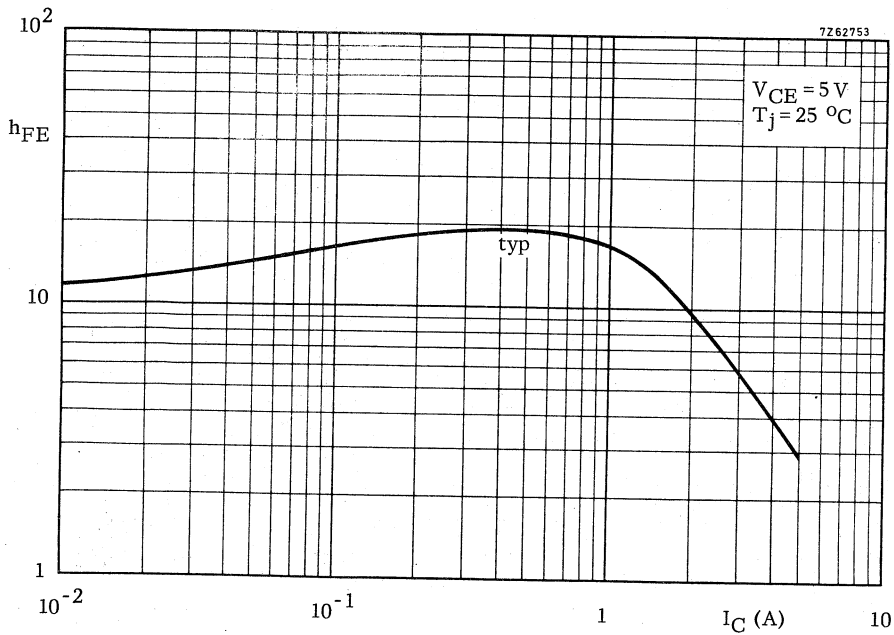
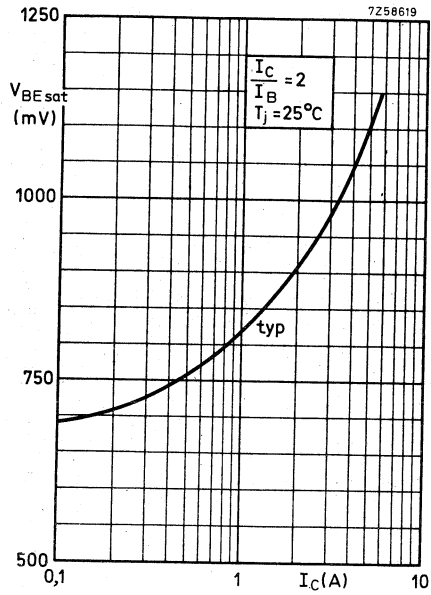
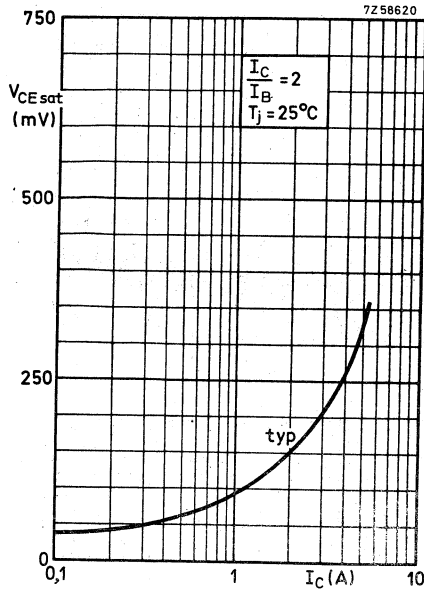
- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- III Repetitive pulse operation in this region is permissible, provided $R_{BE} \leq 100 \text{ } \Omega$; $t_p \leq 20 \text{ } \mu\text{s}$; $\delta \leq 0,25$.

Notes

Information on picture tube arcing is available.

(1) Independent of temperature.





SILICON DIFFUSED POWER TRANSISTOR

High-voltage, high-speed switching n-p-n transistor in a metal envelope intended for use in horizontal deflection circuits of colour television receivers.

QUICK REFERENCE DATA

Collector-emitter voltage ($V_{BE} = 0$, peak value)

V_{CESM} max. 1500 V

Collector current (d.c.)

I_C max. 5 A

Total power dissipation up to $T_{mb} = 25^\circ\text{C}$

P_{tot} max. 80 W

Collector-emitter saturation voltage

$I_C = 4,5 \text{ A}; I_B = 2 \text{ A}$

V_{CEsat} < 1 V

Fall time

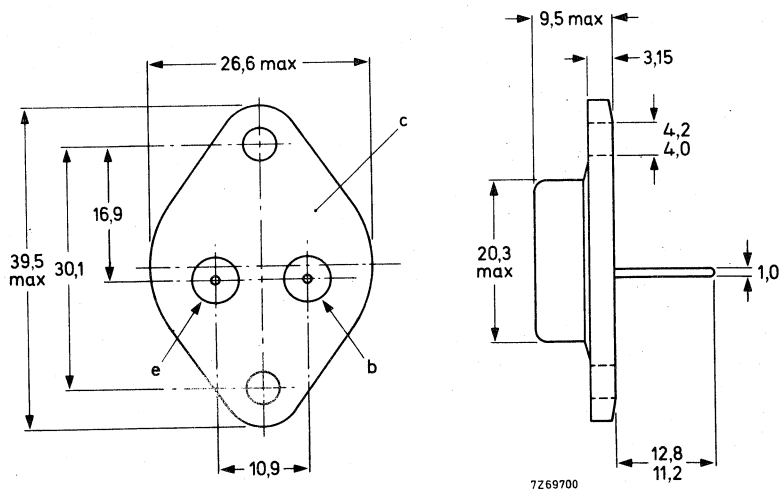
$I_{CM} = 4,5 \text{ A}; I_{B(end)} = 1,4 \text{ A}$

t_f typ. 0,7 μs

MECHANICAL DATA

Fig. 1 TO-3.

Collector connected to case.



For mounting instructions and accessories see Handbook section Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM}	max.	1500 V
Collector-emitter voltage ($R_{BE} \leq 100 \Omega$, peak value)	V_{CERM}	max.	1500 V
Collector-emitter voltage (open base)	V_{CEO}	max.	700 V
Collector current (d.c.)	I_C	max.	5 A
Collector current (peak value)	I_{CM}	max.	7,5 A
Collector current (non-repetitive peak)	I_{CSM}	max.	15 A
Base current (peak value)	I_{BM}	max.	4 A
Reverse base current (d.c. or average over any 20 ms period)	$-I_{B(AV)}$	max.	100 mA
Reverse base current (peak value) *	$-I_{BM}$	max.	4 A
Total power dissipation up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	80 W
Storage temperature	T_{stg}		-65 to + 115 $^\circ\text{C}$
Junction temperature	T_j	max.	115 $^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th \text{ j-mb}}$	max.	1,12 $^\circ\text{C/W}$
--------------------------------	-----------------------	------	-------------------------



* Turn-off current.

CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$V_{BE} = 0; V_{CE} = V_{CESmax}$

$I_{CES} < 1,0\text{ mA}$

D.C. current gain

$I_C = 4,5\text{ A}; V_{CE} = 5\text{ V}$

$h_{FE} > 2,5$

Emitter-base voltage

$I_C = 0; I_E = 10\text{ mA}$

$+V_{EBO} > 5\text{ V}$

$I_C = 0; I_E = 100\text{ mA}$

$+V_{EBO} \text{ typ. } 7\text{ V}$

Saturation voltage

$I_C = 4,5\text{ A}; I_B = 2\text{ A}$

$V_{CEsat} < 1\text{ V}$

$I_C = 4,5\text{ A}; I_B = 2\text{ A}$

$V_{BEsat} < 1,5\text{ V}$

Collector-emitter sustaining voltage

$I_B = 0; I_C = 100\text{ mA}; L = 25\text{ mH}$

$V_{CEOsust} > 700\text{ V}$

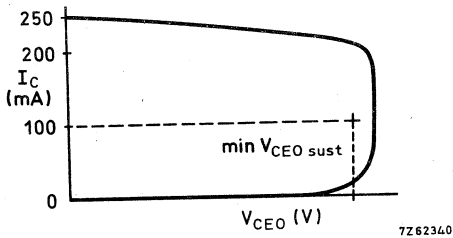


Fig. 2 Oscilloscope display for $V_{CEOsust}$.

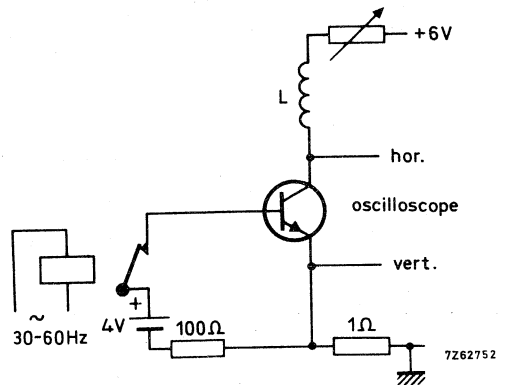


Fig. 3 Test circuit for $V_{CEOsust}$.

CHARACTERISTICS (continued)

Transition frequency at $f = 5 \text{ MHz}$

$I_C = 0,1 \text{ A}; V_{CE} = 5 \text{ V}$

f_T typ. 7 MHz

Collector capacitance at $f = 1 \text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10 \text{ V}$

C_C typ. 125 pF

Switching times (in line deflection circuit)

$L_B = 6 \mu\text{H}; -V_{IM} = 4 \text{ V};$

$I_{CM} = 4,5 \text{ A}; I_{B(\text{end})} = 1,4 \text{ A}$

$(-di_B/dt = 0,6 \text{ A}/\mu\text{s})$

t_f typ. $0,7 \mu\text{s}$
 t_s typ. $6,5 \mu\text{s}$

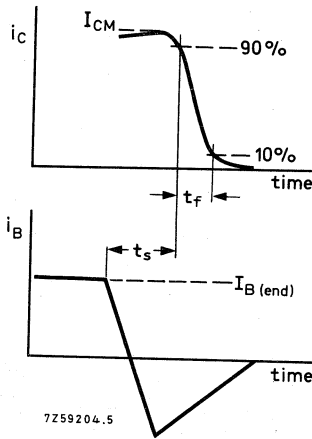


Fig. 4 Switching times.

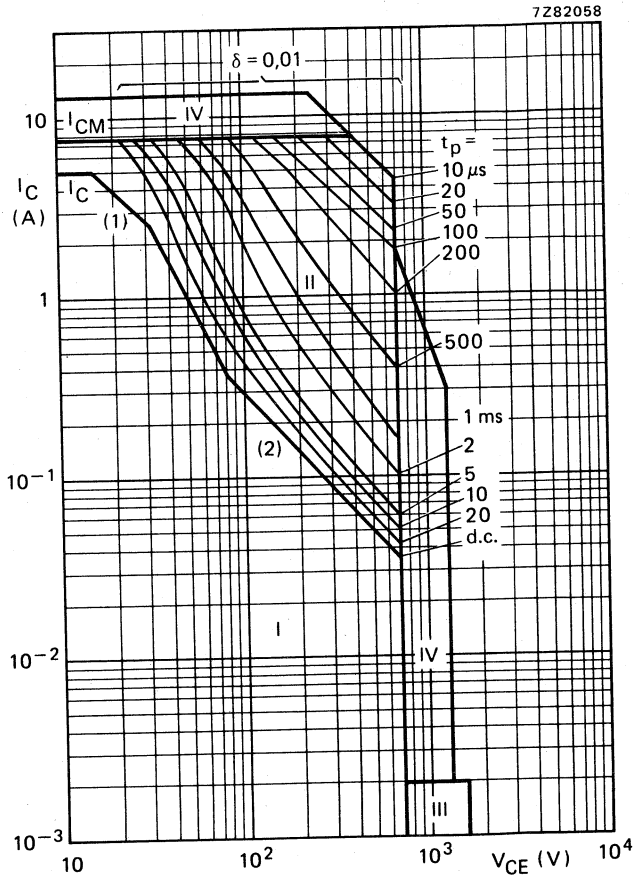


Fig. 5 Safe Operating Area with the transistor forward biased. $T_{mb} \leq 25^\circ\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- III Repetitive pulse operation in this region is permissible, provided $R_{BE} \leq 100 \Omega$; $t_p \leq 20 \mu\text{s}$; $\delta \leq 0,25$.
- IV Transient I_C/V_{CE} limit, e.g. during picture tube flashover (less than 10 line periods);
for V_{CE} less than 700 V then t_p less than or equal to 25 μs
for V_{CE} greater than 700 V then t_p less than 5 μs .

Notes

1. $P_{tot \max}$ and $P_{peak \max}$ lines.
2. Second-breakdown limits (independent of temperature).

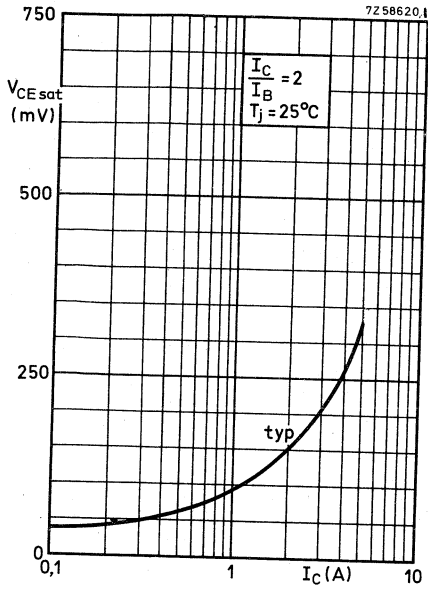


Fig. 6 Collector-emitter saturation voltage.

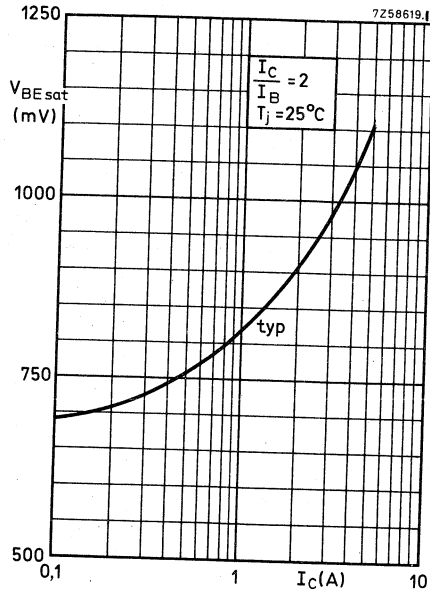


Fig. 7 Base-emitter saturation voltage.

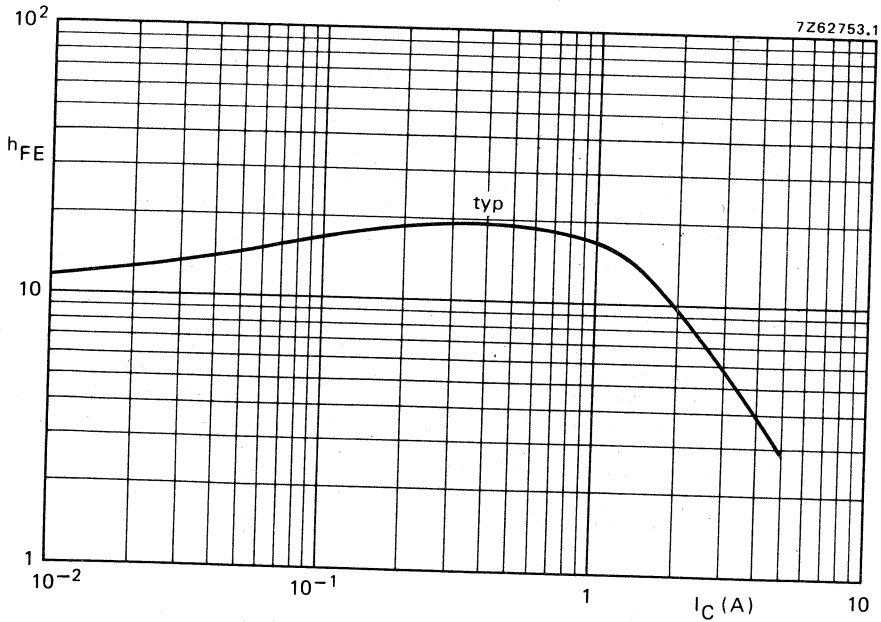


Fig. 8 D.C. current gain. $V_{CE} = 5$ V; $T_j = 25^\circ\text{C}$.

APPLICATION INFORMATION - HORIZONTAL DEFLECTION CIRCUIT WITH BU208A *

In designing horizontal deflection circuits, allowance has to be made for component and operating spreads in order not to exceed any Absolute Maximum Rating. Extensive analysis has shown that, for the peak collector current and the collector-emitter voltage of the output transistor, the total allowance need not be higher than 25%, and the following recommended base-drive and heatsink conditions are based on this figure.

To simplify the presentation, the design curves given refer to nominal conditions. Where the collector current will be modulated by the E-W correction circuit, the average value of the peak collector current applies provided the modulation is less than $\pm 10\%$.

To obtain a short fall time and minimum turn-off dissipation with a high-voltage transistor, the storage time must be sufficiently long and, during turn-off, the negative base-emitter voltage must be sufficiently high. Both requirements can easily be realized by including a small coil in series with the base of the output transistor. However, to reduce base current variations, a series base resistor is also added to most designs. This has the disadvantage of reducing the energy in the base inductance during turn-off, which in turn reduces the negative base-emitter voltage and with large resistor values may lead to an insufficient negative voltage for correct device turn-off. This can be improved by shunting the base resistor by a diode and/or a capacitor. Instead of giving various detailed base circuits based on these considerations, it is a more direct approach to specify the recommended $-di/dt$, see Fig. 11.

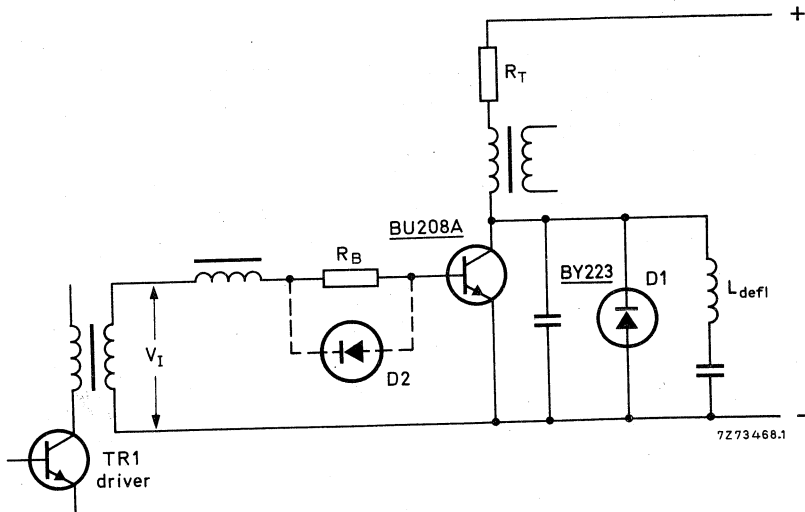


Fig. 9 Simplified horizontal deflection circuit.

* Detailed Application Information is available.

APPLICATION INFORMATION (continued)

The maximum transistor dissipation largely depends on the tolerances in the drive conditions. The dissipation given in Fig. 12 allows for base current and $-di_B/dt$ tolerances in the order of $\pm 20\%$. The curve applies for a limit-case transistor at a mounting base temperature of 100 °C.

The thermal resistance for the heatsink can be calculated from $R_{th\ mb-a} = \frac{100 - T_{amb\ max}}{P_{tot\ max}}$ in which $T_{amb\ max}$ is the maximum ambient temperature of the transistor. In order to assure a value of thermal resistance at which thermal stability is ascertained, the minimum value for T_{amb} in the above equation is 45 °C.

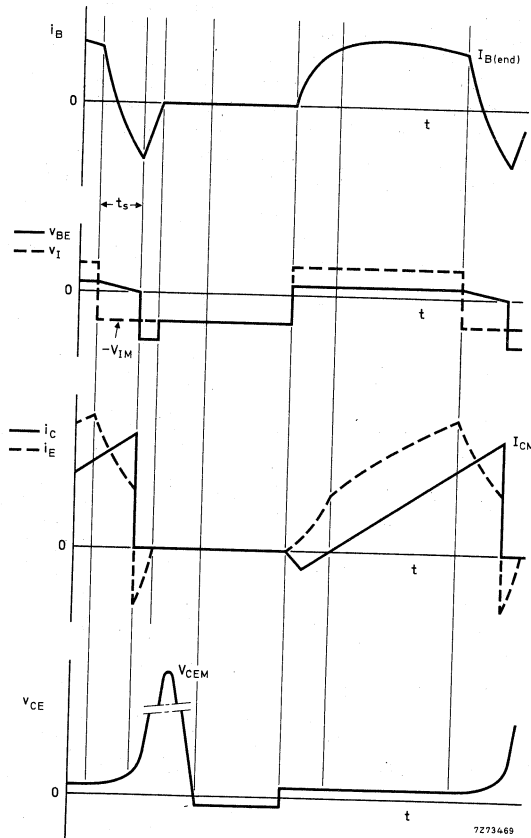


Fig. 10 Fundamental waveforms.

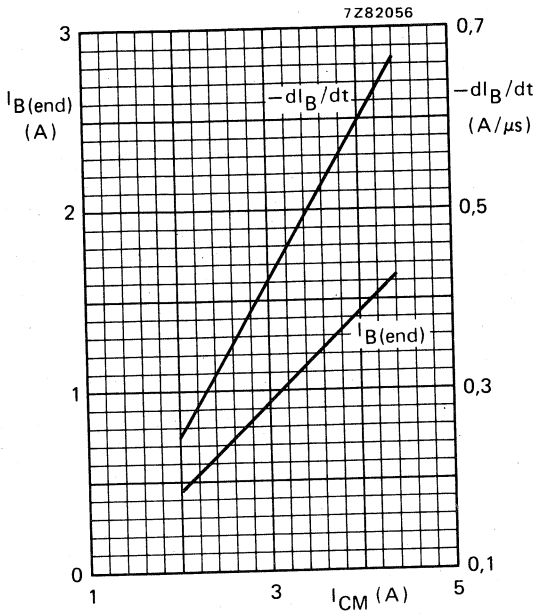


Fig. 11
Nominal end value of the base current and its rate of fall during turn-off as a function of nominal peak collector current to obtain, for a typical transistor, the recommended storage time of 6,5 μ s. (During the storage time and the decay time of the collector current the negative turn-off drive voltage ($-V_{IM}$) must be > 4 V.)

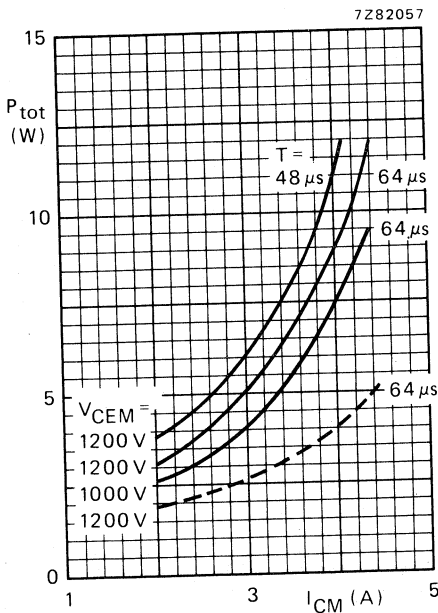


Fig. 12
Continuous lines are maximum values; $T_{mb} = 100$ $^{\circ}$ C; $\delta = 0,18$; base tolerances $\pm 20\%$.
Total dissipation of a limit-case transistor under maximum operating conditions for 625 and 819 lines ($T_{mb} = 100$ $^{\circ}$ C).
The dashed line gives the total dissipation of a typical transistor under nominal conditions ($T_{mb} = 50$ $^{\circ}$ C).

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed switching n-p-n power transistors in TO-3 envelopes, intended for use in the switched-mode power supply of 90° and 110° colour television receivers.

QUICK REFERENCE DATA

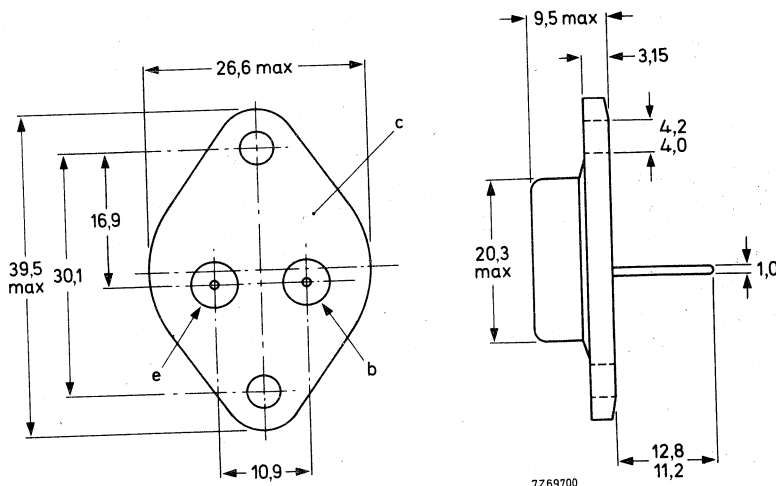
	BU326	BU326A	
Collector-emitter voltage ($V_{BE} = 0$; peak value)	V_{CESM} max. 800	900	V
Collector-emitter voltage (open base)	V_{CEO} max. 375	400	V
Collector current (d.c.)	I_C max. 6	8	A
Collector current (peak value; $t_p < 2$ ms)	I_{CM} max. 8	8	A
Total power dissipation up to $T_{mb} = 50$ °C	P_{tot} max. 60	60	W
Collector-emitter saturation voltage $I_C = 2,5$ A; $I_B = 0,5$ A	$V_{CEsat} <$	1,5	V
Fall time $I_{Con} = 2,5$ A; $I_{Bon} = 0,5$ A; $-I_{Boff} = 1$ A	t_f typ. 0,3	0,3	μs

Dimensions in mm

MECHANICAL DATA

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BU326	BU326A	
Collector-emitter voltage ($V_{BE} = 0$; peak value)	V_{CESM}	max. 800	900	V
Collector-emitter voltage (open base)	V_{CEO}	max. 375	400	V
Collector current (d.c.)	I_C	max. 6		A
Collector current (peak value; $t_p < 2$ ms)	I_{CM}	max. 8		A
Base current (d.c.)	I_B	max. 2		A
Base current (peak value)	I_{BM}	max. 3		A
Reverse base current (d.c. or average over any 20 ms period)	$-I_B(AV)$	max. 0,1		A
Reverse base current (peak value; turn-off current)	$-I_{BM}$	max. 3		A
Total power dissipation up to $T_{mb} = 50$ °C	P_{tot}	max. 60		W
Storage temperature	T_{stg}	-65 to + 150		°C
Junction temperature	T_j	max. 150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th j-mb}$	=	1,65	°C/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current *				
$V_{BE} = 0; V_{CEM} = V_{CESMmax}$	I_{CES}	<	1	mA
$V_{BE} = 0; V_{CEM} = V_{CESMmax}; T_j = 125$ °C	I_{CES}	<	2	mA
Emitter cut-off current				
$I_C = 0; V_{EB} = 10$ V	I_{EBO}	<	10	mA
Saturation voltages				
$I_C = 2,5$ A; $I_B = 0,5$	V_{CEsat}	<	1,5	V
	V_{BEsat}	<	1,4	V
$I_C = 4$ A; $I_B = 1,25$ A	V_{CEsat}	<	3	V
	V_{BEsat}	<	1,6	V
Collector-emitter sustaining voltage (see Figs 2 and 3)				
$I_{Boff} = 0; I_C = 0,1$ A; $L = 25$ mH	$V_{CEO_{sust}}$	>	375	V
	$V_{CEO_{sust}}$	>	400	V
D.C. current gain				
$I_C = 0,6$ A; $V_{CE} = 5$ V	h_{FE}	typ.	30	
Transition frequency at $f = 1$ MHz				
$I_C = 0,2$ A; $V_{CE} = 10$ V	f_T	typ.	6	MHz

* Measured with a half sine-wave voltage (curve tracer).

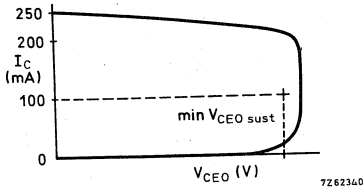


Fig. 2 Oscilloscope display for $V_{CE0\text{ sust.}}$

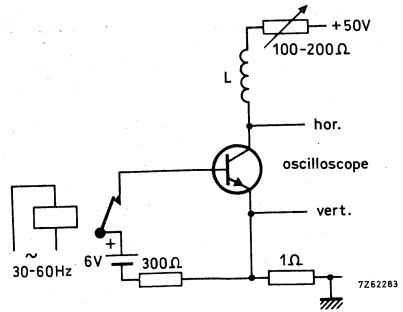


Fig. 3 Test circuit for $V_{CE0\text{ sust.}}$

Switching times (see Figs 4 and 5)

$I_{Con} = 2,5$ A; $V_{CC} = 250$ V;
 $I_{Bon} = 0,5$ A; $-I_{Boff} = 1$ A

Turn-on time

Turn-off time ($t_{off} = t_s + t_f$)
Storage time

Fall time

Fall time at $T_{mb} = 95$ °C

t_{on} typ. 0,3 μ s
 $<$ 0,5 μ s

t_s typ. 2 μ s
 $<$ 3,5 μ s

t_f typ. 0,3 μ s
 $<$ 1 μ s

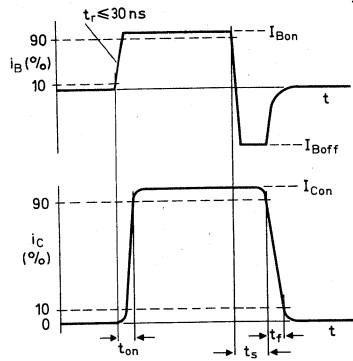
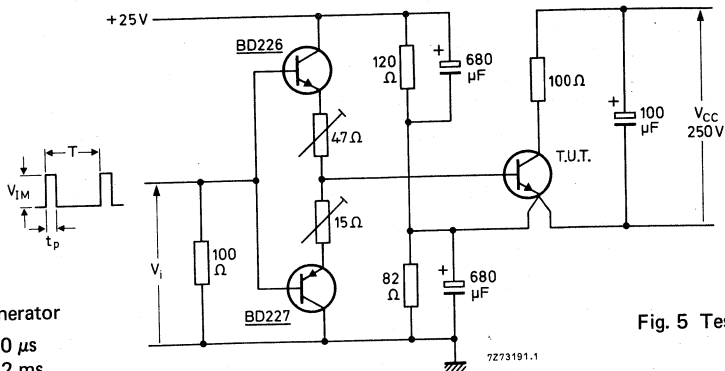


Fig. 4 Waveforms.



Pulse generator

$t_p = 20$ μ s
 $T = 2$ ms
 $V_{IM} = 15$ V

Fig. 5 Test circuit.

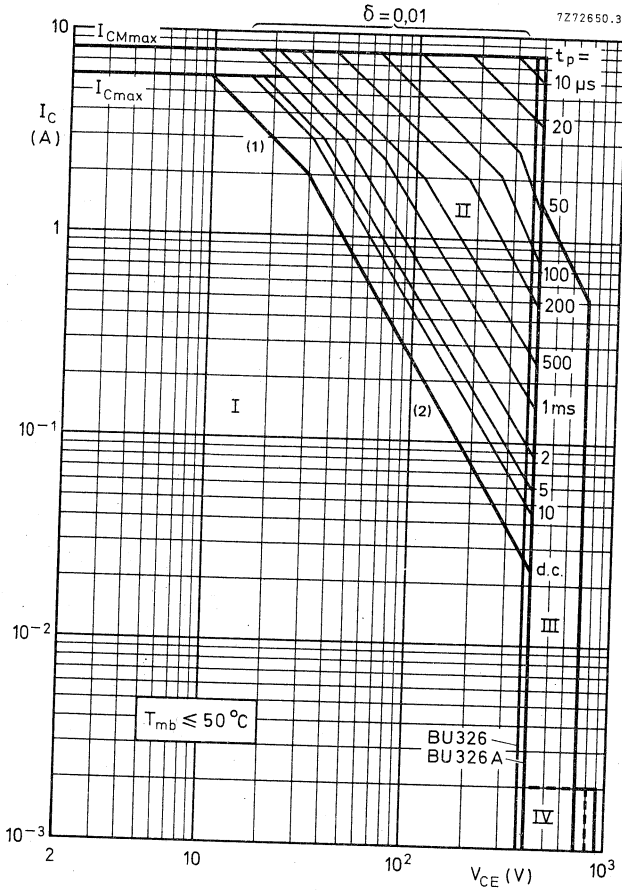


Fig. 6 Safe Operating Area.

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$.

(1) P_{tot} max and P_{peak} max lines.

(2) Second-breakdown limits (independent of temperature).

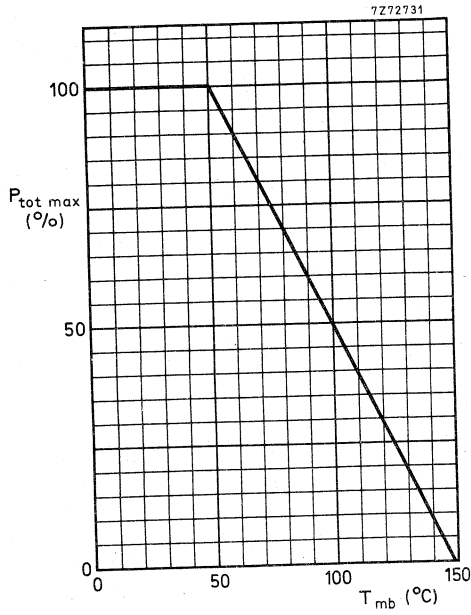


Fig. 7 Power derating curve.

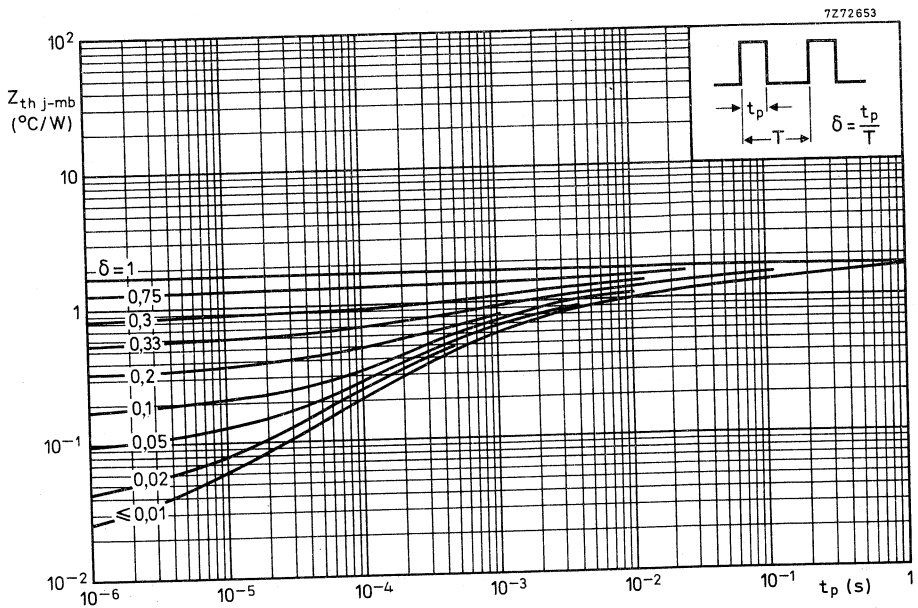


Fig. 8 Pulse power rating chart.

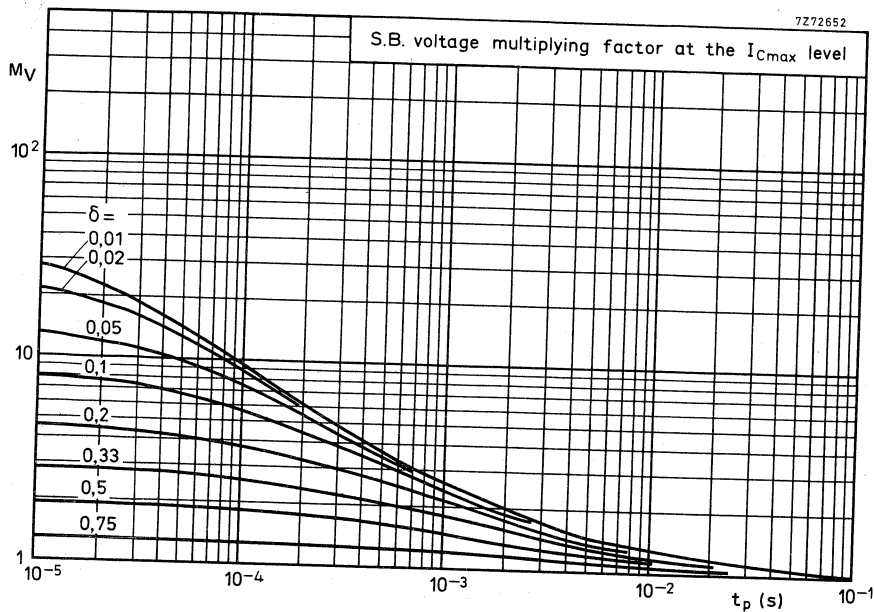


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

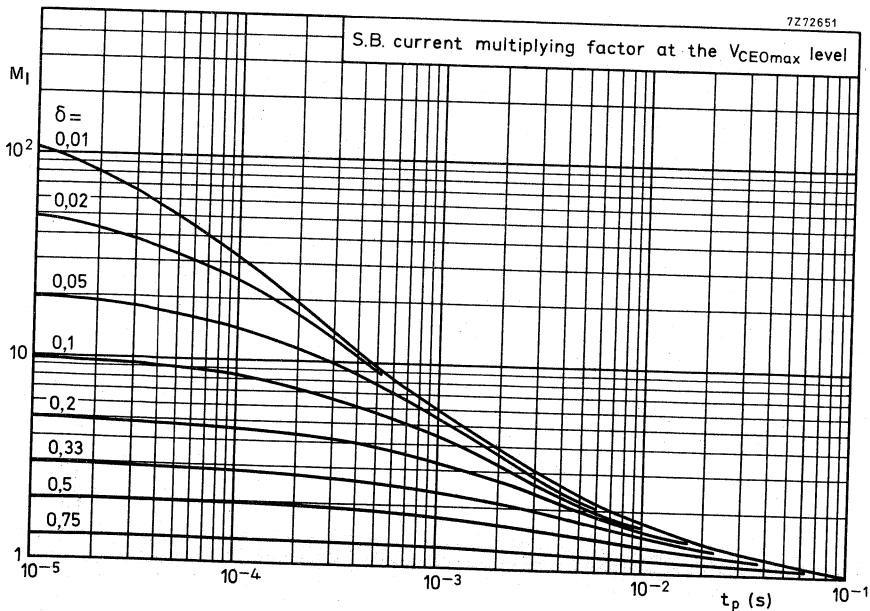


Fig. 10 S.B. current multiplying factor at the V_{CE0max} level.

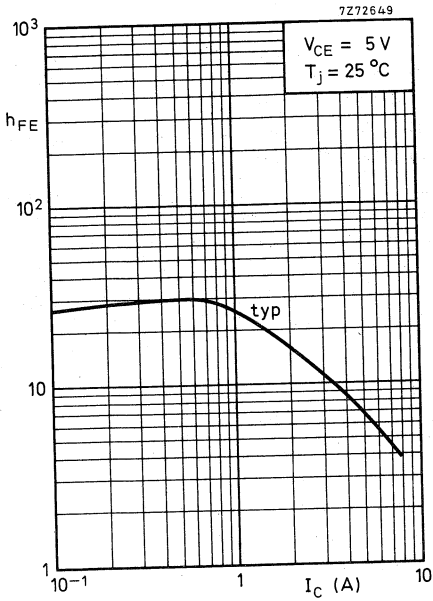


Fig. 11 D.C. current gain.

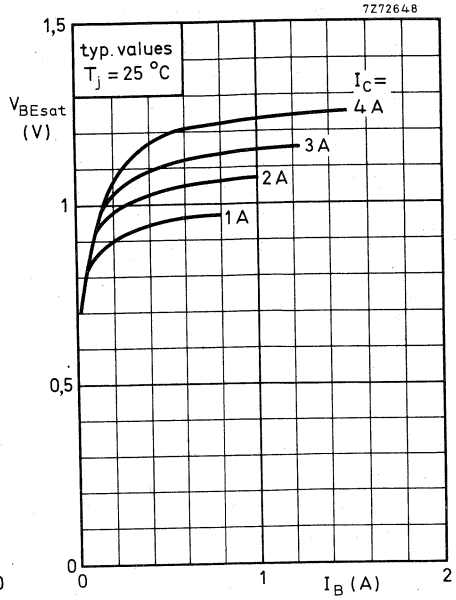


Fig. 12 Base-emitter saturation voltage.

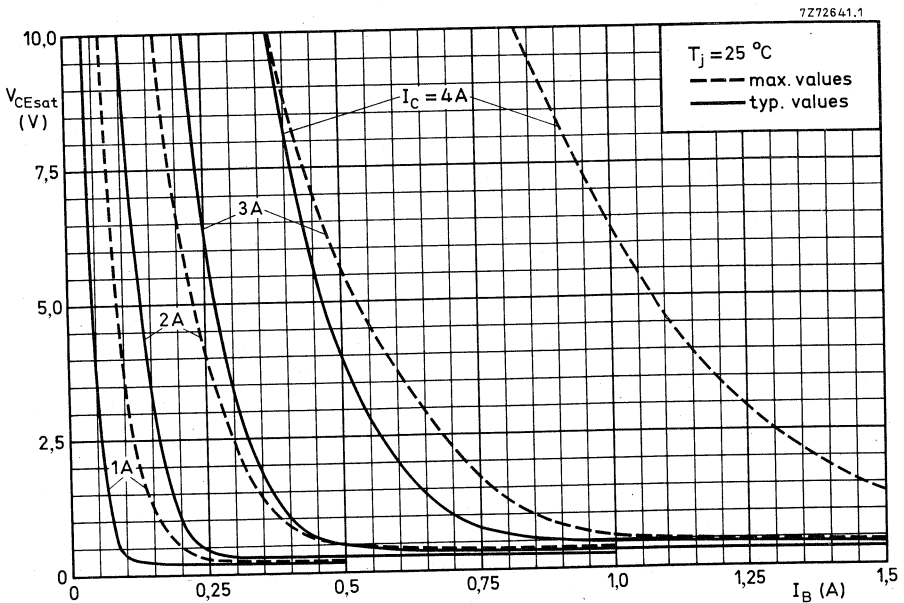


Fig. 13 Collector-emitter saturation voltage.

APPLICATION INFORMATION BU326A (detailed information on request)

Important factors in the design of SMPS circuits are the power losses and heatsink requirements of the supply output transistor and the base drive conditions during turn-off. In SMPS circuits for CTV receivers the duty factor of the collector current generally varies between 0,35 and 0,6.

The operating frequency lies between 15 kHz and 35 kHz and the shape of the collector current varies from rectangular in a forward converter to a sawtooth in a flyback circuit.

As the BU326A will mainly be used in flyback converters the information on optimum base drive and device dissipation given in the graphs on page 10 is concentrated on this application. In these figures I_{CM} represents the highest repetitive peak collector current that can occur in the given circuit, e.g. during overload.

The total power dissipation for a limit-case transistor is given in Fig. 18 which applies for a mounting base temperature of 100 °C. The required thermal resistance for the heatsink can be calculated from

$$R_{th\ mb-a\ max} * = \frac{T_{mb\ max} - T_{amb\ max}}{P_{tot}}$$

* Including additional thermal resistances resulting from mounting hardware.

To ensure thermal stability the thermal resistance of the heatsink used must not exceed the values plotted in Fig. 19.

A practical SMPS output circuit for an output power in the order of 180 W is given in Fig. 15.

At a collector current of 2,5 A and a base current of 0,25 A in this circuit the following turn-off times can be expected.

Storage time
Fall time

	$T_{mb} = 25\ ^\circ C$	$= 100\ ^\circ C$
t_s typ.	1,4	< 20 μs
t_f typ.	0,15	< 0,5 μs

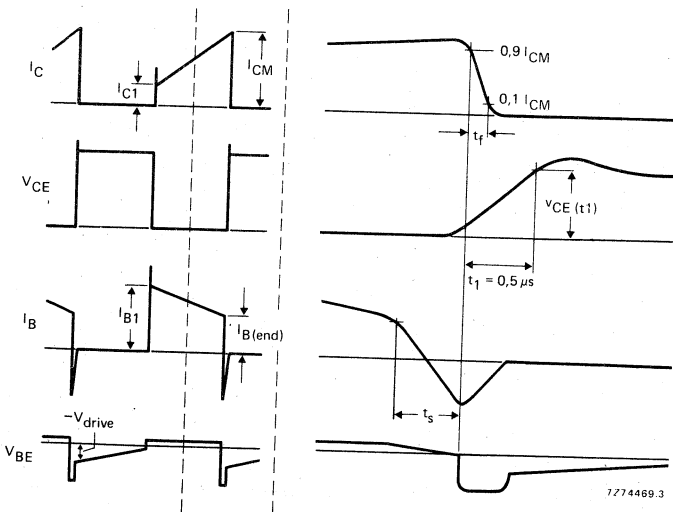


Fig. 14 Relevant waveforms of switching transistor.

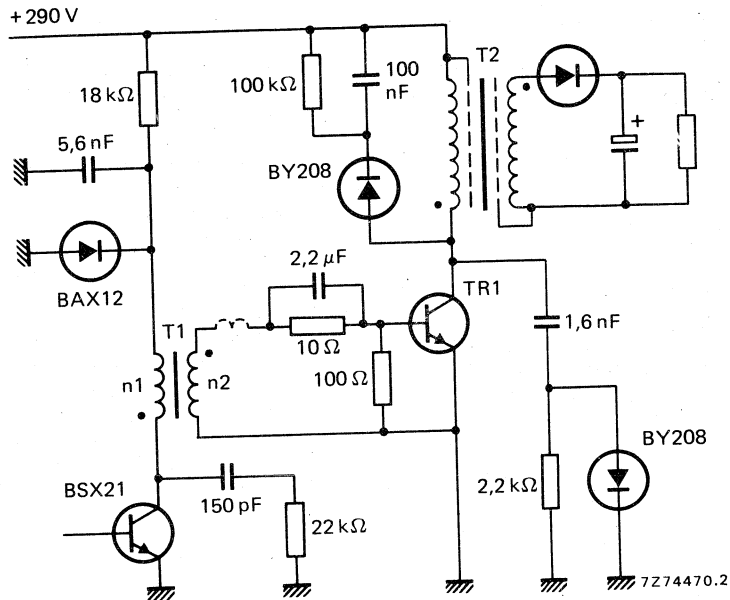


Fig. 15 Practical SMPS output circuit.

TR1 = BU326A

T1 (driver transformer): Core U20; $n_1 = 400$ turns; $n_2 = 25$ turns
total inductance in base circuit $\approx 4,5 \mu\text{H}$ T2 (output transformer): $L_p = 6 \text{ mH}$ $v_{CE}(t_1) < 500 \text{ V}$ (see Fig. 14)

Next page:

Fig. 16 Recommended nominal "end" value of the base current versus maximum peak collector current.

Fig. 17 Minimum required base inductance and recommended negative drive voltage versus maximum peak collector current.

Fig. 18 Maximum total power dissipation of a limit-case transistor if the base current is chosen in accordance with Fig. 16.

Fig. 19 Maximum permissible thermal resistance of the heatsink versus maximum peak collector current to ensure thermal stability.

Note: For all curves the duty factor $\delta = 0,5$, as shown in Fig. 14.

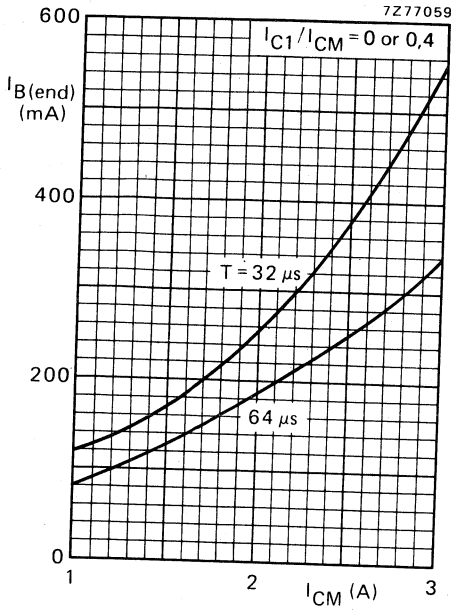


Fig. 16.

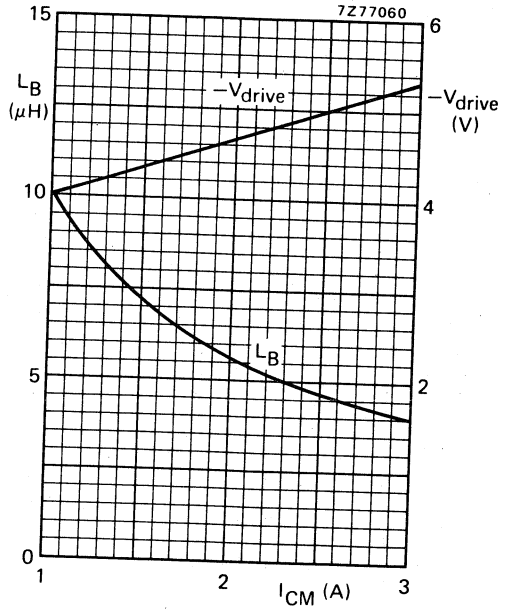


Fig. 17.

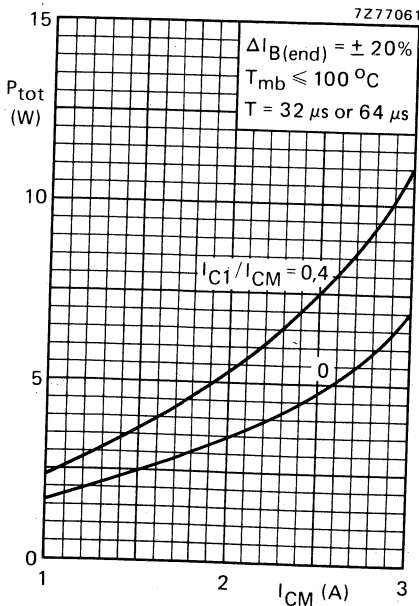


Fig. 18.

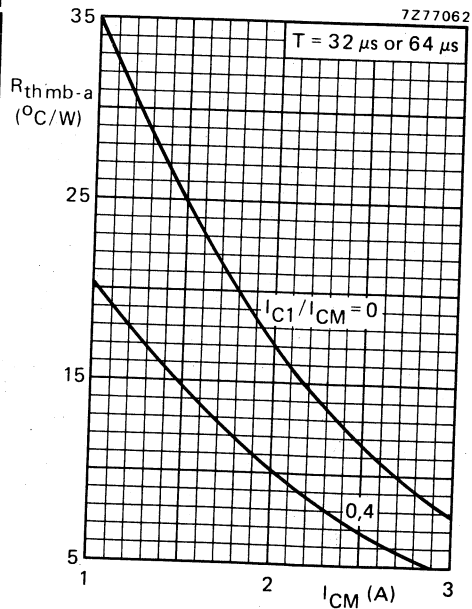


Fig. 19.

SILICON DIFFUSED POWER TRANSISTORS

High voltage, high speed switching n-p-n power transistor in plastic SOT-93 envelope, intended for use in the switched-mode power supply of 90° and 110° colour television receivers.

QUICK REFERENCE DATA

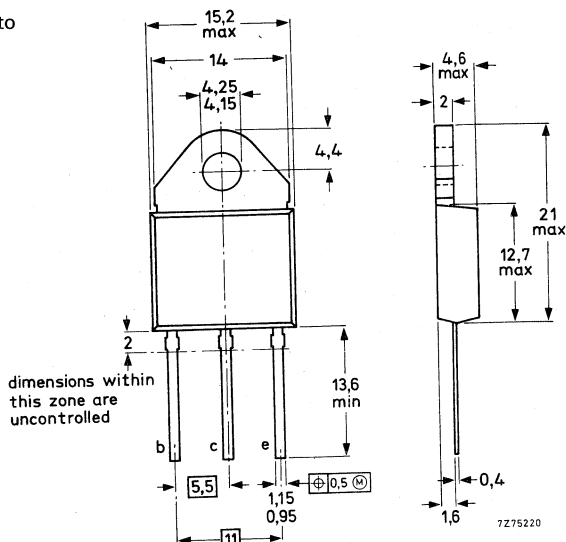
		BU426	426A	433
Collector-emitter voltage ($V_{BE} = 0$; peak value)	V_{CESM} max.	800	900	800 V
Collector-emitter voltage (open base)	V_{CEO} max.	375	400	375 V
Collector current (d.c.)	I_C max.		6	A
Collector current (peak value) $t_p = 2$ ms	I_{CM} max.		8	A
Total power dissipation up to $T_{mb} = 73^\circ\text{C}$	P_{tot} max.		70	W
Collector-emitter saturation voltage $I_C = 2,5$ A; $I_B = 0,5$ A	V_{CEsat} <		1,5	V
Fall time $I_{Con} = 2,5$ A; $I_{Bon} = 0,5$ A; $-I_{Boff} = 1$ A	t_f typ.	0,3	0,3	0,45 μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base



See also chapters Mounting instructions and Accessories.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

			BU426	426A	433
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM}	max.	800	900	800 V
Collector-emitter voltage (open base)	V_{CEO}	max.	375	400	375 V
Collector current (d.c.)	I_C	max.		6	A
Collector current (peak value) $t_p < 2$ ms	I_{CM}	max.		8	A
Base current (d.c.)	I_B	max.		2	A
Base current (peak value)	I_{BM}	max.		3	A
Reverse base current (d.c. or average over any 20 ms period)	$-I_{B(AV)}$	max.		100	mA
Reverse base current (peak value)*	$-I_{BM}$	max.		3	A
Total power dissipation up to $T_{mb} = 73$ °C	P_{tot}	max.		70	W
Storage temperature	T_{stg}		-65 to + 150		°C
Junction temperature	T_j	max.		150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=		1,1	°C/W
--------------------------------	----------------	---	--	-----	------

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current **

$V_{CEM} = 900$ V; $V_{BE} = 0$

I_{CES}	<	1	mA
-----------	---	---	----

$V_{CEM} = 900$ V; $V_{BE} = 0$; $T_j = 125$ °C

I_{CES}	<	2	mA
-----------	---	---	----

D.C. current gain

$I_C = 0,6$ A; $V_{CE} = 5$ V; BU426; BU426A

h_{FE}	typ.	30	
	<	60	

$I_C = 0,6$ A; $V_{CE} = 5$ V; BU433

h_{FE}	typ.	40	
----------	------	----	--

Emitter cut-off current

$I_C = 0$; $V_{EB} = 10$ V

I_{EBO}	<	10	mA
-----------	---	----	----

Transition frequency at $f = 1$ MHz

$I_C = 0,2$ A; $V_{CE} = 10$ V

f_T	typ.	6	MHz
-------	------	---	-----

* Turn-off current.

** Measured with a half sine-wave voltage (curve tracer).

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Emitter cut-off current

$$I_C = 0; V_{EB} = 10\text{ V}$$

$$I_{EBO} < 10\text{ mA}$$

Saturation voltages

$$I_C = 2,5\text{ A}; I_B = 0,5\text{ A}$$

$$V_{CEsat} < 1,5\text{ V}$$

$$V_{BEsat} < 1,4\text{ V}$$

$$I_C = 4\text{ A}; I_B = 1,25\text{ A}$$

$$V_{CEsat} < 3\text{ V}$$

$$V_{BEsat} < 1,6\text{ V}$$

Collector-emitter sustaining voltage

$$I_C = 100\text{ mA}; I_{Boff} = 0; L = 25\text{ mH}; \text{BU426}; \text{BU433}$$

$$V_{CEOsust} > 375\text{ V}$$

$$I_C = 100\text{ mA}; I_{Boff} = 0; L = 25\text{ mH}; \text{BU426A}$$

$$V_{CEOsust} > 400\text{ V}$$

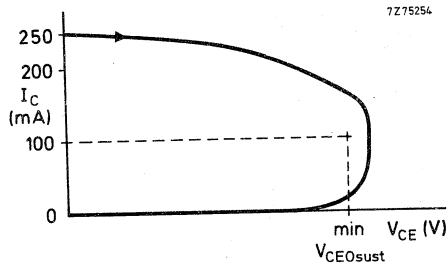


Fig. 2 Oscilloscope display for $V_{CEOsust}$.

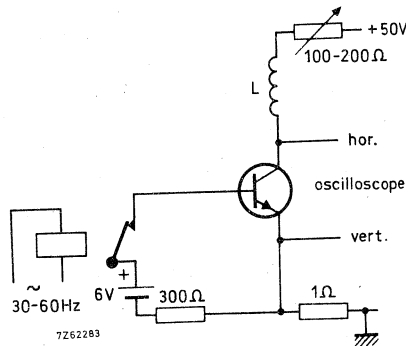


Fig. 3 Test circuit for $V_{CEOsust}$.

CHARACTERISTICS (continued)

Switching times (between 10% and 90% levels)

$I_{Con} = 2,5 \text{ A}; V_{CC} = 250 \text{ V}$

$I_{Bon} = 0,5 \text{ A}; -I_{Boff} = 1 \text{ A}$

Turn-on time

Turn-off time ($t_{off} = t_s + t_f$)

Storage time	Fall time	BU426; 426A	t_{on}	typ. 0,5 μs
			t_s	< 0,6 μs
		BU433	t_s	typ. 2 μs
			t_f	< 3,5 μs
Fall time, $T_{mb} = 95 \text{ }^\circ\text{C}$	BU433	t_f	typ. 0,3 μs	
		t_f	< 0,45 μs	
	BU426; 426A	t_f	< 0,7 μs	
		t_f	typ. 0,7 μs	

t_{on}	typ. 0,5 μs
<	0,6 μs
t_s	typ. 2 μs
<	3,5 μs
t_f	typ. 0,3 μs
<	0,45 μs
t_f	< 0,7 μs
t_f	typ. 0,7 μs
<	1,0 μs
t_f	< 0,75 μs

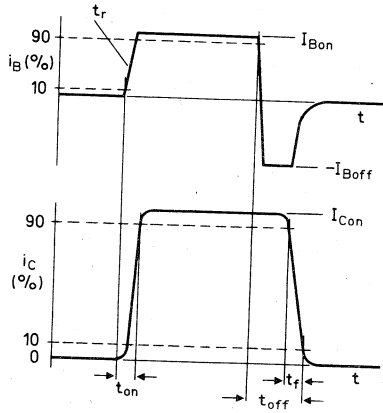
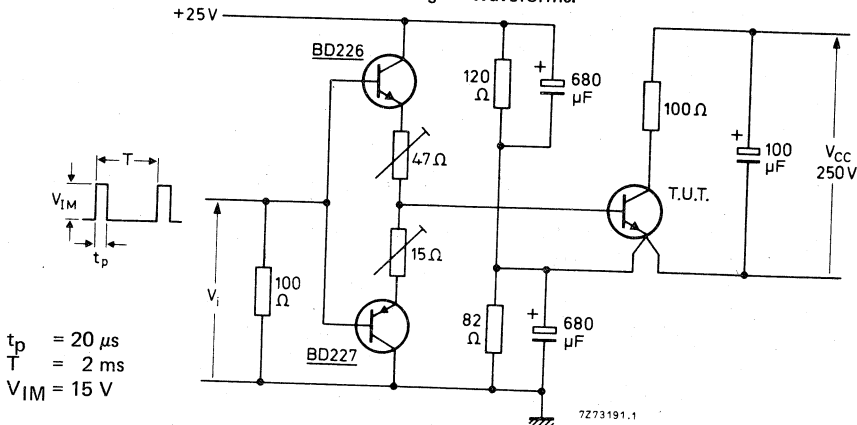


Fig. 4 Waveforms.



$t_p = 20 \mu\text{s}$
 $T = 2 \text{ ms}$
 $V_{IM} = 15 \text{ V}$

Fig. 5 Test circuit.

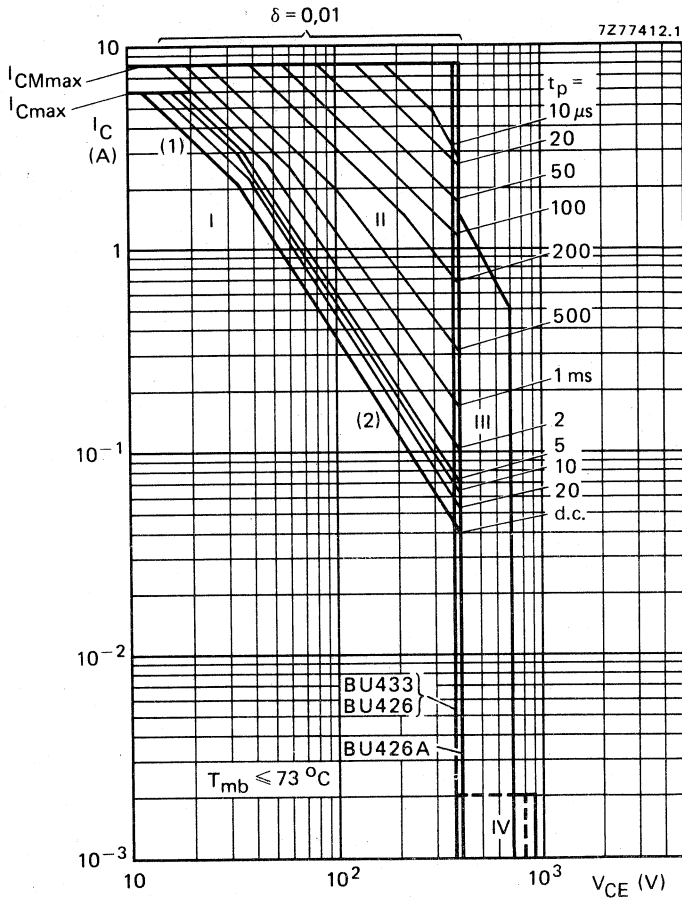


Fig. 6 Safe Operating Area.

- I Region of permissible d.c. operation.
 - II Permissible extension for repetitive pulse operation.
 - III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$.
 - IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2$ ms.
- (1) $P_{tot \max}$ and $P_{peak \max}$ lines.
 (2) Second-breakdown limits (independent of temperature).

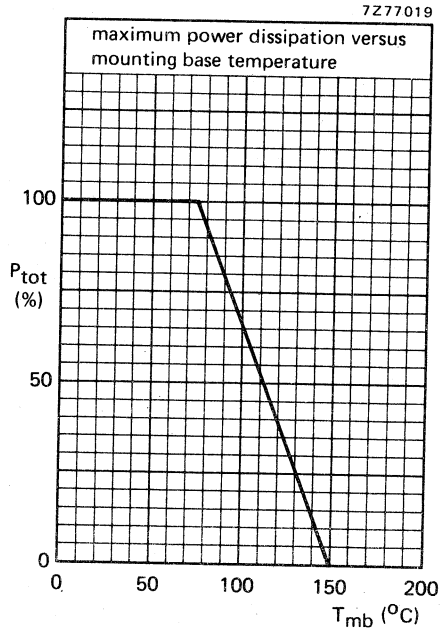


Fig. 7 Power derating curve.

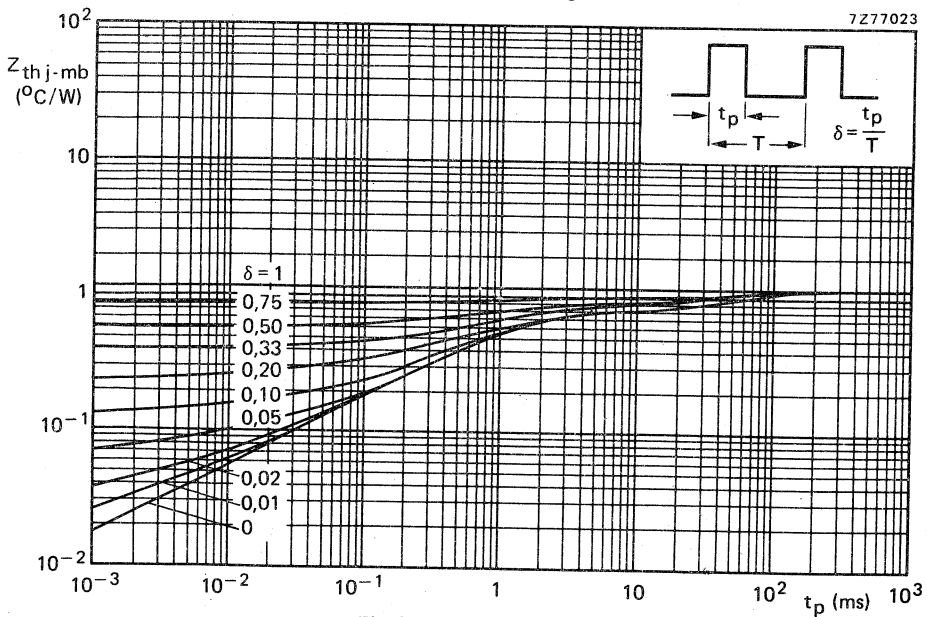


Fig. 8 Pulse power rating chart.

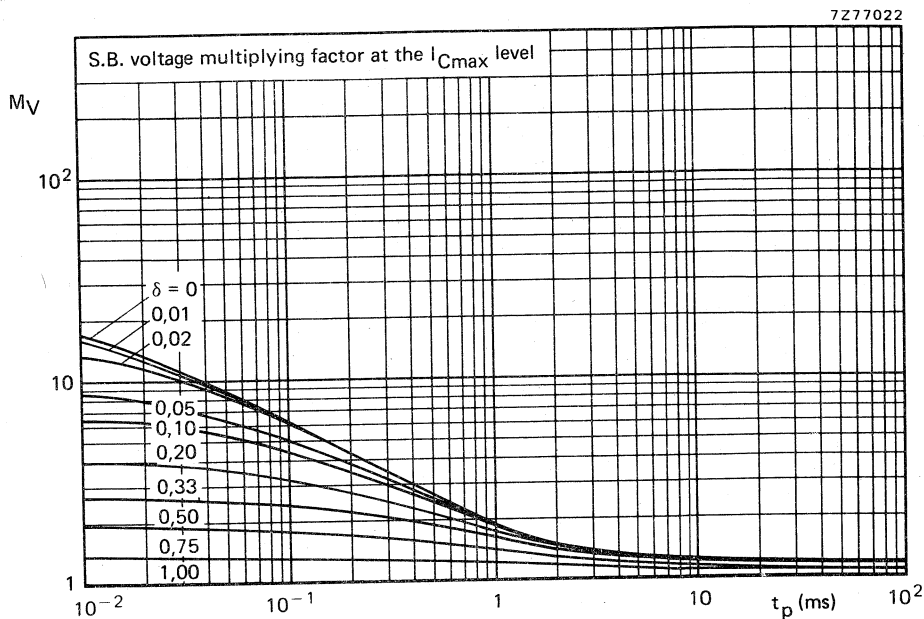


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

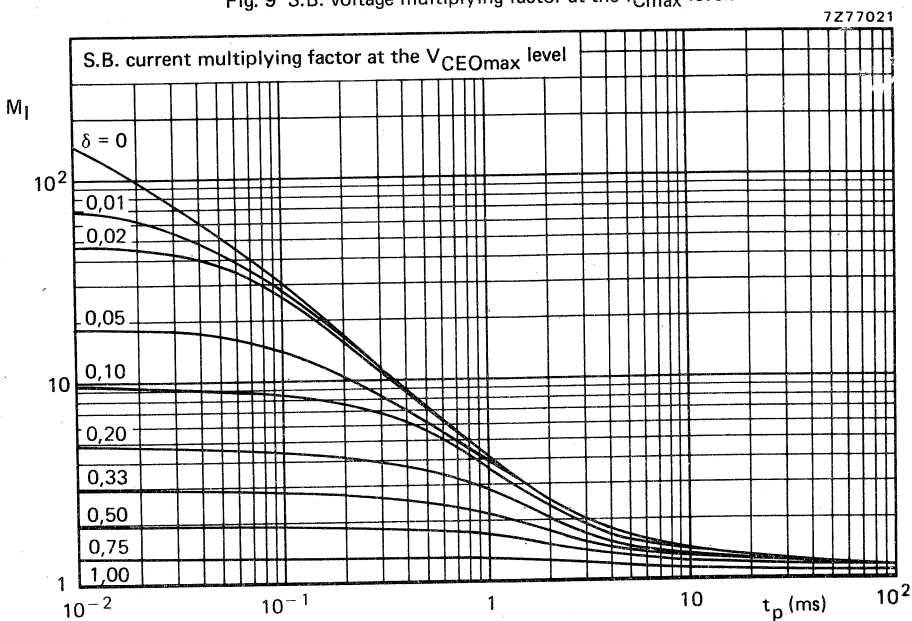


Fig. 10 S.B. current multiplying factor at the V_{CEmax} level.

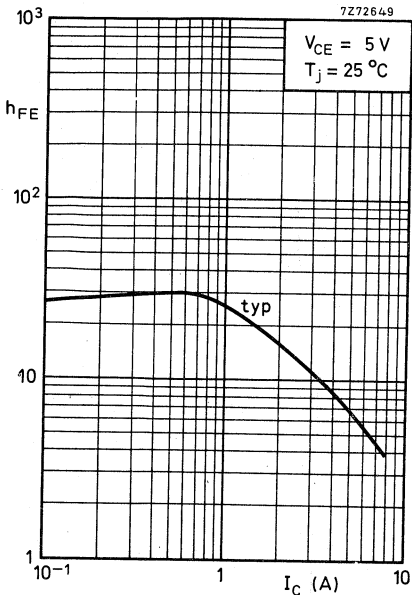


Fig. 11 D.C. current gain
 BU426 and BU426A.

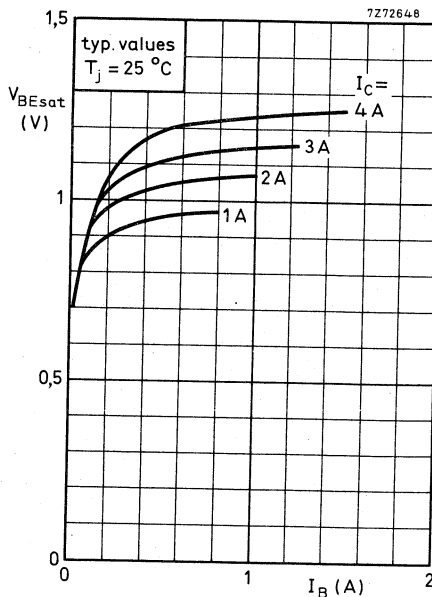


Fig. 12 Base-emitter saturation
 voltage for BU426 and BU426A.

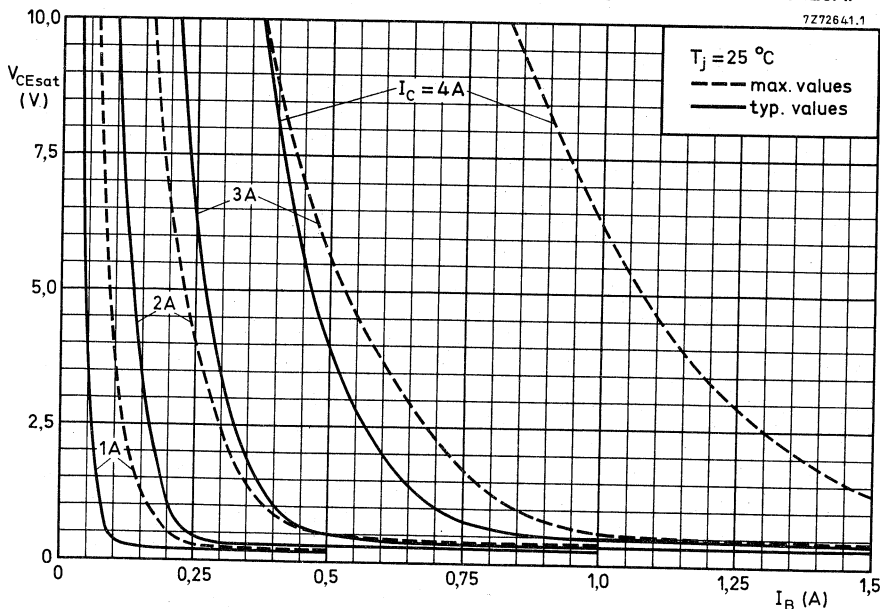


Fig. 13 Collector-emitter saturation voltage for BU426 and BU426A.

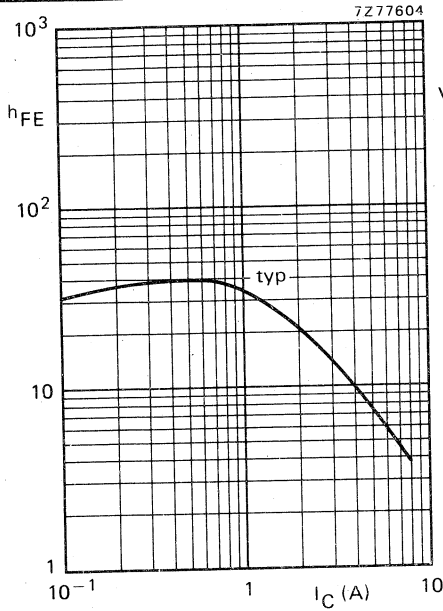


Fig. 14 D.C. current gain for BU433;
 $V_{CE} = 5 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$.

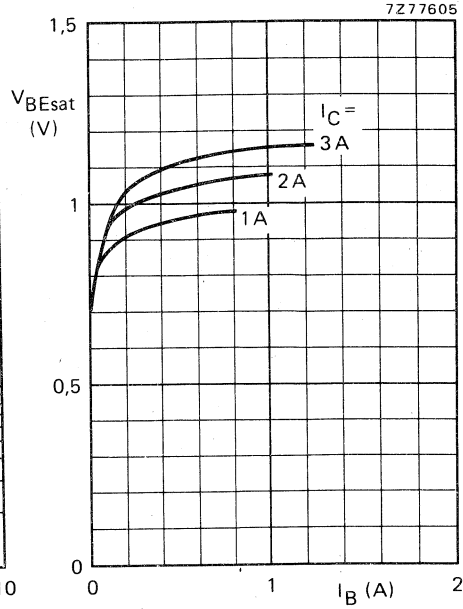


Fig. 15 Base-emitter saturation voltage for BU433; $T_j = 25 \text{ }^\circ\text{C}$.

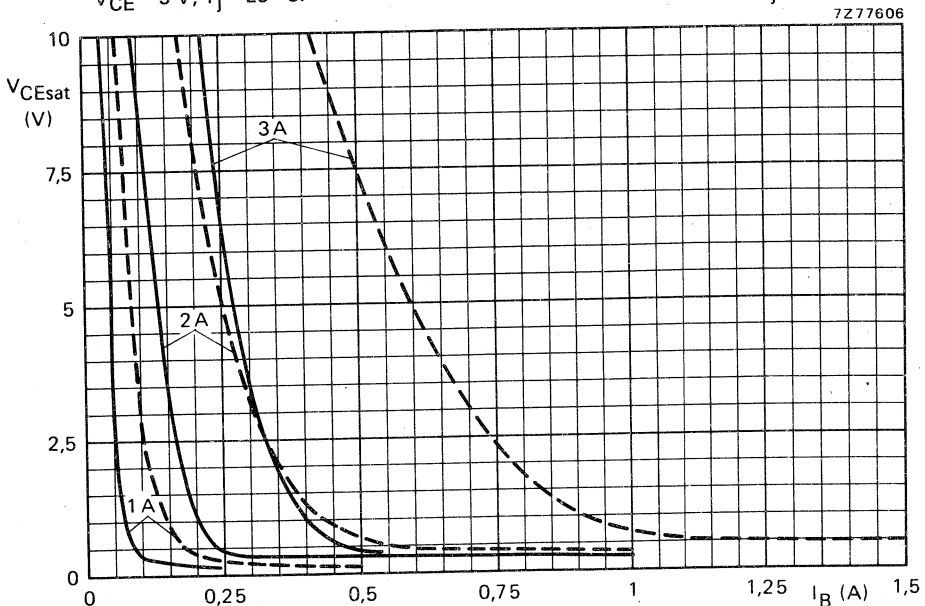


Fig. 16 Typical (—) and maximum (---) values collector-emitter saturation voltage for BU433;
 $T_j = 25 \text{ }^\circ\text{C}$.

APPLICATION INFORMATION (detailed information on request)

Important factors in the design of SMPS circuits are the power losses and heatsink requirements of the supply output transistor and the base drive conditions during turn-off. In SMPS circuits for CTV receivers the duty factor of the collector current generally varies between 0,35 and 0,6.

The operating frequency lies between 15 kHz and 35 kHz and the shape of the collector current varies from rectangular in a forward converter to a sawtooth in a flyback circuit.

All these variables influence the collector dissipation, so that a simple presentation of the design information is only possible if the information is restricted to the main application area of the relevant transistor type. Therefore, as the BU426 or BU426A will mainly be used in flyback converters and the BU433 in forward SMPS, the information of Figs 19, 20, 21 and 22, 23, 24 is based on these applications:

The total power dissipation for a limit-case transistor BU426 or BU433 is given in Figs 21 and 24, which apply for a mounting base temperature of 100 °C. The required thermal resistance for the heatsink can be calculated from:

$$R_{th\ mb-a\ max}^* = \frac{T_{mb\ max} - T_{amb\ max}}{P_{tot}}$$

* Including additional thermal resistances resulting from mounting hardware.

To ensure thermal stability minimum value of T_{amb} in this equation is 40 °C. As indicated, the BU433 will mainly be used in (non-isolated) forward converters, where the turn-off losses are limited by the maximum collector emitter voltage ($\approx 300-350$ V). The rate-of-rise of the voltage during turn-off must be below 1000 V/ μ s. Application of this transistor in low-power flyback converters is also possible, provided that the rate-of-rise is limited to 500 V/ μ s. For the BU426(A) a rate-of-rise of 1000 V/ μ s is permissible. Practical SMPS output circuits for an output power in the order of 180 W are given in Figs 19 and 22. At a collector current of 2,5 A and a base current of 0,25 A in these circuits the following turn-off times can be expected.

		T_{mb}	
		25 °C	100 °C
BU426 (426A)	Storage time t_s	typ. 1,4	< 2,0 μ s
	Fall time t_f	0,15	< 0,5 μ s
BU433	Storage time t_s	typ. 1,4	< 2,0 μ s
	Fall time t_f	0,18	< 0,6 μ s

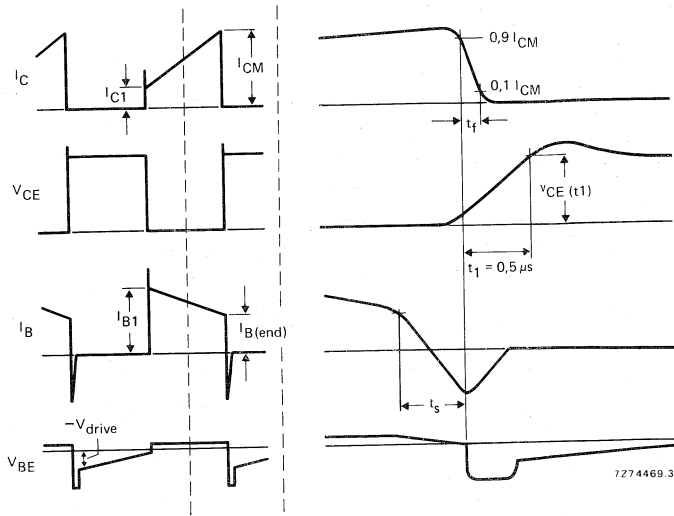


Fig. 17 Relevant waveforms of switching transistor.

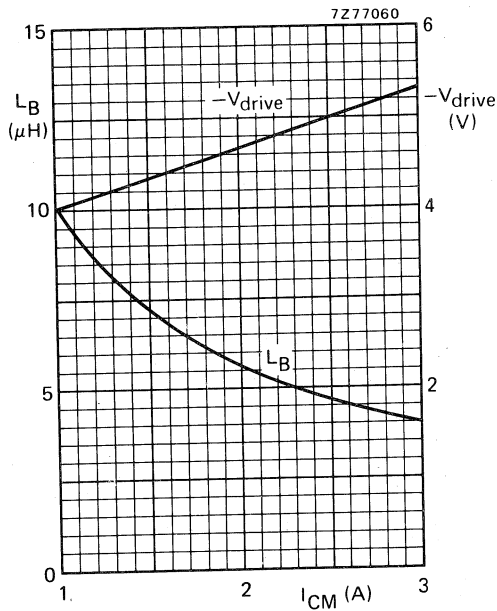


Fig. 18 Minimum required base inductance and recommended negative drive voltage versus maximum peak collector current.

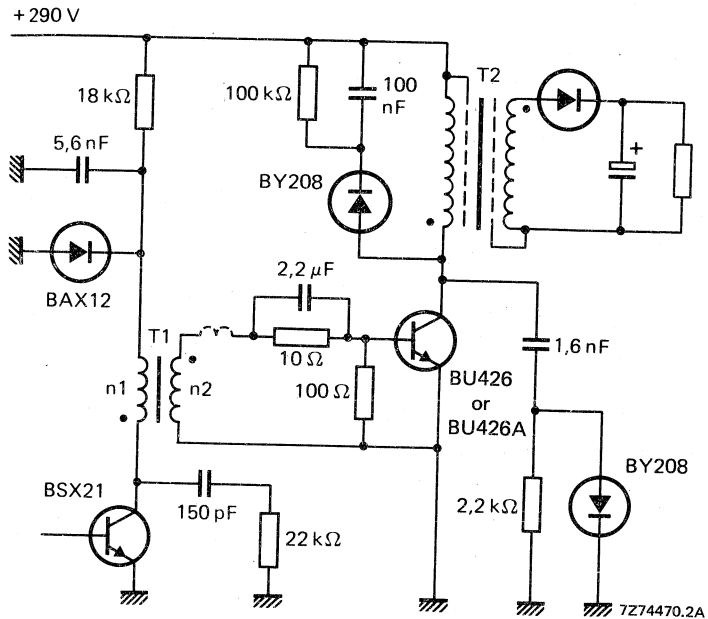


Fig. 19 Practical output circuit of a flyback SMPS of BU426 or BU426A.

T1 (driver transformer)
 core U20; $n_1 = 400$ turns
 $n_2 = 25$ turns

$L_{Btot} \approx 4,5 \mu\text{H}$

T2 (output transformer)
 $L_p = 6 \text{ mH}$

$V_{CE}(t_1) < 500 \text{ V}$ (see Fig. 17)

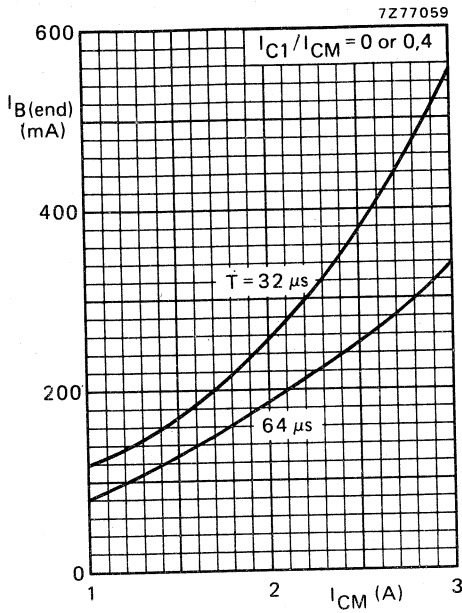


Fig. 20 Recommended nominal "end" value of the base current versus maximum peak collector current.

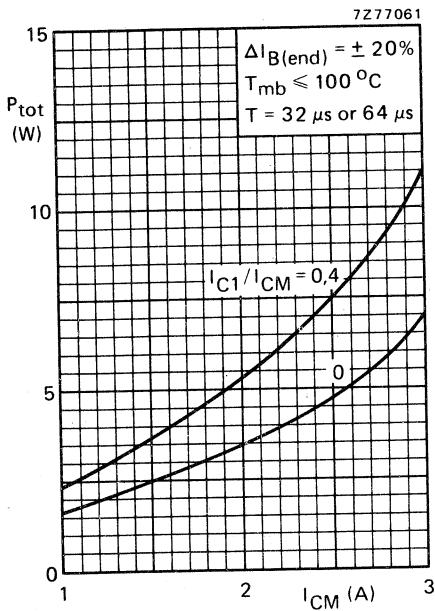


Fig. 21 Maximum total power dissipation of a limit-case transistor of the base current is chosen in accordance with Fig. 20.

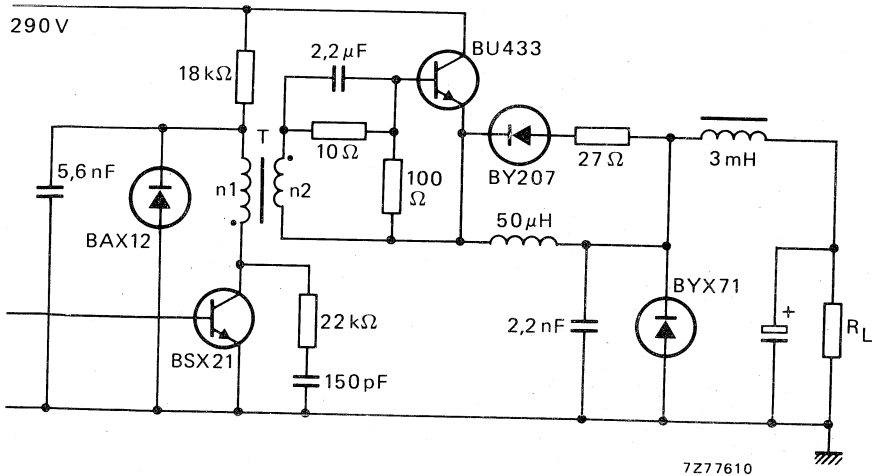


Fig. 22 Practical output circuit of a forward SMPS with BU433.
T (driver transformer): Core U20
 $n_1 = 400$ turns; $n_2 = 25$ turns
 $L_{Btot} \approx 4,5 \mu\text{H}$

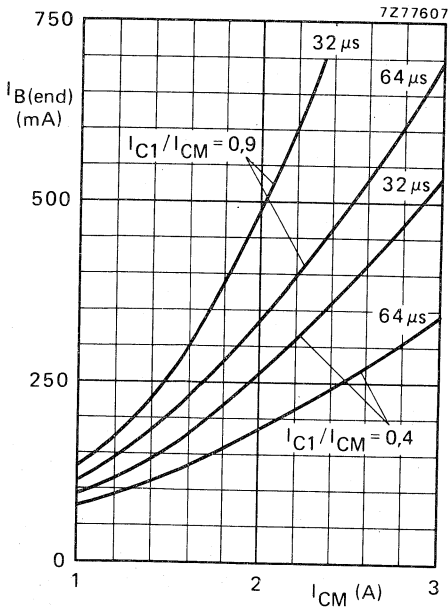


Fig. 23 Recommended nominal "end" value of the base current versus maximum peak collector current.

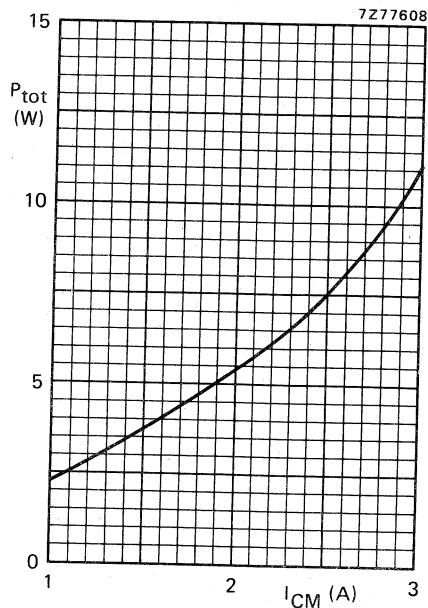


Fig. 24 Maximum total power dissipation of a limit-case transistor if the base current is chosen in accordance with Fig. 23.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated n-p-n power transistors in SOT-82 envelopes, intended for use in converters, inverters, switching regulators, motor control systems and switching applications.

QUICK REFERENCE DATA

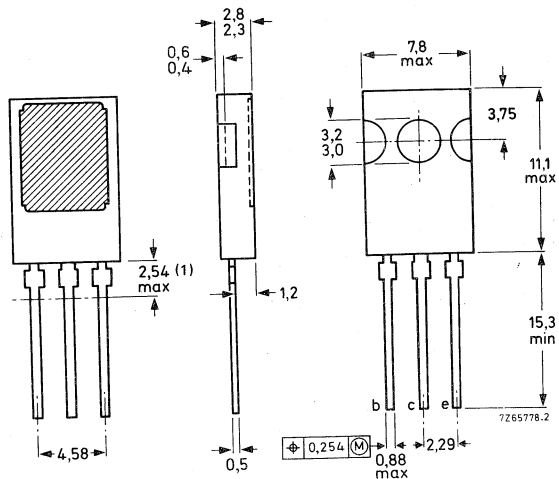
		BUW84	BUW85	
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM} max.	800	1000	V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450	V
Collector current (d.c.)	I_C max.	2		A
Collector current (peak value) $t_p = 2$ ms	I_{CM} max.	3		A
Total power dissipation up to $T_{mb} = 45$ °C	P_{tot} max.	50		W
Collector-emitter saturation voltage $I_C = 1$ A; $I_B = 0,2$ A	V_{CEsat}	< 3		V
Fall time $I_{Con} = 1$ A; $I_{Bon} = 0,2$ A; $-I_{Boff} = 0,4$ A	t_f typ.	0,4		μ s

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-82.

Collector connected to mounting base.



For mounting instructions see Handbook section Accessories.

Accessories: 56353 and 56354.

(1) Within this region the cross-section of the leads is uncontrolled.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

		BUW84	BUW85
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM}	max. 800	1000 V
Collector-emitter voltage (open base)	V_{CEO}	max. 400	450 V
Collector current (d.c.)	I_C	max.	2 A
Collector current (peak value) $t_p = 2$ ms	I_{CM}	max.	3 A
Base current (d.c.)	I_B	max. 0,75	A
Base current (peak value)	I_{BM}	max. 1	A
Reverse base current (peak value) *	$-I_{BM}$	max. 1	A
Total power dissipation up to $T_{mb} = 45$ °C	P_{tot}	max. 50	W
Storage temperature	T_{stg}	-65 to +150	°C
Junction temperature	T_j	max. 150	°C

THERMAL RESISTANCE

From junction to mounting base	R_{thj-mb}	=	2,1	°C/W
From junction to ambient in free air	R_{thj-a}	=	100	°C/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current **

$V_{CEM} = V_{CESMmax}; V_{BE} = 0$

$I_{CES} < 200 \mu A$

$V_{CEM} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

$I_{CES} < 1,5$ mA

D.C. current gain

$I_C = 0,1$ A; $V_{CE} = 5$ V

h_{FE} typ. 50

* Turn-off current.

** Measured with a half sine-wave voltage (curve tracer).

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 1\text{ mA}$

Saturation voltages

$I_C = 0,3\text{ A}; I_B = 30\text{ mA}$

$V_{CEsat} < 1,5\text{ V}$

$I_C = 1\text{ A}; I_B = 0,2\text{ A}$

$V_{CEsat} < 3\text{ V}$

$I_C = 1\text{ A}; I_B = 0,2\text{ A}$

$V_{BEsat} < 1,1\text{ V}$

Collector-emitter sustaining voltage

$I_C = 100\text{ mA}; I_{Boff} = 0; L = 25\text{ mH}$

	<u>BUW84</u>	<u>BUW85</u>	
$V_{CEOsust} >$	400	450	V

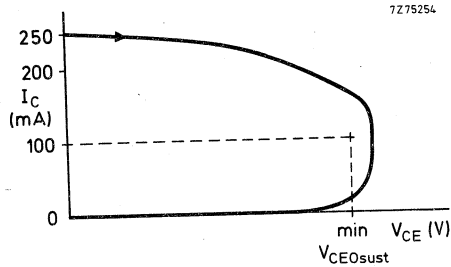


Fig. 2 Oscilloscope display for sustaining voltage.

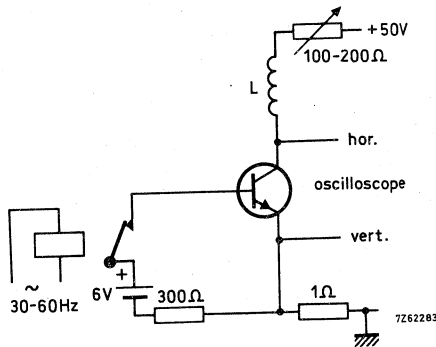


Fig. 3 Test circuit for $V_{CEOsust}$.

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,2\text{ A}; V_{CE} = 10\text{ V}$

Switching times

$I_{Con} = 1\text{ A}; V_{CC} = 250\text{ V}$

$I_{Bon} = 0,2\text{ A}; -I_{Boff} = 0,4\text{ A}$

Turn-on time

Turn-off: Storage time

Fall time

Fall time, $T_{mb} = 95\text{ }^\circ\text{C}$

f_T typ. 20 MHz

t_{on} typ. 0,2 μs
< 0,5 μs

t_s typ. 2 μs
< 3,5 μs

t_f typ. 0,4 μs

t_{ff} < 1,4 μs

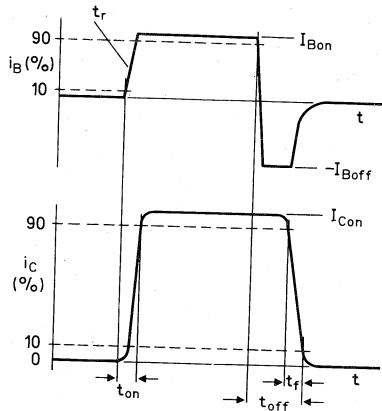


Fig. 4 Waveforms.

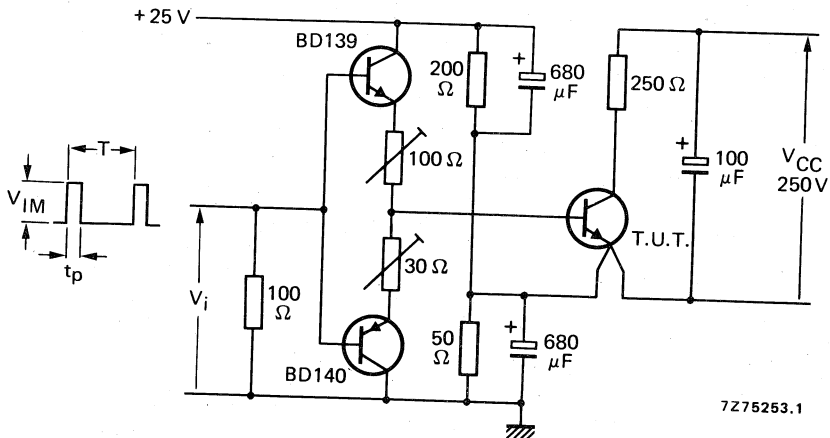


Fig. 5 Test circuit.

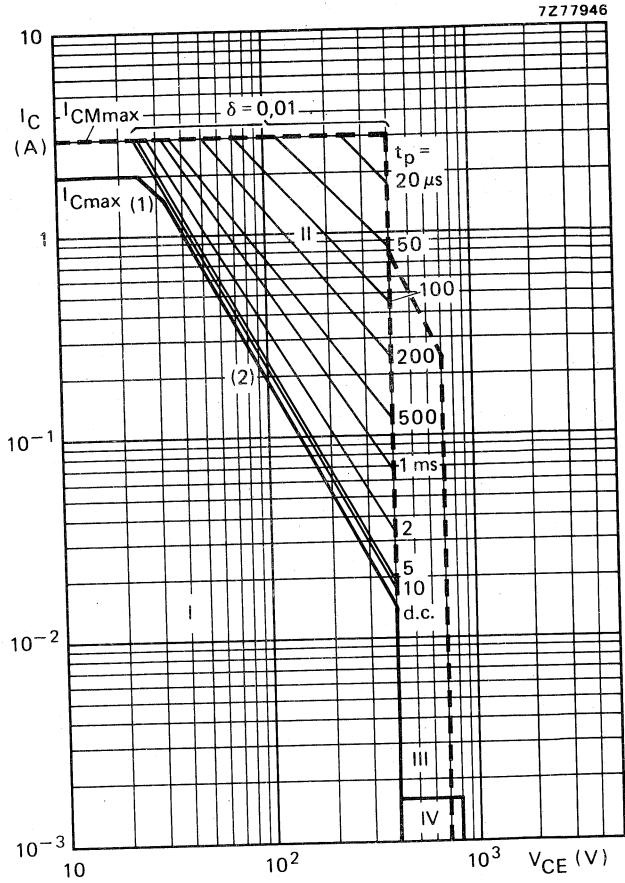


Fig. 6 Safe Operating Area at $T_{mb} \leq 25^\circ\text{C}$ of BUW84.

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu\text{s}$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 \text{ms}$

(1) P_{tot} max line.
(2) Second-breakdown limits (independent of temperature).

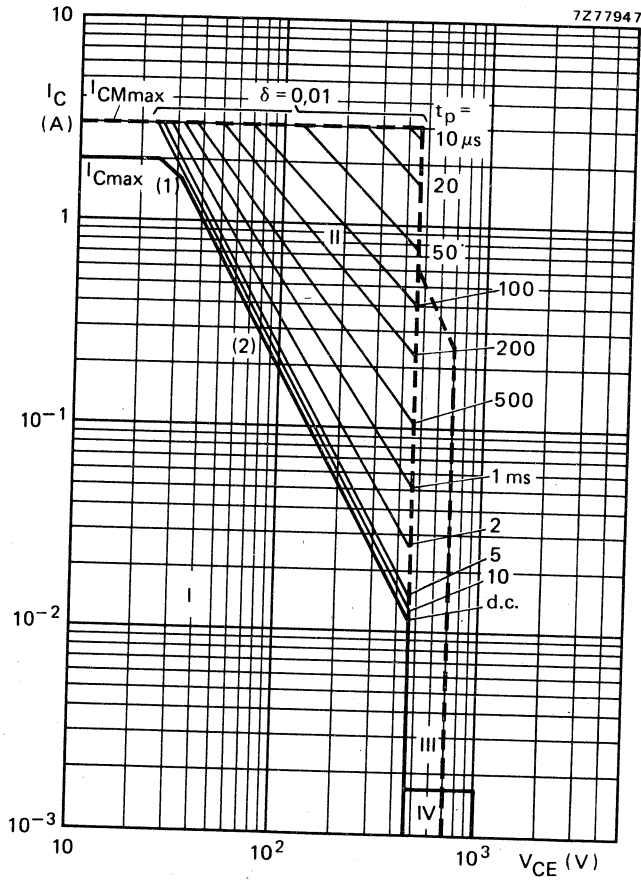


Fig. 7 Safe Operating Area at $T_{mb} \leq 25^\circ C$ of BUW85.

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$

(1) P_{tot} max line.

(2) Second-breakdown limits (independent of temperature).

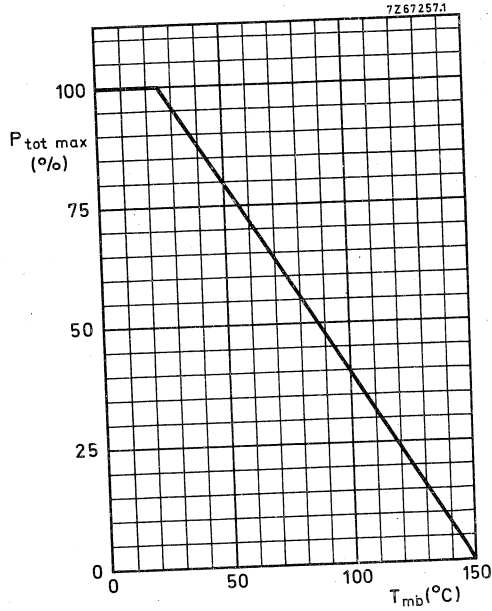


Fig. 8.

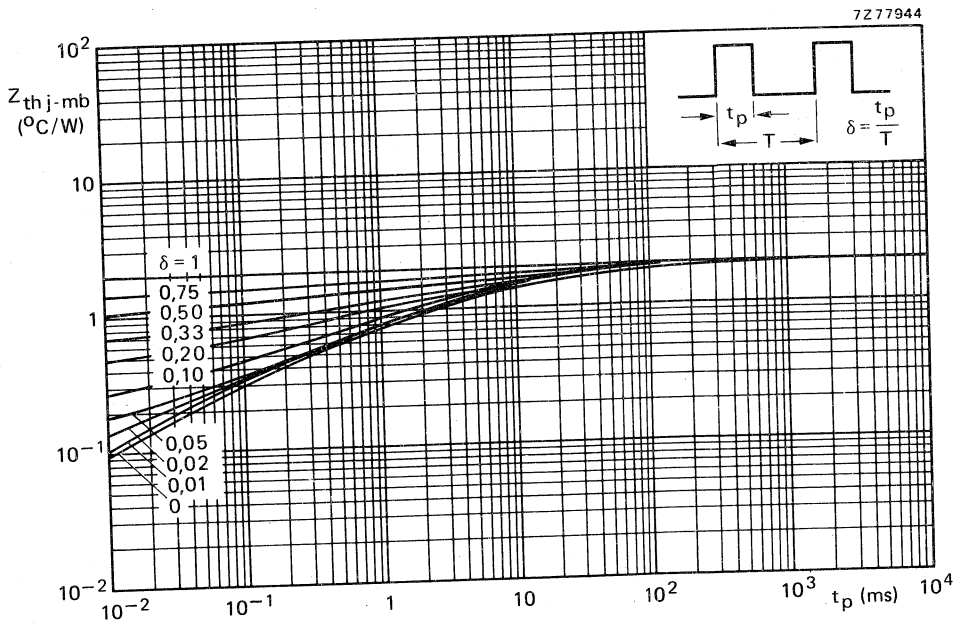
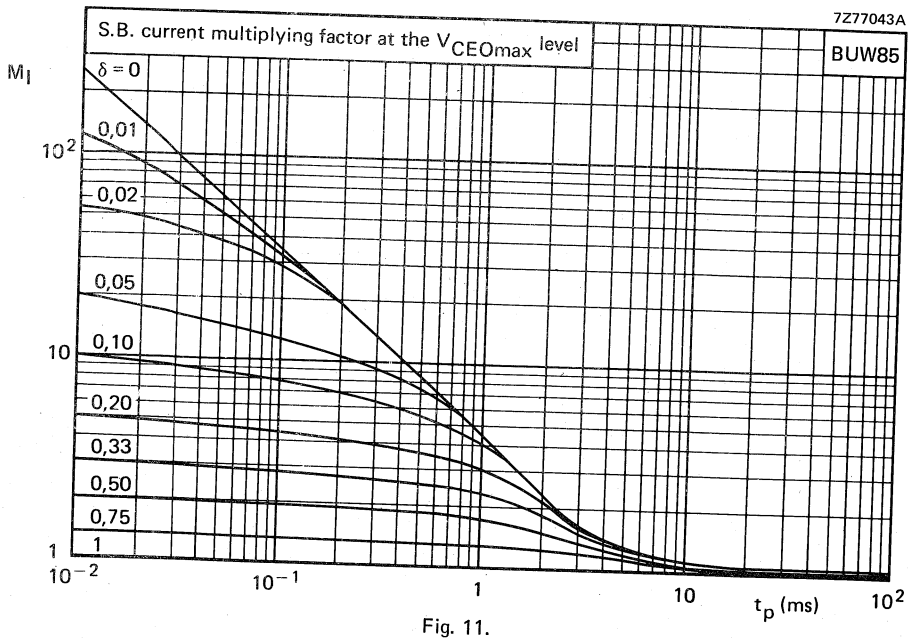
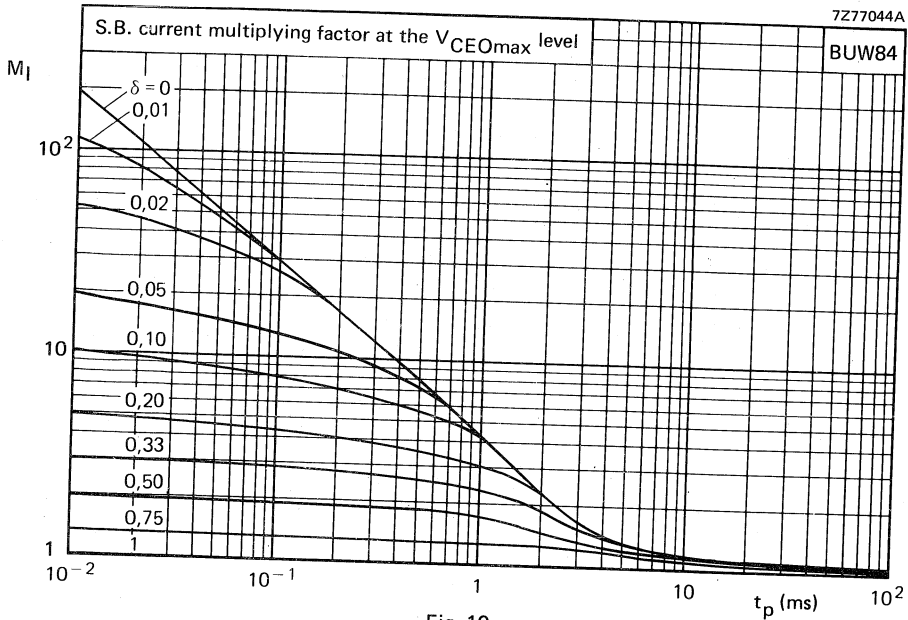


Fig. 9.



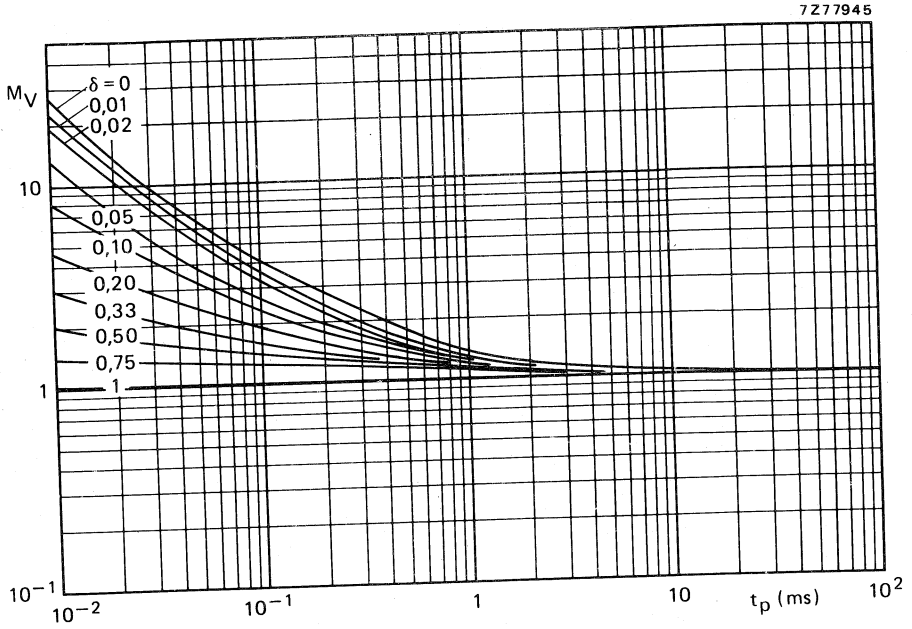


Fig. 12 S.B. voltage multiplying factor at the I_{Cmax} level.

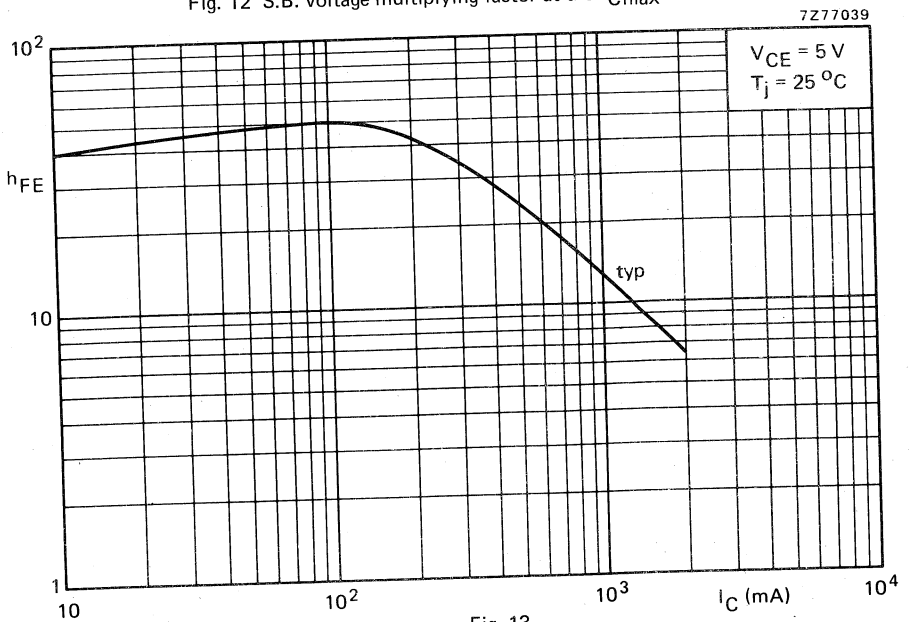


Fig. 13.

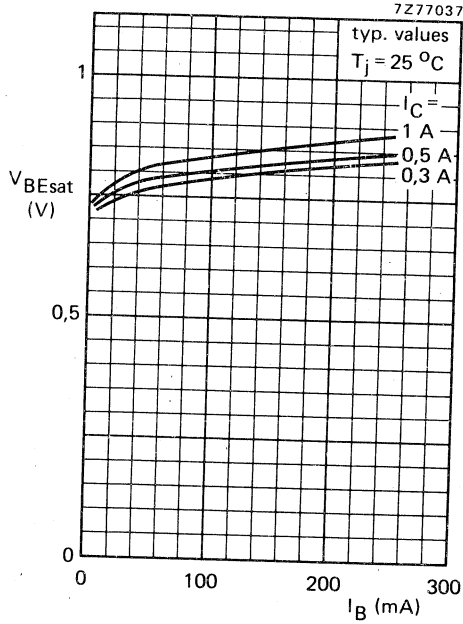


Fig. 14.

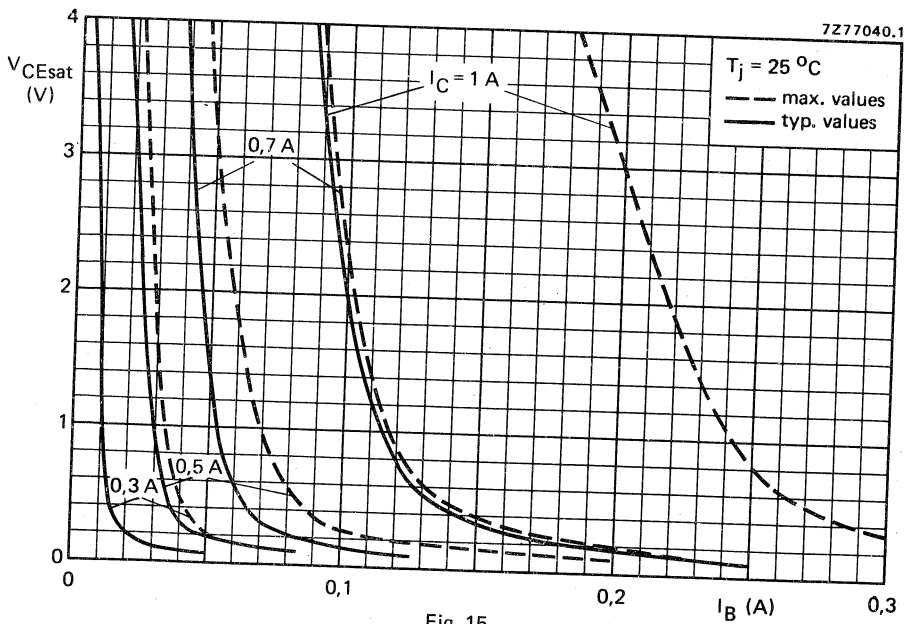


Fig. 15.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed switching n-p-n power transistors in TO-3 envelopes, intended for use in converters, inverters, switching regulators and motor control systems.

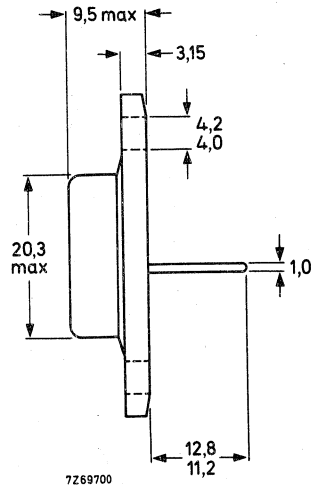
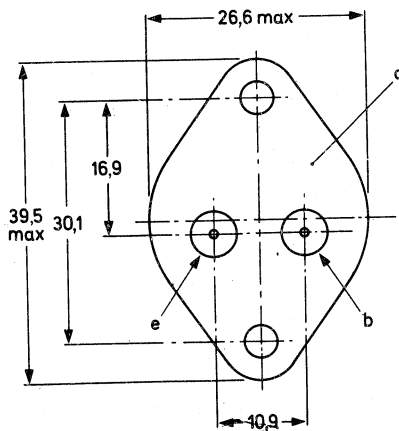
QUICK REFERENCE DATA		BUX80	BUX81	
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM} max.	800	1000	V
Collector-emitter voltage ($R_{BE} = 50 \Omega$)	V_{CER} max.	500	500	V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450	V
Collector current (d. c.)	I_C max.	10		A
Collector current (peak value) $t_p = 2$ ms	I_{CM} max.	15		A
Total power dissipation up to $T_{mb} = 40^\circ C$	P_{tot} max.	100		W
Collector-emitter saturation voltage $I_C = 5$ A; $I_B = 1$ A	$V_{CEsat} <$	1,5		V
Fall time $I_{Con} = 5$ A; $I_{Bon} = 1$ A; $-I_{Boff} = 2$ A	t_f typ.	0,3		μs

MECHANICAL DATA

Dimensions in mm

TO-3

Collector connected to case



For mounting instructions and accessories see section Accessories in handbook SC2.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

		BUX80	BUX81
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM} max.	800	1000 V
Collector-emitter voltage ($R_{BE} = 50 \Omega$)	V_{CER} max.	500	500 V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450 V

Currents

Collector current (d. c.)	I_C max.	10	A
Collector current (peak value) $t_p = 2$ ms	I_{CM} max.	15	A
Base current (d. c.)	I_B max.	4	A
Base current (peak value)	I_{BM} max.	6	A
Reverse base current (d. c. or average over any 20 ms period)	$-I_{B(AV)}$ max.	100	mA
Reverse base current (peak value) I_1	$-I_{BM}$ max.	6	A

Power dissipation

Total power dissipation up to $T_{mb} = 40$ °C	P_{tot} max.	100	W
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Temperatures

Storage temperature	T_{stg}	-65 to +150	°C
Junction temperature	T_j max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th j-mb} =$	1, 1	°C/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current I_2)

$V_{CEM} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	<	1	mA
$V_{CEM} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C	I_{CES}	<	3	mA

D. C. current gain

$I_C = 1, 2$ A; $V_{CE} = 5$ V	h_{FE} typ.	30	
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1) Turn-off current.

2) Measured with a half sine wave voltage (curve tracer).

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Emitter cut-off current

$I_C = 0; V_{EB} = 10\text{ V}$

$I_{EBO} < 10\text{ mA}$

Saturation voltages

$I_C = 5\text{ A}; I_B = 1\text{ A}$

$V_{CEsat} < 1,5\text{ V}$

$V_{BEsat} < 1,4\text{ V}$

$I_C = 8\text{ A}; I_B = 2,5\text{ A}$

$V_{CEsat} < 3\text{ V}$

$V_{BEsat} < 1,8\text{ V}$

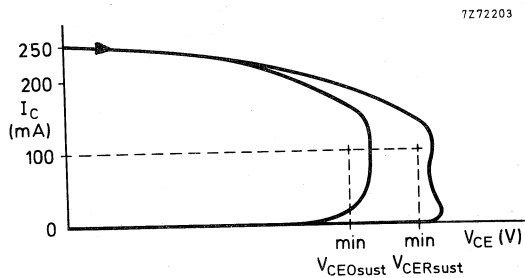
Collector-emitter sustaining voltages

$I_C = 100\text{ mA}; I_{Boff} = 0; L = 25\text{ mH}$

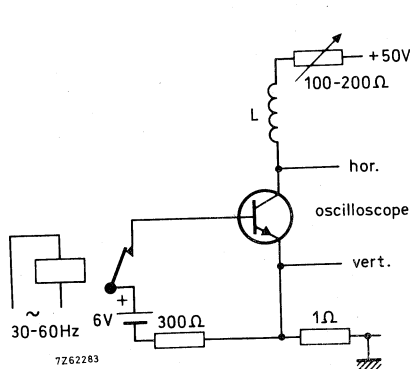
	BUX 80	BUX 81
$V_{CEOsust} >$	400	450
$V_{CERsust} >$	500	500

$I_C = 100\text{ mA}; R_{BE} = 50\ \Omega; L = 15\text{ mH}$

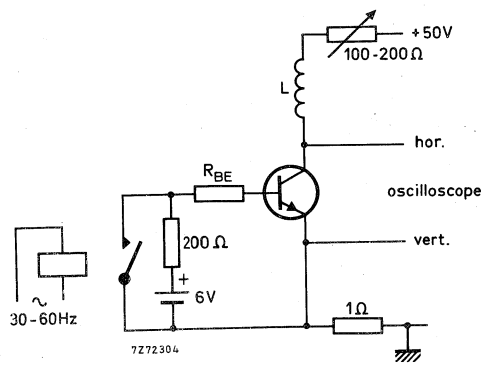
$V_{CERsust} >$	500	500
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Oscilloscope display for sustaining voltages



Test circuit for $V_{CEOsust}$



Test circuit for $V_{CERsust}$

BUX80 BUX81

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,2\text{ A}; V_{CE} = 10\text{ V}$

f_T typ. 6 MHz

Switching times

$I_{Con} = 5\text{ A}; V_{CC} = 250\text{ V}$

$I_{Bon} = 1\text{ A}; -I_{Boff} = 2\text{ A}$

Turn-on time

t_{on} typ. 0,35 μs
< 0,5 μs

Turn-off: Storage time

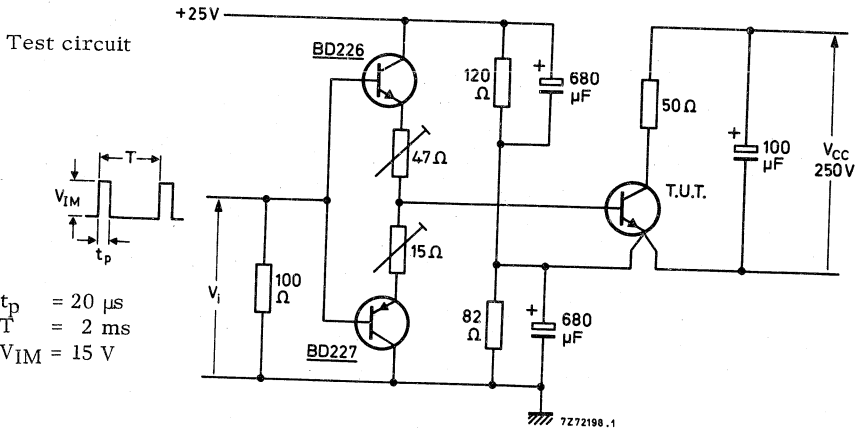
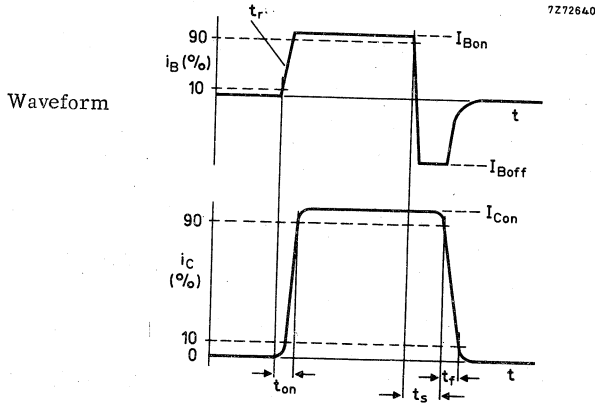
t_s typ. 2,5 μs
< 3,5 μs

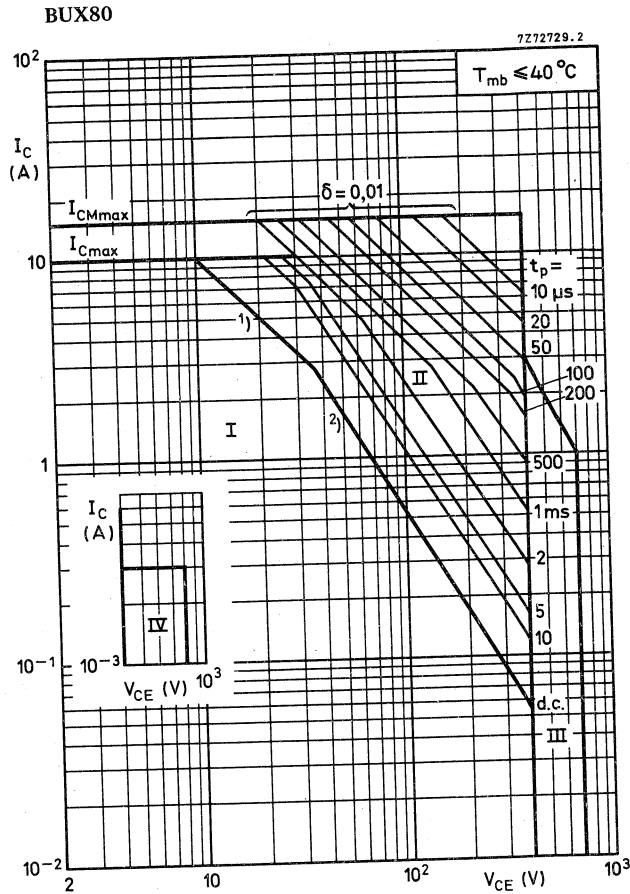
Fall time

t_f typ. 0,3 μs

Fall time, $T_{mb} = 95\text{ }^\circ\text{C}$

t_f < 0,8 μs





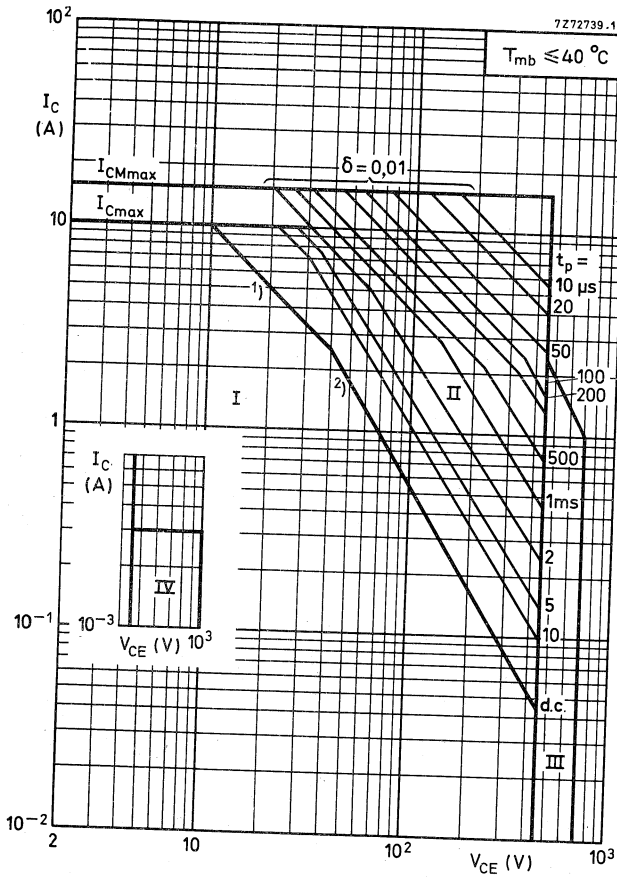
Safe Operating Area

- I Region of permissible d. c. operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu\text{s}$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 \text{ms}$

1) $P_{tot \text{ max}}$ and $P_{\text{peak max}}$ lines.

2) Second-breakdown limits (independent of temperature).

BUX81

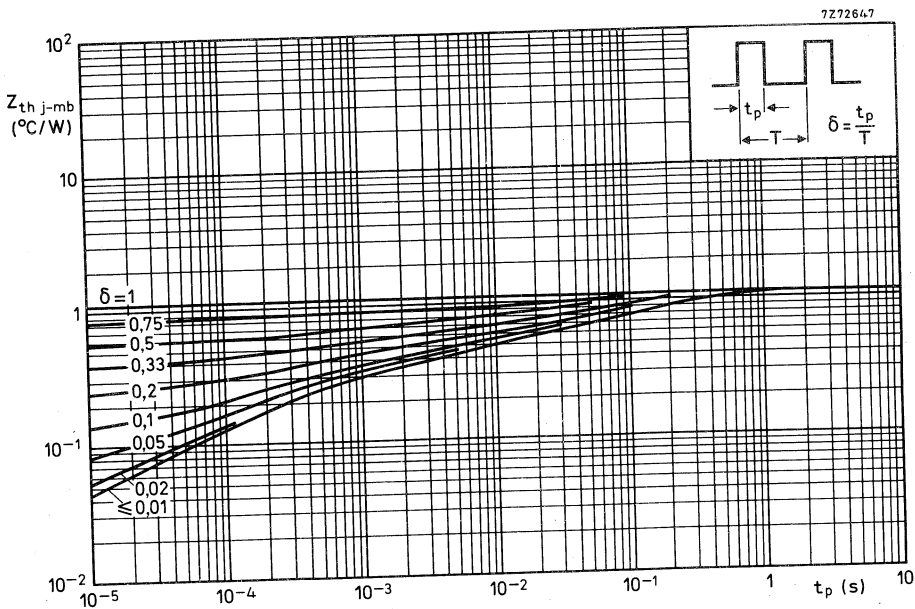
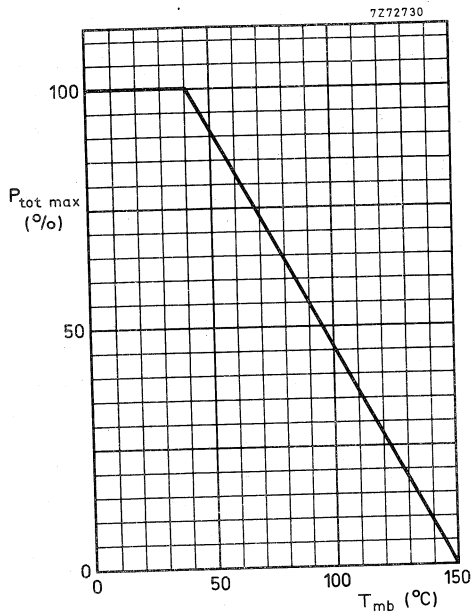


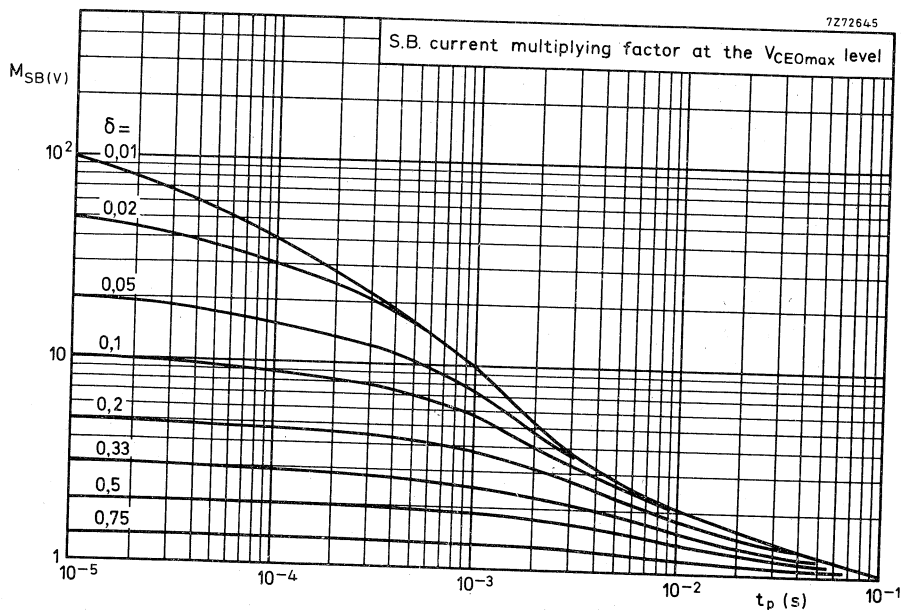
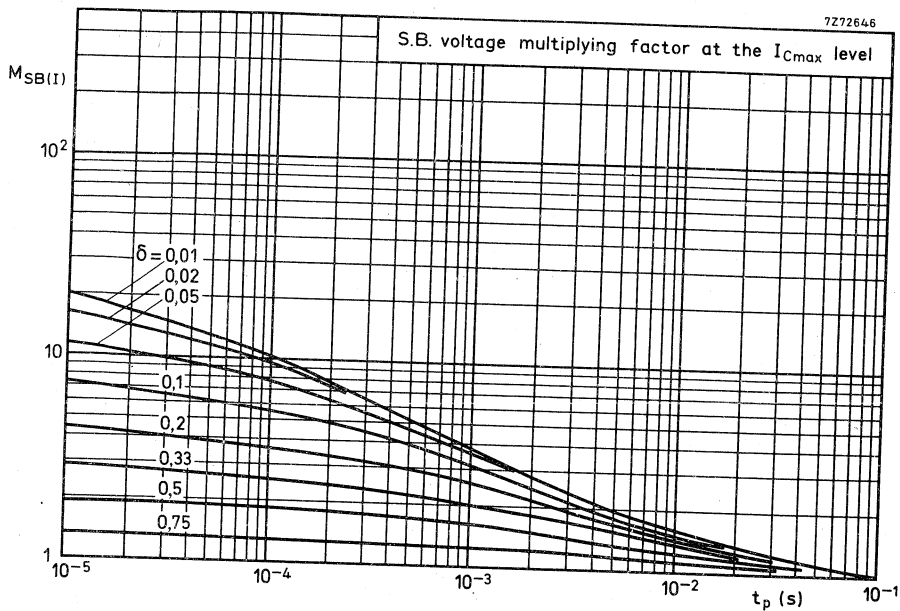
Safe Operating Area

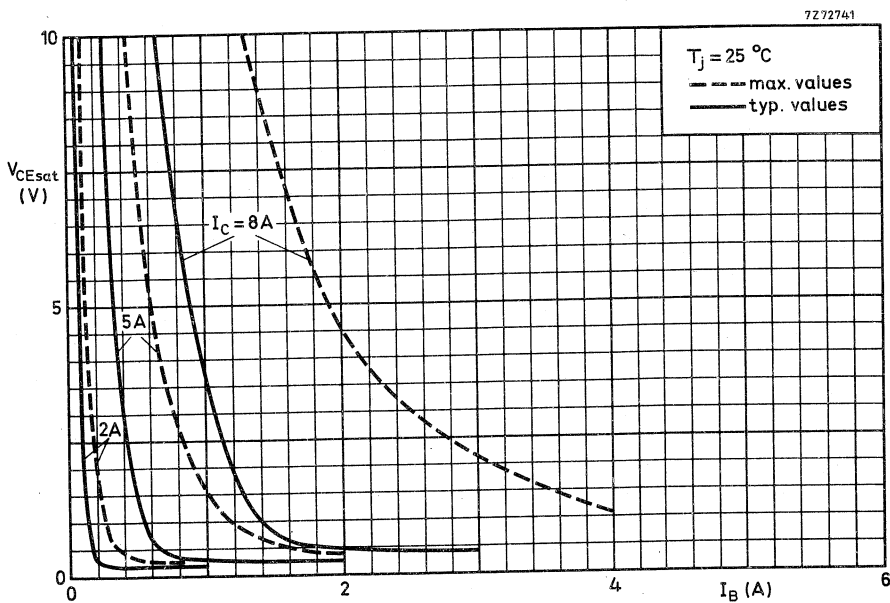
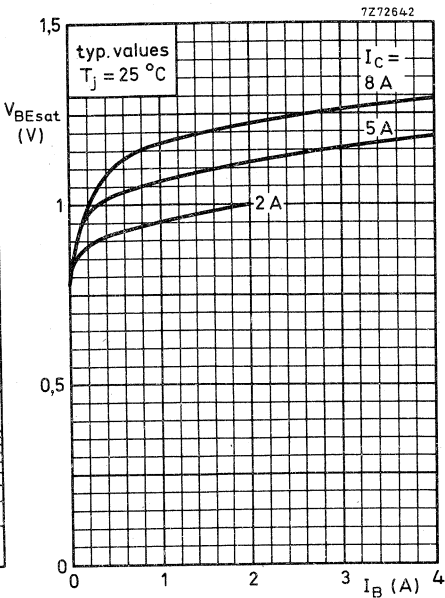
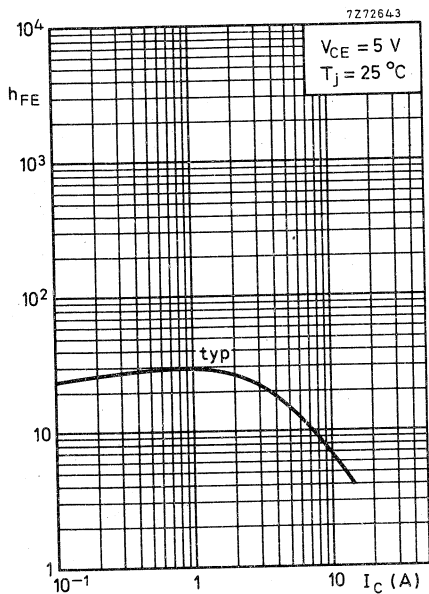
- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$

1) $P_{tot max}$ and $P_{peak max}$ lines.

2) Second-breakdown limits (independent of temperature).







APPLICATION INFORMATION ON BUX80 (detailed information on request)

Important factors in the design of SMPS circuits are the power losses and heatsink requirements of the supply output transistor and the base drive conditions during turn-off. In SMPS circuits with mains isolation the duty factor of the collector current generally varies between 0,25 and 0,5.

The operating frequency lies between 15 kHz and 50 kHz and the shape of the collector current varies from rectangular in a forward converter to a sawtooth in a flyback circuit.

As the BUX80 will mainly be used in forward or push-pull converters the information on optimum base drive and device dissipation given in the graphs on page 12 is concentrated on this application. In these figures I_{CM} represents the highest repetitive peak collector current that can occur in the given circuit, e.g. during overload.

The total power dissipation for a limit-case transistor is given in Fig. 5 which applies for a mounting base temperature of 100 °C. The required thermal resistance for the heatsink can be calculated from

$$R_{th\ mb-a} = \frac{100 - T_{amb\ max}}{P_{tot}}$$

To ensure thermal stability the minimum value of T_{amb} in the above equation is 40 °C.

A practical SMPS output circuit for an output power in the order of 400 W is given in Fig. 2.

At a collector current of 5 A and a base current of 1 A in this circuit the following turn-off times can be expected.

Storage time
Fall time

	$T_{mb} = 25\ ^\circ\text{C}$	100 °C
t_s	typ 2	2,7 μs
t_f	typ 0,18	0,5 μs

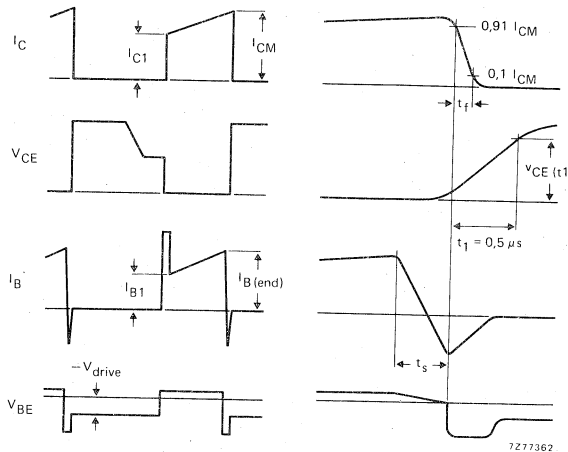


Fig. 1 Relevant waveforms of switching transistor.

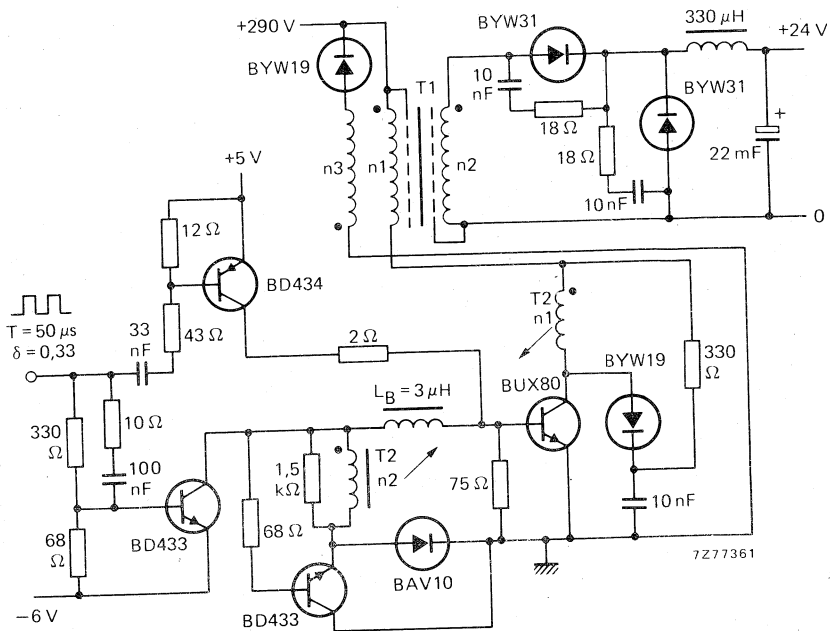


Fig. 2 Practical SMPS output circuit.

T1 (output transformer): Core U64; $n_1 = n_3 = 56$ turns; $n_2 = 17$ turns

T2 (base current transformer): Core U20; $n_1 = 5$ turns; $n_2 = 25$ turns

$v_{CE}(t_1) < 300$ V (see Fig. 1)

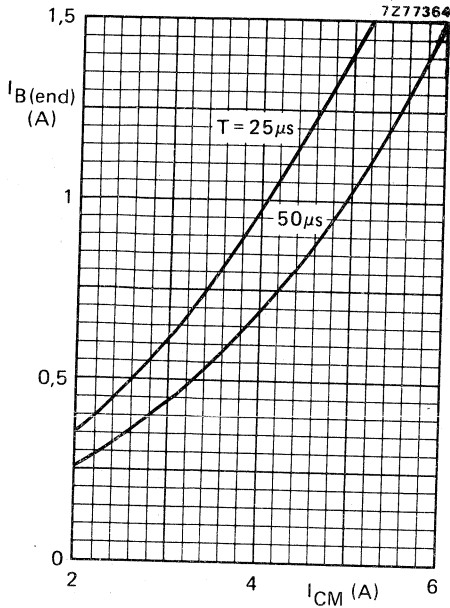


Fig. 3.

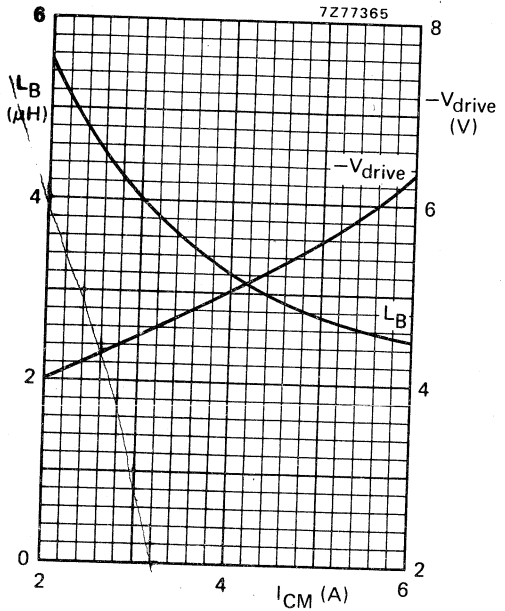


Fig. 4.

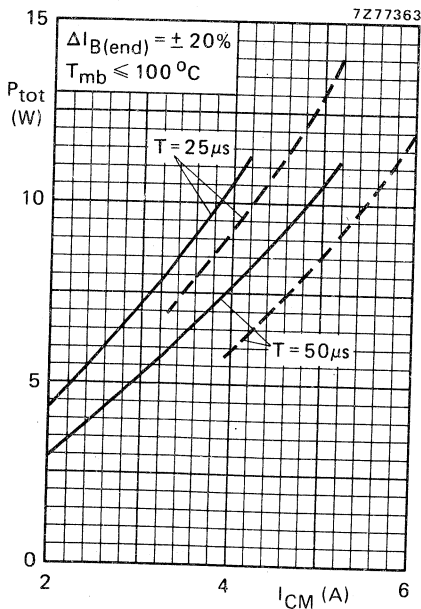


Fig. 5.

Fig. 3 Recommended nominal "end" value of the base current versus maximum peak collector current.

Fig. 4 Minimum required base inductance and recommended negative drive voltage versus maximum peak collector current.

Fig. 5 Maximum total power dissipation of a limit-case transistor if the base current is chosen in accordance with Fig. 3. Solid lines for transformer drive and dotted lines for collector-coupled current drive.

SILICON DIFFUSED POWER TRANSISTORS

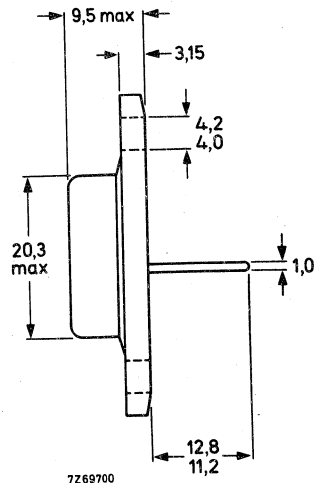
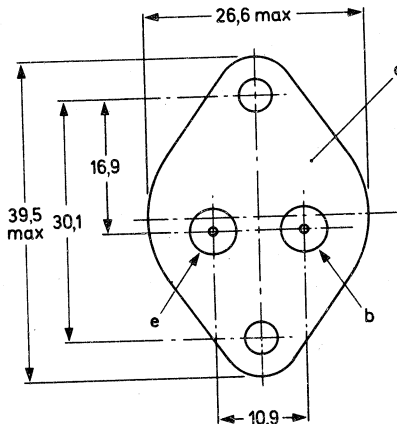
High-voltage, high-speed switching n-p-n power transistors in TO-3 envelopes, intended for use in converters, inverters, switching regulators and motor control systems.

		QUICK REFERENCE DATA	
		BUX82	BUX83
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM} max.	800	1000 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	V_{CER} max.	500	500 V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450 V
Collector current (d. c.)	I_C max.		6 A
Collector current (peak value) $t_p = 2$ ms	I_{CM} max.		8 A
Total power dissipation up to $T_{mb} = 50^\circ C$	P_{tot} max.		60 W
Collector-emitter saturation voltage $I_C = 2,5$ A; $I_B = 0,5$ A	$V_{CEsat} <$		1,5 V
Fall time $I_{Con} = 2,5$ A; $I_{Bon} = 0,5$ A; $-I_{Boff} = 1$ A	t_f typ.		0,3 μs

MECHANICAL DATA

Dimensions in mm

TO-3
Collector connected to case



For mounting instructions and accessories see section Accessories in handbook SC2.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

		BUX82	BUX83
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM} max.	800	1000 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	V_{CER} max.	500	500 V
Collector-emitter voltage (open base)	V_{CEO} max.	400	450 V

Currents

Collector current (d. c.)	I_C max.	6	A
Collector current (peak value) $t_p = 2$ ms	I_{CM} max.	8	A
Base current (d. c.)	I_B max.	2	A
Base current (peak value)	I_{BM} max.	3	A
Reverse base current (d. c. or average over any 20 ms period)	$-I_{B(AV)}$ max.	100	mA
Reverse base current (peak value) 1)	$-I_{BM}$ max.	3	A

Power dissipation

Total power dissipation up to $T_{mb} = 50 \text{ }^\circ\text{C}$	P_{tot} max.	60	W
--	----------------	----	---

Temperatures

Storage temperature	T_{stg}	-65 to +150	$^\circ\text{C}$
Junction temperature	T_j max.	150	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to mounting base	$R_{th j-mb} =$	1,65	$^\circ\text{C/W}$
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CHARACTERISTICS

Collector cut-off current 2)

$$V_{CEM} = V_{CESMmax}; V_{BE} = 0$$

$$V_{CEM} = V_{CESMmax}; V_{BE} = 0; T_j = 125 \text{ }^\circ\text{C}$$

$T_j = 25 \text{ }^\circ\text{C}$ unless otherwise specified

I_{CES}	<	1	mA
I_{CES}	<	2	mA

D. C. current gain

$$I_C = 0,6 \text{ A}; V_{CE} = 5 \text{ V}$$

h_{FE}	typ.	30
----------	------	----

1) Turn-off current.

2) Measured with a half sine wave voltage (curve tracer).

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Emitter cut-off current

$I_C = 0; V_{EB} = 10\text{ V}$

$I_{EBO} < 10\text{ mA}$

Saturation voltages

$I_C = 2,5\text{ A}; I_B = 0,5\text{ A}$

$V_{CEsat} < 1,5\text{ V}$

$V_{BEsat} < 1,4\text{ V}$

$I_C = 4\text{ A}; I_B = 1,25\text{ A}$

$V_{CEsat} < 3\text{ V}$

$V_{BEsat} < 1,6\text{ V}$

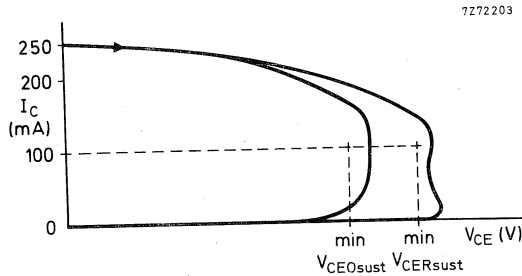
Collector-emitter sustaining voltages

$I_C = 100\text{ mA}; I_{Boff} = 0; L = 25\text{ mH}$

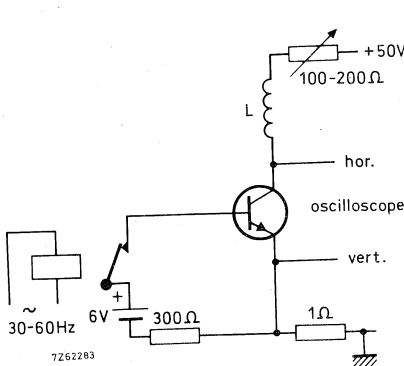
	BUX82	BUX83	
$V_{CE0sust}$	> 400	450	V
$V_{CERsust}$	> 500	500	V

$I_C = 100\text{ mA}; R_{BE} = 100\ \Omega; L = 15\text{ mH}$

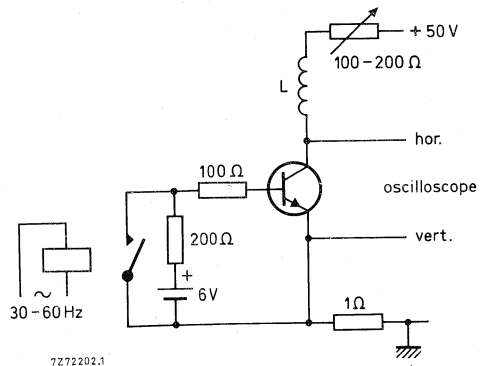
$V_{CERsust} > 500\text{ V}$



Oscilloscope display for sustaining voltages



Test circuit for $V_{CE0sust}$



Test circuit for V_{ERsust}

BUX82 BUX83

CHARACTERISTICS (continued)

$T_j = 25^\circ\text{C}$ unless otherwise specified

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,2\text{ A}; V_{CE} = 10\text{ V}$

f_T typ. 6 MHz

Switching times

$I_{Con} = 2,5\text{ A}; V_{CC} = 250\text{ V}$

$I_{Bon} = 0,5\text{ A}; -I_{Boff} = 1\text{ A}$

Turn-on time

t_{on} typ. 0,3 μs
< 0,5 μs

Turn-off: Storage time

t_s typ. 2 μs
< 3,5 μs

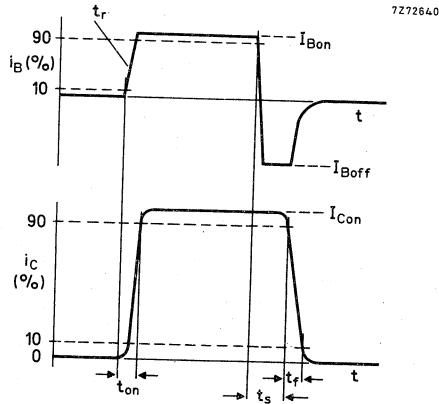
Fall time

t_f typ. 0,3 μs

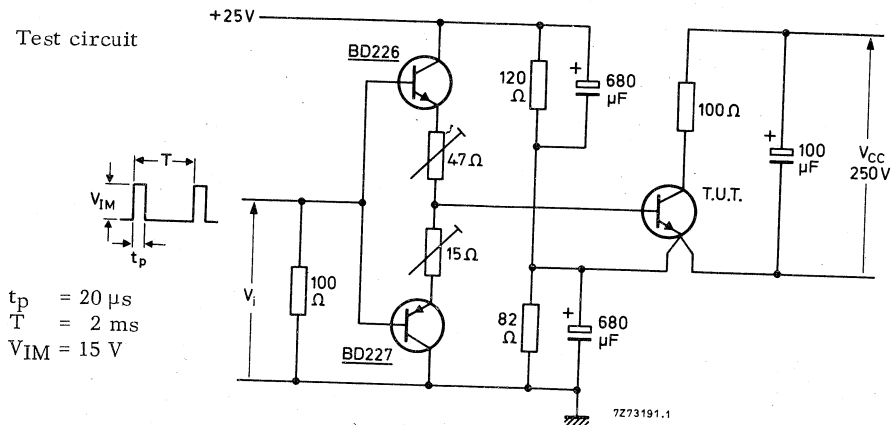
Fall time, $T_{mb} = 95^\circ\text{C}$

t_f < 1 μs

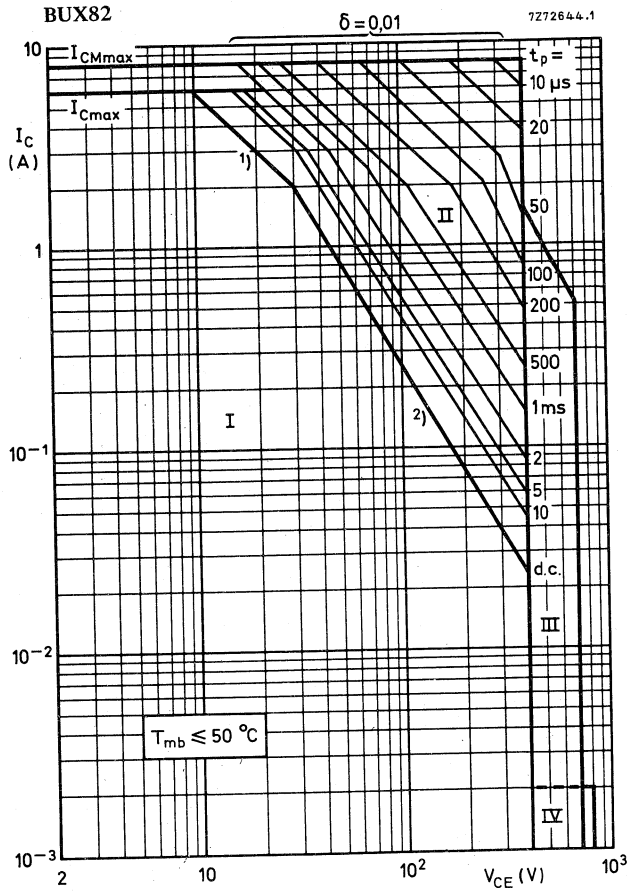
Waveform



Test circuit



$t_p = 20\ \mu\text{s}$
 $T = 2\ \text{ms}$
 $V_{IM} = 15\ \text{V}$

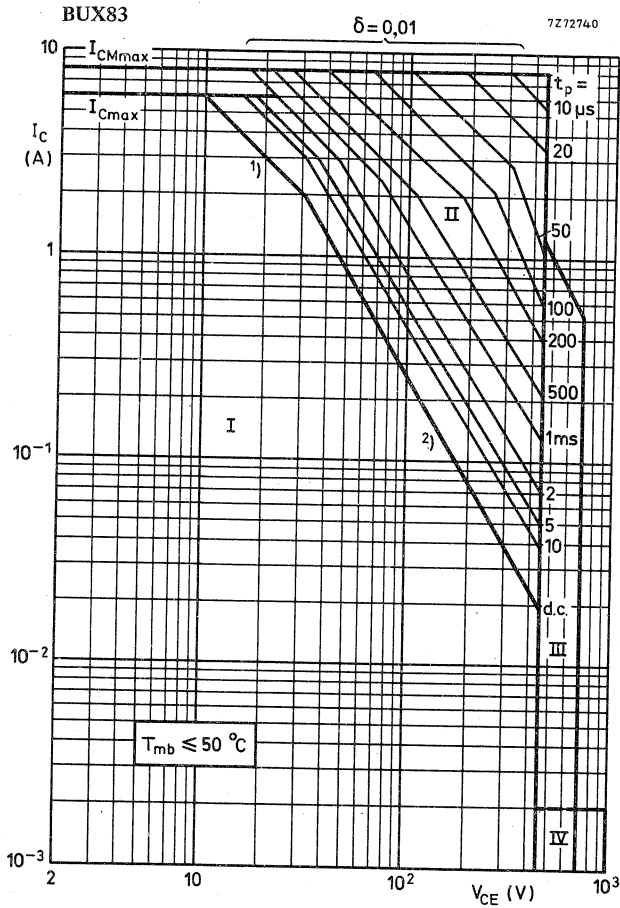


Safe Operating Area

- I Region of permissible d. c. operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$

1) $P_{tot max}$ and $P_{peak max}$ lines.

2) Second-breakdown limits (independent of temperature).

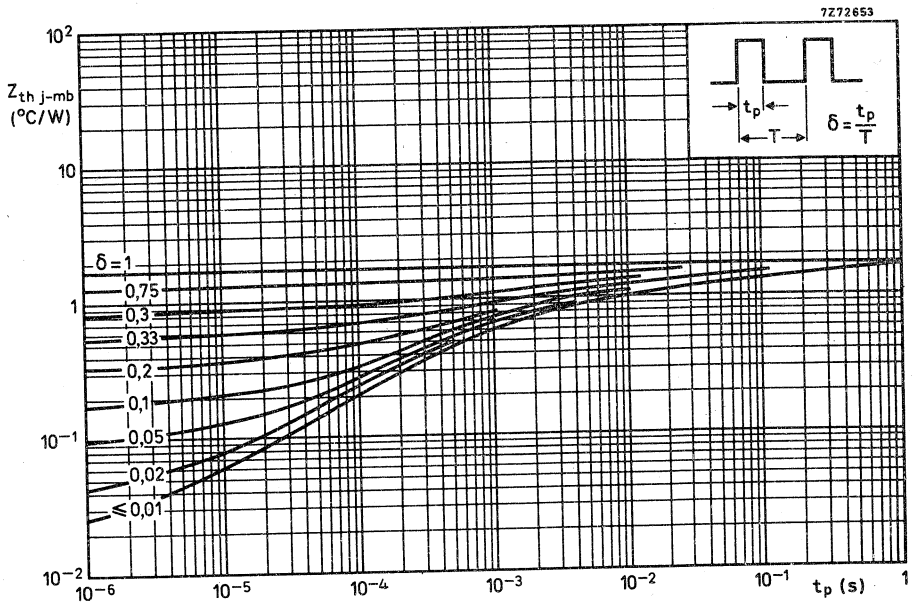
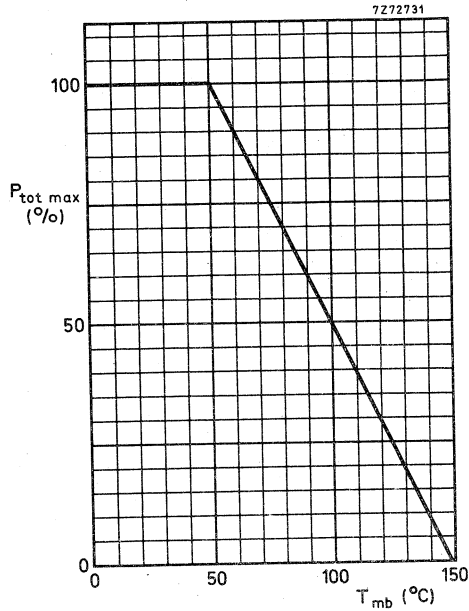


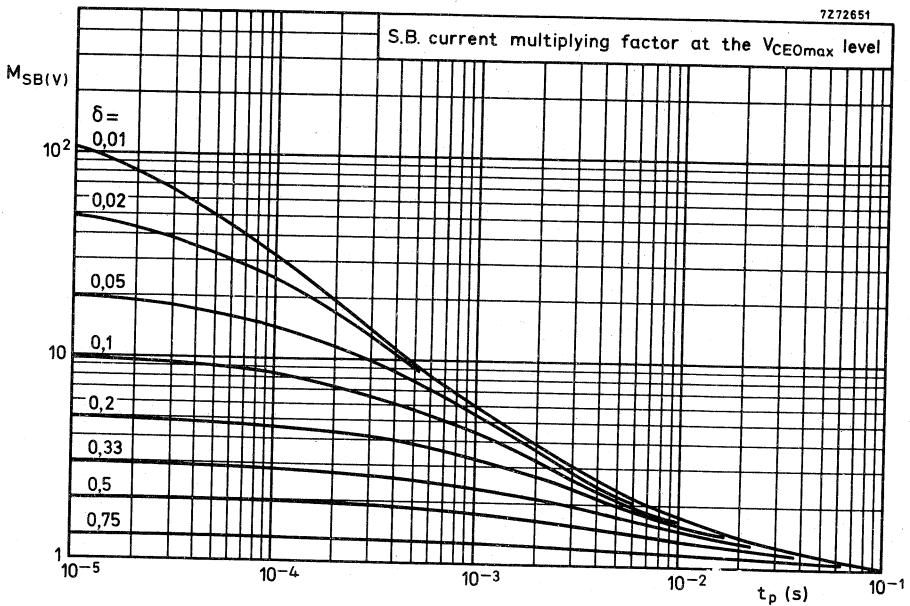
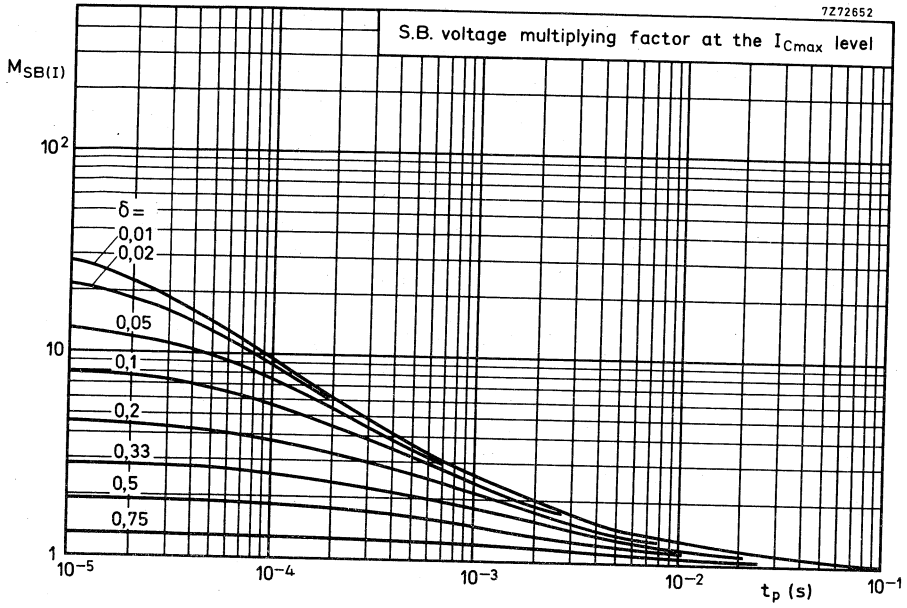
Safe Operating ARea

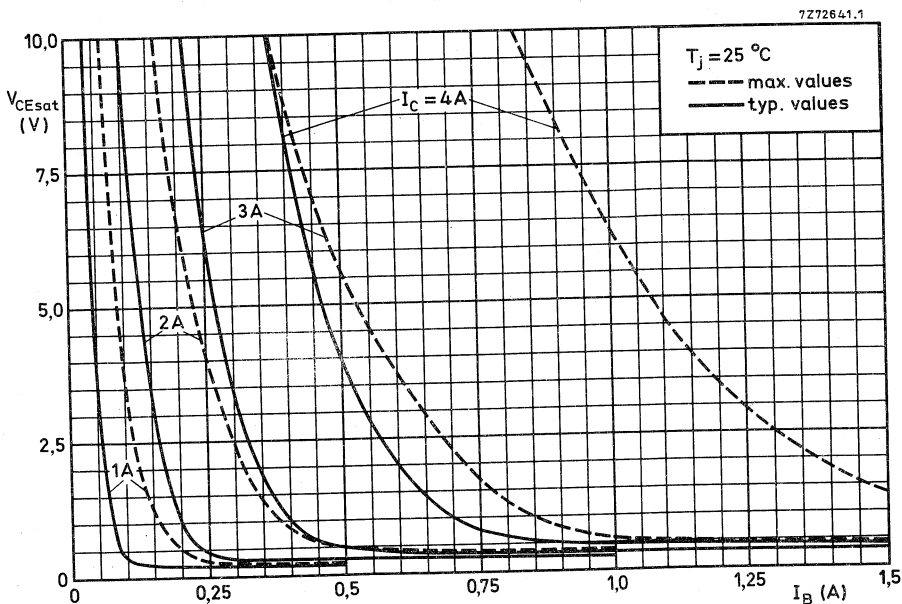
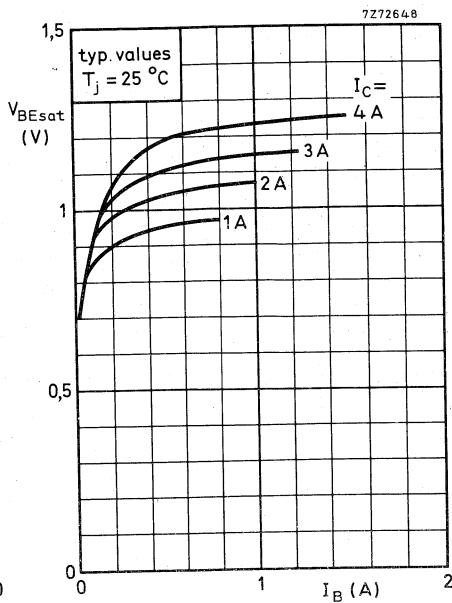
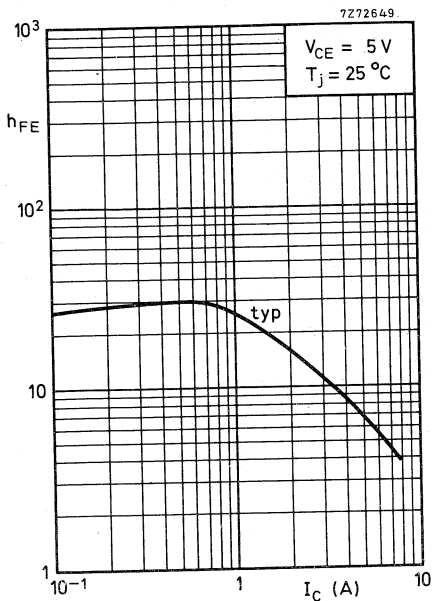
- I Region of permissible d. c. operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$

1) P_{tot} max and P_{peak} max lines.

2) Second-breakdown limits (independent of temperature).







APPLICATION INFORMATION ON BUX82 (detailed information on request)

Important factors in the design of SMPS circuits are the power losses and heatsink requirements of the supply output transistor and the base drive conditions during turn-off. In SMPS circuits with mains isolation the duty factor of the collector current generally varies between 0,25 and 0,5.

The operating frequency lies between 15 kHz and 50 kHz and the shape of the collector current varies from rectangular in a forward converter to a sawtooth in a flyback circuit.

Information on optimum base drive and device dissipation of the BUX82 in a flyback converter is given in Figs 3 to 5. Figs 6 to 8 apply to a forward converter. In these figures I_{CM} represents the highest repetitive peak collector current that can occur in the given circuit, e.g. during overload.

The total power dissipation for a limit-case transistor is given in Figs 5 and 8 which applies for a mounting base temperature of 100 °C. The required thermal resistance for the heatsink can be calculated from

$$R_{th\ mb-a} = \frac{100 - T_{amb\ max}}{P_{tot}}$$

To ensure thermal stability the minimum value of T_{amb} in the above equation is 40 °C.

A practical forward converter output circuit for an output power in the order of 200 W is given in Fig. 2.

At a collector current of 2,5 A and a base current of 0,5 A in this circuit the following turn-off times can be expected.

Storage time
Fall time

	$T_{mb} = 25\ ^\circ\text{C}$		$100\ ^\circ\text{C}$	
t_s	typ	1,9	2,7	μs
t_f	typ	0,17	0,7	μs

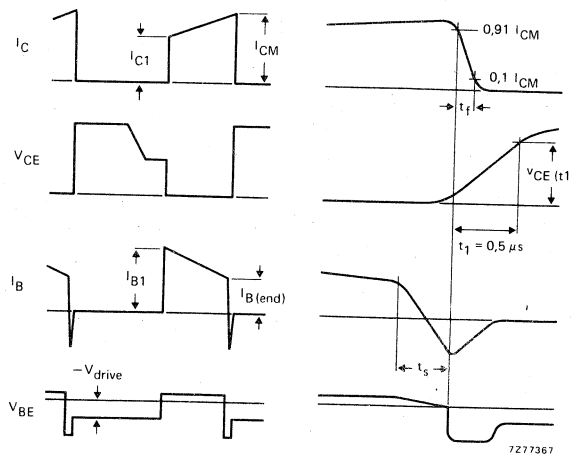


Fig. 1 Relevant waveforms of switching transistor.

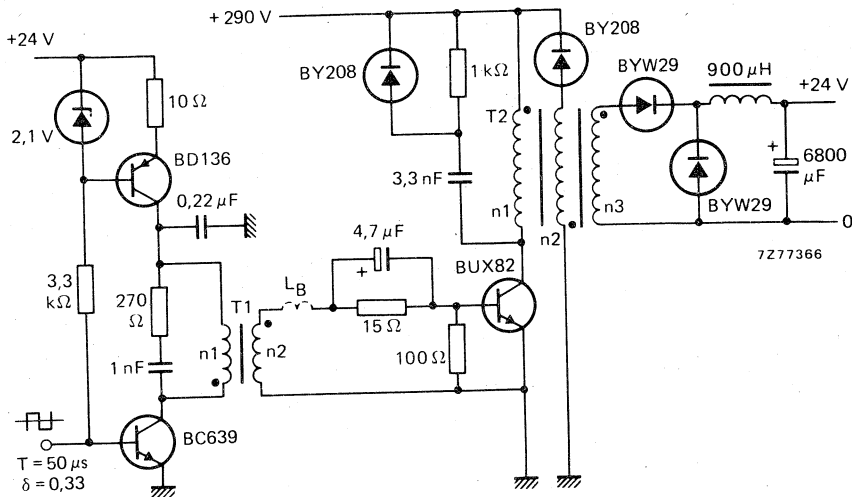


Fig. 2 Practical forward converter SMPS output circuit.

T1 (driver transformer): Core U20; n1 = 75 turns; n2 = 20 turns

T2 (output transformer): Core E55; n1 = n2 = 72 turns; n3 = 19 turns

$V_{CE}(t_1) < 300\text{ V}$ (see Fig. 1)



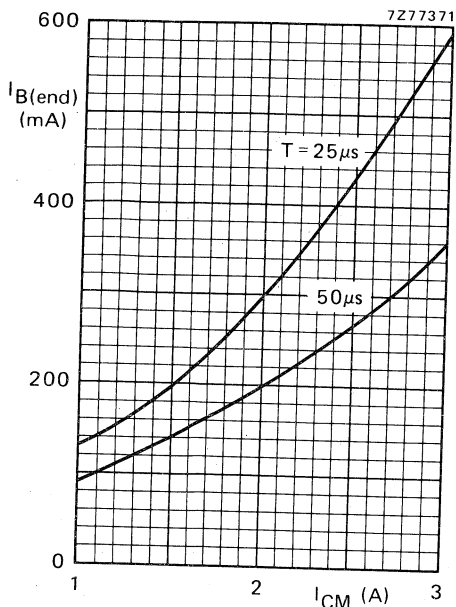


Fig. 3.

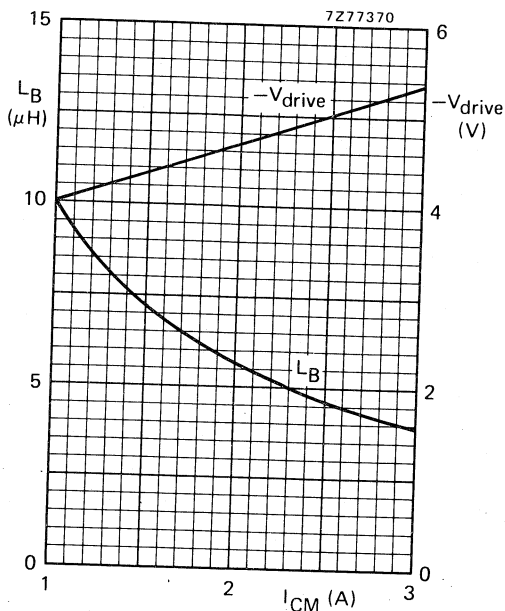


Fig. 4.

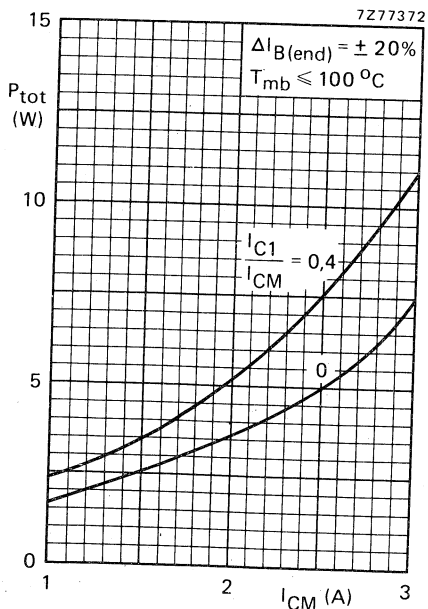


Fig. 5.

Fig. 3 Recommended nominal "end" value of the base current versus maximum peak collector current in a flyback converter.

Fig. 4 Minimum required base inductance and recommended negative drive voltage versus maximum peak collector current.

Fig. 5 Maximum total power dissipation of a limit-case transistor if the base current is chosen in accordance with Fig. 3.

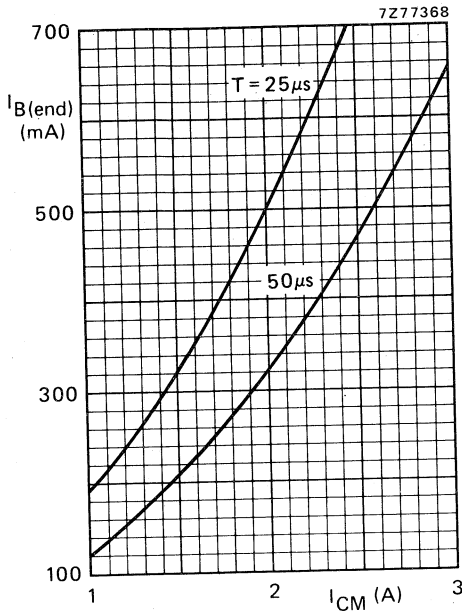


Fig. 6.

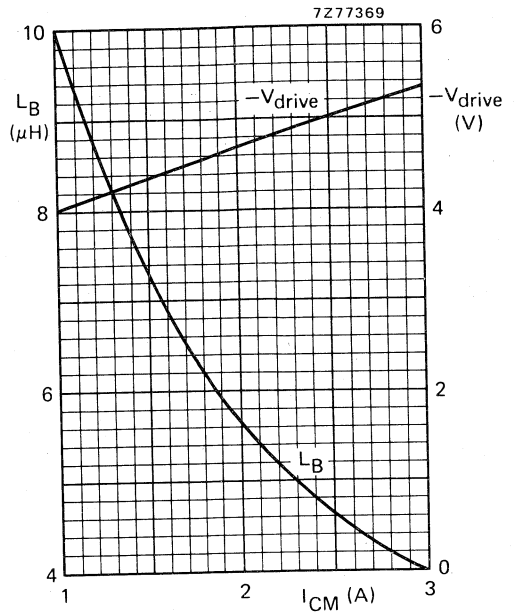


Fig. 7.

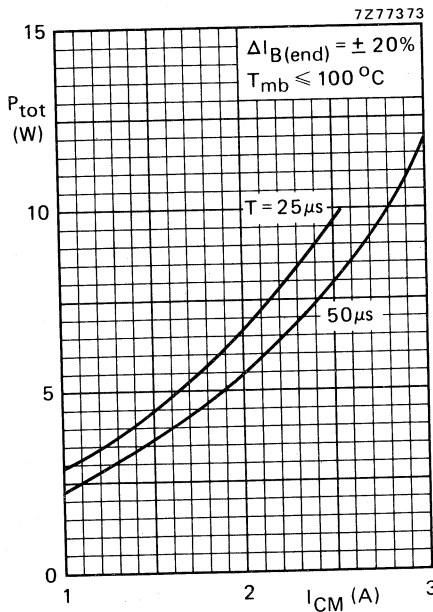


Fig. 8.

Fig. 6 Recommended nominal "end" value of the base current versus maximum peak collector current in a forward converter.

Fig. 7 Minimum required base inductance and recommended negative drive voltage versus maximum peak collector current.

Fig. 8 Maximum total power dissipation of a limit-case transistor if the base current is chosen in accordance with Fig. 6.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated n-p-n power transistors in TO-220 envelopes, intended for use in converters, inverters, switching regulators, motor control systems and switching applications.

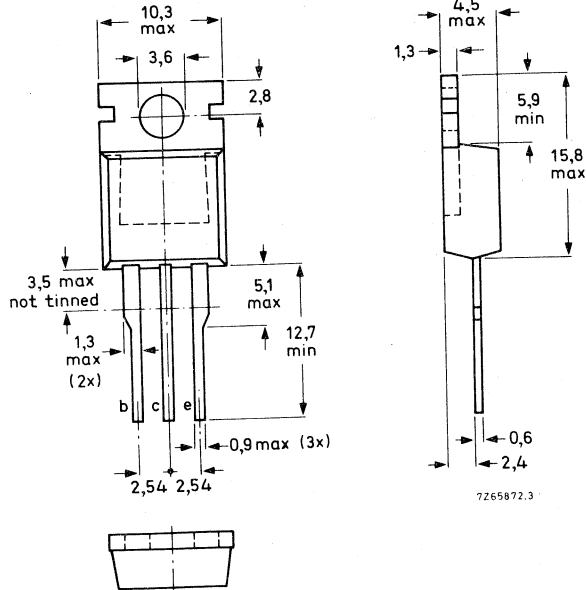
QUICK REFERENCE DATA

		BUX84	BUX85	
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM} max	800	1000	V
Collector-emitter voltage (open base)	V_{CEO} max	400	450	V
Collector current (d.c.)	I_C max	2	A	
Collector current (peak value)	I_{CM} max	3	A	
$t_p = 2$ ms	P_{tot} max	40	W	
Total power dissipation up to $T_{mb} = 50$ °C	V_{CEsat} <	3	V	
Collector-emitter saturation voltage $I_C = 1$ A; $I_B = 0,2$ A	t_f typ	0,4	μ s	
Fall time $I_{Con} = 1$ A; $I_{Bon} = 0,2$ A; $-I_{Boff} = 0,4$ A				

Dimensions in mm

MECHANICAL DATA

TO-220
Collector connected
to mounting base



For mounting instructions and accessories see section Accessories (Handbook SC2).

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

Collector-emitter voltage
($V_{BE} = 0$, peak value)

Collector-emitter voltage (open base)

	BUX84		BUX85	
V_{CESM}	max	800	1000	V
V_{CEO}	max	400	450	V

Currents

Collector current (d.c.)

Collector current (peak value)

$t_p = 2$ ms

Base current (d.c.)

Base current (peak value)

Reverse base current (peak value) *

I_C	max	2	A
I_{CM}	max	3	A
I_B	max	0,75	A
I_{BM}	max	1	A
$-I_{BM}$	max	1	A

Power dissipation

Total power dissipation up to $T_{mb} = 50$ °C

P_{tot}	max	40	W
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Temperatures

Storage temperature

Junction temperature

T_{stg}	-65 to +150	°C
T_j	max 150	°C

THERMAL RESISTANCE

From junction to mounting base

From junction to ambient in free air

$R_{th\ j-mb}$	=	2,5	°C/W
$R_{th\ j-a}$	=	70	°C/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current **

$V_{CEM} = V_{CESMmax}; V_{BE} = 0$

$V_{CEM} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C

I_{CES}	<	200	μA
I_{CES}	<	1,5	mA

D.C. current gain

$I_C = 0,1$ A; $V_{CE} = 5$ V

h_{FE}	typ	50
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* Turn-off current.

** Measured with a half sine-wave voltage (curve tracer).

$T_j = 25^\circ\text{C}$ unless otherwise specified

CHARACTERISTICS (continued)

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 1\text{ mA}$

Saturation voltages

$I_C = 0,3\text{ A}; I_B = 30\text{ mA}$

$I_C = 1\text{ A}; I_B = 0,2\text{ A}$

$I_C = 1\text{ A}; I_B = 0,2\text{ A}$

$V_{CEsat} < 0,8\text{ V}$

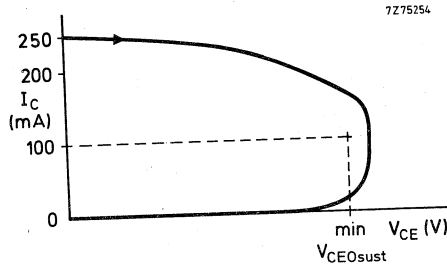
$V_{CEsat} < 1,0\text{ V}$

$V_{BEsat} < 1,1\text{ V}$

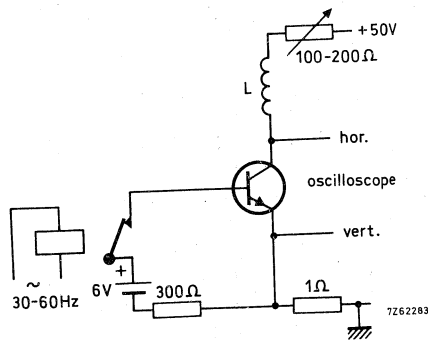
Collector-emitter sustaining voltage

$I_C = 100\text{ mA}; I_{Boff} = 0; L = 25\text{ mH}$

	BUX84	BUX85
$V_{CEOsust} >$	400	450



Oscilloscope display for sustaining voltage.



Test circuit for $V_{CEOsust}$.

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Transition frequency at $f = 1\text{ MHz}$

$I_C = 0,2\text{ A}; V_{CE} = 10\text{ V}$

f_T typ 20 MHz

Switching times

$I_{Con} = 1\text{ A}; V_{CC} = 250\text{ V}$

$I_{Bon} = 0,2\text{ A}; -I_{Boff} = 0,4\text{ A}$

Turn-on time

t_{on} typ 0,2 μs
 $< 0,5\text{ } \mu\text{s}$

Turn-off: Storage time

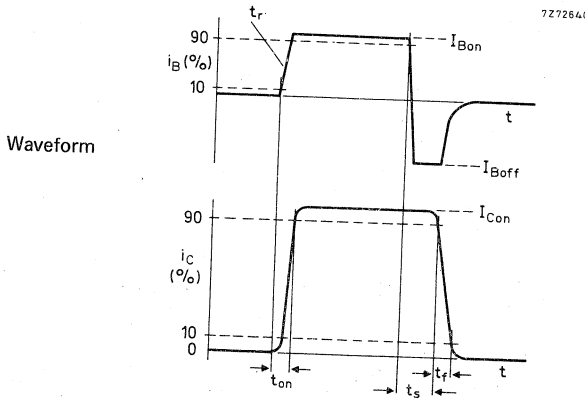
t_s typ 2 μs
 $< 3,5\text{ } \mu\text{s}$

Fall time

t_f typ 0,4 μs

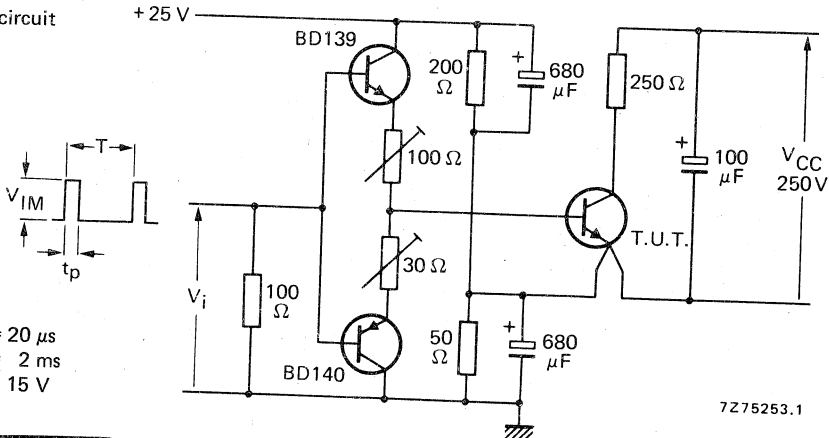
Fall time, $T_{mb} = 95\text{ }^\circ\text{C}$

$t_f < 1,4\text{ } \mu\text{s}$



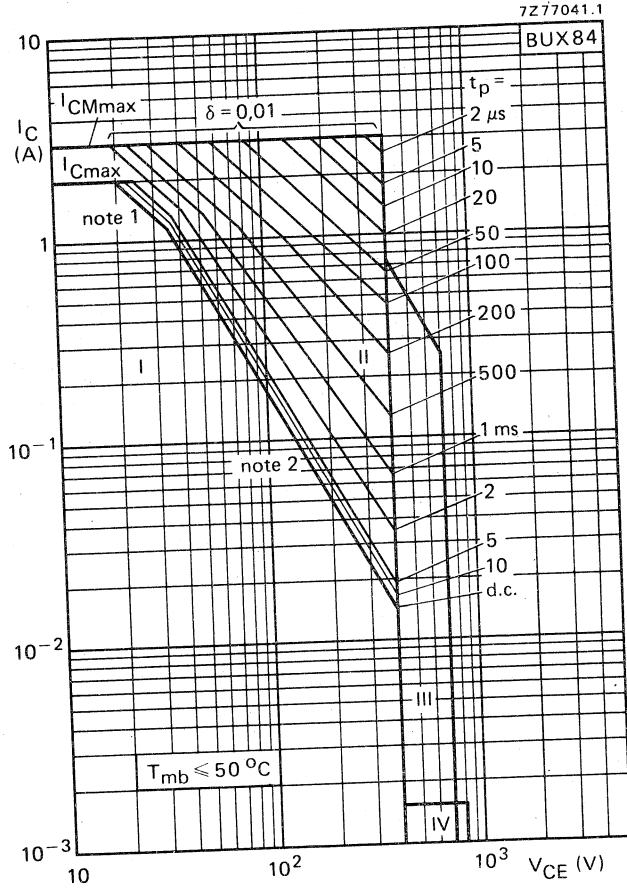
Waveform

Test circuit



$t_p = 20\text{ } \mu\text{s}$
 $T = 2\text{ ms}$
 $V_{IM} = 15\text{ V}$

7275253.1

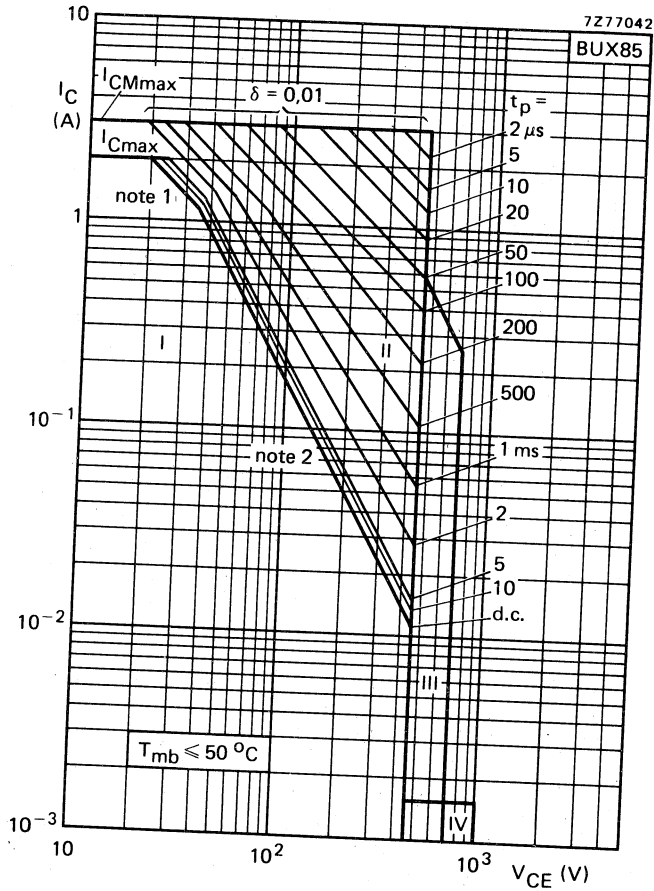


Safe Operating Area

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \text{ } \Omega$ and $t_p \leq 0,6 \text{ } \mu$ s
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 \text{ ms}$

Notes

1. $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
2. Second-breakdown limits (independent of temperature).

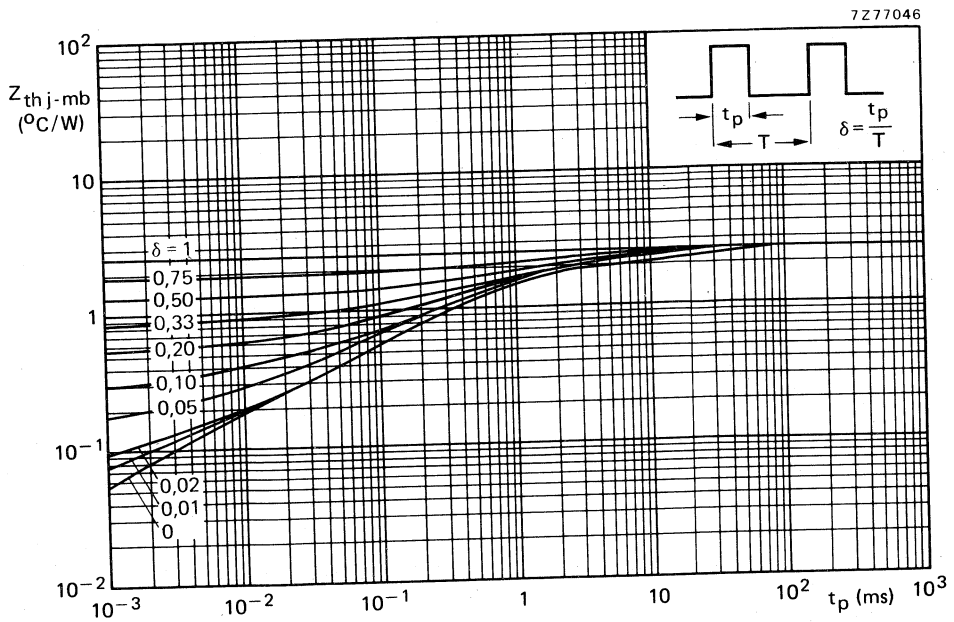
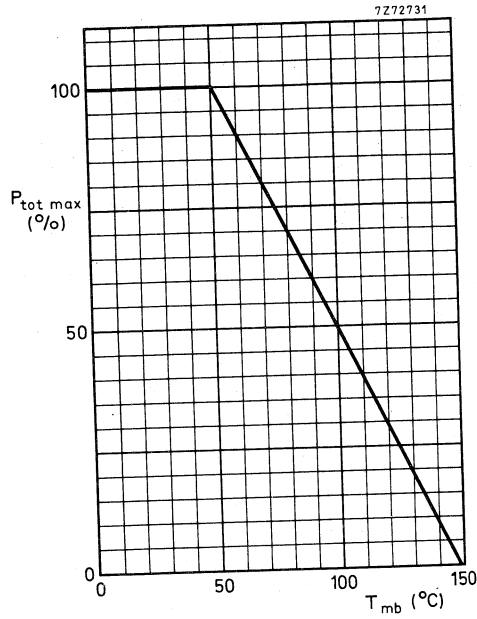


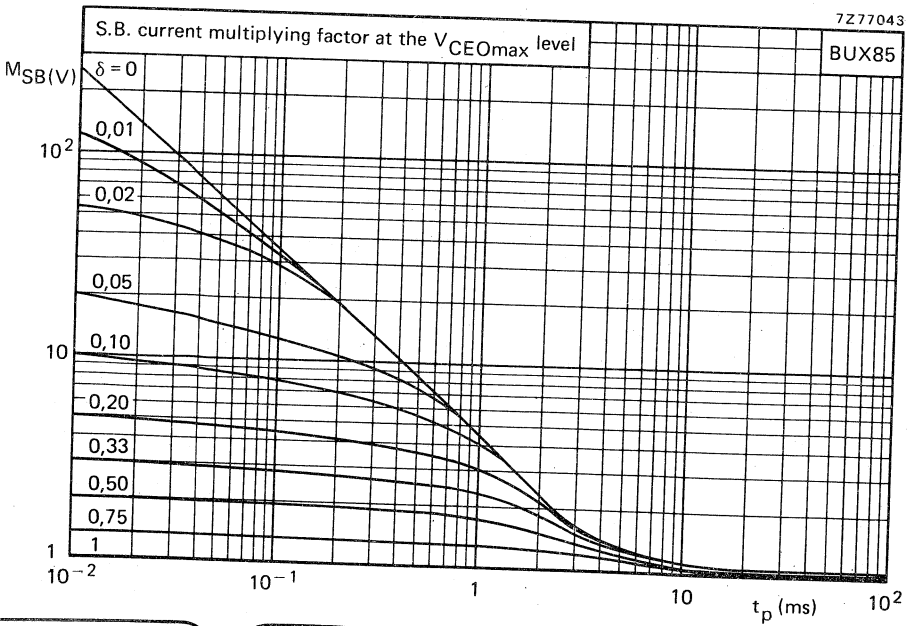
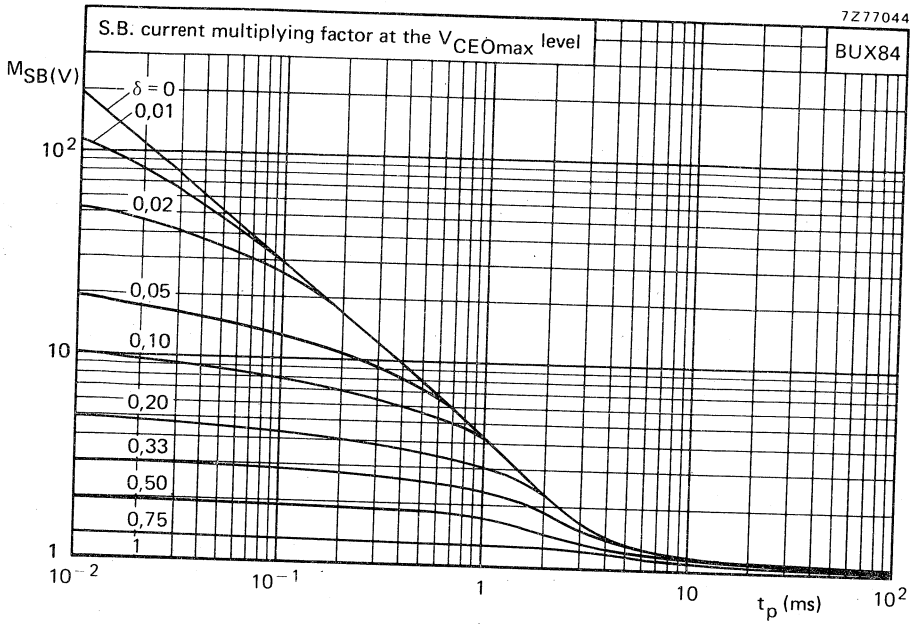
Safe Operating Area

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 \text{ ms}$

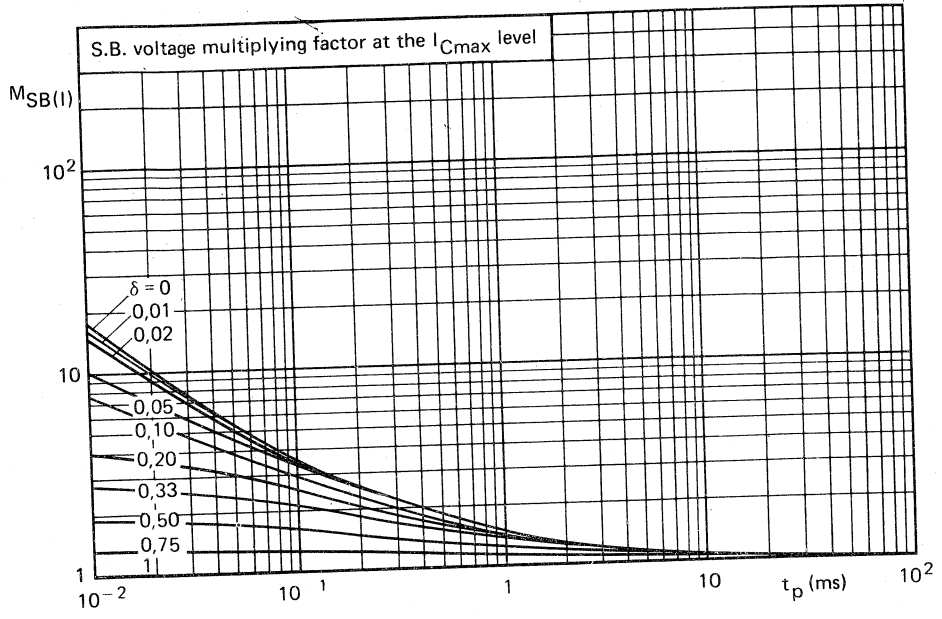
Notes

1. $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.
2. Second-breakdown limits (independent of temperature).

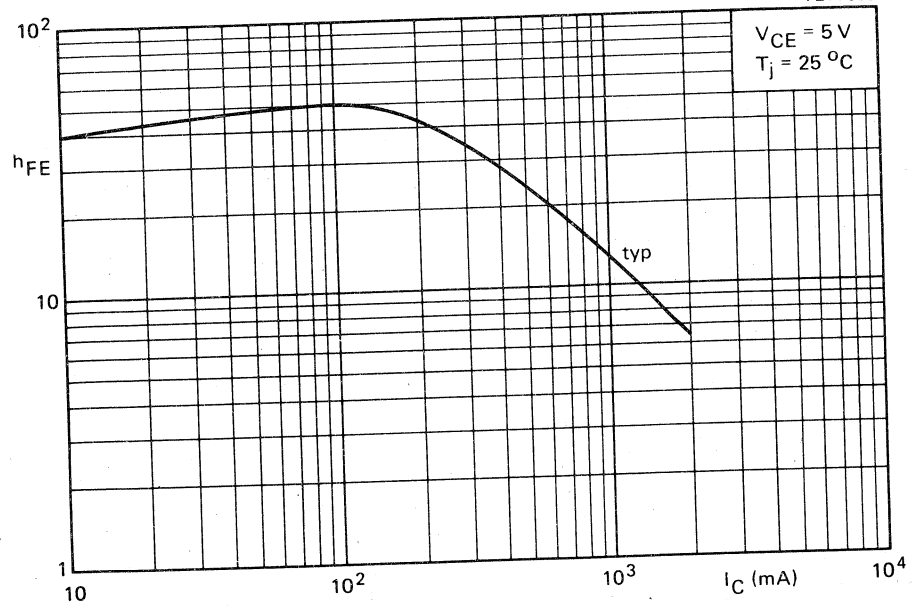


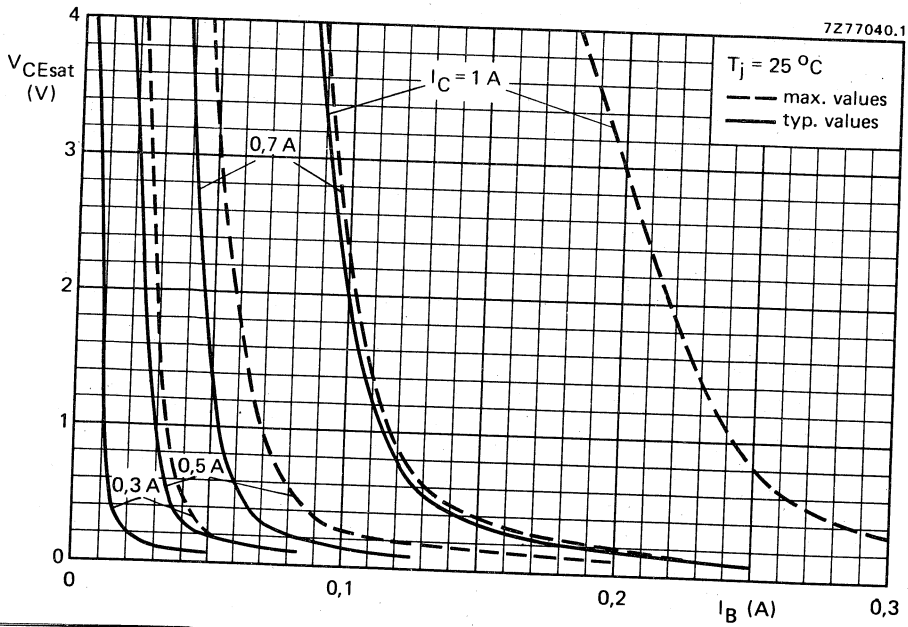
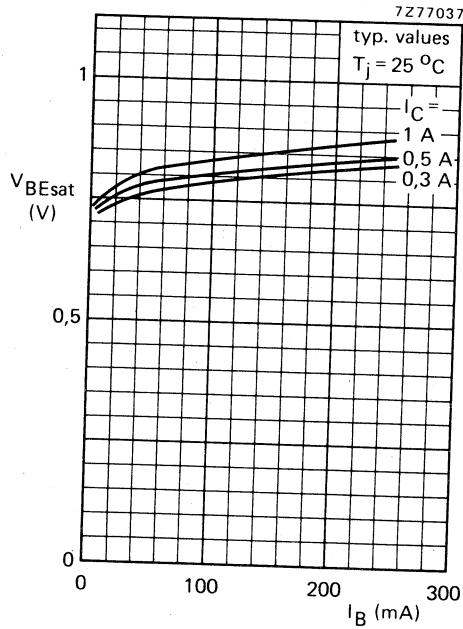


7Z77045



7Z77039





APPLICATION INFORMATION ON BUX84 (detailed information on request)

Important factors in the design of SMPS circuits are the power losses and heatsink requirements of the supply output transistor and the base drive conditions during turn-off. In most SMPS circuits with mains isolation the duty factor of the collector current generally varies between 0,25 and 0,5.

The operating frequency lies between 15 kHz and 50 kHz and the shape of the collector current varies from rectangular in a forward converter to a sawtooth in a flyback circuit.

Information on optimum base drive and device dissipation of the BUX84 in a flyback converter is given in Figs 3 to 5. Figs 6 to 8 apply to a forward converter. In these figures I_{CM} represents the highest repetitive peak collector current that can occur in the given circuit, e.g. during overload.

The total power dissipation for a limit-case transistor is given in Figs 5 and 8 which apply for a mounting base temperature of 100 °C. The required thermal resistance for the heatsink can be calculated from

$$R_{th\ mb-a} = \frac{100 - T_{amb\ max}}{P_{tot}}$$

To ensure thermal stability the minimum value of T_{amb} in the above equation is 40 °C.

A practical SMPS output circuit for an output power in the order of 50 W is given in Fig. 2.

At a collector current of 0,7 A and a base current of 70 mA in this circuit the following turn-off times can be expected.

Storage time
Fall time

	$T_{mb} = 25\text{ °C}$		100 °C	
t_s	typ	2,2	2,8	μs
t_f	typ	0,25	0,85	μs

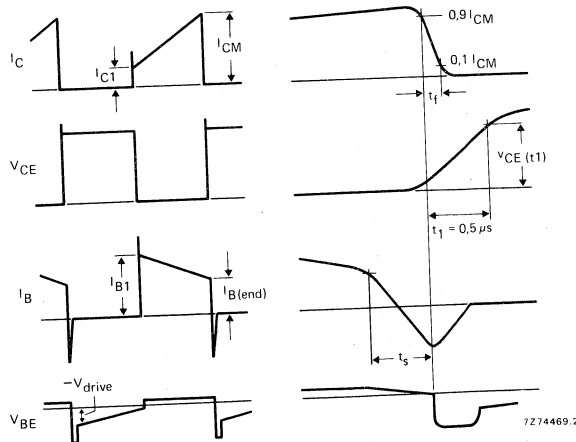


Fig. 1 Relevant waveforms of switching transistor.

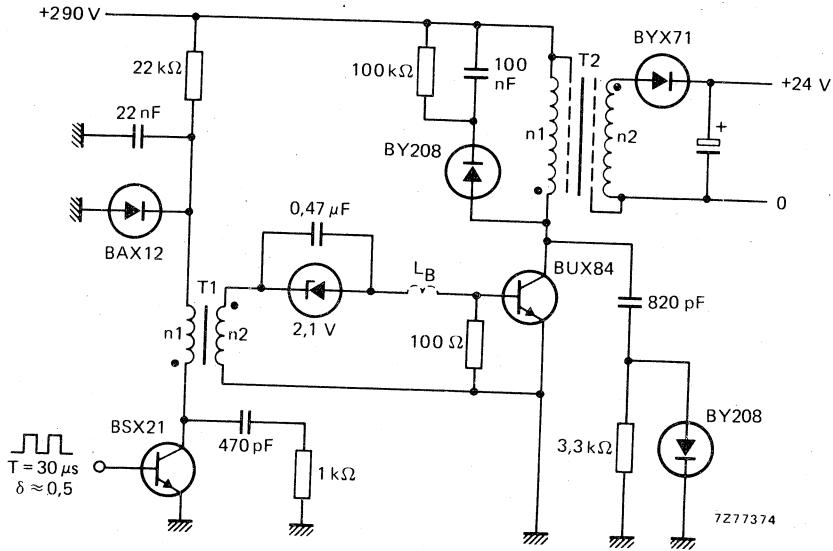


Fig. 2 Practical SMPS output circuit.

T1 (driver transformer): Core U15; $n_1 = 360$ turns; $n_2 = 60$ turns
total inductance in base circuit $\approx 15 \mu\text{H}$

T2 (output transformer): Core E55; primary inductance $L_p = 16 \text{ mH}$
 $n_1 = 116$ turns; $n_2 = 12$ turns

$v_{CE}(t_1) < 300 \text{ V}$ (see Fig. 1)

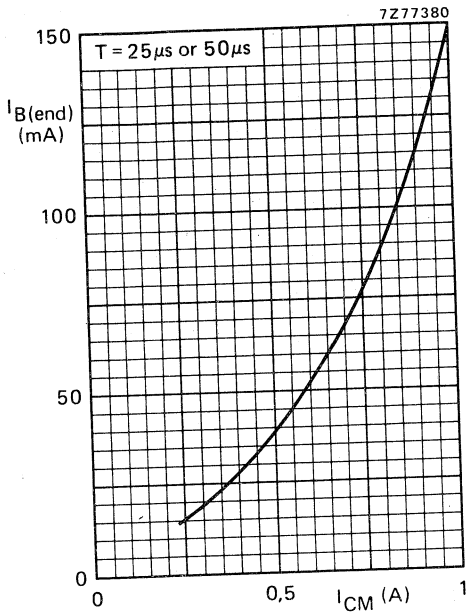


Fig. 3.

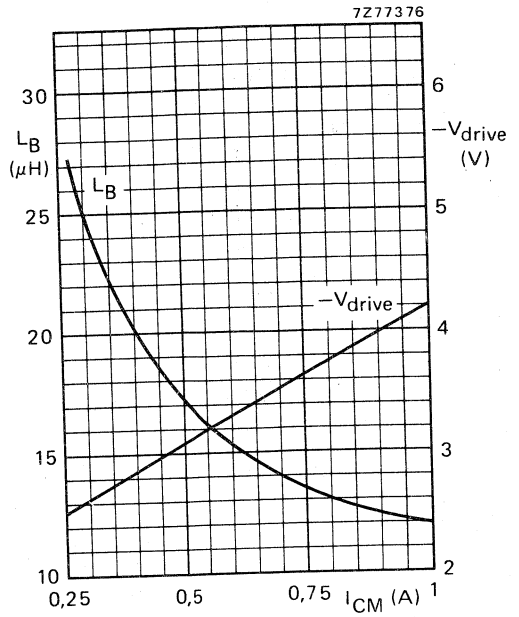


Fig. 4.

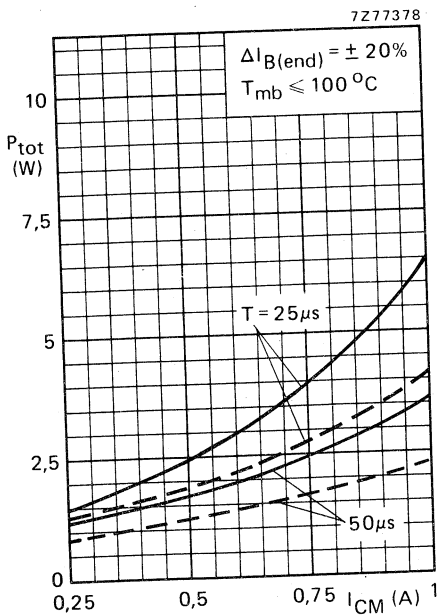


Fig. 5.

Fig. 3 Recommended nominal "end" value of the base current versus maximum peak collector current in a flyback converter.

Fig. 4 Minimum required base inductance and recommended negative drive voltage versus maximum peak collector current.

Fig. 5 Maximum total power dissipation of a limit-case transistor if the base current is chosen in accordance with Fig. 3. Solid lines for $I_{C1}/I_{CM} = 0,4$ and dotted lines for $I_{C1}/I_{CM} = 0$.

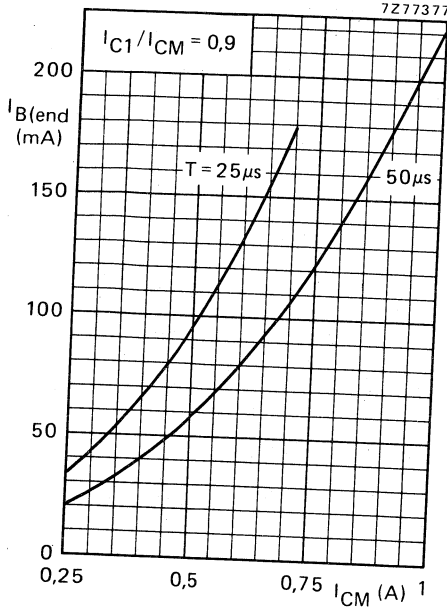


Fig. 6.

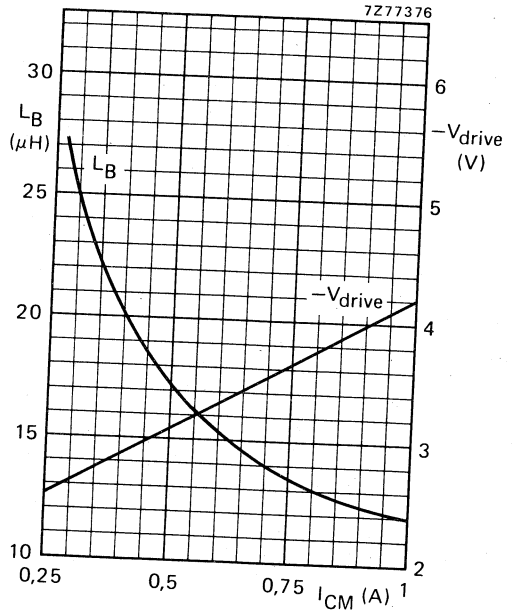


Fig. 7.

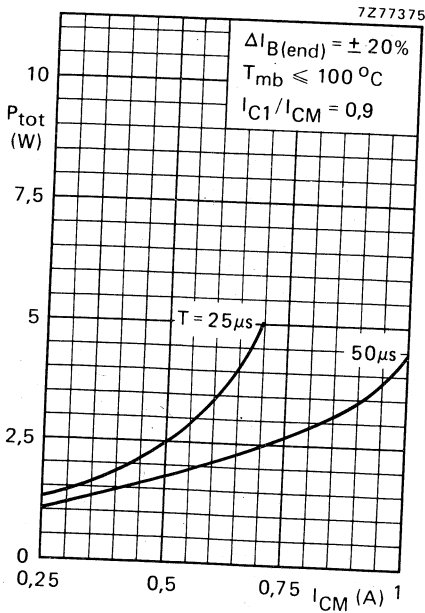


Fig. 8.

Fig. 6 Recommended nominal "end" value of the base current versus maximum peak collector current in a forward converter.

Fig. 7 Minimum required base inductance and recommended negative drive voltage versus maximum peak collector current.

Fig. 8 Maximum total power dissipation of a limit-case transistor if the base current is chosen in accordance with Fig. 6.

SILICON DIFFUSED POWER TRANSISTORS

High-voltage, high-speed, glass-passivated n-p-n power transistors in SOT-32 envelopes, for use in converters, inverters, switching regulators, motor control systems and switching applications.

QUICK REFERENCE DATA

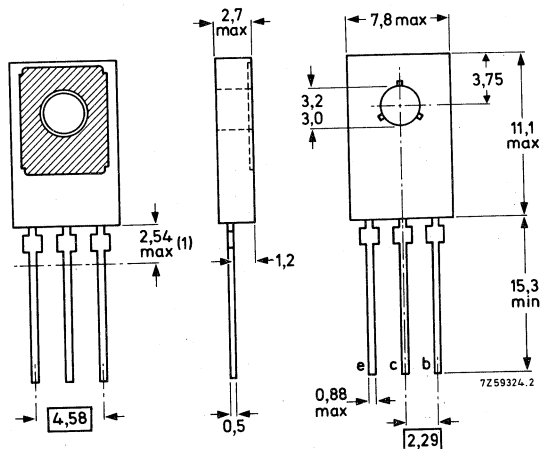
	BUX86	BUX87	
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM} max 800	1000	V
Collector-emitter voltage (open base)	V_{CEO} max 400	450	V
Collector current (d.c.)	I_C max 0,5		A
Collector current (peak value): $t_p = 2$ ms	I_{CM} max 1		A
Total power dissipation up to $T_{mb} = 60$ °C	P_{tot} max 20		W
Collector-emitter saturation voltage: $I_C = 0,2$ A; $I_B = 20$ mA	$V_{CEsat} <$	3	V
Fall time: $I_{Con} = 0,2$ A; $I_{Bon} = 20$ mA; $-I_{Boff} = 40$ mA	t_f typ 0,4		μs

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected to metal part of mounting surface



Accessories: 56326 (washer) or 56353 (clip) for direct mounting and 56353 + 56354 (package) for insulated mounting.

* Within this region the cross-section of the leads is uncontrolled.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

		BUX86	BUX87
Collector-emitter voltage ($V_{BE} = 0$, peak value)	V_{CESM}	max 800	1000 V
Collector-emitter voltage (open base)	V_{CEO}	max 400	450 V

Currents

Collector current (d.c.)	I_C	max 0,5	A
Collector current (peak value): $t_p = 2$ ms	I_{CM}	max 1	A
Base current (d.c.)	I_B	max 0,2	A
Base current (peak value)	I_{BM}	max 0,3	A
Reverse base current (peak value) (note 1)	$-I_{BM}$	max 0,3	A

Power dissipation

Total power dissipation up to $T_{mb} = 60$ °C	P_{tot}	max 20	W
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Temperatures

Storage temperature	T_{stg}	-65 to +150	°C
Junction temperature	T_j	max 150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	= 4,5	°C/W
From junction to ambient in free air	$R_{th\ j-a}$	= 100	°C/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current (note 2)

$V_{CEM} = V_{CESMmax}; V_{BE} = 0$	I_{CES}	< 100	μA
$V_{CEM} = V_{CESMmax}; V_{BE} = 0; T_j = 125$ °C	I_{CES}	< 1	mA

D.C. current gain

$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	typ 50	
-------------------------------	----------	--------	--

Notes

1. Turn-off current
2. Measured with a half sine-wave voltage (curve tracer).

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

$I_{EBO} < 1\text{ mA}$

Saturation voltage

$I_C = 0,1\text{ A}; I_B = 10\text{ mA}$

$V_{CEsat} < 1,5\text{ V}$

$I_C = 0,2\text{ A}; I_B = 20\text{ mA}$

$V_{CEsat} < 3\text{ V}$

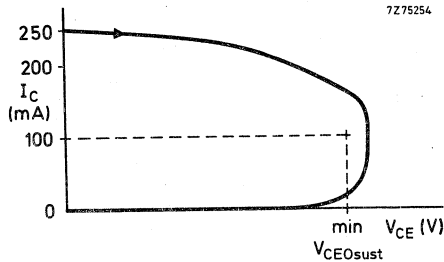
$I_C = 0,2\text{ A}; I_B = 20\text{ mA}$

$V_{BEsat} < 1,0\text{ V}$

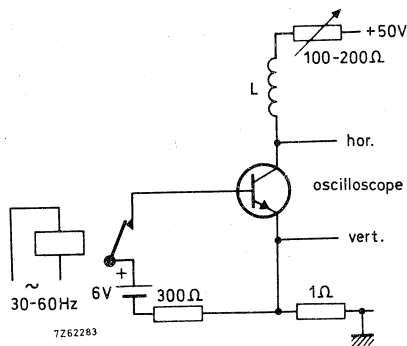
Collector-emitter sustaining voltages

$I_C = 100\text{ mA}; I_{Boff} = 0; L = 25\text{ mH}$

	BUX86	BUX87
$V_{CEOsust}$	400	450



Oscilloscope display for sustaining voltage



Test circuit for $V_{CEOsust}$

CHARACTERISTICS (continued)

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Transition frequency at $f = 1\text{ MHz}$

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$

f_T typ 20 MHz

Switching times

$I_{Con} = 0,2\text{ A}; V_{CC} = 250\text{ V}$

$I_{Bon} = 20\text{ mA}; -I_{Boff} = 40\text{ mA}$

Turn-on time

t_{on} typ 0,25 μs
 $t_{on} < 0,5\text{ } \mu\text{s}$

Turn-off: Storage time

t_s typ 2 μs
 $t_s < 3,5\text{ } \mu\text{s}$

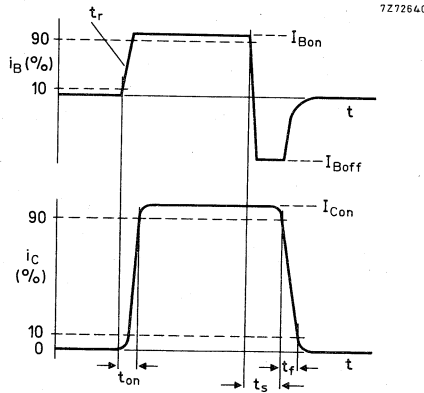
Fall time

t_f typ 0,4 μs

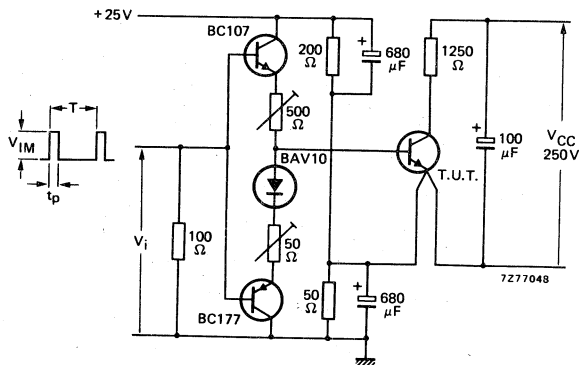
Fall time, $T_{mb} = 95\text{ }^\circ\text{C}$

$t_f < 1,3\text{ } \mu\text{s}$

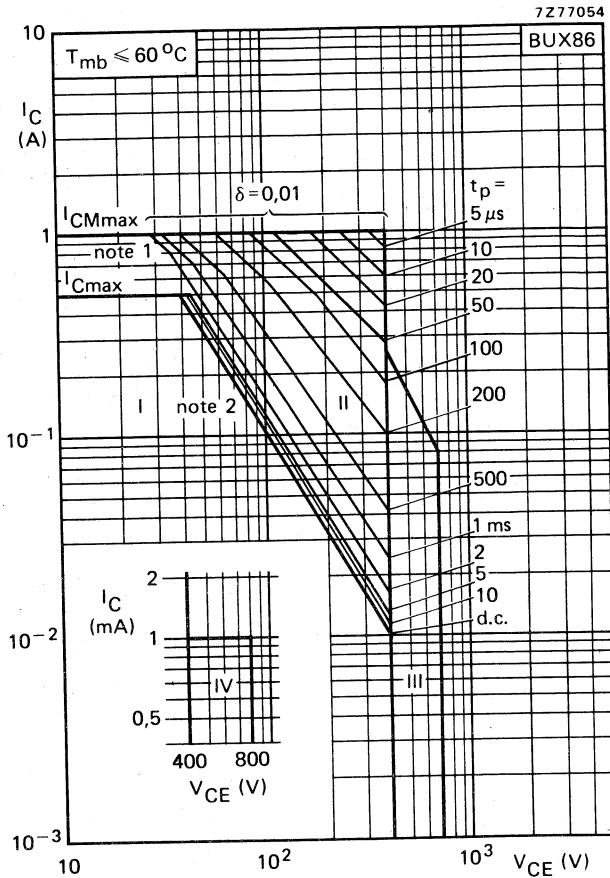
Waveform



Test circuit



$t_p = 20\text{ } \mu\text{s}$
 $T = 2\text{ ms}$
 $V_{IM} = 15\text{ V}$

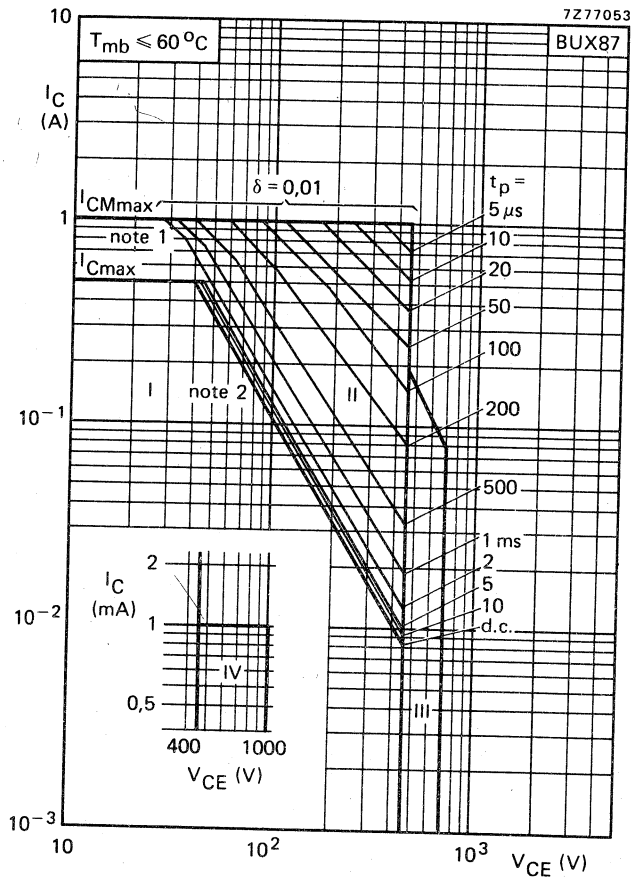


Safe Operating ARea

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu\text{s}$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 \text{ ms}$

Notes

1. $P_{peak max}$ lines.
2. Second-breakdown limits (independent of temperature).

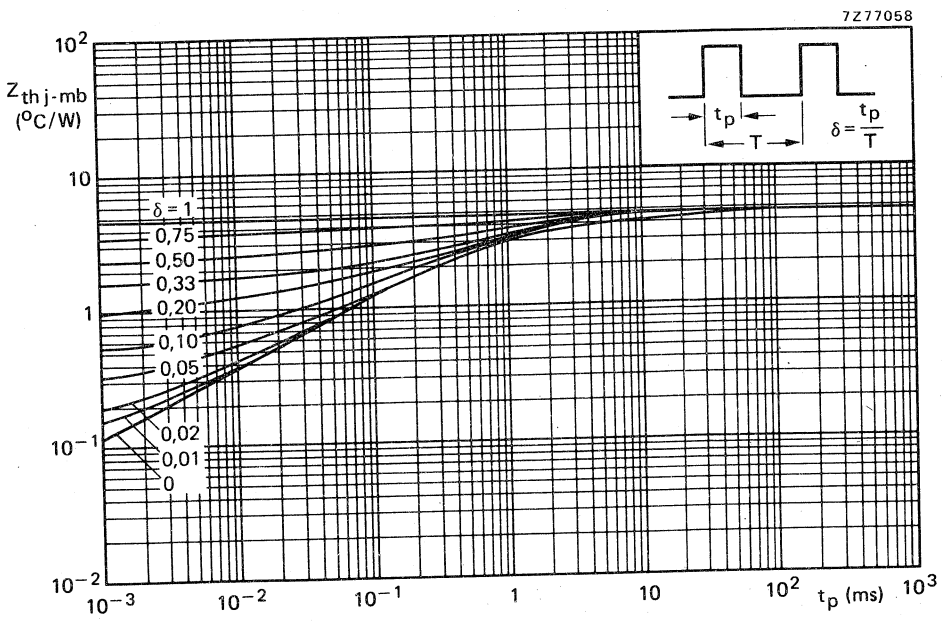
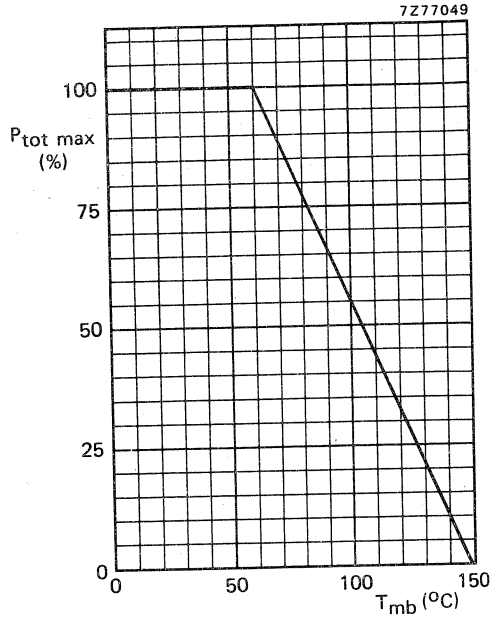


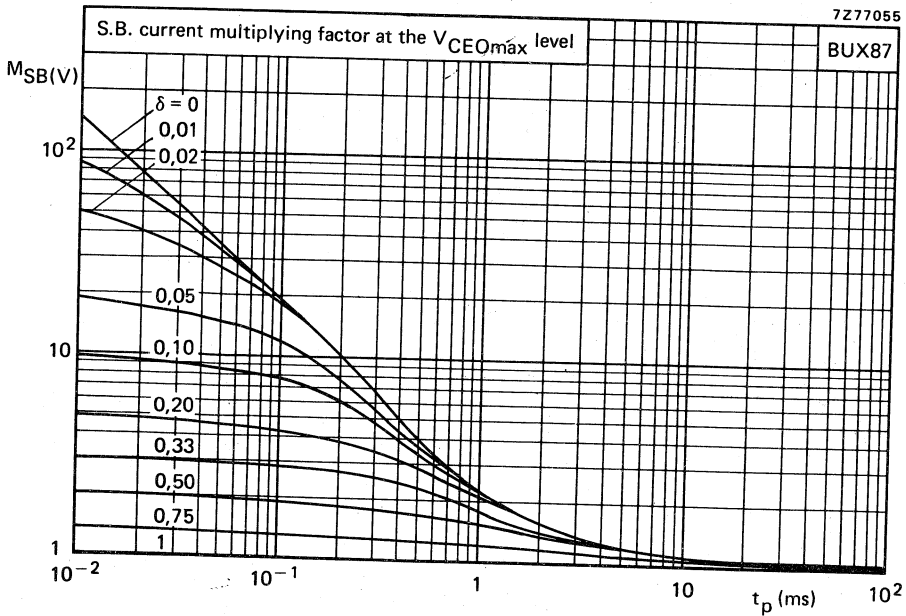
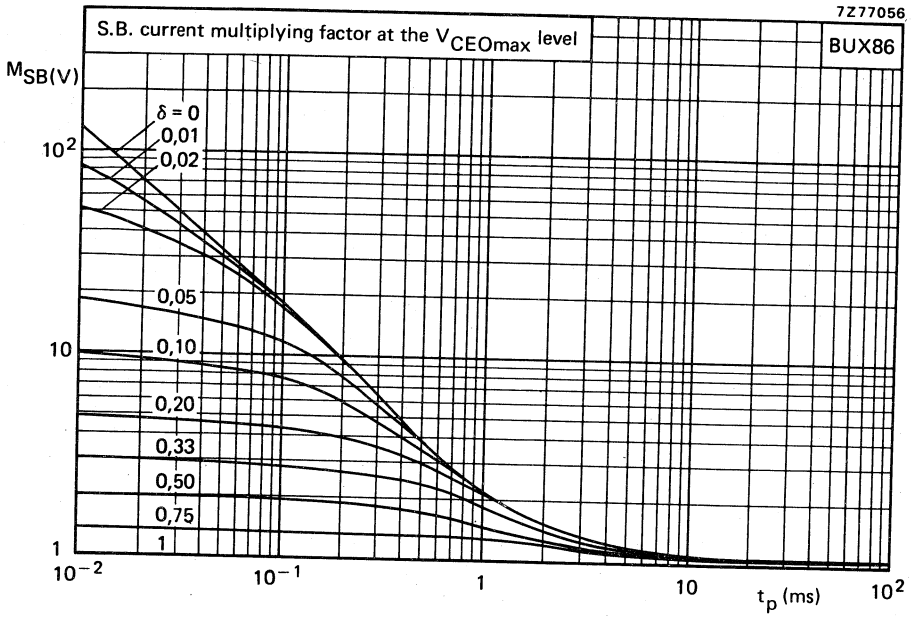
Safe Operating Area

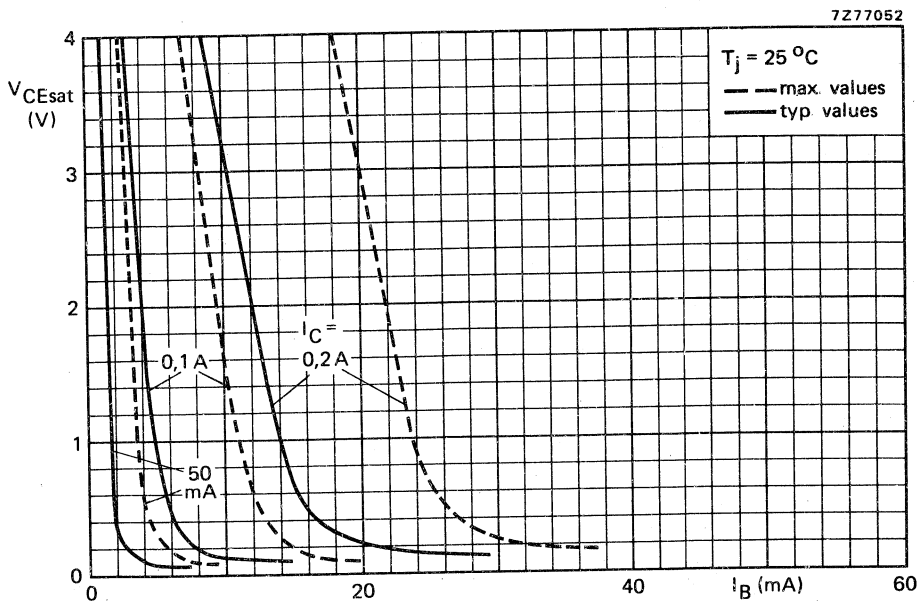
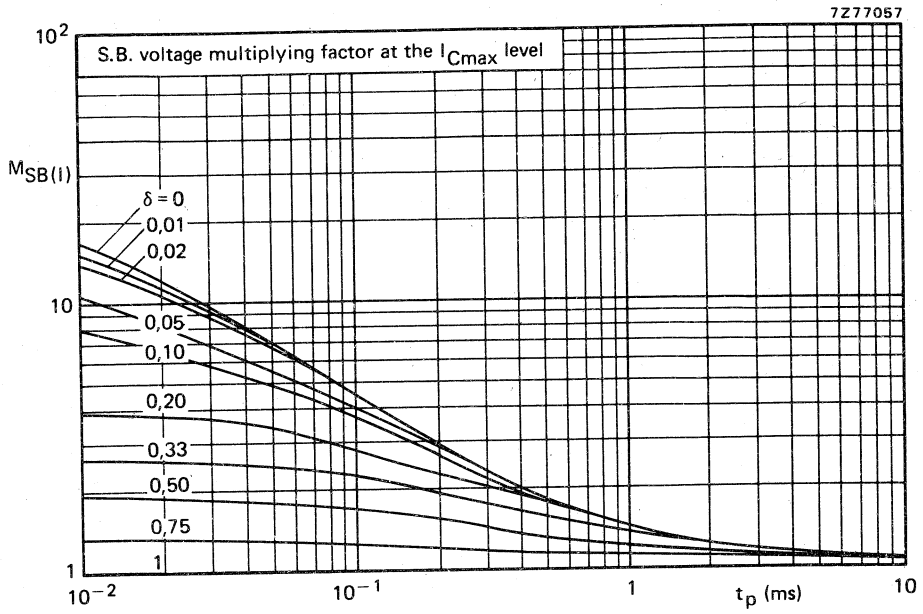
- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leq 100 \Omega$ and $t_p \leq 0,6 \mu s$
- IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leq 0$ and $t_p \leq 2 ms$

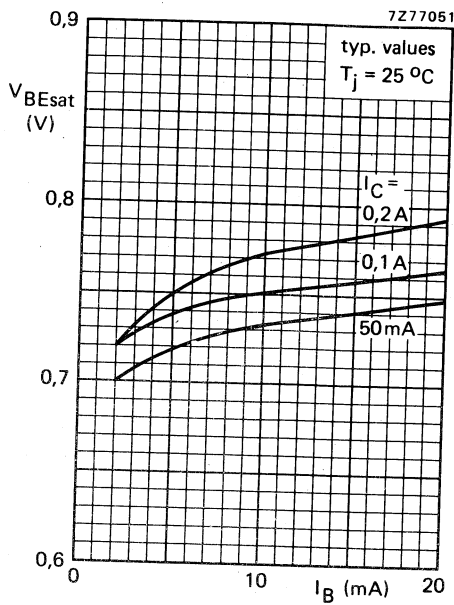
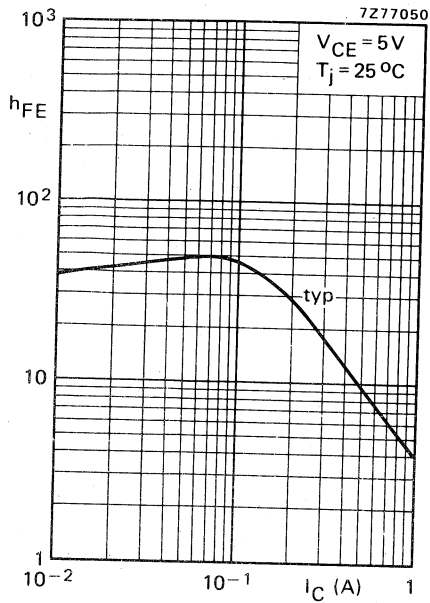
Notes

- 1. Peak max lines.
- 2. Second-breakdown limits (independent of temperature).









APPLICATION INFORMATION ON BUX86 (detailed information on request)

Important factors in the design of SMPS circuits are the power losses and heatsink requirements of the supply output transistor and the base drive conditions during turn-off. In SMPS circuits with mains isolation the duty factor of the collector current generally varies between 0,25 to 0,5.

The operating frequency lies between 15 kHz and 50 kHz and the shape of the collector current varies from rectangular in a forward converter to a sawtooth in a flyback circuit.

As the BUX86 will mainly be used in low-power flyback converters the information on optimum base drive and device dissipation given in the graphs on page 13 is concentrated on this application. In these figures I_{CM} represents the highest repetitive peak collector current that can occur in the given circuit, e.g. during overload.

The total power dissipation for a limit-case transistor is given in Fig. 5 which applies for a mounting base temperature of 100 °C. The required thermal resistance for the heatsink can be calculated from

$$R_{th\ mb-a} = \frac{100 - T_{amb\ max}}{P_{tot}}$$

To ensure thermal stability the minimum value of T_{amb} in the above equation is 40 °C.

A practical SMPS output circuit for an output of power in the order of 15 W is given in Fig. 2.

At a collector current of 200 mA and a base current of 20 mA in this circuit the following turn-off times can be expected.

Storage time
Fall time

	$T_{mb} = 25\text{ °C}$		100 °C	
t_s	typ	1,3	1,8	μs
t_f	typ	0,2	0,8	μs

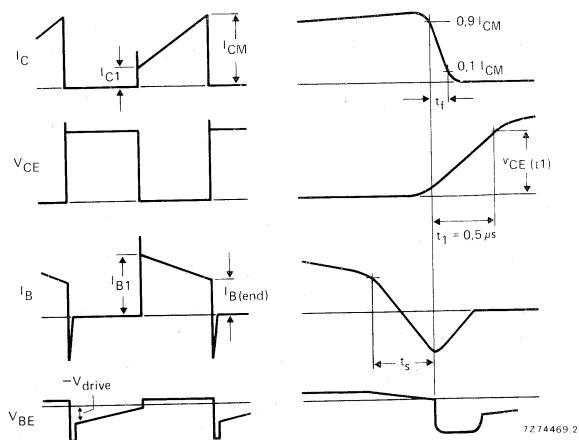


Fig. 1 Relevant waveforms of switching transistor.

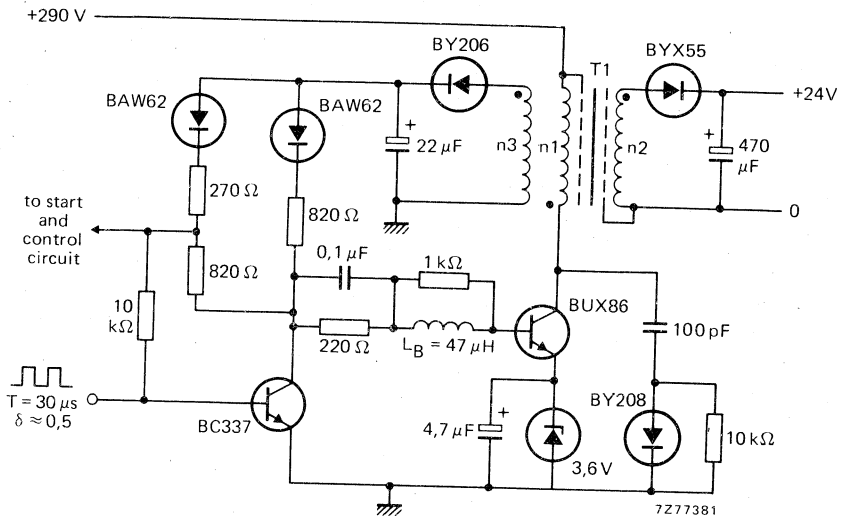


Fig. 2 Practical SMPS output circuit.

T1 (output transformer): Core U20; primary inductance $L_p = 23 \text{ mH}$
 $n_1 = 252$ turns; $n_2 = 27$ turns; $n_3 = 22$ turns

$V_{CE}(t_1) < 300 \text{ V}$ (see Fig. 1)

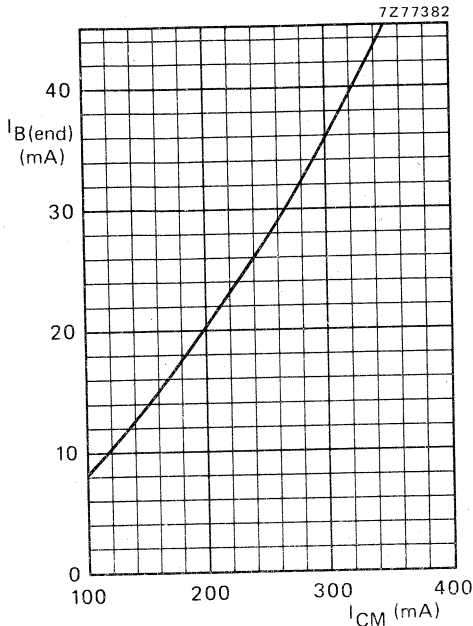


Fig. 3.

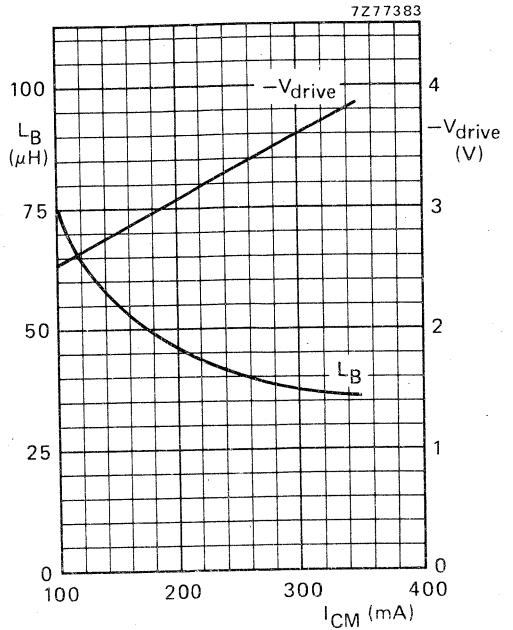


Fig. 4.

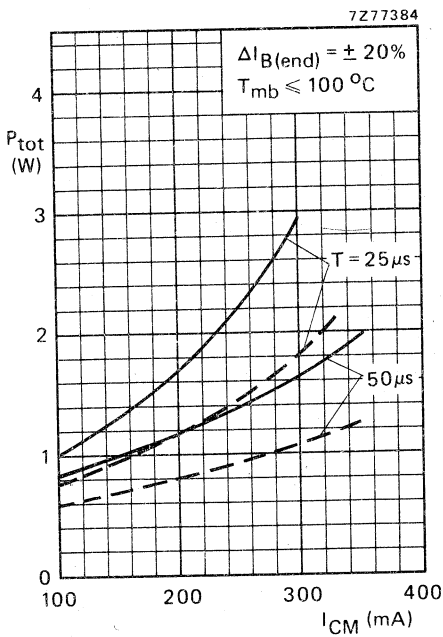


Fig. 5.

Fig. 3 Recommended nominal "end" value of the base current versus maximum peak collector current.

Fig. 4 Minimum required base inductance and recommended negative drive voltage versus maximum peak collector current.

Fig. 5 Maximum total power dissipation of a limit-case transistor if the base current is chosen in accordance with Fig. 3. Solid lines for $I_{C1}/I_{CM} = 0,4$ and dotted lines for $I_{C1}/I_{CM} = 0$.

SILICON DIFFUSED POWER TRANSISTOR

N-P-N transistor in a TO-3 metal envelope, intended for use in linear applications such as hi-fi amplifiers and signal processing circuits. Matched pairs are available.

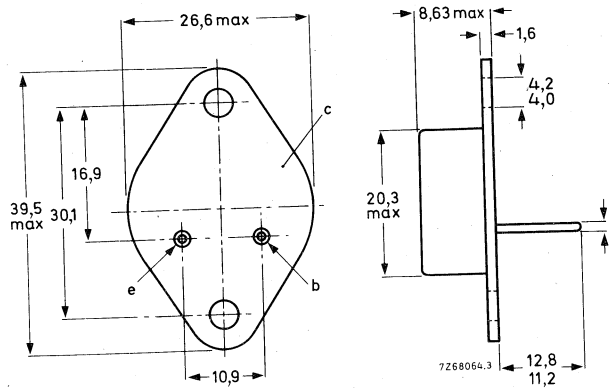
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max. 100 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	V_{CER}	max. 70 V
Collector current (d. c.)	I_C	max. 15 A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max. 115 W
Junction temperature	T_j	max. 200 $^\circ C$
D. C. current gain $I_C = 4 A; V_{CE} = 4 V$	h_{FE}	20 to 70
Transition frequency at $f = 1 MHz$ $I_C = 1 A; V_{CE} = 4 V$	f_T	> 0.8 MHz

MECHANICAL DATA

Dimensions in mm

Collector connected to envelope
TO-3



For mounting instructions and accessories, see section Accessories.

SILICON DIFFUSED POWER TRANSISTORS

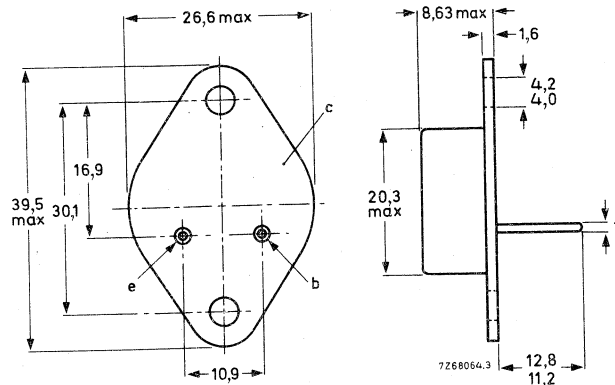
N-P-N transistors in a TO-3 metal envelope, intended for use in a wide variety of linear power applications in audio amplifiers, converters, voltage regulators, power supplies, etc.

QUICK REFERENCE DATA					
			2N3442	2N4347	
Collector-base voltage (open emitter)	V_{CBO}	max.	160	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	140	120	V
Collector current (d. c.)	I_C	max.	10		A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	117		W
Junction temperature	T_j	max.	200		$^\circ\text{C}$
D. C. current gain			20 to 70		
$I_C = 3\text{ A}; V_{CE} = 4\text{ V}; 2\text{N}3442$		h_{FE}			
$I_C = 2\text{ A}; V_{CE} = 4\text{ V}; 2\text{N}4347$					

Dimensions in mm

MECHANICAL DATA

Collector connected to envelope
TO-3



For mounting instructions and accessories, see section Accessories.

MOUNTING INSTRUCTIONS

GENERAL NOTE ON FLAT HEATSINKS

All information on thermal resistances of the accessories combined with flat heatsinks is valid for square heatsinks of 1,5 mm blackened aluminium.

For a few variations the thermal resistance may be derived as follows:

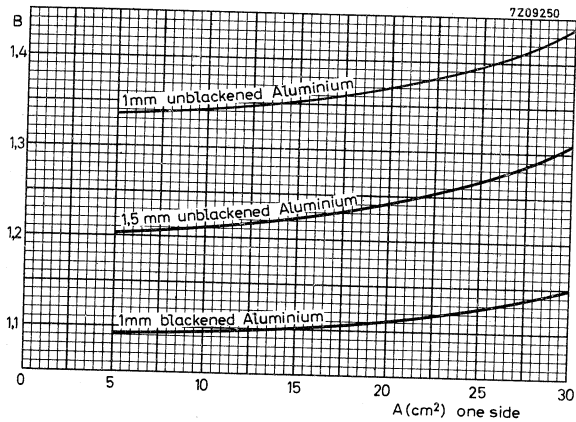
- a. Rectangular heatsinks (sides a and 2a)

When mounted with long side horizontal, multiply by 0,95.

When mounted with short side horizontal, multiply by 1,10.

- b. Unblackened or thinner heatsinks

Multiply by the factor B given below as a function of the heatsink size A.



MOUNTING INSTRUCTIONS FOR SOT-32 AND SOT-82 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rules

1. First fasten the devices to the heatsink before soldering the leads.
2. Avoid axial stress to the leads.
3. Keep mounting tool (e.g. screwdriver) clear of the plastic body.

Heatsink requirements

Minimum thickness: 2 mm.

Flatness in the mounting area: 0,02 mm maximum per 10 mm.

Mounting holes must be deburred and should also be perpendicular to the plane of the heatsink, within 10° tolerance for M2,5 thread and within 2° tolerance for M3 thread. If the hole in the heatsink is threaded, it should be counter-sunk and free of burrs.

Heatsink compound

Values of the thermal resistance from mounting base to heatsink ($R_{th\ mb-h}$) given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.

For insulated mounting, the compound should be applied to the bottom of both device and insulator.

Mounting methods for power transistors

1. Clip mounting (SOT-32 and SOT-82)

Mounting by means of spring clip offers:

- a. A good thermal contact under the crystal area.
- b. Safe insulation for mains and high voltage operation

2. M2,5 and M3 screw mounting. (SOT-32 only).

The spacing washer should be inserted between screw head and body.

Mounting torque for screw mounting:

Minimum torque (for good heat transfer)

0,4 Nm (4 kgcm)

Maximum torque (to avoid damaging the device)

0,6 Nm (6 kgcm)

N.B. when the driven nut or screw is in direct contact with a toothed lock washer the torques are as follows:

Minimum torque (for good heat transfer)

0,55 Nm (5,5 kgcm)

Maximum torque (to avoid damaging the device)

0,80 Nm (8,0 kgcm)

3. Body mounting (SOT-82).

A SOT-82 envelope can be adhesive mounted or soldered into a hybrid circuit.

For soldering a copper plate or an anodized aluminium plate with copper layer is recommended.

When adhesive mounting is applied also a ceramic substrate may be used.



MOUNTING INSTRUCTIONS SOT-32/SOT-82

Pre-heating

For good soldering and avoiding damage to the SOT-82 device pre-heating is recommended to a temperature ≤ 165 °C at a duration ≤ 10 s.

Soldering

Recommended metal-alloy of solder paste (85% metal weight)

a. 62 Sn/36 Pb/2 Ag or b. 60 Sn/40 Pb.

Maximum soldering temperature ≤ 250 °C (soldering plate)

Soldering cycle duration: a without pre-heating ≤ 14 s.

b with pre-heating ≤ 22 s.

Thermal data from mounting base to heatsink

SOT-32, with heatsink compound
SOT-32, without heatsink compound
SOT-82, with heatsink compound
SOT-82, without heatsink compound

R _{th mb-h} (°C/W)			
clip mounting		screw mounting	
direct	insulated	direct	insulated
1,0	3,0	0,5	3,0
3,0	6,0	1,0	6,0
0,4	2,0	—	—
2,0	5,0	—	—

Lead bending

Maximum permissible tensile force on the body, for 5 seconds is 20 N (2 kgf).

The leads can be bent through 90° maximum, twisted or straightened. To keep forces within the above-mentioned limits, the leads are generally clamped near the body, using pliers. The leads should neither be bent nor twisted less than 2,4 mm from the body.

Lead soldering

For devices with a maximum junction temperature ≤ 150 °C.

a. Dip or wave soldering

Temperature ≤ 260 °C at a distance from the body > 5 mm and for a total contact time with soldering bath or waves < 7 s.

b. Hand soldering

Temperature at a distance from the body > 3 mm for a total contact time < 5 s is < 275 °C or < 250 °C for a total contact time of < 10 s.

The body of the device must be kept clear of anything with a temperature > 200 °C.

Avoid any force on body and leads during or after soldering; do not correct the position of the device or of its leads after soldering.

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56353

1. Place the device on the heatsink, applying heatsink compound to the mounting base.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical (see Figs 1 and 2).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body (see Fig. 3).

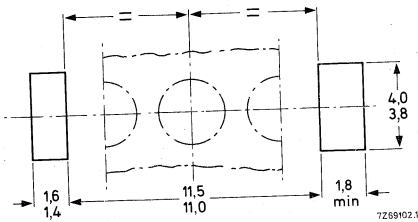


Fig. 1 Heatsink requirements.

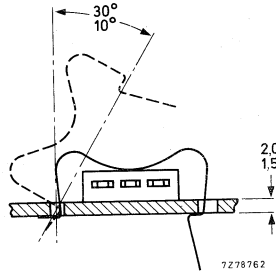


Fig. 2 Mounting spring clip.

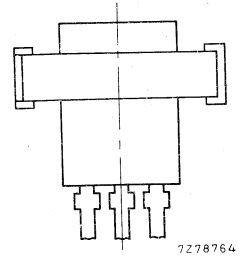


Fig. 3 Position of transistor (top view).

Insulated mounting with clip 56353 and mica 56354 (up to 1000 V insulation)

1. Place the device with the insulator on the heatsink, applying heatsink compound to the bottom of both device and insulator.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical (see Figs 4 and 5).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body (Fig. 6). There should be minimum 3 mm distance between the device and the edge of the insulator for adequate creepage.

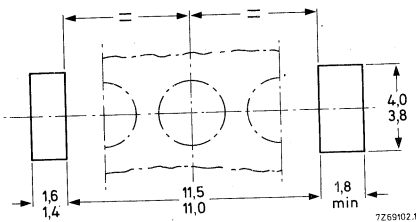


Fig. 4 Heatsink requirements.

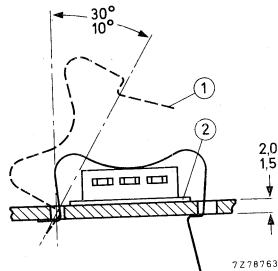


Fig. 5 Mounting.
(1) spring clip 56353.
(2) insulator 56354.

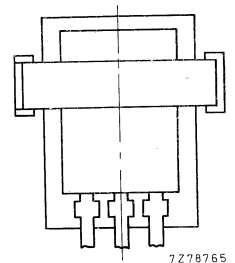


Fig. 6 Position of transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING
Direct mounting with screw and spacing washer

Dimensions in mm

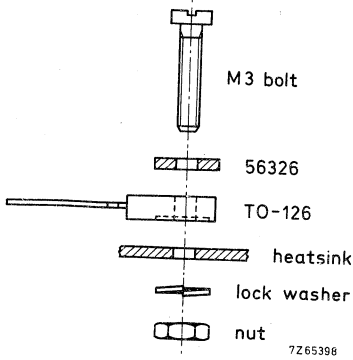


Fig. 7 Assembly through heatsink with nut.

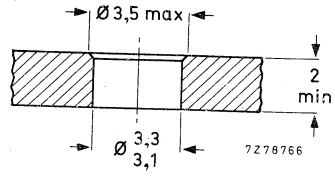


Fig. 8 Heatsink requirements.

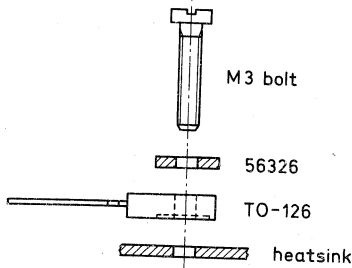


Fig. 9 Assembly into tapped heatsink.

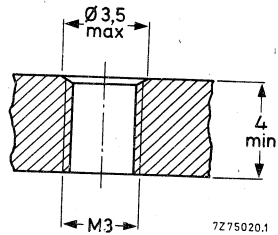


Fig. 10 Heatsink requirements.

INSTRUCTIONS FOR SCREW MOUNTING
Insulated mounting with 56333 (up to 250 V)

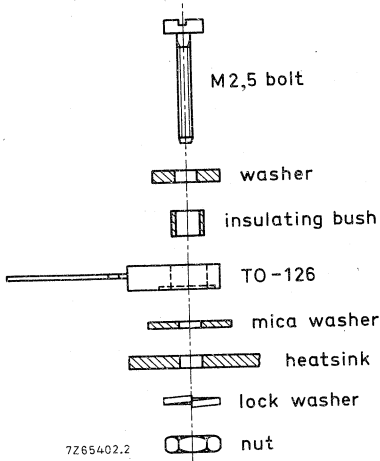


Fig. 11 Assembly through heatsink with nut.

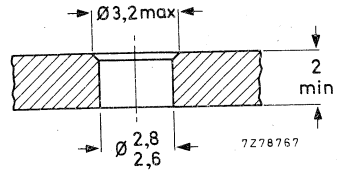


Fig. 12 Heatsink requirements.

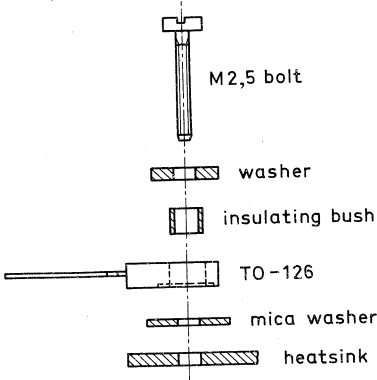


Fig. 13 Assembly with tapped heatsink.

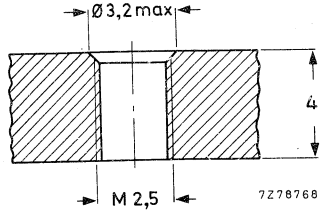


Fig. 14 Heatsink requirements.

MOUNTING INSTRUCTIONS FOR TO-220 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rules

1. First fasten the devices to the heatsink before soldering the leads.
2. Avoid axial stress to the leads.
3. Keep mounting tool (e.g. screwdriver) clear of the plastic body.
4. The rectangular washer may only touch the plastic part of the body; it should not exert any force on that part (screw mounting).

Heatsink requirements

Flatness in the mounting area: 0,02 mm maximum per 10 mm.
Mounting holes must be deburred, see further mounting instructions.

Heatsink compound

Values of the thermal resistance from mounting base to heatsink ($R_{th\ mb-h}$) given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.

For insulated mounting, the compound should be applied to the bottom of both device and insulator.

Mounting methods for power transistors

1. Clip mounting

Mounting by means of spring clip offers:

- a. A good thermal contact under the crystal area, and slightly lower $R_{th\ mb-h}$ values than screw mounting.
- b. Safe insulation for mains operation.

2. M3 screw mounting

It is recommended that the rectangular spacing washer is inserted between screw head and mounting tab.

Mounting torque for screw mounting:

(For thread-forming screws these are final values. Do not use self-tapping screws.)

Minimum torque (for good heat transfer)	0,55 Nm (5,5 kgcm)
Maximum torque (to avoid damaging the device)	0,80 Nm (8,0 kgcm)

N.B.: When a nut or screw is not driven direct against a curved spring washer or lock washer (not for thread-forming screw), the torques are as follows:

Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	0,6 Nm (6 kgcm)

N.B.: Data on accessories are given in separate data sheets.

3. Rivet mounting non-insulated

The device should not be pop-riveted to the heatsink. However, it is permissible to press-rivet providing that eyelet rivets of soft material are used, and the press forces are slowly and carefully controlled so as to avoid shock and deformation of either heatsink or mounting tab.

Thermal data

		clip mounting	screw mounting	
From mounting base to heatsink				
with heatsink compound, direct mounting	$R_{th\ mb-h}$	= 0,3	0,5	$^{\circ}C/W$
without heatsink compound, direct mounting	$R_{th\ mb-h}$	= 1,4	1,4	$^{\circ}C/W$
with heatsink compound and 0,1 mm maximum mica washer	$R_{th\ mb-h}$	= 2,2	—	$^{\circ}C/W$
with heatsink compound and 0,25 mm maximum alumina insulator	$R_{th\ mb-h}$	= 0,8	—	$^{\circ}C/W$
with heatsink compound and 0,05 mm mica washer				
insulated up to 500 V	$R_{th\ mb-h}$	= —	1,4	$^{\circ}C/W$
insulated up to 800 V/1000 V	$R_{th\ mb-h}$	= —	1,6	$^{\circ}C/W$
without heatsink compound and 0,05 mm mica washer				
insulated up to 500 V	$R_{th\ mb-h}$	= —	3,0	$^{\circ}C/W$
insulated up to 800 V/1000 V	$R_{th\ mb-h}$	= —	4,5	$^{\circ}C/W$

Lead bending

Maximum permissible tensile force on the body, for 5 seconds is 20 N (2 kgf).

The leads can be bent through 90° maximum, twisted or straightened. To keep forces within the above-mentioned limits, the leads are generally clamped near the body, using pliers. The leads should neither be bent nor twisted less than 2,4 mm from the body.

Soldering

Lead soldering temperature at > 3 mm from the body; $t_{sld} < 5$ s:

Devices with $T_j\ max \leq 175\ ^{\circ}C$, soldering temperature $T_{sld}\ max = 275\ ^{\circ}C$.

Devices with $T_j\ max \leq 110\ ^{\circ}C$, soldering temperature $T_{sld}\ max = 240\ ^{\circ}C$.

Avoid any force on body and leads during or after soldering: do not correct the position of the device or of its leads after soldering.

It is not permitted to solder the metal tab of the device to a heatsink, otherwise its junction temperature rating will be exceeded.

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56363

1. Place the device on the heatsink, applying heatsink compound to the mounting base.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical (see Figs 1 and 2).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 2a).

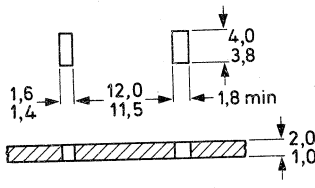


Fig. 1 Heatsink requirements.

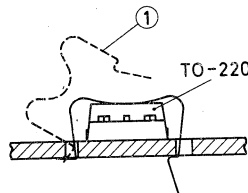


Fig. 2 Mounting.
(1) spring clip.

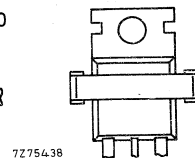


Fig. 2a Position of
transistor (top view).

Insulated mounting with clip 56364

With the insulators 56367 or 56369 insulation up to 2 kV is obtained.

1. Place the device with the insulator on the heatsink, applying heatsink compound to the bottom of both device and insulator.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical (see Figs 3 and 4).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab. There should be minimum 3 mm distance between the device and the edge of the insulator for adequate creepage.

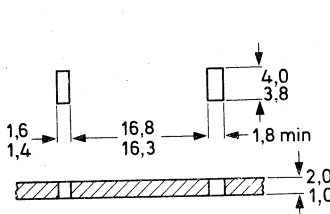


Fig. 3 Heatsink requirements.

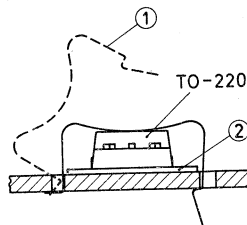


Fig. 4 Mounting.
(1) spring clip.
(2) insulator 56369 or 56367.

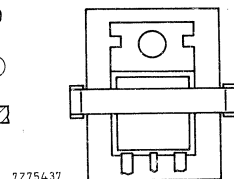


Fig. 4a Position of
transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting with screw and spacing washer

Dimensions in mm

- *through heatsink with nut*

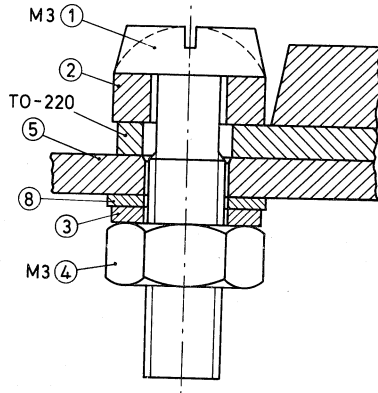
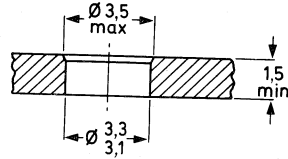


Fig. 5 Assembly.



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Fig. 6 Heatsink requirements.

- (1) M3 screw.
- (2) rectangular washer (56360a).
- (3) toothed lock washer.
- (4) M3 nut.
- (5) heatsink.
- (6) plain washer.

- *into tapped heatsink*

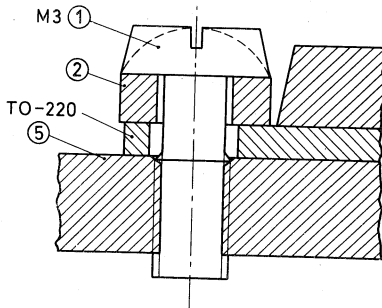
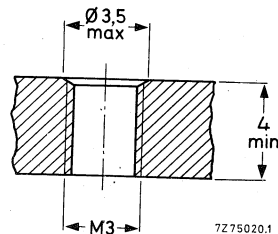


Fig. 7 Assembly.



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Fig. 8 Heatsink requirements.

- (1) M3 screw.
- (2) rectangular washer 56360a.
- (5) heatsink.

Insulated mounting with screw and spacing washer (not recommended where mounting tab is on mains voltage)

- through heatsink with nut.

Dimensions in mm

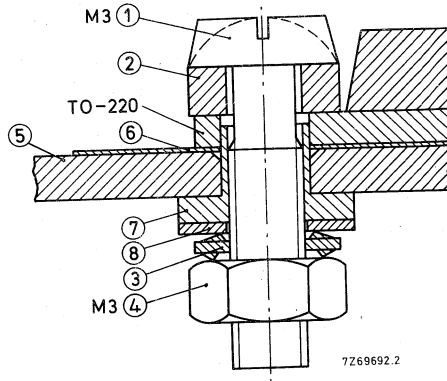


Fig. 9 Assembly.

- (1) M3 screw.
- (2) rectangular washer 56360a.
- (3) toothed lock washer.
- (4) M3 nut.

- (5) heatsink.
- (6) mica insulator 56359b.
- (7) insulating bush 56359c.
- (8) plain washer.

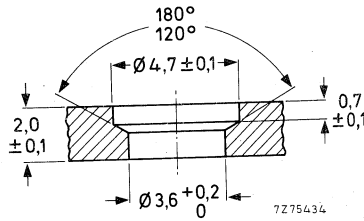


Fig. 10 Heatsink requirements for 500 V insulation.

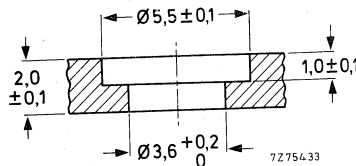


Fig. 11 Heatsink requirements for 800 V insulation.

• into tapped heatsink

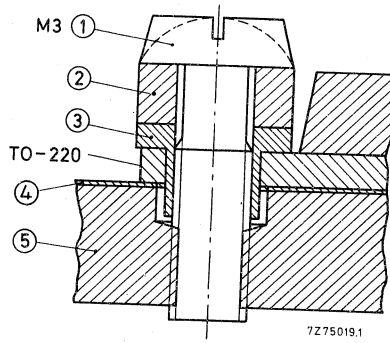


Fig. 12 Assembly.

- (1) M3 screw.
- (2) rectangular washer 56360a.
- (3) rectangular insulation bush 56359d.
- (4) mica insulator 56359b.
- (5) heatsink.

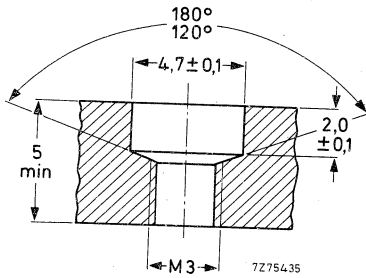


Fig. 13 Heatsink requirements
for 500 V insulation.

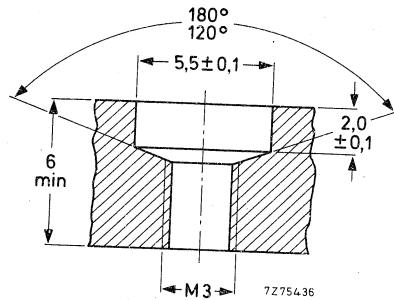


Fig. 14 Heatsink requirements
for 1000 V insulation.

MOUNTING INSTRUCTIONS FOR SOT-93 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rule

Avoid any sudden forces on leads and body; these forces, such as from falling on a hard surface, are easily underestimated.

Heatsink requirements

Flatness in the mounting area: 0,02 mm maximum per 10 mm.
The mounting hole must be deburred.

Heatsink compound

The thermal resistance from mounting base to heatsink ($R_{th\ mb-h}$) can be reduced by applying a metallic-oxide heatsink compound between the contact surfaces. For insulated mounting the compound should be applied to the bottom of both device and insulator.

Maximum play

The bush or the washer may only just touch the plastic part of the body, but should not exert any force on that part. Keep mounting tool (e.g. screwdriver) clear of the plastic body.

Mounting torques

For M3 screw (insulated mounting):

Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	0,6 Nm (6 kgcm)

For M4 screw (direct mounting only):

Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	1,0 Nm (10 kgcm)

Note: The M4 screw head should not touch the plastic part of the envelope.

Lead bending

Maximum permissible tensile force on the body for 5 s	20 N (2 kgf)
---	--------------

No torsion is permitted at the emergence of the leads.

Bending or twisting is not permitted within a lead length of 0,3 mm.

The leads can be bent through 90° maximum, twisted or straightened; to keep forces within the above-mentioned limits, the leads are generally clamped near the body.

Soldering

Recommendations for devices with a maximum junction temperature rating ≤ 175 °C:

a. Dip or wave soldering

Maximum permissible solder temperature is 260 °C at a distance from the body of > 5 mm and for a total contact time with soldering bath or waves of < 7 s.

b. Hand soldering

Maximum permissible temperature is 275 °C at a distance from the body of > 3 mm and for a total contact time with the soldering iron of < 5 s.

The body of the device must not touch anything with a temperature > 200 °C.

It is not permitted to solder the metal tab of the device to a heatsink, otherwise the junction temperature rating will be exceeded.

Avoid any force on body and leads during or after soldering; do not correct the position of the device or of its leads after soldering.

Thermal data

Thermal resistance from mounting base to heatsink

direct mounting

with heatsink compound

without heatsink compound

with 0,05 mm mica washer

with heatsink compound

without heatsink compound

	clip mounting	screw mounting
$R_{th\ mb-h}$	= 0,3	0,3 °C/W
$R_{th\ mb-h}$	= 1,5	0,8 °C/W
$R_{th\ mb-h}$	= 0,8	0,8 °C/W
$R_{th\ mb-h}$	= 3,0	2,2 °C/W

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56379

1. Place the device on the heatsink, applying heatsink compound to the mounting base.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 20° to the vertical (see Fig. 1b).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 1(c)).

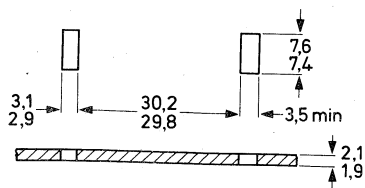


Fig. 1a Heatsink requirements.

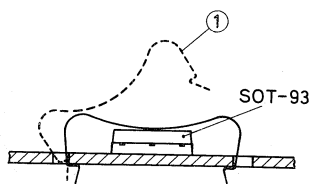


Fig. 1b Mounting.
(1) = spring clip 56379.

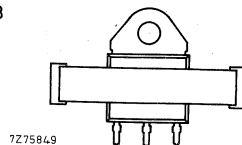


Fig. 1c Position
of the device.

Insulated mounting with clip 56379

With the mica of package 56368 insulation up to 1 kV is obtained.

1. Place the device with the insulator on the heatsink, applying heatsink compound to the bottom of both device and insulator.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 20° to the vertical (see Figs 2a and 2b).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 2c). There should be minimum 3 mm distance between the device and the edge of the insulator for adequate creepage.

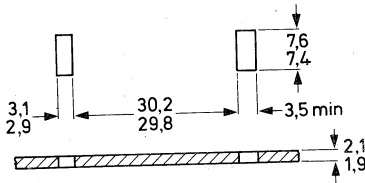


Fig. 2a Heatsink requirements.

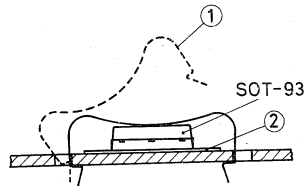


Fig. 2b Mounting.
(1) = spring clip 56379
(2) = insulator 56378

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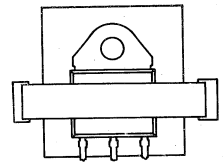


Fig. 2c Position of the device.

INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting

Where vibrations are to be expected the use of a lock washer or of a curved spring washer is recommended, with a plain washer between aluminium heatsink and spring washer.

Insulated screw mounting with nut; up to 800 V.

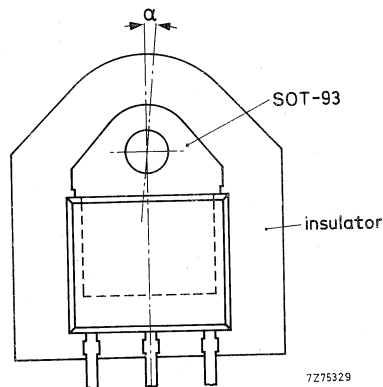


Fig. 3 Mica insulator.
The axial deviation (α)
between SOT-93 and mica
should not exceed 5°.

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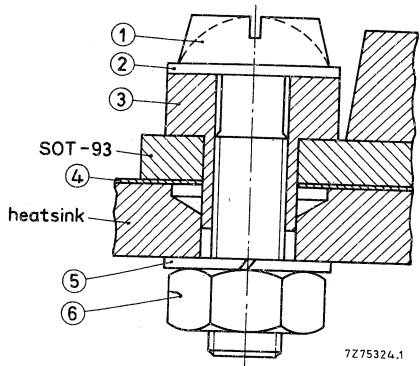


Fig. 4 Assembly.
See also Fig. 3.

- (1) M3 screw
- (2) plain washer
- (3) insulating bush (56368b)
- (4) mica insulator (56368a)
- (5) lock washer
- (6) M3 nut

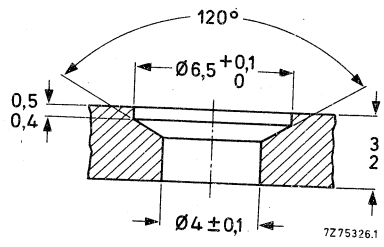


Fig. 5 Heatsink requirements
up to 800 V insulation.

Insulated screw mounting with tapped hole; up to 800 V.

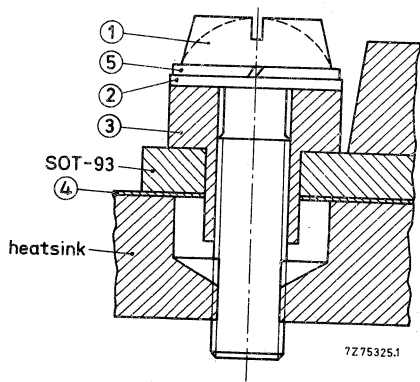


Fig. 6 Assembly.
See also Fig. 3.

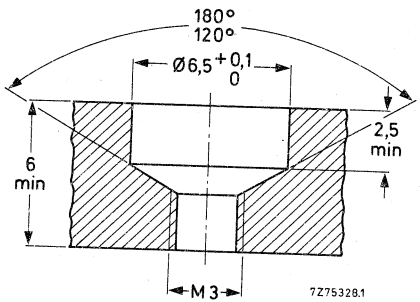


Fig. 7 Heatsink requirements
up to 800 V insulation.

- (1) M3 screw
- (2) plain washer
- (3) insulating bush (56368b)
- (4) mica insulator (56368a)
- (5) lock washer

Insulated screw mounting with insert nut; up to 500 V

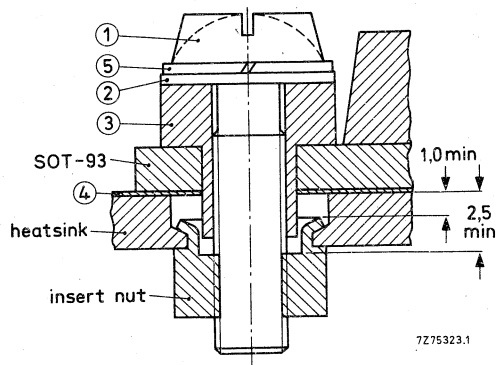


Fig. 8 Assembly and heatsink requirements for 500 V insulation. See also Fig. 3.

- (1) M3 screw
- (2) plain washer
- (3) insulating bush (56368b)
- (4) mica insulator (56368a)
- (5) lock washer

MOUNTING INSTRUCTIONS FOR TO-3 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

Instructions for direct mounting.

Mounting instructions for up to 500 V insulation.

Using insulating bushes 56201c and mica washer 56201d.

Using insulating bushes 56201j or 56261a and mica washer 56201d.

Mounting instructions for 500 to 2000 V insulation.

Using mounting support 56352 and mica washer 56339.

Heatsink requirements

Flatness in the mounting area: 0,05 mm per 40 mm

Mounting holes must be deburred.

Mounting torques

Minimum torque (for good heat transfer)

0,4 Nm (4 kgcm)

Maximum torque (to avoid damaging the transistor)

0,6 Nm (6 kgcm)

N.B.: When the driven nut or screw is in direct contact with a toothed lock washer (e.g. Fig. 10), the torques are as follows:

Minimum torque

0,55 Nm (5,5 kgcm)

Maximum torque

0,8 Nm (8 kgcm)

Thermal data

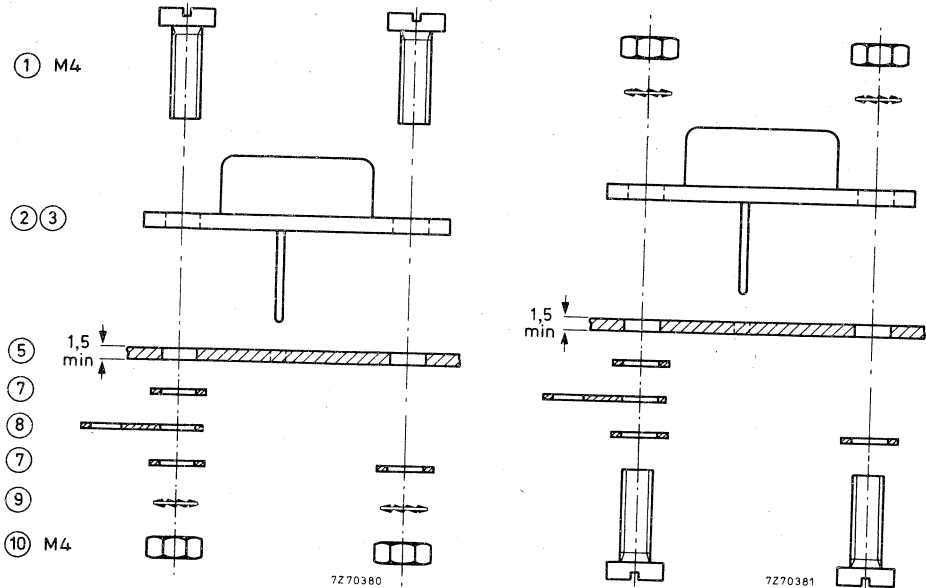
The thermal resistance from mounting base to heatsink ($R_{th\ mb-h}$) can be reduced by applying a heat conducting compound between transistor and heatsink. For insulated mounting the compound should be applied to the bottom of both device and insulator.

	Direct mounting	Insulated mounting		
		500 V mica	2000 V mica	
From mounting base to heatsink without heatsink compound	$R_{th\ mb-h}$ 0,6	1,0	1,25	°C/W
with heatsink compound	$R_{th\ mb-h}$ 0,1	0,3	0,5	°C/W

INSTRUCTIONS FOR DIRECT MOUNTING

The transistors should be mounted with M4 screws, see Figs 1 and 2. Minimum heatsink thickness (for good heat transfer) 1,5 mm. Hole pattern: Fig. 3.

A heatsink with tapped holes or insert nuts can also be used, but a torque washer is necessary between metal washer and transistor. See Fig. 4.



Figs 1 and 2. Direct mounting with nuts

Legend for all figures :

- (1) = screw
- (2) = TO-3 thick base (3, 15 mm)
- (2)(3) = TO-3 thick or thin base
- (3) = TO-3 thin base (1, 6 mm)
- (4) = mica
- (5) = heatsink
- (6) = insulating bush
- (7) = metal washer
- (8) = soldering tag
- (9) = lock washer
- (10) = nut
- (11) = tapped hole
- (12) = insert nut

Dimensions in mm

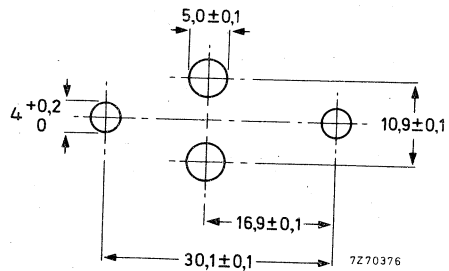


Fig. 3. Hole pattern for direct mounting with nuts

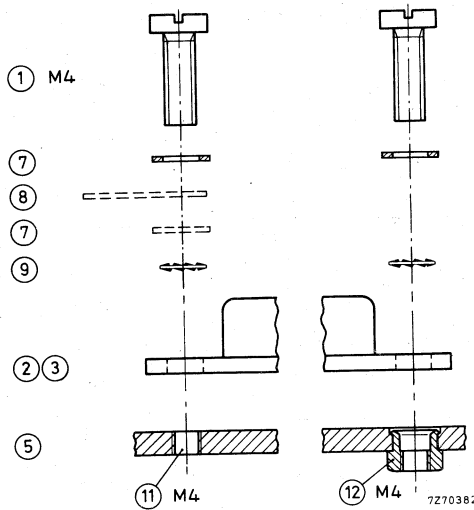


Fig. 4 Direct mounting with tapped holes or insert nuts.

MOUNTING INSTRUCTIONS FOR UP TO 500 V INSULATION

Using insulating bushes 56201c and mica washer 56201d

For the component arrangement with minimum heatsink thickness see Figs 5 and 6. For hole pattern and shape of holes see Figs 7 and 8.

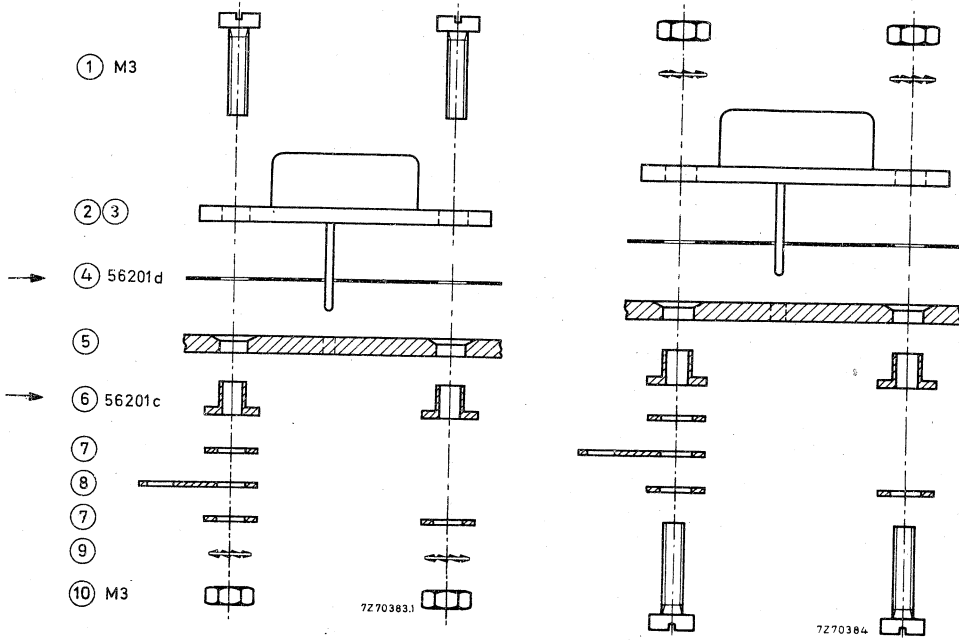
The accessories can also be used for thinbase transistors on a 2,5 mm heatsink provided with M3 insert nuts in an arrangement like Figs 10 and 12.

Using insulating bushes 56201j or 56261a and mica washer 56201d

For an arrangement with M3 screws and nuts see Fig. 9, mounting holes are given in Figs 7 and 8. The accessories can also be used in combination with M3 screws and heatsinks provided with tapped holes or insert nuts. Lock washers are necessary between screw-head and metal washer, see Fig. 10. For an assembly drawing with tapped holes see Fig. 11, with insert nuts see Fig. 12.



MOUNTING INSTRUCTIONS FOR UP TO 500 V INSULATION (continued)



Figs 5 and 6. Insulated mounting (500 V) with 56201c and 56201d

Heatsink thickness: 1,5 to 2,5 mm for thick-base TO-3

2 to 2,5 mm for thin-base TO-3

For legend see page 2.

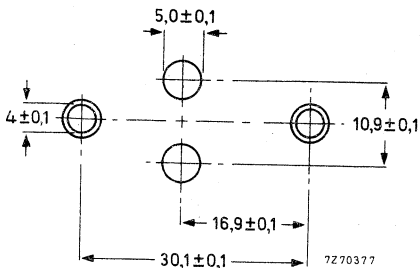


Fig. 7. Hole pattern for 500 V insulation, nut fastening

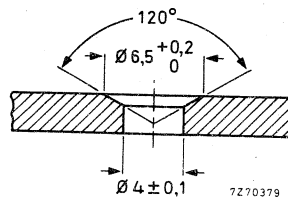


Fig. 8. Shape of hole for 500 V insulation, nut fastening

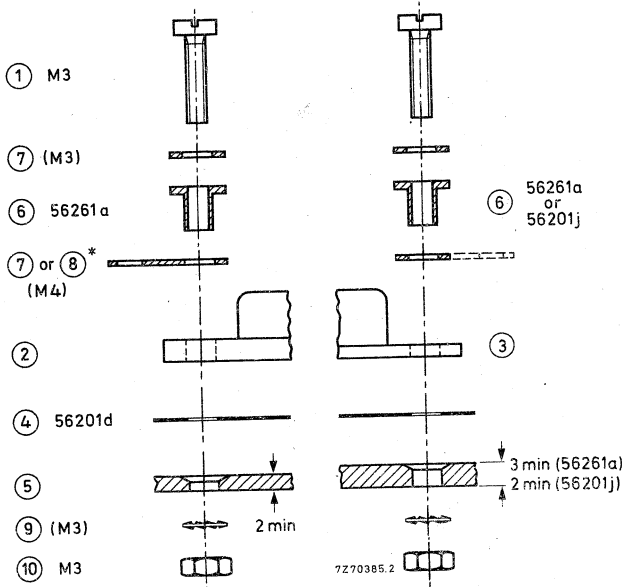


Fig. 9 Insulated mounting (500 V) with nuts.

For legend see page 2.

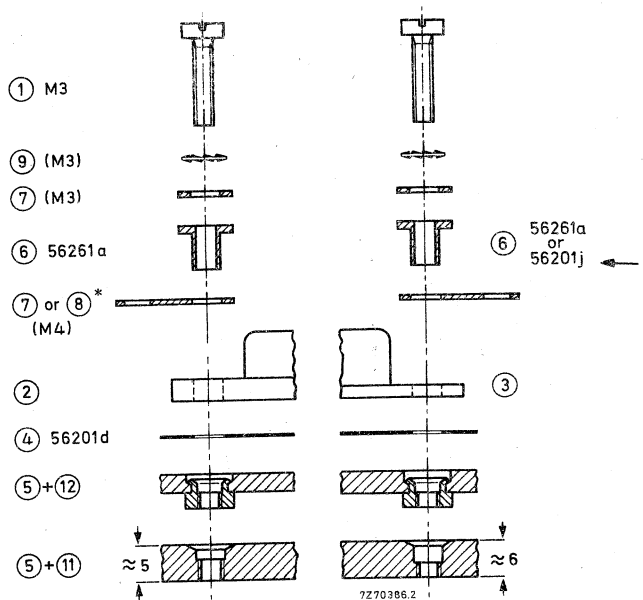


Fig. 10 Insulated mounting (500 V) with tapped holes or insert nuts.

* Thickness approximately 0,6 mm, outer diameter 7,5 mm.

MOUNTING INSTRUCTIONS FOR UP TO 500 V INSULATION (continued)

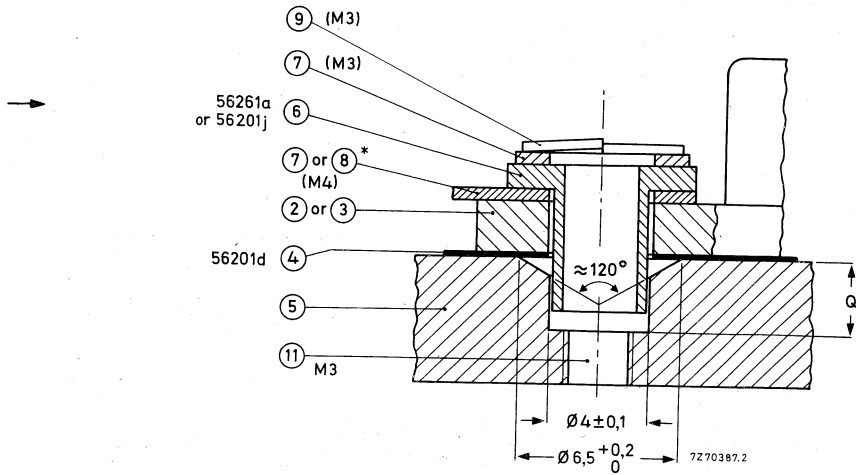


Fig. 11 Assembly (partial) for Fig. 10 - tapped holes.

Q minimum 2 mm for thick-base TO-3 (with 56261a).

Q minimum 3 mm for thin-base TO-3 (with 56261a).

Q minimum 2 mm for thin-base TO-3 (with 56201j).

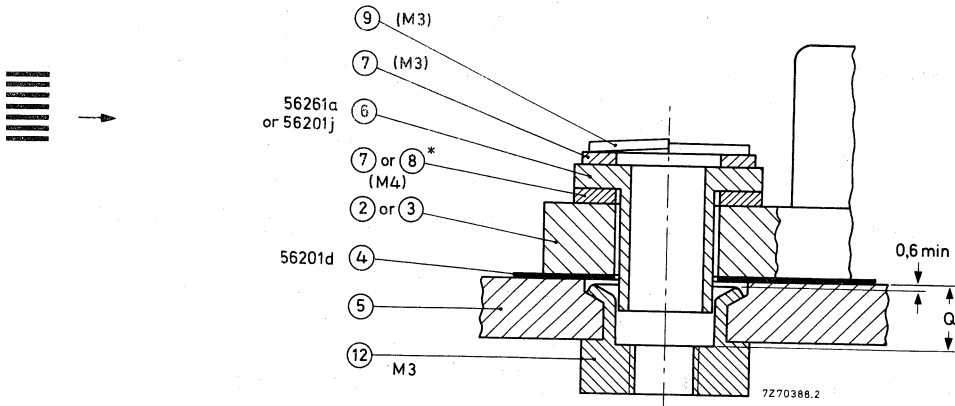


Fig. 12 Assembly (partial) for Fig. 10 - insert nuts and thick-base TO-3.

Q minimum 2 mm for thick-base TO-3 (with 56261a).

Q minimum 3 mm for thin-base TO-3 (with 56261a).

Q minimum 2 mm for thin-base TO-3 (with 56201j).

* Thickness approximately 0,6 mm, outer diameter 7,5 mm.

Legend for all figures:

- (1) screw.
- (2) TO-3 thick base (3,15 mm).
- (2) (3) TO-3 thick or thin base.
- (3) TO-3 thin base (1,6 mm).
- (4) mica.
- (5) heatsink.
- (6) insulating bush.
- (7) metal washer.
- (8) soldering tag.
- (9) lock washer.
- (10) nut.
- (11) tapped hole.
- (12) insert nut.

Dimensions in mm

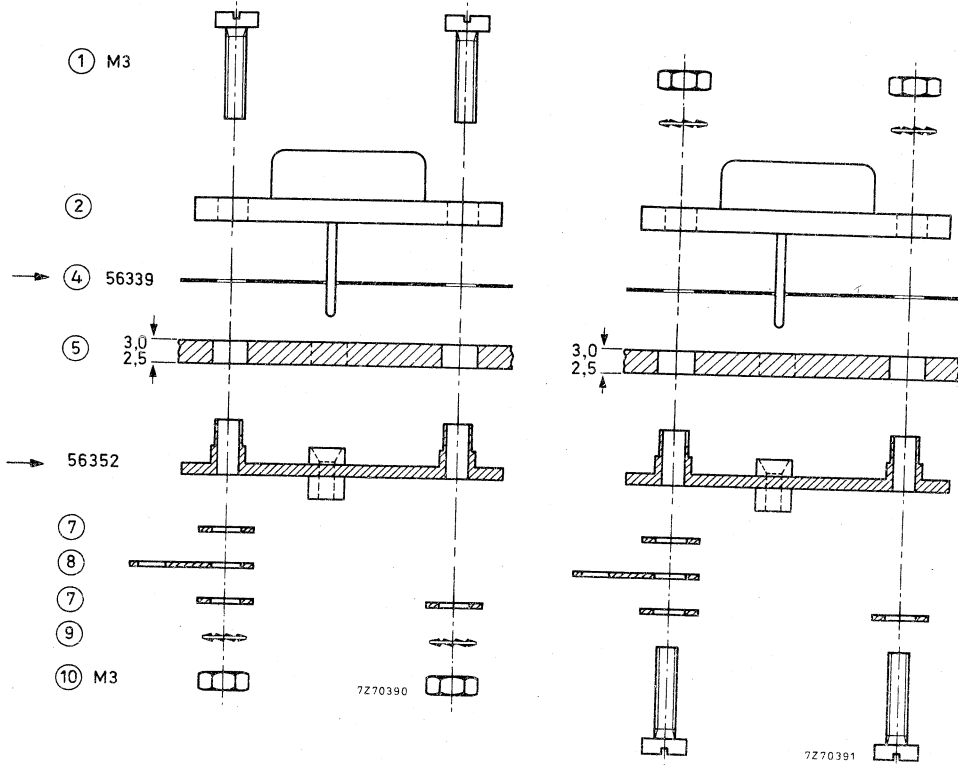
MOUNTING INSTRUCTIONS FOR 500 V TO 2000 V INSULATION (Thick-base TO-3 only)

Using mounting support 56352 and mica washer 56339

The transistor should be mounted with M3 screws. For component arrangement see Figs 13 and 14.
For hole pattern see Fig. 15. Thickness of heatsink 2,5 mm to 3 mm.



MOUNTING INSTRUCTIONS FOR 500 V TO 2000 V INSULATION (continued)



→ Figs 13 and 14 Insulated mounting (500 V - 2000 V, thick-base TO-3) with mica 56339 and mounting support 56352.

For legend see page 2 or 7.

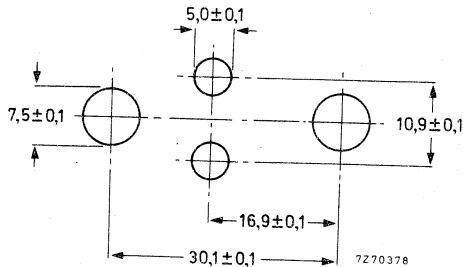


Fig. 15 Hole pattern for Figs 13 and 14.

ACCESSORIES



TYPE NUMBER SURVEY ACCESSORIES

type number	description	envelope
56201c	insulating bushes (up to 500 V)	TO-3
56201d	mica washer (up to 500 V)	TO-3
56201j	insulating bushes (up to 500 V)	TO-3
56261a	insulating bushes (up to 500 V)	TO-3
56326	metal washer	SOT-32
56333	metal washer mica washer insulating bush	SOT-32
56339	mica washer (500 to 2000 V)	TO-3
56352	insulating mounting support	
56353	spring clip	SOT-32/SOT-82
56354	mica insulator	SOT-32/SOT-82
56359b	mica washer (up to 800 V)	TO-220
56359c	insulating bush (up to 800 V)	TO-220
56359d	rectangular insulating washer (up to 1000 V)	TO-220
56360a	rectangular washer (brass)	TO-220
56363	spring clip (direct mounting)	TO-220
56364	spring clip (insulated mounting)	TO-220
56367	alumina insulator	TO-220
56368a	mica insulator	SOT-93
56368b	insulating bush	SOT-93
56369	mica insulator (up to 2 kV)	TO-220
56378	mica insulator	SOT-93
56379	spring clip	SOT-93

CLIP MOUNTING

envelope	direct mounting		insulated mounting			
	clip		mica	clip		
TO-126 (SOT-32)	56353		56354	56353		
SOT-82	56353		56354	56353		
TO-220 (SOT-78)	56363		56369	56364		
SOT-93	56379		56378	56379		

SCREW MOUNTING

envelope	direct mounting		insulated mounting			
	metal washer	mounting material	mica washer	insul. bush	metal washer	mounting material
TO-126 (SOT-32)	56326	M3	←	56333	→	M2,5
TO-220 (SOT-78) up to 800 V up to 1000 V	56360a	M3	56359b 56359b	56359c 56359d	56360a 56360a	M3 M3
SOT-93	—	M4	56368a	56368b		M3
TO-3 (SOT-3) up to 500 V up to 2000 V	—	M4	56201d 56339	56201c; 56201j or 56261a 56352		M3 M3

The accessories mentioned can be supplied on request.

See also chapter Mounting Instructions.

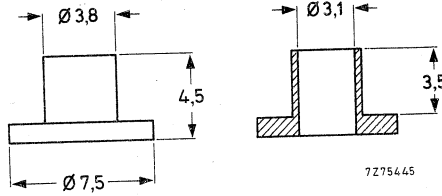
56201c

2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm



TEMPERATURE

Maximum permissible temperature

T_{max} 150 °C

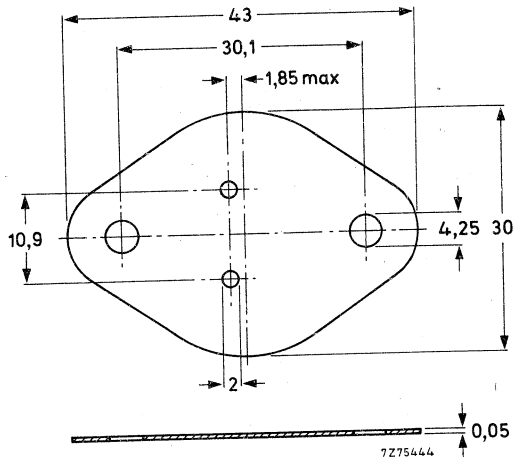
56201d

MICA WASHER

Mica washer for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm



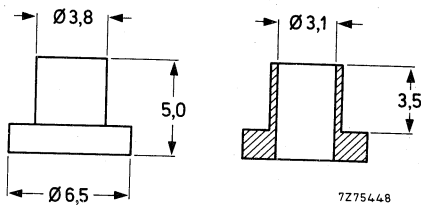
56201j

2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm



TEMPERATURE

Maximum permissible temperature

T_{max} 150 °C

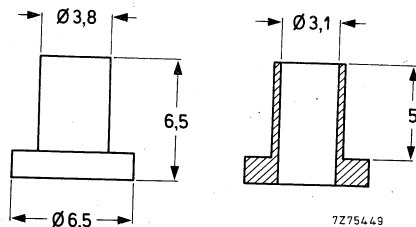
56261a

2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm



TEMPERATURE

Maximum permissible temperature

T_{max} 150 °C

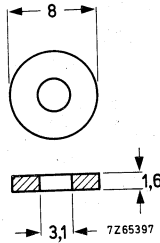
56326

WASHER

Flat metal washer for direct mounting of envelope SOT-32 (TO-126).

MECHANICAL DATA

Dimensions in mm

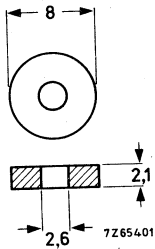


56333

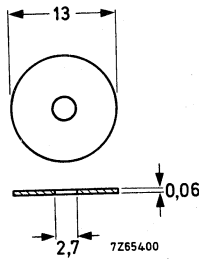
Mounting accessories for insulated mounting of envelope SOT-32 (TO-126); the set consists of a metal washer, a mica washer and an insulating bush.

MECHANICAL DATA

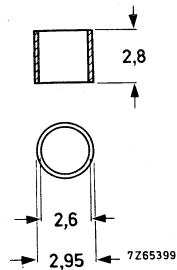
Dimensions in mm



Metal washer.



Mica washer.



Insulating bush.

TEMPERATURE

Maximum permissible temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$

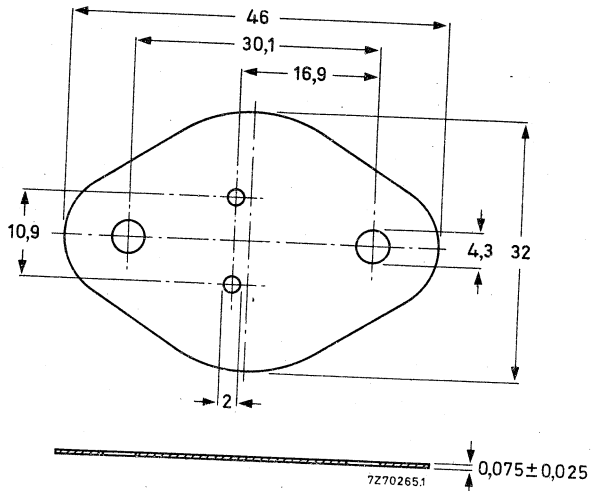
56339

MICA WASHER

Mica washer for 500 to 2000 V insulation of TO-3 envelopes, for which it should be combined with mounting support 56352.

MECHANICAL DATA

Dimensions in mm



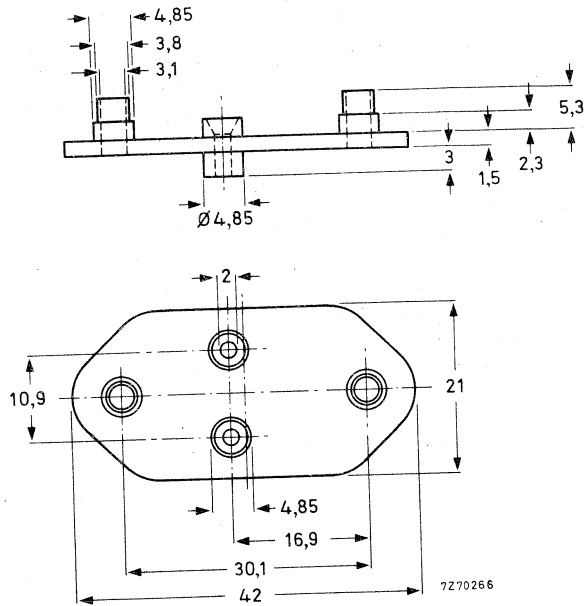
56352

MOUNTING SUPPORT

Mounting support for 500 to 2000 V insulation of thick-base TO-3 envelopes, for which it should be combined with mica washer 56339.

MECHANICAL DATA

Dimensions in mm



TEMPERATURE

Maximum permissible temperature

T_{\max} 125 °C

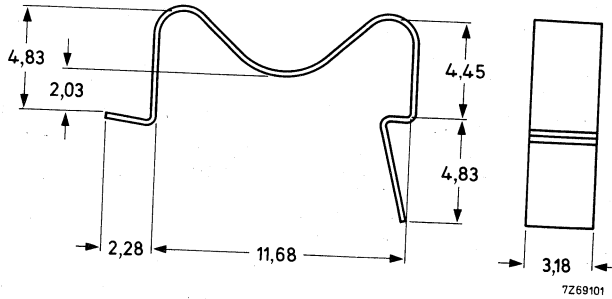
56353

CLIP

for SOT-32 and SOT-82 envelopes

MECHANICAL DATA

Dimensions in mm



Spring clip suitable for heatsink of 1,5 to 2 mm.
See mounting instructions SOT-32/SOT-82 envelopes.

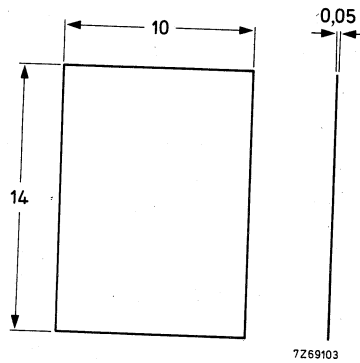
56354

MICA INSULATOR

for SOT-32 and SOT-82 envelopes

MECHANICAL DATA

Dimensions in mm

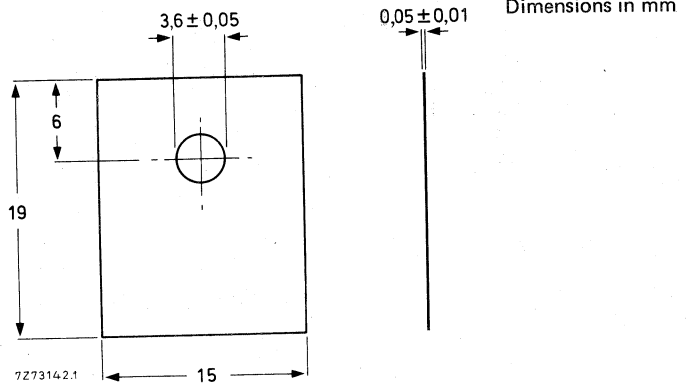


See also chapter Mounting Instructions.

56359b

MICA WASHER
for TO-220 envelopes (up to 800 V)

MECHANICAL DATA



56359c

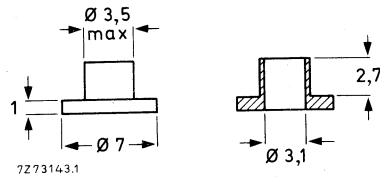
INSULATING BUSH
for TO-220 envelopes (up to 800 V)

MECHANICAL DATA

TEMPERATURE

Maximum permissible
temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$



56359d

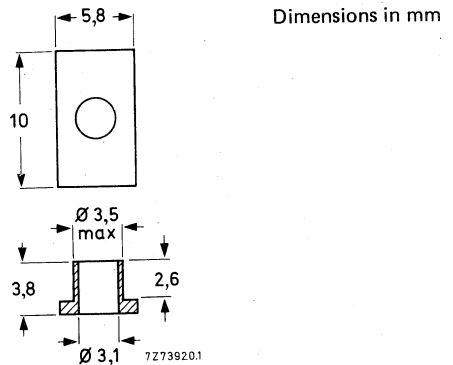
RECTANGULAR INSULATING WASHER
for TO-220 envelopes (up to 1000 V)

MECHANICAL DATA

TEMPERATURE

Maximum permissible
temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$



56360a

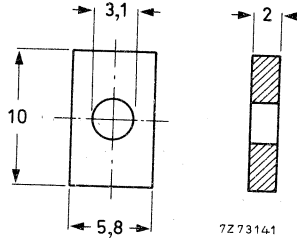
RECTANGULAR WASHER

for direct and insulated mounting of TO-220 envelopes

MECHANICAL DATA

material: brass.

Dimensions in mm



56363

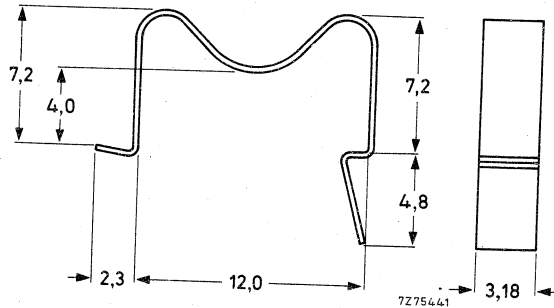
SPRING CLIP

for direct mounting of TO-220 envelopes

MECHANICAL DATA

material: steel, zinc-chromate passivated.

Dimensions in mm



56364

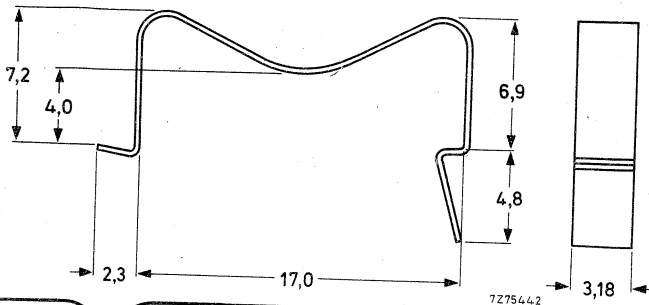
SPRING CLIP

for insulated mounting of TO-220 envelopes

MECHANICAL DATA

material: steel, zinc-chromate passivated.

Dimensions in mm



to be used in conjunction with 56367 or 56369.

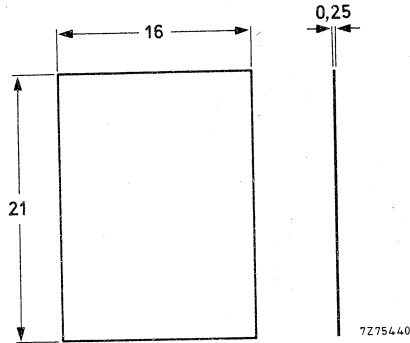
56367

ALUMINA INSULATOR

for insulating mounting of TO-220 envelopes

MECHANICAL DATA

Dimensions in mm



alumina insulator (up to 2 kV)
material: 96-alumina.*

* Because alumina is brittle, extreme care must be taken when mounting devices not to crack the alumina, particularly when used without heatsink compound.

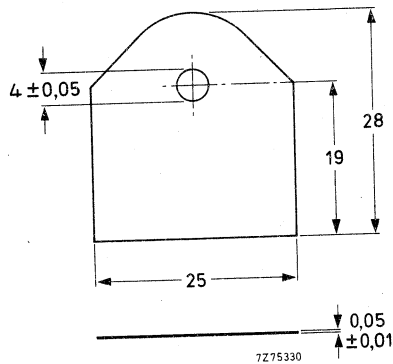
56368a

MICA INSULATOR

for insulated screw mounting of SOT-93 envelopes

MECHANICAL DATA

Dimensions in mm



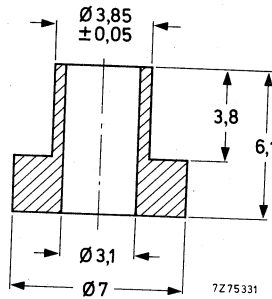
56368b

INSULATING BUSH

for insulated screw mounting of SOT-93 envelopes

MECHANICAL DATA

Dimensions in mm



TEMPERATURE

Maximum permissible temperature

$T_{\text{max}} = 150 \text{ }^\circ\text{C}$

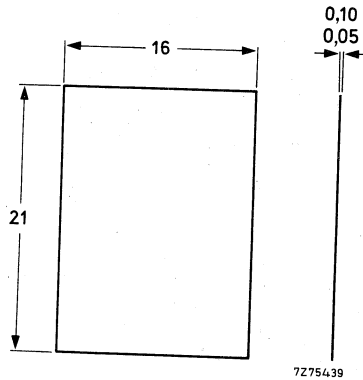
56369

MICA INSULATOR

for insulated clip mounting of TO-220 envelopes (up to 2 kV)

MECHANICAL DATA

Dimensions in mm

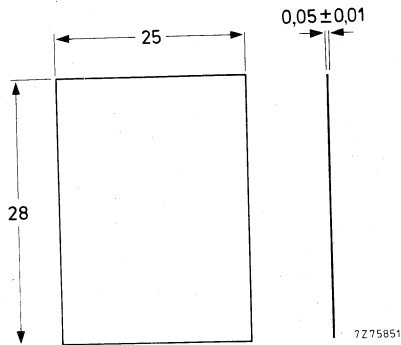


56378

MICA INSULATOR
for SOT-93 clip mounting

MECHANICAL DATA

Dimensions in mm

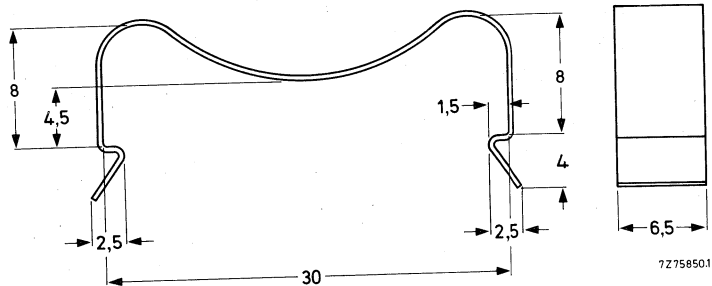


56379

SPRING CLIP
for direct and insulated mounting of SOT-93 envelopes

MECHANICAL DATA

Dimensions in mm

material: CrNi steel NLN-939; thickness $0,4 \pm 0,04$.

HYBRID MODULES

DEVELOPMENT SAMPLE DATA

This information is derived from development samples made available for evaluation. It does not form part of our data handbook system and does not necessarily imply that the device will go into production

OM931
OM961

HYBRID INTEGRATED CIRCUIT HI-FI AUDIO POWER AMPLIFIERS

The OM931 and OM961 are thin-film hybrid integrated circuit hi-fi audio amplifiers for sinusoidal output power up to 60 W. The modules offer maximum design possibilities regarding amplification, ripple rejection, stability for complex loads, etc. The amplifiers have built-in short-circuit protection (SOAR protected), and are especially designed for low transient and harmonic distortion. All built-in resistors are dynamically adjusted for optimum performance over a wide temperature range.

QUICK REFERENCE DATA

		OM931	OM961
Sinusoidal output power for $d_{tot} < 0,2\%$			
$f = 20 \text{ Hz to } 20 \text{ kHz}$			
P_o		$> 30 \text{ W at } \pm 23 \text{ V}$	$> 60 \text{ W at } \pm 31 \text{ V}$
P_o		$> 30 \text{ W at } \pm 26 \text{ V}$	$> 60 \text{ W at } \pm 35 \text{ V}$
Total harmonic distortion			
$P_o = 1 \text{ W}; f = 1 \text{ kHz}$	d_{tot} typ.	0,02	0,02 %

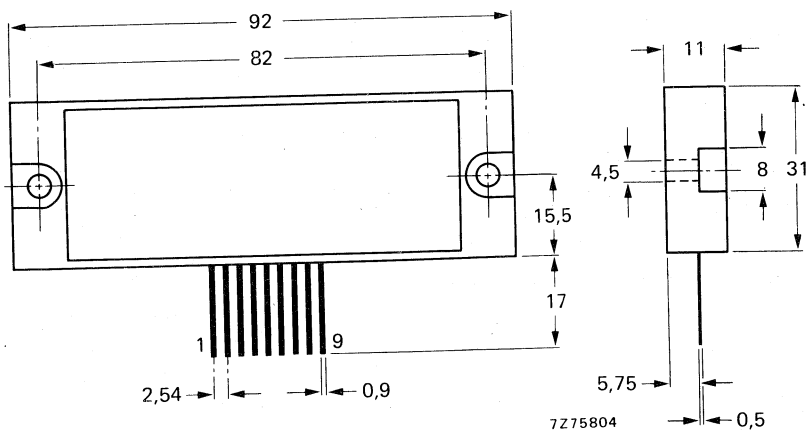


Fig. 1 Outline; dimensions in mm.

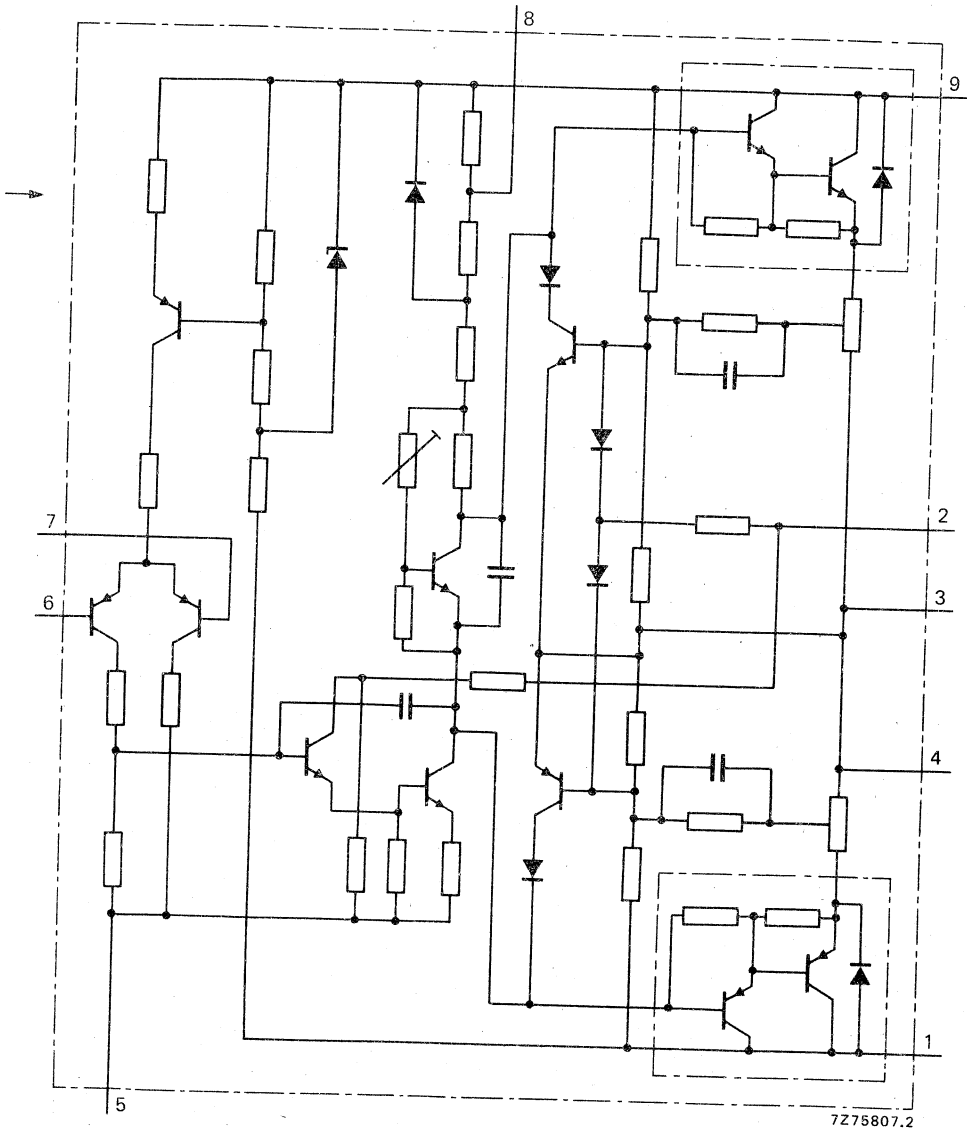


Fig. 2 Circuit diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Symmetrical supply voltage	OM931	V_S	max.	± 40 V
	OM961	V_S	max.	± 45 V
Operating mounting base temperature		T_{mb}	max.	95 °C
Storage temperature		T_{stg}		-30 to +100 °C

CHARACTERISTICS

Mounted on a heatsink with $R_{th\ h-a} = 1,4$ °C/W (OM931) and $R_{th\ h-a} = 0,8$ °C/W (OM961); measured in the circuit of Fig. 3.

DEVELOPMENT SAMPLE DATA

		OM931		OM961	
Symmetrical supply voltage	V_S	typ. ± 23	± 26	± 31	± 35 V
Total supply current (zero signal)	I_{tot}	typ.	80	100	mA
Sinusoidal output power for $d_{tot} < 0,2\%$ f = 20 Hz to 20 kHz (Federal Trade Commission, U.S.A.) $R_L = 4\ \Omega$ $R_L = 8\ \Omega$	P_o P_o	$>$	30	60	W*
		$>$	—	—	60 W*
Clipping level at f = 1 kHz; $R_L = 4\ \Omega$; $d_{tot} = 0,7\%$	P_o	typ.	40	75	W
Total harmonic distortion $P_o = 1$ W; f = 1 kHz	d_{tot}	typ.	0,02	0,02	%
Intermodulation distortion at $f_1 = 250$ Hz and $f_2 = 8$ kHz; amplitude ratio $V_{f1}/V_{f2} = 4/1$ $P_o = 1$ W $P_o =$ rated value	d_{im} d_{im}	typ.	0,05	0,05	%
		typ.	0,1	0,1	%
Input sensitivity for $P_o =$ rated value	V_i	typ.	0,7	1	1,4 V
Input impedance determined by input circuitry	R_i	typ.		10	k Ω
Open loop gain	G_o	typ.		80	dB
Closed loop gain	G_c	typ.		24	dB
Frequency response $P_o =$ rated value -10 dB (-1 dB)	f			30 Hz to 40	kHz
Power bandwidth (-3 dB)	f_p			20 Hz to 40	kHz
Signal-to-noise ratio (unweighted) $P_o = 50$ mW; wide band	S/N	typ.		75	dB
Signal-to-noise ratio (weighted) $P_o = 50$ mW; A-curve	S/N	typ.		87	dB
D.C. output offset voltage	V_{off}	typ.		± 20	mV
Ripple rejection	RR	\geq		65	dB
Output impedance	R_o	typ.		0,05	Ω

* P_o is stated as rated value.

APPLICATION INFORMATION

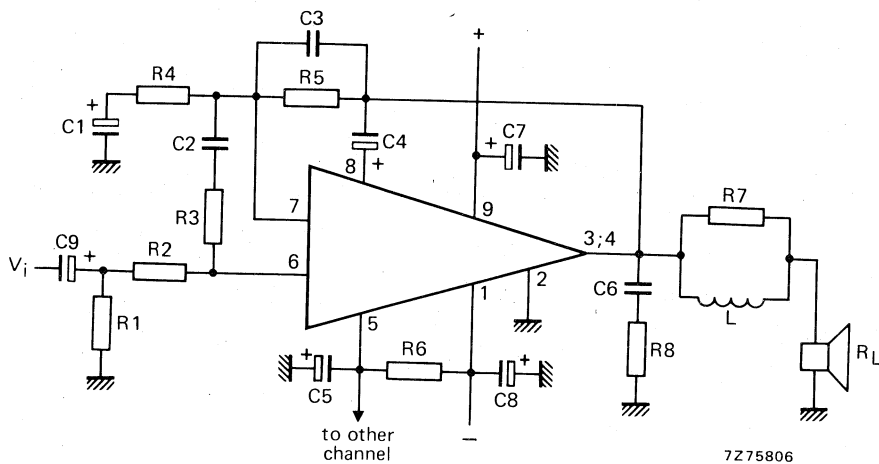


Fig. 3 Example of an amplifier with external components.

List of components:

- R1 = 10 k Ω (0,25 W)
- R2 = 4,7 k Ω (0,25 W)
- R3 = 300 Ω (0,25 W)
- R4 = 680 Ω (0,25 W)
- R5 = 10 k Ω (0,25 W)
- R6 = 22 Ω (0,5 W)
- R7 = 2,2 Ω (0,25 W)
- R8 = 10 Ω (0,5 W)

- C1 = 47 μ F (10 V)
- C2 = 270 pF (10%)
- C3 = 120 pF (10%)
- C4 = 100 μ F
- C5 = 470 μ F
- C6 = 100 nF
- C7 = 10 μ F (63 V)
- C8 = 10 μ F (63 V)
- C9 = 1 μ F (63 V)

L = 4 μ H

R_L = 4 or 8 Ω

MOUNTING RECOMMENDATIONS

The modules are delivered with leads in SIL (single in-line) but leads may also be bent to DIL (dual in-line).

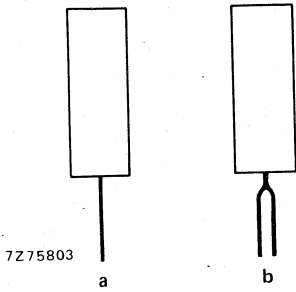
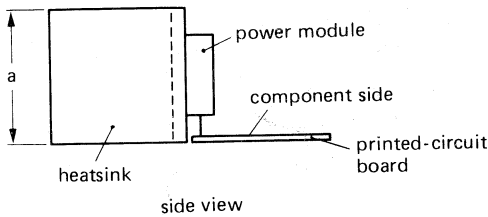


Fig. 4:
a. Single in-line (SIL) leads.
b. Dual in-line (DIL) leads.

DEVELOPMENT SAMPLE DATA



Thermal resistance values from heatsink to ambient for various heatsink lengths (a):

- $R_{th\ h-a} = 1,4\ ^\circ C/W$ a = 50 mm
- $R_{th\ h-a} = 1,0\ ^\circ C/W$ a = 75 mm
- $R_{th\ h-a} = 0,8\ ^\circ C/W$ a = 90 mm

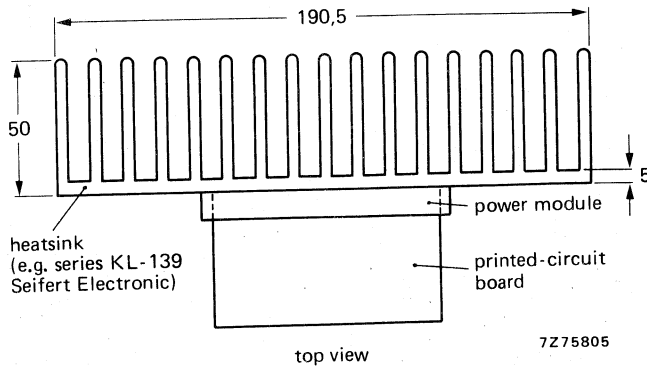


Fig. 5 Example of a heatsink to be used for the module; dimensions in mm.

PRINTED-CIRCUIT BOARDS for OM931 and OM961

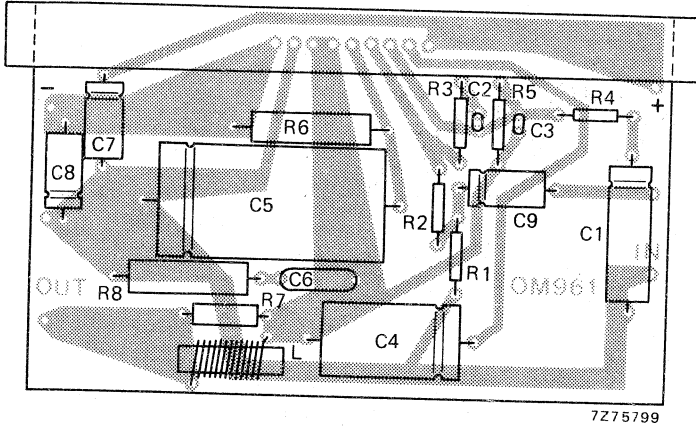


Fig. 6 Component side of SIL-version showing component layout.

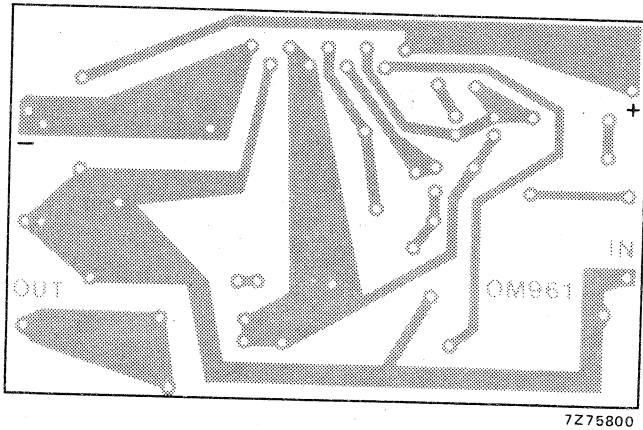


Fig. 7 Component side of DIL-version; for component layout see Fig. 6.

Dimensions in mm

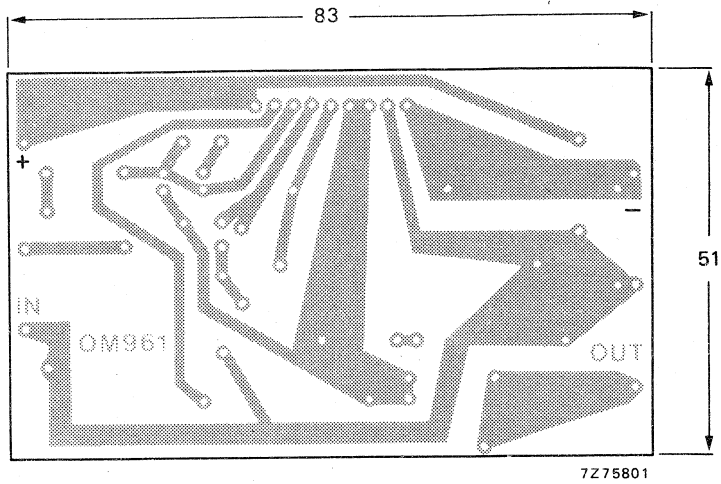


Fig. 8 Track side of SIL-version.

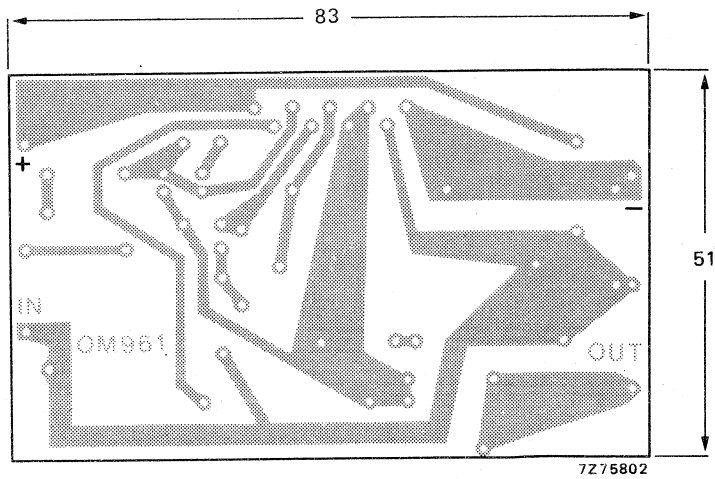



Fig. 9 Track side of DIL-version.

DEVELOPMENT SAMPLE DATA



LOW-FREQUENCY POWER TRANSISTORS



TYPE NUMBER SURVEY
SELECTION GUIDE



GENERAL



TRANSISTOR DATA



MOUNTING INSTRUCTIONS



ACCESSORIES



HYBRID MODULES

Electronic components and materials for professional, industrial and consumer uses from the world-wide Philips Group of Companies

- Argentina:** FAPESA I.y.C., Av. Crovara 2550, Tablada, Prov. de BUENOS AIRES, Tel. 652-7438/7478.
- Australia:** PHILIPS INDUSTRIES HOLDINGS LTD., Elcoma Division, 67 Mars Road, LANE COVE, 2066, N.S.W., Tel. 427 08 88.
- Austria:** ÖSTERREICHISCHE PHILIPS BAUELEMENTE Industrie G.m.b.H., Triester Str. 64, A-1101 WIEN, Tel. 62 91 11.
- Belgium:** M.B.L.E., 80, rue des Deux Gares, B-1070 BRUXELLES, Tel. 523 00 00.
- Brazil:** IBRAPE, Caixa Postal 7383, Av. Brigadeiro Fari Alima, 1735 SAO PAULO, SP, Tel. (011) 211-2600.
- Canada:** PHILIPS ELECTRONICS LTD., Electron Devices Div., 601 Milner Ave., SCARBOROUGH, Ontario, M1B 1M8, Tel. 292-5161.
- Chile:** PHILIPS CHILENA S.A., Av. Santa Maria 0760, SANTIAGO, Tel. 39-40 01.
- Colombia:** SADAPE S.A., P.O. Box 9805, Calle 13, No. 51 + 39, BOGOTA D.E. 1., Tel. 600 600.
- Denmark:** MINIWATT A/S, Emdrupvej 115A, DK-2400 KØBENHAVN NV., Tel. (01) 69 16 22.
- Finland:** OY PHILIPS AB, Elcoma Division, Kaivokatu 8, SF-00100 HELSINKI 10, Tel. 1 72 71.
- France:** R.T.C. LA RADIOTECHNIQUE-COMPELEC, 130 Avenue Ledru Rollin, F-75540 PARIS 11, Tel. 355-44-99.
- Germany:** VALVO, UB Bauelemente der Philips G.m.b.H., Valvo Haus, Burchardstrasse 19, D-2 HAMBURG 1, Tel. (040) 3296-1.
- Greece:** PHILIPS S.A. HELLENIQUE, Elcoma Division, 52, Av. Syngrou, ATHENS, Tel. 915 311.
- Hong Kong:** PHILIPS HONG KONG LTD., Elcoma Div., 15/F Philips Ind. Bldg., 24-28 Kung Yip St., KWAI CHUNG, Tel. NT 24 51 21.
- India:** PEICO ELECTRONICS & ELECTRICALS LTD., Band Box House, 254-D, Dr. Annie Besant Rd., Prabhadevi, BOMBAY-25-DD, Tel. 457 311-5.
- Indonesia:** P.T. PHILIPS-RALIN ELECTRONICS, Elcoma Division, 'Timah' Building, Jl. Jen. Gatot Subroto, P.O. Box 220, JAKARTA, Tel. 44 163.
- Ireland:** PHILIPS ELECTRICAL (IRELAND) LTD., Newstead, Clonskeagh, DUBLIN 14, Tel. 69 33 55.
- Italy:** PHILIPS S.p.A., Sezione Elcoma, Piazza IV Novembre 3, I-20124 MILANO, Tel. 2-6994.
- Japan:** NIHON PHILIPS CORP., Shuwa Shinagawa Bldg., 26-33 Takanawa 3-chome, Minato-ku, TOKYO (108), Tel. 448-5611.
(IC Products) SIGNETICS JAPAN, LTD, TOKYO, Tel. (03)230-1521.
- Korea:** PHILIPS ELECTRONICS (KOREA) LTD., Elcoma Div., Philips House, 260-199 Itaewon-dong, Yongsan-ku, C.P.O. Box 3680, SEOUL, Tel. 794-4202.
- Malaysia:** PHILIPS MALAYSIA SDN. BERHAD, Lot 2, Jalan 222, Section 14, Petaling Jaya, P.O.B. 2163, KUALA LUMPUR, Selangor, Tel. 77 44 11.
- Mexico:** ELECTRONICA S.A. de C.V., Varsovia No. 36, MEXICO 6, D.F., Tel. 533-11-80.
- Netherlands:** PHILIPS NEDERLAND B.V., Afd. Elonco, Boschdijk 525, 5600 PD EINDHOVEN, Tel. (040) 79 33 33.
- New Zealand:** PHILIPS ELECTRICAL IND. LTD., Elcoma Division, 2 Wagener Place, St. Lukes, AUCKLAND, Tel. 867 1169.
- Norway:** NORSK A/S PHILIPS, Electronica, Sørkedalsveien 6, OSLO 3, Tel. 46 38 90.
- Peru:** CADESA, Rocca de Vergallo 247, LIMA 17, Tel. 62 85 99.
- Philippines:** PHILIPS INDUSTRIAL DEV. INC., 2246 Pasong Tamo, P.O. Box 911, Makati Comm. Centre, MAKATI-RIZAL 3116, Tel. 86-89-51 to 59.
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- Singapore:** PHILIPS PROJECT DEV. (Singapore) PTE LTD., Elcoma Div., P.O.B. 340, Toa Payoh CPO, Lorong 1, Toa Payoh, SINGAPORE 12, Tel. 53 88 11.
- South Africa:** EDAC (Pty.) Ltd., 3rd Floor Rainer House, Upper Railway Rd. & Ove St., New Doornfontein, JOHANNESBURG 2001, Tel. 614-2362/9.
- Spain:** COPRESA S.A., Balmes 22, BARCELONA 7, Tel. 301 63 12.
- Sweden:** A.B. ELCOMA, Lidingövägen 50, S-115 84 STOCKHOLM 27, Tel. 08/67 97 80.
- Switzerland:** PHILIPS A.G., Elcoma Dept., Allmendstrasse 140-142, CH-8027 ZÜRICH, Tel. 01/43 22 11.
- Taiwan:** PHILIPS TAIWAN LTD., 3rd Fl., San Min Building, 57-1, Chung Shan N. Rd, Section 2, P.O. Box 22978, TAIPEI, Tel. 5513101-5.
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- Turkey:** TÜRK PHILIPS TICARET A.S., EMET Department, Inonu Cad. No. 78-80, ISTANBUL, Tel. 43 59 10.
- United Kingdom:** MULLARD LTD., Mullard House, Torrington Place, LONDON WC1E 7HD, Tel. 01-580 6633.
- United States:** (Active devices & Materials) AMPEREX SALES CORP., Providence Pike, SLATERSVILLE, R.I. 02876, Tel. (401) 762-9000.
(Passive devices) MEPCO/ELECTRA INC., Columbia Rd., MORRISTOWN, N.J. 07960, Tel. (201) 539-2000.
(IC Products) SIGNETICS CORPORATION, 811 East Arques Avenue, SUNNYVALE, California 94086, Tel. (408) 739-7700.
- Uruguay:** LUZIECTRON S.A., Rondeau 1567, piso 5, MONTEVIDEO, Tel. 9 43 21.
- Venezuela:** IND. VENEZOLANAS PHILIPS S.A., Elcoma Dept., A. Ppal de los Ruices, Edif. Centro Colgate, CARACAS, Tel. 36 05 11.