

PHILIPS

Data handbook



Electronic
components
and materials

Semiconductors

Book S4a

1986

Low-frequency power transistors

Low-frequency power hybrid modules

LOW-FREQUENCY POWER TRANSISTORS AND MODULES

(Book S4a)

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NOTE: For information on high-voltage and switching power transistors see Book S4b.

DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of four series of handbooks:

ELECTRON TUBES	BLUE
SEMICONDUCTORS	RED
INTEGRATED CIRCUITS	PURPLE
COMPONENTS AND MATERIALS	GREEN

The contents of each series are listed on pages iv to viii.

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

When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application information is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Electronic Components and Materials Division is given in our Preferred Type Range catalogue (issued annually).

Information on current Data Handbooks and on how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.

Product specialists are at your service and enquiries will be answered promptly.

ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks comprises:

- T1** Tubes for r.f. heating
- T2a** Transmitting tubes for communications, glass types
- T2b** Transmitting tubes for communications, ceramic types
- T3** Klystrons
- T4** Magnetrons for microwave heating
- T5** Cathode-ray tubes
Instrument tubes, monitor and display tubes, C.R. tubes for special applications
- T6** Geiger-Müller tubes
- T7** Gas-filled tubes (will not be reprinted)
- T8** Colour display systems
Colour TV picture tubes, colour data graphic display tube assemblies, deflection units
- T9** Photo and electron multipliers
- T10** Plumbicon camera tubes and accessories
- T11** Microwave semiconductors and components
- T12** Vidicon and Newvicon camera tubes
- T13** Image intensifiers
- T14** Infrared detectors
- T15** Dry reed switches
- T16** Monochrome tubes and deflection units
Black and white TV picture tubes, monochrome data graphic display tubes, deflection units

Data collations on these subjects are available now.
Data Handbooks will be published in 1985.

SEMICONDUCTORS (RED SERIES)

The red series of data handbooks comprises:

- S1 Diodes**
Small-signal silicon diodes, voltage regulator diodes ($< 1,5 \text{ W}$), voltage reference diodes, tuner diodes, rectifier diodes
- S2a Power diodes**
- S2b Thyristors and triacs**
- S3 Small-signal transistors**
- S4a Low-frequency power transistors and hybrid modules**
- S4b High-voltage and switching power transistors**
- S5 Field-effect transistors**
- S6 R.F. power transistors and modules**
- S7 Surface mounted semiconductors**
- S8 Devices for optoelectronics**
Photosensitive diodes and transistors, light-emitting diodes, displays, photocouplers, infrared sensitive devices, photoconductive devices.
- S9 Power MOS transistors**
- S10 Wideband transistors and wideband hybrid IC modules**
- S11 Microwave transistors**
- S12 Surface acoustic wave devices**
- S13 Semiconductor sensors**

INTEGRATED CIRCUITS (PURPLE SERIES)

The purple series of data handbooks comprises:

EXISTING SERIES

Superseded by:

IC1	Bipolar ICs for radio and audio equipment	IC01N
IC2	Bipolar ICs for video equipment	IC02Na and IC02Nb
IC3	ICs for digital systems in radio, audio and video equipment	IC01N, IC02Na and IC02Nb
IC4	Digital integrated circuits CMOS HE4000B family	
IC5	Digital integrated circuits – ECL ECL10 000 (GX family), ECL100 000 (HX family), dedicated designs	IC08N
IC6	Professional analogue integrated circuits	
IC7	Signetics bipolar memories	
IC8	Signetics analogue circuits	IC11N
IC9	Signetics TTL logic	IC09N and IC15N
IC10	Signetics Integrated Fuse Logic (IFL)	IC13N
IC11	Microprocessors, microcomputers and peripheral circuitry	IC14N

NEW SERIES

IC01N	Radio, audio and associated systems Bipolar, MOS	(published 1985)
IC02Na	Video and associated systems Bipolar, MOS Types MAB8031AH to TDA1524A	(published 1985)
IC02Nb	Video and associated systems Bipolar, MOS Types TDA2501 to TEA1002	(published 1985)
IC03N	Integrated circuits for telephony	(published 1985)
IC04N	HE4000B logic family CMOS	
IC05N	HE4000B logic family – uncased ICs CMOS	(published 1984)
IC06N	High-speed CMOS; PC54/74HC/HCT/HCU Logic family	(published 1985)
Supplement to IC06N	High-speed CMOS; PC74HC/HCT/HCU Logic family	(published 1985)
IC07N	High-speed CMOS; PC54/74HC/HCT/HCU – uncased ICs Logic family	
IC08N	ECL 10K and 100K logic families	(published 1984)
IC09N	TTL logic series	(published 1984)
IC10N	Memories MOS, TTL, ECL	
IC11N	Linear LSI	(published 1985)
IC12N	Semi-custom gate arrays & cell libraries ISL, ECL, CMOS	
IC13N	Semi-custom Integrated Fuse Logic	(published 1985)
IC14N	Microprocessors, microcontrollers & peripherals Bipolar, MOS	(published 1985)
IC15N	FAST TTL logic series	(published 1984)

Note

Books available in the new series are shown with their date of publication.

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

- C1 Programmable controller modules**
PLC modules, PC20 modules
- C2 Television tuners, coaxial aerial input assemblies, surface acoustic wave filters**
- C3 Loudspeakers**
- C4 Ferroxcube potcores, square cores and cross cores**
- C5 Ferroxcube for power, audio/video and accelerators**
- C6 Synchronous motors and gearboxes**
- C7 Variable capacitors**
- C8 Variable mains transformers**
- C9 Piezoelectric quartz devices**
- C10 Connectors**
- C11 Varistors, thermistors and sensors**
- C12 Potentiometers, encoders and switches**
- C13 Fixed resistors**
- C14 Electrolytic and solid capacitors**
- C15 Ceramic capacitors**
- C16 Permanent magnet materials**
- C17 Stepping motors and associated electronics**
- C18 Direct current motors**
- C19 Piezoelectric ceramics**
- C20 Wire-wound components for TVs and monitors**
- C21* Assemblies for industrial use**
HNIL FZ/30 series, NORbits 60-, 61-, 90-series, input devices
- C22 Film capacitors**

* To be issued shortly.

SELECTION GUIDE

SELECTION GUIDE

GENERAL PURPOSE DARLINGTON TRANSISTORS

IC A	pol.	collector-emitter voltage (open base) V _{CEO} (V)										P _{tot} W	case				
		45	60	80	100	120	130	150	200	375	400						
0,5	N														2	TO-202	
	N	BDX42*	BDX43*	BDX44*													TO-126
1	N	BDX45*	BDX46*	BDX47*													
	P	BD675	BD677	BD679	BD681	BD683											
4	N	BD676	BD678	BD680	BD682	BD684											
	P		BDT61	BDT61A	BDT61B	BDT61C											
5	N		BDT60	BDT60A	BDT60B	BDT60C											
	P		TIP110	TIP111	TIP112	BDT60C											
6	N		TIP115	TIP116	TIP117												
	P		TIP120	TIP121	TIP122												
8	N		TIP125	TIP126	TIP127												
	P		BD331	BD333	BD335	BD337											
10	N		BD332	BD334	BD336	BD338											
	P		BD645	BD647	BD649	BD651											
125	N		BD646	BD648	BD650	BD652											
	P																
60	N																
	P																
62,5	N																
	P																
90	N																
	P																
70	N																
	P																
90	N																
	P																
125	N																
	P																

* V_{CER}.

IC	pol.	collector-emitter voltage (open base) V_{CE0} (V)										P_{tot} W	case			
		45	60	80	100	120	130	150	200	375	400					
12	N		BDT65	BDT65A	BDT65B	BDT65C								125	TO-220	
	P		BDT64	BDT64A	BDT64B	BDT64C										
	N		BDV65	BDV65A	BDV65B	BDV65C								125	SOT-93	
	P		BDV64	BDV64A	BDV64B	BDV64C										
	N		BDX65	BDX65A	BDX65B	BDX65C								117	TO-3	
16	N		BDX64	BDX64A	BDX64B	BDX64C								125	TO-3	
	N		BDV67	BDV67A	BDV67B	BDV67C								200	SOT-93	
	P		BDV66	BDV66A	BDV66B	BDV66C										
	N		BDX67	BDX67A	BDX67B	BDX67C								150	TO-3	
	P		BDX66	BDX66A	BDX66B	BDX66C										
25	N		BDX69	BDX69A	BDX69B	BDX69C								200	TO-3	
	P		BDX68	BDX68A	BDX68B	BDX68C										

GENERAL PURPOSE POWER TRANSISTORS

IC	pol.	collector-emitter voltage (open base) V_{CE0} (V)										P_{tot} W	case				
		20	22	32	40	45	60	80	100	120	140						
1	N					BD135	BD137	BD139								8	TO-126
	P					BD136	BD138	BD140									
	N					BD825	BD827	BD829									
	P					BD826	BD828	BD830									
	N					BDW55	BDW57	BDW59									
1,5	P					BDW56	BDW58	BDW60									
	N				BDT29	BDT29A	BDT29B					BDT29C					
	P				BDT30	BDT30A	BDT30B					BDT30C					
	N				TIP29	TIP29A	TIP29B					TIP29C					
	P				TIP30	TIP30A	TIP30B					TIP30C					
1,5	N					BD226	BD228	BD230									
	P					BD227	BD229	BD231									
	N					BD839	BD841	BD843				BD845					
	N					BD840	BD842	BD844				BD846					
	P											BD847					
											BD848						
												BD849					
												BD850					

SELECTION GUIDE

GENERAL PURPOSE POWER TRANSISTORS (continued)

I _C A	pol.	collector-emitter voltage (open base) V _{CEO} (V)								P _{tot} W	case				
		20	22	32	40	45	60	80	100			120	140		
2	N					BD233	BD235	BD237					25	TO-126	
	P					BD234	BD236	BD238							TO-202
	N					BD813	BD815	BD817					12.5		
	P					BD814	BD816	BD818							
3	N					BD239	BD239A	BD239B					30	TO-220	
	P					BD240	BD240A	BD240B							
	N					BD131							15	TO-126	
	P					BD132									
	N	BD329													
	P	BD330													
4	N					BD933	BD935	BD937					30	TO-220	
	P					BD934	BD936	BD938							
	N				BDT31	BDT31A	BDT31B								
	P				BDT32	BDT32A	BDT32B								
	N				TIP31	TIP31A	TIP31B						40	TO-220	
	P				TIP32	TIP32A	TIP32B								
5	N					BD437							36	TO-126	
	P					BD438									
	N		BD433										40	TO-220	
	P		BD434												
6	N					BD241	BD241A	BD241B					40	TO-220	
	P					BD242	BD242A	BD242B							
	N					BDX35	BDX35	BDX37					15	TO-126	
	N					BDX36									
	N					BD947	BD949	BD951					40	TO-220	
	P					BD948	BD950	BD952							
6	N					BD243	BD243A	BD243B					65	TO-220	
	P					BD244	BD244A	BD244B							
	N					BDT41	BDT41A	BDT41B					65	TO-220	
	P					BDT42	BDT42A	BDT42B							
	N					TIP41	TIP41A	TIP41B					80	SOT-93	
	P					TIP42	TIP42A	TIP42B							

IC	pol.	collector-emitter voltage (open base) V_{CE0} (V)										P_{tot} W	case			
		20	22	32	40	45	60	80	100	120	140					
8	N					BD201	BD203	BDX77						60	TO-220	
	P					BD202	BD204	BDX78								
	N						BDX91	BDX93	BDX95					90	TO-3	
	P						BDX92	BDX94	BDX96							
10	N						PH3055T							75	TO-220	
	P						PH2955T									
	N						BDT91	BDT93	BDT95					90	TO-220	
	P						BDT92	BDT94	BDT96							
15	N						BDV91	BDV93	BDV95					100	SOT-93	
	P						BDV92	BDV94	BDV96							
	N				TIP33		TIP33A	TIP33B	TIP33C					80	SOT-93	
	P				TIP34		TIP34A	TIP34B	TIP34C							
15	N						BDT51	BDT53	BDT55					90	TO-220	
	P						BDT52	BDT54	BDT56							
	N						BDT81	BDT83	BDT85					125	TO-220	
	P						BDT82	BDT84	BDT86							
15	N						TIP3055							100	SOT-93	
	P						TIP2955									

Special: TIP47; 48; 49; 50 with V_{CE0} of 250, 300, 350, 400 V respectively at $I_C = 1$ A and $P_{tot} = 40$ W in TO-220.

LOW-VOLTAGE SWITCHING TRANSISTORS

IC	pol.	collector-emitter voltage (open base) V_{CE0} (V)										P_{tot} W	case		
		20	22	32	40	45	60	80	100	120	140				
10	N						BDY92	BDY91	BDY90					40	TO-3
12	N								BDY90A					40	TO-3

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HIGH-VOLTAGE TRANSISTORS video output - deflection - SMPS - motor control

Ic	pol.	collector-emitter voltage (open base) V _{CEO} (V)										P _{tot} W	case	
		160	250	300	350	375	400	450	700	800				
0,05	N		BF469	BF471*									1,8	TO-126
	P		BF470	BF472*									1,6 5	TO-202
	N		BF583	BF585	BF587									TO-202
	N		BF869	BF871*										
	P		BF870	BF872*										
0,1	N		BF419	BF459									6	TO-126
	N	BF457	BF458										6	TO-202
	N	BF857	BF858	BF859										
0,15	N	BF591	BF593										1,3	TO-202
	N			BUX99			BUX86	BUX87					20	TO-126
1,5	N			PH13002			BUX86	BUX87					28	TO-126
	N			PH13003										
2	N			BUX84			BUX84	BUX85					50	SOT-82
	N			BUX84			BUX84	BUX85					40	TO-220
	N			BUX84F			BUX84F	BUX85F					18	SOT-186
2,5	N												75	SOT-93
	N								BU705				85	TO-3
3,5	N						BUX46	BUX46A					100	TO-220
	N						BUT11	BUT11A	BU506;D				20	SOT-186
5	N						BUT11F	BUT11AF					100	SOT-93
	N						BUX11	BUX11A	BU706;D				100	TO-3
	N						BUS11	BUS11A					100	TO-3
	N						BUS21B	BUS21C					70	SOT-93
6	N						BU426	BU426A					70	SOT-93
	N						BU433						60	TO-3
	N						BUX82	BUX83					70	SOT-93
	N						BUV82	BUV83					70	SOT-93
	N												80	TO-3

* V_{CEr}.

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IC A	pol.	collector-emitter voltage (open base) V _{CEO} (V)										P _{tot} W	case			
		160	250	300	350	375	400	450	700	800						
8	N						BUX12	BUX12A							125	SOT-93
	N			BUS22	BUS22A		BUS12	BUS12A						BUV89	125	SOT-93
	N			BUP22	BUP22A		BUS22B	BUS22C							125	TO-3
9	N						BUP22B	BUP22C					BUS08A		125	SOT-93
	N						BUX47	BUX47A							125	TO-3
10	N						BUX80	BUX81							100	TO-3
12	N														160	TO-3
15	N						BUX13	BUX13A							175	SOT-93
	N						BUS13	BUS13A							175	TO-3
	N						BUX48	BUX48A							175	TO-3
30	N						BUP23B	BUP23C							175	SOT-93
	N			BUP23	BUP23A		BUS23B	BUS23C							175	TO-3
	N			BUS23	BUS23A		BUS14	BUS14A							250	TO-3
						BUX98	BUX98A							250	TO-3	

ACCESSORIES

CLIP MOUNTING

envelope	direct mounting		insulated mounting			
	clip		mica	alumina	clip	
TO-126 (SOT-32)	56353		56354		56353	
SOT-82	56353		56354		56353	
TO-220 (SOT-78)	56363		56369 or	56367	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) up to 300 V	56326	M3	56387a	56387b	56326	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	56201j or 56261a 56352		M3 M3

The accessories mentioned can be supplied on request.

See also chapter Mounting Instructions.

SELECTION GUIDE



TO-126
(SOT-32)



SOT-186
(TO-220F)

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*	
BDX44	BDX47		80*	
BF419		6	250	
BF457			160	
BF458			250	
BF459			300	
BD135	BD136	8	45	
BD137	BD138		60	
BD139	BD140		80	
BDW55	BDW56		45	
BDW57	BDW58		60	
BDW59	BDW60		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	400	
BUX87			450	
BD233	BD234	25	45	
BD235	BD236		60	
BD237	BD238		80	
BUX99		28	300	
PH13002			300	
PH13003			400	
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	

* V_{CER}.

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BUX84F		18	400
BUX85F			450
BUT11F		20	400
BUT11AF			450



TO-202
(SOT-128)

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BF583		5 (1, 6)	250
BF585			300
BF587			350
BF869	BF870		250
BF871	BF872		300*
BF591		(1, 3)	170
BF593			210
BF819		6 (1, 2)	250
BF857		6 (2)	160
BF858			250
BF859			300
BD825	BD826	8 (2)	45
BD827	BD828		60
BD829	BD830		80
BD839	BD840	10 (2)	45
BD841	BD842		60
BD843	BD844		80
BD845	BD846		100
BD847	BD848		120
BD849	BD850		140
BD813	BD814	12, 5	45
BD815	BD816		60
BD817	BD818		80

* V_{CER}.
() free air dissipation.

SELECTION GUIDE



TO-220 (SOT-78)

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BD239	BD240	30	45
BD239A	BD240A		60
BD239B	BD240B		80
BD239C	BD240C		100
BD933	BD934		45
BD935	BD936		60
BD937	BD938		80
BD939	BD940		100
BD941	BD942		120
BDT29	BDT30		40
BDT29A	BDT30A		60
BDT29B	BDT30B		80
BDT29C	BDT30C		100
TIP29	TIP30		40
TIP29A	TIP30A	60	
TIP29B	TIP30B	80	
TIP29C	TIP30C	100	
BD241	BD242	40	45
BD241A	BD242A		60
BD241B	BD242B		80
BD241C	BD242C		100
TIP47			250
TIP48			300
TIP49			350
TIP50			400
BD943	BD944		22
BD945	BD946		32
BD947	BD948		45
BD949	BD950		60
BD951	BD952		80
BD953	BD954		100
BD955	BD956	120	
BDT31	BDT32	45	
BDT31A	BDT32A	60	
BDT31B	BDT32B	80	
BDT31C	BDT32C	100	
BUX84		400	
BUX85		450	
TIP31	TIP32	40	
TIP31A	TIP32A	60	
TIP31B	TIP32B	80	
TIP31C	TIP32C	100	

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BDT61	BDT60	50	60
BDT61A	BDT60A		80
BDT61B	BDT60B		100
BDT61C	BDT60C		120
TIP110	TIP115		60
TIP111	TIP116		80
TIP112	TIP117	100	
BD201	BD202	60	45
BD203	BD204		60
BDX77	BDX78		80
BU807			150
BU806			200
BD645	BD646		62,5
BD647	BD648	80	
BD649	BD650	100	
BD651	BD652	120	
BDT21	BDT20	130	
BD243	BD244	65	
BD243A	BD244A		60
BD243B	BD244B		80
BD243C	BD244C		100
BDT41	BDT42		40
BDT41A	BDT42A		60
BDT41B	BDT42B		80
BDT41C	BDT42C		100
TIP41	TIP42		40
TIP41A	TIP42A		60
TIP41B	TIP42B		80
TIP41C	TIP42C		100
TIP120	TIP125		60
TIP121	TIP126		80
TIP122	TIP127	100	
TIP130	TIP135	70	60
TIP131	TIP136		80
TIP132	TIP137		100
PH3055T	PH2955T		75
BDT51	BDT52	90	60
BDT53	BDT54		80
BDT55	BDT56		100
BDT57	BDT58		120
BDT63	BDT62		60
BDT63A	BDT62A		80
BDT63B	BDT62B		100
BDT63C	BDT62C		120
BDT91	BDT92		60
BDT93	BDT94		80
BDT95	BDT96		100

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BUT11		100	400
BUT11A			450
BU506			700
BU506D			700
BDT65	BDT64	125	60
BDT65A	BDT64A		80
BDT65B	BDT64B		100
BDT65C	BDT64C		120
BDT81	BDT82		60
BDT83	BDT84		80
BDT85	BDT86		100
BDT87	BDT88		120



SOT-93
(SOT-93)

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BU426		70	375
BU426A			400
BU433			375
BUV82			400
BUV83			450
BU705			75
TIP33	TIP34	80	40
TIP33A	TIP34A		60
TIP33B	TIP34B		80
TIP33C	TIP34C		100
BDV91	BDV92	100	60
BDV93	BDV94		80
BDV95	BDV96		100
BUW11			400
BUW11A			450
BU706			700
BU706D			700
TIP3055	TIP2955		60

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BDV65	BDV64	125	60
BDV65A	BDV64A		80
BDV65B	BDV64B		100
BDV65C	BDV64C		120
TIP140	TIP145		60
TIP141	TIP146		80
TIP142	TIP147		100
BUP22			300
BUP22A			350
BUP22B			400
BUP22C			450
BUV90			400
BUV90A			400
BUW12			400
BUW12A		450	
BU508A		700	
BU508D		700	
BUV89		800	
BUP23		175	300
BUP23A			350
BUP23B			400
BUP23C			450
BUW13			400
BUW13A			450
BDV67	BDV66		200
BDV67A	BDV66A	80	
BDV67B	BDV66B	100	
BDV67C	BDV66C	120	

SELECTION GUIDE



TO-3
(SOT-3)

type number		P _{tot} W	V _{CEO} V	
NPN	PNP			
BDY90		40	100	
BDY90A			100	
BDY91			80	
BDY92			60	
BUX82			60	400
BUX83			450	
BUY89		80	800	
BUX46		85	400	
BUX46A			450	
BDX63	BDX62	90	60	
BDX91	BDX92		60	
BDX63A	BDX62A		80	
BDX93	BDX94		80	
BDX63B	BDX62B		100	
BDX95	BDX96		100	
BDX63C	BDX62C		120	
BUS11			100	400
BUS11A				450
BUS21				300
BUS21A		350		
BUS21B		400		
BUS21C		450		
BUX80		400		
BUX81		450		
BDX65	BDX64	117		60
BDX65A	BDX64A			80
BDX65B	BDX64B			100
BDX65C	BDX64C			120
BUS12		125		400
BUS12A				450
BUS22				300
BUS22A			350	
BUS22B			400	
BUS22C		450		
BUX47			400	
BUX47A			450	
BDX67	BDX66	150	60	
BDX67A	BDX66A		80	
BDX67B	BDX66B		100	
BDX67C	BDX66C		120	
BU808			700	
BUX88		160	800	

type number		P _{tot} W	V _{CEO} V
NPN	PNP		
BUS13		175	400
BUS13A			450
BUS23			300
BUS23A			350
BUS23B			400
BUS23C			450
BUX48			400
BUX48A			450
BDX69	BDX68		200
BDX69A	BDX68A	80	
BDX69B	BDX68B	100	
BDX69C	BDX68C	120	
BUS14		250	400
BUS14A			450
BUX98			400
BUX98A			450



SOT-82
(SOT-82)

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

TYPE NUMBER SURVEY

TYPE NUMBER SURVEY POWER TRANSISTORS

type number		envelope	P _{tot} W	type number		envelope	P _{tot} W
NPN	PNP			NPN	PNP		
BD131	BD132	TO-126	15	BD651	BD652	TO-220	62, 5
BD135	BD136	TO-126	8	BD675	BD676	TO-126	40
BD137	BD138	TO-126	8	BD677	BD678	TO-126	40
BD139	BD140	TO-126	8	BD679	BD680	TO-126	40
BD201	BD202	TO-220	60	BD681	BD682	TO-126	40
BD203	BD204	TO-220	60	BD683	BD684	TO-126	40
BD226	BD227	TO-126	12, 5	BD813	BD814	TO-202	2
BD228	BD229	TO-126	12, 5	BD815	BD816	TO-202	2
BD230	BD231	TO-126	12, 5	BD817	BD818	TO-202	2
BD233	BD234	TO-126	25	BD825	BD826	TO-202	2
BD235	BD236	TO-126	25	BD827	BD828	TO-202	2
BD237	BD238	TO-126	25	BD829	BD830	TO-202	2
BD239	BD240	TO-220	30	BD839	BD840	TO-202	2
BD239A	BD240A	TO-220	30	BD841	BD842	TO-202	2
BD239B	BD240B	TO-220	30	BD843	BD844	TO-202	2
BD239C	BD240C	TO-220	30	BD845	BD846	TO-202	2
BD241	BD242	TO-220	40	BD847	BD848	TO-202	2
BD241A	BD242A	TO-220	40	BD849	BD850	TO-202	2
BD241B	BD242B	TO-220	40	BD933	BD934	TO-220	30
BD241C	BD242C	TO-220	40	BD835	BD936	TO-220	30
BD243	BD244	TO-220	65	BD937	BD938	TO-220	30
BD243A	BD244A	TO-220	65	BD939	BD940	TO-220	30
BD243B	BD244B	TO-220	65	BD941	BD942	TO-220	30
BD243C	BD244C	TO-220	65	BD943	BD944	TO-220	40
BD329	BD330	TO-126	15	BD945	BD946	TO-220	40
BD331	BD332	SOT-82	60	BD947	BD948	TO-220	40
BD333	BD334	SOT-82	60	BD949	BD950	TO-220	40
BD335	BD336	SOT-82	60	BD951	BD952	TO-220	40
BD337	BD338	SOT-82	60	BD954	BD955	TO-220	40
BD433	BD434	TO-126	36	BD956	BD957	TO-220	40
BD435	BD436	TO-126	36	BDT21	BDT20	TO-220	62, 5
BD437	BD438	TO-126	36	BDT29	BDT30	TO-220	30
BD645	BD646	TO-220	62, 5	BDT29A	BDT30A	TO-220	30
BD647	BD648	TO-220	62, 5	BDT29B	BDT30B	TO-220	30
BD649	BD650	TO-220	62, 5	BDT29C	BDT30C	TO-220	30

TYPE NUMBER SURVEY

type number		envelope	P _{tot} W	type number		envelope	P _{tot} W
NPN	PNP			NPN	PNP		
BDT31	BDT32	TO-220	40	BDV93	BDV94	SOT-93	100
BDT31A	BDT32A	TO-220	40	BDV95	BDV96	SOT-93	100
BDT31B	BDT32B	TO-220	40	BDW55	BDW56	TO-126	8
BDT31C	BDT32C	TO-220	40	BDW57	BDW58	TO-126	8
BDT41	BDT42	TO-220	65	BDW59	BDW60	TO-126	8
BDT41A	BDT42A	TO-220	65	BDX35		TO-126	15
BDT41B	BDT42B	TO-220	65	BDX36		TO-126	15
BDT41C	BDT42C	TO-220	65	BDX37		TO-126	15
BDT51	BDT52	TO-220	90	BDX42	BDX45	TO-126	5
BDT53	BDT54	TO-220	90	BDX43	BDX46	TO-126	5
BDT55	BDT56	TO-220	90	BDX44	BDX47	TO-126	5
BDT57	BDT58	TO-220	90	BDX63	BDX62	TO-3	90
BDT61	BDT60	TO-220	50	BDX63A	BDX62A	TO-3	90
BDT61A	BDT60A	TO-220	50	BDX63B	BDX62B	TO-3	90
BDT61B	BDT60B	TO-220	50	BDX63C	BDX62C	TO-3	90
BDT61C	BDT60C	TO-220	50	BCX65	BDX64	TO-3	117
BDT63	BDT62	TO-220	90	BDX65A	BDX64A	TO-3	117
BDT63A	BDT62A	TO-220	90	BCX65B	BDX64B	TO-3	117
BDT63B	BDT62B	TO-220	90	BDX65C	BDX64C	TO-3	117
BDT63C	BDT62C	TO-220	90	BDX67	BDX66	TO-3	150
BDT65	BDT64	TO-220	125	BDX67A	BDX66A	TO-3	150
BDT65A	BDT64A	TO-220	125	BDX67B	BDX66B	TO-3	150
BDT65B	BDT64B	TO-220	125	BDX67C	BDX66C	TO-3	150
BDT65C	BDT64C	TO-220	125	BDX69	BDX68	TO-3	200
BDT81	BDT82	TO-220	125	BDX69A	BDX68A	TO-3	200
BDT83	BDT84	TO-220	125	BDX69B	BDX68B	TO-3	200
BDT85	BDT86	TO-220	125	BDX69C	BDX68C	TO-3	200
BDT87	BDT88	TO-220	125	BDX77	BDX78	TO-220	60
BDT91	BDT92	TO-220	90	BDX91	BDX92	TO-3	90
BDT93	BDT94	TO-220	90	BDX93	BDX94	TO-3	90
BDT95	BDT96	TO-220	90	BDX95	BDX96	TO-3	90
BDV65	BDV64	SOT-93	125	BDY90		TO-3	40
BDV65A	BDV64A	SOT-93	125	BDY90A		TO-3	40
BDV65B	BDV64B	SOT-93	125	BDY91		TO-3	40
BDV65C	BDV64C	SOT-93	125	BDY92		TO-3	40
BDV67A	BDV66A	SOT-93	175	BF419		TO-126	6
BDV67B	BDV66B	SOT-93	175	BF457		TO-126	6
BDV67C	BDV66C	SOT-93	175	BF458		TO-126	6
BDV67D	BDV66D	SOT-93	175	BF459		TO-126	6
BDV91	BDV92	SOT-93	100	BF469	BF470	TO-126	1, 8

TYPE NUMBER SURVEY

type number		envelope	P _{tot} W	type number		envelope	P _{tot} W
NPN	PNP			NPN	PNP		
BF471	BF472	TO-126	1,8	BUS21A		TO-3	100
BF583		TO-202	1,6	BUS21B		TO-3	100
BF585		TO-202	1,6	BUS21C		TO-3	100
BF587		TO-202	1,6	BUS22		TO-3	125
BF591		TO-202	1,3	BUS22A		TO-3	125
BF593		TO-202	1,3	BUS22B		TO-3	125
BF819		TO-202	6	BUS22C		TO-3	125
BF857		TO-202	6	BUS23		TO-3	175
BF858		TO-202	6	BUS23A		TO-3	175
BF859		TO-202	6	BUS23B		TO-3	175
BF869	BF870	TO-202	5	BUS23C		TO-3	175
BF871	BF872	TO-202	5	BUT11; A		TO-220	100
BU426; A		SOT-93	70	BUT11F		SOT-186	20
BU433		SOT-93	70	BUT11AF		SOT-186	20
BU505		TO-220	75	BUV82; 83		SOT-93	70
BU506		TO-220	100	BUV89		SOT-93A	125
BU506D		TO-220	100	BUV90; A		SOT-93	125
BU508A		SOT-93A	125	BUW11; A		SOT-92	100
BU508D		SOT-93A	125	BUW12; A		SOT-93	125
BU705		SOT-93A	75	BUW13; A		SOT-93	175
BU706		SOT-93A	100	BUW84; 85		SOT-82	50
BU706D		SOT-93A	100	BUX46; A		TO-3	85
BU806		TO-220	60	BUX47; A		TO-3	125
BU807		TO-220	60	BUX48; A		TO-3	175
BU808		TO-3	160	BUX80; 81		TO-3	100
BU824		TO-202	2	BUX82; 83		TO-3	60
BU826		SOT-93	125	BUX84; 85		TO-220	40
BUP22		SOT-93	125	BUX84F		SOT-186	18
BUP22A		SOT-93	125	BUX85F		SOT-186	18
BUP22B		SOT-93	125	BUX86; 87		TO-126	20
BUP22C		SOT-93	125	BUX88		TO-3	160
BUP23		SOT-93	175	BUX90		TO-3	125
BUP23A		SOT-93	175	BUX98; A		TO-3	250
BUP23B		SOT-93	175	BUX99		TO-126	28
BUP23C		SOT-93	175	BUY89		TO-3	80
BUS11; A		TO-3	100	PH3055T	PH2955T	TO-220	75
BUS12; A		TO-3	125	PH13002		TO-126	28
BUS13; A		TO-3	175	PH13003		TO-126	28
BUS14; A		TO-3	250	TIP29	TIP30	TO-220	30
BUS21		TO-3	100	TIP29A	TIP30A	TO-220	30

type number		envelope	P _{tot} W	type number		envelope	P _{tot} W
NPN	PNP			NPN	PNP		
TIP29B	TIP30B	TO-220	30	TIP48		TO-220	40
TIP29C	TIP30C	TO-220	30	TIP49		TO-220	40
TIP31	TIP32	TO-220	40	TIP50		TO-220	40
TIP31A	TIP32A	TO-220	40	TIP110	TIP115	TO-220	50
TIP31B	TIP32B	TO-220	40	TIP111	TIP116	TO-220	50
TIP31C	TIP32C	TO-220	40	TIP112	TIP117	TO-220	50
TIP33	TIP34	SOT-93	80	TIP120	TIP125	TO-220	65
TIP33A	TIP34A	SOT-93	80	TIP121	TIP126	TO-220	65
TIP33B	TIP34B	SOT-93	80	TIP122	TIP127	TO-220	65
TIP33C	TIP34C	SOT-93	80	TIP130	TIP135	TO-220	70
TIP41	TIP42	TO-220	65	TIP131	TIP136	TO-220	70
TIP41A	TIP42A	TO-220	65	TIP132	TIP137	TO-220	70
TIP41B	TIP42B	TO-220	65	TIP140	TIP145	SOT-93	125
TIP41C	TIP42C	TO-220	65	TIP141	TIP146	SOT-93	125
TIP47		TO-220	40	TIP142	TIP147	SOT-93	125
				TIP3055	TIP2955	SOT-93	100

TYPE NUMBER SURVEY ACCESSORIES

type number	description	envelope
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	TO-126
56339	mica washer (500 to 2000 V)	TO-3
56352	insulating mounting support	TO-3
56353	spring clip	TO-126/SOT-82
56354	mica insulator	TO-126/SOT-82
56359b	mica washer (up to 1000 V)	TO-220
56359c	insulating bush (up to 800 V)	TO-220
56359d	rectangular insulating bush (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 (up to 2000 V)	TO-220
56368a	mica insulator (up to 800 V)	SOT-93
56368b	insulating bush (up to 800 V)	SOT-93
56369	mica insulator (up to 2 kV)	TO-220
56378	mica insulator (up to 1500 V)	SOT-93
56379	spring clip	SOT-93
56387a	mica insulator (up to 300 V)	TO-126
56387b	insulating bush (up to 300 V)	TO-126

GENERAL

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:

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

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.

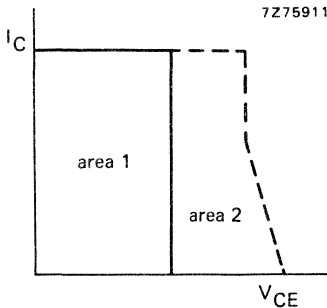


Fig. 1.

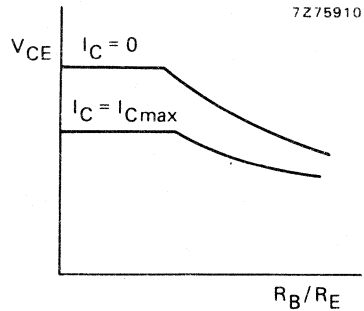


Fig. 2.

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.

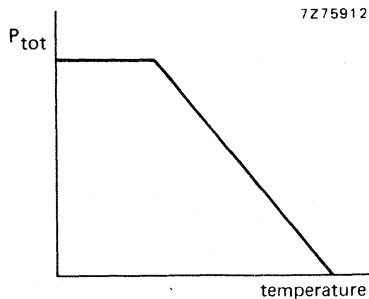


Fig. 3.

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 kelvin per watt (K/W). For mounting base rated devices, the added effect of the contact resistance (R_{th}) 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.

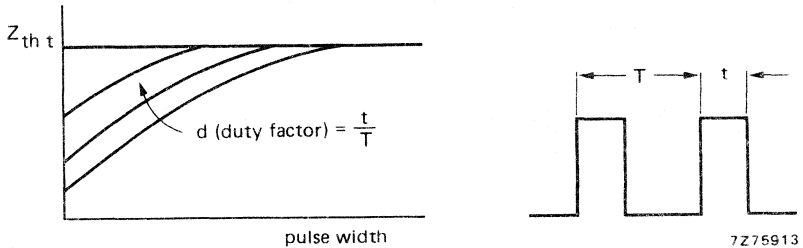


Fig. 4.

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

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

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

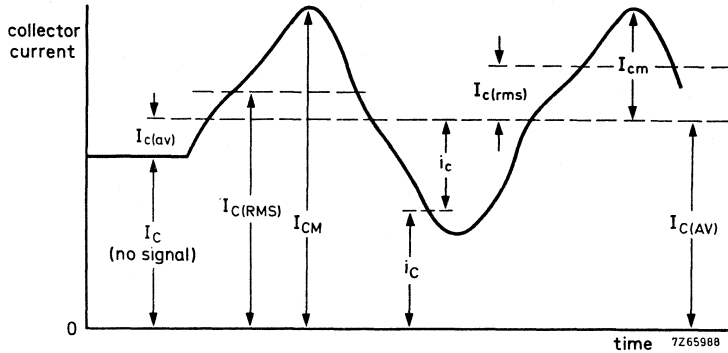
For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

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

Examples: h_i (or h_{11})
 h_o (or h_{22})
 h_f (or h_{21})
 h_r (or h_{12})

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

Examples: h_{fe} (or h_{21e}), h_{FE} (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.

Examples: $Z_i = R_i + jX_i$
 $y_{fe} = g_{fe} + jb_{fe}$

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

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

TRANSISTOR SAFE OPERATING AREA

If a power transistor is to give reliable service, four operating limits must be observed:

- Maximum collector current.
- Maximum collector-emitter voltage.
- Maximum power dissipation.
- Second breakdown limit.

These limits are all specified in the data sheets; the purpose here is to enable designers to make the best use of that information.

Collector current

Maximum collector current I_{Cmax} is specified in the data sheets for d.c. operation. For pulsed operation a higher collector current I_{Cmax} is permitted, for a defined maximum pulse length (max. 20 ms) and duty factor (usually 0,01).

For power switching transistors I_{Csat} is given; this is the value at which switching times and saturation voltage is measured.

Collector-emitter voltage

Maximum collector-emitter voltage V_{CEO} is also specified in the data sheets, but no extension is allowed for pulsed operation. In the case of power transistors specifically designed for switching inductive loads some extension may be allowed, but then only under specified conditions of collector current, base-emitter voltage and emitter-base resistance as stated in the relevant data sheets.

Power dissipation

Maximum power dissipation $P_{tot max}$ is specified in the data sheets for a given mounting base temperature. This is usually 25 °C but may be any, much higher temperature. $P_{tot max}$ applies up to the stated temperature; above it derating must be applied. A power derating curve of the form shown in Fig. 1a and 1b is given in the data sheets. With it, maximum allowable power dissipation can be calculated for any mounting base temperature up to $T_j max$.

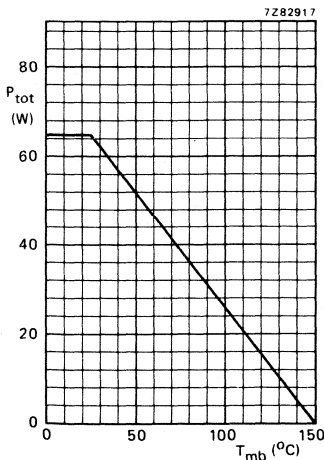
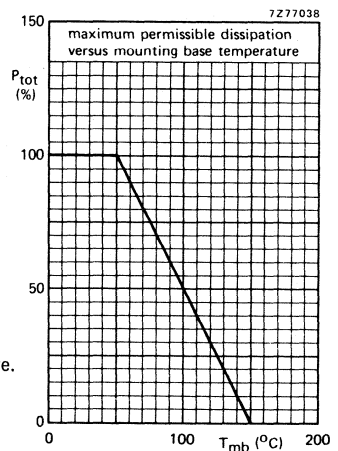


Fig. 1 Power derating curve.

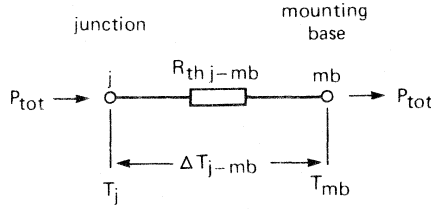


Total power dissipation is given by

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

The second term can usually be disregarded, so $P_{tot} \approx I_C V_{CE}$.

Heat dissipated in the collector-base junction flows through the thermal resistance between junction and mounting base, see Fig. 2.



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Fig. 2 Heat transport in a transistor with power dissipation constant with respect to time.

By analogy with Ohm's law, under steady-state conditions (d.c. operation).

For pulsed operation a higher dissipation is permitted, because

- the junction does not have time to heat up fully unless the pulses are so long as to approximate steady-state conditions;
- the junction has time wholly or partly to cool down in the interval between pulses, except with very high duty factors.

Analogy with

$$P_{tot} = \frac{T_j - T_{mb}}{R_{th\ j-mb}}$$

yields

$$P_{tot\ M} = \frac{T_j - T_{mb}}{Z_{th\ j-mb}}$$

where $P_{tot\ M}$ is the total pulsed power and $Z_{th\ j-mb}$ is the thermal impedance between junction and mounting base. Thermal impedance depends on pulse duration t_p and duty factor $\delta = t_p/T$. T is the pulse period. A family of curves of thermal impedance against pulse duration with duty factor as parameter is shown in Fig. 3.

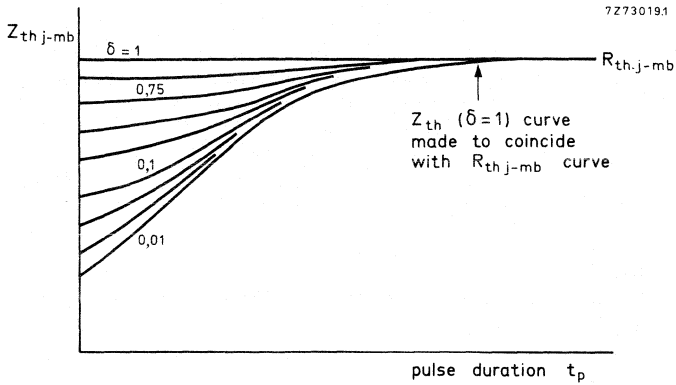


Fig. 3 A typical family of $Z_{th\ j-mb}$ curves for a power transistor.

In essence, at or below $T_{mb\ spec}$ there is a fixed limit to $P_{tot\ M\ max}$; above $T_{mb\ spec}$, $P_{tot\ M\ max}$ declines linearly with increasing mounting base temperature. As illustrated in Fig. 4, for non-rectangular pulses

$$P_{tot\ max} \cdot t_p = \int_{t_1}^{t_2} P \cdot t_p$$

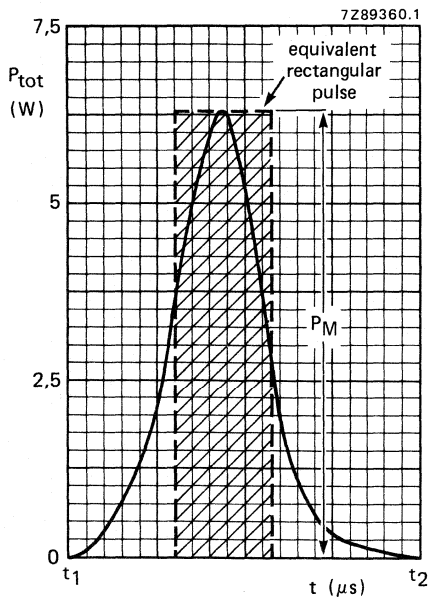


Fig. 4.

Second breakdown

In the forward-biased condition second breakdown is thermally triggered. Consider the chip as a large number of elemental transistors in parallel, some of which will have a lower forward voltage drop than others. Current will tend to concentrate in these, raising their temperature and further lowering their forward voltage drop. Current will concentrate still further, leading to local overheating and eventually to a short circuit between emitter and collector. This effect is dependent of mounting base temperature, which is related to the average junction temperature. Under reverse-bias conditions, when V_{CE} is greater than V_{CE0max} , the chance of second breakdown is always present. This is a particular hazard in timebase and converter applications.

THE SOAR BOUNDARIES

The four limits just described form the boundaries of the Safe Operating Area. Figure 5 shows a SOAR plotted on a log-log grid. The right-hand boundary is formed by V_{CE0max} , which extends up to a collector current of about 300 mA. Above this point, as I_C is increased V_{CE} must be reduced to prevent second breakdown.

The upper boundary is formed by I_{Cmax} , which extends to where the product of I_{Cmax} and V_{CE} equals the maximum allowable power dissipation. From this point I_C must be reduced with increasing V_{CE} , thus forming the maximum power dissipation boundary. The maximum power dissipation boundary normally intersects the second breakdown boundary at some point. However, for values of T_{mb} above $T_{mb spec}$, $P_{tot max}$ must be reduced (as shown by the broken line in Fig. 5), so that the boundary of maximum power dissipation intersects the second breakdown boundary at a lower point. With high values of T_{mb} , the second breakdown boundary may be excluded altogether.

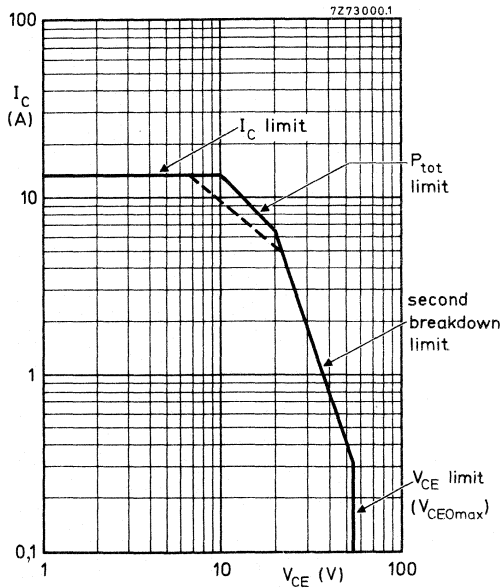


Fig. 5 A typical SOAR graph with boundaries named.

EXTENDING THE SOAR FOR SINGLE-SHOT AND REPETITIVE PULSED OPERATION

The data sheets for power transistors contain, apart from the d.c. SOAR, a set of curves that apply under specific pulse conditions. These will cover some 90% of applications. In addition to these, SOAR curves can be constructed by the circuit designer for specific operating conditions. The various extensions dealt with below will refer to Figs 5, 6 and 7.

I_{CMmax}

The extent to which the I_C boundary can be extended for pulse operation depends on pulse duration and duty factor, the limit being I_{CMmax} , which applies at a duty factor of 0,01 and a pulse length of 20 ms or less. Together the I_{CMmax} and V_{CE0max} boundaries form a rectangle that in no circumstance should be exceeded. Moreover, the rectangle may be reduced by further restrictions imposed by power dissipation and second breakdown. The example shown in Fig. 6 is for an I_{CMmax} of 12 A and a V_{CE0max} of 60 V.

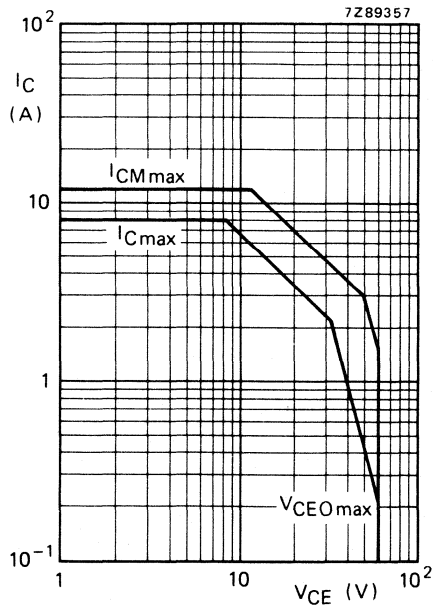


Fig. 6 Maximum collector current and collector-emitter voltage boundaries.

P_{tot max}

The P_{tot max} boundary given in the data sheet usually applies to:

$$T_{mb} = 25 \text{ }^\circ\text{C}; \delta = 0,01 \text{ and } t_p = \text{a range of values, say, } 5 \text{ } \mu\text{s to } 2 \text{ ms.}$$

For any deviations from these values a new P_{tot max} boundary must be constructed.

From

$$P_{\text{tot Mmax}} = \frac{T_{j \text{ max}} - T_{mb}}{Z_{th \text{ j-mb}}};$$

T_{j max} is stated in the data sheets; Z_{th j-mb} can be read from the curve, similar to Fig. 3, also given in the data sheets. Thus P_{tot Mmax} can be calculated and an appropriate boundary can be drawn in the SOAR curve parallel to the P_{tot max} line. An example will illustrate this. Assume:

$$T_{j \text{ max}} = 150 \text{ }^\circ\text{C}; T_{mb} = 80 \text{ }^\circ\text{C}; t_p = 0,2 \text{ ms and } \delta = 0,1.$$

From Fig. 7, Z_{th j-mb} = 0,5 K/W for the given values of t_p and δ.

$$P_{\text{tot Mmax}} = \frac{150 - 80}{0,5} = 140 \text{ W.}$$

Thus from an arbitrary point (say 7 A, 20 V) we can draw a line parallel to the P_{tot max} line (see Fig. 6).

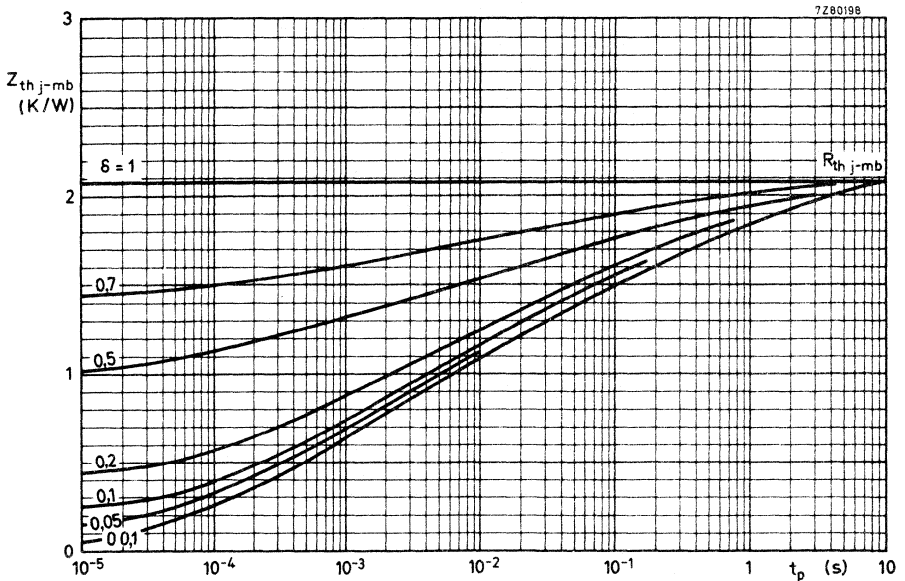


Fig. 7 Transient thermal impedance for example.

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

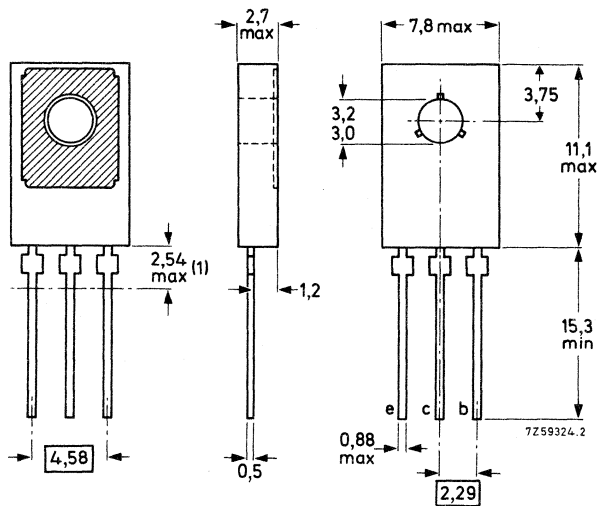
Collector-base voltage (open emitter)	V_{CBO}	max.	70 V
Collector-emitter voltage (open base)	V_{CEO}	max.	45 V
Collector current (peak value)	I_{CM}	max.	6 A
Total power dissipation up to $T_{mb} = 60\text{ }^{\circ}\text{C}$	P_{tot}	max.	15 W
Junction temperature	T_j	max.	150 $^{\circ}\text{C}$
D.C. 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 K/W
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CHARACTERISTICS

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

Collector cut-off current

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

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

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

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

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

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

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

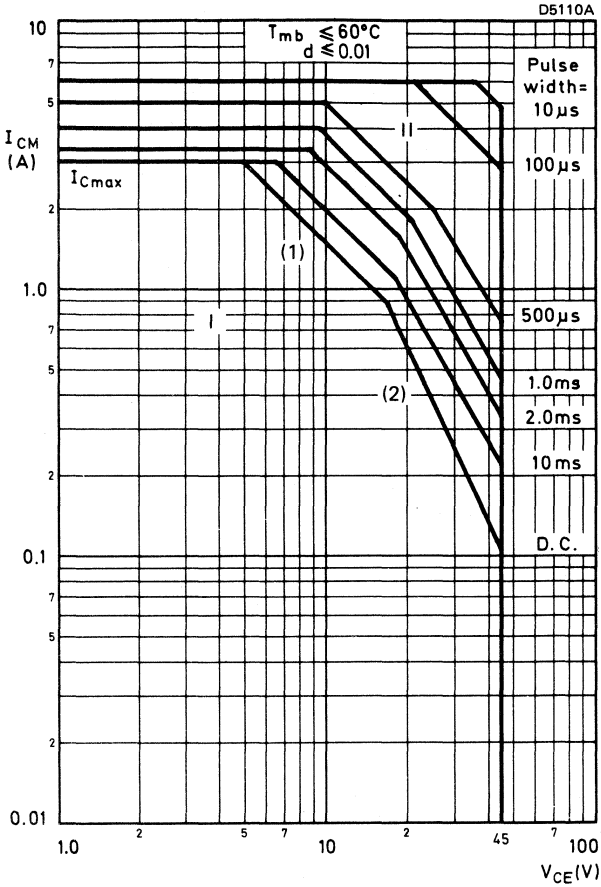


Fig. 2 Safe Operating Area with the transistor forward biased.

- 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).

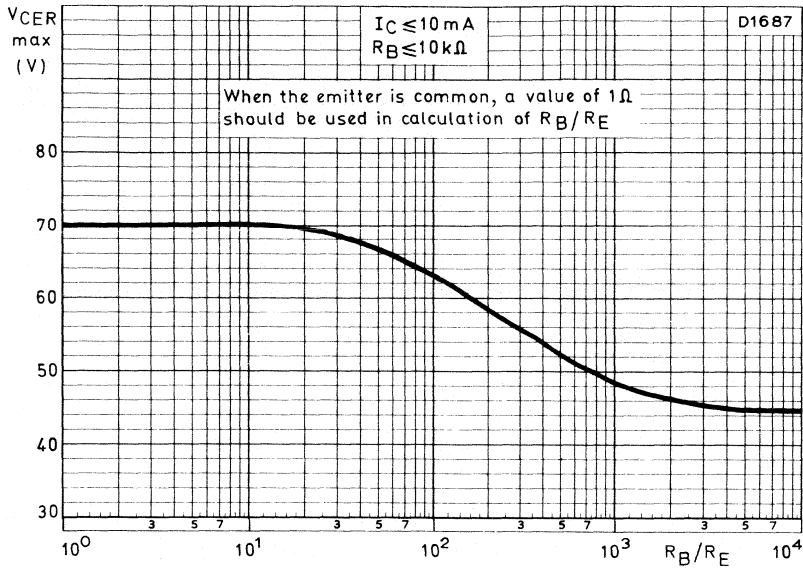


Fig. 3 Maximum allowable collector-emitter voltage as a function of base-emitter resistance.

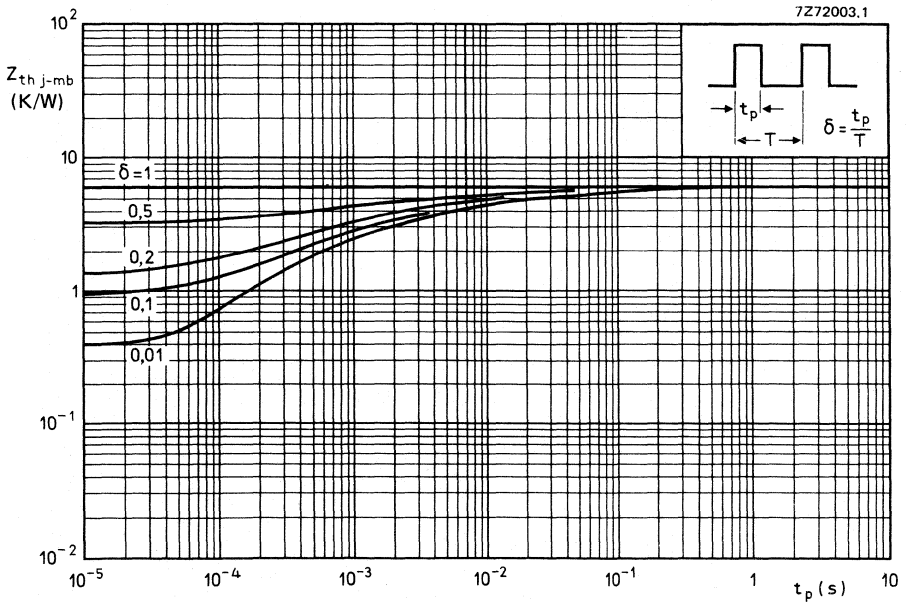


Fig. 4 Pulse power rating chart.

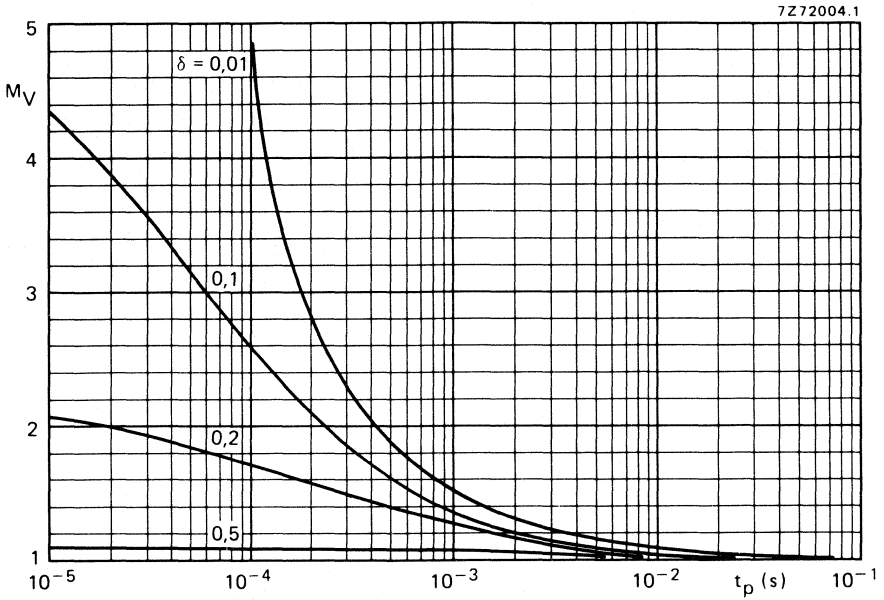


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

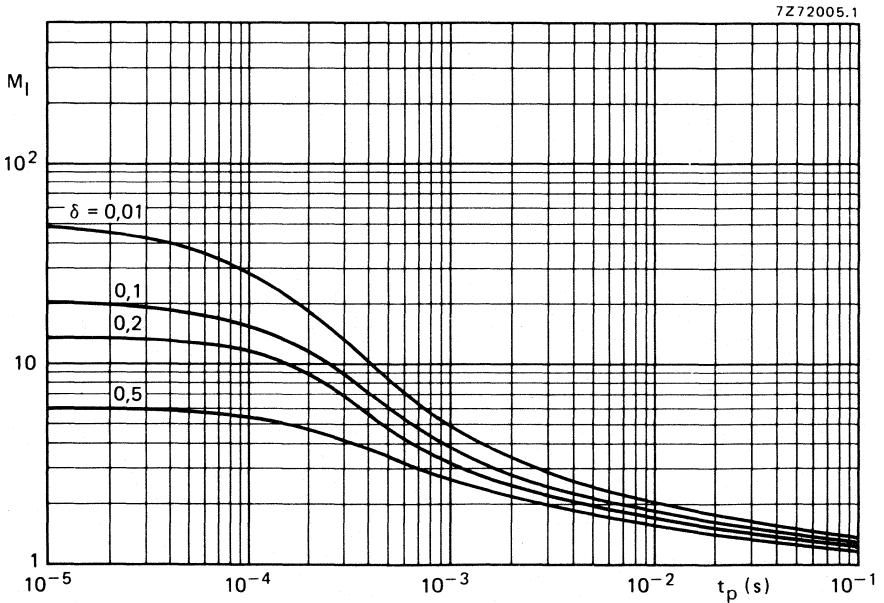


Fig. 6 S.B. current multiplying factor at the V_{CE0max} level.

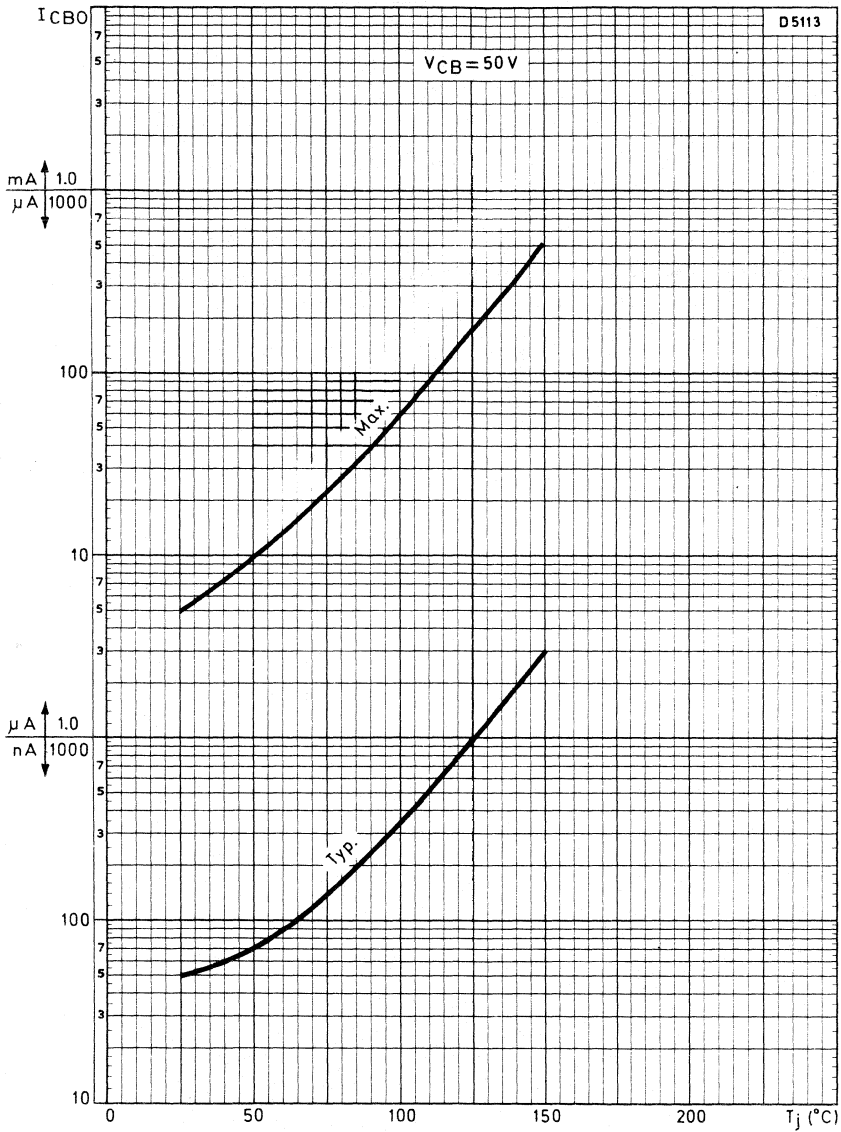


Fig. 7 Collector-base current (open emitter) as a function of the junction temperature.

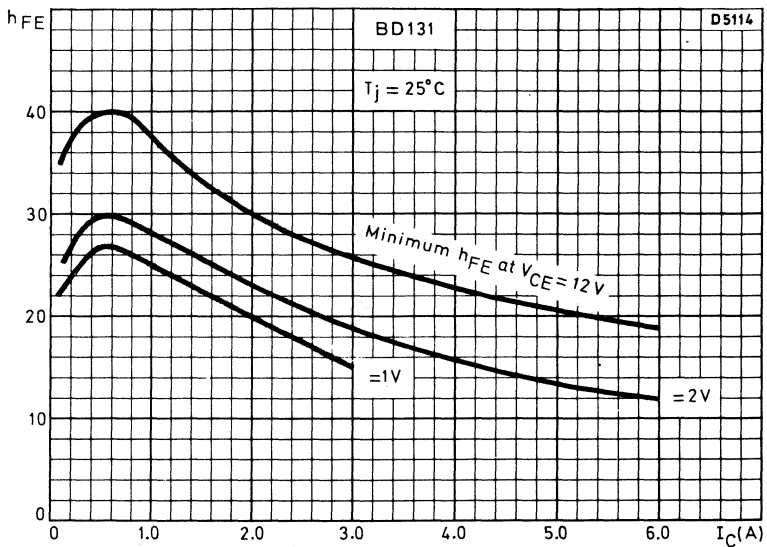


Fig. 8.

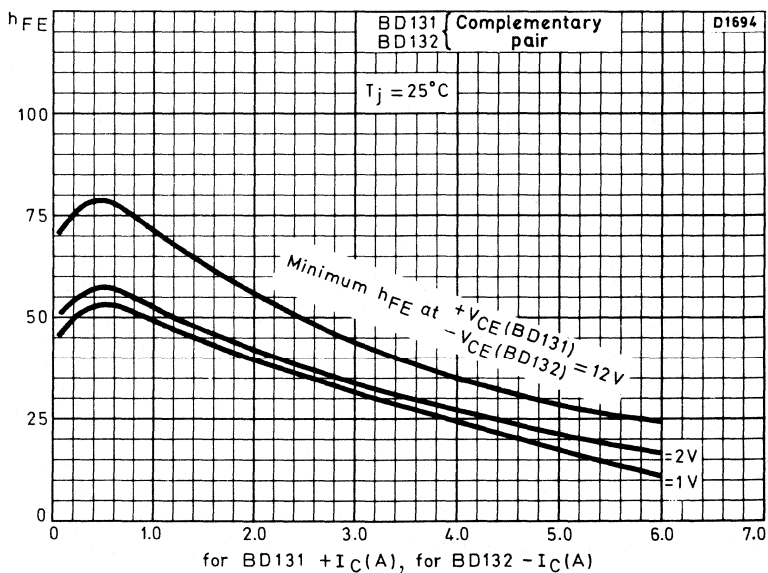


Fig. 9.

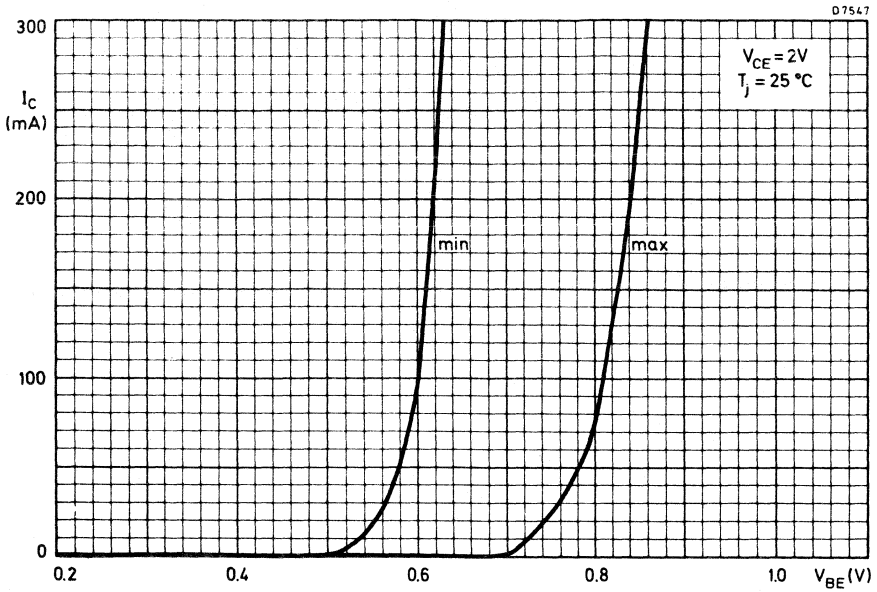


Fig. 10.

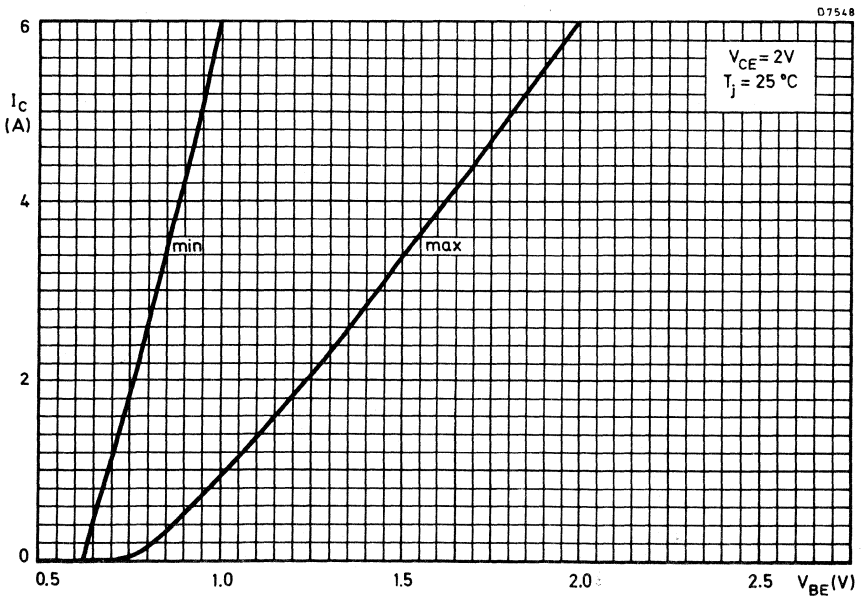


Fig. 11.

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

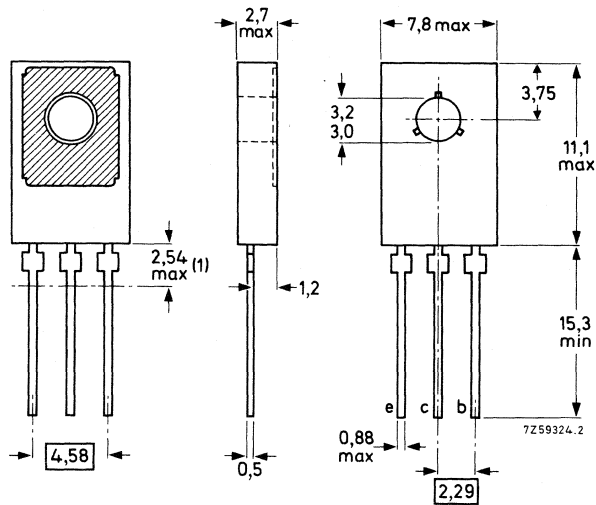
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	45 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	45 V
Collector current (peak value)	$-I_{CM}$ max.	6 A
Total power dissipation up to $T_{mb} = 60\text{ }^{\circ}\text{C}$	P_{tot} max.	15 W
Junction temperature	T_j max.	150 $^{\circ}\text{C}$
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 K/W
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CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified

Collector cut-off current

$$I_E = 0; -V_{CB} = 40\text{ V} \quad -I_{CBO} < 5\text{ }\mu\text{A}$$

$$I_E = 0; -V_{CB} = 40\text{ V}; T_j = 150\text{ }^\circ\text{C} \quad -I_{CBO} < 500\text{ }\mu\text{A}$$

Emitter cut-off current

$$I_C = 0; -V_{EB} = 3\text{ V} \quad -I_{EBO} < 5\text{ }\mu\text{A}$$

Saturation voltages

$$-I_C = 0,5\text{ A}; -I_B = 50\text{ mA} \quad -V_{CEsat} < 0,3\text{ V}$$

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

$$-I_C = 2\text{ A}; -I_B = 200\text{ mA} \quad -V_{CEsat} < 0,7\text{ V}$$

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

D.C. current gain

$$-I_C = 0,5\text{ A}; -V_{CE} = 12\text{ V} \quad h_{FE} > 40$$

$$-I_C = 2\text{ A}; -V_{CE} = 1\text{ V} \quad h_{FE} > 20$$

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

$$-I_C = 0,25\text{ A}; -V_{CE} = 5\text{ V}; T_{amb} = 25\text{ }^\circ\text{C} \quad f_T > 60\text{ MHz}$$

D.C. current gain ratio

$$\text{of the complementary pairs} \\ -I_C = 500\text{ mA}; -V_{CE} = 12\text{ V} \quad h_{FE1}/h_{FE2} < 1,2$$

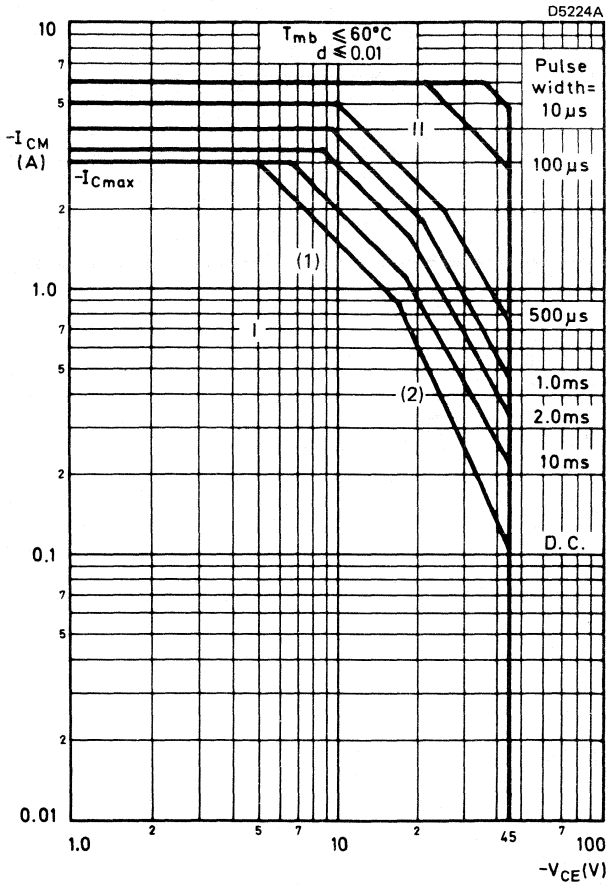


Fig. 2 Safe Operating Area with the transistor forward biased.

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).

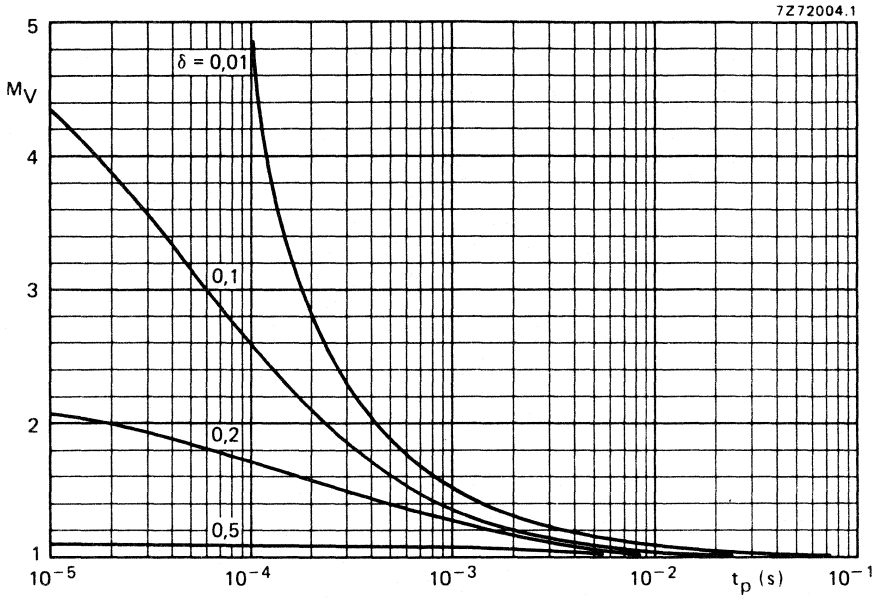


Fig. 3 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

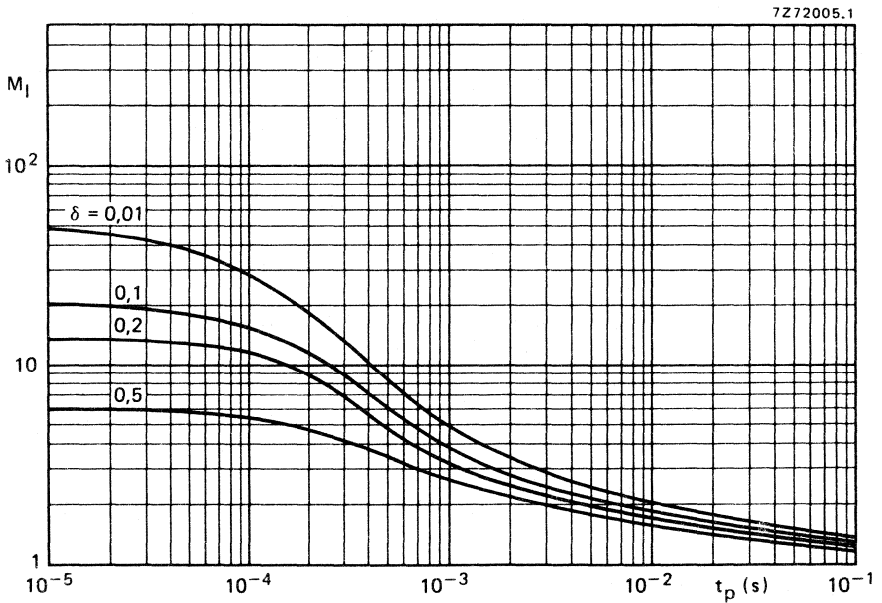


Fig. 4 S.B. current multiplying factor at the $-V_{CEOmax}$ level.

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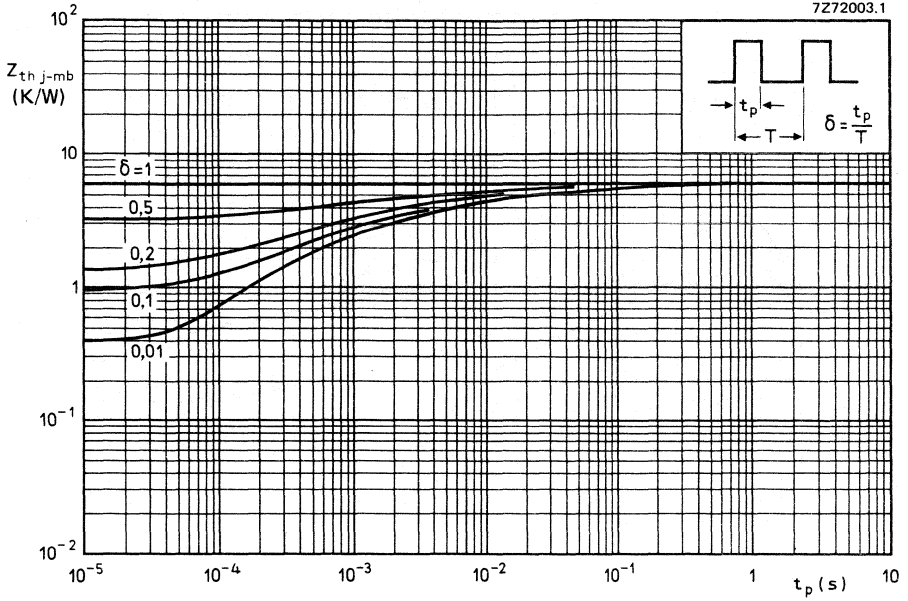


Fig. 5 Pulse power rating chart.

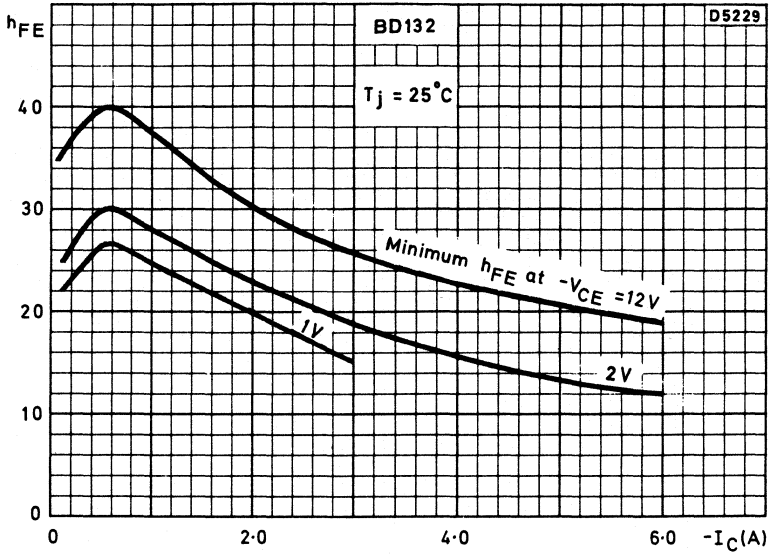


Fig. 6 D.C. current gain.

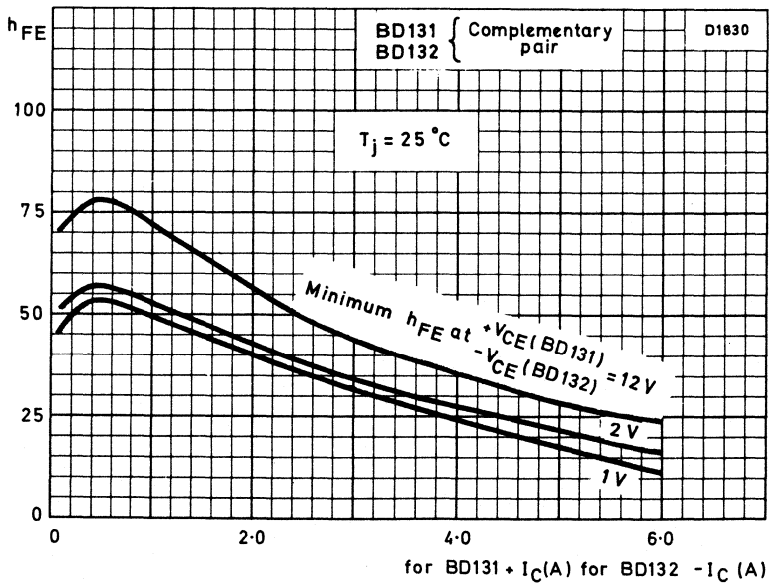


Fig. 7 D.C. current gain ratio.

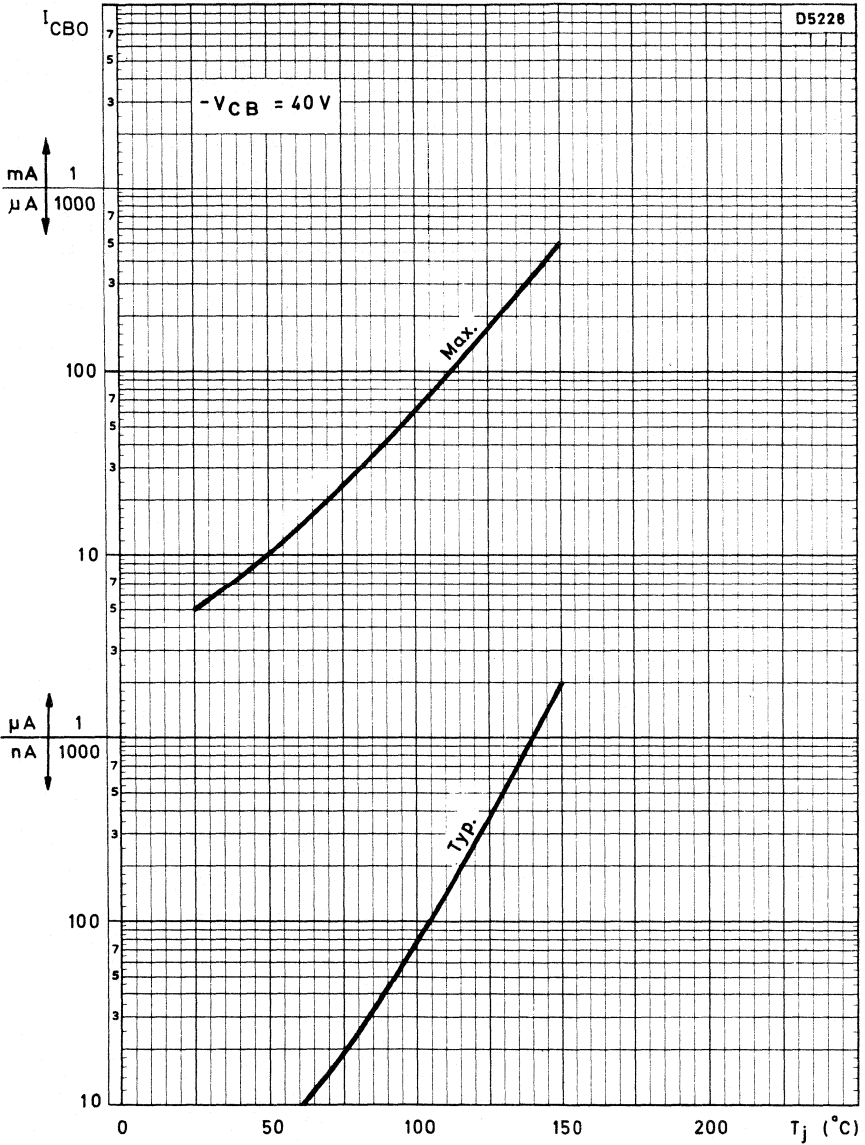


Fig. 8 Collector-base current (open emitter) as a function of the junction temperature.

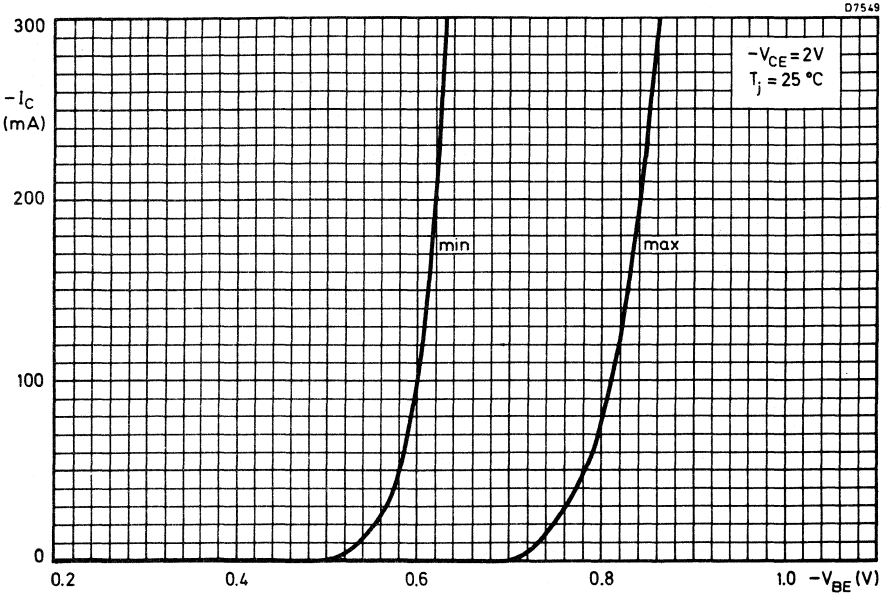


Fig. 9.

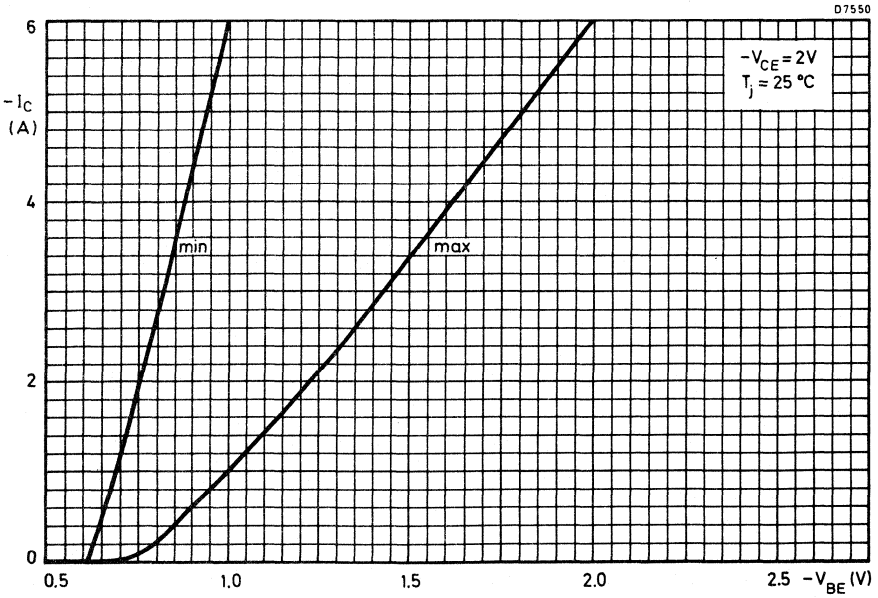


Fig. 10.

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

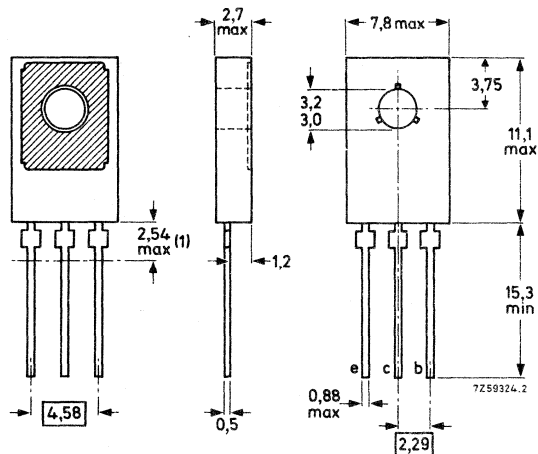
		BD135	BD137	BD139
Collector-base voltage (open emitter)	V_{CB0}	max. 45	60	100 V
Collector-emitter voltage (open base)	V_{CEO}	max. 45	60	80 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	V_{CER}	max. 45	60	100 V
Collector current (peak value)	I_{CM}	max. 2,0	2,0	2,0 A
Total power dissipation 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 $I_C = 150 \text{ mA}; V_{CE} = 2 \text{ V}$	h_{FE}	$>$ 40	40	40
		$<$ 250	250	250
Transition frequency $I_C = 50 \text{ mA}; V_{CE} = 5 \text{ V}$	f_T	typ. 250	250	250 MHz

MECHANICAL DATA

Dimensions in mm

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

Collector connected to metal part of 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)

		BD135	BD137	BD139
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 kΩ)	V _{CER} max.	45	60	100 V
Emitter-base voltage (open collector)	V _{EBO} max.	5	5	5 V
→ Collector current (d.c.)	I _C max.	1,5	1,5	1,5 A
→ Collector current (peak value)	I _{CM} max.	2,0	2,0	2,0 A
Total power dissipation up to T _{mb} = 70 °C	P _{tot} max.	8		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	K/W
From junction to mounting base	R _{th j-mb}	10	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current

I _E = 0; V _{CB} = 30 V	I _{CBO}	<	100 nA
I _E = 0; V _{CB} = 30 V; T _j = 125 °C	I _{CBO}	<	10 μA

Emitter cut-off current

I _C = 0; V _{EB} = 5 V	I _{EBO}	<	10 μA
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Base-emitter voltage

I _C = 500 mA; V _{CE} = 2 V	V _{BE}	<	1 V
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Saturation voltage

I _C = 500 mA; I _B = 50 mA	V _{CEsat}	<	0,5 V
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D.C. current gain

I _C = 5 mA; V _{CE} = 2 V	h _{FE}	>	25
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I_C = 150 mA; V_{CE} = 2 V

BDxxx	h _{FE}	40 to 250
-------	-----------------	-----------

BDxxx-6	h _{FE}	40 to 100
---------	-----------------	-----------

BDxxx-10	h _{FE}	63 to 160
----------	-----------------	-----------

BDxxx-16	h _{FE}	100 to 250
----------	-----------------	------------

I _C = 500 mA; V _{CE} = 2 V	h _{FE}	>	25
--	-----------------	---	----

Transition frequency at f = 35 MHz

I _C = 50 mA; V _{CE} = 5 V	f _T	typ.	250 MHz
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D.C. current gain ratio of matched pairs

BD135/BD136; BD137/BD138; BD139/BD140

I _C = 150 mA; V _{CE} = 2 V	h _{FE1} /h _{FE2}	typ. <	1,3 1,6
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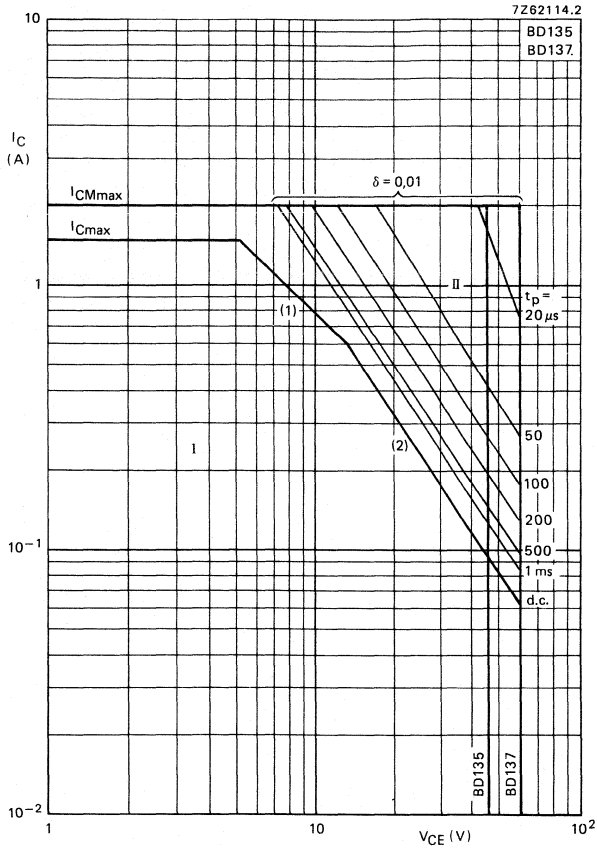


Fig. 2 Safe Operating Area with the transistor forward biased.

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

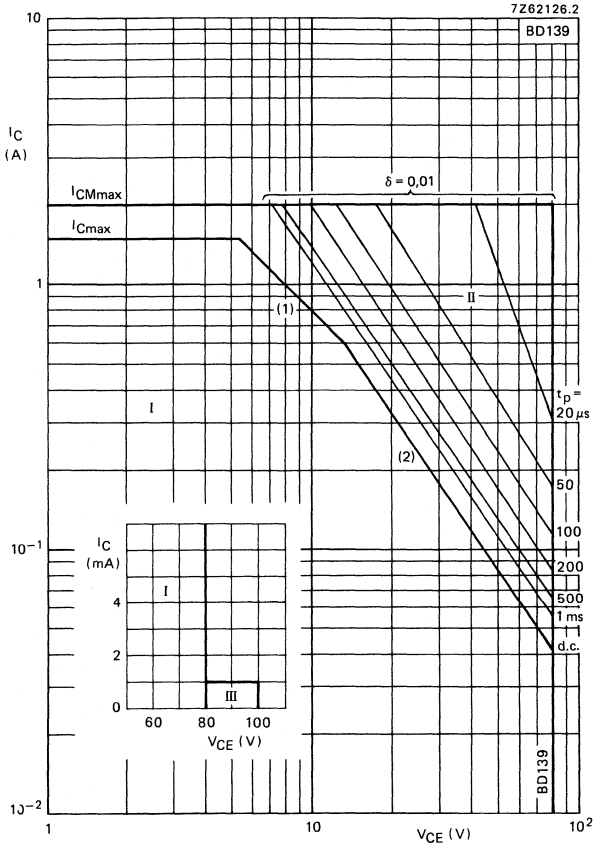


Fig. 3 Safe Operating Area with the transistor forward biased.

- 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) P_{tot} max line
- (2) Second breakdown limit (independent of temperature)

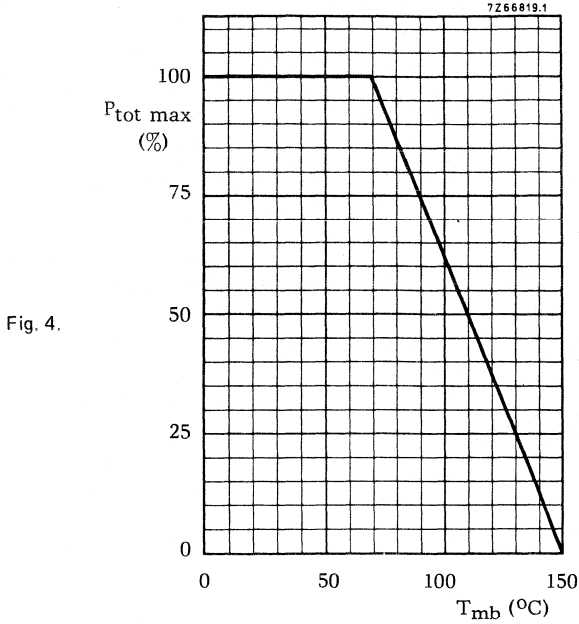


Fig. 4.

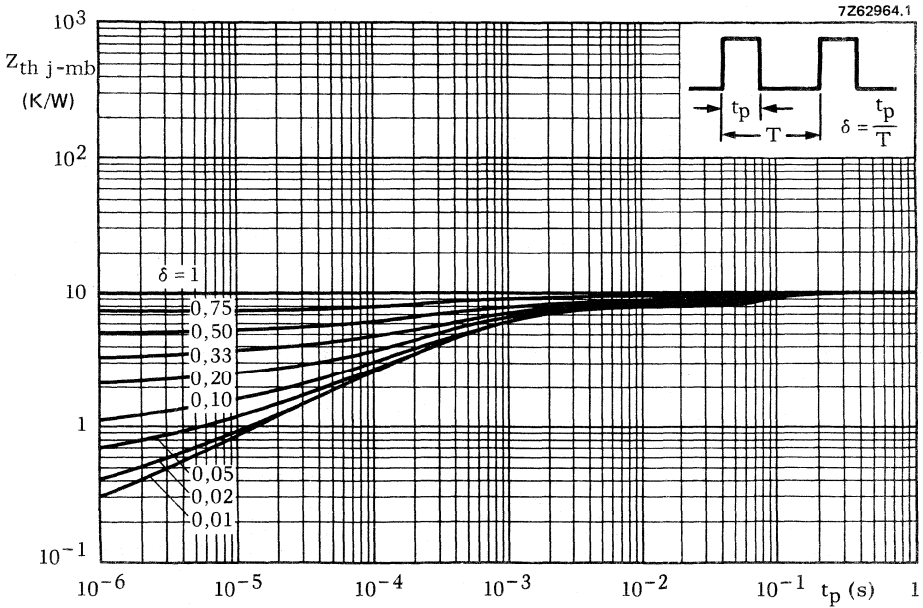


Fig. 5.

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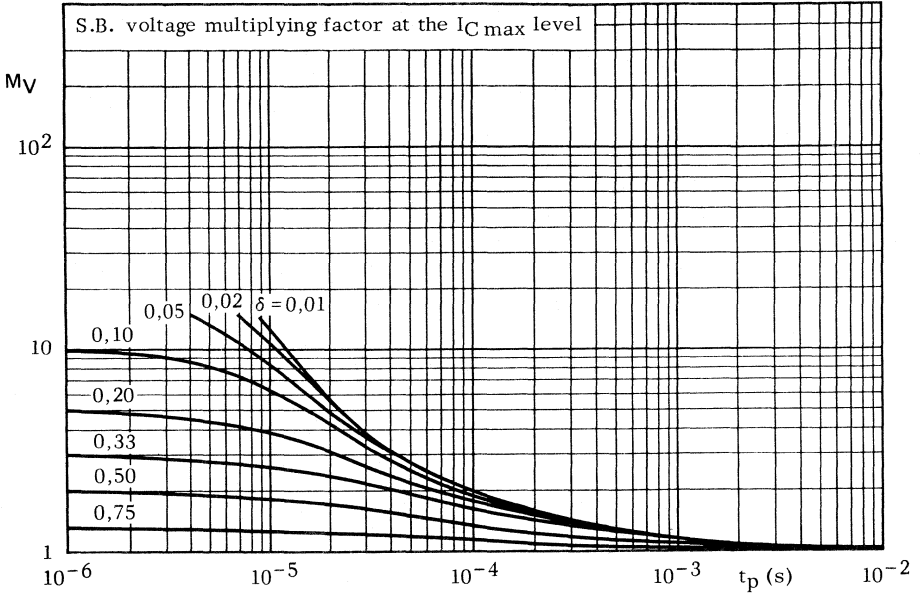


Fig. 6.

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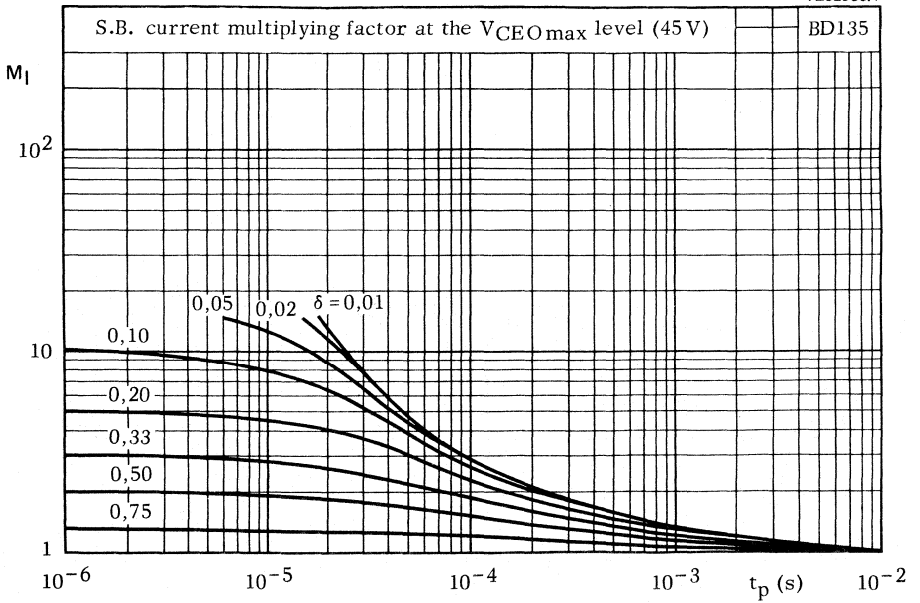
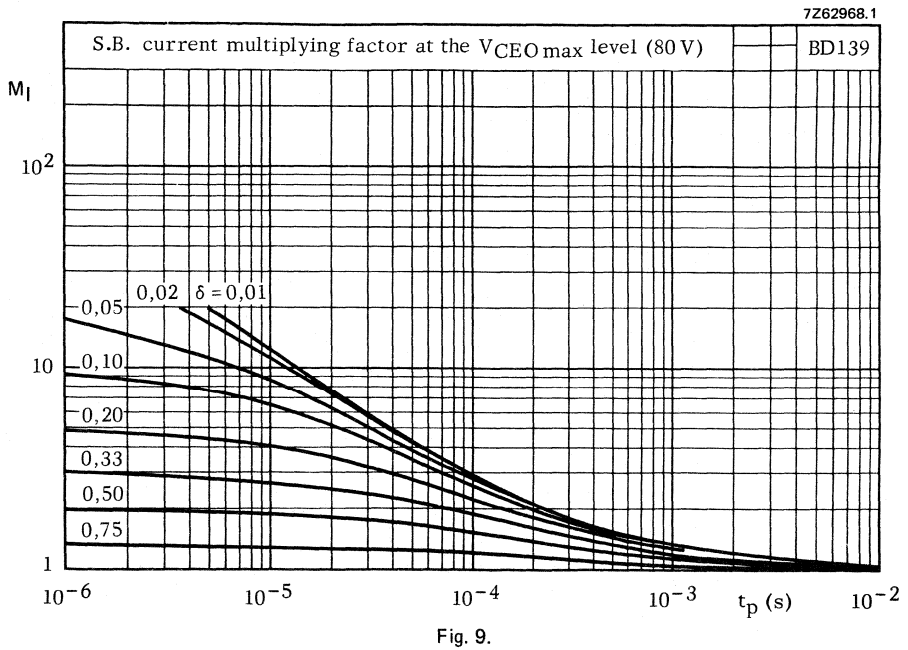
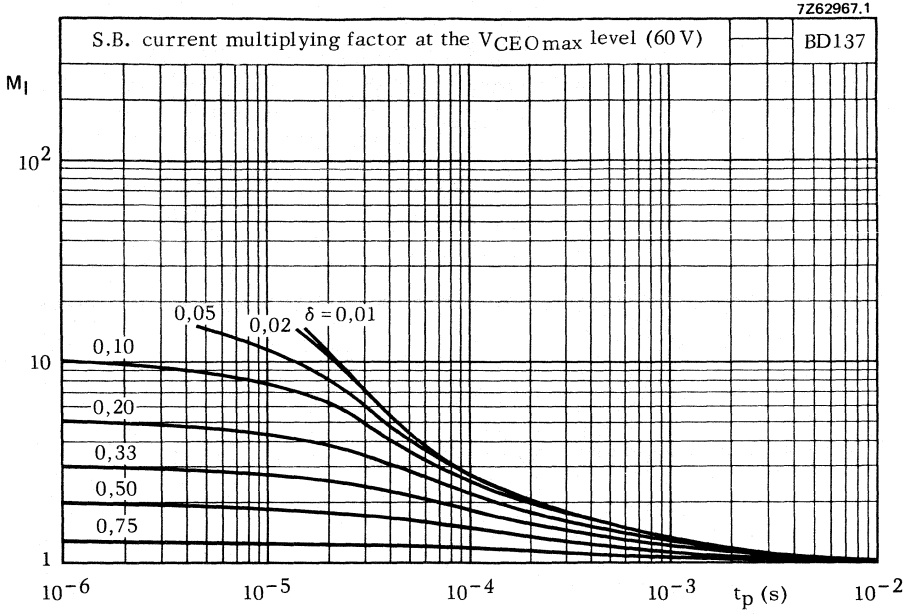


Fig. 7.



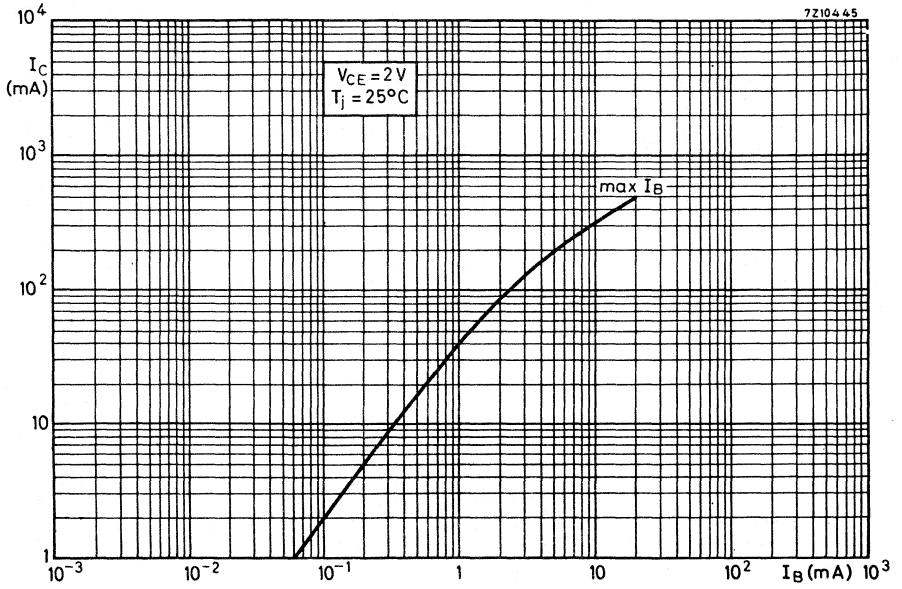


Fig. 10.

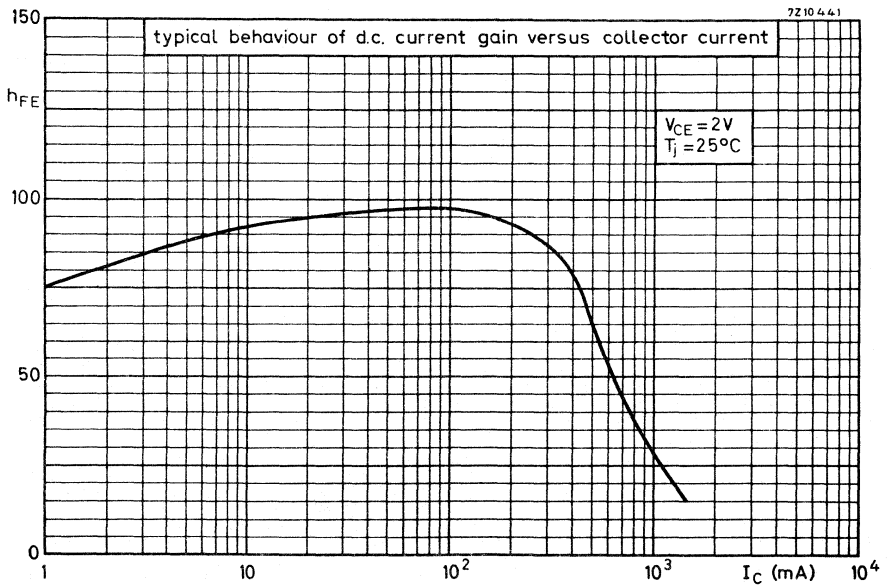


Fig. 11.

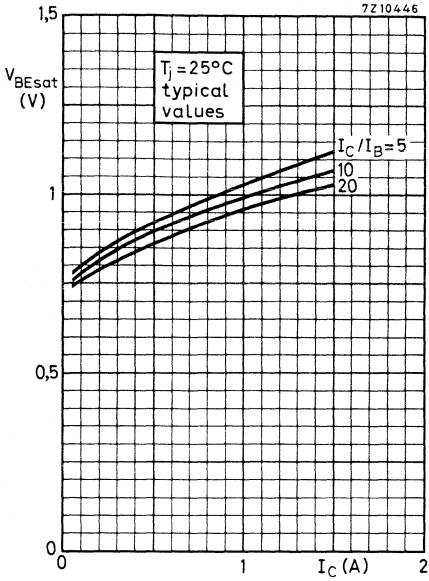


Fig. 12.

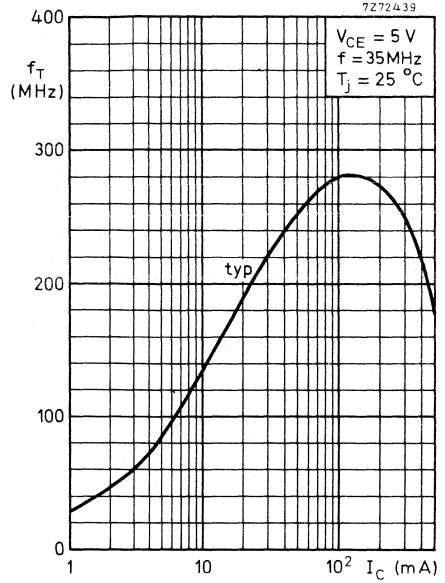


Fig. 13.

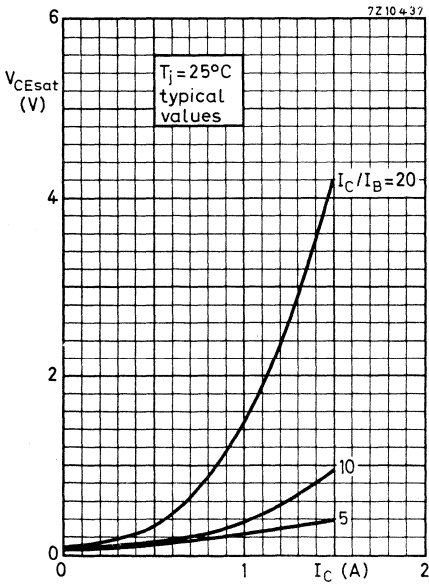


Fig. 14.

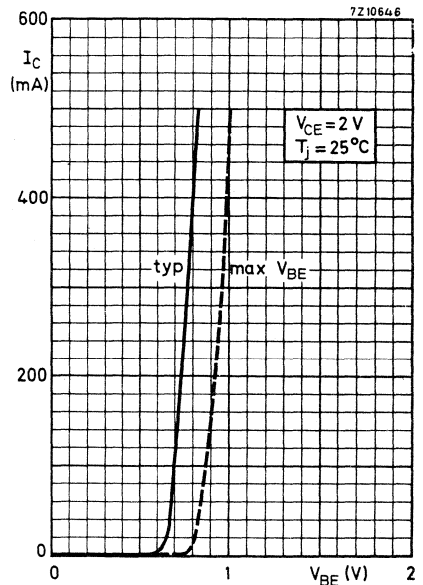


Fig. 15.

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

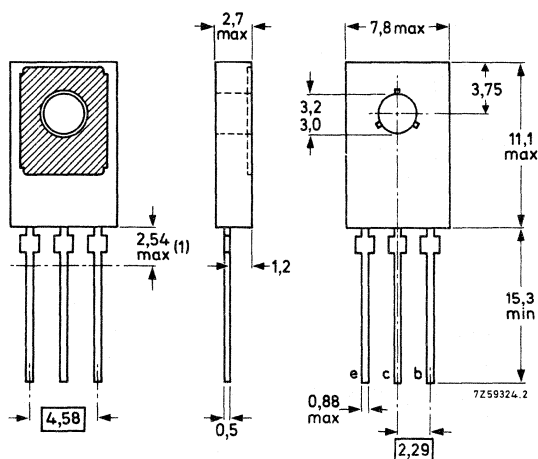
			BD136	BD138	BD140
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	$-V_{CER}$	max.	45	60	100 V
Collector current (peak value)	$-I_{CM}$	max.	2,0	2,0	2,0 A
Total power 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					
$-I_C = 150 \text{ mA}; -V_{CE} = 2 \text{ V}$	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

Dimensions in mm

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

Collector connected to metal part of 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)

		BD136	BD138	BD140
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)	$-V_{EBO}$ max.	5	5	5 V
→ Collector current (d.c.)	$-I_C$ max.	1,5	1,5	1,5 A
→ Collector current (peak value)	$-I_{CM}$ max.	2,0	2,0	2,0 A
Total power dissipation up to $T_{mb} = 70 \text{ }^\circ\text{C}$	P_{tot} max.		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 ambient in free air	$R_{th \text{ j-a}}$	100	K/W
From junction to mounting base	$R_{th \text{ j-mb}}$	10	K/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

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

$h_{FE} > 25$

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

BDxxx

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

BDxxx-06

$h_{FE} \text{ 40 to 100}$

BDxxx-10

$h_{FE} \text{ 63 to 160}$

BDxxx-16

$h_{FE} \text{ 100 to 250}$

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

$h_{FE} > 25$

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

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

$f_T \text{ typ. 75 MHz}$

D.C. current gain ratio of matched pairs

BD135/BD136; BD137/BD138; BD139/BD140

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

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

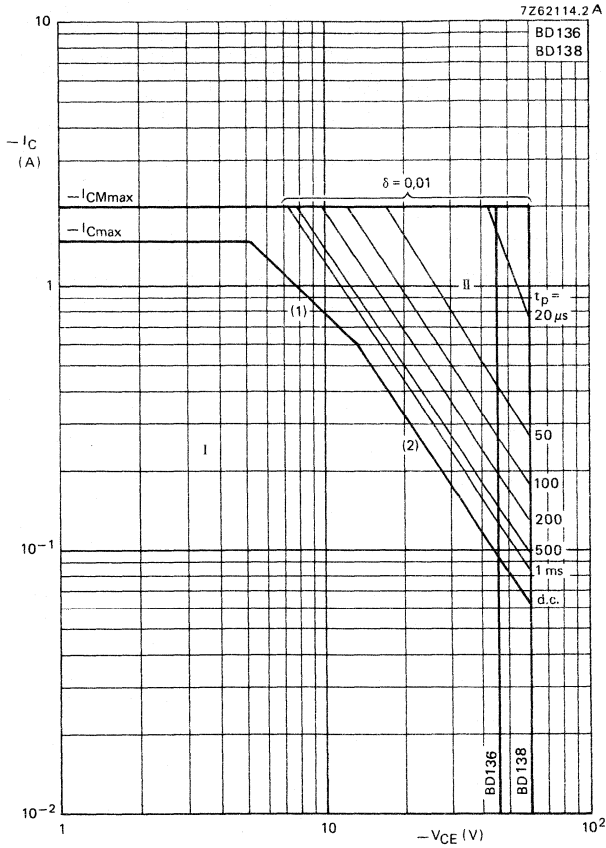


Fig. 2 Safe Operating Area with the transistor forward biased.

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

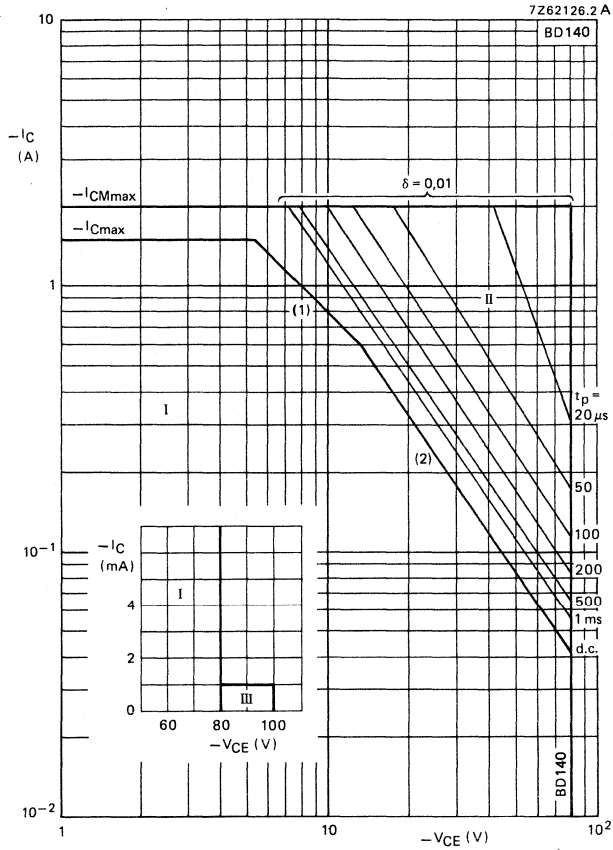
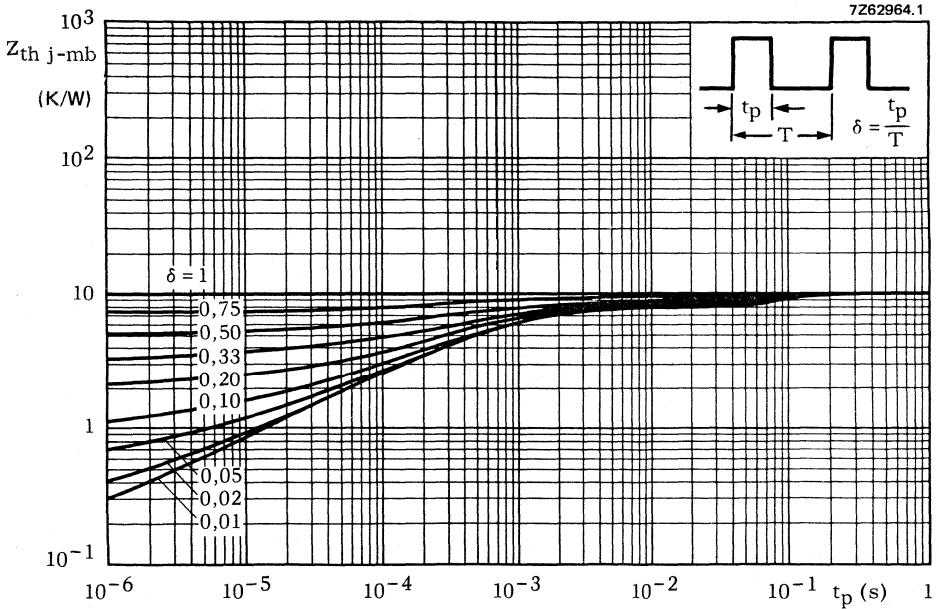
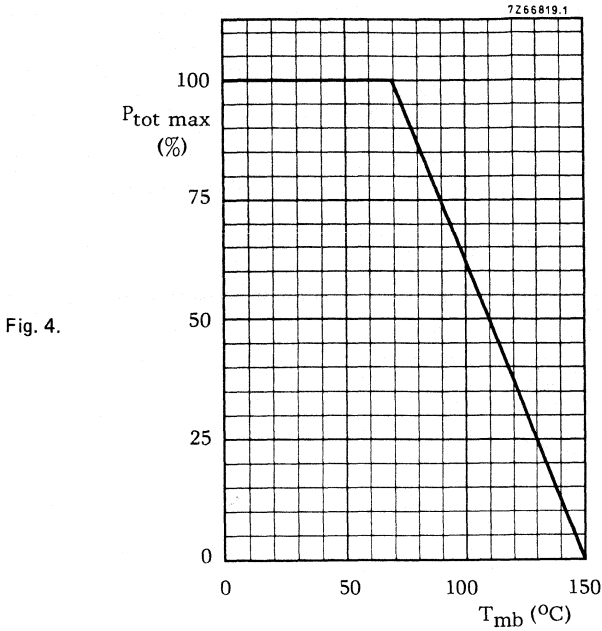


Fig. 3 Safe Operating Area with the transistor forward biased.

- 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) P_{tot} max line
(2) Second breakdown limit (independent of temperature)



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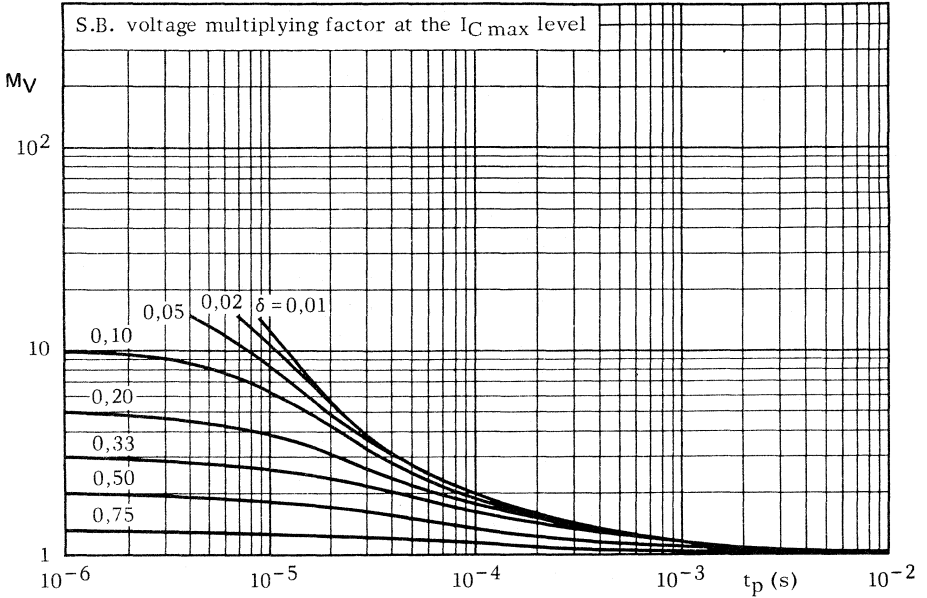


Fig. 6.

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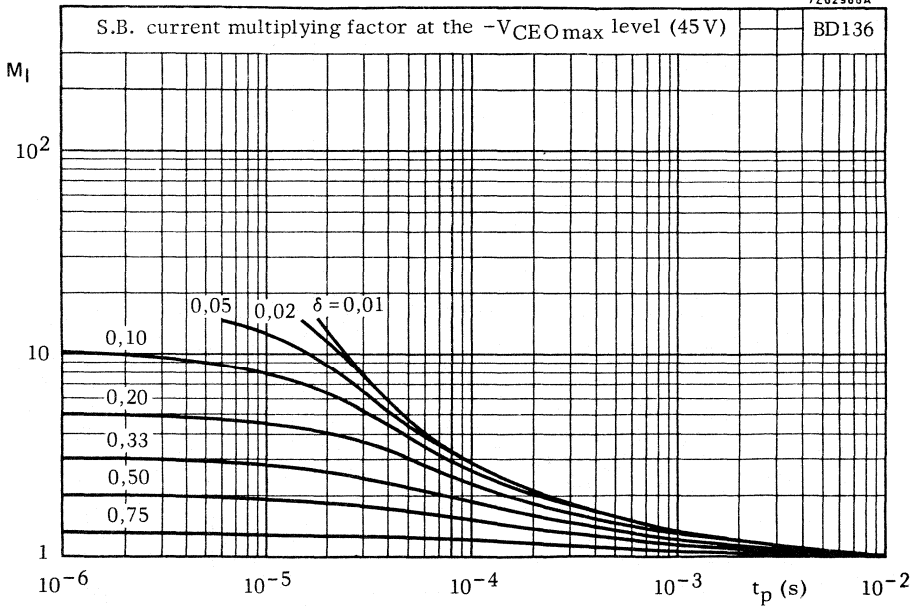
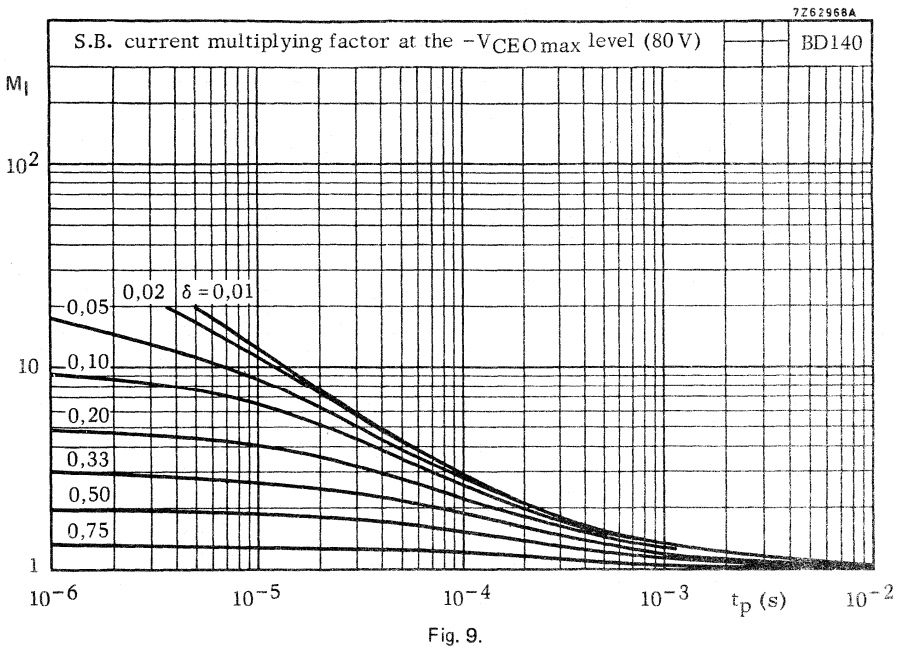
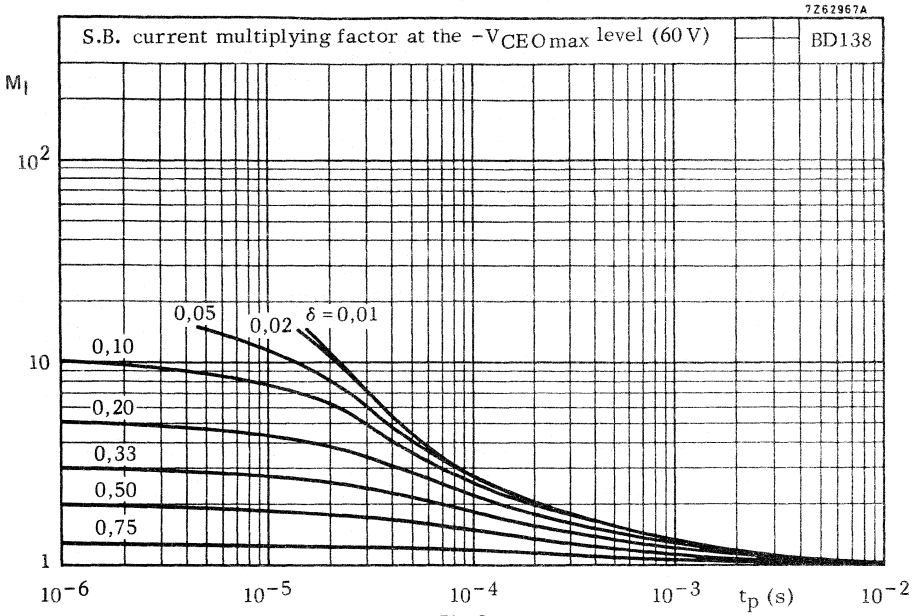


Fig. 7.



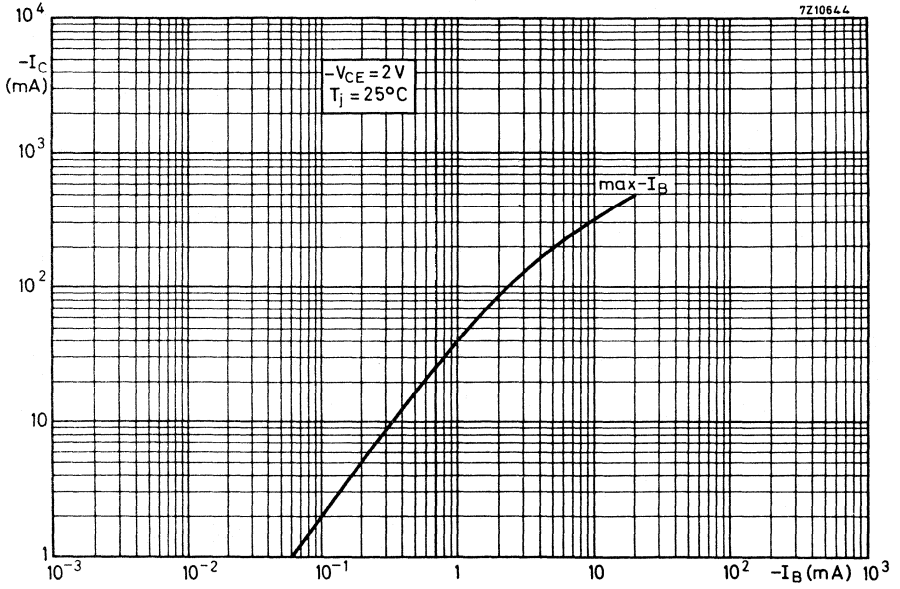


Fig. 10.

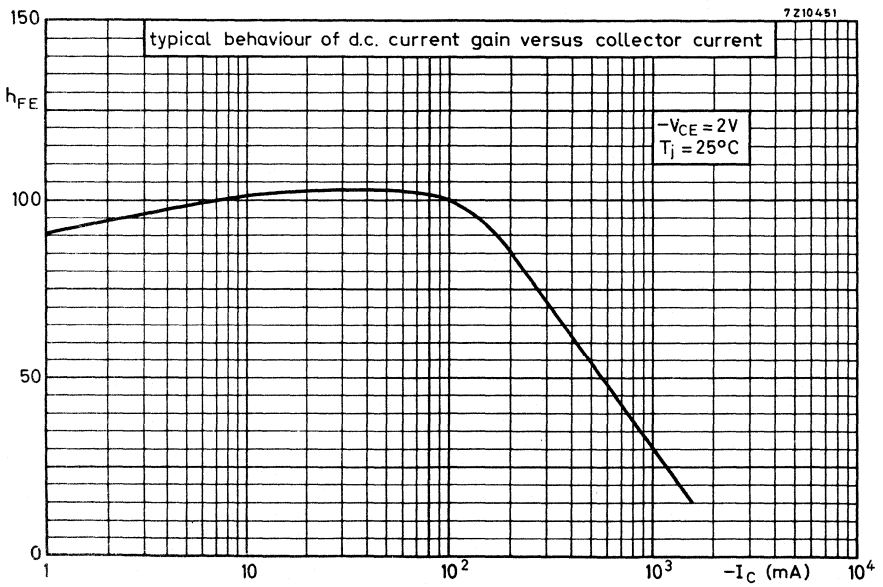


Fig. 11.

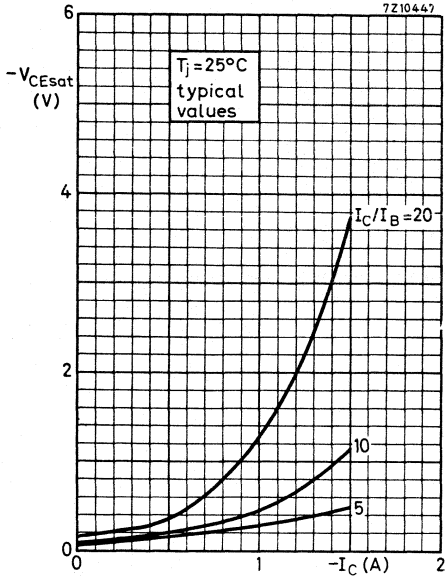


Fig. 12.

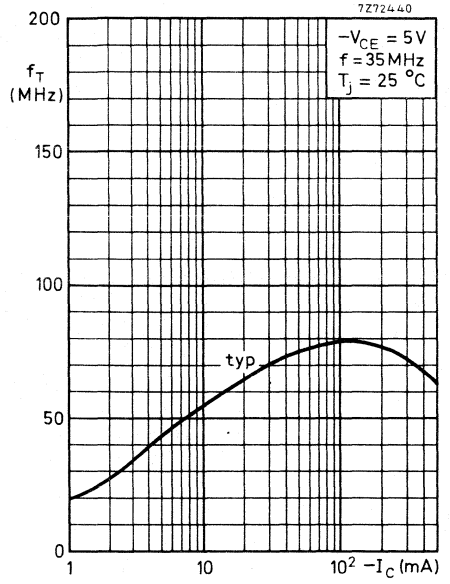


Fig. 13.

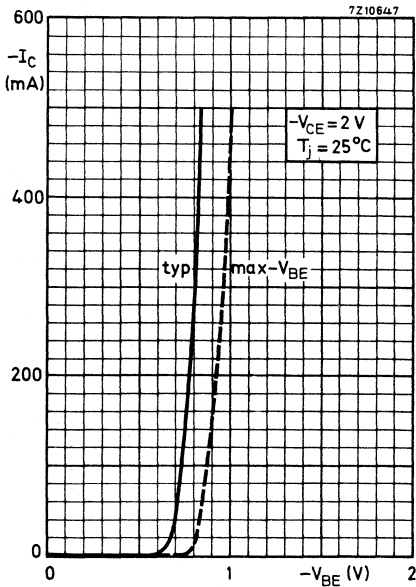


Fig. 14.

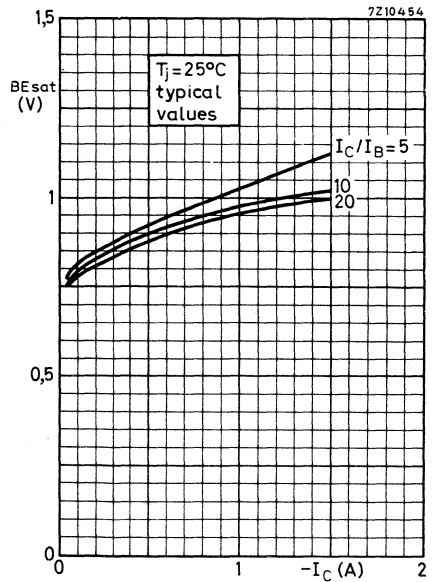


Fig. 15.

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

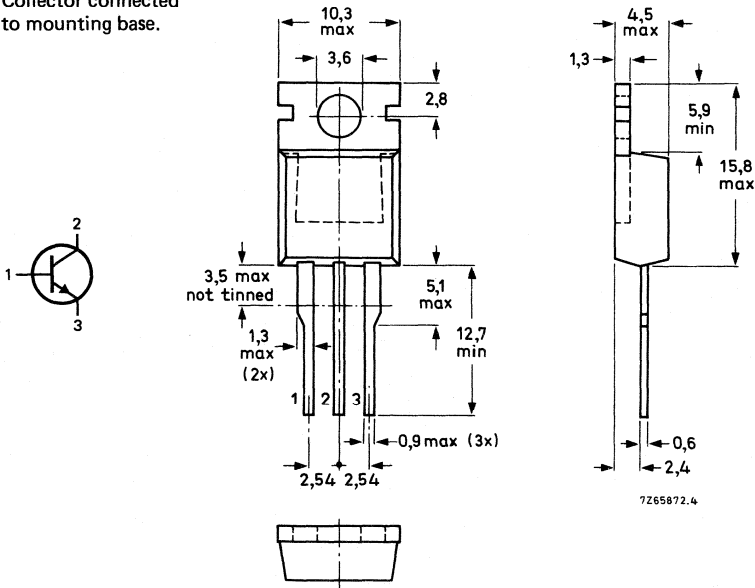
		BD201		BD203	
Collector-emitter voltage (open base)	V_{CEO}	max.	45		60 V
Collector current (d.c.)	I_C	max.	8		8 A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	60		60 W
Cut-off frequency $I_C = 0,3\text{ A}; V_{CE} = 3\text{ V}$	f_{hfe}	>	25		25 kHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220.

Collector connected to mounting base.



See also chapters Mounting Instructions and Accessories.

RATINGS

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

			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
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
Base current (d.c.)	I_B	max.	3	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 mounting base	$R_{th\ j-mb}$	=	2,08	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70	K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current $I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	<	1	mA
$I_E = 0$; $V_{CB} = 40$ V; $T_j = 150$ °C	I_{CBO}	<	1	mA
Emitter cut-off current $I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	5	mA
Base-emitter voltage* $I_C = 3$ A; $V_{CE} = 2$ V	V_{BE}	<	1,5	V
Knee voltage* $I_C = 3$ A; $I_B =$ value for which $I_C = 3,3$ A at $V_{CE} = 2$ V	V_{CEK}	typ.	1	V
Saturation voltage* $I_C = 3$ A; $I_B = 0,3$ A	V_{CEsat}	<	1	V
$I_C = 6$ A; $I_B = 0,6$ A	V_{CEsat}	<	1,5	V
	V_{BEsat}	<	2	V
D.C. current gain* BD201; $I_C = 3$ A; $V_{CE} = 2$ V	h_{FE}	>	30	
BD203; $I_C = 2$ A; $V_{CE} = 2$ V	h_{FE}	>	30	
$I_C = 1$ A; $V_{CE} = 2$ V	h_{FE}	>	30	
Cut-off frequency $I_C = 0,3$ A; $V_{CE} = 3$ V	f_{hfe}	>	25	kHz

* Measured under pulse conditions: $t_p < 300$ μ s, $\delta < 2\%$.

Transition frequency at $f = 1 \text{ MHz}$
 $I_C = 0,3 \text{ A}; V_{CE} = 3 \text{ V}$

$f_T > 7 \text{ MHz}$

D.C. current gain ratio of matched complementary pairs
 $I_C = 1 \text{ A}; V_{CE} = 2 \text{ V}$

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

Forward bias second breakdown
 collector current
 $V_{CE} = 40 \text{ V}; t_p = 0,1 \text{ s}; T_{amb} = 25 \text{ }^\circ\text{C}$

$I(SB) > 1,5 \text{ A}$

Switching times

$I_{Con} = 2 \text{ A}; I_{Bon} = -I_{Boff} = 0,2 \text{ A}$

Turn-on time

$t_{on} < 1 \text{ } \mu\text{s}$

Turn-off time

$t_{off} < 4 \text{ } \mu\text{s}$

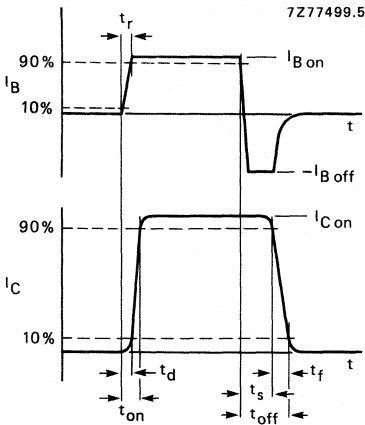


Fig. 2 Switching time waveforms.

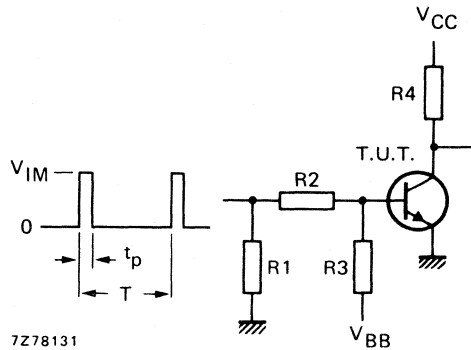


Fig. 3 Switching times test circuit.

- | | |
|---------------------------|---------------------------------|
| $V_{IM} = 15 \text{ V}$ | $R3 = 22 \text{ } \Omega$ |
| $V_{CC} = 20 \text{ V}$ | $R4 = 10 \text{ } \Omega$ |
| $V_{BB} = -4 \text{ V}$ | $t_r = t_f \leq 15 \text{ ns}$ |
| $R1 = -$ | $t_p = 20 \text{ } \mu\text{s}$ |
| $R2 = 33 \text{ } \Omega$ | $T = 500 \text{ } \mu\text{s}$ |

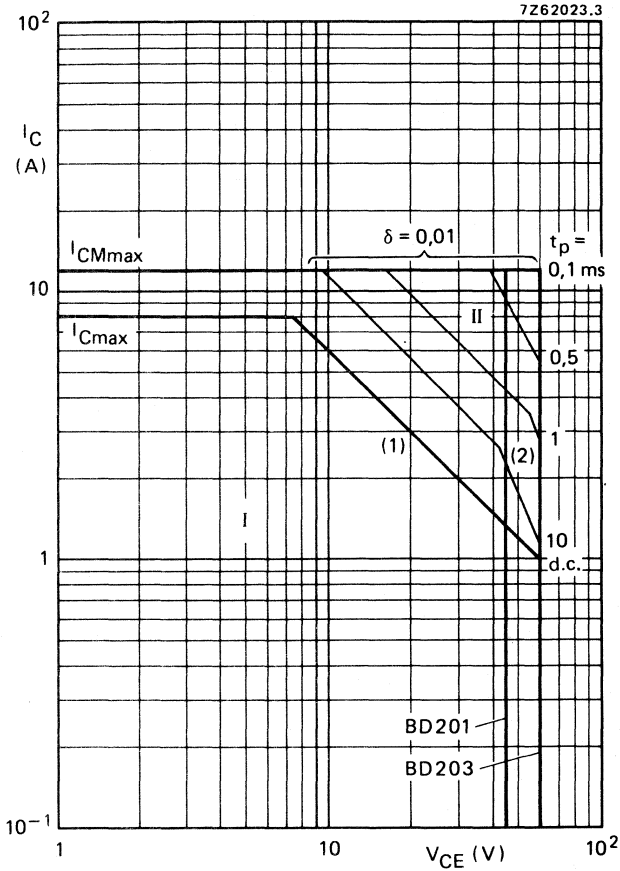


Fig. 4 Safe Operating Area, $T_{mb} \leq 25^\circ\text{C}$.

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

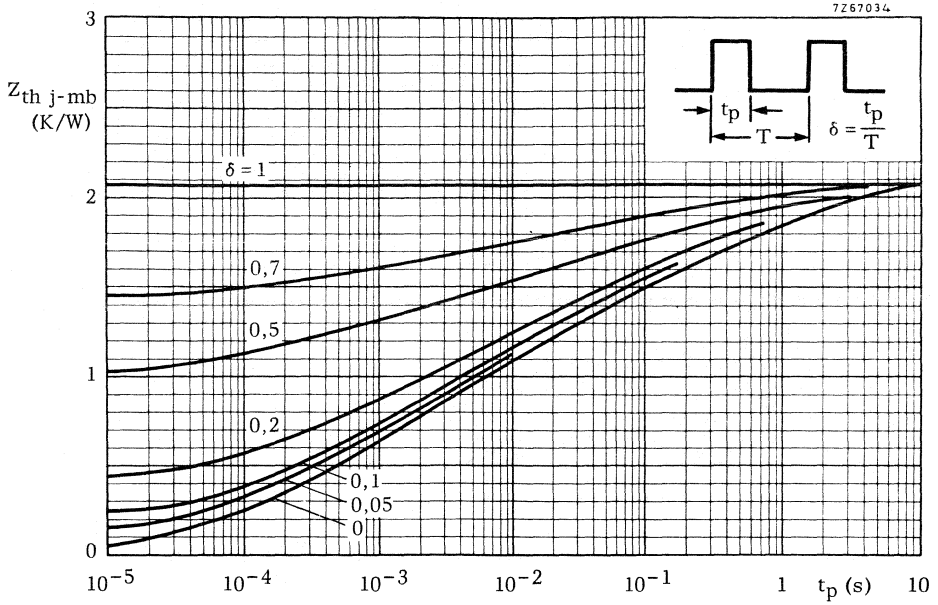


Fig. 5 Pulse power rating chart.

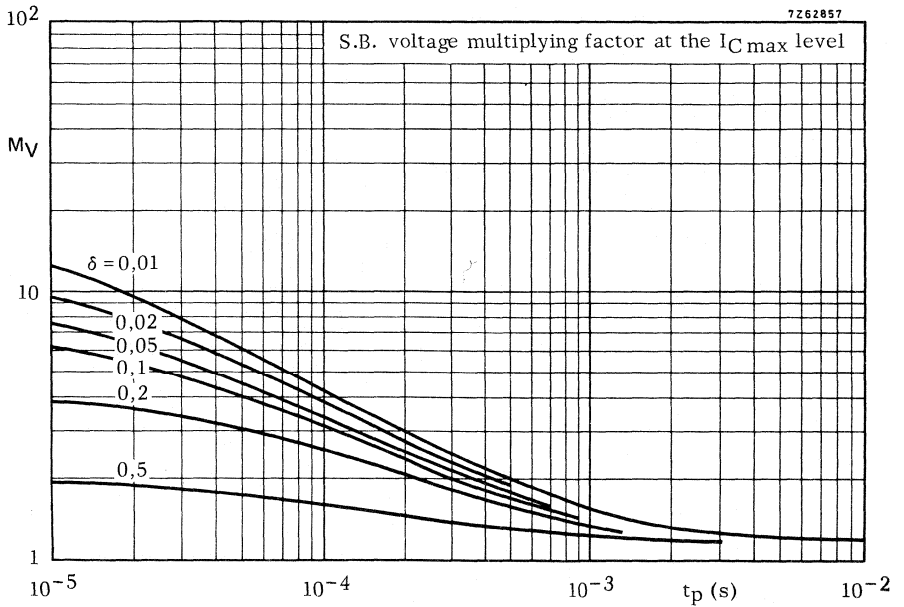


Fig. 6 S.B. voltage multiplying factor at the I_{Cmax} level.

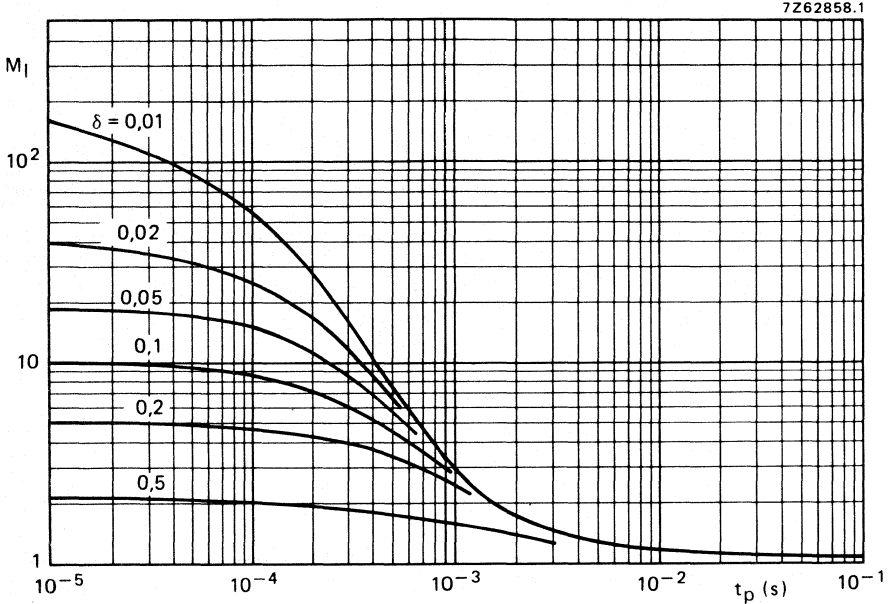


Fig. 7 S.B. current multiplying factor at the V_{CE0} max level.

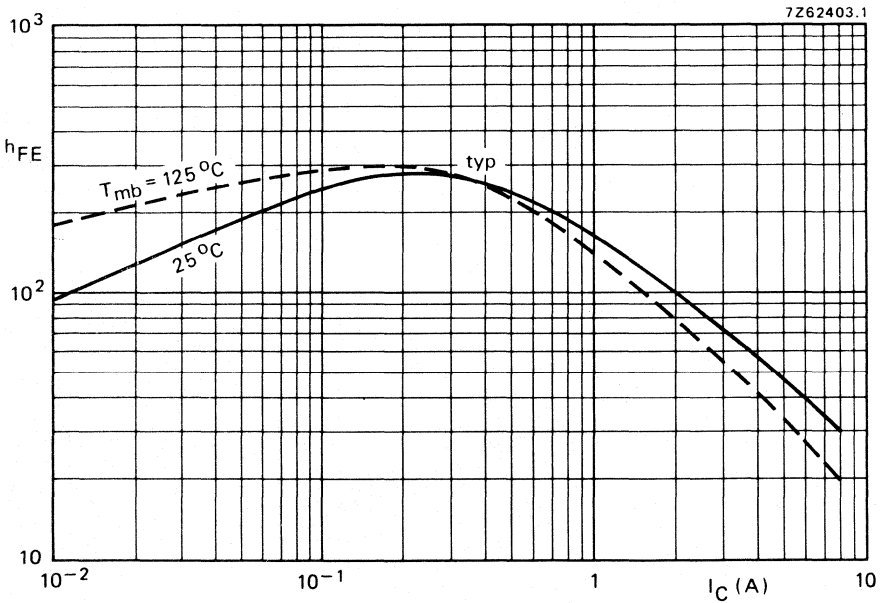


Fig. 8 D.C. current gain. $V_{CE} = 2$ V.

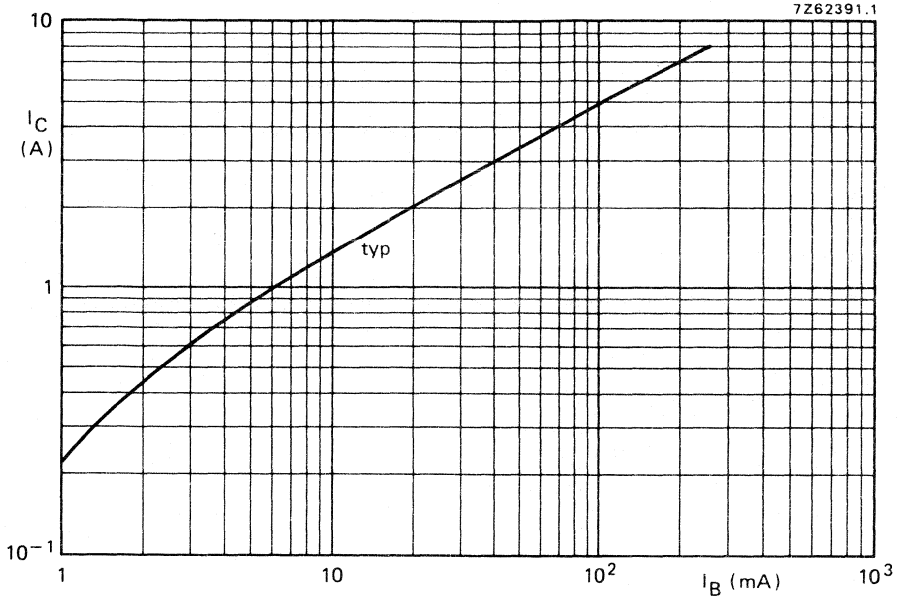


Fig. 9 Collector current as a function of base current. $V_{CE} = 2 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$.

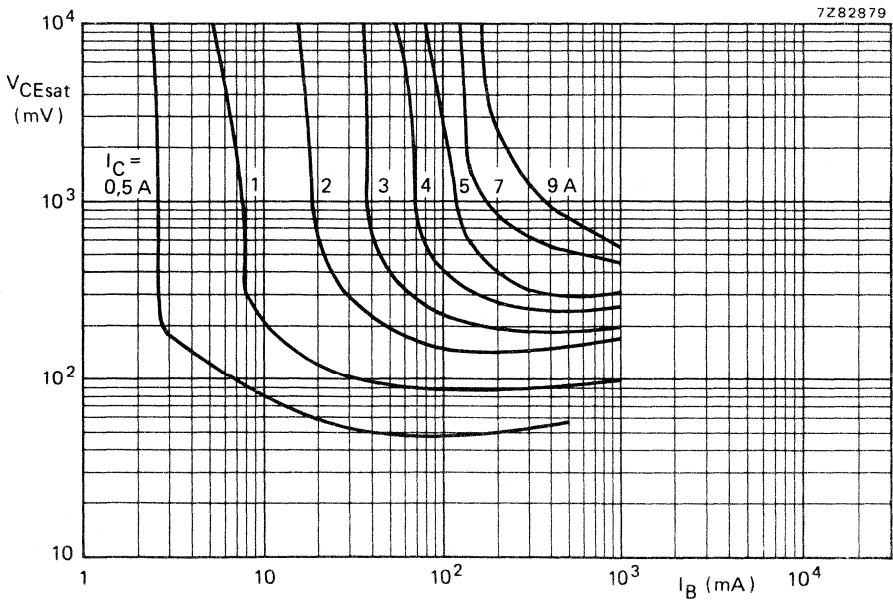


Fig. 10 Typical collector-emitter saturation voltage. $T_j = 25 \text{ }^\circ\text{C}$.

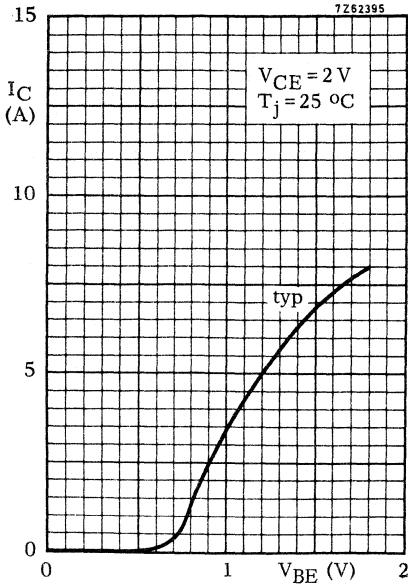


Fig. 11.

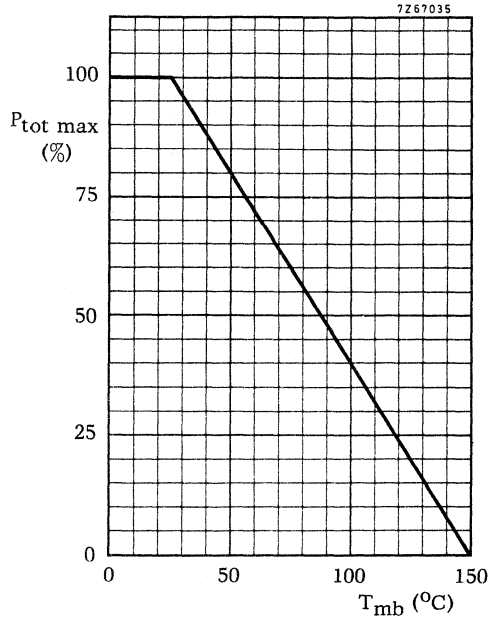


Fig. 12.

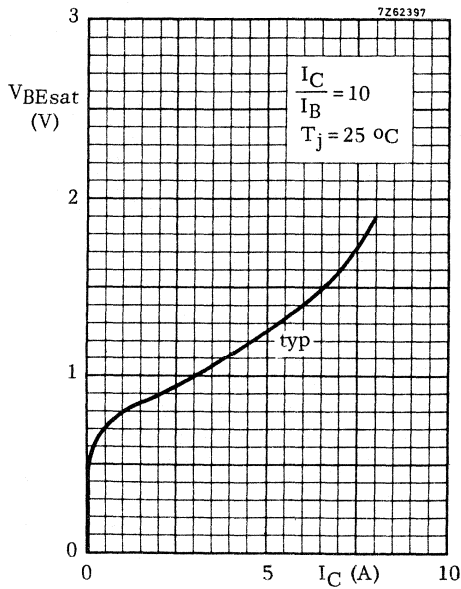


Fig. 13.

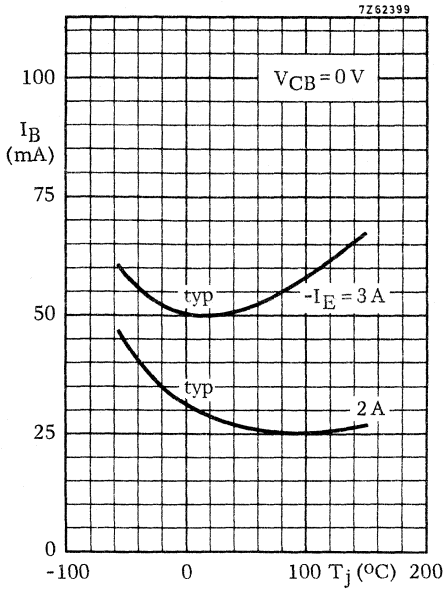


Fig. 14.

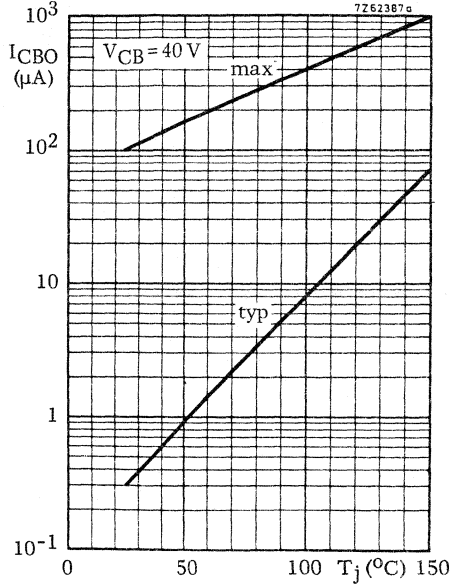


Fig. 15.

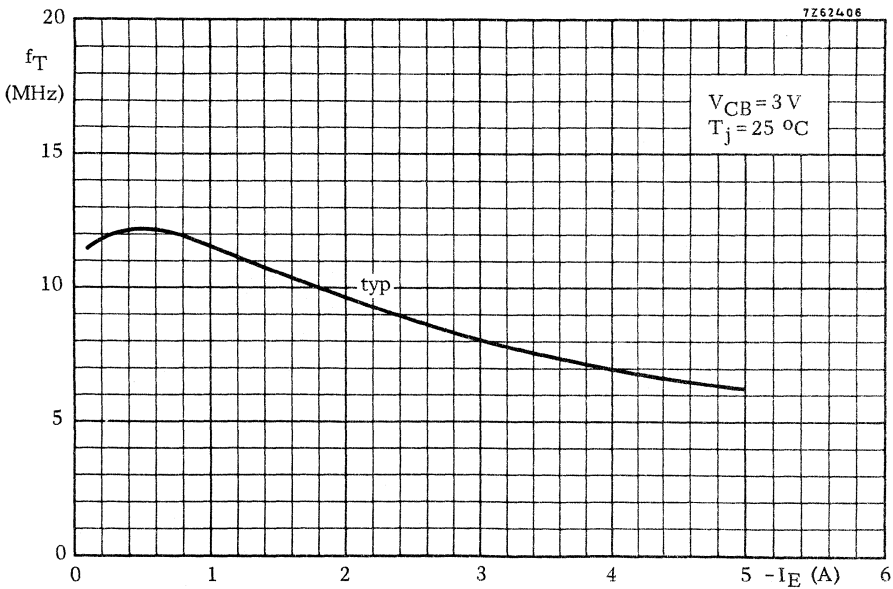


Fig. 16.

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

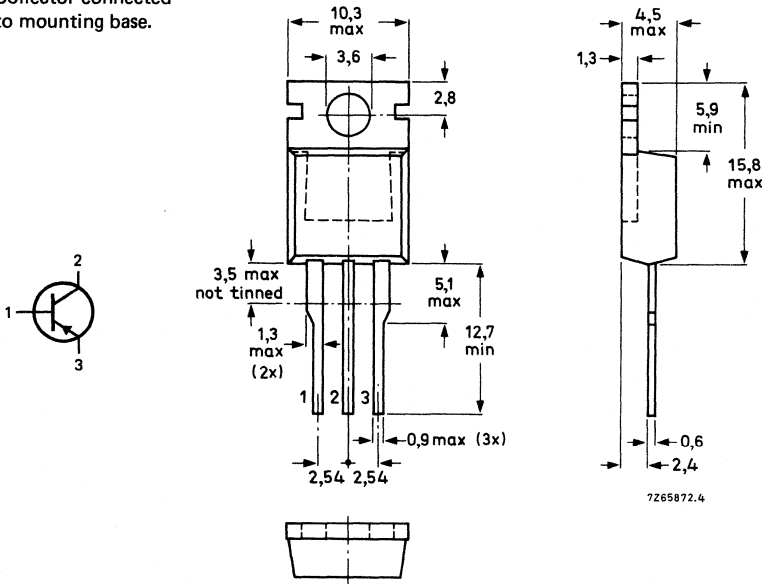
		BD202	BD204	
Collector-emitter voltage (open base)	$-V_{CE0}$ max.	45	60	V
Collector current (d.c.)	$-I_C$ max.	8	8	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	60	60	W
Cut-off frequency $-I_C = 0,3\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe}	> 25	25	kHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220.

Collector connected to mounting base.



See also chapters Mounting Instructions and Accessories.

RATINGS

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

			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
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
Base current (d.c.)	$-I_B$	max.		3	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 mounting base	$R_{th\ j-mb}$	=	2,08	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70	K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current

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

$I_E = 0; -V_{CB} = 40$ V; $T_j = 150$ °C

$-I_{CEO} < 1$ mA

$-I_{CBO} < 1$ mA

Emitter cut-off current

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

$-I_{EBO} < 5$ mA

Collector-emitter breakdown voltage

$I_C = 0,2$ A; $I_B = 0$ BD202

$I_C = 0,2$ A; $I_B = 0$ BD204

$-V_{(BR)CEO} > 45$ V

$-V_{(BR)CEO} > 60$ V

Base-emitter voltage *

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

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

Knee voltage *

$-I_C = 3$ A; $-I_B =$ value at which

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

$-V_{CEK}$ typ. 1 V

Saturation voltages*

$-I_C = 3$ A; $-I_B = 0,3$ A

$-I_C = 6$ A; $-I_B = 0,6$ A

$-V_{CEsat} < 1$ V

$-V_{CEsat} < 1,5$ V

$-V_{BEsat} < 2$ V

D.C. current gain*

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

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

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

$h_{FE} > 30$

$h_{FE} > 30$

$h_{FE} > 30$

* Measured under pulse conditions: $t_p < 300$ μ s, $\delta < 2\%$.

Cut-off frequency

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

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

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

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

$f_T > 7 \text{ MHz}$

D.C. current gain ratio of matched complementary pairs

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

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

Forward bias second breakdown collector current

$V_{CE} = 40 \text{ V}; t_p = 0,1 \text{ s}$

$I_{SB} > 1,5 \text{ A}$

Switching times

$-I_{Con} = 2 \text{ A}; -I_{Bon} = I_{Boff} = 0,2 \text{ A}$

turn-on time

$t_{on} < 1 \mu\text{s}$

turn-off time

$t_{off} < 2 \mu\text{s}$

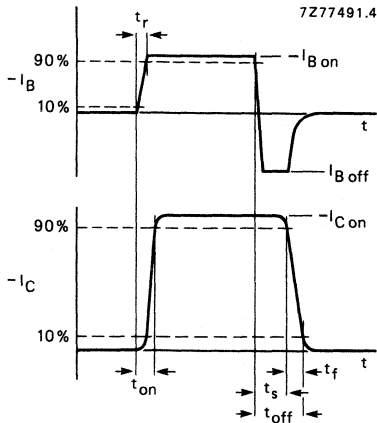


Fig. 2 Switching times waveforms.

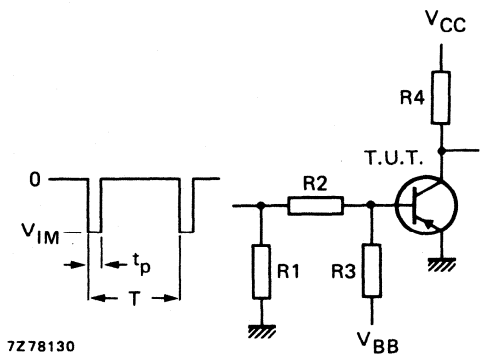


Fig. 3 Switching times test circuit.

$-V_{IM} = 15 \text{ V}$	$R3 = 22 \Omega$
$-V_{CC} = 20 \text{ V}$	$R4 = 10 \Omega$
$+V_{BB} = 4 \text{ V}$	$t_r = t_f = 15 \text{ ns}$
$R1 = 56 \Omega$	$t_p = 10 \mu\text{s}$
$R2 = 33 \Omega$	$T = 500 \mu\text{s}$

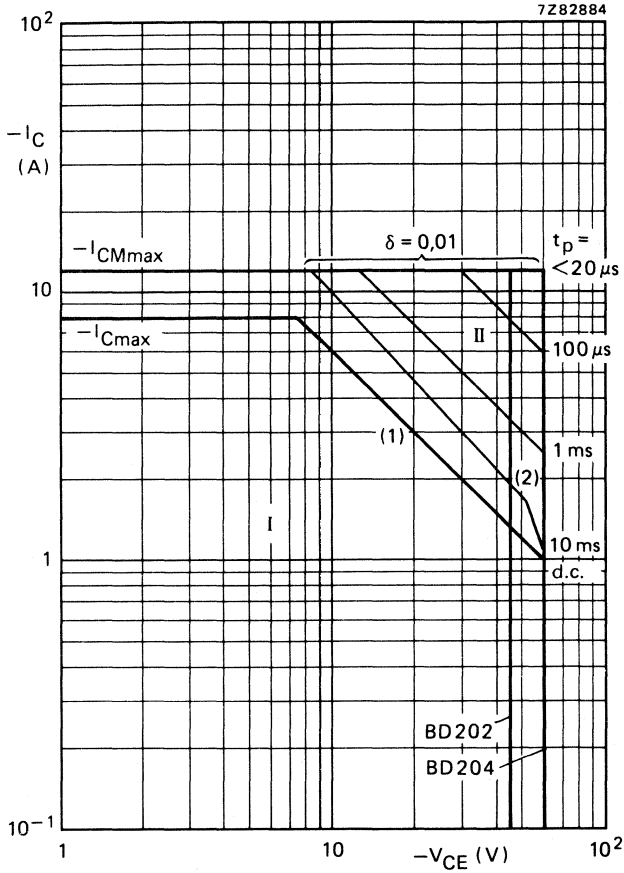


Fig. 4 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

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

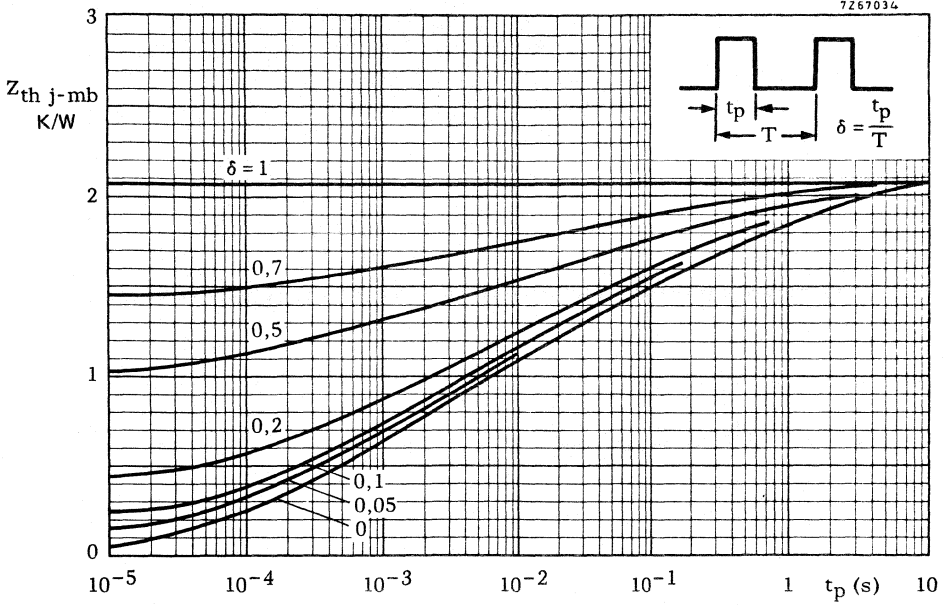


Fig. 5 Pulse power rating chart.

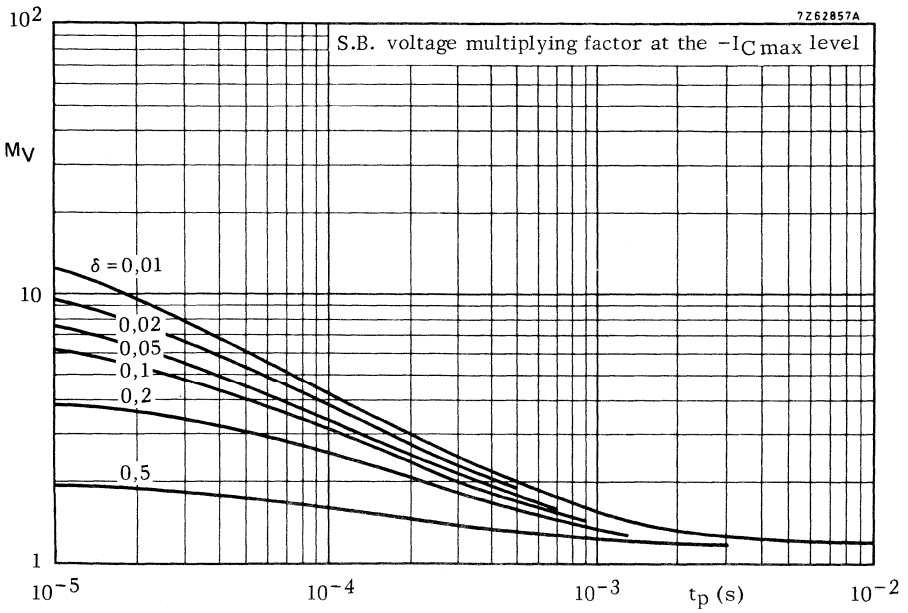


Fig. 6 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

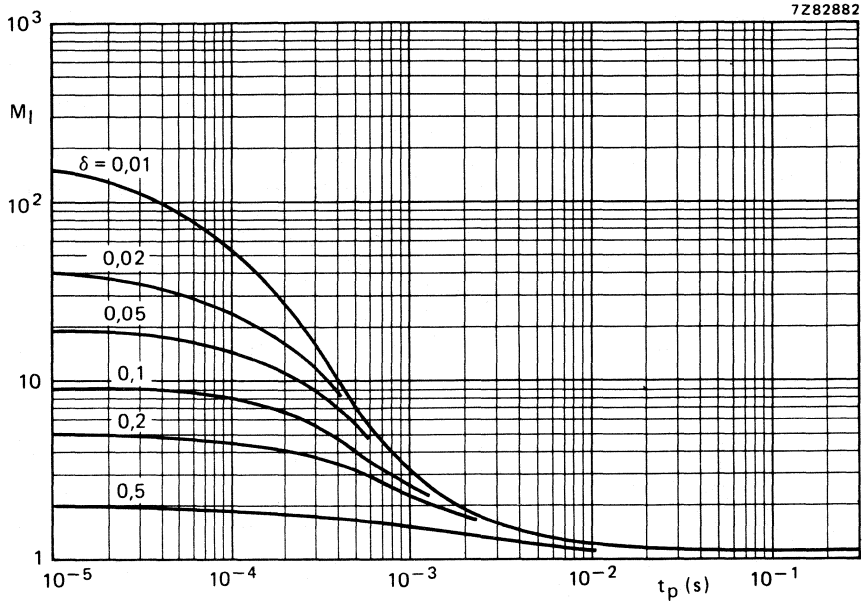


Fig. 7 S.B. current multiplying factor at the $-V_{CEmax}$ level.

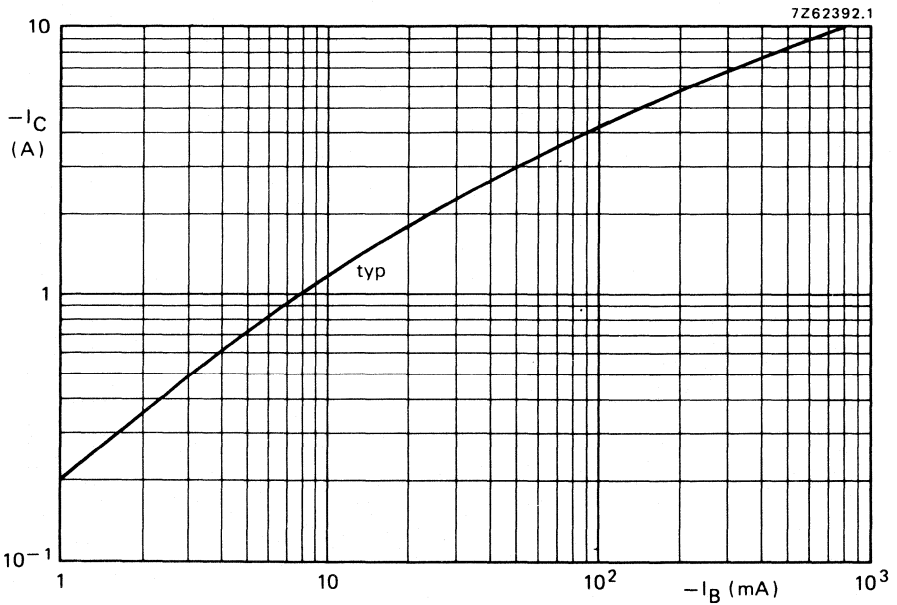


Fig. 8 Typical collector current as a function of base current. $-V_{CE} = 2 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$.

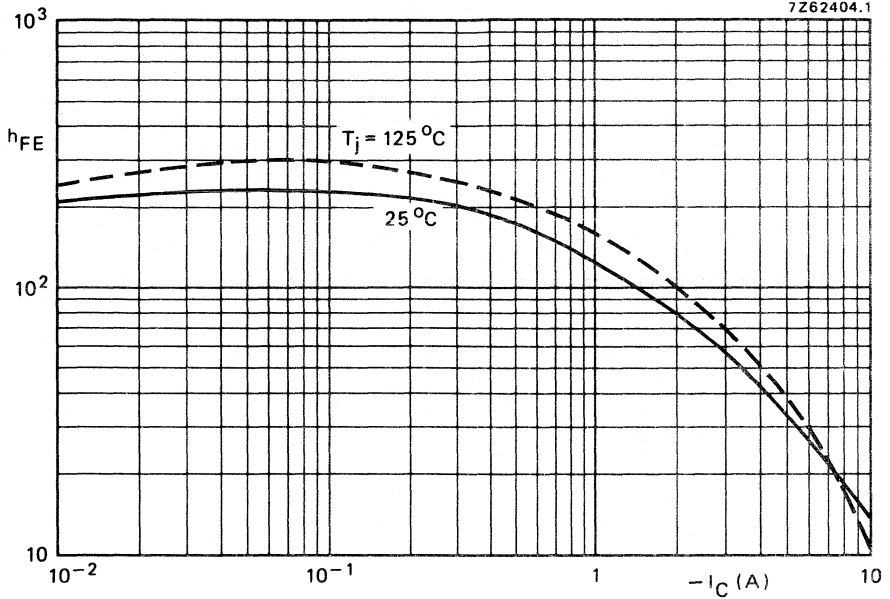


Fig. 9 Typical forward current transfer ratio at $-V_{CE} = 2$ V.

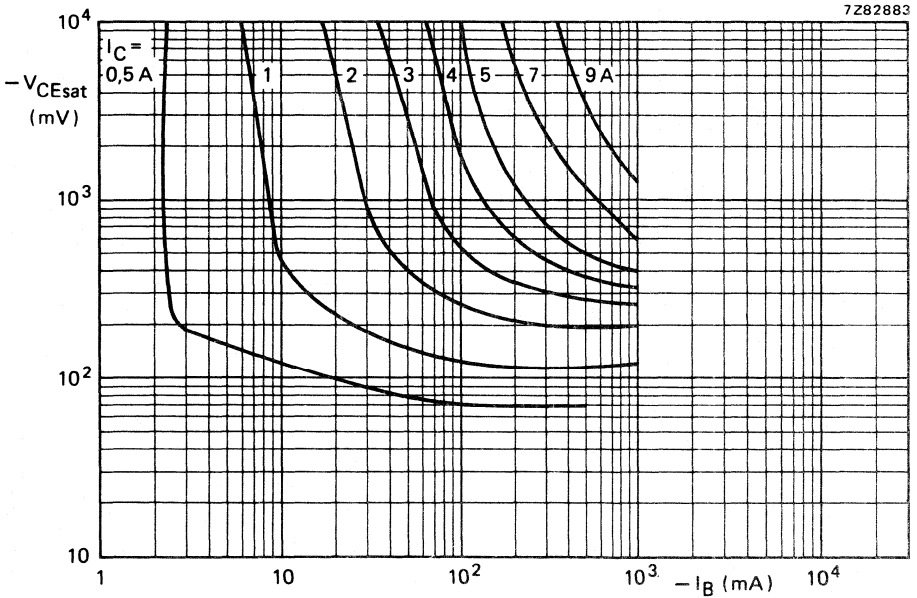


Fig. 10 Typical collector-emitter saturation voltage. $T_j = 25^\circ\text{C}$.

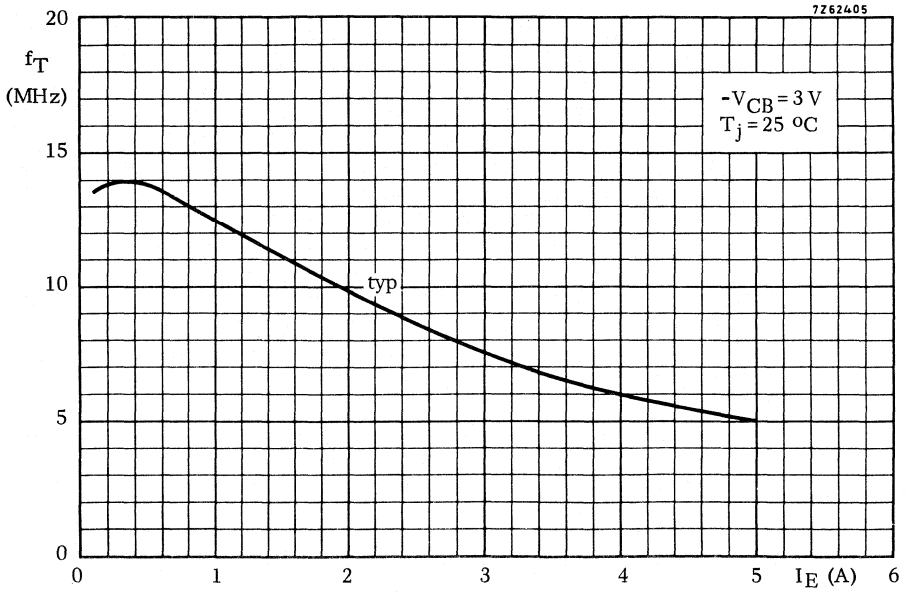


Fig. 11 Typical transition frequency.

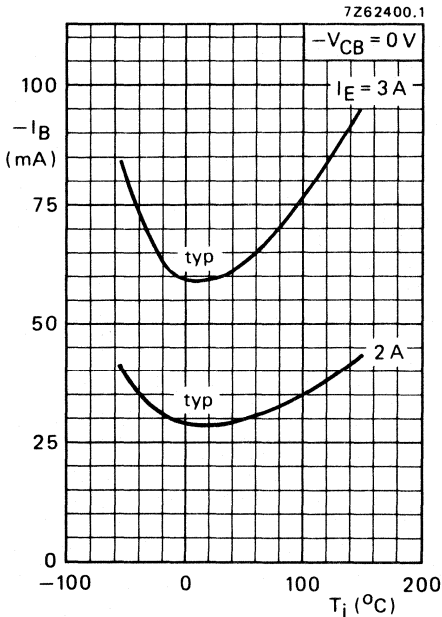


Fig. 12 Typical base current.

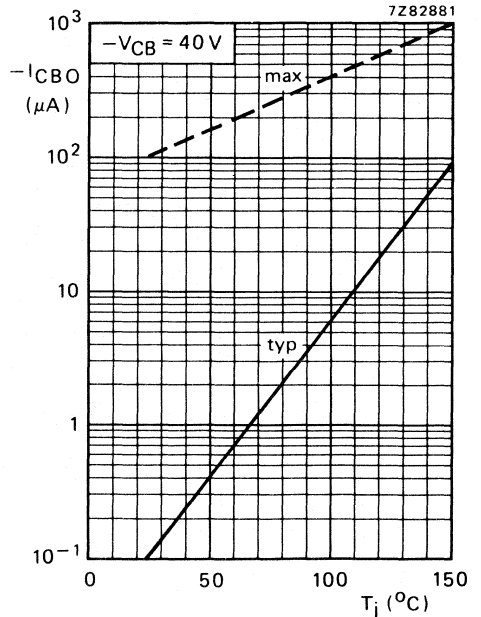


Fig. 13 Collector-base cut-off current.

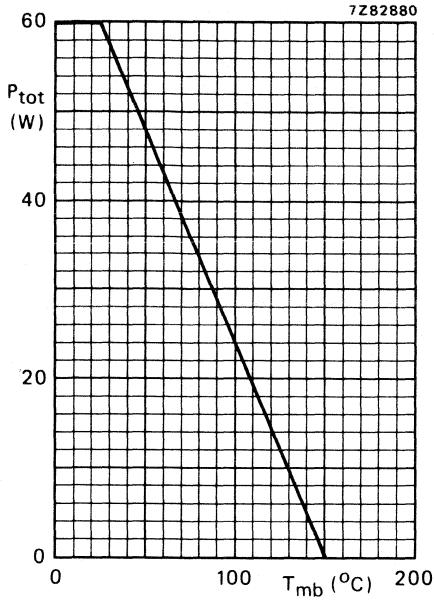


Fig. 14 Total power dissipation

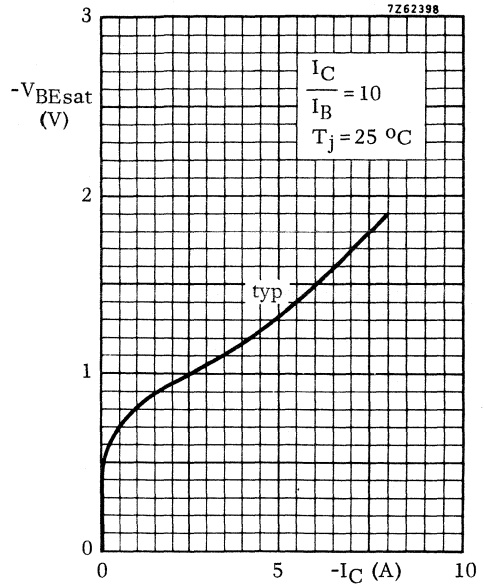


Fig. 15 Base-emitter saturation voltage.

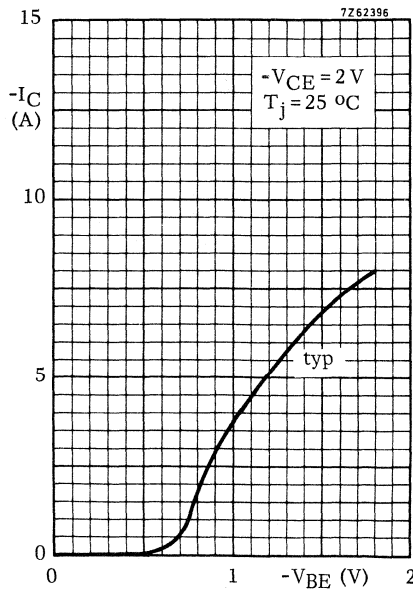


Fig. 16 Typical collector current.

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.

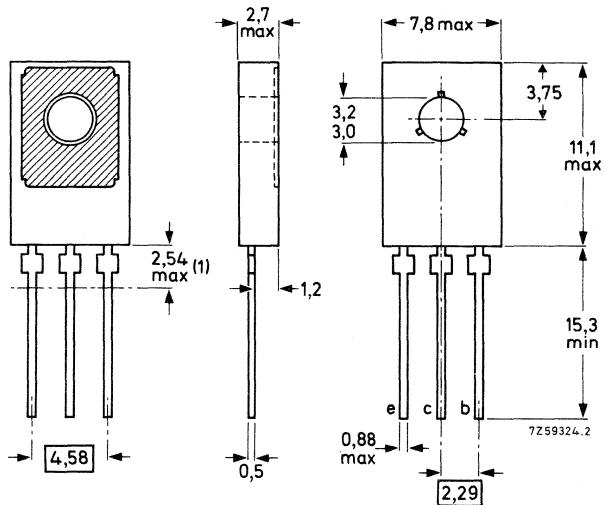
QUICK REFERENCE DATA		BD226	BD228	BD230
Collector-base voltage (open emitter)	V_{CB0}	max. 45	60	100 V
Collector-emitter voltage (open base)	V_{CEO}	max. 45	60	80 V
Collector-emitter voltage ($R_{BE} = 1\text{ k}\Omega$)	V_{CER}	max. 45	60	100 V
Collector current (peak value)	I_{CM}	max. 3	3	3 A
Total 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	h_{FE}	40 to 250		
$I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$				
$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	> 25		
Transition frequency	f_T	typ. 125	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



See 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)

			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 ($R_{BE} = 1\text{ k}\Omega$)	V_{CER}	max.	45	60	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V
Collector current (d. c.)	I_C	max.		1,5		A
Collector current (peak value)	I_{CM}	max.		3		A
Total power dissipation up to $T_{mb} = 62\text{ }^\circ\text{C}$	P_{tot}	max.		12,5		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 ambient in free air	$R_{th\ j-a}$	=		100		K/W
From junction to mounting base	$R_{th\ j-mb}$	=		7		K/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

$I_C = 5\text{ mA}; V_{CE} = 2\text{ V}$ $h_{FE} > 25$

$I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$ $h_{FE} > 40\text{ to }250$

$I_C = 1\text{ A}; V_{CE} = 2\text{ V}$ $h_{FE} > 25$

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

$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$ $f_T \text{ typ. } 125\text{ MHz}$

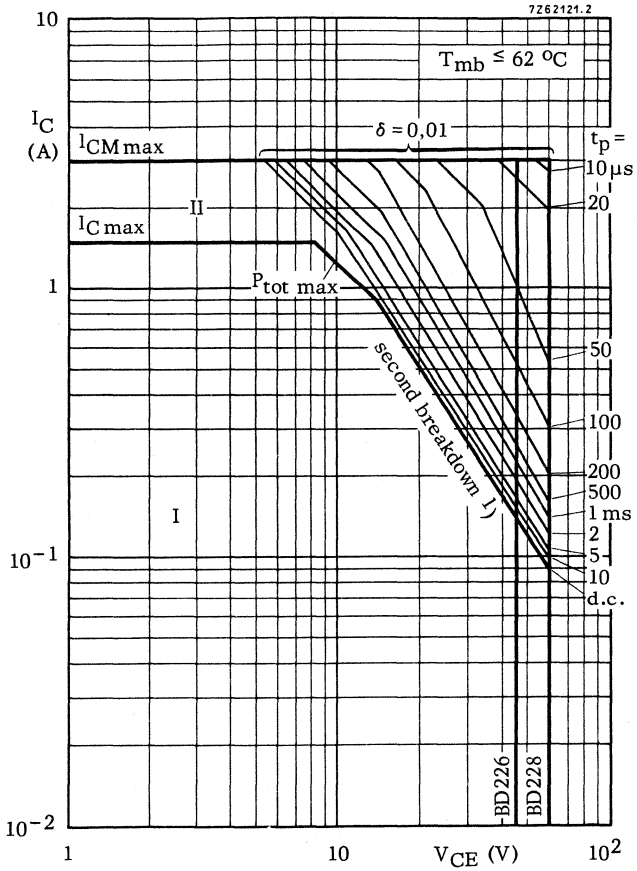
D. C. current gain ratio of
matched pairs

BD226/BD227; BD228/BD229;

BD230/BD231

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

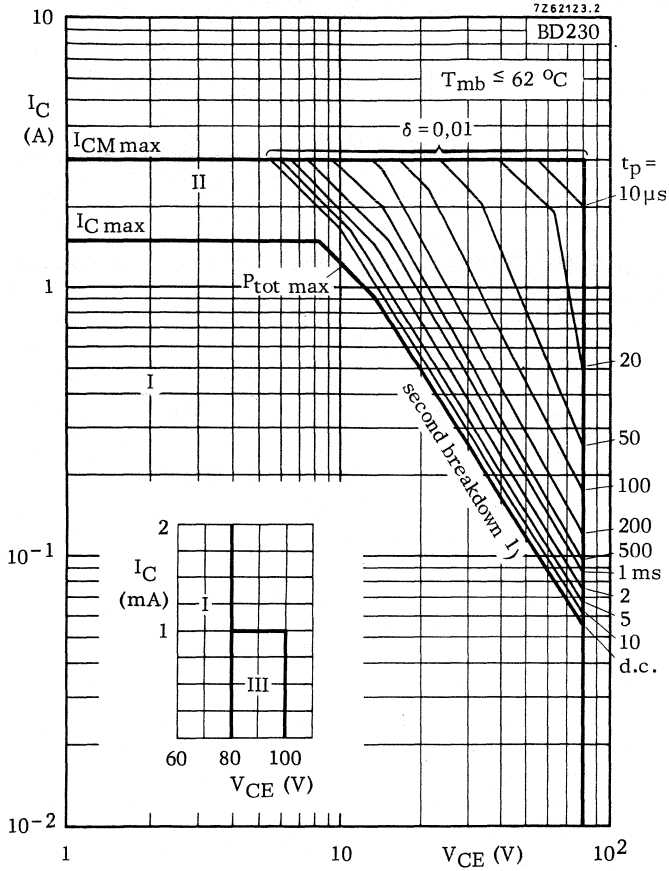
¹⁾ V_{BE} decreases by about 2,3 mV/K with increasing temperature.



Safe Operating Area with the transistor forward biased

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

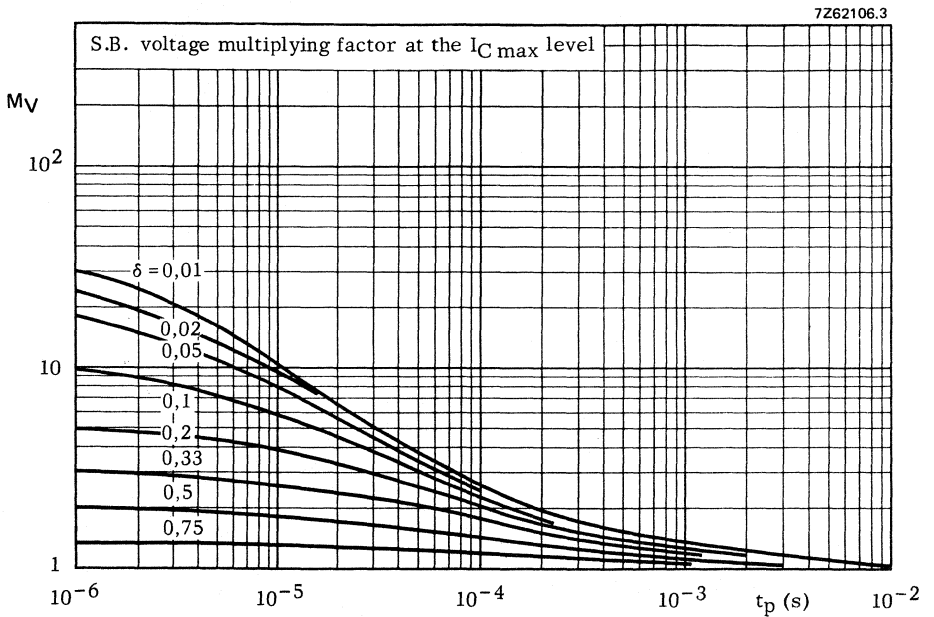
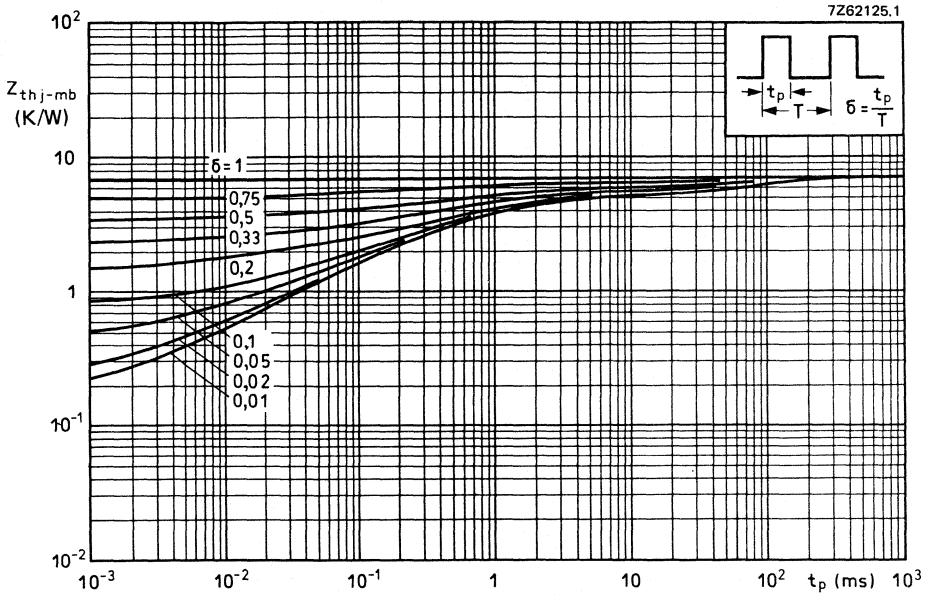
1) Independent of temperature

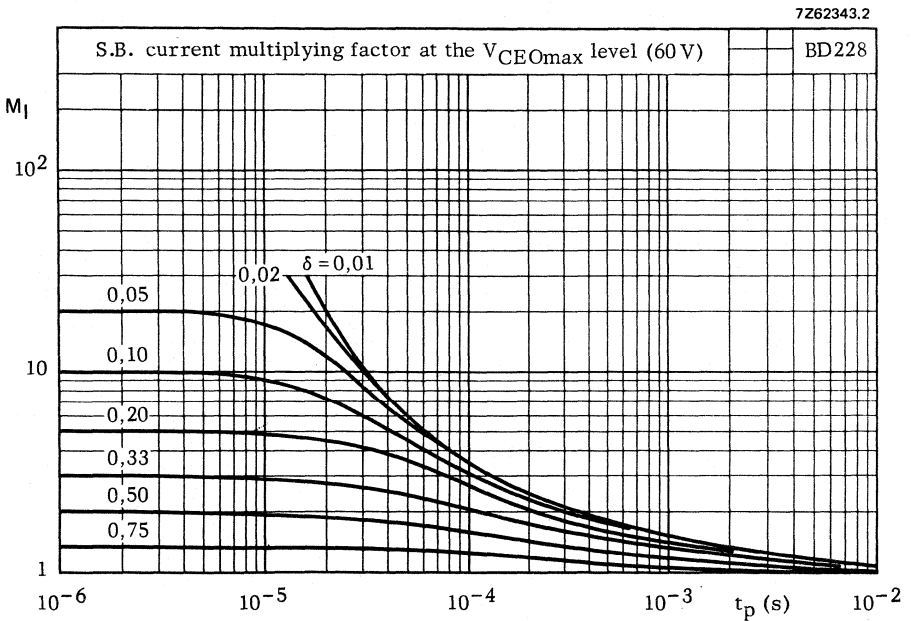
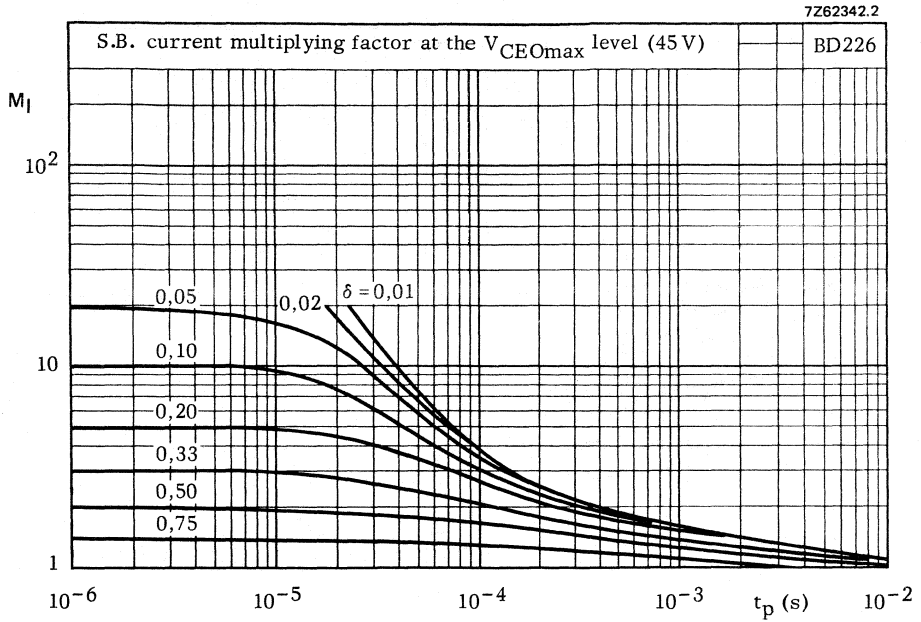


Safe Operating Area with the transistor forward biased

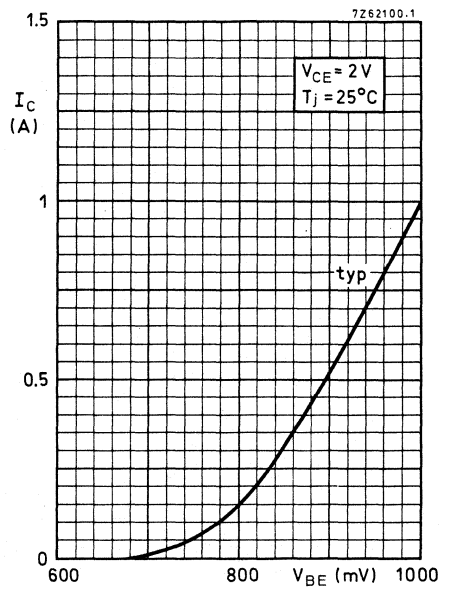
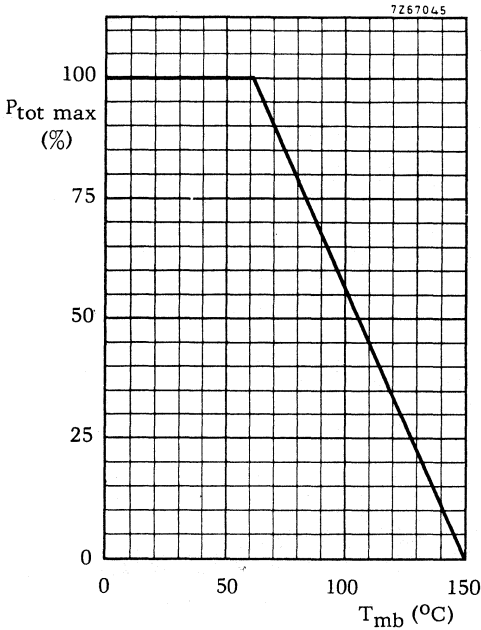
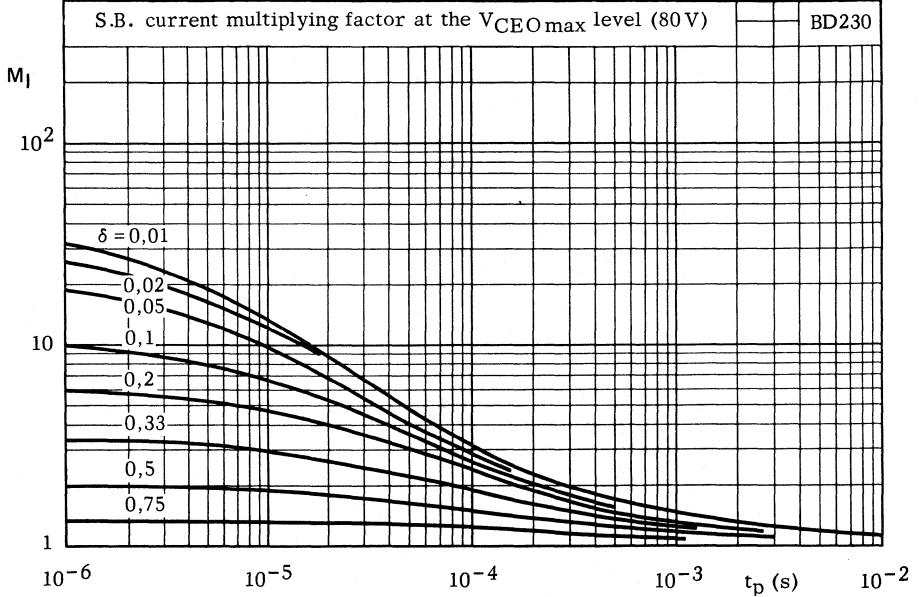
- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 1 \text{ k}\Omega$

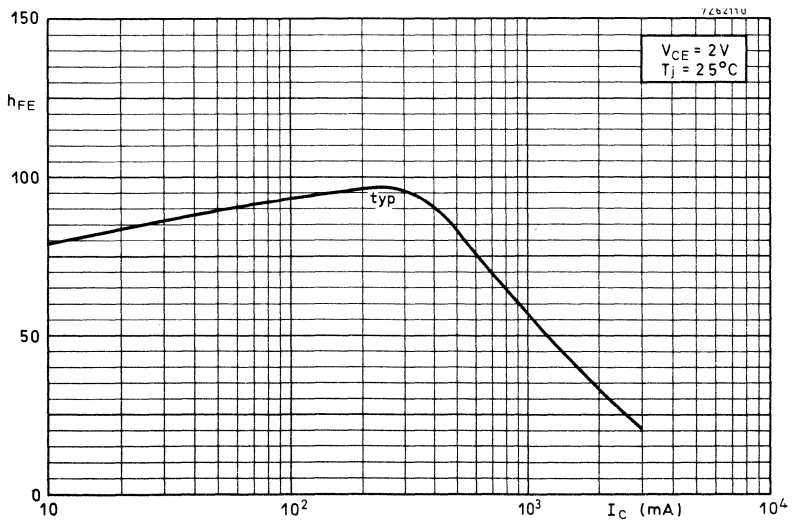
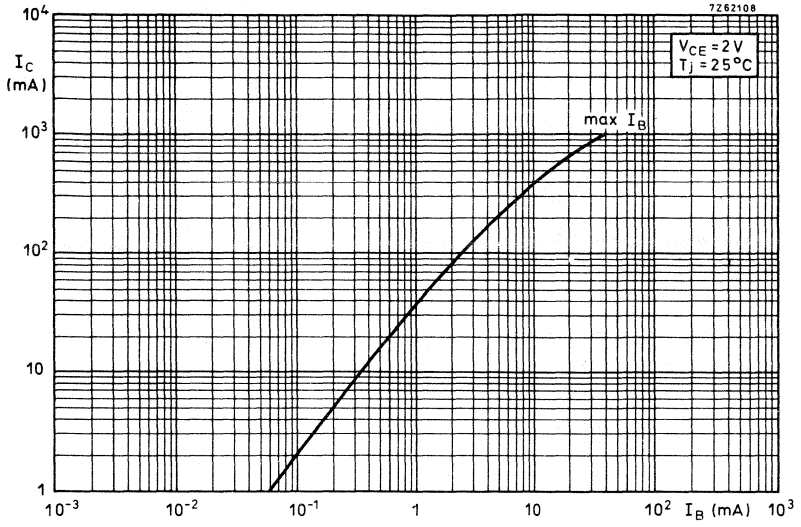
¹⁾ Independent of temperature

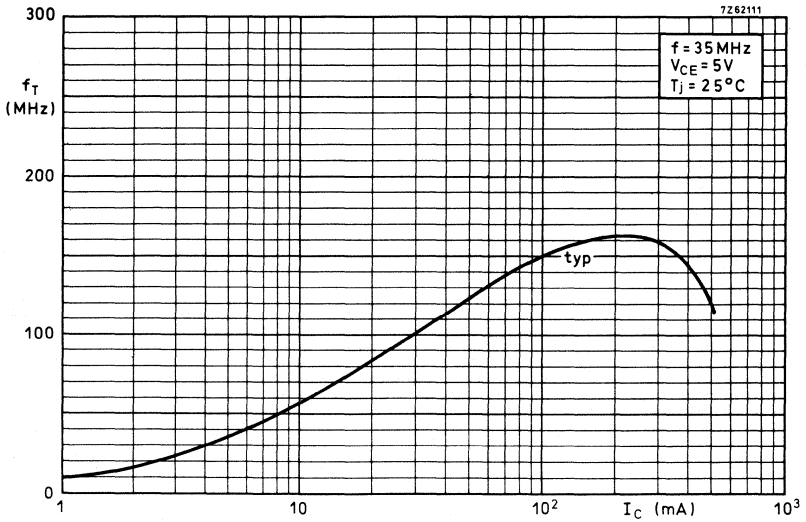
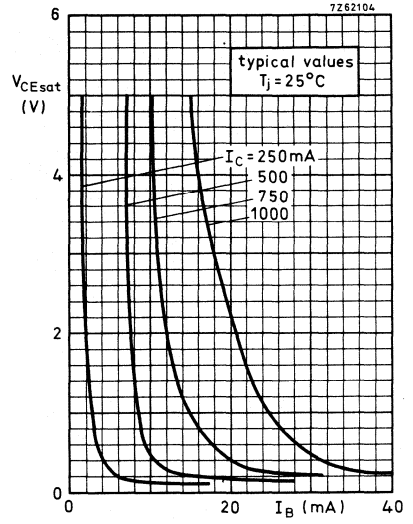
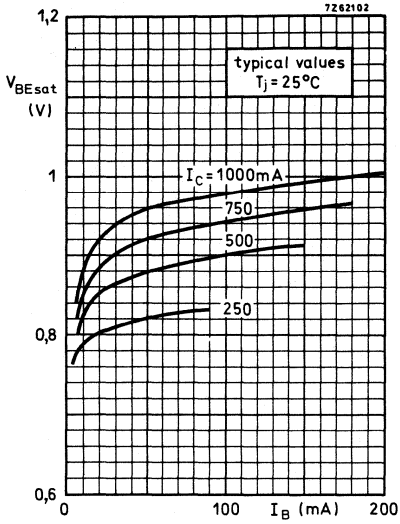




7Z62107.3







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.

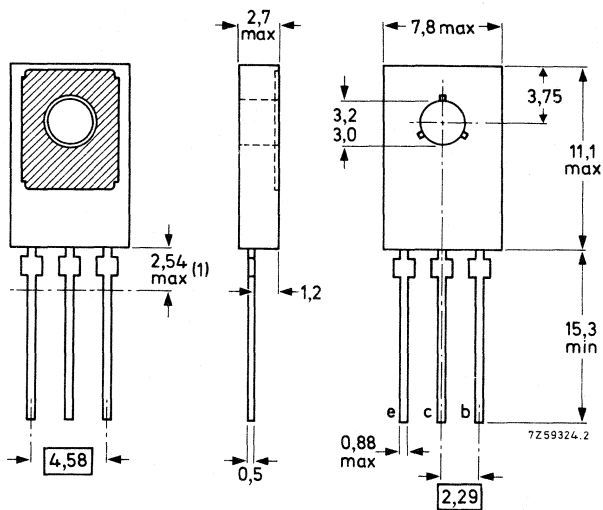
QUICK REFERENCE DATA				
		BD227	BD229	BD231
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 45	60	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 45	60	80 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	$-V_{CER}$	max. 45	60	100 V
Collector current (peak value)	$-I_{CM}$	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	h_{FE}	40 to 250		
$-I_C = 150 \text{ mA}; -V_{CE} = 2 \text{ V}$	h_{FE}	>		
$-I_C = 1 \text{ A}; -V_{CE} = 2 \text{ V}$	h_{FE}	25		
Transition frequency	f_T	typ.	50	MHz
$-I_C = 50 \text{ mA}; -V_{CE} = 5 \text{ V}$	f_T	typ.		

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected to metal part of mounting surface



See 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)

		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
Collector current (d. c.)	$-I_C$	max.	1,5	A
Collector current (peak value)	$-I_{CM}$	max.	3	A
Total power dissipation up to $T_{mb} = 62 \text{ }^\circ\text{C}$	P_{tot}	max.	12,5	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 ambient in free air	$R_{th \text{ j-a}}$	=	100	K/W
From junction to mounting base	$R_{th \text{ j-mb}}$	=	7	K/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

$-I_C = 5\text{ mA}; -V_{CE} = 2\text{ V}$ $h_{FE} > 25$

$-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$ $h_{FE} < 40\text{ to }250$

$-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$ $h_{FE} > 25$

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

$-I_C = 50\text{ mA}; -V_{CE} = 5\text{ V}$ $f_T \text{ typ. } 50\text{ MHz}$

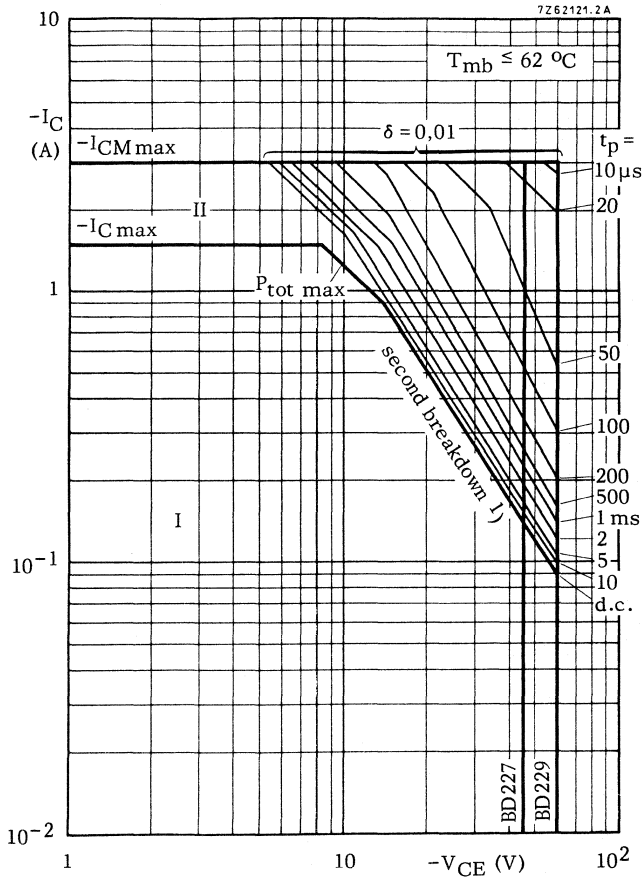
D. C. current gain ratio of
matched pairs

BD226/BD227; BD228/BD229;

BD230/BD231

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

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

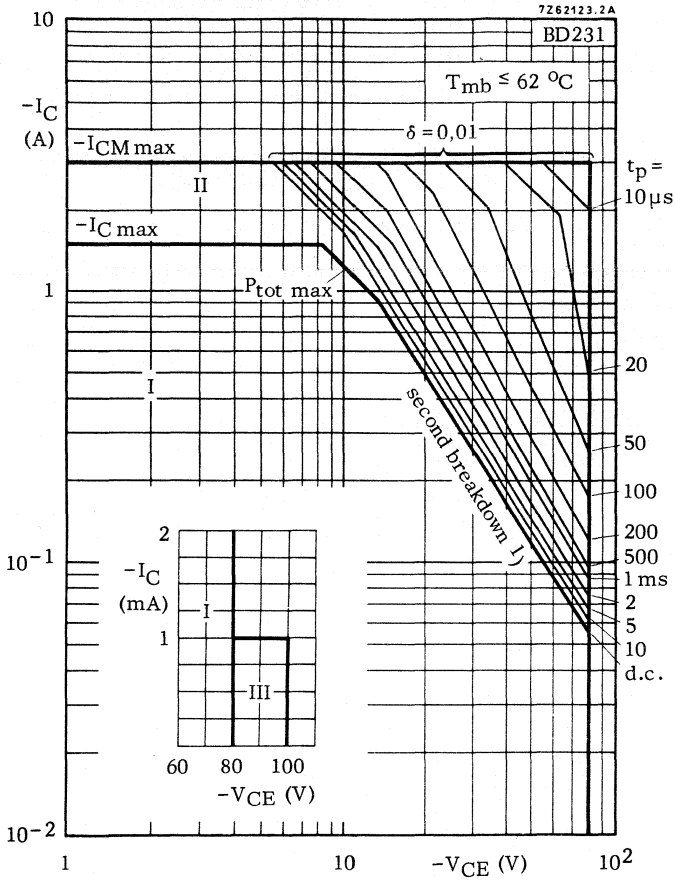


Safe Operating Area with the transistor forward biased

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

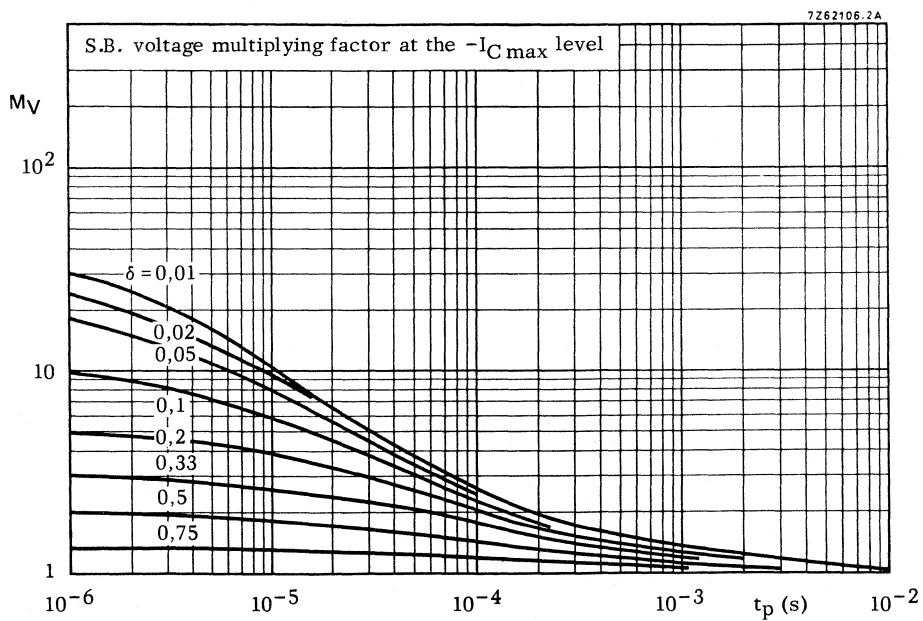
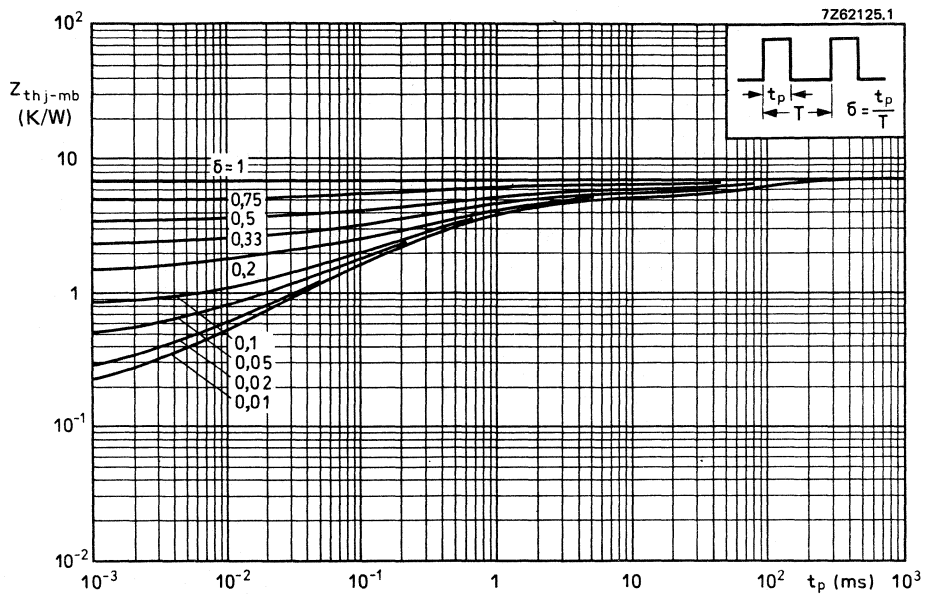
1) Independent of temperature

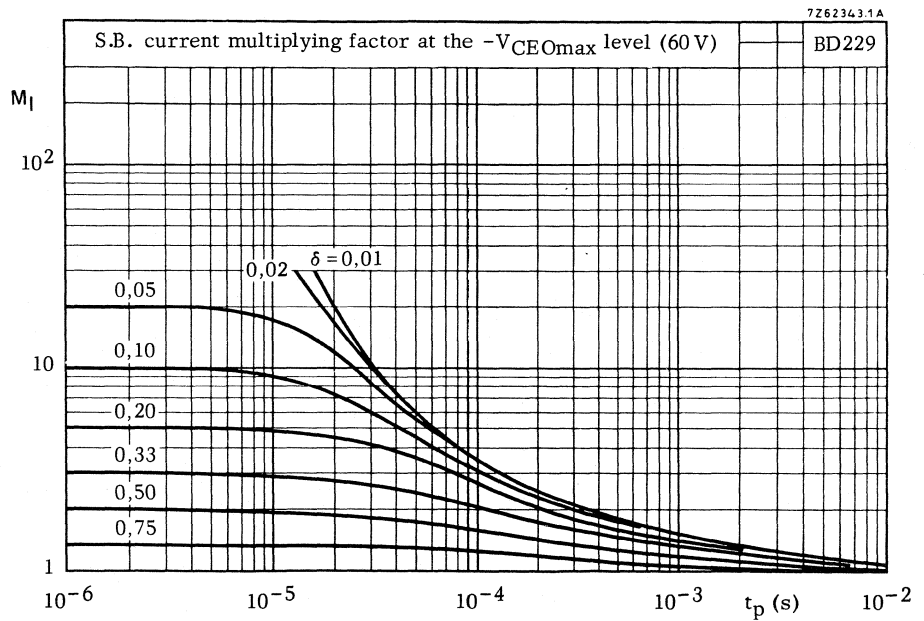
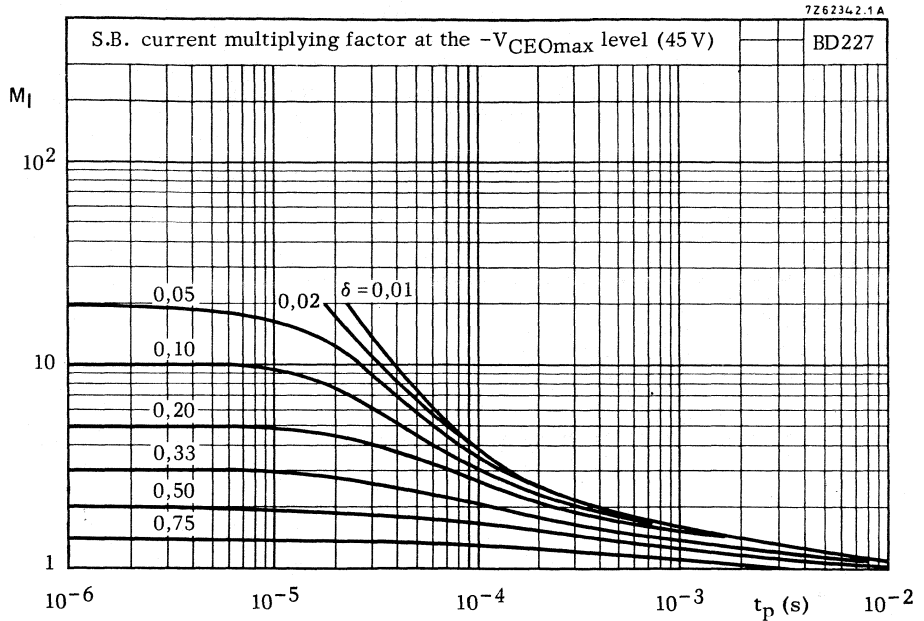


Safe Operating Area with the transistor forward biased

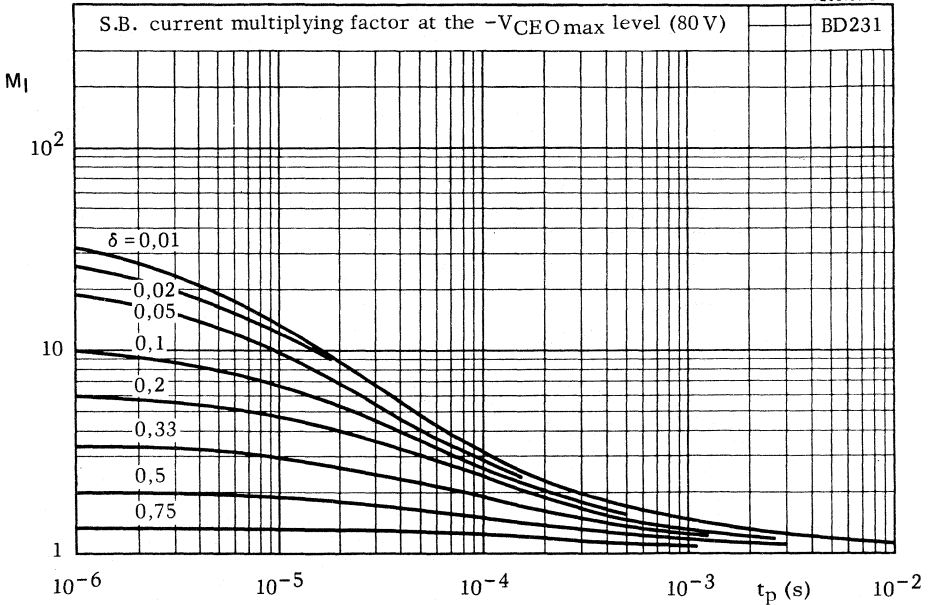
- I Region of permissible d. c. operation
- II Permissible extension for repetitive pulse operation
- III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 1 \text{ k}\Omega$

1) Independent of temperature

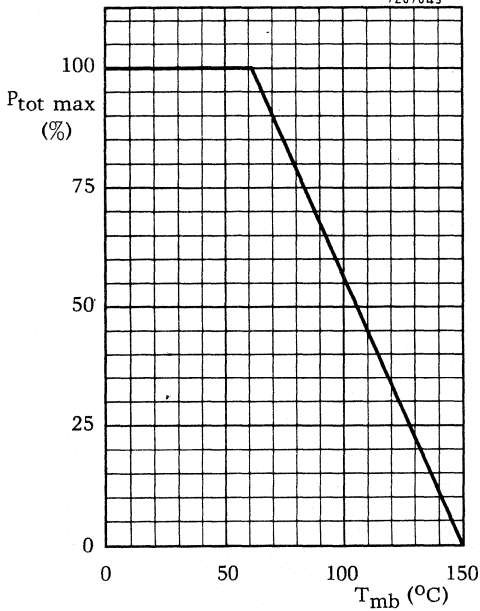




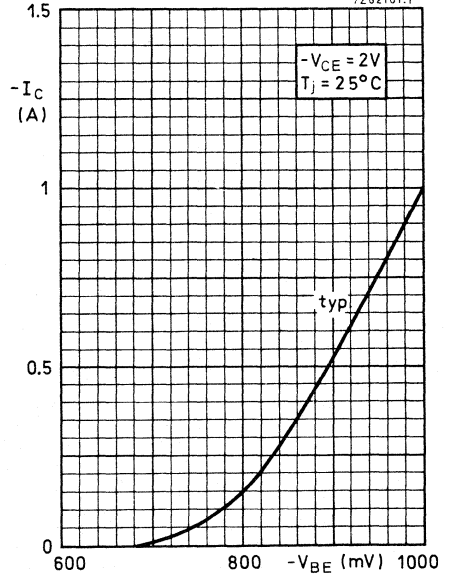
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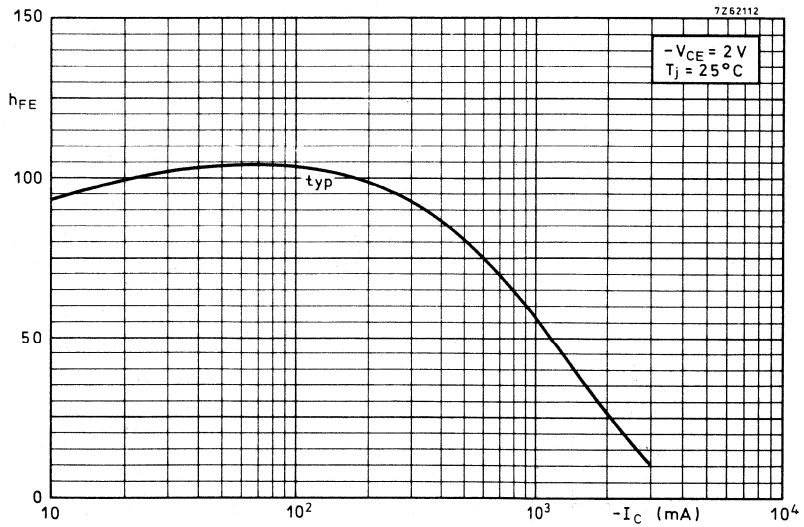
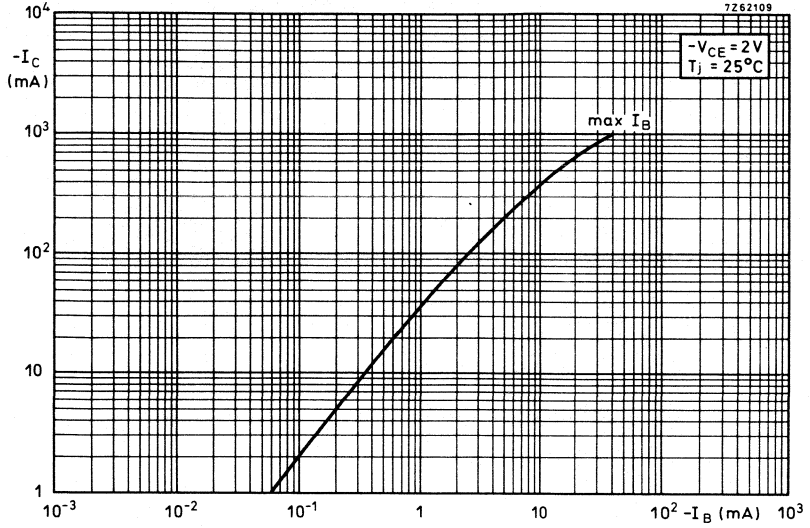


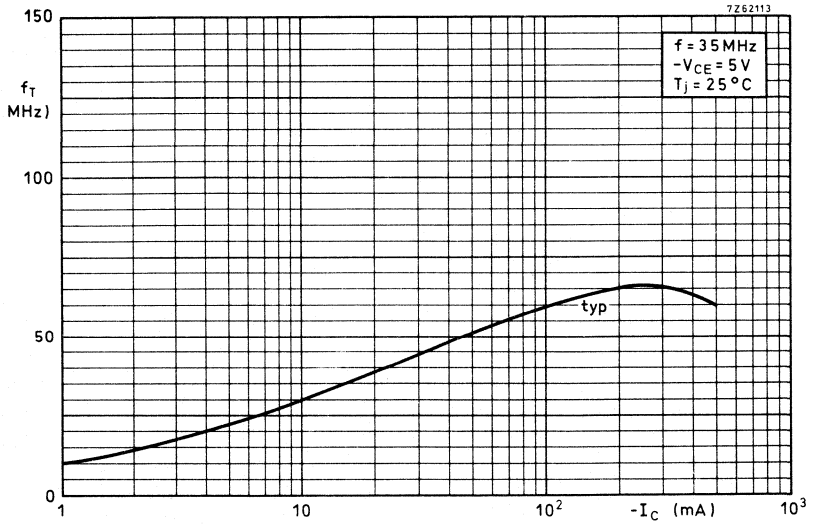
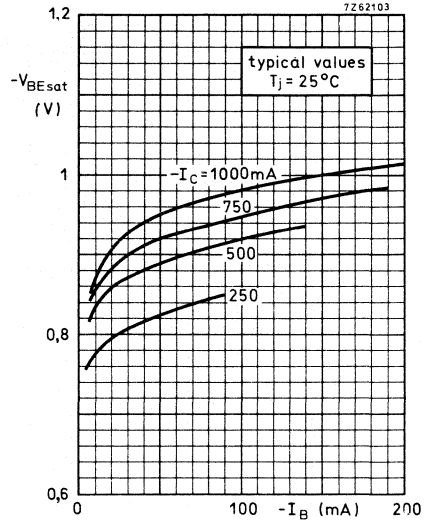
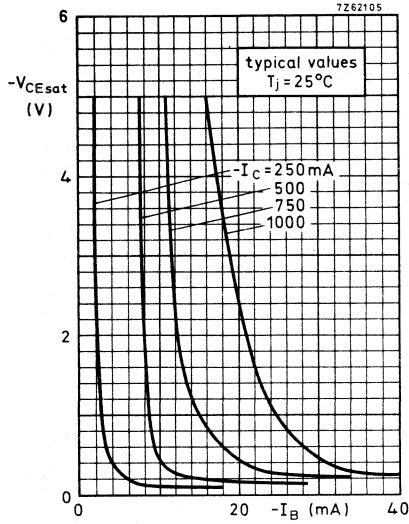
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7Z62101.1







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

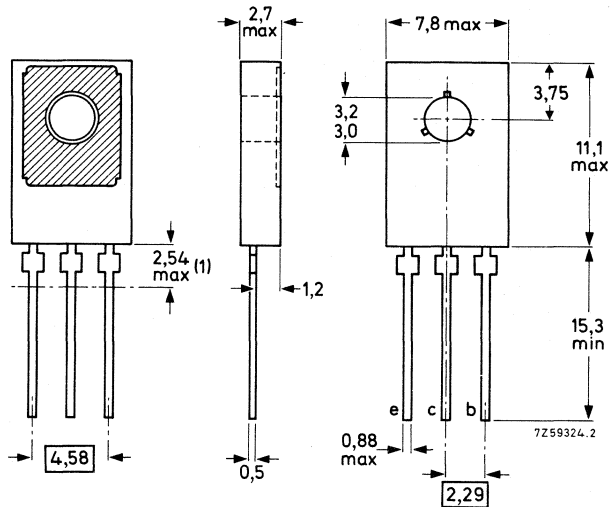
		BD233	BD235	BD237	
Collector-base voltage (open emitter)	V_{CBO} max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO} max.	45	60	80	V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	V_{CER} max.	45	60	100	V
Collector current (peak value)	I_{CM} max.		6		A
Total power dissipation up 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

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

Collector connected to metal part of 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)

			BD233	BD235	BD237	
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_{EBO}	max.	5	5	5	V
Collector current (d.c.)	I_C	max.		2		A
Collector current (peak value)	I_{CM}	max.		6		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.		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 ambient in free air	$R_{th \text{ j-a}}$	=		100		K/W
From junction to mounting base	$R_{th \text{ j-mb}}$	=		5		K/W

CHARACTERISTICS

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

Collector cut-off current

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

$I_{CBO} < 100 \text{ } \mu\text{A}$

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

$I_{CBO} < 3 \text{ mA}$

Emitter cut-off current

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

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

Second-breakdown collector current

$V_{CE} = 40 \text{ V}; t_p = 20 \text{ ms}$

$I_{(SB)C} < 0,5 \text{ A}$

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*

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

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

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

$h_{FE} > 25$

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

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

$f_T > 3 \text{ MHz}$

* 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.

D.C. current gain ratio of matched complementary pairs*

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

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

Switching times

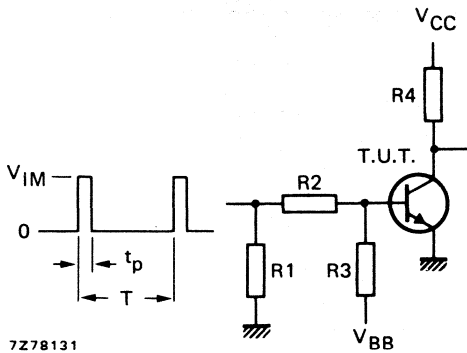
$I_{Con} = 1\text{ A}; I_{Bon} = -I_{Boff} = 0,1\text{ A}$

turn-on time

t_{on} typ. $0,4\text{ }\mu\text{s}$
 < $1\text{ }\mu\text{s}$

turn-off time

t_{off} typ. $1,5\text{ }\mu\text{s}$
 < $3\text{ }\mu\text{s}$



- $V_{IM} = 16\text{ V}$
- $V_{CC} = 20\text{ V}$
- $-V_{BB} = 6,4\text{ V}$
- $R1 = 82\text{ }\Omega$
- $R2 = 82\text{ }\Omega$
- $R3 = 82\text{ }\Omega$
- $R4 = 20\text{ }\Omega$
- $t_r = t_f = 15\text{ ns}$
- $t_p = 10\text{ }\mu\text{s}$
- $T = 500\text{ }\mu\text{s}$

Fig. 2 Test circuit.

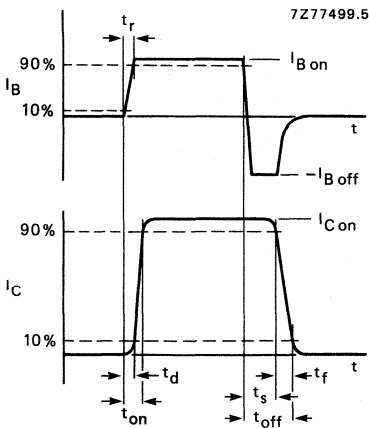


Fig. 3 Switching times waveforms.

* Measured under pulse conditions; $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.

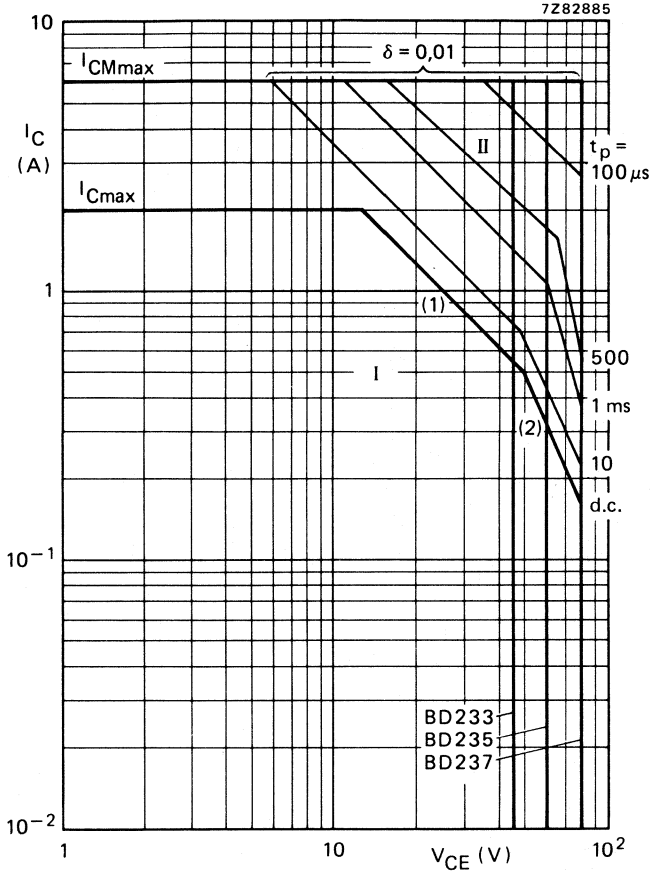


Fig. 4 Safe Operating Area with the transistor forward biased, $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

- 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).

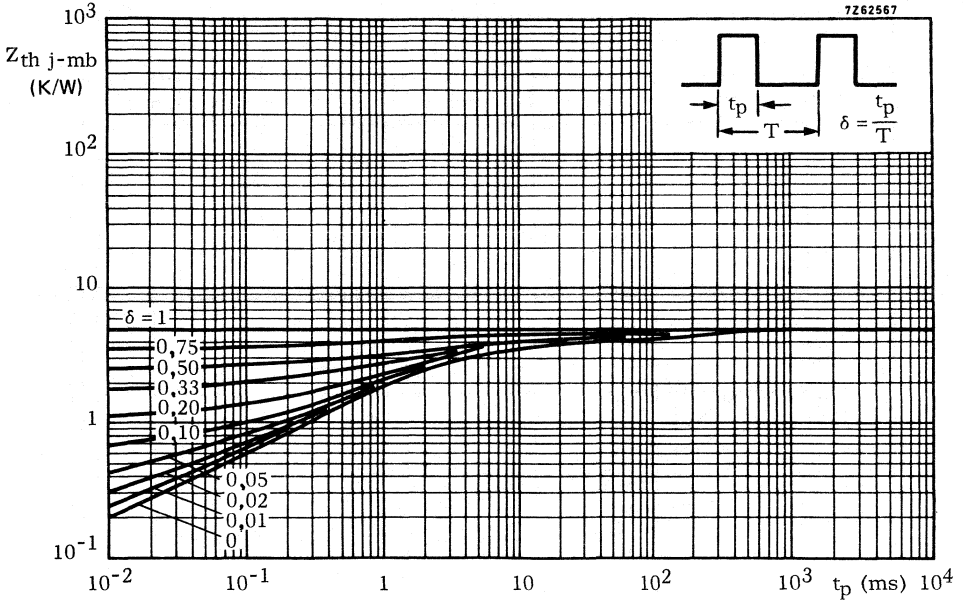
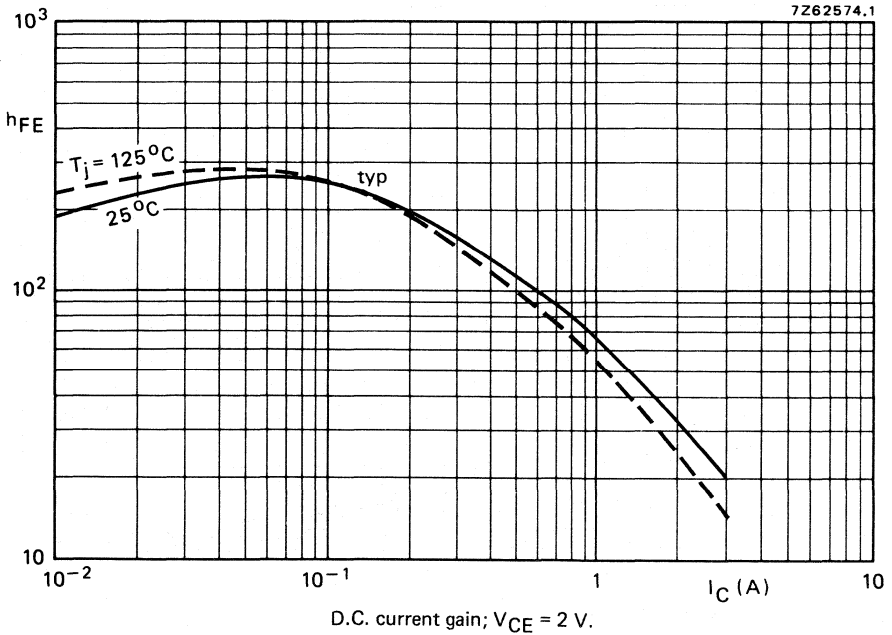


Fig. 5 Pulse power rating chart.



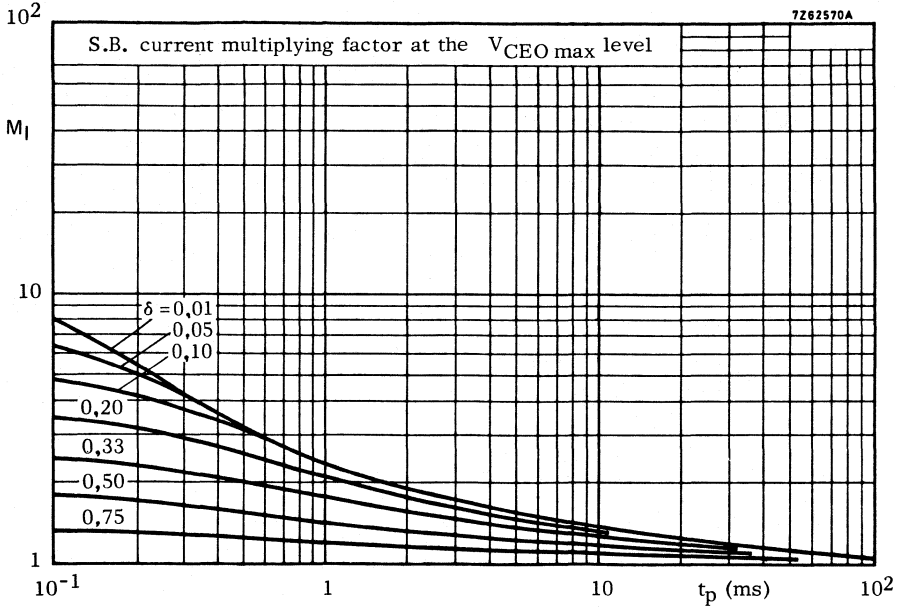


Fig. 7 S.B. current multiplying factor at the $V_{CE0\max}$ level.

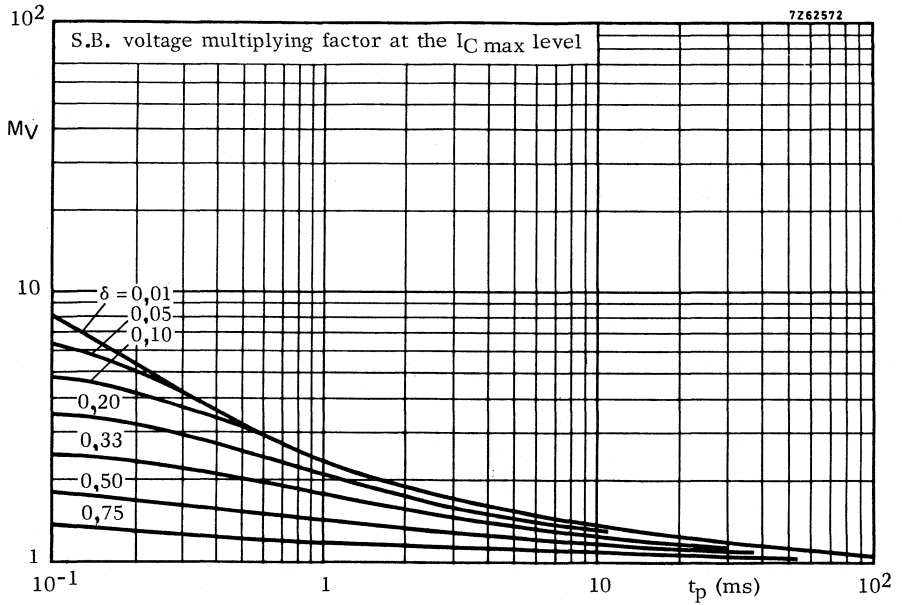


Fig. 8 S.B. voltage multiplying factor at the $I_{C\max}$ level.

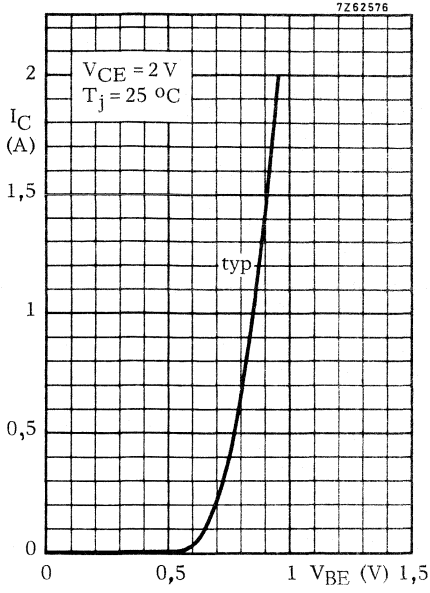


Fig. 9.

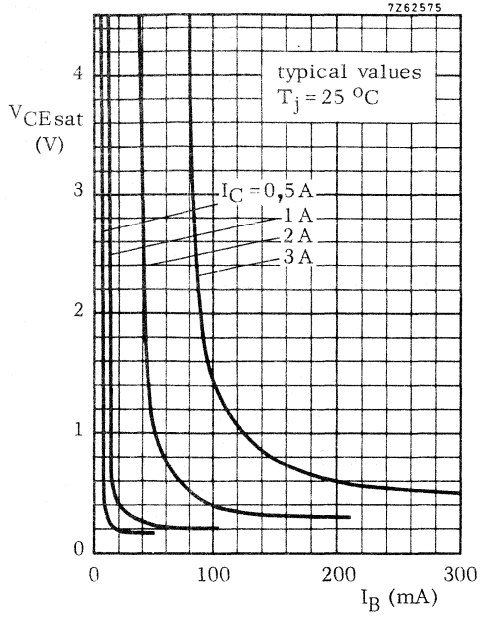


Fig. 10.

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.

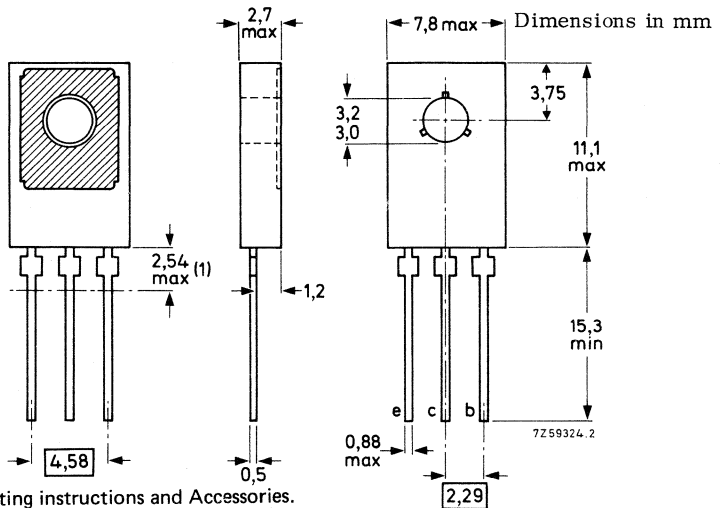
QUICK REFERENCE DATA

			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				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

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)

		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
Collector current (d. c.)	$-I_C$	max.	2		A
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
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		K/W
From junction to mounting base	$R_{th\ j-mb}$	=	5		K/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

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

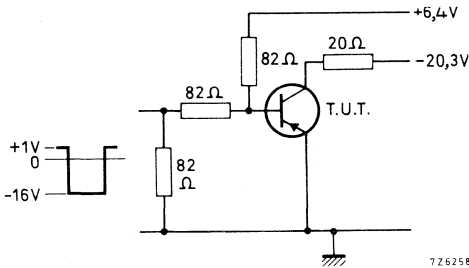
turn-on time

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

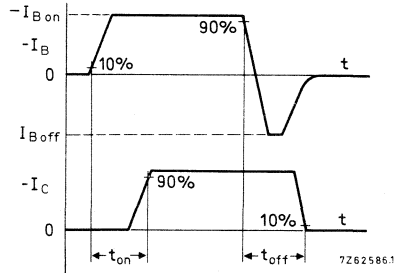
turn-off time

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

Test circuit



7262585



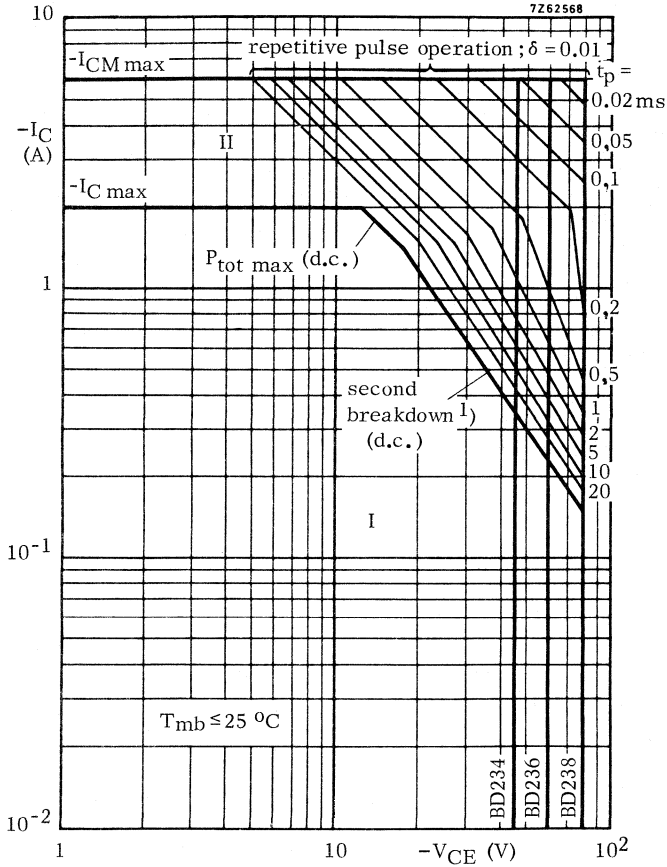
7262586.1

Input pulse:

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

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

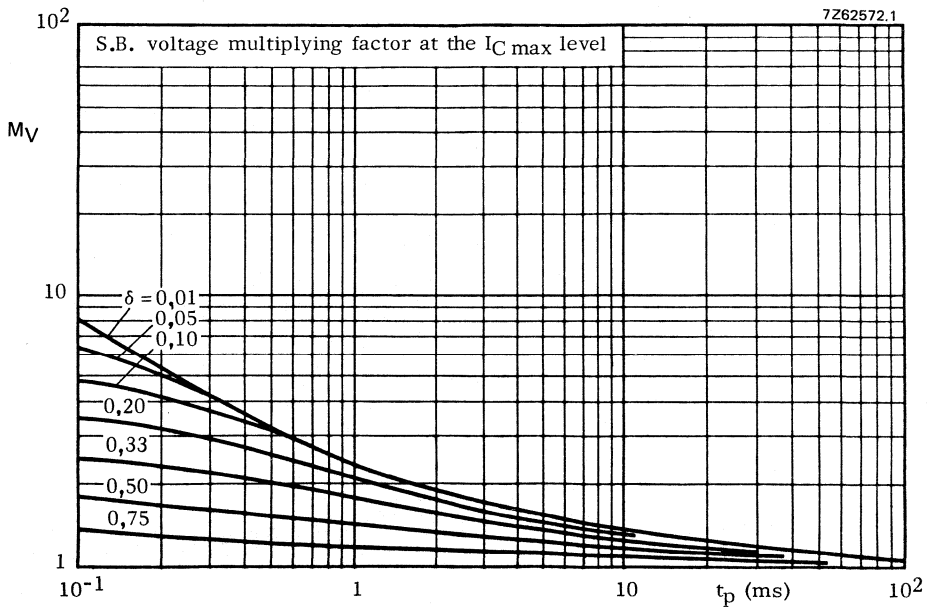
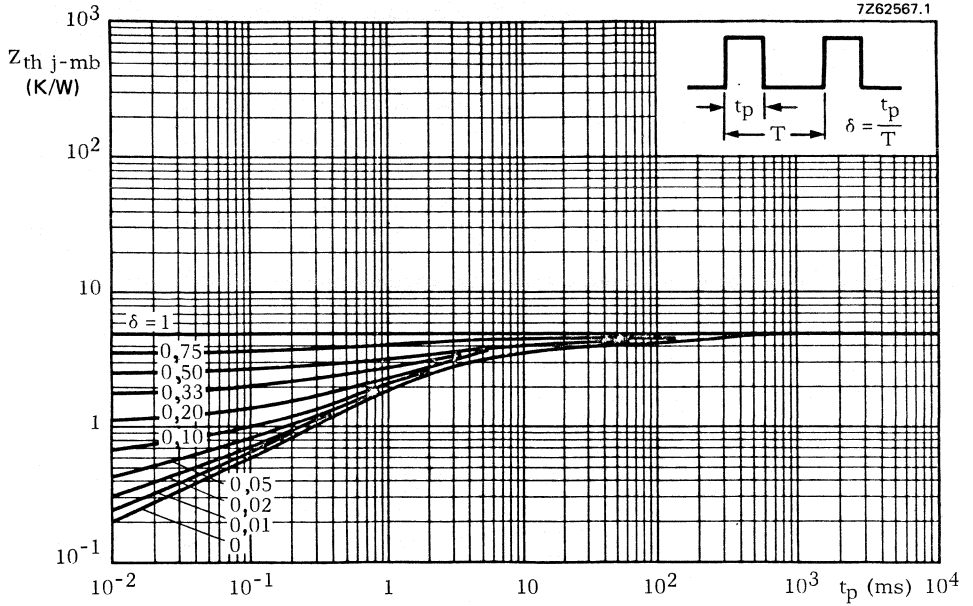
$T = 500\text{ }\mu\text{s}$

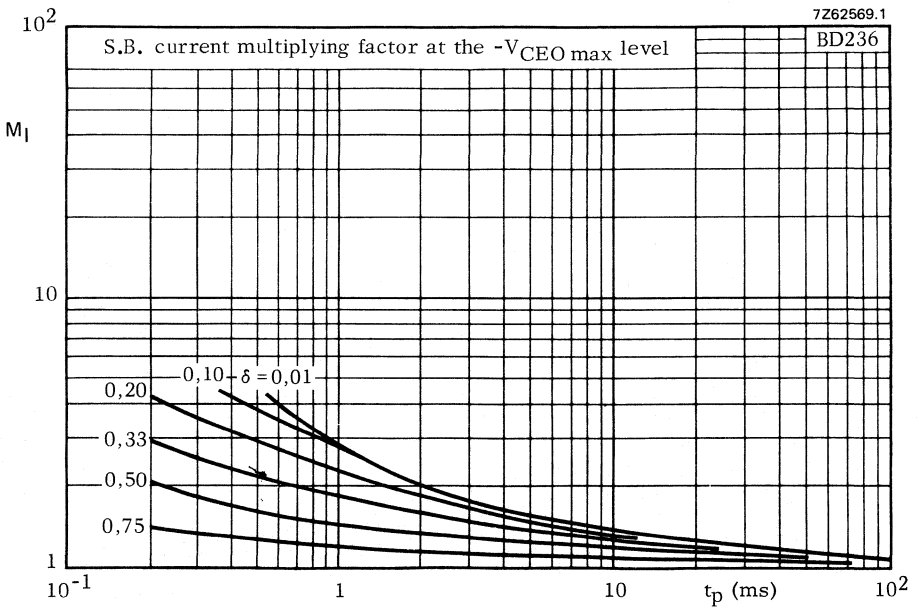
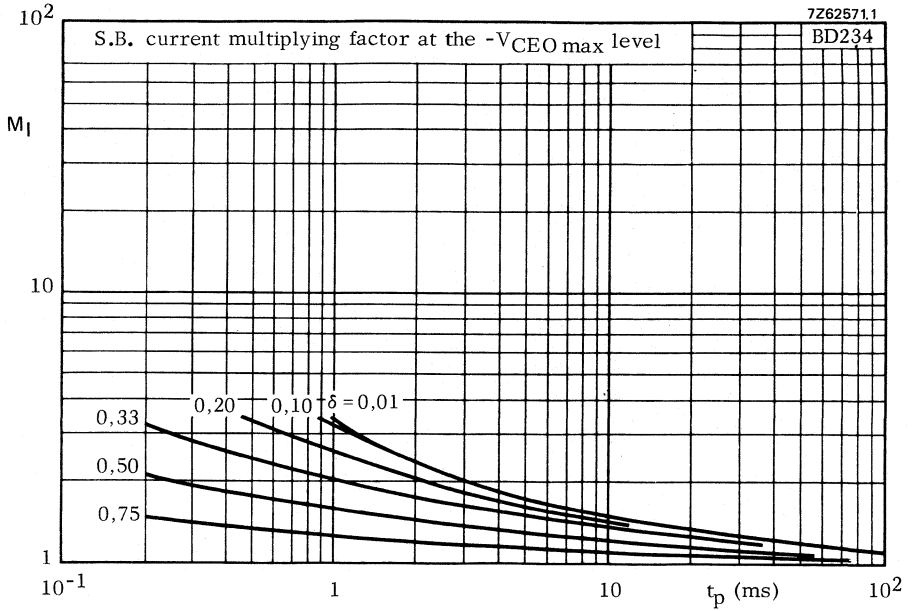


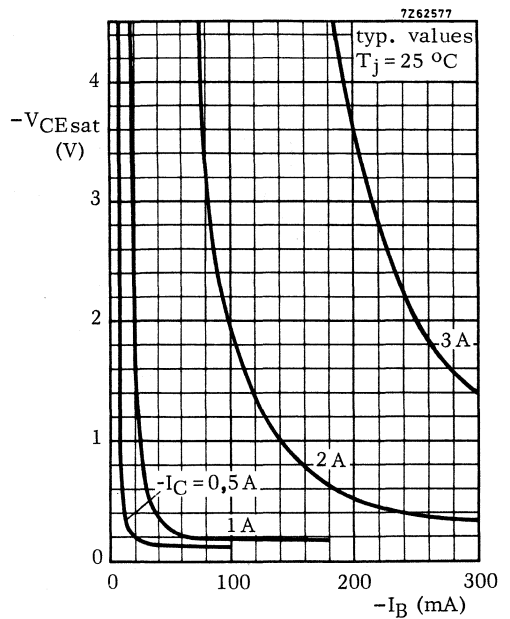
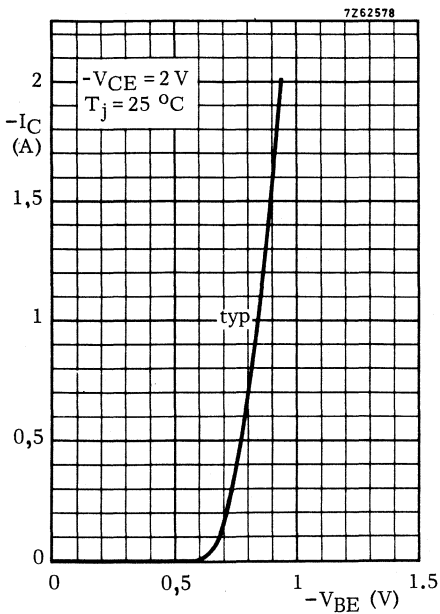
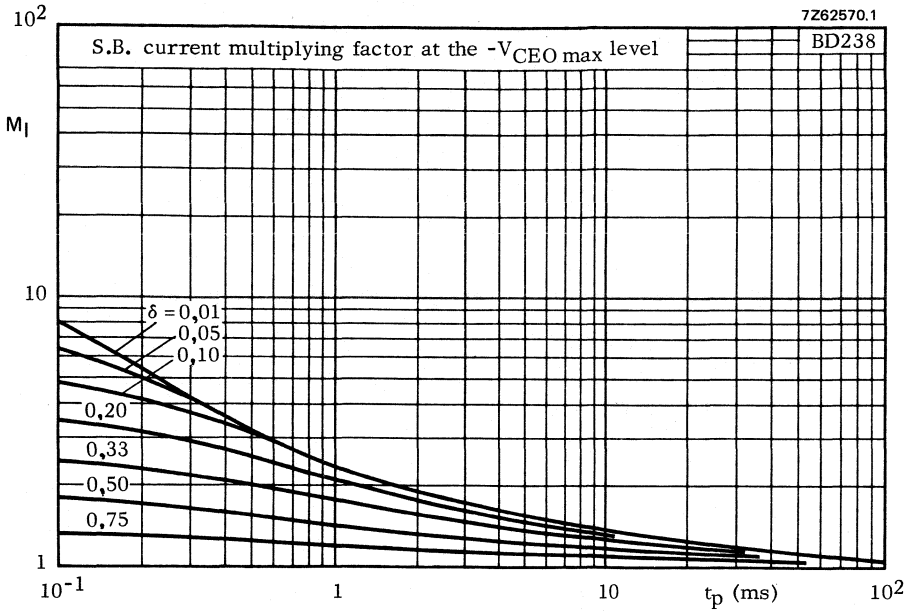
Safe Operating Area with the transistor forward biased

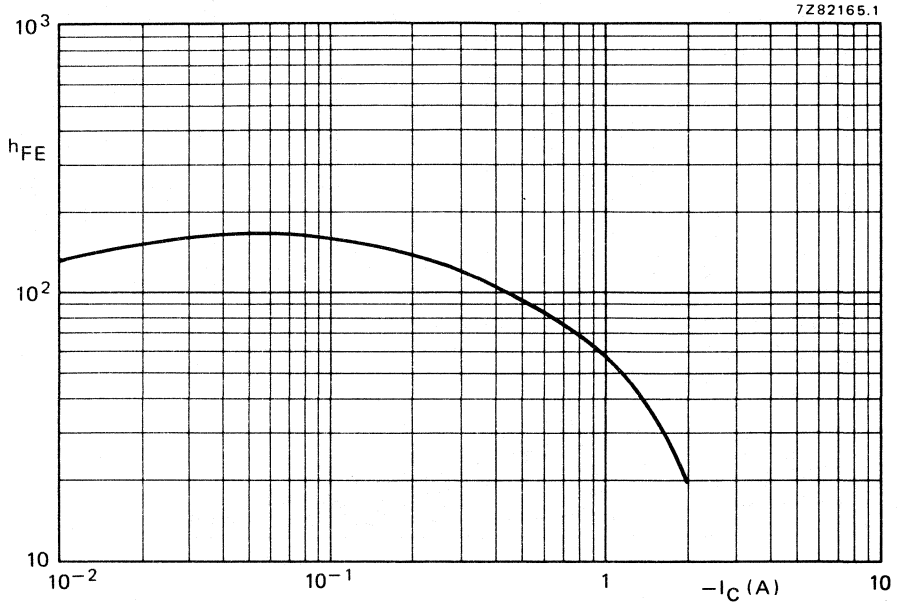
- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation

1) Independent of temperature.









Typical static forward current transfer ratio as a function of the collector current.
 $-V_{CE} = 2 \text{ V}; T_j \leq 25 \text{ }^\circ\text{C}.$

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in audio output stages, general amplifier and high-speed switching applications. P-N-P complements are BD240; 240A; 240B and BD240C.

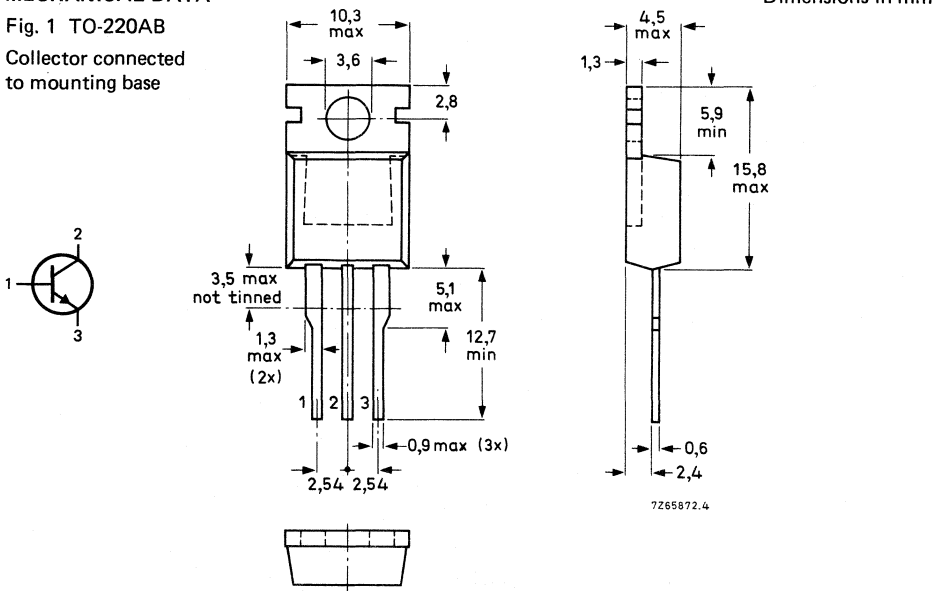
QUICK REFERENCE DATA

	BD239	A	B	C
Collector-base voltage	V_{CB0} max. 45	60	80	100 V
Collector-emitter voltage	V_{CE0} max. 45	60	80	100 V
Collector current (peak value)	I_{CM} max.	7		A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.	30		W
Junction temperature	T_j max.	150		$^{\circ}\text{C}$
D.C. current gain	h_{FE} >	15		
Transition frequency at $f = 1\text{ MHz}$	f_T >	3		MHz
$I_C = 1\text{ A}, V_{CE} = 4\text{ V}$				
$I_C = 200\text{ mA}, V_{CE} = 10\text{ V}$				

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)

		BD239	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	80	100 V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	V_{CER}	max.	55	70	90	115 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	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70	K/W

CHARACTERISTICS

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

		BD239; A	BD239B; C
Collector cut-off current $I_B = 0; V_{CE} = 30 \text{ V}$	I_{CEO}	< 0,3	— mA
$I_B = 0; V_{CE} = 60 \text{ V}$	I_{CEO}	< —	0,3 mA
$V_{BE} = 0; V_{CE} = V_{CEOmax}$	I_{CES}	< 0,2	mA
Emitter cut-off current $I_C = 0; V_{EB} = 5 \text{ V}$	I_{EBO}	< 1	mA
D.C. current gain* $I_C = 200 \text{ mA}; V_{CE} = 4 \text{ V}$	h_{FE}	> 40	
$I_C = 1 \text{ A}; V_{CE} = 4 \text{ V}$	h_{FE}	> 15	
Base-emitter voltage** $I_C = 1 \text{ A}; V_{CE} = 4 \text{ V}$	V_{BE}	< 1,3	V
Collector-emitter saturation voltage* $I_C = 1 \text{ A}; I_B = 0,2 \text{ A}$	V_{CEsat}	< 0,6	V
Turn-off breakdown energy $L = 20 \text{ mH}; I_{CC} = 1,8 \text{ A}$	$E(BR)$	> 32	mJ

* Measured under pulse conditions; $t_p \leq 300 \mu\text{s}$, $\delta \leq 0,02$.

** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

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

$I_C = 0,2 \text{ A}; V_{CE} = 10 \text{ V}$

$f_T > 3 \text{ MHz}$

Switching times

(between 10% and 90% levels)

$I_{Con} = 0,2 \text{ A}; I_{Bon} = -I_{Boff} = 20 \text{ mA}$

Turn-on time

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

Turn-off time

$t_{off} \text{ typ. } 0,8 \mu\text{s}$

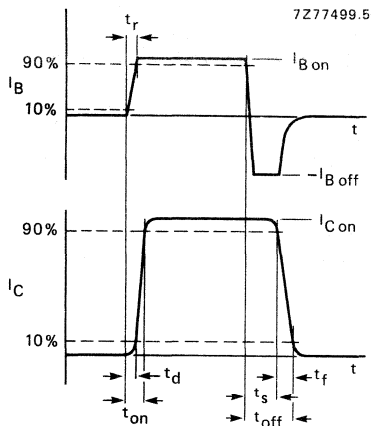
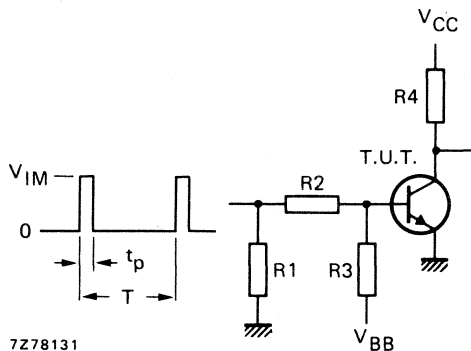


Fig. 2 Switching times waveforms.



- $V_{IM} = 40 \text{ V}$
- $V_{CC} = 30 \text{ V}$
- $-V_{BB} = 4,4 \text{ V}$
- $R1 = 51 \Omega$
- $R2 = 1000 \Omega$
- $R3 = 300 \Omega$
- $R4 = 150 \Omega$
- $t_r = t_f \leq 15 \text{ ns}$
- $t_p = 10 \mu\text{s}$
- $T = 500 \mu\text{s}$

Fig. 3 Switching times test circuit.

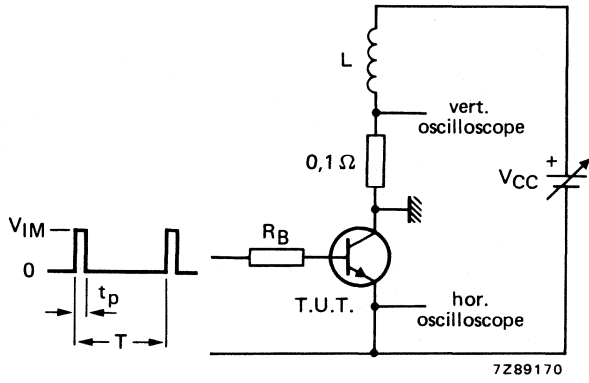


Fig. 4 Test circuit for turn-off breakdown energy.
 $V_{IM} = 12 \text{ V}$; $R_B = 270 \Omega$; $I_{CC} = 1,8 \text{ A}$; $t_p = 1 \text{ ms}$; $\delta = 0,01$.

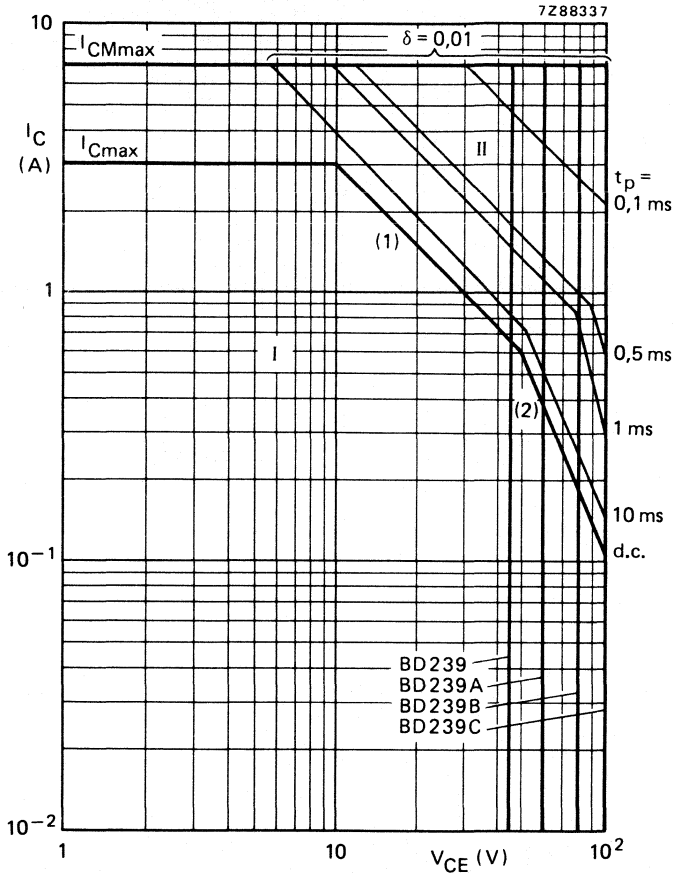


Fig. 5 Safe Operating Area; $T_{mb} = 25\text{ }^\circ\text{C}$.

- 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.

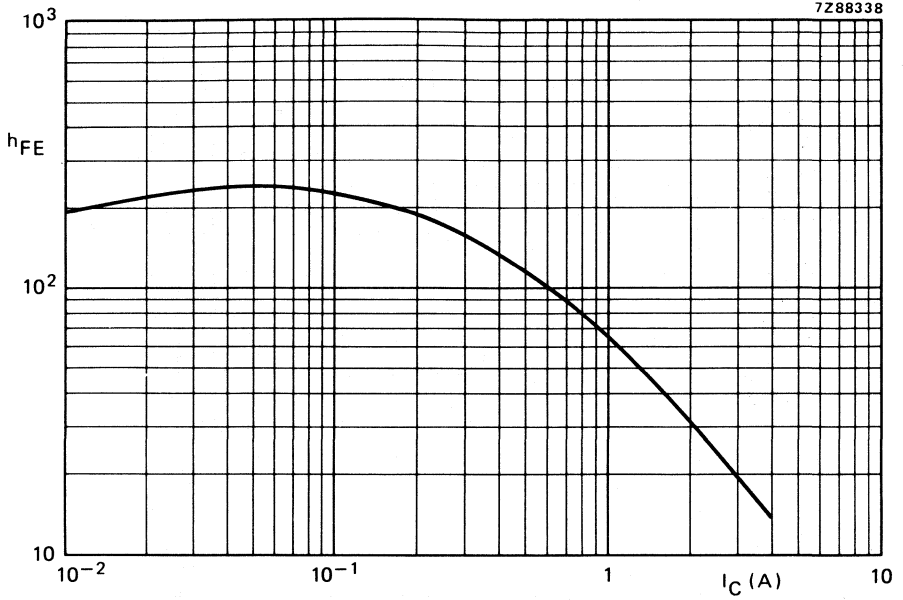


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 4$ V, $T_j = 25$ °C.

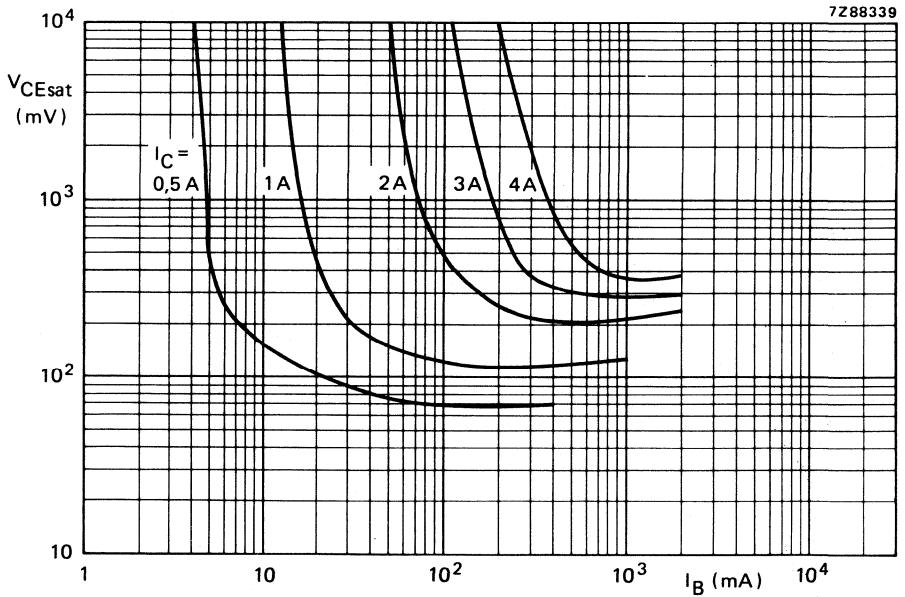


Fig. 7 Typical values collector-emitter saturation voltage at $T_j = 25$ °C.

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 BD239; 239A; 239B; and BD239C.

QUICK REFERENCE DATA

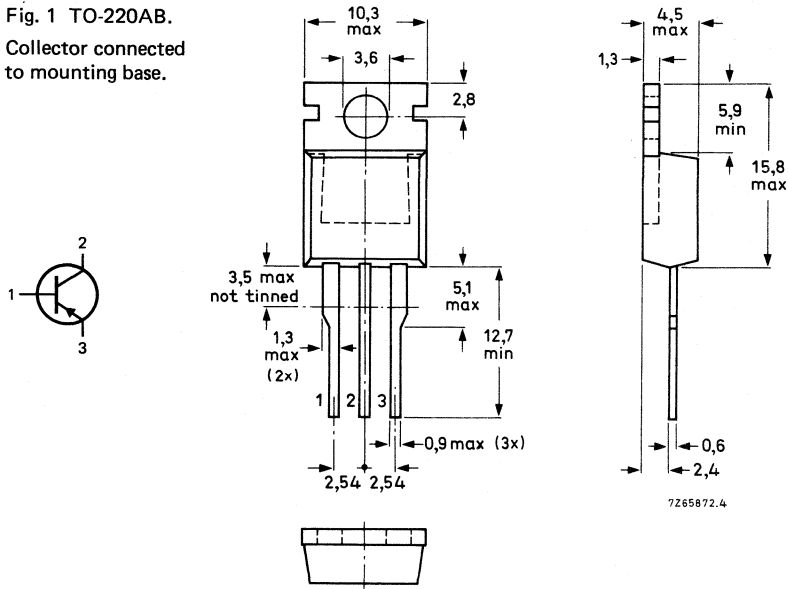
		BD240	A	B	C
Collector-base voltage	$-V_{CBO}$ max.	45	60	80	100 V
Collector-emitter voltage	$-V_{CEO}$ max.	45	60	80	100 V
Collector current (d.c.)	$-I_{CM}$ max.		7		A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.		30		W
Junction temperature	T_j max.		150		$^{\circ}\text{C}$
D.C. current gain			15		
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE} >				
Transition frequency			3		MHz
$-I_C = 200\text{ mA}; -V_{CE} = 10\text{ V}$	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)

			BD240	A	B	C	
Collector-base voltage (open emitter)	$-V_{CB0}$	max.	45	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	$-V_{CER}$	max.	55	70	90	115	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		K/W
From junction to ambient in free air	$R_{th j-a}$	=		70		K/W

CHARACTERISTICS

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

			BD240A	BD240B; C	
Collector cut-off current					
$-I_B = 0; -V_{CE} = 30 \text{ V}$	$-I_{CEO}$	<	0,3	—	mA
$-I_B = 0; -V_{CE} = 60 \text{ V}$	$-I_{CEO}$	<	—	0,3	mA
$-V_{BE} = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CES}$	<	0,2		mA
Emitter cut-off current					
$I_C = 0; -V_{EB} = 5 \text{ V}$	$-I_{EBO}$	<		1	mA
D.C. current gain *					
$-I_C = 200 \text{ mA}; -V_{CE} = 4 \text{ V}$	h_{FE}	>		40	
$-I_C = 1 \text{ A}; -V_{CE} = 4 \text{ V}$	h_{FE}	>		15	
Base-emitter voltage *					
$-I_C = 1 \text{ A}; -V_{CE} = 4 \text{ V}$	$-V_{BE}$	<		1,3	V
Collector-emitter saturation voltage *					
$-I_C = 1 \text{ A}; -I_B = 0,2 \text{ A}$	$-V_{CEsat}$	<		0,6	V
Turn off breakdown energy					
$L = 20 \text{ mH}; -I_{CC} = 1,22 \text{ A}$	$E(BR)$	>		15	mJ

* Measured under pulse conditions: $t_p \leq 300 \mu\text{s}; \delta < 0,02$.

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

$-I_C = 200 \text{ mA}; -V_{CE} = 10 \text{ V}$

$f_T > 3 \text{ MHz}$

Switching times

$-I_{Con} = 0,2 \text{ A}; -I_{B on} = I_{B off} = 20 \text{ mA}$

turn-on time

$t_{on} \text{ typ. } 0,2 \mu\text{s}$

turn-off time

$t_{off} \text{ typ. } 0,4 \mu\text{s}$

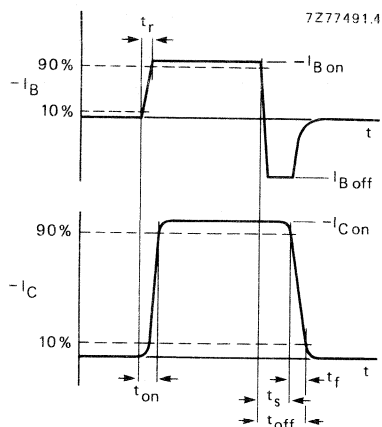
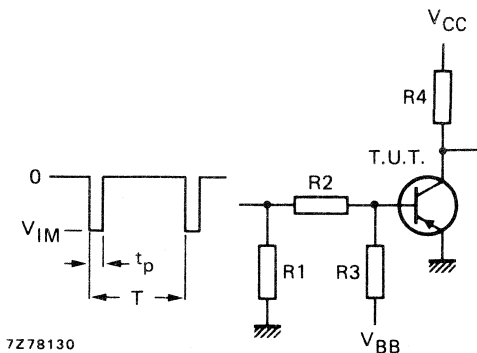


Fig. 2 Switching times waveforms.



- $-V_{IM} = 40 \text{ V}$
- $-V_{CC} = 30 \text{ V}$
- $+V_{BB} = 4,4 \text{ V}$
- $R1 = 51 \Omega$
- $R2 = 1000 \Omega$
- $R3 = 300 \Omega$
- $R4 = 150 \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 10 \mu\text{s}$
- $T = 500 \mu\text{s}$

Fig. 3 Switching times test circuit.

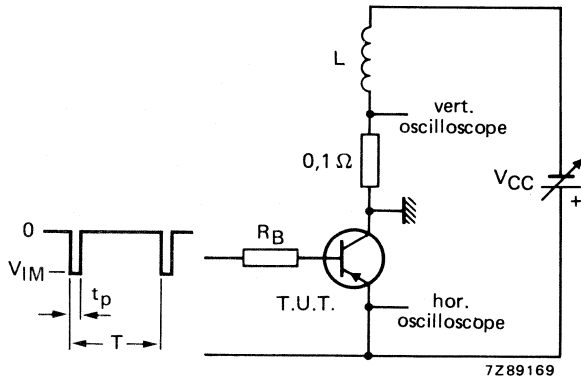


Fig. 4 Test circuit for turn-off breakdown energy.
 $V_{IM} = -12 \text{ V}$; $R_B = 270 \text{ } \Omega$; $-I_{CC} = 1,22 \text{ A}$; $t_p = 1 \text{ ms}$; $\delta = 0,01$.

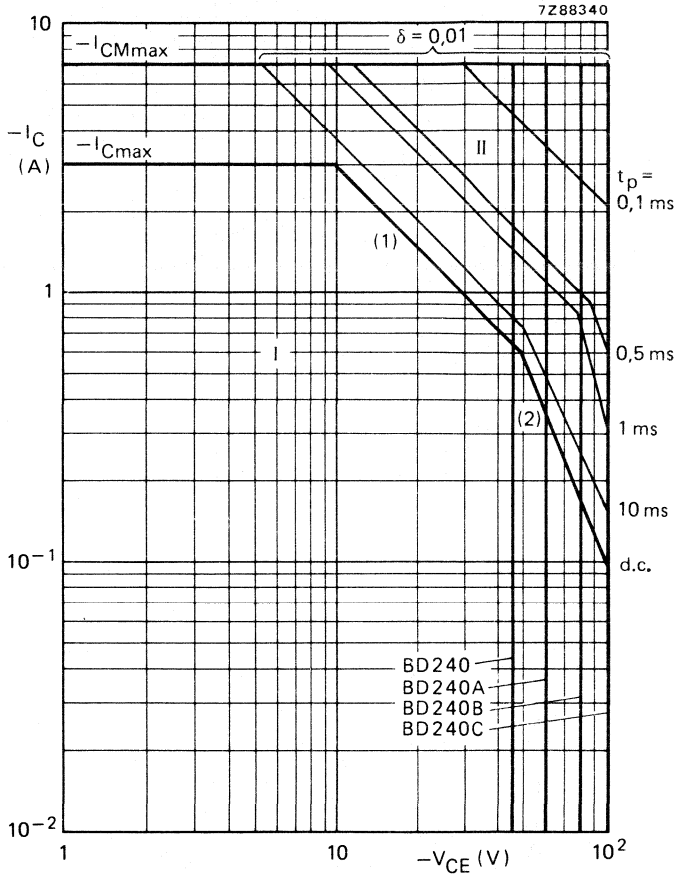


Fig. 5 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- 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.

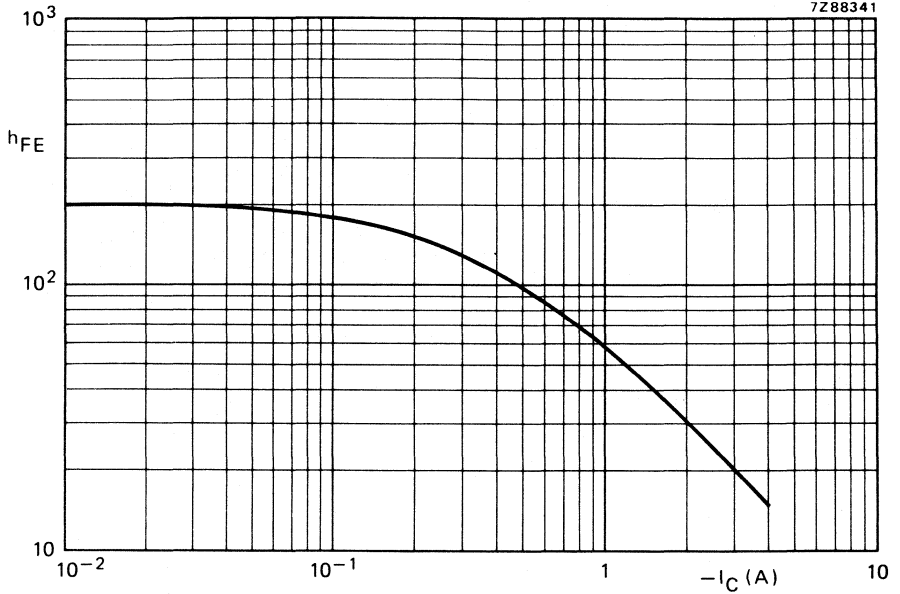


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 4$ V, $T_j = 25$ °C.

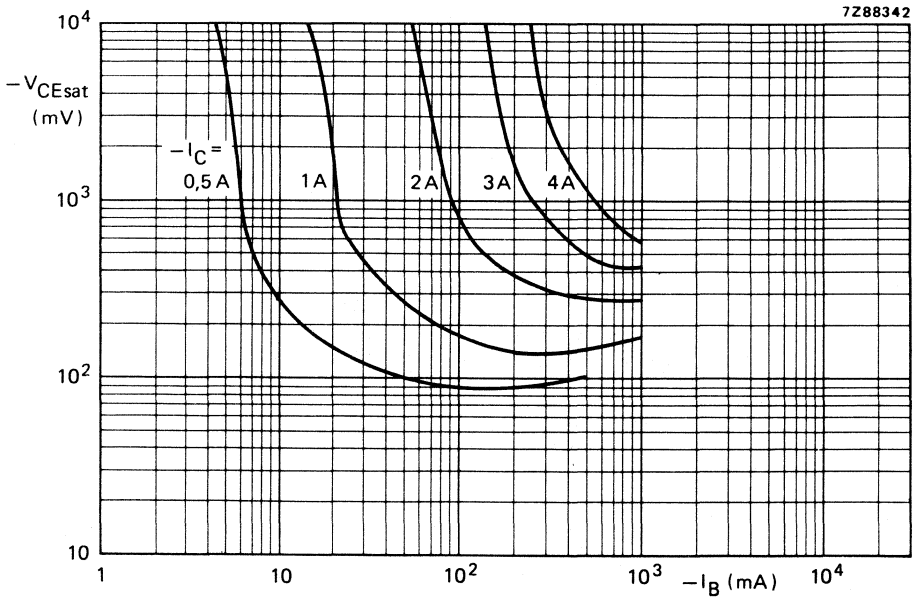


Fig. 7 Typical values collector-emitter saturation voltage at $T_j = 25$ °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in audio output stages, general amplifier and high-speed switching applications. P-N-P complements are BD242; 242A; 242B; and 242C.

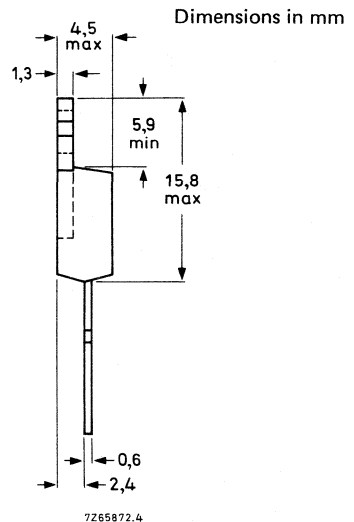
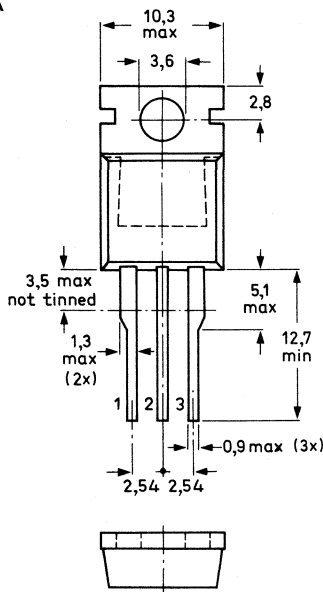
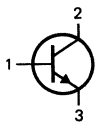
QUICK REFERENCE DATA

	BD241	A	B	C	
Collector-base voltage	V_{CBO} max.	45	60	80	100 V
Collector-emitter voltage	V_{CEO} max.	45	60	80	100 V
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	
Junction temperature	T_j max.	150		$^\circ\text{C}$	
D.C. current gain $I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>		25	
Transition frequency at $f = 1\text{ MHz}$ $I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$	f_T	>		3 MHz	

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)

		BD241	A	B	C
Collector-base voltage (open emitter)	V_{CBO} max.	45	60	80	100 V
Collector-emitter voltage (open base)	V_{CEO} max.	45	60	80	100 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	V_{CER} max.	55	70	90	115 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	$R_{thj-mb} =$	3, 12	K/W
From junction to ambient in free air	$R_{thj-a} =$	70	K/W

CHARACTERISTICS

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

		BD241; A	BD241B; C
Collector cut-off current			
$I_B = 0; V_{CE} = 30 \text{ V}$	$I_{CEO} <$	0,3	— mA
$I_B = 0; V_{CE} = 60 \text{ V}$	$I_{CEO} <$	—	0,3 mA
$V_{BE} = 0; V_{CE} = V_{CEOmax}$	$I_{CES} <$	0,2 mA	
Emitter cut-off current			
$I_C = 0; V_{EB} = 5 \text{ V}$	$I_{EBO} <$	1	mA
D.C. current gain*			
$I_C = 1 \text{ A}; V_{CE} = 4 \text{ V}$	$h_{FE} >$	25	
$I_C = 3 \text{ A}; V_{CE} = 4 \text{ V}$	$h_{FE} >$	10	
Base-emitter voltage**			
$I_C = 3 \text{ A}; V_{CE} = 4 \text{ V}$	$V_{BE} <$	1,8	V
Collector-emitter saturation voltage*			
$I_C = 3 \text{ A}; I_B = 0,6 \text{ A}$	$V_{CESat} <$	1,2	V
Small-signal current gain			
$I_C = 0,5 \text{ A}; V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}$	$ h_{fe} >$	20	
Turn off breakdown energy			
$L = 20 \text{ mH}; I_{CC} = 1,8 \text{ A}$	$E(BR) >$	32	mJ

* Measured under pulse conditions: $t_p \leq 300 \mu\text{s}; \delta < 0,02$.

** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

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

$I_C = 0,5 \text{ A}; V_{CE} = 10 \text{ V}$

$f_T > 3 \text{ MHz}$

Switching times

(between 10% and 90% levels)

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

Turn-on time

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

Turn-off time

t_{off} typ. $1 \mu\text{s}$

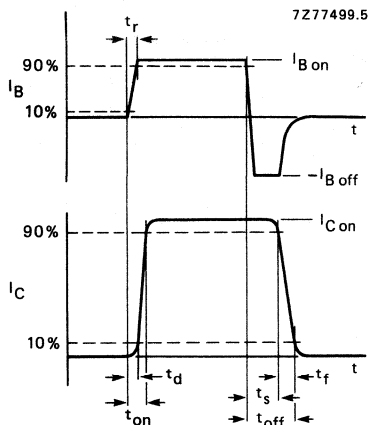


Fig. 2 Switching times waveforms.

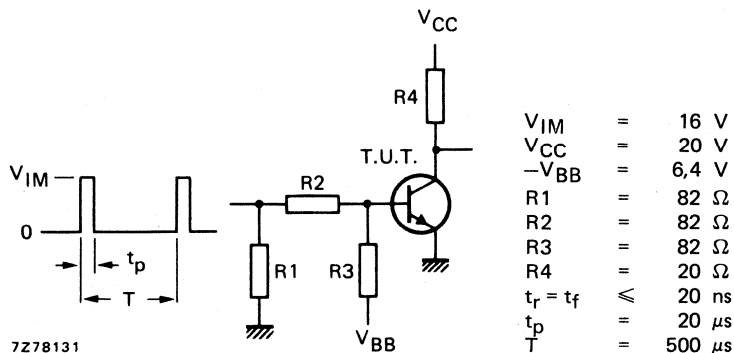


Fig. 3 Switching times test circuit.

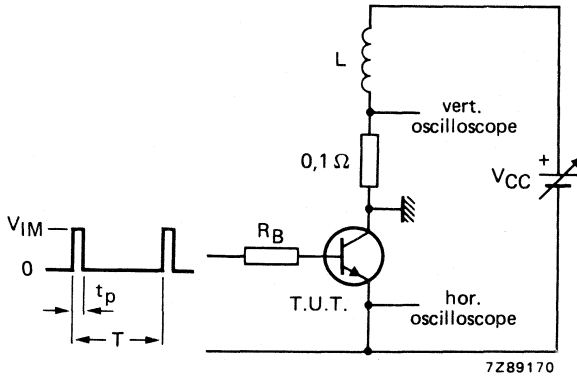


Fig. 4 Test circuit for turn-off breakdown energy.
 $V_{IM} = 12 \text{ V}$; $R_B = 270 \Omega$; $I_{CC} = 1,8 \text{ A}$; $t_p = 1 \text{ ms}$; $\delta = 0,01$.

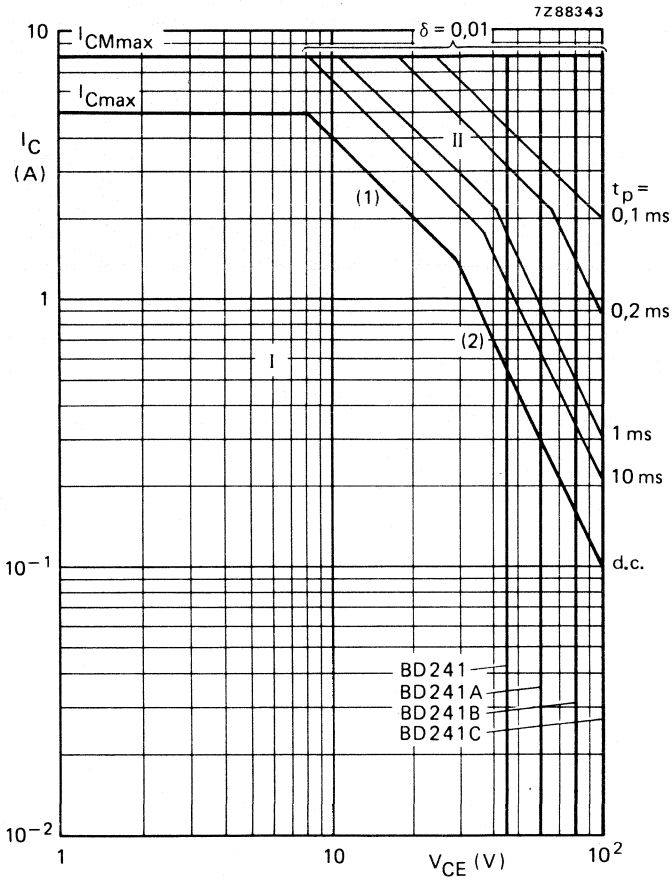


Fig. 5 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- 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.

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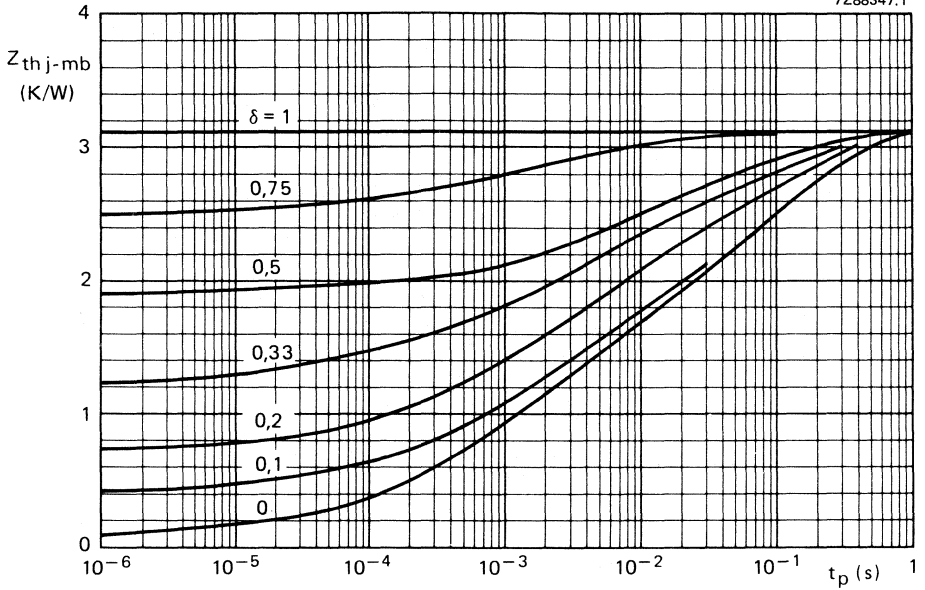


Fig. 6 Power pulse rating chart.

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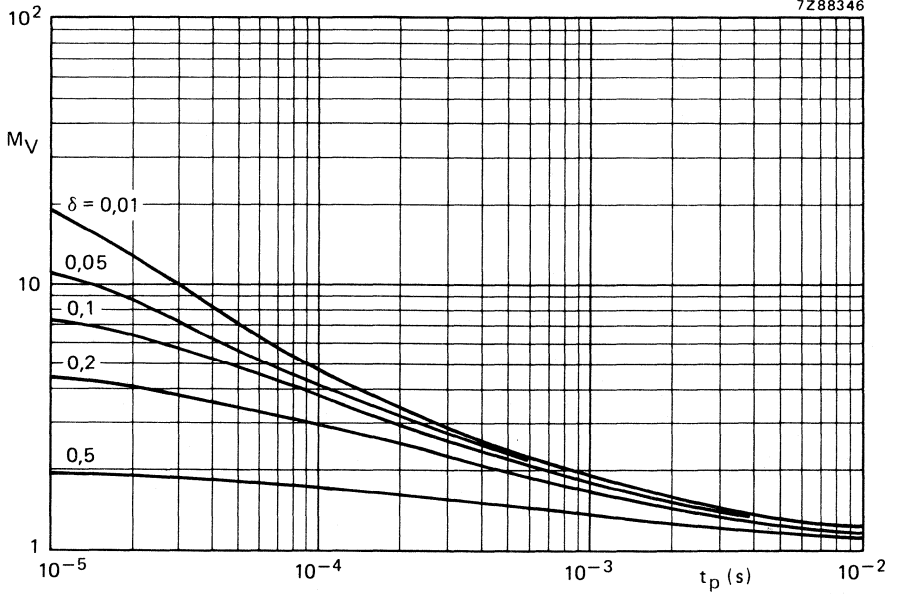


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

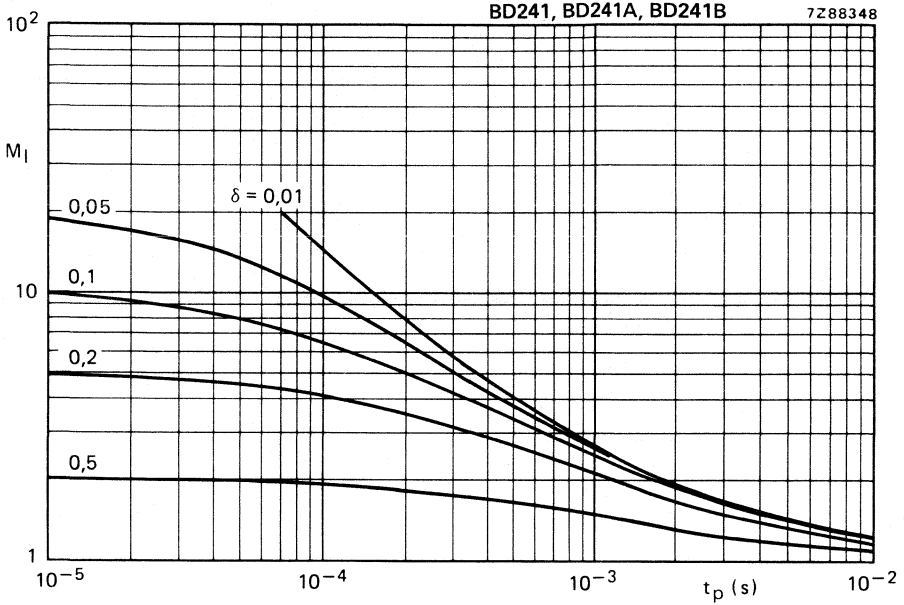


Fig. 8 S.B. current multiplying factor at the V_{CE0max} level.

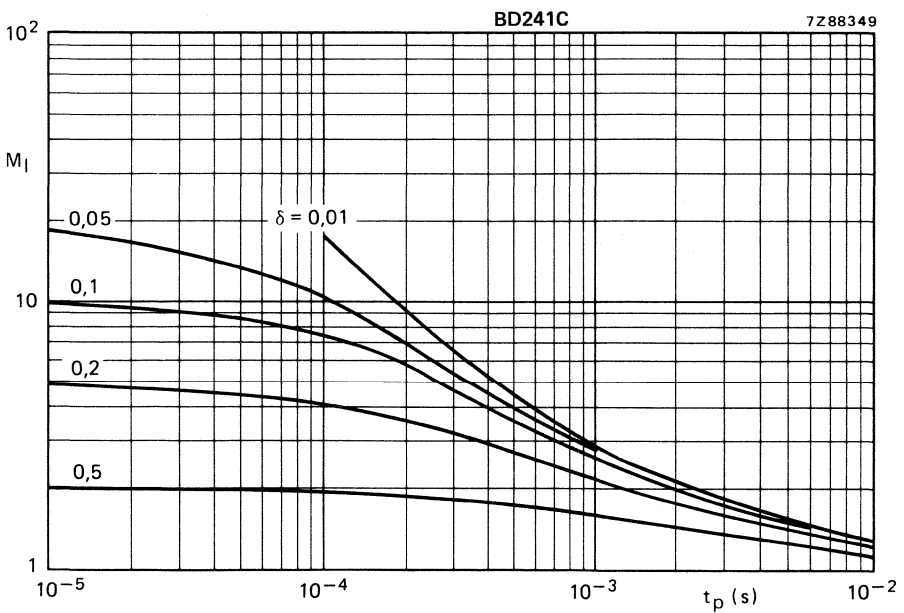


Fig. 9 S.B. current multiplying factor at the V_{CE0max} level.

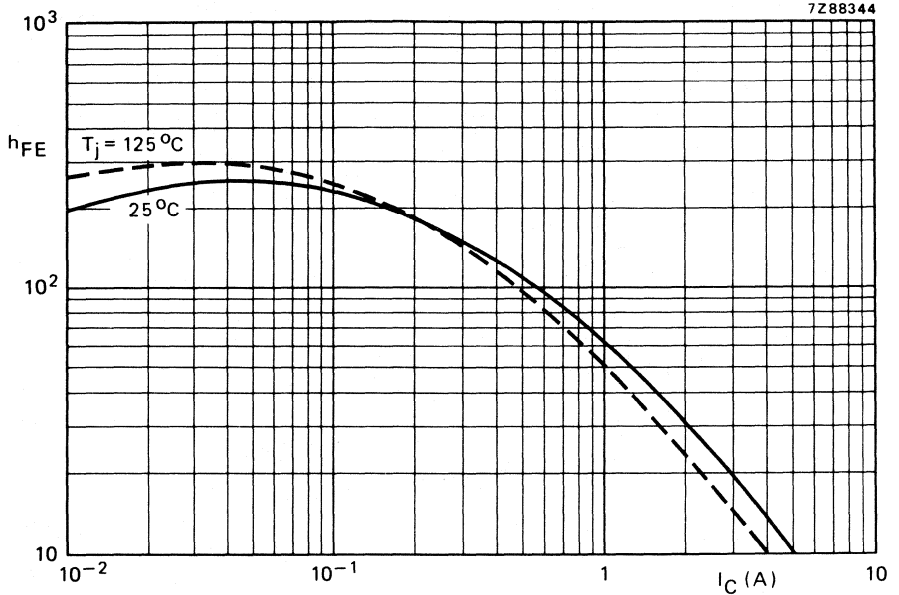


Fig. 10 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 4$ V.

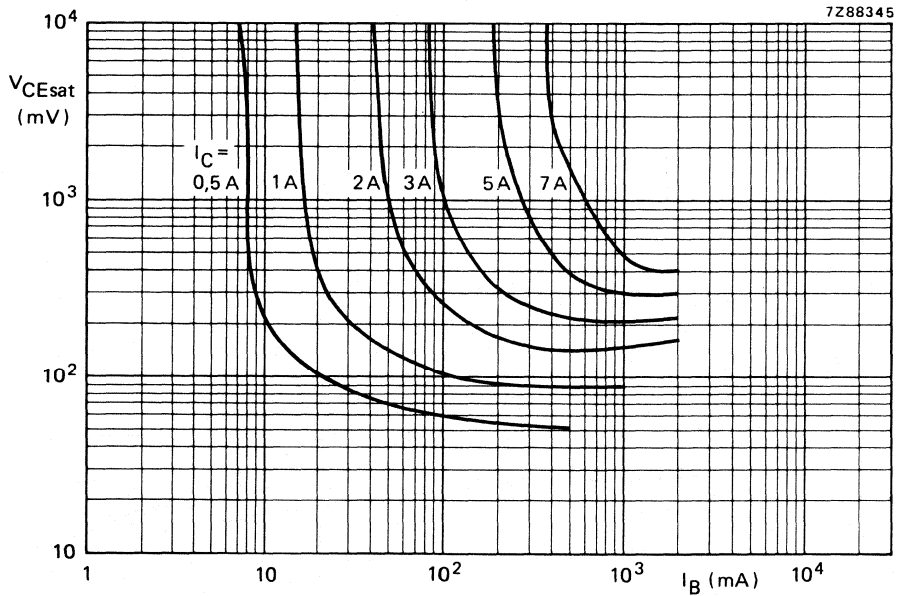


Fig. 11 Typical values collector-emitter saturation voltage at $T_j = 25^\circ\text{C}$.

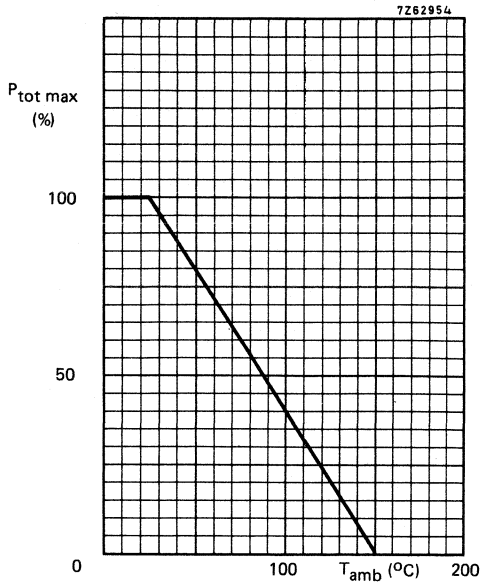


Fig. 12 Power derating curve.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in audio output stages, general amplifier and high-speed switching applications. N-P-N complements are BD241; 241A; 241B and BD241C.

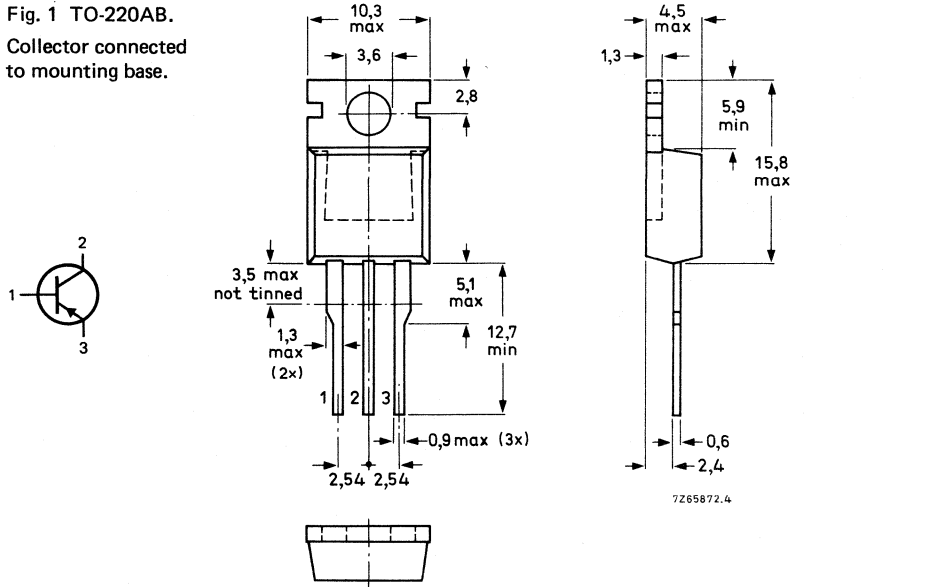
QUICK REFERENCE DATA

		BD242	A	B	C
Collector-base voltage	$-V_{CBO}$ max.	45	60	80	100 V
Collector-emitter voltage	$-V_{CEO}$ max.	45	60	80	100 V
Collector current (d.c.)	$-I_{CM}$ 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					
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	$h_{FE} >$			25	
Transition frequency					
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$	$f_T >$			3	MHz

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)

		BD242	A	B	C
Collector-base voltage (open emitter)	$-V_{CB0}$ max.	45	60	80	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	45	60	80	100 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	$-V_{CER}$ max.	55	70	90	115 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	K/W
From junction to ambient in free air	$R_{th\ j-a}$ =		70	K/W

CHARACTERISTICS

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

		BD242; A	BD242B; C	
Collector cut-off current				
$-I_B = 0; -V_{CE} = 30\text{ V}$	$-I_{CEO} <$	0,3	—	mA
$-I_B = 0; -V_{CE} = 60\text{ V}$	$-I_{CEO} <$	—	0,3	mA
$-V_{BE} = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CES} <$		0,2	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO} <$		1	mA
D.C. current gain *				
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	$h_{FE} >$		25	
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$	$h_{FE} >$		10	
Base-emitter voltage *				
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE} <$		1,8	V
Collector-emitter saturation voltage *				
$-I_C = 3\text{ A}; -I_B = 0,6\text{ A}$	$-V_{CEsat} <$		1,2	V
Small-signal current gain				
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} >$		20	
Turn off breakdown energy				
$L = 20\text{ mH}; -I_{CC} = 1,22\text{ A}$	$E_{(BR)} >$		15	mJ

* Measured under pulse conditions: $t_p \leq 300\ \mu\text{s}; \delta < 0,02$.

Transition frequency at $f = 1 \text{ MHz}$
 $-I_C = 500 \text{ mA}; -V_{CE} = 10 \text{ V}$

$f_T > 3 \text{ MHz}$

Switching times
 $-I_{Con} = 1 \text{ A}; -I_{B on} = I_{B off} = 0,1 \text{ A}$
 turn-on time
 turn-off time

$t_{on} \text{ typ. } 0,3 \mu\text{s}$
 $t_{off} \text{ typ. } 1 \mu\text{s}$

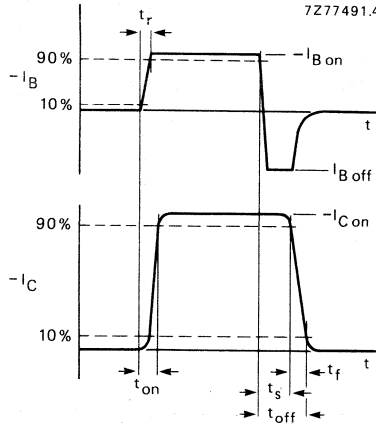


Fig. 2 Switching times waveforms.

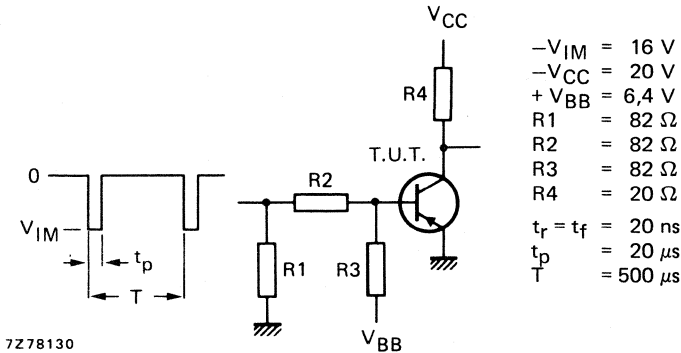


Fig. 3 Switching times test circuit.

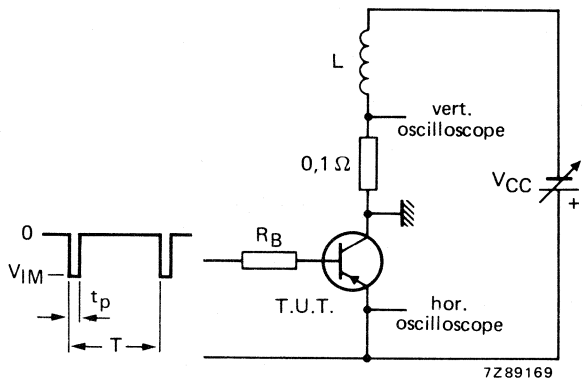


Fig. 4 Test circuit for turn-off breakdown energy.
 $V_{IM} = -12 \text{ V}$; $R_B = 270 \text{ }\Omega$; $-I_{CC} = 1,22 \text{ A}$; $t_p = 1 \text{ ms}$; $\delta = 0,01$.

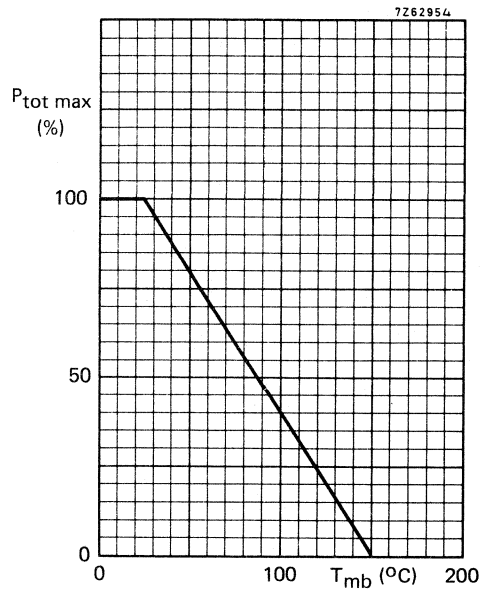


Fig. 4a Power derating curve.

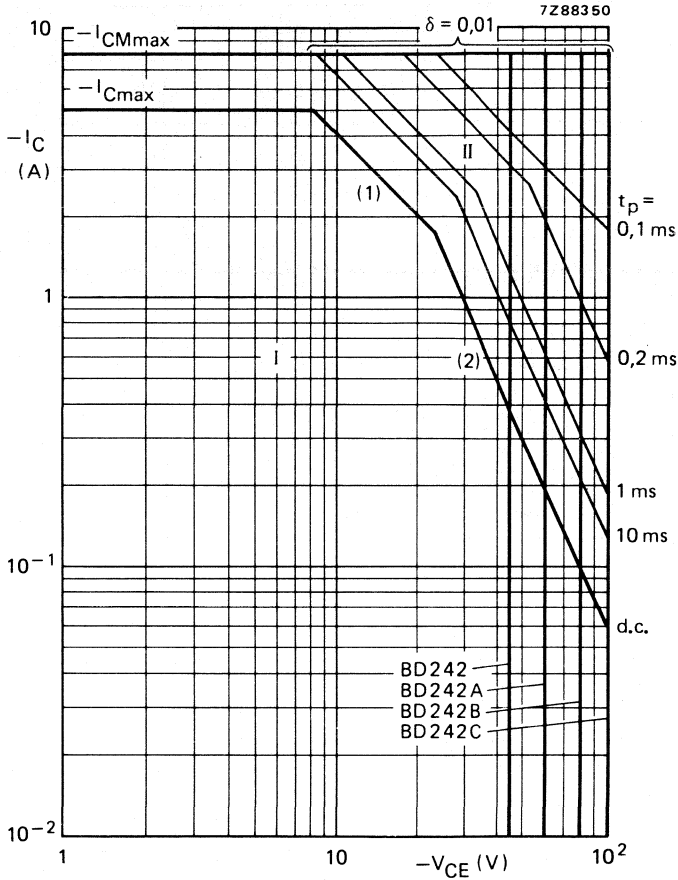


Fig. 5 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- 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.

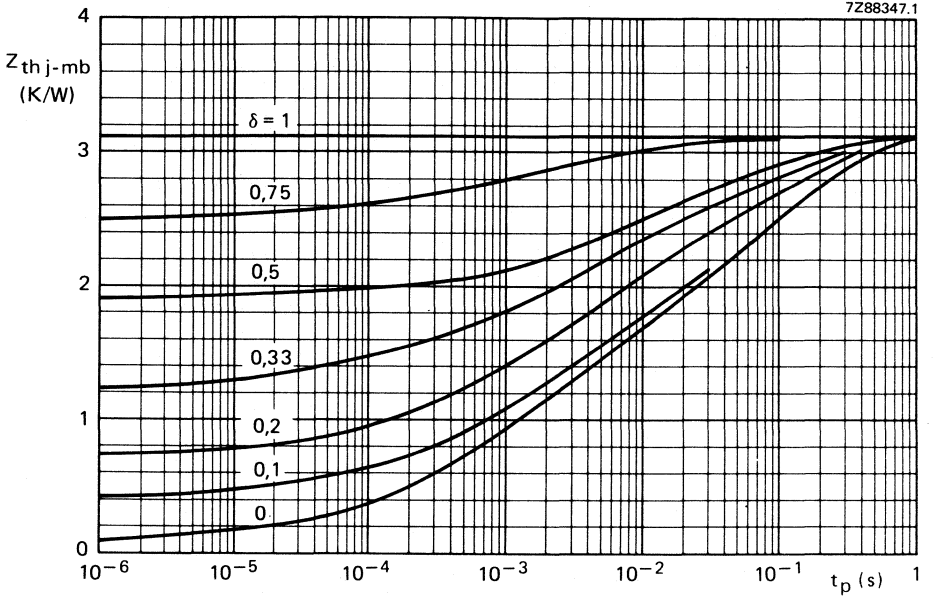


Fig. 6 Power pulse rating chart.

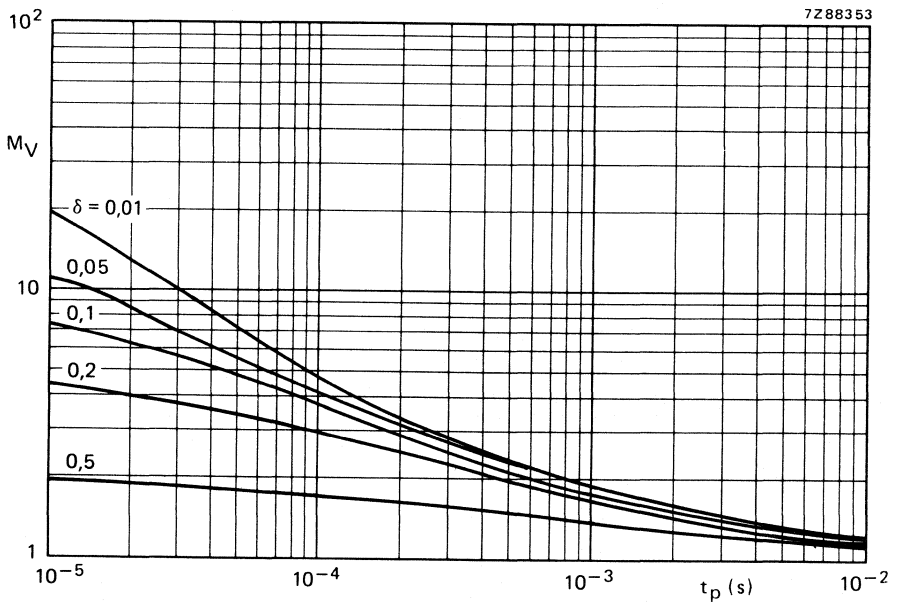


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

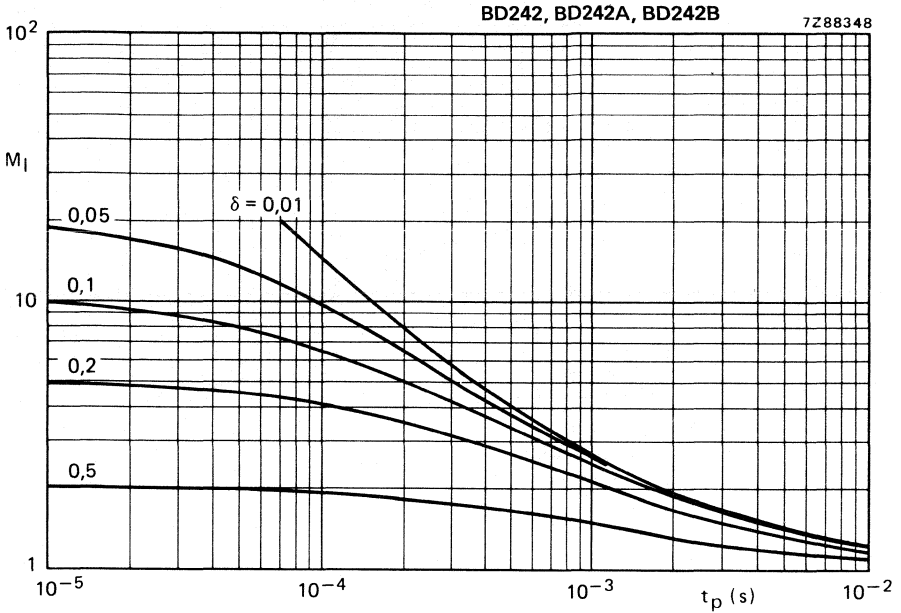


Fig. 8 S.B. current multiplying factor at the V_{CE0max} level.

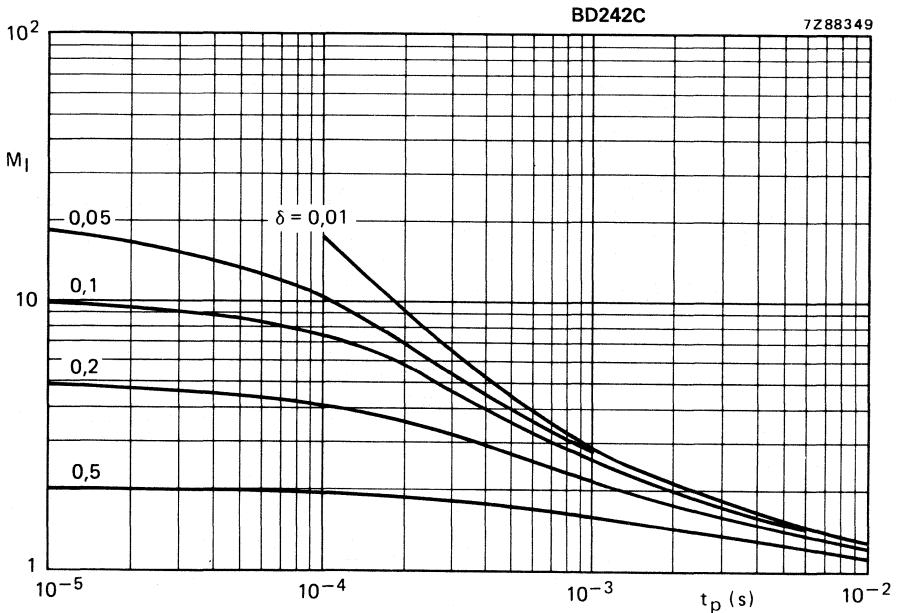


Fig. 9 S.B. current multiplying factor at the V_{CE0max} level.

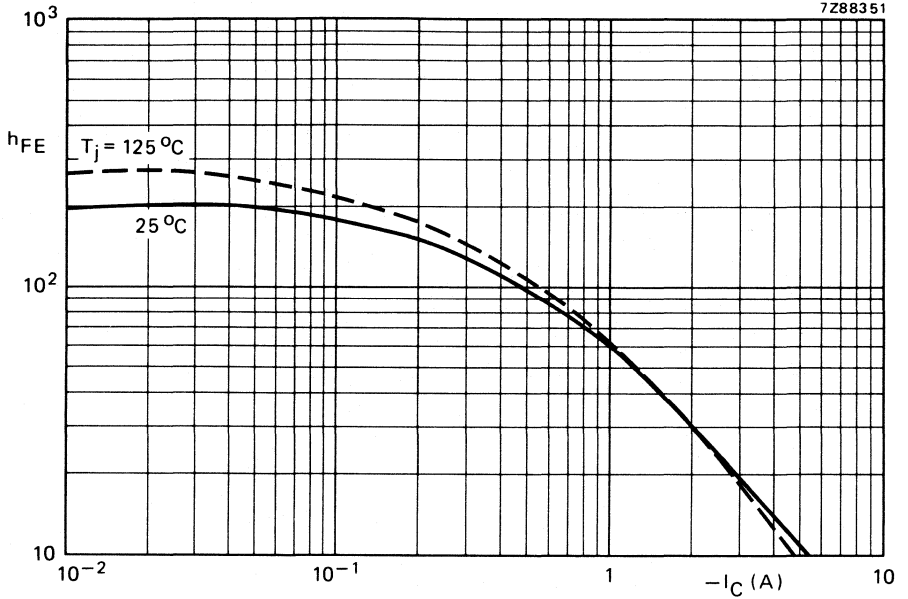


Fig. 10 Typical static forward current transfer ratio as a function of the collector current; $-V_{CE} = 4\text{ V}$.

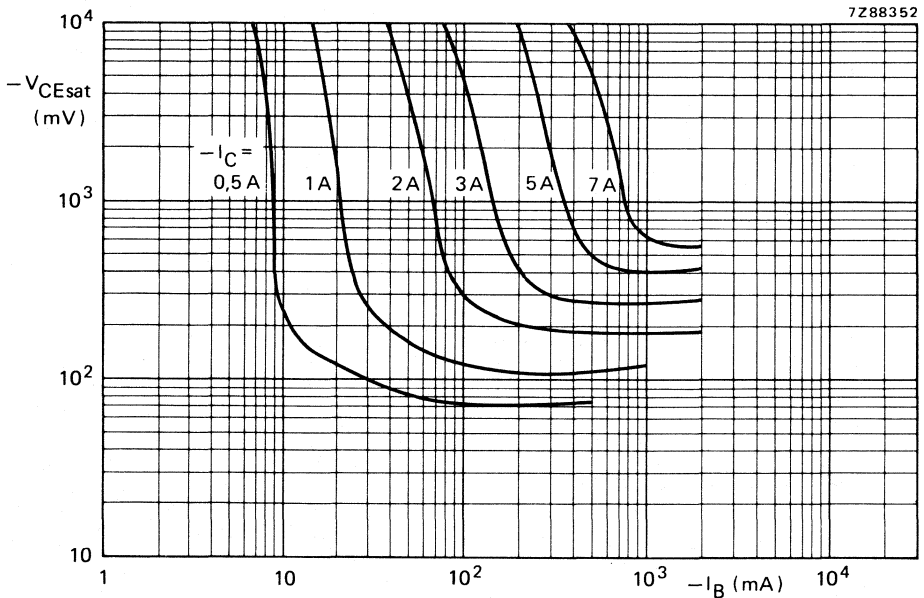


Fig. 11 Typical values collector-emitter saturation voltage at $T_j = 25^\circ\text{C}$.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in general amplifier and switching applications. P-N-P complements are BD244; 244A; 244B; and BD244C.

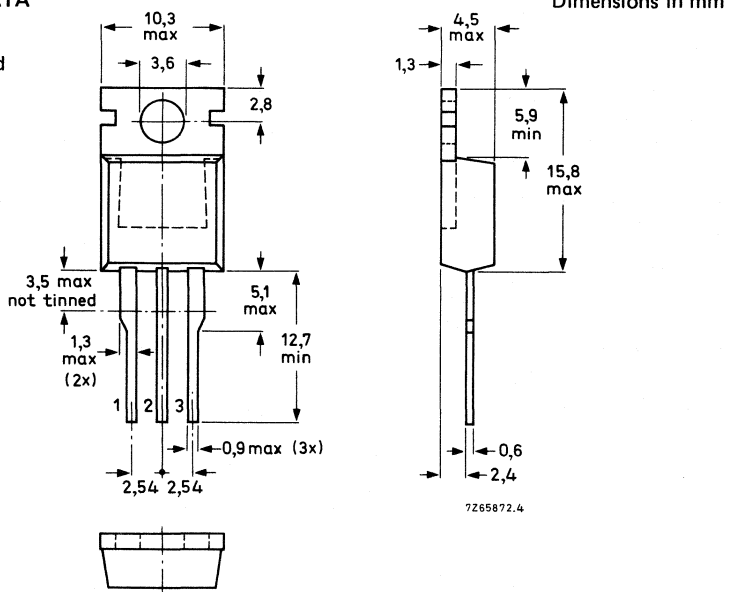
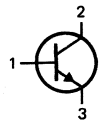
QUICK REFERENCE DATA

		BD243	A	B	C
Collector-base voltage	V_{CBO}	max. 45	60	80	100 V
Collector-emitter voltage	V_{CEO}	max. 45	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.	65		W
Junction temperature	T_j	max.	150		$^{\circ}\text{C}$
D.C. current gain	h_{FE}	>	15		
$I_C = 3\text{ A}; V_{CE} = 4\text{ V}$					
Transition frequency at $f = 1\text{ MHz}$	f_T	>	3		MHz
$I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$					

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)

		BD243	A	B	C
Collector-base voltage (open emitter)	V_{CBO}	max. 45	60	80	100 V
Collector-emitter voltage (open base)	V_{CEO}	max. 45	60	80	100 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	V_{CER}	max. 55	70	90	115 V
Emitter-base voltage (open collector)	V_{EBO}	max.	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.	3		A
Total power dissipation up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	65		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}	=	1,92	K/W
From junction to ambient in free air	R_{thj-a}	=	70	K/W

CHARACTERISTICS

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

		BD243; A	BD243B; C	
Collector cut-off current				
$I_B = 0; V_{CE} = 30 \text{ V}$	I_{CEO}	< 0,7	—	mA
$I_B = 0; V_{CE} = 60 \text{ V}$	I_{CEO}	< —	0,7	mA
$V_{BE} = 0; V_{CE} = V_{CEOmax}$	I_{CES}	< 0,4		mA
Emitter cut-off current				
$I_C = 0; V_{EB} = 5 \text{ V}$	I_{EBO}	< 1		mA
D.C. current gain*				
$I_C = 300 \text{ mA}; V_{CE} = 4 \text{ V}$	h_{FE}	> 30		
$I_C = 3 \text{ A}; V_{CE} = 4 \text{ V}$	h_{FE}	> 15		
Base-emitter voltage**				
$I_C = 6 \text{ A}; V_{CE} = 4 \text{ V}$	V_{BE}	< 2		V
Collector-emitter saturation voltage*				
$I_C = 6 \text{ A}; I_B = 1 \text{ A}$	V_{CEsat}	< 1,5		V
Turn off breakdown energy				
$L = 20 \text{ mH}; I_{CC} = 2,5 \text{ A}$	$E(BR)$	> 62,5		mJ

* Measured under pulse conditions: $t_p \leq 300 \mu\text{s}; \delta < 0,02$.

** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

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

$I_C = 0,5 \text{ A}; V_{CE} = 10 \text{ V}$

$f_T > 3 \text{ MHz}$

Switching times

(between 10% and 90% levels)

$I_{Con} = 1 \text{ A}; I_{B on} = -I_{B off} = 0,1 \text{ A}$

Turn-on time

t_{on} typ. $0,6 \mu\text{s}$

Turn-off time

t_{off} typ. $2 \mu\text{s}$

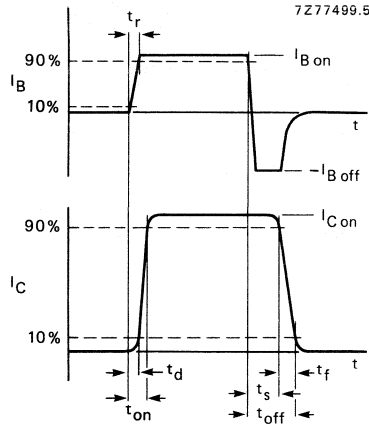


Fig. 2 Switching times waveforms.

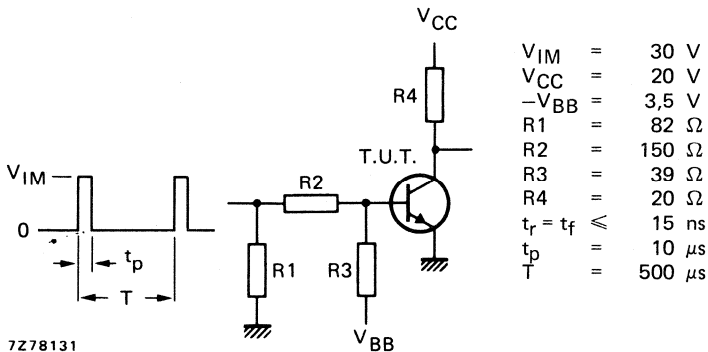


Fig. 3 Switching times test circuit.

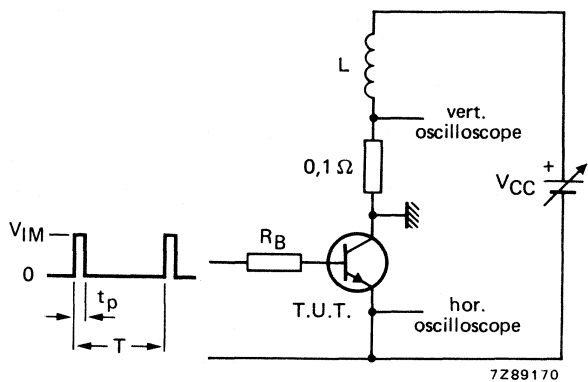


Fig. 4 Test circuit for turn-off breakdown energy.
 $V_{IM} = 12\text{ V}$; $R_B = 270\ \Omega$; $I_{CC} = 2,5\text{ A}$; $t_p = 1\text{ ms}$; $\delta = 0,01$.

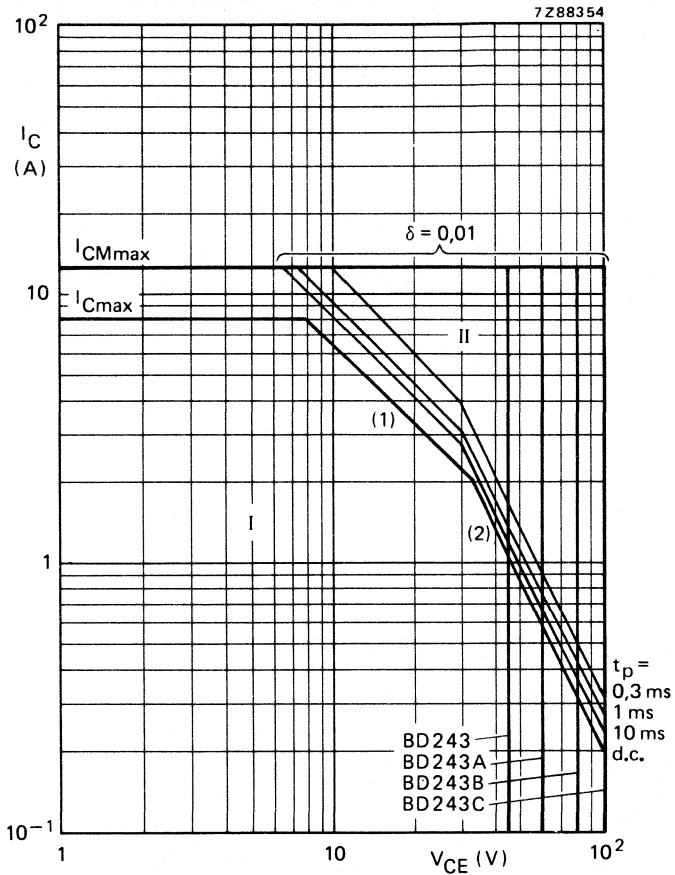


Fig. 5 Safe Operating Area; $T_{mb} = 25^\circ C$.

- 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.

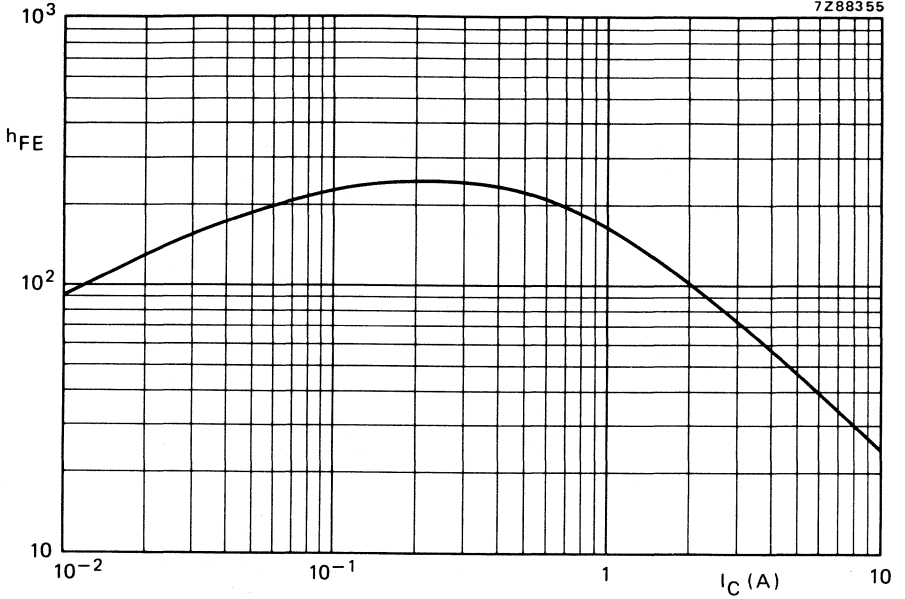


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 4$ V, $T_j = 25$ °C.

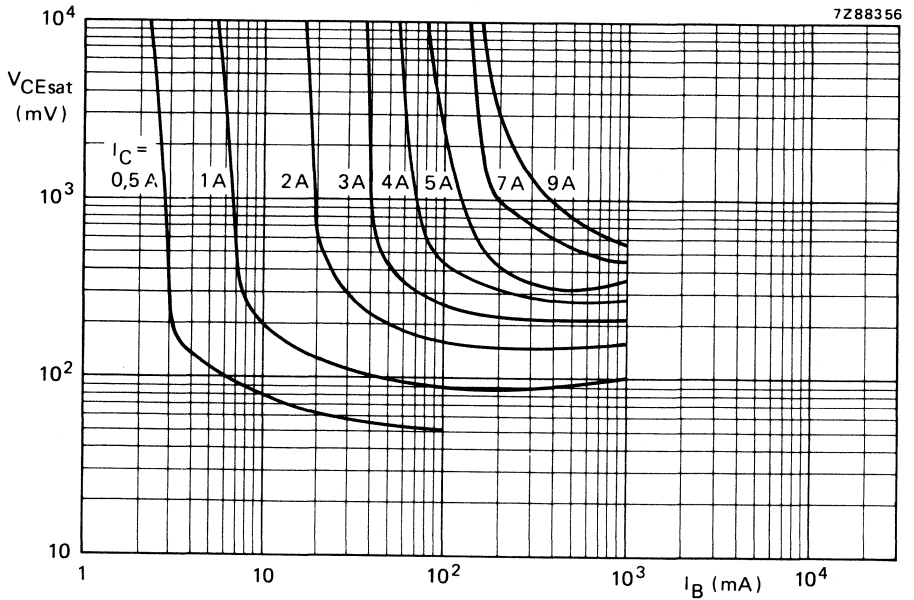


Fig. 7 Typical values collector-emitter saturation voltage at $T_j = 25$ °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in general amplifier and switching applications. N-P-N complements are BD243; 243A; 243B; and BD243C.

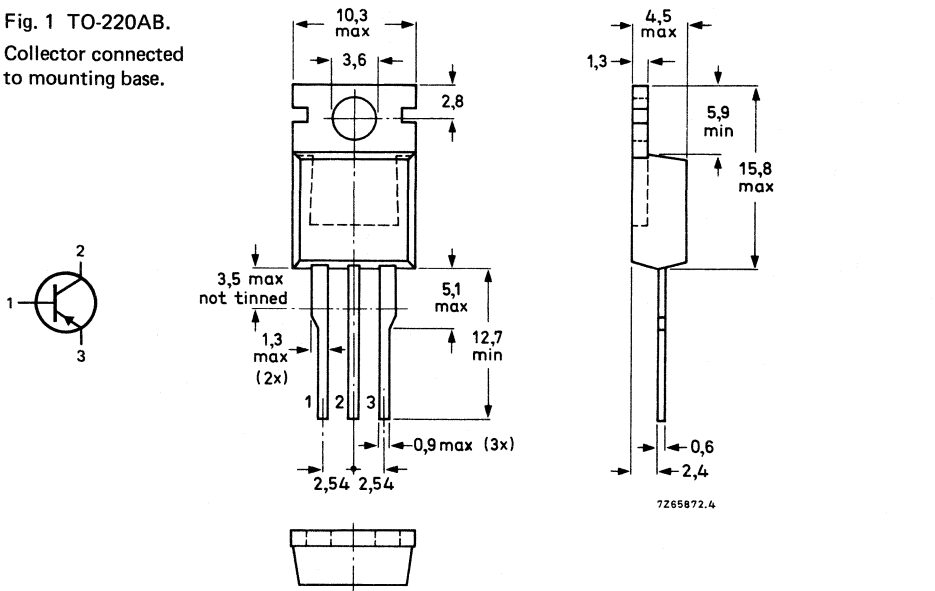
QUICK REFERENCE DATA

		BD244	A	B	C
Collector-base voltage	$-V_{CBO}$ max.	45	60	80	100 V
Collector-emitter voltage	$-V_{CEO}$ max.	45	60	80	100 V
Collector current (d.c.)	$-I_{CM}$ max.	12			A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.	65			W
Junction temperature	T_j max.	150			$^{\circ}\text{C}$
D.C. current gain	h_{FE} >	15			
Transition frequency	f_T >	3			MHz
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$					
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$					

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)

		BD244	A	B	C
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	45	60	80	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	45	60	80	100 V
Collector-emitter voltage ($R_{BE} = 100 \Omega$)	$-V_{CER}$ max.	55	70	90	115 V
Emitter-base voltage (open collector)	$-V_{EBO}$ max.			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.			3	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot} max.			65	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	$R_{th\ j-mb}$ =	1,92	K/W
From junction to ambient in free air	$R_{th\ j-a}$ =	70	K/W

CHARACTERISTICS

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

		BD244; A	BD244B; C	
Collector cut-off current				
$-I_B = 0; -V_{CE} = 30\text{ V}$	$-I_{CEO} <$	0,7	—	mA
$-I_B = 0; -V_{CE} = 60\text{ V}$	$-I_{CEO} <$	—	0,7	mA
$-V_{BE} = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CES} <$		0,4	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO} <$		1	mA
D.C. current gain *				
$-I_C = 300\text{ mA}; -V_{CE} = 4\text{ V}$	$h_{FE} >$		30	
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$	$h_{FE} >$		15	
Base-emitter voltage *				
$-I_C = 6\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE} <$		2	V
Collector-emitter saturation voltage *				
$-I_C = 6\text{ A}; -I_B = 1\text{ A}$	$-V_{CEsat} <$		1,5	V
Turn off breakdown energy				
$L = 20\text{ mH}; -I_{CC} = 2,5\text{ A}$	$E(BR) >$		62,5	mJ

* Measured under pulse conditions: $t_p \leq 300\ \mu\text{s}; \delta < 2\%$.

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

$-I_C = 500 \text{ mA}; -V_{CE} = 10 \text{ V}$

$f_T > 3 \text{ MHz}$

Switching times

$-I_{Con} = 1 \text{ A}; -I_{B on} = I_{B off} = 0,1 \text{ A}$

turn-on time

turn-off time

$t_{on} \text{ typ. } 0,4 \mu\text{s}$

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

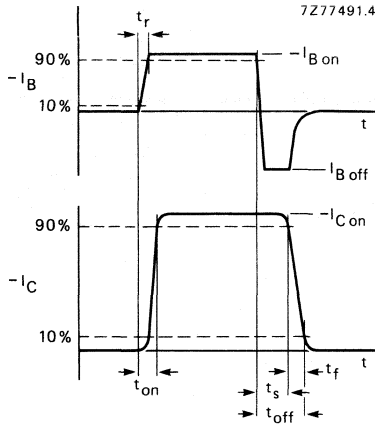


Fig. 2 Switching times waveforms.

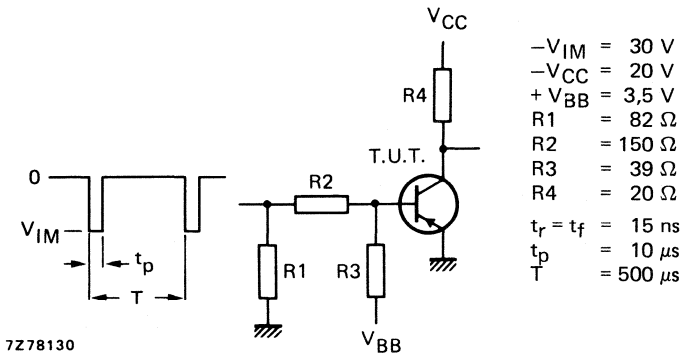


Fig. 3 Switching times test circuit.

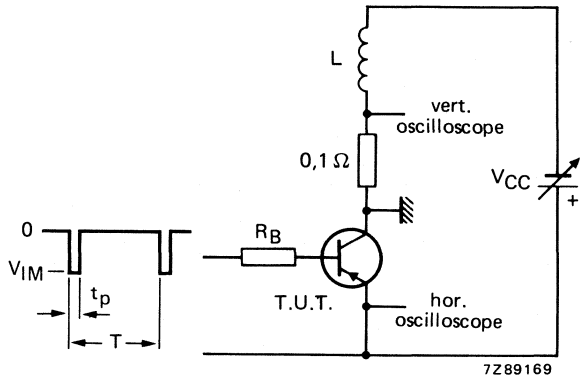


Fig. 4 Test circuit for turn-off breakdown energy.
 $V_{IM} = -12 \text{ V}$; $R_B = 270 \Omega$; $-I_{CC} = 2,5 \text{ A}$; $t_p = 1 \text{ ms}$; $\delta = 0,01$.

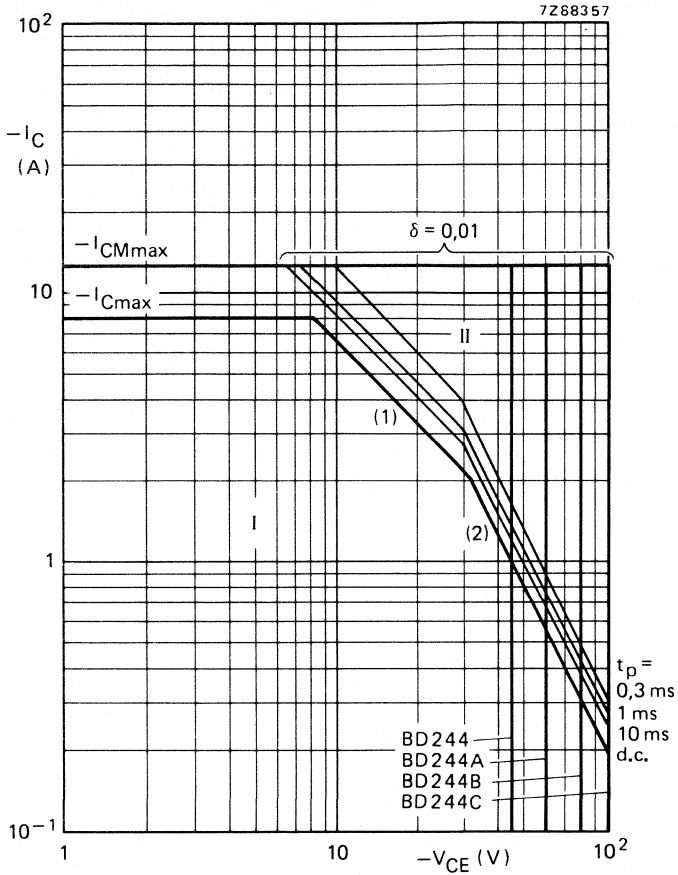


Fig. 5 Safe Operating Area; $T_{mb} = 25^\circ C$.

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.

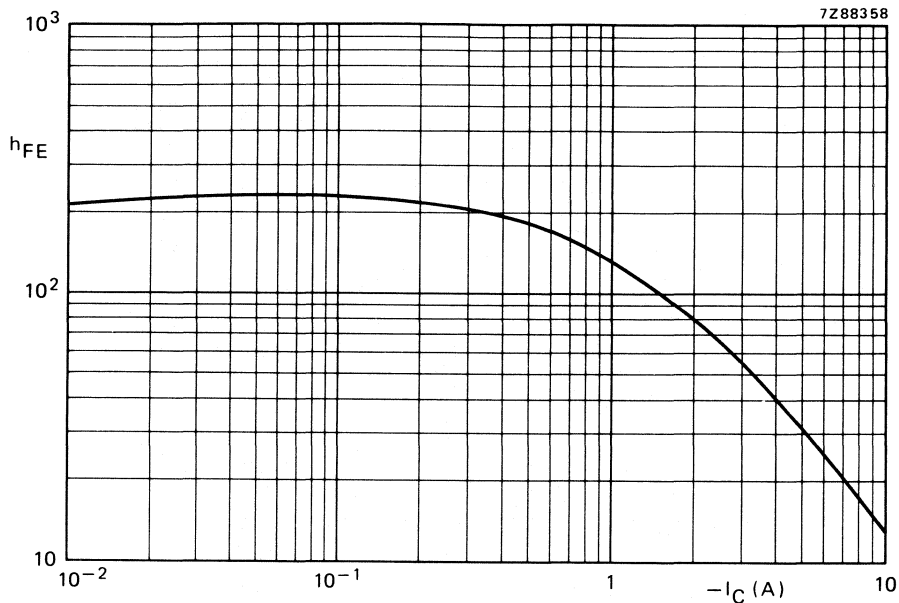


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 4$ V, $T_j = 25$ °C.

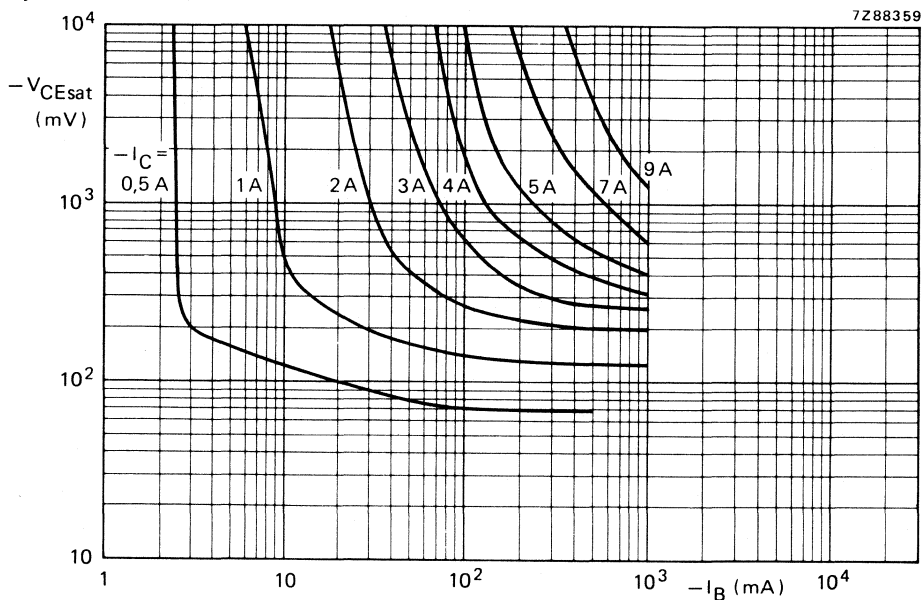


Fig. 7 Typical values collector-emitter saturation voltage at $T_j = 25$ °C.

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.

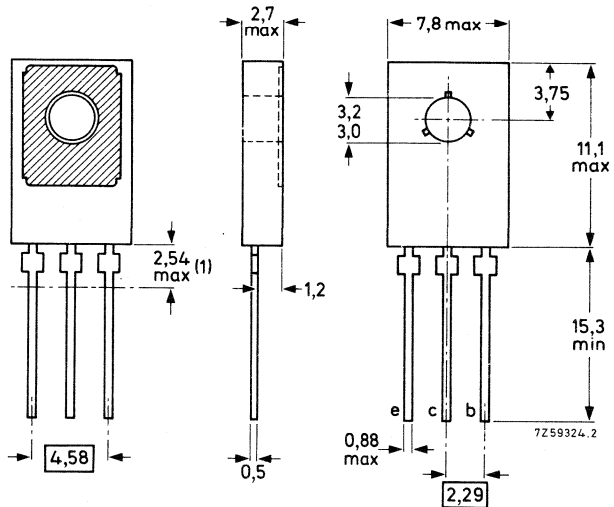
QUICK REFERENCE DATA			
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	32 V
Collector-emitter voltage (open base)	V_{CEO}	max.	20 V
Collector current (peak value)	I_{CM}	max.	3 A
Total power dissipation up to $T_{mb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	15 W
Junction temperature	T_j	max.	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



See 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.	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

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

Total power dissipation up to $T_{mb} = 45\text{ }^\circ\text{C}$	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	$R_{th\ j-mb}$	=	7 K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	100 K/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

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

$h_{FE} > 50$

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

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

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

$h_{FE} > 40$

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

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

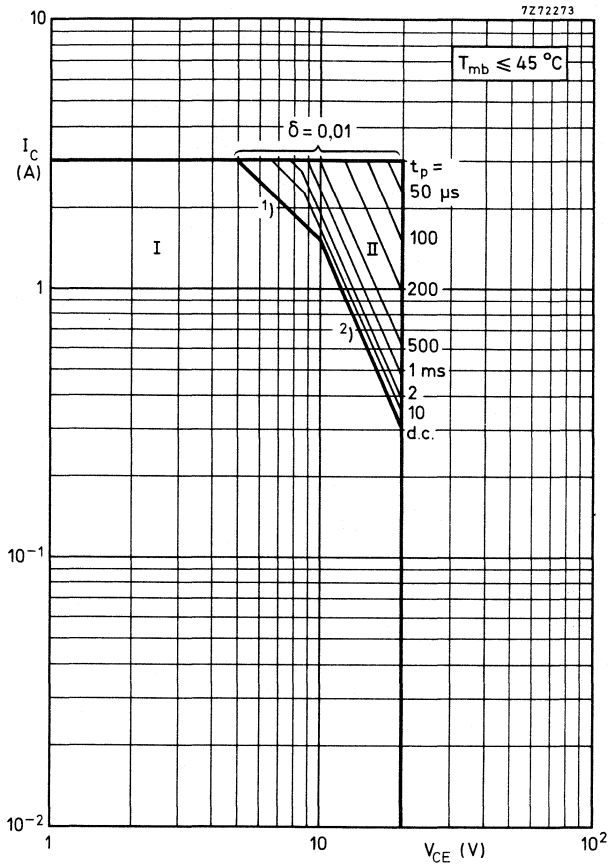
$f_T \text{ typ. } 130\text{ MHz}$

D. C. current gain ratio of
matched pairs

BD329/BD330

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

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



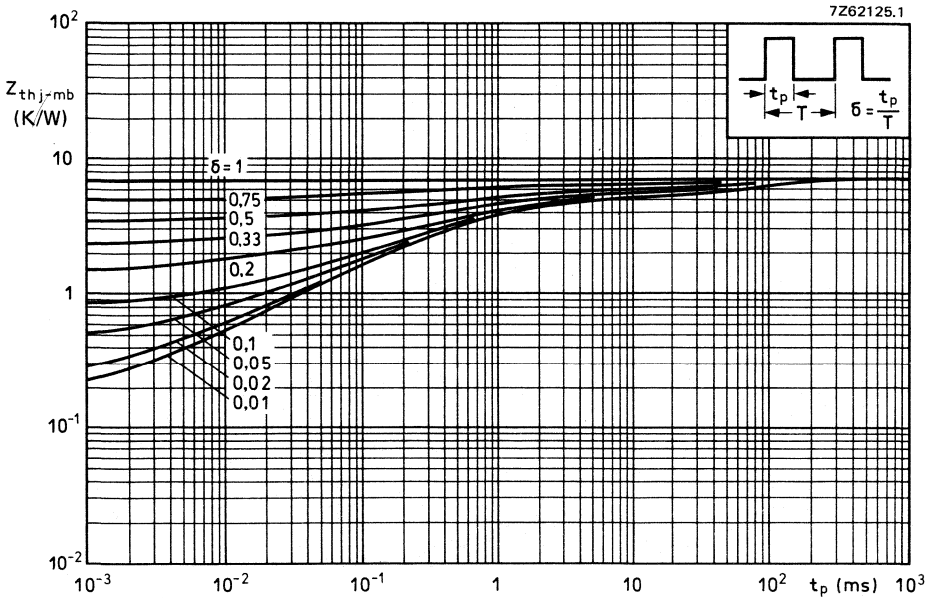
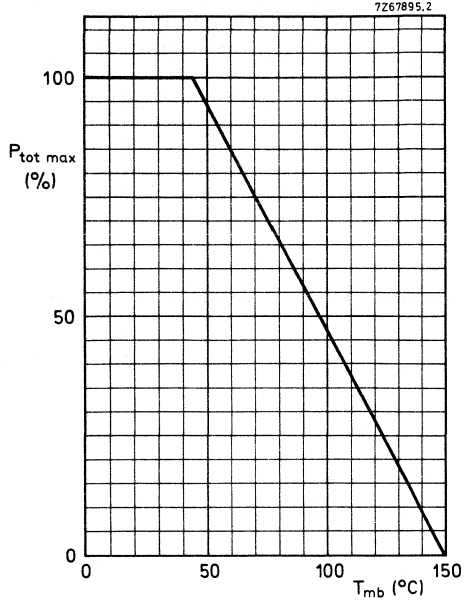
Safe Operating Area with the transistor forward biased

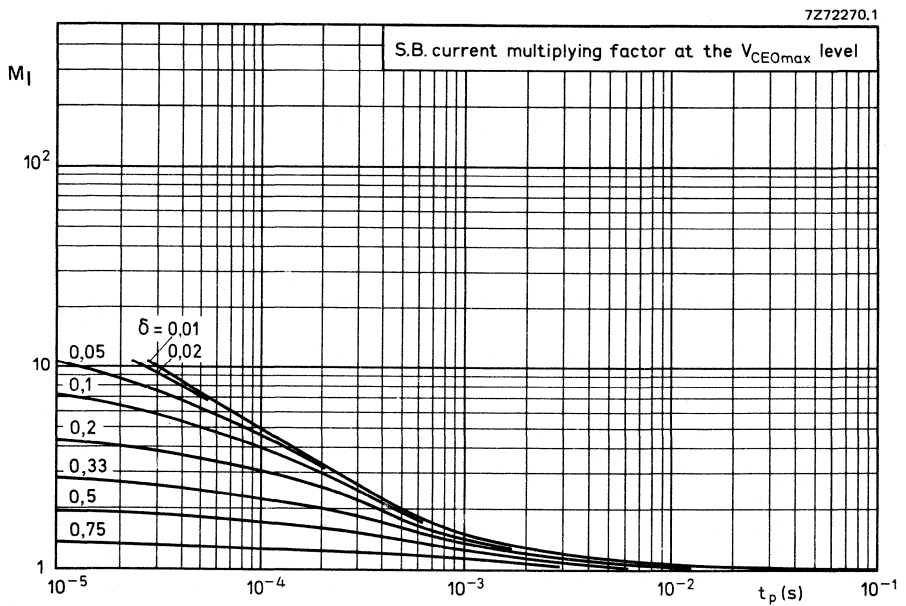
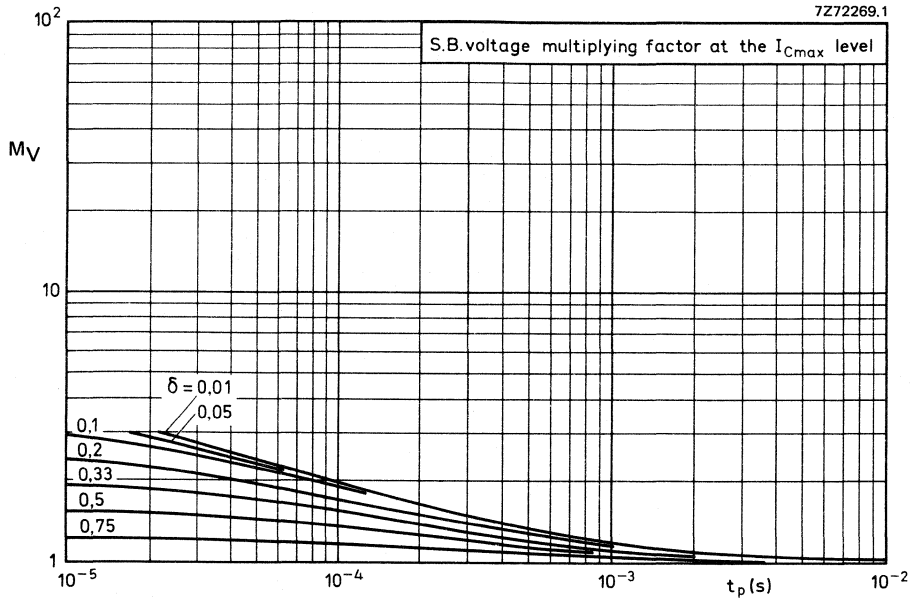
I Region of permissible d. c. operation

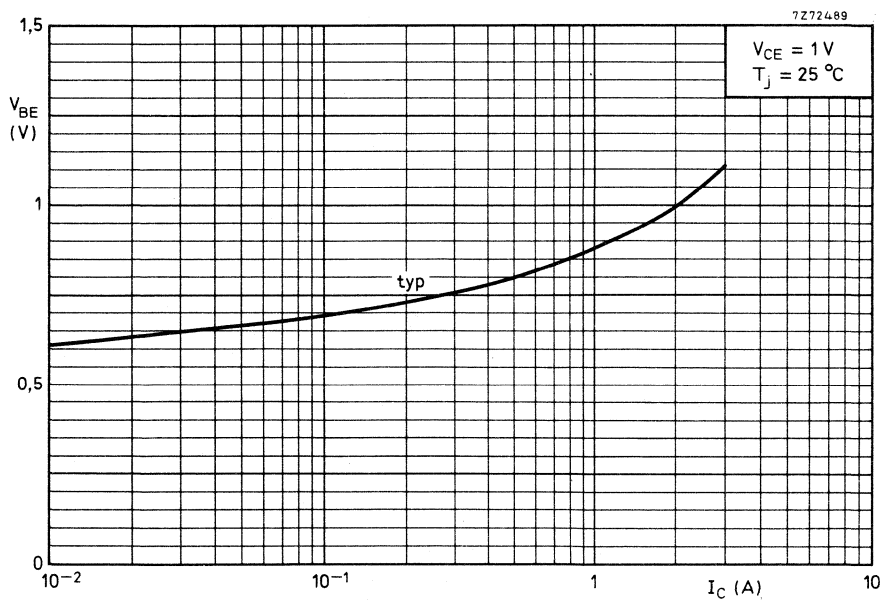
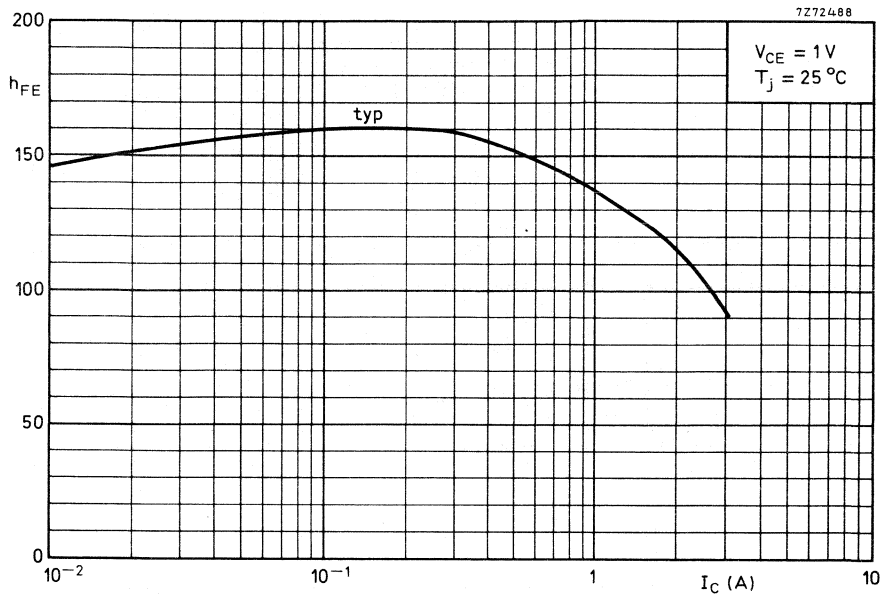
II Permissible extension for repetitive pulse operation

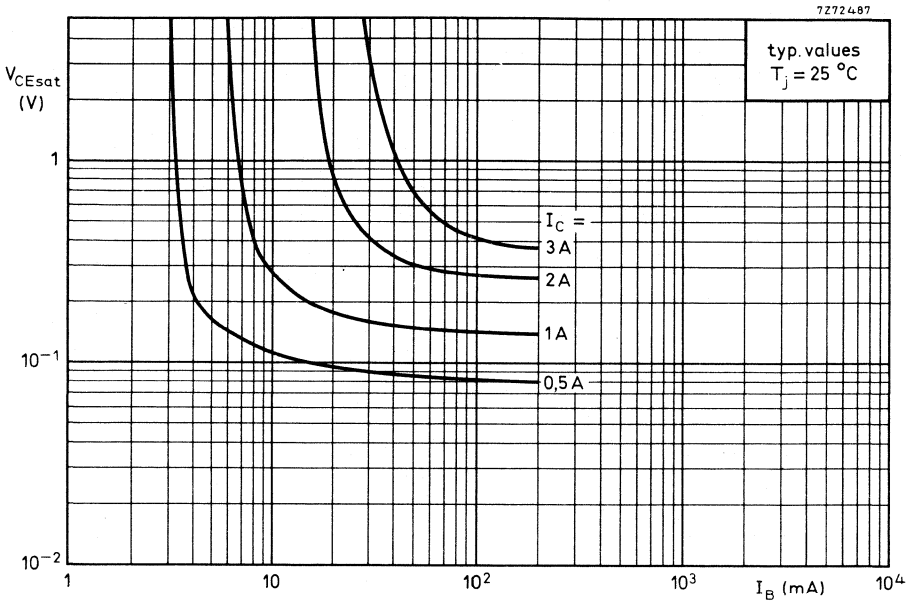
1) P_{tot} max and P_{peak} max lines.

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









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.

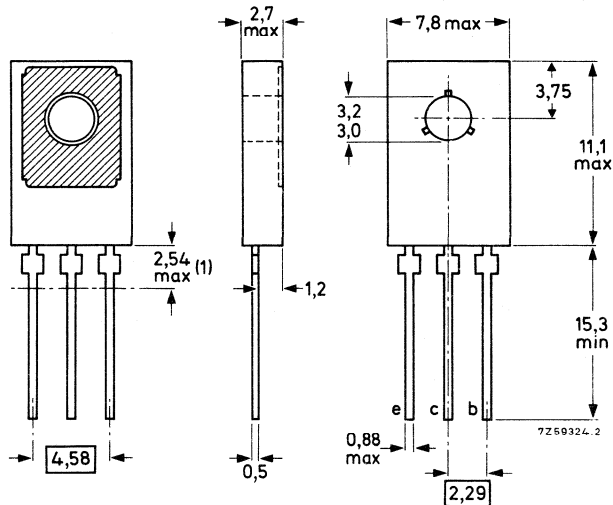
QUICK REFERENCE DATA			
Collector-emitter voltage ($V_{BE} = 0$)	$-V_{CES}$	max.	32 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20 V
Collector current (peak value)	$-I_{CM}$	max.	3 A
Total power dissipation up to $T_{mb} = 45\text{ }^{\circ}\text{C}$	P_{tot}	max.	15 W
Junction temperature	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



See 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.	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

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

Total power dissipation up to $T_{mb} = 45\text{ }^\circ\text{C}$	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	$R_{th\ j-mb}$	=	7 K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	100 K/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

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

$h_{FE} > 50$

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

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

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

$h_{FE} > 40$

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

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

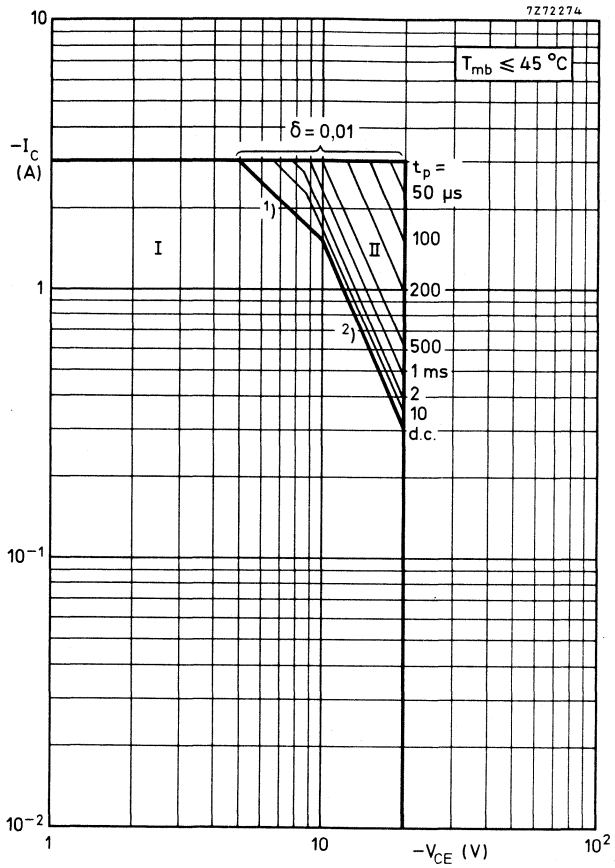
$f_T \text{ typ. } 100\text{ MHz}$

D. C. current gain ratio of
matched pairs

BD329/BD330

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

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



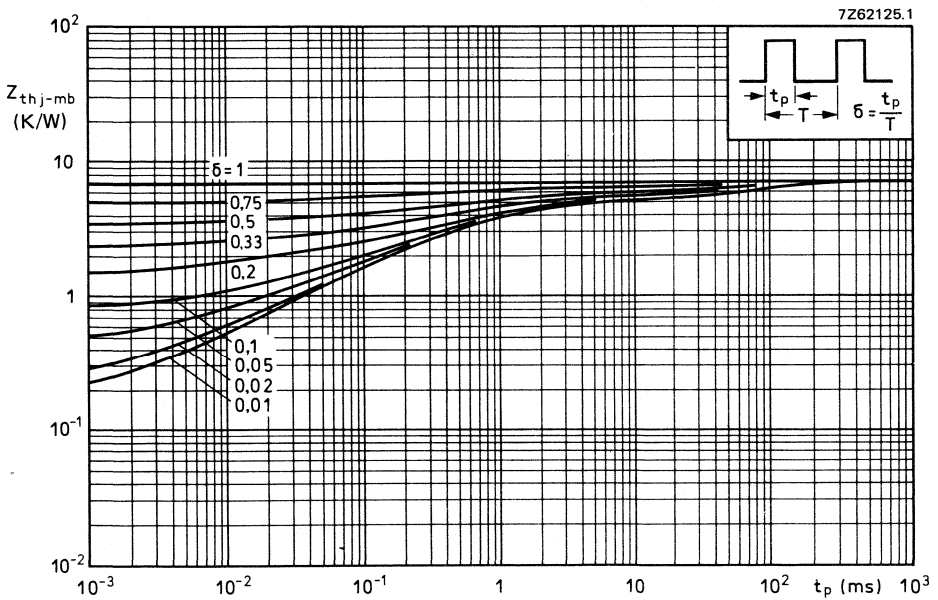
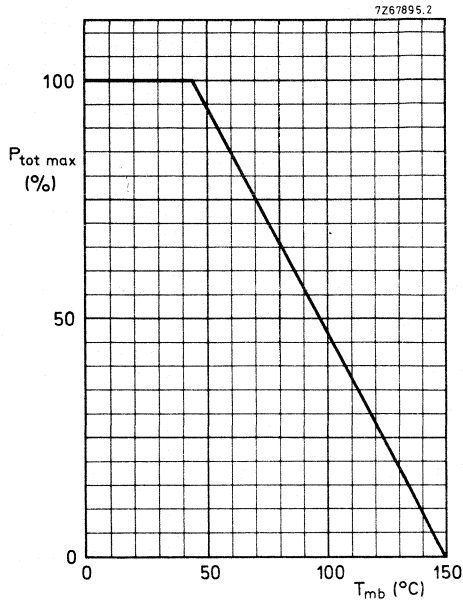
Safe Operating Area with the transistor forward biased

I Region of permissible d.c. operation

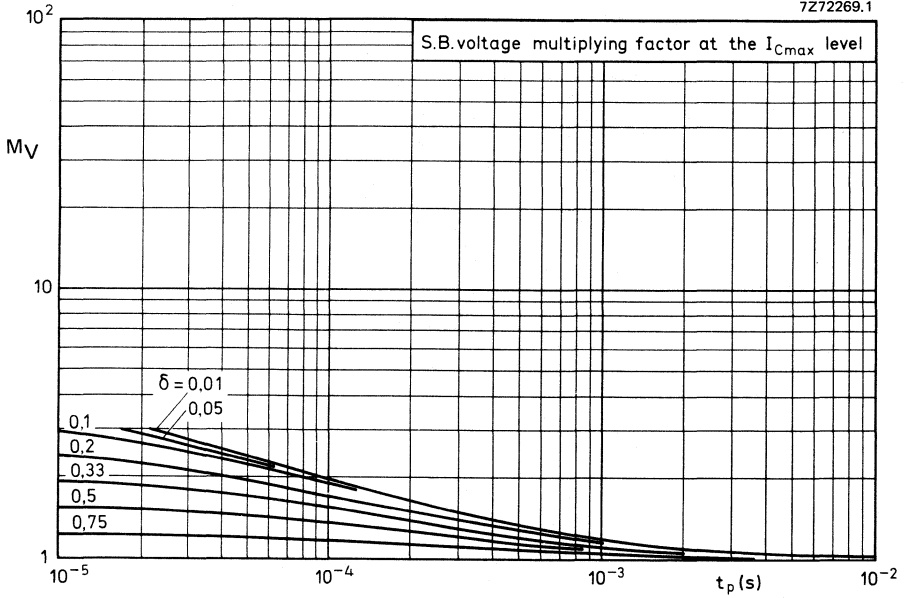
II Permissible extension for repetitive pulse operation

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

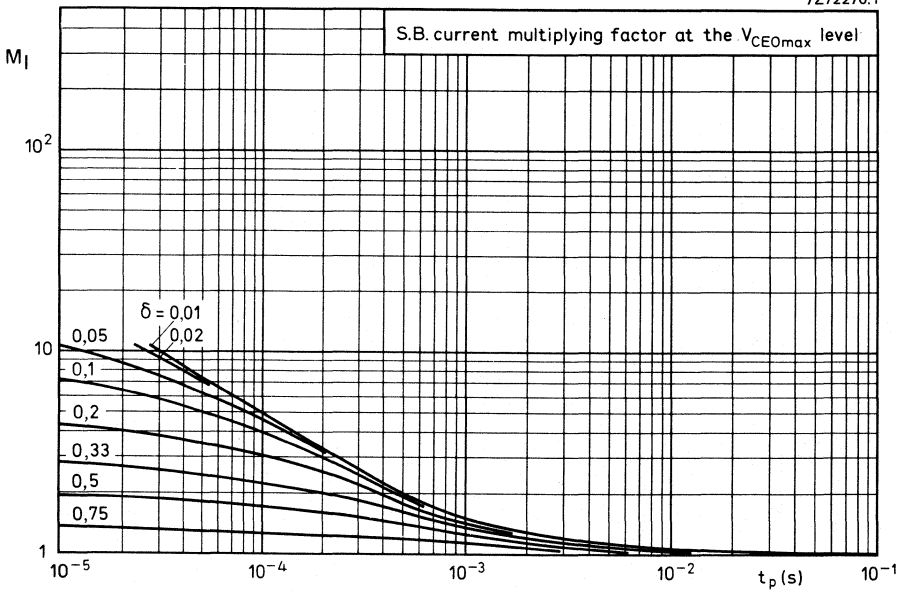
²⁾ Second-breakdown limits (independent of temperature).

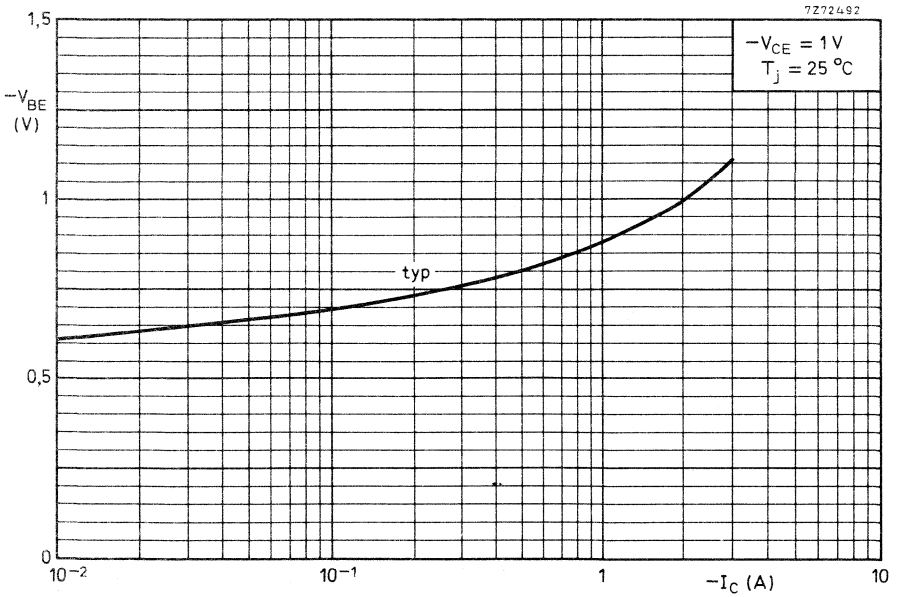


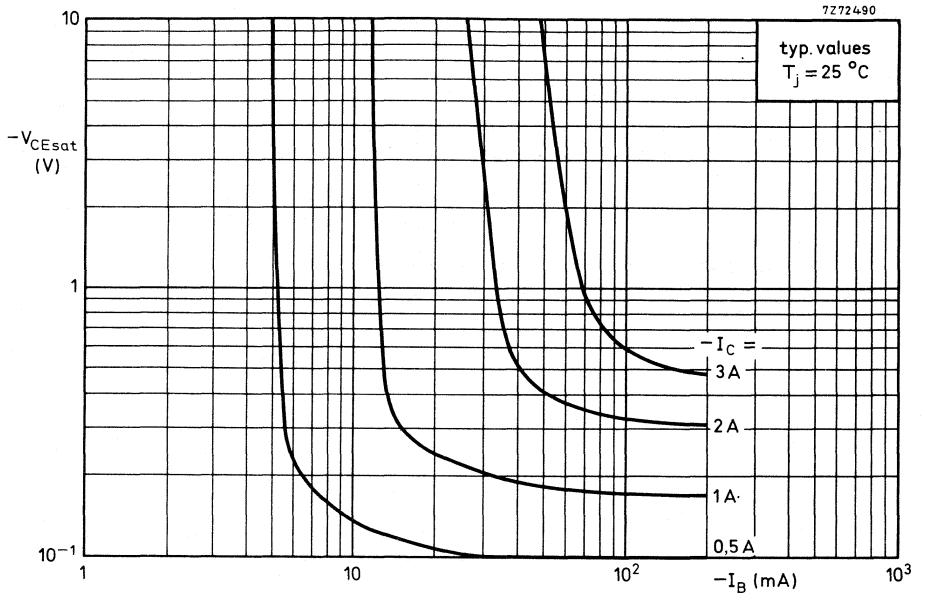
7Z72269.1



7Z72270.1







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.

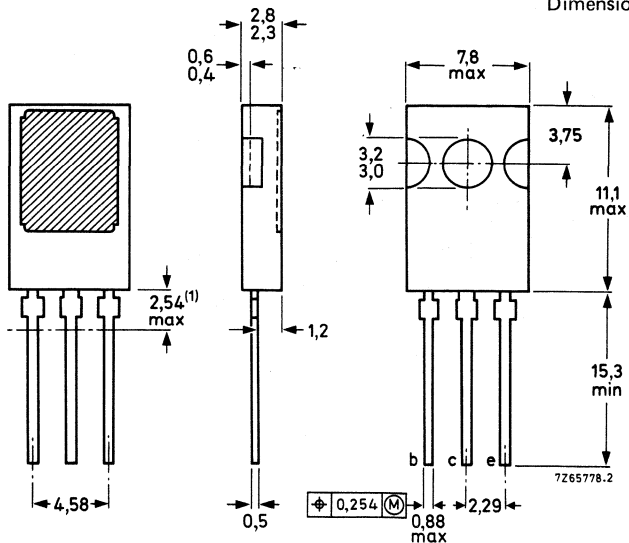
QUICK REFERENCE DATA

		BD331	333	335	337
Collector-base voltage (open emitter)	V_{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	
Base current (d.c.)	I_B max.	150		mA	
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 $I_C = 3,0\text{ A}; V_{CE} = 3\text{ V}$	$h_{FE} >$	750			

MECHANICAL DATA

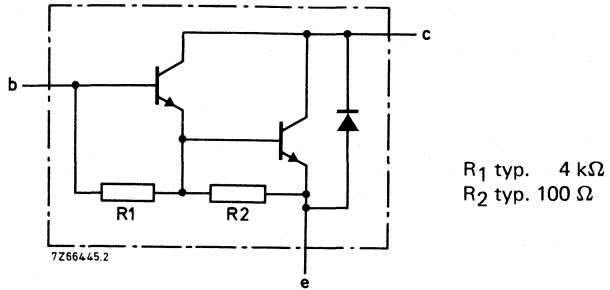
Fig. 1 SOT-82.

Collector connected to metal part of mounting surface



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

See also chapters Mounting Instructions and Accessories.



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 _{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 _{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	K/W
From junction to ambient in free air	R _{th j-a}	=	100	K/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

$$I_E = 0; V_{CB} = V_{CB0\max} \quad I_{CBO} < 0,2\text{ mA}$$

$$I_E = 0; V_{CB} = V_{CB0\max}; T_j = 150\text{ }^\circ\text{C} \quad I_{CBO} < 2\text{ mA}$$

$$I_B = 0; V_{CE} = \frac{1}{2} V_{CEO\max} \quad I_{CEO} < 0,5\text{ mA}$$

Emitter cut-off current

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

D.C. current gain *

$$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 1900$$

$$I_C = 3\text{ A}; V_{CE} = 3\text{ V} \quad h_{FE} > 750$$

$$I_C = 6\text{ A}; V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 3000$$

Base-emitter voltage **

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

Collector-emitter saturation voltage

$$I_C = 3\text{ A}; I_B = 12\text{ mA} \quad V_{CE\text{sat}} < 2\text{ V}$$

Cut-off frequency

$$I_C = 3\text{ A}; V_{CE} = 3\text{ V} \quad f_{hfe} \text{ typ. } 50\text{ kHz}$$

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

$$-I_{\text{Boff}} = 0; I_{\text{Con}} = 4,5\text{ A} \quad E_{(\text{BR})} > 50\text{ mJ}$$

Diode forward voltage

$$I_F = 3\text{ A} \quad V_F \text{ typ. } 1,8\text{ V}$$

D.C. current gain ratio of complementary
matched pairs

$$I_C = 3\text{ A}; V_{CE} = 3\text{ V} \quad h_{FE1}/h_{FE2} < 2,5$$

Small signal current gain

$$I_C = 3\text{ A}; V_{CE} = 3\text{ V}; f = 1\text{ MHz} \quad h_{fe} > 10 \quad \leftarrow$$

Second-breakdown collector current

$$V_{CE} = 60\text{ V}; t_p = 25\text{ ms} \quad I_{(\text{SB})} > 1\text{ A}$$

Switching times

(between 10% and 90% levels)

$$I_{\text{Con}} = 3\text{ A}; I_{\text{Bon}} = -I_{\text{Boff}} = 12\text{ mA}$$

$$\text{Turn-on time} \quad t_{\text{on}} \text{ typ. } 1\text{ }\mu\text{s}$$

$$< 2\text{ }\mu\text{s}$$

$$\text{Turn-off time} \quad t_{\text{off}} \text{ typ. } 5\text{ }\mu\text{s}$$

$$< 10\text{ }\mu\text{s}$$

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

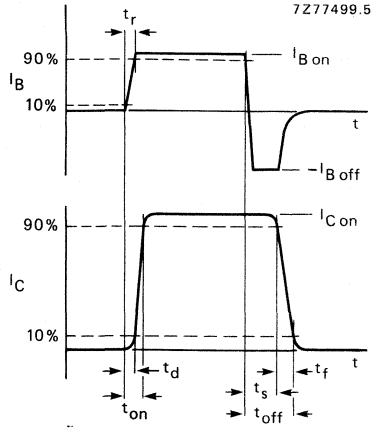
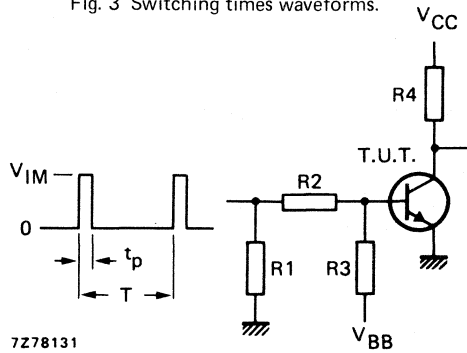
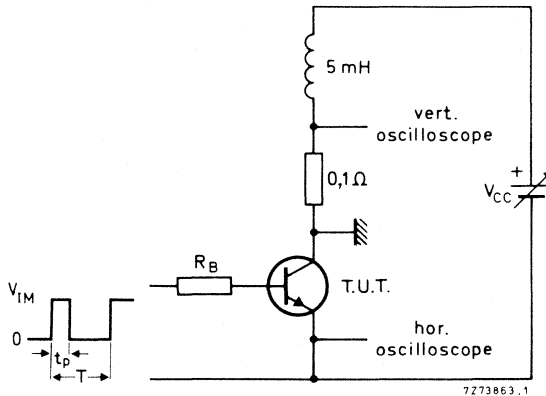


Fig. 3 Switching times waveforms.



- $V_{IM} = 10\text{ V}$
- $V_{CC} = 10\text{ V}$
- $-V_{BB} = 4\text{ V}$
- $R1 = 56\ \Omega$
- $R2 = 410\ \Omega$
- $R3 = 560\ \Omega$
- $R4 = 3\ \Omega$
- $t_r = t_f = 15\text{ ns}$
- $t_p = 10\ \mu\text{s}$
- $T = 500\ \mu\text{s}$

Fig. 4 Switching times test circuit.



- $V_{IM} = 12\text{ V}$
- $R_B = 270\ \Omega$
- $I_C = 4.5\text{ A}$
- $\delta = 1\%$
- $t_p = 1\text{ ms}$

Fig. 5 Test circuit for turn-off breakdown energy.

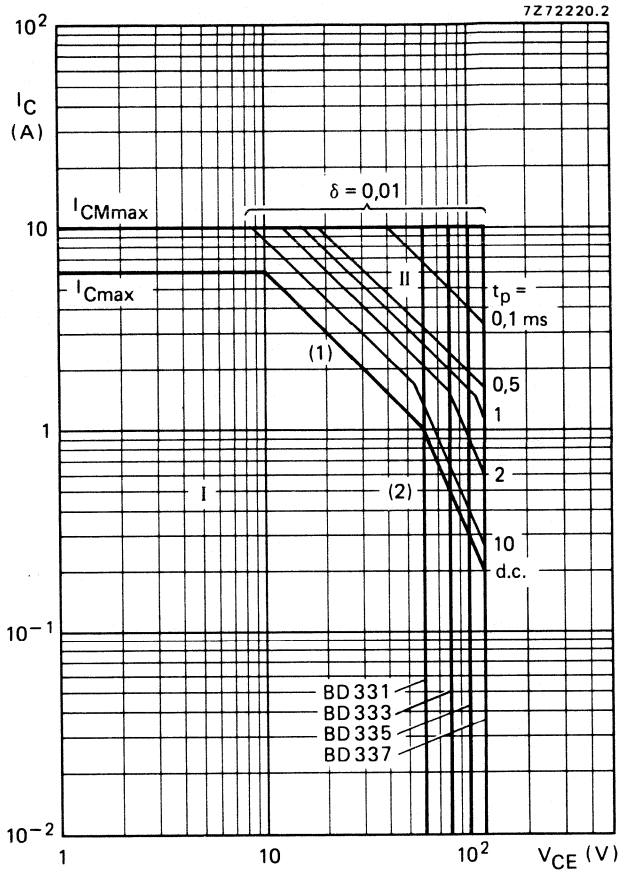


Fig. 6 Safe Operating Area, $T_{mb} \leq 25^\circ\text{C}$.

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).

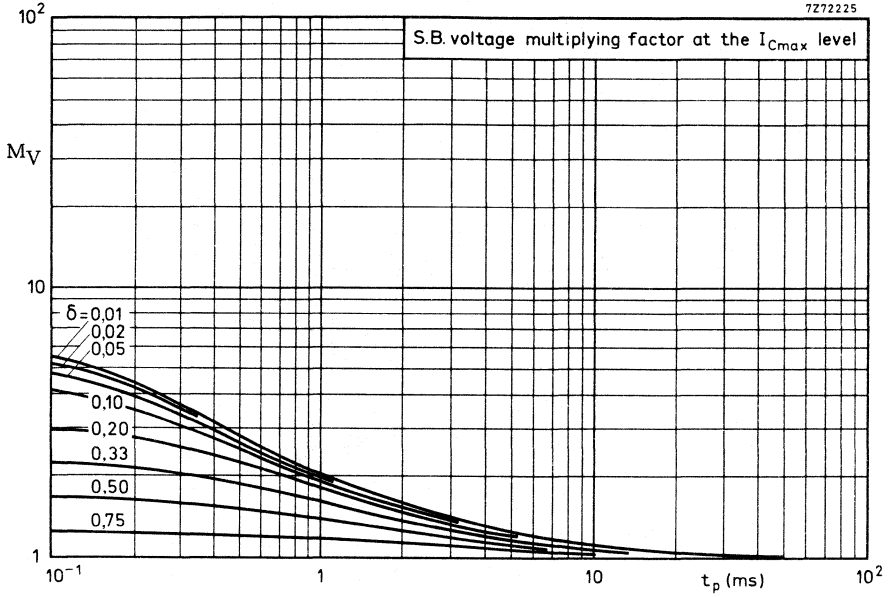


Fig. 7 Second breakdown voltage multiplying factor at I_{Cmax} level.

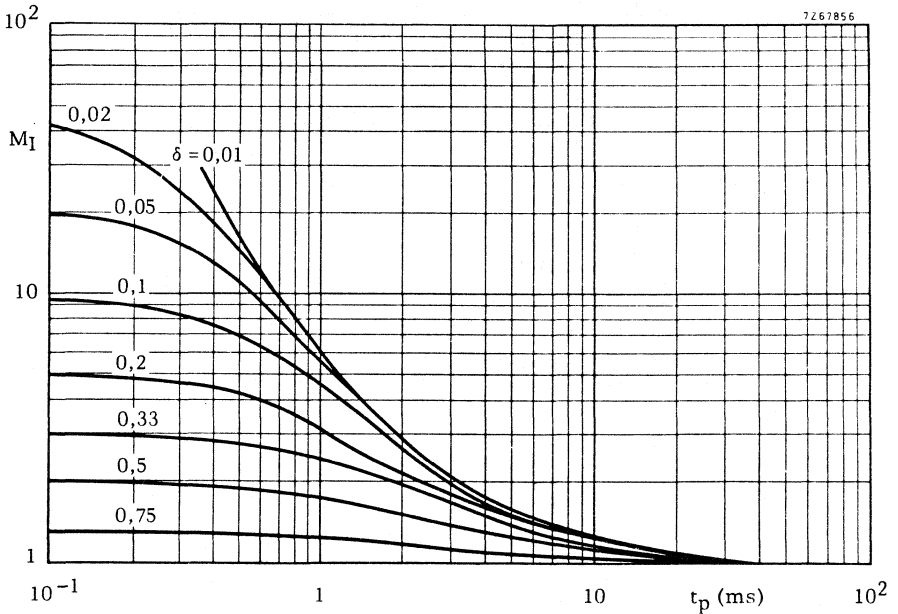


Fig. 8 Second breakdown current multiplying factor at V_{CE0max} level.

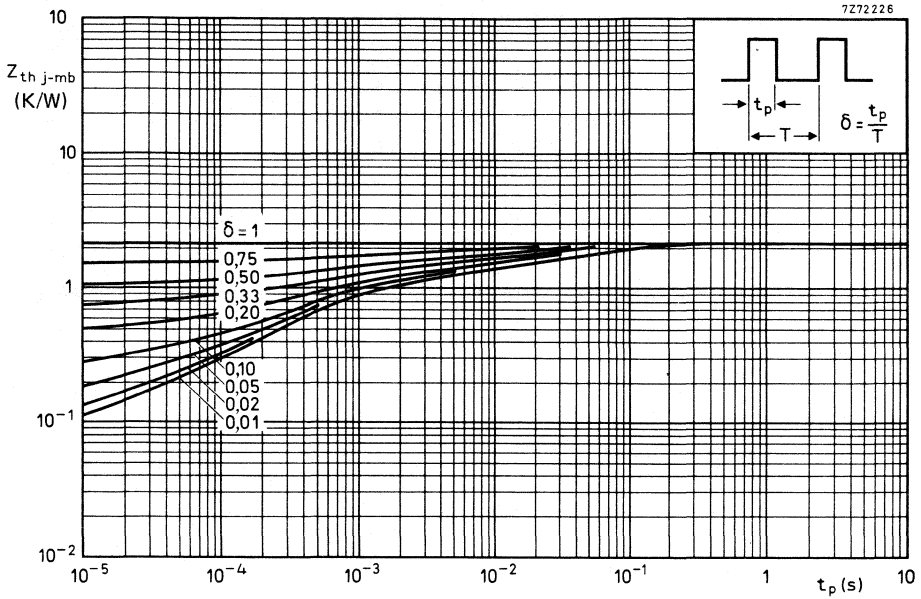


Fig. 9 Pulse power rating chart.

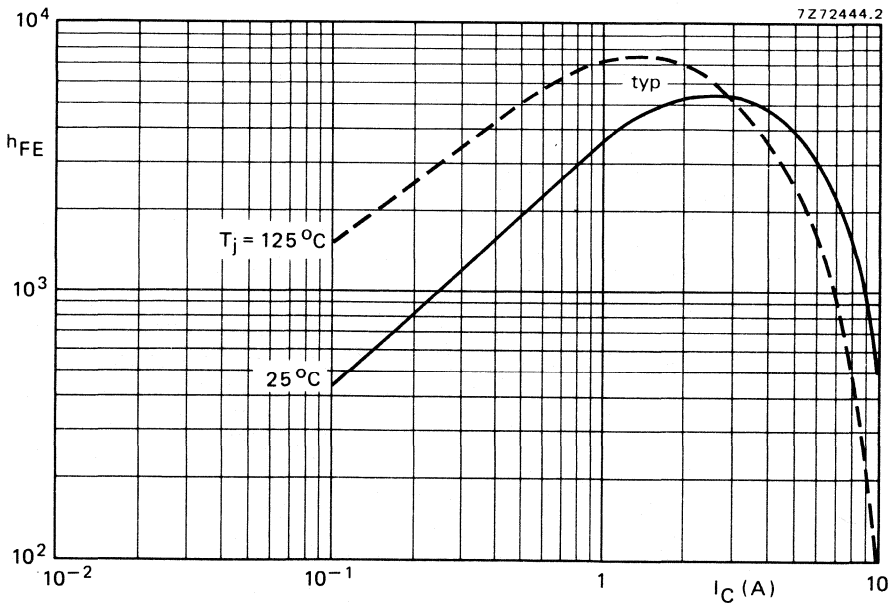
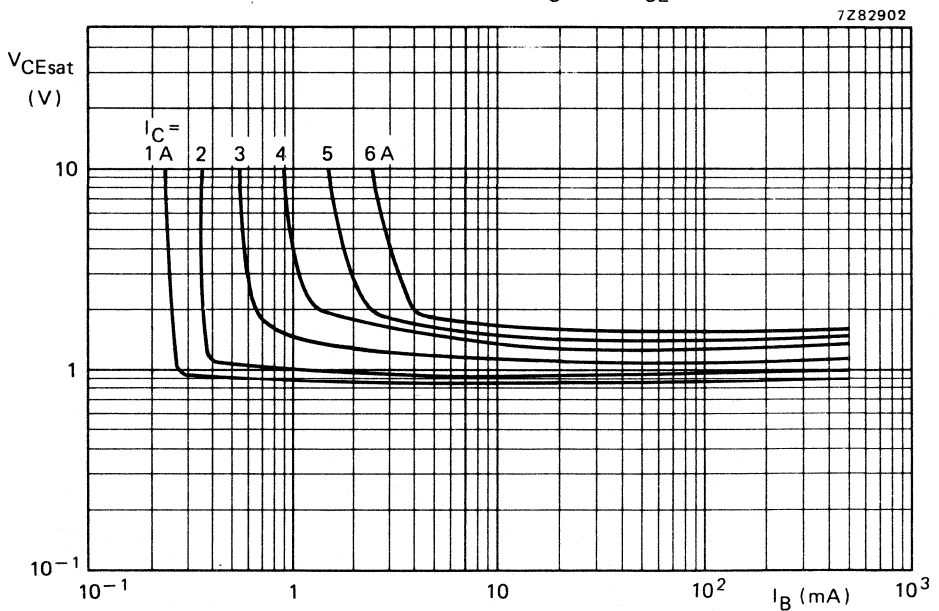
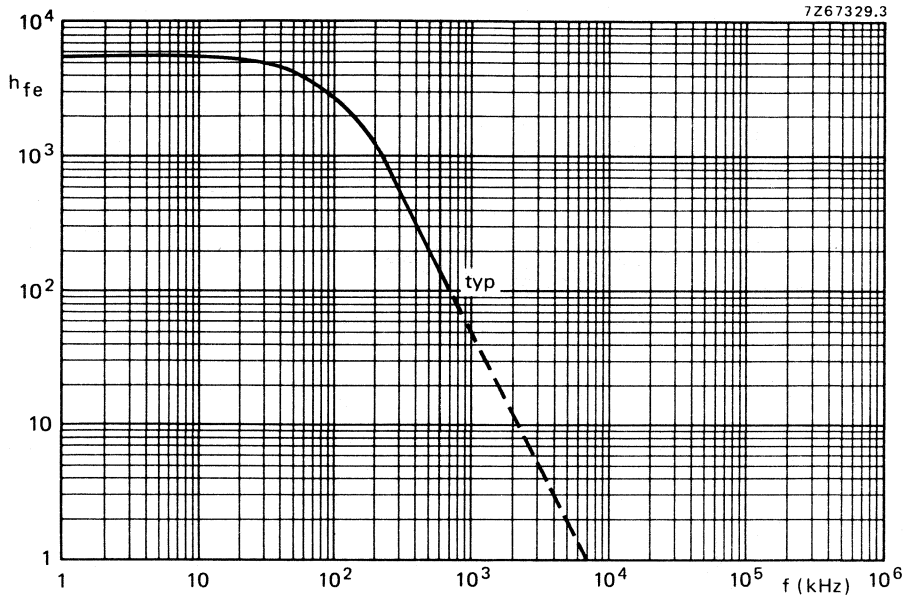


Fig. 10 D.C. current gain. $V_{CE} = 3\text{ V}$.



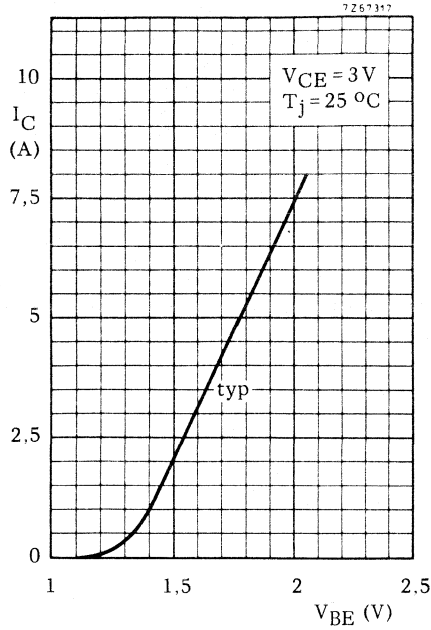


Fig. 13 Collector current.

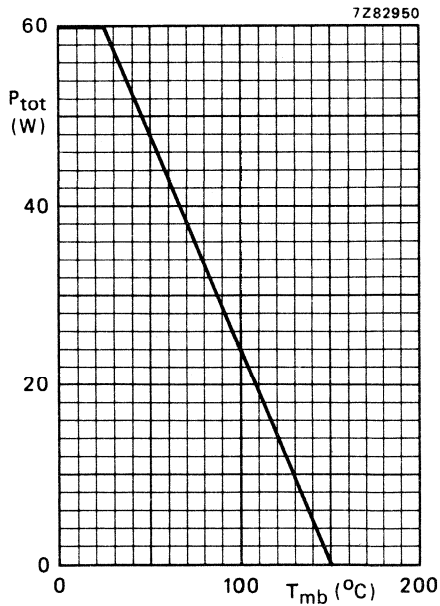


Fig. 14 Power derating curve.

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.

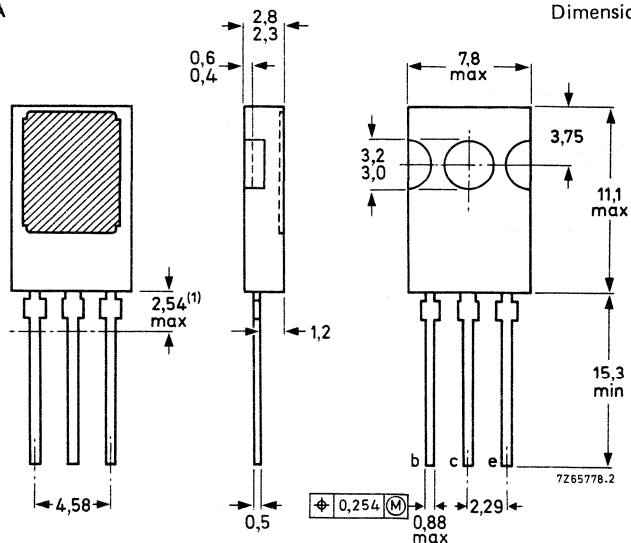
QUICK REFERENCE DATA

		BD332	334	336	338
Collector-base voltage (open emitter)	$-V_{CB0}$	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
Base current (d.c.)	$-I_B$	max. 150			mA
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 $-I_C = 3,0\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}	>			750

MECHANICAL DATA

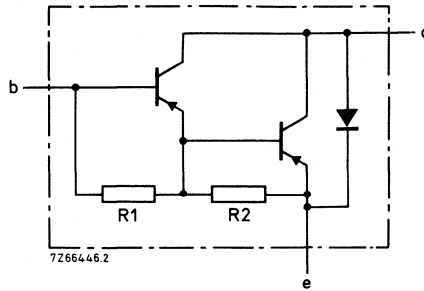
Fig. 1 SOT-82.

Collector connected to metal part of mounting surface.



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

See also chapters Mounting instructions and Accessories.



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 _{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.	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	K/W
From junction to ambient in free air	R _{th j-a}	=	100	K/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

$$I_E = 0; -V_{CB} = -V_{CB0max} \quad -I_{CBO} < 0,2\text{ mA}$$

$$I_E = 0; -V_{CB} = -V_{CB0max}; T_j = 150\text{ }^\circ\text{C} \quad -I_{CBO} < 2\text{ mA}$$

$$I_B = 0; -V_{CE} = -\frac{1}{2} V_{CEO} \quad -I_{CEO} < 0,5\text{ mA}$$

Emitter cut-off current

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

D.C. current gain *

$$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 2700$$

$$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} > 750$$

$$-I_C = 6\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 400$$

Base-emitter voltage **

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

Collector-emitter saturation voltage

$$-I_C = 3\text{ A}; -I_B = 12\text{ mA} \quad -V_{CEsat} < 2\text{ V}$$

Small signal current gain

$$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz} \quad h_{fe} > 10 \quad \leftarrow$$

Cut-off frequency

$$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V} \quad f_{hfe} \text{ typ. } 100\text{ kHz}$$

Diode, forward voltage

$$I_F = 3\text{ A} \quad V_F \text{ typ. } 1,8\text{ V}$$

D.C. current gain ratio of

$$\begin{aligned} &\text{complementary matched pairs} \\ &-I_C = 3\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE1}/h_{FE2} < 2,5 \end{aligned}$$

Second breakdown collector current

$$\begin{aligned} &\text{non-repetitive; without heatsink} \\ &-V_{CE} = 60\text{ V}; t_p = 25\text{ ms} \quad -I_{(SB)} > 1\text{ A} \end{aligned}$$

Switching times (see Figs 3 and 4)

$$\begin{aligned} &-I_{Con} = 3\text{ A}; -I_{Bon} = I_{Boff} = 12\text{ mA} \\ &\text{turn-on time} \quad t_{on} \text{ typ. } 1\text{ } \mu\text{s} \\ &\quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad < 2\text{ } \mu\text{s} \end{aligned}$$

$$\begin{aligned} &\text{turn-off time} \quad t_{off} \text{ typ. } 5\text{ } \mu\text{s} \\ &\quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad < 10\text{ } \mu\text{s} \end{aligned}$$

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

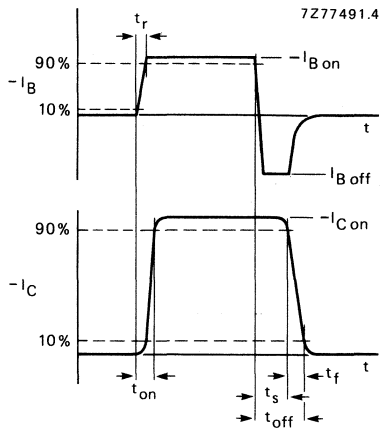
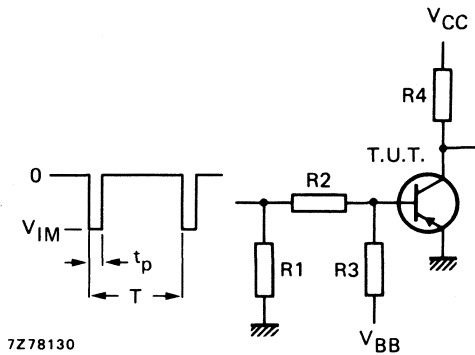


Fig. 3 Switching times waveforms.



- $-V_{IM} = 10\text{ V}$
- $-V_{CC} = 10\text{ V}$
- $V_{BB} = 4\text{ V}$
- $R1 = .56\ \Omega$
- $R2 = 410\ \Omega$
- $R3 = 560\ \Omega$
- $R4 = 3\ \Omega$
- $t_r = t_f = 15\text{ ns}$
- $t_p = 10\ \mu\text{s}$
- $T = 500\ \mu\text{s}$

Fig. 4 Switching times test circuit.

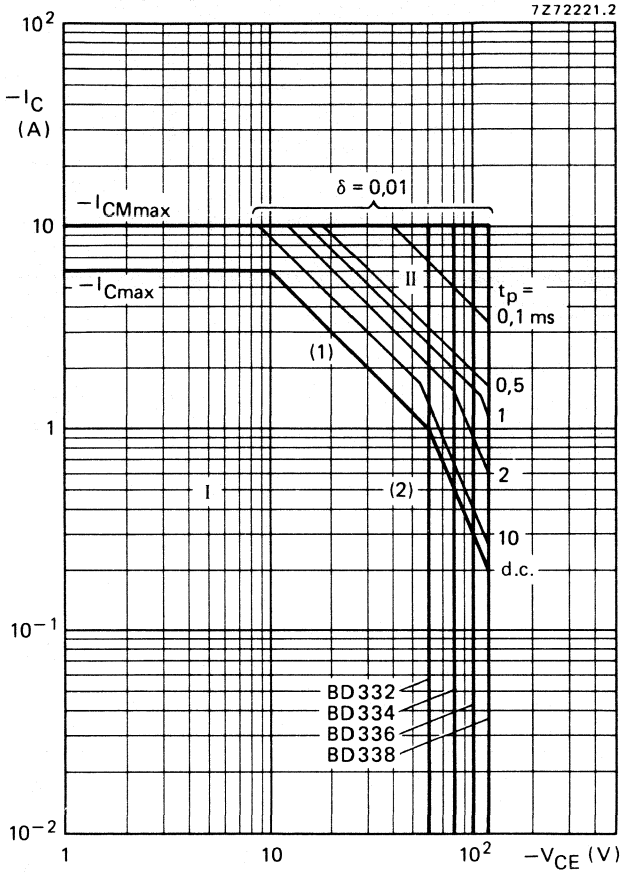


Fig. 5 Safe Operating Area with the transistor forward biased; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

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

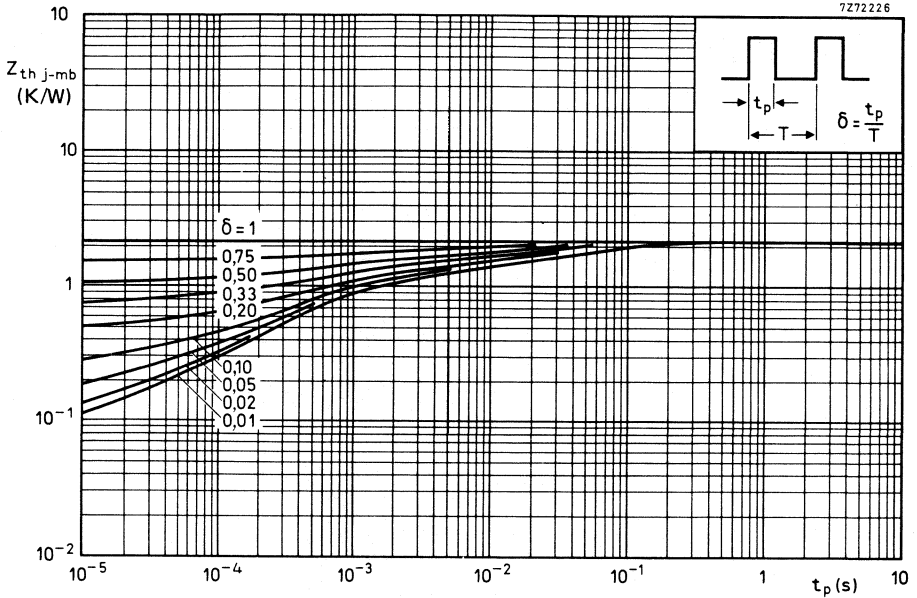


Fig. 6 Pulse power rating chart.

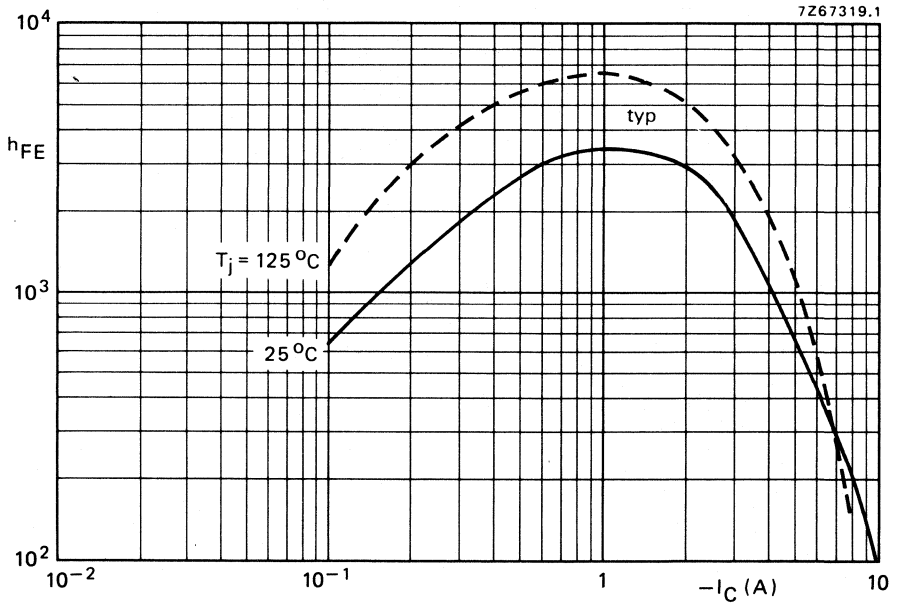


Fig. 7 D.C. current gain at $-V_{CE} = 3\text{ V}$.

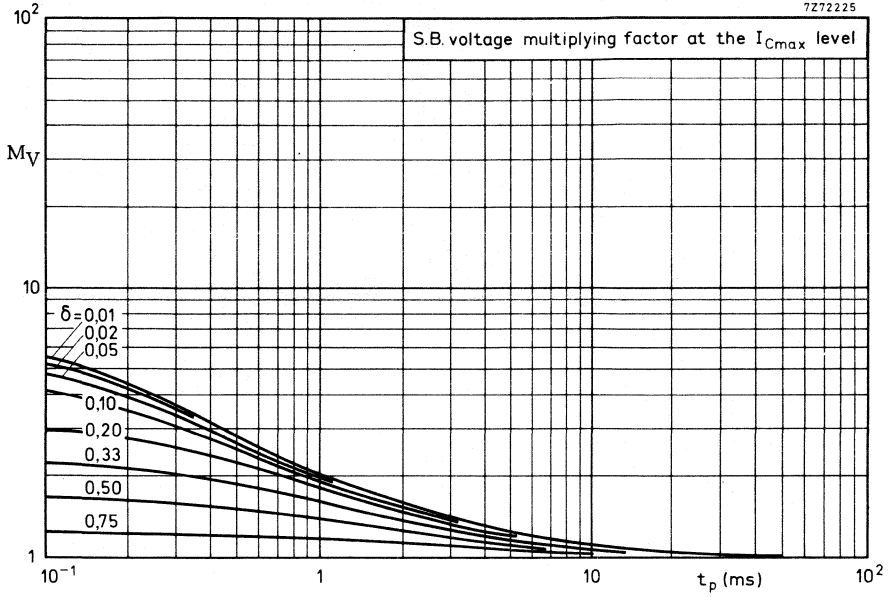


Fig. 8 Second breakdown voltage multiplying factor at the I_{Cmax} level.

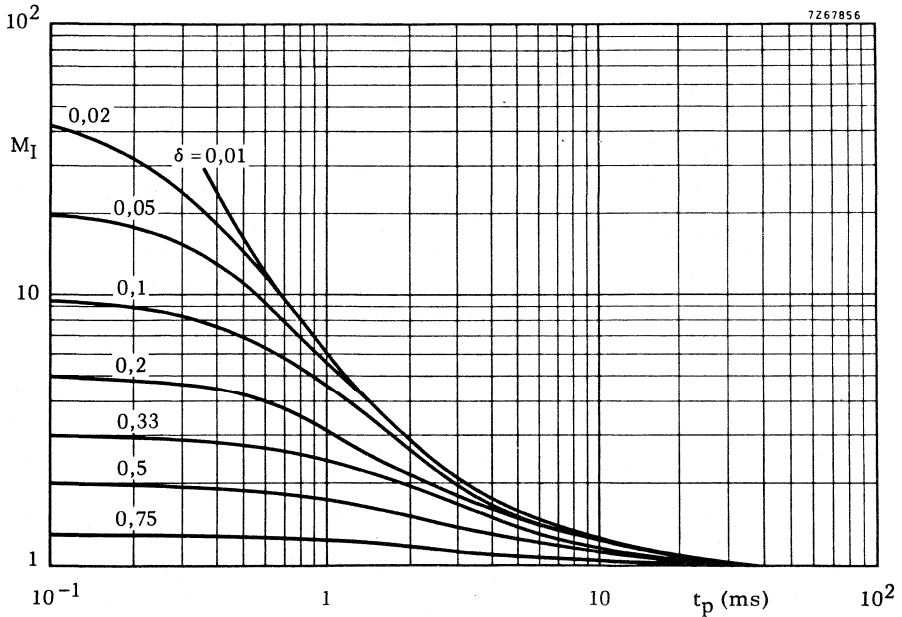


Fig. 9 Second breakdown current multiplying factor at the V_{CE0max} level.

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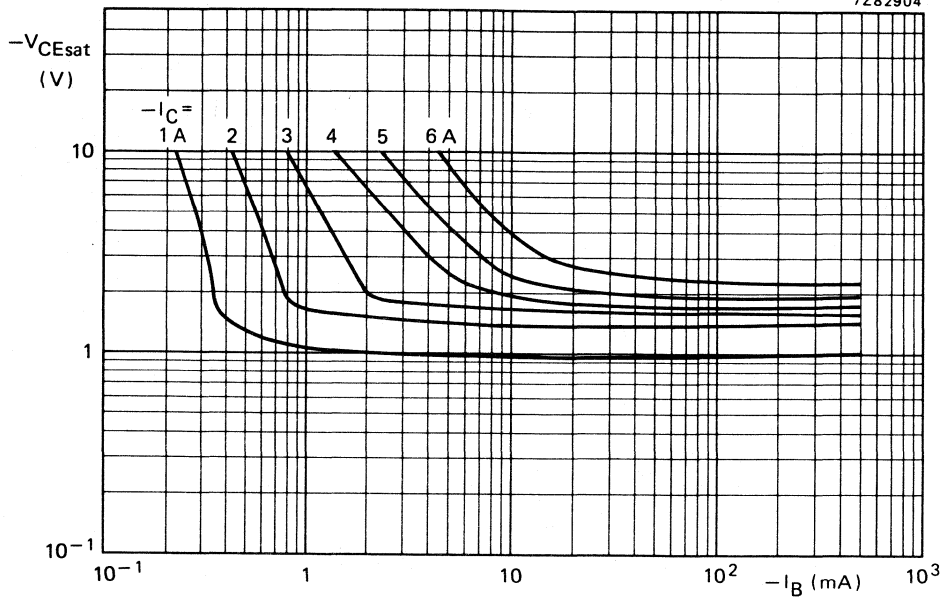


Fig. 10 Typical values collector-emitter saturation voltage. $T_j = 25^\circ\text{C}$.

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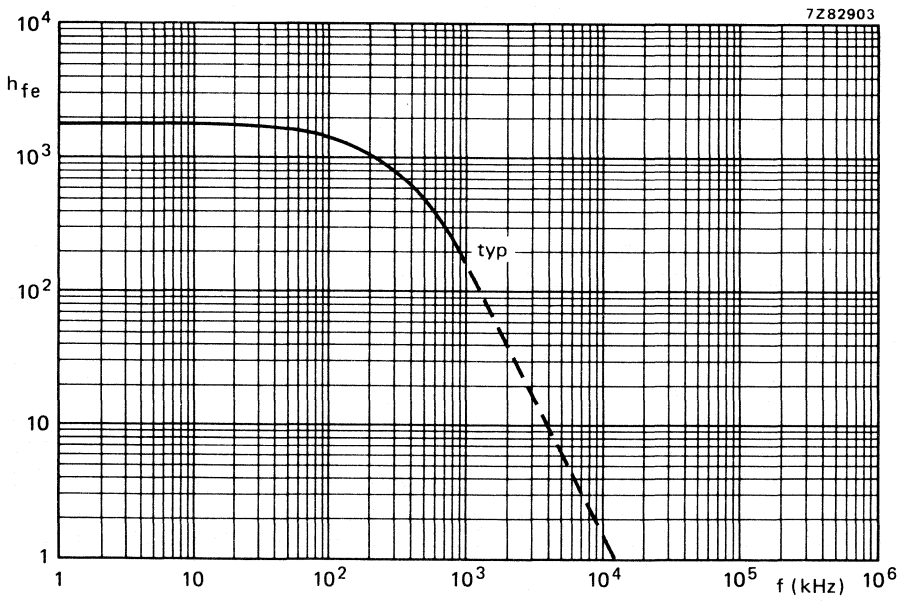


Fig. 11 Small signal current gain. $-I_C = 3\text{ A}$; $-V_{CE} = 3\text{ V}$.

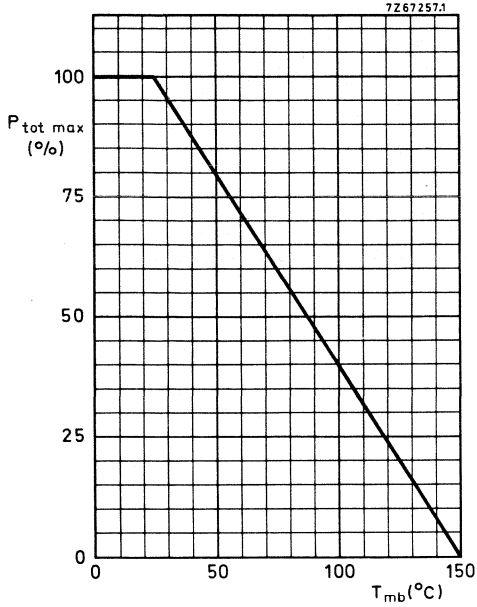


Fig. 12 Power derating curve.

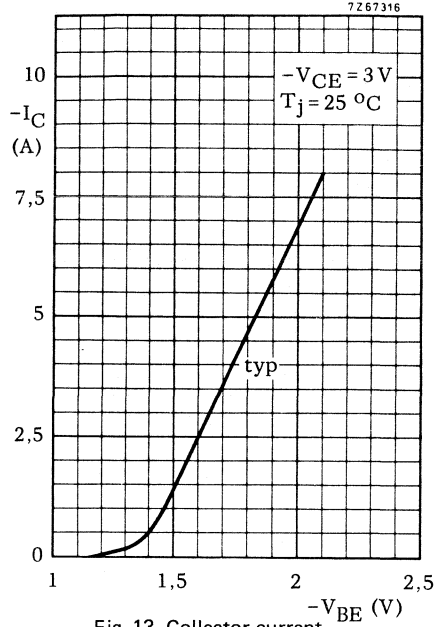


Fig. 13 Collector current.

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

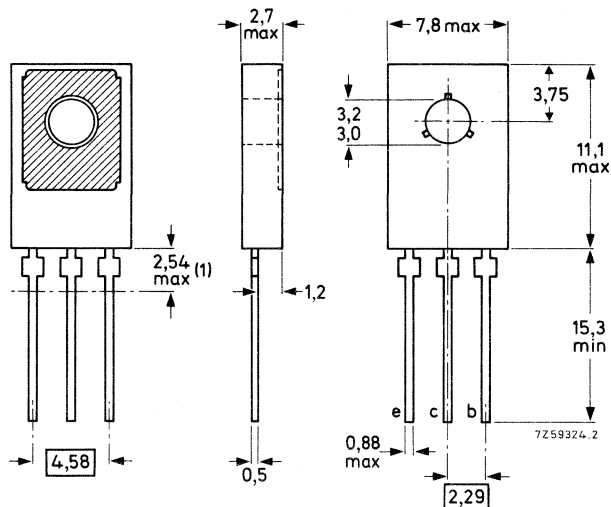
		BD433	BD435	BD437	
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES} max.	22	32	45	V
Collector-emitter voltage (open base)	V_{CEO} max.	22	32	45	V
Collector current (peak value)	I_{CM} max.	7	7	7	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	36	36	36	W
D.C. current gain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

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected
to metal part of
mounting surface



See 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)

			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
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
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.		36		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	$R_{th\ j-mb}$	=		3,5		K/W
From junction to ambient in free air	$R_{th\ j-a}$	=		100		K/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
--------------------------------	-----------	---	---	-------------

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	0, 8	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

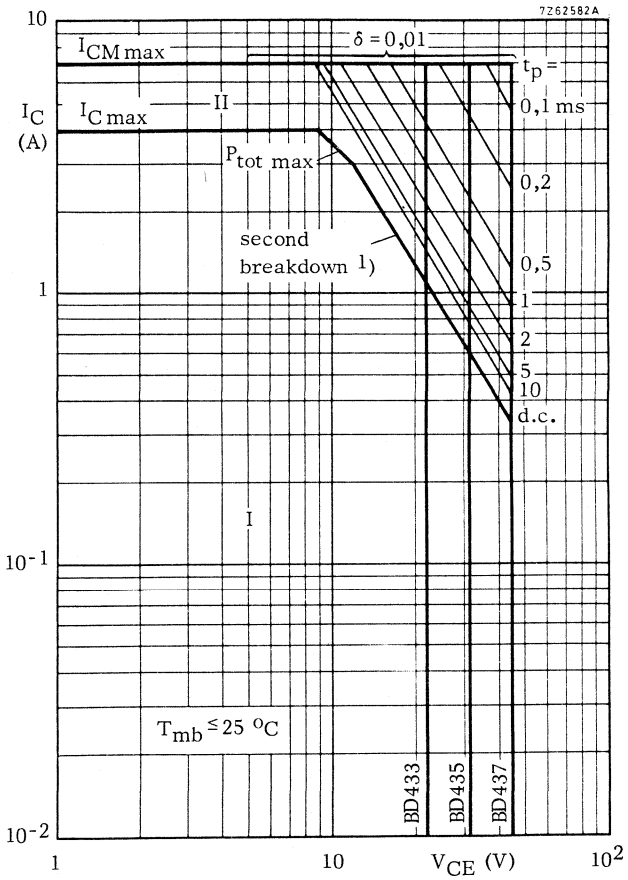
Transition frequency at $f = 1\text{ MHz}$

$I_C = 250\text{ mA}; V_{CE} = 1\text{ V}$	f_T	>	7	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/K with increasing temperature.

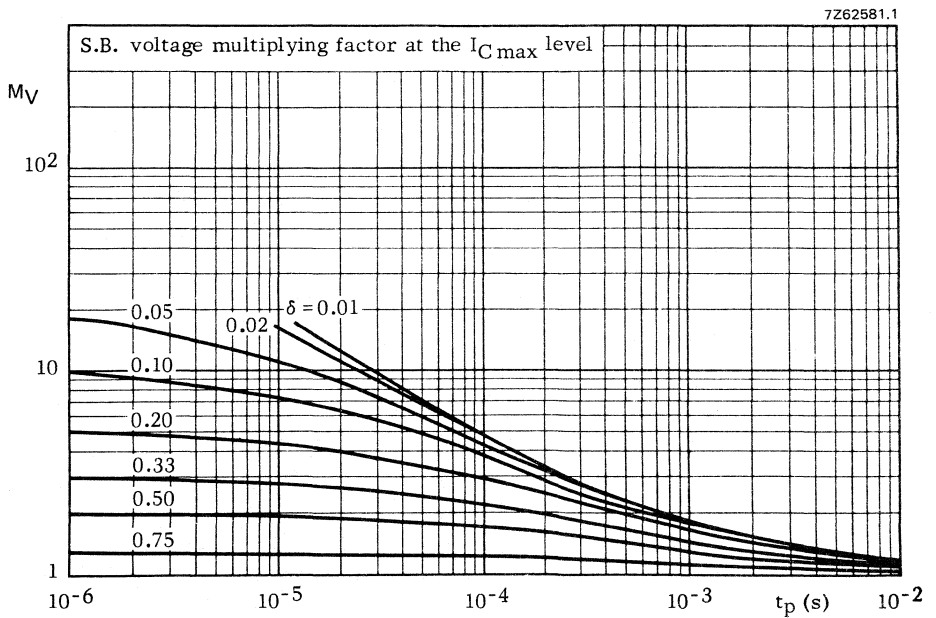
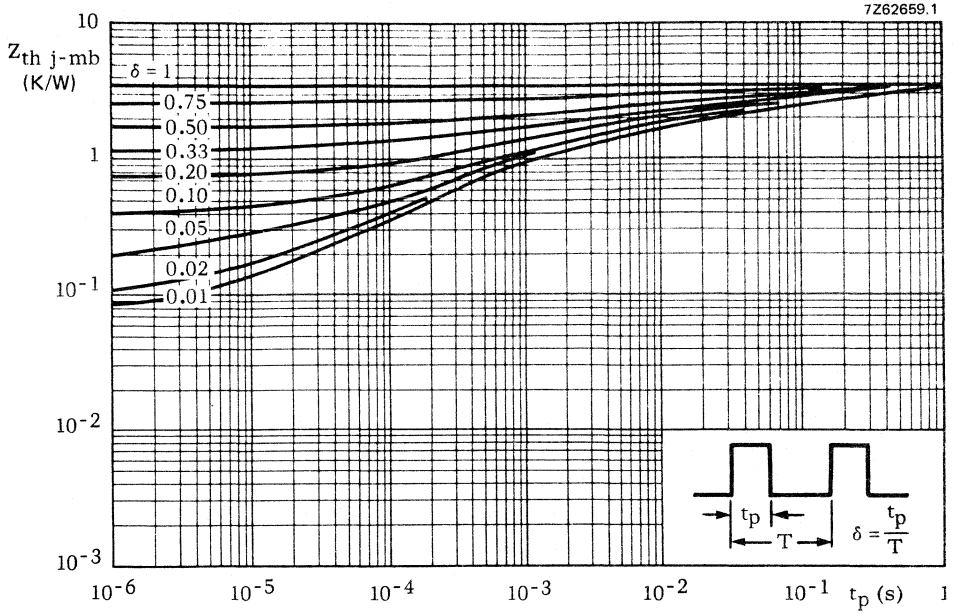


Safe Operating Area with the transistor forward biased

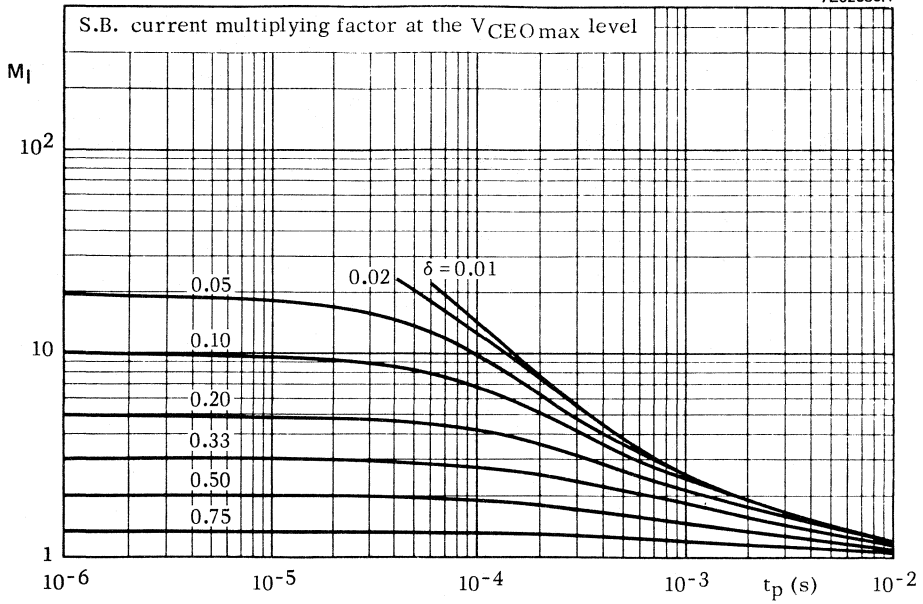
I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

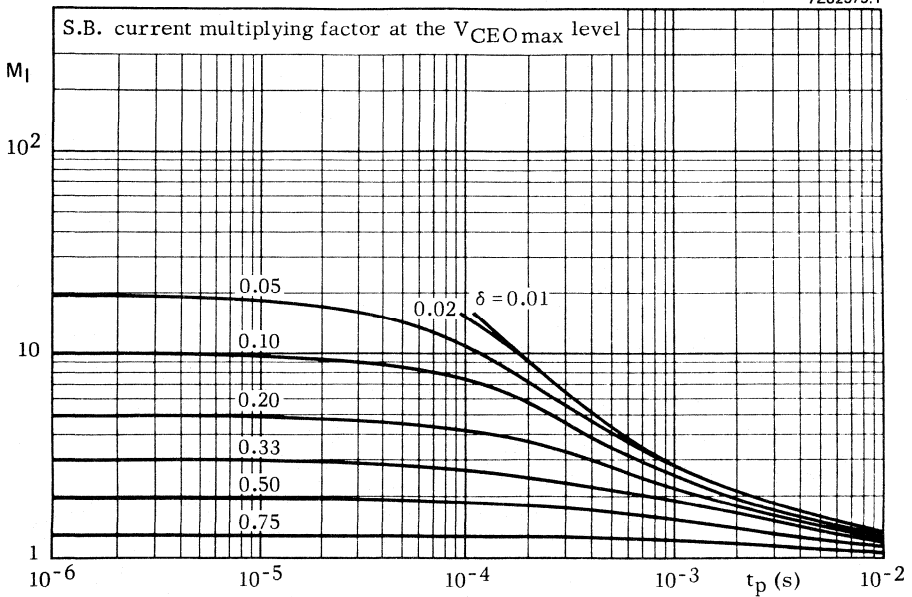
¹⁾ Independent of temperature.

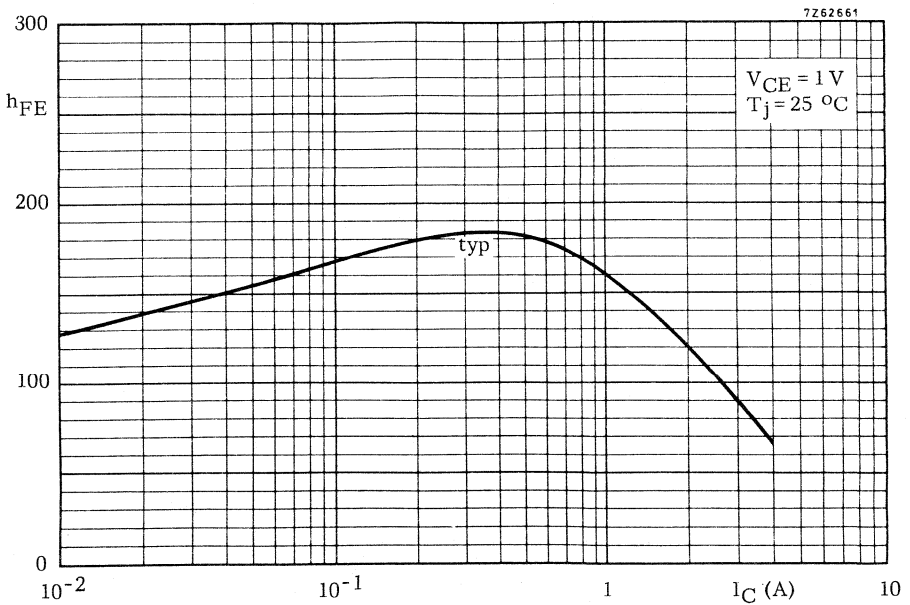
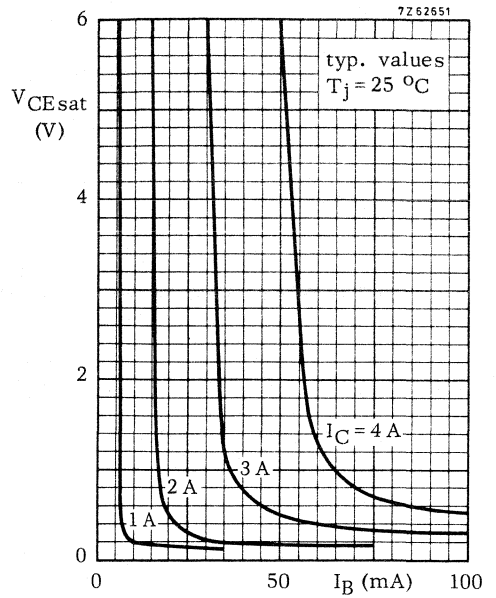
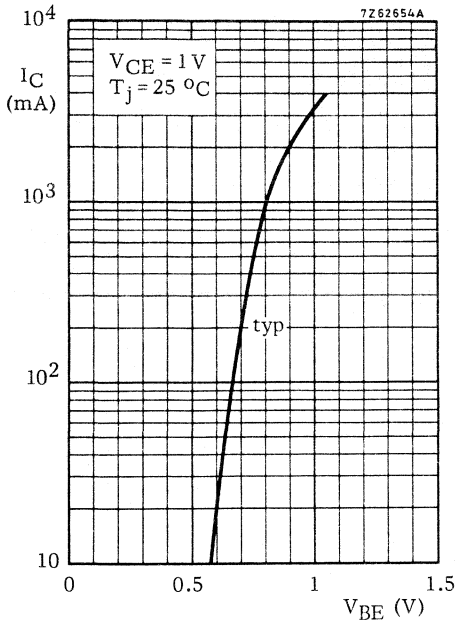


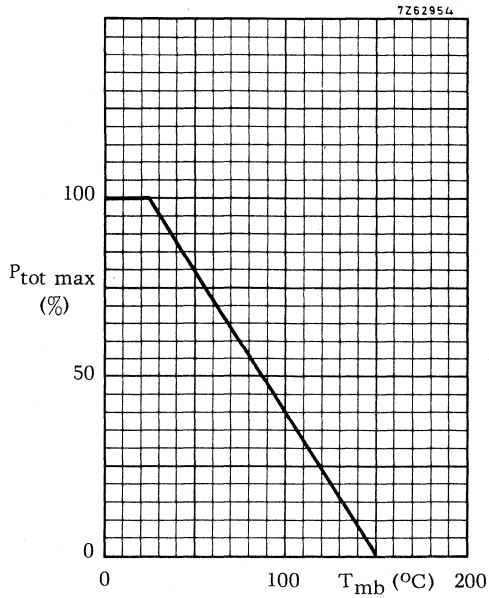
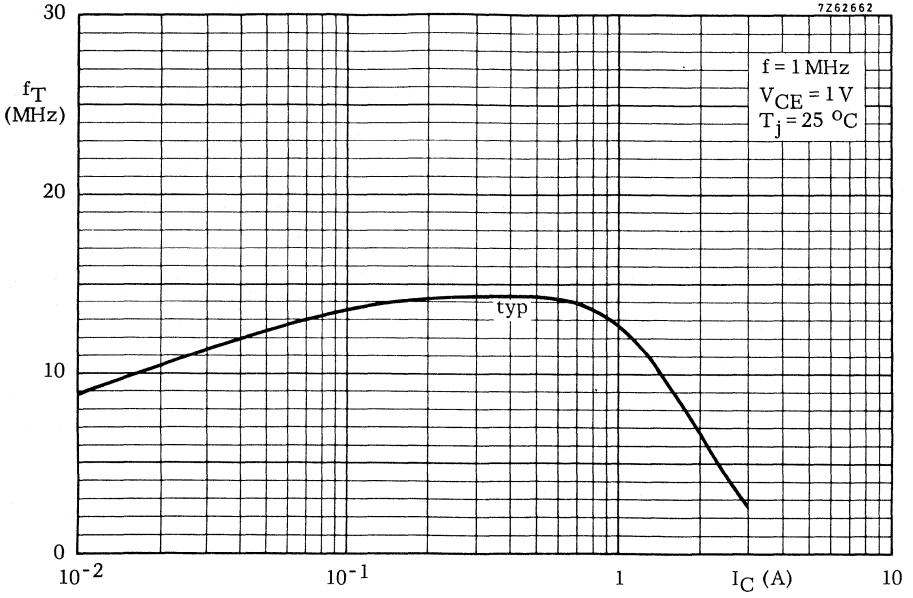
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SILICON EPITAXIAL-BASE POWER TRANSISTORS

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.

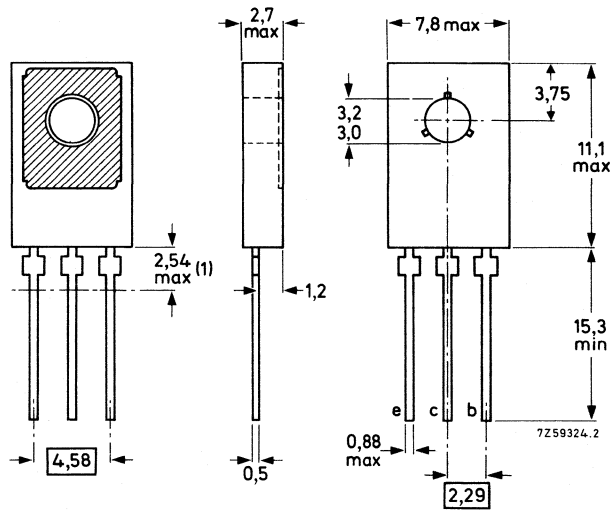
		QUICK REFERENCE DATA			
		BD434	BD436	BD438	
Collector-emitter voltage ($-V_{BE} = 0$)	$-V_{CES}$ max.	22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	22	32	45	V
Collector current (peak value)	$-I_{CM}$ max.	7	7	7	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot} max.	36	36	36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

MECHANICAL DATA

Dimensions in mm

TO-126 (SOT-32)

Collector connected to metal part of mounting surface



See 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)

		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
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
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	36		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	$R_{th\ j-mb}$	=	3,5		K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	100		K/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	0,8	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
		<	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 $f = 1\text{ MHz}$

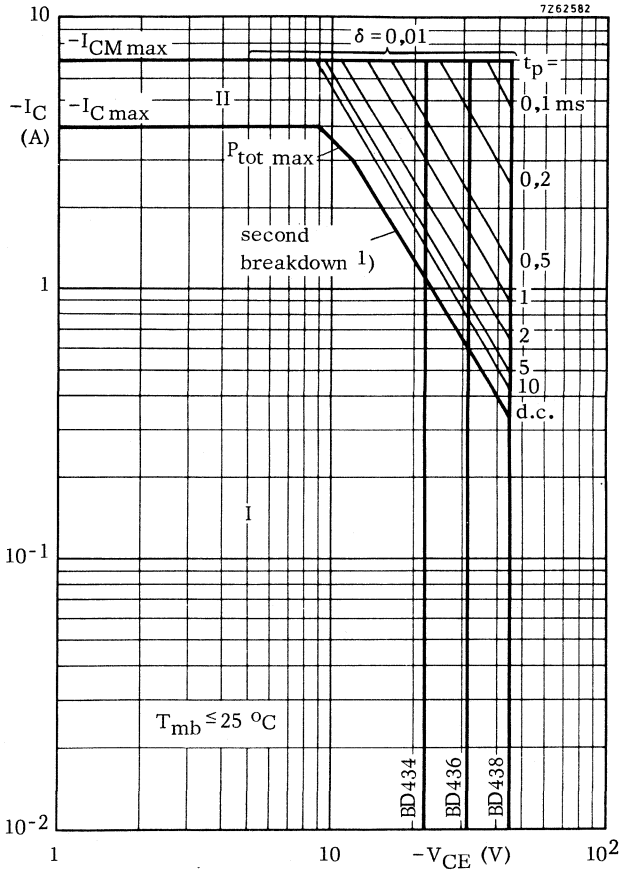
$-I_C = 250\text{ mA}; -V_{CE} = 1\text{ V}$	f_T	>	7	MHz
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D. C. current gain ratio of the complementary pairs

$|I_C| = 500\text{ mA}; |V_{CE}| = 1\text{ V}$

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/K with increasing temperature.

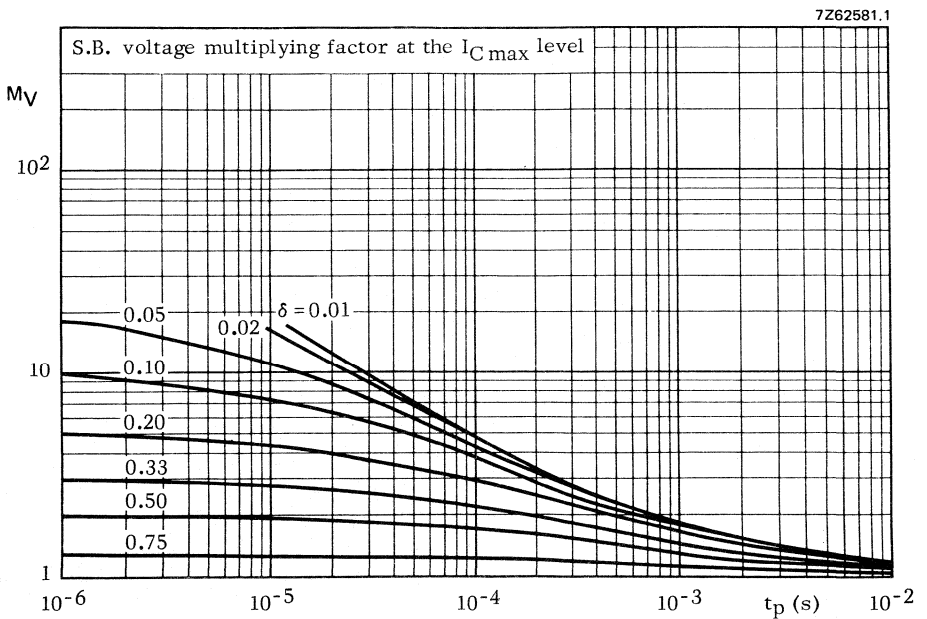
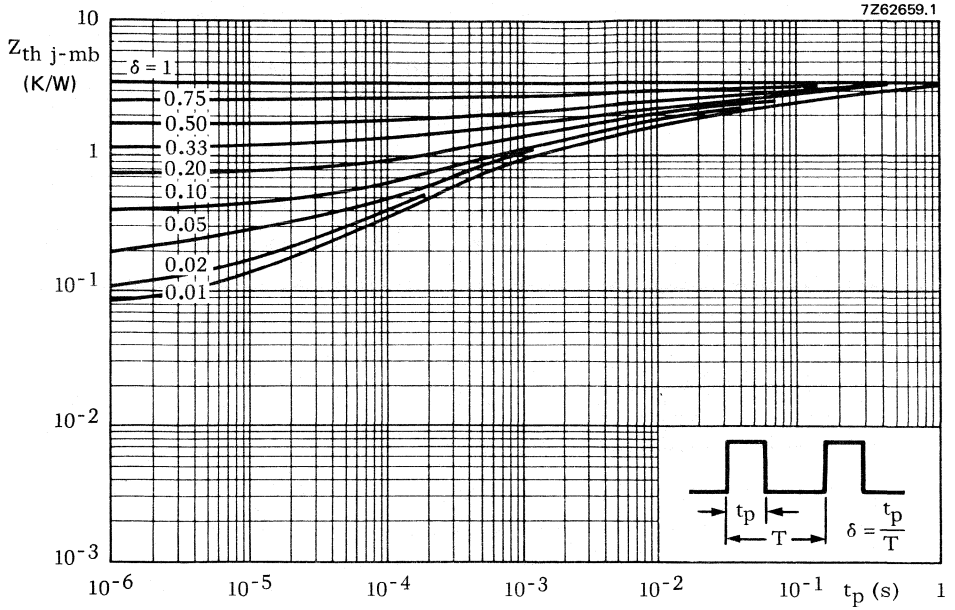


Safe Operating Area with the transistor forward biased

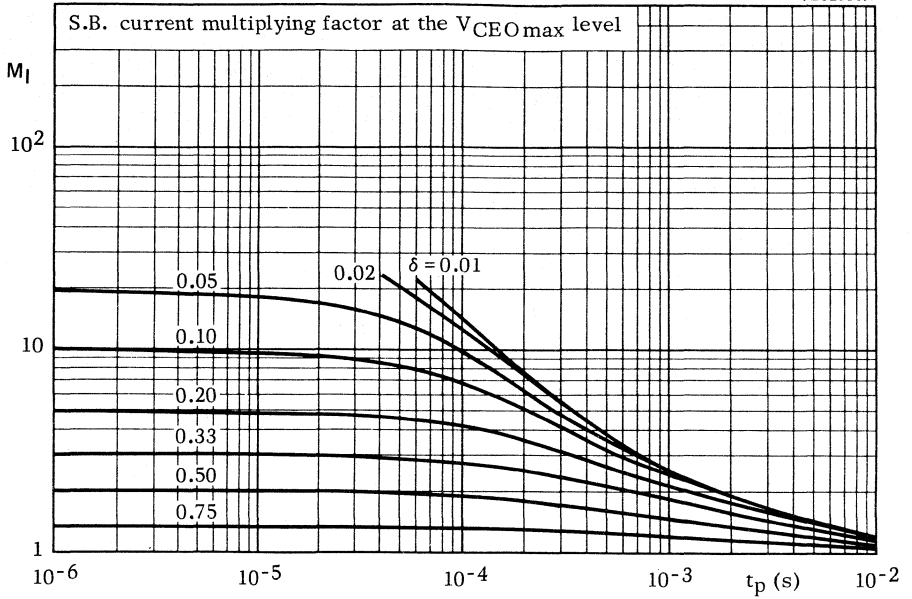
I Region of permissible d. c. operation

II Permissible extension for repetitive pulse operation

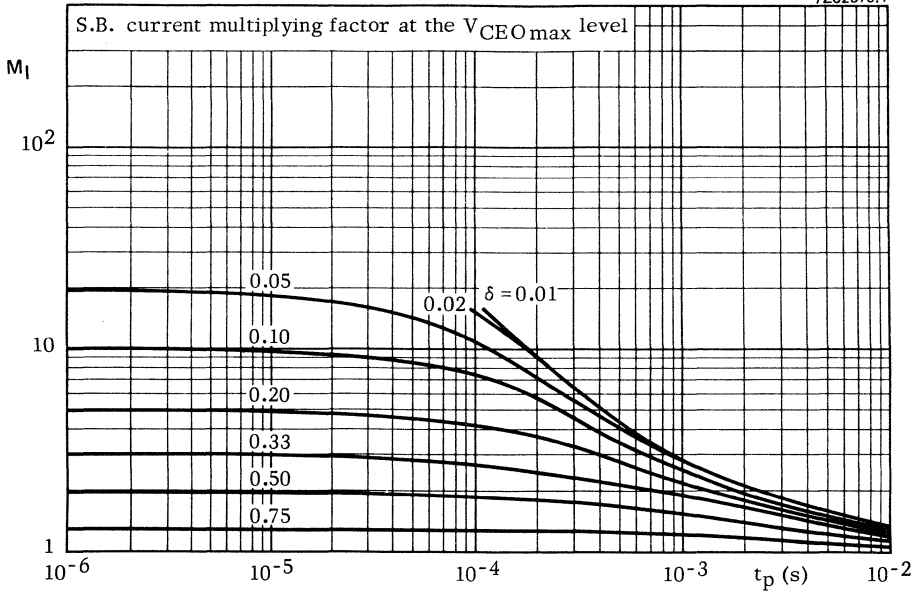
1) Independent of temperature.

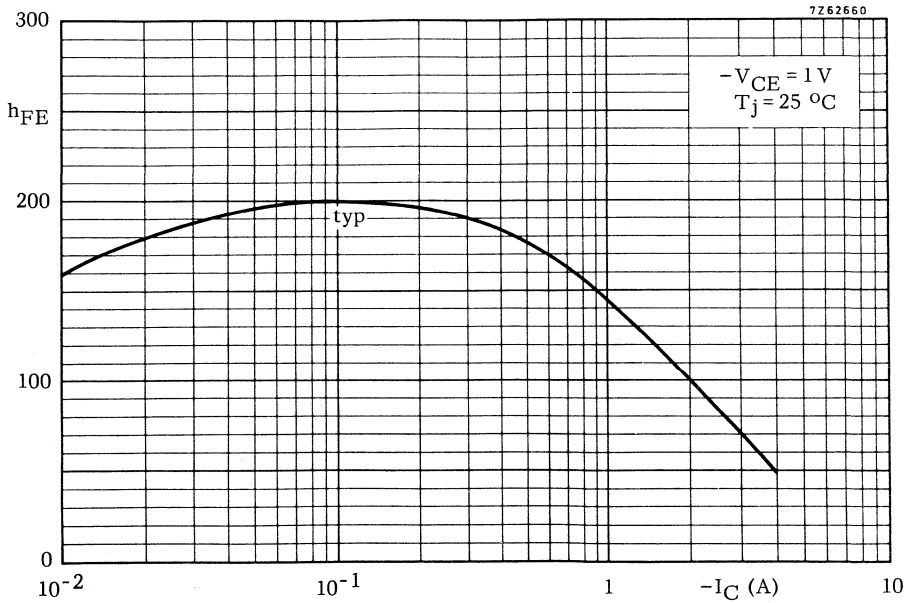
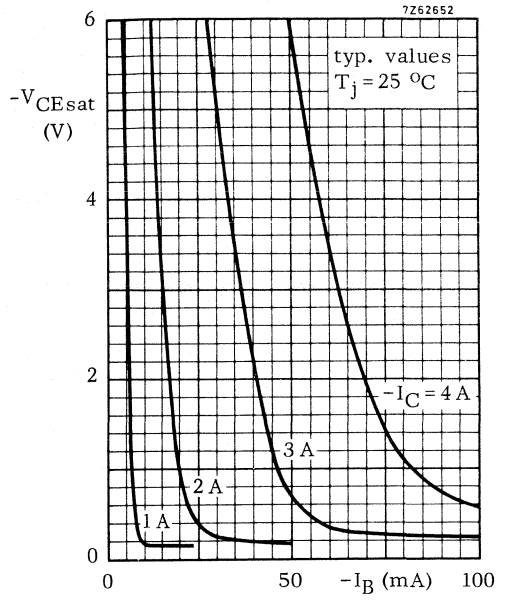
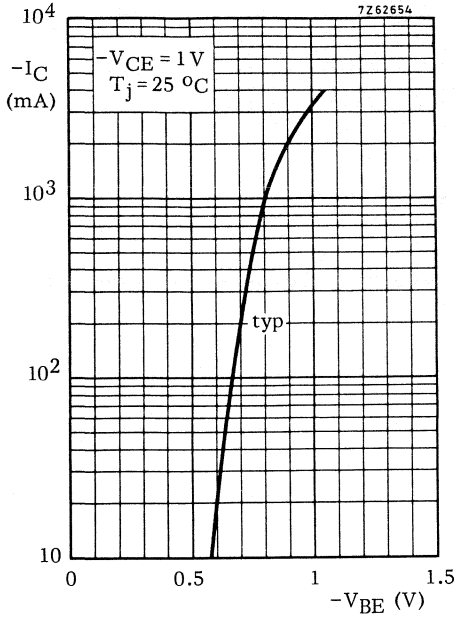


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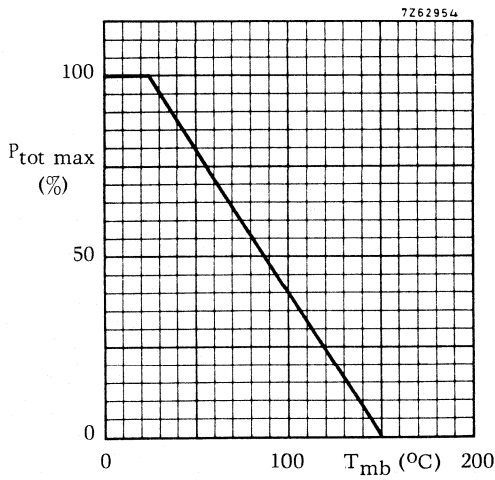
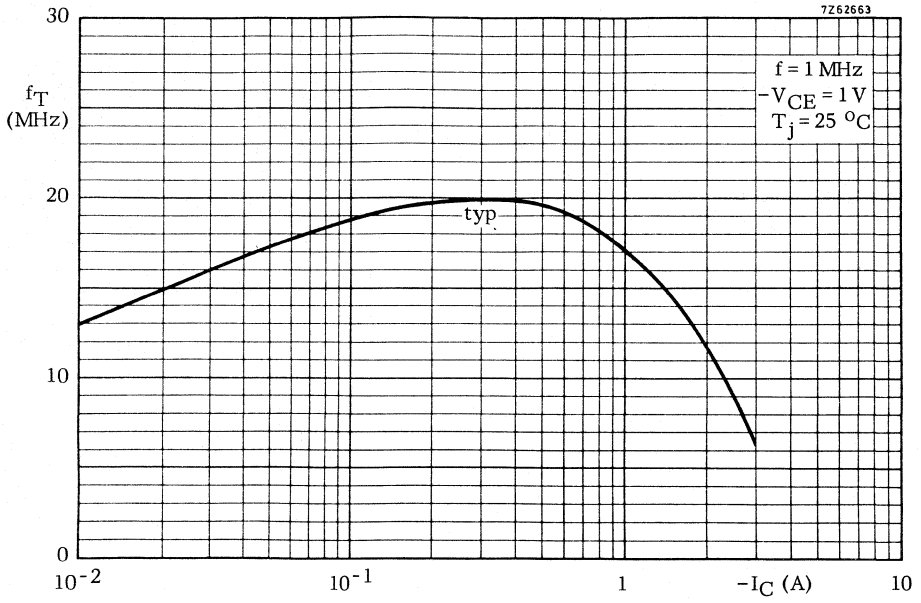


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**BD434; BD436;
BD438**



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.

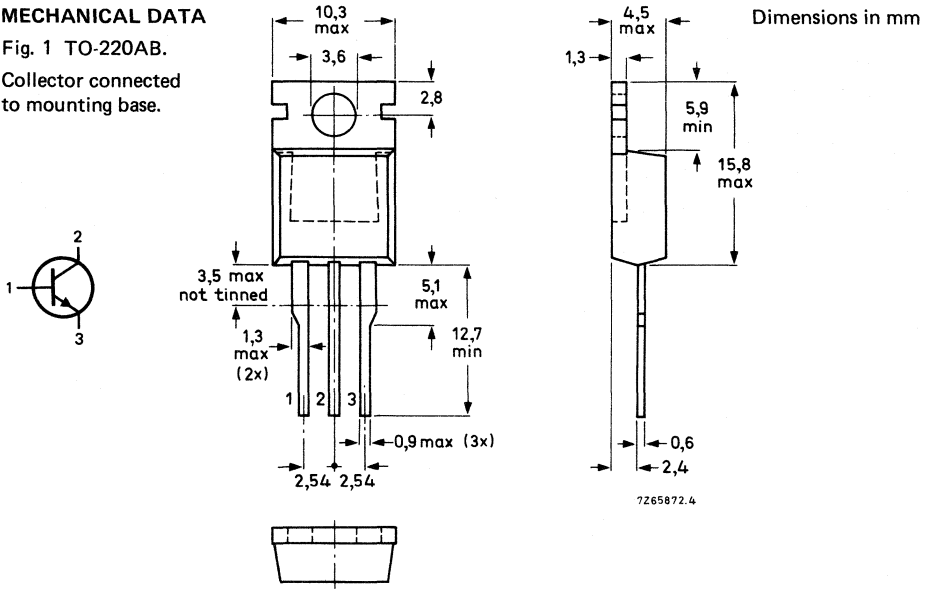
QUICK REFERENCE DATA

		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:					
$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$	h_{FE} typ.		1900		
$I_C = 3,0\text{ A}; V_{CE} = 3\text{ V}$	h_{FE} >		750		
Cut-off frequency: $I_C = 3\text{ A}; V_{CE} = 3\text{ V}$	f_{hfe} typ.		50		kHz

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting Instructions and Accessories.

CIRCUIT DIAGRAM

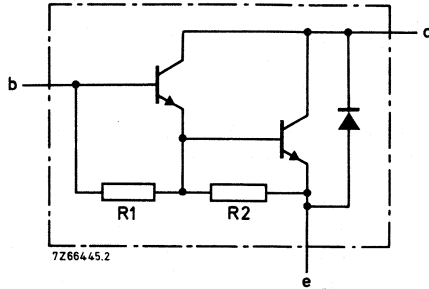


Fig. 2
R₁ typ. 4 kΩ
R₂ typ. 100 Ω

RATINGS

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

			BD645	647	649	651
Collector-base voltage (open emitter)	V _{CB0}	max.	80	100	120	140 V
Collector-emitter voltage (open base)	V _{CE0}	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	K/W
From junction to ambient in free air	R _{th j-a}	=	70	K/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

 $I_E = 0; V_{CB0} = V_{CE0max}$ $I_{CBO} < 0,2\text{ mA}$ $I_E = 0; V_{CB} = \frac{1}{2} V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$ $I_{CBO} < 2\text{ mA}$ $I_B = 0; V_{CE} = \frac{1}{2} V_{CE0max}$ $I_{CEO} < 0,5\text{ mA}$

Emitter cut-off current

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

D.C. current gain (note 1)

 $I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$ h_{FE} typ. 1900 $I_C = 3\text{ A}; V_{CE} = 3\text{ V}$ $h_{FE} > 750$ $I_C = 8\text{ A}; V_{CE} = 3\text{ V}$ h_{FE} typ. 1800

Base-emitter voltage (notes 1 and 2)

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

Saturation voltages (note 1)

 $I_C = 3\text{ A}; I_B = 12\text{ mA}$ $V_{CEsat} < 2\text{ V}$ $I_C = 5\text{ A}; I_B = 50\text{ mA}$ $V_{CEsat} < 2,5\text{ V}$ $V_{BEsat} < 3\text{ V}$

Diode forward voltage

 $I_F = 3\text{ A}$ V_F typ. 1,2 VCollector capacitance at $f = 1\text{ MHz}$ $I_E = I_e = 0; V_{CB} = 10\text{ V}$ C_c typ. 75 pF

Cut-off frequency

 $I_C = 3\text{ A}; V_{CE} = 3\text{ V}$ f_{hfe} typ. 50 kHz

Turn-off breakdown energy with inductive load

 $-I_{Boff} = 0; I_{CM} = 4,5\text{ A}; t_p = 1\text{ ms};$ $T = 100\text{ ms};$ see Fig. 3 $E_{(BR)} > 50\text{ mJ}$

Small signal current gain

 $I_C = 3\text{ A}; V_{CE} = 3\text{ V}; f = 1\text{ MHz}$ $h_{fe} > 10$ ←

Second breakdown collector current

 $V_{CE} = 60\text{ V}; t_p = 0,1\text{ s}$ $I_{(SB)} > 1,04\text{ A}$

Switching times (see Figs 4 and 5)

 $I_{Con} = 3\text{ A}; I_{Bon} = -I_{Boff} = 12\text{ mA}$ turn-on time t_{on} typ. 1,0 μs
< 2,5 μs turn-off time t_{off} typ. 5 μs
< 10 μs

Notes

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

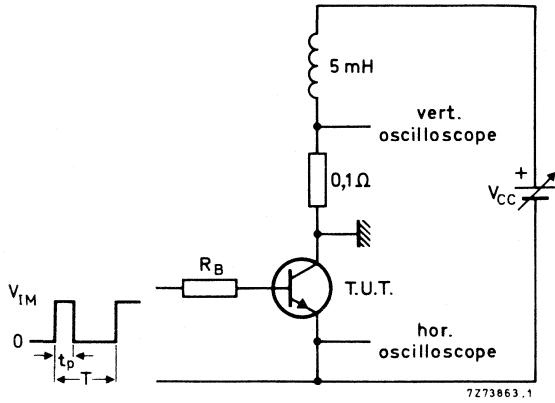


Fig. 3 Test circuit for turn-off breakdown energy.
 $V_{IM} = 12 \text{ V}$; $R_B = 270 \text{ } \Omega$;
 $t_p = 1 \text{ ms}$; $\delta = 1\%$.

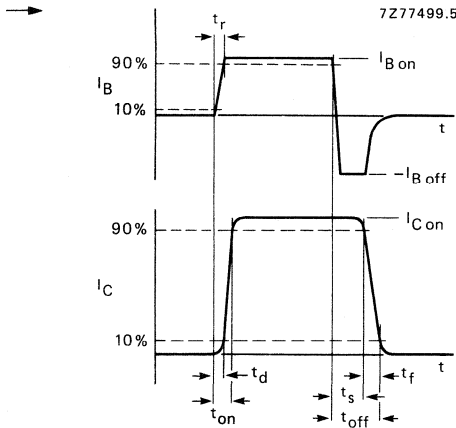
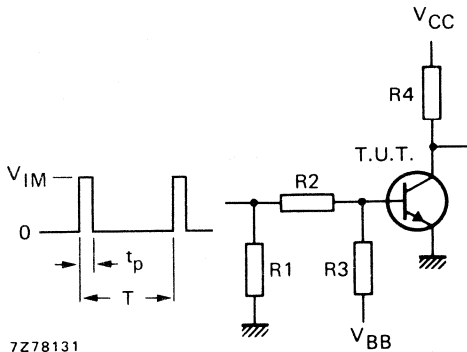


Fig. 4 Switching times waveforms.



- $V_{CC} = 10 \text{ V}$
- $V_{IM} = 10 \text{ V}$
- $-V_{BB} = 4 \text{ V}$
- $R1 = 56 \text{ } \Omega$
- $R2 = 410 \text{ } \Omega$
- $R3 = 560 \text{ } \Omega$
- $R4 = 3 \text{ } \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 10 \text{ } \mu\text{s}$
- $T = 500 \text{ } \mu\text{s}$

Fig. 5 Switching times test circuit.

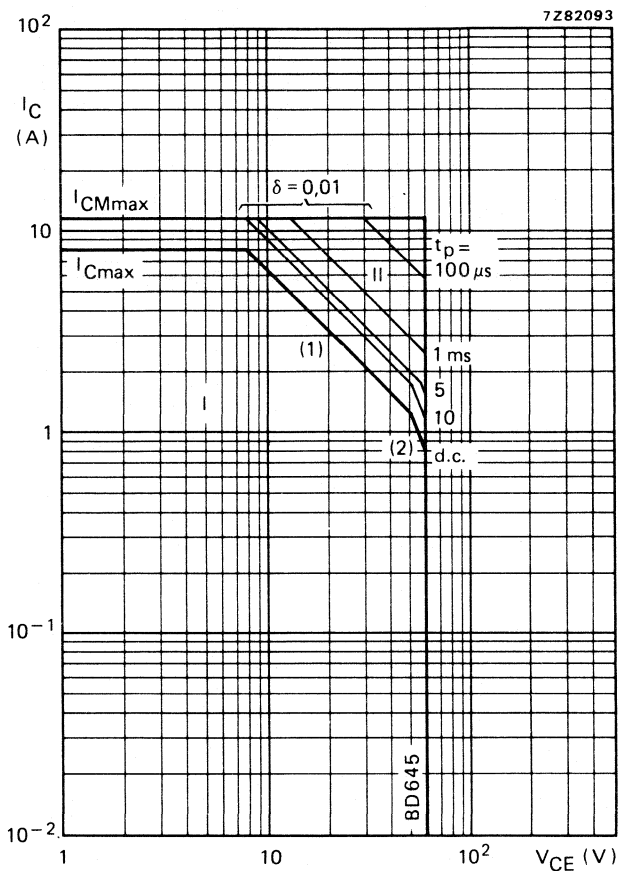


Fig. 6 Safe Operating Area; $T_{mb} = 25\text{ }^\circ\text{C}$

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).

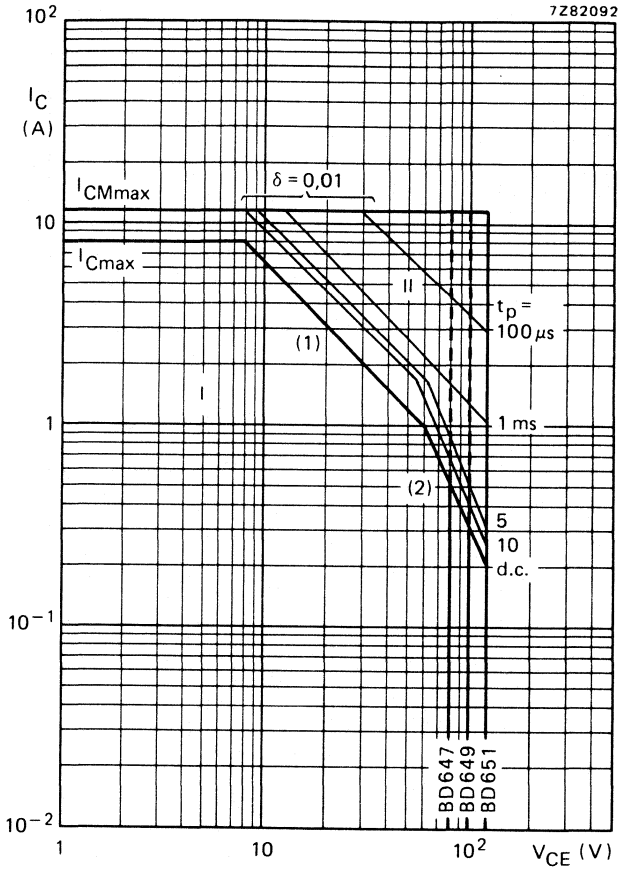


Fig. 7 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- 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).

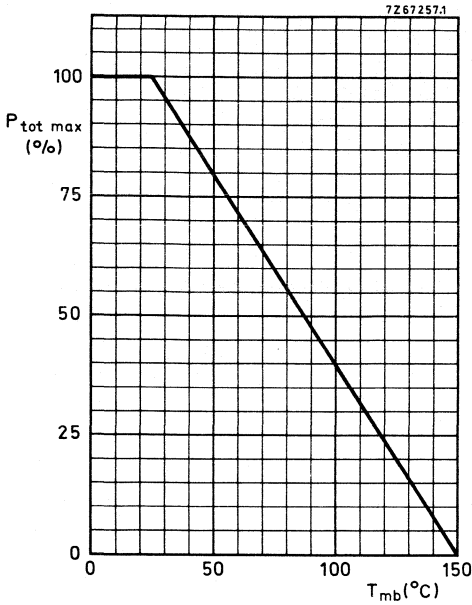


Fig. 8 Power derating curve.

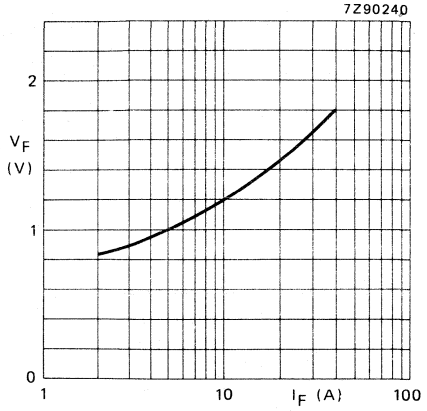


Fig. 8a Typical values forward voltage of collector-emitter diode (see Fig. 2) at $T_j = 25^\circ\text{C}$.

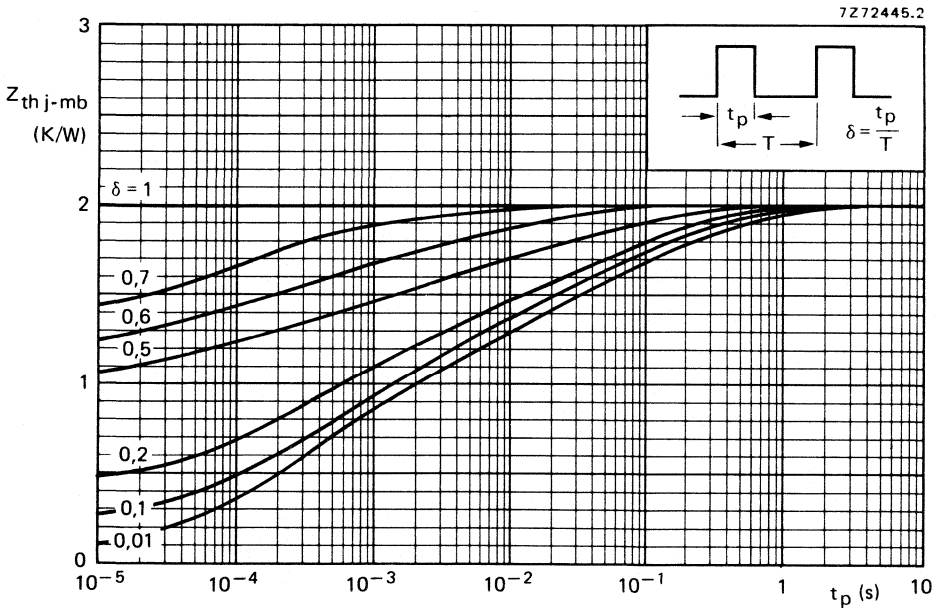


Fig. 9 Pulse power rating chart.

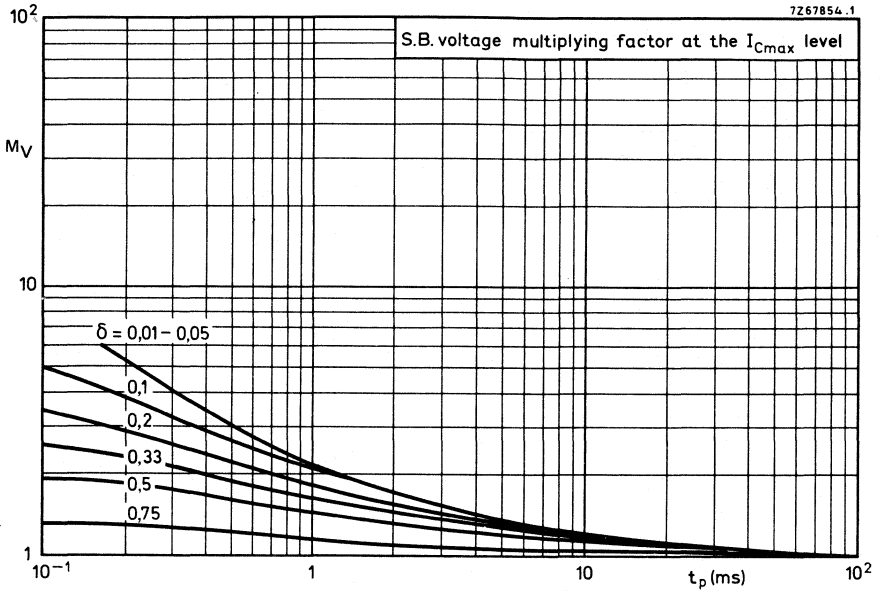


Fig. 10.

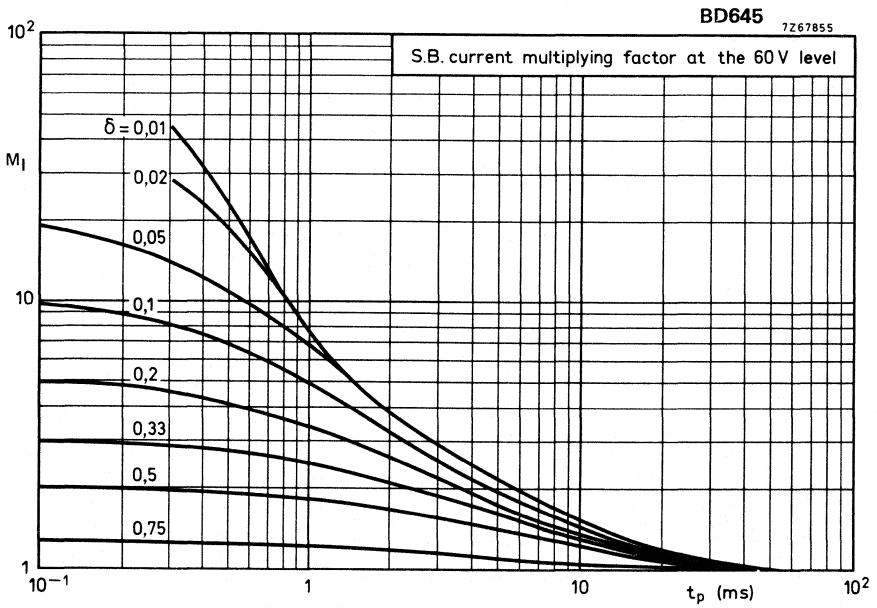


Fig. 11.

BD647; BD649

7Z67856

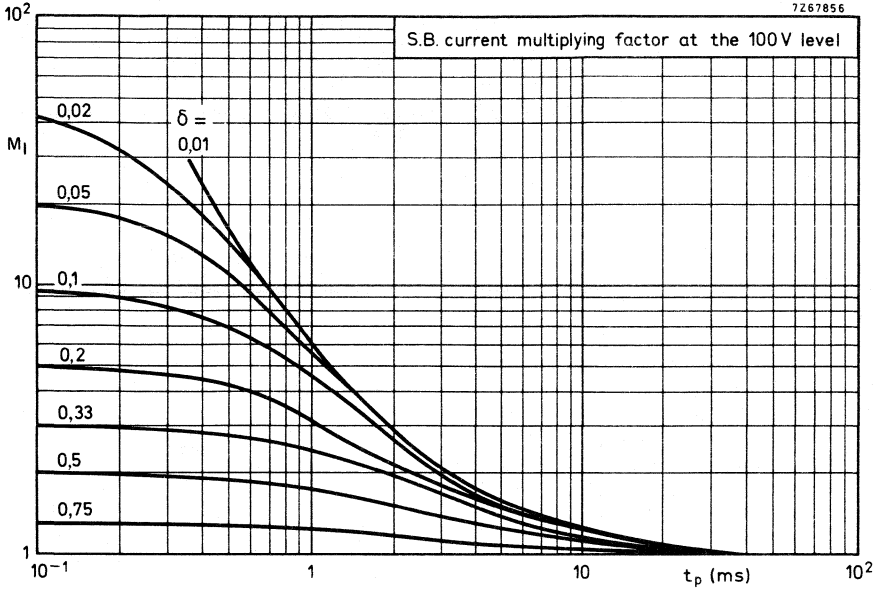


Fig. 12 Second breakdown current multiplying factor at the 100 V level.

BD651

7Z77026.1

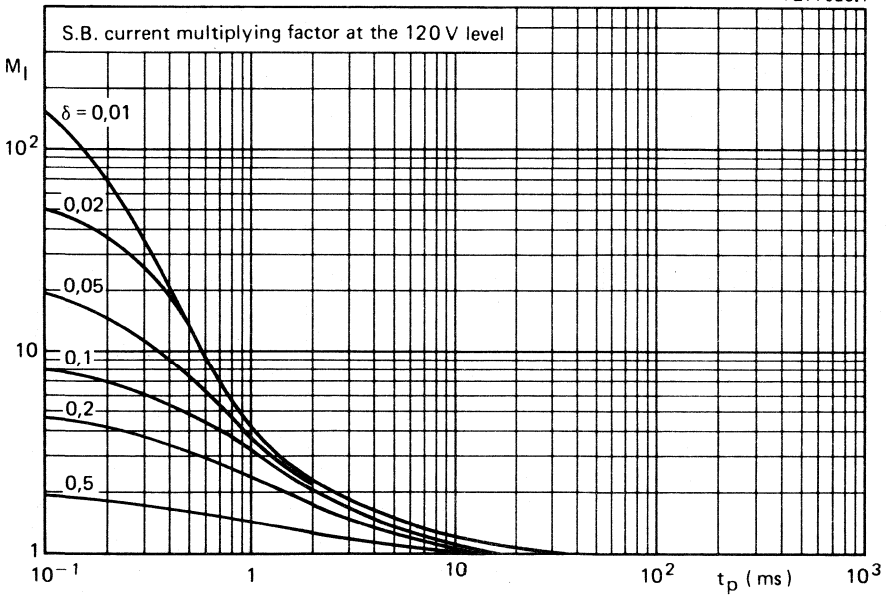


Fig. 13 Second breakdown current multiplying factor at the 120 V level.

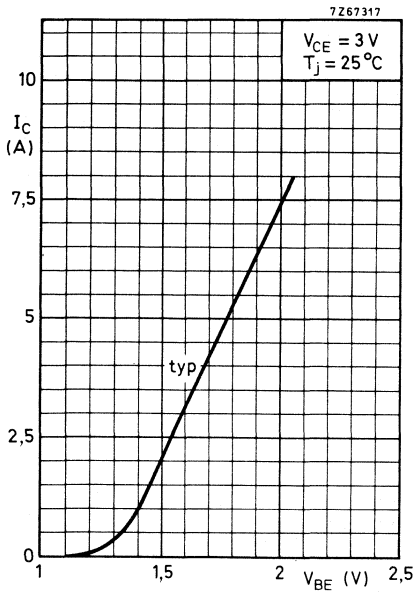


Fig. 14.

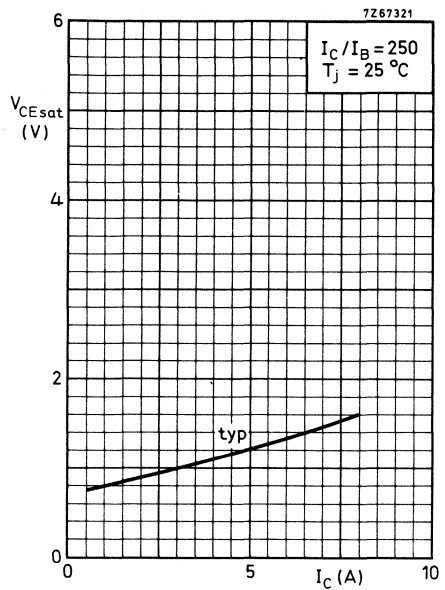


Fig. 15.

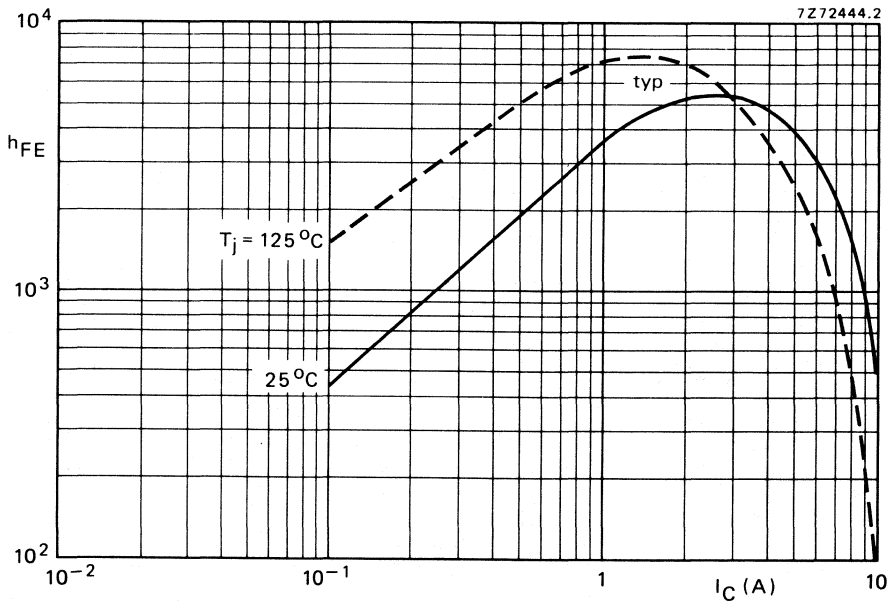


Fig. 16 Typical d.c. current gain. $V_{CE} = 3\text{ V}$.

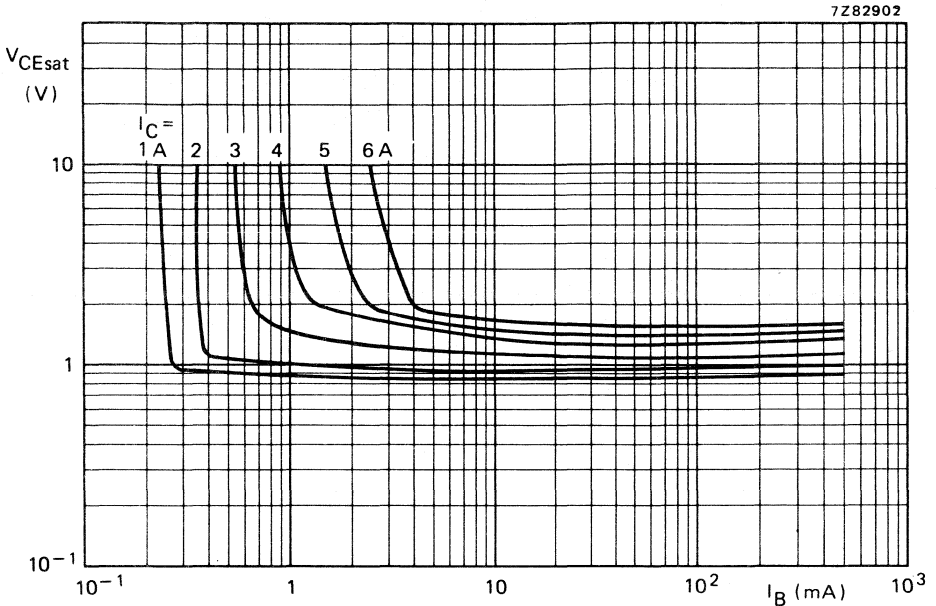


Fig. 17 Typical values collector-emitter saturation voltage. $T_j = 25^\circ C$.

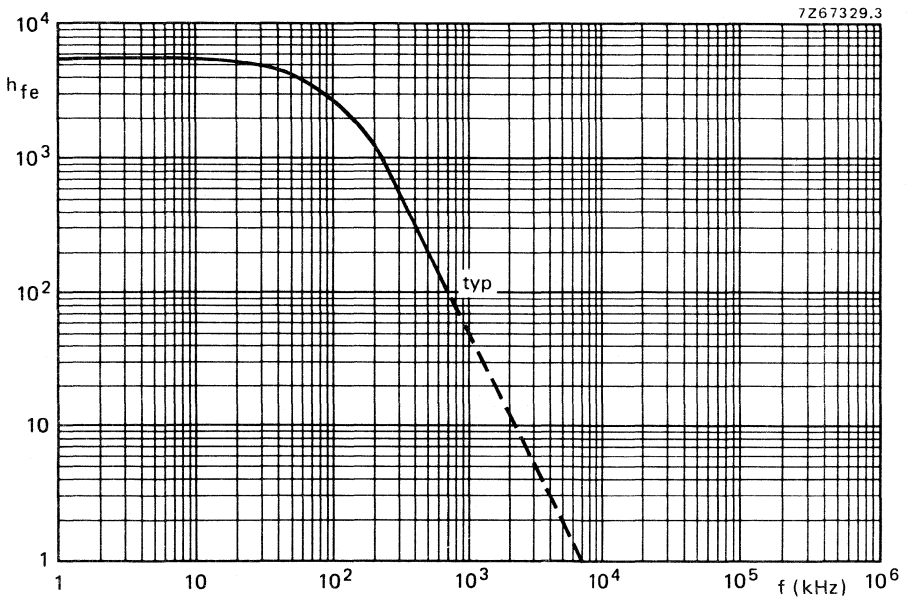


Fig. 18 Small signal current gain at $I_C = 3 A$; $V_{CE} = 3 V$.

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.

QUICK REFERENCE DATA

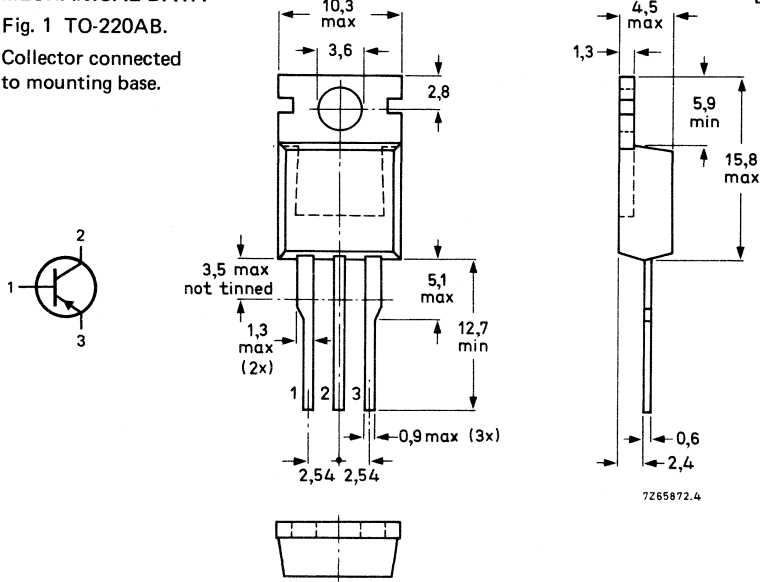
		BD646	648	650	652
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100	120 V
Collector current (peak value)	$-I_{CM}$ max.		12		A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.		62,5		W
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.		2700		
$-I_C = 3,0\text{ A}; -V_{CE} = 3\text{ V}$	$h_{FE} >$		750		
Cut-off frequency:					
$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe} typ.		100		kHz

MECHANICAL DATA

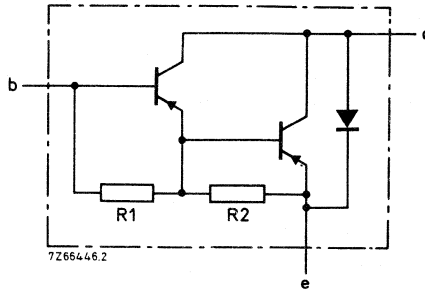
Fig. 1 TO-220AB.

Collector connected to mounting base.

Dimensions in mm



See also chapters Mounting Instructions and Accessories.



R_1 typ. 4 k Ω
 R_2 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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.		62,5		W
Storage temperature	T_{stg}		-65 to +150		$^\circ\text{C}$
Junction temperature *	T_j		150		$^\circ\text{C}$

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j-mb}$ =	2	K/W
From junction to ambient in free air	$R_{th\ j-a}$ =	70	K/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

 $I_E = 0; -V_{CB} = -V_{CBOmax}$ $-I_{CBO}$ $<$ 0,2 mABD646: $-V_{CB} = 40\text{ V}$ $I_E = 0; -V_{CB} = 50\text{ V}$ $-I_{CBO}$ $<$ 2 mABD648: $-V_{CB} = 50\text{ V}$; $T_j = 150\text{ }^\circ\text{C}$ BD650: $-V_{CB} = 60\text{ V}$ BD652: $-V_{CB} = 70\text{ V}$ $I_B = 0; -V_{CE} = \frac{1}{2} V_{CEOmax}$ $-I_{CEO}$ $<$ 0,5 mA

Emitter cut-off current

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

D.C. current gain (note 1)

 $-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V}$ h_{FE} typ. 2700 $-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$ h_{FE} $>$ 750 $-I_C = 8\text{ A}; -V_{CE} = 3\text{ V}$ h_{FE} typ. 200

Base-emitter voltage (notes 1 and 2)

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

Saturation voltages (note 1)

 $-I_C = 3\text{ A}; -I_B = 12\text{ mA}$ $-V_{CEsat}$ $<$ 2 V $-I_C = 5\text{ A}; -I_B = 50\text{ mA}$ $-V_{CEsat}$ $<$ 2,5 V $-V_{BEsat}$ $<$ 3 VCollector capacitance at $f = 1\text{ MHz}$ $I_E = I_e = 0; -V_{CB} = 10\text{ V}$ C_c typ. 75 pF

Cut-off frequency

 $-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$ f_{hfe} typ. 100 kHz

Small-signal current gain

 $-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz}$ h_{fe} $>$ 10 ←

Diode, forward voltage

 $I_F = 3\text{ A}$ V_F typ. 1,8 V

Second-breakdown collector current

 $-V_{CE} = 50\text{ V}; t_p = 0,1\text{ s}$ $-I_{(SB)}$ $>$ 1,25 A

Switching times (between 10% and 90% levels) (Fig. 3)

 $-I_{Con} = 3\text{ A}; -I_{Bon} = I_{Boff} = 12\text{ mA}; V_{CC} = -10\text{ V}$ Turn-on time t_{on} typ. 1 μs $<$ 2 μs Turn-off time t_{off} typ. 5 μs $<$ 10 μs

Notes

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

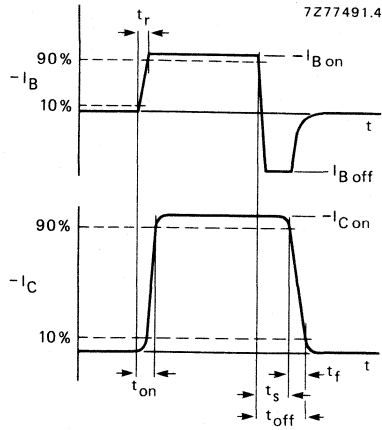
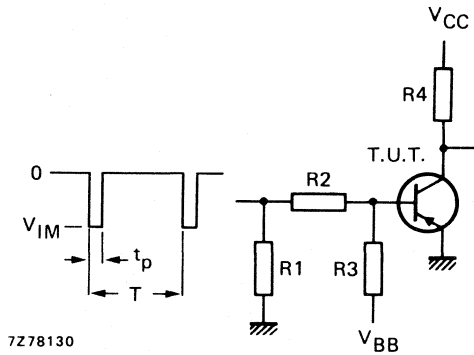


Fig. 3 Switching times waveforms.



- $-V_{IM} = 10 \text{ V}$
- $-V_{CC} = 10 \text{ V}$
- $+V_{BB} = 4 \text{ V}$
- $R1 = 56 \Omega$
- $R2 = 410 \Omega$
- $R3 = 560 \Omega$
- $R4 = 3 \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 10 \mu\text{s}$
- $T = 500 \mu\text{s}$

Fig. 4 Switching times test circuit.

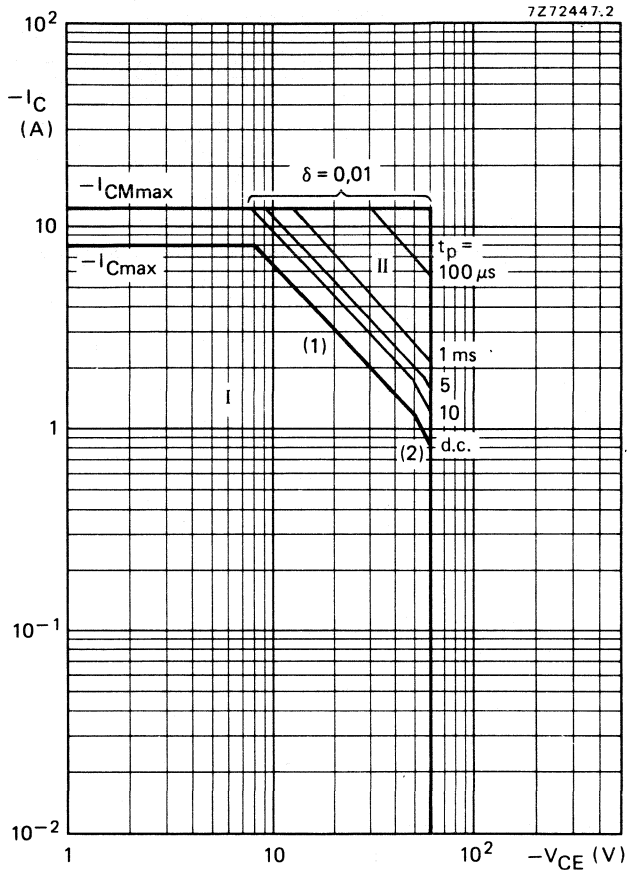


Fig. 5 Safe Operating Area transistor BD646 at $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- 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).

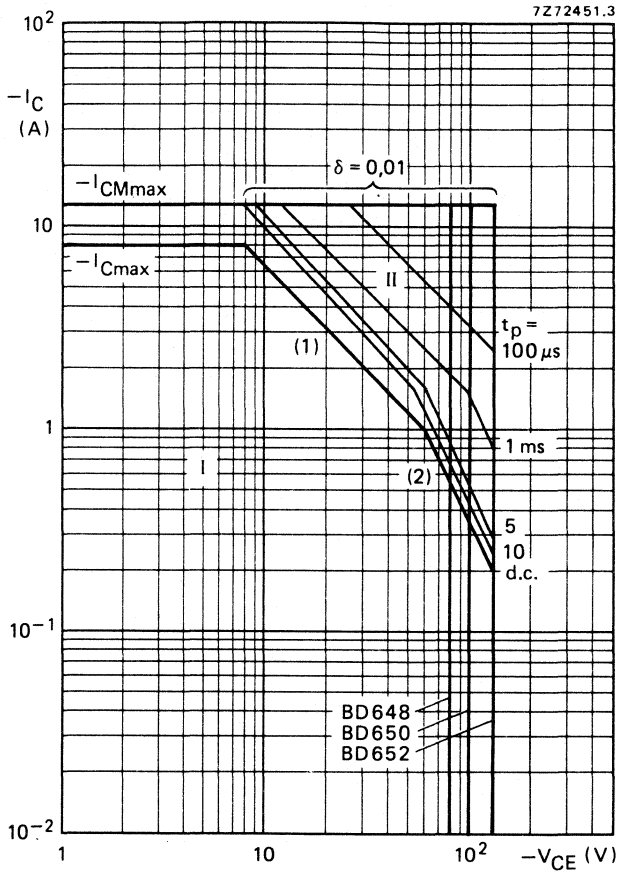


Fig. 6 Safe Operating Area. $T_{mb} = 25\text{ }^{\circ}\text{C}$

- 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).

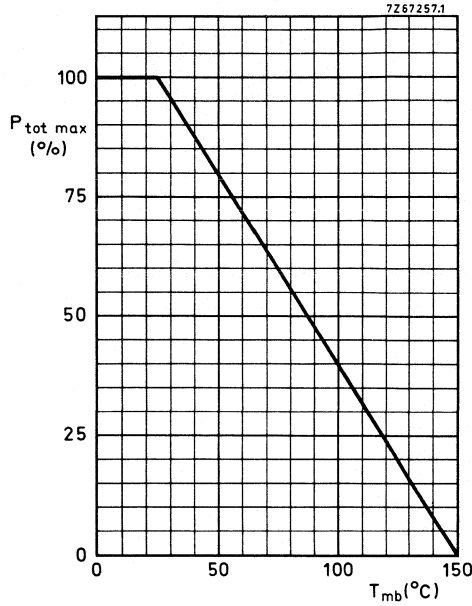


Fig. 7 Power derating curve.

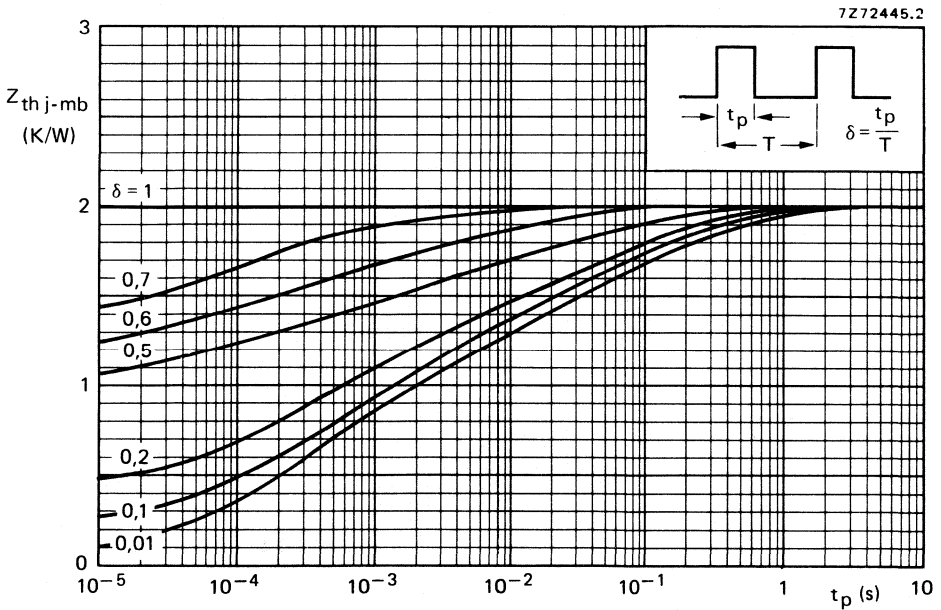


Fig. 8 Pulse power rating chart.

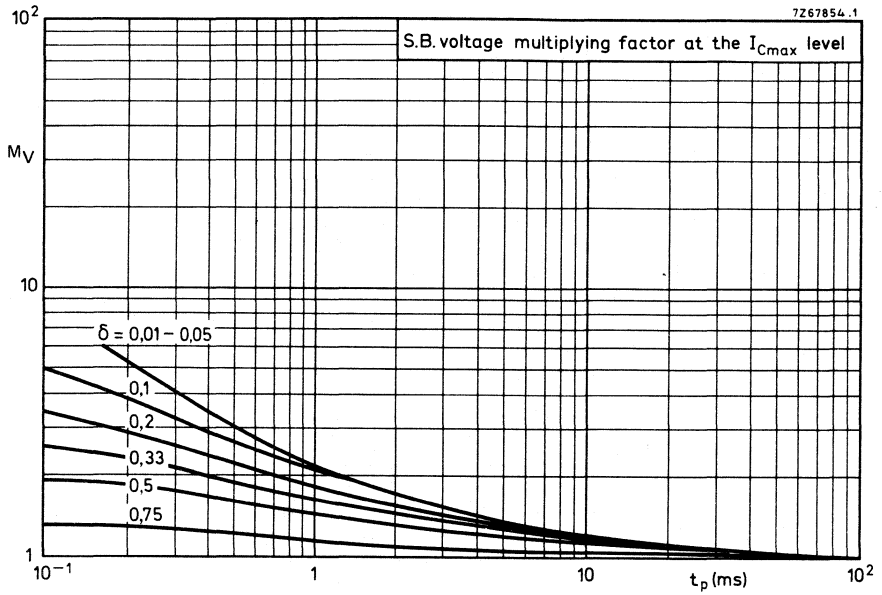


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

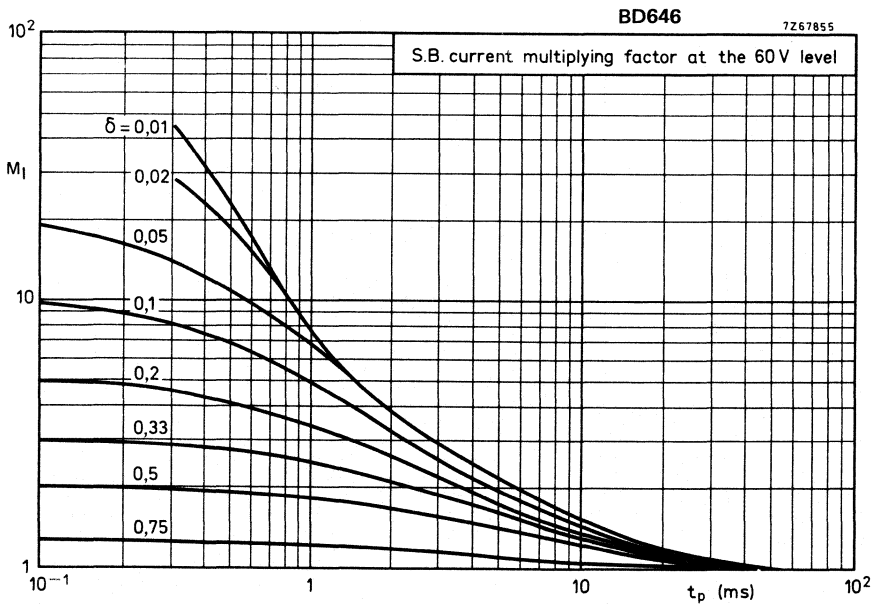


Fig. 10 S.B. current multiplying factor at 60 V level.

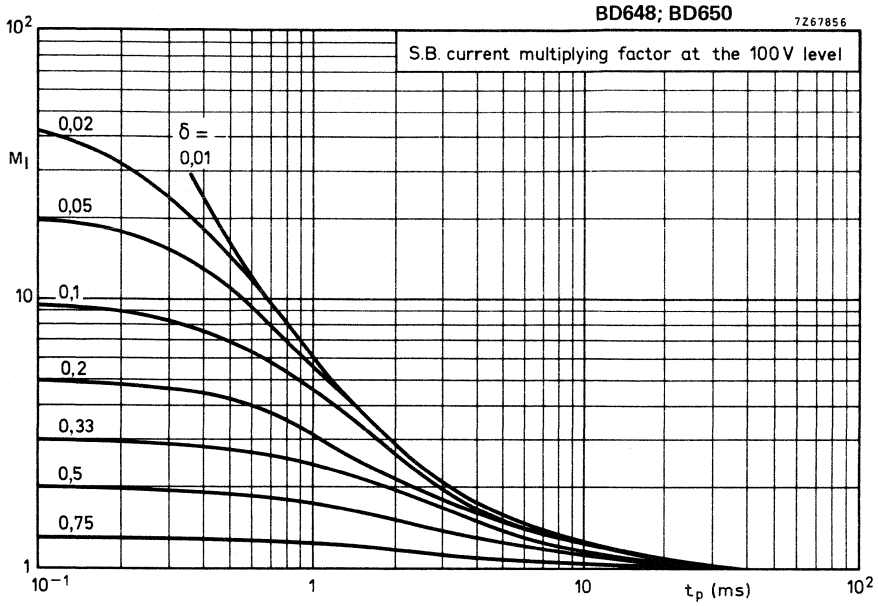


Fig. 11.

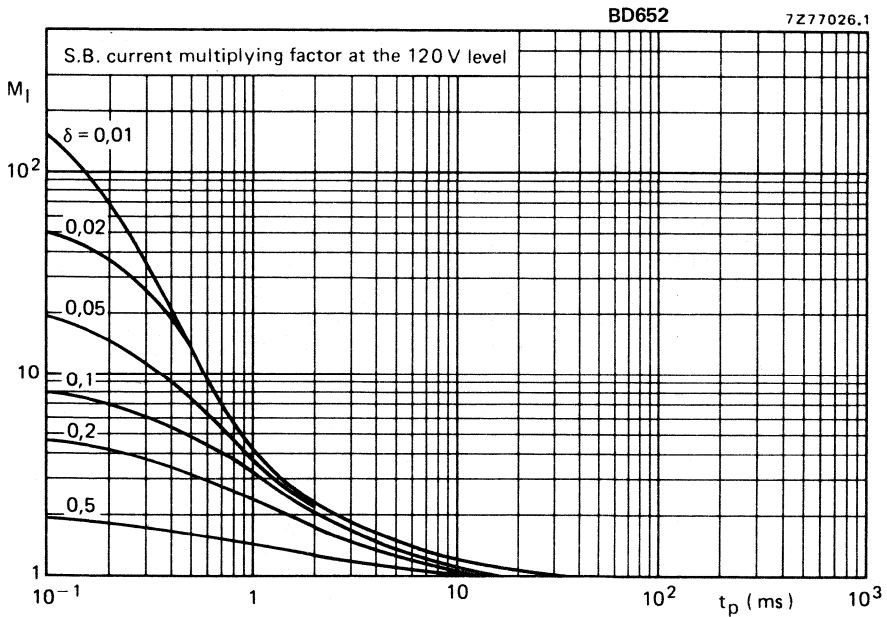


Fig. 12.

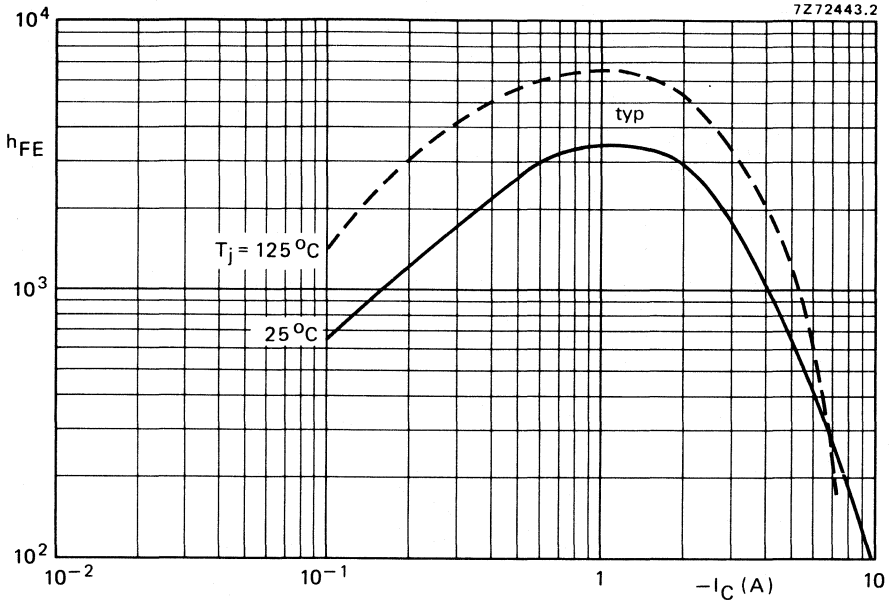


Fig. 13 D.C. current gain at $-V_{CE} = 3\text{ V}$.

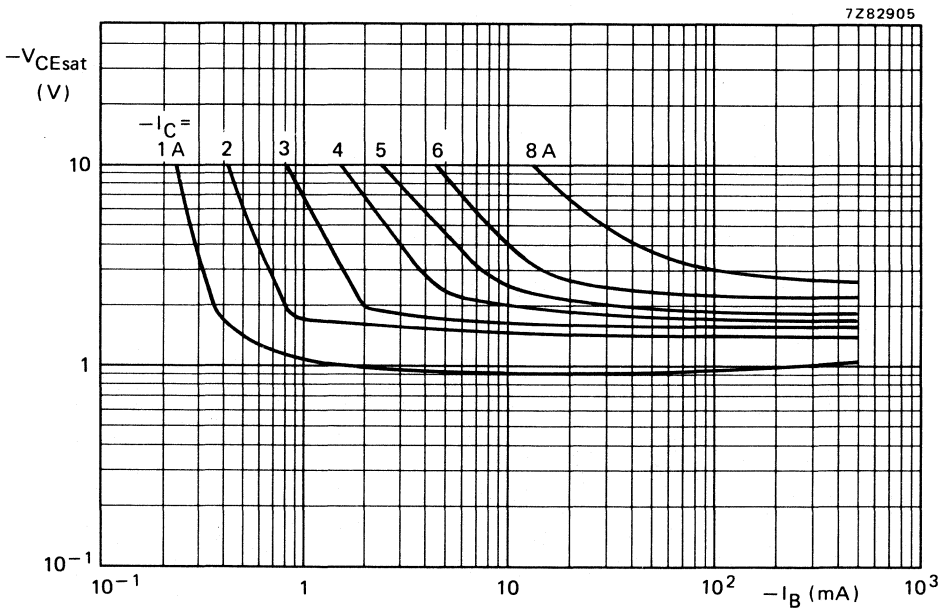


Fig. 14 Typical collector-emitter saturation voltage at $T_j = 25^\circ\text{C}$.

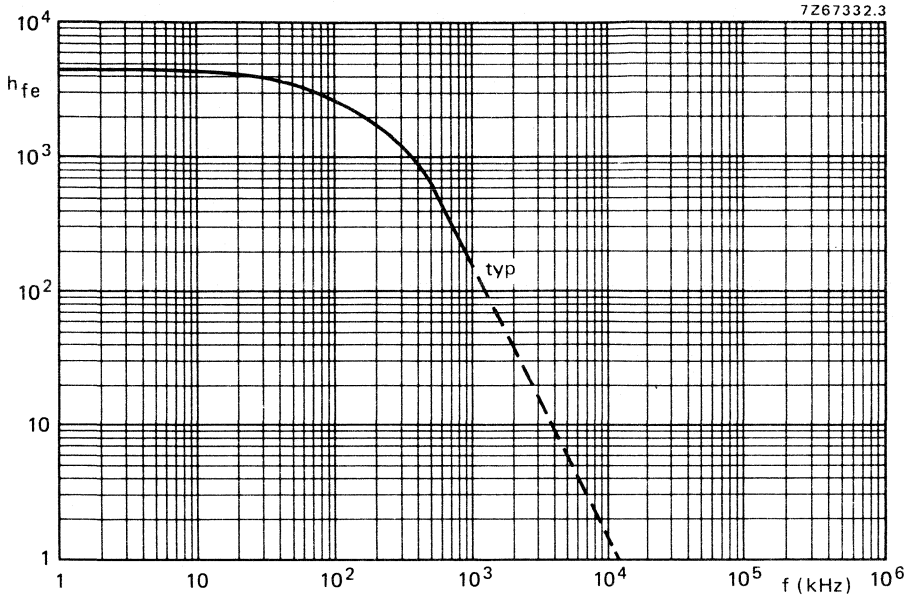


Fig. 15 Small signal current gain at $-I_C = 3 \text{ A}$; $-V_{CE} = 3 \text{ V}$.

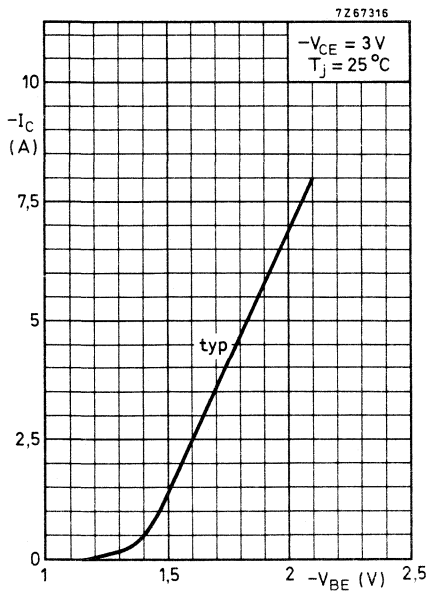


Fig. 16 Collector current.

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.

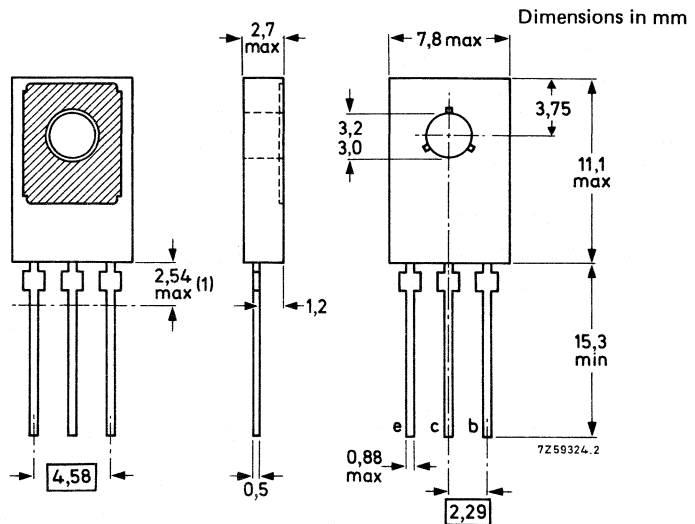
QUICK REFERENCE DATA

			BD675	677	679	681	683
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	140
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120
Collector current (peak value)	I_{CM}	max.	6				A
Total power dissipation up to $T_{mb} = 25\text{ °C}$	P_{tot}	max.	40				W
Junction temperature	T_j	max.	150				°C
D.C. current gain							
$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	typ.	2200				
$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	>	750				
Cut-off frequency							
$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V}$	f_{hfe}	typ.	60				kHz

MECHANICAL DATA

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

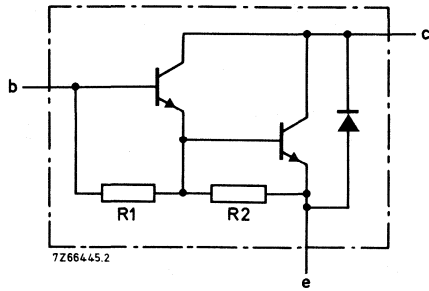
Collector connected to mounting base.



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

See also chapters Mounting Instructions and Accessories.

CIRCUIT DIAGRAM



R_1 typ. $3\text{ k}\Omega$
 R_2 typ. $120\ \Omega$

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 $T_{mb} = 25\ ^\circ\text{C}$	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			K/W
From junction to ambient in free air	$R_{th\ j-a}$	=		100			K/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

$$I_E = 0; V_{CB} = V_{CE0max} \quad I_{CBO} < 0,2\text{ mA}$$

$$I_E = 0; V_{CB} = \frac{1}{2} V_{CB0max}; T_{mb} = 150\text{ }^\circ\text{C} \quad I_{CBO} < 2\text{ mA}$$

$$I_B = 0; V_{CE} = \frac{1}{2} V_{CE0max} \quad I_{CEO} < 0,5\text{ mA}$$

Emitter cut-off current

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

D.C. current gain (note 1)

$$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 2200$$

$$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V} \quad h_{FE} > 750$$

$$I_C = 4\text{ A}; V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 1500$$

Base-emitter voltage (notes 1 and 2)

$$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V (BD675); } I_C = 2\text{ A} \quad V_{BE} < 2,5\text{ V}$$

Collector-emitter saturation voltage (note 1)

$$I_C = 1,5\text{ A}; I_B = 6\text{ mA (BD675); } I_C = 2\text{ A} \quad V_{CEsat} < 2,5\text{ V}$$

Small signal current gain

$$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V}; f = 1\text{ MHz (BD675); } I_C = 2\text{ A} \quad h_{fe} > 10 \quad \leftarrow$$

Cut-off frequency

$$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V (BD675); } I_C = 2\text{ A} \quad f_{hfe} \text{ typ. } 60\text{ kHz}$$

Turn-off breakdown energy with inductive load

$$-I_{Boff} = 0; I_C = 3,5\text{ A; (Fig. 3)} \quad E_{(BR)} > 30\text{ mJ}$$

D.C. current gain ratio of matched complementary pairs

$$I_C = 1,5\text{ A}; V_{CE} = 3\text{ V} \quad h_{FE1}/h_{FE2} < 2,5$$

Diode forward voltage

$$I_F = 1,5\text{ A (BD675); } I_F = 2\text{ A} \quad V_F \text{ typ. } 1,5\text{ V}$$

Second-breakdown collector current

$$V_{CE} = 50\text{ V}; t_p = 20\text{ ms, non rep.; without heatsink} \quad I_{(SB)} > 0,8\text{ A}$$

$$\text{BD675; } V_{CE} = 40\text{ V}; t_p = \text{ms} \quad I_{(SB)} > 1\text{ A}$$

Switching times

(between 10% and 90% levels)

$$I_{Con} = 1,5\text{ A}; I_{Bon} = -I_{Boff} = 6\text{ mA}; V_{CC} = 30\text{ V}$$

$$\text{Turn-on time} \quad t_{on} \text{ typ. } 0,8\text{ } \mu\text{s}$$

$$< 2\text{ } \mu\text{s}$$

$$\text{Turn-off time} \quad t_{off} \text{ typ. } 4,5\text{ } \mu\text{s}$$

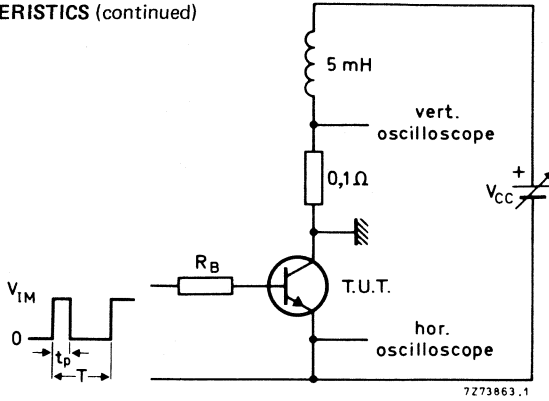
$$< 8\text{ } \mu\text{s}$$

Notes

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

2. V_{BE} decreases by about $3,6\text{ mV/K}$ with increasing temperature.

CHARACTERISTICS (continued)



$V_{IM} = 12 \text{ V}$
 $R_B = 270 \text{ } \Omega$
 $I_{CC} = 3,5 \text{ A}$
 $T = 1 \text{ ms}$
 $\delta = 1 \%$

Fig. 3 Test circuit for turn-off breakdown energy.

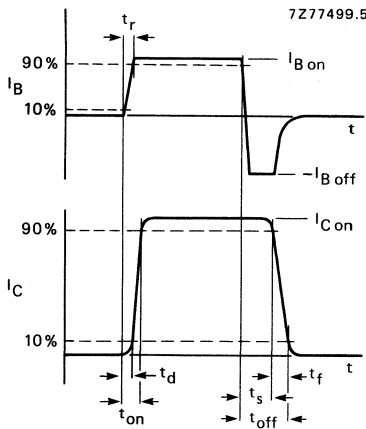
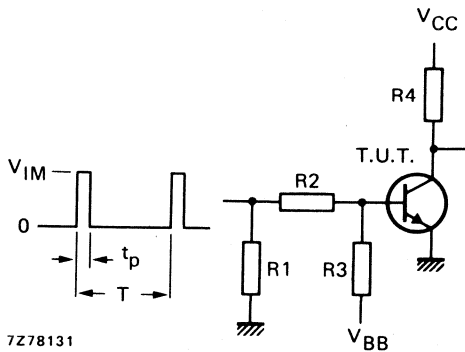


Fig. 4 Switching times waveforms.



$V_{IM} = 12 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $V_{BB} = -3 \text{ V}$
 $R_1 = 56 \text{ } \Omega$
 $R_2 = 1 \text{ k}\Omega$
 $R_3 = 680 \text{ } \Omega$
 $R_4 = 22 \text{ } \Omega$
 $t_r = t_f \leq 15 \text{ ns}$
 $t_p = 10 \text{ } \mu\text{s}$
 $T = 500 \text{ } \mu\text{s}$

Fig. 5 Switching times test circuit.

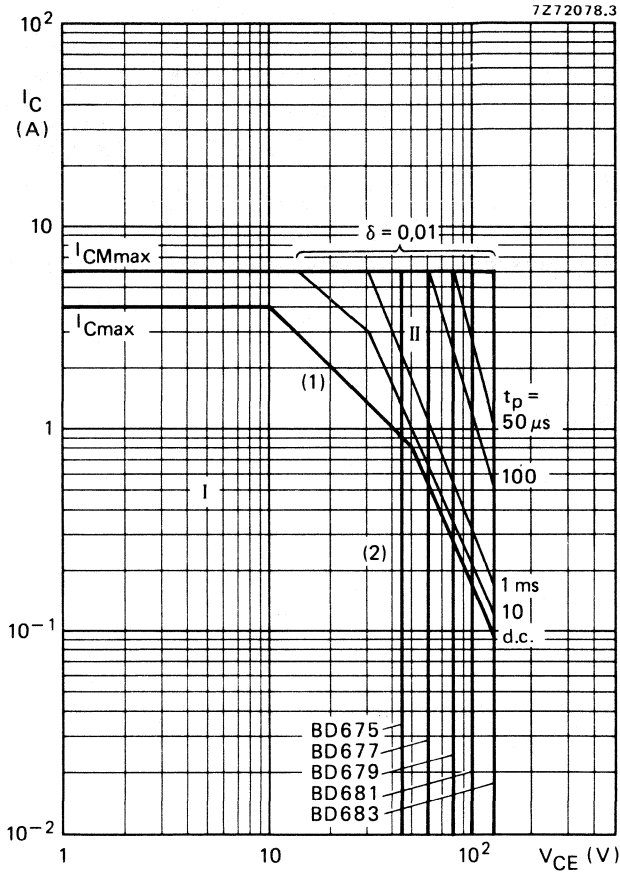


Fig. 6 Safe Operating Area. $T_{mb} = 25^{\circ}\text{C}$.

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

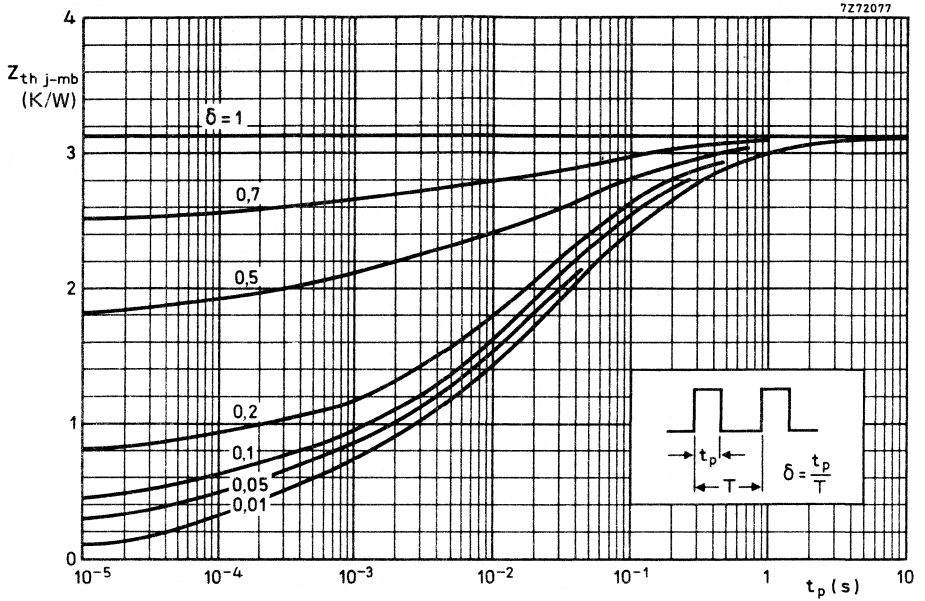


Fig. 7 Pulse power rating chart.

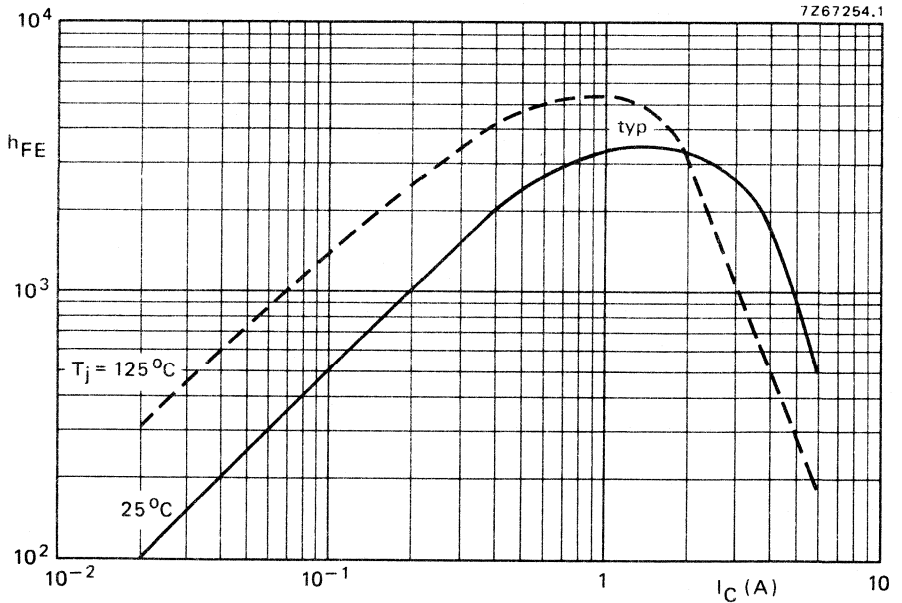


Fig. 8 D.C. current gain at $V_{CE} = 3$ V.

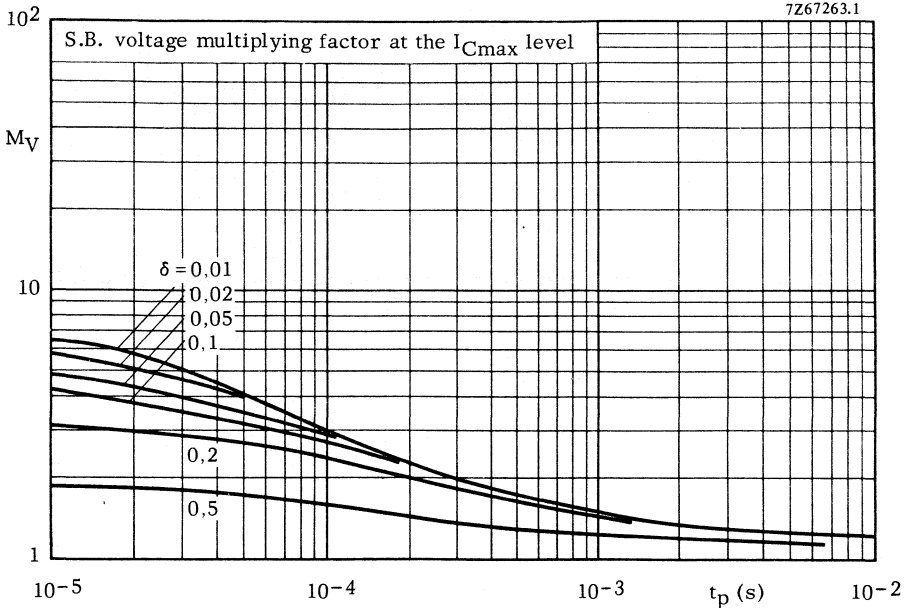


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

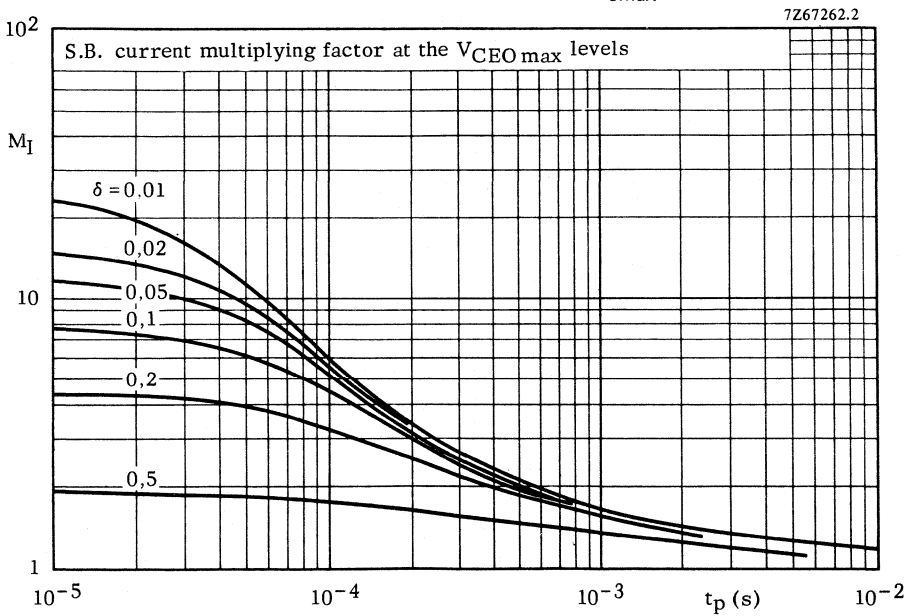


Fig. 10 S.B. current multiplying factor at the V_{CEOmax} levels.

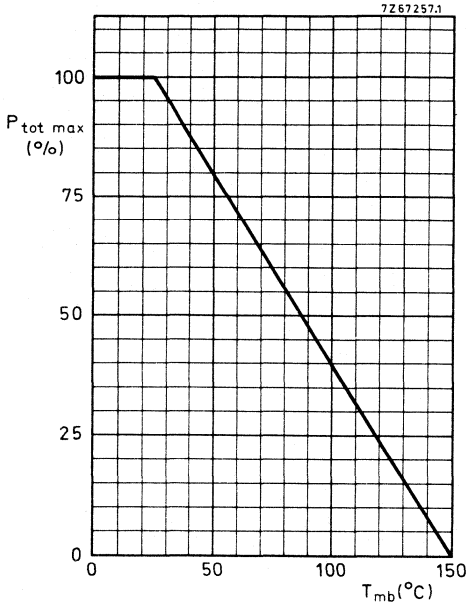


Fig. 11 Power derating curve.

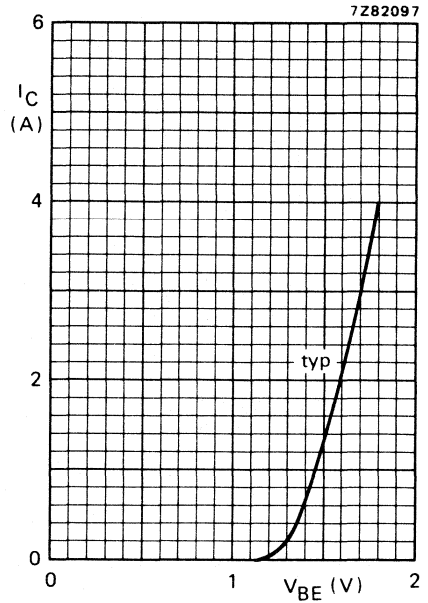


Fig. 12 Typical collector current.

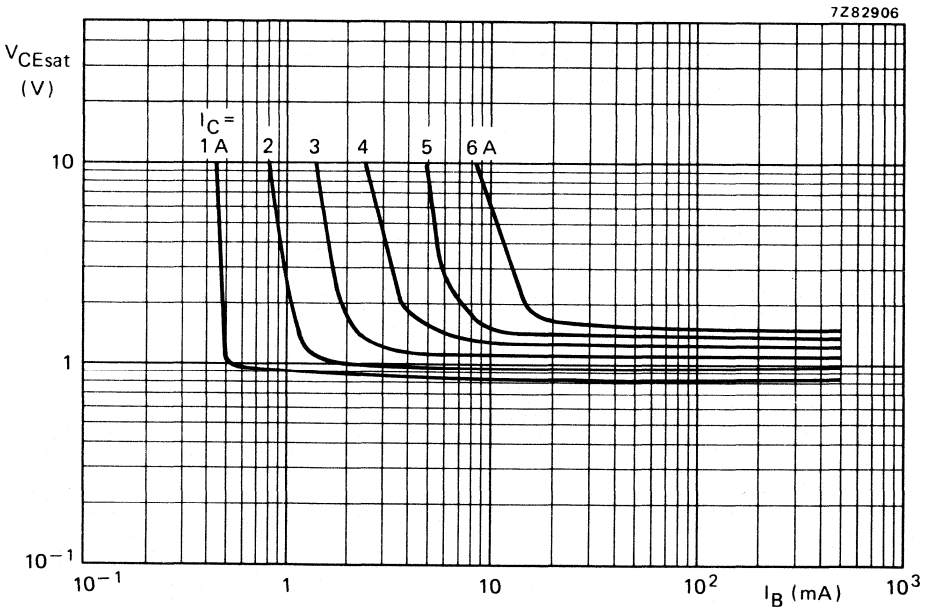


Fig. 13 Typical values collector-emitter saturation voltage. $T_{mb} = 25^\circ C$.

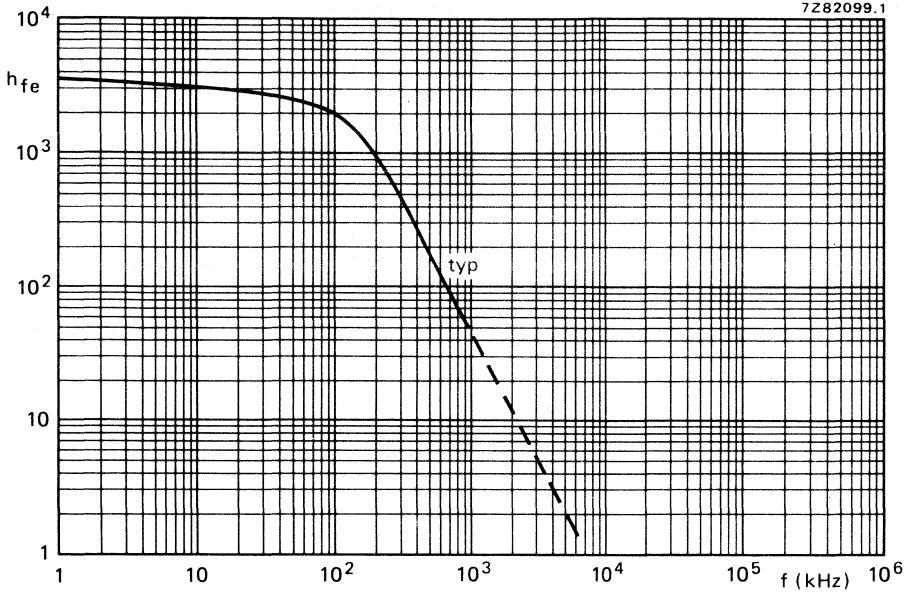


Fig. 14 Small signal current gain. $I_C = 1,5 \text{ A}$; $V_{CE} = 3 \text{ V}$.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial-base transistors in monolithic Darlington circuit for audio and video output applications; SOT-32 plastic envelope. N-P-N complements are BD675, BD677, BD679, BD681 and BD683.

QUICK REFERENCE DATA

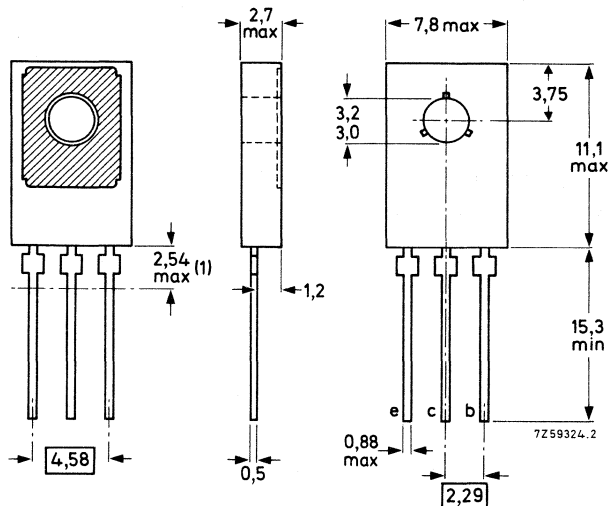
		BD676	678	680	682	684
Collector-base voltage (open emitter)	$-V_{CB0}$ max.	45	60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	45	60	80	100	120 V
Collector-current (peak value)	$-I_{CM}$ max.				6	A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.				40	W
Junction temperature	T_j max.				150	$^{\circ}\text{C}$
D.C. current gain						
$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE} typ.				2200	
$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE} >				750	
Cut-off frequency						
$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe} typ.				60	kHz

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.

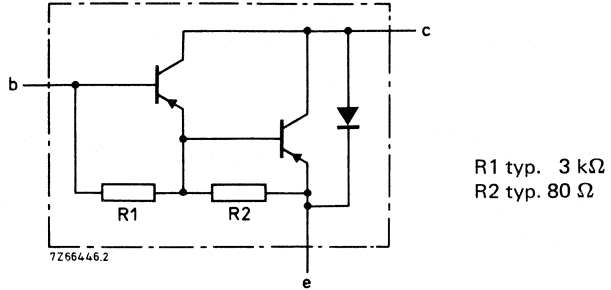


Fig. 2 Darlington circuit diagram.

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	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=		100	K/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

$$I_E = 0; -V_{CB} = -V_{CB0\max} \quad -I_{CB0} < 0,2\text{ mA}$$

$$I_E = 0; -V_{CB} = -0,6 V_{CB0\max}; T_{mb} = 150\text{ }^\circ\text{C} \quad -I_{CB0} < 2\text{ mA}$$

$$I_B = 0; -V_{CE} = -\frac{1}{2} V_{CE0\max} \quad -I_{CEO} < 0,5\text{ mA}$$

Emitter cut-off current

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

D.C. current gain (note 1)

$$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 2200$$

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V}^* \quad h_{FE} > 750$$

$$-I_C = 4\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 650$$

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)

$$-I_C = 1,5\text{ A}; -I_B = 6\text{ mA}^* \quad -V_{CE\text{sat}} < 2,5\text{ V}$$

Small-signal current gain

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz}^* \quad h_{fe} > 10 \quad \leftarrow$$

Cut-off frequency

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V}^* \quad f_{hfe} \text{ typ. } 60\text{ kHz}$$

D.C. current gain ratio of matched complementary pairs

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE1}/h_{FE2} < 2,5$$

Diode, forward voltage

$$I_F = 1,5\text{ A}^* \quad V_F \text{ typ. } 1,5\text{ V}$$

Switching times (see Figs 3 and 4)

$$-I_{Con} = 1,5\text{ A}; -I_{Bon} = I_{Boff} = 6\text{ mA}$$

$$\text{turn-on time} \quad t_{on} \text{ typ. } 0,3\text{ }\mu\text{s} < 1,5\text{ }\mu\text{s}$$

$$\text{turn-off time} \quad t_{off} \text{ typ. } 1,5\text{ }\mu\text{s} < 5\text{ }\mu\text{s}$$

Second-breakdown collector current

$$-V_{CE} = 50\text{ V}; t_p = 20\text{ ms} \quad -I_{(SB)} > 0,8\text{ A}$$

$$\text{for BD676 } -V_{CE} = 40\text{ V} \quad -I_{(SB)} > 1\text{ A}$$

* for BD676 condition $-I_C$ or $-I_F = 2\text{ A}$.

Notes

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

2. V_{BE} decreases by about $3,6\text{ mV/K}$ with increasing temperature.

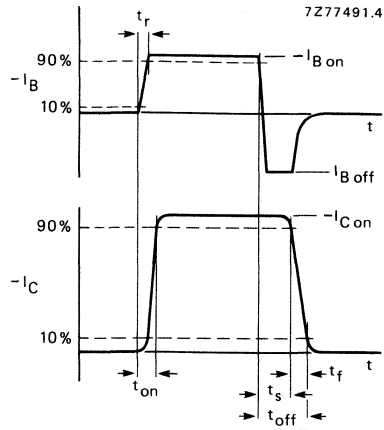


Fig. 3 Switching times waveform.

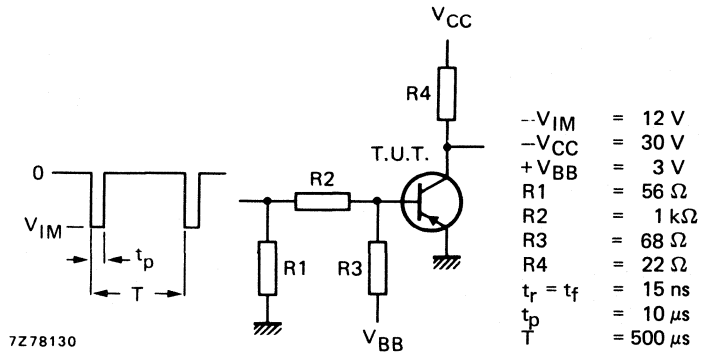


Fig. 4 Switching times test circuits.

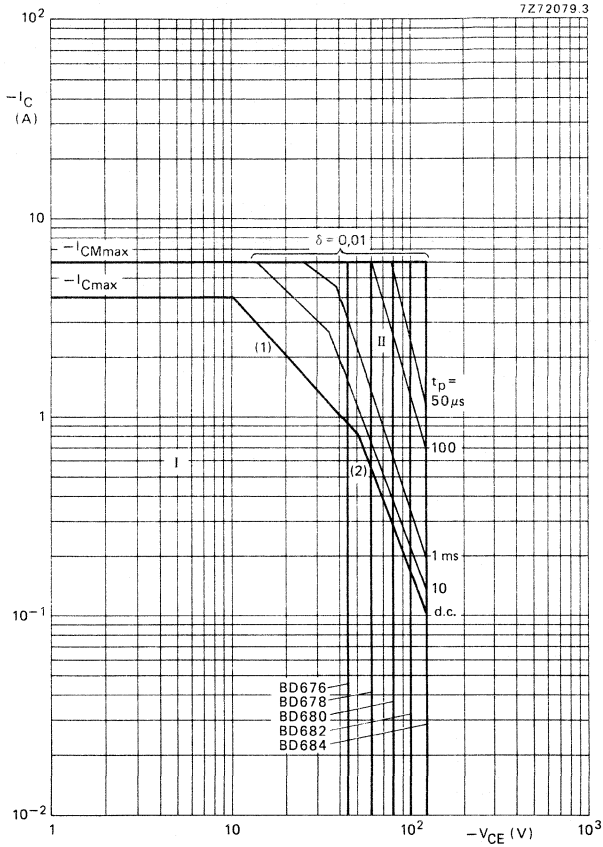


Fig. 5 Safe Operating Area. $T_{mb} = 25^\circ C$.

- 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).

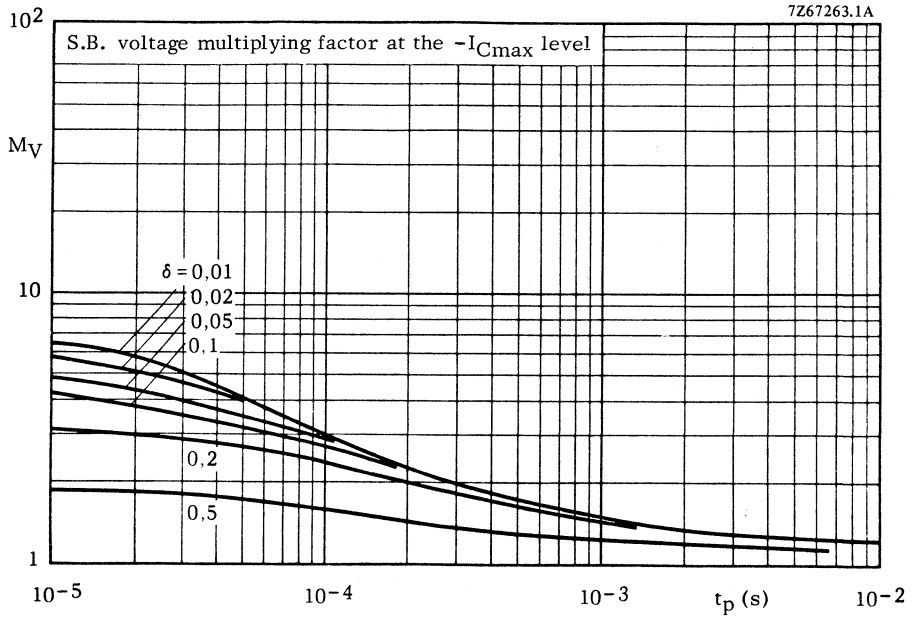


Fig. 6 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

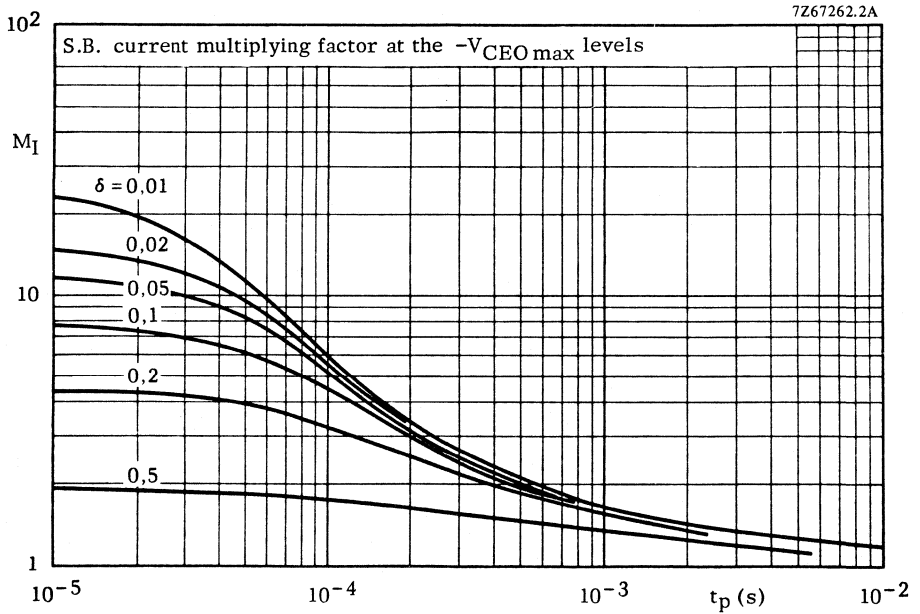


Fig. 7 S.B. current multiplying factor at the $-V_{CEOmax}$ levels.

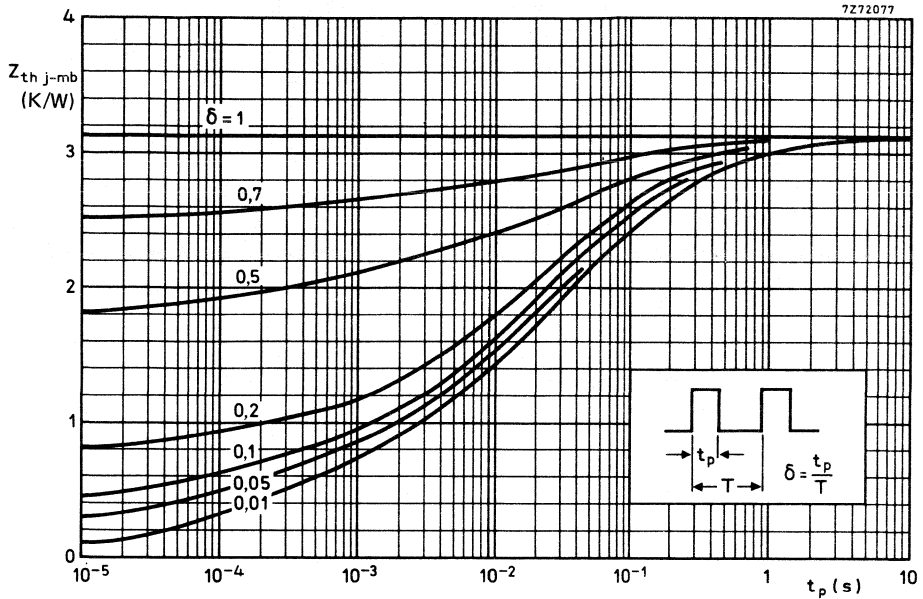


Fig. 8 Pulse power rating chart.

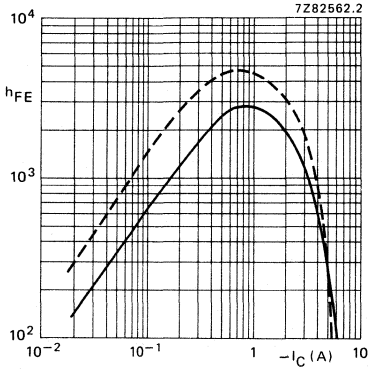


Fig. 9 D.C. current gain. $-V_{CE} = 3$ V;
 — $T_j = 25^\circ\text{C}$;
 - - - $T_j = 125^\circ\text{C}$.

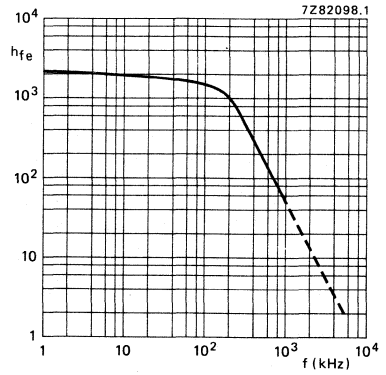


Fig. 10 Typical values small signal current gain. $-I_C = 1,5$ A;
 $-V_{CE} = 3$ V.

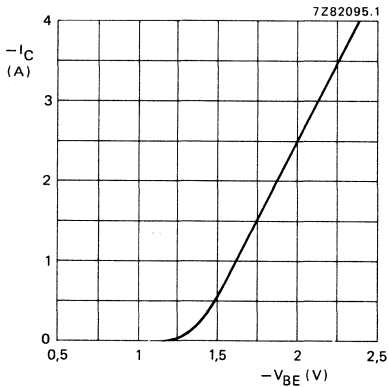


Fig. 11 Typical values; $-V_{CE} = 3$ V
 $T_j = 25^\circ\text{C}$.

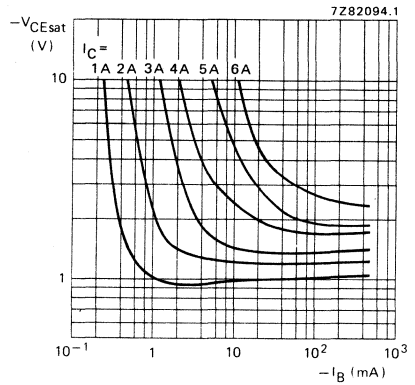


Fig. 12 Typical values collector-emitter saturation voltage as a function of base current. $T_{mb} = 25^\circ\text{C}$.

SILICON EPITAXIAL-BASE POWER TRANSISTORS

N-P-N transistors in a plastic TO-202 envelope intended for use in television and audio amplifier circuits where high peak powers can occur.

P-N-P complements are BD814, BD816 and BD818. Matched pairs can be supplied.

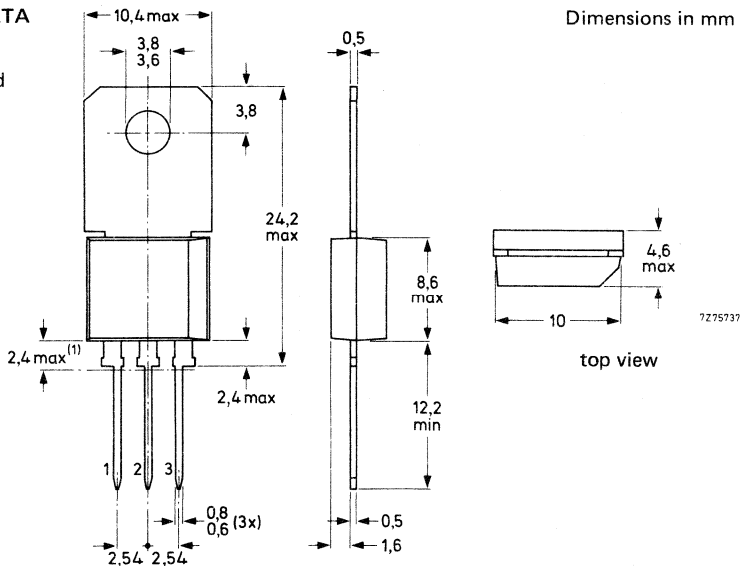
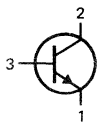
QUICK REFERENCE DATA

		BD813	BD815	BD817
Collector-base voltage	V_{CBO} max.	45	60	100 V
Collector-emitter voltage	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 $T_{amb} = 25 \text{ }^\circ\text{C}$ up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot} max.		2	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

Fig. 1 TO-202.

Collector connected to mounting base.



RATINGS

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

			BD813	BD815	BD817	
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
Collector current (d.c.)	I_C	max.	2			A
Collector current (peak value)	I_{CM}	max.	6			A
Total power dissipation						
at $T_{amb} = 25 \text{ }^\circ\text{C}$ (free air)	P_{tot}	max.	2			W
at $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	12,5			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 ambient in free air	$R_{th j-a}$	=		62,5		K/W
From junction to mounting base	$R_{th j-mb}$	=		10		K/W

CHARACTERISTICS

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

Collector cut-off current

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

$I_{CBO} < 100 \text{ } \mu\text{A}$

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

$I_{CBO} < 3 \text{ mA}$

Emitter cut-off current

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

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

Base-emitter voltage

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

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

Collector-emitter 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 complementary pairs

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

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

Switching times

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

turn-on time

$t_{on} \text{ typ. } 0,4 \mu\text{s}$
 $< 1 \mu\text{s}$

turn-off time

$t_{off} \text{ typ. } 1,5 \mu\text{s}$
 $< 3 \mu\text{s}$

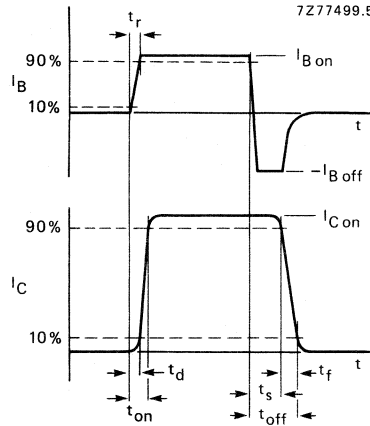


Fig. 2 Switching times waveform.

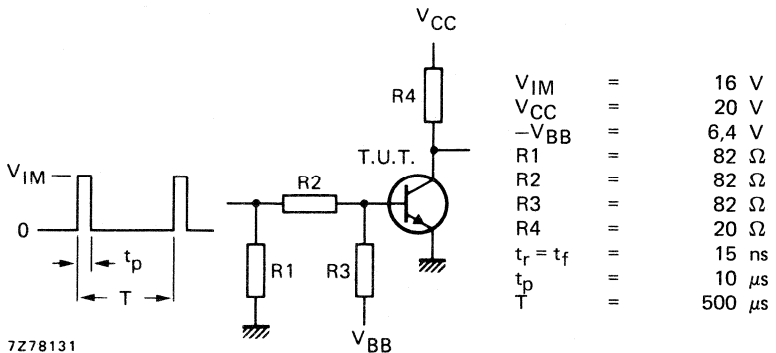


Fig. 3 Switching times test circuit.

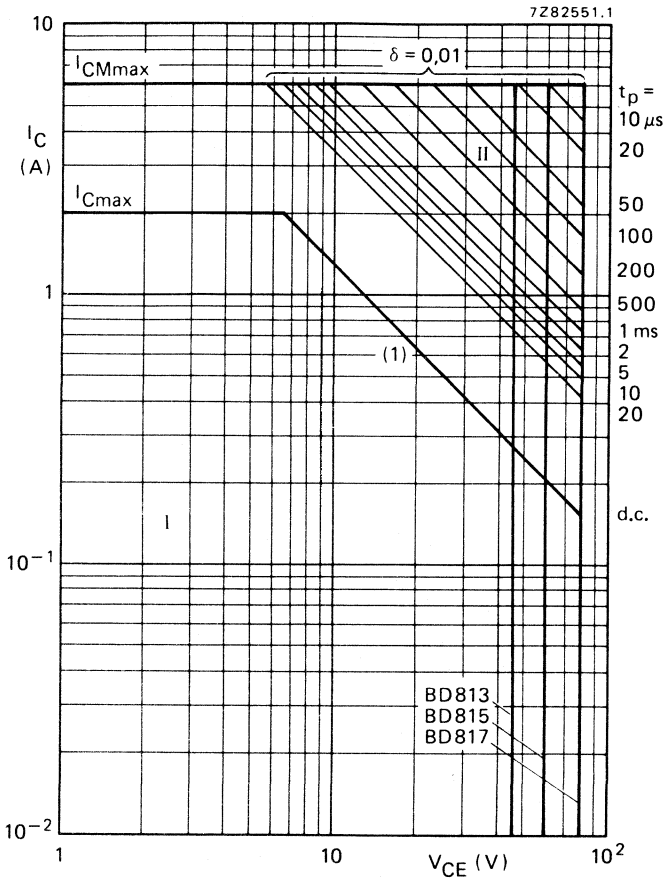
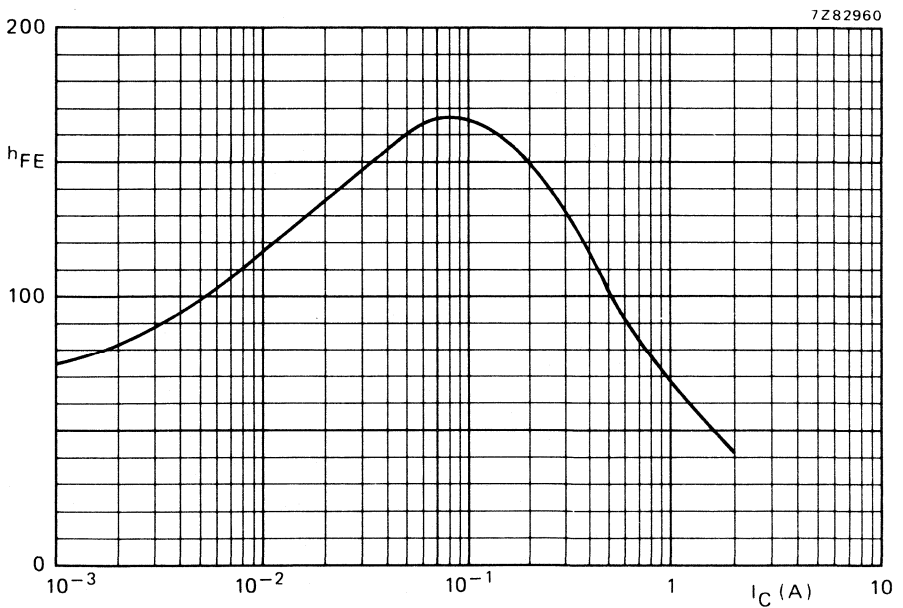
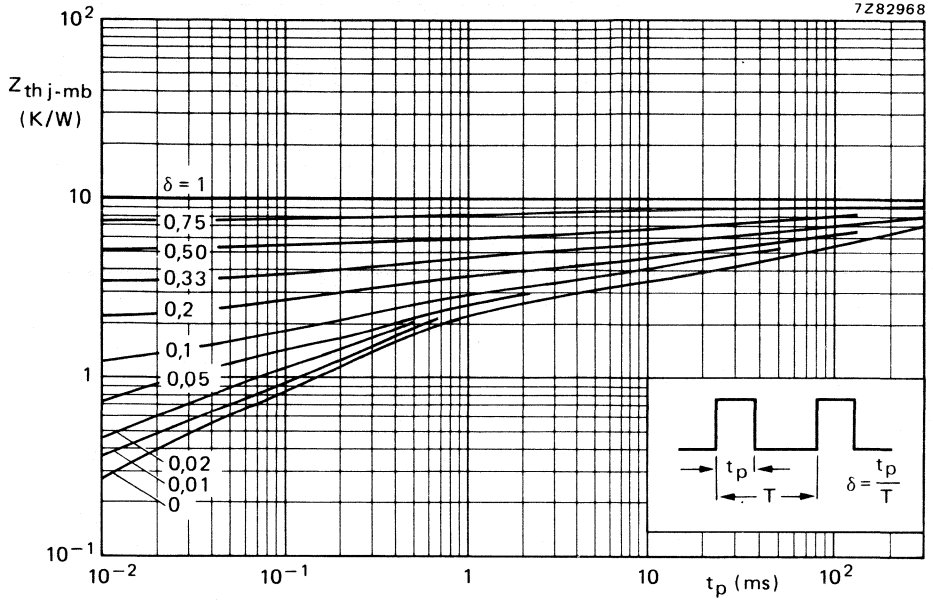


Fig. 4 Safe Operating Area. $T_{mb} \leq 25^\circ\text{C}$.

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



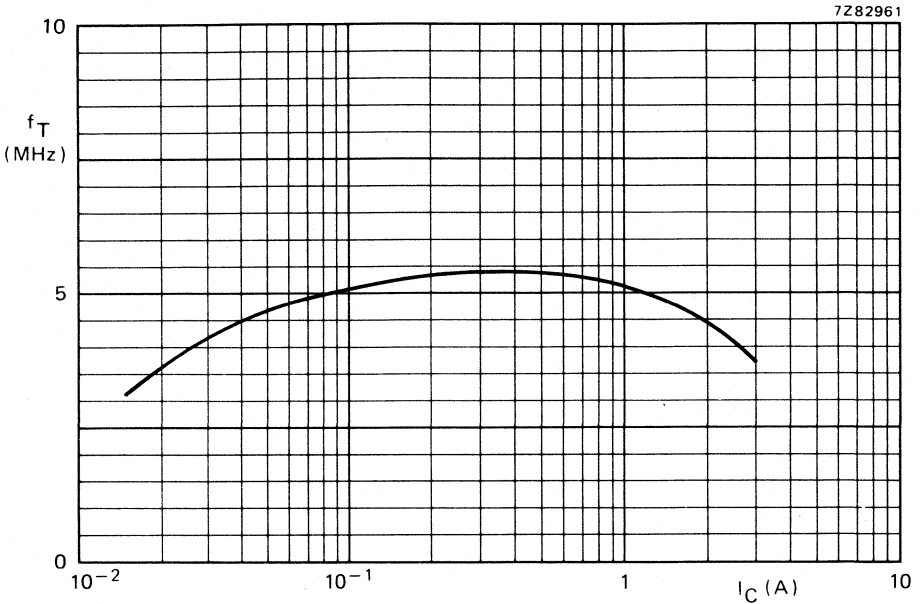


Fig. 7 Typical values transition frequency. $V_{CE} = 10$ V; $f = 1$ MHz; $T_{amb} = 25$ °C.

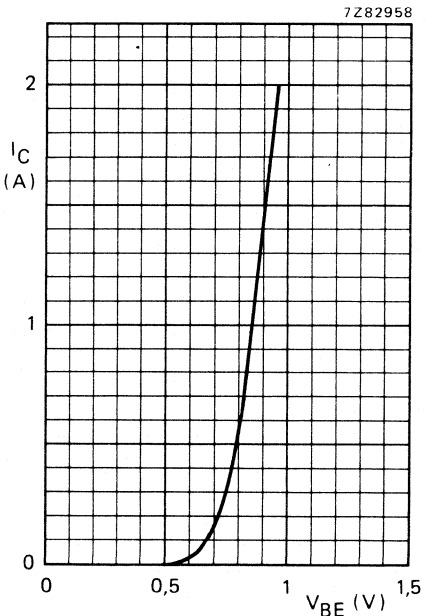


Fig. 8 Typical values $V_{CE} = 2$ V; $T_{amb} = 25$ °C.

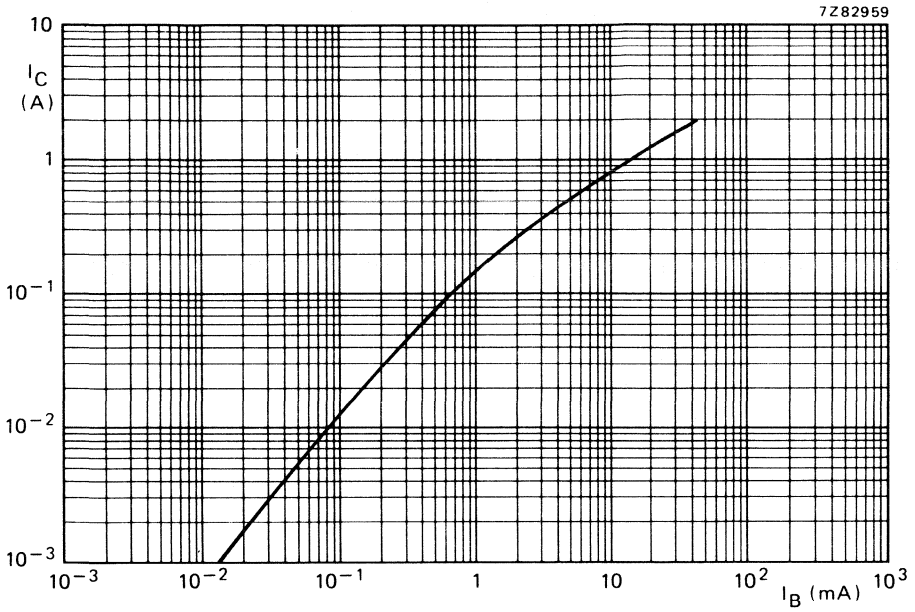


Fig. 9 Typical values at $V_{CE} = 2 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$.

SILICON EPITAXIAL-BASE POWER TRANSISTORS

P-N-P transistors in a plastic TO-202 envelope intended for use in television and audio amplifier circuits where high peak powers can occur.

N-P-N complements are BD813, BD815 and BD817. Matched pairs can be supplied.

QUICK REFERENCE DATA

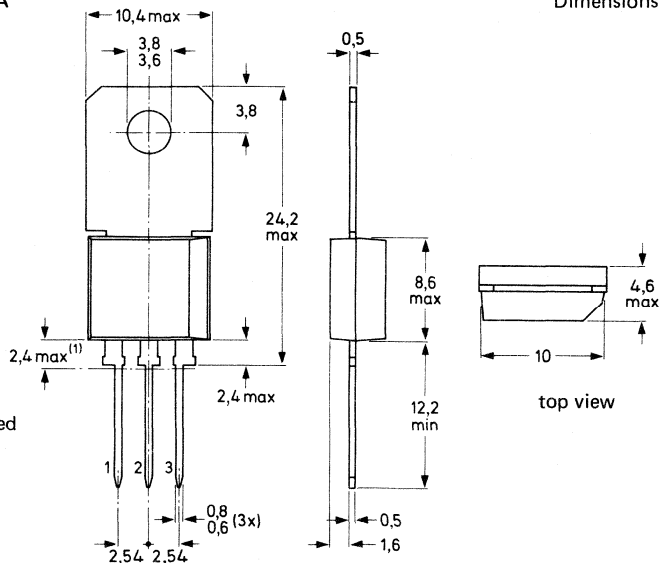
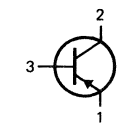
		BD814	BD816	BD818
Collector-base voltage	$-V_{CBO}$ max.	45	60	100 V
Collector-emitter voltage	$-V_{CEO}$ max.	45	60	80 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	$-V_{CER}$ max.	45	60	100 V
Collector current (peak value)	$-I_{CM}$ max.		6	A
Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot} max.		2	W
	P_{tot} max.		12,5	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

Fig. 1 TO-202.

Collector connected to mounting base.



(1) Plastic flash allowed within this zone.

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RATINGS

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

			BD814	BD816	BD818
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
Collector current (d.c.)	$-I_C$	max.		2	A
Collector current (peak value)	$-I_{CM}$	max.		6	A
Total power dissipation at $T_{amb} = 25 \text{ }^\circ\text{C}$ (free air)	P_{tot}	max.		2	W
at $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.		12,5	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 ambient in free air	$R_{th \text{ j-a}}$	=		62,5	K/W
From junction to mounting base	$R_{th \text{ j-mb}}$	=		10	K/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
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
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	

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

BD813/BD814; BD815/BD816; BD817/BD818

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

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

Switching times

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

turn-on time

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

turn-off time

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

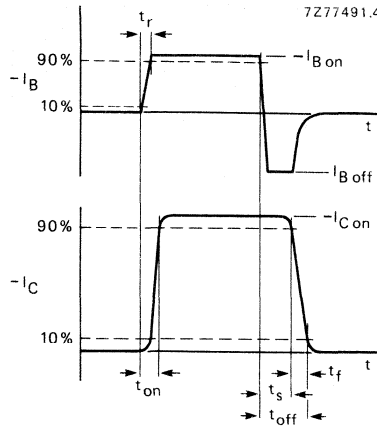


Fig. 2 Switching times waveforms.

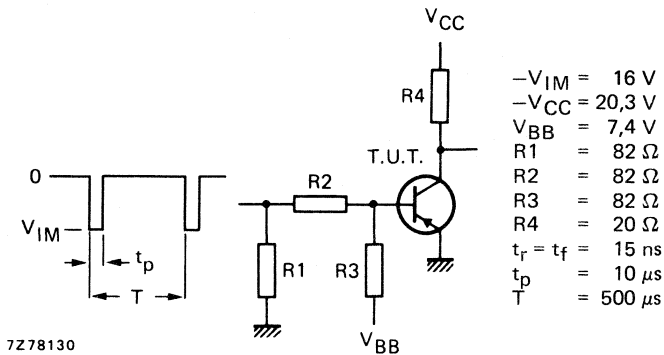


Fig. 3 Switching times test circuit.

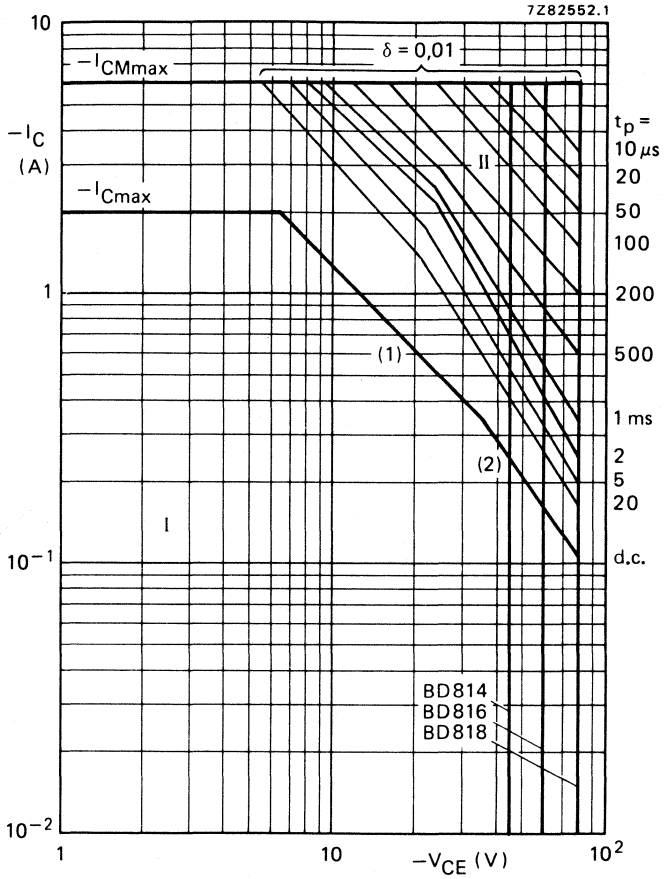


Fig. 4 Safe Operating Area, $T_{mb} \leq 25^\circ\text{C}$.

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

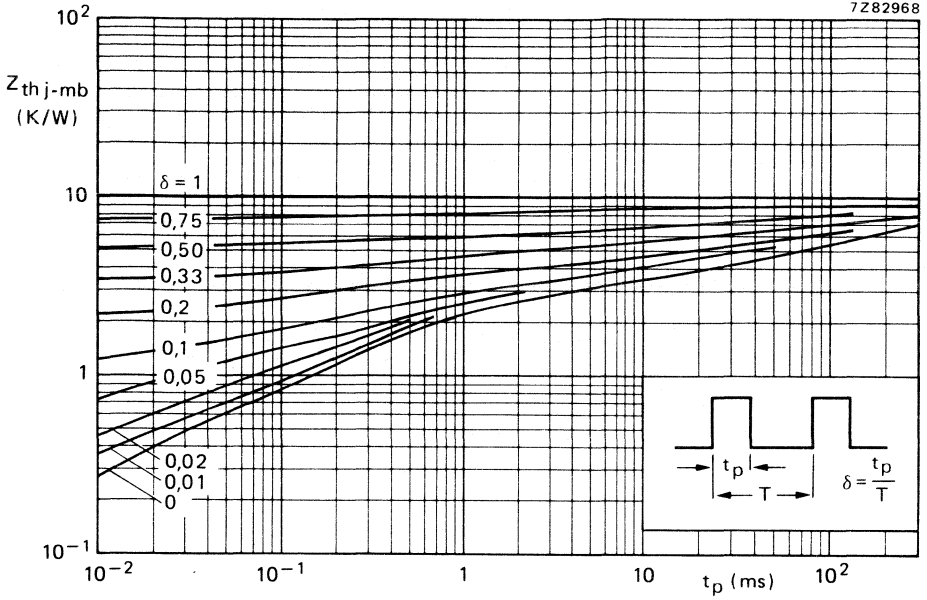


Fig. 5 Pulse power rating chart.

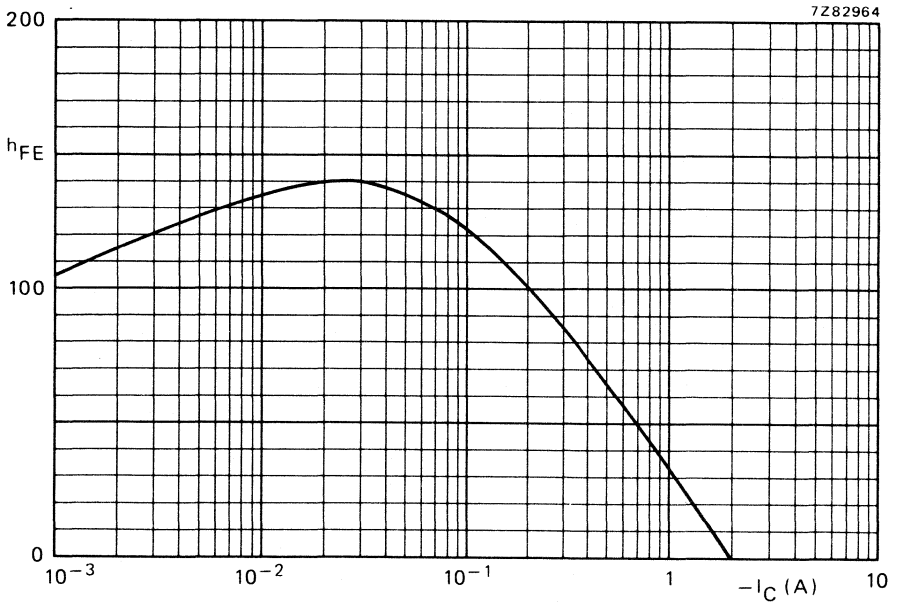


Fig. 6 Typical values d.c. current gain. $-V_{CE} = 2\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$.

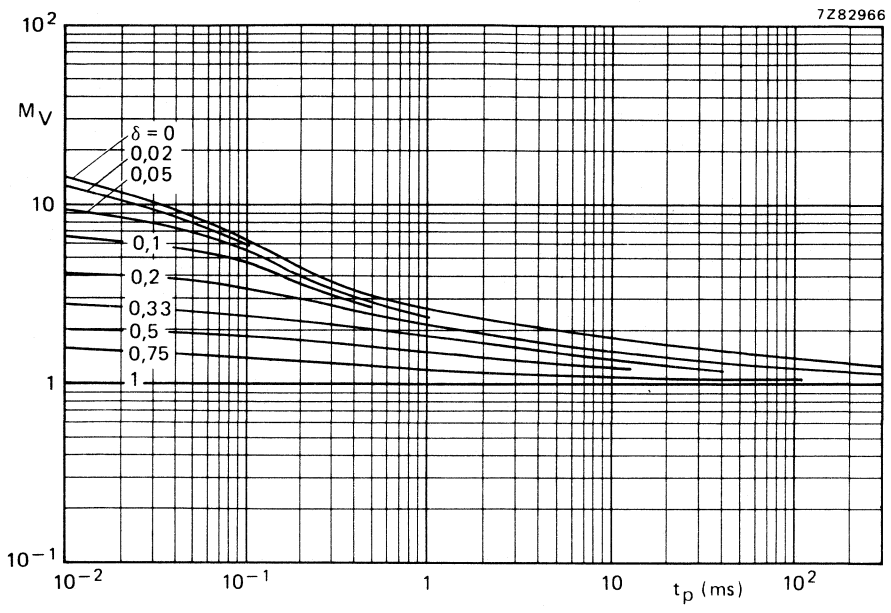


Fig. 7 S.B. voltage multiplying factor at I_{Cmax} level.

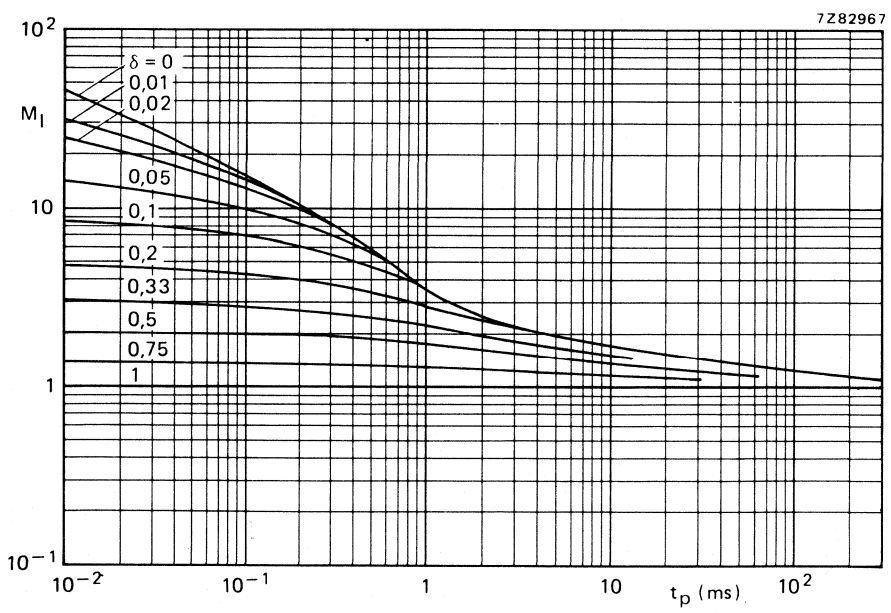


Fig. 8 S.B. current multiplying factor at V_{CE0max} level.

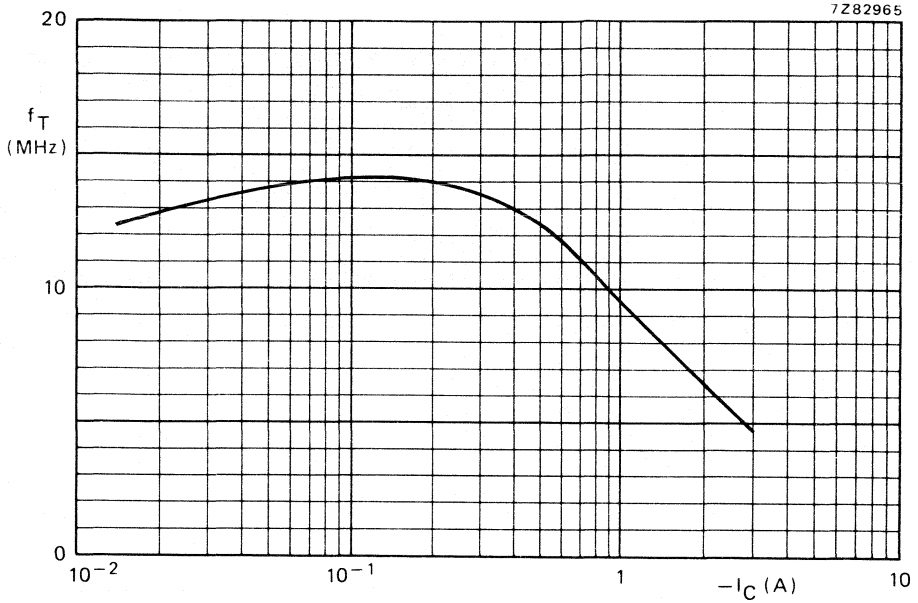


Fig. 9 Typical values transition frequency. $-V_{CE} = 10$ V; $f = 1$ MHz; $T_{amb} = 25$ °C.

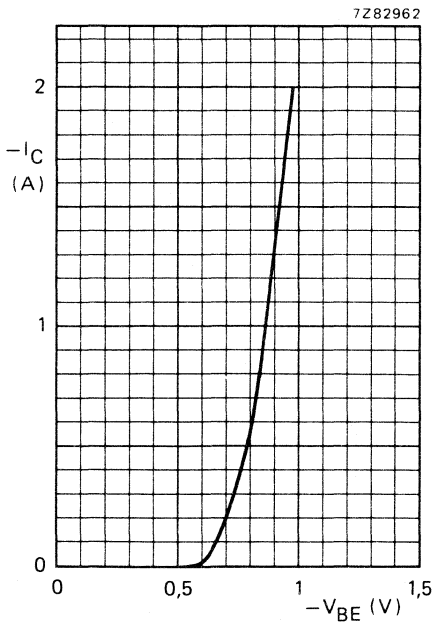


Fig. 10 Typical values. $-V_{CE} = 2$ V; $T_{amb} = 25$ °C.

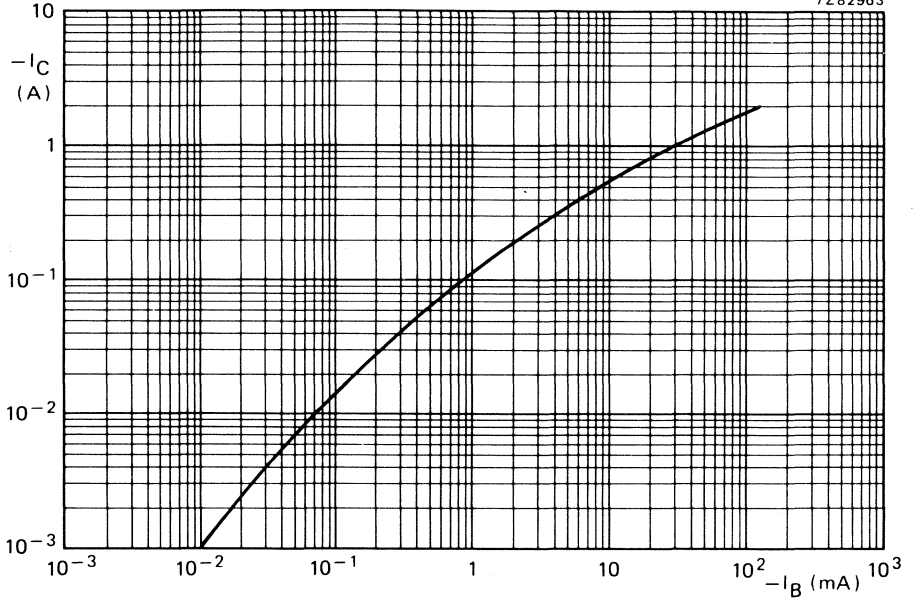


Fig. 11 Typical values at $-V_{CE} = 2 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

General purpose N-P-N transistors, in TO-202 plastic envelopes, recommended for driver-stages in hi-fi amplifiers and television circuits.

P-N-P complements are BD826, BD828 and BD830. Matched pairs can be supplied.

QUICK REFERENCE DATA

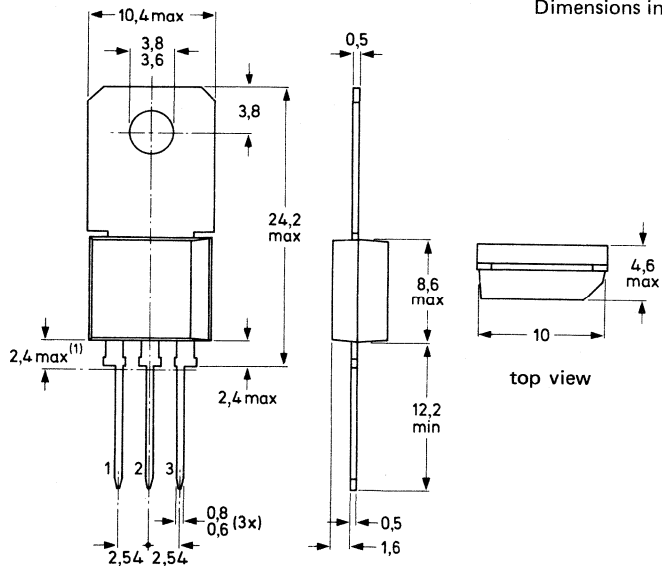
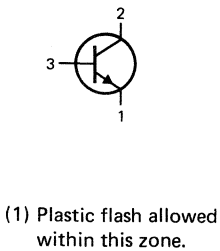
			BD825	BD827	BD829
Collector-base voltage	V_{CBO}	max.	45	60	100 V
Collector-emitter voltage	V_{CEO}	max.	45	60	80 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	V_{CER}	max.	45	60	100 V
Collector current (peak value)	I_{CM}	max.		1,5	A
Total power dissipation at $T_{amb} = 25 \text{ }^\circ\text{C}$ (free air) at $T_{mb} = 50 \text{ }^\circ\text{C}$	P_{tot}	max.		2	W
	P_{tot}	max.		8	W
Junction temperature	T_j	max.		150	$^\circ\text{C}$
D.C. current gain $I_C = 150 \text{ mA}; V_{CE} = 2 \text{ V}$	h_{FE}		40 to 250		
Transition frequency $I_C = 50 \text{ mA}; V_{CE} = 5 \text{ V}$	f_T	typ.	250		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-202.

Collector connected
to mounting base



7275737

RATINGS

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

			BD825	BD827	BD829
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 (d.c.)	I_C	max.		1,0	A
Collector current (peak)	I_{CM}	max.		1,5	A
Total power dissipation					
$T_{amb} = 25 \text{ }^\circ\text{C}$ (free air)	P_{tot}	max.		2	W
$T_{mb} = 50 \text{ }^\circ\text{C}$	P_{tot}	max.		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 ambient in free air	$R_{th \text{ j-a}}$	=		62,5	K/W
From junction to mounting base	$R_{th \text{ j-mb}}$	=		12,5	K/W

CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified**Collector cut-off currents** $I_E = 0; V_{CB} = 30\text{ V}$ $I_{CBO} < 100\text{ nA}$ $I_E = 0; V_{CB} = 30\text{ V}; T_j = 125\text{ }^\circ\text{C}$ $I_{CBO} < 10\text{ }\mu\text{A}$ **Emitter cut-off current** $I_C = 0; V_{EB} = 5\text{ V}$ $I_{EBO} < 10\text{ }\mu\text{A}$ **D.C. current gain** $I_C = 5\text{ mA}; V_{CE} = 2\text{ V}$ $h_{FE} > 25$ $I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$ $h_{FE} 40\text{ to }250$ $I_C = 500\text{ mA}; V_{CE} = 2\text{ V}$ $h_{FE} > 25$ **Collector-emitter saturation voltage** $I_C = 500\text{ mA}; I_B = 50\text{ mA}$ $V_{CEsat} < 0,5\text{ V}$ **Base-emitter voltage** $I_C = 500\text{ mA}; V_{CE} = 2\text{ V}$ $V_{BE} < 1\text{ V}$ **Transition frequency at $f = 35\text{ MHz}$** $I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$ f_T typ. 250 MHz**D.C. current gain ratio of matched complementary pairs** $|I_C| = 150\text{ mA}; |V_{CE}| = 2\text{ V}$ h_{FE1}/h_{FE2} typ. 1,3
< 1,6

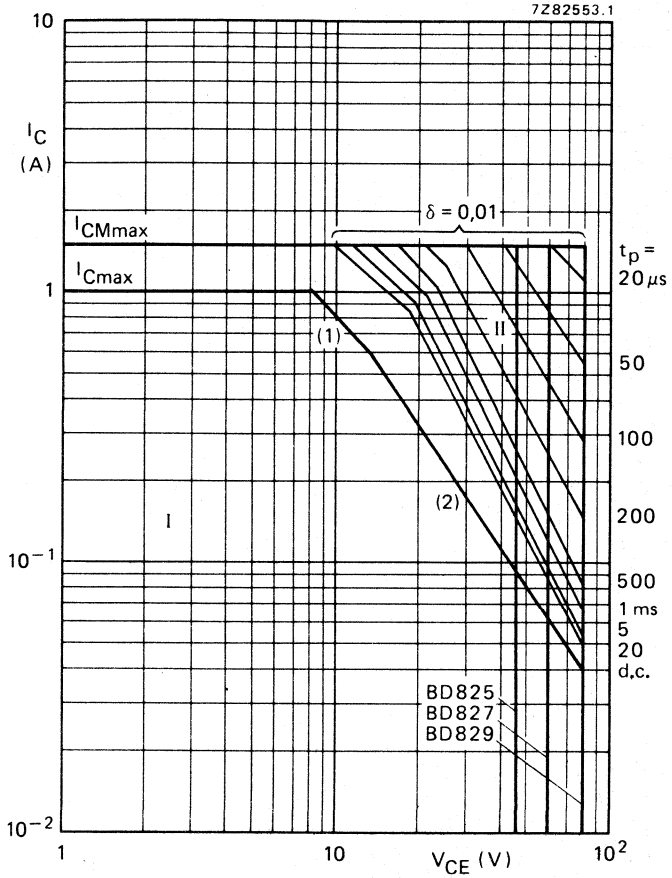
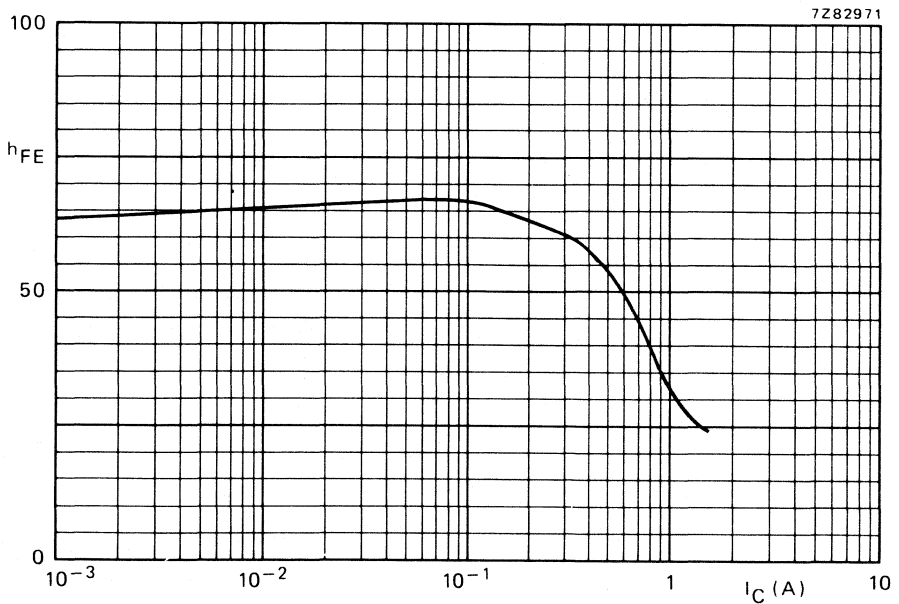
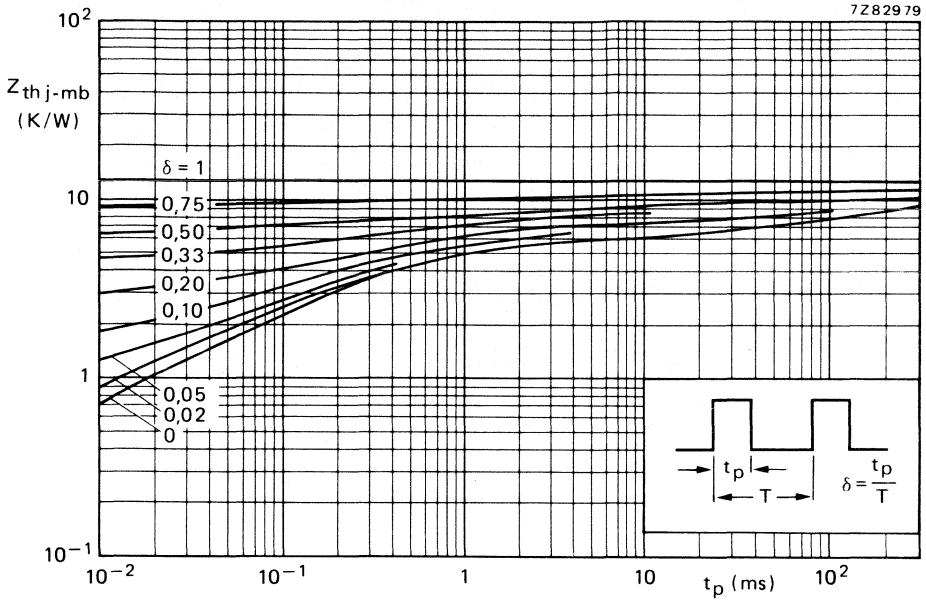


Fig. 2 Safe Operating Area. $T_{mb} \leq 25^\circ\text{C}$.

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



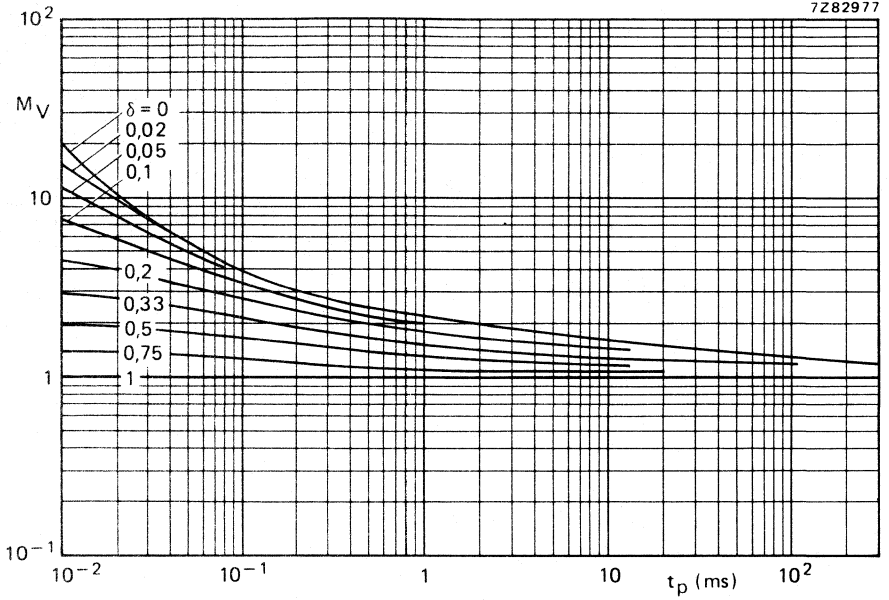


Fig. 5 S.B. voltage multiplying factor at I_{Cmax} level.

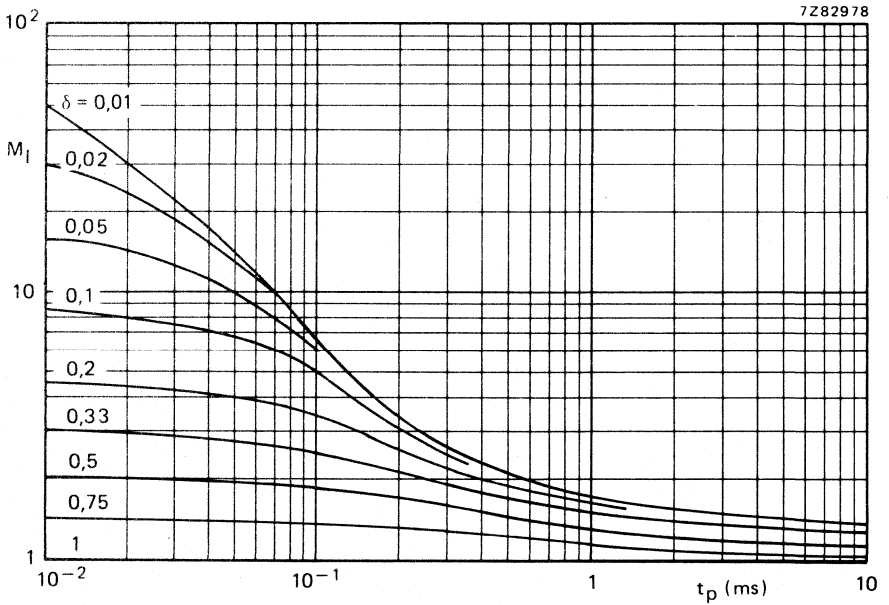


Fig. 6 S.B. current multiplying factor at V_{CEOmax} level.

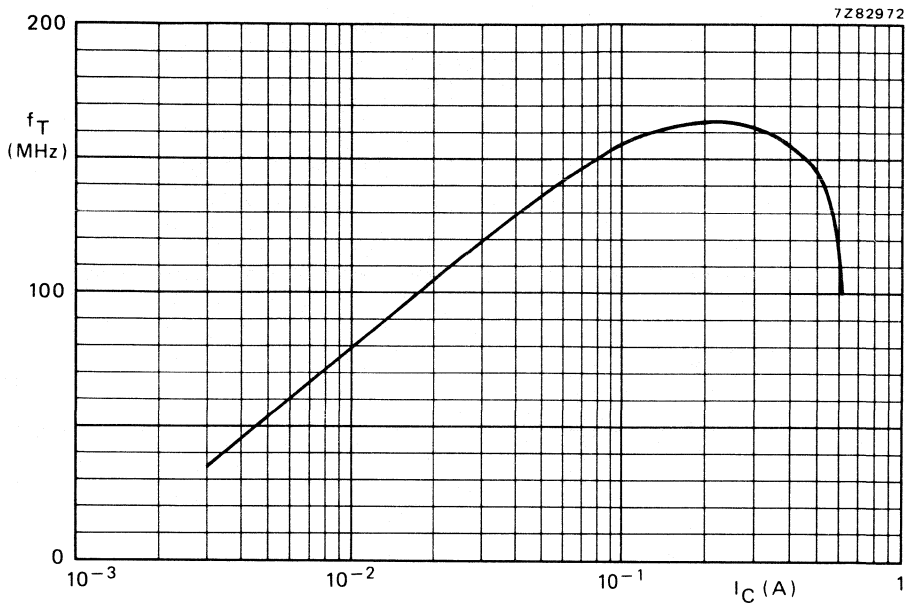


Fig. 7 Typical values transition frequency. $V_{CE} = 5 \text{ V}$; $f = 35 \text{ MHz}$; $T_{amb} = 25 \text{ }^\circ\text{C}$.

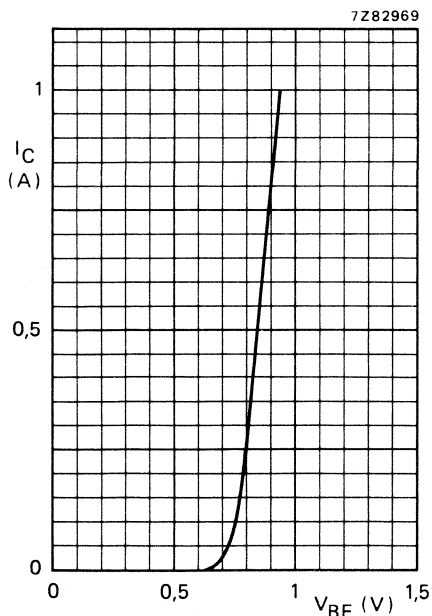


Fig. 8 Typical values. $V_{CE} = 2 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$.

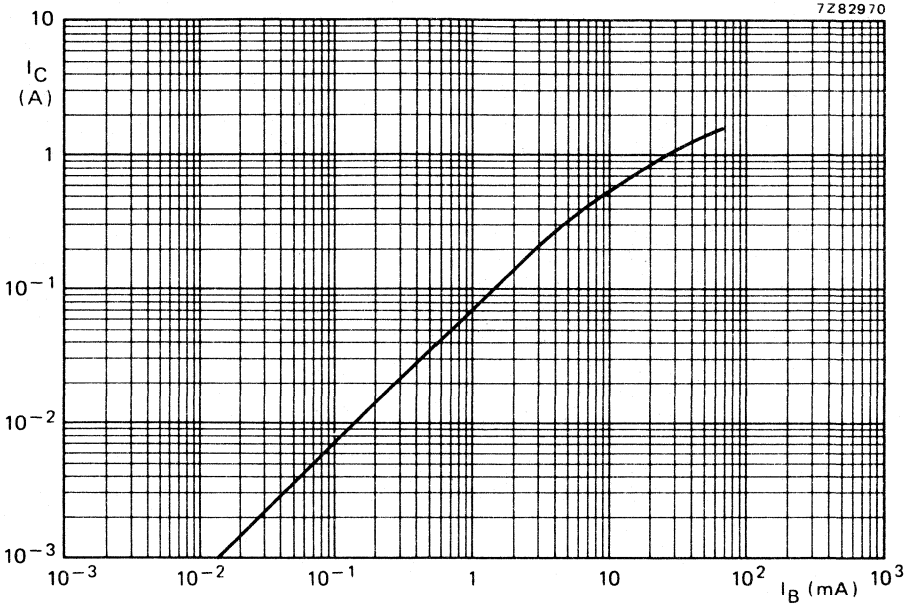


Fig. 9 Typical values at $V_{CE} = 2 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$:

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

General purpose P-N-P transistors, in TO-202 plastic envelopes, recommended for driver stages in hi-fi amplifiers and television circuits.

N-P-N complements are BD825, BD827 and BD829. Matched pairs can be supplied.

QUICK REFERENCE DATA

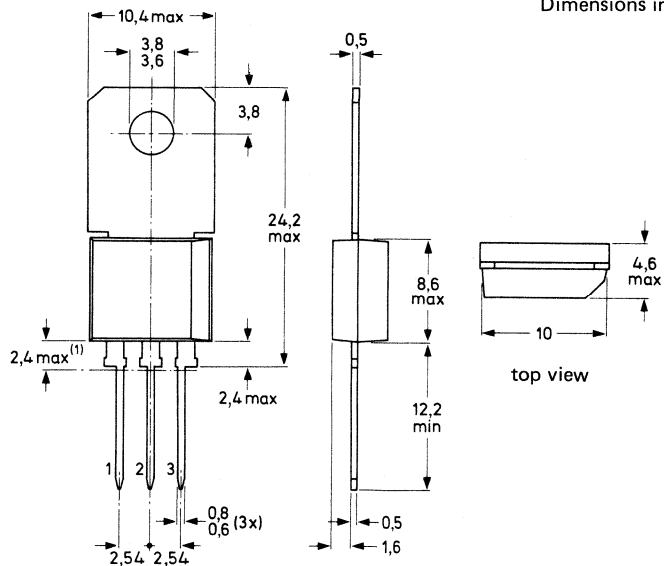
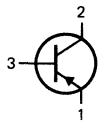
		BD826	BD828	BD830
Collector-base voltage	$-V_{CBO}$	max. 45	60	100 V
Collector-emitter voltage	$-V_{CEO}$	max. 45	60	80 V
Collector-emitter voltage	$-V_{CER}$	max. 45	60	100 V
Collector current (peak value)	$-I_{CM}$	max.	1,5	A
Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}$ (free air) at $T_{mb} = 50\text{ }^{\circ}\text{C}$	P_{tot}	max.	2	W
	P_{tot}	max.	8	W
Junction temperature	T_j	max.	150	$^{\circ}\text{C}$
D.C. current gain $-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$	h_{FE}	40 to 250		
	Transition frequency $-I_C = 50\text{ mA}; -V_{CE} = 5\text{ V}$	f_T	typ. 75	MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-202.

Collector connected to mounting base.



(1) Plastic flash allowed within this zone.

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RATINGS

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

			BD826	BD828	BD830
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
Collector current (d.c.)	$-I_C$	max.	1		A
Collector current (peak value)	$-I_{CM}$	max.	1,5		A
Total power dissipation					
$T_{amb} = 25\text{ }^\circ\text{C}$ (free air)	P_{tot}	max.	2		W
$T_{mb} = 50\text{ }^\circ\text{C}$	P_{tot}	max.	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 ambient in free air	$R_{th\ j-a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j-mb}$	=	12,5	K/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

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

D.C. current gain

 $-I_C = 5\text{ mA}; -V_{CE} = 2\text{ V}$ $h_{FE} > 25$ $-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$ $h_{FE} 40\text{ to }250$ $-I_C = 500\text{ mA}; -V_{CE} = 2\text{ V}$ $h_{FE} > 25$

Collector-emitter saturation voltage

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

Base-emitter voltage

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

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

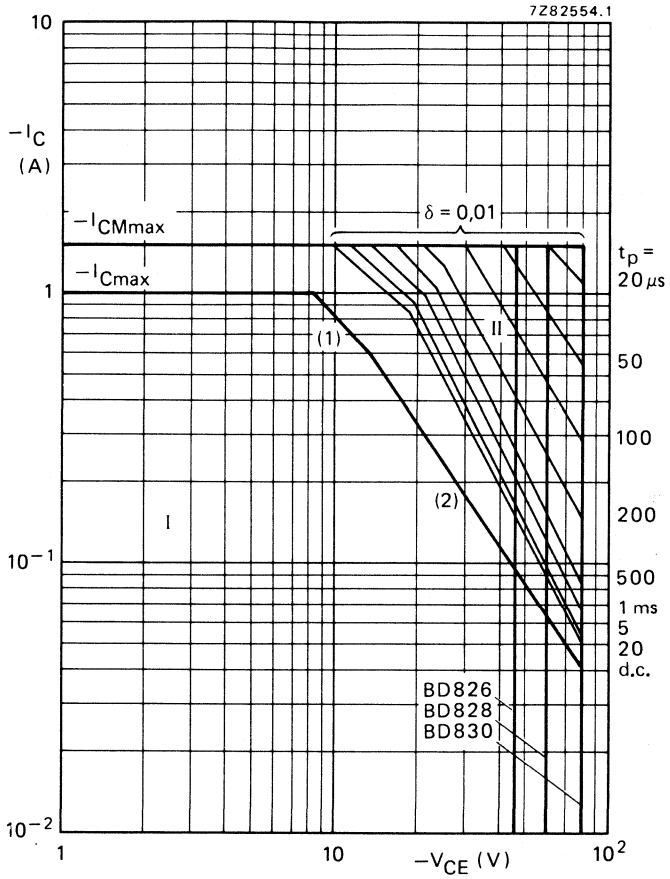
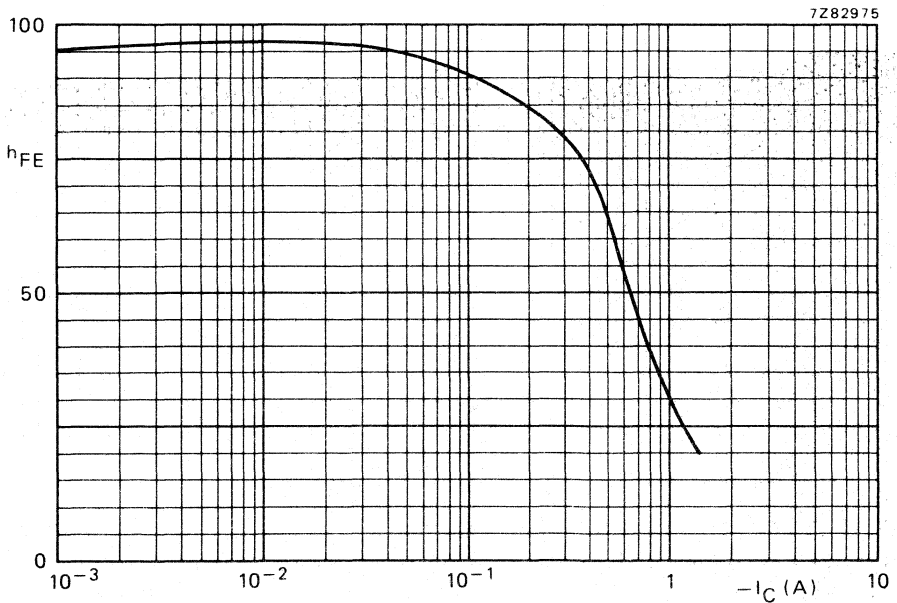
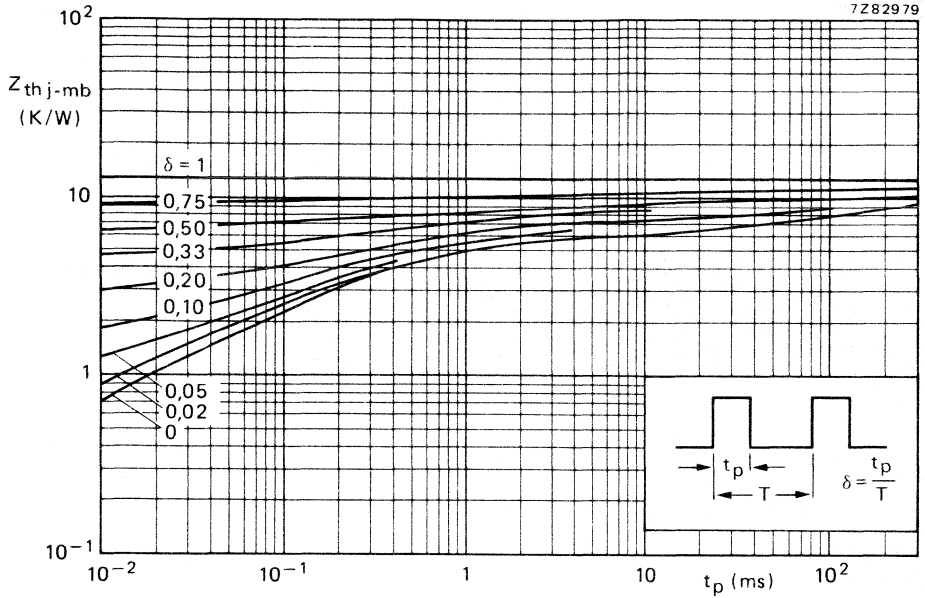


Fig. 2 Safe Operating Area, $T_{mb} \leq 25^\circ C$.

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



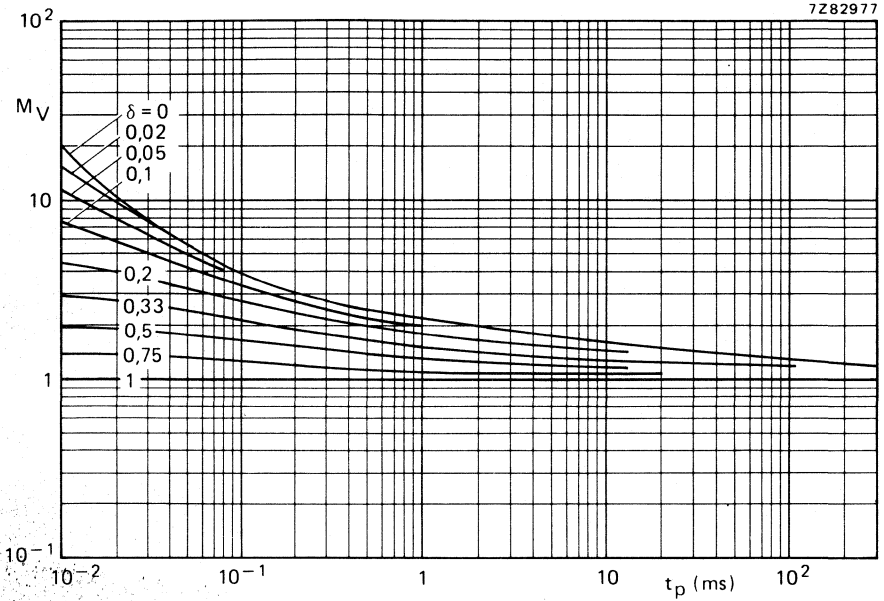


Fig. 5 S.B. voltage multiplying factor at I_{Cmax} level.

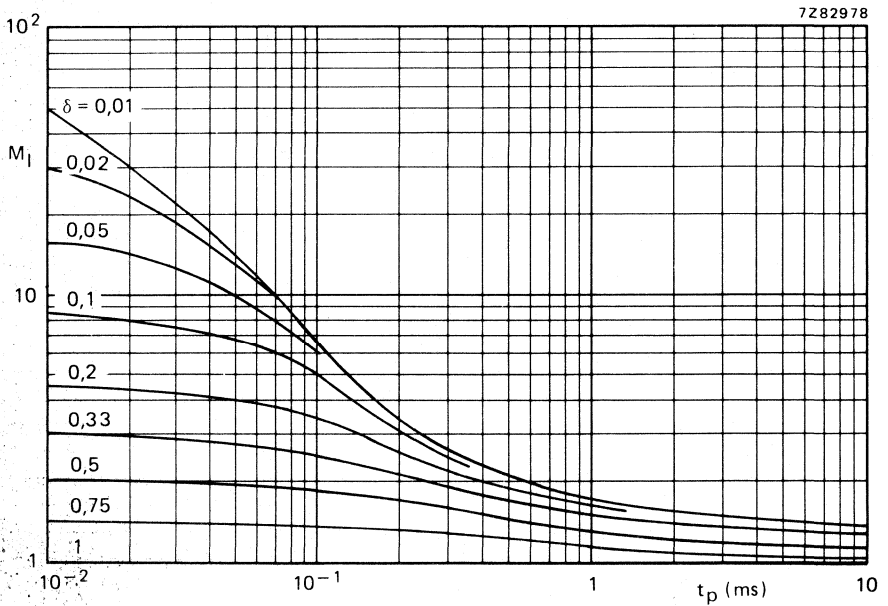


Fig. 6 S.B. current multiplying factor at V_{CE0max} level.

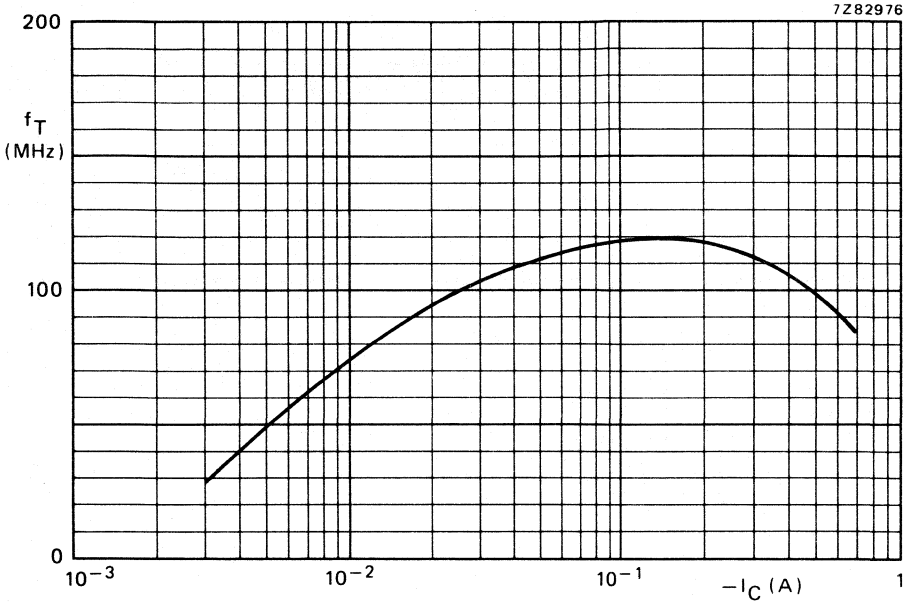


Fig. 7 Typical values transition frequency at $-V_{CE} = 5$ V; $f = 35$ MHz; $T_{amb} = 25$ °C.

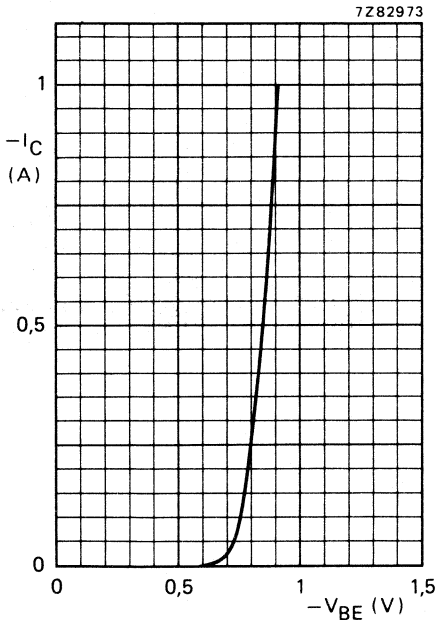


Fig. 8 Typical values. $-V_{CE} = 2$ V; $T_{amb} = 25$ °C.

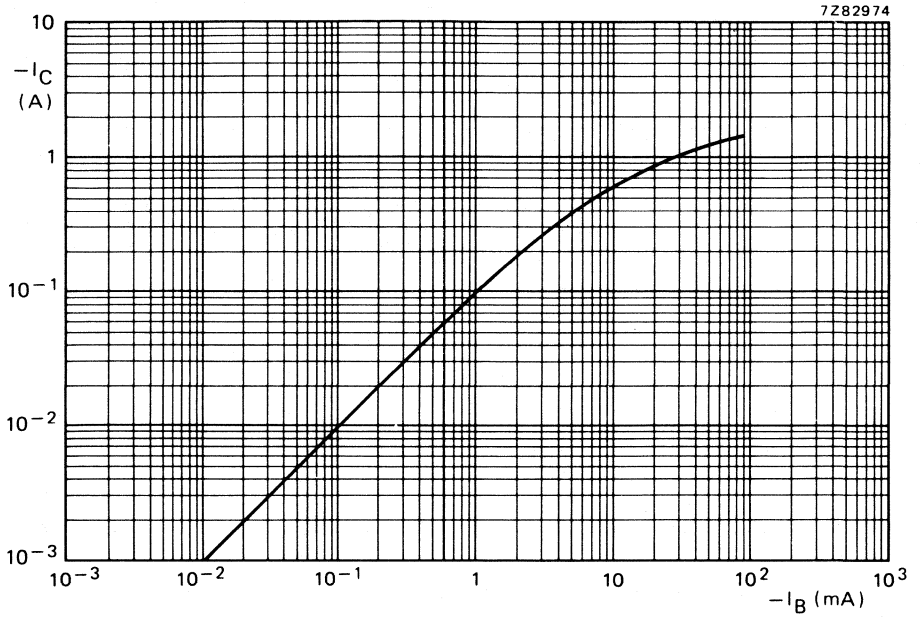


Fig. 9 Typical values at $-V_{CE} = 2 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

N-P-N silicon transistors, in a plastic TO-202 envelope, recommended for use in television circuits and audio applications.

P-N-P complements are BD840, BD842 and BD844.

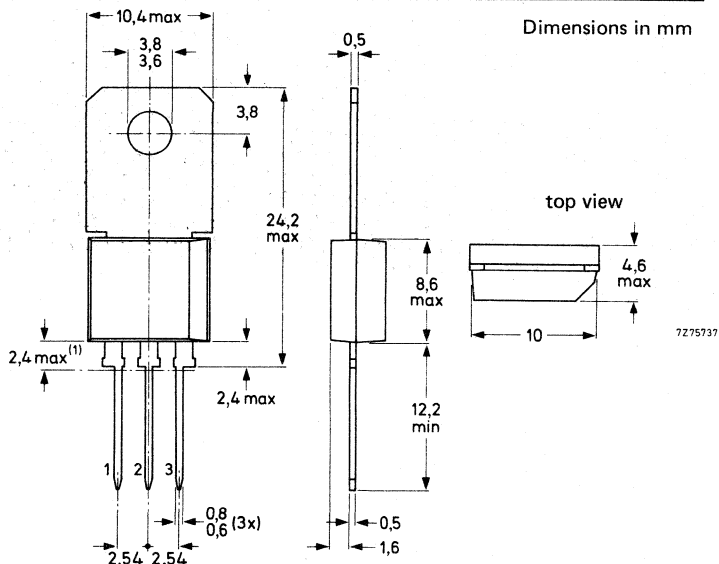
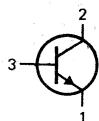
QUICK REFERENCE DATA

		BD839	BD841	BD843	
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		A
Total power dissipation					
$T_{amb} = 25 \text{ }^\circ\text{C}$ (free air)	P_{tot}	max.	2		W
$T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	10		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 at $f = 35 \text{ MHz}$					
$I_C = 50 \text{ mA}; V_{CE} = 5 \text{ V}$	f_T	typ.	125		MHz

MECHANICAL DATA

Fig. 1 TO-202.

Collector connected to mounting base.



(1) Plastic flash allowed within this zone.

RATINGS

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

		BD839	BD841	BD843	
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
Collector current (d.c.)	I_C	max.	1,5		A
Collector current (peak value)	I_{CM}	max.	3		A
Total power dissipation					
$T_{amb} = 25 \text{ }^\circ\text{C}$ (free air)	P_{tot}	max.	2		W
$T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	10		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 ambient in free air	$R_{th\ j-a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j-mb}$	=	12,5	K/W

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

Collector cut-off current

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

I_{CBO}	<	100 nA
I_{CBO}	<	10 μA

Emitter cut-off current

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

I_{EBO}	<	10 μA
-----------	---	------------------

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}	<	0,8 V
-------------	---	-------

D.C. current gain

 $I_C = 5\text{ mA}; V_{CE} = 2\text{ V}$ $I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$ $I_C = 1\text{ A}; V_{CE} = 2\text{ V}$

h_{FE}	>	25
h_{FE}		40 to 250
h_{FE}	>	25

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

BD839/BD840, BD841/BD842, BD843/BD844

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

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

* V_{BE} decreases by about 2,3 mV/K with increasing temperature.

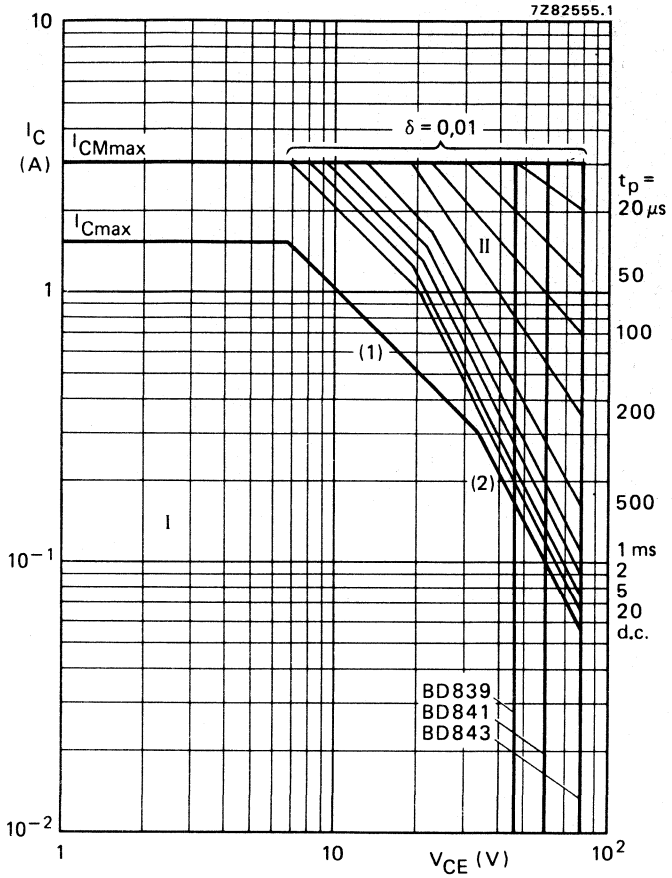


Fig. 2 Safe Operating Area, $T_{mb} \leq 25^\circ C$.

- 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).

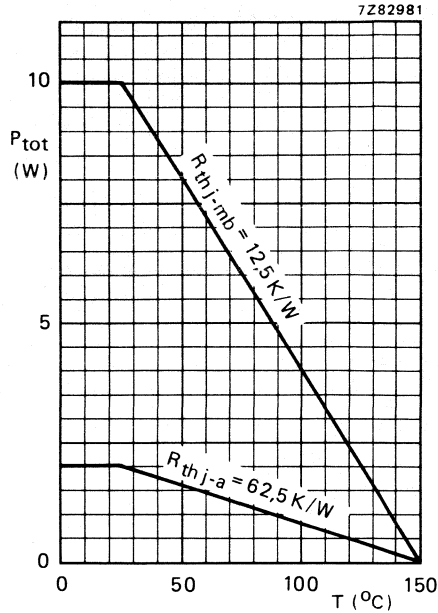


Fig. 3 Power derating curve.

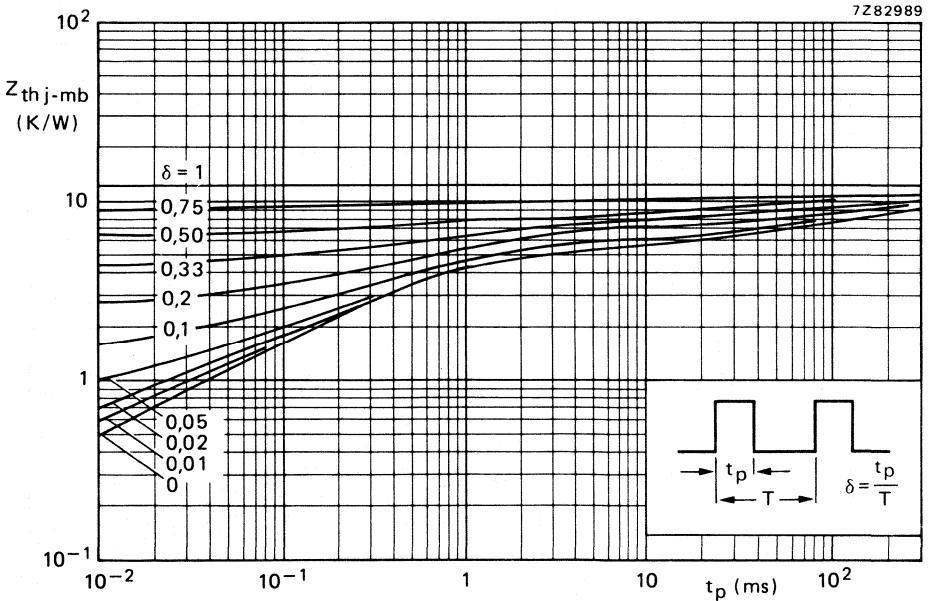


Fig. 4 Pulse power rating chart.

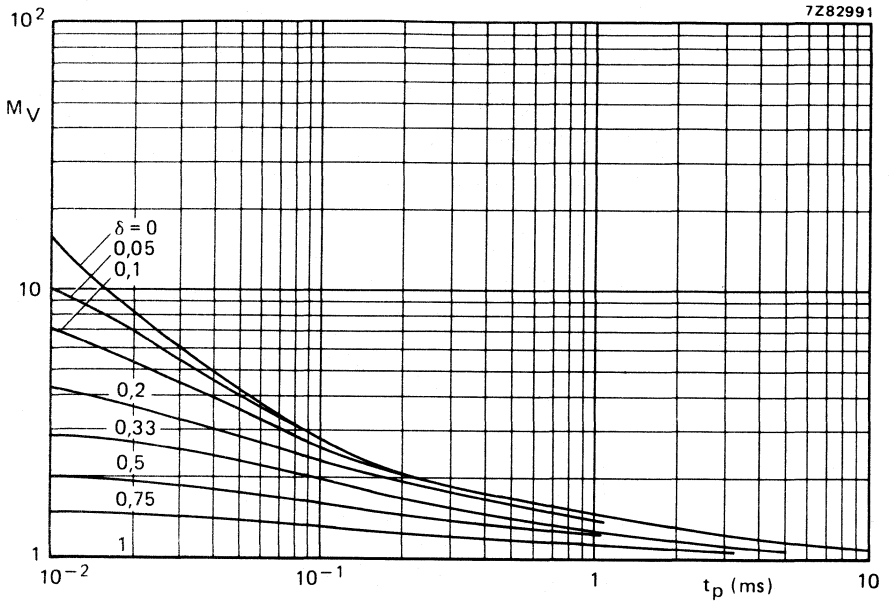


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

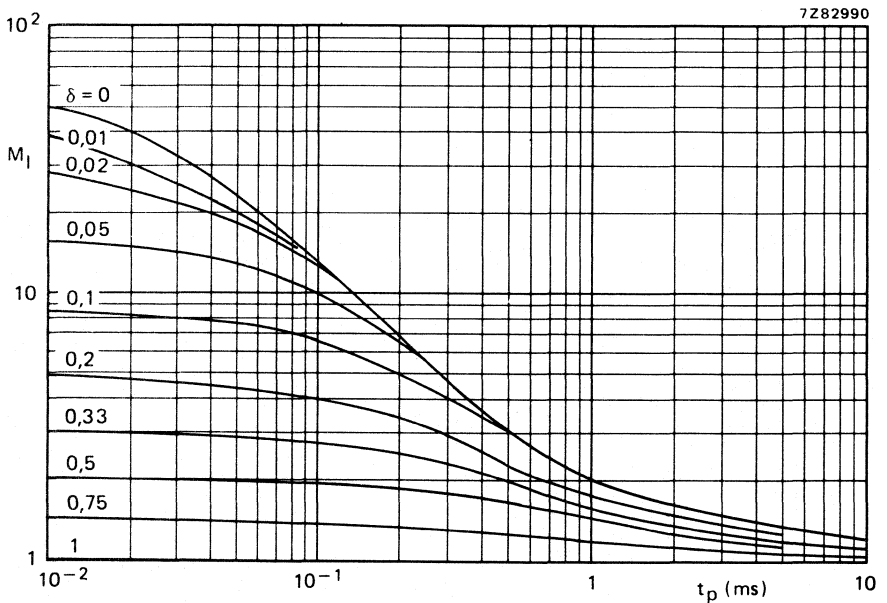


Fig. 6 S.B. current multiplying factor at the V_{CE0max} level.

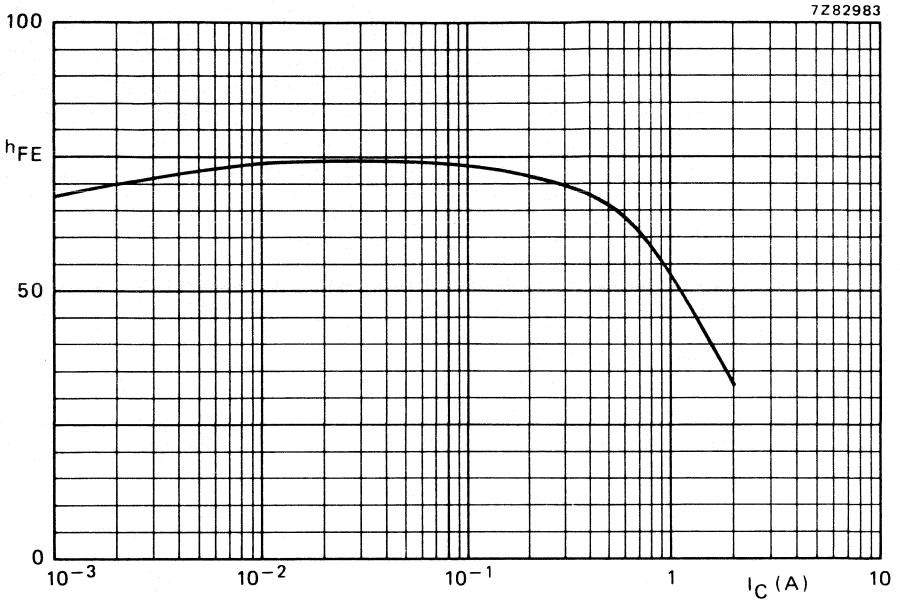


Fig. 7 Typical values d.c. current gain. $V_{CE} = 2\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$.

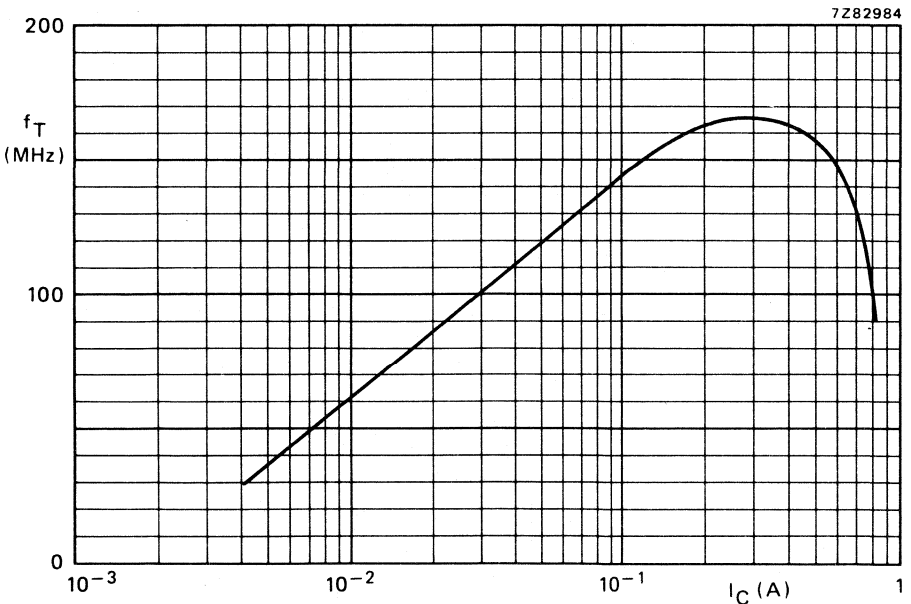


Fig. 8 Typical values transition frequency. $V_{CE} = 5\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$; $f = 35\text{ MHz}$.

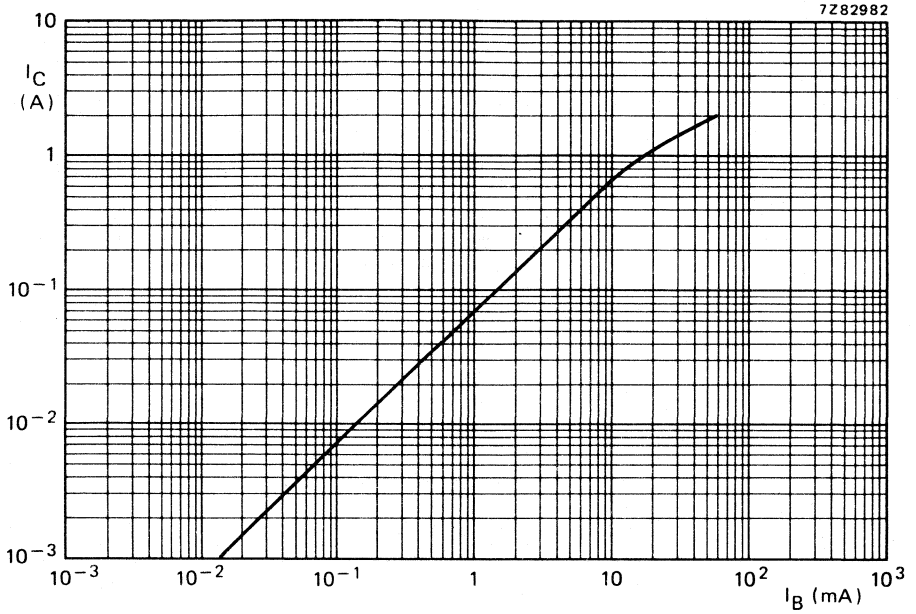


Fig. 9 Typical values at $V_{CE} = 2\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$.

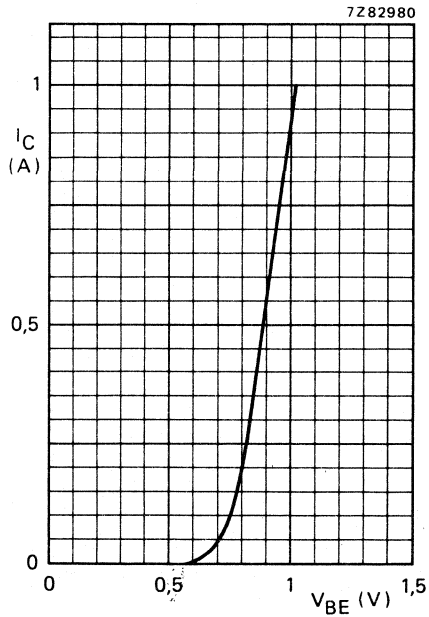


Fig. 10 Typical values. $V_{CE} = 2\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

P-N-P silicon transistors, in a plastic TO-202 envelope, recommended for use in television circuits and audio applications.

N-P-N complements are BD839, BD841 and BD843.

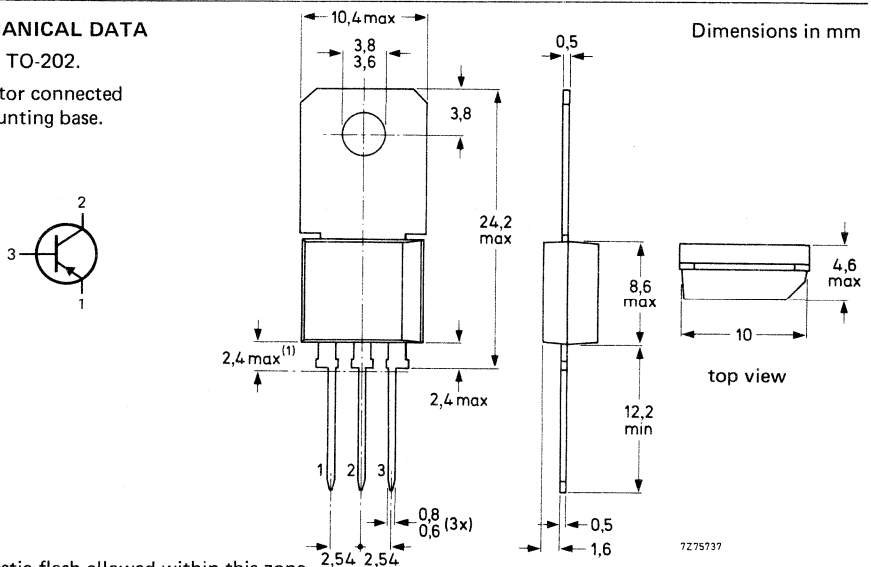
QUICK REFERENCE DATA

		BD840	BD842	BD844	
Collector-base voltage	$-V_{CBO}$	max. 45	60	100	V
Collector-emitter voltage	$-V_{CEO}$	max. 45	60	80	V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	$-V_{CER}$	max. 45	60	100	V
Emitter-base voltage	$-V_{EBO}$	max. 5	5	5	V
Collector current (peak value)	$-I_{CM}$	max.	3		A
Total power dissipation					
$T_{amb} = 25 \text{ }^\circ\text{C}$ (free air)	P_{tot}	max.	2		W
$T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	10		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 at $f = 35 \text{ MHz}$	f_T	typ.	50		MHz

MECHANICAL DATA

Fig. 1 TO-202.

Collector connected to mounting base.



(1) Plastic flash allowed within this zone.

RATINGS

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

		BD840	BD842	BD844	
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
Collector current (d.c.)	$-I_C$	max.	1,5		A
Collector current (peak value)	$-I_{CM}$	max.	3		A
Total power dissipation					
$T_{amb} = 25\text{ }^\circ\text{C}$ (free air)	P_{tot}	max.	2		W
$T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	10		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 ambient in free air	$R_{th\ j-a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j-mb}$	=	12,5	K/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*

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

Collector-emitter saturation voltage

 $-I_C = 1\text{ A}; -I_B = 0,1\text{ A}$ $-V_{CEsat} < 0,8\text{ V}$

D.C. current gain

 $-I_C = 5\text{ mA}; -V_{CE} = 2\text{ V}$ $h_{FE} > 25$ $-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$ $h_{FE} 40\text{ to }250$ $-I_C = 1\text{ A}; -V_{CE} = 2\text{ V}$ $h_{FE} > 25$ Transition frequency at $f = 35\text{ MHz}$ $-I_C = 50\text{ mA}; -V_{CE} = 5\text{ V}$ f_T typ. 50 MHz

D.C. current gain ratio

of BD839/BD840, BD841/BD842, BD843/BD844

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

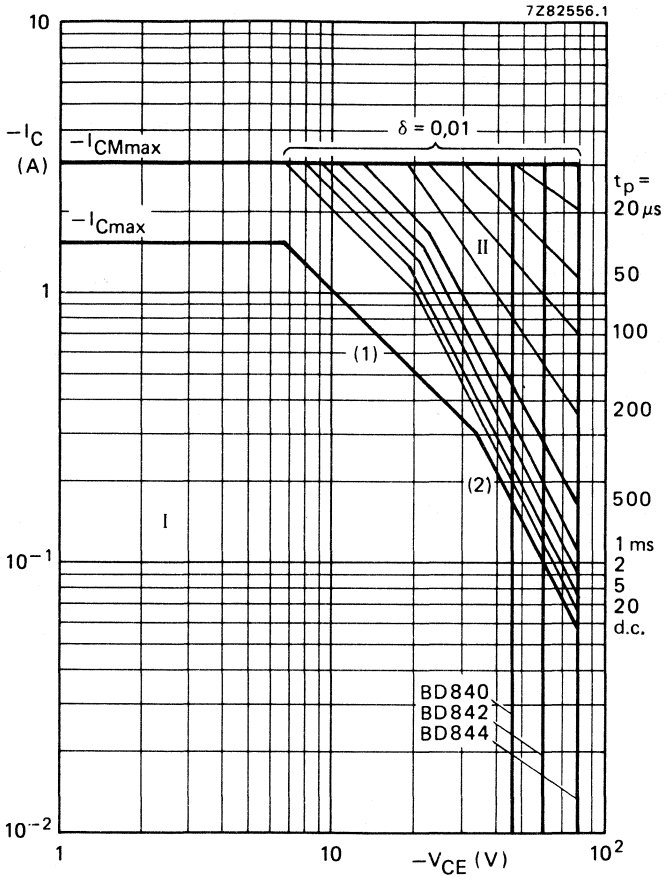


Fig. 2 Safe Operating Area, $T_{mb} \leq 25^\circ\text{C}$.

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

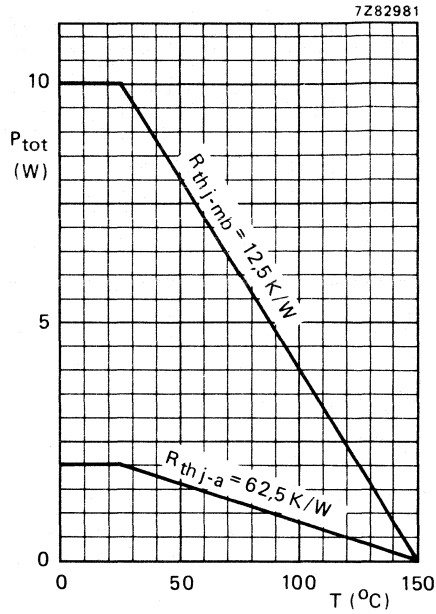


Fig. 3 Power derating curve.

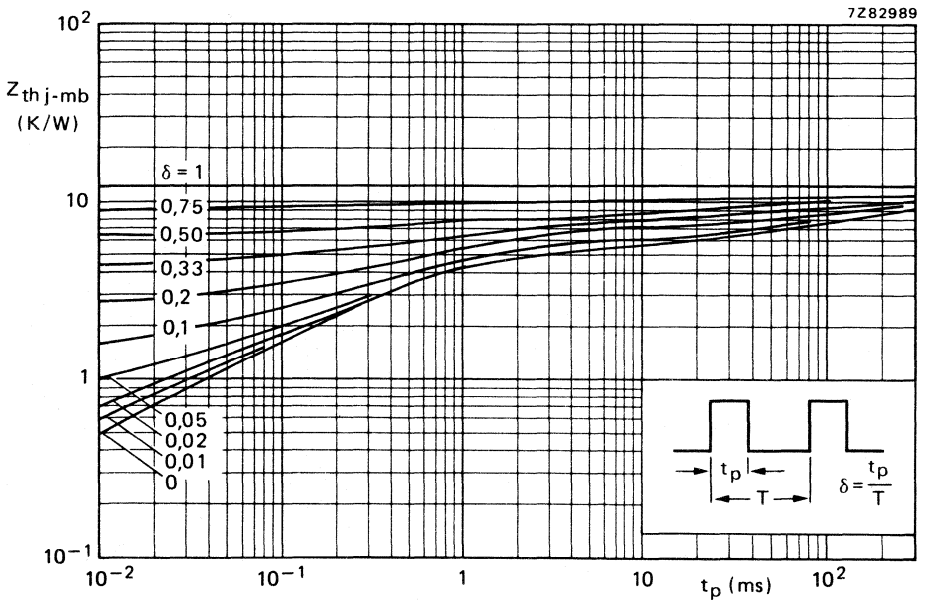


Fig. 4 Pulse power rating chart.

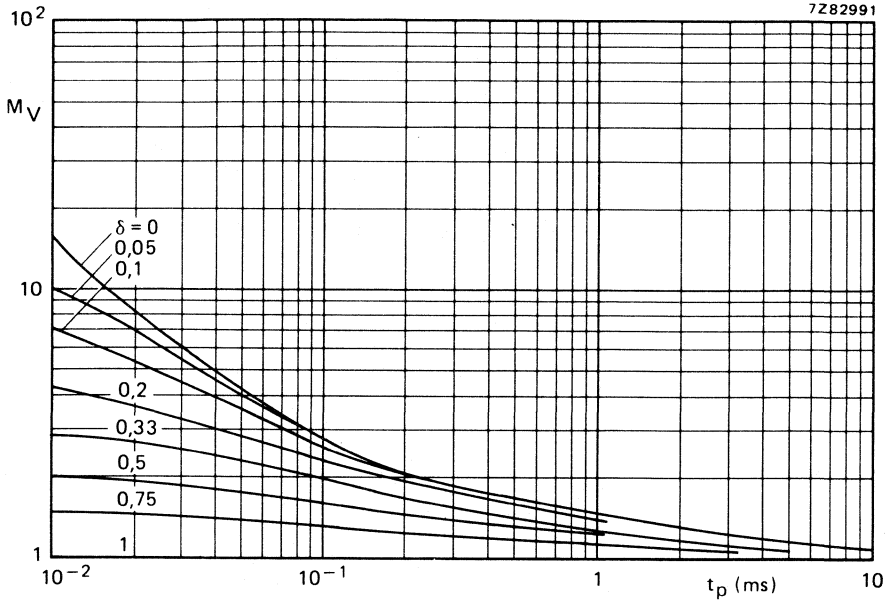


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

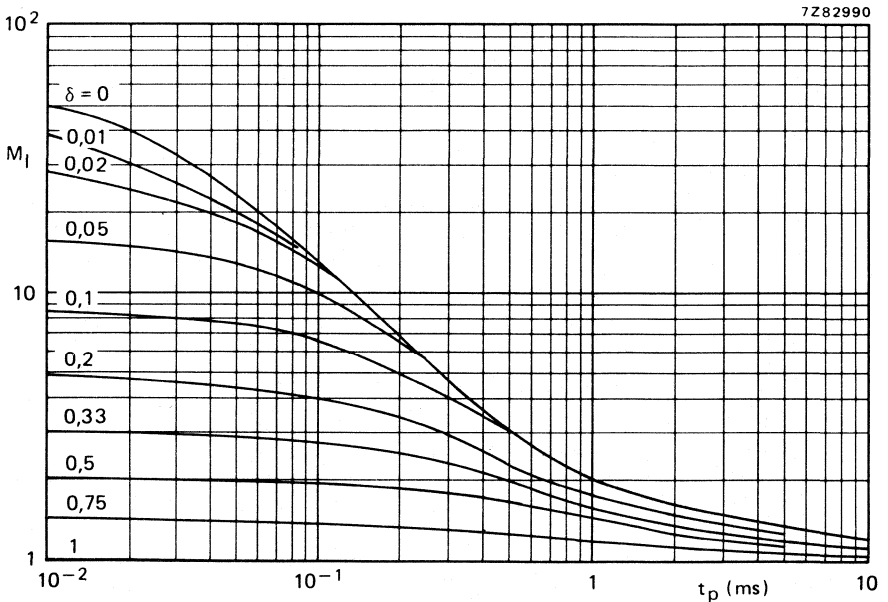


Fig. 6 S.B. current multiplying factor at the V_{CE0max} level.

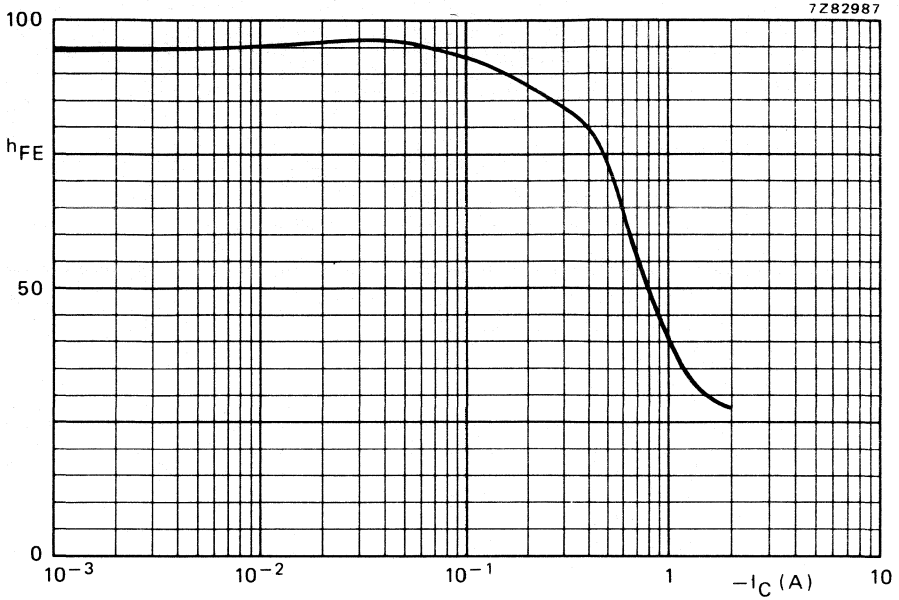


Fig. 7 Typical values d.c. current gain. $-V_{CE} = 2$ V; $T_{amb} = 25$ °C.

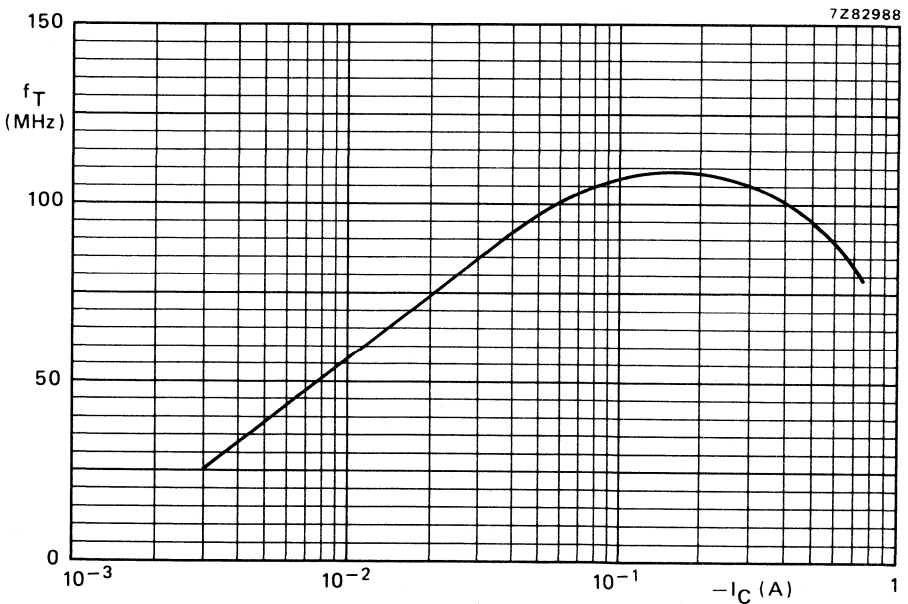


Fig. 8 Typical values transition frequency. $-V_{CE} = 5$ V; $f = 35$ MHz; $T_{amb} = 25$ °C.

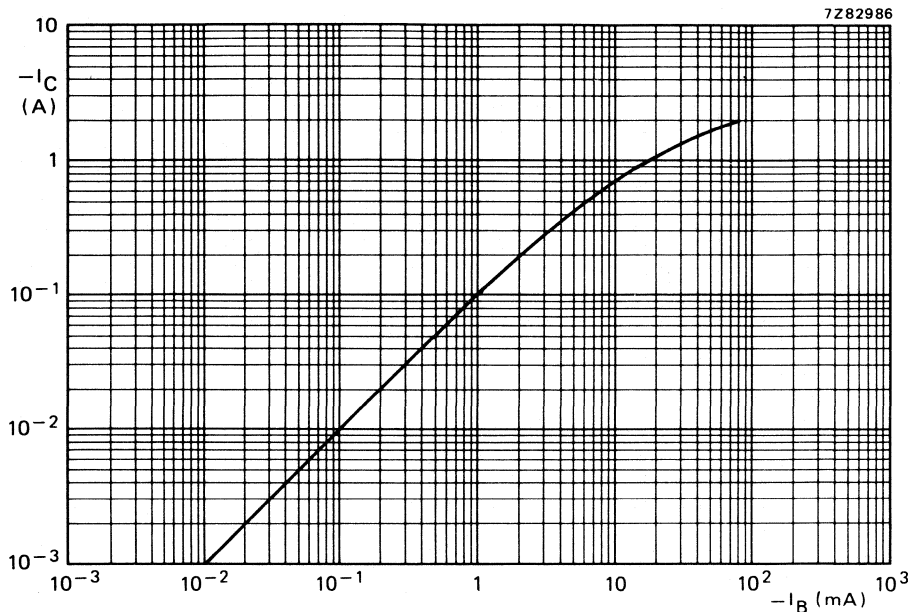


Fig. 9 Typical values at $-V_{CE} = 2 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$.

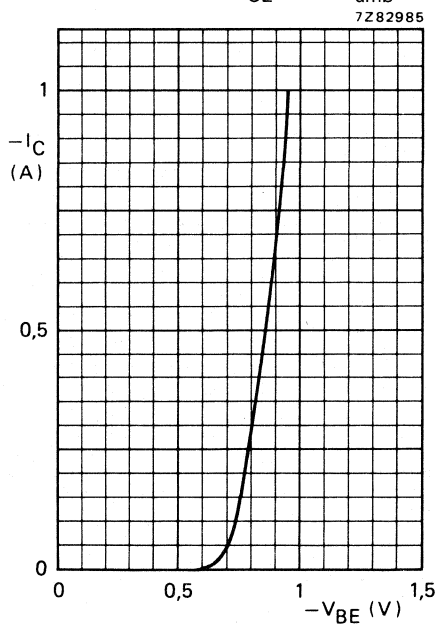


Fig. 10 Typical values. $-V_{CE} = 2 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$.

SILICON EPITAXIAL-BASE POWER TRANSISTORS

General purpose N-P-N transistors, in TO-202 plastic envelopes, recommended for driver-stages in audio amplifiers and television circuits.

P-N-P complements are BD846, BD848 and BD850. Matched pairs can be supplied.

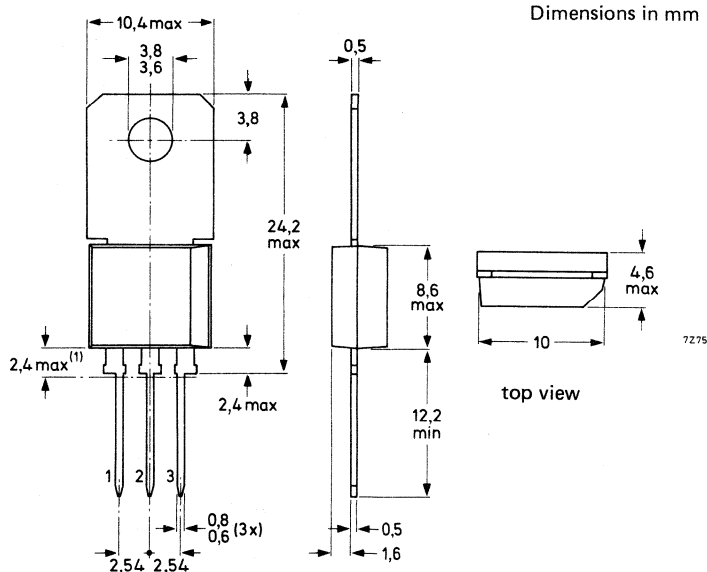
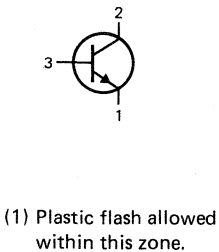
QUICK REFERENCE DATA

		BD845	BD847	BD849	
Collector-base voltage	V_{CBO}	max. 100	120	140	V
Collector-emitter voltage	V_{CEO}	max. 100	120	140	V
Emitter-base voltage	V_{EBO}	max. 5	5	5	V
Collector current (peak value)	I_{CM}	max.	3		A
Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}$ (free air) at $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	2		W
	P_{tot}	max.	10		W
Junction temperature	T_j	max.	150		$^{\circ}\text{C}$
D.C. current gain $I_C = 150\text{ mA}$; $V_{CE} = 5\text{ V}$	h_{FE}		40 to 250		
	Transition frequency at $f = 35\text{ MHz}$ $I_C = 100\text{ mA}$; $V_{CE} = 5\text{ V}$	f_T	typ.	150	

MECHANICAL DATA

Fig. 1 TO-202.

Collector connected to mounting base



RATINGS

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

			BD845	BD847	BD849	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	100	120	140	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V
Collector current (d.c.)	I_C	max.		1,5		A
Collector current (peak value)	I_{CM}	max.		3		A
Total power dissipation						
$T_{amb} = 25\text{ °C}$ (free air)	P_{tot}	max.		2		W
$T_{mb} = 25\text{ °C}$	P_{tot}	max.		10		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	$R_{th\ j-a}$	=		62,5		K/W
From junction to mounting base	$R_{th\ j-mb}$	=		12,5		K/W

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

Collector cut-off currents

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

$I_{CBO} < 1\ \mu\text{A}$

Emitter cut-off current

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

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

D.C. current gain

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

$h_{FE} > 40$

$I_C = 150\ \text{mA}; V_{CE} = 5\ \text{V}$

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

$I_C = 500\ \text{mA}; V_{CE} = 5\ \text{V}$

$h_{FE} > 30$

Collector-emitter saturation voltage

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

$V_{CE\text{sat}} < 1,0\ \text{V}$

Base-emitter voltage

$I_C = 500\ \text{mA}; V_{CE} = 5\ \text{V}$

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

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

$I_C = 100\ \text{mA}; V_{CE} = 5\ \text{V}$

$f_T \quad \text{typ.} \quad 150\ \text{MHz}$

D.C. current gain ratio of matched pairs

BD845/BD846; BD847/BD848; BD849/BD850

$|I_C| = 150\ \text{mA}; |V_{CE}| = 5\ \text{V}$

$h_{FE1}/h_{FE2} < 2,0$

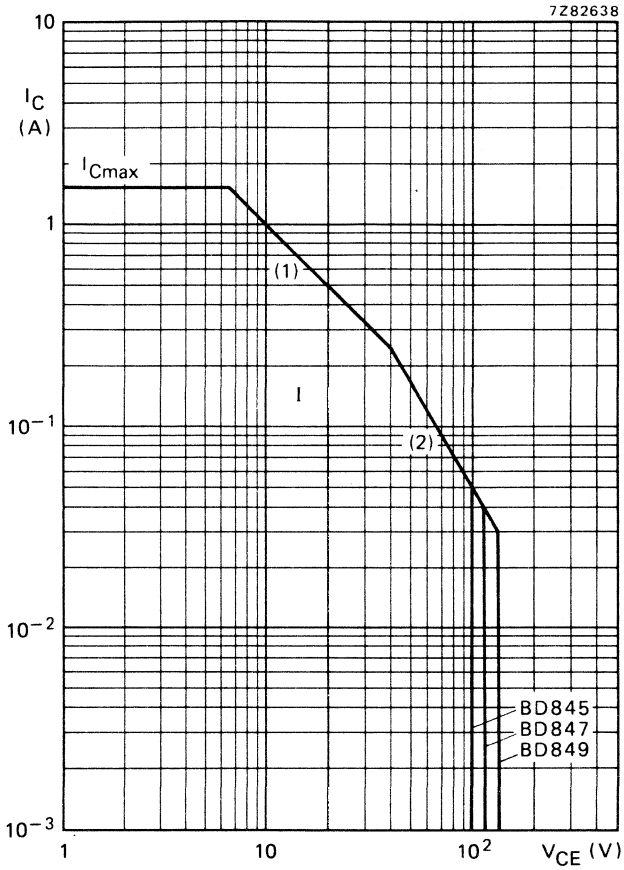


Fig. 2 D.C. SOAR; $T_{mb} \leq 25^\circ C$.

I Region of permissible d.c. operation.

(1) P_{tot} max line.

(2) Second breakdown limit (independent of temperature).

SILICON EPITAXIAL-BASE POWER TRANSISTORS

General purpose P-N-P transistors, in TO-202 plastic envelopes, recommended for driver stages in audio amplifiers and television circuits.

N-P-N complements are BD845, BD847 and BD849. Matched pairs can be supplied.

QUICK REFERENCE DATA

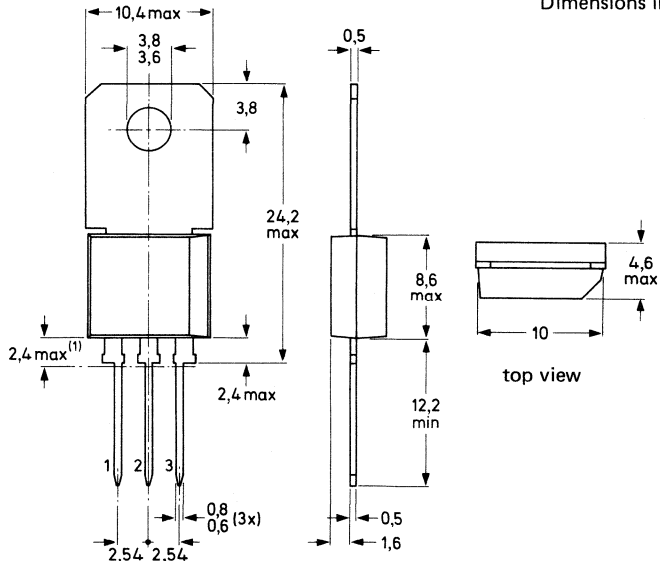
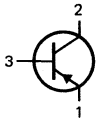
		BD846	BD848	BD850	
Collector-base voltage	$-V_{CBO}$ max.	100	120	140	V
Collector-emitter voltage	$-V_{CEO}$ max.	100	120	140	V
Emitter-base voltage	$-V_{EBO}$ max.	5	5	5	V
Collector current (peak value)	$-I_{CM}$ max.		3		A
Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}$ (free air) at $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.		2		W
	P_{tot} max.		10		W
Junction temperature	T_j max.		150		$^{\circ}\text{C}$
D.C. current gain $-I_C = 150\text{ mA}; -V_{CE} = 5\text{ V}$	h_{FE}		40 to 250		
	Transition frequency at $f = 35\text{ MHz}$ $-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$	f_T typ.		75	

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-202.

Collector connected to mounting base.



(1) Plastic flash allowed within this zone.

7275737

RATINGS

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

			BD846	BD848	BD850	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	100	120	140	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V
Collector current (d.c.)	$-I_C$	max.		1,5		A
Collector current (peak value)	$-I_{CM}$	max.		3,0		A
Total power dissipation						
$T_{amb} = 25\text{ }^\circ\text{C}$ (free air)	P_{tot}	max.		2		W
$T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		10		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 ambient in free air	$R_{th\ j-a}$	=		62,5		K/W
From junction to mounting base	$R_{th\ j-mb}$	=		12,5		K/W

CHARACTERISTICS

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

Collector cut-off current

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

$-I_{CBO} < 1\text{ }\mu\text{A}$

Emitter cut-off current

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

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

D.C. current gain

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

$h_{FE} > 40$

$-I_C = 150\text{ mA}; -V_{CE} = 5\text{ V}$

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

$-I_C = 500\text{ mA}; -V_{CE} = 5\text{ V}$

$h_{FE} > 30$

Collector-emitter saturation voltage

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

$-V_{CE\text{sat}} < 1,0\text{ V}$

Base-emitter voltage

$-I_C = 500\text{ mA}; -V_{CE} = 5\text{ V}$

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

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

$-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$

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

D.C. current gain ratio of matched pairs

BD845/BD846; BD847/BD848; BD849/BD850

$|I_C| = 150\text{ mA}; |V_{CE}| = 5\text{ V}$

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

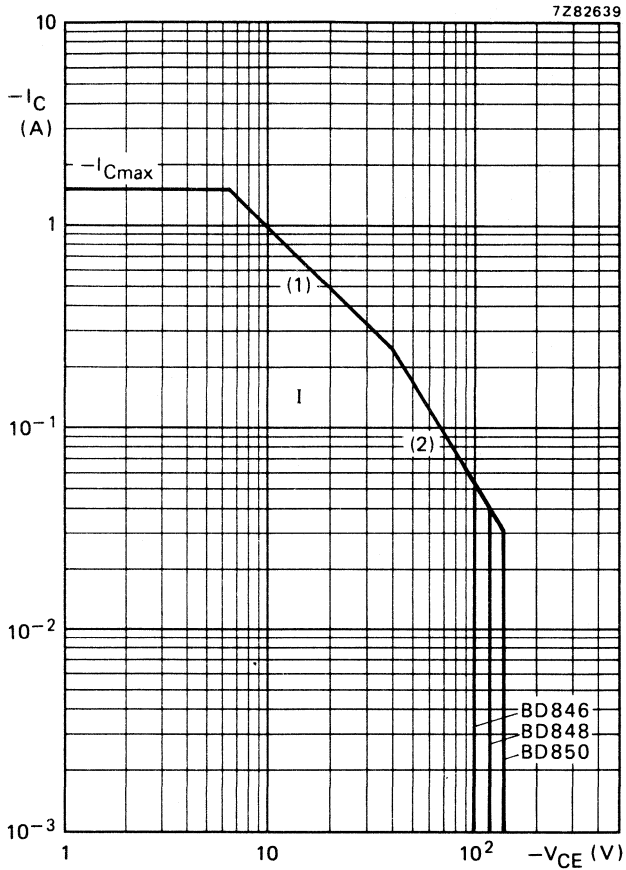


Fig. 2 D.C. SOAR; $T_{mb} \leq 25^\circ\text{C}$.

I Region of permissible d.c. operation.

(1) P_{tot} max line.

(2) Second breakdown limit (independent of temperature).

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.

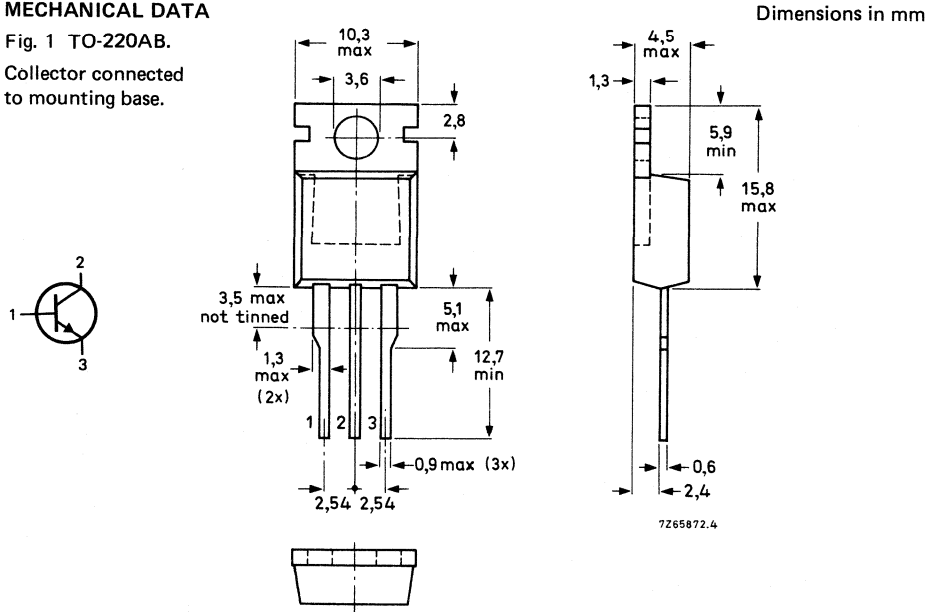
QUICK REFERENCE DATA

		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 $T_{mb} = 25\text{ }^\circ\text{C}$	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

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			K/W
From junction to ambient in free air	$R_{th\ j-a}$	=			70			K/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

$I_{Con} = 1\text{ A}; I_{Bon} = -I_{Boff} = 0,1\text{ A}$ t_{on} typ. 0,4 μs

turn-on time $t_{on} < 1$ μs

Turn-off time t_{off} typ. 1,5 μs

$t_{off} < 3$ μs

Second-breakdown collector current

$V_{CE} = 40\text{ V}; t_p = 0,1\text{ s};$ non-repetitive $I_{(SB)} > 0,75$ A

* Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}; \delta < 2\%$.

** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

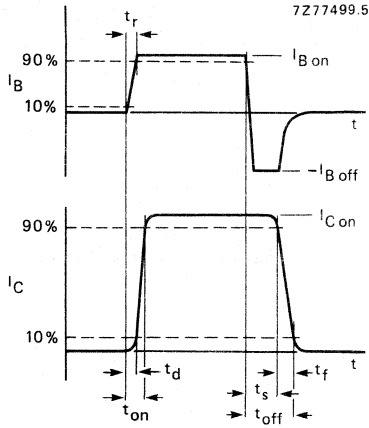


Fig. 2 Switching times waveforms.

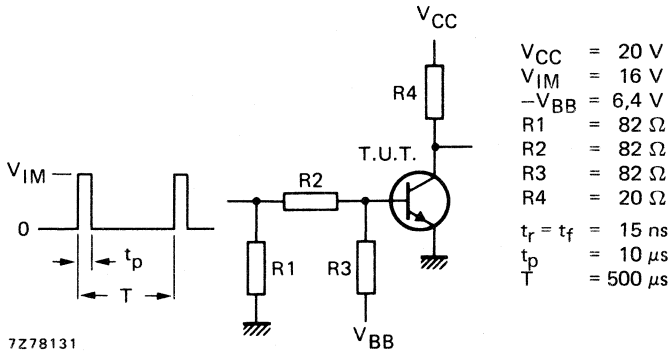


Fig. 3 Switching times test circuit.

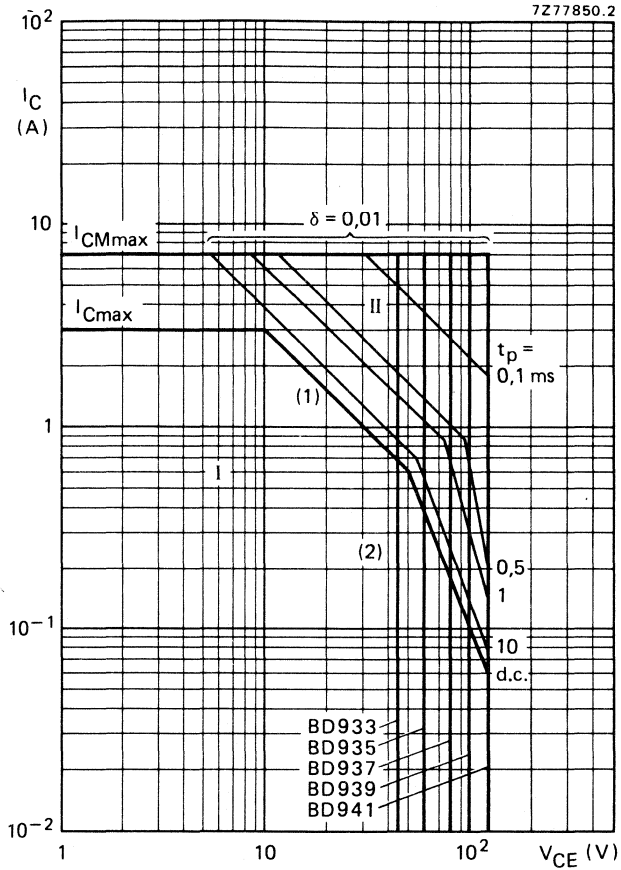


Fig. 4 Safe Operating Area; $T_{mb} = 25^\circ\text{C}$.

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.

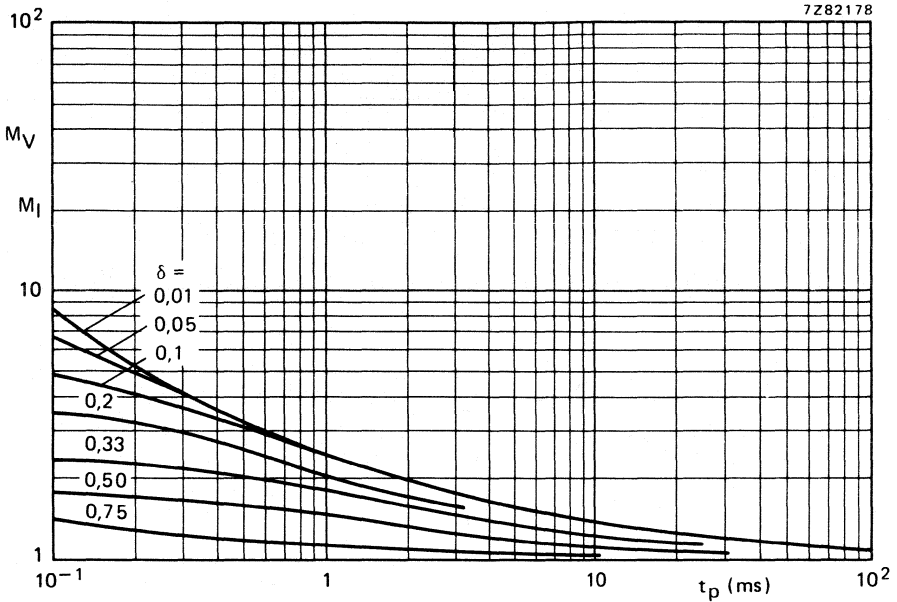


Fig. 5 Second-breakdown voltage multiplying factor at the I_{Cmax} level and second-breakdown current multiplying factor at the V_{CE0max} level.

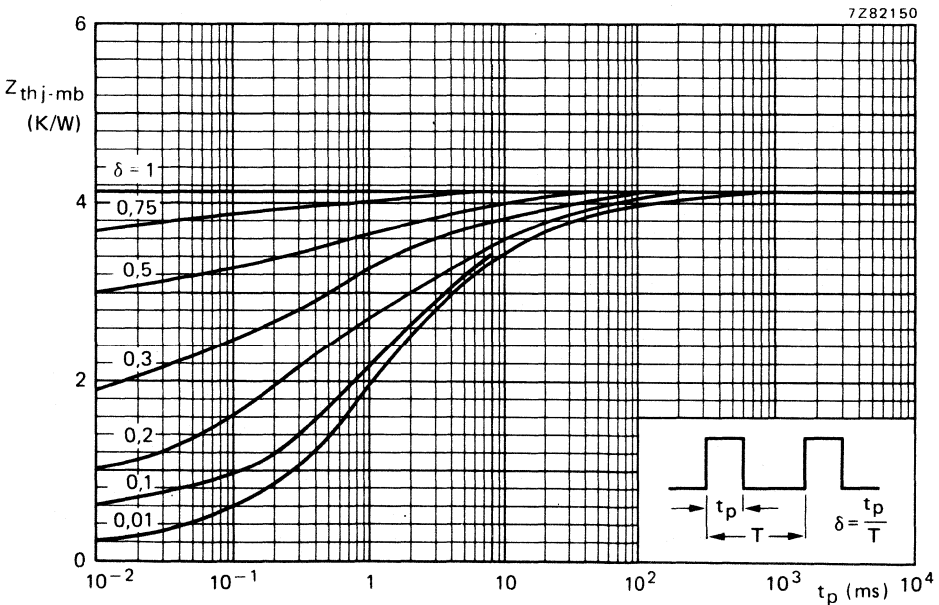


Fig. 6 Pulse power rating chart.

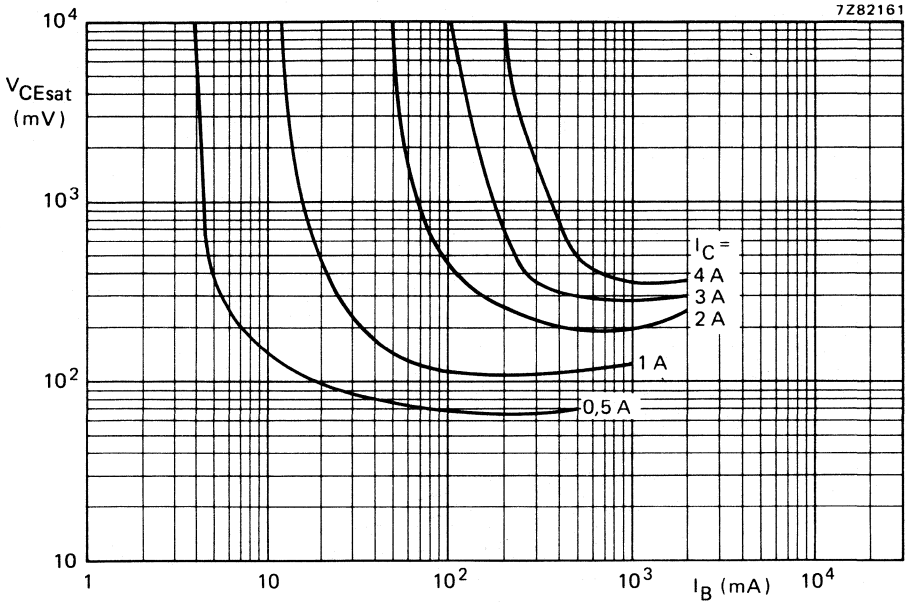


Fig. 7 Typical collector-emitter saturation voltage as a function of base current with collector current as a parameter.

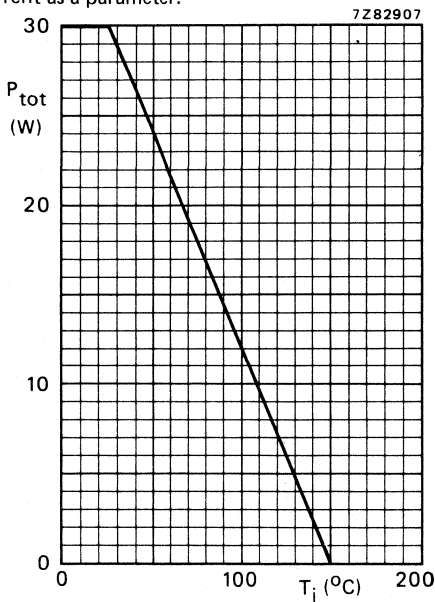


Fig. 8 Power derating curve.

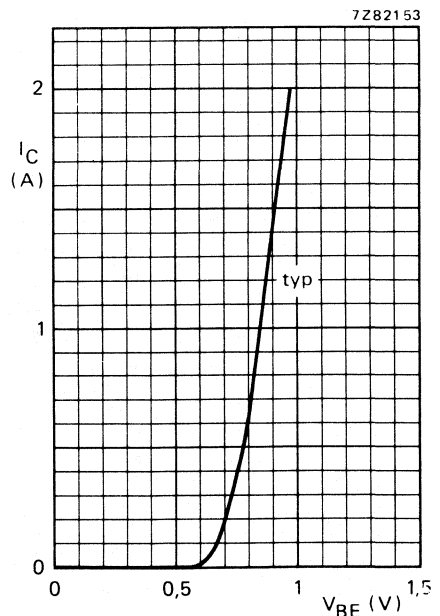


Fig. 9 $V_{CE} = 2 V$; $T_j = 25^{\circ}C$.

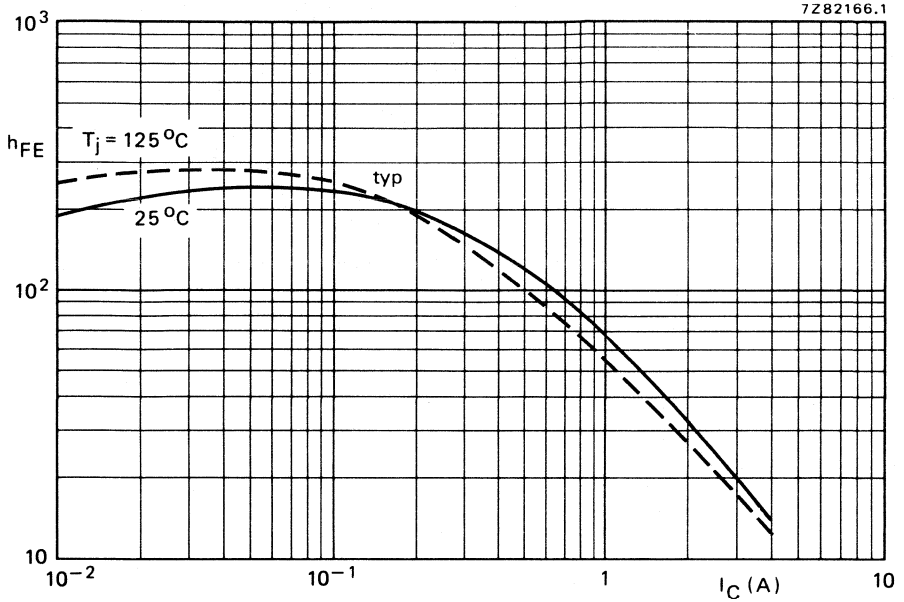


Fig. 10 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 2$ V

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

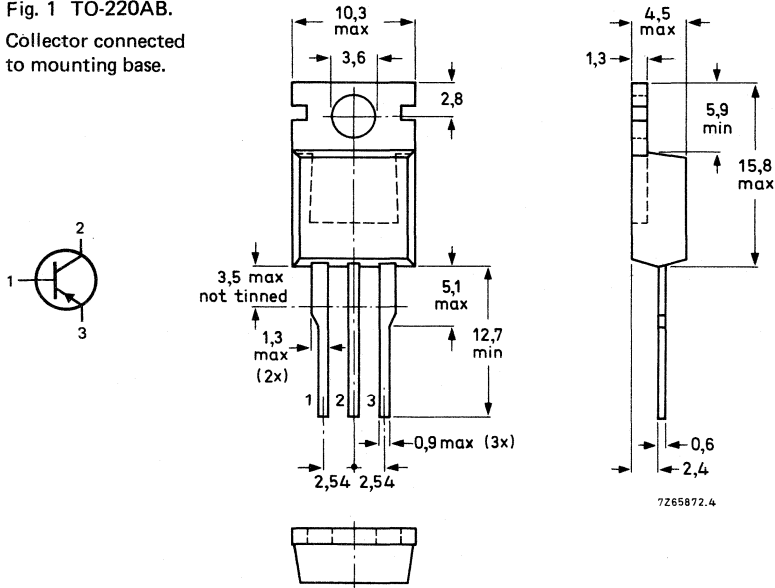
		BD934	936	938	940	942
Collector-base voltage	$-V_{CBO}$ max.	45	60	100	120	140 V
Collector-emitter voltage	$-V_{CEO}$ max.	45	60	80	100	120 V
Collector current (d.c.)	$-I_C$ max.			3		A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot} max.			30		W
Junction temperature	T_j max.			150		$^\circ\text{C}$
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)

			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			K/W
From junction to ambient in free air	$R_{th\ j-a}$	=			70			K/W

CHARACTERISTICS

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

Collector cut-off current

$$-I_E = 0; -V_{CB} = -V_{CBOmax} \quad -I_{CBO} < \quad 0,1 \quad \text{mA}$$

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

$$I_B = 0; -V_{CE} = -V_{CEOmax} \quad -I_{CEO} < \quad 0,5 \quad \text{mA}$$

Emitter cut-off current

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

D.C. current gain (note 1)

$$-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V} \quad h_{FE} \quad 40\text{ to }250$$

$$-I_C = 1\text{ A}; -V_{CE} = 2\text{ V} \quad h_{FE} > \quad 25$$

Base-emitter voltage (notes 1 and 2)

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

Collector-emitter saturation voltage (note 1)

$$-I_C = 1\text{ A}; -I_B = 0,1\text{ A} \quad -V_{CEsat} < \quad 0,6 \quad \text{V}$$

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

$$-I_C = 250\text{ mA}; -V_{CE} = 10\text{ V} \quad f_T > \quad 3 \quad \text{MHz}$$

→ Switching times

$$-I_{Con} = 1\text{ A}; -I_{Bon} = I_{Boff} = 0,1\text{ A} \quad \text{turn-on time} \quad t_{on} \quad \text{typ.} \quad 0,2 \quad \mu\text{s}$$

$$< \quad 0,6 \quad \mu\text{s}$$

$$\text{turn-off time} \quad t_{off} \quad \text{typ.} \quad 0,7 \quad \mu\text{s}$$

$$< \quad 2,4 \quad \mu\text{s}$$

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/K with increasing temperature.

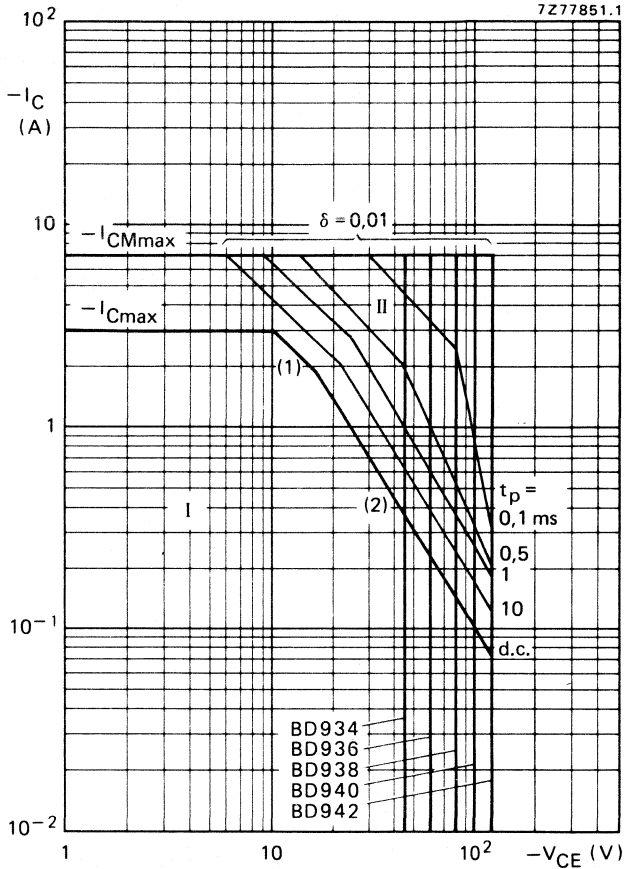


Fig. 2 Safe Operating Area; $T_{mb} = 25^\circ C$.

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.

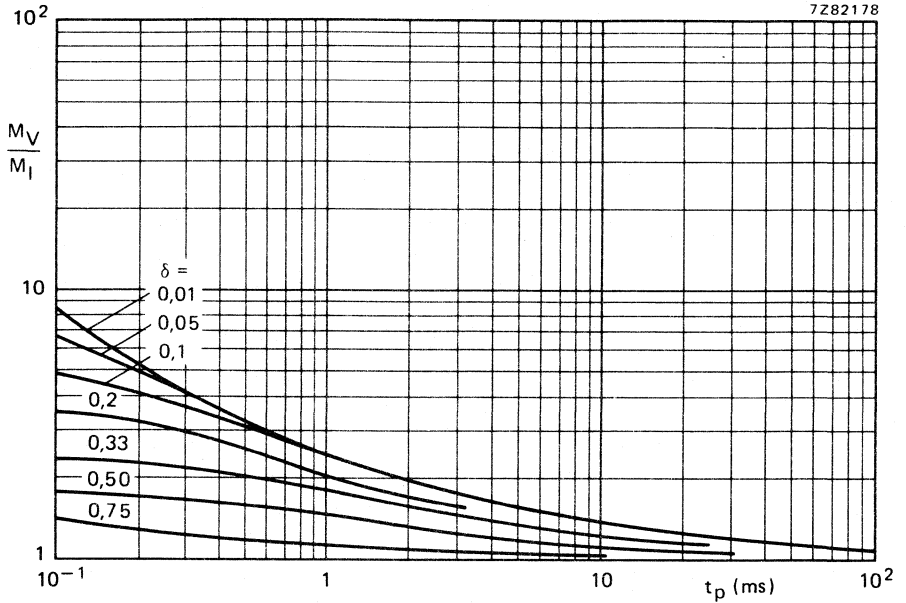


Fig. 3 Second breakdown voltage multiplying factor at the I_{Cmax} level and second breakdown current multiplying factor at the V_{CEOmax} level.

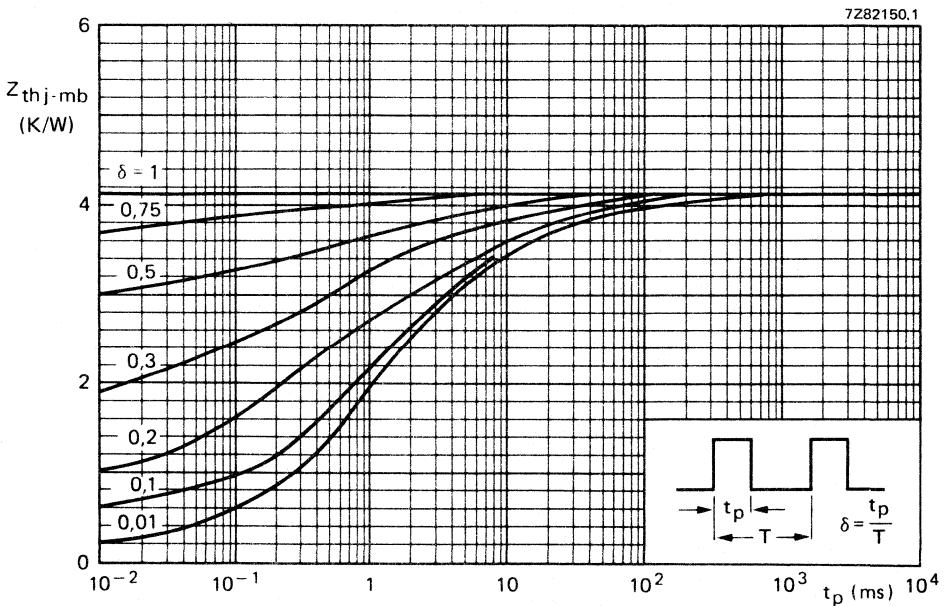


Fig. 4 Pulse power rating chart.

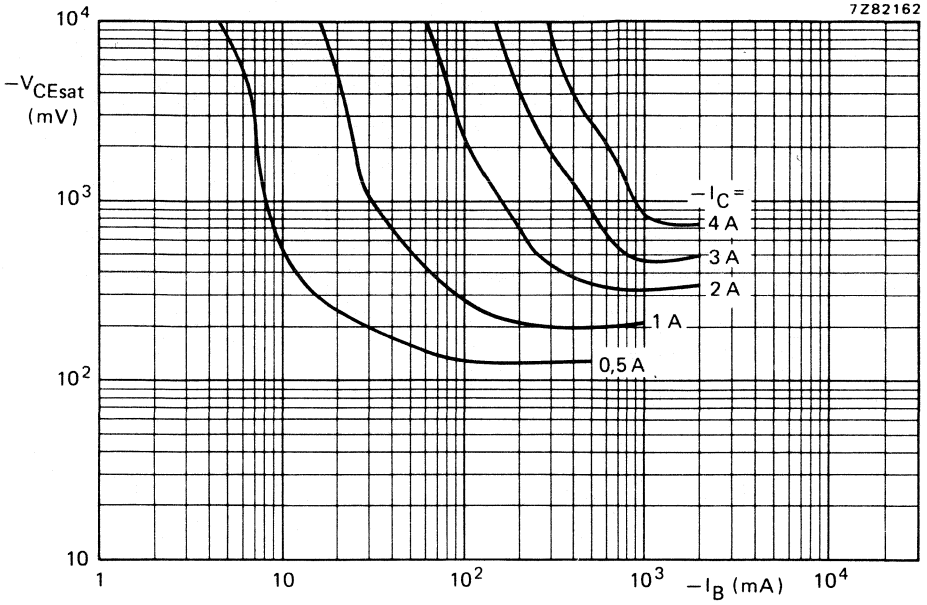


Fig. 5 Typical collector-emitter saturation voltage as a function of base current with collector current as a parameter.

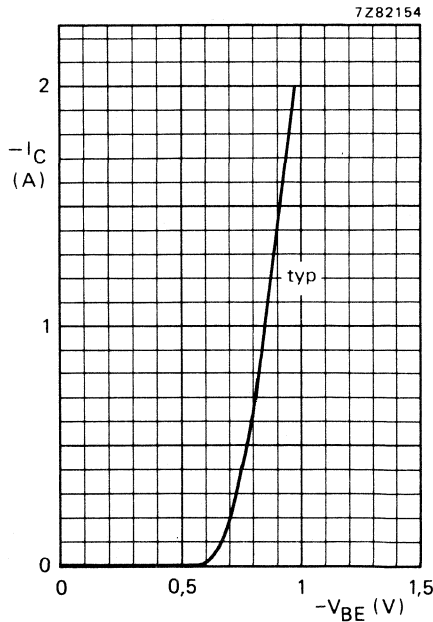


Fig. 6 Typical collector current as a function of base-emitter voltage. $-V_{CE} = 2$ V; $T_j = 25$ °C.

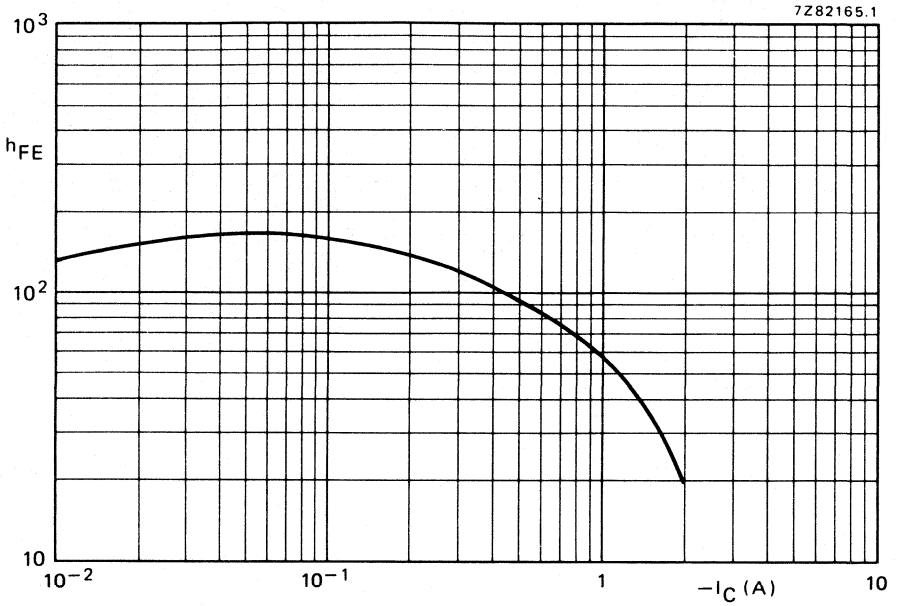


Fig. 7 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 2 \text{ V}$; $T_j \leq 25 \text{ }^\circ\text{C}$.

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

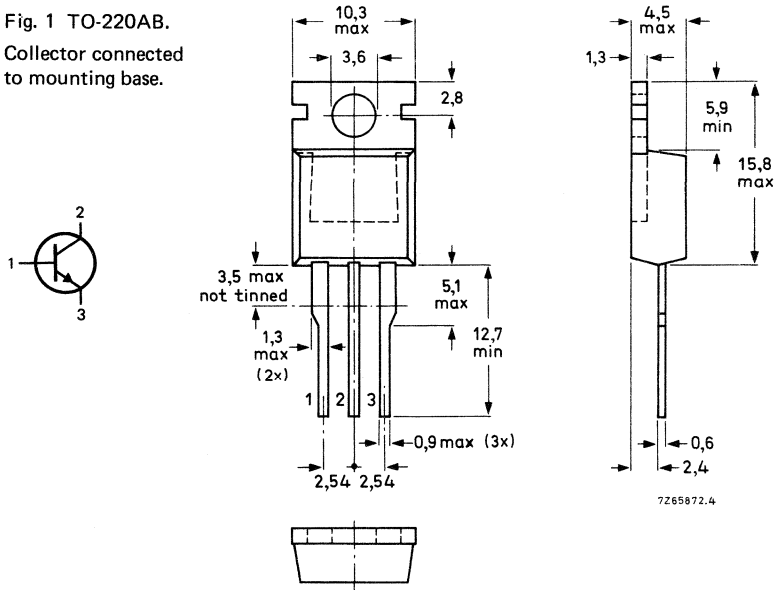
		BD943	945	947
Collector-base voltage (open emitter)	V_{CBO}	max. 22	32	45 V
Collector-emitter voltage (open base)	V_{CEO}	max. 22	32	45 V
Collector current (d.c.)	I_C	max.	5	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	40	W
Junction temperature	T_j	max.	150	$^\circ\text{C}$
D.C. current gain				
$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$	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	
Transition frequency at $f = 1\text{ MHz}$				
$I_C = 250\text{ mA}; V_{CE} = 1\text{ V}$	f_T	>	3	MHz

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_{CB0}	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	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=		70	K/W

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = V_{CB0max}$	I_{CB0}	<		0,1	mA
$I_E = 0; V_{CB} = V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$	I_{CB0}	<		3	mA
15 V; BD943					
$I_B = 0; V_{CE} = 20\text{ V};$ BD945	I_{CE0}	<		0,5	mA
25 V; BD947					

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/K 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 $f = 1 \text{ MHz}$

$I_C = 250 \text{ mA}$; $V_{CE} = 1 \text{ V}$

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

$f_T > 3 \text{ MHz}$

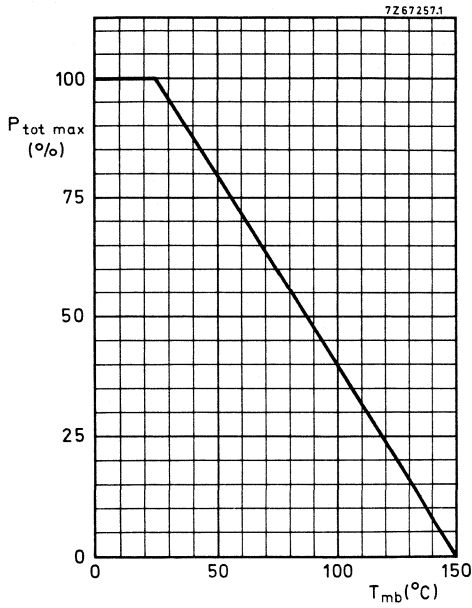


Fig. 2 Power derating curve.

* Measured under pulse conditions; $t_p \leq 300 \mu s$; $\delta < 2\%$.

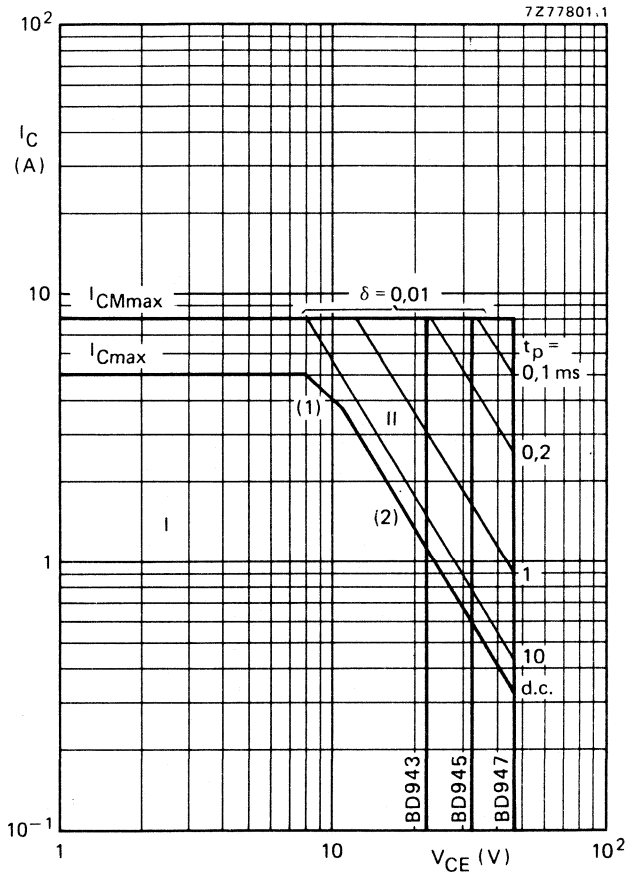


Fig. 3 Safe Operating Area, $T_{mb} = 25^\circ\text{C}$.

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).

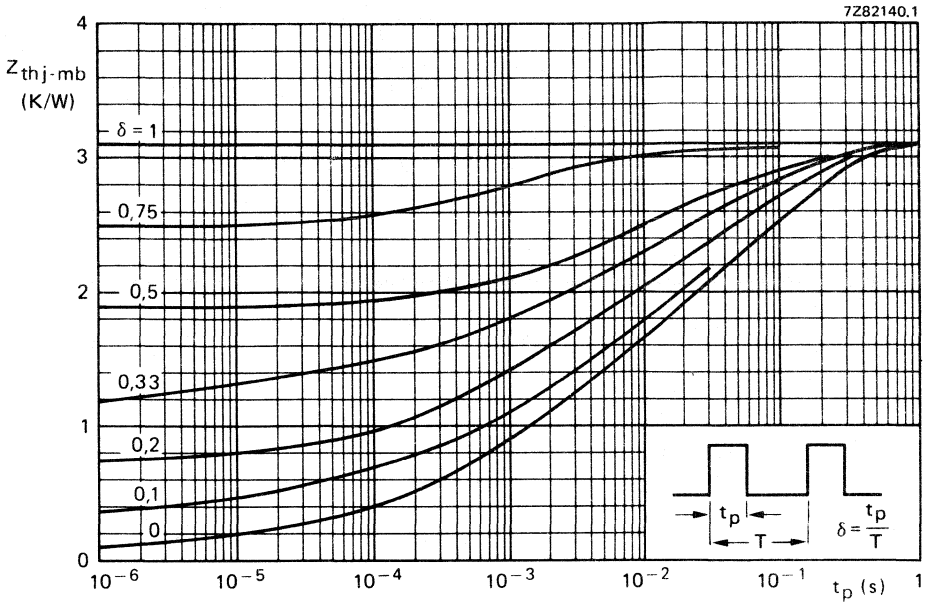


Fig. 4 Pulse power rating chart.

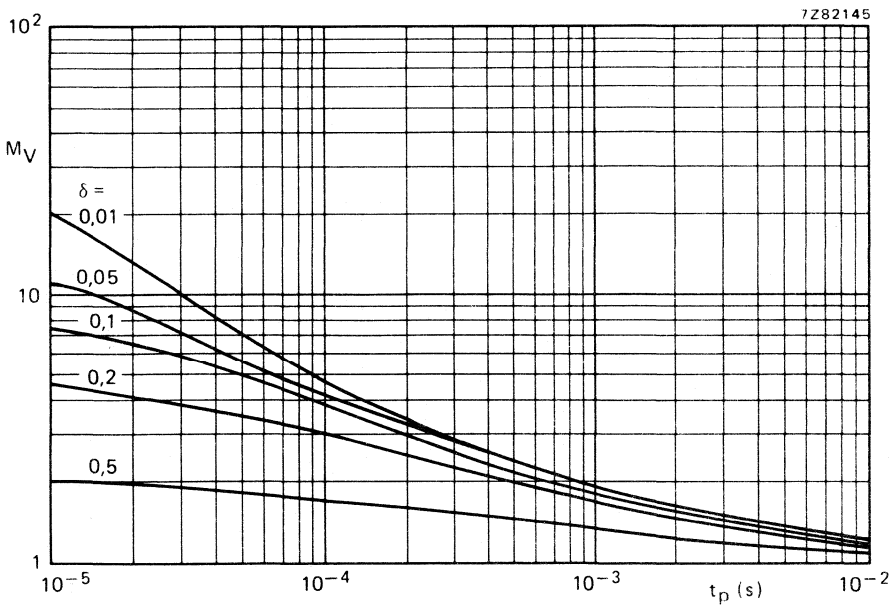


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

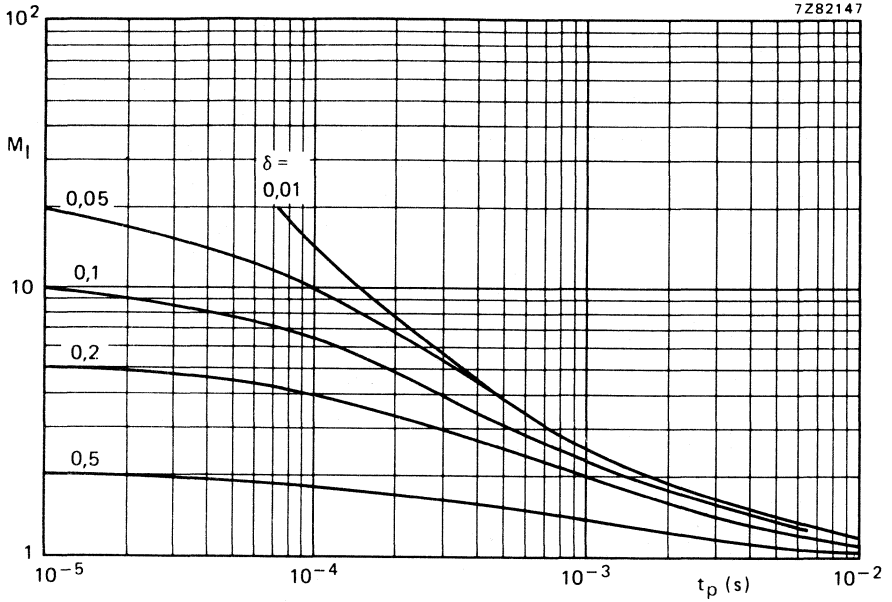


Fig. 6 S.B. current multiplying factor at the V_{CE0max} level for BD943 and BD945.

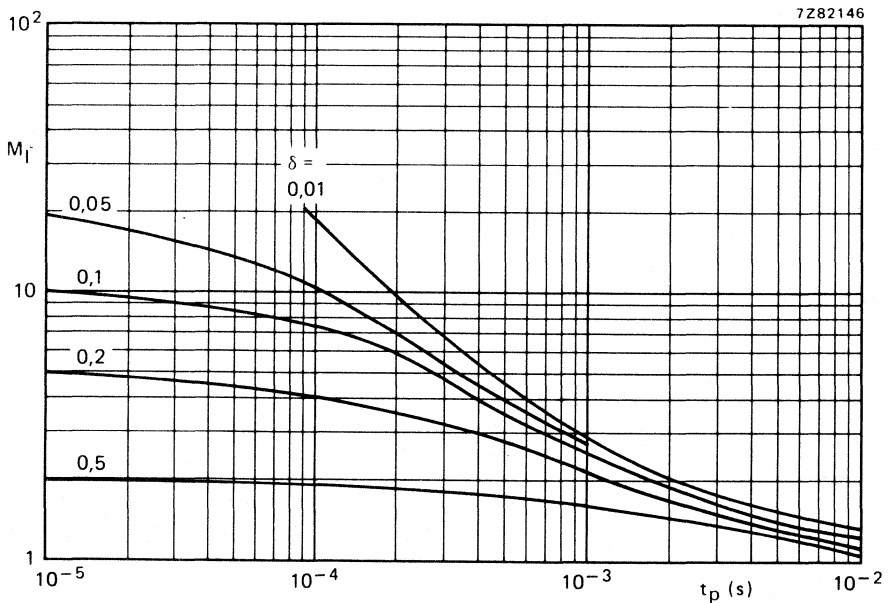


Fig. 7 S.B. current multiplying factor at the V_{CE0max} level for BD947.

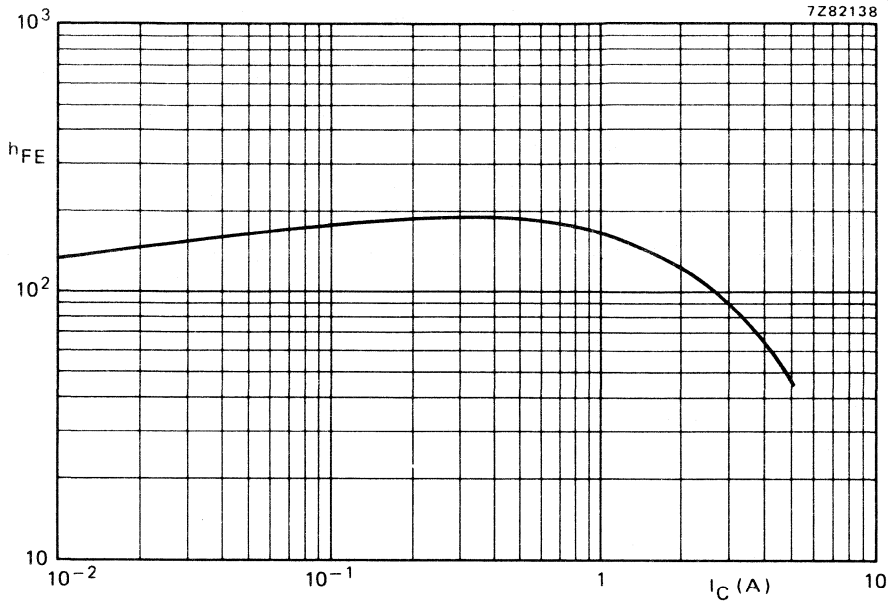


Fig. 8 Typical d.c. current gain at $V_{CE} = 1\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$.

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.

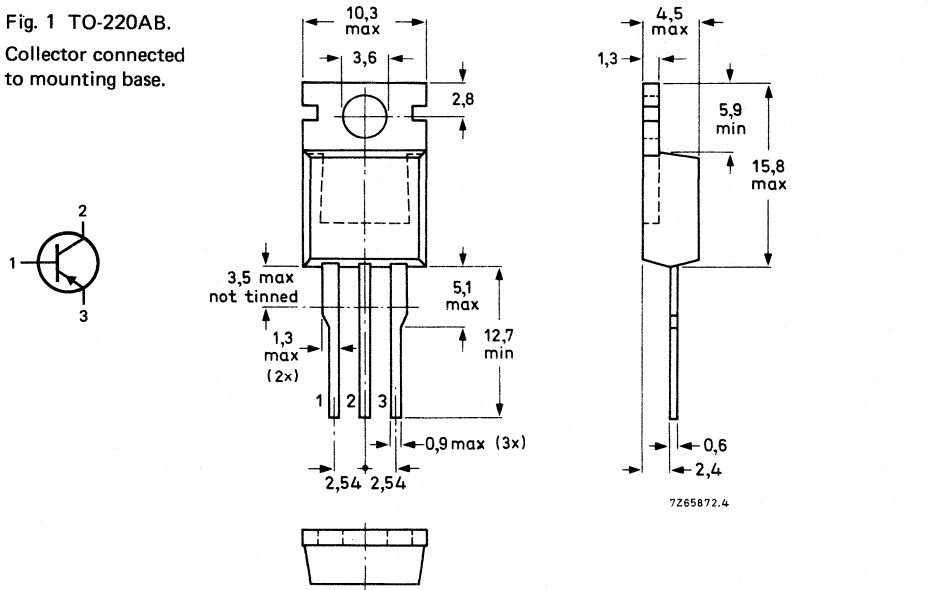
QUICK REFERENCE DATA

			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					
$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	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
Transition frequency at $f = 1\text{ MHz}$					
$-I_C = 250\text{ mA}; -V_{CE} = 1\text{ V}$	f_T	>		3	MHz

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)

			BD944	946	948
Collector-base voltage (open emitter)	$-V_{CB0}$	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	K/W
From junction to ambient (in free air)	$R_{th\ j-a}$	=		70	K/W

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CB0max}$	$-I_{CB0}$	<		0,1	mA
$I_E = 0; -V_{CB} = -V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CB0}$	<		3	mA
$I_B = 0; -V_{CE} = 15\text{ V; BD944}$ $-V_{CE} = 20\text{ V; BD946}$ $-V_{CE} = 25\text{ V; BD948}$	$-I_{CEO}$	<		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)

$-I_C = 10\text{ mA; } -V_{CE} = 5\text{ V}$	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; $t_p \leq 300\text{ }\mu\text{s}; \delta < 2\%$.
2. V_{BE} decreases by about 2,3 mV/K 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 $f = 1 \text{ MHz}$

$-I_C = 250 \text{ mA}; -V_{CE} = 1 \text{ V}$

$-V_{CEK} < 0,8 \text{ V}$

$f_T > 3 \text{ MHz}$

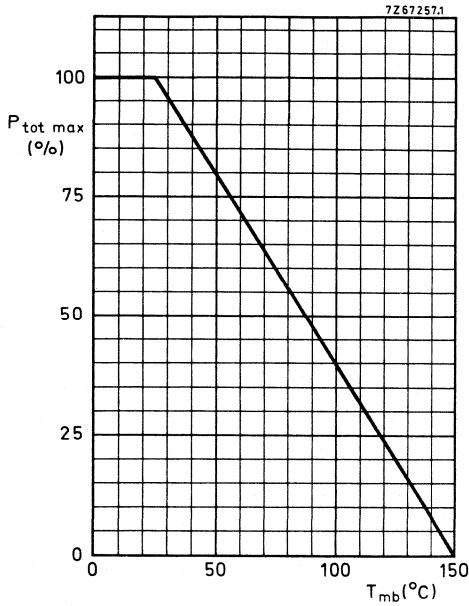


Fig. 2 Power derating curve.

* Measured under pulse conditions; $t_p \leq 300 \mu\text{s}; \delta < 2\%$.

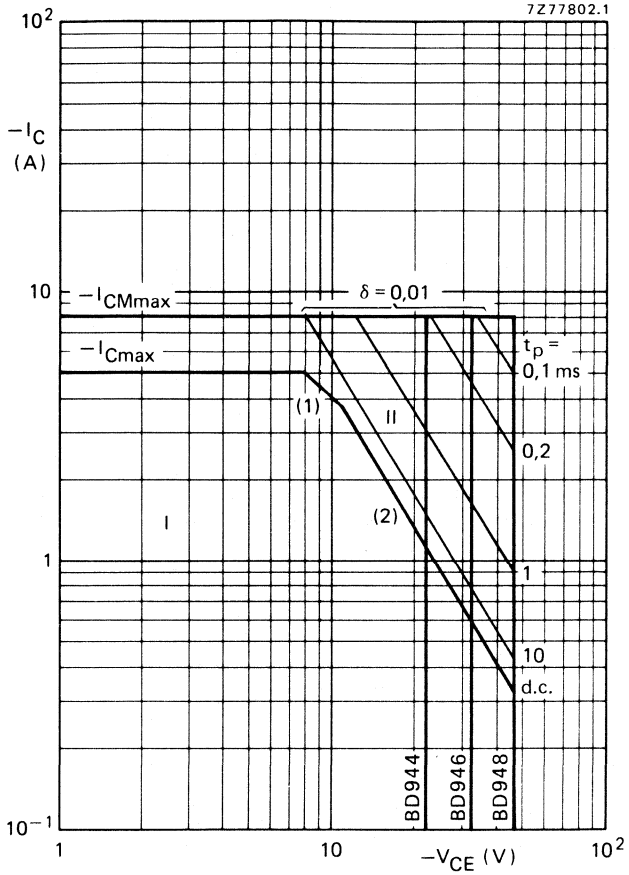


Fig. 3 Safe Operating Area, $T_{mb} = 25 \text{ }^\circ\text{C}$.

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

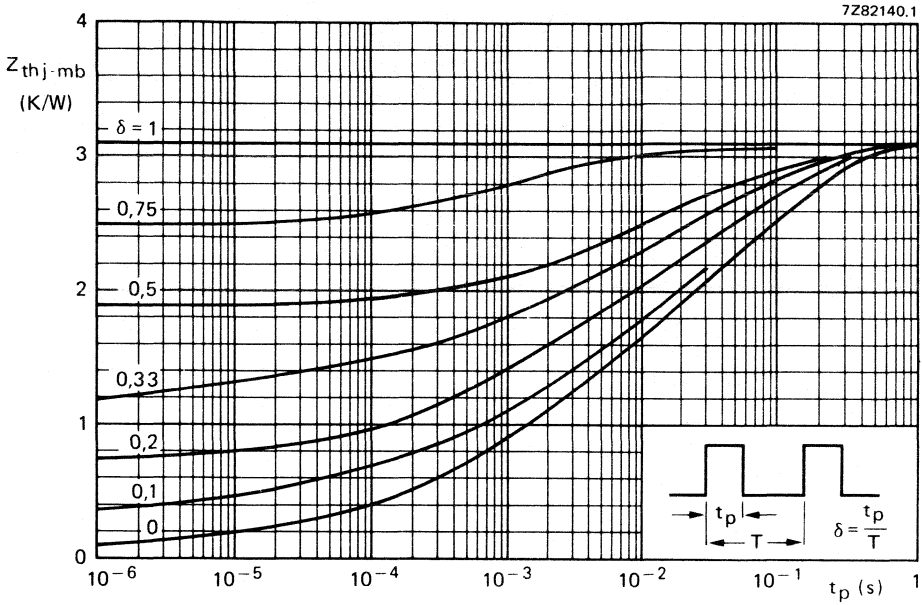


Fig. 4 Pulse power rating chart.

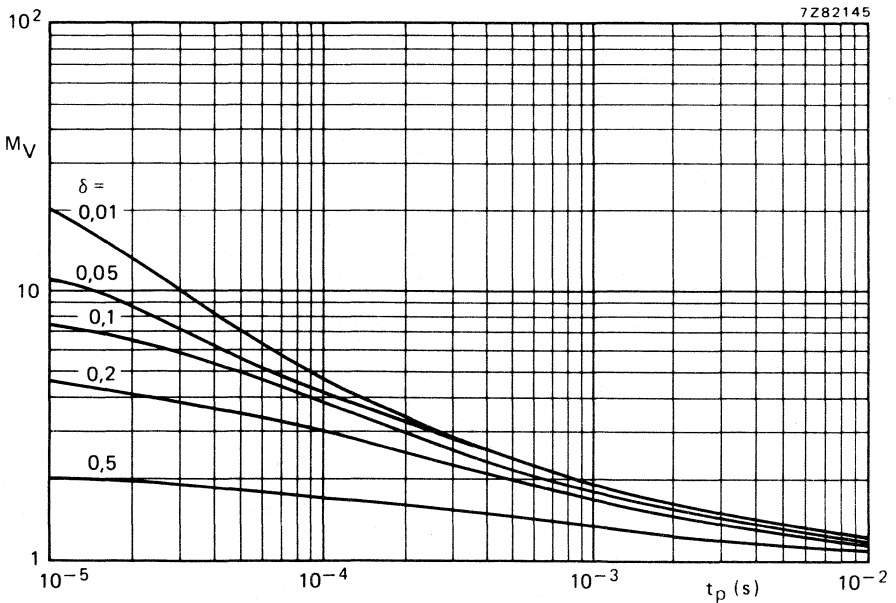


Fig. 5 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

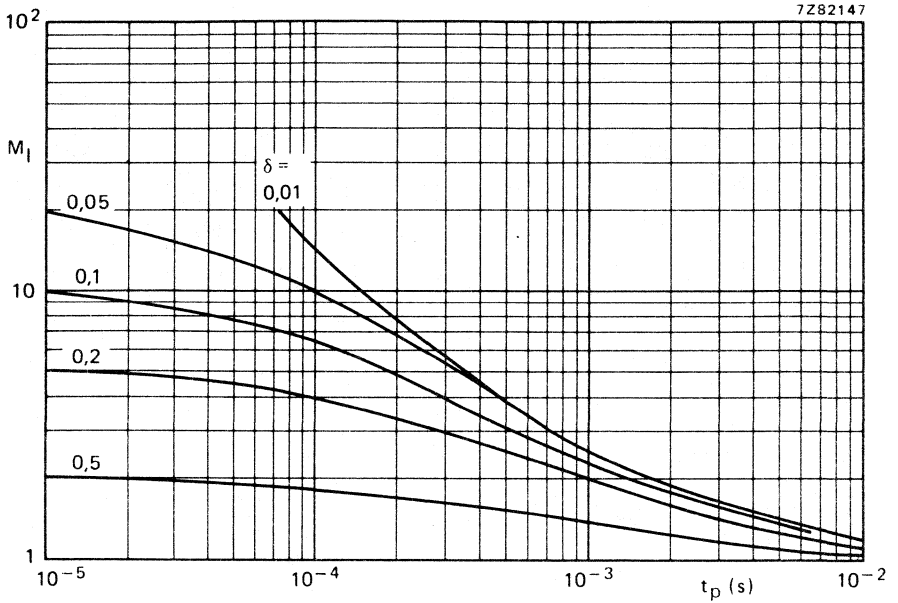


Fig. 6 S.B. current multiplying factor at the $-V_{CE0max}$ level for BD944/946.

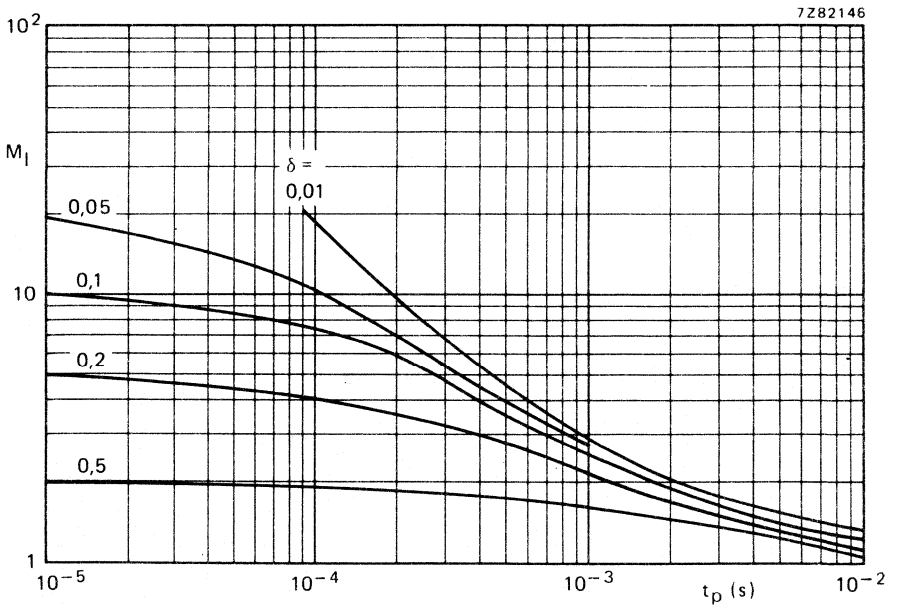


Fig. 7 S.B. current multiplying factor at the $-V_{CE0max}$ level for BD948.

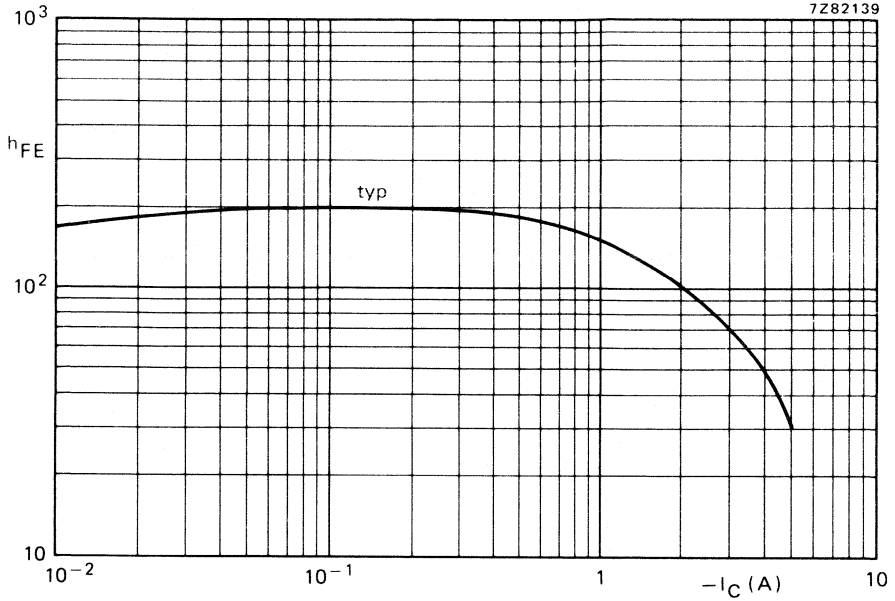


Fig. 8 Typical d.c. current gain at $-V_{CE} = 1$ V; $T_J = 25$ °C.

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.

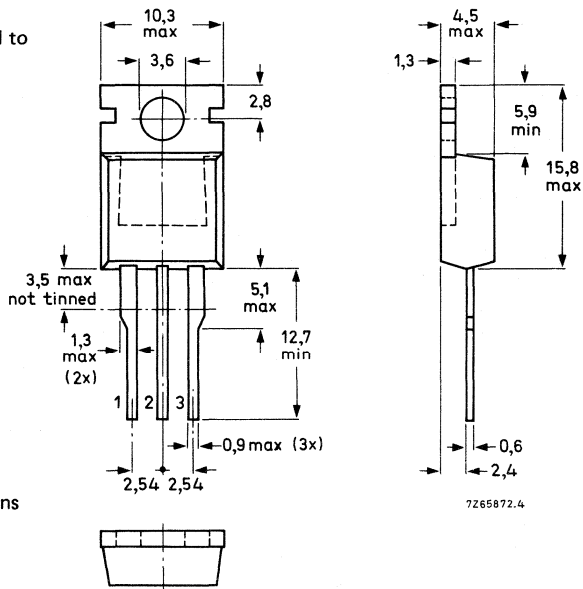
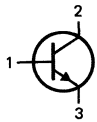
QUICK REFERENCE DATA

		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 $T_{mb} = 25\text{ }^\circ\text{C}$	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.

Dimensions in mm

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_{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		K/W
from junction to ambient (in free air)	$R_{th\ j-a} =$		70		K/W

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = V_{CB0\ max}$	$I_{CB0} <$		0,1		mA
$I_E = 0; V_{CB} = \frac{1}{2} V_{CB0\ max}; T_j = 150\text{ }^\circ\text{C}$	$I_{CB0} <$		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
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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
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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/K 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

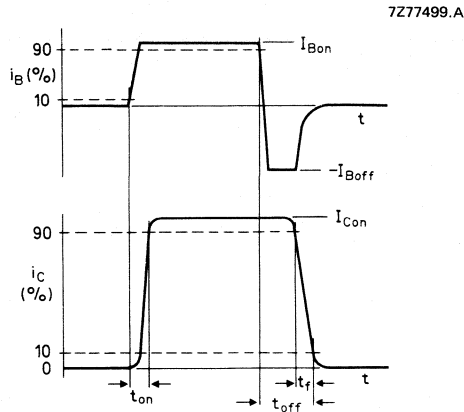
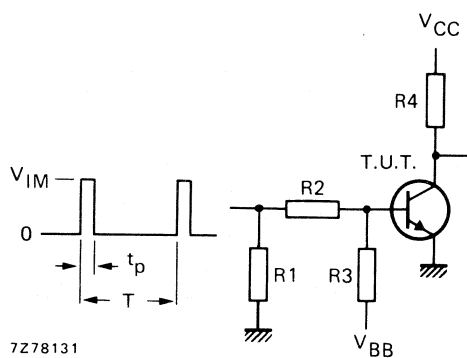


Fig. 2 Switching times waveforms.



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.

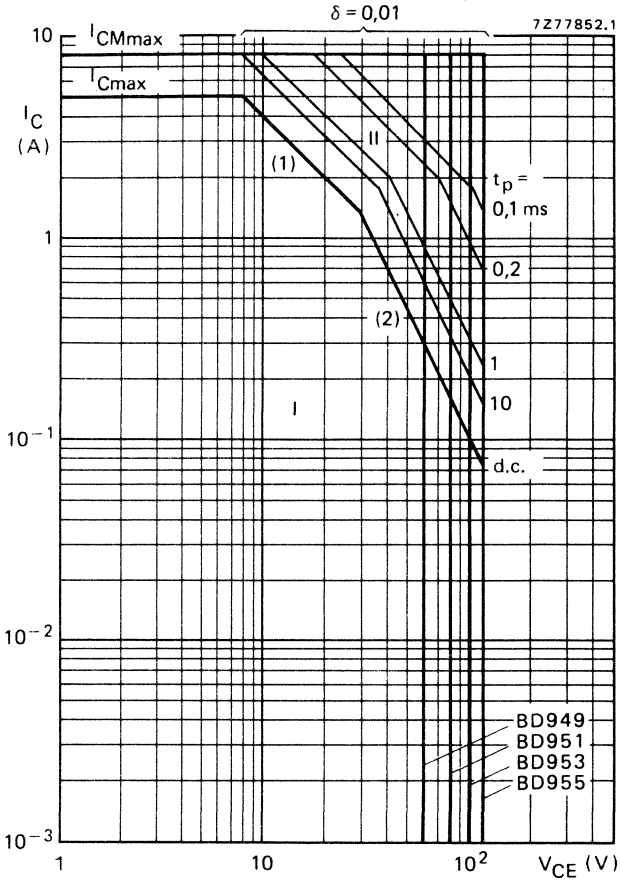


Fig. 4 Safe Operating Area; $T_{mb} \leq 25^\circ\text{C}$.

- 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 limit (independent of temperature).

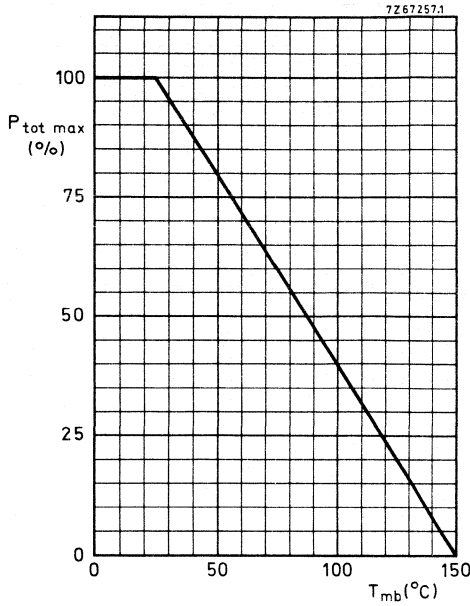


Fig. 5 Power derating curve.

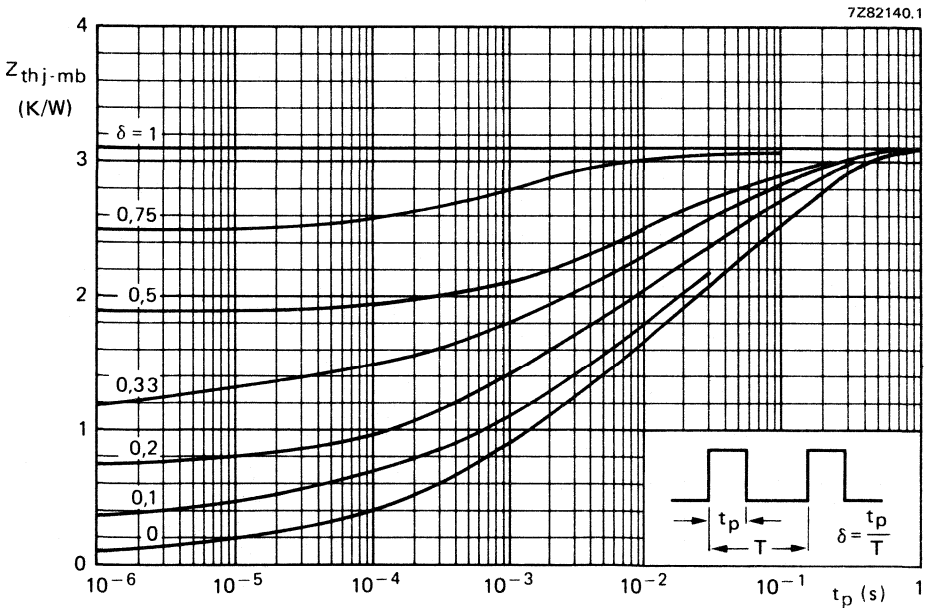


Fig. 6 Pulse power rating chart.

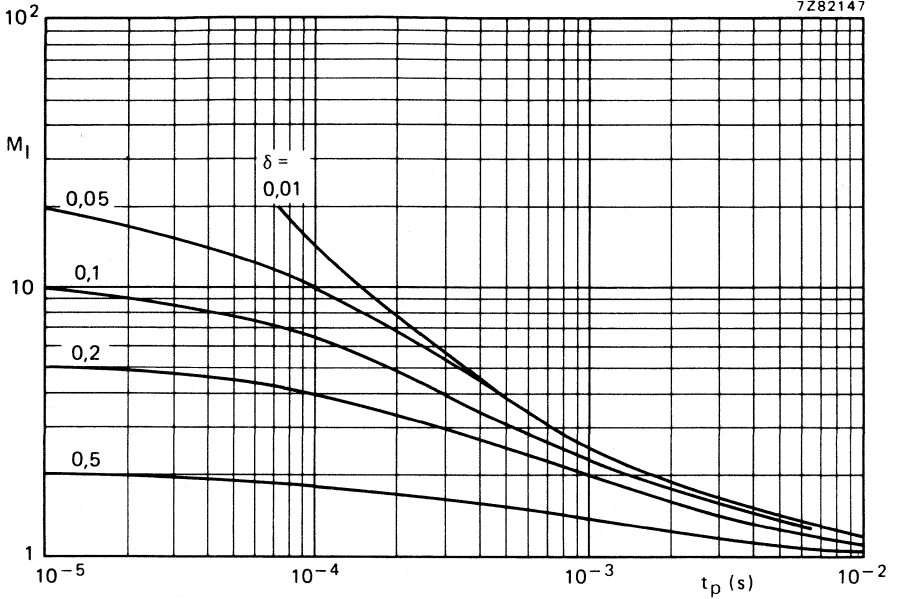


Fig. 7 S.B. current multiplying factor at the $V_{CE0 \max}$ level for BD949/951.

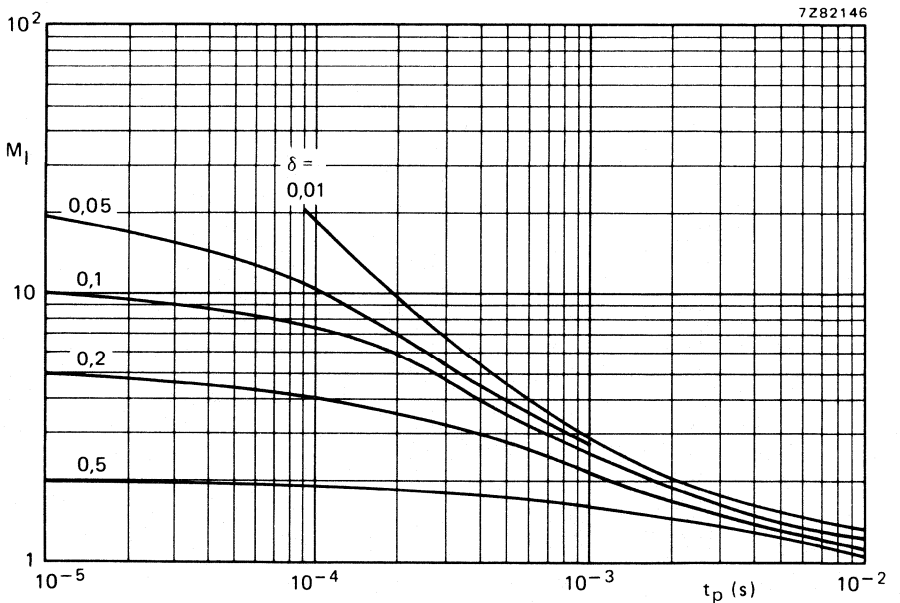


Fig. 8 S.B. current multiplying factor at the $V_{CE0 \max}$ level for BD953/955.

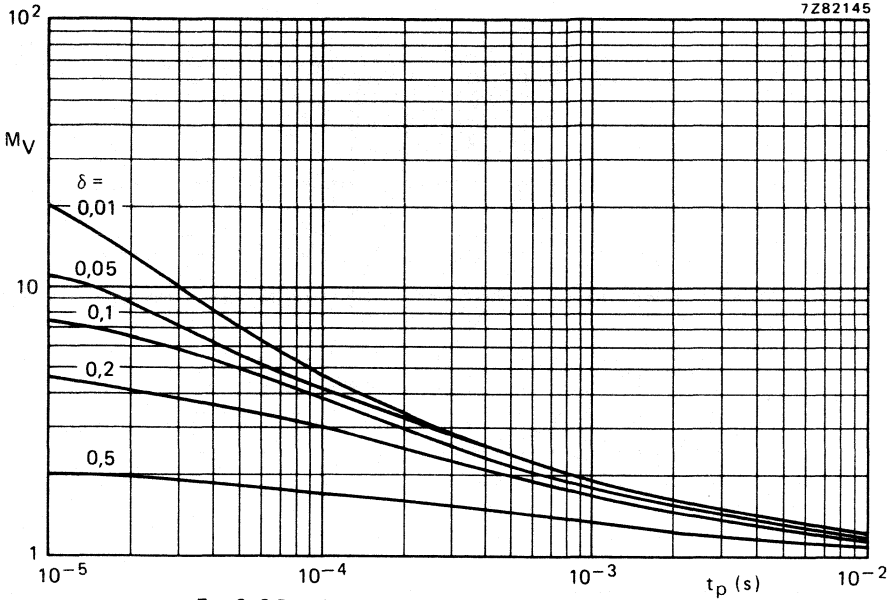


Fig. 9 S.B. voltage multiplying factor at the I_C max level.

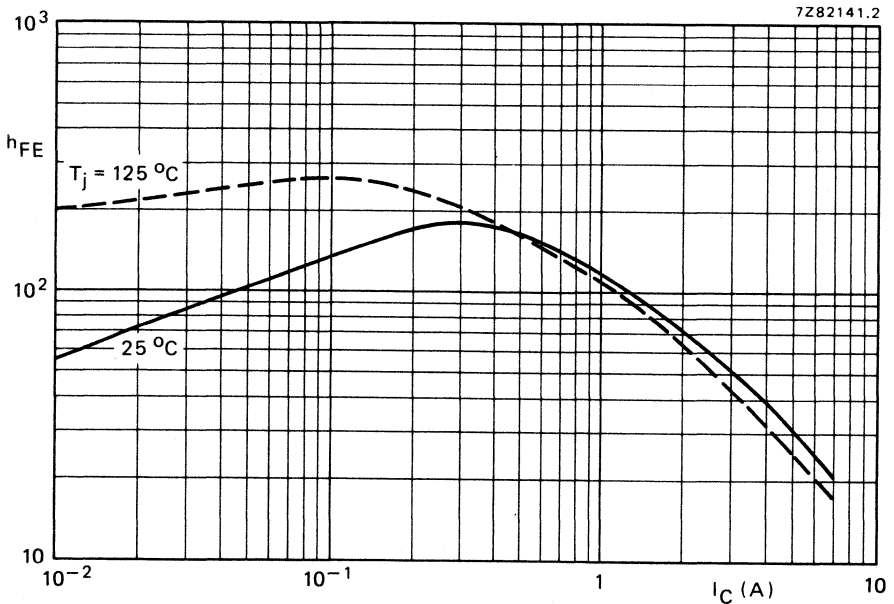


Fig. 10 Typical d.c. current gain at $V_{CE} = 4$ V.

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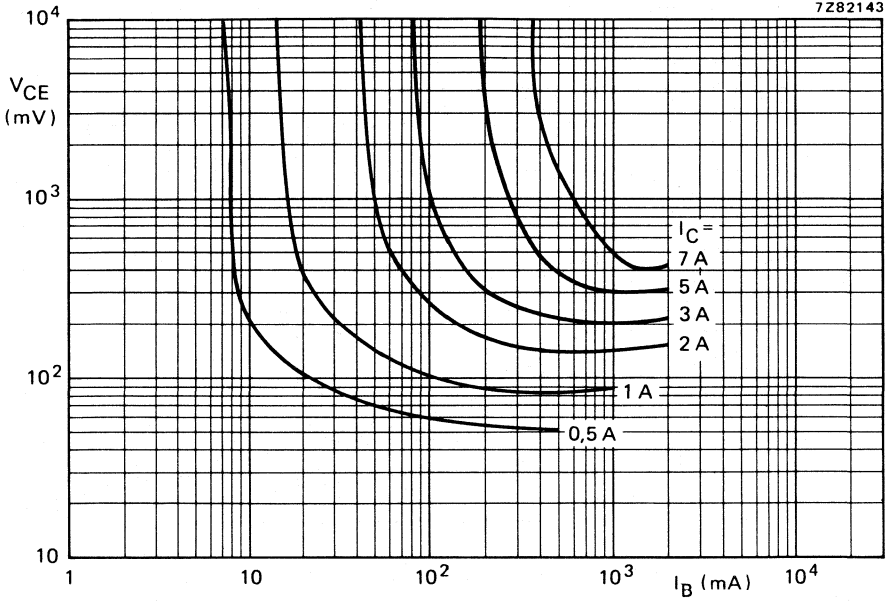


Fig. 11 Collector-emitter voltage as a function of base current.

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.

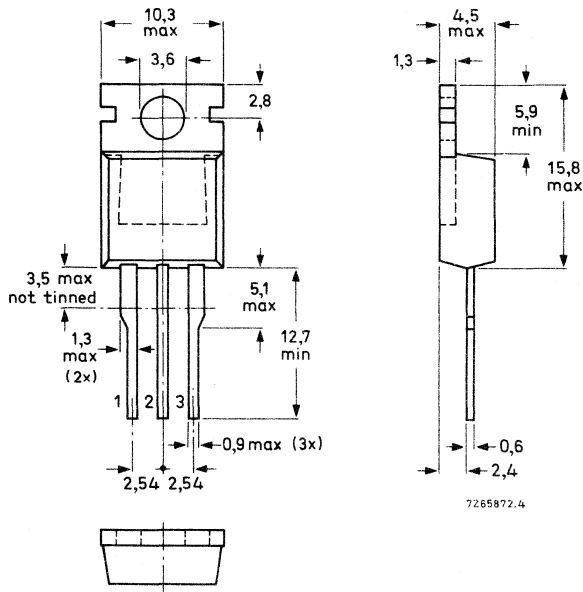
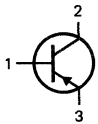
QUICK REFERENCE DATA

	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.)	$-I_C$ 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
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)

		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		K/W
from junction to ambient (in free air)	$R_{th\ j-a}$	=	70		K/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
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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
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Collector-emitter saturation voltage (note 1)

$-I_C = 2\text{ A}; -I_B = 0,2\text{ A}$	$-V_{CEsat}$	<	1		V
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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/K 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

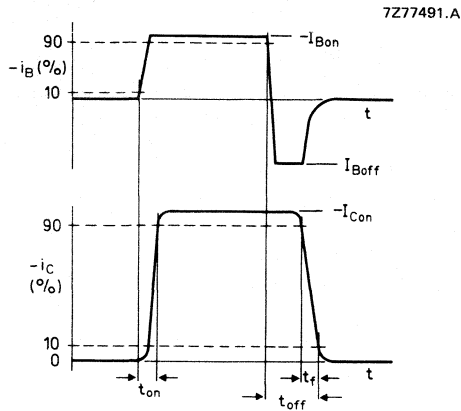
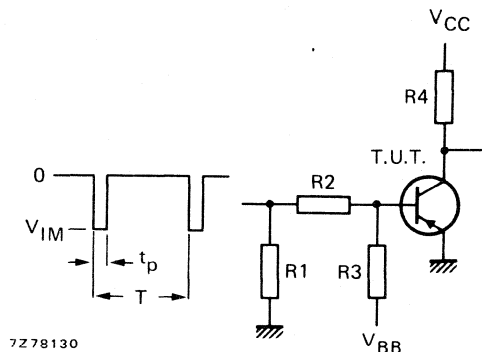


Fig. 2 Switching times waveforms.



$-V_{IM}$	=	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.

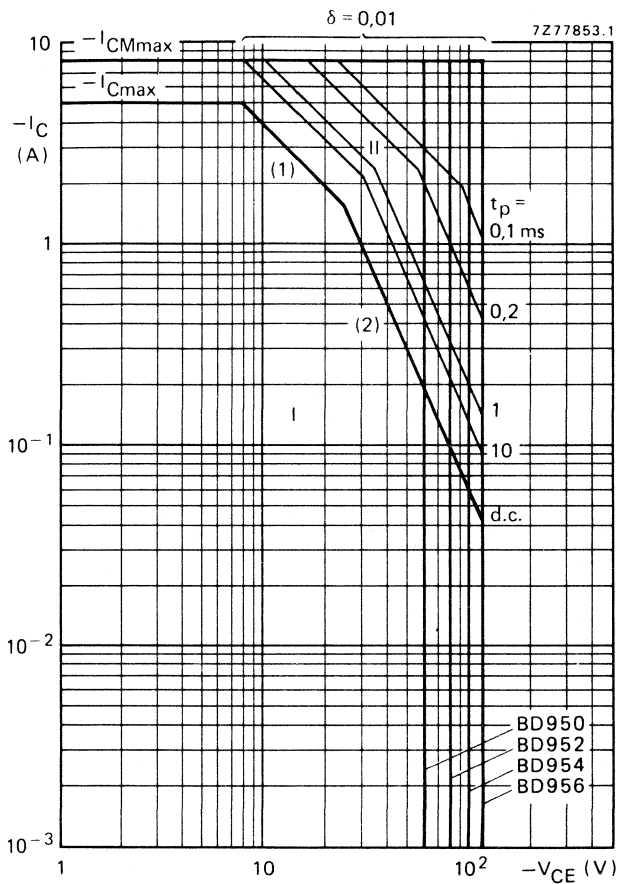


Fig. 4 Safe Operating Area; $T_{mb} \leq 25^\circ\text{C}$.

- 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).

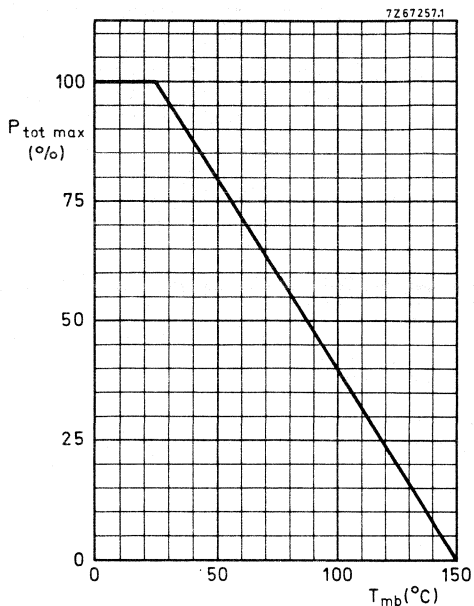


Fig. 5 Power derating curve.

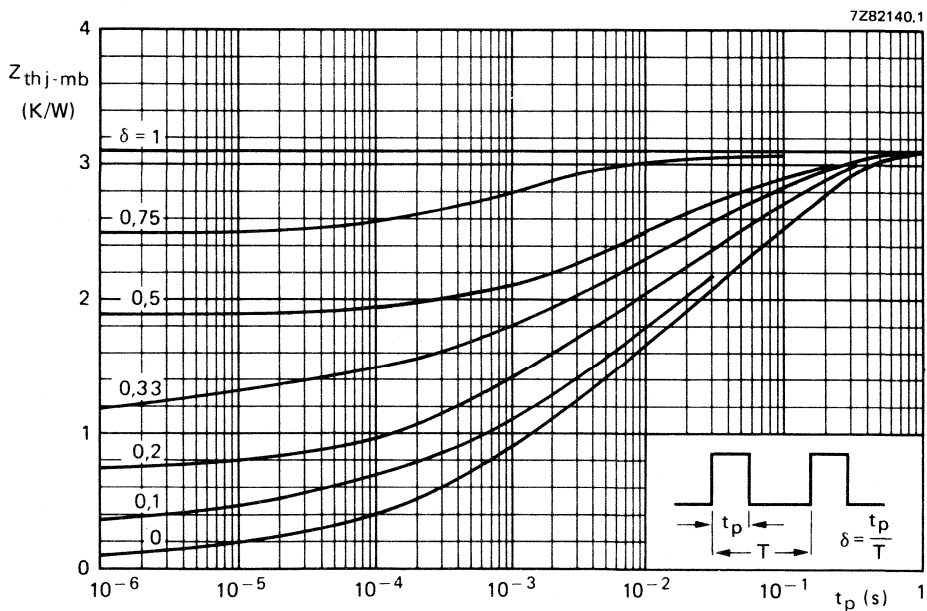


Fig. 6 Pulse power rating chart.

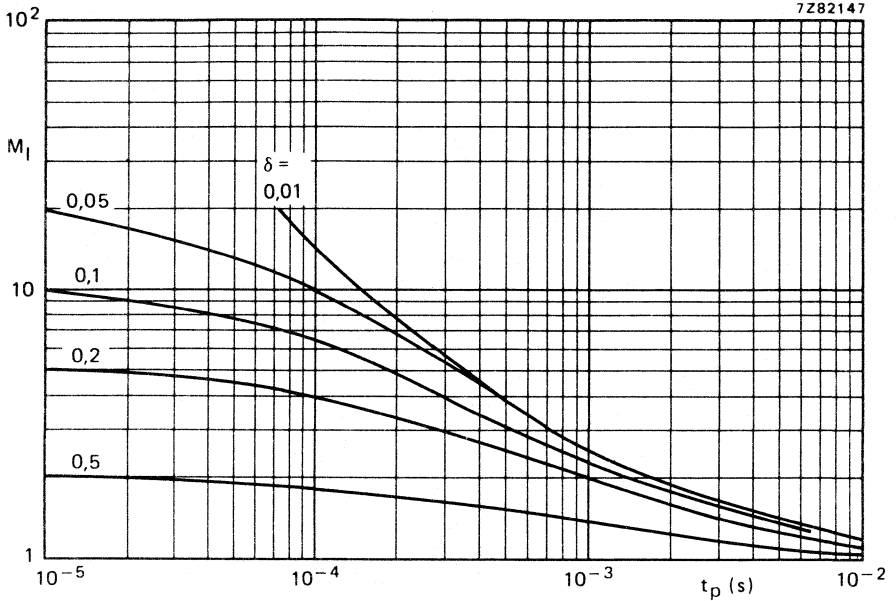


Fig. 7 S.B. current multiplying factor at the $-V_{CEO \max}$ level for BD950 and BD952.

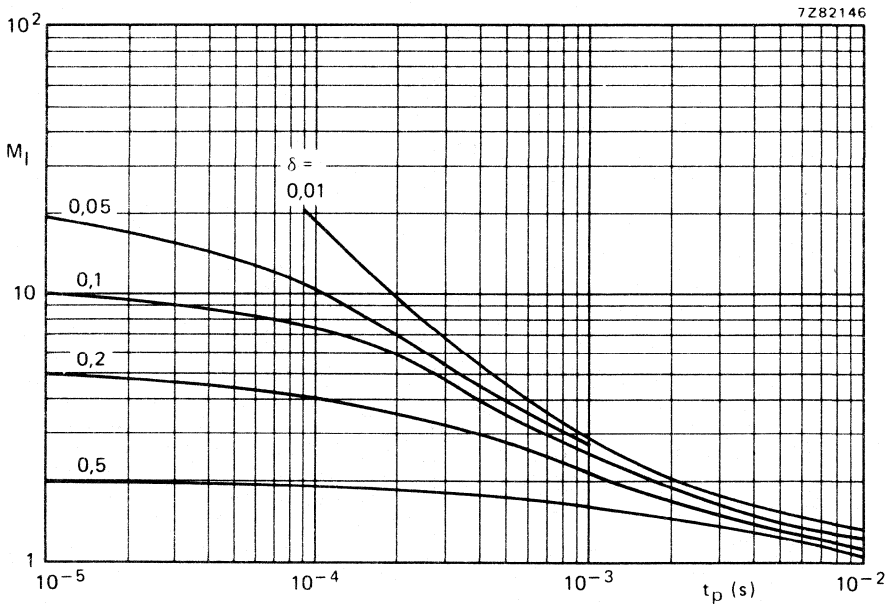


Fig. 8 S.B. current multiplying factor at the $-V_{CEO \max}$ level for BD954 and BD956.

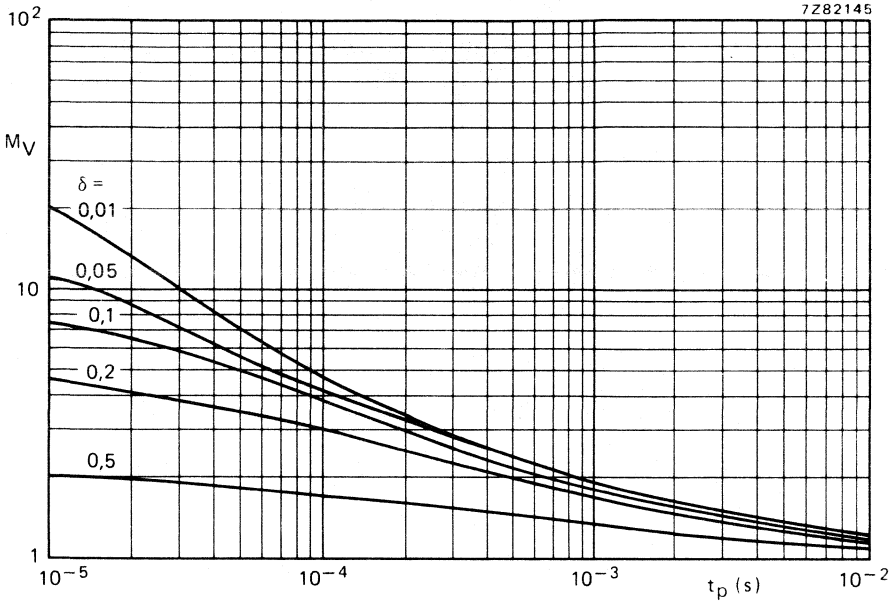


Fig. 9 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

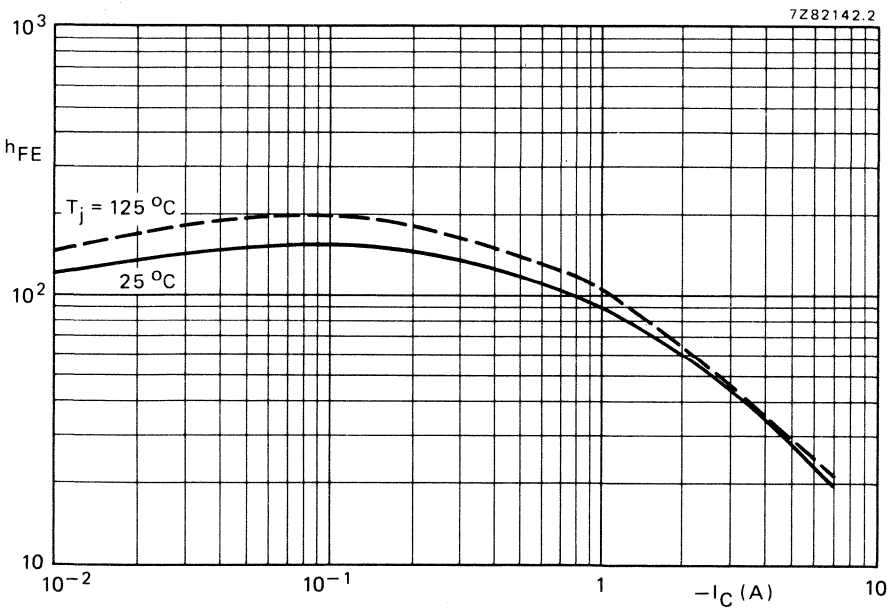


Fig. 10 Typical d.c. current gain at $-V_{CE} = 4$ V.

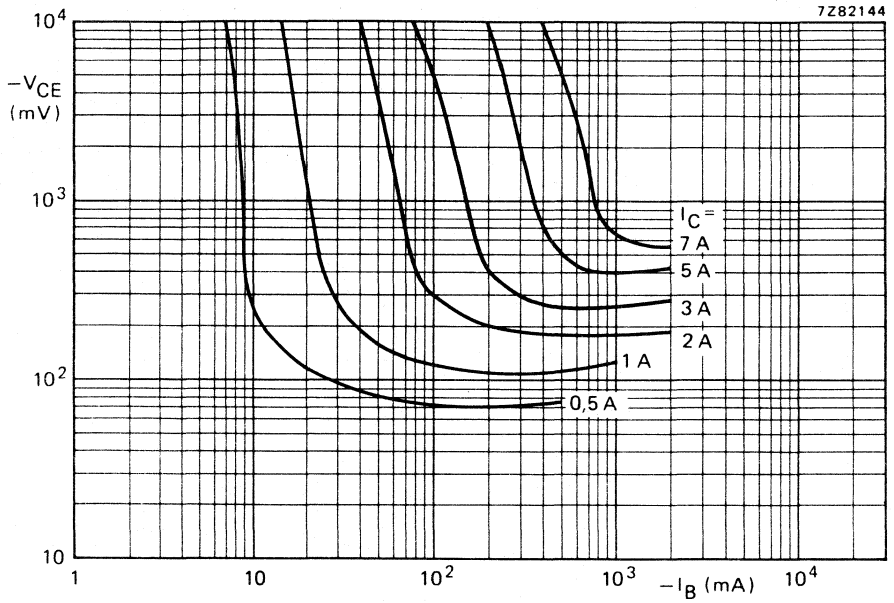


Fig. 11 Collector-emitter voltage as a function of base current.

SILICON DARLINGTON POWER TRANSISTOR

P-N-P silicon power transistor in monolithic Darlington circuit with integrated diode protection, capable of withstanding repetitive high peak power, even at increased ambient temperatures. Specially intended for inductive switching, e.g. motors and relays. N-P-N complement is BDT21.

QUICK REFERENCE DATA

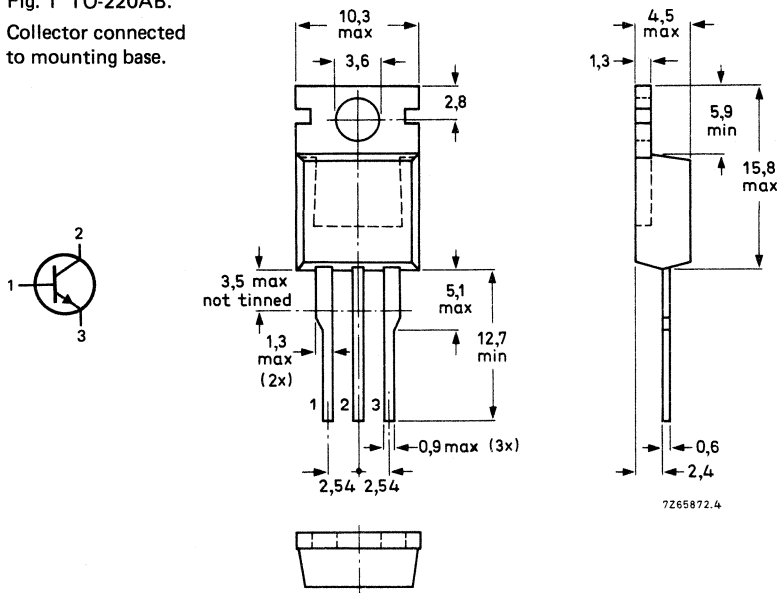
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	130 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	130 V
Collector current (d.c.)	$-I_C$ max.	8 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	62,5 W
Junction temperature	T_j max.	150 $^\circ\text{C}$
Turn-off breakdown energy with inductive load $T_{amb} = 100\text{ }^\circ\text{C}$; $L = 0,6\text{ H}$; $R_S = 100\ \Omega$	$E(BR)$ >	100 mJ

MECHANICAL DATA

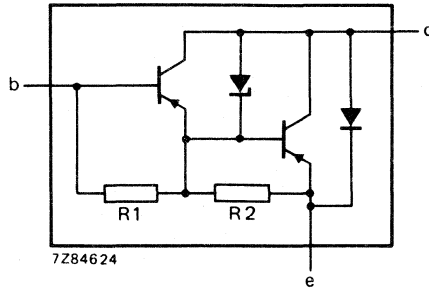
Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.



R₁ typ. 12 kΩ
R₂ typ. 150 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

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

Collector-base voltage (open emitter)	-V _{CB0} max.	130 V
Collector-emitter voltage (open base)	-V _{CEO} max.	130 V
Emitter-base voltage (open collector)	-V _{EBO} max.	6 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 _{thj-mb} =	2 K/W
From junction to ambient	R _{thj-a} =	70 K/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-emitter breakdown voltage

$$I_B = 0; I_C = 10\text{ mA}$$

$$V_{(BR)CEO} > 130\text{ V}$$

Collector cut-off current

$$I_E = 0; -V_{CB} = 100\text{ V}$$

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

$$I_E = 0; -V_{CB} = 60\text{ V}; T_j = 150\text{ }^\circ\text{C}$$

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

$$I_B = 0; -V_{CE} = 60\text{ V}$$

$$-I_{CEO} < 50\text{ }\mu\text{A}$$

Emitter cut-off current

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

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

D.C. current gain (note 1)

$$-I_C = 50\text{ mA}; -V_{CE} = 3\text{ V}$$

$$h_{FE} > 100$$

$$-I_C = 250\text{ mA}; -V_{CE} = 3\text{ V}$$

$$h_{FE} \quad 500\text{ to }3000$$

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

$$h_{FE} > 500$$

$$-I_C = 8\text{ A}; -V_{CE} = 3\text{ V}$$

$$h_{FE} \text{ typ. } 150$$

Base-emitter voltage (notes 1 and 2)

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

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

Collector-emitter saturation voltage (note 1)

$$-I_C = 1\text{ A}; -I_B = 2\text{ mA}$$

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

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

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

Forward voltage collector-emitter diode

$$I_F = 0,1\text{ A}$$

$$V_F < 0,9\text{ V}$$

$$I_F = 8\text{ A}$$

$$V_F \text{ typ. } 2,2\text{ V}$$

Turn-off breakdown energy with inductive load (Fig. 3)

$$E_{(BR)} > 100\text{ mJ}$$

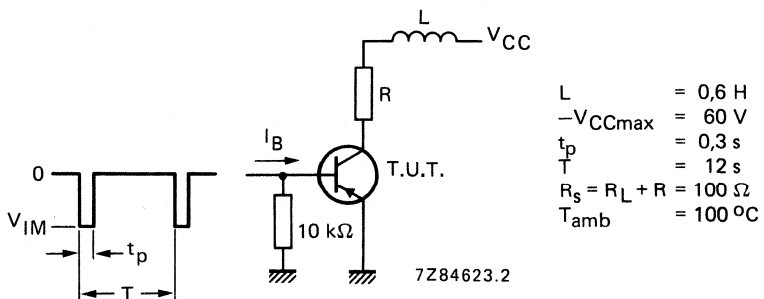


Fig. 3 Test circuit for turn-off breakdown energy.

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

2. $-V_{BE}$ decreases by about $3,6\text{ mV/K}$ with increasing temperature.

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. $0,2 \mu\text{s}$
 t_{off} typ. $1,5 \mu\text{s}$

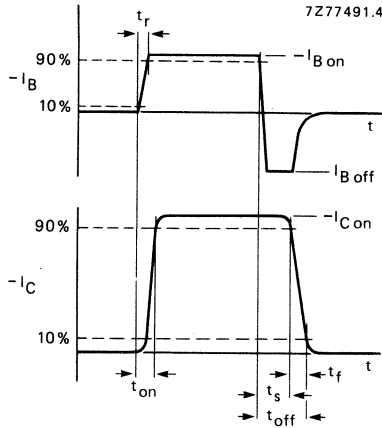


Fig. 4 Switching times waveforms.

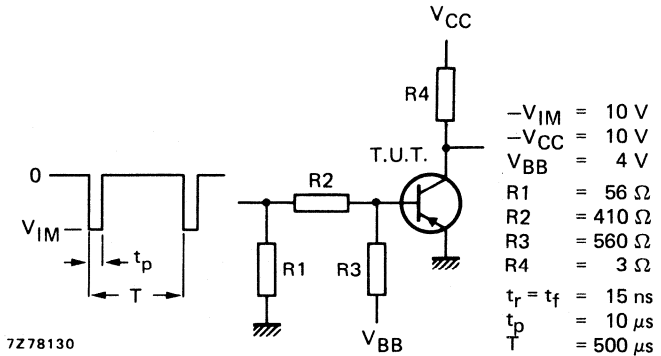


Fig. 5 Switching times test circuit.

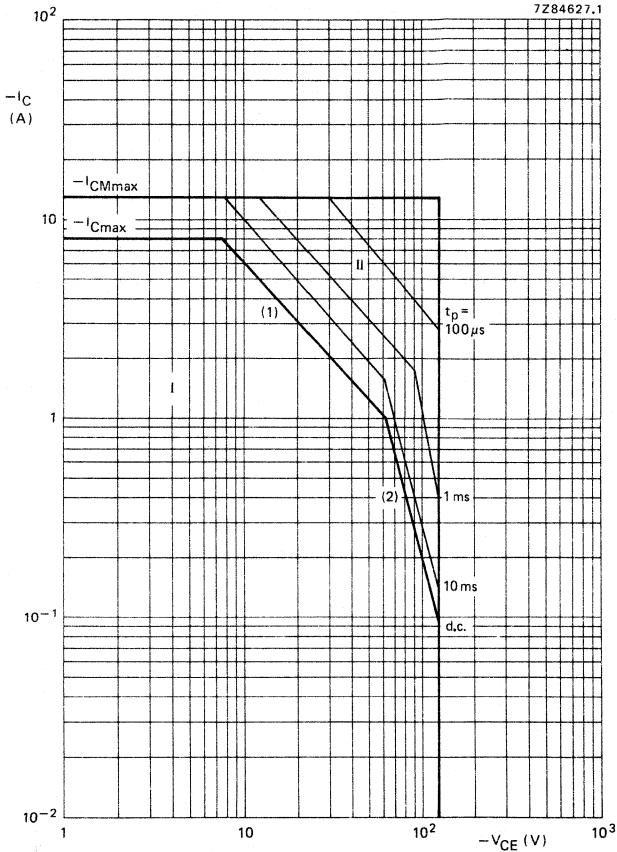


Fig. 6 Safe Operating Area, $T_{mb} \leq 25^\circ\text{C}$

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

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

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

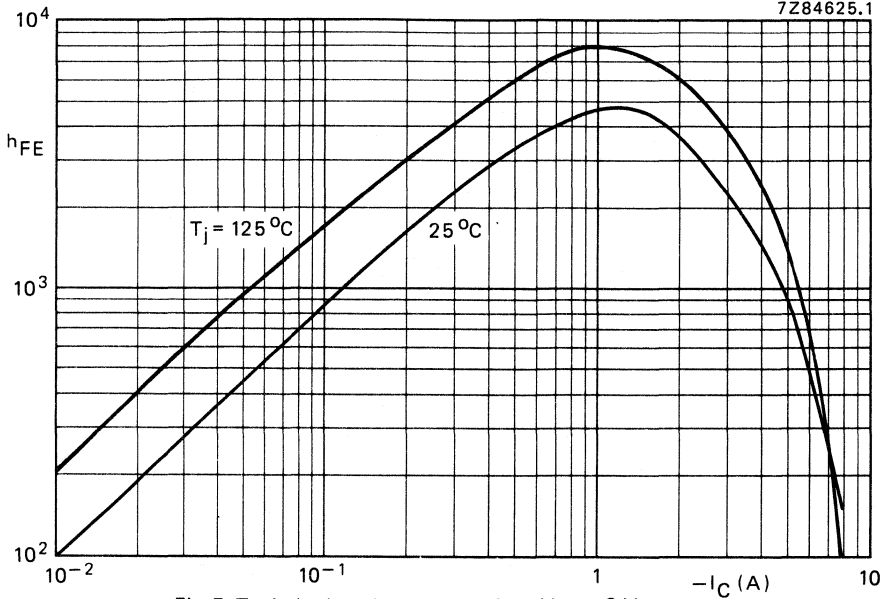


Fig. 7 Typical values d.c. current gain. $-V_{CE} = 3$ V.

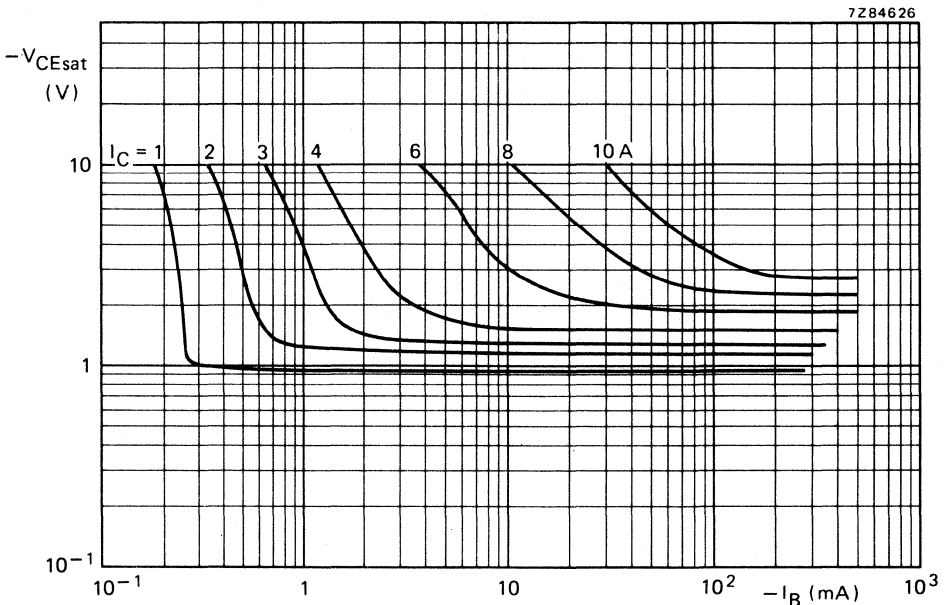


Fig. 8 Typical values collector-emitter saturation voltage, $T_j = 25^\circ\text{C}$.

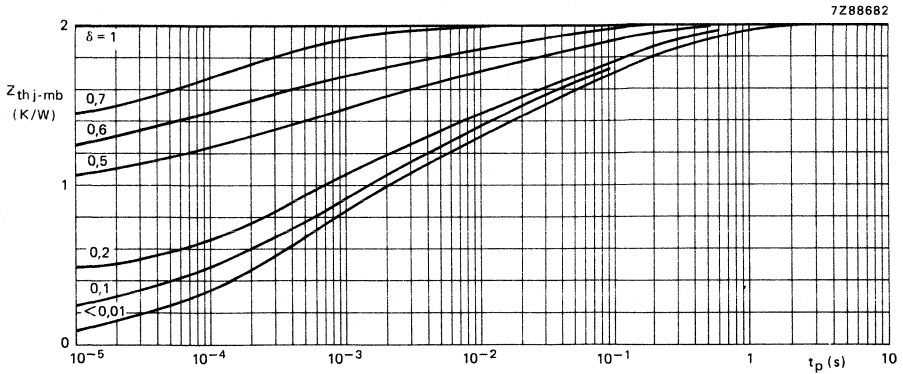


Fig. 9 Pulse power rating chart.

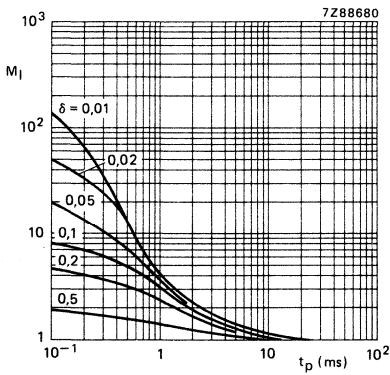


Fig. 10 S.B. current multiplying factor at $V_{CE0} = 120$ V.

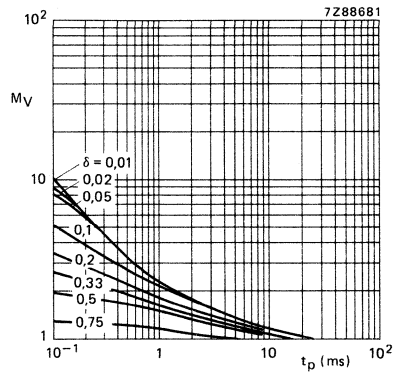


Fig. 11 S.B. voltage multiplying factor at the I_{Cmax} level.

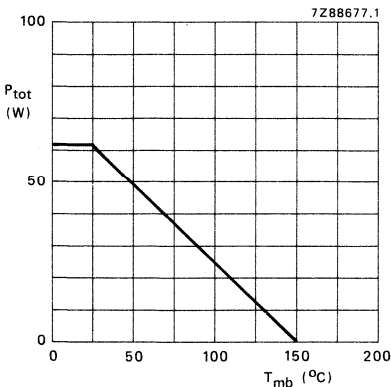


Fig. 12 Power derating curve.

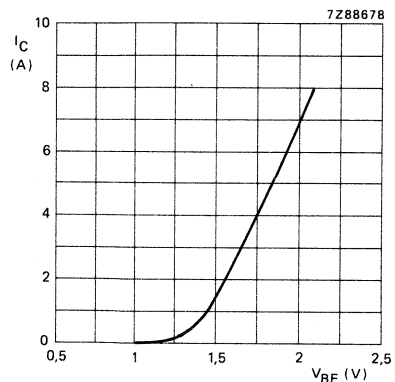


Fig. 13 Typical collector current as a function of base emitter voltage. $V_{CE} = 3$ V; $T_{amb} = 25$ °C.

SILICON DARLINGTON POWER TRANSISTOR

N-P-N silicon power transistor in monolithic Darlington circuit with integrated protection diode, capable of withstanding repetitive high peak power, even at increased ambient temperatures. Specially intended for inductive switching, e.g. motors and relays. P-N-P complement is BDT20.

QUICK REFERENCE DATA

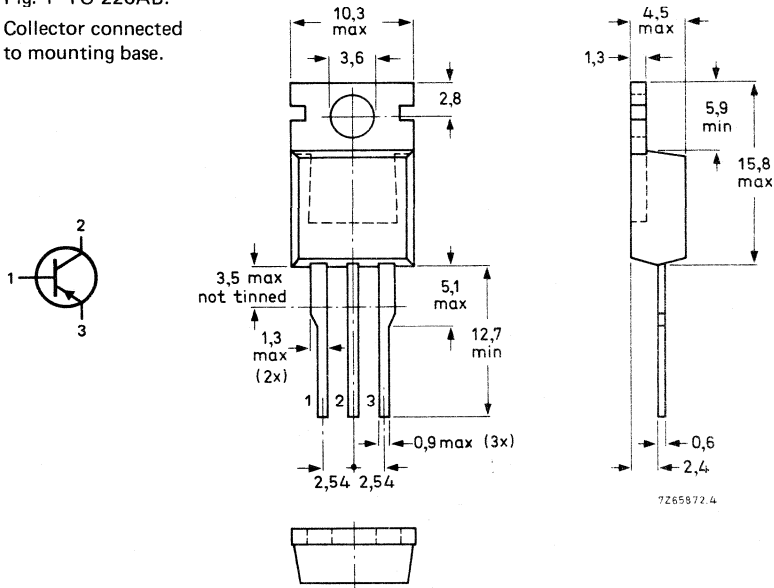
Collector-base voltage (open emitter)	V_{CBO}	max.	130 V
Collector-emitter voltage (open base)	V_{CEO}	max.	130 V
Collector current (d.c.)	I_C	max.	8 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	62,5 W
Junction temperature	T_j	max.	150 $^\circ\text{C}$
Turn-off breakdown energy with inductive load $T_{amb} = 100\text{ }^\circ\text{C}$; $L = 0,6\text{ H}$; $R_S = 100\text{ }\Omega$	$E_{(BR)}$	>	100 mJ

MECHANICAL DATA

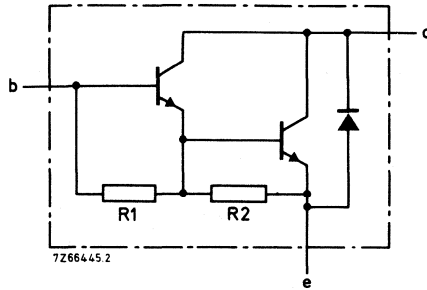
Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.



R₁ typ. 4 kΩ
 R₂ typ. 100 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

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

Collector-base voltage (open emitter)	V _{CB0}	max.	130 V
Collector-emitter voltage (open base)	V _{CEO}	max.	130 V
Emitter-base voltage (open collector)	V _{EBO}	max.	6 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 K/W
From junction to ambient	R _{th j-a}	=	70 K/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-emitter breakdown voltage

$$I_B = 0; I_C = 10\text{ mA}$$

$$V_{(BR)CEO} > 130\text{ V}$$

Collector cut-off current

$$I_E = 0; V_{CB} = 100\text{ V}$$

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

$$I_E = 0; V_{CB} = 60\text{ V}; T_j = 150\text{ }^\circ\text{C}$$

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

$$I_B = 0; V_{CE} = 60\text{ V}$$

$$I_{CEO} < 50\text{ }\mu\text{A}$$

Emitter cut-off current

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

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

D.C. current gain (note 1)

$$I_C = 50\text{ mA}; V_{CE} = 3\text{ V}$$

$$h_{FE} > 100$$

$$I_C = 250\text{ mA}; V_{CE} = 3\text{ V}$$

$$h_{FE} 500\text{ to }3000$$

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

$$h_{FE} > 500$$

$$I_C = 8\text{ A}; V_{CE} = 3\text{ V}$$

$$h_{FE} \text{ typ. } 1800$$

Base-emitter voltage (notes 1 and 2)

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

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

Collector-emitter saturation voltage (note 1)

$$I_C = 1\text{ A}; I_B = 2\text{ mA}$$

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

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

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

Forward voltage collector-emitter diode

$$I_F = 0,1\text{ A}$$

$$V_F < 0,9\text{ V}$$

$$I_F = 8\text{ A}$$

$$V_F \text{ typ. } 1,2\text{ V}$$

Turn-off breakdown energy with inductive load (Fig. 3)

$$E_{(BR)} > 100\text{ mJ}$$

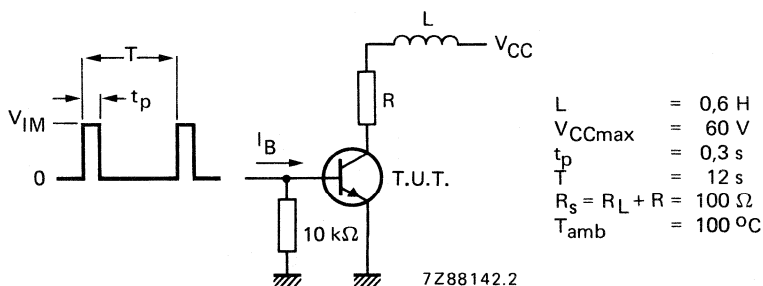


Fig. 3 Test circuit for turn-off breakdown energy.

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

2. V_{BE} decreases by about $3,6\text{ mV/K}$ with increasing temperature.

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. $1 \mu\text{s}$
 t_{off} typ. $5 \mu\text{s}$

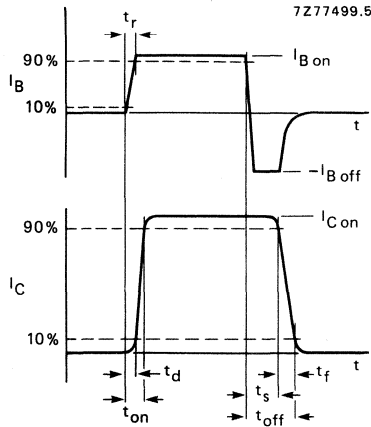
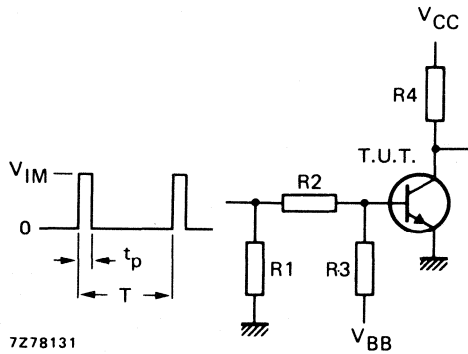


Fig. 4 Switching times waveforms.



- $V_{IM} = 10 \text{ V}$
- $V_{CC} = 10 \text{ V}$
- $-V_{BB} = 4 \text{ V}$
- $R1 = 56 \Omega$
- $R2 = 410 \Omega$
- $R3 = 560 \Omega$
- $R4 = 3 \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 10 \mu\text{s}$
- $T = 500 \mu\text{s}$

Fig. 5 Switching times test circuit.

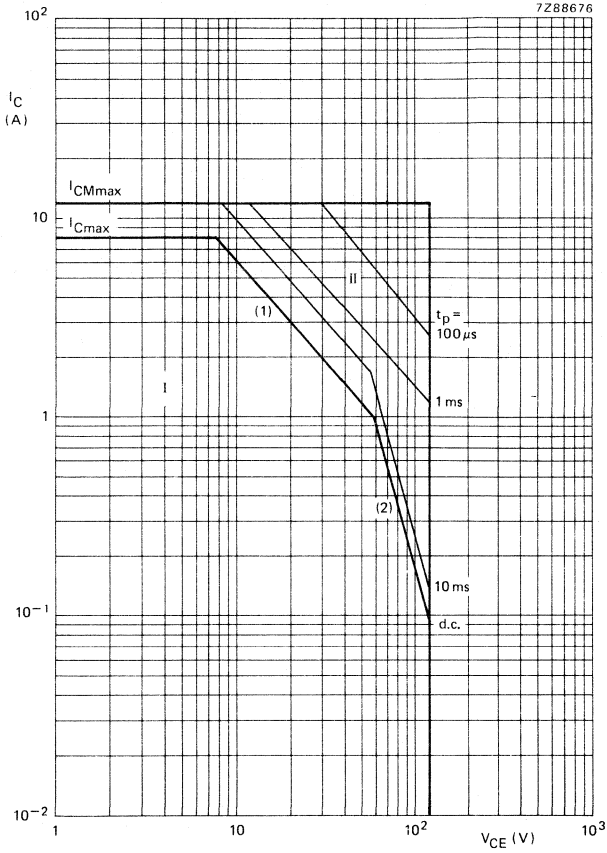


Fig. 6 Safe Operating Area, $T_{mb} \leq 25^\circ C$.

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).

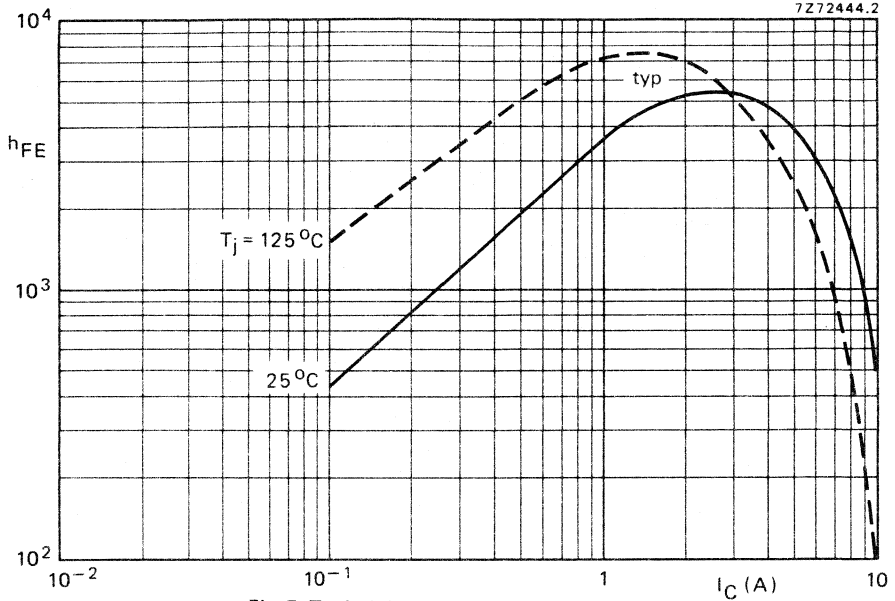


Fig. 7 Typical d.c. current gain. $V_{CE} = 3$ V.

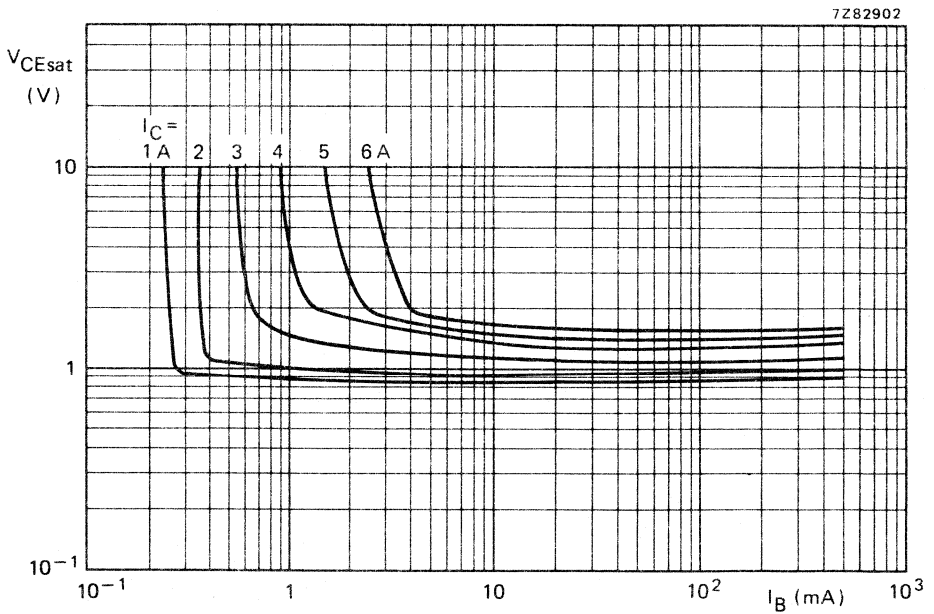


Fig. 8 Typical values collector-emitter saturation voltage. $T_j = 25^\circ\text{C}$.

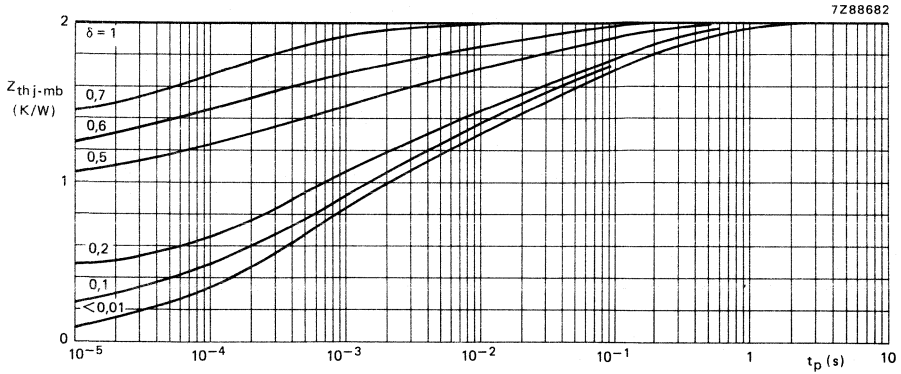


Fig. 9 Pulse power rating chart.

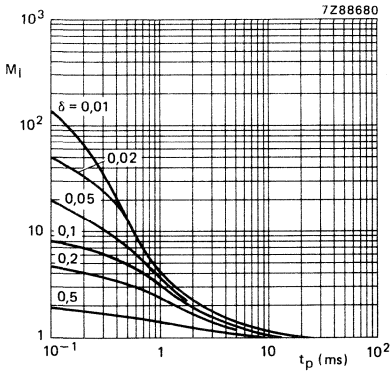


Fig. 10 SB current multiplying factor at $V_{CE0} = 120$ V.

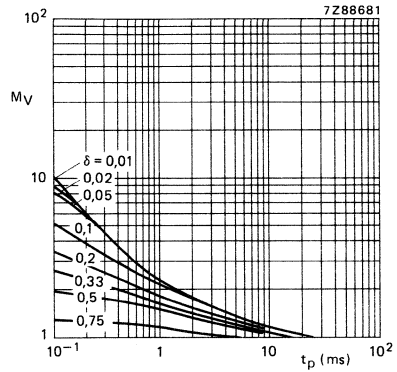


Fig. 11 SB voltage multiplying factor at the $I_{C\max}$ level.

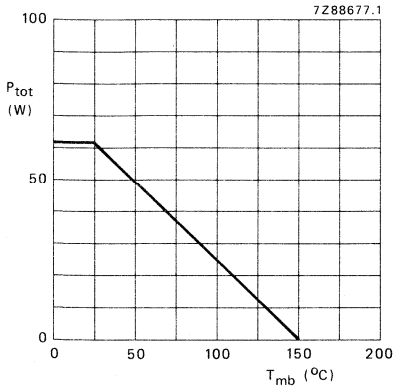


Fig. 12 Power derating curve.

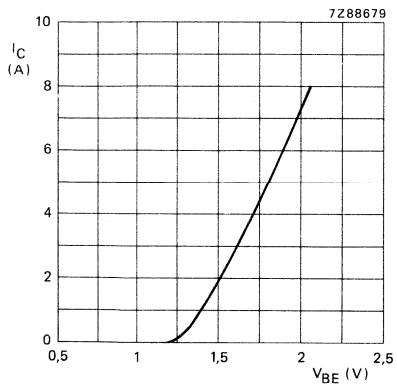


Fig. 13 Typical collector current as a function of base emitter voltage at $V_{CE} = 3$ V; $T_{amb} = 25$ °C.

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 BDT30; 30A; 30B; and BDT30C.

QUICK REFERENCE DATA

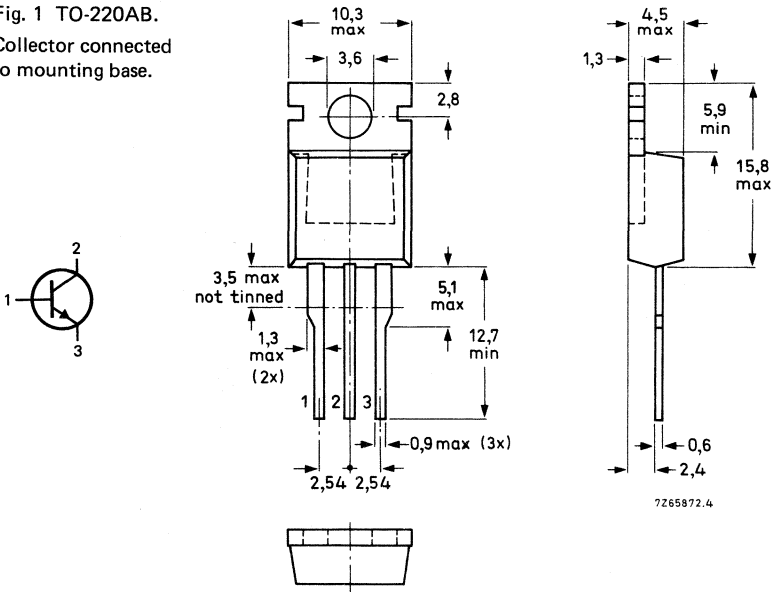
		BDT29	A	B	C	
Collector-base voltage	V_{CBO}	max. 40	60	80	100	V
Collector-emitter voltage	V_{CEO}	max. 40	60	80	100	V
Collector current (peak value)	I_{CM}	max.	3			A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	30			W
Junction temperature	T_j	max.	150			$^{\circ}\text{C}$
D.C. current gain			40			
$I_C = 200\text{ mA}; V_{CE} = 4\text{ V}$	h_{FE}	>	15 to 75			
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}					
Transition frequency at $f = 1\text{ MHz}$			3			MHz
$I_C = 200\text{ mA}; V_{CE} = 10\text{ V}$	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)

		BDT29	A	B	C		
Collector-base voltage (open emitter)	V_{CBO}	max.	40	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
Collector current (d.c.)	I_C	max.	1				A
Collector current (peak value)	I_{CM}	max.	3				A
Base current (d.c.)	I_B	max.	0,4				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			K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70			K/W

CHARACTERISTICS

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

		BDT29; A	BDT29B; C				
Collector cut-off current							
$I_B = 0; V_{CE} = 30\text{ V}$	I_{CEO}	<	0,3	mA			
$I_B = 0; V_{CE} = 60\text{ V}$	I_{CEO}	<	—	mA			
$V_{BE} = 0; V_{CE} = V_{CEOmax}$	I_{CES}	<	0,2	mA			
Emitter cut-off current							
$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<	1	mA			
D.C. current gain*							
$I_C = 200\text{ mA}; V_{CE} = 4\text{ V}$	h_{FE}	>	40				
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}		15 to 75				
Base-emitter voltage**							
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	V_{BE}	<	1,3	V			
Collector-emitter saturation voltage*							
$I_C = 1\text{ A}; I_B = 0,125\text{ A}$	V_{CEsat}	<	0,7	V			
Collector-emitter breakdown voltage*							
$I_B = 0; I_C = 30\text{ mA}$	$V_{(BR)CEO}$	>	40	60	80	100	V
Small-signal current gain							
$I_C = 0,2\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} $	>	20				
Turn off breakdown energy							
$L = 20\text{ mH}; I_{CC} = 1,8\text{ A}$	$E_{(BR)}$	>	32				mJ

* Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}; \delta < 2\%$.

** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

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

$I_C = 0,2 \text{ A}; V_{CE} = 10 \text{ V}$

$f_T > 3 \text{ MHz}$

Switching times

(between 10% and 90% levels)

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

Turn-on time

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

Turn-off time

$t_{off} \text{ typ. } 1 \mu\text{s}$

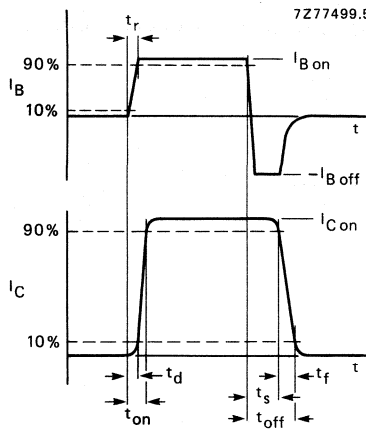


Fig. 2 Switching times waveforms.

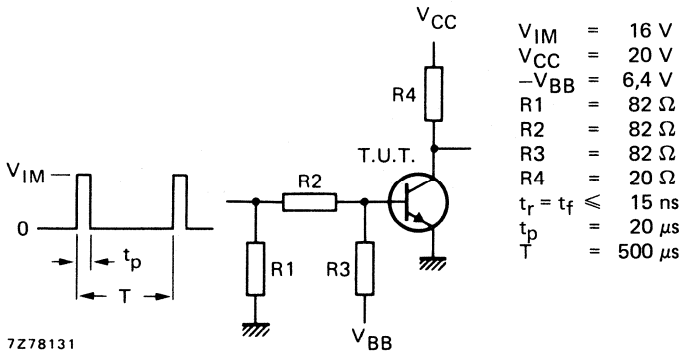


Fig. 3 Switching times test circuit.

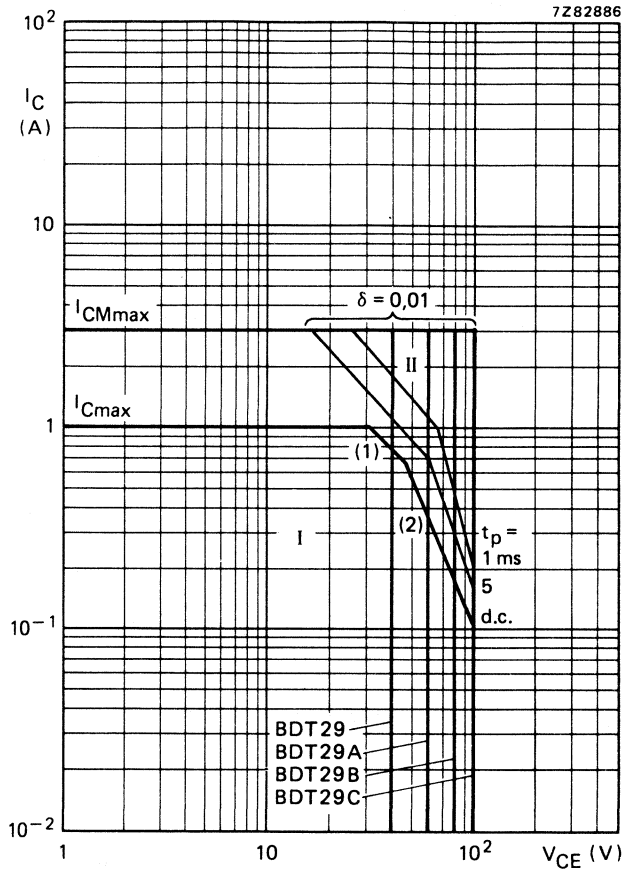


Fig. 4 Safe Operating Area; $T_{mb} = 25\text{ }^\circ\text{C}$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

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

(2) Second breakdown limits, independent of temperature.

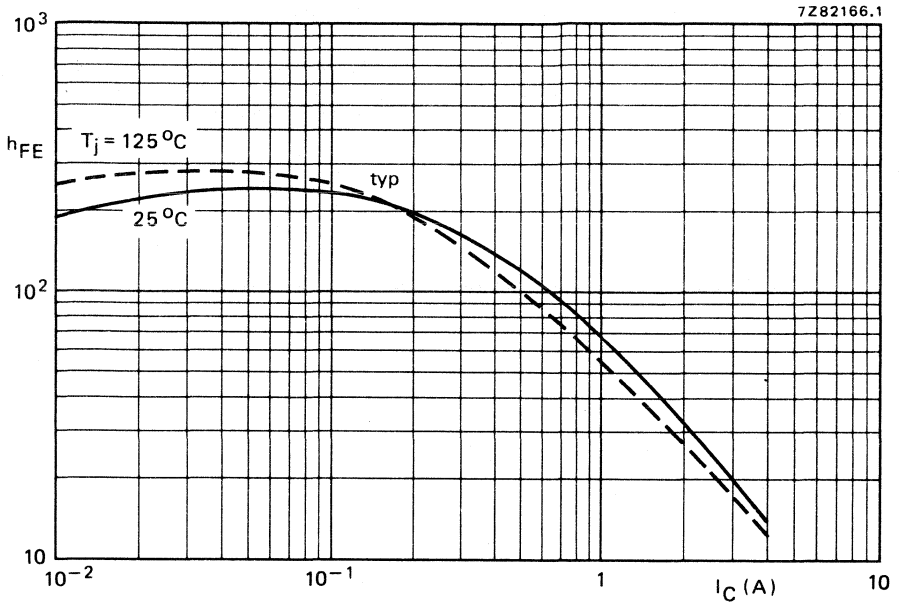


Fig. 5 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 4\text{ V}$.

RATINGS

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

		BDT30			
		A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 40	60	80	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 40	60	80	100 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current (d.c.)	$-I_C$	max.	1		A
Collector current (peak value)	$-I_{CM}$	max.	3		A
Base current (d.c.)	$-I_B$	max.	0,4		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	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70	K/W

CHARACTERISTICS

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

		BDT30;A BDT30B;C	
Collector cut-off current			
$-I_B = 0; -V_{CE} = 30\text{ V}$	$-I_{CEO}$	< 0,3	mA
$-I_B = 0; -V_{CE} = 60\text{ V}$	$-I_{CEO}$	< -	0,3 mA
$-V_{BE} = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CES}$	< 0,2	mA
Emitter cut-off current			
$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO}$	< 1	mA
D.C. current gain*			
$-I_C = 200\text{ mA}; -V_{CE} = 4\text{ V}$	h_{FE}	> 40	
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	> 15 to 75	
Base-emitter voltage*			
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE}$	< 1,3	V
Collector-emitter saturation voltage*			
$-I_C = 1\text{ A}; -I_B = 0,125\text{ A}$	$-V_{CEsat}$	< 0,7	V
Collector-emitter breakdown voltage*			
$I_B = 0; -I_C = 30\text{ mA}$	$-V_{(BR)CEO}$	> 40	60 80 100
Small-signal current gain			
$-I_C = 0,2\text{ A}; -V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	h_{fe}	> 20	
Turn off breakdown energy			
$L = 20\text{ mH}; I_{CC} = 1,22\text{ A}$	$E_{(BR)}$	> 15	mJ

* Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}; \delta < 2\%$.

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

$-I_C = 200 \text{ mA}; -V_{CE} = 10 \text{ V}$

$f_T > 3 \text{ MHz}$

Switching times

$-I_{Con} = 1 \text{ A}; -I_{B on} = I_{B off} = 0,1 \text{ A}$

turn-on time

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

turn-off time

$t_{off} \text{ typ. } 1 \mu\text{s}$

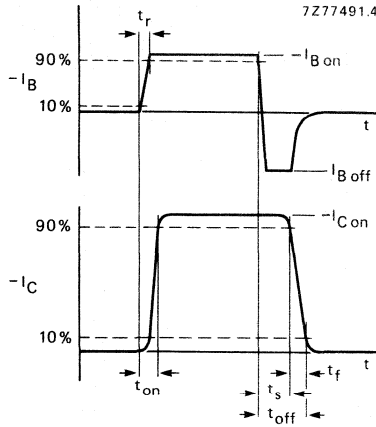


Fig. 2 Switching times waveforms.

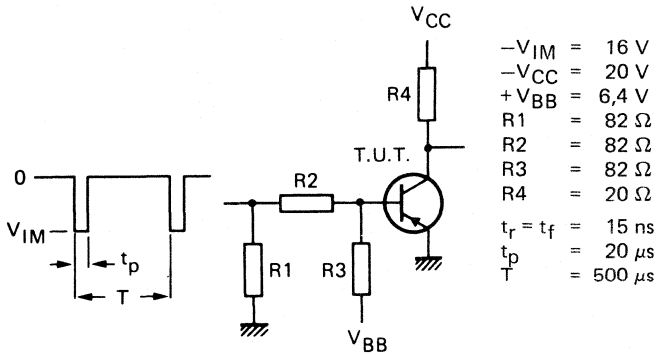


Fig. 3 Switching times test circuit.

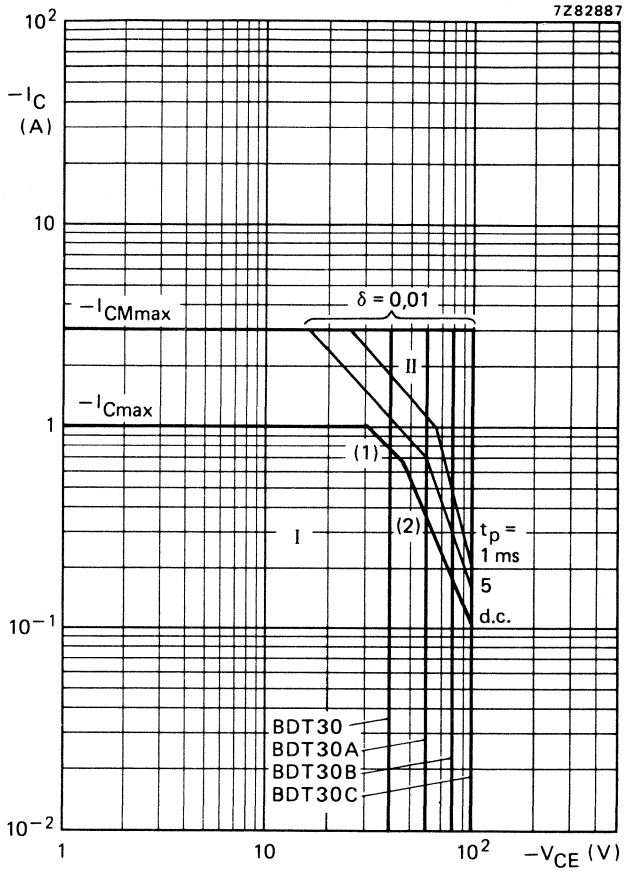


Fig. 4 Safe Operating Area; $T_{mb} = 25\ ^\circ C$.

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.

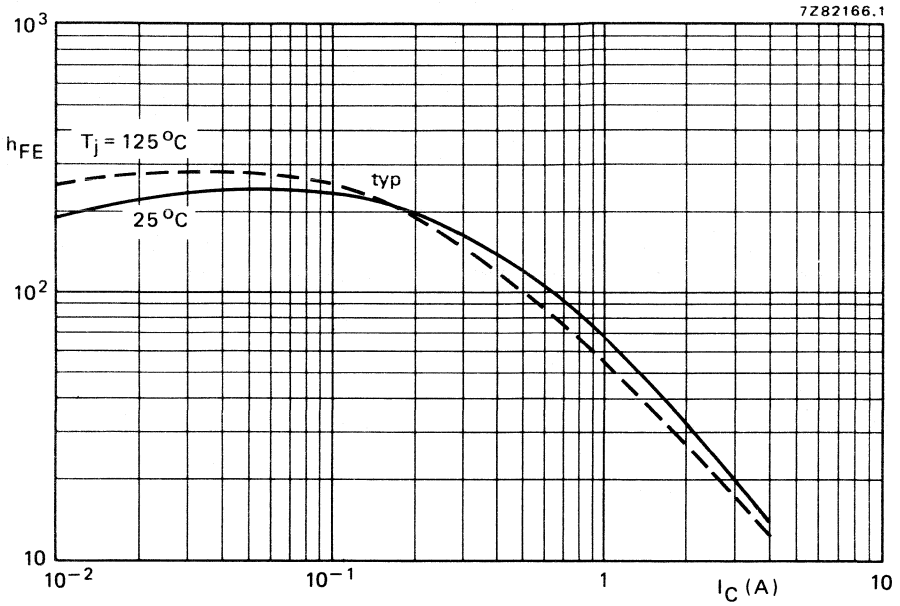


Fig. 5 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 4$ V.

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 BDT32; 32A; 32B; and BDT32C.

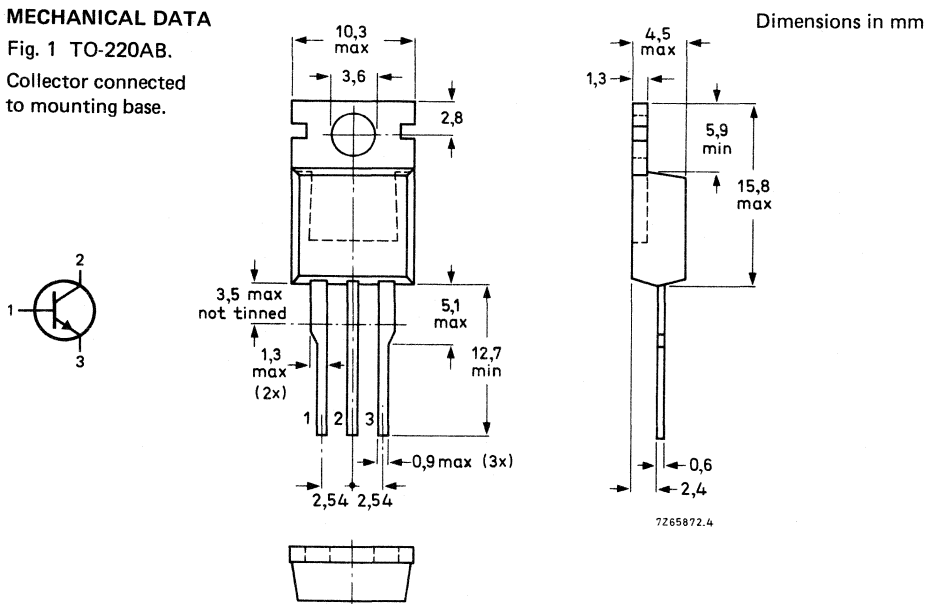
QUICK REFERENCE DATA

		BDT31	A	B	C
Collector-base voltage (open emitter)	V_{CBO}	max. 40	60	80	100 V
Collector-emitter voltage (open base)	V_{CEO}	max. 40	60	80	100 V
Collector current (d.c.)	I_C	max.	3		A
Collector current (peak value)	I_{CM}	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		
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>	25		
$I_C = 3\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}		10 to 50		

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)

		BDT31			
		A	B	C	
Collector-base voltage (open emitter)	V_{CBO} max.	40	60	80	100 V
Collector-emitter voltage (open base)	V_{CEO} max.	40	60	80	100 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.	5			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	K/W
From junction to ambient (in free air)	$R_{th\ j-a}$ =	70	K/W

CHARACTERISTICS

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

		BDT31; A	BDT31B; C
Collector cut-off current			
$I_B = 0; V_{CE} = 30\text{ V}$	I_{CEO} <	0,3	— mA
$I_B = 0; V_{CE} = 60\text{ V}$	I_{CEO} <	—	0,3 mA
$V_{BE} = 0; V_{CE} = V_{CEOmax}$	I_{CES} <	0,2	mA
Emitter cut-off current			
$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO} <	1	mA
D.C. current gain *			
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	h_{FE} >	25	
$I_C = 3\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	10 to 50	
Base-emitter voltage * **			
$I_C = 3\text{ A}; V_{CE} = 4\text{ V}$	V_{BE} <	1,8	V
Collector-emitter saturation voltage *			
$I_C = 3\text{ A}; I_B = 0,375\text{ A}$	V_{CEsat} <	1,2	V
Collector-emitter breakdown voltage *			
$I_B = 0; I_C = 30\text{ mA}$	$V_{(BR)CEO}$ >	40	60 80 100 V
Small-signal current transfer ratio			
$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} $ >	20	
$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ MHz}$	$ h_{fe} $ >	3	
Turn-off breakdown energy			
$L = 20\text{ mH}; I_{CC} = 1,8\text{ A}$	$E_{(BR)}$ >	32	mJ

* Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 2\%$.

** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

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 μs

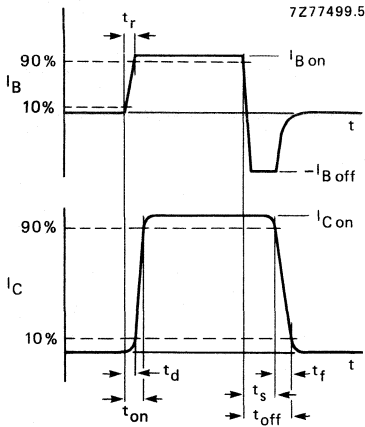


Fig. 2 Switching times waveforms.

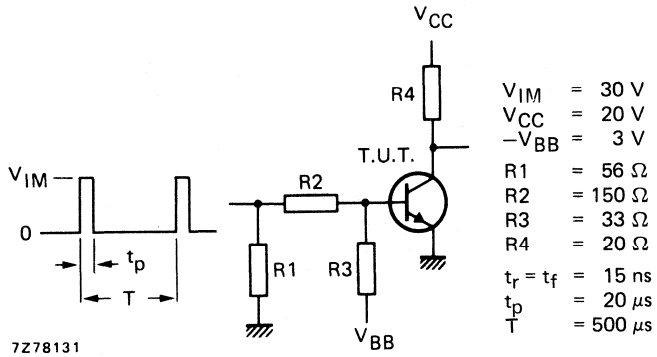


Fig. 3 Switching times test circuit.

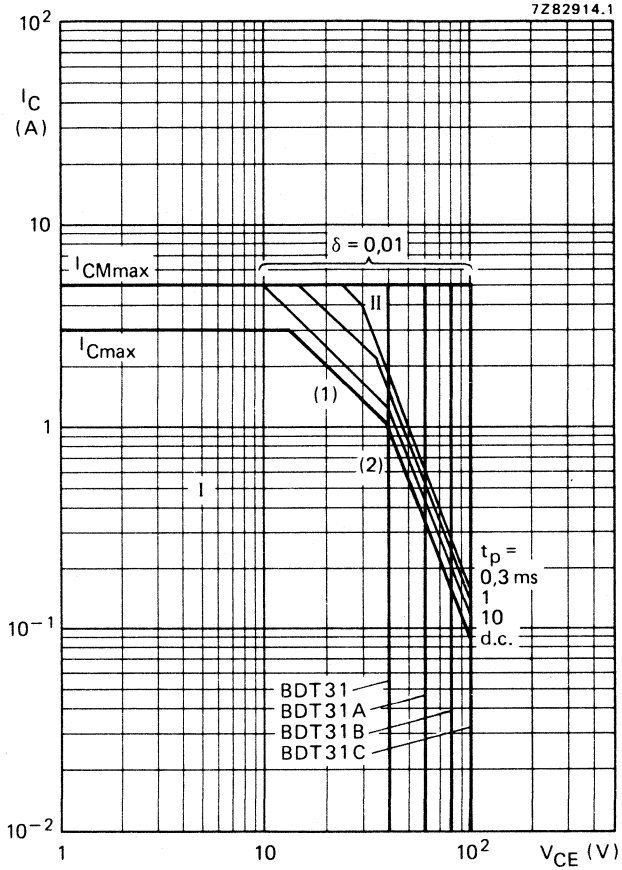


Fig. 4 Safe Operating Area; $T_{mb} = 25\ ^\circ C$.

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).

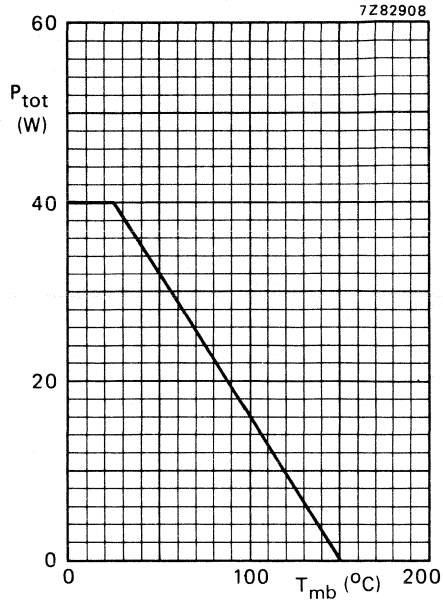


Fig. 5 Power derating curve.

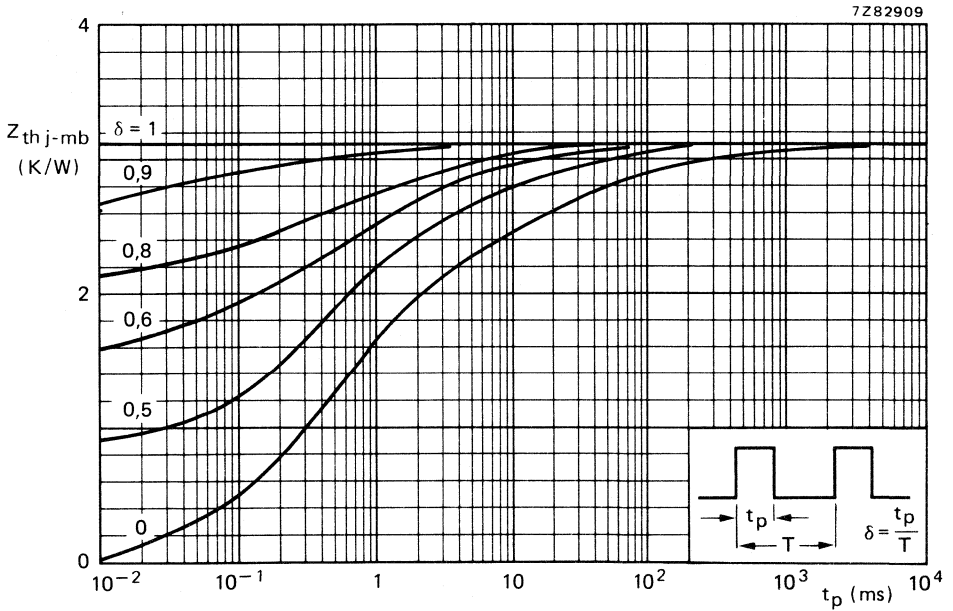


Fig. 6 Pulse power rating chart.

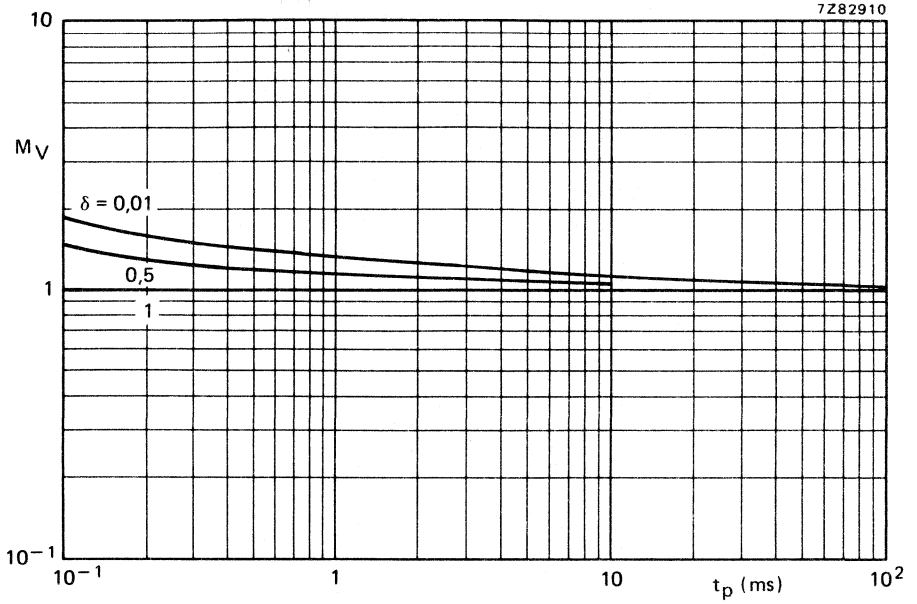


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

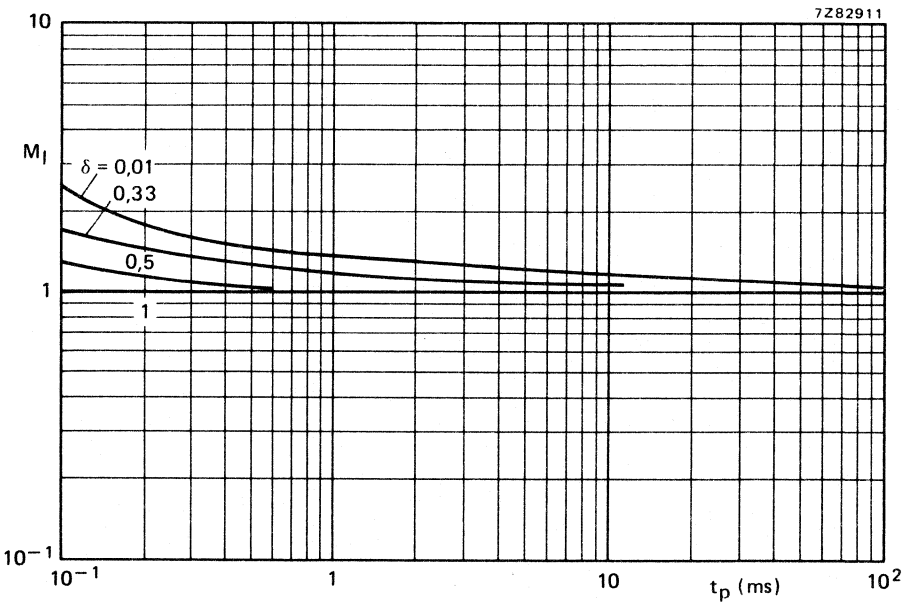


Fig. 8 S.B. current multiplying factor at the V_{CEOmax} level.

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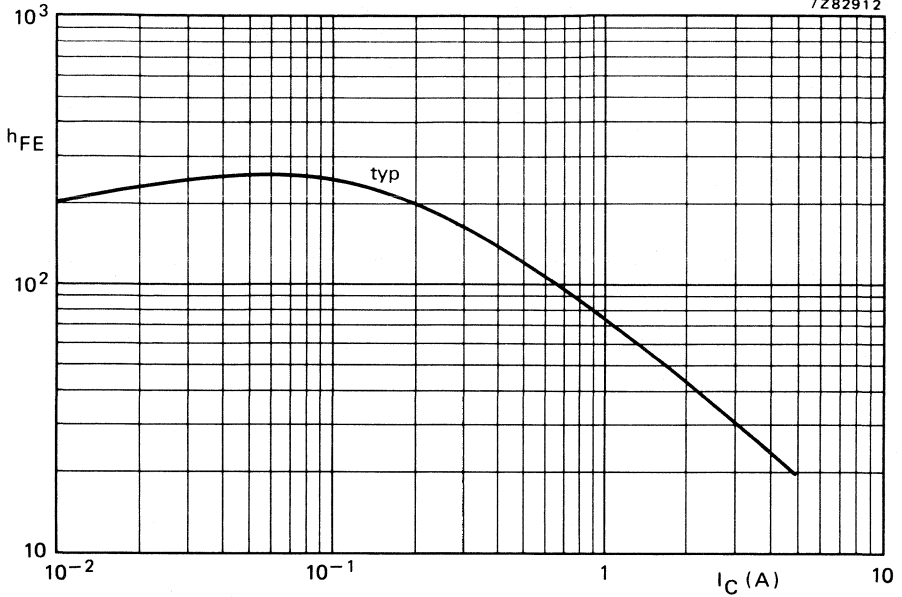


Fig. 9 Typical values d.c. current gain at $V_{CE} = 4$ V.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P transistors in a plastic TO-220 envelope. They are intended for use in a wide range of power amplifiers and for switching applications. N-P-N complements are BDT31; 31A; 31B; and BDT31C.

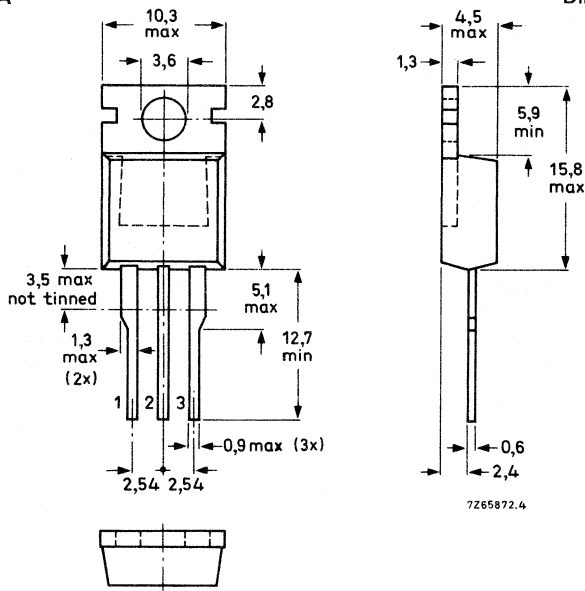
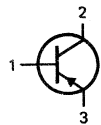
QUICK REFERENCE DATA

		BDT32	A	B	C
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	40	60	80	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	40	60	80	100 V
Collector current (d.c.)	$-I_C$ max.			3	A
Collector current (peak value)	$-I_{CM}$ 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					
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	>		25	
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}			10 to 50	

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)

		BDT32	A	B	C
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 40	60	80	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 40	60	80	100 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.	5		A
Base current	$-I_B$	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	K/W
from junction to ambient (in free air)	$R_{th\ j-a}$	=	70	K/W

CHARACTERISTICS

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

		BDT32; A	B; C
Collector cut-off current			
$I_B = 0; -V_{CE} = 30\text{ V}$	$-I_{CEO}$	< 0,3	mA
$I_B = 0; -V_{CE} = 60\text{ V}$	$-I_{CEO}$	<	0,3 mA
$V_{EB} = 0; -V_{CE} = -V_{CEO}$	$-I_{CES}$	< 0,2	mA
Emitter cut-off current			
$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO}$	<	1 mA
D.C. current gain *			
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	>	25
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	>	10 to 50
Base-emitter voltage * **			
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE}$	<	1,8 V
Collector-emitter saturation voltage			
$-I_C = 3\text{ A}; -I_B = 0,375\text{ A}$	$-V_{CEsat}$	<	1,2 V
Collector-emitter breakdown voltage *			
$I_B = 0; -I_C = 30\text{ mA}$	$-V_{(BR)CEO}$	>	40 60 80 100 V
Small signal current transfer ratio			
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} $	>	20
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}; f = 1\text{ MHz}$	$ h_{fe} $	>	3
Turn-off breakdown energy			
$L = 20\text{ mH}; I_{CC} = 1,22\text{ A}$	$E_{(BR)}$	>	15 mJ

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

** V_{EB} decreases by about 2,3 mV/K with increasing temperature.

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. $0,3 \mu\text{s}$
 t_{off} typ. $1 \mu\text{s}$

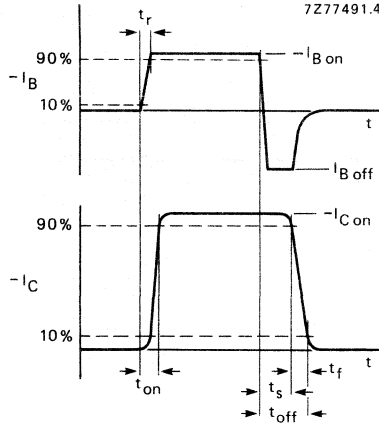
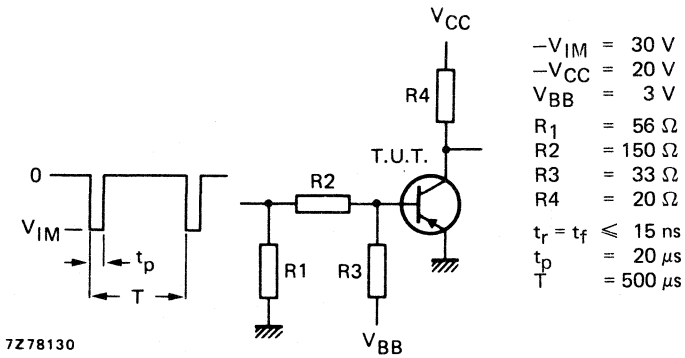


Fig. 2 Switching times waveforms.



- $-V_{IM} = 30 \text{ V}$
- $-V_{CC} = 20 \text{ V}$
- $V_{BB} = 3 \text{ V}$
- $R_1 = 56 \Omega$
- $R_2 = 150 \Omega$
- $R_3 = 33 \Omega$
- $R_4 = 20 \Omega$
- $t_r = t_f \leq 15 \text{ ns}$
- $t_p = 20 \mu\text{s}$
- $T = 500 \mu\text{s}$

Fig. 3 Switching times test circuit.

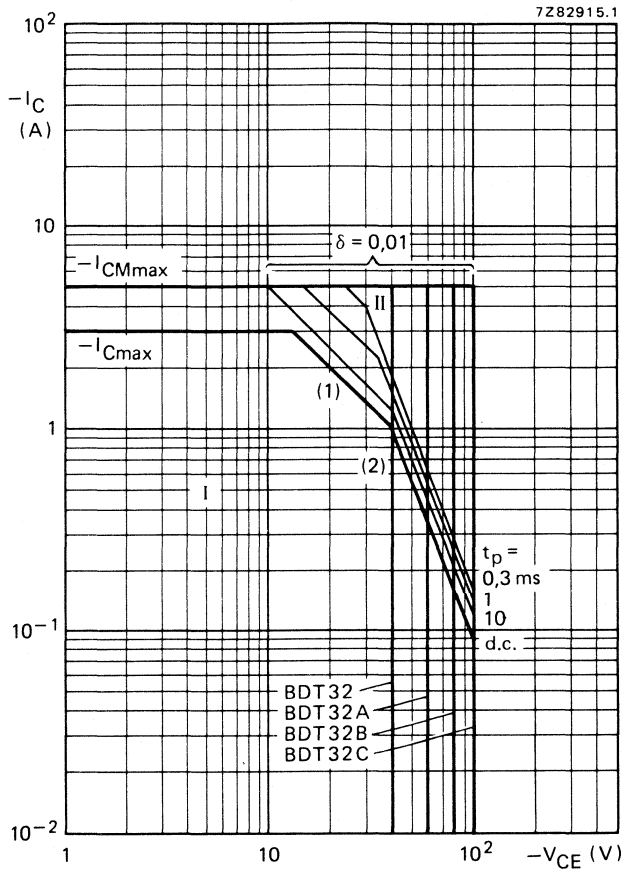


Fig. 4 Safe Operating Area; $T_{mb} \leq 25^\circ\text{C}$.

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

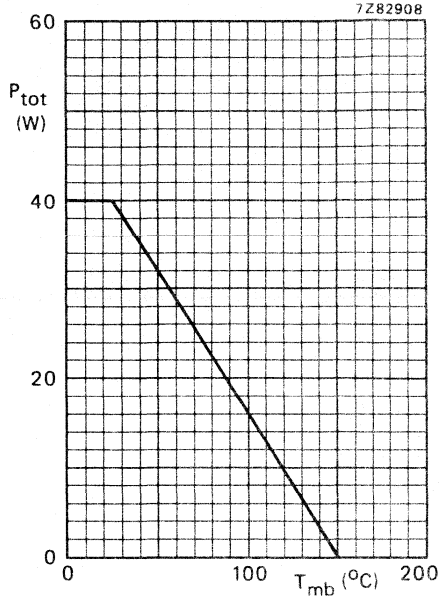


Fig. 5 Power derating curve.

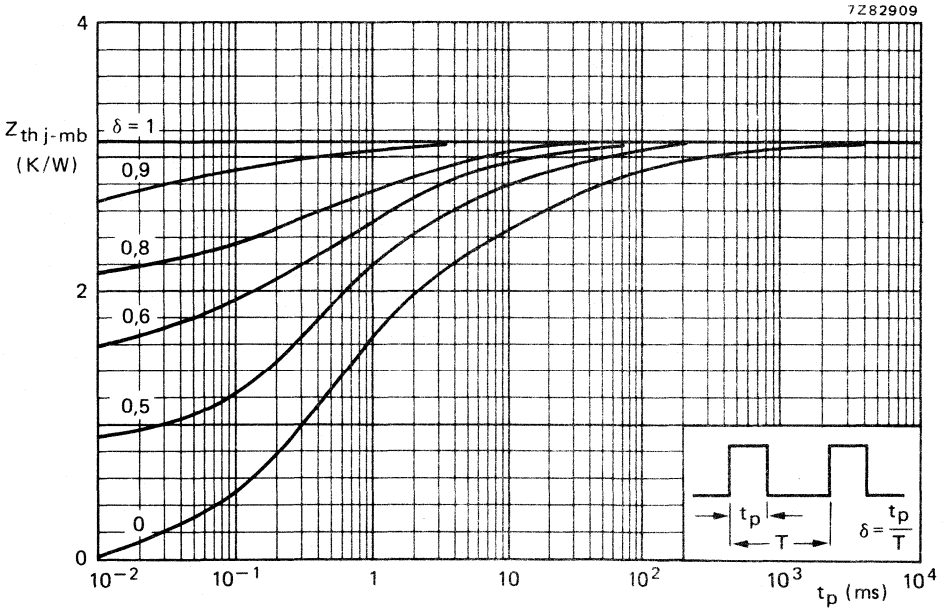


Fig. 6 Pulse power rating chart.

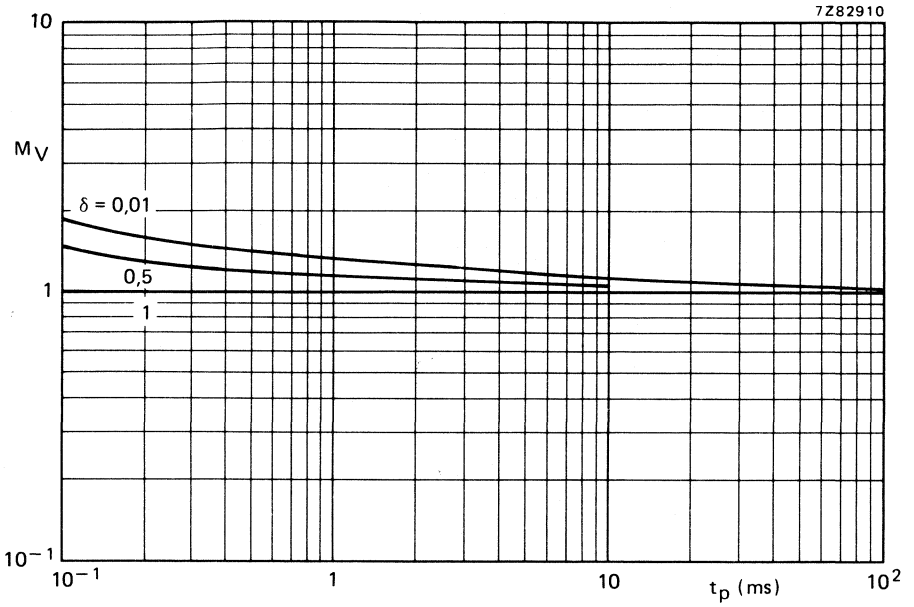


Fig. 7 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

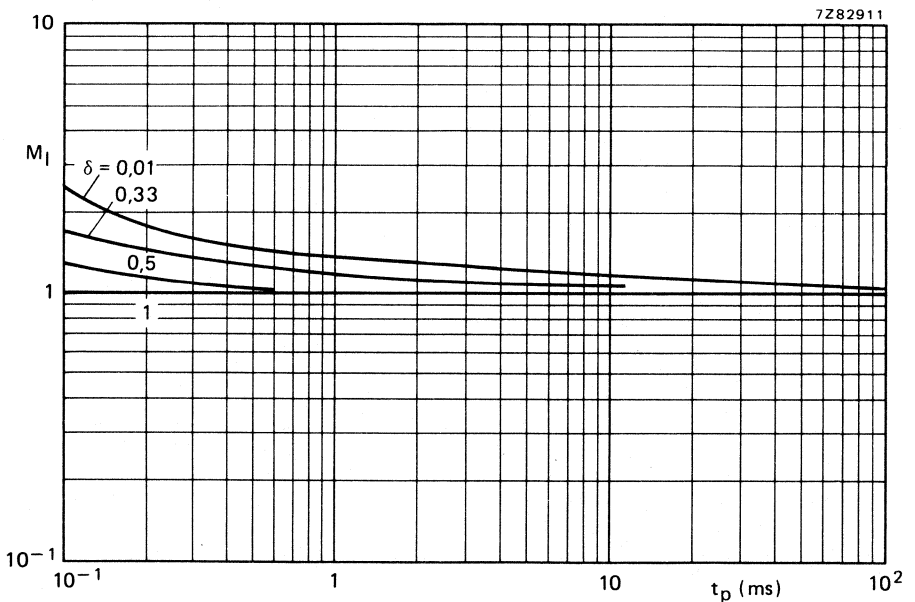


Fig. 8 S.B. current multiplying factor at the $-V_{CEmax}$ level.

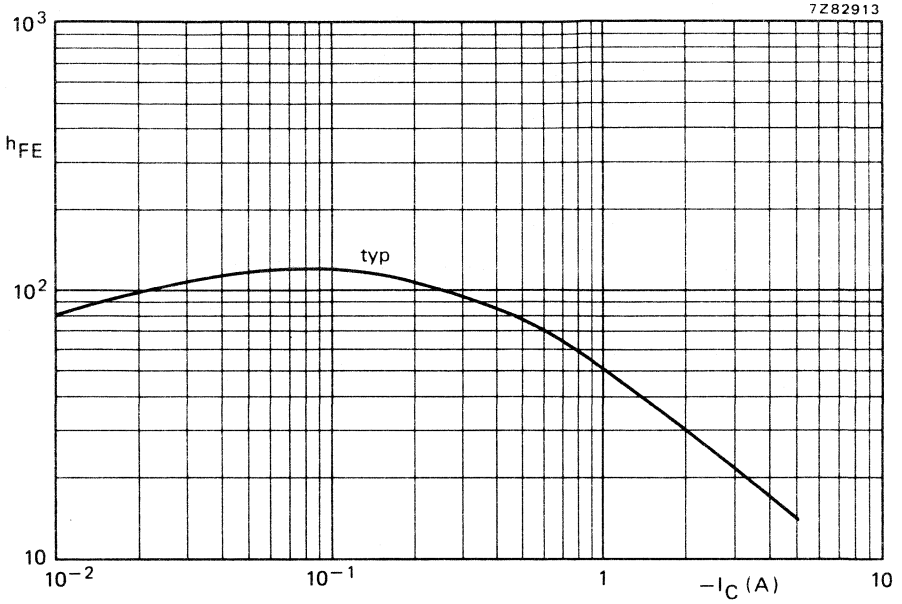


Fig. 9 Typical d.c. current gain at $-V_{CE} = 4$ V; $T_j = 25$ °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in general purpose amplifier and switching applications. P-N-P complements are BDT42; 42A; 42B; and BDT42C.

QUICK REFERENCE DATA

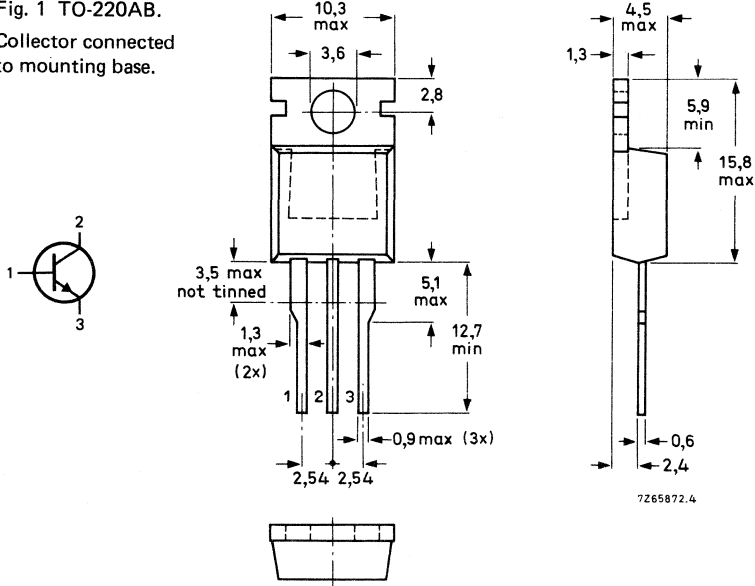
		BDT41	A	B	C		
Collector-base voltage (open emitter)	V_{CBO}	max.	40	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Collector current (d.c.)	I_C	max.		6			A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		65			W
Junction temperature	T_j	max.		150			$^\circ\text{C}$
D.C. current gain $I_C = 3\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}			15 to 75			

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)

			BDT41	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	40	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
Collector current (d.c.)	I_C	max.	6				A
Collector current (peak value)	I_{CM}	max.	10				A
Base current (d.c.)	I_B	max.	3				A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	65				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	$R_{th\ j-mb}$	=		1,92			K/W
From junction to ambient in free air	$R_{th\ j-a}$	=		70			K/W

CHARACTERISTICS

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

			BDT41;A	B;C			
Collector cut-off current							
$I_B = 0; V_{CE} = 30\text{ V}$	I_{CEO}	<	0,7	—	mA		
$I_B = 0; V_{CE} = 60\text{ V}$	I_{CEO}	<	—	0,7	mA		
$V_{BE} = 0; V_{CE} = V_{CEOmax}$	I_{CES}	<		0,4	mA		
Emitter cut-off current							
$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<		1	mA		
D.C. current gain*							
$I_C = 0,3\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>		30			
$I_C = 3\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>		15 to 75			
Base-emitter voltage**							
$I_C = 6\text{ A}; V_{CE} = 4\text{ V}$	V_{BE}	<		2	V		
Collector-emitter saturation voltage*							
$I_C = 6\text{ A}; I_B = 0,6\text{ A}$	V_{CEsat}	<		1,5	V		
Collector-emitter breakdown voltage*							
$I_B = 0; I_C = 30\text{ mA}$	$V_{(BR)CEO}$	>	40	60	80	100	V
Small-signal current transfer ratio							
$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} $	>	20				
Transition frequency at $f = 1\text{ MHz}$							
$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$	f_T	>	3			MHz	

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

** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Turn-off breakdown energy with inductive load (Fig. 4)

$-I_{B\text{off}} = 0$; $I_{CC} = 2,5 \text{ A}$

$E_{(BR)} > 62,5 \text{ mJ}$

Switching times

(between 10% and 90% levels)

$I_{C\text{on}} = 6 \text{ A}$; $I_{B\text{on}} = -I_{B\text{off}} = 0,6 \text{ A}$

Turn-on time

t_{on} typ. $0,6 \mu\text{s}$

Turn-off time

t_{off} typ. $1 \mu\text{s}$

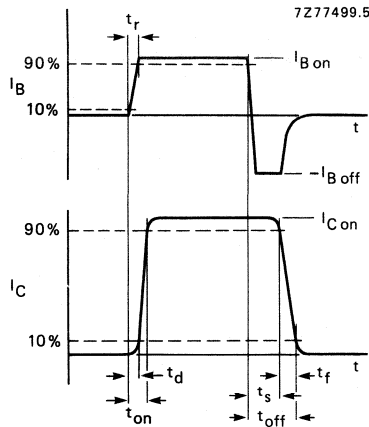


Fig. 2 Switching times waveforms.

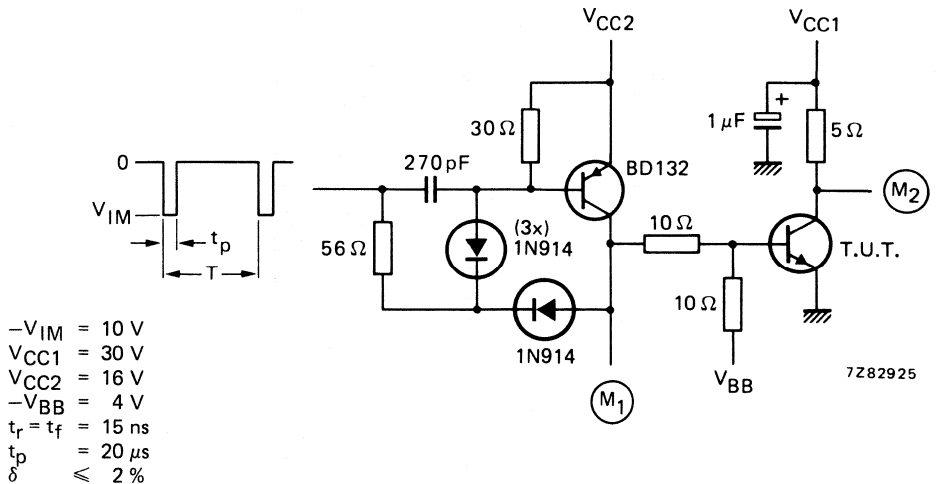


Fig. 3 Switching times test circuit.

Adjust V_{CC2} so that the input to M_1 is 14 V .

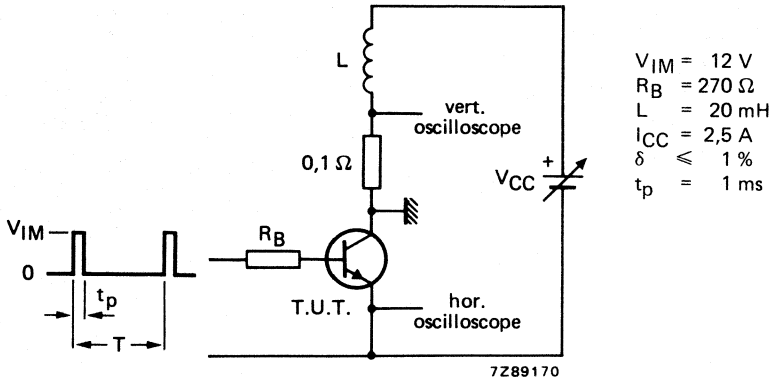


Fig. 4 Test circuit for turn-off breakdown energy.

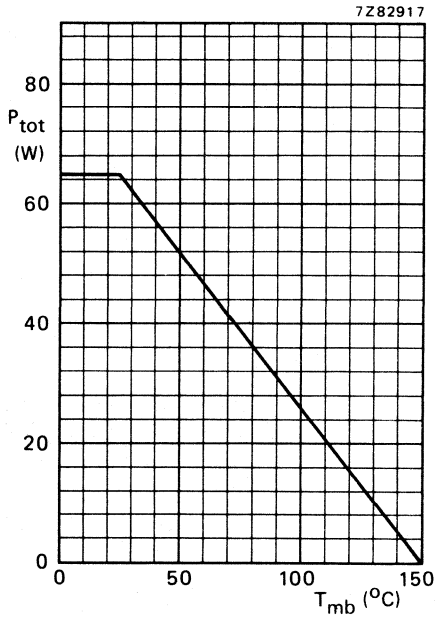


Fig. 5 Power derating curve.

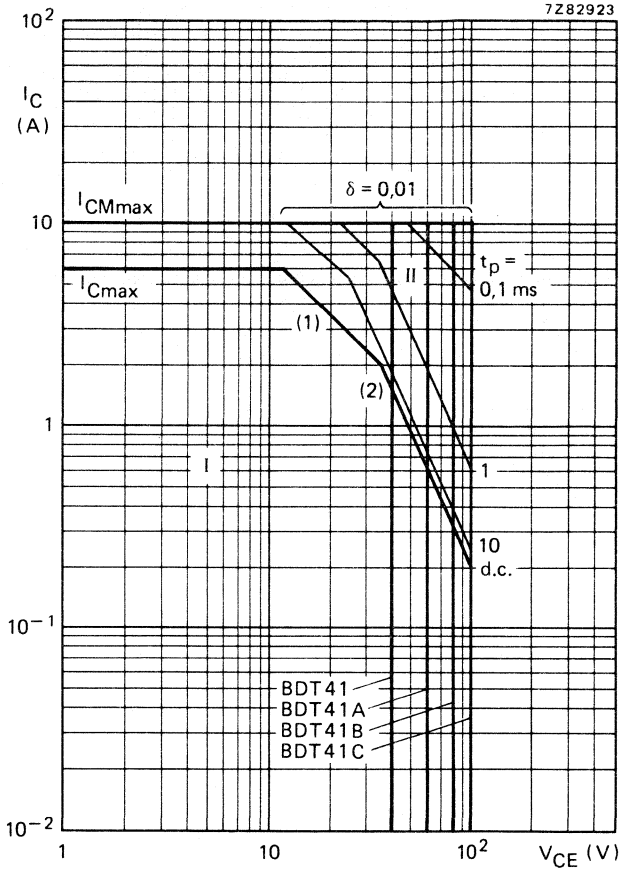


Fig. 6 Safe Operating Area, $T_{mb} = 25\ ^\circ C$.

- 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).

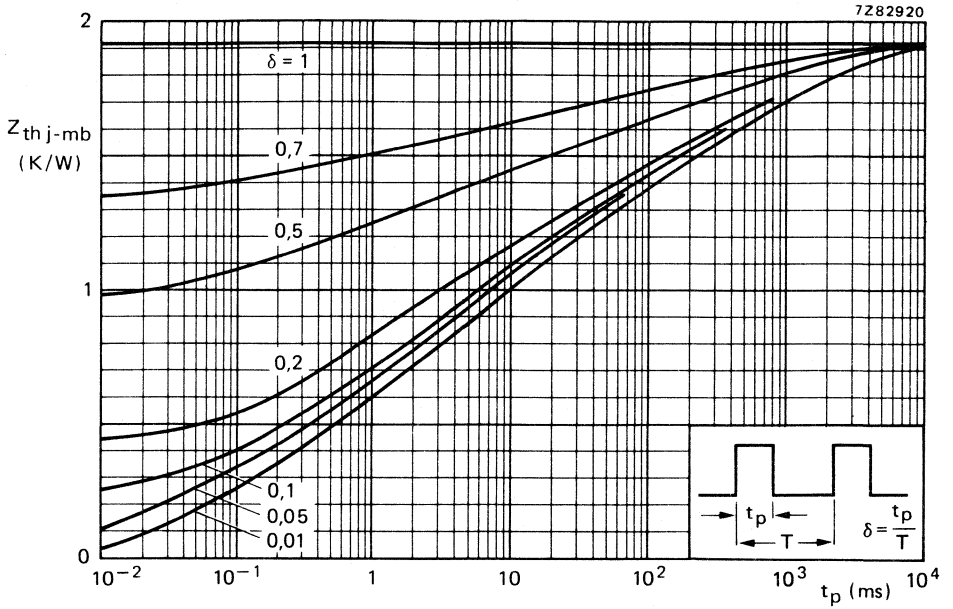


Fig. 7 Pulse power rating chart.

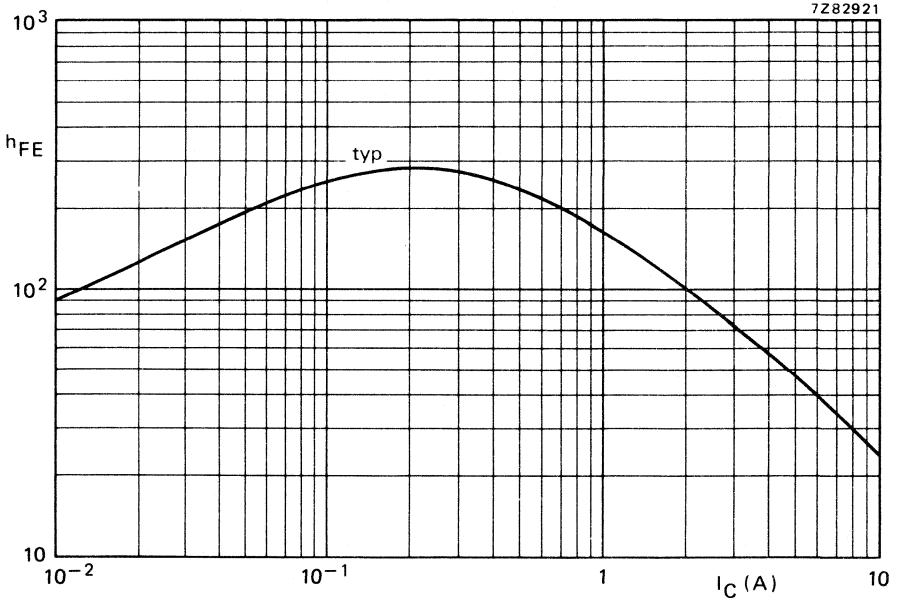


Fig. 8 D.C. current gain at $V_{CE} = 4$ V; $T_j = 25$ °C.

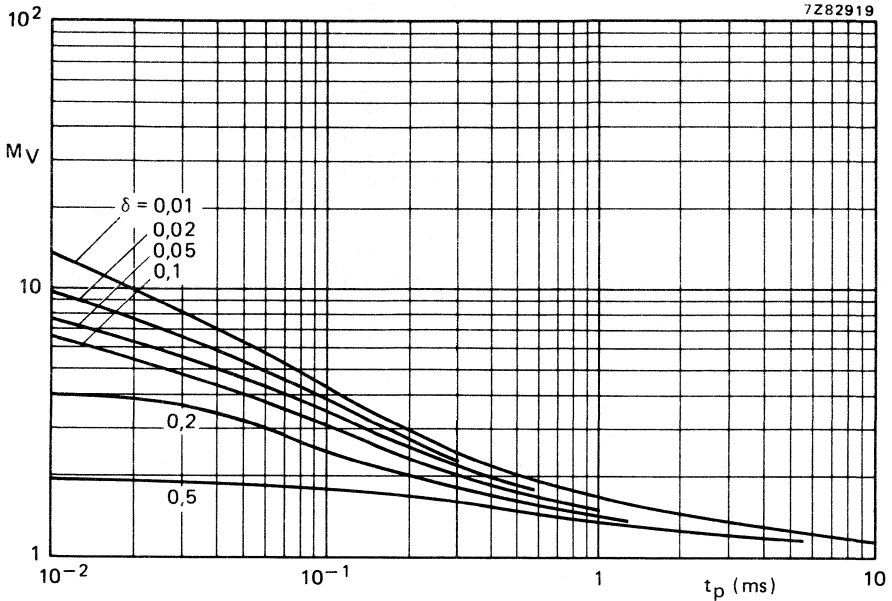


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

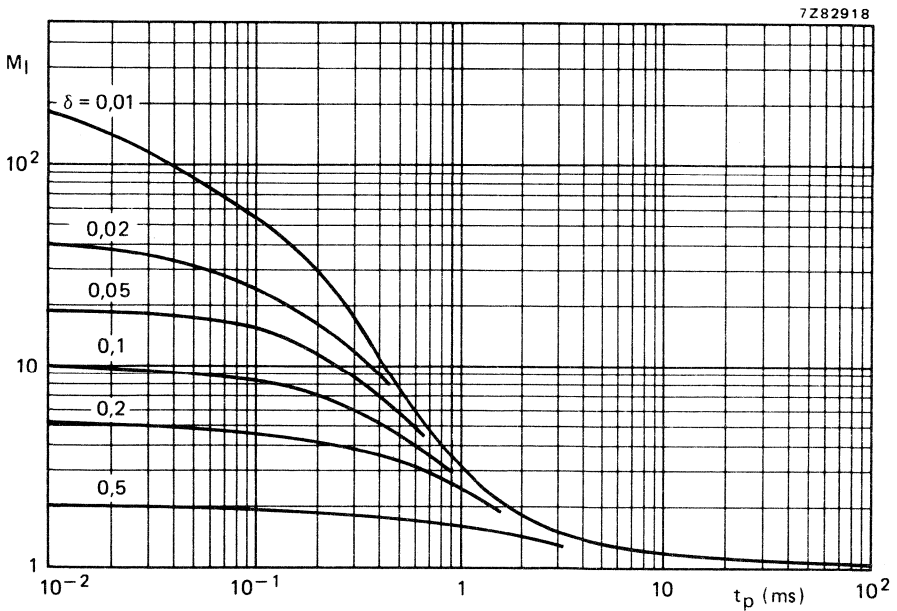


Fig. 10 S.B. current multiplying factor at the V_{CE0max} level.

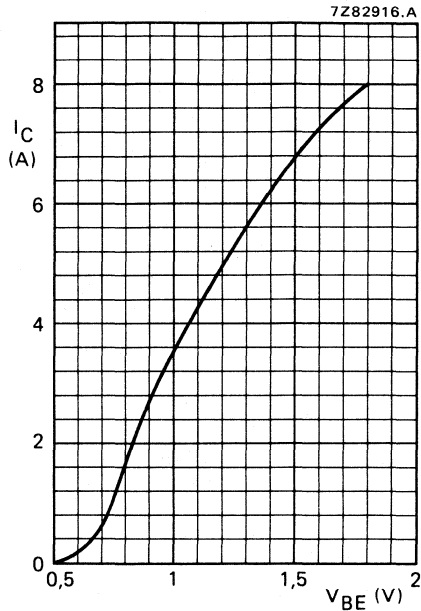


Fig. 11 Typical collector current.
 $V_{CE} = 4 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in general output stages of amplifier circuits and switching applications. N-P-N complements are BDT41; 41A; 41B; and BDT41C.

QUICK REFERENCE DATA

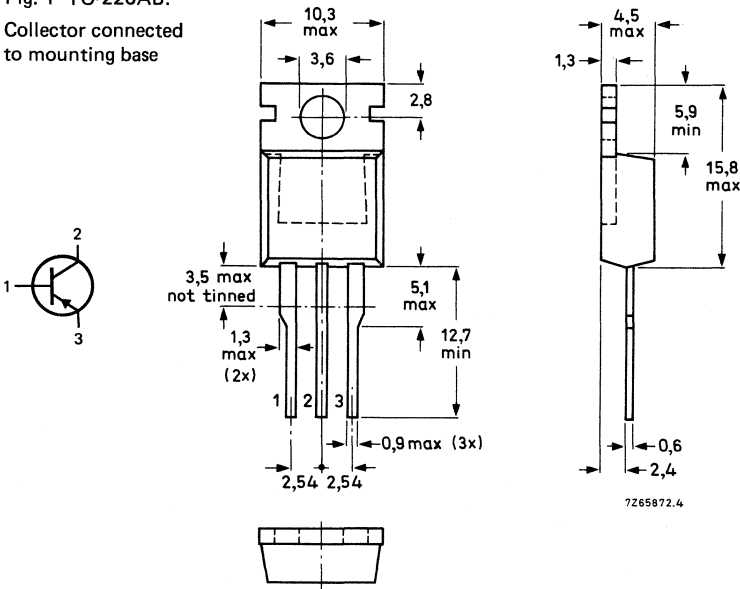
		BDT42			
		A	B	C	
Collector-base voltage	$-V_{CBO}$	max. 40	60	80	100 V
Collector-emitter voltage	$-V_{CEO}$	max. 40	60	80	100 V
Collector current (d.c.)	$-I_C$	max. 6			A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max. 65			W
Junction temperature	T_j	max. 150			$^\circ\text{C}$
D.C. current gain	h_{FE}	15 to 75			
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$					

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)

		BDT42			
		A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 40	60	80	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 40	60	80	100 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current (d.c.)	$-I_C$	max.	6		A
Collector current (peak value)	$-I_{CM}$	max.	10		A
Base current (d.c.)	$-I_B$	max.	3		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	65		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	$R_{th\ j-mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70	K/W

CHARACTERISTICS

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

		BDT42;A		B;C		
Collector cut-off current						
$I_B = 0; -V_{CE} = 30\text{ V}$	$-I_{CEO}$	<	0,7	—	mA	
$I_B = 0; -V_{CE} = 60\text{ V}$	$-I_{CEO}$	<	—	0,7	mA	
$V_{BE} = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CES}$	<	0,4		mA	
Emitter cut-off current						
$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO}$	<	1		mA	
D.C. current gain*						
$-I_C = 300\text{ mA}; -V_{CE} = 4\text{ V}$	h_{FE}	>	30			
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	>	15 to 75			
Base-emitter voltage**						
$-I_C = 6\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE}$	<	2		V	
Collector-emitter saturation voltage*						
$-I_C = 6\text{ A}; -I_B = 0,6\text{ A}$	$-V_{CEsat}$	<	1,5		V	
Collector-emitter breakdown voltage*						
$I_B = 0; -I_C = 30\text{ mA}$	$-V_{(BR)CEO}$	>	BDT42	A	B	C
			40	60	80	100 V
Transition frequency at $f = 1\text{ MHz}$						
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	>	3		MHz	
Small signal current transfer ratio						
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} $	>	20			

* Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}; \delta < 2\%$.

** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Turn-off breakdown energy with inductive load (Fig. 4)

$$I_{B\text{off}} = 0; -I_{CC} = 2,5 \text{ A}$$

Switching times

$$-I_{C\text{on}} = 6 \text{ A}; -I_{B\text{on}} = I_{B\text{off}} = 0,6 \text{ A}$$

turn-on time

turn-off time

$$E(BR) > 62,5 \text{ mJ}$$

$$t_{\text{on}} \quad \text{typ.} \quad 0,4 \text{ } \mu\text{s}$$

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

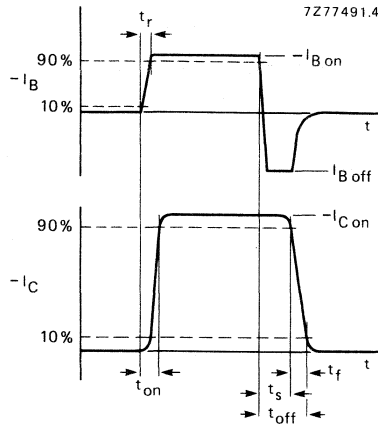
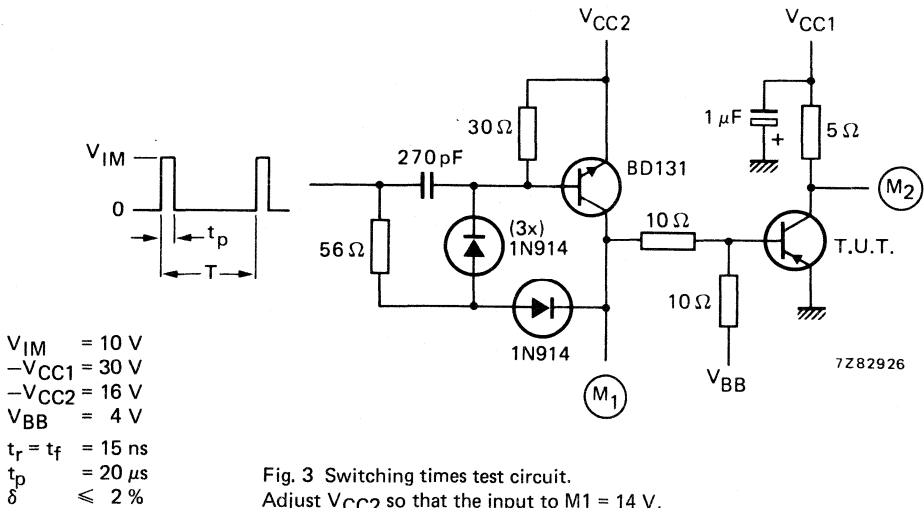


Fig. 2 Switching times waveforms.



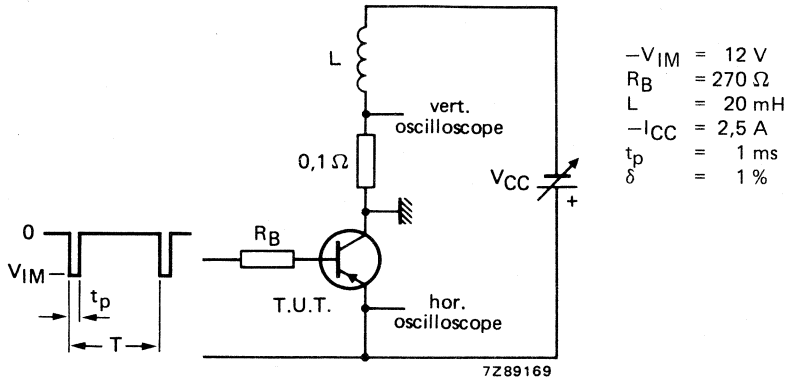


Fig. 4 Test circuit for turn-off breakdown energy.

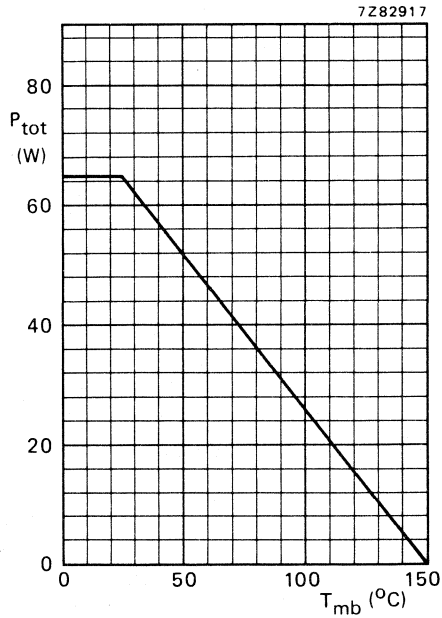


Fig. 5 Power derating curve.

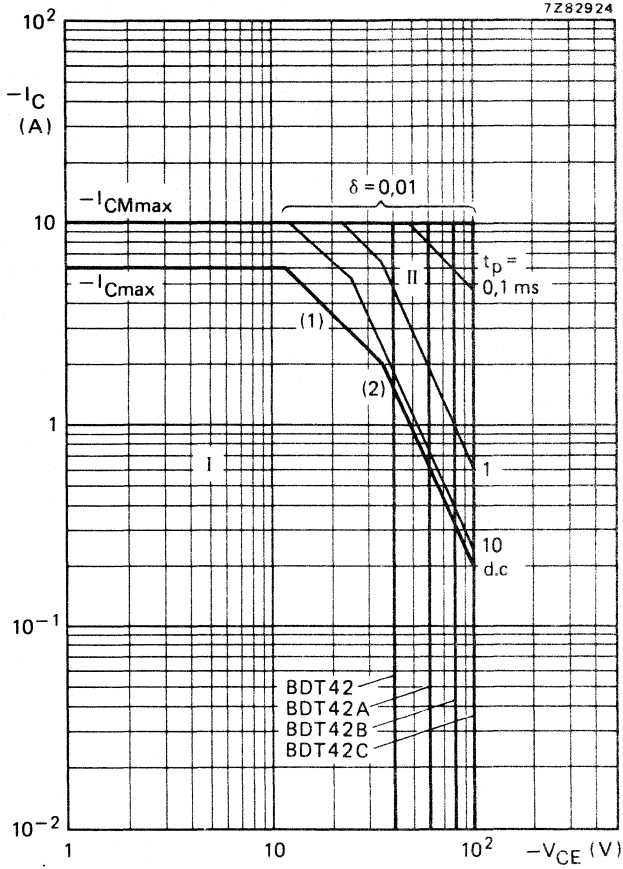


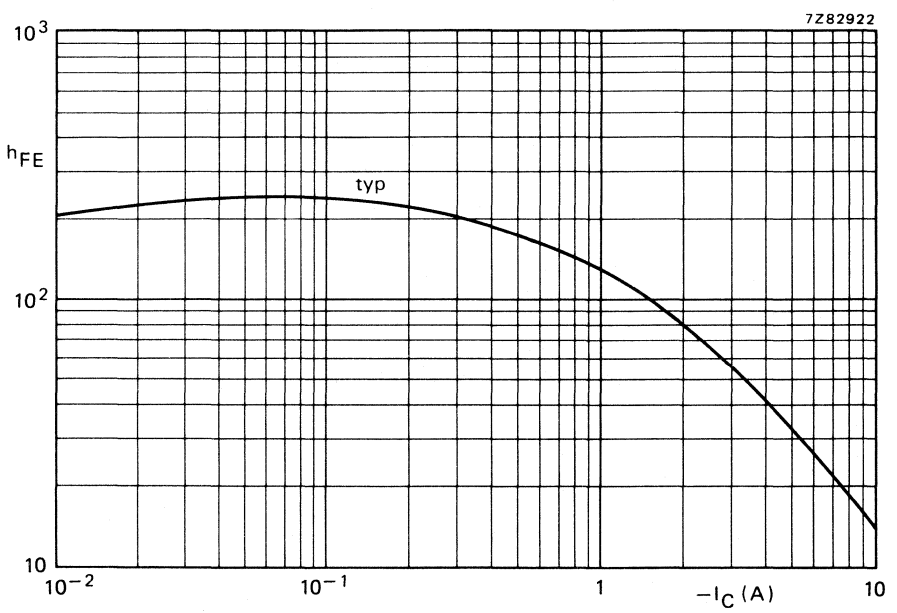
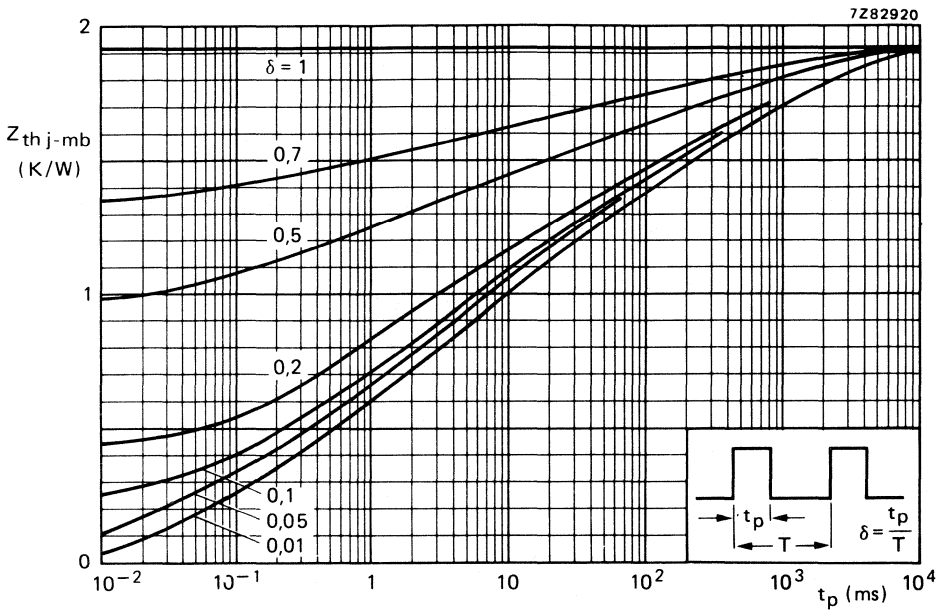
Fig. 6 Safe Operating Area; $T_{mb} = 25^\circ\text{C}$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(2) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.

(3) Second breakdown limits independent of temperature.



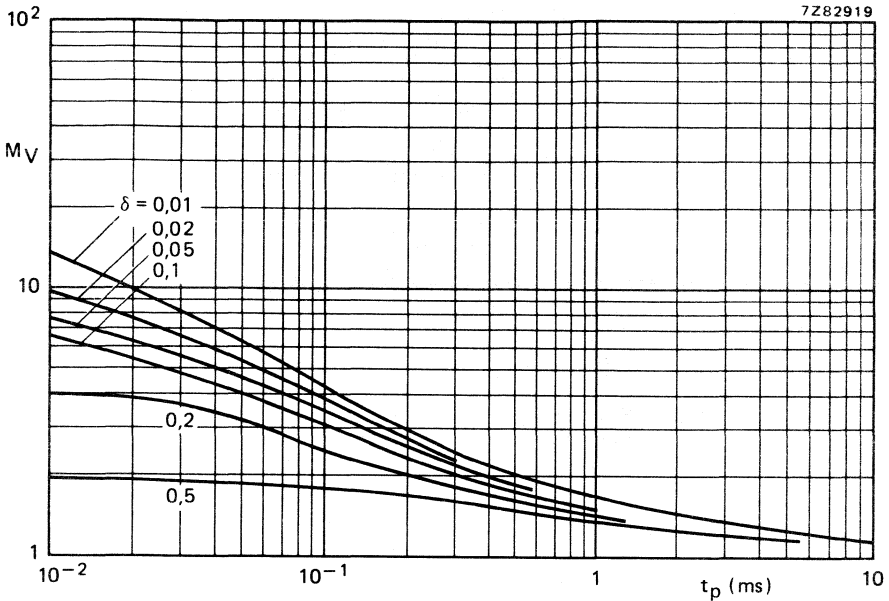


Fig. 9 Second breakdown voltage multiplying factor at the I_{Cmax} level.

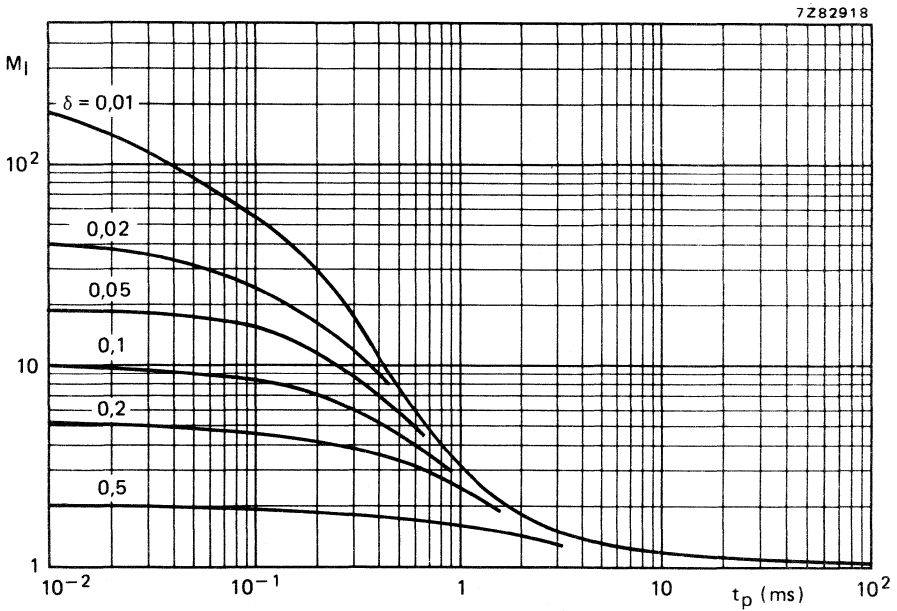


Fig. 10 Second breakdown current multiplying factor at the V_{CEmax} level.

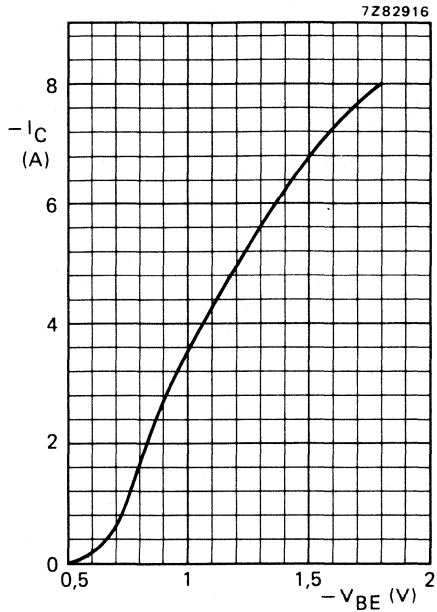


Fig. 11 Typical collector current.
 $-V_{CE} = 4 \text{ V}; T_j = 25 \text{ }^\circ\text{C}.$

SILICON POWER TRANSISTORS

N-P-N transistors in a TO-220 (SOT-78) plastic envelope, designed for use in mobile equipment.

P-N-P complements are BDT52, BDT54, BDT56 and BDT58.

QUICK REFERENCE DATA

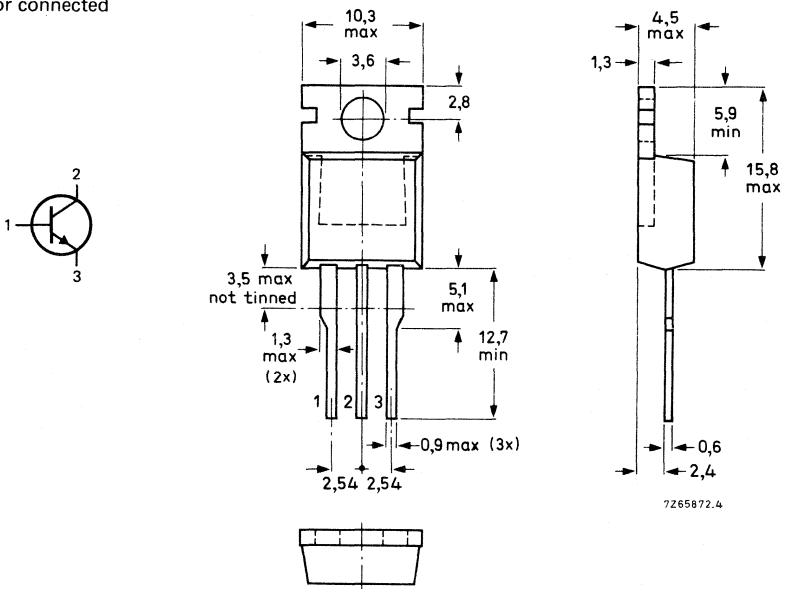
		BDT51	53	55	57
Collector-base voltage (open emitter)	V_{CBO}	max. 60	80	100	120 V
Collector-emitter voltage (open base)	V_{CEO}	max. 60	80	100	120 V
Emitter-base voltage (open collector)	V_{EBO}	max. 7	7	7	7 V
Collector current (peak value)	I_{CM}	max.	25	A	
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	90	W	
Junction temperature	T_j	max.	150	$^{\circ}\text{C}$	

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220 (SOT-78).

Collector connected to case.



See also chapters Mounting instructions and Accessories

RATINGS

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

		BDT51	53	55	57
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. 7	7	7	7 V
Collector current (d.c.)	I_C	max.		15	A
Collector current, peak value	I_{CM}	max.		25	A
Base current (d.c.)	I_B	max.		1,5	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	$R_{th\ j-mb}$	max.		1,4	K/W
From junction to ambient	$R_{th\ j-a}$	max.		70	K/W

CHARACTERISTICS

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

Collector cut-off currents

$I_E = 0; V_{CB} = V_{CB0\ max}$	I_{CBO}	<		0,5	mA
$I_E = 0; V_{CB} = 30\text{ V}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<		1	mA
$I_B = 0; V_{CE} = 0,8\ V_{CEO\ max}$	I_{CEO}	<		1	mA

Emitter cut-off current

$I_C = 0; V_{EB} = 7\text{ V}$	I_{EBO}	<		1	mA
--------------------------------	-----------	---	--	---	----

Collector-emitter saturation voltage*

		BDT51	53	55	57
$I_C = 4,5\text{ A}; I_B = 0,19\text{ A}$	V_{CEsat}	<	0,4	—	— V
$I_C = 4,5\text{ A}; I_B = 0,2\text{ A}$	V_{CEsat}	<	—	0,4	0,5 V
$I_C = 7\text{ A}; I_B = 0,2\text{ A}$	V_{CEsat}	<	0,5	—	— V
$I_C = 7\text{ A}; I_B = 0,3\text{ A}$	V_{CEsat}	<	—	0,5	— V
$I_C = 7\text{ A}; I_B = 0,4\text{ A}$	V_{CEsat}	<	—	—	0,6 V
$I_C = 10\text{ A}; I_B = 0,4\text{ A}$	V_{CEsat}	<	0,8	—	— V
$I_C = 10\text{ A}; I_B = 0,5\text{ A}$	V_{CEsat}	<	—	0,8	— V
$I_C = 10\text{ A}; I_B = 0,6\text{ A}$	V_{CEsat}	<	—	0,9	0,9 V

Base-emitter saturation voltage*

$I_C = 10\text{ A}; I_B = 0,4\text{ A}$	V_{BEsat}	<	1,35	—	— V
$I_C = 10\text{ A}; I_B = 0,5\text{ A}$	V_{BEsat}	<	—	1,4	— V
$I_C = 10\text{ A}; I_B = 0,6\text{ A}$	V_{BEsat}	<	—	—	1,5 V

* Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}; \delta \leq 2\%$.

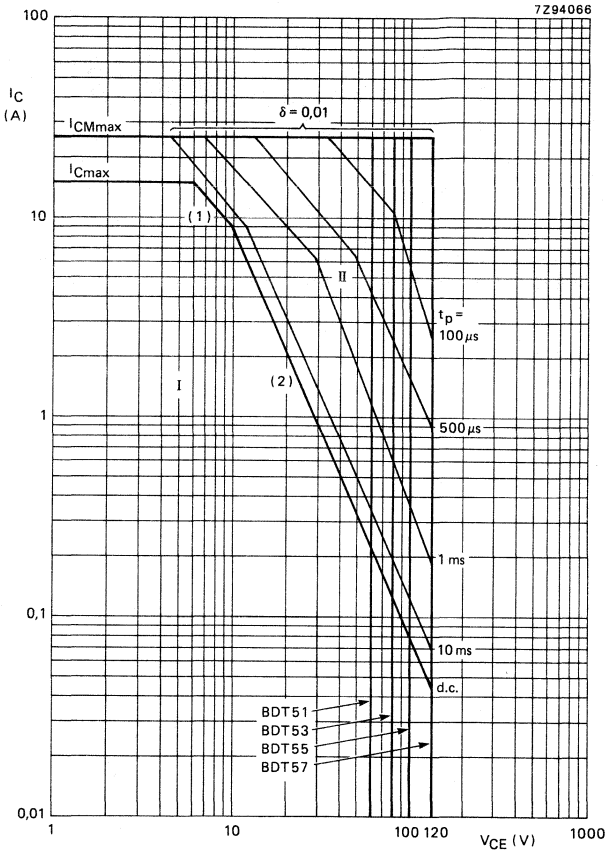


Fig. 2 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$; $T_j = \text{max. } 150\text{ }^{\circ}\text{C}$.

- 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).

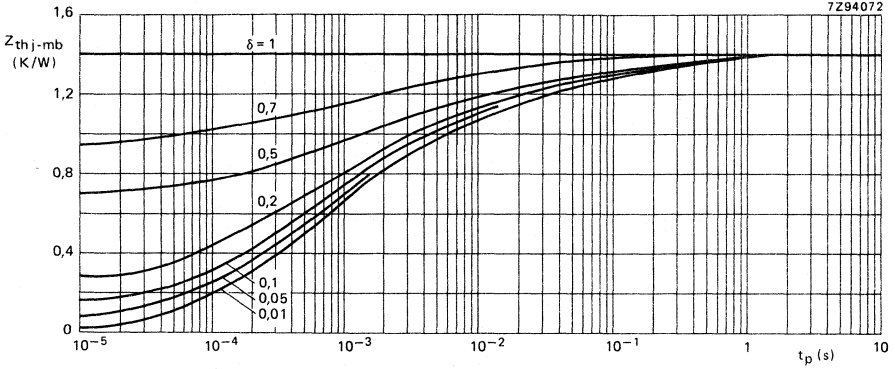


Fig. 3 Pulse power rating chart.

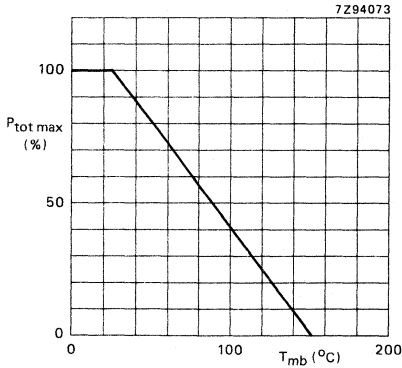


Fig. 4 Power derating curve.

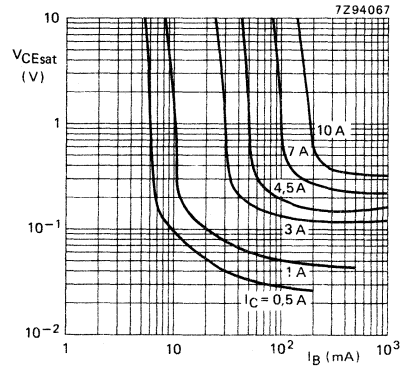


Fig. 5 Collector-emitter saturation voltage; $T_j = 25^\circ\text{C}$.

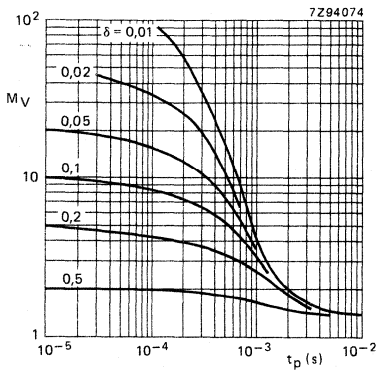


Fig. 6 Second-breakdown current multiplying factor at the $V_{CE0 \text{ max}}$ level.

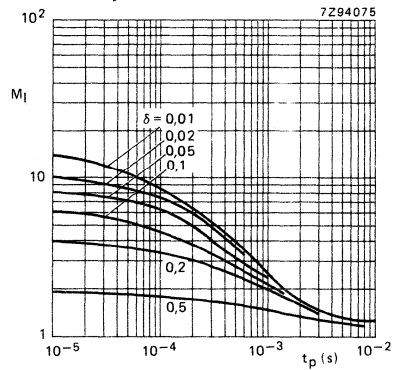


Fig. 7 Second-breakdown voltage multiplying factor at the $I_C \text{ max}$ level.

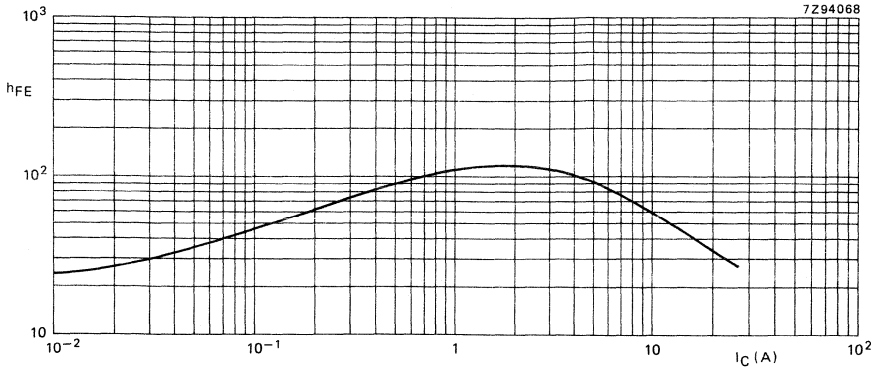


Fig. 8 Typical d.c. current gain; $V_{CE} = 4$ V.

SILICON POWER TRANSISTORS

P-N-P transistors in a TO-220 (SOT-78) plastic envelope, designed for use in mobile equipment.

N-P-N complements are BDT51, BDT53, BDT55 and BDT57.

QUICK REFERENCE DATA

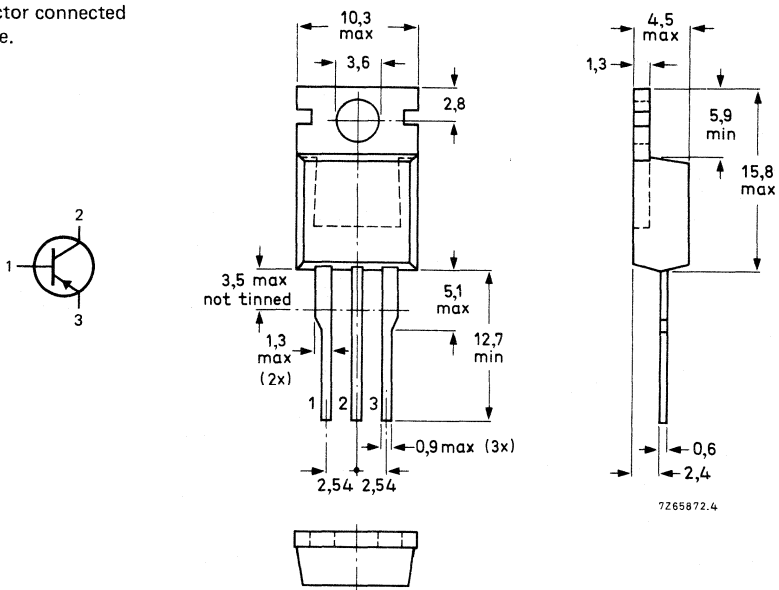
			BDT52	54	56	58
Collector-base voltage, open emitter	$-V_{CBO}$	max.	60	80	100	120 V
Collector-emitter voltage, open base	$-V_{CEO}$	max.	60	80	100	120 V
Emitter-base voltage, open collector	$-V_{EBO}$	max.	7	7	7	7 V
Collector current, peak value	$-I_{CM}$	max.		25		A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.		90		W
Junction temperature	T_j	max.		150		$^{\circ}\text{C}$

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220 (SOT-78).

Collector connected to case.



See also chapters Mounting instructions and Accessories

RATINGS

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

		BDT52	54	56	58
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.	7	7	7	7 V
Collector current (d.c.)	$-I_C$ max.			15	A
Collector current, peak value	$-I_{CM}$ max.			25	A
Base current (d.c.)	$-I_B$ max.			1,5	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	$R_{th\ j-mb}$ max.			1,4	K/W
From junction to ambient	$R_{th\ j-a}$ max.			70	K/W

CHARACTERISTICS

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

Collector cut-off currents

$-I_E = 0; -V_{CB} = V_{CB0}$ max	$-I_{CBO}$ <			0,5	mA
$-I_E = 0; -V_{CB} = 30\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$ <			1	mA
$-I_B = 0; -V_{CE} = 0,8\text{ } V_{CEO}$ max	$-I_{CEO}$ <			1	mA

Emitter cut-off current

$-I_C = 0; -V_{EB} = 7\text{ V}$	$-I_{EBO}$ <			1	mA
----------------------------------	--------------	--	--	---	----

		BDT52	54	56	58
Collector-emitter saturation voltage*					
$-I_C = 4,5\text{ A}; -I_B = 0,19\text{ A}$	$-V_{CEsat}$ <	0,4	0,4	—	— V
$-I_C = 4,5\text{ A}; -I_B = 0,2\text{ A}$	$-V_{CEsat}$ <	—	—	0,4	0,5 V
$-I_C = 7\text{ A}; -I_B = 0,2\text{ A}$	$-V_{CEsat}$ <	0,5	—	—	— V
$-I_C = 7\text{ A}; -I_B = 0,3\text{ A}$	$-V_{CEsat}$ <	—	0,5	0,5	— V
$-I_C = 7\text{ A}; -I_B = 0,4\text{ A}$	$-V_{CEsat}$ <	—	—	—	0,6 V
$-I_C = 10\text{ A}; -I_B = 0,4\text{ A}$	$-V_{CEsat}$ <	0,8	—	—	— V
$-I_C = 10\text{ A}; -I_B = 0,5\text{ A}$	$-V_{CEsat}$ <	—	0,8	—	— V
$-I_C = 10\text{ A}; -I_B = 0,6\text{ A}$	$-V_{CEsat}$ <	—	—	0,9	0,9 V
Base-emitter saturation voltage*					
$-I_C = 10\text{ A}; -I_B = 0,4\text{ A}$	$-V_{BEsat}$ <	1,35	—	—	— V
$-I_C = 10\text{ A}; -I_B = 0,5\text{ A}$	$-V_{BEsat}$ <	—	1,4	—	— V
$-I_C = 10\text{ A}; -I_B = 0,6\text{ A}$	$-V_{BEsat}$ <	—	—	1,5	1,5 V

* Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}; \delta \leq 2\%$.

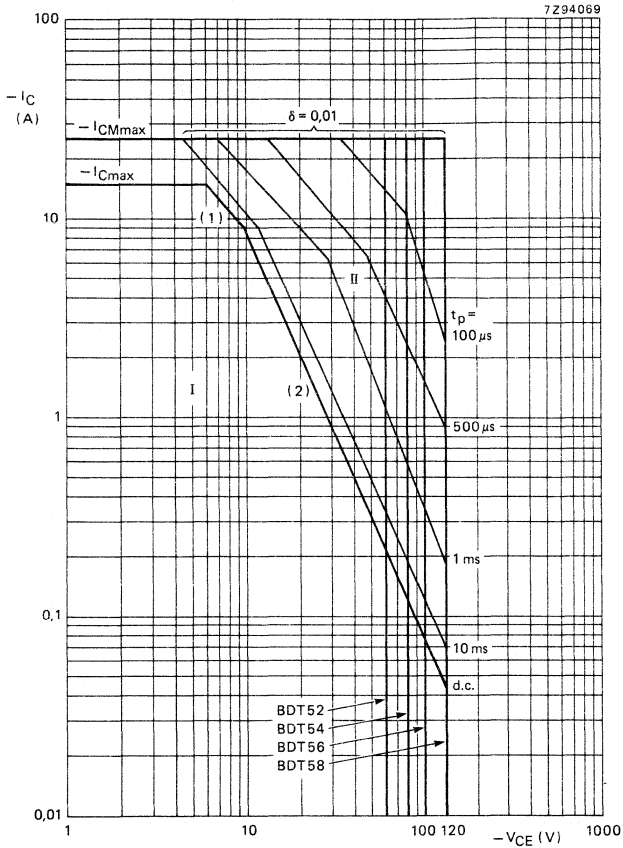


Fig. 2 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$; $T_{j\text{max}} = 150\text{ }^{\circ}\text{C}$.

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

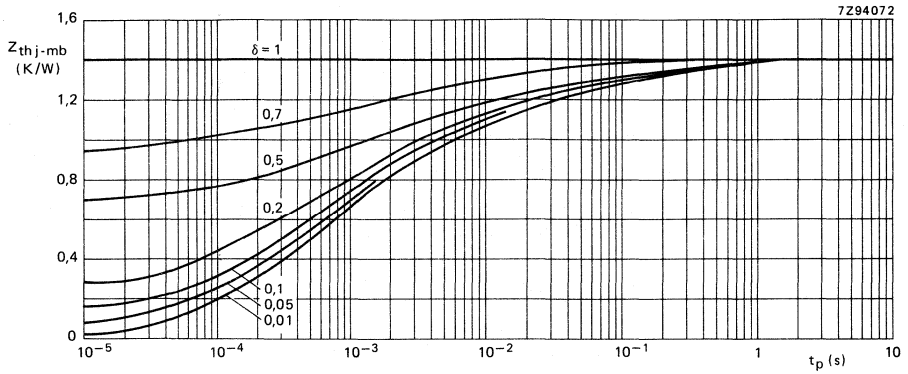


Fig. 3 Pulse power rating chart.

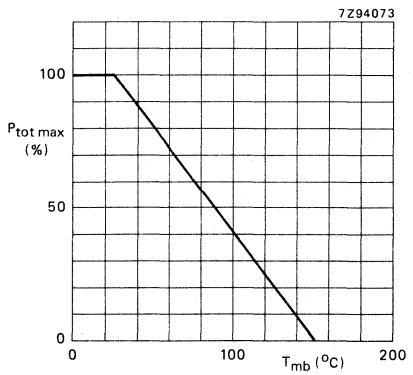


Fig. 4 Power derating curve.

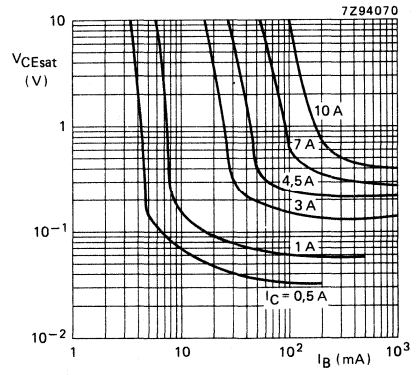


Fig. 5 Collector-emitter saturation voltage; $T_j = 25\text{ }^\circ\text{C}$.

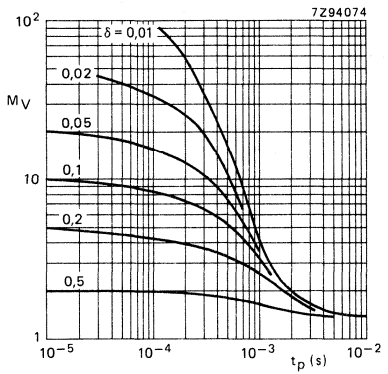


Fig. 6 Second-breakdown current multiplying factor at the $V_{CE0\text{ max}}$ level.

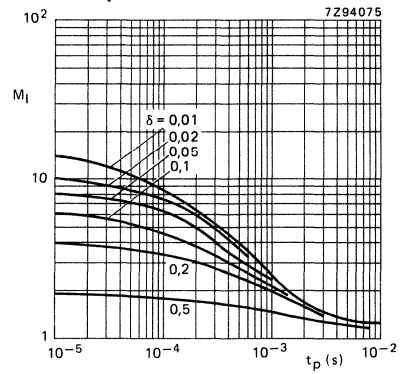


Fig. 7 Second-breakdown voltage multiplying factor at the $I_{C\text{ max}}$ level.

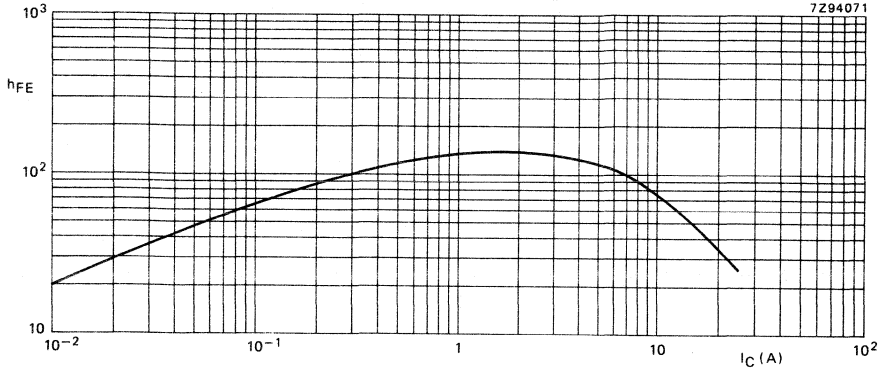


Fig. 8 Typical d.c. current gain; $-V_{CE} = 4$ V.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P silicon power transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier applications.

N-P-N complements are BDT61, BDT61A, BDT61B and BDT61C.

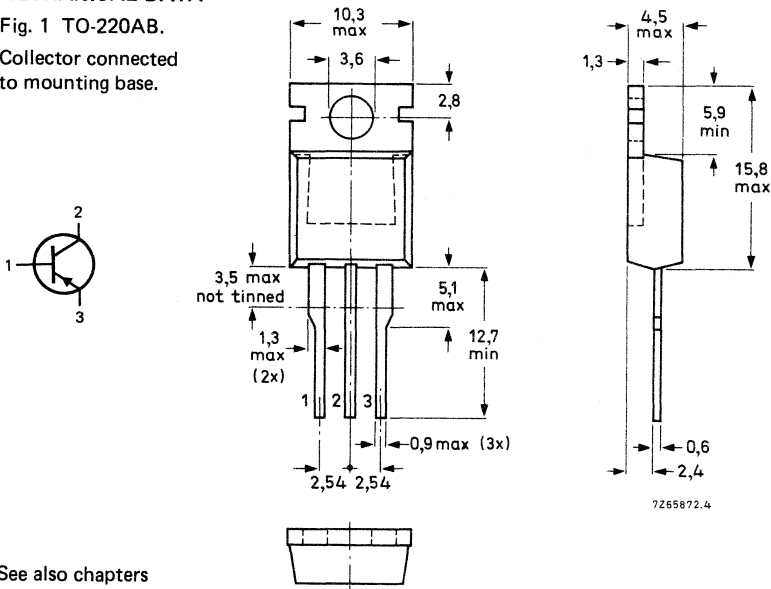
QUICK REFERENCE DATA

		BDT60	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.			4	A
Collector current (peak value)	$-I_{CM}$ max.			6	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.			50	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.			2200	

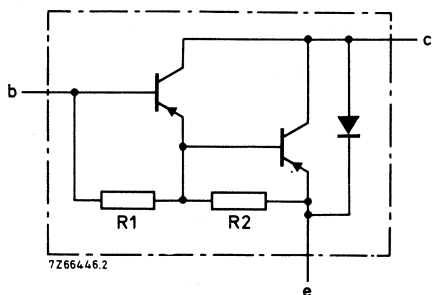
MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters
Mounting instructions
and Accessories.



R1 typ. 6 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

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

		BDT60	A	B	C
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	V
Collector current (d.c.)	$-I_C$ max.			4	A
Collector current (peak value)	$-I_{CM}$ max.			6	A
Reverse diode current	$I_R = I_C$ max.			4	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.			50	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	$R_{th\ j-mb} =$	2,5	K/W
From junction to ambient (in free air)	$R_{th\ j-a} =$	70	K/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

$$I_E = 0; -V_{CB} = -V_{CB0\max} \quad -I_{CBO} < 0,2\text{ mA}$$

$$I_E = 0; -V_{CB} = -\frac{1}{2}V_{CB0\max}; T_j = 150\text{ }^\circ\text{C} \quad -I_{CBO} < 2\text{ mA}$$

$$I_B = 0; -V_{CE} = -\frac{1}{2}V_{CE0\max} \quad -I_{CEO} < 1\text{ mA}$$

Emitter cut-off current

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

Forward bias second-breakdown collector current

$$-V_{CE} = 50\text{ V}; t = 0,1\text{ s}; \text{non-repetitive} \\ (\text{without heatsink}); T_{\text{amb}} = 25\text{ }^\circ\text{C} \quad -I_{(SB)} > 1\text{ A}$$

D.C. current gain*

$$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 2200$$

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} > 750$$

$$-I_C = 4\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 650$$

Base-emitter voltage

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

Collector-emitter saturation voltage*

$$-I_C = 1,5\text{ A}; -I_B = 6\text{ mA} \quad -V_{CE\text{sat}} < 2,5\text{ V}$$

Cut-off frequency

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V} \quad f_{hfe} > 25\text{ kHz}$$

Small-signal current gain at $f = 1\text{ MHz}$

$$-I_C = 1,5\text{ A}; -V_{CE} = 3\text{ V} \quad h_{fe} > 10$$

* Measured under pulse conditions; $t_p < 300\text{ }\mu\text{s}$; $\delta < 2\%$.

CHARACTERISTICS (continued)

Diode, forward voltage

$I_F = 1,5 \text{ A}$

$I_F = 4 \text{ A}$

V_F	<	2 V
V_F	typ.	2,1 V

Switching times

(between 10% and 90% levels)

$-I_{Con} = 1,5 \text{ A}; -I_{Bon} = I_{Boff} = 6 \text{ mA}; -V_{CC} = 30 \text{ V}$

turn-on time

t_{on}	typ.	0,3 μs
	<	1,5 μs

turn-off time

t_{off}	typ.	1,5 μs
	<	5 μs

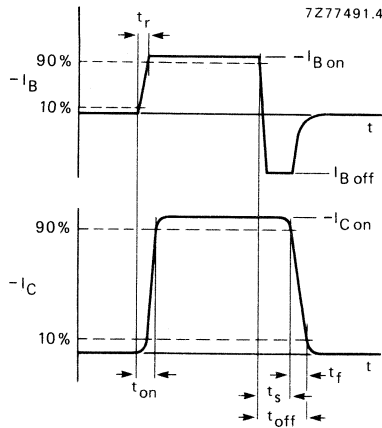


Fig. 3 Switching times waveforms.

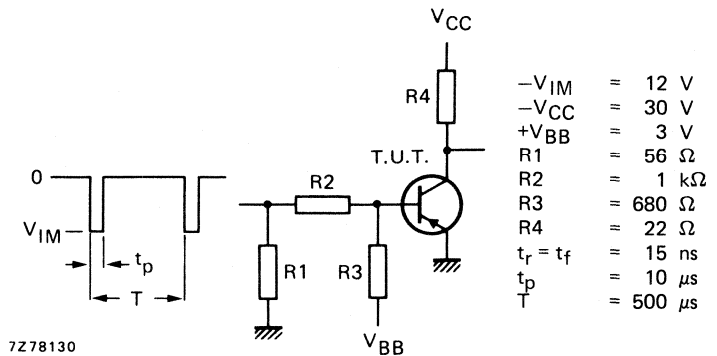


Fig. 4 Switching times test circuit.

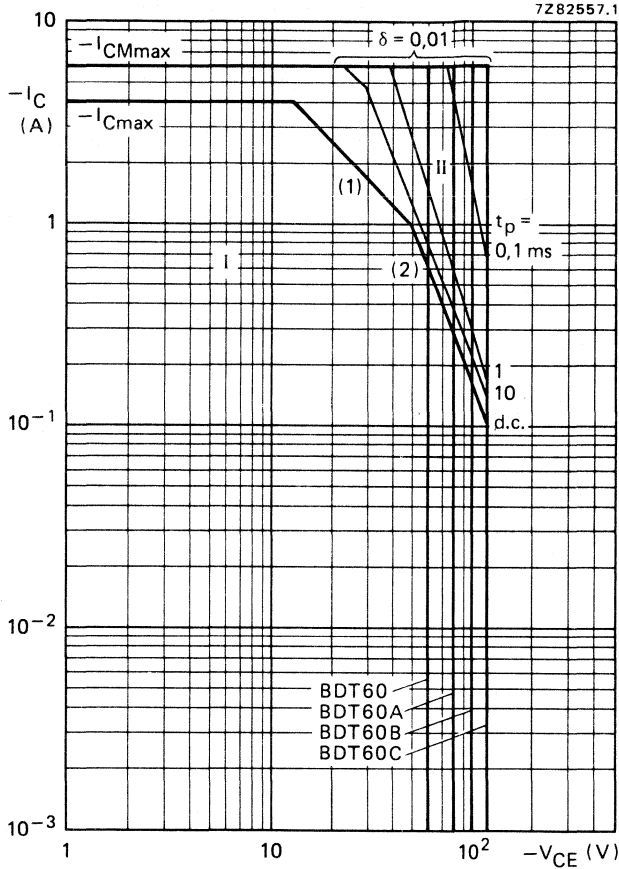


Fig. 5 Safe Operating Area; $T_{mb} = 25\ ^\circ C$.

- 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).

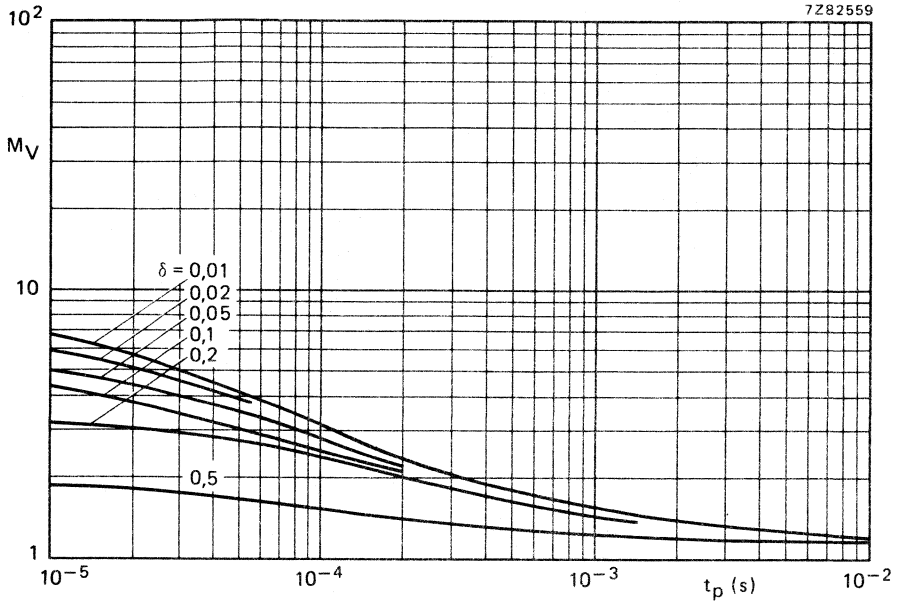


Fig. 6 Second-breakdown voltage multiplying factor at the $I_{C \max}$ level.

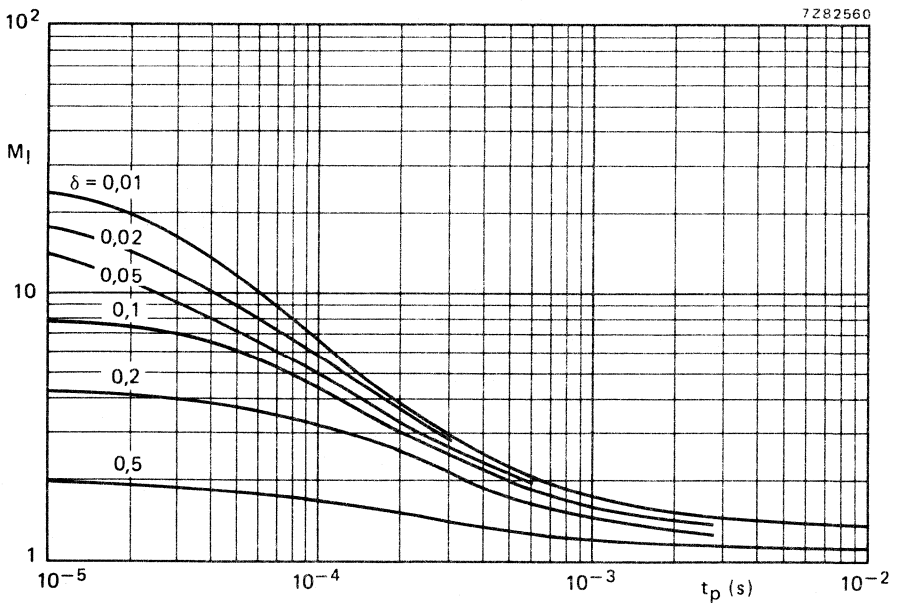


Fig. 7 Second-breakdown current multiplying factor at the $V_{CE0 \max}$ level.

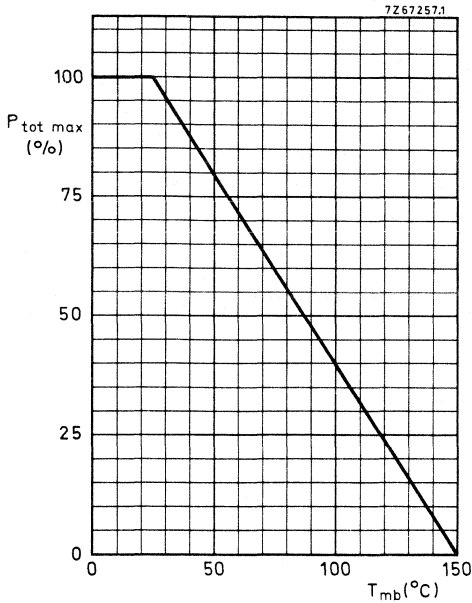


Fig. 8 Power derating curve.

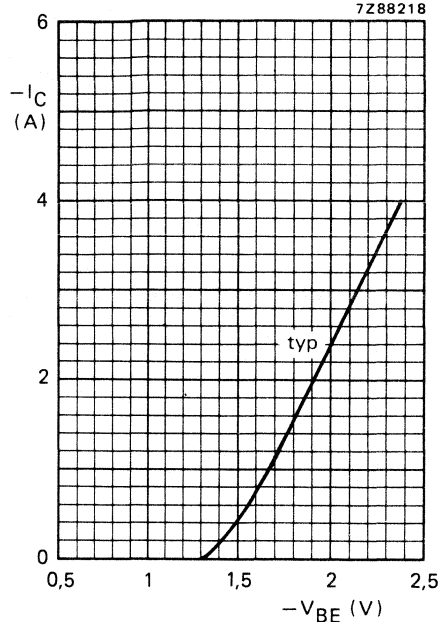


Fig. 9 $-V_{CE} = 3\ V$; $T_j = 25\ °C$.

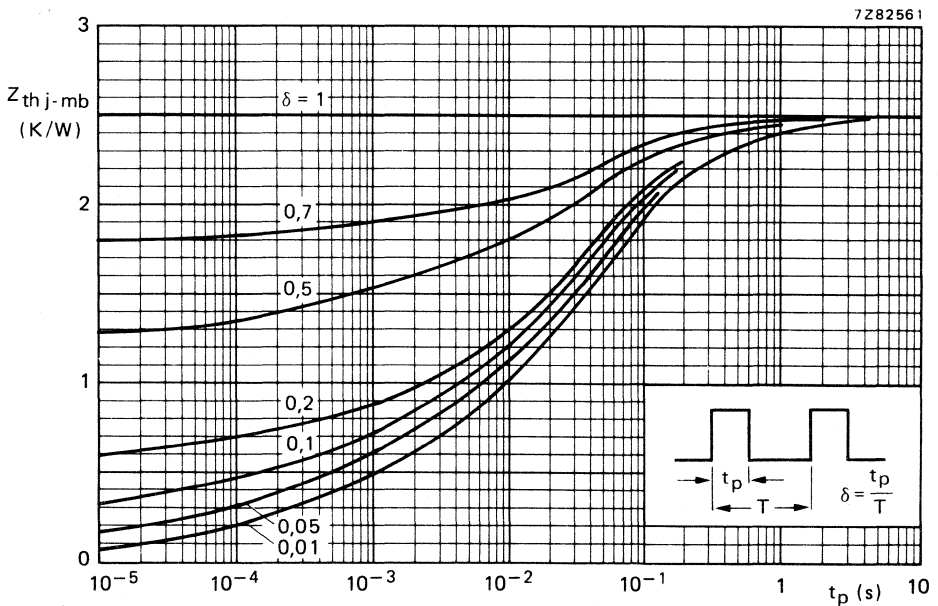


Fig. 10 Pulse power rating chart.

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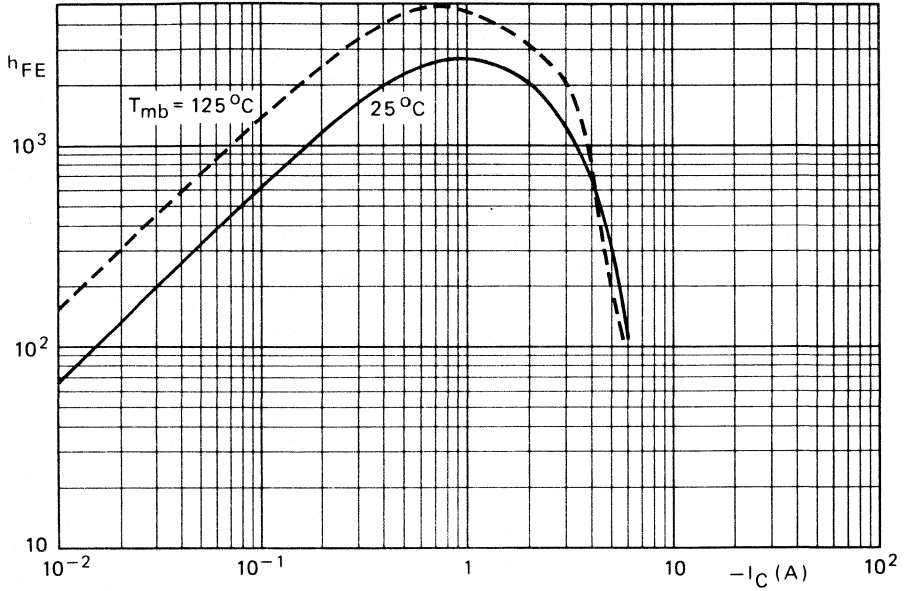


Fig. 11 Typical d.c. current gain. $-V_{CE} = 3$ V.

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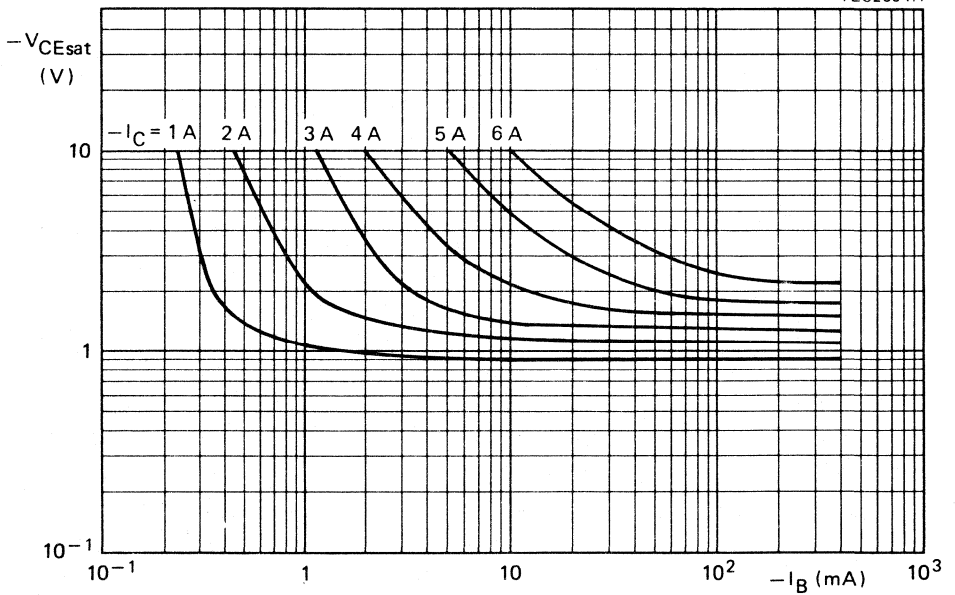


Fig. 12 Typical values collector-emitter saturation voltage at $T_{mb} = 25^\circ\text{C}$.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N silicon power transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier applications.

P-N-P complements are BDT60, 60A, 60B and 60C.

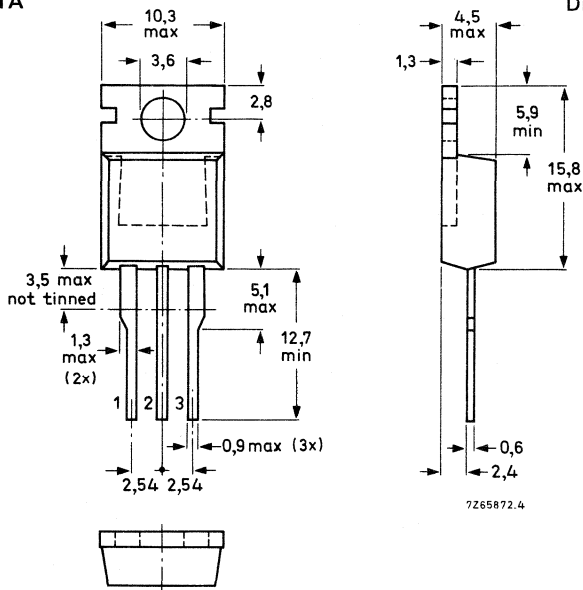
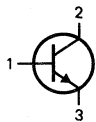
QUICK REFERENCE DATA

		BDT61			
		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.		4	A	
Collector current (peak value)	I_{CM} max.		6	A	
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.		50	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.		2200		

MECHANICAL DATA

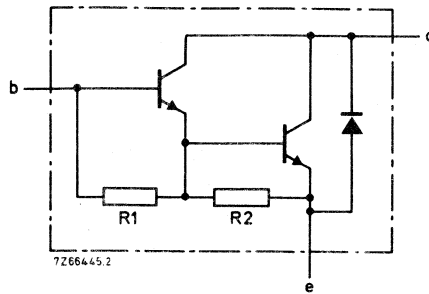
Fig. 1 TO-220AB.

Collector connected to mounting base.



Dimensions in mm

See also chapters Mounting Instructions and Accessories.



R1 typ. 6 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

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

			BDT61			
			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.		4		A
Collector current (peak value)	I_{CM}	max.		6		A
Reverse diode current	$I_R = -I_C$	max.		4		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.		50		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	$R_{th\ j-mb}$	=		2,5		K/W
From junction to ambient (in free air)	$R_{th\ j-a}$	=		70		K/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

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

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

$I_E = 0; V_{CB} = \frac{1}{2}V_{CB0\text{max}}; T_j = 150\text{ }^\circ\text{C}$

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

$I_B = 0; V_{CE} = \frac{1}{2}V_{CE0\text{max}}$

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

Emitter cut-off current

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

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

Forward-bias second-breakdown collector current

$V_{CE} = 50\text{ V}; t = 0,1\text{ s}; \text{non-repetitive}$

(without heatsink); $T_{\text{amb}} = 25\text{ }^\circ\text{C}$

$I_{(SB)} > 1\text{ A}$

D.C. current gain *

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

$h_{FE} \text{ typ. } 2200$

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

$h_{FE} > 750$

$I_C = 4\text{ A}; V_{CE} = 3\text{ V}$

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

Base-emitter voltage *

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

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

Collector-emitter saturation voltage *

$I_C = 1,5\text{ A}; I_B = 6\text{ mA}$

$V_{CE\text{sat}} < 2,5\text{ V}$

Turn-off breakdown energy with inductive load (Fig. 3)

$-I_{B\text{off}} = 0; L = 5\text{ mH}; I_{CC} = 3,2\text{ A}$

$E_{(BR)} > 25\text{ mJ}$

Small-signal current gain at $f = 1\text{ MHz}$

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

$h_{fe} > 10$

Cut-off frequency

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

$f_{hfe} \text{ typ. } 25\text{ kHz}$

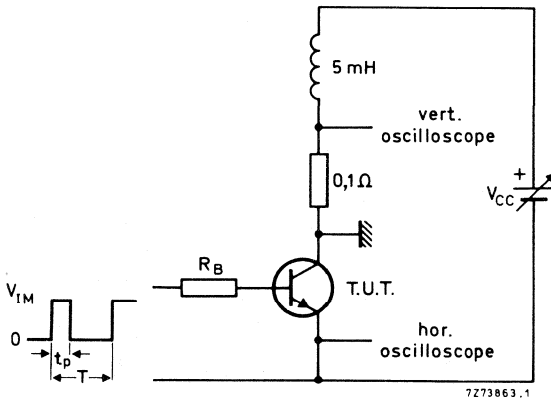


Fig. 3 Turn-off breakdown energy with inductive load.

$$V_{IM} = 12\text{ V}; R_B = 270\ \Omega; \delta = \frac{t_p}{T} \times 100\% = 1\%; I_{CC} = 3,2\text{ A}.$$

* Measured under pulse conditions; $t_p < 300\ \mu\text{s}$; $\delta < 2\%$.

CHARACTERISTICS (continued)

Diode, forward voltage

$I_F = 1,5 \text{ A}$
 $I_F = 4 \text{ A}$

$V_F < 2 \text{ V}$
 $V_F \text{ typ. } 2,1 \text{ V}$

Switching times

(between 10% and 90% levels)

$I_{Con} = 1,5 \text{ A}; I_{Bon} = -I_{Boff} = 6 \text{ mA}$
turn-on time

$t_{on} \text{ typ. } 0,8 \mu\text{s}$
 $< 2 \mu\text{s}$
 $t_{off} \text{ typ. } 4,5 \mu\text{s}$
 $< 8 \mu\text{s}$

turn-off time

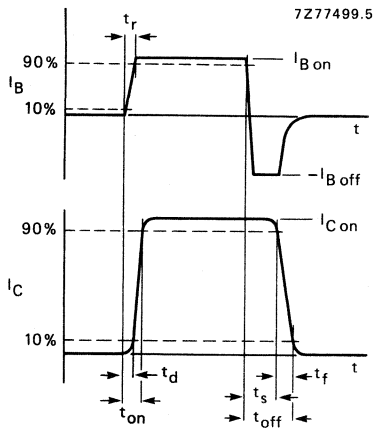
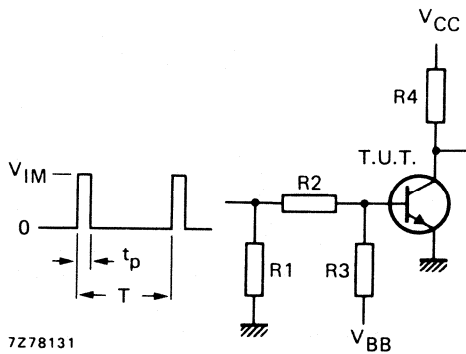


Fig. 4 Switching times waveforms.



$V_{IM} = 12 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BB} = 3 \text{ V}$
 $R1 = 56 \Omega$
 $R2 = 1 \text{ k}\Omega$
 $R3 = 680 \Omega$
 $R4 = 22 \Omega$
 $t_r = t_f = 15 \text{ ns}$
 $t_p = 10 \mu\text{s}$
 $T = 500 \mu\text{s}$

Fig. 5 Switching times test circuit.

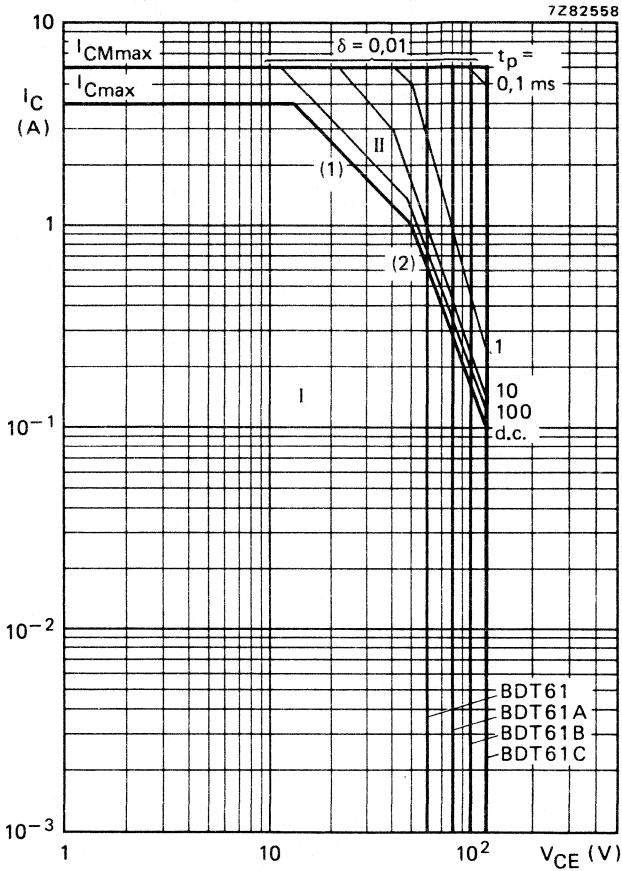


Fig. 6 Safe Operating Area; $T_{mb} = 25 \text{ }^\circ\text{C}$.

- 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).

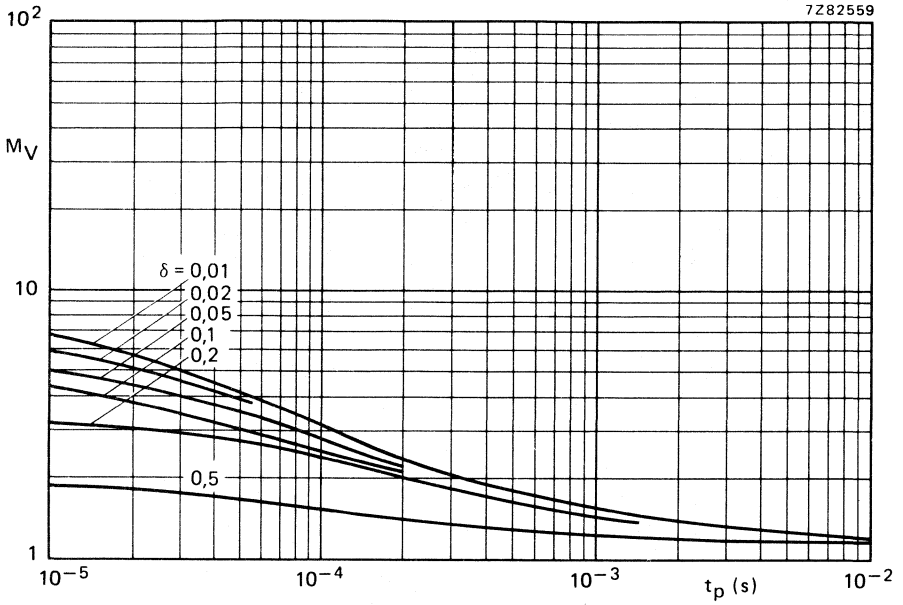


Fig. 7 Second breakdown voltage multiplying factor at the I_{Cmax} level.

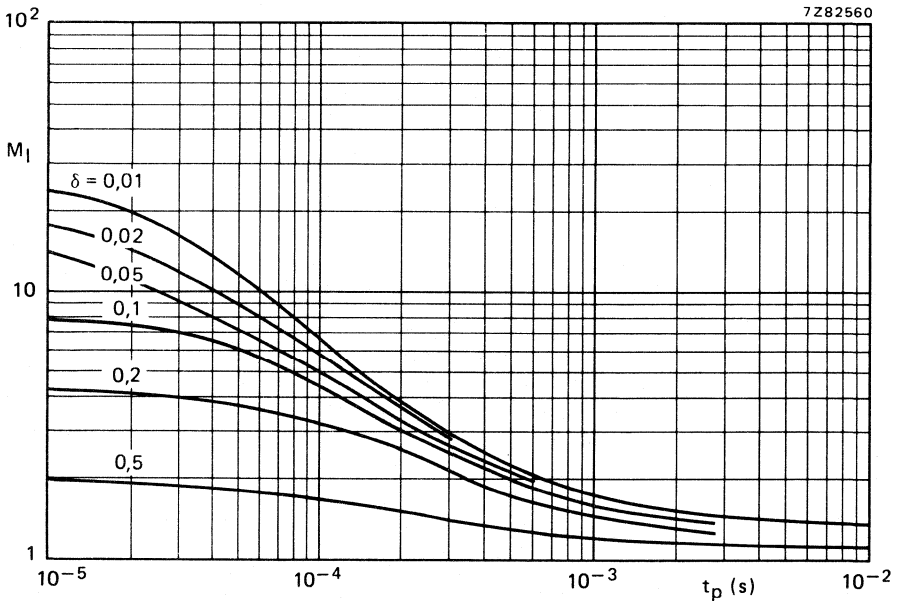


Fig. 8 Second breakdown current multiplying factor at the V_{CEmax} level.

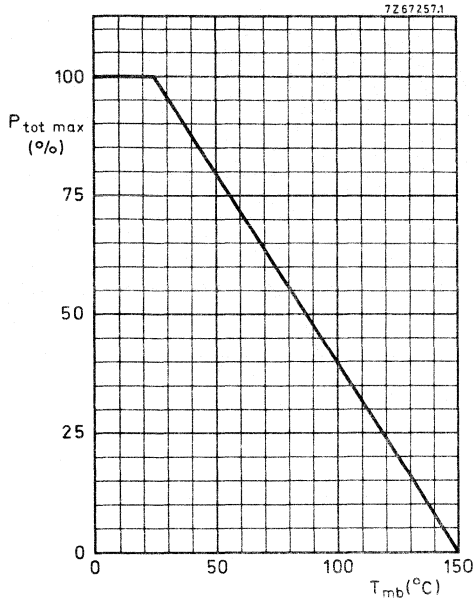


Fig. 9 Power derating curve.

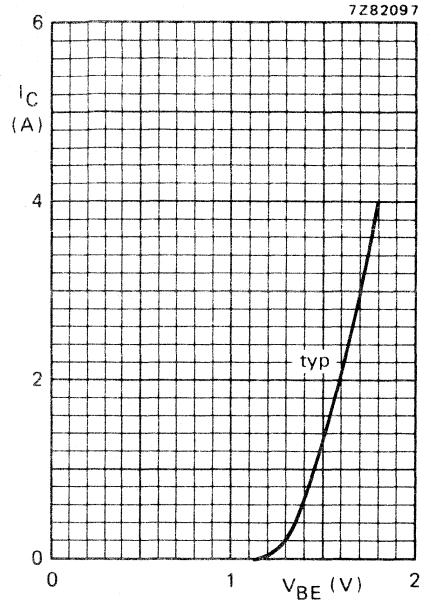


Fig. 10 $V_{CE} = 3\ V; T_j = 25\ °C$.

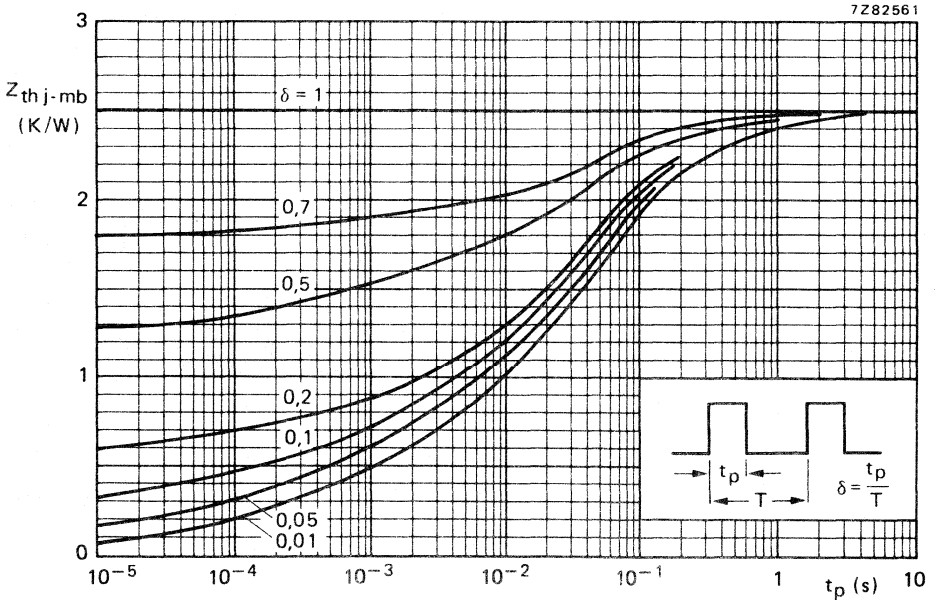


Fig. 11 Pulse power rating chart.

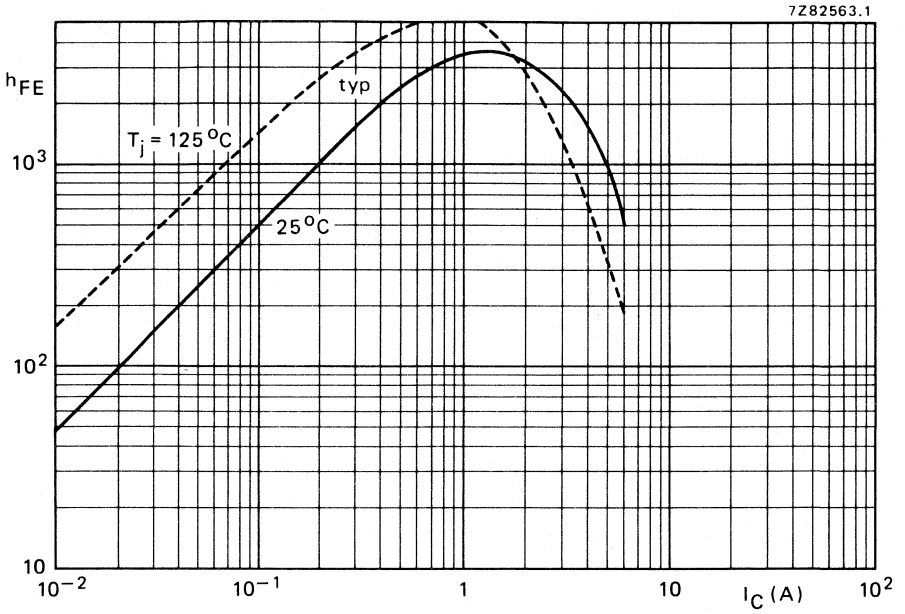


Fig. 12 Typical d.c. current gain. $V_{CE} = 3\text{ V}$.

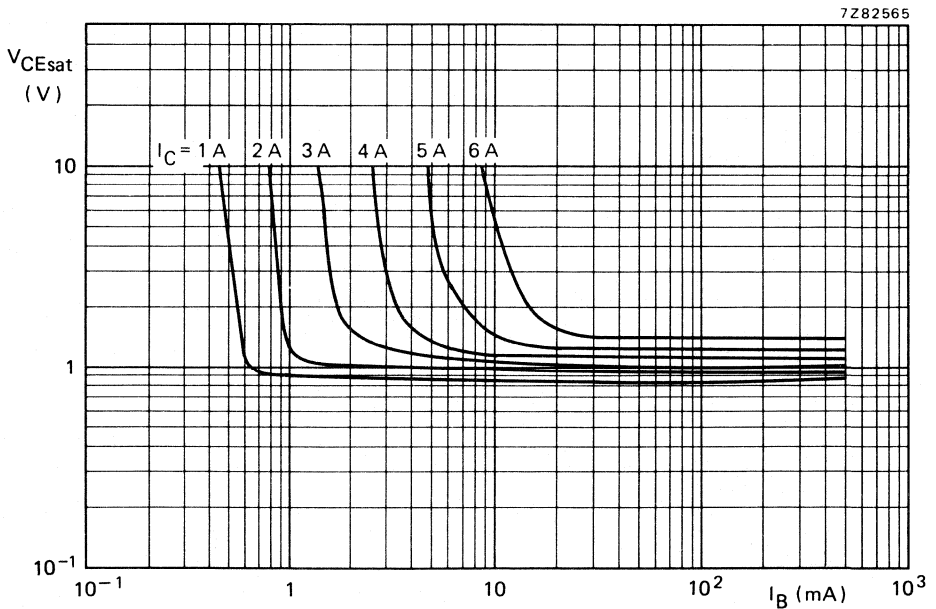


Fig. 13 Typical values collector-emitter saturation voltage at $T_{mb} = 25^\circ\text{C}$.

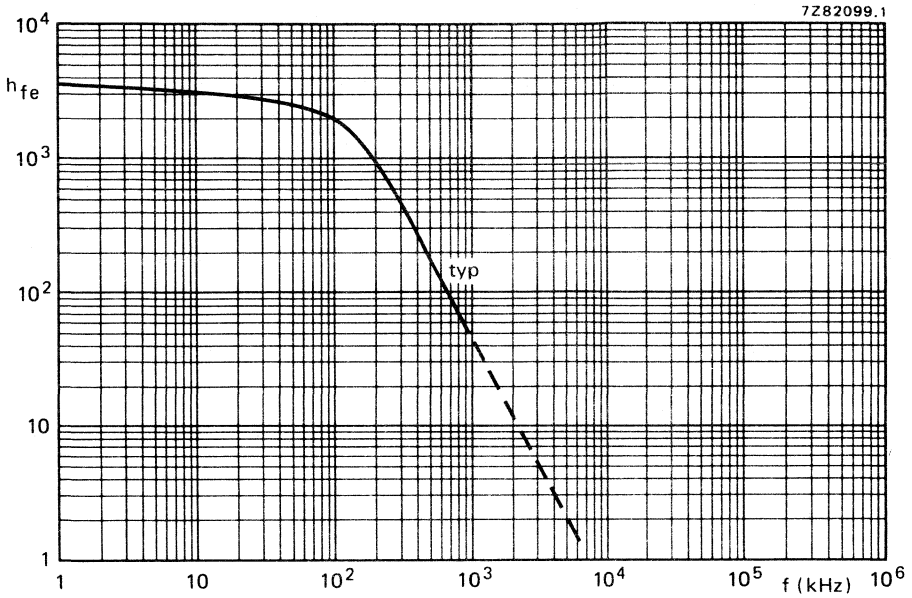


Fig. 14 Small signal current gain. $I_C = 1,5$ A; $V_{CE} = 3$ V; $T_j = 25$ °C.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. TO-220 plastic envelope. N-P-N complements are BDT63, BDT63A, BDT63B and BDT63C.

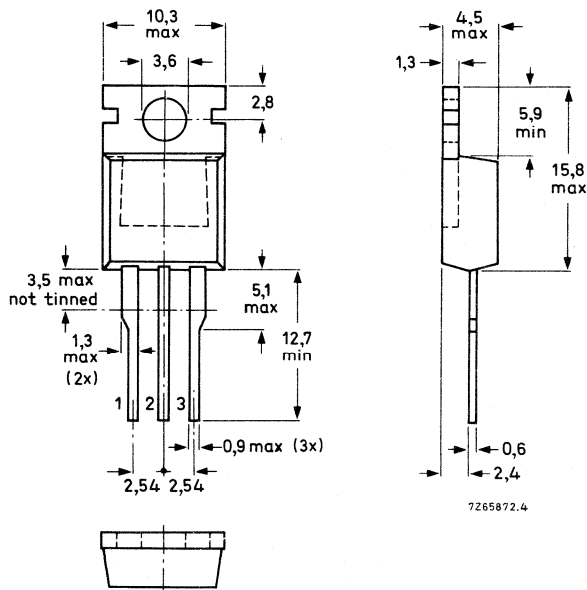
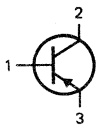
QUICK REFERENCE DATA

		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.

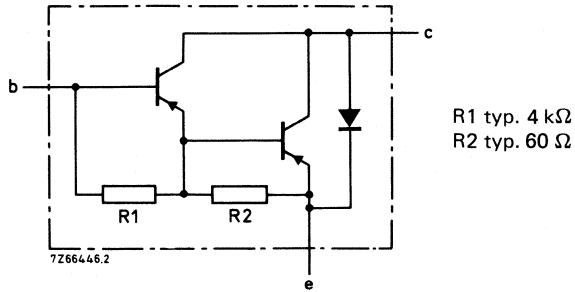


Fig. 2 Circuit diagram.

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	K/W
From junction to ambient (in free air)	$R_{th\ j-a}$ =	70	K/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

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

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

$I_E = 0; -V_{CB} = -\frac{1}{2}V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$

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

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

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

Emitter cut-off current

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

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

Forward bias second-breakdown collector current

$-V_{CE} = 40\text{ V}; t = 0,1\text{ s}; \text{non-repetitive}$

(without heatsink)

BDT62

$I_{(SB)} > 0,45\text{ A}$

BDT62A, B and C

$I_{(SB)} > 1,4\text{ A}$

D.C. current gain*

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

$h_{FE} > 1000$

$-I_C = 10\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 200$

Base-emitter voltage*

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

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

Collector-emitter saturation voltage*

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

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

$-I_C = 8\text{ A}; -I_B = 80\text{ mA}$

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

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 $f = 1\text{ MHz}$

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

$h_{fe} > 10$

* 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. $0,5 \mu\text{s}$
 $< 1,5 \mu\text{s}$

turn-off time

t_{off} typ. $2,5 \mu\text{s}$
 $< 5 \mu\text{s}$

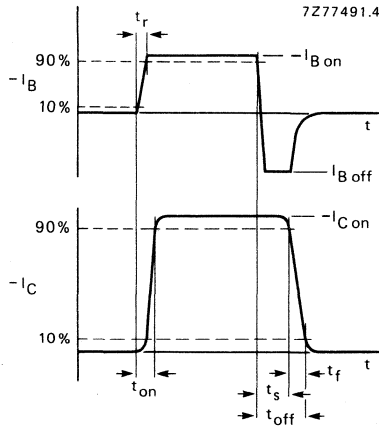
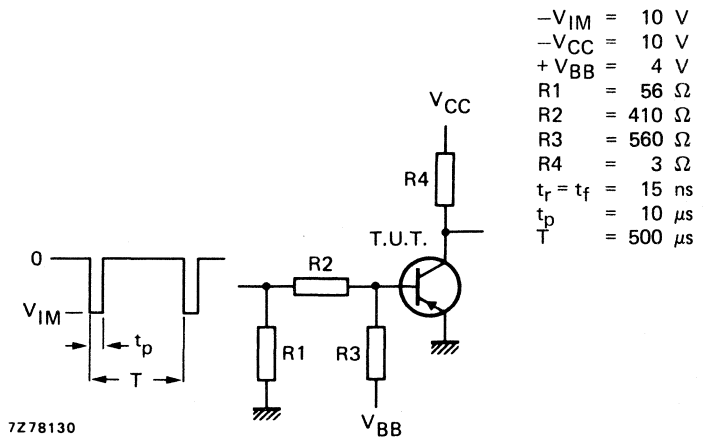


Fig. 3 Switching times waveforms.



- $-V_{IM} = 10 \text{ V}$
- $-V_{CC} = 10 \text{ V}$
- $+V_{BB} = 4 \text{ V}$
- $R1 = 56 \Omega$
- $R2 = 410 \Omega$
- $R3 = 560 \Omega$
- $R4 = 3 \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 10 \mu\text{s}$
- $T = 500 \mu\text{s}$

Fig. 4 Switching times test circuit.

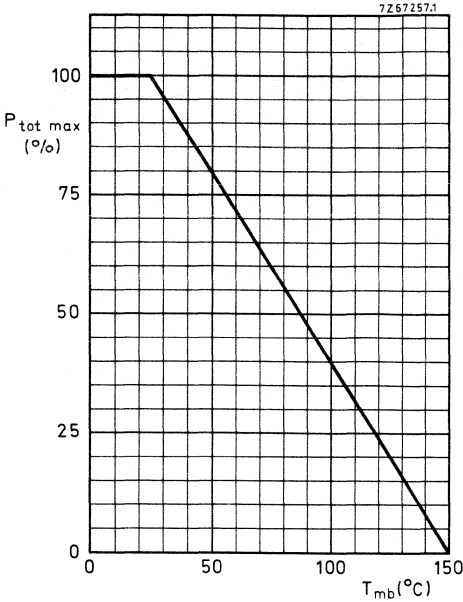


Fig. 5 Power derating curve.

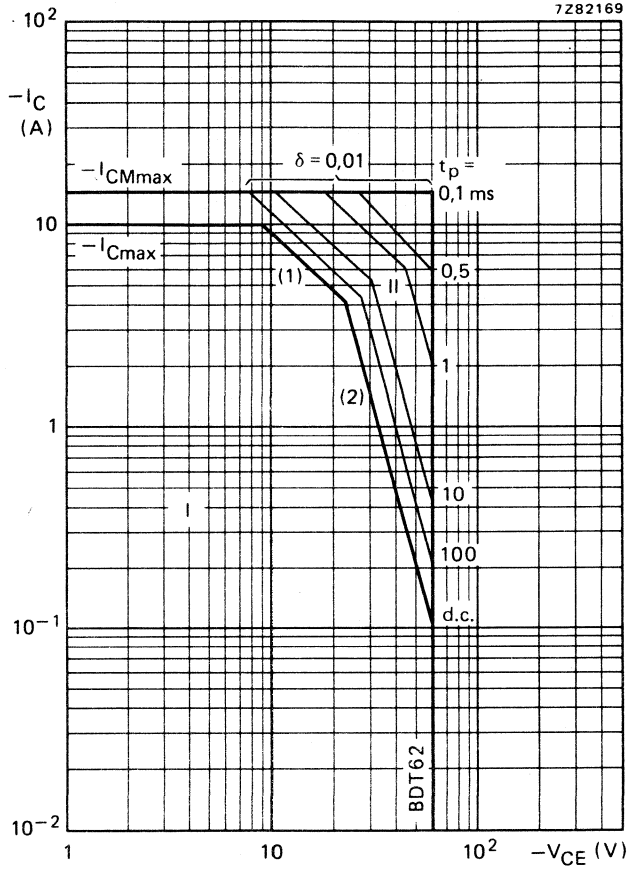


Fig. 6 Safe Operating Area BDT62; $T_{mb} = 25 \text{ }^\circ\text{C}$.

- 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).

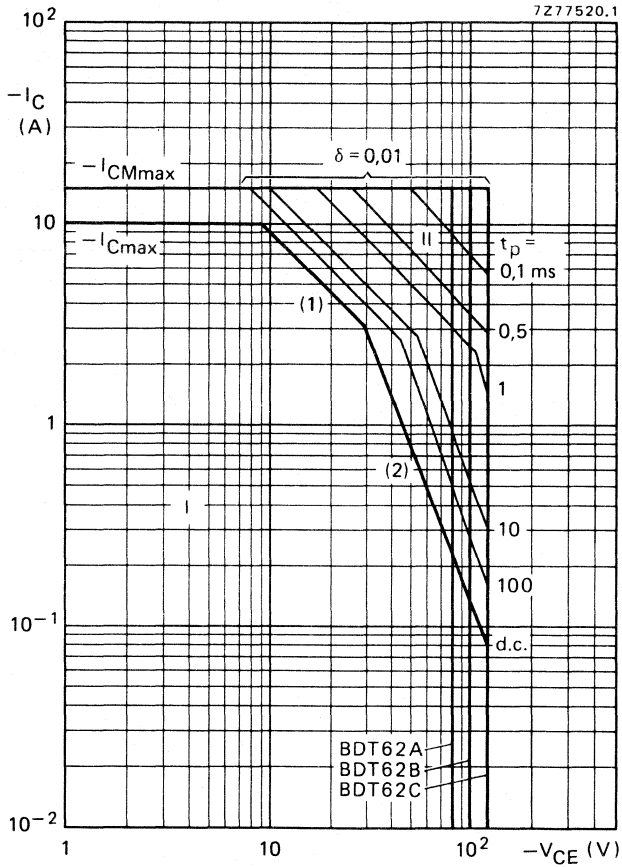


Fig. 7 Safe Operating Area BDT62A; 62B and 62C; $T_{mb} = 25 \text{ }^\circ\text{C}$.

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

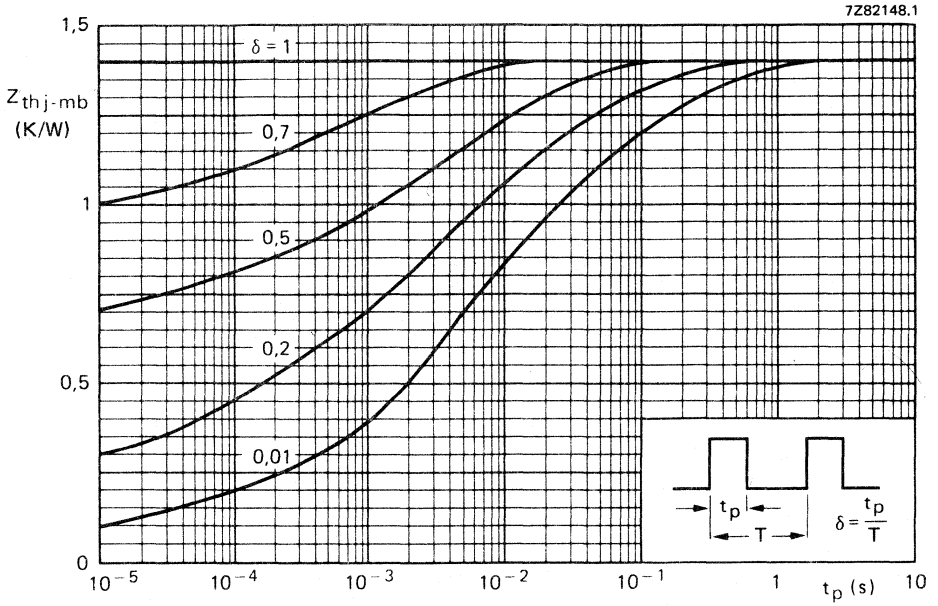


Fig. 8 Pulse power rating chart.

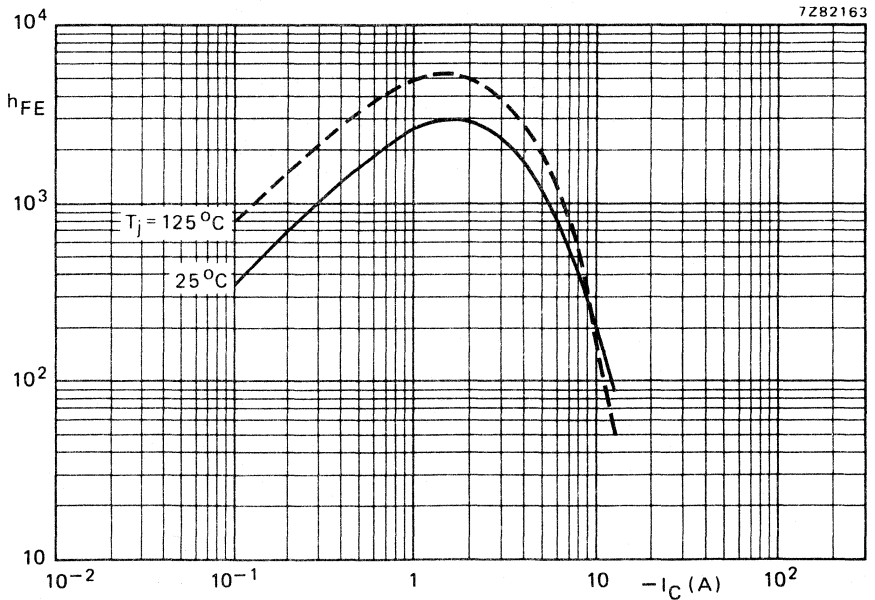


Fig. 9 Typical d.c. current gain at $-V_{CE} = 3\text{ V}$.

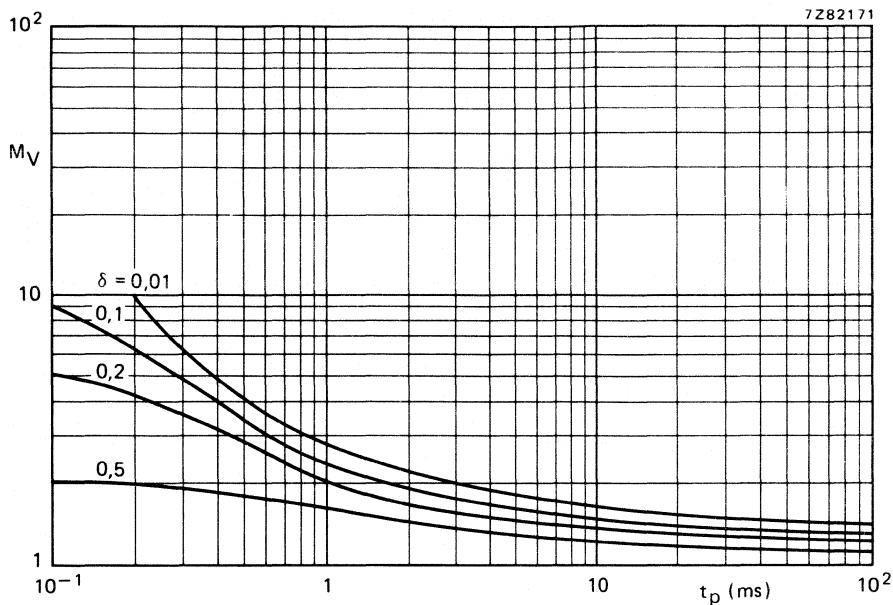


Fig. 10 S.B. voltage multiplying factor at the I_C max level.

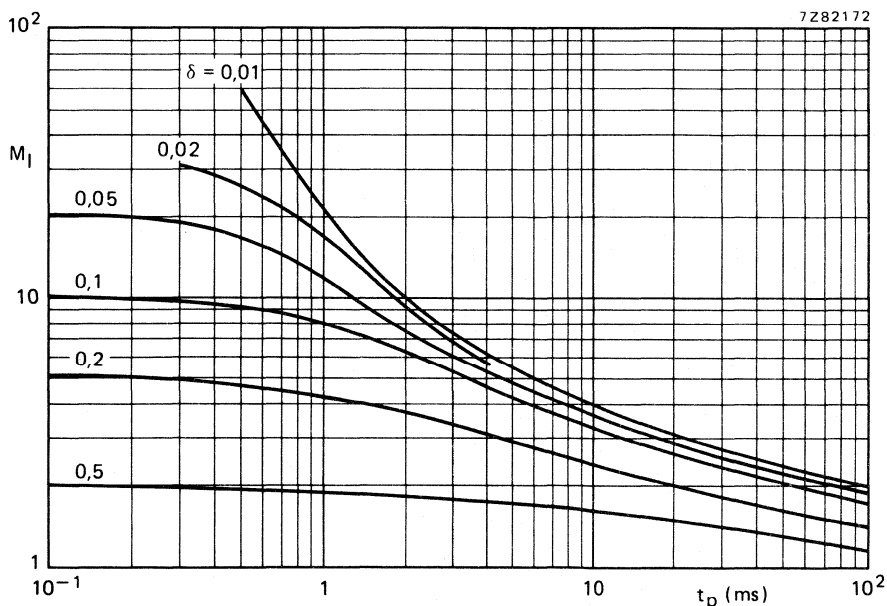


Fig. 11 S.B. current multiplying factor at the V_{CE0} max level.

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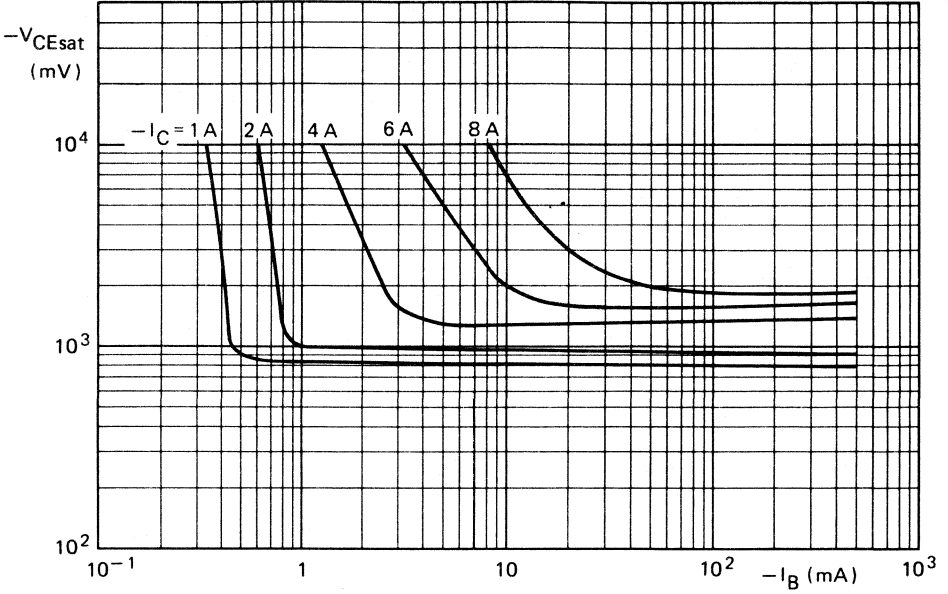


Fig. 12 Typical collector-emitter saturation voltage.

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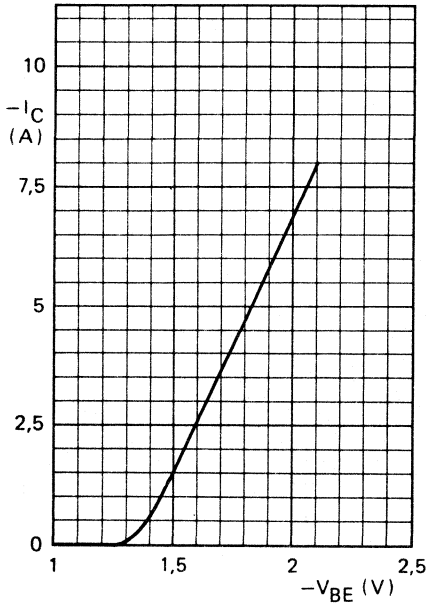


Fig. 13 Typical base emitter voltage as a function of the collector current.

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.

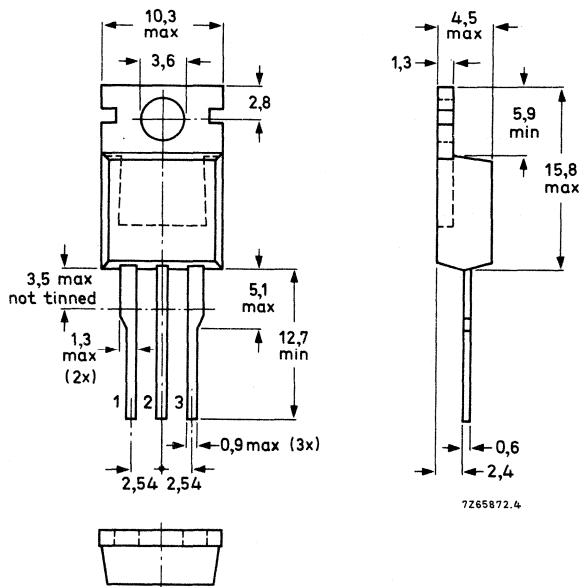
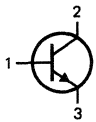
QUICK REFERENCE DATA

		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	max. 10			A
Collector current (peak value) $t_p = 0,3 \text{ ms}; \delta = 10\%$	I_{CM}	max. 15			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 $I_C = 3 \text{ A}; V_{CE} = 3 \text{ V}$	h_{FE}	> 1000			

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters
Mounting instructions
and Accessories.

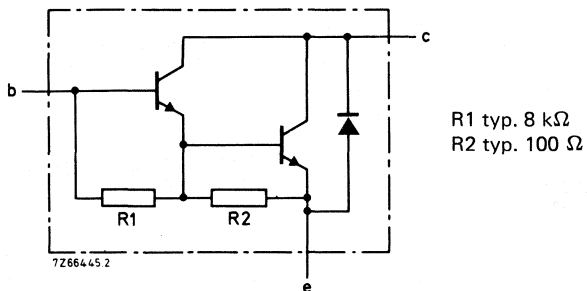


Fig. 2 Circuit diagram.

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) $t_p = 0,3$ 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		K/W
From junction to ambient (in free air)	$R_{th\ j-a}$	=	70		K/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

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

$$I_E = 0; V_{CB} = \frac{1}{2}V_{CB0\max}; T_j = 150\text{ }^\circ\text{C}$$

$$I_B = 0; V_{CE} = \frac{1}{2}V_{CE0\max}$$

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
-----------	---	------

Forward-bias second-breakdown collector current

$$V_{CE} = 60\text{ V}; t = 0,1\text{ s}; \text{non-repetitive}$$

(without heatsink)

$I_{(SB)}$	>	1,5 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}	typ.	3000

Base-emitter voltage*

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

V_{BE}	<	2,5 V
----------	---	-------

Collector-emitter saturation voltage*

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

$$I_C = 8\text{ A}; I_B = 80\text{ mA}$$

$V_{CE\text{sat}}$	<	2 V
$V_{CE\text{sat}}$	<	2,5 V

Diode, forward voltage

$$I_F = 3\text{ A}$$

V_F	<	2 V
-------	---	-----

Turn-off breakdown energy with inductive load (Fig. 6)

$$-I_{B\text{off}} = 0; L = 5\text{ mH}$$

$E_{(BR)}$	>	100 mJ
------------	---	--------

Small-signal current gain at $f = 1\text{ MHz}$

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

h_{fe}	>	10	←
----------	---	----	---

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

t_{on} typ. 1 μs
 < 2,5 μs

turn-off time

t_{off} typ. 5 μs
 < 10 μs

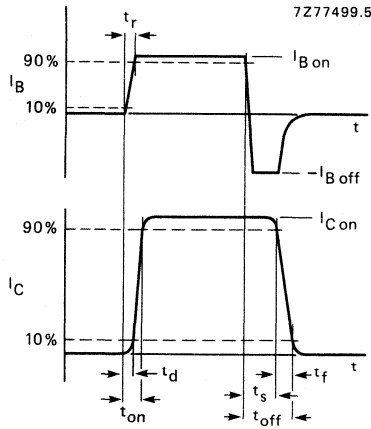
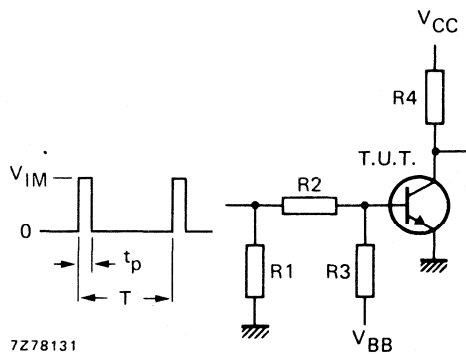


Fig. 3 Switching times waveforms.



- $V_{IM} = 10 \text{ V}$
- $V_{CC} = 10 \text{ V}$
- $-V_{BB} = 4 \text{ V}$
- $R1 = 56 \ \Omega$
- $R2 = 410 \ \Omega$
- $R3 = 560 \ \Omega$
- $R4 = 3 \ \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 10 \ \mu\text{s}$
- $T = 500 \ \mu\text{s}$

Fig. 4 Switching times test circuit.

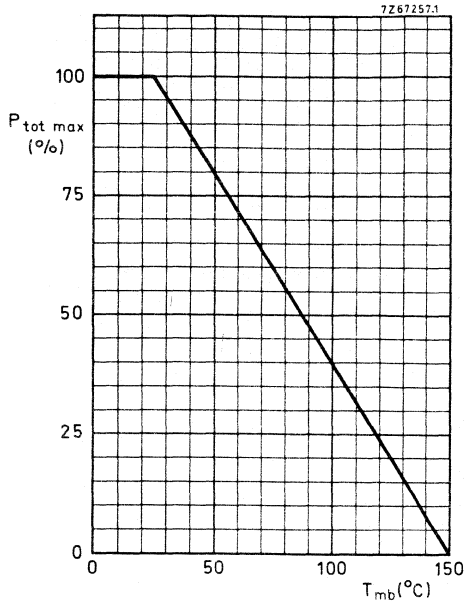


Fig. 5 Power derating curve.

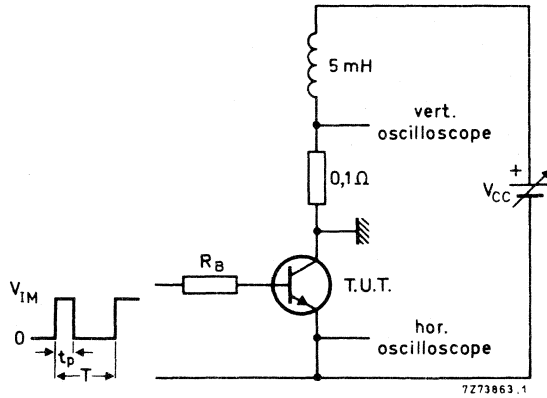


Fig. 6 Turn-off breakdown energy with inductive load.

$V_{IM} = 12\text{ V}; R_B = 270\ \Omega; \delta = \frac{t_p}{T} \times 100\% = 1\%; I_{CC} = 6,3\text{ A.}$

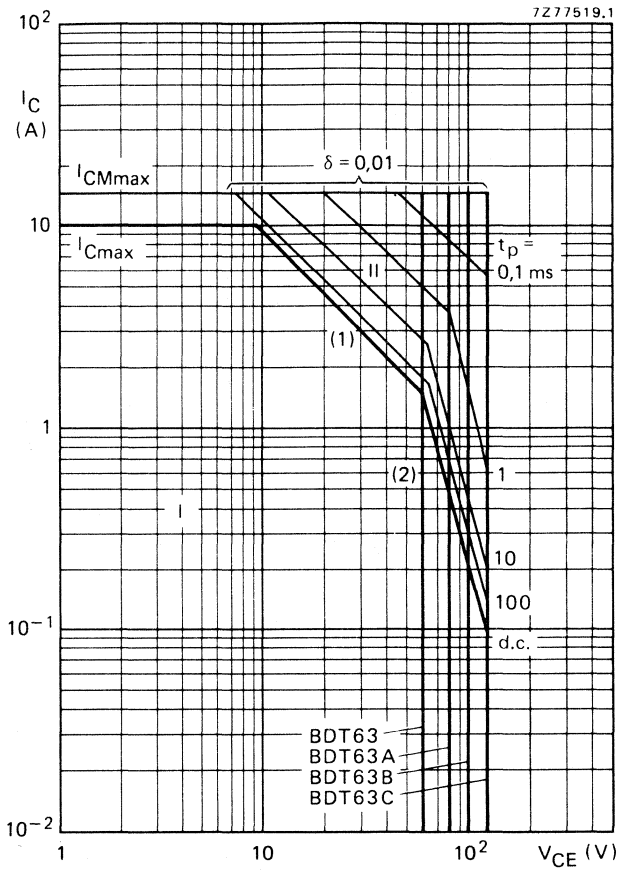


Fig. 7 Safe Operating Area; $T_{mb} = 25\ ^\circ C$.

- 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).

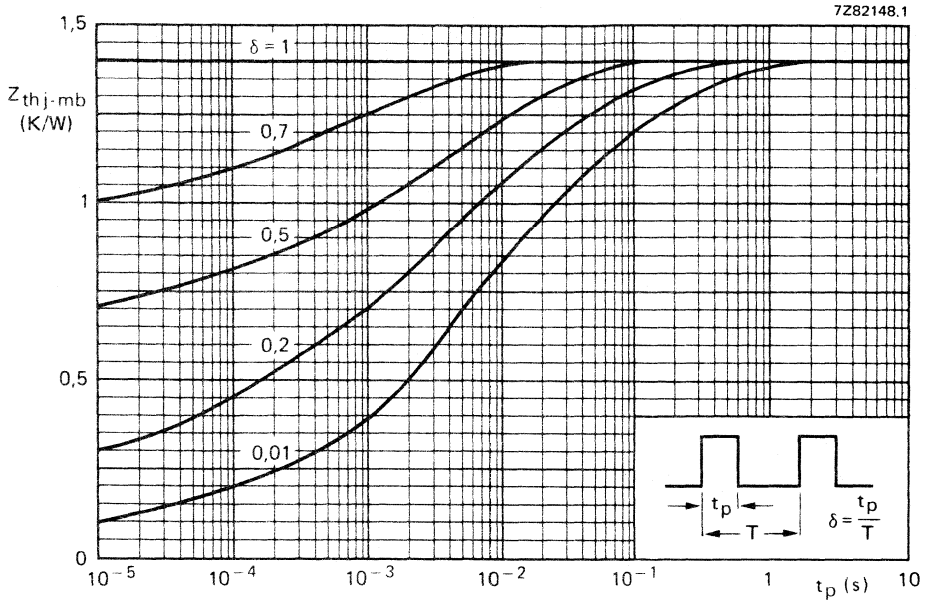


Fig. 8 Pulse power rating chart.

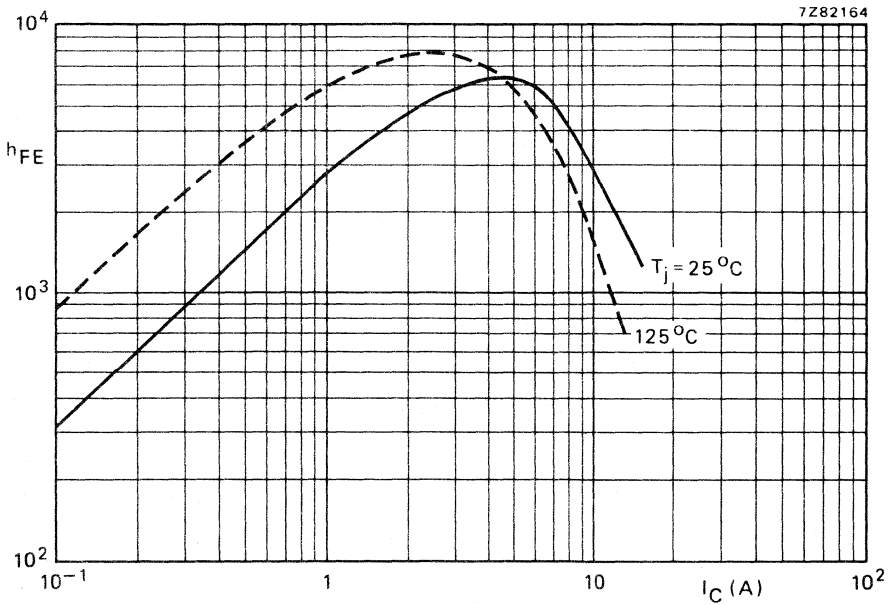


Fig. 9 Typical d.c. current gain at $V_{CE} = 3\text{V}$.

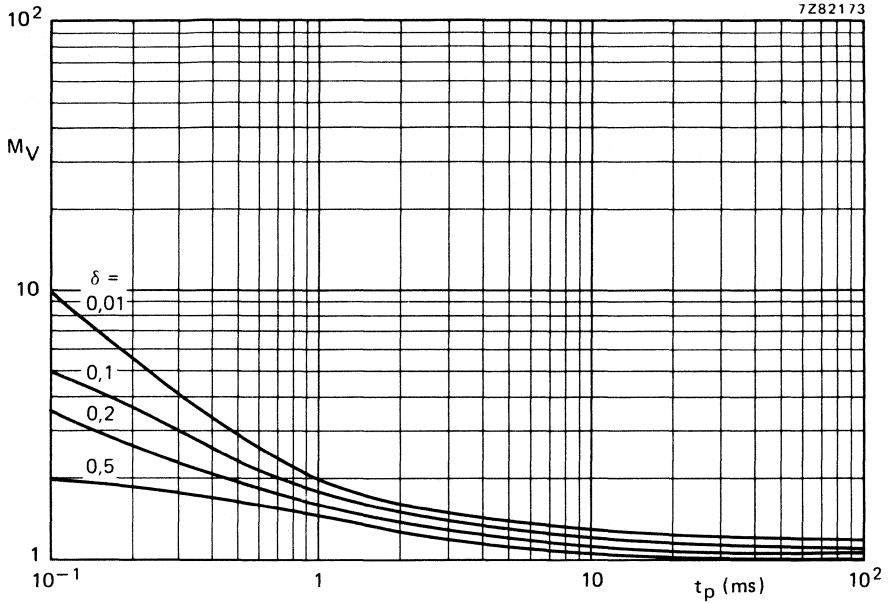


Fig. 10 S.B. voltage multiplying factor at the I_C max level.

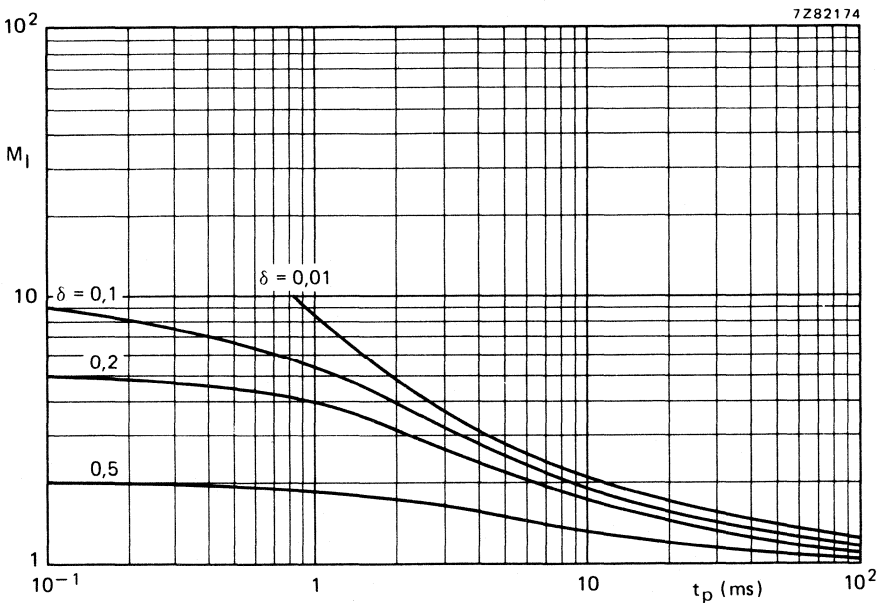


Fig. 11 S.B. current multiplying factor at V_{CE0} level = 60 V and 100 V.

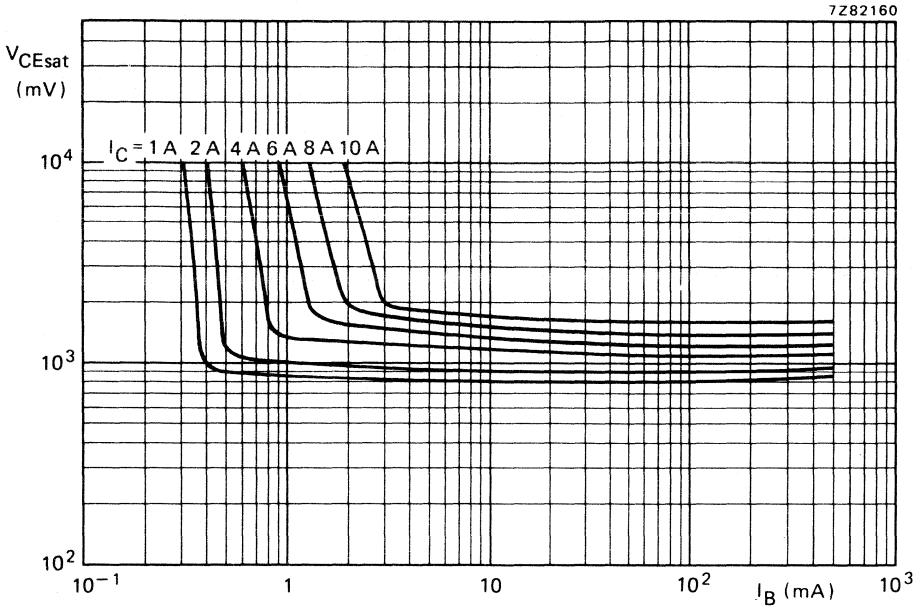


Fig. 12 Typical collector-emitter saturation voltage.

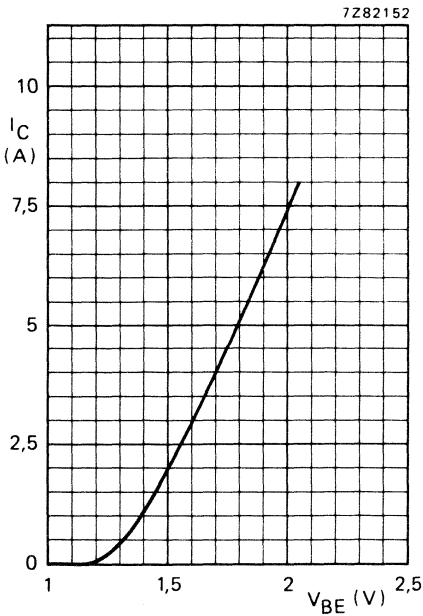


Fig. 13 Typical base-emitter voltage as a function of the collector current.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier and switching applications. TO-220 plastic envelope. N-P-N complements are BDT65, BDT65A, BDT65B and BDT65C.

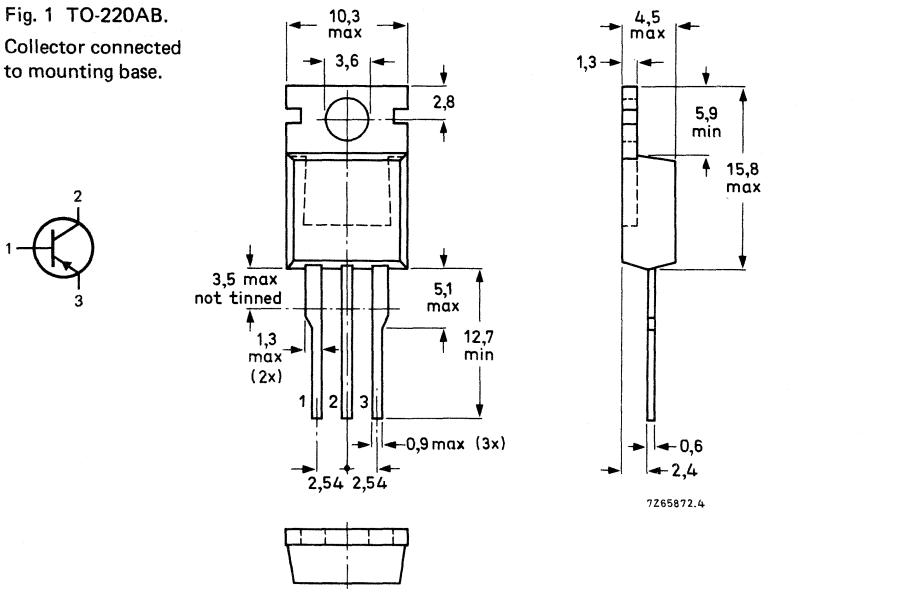
QUICK REFERENCE DATA

		BDT64	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 (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}	$>$			1000
$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$					

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

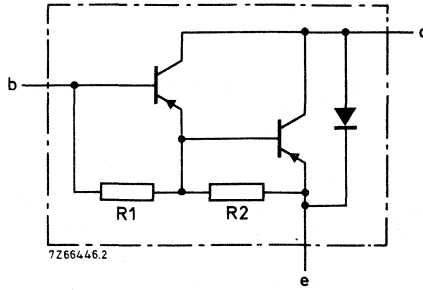


Fig. 2 Circuit diagram. R1 typ. 3 k Ω ; R2 typ. 45 Ω .

RATINGS

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

			BDT64	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.	20			A
Base current (d.c.)	$-I_B$	max.	500			mA
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	125			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	K/W
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CHARACTERISTICS

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

Collector cut-off current

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

$$I_E = 0; -V_{CB} = -\frac{1}{2} V_{CB0\max}; T_j = 150\text{ }^\circ\text{C}$$

$$I_B = 0; -V_{CE} = -\frac{1}{2} V_{CE0\max}$$

$-I_{CBO}$	<	0,4 mA
$-I_{CBO}$	<	2 mA
$-I_{CEO}$	<	1 mA

Emitter cut-off current

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

$-I_{EBO}$	<	5 mA
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D.C. current gain*

$$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$$

$$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$$

$$-I_C = 12\text{ A}; -V_{CE} = 4\text{ V}$$

h_{FE}	typ.	1500
h_{FE}	>	1000
h_{FE}	typ.	750

Base-emitter voltage

$$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$$

$-V_{BE}$	<	2,5 V
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Collector-emitter saturation voltage*

$$-I_C = 5\text{ A}; -I_B = 20\text{ mA}$$

$$-I_C = 10\text{ A}; -I_B = 100\text{ mA}$$

$-V_{CEsat}$	<	2 V
$-V_{CEsat}$	<	3 V

Diode, forward voltage

$$I_F = 5\text{ A}$$

$$I_F = 12\text{ A}$$

V_F	<	2 V
V_F	typ.	2 V

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

$$-V_{CB} = 10\text{ V}; I_E = I_e = 0$$

C_c	typ.	200 pF
-------	------	--------

Second breakdown collector current
non-repetitive; without heatsink

$$-V_{CE} = 60\text{ V}; t_p = 0,1\text{ s}$$

$-I_{SB}$	>	2 A
-----------	---	-----

Switching times (see Figs 3 and 4)

$$-I_{Con} = 5\text{ A}; -I_{Bon} = I_{Boff} = 20\text{ mA}$$

$$-V_{CC} = 30\text{ V}$$

turn-on time

t_{on}	typ.	0,5 μs
	<	2 μs

turn-off time

t_{off}	typ.	2,5 μs
	<	5 μs

Small-signal current gain

$$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz}$$

h_{fe}	>	10
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* Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$; $\delta < 2\%$.

CHARACTERISTICS (continued)

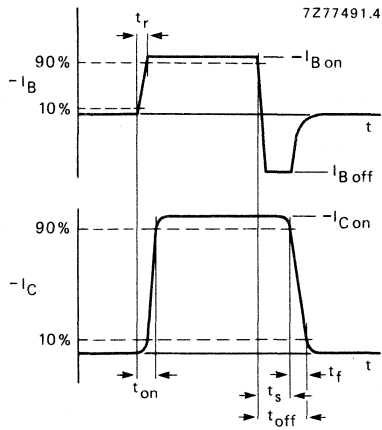
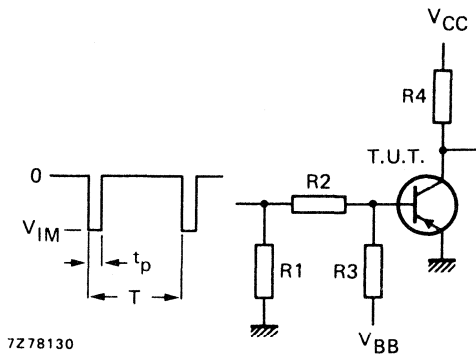


Fig. 3 Switching times waveforms.



- $-V_{IM} = 15 \text{ V}$
- $-V_{CC} = 30 \text{ V}$
- $V_{BB} = 4 \text{ V}$
- $R1 = 56 \ \Omega$
- $R2 = 410 \ \Omega$
- $R3 = 560 \ \Omega$
- $R4 = 6 \ \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 10 \ \mu\text{s}$
- $T = 500 \ \mu\text{s}$

Fig. 4 Switching times test circuit.

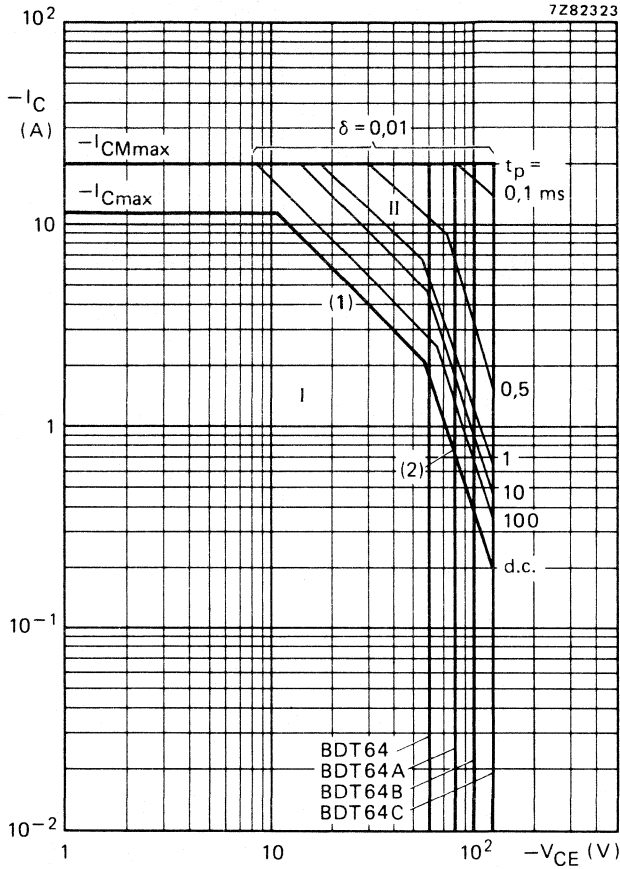


Fig. 5 Safe Operating Area; $T_{mb} = 25 \text{ }^\circ\text{C}$.

- 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).

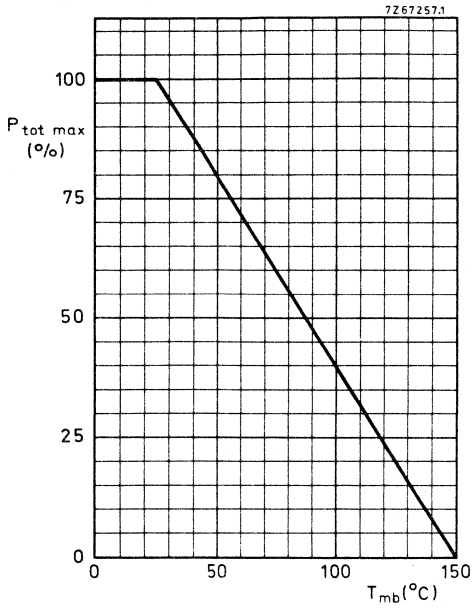


Fig. 6 Power derating curve.

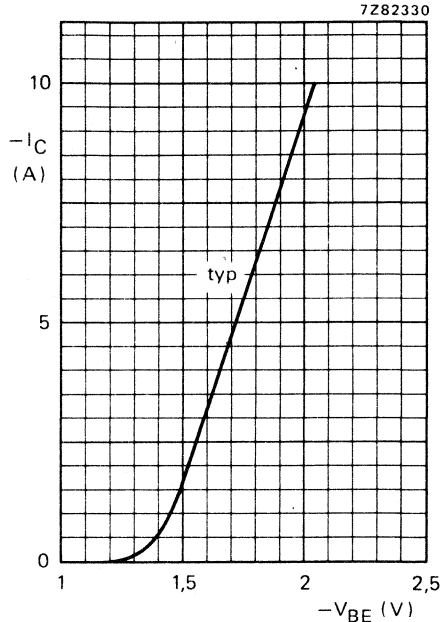


Fig. 7 $-V_{CE} = 3\ V$; $T_{amb} = 25\ ^\circ C$.

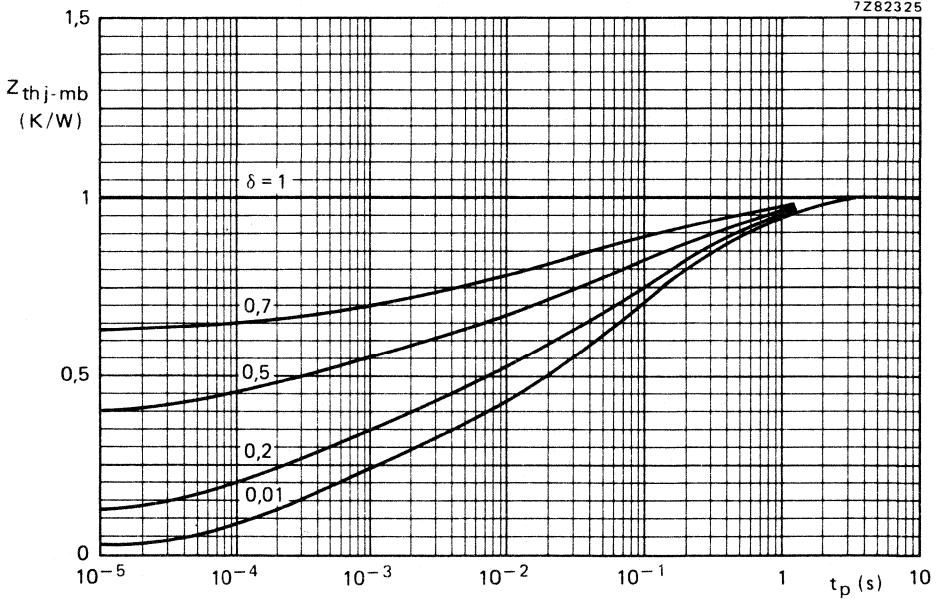


Fig. 8 Pulse power rating chart.

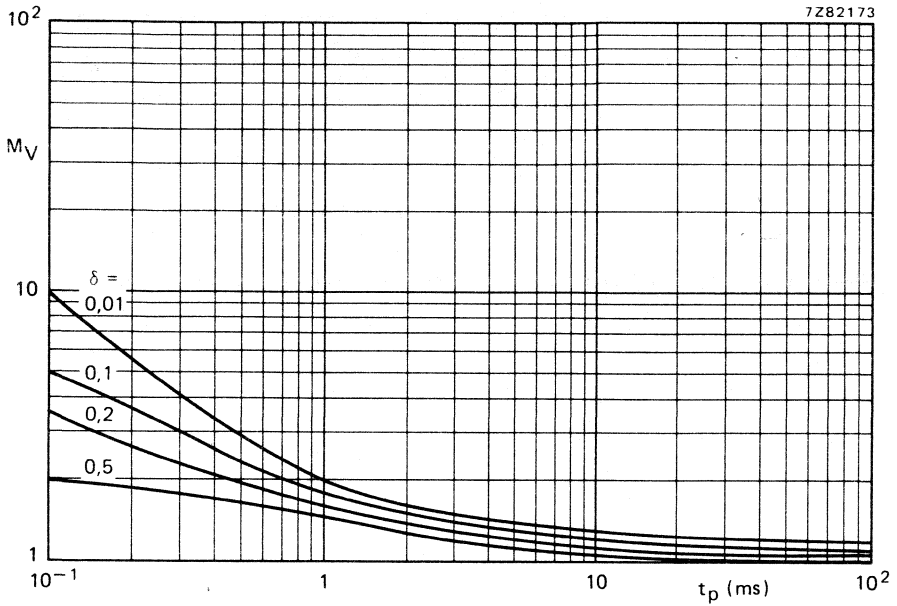


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

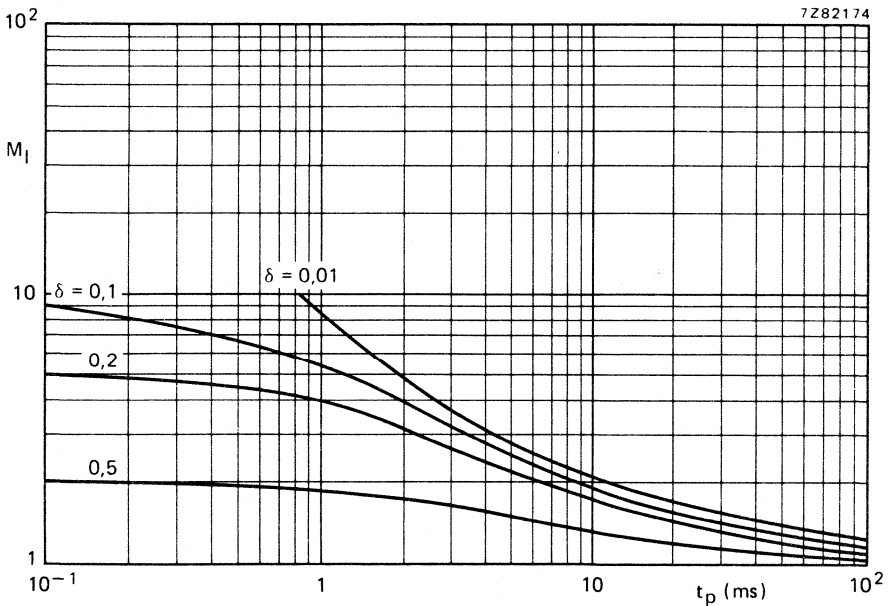


Fig. 10 S.B. current multiplying factor at the V_{CE0max} level.

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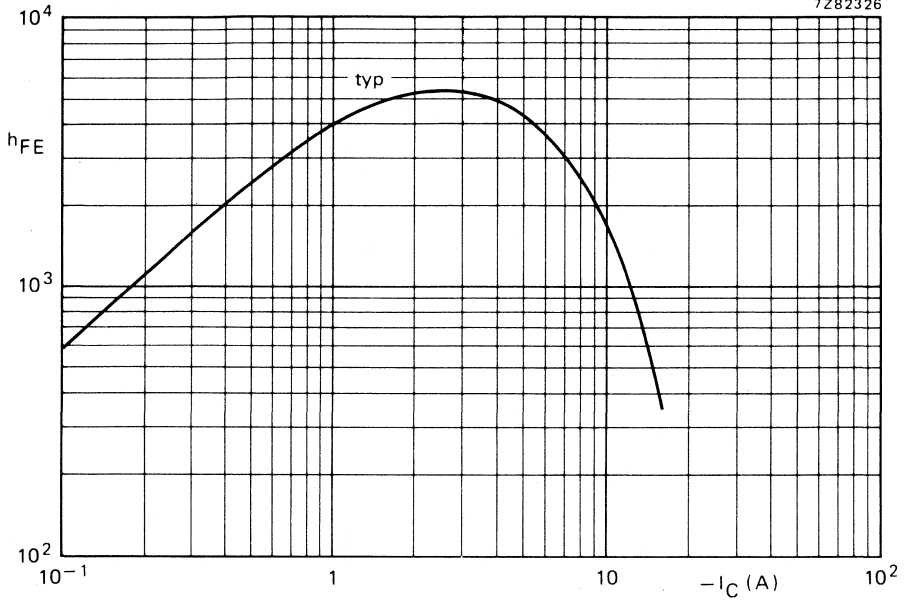


Fig. 11 D.C. current gain. $-V_{CE} = 3$ V; $T_j = 25$ °C.

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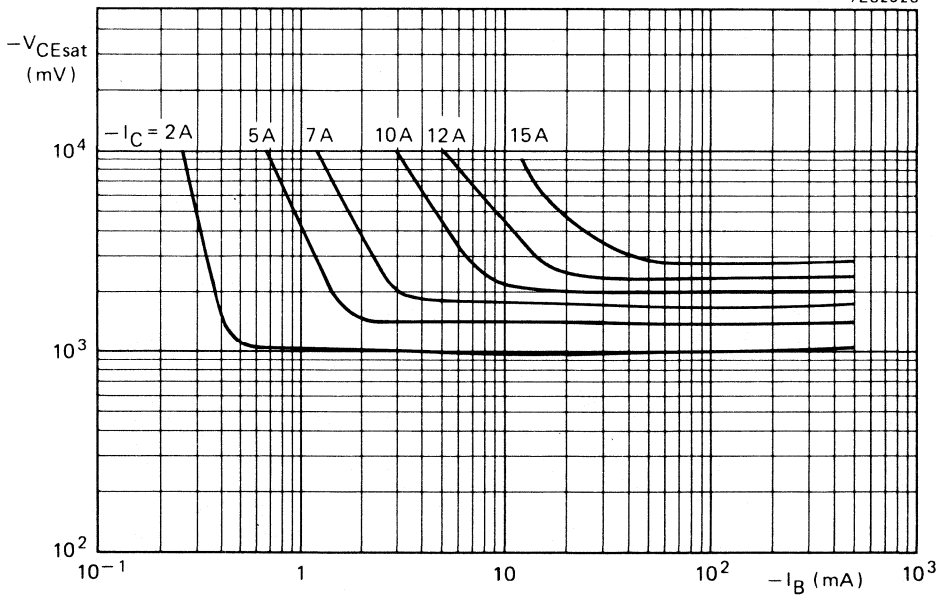


Fig. 12 Typical collector-emitter saturation voltages.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier and switching applications. TO-220 plastic envelope. P-N-P complements are BDT64; BDT64A; BDT64B and BDT64C.

QUICK REFERENCE DATA

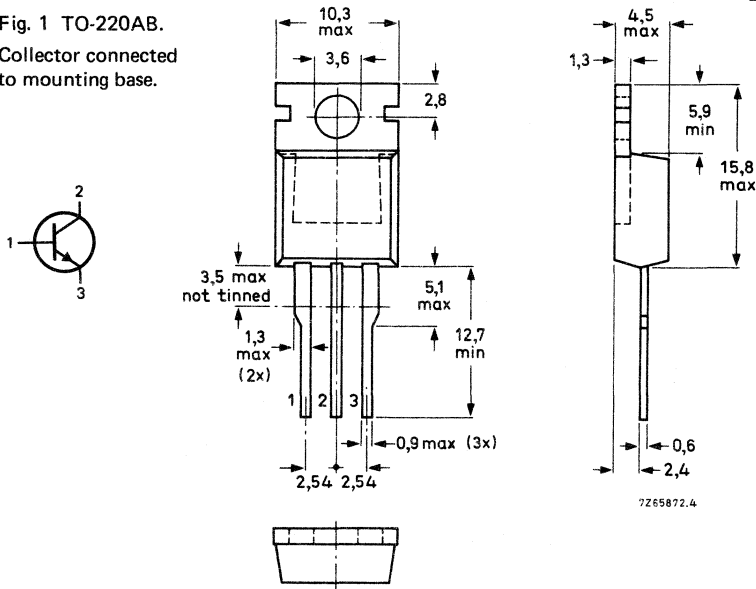
		BDT65	65A	65B	65C
Collector-base voltage (open emitter)	V_{CBO} max.	60	80	100	120 V
Collector-emitter voltage (open base)	V_{CEO} max.	60	80	100	120 V
Emitter-base voltage (open collector)	V_{EBO} max.	5	5	5	5 V
Collector current (peak value)	I_{CM} max.	20		A	
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.	125		W	
Junction temperature	T_j max.	150		$^{\circ}\text{C}$	
D.C. current gain $I_C = 5\text{ A}; V_{CE} = 4\text{ V}$	$h_{FE} >$	1000			

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.

Dimensions in mm



See also chapters Mounting instructions and Accessories.

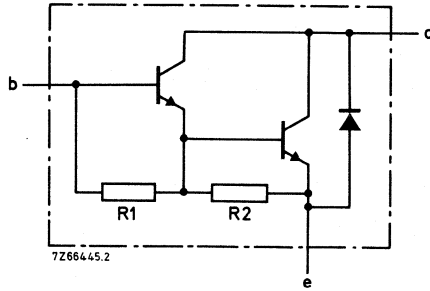


Fig. 2 Circuit diagram. R1 typ. 5 k Ω ; R2 typ. 80 Ω .

RATINGS

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

		BDT65	65A	65B	65C
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.	20			A
Base current (d.c.)	I_B max.	500			mA
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot} max.	125			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	K/W
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CHARACTERISTICS

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

Collector cut-off current

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

$I_{CBO} < 0,4\text{ mA}$

$V_{CB} = \frac{1}{2}V_{CB0\max}; I_E = 0; T_j = 150\text{ }^\circ\text{C}$

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

$I_B = 0; V_{CE} = \frac{1}{2}V_{CE0\max}$

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

Emitter cut-off current

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

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

D.C. current gain*

$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$

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

$I_C = 5\text{ A}; V_{CE} = 4\text{ V}$

$h_{FE} > 1000$

$I_C = 12\text{ A}; V_{CE} = 4\text{ V}$

$h_{FE} \text{ typ. } 1000$

Base-emitter voltage

$I_C = 5\text{ A}; V_{CE} = 4\text{ V}$

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

Collector-emitter saturation voltage*

$I_C = 5\text{ A}; I_B = 20\text{ mA}$

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

$I_C = 10\text{ A}; I_B = 100\text{ mA}$

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

Diode, forward voltage

$I_F = 5\text{ A}$

$V_F < 2\text{ V}$

$I_F = 12\text{ A}$

$V_F \text{ typ. } 2\text{ V}$

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

$V_{CB} = 10\text{ V}; I_E = I_e = 0$

$C_c \text{ typ. } 200\text{ pF}$

Second-breakdown collector current

non-repetitive; without heatsink

$V_{CE} = 60\text{ V}; t_p = 0,1\text{ s}$

$I_{SB} > 2\text{ A}$

Turn-off breakdown energy with inductive load;

$-I_{Boff} = 0; I_{CM} = 6,3\text{ A}$

$L = 5\text{ mH}$ (see Fig. 3)

$E(BR) > 100\text{ mJ}$

Switching times (see Figs 4 and 5)

$I_{Con} = 5\text{ A}; I_{Bon} = -I_{Boff} = 20\text{ mA}$

turn-on time

$t_{on} \text{ typ. } 1\text{ }\mu\text{s}$
 $< 2,5\text{ }\mu\text{s}$

turn-off time

$t_{off} \text{ typ. } 6,0\text{ }\mu\text{s}$
 $< 10\text{ }\mu\text{s}$

Small-signal current gain

$I_C = 5\text{ A}; V_{CE} = 3\text{ V}; f = 1\text{ MHz}$

$h_{fe} > 10$

* Measured under pulse conditions $t_p \leq 300\text{ }\mu\text{s}$; $\delta < 2\%$.

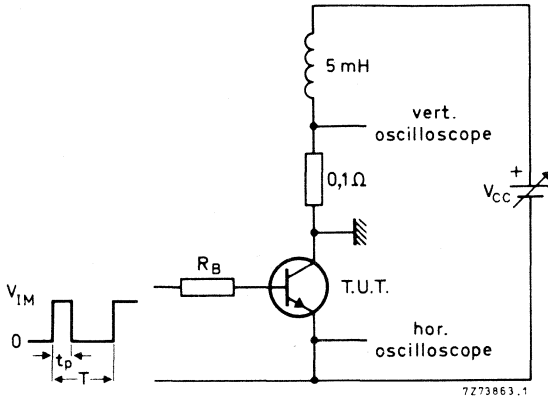


Fig. 3 Test circuit for turn-off breakdown energy.
 $V_{IM} = 12 \text{ V}$; $R_B = 270 \Omega$;
 $t_p = 1 \text{ ms}$; $\delta = 1\%$.

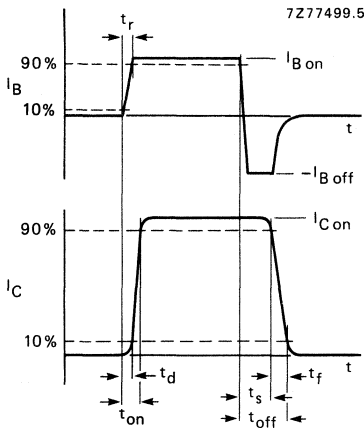
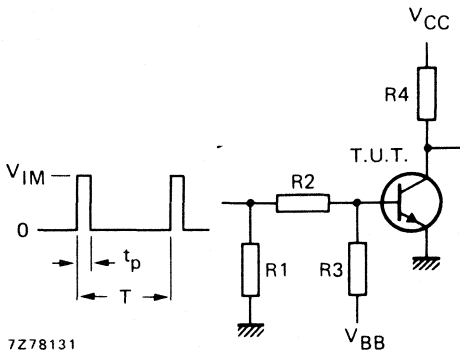


Fig. 4 Switching times waveforms.



$V_{CC} = 30 \text{ V}$
 $V_{IM} = 15 \text{ V}$
 $-V_{BB} = 4 \text{ V}$
 $R1 = 56 \Omega$
 $R2 = 410 \Omega$
 $R3 = 560 \Omega$
 $R4 = 6 \Omega$
 $t_r = t_f = 15 \text{ ns}$
 $t_p = 10 \mu\text{s}$
 $T = 500 \mu\text{s}$

Fig. 5 Switching times test circuit.

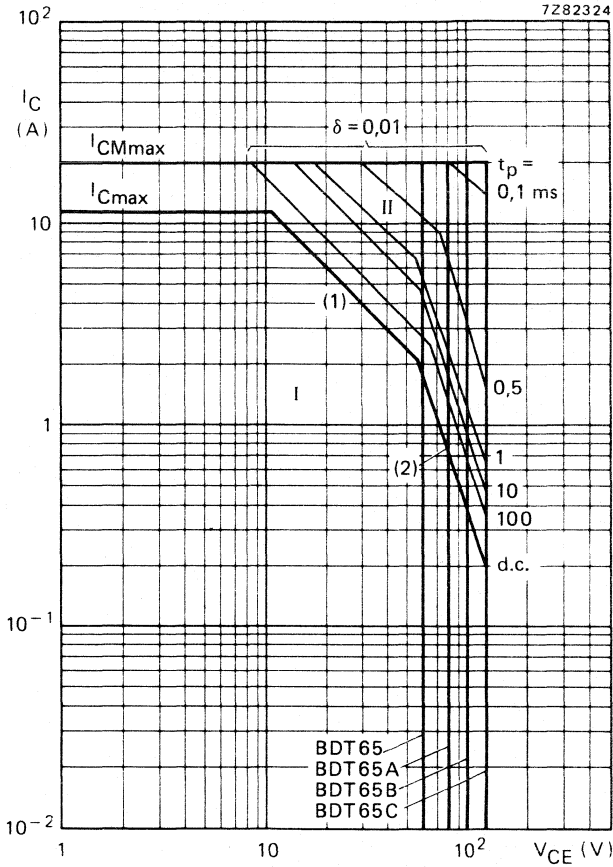


Fig. 6 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

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).

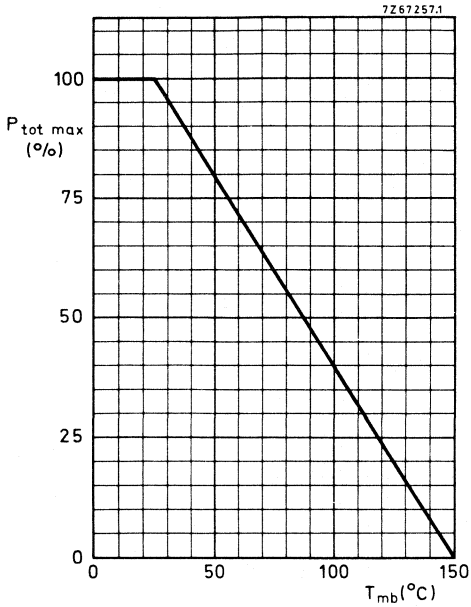


Fig. 7 Power derating curve.

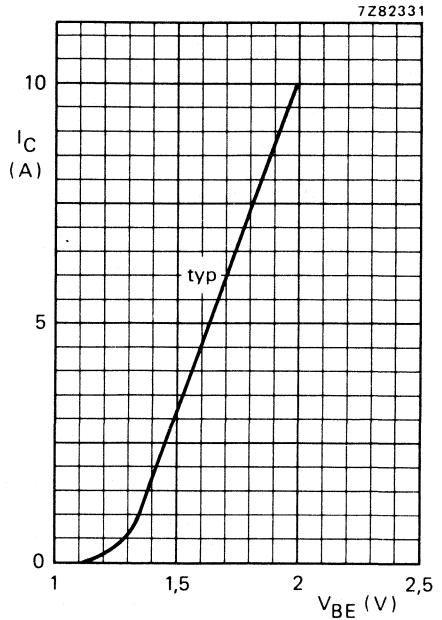


Fig. 8 Base-emitter voltage as a function of collector current. $V_{CE} = 3$ V; $T_{amb} = 25$ °C.

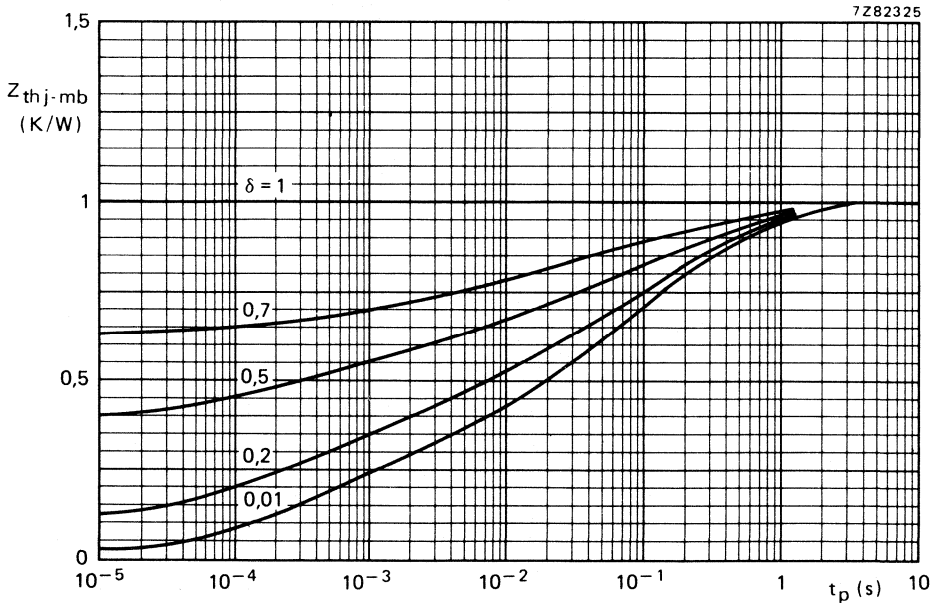


Fig. 9 Pulse power rating chart.

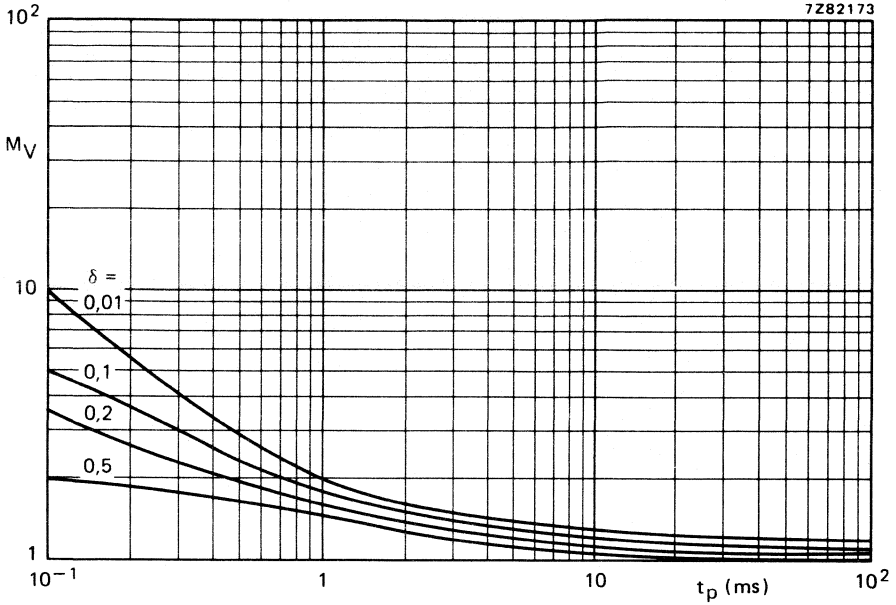


Fig. 10 S.B. voltage multiplying factor at the I_{Cmax} level.

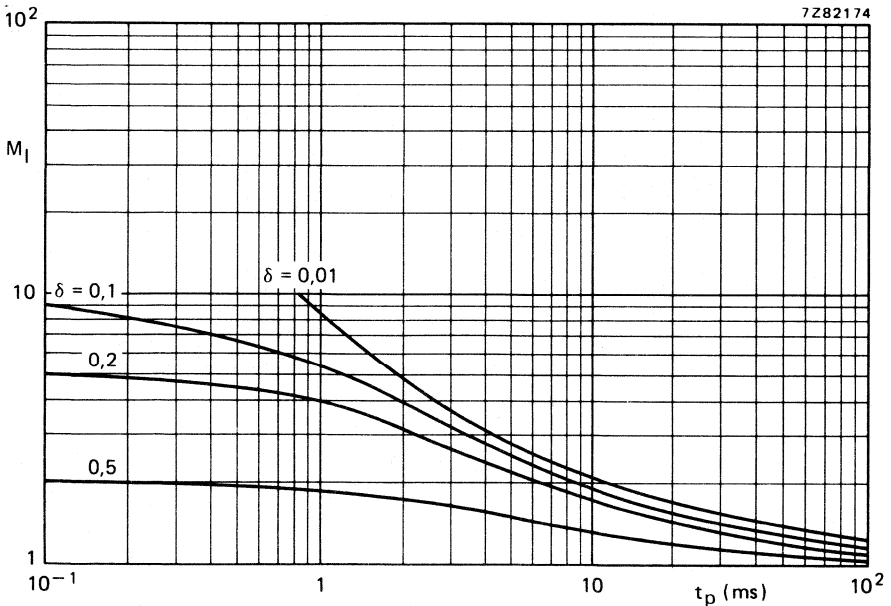


Fig. 11 S.B. current multiplying factor at the V_{CE0max} level.

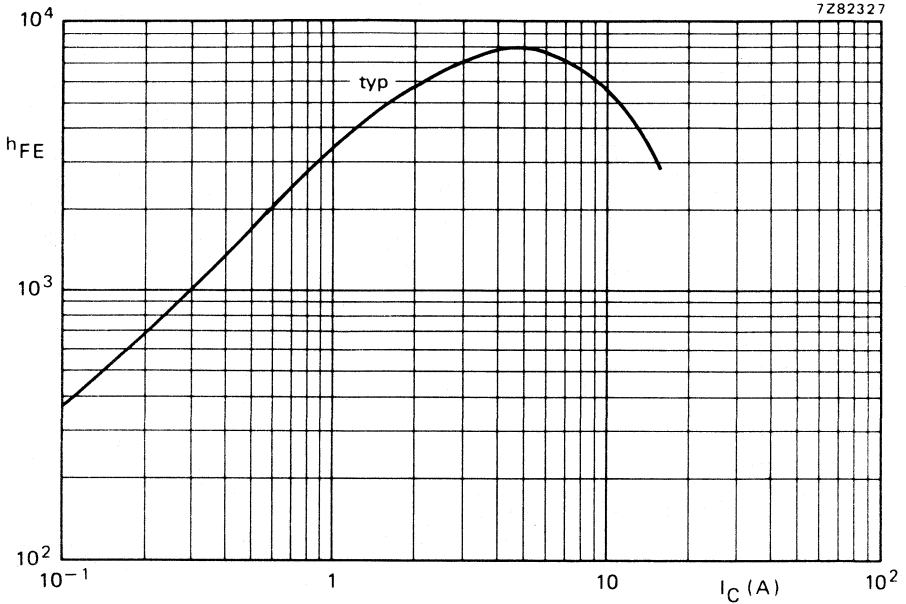


Fig. 12 Typical d.c. current gain as a function of collector current; $V_{CE} = 3\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$.

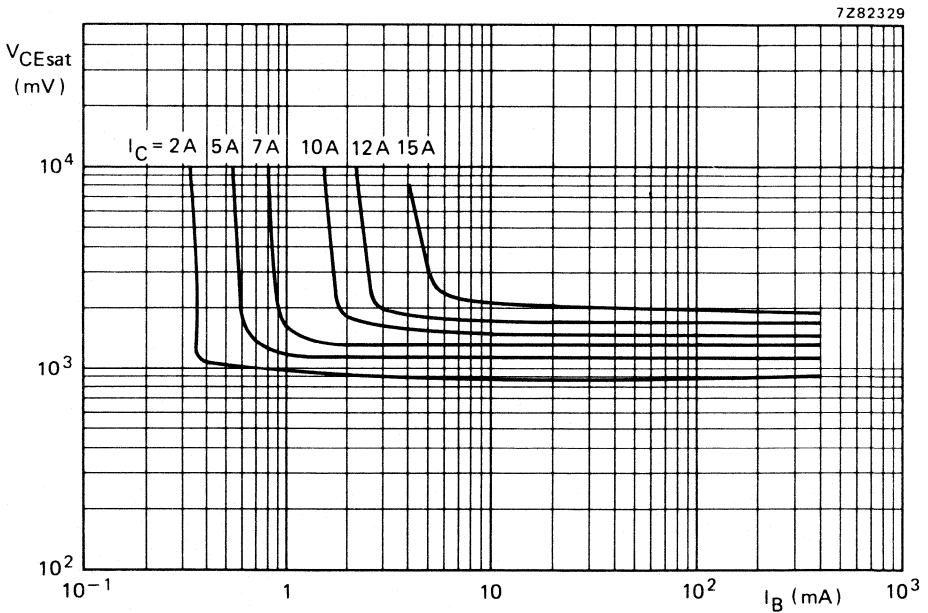


Fig. 13 Typical collector-emitter saturation voltages.

SILICON POWER TRANSISTORS

N-P-N epitaxial base transistors in a TO-220 plastic envelope, designed for use in audio output stages and general amplifier and switching applications.

P-N-P complements are BDT82, BDT84, BDT86 and BDT88.

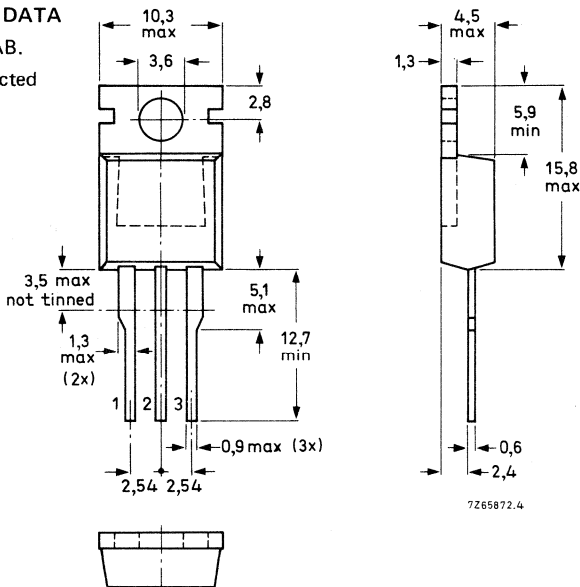
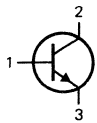
QUICK REFERENCE DATA

		BDT81	BDT83	BDT85	BDT87
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. 7	7	7	7 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 $I_C = 5\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	min. 50			

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to case.



See also chapters Mounting instructions and Accessories

RATINGS

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

			BDT81	BDT83	BDT85	BDT87
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.	7	7	7	7 V
Collector current (d.c.)	I_C	max.	15			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.	125			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	$R_{th\ j-mb}$	max.		1		K/W
From junction to ambient	$R_{th\ j-a}$	max.		70		K/W

CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CB} = V_{CBOmax}$ $I_{CBO} < 1$ mA

$V_{BE} = 0; V_{CE} = 0,8 V_{CBOmax}$ $I_{CES} < 1$ mA

Emitter cut-off current

$I_C = 0; V_{EB} = 7\text{ V}$ $I_{EBO} < 1$ mA

D.C. current gain*

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$ $h_{FE} > 50^*$

$I_C = 5\text{ A}; V_{CE} = 4\text{ V}$ $h_{FE} > 50^*$

Collector-emitter saturation voltage*

$I_C = 5\text{ A}; I_B = 0,5\text{ A}$ $V_{CEsat} < 1$ V*

$I_C = 7\text{ A}; I_B = 0,7\text{ A}$ $V_{CEsat} < 1,6$ V*

Base-emitter voltage*

$I_C = 5\text{ A}; V_{CE} = 4\text{ V}$ $V_{BE} < 1,5$ V*

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

$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$ f_T typ. 10 MHz

Second breakdown collector current

$V_{CE} = 50\text{ V}; t_p = 100\text{ ms}$ $I_{SB} > 2,5$ A

* Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}$; $\delta \leq 2\%$.

Switching times (see Fig. 2)
 $I_C = 7 \text{ A}; I_{B1} = -I_{B2} = 0,7 \text{ A}$

$t_{on} \leq 1 \mu\text{s}$
 $t_{off} \leq 2 \mu\text{s}$

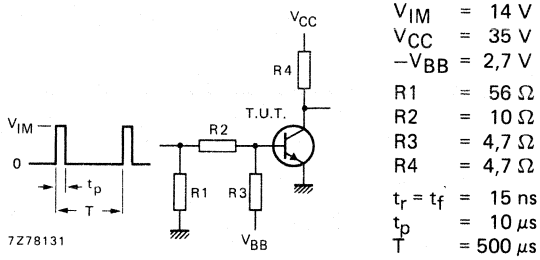


Fig. 2 Switching times test circuit.

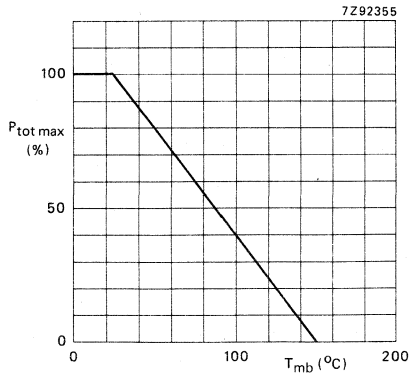


Fig. 3 Power derating curve.

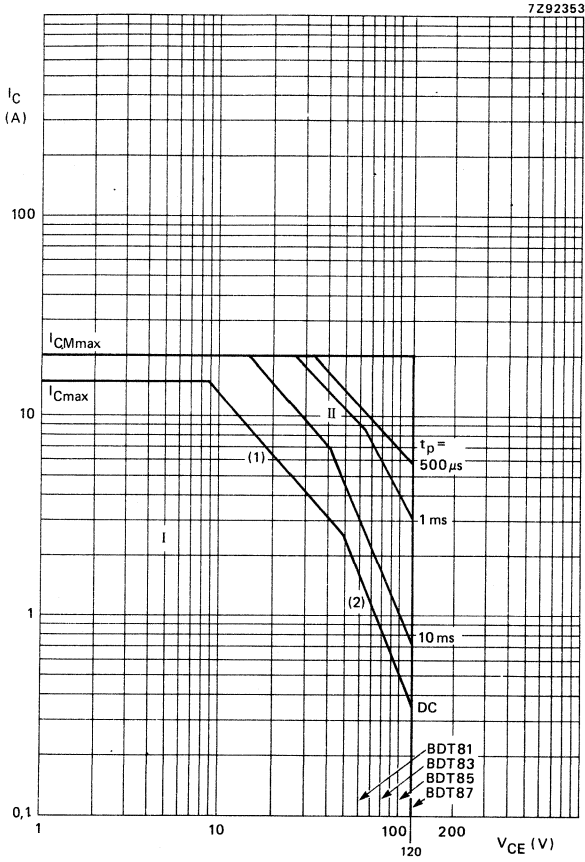


Fig. 4 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$; $\delta = 0,01$.

- 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).

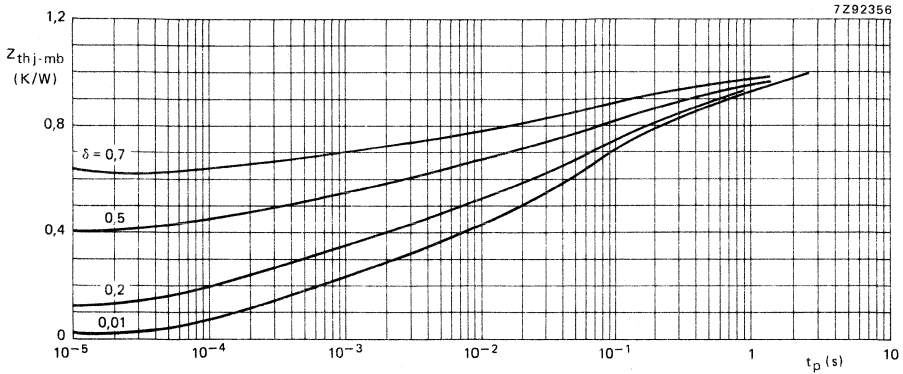


Fig. 5 Pulse power rating chart.

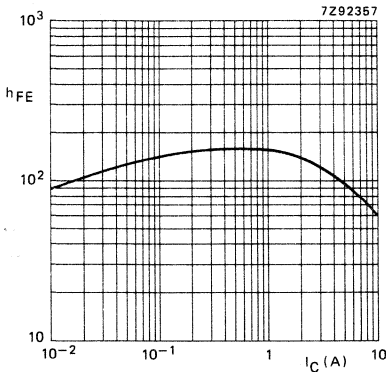


Fig. 6 Typical d.c. current gain;
 $T_{amb} = 25\text{ }^{\circ}\text{C}$; $V_{CE} = 4\text{ V}$.

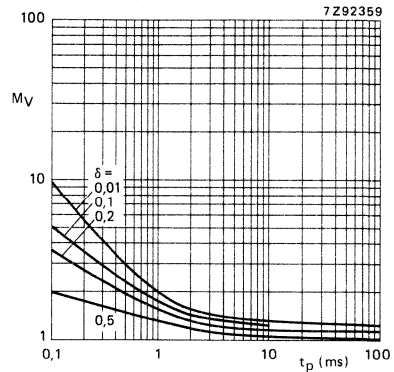


Fig. 7 Second-breakdown voltage multiplying factor at I_{Cmax} level.

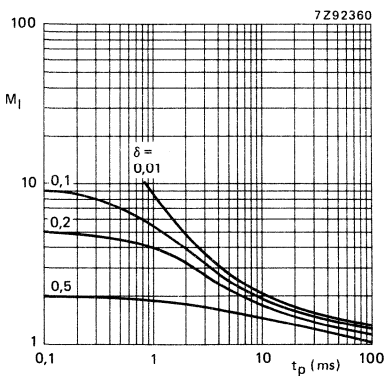


Fig. 8 Second-breakdown current multiplying factor at the V_{CEmax} level.

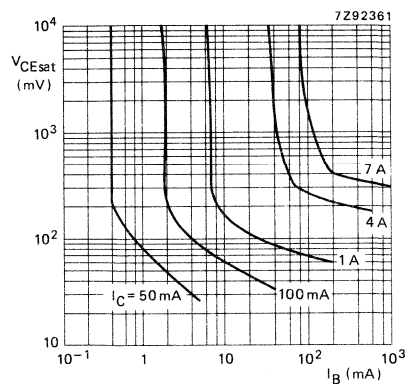


Fig. 9 Typical values collector-emitter saturation voltage.

SILICON POWER TRANSISTORS

P-N-P epitaxial base transistors in a TO-220 plastic envelope, designed for use in audio output stages and general amplifier and switching applications.

N-P-N complements are BDT81, BDT83, BDT85 and BDT87.

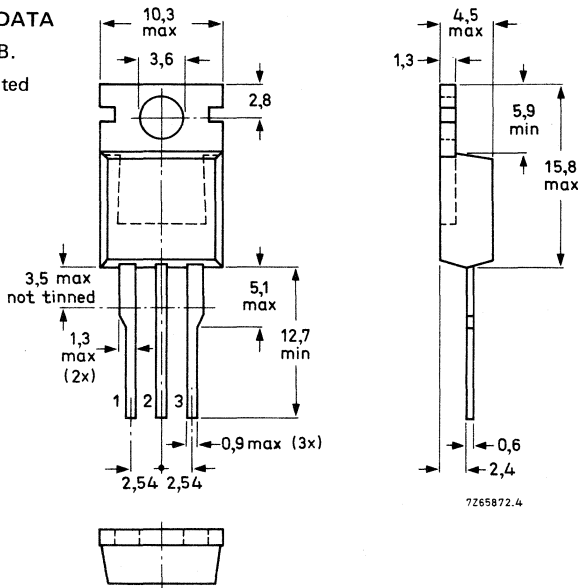
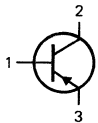
QUICK REFERENCE DATA

		BDT82	BDT84	BDT86	BDT88
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.	7	7	7	7 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 $-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE} min.	50			

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to case.



Dimensions in mm

See also chapters Mounting instructions and Accessories

RATINGS

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

		BDT82	BDT84	BDT86	BDT88
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.	7	7	7	7 V
Collector current (d.c.)	$-I_C$ max.			15	A
Collector current (peak value)	$-I_{CM}$ max.			20	A
Base current (d.c.)	$-I_B$ max.			4	A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot} max.			125	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	$R_{th\ j-mb}$ max.		1	K/W
From junction to ambient	$R_{th\ j-a}$ max.		70	K/W

CHARACTERISTICS

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

Collector cut-off current

$-I_E = 0; -V_{CB} = V_{CB0max}$ $-I_{CBO} <$ 1 mA

$-V_{BE} = 0; -V_{CE} = 0,8 V_{CB0max}$ $-V_{CES} <$ 1 mA

Emitter cut-off current

$-I_C = 0; -V_{EB} = 7\text{ V}$ $-I_{EBO} <$ 1 mA

D.C. current gain*

$-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$ $h_{FE} >$ 50*

$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$ $h_{FE} >$ 50*

Collector-emitter saturation voltage*

$-I_C = 5\text{ A}; -I_B = 0,5\text{ A}$ $-V_{CEsat} <$ 1 V*

$-I_C = 7\text{ A}; -I_B = 0,7\text{ A}$ $-V_{CEsat} <$ 1,6 V*

Base-emitter voltage*

$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$ $-V_{BE} <$ 1,5 V*

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

$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}$ f_T typ. 20 MHz

Second breakdown collector current

$-V_{CE} = 50\text{ V}; t_p = 100\text{ ms}$ $-I_{SB} >$ 2,5 A

(non-repetitive without heatsink)

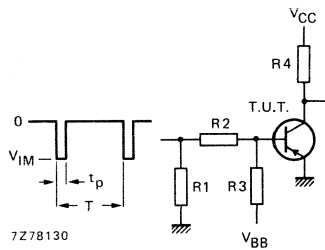
* Measured under pulse conditions: $t_p \leq 300\ \mu\text{s}$; $\delta \leq 2\%$.

Switching times (see Fig. 2)

$$-I_C = 7 \text{ A}; -I_{B1} = I_{B2} = 0,7 \text{ A}$$

$$t_{on} \leq 1 \mu\text{s}$$

$$t_{off} \leq 2 \mu\text{s}$$



- $-V_{IM} = 14 \text{ V}$
- $-V_{CC} = 35 \text{ V}$
- $V_{BB} = 2,7 \text{ V}$
- $R1 = 56 \Omega$
- $R2 = 10 \Omega$
- $R3 = 4,7 \Omega$
- $R4 = 4,7 \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 10 \mu\text{s}$
- $T = 500 \mu\text{s}$

Fig. 2 Switching times test circuit.

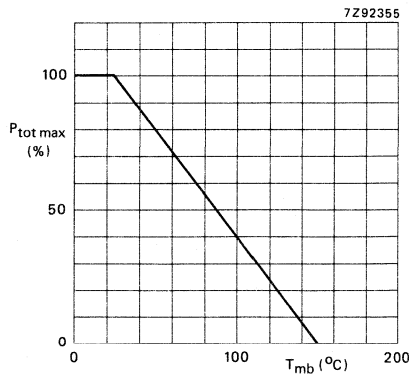


Fig. 3 Power derating curve.

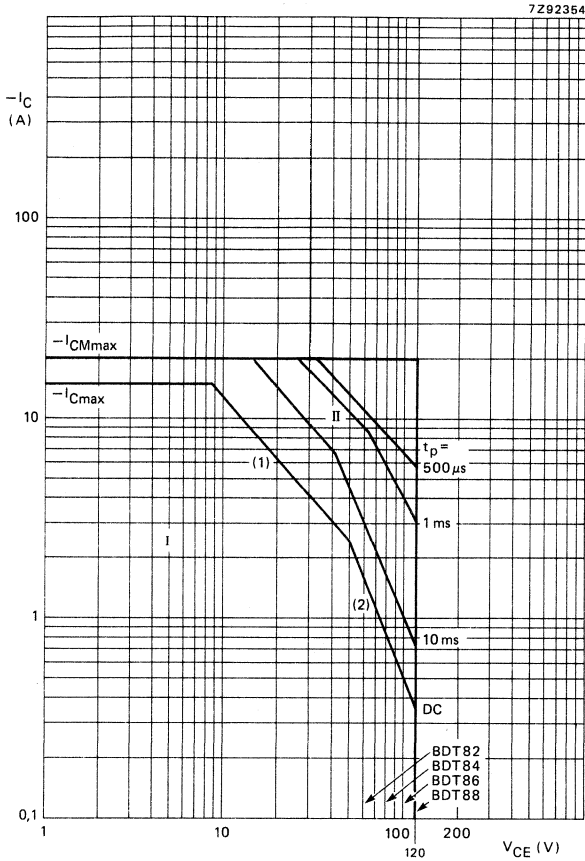


Fig. 4 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$; $\delta = 0,01$.

- 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).

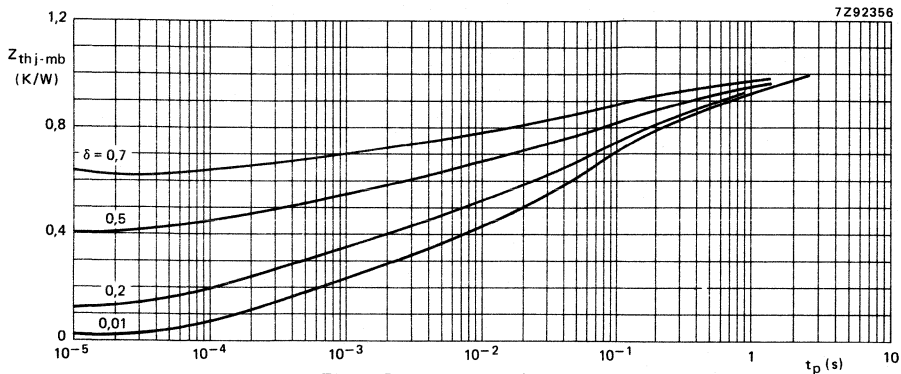


Fig. 5 Pulse power rating chart.

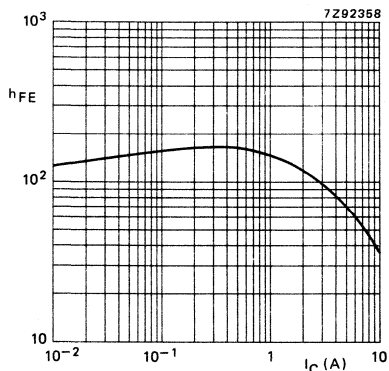


Fig. 6 Typical d.c. current gain;
 $T_{amb} = 25\text{ }^{\circ}\text{C}$; $-V_{CE} = 4\text{ V}$.

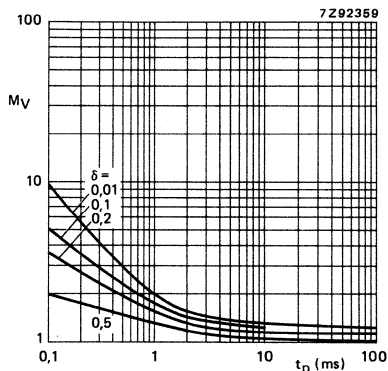


Fig. 7 Second-breakdown voltage multiplying factor at I_{Cmax} level.

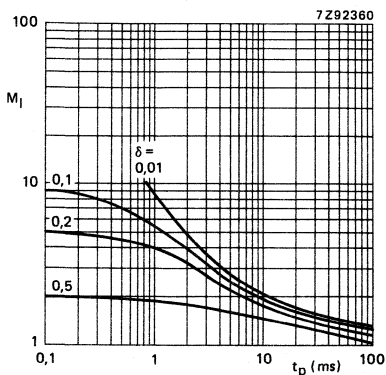


Fig. 8 Second-breakdown current multiplying factor at V_{CE0max} level.

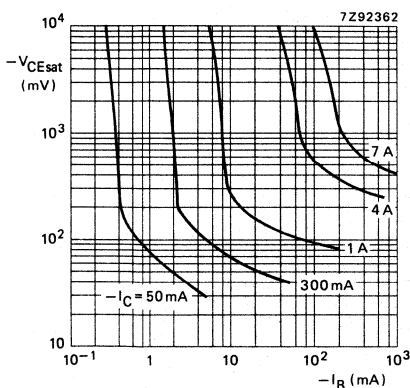


Fig. 9 Typical values collector-emitter saturation voltage.

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.

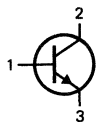
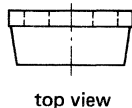
QUICK REFERENCE DATA

		BDT91	BDT93	BDT95
Collector-base voltage (open emitter)	V_{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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	90	W
Junction temperature	T_j	max.	150	$^\circ\text{C}$
D.C. current gain				
$I_C = 4\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}		20 to 200	
$I_C = 10\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>	5	
Transition frequency				
$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$	f_T	>	4	MHz

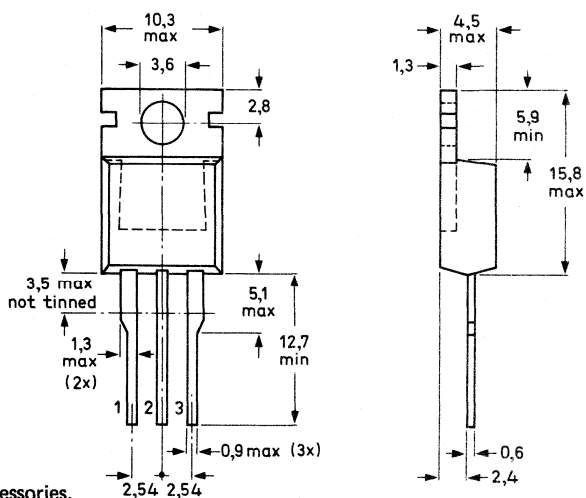
MECHANICAL DATA

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)

		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	$R_{th\ j-mb}$	=	1,4	K/W
From junction to ambient (in free air)	$R_{th\ j-a}$	=	70	K/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
$I_E = 0; V_{CB} = \frac{1}{2}V_{CBOmax}; T_j = 150\text{ }^\circ\text{V}$	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 mV/K 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

t_{on} typ. $0,5 \mu\text{s}$
< $1 \mu\text{s}$

Turn-off time

t_{off} typ. $2 \mu\text{s}$
< $4 \mu\text{s}$

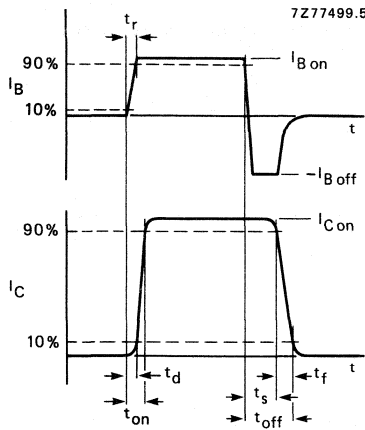


Fig. 2 Switching times waveforms.

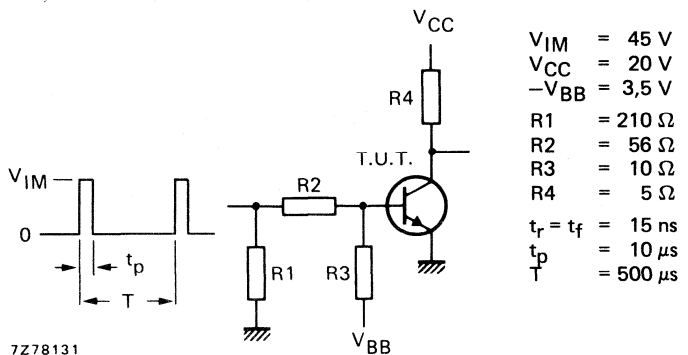


Fig. 3 Switching times test circuit.

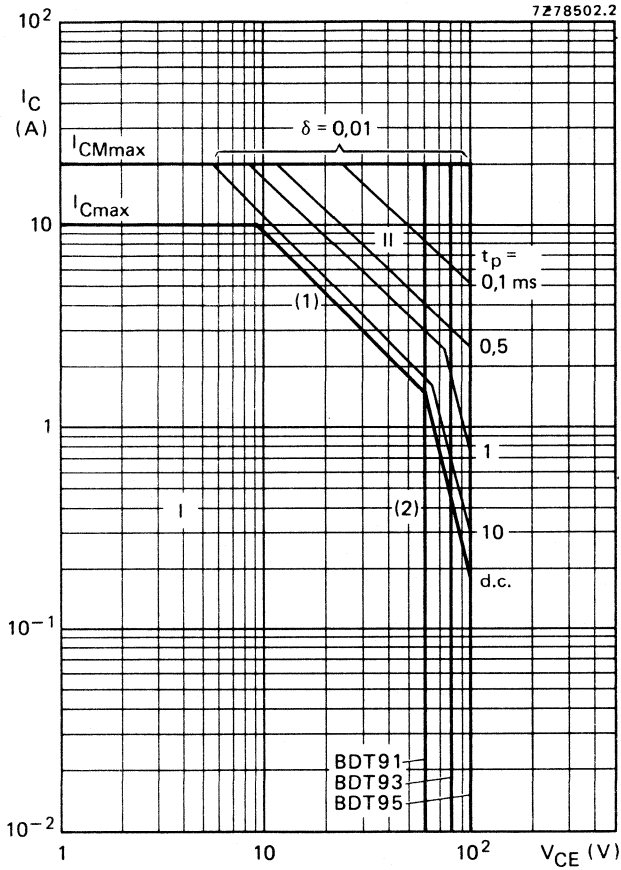


Fig. 4 Safe Operating Area; $T_{mb} = 25^\circ\text{C}$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

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

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

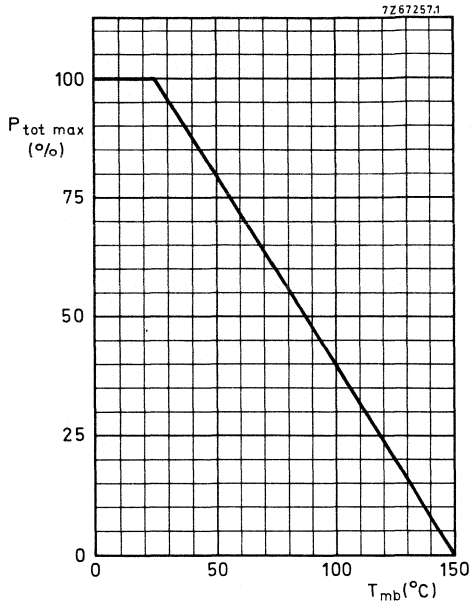


Fig. 5 Power derating curve.

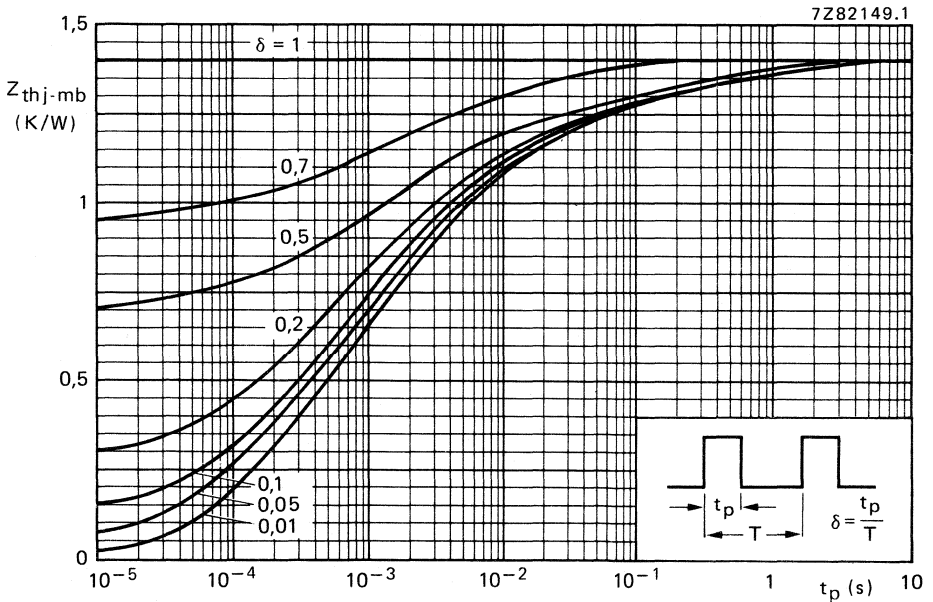


Fig. 6 Pulse power rating chart.

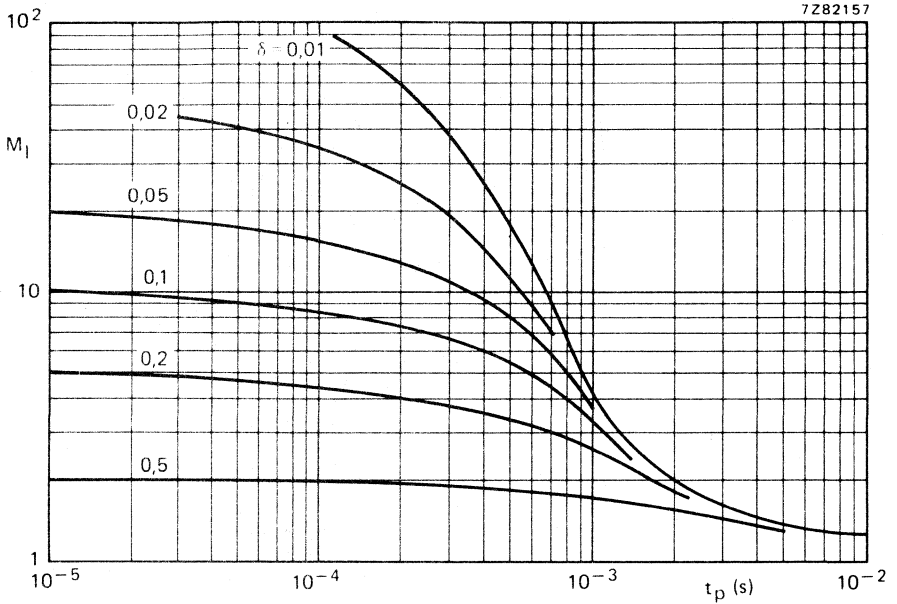


Fig. 7 S.B. current multiplying factor at the V_{CE0max} level.

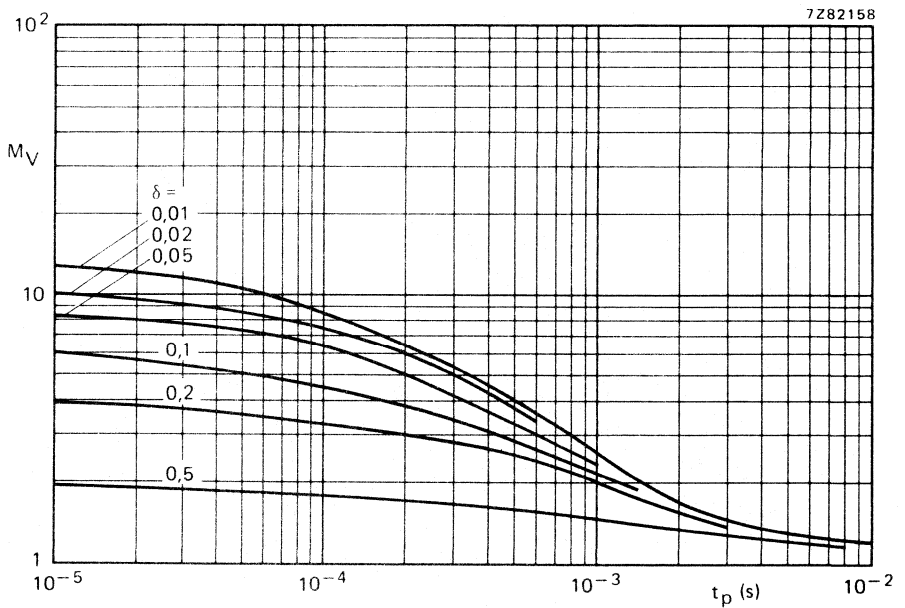


Fig. 8 S.B. voltage multiplying factor at the I_{Cmax} level.

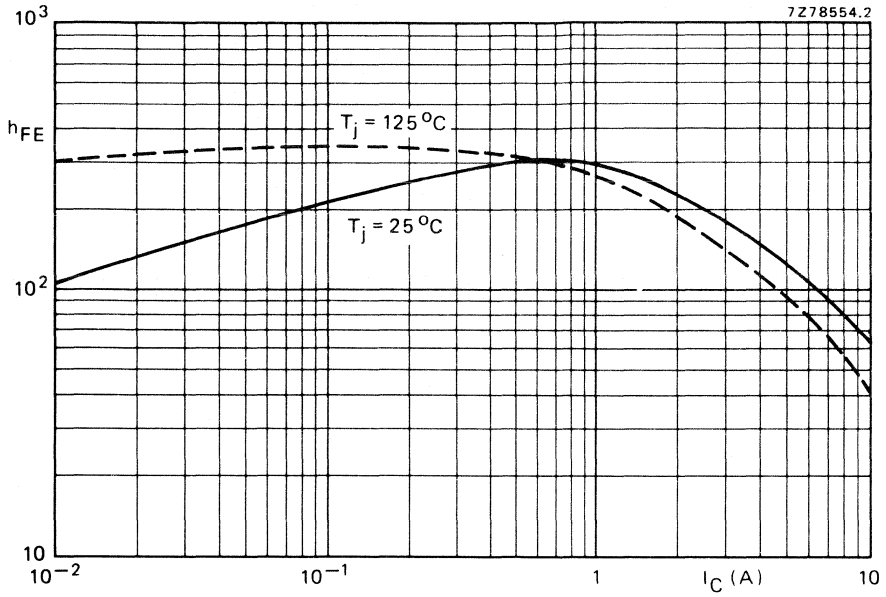


Fig. 9 Typical d.c. current gain at $V_{CE} = 4$ V.

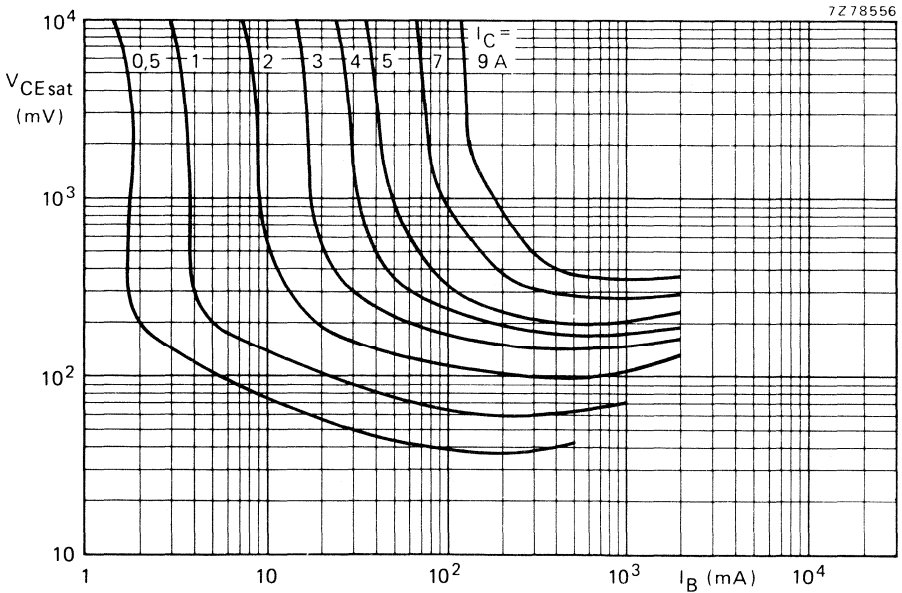


Fig. 10 Typical collector-emitter saturation voltage. $T_{mb} = 25^\circ\text{C}$.

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.

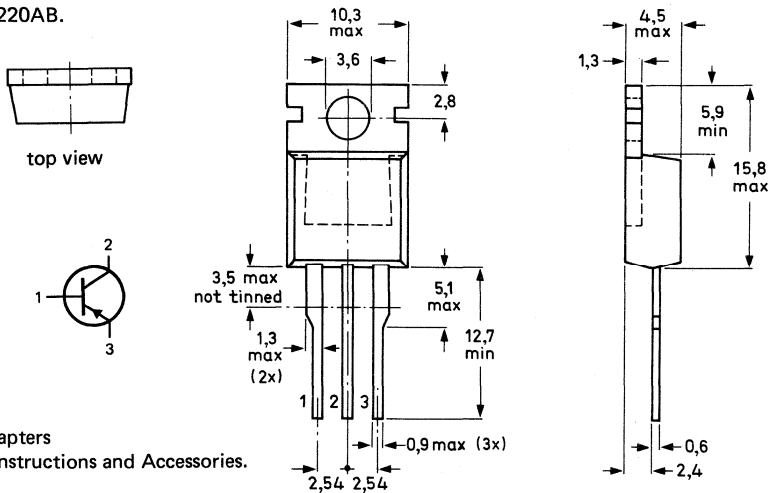
QUICK REFERENCE DATA

		BDT92	BDT94	BDT96
Collector-base voltage (open emitter)	$-V_{CB0}$	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 $T_{mb} = 25\text{ }^\circ\text{C}$	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			4	MHz
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}$	f_T	>		

MECHANICAL DATA

Fig. 1 TO-220AB.

Dimensions in mm



See also chapters
Mounting instructions and Accessories.

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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	$R_{th\ j-mb}$	=	1,4	k/W
From junction to ambient (in free air)	$R_{th\ j-a}$	=	70	K/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
--	-----------	---	----	-----

D.C. current gain ratio of matched pairs

BDT91/92; $-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE1}/h_{FE2}	<	2,5	
---	-------------------	---	-----	--

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 mV/K 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

$t_{on} \begin{matrix} \text{typ.} & 0,5 \mu\text{s} \\ < & 1,5 \mu\text{s} \end{matrix}$

Turn-off time

$t_{off} \begin{matrix} \text{typ.} & 1 \mu\text{s} \\ < & 3 \mu\text{s} \end{matrix}$

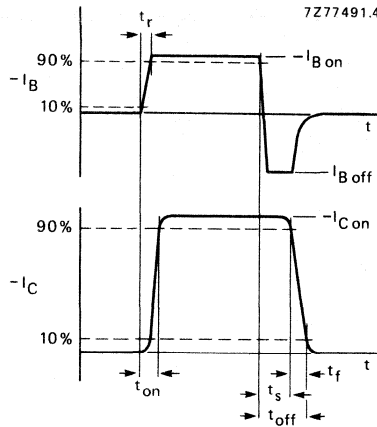


Fig. 2 Switching times waveforms.

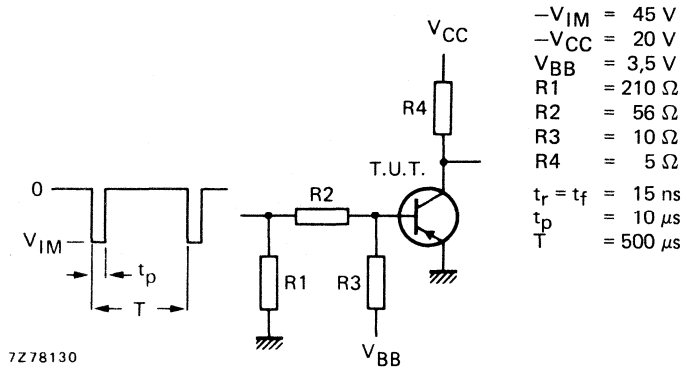


Fig. 3 Switching times test circuit.

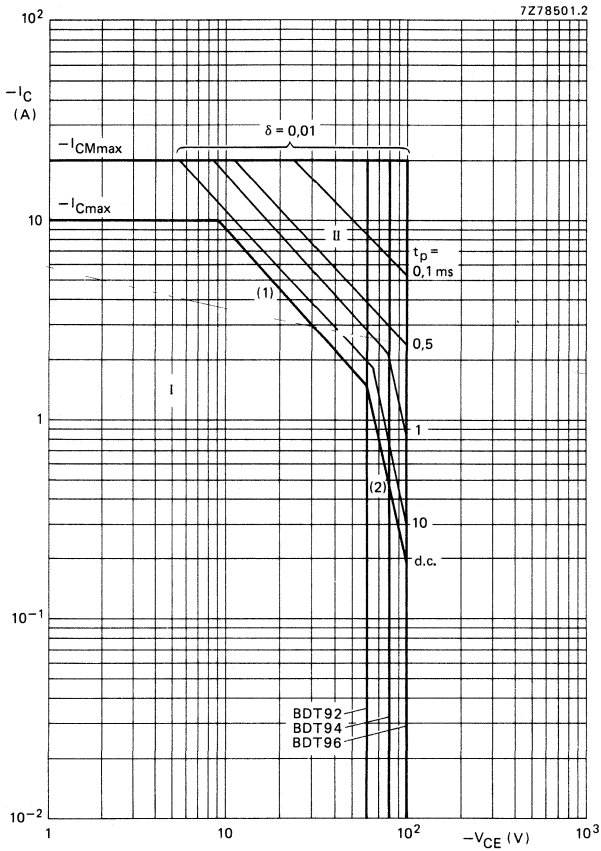


Fig. 4 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

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

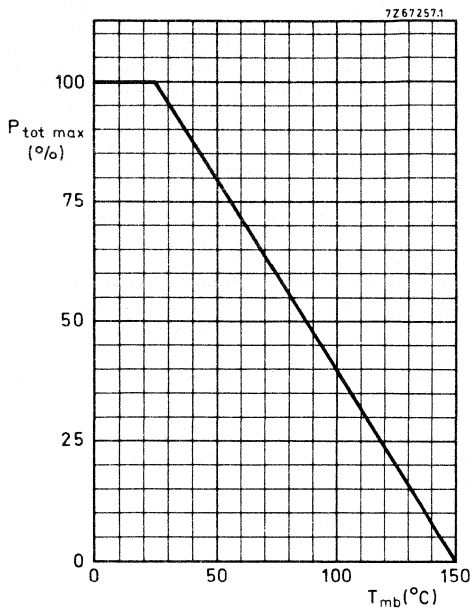


Fig. 5 Power derating curve.

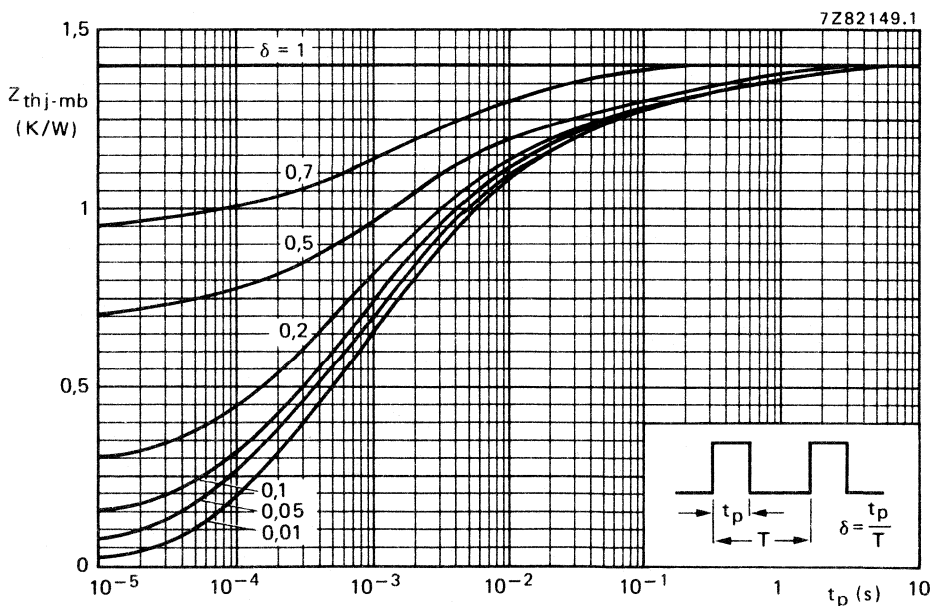


Fig. 6 Pulse power rating chart.

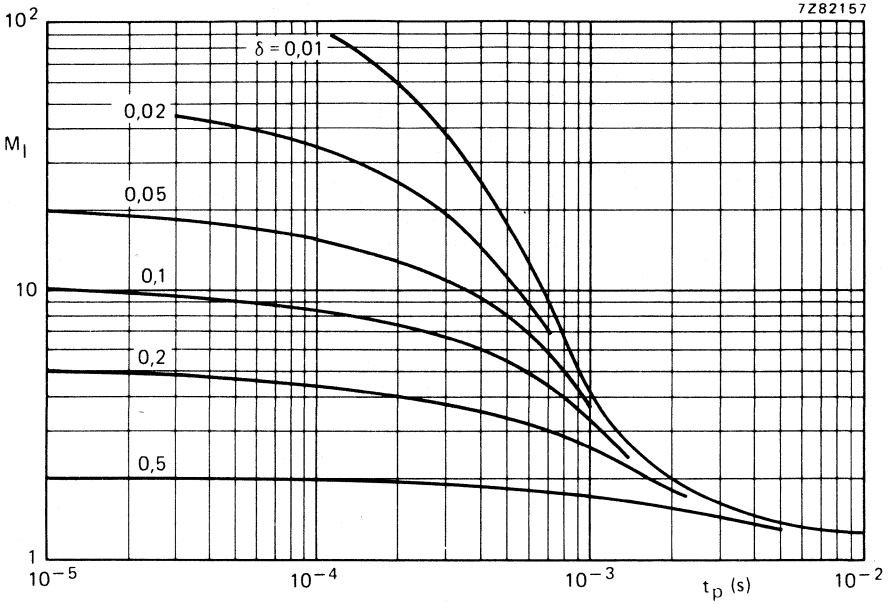


Fig. 7 S.B. current multiplying factor at the V_{CE0max} level.

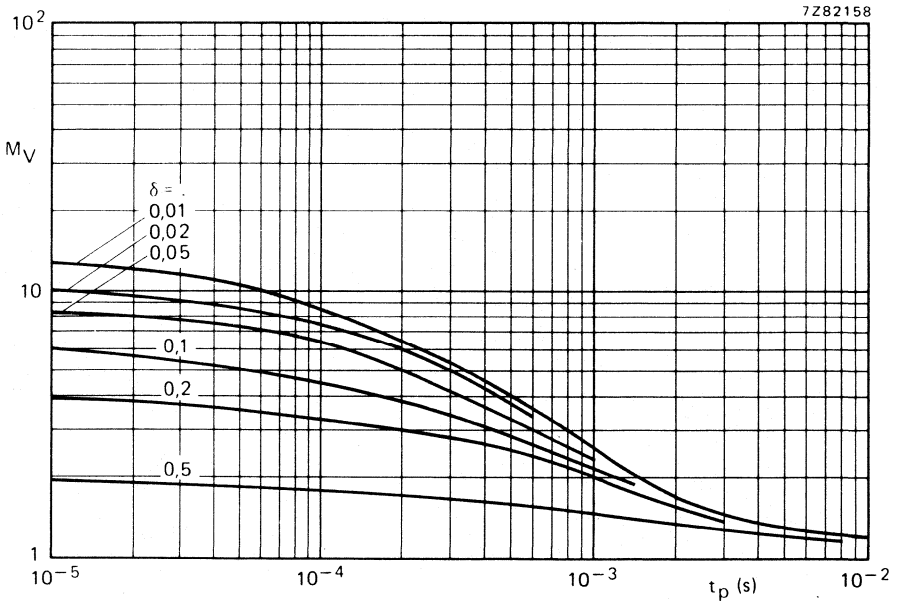


Fig. 8 S.B. voltage multiplying factor at the I_{Cmax} level.

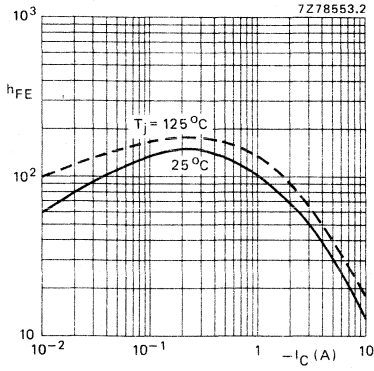


Fig. 9 Typical d.c. current gain at $-V_{CE} = 4\text{ V}$.

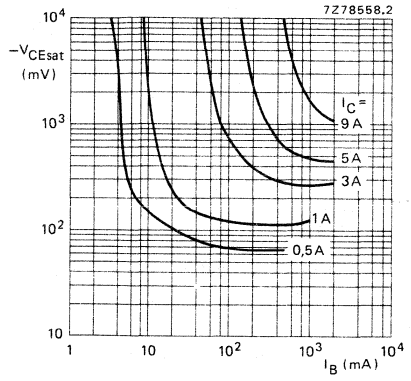


Fig. 10 Typical collector-emitter saturation voltage. $T_{mb} = 25^\circ\text{C}$.

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, 65A, 65B and 65C.

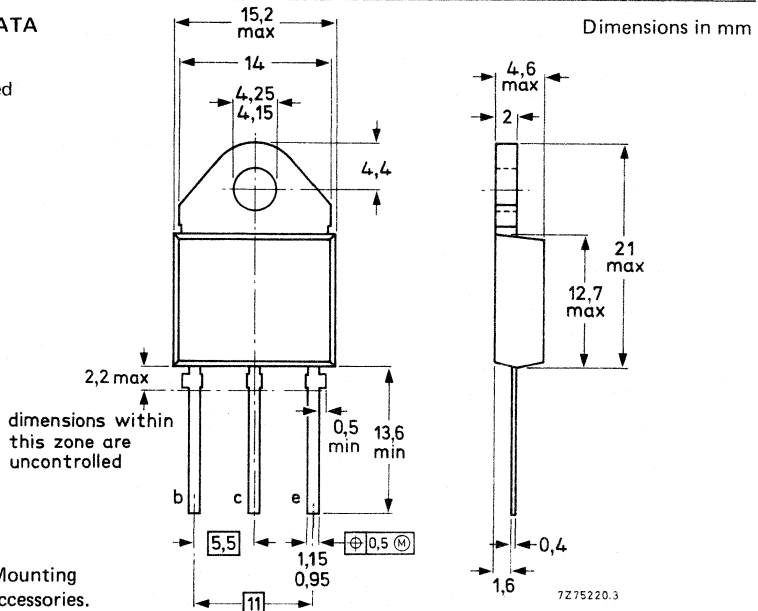
QUICK REFERENCE DATA

		BDV64	A	B	C
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 (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					
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	typ.	1500		
$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	>	1000		
Cut-off frequency					
$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$	f_{hfe}	typ.	100		kHz

MECHANICAL DATA

Fig. 1 SOT-93.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

BDV64; 64A
BDV64B; 64C

CIRCUIT DIAGRAM

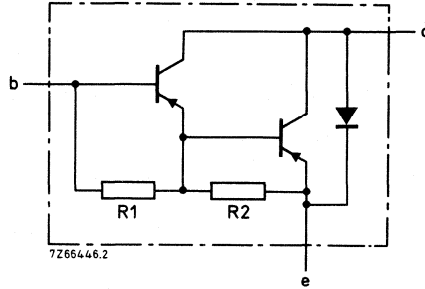


Fig. 2.
R1 typical 5 kΩ
R2 typical 80 Ω.

RATINGS

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

		BDV64	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	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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		125		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		K/W*
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CHARACTERISTICS

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

Collector cut-off currents

$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	400		μA
$I_E = 0; -V_{CB} = -\frac{1}{2}V_{CBOmax}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO}$	<	2		mA
$I_B = 0; -V_{CE} = -\frac{1}{2}V_{CEOmax}$	$-I_{CEO}$	<	1		mA

Emitter cut-off current

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

* 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.

D.C. current gain*

$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	typ.	1500
$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	>	1000
$-I_C = 10\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	typ.	1000

Base-emitter voltage*

$-I_C = 5\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE}$	<	2,5 V**
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Collector-emitter saturation voltage*

$-I_C = 5\text{ A}; -I_B = 20\text{ mA}$	$-V_{CEsat}$	<	2 V
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Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	C_c	typ.	200 pF
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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
$I_F = 12\text{ A}$	V_F	typ.	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	t_{on}	typ.	0,5 μs
Fall time	t_f	typ.	1,0 μs
Turn-off time	t_{off}	typ.	2,0 μs

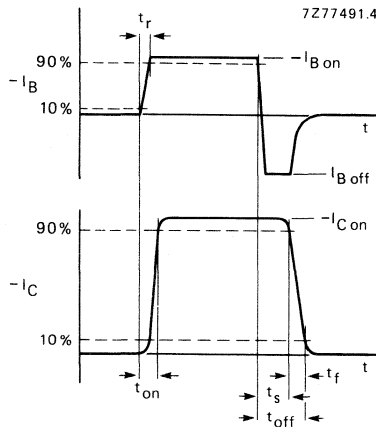


Fig. 3 Waveforms.

* Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$; $\delta < 2\%$.

** $-V_{BE}$ decreases by about 3,6 mV/K with increasing temperature.

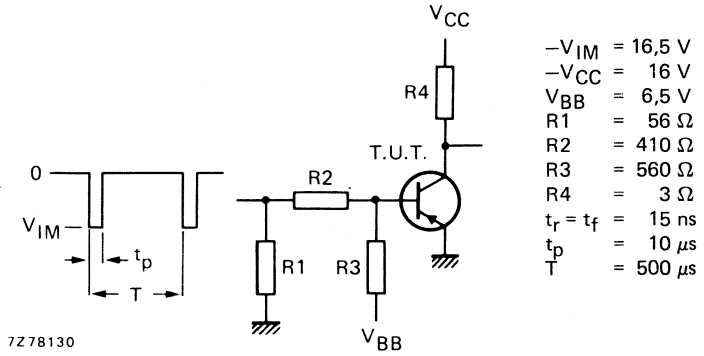


Fig. 4 Switching times test circuit.

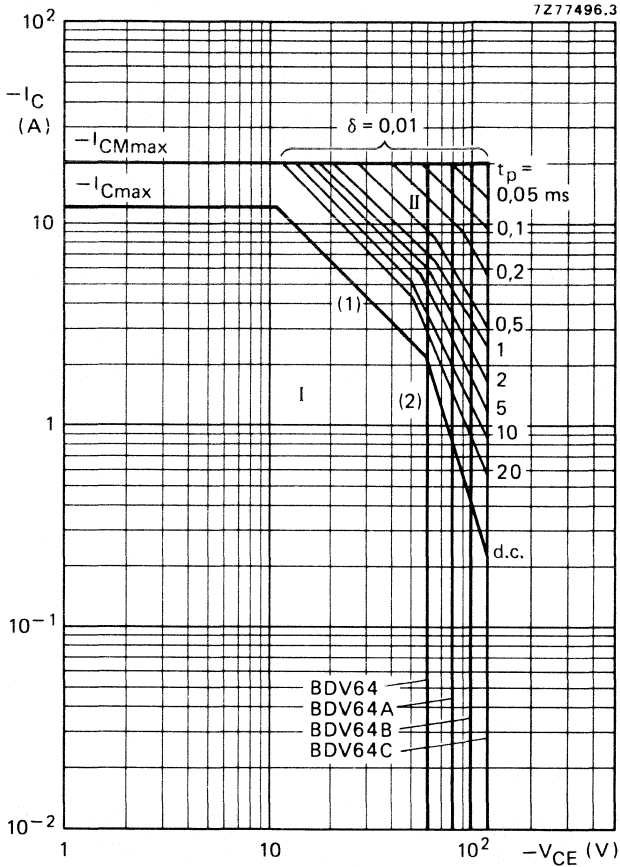


Fig. 5 Safe Operating Area; $T_{mb} \leq 25^\circ\text{C}$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

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

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

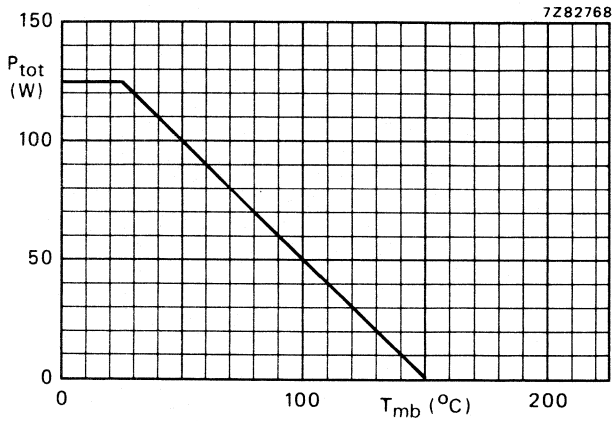


Fig. 6 Power derating curve.

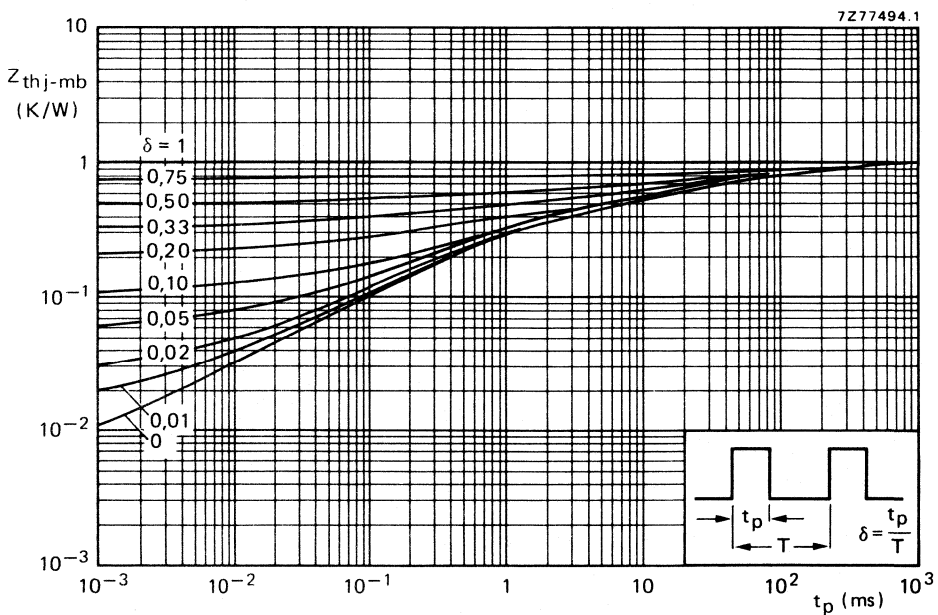


Fig. 7 Pulse power rating chart.

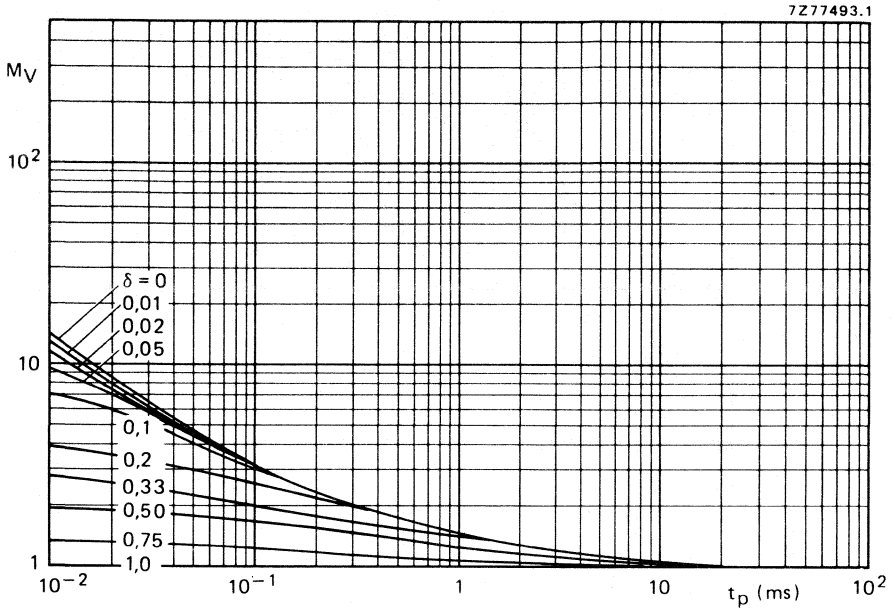


Fig. 8 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

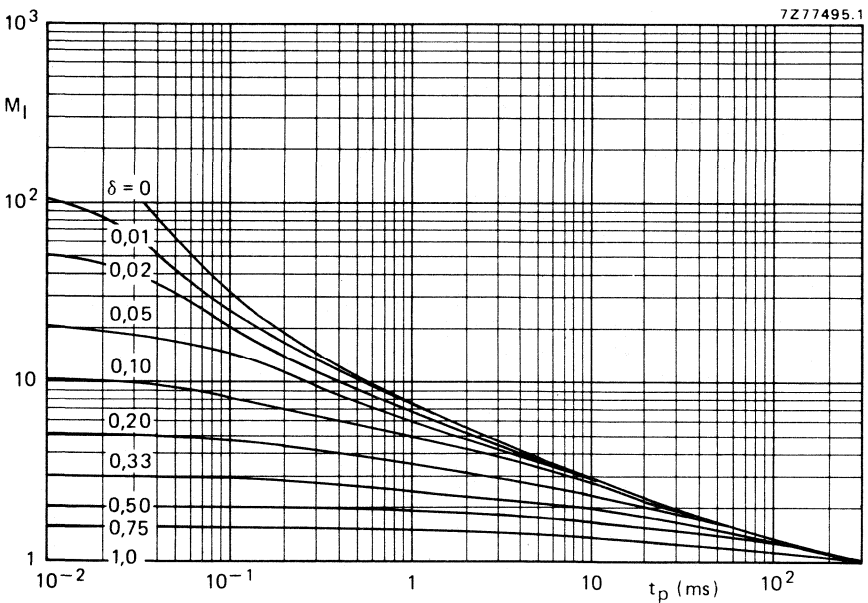


Fig. 9 S.B. current multiplying factor at the $-V_{CE0max}$ level (100 V).

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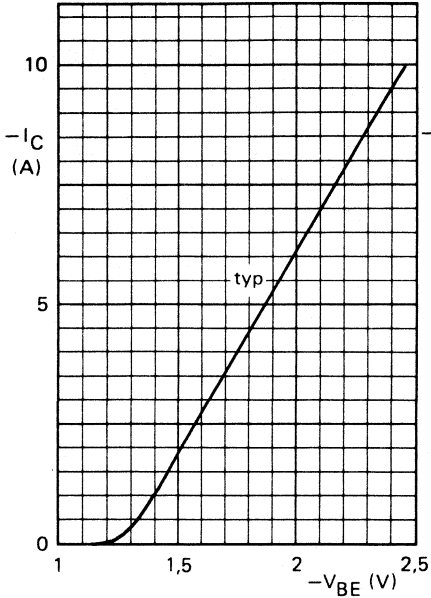


Fig. 10 $-V_{CE} = 4$ V; $T_j = 25$ °C.

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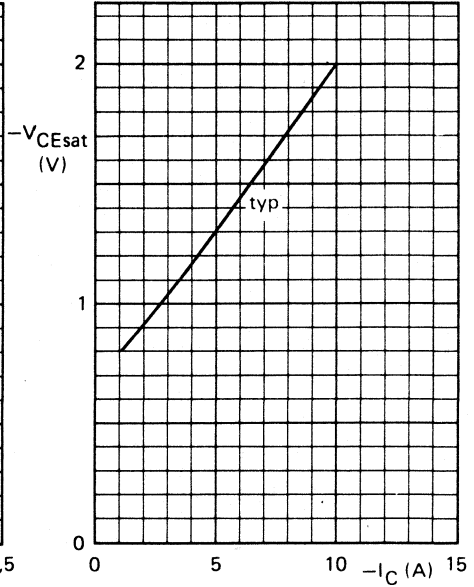


Fig. 11 $-I_C/I_B = 250$; $T_j = 25$ °C.

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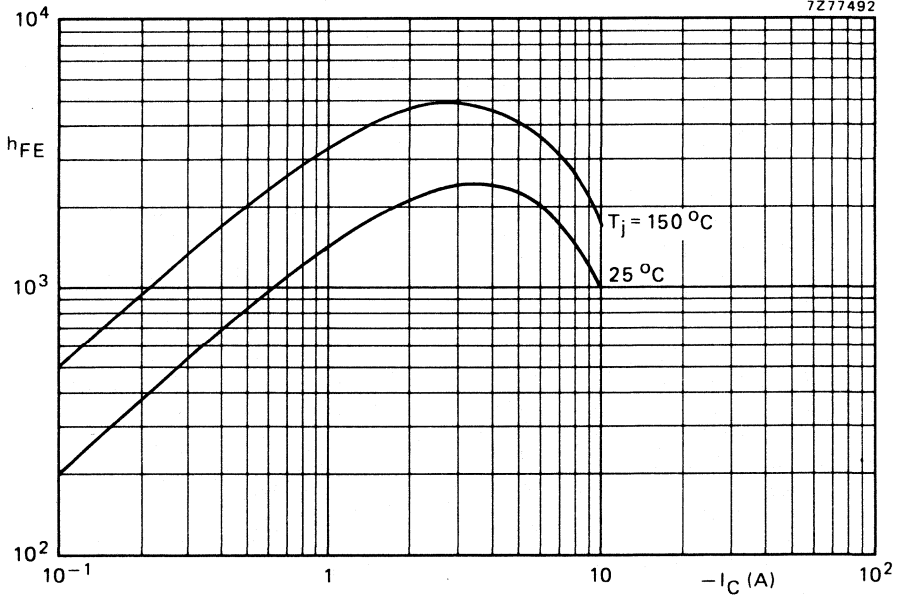


Fig. 12 Typical values; $-V_{CE} = 4$ V.

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, 64B and 64C.

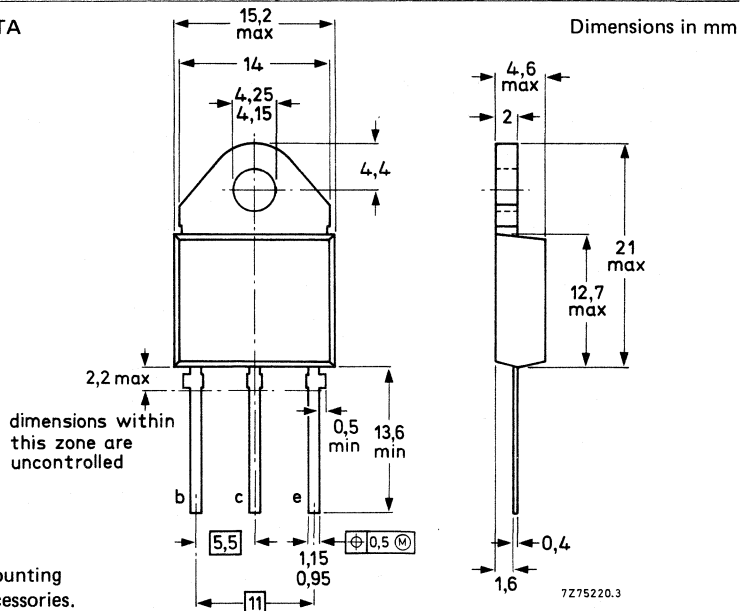
QUICK REFERENCE DATA

		BDV65	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 (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					
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	h_{FE} typ.		1500		
$I_C = 5\text{ A}; V_{CE} = 4\text{ V}$	$h_{FE} >$		1000		
Cut-off frequency					
$I_C = 5\text{ A}; V_{CE} = 4\text{ V}$	f_{hfe} typ.		70		kHz

MECHANICAL DATA

Fig. 1 SOT-93.

Collector connected to mounting-base.



See also chapters Mounting instructions and Accessories.

CIRCUIT DIAGRAM

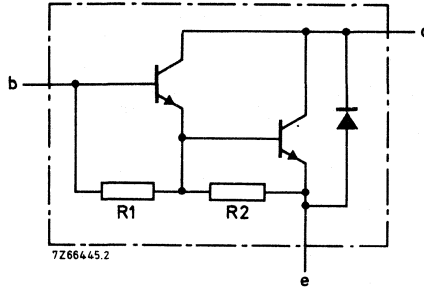


Fig. 2.
R1 typical 5 kΩ
R2 typical 80 Ω.

RATINGS

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

		BDV65	A	B	C	
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.		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 $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		125		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		K/W*
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CHARACTERISTICS

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

Collector cut-off currents

$I_E = 0; V_{CB} = V_{CB0max}$	$I_{CBO} <$	400	μA
$I_E = 0; V_{CB} = \frac{1}{2}V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$	$I_{CBO} <$	2	mA
$I_B = 0; V_{CE} = \frac{1}{2}V_{CEOmax}$	$I_{CEO} <$	1	mA

Emitter cut-off current

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

* 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.

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 V**

Collector-emitter saturation voltage*

$I_C = 5\text{ A}; I_B = 20\text{ mA}$

V_{CEsat} < 2 V

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

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

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

$I_F = 5\text{ A}$
 $I_F = 12\text{ A}$

V_F typ. 1,2 V
 V_F typ. 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

t_{on} typ. 1 μs

Fall time

t_f typ. 3 μs

Turn-off time

t_{off} typ. 6 μs

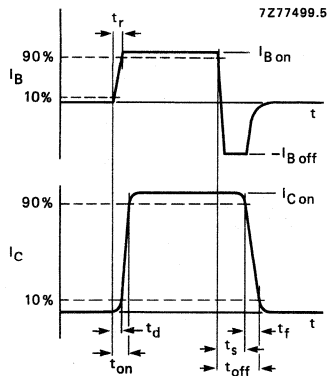


Fig. 3 Waveforms showing $t_{on}; t_s + t_f = t_{off}$.

* Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}; \delta < 2\%$.

** V_{BE} decreases by about 3,6 mV/K with increasing temperature.

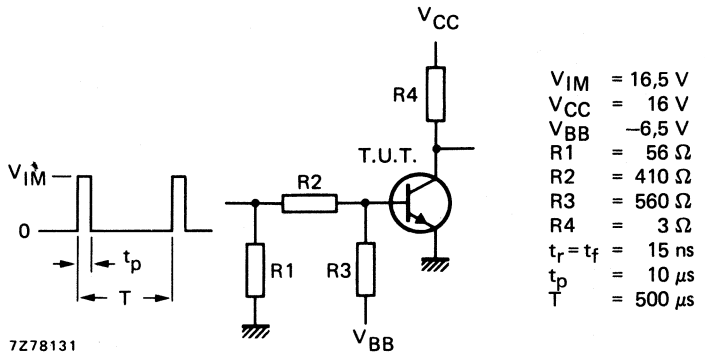


Fig. 4 Switching times test circuit.

Turn-off breakdown energy with inductive load (see also Fig. 5).

$I_{Con} = 6,3$ A; $-I_{Boff} = 0$; $t_p = 1$ ms; $T = 100$ ms

$E(BR) > 100$ mJ

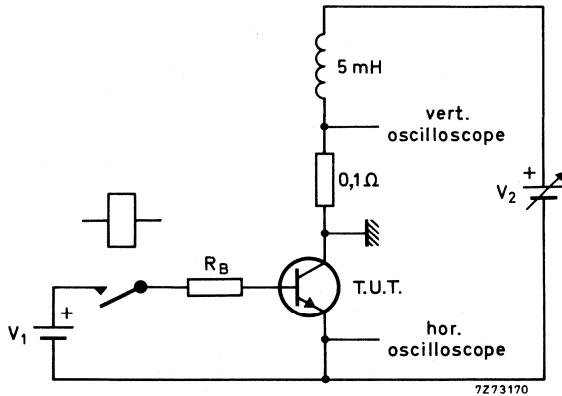


Fig. 5 Test circuit; $V_1 = 12$ V; $R_B = 270$ Ω .

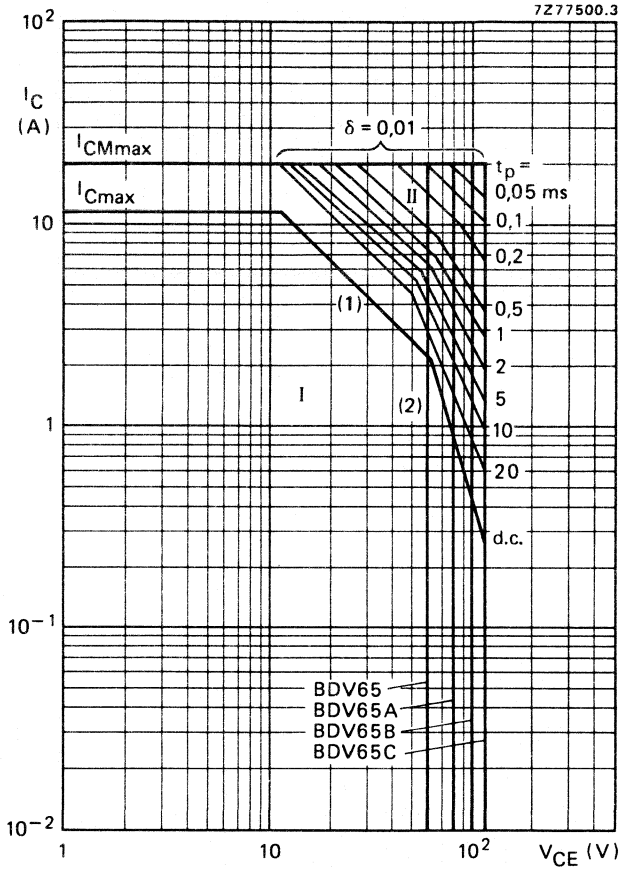


Fig. 6 Safe Operating Area; $T_{mb} \leq 25^\circ\text{C}$.

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).

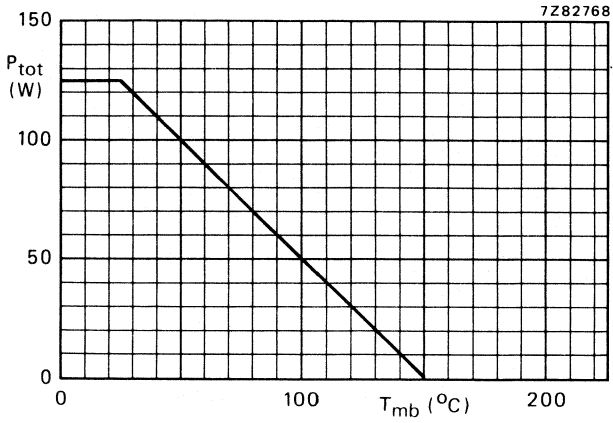


Fig. 7 Power derating curve.

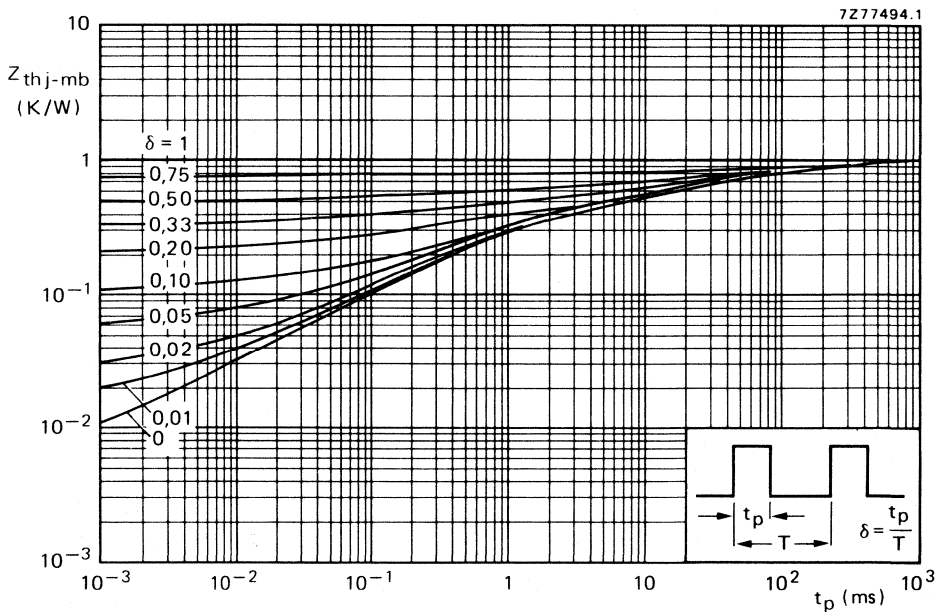


Fig. 8 Pulse power rating chart.

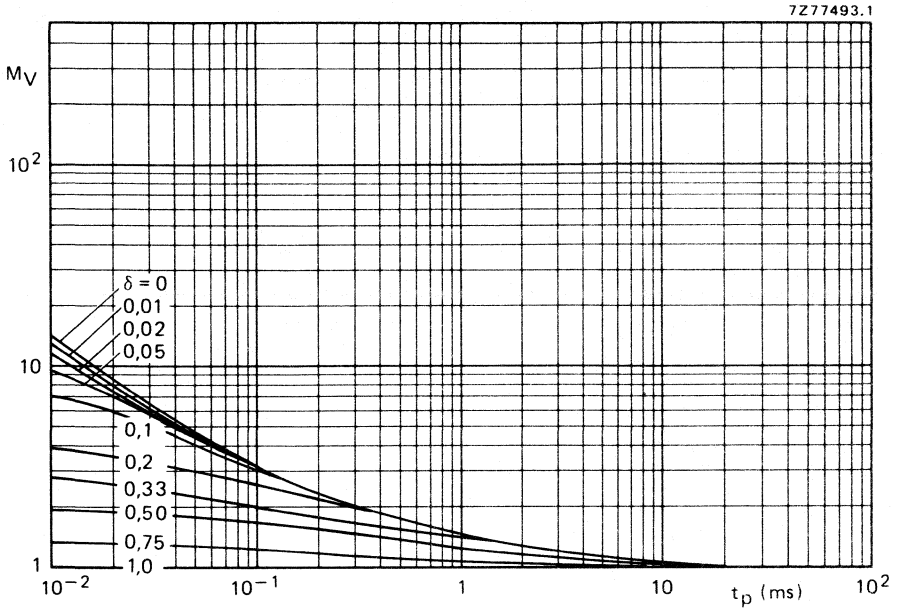


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

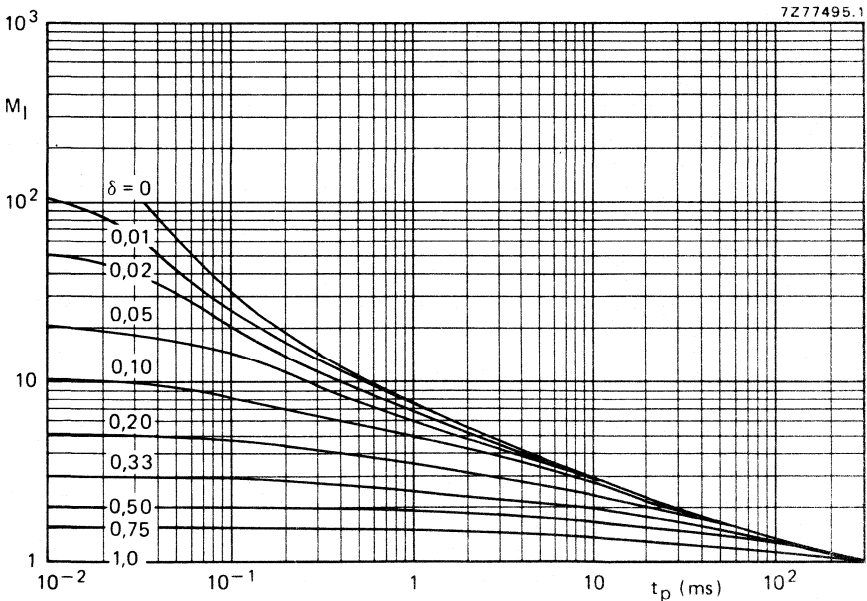


Fig. 10 S.B. current multiplying factor at the V_{CE0max} level (100 V).

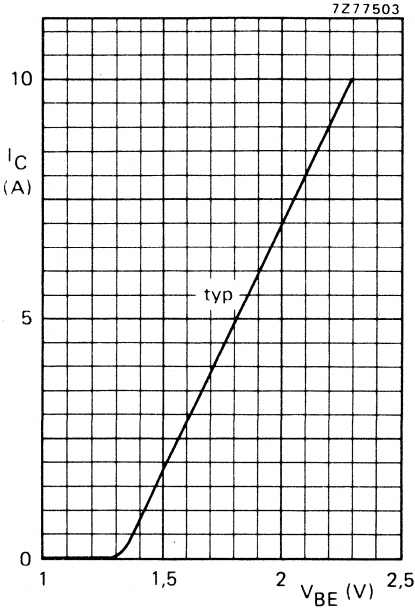


Fig. 11 $V_{CE} = 4$ V; $T_j = 25$ °C.

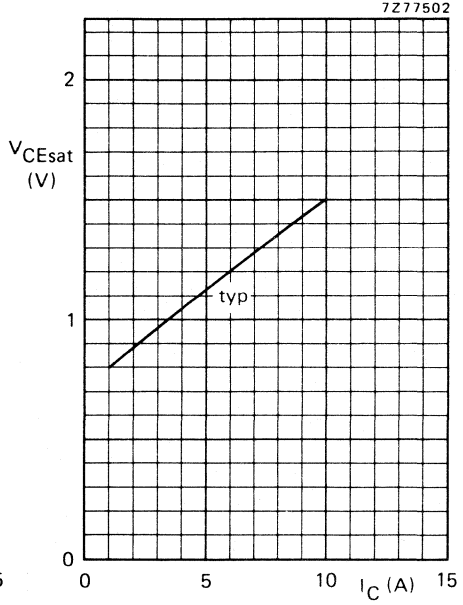


Fig. 12 $I_C/I_B = 250$; $T_j = 25$ °C.

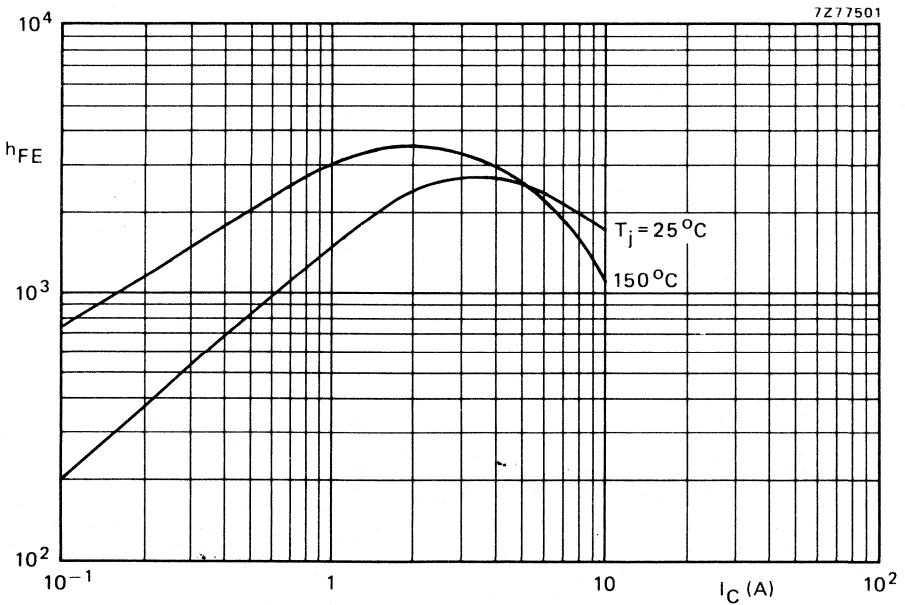


Fig. 13 Typical values; $V_{CE} = 4$ V.

DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base Darlington transistors for audio output stages and general amplifier and switching applications. N-P-N complements are BDV67A; B; C and D. Matched complementary pairs can be supplied.

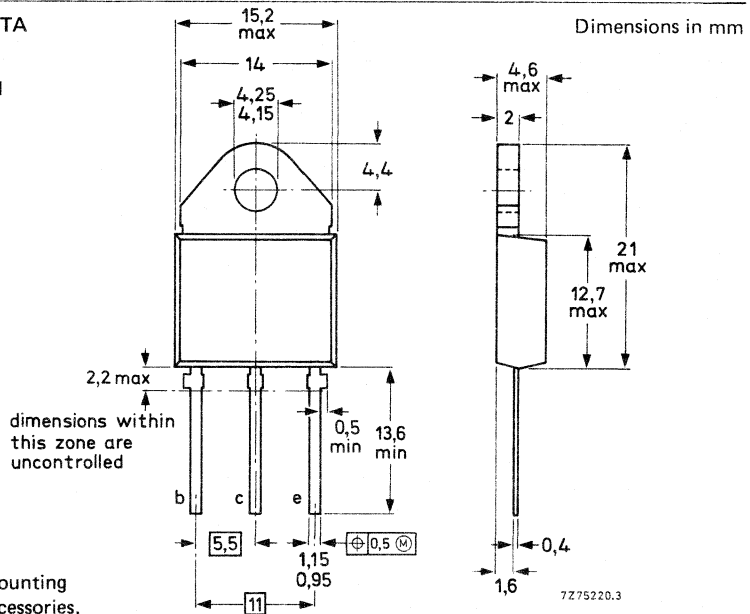
QUICK REFERENCE DATA

		BDV66A	B	C	D
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	100	120	140	160 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	80	100	120	150 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.		175		W
Junction temperature	T_j max.		150		$^{\circ}\text{C}$
D.C. current gain					
$-I_C = 1\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE} typ.		3000		
$-I_C = 10\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE} >		1000		
Cut-off frequency					
$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe} typ.		60		kHz

MECHANICAL DATA

Fig. 1 SOT-93.

Collector connected to mounting base.



**BDV66A; B
BDV66C; D**

CIRCUIT DIAGRAM

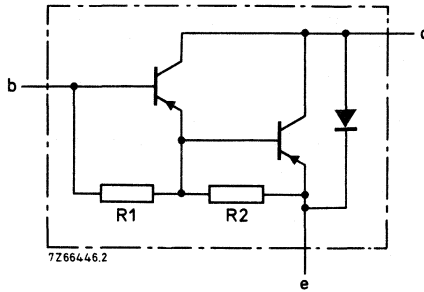


Fig. 2.
R1 typical 3 kΩ
R2 typical 80 Ω

RATINGS

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

		BDV66A	B	C	D
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	100	120	140	160 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	80	100	120	150 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.		0,5		A
→ Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.		175		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*	$R_{th\ j-mb} =$	0,625	K/W
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CHARACTERISTICS

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

Collector cut-off currents

$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO} <$	1	mA
$I_E = 0; -V_{CB} = -\frac{1}{2}V_{CBOmax}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO} <$	4	mA
$I_B = 0; -V_{CE} = -\frac{1}{2}V_{CEOmax}$	$-I_{CEO} <$	3	mA

Emitter cut-off current

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

D.C. current gain*		
$-I_C = 1 \text{ A}; -V_{CE} = 3 \text{ V}$	h_{FE}	typ. 3000
$-I_C = 10 \text{ A}; -V_{CE} = 3 \text{ V}$	h_{FE}	> 1000
$-I_C = 16 \text{ A}; -V_{CE} = 3 \text{ V}$	h_{FE}	typ. 1000
Base-emitter voltage**		
$-I_C = 10 \text{ A}; -V_{CE} = 3 \text{ V}$	$-V_{BE}$	< 2,5 V
Collector-emitter saturation voltage*		
$-I_C = 10 \text{ A}; -I_B = 40 \text{ mA}$	$-V_{CEsat}$	< 2 V
Collector capacitance at $f = 1 \text{ MHz}$		
$I_E = I_e = 0; -V_{CB} = 10 \text{ V}$	C_c	typ. 300 pF
Cut-off frequency		
$-I_C = 5 \text{ A}; -V_{CE} = 3 \text{ V}$	f_{hfe}	typ. 60 kHz
Diode, forward voltage		
$I_F = 10 \text{ A}$	V_F	< 3 V
D.C. current gain ratio of matched complementary pairs		
$-I_C = 10 \text{ A}; -V_{CE} = 3 \text{ V}$	h_{FE1}/h_{FE2}	< 2,5
Small-signal current gain		
$-I_C = 5 \text{ A}; -V_{CE} = 3 \text{ V}; f = 1 \text{ MHz}$	h_{fe}	typ. 40
Switching times		
$-I_{Con} = 10 \text{ A}; -I_{Bon} = I_{Boff} = 40 \text{ mA}; V_{CC} = -12 \text{ V}$		
Turn-on time	t_{on}	typ. 1 μs
Turn-off time	t_{off}	typ. 3,5 μs

* Measured under pulse conditions: $t_p < 300 \mu\text{s}; \delta < 2\%$.** $-V_{BE}$ decreases by about 3,6 mV/K with increasing temperature.

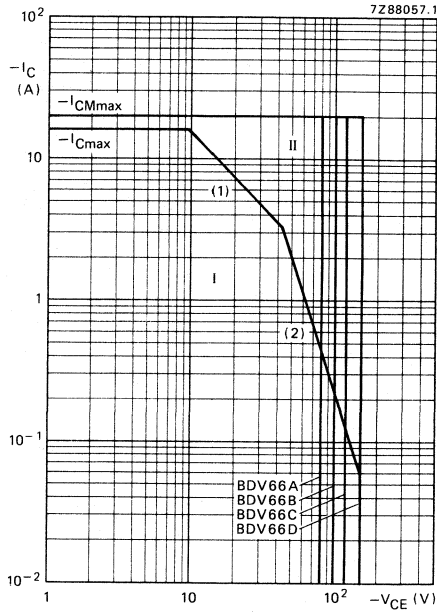


Fig. 3 Safe Operating Area; $T_{mb} \leq 25^\circ C$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) P_{tot} max line.

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

DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base Darlington transistors for audio output stages and general amplifier and switching applications. P-N-P complements are BDV66A, B, C and D. Matched complementary pairs can be supplied.

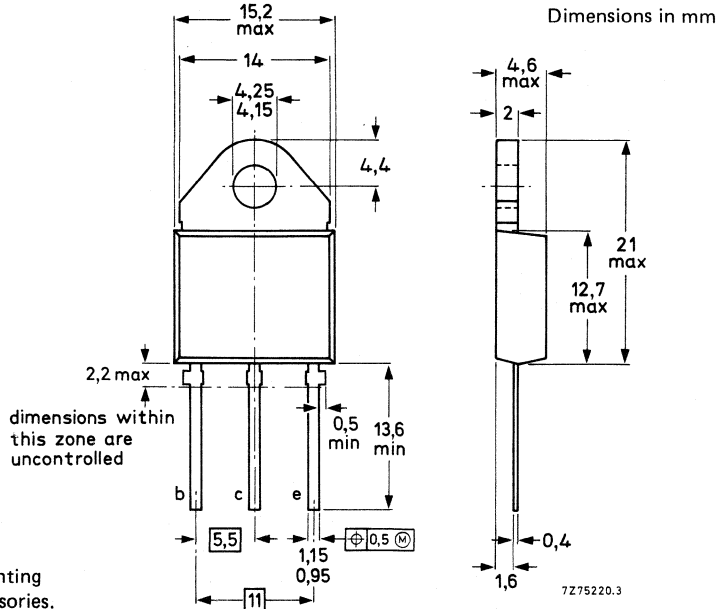
QUICK REFERENCE DATA

		BDV67A				B	C	D
Collector-base voltage (open emitter)	V_{CBO}	max.	100	120	140	160	V	
Collector-emitter voltage (open base)	V_{CEO}	max.	80	100	120	150	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.		200		W		
Junction temperature	T_j	max.		150		$^{\circ}\text{C}$		
D.C. current gain								
$I_C = 1\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	typ.		3000				
$I_C = 10\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	>		1000				
Cut-off frequency								
$I_C = 5\text{ A}; V_{CE} = 3\text{ V}$	f_{hfe}	typ.		60		kHz		

MECHANICAL DATA

Fig. 1 SOT-93.

Collector connected to mounting-base.



CIRCUIT DIAGRAM

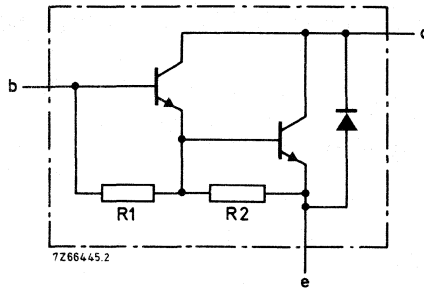


Fig. 2.
R1 typical 3 kΩ
R2 typical 80 Ω

RATINGS

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

		BDV67A				B	C	D
Collector-base voltage (open emitter)	V_{CB0}	max.	100	120	140	160	V	
Collector-emitter voltage (open base)	V_{CEO}	max.	80	100	120	150	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.	0,5			A		
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	200			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	$R_{th\ j-mb}$	=	0,625	K/W
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CHARACTERISTICS

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

Collector cut-off currents

$I_E = 0; V_{CB} = V_{CB0max}$	I_{CBO}	<	1	mA
$I_E = 0; V_{CB} = \frac{1}{2}V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<	4	mA
$I_B = 0; V_{CE} = \frac{1}{2}V_{CEOmax}$	I_{CEO}	<	3	mA

Emitter cut-off current

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

* 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.

D.C. current gain*

$I_C = 1 \text{ A}; V_{CE} = 3 \text{ V}$

$I_C = 10 \text{ A}; V_{CE} = 3 \text{ V}$

$I_C = 16 \text{ A}; V_{CE} = 3 \text{ V}$

h_{FE} typ. 3000

h_{FE} > 1000

h_{FE} typ. 1000

Base-emitter voltage**

$I_C = 10 \text{ A}; V_{CE} = 3 \text{ V}$

V_{BE} < 2,5 V

Collector-emitter saturation voltage*

$I_C = 10 \text{ A}; I_B = 40 \text{ mA}$

V_{CEsat} < 2 V

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

$I_E = I_e = 0; V_{CB} = 10 \text{ V}$

C_C typ. 300 pF

Cut-off frequency

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

f_{hfe} typ. 60 kHz

Diode, forward voltage

$I_F = 10 \text{ A}$

V_F < 3 V

D.C. current gain ratio of matched complementary pairs

$I_C = 10 \text{ A}; V_{CE} = 3 \text{ V}$

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

Small-signal current gain

$I_C = 5 \text{ A}; V_{CE} = 3 \text{ V}; f = 1 \text{ MHz}$

h_{fe} typ. 40

Turn-off breakdown energy with inductive load (see also Fig. 3).

$I_{Con} = 6,3 \text{ A}; -I_{Boff} = 0; t_p = 1 \text{ ms}; T = 100 \text{ ms}$

$E(BR)$ > 150 mJ

Switching times

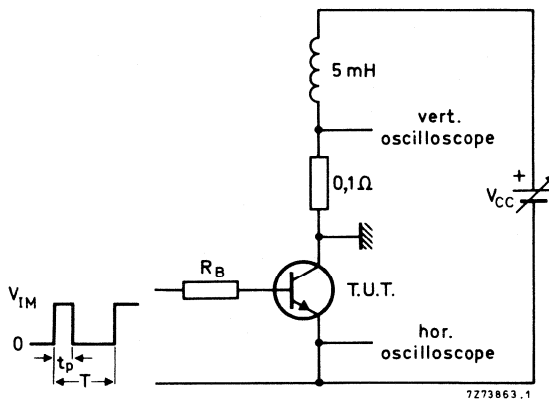
$I_{Con} = 10 \text{ A}; I_{Bon} = -I_{Boff} = 40 \text{ mA}; V_{CC} = 12 \text{ V}$

Turn-on time

t_{on} typ. 1 μs

Turn-off time

t_{off} typ. 3,5 μs

Fig. 3 Test circuit; $V_1 = 12 \text{ V}$; $R_B = 270 \Omega$.* Measured under pulse conditions: $t_p < 300 \mu\text{s}$; $\delta < 2\%$.** V_{BE} decreases by about 3,6 mV/K with increasing temperature.

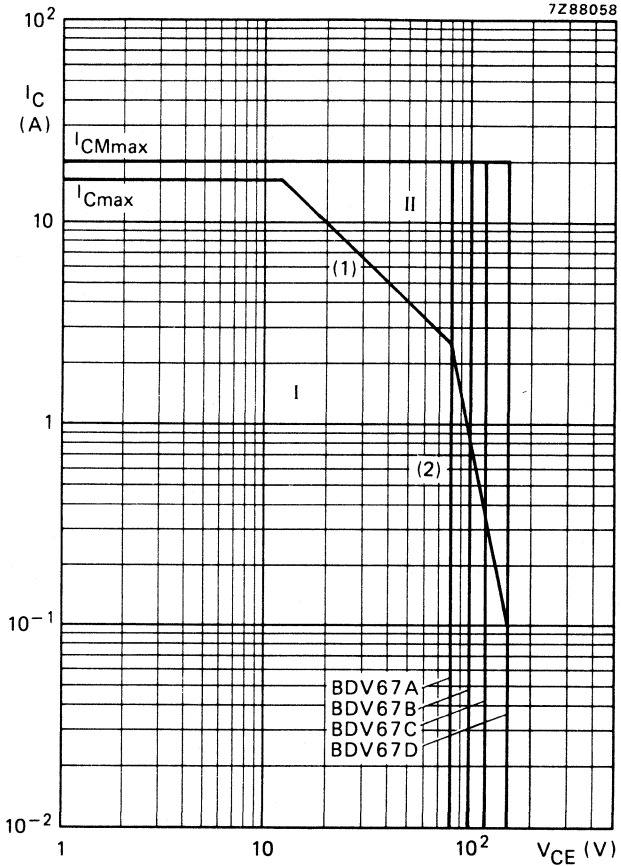


Fig. 4 Safe Operating ARea; $T_{mb} \leq 25$ °C.

- 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).

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N epitaxial base power transistors in the plastic SOT-93 envelope. These transistors are intended for use in audio output stages and general amplifier and switching applications.

P-N-P complements are BDV92, BDV94 and BDV96.

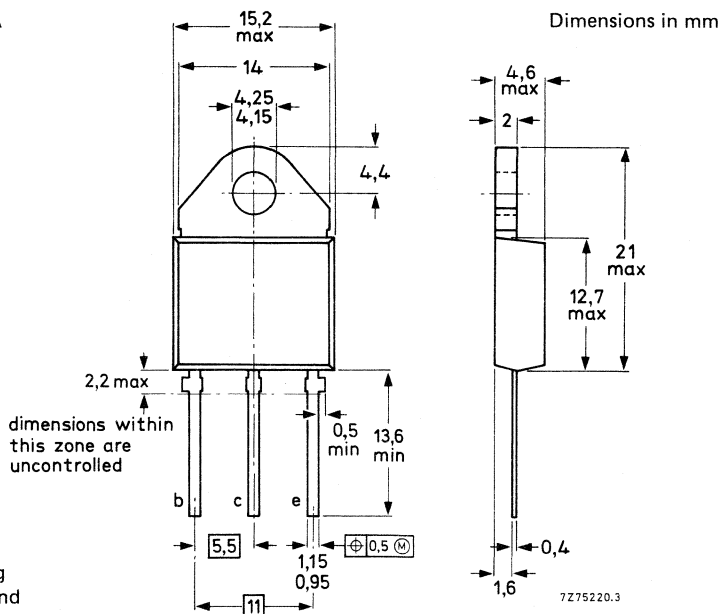
QUICK REFERENCE DATA

			BDV91	BDV93	BDV95
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.	100		W
Junction temperature	T_j	max.	150		$^{\circ}\text{C}$
D.C. current gain					
$I_C = 4\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>	20		
Transition frequency					
$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$	f_T	>	3		MHz

MECHANICAL DATA

Fig. 1 SOT-93 .

Collector connected to mounting base.



RATINGS

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

			BDV91	BDV93	BDV95
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	7	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.		7	A
Emitter current (d.c.)	I_E	max.		14	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		100	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	$R_{th\ j-mb}$	=		1,25	K/W
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CHARACTERISTICS

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

Collector cut-off currents

$I_E = 0; V_{CB} = V_{CBO}\text{ max}$	I_{CBO}	<		0,1	mA
$I_E = 0; V_{CB} = \frac{1}{2}V_{CBO}\text{ max}; T_j = 150\text{ }^\circ\text{C}$	I_{CBO}	<		1	mA
$I_B = 0; V_{CE} = V_{CEO}\text{ max}$	I_{CEO}	<		1	mA

Emitter cut-off current

$I_C = 0; V_{EB} = 7\text{ V}$	I_{EBO}	<		1	mA
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D.C. current gain

$I_C = 4\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>		20	
$I_C = 10\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>		5	

Collector-emitter saturation voltage

$I_C = 4\text{ A}; I_B = 0,4\text{ A}$	$V_{CE\ sat}$	<		1	V
$I_C = 10\text{ A}; I_B = 3,3\text{ A}$	$V_{CE\ sat}$	<		3	V

Base-emitter saturation voltage

$I_C = 4\text{ A}; I_B = 0,4\text{ A}$	$V_{BE\ sat}$	<		1,6	V
--	---------------	---	--	-----	---

Base-emitter voltage

$I_C = 4\text{ A}; V_{CE} = 4\text{ V}$	V_{BE}	<		1,6	V
---	----------	---	--	-----	---

CHARACTERISTICS (continued)

Transition frequency

$I_C = 0,5 \text{ A}; V_{CE} = 10 \text{ V}$

$f_T > 3 \text{ MHz}$

Switching times (between 10% and 90% levels)

$I_{Con} = 4 \text{ A}; I_{Bon} = -I_{Boff} = 0,4 \text{ A}; V_{CC} = 30 \text{ V}$

Turn-on time

$t_{on} \text{ typ. } 0,5 \mu\text{s}$

Turn-off time

$t_{off} \text{ typ. } 2,0 \mu\text{s}$

Fall time

$t_f \text{ typ. } 0,7 \mu\text{s}$

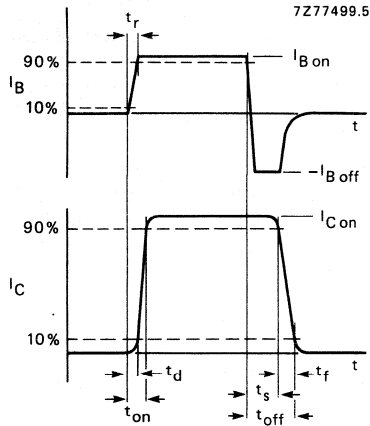


Fig. 2 Switching times waveforms.

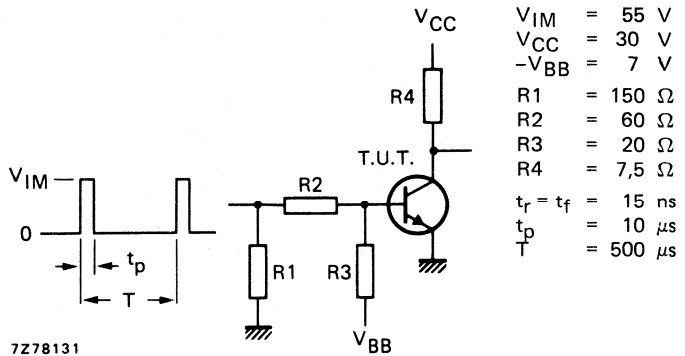


Fig. 3 Switching times test circuit.

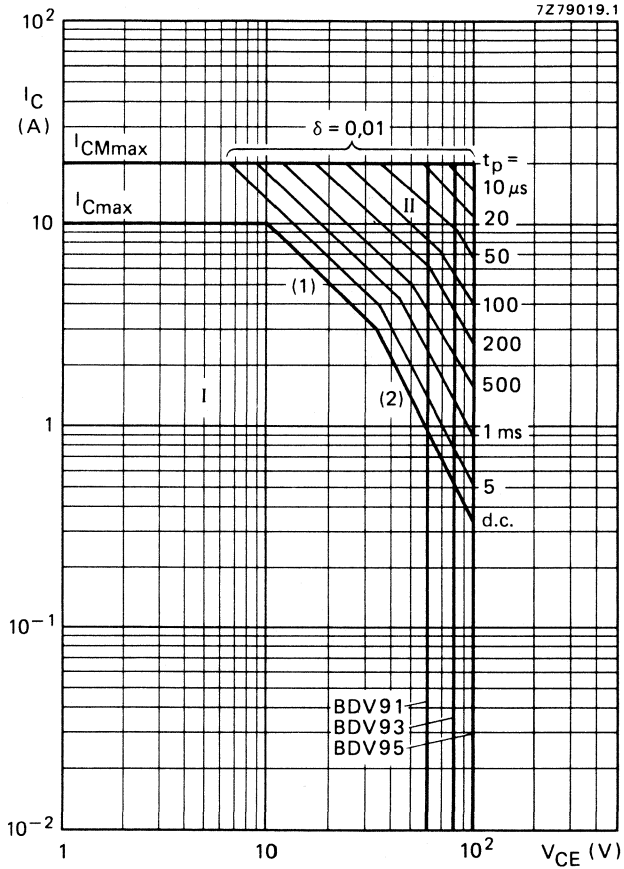


Fig. 4 Safe Operating Area; $T_{mb} = 25^\circ\text{C}$.

- 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.

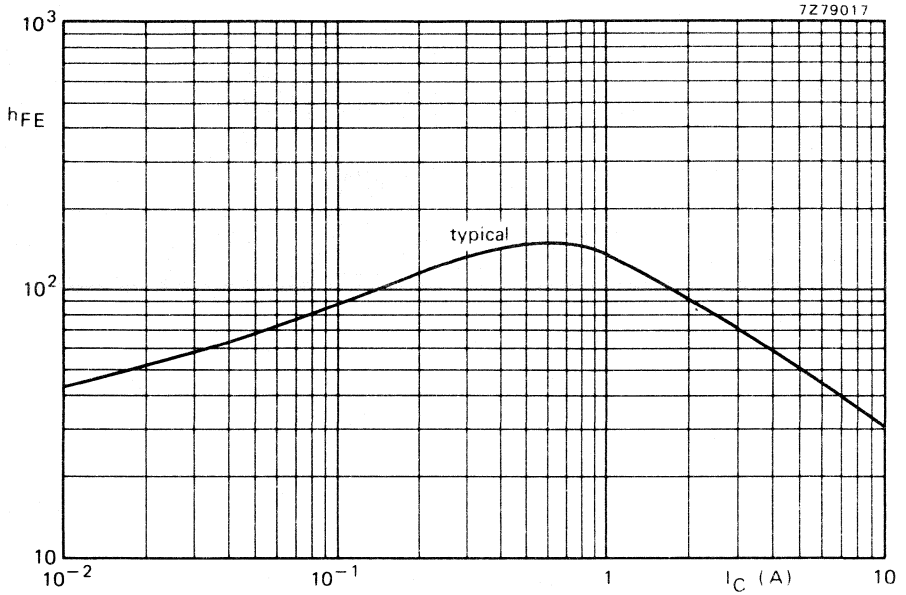


Fig. 5 $V_{CE} = 4$ V; $T_j = 25$ °C.

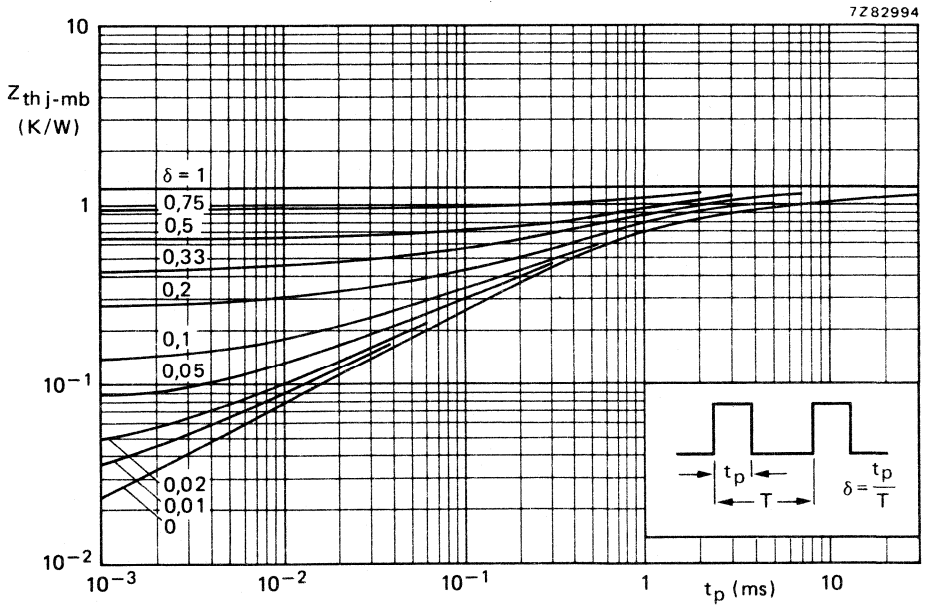


Fig. 6 Pulse power rating chart.

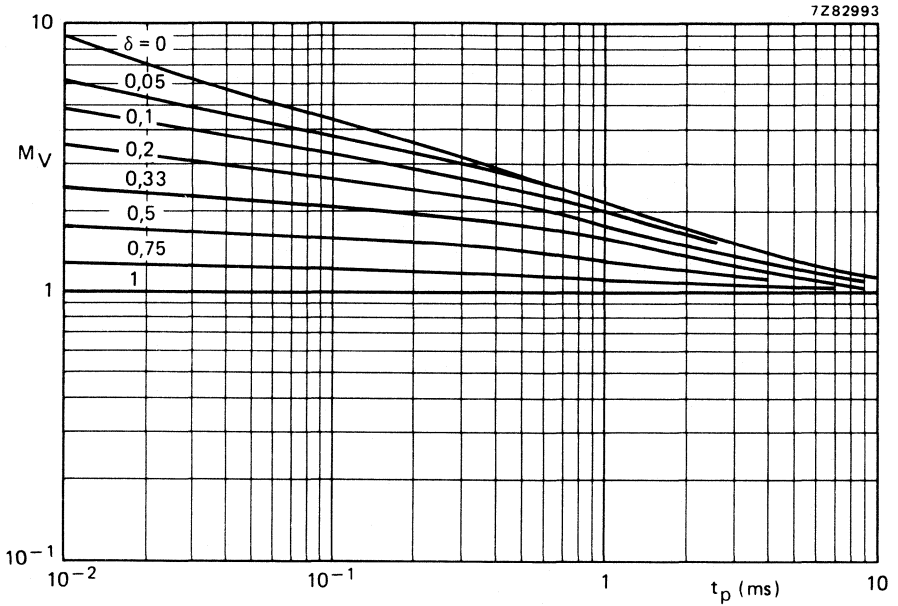


Fig. 7 Second-breakdown voltage multiplying factor at the I_{Cmax} level.

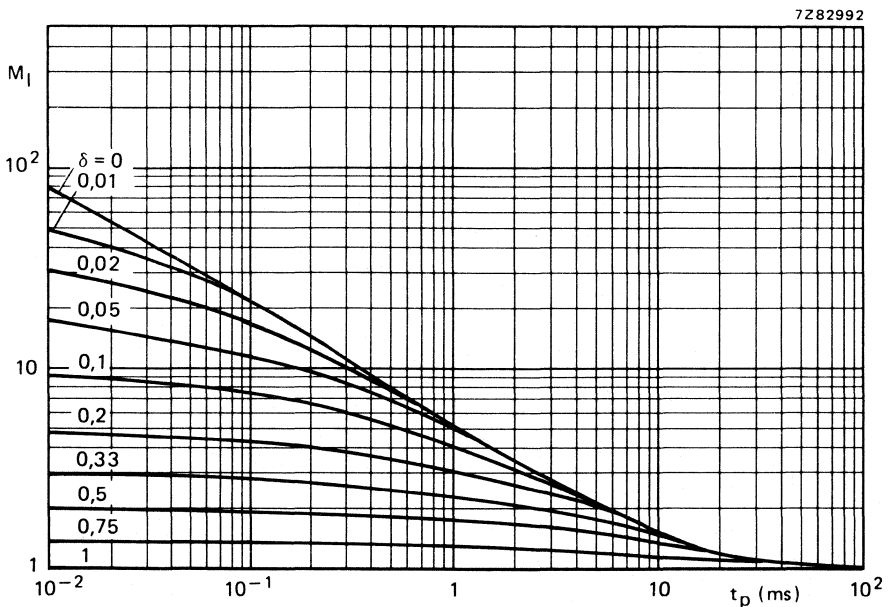


Fig. 8 Second-breakdown current multiplying factor at the V_{CEOmax} level.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P epitaxial base power transistors in the plastic SOT-93 envelope. These transistors are intended for use in audio output stages and general amplifier and switching applications.

N-P-N complements are BDV91, BDV93 and BDV95.

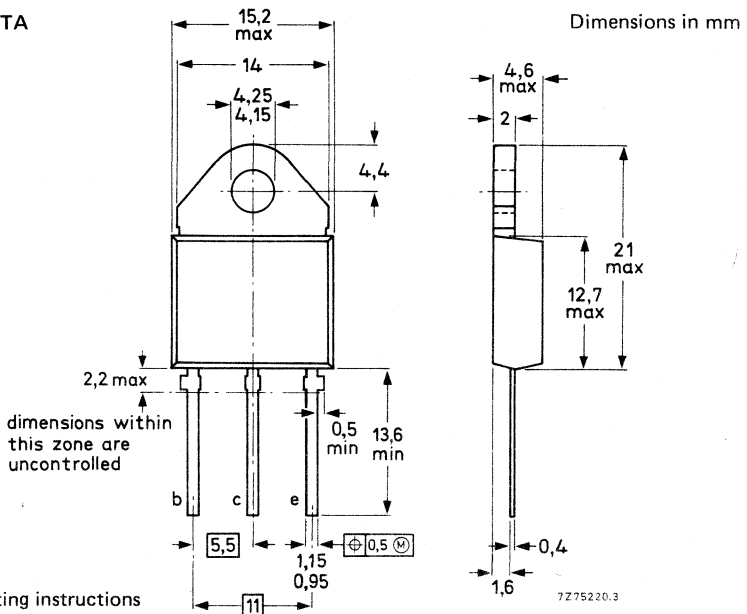
QUICK REFERENCE DATA

		BDV92	BDV94	BDV96
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.	100		W
Junction temperature	T_j max.	150		$^{\circ}\text{C}$
D.C. current gain	$h_{FE} >$	20		
$-I_C = 4\text{ A}; -V_{CE} = 4\text{ V}$				
Transition frequency	$f_T >$	4		MHz
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}$				

MECHANICAL DATA

Fig. 1 SOT-93.

Collector connect to mounting base



7275220.3

RATINGS

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

		BDV92	BDV94	BDV96
Collector-base voltage (open emitter)	$-V_{CB0}$ 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	7	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.	7		A
Emitter current (d.c.)	$-I_E$ max.	14		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	100		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	$R_{th\ j-mb} =$	1,25	K/W
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CHARACTERISTICS

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

Collector cut-off currents

$I_E = 0; -V_{CB} = -V_{CB0max}$	$-I_{CBO} <$	0,1	mA
$I_E = 0; -V_{CB} = -\frac{1}{2}V_{CB0max}; T_j = 150\text{ }^\circ\text{C}$	$-I_{CBO} <$	1	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

$-I_C = 4\text{ A}; -V_{CE} = 4\text{ V}$	$h_{FE} >$	20	
$-I_C = 10\text{ A}; -V_{CE} = 4\text{ V}$	$h_{FE} >$	5	

Collector-emitter saturation voltage

$-I_C = 4\text{ A}; -I_B = 0,4\text{ A}$	$-V_{CEsat} <$	1	V
$-I_C = 10\text{ A}; -I_B = 3,3\text{ A}$	$-V_{CEsat} <$	3	V

Base-emitter saturation voltage

$-I_C = 4\text{ A}; -I_B = 0,4\text{ A}$	$-V_{BEsat} <$	1,6	V
--	----------------	-----	---

Base-emitter voltage

$-I_C = 4\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE} <$	1,6	V
---	-------------	-----	---

CHARACTERISTICS (continued)

Transition frequency

$-I_C = 0,5 \text{ A}; -V_{CE} = 10 \text{ V}$

$f_T > 4 \text{ MHz}$

Switching times (between 10% and 90% levels)

$-I_{Con} = 4 \text{ A}; -I_{Bon} = I_{Boff} = 0,4 \text{ A}; -V_{CC} = 30 \text{ V}$

t_{on}	typ. 0,3 μs
t_{off}	typ. 0,7 μs
t_f	typ. 0,3 μs

Turn-on time
Turn-off time
Fall time

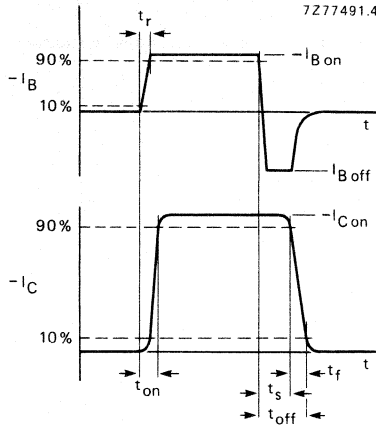
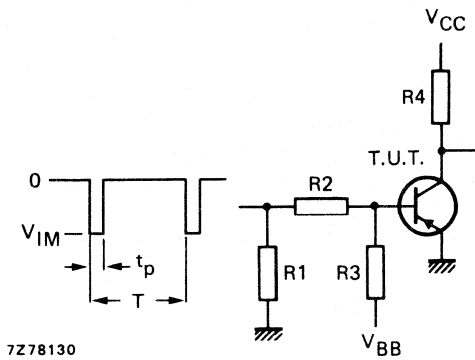


Fig. 2 Switching times waveforms.



$-V_{IM}$	= 55 V
$-V_{CC}$	= 30 V
V_{BB}	= 7 V
$R1$	= 150 Ω
$R2$	= 60 Ω
$R3$	= 20 Ω
$R4$	= 7,5 Ω
$t_r = t_f$	= 15 ns
t_p	= 10 μs
T	= 500 μs

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Fig. 3 Switching times test circuit.

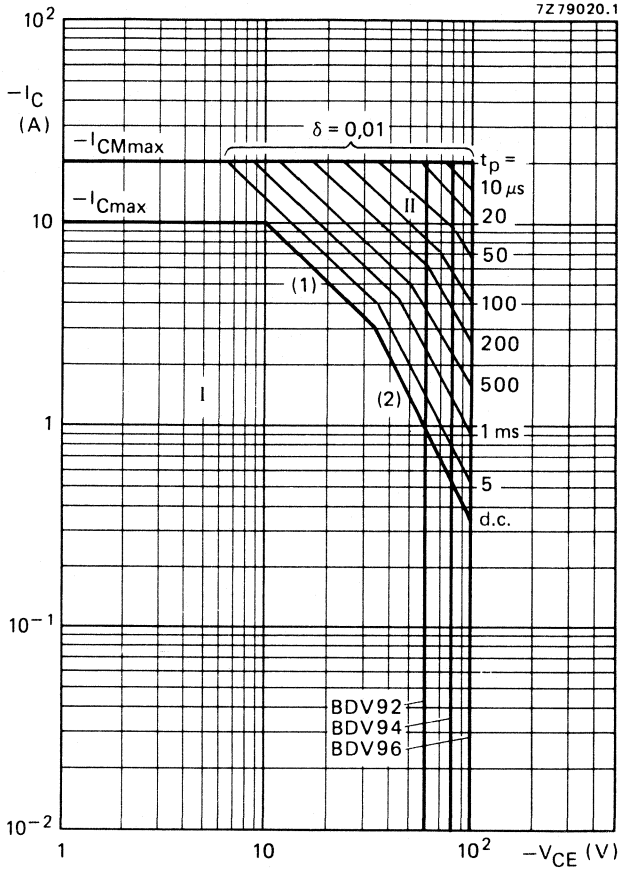


Fig. 4 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

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

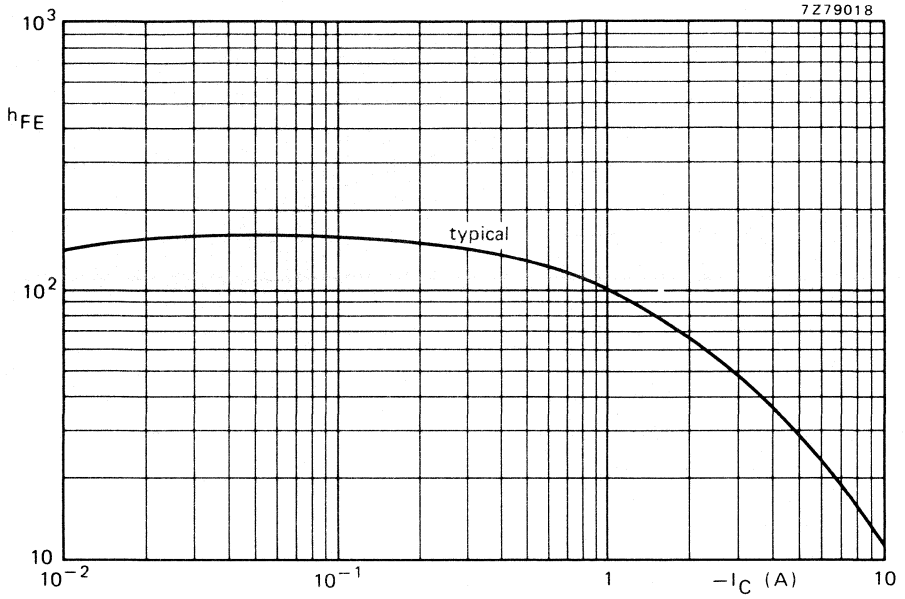


Fig. 5 $-V_{CE} = 4$ V; $T_j = 25$ °C.

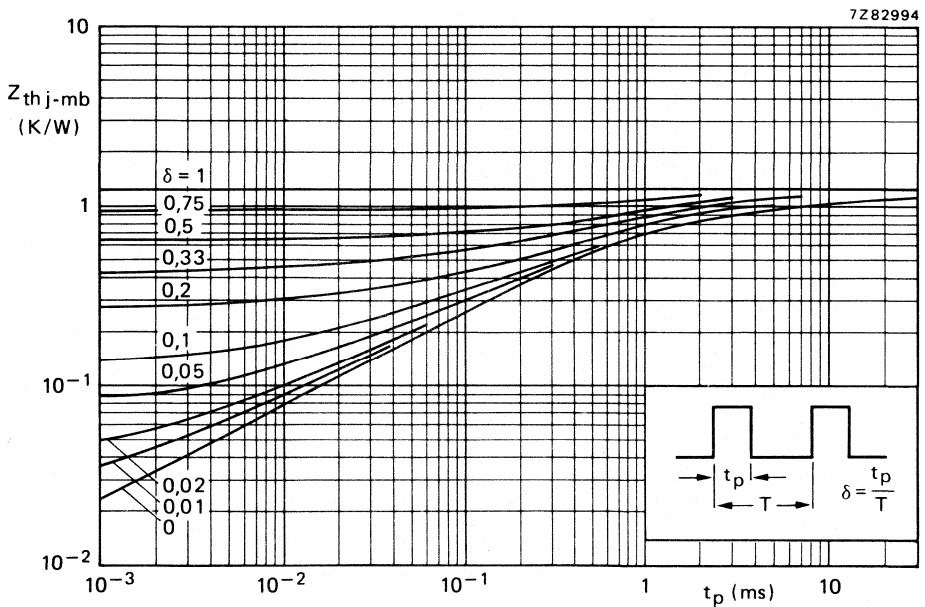


Fig. 6 Pulse power rating chart.

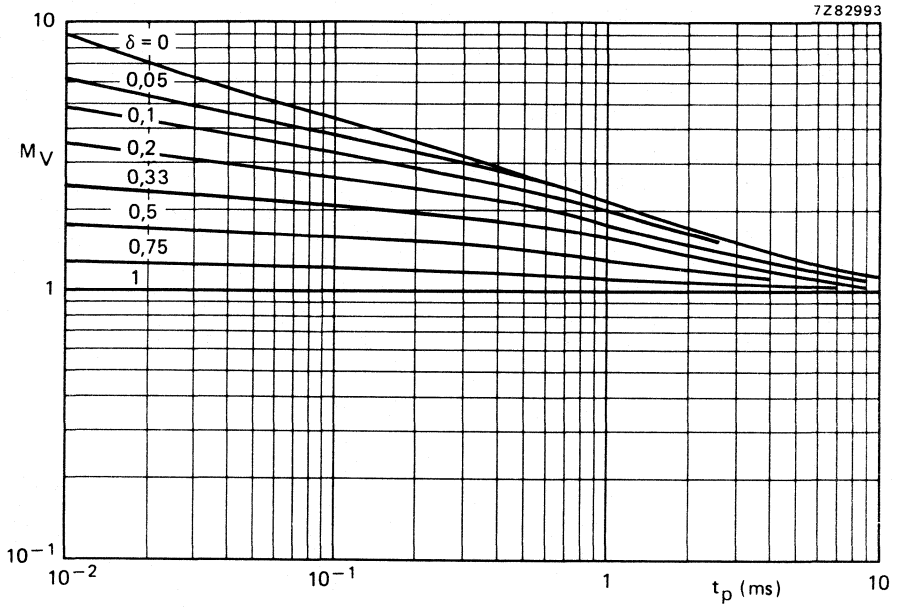


Fig. 7 Second-breakdown voltage multiplying factor at the I_{Cmax} level.

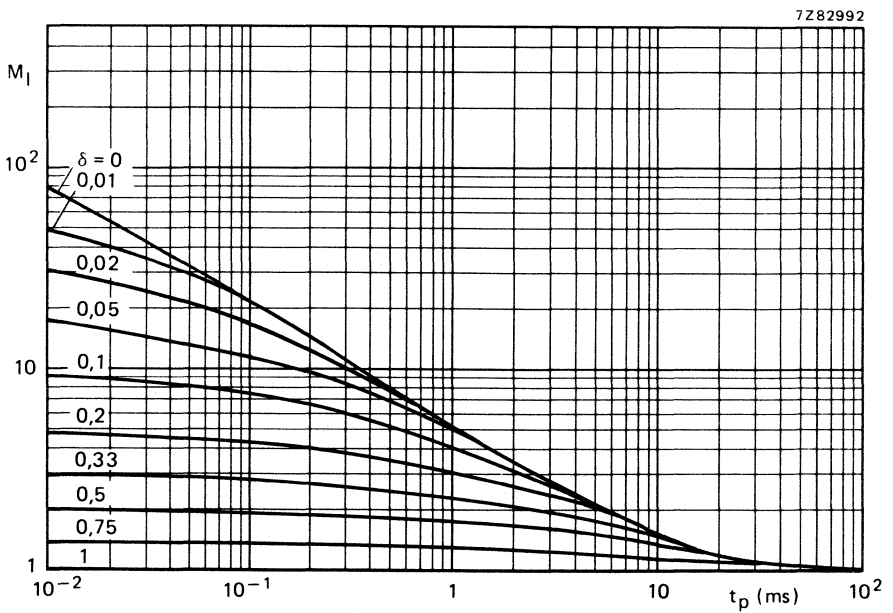


Fig. 8 Second-breakdown current multiplying factor at the V_{CE0max} level.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

N-P-N medium-power transistors in SOT-32 plastic envelopes specially intended for use in professional equipment (i.e. telecommunication). The high degree of reliability has been achieved by using process steps and materials which have been proved to be highly reliable.

Features of this product: ● unimetal (gold-to-gold) ultrasonic wire bonding;
● gold silicon eutectic chip bond;
● glass-passivated chip;
● silicone plastic

P-N-P complements are BDW56, BDW58 and BDW60.

QUICK REFERENCE DATA

		BDW55	BDW57	BDW59
Collector-base voltage (open emitter)	V_{CBO}	max. 45	60	100 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	V_{CER}	max. 45	60	100 V
Collector-emitter voltage (open base)	V_{CEO}	max. 45	60	80 V
Collector current (peak value)	I_{CM}	max.	1,5	A
Total power dissipation up to $T_{mb} = 95 \text{ }^\circ\text{C}$	P_{tot}	max.	8	W
Junction temperature	T_j	max.	175	$^\circ\text{C}$
D.C. current gain $I_C = 150 \text{ mA}; V_{CE} = 2 \text{ V}$	h_{FE}	>	40 to 250	
Transition frequency $I_C = 50 \text{ mA}; V_{CE} = 5 \text{ V}$	f_T	typ.	250	MHz

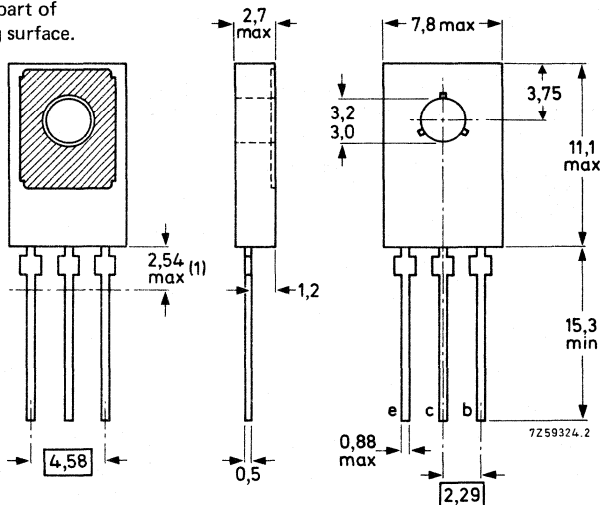
MECHANICAL DATA

MECHANICAL DATA

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

Collector connected to metal part of mounting surface.

Dimensions in mm



(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).

	BDW55	BDW57	BDW59
Collector-base voltage (open emitter)	V_{CBO} max. 45	60	100 V
Collector-emitter voltage ($R_{BE} = 1\text{ k}\Omega$)	V_{CER} max. 45	60	100 V
Collector-emitter voltage (open base)	V_{CEO} max. 45	60	80 V
Emitter-base voltage (open collector)	V_{EBO} max. 5	5	5 V
Collector current (d.c.)	I_C max.	1	A
Collector current (peak value)	I_{CM} max.	1,5	A
Total power dissipation up to $T_{mb} = 95\text{ }^\circ\text{C}$	P_{tot} max.	8	W
Storage temperature	T_{stg}	-65 to +175	$^\circ\text{C}$
Junction temperature	T_j max.	175	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$ =	100	K/W
From junction to mounting base	$R_{th\ j-mb}$ =	10	K/W

CHARACTERISTICS

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

Collector cut-off current

 $I_E = 0; V_{CB} = V_{CB0\text{max}}$ $I_E = 0; V_{CB} = 30, 45, 70\text{ V (resp.)}; T_j = 150\text{ }^\circ\text{C}$ $I_{CBO} < 100\text{ nA}$ $I_{CBO} < 10\text{ }\mu\text{A}$

Emitter cut-off current

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

Base-emitter voltage

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

Collector-emitter saturation voltage

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

D.C. current gain

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

Switching times (see also Figs 2 and 3)

 $I_{Con} = 150\text{ mA}; I_{Bon} = -I_{Boff} = 15\text{ mA};$ $V_{CC} = 10,2\text{ V}$

Turn-on delay time

 $t_d \quad \text{typ. } 30\text{ ns}$

Turn-on rise time

 $t_r \quad \text{typ. } 30\text{ ns}$

Turn-off storage time

 $t_s \quad \text{typ. } 500\text{ ns}$

Turn-off fall time

 $t_f \quad \text{typ. } 80\text{ ns}$

CHARACTERISTICS (continued)

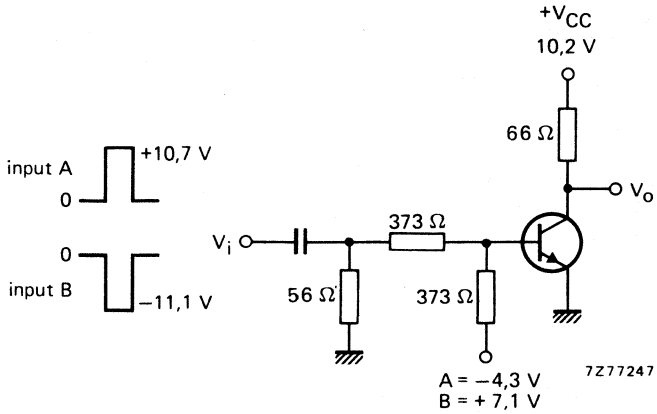


Fig. 2 Test circuit for measuring switching times.

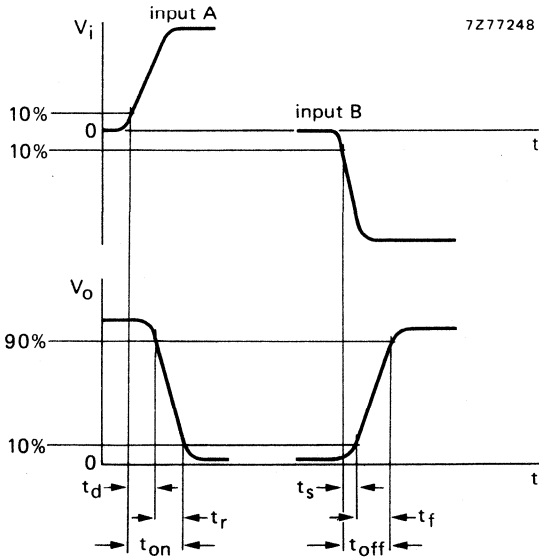


Fig. 3 Switching times waveforms.

Equipment

- pulse generator; rise time = 1 ns.
- double-beam or dual-trace oscilloscope; rise time < 5 ns.

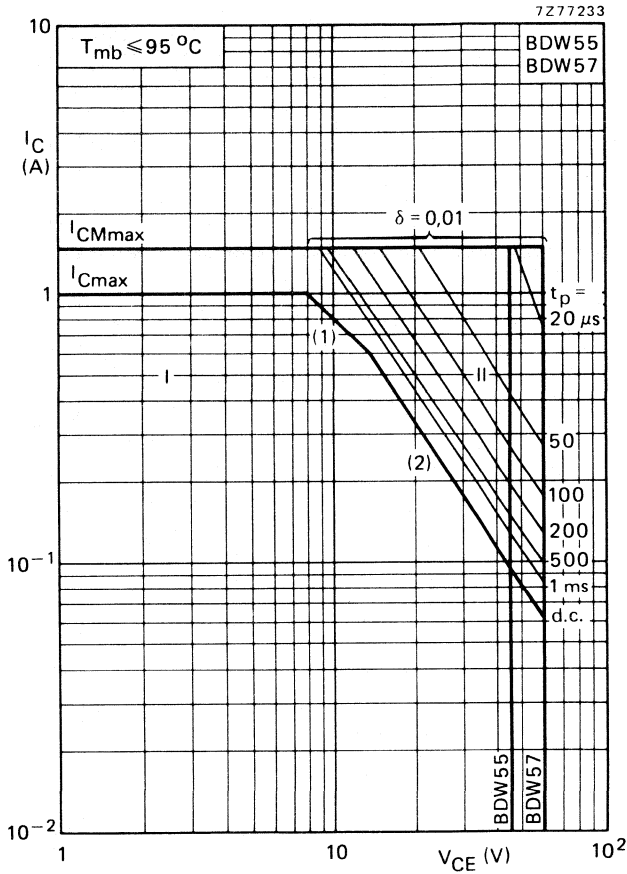


Fig. 4 Safe Operating Area.

- 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).

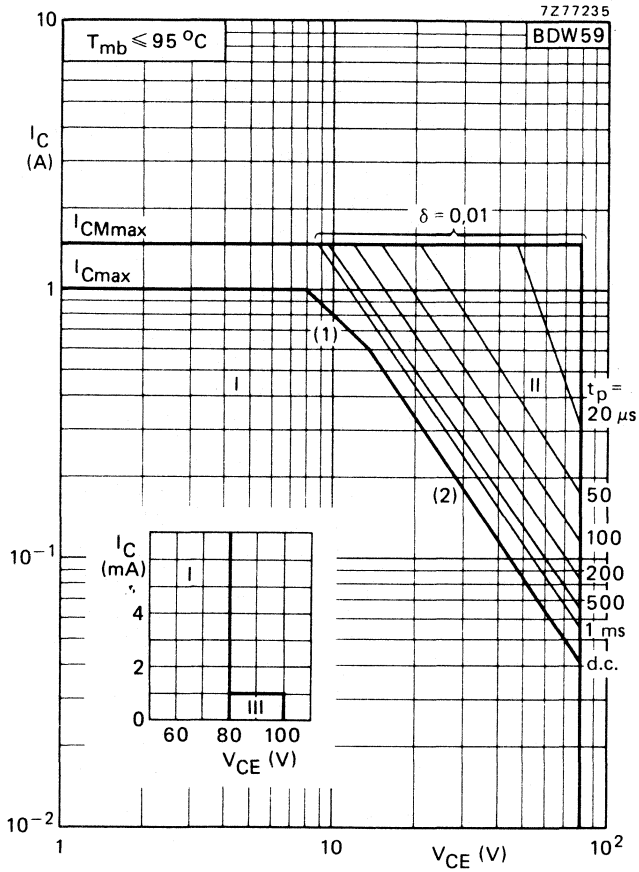


Fig. 5 Safe Operating Area.

- I Region of permissible d.c. operation.
 - II Permissible extension for repetitive pulse operation.
 - III Repetitive pulse operation in this region is permissible, provided $R_{BE} \leq 1 \text{ k}\Omega$.
- (1) $P_{tot \text{ max}}$ and $P_{tot \text{ peak max}}$ lines.
(2) Second-breakdown limits (independent of temperature).

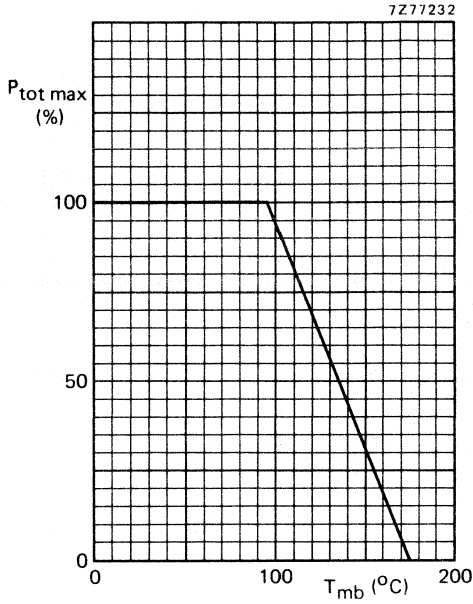


Fig. 6.

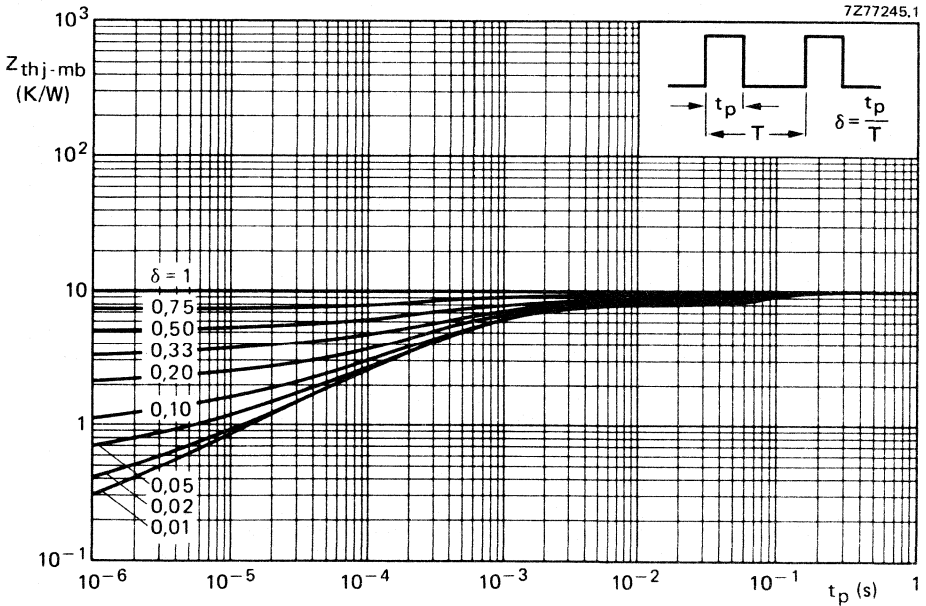


Fig. 7.

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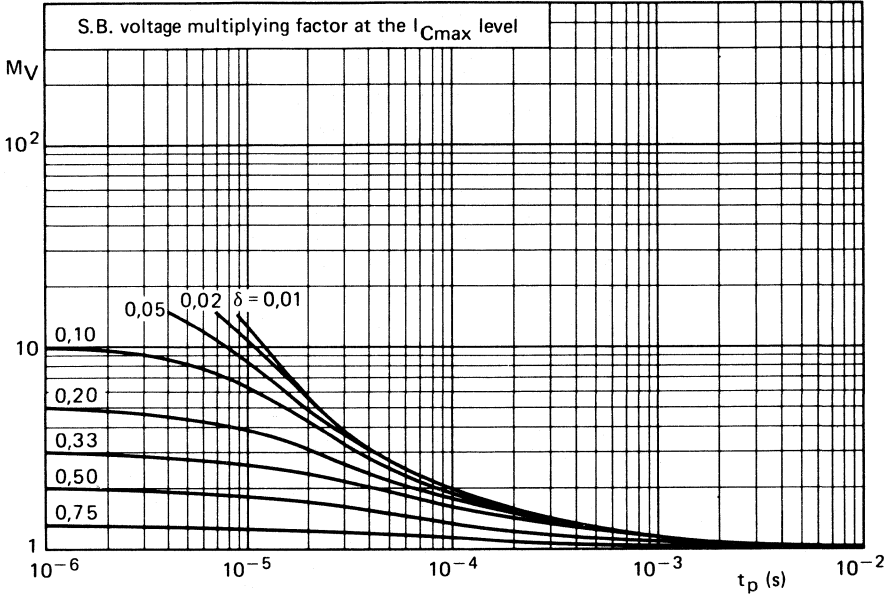


Fig. 8.

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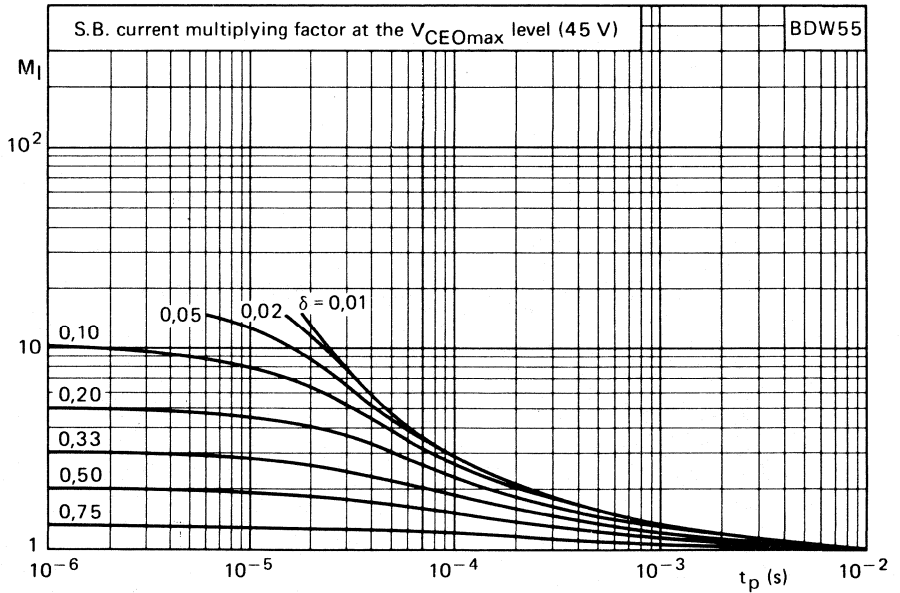


Fig. 9.

7277239

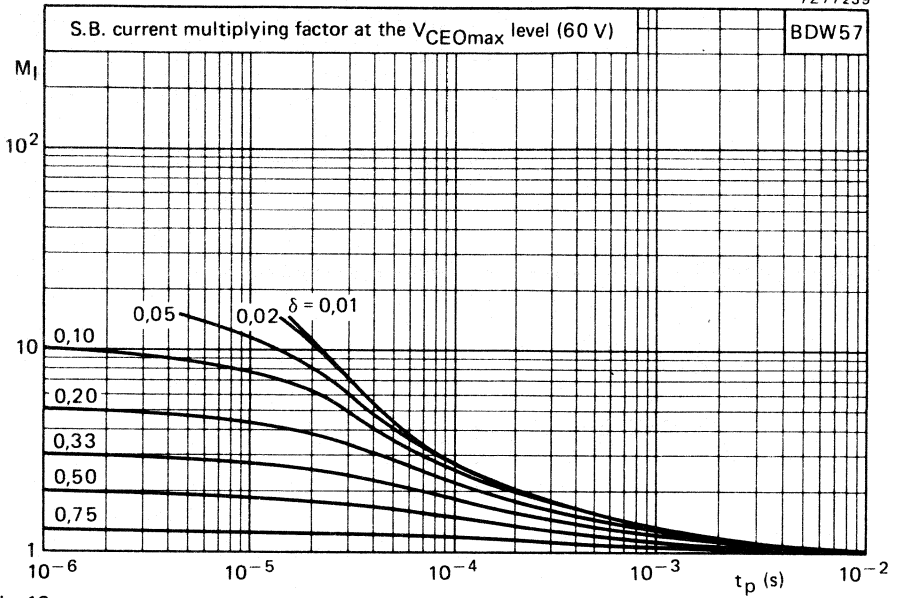


Fig. 10.

7277241

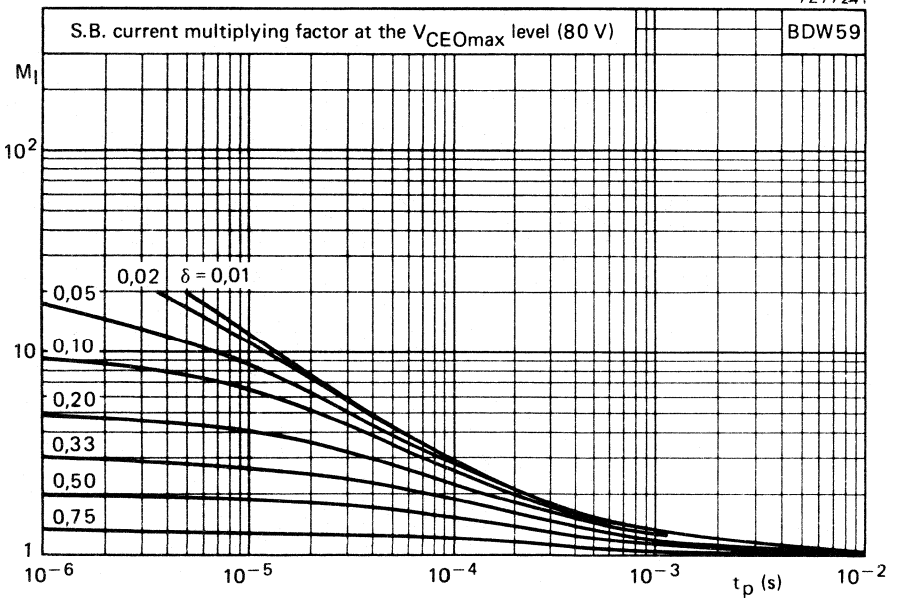


Fig. 11.

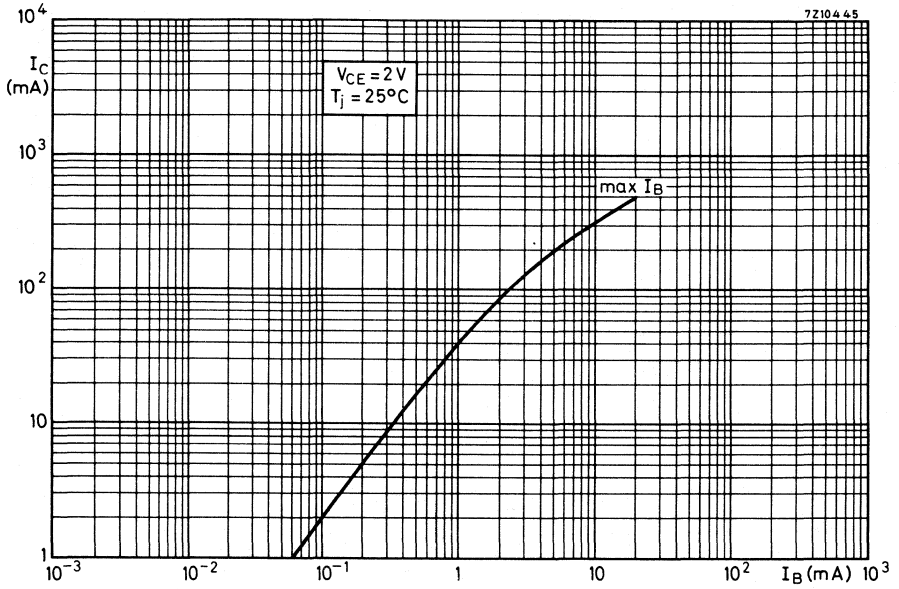


Fig. 12.

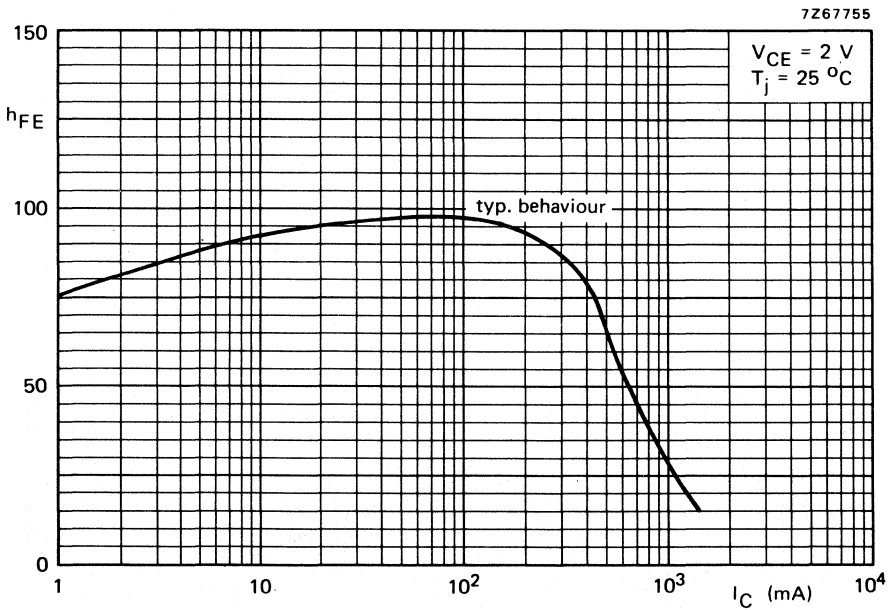


Fig. 13.

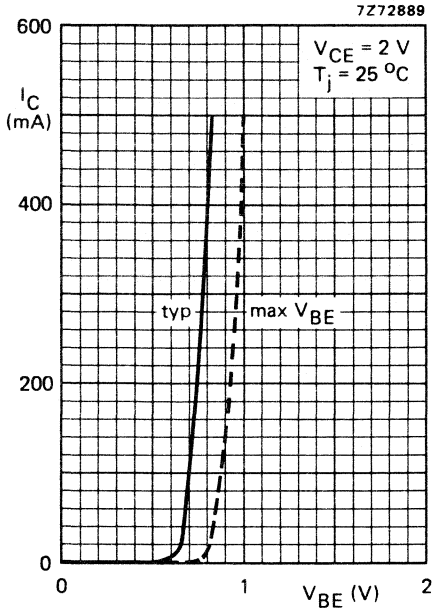


Fig. 14.

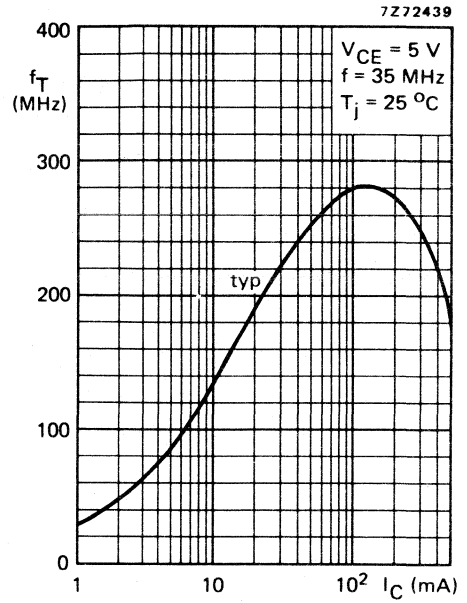


Fig. 15.

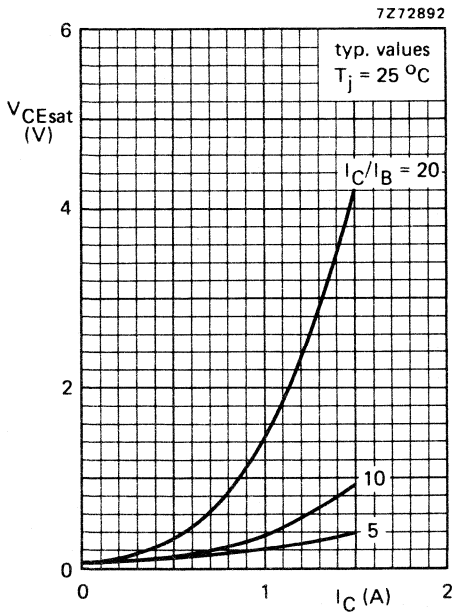


Fig. 16.

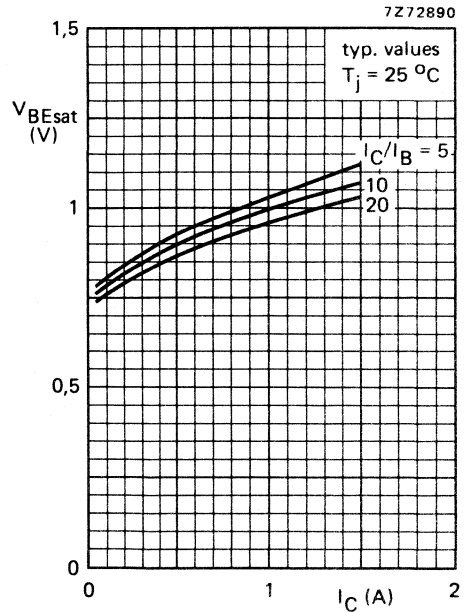


Fig. 17.

SILICON PLANAR EPITAXIAL POWER TRANSISTORS

P-N-P medium-power transistors in SOT-32 plastic envelopes specially intended for use in professional equipment (i.e. telecommunication). The high degree of reliability has been achieved by using process steps and materials which have been proved to be highly reliable.

- Features of this product:
- unimetal (gold-to-gold) ultrasonic wire bonding;
 - gold silicon eutectic chip bond;
 - glass-passivated chip;
 - silicone plastic.

N-P-N complements are BDW55, BDW57 and BDW59.

QUICK REFERENCE DATA

		BDW56	BDW58	BDW60
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 45	60	100 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	$-V_{CER}$	max. 45	60	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 45	60	80 V
Collector current (peak value)	$-I_{CM}$	max.	1,5	A
Total power dissipation up to $T_{mb} = 95 \text{ }^\circ\text{C}$	P_{tot}	max.	8	W
Junction temperature	T_j	max.	175	$^\circ\text{C}$
D.C. current gain $-I_C = 150 \text{ mA}; -V_{CE} = 2 \text{ V}$	h_{FE}	>	40 to 250	
Transition frequency $-I_C = 50 \text{ mA}; -V_{CE} = 5 \text{ V}$	f_T	typ.	75	MHz

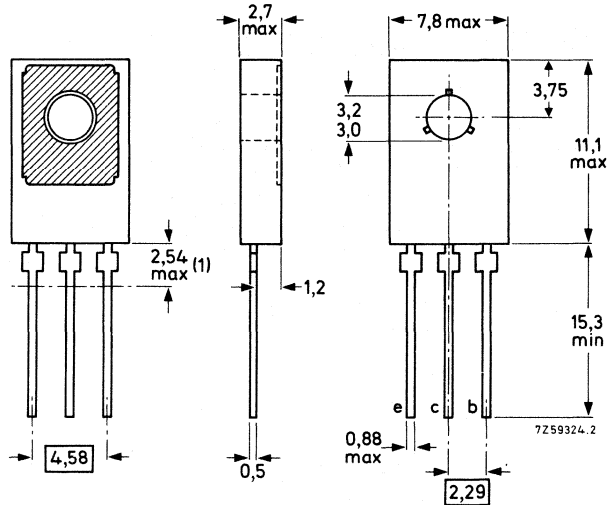
MECHANICAL DATA

MECHANICAL DATA

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

Collector connected to metal part of mounting surface.

Dimensions in mm



(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)

			BDW56	BDW58	BDW60
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100 V
Collector-emitter voltage ($R_{BE} = 1 \text{ k}\Omega$)	$-V_{CER}$	max.	45	60	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5 V
Collector current (d.c.)	$-I_C$	max.		1	A
Collector current (peak value)	$-I_{CM}$	max.		1,5	A
Total power dissipation up to $T_{mb} = 95 \text{ }^\circ\text{C}$	P_{tot}	max.		8	W
Storage temperature	T_{stg}			-65 to +175	$^\circ\text{C}$
Junction temperature	T_j	max.		175	$^\circ\text{C}$

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th j-a}$	=		100	K/W
From junction to mounting base	$R_{th j-mb}$	=		10	K/W

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

Collector cut-off current

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

$I_E = 0; -V_{CB} = 30, 45, 70\text{ V (resp.)}; T_j = 150\text{ }^\circ\text{C}$

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

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

Emitter cut-off current

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

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

Base-emitter voltage

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

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

Collector-emitter saturation voltage

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

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

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 $f = 35\text{ MHz}$;

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

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

Switching times (see also Figs 2 and 3)

$-I_{Con} = 150\text{ mA}; -I_{Bon} = I_{Boff} = 15\text{ mA};$

$-V_{CC} = 10,2\text{ V}$

Turn-on delay time

$t_d \text{ typ. } 30\text{ ns}$

Turn-on rise time

$t_r \text{ typ. } 40\text{ ns}$

Turn-off storage time

$t_s \text{ typ. } 500\text{ ns}$

Turn-off fall time

$t_f \text{ typ. } 80\text{ ns}$

CHARACTERISTICS (continued)

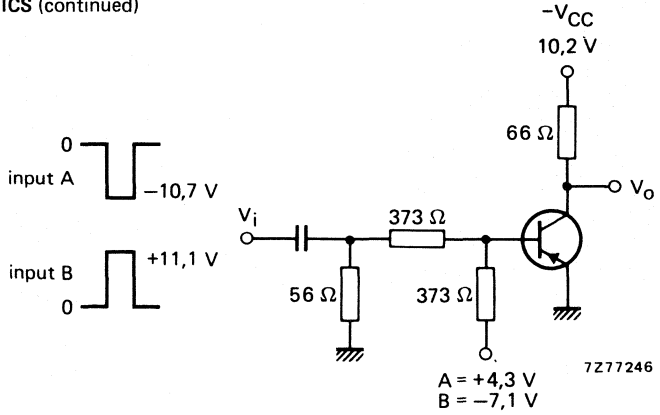


Fig. 2 Test circuit for measuring switching times.

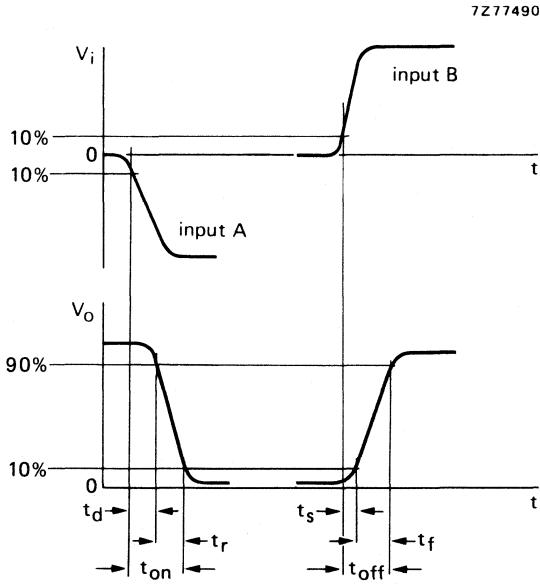


Fig. 3 Switching time waveforms.

Equipment

pulse generator; rise time = 1 ns.
double-beam or dual-trace oscilloscope; rise time < 5 ns.

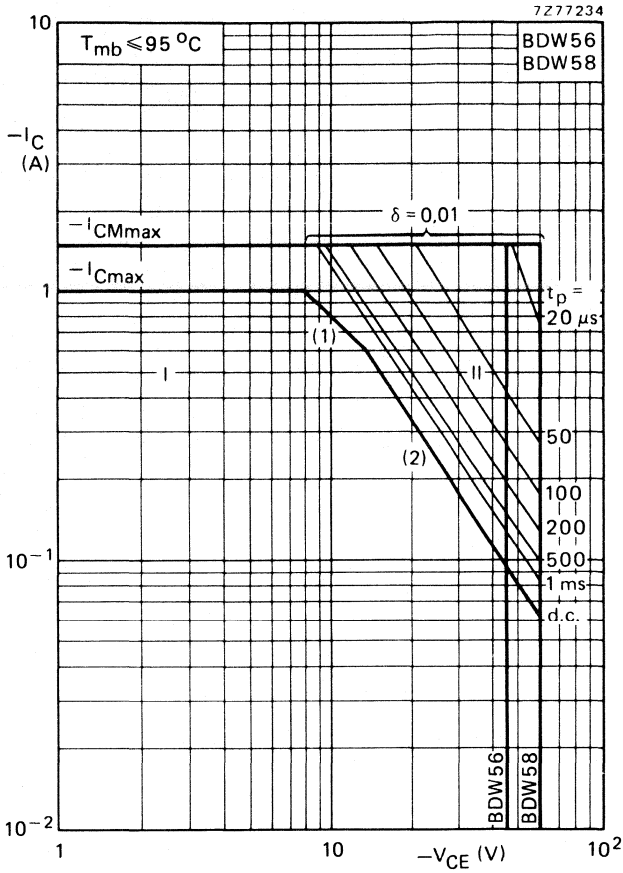


Fig. 4 Safe Operating Area.

- 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).

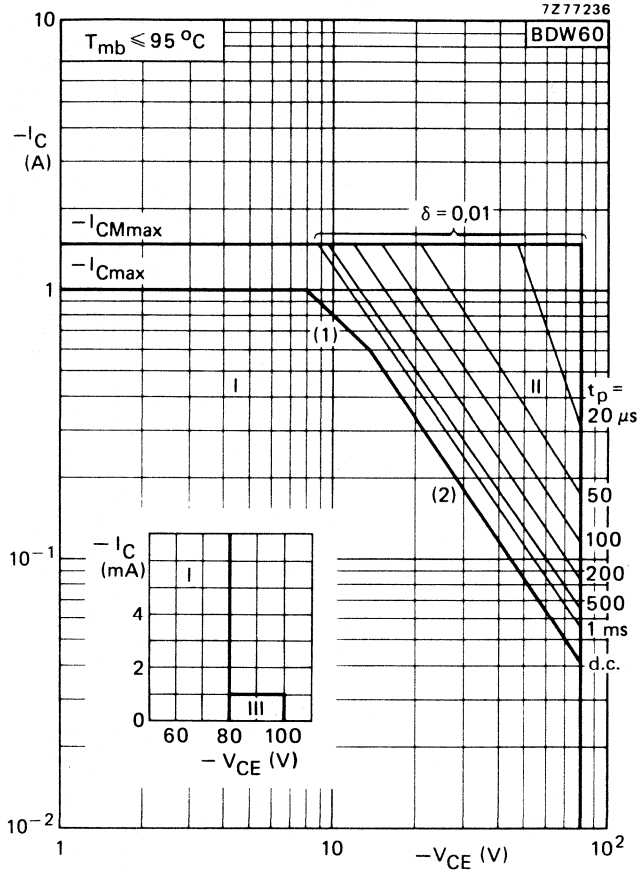


Fig. 5 Safe Operating Area.

- I Region of permissible d.c. operation
 - II Permissible extension for repetitive pulse operation
 - III Repetitive pulse operation in this region is permissible provided $R_{BE} \leq 1 \text{ k}\Omega$
- (1) $P_{tot \text{ max}}$ and $P_{tot \text{ peak max}}$ lines
- (2) Second-breakdown limits (independent of temperature).

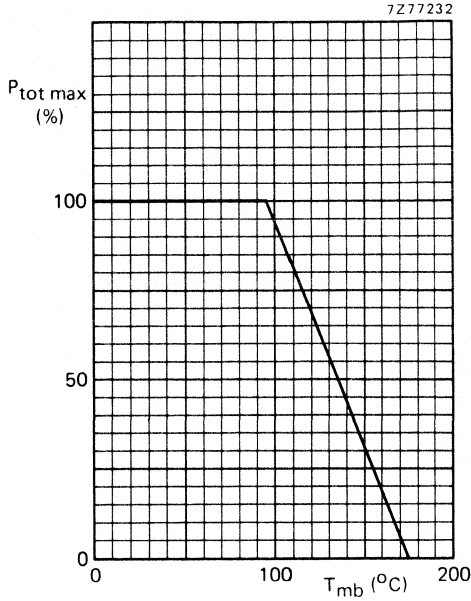


Fig. 6.

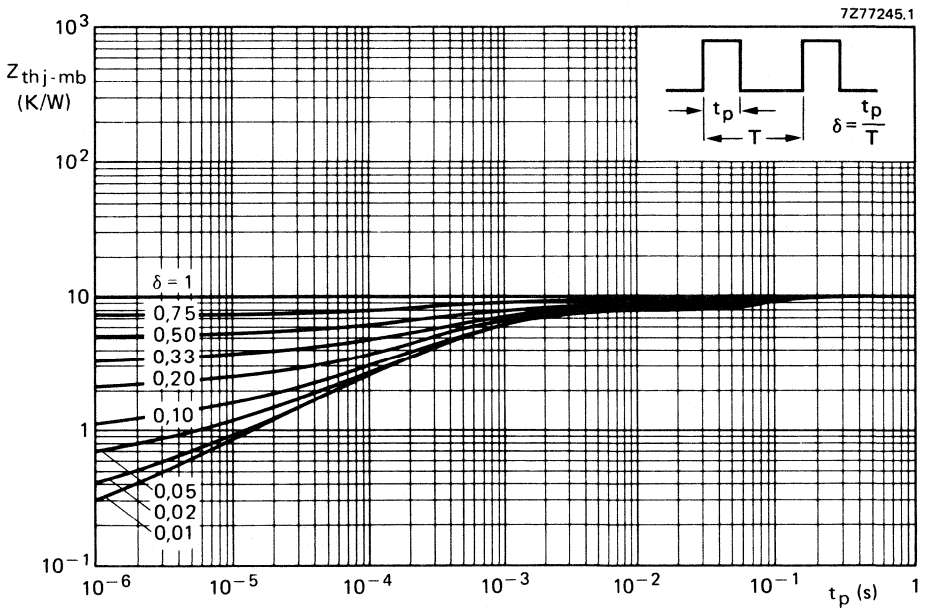


Fig. 7.

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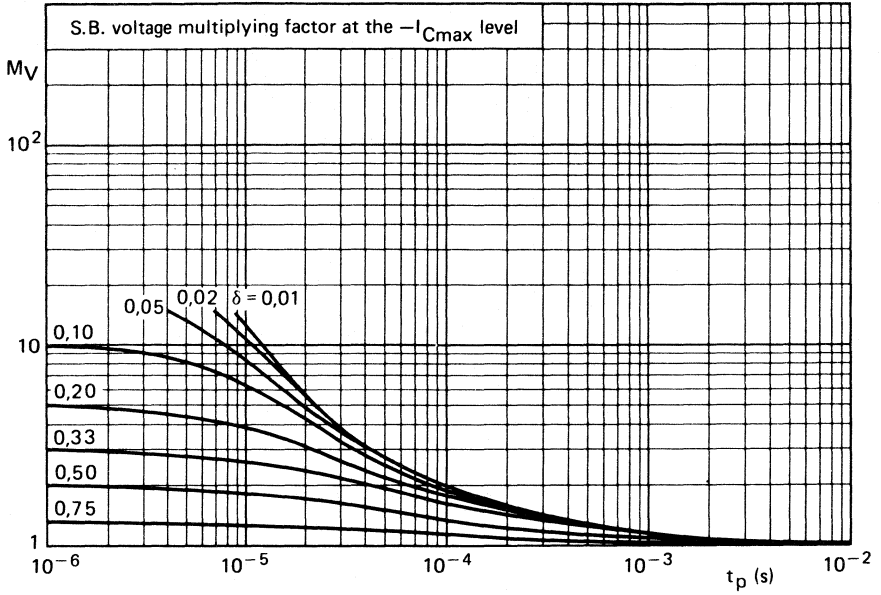


Fig. 8.

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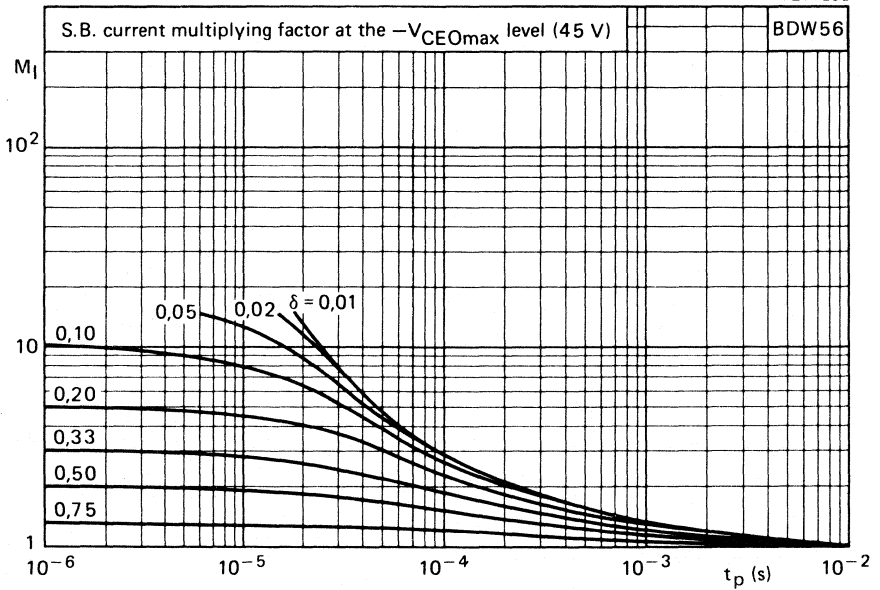


Fig. 9.

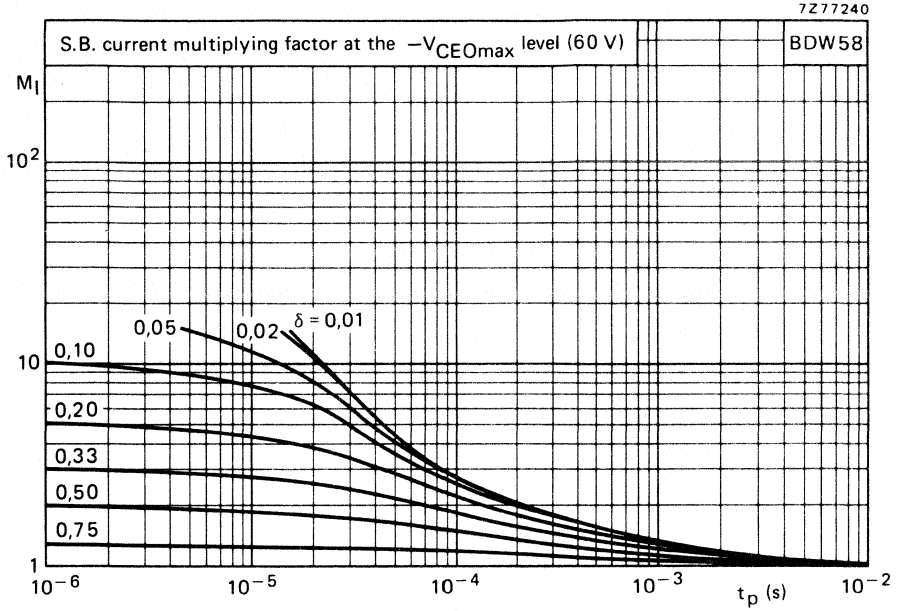


Fig. 10.

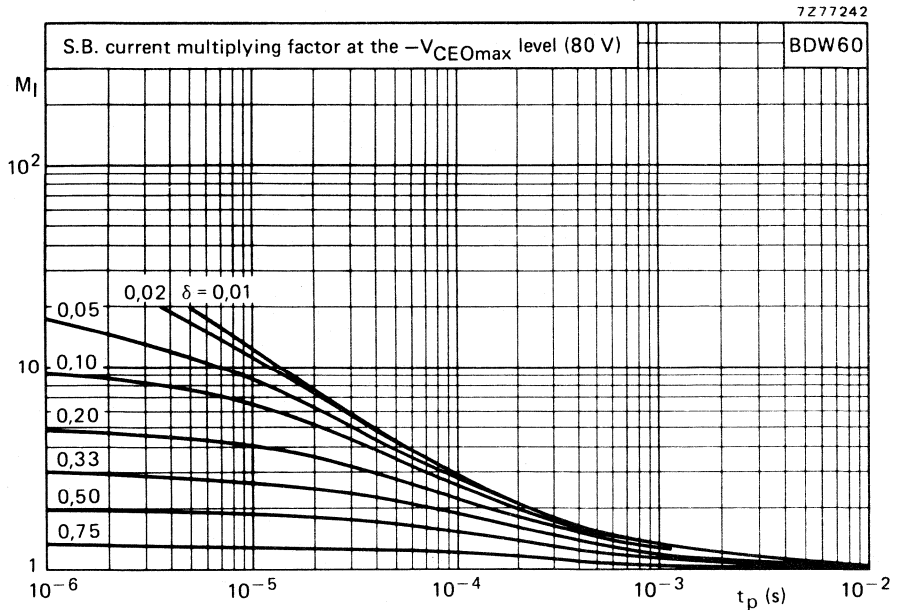


Fig. 11.

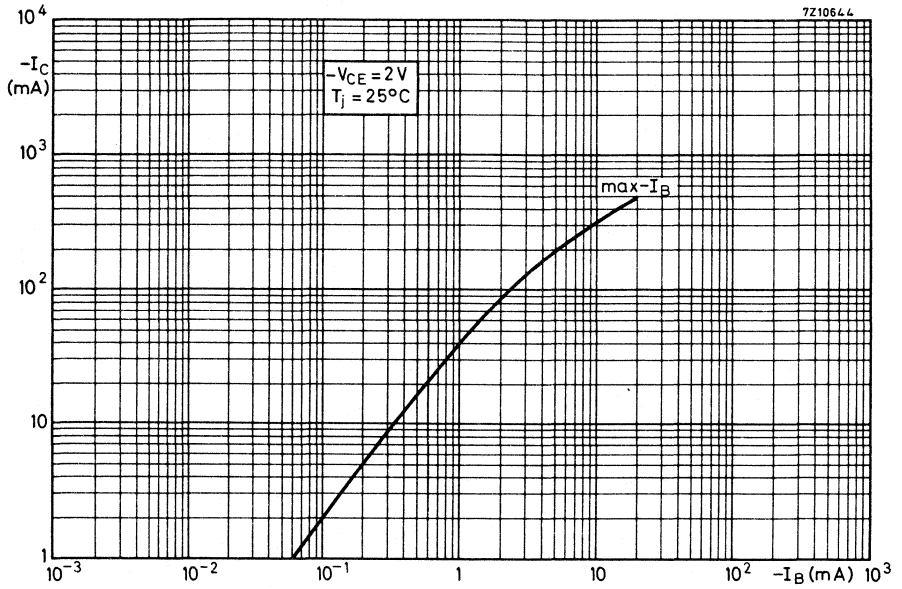


Fig. 12.

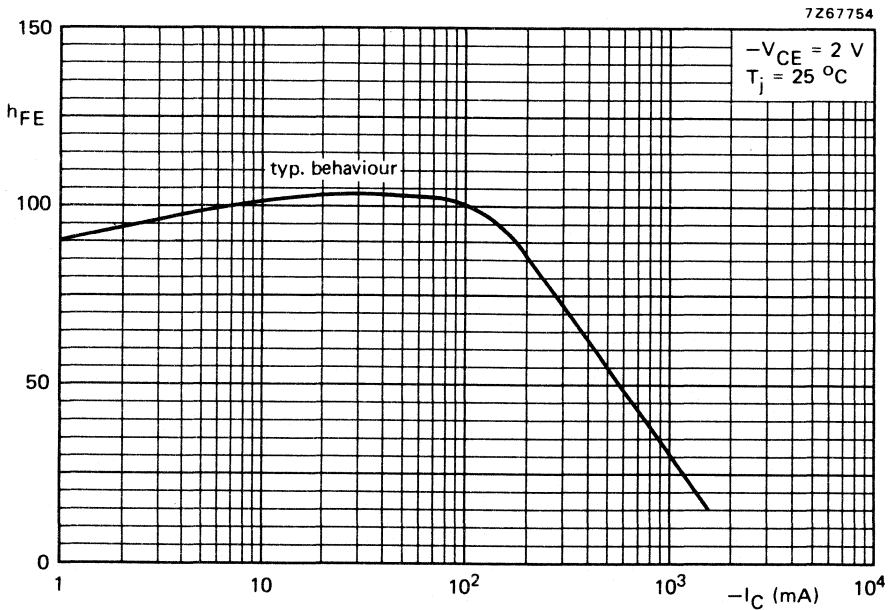


Fig. 13.

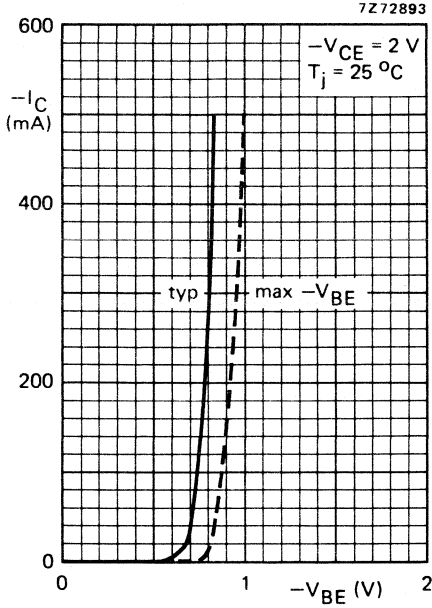


Fig. 14.

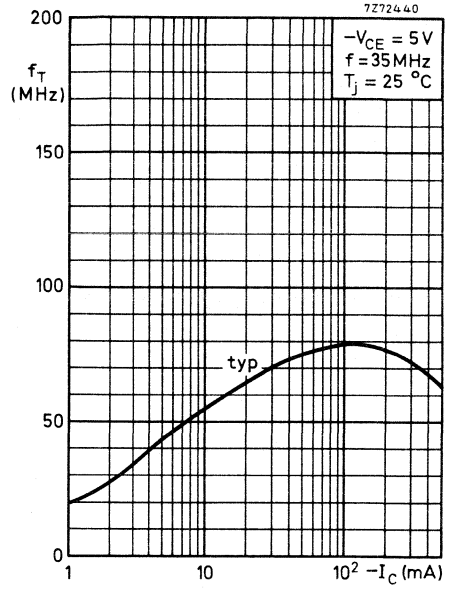


Fig. 15.

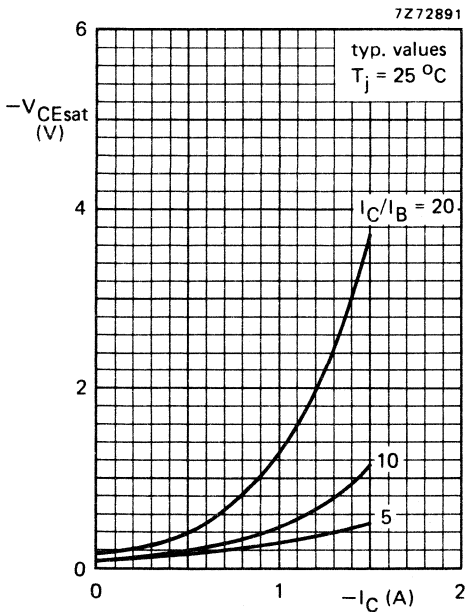


Fig. 16.

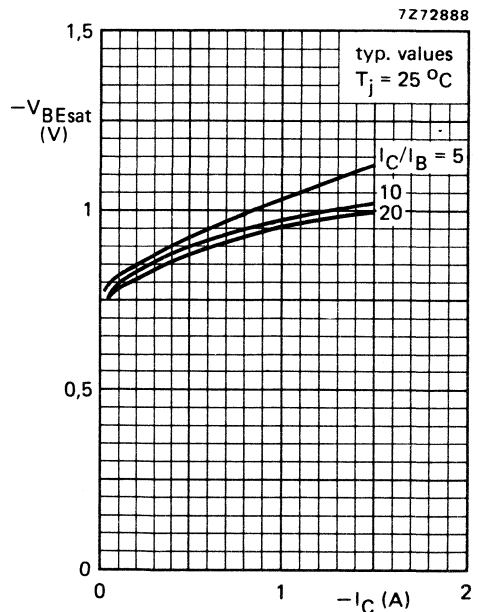


Fig. 17.

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

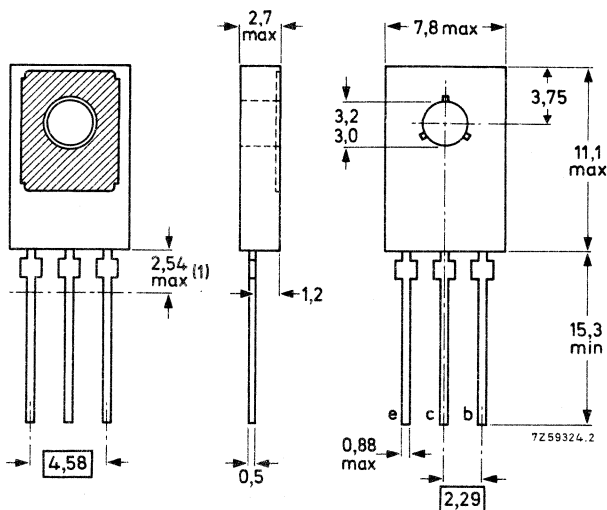
		BDX35	BDX36	BDX37
Collector-base voltage (open emitter)	V_{CBO}	max. 100	120	120 V
Collector-emitter voltage (open base)	V_{CEO}	max. 60	60	80 V
Collector current (peak value)	I_{CM}	max. 10	10	10 A
Total power dissipation up to $T_{mb} = 75\text{ }^{\circ}\text{C}$	P_{tot}	max. 15	15	15 W
D.C. current 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	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=		100	K/W

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

Collector cut-off current

 $I_E = 0; V_{CB} = 80\text{ V}$ BDX35 $I_{CBO} < 10\text{ }\mu\text{A}$ $I_E = 0; V_{CB} = 80\text{ V}; T_j = 100\text{ }^\circ\text{C}$ BDX35 $I_{CBO} < 50\text{ }\mu\text{A}$ $I_E = 0; V_{CB} = 100\text{ V}$ BDX36/37 $I_{CBO} < 10\text{ }\mu\text{A}$ $I_E = 0; V_{CB} = 100\text{ V}; T_j = 100\text{ }^\circ\text{C}$ BDX36/37 $I_{CBO} < 50\text{ }\mu\text{A}$

Emitter cut-off current

 $I_C = 0; V_{EB} = 4\text{ V}$ I_{EBO} typ. 5 nA
< 10 μA $I_C = 0; V_{EB} = 5\text{ V}$ $I_{EBO} < 1\text{ mA}$

D.C. current gain

 $I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$ BDX35/36 h_{FE} 45 to 450BDX37 h_{FE} typ. 130 h_{FE} typ. 80

Collector-emitter saturation voltage

 $I_C = 5\text{ A}; I_B = 0,5\text{ A}$ BDX35/37 $V_{CEsat} < 0,9\text{ V}$ BDX36 $V_{CEsat} < 0,7\text{ V}$ $I_C = 7\text{ A}; I_B = 0,7\text{ A}$ BDX35/37 $V_{CEsat} < 1,2\text{ V}$ $I_C = 10\text{ A}; I_B = 1\text{ A}$ BDX36 $V_{CEsat} < 1,5\text{ V}$

Base-emitter saturation voltage

 $I_C = 5\text{ A}; I_B = 0,5\text{ A}$ $V_{BEsat} < 1,6\text{ V}$ $I_C = 7\text{ A}; I_B = 0,7\text{ A}$ BDX35/37 $V_{BEsat} < 1,8\text{ V}$ $I_C = 10\text{ A}; I_B = 1\text{ A}$ BDX36 $V_{BEsat} < 2,2\text{ V}$ Collector capacitance at $f = 1\text{ MHz}$ $I_E = I_e = 0; V_{CB} = 10\text{ V}$ C_c typ. 40 pF
< 60 pFTransition frequency at $f = 35\text{ MHz}$ $I_C = 0,5\text{ A}; V_{CE} = 5\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$ f_T typ. 100 MHz

Switching times

(between 10% and 90% levels)

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

turn-on time

 t_{on} typ. 0,06 μs
< 0,1 μs

turn-off time

 t_{off} typ. 0,6 μs
< 0,8 μs $I_{Con} = 2\text{ A}; I_{Bon} = -I_{Boff} = 0,2\text{ A}$

turn-on time

 $t_{on} < 80\text{ ns}$

turn-off time

 t_{off} typ. 0,45 μs
< 0,7 μs $I_{Con} = 5\text{ A}; I_{Bon} = -I_{Boff} = 0,5\text{ A}$

turn-on time

 t_{on} typ. 180 ns
< 300 ns

turn-off time

 t_{off} typ. 320 ns
< 500 ns

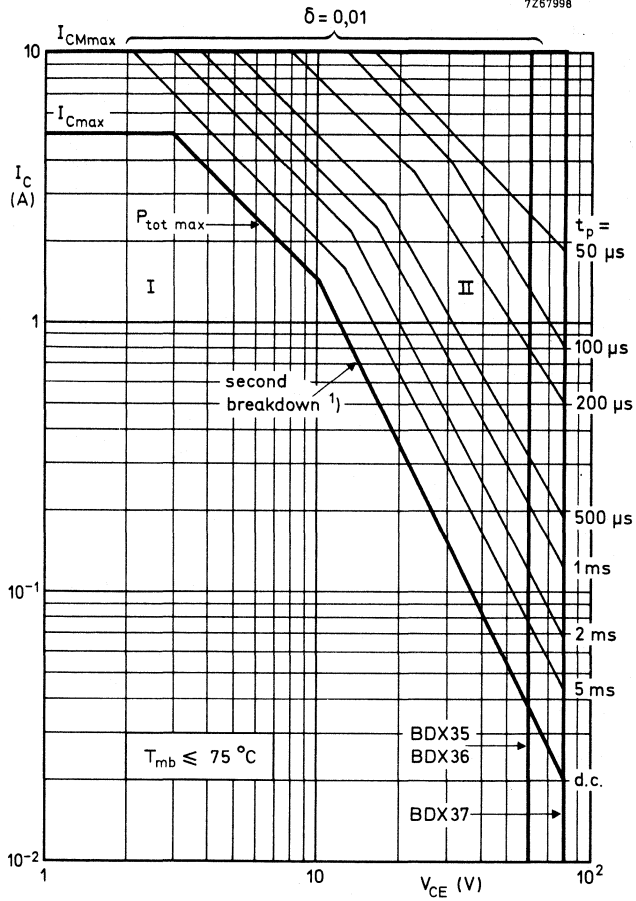


Fig. 2 Safe Operating Area with the transistor forward biased.

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

1) Independent of temperature.

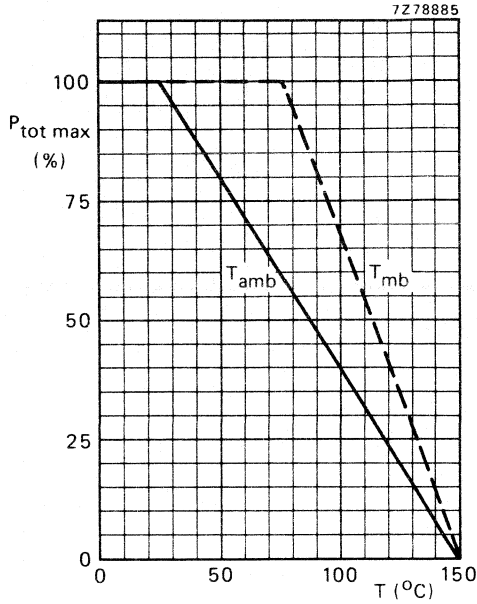


Fig. 3 Power derating curve.

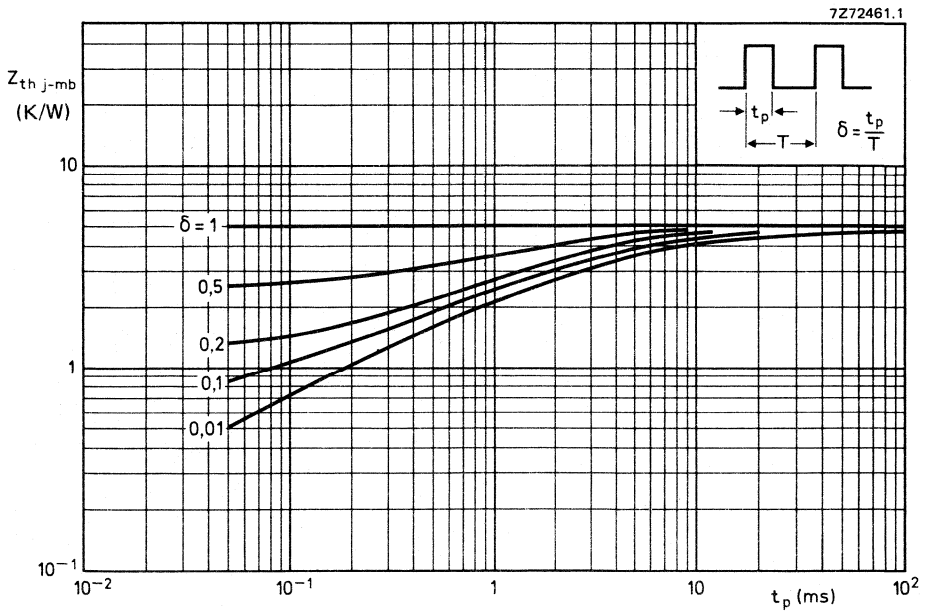


Fig. 4 Pulse power rating chart.

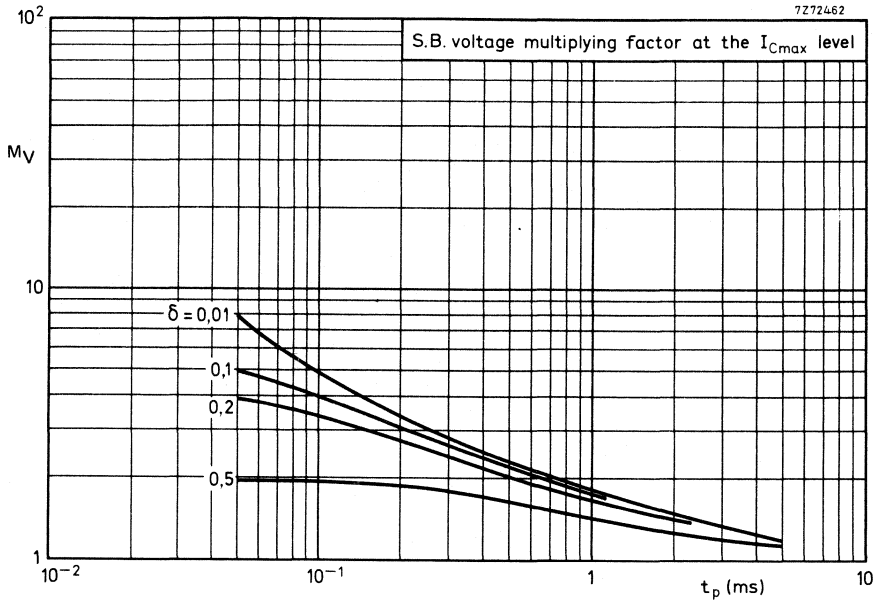


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

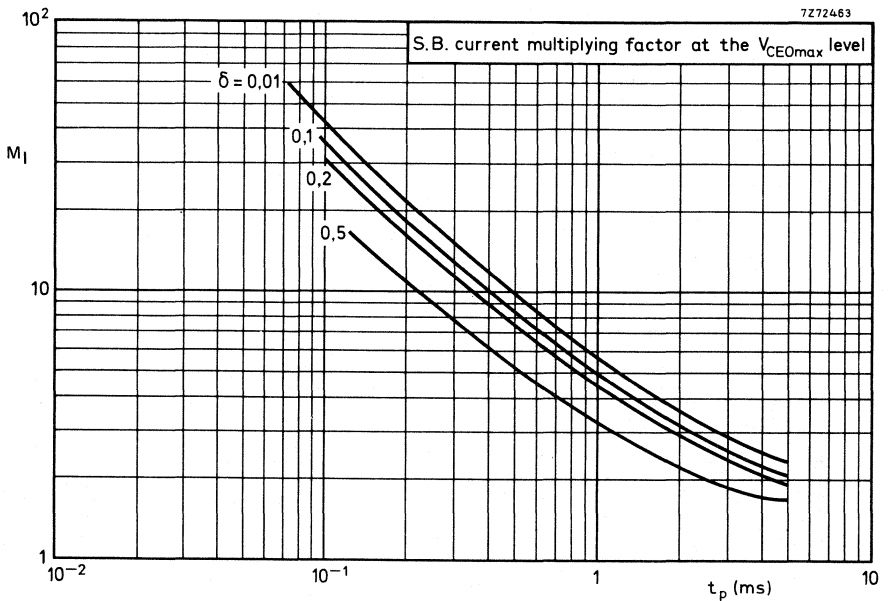


Fig. 6 S.B. current multiplying factor at the V_{CE0max} level.

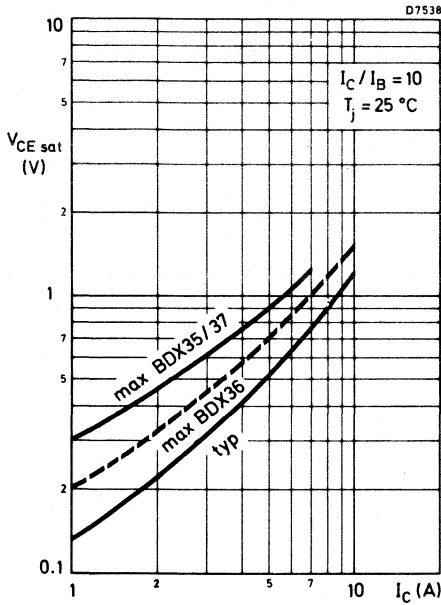


Fig. 7 Collector-emitter saturation voltage as a function of the collector current.

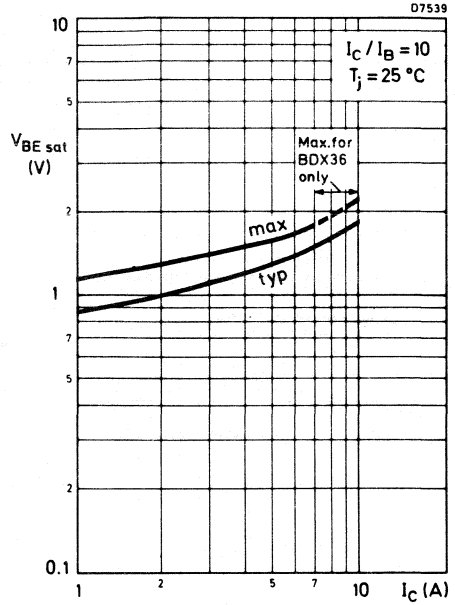


Fig. 8 Base-emitter saturation voltage as a function of the collector current.

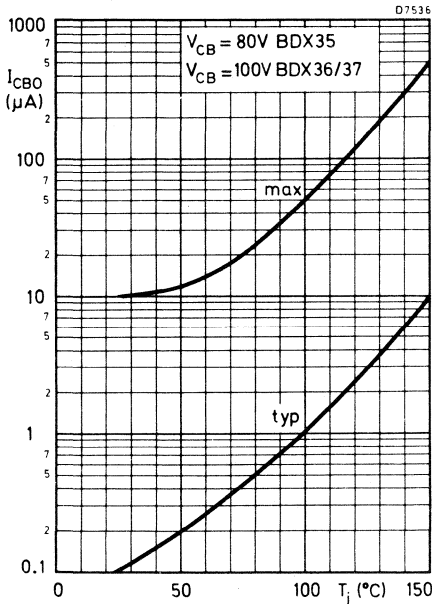


Fig. 9 Collector-base current with an open emitter as a function of junction temperature.

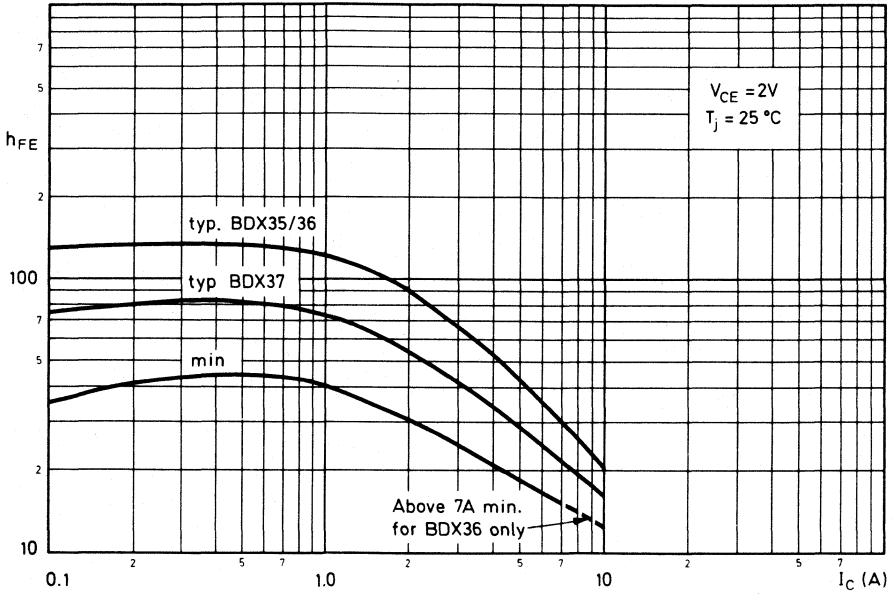


Fig. 10 D.C. current gain as a function of collector current.

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.

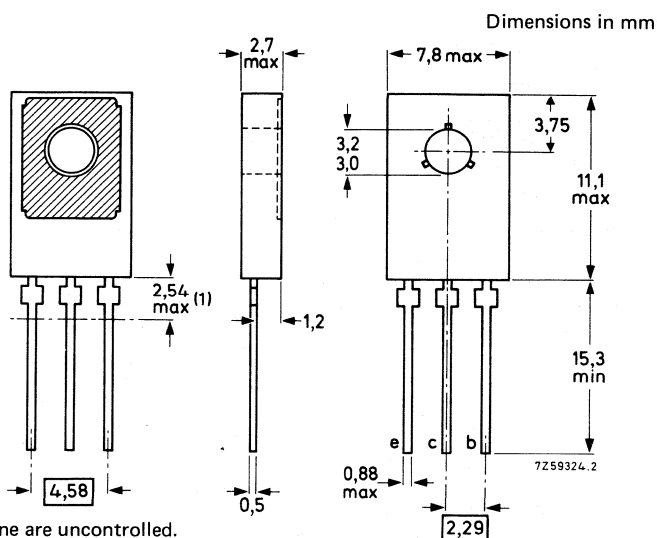
QUICK REFERENCE DATA

		BDX42	BDX43	BDX44
Collector-base voltage (open emitter)	V_{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 $I_C = 500\text{ mA}$; $V_{CE} = 10\text{ V}$	h_{FE} >	2000	2000	2000
Collector-emitter saturation voltage $I_C = 1\text{ A}$; $I_B = 1\text{ mA}$ $I_C = 1\text{ A}$; $I_B = 4\text{ mA}$	V_{CEsat} <	—	1,6	— V
	V_{CEsat} <	1,6	—	1,6 V
Turn-off time $I_C = 500\text{ mA}$; $I_{Bon} = -I_{Boff} = 0,5\text{ mA}$	t_{off} typ.	1500	1500	1500 ns

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.

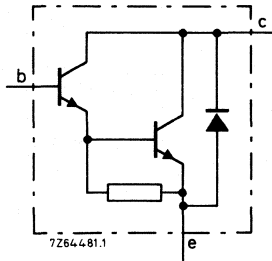


Fig. 2 Circuit diagram.

RATINGS

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

		BDX42	BDX43	BDX44
Collector-base voltage (open emitter)	V_{CBO}	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 $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	1,25	W
up to $T_{mb} = 100\text{ }^\circ\text{C}$	P_{tot}	max.	5	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 ambient	$R_{th\ j-a}$	=	100	K/W
From junction to mounting base	$R_{th\ j-mb}$	=	10	K/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 $I_{CES} < 10\text{ }\mu\text{A}$

$V_{BE} = 0; V_{CE} = 60\text{ V}$

BDX43 $I_{CES} < 10\text{ }\mu\text{A}$

$V_{BE} = 0; V_{CE} = 80\text{ V}$

BDX44 $I_{CES} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$

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

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

$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}$

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

$I_C = 1\text{ A}; I_B = 1\text{ mA}$

BDX43 $V_{CEsat} < 1,6\text{ V}$

$I_C = 1\text{ A}; I_B = 4\text{ mA}$

BDX42, 44 $V_{CEsat} < 1,6\text{ V}$

$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}; T_j = 150\text{ }^\circ\text{C}$

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

$I_C = 1\text{ A}; I_B = 1\text{ mA}; T_j = 150\text{ }^\circ\text{C}$

BDX43 $V_{CEsat} < 1,8\text{ V}$

$I_C = 1\text{ A}; I_B = 4\text{ mA}; T_j = 150\text{ }^\circ\text{C}$

BDX42, 44 $V_{CEsat} < 1,6\text{ V}$

Base-emitter saturation voltage

$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}$

$V_{BEsat} < 1,9\text{ V}$

$I_C = 1\text{ A}; I_B = 1\text{ mA}$

BDX43 $V_{BEsat} < 2,2\text{ V}$

$I_C = 1\text{ A}; I_B = 4\text{ mA}$

BDX42, 44 $V_{BEsat} < 2,2\text{ V}$

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

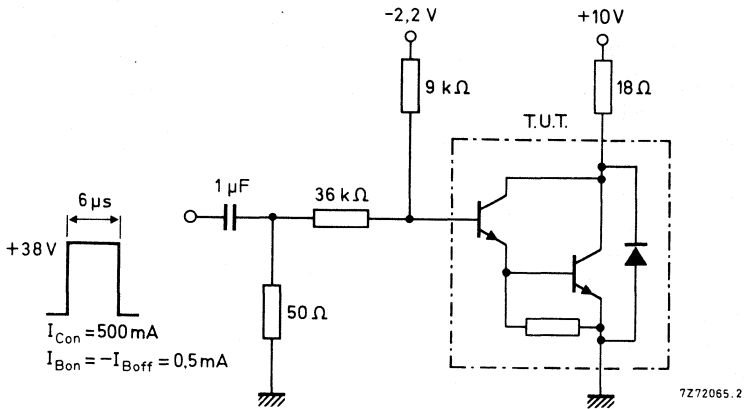


Fig. 3 Test circuit for 500 mA switching.

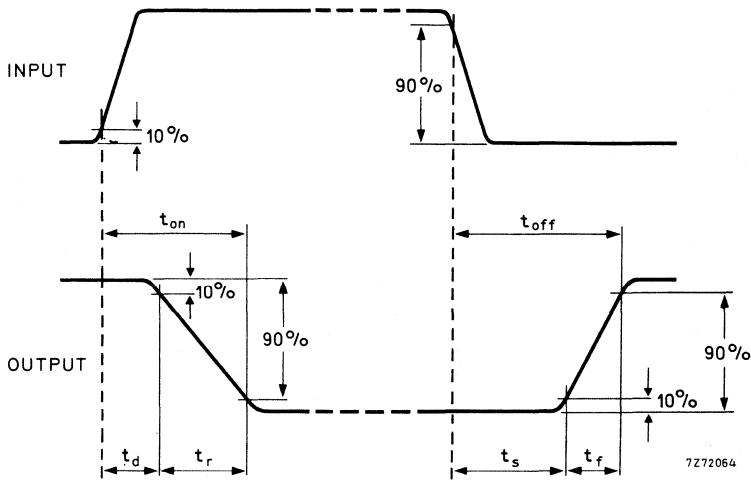


Fig. 4 Switching waveforms.

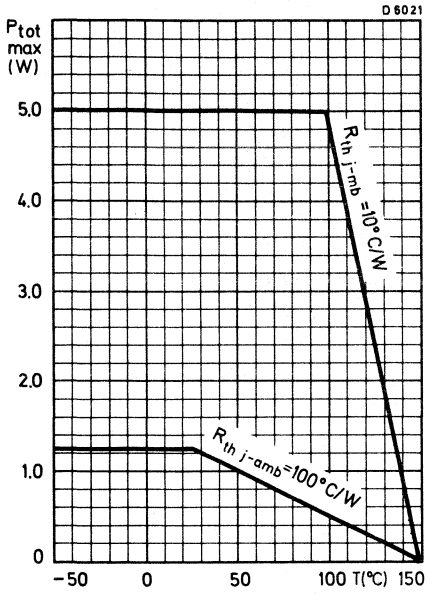


Fig. 5.

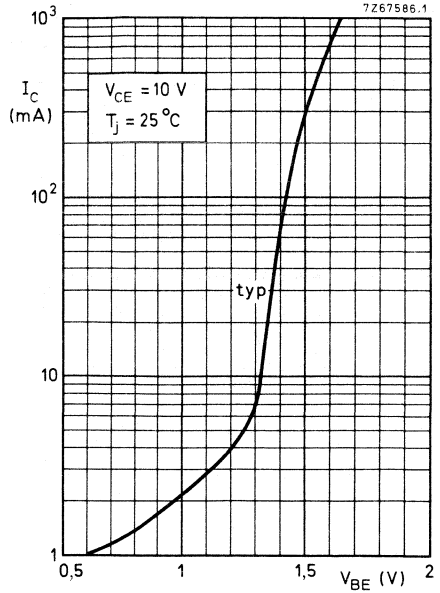


Fig. 6.

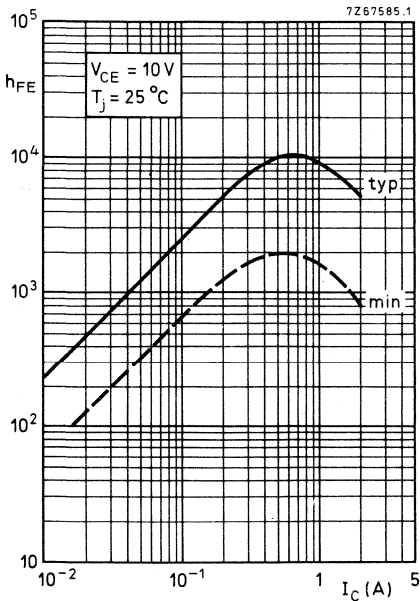


Fig. 7.

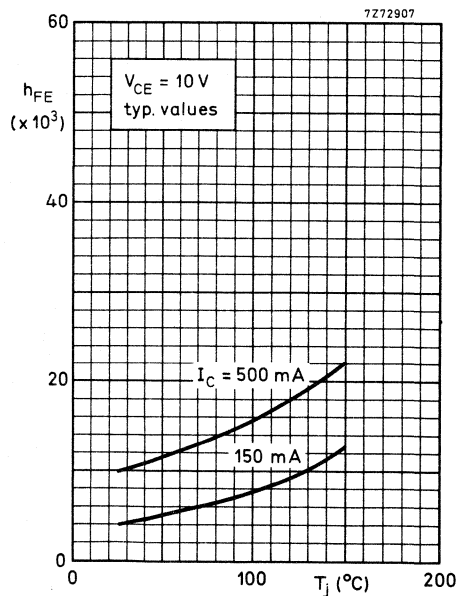


Fig. 8.

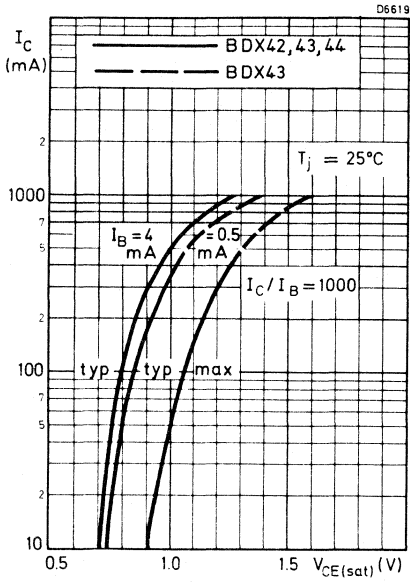


Fig. 9.

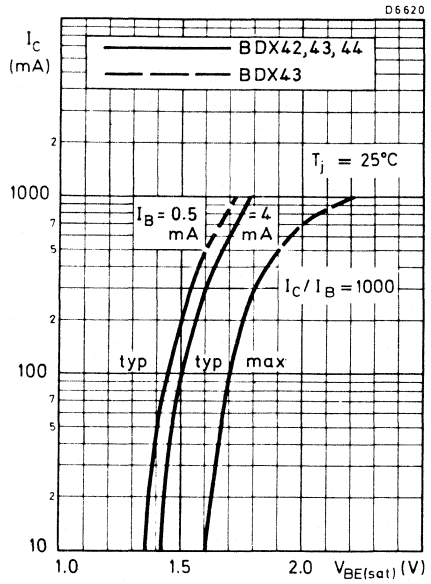


Fig. 10.

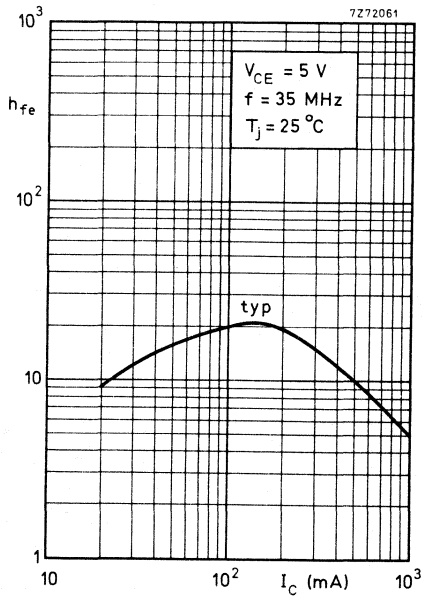


Fig. 11.

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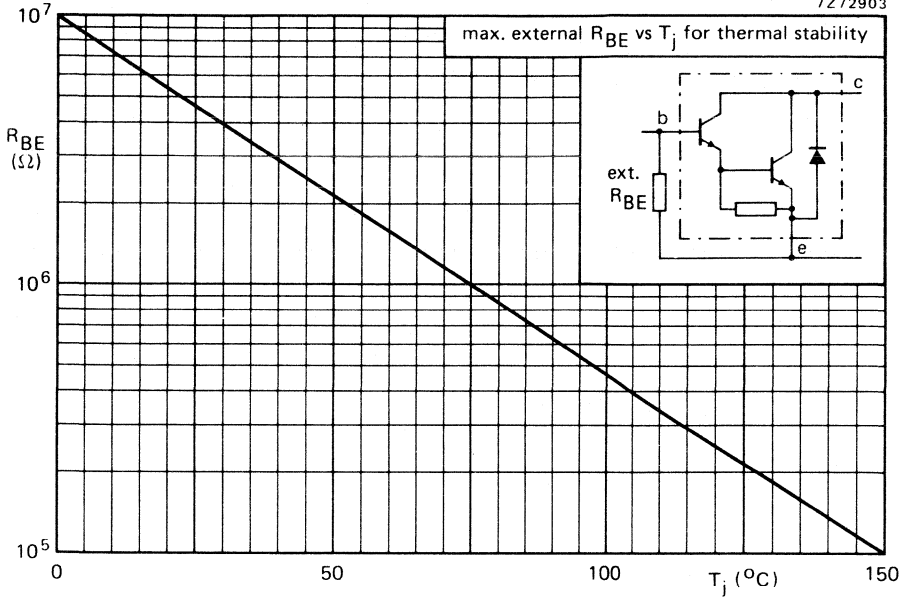


Fig. 12.

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.

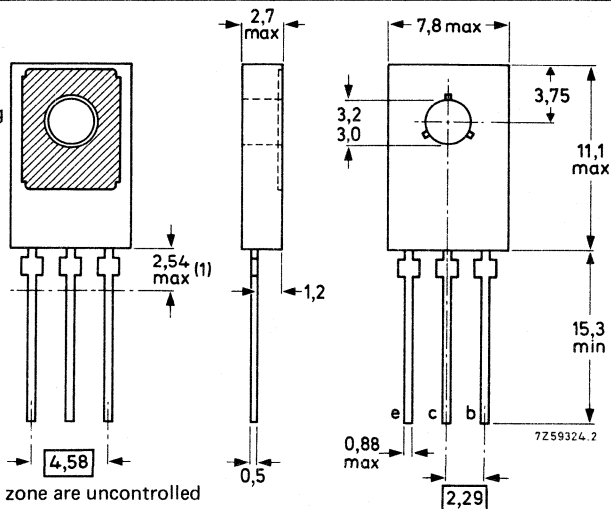
QUICK REFERENCE DATA

		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 $-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$	$h_{FE} >$	2000	2000	2000
Collector-emitter saturation voltage $-I_C = 1\text{ A}; -I_B = 1\text{ mA}$ $-I_C = 1\text{ A}; -I_B = 4\text{ mA}$	$-V_{CEsat} <$	—	1,6	— V
	$-V_{CEsat} <$	1,6	—	1,6 V
Turn-off time $-I_C = 500\text{ mA}; -I_{Bon} = I_{Boff} = 0,5\text{ mA}$	t_{off} typ.	1500	1500	1500 ns

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.

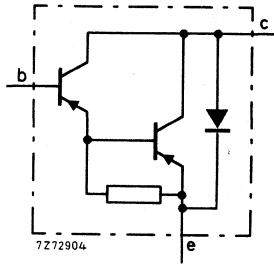


Fig. 2 Circuit diagram.

RATINGS

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

			BDX45	BDX46	BDX47
Collector-base voltage (open emitter)	$-V_{CBO}$	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 $T_{amb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		1,25	W
up to $T_{mb} = 100\text{ }^\circ\text{C}$	P_{tot}	max.		5	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 ambient	$R_{th\ j-a}$	=		100	K/W
From junction to mounting base	$R_{th\ j-mb}$	=		10	K/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

$V_{BE} = 0; -V_{CE} = 45\text{ V}$	BDX45	$-I_{CES}$	<	10 μA
$V_{BE} = 0; -V_{CE} = 60\text{ V}$	BDX46	$-I_{CES}$	<	10 μA
$V_{BE} = 0; -V_{CE} = 80\text{ V}$	BDX47	$-I_{CES}$	<	10 μA

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$		$-I_{EBO}$	<	10 μA
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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
$-I_C = 1\text{ A}; -I_B = 1\text{ mA}$	BDX46	$-V_{CEsat}$	<	1,6 V
$-I_C = 1\text{ A}; -I_B = 4\text{ mA}$	BDX45, 47	$-V_{CEsat}$	<	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
$-I_C = 1\text{ A}; -I_B = 1\text{ mA}; T_j = 150\text{ }^\circ\text{C}$	BDX46	$-V_{CEsat}$	<	1,8 V
$-I_C = 1\text{ A}; -I_B = 4\text{ mA}; T_j = 150\text{ }^\circ\text{C}$	BDX45, 47	$-V_{CEsat}$	<	1,6 V

Base-emitter saturation voltage

$-I_C = 500\text{ mA}; -I_B = 0,5\text{ mA}$		$-V_{BEsat}$	<	1,9 V
$-I_C = 1\text{ A}; -I_B = 1\text{ mA}$	BDX46	$-V_{BEsat}$	<	2,2 V
$-I_C = 1\text{ A}; -I_B = 4\text{ mA}$	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
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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

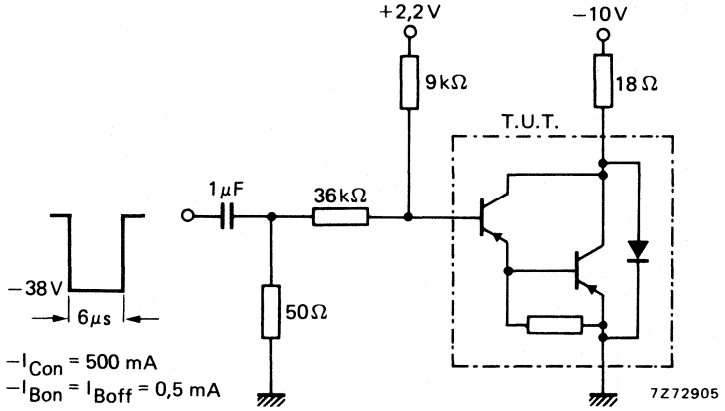


Fig. 3 Test circuit for 500 mA switching.

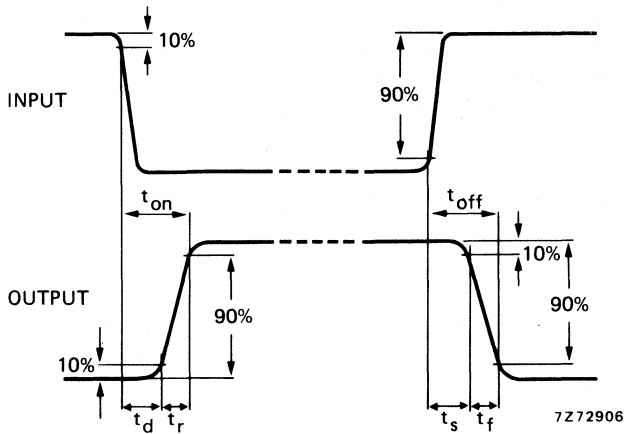


Fig. 4 Switching waveforms.

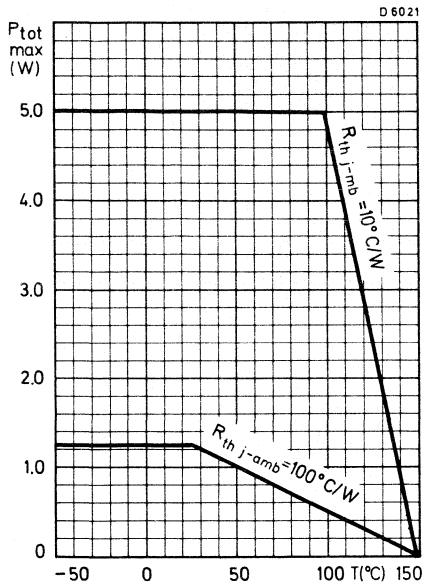


Fig. 5.

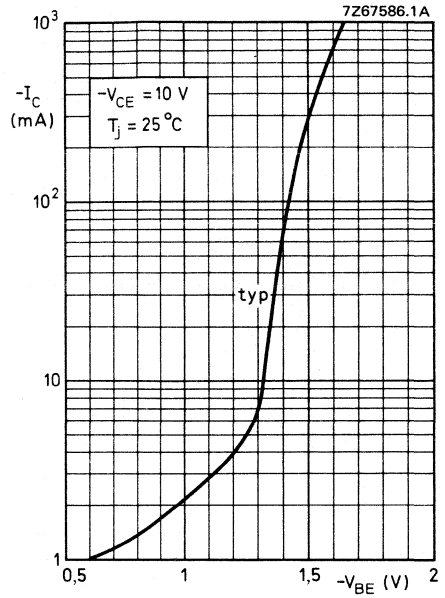


Fig. 6.

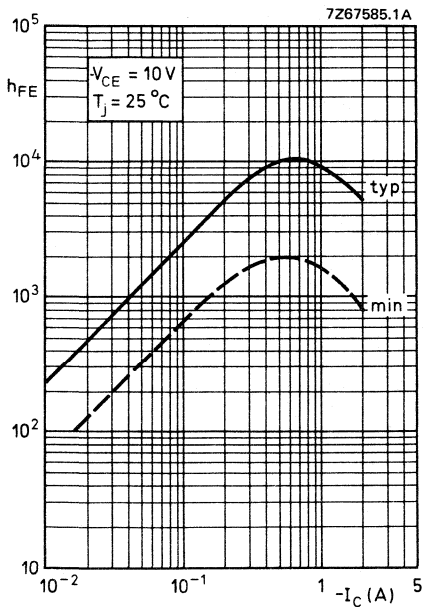


Fig. 7.

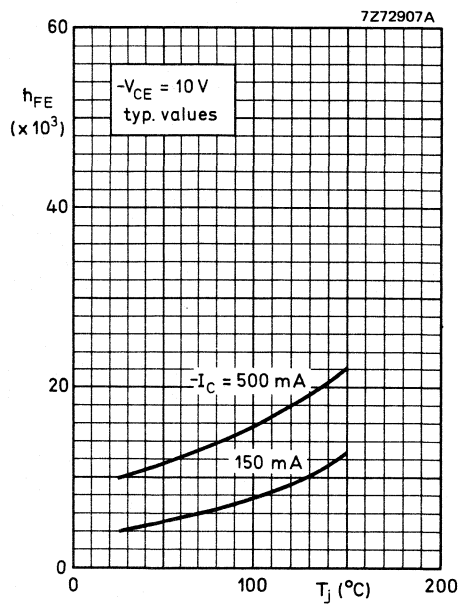


Fig. 8.

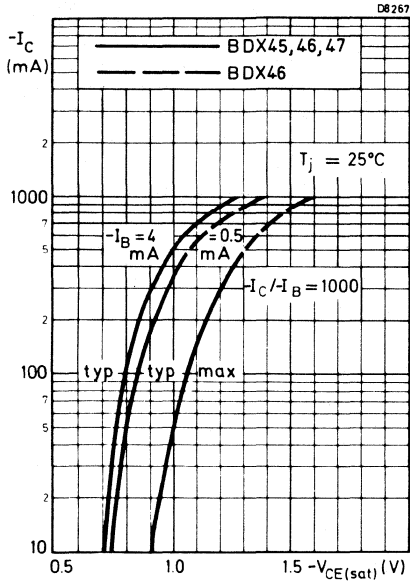


Fig. 9.

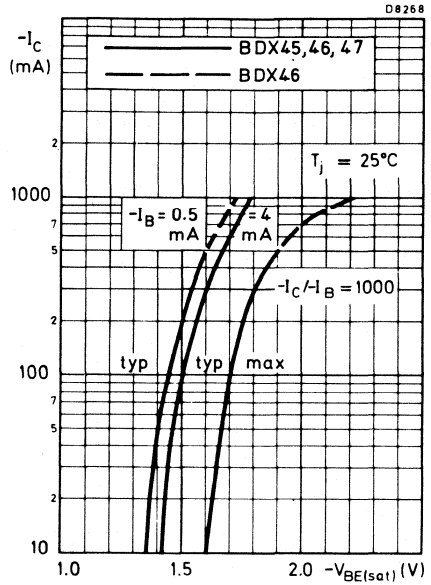


Fig. 10.

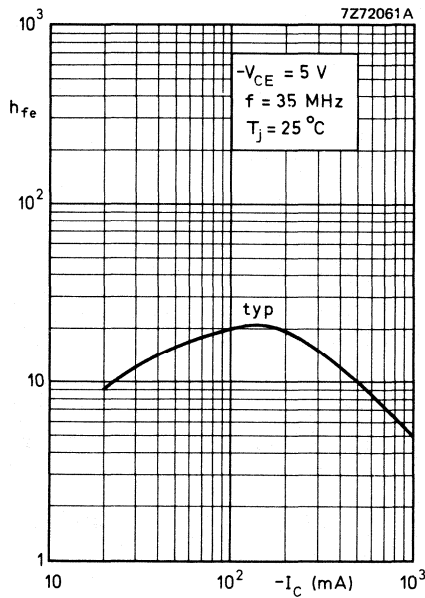


Fig. 11.

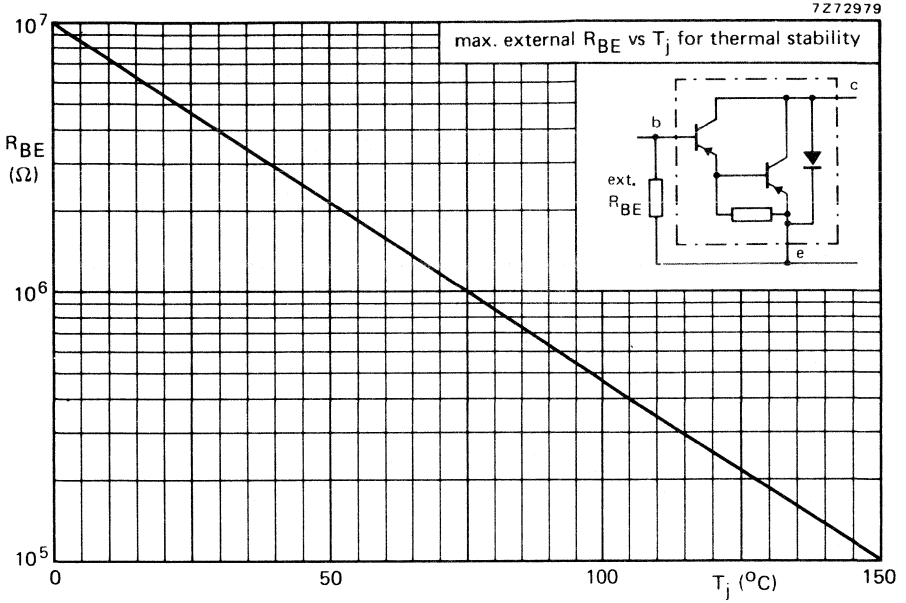


Fig. 12.

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.

QUICK REFERENCE DATA

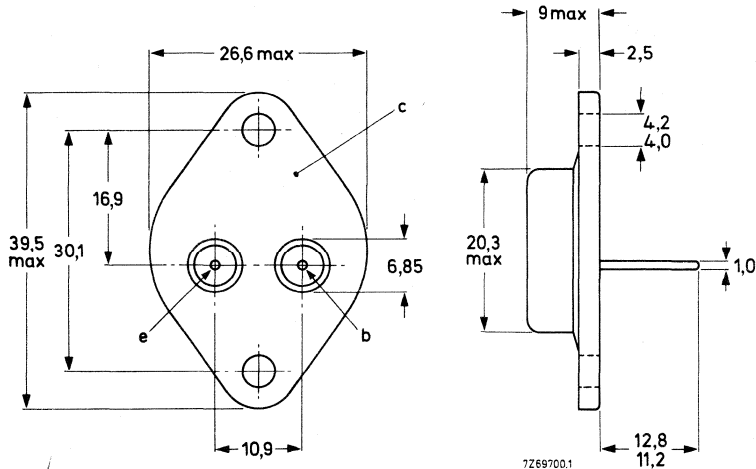
		BDX62	62A	62B	62C
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100	120 V
Collector current (peak value)	$-I_{CM}$ max.	12			A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.	90			W
Junction temperature	T_j max.	200			$^{\circ}\text{C}$
D.C. current gain					
$-I_C = 0,5\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE} typ.	1500			
$-I_C = 3,0\text{ A}; -V_{CE} = 3\text{ V}$	$h_{FE} >$	1000			
Cut-off frequency					
$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe} typ.	100			kHz

MECHANICAL DATA

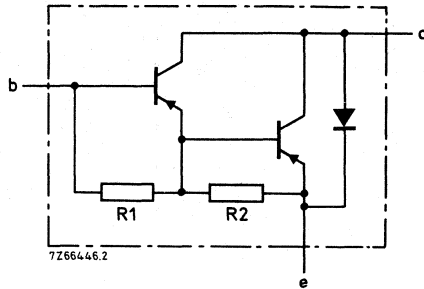
Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting instructions and Accessories.



R_1 typ. $6\text{ k}\Omega$
 R_2 typ. $80\ \Omega$

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 $T_{mb} = 25\ ^\circ\text{C}$	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	K/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

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

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

$I_E = 0; -V_{CB} = 40\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX62}$

$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX62A}$

$I_E = 0; -V_{CB} = 60\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX62B}$

$I_E = 0; -V_{CB} = 70\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX62C}$

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

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

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

Emitter cut-off current

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

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

D.C. current gain (note 1)

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

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

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

$h_{FE} > 1000$

$-I_C = 8\text{ A}; -V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 750$

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)

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

$-V_{CE\text{sat}} < 2\text{ V}$

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

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$

$C_c \text{ typ. } 100\text{ pF}$

Cut-off frequency

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

$f_{hfe} \text{ typ. } 100\text{ kHz}$

Small-signal current gain

$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz}$

$h_{fe} \text{ typ. } 100$

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.
2. $-V_{BE}$ decreases by about $3,6\text{ mV/K}$ 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. $2,5 \mu\text{s}$

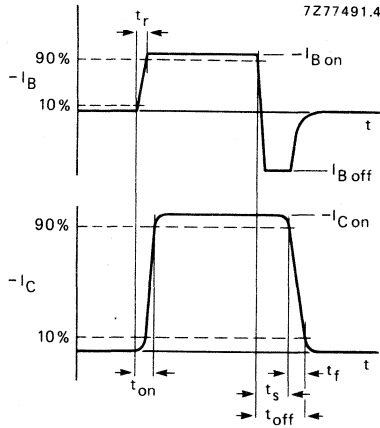


Fig. 3 Switching times waveforms.

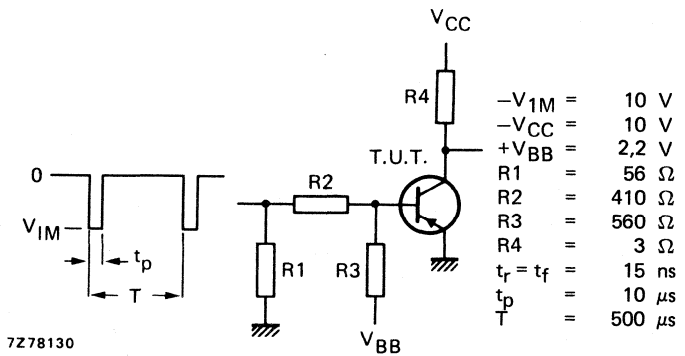


Fig. 4 Switching times test circuit.

Diode forward voltage
 $I_F = 3 \text{ A}$

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

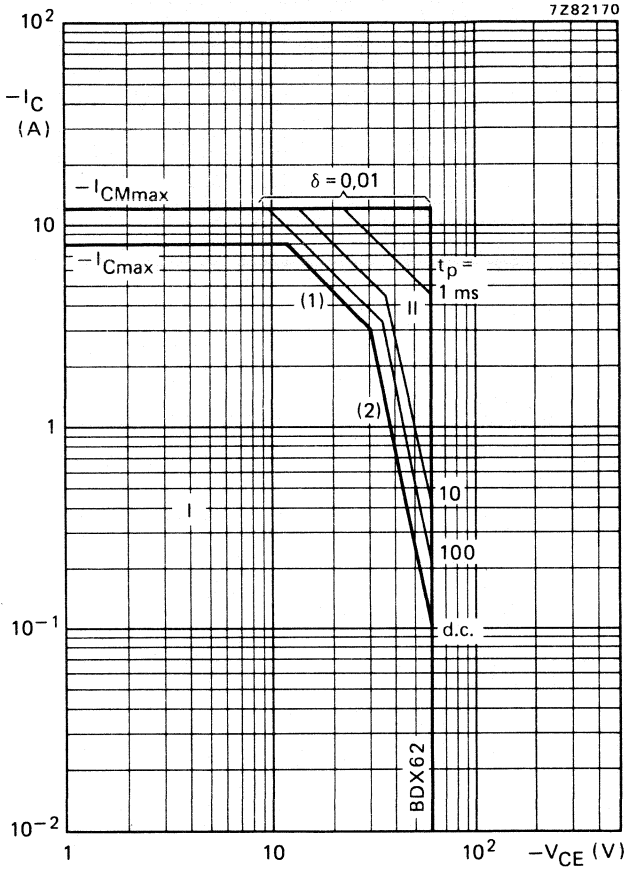


Fig. 5 Safe Operating Area; $T_{mb} = 25 \text{ }^\circ\text{C}$.

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

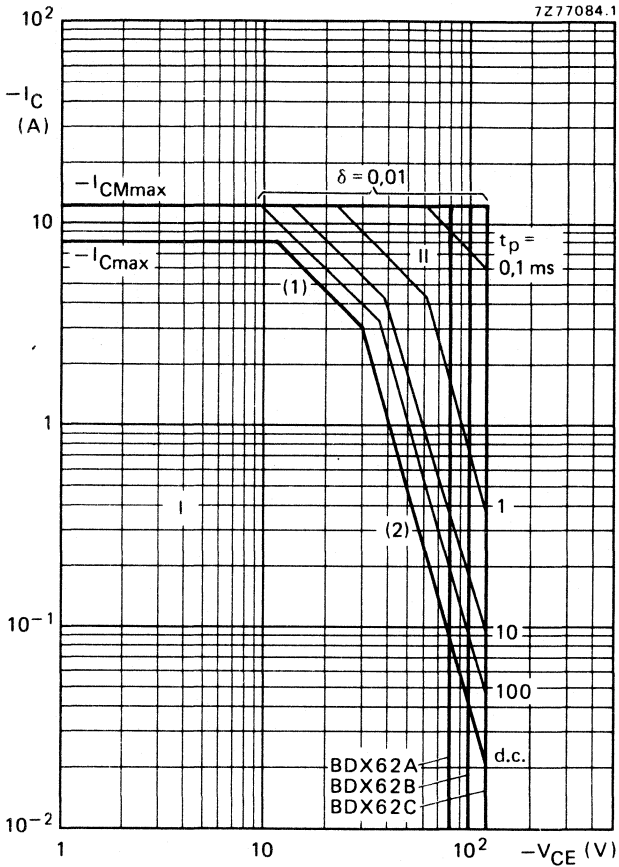


Fig. 6 Safe Operating Area; $T_{mb} = 25 \text{ }^\circ\text{C}$.

- 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).

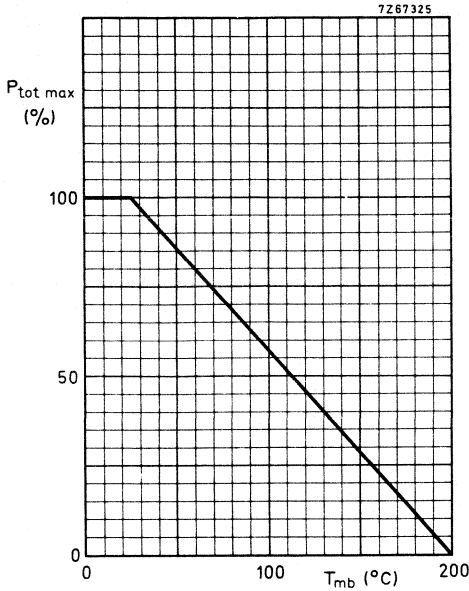


Fig. 7 Power derating curve.

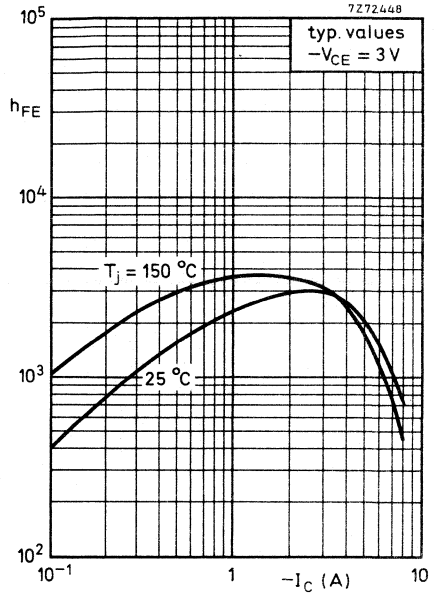


Fig. 8 D.C. current gain.

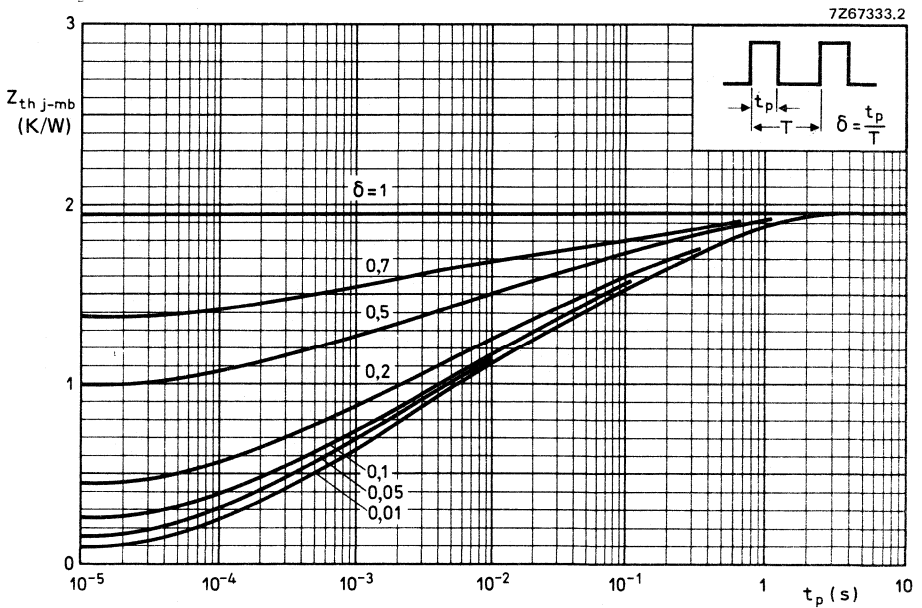


Fig. 9 Pulse power rating chart.

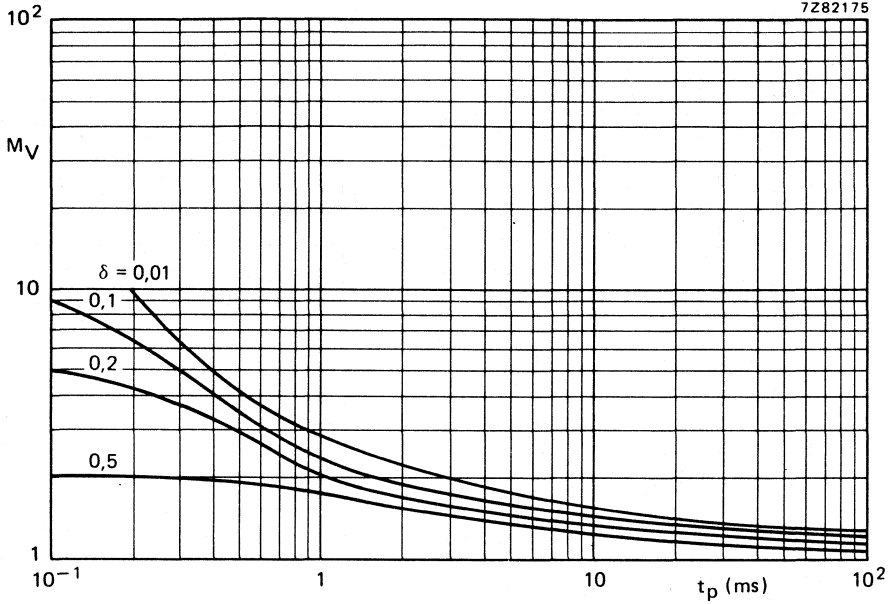


Fig. 10 S.B. voltage multiplying factor at the I_{Cmax} level.

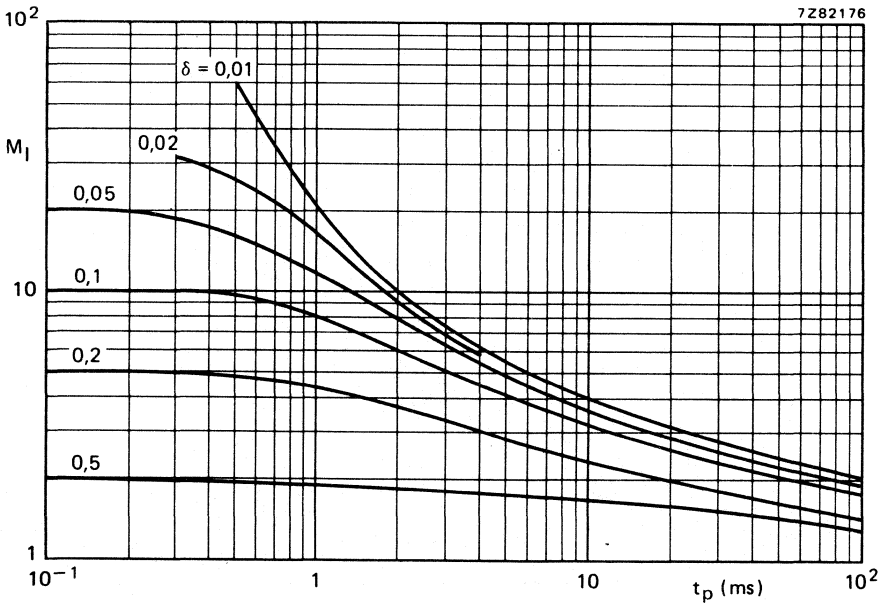


Fig. 11 S.B. current multiplying factor at the V_{CEO} 100 V and 60 V level.

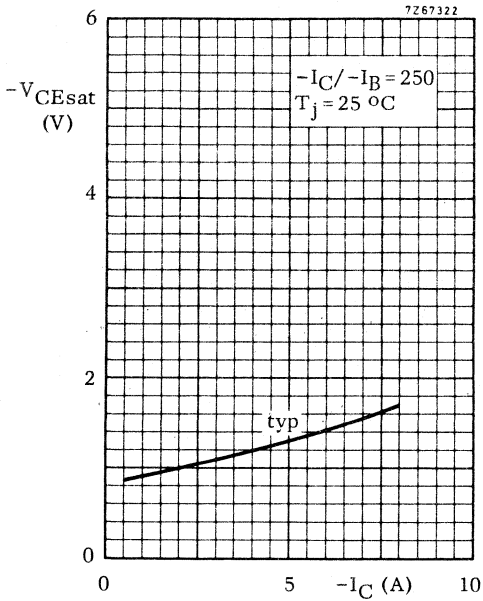


Fig. 12.

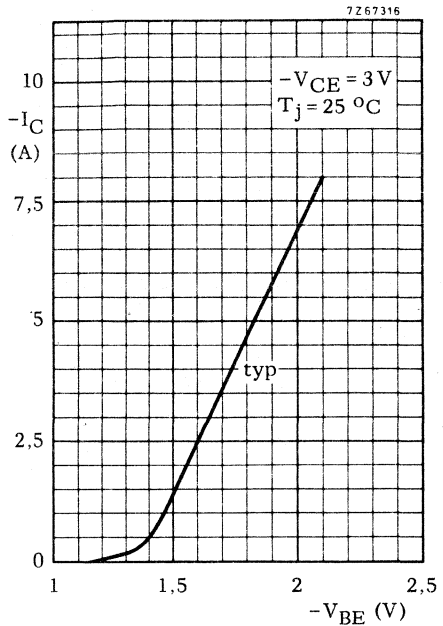


Fig. 13.

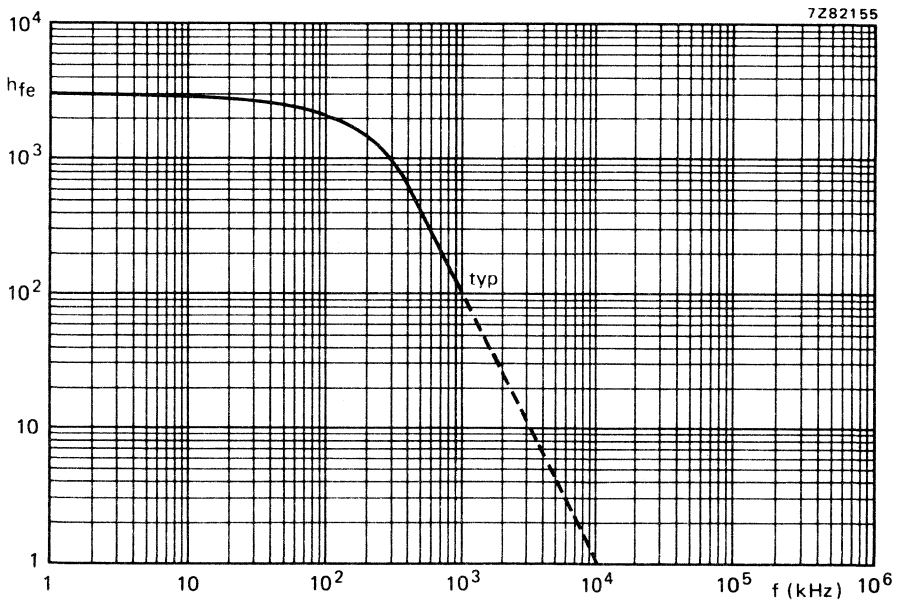


Fig. 14 Small signal current gain at $-I_C = 3\text{ A}$; $-V_{CE} = 3\text{ V}$.

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.

QUICK REFERENCE DATA

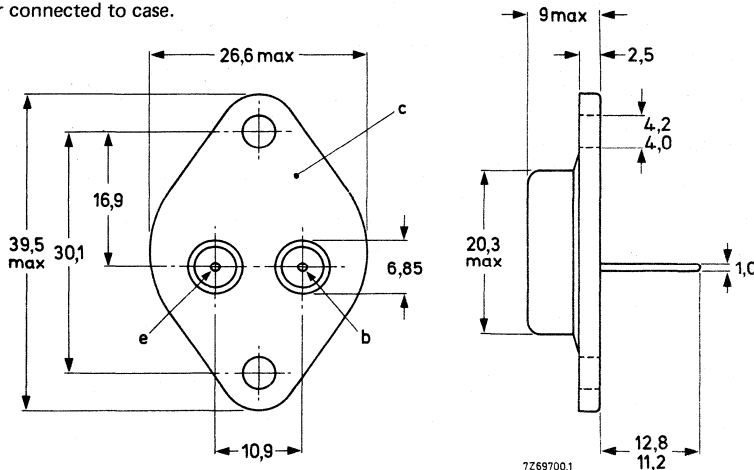
			BDX63	63A	63B	63C
Collector-base voltage (open emitter)	V_{CB0}	max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120 V
Collector current (peak value)	I_{CM}	max.	12			A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	90			W
Junction temperature	T_j	max.	200			$^{\circ}\text{C}$
D.C. current gain						
$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	typ.	2500			
$I_C = 3,0\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	>	1000			
Cut-off frequency						
$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$	f_{hfe}	typ.	100			kHz

MECHANICAL DATA

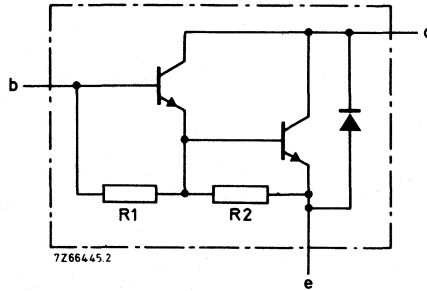
Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting Instructions and Accessories.



R1 typ. 8 k Ω
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 °C	P _{tot} max.	90			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} =	1,94	K/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

 $I_E = 0; V_{CB} = V_{CE0max}$ $I_{CBO} < 0,2\text{ mA}$ $I_E = 0; V_{CB} = \frac{1}{2}V_{CB0max}; T_j = 200\text{ }^\circ\text{C}$ $I_{CBO} < 2\text{ mA}$ $I_B = 0; V_{CE} = \frac{1}{2}V_{CE0max}$ $I_{CEO} < 0,5\text{ mA}$

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} typ. 2500 $I_C = 3\text{ A}; V_{CE} = 3\text{ V}$ $h_{FE} > 1000$ $I_C = 8\text{ A}; V_{CE} = 3\text{ V}$ h_{FE} typ. 2600

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 typ. 100 pF

Cut-off frequency

 $I_C = 3\text{ A}; V_{CE} = 3\text{ V}$ f_{hfe} typ. 100 kHz

Turn-off breakdown energy with inductive load (Fig. 4)

 $-I_{Boff} = 0; I_{Con} = 4,5\text{ A}; t_p = 1\text{ ms};$ $T = 100\text{ ms}$ $E(BR) > 50\text{ mJ}$

Small signal current gain

 $I_C = 3\text{ A}; V_{CE} = 3\text{ V}; f = 1\text{ MHz}$ h_{fe} typ. 100 ←

Diode, forward voltage

 $I_F = 3\text{ A}$ V_F typ. 1,2 V

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.2. V_{BE} decreases by about 3,6 mV/K with increasing temperature.

CHARACTERISTICS (continued)

Switching times

(between 10% and 90% levels)

$I_{C on} = 3 \text{ A}; I_{B on} = -I_{B off} = 12 \text{ mA}$

turn-on time

turn-off time

$t_{on} \text{ typ. } 0,5 \mu\text{s}$
 $t_{off} \text{ typ. } 5 \mu\text{s}$

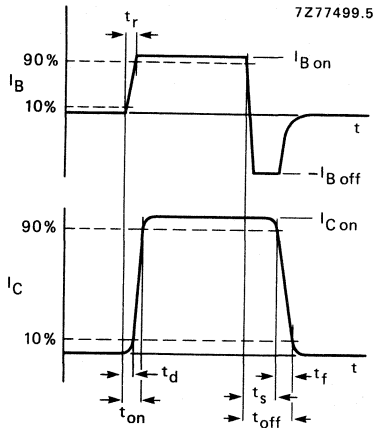


Fig. 3 Switching time waveforms.

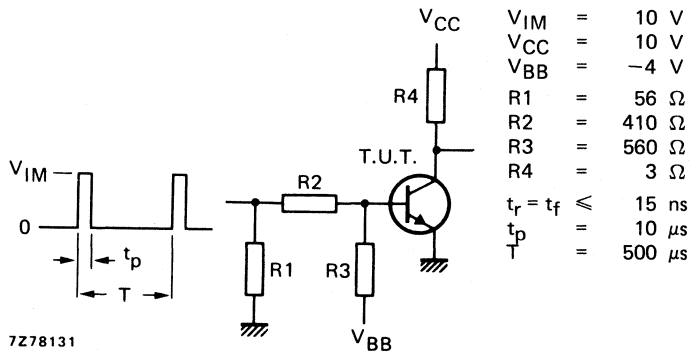


Fig. 4 Switching times test circuit.

Diode, forward voltage
 $I_F = 3 \text{ A}$

V_F typ. 1,2 V

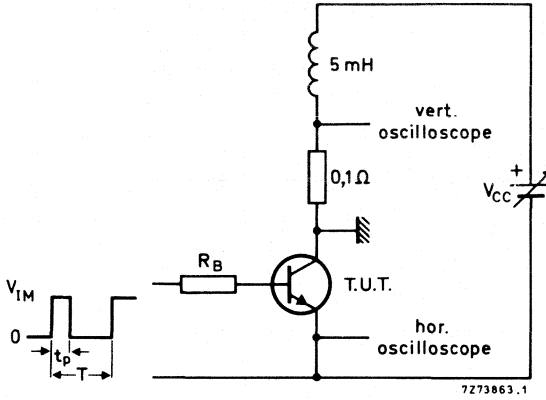


Fig. 5 Test circuit for turn-off breakdown energy.
 $V_{IM} = 12 \text{ V}$; $R_B = 270 \Omega$; $I_{CC} = 4,5 \text{ A}$; $t_p = 1 \text{ ms}$; $\delta = 1\%$.

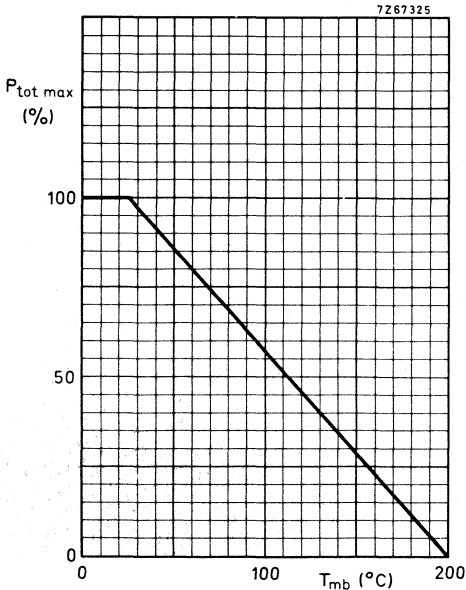


Fig. 6 Power derating curve.

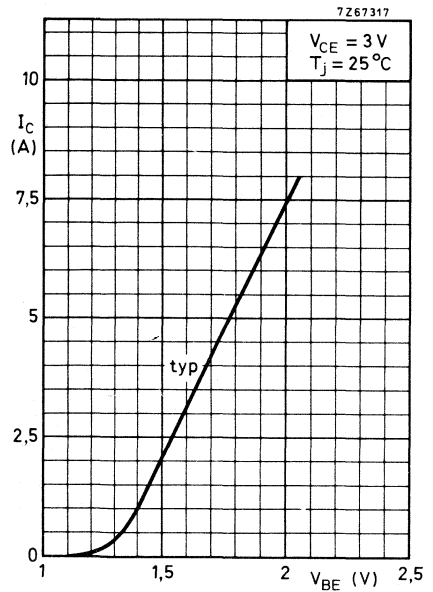


Fig. 7.

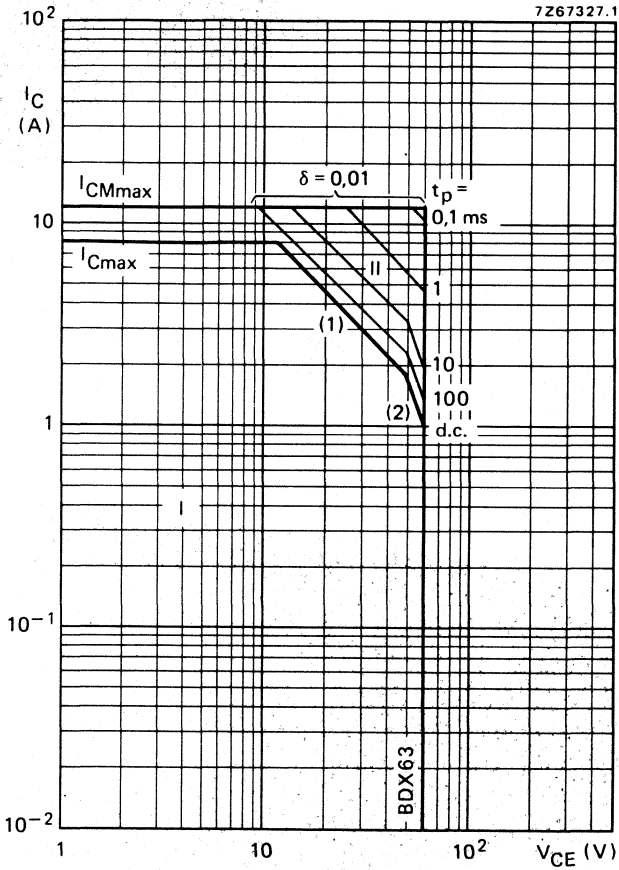


Fig. 8 Safe Operating Area, $T_{mb} \leq 25^\circ\text{C}$.

- 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).

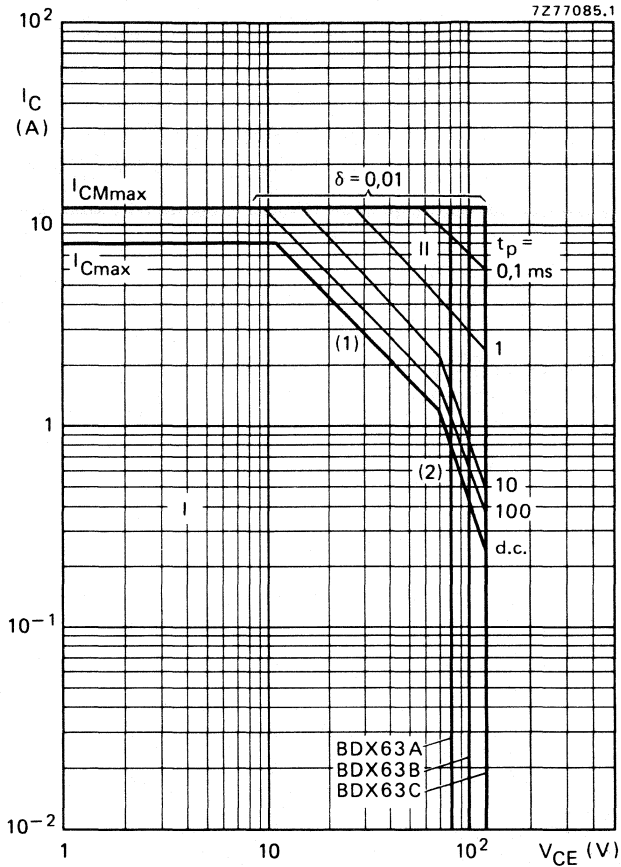


Fig. 9 Safe Operating Area. $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

- 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).

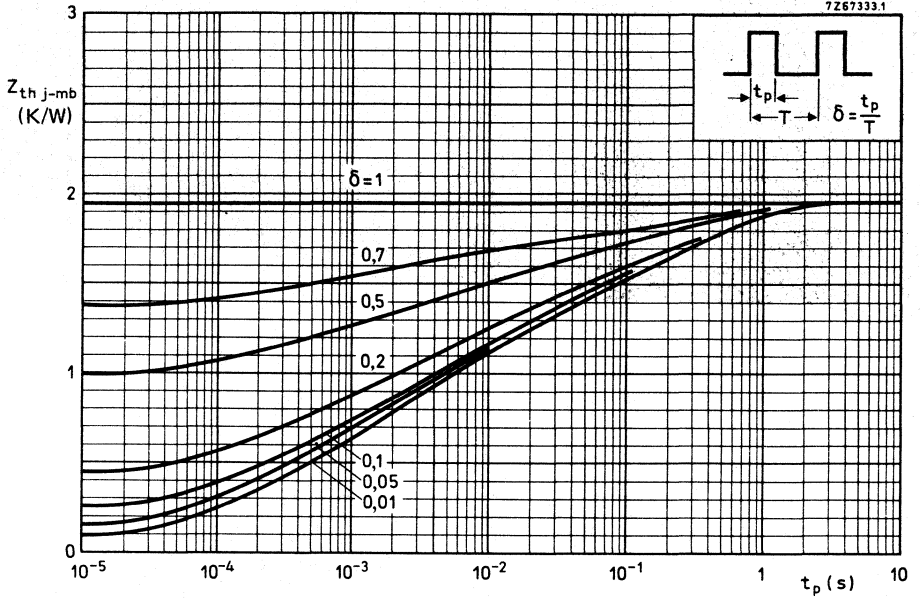


Fig. 10 Pulse power rating chart.

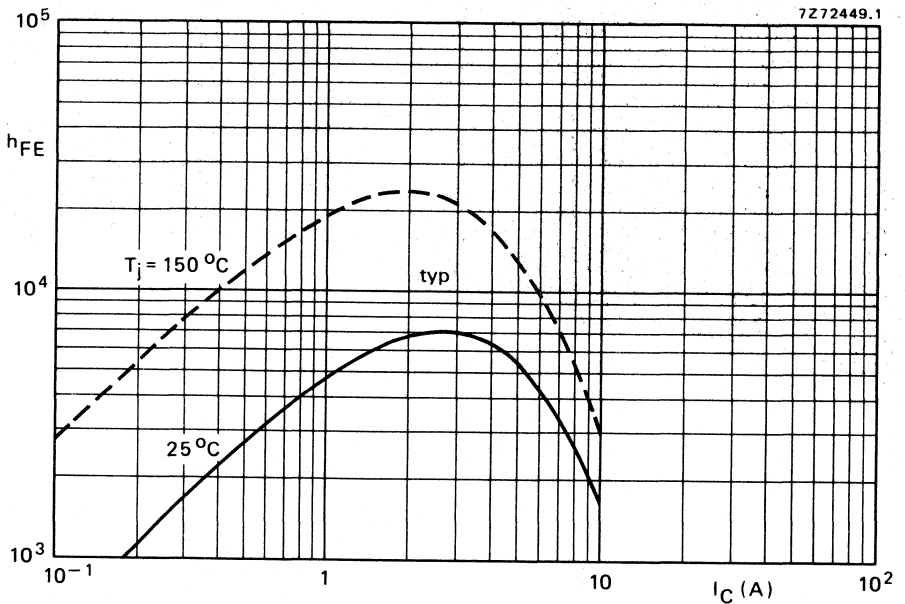


Fig. 11 Typical values d.c. current gain at $V_{CE} = 3$ V.

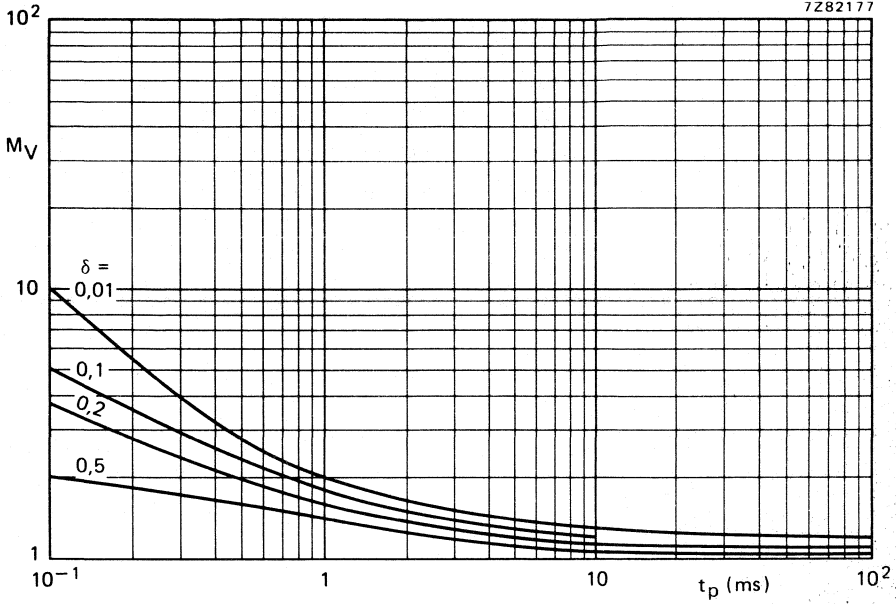


Fig. 12 S.B. voltage multiplying factor at the I_{Cmax} level.

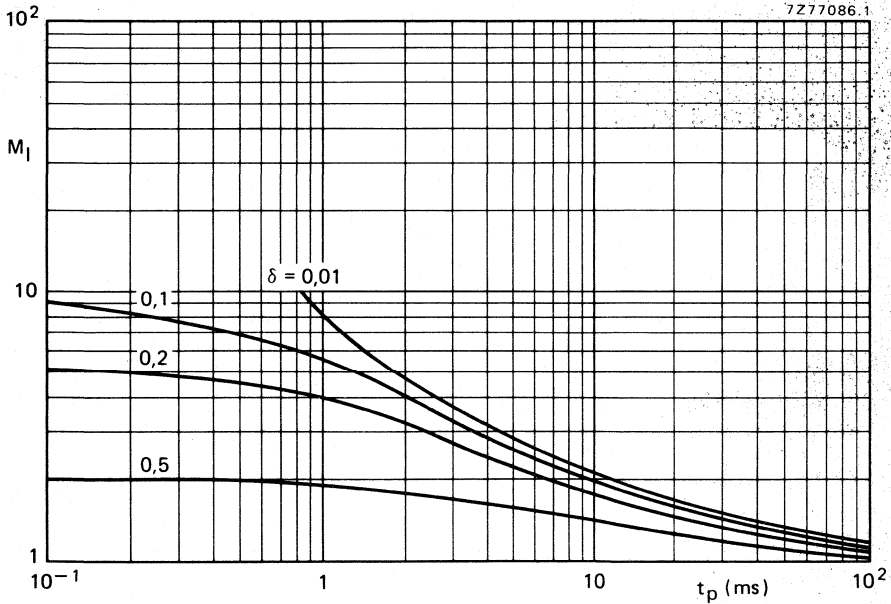


Fig. 13 S.B. current multiplying factor at the V_{CE0} 100 V and 60 V level.

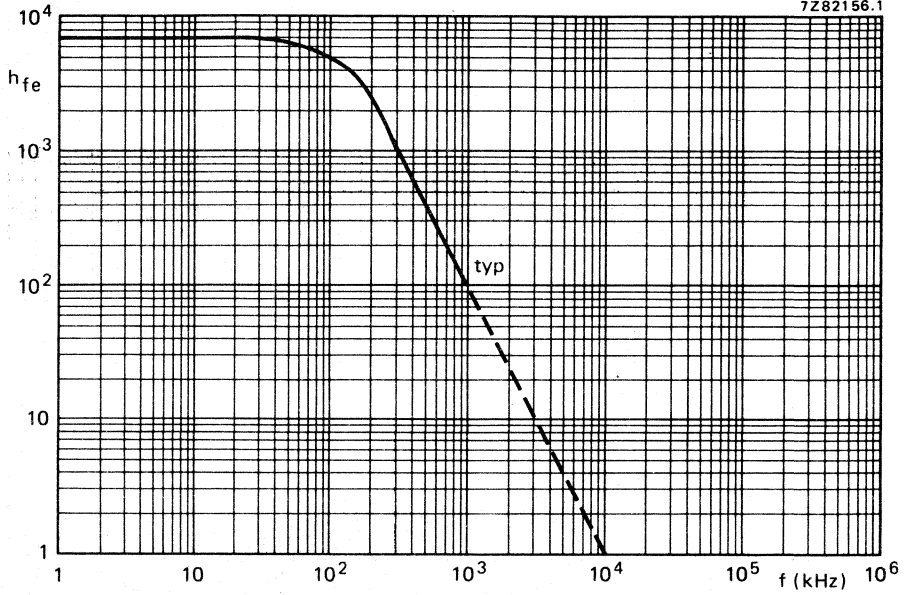


Fig. 14 Small-signal current gain at $I_C = 3$ A; $V_{CE} = 3$ V.

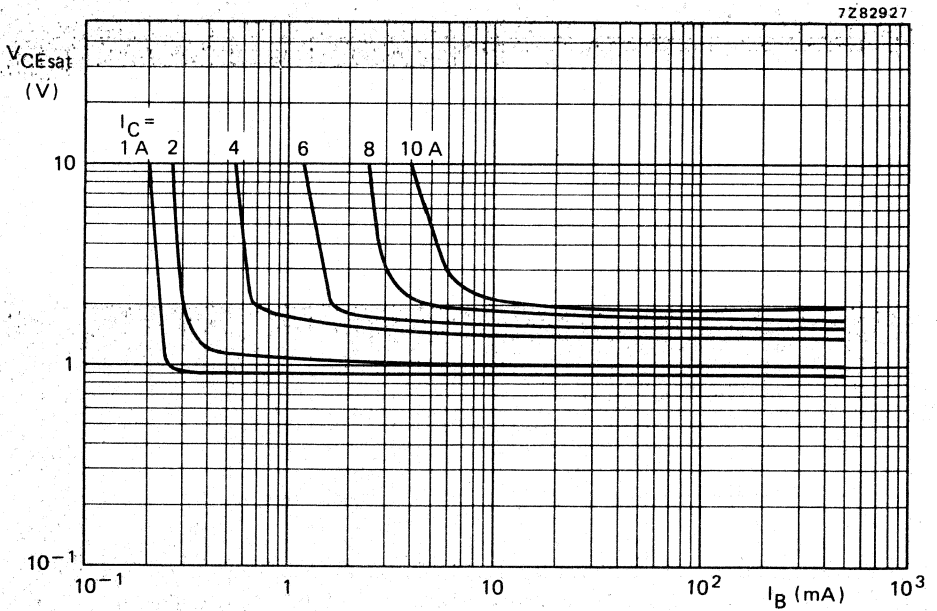


Fig. 15 Typical values collector-emitter saturation voltage at $T_j = 25$ °C.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope. N-P-N complements are BDX65, BDX65A, BDX65B and BDX65C.

QUICK REFERENCE DATA

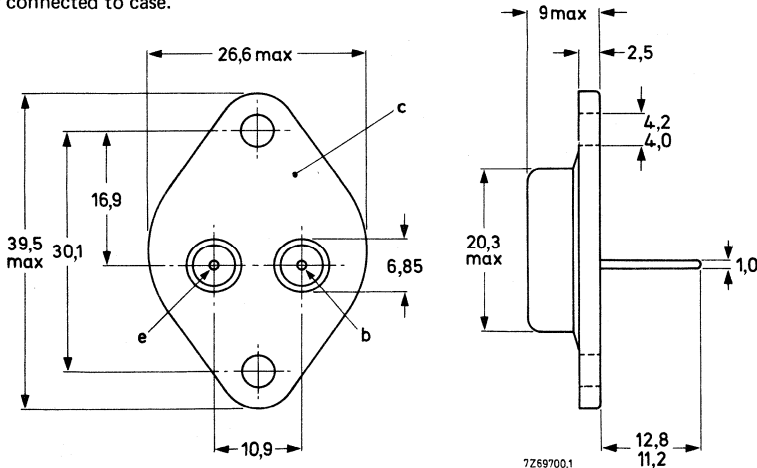
			BDX64	64A	64B	64C
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120 V
Collector current (peak value)	$-I_{CM}$	max.	16			A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	117			W
Junction 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.

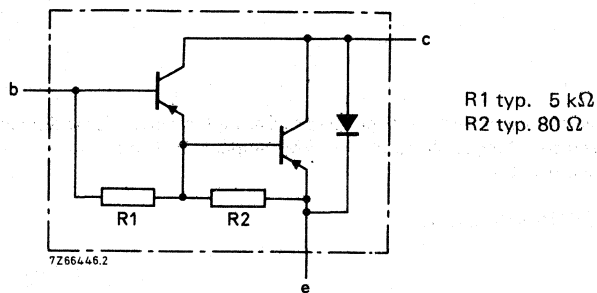


Fig. 2 Circuit diagram.

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 $T_{mb} = 25^\circ\text{C}$	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	K/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

$$I_E = 0; -V_{CB} = -V_{CB0\text{max}} \quad -I_{CBO} < 0,4\text{ mA}$$

$$I_E = 0; -V_{CB} = 40\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX64}$$

$$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX64A} \quad -I_{CBO} < 3\text{ mA}$$

$$I_E = 0; -V_{CB} = 60\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX64B}$$

$$I_E = 0; -V_{CB} = 70\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX64C}$$

$$I_B = 0; -V_{CE} = -\frac{1}{2} V_{CE0\text{max}} \quad -I_{CEO} < 1\text{ mA}$$

Emitter cut-off current

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

D.C. current gain (note 1)

$$-I_C = 1\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 1500$$

$$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} > 1000$$

$$-I_C = 12\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 750$$

Base-emitter voltage (notes 1 and 2)

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

Collector-emitter saturation voltage (note 1)

$$-I_C = 5\text{ A}; -I_B = 20\text{ mA} \quad -V_{CE\text{sat}} < 2\text{ V}$$

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

$$I_E = I_e = 0; -V_{CB} = 10\text{ V} \quad C_c \text{ typ. } 200\text{ pF}$$

Cut-off frequency

$$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V} \quad f_{hfe} \text{ typ. } 80\text{ kHz}$$

Small-signal current gain

$$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz} \quad h_{fe} \text{ typ. } 30$$

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.2. $-V_{BE}$ decreases by about $3,6\text{ mV/K}$ 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)

$-I_{C\text{on}} = 5 \text{ A}; -I_{B\text{on}} = I_{B\text{off}} = 20 \text{ mA}$

turn-on time

t_{on} typ. $1 \mu\text{s}$

turn-off time

t_{off} typ. $2,5 \mu\text{s}$

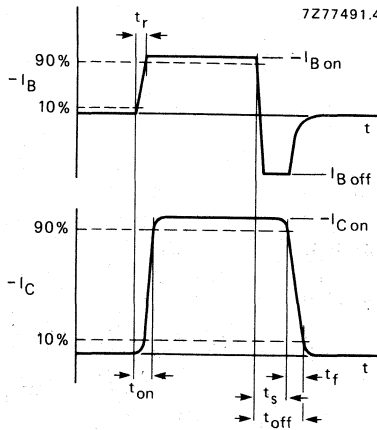


Fig. 3 Switching times waveforms.

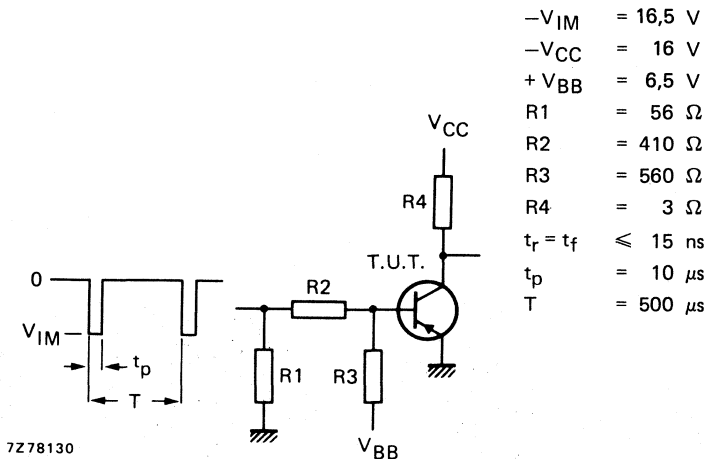


Fig. 4 Switching times test circuit.

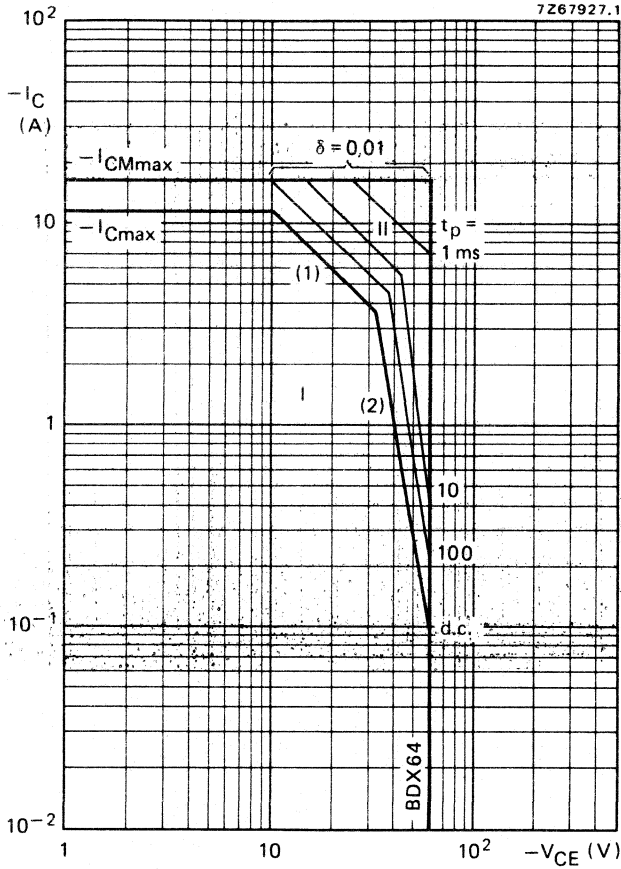


Fig. 5 Safe Operating Area; $T_{mb} \leq 25^\circ\text{C}$.

- 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).

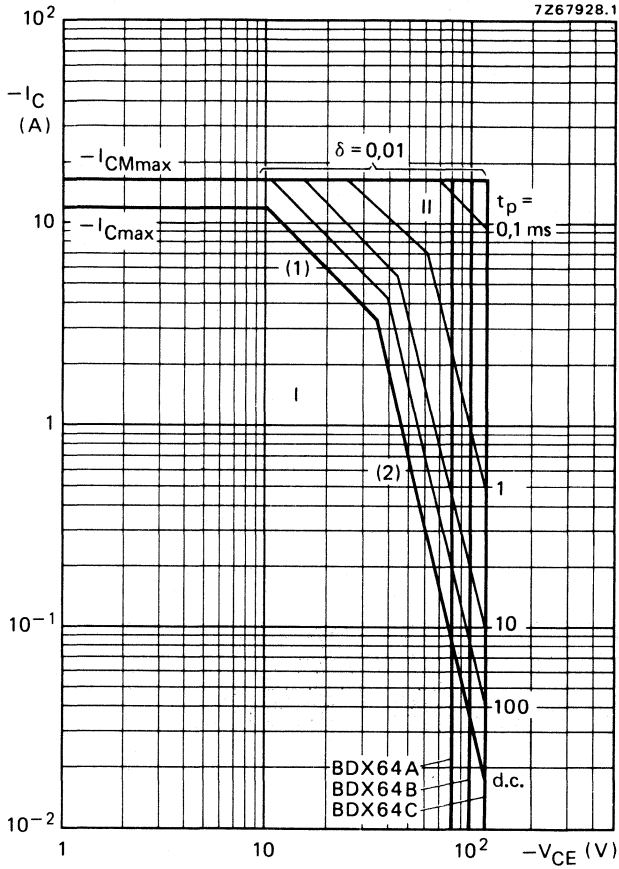


Fig. 6 Safe Operating ARea; $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

- 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).

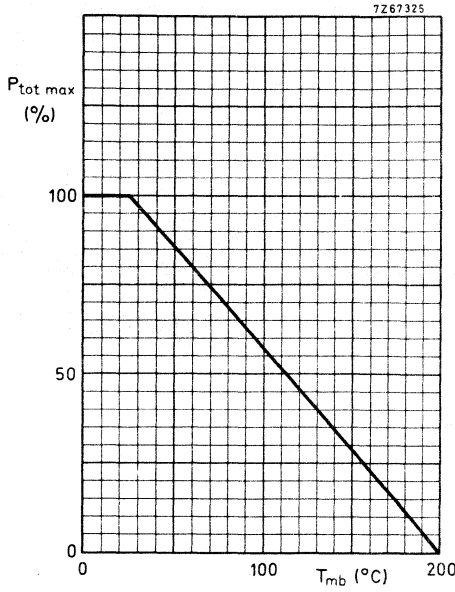


Fig. 7 Power derating curve.

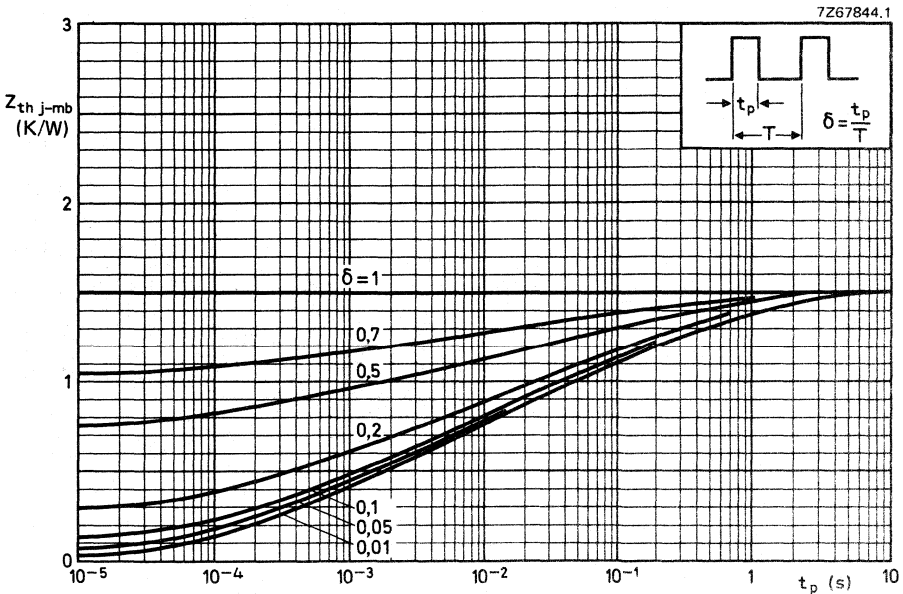


Fig. 8 Pulse power rating chart.

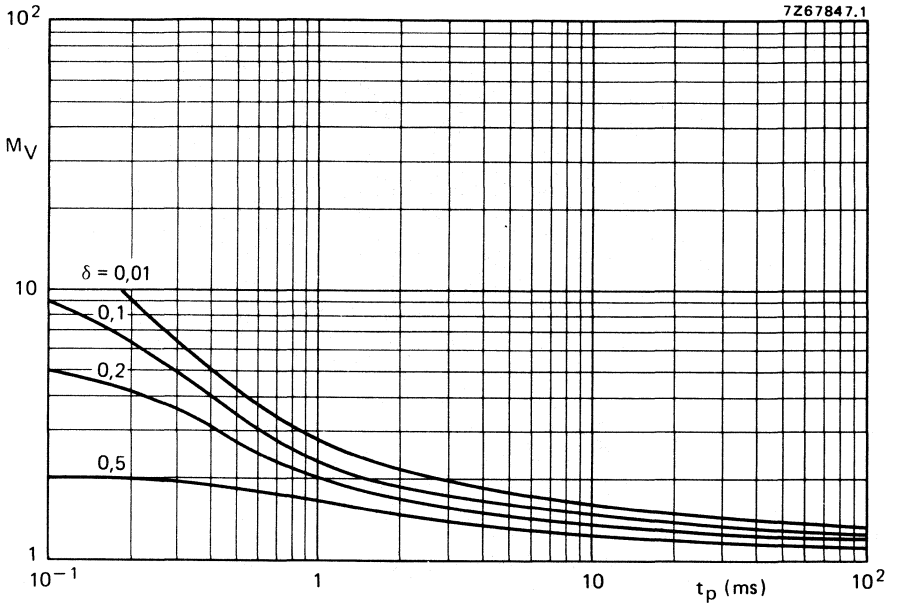


Fig. 9 S.B. voltage multiplying factor at the $-I_{C \max}$ level.

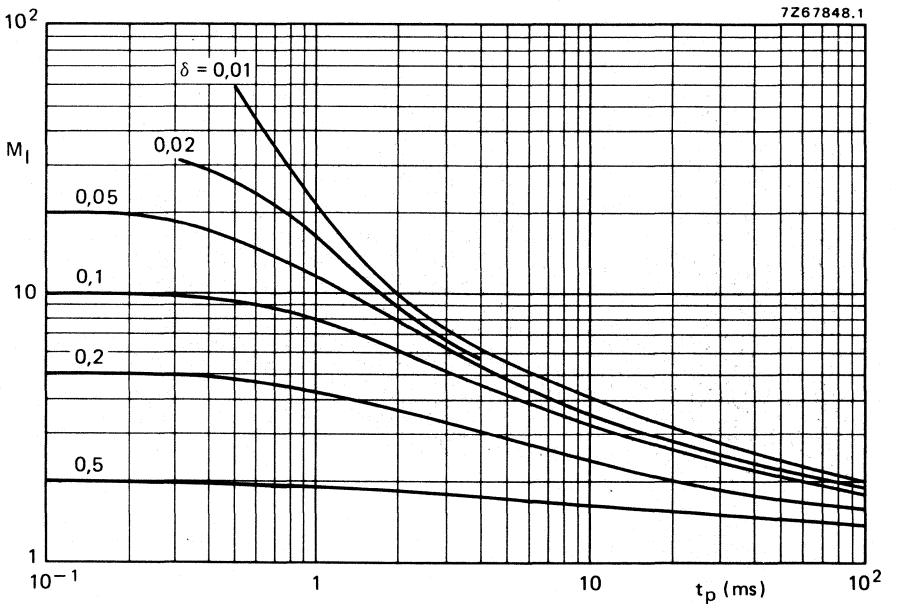


Fig. 10 S.B. current multiplying factor at $-V_{CEO}$ 100 V and 60 V level.

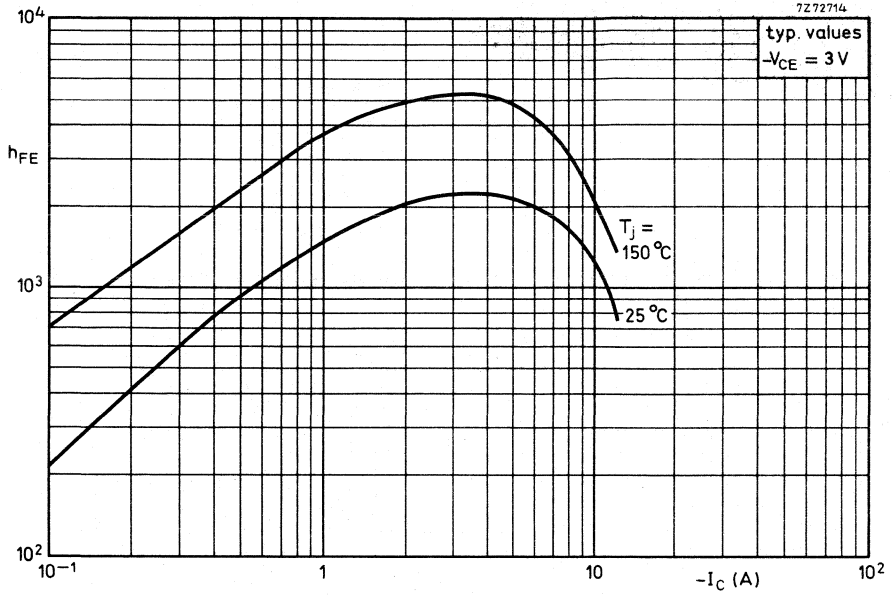


Fig. 11 D.C. current gain.

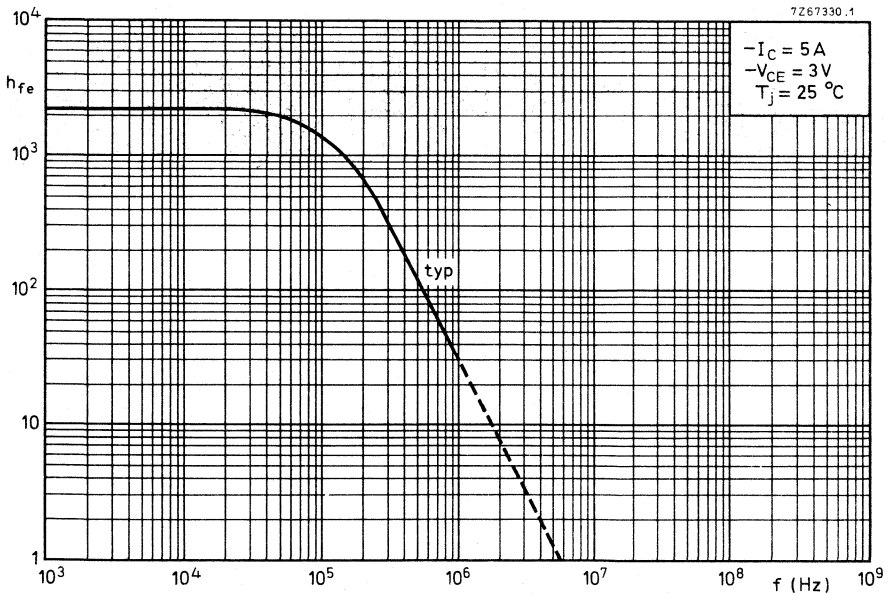


Fig. 12 Small-signal current gain.

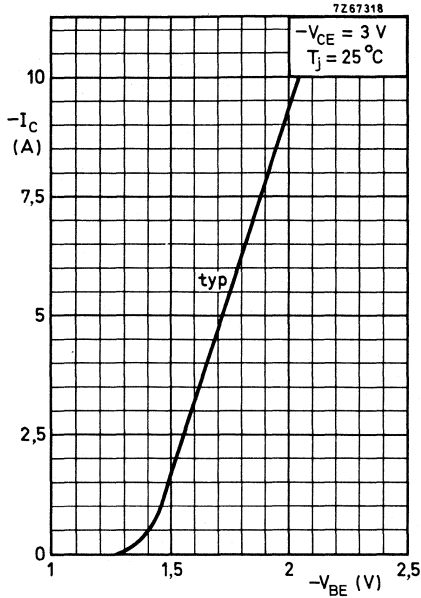


Fig. 13 Typical collector current.

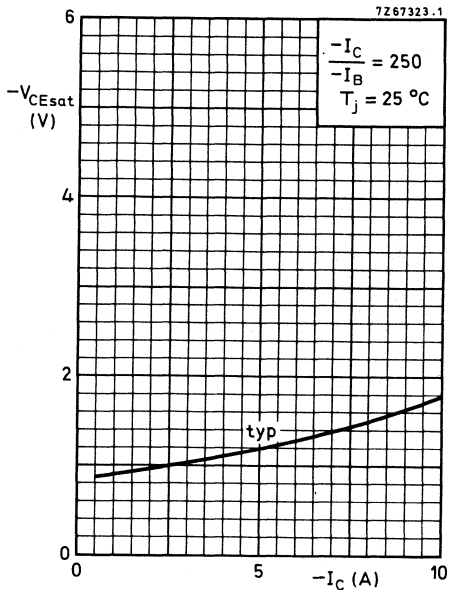


Fig. 14 Typical collector-emitter saturation voltage.

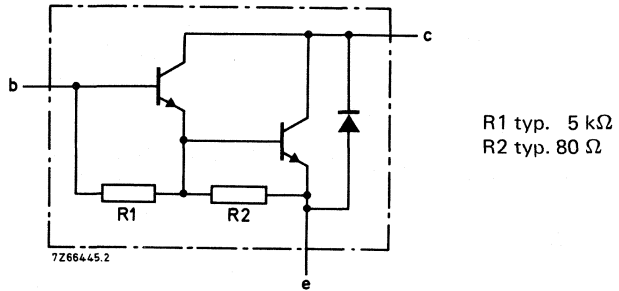


Fig. 2 Circuit diagram.

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 $T_{mb} = 25\text{ }^\circ\text{C}$	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		K/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

$I_E = 0; V_{CB} = V_{CE0max}$

$I_{CBO} < 0,4\text{ mA}$

$I_E = 0; V_{CB} = \frac{1}{2} V_{CB0max}; T_j = 200\text{ }^\circ\text{C}$

$I_{CBO} < 3\text{ mA}$

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

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

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} typ. 3300

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

$h_{FE} > 1000$

$I_C = 12\text{ A}; V_{CE} = 3\text{ V}$

h_{FE} typ. 3700

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 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)

$-I_{Boff} = 0; I_{CC} = 6,3\text{ A}$

$E_{(BR)} > 100\text{ mJ}$

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.
2. V_{BE} decreases by about 3,6 mV/K 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)

$I_{Con} = 5 \text{ A}; I_{Bon} = -I_{Boff} = 20 \text{ mA}$

Turn-on time

t_{on} typ. 1 μs

Turn-off time

t_{off} typ. 6 μs

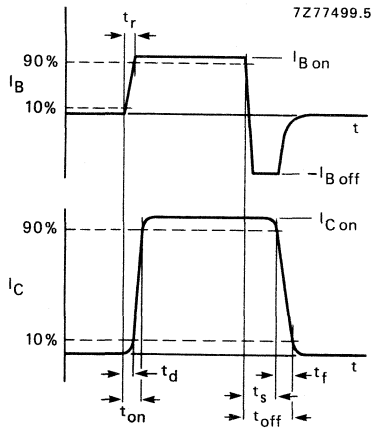
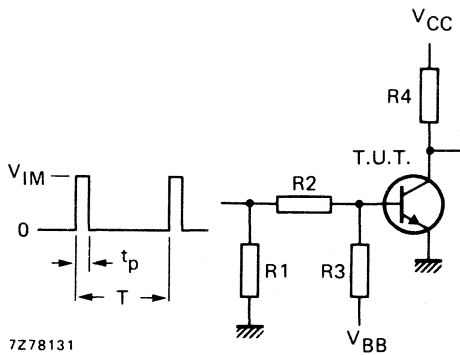


Fig. 3 Switching times waveforms.



- $V_{IM} = 15 \text{ V}$
- $V_{CC} = 15 \text{ V}$
- $-V_{BB} = 4 \text{ V}$
- $R1 = 56 \ \Omega$
- $R2 = 410 \ \Omega$
- $R3 = 560 \ \Omega$
- $R4 = 3 \ \Omega$
- $t_r = t_f \leq 15 \text{ ns}$
- $t_p = 10 \ \mu\text{s}$
- $T = 500 \ \mu\text{s}$

Fig. 4 Switching times test circuit.

CHARACTERISTICS (continued)

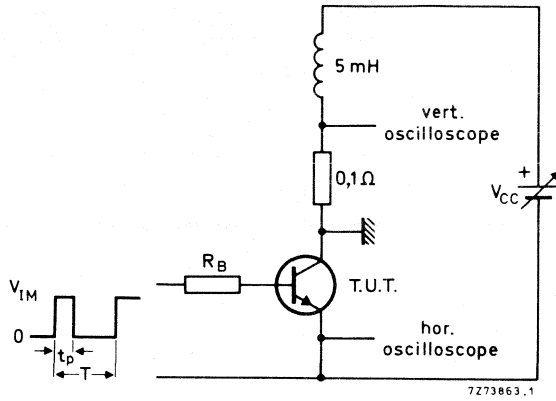


Fig. 5 Test circuit for turn-off breakdown energy. $V_{IM} = 12 \text{ V}$; $R_B = 270 \text{ }\Omega$; $I_{CC} = 6,3 \text{ A}$; $\delta = 1\%$.

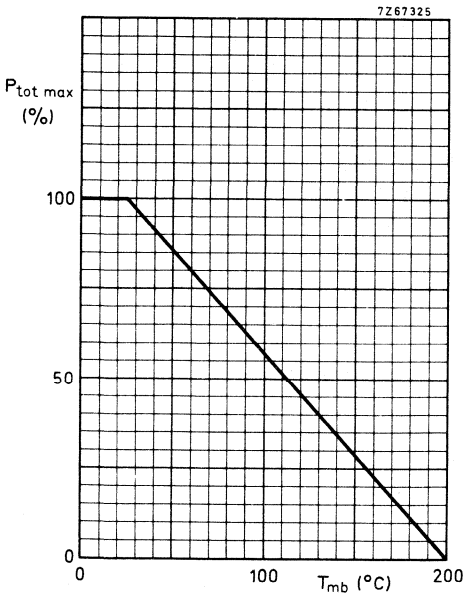


Fig. 6 Power derating curve.

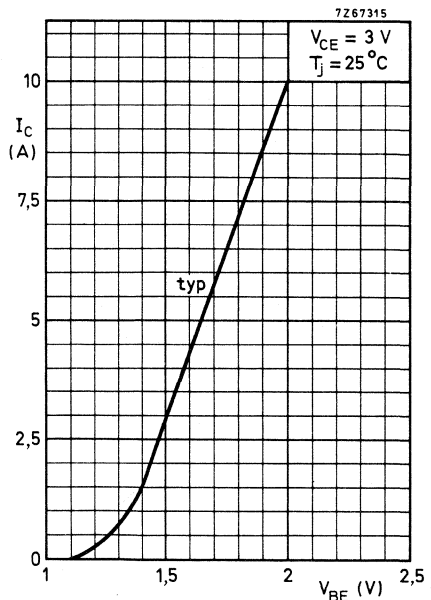


Fig. 7 Typical collector current.

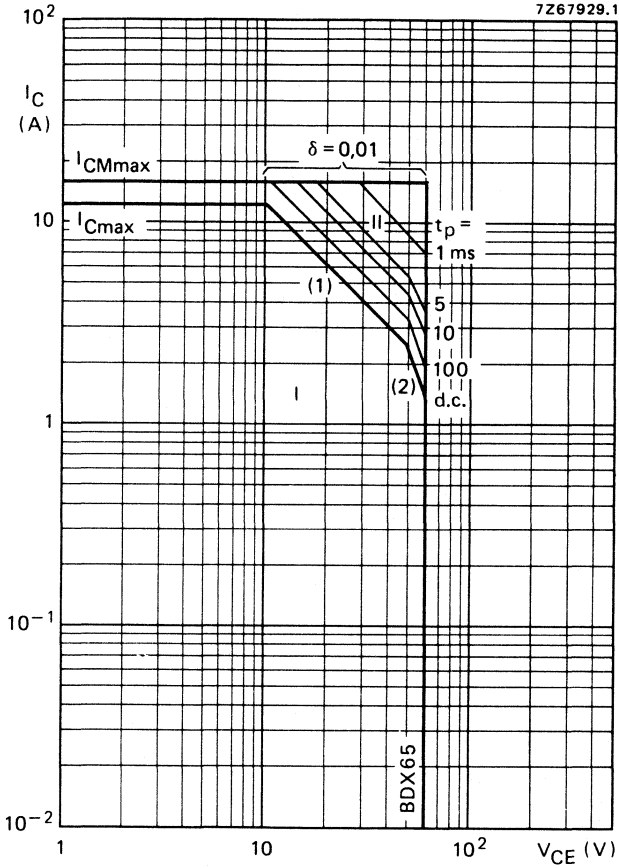


Fig. 8 Safe Operating Area at $T_{mb} \leq 25 \text{ }^\circ\text{C}$ of BDX65.

- 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).

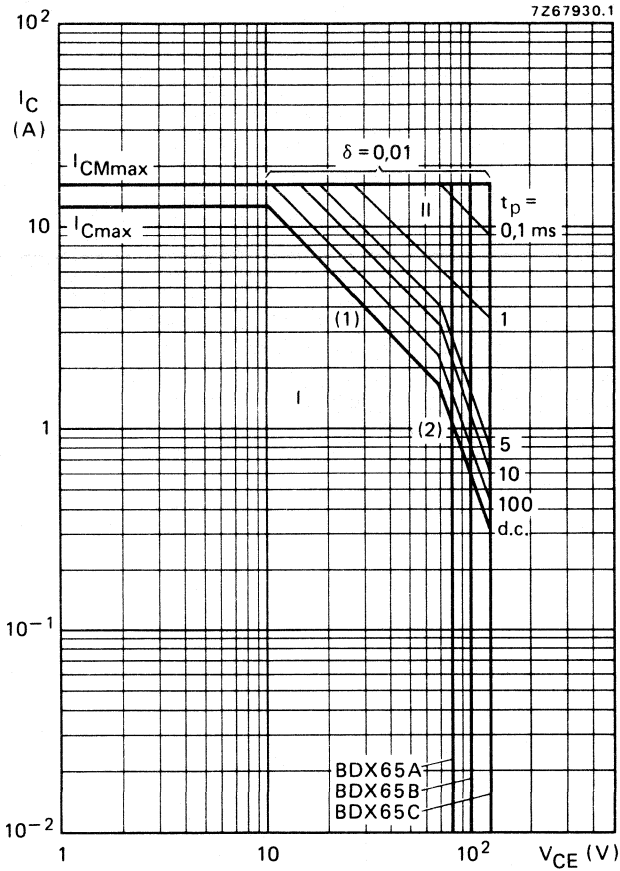


Fig. 9 Safe Operating Area at $T_{mb} \leq 25^\circ\text{C}$.

- 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).

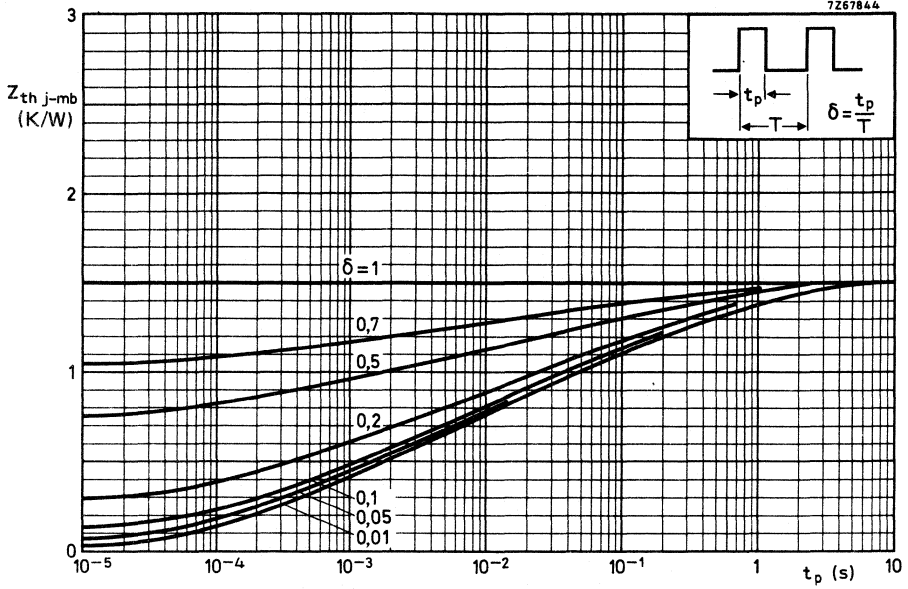


Fig. 10 Pulse power rating chart.

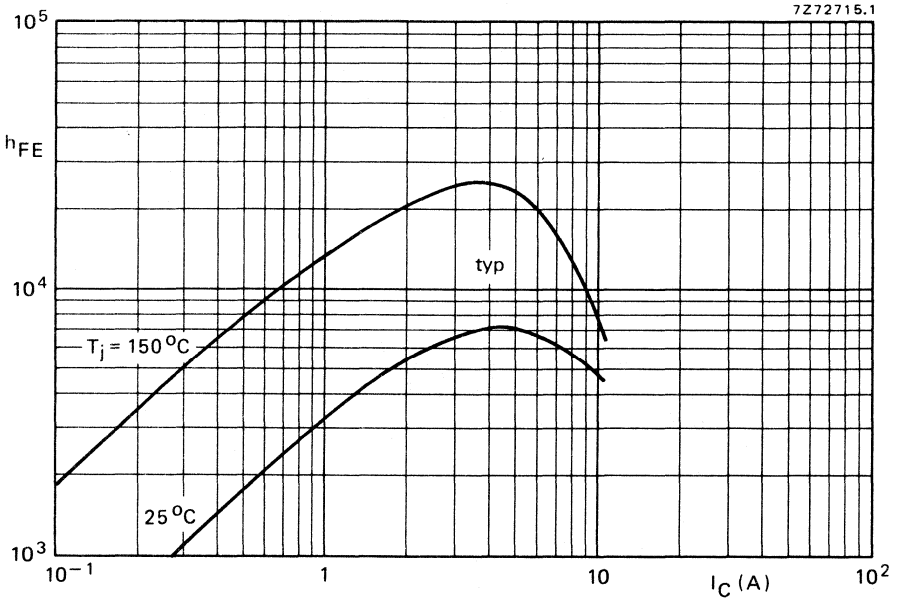


Fig. 11 Typical d.c. current gain at $V_{CE} = 3$ V.

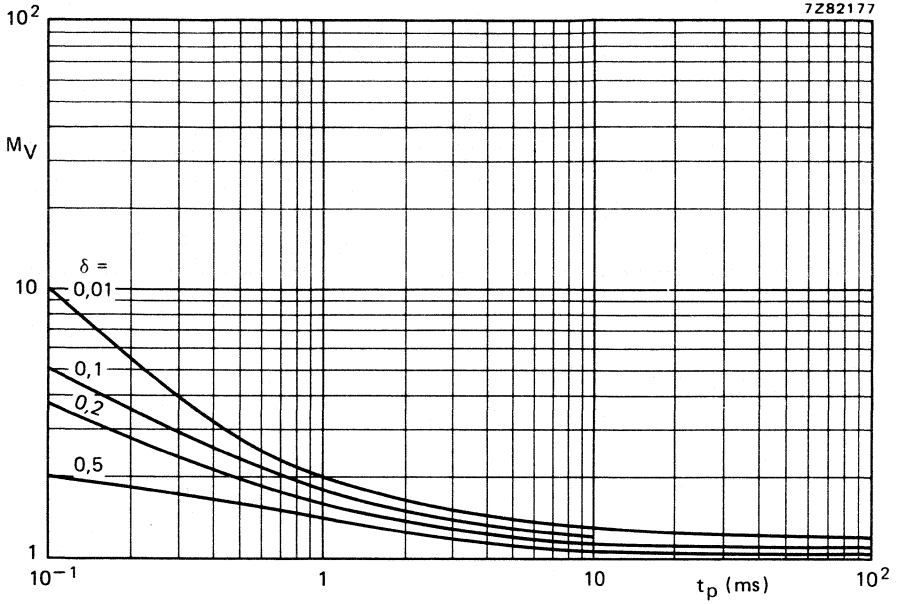


Fig. 12 S.B. voltage multiplying factor at the I_{Cmax} level.

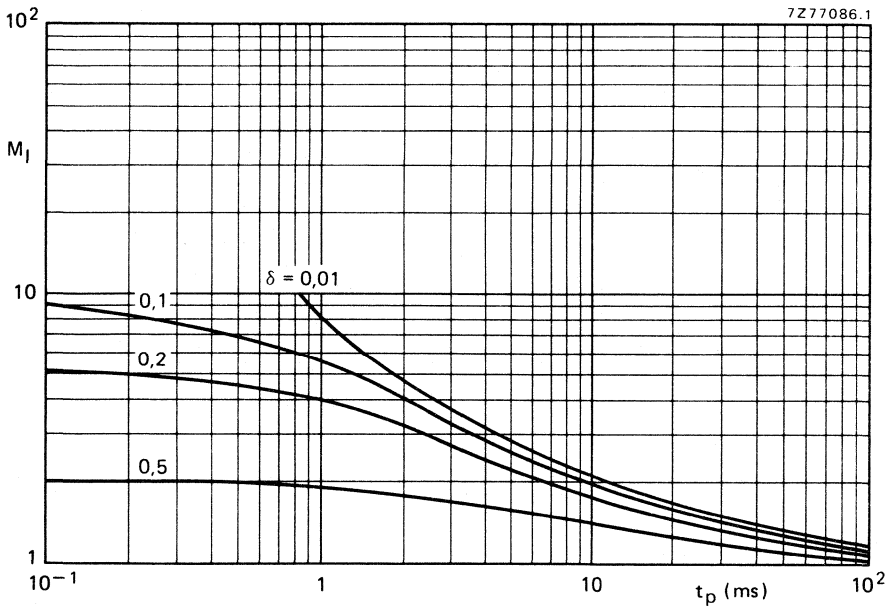


Fig. 13 S.B. current multiplying factor at V_{CEO} 100 V and 60 V level.

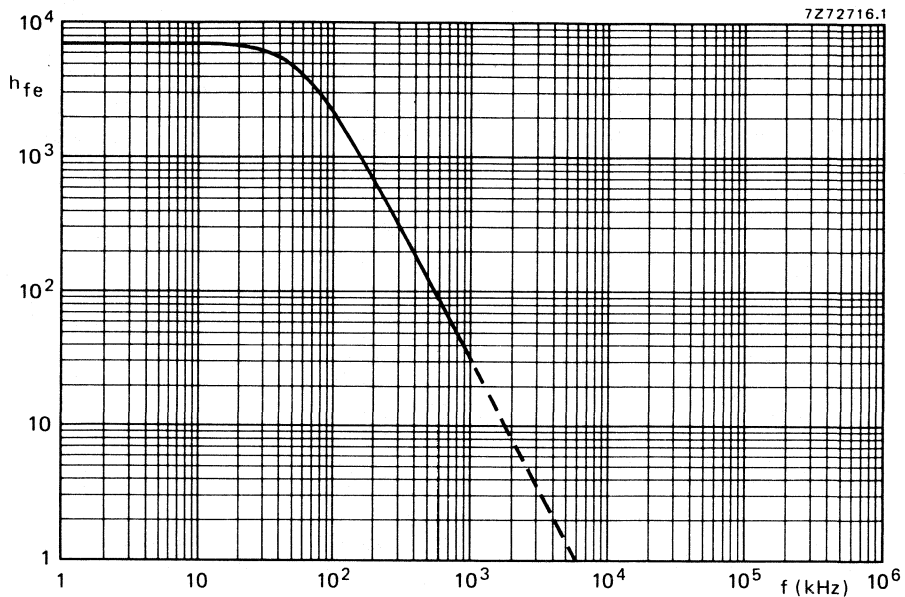


Fig. 14 Typical small-signal current gain, $I_C = 5 \text{ A}$; $V_{CE} = 3 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$.

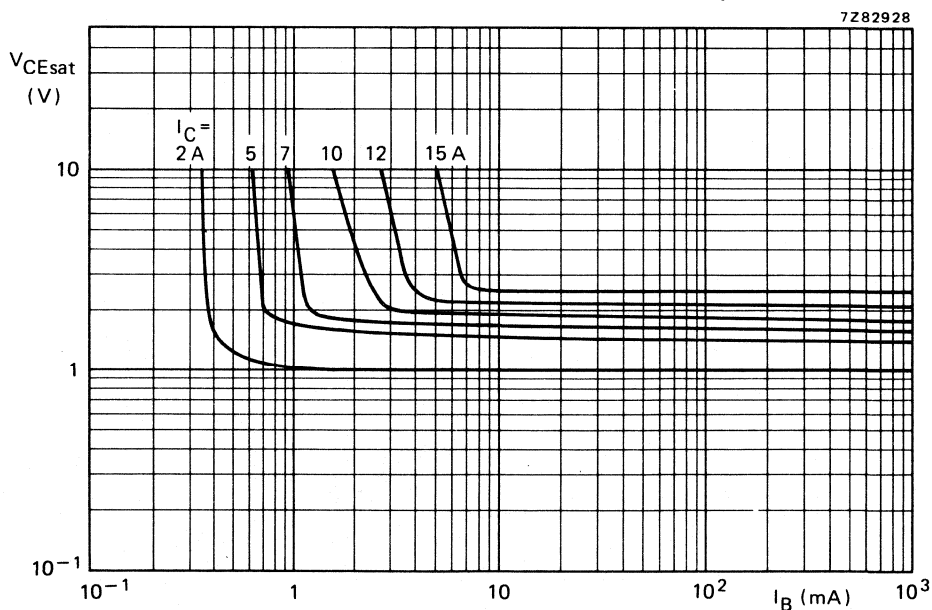


Fig. 15 Typical values collector-emitter saturation voltage. $T_{amb} = 25 \text{ }^\circ\text{C}$.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope. N-P-N complements are BDX67, BDX67A, BDX67B and BDX67C.

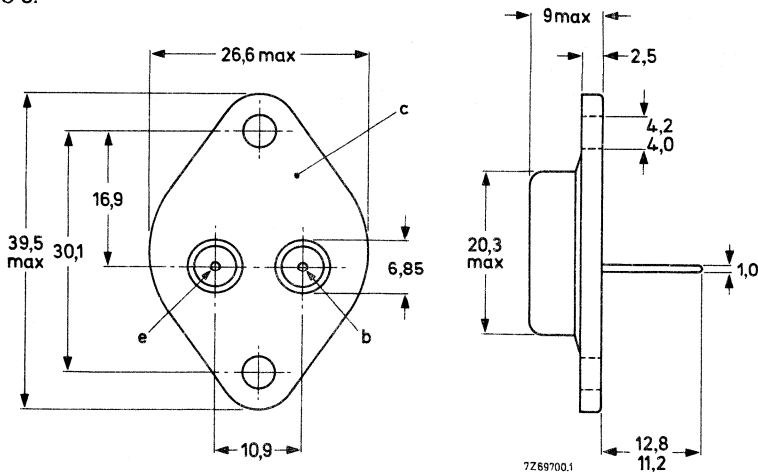
QUICK REFERENCE DATA

		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	h_{FE}	typ. 2000			
$-I_C = 1\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}	> 1000			
$-I_C = 10\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE}				
Cut-off frequency	f_{hfe}	typ. 60			kHz
$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe}				

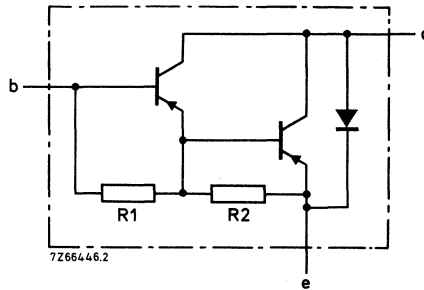
MECHANICAL DATA

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.)	$-I_C$	max.	16		A
Collector current (peak value)	$-I_{CM}$	max.	20		A
Base current	$-I_B$	max.	250		mA
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	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_{thj-mb}	=	1,17	K/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

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

Collector cut-off current

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

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

$I_E = 0; -V_{CB} = 40 \text{ V}; T_j = 200^\circ\text{C}; \text{BDX66}$

$I_E = 0; -V_{CB} = 50 \text{ V}; T_j = 200^\circ\text{C}; \text{BDX66A}$

$I_E = 0; -V_{CB} = 60 \text{ V}; T_j = 200^\circ\text{C}; \text{BDX66B}$

$I_E = 0; -V_{CB} = 70 \text{ V}; T_j = 20^\circ\text{C}; \text{BDX66C}$

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

$I_B = 0; -V_{CE} = -\frac{1}{2}V_{CE0\text{max}}$

$-I_{CEO} < 3 \text{ mA}$

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 $f = 1 \text{ MHz}$

$I_E = I_B = 0; -V_{CB} = 10 \text{ V}$

$C_c \text{ typ. } 300 \text{ pF}$

Cut-off frequency

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

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

Small-signal current gain

$-I_C = 5 \text{ A}; -V_{CE} = 3 \text{ V}; f = 1 \text{ MHz}$

$h_{fe} \text{ typ. } 50$

Diode, forward voltage

$I_F = 10 \text{ A}$

$V_F \text{ typ. } 2 \text{ V}$

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

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 μs
t_{off}	typ.	3,5 μs

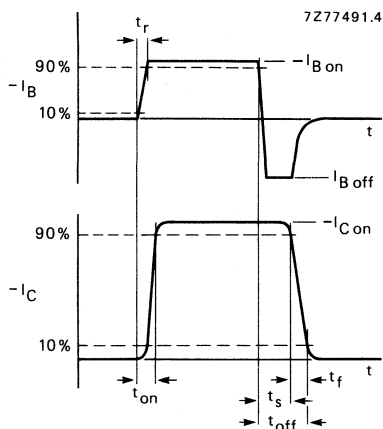
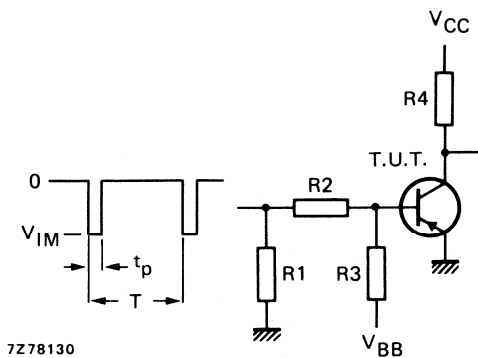


Fig. 3 Switching times waveforms.



- $-V_{IM} = 18\text{ V}$
- $-V_{CC} = 12\text{ V}$
- $+V_{BB} = 3\text{ V}$
- $R1 = 56\ \Omega$
- $R2 = 220\ \Omega$
- $R3 = 180\ \Omega$
- $R4 = 1\ \Omega$
- $t_r = t_f = 15\text{ ns}$
- $t_p = 10\ \mu\text{s}$
- $T = 500\ \mu\text{s}$

Fig. 4 Switching times test circuit.

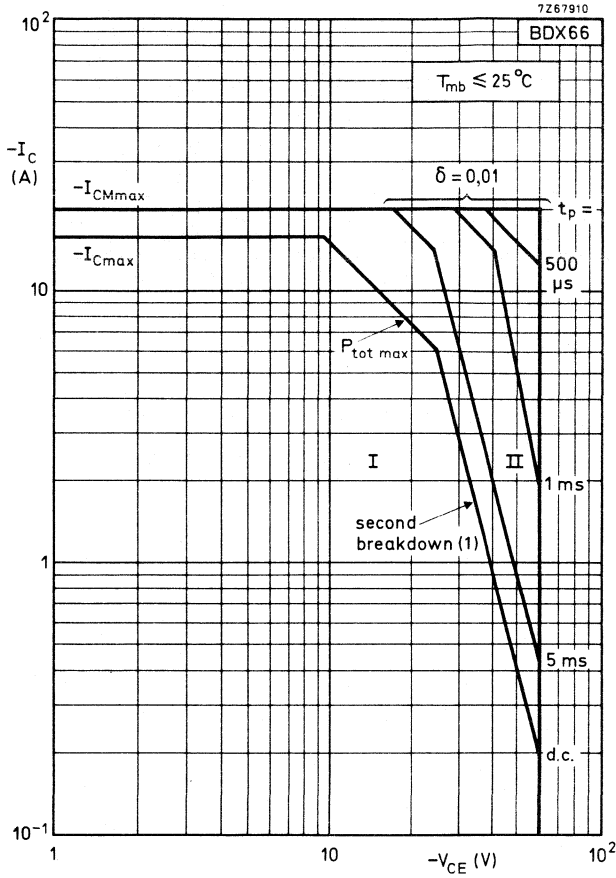


Fig. 5 Safe Operating Area with the transistor forward biased.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) Independent of temperature.

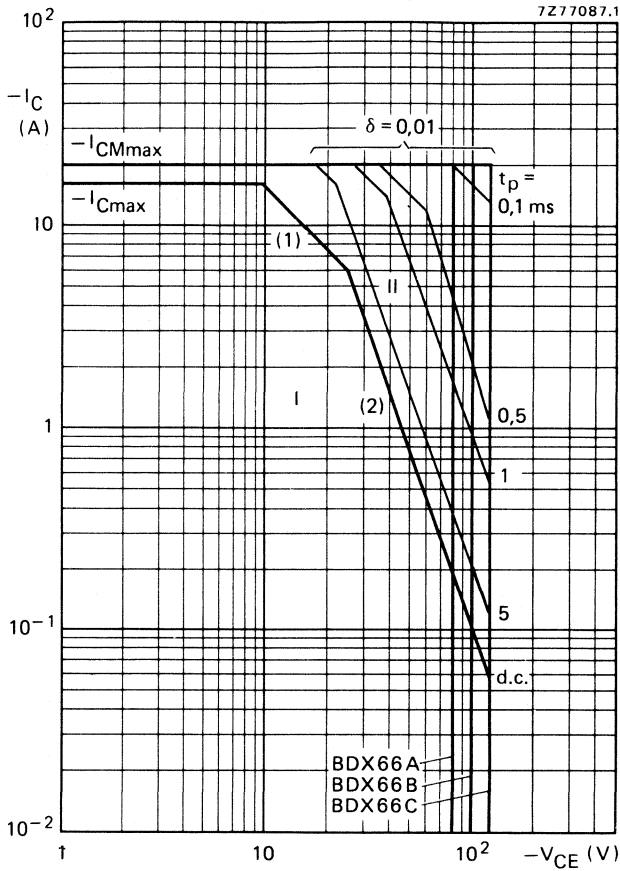


Fig. 6 Safe Operating Area.

- 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).

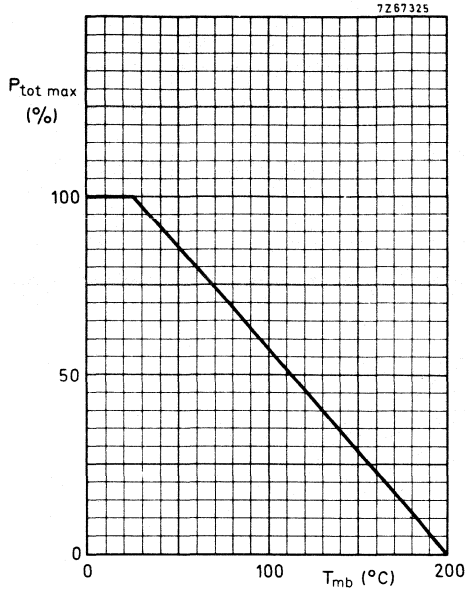


Fig. 7 Power derating curve.

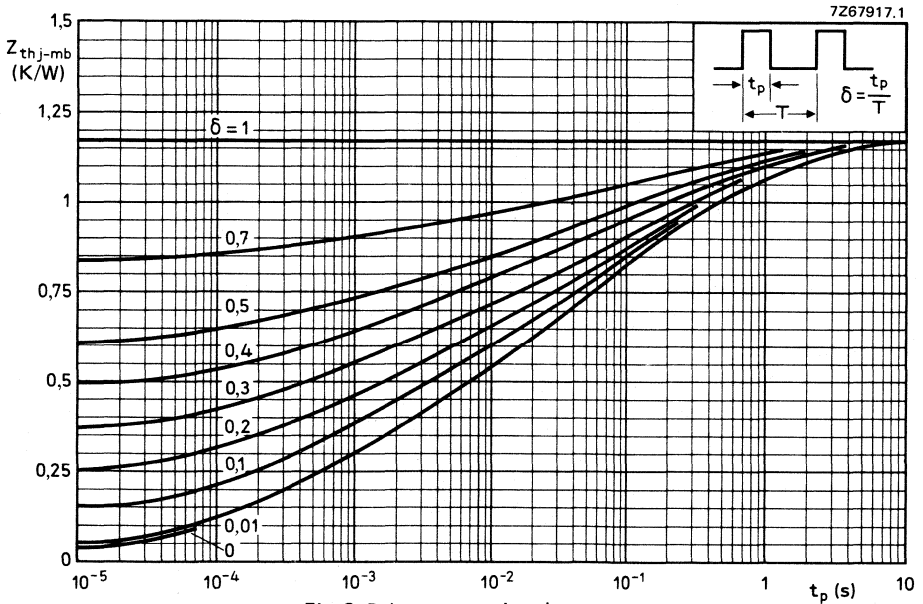


Fig. 8 Pulse power rating chart.

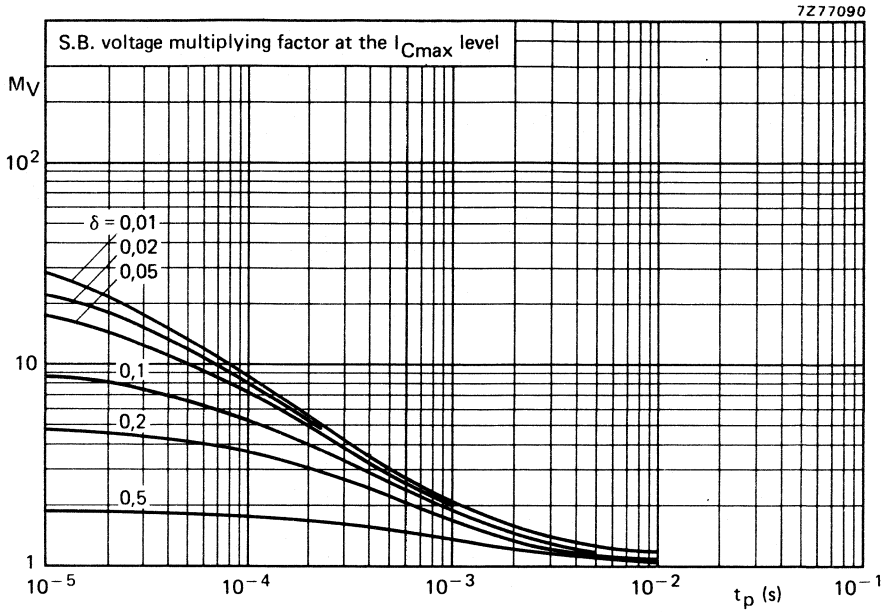


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

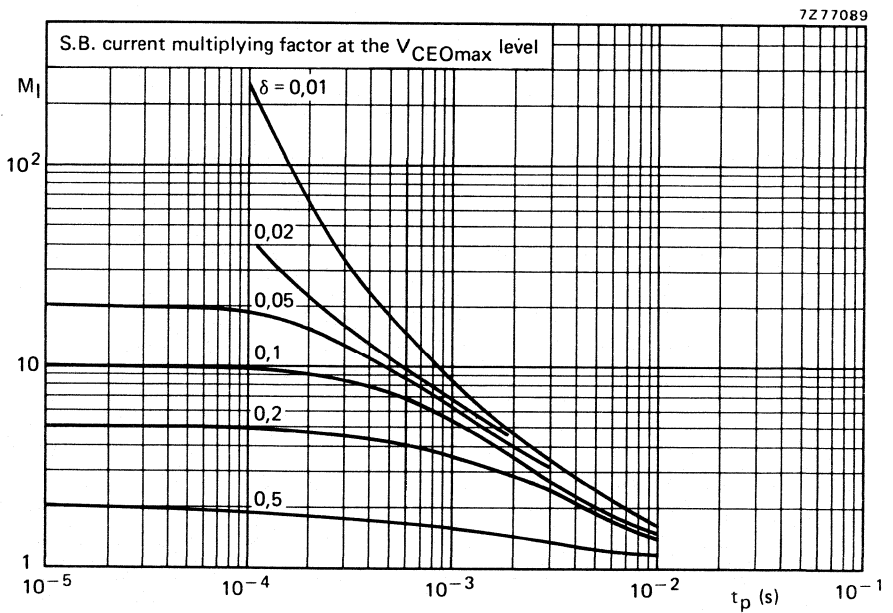


Fig. 10 S.B. current multiplying factor at the V_{CE0max} level.

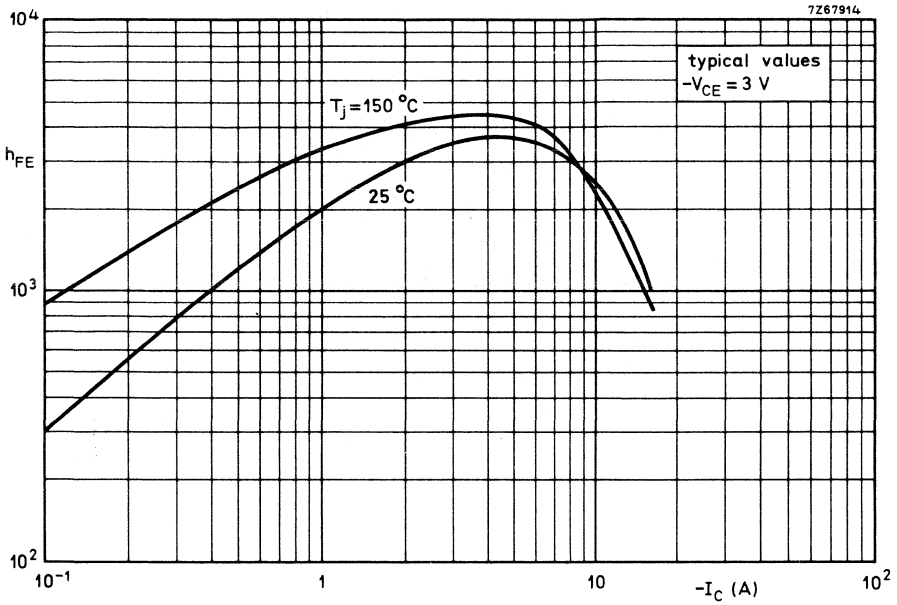


Fig. 11 D.C. current gain.

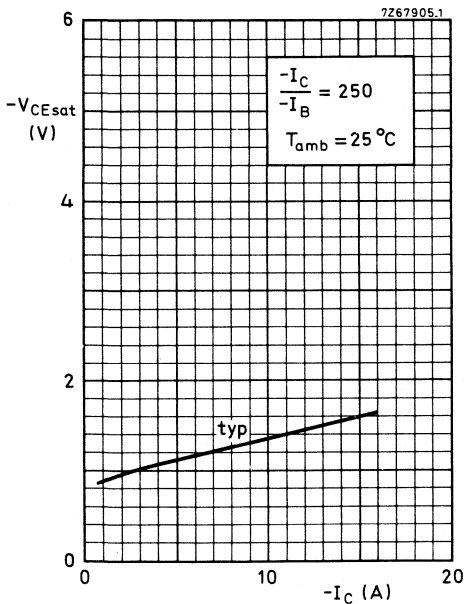


Fig. 12 Collector-emitter saturation voltage.

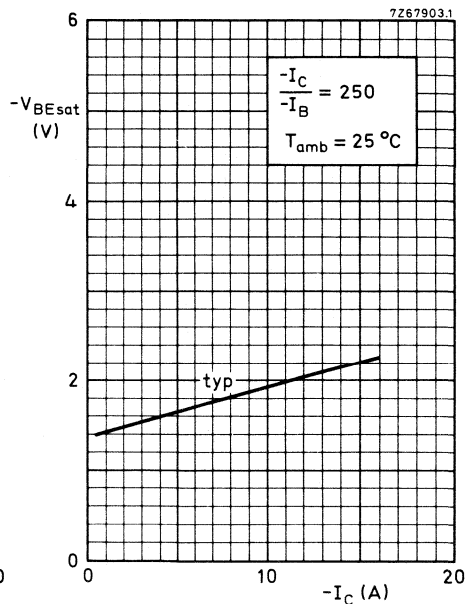


Fig. 13 Base-emitter saturation voltage.

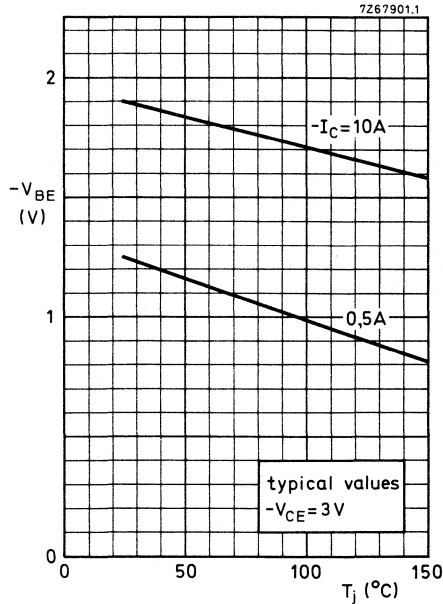


Fig. 14 Typical base-emitter voltage.

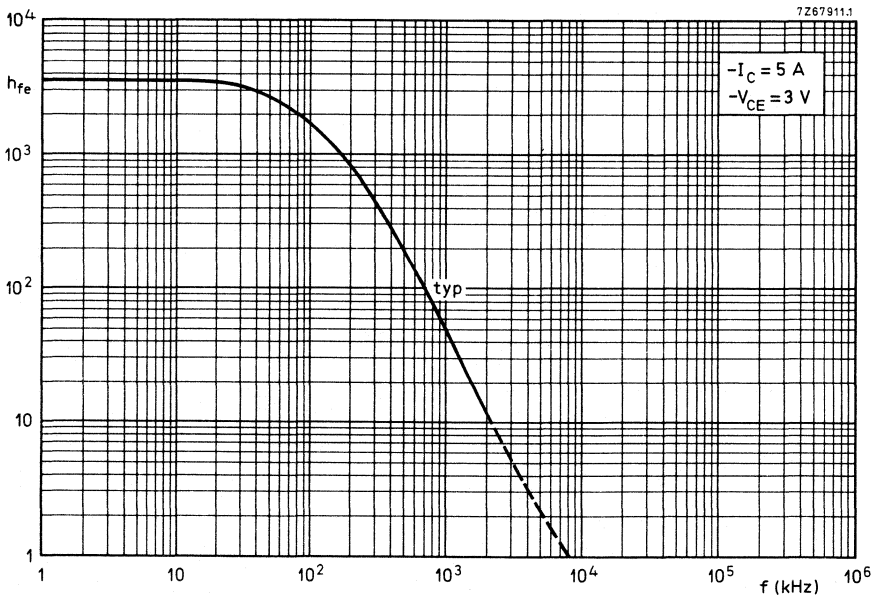


Fig. 15 Small-signal current gain.

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.

QUICK REFERENCE DATA

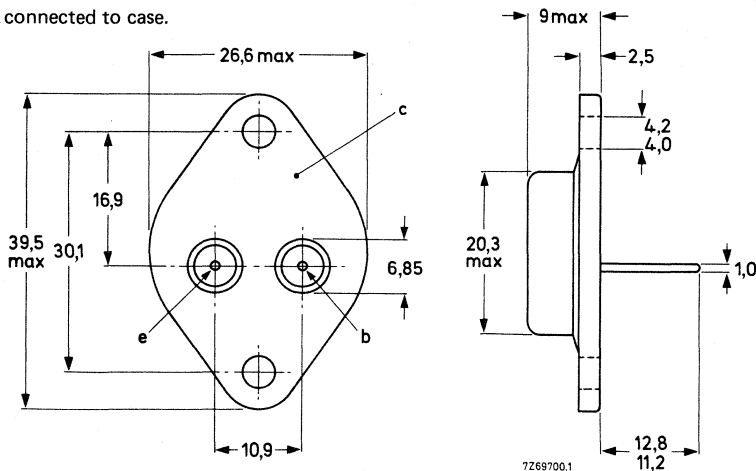
			BDX67	67A	67B	67C
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120 V
Collector current (peak value)	I_{CM}	max.			20	A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.			150	W
Junction 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.			5200	
$I_C = 10\text{ A}; V_{CE} = 3\text{ V}$	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.

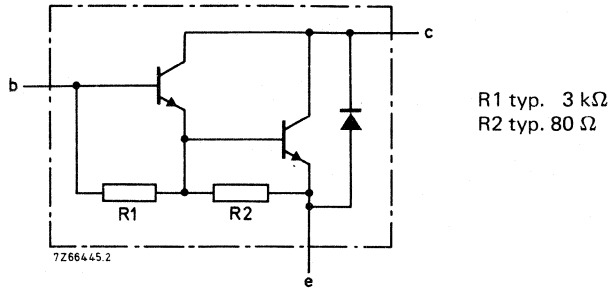


Fig. 2 Circuit diagram.

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 $T_{mb} = 25\text{ }^\circ\text{C}$	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	K/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

$I_E = 0; V_{CB} = V_{CE0max}$

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

$I_E = 0; V_{CB} = \frac{1}{2} V_{CBOmax}; T_j = 200\text{ }^\circ\text{C}$

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

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

$I_{CEO} < 3\text{ mA}$

Emitter-cut-off current

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

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

D.C. current gain *

$I_C = 1\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 5200$

$I_C = 10\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} > 1000$

$I_C = 16\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 4000$

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

$-I_{Boff} = 0; I_{CC} = 7,8\text{ A}; \text{ see Fig. 5}$

$E_{(BR)} > 150\text{ mJ}$

Small-signal current gain

$I_C = 5\text{ A}; V_{CE} = 3\text{ V}; f = 1\text{ MHz}$

$h_{fe} \text{ typ. } 20$

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

t_{on} typ. $1\text{ }\mu\text{s}$

turn-off time

t_{off} typ. $3,5\text{ }\mu\text{s}$

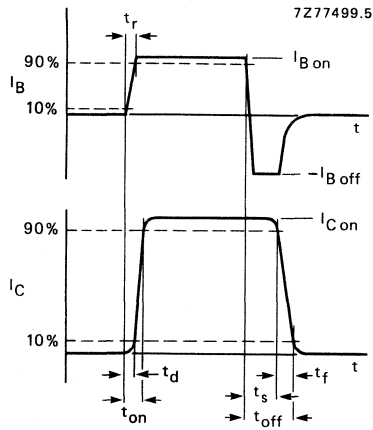


Fig. 3 Switching times waveforms.

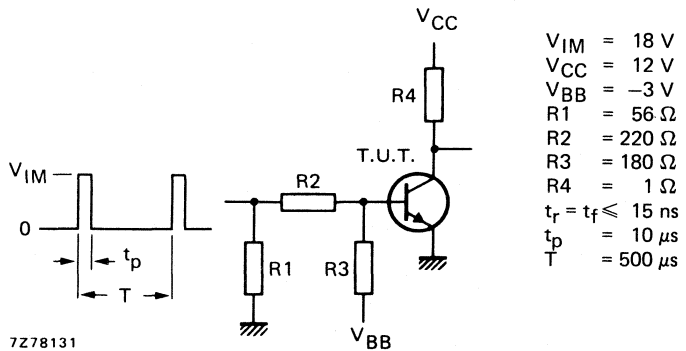


Fig. 4 Switching times test circuit.

CHARACTERISTICS (continued)

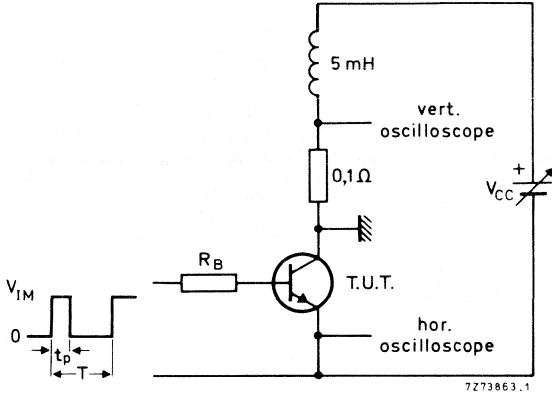


Fig. 5 Test circuit for turn-off breakdown energy. $V_{IM} = 12 \text{ V}$; $R_B = 270 \text{ }\Omega$; $I_{CC} = 7,8 \text{ A}$; $t_p = 1 \text{ ms}$; $\delta = 1\%$.

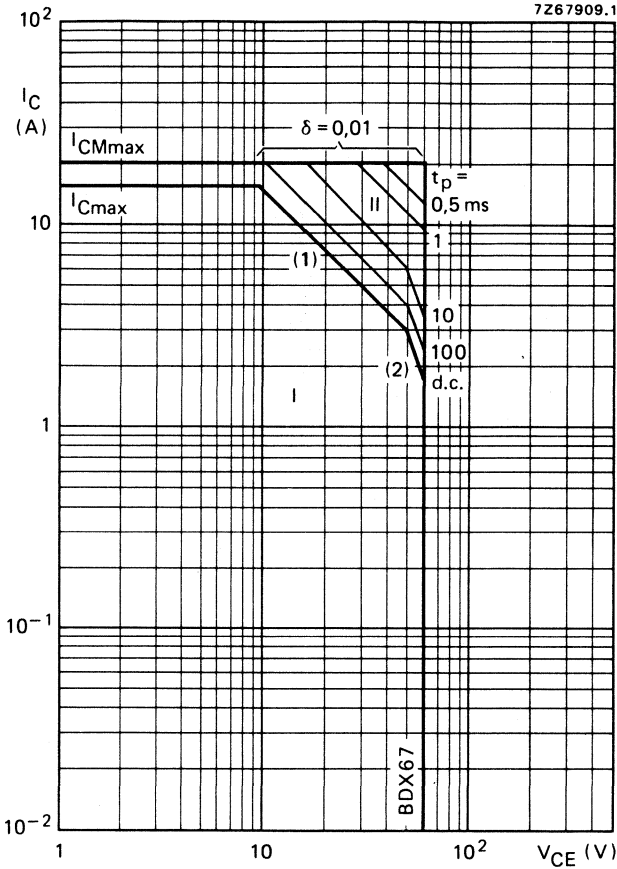


Fig. 6 Safe Operating Area at $T_{mb} = 25^\circ\text{C}$ of BDX67.

- 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).

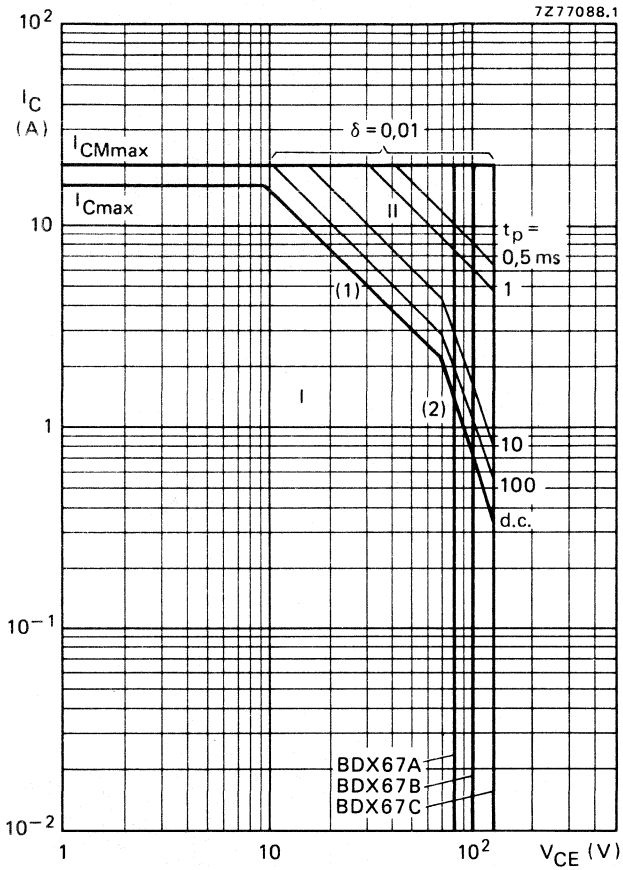


Fig. 7 Safe Operating Area at $T_{mb} = 25^\circ\text{C}$.

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).

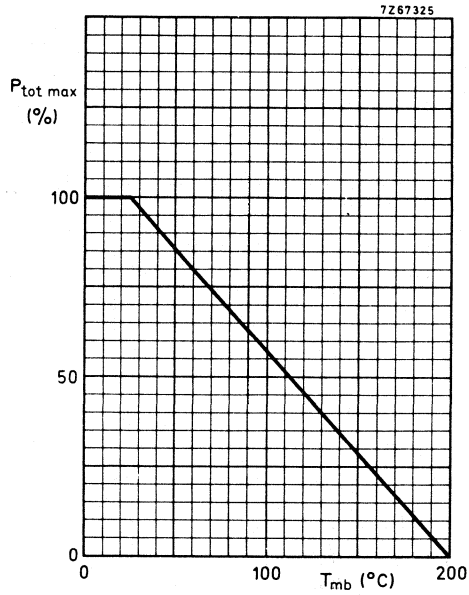


Fig. 8 Power derating curve.

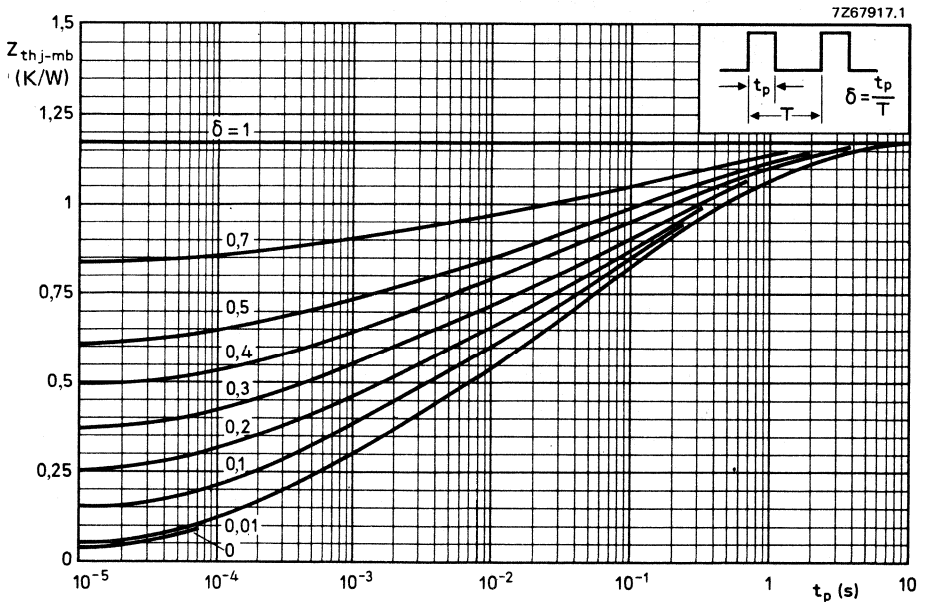


Fig. 9 Pulse power rating chart.

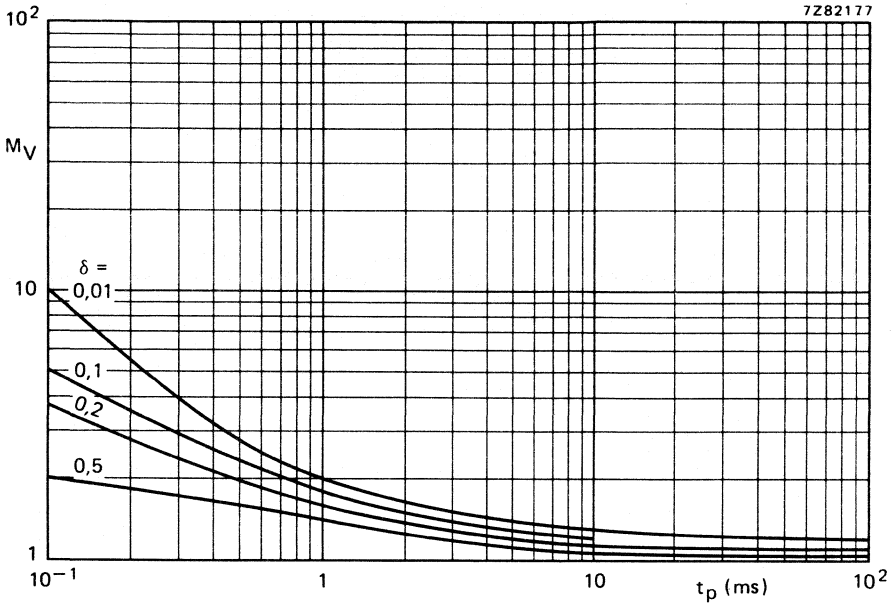


Fig. 10 S.B. voltage multiplying factor at the I_{Cmax} level.

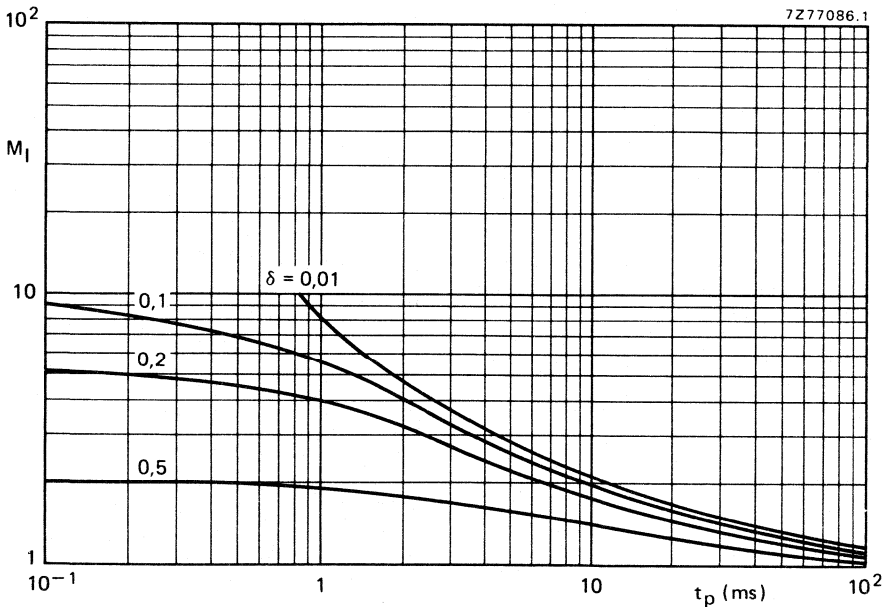


Fig. 11 S.B. current multiplying factor at the V_{CE0max} level.

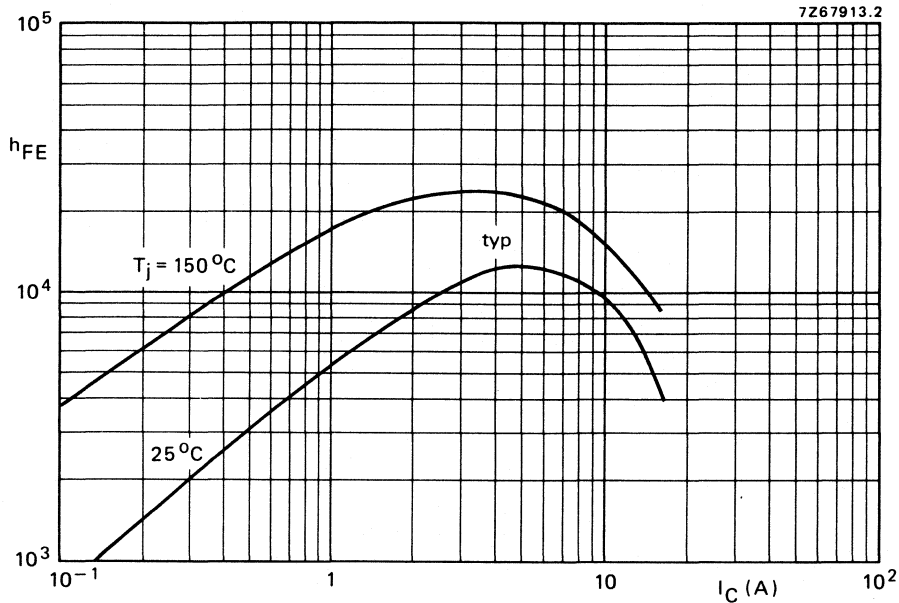


Fig. 12 D.C. current gain.

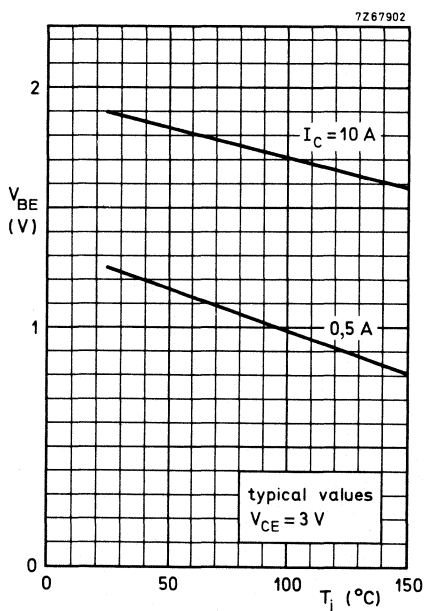


Fig. 13 Typical base-emitter voltage.

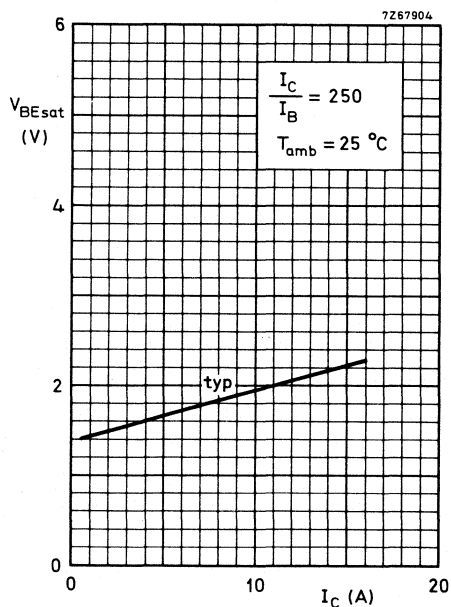


Fig. 14 Base-emitter saturation voltage.

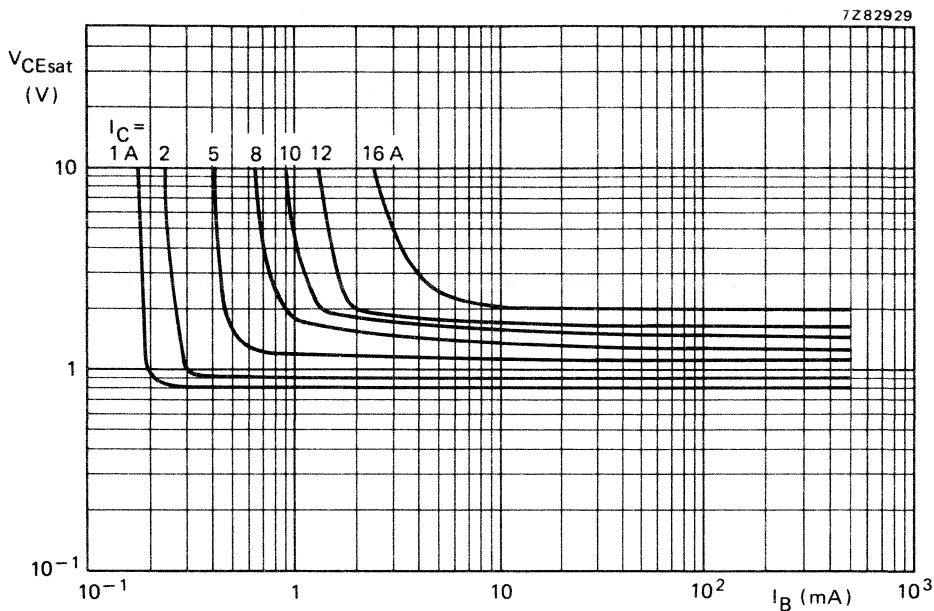


Fig. 15 Typical values collector-emitter saturation voltage at $T_j = 25$ °C.

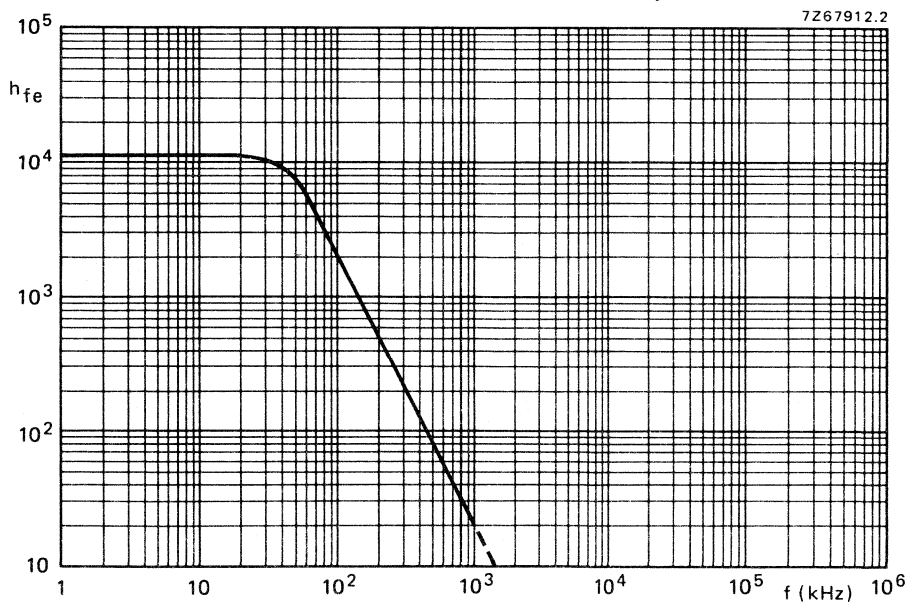


Fig. 16 Small-signal current gain, $I_C = 5$ A; $V_{CE} = 3$ V.

DARLINGTON POWER TRANSISTORS

P-N-P Darlington's for audio output stages and general amplifier and switching applications. In a TO-3 envelope. N-P-N complements are BDX69, BDX69A, BDX69B and BDX69C.

QUICK REFERENCE DATA

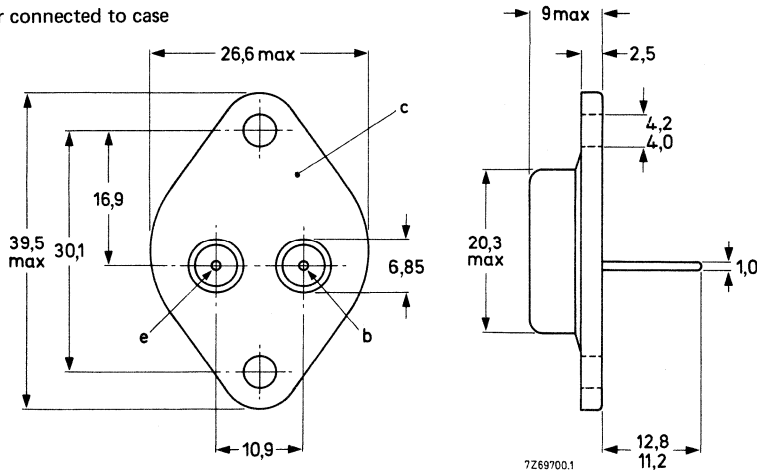
		BDX68	68A	68B	68C	
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100	120	V
Collector current (peak value)	$-I_{CM}$ max.	40				A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.	200				W
Junction temperature	T_j max.	200				$^{\circ}\text{C}$
D.C. current gain						
$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE} typ.	3000				
$-I_C = 20\text{ A}; -V_{CE} = 3\text{ V}$	h_{FE} >	1000				
Cut-off frequency						
$-I_C = 10\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe} typ.	60				kHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.

Collector connected to case



See also chapters Mounting instructions and Accessories.

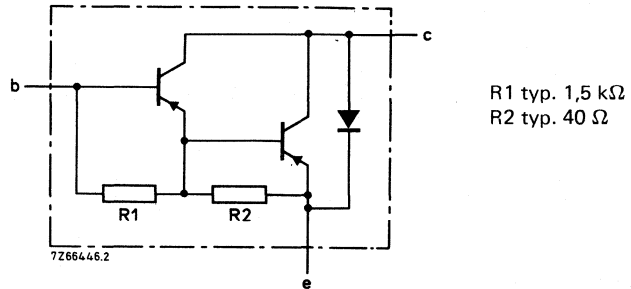


Fig. 2 Circuit diagram.

RATINGS

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

			BDX68	68A	68B	68C	
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.		25			A
Collector current (peak value)	$-I_{CM}$	max.		40			A
Base current	$-I_B$	max.		500			mA
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.		200			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	$R_{th\ j-mb}$	=		0,875			K/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

$$I_E = 0; -V_{CB} = -V_{CB0max} \quad -I_{CBO} < 2\text{ mA}$$

$$I_E = 0; -V_{CB} = -\frac{1}{2}V_{CB0max}; T_j = 200\text{ }^\circ\text{C} \quad -I_{CBO} < 10\text{ mA}$$

$$I_B = 0; -V_{CE} = -\frac{1}{2}V_{CE0max} \quad -I_{CEO} < 6\text{ mA}$$

Emitter cut-off current

$$I_C = 0; -V_{EB} = 5\text{ V} \quad -I_{EBO} < 10\text{ mA}$$

D.C. current gain*

$$-I_C = 5\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 3000$$

$$-I_C = 20\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} > 1000$$

$$-I_C = 30\text{ A}; -V_{CE} = 3\text{ V} \quad h_{FE} \text{ typ. } 1000$$

Base-emitter voltage*

$$-I_C = 20\text{ A}; -V_{CE} = 3\text{ V} \quad -V_{BE} < 2,5\text{ V}$$

Collector-emitter saturation voltage*

$$-I_C = 20\text{ A}; -I_B = 80\text{ mA} \quad -V_{CEsat} < 2\text{ V}$$

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

$$I_E = I_e = 0; -V_{CB} = 10\text{ V} \quad C_c \text{ typ. } 600\text{ pF}$$

Cut-off frequency

$$-I_C = 10\text{ A}; -V_{CE} = 3\text{ V} \quad f_{hfe} \text{ typ. } 60\text{ kHz}$$

Small-signal current gain

$$-I_C = 10\text{ A}; -V_{CE} = 3\text{ V}; f = 1\text{ MHz} \quad h_{fe} \text{ typ. } 20$$

Diode, forward voltage

$$I_F = 20\text{ A} \quad V_F \text{ typ. } 2,0\text{ V}$$

Switching times

(between 10% and 90% levels)

$$-I_{Con} = 20\text{ A}; -I_{Bon} = I_{Boff} = 80\text{ mA} \quad \text{turn-on time} \quad t_{on} \text{ typ. } 1\text{ }\mu\text{s}$$

$$\text{turn-off time} \quad t_{off} \text{ typ. } 3,5\text{ }\mu\text{s}$$

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

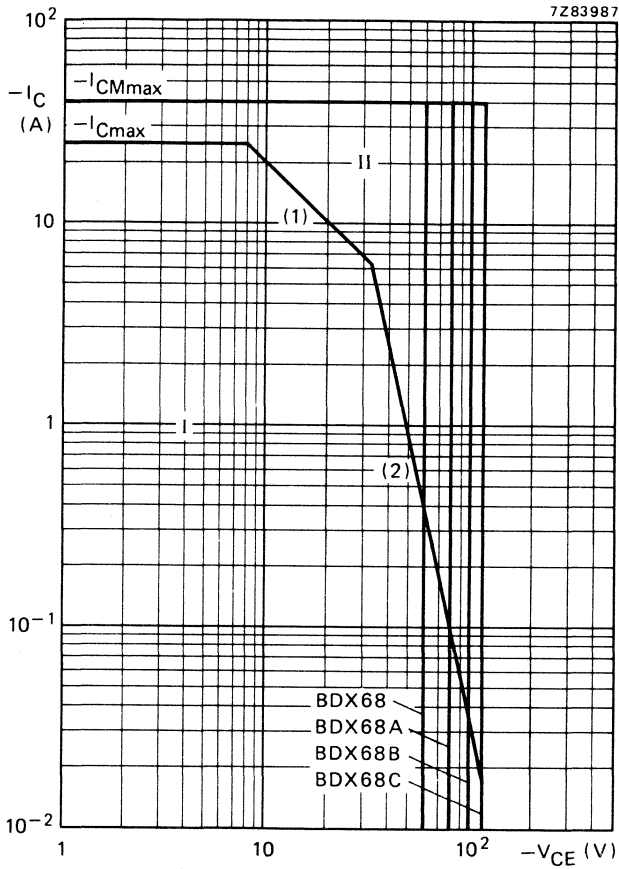


Fig. 3 Safe Operating Area.

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).

DARLINGTON POWER TRANSISTORS

N-P-N Darlington transistors for audio output stages and general amplifier and switching applications. In TO-3 envelope. P-N-P complements are BDX68, BDX68A, BDX68B and BDX68C.

QUICK REFERENCE DATA

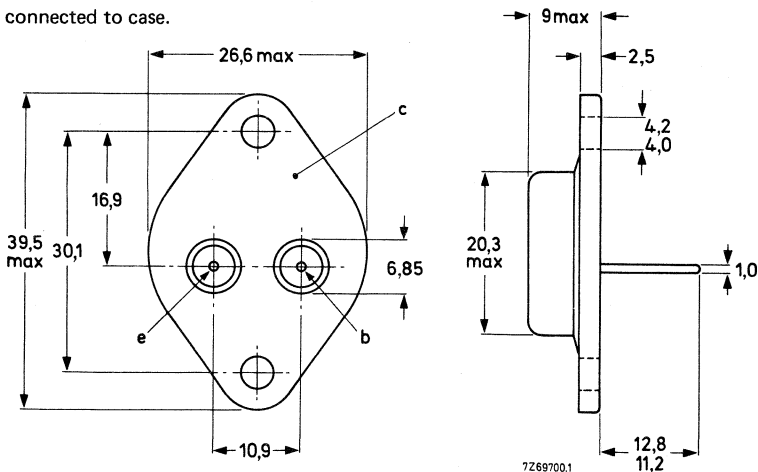
		BDX69	69A	69B	69C		
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.	40			A	
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	200			W	
Junction temperature	T_j	max.	200			$^{\circ}\text{C}$	
D.C. current gain							
$I_C = 5\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	typ.	3000				
$I_C = 20\text{ A}; V_{CE} = 3\text{ V}$	h_{FE}	>	1000				
Cut-off frequency							
$I_C = 10\text{ A}; V_{CE} = 3\text{ V}$	f_{hfe}	typ.	50			kHz	

MECHANICAL DATA

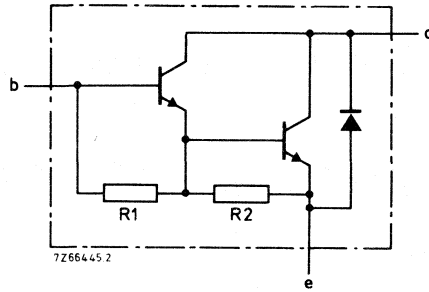
Dimensions in mm

Fig. 1 TO.3.

Collector connected to case.



See also chapters Mounting Instructions and Accessories



R1 typ. 1,5 kΩ
R2 typ. 40 Ω

Fig. 2 Circuit diagram.

RATINGS

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

			BDX69	69A	69B	69C	
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.	25				A
Collector current (peak value)	I_{CM}	max.	40				A
Base current (d.c.)	I_B	max.	500				mA
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	200				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	$R_{th\ j-mb}$	=	0,875	K/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

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

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

$I_E = 0; V_{CB} = \frac{1}{2}V_{CB0\max}; T_j = 200\text{ }^\circ\text{C}$

$I_{CBO} < 10\text{ mA}$

$I_B = 0; V_{CE} = \frac{1}{2}V_{CE0\max}$

$I_{CEO} < 6\text{ mA}$

Emitter cut-off current

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

$I_{EBO} < 10\text{ mA}$

D.C. current gain*

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

$h_{FE} \text{ typ. } 3000$

$I_C = 20\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} > 1000$

$I_C = 30\text{ A}; V_{CE} = 3\text{ V}$

$h_{FE} \text{ typ. } 4000$

Base-emitter voltage*

$I_C = 20\text{ A}; V_{CE} = 3\text{ V}$

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

Collector-emitter saturation voltage*

$I_C = 20\text{ A}; I_B = 80\text{ mA}$

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

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

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_c \text{ typ. } 600\text{ pF}$

Cut-off frequency

$I_C = 10\text{ A}; V_{CE} = 3\text{ V}$

$f_{hfe} \text{ typ. } 50\text{ kHz}$

Small-signal current gain

$I_C = 10\text{ A}; V_{CE} = 3\text{ V}; f = 1\text{ MHz}$

$h_{fe} \text{ typ. } 20$

Diode, forward voltage

$I_F = 20\text{ A}$

$V_F \text{ typ. } 2,5\text{ V}$

Switching times

(between 10% and 90% levels)

$I_{Con} = 20\text{ A}; I_{Bon} = -I_{Boff} = 80\text{ mA}$

turn-on time

$t_{on} \text{ typ. } 1\text{ }\mu\text{s}$

turn-off time

$t_{off} \text{ typ. } 3,5\text{ }\mu\text{s}$

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

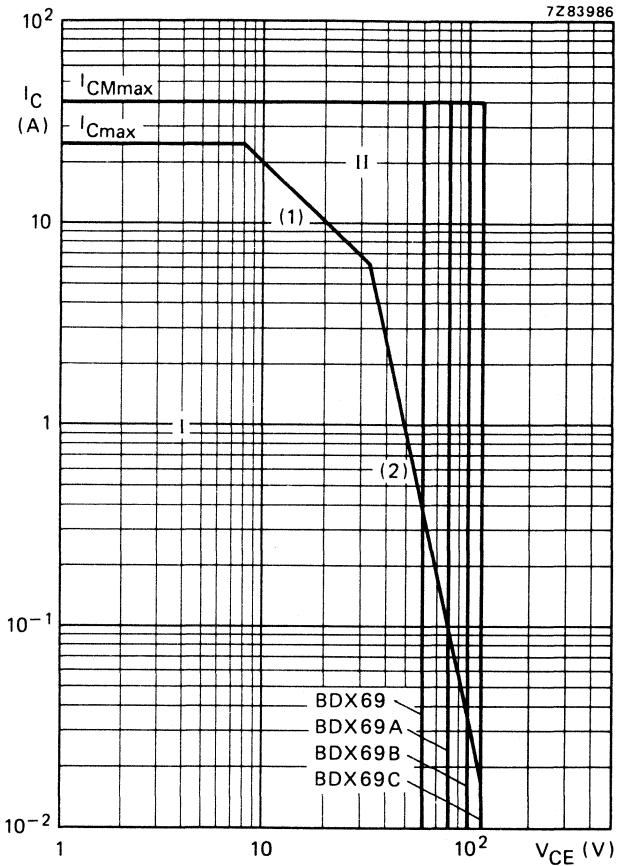


Fig. 3 Safe Operating Area at $T_{mb} = 25^\circ\text{C}$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(1) P_{tot} max line.

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

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

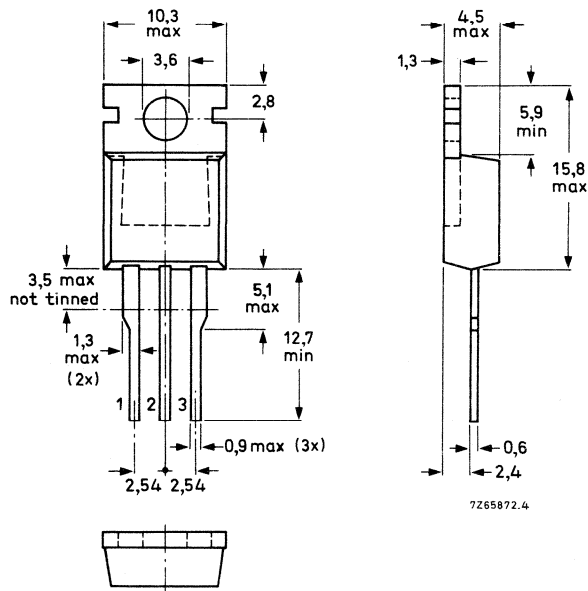
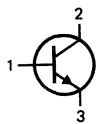
Collector-emitter voltage (open base)	V_{CEO}	max.	80 V
Collector-base voltage (open emitter)	V_{CBO}	max.	100 V
Collector current (d.c.)	I_C	max.	8 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	60 W
D.C. current gain $I_C = 2\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	>	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



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.	100 V
Collector-emitter voltage (open base)	V_{CE0}	max.	80 V
Emitter-base voltage (open collector)	V_{EB0}	max.	5 V
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 (surge) ($t_p \leq 2$ ms)	I_{CS}	max.	25 A
Base current (d.c.)	I_B	max.	3 A
Storage temperature	T_{stg}		-65 to +150 °C
Junction temperature	T_j	max.	150 °C
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	60 W

THERMAL RESISTANCE

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

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current

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

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

$$I_E = 0; V_{CB} = 70\text{ V}; T_j = 150\text{ °C}$$

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

$$I_E = 0; V_{CB} = 100\text{ V}$$

$$I_{CBO} < 0,1\text{ mA}$$

Emitter cut-off current

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

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

Base-emitter voltage*

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

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

Knee voltage*

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

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

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

Saturation voltages

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

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

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

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

$$I_C = 6\text{ A}; I_B = 0,6\text{ A}$$

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

$$I_C = 6\text{ A}; I_B = 0,6\text{ A}$$

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

D.C. current gain*

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

$$h_{FE} > 30$$

Cut-off frequency

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

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

* Measured under pulse conditions; $t_p \leq 300\text{ }\mu\text{s}$; $\delta \leq 2\%$.

Transition frequency at $f = 1$ MHz $-I_E = 0,3$ A; $V_{CB} = 3$ V	f_T	>	7 MHz
Collector-emitter breakdown voltage * $I_C = 0,2$ A; $I_B = 0$	$V_{(BR)CEO}$	>	80 V
Forward bias second-breakdown collector current $V_{CE} = 50$ V; $t_p = 0,1$ s $T_{amb} = 25$ °C without heatsink	$I_{(SB)}$	>	1,2 A
Collector capacitance at $f = 1$ MHz $V_{CB} = 10$ V; $I_E = 0$	C_c	<	200 pF
Switching times (between 10% and 90% levels) $I_{Con} = 2$ A; $I_{Bon} = -I_{Boff} = 0,2$ A			
Turn-on time	t_{on}	typ.	1 μ s
Turn-off time	t_{off}	typ.	4 μ s

* Measured under pulse conditions: $t_p < 300$ μ s, $\delta < 2\%$.

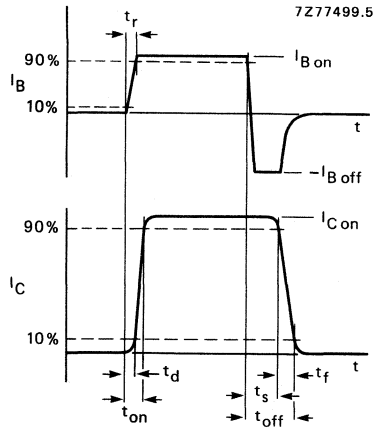


Fig. 2 Switching times waveforms.

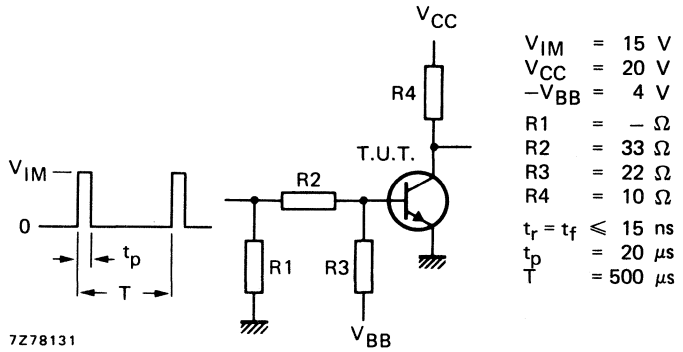


Fig. 3 Switching times test circuit.

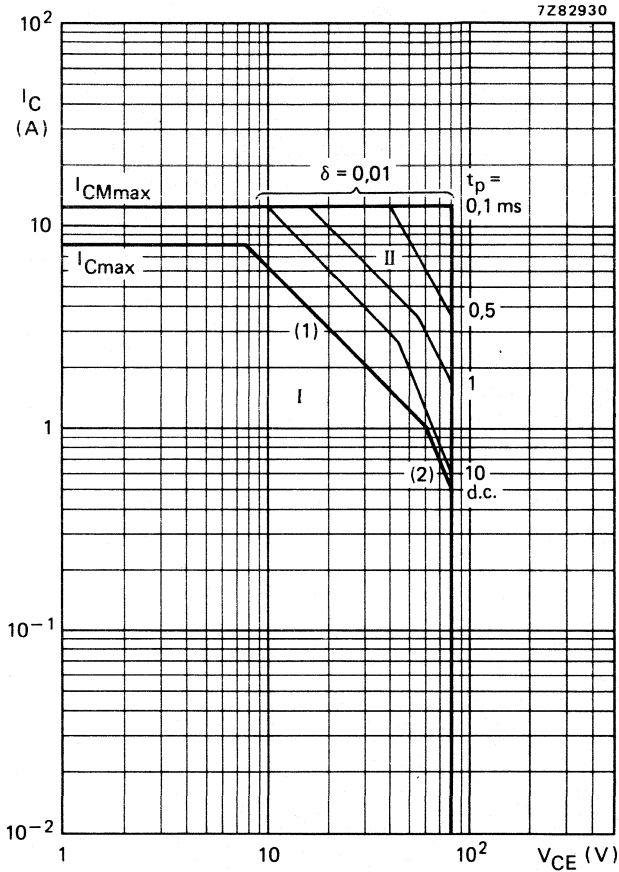


Fig. 4 Safe Operating Area at $T_{mb} \leq 25$ °C.

- 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).

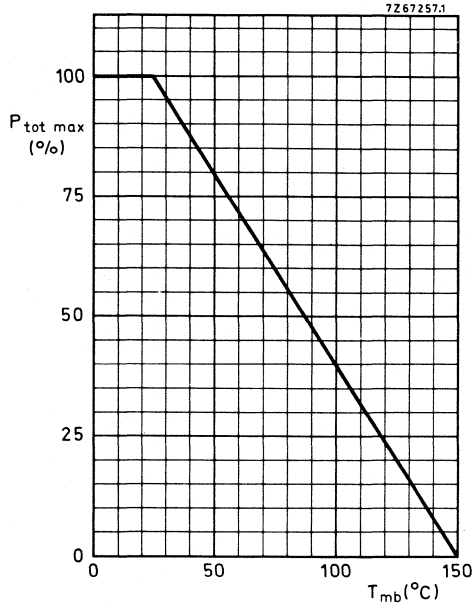


Fig. 5 Power derating curve.

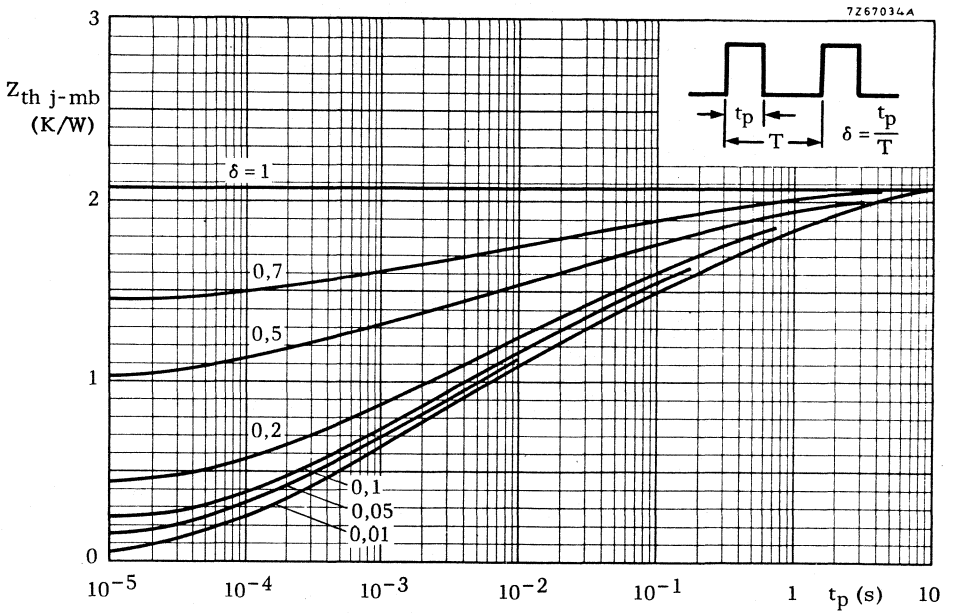


Fig. 6 Pulse power rating chart.

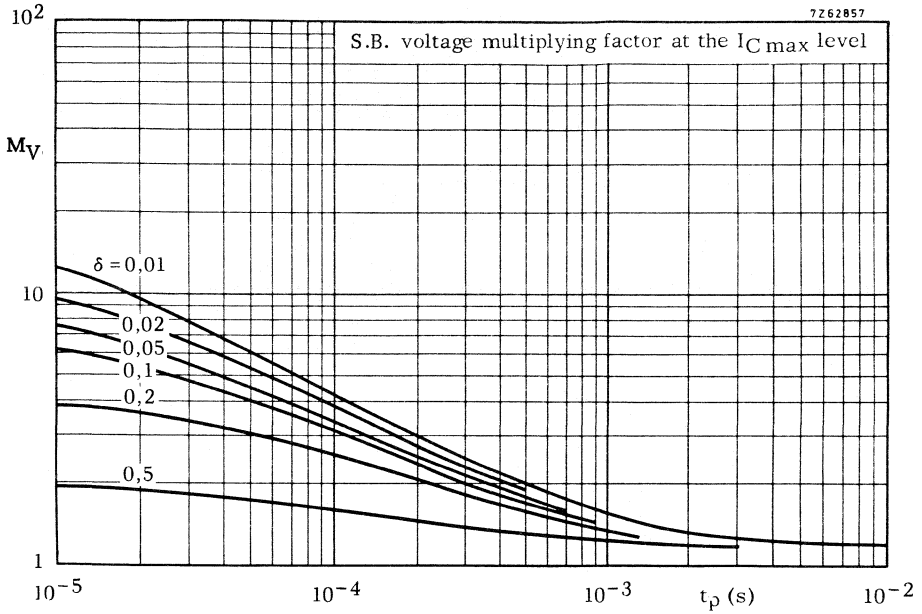


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

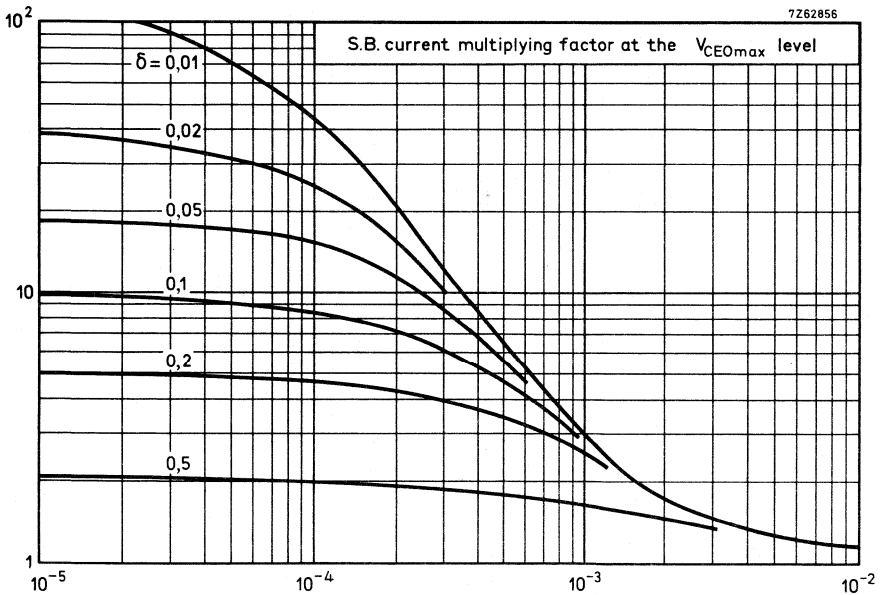


Fig. 8 S.B. current multiplying factor at the V_{CE0max} level.

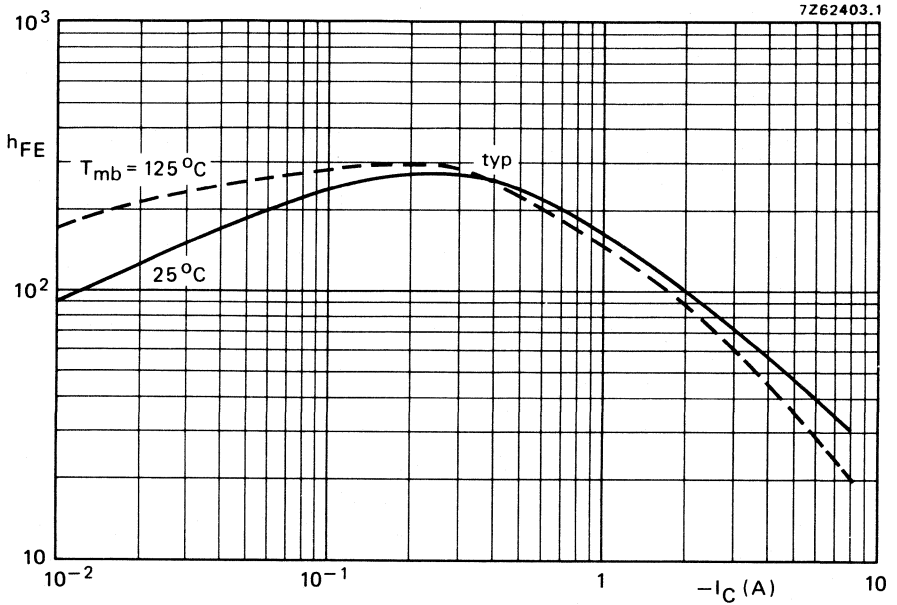


Fig. 9 D.C. current gain at $V_{CE} = 2$ V.

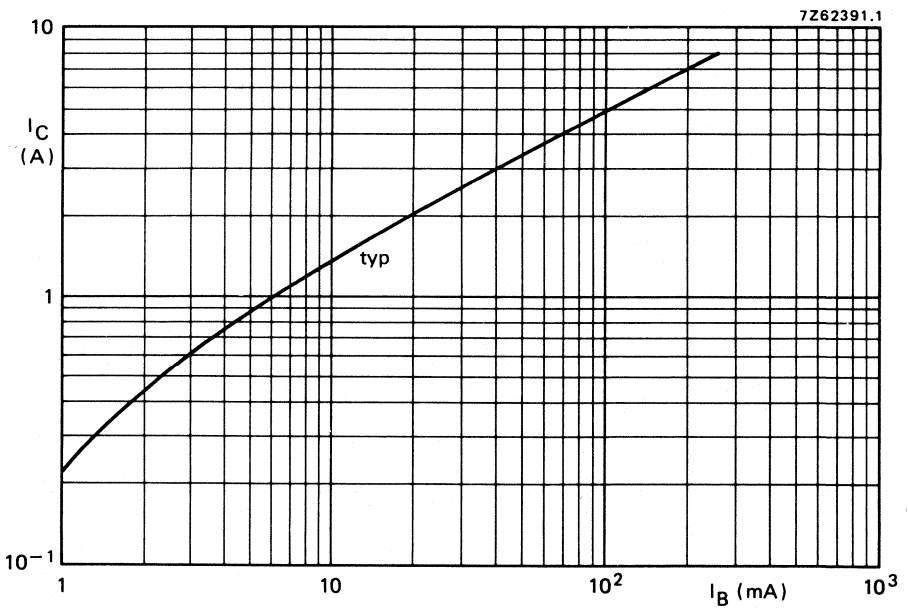


Fig. 10 Typical collector current. $T_j = 25^\circ\text{C}$; $V_{CE} = 2$ V.

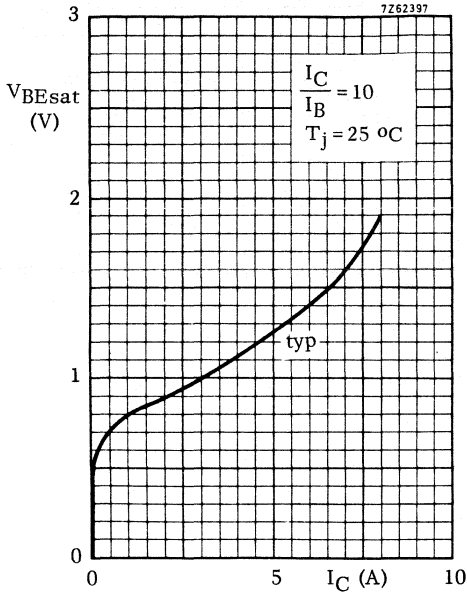


Fig. 11 Base-emitter saturation voltage.

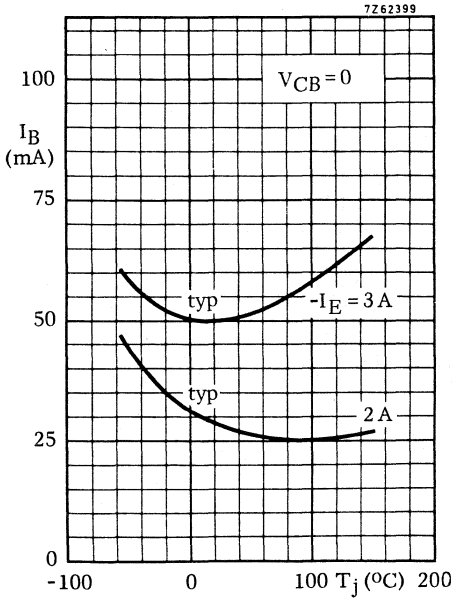


Fig. 12 Base current.

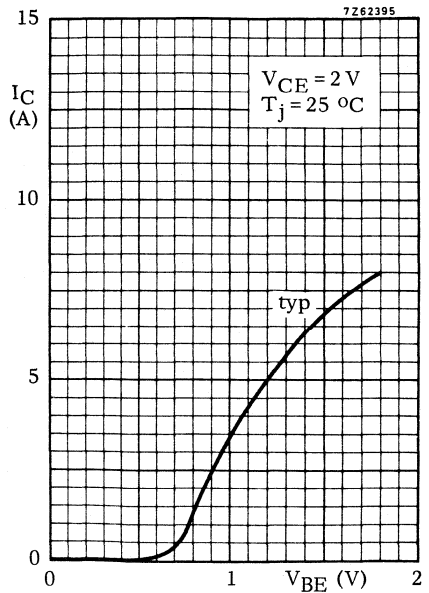


Fig. 13 Collector current.

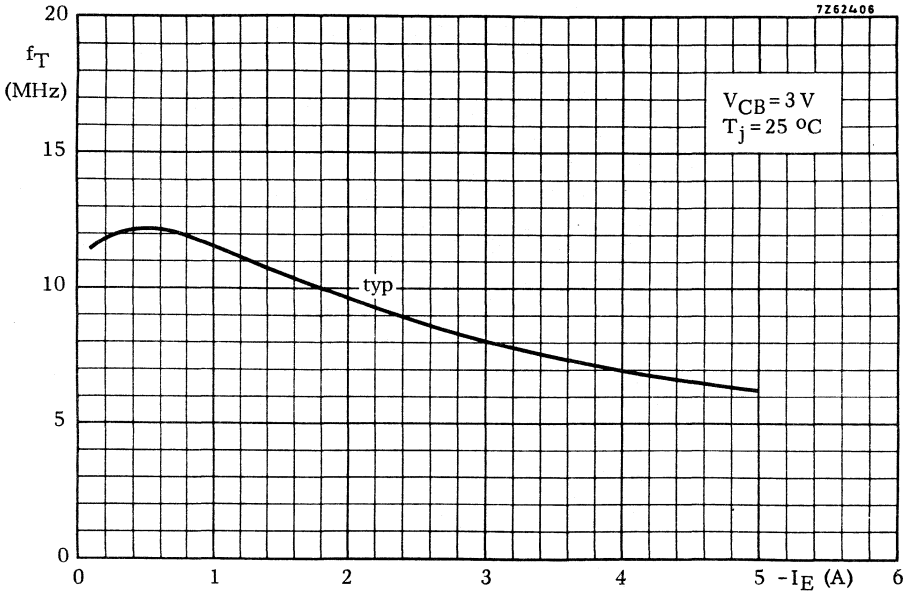


Fig. 14 Typical values transition frequency at $V_{CB} = 3\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$.

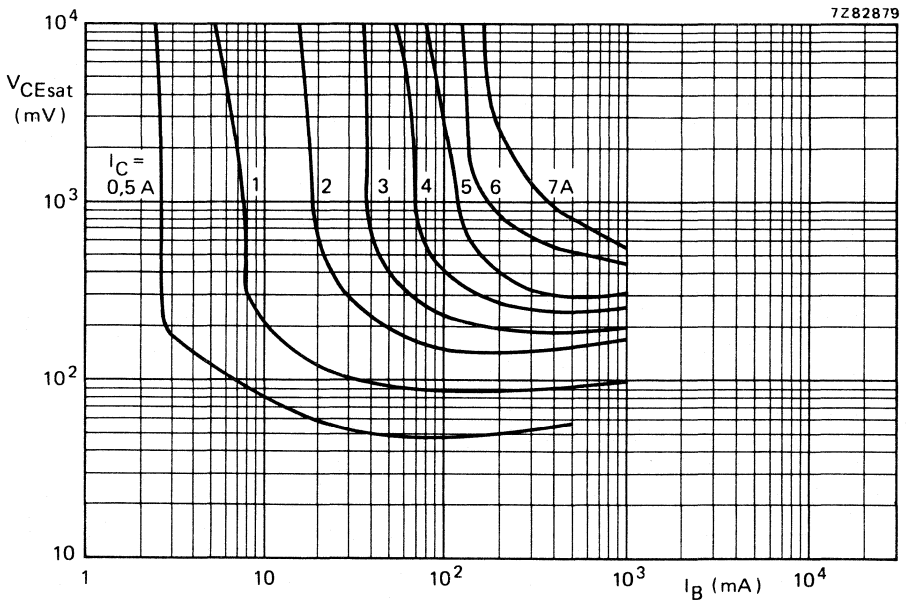


Fig. 15 Typical values collector-emitter saturation voltage at $T_j = 25\text{ }^\circ\text{C}$.

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

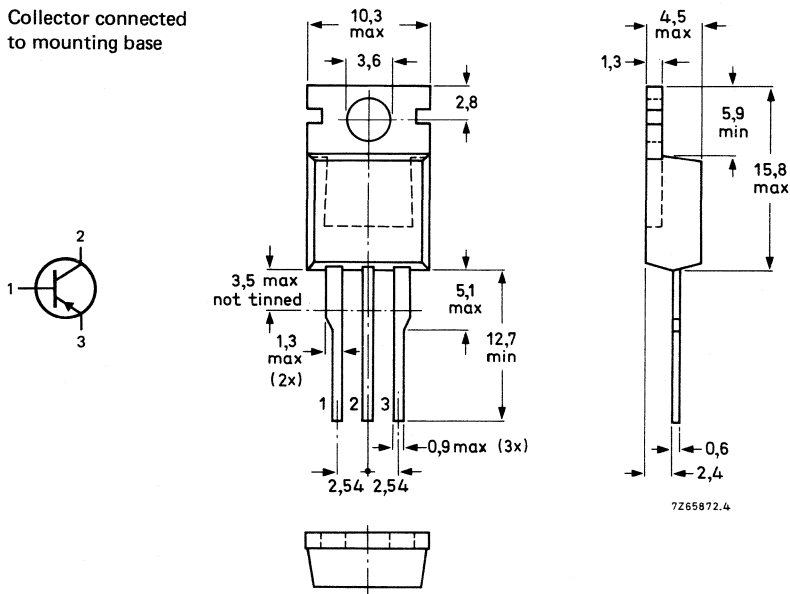
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	80 V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80 V
Collector current (d.c.)	$-I_C$	max.	8 A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	60 W
D.C. current gain			
$-I_C = 2\text{ A}; -V_{CE} = 2\text{ V}$	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

Fig. 1 TO-220

Collector connected
to mounting base



See also chapters Mounting Instructions and Accessories.

RATINGS

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	80 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V
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 (surge) $t_p \leq 2$ ms	$-I_{CS}$	max.	25 A
Base current (d.c.)	$-I_B$	max.	3 A
Storage temperature	T_{stg}		-65 to + 150 °C
Junction temperature	T_j	max.	150 °C
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	60 W

THERMAL RESISTANCE

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

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current

$I_B = 0; -V_{CE} = 30$ V	$-I_{CEO}$	<	1 mA
$I_E = 0; -V_{CB} = 70$ V; $T_j = 150$ °C	$-I_{CBO}$	<	2 mA
$I_E = 0; -V_{CB} = 100$ V	$-I_{CBO}$	<	0,1 mA

Emitter cut-off current

$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	2 mA
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Base-emitter voltage*

$-I_C = 3$ A; $-V_{CE} = 2$ V	$-V_{BE}$	<	1,5 V
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Knee voltage*

$-I_C = 3$ A; $-I_B =$ value at which			
$-I_C = 3,3$ A at $-V_{CE} = 2$ V	$-V_{CEK}$	typ.	1 V

Saturation voltages*

$-I_C = 3$ A; $-I_B = 0,3$ A	$-V_{CEsat}$	<	1 V
$-I_C = 2$ A; $-I_B = 0,2$ A	$-V_{CEsat}$	<	0,6 V
$-I_C = 6$ A; $-I_B = 0,6$ A	$-V_{CEsat}$	<	1,5 V
$-I_C = 6$ A; $-I_B = 0,6$ A	$-V_{BEsat}$	<	2 V

* Measured under pulse conditions: $t_p < 300$ μ s, $\delta < 2\%$.

Collector-emitter breakdown voltage*

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

$V_{(BR)CEO} > 80 \text{ V}$

D.C. current gain*

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

$h_{FE} > 30$

Cut-off frequency

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

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

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

$-I_E = 0,3 \text{ A}; -V_{CB} = 3 \text{ V}$

$f_T > 7 \text{ MHz}$

Forward bias second-breakdown collector current

$-V_{CE} = 50 \text{ V}; t_p = 0,1 \text{ s}; T_{amb} = 25 \text{ }^\circ\text{C}$

$I_{(SB)} > 1,2 \text{ A}$

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

$-V_{CB} = 10 \text{ V}; I_E = 0$

$C_c < 200 \text{ pF}$

Switching times

(between 10% and 90% levels)

$-I_{Con} = 2 \text{ A}; -I_{Bon} = I_{Boff} = 0,2 \text{ A};$

turn-on time

$t_{on} \text{ typ. } 1 \text{ } \mu\text{s}$

turn-off time

$t_{off} \text{ typ. } 2 \text{ } \mu\text{s}$

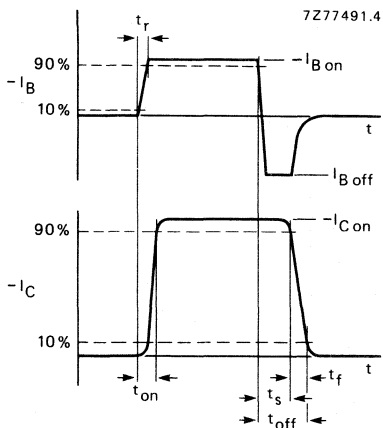


Fig. 2 Switching times waveforms.

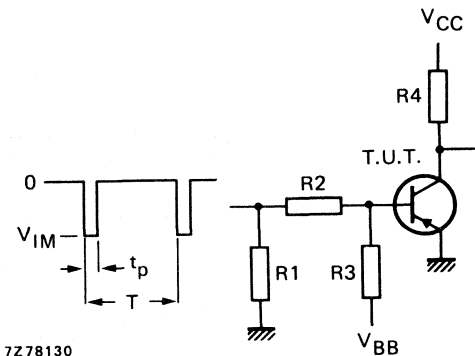


Fig. 3 Switching times test circuit.

$-V_{IM} = 15 \text{ V}$	$R1 = 56 \text{ } \Omega$	$t_r = t_f = 15 \text{ ns}$
$-V_{CC} = 20 \text{ V}$	$R2 = 33 \text{ } \Omega$	$t_p = 10 \text{ } \mu\text{s}$
$+V_{BB} = 4 \text{ V}$	$R3 = 22 \text{ } \Omega$	$T = 500 \text{ } \mu\text{s}$
	$R4 = 10 \text{ } \Omega$	

* Measured under pulse conditions $t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 2\%$.

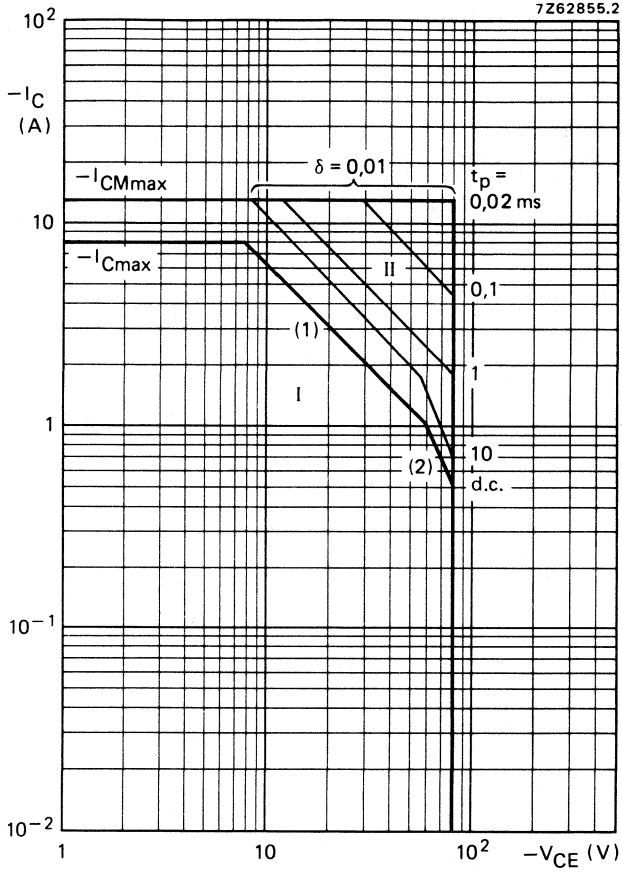


Fig. 4 Safe Operating Area at $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

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

- (1) $P_{tot \text{ max}}$ and $P_{tot \text{ peak max}}$ lines.
- (2) Second-breakdown limits (independent of temperature).

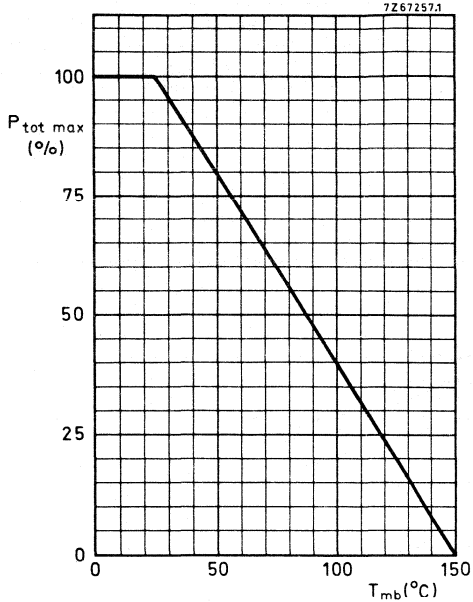


Fig. 5 Power derating curve.

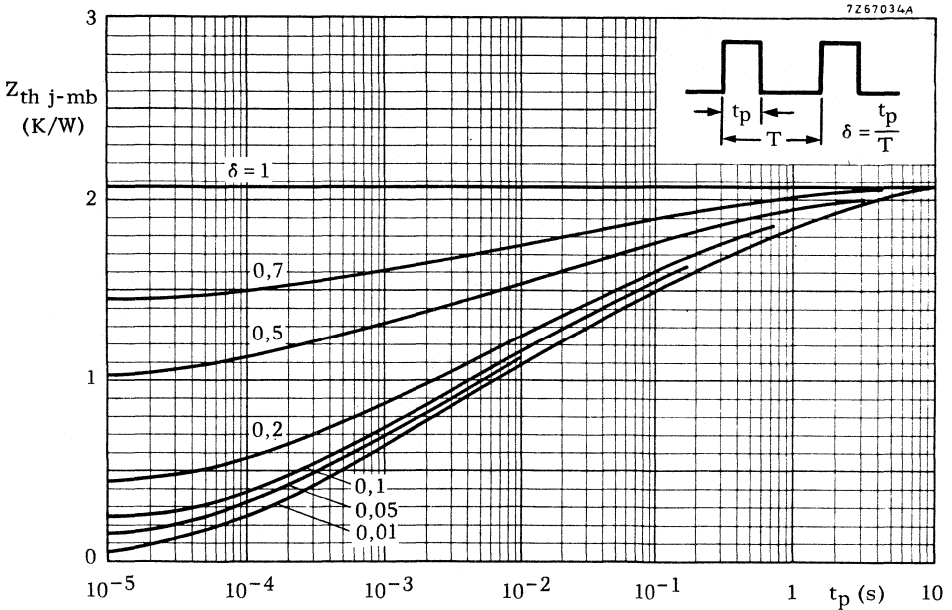


Fig. 6 Pulse power rating chart.

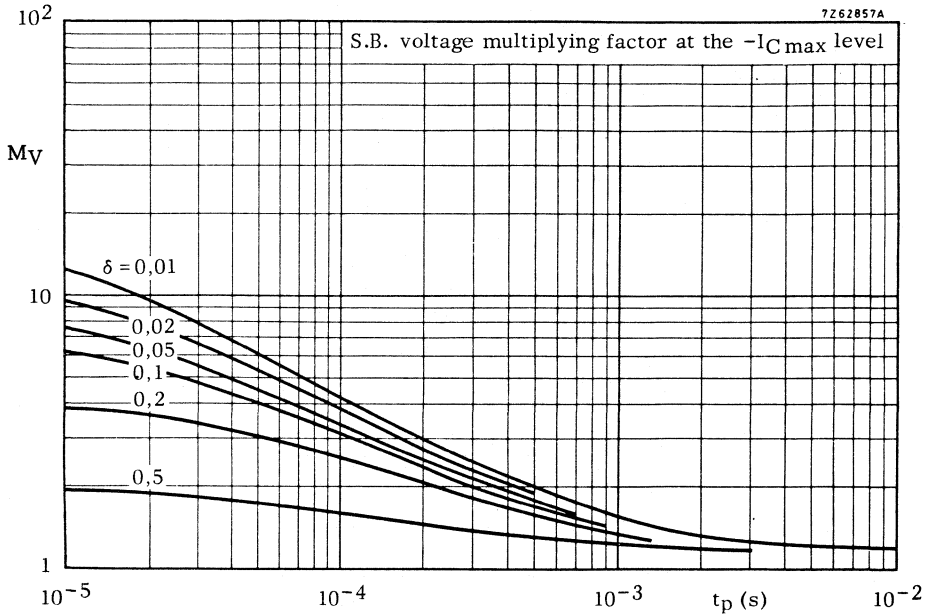


Fig. 7 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

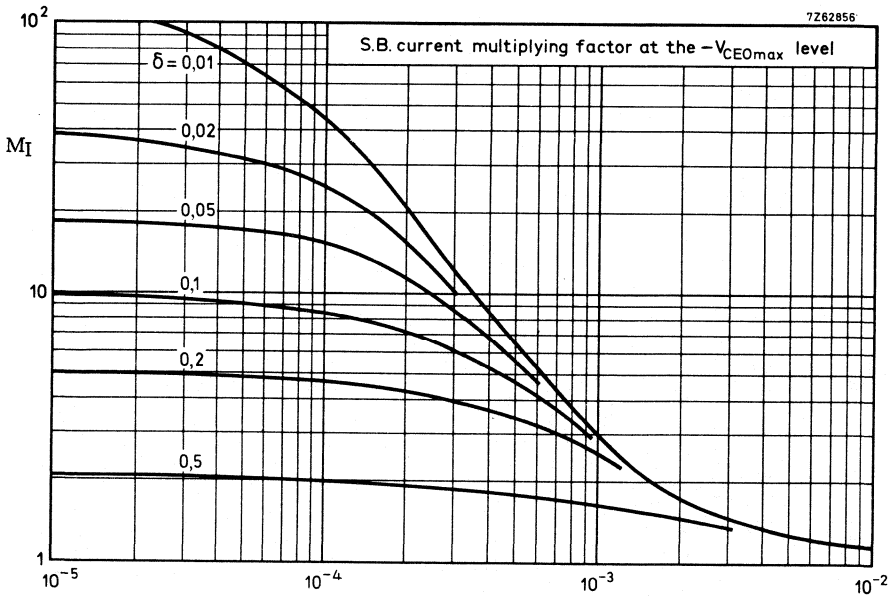


Fig. 8 S.B. current multiplying factor at the $-V_{CE0max}$ level.

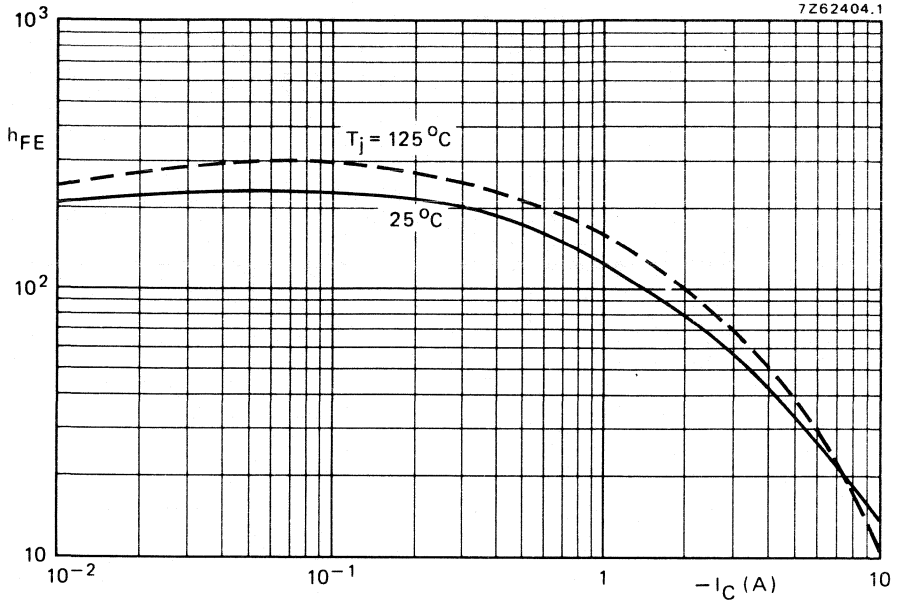


Fig. 9 D.C. current gain at $-V_{CE} = 2\text{ V}$.

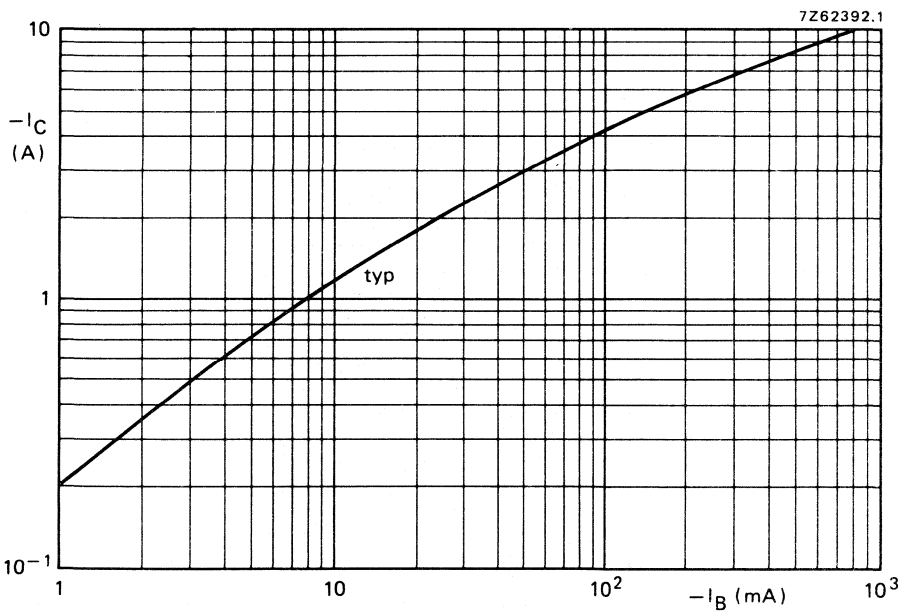


Fig. 10 Typical values collector current. $-V_{CE} = 2\text{ V}$; $T_j = 25^\circ\text{C}$.

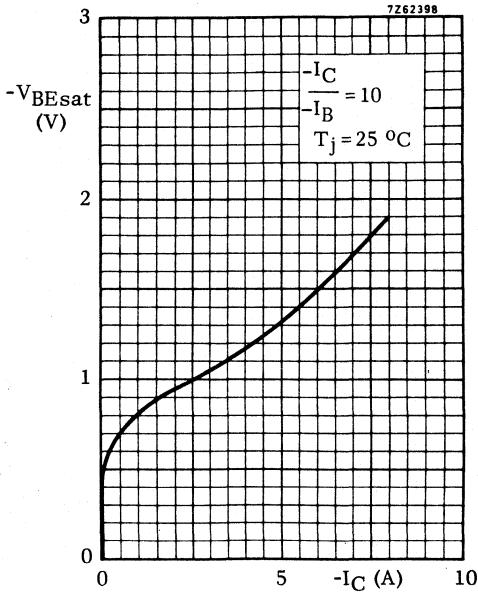


Fig. 11 Base-emitter saturation voltage.

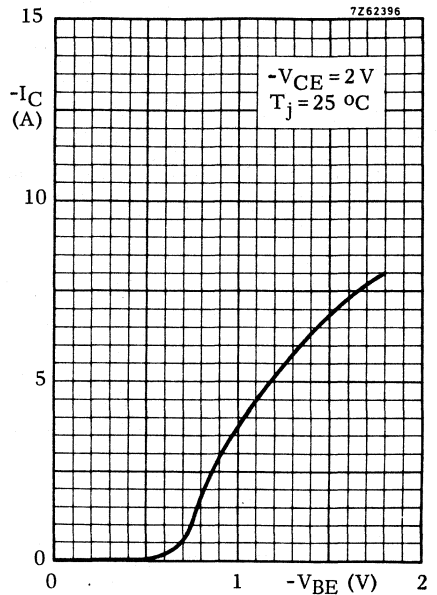


Fig. 12 Collector current.

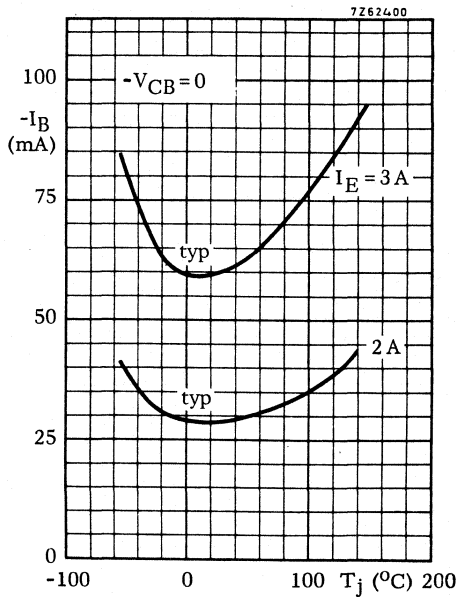


Fig. 13.

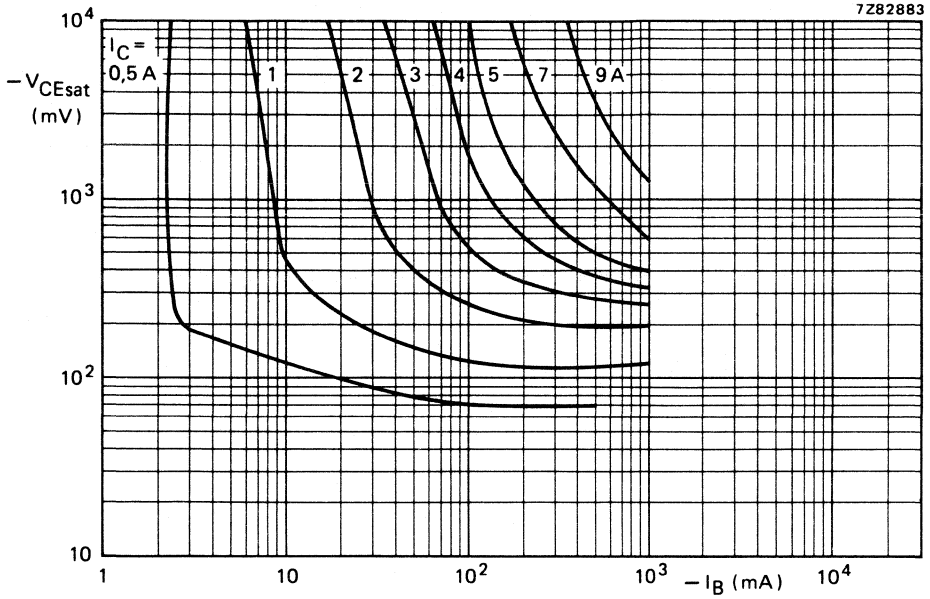


Fig. 14 Typical values collector-emitter saturation voltage at $T_j = 25^\circ\text{C}$.

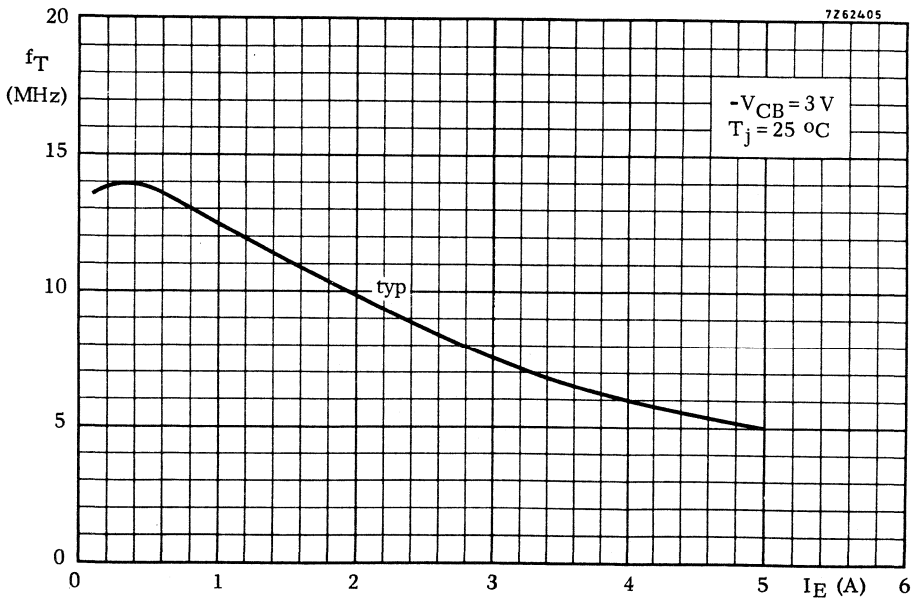


Fig. 15.

SILICON EPITAXIAL BASE 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

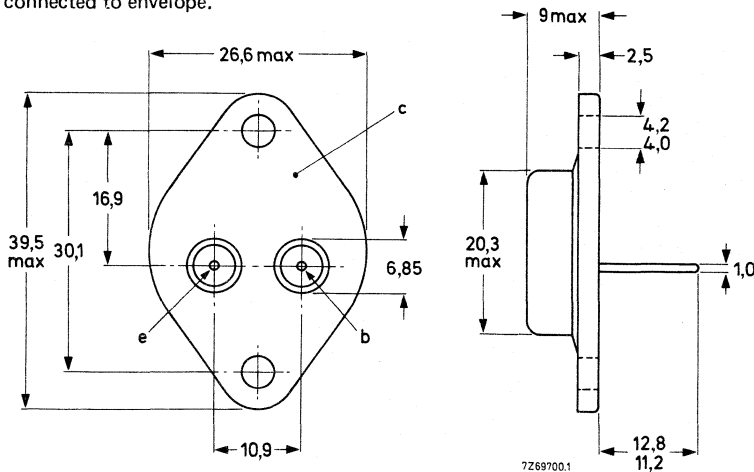
		BDX91	BDX93	BDX95
Collector-base voltage (open emitter)	V_{CBO}	max. 60	80	100 V
Collector-emitter voltage (open base)	V_{CEO}	max. 60	80	100 V
Collector current (peak value)	I_{CM}	max.	12	A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	90	W
Junction temperature	T_j	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

Fig. 1 TO-3.

Collector connected to envelope.



See also chapters Mounting Instructions and Accessories.

RATINGS

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

		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
Collector current (d.c.)	I_C	max.	8	A
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
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	K/W
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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
$I_E = 0; V_{CB} = \frac{1}{2}V_{CBOmax}; T_j = 200^\circ\text{C}$	I_{CBO}	<	2	mA
$I_B = 0; V_{CE} = V_{CEOmax}$	I_{CEO}	<	1	mA
Emitter cut-off current $I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<	1	mA
D.C. current gain* $I_C = 3\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	>	20	
$I_C = 5\text{ A}; V_{CE} = 2\text{ V}$	h_{FE}	>	10	
Base-emitter voltage* $I_C = 3\text{ A}; V_{CE} = 2\text{ V}$	V_{BE}	<	1,4	V
Collector-emitter saturation voltage* $I_C = 3\text{ A}; I_B = 0,3\text{ A}$	V_{CEsat}	<	0,8	V
$I_C = 5\text{ A}; I_B = 1\text{ A}$	V_{CEsat}	<	1	V
Base-emitter saturation voltage* $I_C = 3\text{ A}; I_B = 0,3\text{ A}$	V_{BEsat}	<	1,5	V
$I_C = 5\text{ A}; I_B = 1\text{ A}$	V_{BEsat}	<	2	V

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

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

$I_C = 1 \text{ A}; V_{CE} = 10 \text{ V}$

$f_T > 4 \text{ MHz}$

Collector-emitter breakdown voltage*

$I_C = 100 \text{ mA}$

$V_{(BR)CEO} >$	60	80	100 V
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Switching times

(between 10% and 90% levels)

$I_{Con} = 3 \text{ A}; I_{Bon} = -I_{Boff} = 0,3 \text{ A}$

Turn-on time

t_{on}	typ.	0,2	μs
	<	1	μs

Turn-off time

t_{off}	typ.	1,2	μs
	<	2	μs

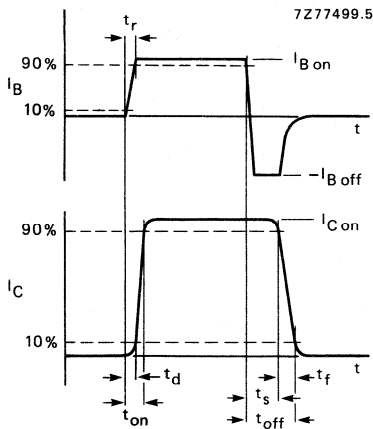
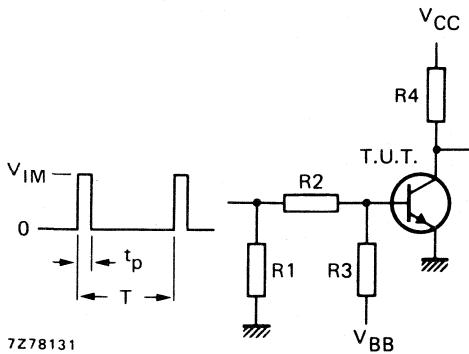


Fig. 2 Switching times waveforms.



- $V_{IM} = 55 \text{ V}$
- $V_{CC} = 30 \text{ V}$
- $-V_{BB} = 5 \text{ V}$
- $R1 = 150 \Omega$
- $R2 = 82 \Omega$
- $R3 = 20 \Omega$
- $R4 = 10 \Omega$
- $t_r = t_f \leq 15 \text{ ns}$
- $t_p = 10 \mu\text{s}$
- $T = 500 \mu\text{s}$

Fig. 3 Switching times test circuit.

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

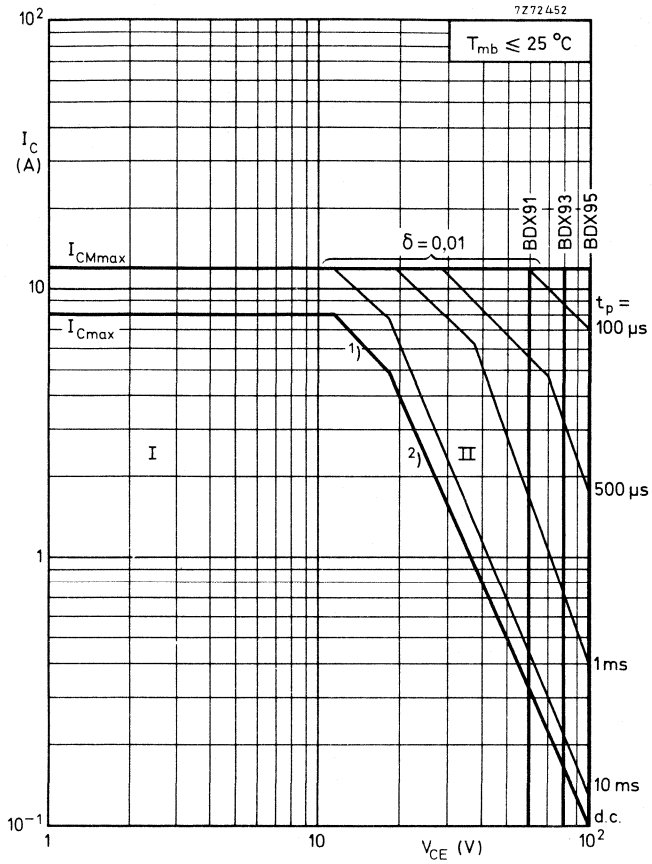


Fig. 4 Safe Operating Area at $T_{mb} \leq 25\text{ }^{\circ}\text{C}$.

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

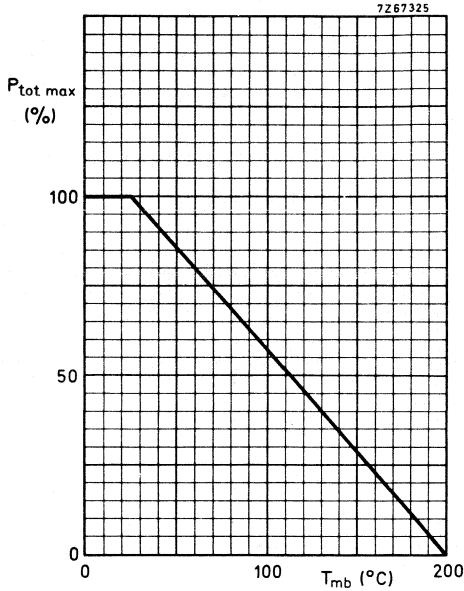


Fig. 5 Power derating curve

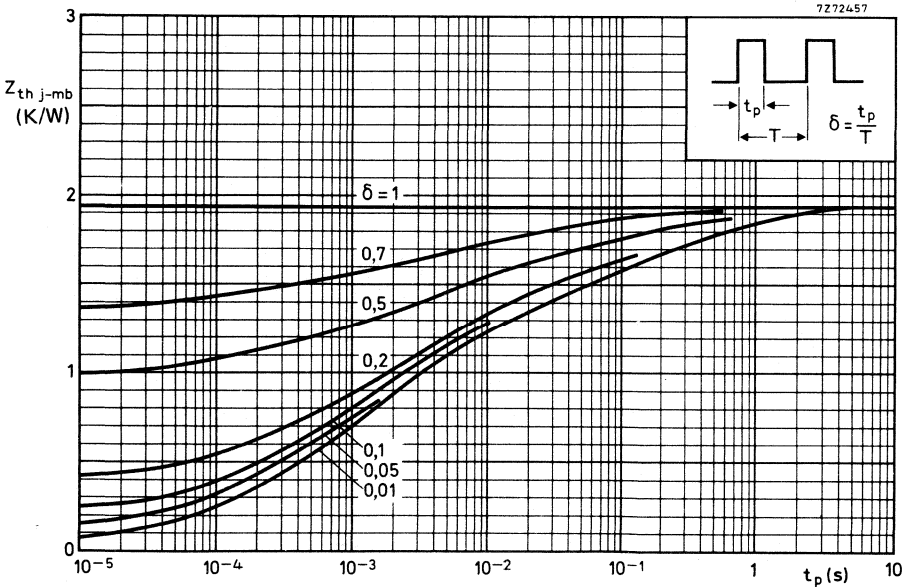


Fig. 6 Pulse power rating chart.

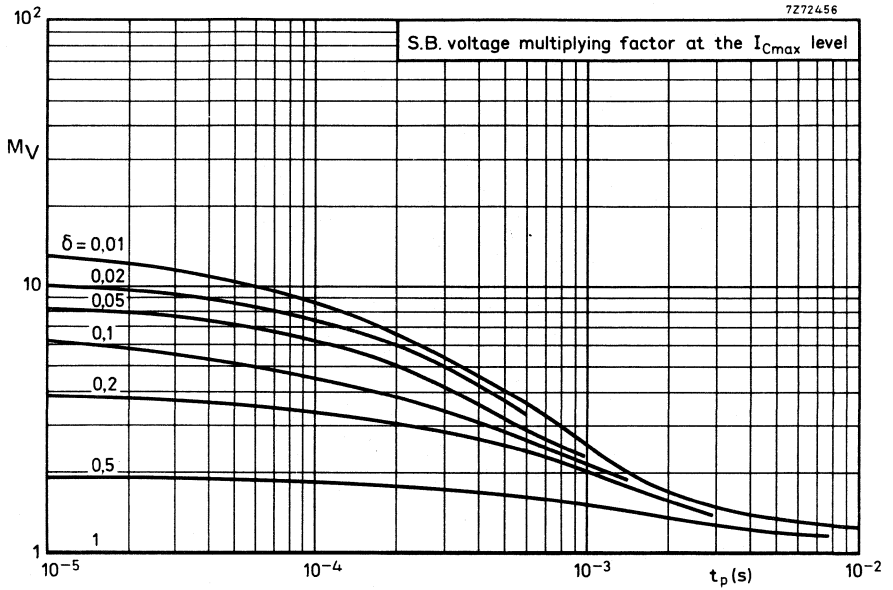


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

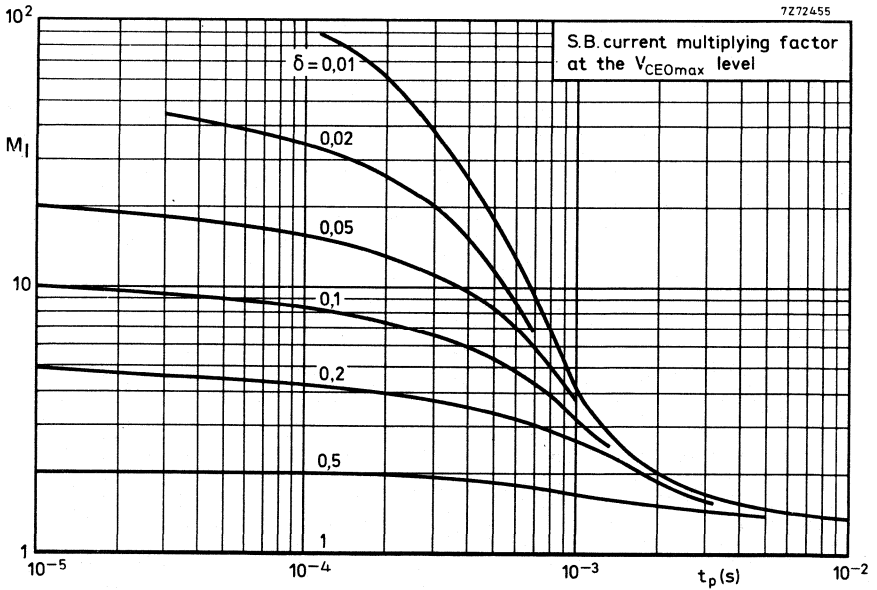


Fig. 8 S.B. current multiplying factor at the V_{CE0max} level.

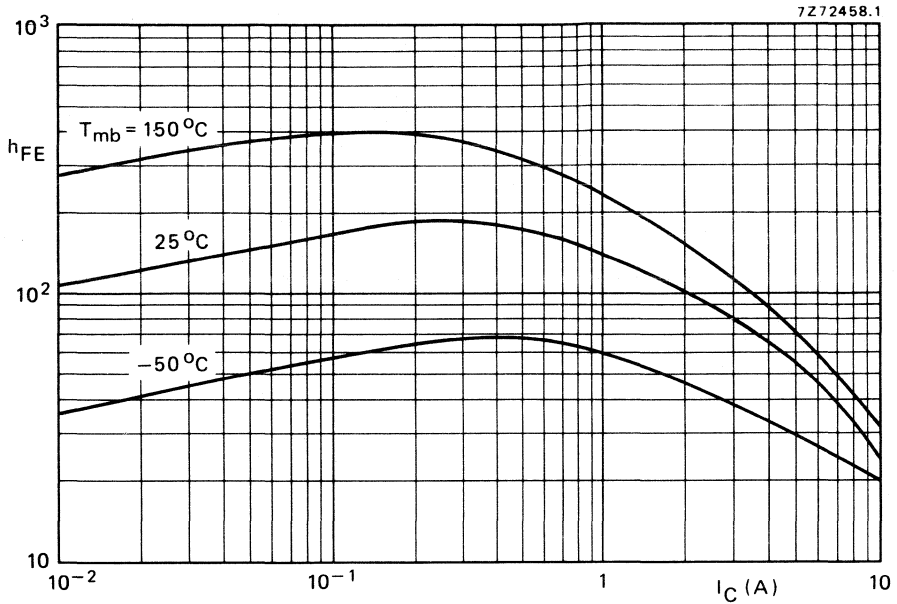


Fig. 9 D.C. current gain at $V_{CE} = 2$ V; $T_j = 25^\circ\text{C}$.

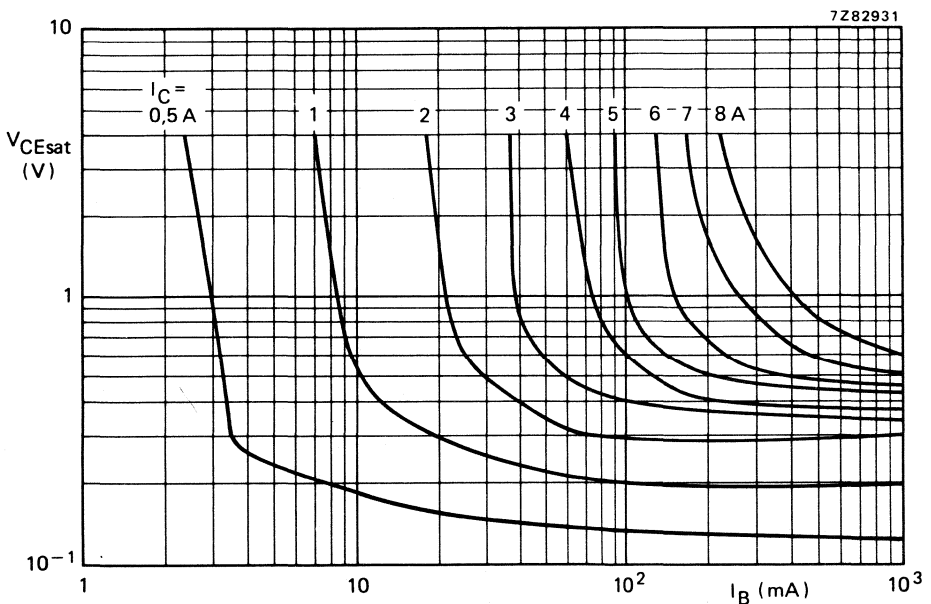


Fig. 10 Typical values collector-emitter saturation voltage.

SILICON EPITAXIAL BASE 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.

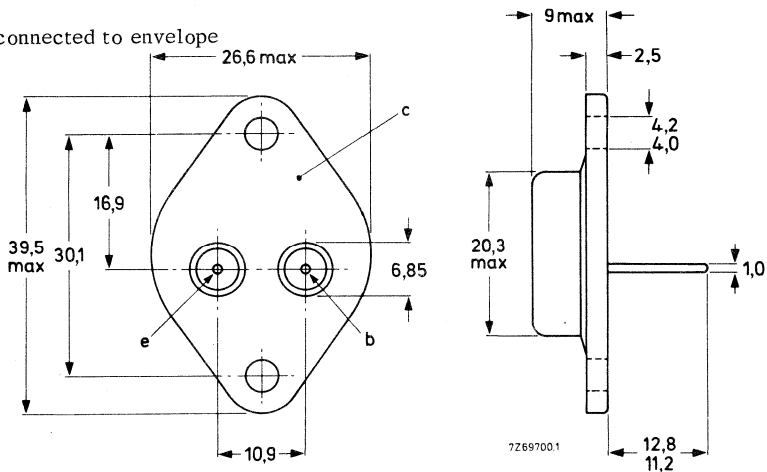
QUICK REFERENCE DATA		BDX92	BDX94	BDX96	
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	80	100	V
Collector current (peak value)	$-I_{CM}$ max.	12		A	
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot} max.	90		W	
Junction temperature	T_j max.	200		$^{\circ}\text{C}$	
D.C. current gain		20			
$-I_C = 3\text{ A}; -V_{CE} = 2\text{ V}$	h_{FE}	20			
Transition frequency		4		MHz	
$-I_C = 1\text{ A}; -V_{CE} = 10\text{ V}$	f_T	4		MHz	

MECHANICAL DATA

Dimensions in mm

TO-3

Collector connected to envelope



See also chapters Mounting instructions and Accessories.

BDX92
BDX94
BDX96

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

		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
Collector current (d. c.)	$-I_C$ max.		8		A
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
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		K/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
$I_E = 0; -V_{CB} = 30\text{ V}; T_j = 200\text{ }^\circ\text{C}; \text{BDX92}$	$-I_{CBO}$	<	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
---------------------------------	------------	---	---	----

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
---	-----------	---	-----	---

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
--	----------	---	----

Transition frequency

$-I_C = 1\text{ A}; -V_{CE} = 10\text{ V}$	f_T	>	4	MHz
--	-------	---	---	-----

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

BDX92
BDX94
BDX96

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

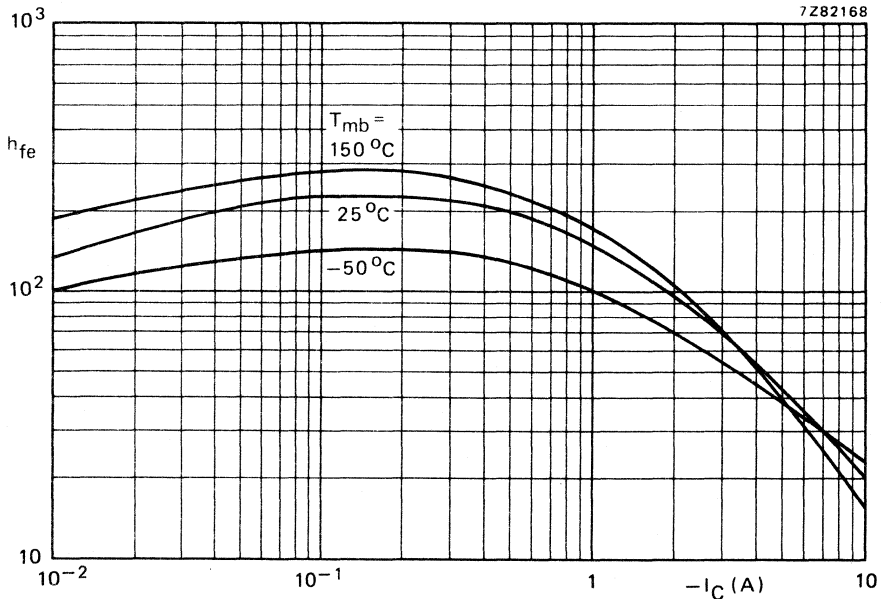
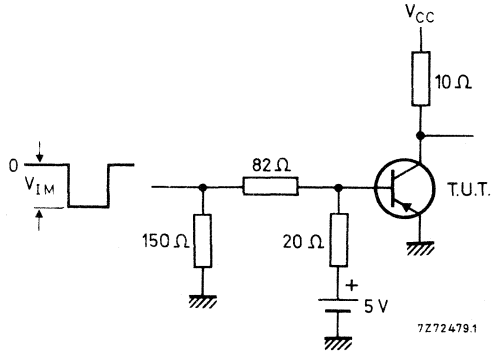
t_{on} typ. 0,2 μs
 < 1 μs

Turn-off time

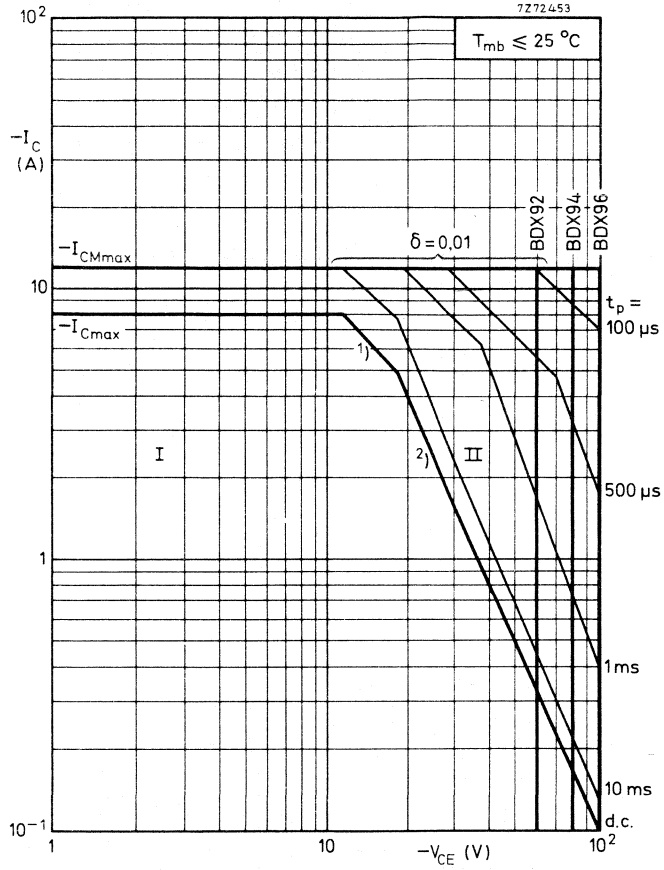
t_{off} typ. 1 μs
 < 2 μs

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

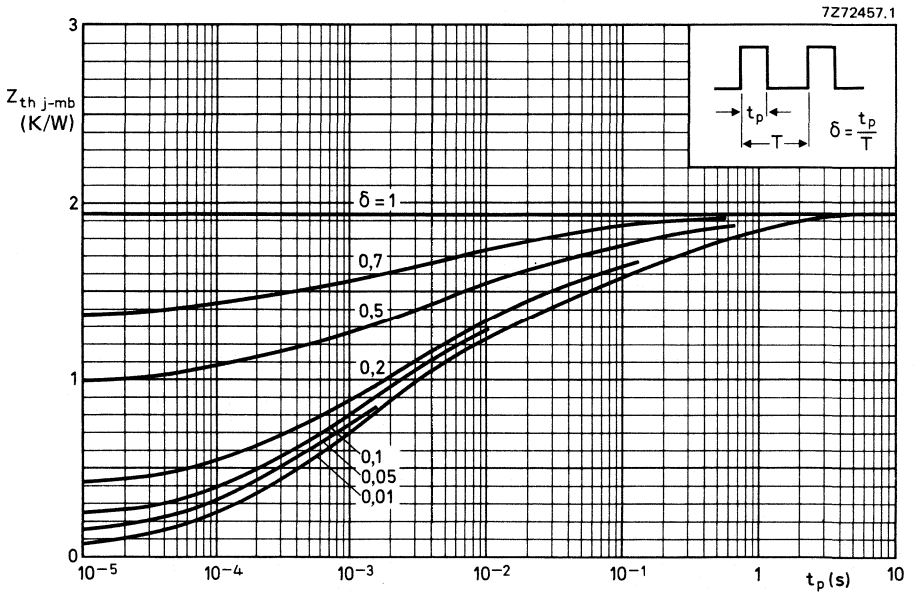
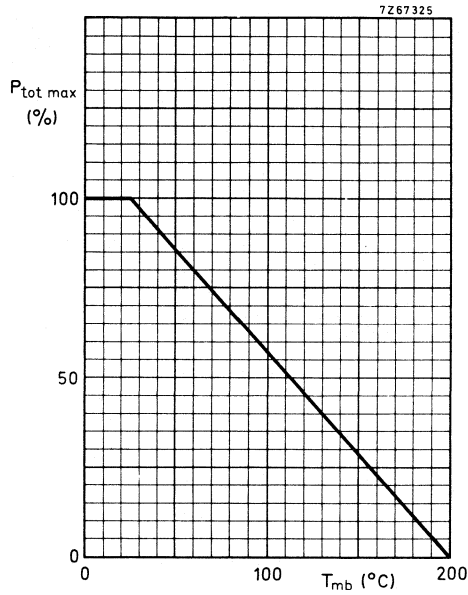
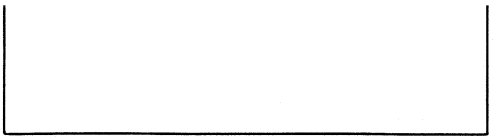
I Region of permissible d.c. operation

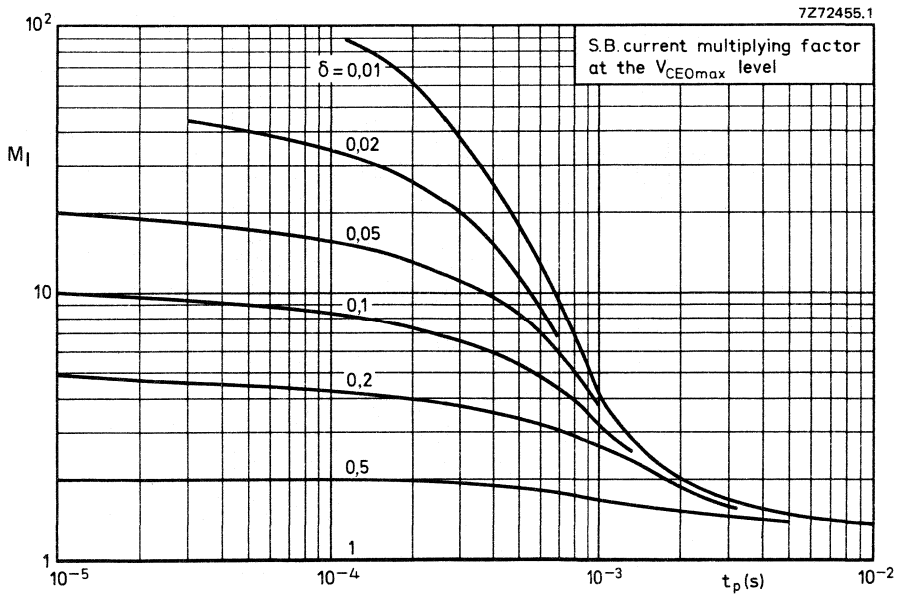
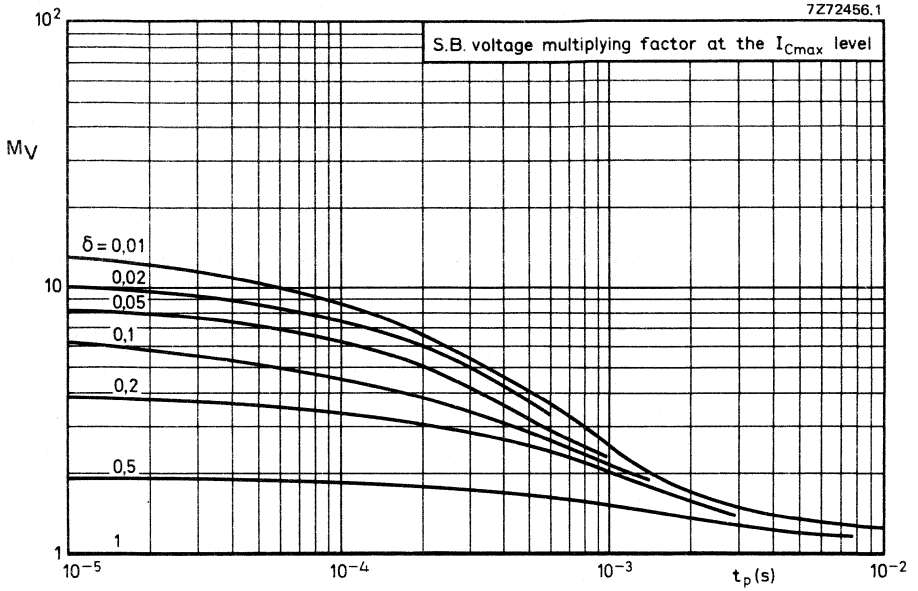
II Permissible extension for repetitive pulse operation

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

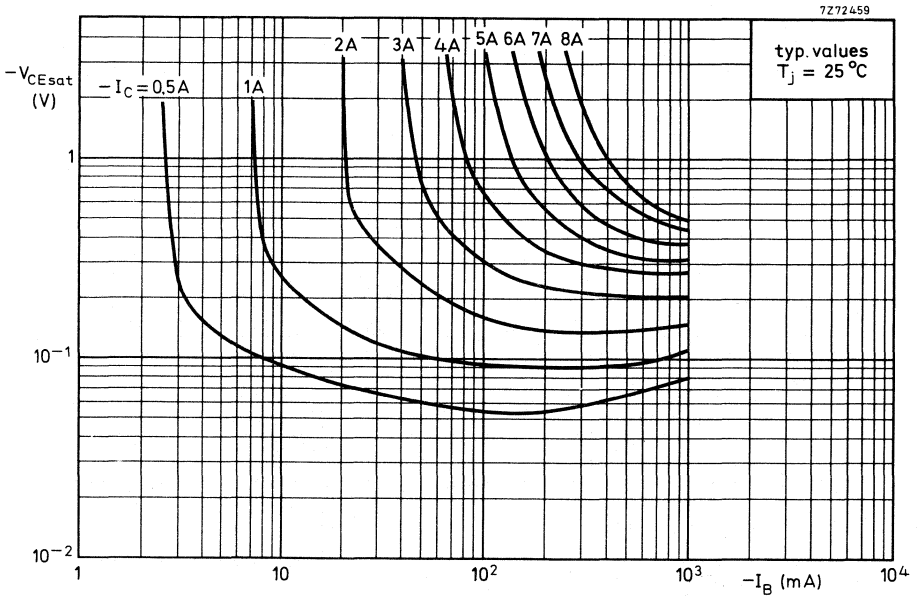
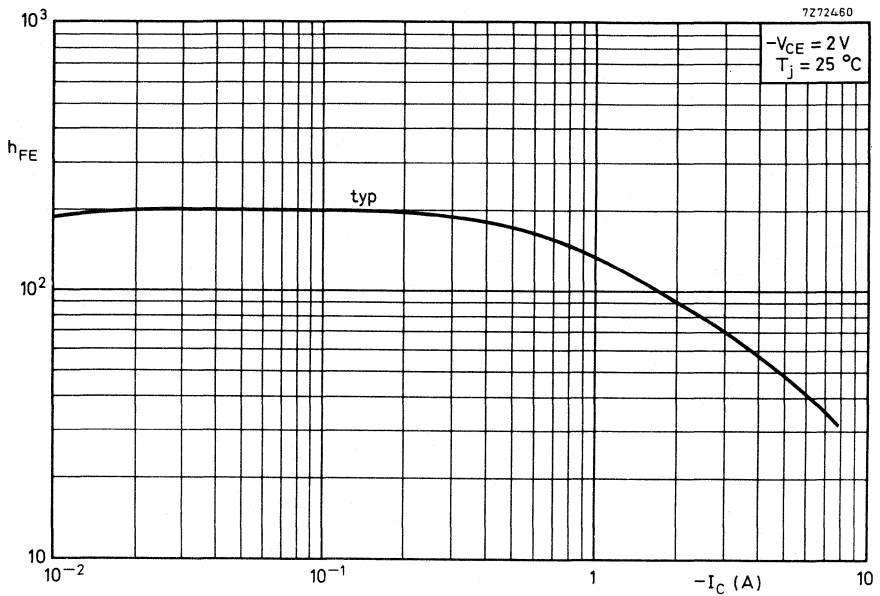
2) Second-breakdown limits (independent of temperature).

BDX92
BDX94
BDX96





BDX92
BDX94
BDX96



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

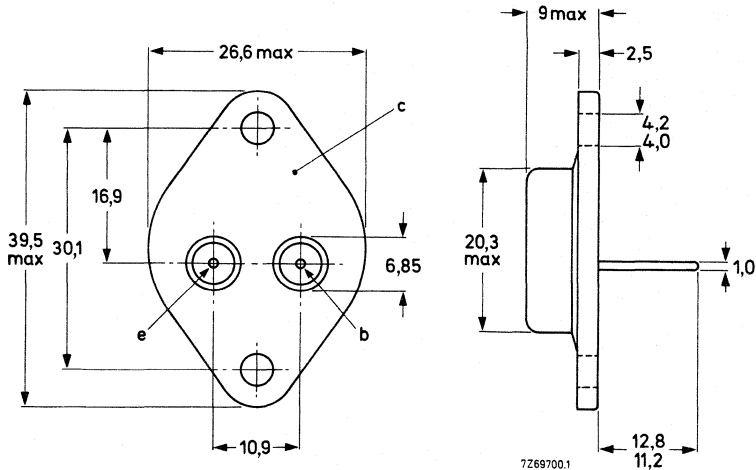
		BDY90	BDY91	BDY92	
Collector-base voltage (open emitter)	V_{CBO}	max. 120	100	80	V
Collector-emitter voltage (open base)	V_{CEO}	max. 100	80	60	V
Collector current (peak value)	I_{CM}	max.	15		A
Total power dissipation up to $T_{mb} = 70^\circ\text{C}$	P_{tot}	max.	40		W
Collector-emitter saturation voltage $I_C = 10\text{ A}; I_B = 1\text{ A}$	V_{CEsat}	<	1		V
Fall time $I_C = 5\text{ A}; I_B = -I_{BM} = 0,5\text{ A}$ $V_{CC} = 30\text{ V}$	t_f	<	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		MHz

MECHANICAL DATA

Dimensions in mm

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)

		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
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
Total power dissipation up to $T_{mb} = 70$ °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	$R_{th\ j-mb}$	=	2,0		K/W
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CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current

$V_{EB} = 1,5$ V; $V_{CE} = V_{CEXmax}$;	I_{CEX}	<	1		mA
$V_{EB} = 1,5$ V; $V_{CE} = V_{CEXmax}$; $T_{mb} = 150$ °C	I_{CEX}	<	3		mA

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	V_{CEsat}	<	1,0		V
	V_{BEsat}	<	1,5		V

CHARACTERISTICS

D.C. current gain

$I_C = 1 \text{ A}; V_{CE} = 2 \text{ V}$
 $I_C = 5 \text{ A}; V_{CE} = 5 \text{ V}$
 $I_C = 10 \text{ A}; V_{CE} = 5 \text{ V}$

$h_{FE} > 35$
 $h_{FE} 30 \text{ to } 120$
 $h_{FE} > 20$

Transition frequency at $f = 5 \text{ MHz}$

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

$f_T \text{ typ. } 70 \text{ MHz}$

Switching times

Turn on time

$I_C = 5 \text{ A}; I_B = -I_{BM} = 0,5 \text{ A}$
 $V_{CC} = 30 \text{ V}$

$t_{on} < 0,35 \mu\text{s}$

Turn off time

$I_C = 5 \text{ A}; I_B = -I_{BM} = 0,5 \text{ A}$
 $V_{CC} = 30 \text{ V}$ storage time
 fall time

$t_s < 1,3 \mu\text{s}$
 $t_f < 0,2 \mu\text{s}$

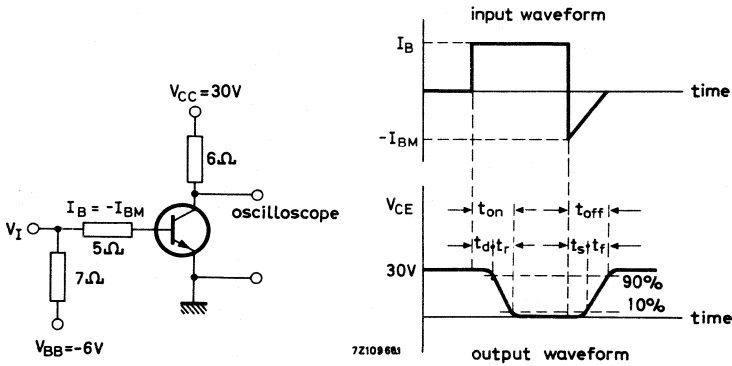


Fig. 2 Test circuit and waveforms.

Pulse generator:

Rise time $t_r < 50 \text{ ns}$
 Fall time $t_f < 50 \text{ ns}$

Pulse duration $t_p = 20 \mu\text{s}$
 Duty cycle $\delta = 0,02$

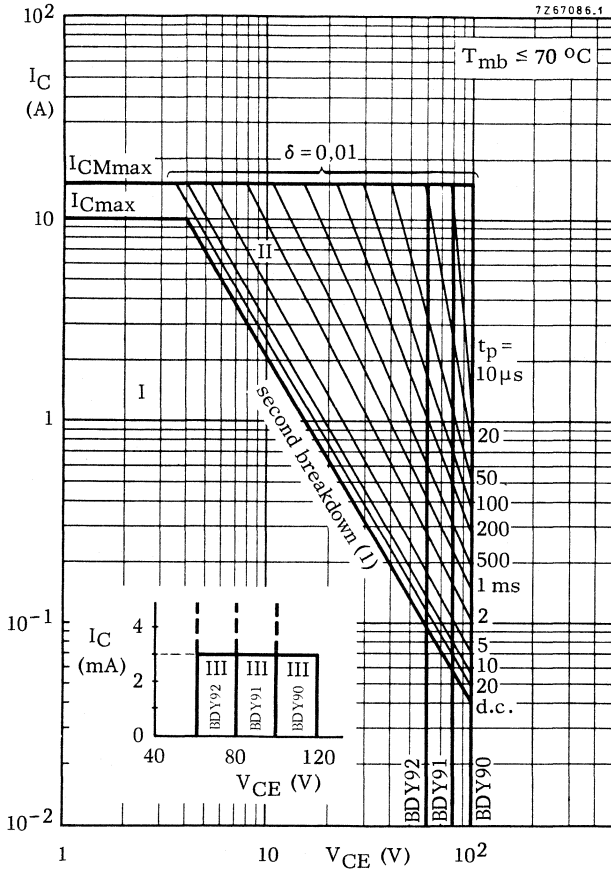


Fig. 3 Safe Operating Area (Regions I and II forward biased).

- I Region of permissible d.c. operation
 - II Permissible extension for repetitive pulse operation
 - III Repetitive pulse operation in this region is allowable, provided $-V_{BE} \geq 1,5 V$
- (1) Independent of temperature

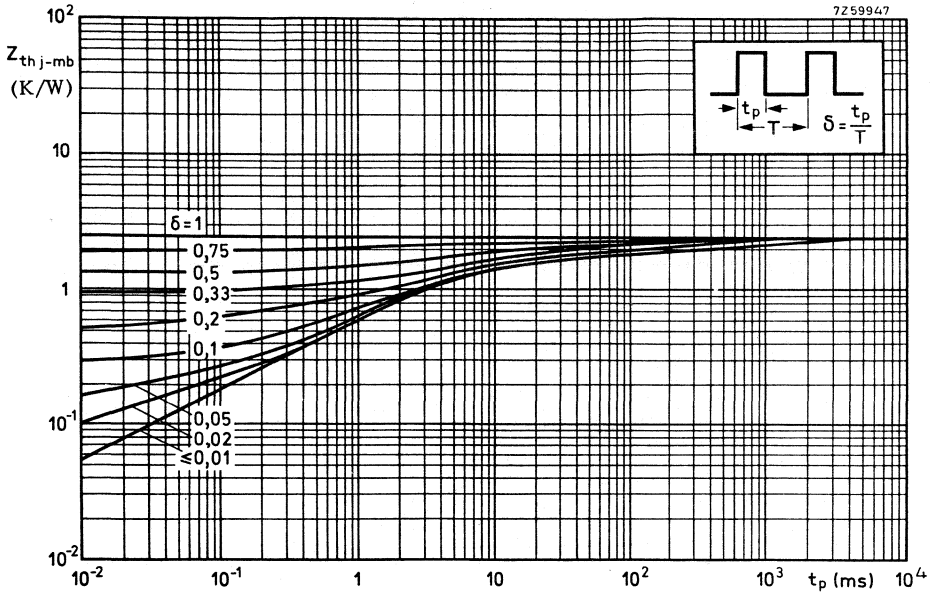


Fig. 4 Pulse power rating chart.

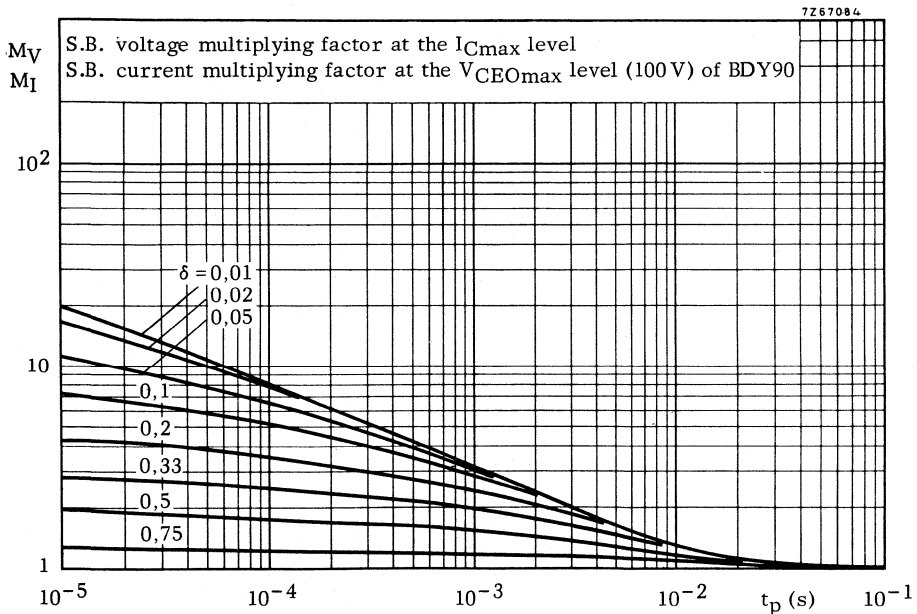
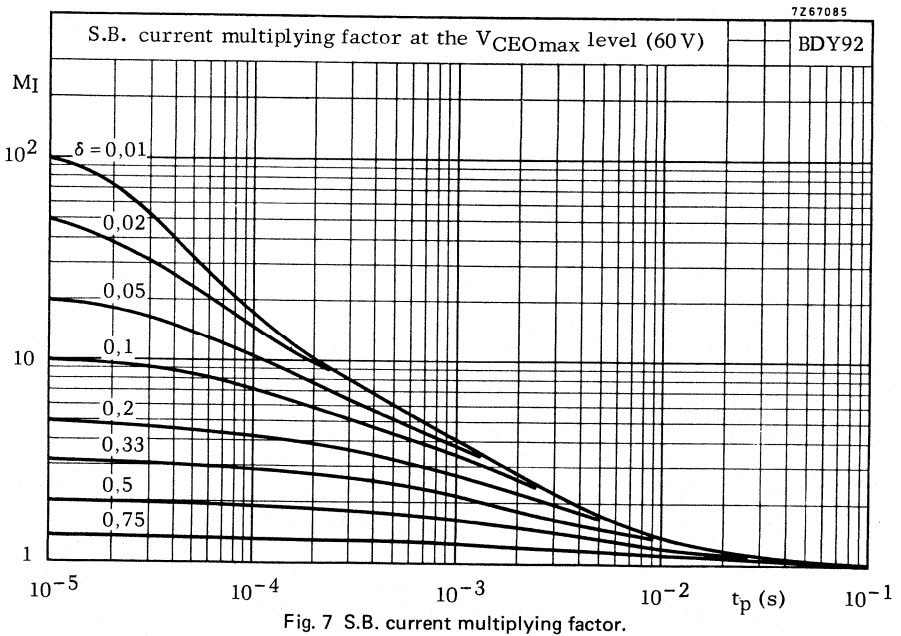
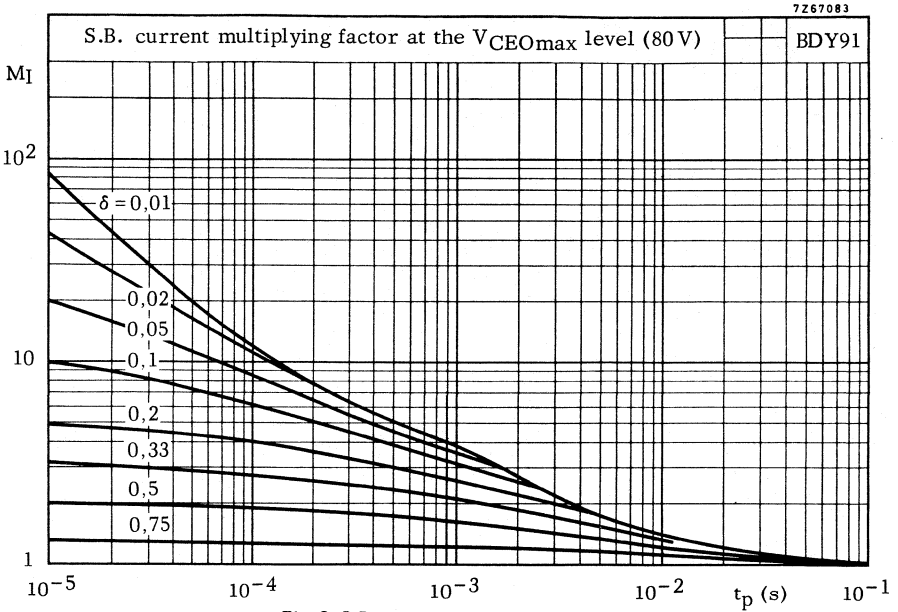


Fig. 5 S.B. voltage multiplying factor at the I_C max level.
S.B. current multiplying factor at the BDY90 V_{CE0max} level (100 V).



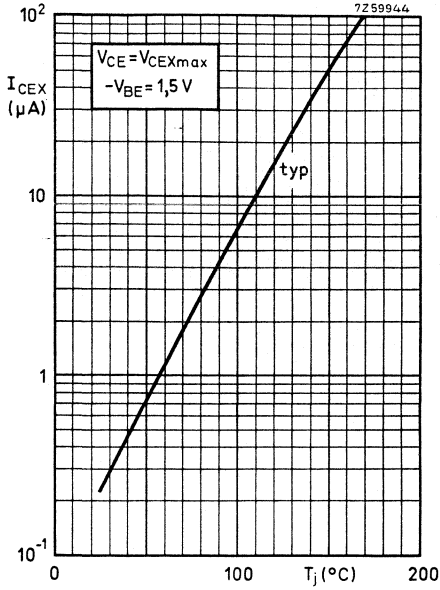


Fig. 8 Collector-emitter current.

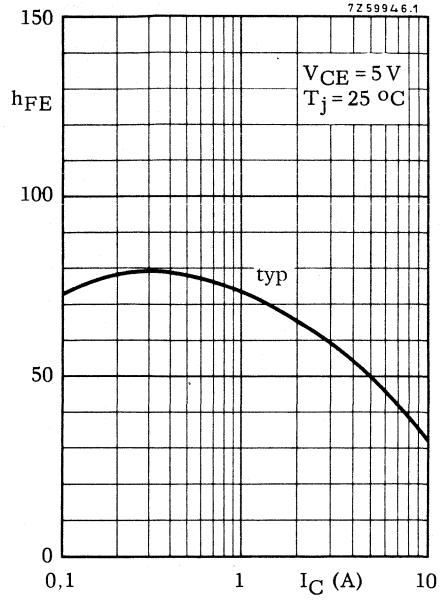


Fig. 9 D.C. current gain.

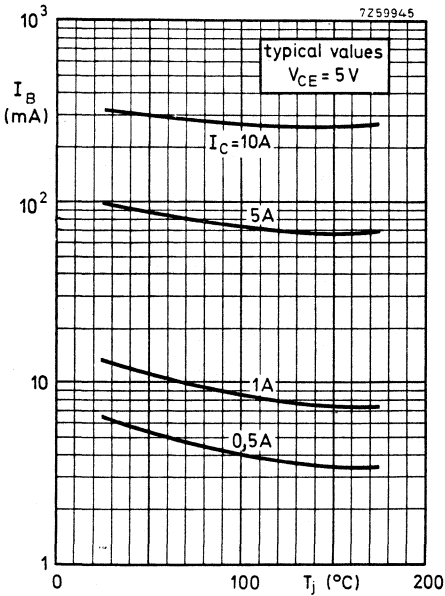


Fig. 10 Typical base current.

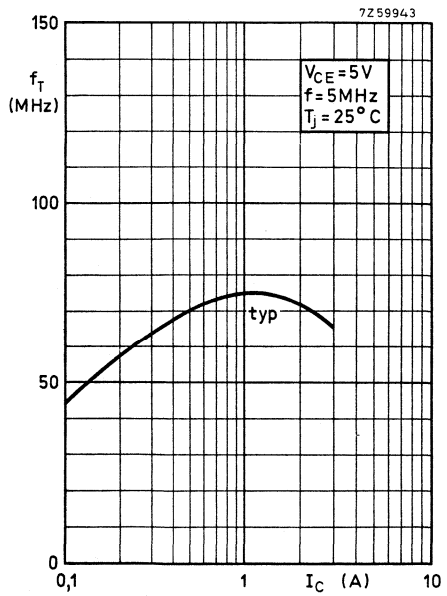


Fig. 11 Transition frequency.

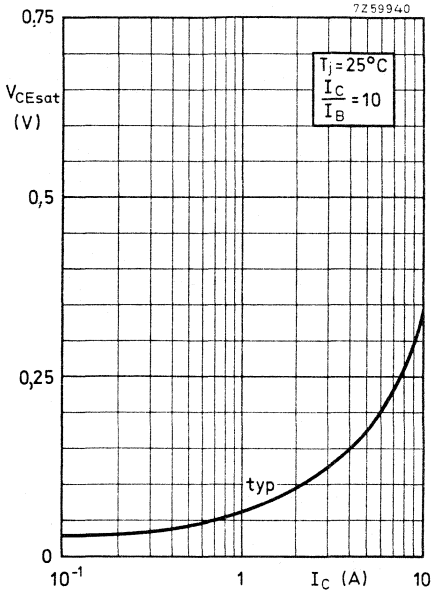


Fig. 12 Collector-emitter saturation voltage as a function of collector current.

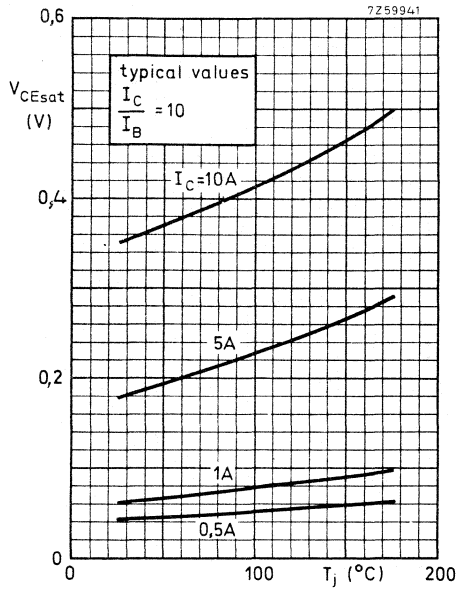


Fig. 13 Collector-emitter saturation voltage as a function of junction temperature.

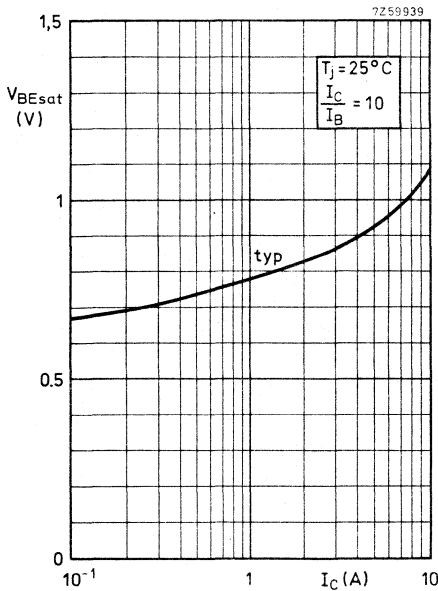


Fig. 14 Typical base-emitter saturation voltage.

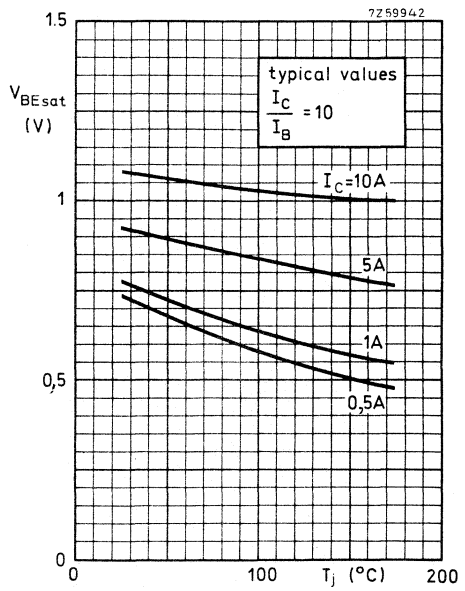


Fig. 15 Typical base-emitter saturation voltage.

SILICON DIFFUSED POWER TRANSISTOR

High-speed switching n-p-n transistor in a metal envelope intended for use in converters, inverters, switching regulators and switching control amplifiers.

QUICK REFERENCE DATA

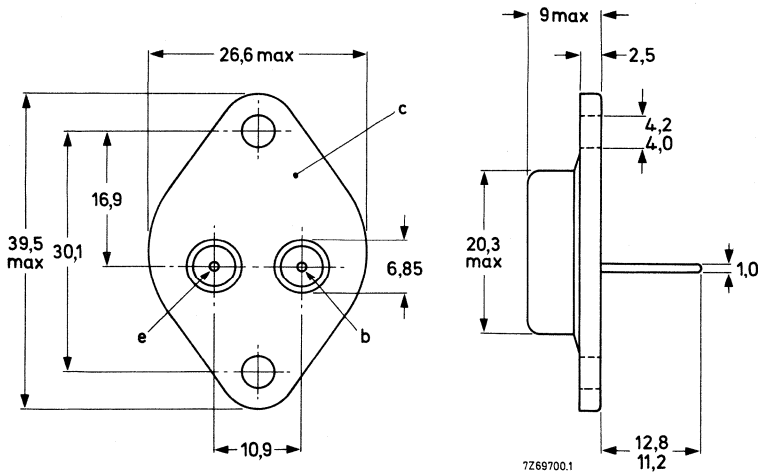
Collector-base voltage (open emitter)	V_{CBO}	max.	120 V
Collector-emitter voltage (open base)	V_{CEO}	max.	100 V
Collector current (peak value)	I_{CM}	max.	15 A
Total power dissipation up to $T_{mb} = 70\text{ }^{\circ}\text{C}$	P_{tot}	max.	40 W
Collector-emitter saturation voltage $I_C = 12\text{ A}; I_B = 1,2\text{ A}$	V_{CEsat}	<	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 μs
Transition frequency at $f = 5\text{ MHz}$ $I_C = 0,5\text{ A}; V_{CE} = 5\text{ V}$	f_T	typ.	70 MHz

MECHANICAL DATA

Dimensions in mm

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)

Collector-base voltage (open emitter)	V_{CBO}	max.	120 V
Collector-emitter voltage ($V_{EB} = 1,5$ V)	V_{CEX}	max.	120 V
Collector-emitter voltage (open base)	V_{CEO}	max.	100 V
Emitter-base voltage (open collector)	V_{EBO}	max.	6 V
Collector current (d.c.)	I_C	max.	12 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.	15 A
Emitter current (peak value)	$-I_{EM}$	max.	15 A
Total power dissipation up to $T_{mb} = 70$ °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	$R_{th\ j-mb}$	=	2,0 K/W
--------------------------------	----------------	---	---------

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current

$V_{EB} = 1,5$ V; $V_{CE} = V_{CEXmax}$; $T_{mb} = 150$ °C

I_{CEX}	<	3 mA
-----------	---	------

Saturation voltages

$I_C = 5$ A; $I_B = 0,5$ A

V_{CEsat}	<	0,5 V
-------------	---	-------

V_{BEsat}	<	1,2 V
-------------	---	-------

$I_C = 12$ A; $I_B = 1,2$ A

V_{CEsat}	<	1,0 V
-------------	---	-------

V_{BEsat}	<	1,5 V
-------------	---	-------

D.C. current gain

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

h_{FE}	>	35
----------	---	----

$I_C = 5$ A; $V_{CE} = 5$ V

h_{FE}		30 to 120
----------	--	-----------

$I_C = 12$ A; $V_{CE} = 5$ V

h_{FE}	>	20
----------	---	----

Transition frequency at $f = 5$ MHz

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

f_T	typ.	70 MHz
-------	------	--------

Switching times

Turn on time

$$I_C = 5 \text{ A}; I_B = -I_{BM} = 0,5 \text{ A}; V_{CC} = 30 \text{ V}$$

$$t_{on} < 0,35 \mu\text{s}$$

Turn off time

$$I_C = 5 \text{ A}; I_B = -I_{BM} = 0,5 \text{ A}; V_{CC} = 30 \text{ V}$$

storage time

$$t_s < 1,3 \mu\text{s}$$

fall time

$$t_f < 0,2 \mu\text{s}$$

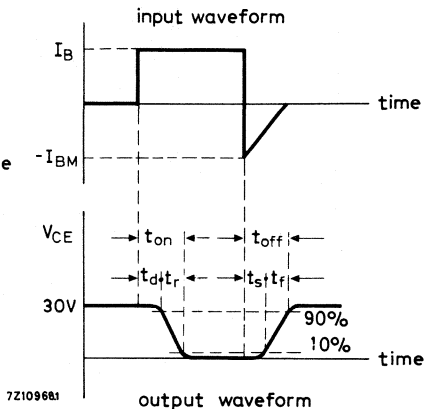
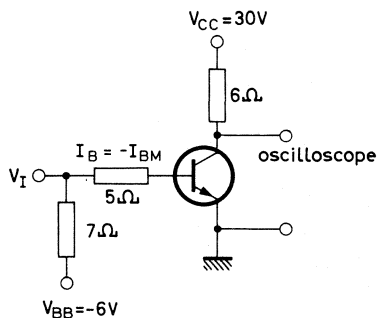


Fig. 2 Test circuit and waveforms.

Pulse generator:

Rise time $t_r < 50 \text{ ns}$

Fall time $t_f < 50 \text{ ns}$

Pulse duration $t_p = 20 \mu\text{s}$

Duty factor $\delta = 0,02$

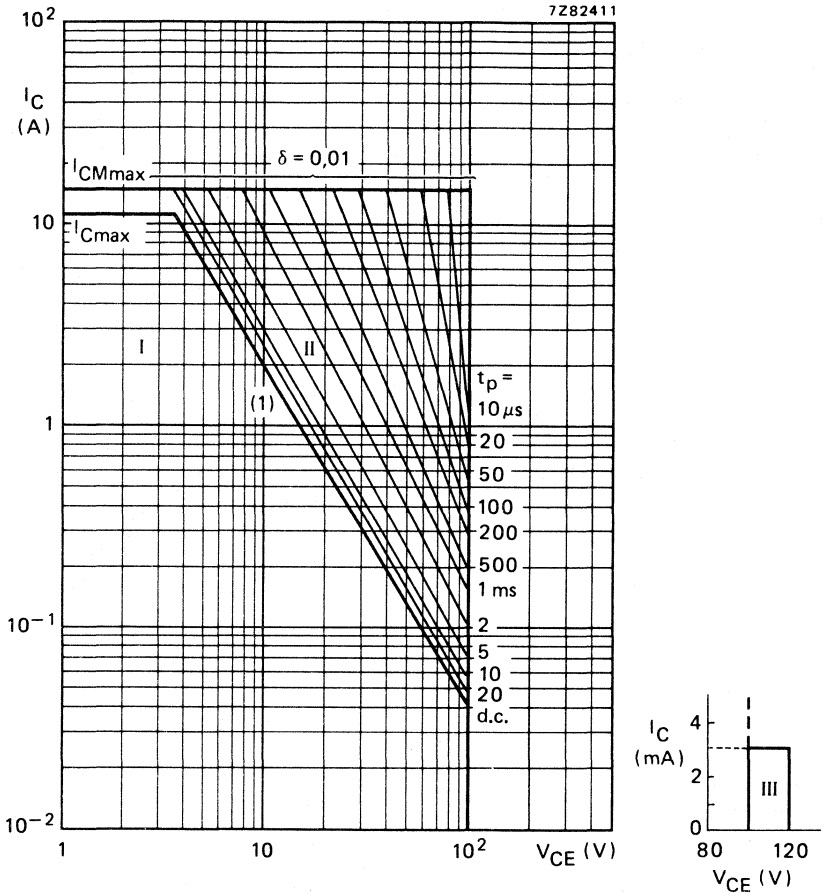


Fig. 3 Safe Operating Area (regions I and II forward biased). $T_{mb} \leq 70^\circ C$.

- I Region of permissible d.c. operation
- II Permissible extension for repetitive pulse operation
- III Repetitive pulse operation in this region is permissible, provided $-V_{BE} \geq 1,5 V$
- (1) Second breakdown limits (independent of temperature)

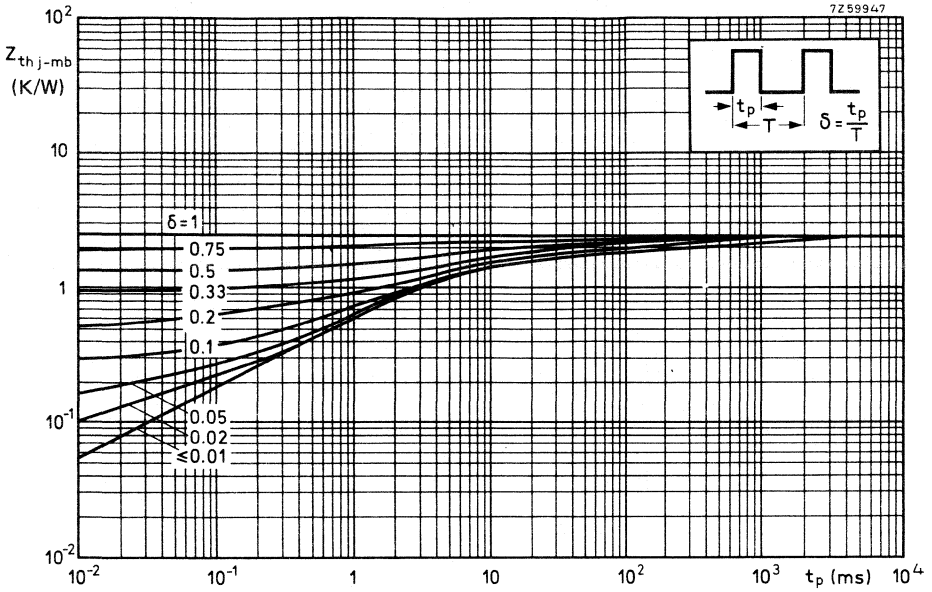


Fig. 4.

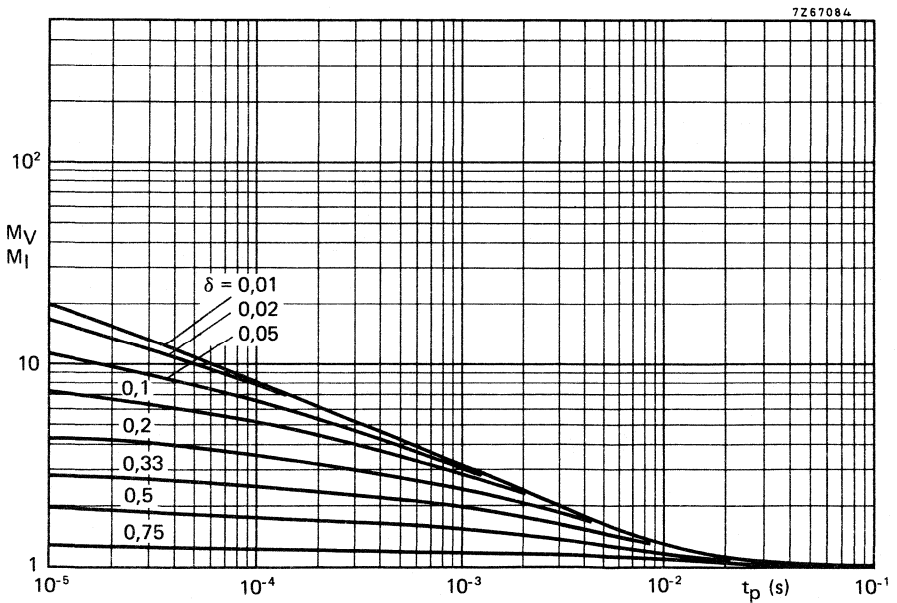


Fig. 5 SB voltage multiplying factor at I_{Cmax} level and SB current multiplying factor at V_{CE0max} level.

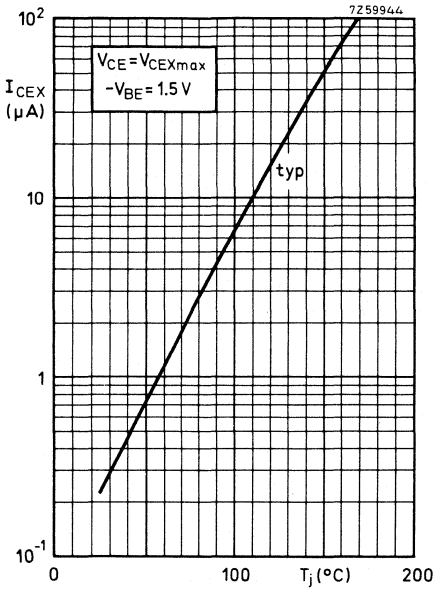


Fig. 6 Collector-emitter current as a function of junction temperature.

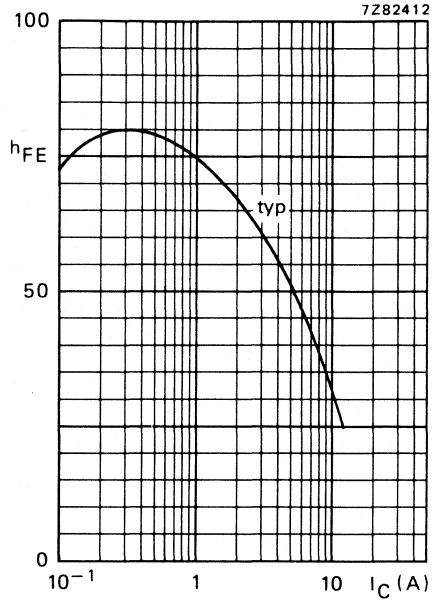


Fig. 7 D.C. current gain at $V_{CE} = 5 V$ and $T_j = 25^{\circ}C$.

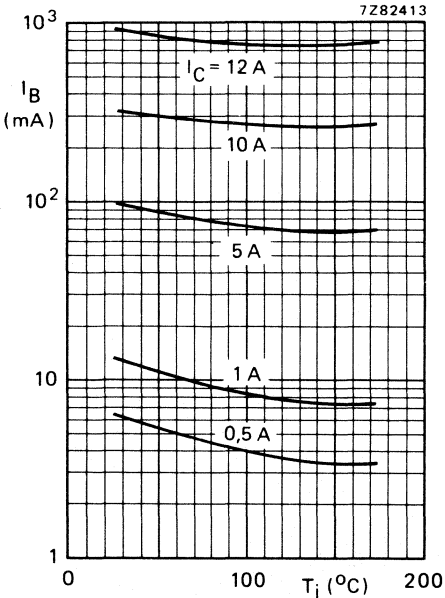


Fig. 8 Typical base current at $V_{CE} = 5 V$.

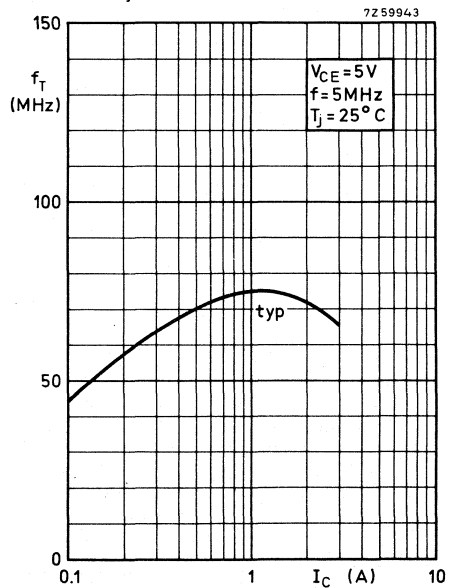


Fig. 9 Transition frequency as a function of the collector current.

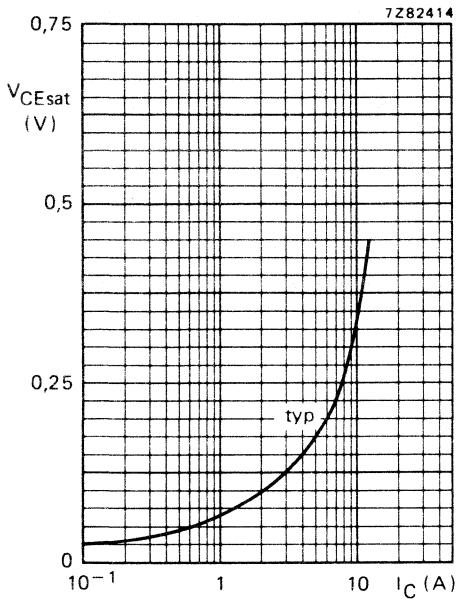


Fig. 10 Collector-emitter saturation voltage at $I_C/I_B = 10$; $T_j = 25^\circ\text{C}$.

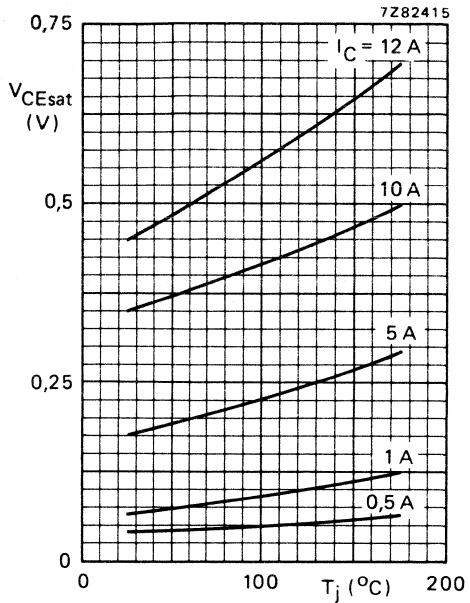


Fig. 11 Typical collector-emitter saturation voltage at $I_C/I_B = 10$.

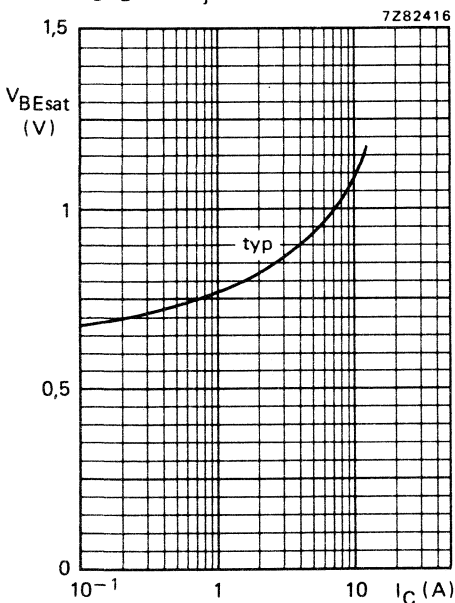


Fig. 12 Typical base-emitter saturation voltage at $I_C/I_B = 10$ and $T_j = 25^\circ\text{C}$.

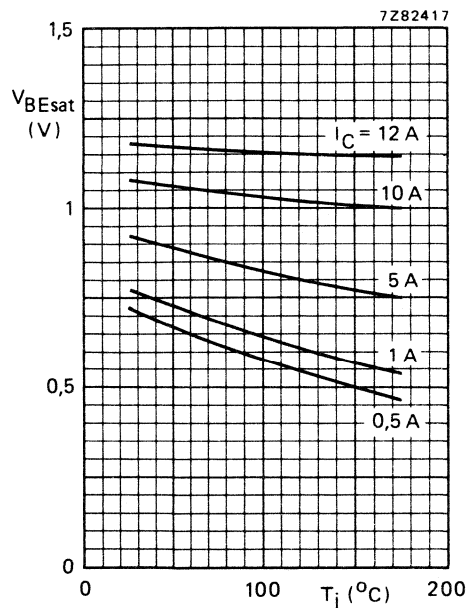


Fig. 13 Typical base-emitter saturation voltage at $I_C/I_B = 10$.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

PH2955T

SILICON EPITAXIAL-BASE POWER TRANSISTOR

P-N-P transistor in a plastic envelope. With its n-p-n complement PH3055T 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

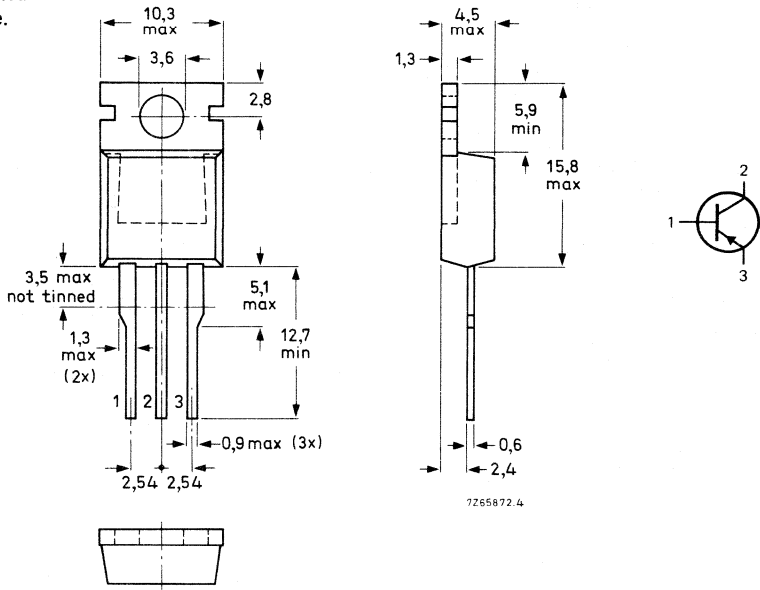
Collector-emitter voltage (open base)	$-V_{CE0}$ max.	60 V
Collector current (d.c.)	$-I_C$ max.	10 A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot} max.	75 W
Transition frequency at $f = 1$ MHz $-I_C = 0,5$ A; $-V_{CE} = 10$ V	f_T	> 2 MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

RATINGS

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	70 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V
Collector current (d.c.)	$-I_C$	max.	10 A
Collector current (peak value, $t_p \leq 10$ ms)	$-I_{CM}$	max.	12 A
Base current (d.c.)	$-I_B$	max.	4 A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	75 W
Storage temperature	T_{stg}		-65 to + 175 °C
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1,67 K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70 K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current

$I_B = 0; -V_{CE} = 30$ V	$-I_{CEO}$	<	0,7 mA
$I_E = 0; -V_{CB} = 70$ V	$-I_{CBO}$	<	1 mA
$I_E = 0; -V_{CB} = 70$ V; $T_j = 150$ °C	$-I_{CBO}$	<	5 mA
$V_{BE} = 1,5$ V; $-V_{CB} = 70$ V	$-I_{CEX}$	<	1 mA
$V_{BE} = 1,5$ V; $-V_{CB} = 70$ V; $T_j = 150$ °C	$-I_{CEX}$	<	5 mA

Emitter cut-off current

$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	5 mA
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Saturation voltages*

$-I_C = 4$ A; $-I_B = 0,4$ A	$-V_{CEsat}$	<	0,8 V
	$-V_{BEsat}$	<	1,8 V
$-I_C = 10$ A; $-I_B = 3,3$ A	$-V_{CEsat}$	<	4 V

Base-emitter voltage*

$-I_C = 4$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	1,8 V
-------------------------------	-----------	---	-------

D.C. current gain*

$-I_C = 4$ A; $-V_{CE} = 4$ V	h_{FE}		20 to 70
$-I_C = 10$ A; $-V_{CE} = 4$ V	h_{FE}	>	5

Transition frequency at $f = 1$ MHz

$-I_C = 0,5$ A; $-V_{CE} = 10$ V	f_T	>	2 MHz
----------------------------------	-------	---	-------

* Measured under pulse conditions: $t_p < 300$ μ s, $\delta < 2\%$.

Switching times

$-I_{C\text{on}} = 2 \text{ A}; I_{B\text{on}} = I_{B\text{off}} = 0,2 \text{ A}$

turn-on time

turn-off time

$t_{\text{on}} < 1 \mu\text{s}$

$t_{\text{off}} < 2 \mu\text{s}$

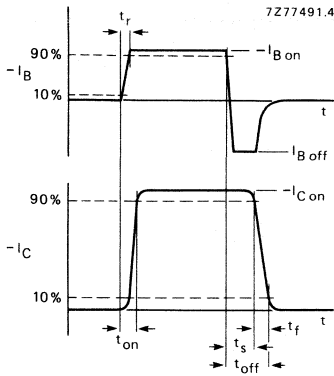


Fig. 2 Switching times waveforms.

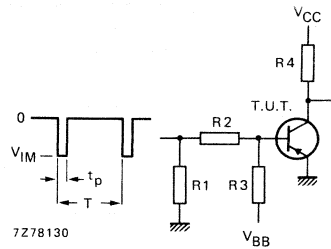


Fig. 3 Switching times test circuit.

- | | |
|--------------------------|-----------------------------|
| $-V_{IM} = 15 \text{ V}$ | $R3 = 22 \Omega$ |
| $-V_{CC} = 20 \text{ V}$ | $R4 = 10 \Omega$ |
| $+V_{BB} = 4 \text{ V}$ | $t_r = t_f = 15 \text{ ns}$ |
| $R1 = 56 \Omega$ | $t_p = 10 \mu\text{s}$ |
| $R2 = 33 \Omega$ | $T = 500 \mu\text{s}$ |

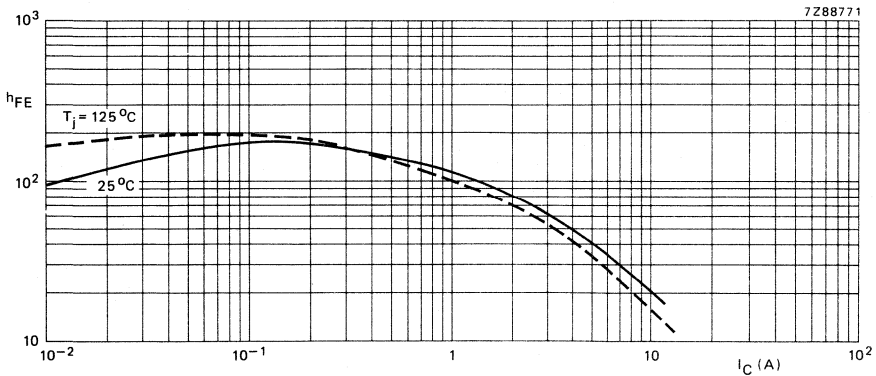


Fig. 4 Typical values d.c. current gain at $-V_{CE} = 2 \text{ V}$.

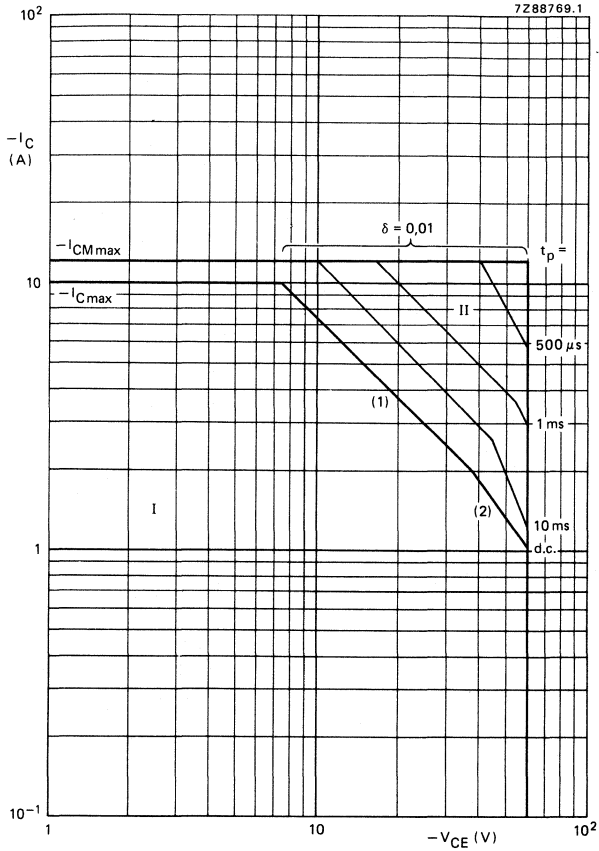


Fig. 5 Safe Operating Area; $T_{mb} = 25\text{ }^\circ\text{C}$.

- 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).

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

PH3055T

SILICON EPITAXIAL-BASE POWER TRANSISTOR

N-P-N transistor in a plastic envelope. With its p-n-p complement PH2955T 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

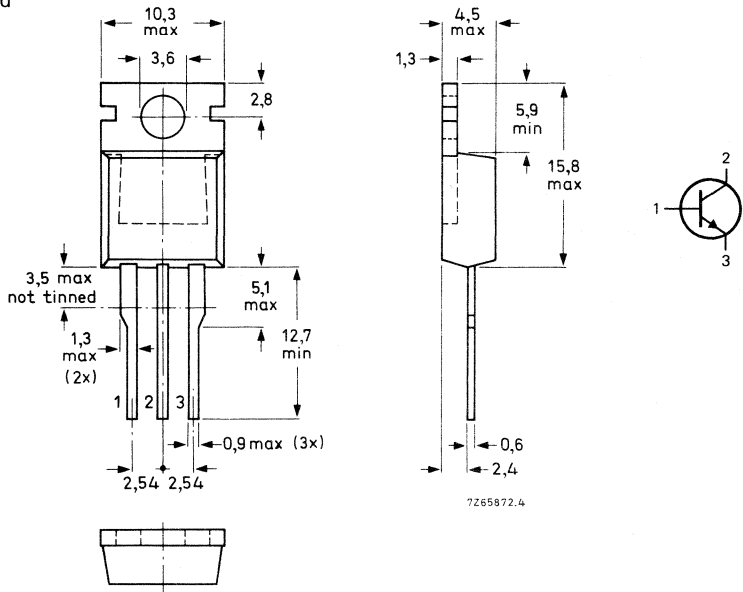
Collector-emitter voltage (open base)	V_{CE0}	max.	60 V
Collector current (d.c.)	I_C	max.	10 A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	75 W
Transition frequency at $f = 1\text{ MHz}$ $I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$	f_T	>	2 MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220.

Collector connected to mounting base.



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.	70 V
Collector-emitter voltage (open base)	V_{CE0}	max.	60 V
Emitter-base voltage (open collector)	V_{EB0}	max.	5 V
Collector current (d.c.)	I_C	max.	10 A
Collector current (peak value, $t_p \leq 10$ ms)	I_{CM}	max.	12 A
Base current (d.c.)	I_B	max.	4 A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	75 W
Storage temperature	T_{stg}		-65 to + 175 °C
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1,67 K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70 K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current

$I_B = 0; V_{CE} = 30$ V	I_{CE0}	<	0,7 mA
$I_E = 0; V_{CB} = 70$ V	I_{CB0}	<	1 mA
$I_E = 0; V_{CB} = 70$ V; $T_j = 150$ °C	I_{CB0}	<	5 mA
$V_{CE} = 70$ V; $V_{BE} = -1,5$ V	I_{CEX}	<	1 mA
$V_{CE} = 70$ V; $V_{BE} = -1,5$ V; $T_j = 150$ °C	I_{CEX}	<	5 mA

Emitter cut-off current

$I_C = 0; V_{EB} = 5$ V	I_{E0}	<	5 mA
-------------------------	----------	---	------

Base-emitter voltage*

$I_C = 4$ A; $V_{CE} = 4$ V	V_{BE}	<	1,8 V
-----------------------------	----------	---	-------

Saturation voltage*

$I_C = 4$ A; $I_B = 0,4$ A	V_{CEsat}	<	0,8 V
	V_{BEsat}	<	1,8 V
$I_C = 10$ A; $I_B = 3,3$ A	V_{CEsat}	<	4 V

D.C. current gain*

$I_C = 4$ A; $V_{CE} = 4$ V	h_{FE}		20 to 70
$I_C = 10$ A; $V_{CE} = 4$ V	h_{FE}	>	5

Transition frequency at $f = 1$ MHz

$I_C = 0,5$ A; $V_{CE} = 10$ V	f_T	>	2 MHz
--------------------------------	-------	---	-------

* Measured under pulse conditions: $t_p < 300$ μ s, $\delta < 2\%$.

Switching times

$I_{Con} = 2 \text{ A}; I_{Bon} = -I_{Boff} = 0,2 \text{ A}$

Turn-on time

Turn-off time

$t_{on} < 1 \mu\text{s}$

$t_{off} < 4 \mu\text{s}$

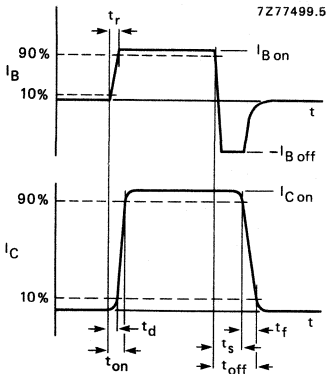


Fig. 2 Switching time waveforms.

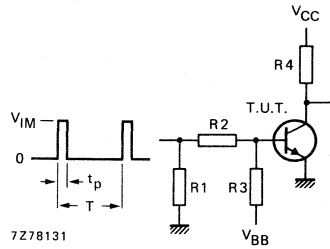


Fig. 3 Switching times test circuit.

- | | |
|-------------------------|--------------------------------|
| $V_{IM} = 15 \text{ V}$ | $R3 = 22 \Omega$ |
| $V_{CC} = 20 \text{ V}$ | $R4 = 10 \Omega$ |
| $V_{BB} = -4 \text{ V}$ | $t_r = t_f \leq 15 \text{ ns}$ |
| $R1 = \text{none}$ | $t_p = 20 \mu\text{s}$ |
| $R2 = 33 \Omega$ | $T = 500 \mu\text{s}$ |

DEVELOPMENT DATA

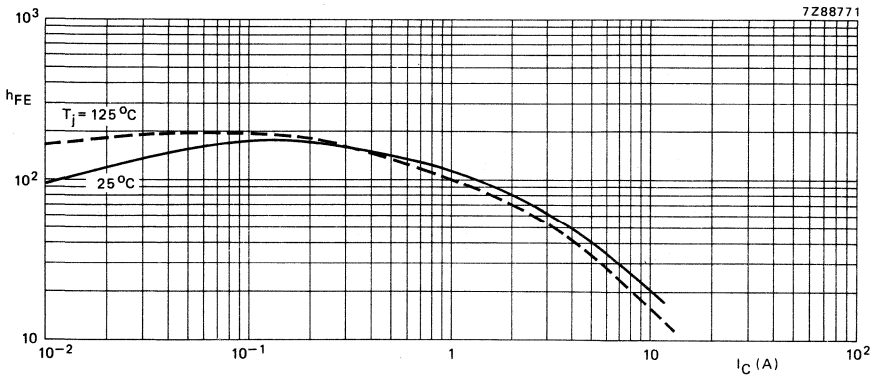


Fig. 4 Typical values d.c. current gain at $V_{CE} = 2 \text{ V}$.

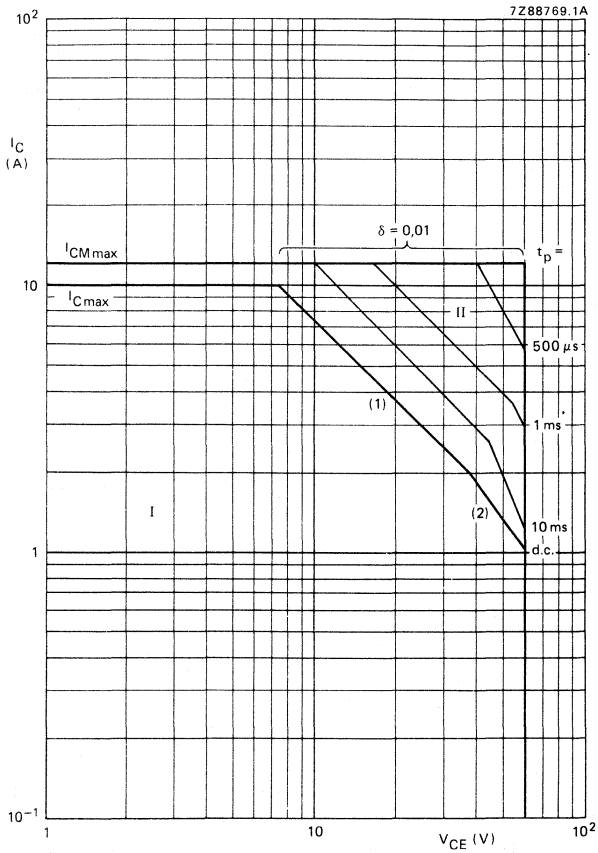


Fig. 5 Safe Operating Area, $T_{mb} \leq 25^\circ\text{C}$.

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

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.

QUICK REFERENCE DATA

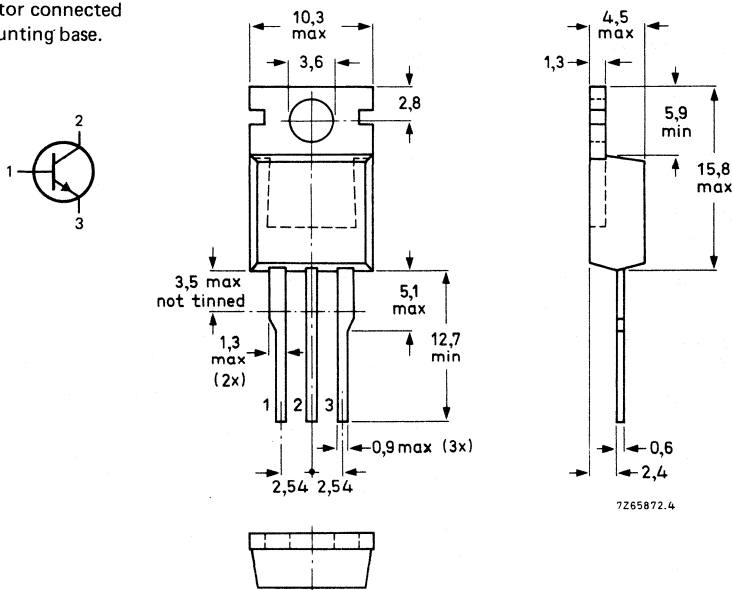
		TIP29	A	B	C
Collector-base voltage	V_{CBO}	max. 80	100	120	140 V
Collector-emitter voltage	V_{CEO}	max. 40	60	80	100 V
Collector current (peak value)	I_{CM}	max.	3		A
Total power dissipation up to $T_{mb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	max.	30		W
Junction temperature	T_j	max.	150		$^{\circ}\text{C}$
D.C. current gain			40		
$I_C = 200\text{ mA}; V_{CE} = 4\text{ V}$	h_{FE}	>	15 to 75		
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}				
Transition frequency at $f = 1\text{ MHz}$			3		MHz
$I_C = 200\text{ mA}; V_{CE} = 10\text{ V}$	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)

		TIP29	A	B	C		
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5				V
Collector current (d.c.)	I_C	max.	1				A
Collector current (peak value)	I_{CM}	max.	3				A
Base current (d.c.)	I_B	max.	0,4				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			K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70			K/W

CHARACTERISTICS

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

		TIP29; A	TIP29B; C				
Collector cut-off current							
$I_B = 0; V_{CE} = 30\text{ V}$	I_{CEO}	<	0,3	mA			
$I_B = 0; V_{CE} = 60\text{ V}$	I_{CEO}	<	-	mA			
$V_{BE} = 0; V_{CE} = V_{CBOmax}$	I_{CES}	<	0,2	mA			
Emitter cut-off current							
$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<	1	mA			
D.C. current gain*							
$I_C = 200\text{ mA}; V_{CE} = 4\text{ V}$	h_{FE}	>	40				
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}		15 to 75				
Base-emitter voltage**							
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	V_{BE}	<	1,3	V			
Collector-emitter saturation voltage*							
$I_C = 1\text{ A}; I_B = 0,125\text{ A}$	V_{CEsat}	<	0,7	V			
Collector-emitter breakdown voltage*							
$I_B = 0; I_C = 30\text{ mA}$	$V_{(BR)CEO}$	>	40	60	80	100	V
Small-signal current gain							
$I_C = 0,2\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} $	>	20				
Turn-off breakdown energy							
$L = 20\text{ mH}; I_{CC} = 1,8\text{ A}$	$E_{(BR)}$	>	32			mJ	

* Measured under pulse conditions: $t_p \leq 300\text{ }\mu\text{s}$; $\delta < 2\%$.

** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Transition frequency at $f = 1 \text{ MHz}$
 $I_C = 0,2 \text{ A}; V_{CE} = 10 \text{ V}$

$f_T > 3 \text{ MHz}$

Switching times
 (between 10% and 90% levels)

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

Turn-on time

t_{on} typ. $0,4 \mu\text{s}$

Turn-off time

t_{off} typ. $1,5 \mu\text{s}$

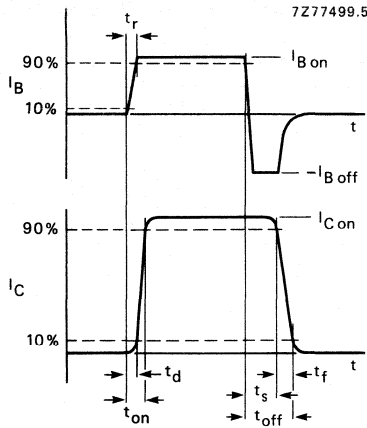


Fig. 2 Switching times waveforms.

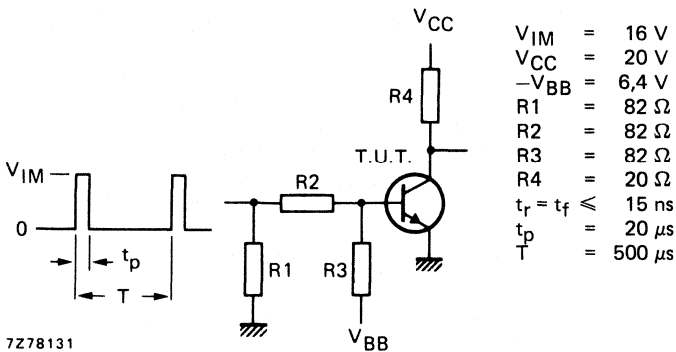


Fig. 3 Switching times test circuit.

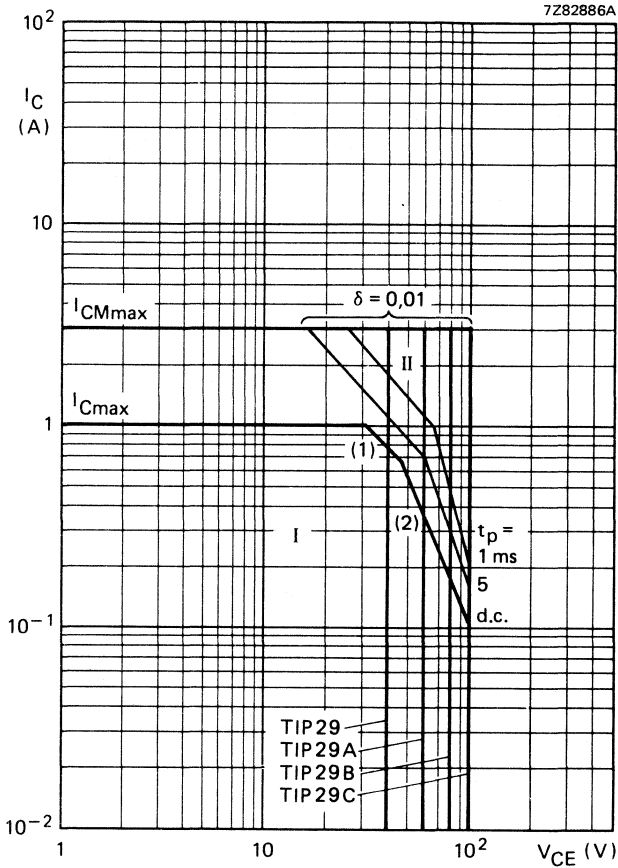


Fig. 4 Safe Operating Area; $T_{mb} = 25 \text{ }^\circ\text{C}$.

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.

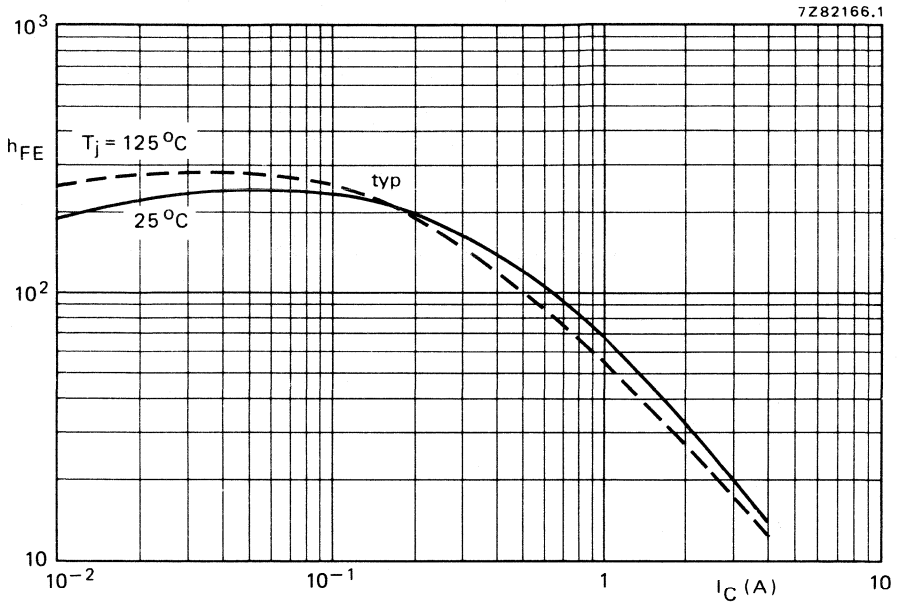


Fig. 5 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 4$ V.

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.

QUICK REFERENCE DATA

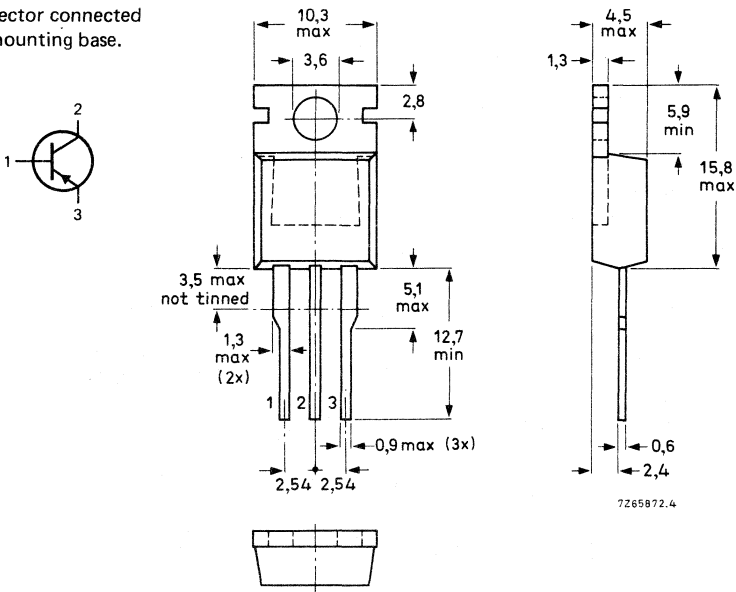
Collector-base voltage	$-V_{CB0}$	max.	TIP30 80	A 100	B 120	C 140	V
Collector-emitter voltage	$-V_{CE0}$	max.	40	60	80	100	V
Collector current (d.c.)	$-I_{CM}$	max.	3			A	
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	30			W	
Junction temperature	T_j	max.	150			$^\circ\text{C}$	
D.C. current gain $-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}		15 to 75				
Transition frequency $-I_C = 200\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	$>$	3			MHz	

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting Instructions and Accessories.

TIP30; A; B; C

RATINGS

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

		TIP30	A	B	C		
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5				V
Collector current (d.c.)	$-I_C$	max.	1				A
Collector current (peak value)	$-I_{CM}$	max.	3				A
Base current (d.c.)	$-I_B$	max.	0,4				A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	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			K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70			K/W

CHARACTERISTICS

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

		TIP30:A	TIP30B:C		
Collector cut off current					
$-I_B = 0; -V_{CE} = 30\text{V}$	$-I_{CEO}$	< 0,3	-		mA
$-I_B = 0; -V_{CE} = 60\text{V}$	$-I_{CEO}$	< -	0,3		mA
$-V_{BE} = 0; -V_{CE} = -V_{CBOmax}$	$-I_{CES}$	< 0,2			mA
Emitter cut-off current					
$I_C = 0; -V_{EB} = 5\text{V}$	$-I_{EBO}$	< 1			mA
D.C. current gain*					
$-I_C = 200\text{ mA}; -V_{CE} = 4\text{ V}$	h_{FE}	> 40			
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	> 15 to 75			
Base-emitter voltage*					
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE}$	< 1,3			V
Collector-emitter saturation voltage*					
$-I_C = 1\text{ A}; -I_B = 0,125\text{ A}$	$-V_{CEsat}$	< 0,7			V
Collector-emitter breakdown voltage*					
$I_B = 0; -I_C = 30\text{ mA}$	$-V_{(BR)CEO}$	> 40	60	80	100
Small-signal current gain					
$-I_C = 0,2\text{ A}; -V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} $	> 20			
Turn-off breakdown energy					
$L = 20\text{ mH}; I_{CC} = 1,22\text{ A}$	$E_{(BR)}$	> 15			mJ

* Measured under pulse conditions: $t_p \leq 300\ \mu\text{s}; \delta < 2\%$.

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

$-I_C = 200 \text{ mA}; -V_{CE} = 10 \text{ V}$

$f_T > 3 \text{ MHz}$

Switching times

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

turn-on time

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

turn-off time

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

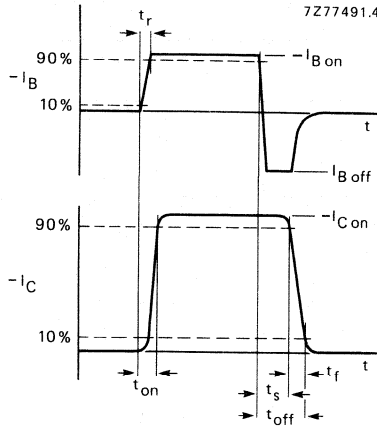
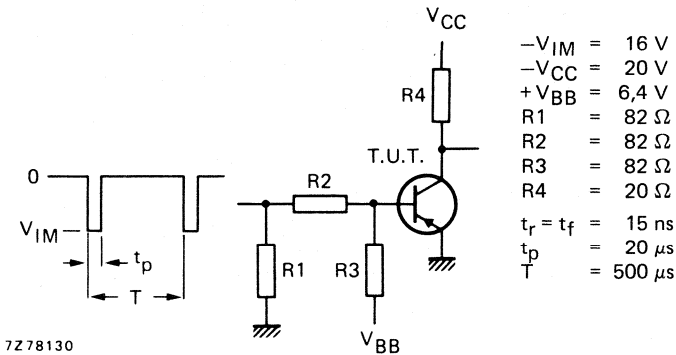


Fig. 2 Switching times waveforms.



- $-V_{IM} = 16 \text{ V}$
- $-V_{CC} = 20 \text{ V}$
- $+V_{BB} = 6,4 \text{ V}$
- $R1 = 82 \Omega$
- $R2 = 82 \Omega$
- $R3 = 82 \Omega$
- $R4 = 20 \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 20 \mu\text{s}$
- $T = 500 \mu\text{s}$

Fig. 3 Switching times test circuit.

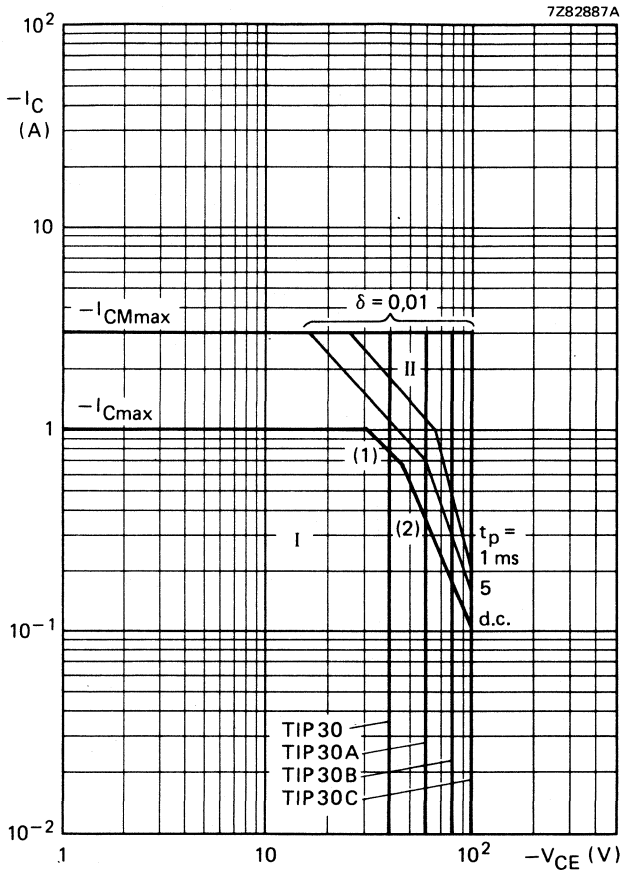


Fig. 4 Safe Operating Area; $T_{mb} = 25^\circ C$.

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.

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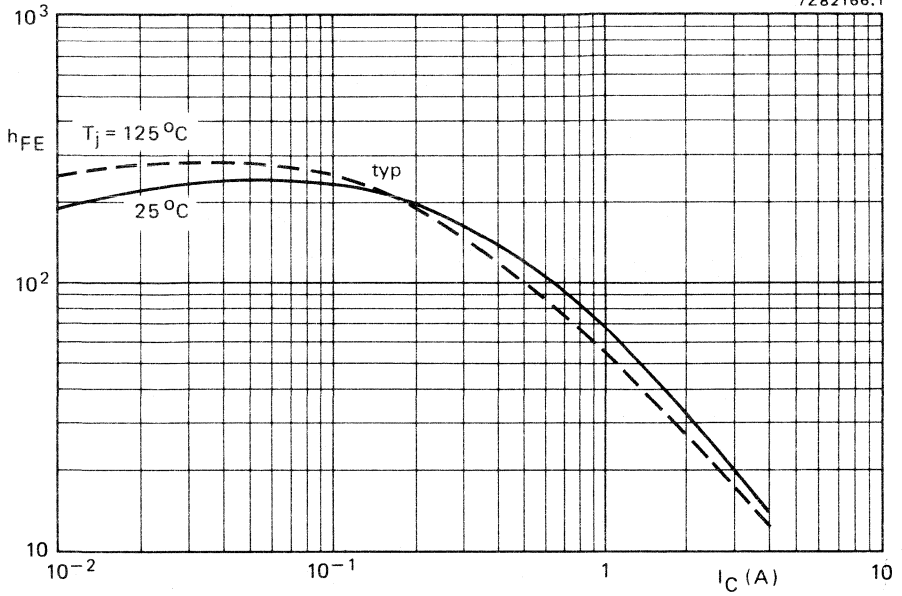


Fig. 5 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 4\text{ V}$.

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.

QUICK REFERENCE DATA

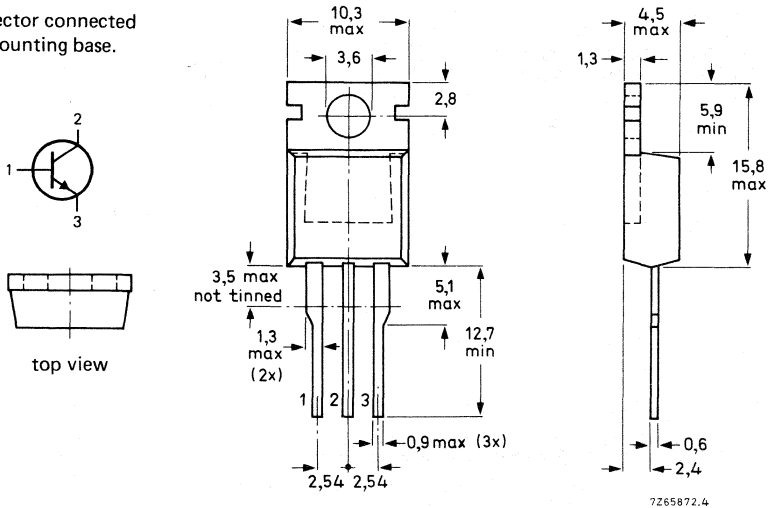
		TIP31	A	B	C
Collector-base voltage (open emitter)	V_{CBO}	max. 80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO}	max. 40	60	80	100 V
Collector current (d.c.)	I_C	max.	3		A
Collector current (peak value)	I_{CM}	max.	5		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	40		W
Junction temperature	T_j	max.	150		$^\circ\text{C}$
D.C. current gain			25		
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>	25		
$I_C = 3\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}		10 to 50		

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)

		TIP31	A	B	C
Collector-base voltage (open emitter)	V_{CBO} max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO} max.	40	60	80	100 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.			5	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	K/W
From junction to ambient (in free air)	$R_{th\ j-a} =$		70	K/W

CHARACTERISTICS

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

		TIP31; A	TIP31B; C
Collector cut-off current $I_B = 0; V_{CE} = 30\text{ V}$	$I_{CEO} <$	0,3	— mA
$I_B = 0; V_{CE} = 60\text{ V}$	$I_{CEO} <$	—	0,3 mA
$V_{BE} = 0; V_{CE} = V_{CBOmax}$	$I_{CES} <$		0,2 mA
Emitter cut-off current $I_C = 0; V_{EB} = 5\text{ V}$	$I_{EBO} <$		1 mA
D.C. current gain *	$h_{FE} >$		25
$I_C = 1\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}		10 to 50
$I_C = 3\text{ A}; V_{CE} = 4\text{ V}$	$V_{BE} <$		1,8 V
Base-emitter voltage ** $I_C = 3\text{ A}; V_{CE} = 4\text{ V}$	$V_{CEsat} <$		1,2 V
Collector-emitter saturation voltage * $I_C = 3\text{ A}; I_B = 0,375\text{ A}$	$V_{(BR)CEO} >$	TIP31	A B C
Collector-emitter breakdown voltage * $I_B = 0; I_C = 30\text{ mA}$		40	60 80 100 V
Small-signal current transfer ratio $I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} >$		20
$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ MHz}$	$ h_{fe} >$		3
Turn-off breakdown energy $L = 20\text{ mH}; I_{CC} = 1,8\text{ A}$	$E_{(BR)} >$		32 mJ

* Measured under pulse conditions: $t_p \leq 300\ \mu\text{s}; \delta \leq 2\%$.

** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

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.	0,4 μs
t_{off}	typ.	1,5 μs

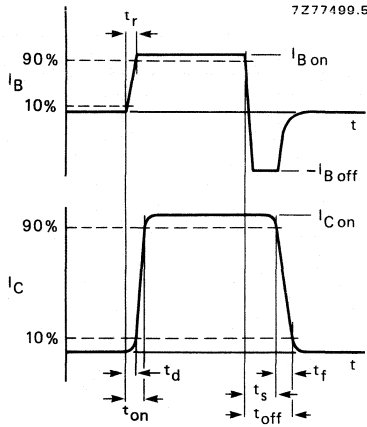


Fig. 2 Switching times waveforms.

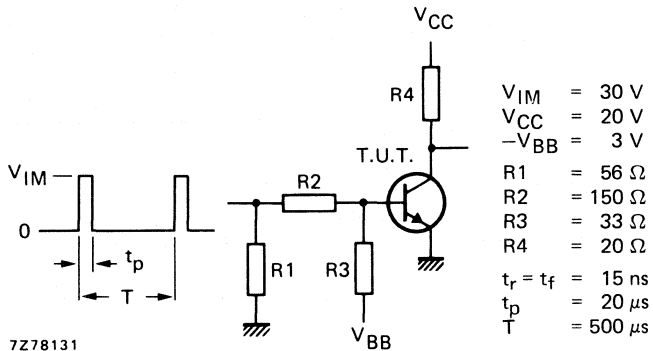


Fig. 3 Switching times test circuit.

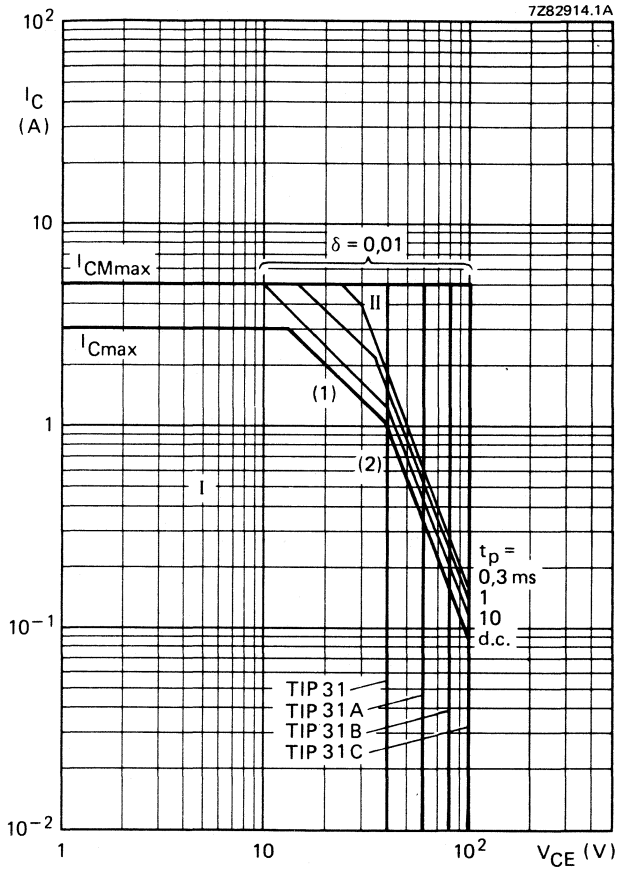


Fig. 4 Safe Operating Area; $T_{mb} = 25 \text{ }^\circ\text{C}$.

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).

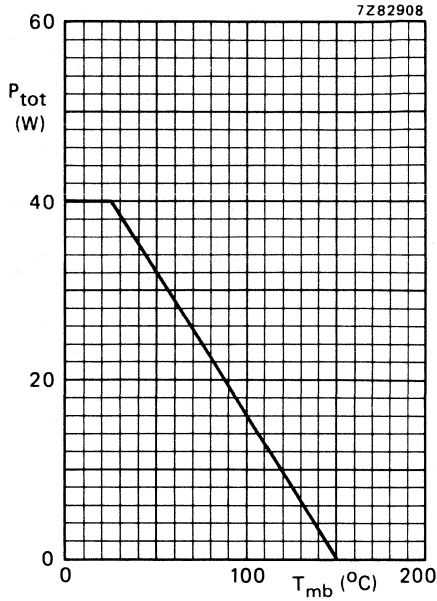


Fig. 5 Power derating curve.

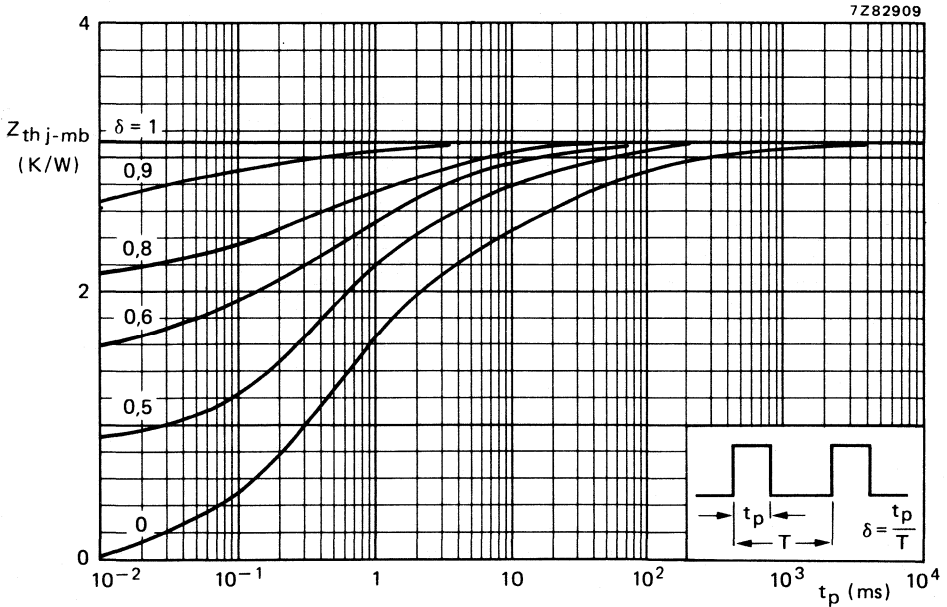


Fig. 6 Pulse power rating chart.

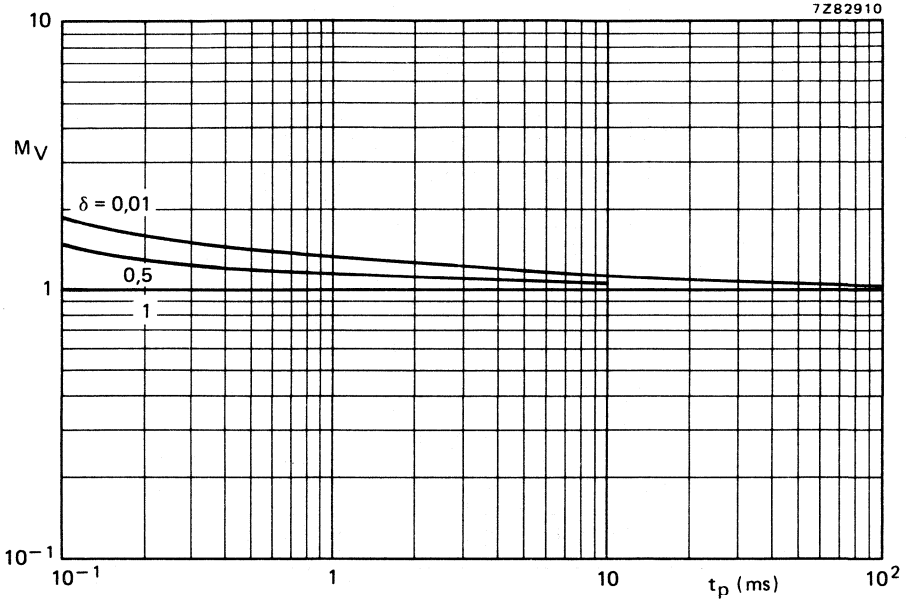


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

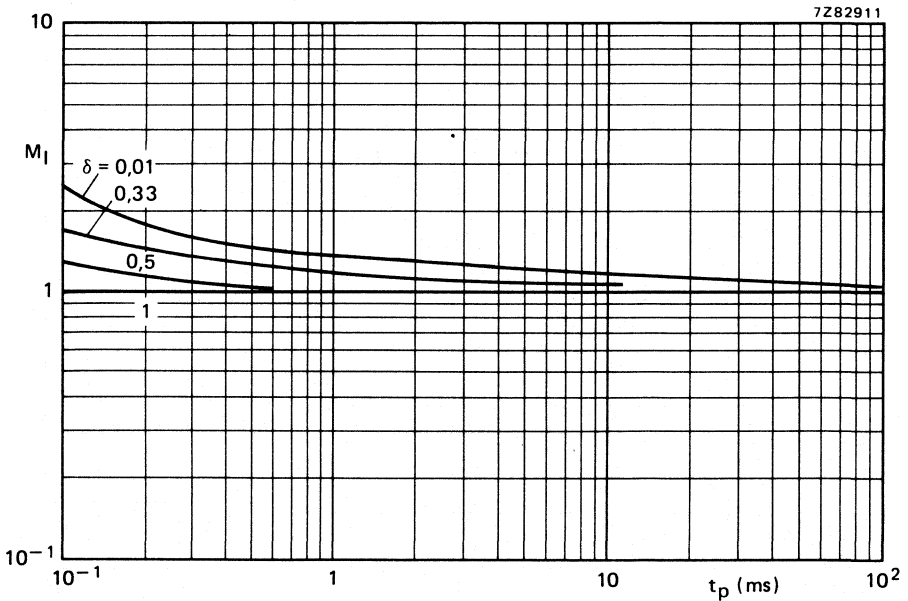


Fig. 8 S.B. current multiplying factor at the V_{CEOmax} level.

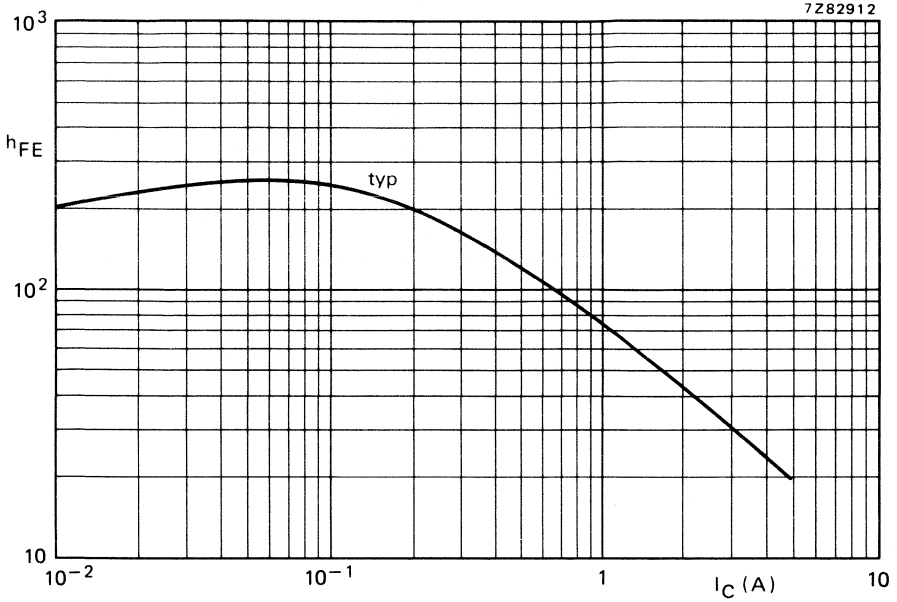


Fig. 9 Typical values d.c. current gain at $V_{CE} = 4$ V.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P transistors in a plastic TO-220 envelope. They are intended for use in a wide range of power amplifiers and for switching applications.

QUICK REFERENCE DATA

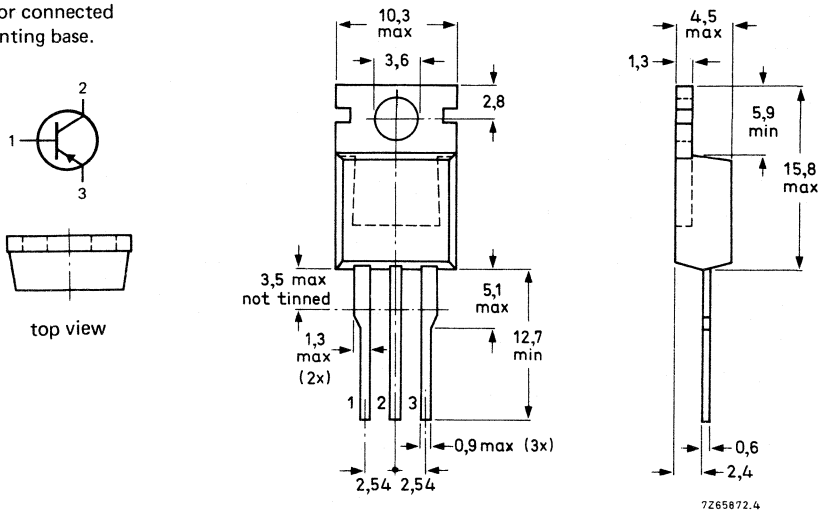
	TIP32	A	B	C	
Collector-base voltage (open emitter)	$-V_{CB0}$ max.	80	100	120	140 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	40	60	80	100 V
Collector current (d.c.)	$-I_C$ max.	3		A	
Collector current (peak value)	$-I_{CM}$ max.	5		A	
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot} max.	40		W	
Junction temperature	T_j max.	150		$^\circ\text{C}$	
D.C. current gain	h_{FE}	>		25	
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$				10 to 50	
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$					

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)

		TIP32				
		A	B	C		
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 40	60	80	100	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.	5			A
Base current	$-I_B$	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		K/W
from junction to ambient (in free air)	$R_{th\ j-a}$	=	70		K/W

CHARACTERISTICS

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

		TIP32; A		B; C		
Collector cut-off current						
$I_B = 0; -V_{CE} = 30\text{ V}$	$-I_{CEO}$	< 0,3		< mA		
$I_B = 0; -V_{CE} = 60\text{ V}$	$-I_{CEO}$	<		0,3 mA		
$V_{EB} = 0; -V_{CE} = -V_{CBO}$	$-I_{CES}$	< 0,2		< mA		
Emitter cut-off current						
$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO}$	<		1 mA		
D.C. current gain *						
$-I_C = 1\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	>		25		
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	>		10 to 50		
Base-emitter voltage **						
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE}$	<		1,8 V		
Collector-emitter saturation voltage						
$-I_C = 3\text{ A}; -I_B = 0,375\text{ A}$	$-V_{CEsat}$	<		1,2 V		
Collector-emitter breakdown voltage *						
$I_B = 0; -I_C = 30\text{ mA}$	$-V_{(BR)CEO}$	TIP32	A	B	C	
		> 40	> 60	> 80	> 100	V
Small signal current transfer ratio						
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} $	>		20		
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}; f = 1\text{ MHz}$	$ h_{fe} $	>		3		
Turn-off breakdown energy						
$L = 20\text{ mH}; I_{CC} = 1,22\text{ A}$	$E_{(BR)}$	>		15 mJ		

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

** V_{EB} decreases by about 2,3 mV/K with increasing temperature.

Switching times

(between 10% and 90% levels)

$-I_{Con} = 1 \text{ A}; -I_{B on} = I_{B off} = 0,1 \text{ A}$

Turn-on time

Turn-off time

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

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

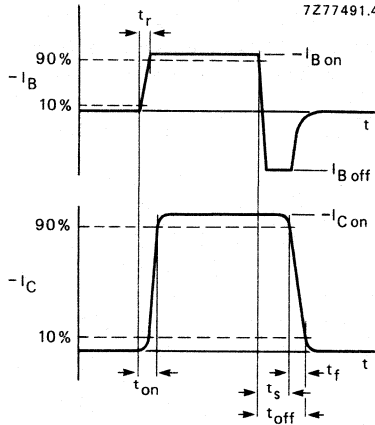


Fig. 2 Switching times waveforms.

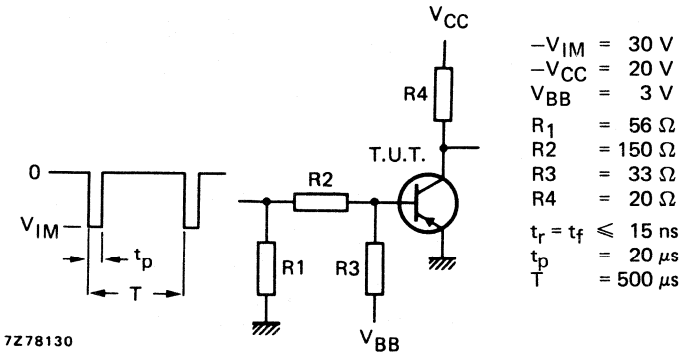


Fig. 3 Switching times test circuit.

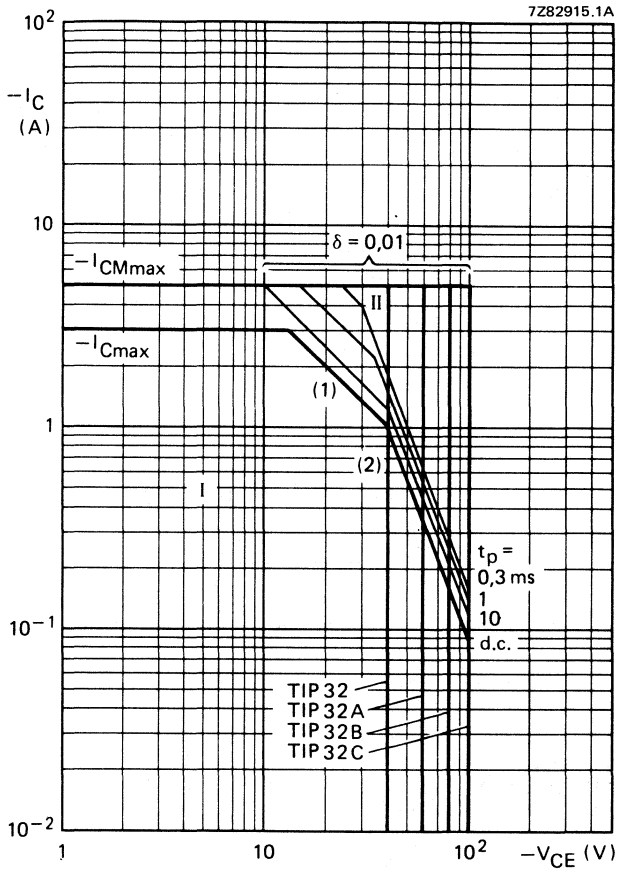


Fig. 4 Safe Operating Area; $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

- 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).

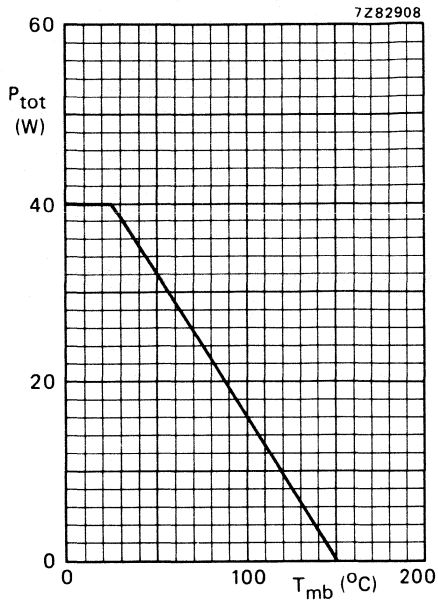


Fig. 5 Power derating curve.

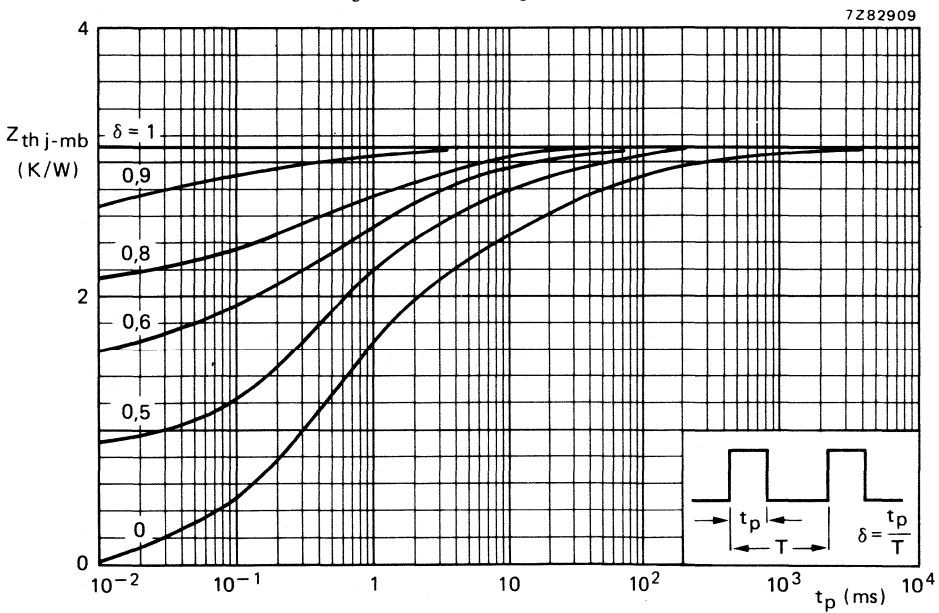


Fig. 6 Pulse power rating chart.

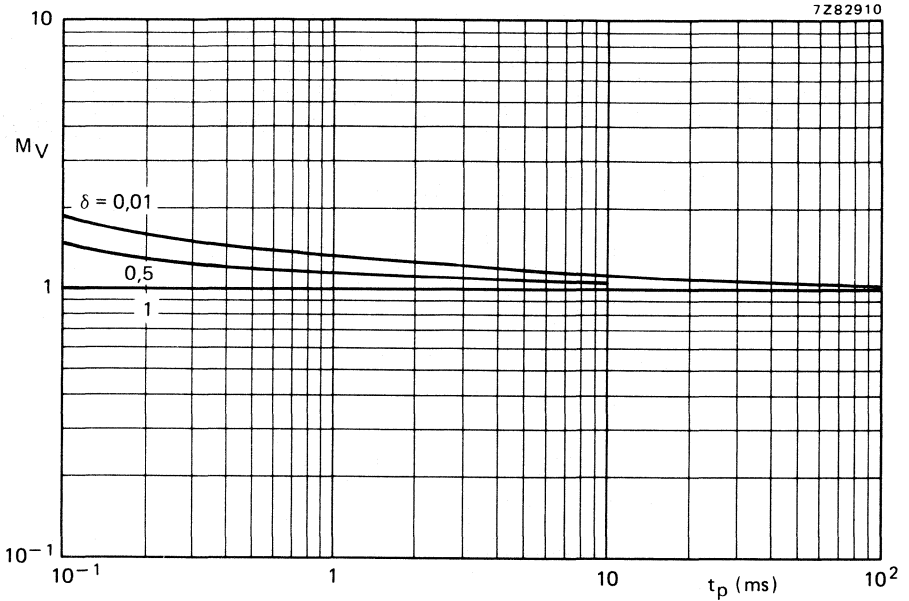


Fig. 7 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

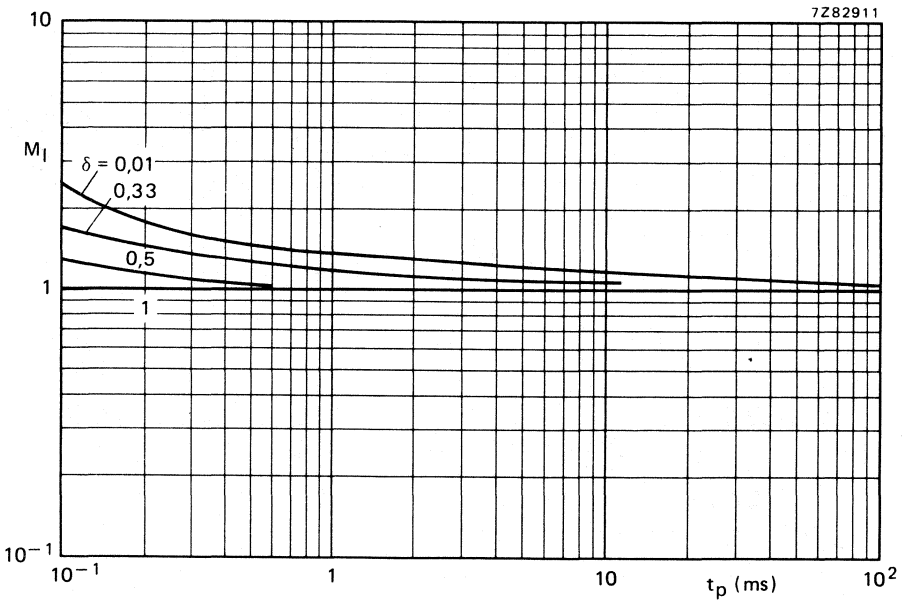


Fig. 8 S.B. current multiplying factor at the $-V_{CEmax}$ level.

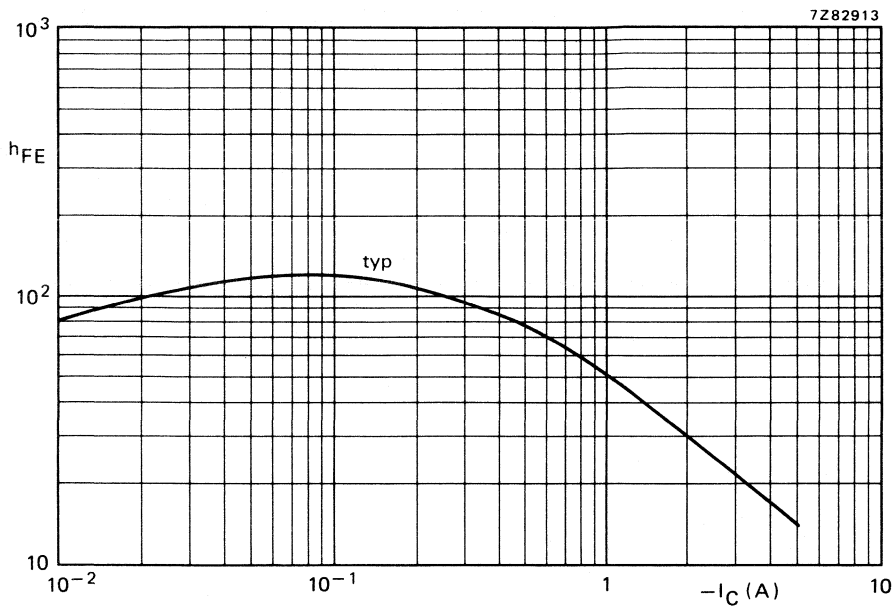


Fig. 9 Typical d.c. current gain at $-V_{CE} = 4$ V; $T_j = 25$ °C.

SILICON POWER TRANSISTORS

N-P-N epitaxial-base power transistors in the plastic SOT-93 envelope. These transistors are intended for use in audio output stages and general amplifier and switching applications. P-N-P complements are TIP34, TIP34A, TIP34B and TIP34C.

QUICK REFERENCE DATA

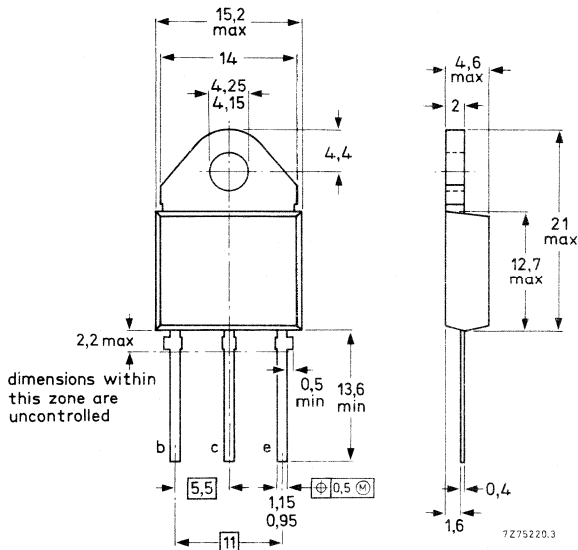
			TIP33	33A	33B	33C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Collector current (d.c.)	I_C	max.			10		A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}	max.			15		A
Power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.			80		W
D.C. current gain	h_{FE}				20 to 100		
$V_{CE} = 4$ V; $I_C = 3$ A	Collector-emitter saturation voltage	$V_{CEsat} <$			1		V
$I_C = 3$ A; $I_B = 0,3$ A							

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



RATINGS

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

			TIP33	33A	33B	33C
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100 V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5 V
Collector current (d.c.)	I_C	max.			10	A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}	max.			15	A
Base current (d.c.)	I_B	max.			3	A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.			80	W
Total power dissipation in free air	P_{tot}	max.			3,5	W
Storage temperature	T_{stg}				-65 to + 150	°C
Junction temperature	T_j	max.			150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th j-mb}$	=			1,56	K/W
From junction to ambient in free air	$R_{th j-a}$	=			35,7	K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off currents

$V_{CE} = V_{CBOmax}; I_B = 0$		I_{CES}	<		0,4	mA
$V_{CE} = 30$ V; $I_B = 0$	TIP33	I_{CEO}	<		0,7	mA
	TIP33A	I_{CEO}	<		0,7	mA
$V_{CE} = 60$ V; $I_B = 0$	TIP33B	I_{CEO}	<		0,7	mA
	TIP33C	I_{CEO}	<		0,7	mA

Emitter cut-off current

$V_{EB} = 5$ V; $I_C = 0$		I_{EBO}	<		1	mA
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Collector-emitter sustaining voltage

$I_C = 30$ mA; $I_B = 0$	TIP33	$V_{CEOsust}$	>		40	V
	TIP33A	$V_{CEOsust}$	>		60	V
	TIP33B	$V_{CEOsust}$	>		80	V
	TIP33C	$V_{CEOsust}$	>		100	V

D.C. current gain

$V_{CE} = 4$ V; $I_C = 1$ A		h_{FE}	>		40	
$V_{CE} = 4$ V; $I_C = 3$ A		h_{FE}			20 to 100	

Base-emitter voltage

$V_{CE} = 4$ V; $I_C = 3$ A		V_{BE}	<		1,6	V
$V_{CE} = 4$ V; $I_C = 10$ A		V_{BE}	<		3	V

Collector-emitter saturation voltage

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

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

$I_C = 10 \text{ A}; I_B = 2,5 \text{ A}$

$V_{CEsat} < 4 \text{ V}$

Small-signal current gain

$V_{CE} = 10 \text{ V}; I_C = 0,5 \text{ A}; f = 1 \text{ kHz}$

$h_{fe} > 20$

Transition frequency

$V_{CE} = 10 \text{ V}; I_C = 0,5 \text{ A}; f = 1 \text{ MHz}$

$f_T > 3 \text{ MHz}$

Turn-off breakdown energy (see Fig. 2)

$L = 20 \text{ mH}; I_C = 2,5 \text{ A}$

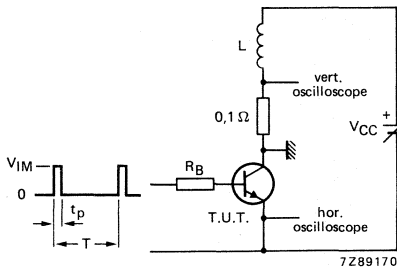
$E_{(BR)} > 62,5 \text{ mJ}$

Switching times (see Figs 3 and 4)

$I_C = 6 \text{ A}; I_{Bon} = -I_{Boff} = 0,6 \text{ A}; V_{CC} = 30 \text{ V}$

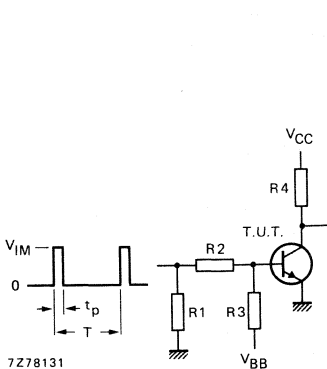
turn-on time t_{on} typ. 0,6 μs

turn-off time t_{off} typ. 1,7 μs



$V_{IM} = 12 \text{ V}$
 $R_B = 270 \Omega$
 $L = 20 \text{ mH}$
 $I_{CC} = 2,5 \text{ A}$
 $\delta \leq 1 \%$
 $t_p = 1 \text{ ms}$

Fig. 2 Test circuit for turn-off breakdown energy.



$V_{IM} = 47 \text{ V}$
 $V_{CC} = 30 \text{ V}$
 $-V_{BB} = 4 \text{ V}$
 $R_1 = 56 \Omega$
 $R_2 = 39 \Omega$
 $R_3 = 10 \Omega$
 $R_4 = 5 \Omega$
 $t_r = t_f = 15 \text{ ns}$
 $t_p = 10 \mu\text{s}$
 $T = 500 \mu\text{s}$

Fig. 3 Switching times test circuit.

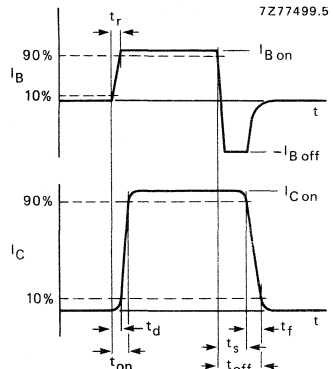


Fig. 4 Switching times waveforms.

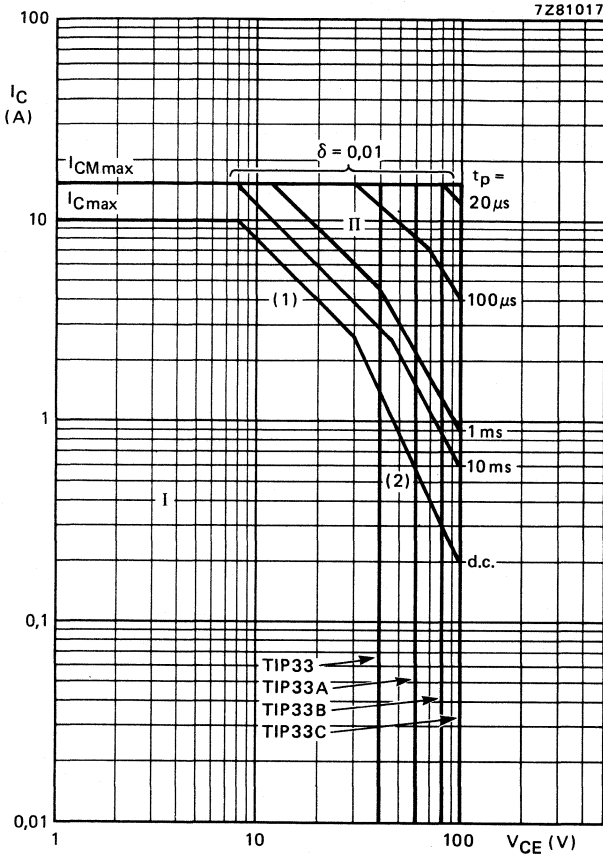


Fig. 5 Safe Operating Area at $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

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

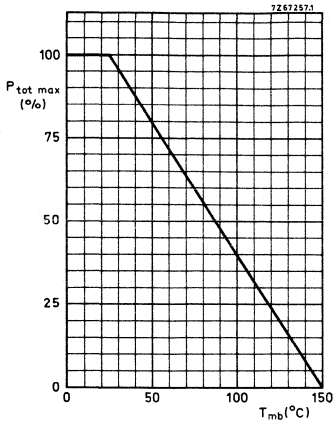


Fig. 6 Power derating curve.

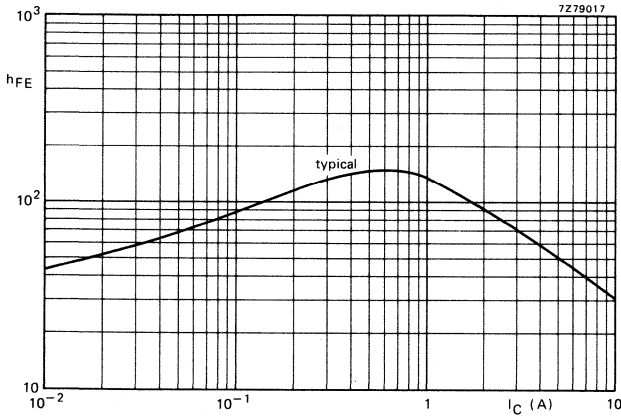


Fig. 7 $V_{CE} = 4\ V$; $T_j = 25\ ^\circ C$.

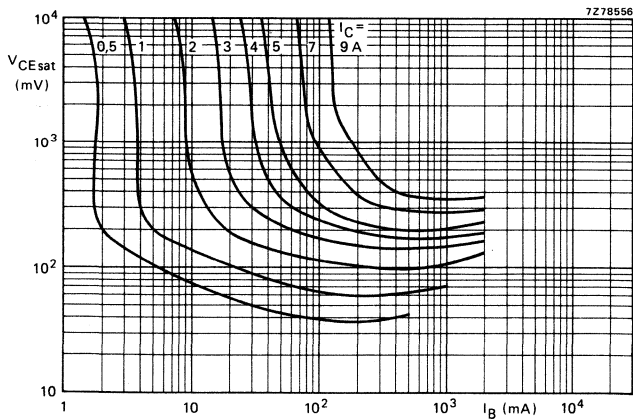


Fig. 8 Typical collector-emitter saturation voltage; $T_j = 25\ ^\circ C$.

SILICON POWER TRANSISTORS

P-N-P epitaxial-base power transistors in the plastic SOT-93 envelope. These transistors are intended for use in audio output stages and general amplifier and switching applications. N-P-N complements are TIP33, TIP33A, TIP33B and TIP33C.

QUICK REFERENCE DATA

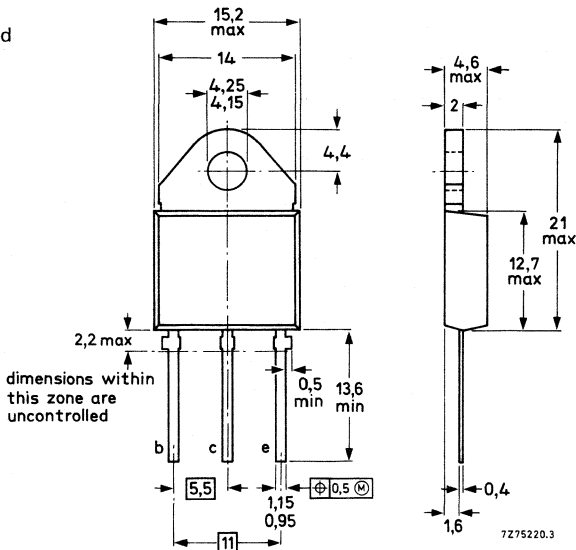
		TIP34	34A	34B	34C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 40	60	80	100	V
Collector current (d.c.)	$-I_C$			10		A
Collector current (peak value); $t_p \leq 0,3$ ms	$-I_{CM}$			15		A
Power dissipation up to $T_{mb} = 25$ °C	P_{tot}			80		W
D.C. current gain				20 to 100		
$-V_{CE} = 4$ V; $-I_C = 3$ A	h_{FE}					
Collector-emitter saturation voltage						
$-I_C = 3$ A; $-I_B = 0,3$ A	$-V_{CEsat}$	<		1		V

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



RATINGS

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

			TIP34	34A	34B	34C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V
Collector current (d.c.)	$-I_C$	max.			10		A
Collector current (peak value); $t_p \leq 0,3$ ms	$-I_{CM}$	max.			15		A
Base current (d.c.)	$-I_B$	max.			3		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.			80		W
Total power dissipation in free air	P_{tot}	max.			3,5		W
Storage temperature	T_{stg}				-65 to +150		°C
Junction temperature	T_j	max.			150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th j-mb}$	=			1,56		K/W
From junction to ambient in free air	$R_{th j-a}$	=			35,7		K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off currents

$-V_{CE} = -V_{CBOmax}; V_{BE} = 0$		$-I_{CES}$	<		0,4		mA
$-V_{CE} = 30$ V; $I_B = 0$	TIP34	$-I_{CEO}$	<		0,7		mA
	TIP34A	$-I_{CEO}$	<		0,7		mA
$-V_{CE} = 60$ V; $I_B = 0$	TIP34B	$-I_{CEO}$	<		0,7		mA
	TIP34C	$-I_{CEO}$	<		0,7		mA

Emitter cut-off current

$-V_{EB} = 5$ V; $I_C = 0$		$-I_{EBO}$	<		1		mA
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Collector-emitter sustaining voltage

$-I_C = 30$ mA; $I_B = 0$	TIP34	$-V_{CEO_{sust}}$	>		40		V
	TIP34A	$-V_{CEO_{sust}}$	>		60		V
	TIP34B	$-V_{CEO_{sust}}$	>		80		V
	TIP34C	$-V_{CEO_{sust}}$	>		100		V

D.C. current gain

$-V_{CE} = 4$ V; $-I_C = 1$ A		h_{FE}	>		40		
$-V_{CE} = 4$ V; $-I_C = 3$ A		h_{FE}			20 to 100		

Base-emitter voltage

$-V_{CE} = 4$ V; $-I_C = 3$ A		$-V_{BE}$	<		1,6		V
$-V_{CE} = 4$ V; $-I_C = 10$ A		$-V_{BE}$	<		3		V

Collector-emitter saturation voltage

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

$-I_C = 10 \text{ A}; -I_B = 2,5 \text{ A}$

Small-signal current gain

$-V_{CE} = 10 \text{ V}; -I_C = 0,5 \text{ A}; f = 1 \text{ kHz}$

Transition frequency

$-V_{CE} = 10 \text{ V}; -I_C = 0,5 \text{ A}; f = 1 \text{ MHz}$

Turn-off breakdown energy (see Fig. 2)

$L = 20 \text{ mH}; -I_C = 2,5 \text{ A}$

Switching times (see Figs 3 and 4)

$-I_C = 6 \text{ A}; -I_{B\text{on}} = +I_{B\text{off}} = 0,6 \text{ A}; -V_{CC} = 30 \text{ V}$

turn-on time

turn-off time

$-V_{CE\text{sat}} < 1 \text{ V}$

$-V_{CE\text{sat}} < 4 \text{ V}$

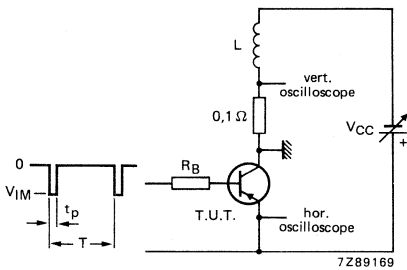
$h_{fe} > 20$

$f_T > 3 \text{ MHz}$

$E_{(BR)} > 62,5 \text{ mJ}$

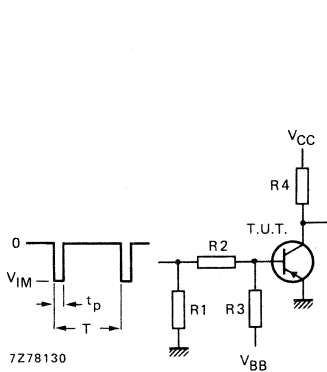
$t_{\text{on}} \text{ typ. } 0,4 \text{ } \mu\text{s}$

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



$-V_{IM} = 12 \text{ V}$
 $R_B = 270 \text{ } \Omega$
 $L = 20 \text{ mH}$
 $-I_{CC} = 2,5 \text{ A}$
 $t_p = 1 \text{ ms}$
 $\delta = 1 \%$

Fig. 2 Test circuit for turn-off breakdown energy.



$-V_{IM} = 47 \text{ V}$
 $-V_{CC} = 30 \text{ V}$
 $V_{BB} = 4 \text{ V}$
 $R_1 = 56 \text{ } \Omega$
 $R_2 = 39 \text{ } \Omega$
 $R_3 = 10 \text{ } \Omega$
 $R_4 = 5 \text{ } \Omega$
 $t_r = t_f = 15 \text{ ns}$
 $t_p = 10 \text{ } \mu\text{s}$
 $T = 500 \text{ } \mu\text{s}$

Fig. 3 Switching times test circuit.

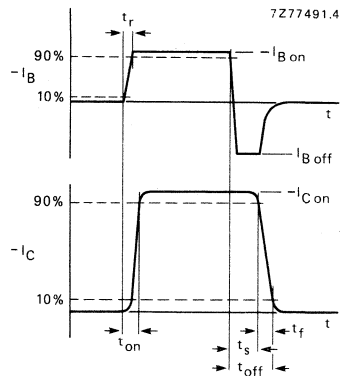


Fig. 4 Switching times waveforms.

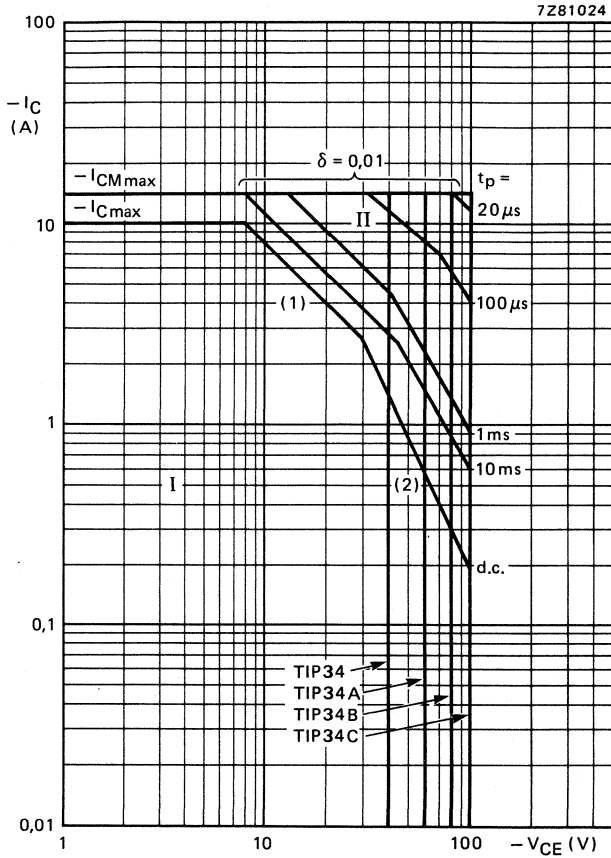


Fig. 5 Safe Operating Area at $T_{mb} = 25^\circ C$.

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

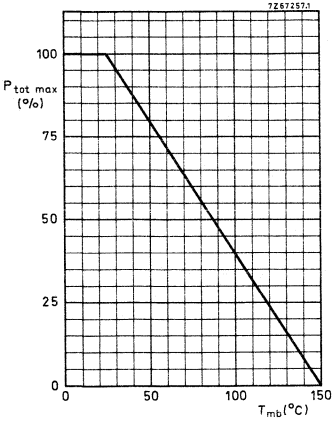


Fig. 6 Power derating curve.

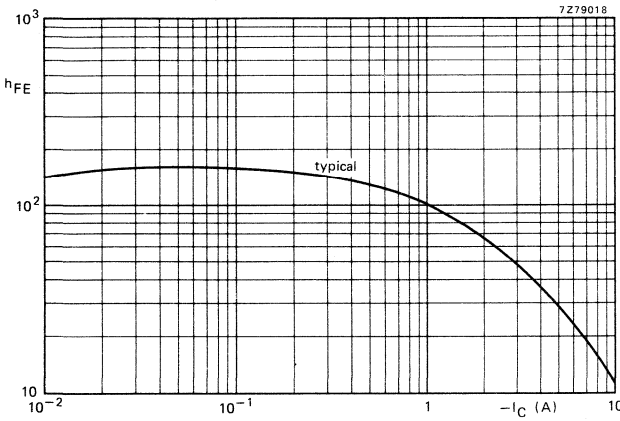


Fig. 7 $-V_{CE} = 4\ V$; $T_j = 25\ ^\circ C$.

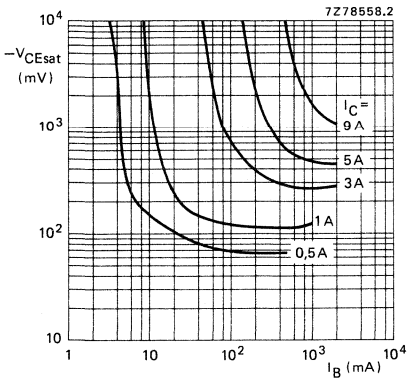


Fig. 8 Typical collector-emitter saturation voltage. $T_j = 25\ ^\circ C$.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in general purpose amplifier and switching applications.

QUICK REFERENCE DATA

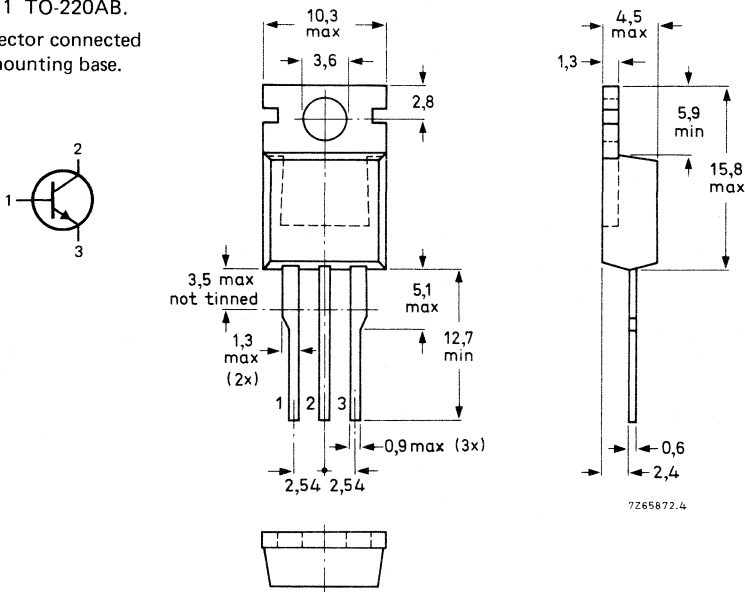
		TIP41	A	B	C
Collector-base voltage (open emitter)	V_{CBO}	max. 80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO}	max. 40	60	80	100 V
Collector current (d.c.)	I_C	max.	6		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	65		W
Junction temperature	T_j	max.	150		$^\circ\text{C}$
D.C. current gain $I_C = 3\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}		15 to 75		

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)

			TIP41	A	B	C
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100 V
Emitter-base voltage (open collector)	V_{EBO}	max.	5			V
Collector current (d.c.)	I_C	max.	6			A
Collector current (peak value)	I_{CM}	max.	10			A
Base current (d.c.)	I_B	max.	3			A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	65			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	$R_{th\ j-mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	70	K/W

CHARACTERISTICS

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

			TIP41; A	B; C		
Collector cut-off current						
$I_B = 0; V_{CE} = 30\text{ V}$	I_{CEO}	<	0,7	—	mA	
$I_B = 0; V_{CE} = 60\text{ V}$	I_{CEO}	<	—	0,7	mA	
$V_{BE} = 0; V_{CE} = V_{CBOmax}$	I_{CES}	<	0,4		mA	
Emitter cut-off current						
$I_C = 0; V_{EB} = 5\text{ V}$	I_{EBO}	<	1		mA	
D.C. current gain*						
$I_C = 0,3\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>	30			
$I_C = 3\text{ A}; V_{CE} = 4\text{ V}$	h_{FE}	>	15 to 75			
Base-emitter voltage**						
$I_C = 6\text{ A}; V_{CE} = 4\text{ V}$	V_{BE}	<	2		V	
Collector-emitter saturation voltage*						
$I_C = 6\text{ A}; I_B = 0,6\text{ A}$	V_{CEsat}	<	1,5		V	
Collector-emitter breakdown voltage*						
$I_B = 0; I_C = 30\text{ mA}$	$V_{(BR)CEO}$	>	TIP41	A	B	C
			40	60	80	100 V
Small-signal current transfer ratio						
$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} $	>	20			
Transition frequency at $f = 1\text{ MHz}$						
$I_C = 0,5\text{ A}; V_{CE} = 10\text{ V}$	f_T	>	3			MHz

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

** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Turn-off breakdown energy with inductive load (Fig. 4)

$-I_{B\text{off}} = 0; I_{CC} = 2,5 \text{ A}$

$E_{(BR)} > 62,5 \text{ mJ}$

Switching times

(between 10% and 90% levels)

$I_{C\text{on}} = 6 \text{ A}; I_{B\text{on}} = -I_{B\text{off}} = 0,6 \text{ A}$

Turn-on time

$t_{\text{on}} \text{ typ. } 0,6 \mu\text{s}$

Turn-off time

$t_{\text{off}} \text{ typ. } 1 \mu\text{s}$

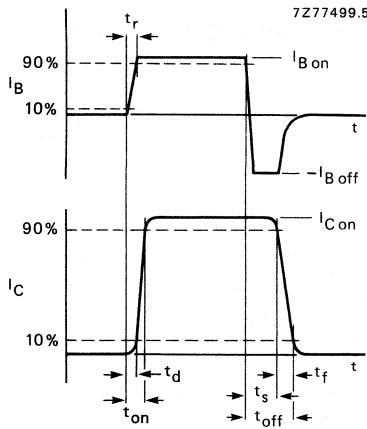


Fig. 2 Switching times waveforms.

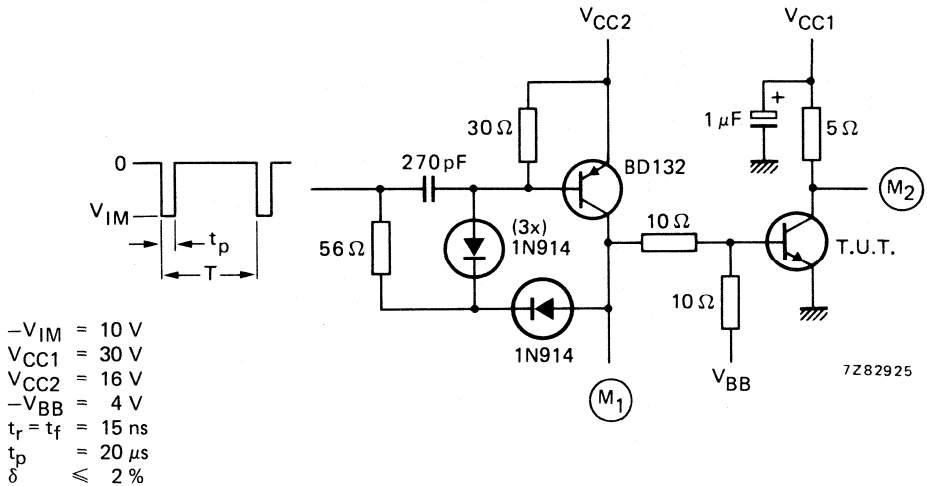


Fig. 3 Switching times test circuit.
Adjust V_{CC2} so that the input to $M_1 = 14 \text{ V}$.

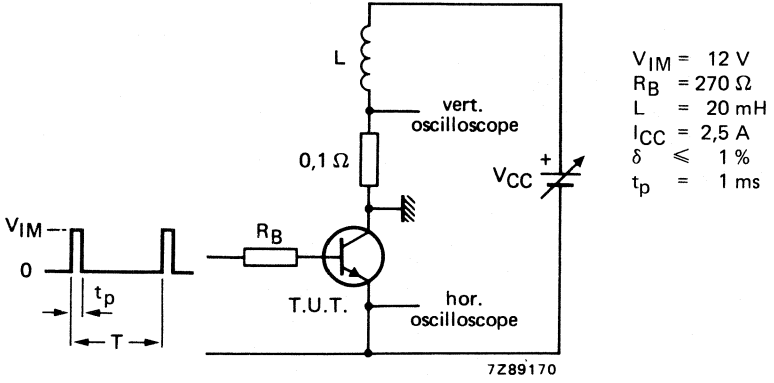


Fig. 4 Test circuit for turn-off breakdown energy.

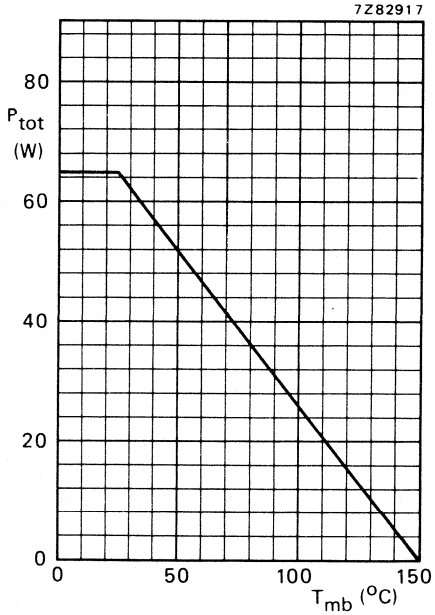


Fig. 5 Power derating curve.

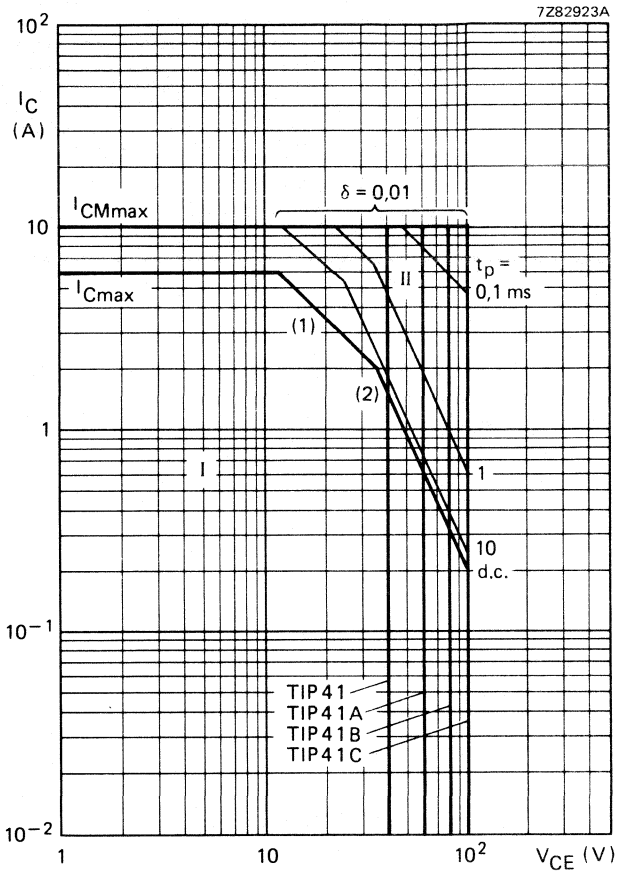


Fig. 6 Safe Operating ARea, $T_{mb} = 25 \text{ }^\circ\text{C}$.

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).

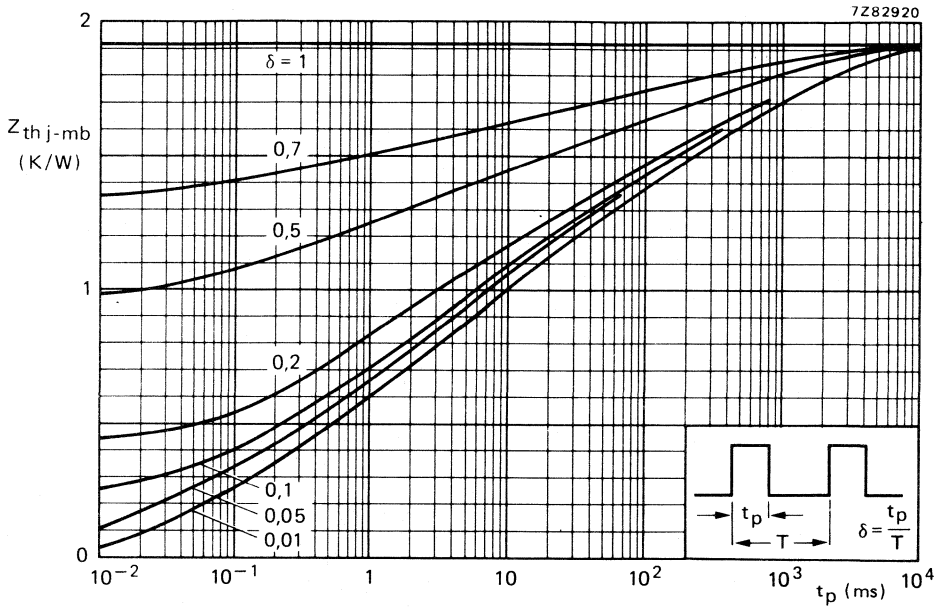


Fig. 7 Pulse power rating chart.

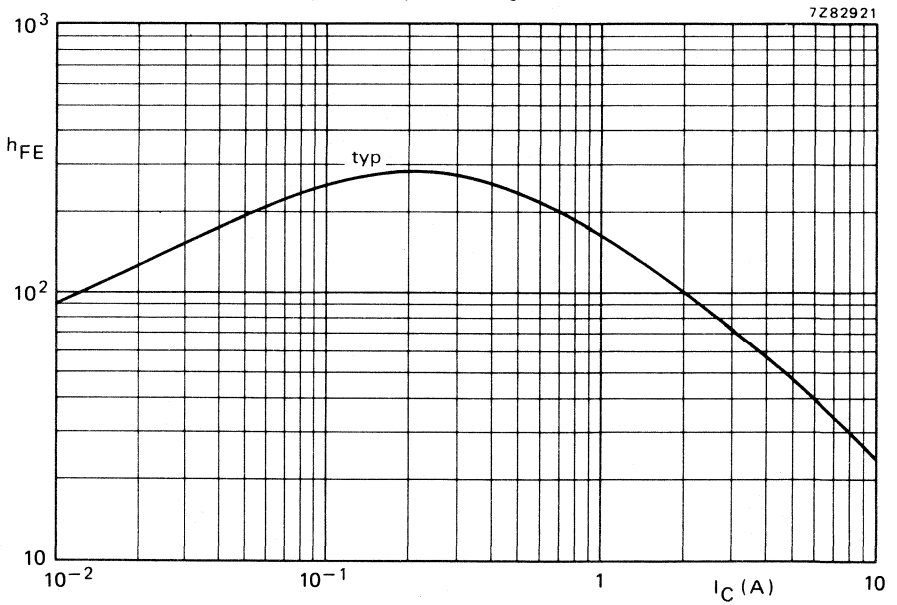


Fig. 8 D.C. current gain at $V_{CE} = 4$ V; $T_j = 25$ °C.

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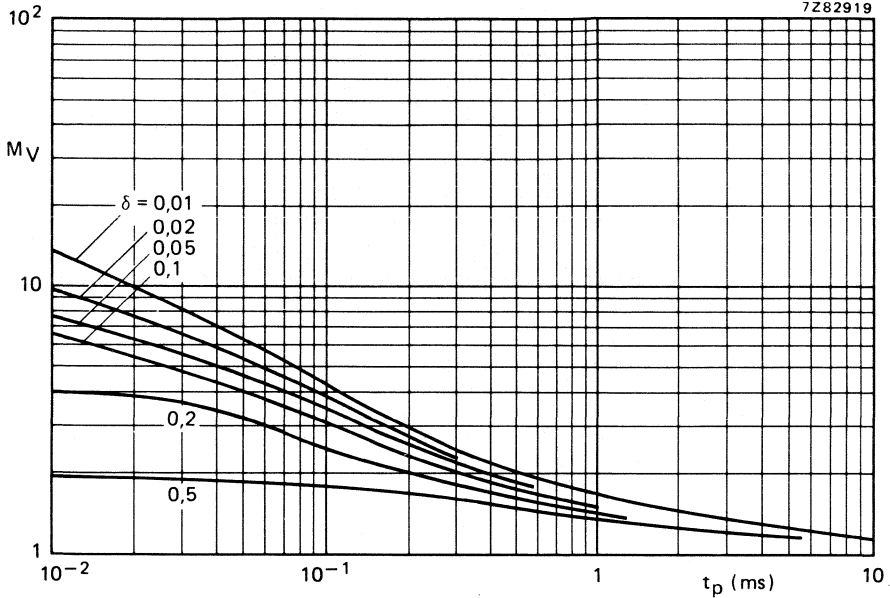


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

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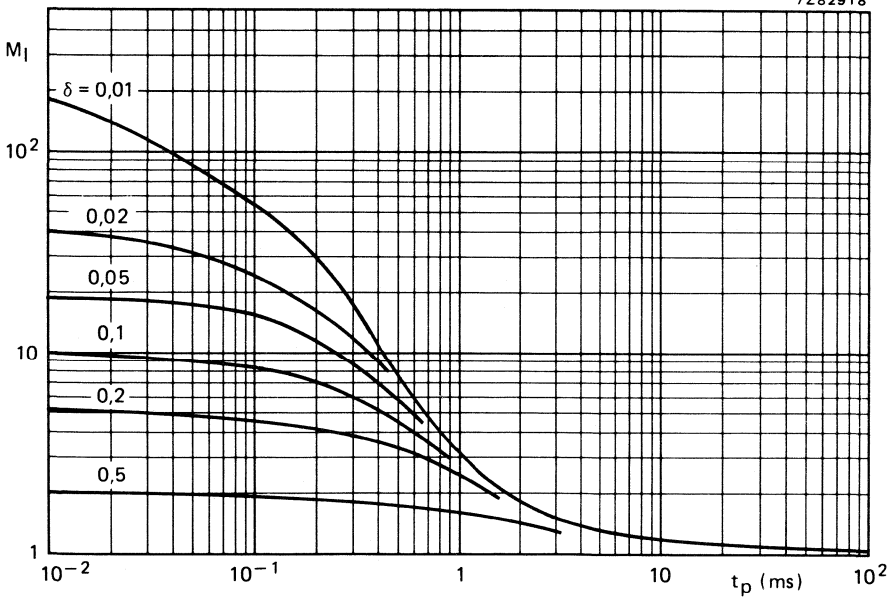


Fig. 10 S.B. current multiplying factor at the V_{CE0max} level.

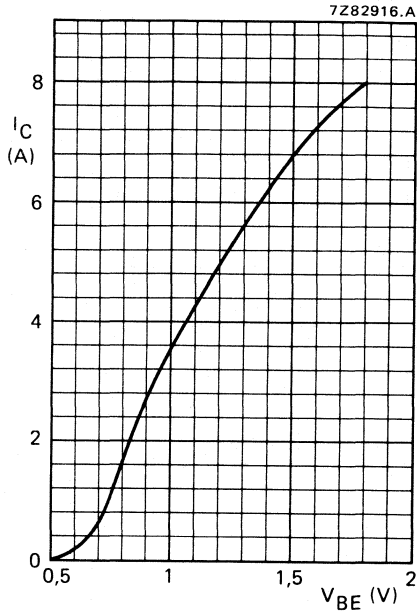


Fig. 11 Typical collector current.
 $V_{CE} = 4 \text{ V}; T_J = 25 \text{ }^\circ\text{C}.$

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in general output stages of amplifier circuits and switching applications.

QUICK REFERENCE DATA

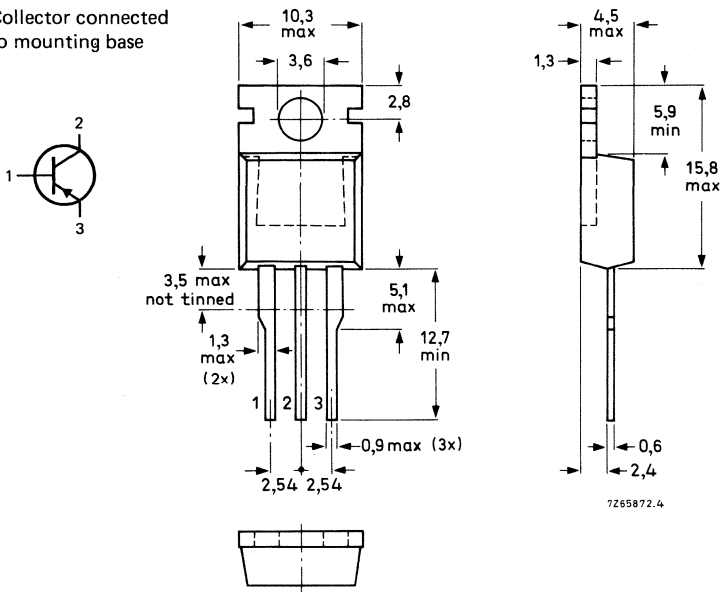
		TIP42	A	B	C
Collector-base voltage	$-V_{CBO}$	max. 80	100	120	140 V
Collector-emitter voltage	$-V_{CEO}$	max. 40	60	80	100 V
Collector current (d.c.)	$-I_C$	max.	6		A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	P_{tot}	max.	65		W
Junction temperature	T_j	max.	150		$^\circ\text{C}$
D.C. current gain	h_{FE}		15 to 75		

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)

			TIP42	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	100	120	140	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5				V
Collector current (d.c.)	$-I_C$	max.	6				A
Collector current (peak value)	$-I_{CM}$	max.	10				A
Base current (d.c.)	$-I_B$	max.	3				A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	65				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	$R_{th\ j-mb}$	=		1,92		K/W
From junction to ambient in free air	$R_{th\ j-a}$	=		70		K/W

CHARACTERISTICS

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

			TIP42; A		B; C	
Collector cut-off current						
$I_B = 0; -V_{CE} = 30\text{ V}$	$-I_{CEO}$	<	0,7		-	mA
$I_B = 0; -V_{CE} = 60\text{ V}$	$-I_{CEO}$	<	-		0,7	mA
$V_{BE} = 0; -V_{CE} = -V_{CBOmax}$	$-I_{CES}$	<	0,4			mA
Emitter cut-off current						
$I_C = 0; -V_{EB} = 5\text{ V}$	$-I_{EBO}$	<			1	mA
D.C. current gain*						
$-I_C = 300\text{ mA}; -V_{CE} = 4\text{ V}$	h_{FE}	>			30	
$-I_C = 3\text{ A}; -V_{CE} = 4\text{ V}$	h_{FE}	.			15 to 75	
Base-emitter voltage**						
$-I_C = 6\text{ A}; -V_{CE} = 4\text{ V}$	$-V_{BE}$	<			2	V
Collector-emitter saturation voltage*						
$-I_C = 6\text{ A}; -I_B = 0,6\text{ A}$	$-V_{CEsat}$	<			1,5	V
Collector-emitter breakdown voltage*			TIP42	A	B	C
$I_B = 0; -I_C = 30\text{ mA}$	$-V_{(BR)CEO}$	>	40	60	80	100
Transition frequency at $f = 1\text{ MHz}$						
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$	f_T	>			3	MHz
Small signal current transfer ratio						
$-I_C = 0,5\text{ A}; -V_{CE} = 10\text{ V}; f = 1\text{ kHz}$	$ h_{fe} $	>			20	

* Measured under pulse conditions: $t_p \leq 300\ \mu\text{s}; \delta < 2\%$.

** V_{EB} decreases by about 2,3 mV/K with increasing temperature.

Turn-off breakdown energy with inductive load (Fig. 4)

$$I_{B\text{off}} = 0; -I_{CC} = 2,5 \text{ A}$$

$$E_{(BR)} > 62,5 \text{ mJ}$$

Switching times

$$-I_{C\text{on}} = 6 \text{ A}; -I_{B\text{on}} = I_{B\text{off}} = 0,6 \text{ A}$$

$$t_{\text{on}} \quad \text{typ.} \quad 0,4 \mu\text{s}$$

turn-on time

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

turn-off time

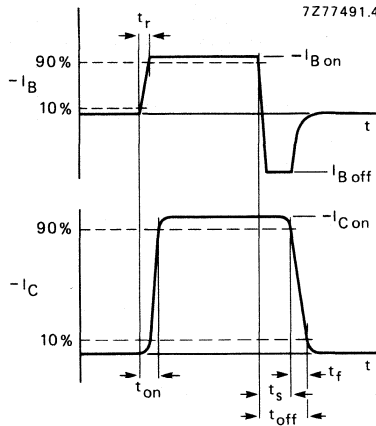
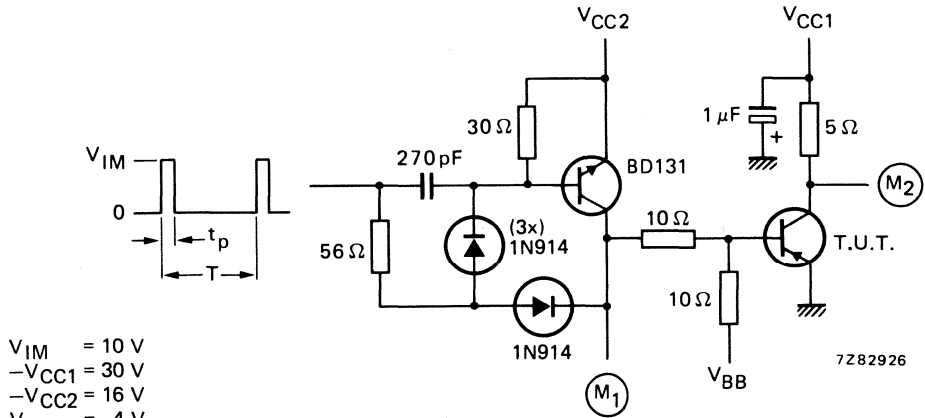
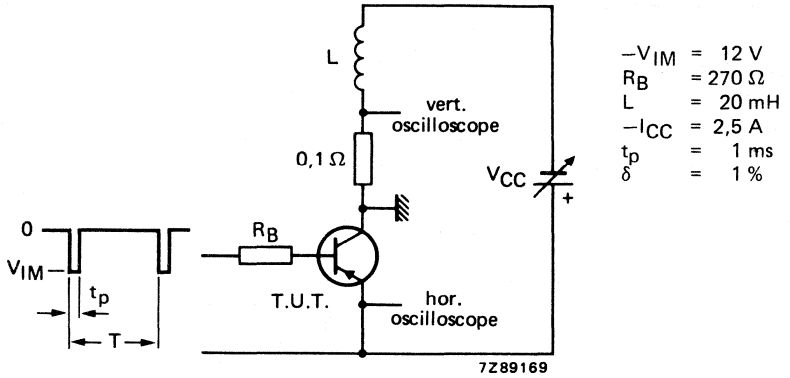


Fig. 2 Switching times waveforms.



- $V_{IM} = 10 \text{ V}$
- $-V_{CC1} = 30 \text{ V}$
- $-V_{CC2} = 16 \text{ V}$
- $V_{BB} = 4 \text{ V}$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 20 \mu\text{s}$
- $\delta \leq 2 \%$

Fig. 3 Switching times test circuit.
Adjust V_{CC2} so that the input to M1 = 14 V.



- $-V_{IM} = 12\text{ V}$
- $R_B = 270\ \Omega$
- $L = 20\text{ mH}$
- $-I_{CC} = 2,5\text{ A}$
- $t_p = 1\text{ ms}$
- $\delta = 1\%$

Fig. 4 Test circuit for turn-off breakdown energy.

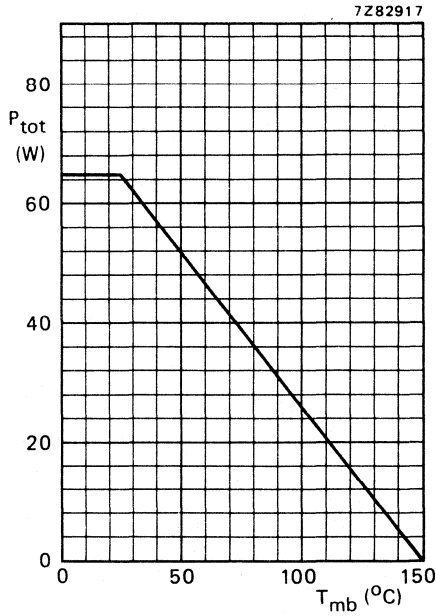


Fig. 5 Power derating curve.

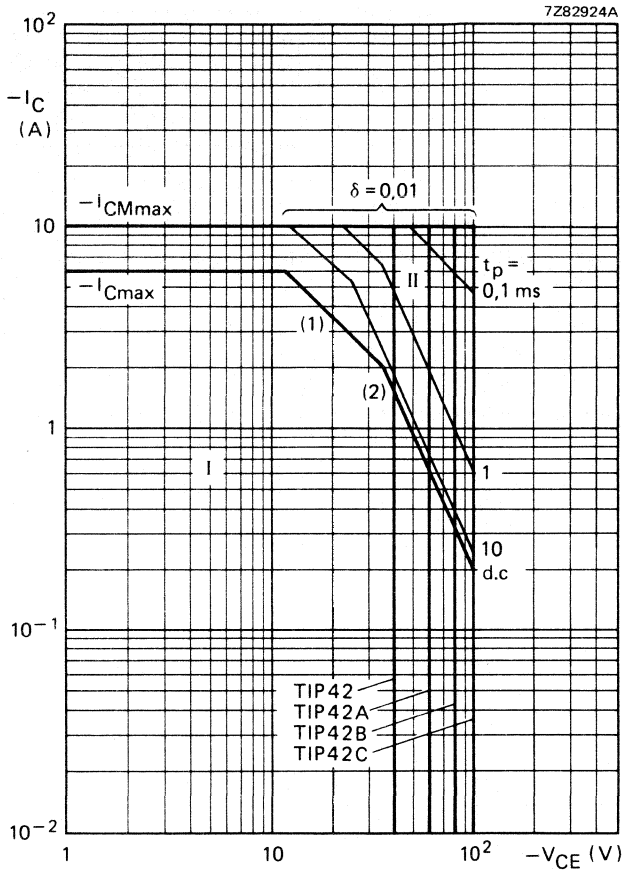


Fig. 6 Safe Operating Area; $T_{mb} = 25^\circ\text{C}$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(2) $P_{tot \text{ max}}$ and $P_{peak \text{ max}}$ lines.

(3) Second breakdown limits independent of temperature.

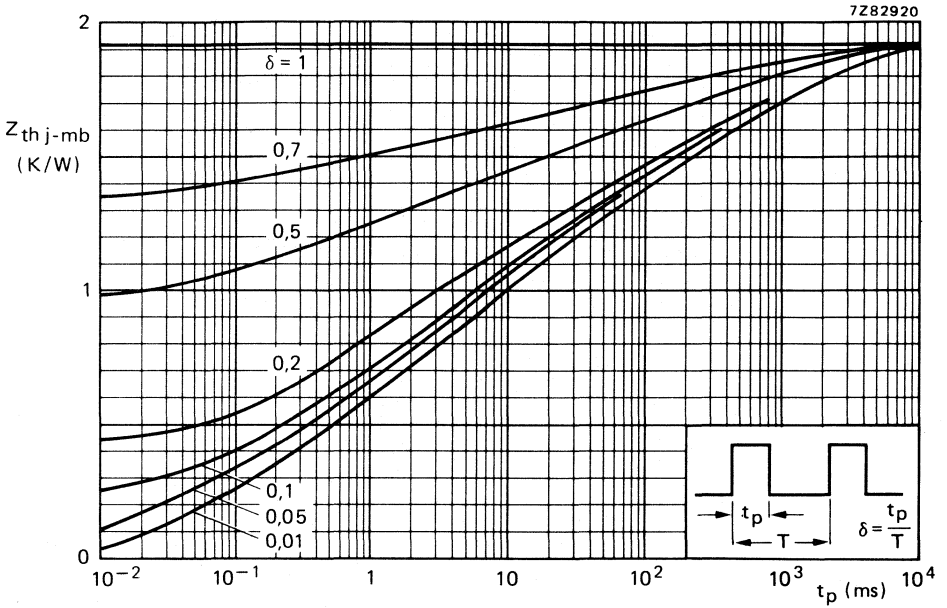


Fig. 7 Pulse power rating chart.

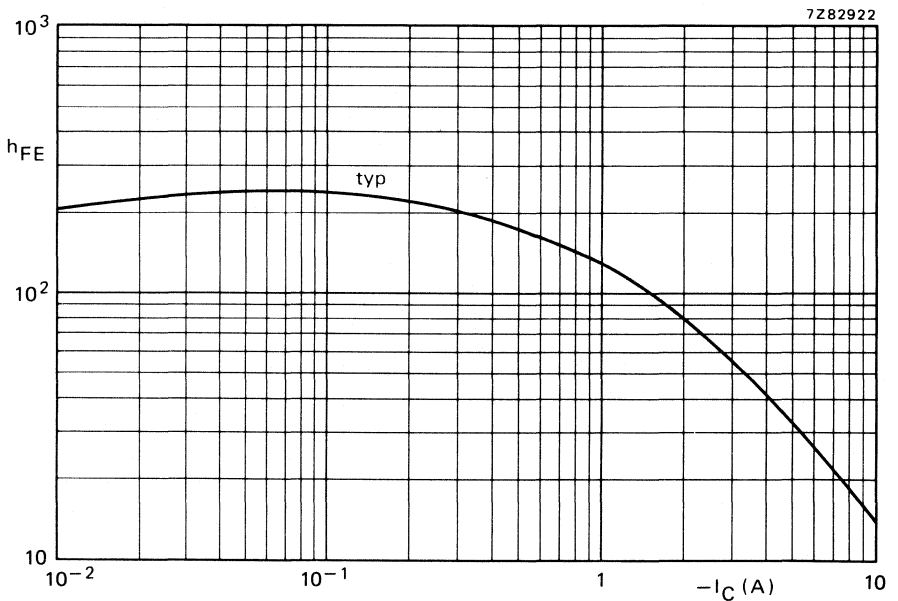


Fig. 8 Typical values d.c. current gain. $-V_{CE} = 4$ V; $T_j = 25$ °C.

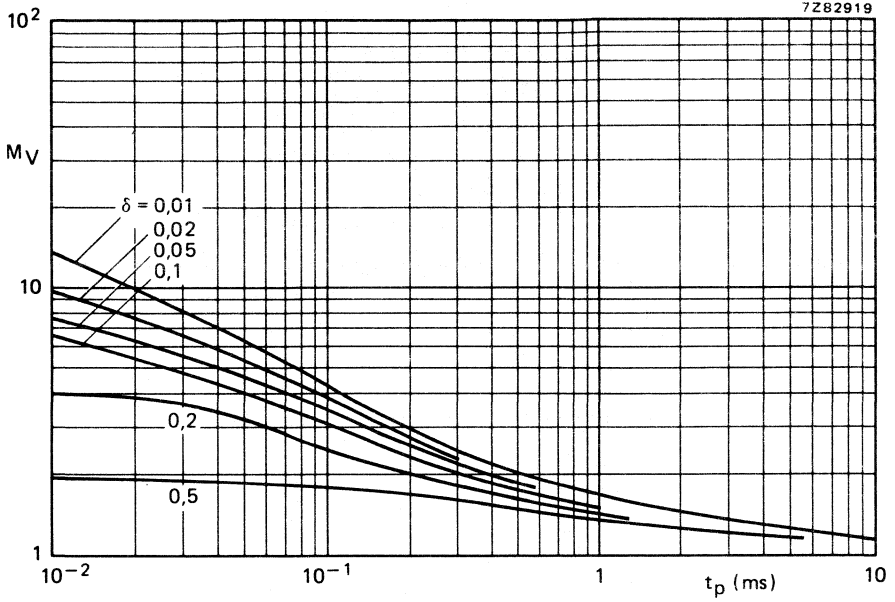


Fig. 9 Second breakdown voltage multiplying factor at the I_{Cmax} level.

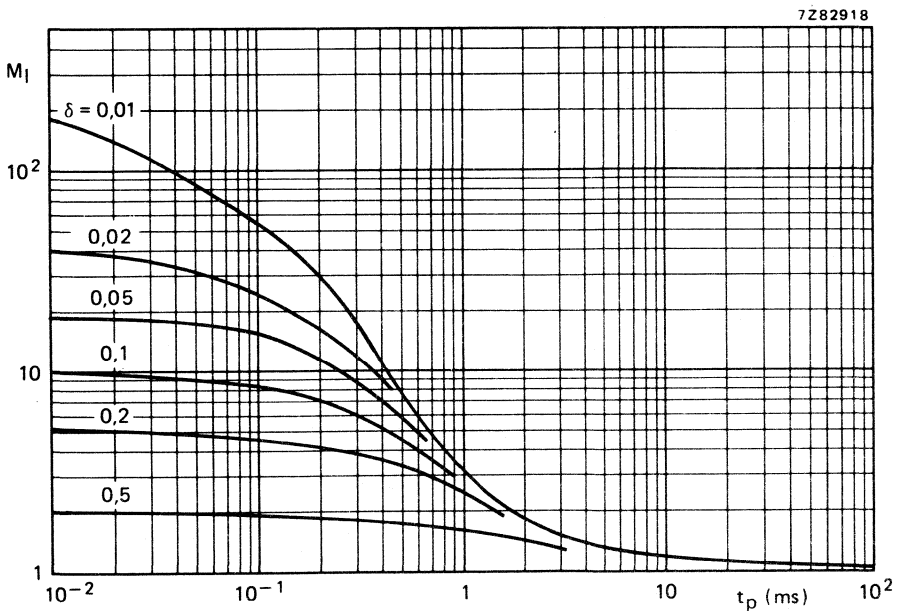


Fig. 10 Second breakdown current multiplying factor at the V_{CEOmax} level.

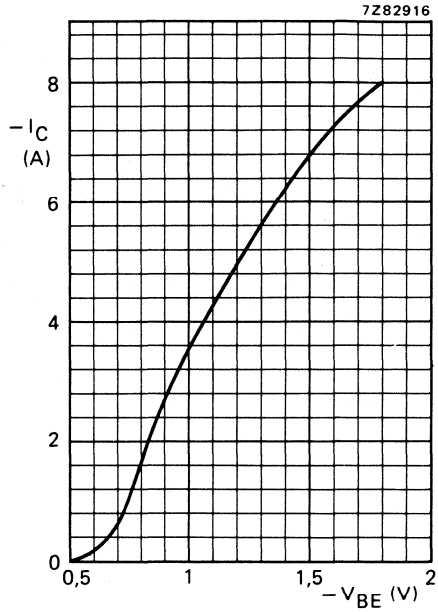


Fig. 11 Typical collector current.
 $-V_{CE} = 4 \text{ V}; T_j = 25 \text{ }^\circ\text{C}.$

SILICON DIFFUSED POWER TRANSISTORS

Medium-voltage, high-speed, glass-passivated n-p-n power transistors in TO-220 envelope for amplifier and switching applications.

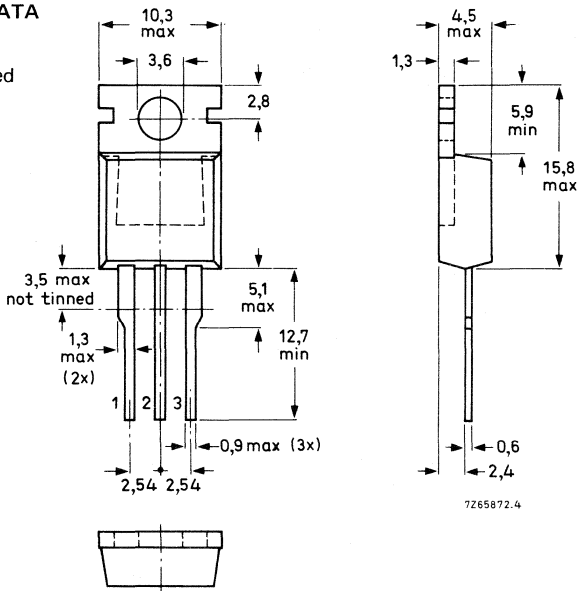
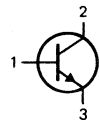
QUICK REFERENCE DATA

			TIP47	48	49	50	
Collector-base voltage (open emitter)	V_{CBO}	max.	350	400	450	500	V
Collector-emitter voltage (open base)	V_{CEO}	max.	250	300	350	400	V
Collector current (d.c.)	I_C	max.		1			A
Collector current (peak value); $t_p \leq 1$ ms	I_{CM}	max.		2			A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.		40			W
Collector-emitter saturation voltage $I_C = 1$ A; $I_B = 0,2$ A	V_{CEsat}	<		1			V
Turn-off time $I_{Con} = 1$ A; $I_{Bon} = -I_{Boff} = 100$ mA; $V_{CC} = 200$ V	t_{off}	typ.		2			μs

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



TIP47; TIP48 TIP49; TIP50

RATINGS

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

			TIP47	48	49	50	
Collector-base voltage ($V_{BE} = 0$)	V_{CES}	max.	350	400	450	500	V
Collector-emitter voltage (open base)	V_{CEO}	max.	250	300	350	400	V
Emitter-base voltage (open collector)	V_{EBO}	max.			5		V
Collector current (d.c.)	I_C	max.			1		A
Collector-current (peak value); $t_p = 1$ ms	I_{CM}	max.			2		A
Base current (d.c.)	I_B	max.			0,6		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.			40		W
Total power dissipation in free air	P_{tot}	max.			2		W
Storage temperature	T_{stg}		-65 to +150				°C
Junction temperature	T_j		150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=		3,12		K/W
From junction to ambient in free air	$R_{th\ j-a}$	=		62,5		K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current

$V_{CE} = V_{CESmax}; V_{BE} = 0$	I_{CES}	<		1		mA
$V_{CE} = 150$ V; $I_B = 0$	TIP47 I_{CEO}	<		1		mA
$V_{CE} = 200$ V; $I_B = 0$	TIP48 I_{CEO}	<		1		mA
$V_{CE} = 250$ V; $I_B = 0$	TIP49 I_{CEO}	<		1		mA
$V_{CE} = 300$ V; $I_B = 0$	TIP50 I_{CEO}	<		1		mA

Emitter cut-off current

$V_{EB} = 5$ V; $I_C = 0$	I_{EBO}	<		1		mA
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D.C. current gain

$V_{CE} = 10$ V; $I_C = 0,3$ A	h_{FE}			30 – 150		
$V_{CE} = 10$ V; $I_C = 1$ A	h_{FE}	>		10		

Collector-emitter saturation voltage

$I_C = 1$ A; $I_B = 0,2$ A	V_{CEsat}	<		1,0		V
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Base-emitter voltage

$V_{CE} = 10$ V; $I_C = 1$ A	V_{BE}	<		1,5		V
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Transition frequency

$V_{CE} = 10$ V; $I_C = 0,2$ A; $f = 2$ MHz	f_T	>		5		MHz
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Small-signal current gain

$V_{CE} = 10$ V; $I_C = 0,2$ A; $f = 1$ kHz	h_{fe}	>		25		
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Turn-off breakdown energy

$L = 100 \text{ mH}; I_C = 0,63 \text{ A}$

$E(BR) > 20 \text{ mJ}$

Collector-emitter sustaining voltage

$I_C = 30 \text{ mA}; I_B = 0;$

TIP47 $V_{CEOsust} > 250 \text{ V}$

$L = 25 \text{ mH}$

TIP48 $V_{CEOsust} > 300 \text{ V}$

TIP49 $V_{CEOsust} > 350 \text{ V}$

TIP50 $V_{CEOsust} > 400 \text{ V}$

Switching times

$I_C = 1 \text{ A}; I_{Bon} = -I_{Boff} = 100 \text{ mA};$

$V_{CC} = 200 \text{ V}$

turn-on time

$t_{on} \text{ typ. } 0,2 \text{ } \mu\text{s}$

turn-off time

$t_{off} \text{ typ. } 2,0 \text{ } \mu\text{s}$

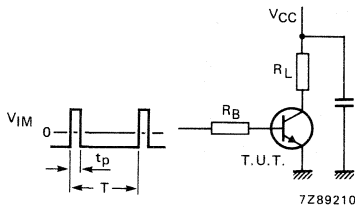


Fig. 2 Switching times test circuit with resistive load;

$V_{IM} = -5 \text{ to } +8 \text{ V}; V_{CC} = 200 \text{ V};$

$t_p = 20 \text{ } \mu\text{s}; \delta = t_p/T = 1\%.$

The values of R_B and R_L are selected in accordance with I_{Con} and I_B requirements.

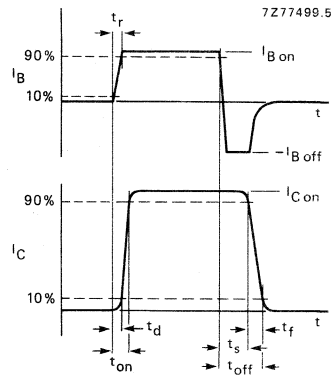


Fig. 3 Switching times waveforms.

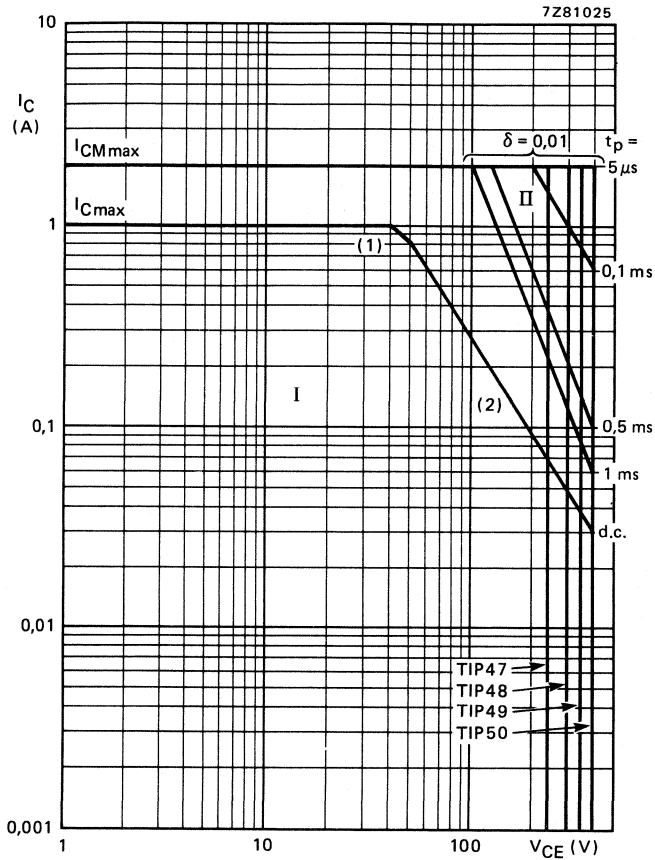


Fig. 4 Safe Operating ARea at $T_{mb} \leq 25 \text{ }^\circ\text{C}$.

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

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier and switching applications. TO-220AB plastic envelope. P-N-P complements are TIP115, TIP116 and TIP117.

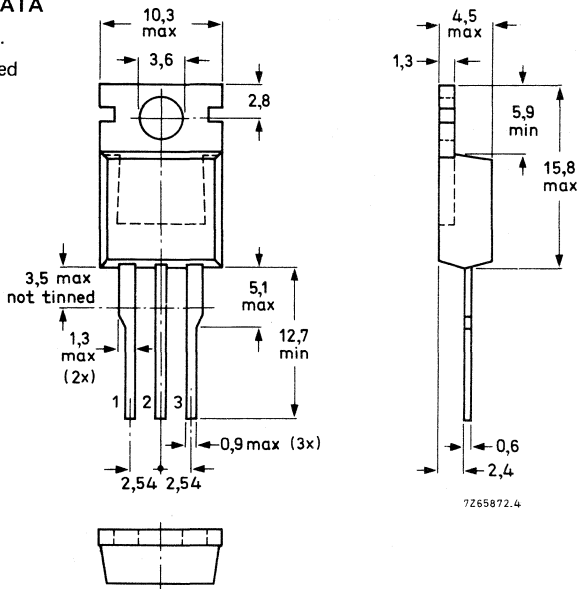
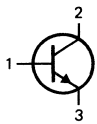
QUICK REFERENCE DATA

			TIP110	TIP111	TIP112	
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.		4		A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}	max.		6		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.		50		W
D.C. current gain						
$V_{CE} = 4$ V; $I_C = 2$ A	h_{FE}	>		500		
Collector-emitter saturation voltage						
$I_C = 2$ A; $I_B = 8$ mA	V_{CEsat}	<		2,5		V

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



Dimensions in mm

TIP110 TIP111 TIP112

CIRCUIT DIAGRAM

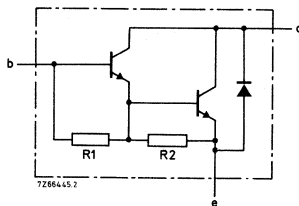


Fig. 2.

R1 typ. 6 k Ω

R2 typ. 100 Ω

RATINGS

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

			TIP110	TIP111	TIP112	
Collector-base voltage (open emitter)	V_{CB0}	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.	4			A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}	max.	6			A
Base current (d.c.)	I_B	max.	50			mA
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	50			W
Total power dissipation in free air	P_{tot}	max.	2			W
Storage temperature	T_{stg}		-65 to + 150			°C
Junction temperature	T_j	max.	150			°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th j-mb}$	=	2,5	K/W
From junction to ambient in free air	$R_{th j-a}$	=	62,5	K/W

CHARACTERISTICS

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

Collector cut-off currents

$V_{CB} = V_{CB0max}; I_E = 0$	I_{CBO}	<	1	mA
$V_{CE} = 1/2 V_{CE0max}; I_B = 0$	I_{CEO}	<	2	mA

Emitter cut-off current

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

$I_C = 30\text{ mA}; I_B = 0$	TIP110	$V_{CE0sust}$	>	60	V
	TIP111	$V_{CE0sust}$	>	80	V
	TIP112	$V_{CE0sust}$	>	100	V

D.C. current gain

$V_{CE} = 4\text{ V}; I_C = 1\text{ A}$	h_{FE}	>	1000
$V_{CE} = 4\text{ V}; I_C = 2\text{ A}$	h_{FE}	>	500

Base-emitter voltage

$V_{CE} = 4\text{ V}; I_C = 2\text{ A}$	V_{BE}	<	2,8	V
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Collector-emitter saturation voltage

$I_C = 2\text{ A}; I_B = 8\text{ mA}$	V_{CEsat}	<	2,5	V
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Switching times

$I_C = 2\text{ A}; I_{B0n} = -I_{B0ff} = 8\text{ mA}; V_{CC} = 30\text{ V}$

turn-on time	t_{on}	typ.	2,6	μs
turn-off time	t_{off}	typ.	4,5	μs

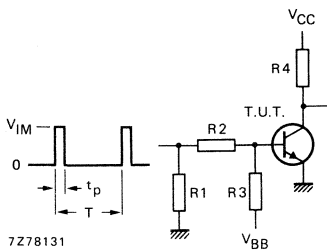


Fig. 3 Switching times test circuit with resistive load.

- $V_{IM} = 12\text{ V}$
- $V_{CC} = 30\text{ V}$
- $-V_{BB} = 5\text{ V}$
- $R1 = 56\text{ }\Omega$
- $R2 = 750\text{ }\Omega$
- $R3 = 910\text{ }\Omega$
- $R4 = 15\text{ }\Omega$
- $t_r = t_f = 15\text{ ns}$
- $t_p = 10\text{ }\mu\text{s}$
- $T = 500\text{ }\mu\text{s}$

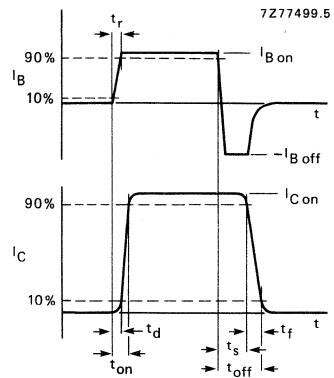


Fig. 4 Switching times waveforms.

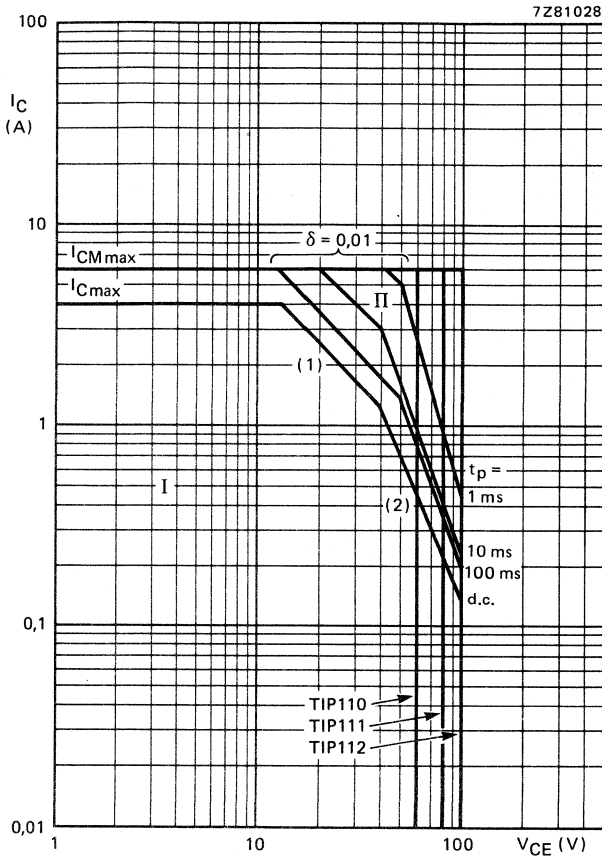


Fig. 5 Safe Operating ARea; $T_{mb} = 25\text{ }^\circ\text{C}$.

- 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).

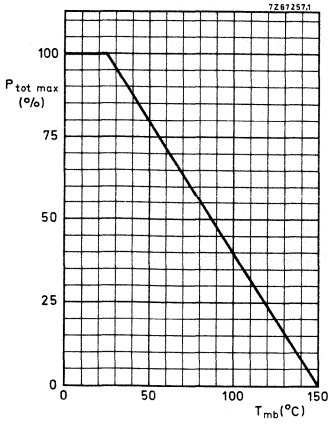


Fig. 6 Power derating curve.

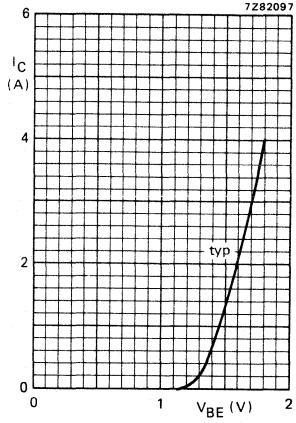


Fig. 7 $V_{CE} = 4V; T_j = 25^\circ C$.

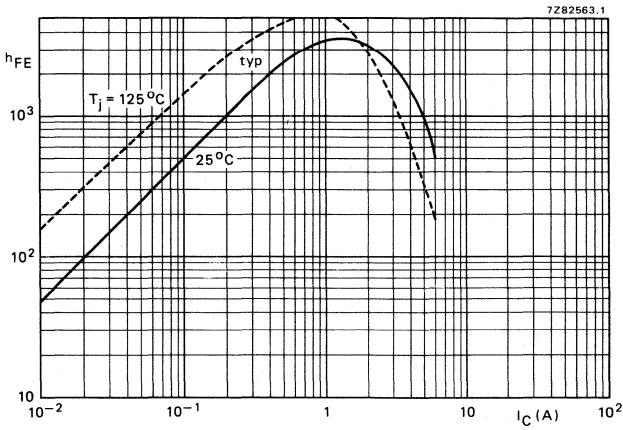


Fig. 8 Typical d.c. current gain; $V_{CE} = 4V$.

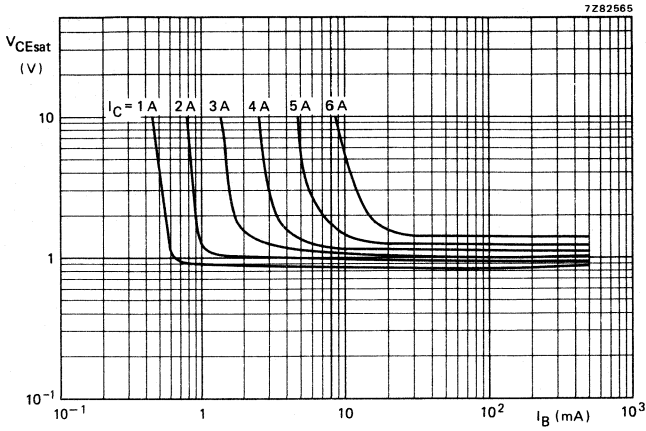


Fig. 9 Typical values; $T_j = 25^\circ C$.

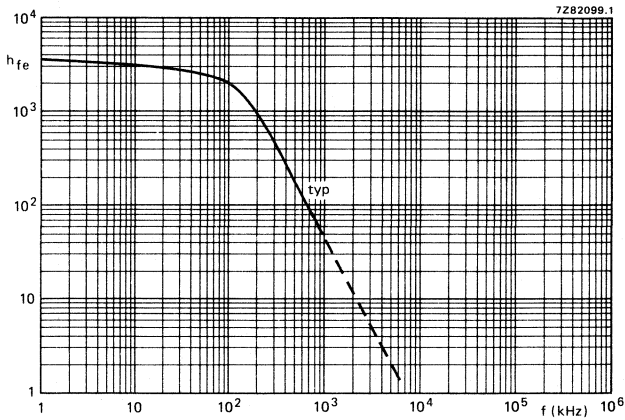


Fig. 10 Small-signal current gain; $I_C = 1,5 A$; $V_{CE} = 4 V$; $T_j = 25^\circ C$.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general purpose amplifier and switching applications. TO-220AB plastic envelope. N-P-N complements are TIP110, TIP111 and TIP112.

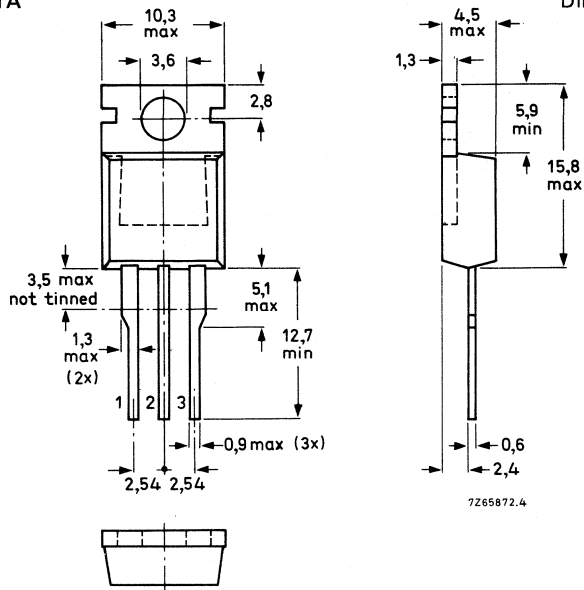
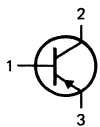
QUICK REFERENCE DATA

			TIP115	TIP116	TIP117	
Collector-base voltage (open emitter)	$-V_{CB0}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Collector current (d.c.)	$-I_C$	max.		4		A
Collector current (peak value); $t_p \leq 0,3$ ms	$-I_{CM}$	max.		6		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.		50		W
D.C. current gain						
$-V_{CE} = 4$ V; $-I_B = 2$ A	h_{FE}	>		500		
Collector-emitter saturation voltage						
$-I_C = 2$ A; $-I_B = 8$ mA	$-V_{CEsat}$	<		2,5		V

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



Dimensions in mm

TIP115 TIP116
TIP117

CIRCUIT DIAGRAM

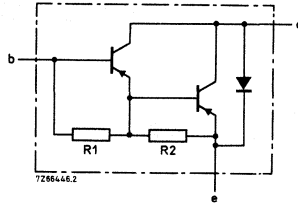


Fig. 2.
R1 typ. 6 k Ω
R2 typ. 100 Ω

RATINGS

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

			TIP115	TIP116	TIP117	
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.		4		A
Collector current (peak value); $t_p \leq 0,3$ ms	$-I_{CM}$	max.		6		A
Base current (d.c.)	$-I_B$	max.		50		mA
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.		50		W
Total power dissipation in free air	P_{tot}	max.		2		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}	=		2,5		K/W
From junction to ambient in free air	R_{thj-a}	=		62,5		K/W

CHARACTERISTICS

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

Collector cut-off currents

$-V_{CB} = -V_{CB0max}; I_E = 0$	$-I_{CBO}$	<	1	mA
$-V_{CE} = 1/2 V_{CE0max}; I_B = 0$	$-I_{CEO}$	<	2	mA

Emitter cut-off current

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

$-I_C = 30\text{ mA}; I_B = 0$	TIP115	$-V_{CE0sust}$	>	60	V
	TIP116	$-V_{CE0sust}$	>	80	V
	TIP117	$-V_{CE0sust}$	>	100	V

D.C. current gain

$-V_{CE} = 4\text{ V}; -I_C = 1\text{ A}$	h_{FE}	>	1000
$-V_{CE} = 4\text{ V}; -I_C = 2\text{ A}$	h_{FE}	>	500

Base-emitter voltage

$-V_{CE} = 4\text{ V}; -I_C = 2\text{ A}$	$-V_{BE}$	<	2,8	V
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Collector-emitter saturation voltage

$-I_C = 2\text{ A}; -I_B = 8\text{ mA}$	$-V_{CEsat}$	<	2,5	V
---	--------------	---	-----	---

Switching times

$-I_C = 2\text{ A}; -I_{Bon} = + I_{Boff} = 8\text{ mA};$
 $-V_{CC} = 30\text{ V}$

turn-on time	t_{on}	typ.	2,6	μs
turn-off time	t_{off}	typ.	4,5	μs

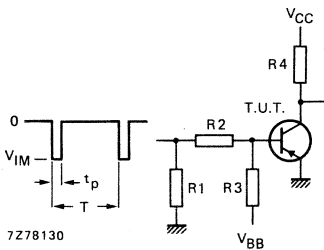


Fig. 3 Switching times test circuit.

$-V_{IM} = 12\text{ V}$	$R1 = 56\ \Omega$	$t_r = t_f = 15\text{ ns}$
$-V_{CC} = 30\text{ V}$	$R2 = 750\ \Omega$	$t_p = 10\ \mu\text{s}$
$+V_{BB} = 5\text{ V}$	$R3 = 910\ \Omega$	$T = 500\ \mu\text{s}$
	$R4 = 15\ \Omega$	

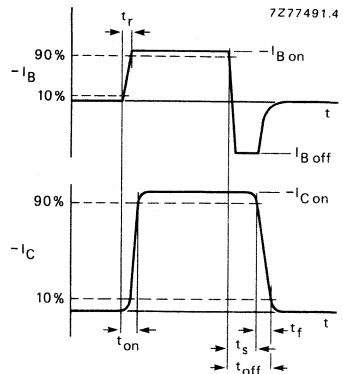


Fig. 4 Switching times waveforms.

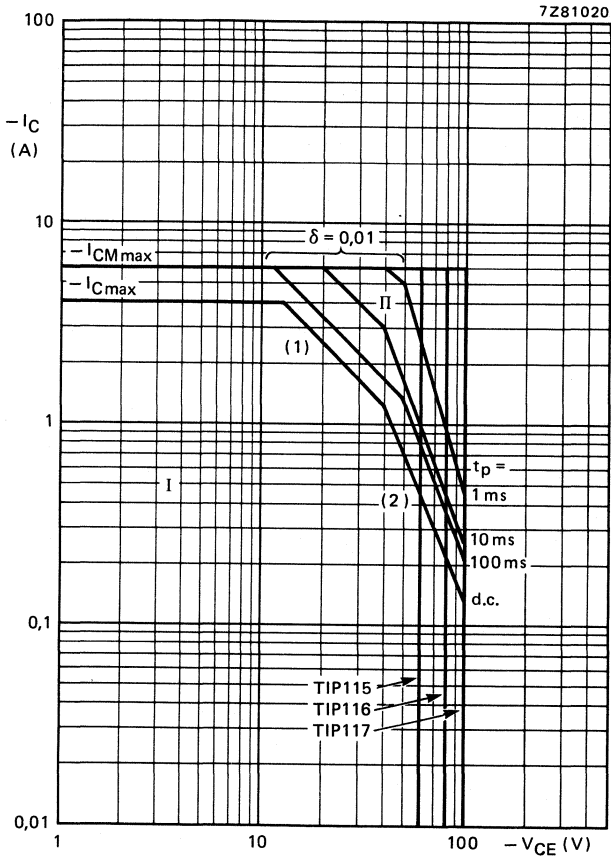


Fig. 5 Safe Operating ARea; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- 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).

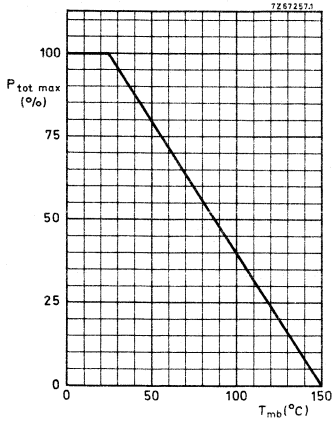


Fig. 6 Power derating curve.

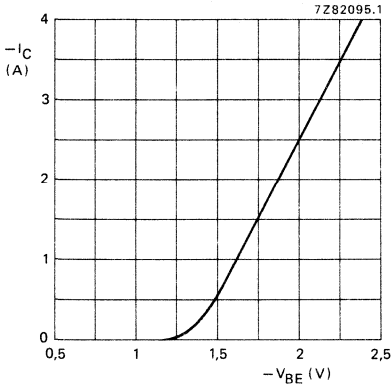


Fig. 7 $-V_{CE} = 4\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$; typical values.

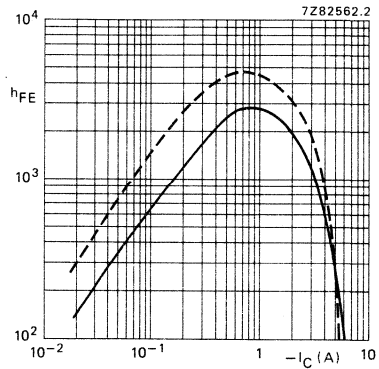


Fig. 8 Typical d.c. current gain; $-V_{CE} = 4\text{ V}$;
— $T_j = 25\text{ }^\circ\text{C}$; - - - $T_j = 125\text{ }^\circ\text{C}$.

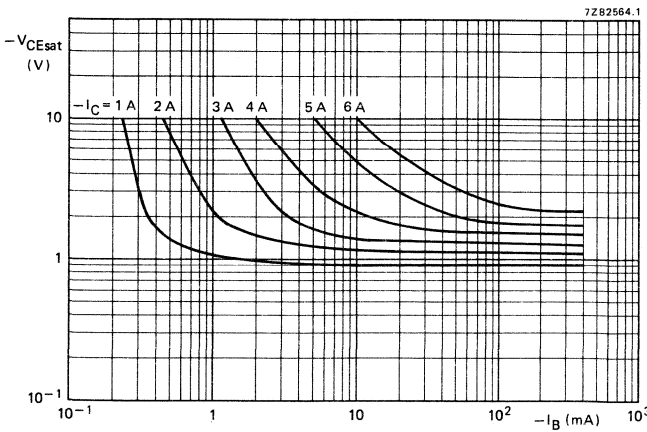


Fig. 9 Typical collector-emitter saturation voltage at $T_j = 25\text{ }^\circ\text{C}$.

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 TIP125, TIP126 and TIP127.

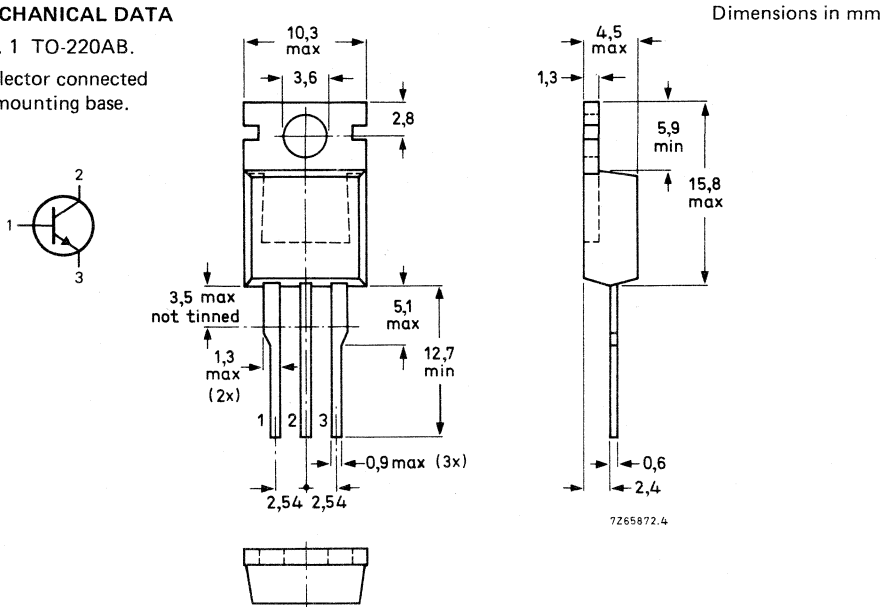
QUICK REFERENCE DATA

		TIP120	TIP121	TIP122	
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.	5		A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}	max.	8		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	65		W
D.C. current gain					
$V_{CE} = 3$ V; $I_C = 3$ A	h_{FE}	>	1000		
Collector-emitter saturation voltage					
$I_C = 3$ A; $I_B = 12$ mA	V_{CEsat}	<	2,0		V

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



CIRCUIT DIAGRAM

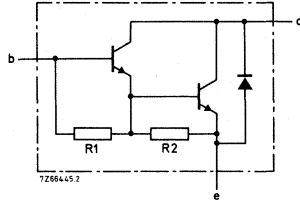


Fig. 2.
R1 typ. 4 kΩ
R2 typ. 100 Ω

RATINGS

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

			TIP120	TIP121	TIP122	
Collector-base voltage ($I_E = 0$)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage ($I_B = 0$)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage ($I_C = 0$)	V_{EBO}	max.		5		V
Collector current (d.c.)	I_C	max.		5		A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}	max.		8		A
Base current (d.c.)	I_B	max.		0,1		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.		65		W
Total power dissipation in free air	P_{tot}	max.		2		W
Storage temperature	T_{stg}		-65 to + 150			°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=		1,92		K/W
From junction to ambient in free air	$R_{th\ j-a}$	=		62,5		K/W

CHARACTERISTICS

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

Collector cut-off currents

$V_{CB} = V_{CB0max}; I_E = 0$	I_{CBO}	<	0,2	mA
$V_{CE} = 1/2 V_{CE0max}; I_B = 0$	I_{CEO}	<	0,5	mA

Emitter cut-off current

$V_{EB} = 5\text{ V}; I_C = 0$	I_{EBO}	<	5,0	mA
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Collector-emitter sustaining voltage

$I_C = 30\text{ mA}; I_B = 0$	TIP120	$V_{CE0sust}$	>	60	V
	TIP121	$V_{CE0sust}$	>	80	V
	TIP122	$V_{CE0sust}$	>	100	V

D.C. current gain

$V_{CE} = 3\text{ V}; I_C = 0,5\text{ A}$	h_{FE}	>	1000
$V_{CE} = 3\text{ V}; I_C = 3\text{ A}$	h_{FE}	>	1000

Base-emitter voltage

$V_{CE} = 3\text{ V}; I_C = 3\text{ A}$	V_{BE}	<	2,5	V
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Collector-emitter saturation voltage

$I_C = 3\text{ A}; I_B = 12\text{ mA}$	V_{CEsat}	<	2,0	V
$I_C = 5\text{ A}; I_B = 20\text{ mA}$	V_{CEsat}	<	4,0	V

Switching times

$I_C = 3\text{ A}; I_{Bon} = -I_{Boff} = 12\text{ mA};$
 $V_{CC} = 30\text{ V}$

turn-on time	t_{on}	typ.	1,5	μs
turn-off time	t_{off}	typ.	8,5	μs

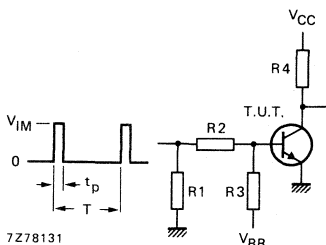


Fig. 3 Switching times test circuit.

$V_{CC} = 30\text{ V}$ $R1 = 56\text{ }\Omega$ $t_r = t_f = 15\text{ ns}$
 $V_{IM} = 10\text{ V}$ $R2 = 410\text{ }\Omega$ $t_p = 10\text{ }\mu\text{s}$
 $-V_{BB} = 5\text{ V}$ $R3 = 560\text{ }\Omega$ $T = 500\text{ }\mu\text{s}$
 $R4 = 10\text{ }\Omega$

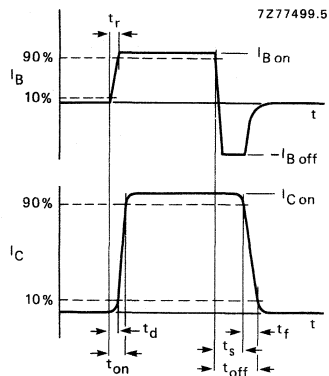


Fig. 4 Switching times waveforms.

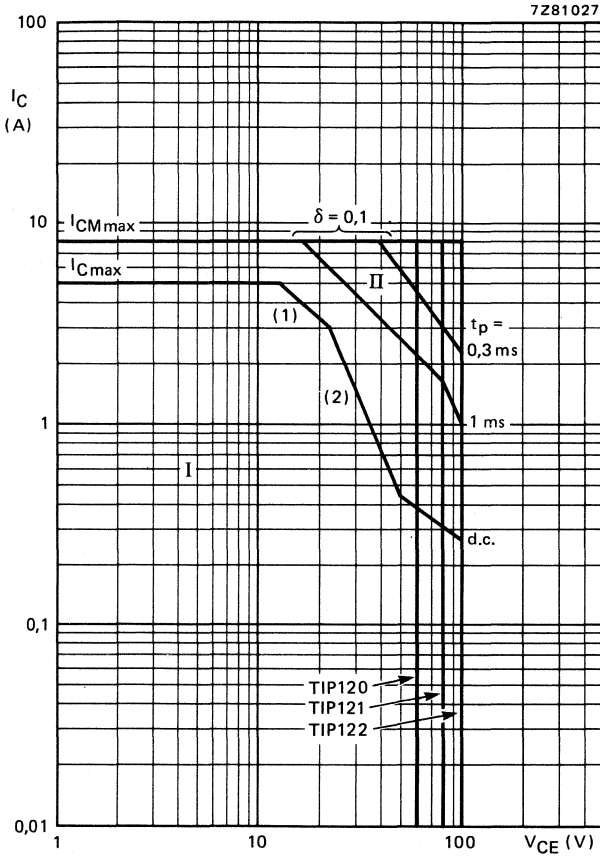


Fig. 5 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- 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).

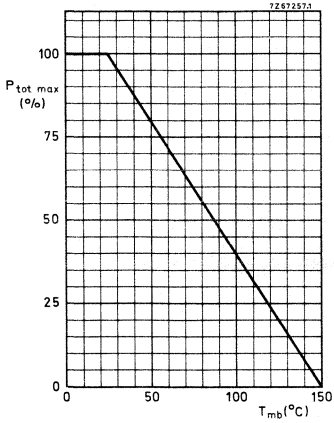


Fig. 6 Power derating curve.

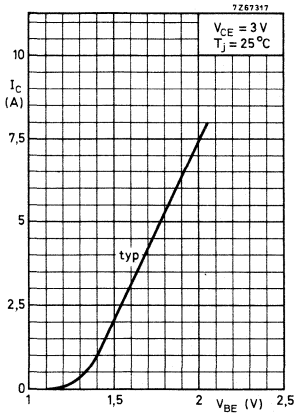


Fig. 7.

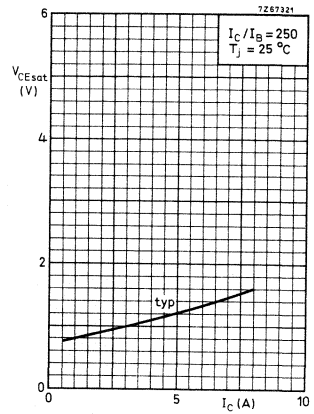


Fig. 8.

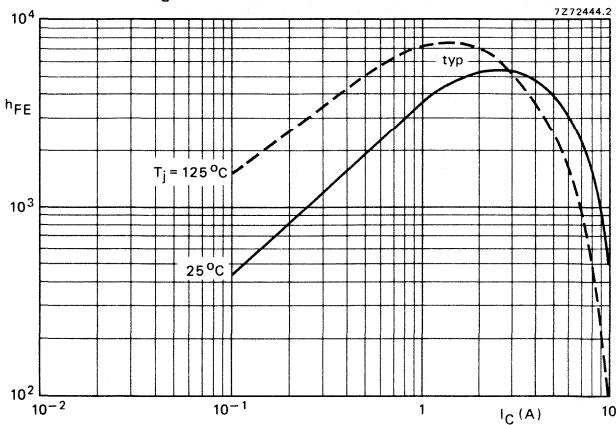


Fig. 9 Typical d.c. current gain; $V_{CE} = 3\ V$.

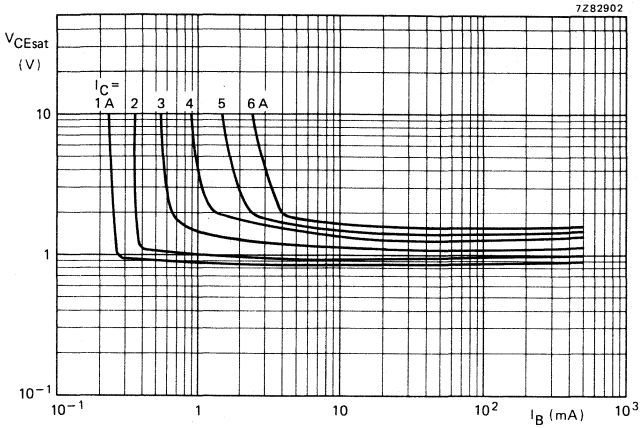


Fig. 10 Typical values; $T_j = 25^\circ\text{C}$.

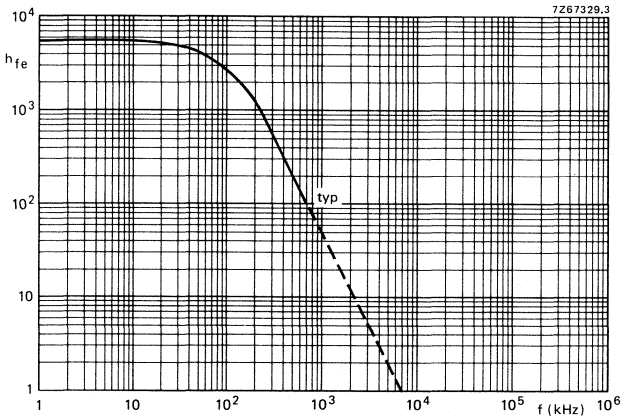


Fig. 11 Small signal current gain at $I_C = 3\text{ A}$; $V_{CE} = 3\text{ V}$; $T_j = 25^\circ\text{C}$.

SILICON DARLINGTON POWER TRANSISTORS

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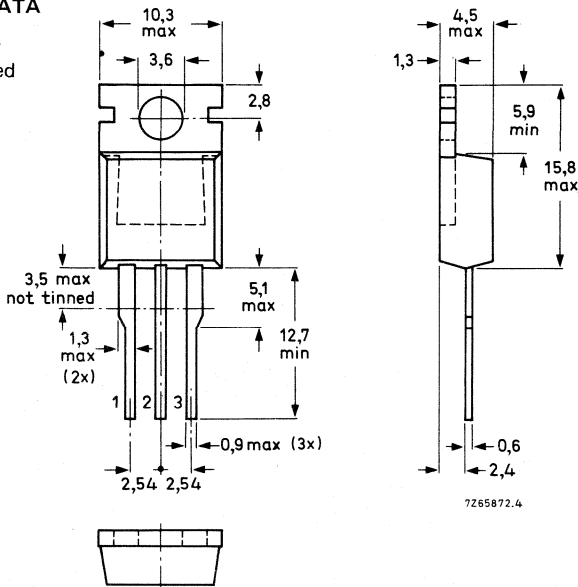
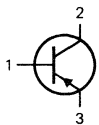
QUICK REFERENCE DATA

			TIP125	TIP126	TIP127	
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.		5		A
Collector current (peak value; $t_p \leq 0,3$ ms)	$-I_{CM}$	max.		8		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.		65		W
D.C. current gain						
$-V_{CE} = 3$ V; $-I_C = 3$ A	h_{FE}	>		1000		
Collector-emitter saturation voltage						
$-I_C = 3$ A; $-I_B = 12$ mA	$-V_{CEsat}$	<		2,0		V

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



Dimensions in mm

CIRCUIT DIAGRAM

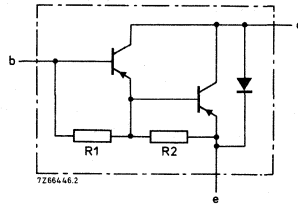


Fig. 2.
R1 typ. 4 kΩ
R2 typ. 80 Ω

RATINGS

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

			TIP125	TIP126	TIP127	
Collector-base voltage ($I_E = 0$)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage ($I_B = 0$)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage ($I_C = 0$)	$-V_{EBO}$	max.	5			V
Collector current (d.c.)	$-I_C$	max.	5			A
Collector current (peak value); $t_p \leq 0,3$ ms	$-I_{CM}$	max.	8			A
Base current (d.c.)	$-I_B$	max.	0,1			A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	65			W
Total power dissipation in free air	P_{tot}	max.	2			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}	=	1,92	K/W
From junction to ambient in free air	R_{thj-a}	=	62,5	K/W

CHARACTERISTICS

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

Collector cut-off currents

$V_{CB} = V_{CB0max}; I_E = 0$	$-I_{CBO}$	<	0,2	mA
$V_{CE} = 1/2 V_{CE0max}; I_B = 0$	$-I_{CEO}$	<	0,5	mA

Emitter cut-off current

$-V_{EB} = 5\text{ V}; I_C = 0$	$-I_{EBO}$	<	5,0	mA
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Collector-emitter sustaining voltage

$-I_C = 30\text{ mA}; I_B = 0$	TIP125	$-V_{CE0sust}$	>	60	V
	TIP126	$-V_{CE0sust}$	>	80	V
	TIP127	$-V_{CE0sust}$	>	100	V

D.C. current gain

$-V_{CE} = 3\text{ V}; -I_C = 0,5\text{ A}$	h_{FE}	>	1000
$-V_{CE} = 3\text{ V}; -I_C = 3\text{ A}$	h_{FE}	>	1000

Base-emitter voltage

$-V_{CE} = 3\text{ V}; -I_C = 3\text{ A}$	$-V_{BE}$	<	2,5	V
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Collector-emitter saturation voltage

$-I_C = 3\text{ A}; -I_B = 12\text{ mA}$	$-V_{CEsat}$	<	2,0	V
$-I_C = 5\text{ A}; -I_B = 20\text{ mA}$	$-V_{CEsat}$	<	4,0	V

Switching times

$-I_C = 3\text{ A}; -I_{Bon} = I_{Boff} = 12\text{ mA};$
 $-V_{CC} = 30\text{ V}$

turn-on time	t_{on}	typ.	1,5	μs
turn-off time	t_{off}	typ.	8,5	μs

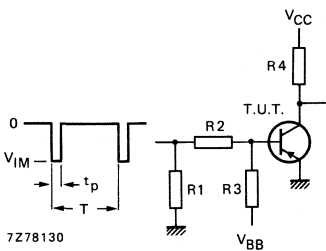


Fig. 3 Switching times test circuit.

$-V_{IM} = 10\text{ V}$	$R1 = 56\text{ }\Omega$	$t_r = t_f = 15\text{ ns}$
$-V_{CC} = 30\text{ V}$	$R2 = 410\text{ }\Omega$	$t_p = 10\text{ }\mu\text{s}$
$+V_{BB} = 5\text{ V}$	$R3 = 560\text{ }\Omega$	$T = 500\text{ }\mu\text{s}$
	$R4 = 10\text{ }\Omega$	

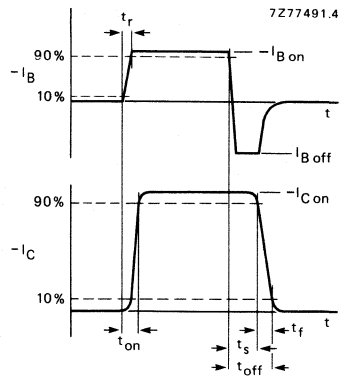


Fig. 4 Switching times waveforms.

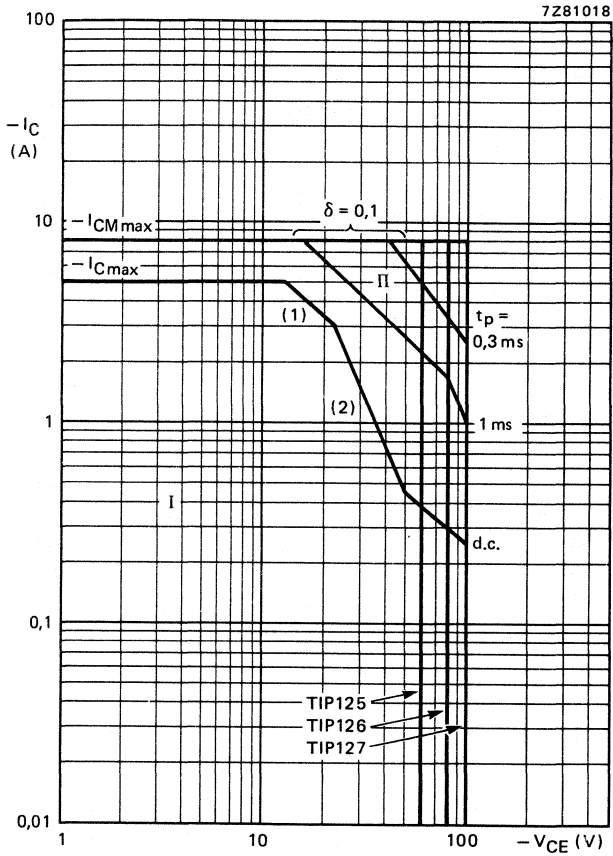


Fig. 5 Safe Operating ARea at $T_{mb} = 25 \text{ }^\circ\text{C}$.

- 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).

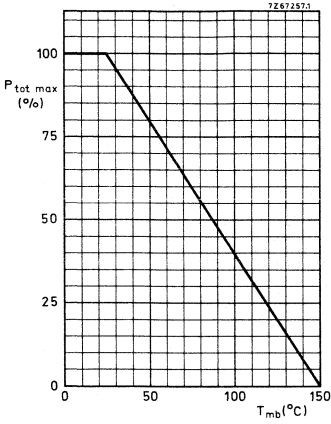


Fig. 6 Power derating curve.

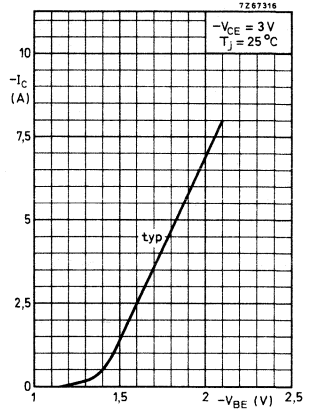


Fig. 7.

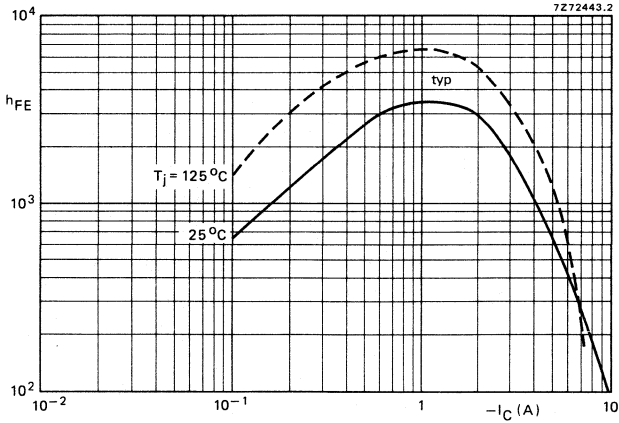


Fig. 8 D.C. current gain at $-V_{CE} = 3 V$.

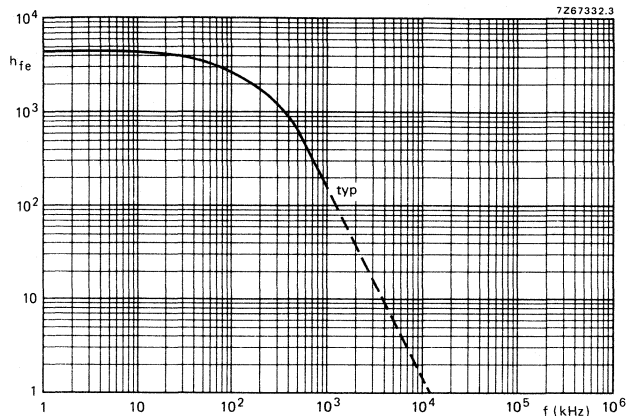


Fig. 9 Small-signal current gain at $-I_C = 3 \text{ A}$; $-V_{CE} = 3 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$.

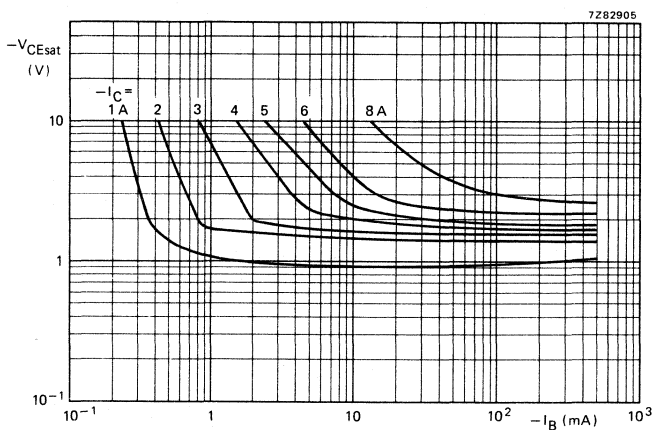


Fig. 10 Typical collector-emitter saturation voltage at $T_j = 25 \text{ }^\circ\text{C}$.

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-220AB plastic envelope. P-N-P equivalents are TIP135, TIP136 and TIP137.

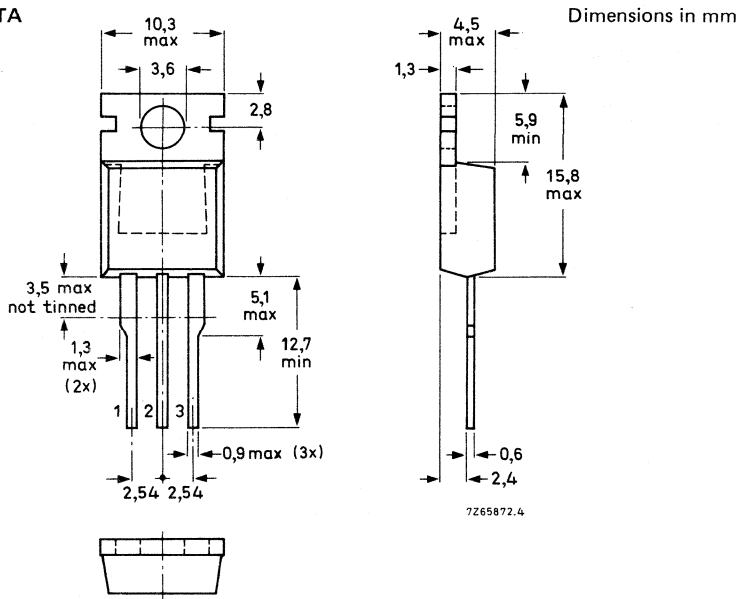
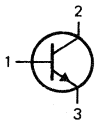
QUICK REFERENCE DATA

		TIP130	TIP131	TIP132	
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		8		A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}		12		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}		70		W
D.C. current gain			1000 to 15 000		
$V_{CE} = 4$ V; $I_C = 4$ A	h_{FE}				
Collector-emitter saturation voltage			2		V
$I_C = 4$ A; $I_B = 16$ mA	V_{CEsat}	<			

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



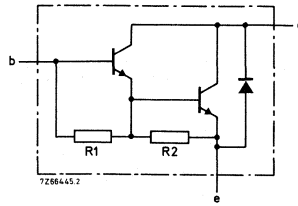


Fig. 2.
R1 typ. 8 k Ω
R2 typ. 100 k Ω

RATINGS

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

			TIP130	TIP131	TIP132	
Collector-base voltage ($I_E = 0$)	V_{CB0}	max.	60	80	100	V
Collector-emitter voltage ($I_B = 0$)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage ($I_C = 0$)	V_{EBO}	max.	5	5	5	V
Collector current (d.c.)	I_C	max.		8		A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}	max.		12		A
Base current (d.c.)	I_B	max.		0,3		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.		70		W
Total power dissipation in free air	P_{tot}	max.		2		W
Storage temperature	T_{stg}			-65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=		1,79		K/W
From junction to ambient in free air	$R_{th\ j-a}$	=		62,5		K/W

CHARACTERISTICS

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

Collector cut-off currents

$V_{CB} = V_{CB0max}; I_E = 0$	I_{CBO}	<	0,2	mA
$V_{CB} = V_{CB0max}; I_E = 0; T_j = 100\text{ }^\circ\text{C}$	I_{CBO}	<	1	mA
$V_{CE} = 1/2 V_{CE0max}; I_B = 0$	I_{CEO}	<	0,5	mA

Emitter cut-off current

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

$I_C = 30\text{ mA}; I_B = 0$	TIP130	$V_{CE0sust}$	>	60	V
	TIP131	$V_{CE0sust}$	>	80	V
	TIP132	$V_{CE0sust}$	>	100	V

D.C. current gain

$V_{CE} = 4\text{ V}; I_C = 1\text{ A}$	h_{FE}	>	500	
$V_{CE} = 4\text{ V}; I_C = 4\text{ A}$	h_{FE}		1000 to 15 000	

Base-emitter voltage

$V_{CE} = 4\text{ V}; I_C = 4\text{ A}$	V_{BE}	<	2,5	V
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Collector-emitter saturation voltage

$I_C = 4\text{ A}; I_B = 16\text{ mA}$	V_{CEsat}	<	2	V
$I_C = 6\text{ A}; I_B = 30\text{ mA}$	V_{CEsat}	<	3	V

Collector-base capacitance

$V_{CB} = 10\text{ V}; I_E = 0$	C_{ob}	<	200	pF
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Switching times

$I_C = 3\text{ A}; I_{Bon} = -I_{Boff} = 12\text{ mA}$				
$V_{CC} = 10\text{ V}$				
turn-on time	t_{on}	typ.	1	μs
turn-off time	t_{off}	typ.	5	μs

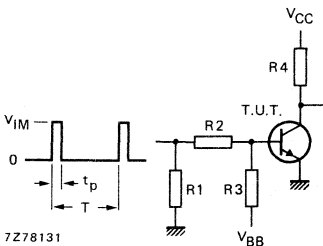


Fig. 3 Switching times test circuit with resistive load.

$V_{IM} = 10\text{ V}$	$R1 = 56\text{ }\Omega$	$t_r = t_f = 15\text{ ns}$
$V_{CC} = 10\text{ V}$	$R2 = 410\text{ }\Omega$	$t_p = 10\text{ }\mu\text{s}$
$-V_{BB} = 4\text{ V}$	$R3 = 560\text{ }\Omega$	$T = 500\text{ }\mu\text{s}$
	$R4 = 3\text{ }\Omega$	

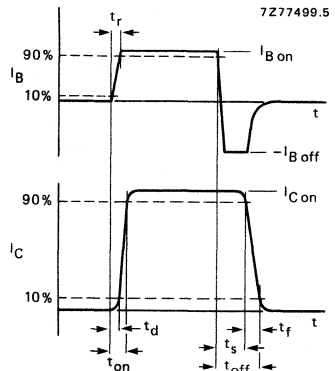


Fig. 4 Switching times waveforms.

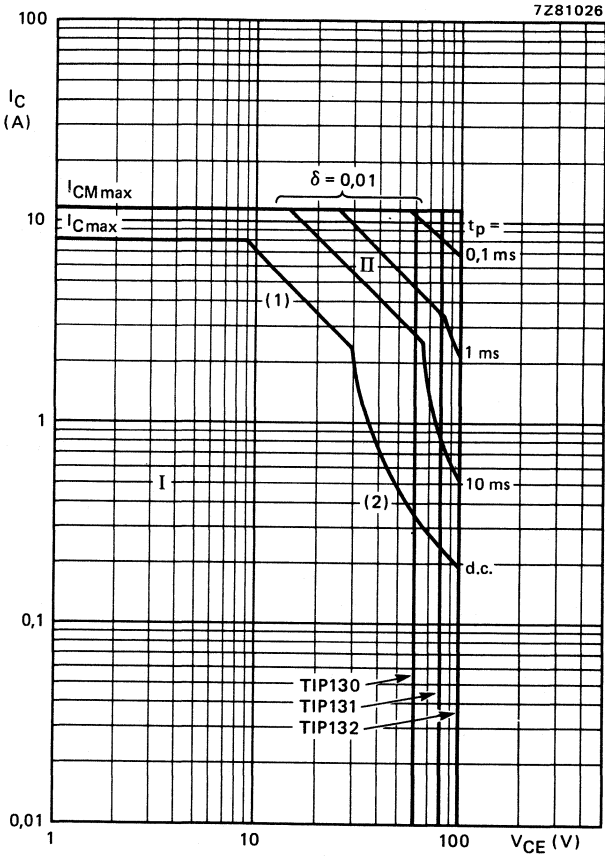


Fig. 5 Safe Operating Area; $T_{mb} = 25\ ^\circ\text{C}$.

- 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).

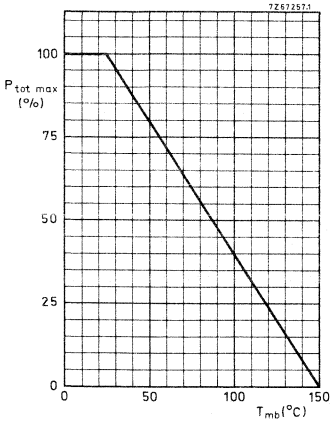


Fig. 6 Power derating curve.

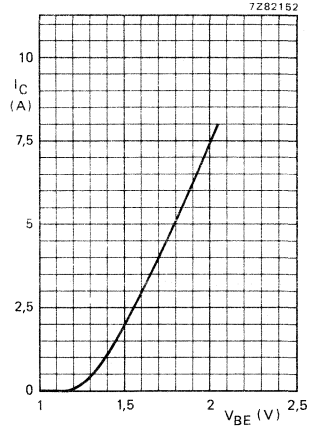


Fig. 7 Typical values;
 $V_{CE} = 4 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$.

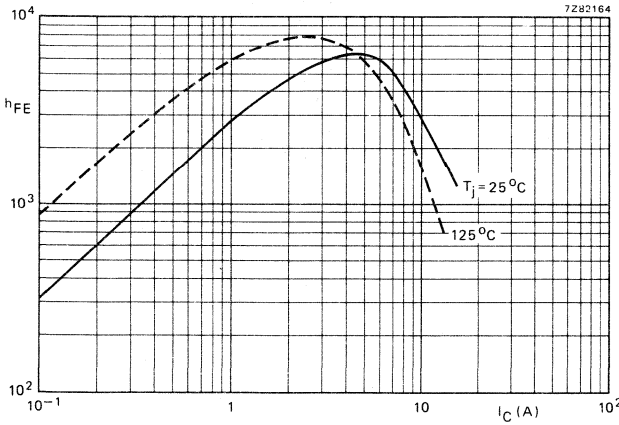


Fig. 8 Typical d.c. current gain at $V_{CE} = 4 \text{ V}$.

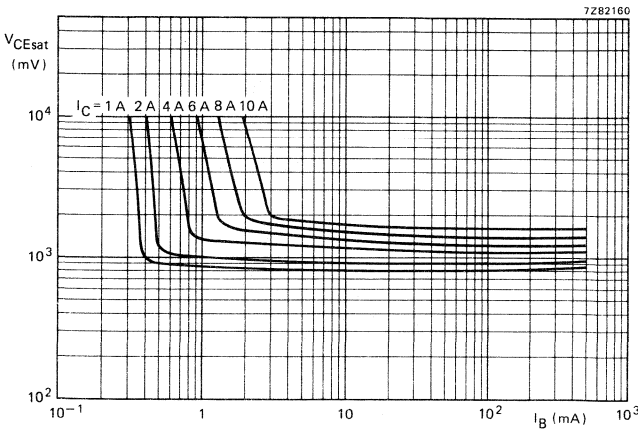


Fig. 9 Typical values;
 $T_j = 25 \text{ }^\circ\text{C}$.

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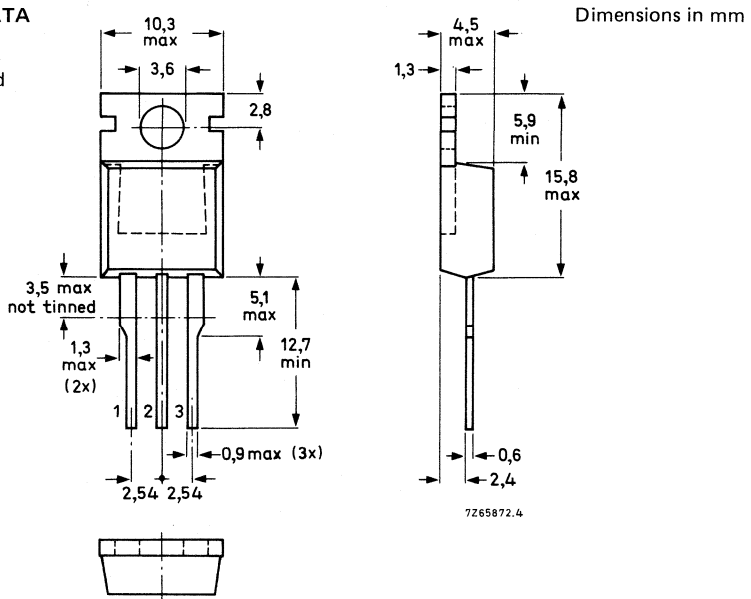
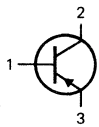
QUICK REFERENCE DATA

			TIP135	TIP136	TIP137	
Collector-base voltage (open emitter)	$-V_{CB0}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Collector current (d.c.)	$-I_C$	max.	8			A
Collector current (peak value); $t_p \leq 0,3$ ms	$-I_{CM}$	max.	12			A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.	70			W
D.C. current gain			1000 to 15 000			
$-V_{CE} = 4$ V; $-I_C = 4$ A	h_{FE}		1000 to 15 000			
Collector-emitter saturation voltage			2			V
$-I_C = 4$ A; $-I_B = 16$ mA	$-V_{CEsat}$	<	2			V

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



CIRCUIT DIAGRAM

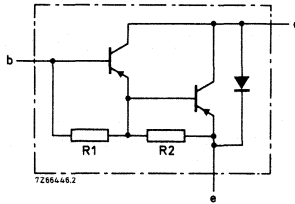


Fig. 2.
R1 typ. 4 kΩ
R2 typ. 60 Ω

RATINGS

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

			TIP135	TIP136	TIP137	
Collector-base voltage ($I_E = 0$)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage ($I_B = 0$)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage ($I_C = 0$)	$-V_{EBO}$	max.	5	5	5	V
Collector current (d.c.)	$-I_C$	max.		8		A
Collector current (peak value); $t_p \leq 0,3$ ms	$-I_{CM}$	max.		12		A
Base current (d.c.)	$-I_B$	max.		0,3		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.		70		W
Total power dissipation in free air	P_{tot}	max.		2		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}	=		1,79		K/W
From junction to ambient in free air	R_{thj-a}	=		62,5		K/W

CHARACTERISTICS

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

Collector cut-off currents

$-V_{CB} = -V_{CB0max}; I_E = 0$	$-I_{CBO}$	<	0,2	mA
$-V_{CB} = -V_{CB0max}; I_E = 0; T_j = 100\text{ }^\circ\text{C}$	$-I_{CBO}$	<	1	mA
$-V_{CE} = -1/2 V_{CEOmax}; I_B = 0$	$-I_{CEO}$	<	0,5	mA

Emitter cut-off current

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

$-I_C = 30\text{ mA}; I_B = 0$	TIP135	$-V_{CE0sust}$	>	60	V
	TIP136	$-V_{CE0sust}$	>	80	V
	TIP137	$-V_{CE0sust}$	>	100	V

D.C. current gain

$-V_{CE} = 4\text{ V}; -I_C = 1\text{ A}$	h_{FE}	>	500	
$-V_{CE} = 4\text{ V}; -I_C = 4\text{ A}$	h_{FE}		1000 to 15 000	

Base-emitter voltage

$-V_{CE} = 4\text{ V}; -I_C = 4\text{ A}$	$-V_{BE}$	<	2,5	V
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Collector-emitter saturation voltage

$-I_C = 4\text{ A}; -I_B = 16\text{ mA}$	$-V_{CEsat}$	<	2	V
$-I_C = 6\text{ A}; -I_B = 30\text{ mA}$	$-V_{CEsat}$	<	3	V

Collector-base capacitance

$-V_{CB} = 10\text{ V}; I_E = 0$	C_{ob}	<	200	pF
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Switching times

$-I_C = 3\text{ A}; -I_{Bon} = + I_{Boff} = 12\text{ mA}$

$-V_{CC} = 10\text{ V}$

turn-on time	t_{on}	typ.	0,5	μs
turn-off time	t_{off}	typ.	2,5	μs

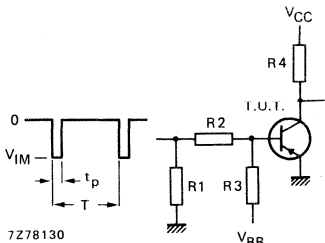


Fig. 3 Switching times test circuit.

$-V_{IM} = 10\text{ V}$	$R1 = 56\text{ }\Omega$	$t_r = t_f = 15\text{ ns}$
$-V_{CC} = 10\text{ V}$	$R2 = 410\text{ }\Omega$	$t_p = 10\text{ }\mu\text{s}$
$+V_{BB} = 4\text{ V}$	$R3 = 560\text{ }\Omega$	$T = 500\text{ }\mu\text{s}$
	$R4 = 3\text{ }\Omega$	

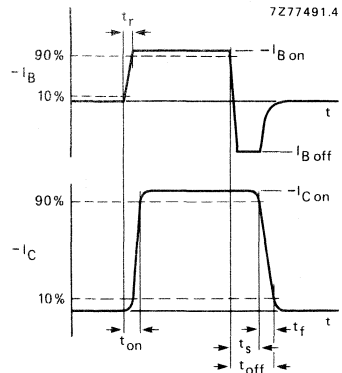


Fig. 4 Switching times waveforms.

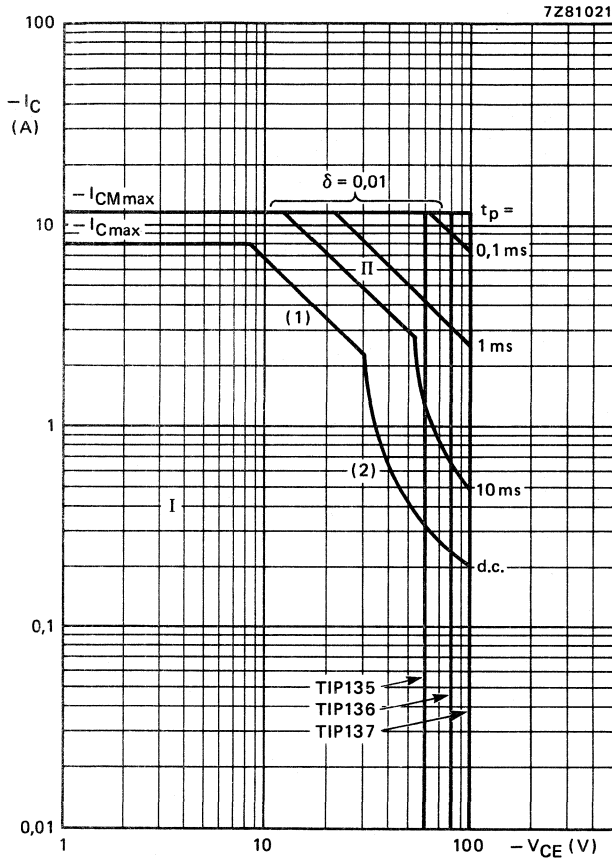


Fig. 5 Safe Operating Area; $T_{mb} = 25 \text{ }^\circ\text{C}$.

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

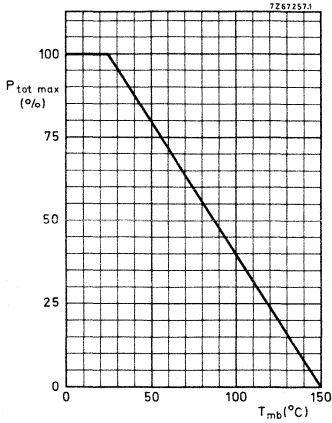


Fig. 6 Power derating curve.

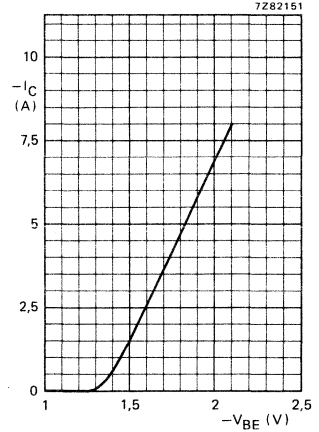


Fig. 7 Typical values;
 $-V_{CE} = 4 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$.

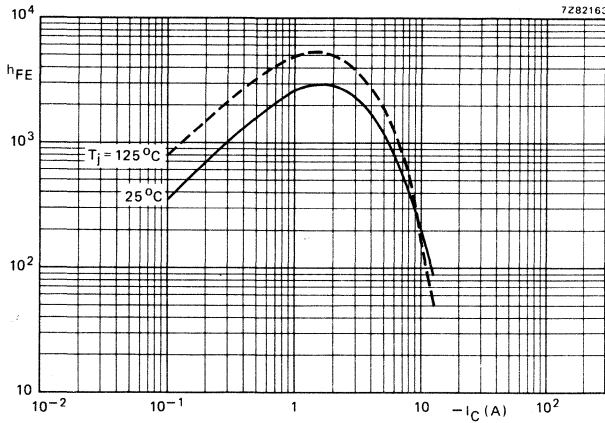


Fig. 8 Typical d.c. current gain at $-V_{CE} = 4 \text{ V}$.

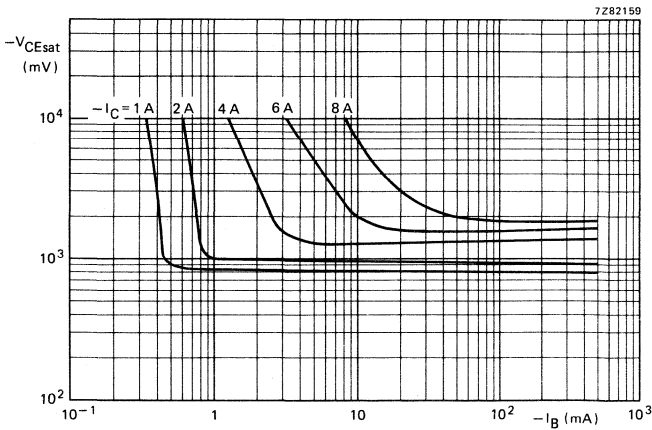


Fig. 9 Typical collector-emitter saturation voltage; $T_j = 25 \text{ }^\circ\text{C}$.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. SOT-93 plastic envelope. P-N-P complements are TIP145, TIP146 and TIP147.

QUICK REFERENCE DATA

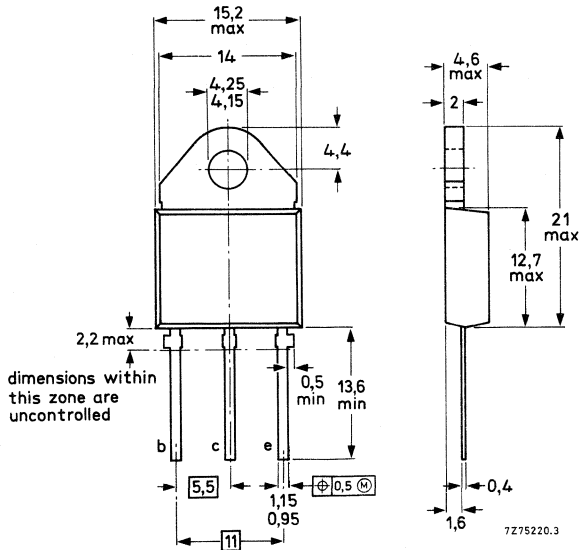
			TIP140	TIP141	TIP142	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (d.c.)	I_C	max.		10		A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}	max.		15		A
Total power dissipation up to $T_{mb} = 25$ °C	P_{tot}	max.		125		W
D.C. current gain	h_{FE}	>		1000		
$V_{CE} = 4$ V; $I_C = 5$ A						
Collector-emitter saturation voltage	V_{CEsat}	<		2,0		V
$I_C = 5$ A; $I_B = 10$ mA						

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



TIP140 TIP141
TIP142

CIRCUIT DIAGRAM

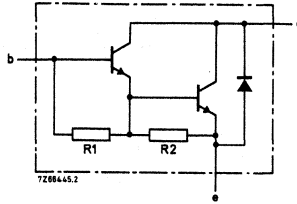


Fig. 2.
R1 typ. 5 kΩ
R2 typ. 80 Ω

RATINGS

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

			TIP140	TIP141	TIP142	
Collector-base voltage ($I_E = 0$)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage ($I_B = 0$)	V_{CEO}	max.	60	80	100	V
Emitter-base voltage ($I_C = 0$)	V_{EBO}	max.		5		V
Collector current (d.c.)	I_C	max.		10		A
Collector current (peak value); $t_p \leq 0,3$ ms	I_{CM}	max.		15		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
Total power dissipation in free air	P_{tot}	max.		3,5		W
Storage temperature	T_{stg}			-65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	R_{thj-mb}	=		1		K/W
From junction to ambient in free air	R_{thj-a}	=		35,7		K/W

CHARACTERISTICS

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

Collector cut-off currents

$V_{CB} = V_{CB0max}; I_E = 0$	I_{CBO}	<	1	mA
$V_{CE} = 1/2 V_{CE0max}; I_B = 0$	I_{CEO}	<	2	mA

Emitter cut-off current

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

$I_C = 30\text{ mA}; I_B = 0$	TIP140	$V_{CE0sust}$	>	60	V
	TIP141	$V_{CE0sust}$	>	80	V
	TIP142	$V_{CE0sust}$	>	100	V

D.C. current gain

$V_{CE} = 4\text{ V}; I_C = 5\text{ A}$	h_{FE}	>	1000
$V_{CE} = 4\text{ V}; I_C = 10\text{ A}$	h_{FE}	>	500

Base-emitter voltage

$V_{CE} = 4\text{ V}; I_C = 10\text{ A}$	V_{BE}	<	3	V
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Collector-emitter saturation voltage

$I_C = 5\text{ A}; I_B = 10\text{ mA}$	V_{CEsat}	<	2	V
$I_C = 10\text{ A}; I_B = 40\text{ mA}$	V_{CEsat}	<	3	V

Switching times (see Figs 3 and 4)

$I_C = 10\text{ A}; I_{Bon} = -I_{Boff} = 40\text{ mA}$

$V_{CC} = 30\text{ V}$

turn-on time	t_{on}	typ.	0,9	μs
turn-off time	t_{off}	typ.	11	μs

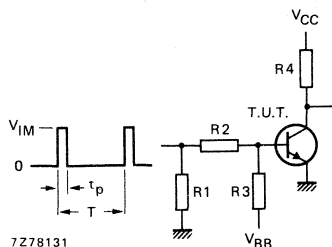


Fig. 3 Switching times test circuit.

$V_{IM} = 33\text{ V}$	$R1 = 56\ \Omega$	$t_r = t_f = 15\text{ ns}$
$V_{CC} = 30\text{ V}$	$R2 = 410\ \Omega$	$t_p = 10\ \mu\text{s}$
$V_{BB} = -4,2\text{ V}$	$R3 = 150\ \Omega$	$T = 500\ \mu\text{s}$
	$R4 = 3\ \Omega$	

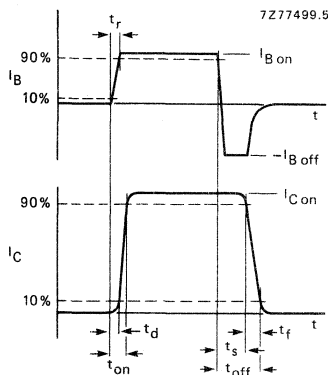


Fig. 4 Waveforms showing t_{on} ; $t_s + t_f = t_{off}$.

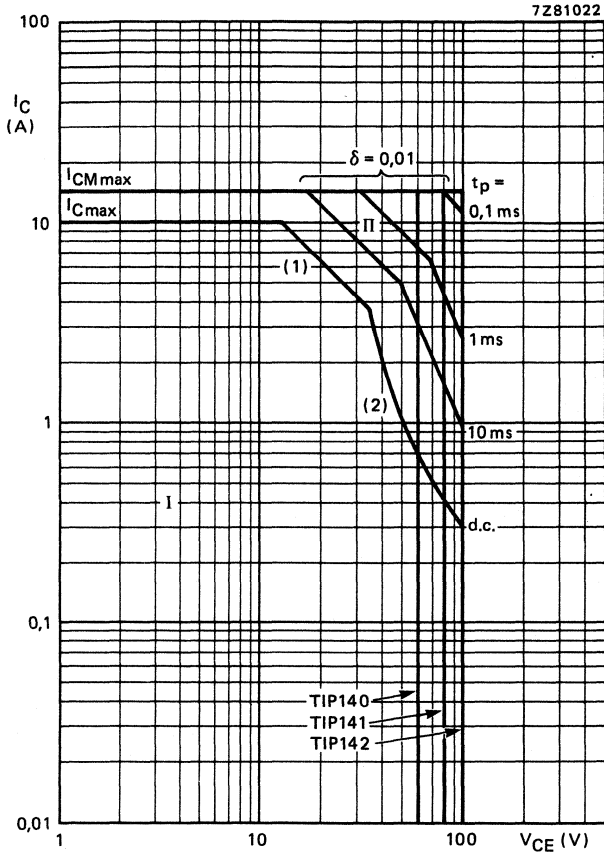


Fig. 5 Safe Operating Area; $T_{mb} \leq 25\ ^\circ C$.

- 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).

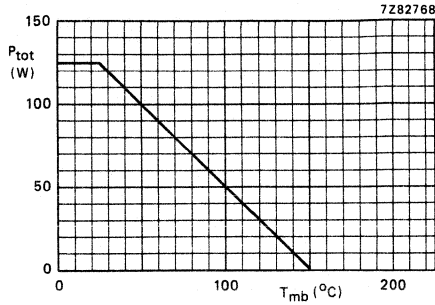


Fig. 6 Power derating curve.

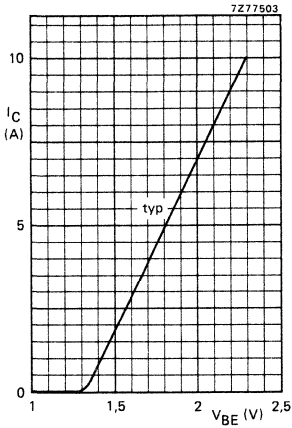


Fig. 7 $V_{CE} = 4\text{ V}; T_j = 25\text{ }^\circ\text{C}$.

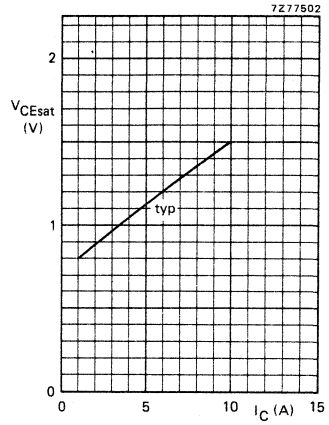


Fig. 8 $I_C/I_B = 250; T_j = 25\text{ }^\circ\text{C}$.

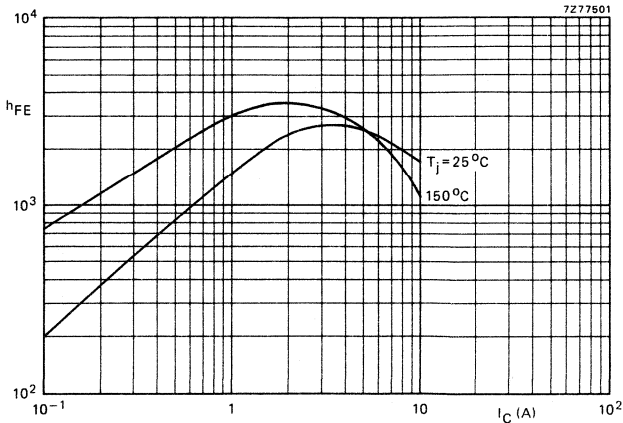


Fig. 9 Typical values; $V_{CE} = 4\text{ V}$.

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial-base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. SOT-93 plastic envelope. NPN complements are TIP140, TIP141 and TIP142.

QUICK REFERENCE DATA

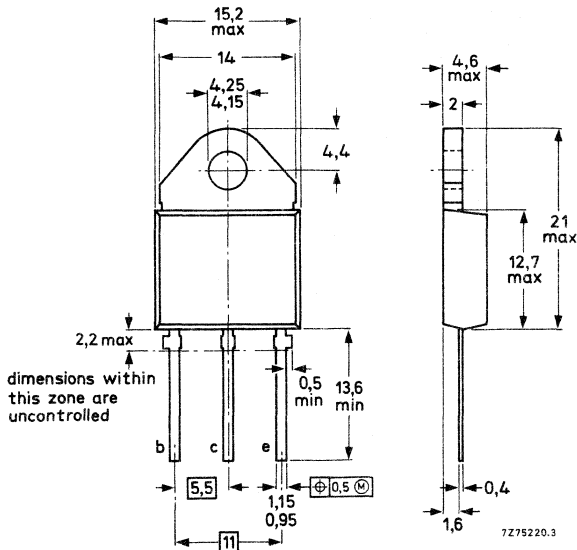
		TIP145	TIP146	TIP147	
Collector-base voltage (open emitter)	$-V_{CB0}$	max. 60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 60	80	100	V
Collector current (d.c.)	$-I_C$		10		A
Collector current (peak value); $t_p \leq 0,3$ ms	$-I_{CM}$	max.	15		A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	125		W
D.C. current gain					
$-V_{CE} = 4$ V; $-I_C = 5$ A	h_{FE}	>	1000		
Collector-emitter saturation voltage					
$-I_C = 5$ A; $-I_B = 10$ mA	$-V_{CEsat}$	<	2,0		V

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



TIP145 TIP146 TIP147

CIRCUIT DIAGRAM

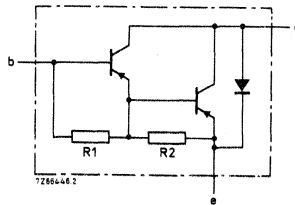


Fig. 2.
R1 typ. 5 k Ω
R2 typ. 80 Ω

RATINGS

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

			TIP145	TIP146	TIP147	
Collector-base voltage ($I_E = 0$)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage ($I_B = 0$)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage ($I_C = 0$)	$-V_{EBO}$	max.	5			V
Collector current (d.c.)	$-I_C$	max.	10			A
Collector current (peak value); $t_p \leq 0,3$ ms	$-I_{CM}$	max.	15			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
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	3,5			W
Storage temperature	T_{stg}		-65 to + 150			°C
Junction temperature	T_j	max.	150			°C

THERMAL RESISTANCE

From junction to mounting base	R_{thj-mb}	=	1	K/W
From junction to ambient in free air	R_{thj-a}	=	35,7	K/W

CHARACTERISTICS

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

Collector cut-off currents

$-V_{CB} = -V_{CBOmax}; I_E = 0$	$-I_{CBO}$	<	1	mA
$-V_{CE} = 1/2 V_{CEOmax}; I_B = 0$	$-I_{CEO}$	<	2	mA

Emitter cut-off current

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

$-I_C = 30\text{ mA}; I_B = 0$	TIP145	$-V_{CEO_{sust}}$	>	60	V
	TIP146	$-V_{CEO_{sust}}$	>	80	V
	TIP147	$-V_{CEO_{sust}}$	>	100	V

D.C. current gain

$-V_{CE} = 4\text{ V}; -I_C = 5\text{ A}$	h_{FE}	>	1000
$-V_{CE} = 4\text{ V}; -I_C = 10\text{ A}$	h_{FE}	>	500

Base-emitter voltage

$-V_{CE} = 4\text{ V}; -I_C = 10\text{ A}$	$-V_{BE}$	<	3	V
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Collector-emitter saturation voltage

$-I_C = 5\text{ A}; -I_B = 10\text{ mA}$	$-V_{CE_{sat}}$	<	2	V
$-I_C = 10\text{ A}; -I_B = 40\text{ mA}$	$-V_{CE_{sat}}$	<	3	V

Switching times (see Figs 3 and 4)

$-I_C = 10\text{ A}; -I_{Bon} = I_{Boff} = 40\text{ mA}$
 $-V_{CC} = 30\text{ V}$

turn-on time	t_{on}	typ.	0,9	μs
turn-off time	t_{off}	typ.	11	μs

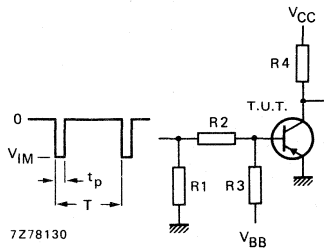


Fig. 3 Switching times test circuit.

$-V_{IM} = 33\text{ V}$	$R1 = 56\text{ }\Omega$	$t_r = t_f = 15\text{ ns}$
$-V_{CC} = 30\text{ V}$	$R2 = 410\text{ }\Omega$	$t_p = 10\text{ }\mu\text{s}$
$V_{BB} = 4,2\text{ V}$	$R3 = 150\text{ }\Omega$	$T = 500\text{ }\mu\text{s}$
	$R4 = 3\text{ }\Omega$	

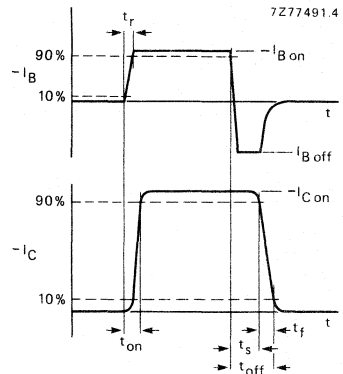


Fig. 4 Switching times waveforms.

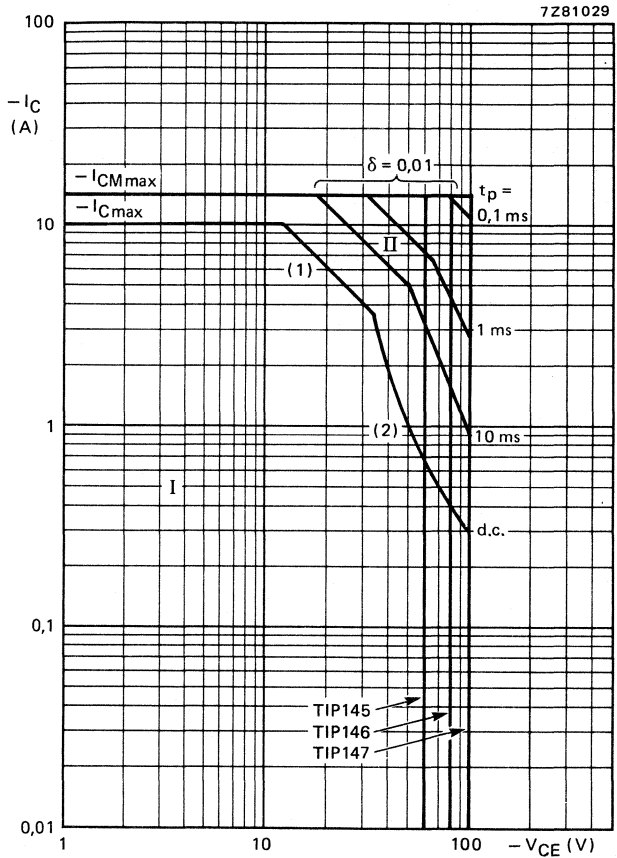


Fig. 5 Safe Operating Area; $T_{mb} \leq 25^\circ\text{C}$.

- 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)

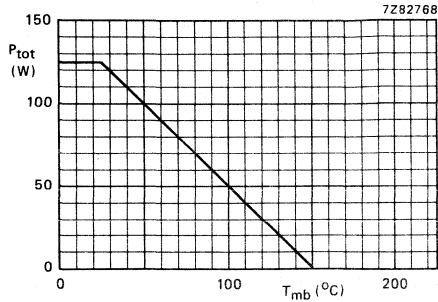


Fig. 6 Power derating curve.

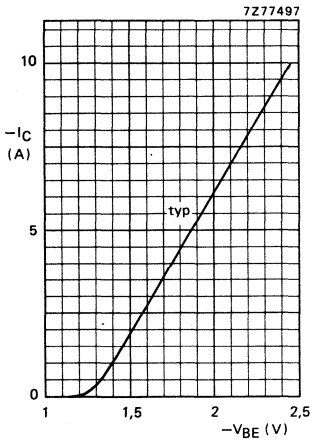


Fig. 7 $-V_{CE} = 4$ V; $T_j = 25$ °C.

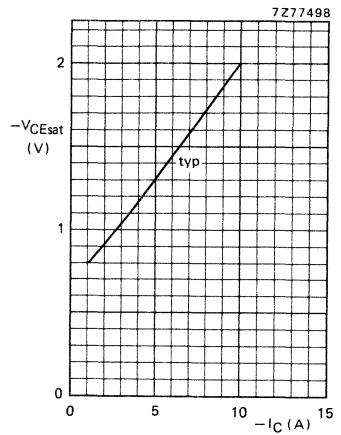


Fig. 8 $-I_C/I_B = 250$; $T_j = 25$ °C.

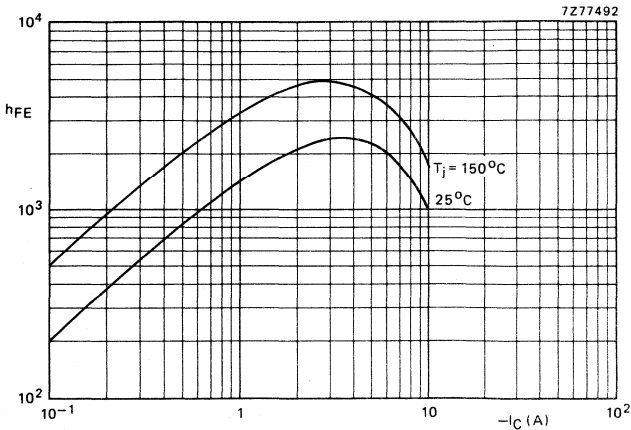


Fig. 9 Typical values; $-V_{CE} = 4$ V.

RATINGS

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

Collector-base voltage ($I_E = 0$)	$-V_{CBO}$	max.	100 V
Collector-emitter voltage ($R_{BE} \leq 100 \Omega$)	$-V_{CER}$	max.	70 V
Collector-emitter voltage ($I_B = 0$)	$-V_{CEO}$	max.	60 V
Emitter-base voltage ($I_C = 0$)	$-V_{EBO}$	max.	7 V
Collector current (d.c.)	$-I_C$	max.	15 A
Base current (d.c.)	$-I_B$	max.	7 A
Total power dissipation up to $T_{mb} = 25^\circ\text{C}$	P_{tot}	max.	100 W
Total power dissipation in free air	P_{tot}	max.	3,5 W
Storage temperature	T_{stg}		-65 to + 150 °C
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1,25 K/W
From junction to ambient in free air	$R_{th\ j-a}$	=	35,7 K/W

CHARACTERISTICS

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

Collector cut-off currents

$-V_{CE} = 100\text{ V}; +V_{BE} = 1,5\text{ V}$	$-I_{CEX}$	<	5 mA
$-V_{CE} = 30\text{ V}; I_B = 0$	$-I_{CEO}$	<	0,7 mA

Emitter cut-off current

$-V_{EB} = 7\text{ V}; I_C = 0$	$-I_{EBO}$	<	5 mA
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Collector-emitter sustaining voltage

$-I_C = 30\text{ mA}; I_B = 0$	$-V_{CEO_{sust}}$	>	60 V
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D.C. current gain

$-V_{CE} = 4\text{ V}; -I_C = 4\text{ A}$	h_{FE}		20 - 70
$-V_{CE} = 4\text{ V}; -I_C = 10\text{ A}$	h_{FE}	>	5

Base-emitter voltage

$-V_{CE} = 4\text{ V}; -I_C = 4\text{ A}$	$-V_{BE}$	<	1,8 V
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Collector-emitter saturation voltage

$-I_C = 4\text{ A}; -I_B = 0,4\text{ A}$	$-V_{CE_{sat}}$	<	1,1 V
$-I_C = 10\text{ A}; -I_B = 3,3\text{ A}$	$-V_{CE_{sat}}$	<	3,0 V

Small-signal current gain

$-V_{CE} = 10\text{ V}; -I_C = 0,5\text{ A}; f = 1\text{ kHz}$	h_{fe}	>	20
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Transition frequency

$-V_{CE} = 10\text{ V}; -I_C = 0,5\text{ A}; f = 1\text{ MHz}$	f_T	>	3 MHz
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Unclamped inductive load energy

$L = 20 \text{ mH}; -I_C = 2,5 \text{ A}$

Switching times

$-I_C = 6 \text{ A}; -I_{B\text{on}} = I_{B\text{off}} = 0,6 \text{ A}; -V_{CC} = 30 \text{ V}$

turn-on time

turn-off time

$E(\text{BR}) < 62,5 \text{ mJ}$

$t_{\text{on}} \text{ typ. } 0,4 \mu\text{s}$

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

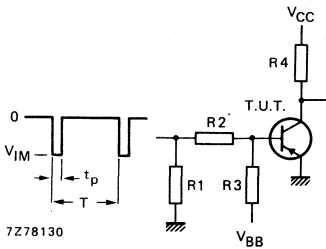


Fig. 2 Switching times test circuit.

- $-V_{CC} = 30 \text{ V}$
- $-V_{IM} = 24 \text{ V}$
- $V_{BB} = 4 \text{ V}$
- $R1 = 56 \Omega$
- $R2 = 24 \Omega$
- $R3 = 10 \Omega$
- $R4 = 5 \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 10 \mu\text{s}$
- $T = 500 \mu\text{s}$

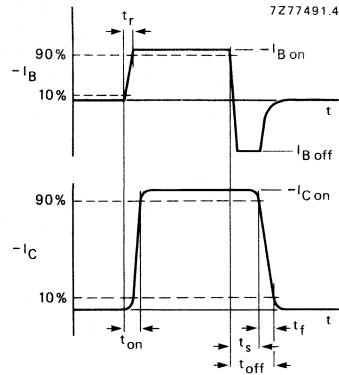


Fig. 3 Switching times waveforms.

7Z81019

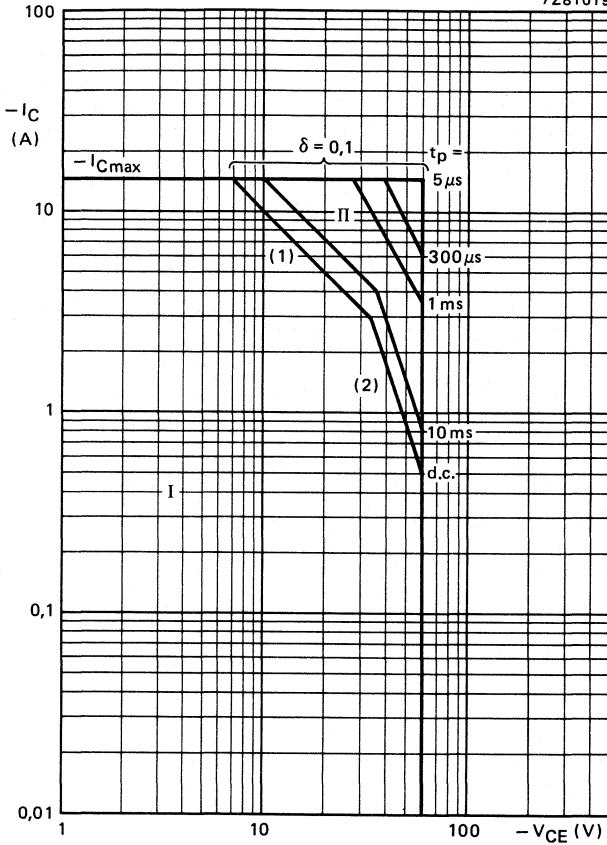


Fig. 4 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

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

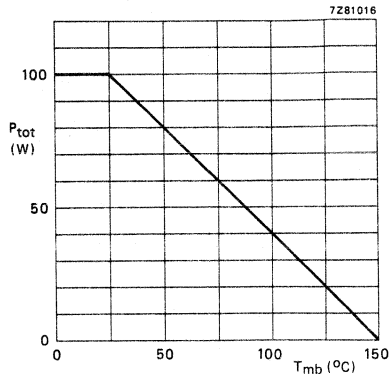


Fig. 5 Power derating curve.

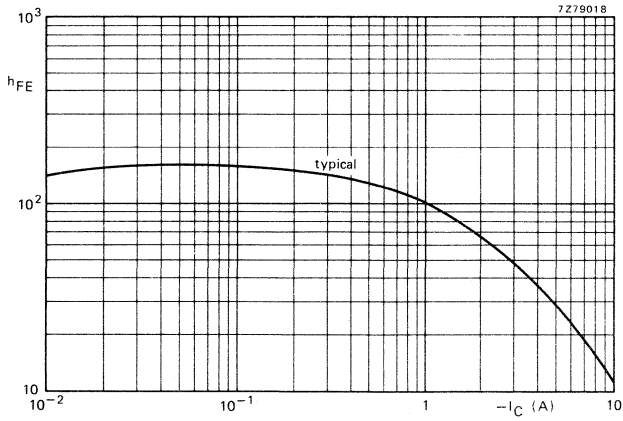


Fig. 6 $-V_{CE} = 4\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$

SILICON POWER TRANSISTOR

N-P-N epitaxial-base power transistor in a plastic SOT-93 envelope for use in audio output stages and general amplifier and switching applications. P-N-P complement is TIP2955.

QUICK REFERENCE DATA

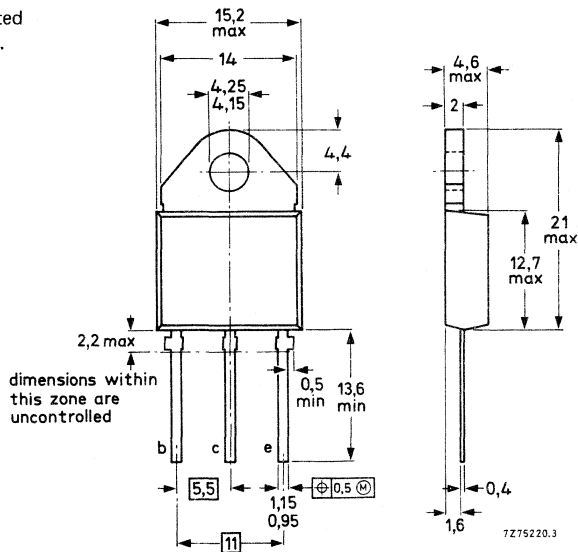
Collector-base voltage (open emitter)	V_{CBO}	max.	100 V
Collector-emitter voltage ($R_{BE} \leq 100 \Omega$)	V_{CER}	max.	70 V
Collector current (d.c.)	I_C	max.	15 A
Total power dissipation up to $T_{mb} = 25^\circ C$	P_{tot}	max.	100 W
D.C. current gain	h_{FE}		20 to 70
Collector-emitter saturation voltage	V_{CEsat}	<	1,1 V
Transition frequency	f_T	>	3 MHz
$V_{CE} = 4 V; I_C = 4 A$			
$I_C = 4 A; I_B = 0,4 A$			
$V_{CE} = 10 V; I_C = 0,5 A; f = 1 MHz$			

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



RATINGS

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

Collector-base voltage ($I_E = 0$)	V_{CBO}	max.	100 V
Collector-emitter voltage ($R_{BE} \leq 100 \Omega$)	V_{CEr}	max.	70 V
Collector-emitter voltage ($I_B = 0$)	V_{CEO}	max.	60 V
Emitter-base voltage ($I_C = 0$)	V_{EBO}	max.	7 V
Collector current (d.c.)	I_C	max.	15 A
Base current (d.c.)	I_B	max.	7 A
Total power dissipation up to $T_{mb} = 25 \text{ }^\circ\text{C}$	P_{tot}	max.	100 W
Total power dissipation in free air	P_{tot}	max.	3,5 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}	=	1,25 K/W
From junction to ambient in free air	R_{thj-a}	=	35,7 K/W

CHARACTERISTICS

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

Collector cut-off currents

$V_{CE} = 100 \text{ V}; -V_{BE} = 1,5 \text{ V}$	I_{CEX}	<	5 mA
$V_{CE} = 30 \text{ V}; I_B = 0$	I_{CEO}	<	0,7 mA

Emitter cut-off current

$V_{EB} = 7 \text{ V}; I_C = 0$	I_{EBO}	<	5 mA
---------------------------------	-----------	---	------

Collector-emitter sustaining voltage

$I_C = 30 \text{ mA}; I_B = 0$	$V_{CEO_{sust}}$	>	60 V
--------------------------------	------------------	---	------

D.C. current gain

$V_{CE} = 4 \text{ V}; I_C = 4 \text{ A}$	h_{FE}		20 to 70
$V_{CE} = 4 \text{ V}; I_C = 10 \text{ A}$	h_{FE}	>	5

Base-emitter voltage

$V_{CE} = 4 \text{ V}; I_C = 4 \text{ A}$	V_{BE}	<	1,8 V
---	----------	---	-------

Collector-emitter saturation voltage

$I_C = 4 \text{ A}; I_B = 0,4 \text{ A}$	$V_{CE_{sat}}$	<	1,1 V
$I_C = 10 \text{ A}; I_B = 3,3 \text{ A}$	$V_{CE_{sat}}$	<	3,0 V

Small-signal current gain

$V_{CE} = 10 \text{ V}; I_C = 0,5 \text{ A}; f = 1 \text{ kHz}$	h_{fe}	>	20
---	----------	---	----

Transition frequency

$V_{CE} = 10 \text{ V}; I_C = 0,5 \text{ A}; f = 1 \text{ MHz}$	f_T	>	3 MHz
---	-------	---	-------

Unclamped inductive load energy

$L = 20 \text{ mH}; I_C = 2,5 \text{ A}$

Switching times (see Figs 2 and 3)

$I_C = 6 \text{ A}; I_{B\text{on}} = -I_{B\text{off}} = 0,6 \text{ A}; V_{CC} = 30 \text{ V}$

turn-on time

turn-off time

$E(\text{BR}) > 62,5 \text{ mJ}$

$t_{\text{on}} \text{ typ. } 0,6 \mu\text{s}$

$t_{\text{off}} \text{ typ. } 1,0 \mu\text{s}$

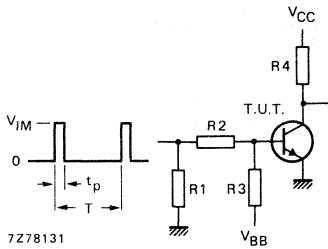


Fig. 2 Switching times test circuit.

- $V_{CC} = 30 \text{ V}$
- $V_{IM} = 24 \text{ V}$
- $V_{BB} = -4 \text{ V}$
- $R1 = 56 \Omega$
- $R2 = 24 \Omega$
- $R3 = 10 \Omega$
- $R4 = 5 \Omega$
- $t_r = t_f = 15 \text{ ns}$
- $t_p = 10 \mu\text{s}$
- $T = 500 \mu\text{s}$

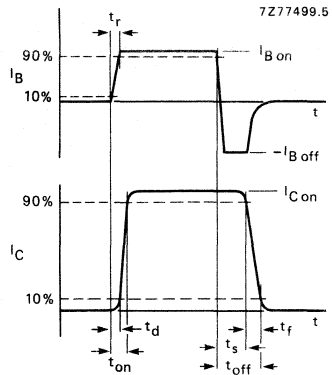


Fig. 3 Switching times waveforms.

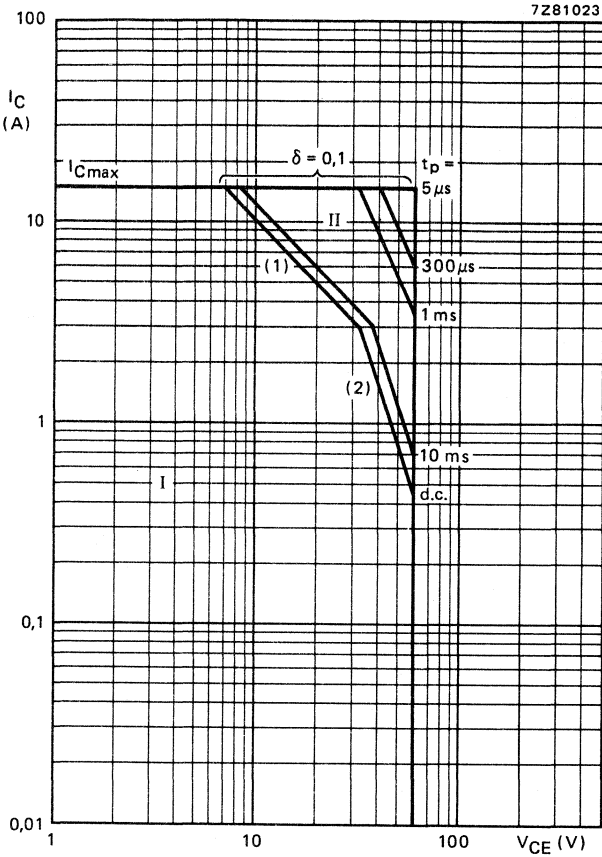


Fig. 4 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

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

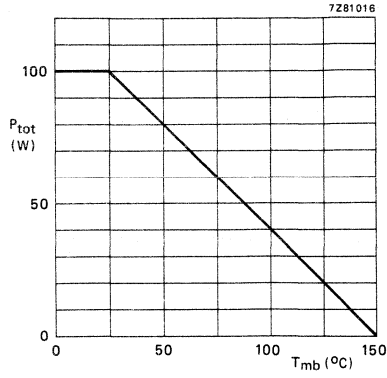


Fig. 5 Power derating curve.

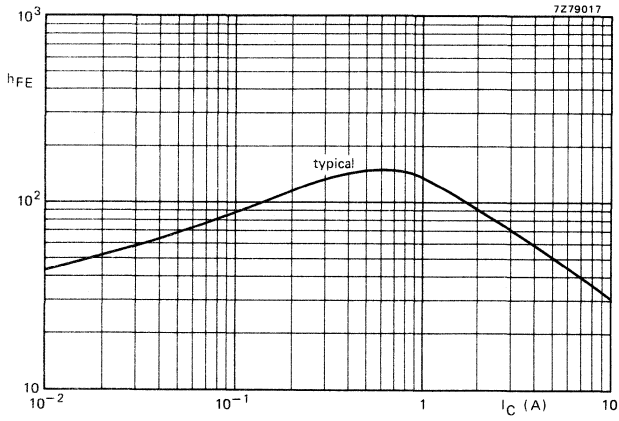


Fig. 6 $V_{CE} = 4\text{ V}$; $T_j = 25\text{ }^\circ\text{C}$.

HYBRID MODULES

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

Sinusoidal output power for $d_{tot} < 0,2\%$

$f = 20 \text{ Hz to } 20 \text{ kHz}$

$R_L = 4 \Omega$

$R_L = 8 \Omega$

Total harmonic distortion

$P_o = 1 \text{ W}; f = 1 \text{ kHz}$

	OM931	OM961
P_o	$> 30 \text{ W at } \pm 23 \text{ V}$	$> 60 \text{ W at } \pm 31 \text{ V}$
P_o	$> 30 \text{ W at } \pm 26 \text{ V}$	$> 60 \text{ W at } \pm 35 \text{ V}$
d_{tot}	typ. 0,02	0,02 %

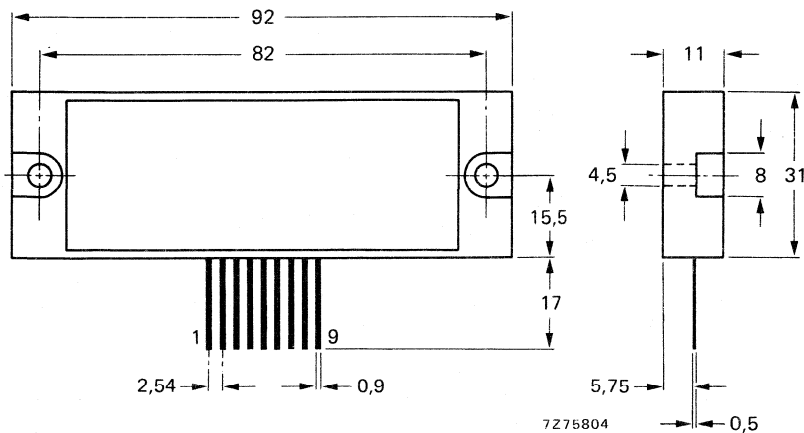


Fig. 1 Outline; dimensions in mm.

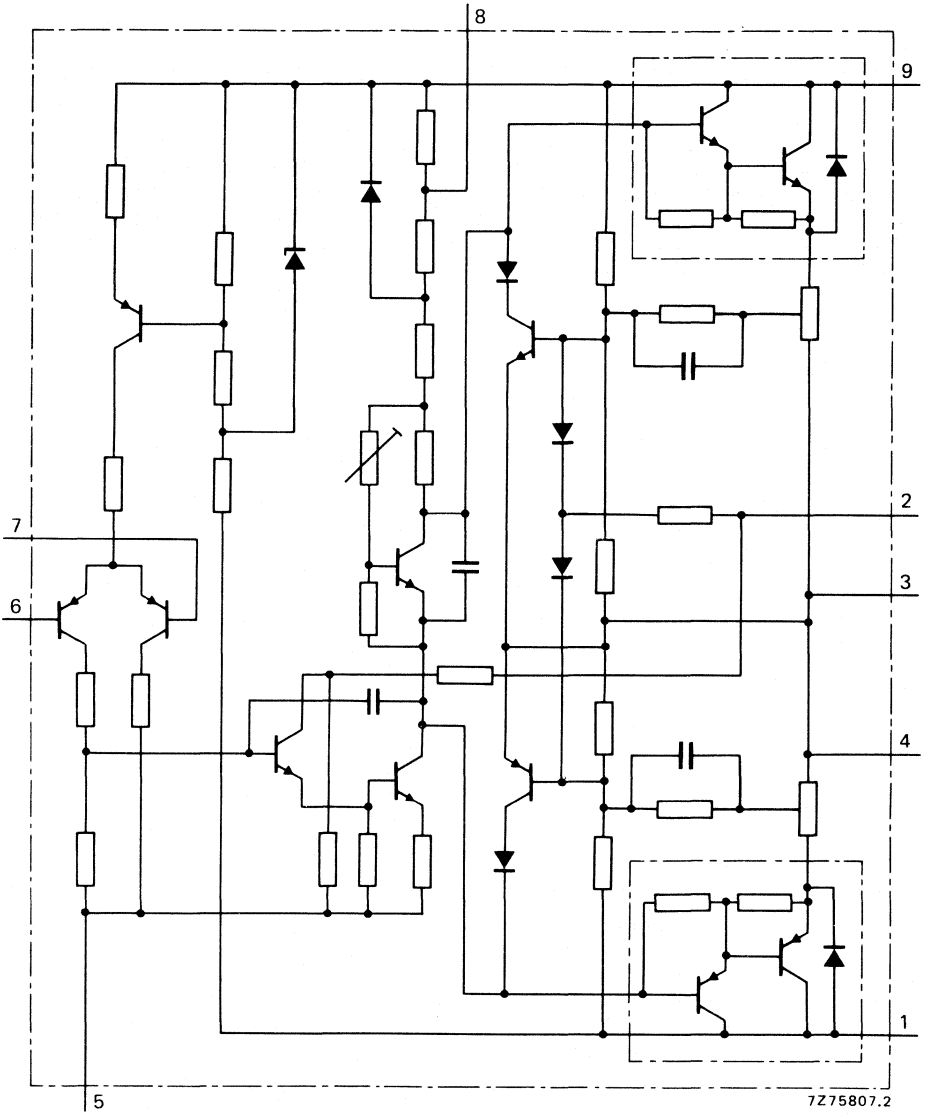


Fig. 2 Circuit diagram.

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 $R_{th\ h-a} = 1,4$ K/W (OM931) and $R_{th\ h-a} = 0,8$ K/W (OM961); measured in the circuit of Fig. 3.

		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	>	30	60	W*	
	P_o	>	—	—	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 $P_o = \text{rated value}$	d_{im}	typ.	0,05	0,05	%	
	d_{im}	typ.	0,1	0,1	%	
Input sensitivity for $P_o = \text{rated value}$	V_i	typ.	0,7 1	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 $P_o = \text{rated value} - 10$ 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

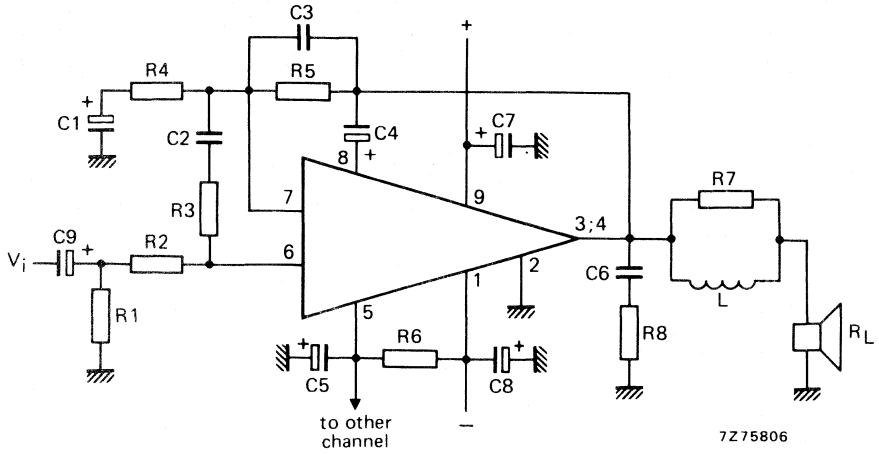


Fig. 3 Example of an amplifier with external components.

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).

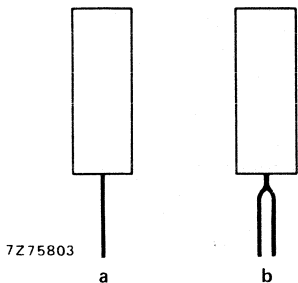
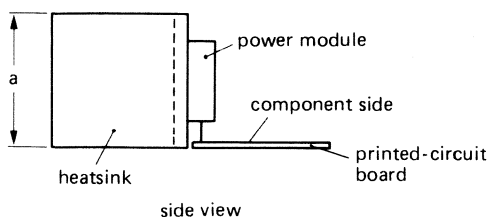


Fig. 4:
a. Single in-line (SIL) leads.
b. Dual in-line (DIL) leads.



Thermal resistance values from heatsink to ambient for various heatsink lengths (a):

- $R_{th\ h-a} = 1,4\ K/W: a = 50\ mm$
- $R_{th\ h-a} = 1,0\ K/W: a = 75\ mm$
- $R_{th\ h-a} = 0,8\ K/W: a = 90\ mm$

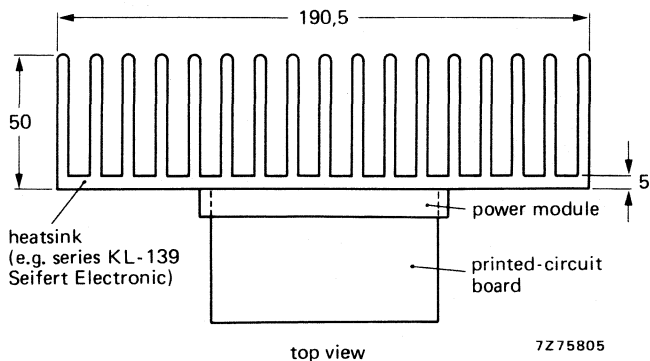


Fig. 5 Example of a heatsink to be used for the module; dimensions in mm.

PRINTED-CIRCUIT BOARDS for OM931 and OM961

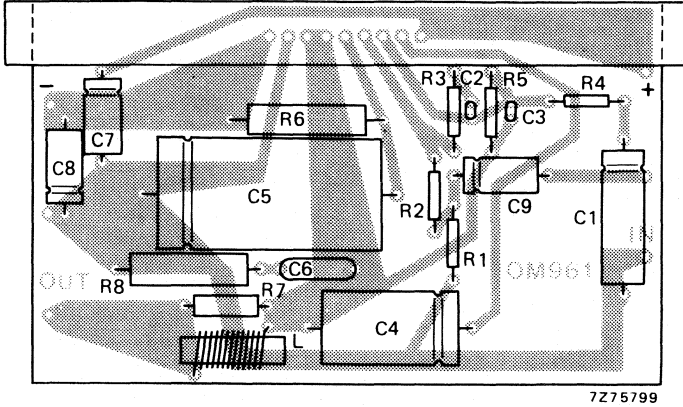


Fig. 6 Component side of SIL-version showing component layout.

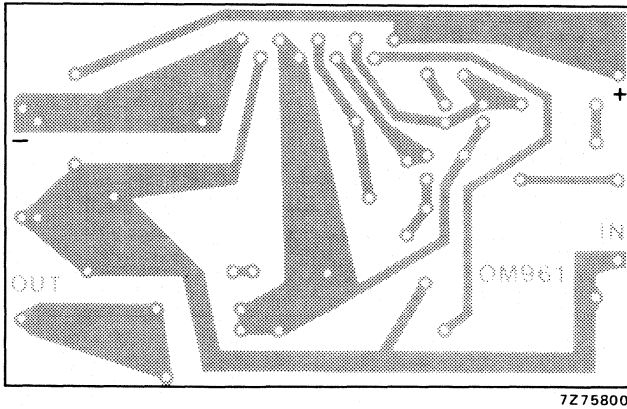


Fig. 7 Component side of DIL-version; for component layout see Fig. 6.

Dimensions in mm

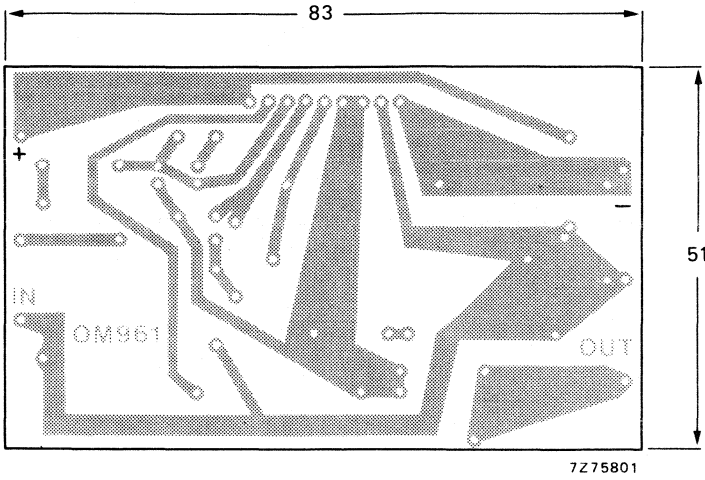


Fig. 8 Track side of SIL-version.

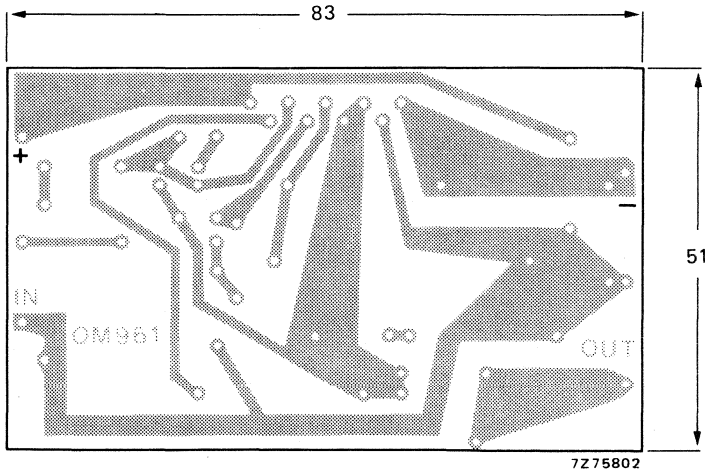


Fig. 9 Track side of DIL-version.

ACCESSORIES

TYPE NUMBER SURVEY ACCESSORIES

type number	description	envelope
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	TO-126
56339	mica washer (500 to 2000 V)	TO-3
56352	insulating mounting support	TO-3
56353	spring clip	TO-126/SOT-82
56354	mica insulator	TO-126/SOT-82
56359b	mica washer (up to 1000 V)	TO-220
56359c	insulating bush (up to 800 V)	TO-220
56359d	rectangular insulating bush (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 (up to 2000 V)	TO-220
56368a	mica insulator (up to 800 V)	SOT-93
56368b	insulating bush (up to 800 V)	SOT-93
56369	mica insulator (up to 2 kV)	TO-220
56378	mica insulator (up to 1500 V)	SOT-93
56379	spring clip	SOT-93
56387a	mica insulator (up to 300 V)	TO-126
56387b	insulating bush (up to 300 V)	TO-126

SELECTION GUIDE

CLIP MOUNTING

envelope	direct mounting		insulated mounting			
	clip		mica	alumina	clip	
TO-126 (SOT-32)	56353		56354		56353	
SOT-82	56353		56354		56353	
TO-220 (SOT-78)	56363		56369 or	56367	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) up to 300 V	56326	M3	56387a	56387b	56326	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	—	M4	56201d	56201j or 56261a		M3
up to 2000 V			56339	56352		M3

The accessories mentioned can be supplied on request.

See also chapter Mounting Instructions.

Mounting TO-126 and SOT-82 envelopes.

56353

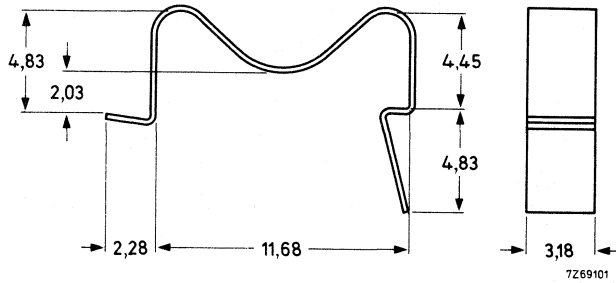
CLIP

for TO-126 and SOT-82 envelopes

MECHANICAL DATA

Material: high carbon spring steel

Dimensions in mm



Spring clip suitable for heatsink of 1,5 to 2 mm.

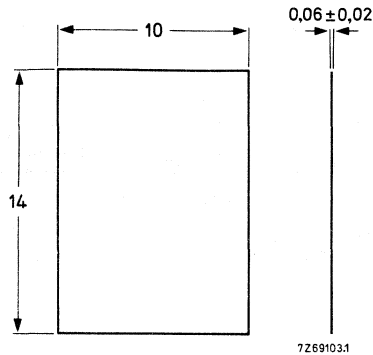
56354

MICA INSULATOR

for TO-126 and SOT-82 envelopes

MECHANICAL DATA

Dimensions in mm



Mounting of TO-126 envelopes

56326

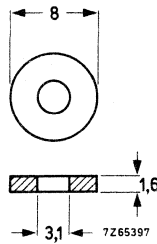
WASHER

for direct mounting of TO-126 envelopes

MECHANICAL DATA

Dimensions in mm

Material: brass, nickel plated



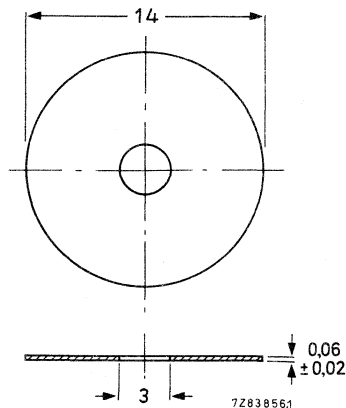
56387a

MICA WASHER

for insulated screw mounting of TO-126 envelopes (up to 300 V)

MECHANICAL DATA

Dimensions in mm



Mounting of TO-126 envelopes

56387b

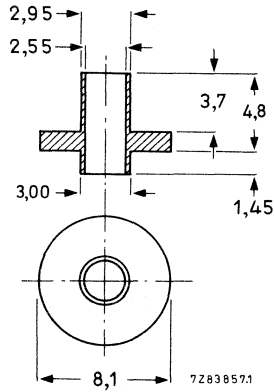
INSULATING BUSH

for insulated screw mounting of TO-126 envelopes (up to 300 V)

MECHANICAL DATA

Material: polyester

Dimensions in mm



TEMPERATURE

Maximum permissible temperature

T_{\max} 150 °C

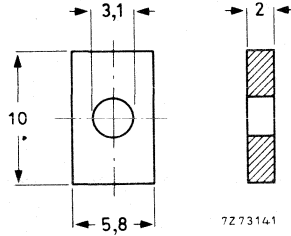
56360a

RECTANGULAR WASHER

For direct and insulated mounting.

MECHANICAL DATA

Material: brass; nickel plated.



Dimensions in mm

56363

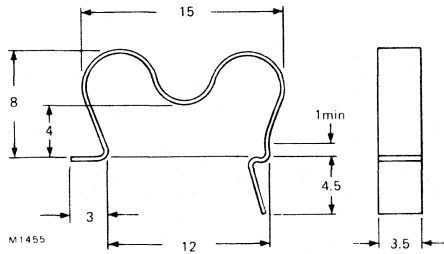
SPRING CLIP

For direct mounting.

MECHANICAL DATA

Material: stainless steel; for mounting on heatsink of 1.0 to 2.0 mm.

Recommended force of clip on device is 20 N (2 kgf).



Dimensions in mm

56364

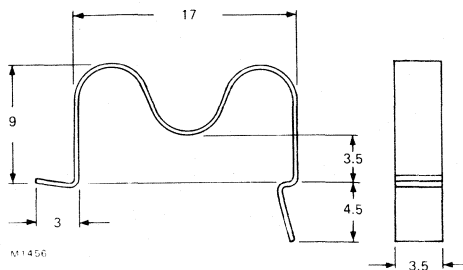
SPRING CLIP

For insulated mounting.

MECHANICAL DATA

Material: stainless steel; for mounting on heatsink of 1.0 to 1.5 mm.

Recommended force of clip on device is 20 N (2 kgf).



Dimensions in mm

To be used in conjunction with insulators 56367 or 56369

56367

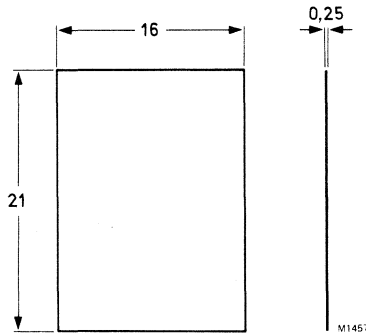
ALUMINA INSULATOR

For insulated clip mounting up to 2 kV.

MECHANICAL DATA

Material: 96-alumina.

Dimensions in mm



*Because alumina is brittle, extreme care must be taken when mounting devices not to crack the alumina, particularly when used without heatsink compound.

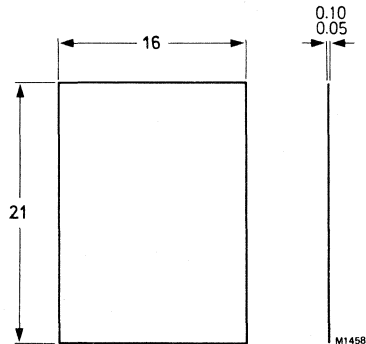
56369

MICA INSULATOR

For insulated clip mounting up to 2 kV.

MECHANICAL DATA

Dimensions in mm



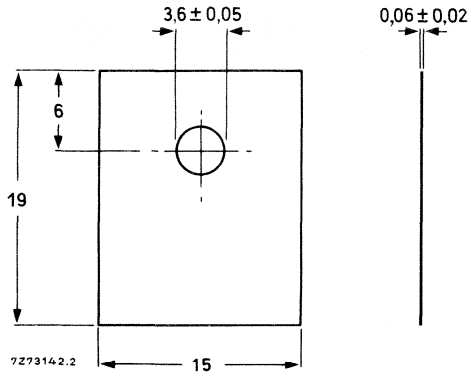
Mounting TO-220 envelopes

56359b

MICAWASHER

for TO-220 envelopes (up to 1000 V)

Dimensions in mm



56360a

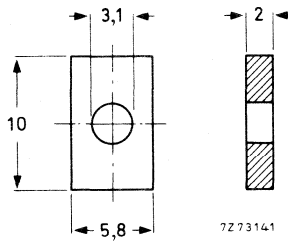
RECTANGULAR WASHER

for direct and insulated mounting of TO-220 envelopes

MECHANICAL DATA

Material: brass; nickel plated.

Dimensions in mm



Mounting TO-220 envelopes

56359c

INSULATING BUSH

for TO-220 envelopes (up to 800 V)

MECHANICAL DATA

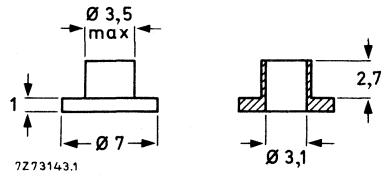
Material: polyester

TEMPERATURE

Maximum permissible temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$

Dimensions in mm



56359d

RECTANGULAR INSULATING BUSH

for TO-220 envelopes (up to 1000 V)

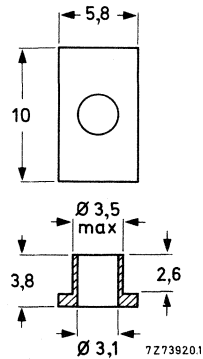
MECHANICAL DATA

TEMPERATURE

Maximum permissible temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$

Dimensions in mm



Clip mounting of SOT-93 envelopes

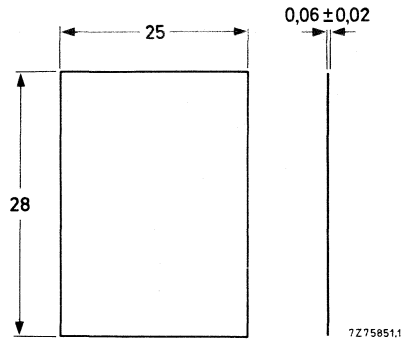
56378

MICA INSULATOR

for SOT-93 clip mounting (up to 1500 V)

MECHANICAL DATA

Dimensions in mm



56379

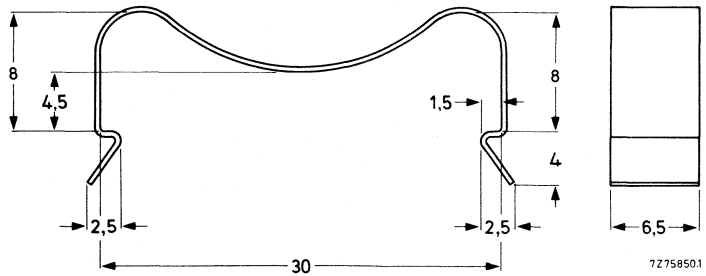
SPRING CLIP

for direct and insulated mounting of SOT-93 envelopes

MECHANICAL DATA

Dimensions in mm

Material:
CrNi steel NLN-939;
thickness $0,4 \pm 0,04$.



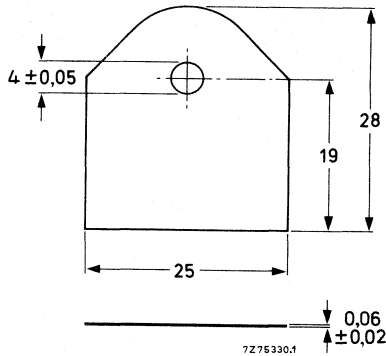
Screw mounting of SOT-93 envelopes

56368a MICA INSULATOR

for insulated screw mounting of SOT-93 envelopes (up to 800 V)

MECHANICAL DATA

Dimensions in mm



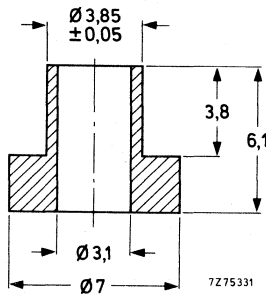
56368b INSULATING BUSH

for insulated screw mounting of SOT-93 envelopes (up to 800 V)

MECHANICAL DATA

Dimensions in mm

Material: polyester



TEMPERATURE

Maximum permissible temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$

Mounting TO-3 envelopes

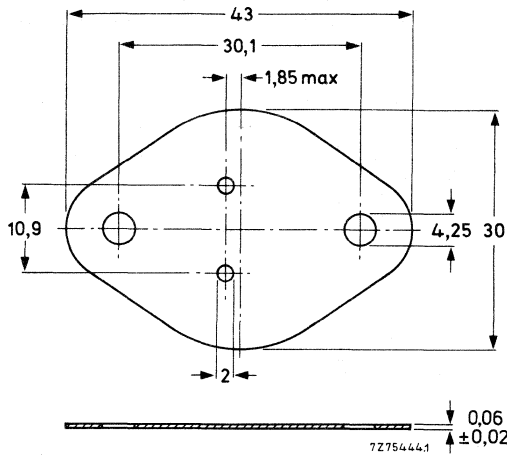
56201d

MICA WASHER

Mica washer for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm



56201j

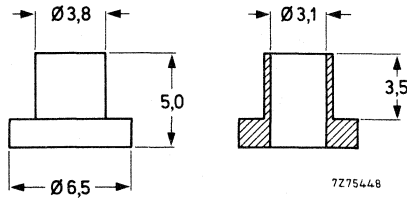
2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Dimensions in mm

material: polyester



TEMPERATURE

Maximum permissible temperature

$T_{max} = 150\text{ }^{\circ}\text{C}$

Mounting TO-3 envelopes

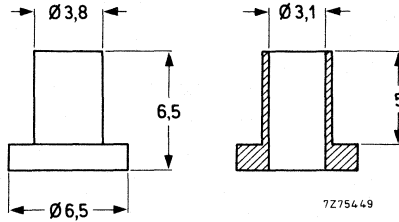
56261a 2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of TO-3 envelopes.

MECHANICAL DATA

Material: polyester

Dimensions in mm



TEMPERATURE

Maximum permissible temperature

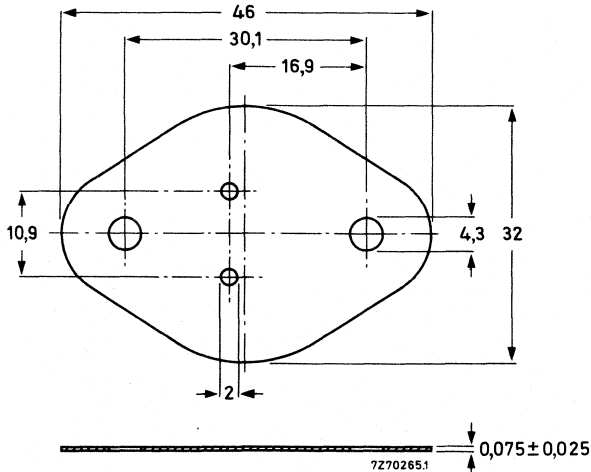
$T_{max} = 150\text{ }^{\circ}\text{C}$

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



Mounting TO-3 envelopes

56352

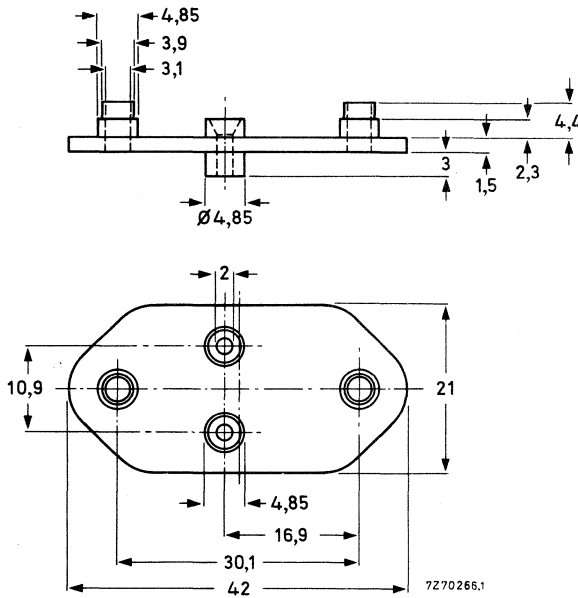
MOUNTING SUPPORT

Mounting support for 500 to 2000 V insulation of TO-3 envelopes, for which it should be combined with mica washer 56339.

MECHANICAL DATA

Dimensions in mm

Material: polyester



TEMPERATURE

Maximum permissible temperature

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

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:

- 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.
- Unblackened or thinner heatsinks
 - Multiply by the factor given in Fig. 1 as a function of the heatsink size A .

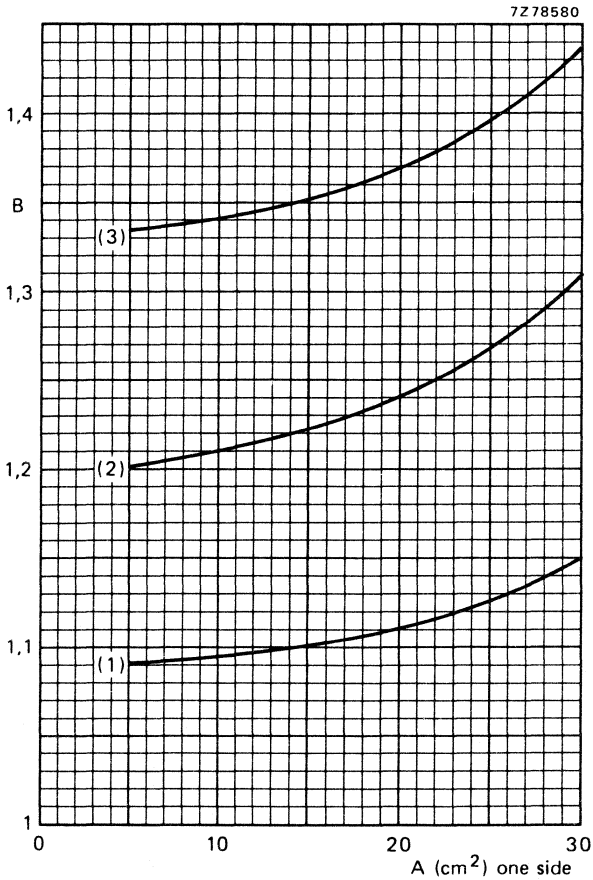


Fig. 1 Multiplication factor (B) as a function of heatsink area (A).

- (1) 1 mm blackened aluminium.
- (2) 1,5 mm unblackened aluminium.
- (3) 1 mm unblackened aluminium.

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 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.

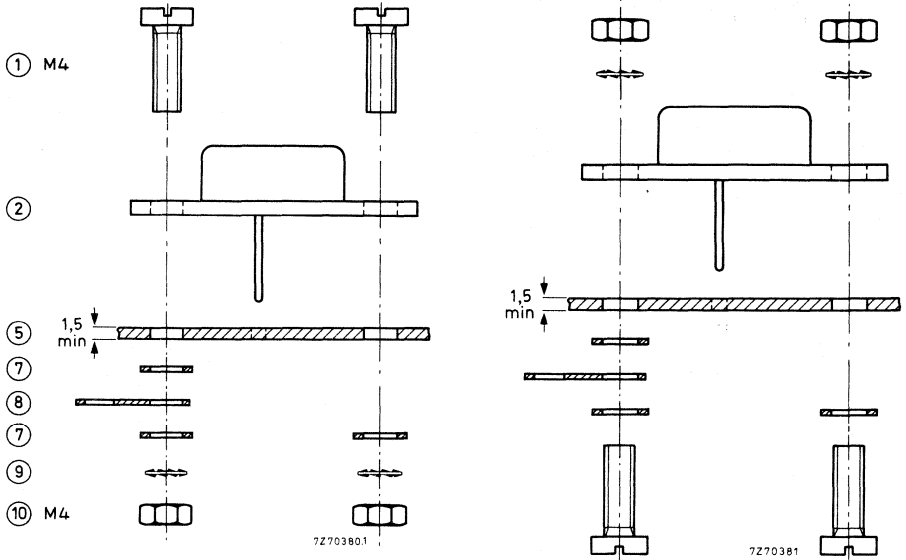
	Direct mounting	Insulated mounting		
		500 V mica	2000 V mica	
From mounting base to heatsink without heatsink compound	$R_{th\ mb-h}$ 0,6	1,0	1,25	K/W
with heatsink compound	$R_{th\ mb-h}$ 0,1	0,3	0,5	K/W

MOUNTING INSTRUCTIONS TO-3

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

- (1) = screw
 - (2) = TO-3
 - (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

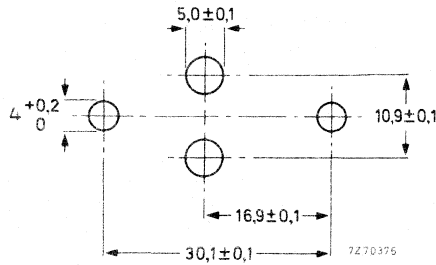


Fig. 3 Hole pattern for direct mounting with nuts.

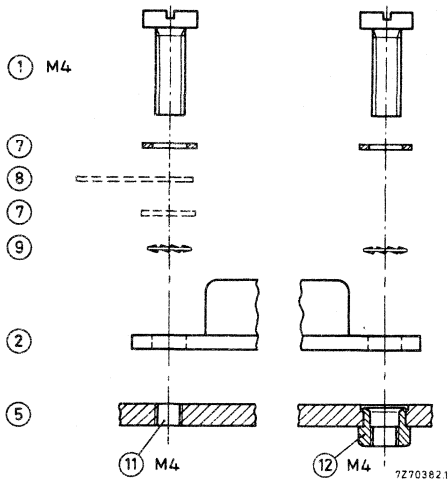


Fig. 4 Direct mounting with tapped holes or insert nuts.

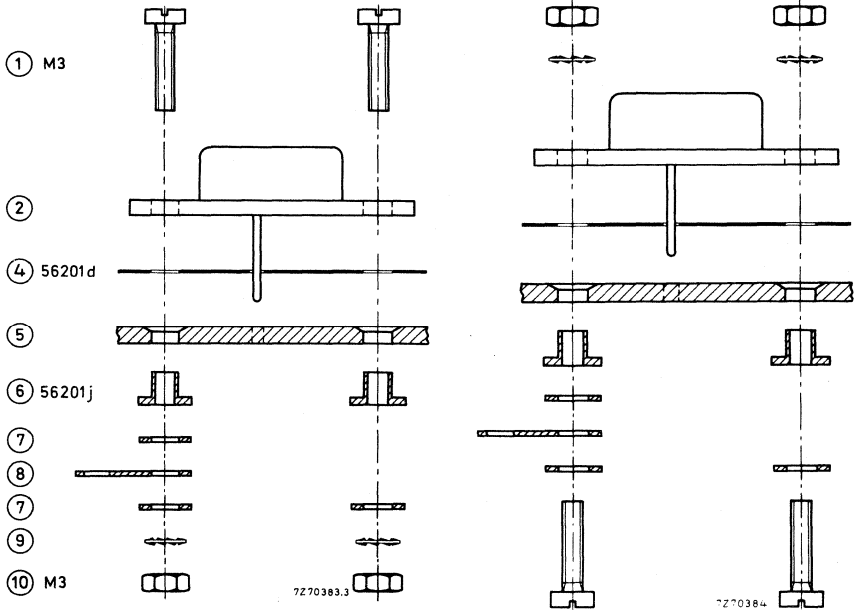
MOUNTING INSTRUCTIONS FOR UP TO 500 V INSULATION

Using insulating bushes 56201j 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.

Using insulating bush 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.



Figs 5 and 6. Insulated mounting (500 V) with 56201j and 56201d. Heatsink thickness: 1,5 to 2,5 mm.

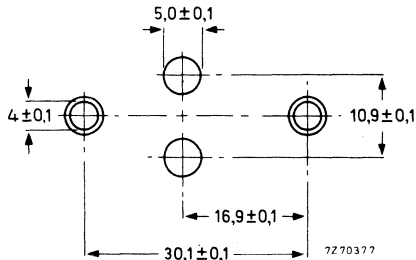


Fig. 7 Hole pattern for 500 V insulation, nut fastening.

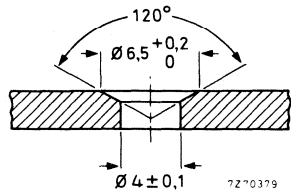


Fig. 8 Shape of hole for 500 V insulation, nut fastening.

For legend see page 890.

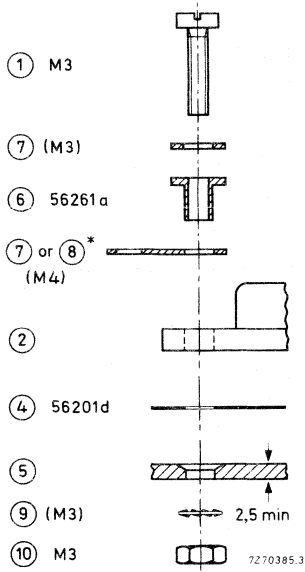


Fig. 9 Insulated mounting (500 V) with nuts.

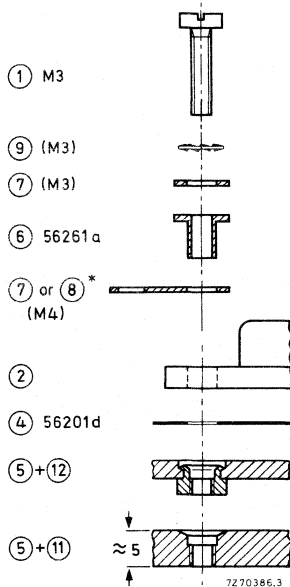


Fig. 10 Insulated mounting (500 V) with tapped holes or insert nuts.

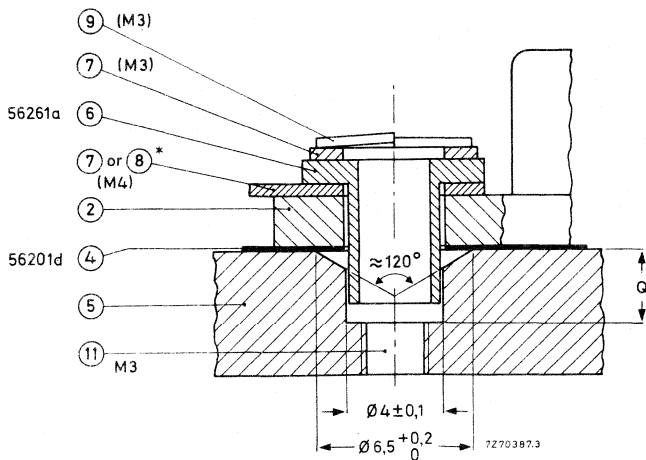


Fig. 11 Assembly (partial) for Fig. 10 - tapped holes.
Q minimum 2,5 mm.

For legend see page 890.

* Thickness approximately 0,6 mm, outer diameter 7,5 mm.

MOUNTING INSTRUCTIONS TO-3

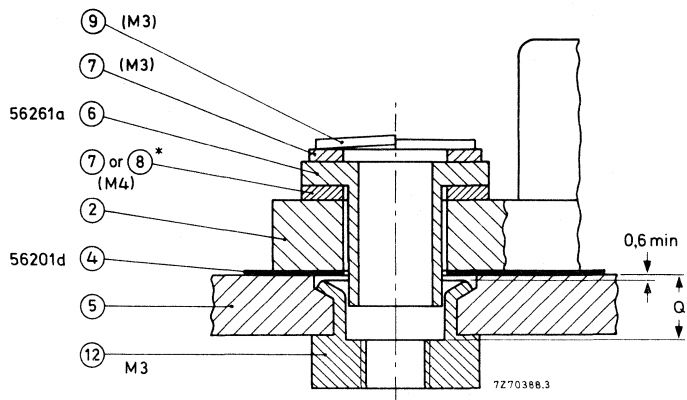


Fig. 12 Assembly (partial) for Fig. 10 - insert nuts Q minimum 2,5 mm.

For legend see page 890.

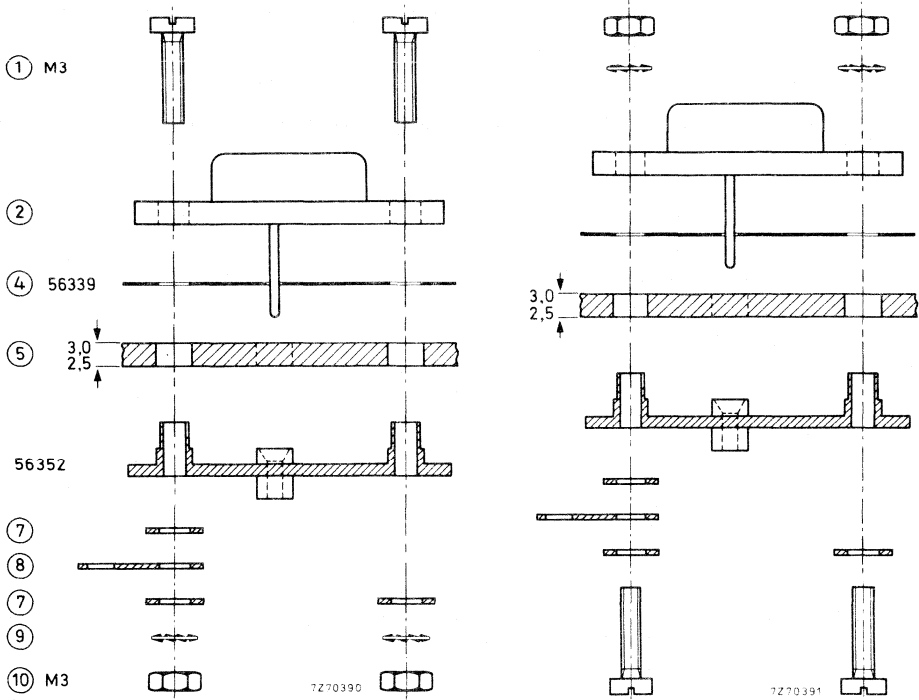
Dimensions in mm

* Thickness approximately 0,6 mm, outer diameter 7,5 mm.

MOUNTING INSTRUCTIONS FOR 500 V TO 2000 V INSULATION

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.



Figs 13 and 14. Insulated mounting (500 V–2000 V).

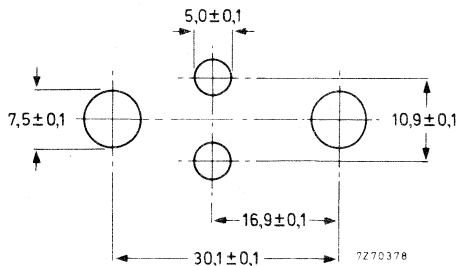


Fig. 15 Hole pattern for Figs 13 and 14.

For legend see page 890.

MOUNTING INSTRUCTIONS FOR TO-126 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 (TO-126 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. (TO-126 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 TO-126/SOT-82

Thermal data

From mounting base to heatsink

	$R_{th\ mb-h}$ (K/W)			
	clip mounting		screw mounting	
	direct	insulated	direct	insulated
TO-126, with heatsink compound	1,0	3,0	0,5	3,0
TO-126, without heatsink compound	3,0	6,0	1,0	6,0
SOT-82, with heatsink compound	0,4	2,0	—	—
SOT-82, without heatsink compound	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.

Mounting base soldering

Recommended metal-alloy of solder paste (85% metal weight)

62 Sn/36 Pb/2 Ag or 60 Sn/40 Pb.

Maximum soldering temperature ≤ 200 °C (tab-temperature).

Soldering cycle duration including pre-heating ≤ 30 sec.

For good soldering and avoiding damage to the encapsulation pre-heating is recommended to a temperature ≤ 165 °C at a duration ≤ 10 s.

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).

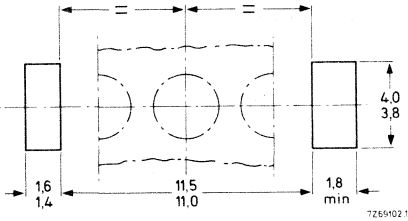


Fig. 1 Heatsink requirements.

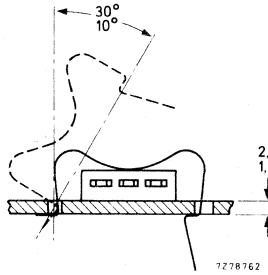


Fig. 2 Mounting spring clip.

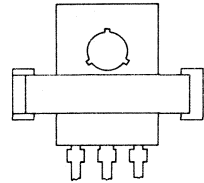


Fig. 3 Position of transistor (top view).

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). Ensure that the device is centred on the mica insulator to prevent creepage.

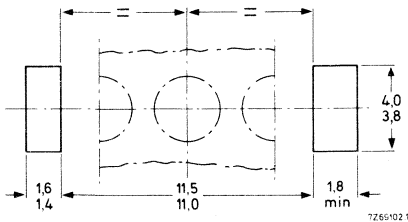


Fig. 4 Heatsink requirements.

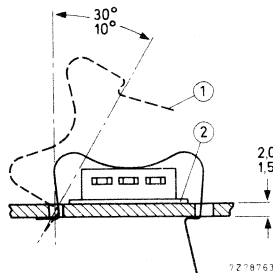


Fig. 5 Mounting.
(1) spring clip 56353.
(2) insulator 56354.

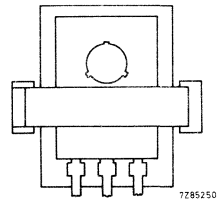


Fig. 6 Position of transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING
Direct mounting with screw and spacing washer

Dimensions in mm

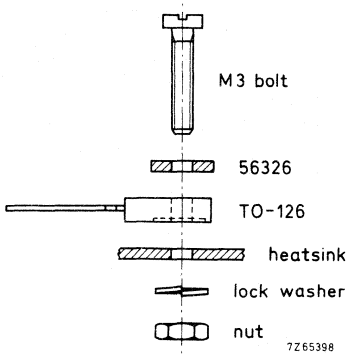


Fig. 7 Assembly through heatsink with nut.

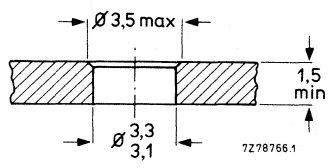


Fig. 8 Heatsink requirements.

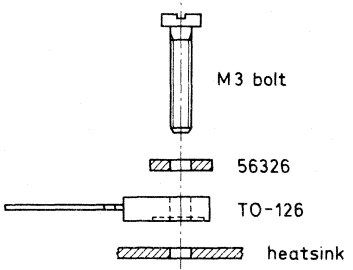


Fig. 9 Assembly into tapped heatsink.

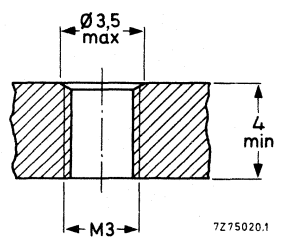


Fig. 10 Heatsink requirements.

INSTRUCTIONS FOR SCREW MOUNTING

Insulated mounting with 56326, 56387a and 56387b (up to 300 V)

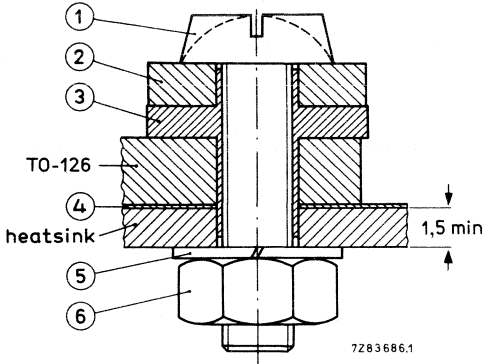


Fig. 15 Assembly through heatsink with nut.

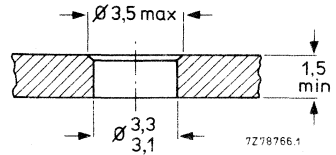


Fig. 16 Heatsink requirements.

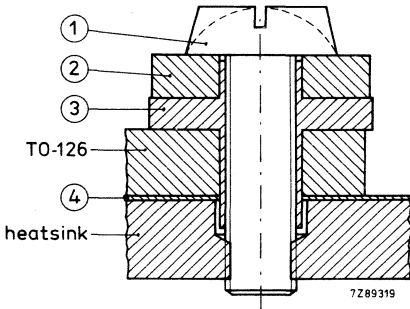


Fig. 17 Assembly with tapped heatsink.

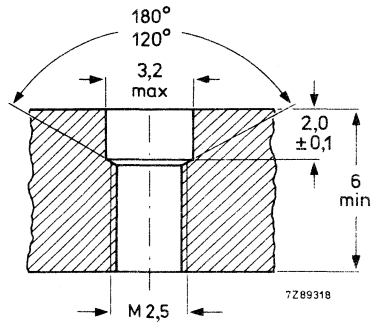


Fig. 18 Heatsink requirements.

Legend

- 1 M2,5 screw
- 2 metal washer 56326
- 3 insulating bush 56387b

- 4 mica washer 56387 a
- 5 lock washer
- 6 M2,5 nut

MOUNTING INSTRUCTIONS FOR TO-220 AND SOT-186 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rules

1. First fasten the device 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 with a spring clip gives:

- 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	K/W
without heatsink compound, direct mounting	$R_{th\ mb-h}$	= 1,4	1,4	K/W
with heatsink compound and 0,1 mm maximum mica washer	$R_{th\ mb-h}$	= 2,2	—	K/W
with heatsink compound and 0,25 mm maximum alumina insulator	$R_{th\ mb-h}$	= 0,8	—	K/W
with heatsink compound and 0,05 mm mica washer insulated up to 500 V	$R_{th\ mb-h}$	= —	1,4	K/W
insulated up to 800 V/1000 V	$R_{th\ mb-h}$	= —	1,6	K/W
without heatsink compound and 0,05 mm mica washer insulated up to 500 V	$R_{th\ mb-h}$	= —	3,0	K/W
insulated up to 800 V/1000 V	$R_{th\ mb-h}$	= —	4,5	K/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 $T_{j\ max} \leq 175$ °C, soldering temperature $T_{sld\ max} = 275$ °C.

Devices with $T_{j\ max} \leq 110$ °C, soldering temperature $T_{sld\ max} = 240$ °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.

Mounting base soldering

Recommended metal-alloy of solder paste (85% metal weight)

62 Sm/36 Pb/2 Ag or 60 Sn/40 Pb.

Maximum soldering temperature ≤ 200 °C (tab-temperature).

Soldering cycle duration including pre-heating ≤ 30 sec.

For good soldering and avoiding damage to the encapsulation pre-heating is recommended to a temperature ≤ 165 °C at a duration ≤ 10 s.

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56363

1. Apply heatsink compound to the mounting base, then place the transistor on the heatsink.
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).

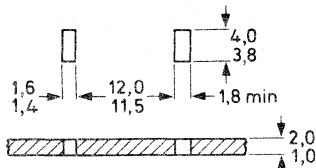


Fig. 1 Heatsink requirements.

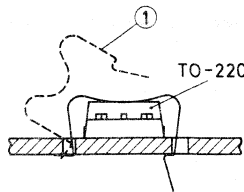


Fig. 2 Mounting.
(1) spring clip 56363.

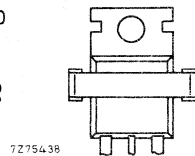


Fig. 2a Position of
transistor (top view).

Insulated mounting with clip 56364

With the insulators 56367 or 56369 insulation up to 2 kV is obtained.

1. Apply heatsink compound to the bottom of both transistor and insulator, then place the transistor with the insulator on the heatsink.
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. Ensure that the device is centred on the mica insulator to prevent creepage.

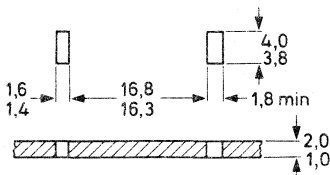


Fig. 3 Heatsink requirements.

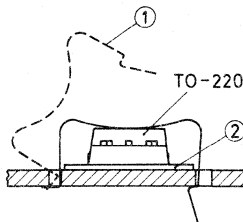


Fig. 4 Mounting.
(1) spring clip 56364.
(2) insulator 56369 or 56367.

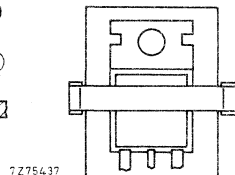


Fig. 4a Position of
transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting with screw and spacing washer

- *through heatsink with nut*

Dimensions in mm

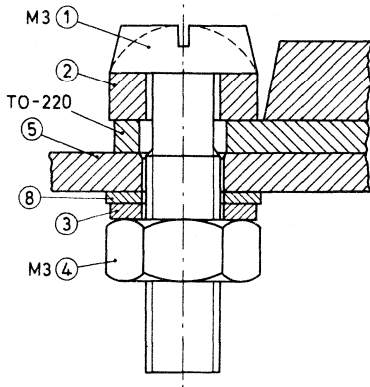


Fig. 5 Assembly.

- (1) M3 screw.
- (2) rectangular washer (56360a).
- (3) lock washer.
- (4) M3 nut.
- (5) heatsink.
- (8) plain washer.

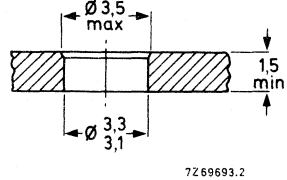


Fig. 6 Heatsink requirements.

- *into tapped heatsink*

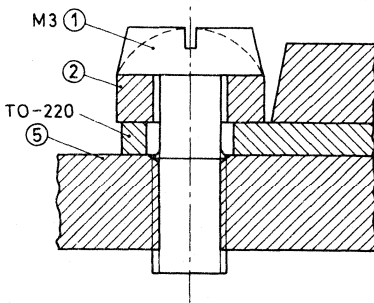


Fig. 7 Assembly.

- (1) M3 screw.
- (2) rectangular washer 56360a.
- (5) heatsink.

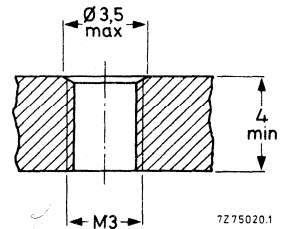


Fig. 8 Heatsink requirements.

Insulated mounting with screw and spacing washer
 (not recommended where mounting tab is on mains voltage)

Dimensions in mm

● *through heatsink with nut*

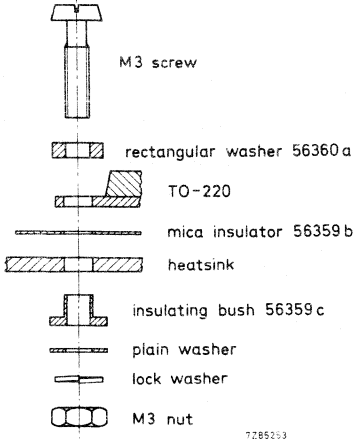


Fig. 9 Insulated screw mounting with rectangular washer. Known as a "bottom mounting".

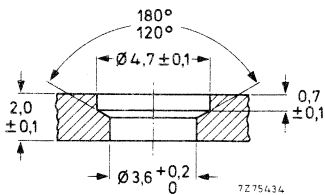


Fig. 10 Heatsink requirements for 500 V insulation.

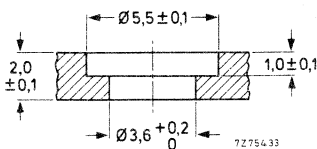


Fig. 11 Heatsink requirements for 800 V insulation.

● *into tapped heatsink*

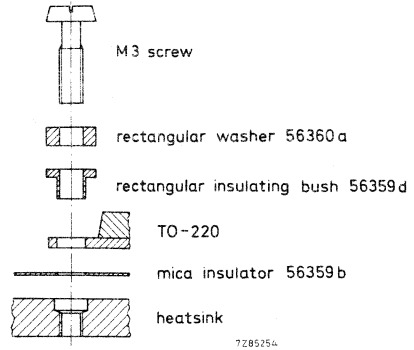


Fig. 12 Insulated screw mounting with rectangular washer into tapped heatsink. Known as a "top mounting".

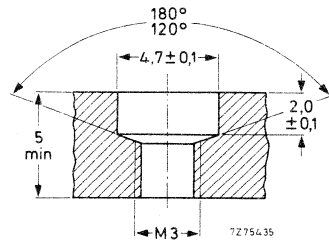


Fig. 13 Heatsink requirements for 500 V insulation.

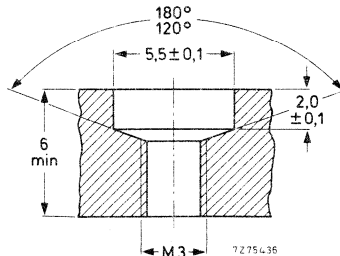


Fig. 14 Heatsink requirements for 1000 V insulation.

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. In the direct screw mounting an M4 screw must be used; an M3 screw in the insulating mounting.

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.

MOUNTING INSTRUCTIONS SOT-93

Soldering

Recommendations for devices with a maximum junction temperature rating $\leq 175\text{ }^{\circ}\text{C}$:

a. Dip or wave soldering

Maximum permissible solder temperature is $260\text{ }^{\circ}\text{C}$ at a distance from the body of $> 5\text{ mm}$ and for a total contact time with soldering bath or waves of $< 7\text{ s}$.

b. Hand soldering

Maximum permissible temperature is $275\text{ }^{\circ}\text{C}$ at a distance from the body of $> 3\text{ mm}$ and for a total contact time with the soldering iron of $< 5\text{ s}$.

The body of the device must not touch anything with a temperature $> 200\text{ }^{\circ}\text{C}$.

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 K/W
$R_{th\ mb-h}$ =	1,5	0,8 K/W
$R_{th\ mb-h}$ =	0,8	0,8 K/W
$R_{th\ mb-h}$ =	3,0	2,2 K/W

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56379

- Place the device on the heatsink, applying heatsink compound to the mounting base.
- 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).
- 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)).

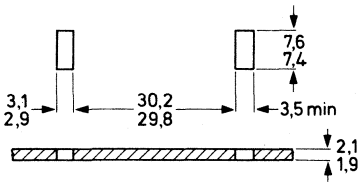


Fig. 1a Heatsink requirements.

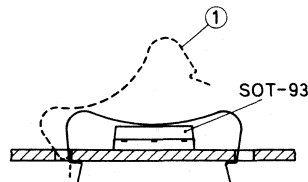


Fig. 1b Mounting.
(1) = spring clip 56379.

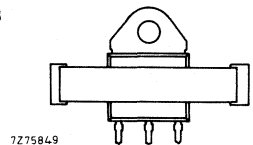
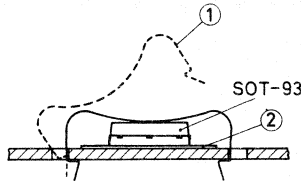
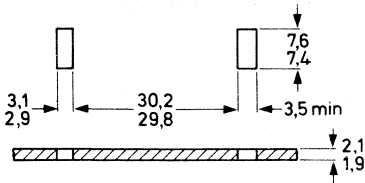


Fig. 1c Position
of the device.

Insulated mounting with clip 56379

With the mica 56378 insulation up to 1500 V 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.



7Z7584B

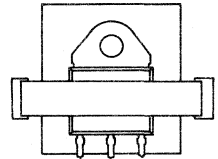


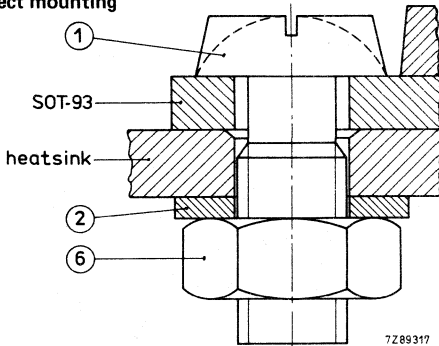
Fig. 2a Heatsink requirements.

Fig. 2b Mounting.
(1) = spring clip 56379
(2) = insulator 56378

Fig. 2c Position of the device.

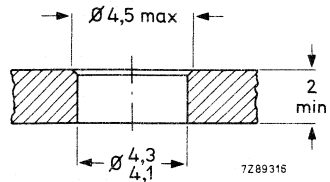
INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting



7Z89317

Fig. 3a Assembly through heatsink with nut.



7Z89315

Fig. 3b Heatsink requirements.

When screw mounting the SOT-93 envelope, it is particularly important to apply a thin, even layer of heatsink compound to the mounting base, and to apply torque to the screw slowly so that the compound has time to flow and the mounting base is not deformed. Most SOT-93 envelopes contain a crystal larger than that in the other plastic envelopes, and it is more likely to crack if the mounting base is deformed.

Legend: (1) M4 screw; (2) plain washer; (6) M4 nut.

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.

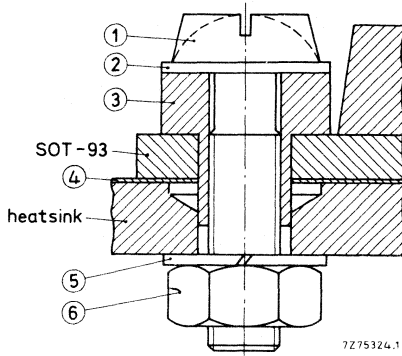


Fig. 4 Assembly.
See also Fig. 9.

- (1) M3 screw
- (2) plain washer
- (3) insulating bush (56368b)
- (4) mica insulator (56368a)
- (5) lock washer
- (6) M3 nut

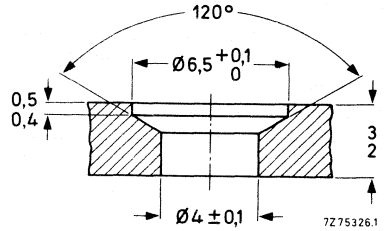


Fig. 5 Heatsink requirements
up to 800 V insulation.

Insulated screw mounting with tapped hole; up to 800 V.

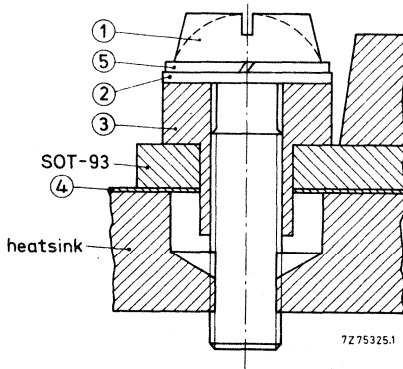


Fig. 6 Assembly.
See also Fig. 9.

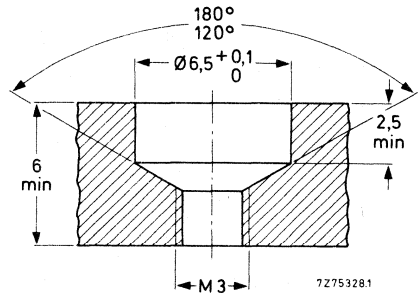


Fig. 7 Heatsink requirements
up to 800 V insulation.

- (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

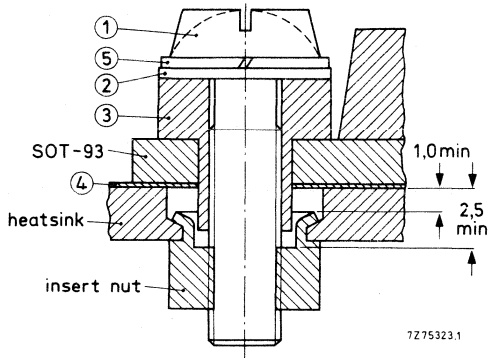


Fig. 8 Assembly and heatsink requirements for 500 V insulation. See also Fig. 3.

- (1) M3 screw
- (2) plain washer
- (3) insulating bush (56368b)
- (4) mica insulator (56368a)
- (5) lock washer

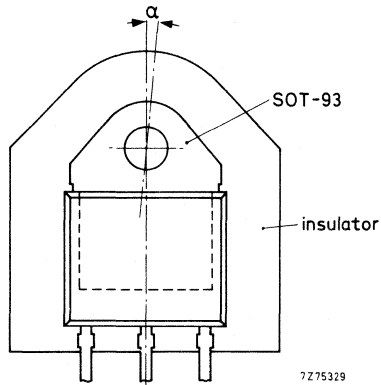


Fig. 9 Mica insulator.

The axial deviation (α) between SOT-93 and mica should not exceed 5° .

NOTES

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INDEX OF TYPE NUMBERS

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

type no.	book	section	type no.	book	section	type no.	book	section
BA220	S1	SD	BAS29	S7/S1	Mm/SD	BAV101	S7/S1	Mm/SD
BA221	S1	SD	BAS31	S7/S1	Mm/SD	BAV102	S7/S1	Mm/SD
BA223	S1	T	BAS32	S7/S1	Mm/SD	BAV103	S7/S1	Mm/SD
BA281	S1	SD	BAS35	S7/S1	Mm/SD	BAW56	S7/S1	Mm/SD
BA314	S1	Vrg	BAS45	S1	SD	BAW62	S1	SD
BA315	S1	Vrg	BAS56	S1	SD	BAX12	S1	SD
BA316	S1	SD	BAT17	S7/S1	Mm/T	BAX14	S1	SD
BA317	S1	SD	BAT18	S7/S1	Mm/T	BAX18	S1	SD
BA318	S1	SD	BAT54	S1	SD	BAY80	S1	SD
BA423	S1	T	BAT74	S1	SD	BB112	S1	T
BA480	S1	T	BAT81	S1	T	BB119	S1	T
BA481	S1	T	BAT82	S1	T	BB130	S1	T
BA482	S1	T	BAT83	S1	T	BB204B	S1	T
BA483	S1	T	BAT85	S1	T	BB204G	S1	T
BA484	S1	T	BAT86	S1	T	BB212	S1	T
BA682	S1	T	BAV10	S1	SD	BB405B	S1	T
BA683	S1	T	BAV18	S1	SD	BB417	S1	T
BAS11	S1	SD	BAV19	S1	SD	BB809	S1	T
BAS15	S1	SD	BAV20	S1	SD	BB909A	S1	T
BAS16	S7/S1	Mm/SD	BAV21	S1	SD	BB909B	S1	T
BAS17	S7/S1	Mm/Vrg	BAV23	S7/S1	Mm/SD	BBY31	S7/S1	Mm/T
BAS19	S7/S1	Mm/SD	BAV45	S1	Sp	BBY40	S7/S1	Mm/T
BAS20	S7/S1	Mm/SD	BAV70	S7/S1	Mm/SD	BC107	S3	Sm
BAS21	S7/S1	Mm/SD	BAV99	S7/S1	Mm/SD	BC108	S3	Sm
BAS28	S7/S1	Mm/SD	BAV100	S7/S1	Mm/SD	BC109	S3	Sm

Mm = Microminiature semiconductors
for hybrid circuits
SD = Small-signal diodes

Sp = Special diodes
T = Tuner diodes
Vrg = Voltage regulator diodes
Sm = Small-signal transistors

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type no.	book	section	type no.	book	section	type no.	book	section
BC140	S3	Sm	BC818	S7	Mm	BCX51	S7	Mm
BC141	S3	Sm	BC846	S7	Mm	BCX52	S7	Mm
BC146	S3	Sm	BC847	S7	Mm	BCX53	S7	Mm
BC160	S3	Sm	BC848	S7	Mm	BCX54	S7	Mm
BC161	S3	Sm	BC849	S7	Mm	BCX55	S7	Mm
BC177	S3	Sm	BC850	S7	Mm	BCX56	S7	Mm
BC178	S3	Sm	BC856	S7	Mm	BCX68	S7	Mm
BC179	S3	Sm	BC857	S7	Mm	BCX69	S7	m
BC200	S3	Sm	BC858	S7	Mm	BCX70*	S7	Mm
BC264A	S5	FET	BC859	S7	Mm	BCX71*	S7	Mm
BC264B	S5	FET	BC860	S7	Mm	BCY56	S3	Sm
BC264C	S5	FET	BC868	S7	Mm	BCY57	S3	Sm
BC264D	S5	FET	BC869	S7	Mm	BCY58	S3	Sm
BC327;A	S3	Sm	BCF29;R	S7	Mm	BCY59	S3	Sm
BC328	S3	Sm	BCF30;R	S7	Mm	BCY70	S3	Sm
BC337;A	S3	Sm	BCF32;R	S7	Mm	BCY71	S3	Sm
BC338	S3	Sm	BCF33;R	S7	Mm	BCY72	S3	Sm
BC368	S3	Sm	BCF70;R	S7	Mm	BCY78	S3	Sm
BC369	S3	Sm	BCF81;R	S7	Mm	BCY79	S3	Sm
BC375	S3	Sm	BCV61	S7	Mm	BCY87	S3	Sm
BC376	S3	Sm	BCV62	S7	Mm	BCY88	S3	Sm
BC546	S3	Sm	BCV71;R	S7	Mm	BCY89	S3	Sm
BC547	S3	Sm	BCV72;R	S7	Mm	BD131	S4a	P
BC548	S3	Sm	BCW29;R	S7	Mm	BD132	S4a	P
BC549	S3	Sm	BCW30;R	S7	Mm	BD135	S4a	P
BC550	S3	Sm	BCW31;R	S7	Mm	BD136	S4a	P
BC556	S3	Sm	BCW32;R	S7	Mm	BD137	S4a	P
BC557	S3	Sm	BCW33;R	S7	Mm	BD138	S4a	P
BC558	S3	Sm	BCW60*	S7	Mm	BD139	S4a	P
BC559	S3	Sm	BCW61*	S7	Mm	BD140	S4a	P
BC560	S3	Sm	BCW69;R	S7	Mm	BD201	S4a	P
BC635	S3	Sm	BCW70;R	S7	Mm	BD202	S4a	P
BC636	S3	Sm	BCW71;R	S7	Mm	BD203	S4a	P
BC637	S3	Sm	BCW72;R	S7	Mm	BD204	S4a	P
BC638	S3	Sm	BCW81;R	S7	Mm	BD226	S4a	P
BC639	S3	Sm	BCW89;R	S7	Mm	BD227	S4a	P
BC640	S3	Sm	BCX17;R	S7	Mm	BD228	S4a	P
BC807	S7	Mm	BCX18;R	S7	Mm	BD229	S4a	P
BC808	S7	Mm	BCX19;R	S7	Mm	BD230	S4a	P
BC817	S7	Mm	BCX20;R	S7	Mm	BD231	S4a	P

* = series

FET = Field-effect transistors

Mm = Microminiature semiconductors
for hybrid circuits

P = Low-frequency power transistors

Sm = Small-signal transistors

type no.	book	section	type no.	book	section	type no.	book	section
BD233	S4a	P	BD433	S4a	P	BD843	S4a	P
BD234	S4a	P	BD434	S4a	P	BD844	S4a	P
BD235	S4a	P	BD435	S4a	P	BD845	S4a	P
BD236	S4a	P	BD436	S4a	P	BD846	S4a	P
BD237	S4a	P	BD437	S4a	P	BD847	S4a	P
BD238	S4a	P	BD438	S4a	P	BD848	S4a	P
BD239	S4a	P	BD645	S4a	P	BD849	S4a	P
BD239A	S4a	P	BD646	S4a	P	BD850	S4a	P
BD239B	S4a	P	BD647	S4a	P	BD933	S4a	P
BD239C	S4a	P	BD648	S4a	P	BD934	S4a	P
BD240	S4a	P	BD649	S4a	P	BD935	S4a	P
BD240A	S4a	P	BD650	S4a	P	BD936	S4a	P
BD240B	S4a	P	BD651	S4a	P	BD937	S4a	P
BD240C	S4a	P	BD652	S4a	P	BD938	S4a	P
BD241	S4a	P	BD675	S4a	P	BD939	S4a	P
BD241A	S4a	P	BD676	S4a	P	BD940	S4a	P
BD241B	S4a	P	BD677	S4a	P	BD941	S4a	P
BD241C	S4a	P	BD678	S4a	P	BD942	S4a	P
BD242	S4a	P	BD679	S4a	P	BD943	S4a	P
BD242A	S4a	P	BD680	S4a	P	BD944	S4a	P
BD242B	S4a	P	BD681	S4a	P	BD945	S4a	P
BD242C	S4a	P	BD682	S4a	P	BD946	S4a	P
BD243	S4a	P	BD683	S4a	P	BD947	S4a	P
BD243A	S4a	P	BD684	S4a	P	BD948	S4a	P
BD243B	S4a	P	BD813	S4a	P	BD949	S4a	P
BD243C	S4a	P	BD814	S4a	P	BD950	S4a	P
BD244	S4a	P	BD815	S4a	P	BD951	S4a	P
BD244A	S4a	P	BD816	S4a	P	BD952	S4a	P
BD244B	S4a	P	BD817	S4a	P	BD953	S4a	P
BD244C	S4a	P	BD818	S4a	P	BD954	S4a	P
BD329	S4a	P	BD825	S4a	P	BD955	S4a	P
BD330	S4a	P	BD826	S4a	P	BD956	S4a	P
BD331	S4a	P	BD827	S4a	P	BDT20	S4a	P
BD332	S4a	P	BD828	S4a	P	BDT21	S4a	P
BD333	S4a	P	BD829	S4a	P	BDT29	S4a	P
BD334	S4a	P	BD830	S4a	P	BDT29A	S4a	P
BD335	S4a	P	BD839	S4a	P	BDT29B	S4a	P
BD336	S4a	P	BD840	S4a	P	BDT29C	S4a	P
BD337	S4a	P	BD841	S4a	P	BDT30	S4a	P
BD338	S4a	P	BD842	S4a	P	BDT30A	S4a	P

P = Low-frequency power transistors

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type no.	book	section	type no.	book	section	type no.	book	section
BDT30B	S4a	P	BDT63B	S4a	P	BDV91	S4a	P
BDT30C	S4a	P	BDT63C	S4a	P	BDV92	S4a	P
BDT31	S4a	P	BDT64	S4a	P	BDV93	S4a	P
BDT31A	S4a	P	BDT64A	S4a	P	BDV94	S4a	P
BDT31B	S4a	P	BDT64B	S4a	P	BDV95	S4a	P
BDT31C	S4a	P	BDT64C	S4a	P	BDV96	S4a	P
BDT32	S4a	P	BDT65	S4a	P	BDW55	S4a	P
BDT32A	S4a	P	BDT65A	S4a	P	BDW56	S4a	P
BDT32B	S4a	P	BDT65B	S4a	P	BDW57	S4a	P
BDT32C	S4a	P	BDT65C	S4a	P	BDW58	S4a	P
BDT41	S4a	P	BDT81	S4a	P	BDW59	S4a	P
BDT41A	S4a	P	BDT82	S4a	P	BDW60	S4a	P
BDT41B	S4a	P	BDT83	S4a	P	BDX35	S4a	P
BDT41C	S4a	P	BDT84	S4a	P	BDX36	S4a	P
BDT42	S4a	P	BDT85	S4a	P	BDX37	S4a	P
BDT42A	S4a	P	BDT86	S4a	P	BDX42	S4a	P
BDT42B	S4a	P	BDT87	S4a	P	BDX43	S4a	P
BDT42C	S4a	P	BDT88	S4a	P	BDX44	S4a	P
BDT51	S4a	P	BDT91	S4a	P	BDX45	S4a	P
BDT52	S4a	P	BDT92	S4a	P	BDX46	S4a	P
BDT53	S4a	P	BDT93	S4a	P	BDX47	S4a	P
BDT54	S4a	P	BDT94	S4a	P	BDX62	S4a	P
BDT55	S4a	P	BDT95	S4a	P	BDX62A	S4a	P
BDT56	S4a	P	BDT96	S4a	P	BDX62B	S4a	P
BDT57	S4a	P	BDV64	S4a	P	BDX62C	S4a	P
BDT58	S4a	P	BDV64A	S4a	P	BDX63	S4a	P
BDT60	S4a	P	BDV64B	S4a	P	BDX63A	S4a	P
BDT60A	S4a	P	BDV64C	S4a	P	BDX63B	S4a	P
BDT60B	S4a	P	BDV65	S4a	P	BDX63C	S4a	P
BDT60C	S4a	P	BDV65A	S4a	P	BDX64	S4a	P
BDT61	S4a	P	BDV65B	S4a	P	BDX64A	S4a	P
BDT61A	S4a	P	BDV65C	S4a	P	BDX64B	S4a	P
BDT61B	S4a	P	BDV66A	S4a	P	BDX64C	S4a	P
BDT61C	S4a	P	BDV66B	S4a	P	BDX65	S4a	P
BDT62	S4a	P	BDV66C	S4a	P	BDX65A	S4a	P
BDT62A	S4a	P	BDV66D	S4a	P	BDX65B	S4a	P
BDT62B	S4a	P	BDV67A	S4a	P	BDX65C	S4a	P
BDT62C	S4a	P	BDV67B	S4a	P	BDX66	S4a	P
BDT63	S4a	P	BDV67C	S4a	P	BDX66A	S4a	P
BDT63A	S4a	P	BDV67D	S4a	P	BDX66B	S4a	P

P = Low-frequency power transistors

type no.	book	section	type no.	book	section	type no.	book	section
BDX66C	S4a	P	BF410A	S5	FET	BF623	S7	Mm
BDX67	S4a	P	BF410B	S5	FET	BF660;R	S7	Mm
BDX67A	S4a	P	BF410C	S5	FET	BF689K	S10	WBT
BDX67B	S4a	P	BF410D	S5	FET	BF763	S10	WBT
BDX67C	S4a	P	BF419	S4b	HVP	BF767	S7	Mm
BDX68	S4a	P	BF420	S3	Sm	BF819	S4b	HVP
BDX68A	S4a	P	BF421	S3	Sm	BF820	S7	Mm
BDX68B	S4a	P	BF422	S3	Sm	BF821	S7	Mm
BDX68C	S4a	P	BF423	S3	Sm	BF822	S7	Mm
BDX69	S4a	P	BF450	S3	Sm	BF823	S7	Mm
BDX69A	S4a	P	BF451	S3	Sm	BF824	S7	Mm
BDX69B	S4a	P	BF457	S4b	HVP	BF857	S4b	HVP
BDX69C	S4a	P	BF458	S4b	HVP	BF858	S4b	HVP
BDX77	S4a	P	BF459	S4b	HVP	BF859	S4b	HVP
BDX78	S4a	P	BF469	S4b	HVP	BF869	S4b	HVP
BDX91	S4a	P	BF470	S4b	HVP	BF870	S4b	HVP
BDX92	S4a	P	BF471	S4b	HVP	BF871	S4b	HVP
BDX93	S4a	P	BF472	S4b	HVP	BF872	S4b	HVP
BDX94	S4a	P	BF483	S3	Sm	BF926	S3	Sm
BDX95	S4a	P	BF485	S3	Sm	BF936	S3	Sm
BDX96	S4a	P	BF487	S3	Sm	BF939	S3	Sm
BDY90	S4a	P	BF494	S3	Sm	BF960	S5	FET
BDY90A	S4a	P	BF495	S3	Sm	BF964	S5	FET
BDY91	S4a	P	BF496	S3	Sm	BF966	S5	FET
BDY92	S4a	P	BF510	S7/S5	Mm/FET	BF967	S3	Sm
BF198	S3	Sm	BF511	S7/S5	Mm/FET	BF970	S3	Sm
BF199	S3	Sm	BF512	S7/S5	Mm/FET	BF979	S3	Sm
BF240	S3	Sm	BF513	S7/S5	Mm/FET	BF980	S5	FET
BF241	S3	Sm	BF536	S7	Mm	BF981	S5	FET
BF245A	S5	FET	BF550;R	S7	Mm	BF982	S5	FET
BF245B	S5	FET	BF569	S7	Mm	BF989	S7/S5	Mm/FET
BF245C	S5	FET	BF579	S7	Mm	BF990	S7/S5	Mm/FET
BF247A	S5	FET	BF583	S4b	HVP	BF991	S7/S5	Mm/FET
BF247B	S5	FET	BF585	S4b	HVP	BF992	S7/S5	Mm/FET
BF247C	S5	FET	BF587	S4b	HVP	BF994	S7/S5	Mm/FET
BF256A	S5	FET	BF591	S4b	HVP	BF996	S7/S5	Mm/FET
BF256B	S5	FET	BF593	S4b	HVP	BFG23	S10	WBT
BF256C	S5	FET	BF620	S7	Mm	BFG32	S10	WBT
BF324	S3	Sm	BF621	S7	Mm	BFG34	S10	WBT
BF370	S3	Sm	BF622	S7	Mm	BFG51	S10	WBT

FET = Field-effect transistors
HVP = High-voltage power transistors
Mm = Microminiature semiconductors
for hybrid circuits

P = Low-frequency power transistors
Sm = Small-signal transistors
WBT = Wideband hybrid IC transistors

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type no.	book	section	type no.	book	section	type no.	book	section
BFG65	S10	WBT	BFR31	S5/S7	FET/Mm	BFW17A	S10	WBT
BFG90A	S10	WBT	BFR49	S10	WBT	BFW30	S10	WBT
BFG91A	S10	WBT	BFR53;R	S7	Mm	BFW61	S5	FET
BFG96	S10	WBT	BFR54	S3	Sm	BFW92	S10	WBT
BFP90A	S10	WBT	BFR64	S10	WBT	BFW92A	S10	WBT
BFP91A	S10	WBT	BFR65	S10	WBT	BFW93	S10	WBT
BFP96	S10	WBT	BFR84	S5	FET	BFX29	S3	Sm
BFQ10	S5	FET	BFR90	S10	WBT	BFX30	S3	Sm
BFQ11	S5	FET	BFR90A	S10	WBT	BFX34	S3	Sm
BFQ12	S5	FET	BFR91	S10	WBT	BFX84	S3	Sm
BFQ13	S5	FET	BFR91A	S10	WBT	BFX85	S3	Sm
BFQ14	S5	FET	BFR92;R	S7	Mm	BFX86	S3	Sm
BFQ15	S5	FET	BFR92A;R	S7	Mm	BFX87	S3	Sm
BFQ16	S5	FET	BFR93;R	S7	Mm	BFX88	S3	Sm
BFQ17	S7	Mm	BFR93A;R	S7	Mm	BFX89	S10	WBT
BFQ18A	S7	Mm	BFR94	S10	WBT	BFY50	S3	Sm
BFQ19	S7	Mm	BFR95	S10	WBT	BFY51	S3	Sm
BFQ22S	S10	WBT	BFR96	S10	WBT	BFY52	S3	Sm
BFQ23	S10	WBT	BFR96S	S10	WBT	BFY55	S3	Sm
BFQ23C	S10	WBT	BFR101A;B	S7/S5	Mm/FET	BFY90	S10	WBT
BFQ24	S10	WBT	BFS17;R	S7	Mm	BG2000	S1	RT
BFQ32	S10	WBT	BFS18;R	S7	Mm	BG2097	S1	RT
BFQ32C	S10	WBT	BFS19;R	S7	Mm	BGD102	S10	WBM
BFQ32S	S10	WBT	BFS20;R	S7	Mm	BGD102E	S10	WBM
BFQ33	S10	WBT	BFS21	S5	FET	BGD104	S10	WBM
BFQ34	S10	WBT	BFS21A	S5	FET	BGD104E	S10	WBM
BFQ34T	S10	WBT	BFS22A	S6	RFP	BGX11*	S2b	ThM
BFQ42	S6	RFP	BFS23A	S6	RFP	BGX12*	S2b	ThM
BFQ43	S6	RFP	BFT24	S10	WBT	BGX13*	S2b	ThM
BFQ51	S10	WBT	BFT25;R	S7	Mm	BGX14*	S2b	ThM
BFQ51C	S10	WBT	BFT44	S3	Sm	BGX15*	S2b	ThM
BFQ52	S10	WBT	BFT45	S3	Sm	BGX17*	S2b	ThM
BFQ53	S10	WBT	BFT46	S7/S5	Mm/FET	BGX25	S2a	ThM
BFQ63	S10	WBT	BFT92;R	S7	Mm	BGY22	S6	RFP
BFQ65	S10	WBT	BFT93;R	S7	Mm	BGY22A	S6	RFP
BFQ66	S10	WBT	BFW10	S5	FET	BGY23	S6	RFP
BFQ68	S10	WBT	BFW11	S5	FET	BGY23A	S6	RFP
BFQ136	S10	WBT	BFW12	S5	FET	BGY32	S6	RFP
BFR29	S5	FET	BFW13	S5	FET	BGY33	S6	RFP
BFR30	S5/S7	FET/Mm	BFW16A	S10	WBT	BGY35	S6	RFP

* = series

FET = Field-effect transistors

Mm = Microminiature semiconductors
for hybrid circuits

RFP = R.F. power transistors and modules

RT = Tripler

Sm = Small-signal transistors

ThM = Thyristor modules

WBM = Wideband hybrid IC modules

WBT = Wideband hybrid IC transistors

type no.	book	section	type no.	book	section	type no.	book	section
BGY36	S6	RFP	BLU45/12	S6	RFP	BLW33	S6	RFP
BGY40A	S6	RFP	BLU50	S6	RFP	BLW34	S6	RFP
BGY40B	S6	RFP	BLU51	S6	RFP	BLW50F	S6	RFP
BGY41A	S6	RFP	BLU52	S6	RFP	BLW60	S6	RFP
BGY41B	S6	RFP	BLU53	S6	RFP	BLW60C	S6	RFP
BGY43	S6	RFP	BLU60/12	S6	RFP	BLW76	S6	RFP
BGY45A	S6	RFP	BLU97	S6	RFP	BLW77	S6	RFP
BGY45B	S6	RFP	BLU98	S6	RFP	BLW78	S6	RFP
BGY46A	S6	RFP	BLU99	S6	RFP	BLW79	S6	RFP
BGY46B	S6	RFP	BLV10	S6	RFP	BLW80	S6	RFP
BGY47*	S6	RFP	BLV11	S6	RFP	BLW81	S6	RFP
BGY50	S10	WBM	BLV20	S6	RFP	BLW82	S6	RFP
BGY51	S10	WBM	BLV21	S6	RFP	BLW83	S6	RFP
BGY52	S10	WBM	BLV25	S6	RFP	BLW84	S6	RFP
BGY53	S10	WBM	BLV30	S6	RFP	BLW85	S6	RFP
BGY54	S10	WBM	BLV30/12	S6	RFP	BLW86	S6	RFP
BGY55	S10	WBM	BLV31	S6	RFP	BLW87	S6	RFP
BGY56	S10	WBM	BLV32F	S6	RFP	BLW89	S6	RFP
BGY57	S10	WBM	BLV33	S6	RFP	BLW90	S6	RFP
BGY58	S10	WBM	BLV33F	S6	RFP	BLW91	S6	RFP
BGY58A	S10	WBM	BLV36	S6	RFP	BLW95	S6	RFP
BGY59	S10	WBM	BLV37	S6	RFP	BLW96	S6	RFP
BGY60	S10	WBM	BLV45/12	S6	RFP	BLW97	S6	RFP
BGY61	S10	WBM	BLV57	S6	RFP	BLW98	S6	RFP
BGY65	S10	WBM	BLV59	S6	RFP	BLW99	S6	RFP
BGY67	S10	WBM	BLV75/12	S6	RFP	BLX13	S6	RFP
BGY67A	S10	WBM	BLV80/28	S6	RFP	BLX13C	S6	RFP
BGY70	S10	WBM	BLV90	S6	RFP	BLX14	S6	RFP
BGY71	S10	WBM	BLV91	S6	RFP	BLX15	S6	RFP
BGY74	S10	WBM	BLV92	S6	RFP	BLX39	S6	RFP
BGY75	S10	WBM	BLV93	S6	RFP	BLX65	S6	RFP
BGY84	S10	WBM	BLV94	S6	RFP	BLX65E	S6	RFP
BGY84A	S10	WBM	BLV95	S6	RFP	BLX67	S6	RFP
BGY85	S10	WBM	BLV96	S6	RFP	BLX68	S6	RFP
BGY85A	S10	WBM	BLV97	S6	RFP	BLX69A	S6	RFP
BGY93A	S6	RFP	BLV98	S6	RFP	BLX91A	S6	RFP
BGY93B	S6	RFP	BLV99	S6	RFP	BLX91CB	S6	RFP
BGY93C	S6	RFP	BLW29	S6	RFP	BLX92A	S6	RFP
BLU20/12	S6	RFP	BLW31	S6	RFP	BLX93A	S6	RFP
BLU30/12	S6	RFP	BLW32	S6	RFP	BLX94A	S6	RFP

* = series

RFP = R.F. power transistors and modules

WBM = Wideband hybrid IC modules

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type no.	book	section	type no.	book	section	type no.	book	section
BLX94C	S6	RFP	BS170	S5	FET	BSS61	S3	Sm
BLX95	S6	RFP	BSD10	S5	FET	BSS62	S3	Sm
BLX96	S6	RFP	BSD12	S5	FET	BSS63;R	S7	Mm
BLX97	S6	RFP	BSD20	S5/7	FET	BSS64;R	S7	Mm
BLX98	S6	RFP	BSD22	S5/7	FET	BSS68	S3	Sm
BLY85	S6	RFP	BSD212	S5	FET	BSS83	S5/7	FET/Mm
BLY87A	S6	RFP	BSD213	S5	FET	BST15	S7	Mm
BLY87C	S6	RFP	BSD214	S5	FET	BST16	S7	Mm
BLY88A	S6	RFP	BSD215	S5	FET	BST39	S7	Mm
BLY88C	S6	RFP	BSR12;R	S7	Mm	BST40	S7	Mm
BLY89A	S6	RFP	BSR13;R	S7	Mm	BST50	S7	Mm
BLY89C	S6	RFP	BSR14;R	S7	Mm	BST51	S7	Mm
BLY90	S6	RFP	BSR15;R	S7	Mm	BST52	S7	Mm
BLY91A	S6	RFP	BSR16;R	S7	Mm	BST60	S7	Mm
BLY91C	S6	RFP	BSR17;R	S7	Mm	BST61	S7	Mm
BLY92A	S6	RFP	BSR17A;R	S7	Mm	BST62	S7	Mm
BLY92C	S6	RFP	BSR18;R	S7	Mm	BST70A	S5	FET
BLY93A	S6	RFP	BSR18A;R	S7	Mm	BST72A	S5	FET
BLY93C	S6	RFP	BSR30	S7	Mm	BST74A	S5	FET
BLY94	S6	RFP	BSR31	S7	Mm	BST76A	S5	FET
BLY97	S6	RFP	BSR32	S7	Mm	BST78	S5	FET
BPF10	S8	PDT	BSR33	S7	Mm	BST80	S5	FET
BPF24	S8	PDT	BSR40	S7	Mm	BST82	S5	FET
BPW22A	S8	PDT	BSR41	S7	Mm	BST84	S5	FET
BPW50	S8	PDT	BSR42	S7	Mm	BST86	S5	FET
BPX25	S8	PDT	BSR43	S7	Mm	BST90	S5	FET
BPX29	S8	PDT	BSR50	S3	Sm	BST97	S5	FET
BPX40	S8	PDT	BSR51	S3	Sm	BST100	S5	FET
BPX41	S8	PDT	BSR52	S3	Sm	BST110	S5	FET
BPX42	S8	PDT	BSR56	S7/S5	Mm/FET	BST120	S5	FET
BPX71	S8	PDT	BSR57	S7/S5	Mm/FET	BST122	S5	FET
BPX72	S8	PDT	BSR58	S7/S5	Mm/FET	BSV15	S3	Sm
BPX95C	S8	PDT	BSR60	S3	Sm	BSV16	S3	Sm
BR100/03	S2b	Th	BSR61	S3	Sm	BSV17	S3	Sm
BR101	S3	Sm	BSR62	S3	Sm	BSV52;R	S7	Mm
BRY39	S3	Sm	BSS38	S3	Sm	BSV64	S3	Sm
BRY56	S3	Sm	BSS50	S3	Sm	BSV78	S5	FET
BRY61	S7	Mm	BSS51	S3	Sm	BSV79	S5	FET
BRY62	S7	Mm	BSS52	S3	Sm	BSV80	S5	FET
BS107	S5	FET	BSS60	S3	Sm	BSV81	S5	FET

FET = Field-effect transistors

Mm = Microminiature semiconductors
for hybrid circuits

Sm = Small-signal transistors

PDT = Photodiodes or transistors

Th = Thyristors

Tri = Triacs

RFP = R.F. power transistors and modules

type no.	book	section	type no.	book	section	type no.	book	section
BSW66A	S3	Sm	BTY91*	S2b	Th	BUX48;A	S4b	SP
BSW67A	S3	Sm	BU426	S4b	SP	BUX80	S4b	SP
BSW68A	S3	Sm	BU426A	S4b	SP	BUX81	S4b	SP
BSX19	S3	Sm	BU433	S4b	SP	BUX82	S4b	SP
BSX20	S3	Sm	BU505	S4b	SP	BUX83	S4b	SP
BSX45	S3	Sm	BU506	S4b	SP	BUX84	S4b	SP
BSX46	S3	Sm	BU506D	S4b	SP	BUX84F	S4b	SP
BSX47	S3	Sm	BU508A	S4b	SP	BUX85	S4b	SP
BSX59	S3	Sm	BU508D	S4b	SP	BUX85F	S4b	SP
BSX60	S3	Sm	BU705	S4b	SP	BUX86	S4b	SP
BSX61	S3	Sm	BU706	S4b	SP	BUX87	S4b	SP
BSY95A	S3	Sm	BU706D	S4b	SP	BUX88	S4b	SP
BT136*	S2b	Tri	BU806	S4b	SP	BUX90	S4b	SP
BT137*	S2b	Tri	BU807	S4b	SP	BUX98	S4b	SP
BT138*	S2b	Tri	BU804	S4b	SP	BUX98A	S4b	SP
BT139*	S2b	Tri	BU824	S4b	SP	BUX99	S4b	SP
BT149*	S2b	Th	BU826	S4b	SP	BUY89	S4b	SP
BT151*	S2b	Th	BUP22*	S4b	SP	BUZ10	S9	PM
BT152*	S2b	Th	BUP23*	S4b	SP	BUZ10A	S9	PM
BT153	S2b	Th	BUS11;A	S4b	SP	BUZ11	S9	PM
BT155*	S2b	Th	BUS12;A	S4b	SP	BUZ11A	S9	PM
BT157*	S2b	Th	BUS13;A	S4b	SP	BUZ14	S9	PM
BTW24*	S2b	Th	BUS14;A	S4b	SP	BUZ15	S9	PM
BTV34*	S2b	Tri	BUS21*	S4b	SP	BUZ20	S9	PM
BTV58*	S2b	Th	BUS22*	S4b	SP	BUZ21	S9	PM
BTV59*	S2b	Th	BUS23*	S4b	SP	BUZ23	S9	PM
BTW60*	S2b	Th	BUT11;A	S4b	SP	BUZ24	S9	PM
BTW23*	S2b	Th	BUT11F	S4b	SP	BUZ25	S9	PM
BTW38*	S2b	Th	BUT11AF	S4b	SP	BUZ30	S9	PM
BTW40*	S2b	Th	BUV82	S4b	SP	BUZ31	S9	PM
BTW42*	S2b	Th	BUV83	S4b	SP	BUZ32	S9	PM
BTW43*	S2b	Tri	BUV89	S4b	SP	BUZ33	S9	PM
BTW45*	S2b	Th	BUV90;A	S4b	SP	BUZ34	S9	PM
BTW58*	S2b	Th	BUW11;A	S4b	SP	BUZ35	S9	PM
BTW59*	S2b	Th	BUW12;A	S4b	SP	BUZ36	S9	PM
BTW63*	S2b	Th	BUW13;A	S4b	SP	BUZ40	S9	PM
BTW92*	S2b	Th	BUW84	S4b	SP	BUZ41A	S9	PM
BTX18*	S2b	Th	BUW85	S4b	SP	BUZ42	S9	PM
BTX94*	S2b	Tri	BUX46;A	S4b	SP	BUZ43	S9	PM
BTY79*	S2b	Th	BUX47;A	S4b	SP	BUZ44A	S9	PM

* = series

PM = Power MOS transistors

R = Rectifier diodes

SP = Low-frequency switching power transistors

Sm = Small-signal transistors

Th = Thyristors

Tri = Triacs

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type no.	book	section	type no.	book	section	type no.	book	section
BUZ45	S9	PM	BY505	S1	R	BYV36*	S1	R
BUZ45A	S9	PM	BY509	S1	R	BYV39*	S2a	R
BUZ45B	S9	PM	BY527	S1	R	BYV42*	S2a	R
BUZ45C	S9	PM	BY584	S1	R	BYV43*	S2a	R
BUZ46	S9	PM	BY588	S1	R	BYV72*	S2a	R
BUZ50A	S9	PM	BY609	S1	R	BYV73*	S2a	R
BUZ50B	S9	PM	BY610	S1	R	BYV79*	S2a	R
BUZ53A	S9	PM	BY614	S1	R	BYV92*	S2a	R
BUZ54	S9	PM	BY619	S1	R	BYV95A	S1	R
BUZ54A	S9	PM	BY620	S1	R	BYV95B	S1	R
BUZ60	S9	PM	BY707	S1	R	BYV95C	S1	R
BUZ60B	S9	PM	BY708	S1	R	BYV96D	S1	R
BUZ63	S9	PM	BY709	S1	R	BYV96E	S1	R
BUZ63B	S9	PM	BY710	S1	R	BYW25*	S2a	R
BUZ64	S9	PM	BY711	S1	R	BYW29*	S2a	R
BUZ71	S9	PM	BY712	S1	R	BYW30*	S2a	R
BUZ71A	S9	PM	BY713	S1	R	BYW31*	S2a	R
BUZ72	S9	PM	BY714	S1	R	BYW54	S1	R
BUZ72A	S9	PM	BYD13*	S1	R	BYW55	S1	R
BUZ73A	S9	PM	BYD33*	S1	R	BYW56	S1	R
BUZ74	S9	PM	BYD73*	S1	R	BYW92*	S2a	R
BUZ74A	S9	PM	BYM56*	S1	R	BYW93*	S2a	R
BUZ76	S9	PM	BYQ28*	S2a	R	BYW94*	S2a	R
BUZ76A	S9	PM	BYR29*	S2a	R	BYW95A	S1	R
BUZ80	S9	PM	BYT79*	S2a	R	BYW95B	S1	R
BUZ80A	S9	PM	BYV10	S1	R	BYW95C	S1	R
BUZ83	S9	PM	BYV19*	S2a	R	BYW96D	S1	R
BUZ83A	S9	PM	BYV20*	S2a	R	BYW96E	S1	R
BUZ84	S9	PM	BYV21*	S2a	R	BYX25*	S2a	R
BUZ84A	S9	PM	BYV22*	S2a	R	BYX30*	S2a	R
BY228	S1	R	BYV23*	S2a	R	BYX32*	S2a	R
BY229*	S2a	R	BYV24*	S2a	R	BYX38*	S2a	R
BY249*	S2a	R	BYV26*	S1	R	BYX39*	S2a	R
BY260*	S2a	R	BYV27*	S1/S2a	R	BYX42*	S2a	R
BY261*	S2a	R	BYV28*	S1/S2a	R	BYX46*	S2a	R
BY329*	S2a	R	BYV29*	S2a	R	BYX50*	S2a	R
BY359*	S2a	R	BYV30*	S2a	R	BYX52*	S2a	R
BY438	S1	R	BYV32*	S2a	R	BYX56*	S2a	R
BY448	S1	R	BYV33*	S2a	R	BYX90G	S1	R
BY458	S1	R	BYV34*	S2a	R	BYX94	S1	R

* = series

R = Rectifier diodes

PM = Power MOS transistors

type no.	book	section	type no.	book	section	type no.	book	section
BYX96*	S2a	R	CFX33	S11	M	CQV61A(L)	S8	LED
BYX97*	S2a	R	CNX21	S8	PhC	CQV62(L)	S8	LED
BYX98*	S2a	R	CNX35	S8	PhC	CQV70(L)	S8	LED
BYX99*	S2a	R	CNX36	S8	PhC	CQV70A(L)	S8	LED
BZD23	S1	Vrg	CNX37	S8	PhC	CQV71A(L)	S8	LED
BZT03	S1	Vrg	CNX38	S8	PhC	CQV72(L)	S8	LED
BZV10	S1	Vrf	CNX44	S8	PhC	CQV80L	S8	LED
BZV11	S1	Vrf	CNX48	S8	PhC	CQV80AL	S8	LED
BZV12	S1	Vrf	CNX62	S8	PhC	CQV81L	S8	LED
BZV13	S1	Vrf	CNY50	S8	PhC	CQV82L	S8	LED
BZV14	S1	Vrf	CNY52	S8	PhC	CQW10(L)	S8	LED
BZV37	S1	Vrf	CNY53	S8	PhC	CQW10A(L)	S8	LED
BZV46	S1	Vrg	CNY57	S8	PhC	CQW10B(L)	S8	LED
BZV49*	S1/S7	Vrg/Mm	CNY57A	S8	PhC	CQW11A(L)	S8	LED
BZV55*	S7	Mm	CNY62	S8	PhC	CQW11B(L)	S8	LED
BZV85*	S1	Vrg	CNY63	S8	PhC	CQW12(L)	S8	LED
BZW03	S1	Vrg	CQ209S	S8	D	CQW12B(L)	S8	LED
BZW14	S1	Vrg	CQ216X	S8	D	CQW20A	S8	LED
BZW70*	S2a	TS	CQ216Y	S8	D	CQW21	S8	LED
BZW86*	S2a	TS	CQ327;R	S8	D	CQW22	S8	LED
BZW91*	S2a	TS	CQ330;R	S8	D	CQW24(L)	S8	LED
BZX55*	S1	Vrg	CQ331;R	S8	D	CQW54	S8	LED
BZX70*	S2a	Vrg	CQ332;R	S8	D	CQX10	S8	LED
BZX75*	S1	Vrg	CQ427;R	S8	D	CQX11	S8	LED
BZX79*	S1	Vrg	CQ430;R	S8	D	CQX12	S8	LED
BZX84*	S7/S1	Mm/Vrg	CQ431;R	S8	D	CQX24(L)	S8	LED
BZX90	S1	Vrf	CQ432;R	S8	D	CQX51	S8	LED
BZX91	S1	Vrf	CQF24	S8	Ph	CQX54(L)	S8	LED
BZX92	S1	Vrf	CQL10A	S8	Ph	CQX64(L)	S8	LED
BZX93	S1	Vrf	CQL13	S8	Ph	CQX74(L)	S8	LED
BZX94	S1	Vrf	CQL13A	S8	Ph	CQX74Y	S8	LED
BZY91*	S2a	Vrg	CQL14A	S8	Ph	CQY11B	S8	LED
BZY93*	S2a	Vrg	CQL14B	S8	Ph	CQY11C	S8	LED
BZY95*	S2a	Vrg	CQN10	S8	LED	CQY24B(L)	S8	LED
BZY96*	S2a	Vrg	CQN11	S8	LED	CQY49B	S8	LED
CFX13	S11	M	CQT10	S8	LED	CQY49C	S8	LED
CFX21	S11	M	CQT11	S8	LED	CQY50	S8	LED
CFX30	S11	M	CQT12	S8	LED	CQY52	S8	LED
CFX31	S11	M	CQV60(L)	S8	LED	CQY54A	S8	LED
CFX32	S11	M	CQV60A(L)	S8	LED	CQY58A	S8	LED

* = series

D = Displays

LED = Light-emitting diodes

M = Microwave transistors

Mm = Microminiature semiconductors

Ph = Photoconductive devices

PhC = Photocouplers

R = Rectifier diodes

TS = Transient suppressor diodes

Vrf = Voltage reference diodes

Vrg = Voltage regulator diodes

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type no.	book	section	type no.	book	section	type no.	book	section
CQY89A	S8	LED	LV3742E16R	S11	M	OSB9210	S2a	St
CQY94	S8	LED	LV3742E24R	S11	M	OSB9215	S2a	St
CQY94B(L)	S8	LED	LWE2015R	S11	M	OSB9410	S2a	St
CQY95B	S8	LED	LWE2025R	S11	M	OSB9415	S2a	St
CQY96(L)	S8	LED	LZ1418E100RS11	M		OSM9110	S2a	St
CQY97A	S8	LED	MKB12040WS	S11	M	OSM9115	S2a	St
LAE2001R	S11	M	MKB12100WS	S11	M	OSM9210	S2a	St
LAE4001Q	S11	M	MKB12140W	S11	M	OSM9215	S2a	St
LAE4001R	S11	M	MO6075B200ZS11	M		OSM9410	S2a	St
LAE4002S	S11	M	MO6075B400ZS11	M		OSM9415	S2a	St
LAE6000Q	S11	M	MRB12175YR	S11	M	OSM9510	S2a	St
LBE1004R	S11	M	MRB12350YR	S11	M	OSM9511	S2a	St
LBE1010R	S11	M	MS1011B700YS11	M		OSM9512	S2a	St
LBE2003S	S11	M	MS6075B800ZS11	M		OSS9110	S2a	St
LBE2005Q	S11	M	MSB12900Y	S11	M	OSS9115	S2a	St
LBE2008T	S11	M	MZ0912B75Y	S11	M	OSS9210	S2a	St
LBE2009S	S11	M	MZ0912B150YS11	M		OSS9215	S2a	St
LCE1010R	S11	M	OM286	S13	SEN	OSS9410	S2a	St
LCE2003S	S11	M	OM287	S13	SEN	OSS9415	S2a	St
LCE2005Q	S11	M	OM320	S10	WBM	PBMF4391	S5	FET
LCE2008T	S11	M	OM321	S10	WBM	PBMF4392	S5	FET
LCE2009S	S11	M	OM322	S10	WBM	PBMF4393	S5	FET
LJE42002T	S11	M	OM323	S10	WBM	PDE1001U	S11	M
LKE1004R	S11	M	OM323A	S10	WBM	PDE1003U	S11	M
LKE2002T	S11	M	OM335	S10	WBM	PDE1005U	S11	M
LKE2004T	S11	M	OM336	S10	WBM	PDE1010U	S11	M
LKE2015T	S11	M	OM337	S10	WBM	PEE1001U	S11	M
LKE21004R	S11	M	OM337A	S10	WBM	PEE1003U	S11	M
LKE21015T	S11	M	OM339	S10	WBM	PEE1005U	S11	M
LKE21050T	S11	M	OM345	S10	WBM	PEE1010U	S11	M
LKE27010R	S11	M	OM350	S10	WBM	PH2222;R	S3	Sm
LKE27025R	S11	M	OM360	S10	WBM	PH2222A;R	S3	Sm
LKE32002T	S11	M	OM361	S10	WBM	PH2369	S3	Sm
LKE32004T	S11	M	OM370	S10	WBM	PH2907;R	S3	Sm
LTE42005S	S11	M	OM386	S13	SEN	PH2907A;R	S3	Sm
LTE42008R	S11	M	OM387	S13	SEN	PH2955T	S4a	P
LTE42012R	S11	M	OM931	S4a	P	PH3055T	S4a	P
LV1721E50R	S11	M	OM961	S4a	P	PH5415	S3	Sm
LV2024E45R	S11	M	OSB9110	S2a	St	PH5416	S3	Sm
LV2327E40R	S11	M	OSB9115	S2a	St	PH13002	S4b	SP

FET = Field-effect transistors

LED = Light-emitting diodes

M = Microwave transistors

P = Low-frequency power transistors

SEN = Sensors

Sm = Small-signal transistors

St = Rectifier stacks

WBM = Wideband hybrid IC modules

type no.	book	section	type no.	book	section	type no.	book	section
PH13003	S4b	SP	RPY89	S8	I	TIP115	S4a	P
PHSD51	S2a	R	RPY90*	S8	I	TIP116	S4a	P
PKB3001U	S11	M	RPY91*	S8	I	TIP117	S4a	P
PKB3003U	S11	M	RPY93	S8	I	TIP120	S4a	P
PKB3005U	S11	M	RPY94	S8	I	TIP121	S4a	P
PKB12005U	S11	M	RPY95	S8	I	TIP122	S4a	P
PKB20010U	S11	M	RPY96	S8	I	TIP125	S4a	P
PKB23001U	S11	M	RPY97	S8	I	TIP126	S4a	P
PKB23003U	S11	M	RV3135B5X	S11	M	TIP127	S4a	P
PKB23005U	S11	M	RX1214B300Y	S11	M	TIP130	S4a	P
PKB25006T	S11	M	RXB12350Y	S11	M	TIP131	S4a	P
PKB32001U	S11	M	RZ1214B35Y	S11	M	TIP132	S4a	P
PKB32003U	S11	M	RZ1214B60W	S11	M	TIP135	S4a	P
PKB32005U	S11	M	RZ1214B65Y	S11	M	TIP136	S4a	P
PPC5001T	S11	M	RZ1214B125W	S11	M	TIP137	S4a	P
PQC5001T	S11	M	RZ1214B125Y	S11	M	TIP140	S4a	P
PTB23001X	S11	M	RZ1214B150Y	S11	M	TIP141	S4a	P
PTB23003X	S11	M	RZ2833B45W	S11	M	TIP145	S4a	P
PTB23005X	S11	M	RZ3135B15U	S11	M	TIP146	S4a	P
PTB32001X	S11	M	RZ3135B15W	S11	M	TIP147	S4a	P
PTB32003X	S11	M	RZ3135B25U	S11	M	TIP2955	S4a	P
PTB32005X	S11	M	RZ3135B30W	S11	M	TIP3055	S4a	P
PTB42001X	S11	M	RZB12100Y	S11	M	1N821;A	S1	Vrf
PTB42002X	S11	M	RZB12350Y	S11	M	1N823;A	S1	Vrf
PTB42003X	S11	M	RZZ1214B300YS11	M		1N825;A	S1	Vrf
PV3742B4X	S11	M	TIP29*	S4a	P	1N827;A	S1	Vrf
PVB42004X	S11	M	TIP30*	S4a	P	1N829;A	S1	Vrf
PZ1418B15U	S11	M	TIP31*	S4a	P	1N914	S1	SD
PZ1418B30U	S11	M	TIP32*	S4a	P	1N916	S1	SD
PZ1721B12U	S11	M	TIP33*	S4a	P	1N3879	S2a	R
PZ1721B25U	S11	M	TIP34*	S4a	P	1N3880	S2a	R
PZ2024B10U	S11	M	TIP41*	S4a	P	1N3881	S2a	R
PZ2024B20U	S11	M	TIP42*	S4a	P	1N3882	S2a	R
PZB16035U	S11	M	TIP47	S4a	P	1N3883	S2a	R
PZB27020U	S11	M	TIP48	S4a	P	1N3889	S2a	R
RPY58A	S8	Ph	TIP49	S4a	P	1N3890	S2a	R
RPY76B	S8	Ph	TIP50	S4a	P	1N3891	S2a	R
RPY86	S8	I	TIP110	S4a	P	1N3892	S2a	R
RPY87	S8	I	TIP111	S4a	P	1N3893	S2a	R
RPY88	S8	I	TIP112	S4a	P	1N3909	S2a	R

- * = series
- I = Infrared devices
- M = Microwave transistors
- P = Low-frequency power transistors
- Ph = Photoconductive devices
- R = Rectifier diodes

- RFP = R.F. power transistors and modules
- SD = Small-signal diodes
- Sm = Small-signal transistors
- SP = Low-frequency switching power transistors
- Vrf = Voltage reference diodes

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type no.	book	section	type no.	book	section	type no.	book	section
1N3910	S2a	R	2N2369	S3	Sm	2N4391	S5	FET
1N3911	S2a	R	2N2369A	S3	Sm	2N4392	S5	FET
1N3912	S2a	R	2N2483	S3	Sm	2N4393	S5	FET
1N3913	S2a	R	2N2484	S3	Sm	2N4427	S6	RFP
1N4001G	S1	R	2N2904	S3	Sm	2N4856	S5	FET
1N4002G	S1	R	2N2904A	S3	Sm	2N4857	S5	FET
1N4003G	S1	R	2N2905	S3	Sm	2N4858	S5	FET
1N4004G	S1	R	2N2905A	S3	Sm	2N4859	S5	FET
1N4005G	S1	R	2N2906	S3	Sm	2N4860	S5	FET
1N4006G	S1	R	2N2906A	S3	Sm	2N4861	S5	FET
1N4007G	S1	R	2N2907	S3	Sm	2N5400	S3	Sm
1N4148	S1	SD	2N2907A	S3	Sm	2N5401	S3	Sm
1N4150	S1	SD	2N3019	S3	Sm	2N5415	S3	Sm
1N4151	S1	SD	2N3020	S3	Sm	2N5416	S3	Sm
1N4153	S1	SD	2N3053	S3	Sm	2N5550	S3	Sm
1N4446	S1	SD	2N3375	S6	RFP	2N5551	S3	Sm
1N4448	S1	SD	2N3553	S6	RFP	2N6659	S5	FET
1N4531	S1	SD	2N3632	S6	RFP	2N6660	S5	FET
1N4532	S1	SD	2N3822	S5	FET	2N6661	S5	FET
1N5059	S1	R	2N3823	S5	FET	61SV	S8	I
1N5060	S1	R	2N3866	S6	RFP	375CQY/B	S8	Ph
1N5061	S1	R	2N3903	S3	Sm	497CQF/A	S8	Ph
1N5062	S1	R	2N3904	S3	Sm	498CQL	S8	Ph
1N5832	S2a	R	2N3905	S3	Sm	56201d	S4b	A
1N5833	S2a	R	2N3906	S3	Sm	56201j	S4b	A
1N5834	S2a	R	2N3924	S6	RFP	56245	S3, 10	A
1N6097	S2a	R	2N3926	S6	RFP	56246	S3, 10	A
1N6098	S2a	R	2N3927	S6	RFP	56261a	S4b	A
2N918	S10	WBT	2N3966	S5	FET	56264a, b	S2a/b	A
2N929	S3	Sm	2N4030	S3	Sm	56295	S2a/b	A
2N930	S3	Sm	2N4031	S3	Sm	56326	S4b	A
2N1613	S3	Sm	2N4032	S3	Sm	56339	S4b	A
2N1711	S3	Sm	2N4033	S3	Sm	56352	S4b	A
2N1893	S3	Sm	2N4091	S5	FET	56353	S4b	A
2N2219	S3	Sm	2N4092	S5	FET	56354	S4b	A
2N2219A	S3	Sm	2N4093	S5	FET	56359b	S2, 4b	A
2N2222	S3	Sm	2N4123	S3	Sm	56359c	S2, 4b	A
2N2222A	S3	Sm	2N4124	S3	Sm	56359d	S2, 4b	A
2N2297	S3	Sm	2N4125	S3	Sm	56360a	S2, 4b	A
2N2368	S3	Sm	2N4126	S3	Sm	56363	S2, 4b	A

A = Accessories
 FET = Field-effect transistors
 I = Infrared devices
 Ph = Photoconductive devices
 R = Rectifier diodes

RFP = R.F. power transistors and modules
 SD = Small-signal diodes
 Sm = Small-signal transistors
 WBT = Wideband transistors

type no.	book	section
56364	S2, 4b	A
56367	S2a/b	A
56368a	S2, 4b	A
56368b	S2, 4b	A
56369	S2, 4b	A
56378	S2, 4b	A
56379	S2, 4b	A
56387a, b	S4b	A

A = Accessories

NOTES

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