PHILIPS

Data handbook

PHILIPS

Electronic components and materials

Semiconductors

Part 4a November 1983

Low-frequency power transistors

Low-frequency power hybrid modules

SEMICONDUCTORS

PART 4a - NOVEMBER 1983

LOW-FREQUENCY POWER TRANSISTORS

DATA HANDBOOK SYSTEM
SEMICONDUCTOR INDEX

TYPE NUMBER SURVEY
SELECTION GUIDE

GENERAL

TRANSISTOR DATA

MOUNTING INSTRUCTIONS

ACCESSORIES

HYBRID MODULES

DATA HANDBOOK SYSTEM

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

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

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

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

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

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks is comprised of the following parts:

C1 **Assemblies for industrial use**
PLC modules, PC20 modules, HNIL FZ/30 series, NORbits 60-, 61-, 90-series, input devices, hybrid ICs

C2 **Television tuners, video modulators, surface acoustic wave filters**

C3 **Loudspeakers**

C4 **Ferroxcube potcores, square cores and cross cores**

C5 **Ferroxcube for power, audio/video and accelerators**

C6 **Electric motors and accessories**
Permanent magnet synchronous motors, stepping motors, direct current motors

C7 **Variable capacitors**

C8 **Variable mains transformers**

C9 **Piezoelectric quartz devices**
Quartz crystal units, temperature compensated crystal oscillators, compact integrated oscillators, quartz crystal cuts for temperature measurements

C10 **Connectors**

C11 **Non-linear resistors**
Voltage dependent resistors (VDR), light dependent resistors (LDR), negative temperature coefficient thermistors (NTC), positive temperature coefficient thermistors (PTC)

C12 **Variable resistors and test switches**

C13 **Fixed resistors**

C14 **Electrolytic and solid capacitors**

C15 **Film capacitors, ceramic capacitors**

C16 **Piezoelectric ceramics, permanent magnet materials**

ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks is comprised of the following parts:

- **T1** **Tubes for r.f. heating**
- **T2** **Transmitting tubes for communications**
- **T3** **Klystrons, travelling-wave tubes, microwave diodes**
- **ET3** **Special Quality tubes, miscellaneous devices** (will not be reprinted)
- **T4** **Magnetrons**
- **T5** **Cathode-ray tubes**
  Instrument tubes, monitor and display tubes, C.R. tubes for special applications
- **T6** **Geiger-Müller tubes**
- **T7** **Gas-filled tubes**
  Segment indicator tubes, indicator tubes, dry reed contact units, thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes, associated accessories
- **T8** **Picture tubes and components**
  Colour TV picture tubes, black and white TV picture tubes, colour monitor tubes for data graphic display, monochrome monitor tubes for data graphic display, components for colour television, components for black and white television and monochrome data graphic display
- **T9** **Photo and electron multipliers**
  Photomultiplier tubes, phototubes, single channel electron multipliers, channel electron multiplier plates
- **T10** **Camera tubes and accessories, image intensifiers**
- **T11** **Microwave semiconductors and components**

SEMICONDUCTORS (RED SERIES)

The red series of data handbooks is comprised of the following parts:

S1 **Diodes**
Small-signal germanium diodes, small-signal silicon diodes, voltage regulator diodes($<$ 1,5 W), voltage reference diodes, tuner diodes, rectifier diodes

S2 **Power diodes, thyristors, triacs**
Rectifier diodes, voltage regulator diodes ($>$ 1,5 W), rectifier stacks, thyristors, 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 **Microminiature semiconductors for hybrid circuits**

S8 **Devices for optoelectronics**
Photosensitive diodes and transistors, light-emitting diodes, displays, photocouplers, infrared sensitive devices, photoconductive devices.

S9 Taken into handbook T11 of the blue series

S10 **Wideband transistors and wideband hybrid IC modules**

INTEGRATED CIRCUITS (PURPLE SERIES)

The purple series of data handbooks is comprised of the following parts:

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

INDEX OF TYPE NUMBERS

Data Handbooks S1 to S10

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
AA119	S1	GD	BAS19	S7/S1	Mm/SD	BB109G	S1	T
AAZ15	S1	GD	BAS20	S7/S1	Mm/SD	BB112	S1	T
AAZ17	S1	GD	BAS21	S7/S1	Mm/SD	BB119	S1	T
AAZ18	S1	GD	BAT17	S7/S1	Mm/T	BB130	S1	T
BA220	S1	SD	BAT18	S7/S1	Mm/T	BB204B	S1	T
BA221	S1	SD	BAT81	S1	T	BB204G	S1	T
BA223	S1	T	BAT82	S1	T	BB212	S1	T
BA243	S1	T	BAT83	S1	T	BB405B	S1	T
BA244	S1	T	BAT85	S1	T	BB405G	S1	T
BA280	S1	T	BAV10	S1	SD	BB417	S1	T
BA314	S1	Vrg	BAV18	S1	SD	BB809	S1	T
BA315	S1	Vrg	BAV19	S1	SD	BB909A	S1	T
BA316	S1	SD	BAV20	S1	SD	BB909B	S1	T
BA317	S1	SD	BAV21	S1	SD	BBY31	S7/S1	Mm/T
BA318	S1	SD	BAV45	S1	Sp	BBY40	S7/S1	Mm/T
BA379	S1	T	BAV70	S7/S1	Mm/SD	BC107	S3	Sm
BA423	S1	T	BAV99	S7/S1	Mm/SD	BC108	S3	Sm
BA481	S1	T	BAW56	S7/S1	Mm/SD	BC109	S3	Sm
BA482	S1	T	BAW62	S1	SD	BC146	S3	Sm
BA483	S1	T	BAX12	S1	SD	BC177	S3	Sm
BA484	S1	T	BAX12A	S1	SD	BC178	S3	Sm
BAS11	S1	SD	BAX14	S1	SD	BC179	S3	Sm
BAS16	S7/S1	Mm/SD	BAX18	S1	SD	BC200	S3	Sm
BAS17	S7/S1	Mm/Vrg	BB105B	S1	T	BC264A	S5	FET
BAS18	S1	SD	BB105G	S1	T	BC264B	S5	FET

FET = Field-effect transistors
GD = Germanium diodes
Mm = Microminiature semiconductors for hybrid circuits
SD = Small-signal diodes
Sm = Small-signal transistors
Sp = Special diodes
T = Tuner diodes
Vrg = Voltage regulator diodes

type no.	book	section	type no.	book	section	type no.	book	section
BC264C	S5	FET	BC868	S7	Mm	BCY71	S3	Sm
BC264D	S5	FET	BC869	S7	Mm	BCY72	S3	Sm
BC327;A	S3	Sm	BCF29;R	S7	Mm	BCY78	S3	Sm
BC328	S3	Sm	BCF30;R	S7	Mm	BCY79	S3	Sm
BC337;A	S3	Sm	BCF32;R	S7	Mm	BCY87	S3	Sm
BC338	S3	Sm	BCF33;R	S7	Mm	BCY88	S3	Sm
BC368	S3	Sm	BCF70;R	S7	Mm	BCY89	S3	Sm
BC369	S3	Sm	BCF81;R	S7	Mm	BD131	S4a	P
BC375	S3	Sm	BCV71;R	S7	Mm	BD132	S4a	P
BC376	S3	Sm	BCV72;R	S7	Mm	BD135	S4a	P
BC546	S3	Sm	BCW29;R	S7	Mm	BD136	S4a	P
BC547	S3	Sm	BCW30;R	S7	Mm	BD137	S4a	P
BC548	S3	Sm	BCW31;R	S7	Mm	BD138	S4a	P
BC549	S3	Sm	BCW32;R	S7	Mm	BD139	S4a	P
BC550	S3	Sm	BCW33;R	S7	Mm	BD140	S4a	P
BC556	S3	Sm	BCW60*	S7	Mm	BD201	S4a	P
BC557	S3	Sm	BCW61*	S7	Mm	BD202	S4a	P
BC558	S3	Sm	BCW69;R	S7	Mm	BD203	S4a	P
BC559	S3	Sm	BCW70;R	S7	Mm	BD204	S4a	P
BC560	S3	Sm	BCW71;R	S7	Mm	BD226	S4a	P
BC635	S3	Sm	BCW72;R	S7	Mm	BD227	S4a	P
BC636	S3	Sm	BCW81;R	S7	Mm	BD228	S4a	P
BC637	S3	Sm	BCW89;R	S7	Mm	BD229	S4a	P
BC638	S3	Sm	BCX17;R	S7	Mm	BD230	S4a	P
BC639	S3	Sm	BCX18;R	S7	Mm	BD231	S4a	P
BC640	S3	Sm	BCX19;R	S7	Mm	BD233	S4a	P
BC807	S7	Mm	BCX20;R	S7	Mm	BD234	S4a	P
BC808	S7	Mm	BCX51	S7	Mm	BD235	S4a	P
BC817	S7	Mm	BCX52	S7	Mm	BD236	S4a	P
BC818	S7	Mm	BCX53	S7	Mm	BD237	S4a	P
BC846	S7	Mm	BCX54	S7	Mm	BD238	S4a	P
BC847	S7	Mm	BCX55	S7	Mm	BD239	S4a	P
BC848	S7	Mm	BCX56	S7	Mm	BD239A	S4a	P
BC849	S7	Mm	BCX70*	S7	Mm	BD239B	S4a	P
BC850	S7	Mm	BCX71*	S7	Mm	BD239C	S4a	P
BC856	S7	Mm	BCY56	S3	Sm	BD240	S4a	P
BC857	S7	Mm	BCY57	S3	Sm	BD240A	S4a	P
BC858	S7	Mm	BCY58	S3	Sm	BD240B	S4a	P
BC859	S7	Mm	BCY59	S3	Sm	BD240C	S4a	P
BC860	S7	Mm	BCY70	S3	Sm	BD241	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
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
BD433	S4a	P	BD843	S4a	P	BDT30B	S4a	P
BD434	S4a	P	BD844	S4a	P	BDT30C	S4a	P
BD435	S4a	P	BD845	S4a	P	BDT31	S4a	P
BD436	S4a	P	BD846	S4a	P	BDT31A	S4a	P
BD437	S4a	P	BD847	S4a	P	BDT31B	S4a	P
BD438	S4a	P	BD848	S4a	P	BDT31C	S4a	P
BD645	S4a	P	BD849	S4a	P	BDT32	S4a	P
BD646	S4a	P	BD850	S4a	P	BDT32A	S4a	P
BD647	S4a	P	BD933	S4a	P	BDT32B	S4a	P
BD648	S4a	P	BD934	S4a	P	BDT32C	S4a	P
BD649	S4a	P	BD935	S4a	P	BDT41	S4a	P
BD650	S4a	P	BD936	S4a	P	BDT41A	S4a	P
BD651	S4a	P	BD937	S4a	P	BDT41B	S4a	P
BD652	S4a	P	BD938	S4a	P	BDT41C	S4a	P
BD675	S4a	P	BD939	S4a	P	BDT42	S4a	P

P = Low-frequency power transistors

type no.	book	section	type no.	book	section	type no.	book	section
BDT42A	S4a	P	BDV65C	S4a	P	BDX64B	S4a	P
BDT42B	S4a	P	BDV66A	S4a	P	BDX64C	S4a	P
BDT42C	S4a	P	BDV66B	S4a	P	BDX65	S4a	P
BDT60	S4a	P	BDV66C	S4a	P	BDX65A	S4a	P
BDT60A	S4a	P	BDV66D	S4a	P	BDX65B	S4a	P
BDT60B	S4a	P	BDV67A	S4a	P	BDX65C	S4a	P
BDT60C	S4a	P	BDV67B	S4a	P	BDX66	S4a	P
BDT61	S4a	P	BDV67C	S4a	P	BDX66A	S4a	P
BDT61A	S4a	P	BDV67D	S4a	P	BDX66B	S4a	P
BDT61B	S4a	P	BDV91	S4a	P	BDX66C	S4a	P
BDT61C	S4a	P	BDV92	S4a	P	BDX67	S4a	P
BDT62	S4a	P	BDV93	S4a	P	BDX67A	S4a	P
BDT62A	S4a	P	BDV94	S4a	P	BDX67B	S4a	P
BDT62B	S4a	P	BDV95	S4a	P	BDX67C	S4a	P
BDT62C	S4a	P	BDV96	S4a	P	BDX68	S4a	P
BDT63	S4a	P	BDW55	S4a	P	BDX68A	S4a	P
BDT63A	S4a	P	BDW56	S4a	P	BDX68B	S4a	P
BDT63B	S4a	P	BDW57	S4a	P	BDX68C	S4a	P
BDT63C	S4a	P	BDW58	S4a	P	BDX69	S4a	P
BDT64	S4a	P	BDW59	S4a	P	BDX69A	S4a	P
BDT64A	S4a	P	BDW60	S4a	P	BDX69B	S4a	P
BDT64B	S4a	P	BDX35	S4a	P	BDX69C	S4a	P
BDT64C	S4a	P	BDX36	S4a	P	BDX77	S4a	P
BDT65	S4a	P	BDX37	S4a	P	BDX78	S4a	P
BDT65A	S4a	P	BDX42	S4a	P	BDX91	S4a	P
BDT65B	S4a	P	BDX43	S4a	P	BDX92	S4a	P
BDT65C	S4a	P	BDX44	S4a	P	BDX93	S4a	P
BDT91	S4a	P	BDX45	S4a	P	BDX94	S4a	P
BDT92	S4a	P	BDX46	S4a	P	BDX95	S4a	P
BDT93	S4a	P	BDX47	S4a	P	BDX96	S4a	P
BDT94	S4a	P	BDX62	S4a	P	BDY90	S4a	P
BDT95	S4a	P	BDX62A	S4a	P	BDY90A	S4a	P
BDT96	S4a	P	BDX62B	S4a	P	BDY91	S4a	P
BDV64	S4a	P	BDX62C	S4a	P	BDY92	S4a	P
BDV64A	S4a	P	BDX63	S4a	P	BF180	S3	Sm
BDV64B	S4a	P	BDX63A	S4a	P	BF181	S3	Sm
BDV64C	S4a	P	BDX63B	S4a	P	BF182	S3	Sm
BDV65	S4a	P	BDX63C	S4a	P	BF183	S3	Sm
BDV65A	S4a	P	BDX64	S4a	P	BF198	S3	Sm
BDV65B	S4a	P	BDX64A	S4a	P	BF199	S3	Sm

P = Low-frequency power transistors
Sm = Small-signal transistors

type no.	book	section	type no.	book	section	type no.	book	section
BF200	S3	Sm	BF569	S7	Mm	BFG91A	S10	WBT
BF240	S3	Sm	BF579	S7	Mm	BFG96	S10	WBT
BF241	S3	Sm	BF620	S7	Mm	BFP90A	S10	WBT
BF245A	S5	FET	BF621	S7	Mm	BFP91A	S10	WBT
BF245B	S5	FET	BF622	S7	Mm	BFP96	S10	WBT
BF245C	S5	FET	BF623	S7	Mm	BFQ10	S5	FET
BF246A	S5	FET	BF660;R	S7	Mm	BFQ11	S5	FET
BF246B	S5	FET	BF689K	S10	WBT	BFQ12	S5	FET
BF246C	S5	FET	BF767	S7	Mm	BFQ13	S5	FET
BF256A	S5	FET	BF819	S4b	HVP	BFQ14	S5	FET
BF256B	S5	FET	BF820	S7	Mm	BFQ15	S5	FET
BF256C	S5	FET	BF821	S7	Mm	BFQ16	S5	FET
BF324	S3	Sm	BF822	S7	Mm	BFQ17	S7	Mm
BF370	S3	Sm	BF823	S7	Mm	BFQ18A	S7	Mm
BF410A	S5	FET	BF857	S4b	HVP	BFQ19	S7	Mm
BF410B	S5	FET	BF858	S4b	HVP	BFQ22	S10	WBT
BF410C	S5	FET	BF859	S4b	HVP	BFQ22S	S10	WBT
BF410D	S5	FET	BF869	S4b	HVP	BFQ23	S10	WBT
BF419	S4b	HVP	BF870	S4b	HVP	BFQ24	S10	WBT
BF422	S3	Sm	BF871	S4b	HVP	BFQ32	S10	WBT
BF423	S3	Sm	BF872	S4b	HVP	BFQ33	S10	WBT
BF450	S3	Sm	BF926	S3	Sm	BFQ34	S10	WBT
BF451	S3	Sm	BF936	S3	Sm	BFQ34T	S10	WBT
BF457	S4b	HVP	BF939	S3	Sm	BFQ42	S6	RFP
BF458	S4b	HVP	BF960	S5	FET	BFQ43	S6	RFP
BF459	S4b	HVP	BF964	S5	FET	BFQ51	S10	WBT
BF469	S4b	HVP	BF966	S5	FET	BFQ52	S10	WBT
BF470	S4b	HVP	BF967	S3	Sm	BFQ53	S10	WBT
BF471	S4b	HVP	BF970	S3	Sm	BFQ63	S10	WBT
BF472	S4b	HVP	BF979	S3	Sm	BFQ65	S10	WBT
BF480	S3	Sm	BF980	S5	FET	BFQ66	S10	WBT
BF494	S3	Sm	BF981	S5	FET	BFQ68	S10	WBT
BF495	S3	Sm	BF982	S5	FET	BFR29	S5	FET
BF496	S3	Sm	BF989	S7	Mm	BFR30	S7	Mm
BF510	S7	Mm	BF990	S7	Mm	BFR31	S7	Mm
BF511	S7	Mm	BF991	S7	Mm	BFR49	S10	WBT
BF512	S7	Mm	BF992	S7	Mm	BFR53;R	S7	Mm
BF513	S7	Mm	BF994	S7	Mm	BFR54	S3	Sm
BF536	S7	Mm	BF996	S7	Mm	BFR64	S10	WBT
BF550;R	S7	Mm	BFG90A	S10	WBT	BFR65	S10	WBT

FET = Field-effect transistors
HVP = High-voltage power transistors
Mm = Microminiature semiconductors for hybrid circuits
RFP = R.F. power transistors and modules
Sm = Small-signal transistors
WBT = Wideband hybrid IC transistors

type no.	book	section
BFR84	S5	FET
BFR90	S10	WBT
BFR90A	S10	WBT
BFR91	S10	WBT
BFR91A	S10	WBT
BFR92;R	S7	Mm
BFR92A;R	S7	Mm
BFR93;R	S7	Mm
BFR93A;R	S7	Mm
BFR94	S10	WBT
BFR95	S10	WBT
BFR96	S10	WBT
BFR96S	S10	WBT
BFR101A;B	S7	Mm
BFS17;R	S7	Mm
BFS18;R	S7	Mm
BFS19;R	S7	Mm
BFS20;R	S7	Mm
BFS21	S5	FET
BFS21A	S5	FET
BFS22A	S6	RFP
BFS23A	S6	RFP
BFT24	S10	WBT
BFT25;R	S7	Mm
BFT44	S3	Sm
BFT45	S3	Sm
BFT46	S7	Mm
BFT92;R	S7	Mm
BFT93;R	S7	Mm
BFW10	S5	FET
BFW11	S5	FET
BFW12	S5	FET
BFW13	S5	FET
BFW16A	S10	WBT
BFW17A	S10	WBT
BFW30	S10	WBT
BFW61	S5	FET
BFW92	S10	WBT
BFW92A	S10	WBT
BFW93	S10	WBT
BFX29	S3	Sm
BFX30	S3	Sm
BFX34	S3	Sm
BFX84	S3	Sm
BFX85	S3	Sm
BFX86	S3	Sm
BFX87	S3	Sm
BFX88	S3	Sm
BFX89	S10	WBT
BFY50	S3	Sm
BFY51	S3	Sm
BFY52	S3	Sm
BFY55	S3	Sm
BFY90	S10	WBT
BG2000	S1	RT
BG2097	S1	RT
BGX11*	S2	ThM
BGX12*	S2	ThM
BGX13*	S2	ThM
BGX14*	S2	ThM
BGX15*	S2	ThM
BGX17*	S2	ThM
BGY22	S6	RFP
BGY22A	S6	RFP
BGY23	S6	RFP
BGY23A	S6	RFP
BGY32	S6	RFP
BGY33	S6	RFP
BGY35	S6	RFP
BGY36	S6	RFP
BGY40A	S6	RFP
BGY40B	S6	RFP
BGY41A	S6	RFP
BGY41B	S6	RFP
BGY43	S6	RFP
BGY50	S10	WBM
BGY51	S10	WBM
BGY52	S10	WBM
BGY53	S10	WBM
BGY54	S10	WBM
BGY55	S10	WBM
BGY56	S10	WBM
BGY57	S10	WBM
BGY58	S10	WBM
BGY58A	S10	WBT
BGY59	S10	WBM
BGY60	S10	WBM
BGY61	S10	WBT
BGY65	S10	WBT
BGY67	S10	WBT
BGY70	S10	WBT
BGY71	S10	WBT
BGY74	S10	WBM
BGY75	S10	WBM
BLV10	S6	RFP
BLV11	S6	RFP
BLV20	S6	RFP
BLV21	S6	RFP
BLV25	S6	RFP
BLV30	S6	RFP
BLV31	S6	RFP
BLV32F	S6	RFP
BLV33	S6	RFP
BLV33F	S6	RFP
BLV36	S6	RFP
BLV57	S6	RFP
BLW29	S6	RFP
BLW31	S6	RFP
BLW32	S6	RFP
BLW33	S6	RFP
BLW34	S6	RFP
BLW50F	S6	RFP
BLW60	S6	RFP
BLW60C	S6	RFP
BLW64	S6	RFP
BLW75	S6	RFP
BLW76	S6	RFP
BLW77	S6	RFP
BLW78	S6	RFP
BLW79	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
BLW80	S6	RFP
BLW81	S6	RFP
BLW82	S6	RFP
BLW83	S6	RFP
BLW84	S6	RFP
BLW85	S6	RFP
BLW86	S6	RFP
BLW87	S6	RFP
BLW89	S6	RFP
BLW90	S6	RFP
BLW91	S6	RFP
BLW95	S6	RFP
BLW96	S6	RFP
BLW98	S6	RFP
BLX13	S6	RFP
BLX13C	S6	RFP
BLX14	S6	RFP
BLX15	S6	RFP
BLX39	S6	RFP
BLX65	S6	RFP
BLX66	S6	RFP
BLX67	S6	RFP
BLX68	S6	RFP
BLX69A	S6	RFP
BLX91A	S6	RFP
BLX92A	S6	RFP
BLX93A	S6	RFP
BLX94A	S6	RFP
BLX94C	S6	RFP
BLX95	S6	RFP
BLX96	S6	RFP
BLX97	S6	RFP
BLX98	S6	RFP
BLY33	S6	RFP
BLY34	S6	RFP
BLY35	S6	RFP
BLY36	S6	RFP
BLY83	S6	RFP
BLY84	S6	RFP
BLY85	S6	RFP
BLY87A	S6	RFP
BLY87C	S6	RFP
BLY88A	S6	RFP
BLY88C	S6	RFP
BLY89A	S6	RFP
BLY89C	S6	RFP
BLY90	S6	RFP
BLY91A	S6	RFP
BLY91C	S6	RFP
BLY92A	S6	RFP
BLY92C	S6	RFP
BLY93A	S6	RFP
BLY93C	S6	RFP
BLY94	S6	RFP
BLY97	S6	RFP
BPF10	S8	PDT
BPF24	S8	PDT
BPW22A	S8	PDT
BPW50	S8	PDT
BPX25	S8	PDT
BPX29	S8	PDT
BPX40	S8	PDT
BPX41	S8	PDT
BPX42	S8	PDT
BPX71	S8	PDT
BPX72	S8	PDT
BPX95C	S8	PDT
BR100/03	S2	Th
BR101	S3	Sm
BRY39	S3	Sm
BRY56	S3	Sm
BRY61	S7	Mm
BRY62	S7	Mm
BSR12;R	S7	Mm
BSR13;R	S7	Mm
BSR14;R	S7	Mm
BSR15;R	S7	Mm
BSR16;R	S7	Mm
BSR17;R	S7	Mm
BSR17A;R	S7	Mm
BSR18;R	S7	Mm
BSR18A;R	S7	Mm
BSR30	S7	Mm
BSR31	S7	Mm
BSR32	S7	Mm
BSR33	S7	Mm
BSR40	S7	Mm
BSR41	S7	Mm
BSR42	S7	Mm
BSR43	S7	Mm
BSR50	S3	Sm
BSR51	S3	Sm
BSR52	S3	Sm
BSR56	S7	Mm
BSR57	S7	Mm
BSR58	S7	Mm
BSR60	S3	Sm
BSR61	S3	Sm
BSR62	S3	Sm
BSS38	S3	Sm
BSS50	S3	Sm
BSS51	S3	Sm
BSS52	S3	Sm
BSS60	S3	Sm
BSS61	S3	Sm
BSS62	S3	Sm
BSS63;R	S7	Mm
BSS64;R	S7	Mm
BSS68	S3	Sm
BST15	S7	Mm
BST16	S7	Mm
BST50	S7	Mm
BST51	S7	Mm
BST52	S7	Mm
BST60	S7	Mm
BST61	S7	Mm
BST62	S7	Mm
BSV15	S3	Sm
BSV16	S3	Sm
BSV17	S3	Sm

Mm = Microminiature semiconductors for hybrid circuits
PDT = Photodiodes or transistors
RFP = R.F. power transistors and modules
Sm = Small-signal transistors
Th = Thyristors

type no.	book	section
BSV52;R	S7	Mm
BSV64	S3	Sm
BSV78	S5	FET
BSV79	S5	FET
BSV80	S5	FET
BSV81	S5	FET
BSW66A	S3	Sm
BSW67A	S3	Sm
BSW68A	S3	Sm
BSX19	S3	Sm
BSX20	S3	Sm
BSX45	S3	Sm
BSX46	S3	Sm
BSX47	S3	Sm
BSX59	S3	Sm
BSX60	S3	Sm
BSX61	S3	Sm
BSY95A	S3	Sm
BT136*	S2	Tri
BT137*	S2	Tri
BT138*	S2	Tri
BT139*	S2	Tri
BT149*	S2	Th
BT151*	S2	Th
BT152*	S2	Th
BT153	S2	Th
BT154	S2	Th
BT155*	S2	Th
BTV24*	S2	Th
BTV34*	S2	Tri
BTV58*	S2	Th
BTW23*	S2	Th
BTW30S*	S2	Th
BTW31W*	S2	Th
BTW38*	S2	Th
BTW40*	S2	Th
BTW42*	S2	Th
BTW43*	S2	Tri
BTW45*	S2	Th
BTW47*	S2	Th
BTW58*	S2	Th
BTW63*	S2	Th
BTW92*	S2	Th
BTX18*	S2	Th
BTX94*	S2	Tri
BTY79*	S2	Th
BTY87*	S2	Th
BTY91*	S2	Th
BU208A	S4b	SP
BU208B	S4b	SP
BU326	S4b	SP
BU326A	S4b	SP
BU426	S4b	SP
BU426A	S4b	SP
BU433	S4b	SP
BU505	S4b	SP
BU508A	S4b	SP
BU705	S4b	SP
BU806	S4b	SP
BU807	S4b	SP
BU824	S4b	SP
BU826	S4b	SP
BUS11;A	S4b	SP
BUS12;A	S4b	SP
BUS13;A	S4b	SP
BUS14;A	S4b	SP
BUT11;A	S4b	SP
BUV82	S4b	SP
BUV83	S4b	SP
BUV89	S4b	SP
BUW11;A	S4b	SP
BUW12;A	S4b	SP
BUW13;A	S4b	SP
BUW84	S4b	SP
BUW85	S4b	SP
BUX46;A	S4b	SP
BUX47;A	S4b	SP
BUX48;A	S4b	SP
BUX80	S4b	SP
BUX81	S4b	SP
BUX82	S4b	SP
BUX83	S4b	SP
BUX84	S4b	SP
BUX85	S4b	SP
BUX86	S4b	SP
BUX87	S4b	SP
BUX88	S4b	SP
BUX90	S4b	SP
BUX98	S4b	SP
BUX98A	S4b	SP
BUY89	S4b	SP
BY184	S1	R
BY188G	S1	R
BY223	S2	R
BY224*	S2	R
BY225*	S2	R
BY228	S1	R
BY229*	S2	R
BY249	S2	R
BY260*	S2	R
BY261*	S2	R
BY277*	S2	R
BY438	S1	R
BY448	S1	R
BY458	S1	R
BY476	S1	R
BY477	S1	R
BY478	S1	R
BY505	S1	R
BY509	S1	R
BY527	S1	R
BY584	S1	R
BY609	S1	R
BY610	S1	R
BYV20	S2	R
BYV21*	S2	R
BYV22	S2	R
BYV23	S2	R
BYV24	S2	R
BYV27	S1	R

* = series
FET = Field-effect transistors
Mm = Microminiature semiconductors for hybrid circuits
R = Rectifier diodes
Sm = Small-signal transistors
SP = Low-frequency switching power transistors
Th = Thyristors
Tri = Triacs

type no.	book	section	type no.	book	section	type no.	book	section
BYV28	S1	R	BYX90	S1	R	CNX38	S8	PhC
BYV30*	S2	R	BYX91*	S1	R	CNX44	S8	PhC
BYV32*	S2	R	BYX94	S1	R	CNX48	S8	PhC
BYV92*	S2	R	BYX96*	S2	R	CNX62	S8	PhC
BYV95A	S1	R	BYX97*	S2	R	CNY50	S8	PhC
BYV95B	S1	R	BYX98*	S2	R	CNY52	S8	PhC
BYV95C	S1	R	BYX99*	S2	R	CNY53	S8	PhC
BYV96D	S1	R	BZT03	S1	Vrg	CNY57	S8	PhC
BYV96E	S1	R	BZV10	S1	Vrf	CNY57A	S8	PhC
BYW19*	S2	R	BZV11	S1	Vrf	CNY62	S8	PhC
BYW25	S2	R	BZV12	S1	Vrf	CNY63	S8	PhC
BYW29*	S2	R	BZV13	S1	Vrf	CQ209S	S8	D
BYW30*	S2	R	BZV14	S1	Vrf	CQ216X	S8	D
BYW31*	S2	R	BZV15*	S2	Vrf	CQ216Y	S8	D
BYW54	S1	R	BZV37	S1	Vrf	CQ327;R	S8	D
BYW55	S1	R	BZV46	S1	Vrg	CQ330;R	S8	D
BYW56	S1	R	BZV49*	S1/S7	Vrg	CQ331;R	S8	D
BYW92*	S2	R	BZV85	S1	Vrg	CQ332;R	S8	D
BYW93*	S2	R	BZW70*	S2	TS	CQ427;R	S8	D
BYW94*	S2	R	BZW86*	S2	TS	CQ430;R	S8	D
BYW95A	S1	R	BZW91*	S2	TS	CQ431;R	S8	D
BYW95B	S1	R	BZX55	S1	Vrg	CQ432;R	S8	D
BYW95C	S1	R	BZX70*	S2	Vrg	CQF24	S8	Ph
BYW96D	S1	R	BZX75	S1	Vrg	CQL10A	S8	Ph
BYW96E	S1	R	BZX79*	S1	Vrg	CQL13	S8	Ph
BYX10	S1	R	BZX84*	S7/S1	Mm/Vrg	CQL13A	S8	Ph
BYX22*	S2	R	BZX87*	S1	Vrg	CQL14A	S8	Ph
BYX25*	S2	R	BZX90	S1	Vrf	CQL14B	S8	Ph
BYX30*	S2	R	BZX91	S1	Vrf	CQN10	S8	LED
BYX32*	S2	R	BZX92	S1	Vrf	CQN11	S8	LED
BYX38*	S2	R	BZX93	S1	Vrf	CQT10	S8	LED
BYX39*	S2	R	BZX94	S1	Vrf	CQT11	S8	LED
BYX42*	S2	R	BZY91*	S2	Vrg	CQT12	S8	LED
BYX45*	S2	R	BZY93*	S2	Vrg	CQV60(L)	S8	LED
BYX46*	S2	R	BZY95*	S2	Vrg	CQV60A(L)	S8	LED
BYX49*	S2	R	BZY96*	S2	Vrg	CQV61A(L)	S8	LED
BYX50*	S2	R	CNX21	S8	PhC	CQV62(L)	S8	LED
BYX52*	S2	R	CNX35	S8	PhC	CQV70(L)	S8	LED
BYX56*	S2	R	CNX36	S8	PhC	CQV70A(L)	S8	LED
BYX71*	S2	R	CNX37	S8	PhC	CQV71A(L)	S8	LED

* = series
D = Displays
LED = Light emitting diodes
Mm = Microminiature semiconductors for hybrid circuits
Ph = Photoconductive devices
PhC = Photocouplers
R = Rectifier diodes
TS = Transient suppressor diodes
Vrf = Voltage reference diodes
Vrg = Voltage regulator diodes

INDEX

type no.	book	section
CQV72(L)	S8	LED
CQV80L	S8	LED
CQV80AL	S8	LED
CQV81L	S8	LED
CQV82L	S8	LED
CQW10(L)	S8	LED
CQW10A(L)	S8	LED
CQW10B(L)	S8	LED
CQW11A(L)	S8	LED
CQW11B(L)	S8	LED
CQW12(L)	S8	LED
CQW12B(L)	S8	LED
CQW20A	S8	LED
CQW21	S8	LED
CQW22	S8	LED
CQW24(L)	S8	LED
CQW54	S8	LED
CQX10	S8	LED
CQX11	S8	LED
CQX12	S8	LED
CQX24(L)	S8	LED
CQX51	S8	LED
CQX54(L)	S8	LED
CQX64(L)	S8	LED
CQX74(L)	S8	LED
CQX74Y	S8	LED
CQY11B	S8	LED
CQY11C	S8	LED
CQY24B(L)	S8	LED
CQY49B	S8	LED
CQY49C	S8	LED
CQY50	S8	LED
CQY52	S8	LED
CQY54A	S8	LED
CQY58A	S8	LED
CQY89A	S8	LED
CQY94	S8	LED
CQY94B(L)	S8	LED
CQY95B	S8	LED
CQY96(L)	S8	LED
CQY97A	S8	LED
OA90	S1	GD
OA91	S1	GD
OA95	S1	GD
OM320	S10	WBM
OM321	S10	WBM
OM322	S10	WBM
OM323	S10	WBM
OM323A	S10	WBM
OM335	S10	WBM
OM336	S10	WBM
OM337	S10	WBM
OM337A	S10	WBM
OM339	S10	WBM
OM345	S10	WBM
OM350	S10	WBM
OM360	S10	WBM
OM361	S10	WBM
OM370	S10	WBM
OM931	S4a	P
OM961	S4a	P
OSB9110	S2	St
OSB9210	S2	St
OSB9410	S2	St
OSM9110	S2	St
OSM9210	S2	St
OSM9410	S2	St
OSM9510	S2	St
OSM9511	S2	St
OSM9512	S2	St
OSS9110	S2	St
OSS9210	S2	St
OSS9410	S2	St
PH2222;R	S3	Sm
PH2222A;R	S3	Sm
PH2369	S3	Sm
PH2907;R	S3	Sm
PH2907A;R	S3	Sm
PH2955T	S4a	P
PH3055T	S4a	P
PH40*	S2	R
PH70*	S2	R
RPY58A	S8	Ph
RPY76B	S8	Ph
RPY86	S8	I
RPY87	S8	I
RPY88	S8	I
RPY89	S8	I
RPY90*	S8	I
RPY91*	S8	I
RPY93	S8	I
RPY94	S8	I
RPY95	S8	I
RPY96	S8	I
RPY97	S8	I
RTC901	S8	Ar
RTC902	S8	Ar
RTC903	S8	Ar
RTC904	S8	Ar
1N821;A	S1	Vrf
1N823;A	S1	Vrf
1N825;A	S1	Vrf
1N827;A	S1	Vrf
1N829;A	S1	Vrf
1N914	S1	SD
1N916	S1	SD
1N3879	S2	R
1N3880	S2	R
1N3881	S2	R
1N3882	S2	R
1N3889	S2	R
1N3890	S2	R
1N3891	S2	R
1N3892	S2	R
1N3899	S2	R
1N3900	S2	R
1N3901	S2	R
1N3902	S2	R
1N3903	S2	R
1N3909	S2	R

* = series
Ar = Arrays
GD = Germanium diodes
I = Infrared devices
LED = Light emitting diodes
P = Low-frequency power transistors
Ph = Photoconductive devices
R = Rectifier diodes
SD = Small-signal diodes
Sm = Small-signal transistors
St = Rectifier stacks
Vrf = Voltage reference diodes
WBM = Wideband hybrid IC modules

type no.	book	section	type no.	book	section	type no.	book	section
1N3910	S2	R	2N2369A	S3	Sm	2N4392	S5	FET
1N3911	S2	R	2N2483	S3	Sm	2N4393	S5	FET
1N3912	S2	R	2N2484	S3	Sm	2N4427	S6	RFP
1N3913	S2	R	2N2904	S3	Sm	2N4856	S5	FET
1N4001G	S1	R	2N2904A	S3	Sm	2N4857	S5	FET
1N4002G	S1	R	2N2905	S3	Sm	2N4858	S5	FET
1N4003G	S1	R	2N2905A	S3	Sm	2N4859	S5	FET
1N4004G	S1	R	2N2906	S3	Sm	2N4860	S5	FET
1N4005G	S1	R	2N2906A	S3	Sm	2N4861	S5	FET
1N4006G	S1	R	2N2907	S3	Sm	2N5415	S3	Sm
1N4007G	S1	R	2N2907A	S3	Sm	2N5416	S3	Sm
1N4148	S1	SD	2N3019	S3	Sm	61SV	S8	I
1N4150	S1	SD	2N3020	S3	Sm	375CQY/B	S8	Ph
1N4151	S1	SD	2N3053	S3	Sm	497CQF/A	S8	Ph
1N4154	S1	SD	2N3375	S6	RFP	498CQL	S8	Ph
1N4446	S1	SD	2N3553	S6	RFP	56201d	S4b	A
1N4448	S1	SD	2N3632	S6	RFP	56201j	S4b	A
1N4531	S1	SD	2N3822	S5	FET	56230	S2	HE
1N4532	S1	SD	2N3823	S5	FET	56231	S2	HE
1N5059	S1	R	2N3866	S6	RFP	56245	S3,6,10	A
1N5060	S1	R	2N3903	S3	Sm	56246	S3,5,10	A
1N5061	S1	R	2N3904	S3	Sm	56253	S2	DH
1N5062	S1	R	2N3905	S3	Sm	56256	S2	DH
2N918	S10	WBT	2N3906	S3	Sm	56261a	S4b	A
2N929	S3	Sm	2N3924	S6	RFP	56262A	S2	A
2N930	S3	Sm	2N3926	S6	RFP	56264A	S2	A
2N1613	S3	Sm	2N3927	S6	RFP	56268	S2	DH
2N1711	S3	Sm	2N3966	S5	FET	56290	S2	HE
2N1893	S3	Sm	2N4030	S3	Sm	56295	S2	A
2N2218	S3	Sm	2N4031	S3	Sm	56312	S2	DH
2N2218A	S3	Sm	2N4032	S3	Sm	56313	S2	DH
2N2219	S3	Sm	2N4033	S3	Sm	56316	S2	A
2N2219A	S3	Sm	2N4091	S5	FET	56317	S2	A
2N2221	S3	Sm	2N4092	S5	FET	56326	S4b	A
2N2221A	S3	Sm	2N4093	S5	FET	56339	S4b	A
2N2222	S3	Sm	2N4123	S3	Sm	56348	S2	DH
2N2222A	S3	Sm	2N4124	S3	Sm	56350	S2	DH
2N2297	S3	Sm	2N4125	S3	Sm	56352	S4b	A
2N2368	S3	Sm	2N4126	S3	Sm	56353	S4b	A
2N2369	S3	Sm	2N4391	S5	FET	56354	S4b	A

A = Accessories
DH = Diecast heatsinks
FET = Field-effect transistors
HE = Heatsink extrusions
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 hybrid IC transistors

type no.	book	section	type no.	book	section	type no.	book	section
56359b	S4b	A	56364	S2,S4b	A	56369	S2,S4b	A
56359c	S4b	A	56366	S2	A	56378	S4b	A
56359d	S4b	A	56367	S2	A	56379	S4b	A
56360a	S4b	A	56368a	S4b	A	56387a,b	S4b	A
56363	S2,S4b	A	56368b	S4b	A			

A = Accessories

TYPE NUMBER SURVEY

TYPE NUMBER SURVEY POWER TRANSISTORS

type number NPN	type number PNP	envelope	P_{tot} W	type number NPN	type number PNP	envelope	P_{tot} W
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	BD935	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	BD953	BD954	TO-220	40
BD433	BD434	TO-126	36	BD955	BD956	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 NPN	PNP	envelope	P_{tot} W	type number NPN	PNP	envelope	P_{tot} W
BDT31	BDT32	TO-220	40	BDX43	BDX46	TO-126	5
BDT31A	BDT32A	TO-220	40	BDX44	BDX47	TO-126	5
BDT31B	BDT32B	TO-220	40	BDX63	BDX62	TO-3	90
BDT31C	BDT32C	TO-220	40	BDX63A	BDX62A	TO-3	90
BDT41	BDT42	TO-220	65	BDX63B	BDX62B	TO-3	90
BDT41A	BDT42A	TO-220	65	BDX63C	BDX62C	TO-3	90
BDT41B	BDT42B	TO-220	65	BDX65	BDX64	TO-3	117
BDT41C	BDT42C	TO-220	65	BDX65A	BDX64A	TO-3	117
BDT61	BDT60	TO-220	50	BDX65B	BDX64B	TO-3	117
BDT61A	BDT60A	TO-220	50	BDX65C	BDX64C	TO-3	117
BDT61B	BDT60B	TO-220	50	BDX67	BDX66	TO-3	150
BDT61C	BDT60C	TO-220	50	BDX67A	BDX66A	TO-3	150
BDT63	BDT62	TO-220	90	BDX67B	BDX66B	TO-3	150
BDT63B	BDT62B	TO-220	90	BDX67C	BDX66C	TO-3	150
BDT63C	BDT62C	TO-220	90	BDX69	BDX68	TO-3	200
BDT65	BDT64	TO-220	125	BDX69A	BDX68A	TO-3	200
BDT65A	BDT64A	TO-220	125	BDX69B	BDX68B	TO-3	200
BDT65B	BDT64B	TO-220	125	BDX69C	BDX68C	TO-3	200
BDT65C	BDT64C	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	200	BF419		TO-126	6
BDV67B	BDV66B	SOT-93	200	BF457		TO-126	6
BDV67C	BDV66C	SOT-93	200	BF458		TO-126	6
BDV67D	BDV66D	SOT-93	200	BF459		TO-126	6
BDV91	BDV92	SOT-93	100	BF469	BF470	TO-126	1,8
BDV93	BDV94	SOT-93	100	BF471	BF472	TO-126	1,8
BDV95	BDV96	SOT-93	100	BF819		TO-202	6
BDW55	BDW56	TO-126	8	BF857		TO-202	6
BDW57	BDW58	TO-126	8	BF858		TO-202	6
BDW59	BDW60	TO-126	8	BF859		TO-202	6
BDX35		TO-126	15	BF869	BF870	TO-202	5
BDX36		TO-126	15	BF871	BF872	TO-202	5
BDX37		TO-126	15	BU208A		TO-3	80
BDX42	BDX45	TO-126	5	BU208B		TO-3	80

type number NPN	PNP	envelope	P_{tot} W	type number NPN	PNP	envelope	P_{tot} W
BU326;A		TO-3	60	BUV82;83		SOT-93	70
BU426;A		SOT-93	70	BUV89		SOT-93A	125
BU433		SOT-93	70	BUW11;A		SOT-93	100
BU505		TO-220	75	BUW12;A		SOT-93	125
BU508A		SOT-93A	125	BUW13;A		SOT-93	175
BU705		SOT-93A	75	BUW84;85		SOT-82	50
BU806		TO-220	60	BUX46;A		TO-3	85
BU807		TO-220	60	BUX47;A		TO-3	125
BU824		TO-202	2	BUX48;A		TO-3	175
BU826		SOT-93	125	BUX80;81		TO-3	100
BUS11;A		TO-3	100	BUX82;83		TO-3	60
BUS12;A		TO-3	125	BUX84;85		TO-220	40
BUS13;A		TO-3	175	BUX86;87		TO-126	20
BUS14;A		TO-3	250	BUX88		TO-3	160
BUT11;A		TO-220	100	BUX90		TO-3	125
				BUX98;A		TO-3	250
				BUY89		TO-3	80
				PH3055T	PH2955T	TO-220	75

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

GENERAL PURPOSE DARLINGTON TRANSISTORS

I_C A	pol.	collector-emitter voltage (open base) V_{CEO} (V) 45	60	80	100	120	130	150	200			P_{tot} W	case
1	N	BDX42*	BDX43*	BDX44*								5	TO-126
	P	BDX45*	BDX46*	BDX47*									
4	N	BD675	BD677	BD679	BD681	BD683						40	TO-126
	P	BD676	BD678	BD680	BD682	BD684							
	N		BDT61	BDT61A	BDT61B	BDT61C						50	TO-220
	P		BDT60	BDT60A	BDT60B	BDT60C							
6	N		BD331	BD333	BD335	BD337						60	SOT-82
	P		BD332	BD334	BD336	BD338							
8	N		BD645	BD647	BD649	BD651						62,5	TO-220
	P		BD646	BD648	BD650	BD652							
	N							BU807	BU806			60	TO-220
	N						BDT21					62,5	TO-220
	P						BDT20						
	N		BDX63	BDX63A	BDX63B	BDX63C						90	TO-3
	P		BDX62	BDX62A	BDX62B	BDX62C							
10	N		BDT63	BDT63A	BDT63B	BDT63C						90	TO-220
	P		BDT62	BDT62A	BDT62B	BDT62C							
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
	P		BDX64	BDX64A	BDX64B	BDX64C							
16	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							

* V_{CER}

HIGH-VOLTAGE TRANSISTORS video output - deflection - SMPS - motorcontrol

I_C A	pol.	collector-emitter voltage (open base) V_{CEO} (V) 160	250	300	375	400	450	700	800			P_{tot} W	case
0,05	N		BF469	BF471*								1,8	TO-126
	P		BF470	BF472*									
	N		BF869	BF871*								5	TO-202
	P		BF870	BF872*									
0,1	N		BF419									6	TO-126
	N	BF457	BF458	BF459									
	N		BF819									6	TO-202
	N	BF857	BF858	BF859									
0,5	N					BUX86	BUX87					20	TO-126
2	N					BUW84	BUW85					50	SOT-82
	N					BUX84	BUX85					40	TO-220
3,5	N					BUX46	BUX46A					85	TO-3
5	N					BUT11	BUT11A					100	TO-220
	N					BUW11	BUW11A					100	SOT-93
	N					BUS11	BUS11A					100	TO-3
6	N				BU326	BU326A						60	TO-3
	N				BU426	BU426A						70	SOT-93
	N				BU433							70	SOT-93
	N					BUX82	BUX83					60	TO-3
	N					BUV82	BUV83					70	SOT-93
	N								BUY89			80	TO-3
8	N								BUV89			125	SOT-93
	N					BUW12	BUW12A					125	SOT-93
	N					BUS12	BUS12A					125	TO-3
	N							BU508A				125	SOT-93
9	N					BUX47	BUX47A					125	TO-3
10	N					BUX80	BUX81					100	TO-3
12	N								BUX88			160	TO-3
15	N					BUW13	BUW13A					175	SOT-93
	N					BUS13	BUS13A					175	TO-3
	N					BUX48	BUX48A					175	TO-3
30	N					BUS14	BUS14A					250	TO-3
	N					BUX98	BUX98A					250	TO-3

* V_{CER}

GENERAL PURPOSE POWER TRANSISTORS

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		
1	N					BD135	BD137	BD139				8	TO-126
	P					BD136	BD138	BD140					
	N					BD825	BD827	BD829					TO-202
	P					BD826	BD828	BD830					
	N					BDW55	BDW57	BDW59					TO-126
	P					BDW56	BDW58	BDW60					
	N				BDT29		BDT29A	BDT29B	BDT29C			30	TO-220
	P				BDT30		BDT30A	BDT30B	BDT30C				
1,5	N					BD226	BD228	BD230				12,5	TO-126
	P					BD227	BD229	BD231					
	N					BD839	BD841	BD843	BD845	BD847	BD849	10	TO-202
	P					BD840	BD842	BD844	BD846	BD848	BD850		
2	N					BD233	BD235	BD237				25	TO-126
	P					BD234	BD236	BD238					
	N					BD813	BD815	BD817				12,5	TO-202
	P					BD814	BD816	BD818					
3	N					BD239	BD239A	BD239B	BD239C			30	TO-220
	P					BD240	BD240A	BD240B	BD240C				
	N					BD131						15	TO-126
	P					BD132							
	N	BD329											
	P	BD330											
	N					BD933	BD935	BD937	BD939	BD941		30	TO-220
	P					BD934	BD936	BD938	BD940	BD942			
	N				BDT31		BDT31A	BDT31B	BDT31C				
	P				BDT32		BDT32A	BDT32B	BDT32C				
4	N		BD433	BD435	BD437							36	TO-126
	P		BD434	BD436	BD438								

GENERAL PURPOSE POWER TRANSISTORS

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		
5	N					BD241	BD241A	BD241B	BD241C			40	TO-220
	P					BD240	BD240A	BD240B	BD240C				
	N						BDX35					15	TO-126
	N						BDX36						
	N		BD943	BD945		BD947	BD949	BD951	BD955	BD953		40	TO-220
	P		BD944	BD946		BD948	BD950	BD952	BD956	BD954			
6	N					BD243	BD243A	BD243B	BD243C			65	TO-220
	P					BD244	BD244A	BD244B	BD244C				
	N				BDT41		BDT41A	BDT41B	BDT41C			65	TO-220
	P				BDT42		BDT42A	BDT42B	BDT42C				
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				
	N						BDV91	BDV93	BDV95			100	SOT-93
	P						BDV92	BDV94	BDV96				

LOW-VOLTAGE SWITCHING TRANSISTORS

I_C A	pol.	collector-emitter voltage (open base) V_{CEO} (V)										P_{tot} W	case
							60	80	100				
10	N						BDY92	BDY91	BDY90			40	TO-3
12	N								BDY90A			40	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	

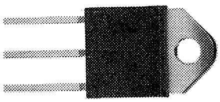
SCREW MOUNTING

envelope	direct mounting		insulated mounting			
	metal washer	mounting material	mica washer	insul. bush	metal washer	mounting material
TO-126 (SOT-32)	56326	M3				
up to 300 V			56387a	56387b	56326	M2,5
TO-220 (SOT-78)	56360a	M3				
up to 800 V			56359b	56359c	56360a	M3
up to 1000 V			56359b	56359d	56360a	M3
SOT-93	–	M4	56368a	56368b		M3
TO-3 (SOT-3)	–	M4				
up to 500 V			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.

SOT-82
(SOT-82)

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



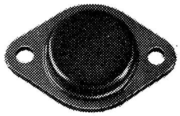
SOT-93
(SOT-93)

type number		P_{tot}	V_{CEO}
NPN	PNP	W	V
BU426		70	375
BU426A			400
BU433			375
BUV82			400
BUV83			450
BDV91	BDV92	100	60
BDV93	BDV94		80
BDV95	BDV96		100
BUW11			400
BUW11A			450
BDV65	BDV64	125	60
BDV65A	BDV64A		80
BDV65B	BDV64B		100
BDV65C	BDV64C		120
BUW12			400
BUW12A			450
BU508A			700
BUV89			800
BUW13		175	400
BUW13A			450
BDV67	BDV66	200	60
BDV67A	BDV66A		80
BDV67B	BDV66B		100
BDV67C	BDV66C		120

TO-126
(SOT-32)

type number		P_{tot}	V_{CEO}
NPN	PNP	W	V
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	8	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
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

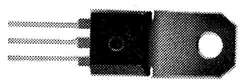
* V_{CER}



TO-3
(SOT-3)

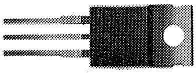
type number NPN	type number PNP	P_{tot} W	V_{CEO} V
BDY90		40	100
BDY90A			100
BDY91			80
BDY92			60
BU326		60	375
BU326A			400
BUX82		60	400
BUX83			450
BUY89		80	800
BUX46		85	400
BUX46A			450
BDX63	BDX62	90	60
BDX91	BDX92		60
BDX63A	BDX62A		80
BDX93	BDX94		80
BDX63B	BDX62B		100
BDX95	BDX96		100
BDX63C	BDX62C		120
BUS11		100	400
BUS11A			450
BUX80		100	400
BUX81			450
BDX65	BDX64	117	60
BDX65A	BDX64A		80
BDX65B	BDX64B		100
BDX65C	BDX64C		120
BUS12		125	400
BUS12A			450
BUX47			400
BUX47A			450
BDX67	BDX66	150	60
BDX67A	BDX66A		80
BDX67B	BDX66B		100
BDX67C	BDX66C		120
BUX88		160	800

type number NPN	type number PNP	P_{tot} W	V_{CEO} V
BUS13		175	400
BUS13A			450
BUX48			400
BUX48A			450
BDX69	BDX68	200	60
BDX69A	BDX68A		80
BDX69B	BDX68B		100
BDX69C	BDX68C		120
BUS14		250	400
BUS14A			450
BUX98			400
BUX98A			450



type number NPN	type number PNP	P_{tot} W	V_{CEO} V
BF869	BF870	5(1,6)	250
BF871	BF872		300*
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 (2)	45
BD815	BD816		60
BD817	BD818		80

* V_{CER}
( ) free air dissipation



TO-220
(SOT-78)

type number		P_{tot}	V_{CEO}
NPN	PNP	W	V
BD239	BD240	30	45
BD239A	BD240A		60
BD239B	BD240B		80
BD239C	BD240C		100
BD933	BD934	30	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
BD241	BD240	40	45
BD241A	BD241A		60
BD241B	BD241B		80
BD241C	BD241C		100
BD943	BD944	40	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		40	400
BUX85			450
BDT61	BDT60	50	60
BDT61A	BDT60A		80
BDT61B	BDT60B		100
BDT61C	BDT60C		120
BD201	BD202	60	45
BD203	BD204		60
BDX77	BDX78		80
BU807		60	150
BU806			200

type number		P_{tot}	V_{CEO}
NPN	PNP	W	V
BD645	BD646	62,5	60
BD647	BD648		80
BD649	BD650		100
BD651	BD652		120
BDT21	BDT20	62,5	130
BD243	BD244	65	45
BD243A	BD244A		60
BD243B	BD244B		80
BD243C	BD244C		100
BDT41	BDT42	65	40
BDT41A	BDT42A		60
BDT41B	BDT42B		80
BDT41C	BDT42C		100
PH3055T	PH2955T	75	60
BDT91	BDT92	90	60
BDT93	BDT94		80
BDT95	BDT96		100
BDT63	BDT62	90	60
BDT63A	BDT62A		80
BDT63B	BDT62B		100
BDT63C	BDT62C		120
BUT11		100	400
BUT11A			450
BDT65	BDT64	125	60
BDT65A	BDT64A		80
BDT65B	BDT64B		100
BDT65C	BDT64C		120

GENERAL

Transistor ratings
Rating systems
Letter symbols
SOAR curves

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} (IE = 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 $\frac{R_B}{R_E}$, $\leqslant y$ which are equivalent conditions under which the device may be cut-off.

V_{CEmax} (I_C = x 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).

This curve is divided into two areas:

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

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

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

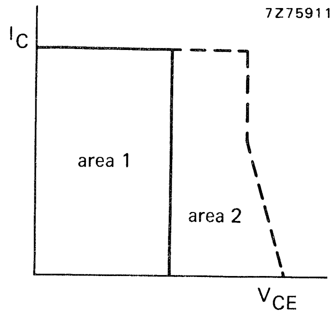


Fig. 1.

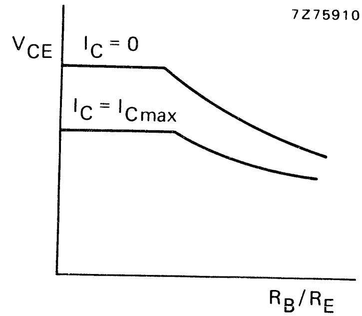


Fig. 2.

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

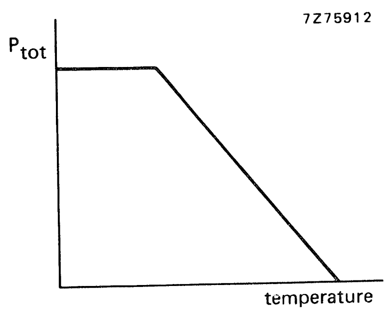


Fig. 3.

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 ($R_{th\ h}$) normally expressed in degrees kelvin per watt (K/W). For a mounting base rated device, the added effect of the contact resistance ($R_{th\ i}$) must be taken into account.

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

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:

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

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

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.

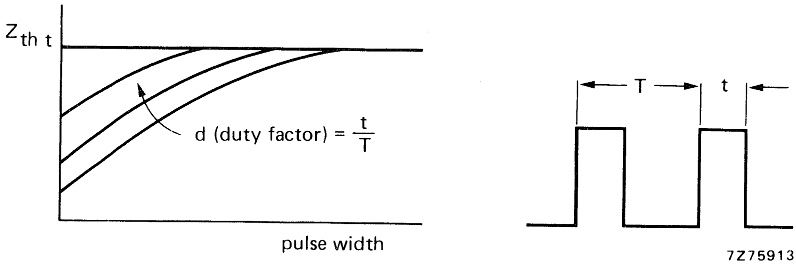


Fig. 4.

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

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

where $Z_{th\ t}$ and d are given in the above chart and $R_{th\ c\text{-}a}$ is the thermal resistance between case and ambient for case rated device. For mounting base rated device, it is equal to $R_{th\ h} + R_{th\ i}$ 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 $Z_{th\ t}$.

Temperature ratings

T_{jmax}	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_{jmax} (continous operation)	The maximum permissible continuous value.
T_{jmax} (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

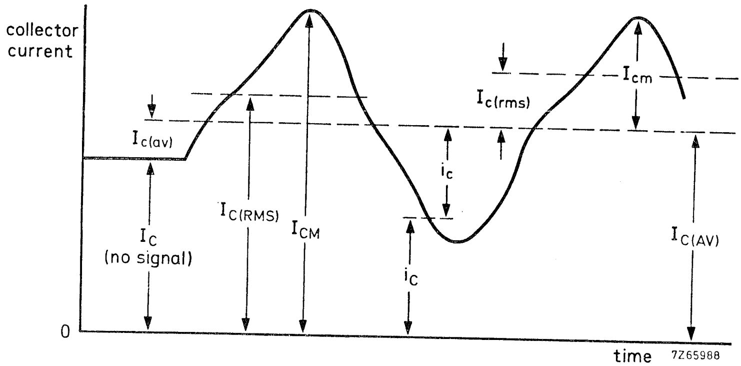
For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

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: Re (h_{ib}) etc. for the real part of h_{ib}
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 (usually 10 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 given in the data sheets. With it, maximum allowable power dissipation can be calculated for any mounting base temperature up to $T_{j\,max}$.

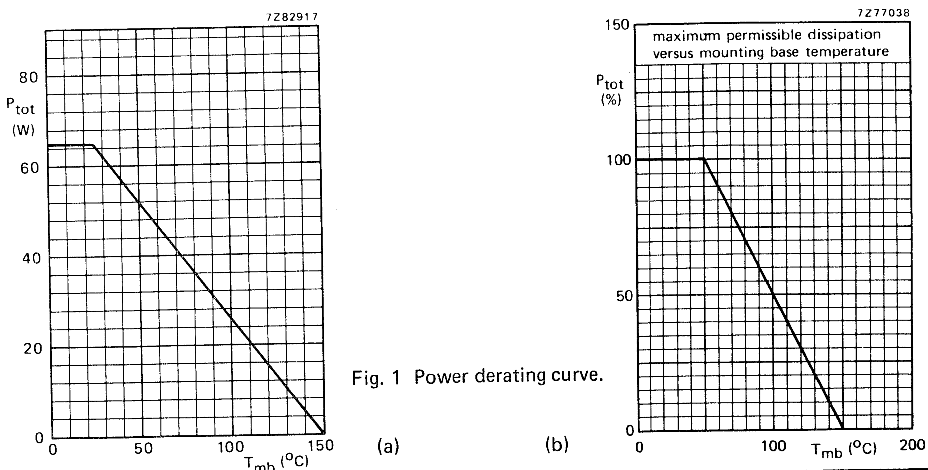


Fig. 1 Power derating curve.

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.

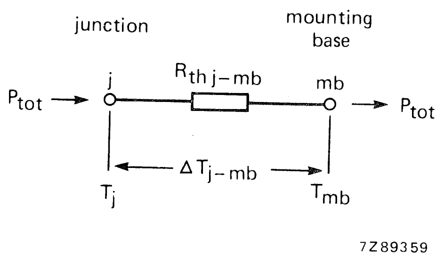


Fig. 2 Heat transport in a transistor with power dissipation constant with respect to time.

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

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

There are two limitations to P_{tot}
– When $T_{mb} \leqslant T_{mb\,spec}$

$$P_{tot\,max} = \frac{\Delta T_{j\text{-}mb\,max}}{R_{th\,j\text{-}mb}}.$$

– when $T_{mb} > T_{mb\,spec}$

$$P_{tot\,max} = \frac{\Delta T_{j\,max} - T_{mb}}{R_{th\,j\text{-}mb}}$$

$T_{mb\,spec}$ being the mounting base temperature at which $P_{tot\,max}$ is specified in the data sheets, and

$$\Delta T_{j\text{-}mb\,max} = T_{j\,max} - T_{mb\,spec}.$$

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

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

yields

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

where $P_{tot\,M}$ is the total pulsed power and $Z_{th\,j\text{-}mb}$ 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.

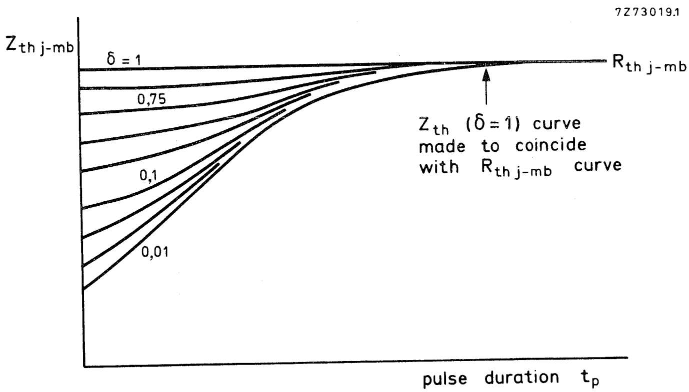


Fig. 3 A typical family of $Z_{th\,j\text{-}mb}$ curves for a power transistor.

Similar limitations apply as in the steady-state conditions:

(a) When $T_{mb} \leqslant T_{mb\,spec}$

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

(b) When $T_{mb} > T_{mb\,spec}$

$$P_{tot\,M\,max} = \frac{T_{j\,max} - T_{mb}}{Z_{th\,j\text{-}mb}}.$$

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

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

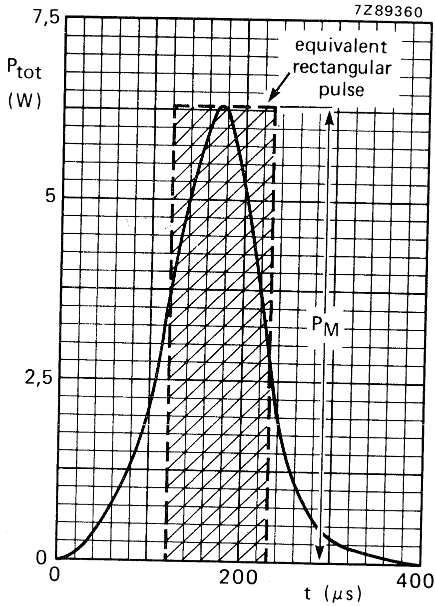


Fig. 4.

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 independent of mounting base temperature, which is related to the average junction temperature. Under reverse-bias conditions, when V_{CE} is greater than V_{CEOmax}, 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_{CEOmax}, 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.

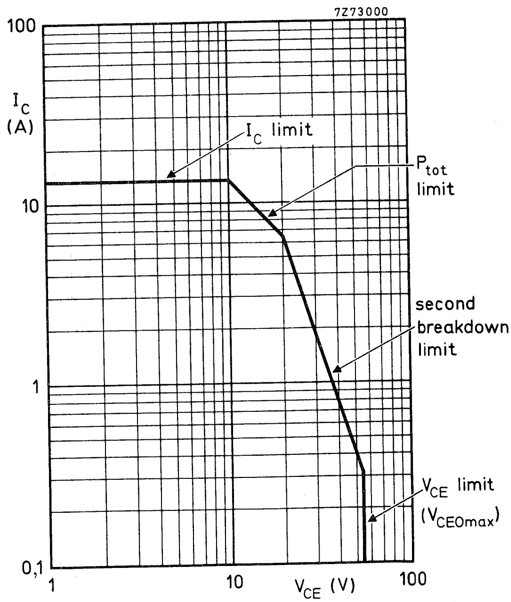


Fig. 5 A typical SOAR graph with boundaries named.

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 8.

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_{CEOmax} 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_{CEOmax} of 60 V.

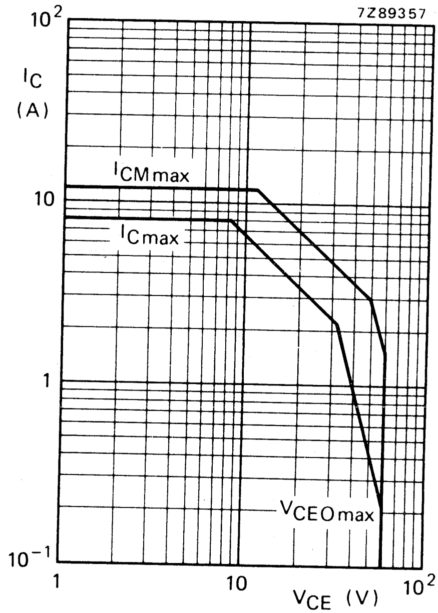


Fig. 6 Maximum collector current and collector-emitter voltage boundaries.

$P_{tot\,max}$

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

T_{mb} = 25 °C; δ = 0,01 and t_p = a range of values, say, 5 μs to 2 ms.

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

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

$T_{j\,max}$ is stated in the data sheets; $Z_{th\,j\text{-}mb}$ can be read from the curve, similar to Fig. 3, also given in the data sheets. Thus $P_{tot\,M\,max}$ 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:

$T_{j\,max}$ = 150 °C; $T_{mb\,spec}$ = 25 °C; t_p = 0,2 ms and δ = 0,1.

From Fig. 7, $Z_{th\,j\text{-}mb}$ = 0,42 K/W for the given values of t_p and δ.

$$P_{tot\,M\,max} = \frac{150 - 80}{0,42} = 166\text{ W}.$$

Thus from an arbitary point (say 8,3 A, 20 V) we can draw a line parallel to the $P_{tot\,max}$ line (see Fig. 6).

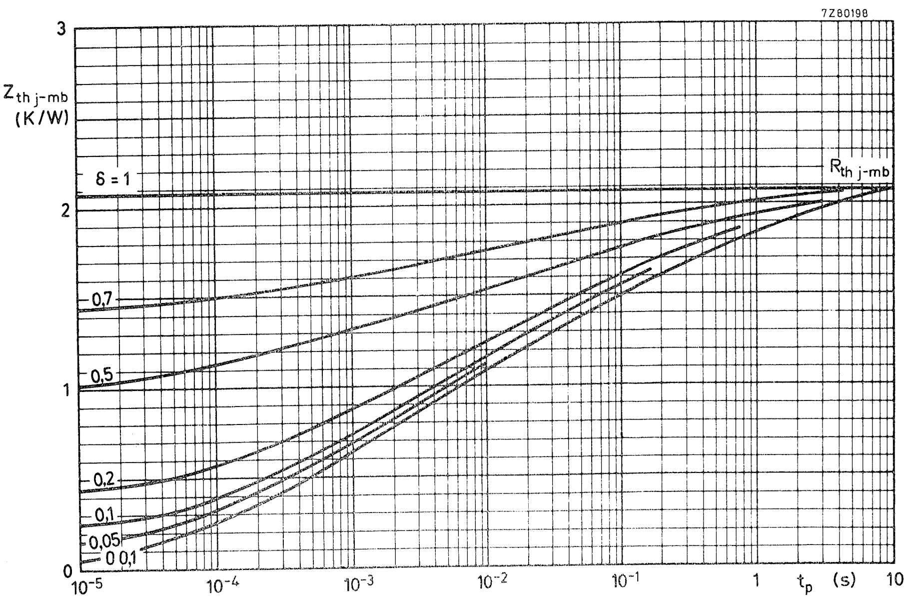


Fig. 7 Transient thermal impedance for example.

Second breakdown

The permissible extension to the second breakdown boundary is found with the aid of two multiplying factors:

M_V – the voltage multiplying factor
M_I – the current multiplying factors.*

Curves for these two factors are given in the data sheets as functions of pulse time with duty factor as parameter (see Fig. 8).

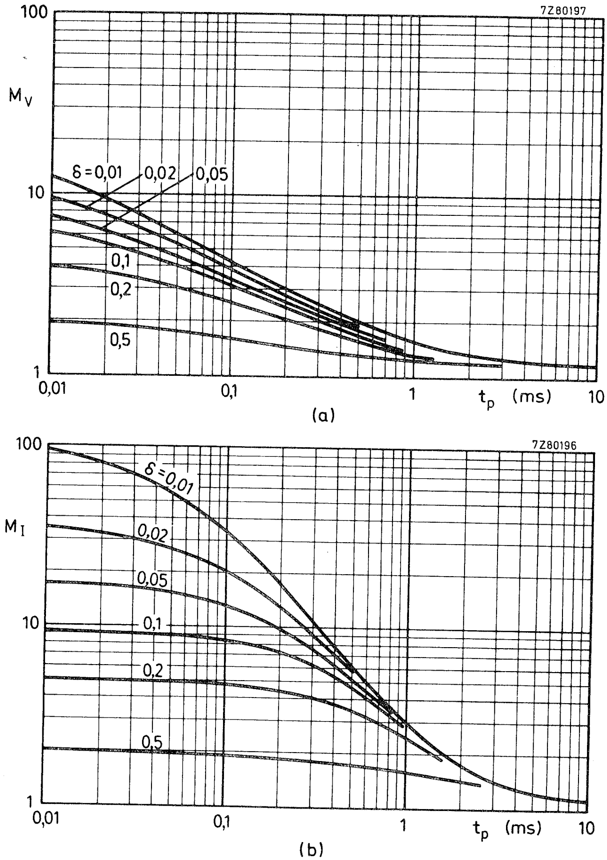


Fig. 8 Second breakdown multiplying factors as a function of pulse time, with duty factor as a parameter.

M_V is used to calculate the point on the V_{CEOmax} boundary at which voltage derating must commence as I_C increases. Similarly, M_I is used to calculate the point on the I_{CMmax} line at which current derating must commence as V_{CE} increases.

* Prior to 1973 M_V was known as $M_{SB(I)}$ and M_I as $M_{SB(V)}$.

Referring to Fig. 9, where B is the point on the V_{CEOmax} boundary at which voltage derating commences, B′ can be calculated by:

$$I_{C(B')} = I_{C(B)} \times M_I.$$

Similarly for I_C; although here A, the point on the I_C curve at which current derating commences, is first determined by extending the second breakdown boundary to where the two would intersect if $P_{tot\,max}$ did not intervene. A′ is then given by

$$V_{CA(S')} = V_{CE(A)} \times M_V.$$

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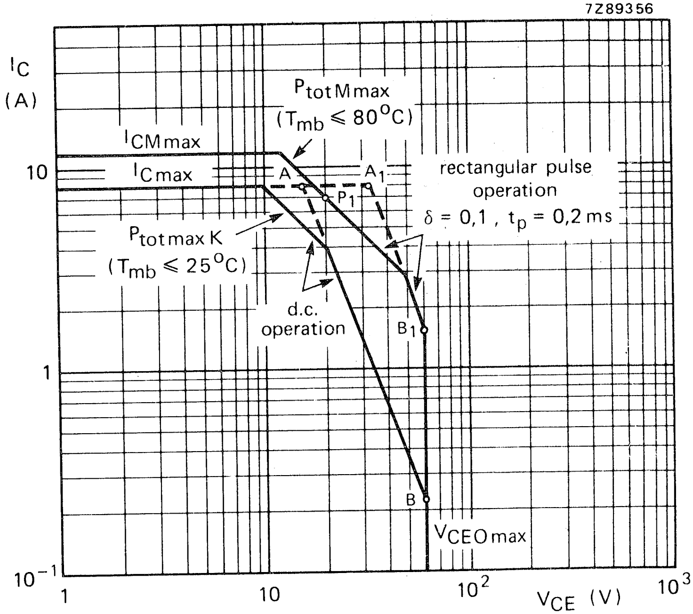


Fig. 9 Construction of the pulse operating area.

An example is worked in Fig. 9 for t_p = 0,2 ms and δ = 0,1.
From Fig. 8, M_V = 2,4 and M_I = 7,3:

$$I_{C(B')} = 0{,}22 \times 7{,}3 = 1{,}6 \text{ A}$$
$$V_{CE(A')} = 13 \times 2{,}4 = 31 \text{ V}.$$

These two points are then joined as in Fig. 9.

PULSE TRAINS AND COMPOSITE WAVEFORMS

Straightforward techniques exist for calculating the thermal and second breakdown effects of pulse trains and composite waveforms.

Thermal considerations

Consider a train of rectangular pulses as shown in Fig. 10. The junction will alternately heat and partly cool until a steady-state temperature is reached as shown in the lower part of Fig. 10. To approximate the final junction temperature only the effects of the first two or three pulses need be considered.

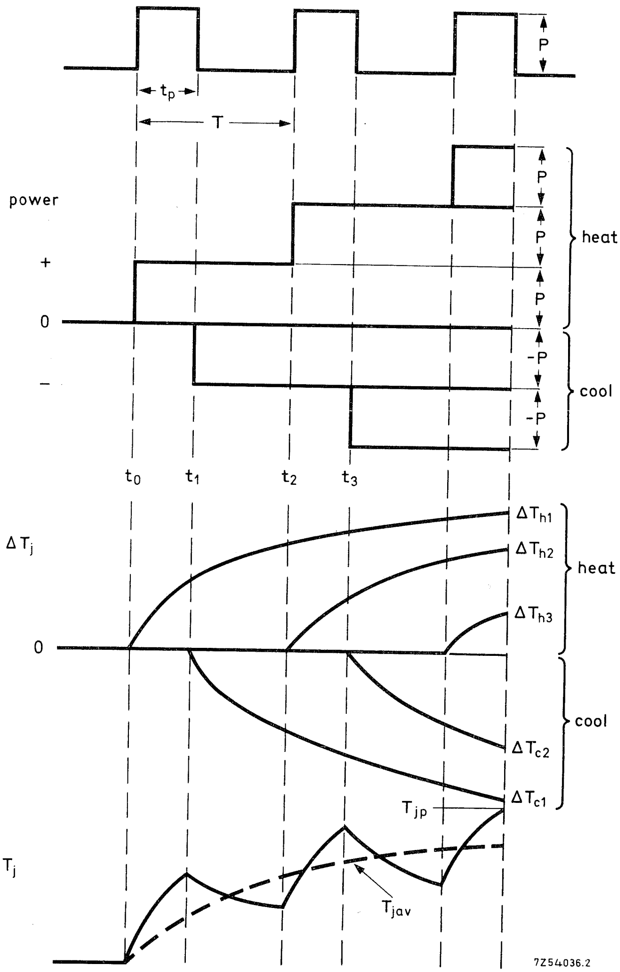


Fig. 10 The heating effect of three equidistant, equal-magnitude pulses. $T_{j\,av}$ is the average junction temperature. P = 100 W, t_p = 100 μs; T = 1 ms and δ = 0,1.

Referring to Fig. 10, where P = 100 W, t_p = 100 μs and δ = 0,1, the first pulse causes the junction to heat up; at the end of the pulse it starts to cool down until the second pulse recommences the heating cycle. We can replace the first pulse with a *continuous* heating pulse at t_0 and a *continuous* cooling pulse starting at t_1. Similarly for the second pulse, we can superimpose a continuous heating pulse starting at t_2 and a cooling pulse starting at t_3. Repeating this for successive pulses allows us to calculate T_j for any point in the pulse train. For instance, the cumulative change in junction temperature at the end of the third pulse is:

$$\Delta T_j = \Delta T_{h1} - \Delta T_{c1} + \Delta T_{h2} - \Delta T_{c2} + \Delta T_{h3},$$

where the subscripts h and c refer to heating and cooling respectively. With times taken from Fig. 10,

$T_{h1} = PZ_{th}(2{,}1\ ms)$
$T_{h2} = PZ_{th}(1{,}1\ ms)$
$T_{h3} = PZ_{th}(0{,}1\ ms)$

and

$T_{c1} = -PZ_{th}(2{,}0\ ms)$
$T_{c2} = -PZ_{th}(1{,}0\ ms)$

Taking values for Z_{th} from Fig. 11 we get

$$\Delta T_j = 100(0{,}58 - 0{,}56 + 0{,}51 - 0{,}51 + 0{,}32) = 34\ ^oC.$$

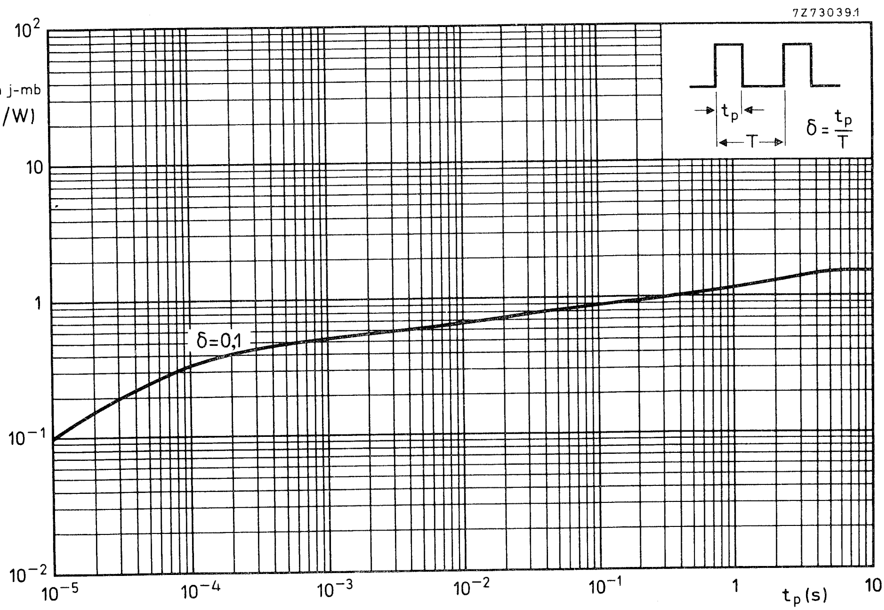


Fig. 11 Curve of $Z_{th\ j\text{-}mb} = f(t_p)$.

The same procedure can be used for long or continuous pulse trains, but calculating for a large number of pulses is very tedious. A sufficiently close approximation can be made by calculating for two pulses, assuming that the first is preceded by a continuous pulse of P_{av} as shown in Fig. 12. By this method

$$\Delta T_j = \Delta T_{h\,av} + \Delta T_{h1} - \Delta T_{c1} + \Delta T_{h2}.$$

The calculations are then made as before. To remove any doubt as to the closeness of the approximation the effect of a third pulse can be calculated. Composite waveforms can be treated similarly: divide the composite waveform into equivalent rectangular pulses and calculate the junction temperature accordingly.

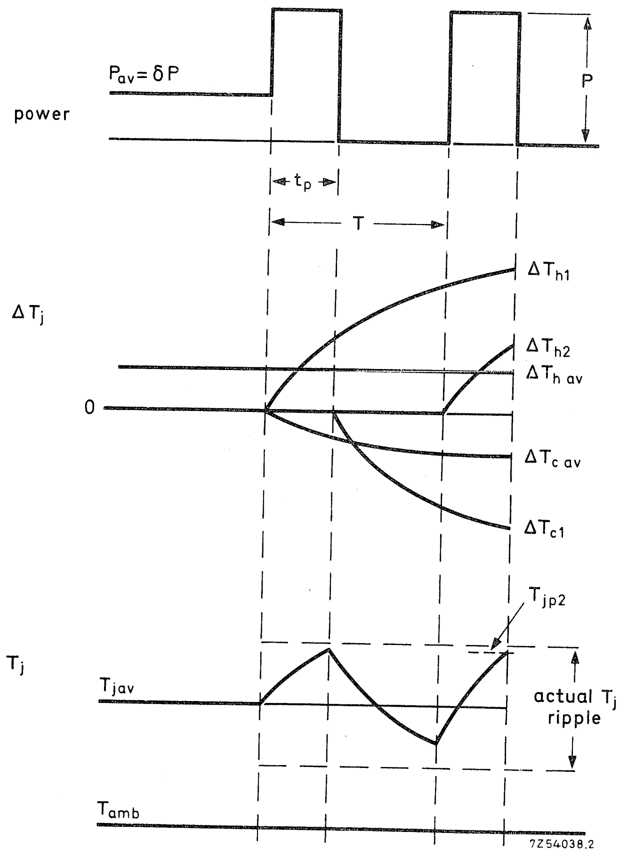


Fig. 12.

Figure 13 shows the current, voltage and power waveforms of the out put transistor in a television receiver vertical output stage. P_{tot} has been divided into four equivalent rectangular parts having the same peak values and energy content as the original waveform.

$$P_{tot\,av} = P_1\delta_1 + P_2\delta_2 + P_3\delta_3 + P_4\delta_4$$
$$= (16 \times 0{,}003) + (13 \times 0{,}11) +$$
$$+ (5{,}2 \times 0{,}66) + (40 \times 0{,}0007)$$
$$= 4{,}936 \text{ W}.$$

Assuming that the $R_{th\ j\text{-}mb}$ for the transistor is 2,5 K/W, the average rise in mounting base temperature will be about 12,5 °C.

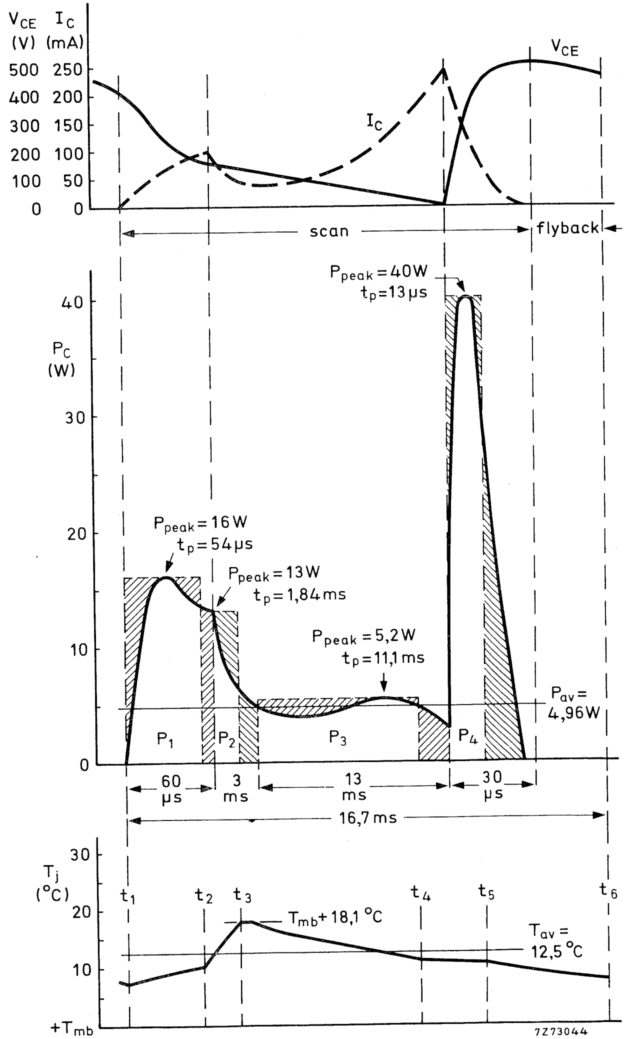


Fig. 13 Power waveforms showing their division into rectangular pulses and the junction temperature variations which they cause.

Using the same method as for pulse trains, peak temperatures at the end of each pulse can be calculated by

$$T_{j\text{-}mb(t1)} = P_{av}R_{th\ j\text{-}mb} - P_{av}Z_{th\ j\text{-}mb(16,1\ ms)} + P_1Z_{th(16,1\ ms)}.$$

For the temperature at the end of the second pulse (t_2) two further terms are added:

$$-P_1Z_{th(16,04\ ms)} + P_2Z_{th(16,04\ ms)}.$$

For t_3 yet another two terms:

$$-P_3Z_{th(13,02\ ms)} + P_4Z_{th(13,03\ ms)}.$$

For each successive pulse a negative term (end of the previous pulse) and a positive term (start of the succeeding pulse) are added. Calculated temperatures are shown in Table 1: note that the highest temperature is reached at the end of pulse 2 (t_3). Even assuming a T_{mb} of 100 °C, T_j will remain within the $T_{j\ max}$ of 150 °C specified for this transistor.

TABLE 1 Calculated temperatures for the power waveform of Fig. 13.

time	t_1	t_2	t_3	t_4	t_5	$t_6(t_s)$	
$\Delta T_{j\text{-}mb}$	8,54	11,34	18,1	12,76	12,3	8,54	°C

EXAMPLE OF A SOAR CALCULATION

To illustrate the foregoing we will take the example of a BU426A transistor operating in a 200 W switched-mode power supply (SMPS).

Waveforms of collector current, collector-emitter voltage and power dissipation are shown in Figs 14, 15 and 16. These are translated into an equivalent rectangular pulse train in Fig. 17. This will enable us to calculate peak junction temperature at any instant.

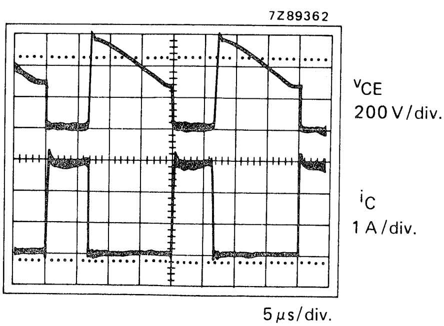


Fig. 14 Collector-current and collector-emitter voltage waveforms of a BU426A transistor in a 200 W SMPS.

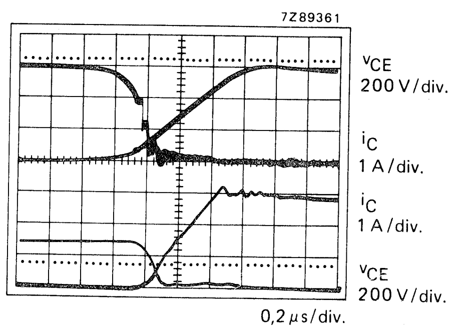


Fig. 15 Waveforms during turn-on and turn-off (lower part).

The duration of this equivalent pulse train is then given by

$$t_p' = \frac{P_{tot\,av} \times T}{P_M'} \text{ and } \delta' = \frac{t_p'}{T}.$$

First, from Fig. 17, heating and cooling pulses are plotted as in Fig. 18. Parameters are then tabulated as shown:

$P_{turn\text{-}on}$	= 66 W		P_{sat}	= 10 W		$P_{turn\text{-}off}$	= 56 W
$t_{p\,on}$	= 0,8 μs		$t_{p\,sat}$	= 2,2 μs		$t_{p\,off}$	= 0,6 μs
δ_{on}	= 0,04		δ_{sat}	= 0,11		δ_{off}	= 0,03

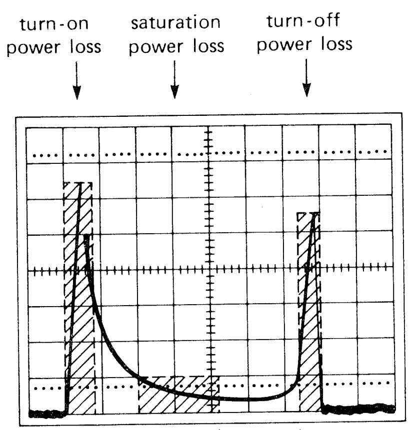


Fig. 16 Power loss and resultant rectangular power pulses.

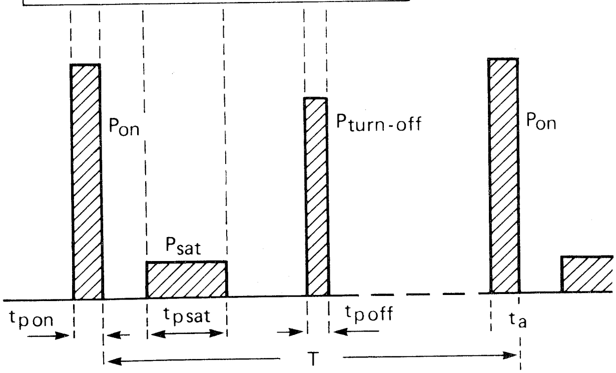


Fig. 17.

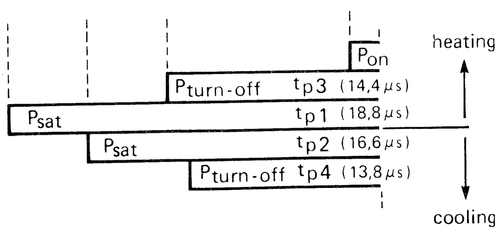


Fig. 18.

From Fig. 17 we can determine δ_p and t_p for each condition and from the BU426 data sheets the relevant Z_{th}.

	p1	p2	p3	p4	p5	unit
t	18,8	16,6	14,4	13,8	0,8	μs
δ	0,94	0,83	0,72	0,7	0,04	
Z_{th}	1,05	0,95	0,85	0,8	0,06	K/W

From

$$\Delta T_j = \Delta T_{h1} - \Delta T_{c1} + \Delta T_{h2} - \Delta T_{c2} + \Delta T_{h3}$$

$$\Delta T_{j\text{-}mb(ta)} = (P_{sat} \times Z_{th(tp1)}) - (P_{sat} \times Z_{th(tp2)}) +$$
$$+ (P_{turn\text{-}off} \times Z_{th(tp3)}) - (P_{turn\text{-}off} \times Z_{th(tp4)}) + (P_{on} \times Z_{th(tp\ on)})$$

$$\Delta T_{j\text{-}mb(ta)} = 10(1{,}05 - 0{,}95) + 56(0{,}83 - 0{,}8) + 66(0{,}06) = 7{,}76\ K.$$

Thus, at time t_a the peak junction temperature is 7,76 K higher than the average mounting base temperature. The $\Delta T_{j\text{-}mb}$ arising from the other power pulses can be calculated in the same way.

Average mounting base temperature depends on the size of the heatsink, ambient temperature (T_a) and average dissipation.

From

$$P_{tot\ av} = P_1\delta_1 + P_2\delta_2 + P_3\delta_3 + P_4\delta_4.$$

$$P_{tot\ av} = \delta_{on} \times P_{on} + \delta_{sat} \times P_{sat} + \delta_{turn\text{-}off} \times P_{off}$$

$$= 0{,}04 \times 66 + 0{,}11 \times 10 + 0{,}03 \times 56 = 5{,}4\ W.$$

Assuming a maximum mounting base temperature of 100 °C and an ambient temperature of 60 °C the thermal resistance of the heatsink required will be

$$R_{th\ mb\text{-}a} = \frac{T_{mb} - T_a}{P_{tot\ av}} = \frac{100 - 60}{5{,}4} = 7{,}4\ K/W.$$

If this is the case, the peak junction temperature at the end of the turn-on power pulse will be 107,76 °C, which is well within the maximum allowable junction temperature of 150 °C.

The pulse SOAR can be calculated using M_I, M_V and Z_{th} factors as described earlier. The turn-on, saturation and turn-off power pulses should be combined into a single pulse of amplitude P′ equal to the highest amplitude power pulse (here, P_{on}) and duration t_p'.

$$P_{tot\ av} = P' = 66\ W.$$

$$\delta' = \frac{5{,}4}{66} = 0{,}082.$$

$$t_p' + \delta' T = 1{,}64\ \mu s.$$

From the BU426A data, for this power pulse $Z_{th\ j\text{-}mb} = 0{,}10$ K/W; $M_I \approx 12$; $M_V \approx 7{,}5$; $V_{CE(A')} = 7{,}5 \times 12 = 90$ V; $I_{C(B')} = 12 \times 40 = 480$ mA.

$$P_{tot\,max} = \frac{T_j - T_{mb}}{Z_{th\,j\text{-}mb}} = \frac{150 - 100}{0,1} = 500\text{ W.}$$

The relevant pulse SOAR is shown in Fig. 19, in which the operating point for the full cycle has also been plotted. It can be seen that it remains well within the SOAR.

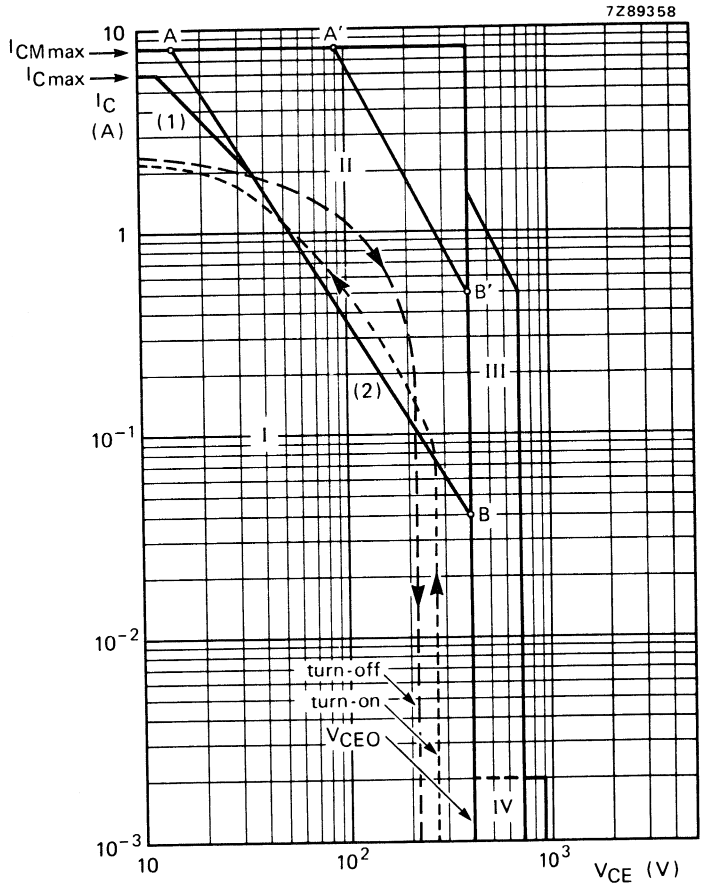


Fig. 19 Safe Operating ARea BU426A at $T_{mb} \leqslant 73$ °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

III Area of permissible operation during turn-on in single-transistor converters, provided $R_{BE} \leqslant 100\ \Omega$ and $t_p \leqslant 0,6\ \mu s$.

IV Repetitive pulse operation in this region is permissible, provided $V_{BE} \leqslant 0$ and $t_p \leqslant 2$ ms.

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

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

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

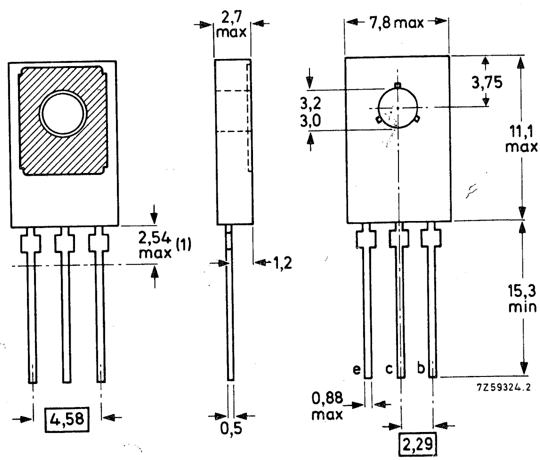
Collector-base voltage (open emitter)	V_{CBO}	max.	70	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	V
Collector current (peak value)	I_{CM}	max.	6	A
Total power dissipation up to T_{mb} = 60 °C	P_{tot}	max.	15	W
Junction temperature	T_j	max.	150	°C
D.C. current gain I_C = 0,5 A; V_{CE} = 12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

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 °C	P_{tot}	max.	15	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	6	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = 50$ V	I_{CBO}	<	5 μA
$I_E = 0$; $V_{CB} = 50$ V; $T_j = 150$ °C	I_{CBO}	<	500 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	5 μA
Saturation voltages			
$I_C = 0{,}5$ A; $I_B = 50$ mA	V_{CEsat}	<	0,3 V
	V_{BEsat}	<	1,2 V
$I_C = 2$ A; $I_B = 200$ mA	V_{CEsat}	<	0,7 V
	V_{BEsat}	<	1,5 V
D.C. current gain			
$I_C = 0{,}5$ A; $V_{CE} = 12$ V	h_{FE}	>	40
$I_C = 2$ A; $V_{CE} = 1$ V	h_{FE}	>	20
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	60 pF
Transition frequency at f = 35 MHz			
$I_C = 0{,}25$ A; $V_{CE} = 5$ V; $T_{amb} = 25$ °C	f_T	>	60 MHz
D.C. current gain ratio of the complementary pairs			
$I_C = 0{,}5$ A; $V_{CE} = 12$ V	h_{FE1}/h_{FE2}	<	1,2

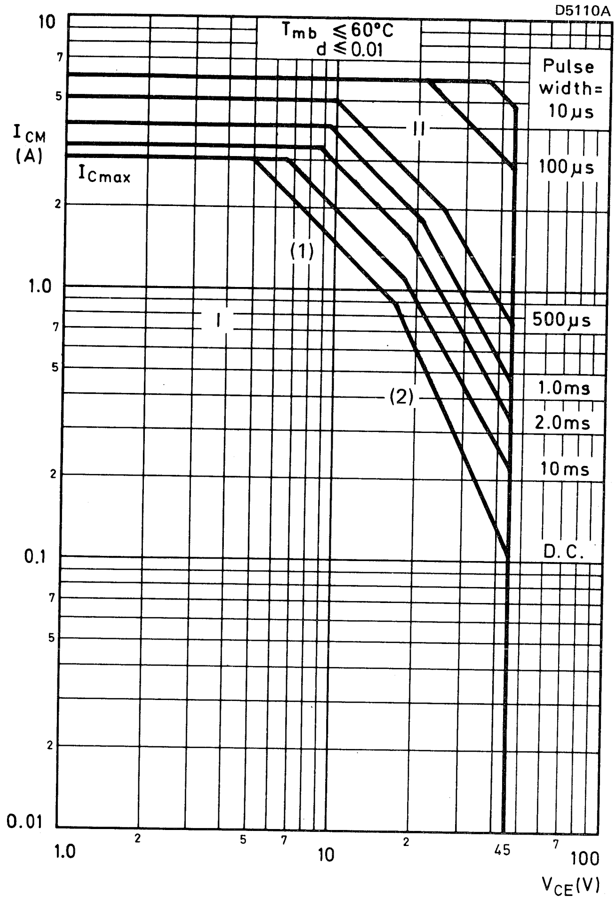


Fig. 2 Safe Operating ARea with the transistor forward biased.

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).

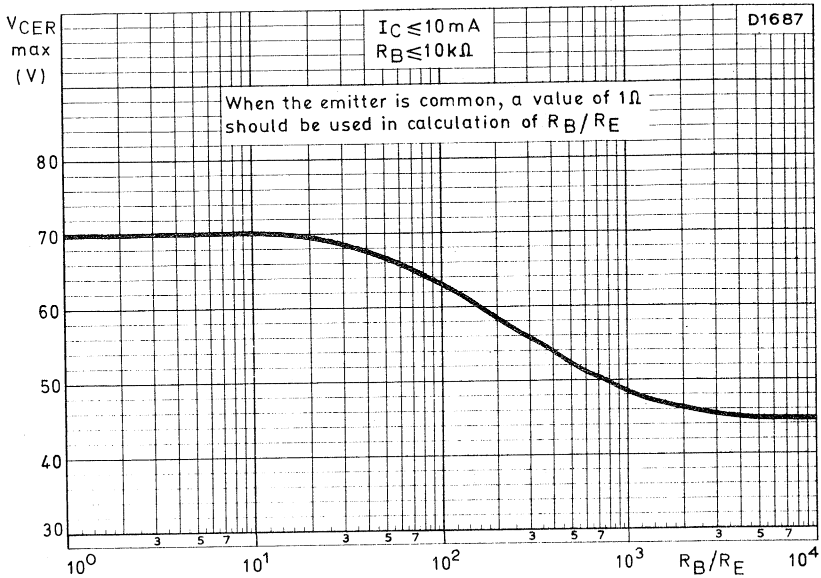


Fig. 3 Maximum allowable collector-emitter voltage as a function of base-emitter resistance.

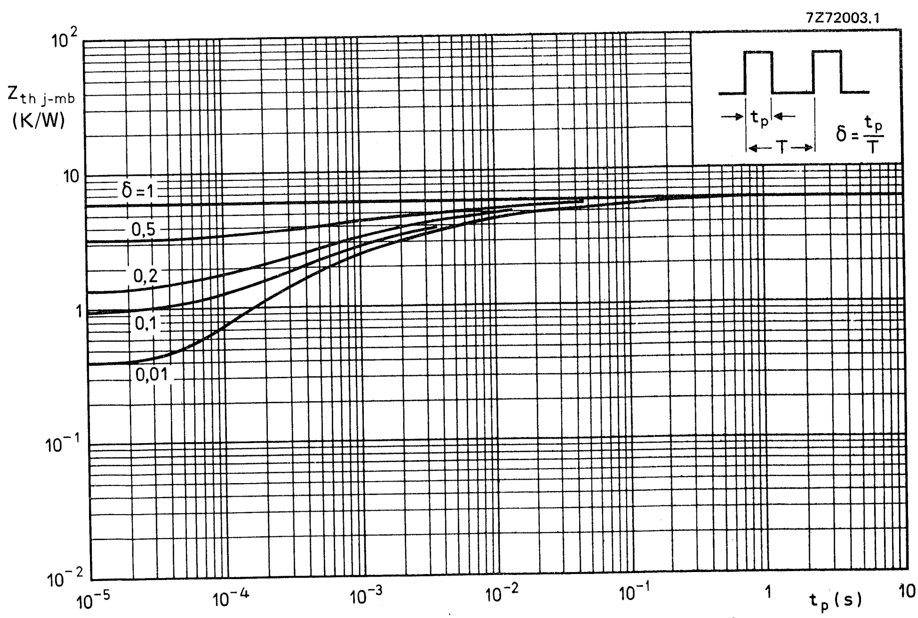


Fig. 4 Pulse power rating chart.

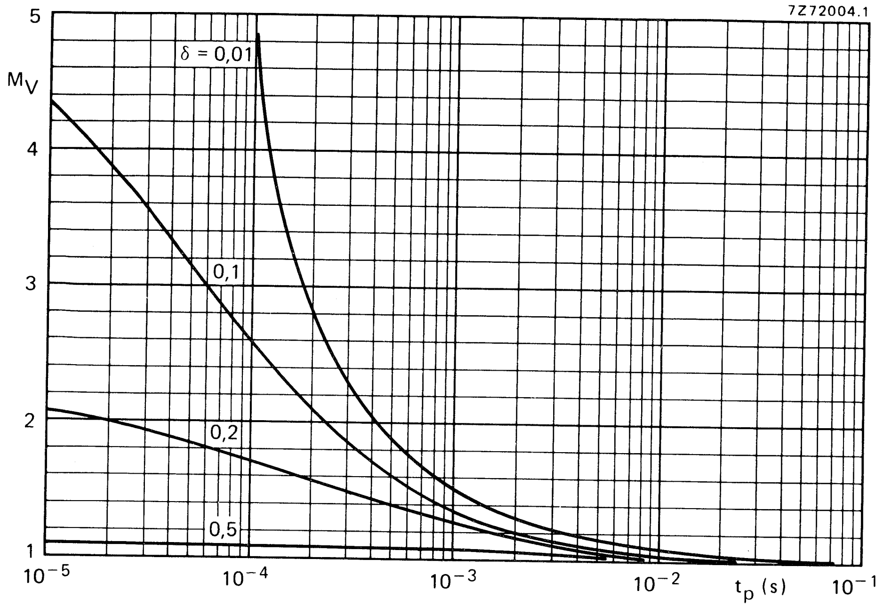


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

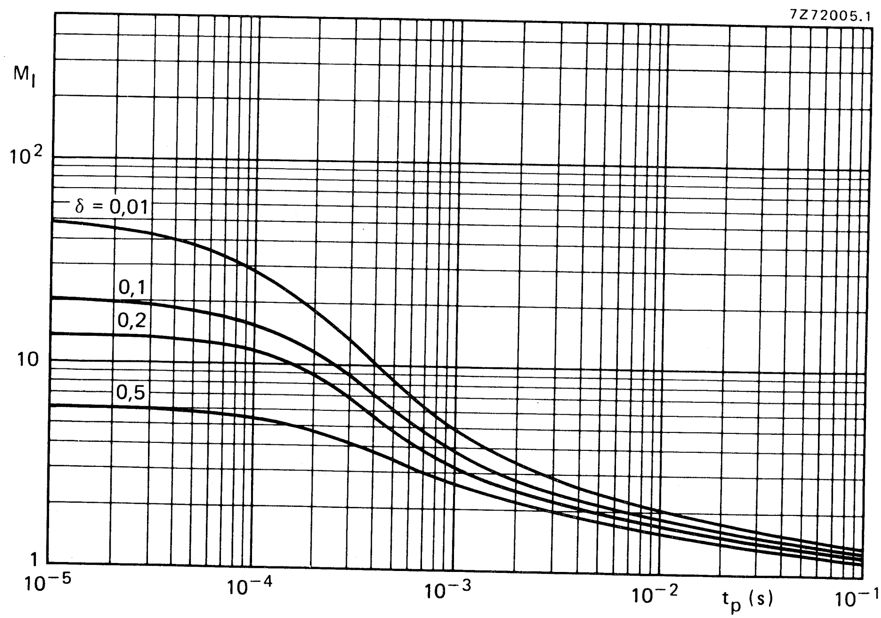


Fig. 6 S.B. current multiplying factor at the V_{CEOmax} level.

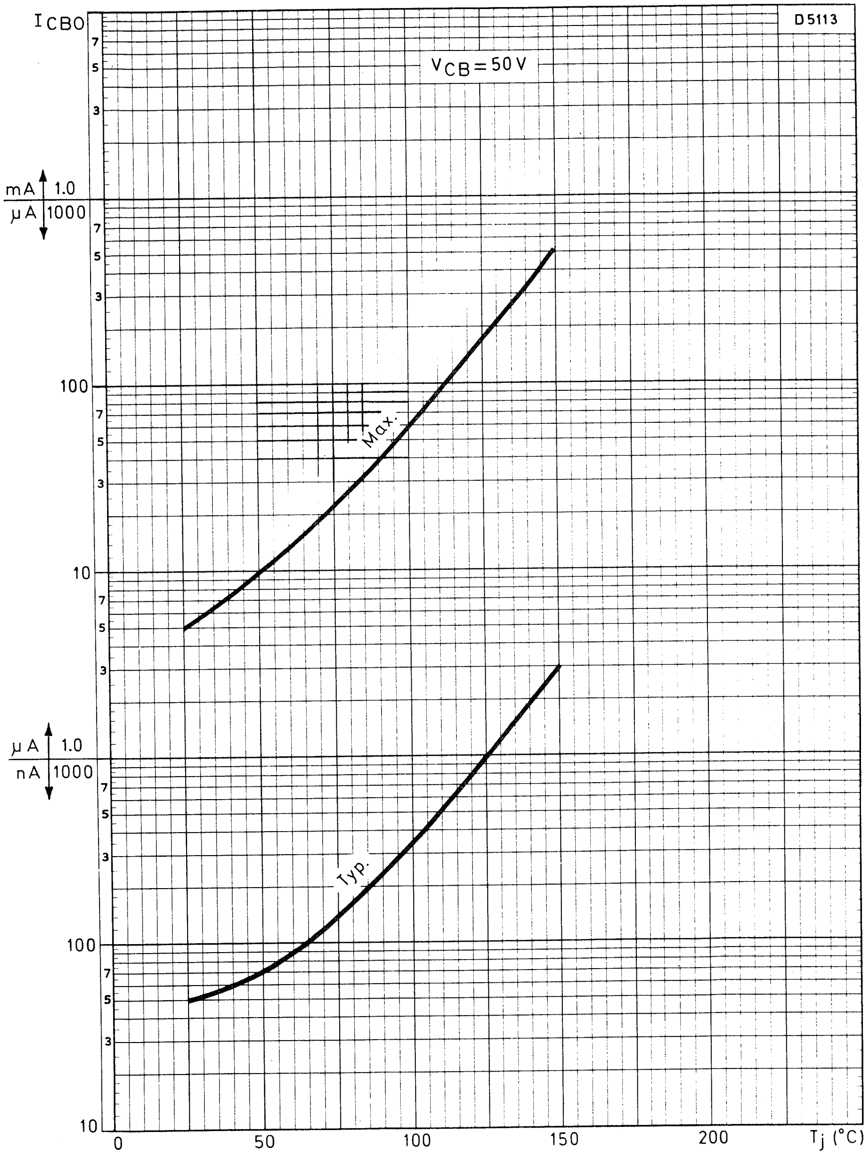


Fig. 7 Collector-base current (open emitter) as a function of the junction temperature.

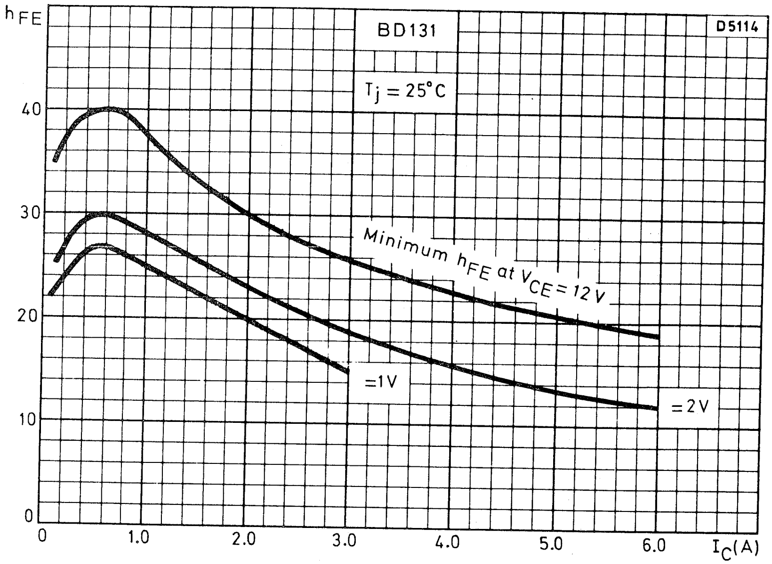

hFE
BD131
D5114
Tj = 25°C
40
30
20
10
0
Minimum hFE at VCE = 12 V
=1V
=2V
0
1.0
2.0
3.0
4.0
5.0
6.0
IC(A)

Fig. 8.

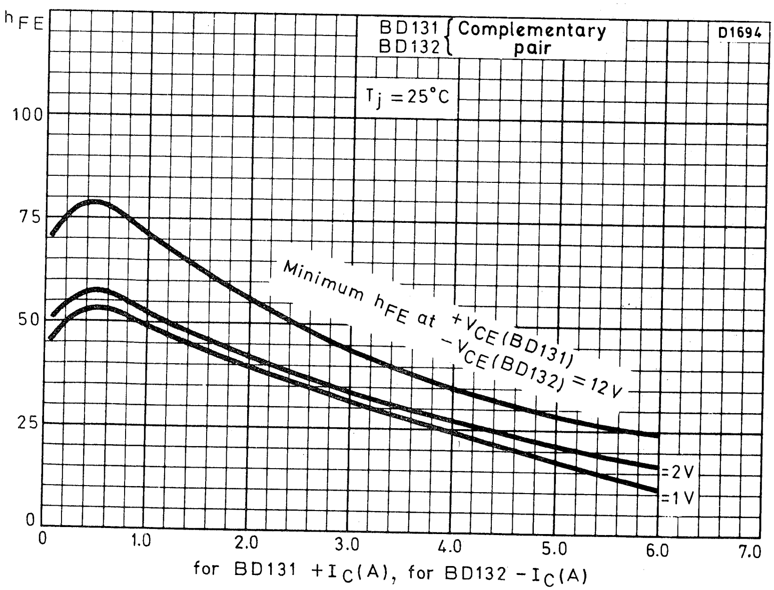

hFE
BD131
BD132
Complementary pair
D1694
Tj = 25°C
100
75
50
25
0
Minimum hFE at +VCE(BD131) −VCE(BD132) = 12 V
=2V
=1V
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
for BD131 +IC(A), for BD132 −IC(A)

Fig. 9.

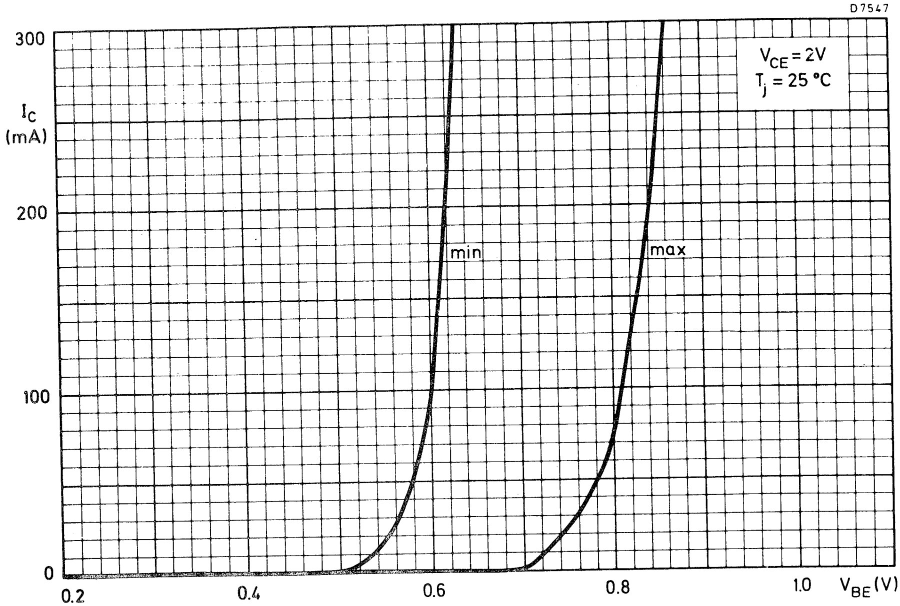

D7547
V_{CE} = 2V
T_j = 25 °C
I_C
(mA)
300
200
100
0
min
max
0.2
0.4
0.6
0.8
1.0
V_{BE}(V)

Fig. 10.

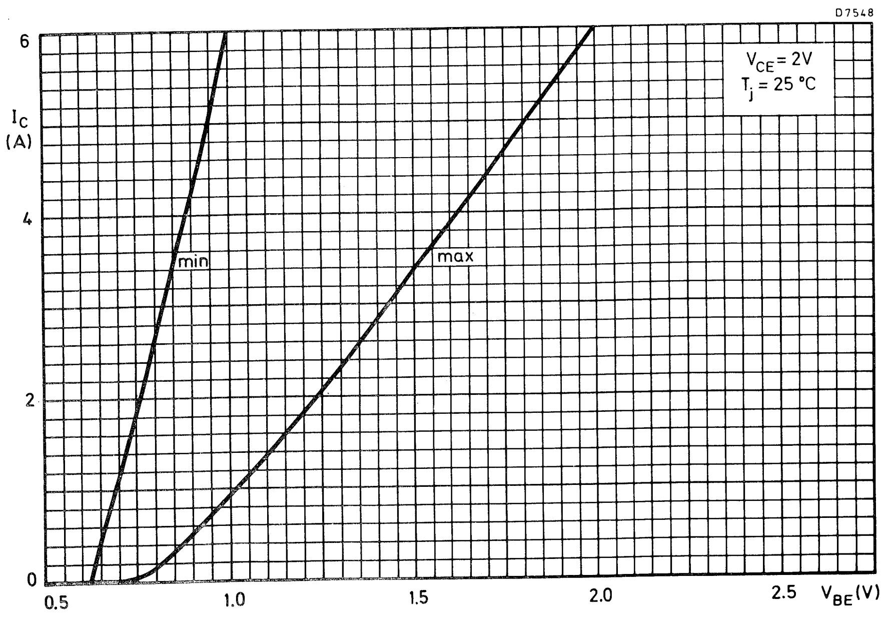

D7548
V_{CE} = 2V
T_j = 25 °C
I_C
(A)
6
4
2
0
min
max
0.5
1.0
1.5
2.0
2.5
V_{BE}(V)

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

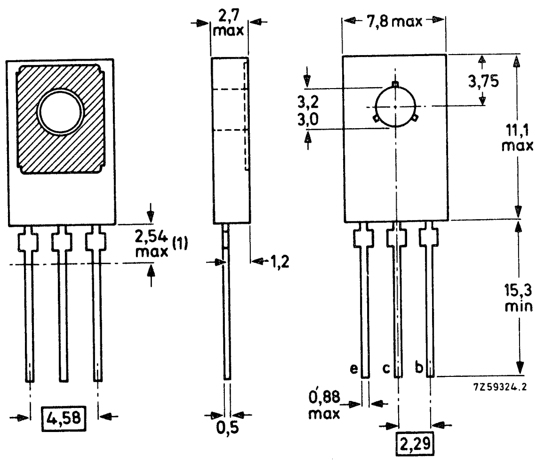
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	V
Collector current (peak value)	$-I_{CM}$	max.	6	A
Total power dissipation up to T_{mb} = 60 °C	P_{tot}	max.	15	W
Junction temperature	T_j	max.	150	°C
D.C. current gain $-I_C$ = 0,5 A;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

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 °C	P_{tot}	max.	15 W
Storage temperature	T_{stg}		−65 to + 150 °C
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	6 K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0; -V_{CB} = 40$ V	$-I_{CBO}$	<	5 μA
$I_E = 0; -V_{CB} = 40$ V; $T_j = 150$ °C	$-I_{CBO}$	<	500 μA
Emitter cut-off current			
$I_C = 0; -V_{EB} = 3$ V	$-I_{EBO}$	<	5 μA
Saturation voltages			
$-I_C = 0,5$ A; $-I_B = 50$ mA	$-V_{CEsat}$	<	0,3 V
	$-V_{BEsat}$	<	1,2 V
$-I_C = 2$ A; $-I_B = 200$ mA	$-V_{CEsat}$	<	0,7 V
	$-V_{BEsat}$	<	1,5 V
D.C. current gain			
$-I_C = 0,5$ A; $-V_{CE} = 12$ V	h_{FE}	>	40
$-I_C = 2$ A; $-V_{CE} = 1$ V	h_{FE}	>	20
Transition frequency at f = 35 MHz			
$-I_C = 0,25$ A; $-V_{CE} = 5$ V; $T_{amb} = 25$ °C	f_T	>	60 MHz
D.C. current gain ratio of the complementary pairs			
$-I_C = 500$ mA; $-V_{CE} = 12$ V	h_{FE1}/h_{FE2}	<	1,2

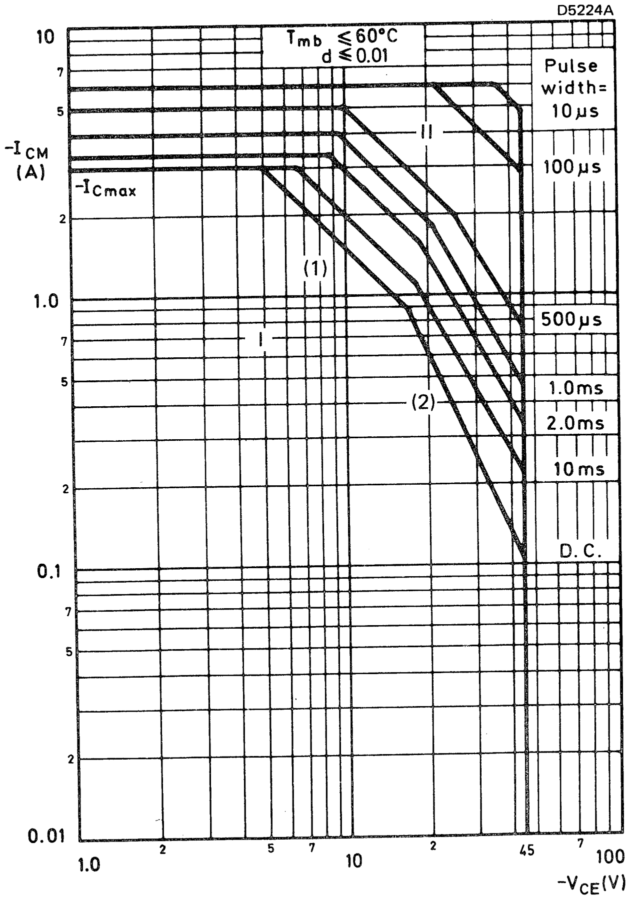


Fig. 2 Safe Operating ARea with the transistor forward biased.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

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

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

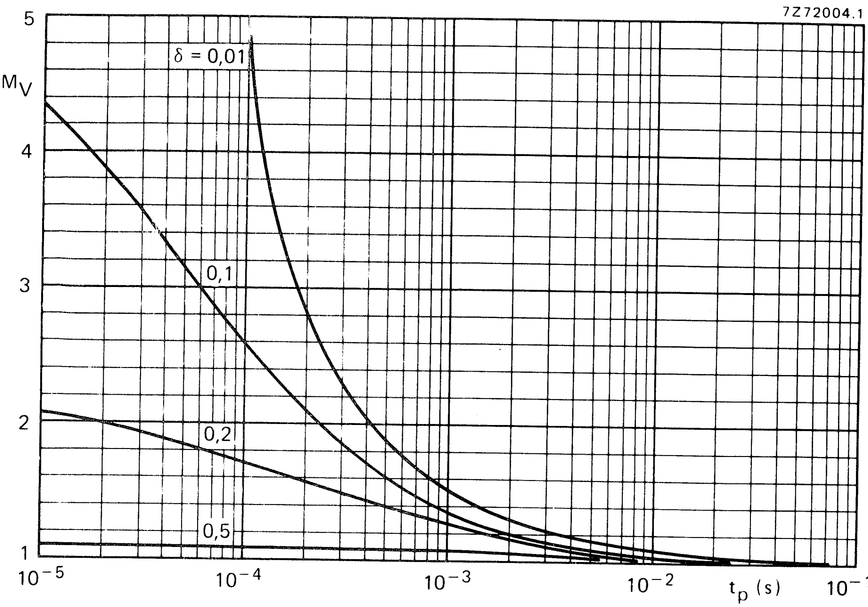


Fig. 3 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

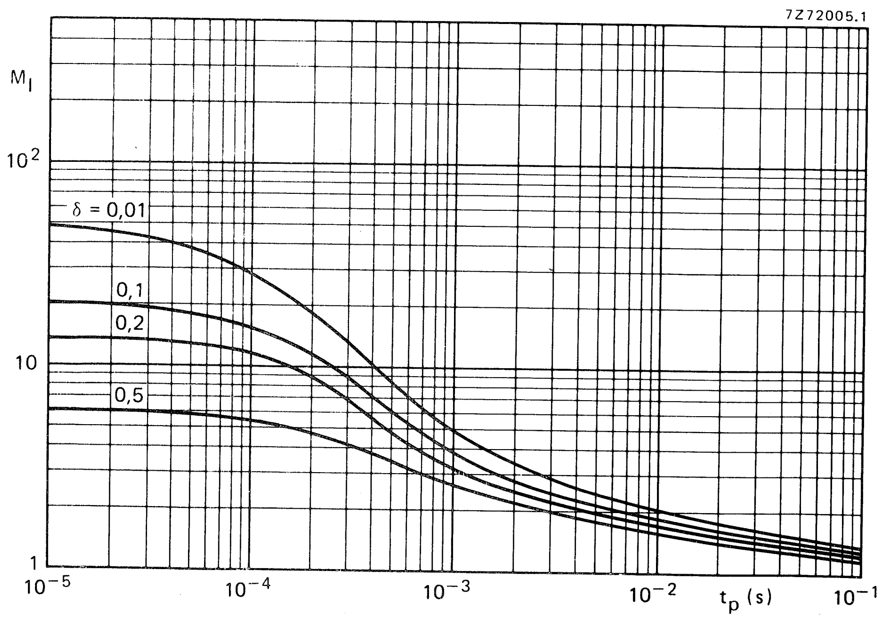


Fig. 4 S.B. current multiplying factor at the $-V_{CEOmax}$ level.

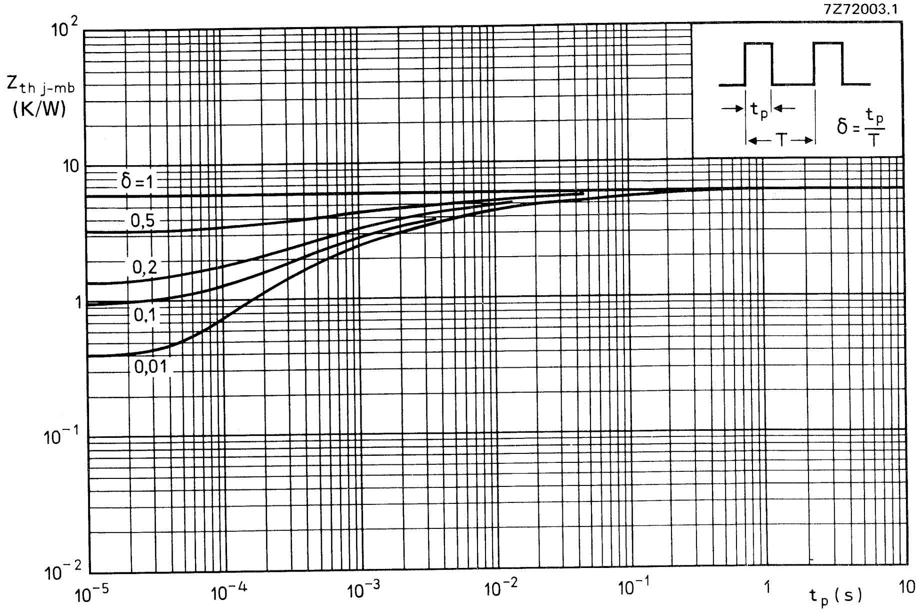


Fig. 5 Pulse power rating chart.

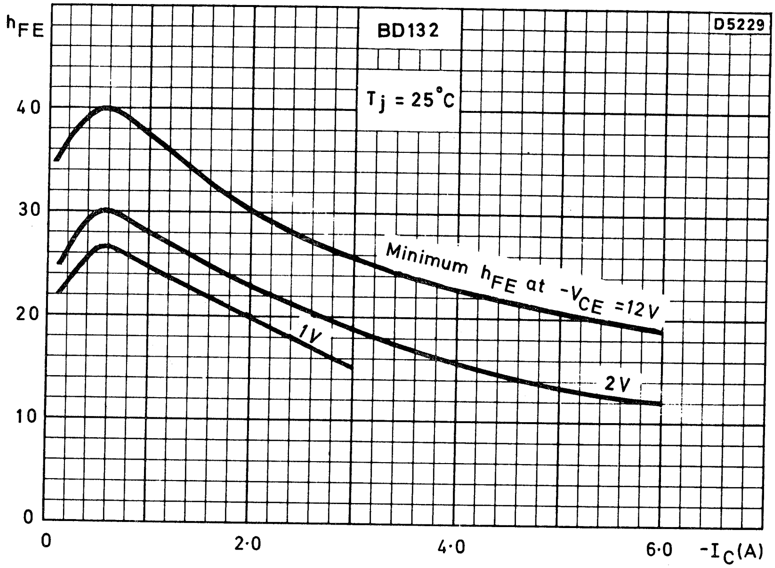


Fig. 6 D.C. current gain.

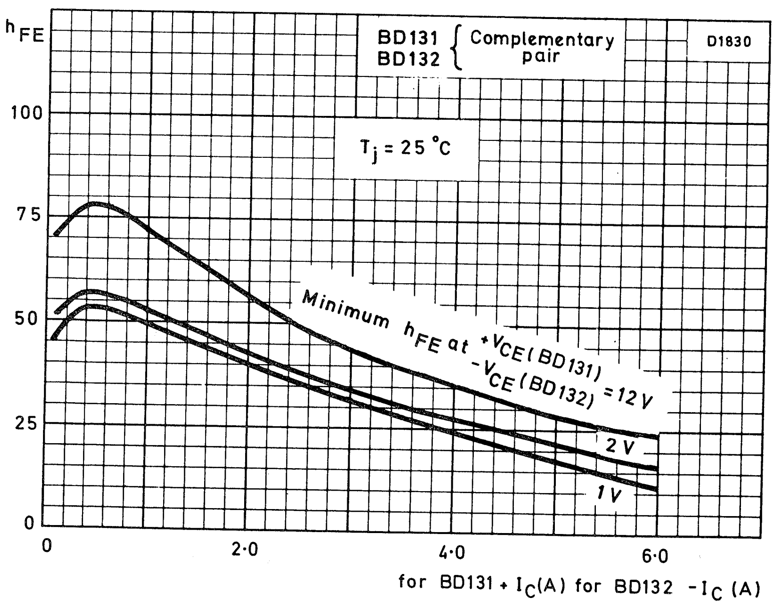


Fig. 7 D.C. current gain ratio.

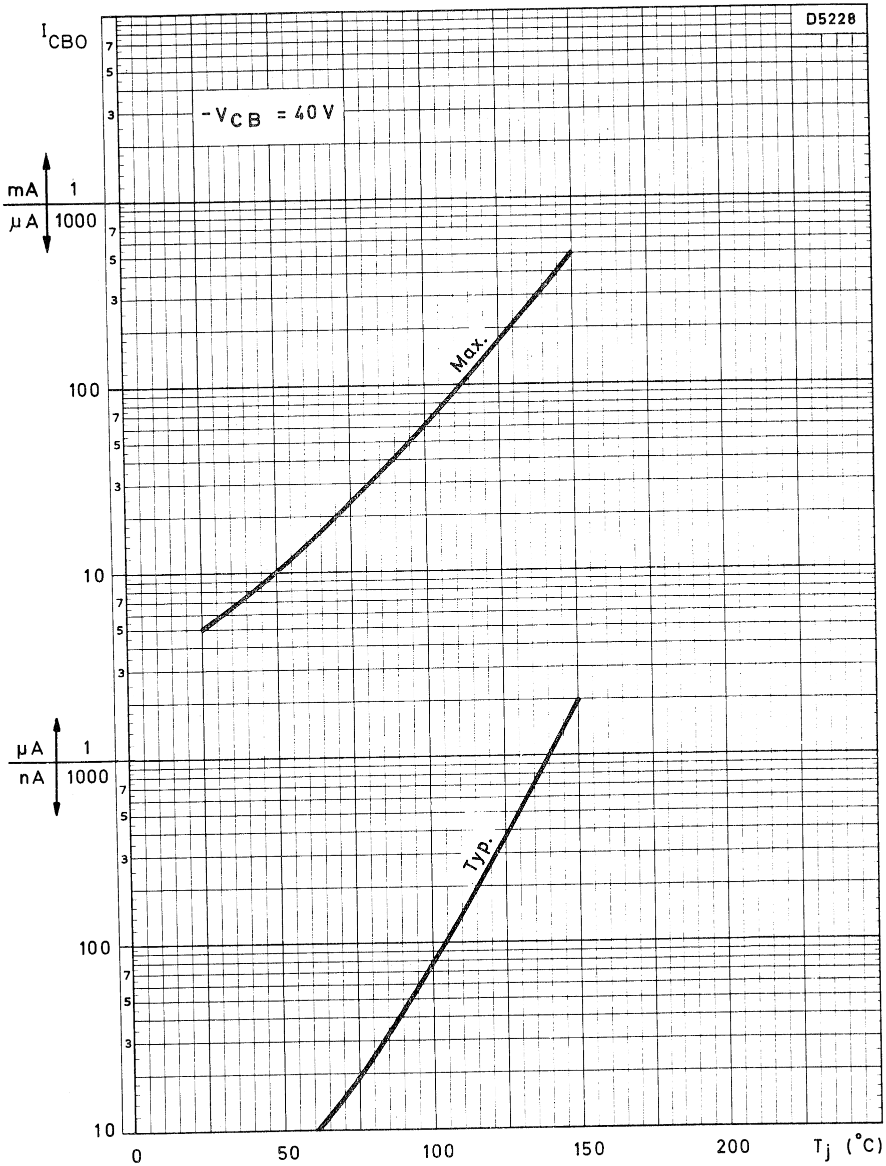


Fig. 8 Collector-base current (open emitter) as a function of the junction temperature.

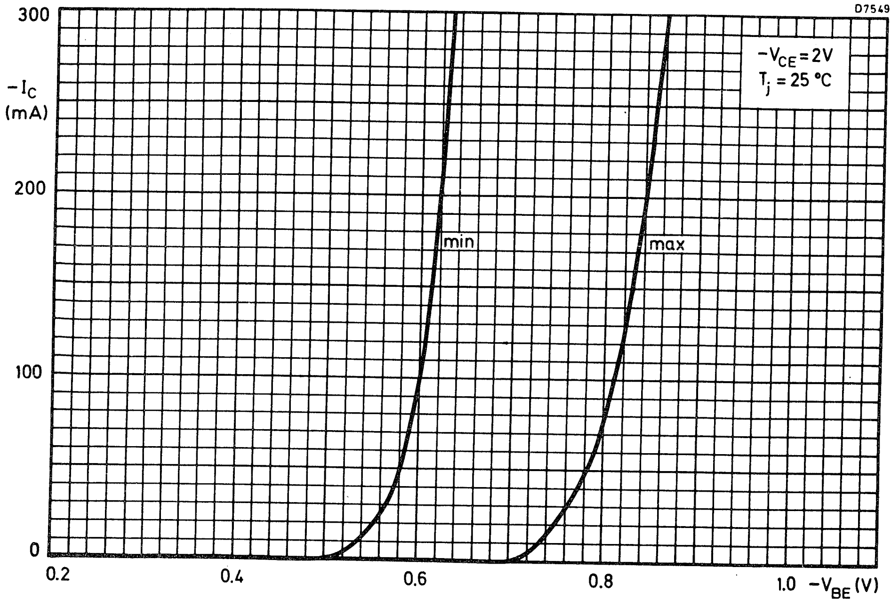

D7549
300
200
100
0
$-I_C$
(mA)
$-V_{CE} = 2V$
$T_j = 25\ °C$
min
max
0.2
0.4
0.6
0.8
1.0
$-V_{BE}$ (V)

Fig. 9.

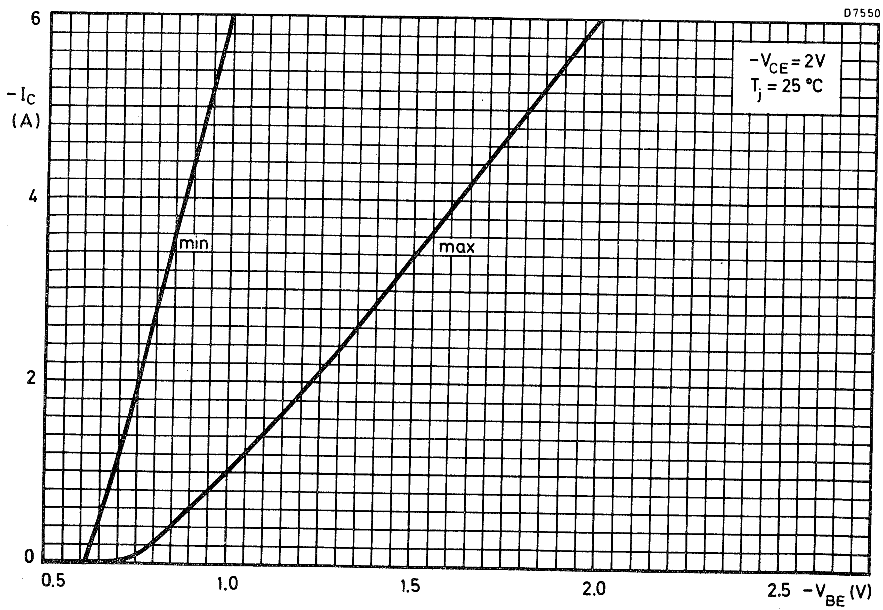

D7550
6
4
2
0
$-I_C$
(A)
$-V_{CE} = 2V$
$T_j = 25\ °C$
min
max
0.5
1.0
1.5
2.0
2.5
$-V_{BE}$ (V)

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

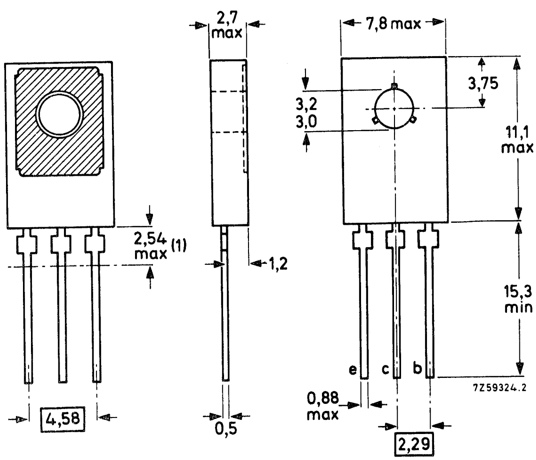
			BD135	BD137	BD139	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.	1,5	1,5	1,5	A
Total power dissipation up to T_{mb}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

MECHANICAL DATA

Dimensions in mm

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)

Voltages

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

Currents

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

Power dissipation

Total power dissipation up to T_{mb} = 70 °C	P_{tot}	max.	8	W

Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

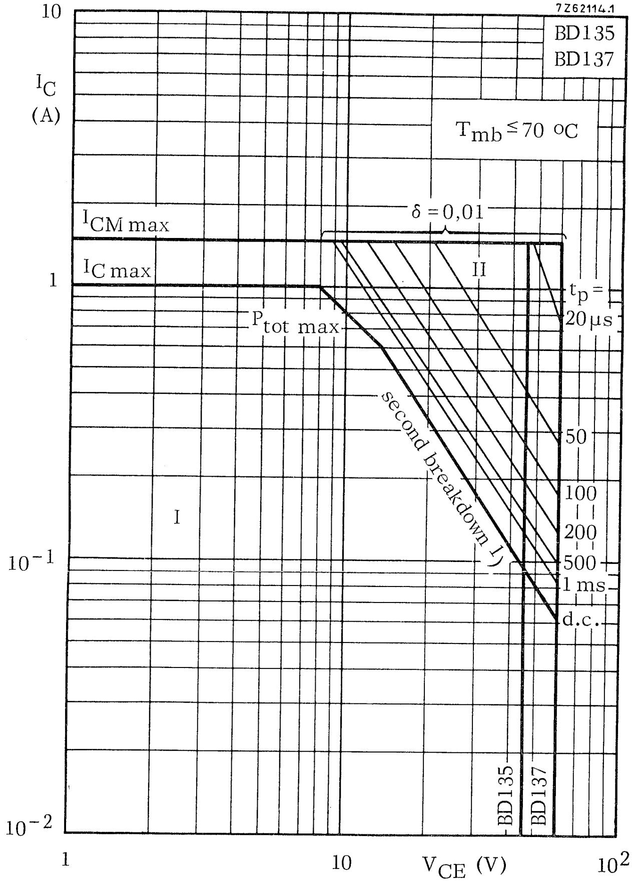
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	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
Base-emitter voltage			
I_C = 500 mA; V_{CE} = 2 V	V_{BE}	<	1 V
Saturation voltage			
I_C = 500 mA; I_B = 50 mA	V_{CEsat}	<	0,5 V
D.C. current gain			
I_C = 5 mA; V_{CE} = 2 V	h_{FE}	>	25
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
D.C. current gain ratio of matched pairs			
BD135/BD136; BD137/BD138; BD139/BD140		typ.	1,3
$\|I_C\|$ = 150 mA; $\|V_{CE}\|$ = 2 V	h_{FE1}/h_{FE2}	<	1,6



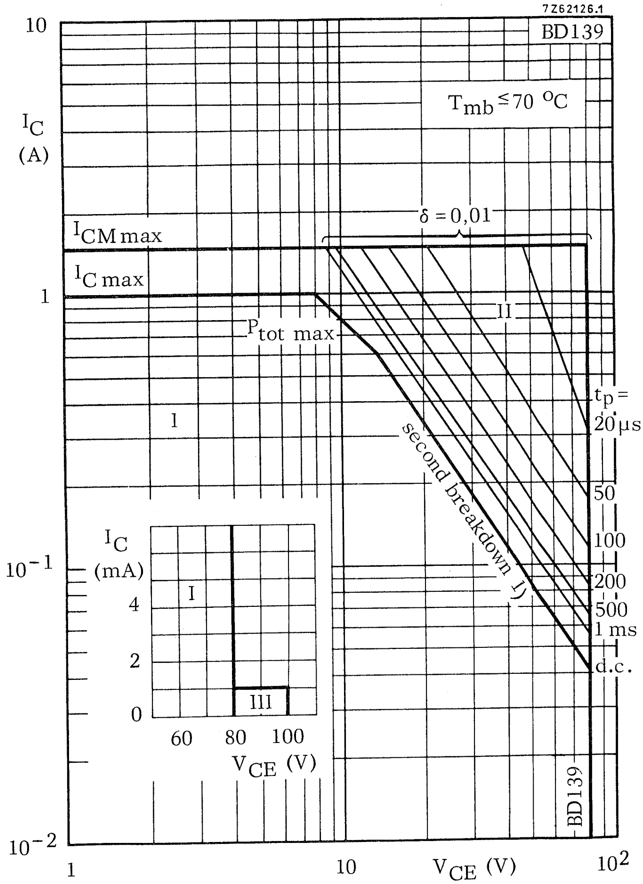
Safe Operating Area with the transistor forward biased

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

---

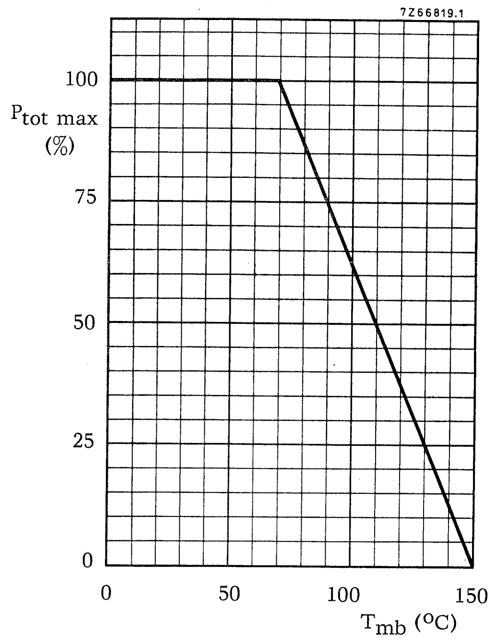
1) Independent of temperature

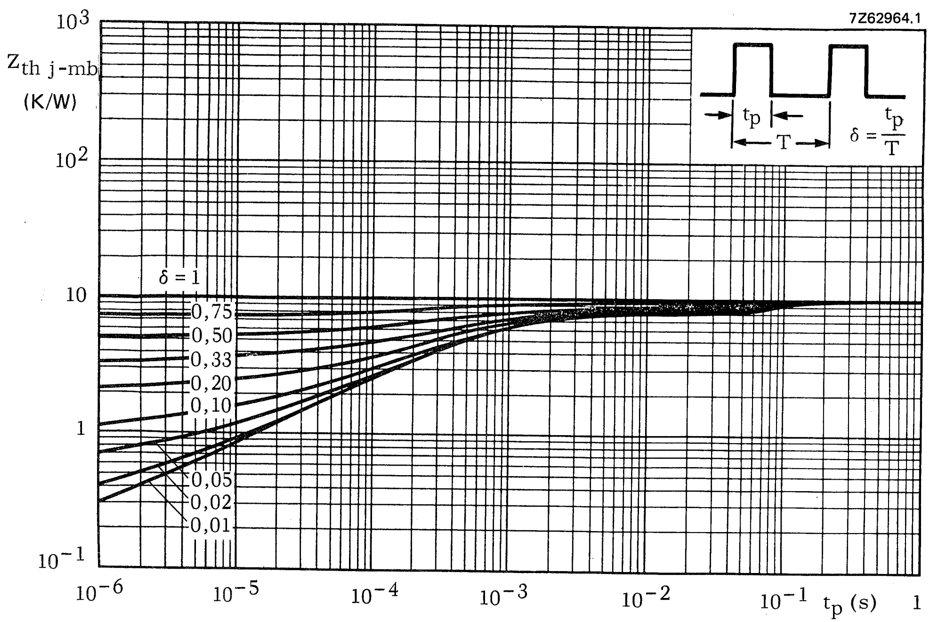


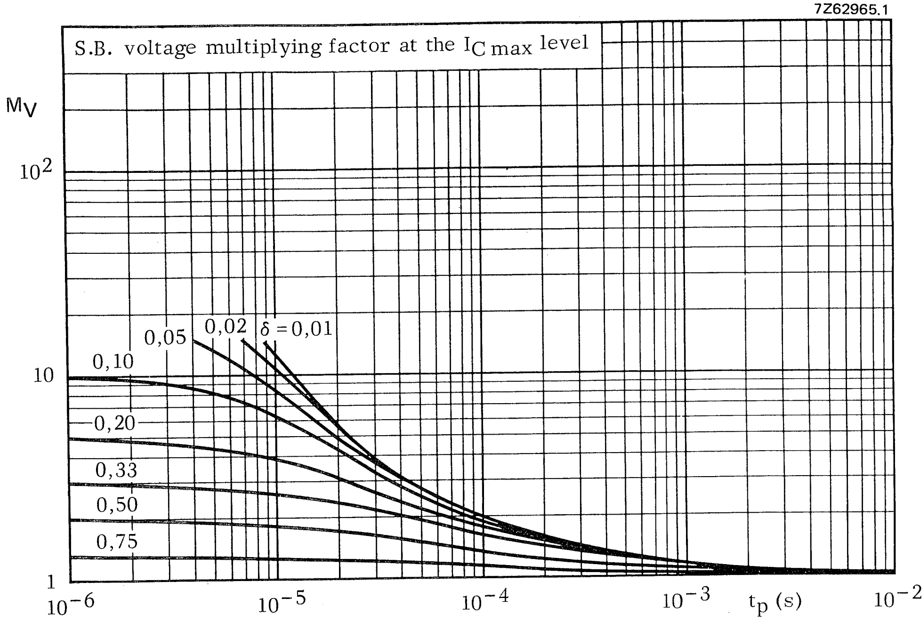
Safe Operating Area with the transistor forward biased

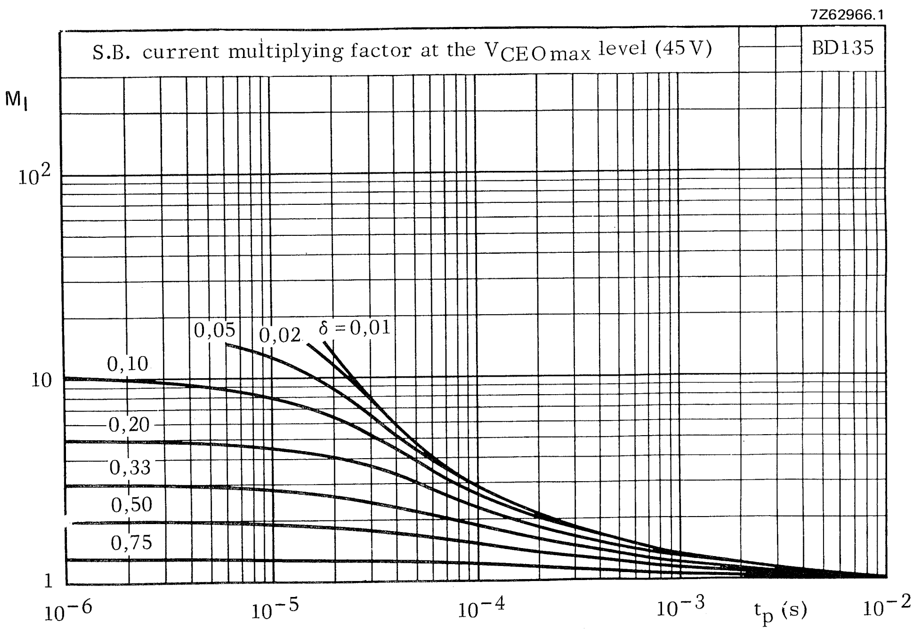
I Region of permissible d.c. operation
II Permissible extension for repetitive pulsed operation
III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 1$ kΩ

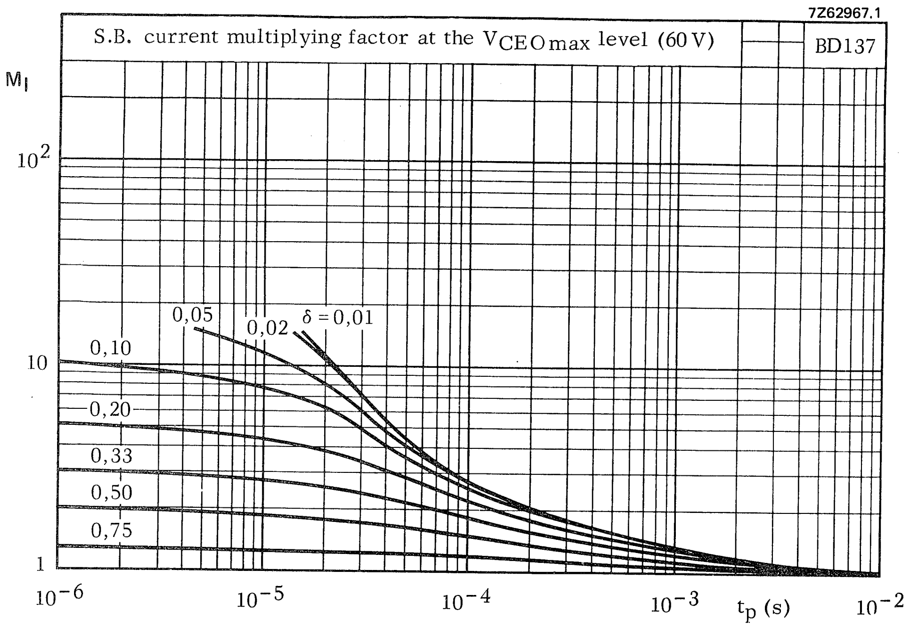
1) Independent of temperature

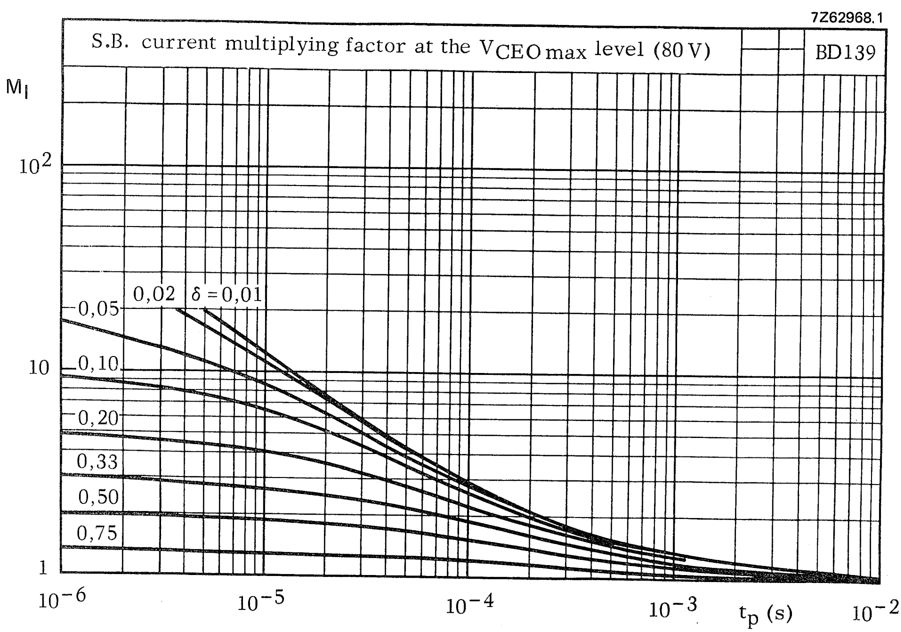

7Z66819.1
100
$P_{tot\ max}$ (%)
75
50
25
0
0
50
100
150
T_{mb} (°C)

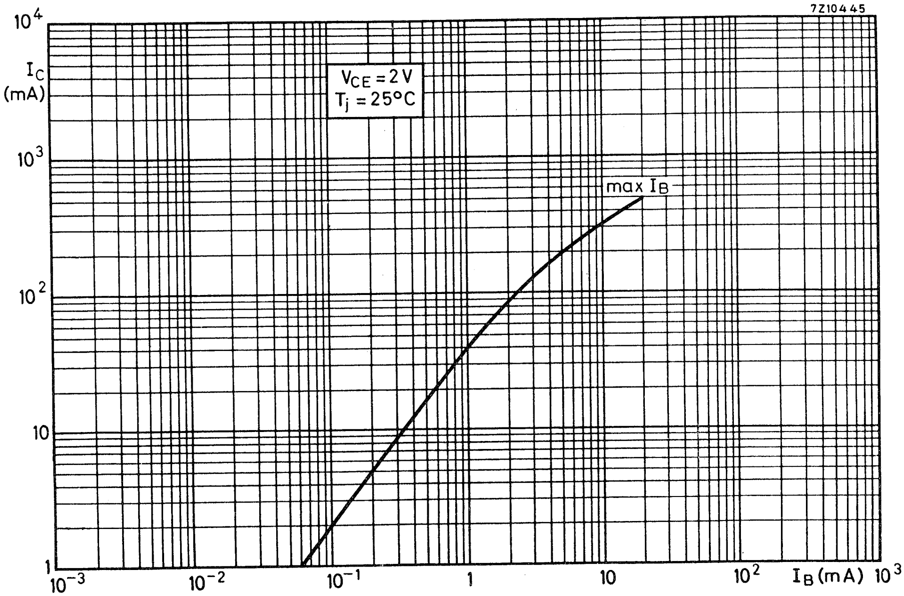

7Z62964.1
10^3
$Z_{th\ j\text{-}mb}$ (K/W)
10^2
10
1
10^{-1}
δ = 1
0,75
0,50
0,33
0,20
0,10
0,05
0,02
0,01
t_p
T
$\delta = \frac{t_p}{T}$
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
t_p (s)
1

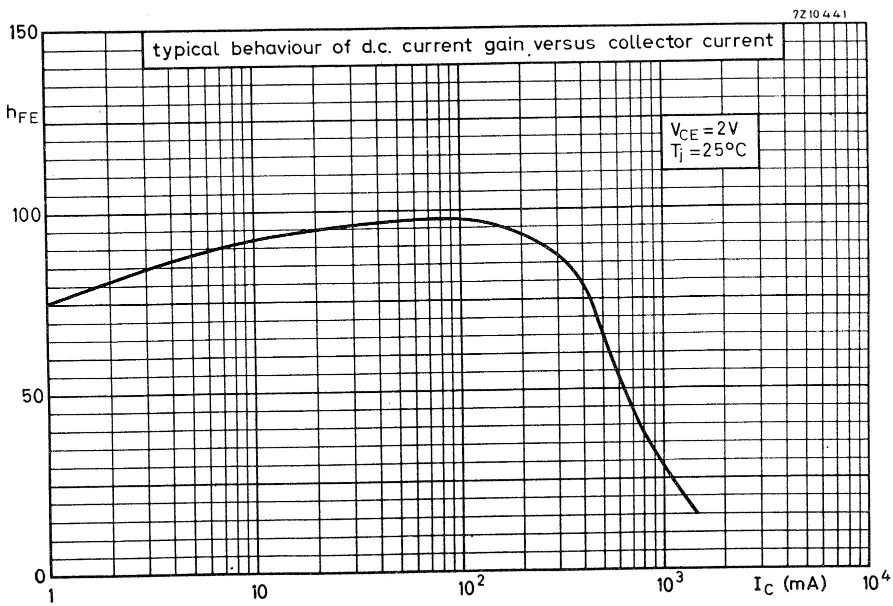

7Z62965.1
S.B. voltage multiplying factor at the $I_{C\,max}$ level
M_V
10^2
10
1
0,05
0,02
$\delta = 0,01$
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

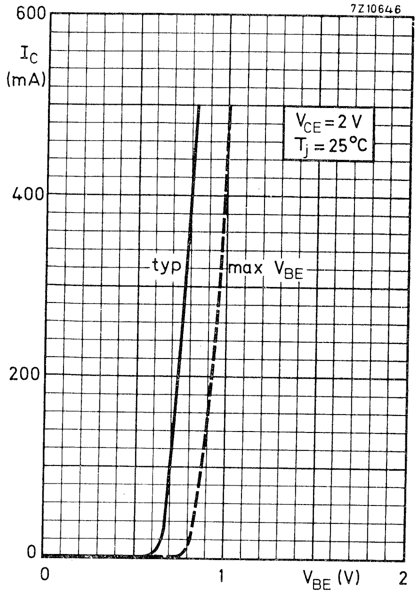

7Z62966.1
S.B. current multiplying factor at the $V_{CEO\,max}$ level (45 V)
BD135
M_I
10^2
10
1
0,05
0,02
$\delta = 0,01$
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

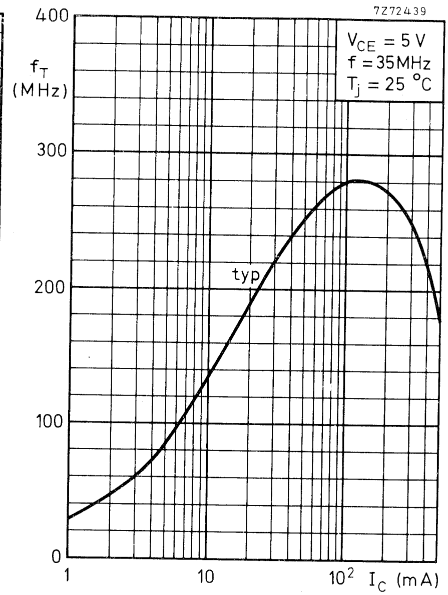

7Z62967.1
S.B. current multiplying factor at the VCEOmax level (60 V)
BD137
MI
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^-6
10^-5
10^-4
10^-3
tp (s)
10^-2

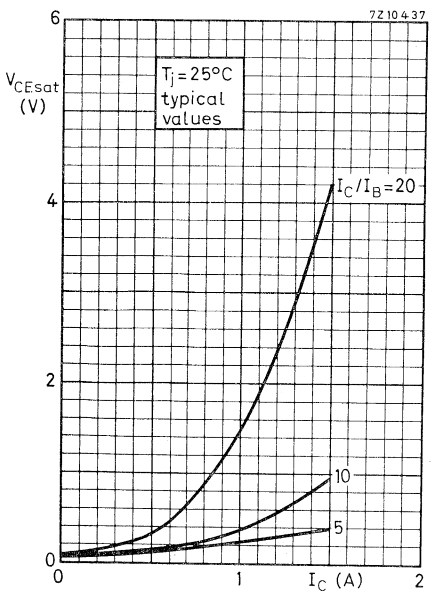

7Z62968.1
S.B. current multiplying factor at the VCEOmax level (80 V)
BD139
MI
10^2
10
1
0,02
δ = 0,01
0,05
0,10
0,20
0,33
0,50
0,75
10^-6
10^-5
10^-4
10^-3
tp (s)
10^-2

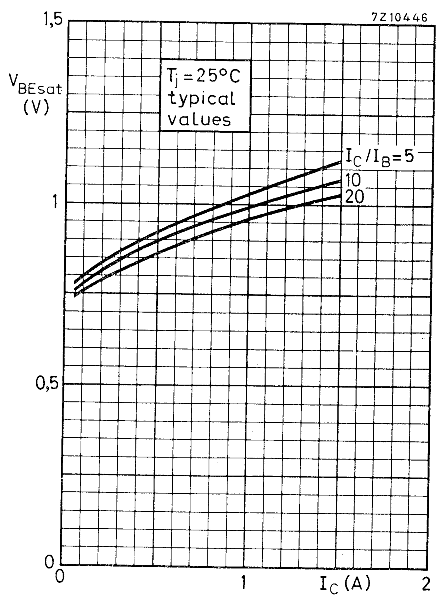

7Z10445
10^4
I_C (mA)
V_{CE} = 2 V
T_j = 25°C
10^3
max I_B
10^2
10
1
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
I_B (mA)
10^3


7Z10441
typical behaviour of d.c. current gain versus collector current
150
h_{FE}
V_{CE} = 2V
T_j = 25°C
100
50
0
1
10
10^2
10^3
I_C (mA)
10^4


7Z10646
600
I_C
(mA)
400
200
0
0
1
V_{BE} (V)
2
V_{CE} = 2 V
T_j = 25 °C
typ
max V_{BE}


7Z72439
400
f_T
(MHz)
300
200
100
0
1
10
10^2
I_C (mA)
V_{CE} = 5 V
f = 35MHz
T_j = 25 °C
typ


7Z10437
6
V_{CEsat}
(V)
4
2
0
0
1
I_C (A)
2
T_j = 25°C
typical
values
I_C/I_B = 20
10
5


7Z10446
1,5
V_{BEsat}
(V)
1
0,5
0
0
1
I_C (A)
2
T_j = 25°C
typical
values
I_C/I_B = 5
10
20

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

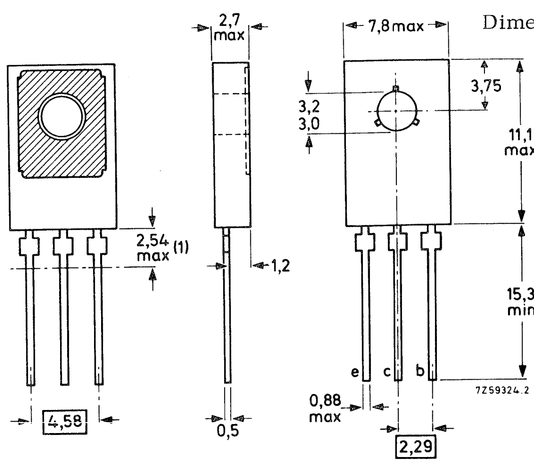
			BD136	BD138	BD140	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Collector current (peak value)	$-I_{CM}$	max.	1,5	1,5	1,5	A
Total power dissipation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

MECHANICAL DATA

Dimensions in mm

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)

Voltages

			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 kΩ)	$-V_{CER}$	max.	45	60	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V

Currents

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

Power dissipation

Total power dissipation up to T_{mb} = 70 °C	P_{tot}	max.	8	W

Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

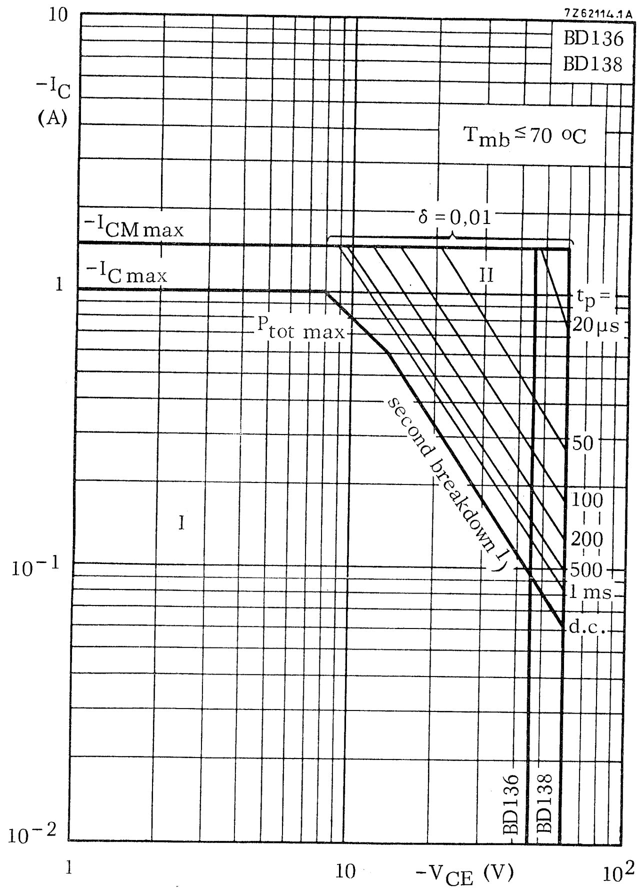
THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

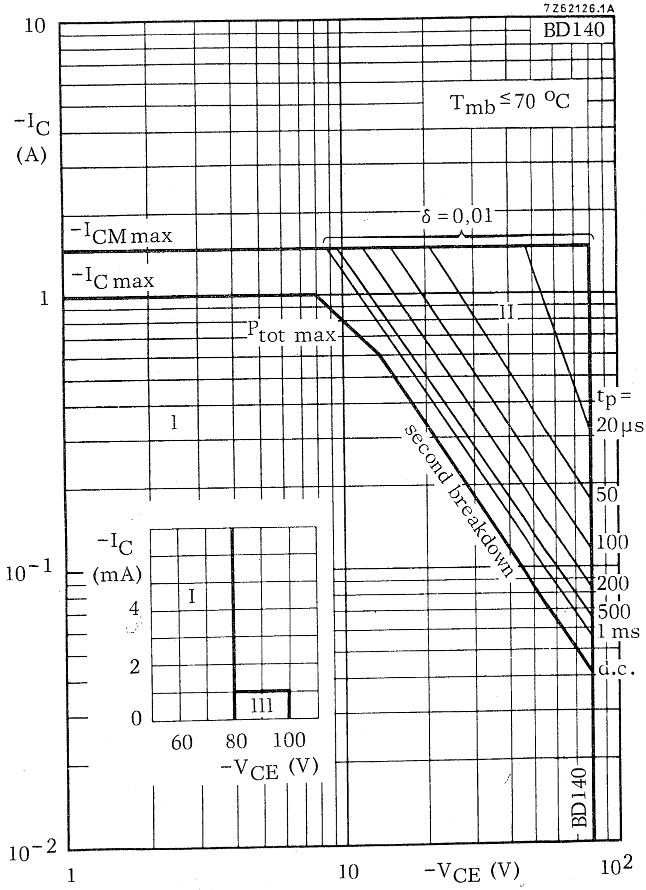
Collector cut-off current			
$I_E = 0$; $-V_{CB} = 30$ V	$-I_{CBO}$	<	100 nA
$I_E = 0$; $-V_{CB} = 30$ V; $T_j = 125$ °C	$-I_{CBO}$	<	10 μA
Emitter cut-off current			
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	10 μA
Base-emitter voltage			
$-I_C = 500$ mA; $-V_{CE} = 2$ V	$-V_{EB}$	<	1 V
Saturation voltage			
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	0,5 V
D.C. current gain			
$-I_C = 5$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25
$-I_C = 150$ mA; $-V_{CE} = 2$ V			
BDxxx	h_{FE}		40 to 250
BDxxx-06	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.	75 MHz
D.C. current gain ratio of matched pairs			
BD135/BD136; BD137/BD138; BD139/BD140			
$\lvert I_C \rvert = 150$ mA; $\lvert V_{CE} \rvert = 2$ V	h_{FE1}/h_{FE2}	typ.	1,3
		<	1,6



Safe Operating Area with the transistor forward biased

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

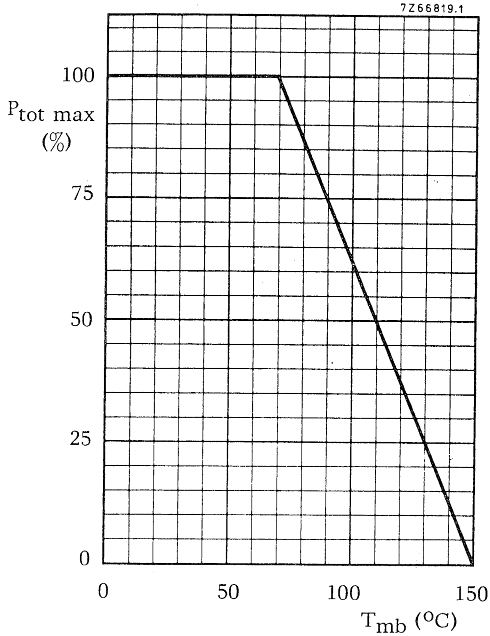
1) Independent of temperature

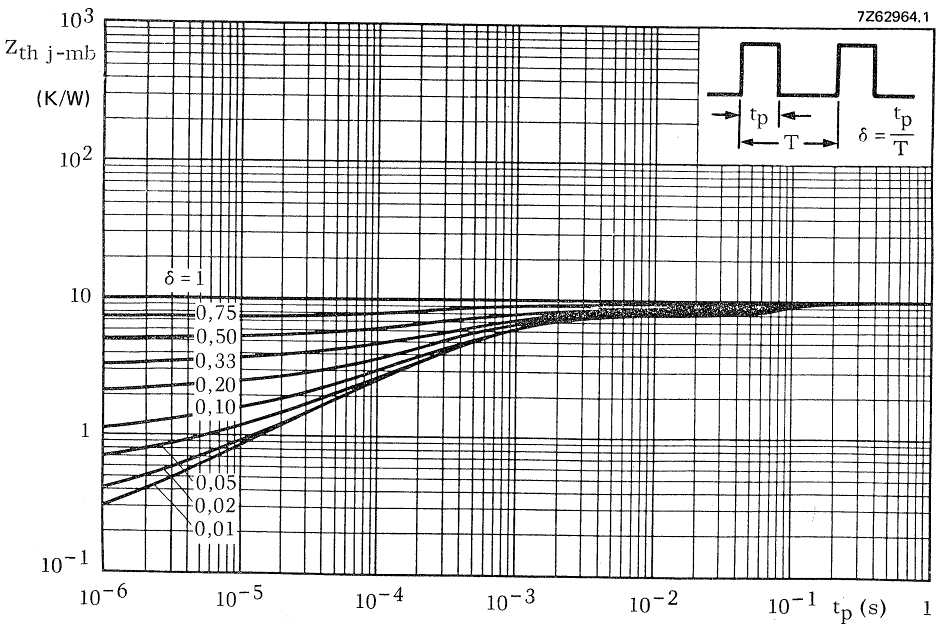


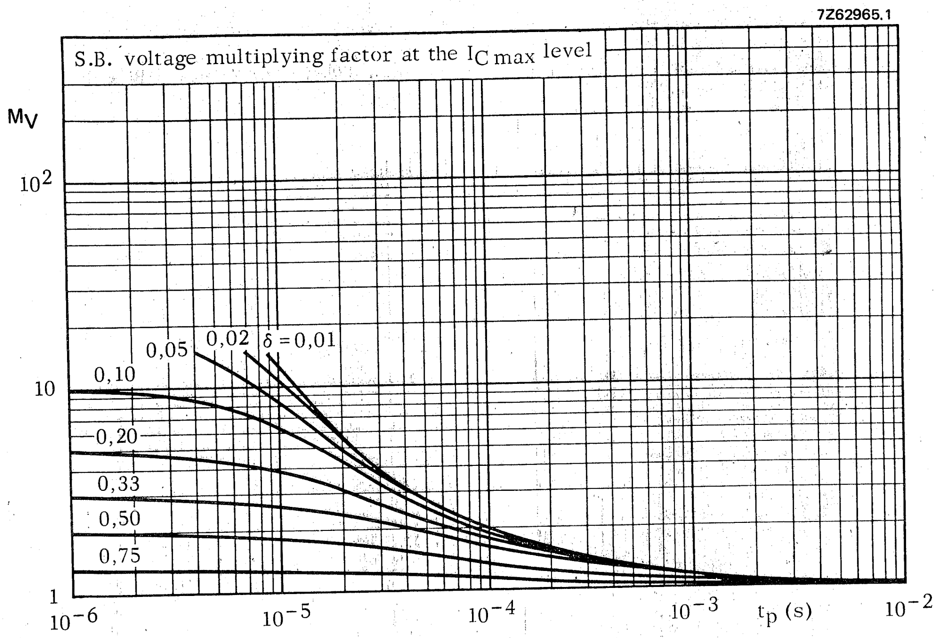
Safe Operating Area with the transistor forward biased

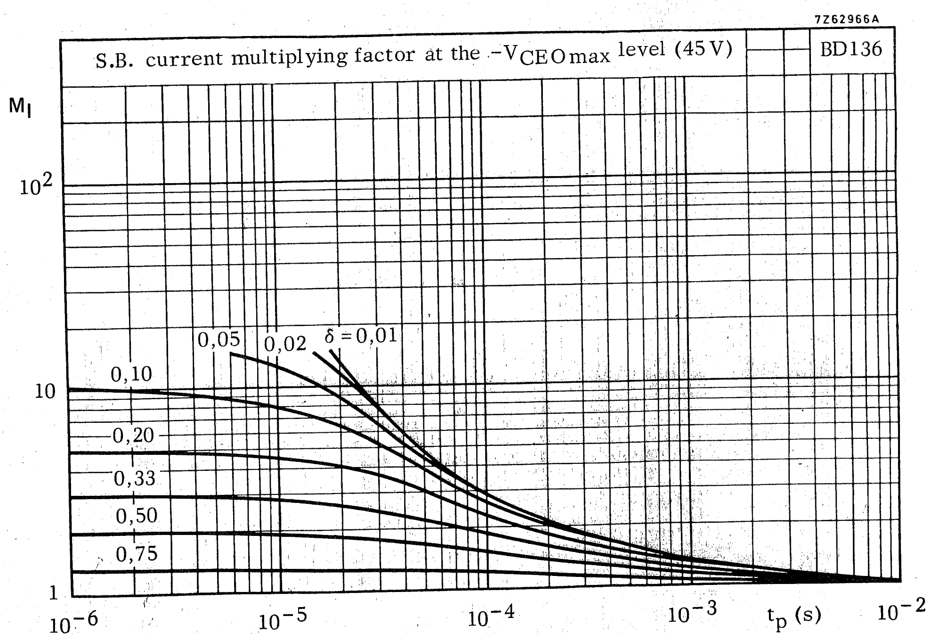
I Region of permissible d.c. operation
II Permissible extension for repetitive pulse operation
III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 1$ kΩ.

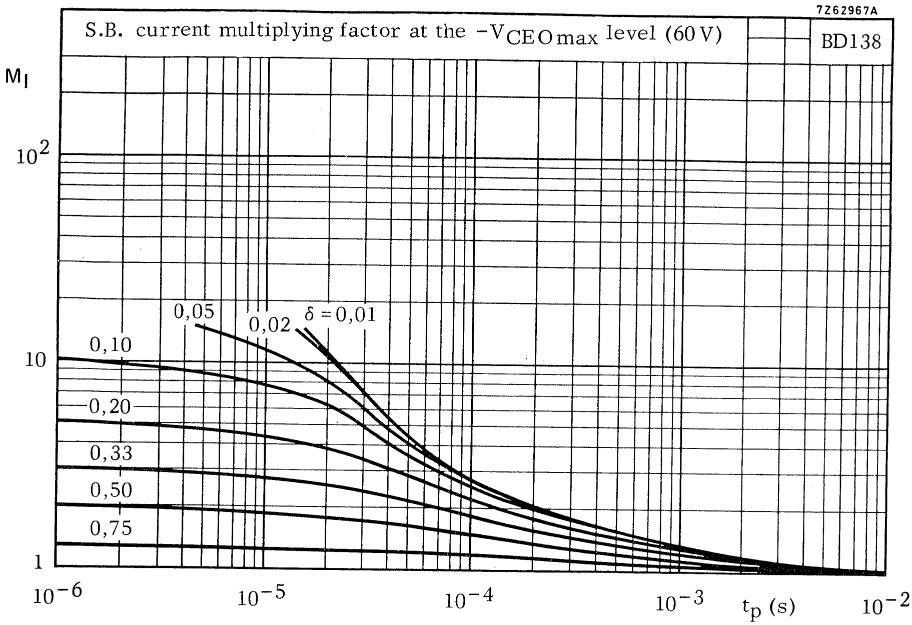
1) Independent of temperature

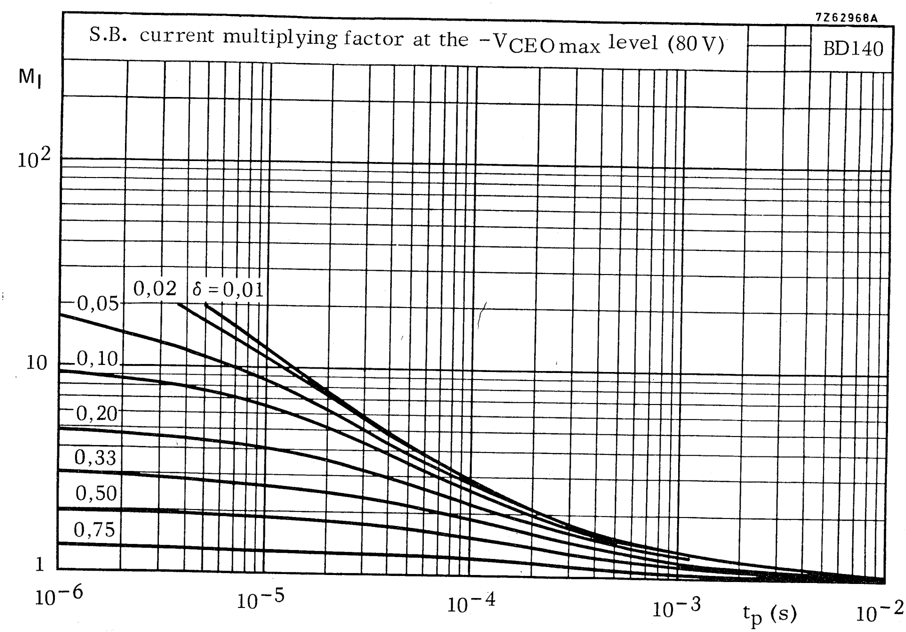

7Z66819.1
100
Ptot max
(%)
75
50
25
0
0
50
100
150
Tmb (°C)

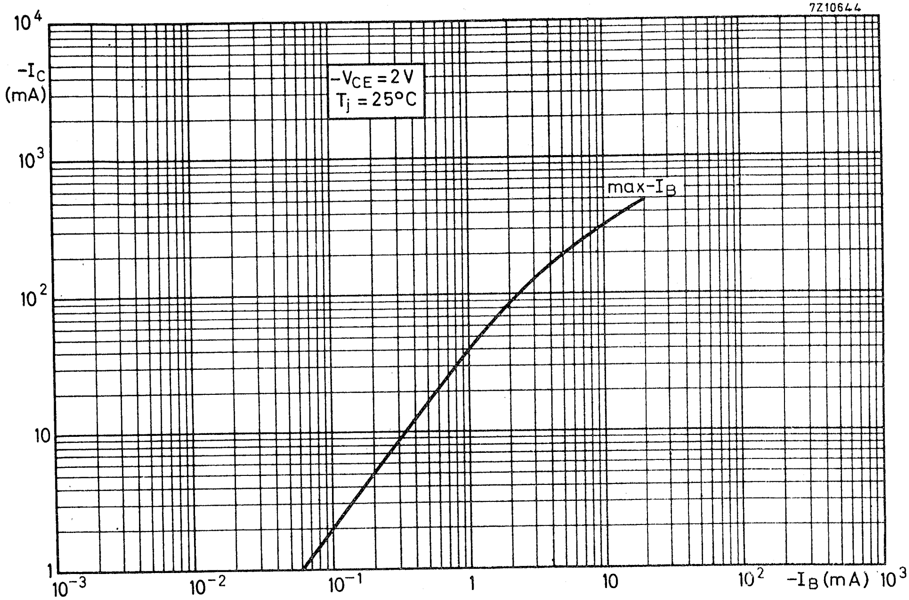

7Z62964.1
10³
Zth j-mb
(K/W)
10²
10
1
10⁻¹
δ = 1
0,75
0,50
0,33
0,20
0,10
0,05
0,02
0,01
tp
T
δ = tp/T
10⁻⁶
10⁻⁵
10⁻⁴
10⁻³
10⁻²
10⁻¹
tp (s)
1

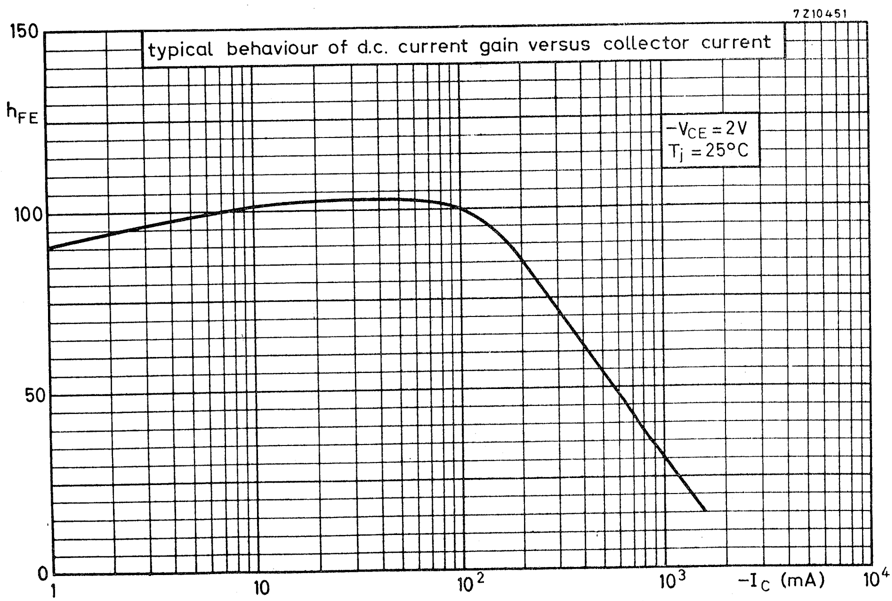

7Z62965.1
S.B. voltage multiplying factor at the I_C max level
M_V
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

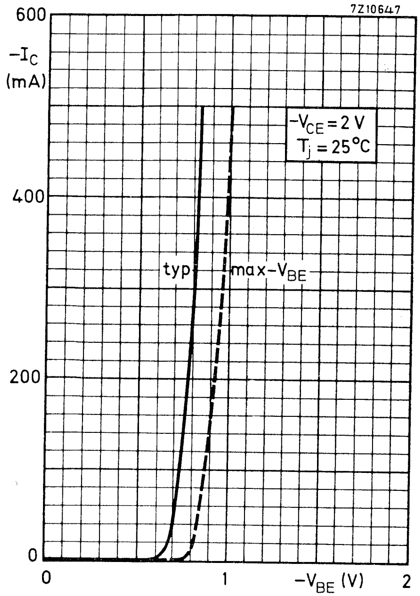

7Z62966A
S.B. current multiplying factor at the $-V_{CEO}$max level (45 V)
BD136
M_I
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

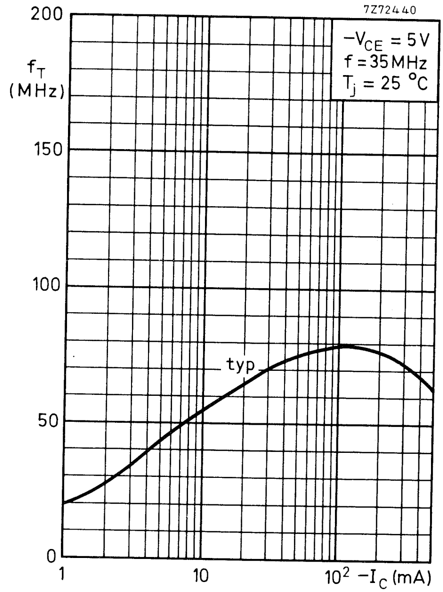

7Z62967A
S.B. current multiplying factor at the $-V_{CEO\,max}$ level (60 V)
BD138
M_I
10^2
10
1
0,05
0,02
$\delta = 0{,}01$
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

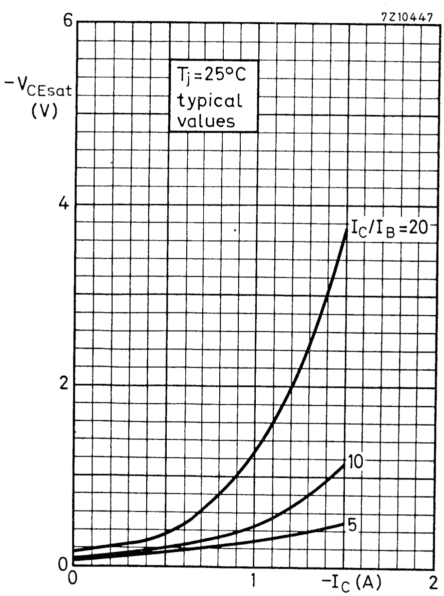

7Z62968A
S.B. current multiplying factor at the $-V_{CEO\,max}$ level (80 V)
BD140
M_I
10^2
10
1
0,02
$\delta = 0{,}01$
0,05
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

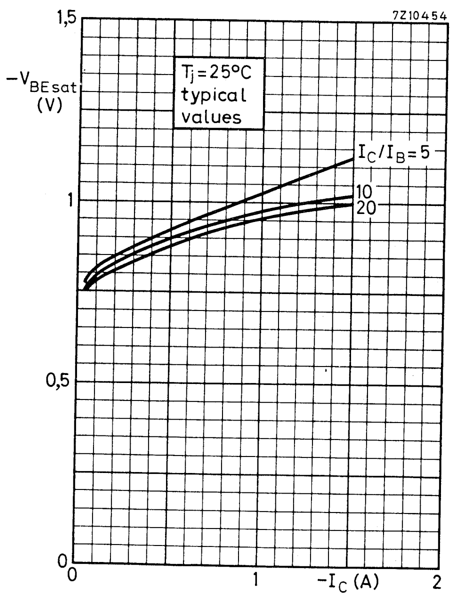

7Z10644
$-V_{CE} = 2\,V$
$T_j = 25\,°C$
$-I_C$ (mA)
max-I_B
$-I_B$ (mA)
10^4
10^3
10^2
10
1
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3


7Z10451
typical behaviour of d.c. current gain versus collector current
$-V_{CE} = 2\,V$
$T_j = 25\,°C$
h_{FE}
150
100
50
0
1
10
10^2
10^3
$-I_C$ (mA)
10^4


7Z10647
600
$-I_C$
(mA)
400
200
0
0
1
2
$-V_{BE}$ (V)
$-V_{CE} = 2$ V
$T_j = 25°C$
typ
max-V_{BE}


7Z72440
200
f_T
(MHz)
150
100
50
0
1
10
10^2
$-I_C$ (mA)
$-V_{CE} = 5$ V
f = 35 MHz
$T_j = 25$ °C
typ


7Z10447
6
$-V_{CEsat}$
(V)
4
2
0
0
1
2
$-I_C$ (A)
$T_j = 25°C$
typical
values
$I_C/I_B = 20$
10
5


7Z10454
1,5
$-V_{BEsat}$
(V)
1
0,5
0
0
1
2
$-I_C$ (A)
$T_j = 25°C$
typical
values
$I_C/I_B = 5$
10
20

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

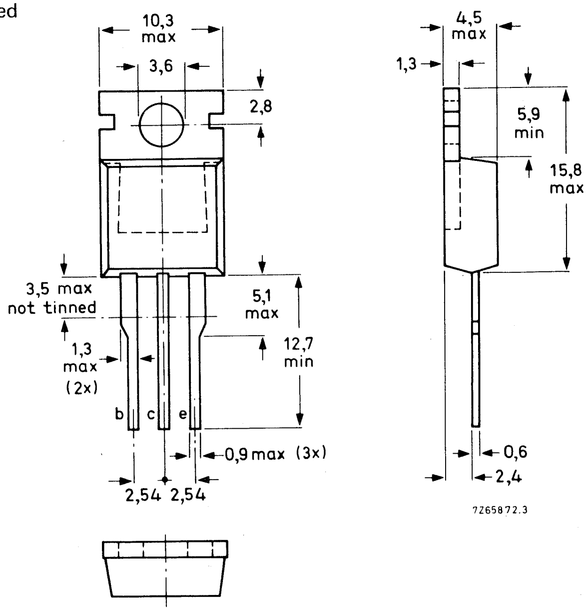
			BD201	BD203	
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	V
Collector current (d.c.)	I_C	max.	8	8	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	60	60	W
Cut-off frequency I_C = 0,3 A; V_{CE} = 3 V	f_{hfe}	>	25	25	kHz

MECHANICAL DATA

Dimensions in mm

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	$R_{th\ j\text{-}mb}$	=	2,08	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	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: $t_p < 300\ \mu s$, $\delta < 2\%$.

Transition frequency at f = 1 MHz I_C = 0,3 A; V_{CE} = 3 V	f_T	>	7 MHz ←
D.C. current gain ratio of matched complementary pairs I_C = 1 A; V_{CE} = 2 V	h_{FE1}/h_{FE2}	<	2,5
Forward bias second breakdown collector current V_{CE} = 40 V; t_p = 0,1 s; T_{amb} = 25 °C	$I_{(SB)}$	>	1,5 A
Switching times I_{Con} = 2 A; I_{Bon} = $-I_{Boff}$ = 0,2 A			
Turn-on time	t_{on}	<	1 µs
Turn-off time	t_{off}	<	4 µs

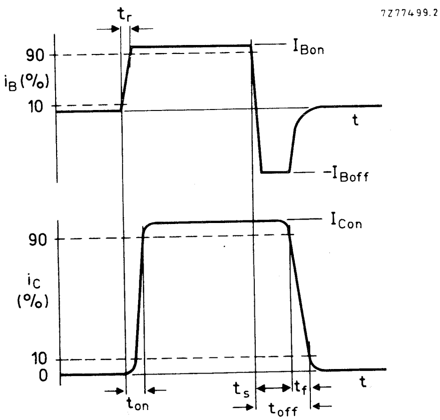


Fig. 2 Switching time waveforms.

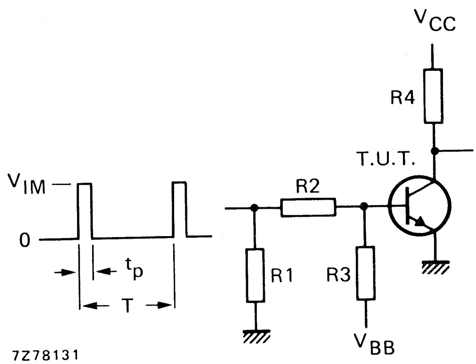


Fig. 3 Switching times test circuit.

V_{IM} =	15 V	R3 =	22 Ω
V_{CC} =	20 V	R4 =	10 Ω
V_{BB} =	−4 V	$t_r = t_f$ ⩽	15 ns
R1 =	–	t_p =	20 µs
R2 =	33 Ω	T =	500 µs

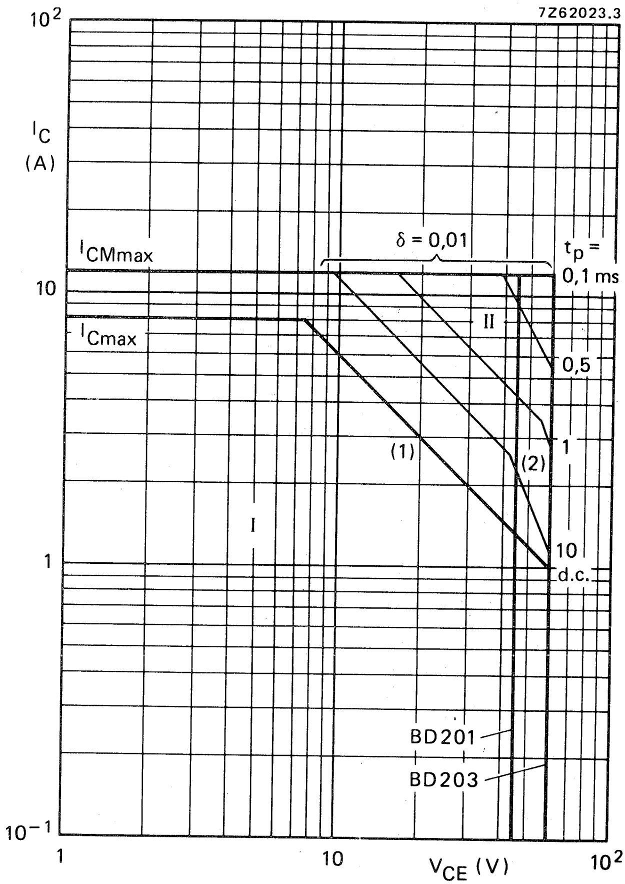


Fig. 4 Safe Operating ARea, $T_{mb} \leq 25\ ^{o}C$.

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).

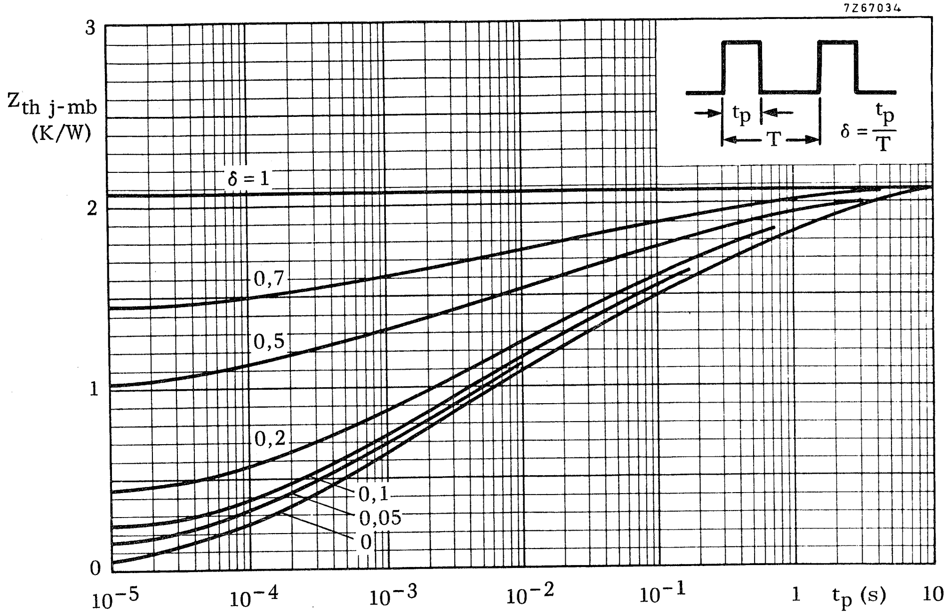


Fig. 5 Pulse power rating chart.

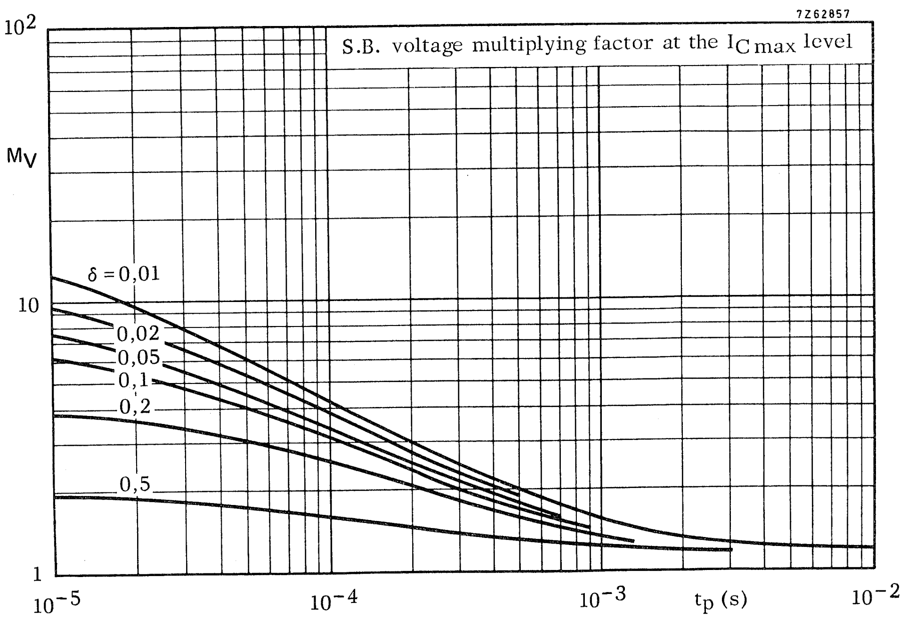


Fig. 6 S.B. voltage multiplying factor at the I_{Cmax} level.

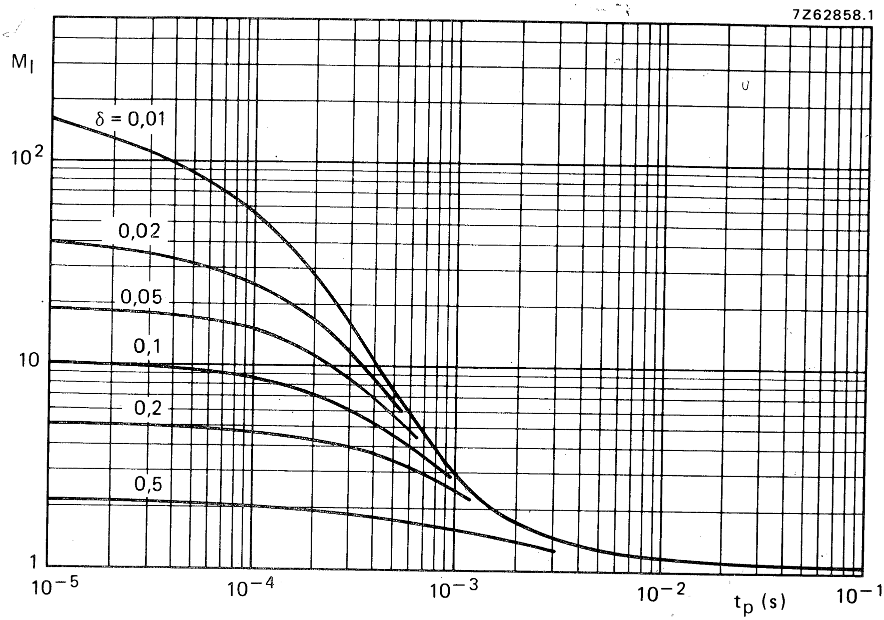


Fig. 7 S.B. current multiplying factor at the $V_{CEO\,max}$ level.

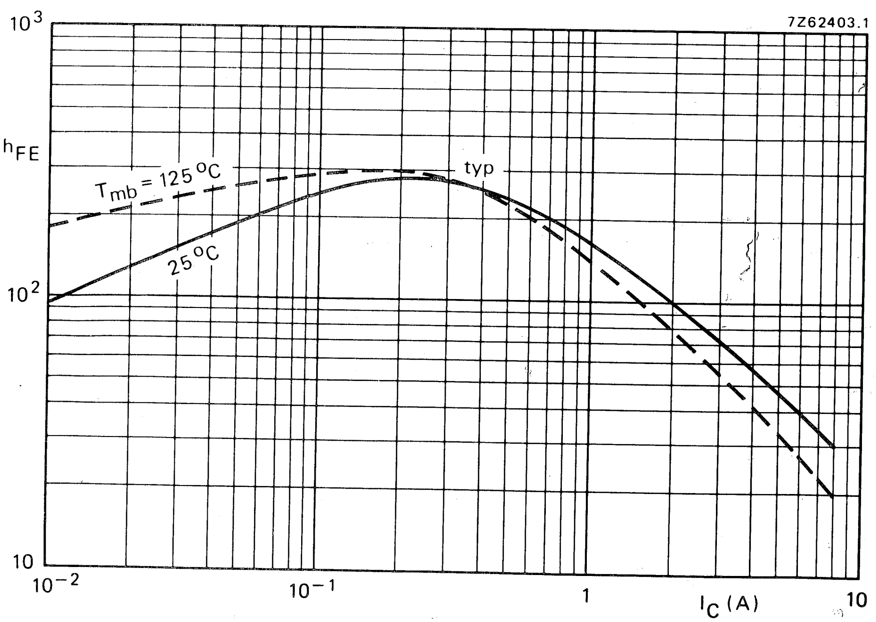


Fig. 8 D.C. current gain. V_{CE} = 2 V.

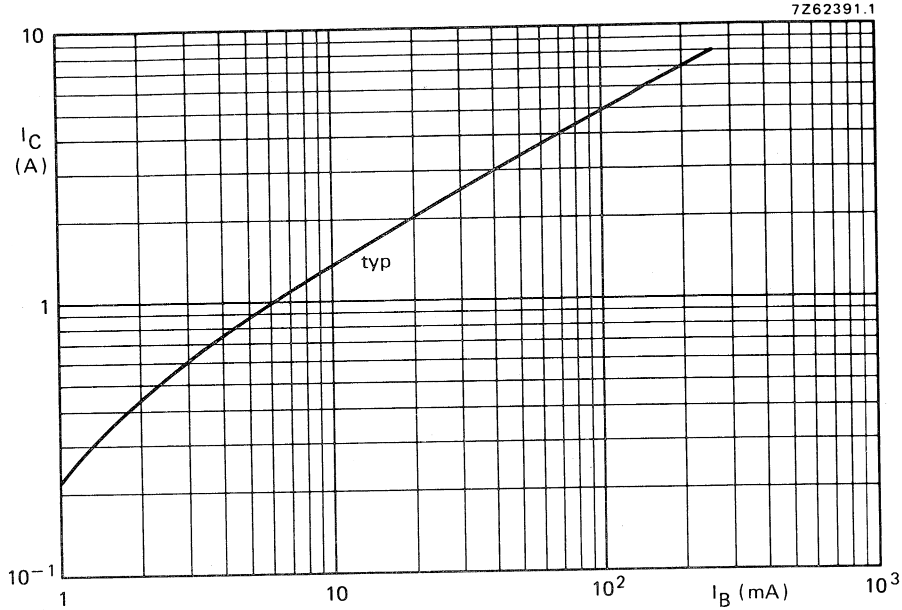


Fig. 9 Collector current as a function of base current. V_{CE} = 2 V; T_j = 25 °C.

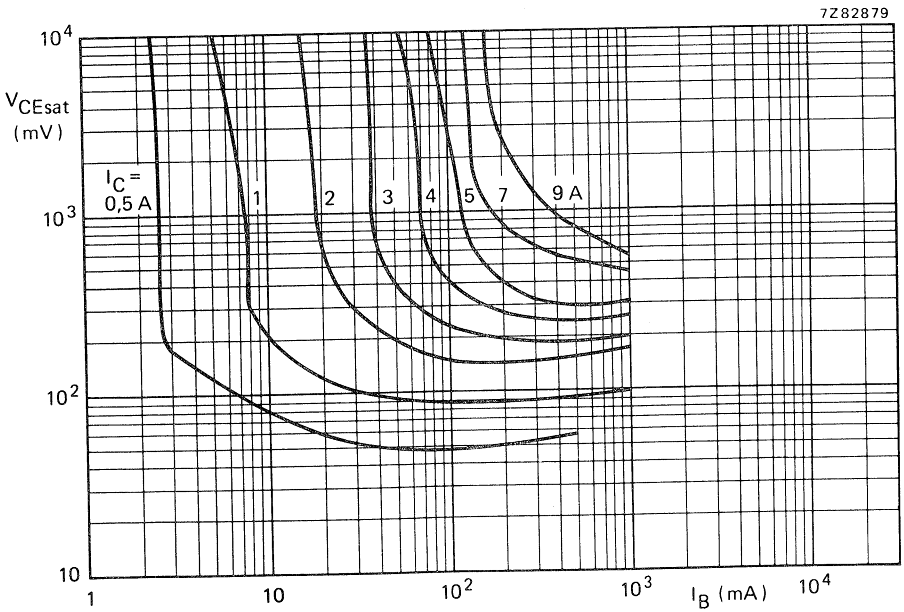


Fig. 10 Typical collector-emitter saturation voltage. T_j = 25 °C.

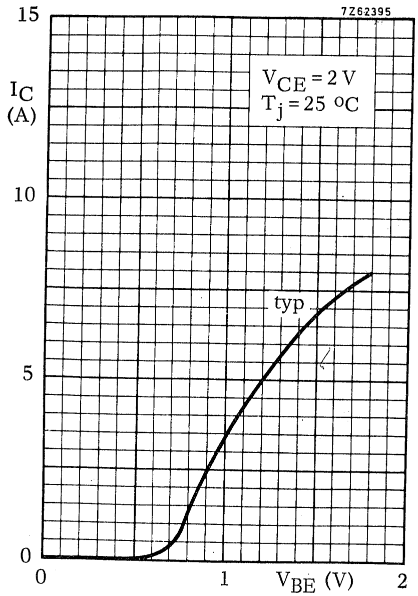


Fig. 11.

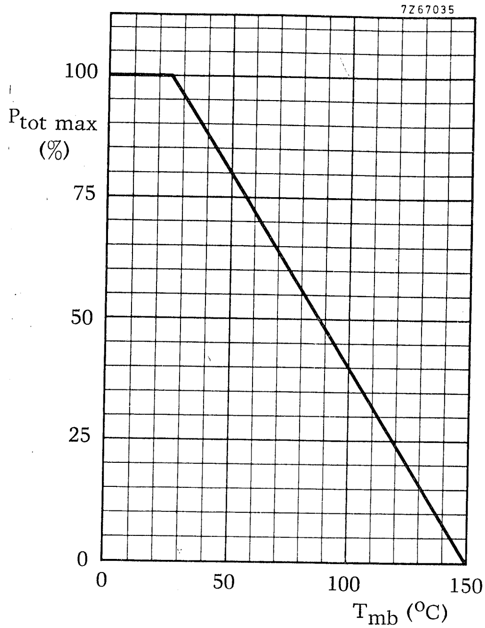


Fig. 12.

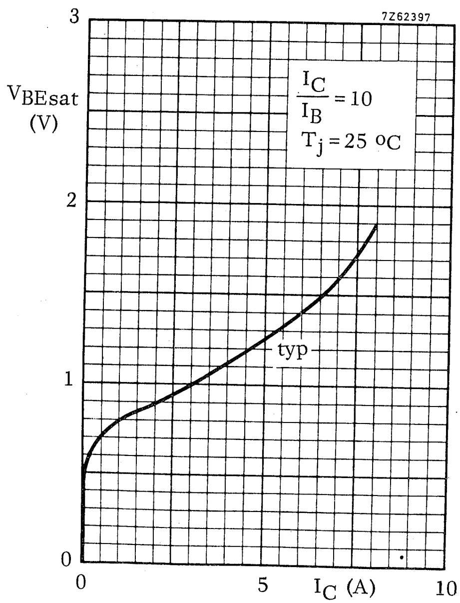


Fig. 13.

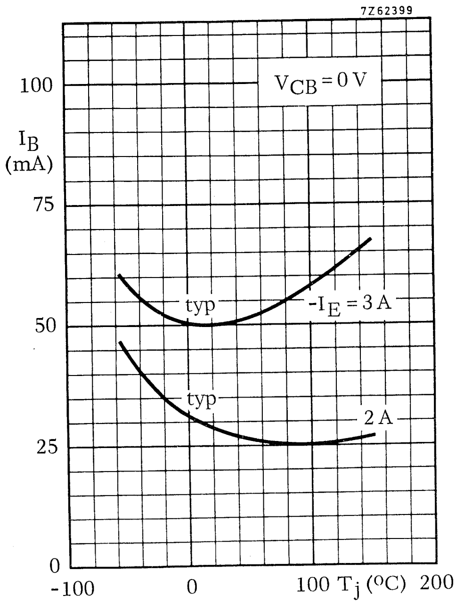


Fig. 14.

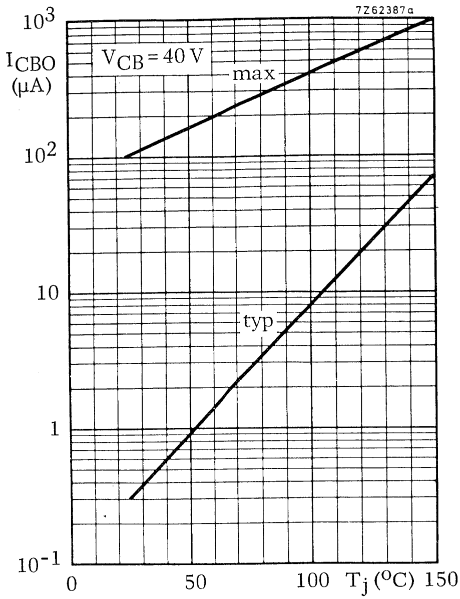


Fig. 15.

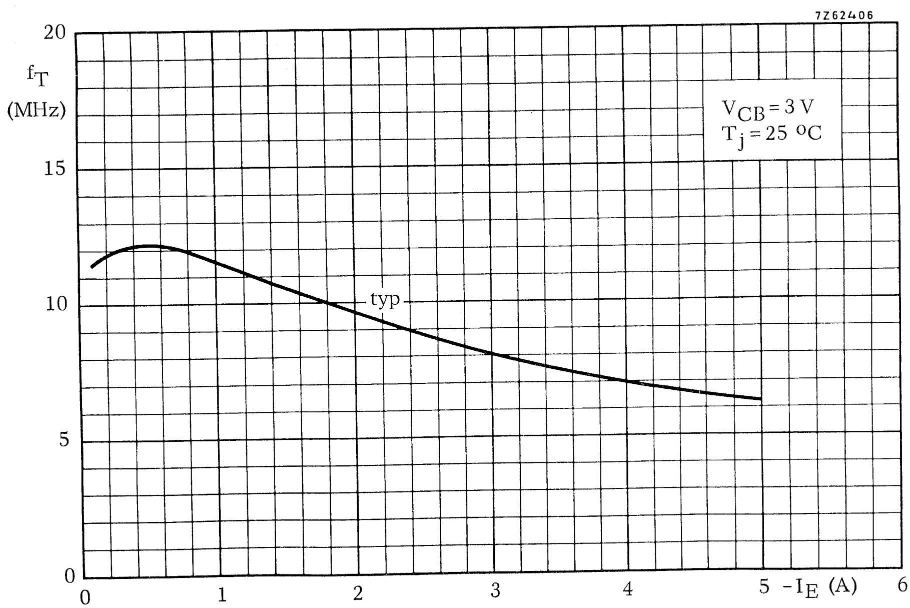


Fig. 16.

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

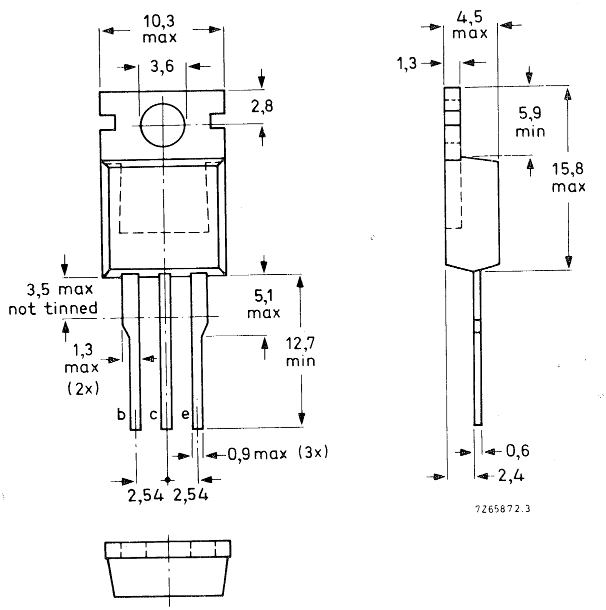
			BD202	BD204	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	V
Collector current (d.c.)	$-I_C$	max.	8	8	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	60	60	W
Cut-off frequency $-I_C$ = 0,3 A; $-V_{CE}$ = 3 V	f_{hfe}	>	25	25	kHz

MECHANICAL DATA

Dimensions in mm

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, $t_p \leqslant 10$ ms)	$-I_{CM}$	max.	12	A
Collector current (non-repetitive peak value, $t_p \leqslant 2$ 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	$R_{th\ j\text{-}mb}$	=	2,08	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	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
Collector-emitter breakdown voltage				
$I_C = 0,2$ A; $I_B = 0$ BD202	$-V_{(BR)CEO}$	>	45	V
$I_C = 0,2$ A; $I_B = 0$ BD204	$-V_{(BR)CEO}$	>	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	$-V_{CEsat}$	<	1	V
$-I_C = 6$ A; $-I_B = 0,6$ A	$-V_{CEsat}$	<	1,5	V
	$-V_{BEsat}$	<	2	V
D.C. current gain*				
$-I_C = 3$ A; $-V_{CE} = 2$ V BD202	h_{FE}	>	30	
$-I_C = 2$ A; $-V_{CE} = 2$ V BD204	h_{FE}	>	30	
$-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE}	>	30	

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

Cut-off frequency $-I_C$ = 0,3 A; $-V_{CE}$ = 3 V	f_{hfe}	>	25 kHz
Transition frequency at f = 1 MHz $-I_C$ = 0,3 A; $-V_{CE}$ = 3 V	f_T	>	7 MHz ←
D.C. current gain ratio of matched complementary pairs $-I_C$ = 1 A; $-V_{CE}$ = 2 V	h_{FE1}/h_{FE2}	<	2,5
Forward bias second breakdown collector current V_{CE} = 40 V; t_p = 0,1 s	I_{SB}	>	1,5 A
Switching times $-I_{Con}$ = 2 A; $-I_{Bon}$ = I_{Boff} = 0,2 A			
turn-on time	t_{on}	<	1 μs
turn-off time	t_{off}	<	2 μs

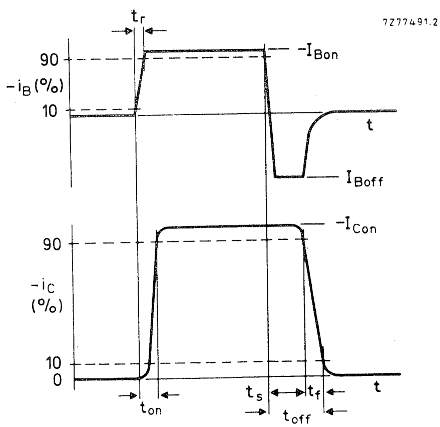


Fig. 2 Switching times waveforms.

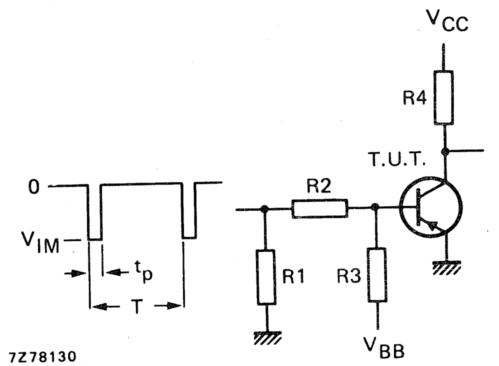


Fig. 3 Switching times test circuit.

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

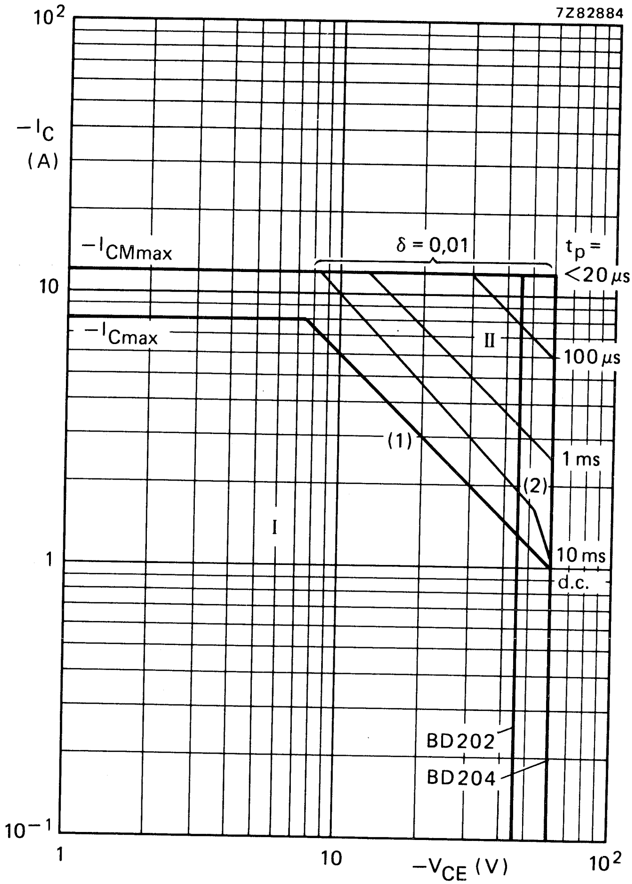


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

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).

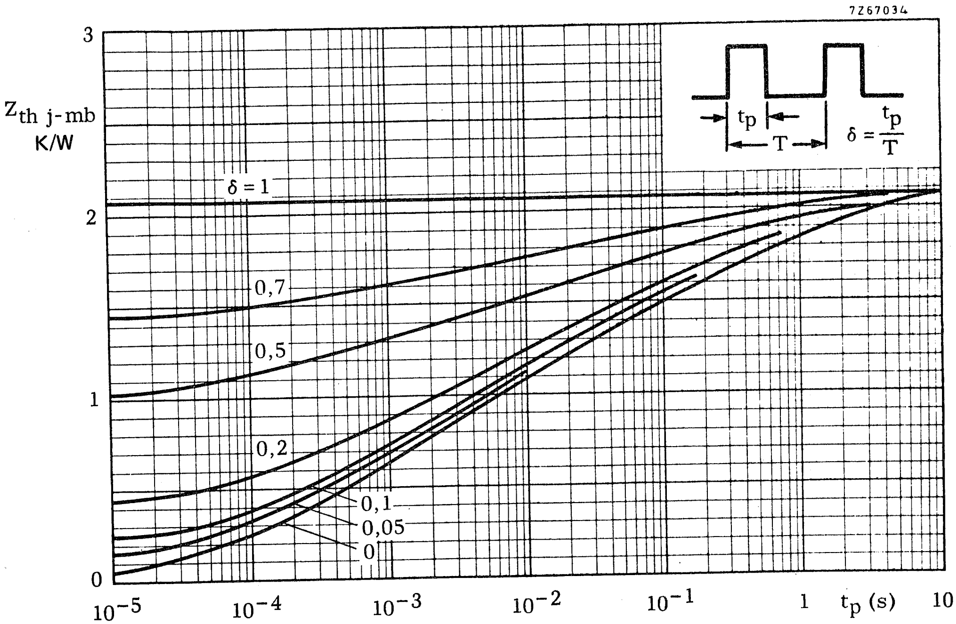


Fig. 5 Pulse power rating chart.

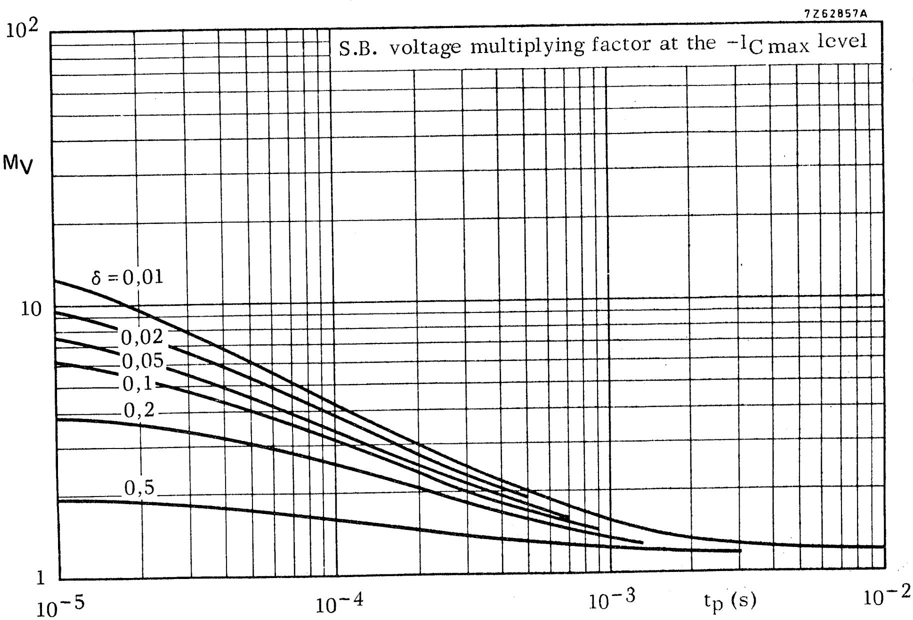


Fig. 6 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

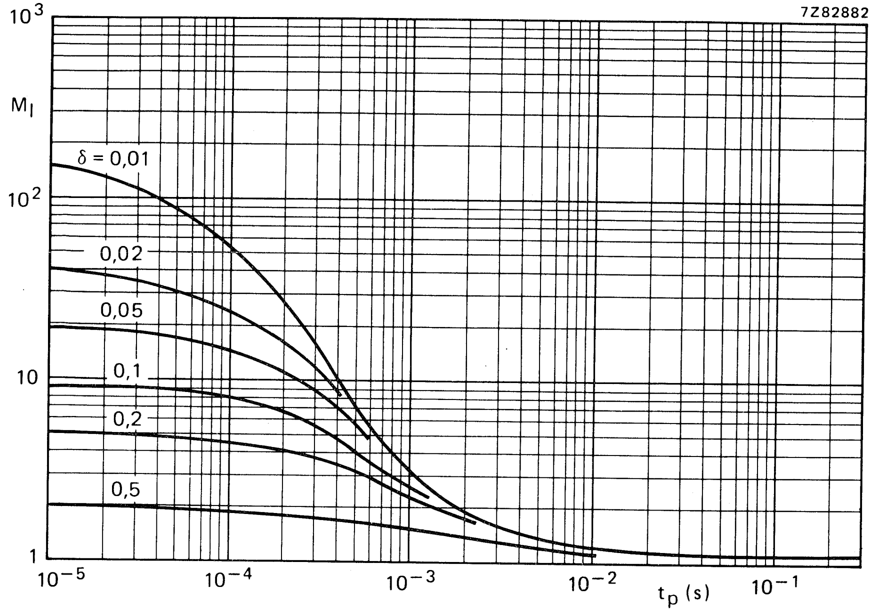


Fig. 7 S.B. current multiplying factor at the $-V_{CEOmax}$ level.

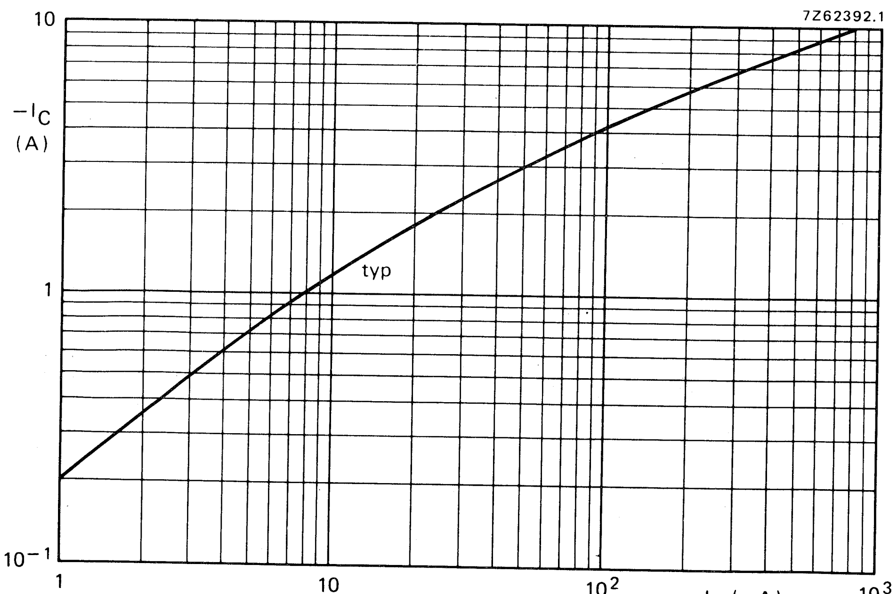


Fig. 8 Typical collector current as a function of base current. $-V_{CE} = 2$ V; $T_j = 25$ °C.

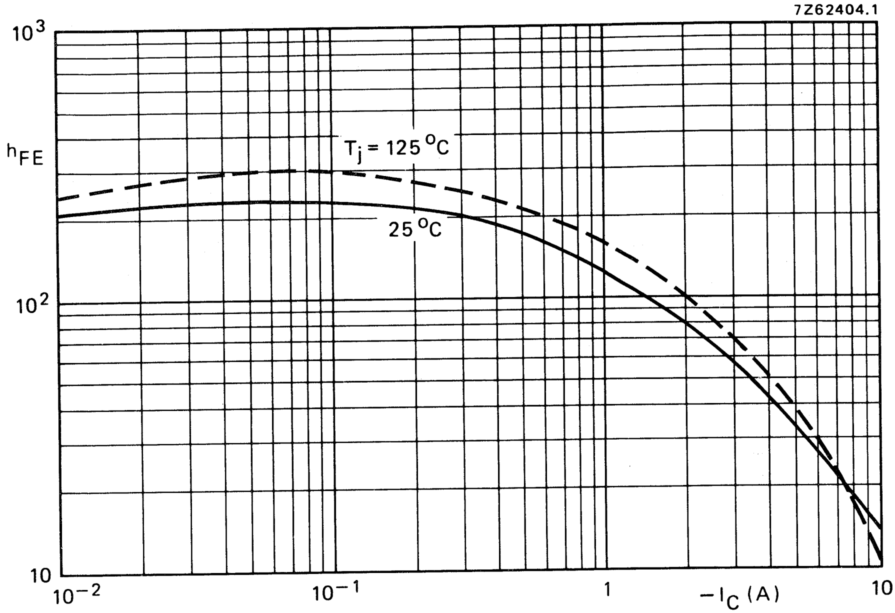


Fig. 9 Typical forward current transfer ratio at $-V_{CE} = 2$ V.

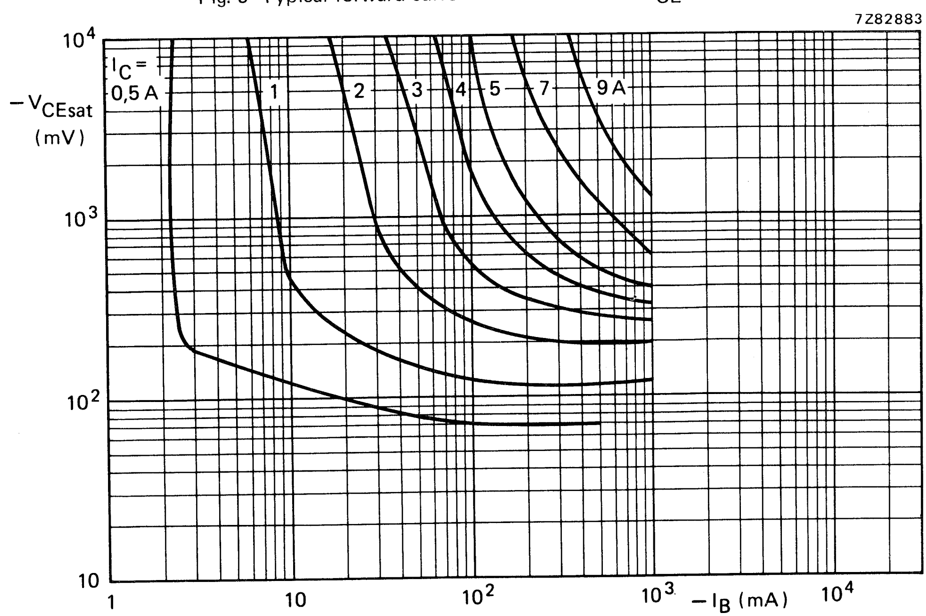


Fig. 10 Typical collector-emitter saturation voltage. $T_j = 25\ ^oC$.

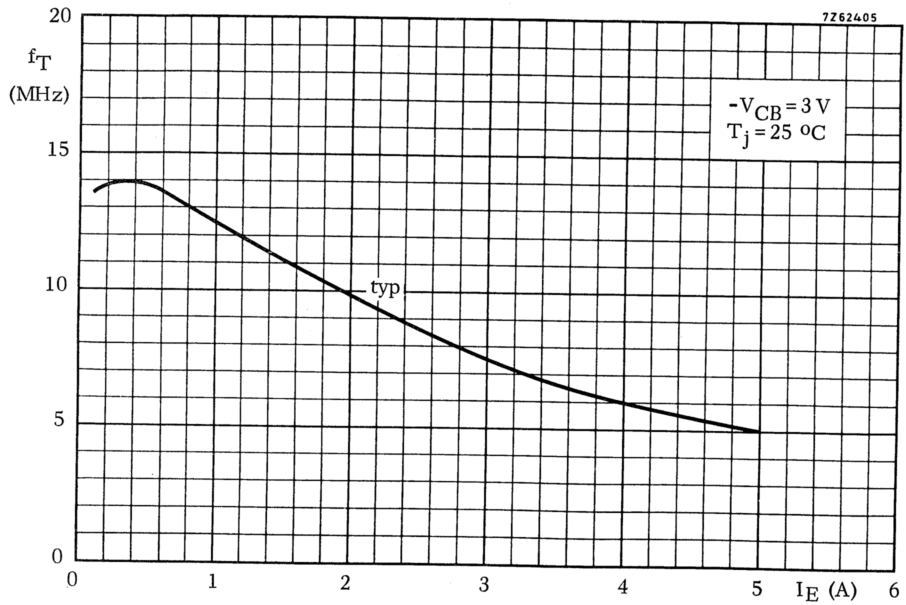


Fig. 11 Typical transition frequency.

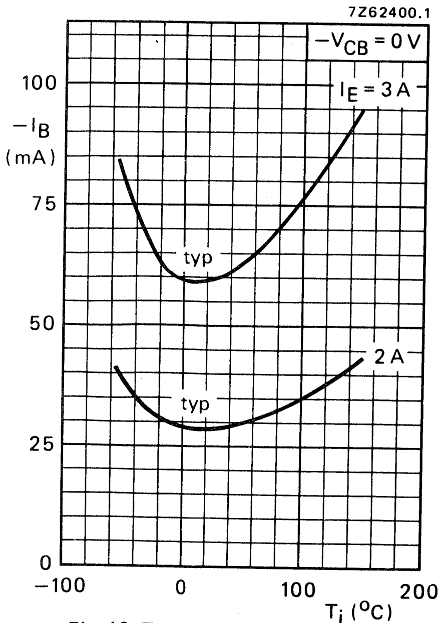


Fig. 12 Typical base current.

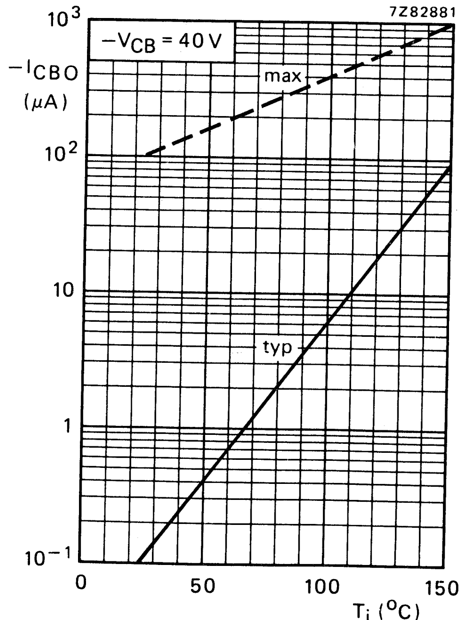


Fig. 13 Collector-base cut-off current.

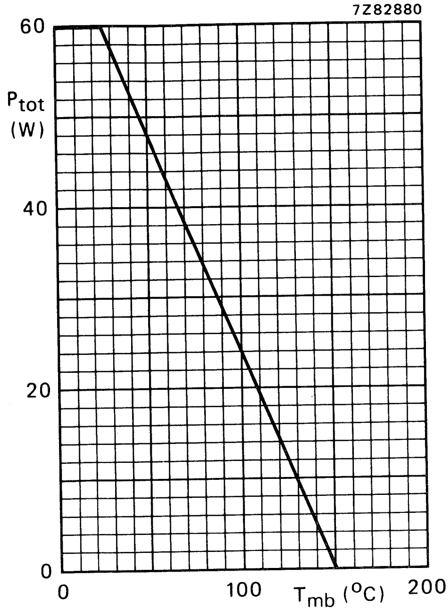


Fig. 14 Total power dissipation

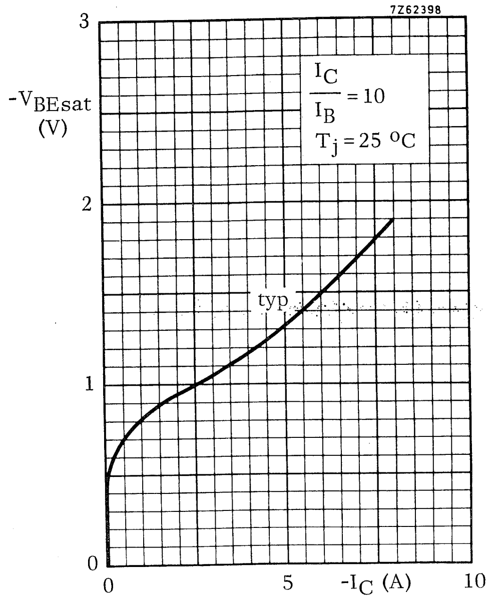


Fig. 15 Base-emitter saturation voltage.

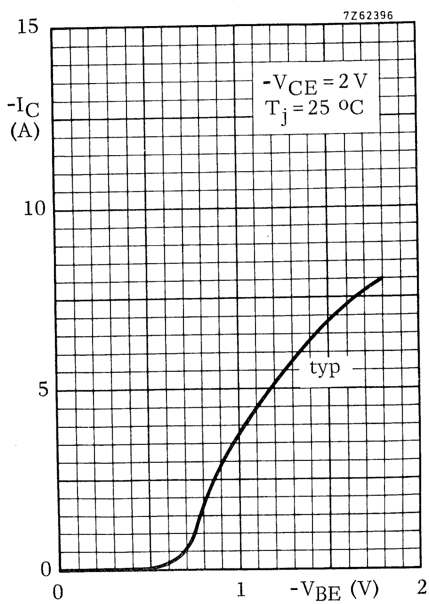


Fig. 16 Typical collector current.

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

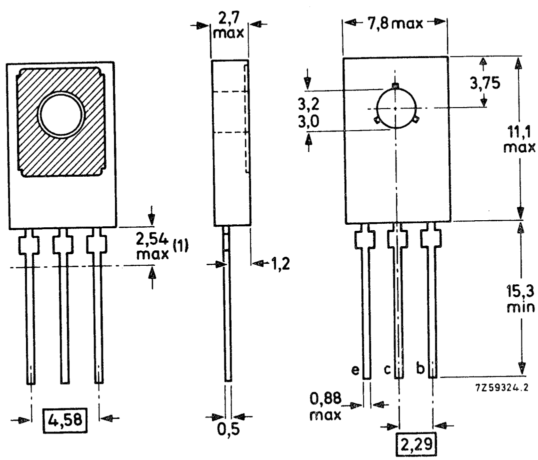
			BD226	BD228	BD230	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.	3	3	3	A
Total power dissipation up to T_{mb} =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

Voltages

			BD226	BD228	BD230	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V

Currents

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

Power dissipation

Total power dissipation up to T_{mb} = 62 °C	P_{tot}	max.	12,5	W

Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

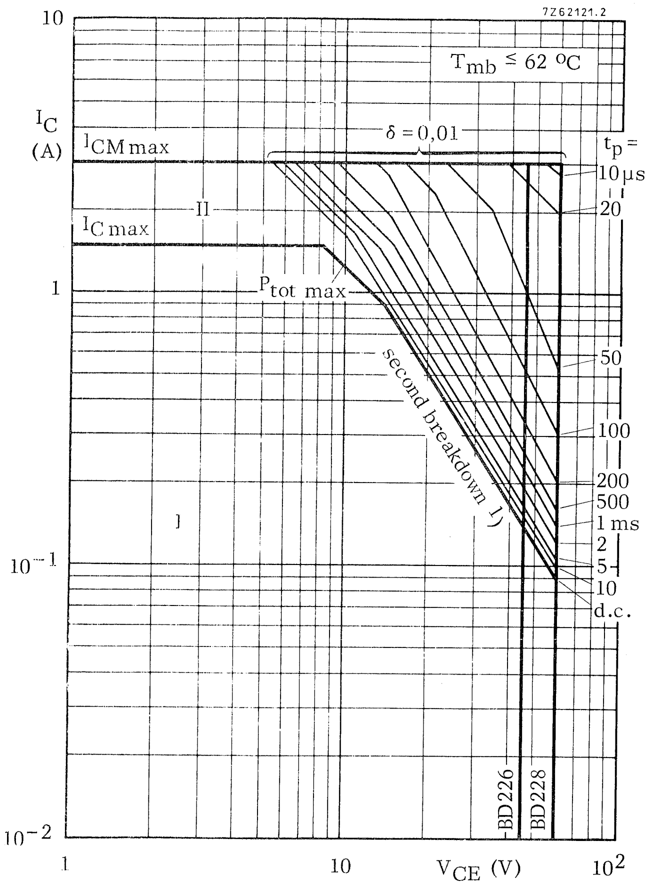
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	7	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
Base-emitter voltage [1]				
$I_C = 1$ A; $V_{CE} = 2$ V	V_{BE}	<	1,3	V
Saturation voltage				
$I_C = 1$ A; $I_B = 0.1$ A	V_{CEsat}	<	0,8	V
D.C. current gain				
$I_C = 5$ mA; $V_{CE} = 2$ V	h_{FE}	>	25	
$I_C = 150$ mA; $V_{CE} = 2$ V	h_{FE}		40 to 250	←
$I_C = 1$ A ; $V_{CE} = 2$ V	h_{FE}	>	25	
Transition frequency at f = 35 MHz				
$I_C = 50$ mA; $V_{CE} = 5$ V	f_T	typ.	125	MHz
D.C. current gain ratio of matched pairs				
BD226/BD227; BD228/BD229;				
BD230/BD231				
$\|I_C\| = 150$ mA; $\|V_{CE}\| = 2$ V	h_{FE1}/h_{FE2}	typ. <	1,3 1,6	

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

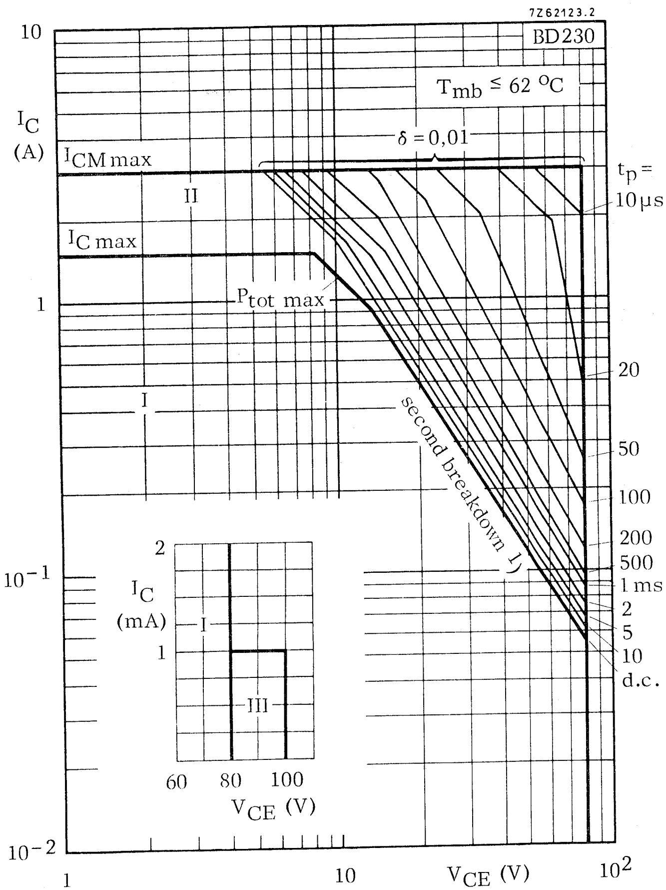


Safe Operating Area with the transistor forward biased

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

1) Independent of temperature



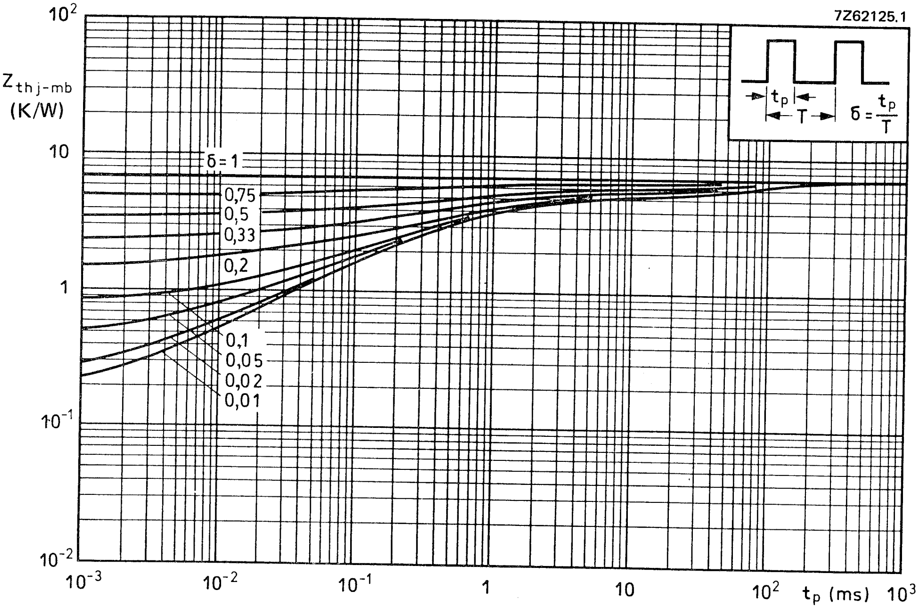
Safe Operating Area with the transistor forward biased

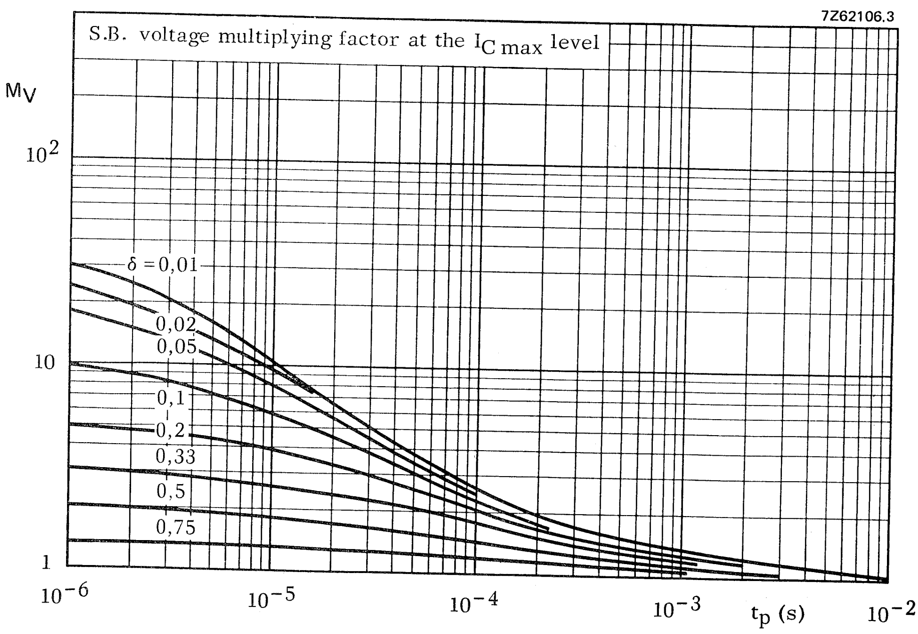
I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

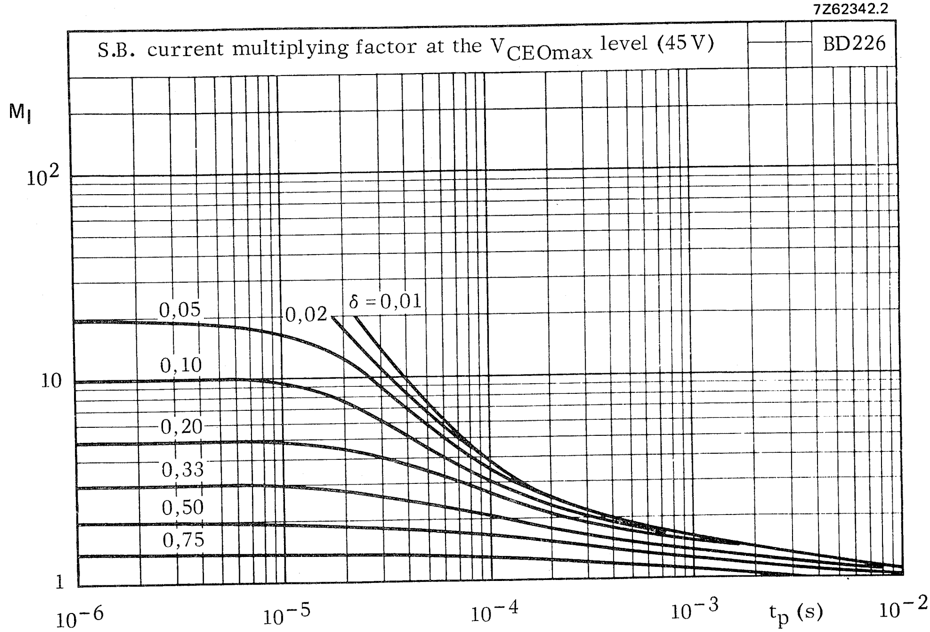
III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 1\ k\Omega$

1) Independent of temperature

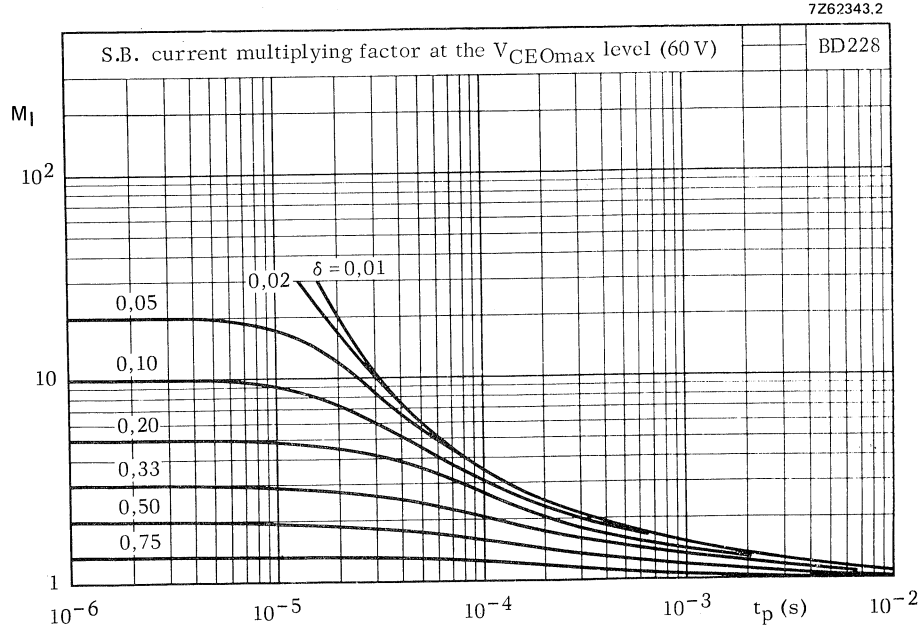

7Z62125.1
$Z_{th\,j\text{-}mb}$ (K/W)
δ = 1
0,75
0,5
0,33
0,2
0,1
0,05
0,02
0,01
$\delta = \frac{t_p}{T}$
t_p
T
10^{-2}
10^{-1}
1
10
10^2
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t_p (ms)
10^3

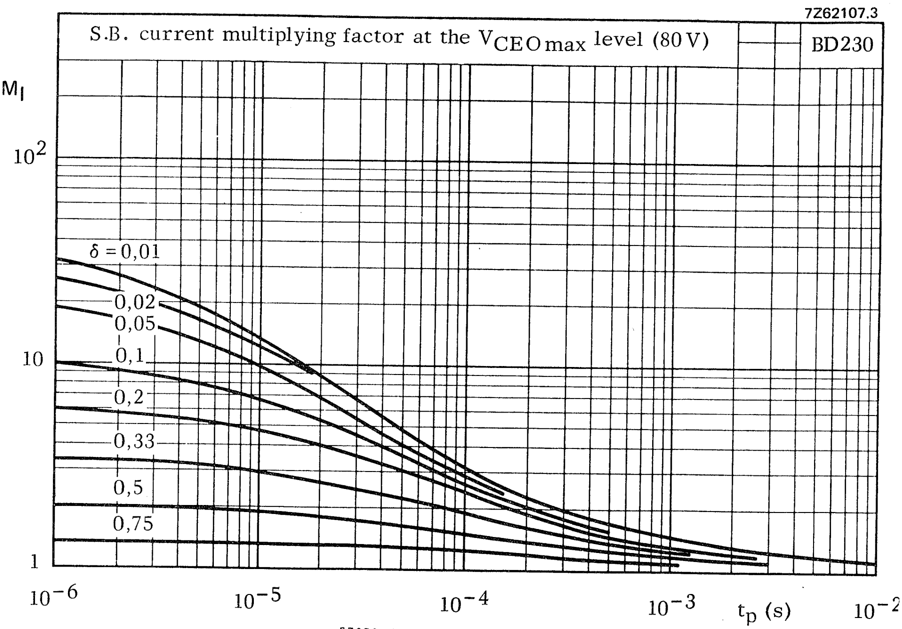

7Z62106.3
S.B. voltage multiplying factor at the $I_{C\,max}$ level
M_V
10^2
10
1
δ = 0,01
0,02
0,05
0,1
0,2
0,33
0,5
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

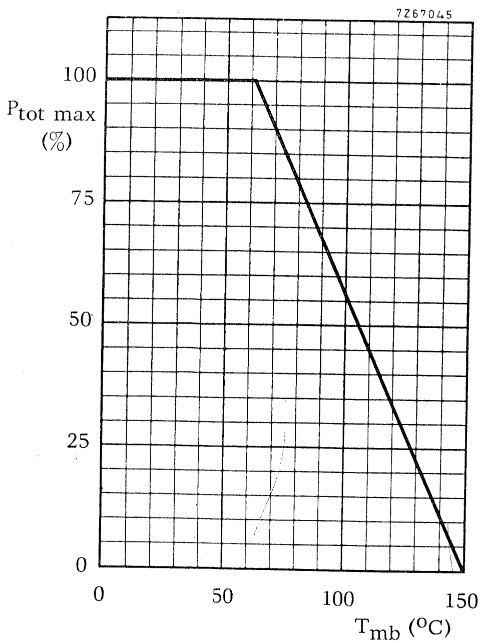
7Z62342.2

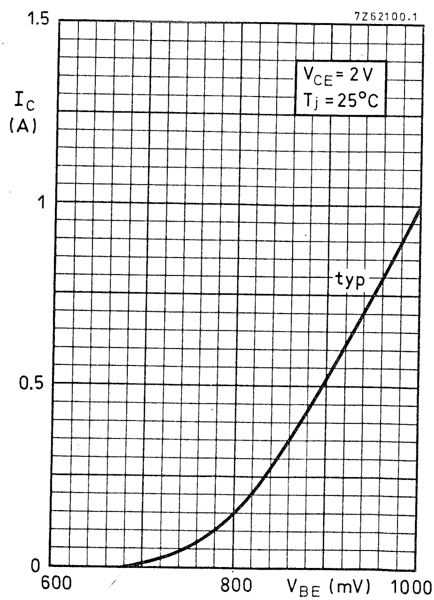


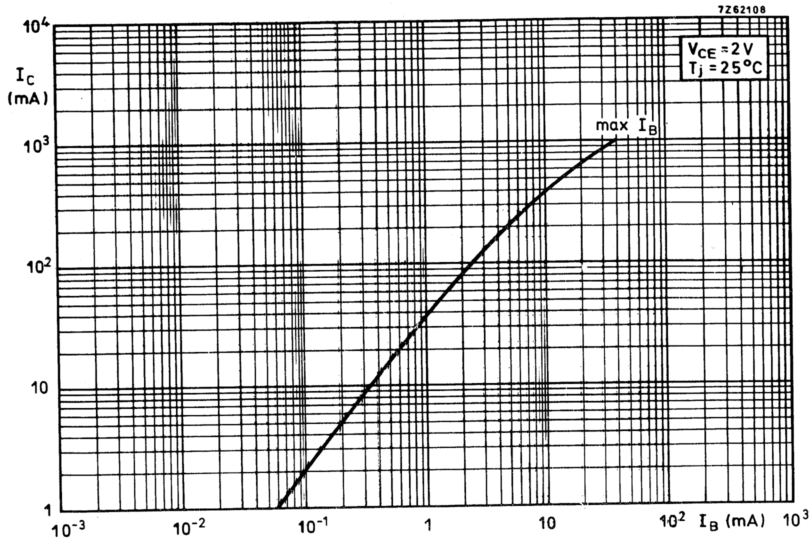
7Z62343.2

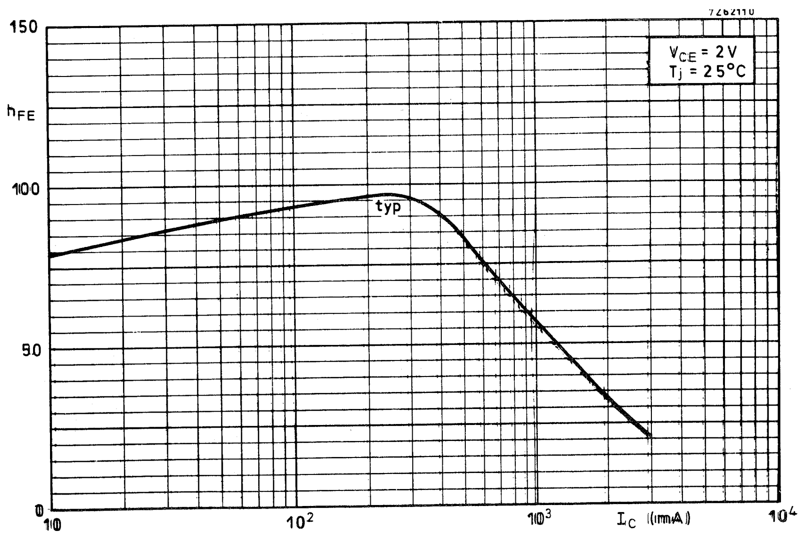


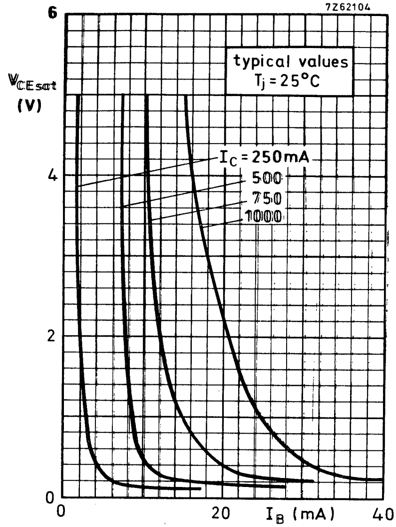

7Z62107.3
S.B. current multiplying factor at the VCEOmax level (80 V)
BD230
MI
10^2
10
1
δ = 0,01
0,02
0,05
0,1
0,2
0,33
0,5
0,75
10^-6
10^-5
10^-4
10^-3
tp (s)
10^-2

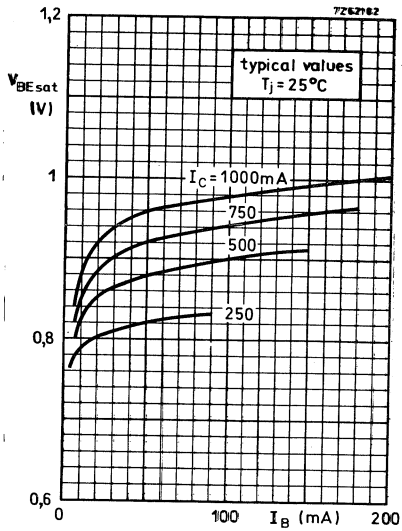

7Z67045
100
Ptot max
(%)
75
50
25
0
0
50
100
150
Tmb (°C)

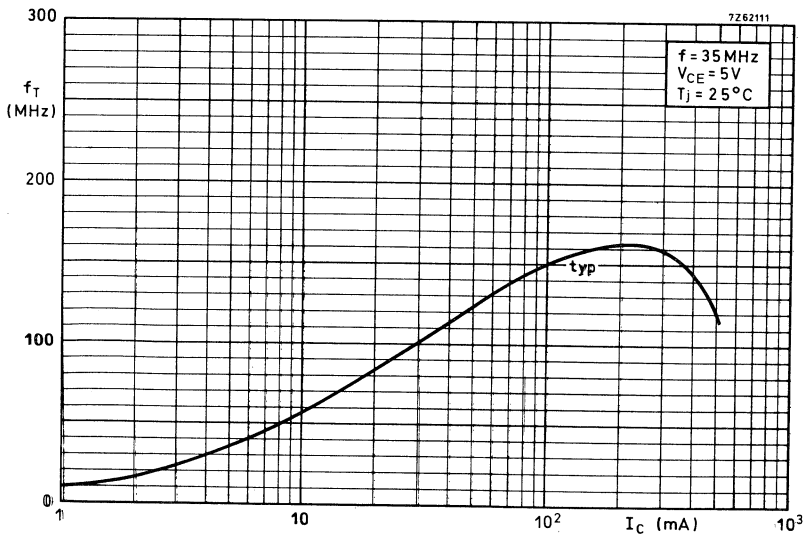

7Z62100.1
1.5
IC
(A)
VCE = 2 V
Tj = 25°C
1
typ
0.5
0
600
800
VBE (mV)
1000


7Z62108
V_{CE} = 2 V
T_j = 25 °C
I_C (mA)
max I_B
10^4
10^3
10^2
10
1
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
I_B (mA)
10^3


7Z62110
V_{CE} = 2 V
T_j = 25 °C
h_{FE}
typ
150
100
50
0
10
10^2
10^3
I_C (mA)
10^4


7Z62104
typical values
$T_j = 25°C$
V_{CEsat}
(V)
$I_C = 250mA$
500
750
1000
6
4
2
0
0
20
I_B (mA)
40


7Z62102
typical values
$T_j = 25°C$
V_{BEsat}
(V)
$I_C = 1000mA$
750
500
250
1,2
1
0,8
0,6
0
100
I_B (mA)
200


7Z62111
f = 35 MHz
$V_{CE} = 5V$
$T_j = 25°C$
f_T
(MHz)
typ
300
200
100
0
1
10
10^2
I_C (mA)
10^3

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

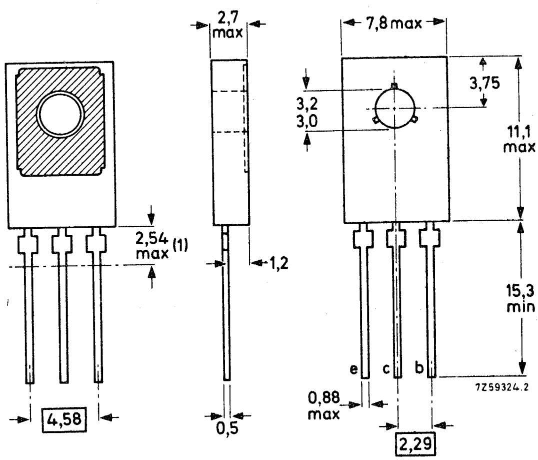
			BD227	BD229	BD231	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Collector current (peak value)	$-I_{CM}$	max.	3	3	3	A
Total power dissipation up to T_{mb} = 62 °C	P_{tot}	max.	12,5	12,5	12,5	W
Junction temperature	T_j	max.	150	150	150	°C
D.C. current gain						
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}			40 to 250		
$-I_C$ = 1 A; $-V_{CE}$ = 2 V	h_{FE}	>		25		
Transition frequency						
$-I_C$ = 50 mA; $-V_{CE}$ = 5 V	f_T	typ.		50		MHz

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)

Voltages

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

Currents

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

Power dissipation

Total power dissipation up to T_{mb} = 62 °C	P_{tot}	max.	12,5	W

Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

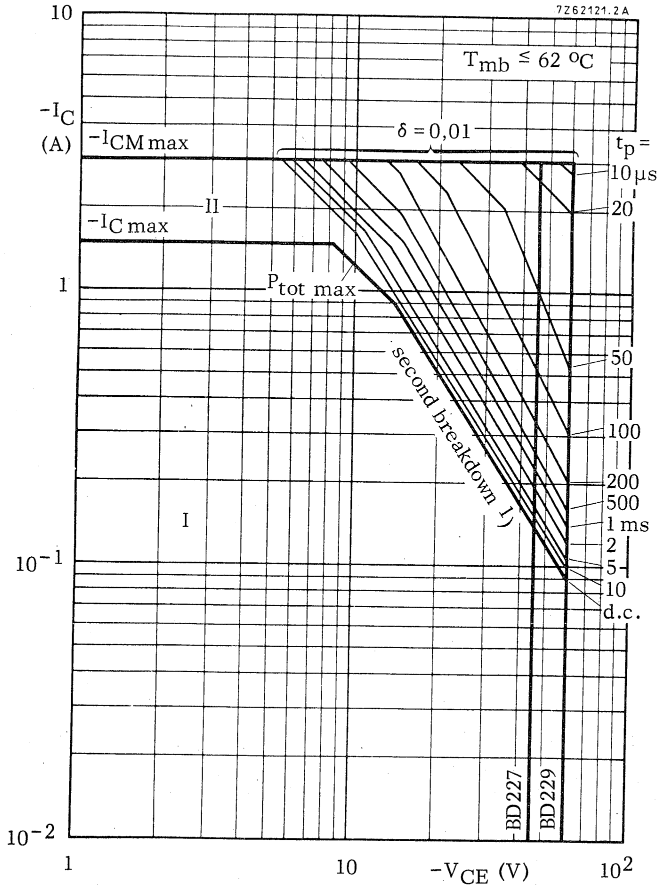
THERMAL RESISTANCE

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

CHARACTERISTICS $T_j = 25\ ^oC$ 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; $T_j = 125\ ^oC$	$-I_{CBO}$	<	10	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	10	μA
Base-emitter voltage [1]				
$-I_C = 1$ A; $-V_{CE} = 2$ V	$-V_{BE}$	<	1,3	V
Saturation voltage				
$-I_C = 1$ A; $-I_B = 0.1$ A	$-V_{CEsat}$	<	0,8	V
D.C. current gain				
$-I_C = 5$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25	
$-I_C = 150$ mA; $-V_{CE} = 2$ V	h_{FE}	<	40 to 250	
$-I_C = 1$ A ; $-V_{CE} = 2$ V	h_{FE}	>	25	
Transition frequency at f = 35 MHz				
$-I_C = 50$ mA; $-V_{CE} = 5$ V	f_T	typ.	50	MHz
D.C. current gain ratio of matched pairs				
BD226/BD227; BD228/BD229;				
BD230/BD231				
$\|I_C\| = 150$ mA; $\|V_{CE}\| = 2$ V	h_{FE1}/h_{FE2}	typ. <	1,3 1,6	

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

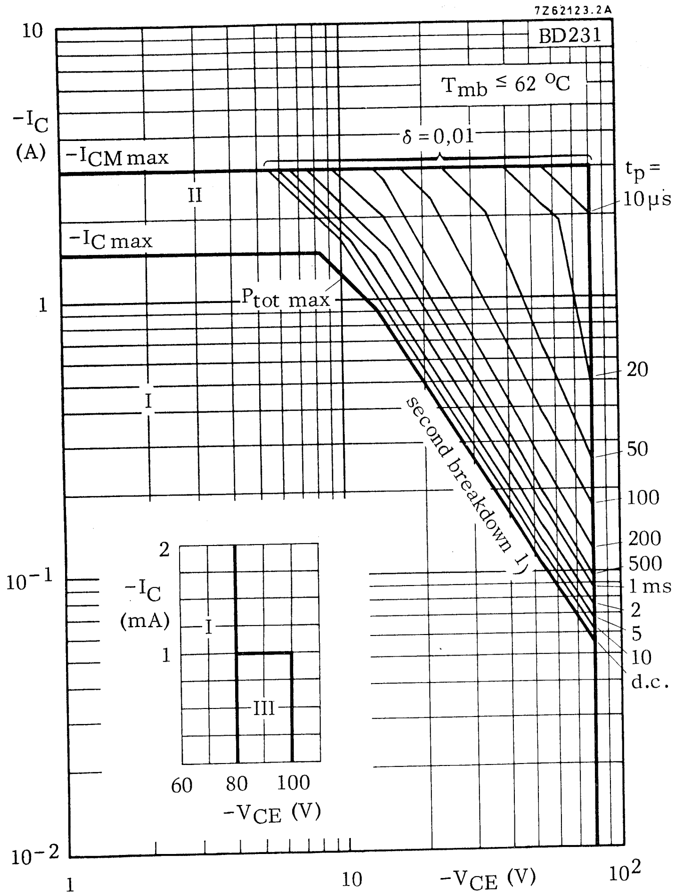


Safe Operating Area with the transistor forward biased

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

1) Independent of temperature



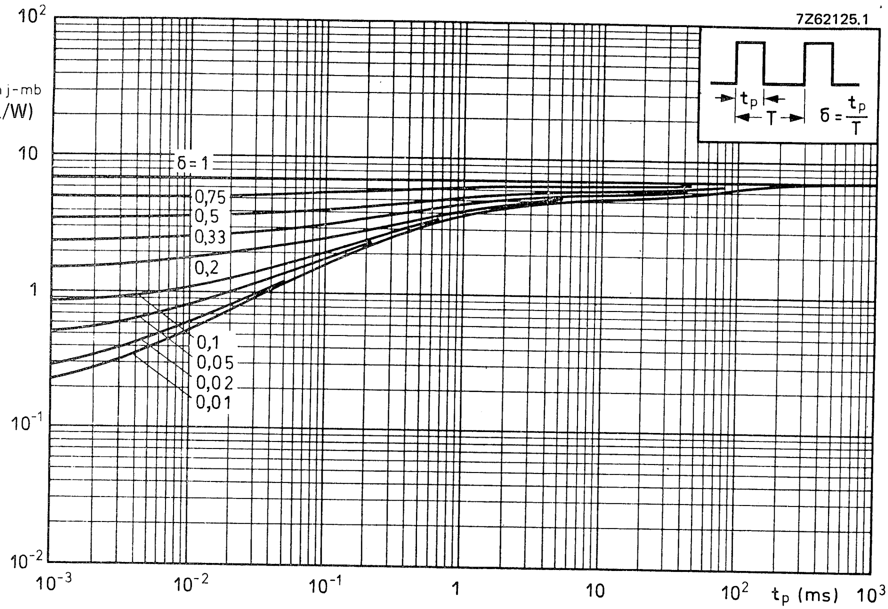
Safe Operating Area with the transistor forward biased

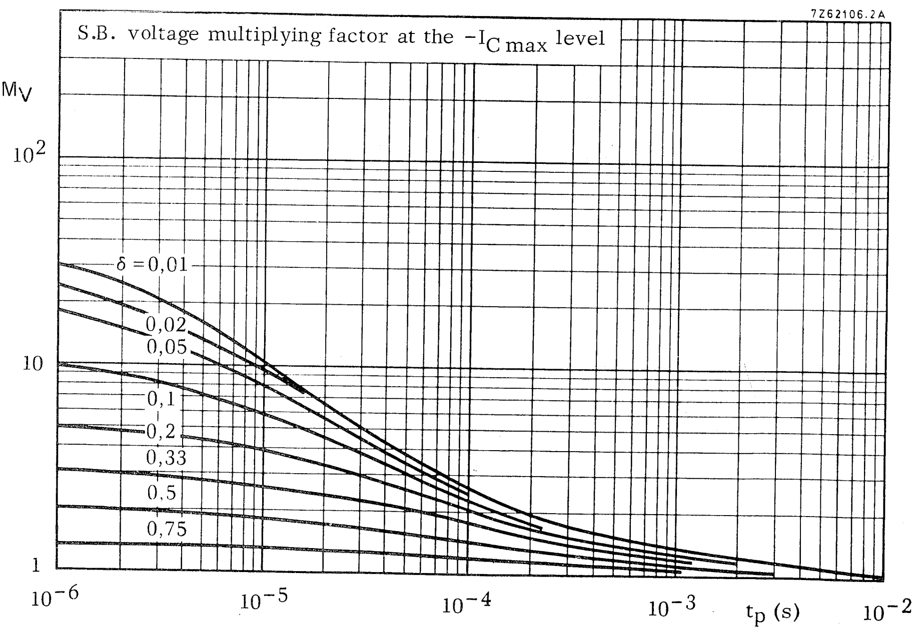
I Region of permissible d.c. operation

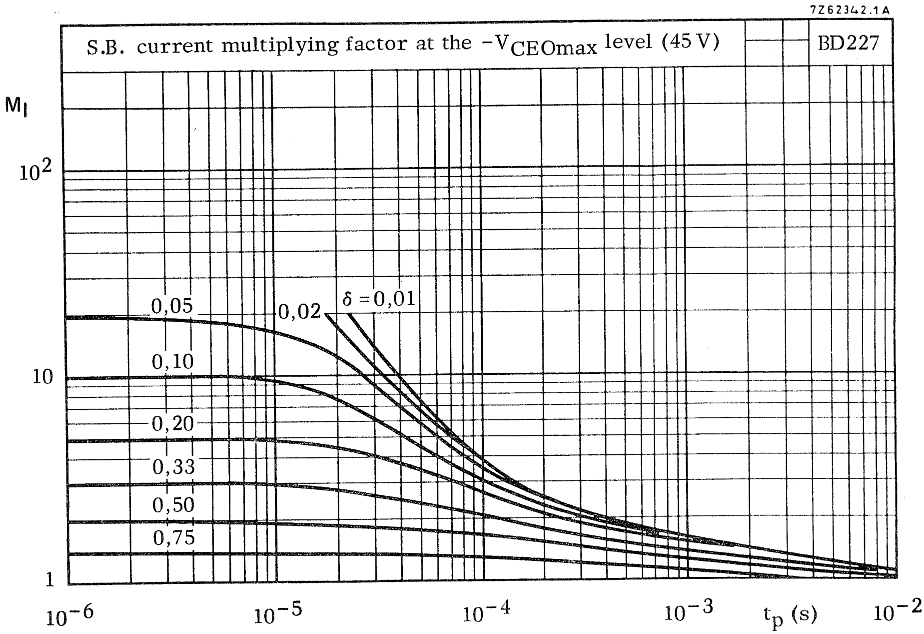
II Permissible extension for repetitive pulse operation

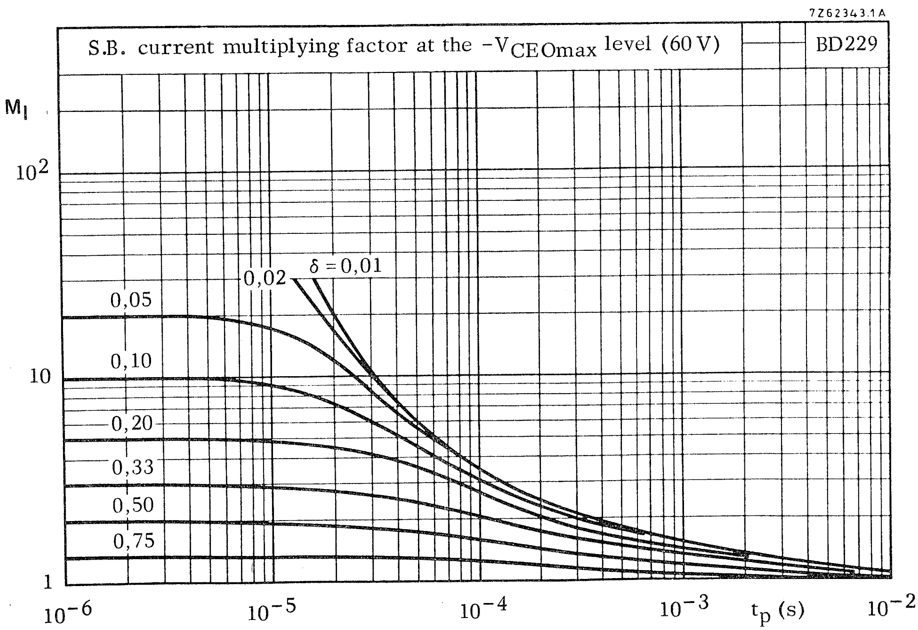
III Repetitive pulse operation in this region is allowable, provided $R_{BE} \leq 1\ k\Omega$

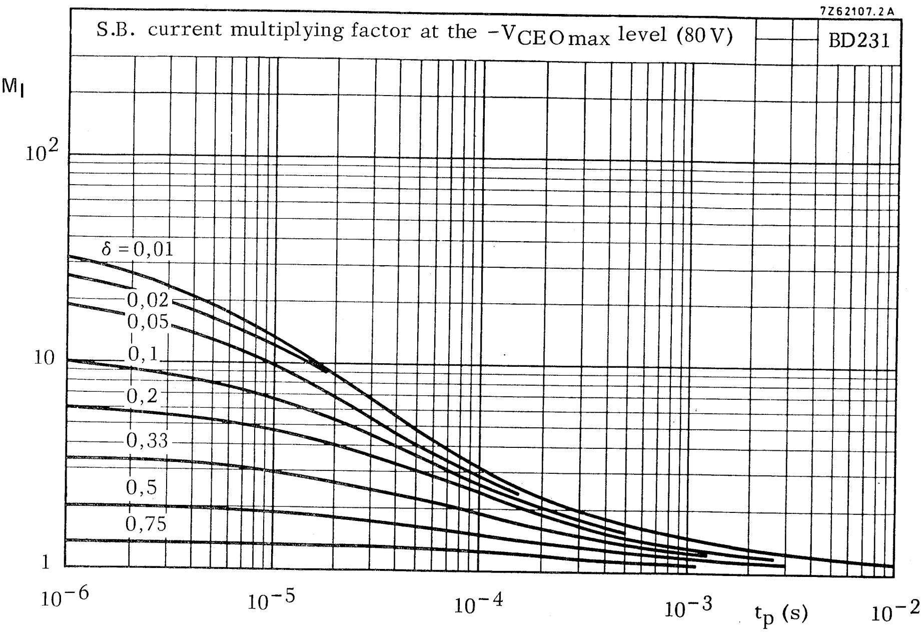
1) Independent of temperature

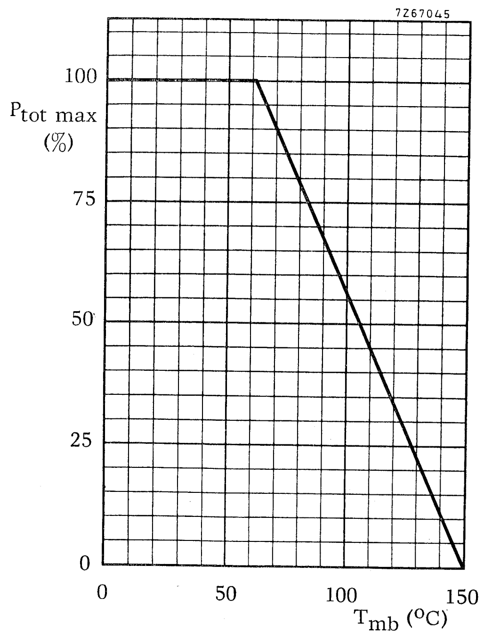

7Z62125.1
$Z_{th\,j\text{-}mb}$ (K/W)
$\delta = \frac{t_p}{T}$
δ = 1
0,75
0,5
0,33
0,2
0,1
0,05
0,02
0,01
t_p (ms)

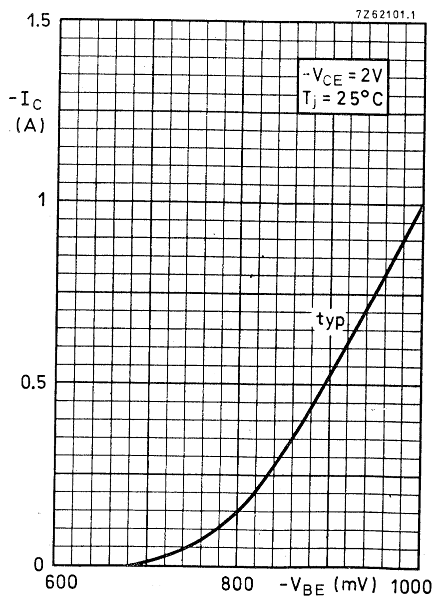

7Z62106.2A
S.B. voltage multiplying factor at the $-I_{C\,max}$ level
M_V
δ = 0,01
0,02
0,05
0,1
0,2
0,33
0,5
0,75
t_p (s)

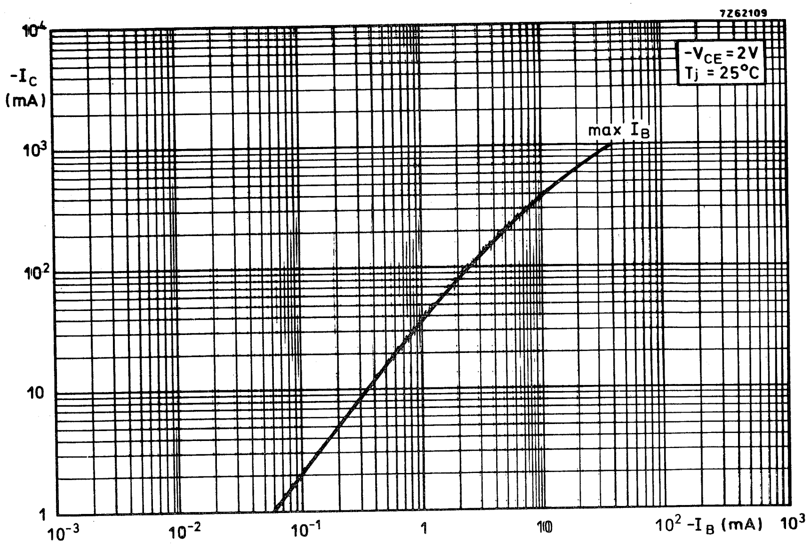

7Z62342.1A
S.B. current multiplying factor at the $-V_{CEOmax}$ level (45 V)
BD227
M_I
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

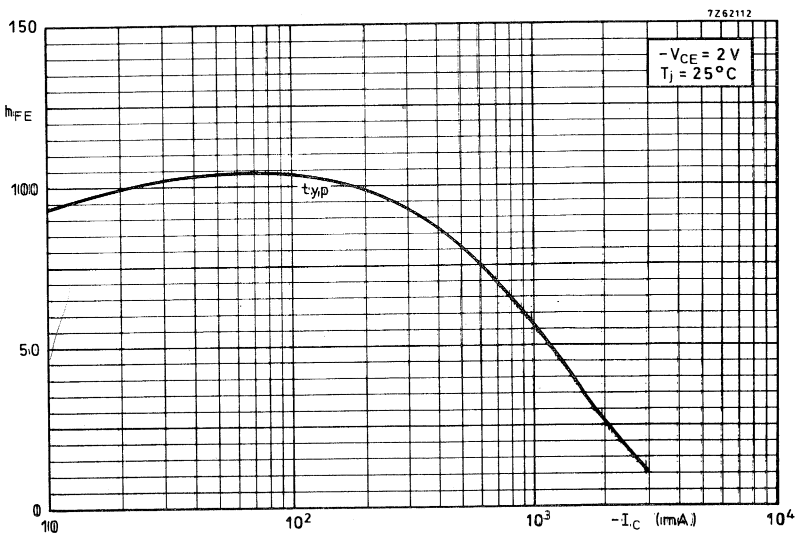

7Z62343.1A
S.B. current multiplying factor at the $-V_{CEOmax}$ level (60 V)
BD229
M_I
10^2
10
1
0,02
δ = 0,01
0,05
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

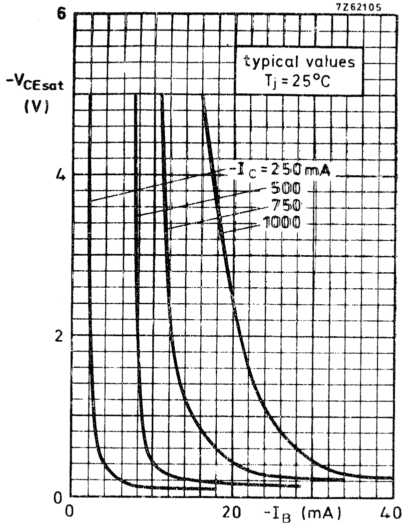

7Z62107.2A
S.B. current multiplying factor at the $-V_{CEOmax}$ level (80 V)
BD231
M_I
10^2
10
1
δ = 0,01
0,02
0,05
0,1
0,2
0,33
0,5
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

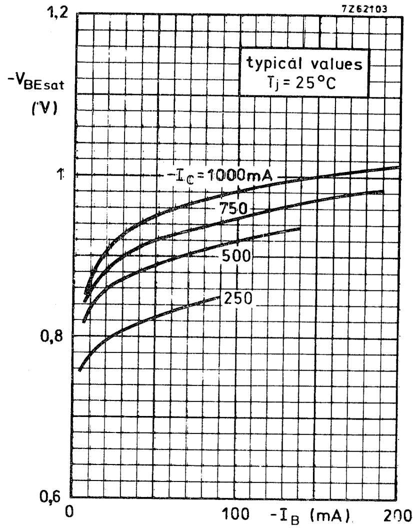

7Z67045
100
$P_{tot\ max}$ (%)
75
50
25
0
0
50
100
150
T_{mb} (°C)

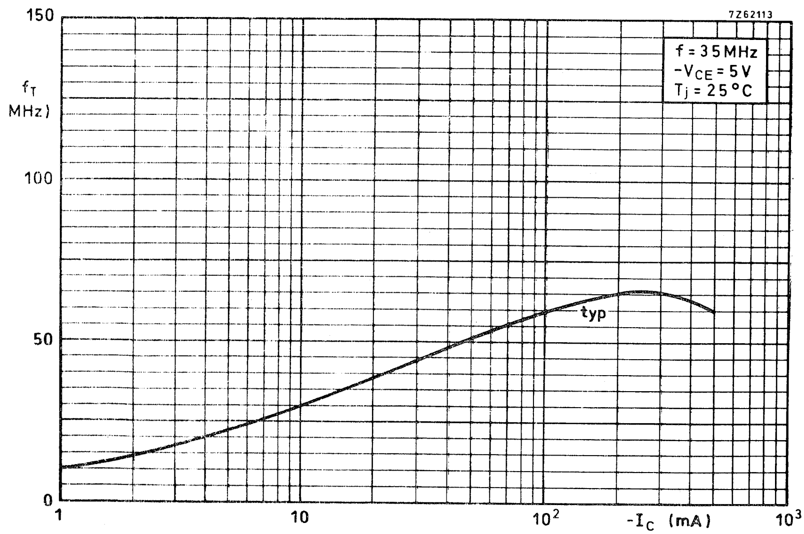

7Z62101.1
1.5
$-I_C$ (A)
1
0.5
0
$-V_{CE}$ = 2V
T_j = 25°C
typ
600
800
$-V_{BE}$ (mV)
1000


7Z62109
$-I_C$ (mA)
10^4
10^3
10^2
10
1
$-V_{CE}$ = 2V
T_j = 25°C
max I_B
10^{-3}
10^{-2}
10^{-1}
1
10
10^2 $-I_B$ (mA)
10^3


7Z62112
h_{FE}
150
100
50
0
$-V_{CE}$ = 2 V
T_j = 25°C
typ
10
10^2
10^3
$-I_C$ (mA)
10^4


7Z62105
typical values
$T_j = 25°C$
$-V_{CEsat}$ (V)
$-I_C$ = 250 mA
500
750
1000
6
4
2
0
0
20
40
$-I_B$ (mA)


7Z62103
typical values
$T_j = 25°C$
$-V_{BEsat}$ (V)
$-I_C$ = 1000 mA
750
500
250
1,2
1
0,8
0,6
0
100
200
$-I_B$ (mA)


7Z62113
f = 35 MHz
$-V_{CE} = 5$ V
$T_j = 25°C$
f_T (MHz)
typ
150
100
50
0
1
10
10^2
10^3
$-I_C$ (mA)

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

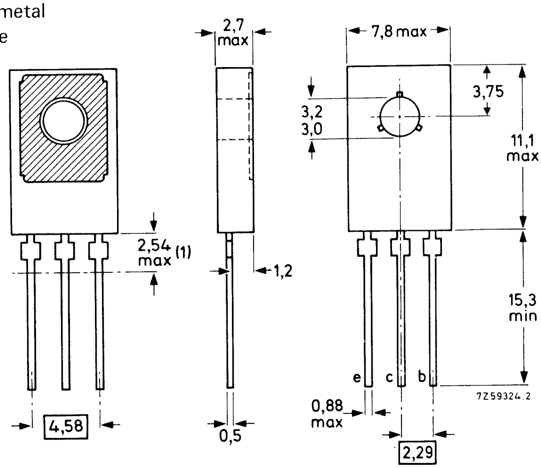
			BD233	BD235	BD237	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.		6		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		25		W
Junction temperature	T_j	max.		150		°C
D.C. current gain I_C = 1 A; V_{CE} = 2 V	h_{FE}	>		25		
Transition frequency I_C = 250 mA; V_{CE} = 10 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_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V

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 °C	P_{tot}	max.	25	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	$R_{th\ j\text{-}a}$	=	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

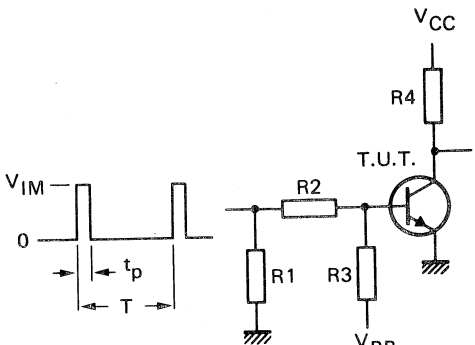
Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	100	μA
$I_E = 0$; $V_{CB} = V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	3	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	1	mA
Second-breakdown collector current				
V_{CE} = 40 V; t_p = 20 ms	$I_{(SB)C}$	<	0,5	A
Base-emitter voltage*				
I_C = 1 A; V_{CE} = 2 V	V_{BE}	<	1,3	V
Saturation voltage*				
I_C = 1 A; I_B = 0,1 A	V_{CEsat}	<	0,6	V
D.C. current gain*				
I_C = 150 mA; V_{CE} = 2 V	h_{FE}		40 to 250	
I_C = 1 A; V_{CE} = 2 V	h_{FE}	>	25	
Transition frequency at f = 1 MHz				
I_C = 250 mA; V_{CE} = 10 V	f_T	>	3	MHz

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

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified.

D.C. current gain ratio of matched complementary pairs*			
$\vert I_C \vert$ = 150 mA; $\vert V_{CE} \vert$ = 2 V	h_{FE1}/h_{FE2}	<	1,6
Switching times			
I_{Con} = 1 A; $I_{Bon} = -I_{Boff}$ = 0,1 A			
turn-on time	t_{on}	typ.	0,4 μs
		<	1 μs
turn-off time	t_{off}	typ.	1,5 μs
		<	3 μs



7Z78131

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

Fig. 2 Test circuit.

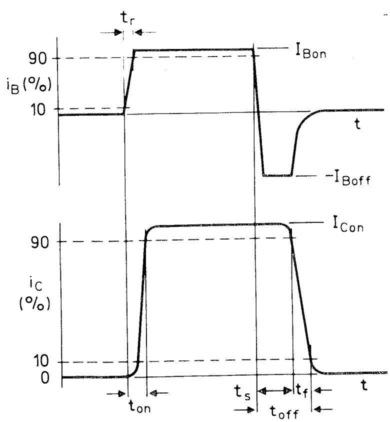


Fig. 3 Switching times waveforms.

* Measured under pulse conditions; t_p < 300 μs, δ < 2%.

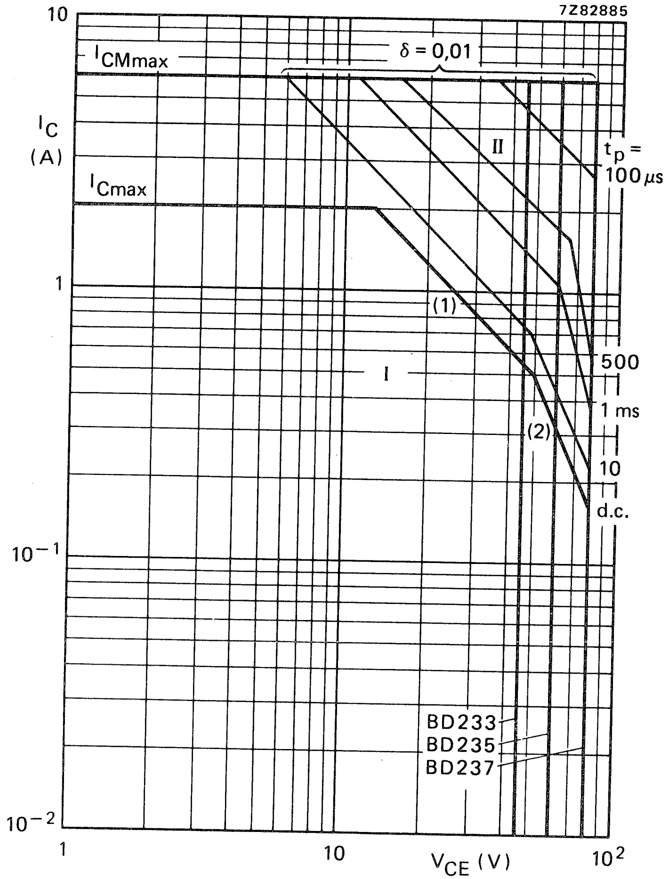


Fig. 4 Safe Operating Area with the transistor forward biased, $T_{mb} \leqslant 25$ °C.

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).

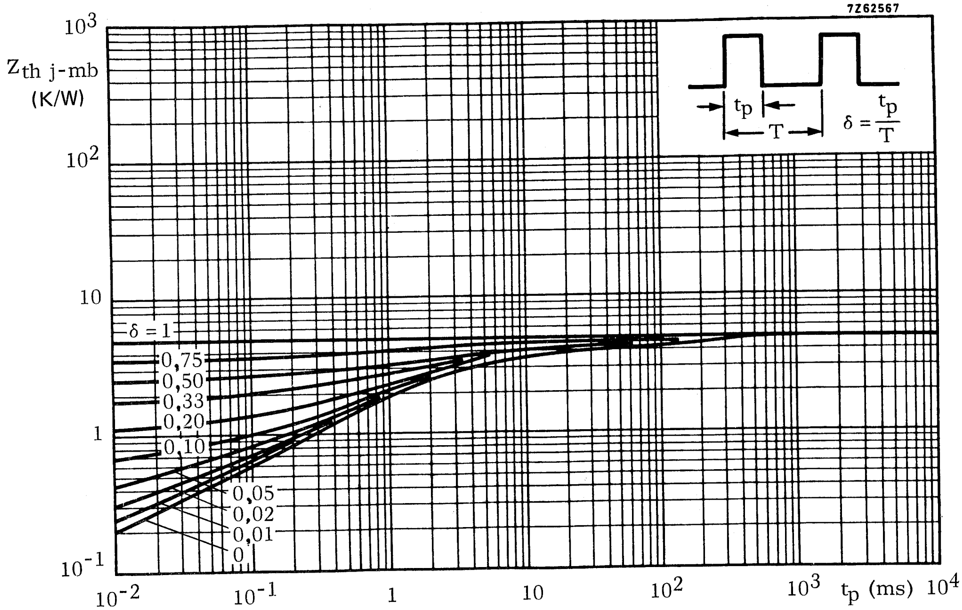
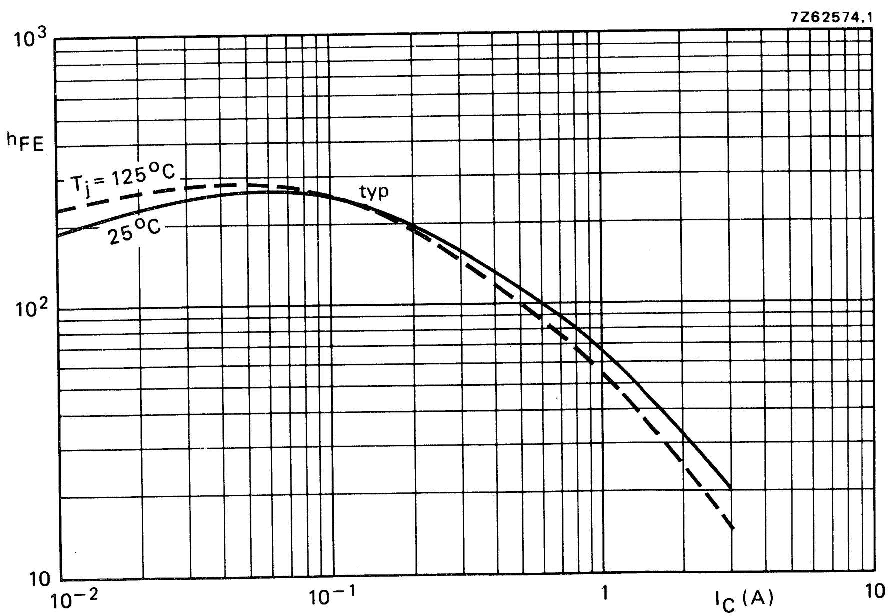


Fig. 5 Pulse power rating chart.



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

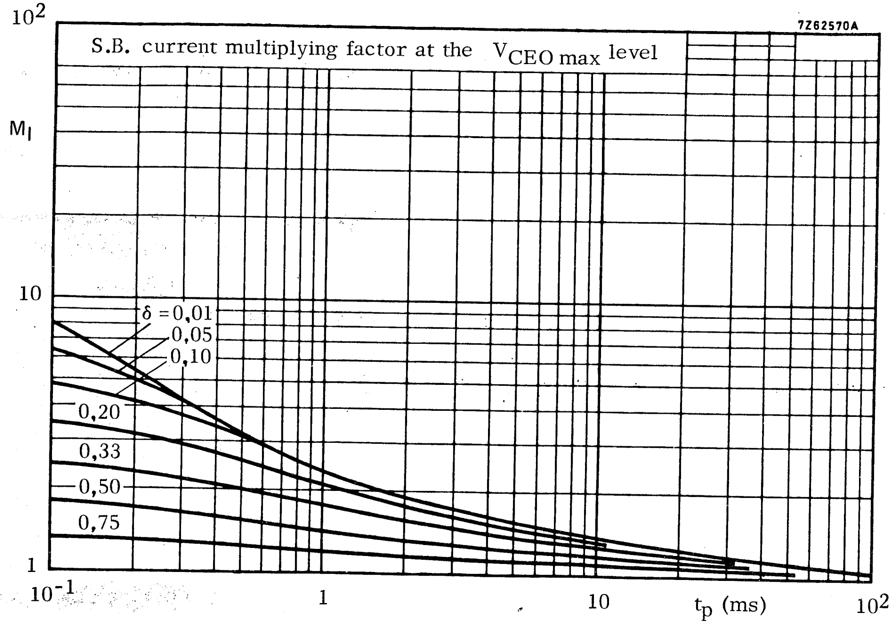


Fig. 7 S.B. current multiplying factor at the V_{CEOmax} level.

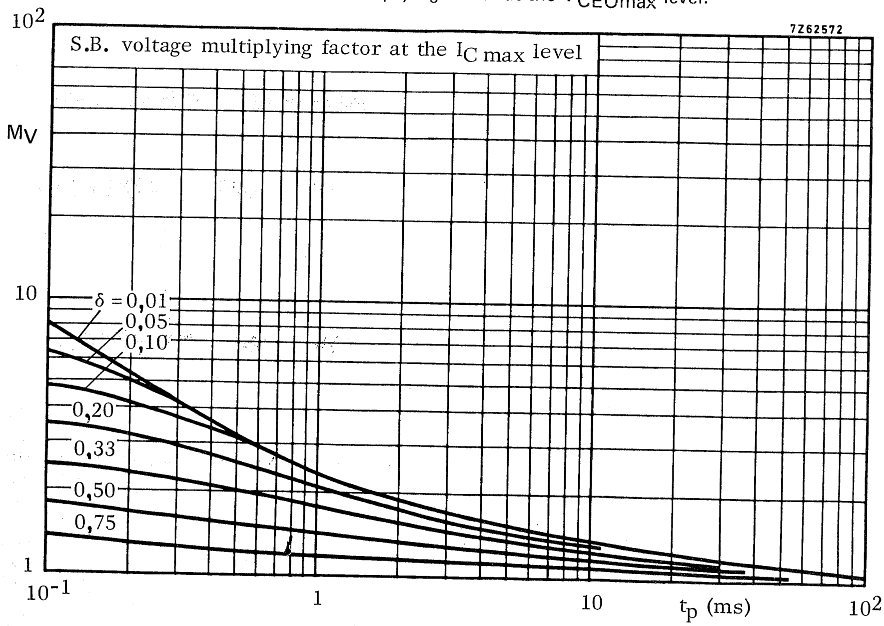


Fig. 8 S.B. voltage multiplying factor at the I_{Cmax} level.

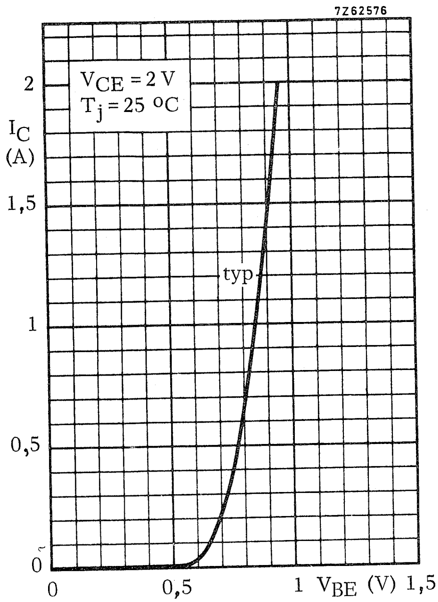

7Z62576
V_{CE} = 2 V
T_j = 25 °C
I_C (A)
2
1,5
1
0,5
0
typ
0
0,5
1
V_{BE} (V)
1,5

Fig. 9.

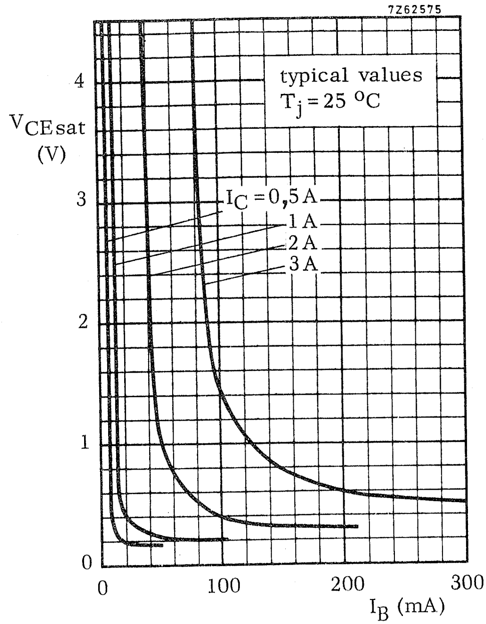

7Z62575
typical values
T_j = 25 °C
V_{CEsat} (V)
4
3
2
1
0
I_C = 0,5 A
1 A
2 A
3 A
0
100
200
300
I_B (mA)

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

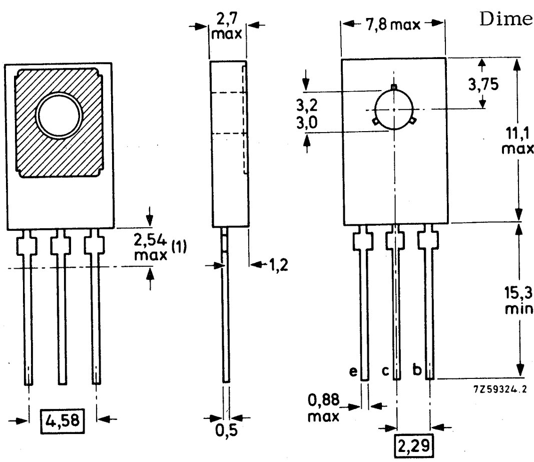
			BD234	BD236	BD238	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Collector current (peak value)	$-I_{CM}$	max.		6		A
Total power dissipation up to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

MECHANICAL DATA

Dimensions in mm

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)

Voltages

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

Currents

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

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	25	W

Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

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

CHARACTERISTICS T_j = 25 °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 °C	$-I_{CBO}$	<	3	mA

Emitter cut-off current

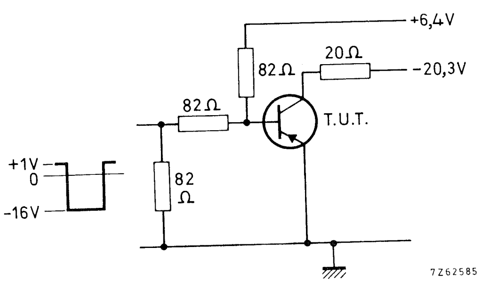
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	1	mA

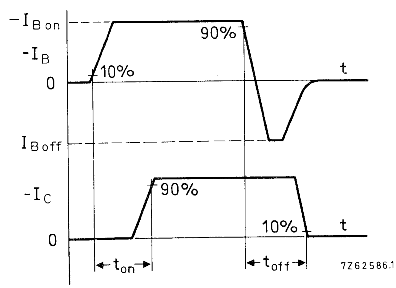
CHARACTERISTICS (continued)

T_j = 25 °C

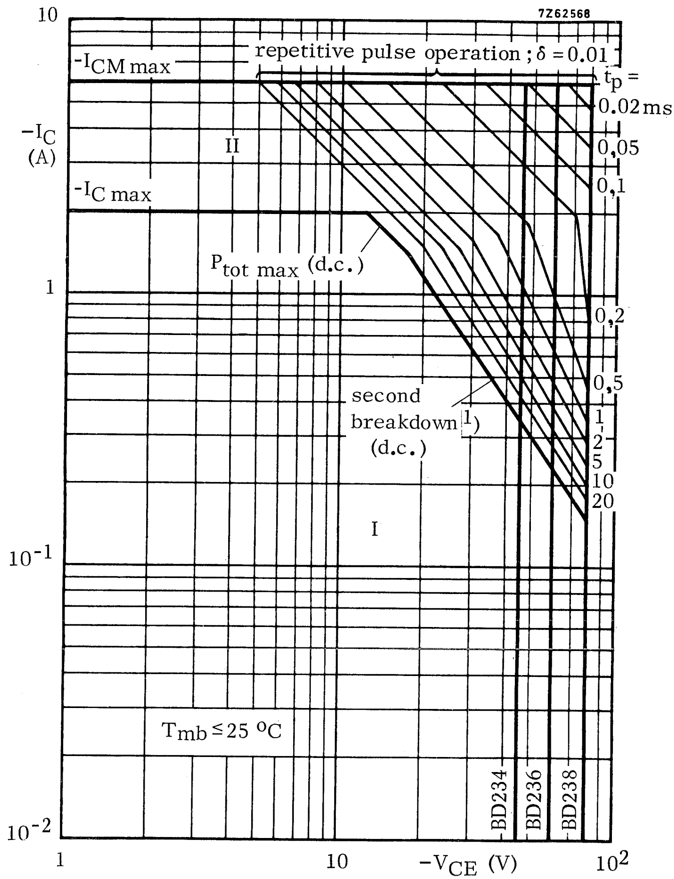
Base-emitter voltage			
$-I_C$ = 1 A; $-V_{CE}$ = 2 V	$-V_{BE}$	<	1,3 V
Saturation voltage			
$-I_C$ = 1 A; $-I_B$ = 0,1 A	$-V_{CEsat}$	<	0,6 V
D.C. current gain			
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}		40 to 250
$-I_C$ = 1 A; $-V_{CE}$ = 2 V	h_{FE}	>	25
Transition frequency at f = 1 MHz			
$-I_C$ = 250 mA; $-V_{CE}$ = 10 V	f_T	>	3 MHz
D.C. current gain ratio of matched pairs BD233/BD234; BD235/BD236; BD237/BD238			
$\lvert I_C \rvert$ = 150 mA; $\lvert V_{CE} \rvert$ = 2 V	h_{FE1}/h_{FE2}	<	1,6
Switching times			
$-I_{Con}$ = 1 A; $-I_{Bon}$ = I_{Boff} = 0,1 A			
turn-on time	t_{on}	typ	0,3 µs
turn-off time	t_{off}	typ	0,7 µs

Test circuit





Input pulse:
$t_r = t_f$ = 15 ns
t_p = 10 µs
T = 500 µs

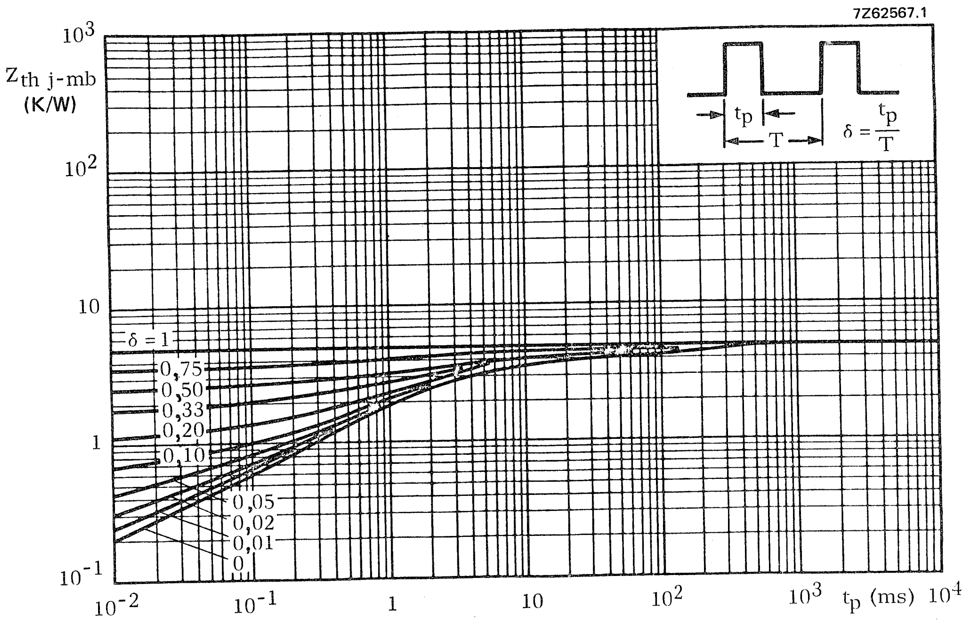


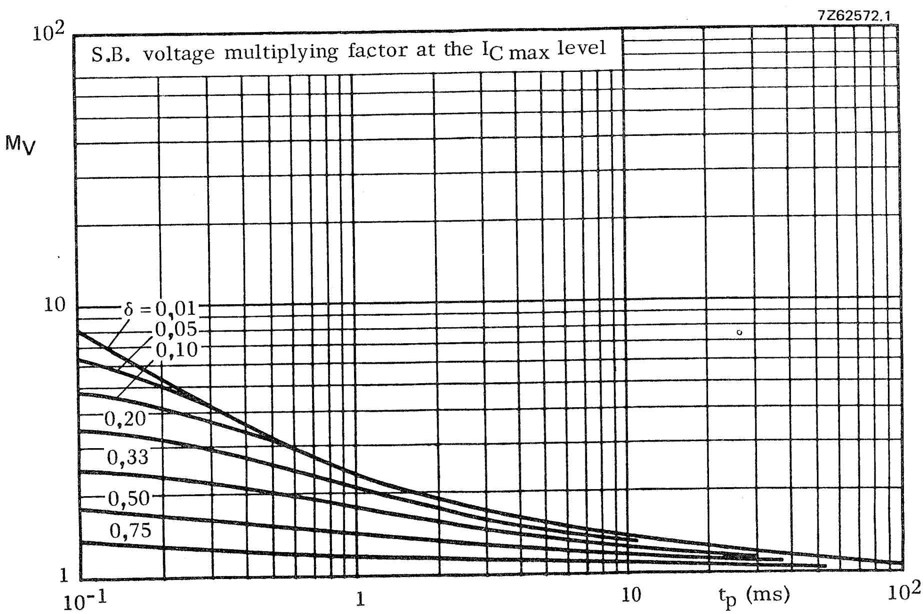
Safe Operating Area with the transistor forward biased

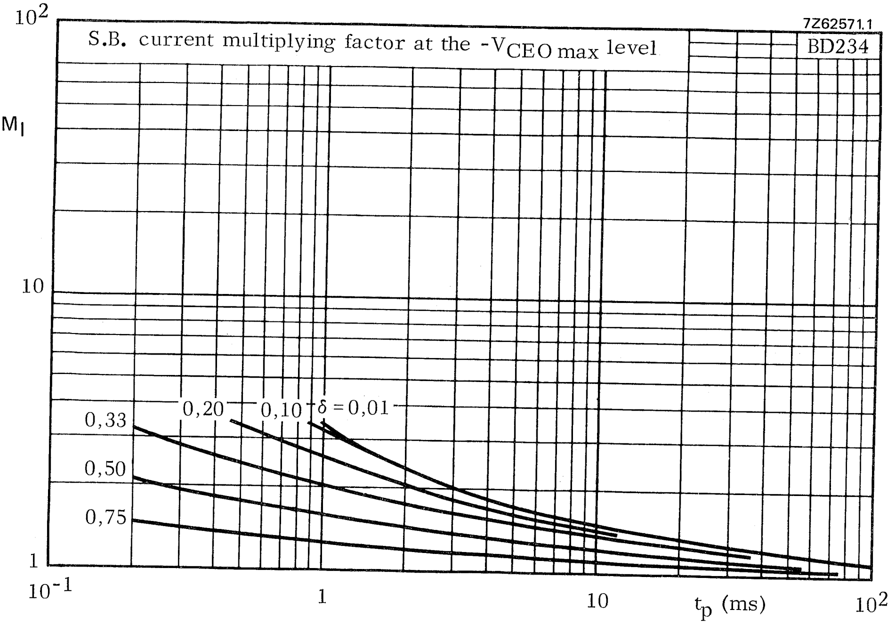
I Region of permissible d.c. operation

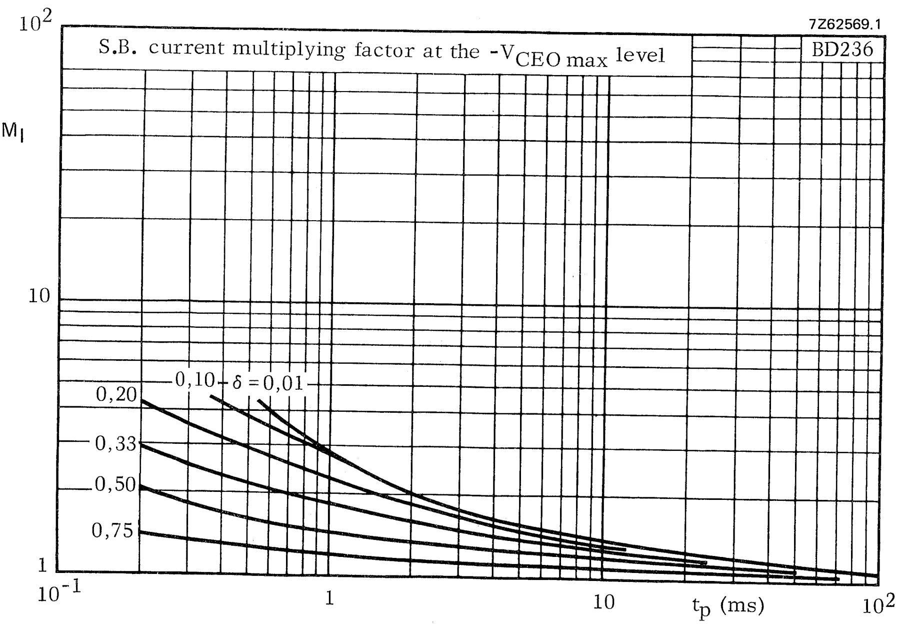
II Permissible extension for repetitive pulse operation

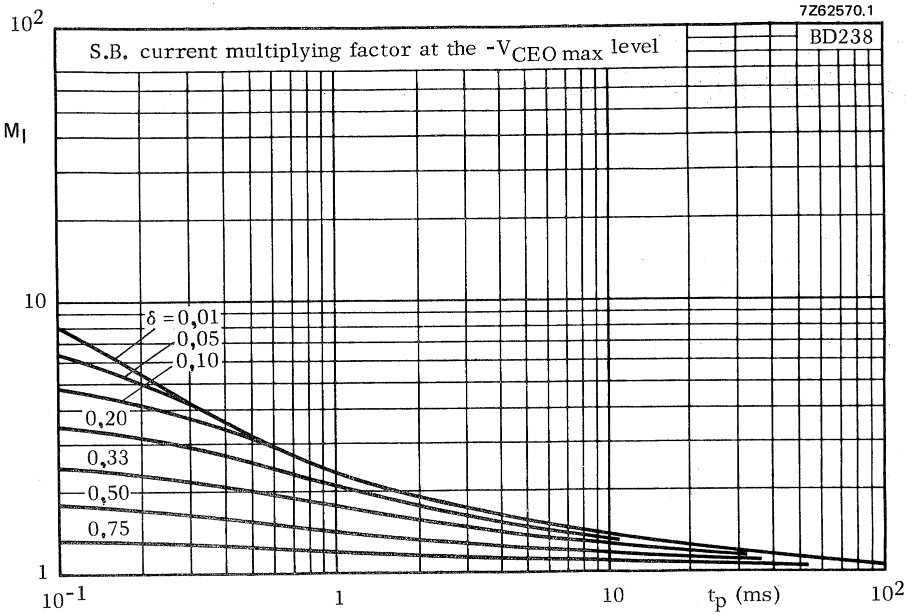
1) Independent of temperature.

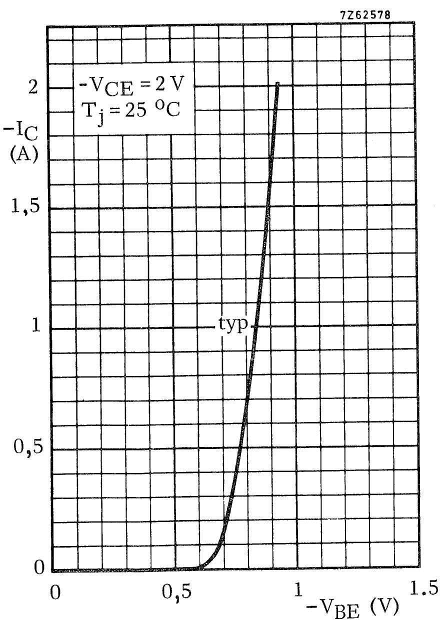

7Z62567.1
$Z_{th\ j\text{-}mb}$ (K/W)
10^3
10^2
10
1
10^{-1}
$\delta = 1$
0,75
0,50
0,33
0,20
0,10
0,05
0,02
0,01
0
t_p
T
$\delta = \frac{t_p}{T}$
10^{-2}
10^{-1}
1
10
10^2
10^3
t_p (ms)
10^4

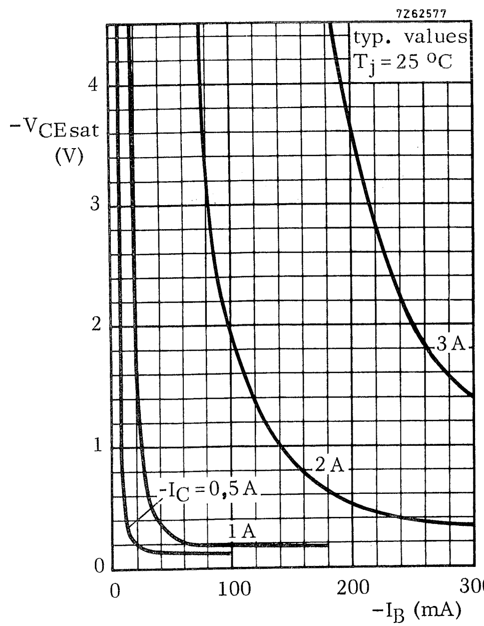

7Z62572.1
S.B. voltage multiplying factor at the $I_{C\,max}$ level
M_V
10^2
10
1
$\delta = 0,01$
0,05
0,10
0,20
0,33
0,50
0,75
10^{-1}
1
10
t_p (ms)
10^2

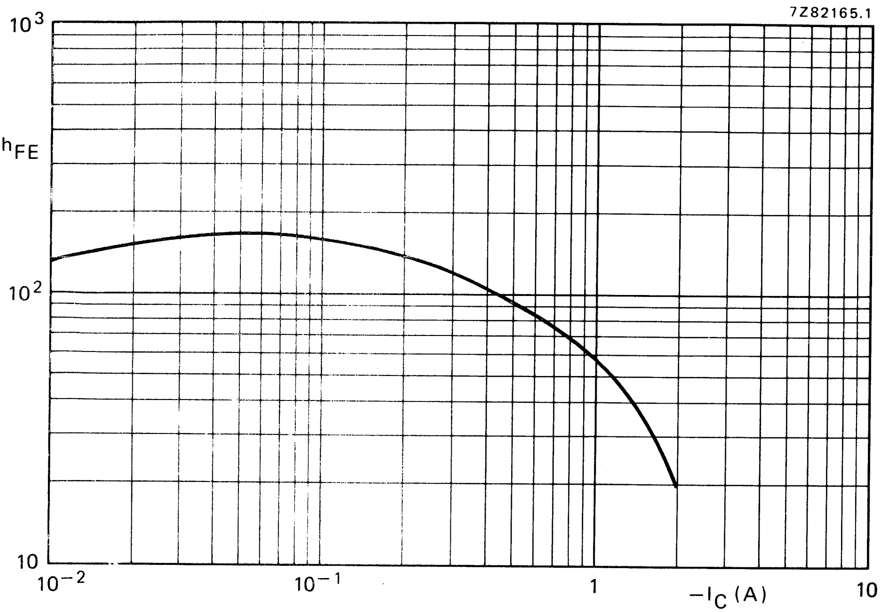

7Z62571.1
S.B. current multiplying factor at the -VCEO max level
BD234
M1
10^2
10
1
10^-1
1
10
tp (ms)
10^2
0,33
0,20
0,10
δ = 0,01
0,50
0,75


7Z62569.1
S.B. current multiplying factor at the -VCEO max level
BD236
M1
10^2
10
1
10^-1
1
10
tp (ms)
10^2
0,20
0,10
δ = 0,01
0,33
0,50
0,75


7Z62570.1
S.B. current multiplying factor at the -VCEO max level
BD238
MI
10²
10
1
δ = 0,01
0,05
0,10
0,20
0,33
0,50
0,75
10⁻¹
1
10
tp (ms)
10²


7Z62578
-VCE = 2 V
Tj = 25 °C
-IC
(A)
2
1,5
1
0,5
0
typ
0
0,5
1
1.5
-VBE (V)


7Z62577
typ. values
Tj = 25 °C
-VCEsat
(V)
4
3
2
1
0
3 A
2 A
-IC = 0,5 A
1 A
0
100
200
300
-IB (mA)



Typical static forward current transfer ratio as a function of the collector current.
$-V_{CE} = 2$ V; $T_j \leqslant 25$ °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.

QUICK REFERENCE DATA

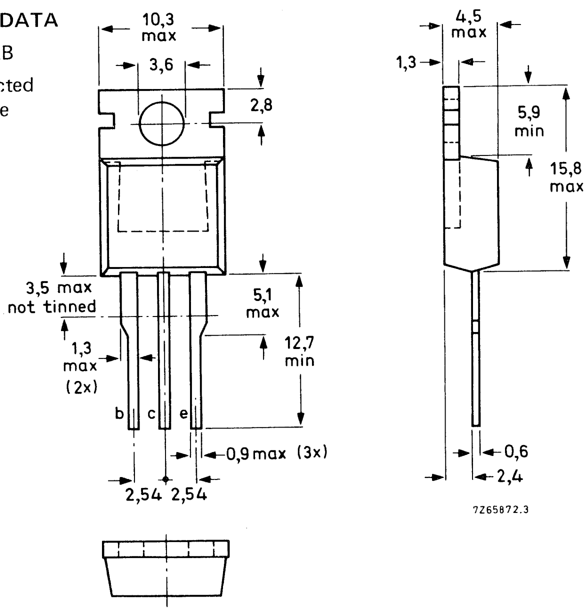
			BD239	A	B	C	
Collector-base voltage	V_{CBO}	max.	45	60	80	100	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	100	V
Collector current (peak value)	I_{CM}	max.		7			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		30			W
Junction temperature	T_j	max.		150			°C
D.C. current gain I_C = 1 A,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

			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 Ω)	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 °C	P_{tot}	max.	30				W
Storage temperature	T_{stg}		−65 to +150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$T_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

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

* Measured under pulse conditions; $t_p \leqslant 300\ \mu s$, $\delta \leqslant 0{,}02$.
** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Transition frequency at f = 1 MHz I_C = 0,2 A; V_{CE} = 10 V	f_T	>	3 MHz
Switching times (between 10% and 90% levels)			
I_{Con} = 0,2 A; I_{Bon} = $-I_{Boff}$ = 20 mA			
Turn-on time	t_{on}	typ.	0,3 µs
Turn-off time	t_{off}	typ.	0,8 µs

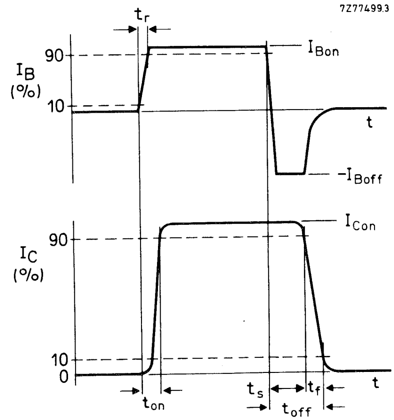
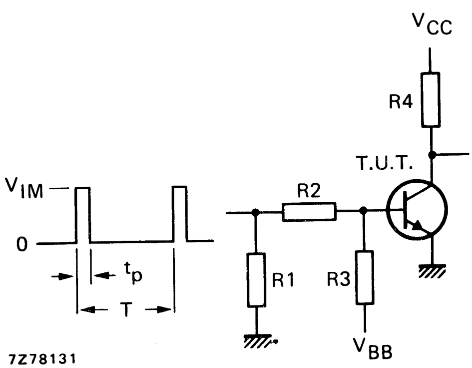


Fig. 2 Switching times waveforms.



V_{IM}	=	40 V
V_{CC}	=	30 V
$-V_{BB}$	=	4,4 V
R1	=	51 Ω
R2	=	1000 Ω
R3	=	300 Ω
R4	=	150 Ω
$t_r = t_f$	≤	15 ns
t_p	=	10 µs
T	=	500 µs

Fig. 3 Switching times test circuit.

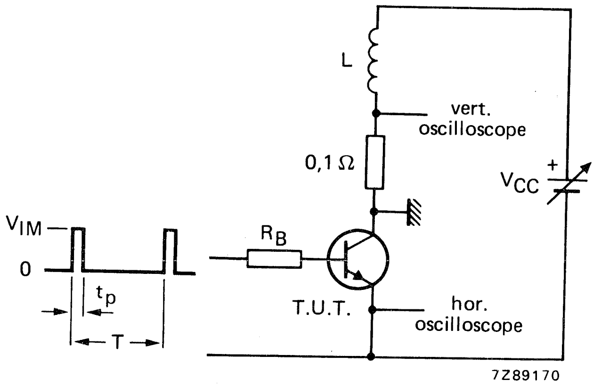


Fig. 4 Test circuit for turn-off breakdown energy.
V_{IM} = 12 V; R_B = 270 Ω; I_{CC} = 1,8 A; t_p = 1 ms; δ = 0,01.

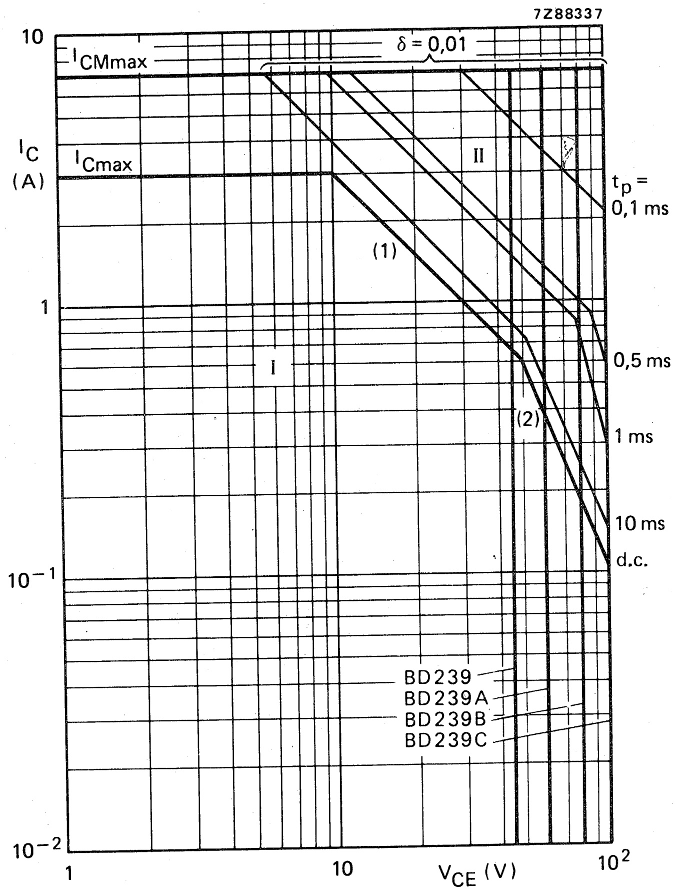


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

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.

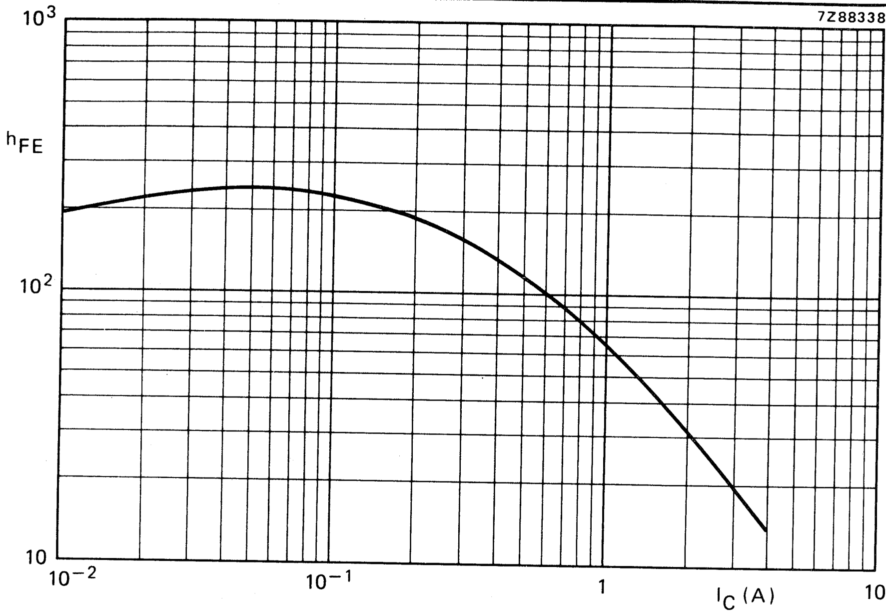


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. V_{CE} = 4 V, T_j = 25 °C.

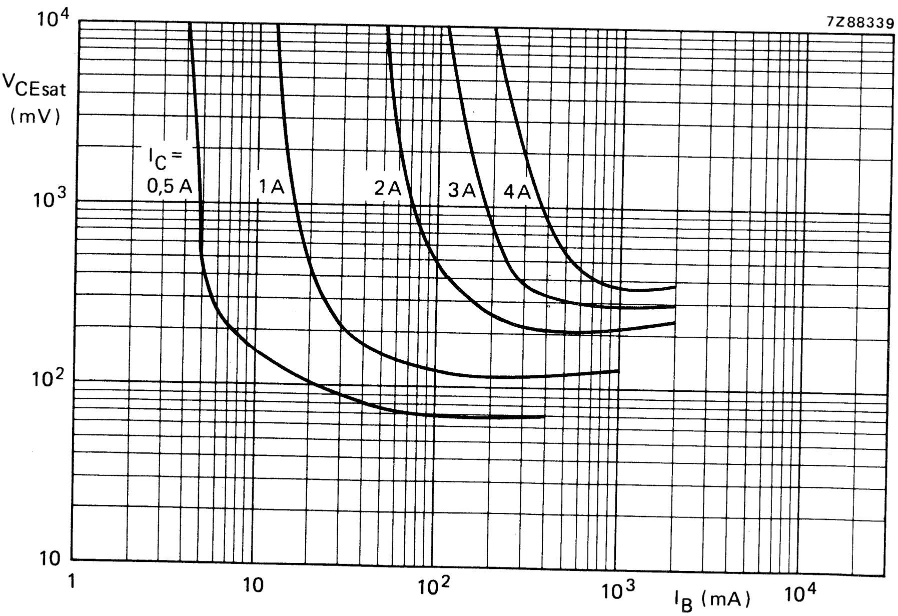


Fig. 7 Typical values collector-emitter saturation voltage at T_j = 25 °C.

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.

QUICK REFERENCE DATA

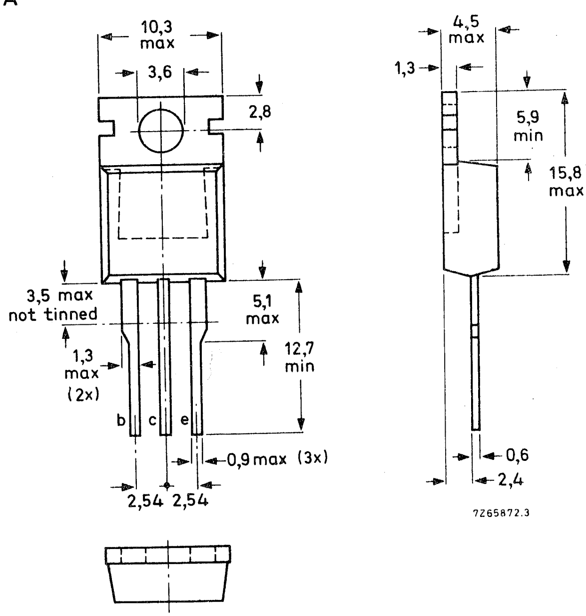
			BD240	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	45	60	80	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	100	V
Collector current (d.c.)	$-I_{CM}$	max.	7				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$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

			BD240	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 Ω)	$-V_{CER}$	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 °C	P_{tot}	max.	30				W
Storage temperature	T_{stg}		–65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

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

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

Transition frequency at f = 1 MHz $-I_C$ = 200 mA; $-V_{CE}$ = 10 V	f_T	>	3 MHz
Switching times $-I_{Con}$ = 0,2 A; $-I_{Bon}$ = I_{Boff} = 20 mA			
turn-on time	t_{on}	typ.	0,2 μs
turn-off time	t_{off}	typ.	0,4 μs

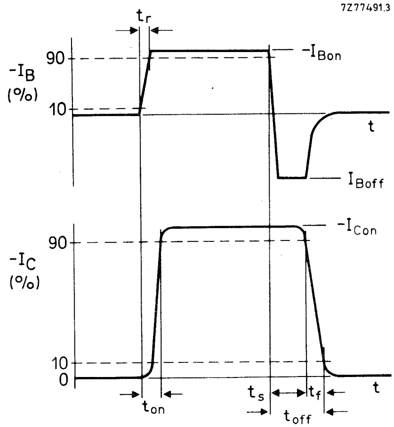
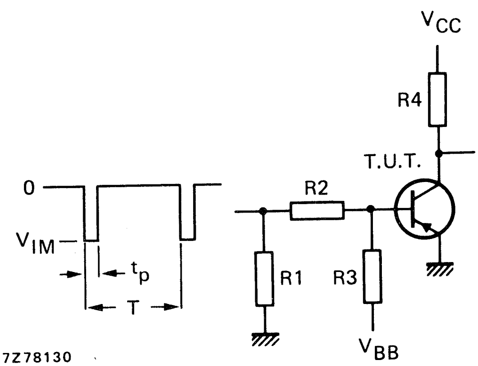


Fig. 2 Switching times waveforms.



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

Fig. 3 Switching times test circuit.

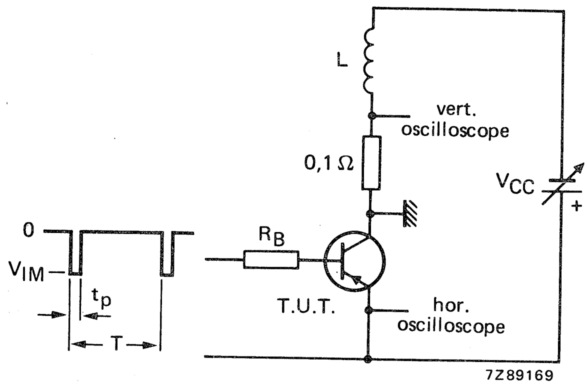


Fig. 4 Test circuit for turn-off breakdown energy.
$V_{IM} = -12$ V; $R_B = 270\ \Omega$; $-I_{CC} = 1,22$ A; $t_p = 1$ ms; $\delta = 0,01$.

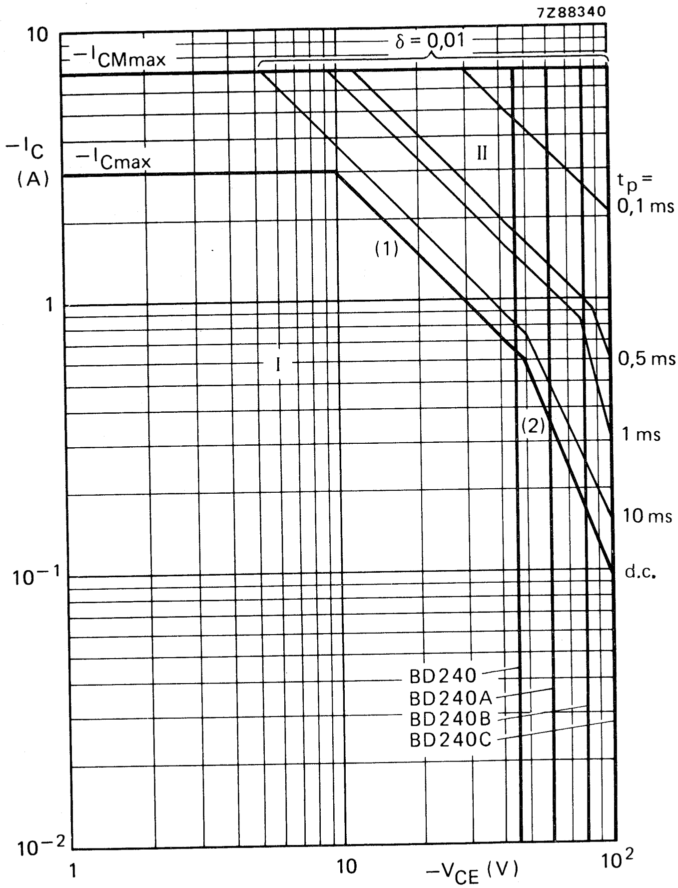


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

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.

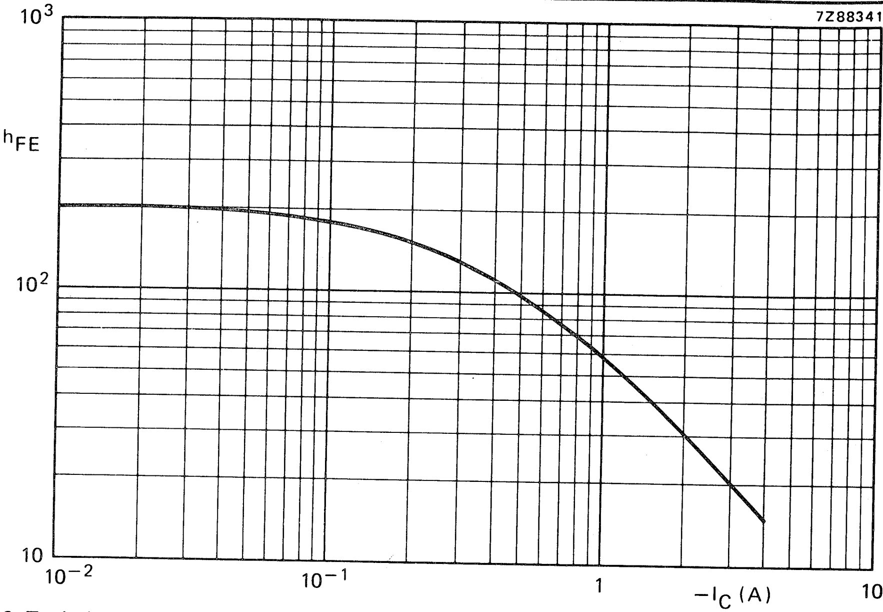


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 4$ V, $T_j = 25$ °C.

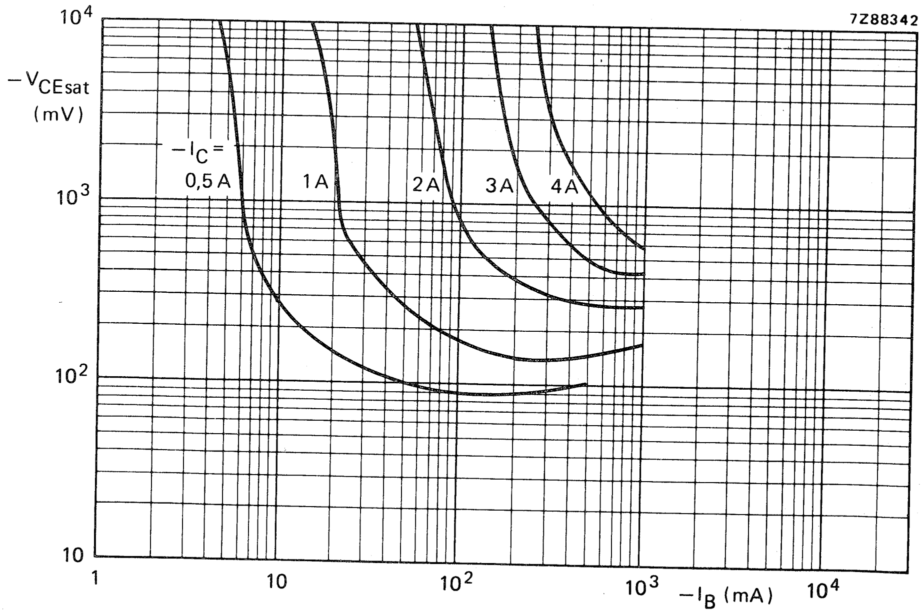


Fig. 7 Typical values collector-emitter saturation voltage at $T_j = 25$ °C.

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.

QUICK REFERENCE DATA

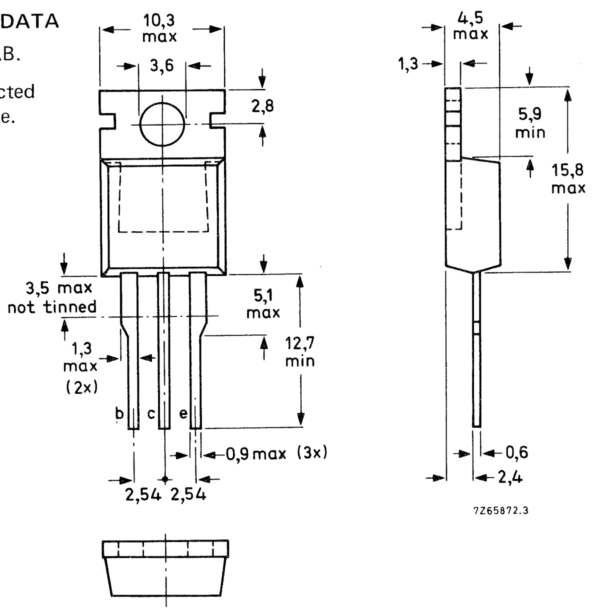
			BD241	A	B	C	
Collector-base voltage	V_{CBO}	max.	45	60	80	100	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	100	V
Collector current (peak value)	I_{CM}	max.		8			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40			W
Junction temperature	T_j	max.		150			°C
D.C. current gain I_C = 1 A; V_{CE} = 4 V	h_{FE}	>		25			
Transition frequency at f = 1 MHz I_C = 500 mA; V_{CE} = 10 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)

			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 Ω)	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 °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	$R_{th\,j\text{-}mb}$	=	3, 12	K/W
From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

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

* Measured under pulse conditions: $t_p \leq 300\ \mu s$; $\delta < 0{,}02$.
** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Transition frequency at f = 1 MHz I_C = 0,5 A; V_{CE} = 10 V	f_T	>	3 MHz
Switching times (between 10% and 90% levels) I_{Con} = 1 A; I_{Bon} = $-I_{Boff}$ = 0,1 A			
Turn-on time	t_{on}	typ.	0,3 μs
Turn-off time	t_{off}	typ.	1 μs

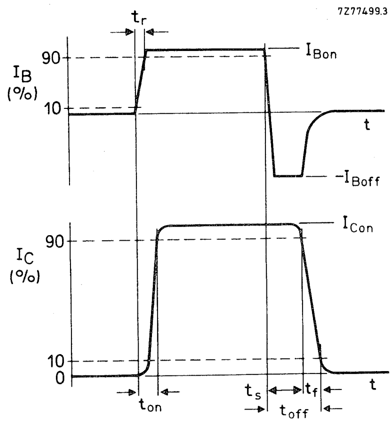
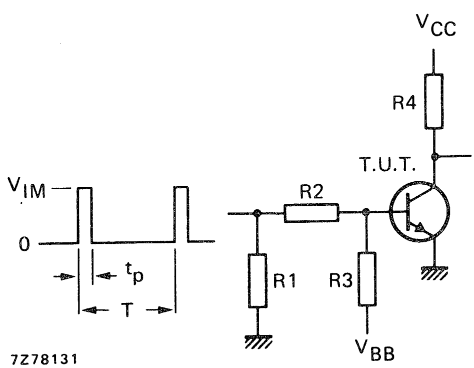


Fig. 2 Switching times waveforms.



V_{IM}	=	16	V
V_{CC}	=	20	V
$-V_{BB}$	=	6,4	V
R1	=	82	Ω
R2	=	82	Ω
R3	=	82	Ω
R4	=	20	Ω
$t_r = t_f$	⩽	20	ns
t_p	=	20	μs
T	=	500	μs

Fig. 3 Switching times test circuit.

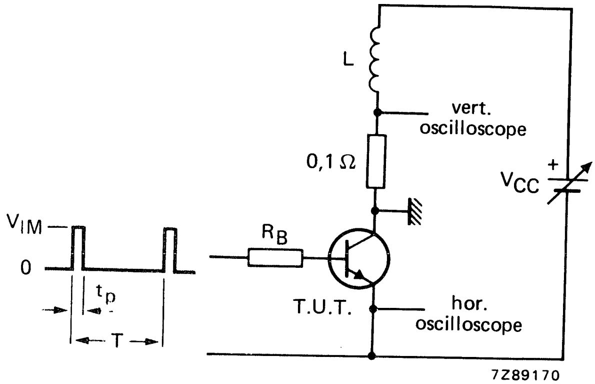


Fig. 4 Test circuit for turn-off breakdown energy.
V_{IM} = 12 V; R_B = 270 Ω; I_{CC} = 1,8 A; t_p = 1 ms; δ = 0,01.

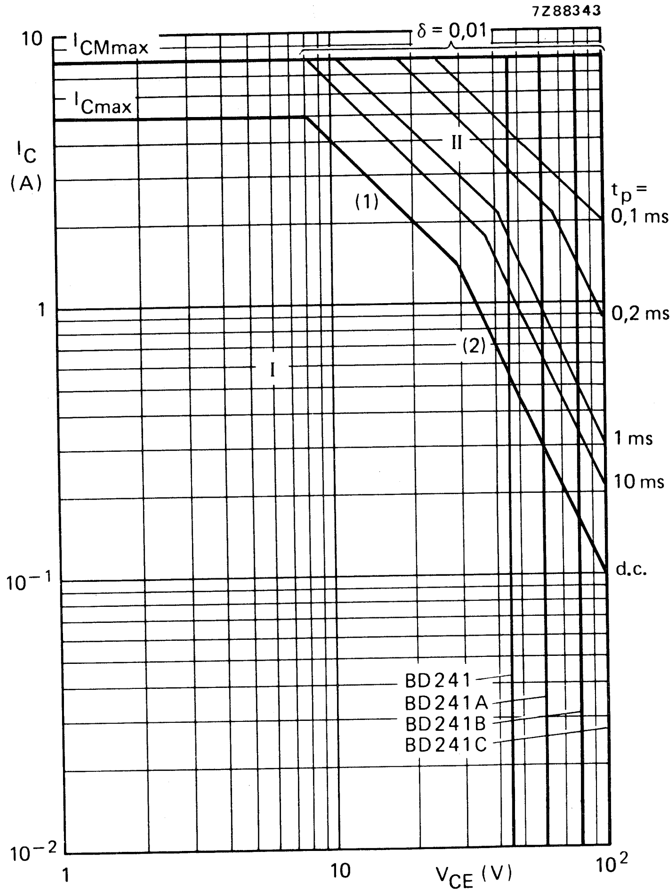


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

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.

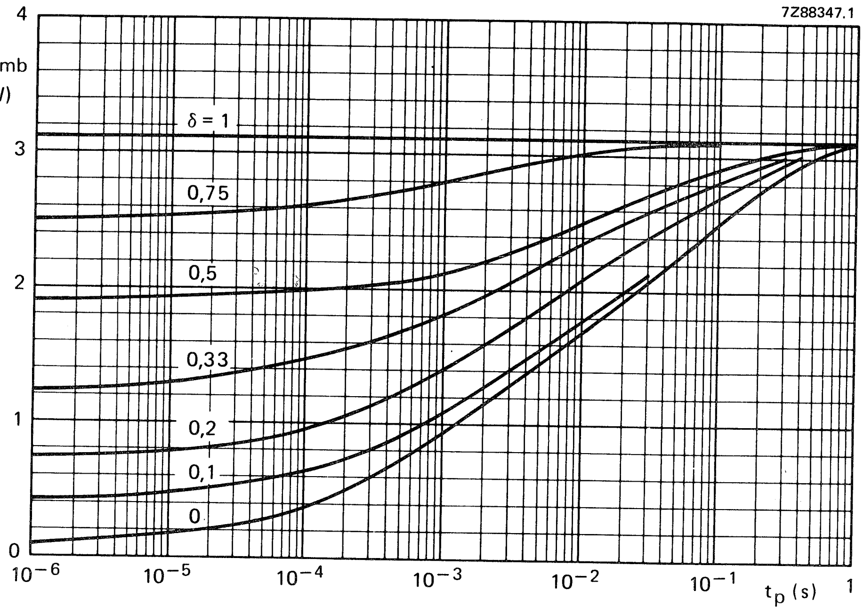


Fig. 6 Power pulse rating chart.

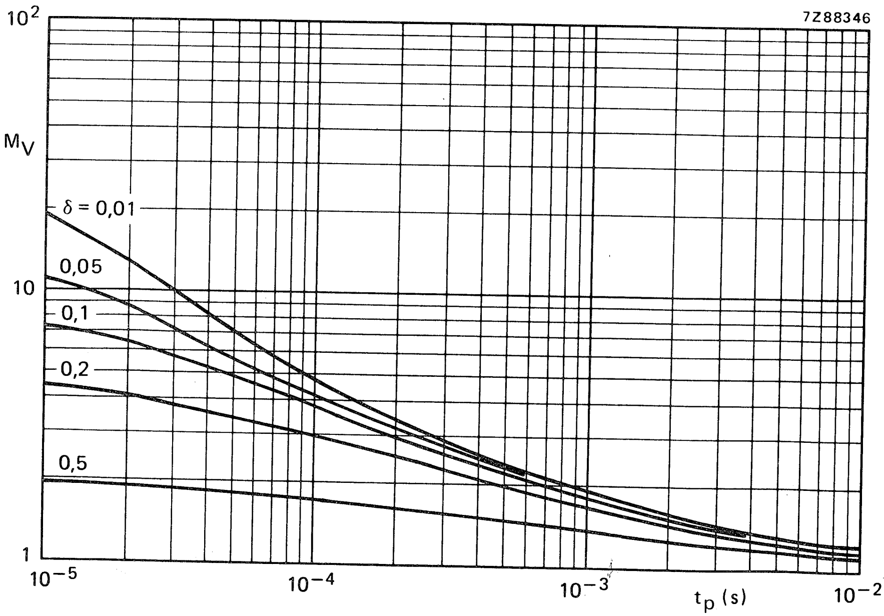


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

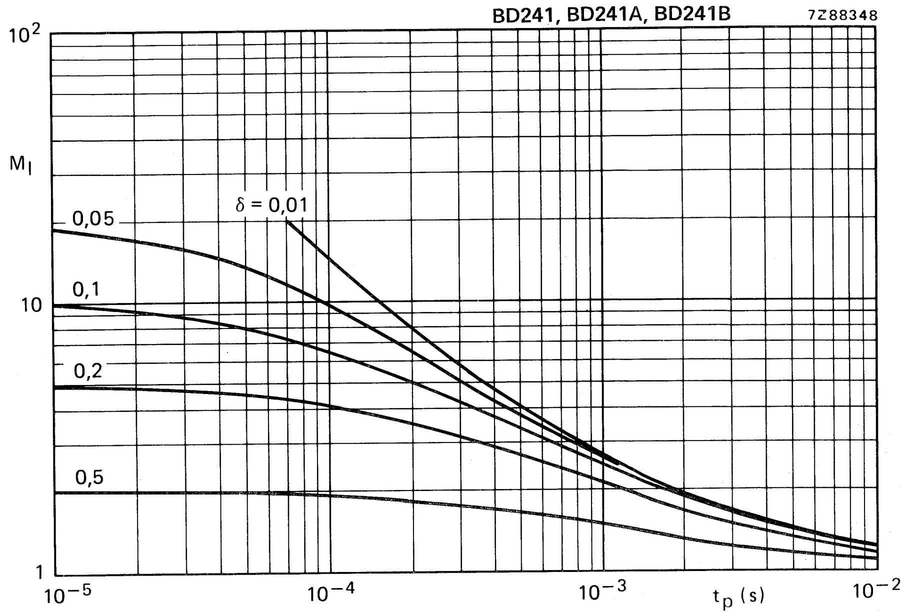


Fig. 8 S.B. current multiplying factor at the V_{CEOmax} level.

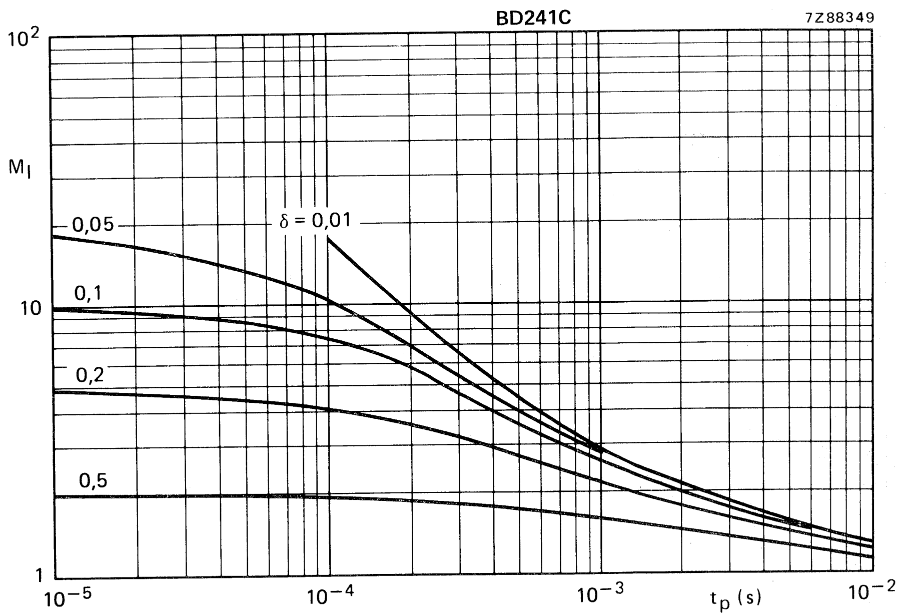


Fig. 9 S.B. current multiplying factor at the V_{CEOmax} level.

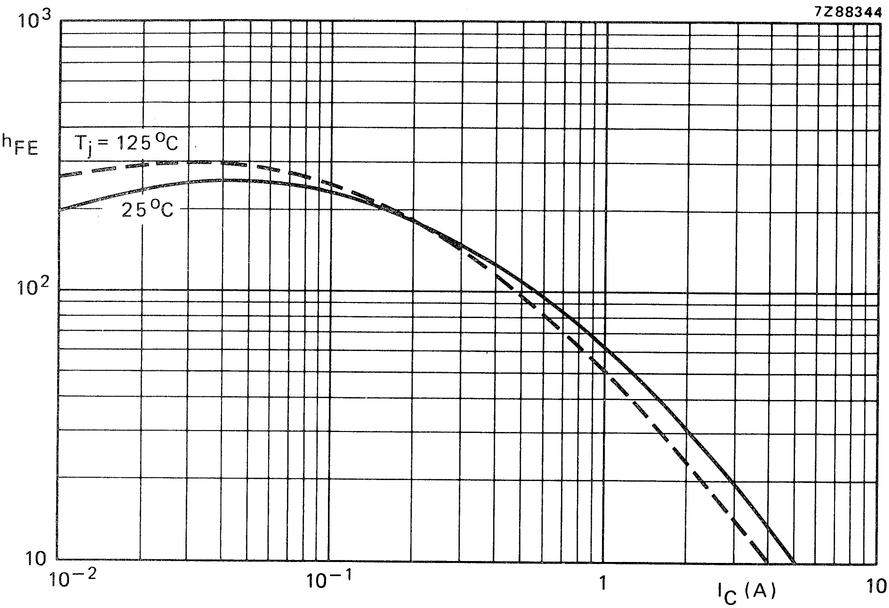


Fig. 10 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 4$ V.

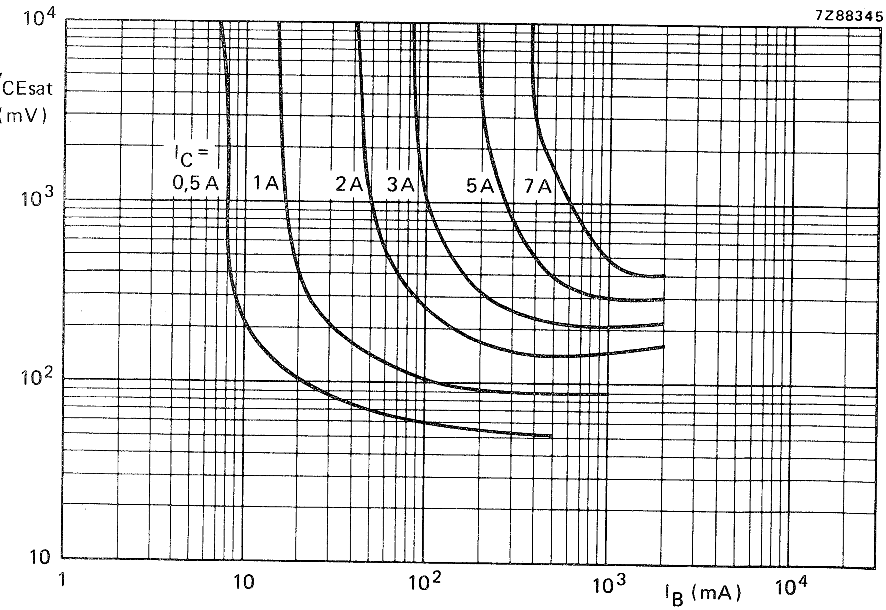


Fig. 11 Typical values collector-emitter saturation voltage at $T_j = 25\,^oC$.

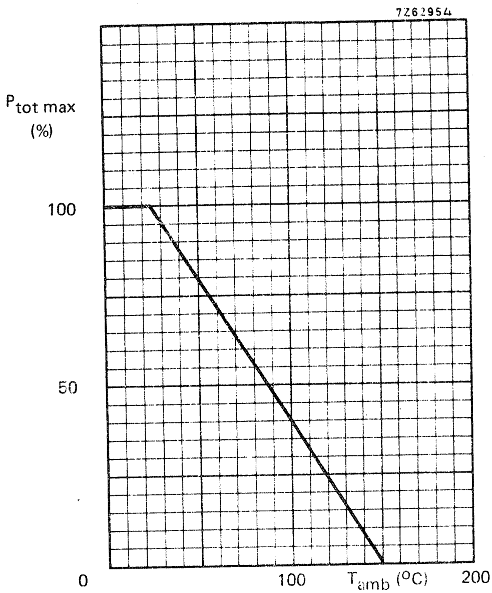


Fig. 12 Power derating curve.

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.

QUICK REFERENCE DATA

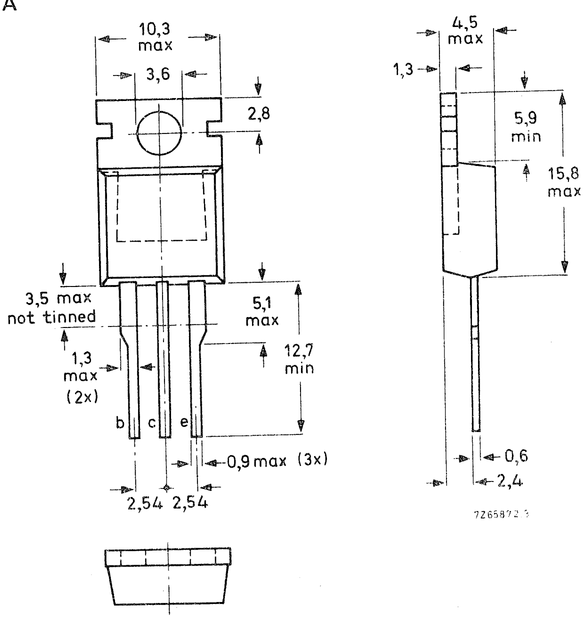
			BD242	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	45	60	80	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	100	V
Collector current (d.c.)	$-I_{CM}$	max.		8			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40			W
Junction temperature	T_j	max.		150			°C
D.C. current gain $-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	>		25			
Transition frequency $-I_C$ = 500 mA; $-V_{CE}$ = 10 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)

			BD242	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 Ω)	$-V_{CER}$	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 °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	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

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

* Measured under pulse conditions: $t_p \leqslant 300\ \mu s$; $\delta < 0,02$.

Transition frequency at f = 1 MHz $-I_C$ = 500 mA; $-V_{CE}$ = 10 V	f_T	>	3 MHz
Switching times $-I_{Con}$ = 1 A; $-I_{Bon}$ = I_{Boff} = 0,1 A			
turn-on time	t_{on}	typ.	0,3 μs
turn-off time	t_{off}	typ.	1 μs

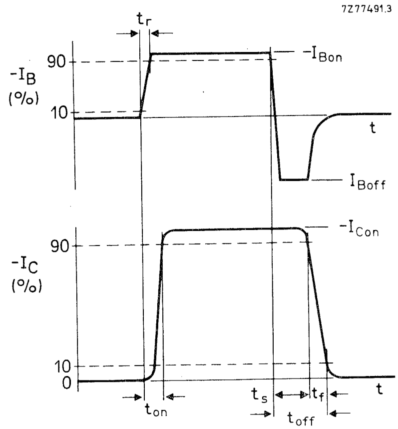
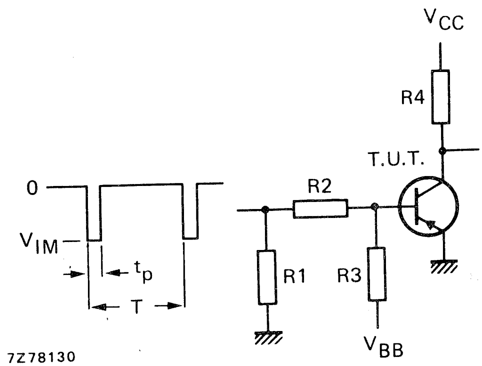


Fig. 2 Switching times waveforms.



$-V_{IM}$ = 16 V
$-V_{CC}$ = 20 V
$+V_{BB}$ = 6,4 V
R1 = 82 Ω
R2 = 82 Ω
R3 = 82 Ω
R4 = 20 Ω
$t_r = t_f$ = 20 ns
t_p = 20 μs
T = 500 μs

Fig. 3 Switching times test circuit.

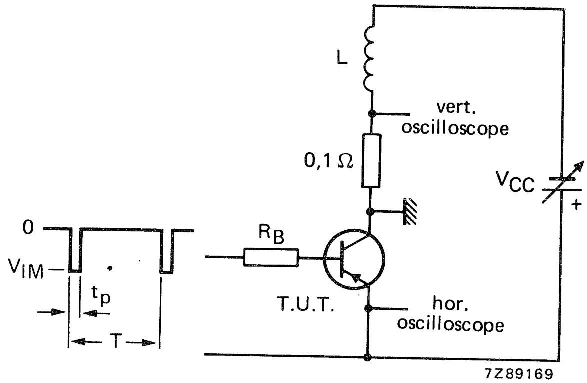


Fig. 4 Test circuit for turn-off breakdown energy.
$V_{IM} = -12$ V; $R_B = 270\ \Omega$; $-I_{CC} = 1{,}22$ A; $t_p = 1$ ms; $\delta = 0{,}01$.

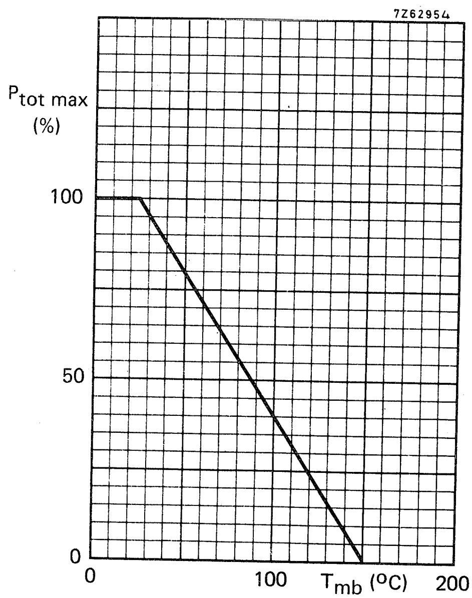


Fig. 4a Power derating curve.

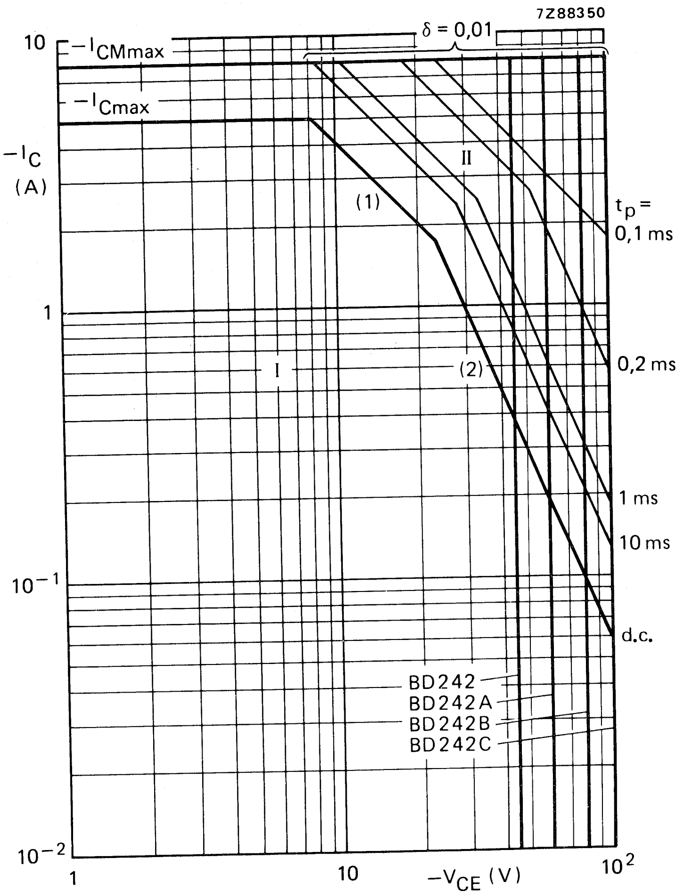


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

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.

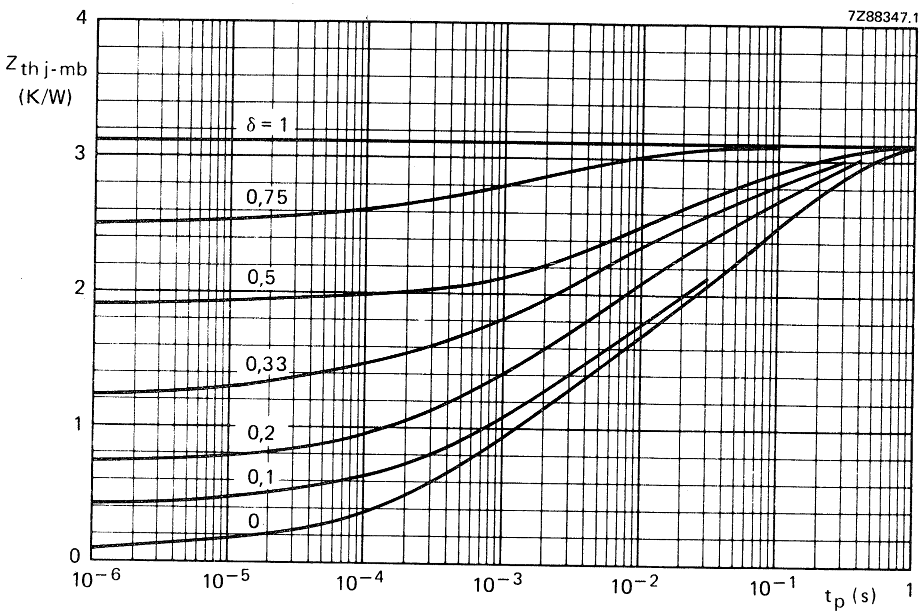


Fig. 6 Power pulse rating chart.

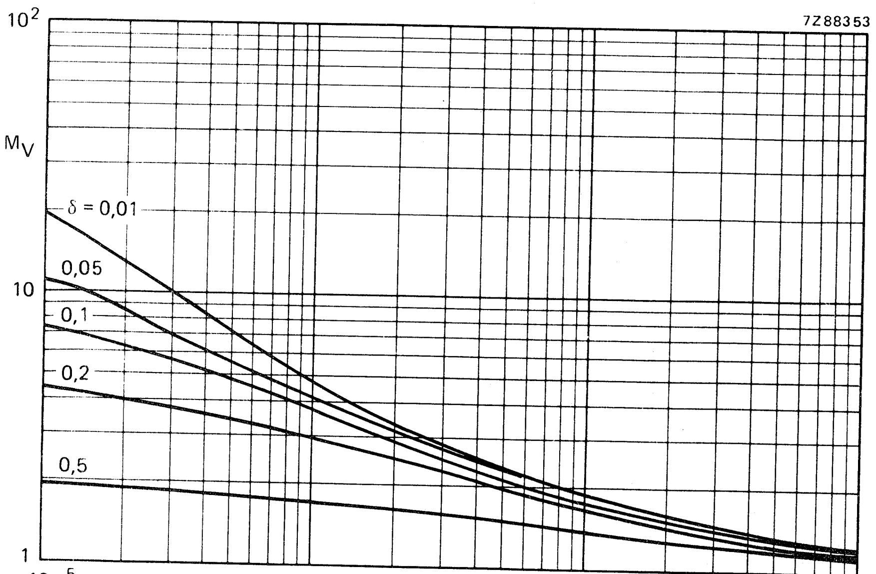


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

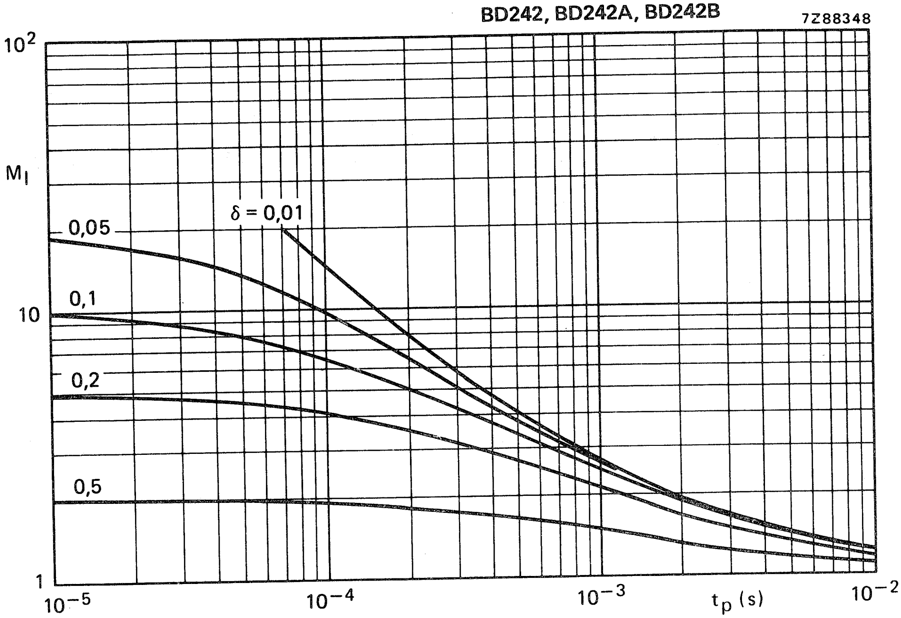


Fig. 8 S.B. current multiplying factor at the V_{CEOmax} level.

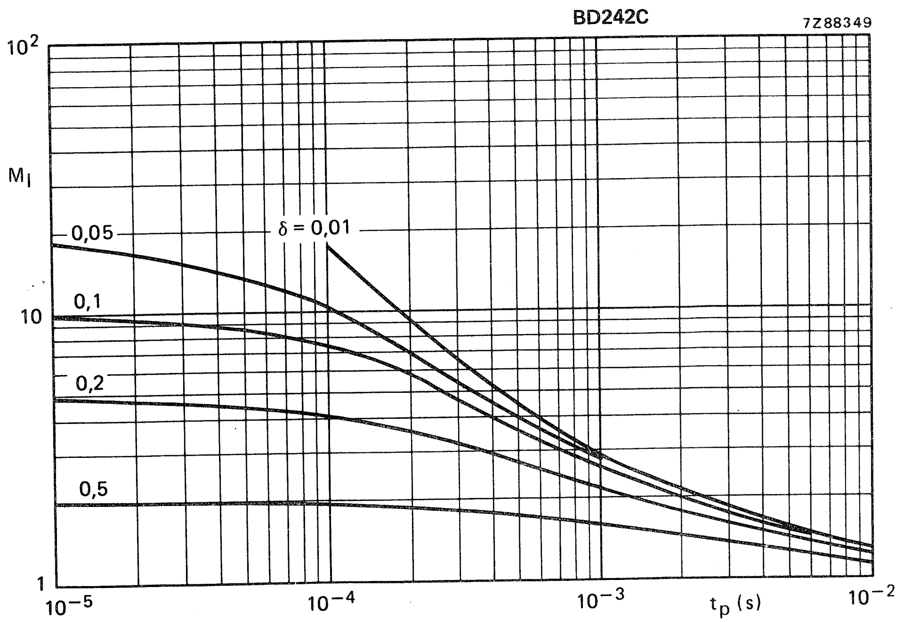


Fig. 9 S.B. current multiplying factor at the V_{CEOmax} level.

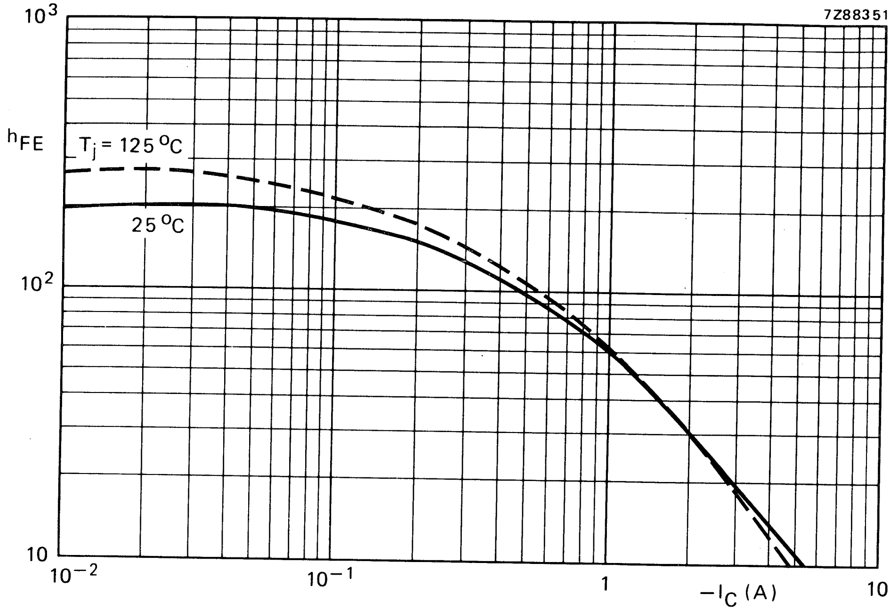


Fig. 10 Typical static forward current transfer ratio as a function of the collector current; $-V_{CE} = 4$ V.

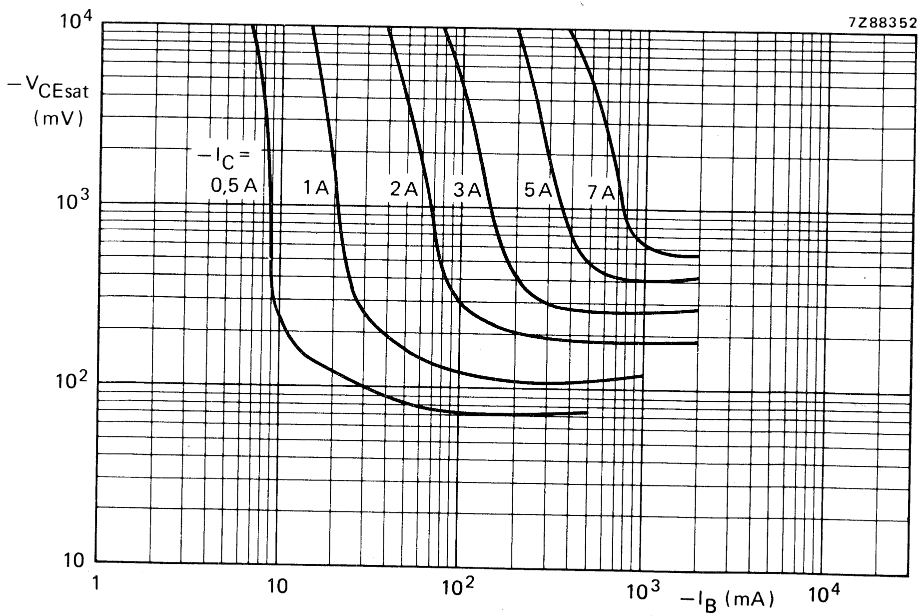


Fig. 11 Typical values collector-emitter saturation voltage at $T_j = 25\ ^oC$.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in general amplifier and switching applications.

QUICK REFERENCE DATA

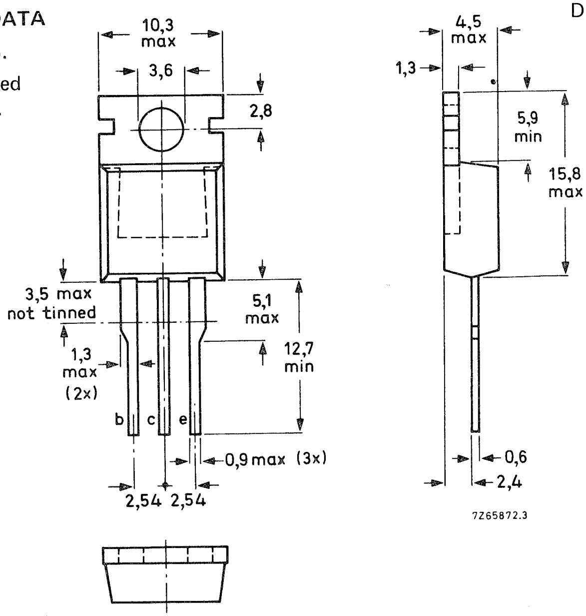
			BD243	A	B	C	
Collector-base voltage	V_{CBO}	max.	45	60	80	100	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	100	V
Collector current (peak value)	I_{CM}	max.		12			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		65			W
Junction temperature	T_j	max.		150			°C
D.C. current gain I_C = 3 A; V_{CE} = 4 V	h_{FE}	>		15			
Transition frequency at f = 1 MHz I_C = 500 mA; V_{CE} = 10 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)

			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 Ω)	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 °C	P_{tot}	max.	65				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

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

* Measured under pulse conditions: $t_p \leq 300\,\mu s$; $\delta < 0{,}02$.
** V_{BE} decreases by about 2,3 mV/K with increasing temperature.

Transition frequency at f = 1 MHz I_C = 0,5 A; V_{CE} = 10 V	f_T	>	3 MHz
Switching times (between 10% and 90% levels) I_{Con} = 1 A; I_{Bon} = $-I_{Boff}$ = 0,1 A			
Turn-on time	t_{on}	typ.	0,6 μs
Turn-off time	t_{off}	typ.	2 μs

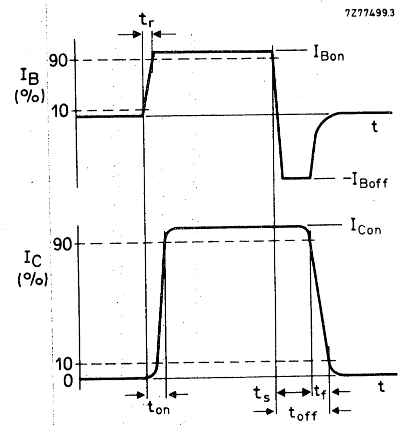
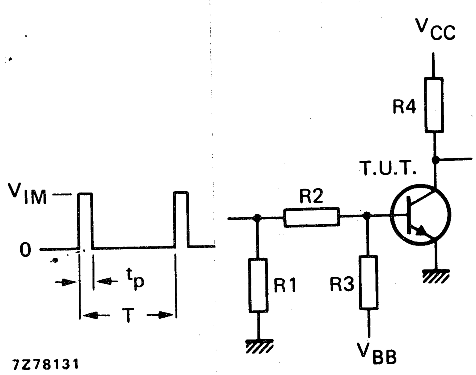


Fig. 2 Switching times waveforms.



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
$t_r = t_f \leqslant$ 15 ns
t_p = 10 μs
T = 500 μs

Fig. 3 Switching times test circuit.

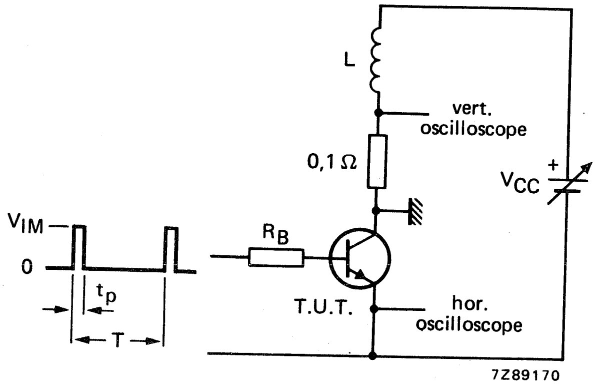


Fig. 4 Test circuit for turn-off breakdown energy.
V_{IM} = 12 V; R_B = 270 Ω; I_{CC} = 2,5 A; t_p = 1 ms; δ = 0,01.

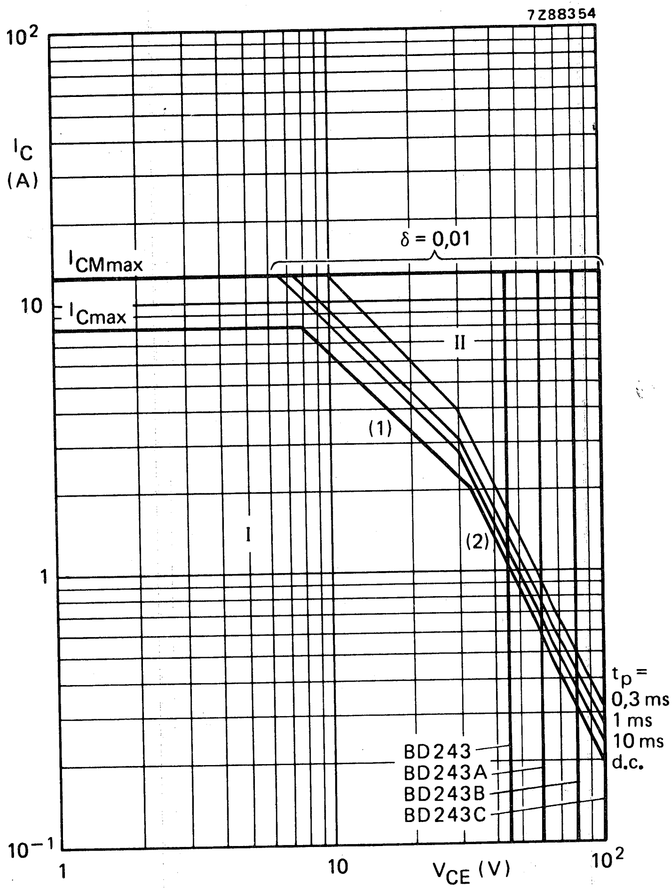


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

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.

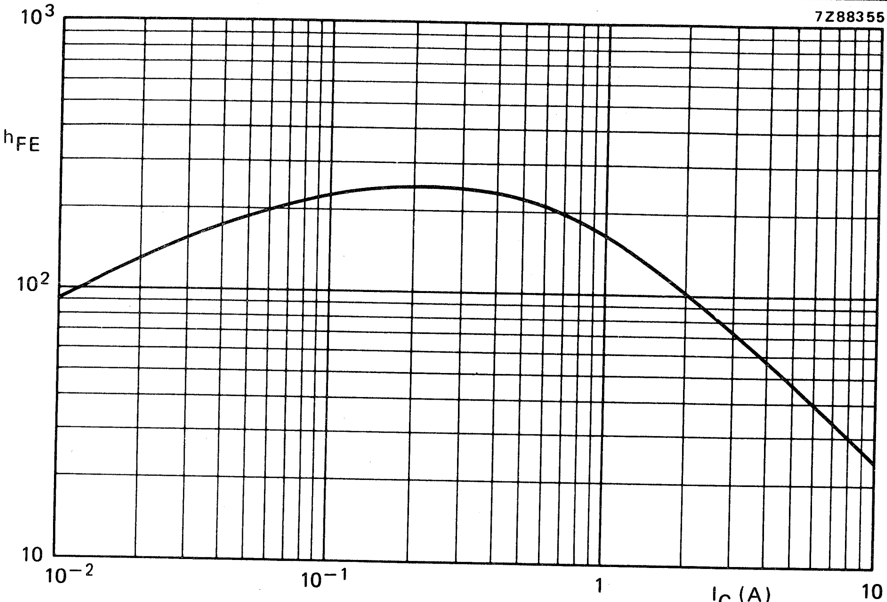


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. V_{CE} = 4 V, T_j = 25 °C.

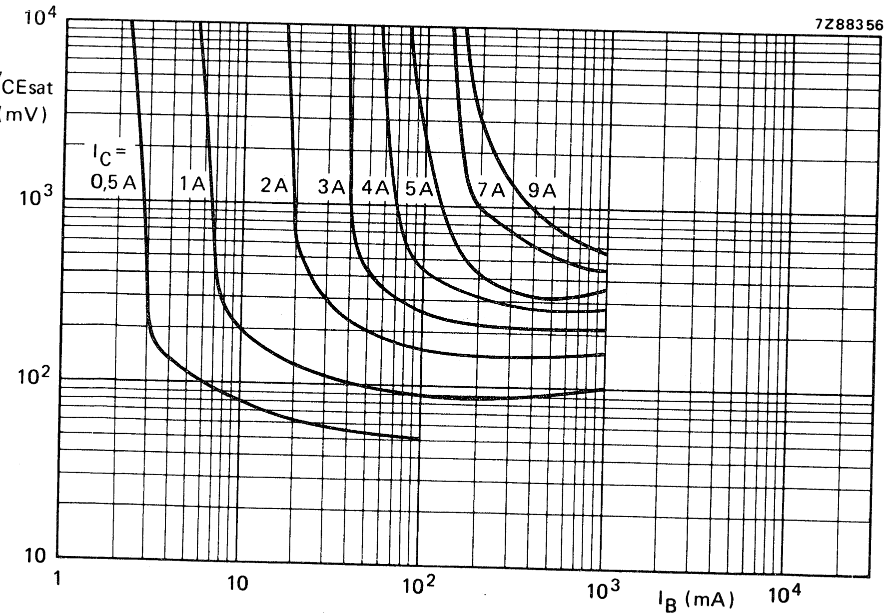


Fig. 7 Typical values collector-emitter saturation voltage at T_j = 25 °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in general amplifier and switching applications.

QUICK REFERENCE DATA

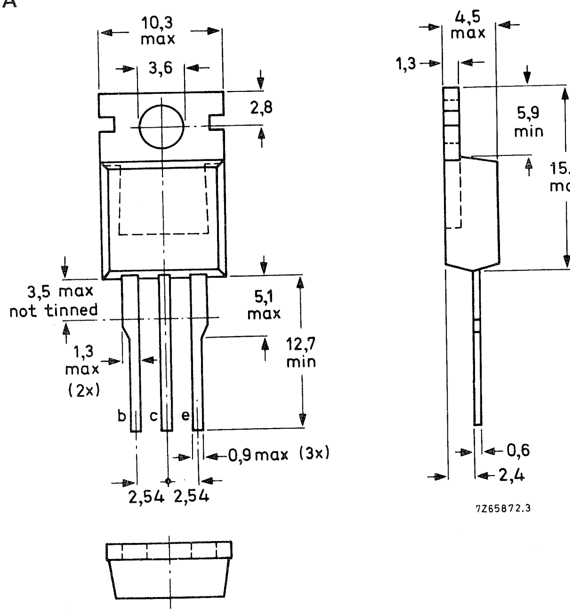
			BD244	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	45	60	80	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	100	V
Collector current (d.c.)	$-I_{CM}$	max.	12				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	65				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$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

			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 Ω)	$-V_{CER}$	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 °C	P_{tot}	max.	65				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

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

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

Transition frequency at f = 1 MHz $-I_C$ = 500 mA; $-V_{CE}$ = 10 V	f_T > 3 MHz
Switching times $-I_{Con}$ = 1 A; $-I_{Bon}$ = I_{Boff} = 0,1 A	
turn-on time	t_{on} typ. 0,4 μs
turn-off time	t_{off} typ. 0,7 μs

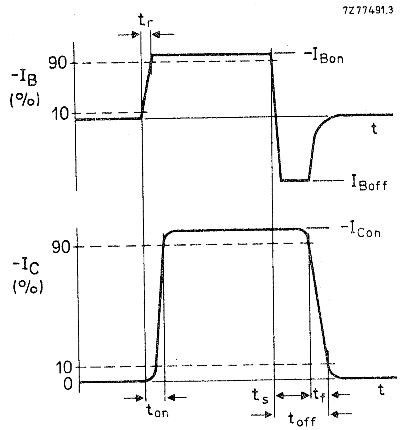
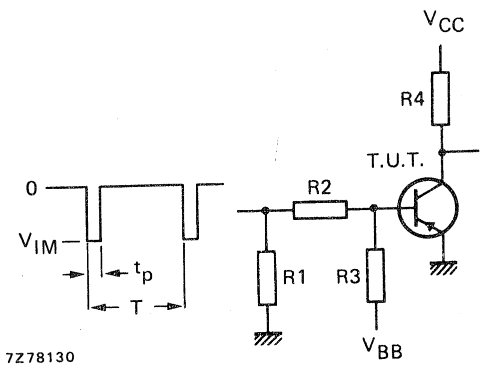


Fig. 2 Switching times waveforms.



$-V_{IM}$	=	30 V
$-V_{CC}$	=	20 V
$+V_{BB}$	=	3,5 V
R1	=	82 Ω
R2	=	150 Ω
R3	=	39 Ω
R4	=	20 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

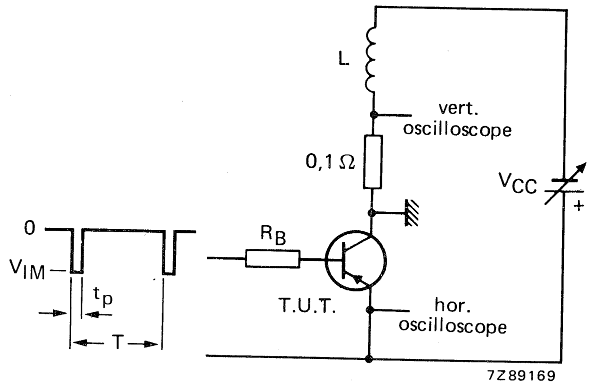


Fig. 4 Test circuit for turn-off breakdown energy.
$V_{IM} = -12$ V; $R_B = 270\ \Omega$; $-I_{CC} = 2{,}5$ A; $t_p = 1$ ms; $\delta = 0{,}01$.

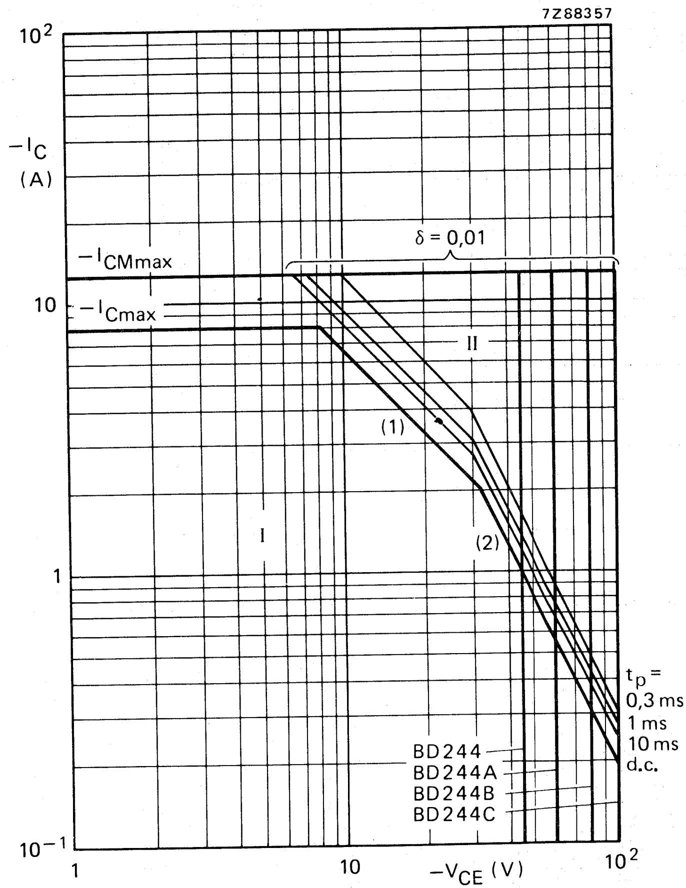


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

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.

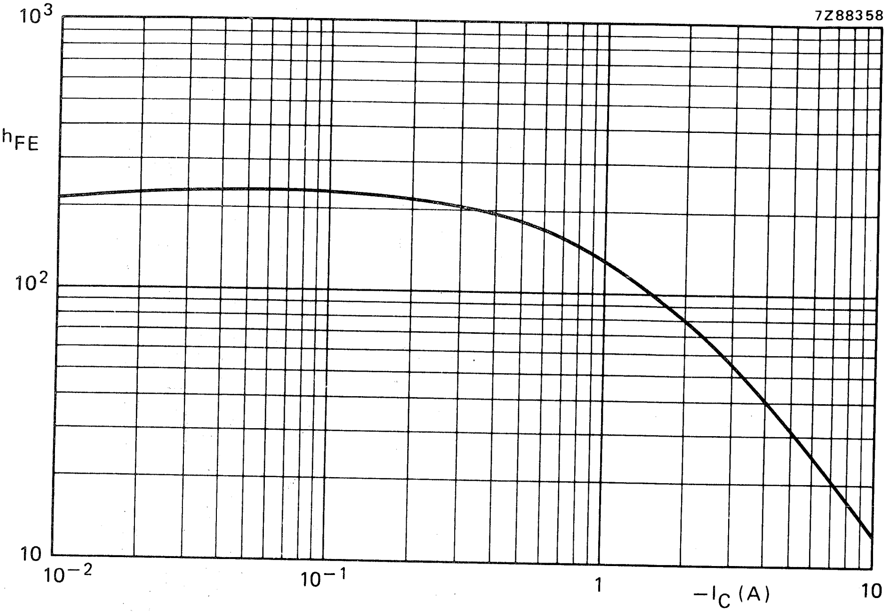


Fig. 6 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 4$ V, $T_j = 25$ °C.

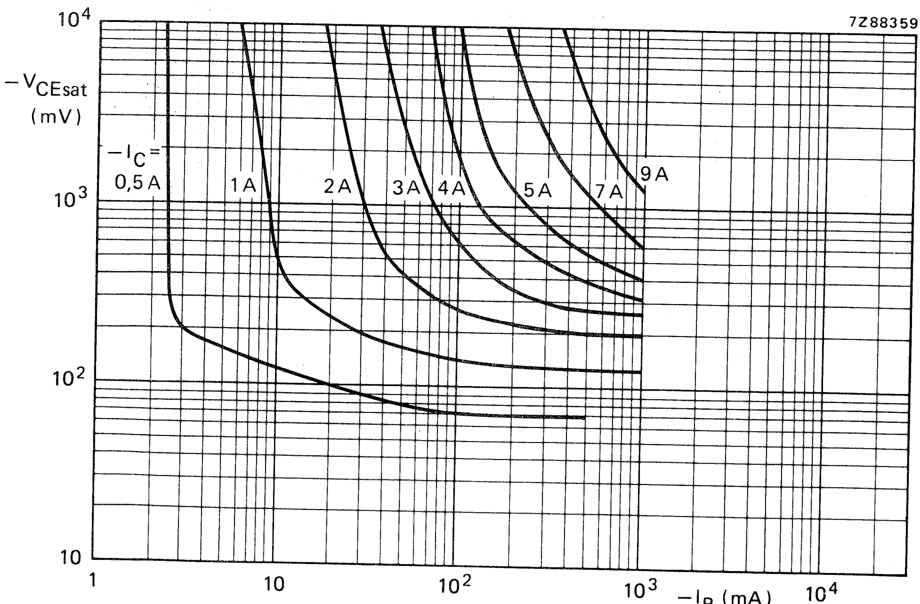


Fig. 7 Typical values collector-emitter saturation voltage at $T_j = 25$ °C.

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

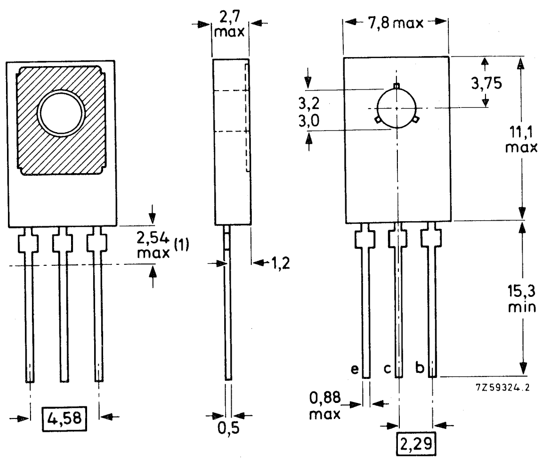
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	32	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (peak value)	I_{CM}	max.	3	A
Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	15	W
Junction temperature	T_j	max.	150	°C
D.C. current gain I_C = 0,5 A; V_{CE} = 1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

Voltages

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

Currents

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

Power dissipation

Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	15	W

Temperatures

Storage temperature	T_{stg}		− 65 to +150	°C
Junction temperature	T_j	max.	150	°C

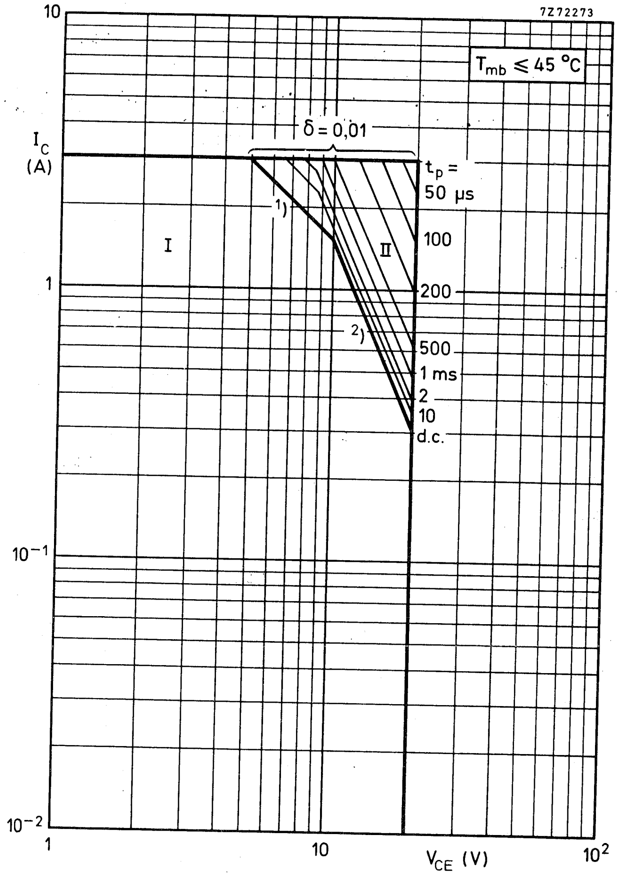
THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 32$ V	I_{CBO}	<	10	µA
$I_E = 0$; $V_{CB} = 32$ V; $T_j = 150$ °C	I_{CBO}	<	1	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	µA
Base-emitter voltage				
$I_C = 5$ mA; $V_{CE} = 10$ V	V_{BE}	typ.	0,6	V
$I_C = 2$ A; $V_{CE} = 1$ V	V_{BE}	<	1,2	V
Collector-emitter saturation voltage				
$I_C = 2$ A; $I_B = 0,2$ A	V_{CEsat}	<	0,5	V
D.C. current gain				
$I_C = 5$ mA; $V_{CE} = 10$ V	h_{FE}	>	50	
$I_C = 0,5$ A; $V_{CE} = 1$ V	h_{FE}		85 to 375	
$I_C = 2$ A; $V_{CE} = 1$ V	h_{FE}	>	40	
Transition frequency at f = 35 MHz				
$I_C = 50$ mA; $V_{CE} = 5$ V	f_T	typ.	130	MHz
D.C. current gain ratio of matched pairs				
BD329/BD330				
$\lvert I_C \rvert = 0,5$ A; $\lvert V_{CE} \rvert = 1$ V	h_{FE1}/h_{FE2}	<	1,6	



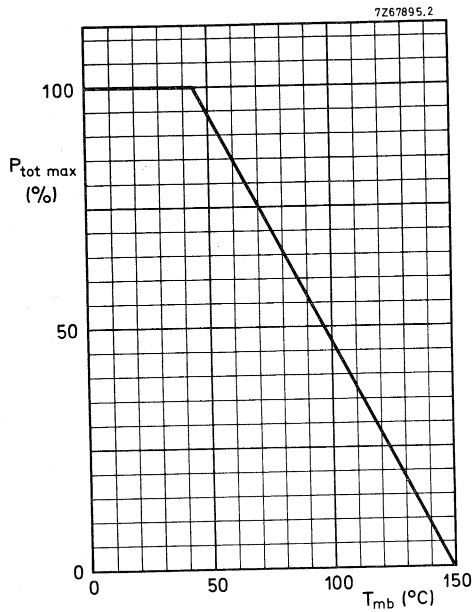
Safe Operating ARea with the transistor forward biased

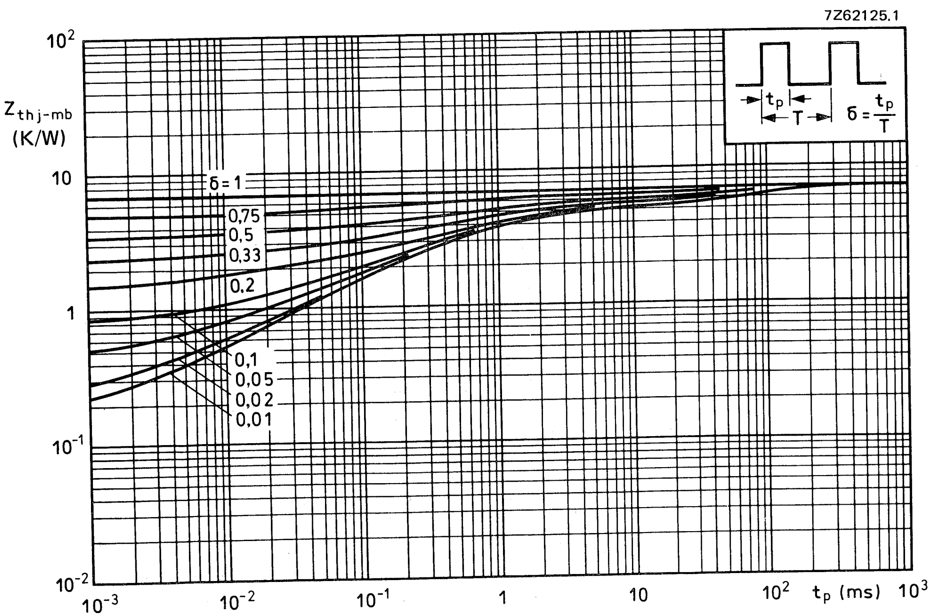
I Region of permissible d.c. operation

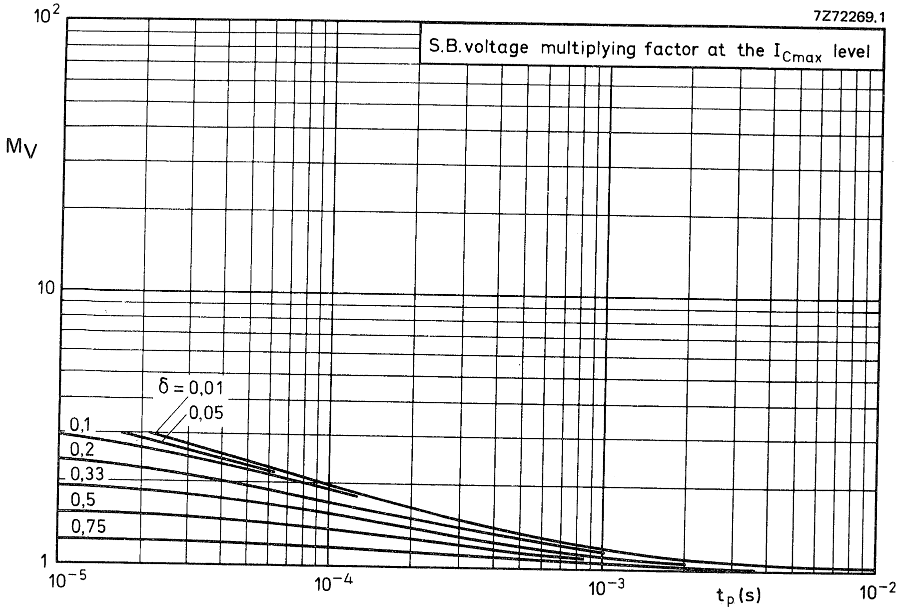
II Permissible extension for repetive pulse operation

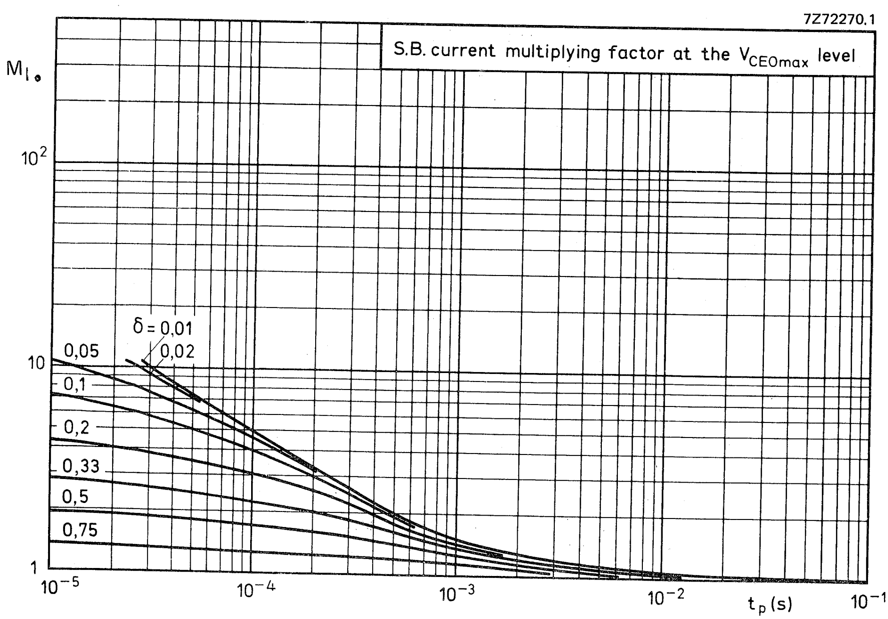
1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

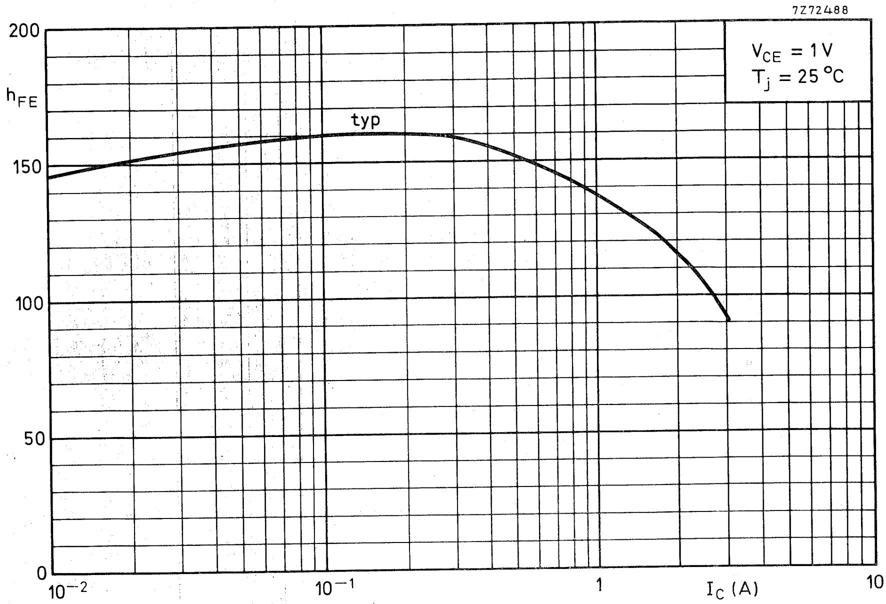
2) Second-breakdown limits (independent of temperature).

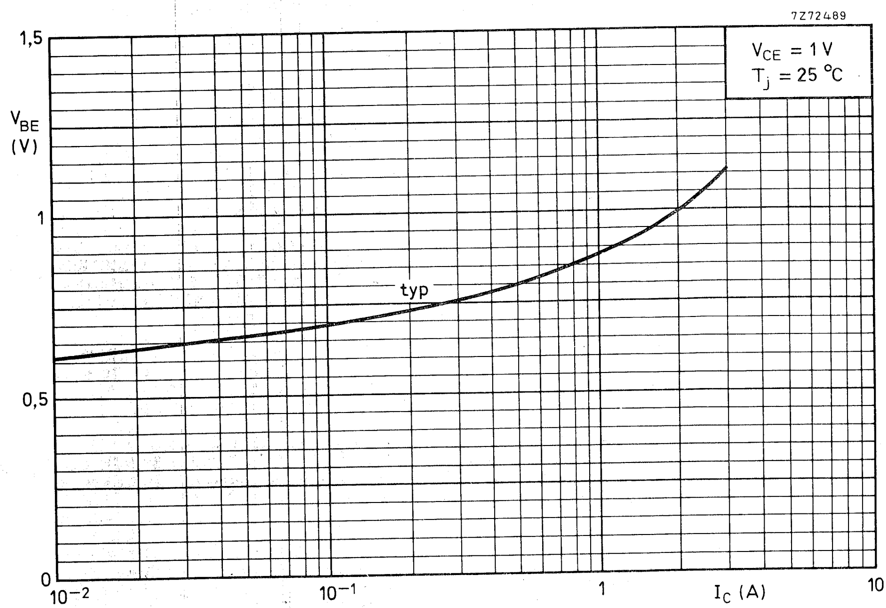

7Z67895.2
100
50
0
P tot max
(%)
0
50
100
150
T mb (°C)

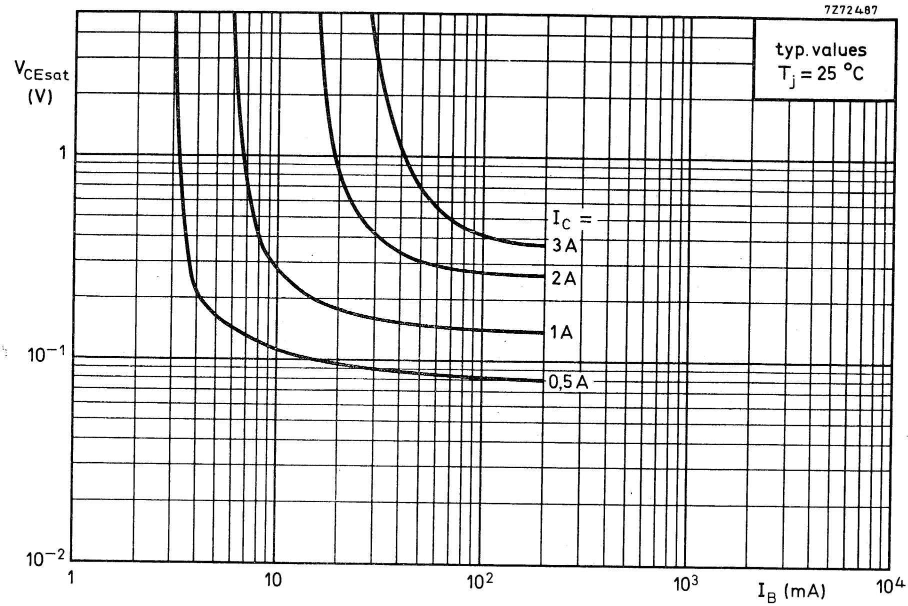

7Z62125.1
10^2
10
1
10^-1
10^-2
Z th j-mb
(K/W)
δ = 1
0,75
0,5
0,33
0,2
0,1
0,05
0,02
0,01
t p
T
δ = t p / T
10^-3
10^-2
10^-1
1
10
10^2
t p (ms)
10^3


7Z72269.1
S.B. voltage multiplying factor at the I_{Cmax} level
M_V
10^2
10
1
$\delta = 0,01$
0,05
0,1
0,2
0,33
0,5
0,75
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}


7Z72270.1
S.B. current multiplying factor at the V_{CEOmax} level
M_{I_0}
10^2
10
1
$\delta = 0,01$
0,02
0,05
0,1
0,2
0,33
0,5
0,75
10^{-5}
10^{-4}
10^{-3}
10^{-2}
t_p (s)
10^{-1}


7Z72488
V_{CE} = 1 V
T_j = 25 °C
h_{FE}
typ
200
150
100
50
0
10^{-2}
10^{-1}
1
10
I_C (A)


7Z72489
V_{CE} = 1 V
T_j = 25 °C
V_{BE} (V)
typ
1,5
1
0,5
0
10^{-2}
10^{-1}
1
10
I_C (A)


7Z72487
typ. values
$T_j = 25\ ^\circ C$
V_{CEsat} (V)
1
10^{-1}
10^{-2}
1
10
10^2
10^3
10^4
I_B (mA)
I_C =
3 A
2 A
1 A
0,5 A

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

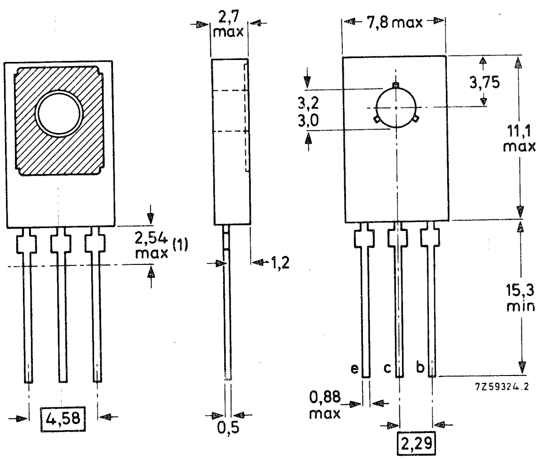
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Collector current (peak value)	$-I_{CM}$	max.	3	A
Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	15	W
Junction temperature	T_j	max.	150	°C
D.C. current gain $-I_C$ = 0,5 A;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

Voltages

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

Currents

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

Power dissipation

Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	15	W

Temperatures

Storage temperature	T_{stg}		− 65 to +150	°C
Junction temperature	T_j	max.	150	°C

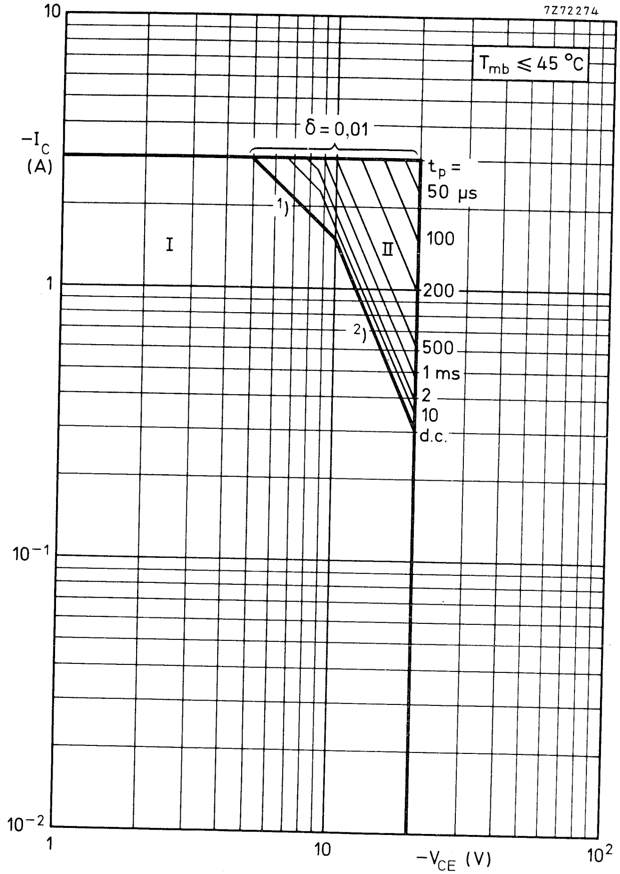
THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 32$ V	$-I_{CBO}$	<	10	µA
$I_E = 0$; $-V_{CB} = 32$ V; $T_j = 150$ °C	$-I_{CBO}$	<	1	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	10	µA
Base-emitter voltage				
$-I_C = 5$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	0,6	V
$-I_C = 2$ A; $-V_{CE} = 1$ V	$-V_{BE}$	<	1,2	V
Collector-emitter saturation voltage				
$-I_C = 2$ A; $-I_B = 0,2$ A	$-V_{CEsat}$	<	0,5	V
D.C. current gain				
$-I_C = 5$ mA; $-V_{CE} = 10$ V	h_{FE}	>	50	
$-I_C = 0,5$ A; $-V_{CE} = 1$ V	h_{FE}		85 to 375	
$-I_C = 2$ A; $-V_{CE} = 1$ V	h_{FE}	>	40	
Transition frequency at f = 35 MHz				
$-I_C = 50$ mA; $-V_{CE} = 5$ V	f_T	typ.	100	MHz
D.C. current gain ratio of matched pairs BD329/BD330				
$\lvert I_C \rvert = 0,5$ A; $\lvert V_{CE} \rvert = 1$ V	h_{FE1}/h_{FE2}	<	1,6	



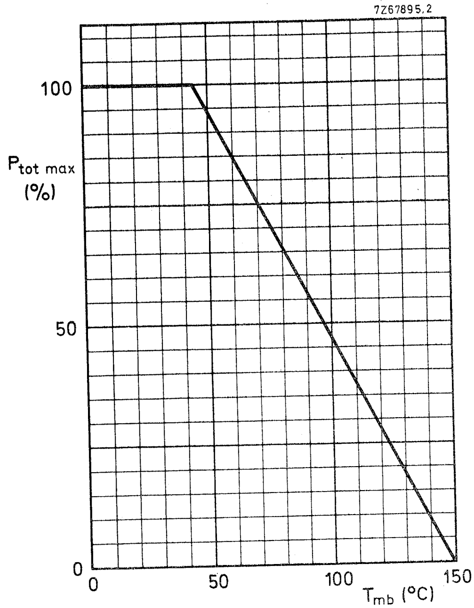
Safe Operating ARea with the transistor forward biased

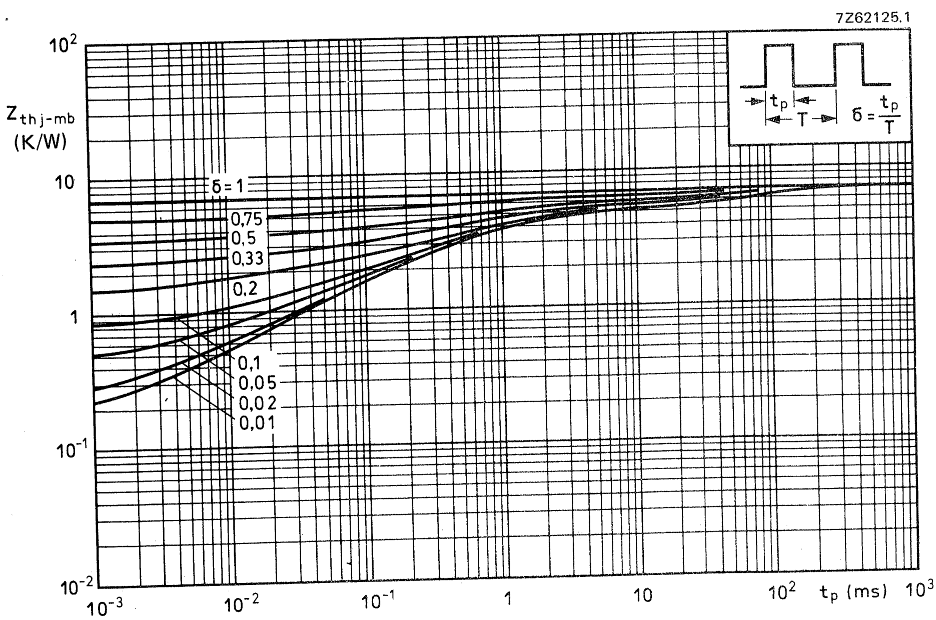
I Region of permissible d. c. operation
II Permissible extension for repetitive pulse operation

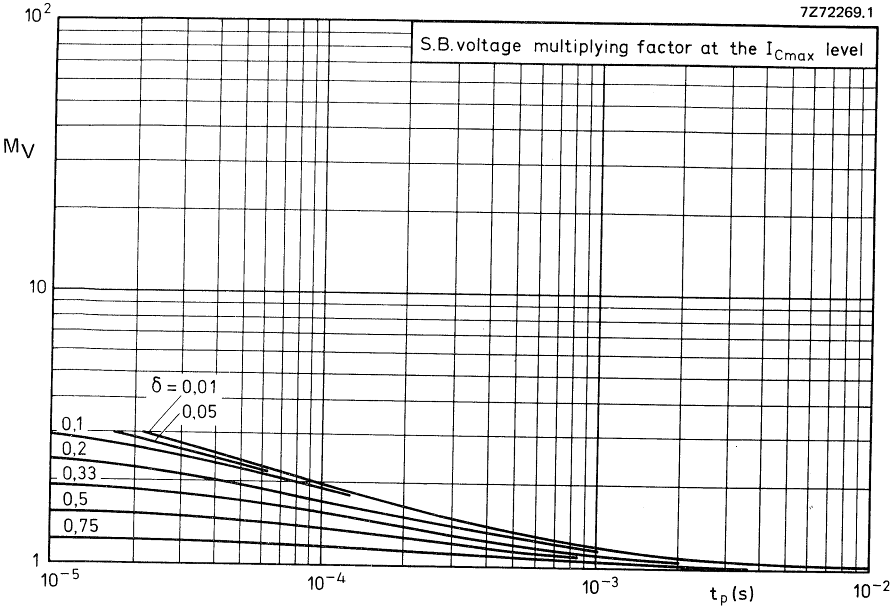
---

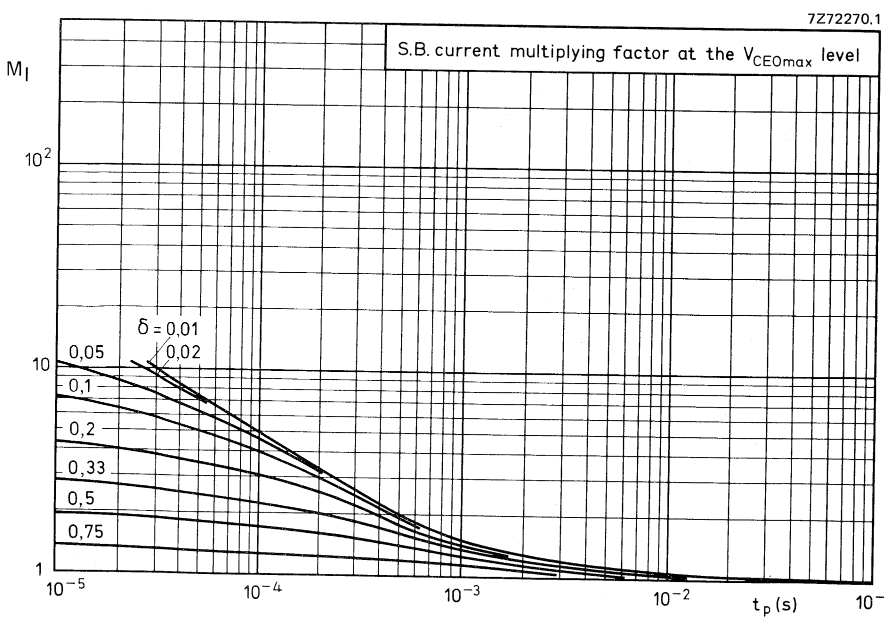
1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

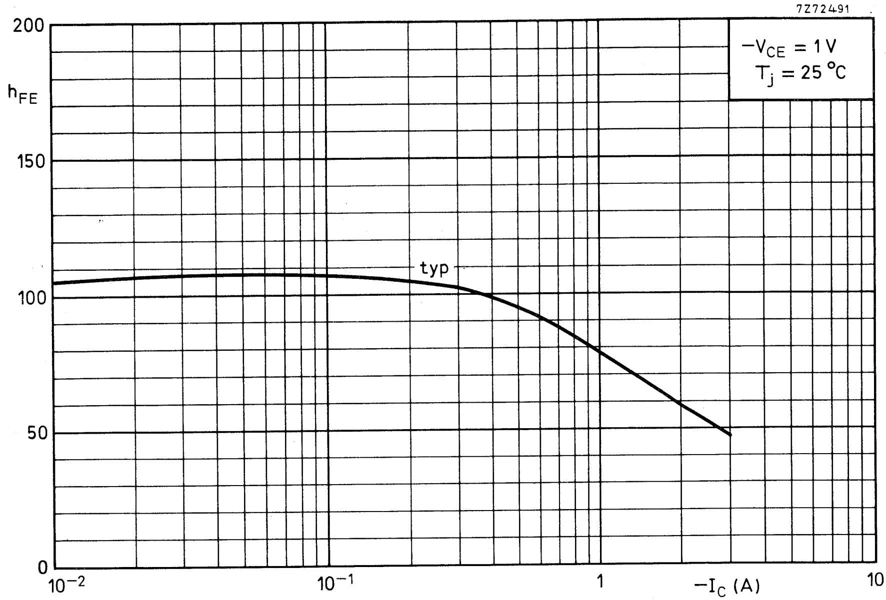
2) Second-breakdown limits (independent of temperature).

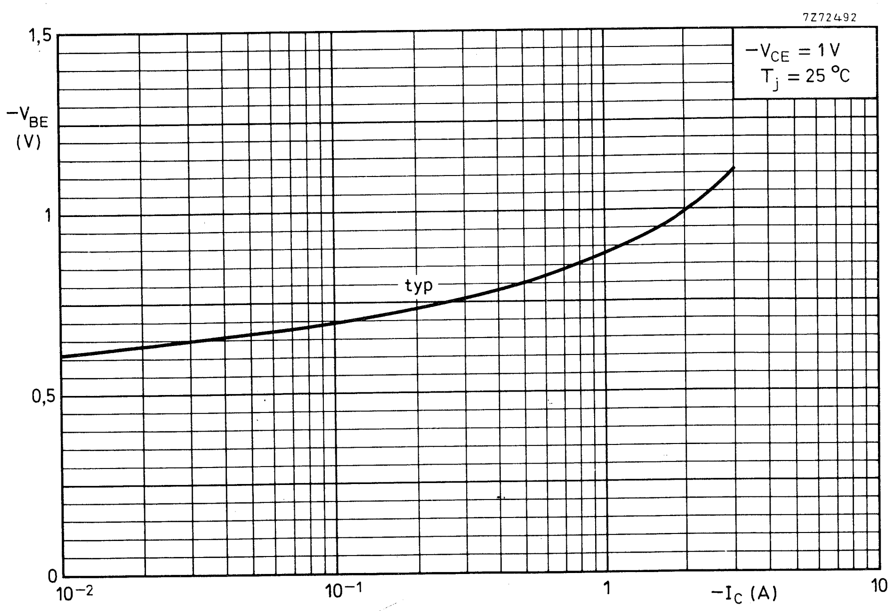

7Z67895.2
100
$P_{tot\ max}$
(%)
50
0
0
50
100
150
T_{mb} (°C)

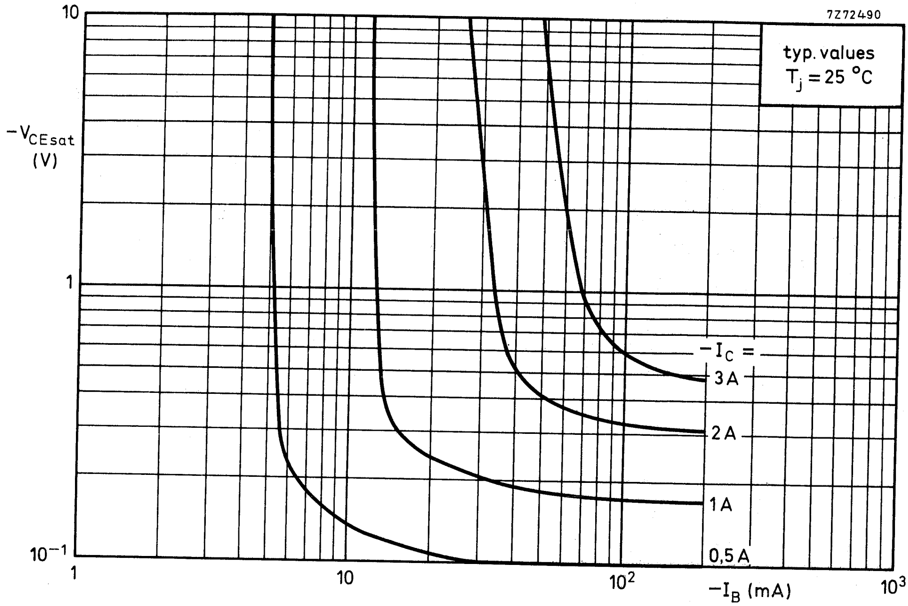

7Z62125.1
10^2
$Z_{th\ j\text{-}mb}$
(K/W)
10
1
10^{-1}
10^{-2}
δ = 1
0,75
0,5
0,33
0,2
0,1
0,05
0,02
0,01
t_p
T
$\delta = \frac{t_p}{T}$
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t_p (ms)
10^3


7Z72269.1
S.B. voltage multiplying factor at the I_{Cmax} level
M_V
10^2
10
1
δ = 0,01
0,05
0,1
0,2
0,33
0,5
0,75
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}


7Z72270.1
S.B. current multiplying factor at the V_{CEOmax} level
M_I
10^2
10
1
δ = 0,01
0,02
0,05
0,1
0,2
0,33
0,5
0,75
10^{-5}
10^{-4}
10^{-3}
10^{-2}
t_p (s)
10^{-1}


7Z72491
$-V_{CE}$ = 1 V
T_j = 25 °C
h_{FE}
200
150
100
50
0
typ
10^{-2}
10^{-1}
1
$-I_C$ (A)
10


7Z72492
$-V_{CE}$ = 1 V
T_j = 25 °C
$-V_{BE}$ (V)
1,5
1
0,5
0
typ
10^{-2}
10^{-1}
1
$-I_C$ (A)
10


7Z72490
typ. values
$T_j = 25\ ^\circ C$
$-V_{CEsat}$ (V)
10
1
10^{-1}
1
10
10^2
10^3
$-I_B$ (mA)
$-I_C$ =
3 A
2 A
1 A
0,5 A

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

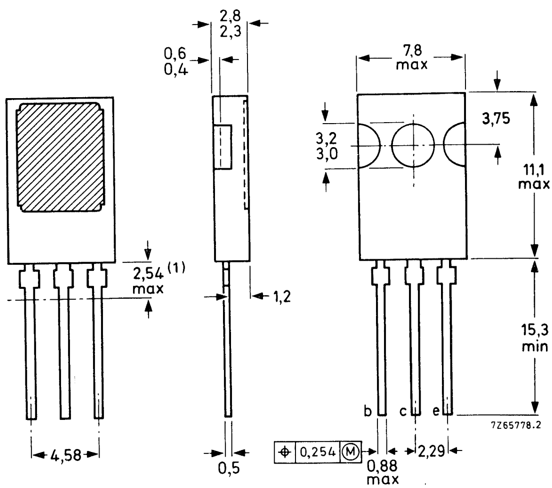
			BD331	333	335	337	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector-current (d.c.)	I_C	max.	6				A
Base current (d.c.)	I_B	max.	150				mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	60				W
Junction temperature	T_j	max.	150				°C
D.C. current gain I_C = 3,0 A; V_{CE} = 3 V	h_{FE}	>	750				

MECHANICAL DATA

Dimensions in mm

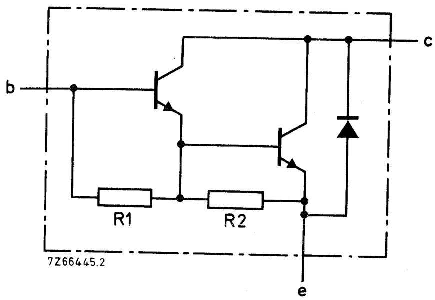
Fig. 1 SOT-82.

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.



R_1 typ. 4 kΩ
R_2 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_{EBO}	max.	5	5	5	5	V
Collector current (d.c.)	I_C	max.	6				A
Collector current (peak value) $t_p \leqslant 10$ ms; $\delta \leqslant 0,1$	I_{CM}	max.	10				A
Base current (d.c.)	I_B	max.	150				mA
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	60				W
Storage temperature	T_{stg}		−65 to + 150				^oC
Junction temperature *	T_j	max.	150				^oC

THERMAL RESISTANCE *

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

Collector cut-off current			
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	0,2 mA
$I_E = 0$; $V_{CB} = V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	2 mA
$I_B = 0$; $V_{CE} = ½ V_{CEOmax}$	I_{CEO}	<	0,5 mA
Emitter cut-off current			
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5 mA
D.C. current gain *			
I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.	1900
I_C = 3 A; V_{CE} = 3 V	h_{FE}	>	750
I_C = 6 A; V_{CE} = 3 V	h_{FE}	typ.	3000
Base-emitter voltage **			
I_C = 3 A; V_{CE} = 3 V	V_{BE}	<	2,5 V
Collector-emitter saturation voltage			
I_C = 3 A; I_B = 12 mA	V_{CEsat}	<	2 V
Cut-off frequency			
I_C = 3 A; V_{CE} = 3 V	f_{hfe}	typ.	50 kHz
Turn-off breakdown energy with inductive load (see Fig. 12)			
$-I_{Boff} = 0$; I_{Con} = 4,5 A	$E_{(BR)}$	>	50 mJ
Diode forward voltage			
I_F = 3 A	V_F	typ.	1,8 V
D.C. current gain ratio of complementary matched pairs			
I_C = 3 A; V_{CE} = 3 V	h_{FE1}/h_{FE2}	<	2,5
Small signal current gain			
I_C = 3 A; V_{CE} = 3 V; f = 1 MHz	h_{fe}	typ.	50
Second-breakdown collector current			
V_{CE} = 60 V; t_p = 25 ms	$I_{(SB)}$	>	1 A
Switching times (between 10% and 90% levels)			
I_{Con} = 3 A; $I_{Bon} = -I_{Boff}$ = 12 mA			
Turn-on time	t_{on}	typ.	1 μs
		<	2 μs
Turn-off time	t_{off}	typ.	5 μs
		<	10 μs

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

** V_{BE} decreases by about 3,8 mV/K with increasing temperature.

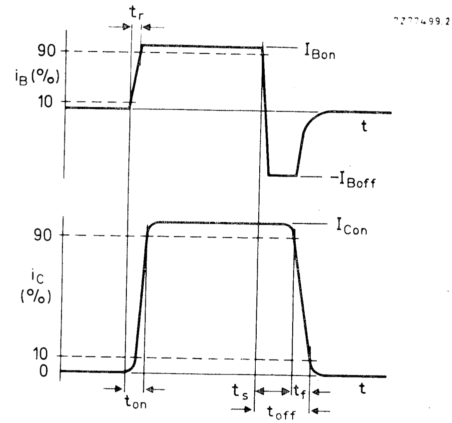


Fig. 3 Switching times waveforms.

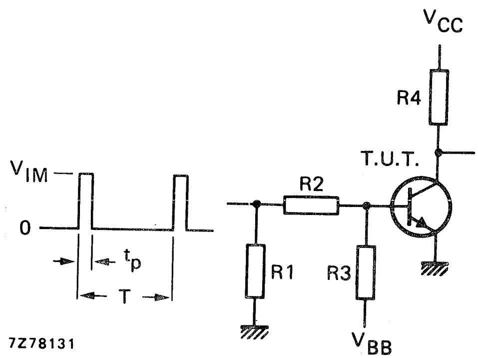


Fig. 4 Switching times test circuit.

V_{IM} = 10 V
V_{CC} = 10 V
$-V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 3 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

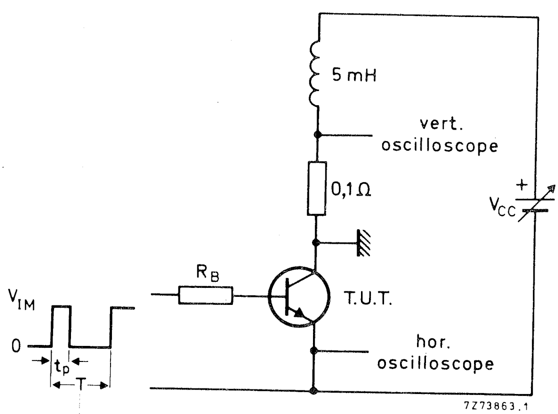


Fig. 5 Test circuit for turn-off breakdown energy.

V_{IM} = 12 V
R_B = 270 Ω
I_C = 4,5 A
δ = 1 %
t_p = 1 ms

7Z72220.2

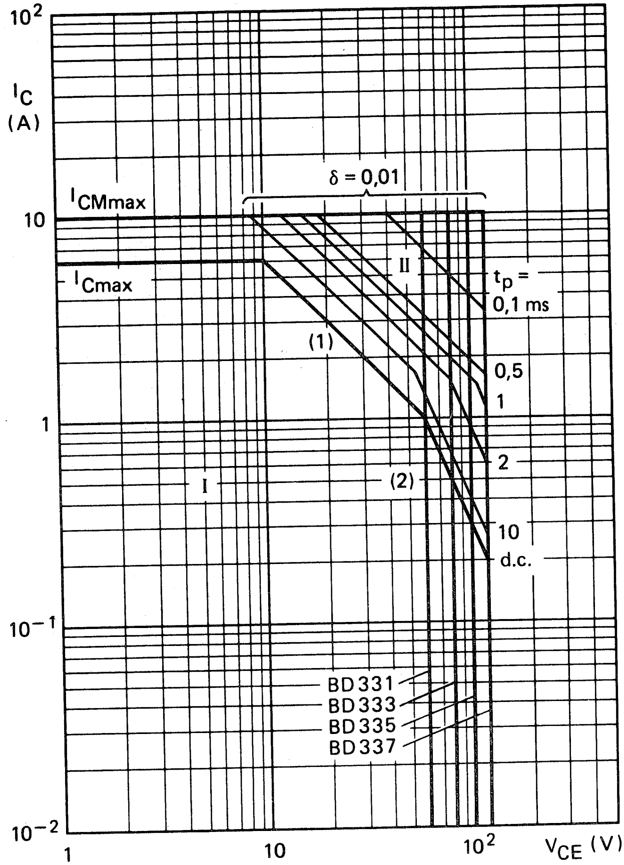


Fig. 6 Safe Operating ARea, $T_{mb} \leqslant 25\ ^{o}C$.

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).

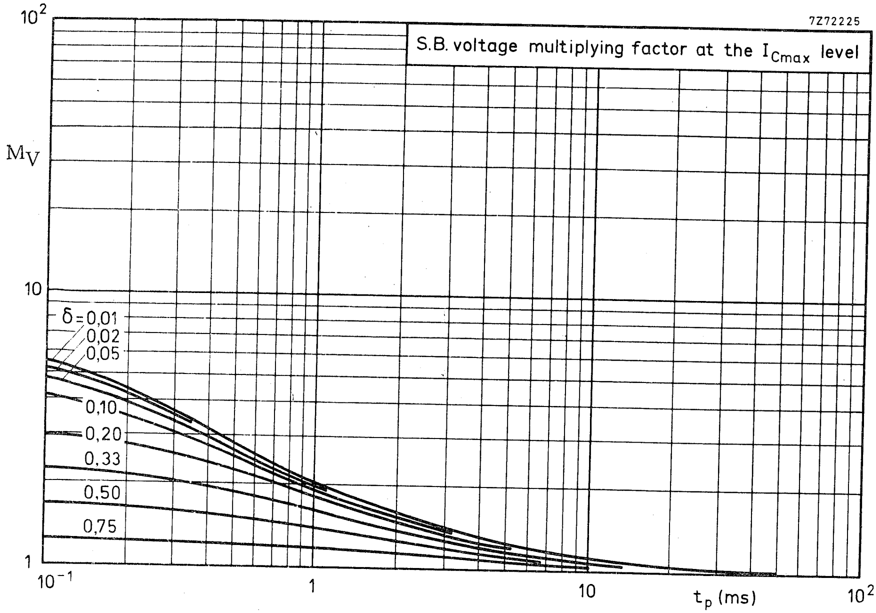


Fig. 7 Second breakdown voltage multiplying factor at I_{Cmax} level.

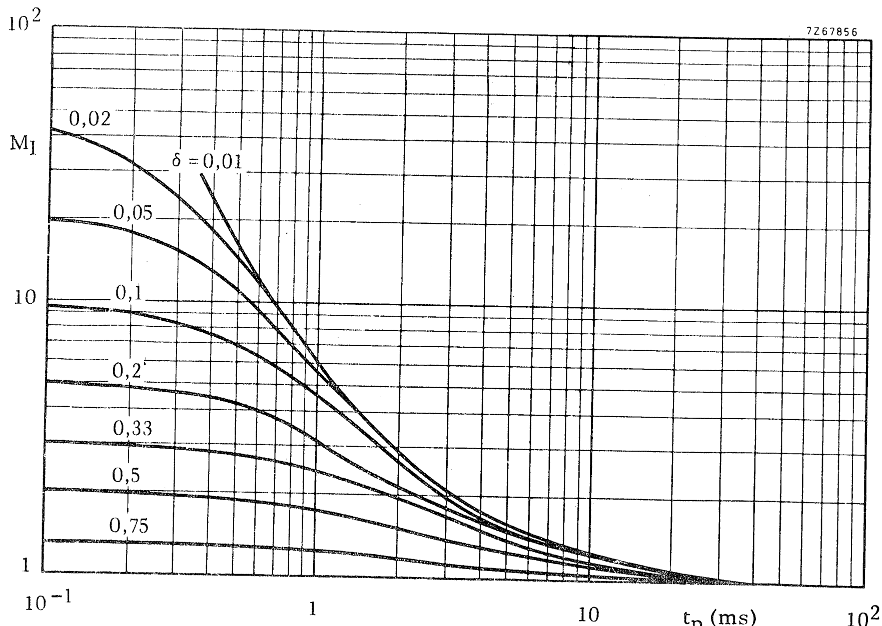


Fig. 8 Second breakdown current multiplying factor at V_{CEOmax} level.

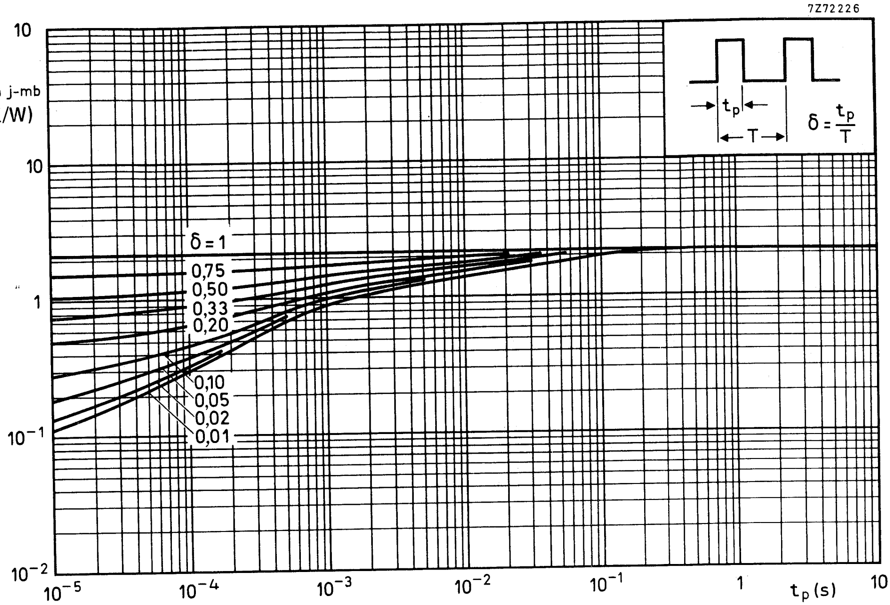


Fig. 9 Pulse power rating chart.

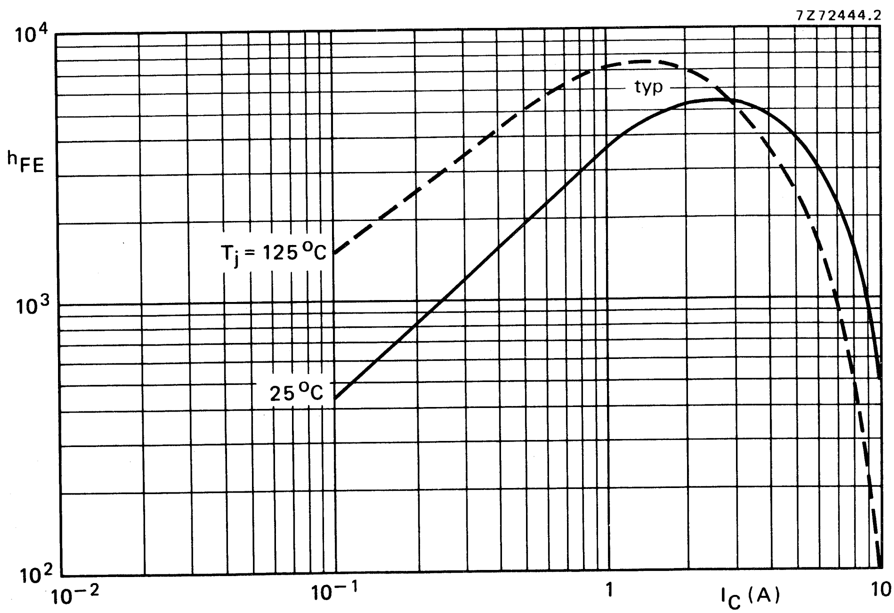


Fig. 10 D.C. current gain. $V_{CE} = 3$ V.

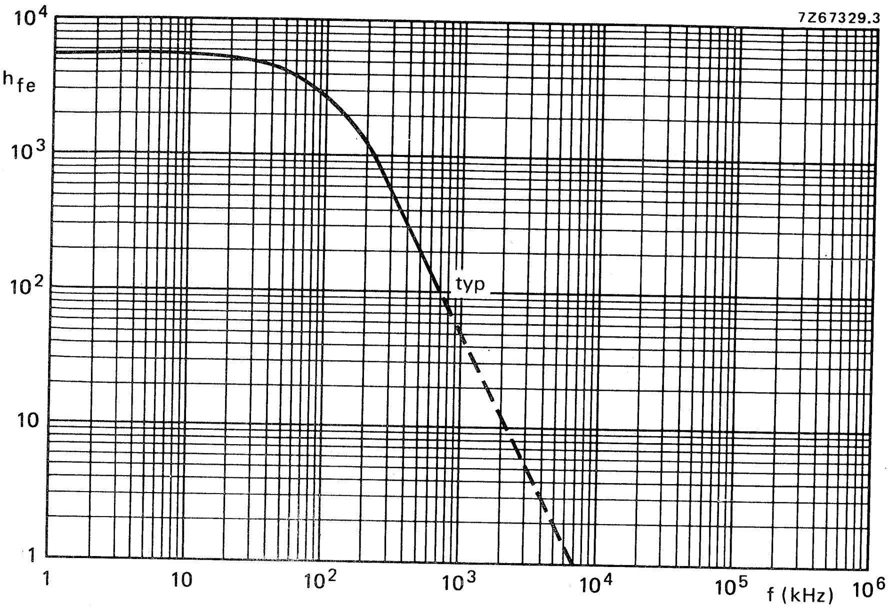


Fig. 11 Small signal current gain at I_C = 3 A; V_{CE} = 3 V.

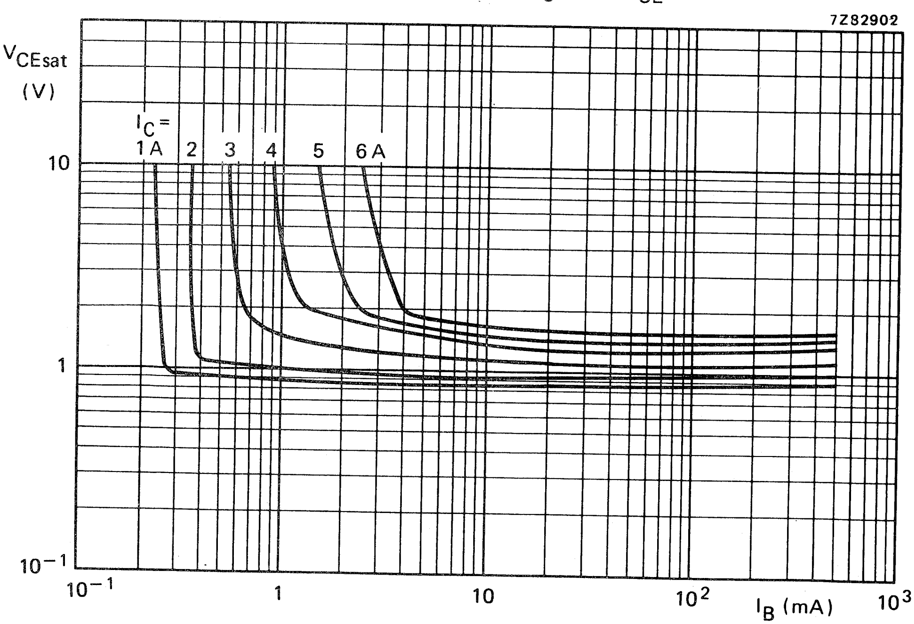


Fig. 12 Typical values collector-emitter saturation. T_j = 25 °C.

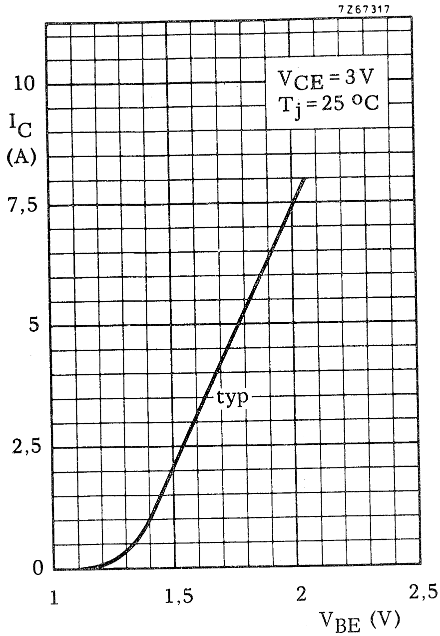


Fig. 13 Collector current.

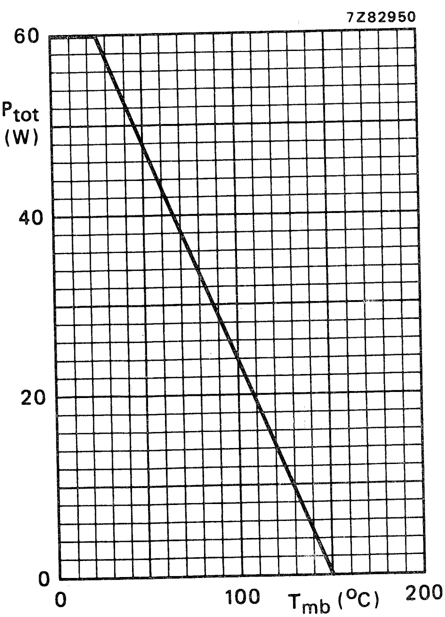


Fig. 14 Power derating curve.

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

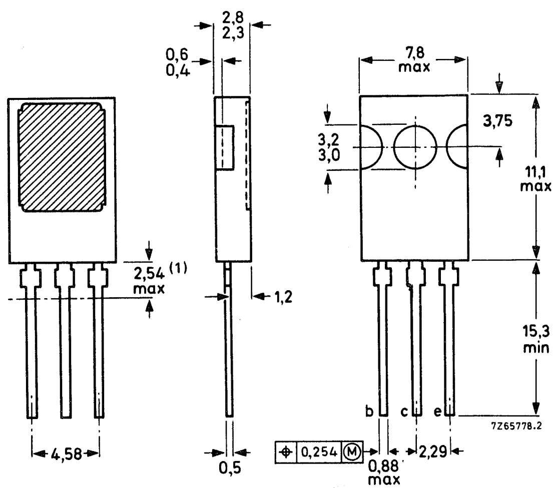
			BD332	334	336	338	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector-current (d.c.)	$-I_C$	max.		6			A
Base current (d.c.)	$-I_B$	max.		150			mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		60			W
Junction temperature	T_j	max.		150			°C
D.C. current gain $-I_C$ = 3,0 A; $-V_{CE}$ = 3 V	h_{FE}	>		750			

MECHANICAL DATA

Dimensions in mm

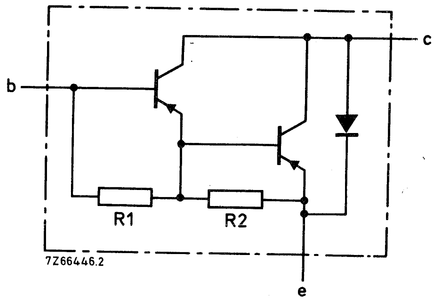
Fig. 1 SOT-82.

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.



R_1 typ. 4 kΩ
R_2 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) $t_p \leqslant 10$ ms; $\delta \leqslant 0{,}1$	$-I_{CM}$	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	$R_{th\ j\text{-}mb}$	=	2,08	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	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 °C unless otherwise specified

Collector cut-off current			
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,2 mA
$I_E = 0; -V_{CB} = -V_{CBOmax}; T_j = 150\ ^oC$	$-I_{CBO}$	<	2 mA
$I_B = 0; -V_{CE} = -½\ V_{CEO}$	$-I_{CEO}$	<	0,5 mA
Emitter cut-off current			
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	5 mA
D.C. current gain *			
$-I_C = 0,5$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	2700
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE}	>	750
$-I_C = 6$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	400
Base-emitter voltage **			
$-I_C = 3$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5 V
Collector-emitter saturation voltage			
$-I_C = 3$ A; $-I_B = 12$ mA	$-V_{CEsat}$	<	2 V
Small signal current gain			
$-I_C = 3$ A; $-V_{CE} = 3$ V; f = 1 MHz	$\|h_{fe}\|$	typ.	150
Cut-off frequency			
$-I_C = 3$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	100 kHz
Diode, forward voltage			
$I_F = 3$ A	V_F	typ.	1,8 V
D.C. current gain ratio of complementary matched pairs			
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE1}/h_{FE2}	<	2,5
Second breakdown collector current non-repetitive; without heatsink			
$-V_{CE} = 60$ V; $t_p = 25$ ms	$-I_{(SB)}$	>	1 A
Switching times (see Figs 3 and 4)			
$-I_{Con} = 3$ A; $-I_{Bon} = I_{Boff} = 12$ mA			
turn-on time	t_{on}	typ.	1 μs
		<	2 μs
turn-off time	t_{off}	typ.	5 μs
		<	10 μs

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

** V_{BE} decreases by about 3,8 mV/K with increasing temperature.

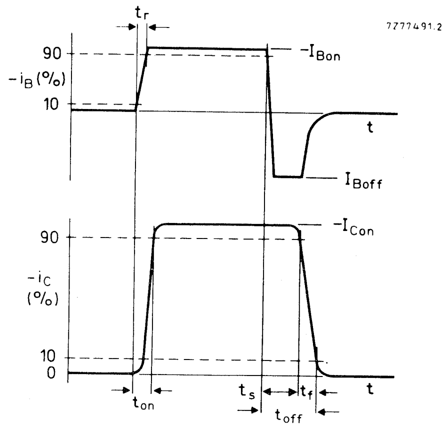
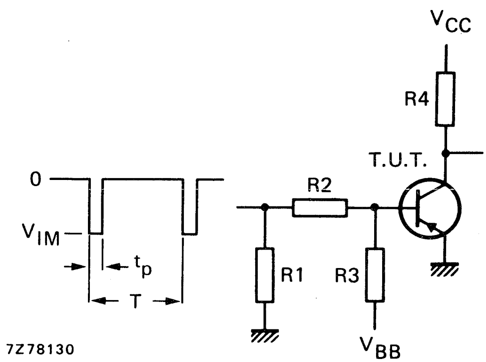


Fig. 3 Switching times waveforms.



$-V_{IM}$	=	10 V
$-V_{CC}$	=	10 V
V_{BB}	=	4 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	3 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

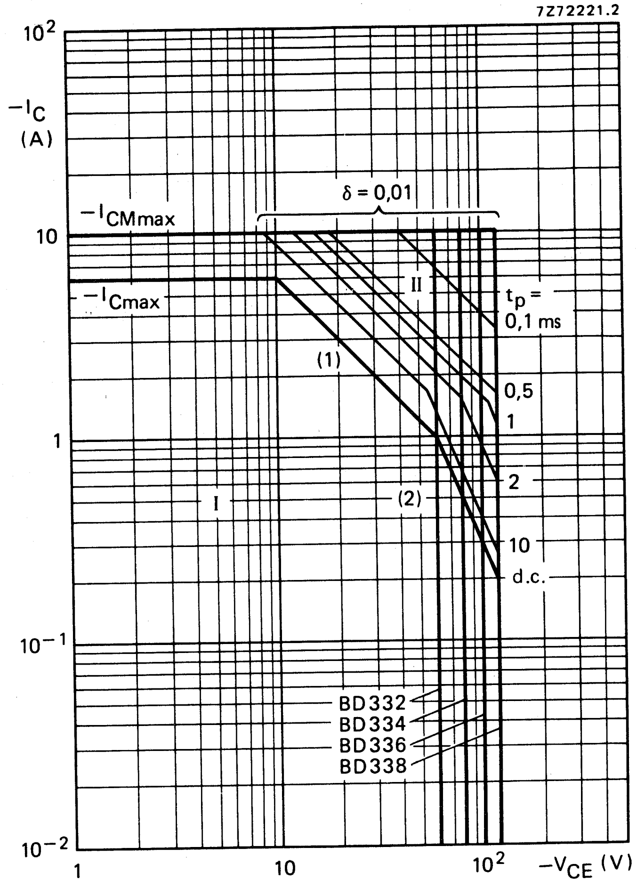


Fig. 5 Safe Operating Area with the transistor forward biased; T_{mb} = 25 °C.

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).

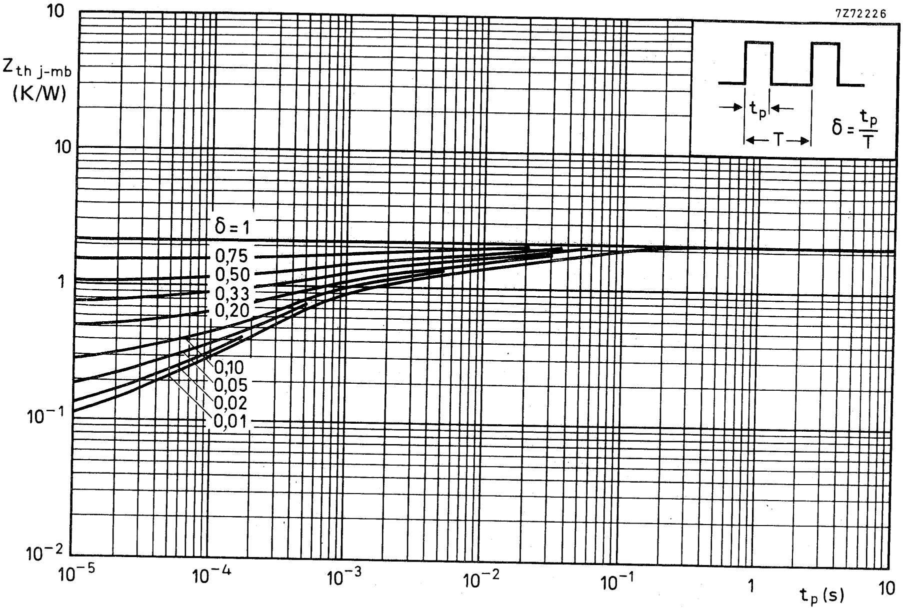


Fig. 6 Pulse power rating chart.

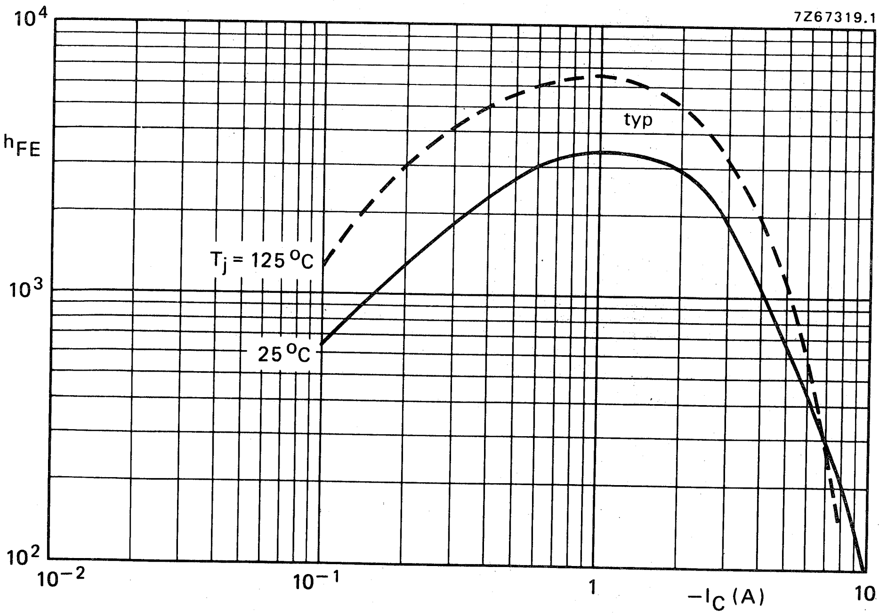


Fig. 7 D.C. current gain at $-V_{CE} = 3$ V.

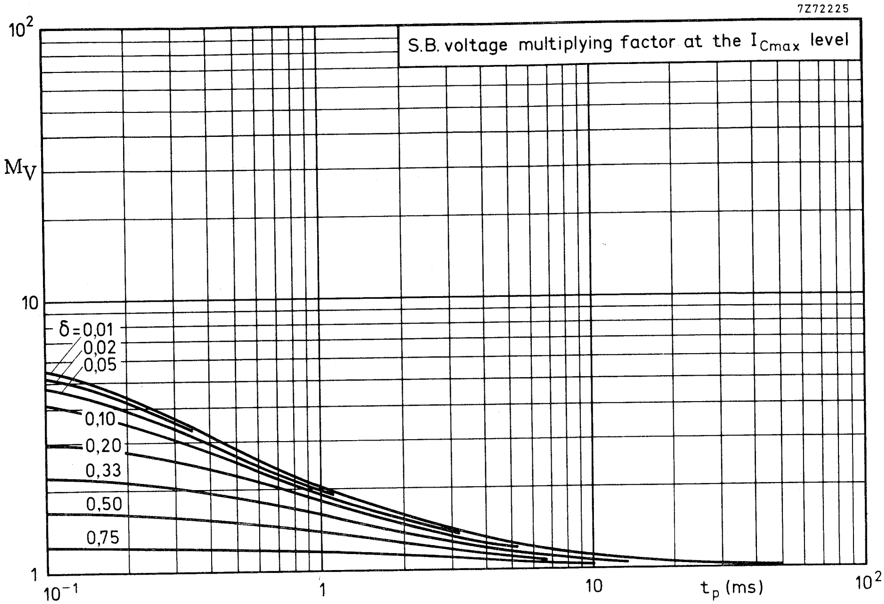


Fig. 8 Second breakdown voltage multiplying factor at the I_{Cmax} level.

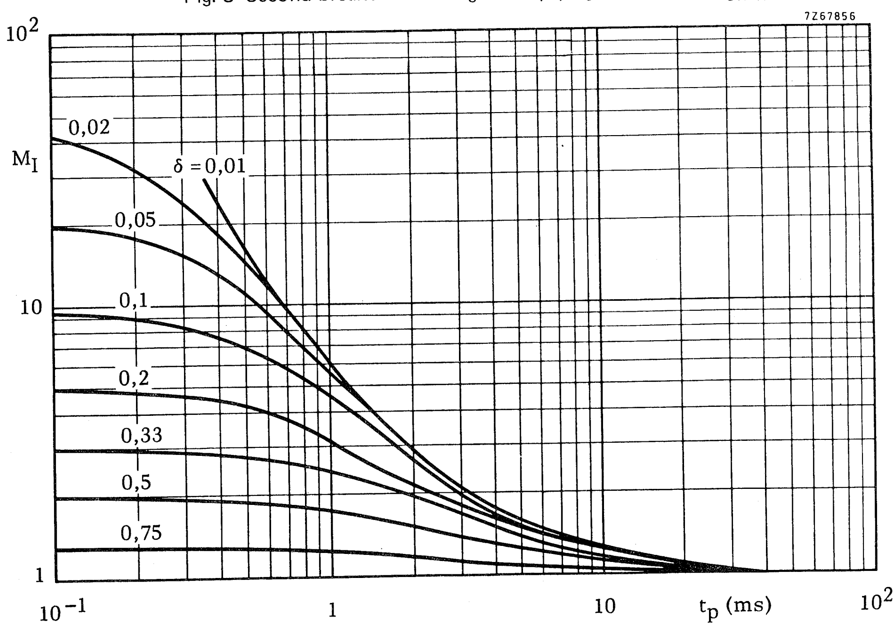


Fig. 9 Second breakdown current multiplying factor at the V_{CEOmax} level.

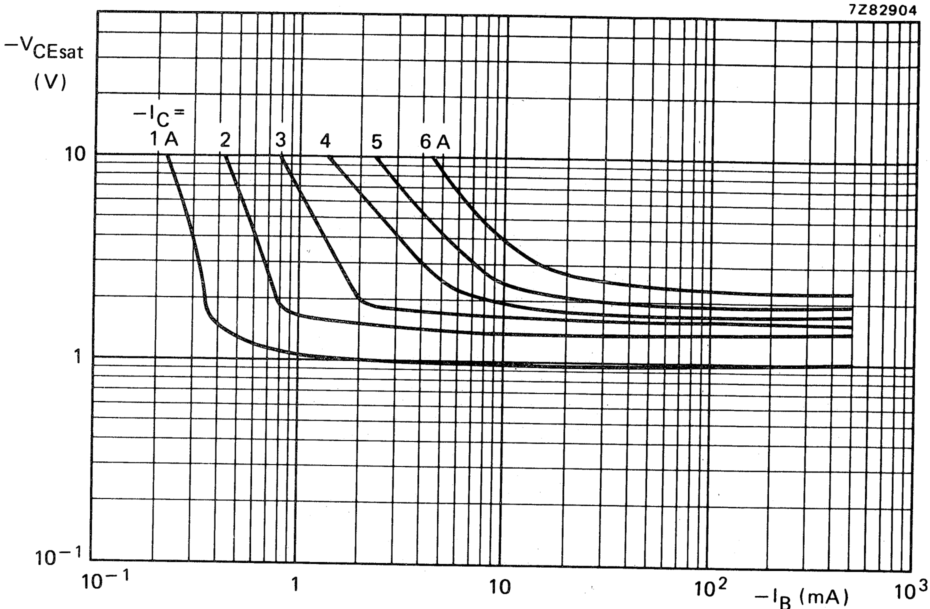


Fig. 10 Typical values collector-emitter saturation voltage. T_j = 25 °C.

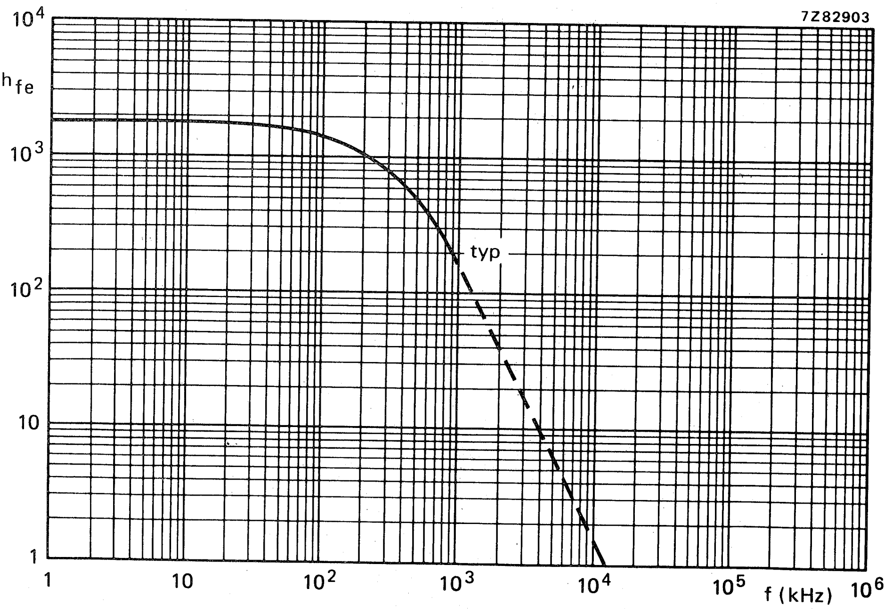


Fig. 11 Small signal current gain. $-I_C$ = 3 A; $-V_{CE}$ = 3 V.

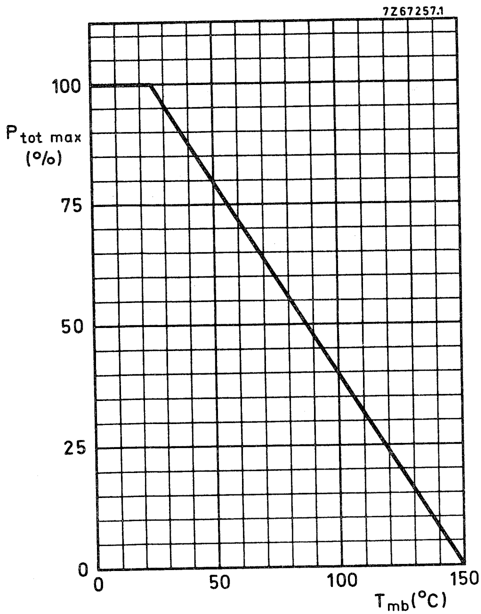


Fig. 12 Power derating curve.

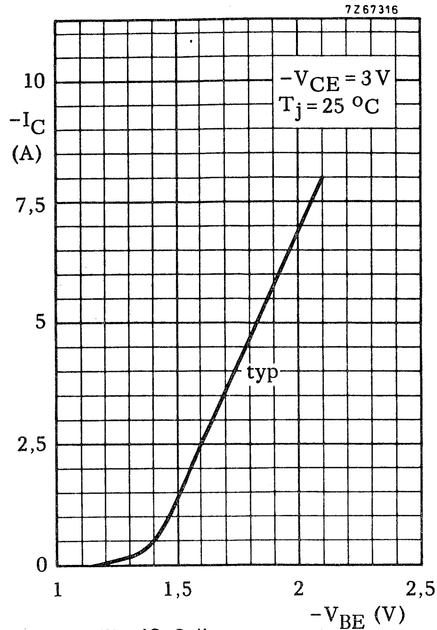


Fig. 13 Collector current.

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

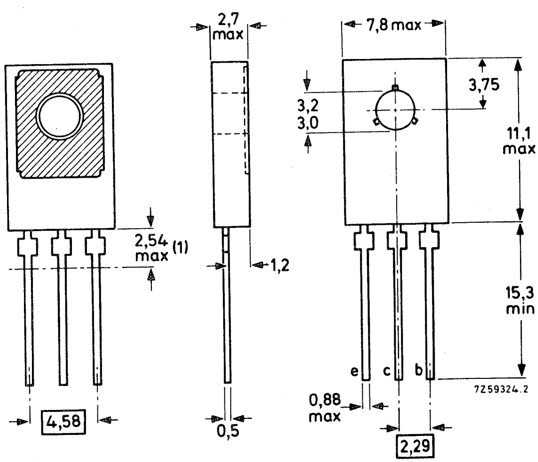
			BD433	BD435	BD437	
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	22	32	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	22	32	45	V
Collector current (peak value)	I_{CM}	max.	7	7	7	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	36	36	36	W
D.C. current gain I_C = 2 A; V_{CE} = 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)

Voltages

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

Currents

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

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	36	W

Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current

I_E = 0; V_{CB} = V_{CBOmax}	I_{CBO}	<	100	μA
I_E = 0; V_{CB} = 10 V; T_j = 150 °C	I_{CBO}	<	1	mA
I_E = 0; V_{CB} = V_{CBOmax}; T_j = 150 °C	I_{CBO}	<	3	mA

Emitter cut-off current

I_C = 0; V_{EB} = 5 V	I_{EBO}	<	1	mA

			BD433	BD435	BD437	
Knee voltage						
I_C = 2 A; I_B = value for which I_C = 2,2 A at V_{CE} = 1 V	V_{CEK}	<	0,8	0,8	0,8	V
Base-emitter voltage [1]						
I_C = 10 mA; V_{CE} = 5 V	V_{BE}	typ.	580	580	580	mV
I_C = 2 A; V_{CE} = 1 V	V_{BE}	<	1,1	1,1	–	V
I_C = 3 A; V_{CE} = 1 V	V_{BE}	<	–	–	1,3	V
Collector-emitter saturation voltage						
I_C = 2 A; I_B = 0,2 A	V_{CEsat}	<	0,5	0,5	–	V
I_C = 3 A; I_B = 0,3 A	V_{CEsat}	<	–	–	0,7	V
D.C. current gain						
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	>	25	25	25	
I_C = 500 mA; V_{CE} = 1 V	h_{FE}	>	85	85	85	
		<	475	475	375	
I_C = 2 A; V_{CE} = 1 V	h_{FE}	>	50	50	40	
I_C = 3 A; V_{CE} = 1 V	h_{FE}	>	–	–	30	

Transition frequency at f = 1 MHz

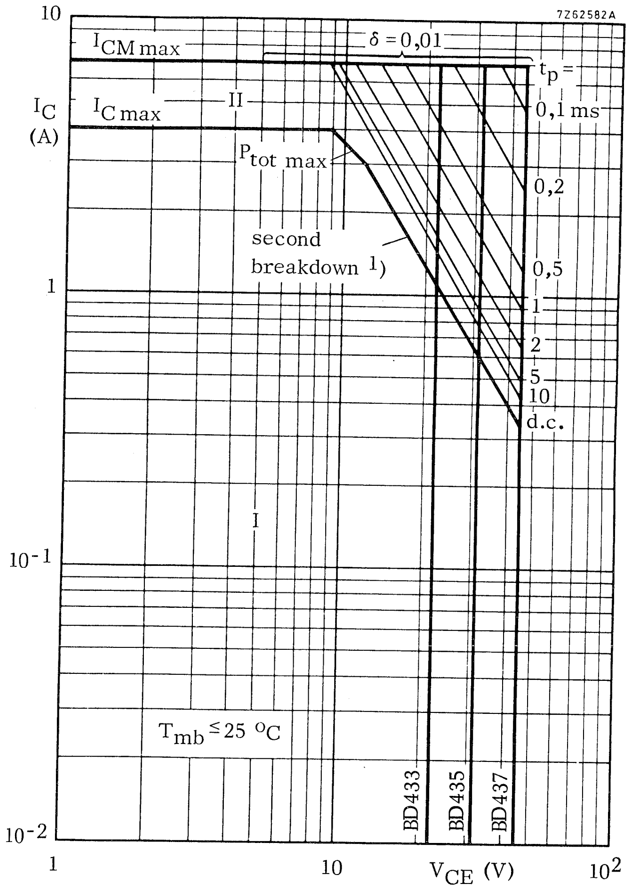
I_C = 250 mA; V_{CE} = 1 V	f_T	>	7	MHz ←

D.C. current gain ratio of the complementary pairs

$|I_C|$ = 500 mA; $|V_{CE}|$ = 1 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.

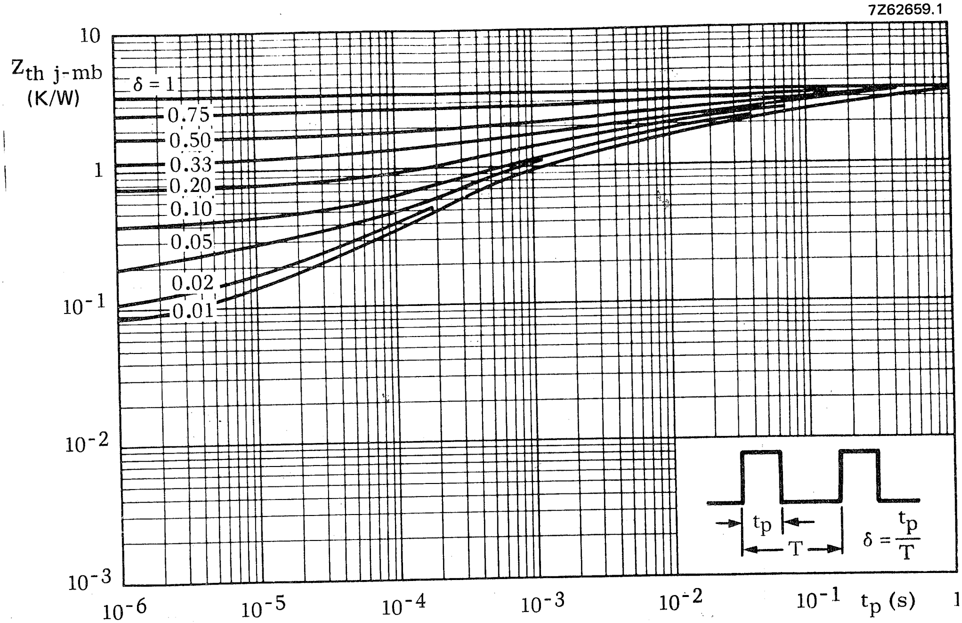


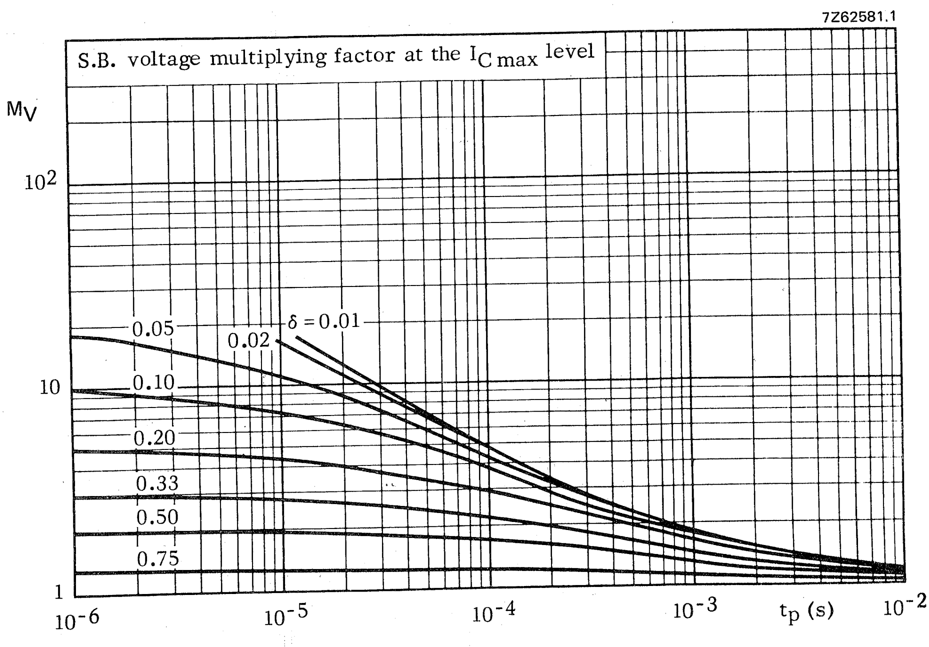
Safe Operating ARea with the transistor forward biased

I Region of permissible d.c. operation

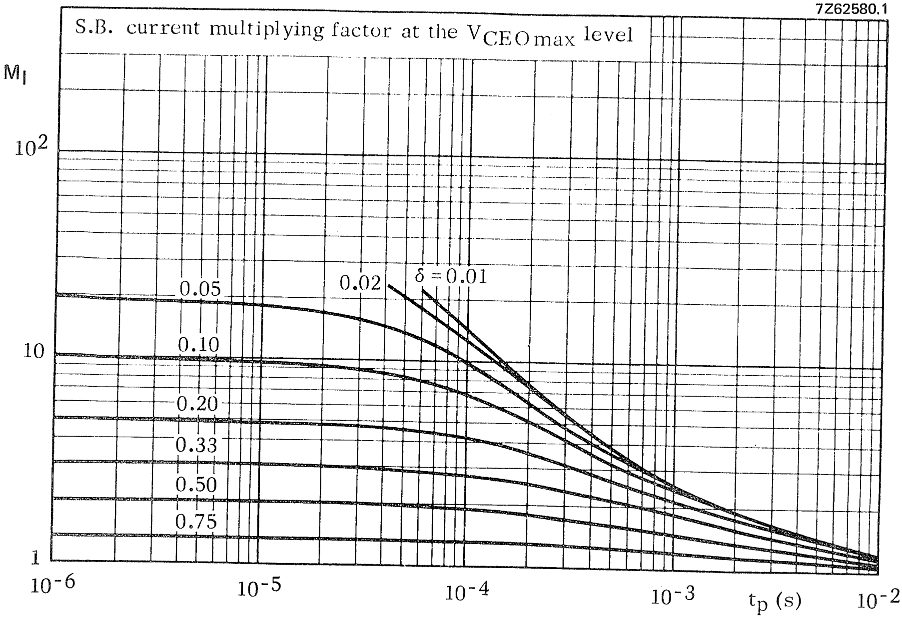
II Permissible extension for repetitive pulse operation

1) Independent of temperature.

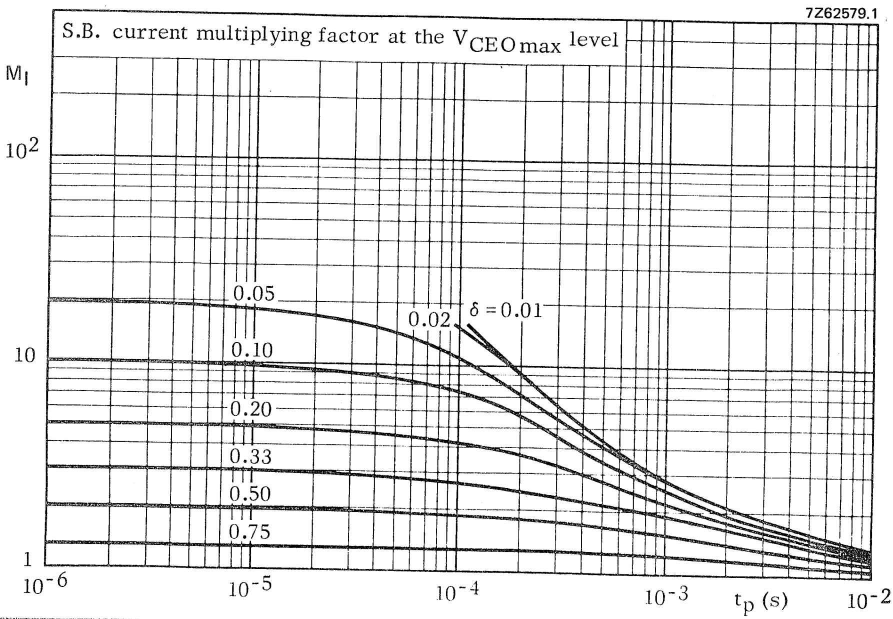

7Z62659.1
10
$Z_{th\ j\text{-}mb}$ (K/W)
$\delta = 1$
0.75
0.50
0.33
0.20
0.10
0.05
0.02
0.01
1
10^{-1}
10^{-2}
10^{-3}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
t_p (s)
1
t_p
T
$\delta = \frac{t_p}{T}$

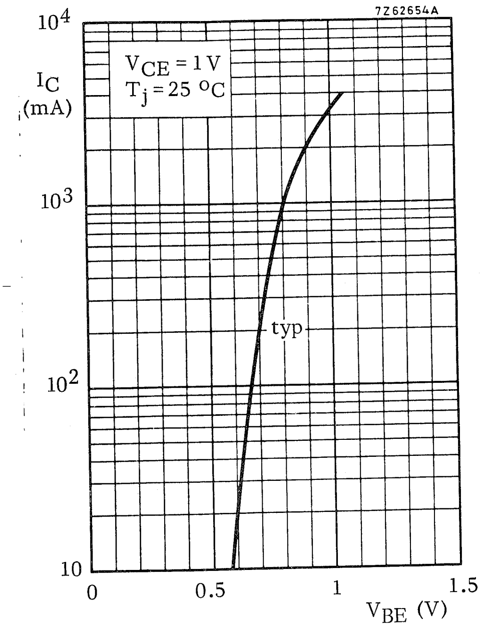

7Z62581.1
S.B. voltage multiplying factor at the $I_{C\,max}$ level
M_V
10^2
10
1
0.05
0.02
$\delta = 0.01$
0.10
0.20
0.33
0.50
0.75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

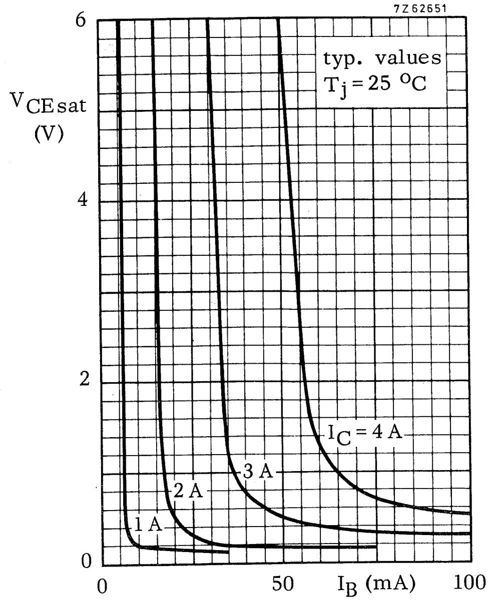
BD433; BD435

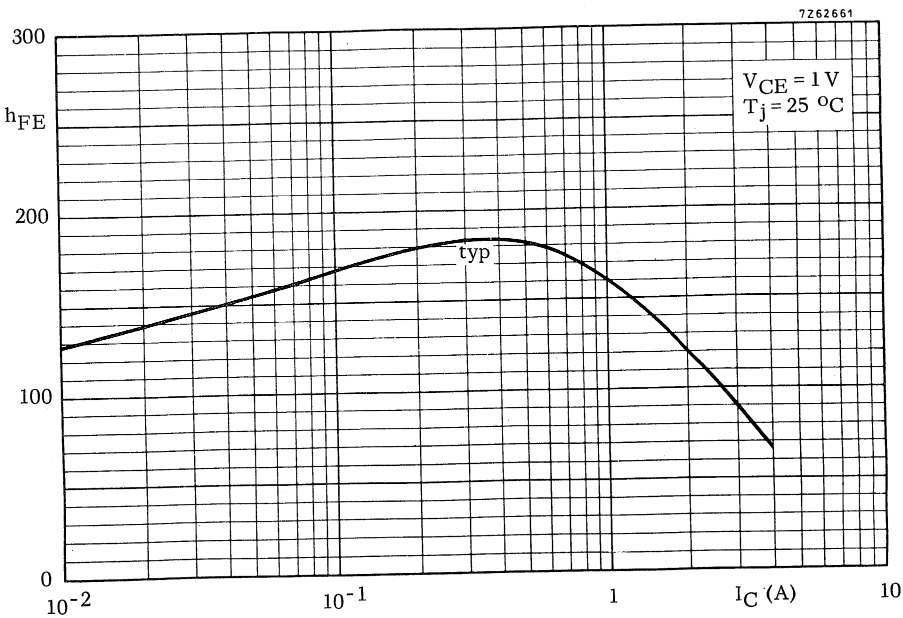


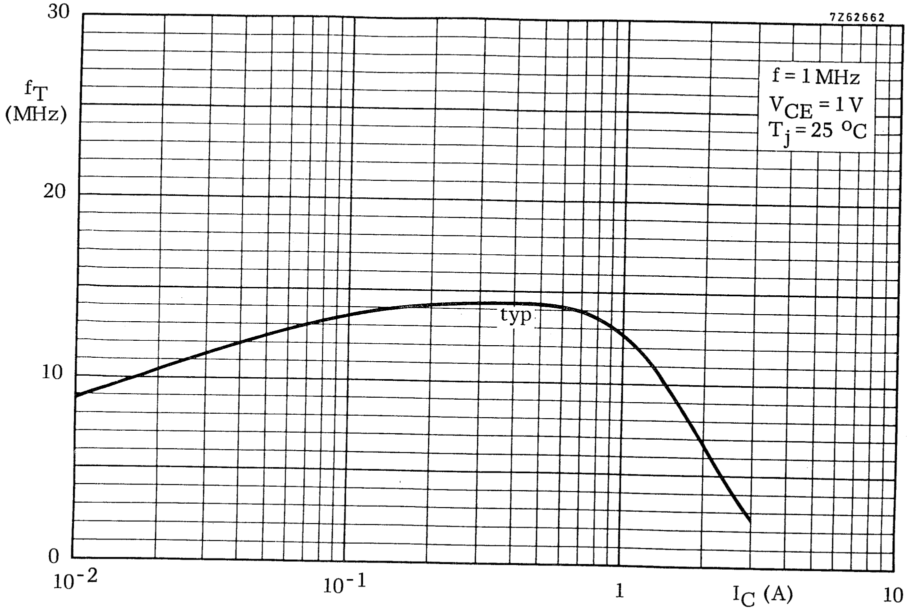
BD437

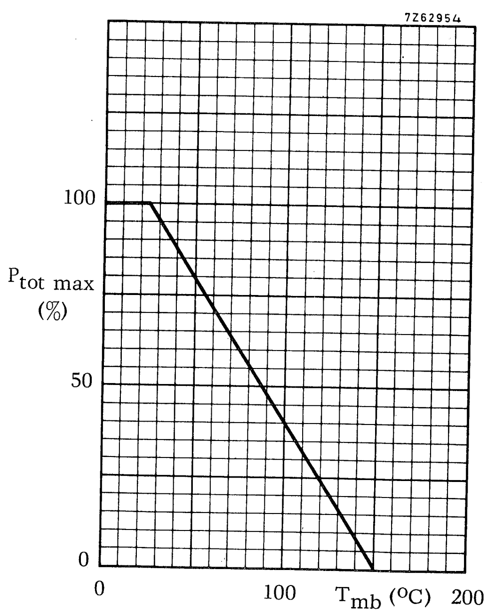



7Z62654A
10^4
I_C (mA)
$V_{CE} = 1\,V$
$T_j = 25\ ^oC$
10^3
typ
10^2
10
0
0.5
1
1.5
V_{BE} (V)


7Z62651
6
V_{CEsat} (V)
typ. values
$T_j = 25\ ^oC$
4
2
$I_C = 4\,A$
3 A
2 A
1 A
0
0
50
I_B (mA)
100


7Z62661
300
h_{FE}
$V_{CE} = 1\,V$
$T_j = 25\ ^oC$
200
typ
100
0
10^{-2}
10^{-1}
1
I_C (A)
10


7Z62662
30
20
10
0
f_T
(MHz)
f = 1 MHz
V_{CE} = 1 V
T_j = 25 °C
typ
10^{-2}
10^{-1}
1
I_C (A)
10


7Z62954
100
$P_{tot\ max}$
(%)
50
0
0
100
T_{mb} (°C)
200

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

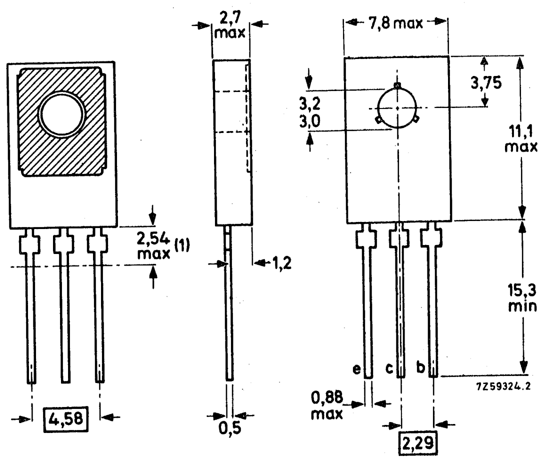
			BD434	BD436	BD438	
Collector-emitter voltage ($-V_{BE} = 0$)	$-V_{CES}$	max.	22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	22	32	45	V
Collector current (peak value)	$-I_{CM}$	max.	7	7	7	A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	36	36	36	W
D.C. current gain $-I_C = 2$ 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)

Voltages

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

Currents

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

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	36	W

Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

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

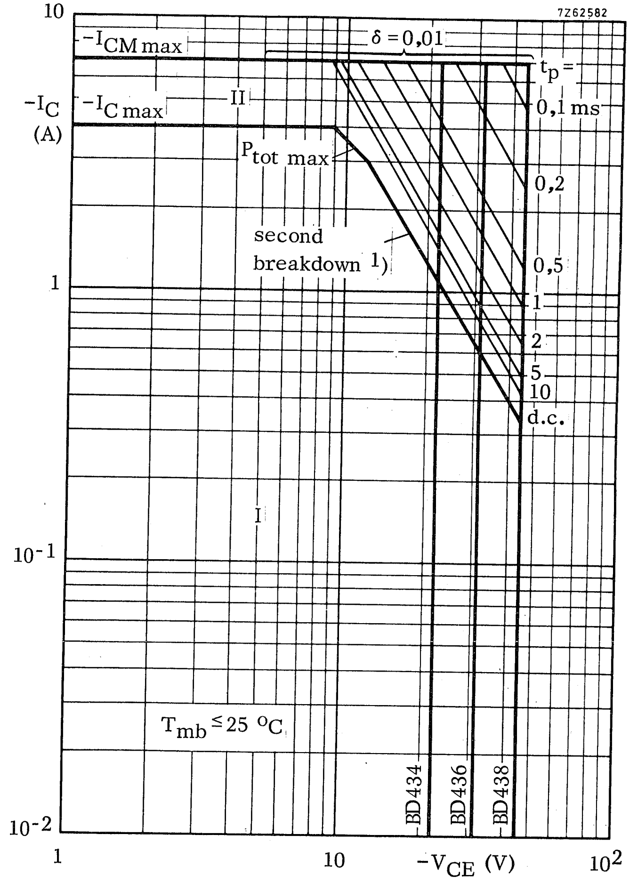
CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	100	μA
$I_E = 0$; $-V_{CB} = 10$ V; $T_j = 150$ °C	$-I_{CBO}$	<	1	mA
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$; $T_j = 150$ °C	$-I_{CBO}$	<	3	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	1	mA

			BD434	BD436	BD438	
Knee voltage						
$-I_C = 2$ A; $-I_B$ = value for which $-I_C = 2,2$ A at $-V_{CE} = 1$ V	$-V_{CEK}$	<	0,8	0,8	0,8	V
Base-emitter voltage [1]						
$-I_C = 10$ mA; $-V_{CE} = 5$ V	$-V_{BE}$	typ.	580	580	580	mV
$-I_C = 2$ A; $-V_{CE} = 1$ V	$-V_{BE}$	<	1,1	1,1	–	V
$-I_C = 3$ A; $-V_{CE} = 1$ V	$-V_{BE}$	<	–	–	1,3	V
Collector-emitter saturation voltage						
$-I_C = 2$ A; $-I_B = 0,2$ A	$-V_{CEsat}$	<	0,5	0,5	–	V
$-I_C = 3$ A; $-I_B = 0,3$ A	$-V_{CEsat}$	<	–	–	0,7	V
D.C. current gain						
$-I_C = 10$ mA; $-V_{CE} = 5$ V	h_{FE}	>	25	25	25	
$-I_C = 500$ mA; $-V_{CE} = 1$ V	h_{FE}	>	85	85	85	
		<	475	475	375	
$-I_C = 2$ A; $-V_{CE} = 1$ V	h_{FE}	>	50	50	40	
$-I_C = 3$ A; $-V_{CE} = 1$ V	h_{FE}	>	–	–	30	

Transition frequency at f = 1 MHz				
$-I_C = 250$ mA; $-V_{CE} = 1$ V	f_T	>	7	MHz ←
D.C. current gain ratio of the complementary pairs				
$\|I_C\| = 500$ mA; $\|V_{CE}\| = 1$ 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.

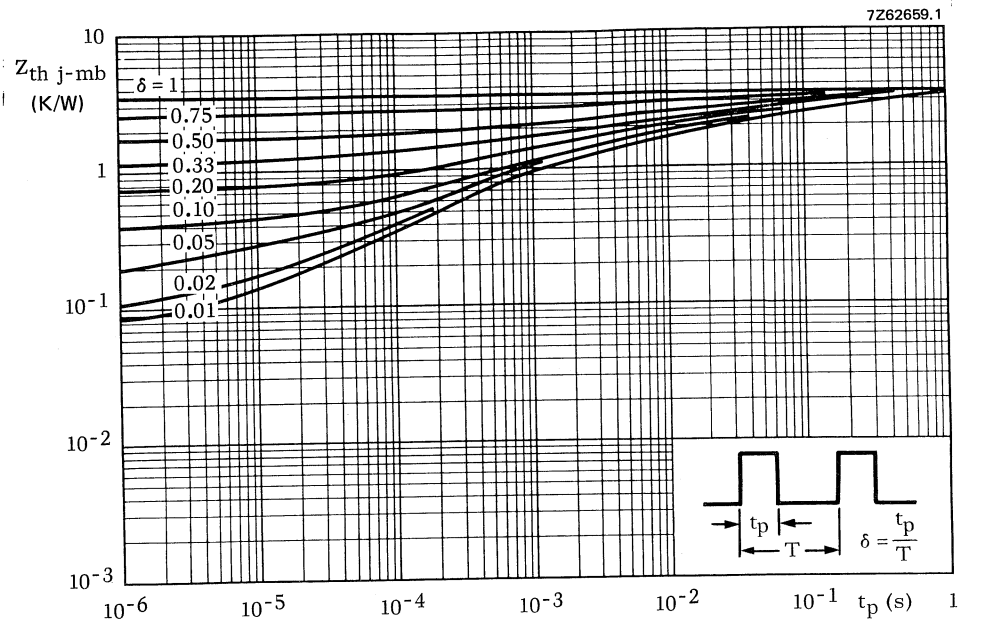


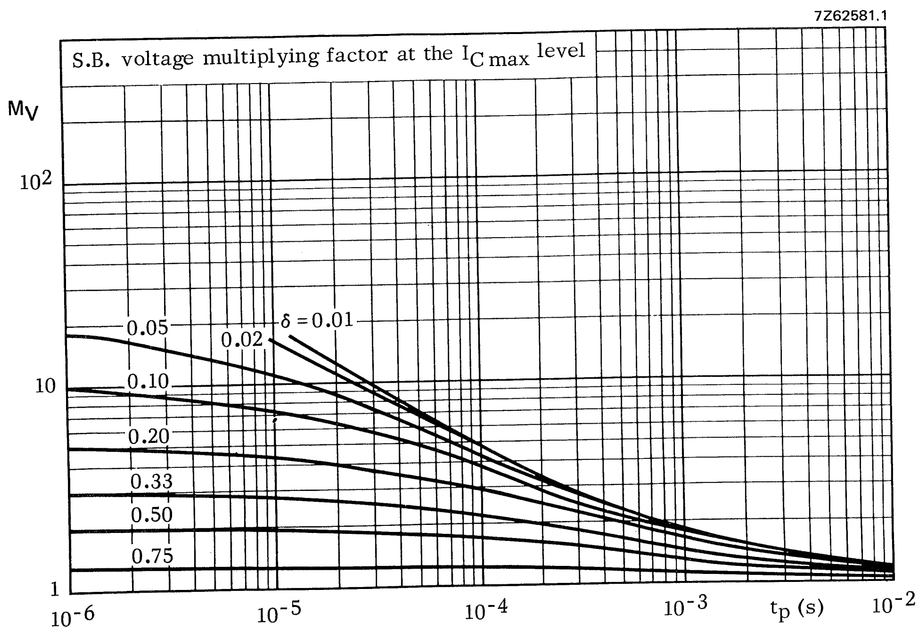
Safe Operating ARea with the transistor forward biased

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

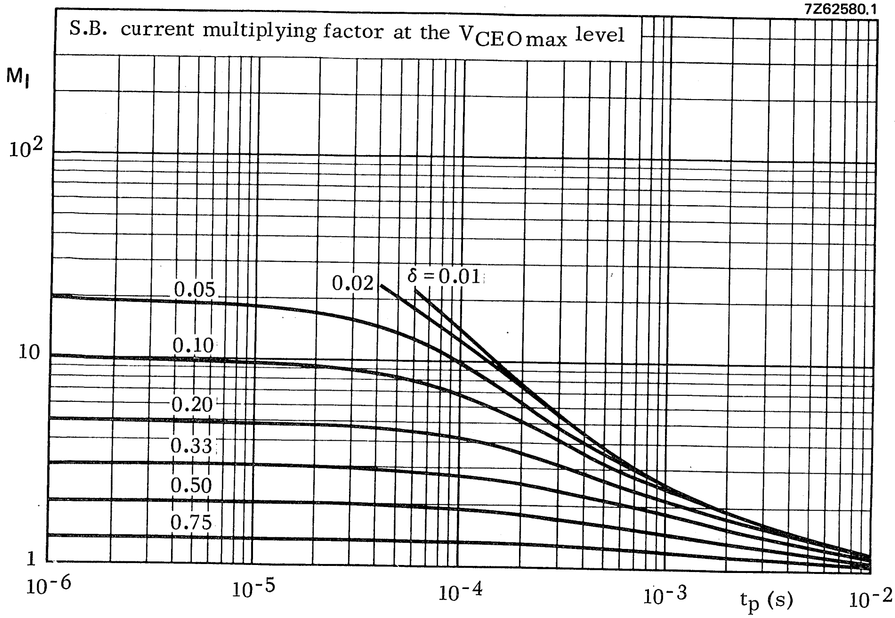
1) Independent of temperature.


7Z62659.1
Zth j-mb
(K/W)
10
1
10^-1
10^-2
10^-3
δ = 1
0.75
0.50
0.33
0.20
0.10
0.05
0.02
0.01
tp
T
δ = tp/T
10^-6
10^-5
10^-4
10^-3
10^-2
10^-1
tp (s)
1


7Z62581.1
S.B. voltage multiplying factor at the IC max level
MV
10^2
10
1
0.05
0.02
δ = 0.01
0.10
0.20
0.33
0.50
0.75
10^-6
10^-5
10^-4
10^-3
tp (s)
10^-2

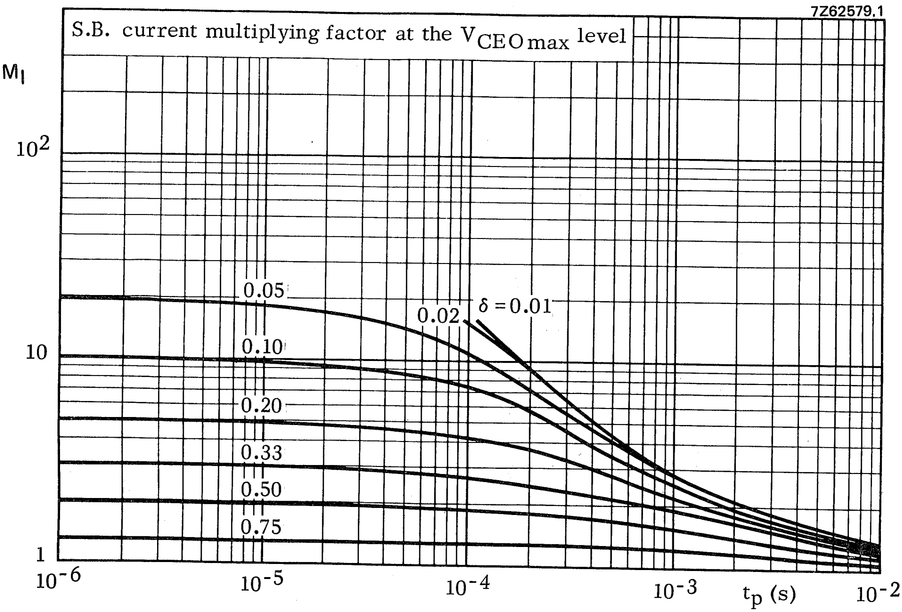
BD434; BD436

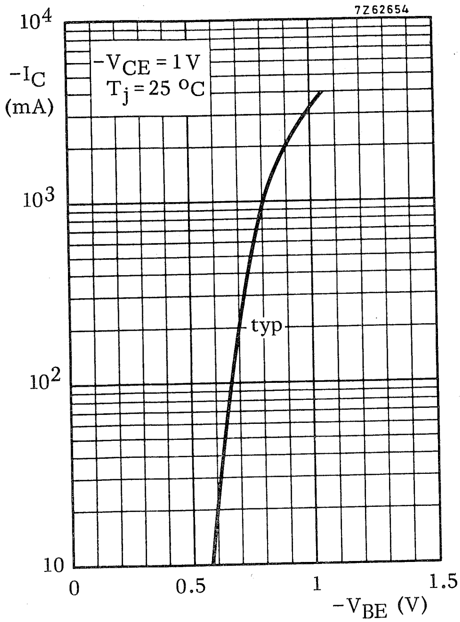
7Z62580.1

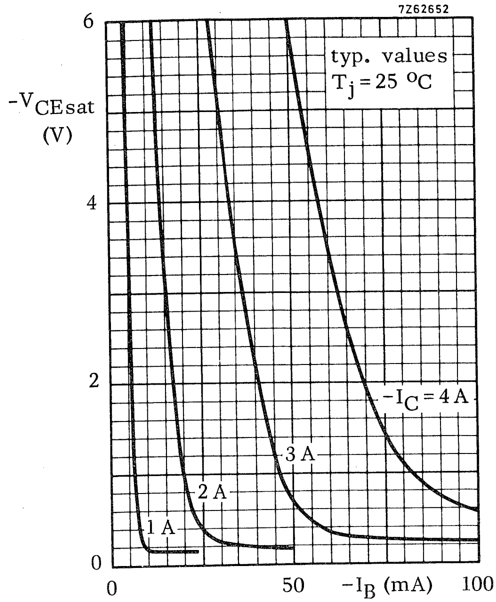


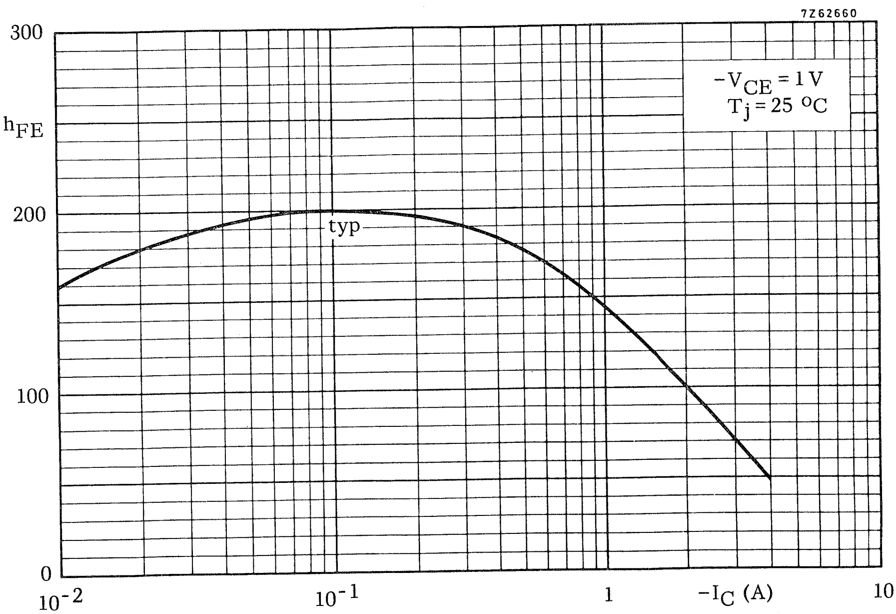
BD438

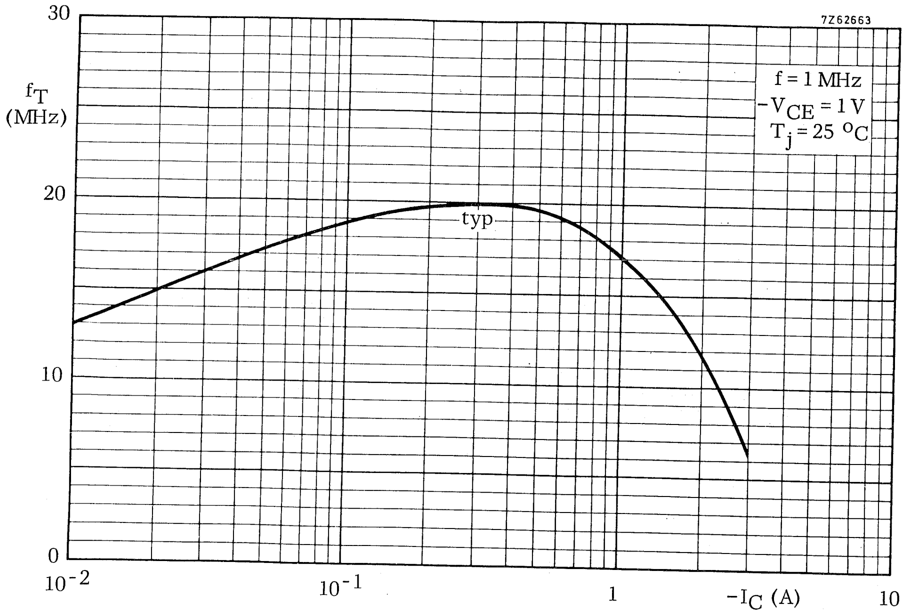
7Z62579.1

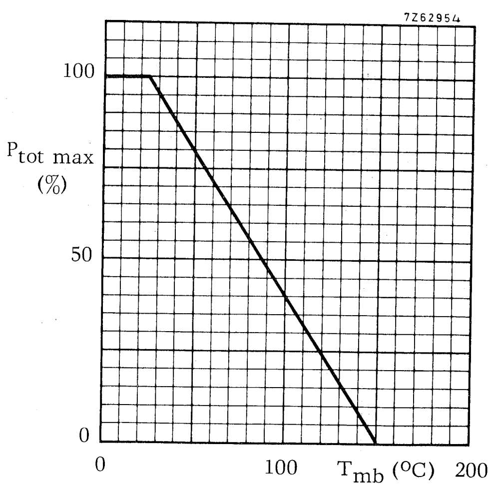



7Z62654
10^4
$-I_C$ (mA)
$-V_{CE} = 1$ V
$T_j = 25$ °C
10^3
typ
10^2
10
0
0.5
1
1.5
$-V_{BE}$ (V)


7Z62652
6
$-V_{CEsat}$ (V)
typ. values
$T_j = 25$ °C
4
2
$-I_C = 4$ A
3 A
2 A
1 A
0
0
50
$-I_B$ (mA)
100


7Z62660
300
h_{FE}
$-V_{CE} = 1$ V
$T_j = 25$ °C
200
typ
100
0
10^{-2}
10^{-1}
1
$-I_C$ (A)
10


7Z62663
30
20
10
0
f_T
(MHz)
f = 1 MHz
$-V_{CE}$ = 1 V
T_j = 25 °C
typ
10^{-2}
10^{-1}
1
$-I_C$ (A)
10


7Z62954
100
$P_{tot\ max}$
(%)
50
0
0
100
T_{mb} (°C)
200

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

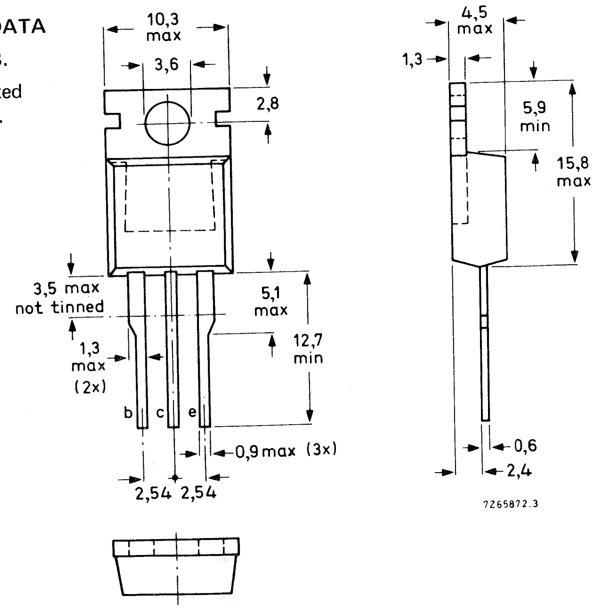
			BD645	647	649	651	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.	12				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	62,5				W
Junction temperature	T_j	max.	150				°C
D.C. current gain:							
I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.	1900				
I_C = 3,0 A; V_{CE} = 3 V	h_{FE}	>	750				
Cut-off frequency: I_C = 3 A; V_{CE} = 3 V	f_{hfe}	typ.	50				kHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting Instructions and Accessories.

CIRCUIT DIAGRAM

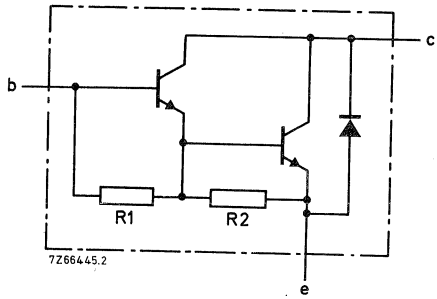


Fig. 2
R_1 typ. 4 kΩ
R_2 typ. 100 Ω

RATINGS

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

			BD645	647	649	651	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V

Collector current (d.c.)	I_C	max.	8	A
Collector current (peak value)	I_{CM}	max.	12	A
Base current (d.c.)	I_B	max.	150	mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	62,5	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature *	T_j	max.	150	°C

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	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 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CBO} = V_{CEOmax}$	I_{CBO}	<	0,2	mA
$I_E = 0$; $V_{CB} = ½ V_{CBOmax}$; $T_j = 150$ °C	I_{CBO}	<	2	mA
$I_B = 0$; $V_{CE} = ½ V_{CEOmax}$	I_{CEO}	<	0,5	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	5	mA
D.C. current gain (note 1)				
$I_C = 0,5$ A; $V_{CE} = 3$ V	h_{FE}	typ.	1900	
$I_C = 3$ A; $V_{CE} = 3$ V	h_{FE}	>	750	
$I_C = 8$ A; $V_{CE} = 3$ V	h_{FE}	typ.	1800	
Base-emitter voltage (notes 1 and 2)				
$I_C = 3$ A; $V_{CE} = 3$ V	V_{BE}	<	2,5	V
Saturation voltages (note 1)				
$I_C = 3$ A; $I_B = 12$ mA	V_{CEsat}	<	2	V
$I_C = 5$ A; $I_B = 50$ mA	V_{CEsat}	<	2,5	V
	V_{BEsat}	<	3	V
Diode forward voltage				
$I_F = 3$ A	V_F	typ.	1,2	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	75	pF
Cut-off frequency				
$I_C = 3$ A; $V_{CE} = 3$ V	f_{hfe}	typ.	50	kHz
Turn-off breakdown energy with inductive load				
$-I_{Boff} = 0$; $I_{CM} = 4,5$ A; $t_p = 1$ ms; T = 100 ms; see Fig. 3	$E_{(BR)}$	>	50	mJ
Small signal current gain				
$I_C = 3$ A; $V_{CE} = 3$ V; f = 1 MHz	$\|h_{fe}\|$	typ.	50	
Second breakdown collector current				
$V_{CE} = 60$ V; $t_p = 0,1$ s	$I_{(SB)}$	>	1,04	A
Switching times (see Figs 4 and 5)				
$I_{Con} = 3$ A; $I_{Bon} = -I_{Boff} = 12$ 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: $t_p < 300$ μs, $\delta < 2\%$.
2. V_{BE} decreases by about 3,8 mV/K with increasing temperature.

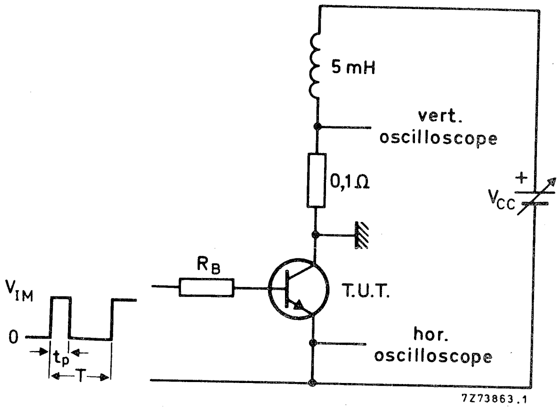


Fig. 3 Test circuit for turn-off breakdown energy.
V_{IM} = 12 V; R_B = 270 Ω;
t_p = 1 ms; δ = 1%.

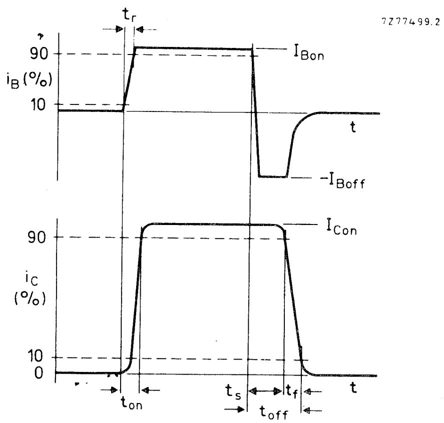
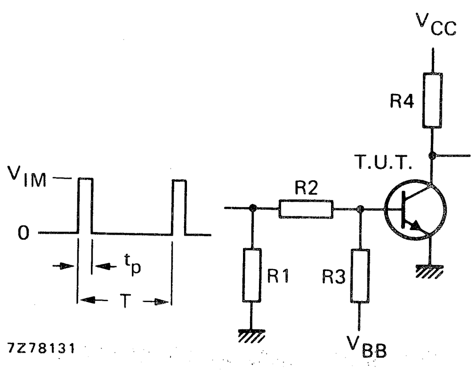


Fig. 4 Switching times waveforms.



V_{CC} = 10 V
V_{IM} = 10 V
$-V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 3 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 5 Switching times test circuit.

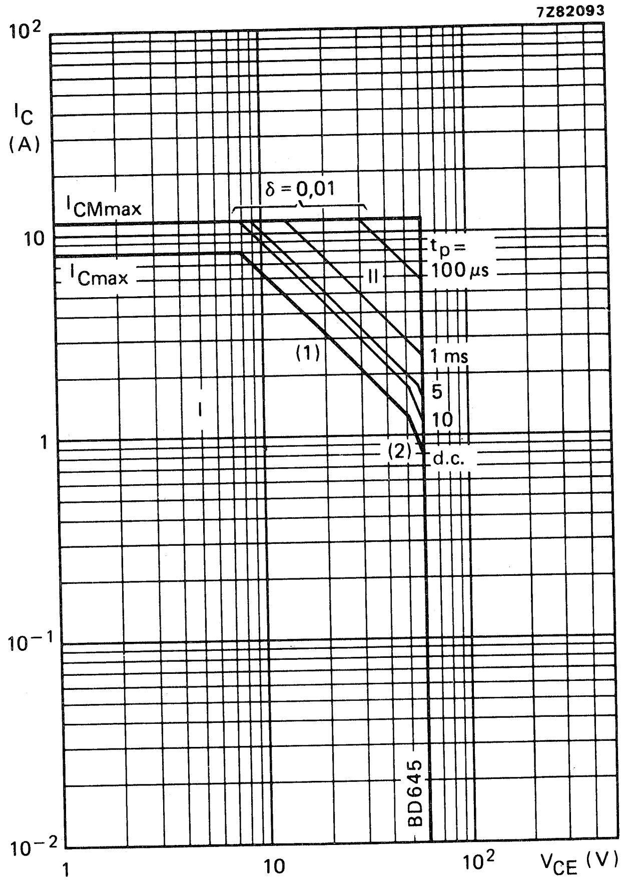


Fig. 6 Safe Operating ARea; T_{mb} = 25 °C

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).

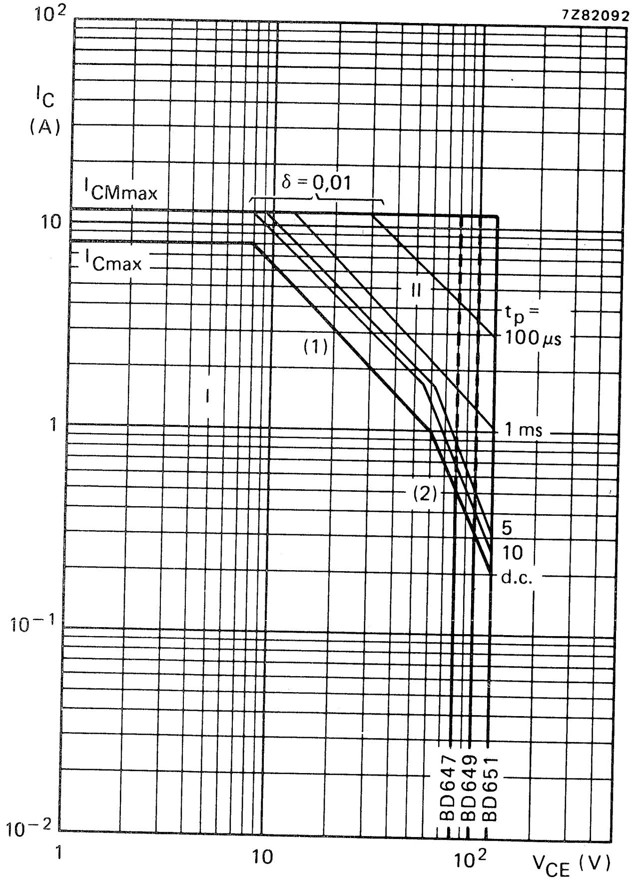


Fig. 7 Safe Operating ARea; T_{mb} = 25 °C.

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).

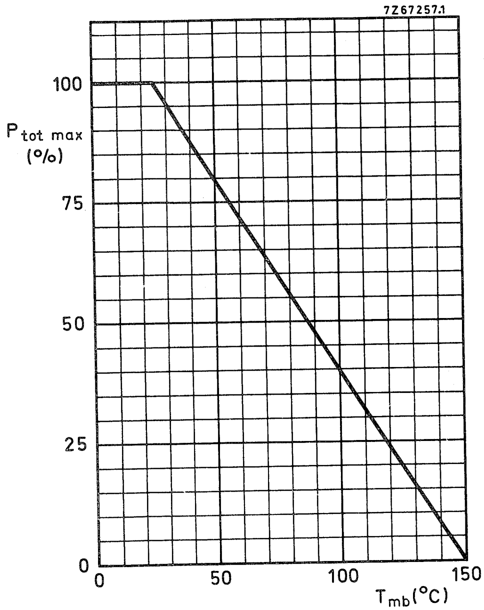


Fig. 8 Power derating curve.

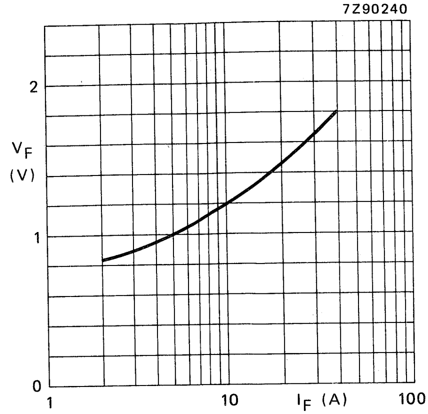


Fig. 8a Typical values forward voltage of collector-emitter diode (see Fig. 2) at T_j = 25 °C.

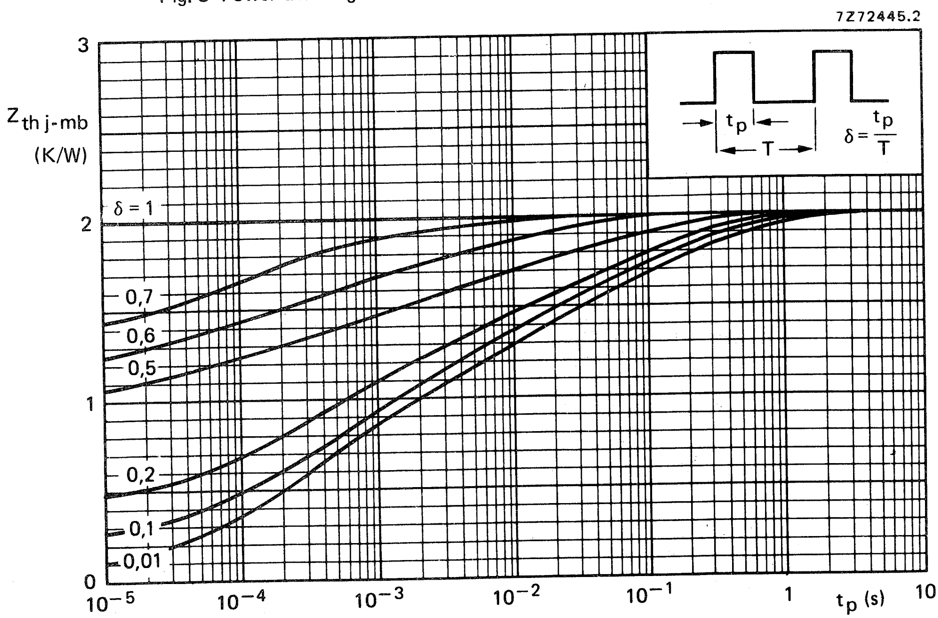


Fig. 9 Pulse power rating chart.

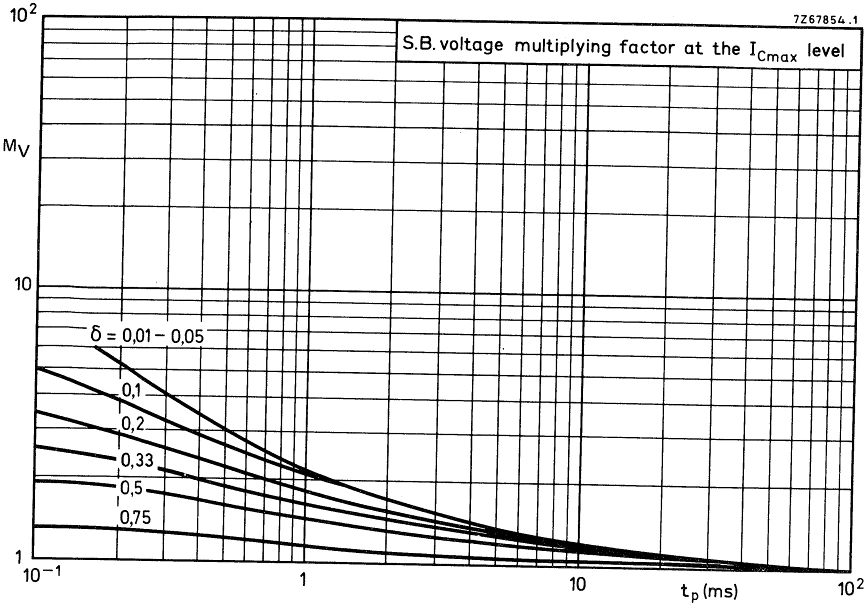

7Z67854.1
S.B. voltage multiplying factor at the I_{Cmax} level
10^2
M_V
10
1
δ = 0,01 – 0,05
0,1
0,2
0,33
0,5
0,75
10^{-1}
1
10
t_p (ms)
10^2

Fig. 10.

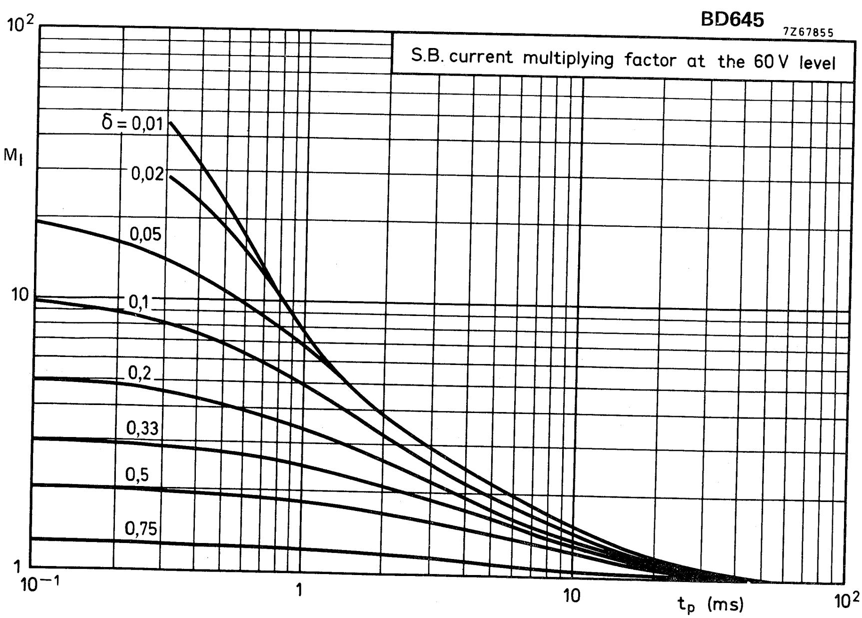

BD645
7Z67855
S.B. current multiplying factor at the 60 V level
10^2
M_I
10
1
δ = 0,01
0,02
0,05
0,1
0,2
0,33
0,5
0,75
10^{-1}
1
10
t_p (ms)
10^2

Fig. 11.

BD647; BD649

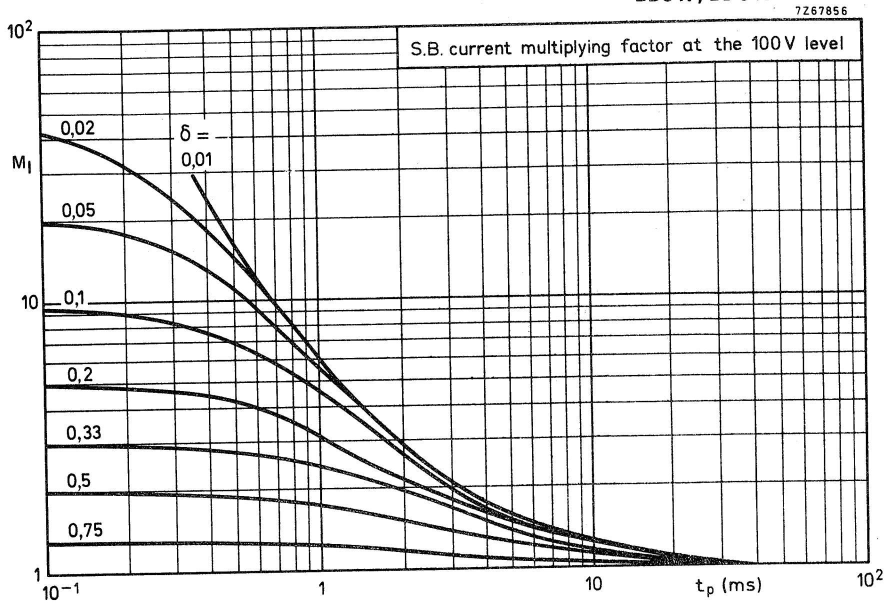


Fig. 12 Second breakdown current multiplying factor at the 100 V level.

BD651

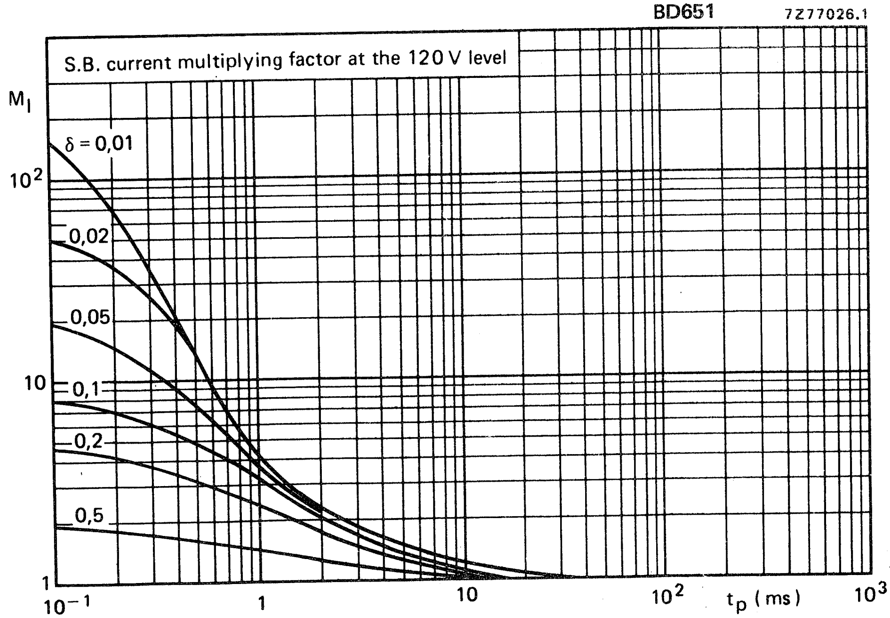


Fig. 13 Second breakdown current multiplying factor at the 120 V level.

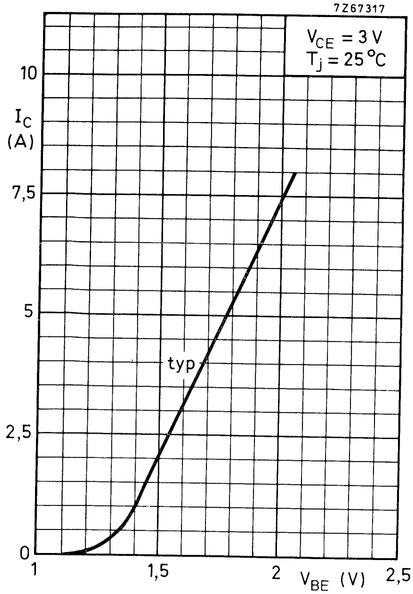


Fig. 14.

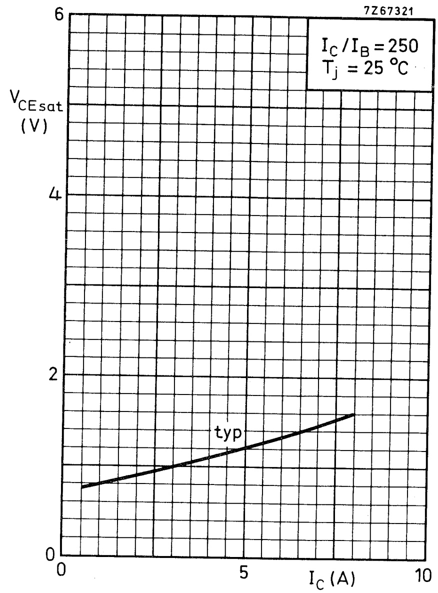


Fig. 15.

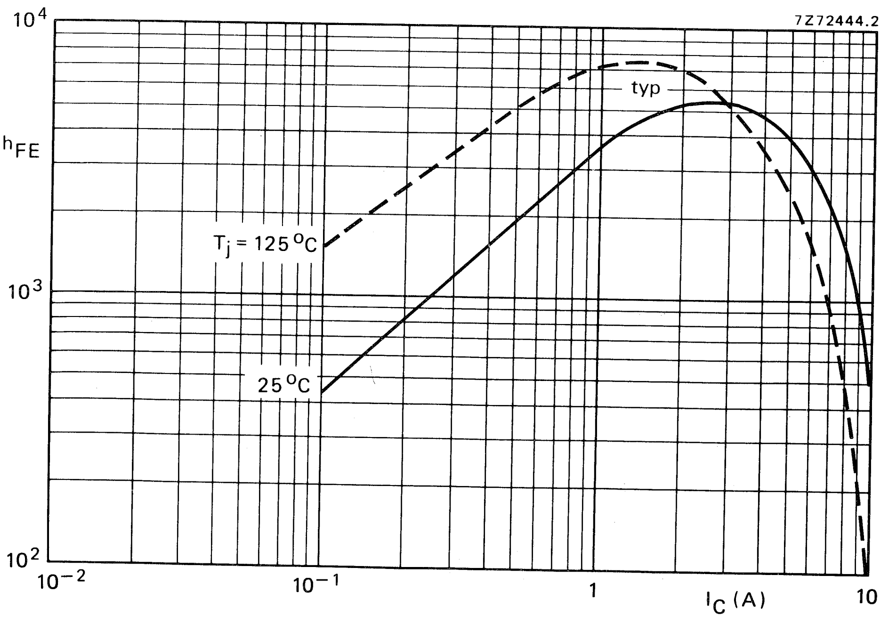


Fig. 16 Typical d.c. current gain. V_{CE} = 3 V.

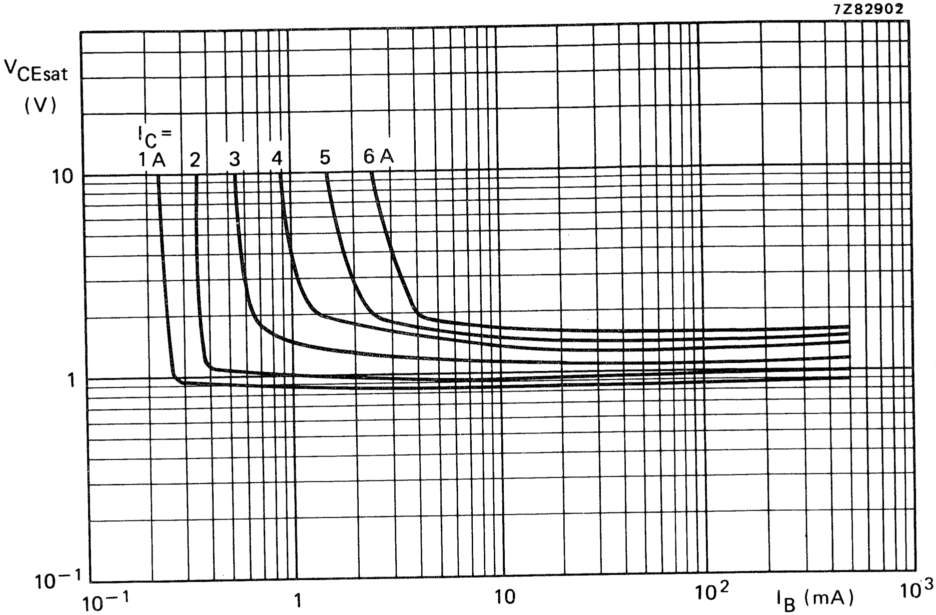


Fig. 17 Typical values collector-emitter saturation voltage. T_j = 25 °C.

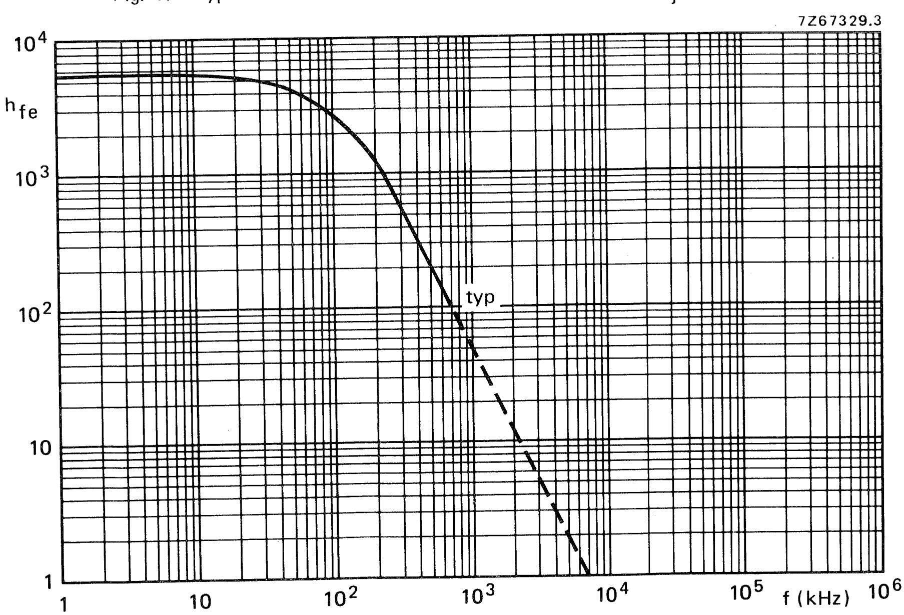


Fig. 18 Small signal current gain at I_C = 3 A; V_{CE} = 3 V.

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

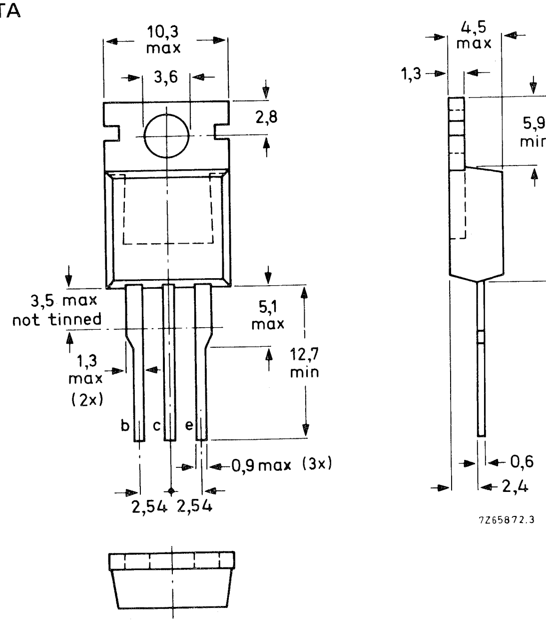
			BD646	648	650	652	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (peak value)	$-I_{CM}$	max.	12				A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.	62,5				W
Junction temperature	T_j	max.	150				^oC
D.C. current gain:							
$-I_C = 0,5$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	2700				
$-I_C = 3,0$ A; $-V_{CE} = 3$ V	h_{FE}	>	750				
Cut-off frequency:							
$-I_C = 3$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	100				kHz

MECHANICAL DATA

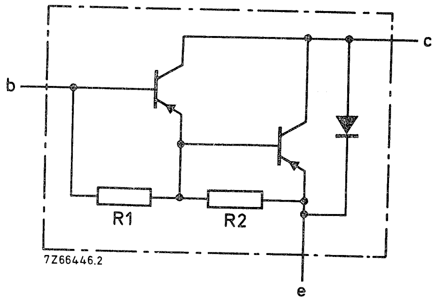
Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting Instructions and Accessories.



R$_1$ typ. 4 kΩ
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 °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	$R_{th\ j\text{-}mb}$ =	2	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$ =	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 °C unless otherwise specified

Collector cut-off current			
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,2 mA
$I_E = 0$; BD646: $-V_{CB} = 40$ V; BD648: $-V_{CB} = 50$ V; BD650: $-V_{CB} = 60$ V; BD652: $-V_{CB} = 70$ V; $T_j = 150$ °C	$-I_{CBO}$	<	2 mA
$I_B = 0; -V_{CE} = ½ V_{CEOmax}$	$-I_{CEO}$	<	0,5 mA
Emitter cut-off current			
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	5 mA
D.C. current gain (note 1)			
$-I_C = 0,5$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	2700
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE}	>	750
$-I_C = 8$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	200
Base-emitter voltage (notes 1 and 2)			
$-I_C = 3$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5 V
Saturation voltages (note 1)			
$-I_C = 3$ A; $-I_B = 12$ mA	$-V_{CEsat}$	<	2 V
$-I_C = 5$ A; $-I_B = 50$ mA	$-V_{CEsat}$	<	2,5 V
	$-V_{BEsat}$	<	3 V
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0; -V_{CB} = 10$ V	C_c	typ.	75 pF
Cut-off frequency			
$-I_C = 3$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	100 kHz
Small-signal current gain			
$-I_C = 3$ A; $-V_{CE} = 3$ V; f = 1 MHz	$\|h_{fe}\|$	typ.	150
Diode, forward voltage			
$I_F = 3$ A	V_F	typ.	1,8 V
Second-breakdown collector current			
$-V_{CE} = 50$ V; $t_p = 0,1$ s	$-I_{(SB)}$	>	1,25 A
Switching times (between 10% and 90% levels) (Fig. 3)			
$-I_{Con} = 3$ A; $-I_{Bon} = I_{Boff} = 12$ mA; $V_{CC} = -10$ 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: $t_p < 300$ μs, $\delta < 2\%$.
2. $-V_{BE}$ decreases by about 3,8 mV/K with increasing temperature.

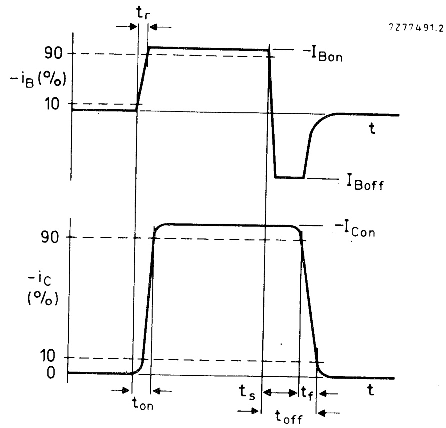
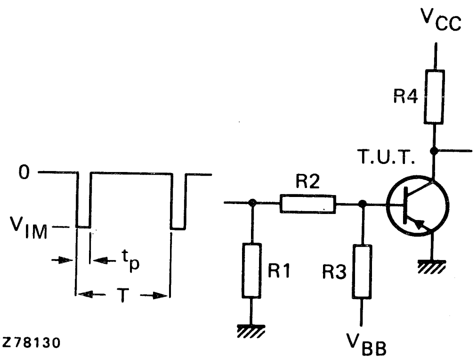


Fig. 3 Switching times waveforms.



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

Fig. 4 Switching times test circuit.

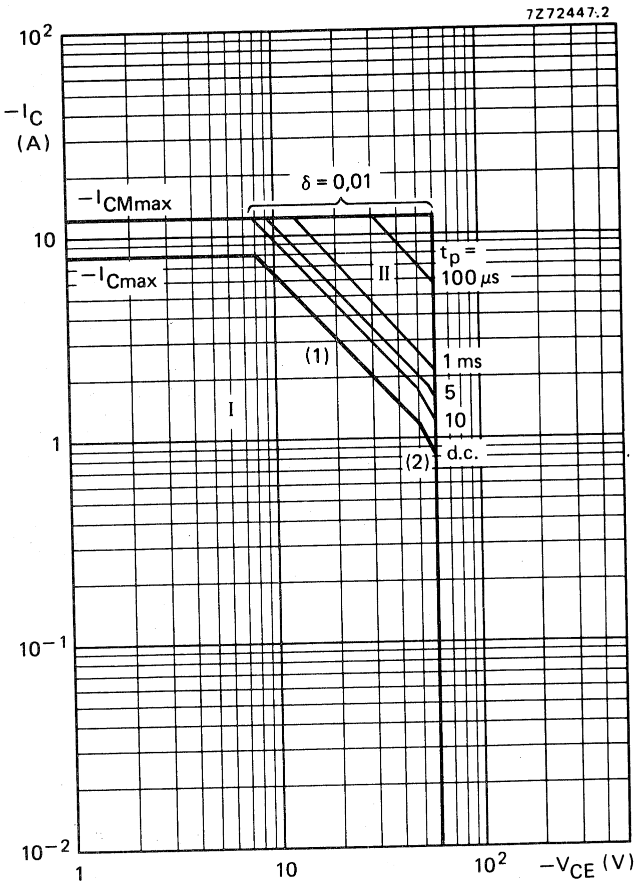


Fig. 5 Safe Operating ARea transistor BD646 at T_{mb} = 25 °C.

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).

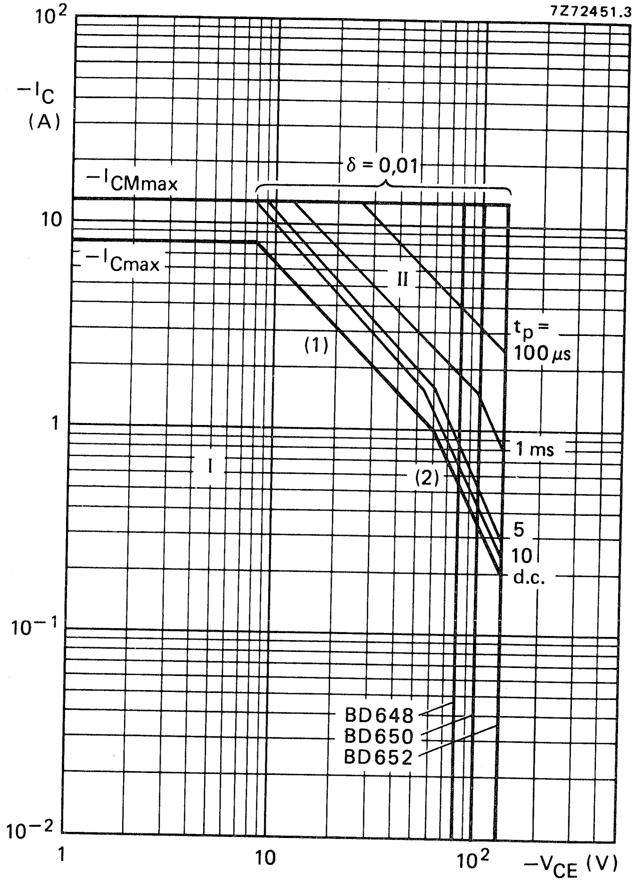


Fig. 6 Safe Operating ARea. $T_{mb} = 25\ ^oC$

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).

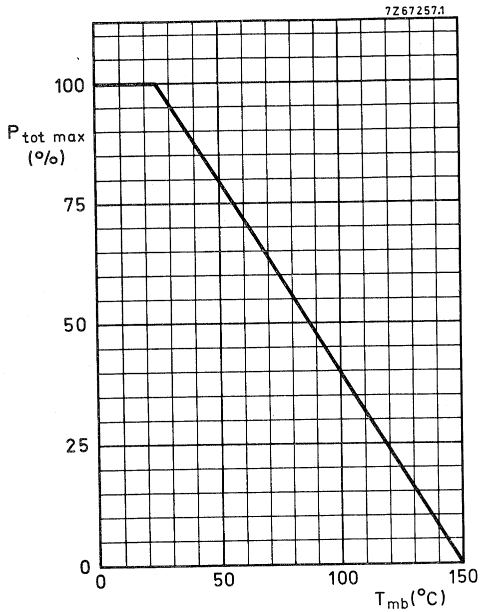


Fig. 7 Power derating curve.

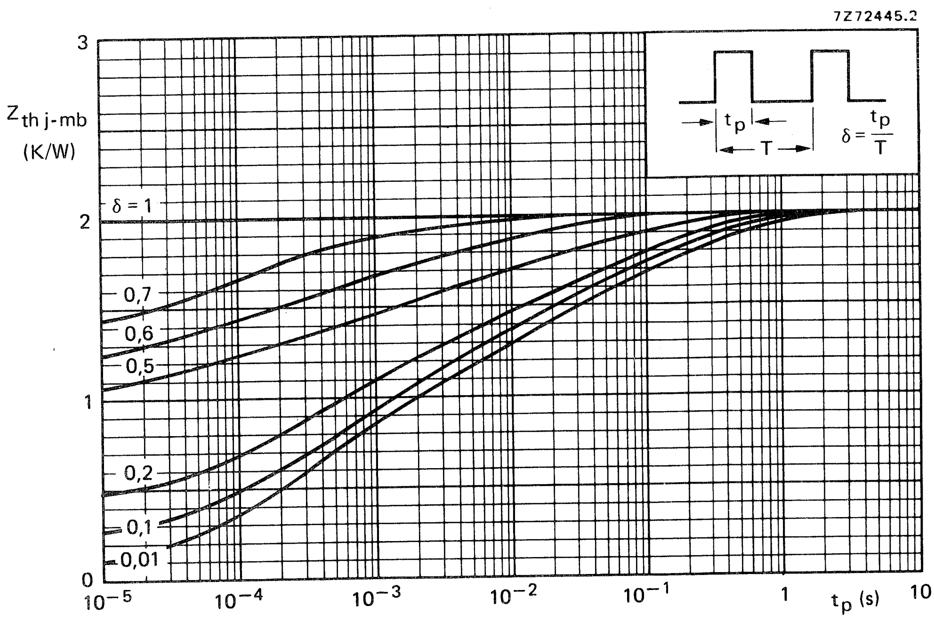


Fig. 8 Pulse power rating chart.

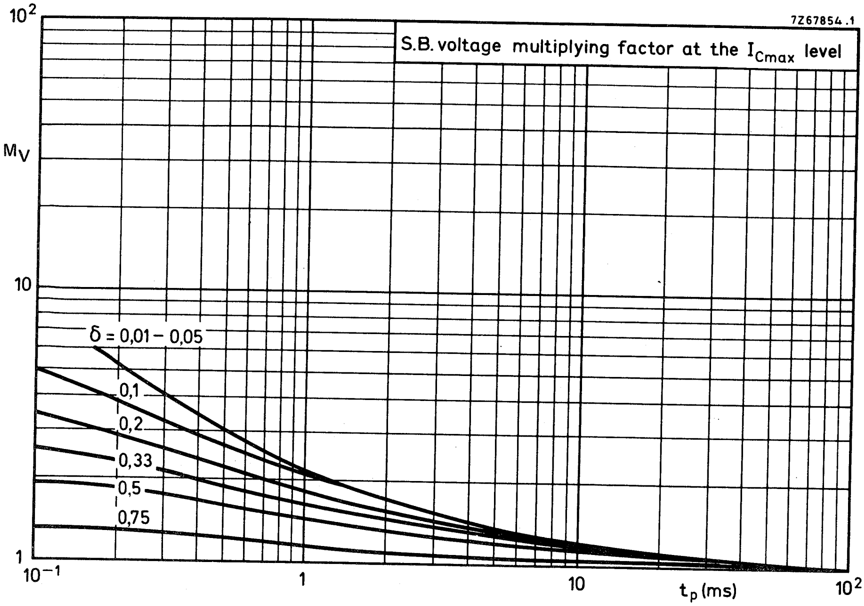


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

BD646

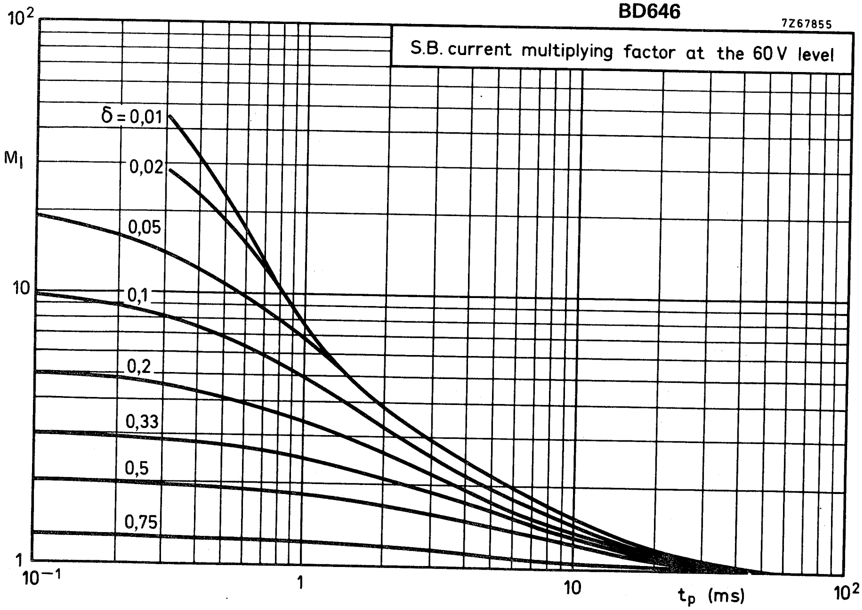


Fig. 10 S.B. current multiplying factor at 60 V level.

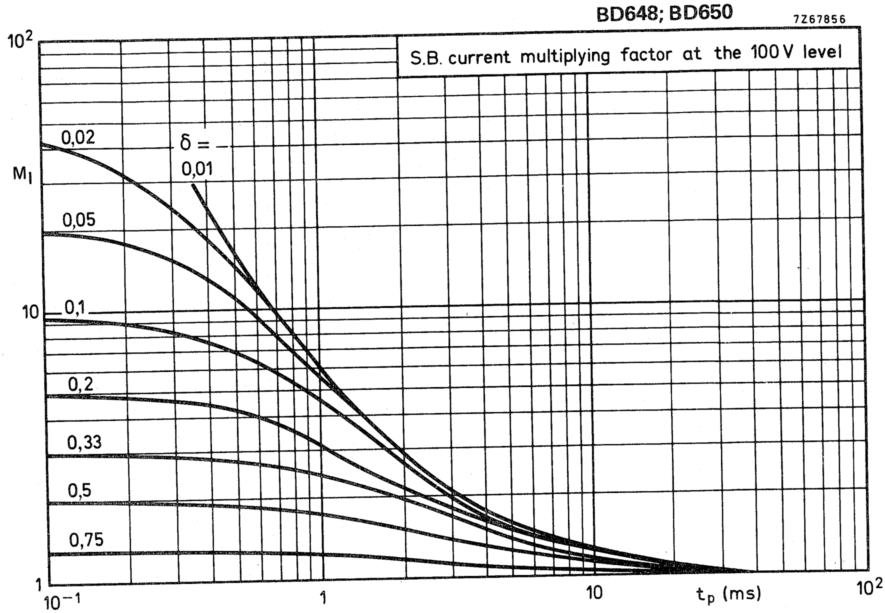

BD648; BD650
7Z67856
S.B. current multiplying factor at the 100 V level
10^2
M_I
10
1
0,02
δ =
0,01
0,05
0,1
0,2
0,33
0,5
0,75
10^{-1}
1
10
t_p (ms)
10^2

Fig. 11.

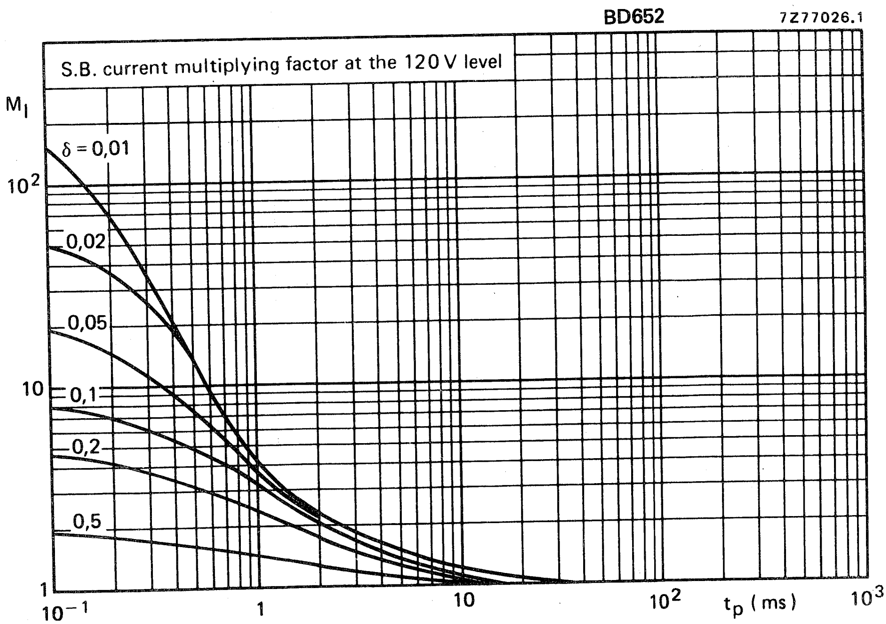

BD652
7Z77026.1
S.B. current multiplying factor at the 120 V level
M_I
δ = 0,01
10^2
0,02
0,05
10
0,1
0,2
0,5
1
10^{-1}
1
10
10^2
t_p (ms)
10^3

Fig. 12.

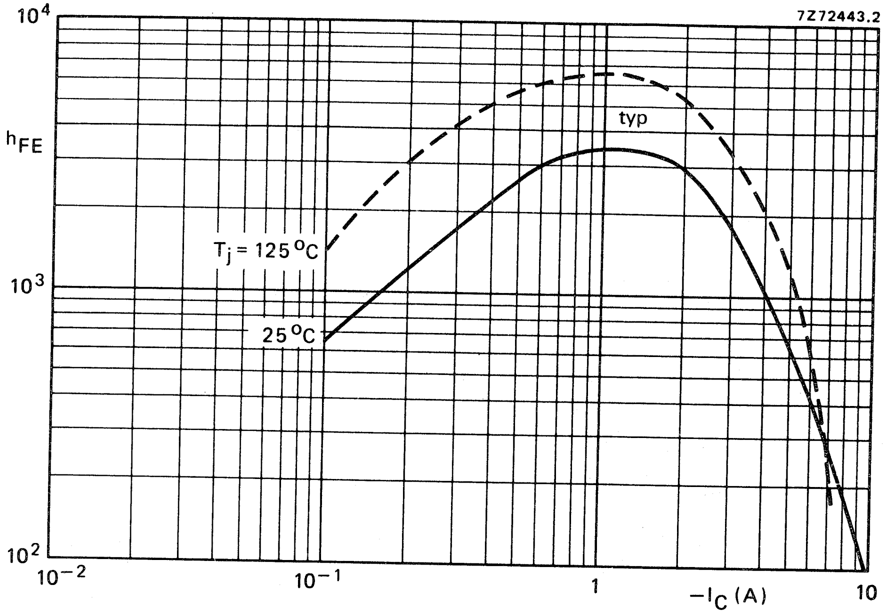


Fig. 13 D.C. current gain at $-V_{CE} = 3$ V.

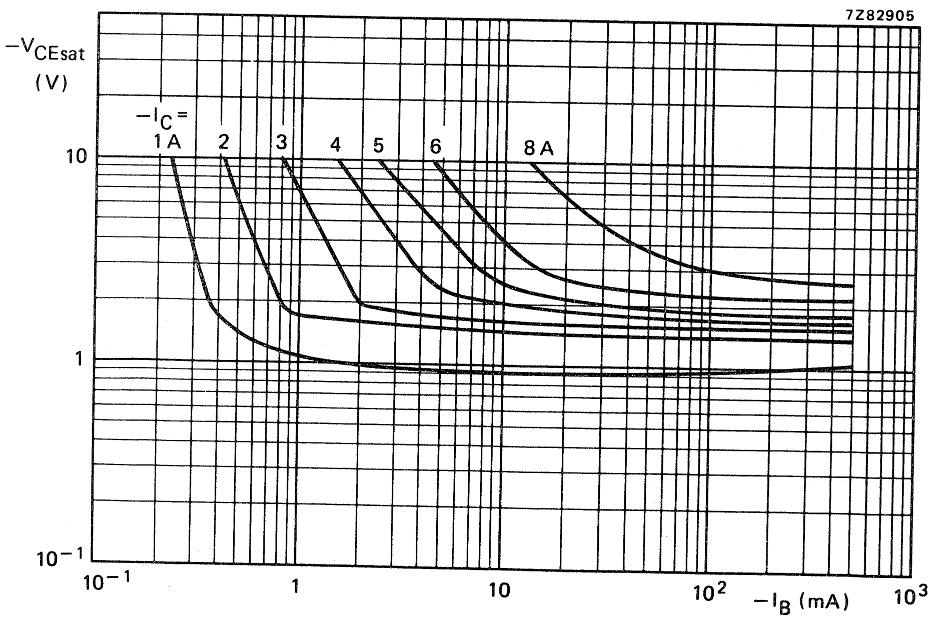


Fig. 14 Typical collector-emitter saturation voltage at $T_j = 25\ ^oC$.

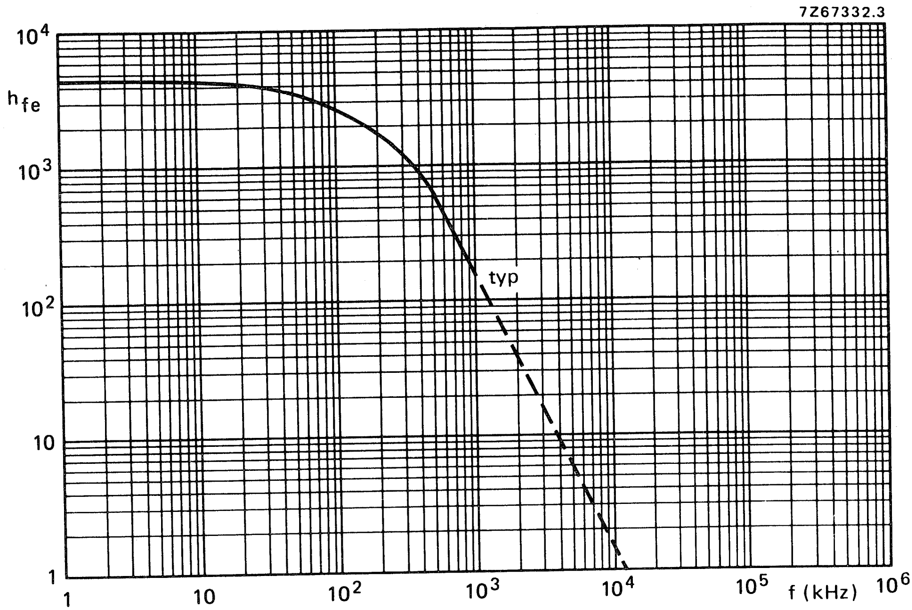


Fig. 15 Small signal current gain at $-I_C = 3$ A; $-V_{CE} = 3$ V.

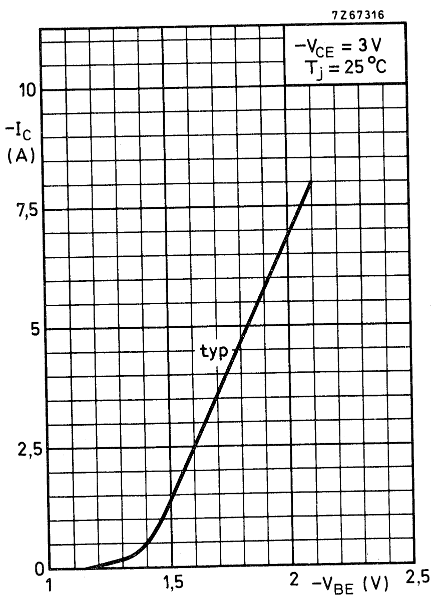


Fig. 16 Collector current.

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

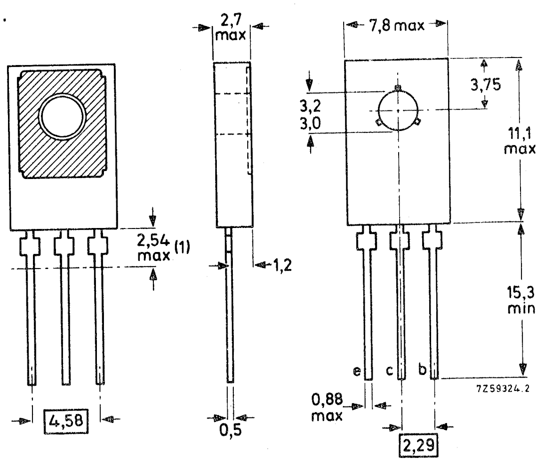
			BD675	677	679	681	683	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.			6			A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.			40			W
Junction temperature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

MECHANICAL DATA

Dimensions in mm

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

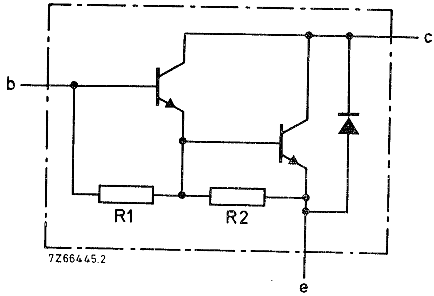
Collector connected to mounting base.



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

See also chapters Mounting Instructions and Accessories.

CIRCUIT DIAGRAM



R1 typ. 3 kΩ
R2 typ. 120 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

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

			BD675	677	679	681	683	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	5	V
Collector current (d.c.)	I_C	max.	4					A
Collector current (peak value)	I_{CM}	max.	6					A
Base current (d.c.)	I_B	max.	100					mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	40					W
Storage temperature	T_{stg}		−65 to + 150					°C
Junction temperature	T_j	max.	150					°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W

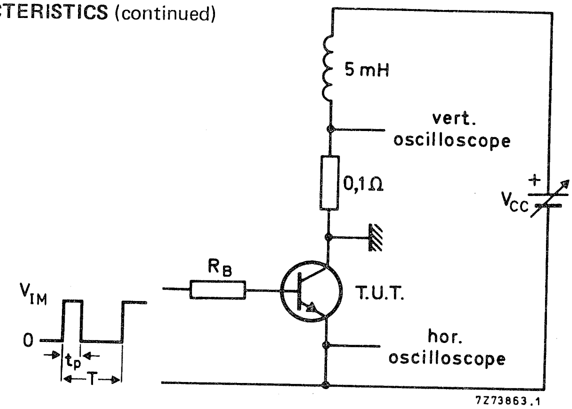
CHARACTERISTICS

T_j = 25 °C, unless otherwise specified; where I_C = 1,5 A for BD675 read I_C = 2 A.

Collector cut-off current			
$I_E = 0$; $V_{CB} = V_{CEOmax}$	I_{CBO}	<	0,2 mA
$I_E = 0$; $V_{CB} = ½ V_{CBOmax}$; T_{mb} = 150 °C	I_{CBO}	<	2 mA
$I_B = 0$; $V_{CE} = ½ V_{CEOmax}$	I_{CEO}	<	0,5 mA
Emitter cut-off current			
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5 mA
D.C. current gain (note 1)			
I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.	2200
I_C = 1,5 A; V_{CE} = 3 V	h_{FE}	>	750
I_C = 4 A; V_{CE} = 3 V	h_{FE}	typ.	1500
Base-emitter voltage (notes 1 and 2)			
I_C = 1,5 A; V_{CE} = 3 V (BD675; I_C = 2 A)	V_{BE}	<	2,5 V
Collector-emitter saturation voltage (note 1)			
I_C = 1,5 A; I_B = 6 mA (BD675; I_C = 2 A)	V_{CEsat}	<	2,5 V
Small signal current gain			
I_C = 1,5 A; V_{CE} = 3 V; f = 1 MHz (BD675; I_C = 2 A)	$\|h_{fe}\|$	typ.	50
Cut-off frequency			
I_C = 1,5 A; V_{CE} = 3 V (BD675; I_C = 2 A)	f_{hfe}	typ.	60 kHz
Turn-off breakdown energy with inductive load			
$-I_{Boff}$ = 0; I_C = 3,5 A; (Fig. 3)	$E_{(BR)}$	>	30 mJ
D.C. current gain ratio of matched complementary pairs			
I_C = 1,5 A; V_{CE} = 3 V	h_{FE1}/h_{FE2}	<	2,5
Diode forward voltage			
I_F = 1,5 A (BD675; I_F = 2 A)	V_F	typ.	1,5 V
Second-breakdown collector current			
V_{CE} = 50 V; t_p = 20 ms, non rep.; without heatsink	$I_{(SB)}$	>	0,8 A
BD675; V_{CE} = 40 V; t_p = ms	$I_{(SB)}$	>	1 A
Switching times (between 10% and 90% levels)			
I_{Con} = 1,5 A; $I_{Bon} = -I_{Boff}$ = 6 mA; V_{CC} = 30 V			
Turn-on time	t_{on}	typ.	0,8 μs
		<	2 μs
Turn-off time	t_{off}	typ.	4,5 μs
		<	8 μs

Notes
1. Measured under pulse conditions: t_p < 300 μs; δ < 2%.
2. V_{BE} decreases by about 3,6 mV/K with increasing temperature.

CHARACTERISTICS (continued)



V_{IM} = 12 V
R_B = 270 Ω
I_{CC} = 3,5 A
T = 1 ms
δ = 1 %

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

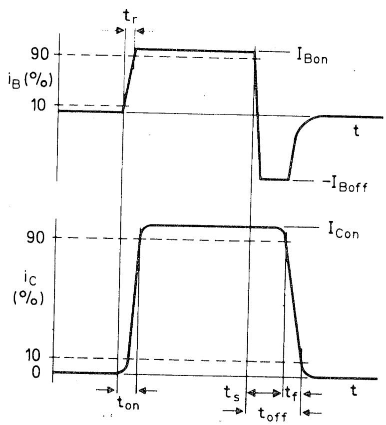
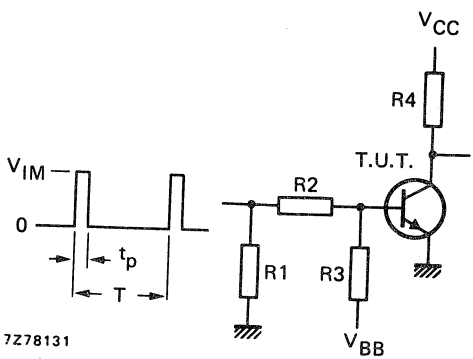


Fig. 4 Switching times waveforms.



V_{IM} = 12 V
V_{CC} = 30 V
V_{BB} = −3 V
R1 = 56 Ω
R2 = 1 kΩ
R3 = 680 Ω
R4 = 22 Ω
$t_r = t_f \leqslant 15$ ns
t_p = 10 μs
T = 500 μs

Fig. 5 Switching times test circuit.

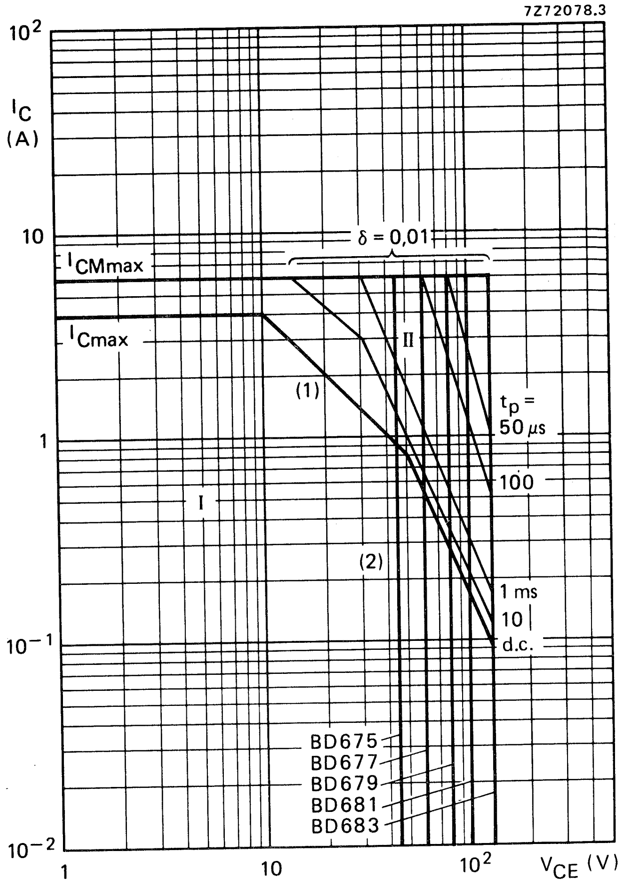


Fig. 6 Safe Operating ARea. T_{mb} = 25 °C.

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).

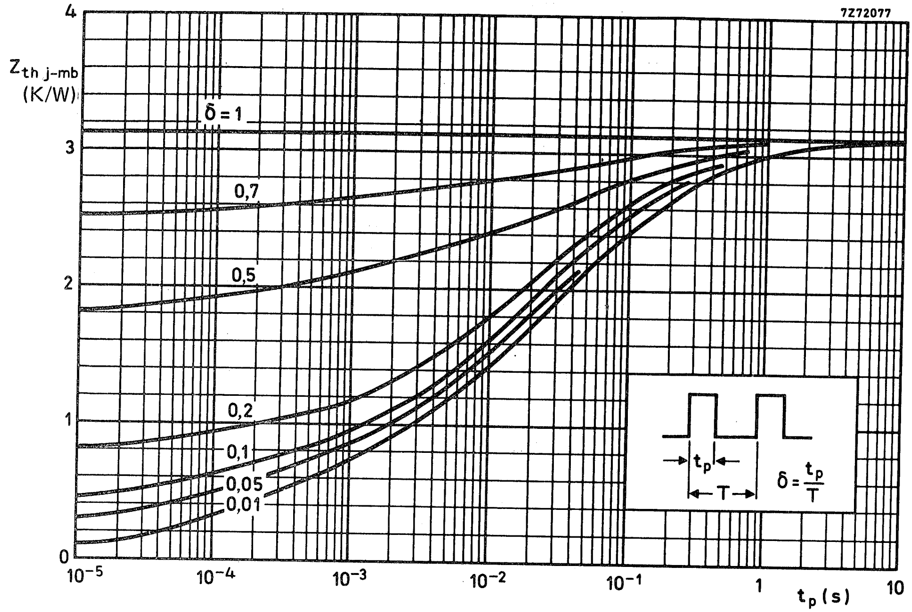


Fig. 7 Pulse power rating chart.

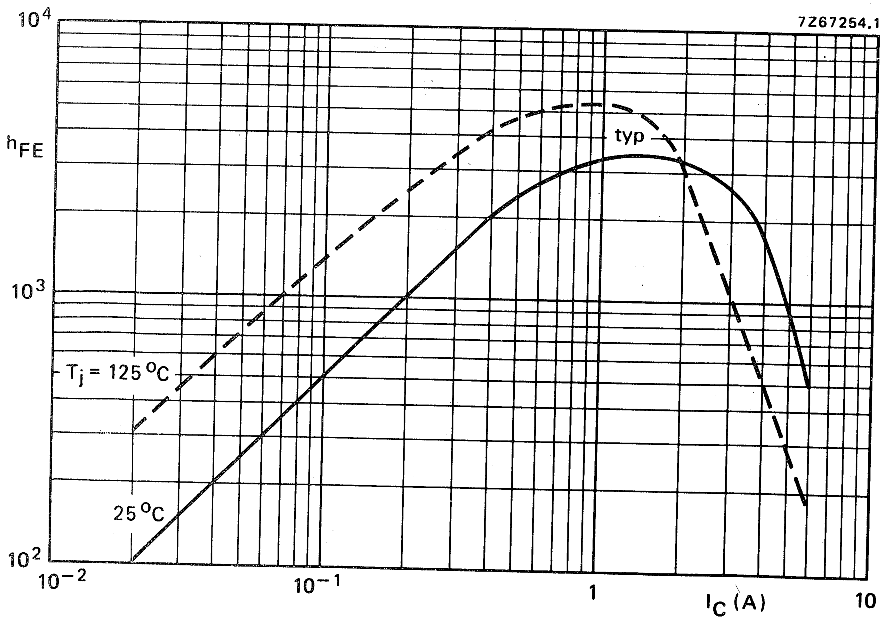


Fig. 8 D.C. current gain at V_{CE} = 3 V.

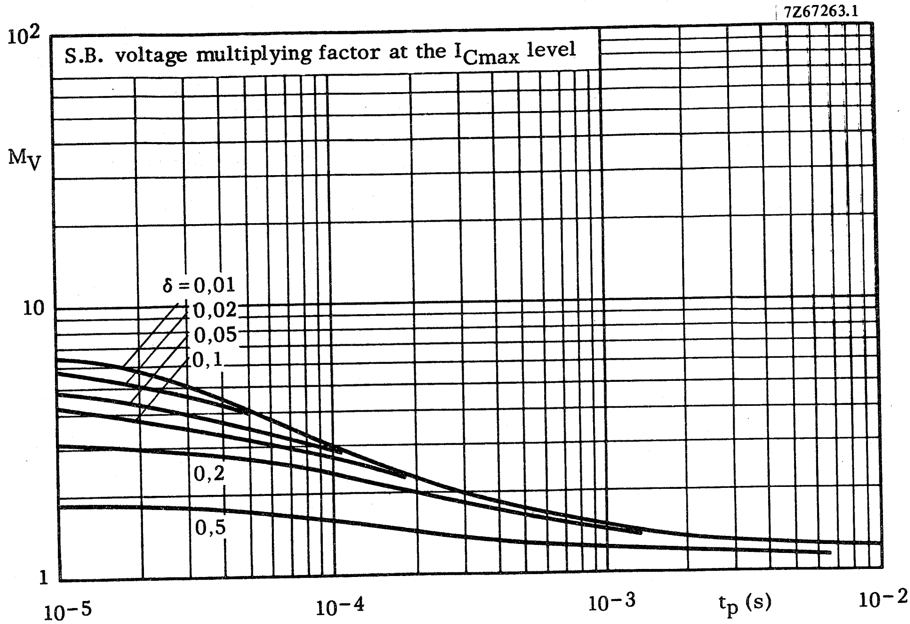


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

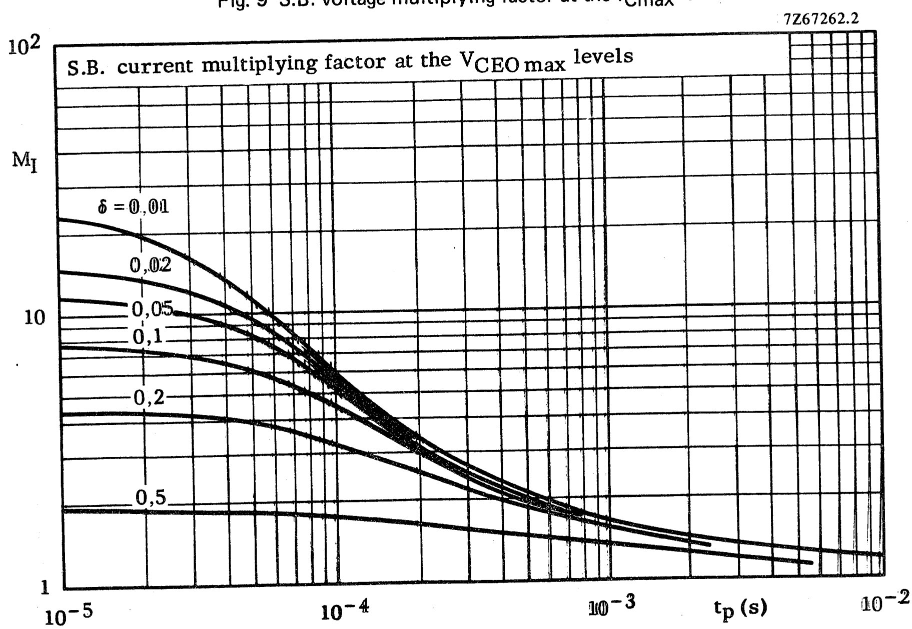


Fig. 10 S.B. current multiplying factor at the V_{CEOmax} levels.

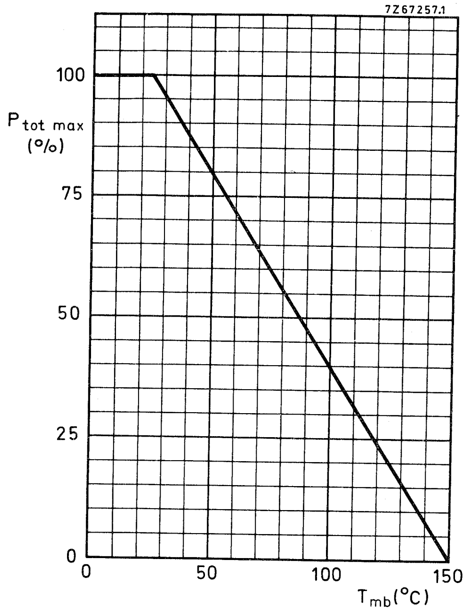


Fig. 11 Power derating curve.

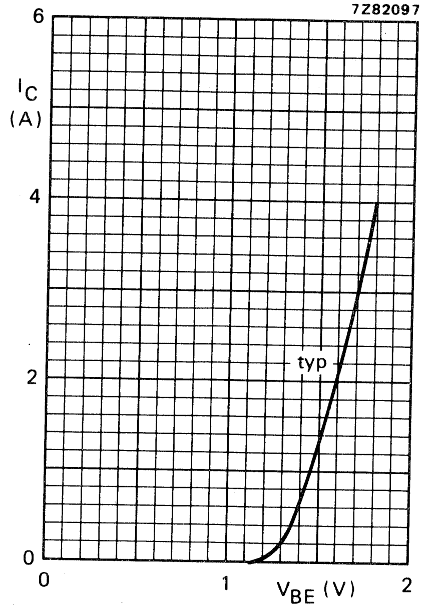


Fig. 12 Typical collector current.

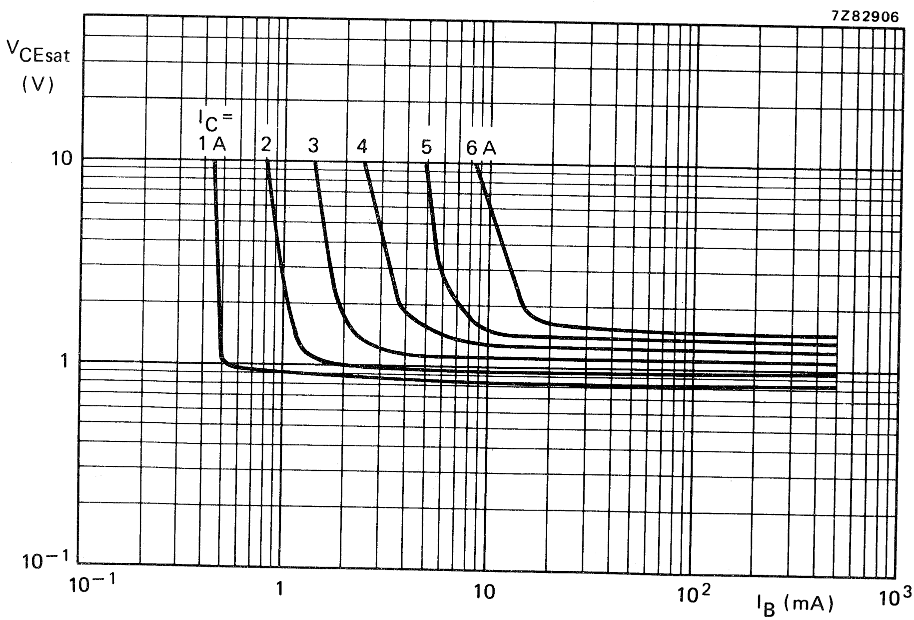


Fig. 13 Typical values collector-emitter saturation voltage. T_{mb} = 25 °C.

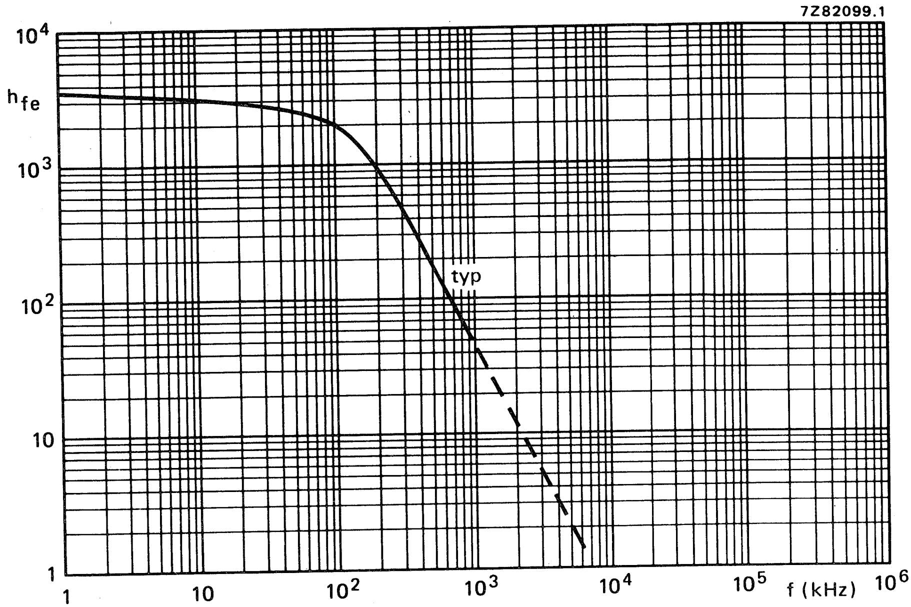


Fig. 14 Small signal current gain. I_C = 1,5 A; V_{CE} = 3 V.

SILICON DARLINGTON POWER TRANSISTORS

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

QUICK REFERENCE DATA

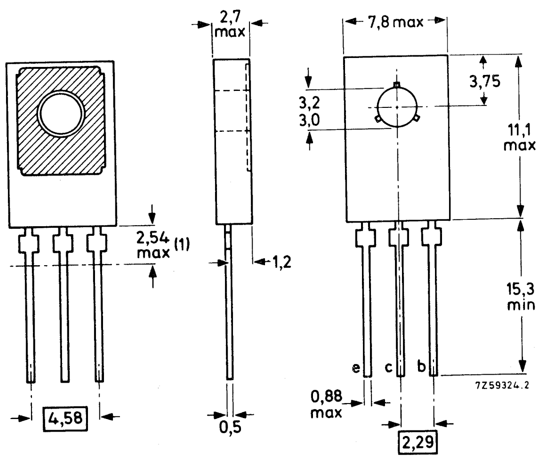
			BD676	678	680	682	684	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Collector-current (peak value)	$-I_{CM}$	max.			6			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.			40			W
Junction temperature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

MECHANICAL DATA

Dimensions in mm

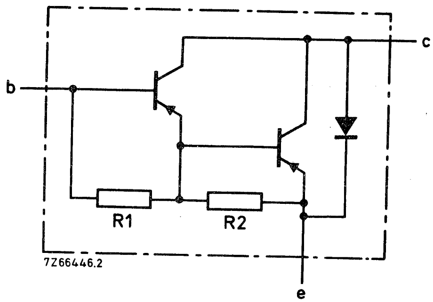
Fig. 1 TO-126 (SOT-32).

Collector connected to mounting base.



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

See also chapters Mounting instructions and Accessories.



R1 typ. 3 kΩ
R2 typ. 80 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

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

			BD676	678	680	682	684	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	5	V
Collector current (d.c.)	$-I_C$	max.			4			A
Collector current (peak value)	$-I_{CM}$	max.			6			A
Base current (d.c.)	$-I_B$	max.			100			mA
Total power dissipation up to T_{mb} = 25 °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	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified; where $-I_C$ = 1,5 A for BD676 read $-I_C$ = 2 A.

Collector cut-off current			
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,2 mA
$I_E = 0; -V_{CB} = -0,6\ V_{CBOmax}; T_{mb} = 150\ °C$	$-I_{CBO}$	<	2 mA ←
$I_B = 0; -V_{CE} = -½\ V_{CEOmax}$	$-I_{CEO}$	<	0,5 mA
Emitter cut-off current			
$I_C = 0; -V_{EB} = 5\ V$	$-I_{EBO}$	<	5 mA
D.C. current gain (note 1)			
$-I_C = 0,5\ A; -V_{CE} = 3\ V$	h_{FE}	typ.	2200 ←
$-I_C = 1,5\ A; -V_{CE} = 3\ V$ *	h_{FE}	>	750
$-I_C = 4\ A; -V_{CE} = 3\ V$	h_{FE}	typ.	650 ←
Base-emitter voltage (notes 1 and 2)			
$-I_C = 1,5\ A; -V_{CE} = 3\ V$ *	$-V_{BE}$	<	2,5 V
Collector-emitter saturation voltage (note 1)			
$-I_C = 1,5\ A; -I_B = 6\ mA$ *	$-V_{CEsat}$	<	2,5 V
Small-signal current gain			
$-I_C = 1,5\ A; -V_{CE} = 3\ V; f = 1\ MHz$ *	$\|h_{fe}\|$	typ.	50
Cut-off frequency			
$-I_C = 1,5\ A; -V_{CE} = 3\ V$ *	f_{hfe}	typ.	60 kHz
D.C. current gain ratio of matched complementary pairs			
$-I_C = 1,5\ A; -V_{CE} = 3\ V$	h_{FE1}/h_{FE2}	<	2,5
Diode, forward voltage			
$I_F = 1,5\ A$ *	V_F	typ.	1,5 V
Switching times (see Figs 3 and 4)			
$-I_{Con} = 1,5\ A; -I_{Bon} = I_{Boff} = 6\ mA$			
turn-on time	t_{on}	typ.	0,3 μs
		<	1,5 μs
turn-off time	t_{off}	typ.	1,5 μs
		<	5 μs
Second-breakdown collector current			
$-V_{CE} = 50\ V; t_p = 20\ ms$	$-I_{(SB)}$	>	0,8 A
for BD676 $-V_{CE} = 40\ V$	$-I_{(SB)}$	>	1 A

* for BD676 condition $-I_C$ or $-I_F$ = 2 A.

Notes
1. Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.
2. V_{BE} decreases by about 3,6 mV/K with increasing temperature.

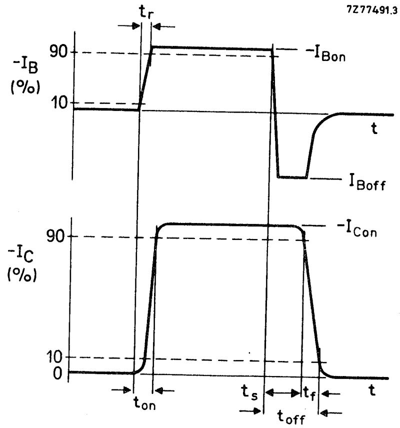
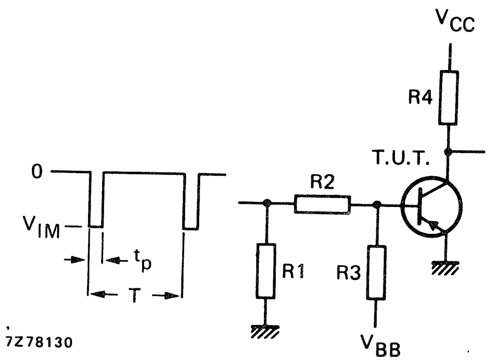


Fig. 3 Switching times waveform.



$-V_{IM}$ = 12 V
$-V_{CC}$ = 30 V
$+V_{BB}$ = 3 V
R1 = 56 Ω
R2 = 1 kΩ
R3 = 630 Ω
R4 = 22 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 4 Switching times test circuits.

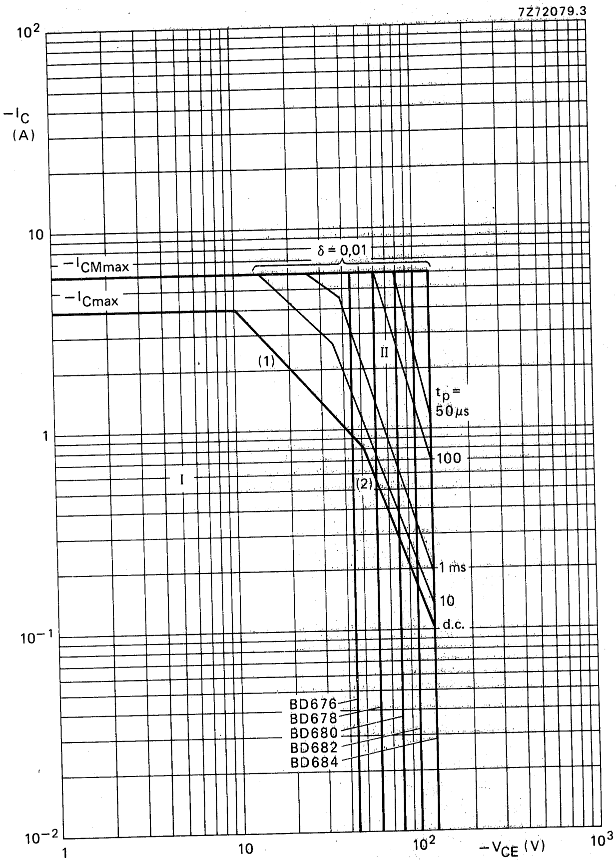


Fig. 5 Safe Operating ARea. T_{mb} = 25 °C.

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).

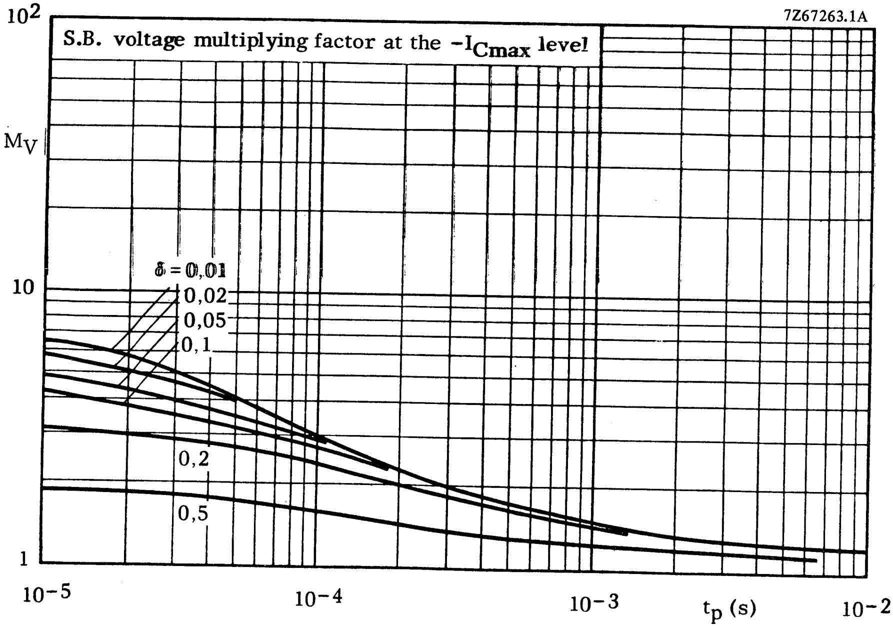


Fig. 6 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

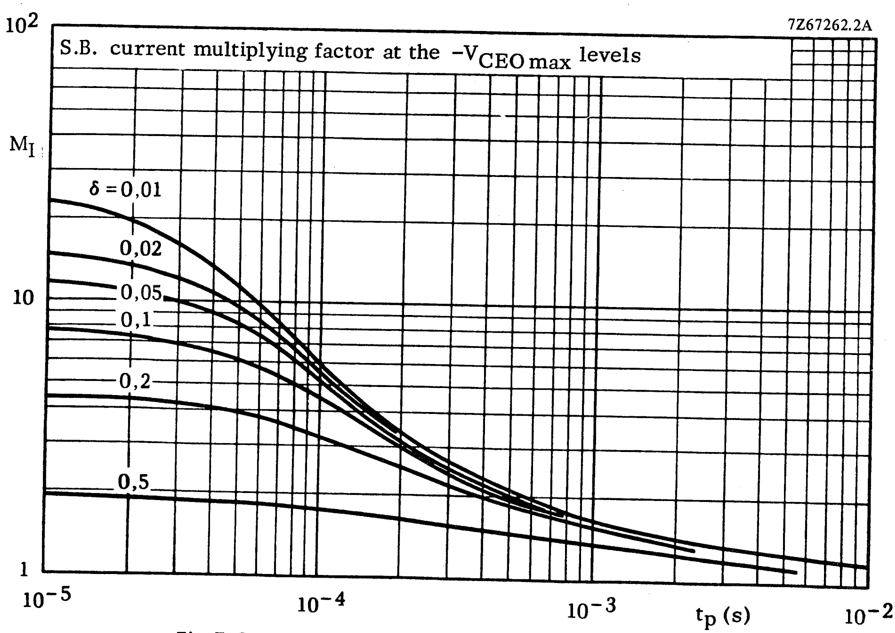


Fig. 7 S.B. current multiplying factor at the $-V_{CEOmax}$ levels.

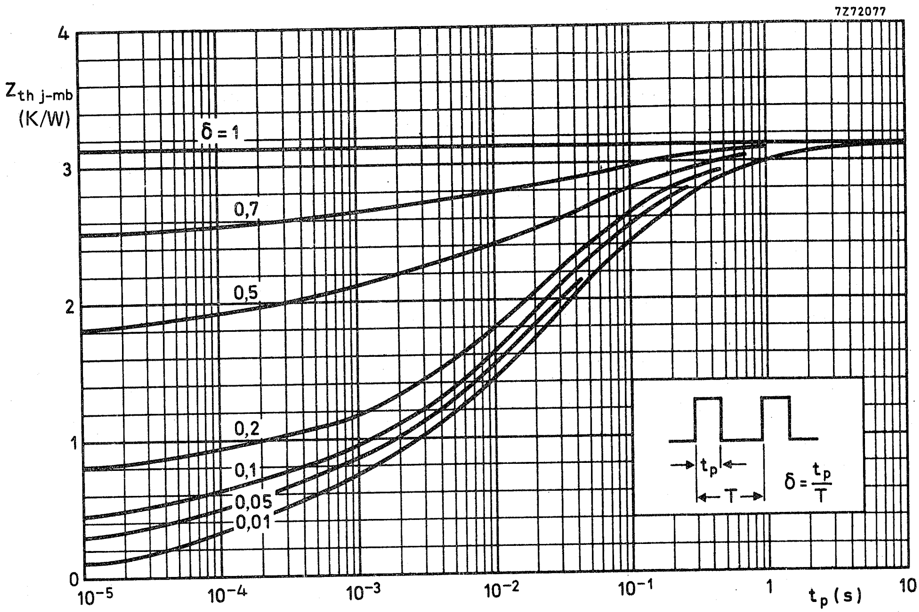


Fig. 8 Pulse power rating chart.

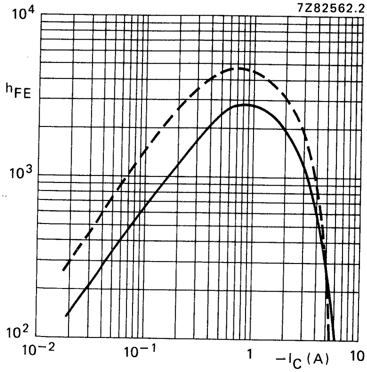


Fig. 9 D.C. current gain. $-V_{CE} = 3$ V;
———— $T_j = 25$ °C;
– – – – $T_j = 125$ °C.

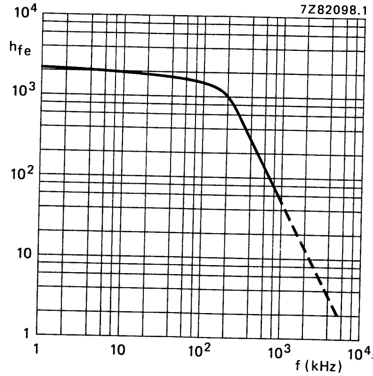


Fig. 10 Typical values small signal current gain. $-I_C = 1{,}5$ A; $-V_{CE} = 3$ V.

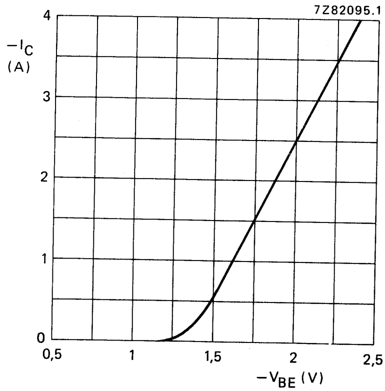


Fig. 11 Typical values; $-V_{CE} = 3$ V $T_j = 25$ °C.

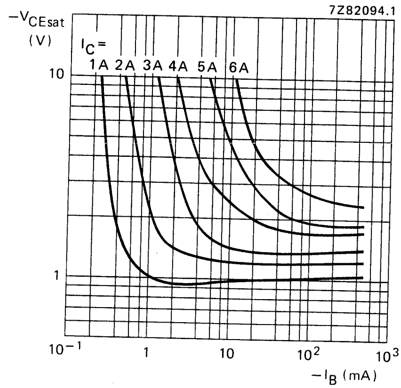


Fig. 12 Typical values collector-emitter saturation voltage as a function of base current. $T_{mb} = 25$ °C.

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

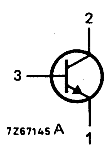
			BD813	BD815	BD817	
Collector-base voltage	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.		6		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		2		W
up to T_{mb} = 25 °C	P_{tot}	max.		12,5		W
Junction temperature	T_j	max.		150		°C
D.C. current gain I_C = 1 A; V_{CE} = 2 V	h_{FE}	>		25		
Transition frequency I_C = 250 mA; V_{CE} = 10 V	f_T	>		3		MHz

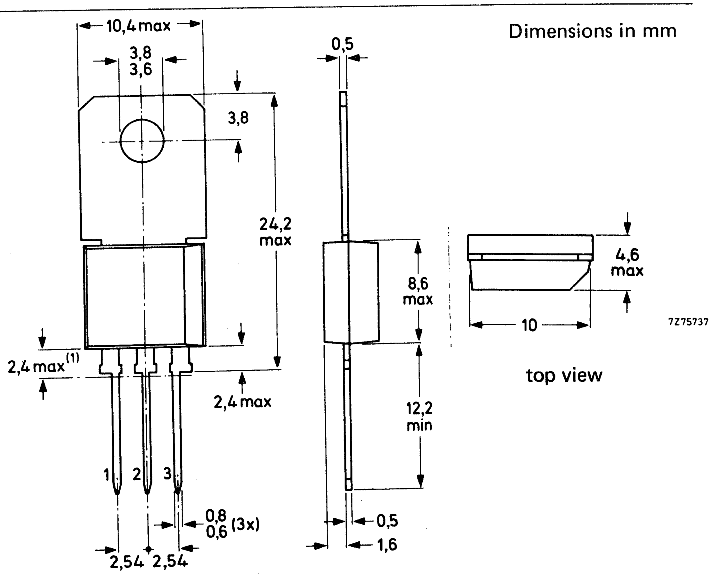
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-202.

Collector connected to mounting base.





(1) Plastic flash allowed within this zone.

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

CHARACTERISTICS

T_j = 25 °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 °C	I_{CBO}	<	3	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	1	mA
Base-emitter voltage				
I_C = 1 A; V_{CE} = 2 V	V_{BE}	<	1,3	V
Collector-emitter saturation voltage				
I_C = 1 A; I_B = 0,1 A	V_{CEsat}	<	0,6	V
D.C. current gain				
I_C = 150 mA; V_{CE} = 2 V	h_{FE}		40 to 250	
I_C = 1 A; V_{CE} = 2 V	h_{FE}	>	25	

Transition frequency at f = 1 MHz I_C = 250 mA; V_{CE} = 10 V	f_T	>	3 MHz
D.C. current gain ratio of matched complementary pairs $\|I_C\|$ = 150 mA; $\|V_{CE}\|$ = 2 V	h_{FE1}/h_{FE2}	<	1,6
Switching times I_{Con} = 1 A; I_{Bon} = $-I_{Boff}$ = 0,1 A turn-on time	t_{on}	typ. <	0,4 μs 1 μs
turn-off time	t_{off}	typ. <	1,5 μs 3 μs

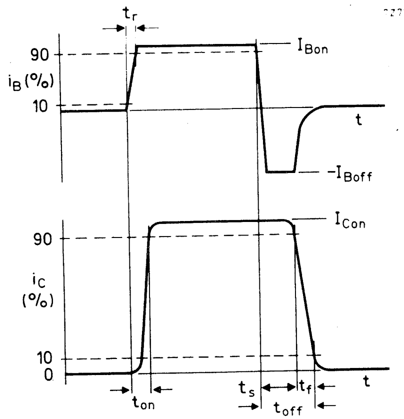
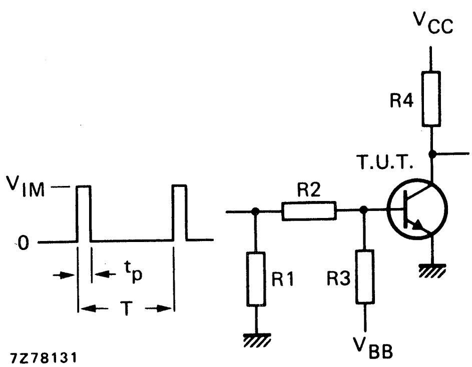


Fig. 2 Switching times waveform.



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

Fig. 3 Switching times test circuit.

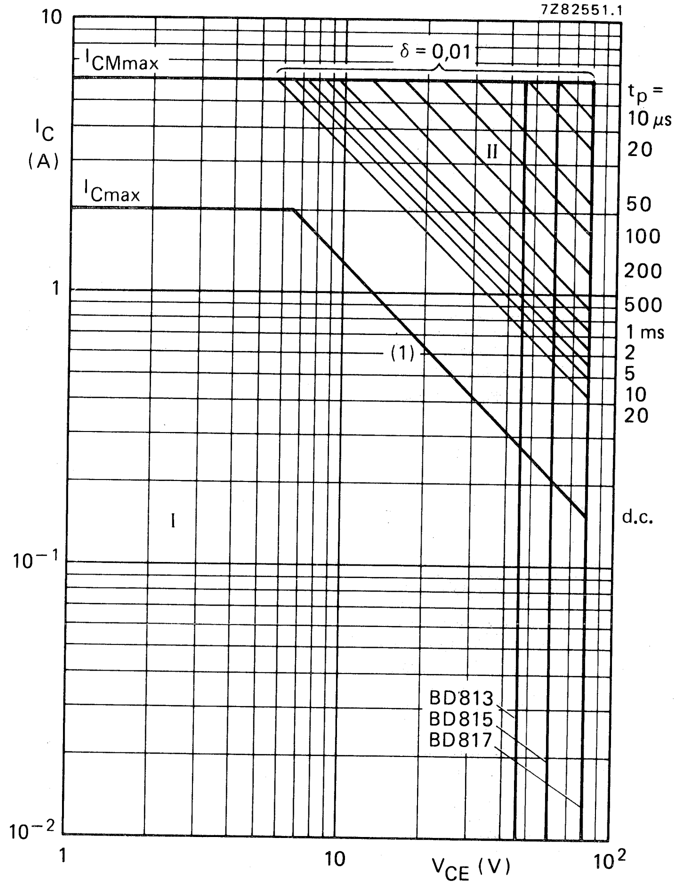


Fig. 4 Safe Operating ARea. $T_{mb} \leqslant 25$ °C.

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).

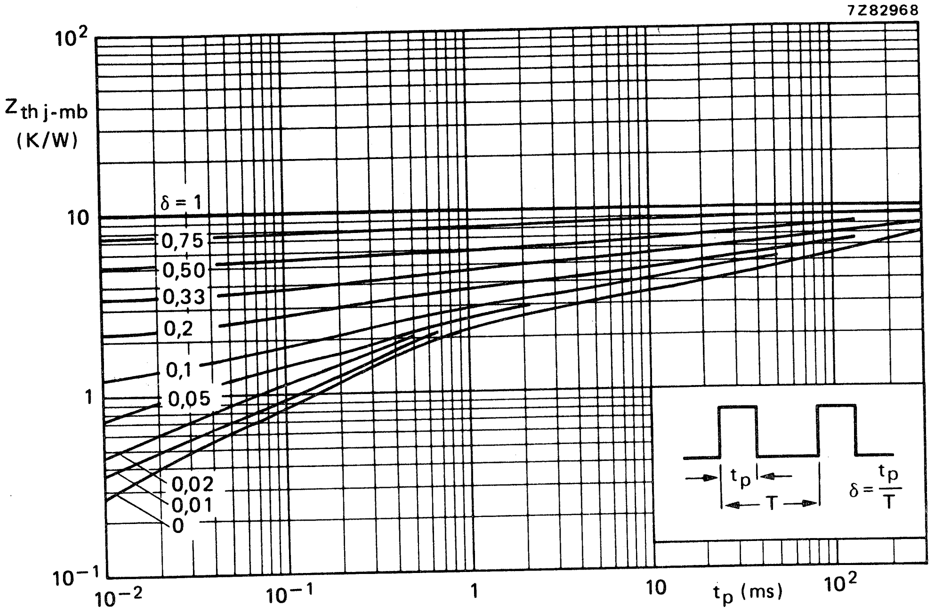


Fig. 5 Pulse power rating chart.

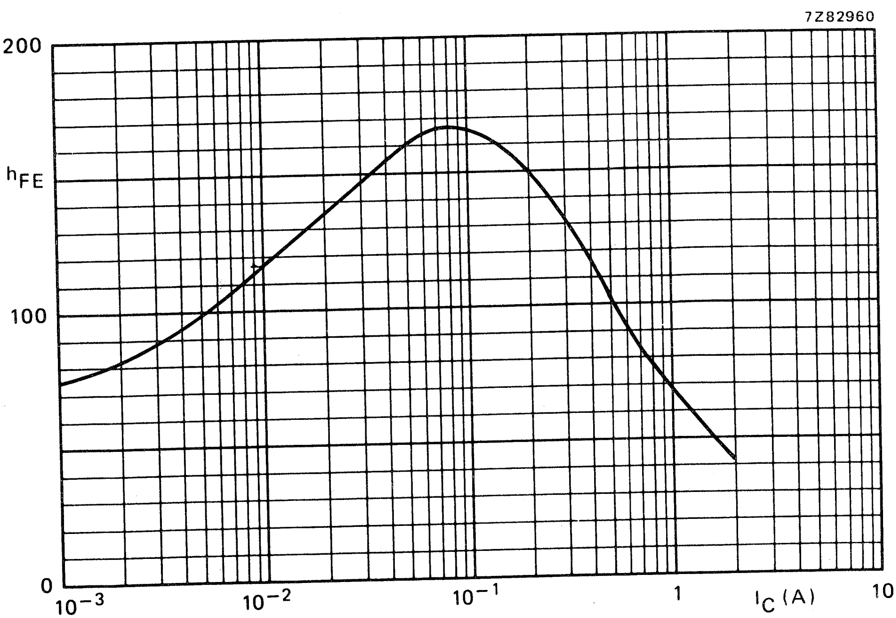


Fig. 6 Typical values d.c. current gain. V_{CE} = 2 V; T_{amb} = 25 °C.

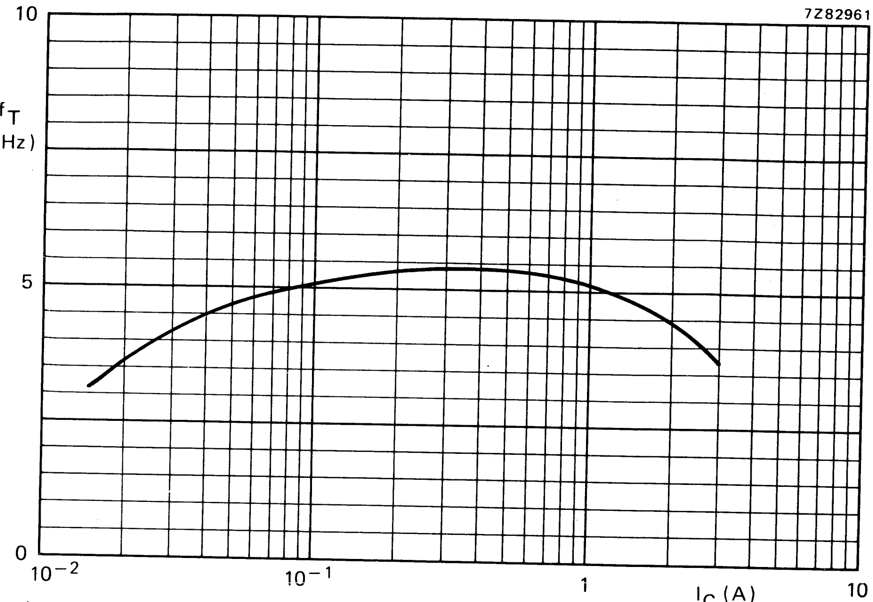


Fig. 7 Typical values transition frequency. V_{CE} = 10 V; f = 1 MHz; T_{amb} = 25 °C.

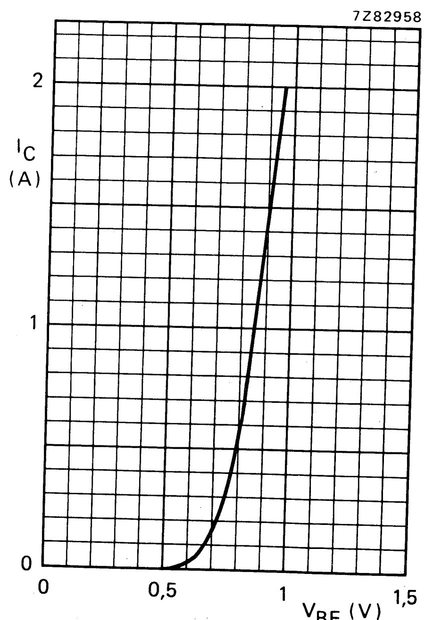


Fig. 8 Typical values V_{CE} = 2 V; T_{amb} = 25 °C.

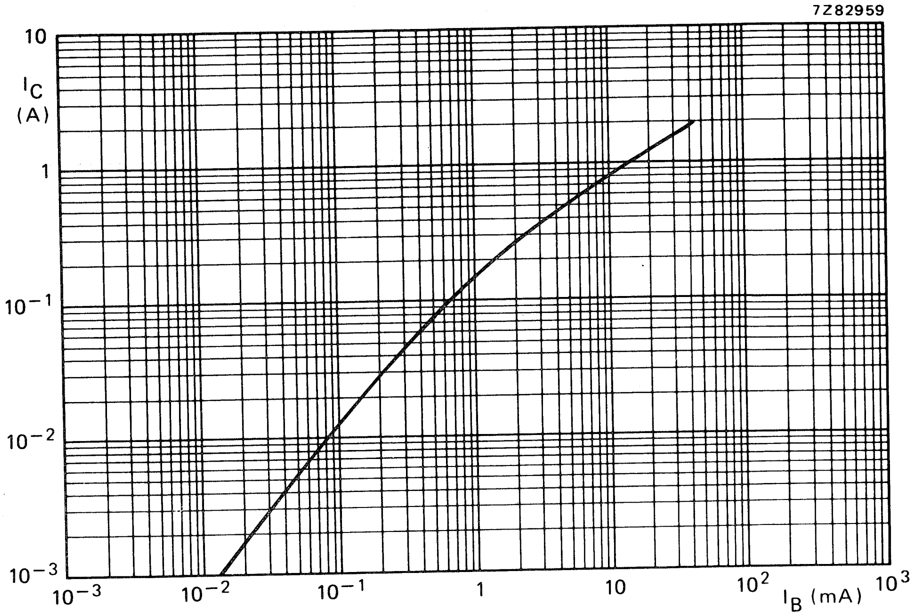


Fig. 9 Typical values at V_{CE} = 2 V; T_{amb} = 25 °C.

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

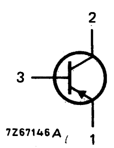
			BD814	BD816	BD818	
Collector-base voltage	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Collector current (peak value)	$-I_{CM}$	max.		6		A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.		2		W
up to T_{mb} = 25 °C	P_{tot}	max.		12,5		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
$-I_C$ = 1 A; $-V_{CE}$ = 2 V	h_{FE}	>		25		
Transition frequency						
$-I_C$ = 250 mA; $-V_{CE}$ = 10 V	f_T	>		3		MHz

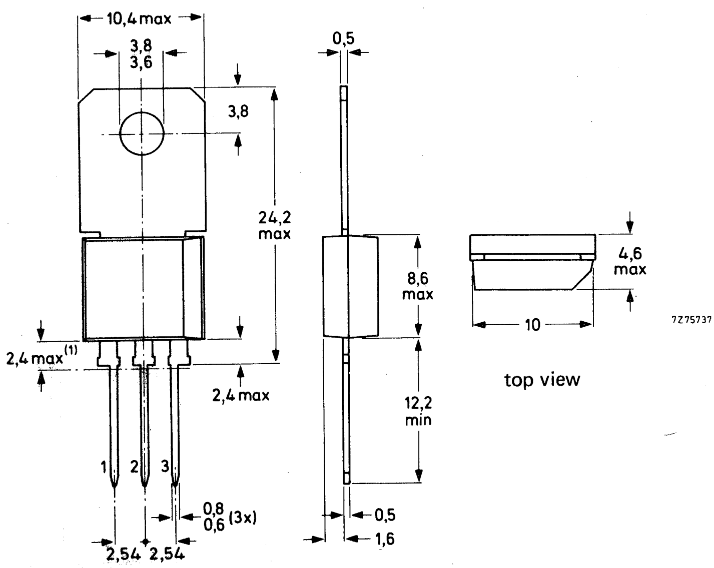
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-202.

Collector connected to mounting base.





(1) Plastic flash allowed within this zone.

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

CHARACTERISTICS

T_j = 25 °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 °C	$-I_{CBO}$	<	3	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	1	mA
Base-emitter voltage				
$-I_C = 1$ A; $-V_{CE} = 2$ V	$-V_{BE}$	<	1,3	V
Collector-emitter saturation voltage				
$-I_C = 1$ A; $-I_B = 0,1$ A	$-V_{CEsat}$	<	0,6	V
D.C. current gain				
$-I_C = 150$ mA; $-V_{CE} = 2$ V	h_{FE}		40 to 250	
$-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE}	>	25	

Transition frequency at f = 1 MHz $-I_C$ = 250 mA; $-V_{CE}$ = 10 V	f_T	>	3 MHz
D.C. current gain ratio of matched pairs BD813/BD814; BD815/BD816; BD817/BD818 $\|I_C\|$ = 150 mA; $\|V_{CE}\|$ = 2 V	h_{FE1}/h_{FE2}	<	1,6
Switching times $-I_{Con}$ = 1 A; $-I_{Bon}$ = I_{Boff} = 0,1 A			
turn-on time	t_{on}	typ.	0,3 μs
turn-off time	t_{off}	typ.	0,7 μs

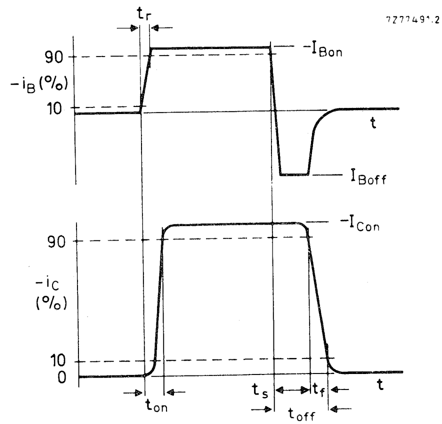
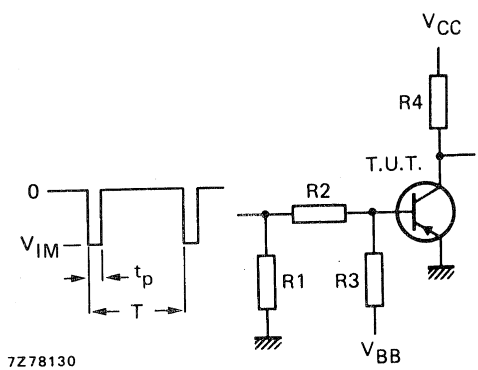


Fig. 2 Switching times waveforms.



$-V_{IM}$ = 16 V
$-V_{CC}$ = 20,3 V
V_{BB} = 7,4 V
R1 = 82 Ω
R2 = 82 Ω
R3 = 82 Ω
R4 = 20 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 3 Switching times test circuit.

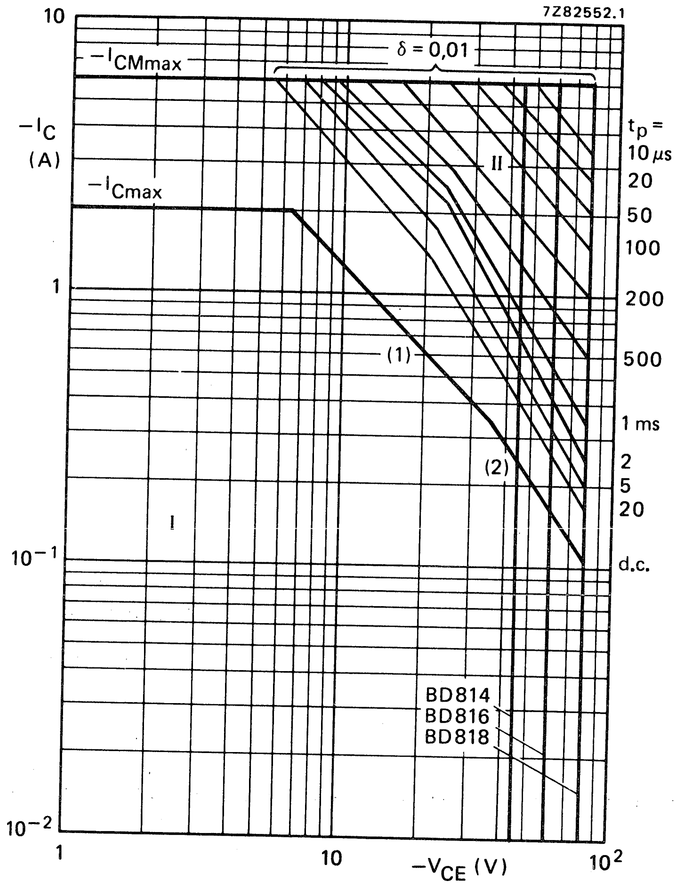


Fig. 4 Safe Operating ARea, $T_{mb} \leq 25\ ^oC$.

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).

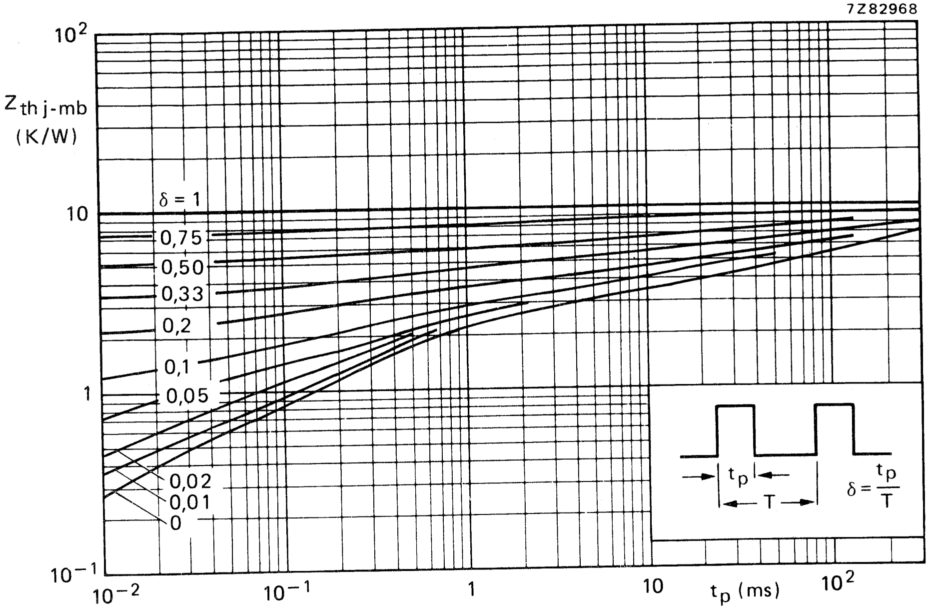


Fig. 5 Pulse power rating chart.

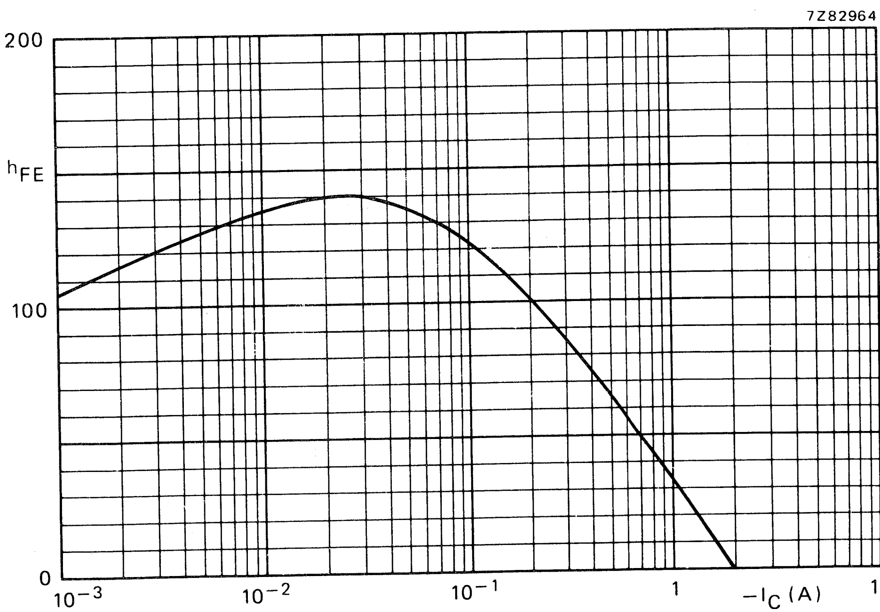


Fig. 6 Typical values d.c. current gain. $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

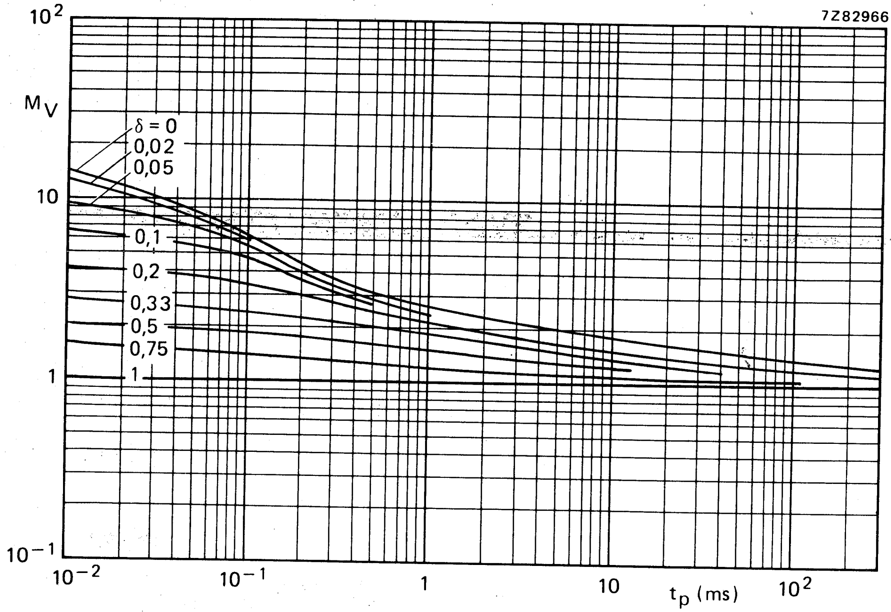


Fig. 7 S.B. voltage multiplying factor at I_{Cmax} level.

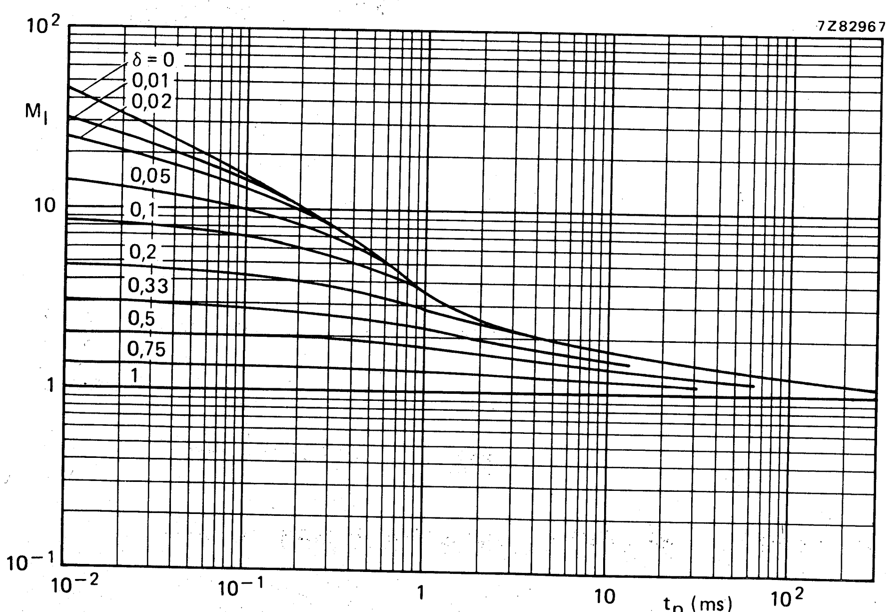


Fig. 8 S.B. current multiplying factor at V_{CEOmax} level.

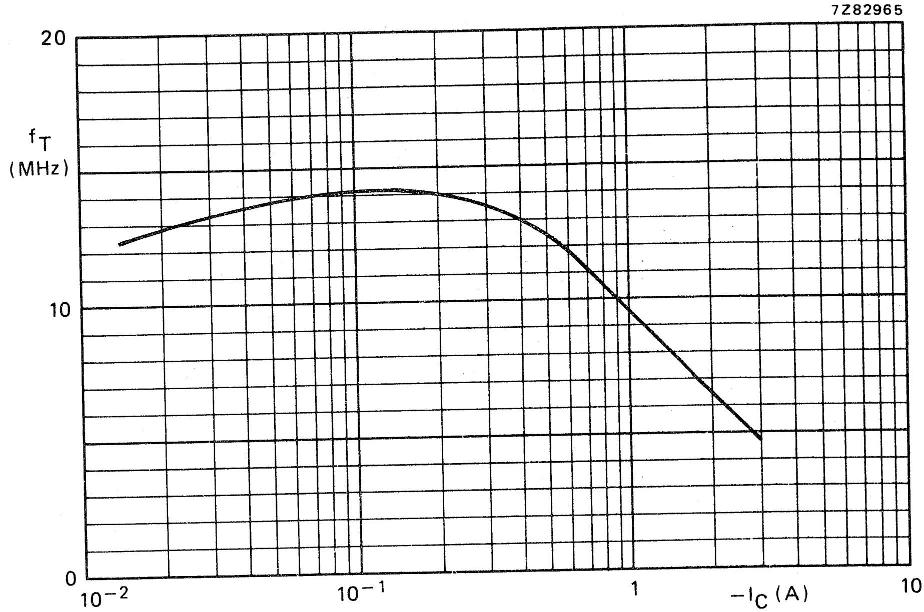


Fig. 9 Typical values transition frequency. $-V_{CE}$ = 10 V; f = 1 MHz; T_{amb} = 25 °C.

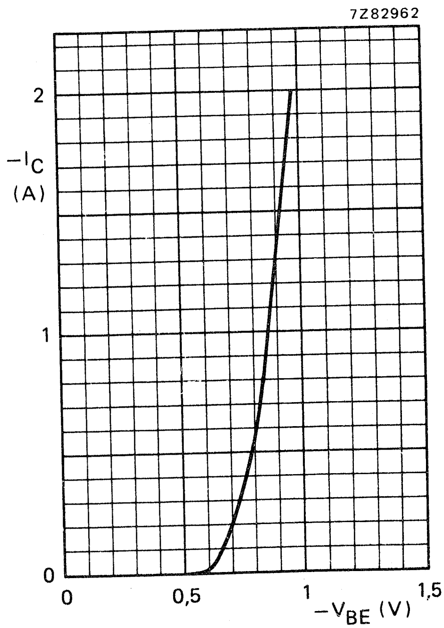


Fig. 10 Typical values. $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

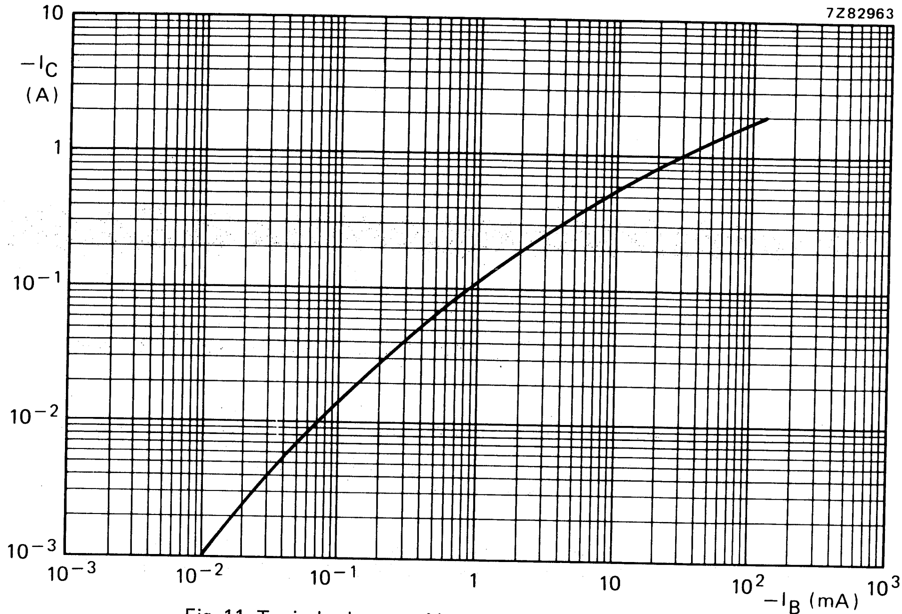


Fig. 11 Typical values at $-V_{CE} = 2$ V; $T_{amb} = 25$ °C.

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

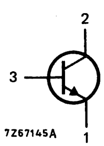
			BD825	BD827	BD829	
Collector-base voltage	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.		1,5		A
Total power dissipation						
at T_{amb} = 25 °C (free air)	P_{tot}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

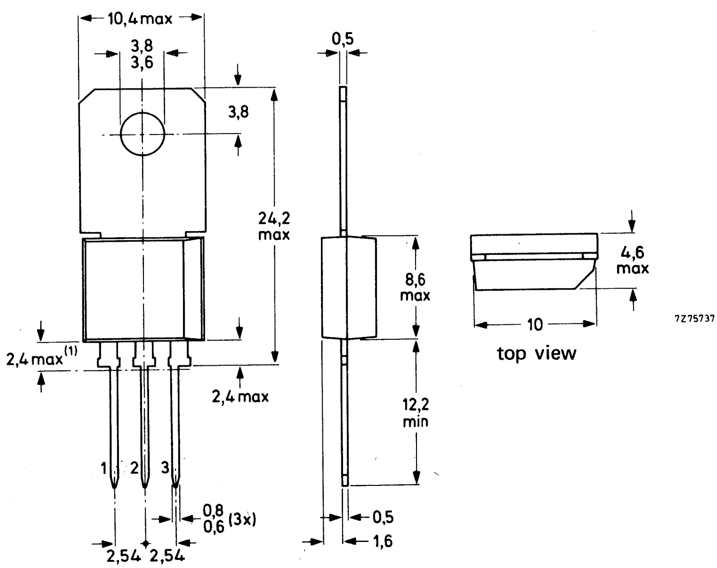
MECHANICAL DATA

Dimensions in mm

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)

			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 kΩ)	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 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 50 °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	$R_{th\ j\text{-}a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents			
$I_E = 0$; 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
D.C. current gain			
I_C = 5 mA; V_{CE} = 2 V	h_{FE}	>	25
I_C = 150 mA; V_{CE} = 2 V	h_{FE}		40 to 250
I_C = 500 mA; V_{CE} = 2 V	h_{FE}	>	25
Collector-emitter saturation voltage			
I_C = 500 mA; I_B = 50 mA	V_{CEsat}	<	0,5 V
Base-emitter voltage			
I_C = 500 mA; V_{CE} = 2 V	V_{BE}	<	1 V
Transition frequency at f = 35 MHz			
I_C = 50 mA; V_{CE} = 5 V	f_T	typ.	250 MHz
D.C. current gain ratio of matched complementary pairs		typ.	1,3
$\lvert I_C \rvert$ = 150 mA; $\lvert V_{CE} \rvert$ = 2 V	h_{FE1}/h_{FE2}	<	1,6

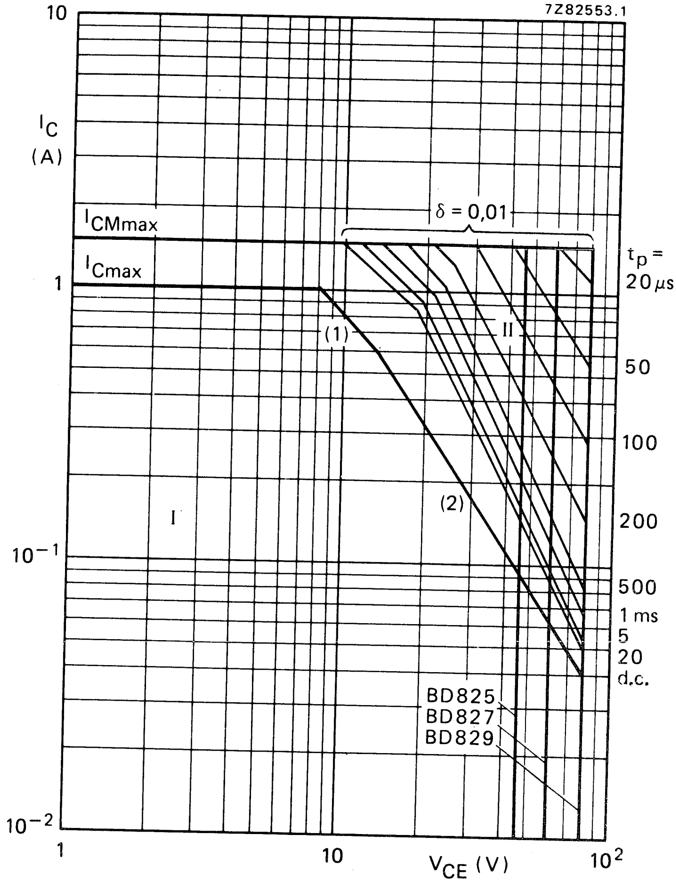


Fig. 2 Safe Operating ARea. $T_{mb} \leq 25\,^{o}C$.

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).

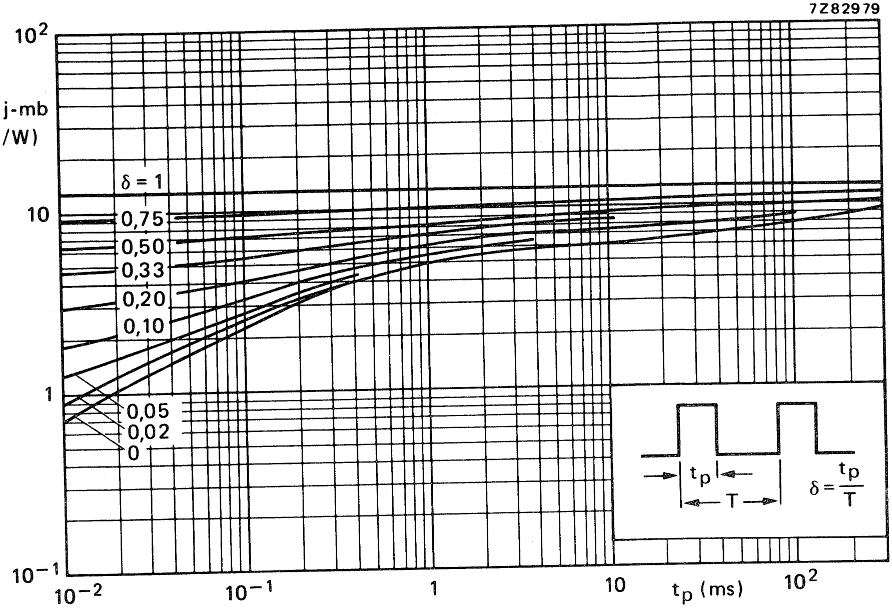


Fig. 3 Pulse power rating chart.

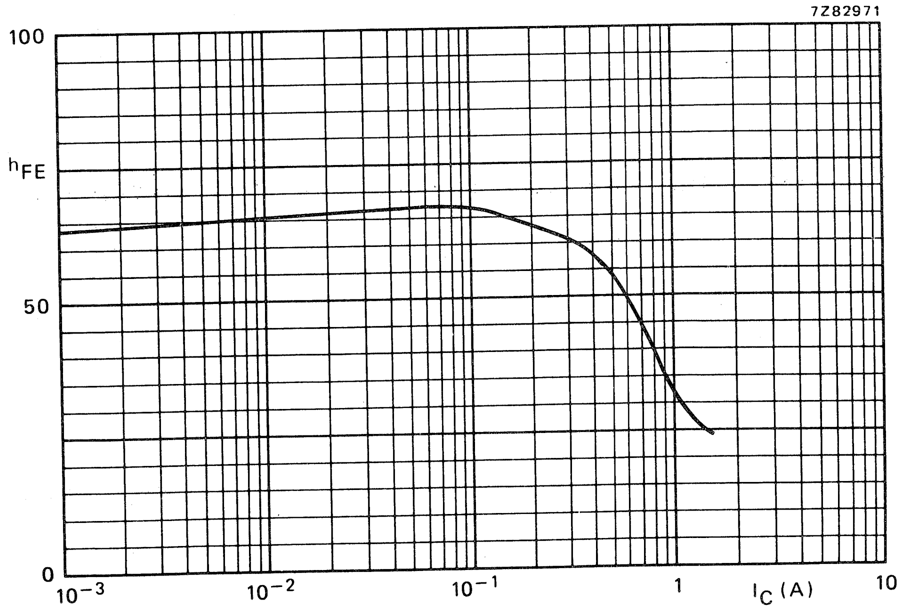


Fig. 4 Typical values d.c. current gain. V_{CE} = 2 V; T_{amb} = 25 °C.

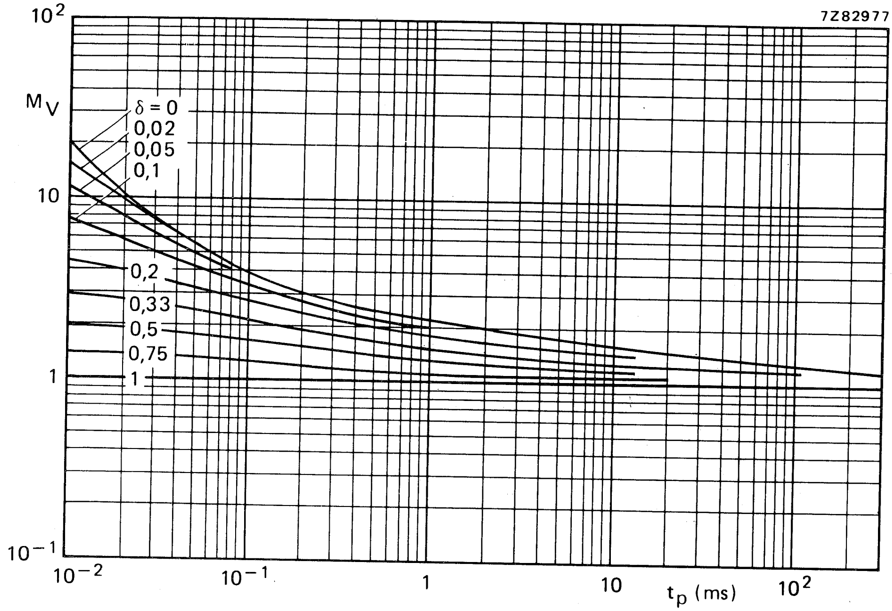


Fig. 5 S.B. voltage multiplying factor at I_{Cmax} level.

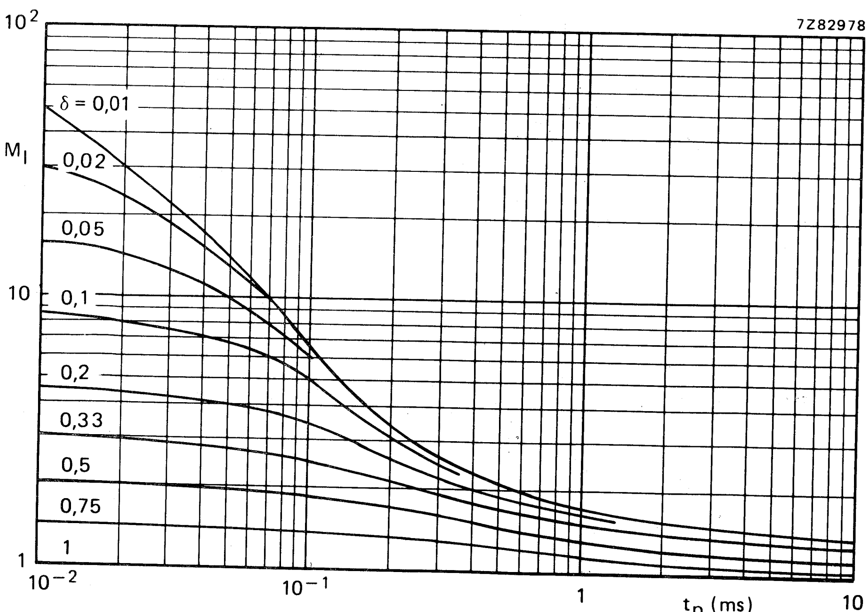


Fig. 6 S.B. current multiplying factor at V_{CEOmax} level.

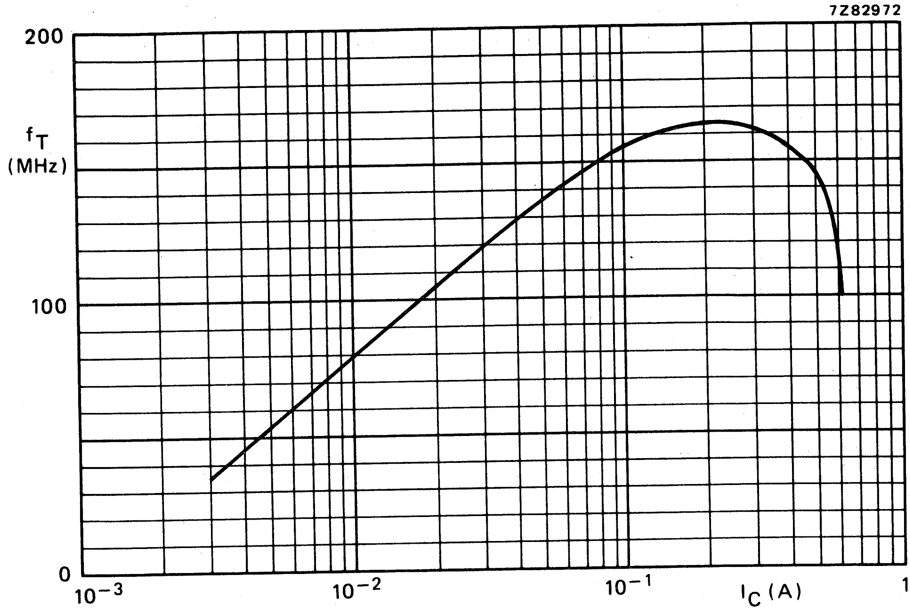


Fig. 7 Typical values transition frequency. V_{CE} = 5 V; f = 35 MHz; T_{amb} = 25 °C.

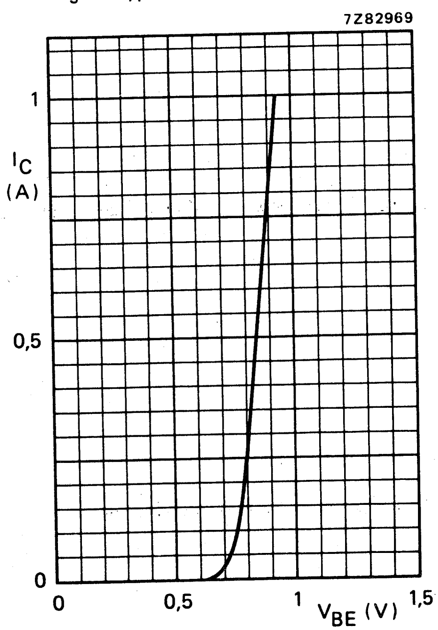


Fig. 8 Typical values. V_{CE} = 2 V; T_{amb} = 25 °C.

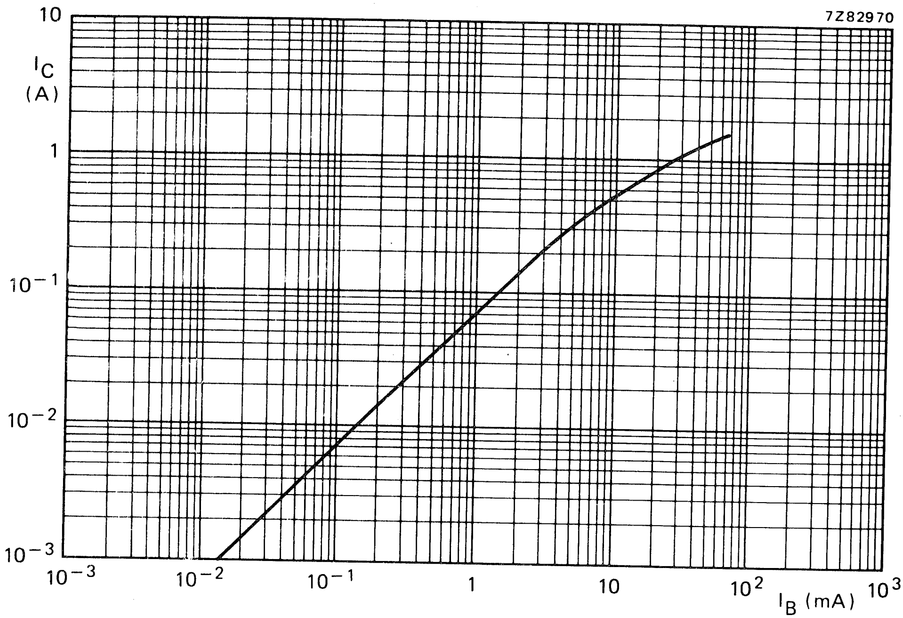


Fig. 9 Typical values at V_{CE} = 2 V; T_{amb} = 25 ^oC:

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

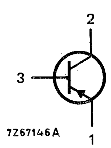
			BD826	BD828	BD830	
Collector-base voltage	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage	$-V_{CER}$	max.	45	60	100	V
Collector current (peak value)	$-I_{CM}$	max.		1,5		A
Total power dissipation						
at T_{amb} = 25 °C (free air)	P_{tot}	max.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

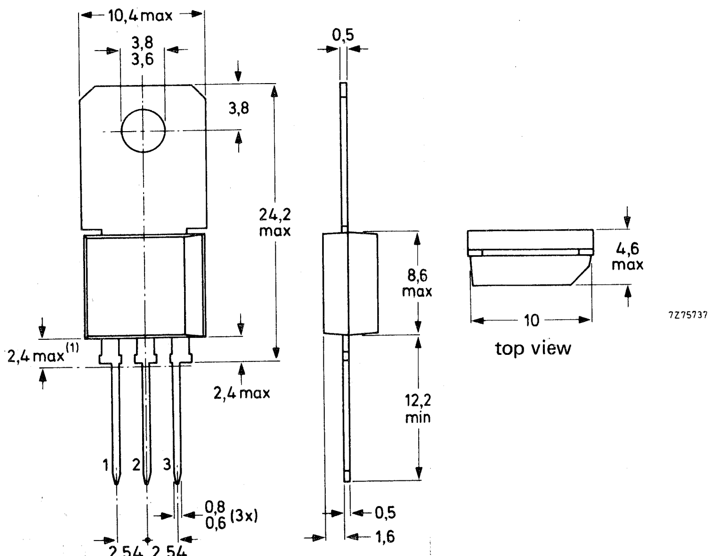
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-202.

Collector connected to mounting base.





(1) Plastic flash allowed within this zone.

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 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		A
Collector current (peak value)	$-I_{CM}$	max.		1,5		A
Total power dissipation						
T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 50 °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	$R_{th\ j\text{-}a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12,5	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
D.C. current gain			
$-I_C = 5$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25
$-I_C = 150$ mA; $-V_{CE} = 2$ V	h_{FE}		40 to 250
$-I_C = 500$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25
Collector-emitter saturation voltage			
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	0,5 V
Base-emitter voltage			
$-I_C = 500$ mA; $-V_{CE} = 2$ V	$-V_{BE}$	<	1 V
Transition frequency at f = 35 MHz			
$-I_C = 50$ mA; $-V_{CE} = 5$ V	f_T	typ.	75 MHz
D.C. current gain ratio of matched complementary pairs			
$\lvert I_C \rvert = 150$ mA; $\lvert V_{CE} \rvert = 2$ V	h_{FE1}/h_{FE2}	typ.	1,3
		<	1,6

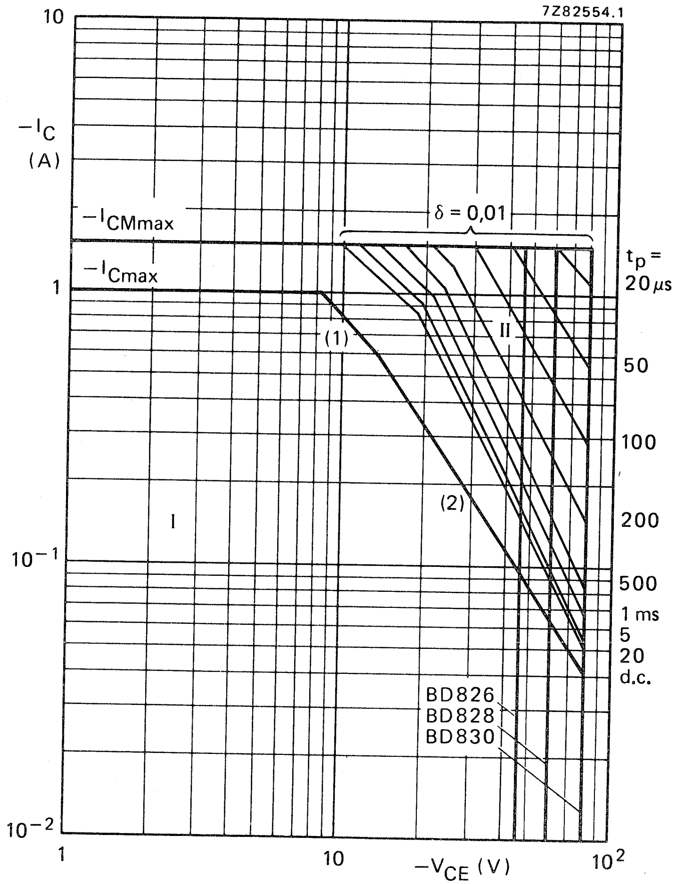


Fig. 2 Safe Operating ARea, $T_{mb} \leq 25$ °C.

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).

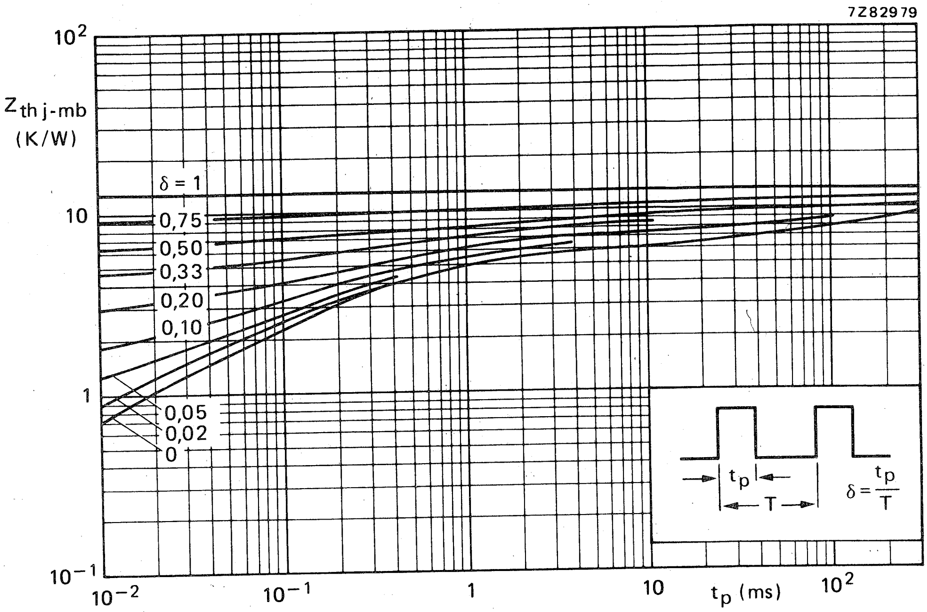


Fig. 3 Pulse power rating chart.

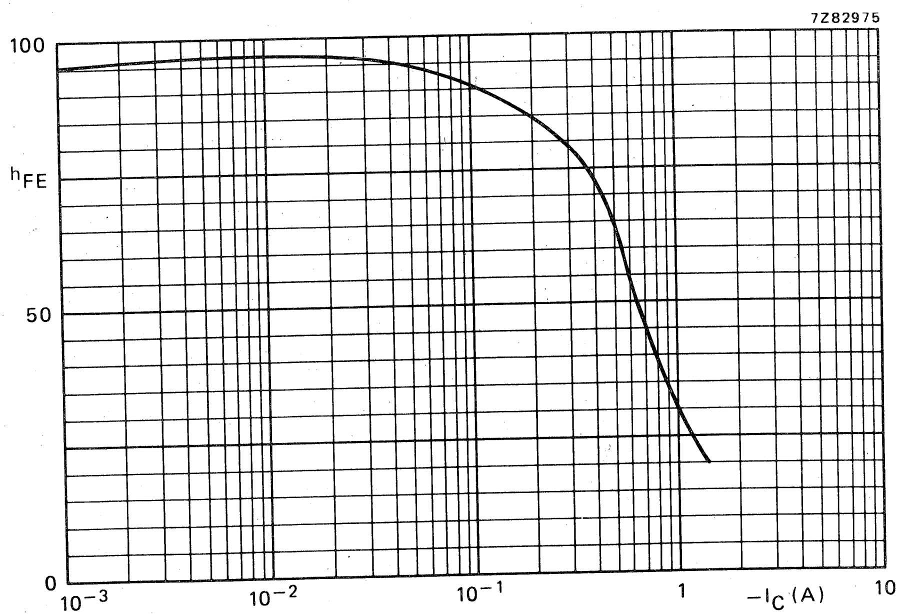


Fig. 4 Typical values d.c. current gain. $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

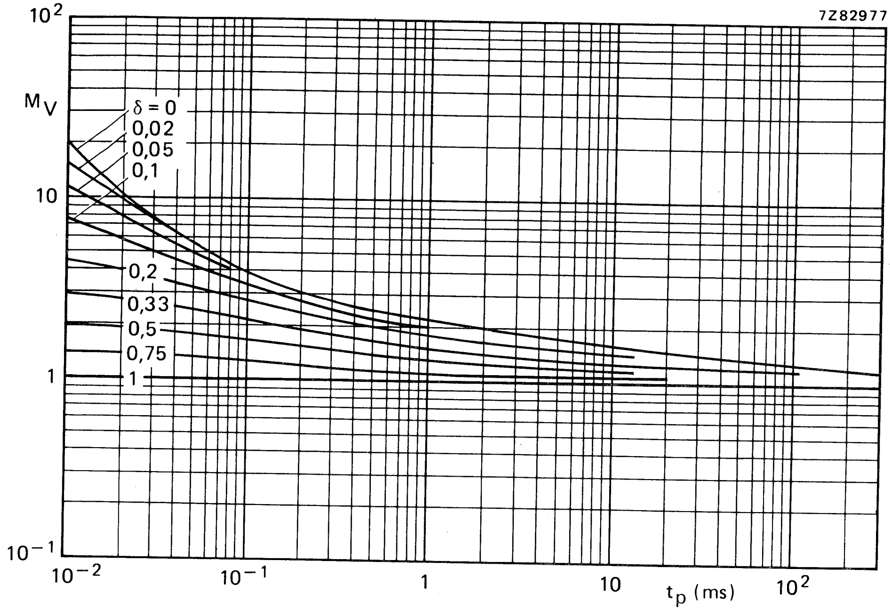


Fig. 5 S.B. voltage multiplying factor at I_{Cmax} level.

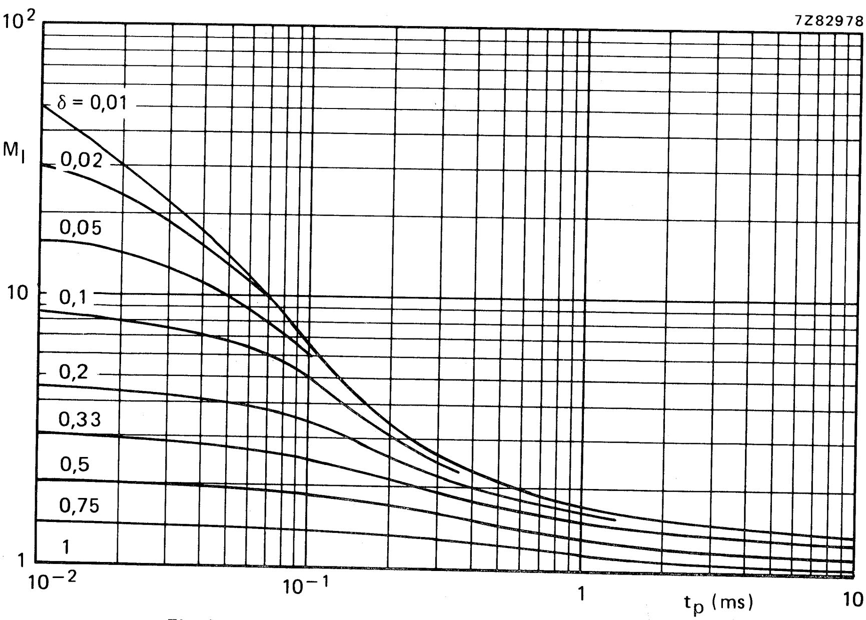


Fig. 6 S.B. current multiplying factor at V_{CEOmax} level.

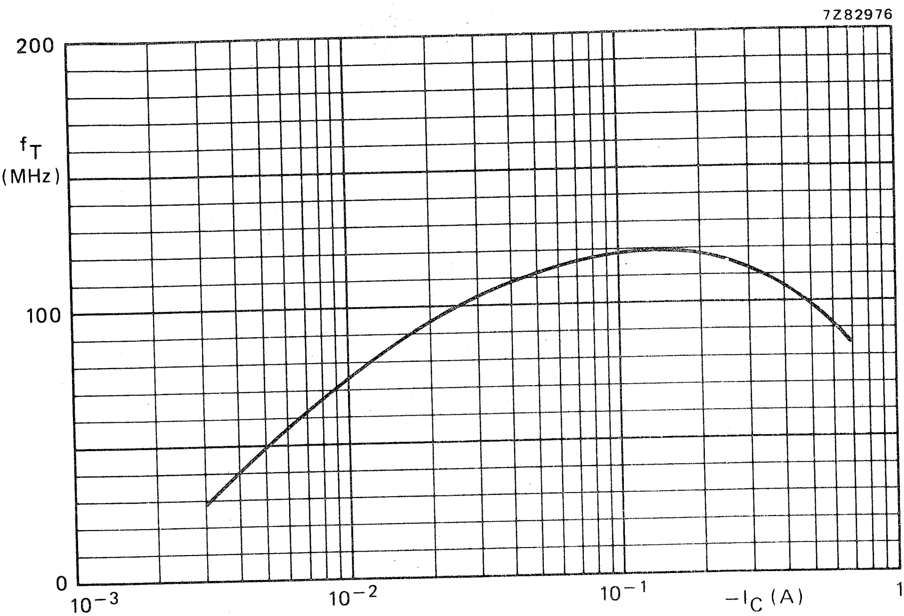


Fig. 7 Typical values transition frequency at $-V_{CE}$ = 5 V; f = 35 MHz; T_{amb} = 25 °C.

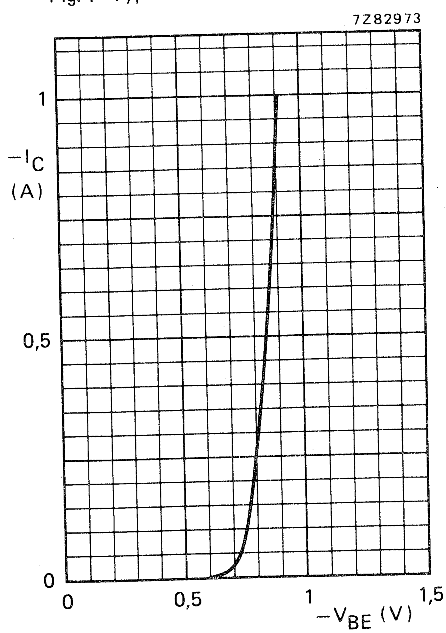


Fig. 8 Typical values. $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

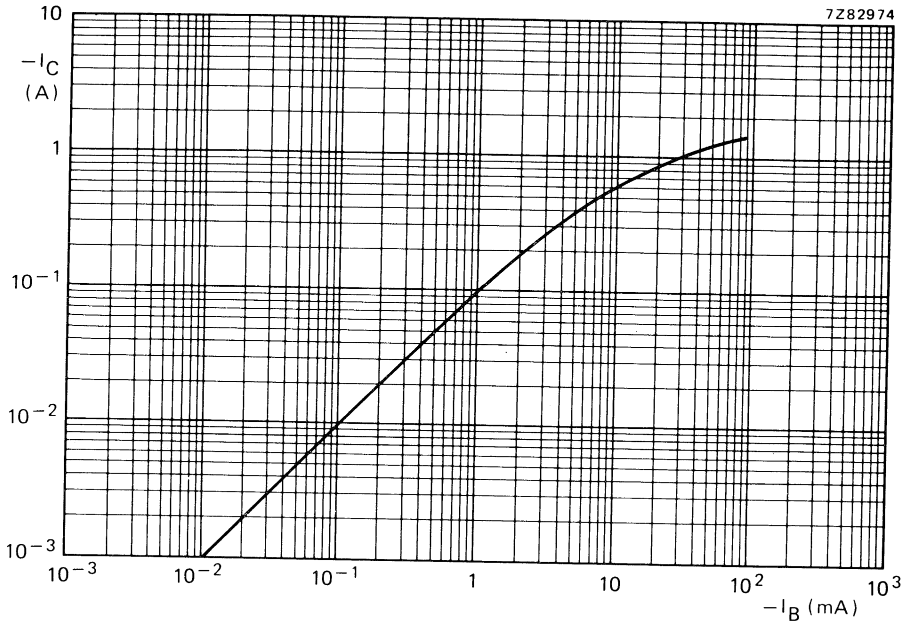


Fig. 9 Typical values at $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

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

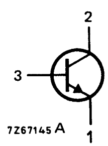
			BD839	BD841	BD843	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.		3		A
Total power dissipation						
T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 25 °C	P_{tot}	max.		10		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
I_C = 1 A; V_{CE} = 2 V	h_{FE}	>		25		
Transition frequency at f = 35 MHz						
I_C = 50 mA; V_{CE} = 5 V	f_T	typ.		125		MHz

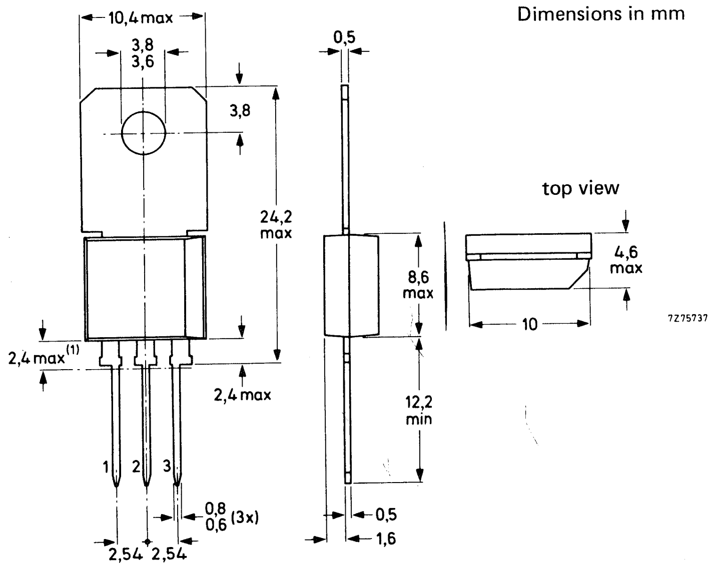
MECHANICAL DATA

Dimensions in mm

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 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		A
Collector current (peak value)	I_{CM}	max.		3		A
Total power dissipation						
T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 25 °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	$R_{th\ j\text{-}a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12,5	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
Base-emitter voltage*			
$I_C = 1$ A; $V_{CE} = 2$ V	V_{BE}	<	1,3 V
Collector-emitter saturation voltage			
$I_C = 1$ A; $I_B = 0{,}1$ A	V_{CEsat}	<	0,8 V
D.C. current gain			
$I_C = 5$ mA; $V_{CE} = 2$ V	h_{FE}	>	25
$I_C = 150$ mA; $V_{CE} = 2$ V	h_{FE}		40 to 250 ←
$I_C = 1$ A; $V_{CE} = 2$ V	h_{FE}	>	25
Transition frequency at f = 35 MHz			
$I_C = 50$ mA; $V_{CE} = 5$ V	f_T	typ.	125 MHz
D.C. current gain ratio of BD839/BD840, BD841/BD842, BD843/BD844		typ.	1,3
$\lvert I_C \rvert = 150$ mA; $\lvert V_{CE} \rvert = 2$ V	h_{FE1}/h_{FE2}	<	1,6

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

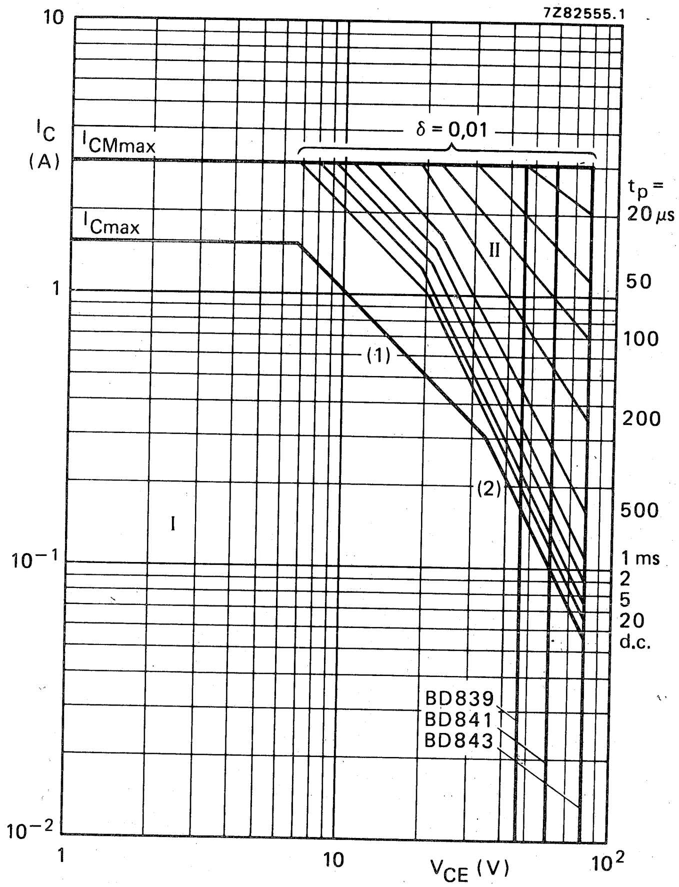


Fig. 2 Safe Operating ARea, $T_{mb} \leqslant 25\ ^{o}C$.

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).

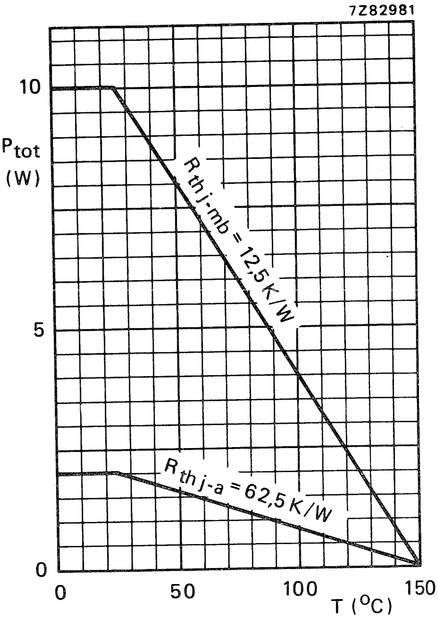


Fig. 3 Power derating curve.

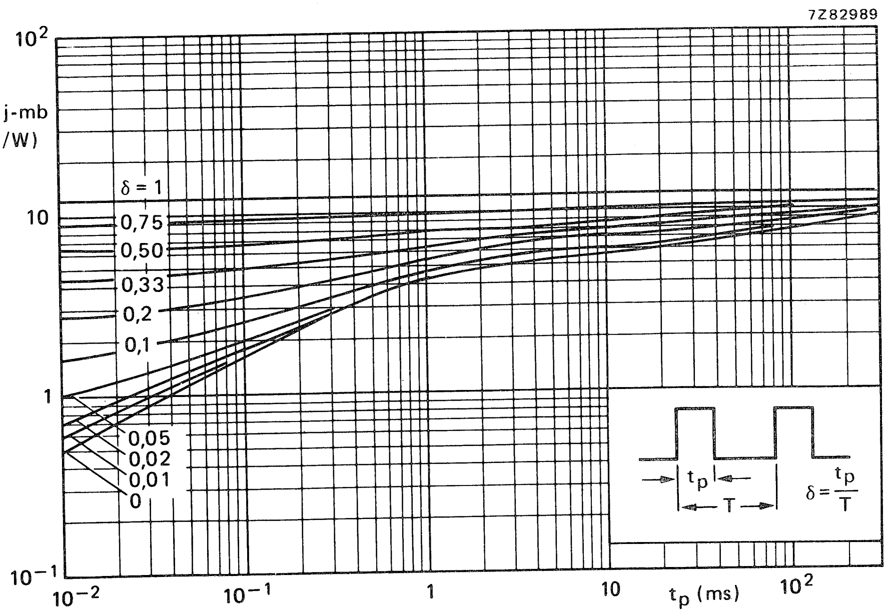


Fig. 4 Pulse power rating chart.

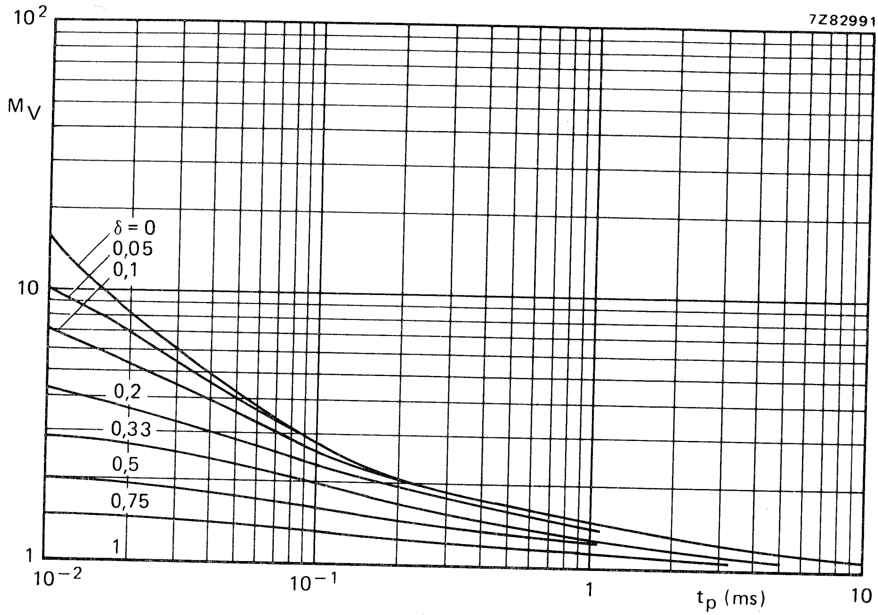


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

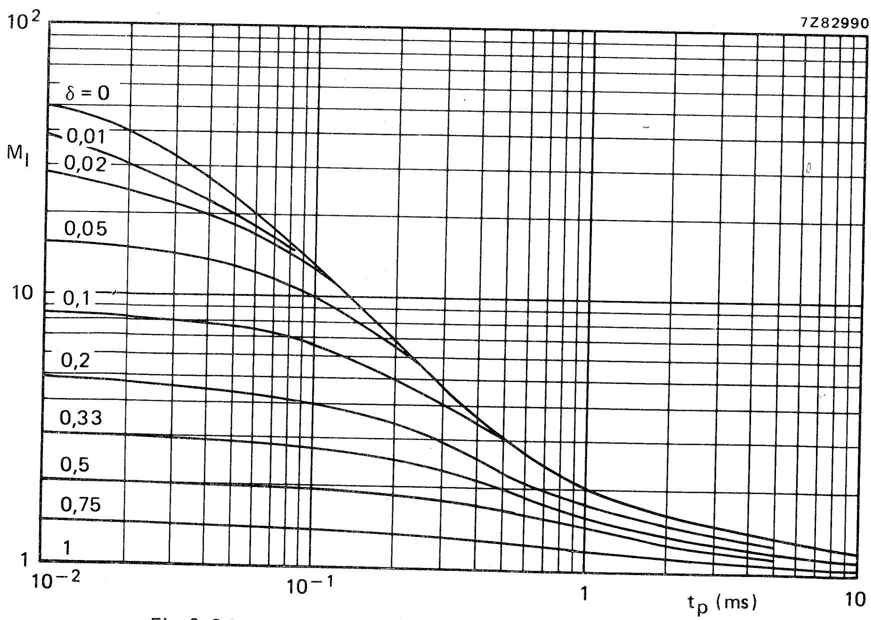


Fig. 6 S.B. current multiplying factor at the V_{CEOmax} level.

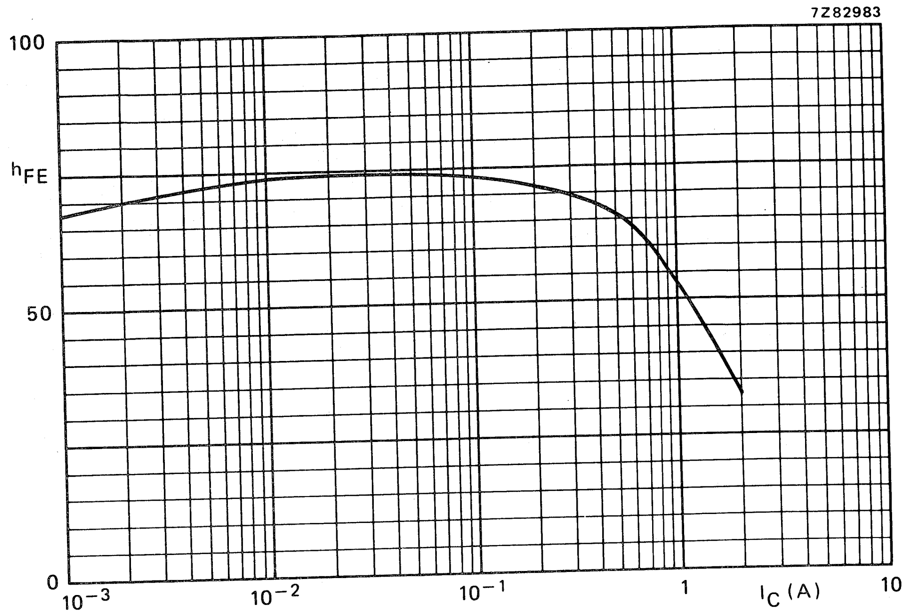


Fig. 7 Typical values d.c. current gain. V_{CE} = 2 V; T_{amb} = 25 °C.

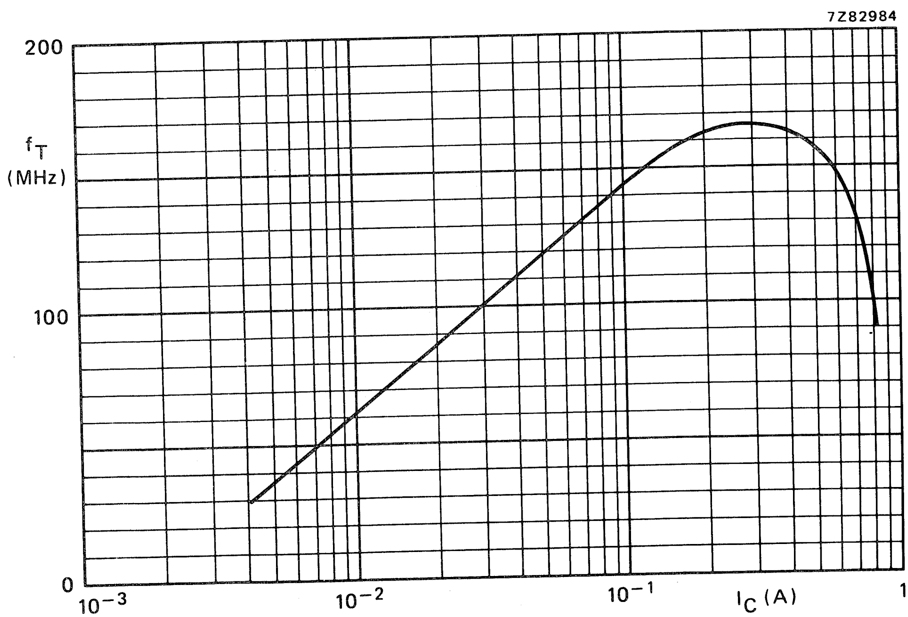


Fig. 8 Typical values transition frequency. V_{CE} = 5 V; T_{amb} = 25 °C; f = 35 MHz.

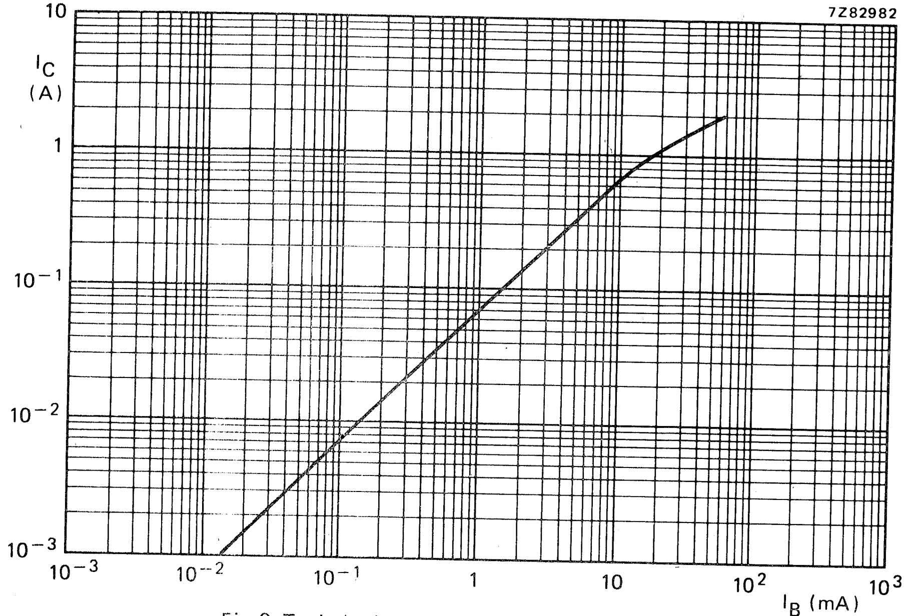


Fig. 9 Typical values at V_{CE} = 2 V; T_{amb} = 25 °C.

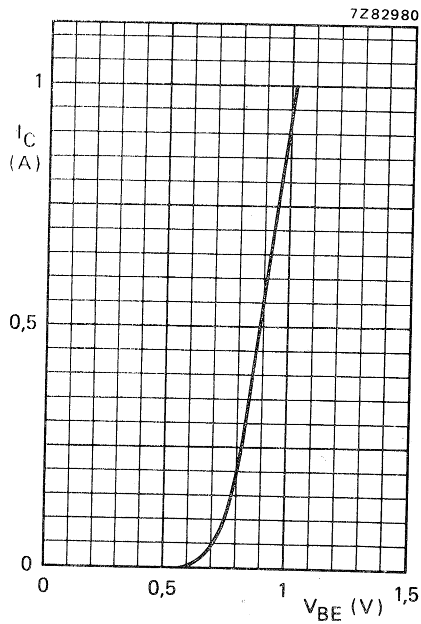


Fig. 10 Typical values. V_{CE} = 2 V; T_{amb} = 25 °C.

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

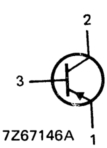
			BD840	BD842	BD844	
Collector-base voltage	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Emitter-base voltage	$-V_{EBO}$	max.	5	5	5	V
Collector current (peak value)	$-I_{CM}$	max.		3		A
Total power dissipation						
T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 25 °C	P_{tot}	max.		10		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
$-I_C$ = 1 A; $-V_{CE}$ = 2 V	h_{FE}	>		25		
Transition frequency at f = 35 MHz	f_T	typ.		50		MHz

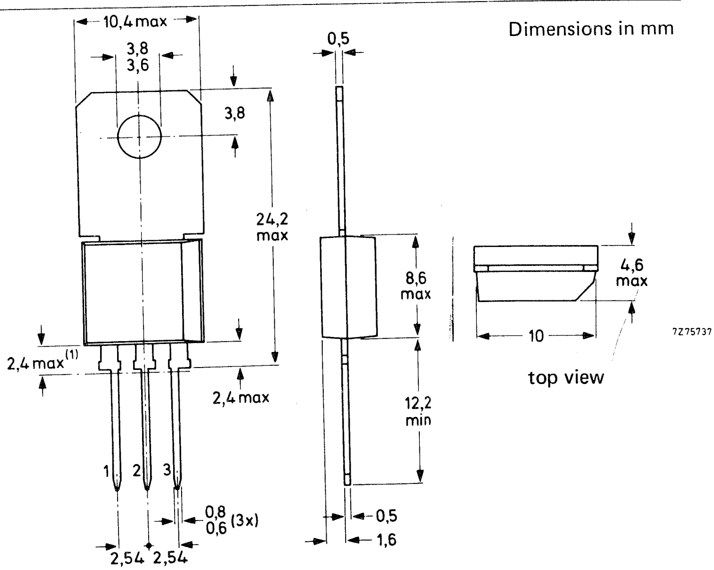
MECHANICAL DATA

Dimensions in mm

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 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		A
Collector current (peak value)	$-I_{CM}$	max.		3		A
Total power dissipation						
T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 25 °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	$R_{th\ j\text{-}a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12,5	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
Base-emitter voltage*			
$-I_C = 1$ A; $-V_{CE} = 2$ V	$-V_{BE}$	<	1,3 V
Collector-emitter saturation voltage			
$-I_C = 1$ A; $-I_B = 0{,}1$ A	$-V_{CEsat}$	<	0,8 V
D.C. current gain			
$-I_C = 5$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25
$-I_C = 150$ mA; $-V_{CE} = 2$ V	h_{FE}		40 to 250 ←
$-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE}	>	25
Transition frequency at f = 35 MHz			
$-I_C = 50$ mA; $-V_{CE} = 5$ V	f_T	typ.	50 MHz
D.C. current gain ratio			
of BD839/BD840, BD841/BD842, BD843/BD844		typ.	1,3
$\lvert I_C \rvert = 150$ mA; $\lvert V_{CE} \rvert = 2$ V	h_{FE1}/h_{FE2}	<	1,6

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

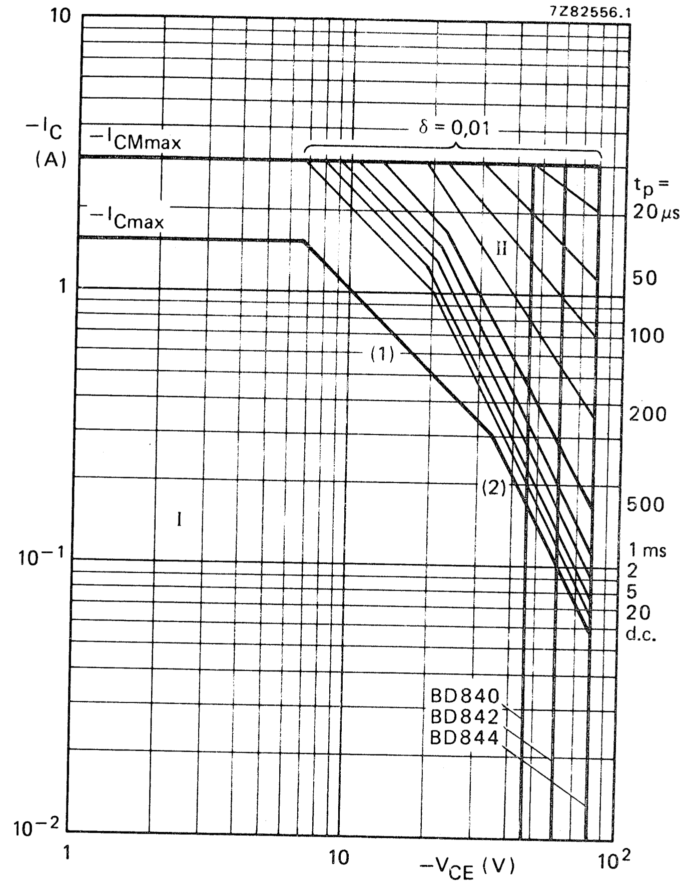


Fig. 2 Safe Operating ARea, $T_{mb} \leq 25\ ^oC$.

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).

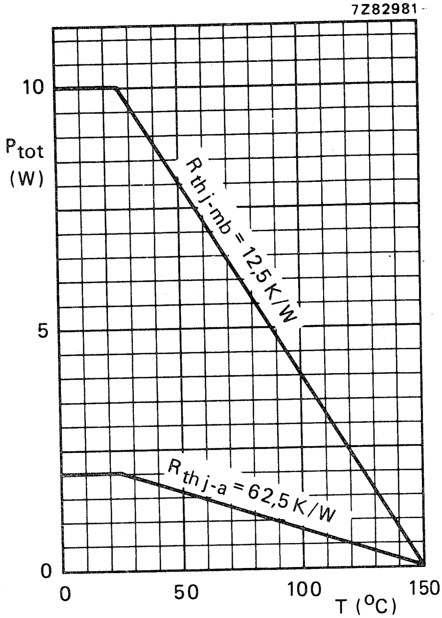


Fig. 3 Power derating curve.

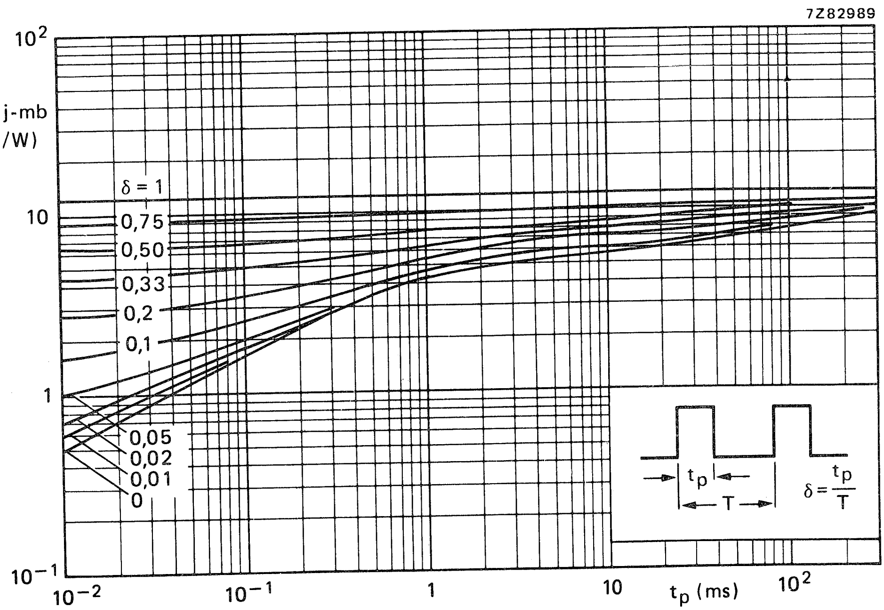


Fig. 4 Pulse power rating chart.

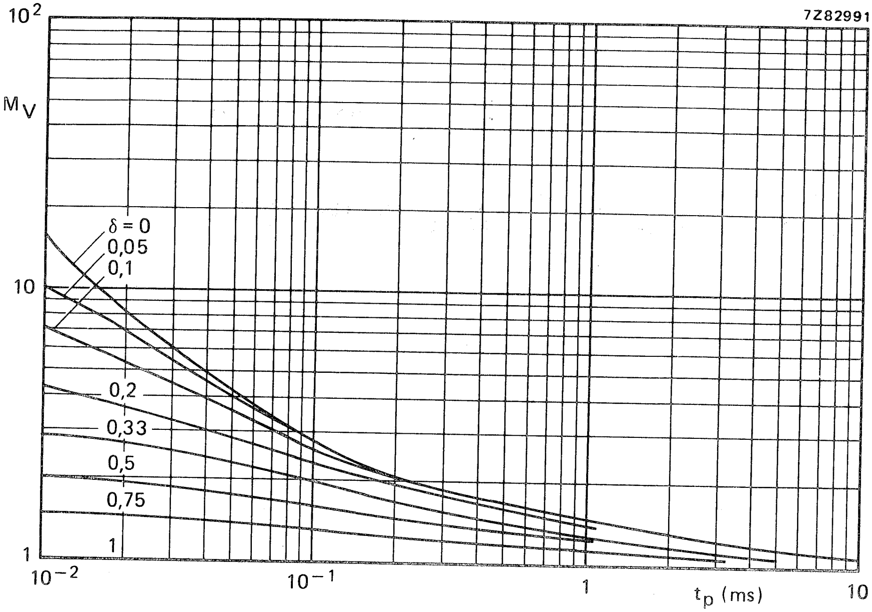


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

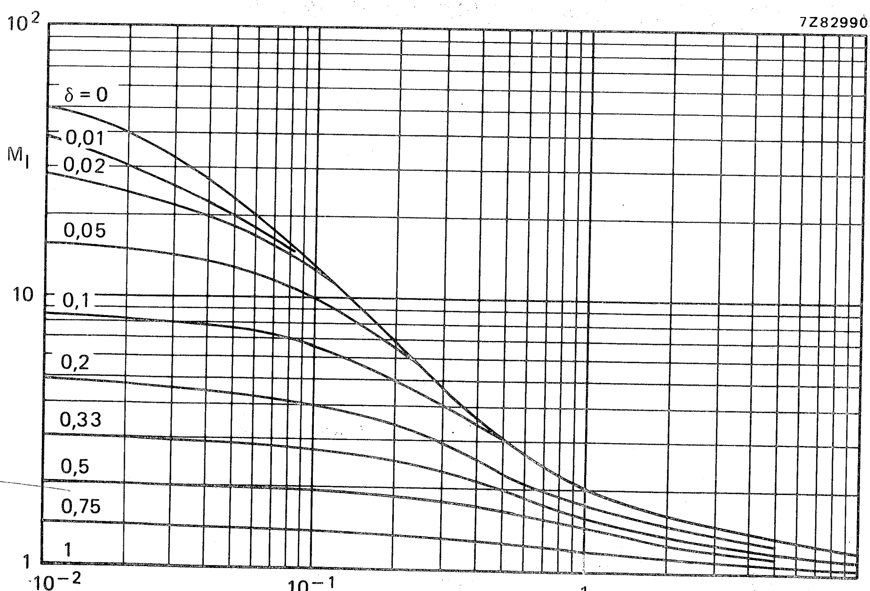


Fig. 6 S.B. current multiplying factor at the V_{CEOmax} level.

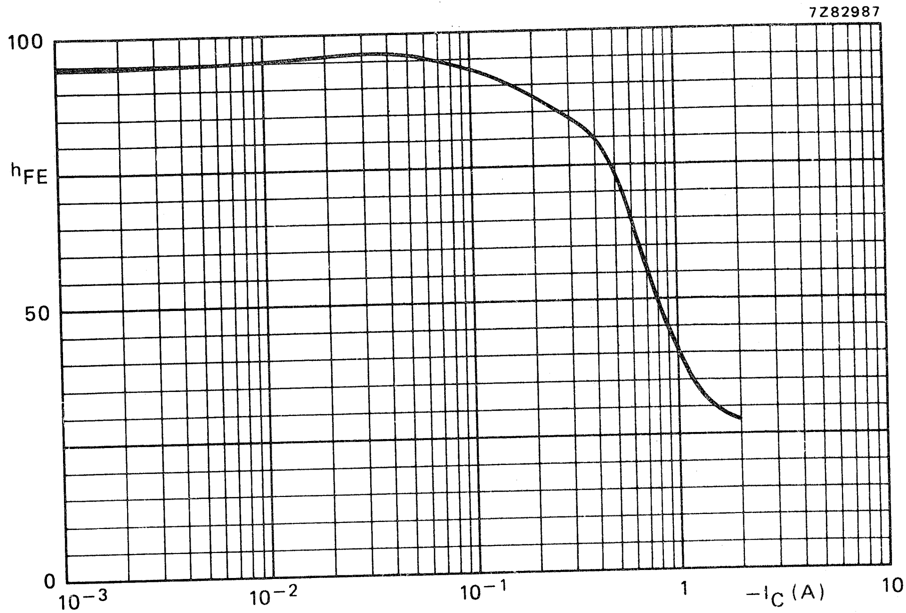


Fig. 7 Typical values d.c. current gain. $-V_{CE} = 2$ V; $T_{amb} = 25$ °C.

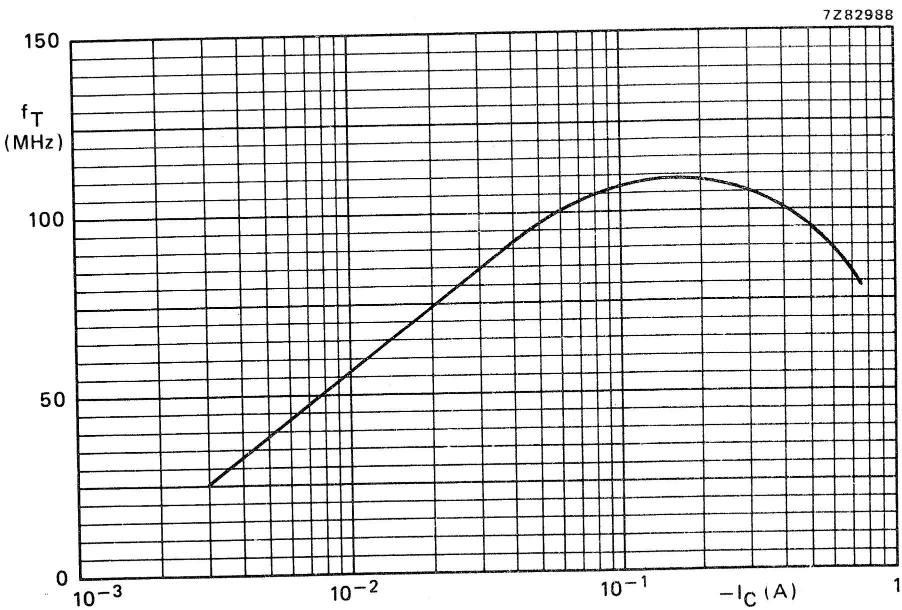


Fig. 8 Typical values transition frequency. $-V_{CE} = 5$ V; f = 35 MHz; $T_{amb} = 25$ °C.

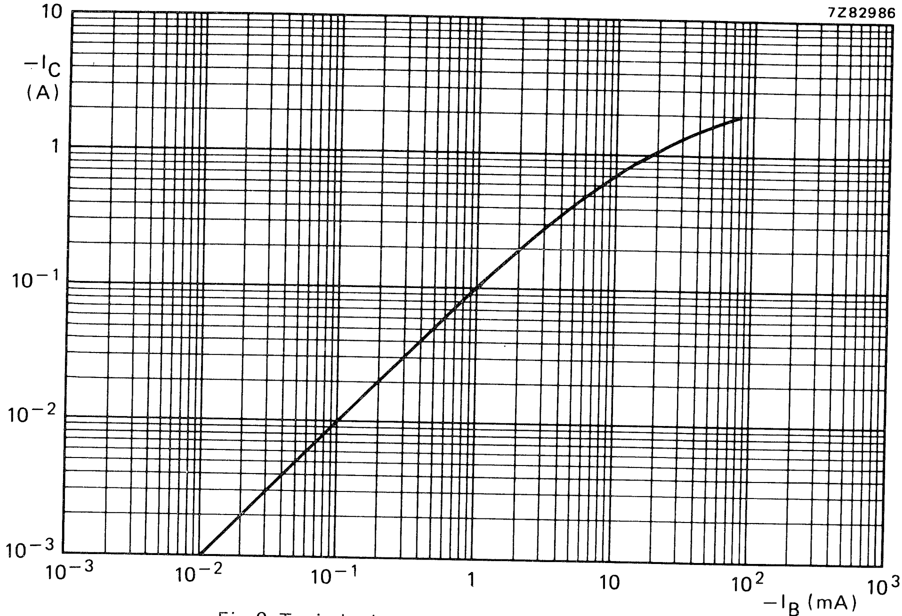


Fig. 9 Typical values at $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

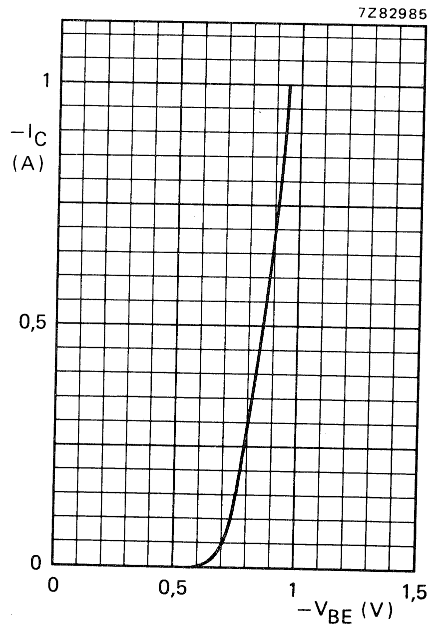


Fig. 10 Typical values. $-V_{CE}$ = 2 V; T_{amb} = 25 °C.

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

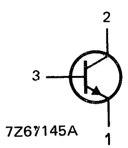
			BD845	BD847	BD849	
Collector-base voltage	V_{CBO}	max.	100	120	140	V
Collector-emitter voltage	V_{CEO}	max.	100	120	140	V
Emitter-base voltage	V_{EBO}	max.	5	5	5	V
Collector current (peak value)	I_{CM}	max.		3		A
Total power dissipation						
at T_{amb} = 25 °C (free air)	P_{tot}	max.		2		W
at T_{mb}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

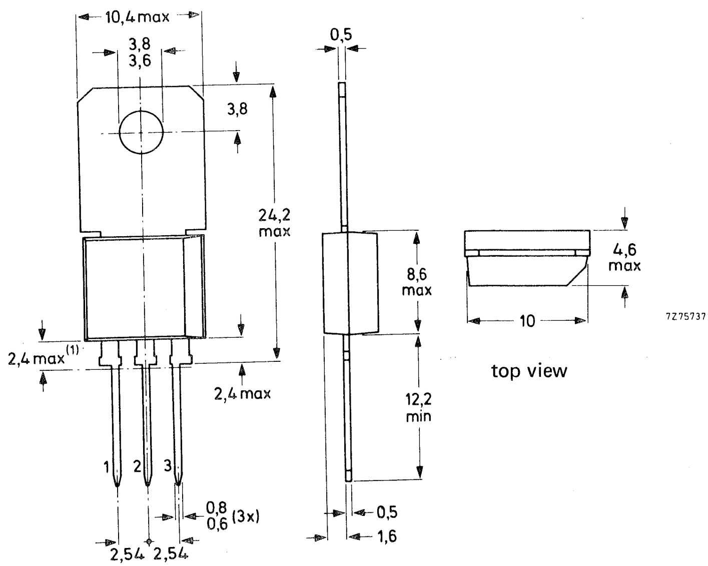
MECHANICAL DATA

Dimensions in mm

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)

			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 °C (free air)	P_{tot}	max.	2	W
T_{mb} = 25 °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	$R_{th\ j\text{-}a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents $I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	1 μA
Emitter cut-off current $I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10 μA
D.C. current gain I_C = 10 mA; V_{CE} = 5 V	h_{FE}	>	40
I_C = 150 mA; V_{CE} = 5 V	h_{FE}		40 to 250
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	>	30
Collector-emitter saturation voltage I_C = 500 mA; I_B = 50 mA	V_{CEsat}	<	1,0 V
Base-emitter voltage I_C = 500 mA; V_{CE} = 5 V	V_{BE}	<	1,3 V
Transition frequency at f = 35 MHz I_C = 100 mA; V_{CE} = 5 V	f_T	typ.	150 MHz
D.C. current gain ratio of matched pairs BD845/BD846; BD847/BD848; BD849/BD850 $\|I_C\|$ = 150 mA; $\|V_{CE}\|$ = 5 V	h_{FE1}/h_{FE2}	<	2,0

DEVELOPMENT SAMPLE DATA

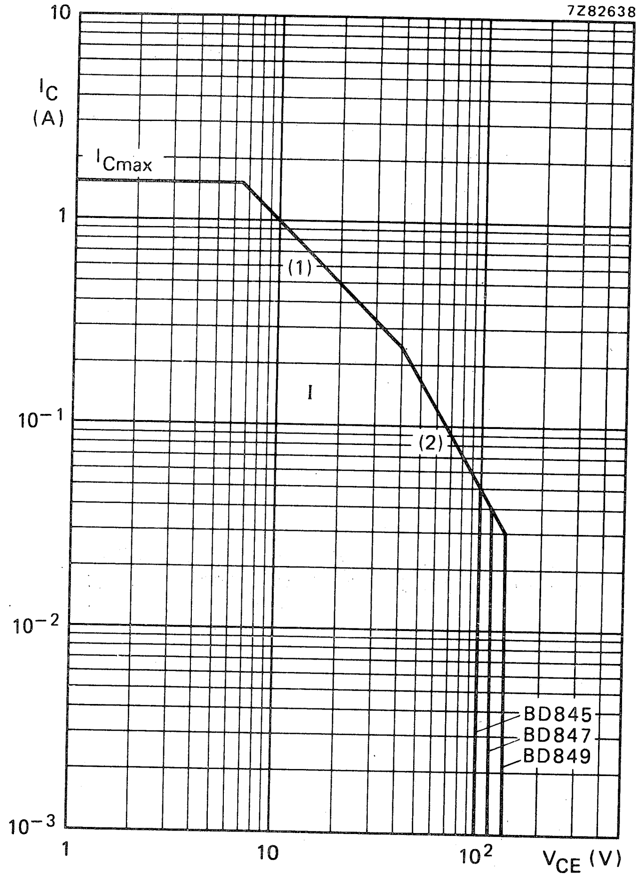


Fig. 2 D.C. SOAR; $T_{mb} \leq 25\ ^oC$.

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

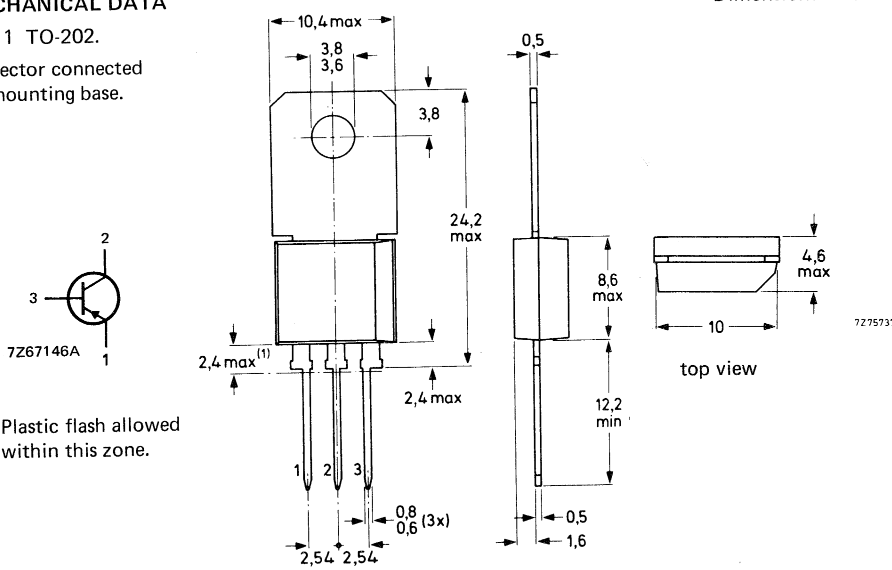
			BD846	BD848	BD850	
Collector-base voltage	$-V_{CBO}$	max.	100	120	140	V
Collector-emitter voltage	$-V_{CEO}$	max.	100	120	140	V
Emitter-base voltage	$-V_{EBO}$	max.	5	5	5	V
Collector current (peak value)	$-I_{CM}$	max.		3		A
Total power dissipation						
at T_{amb} = 25 °C (free air)	P_{tot}	max.		2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

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 °C (free air)	P_{tot}	max.		2		W
T_{mb} = 25 °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	$R_{th\ j\text{-}a}$	=	62,5	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	12,5	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current $I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	1 μA
Emitter cut-off current $I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	10 μA
D.C. current gain $-I_C = 10$ mA; $-V_{CE} = 5$ V	h_{FE}	>	40
$-I_C = 150$ mA; $-V_{CE} = 5$ V	h_{FE}		40 to 250
$-I_C = 500$ mA; $-V_{CE} = 5$ V	h_{FE}	>	30
Collector-emitter saturation voltage $-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	1,0 V
Base-emitter voltage $-I_C = 500$ mA; $-V_{CE} = 5$ V	$-V_{BE}$	<	1,3 V
Transition frequency at f = 35 MHz $-I_C = 100$ mA; $-V_{CE} = 5$ V	f_T	typ.	75 MHz
D.C. current gain ratio of matched pairs BD845/BD846; BD847/BD848; BD849/BD850 $\|I_C\| = 150$ mA; $\|V_{CE}\| = 5$ V	h_{FE1}/h_{FE2}	<	2

DEVELOPMENT SAMPLE DATA

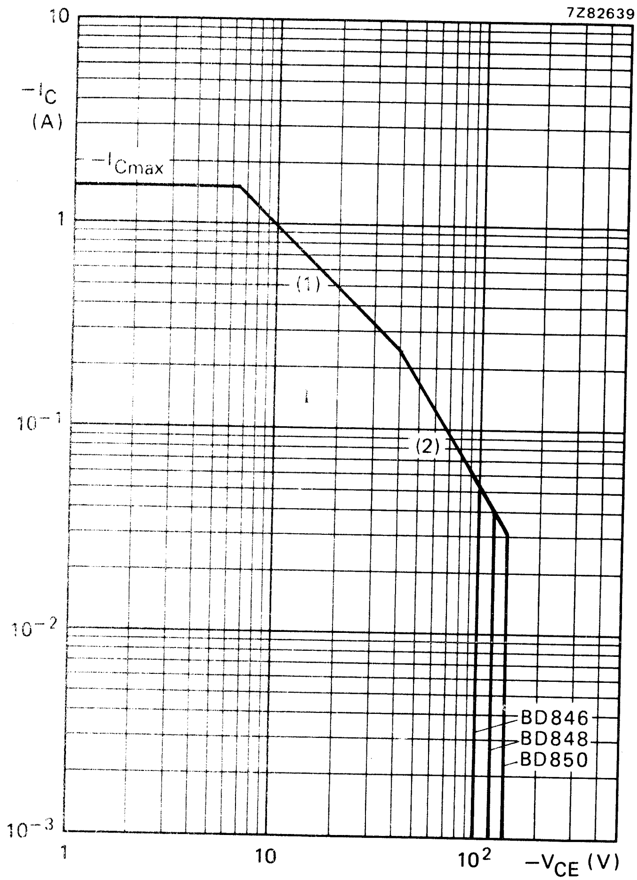


Fig. 2 D.C. SOAR; $T_{mb} \leqslant 25\ ^oC$.

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

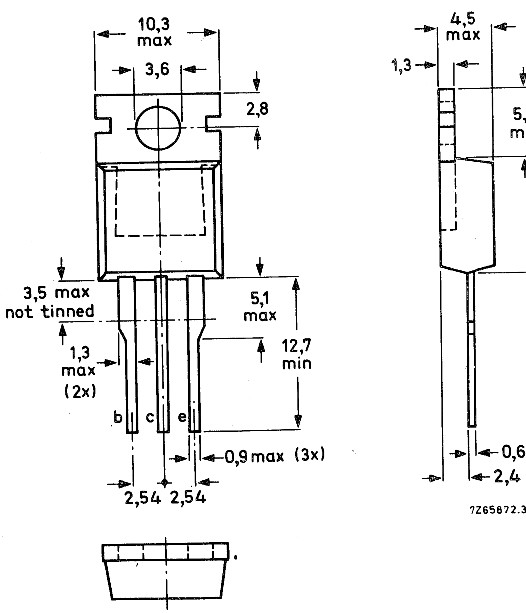
			BD933	935	937	939	941	
Collector-base voltage	V_{CBO}	max.	45	60	100	120	140	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	100	120	V
Collector current (d.c.)	I_C	max.			3			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.			30			W
Junction temperature	T_j	max.			150			°C
D.C. current gain								
I_C = 150 mA; V_{CE} = 2 V	h_{FE}				40 to 250			
I_C = 1 A; V_{CE} = 2 V	h_{FE}	>			25			
Transition frequency								
I_C = 250 mA; V_{CE} = 10 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)

			BD933	935	937	939	941	
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 °C	P_{tot}	max.	30					W
Storage temperature	T_{stg}		−65 to + 150					°C
Junction temperature	T_j	max.	150					°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	0,1	mA
$I_E = 0$; $V_{CB} = V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	3	mA
$I_E = 0$; $V_{CE} = V_{CEOmax}$	I_{CEO}	<	0,5	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	1	mA
D.C. current gain *				
I_C = 150 mA; V_{CE} = 2 V	h_{FE}		40 to 250	
I_C = 1 A; V_{CE} = 2 V	h_{FE}	>	25	
Base-emitter voltage **				
I_C = 1 A; V_{CE} = 2 V	V_{BE}	<	1,3	V
Collector-emitter saturation voltage *				
I_C = 1 A; I_B = 0,1 A	V_{CEsat}	<	0,6	V
Transition frequency at f = 1 MHz				
I_C = 250 mA; V_{CE} = 10 V	f_T	>	3	MHz
Switching times				
I_{Con} = 1 A; $I_{Bon} = -I_{Boff}$ = 0,1 A				
turn-on time	t_{on}	typ	0,4	μs
		<	1	μs
Turn-off time	t_{off}	typ.	1,5	μs
		<	3	μs
Second-breakdown collector current				
V_{CE} = 40 V; t_p = 0,1 s; non-repetitive	$I_{(SB)}$	>	0,75	A

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

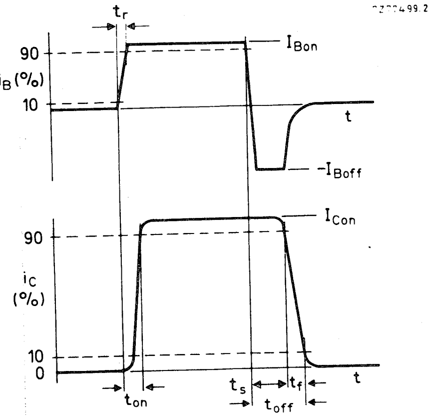
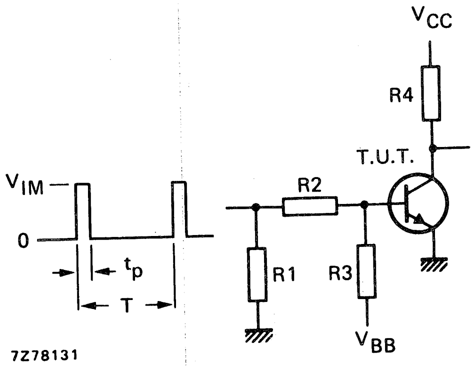


Fig. 2 Switching times waveforms.



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

Fig. 3 Switching times test circuit.

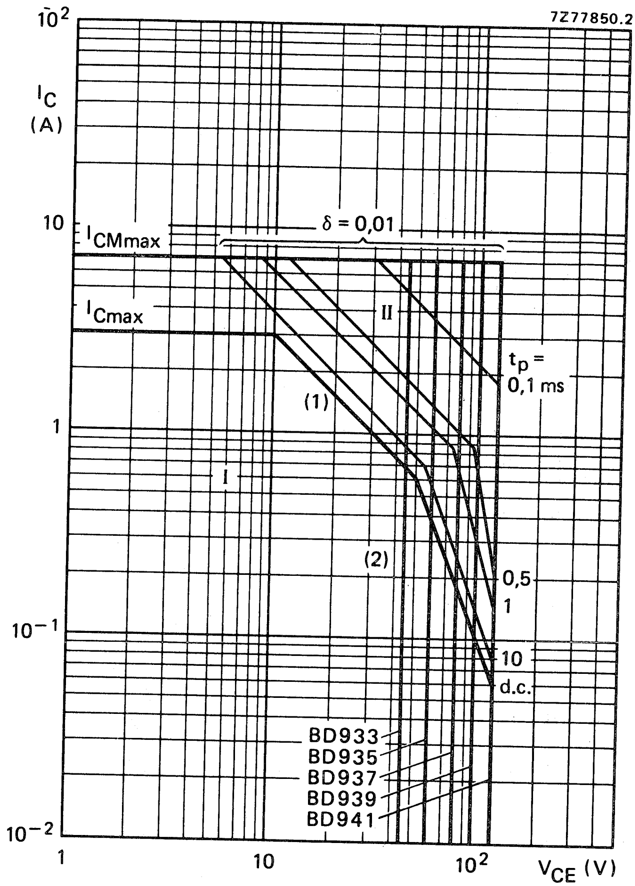


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

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.

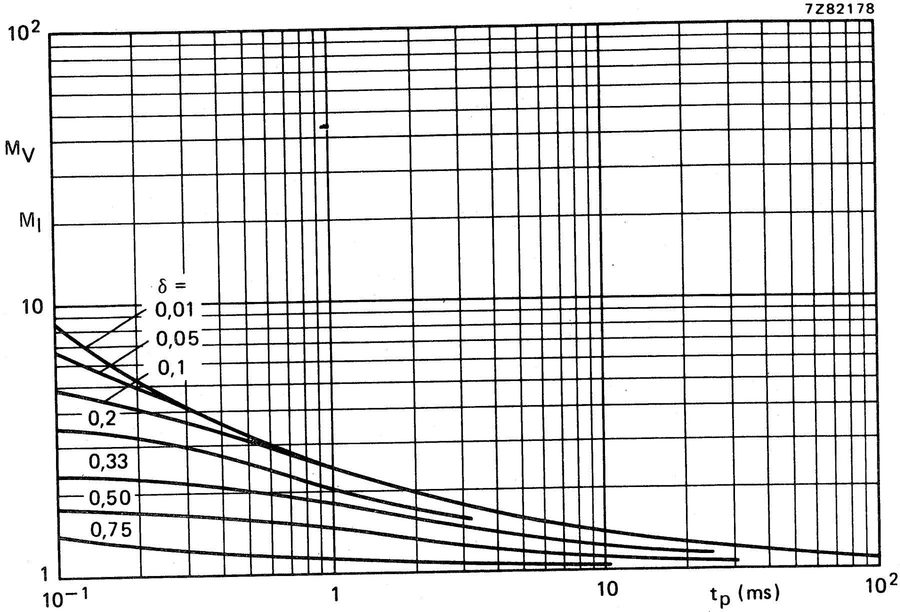


Fig. 5 Second-breakdown voltage multiplying factor at the I_{Cmax} level and second-breakdown current multiplying factor at the V_{CEOmax} level.

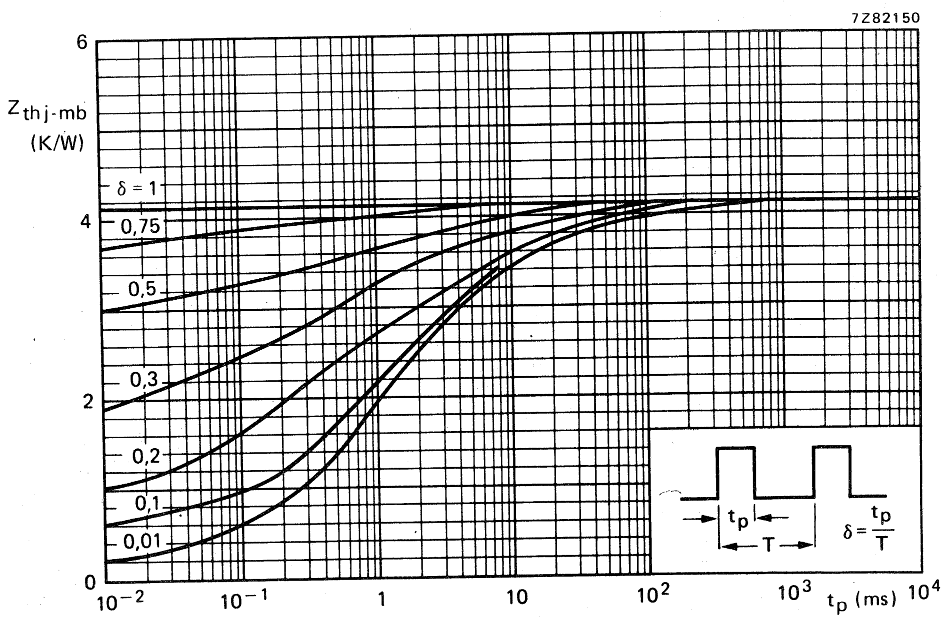


Fig. 6 Pulse power rating chart.

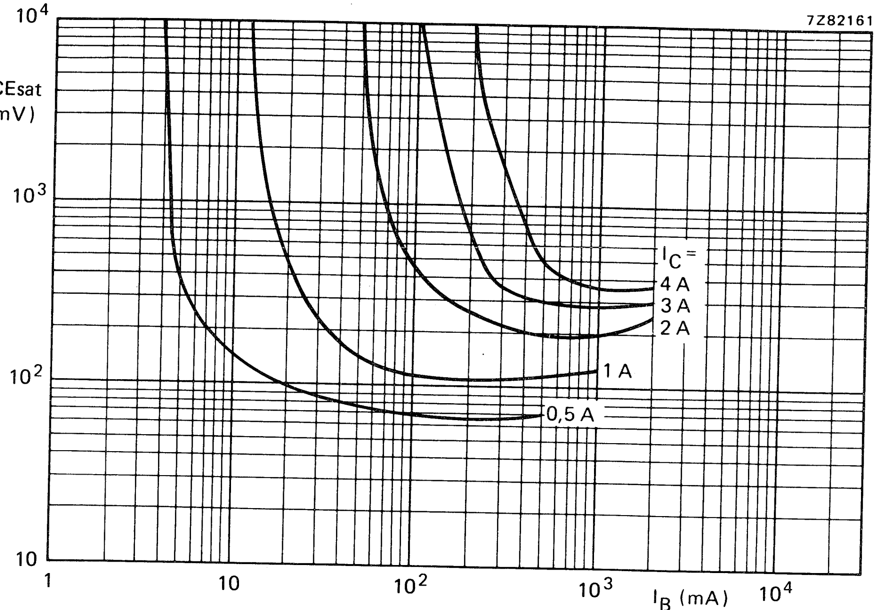


Fig. 7 Typical collector-emitter saturation voltage as a function of base current with collector current as a parameter.

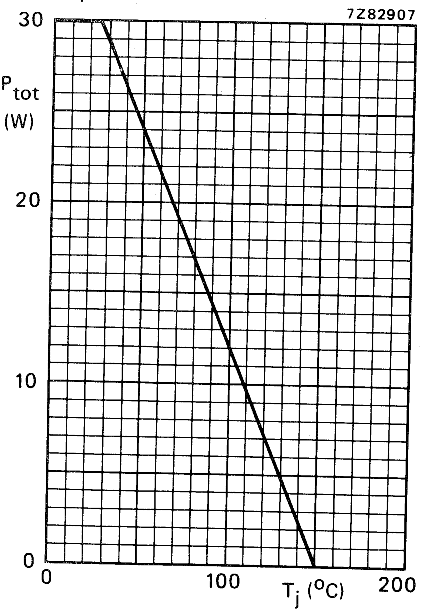


Fig. 8 Power derating curve.

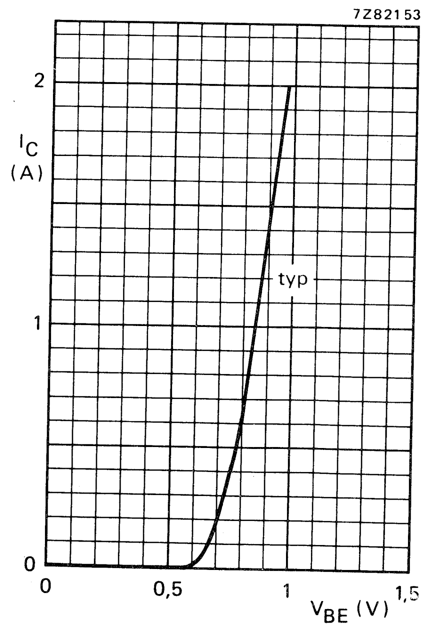


Fig. 9 $V_{CE} = 2$ V; $T_j = 25$ °C.

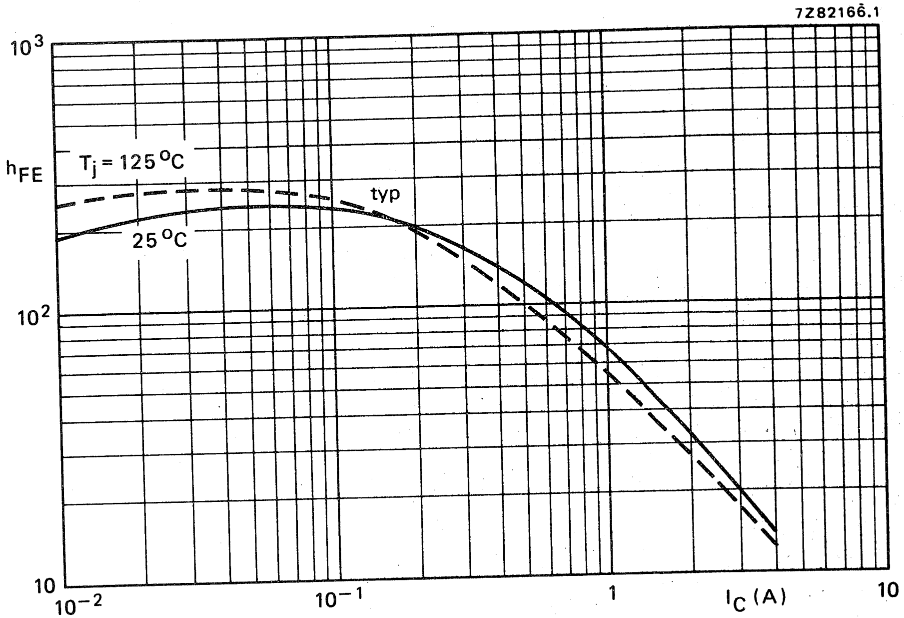


Fig. 10 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 2$ V.

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

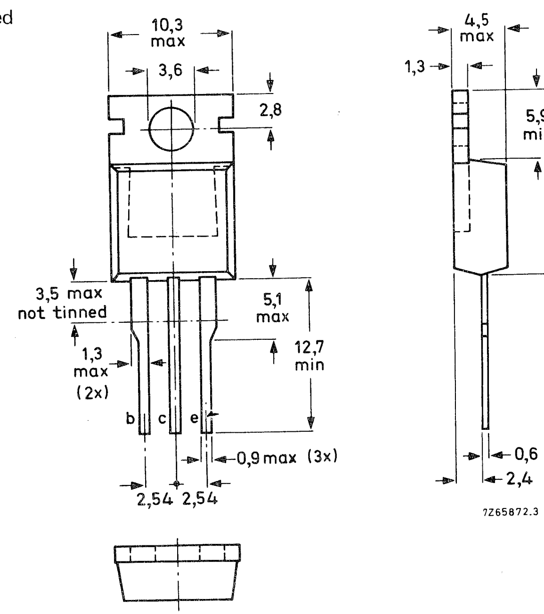
			BD934	936	938	940	942	
Collector-base voltage	$-V_{CBO}$	max.	45	60	100	120	140	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	100	120	V
Collector current (d.c.)	$-I_C$	max.			3			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.			30			W
Junction temperature	T_j	max.			150			°C
D.C. current gain								
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}				40 to 250			
$-I_C$ = 1 A; $-V_{CE}$ = 2 V	h_{FE}	>			25			
Transition frequency								
$-I_C$ = 250 mA; $-V_{CE}$ = 10 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)

			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 °C	P_{tot}	max.	30	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$-I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,1	mA
$-I_E = 0; -V_{CB} = -V_{CBOmax}; T_j = 150\ °C$	$-I_{CBO}$	<	3	mA
$I_B = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CEO}$	<	0,5	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 5\ V$	$-I_{EBO}$	<	1	mA
D.C. current gain (note 1)				
$-I_C = 150\ mA; -V_{CE} = 2\ V$	h_{FE}		40 to 250	
$-I_C = 1\ A; -V_{CE} = 2\ V$	h_{FE}	>	25	
Base-emitter voltage (notes 1 and 2)				
$-I_C = 1\ A; -V_{CE} = 2\ V$	$-V_{BE}$	<	1,3	V
Collector-emitter saturation voltage (note 1)				
$-I_C = 1\ A; -I_B = 0,1\ A$	$-V_{CEsat}$	<	0,6	V
Transition frequency at f = 1 MHz				
$-I_C = 250\ mA; -V_{CE} = 10\ V$	f_T	>	3	MHz
Switching times				
$-I_{Con} = 1\ A; -I_{Bon} = I_{Boff} = 0,1\ A$				
turn-on time	t_{on}	typ.	0,3	µs
turn-off time	t_{off}	typ.	0,7	µs

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

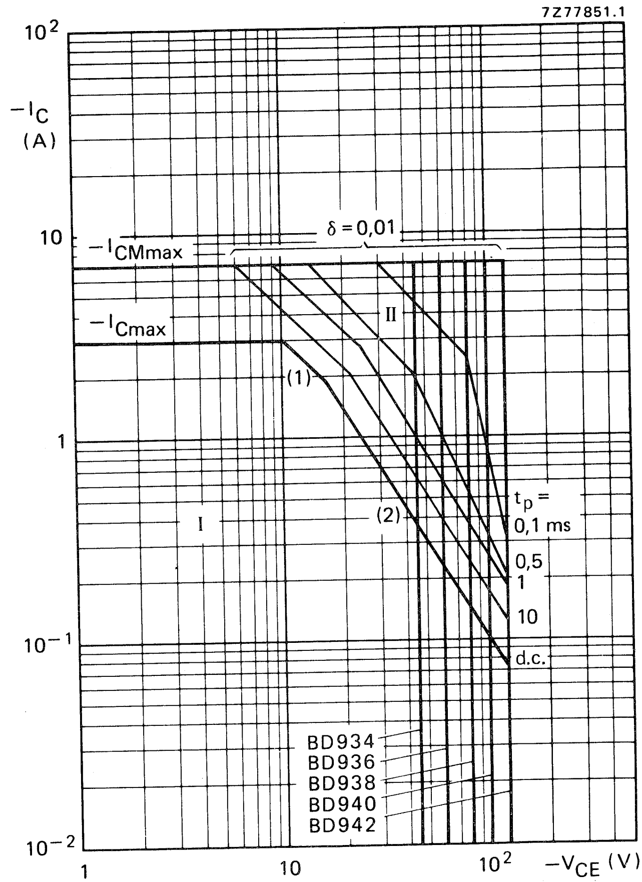


Fig. 2 Safe Operating ARea; T_{mb} = 25 °C.

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.

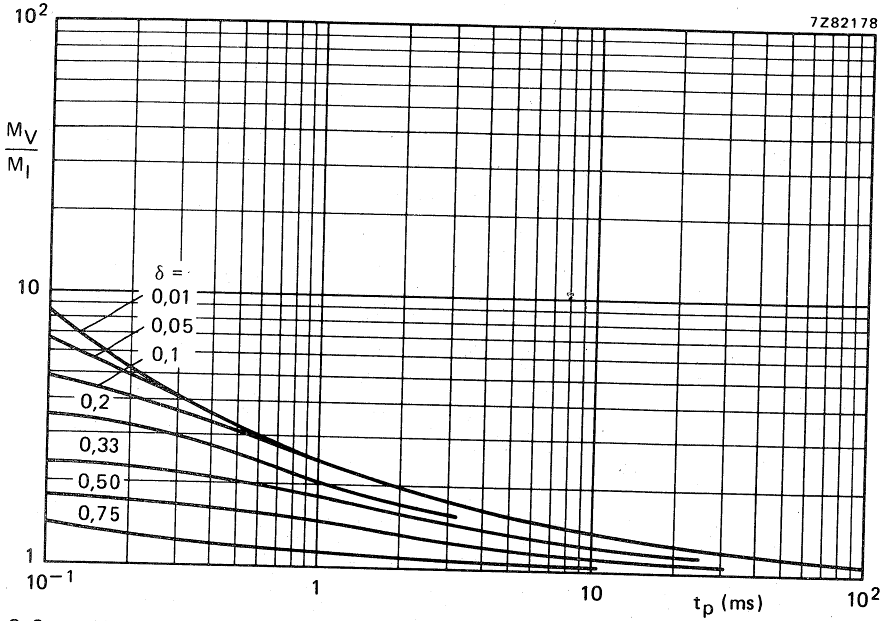


Fig. 3 Second breakdown voltage multiplying factor at the I_{Cmax} level and second breakdown current multiplying factor at the V_{CEOmax} level.

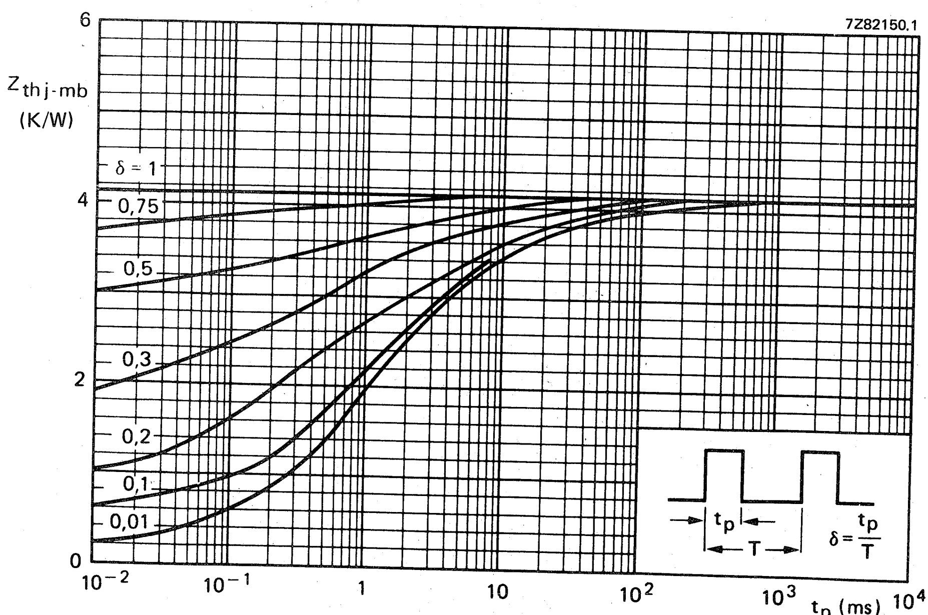


Fig. 4 Pulse power rating chart.

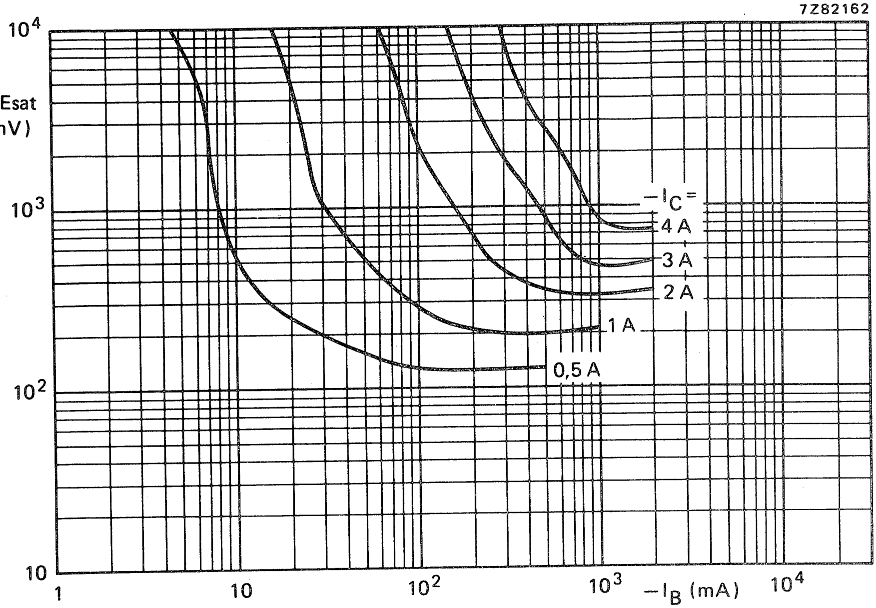


Fig. 5 Typical collector-emitter saturation voltage as a function of base current with collector current as a parameter.

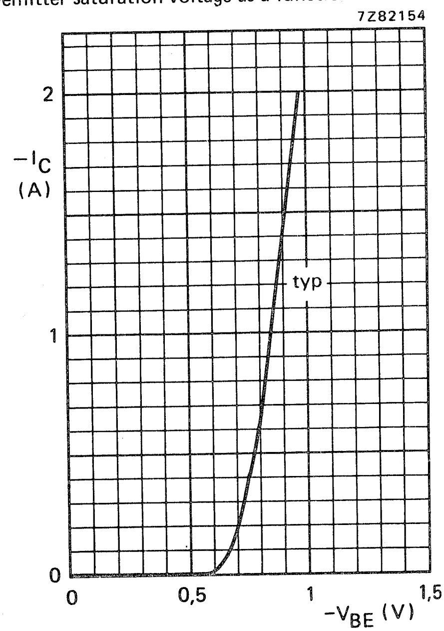


Fig. 6 Typical collector current as a function of base-emitter voltage. $-V_{CE}$ = 2 V; T_j = 25 °C.

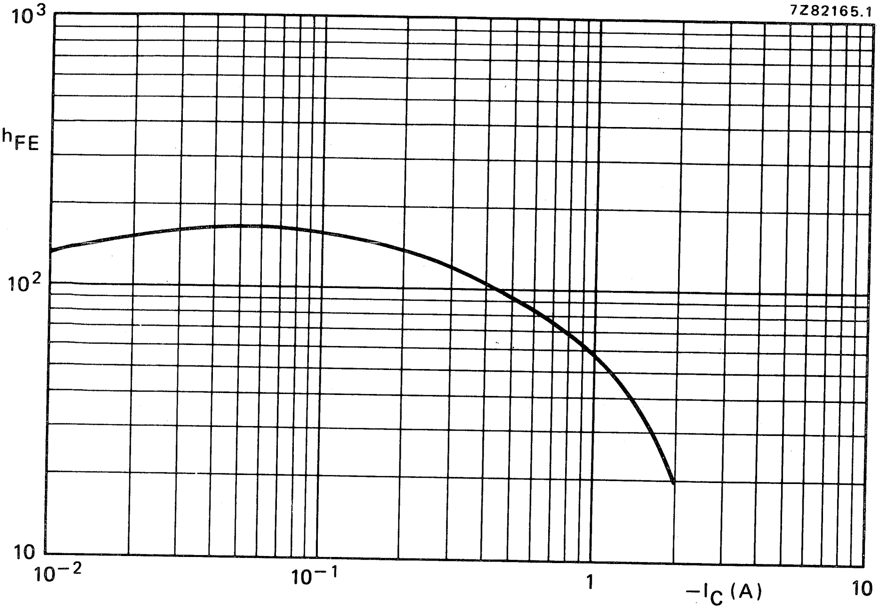


Fig. 7 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 2$ V; $T_j \leqslant 25$ °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in audio output stages and general purpose amplifier applications. P-N-P complements are BD944; 946 and 948.

QUICK REFERENCE DATA

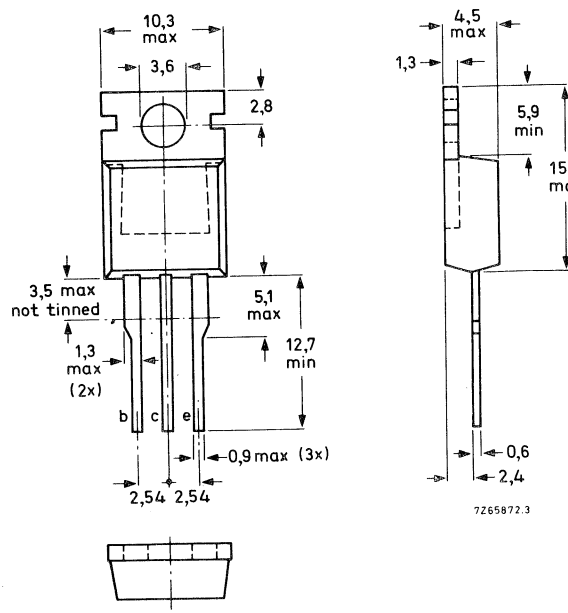
			BD943	945	947	
Collector-base voltage (open emitter)	V_{CBO}	max.	22	32	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	22	32	45	V
Collector current (d.c.)	I_C	max.		5		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	>		25		
I_C = 500 mA; V_{CE} = 1 V	h_{FE}			85 to 475		
I_C = 2 A; V_{CE} = 1 V	h_{FE}	>	50	50	40	
Transition frequency at f = 1 MHz						
I_C = 250 mA; V_{CE} = 1 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_{CBO}	max.	22	32	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	22	32	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5		V
Collector current (d.c.)	I_C	max.		5		A
Collector current (peak value)	I_{CM}	max.		8		A
Base current (d.c.)	I_B	max.		1		A
Total power dissipation up to T_{mb} = 25 °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	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD943	945	947	
Collector cut-off current						
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<		0,1		mA
$I_E = 0$; $V_{CB} = V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<		3		mA
$I_B = 0$; V_{CE} = 15 V; BD943 / 20 V; BD945 / 25 V; BD947	I_{CEO}	<		0,5		mA
Emitter cut-off current						
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<		1		mA
D.C. current gain (note 1)						
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	>		25		
I_C = 500 mA; V_{CE} = 1 V	h_{FE}			85 to 475		
I_C = 2 A; V_{CE} = 1 V	h_{FE}	>	50	50	40	
I_C = 3 A; V_{CE} = 1 V	h_{FE}	>	–	–	30	
Base-emitter voltage (notes 1 and 2)						
I_C = 2 A; V_{CE} = 1 V	V_{BE}	<	1,1	1,1	–	V
I_C = 3 A; V_{CE} = 1 V	V_{BE}	<	–	–	1,3	V
Collector-emitter saturation voltage (note 1)						
I_C = 2 A; I_B = 0,2 A	V_{CEsat}	<	0,5	0,5	–	V
I_C = 3 A; I_B = 0,3 A	V_{CEsat}	<	–	–	0,7	V

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

Knee voltage*			
I_C = 2 A; I_B value for which I_C = 2,2 A and V_{CE} = 1 V	V_{CEK}	<	0,8 V
Transition frequency at f = 1 MHz I_C = 250 mA; V_{CE} = 1 V	f_T	>	3 MHz

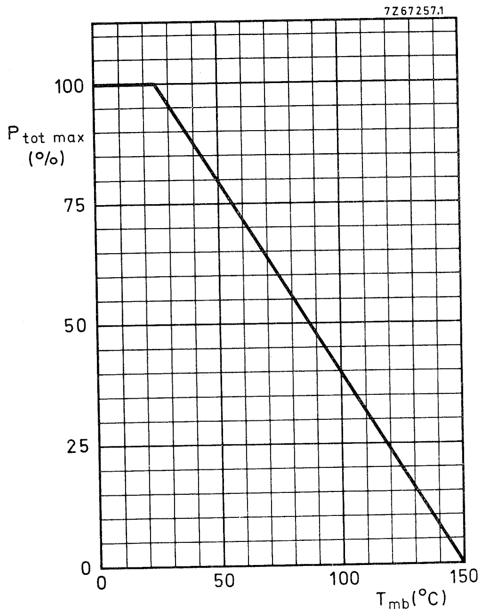


Fig. 2 Power derating curve.

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

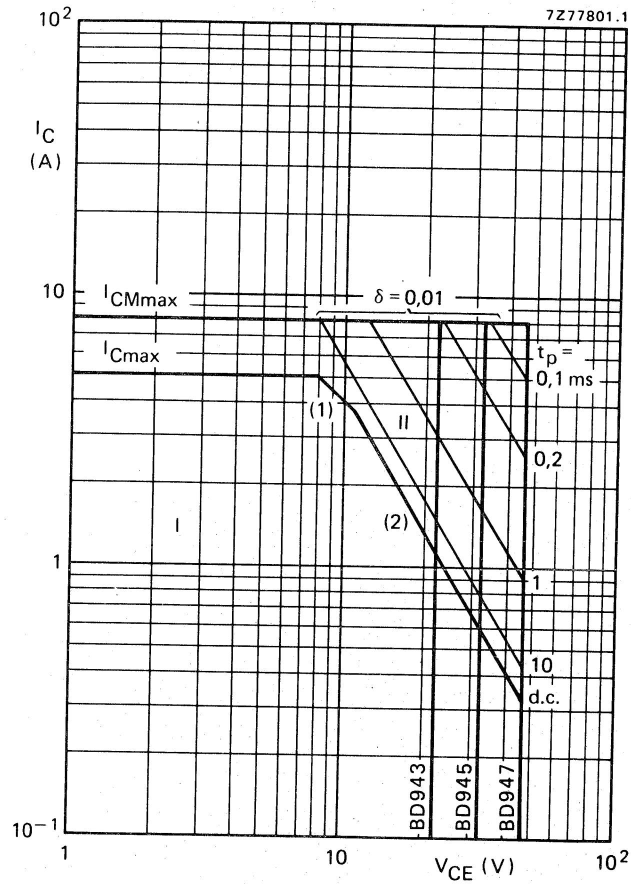


Fig. 3 Safe Operating ARea, $T_{mb} = 25\ ^oC$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

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

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

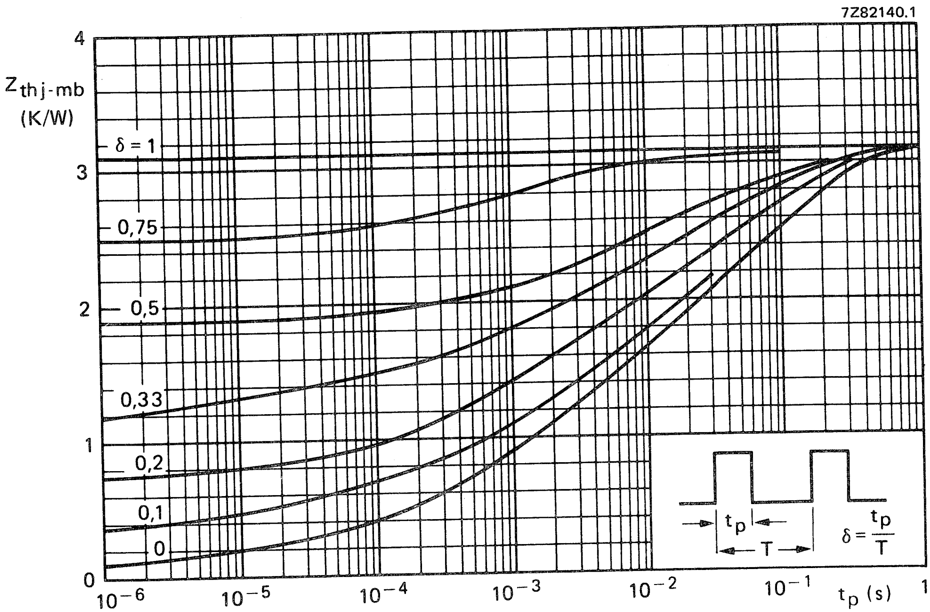


Fig. 4 Pulse power rating chart.

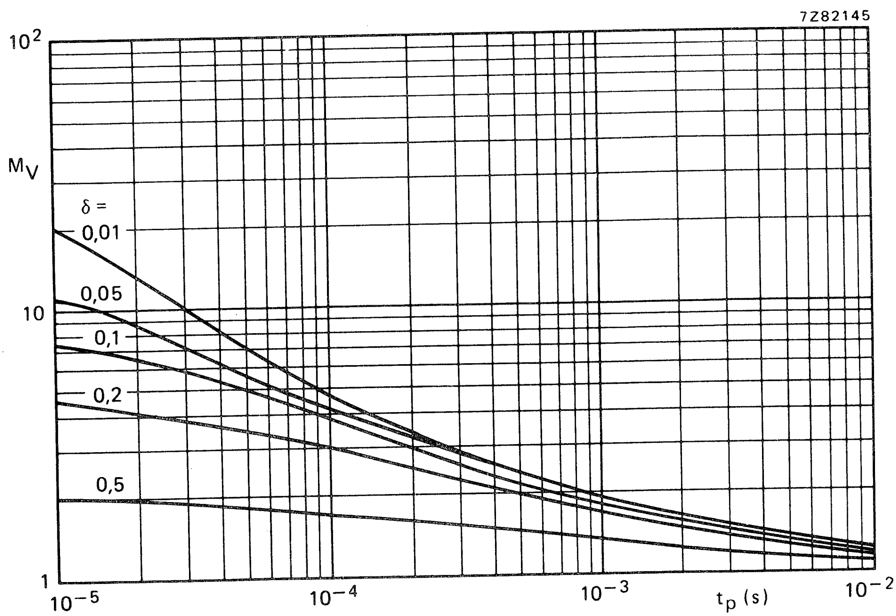


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

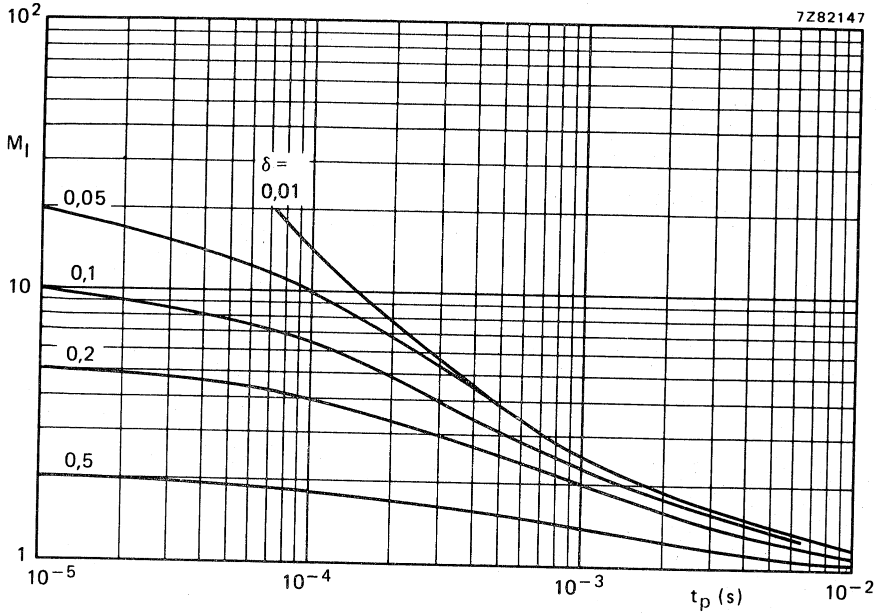


Fig. 6 S.B. current multiplying factor at the V_{CEOmax} level for BD943 and BD945.

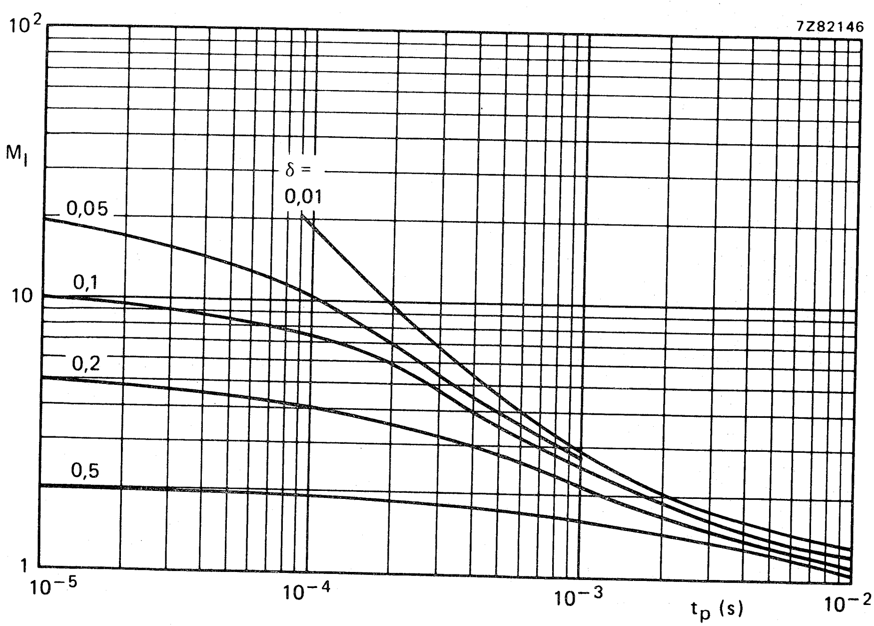


Fig. 7 S.B. current multiplying factor at the V_{CEOmax} level for BD947.

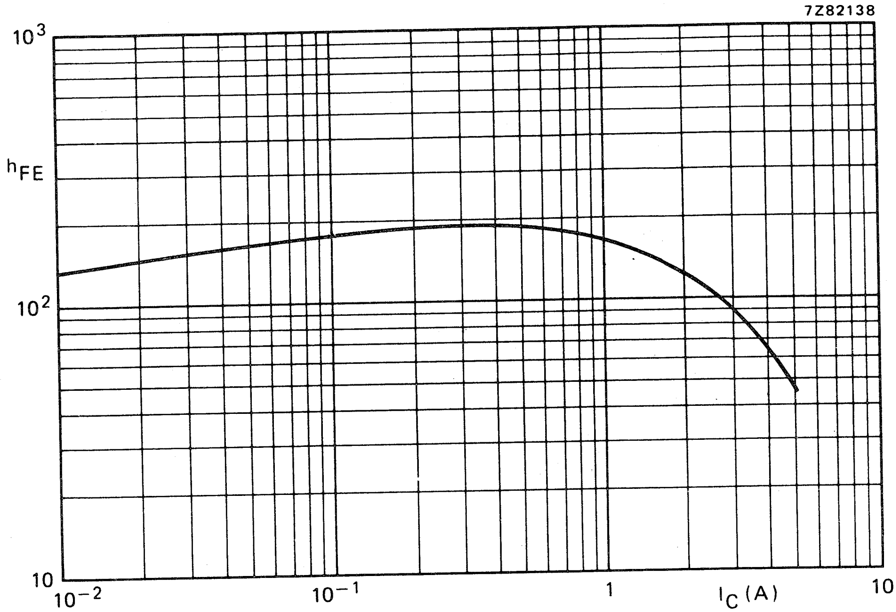


Fig. 8 Typical d.c. current gain at V_{CE} = 1 V; T_j = 25 °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P silicon transistors in a plastic envelope intended for use in audio output stages and general purpose amplifiers. N-P-N complements are BD943; 945 and 947.

QUICK REFERENCE DATA

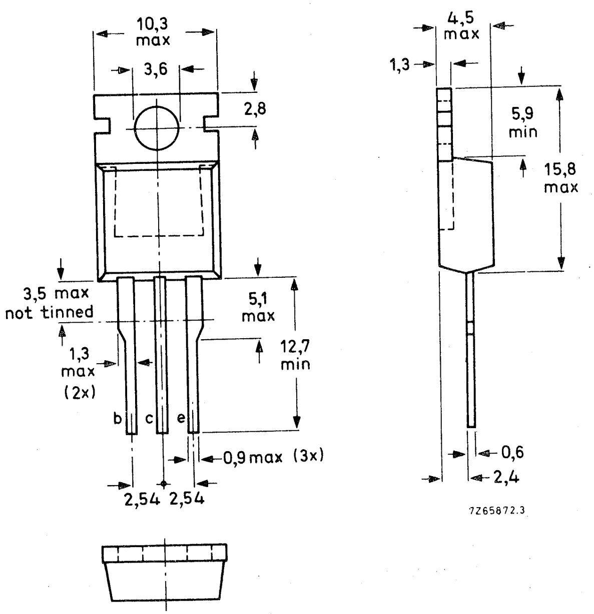
			BD944	946	948	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	22	32	45	V
Collector current (d.c.)	$-I_C$	max.		5		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	h_{FE}	>		25		
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}			85 to 475		
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	h_{FE}	>	50	50	40	
Transition frequency at f = 1 MHz						
$-I_C$ = 250 mA; $-V_{CE}$ = 1 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)

			BD944	946	948	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	22	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	22	32	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5		V
Collector current (d.c.)	$-I_C$	max.		5		A
Collector current (peak value)	$-I_{CM}$	max.		8		A
Base current (d.c.)	$-I_B$	max.		1		A
Total power dissipation up to T_{mb} = 25 °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	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BD944	946	948	
Collector cut-off current						
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<		0,1		mA
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$; T_j = 150 °C	$-I_{CBO}$	<		3		mA
$I_B = 0$; $-V_{CE}$ = 15 V; BD944 $-V_{CE}$ = 20 V; BD946 $-V_{CE}$ = 25 V; BD948	$-I_{CEO}$	<		0,5		mA
Emitter cut-off current						
$-I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<		1		mA
D.C. current gain (note 1)						
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	h_{FE}	>		25		
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}			85 to 475		
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	h_{FE}	>	50	50	40	
$-I_C$ = 3 A; $-V_{CE}$ = 1 V	h_{FE}	>	–	–	30	
Base-emitter voltage (notes 1 and 2)						
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	$-V_{BE}$	<	1,1	1,1	–	V
$-I_C$ = 3 A; $-V_{CE}$ = 1 V	$-V_{BE}$	<	–	–	1,3	V
Collector-emitter saturation voltage (note 1)						
$-I_C$ = 2 A; $-I_B$ = 0,2 A	$-V_{CEsat}$	<	0,5	0,5	–	V
$-I_C$ = 3 A; $-I_B$ = 0,3 V	$-V_{CEsat}$	<	–	–	0,7	V

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

Knee voltage * $-I_C = 2$ A; $-I_B$ = value for which $-I_C = 2{,}2$ A and $-V_{CE} = 1$ V	$-V_{CEK}$	<	0,8 V
Transition frequency at f = 1 MHz $-I_C = 250$ mA; $-V_{CE} = 1$ V	f_T	>	3 MHz

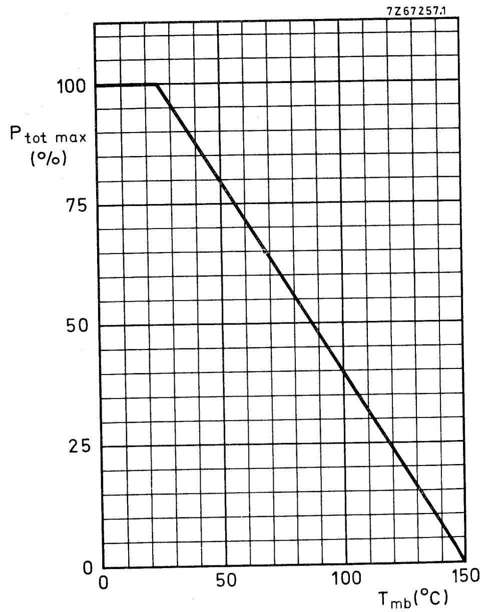


Fig. 2 Power derating curve.

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

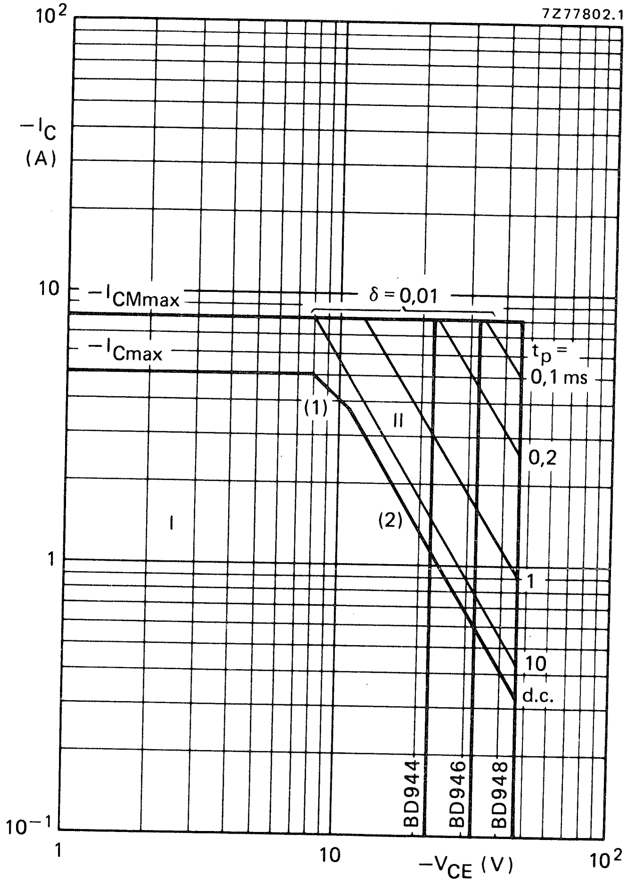


Fig. 3 Safe Operating ARea, $T_{mb} = 25\ ^oC$.

I Region of permissible d.c operation.

II Permissible extension for repetitive pulse operation.

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

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

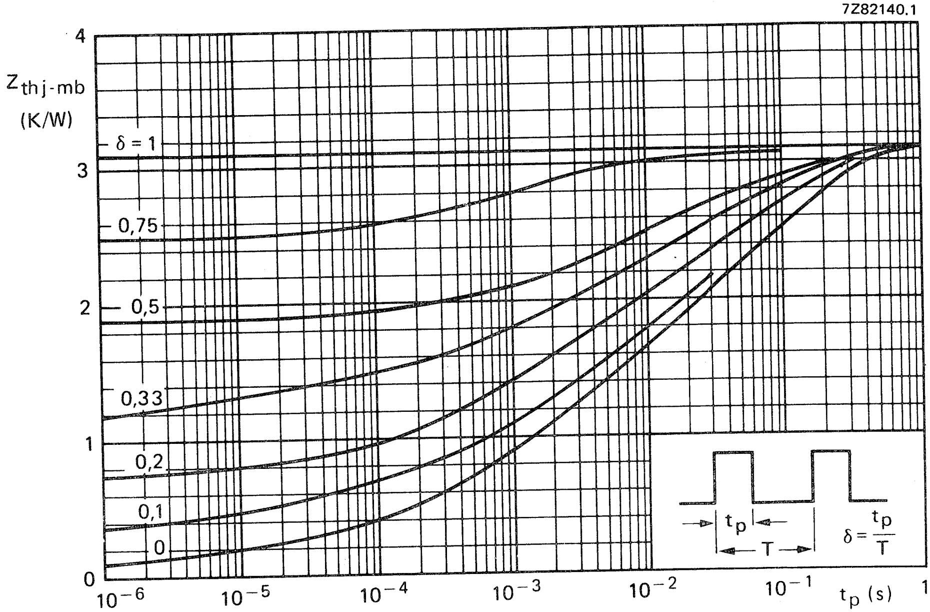


Fig. 4 Pulse power rating chart.

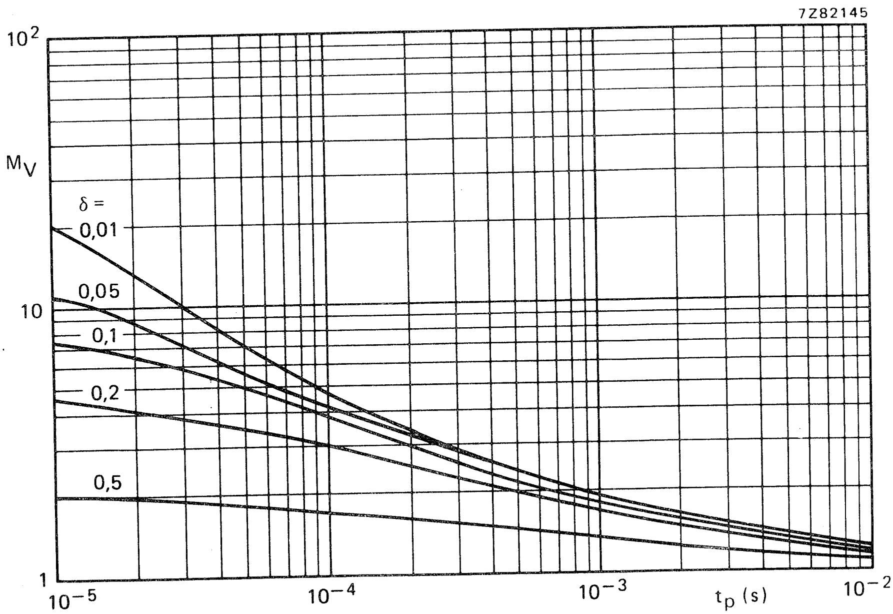


Fig. 5 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

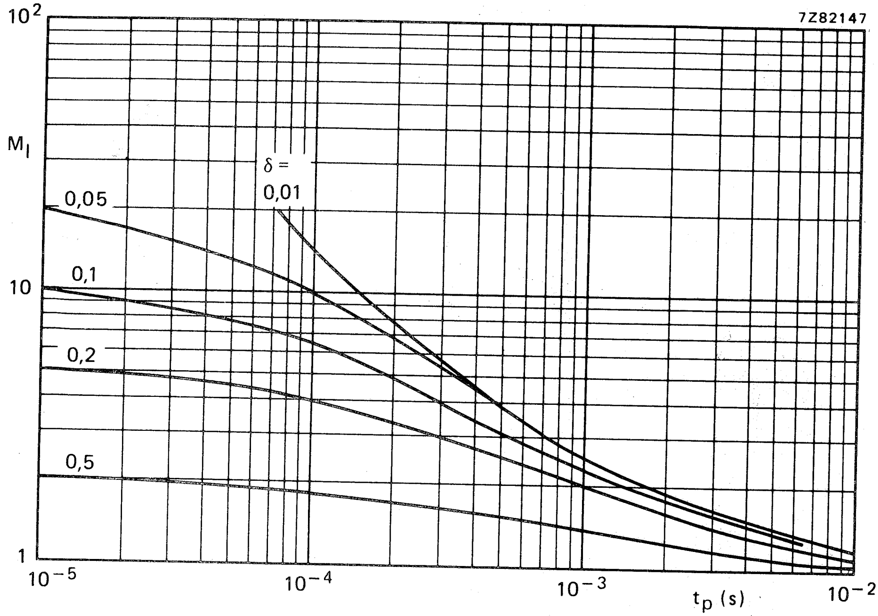


Fig. 6 S.B. current multiplying factor at the $-V_{CEOmax}$ level for BD944/946.

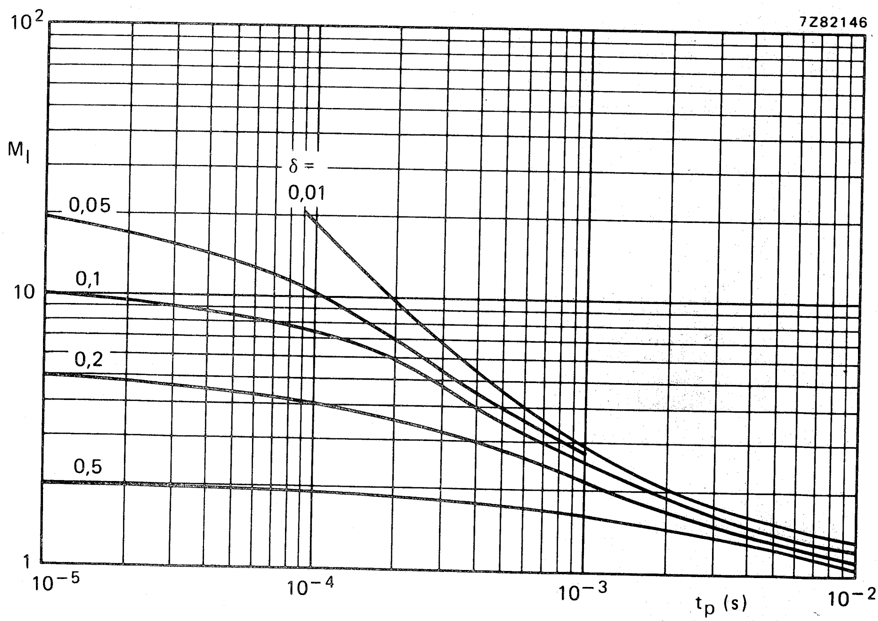


Fig. 7 S.B. current multiplying factor at the $-V_{CEOmax}$ level for BD948.

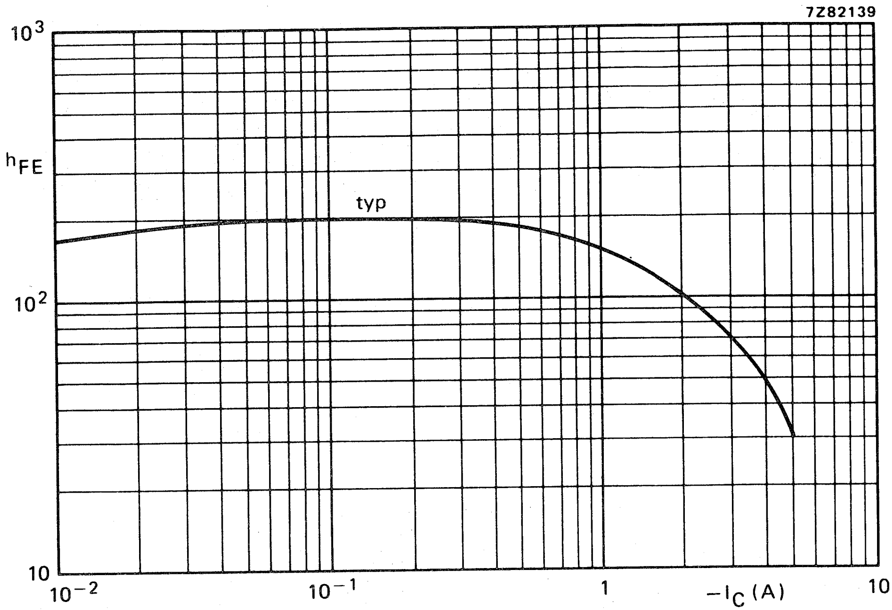


Fig. 8 Typical d.c. current gain at $-V_{CE}$ = 1 V; T_j = 25 °C.

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

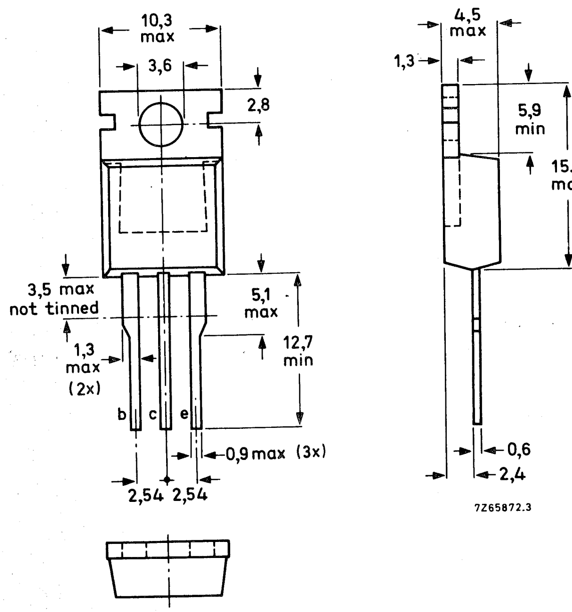
			BD949	BD951	BD953	BD955	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (d.c.)	I_C	max.		5			A
Collector current (peak value)	I_{CM}	max.		8			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40			W
Junction temperature	T_j	max.		150			°C
D.C. current gain							
I_C = 0,5 A; V_{CE} = 4 V	h_{FE}	>		40			
I_C = 2 A; V_{CE} = 4 V	h_{FE}	>		20			

MECHANICAL DATA

Fig. 1 TO-220AB.

Dimensions in mm

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

RATINGS

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

			BD949	951	953	955	
Collector-base voltage (open emitter)	V_{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 °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	$R_{th\ j\text{-}mb}$	=	3,12	K/W
from junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBO\,max}$	I_{CBO}	<	0,1	mA
$I_E = 0$; $V_{CB} = ½\,V_{CBO\,max}$; T_j = 150 °C	I_{CBO}	<	2	mA
$I_B = 0$; $V_{CE} = ½\,V_{CEO\,max}$	I_{CEO}	<	0,5	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	1	mA
D.C. current gain (note 1)				
I_C = 0,5 A; V_{CE} = 4 V	h_{FE}	>	40	
I_C = 2 A; V_{CE} = 4 V	h_{FE}	>	20	
Base-emitter voltage (notes 1 and 2)				
I_C = 2 A; V_{CE} = 4 V	V_{BE}	<	1,4	V
Collector-emitter saturation voltage (note 1)				
I_C = 2 A; I_B = 0,2 A	V_{CEsat}	<	1	V
Transition frequency at f = 1 MHz				
I_C = 0,5 A; V_{CE} = 4 V	f_T	>	3	MHz

(1) Measured under pulse conditions: $t_p \leqslant 300\ \mu s$, $\delta < 2\%$.
(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 A; I_{Bon} = $-I_{Boff}$ = 0,1 A

Turn-on time	t_{on}	typ.	0,3 µs
Turn-off time	t_{off}	typ.	1,5 µs

7Z77499.A

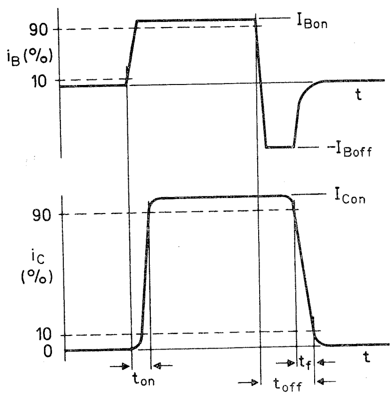
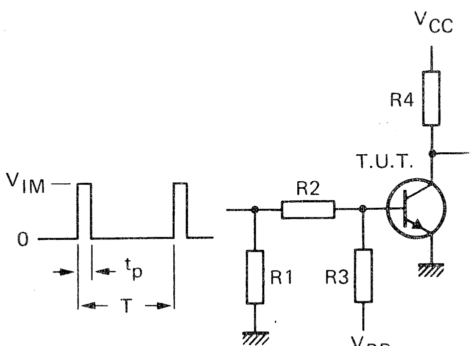


Fig. 2 Switching times waveforms.



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
$t_r = t_f$ ⩽ 15 ns
t_p = 10 µs
T = 500 µs

7Z78131

Fig. 3 Switching times test circuit.

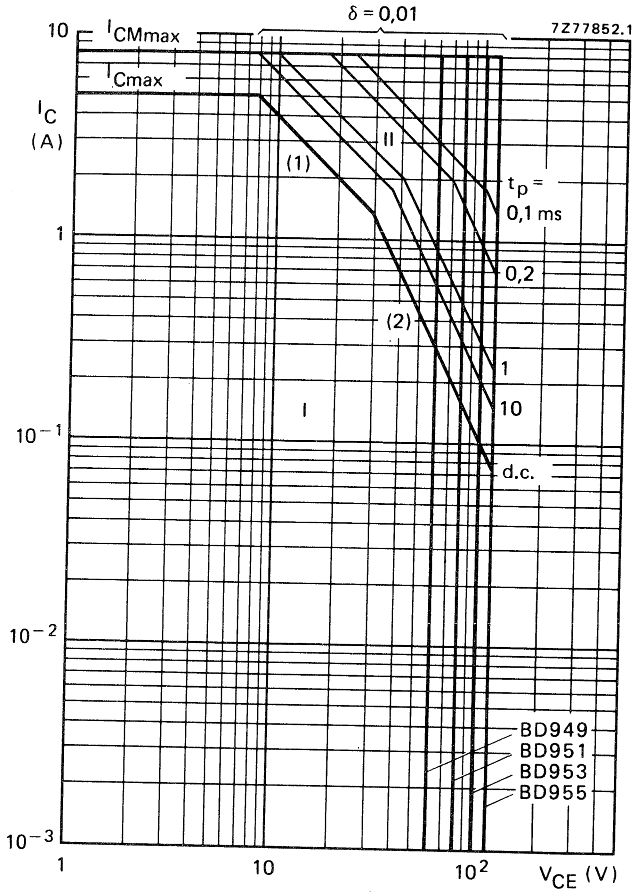


Fig. 4 Safe Operating ARea; $T_{mb} \leqslant 25$ °C.

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).

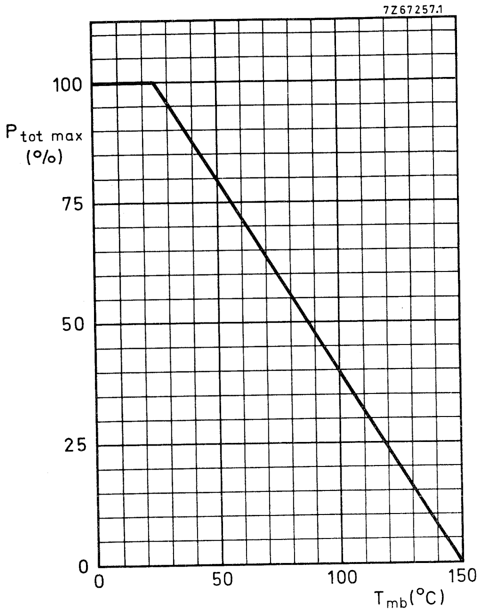


Fig. 5 Power derating curve.

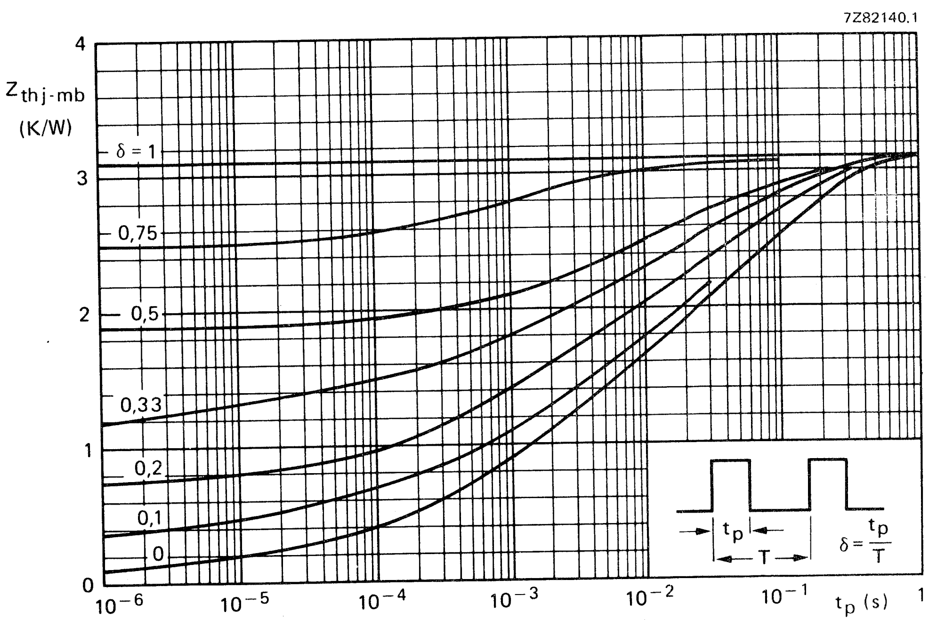


Fig. 6 Pulse power rating chart.

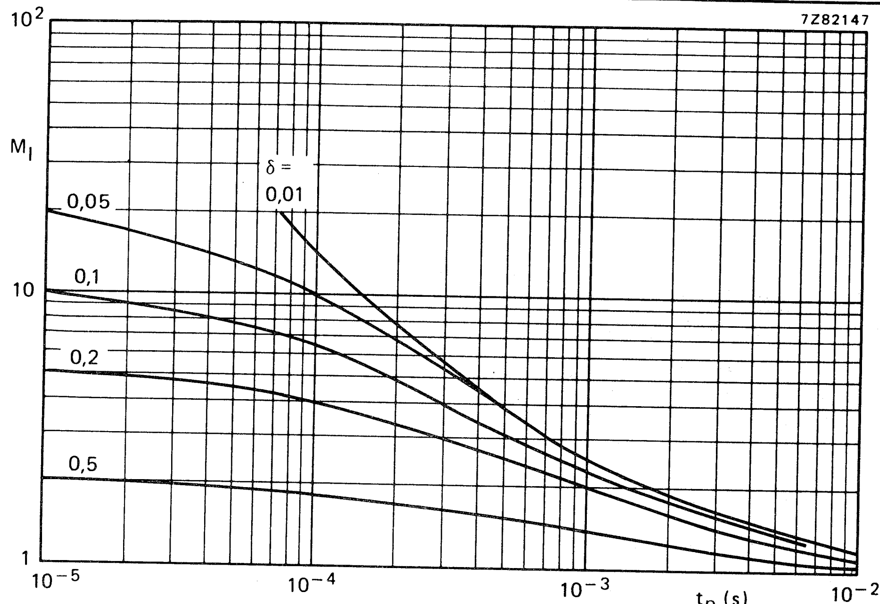


Fig. 7 S.B. current multiplying factor at the $V_{CEO\,max}$ level for BD949/951.

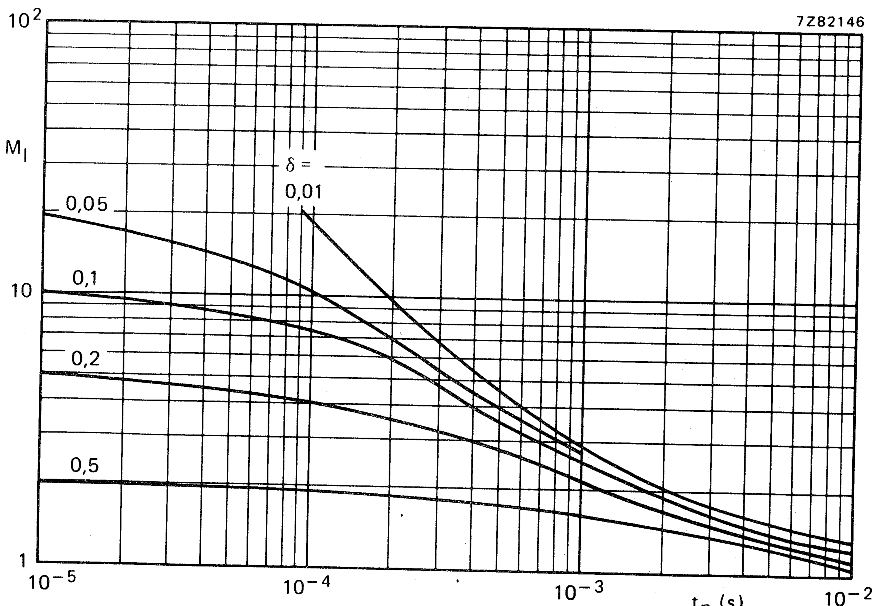


Fig. 8 S.B. current multiplying factor at the $V_{CEO\,max}$ level for BD953/955.

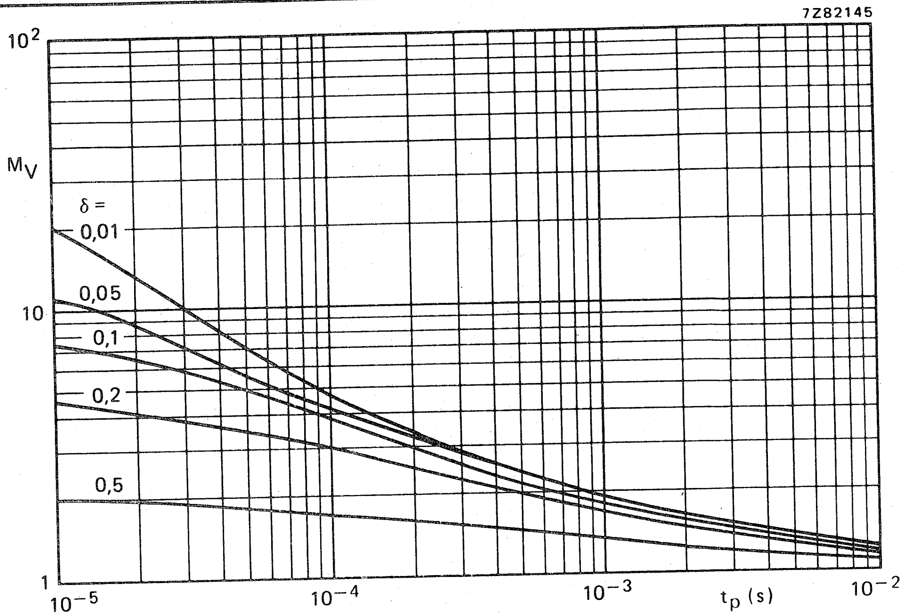


Fig. 9 S.B. voltage multiplying factor at the $I_{C\,max}$ level.

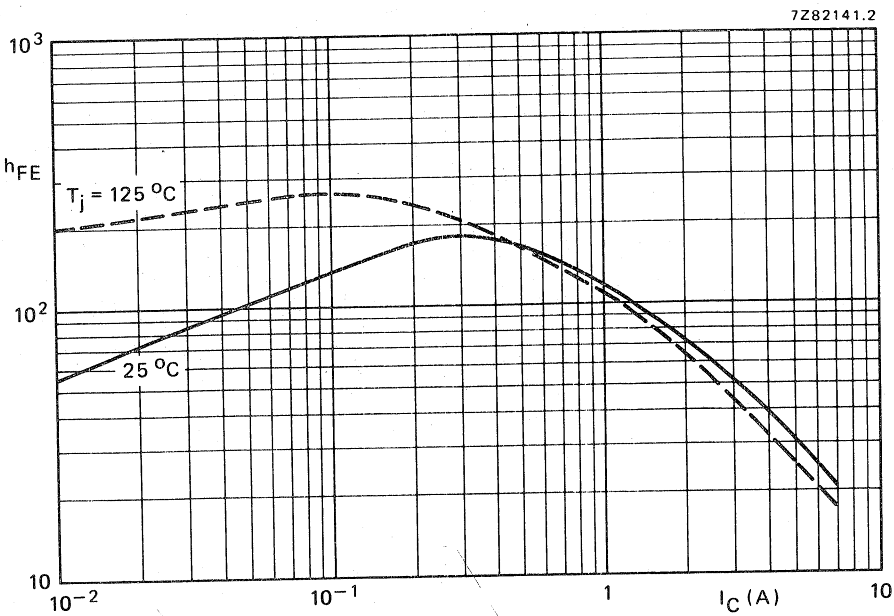


Fig. 10 Typical d.c. current gain at V_{CE} = 4 V.

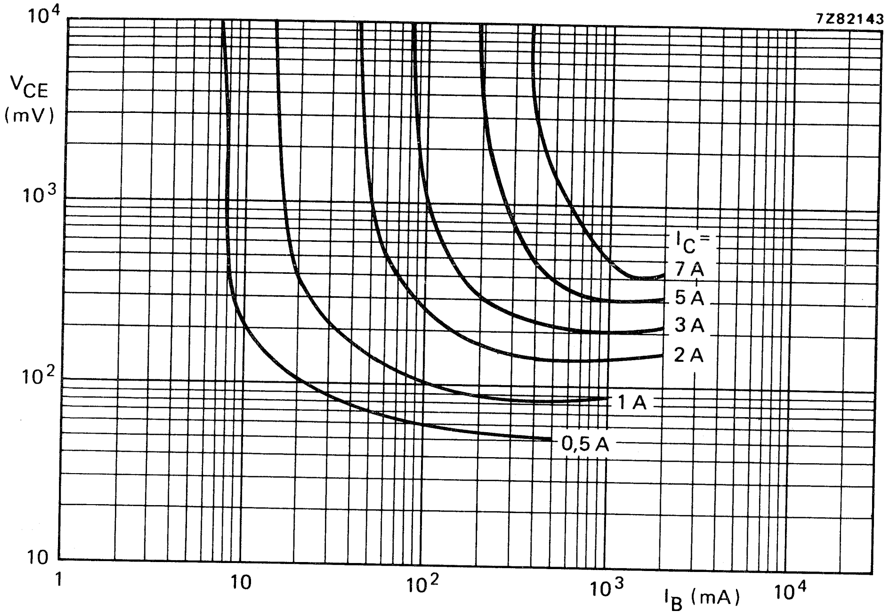


Fig. 11 Collector-emitter voltage as a function of base current.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P transistors in a plastic TO-220 envelope. With their n-p-n complements BD949; 951; 953 and 955 they are intended for use in a wide range of power amplifiers and for switching applications.

QUICK REFERENCE DATA

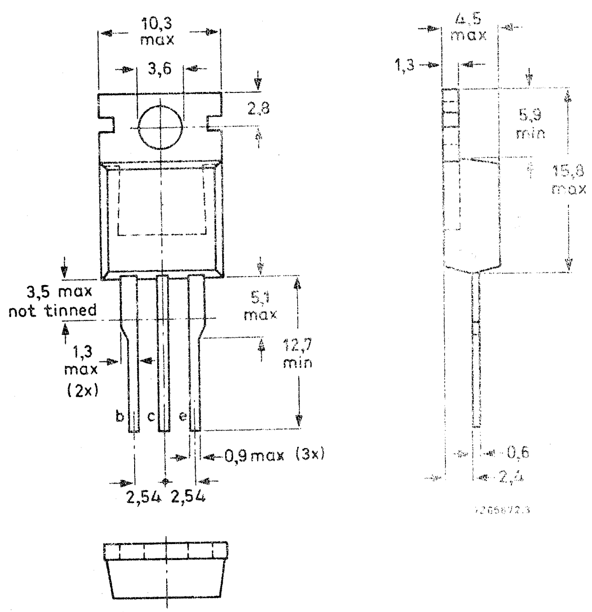
			BD950	952	954	956	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (d.c.)	$-I_C$	max.		5			A
Collector current (peak value)	$-I_{CM}$	max.		8			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40			W
Junction temperature	T_j	max.		150			°C
D.C. current gain							
$-I_C$ = 0,5 A; $-V_{CE}$ = 4 V	h_{FE}	>		40			
$-I_C$ = 2 A; $-V_{CE}$ = 4 V	h_{FE}	>		20			

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)

			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 °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	$R_{th\ j\text{-}mb}$	=	3,12	K/W
from junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = -V_{CBO\,max}$	$-I_{CBO}$	<	0,1	mA
$I_E = 0$; $-V_{CB} = -½\,V_{CBO\,max}$; T_j = 150 °C	$-I_{CBO}$	<	2	mA
$I_B = 0$; $-V_{CE} = -½\,V_{CEO\,max}$	$-I_{CEO}$	<	0,5	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	1	mA
D.C. current gain (note 1)				
$-I_C$ = 0,5 A; $-V_{CE}$ = 4 V	h_{FE}	>	40	
$-I_C$ = 2 A; $-V_{CE}$ = 4 V	h_{FE}	>	20	
Base-emitter voltage (notes 1 and 2)				
$-I_C$ = 2 A; $-V_{CE}$ = 4 V	$-V_{BE}$	<	1,4	V
Collector-emitter saturation voltage (note 1)				
$-I_C$ = 2 A; $-I_B$ = 0,2 A	$-V_{CEsat}$	<	1	V
Transition frequency at f = 1 MHz				
$-I_C$ = 0,5 A; $-V_{CE}$ = 4 V	f_T	>	3	MHz

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

CHARACTERISTICS (continued)

Switching times
(between 10% and 90% levels)
$I_{Con} = 1$ A; $-I_{Bon} = I_{Boff} = 0{,}1$ A

Turn-on time	t_{on}	typ.	0,1 µs
Turn-off time	t_{off}	typ.	0,4 µs

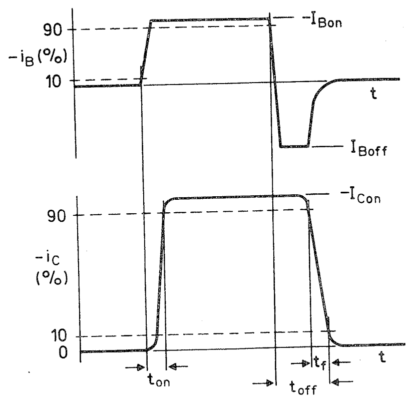
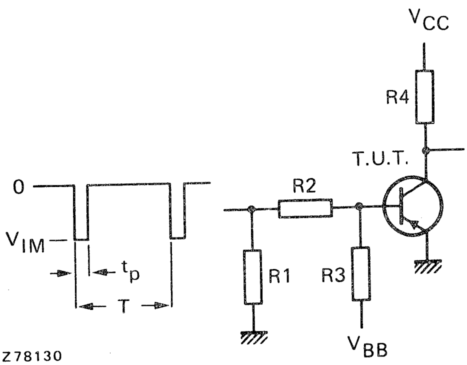


Fig. 2 Switching times waveforms.



$-V_{IM}$ = 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.

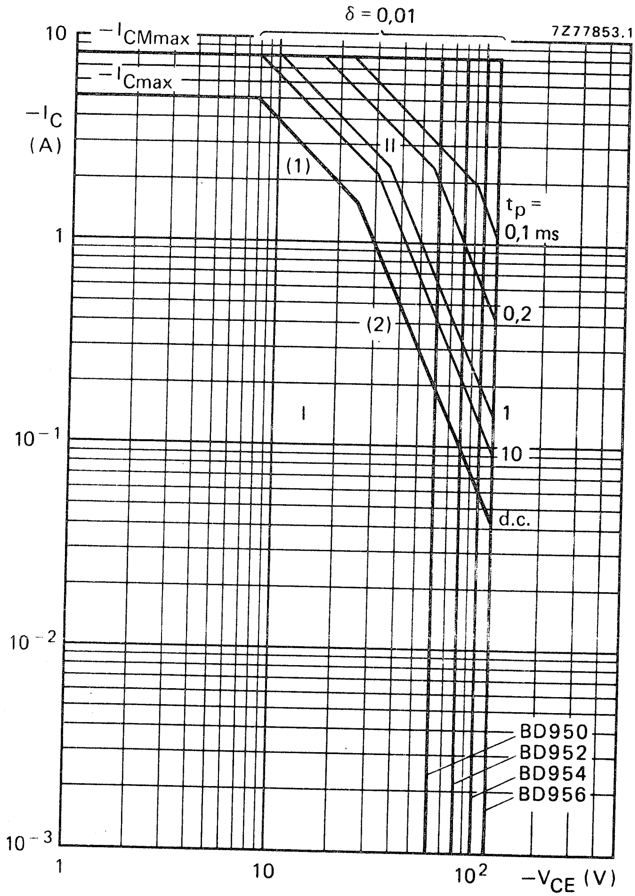


Fig. 4 Safe Operating ARea; $T_{mb} \leqslant 25\ ^oC$.

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).

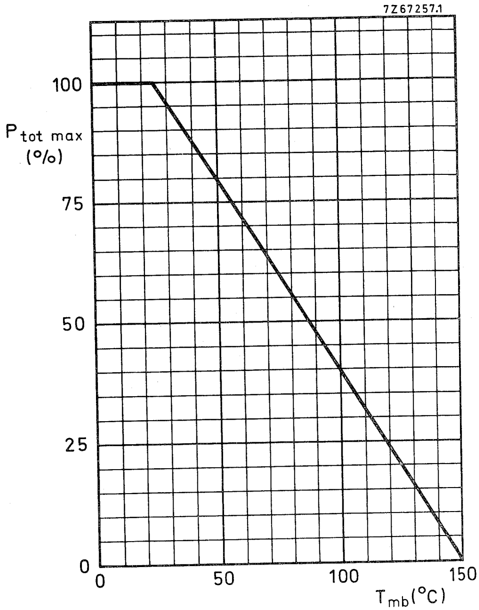


Fig. 5 Power derating curve.

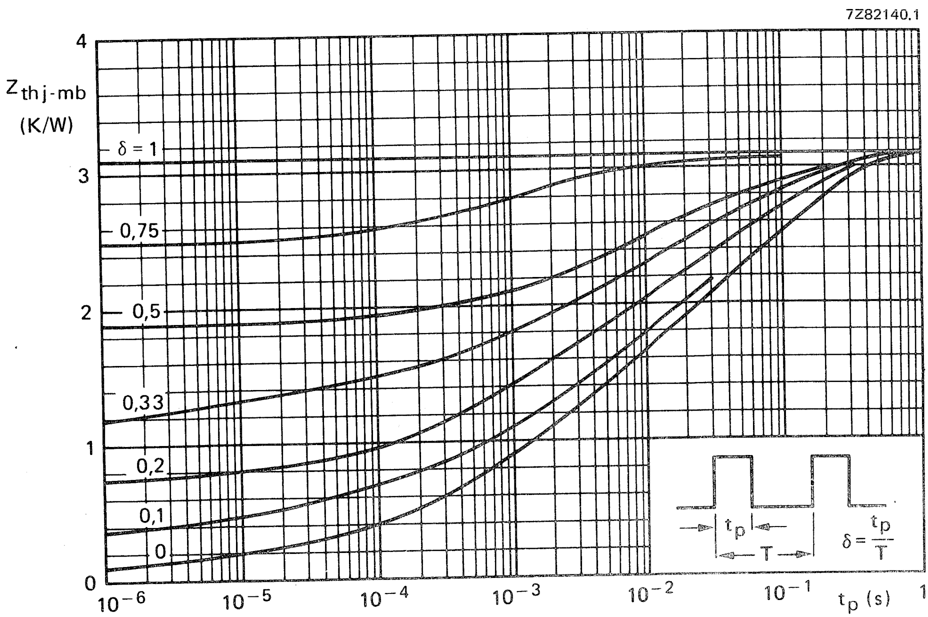


Fig. 6 Pulse power rating chart.

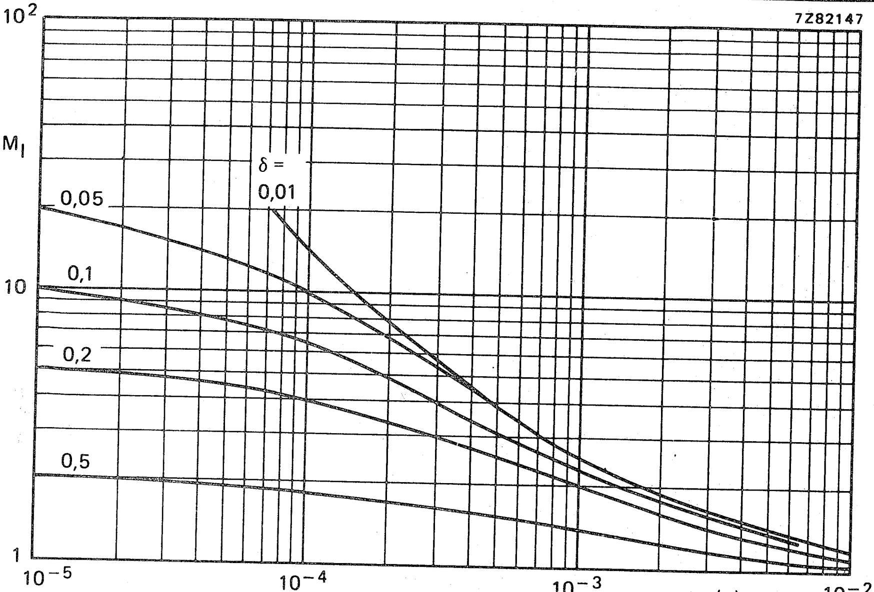


Fig. 7 S.B. current multiplying factor at the $-V_{CEO\,max}$ level for BD950 and BD952.

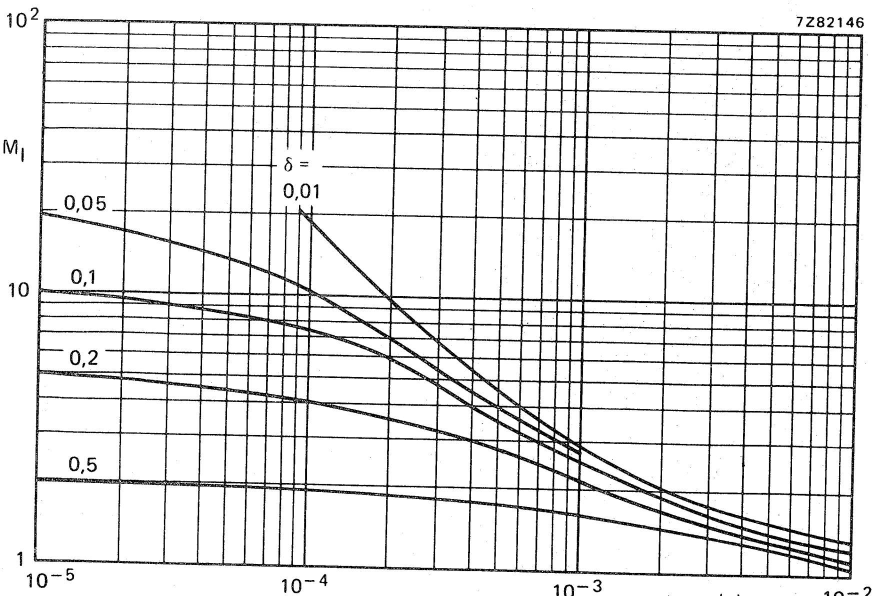


Fig. 8 S.B. current multiplying factor at the $-V_{CEO\,max}$ level for BD954 and BD956.

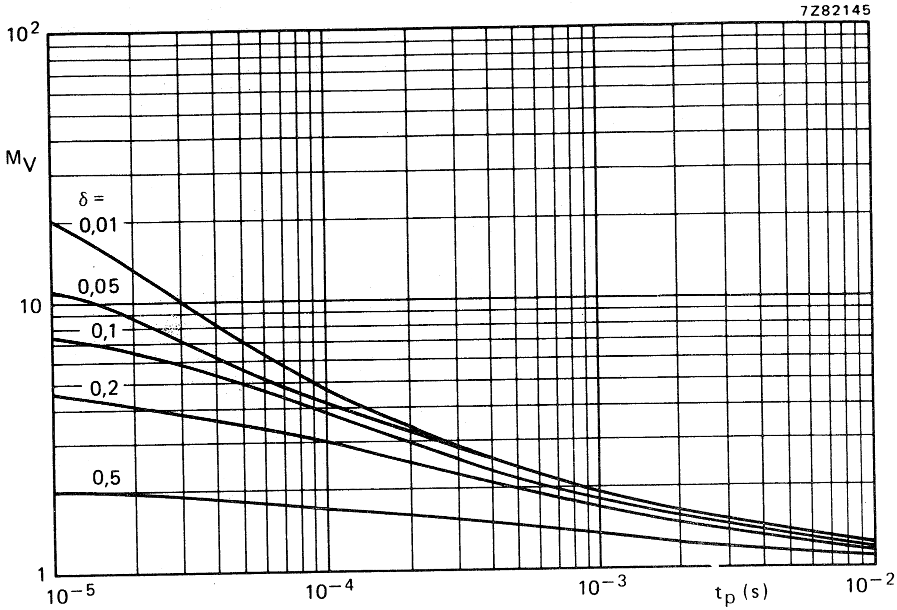


Fig. 9 S.B. voltage multiplying factor at the $-I_{C\,max}$ level.

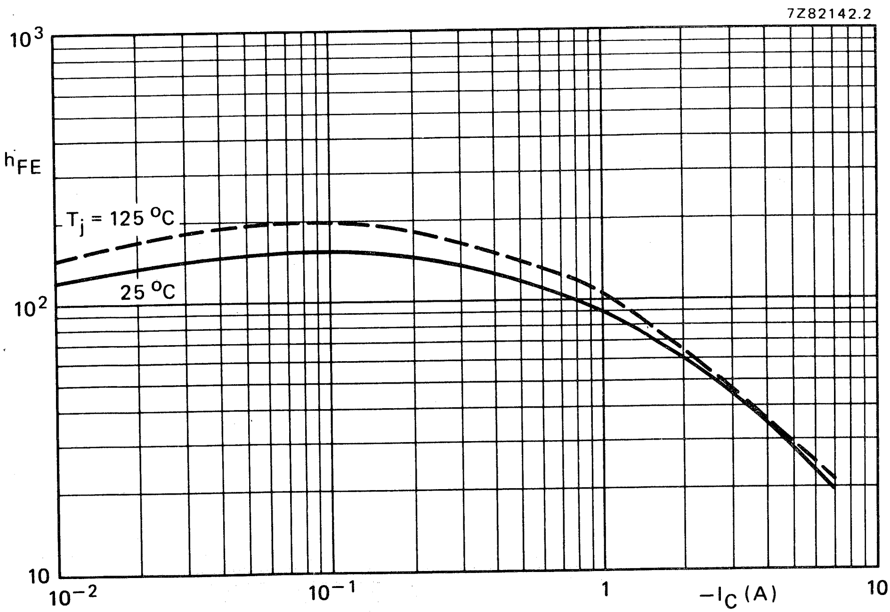


Fig. 10 Typical d.c. current gain at $-V_{CE}$ = 4 V.

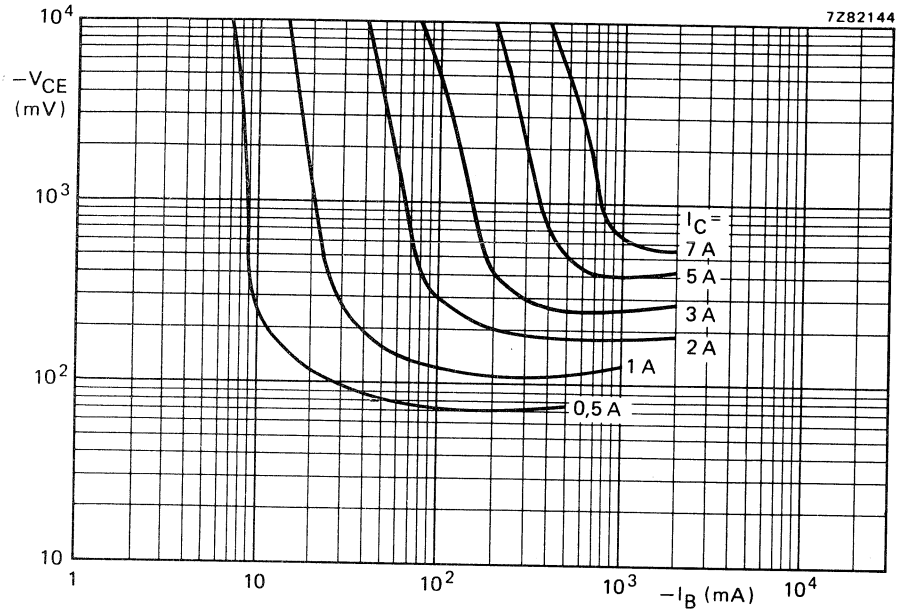


Fig. 11 Collector-emitter voltage as a function of base current.

SILICON DARLINGTON POWER 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.

QUICK REFERENCE DATA

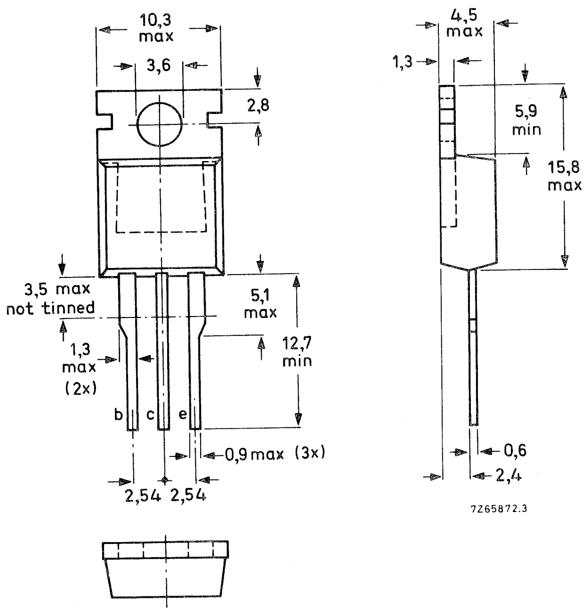
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	130 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	130 V
Collector current (d.c.)	$-I_C$	max.	8 A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	62,5 W
Junction temperature	T_j	max.	150 °C
Turn-off breakdown energy with inductive load T_{amb} = 100 °C; L = 0,6 H; R_S = 100 Ω	$E_{(BR)}$	>	100 mJ

MECHANICAL DATA

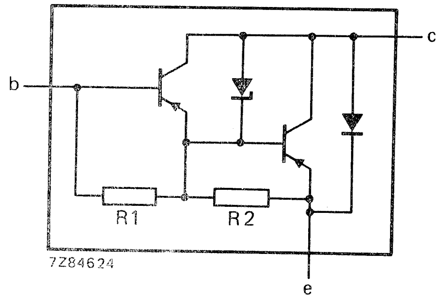
Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.



R_1 typ. 12 kΩ
R_2 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)	$-V_{CBO}$	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 *

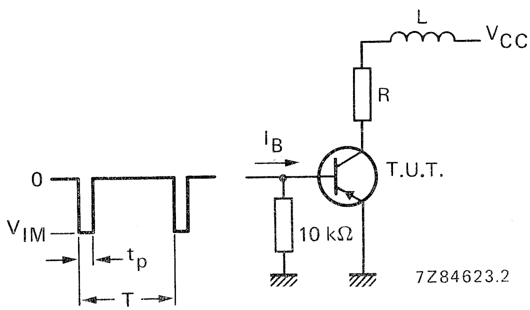
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2	K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	70	K/W

* 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 °C unless otherwise specified

Collector-emitter breakdown voltage			
I_B = 0; I_C = 10 mA	$V_{(BR)CEO}$	>	130 V
Collector cut-off current			
I_E = 0; $-V_{CB}$ = 100 V	$-I_{CBO}$	<	0,2 mA
I_E = 0; $-V_{CB}$ = 60 V; T_j = 150 °C	$-I_{CBO}$	<	2 mA
I_B = 0; $-V_{CE}$ = 60 V	$-I_{CEO}$	<	50 μA
Emitter cut-off current			
I_C = 0; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	1 mA
D.C. current gain (note 1)			
$-I_C$ = 50 mA; $-V_{CE}$ = 3 V	h_{FE}	>	100
$-I_C$ = 250 mA; $-V_{CE}$ = 3 V	h_{FE}		500 to 3000
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	h_{FE}	>	500
$-I_C$ = 8 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	150
Base-emitter voltage (notes 1 and 2)			
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	$-V_{BE}$	<	3 V
Collector-emitter saturation voltage (note 1)			
$-I_C$ = 1 A; $-I_B$ = 2 mA	$-V_{CEsat}$	<	1,5 V
$-I_C$ = 3 A; $-I_B$ = 12 mA	$-V_{CEsat}$	<	2 V
Forward voltage collector-emitter diode			
I_F = 0,1 A	V_F	<	0,9 V
I_F = 8 A	V_F	typ.	2,2 V
Turn-off breakdown energy with inductive load (Fig. 3)	$E_{(BR)}$	>	100 mJ



L	= 0,6 H
$-V_{CCmax}$	= 60 V
t_p	= 0,3 s
T	= 12 s
$R_s = R_L + R$	= 100 Ω
T_{amb}	= 100 °C

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

1. Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.
2. $-V_{BE}$ decreases by about 3,6 mV/K with increasing temperature.

Switching times
(between 10% and 90% levels)
$-I_{Con} = 3$ A; $-I_{Bon} = I_{Boff} = 12$ mA

turn-on time	t_{on}	typ. 0,2 μs
turn-off time	t_{off}	typ. 1,5 μs

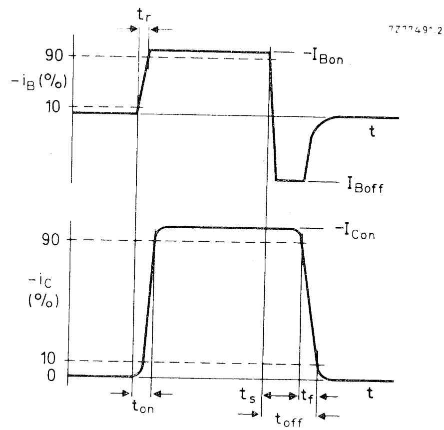


Fig. 4 Switching times waveforms.

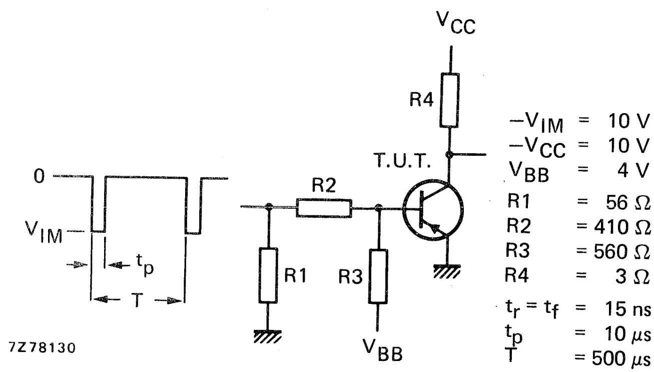


Fig. 5 Switching times test circuit.

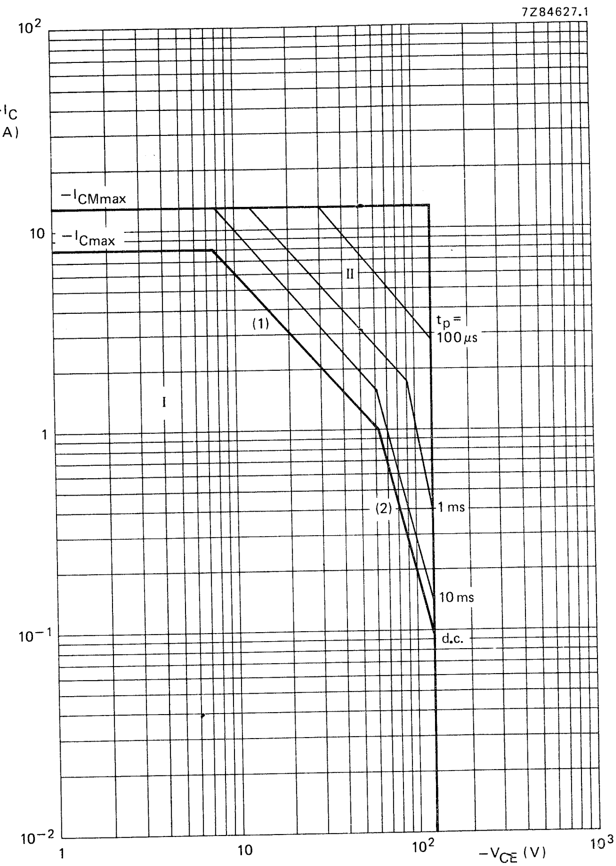


Fig. 6 Safe Operating ARea, $T_{mb} \leqslant 25\ ^oC$

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).

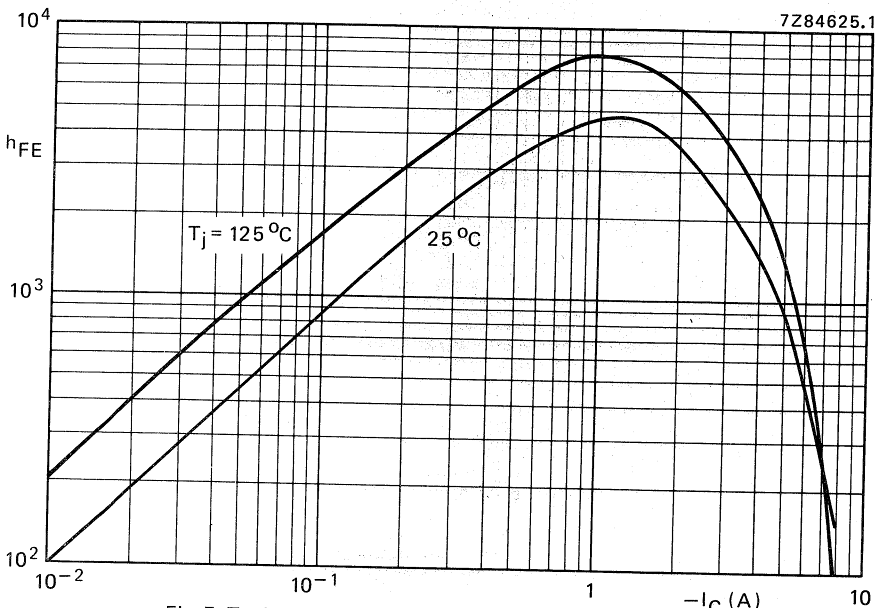


Fig. 7 Typical values d.c. current gain. $-V_{CE} = 3$ V.

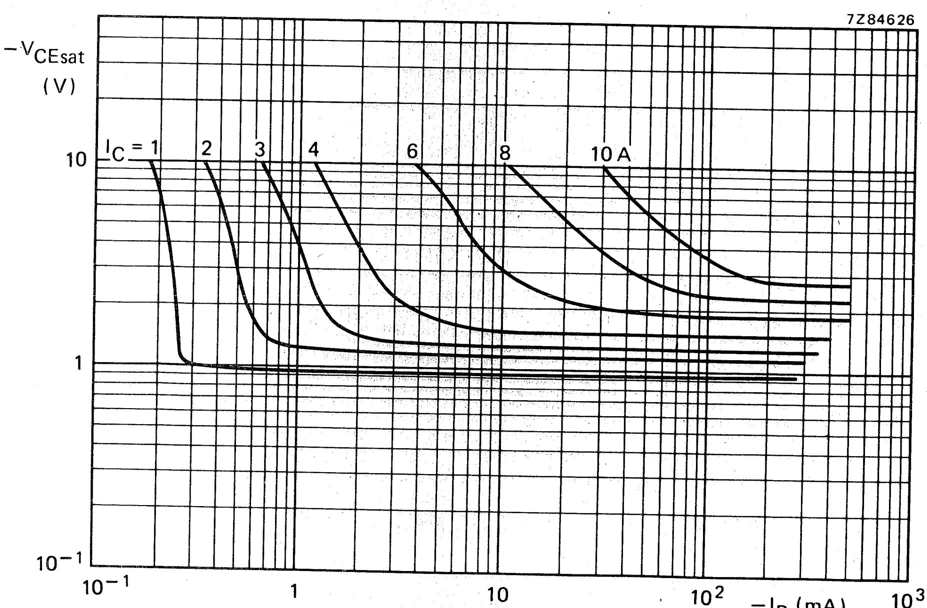


Fig. 8 Typical values collector-emitter saturation voltage, $T_j = 25\,^oC$.

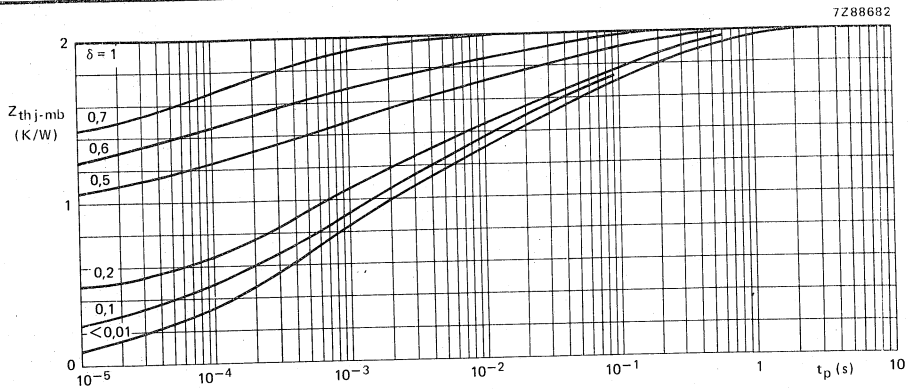


Fig. 9 Pulse power rating chart.

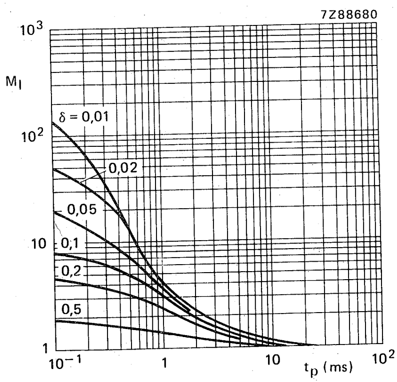


Fig. 10 S.B. current multiplying factor at V_{CEO} = 120 V.

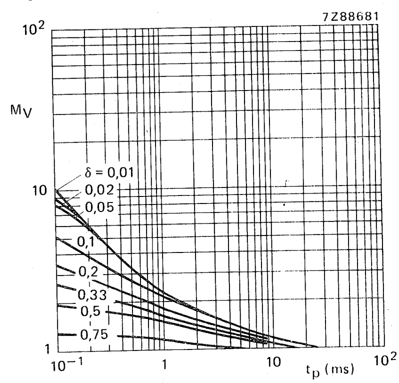


Fig. 11 S.B. voltage multiplying factor at the I_{Cmax} level.

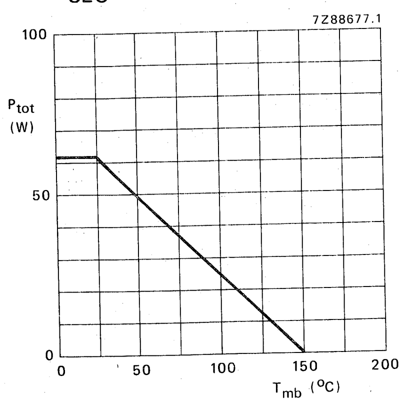


Fig. 12 Power derating curve.

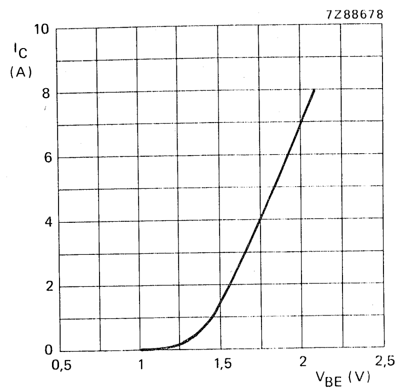


Fig. 13 Typical collector current as a function of base emitter voltage. V_{CE} = 3 V; T_{amb} = 25 °C.

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.

QUICK REFERENCE DATA

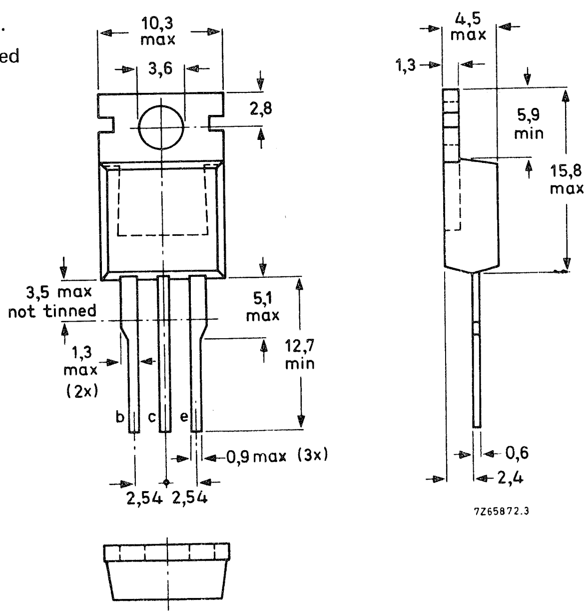
Collector-base voltage (open emitter)	V_{CBO}	max.	130 V
Collector-emitter voltage (open base)	V_{CEO}	max.	130 V
Collector current (d.c.)	I_C	max.	8 A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	62,5 W
Junction temperature	T_j	max.	150 °C
Turn-off breakdown energy with inductive load T_{amb} = 100 °C; L = 0,6 H; R_S = 100 Ω	$E_{(BR)}$	>	100 mJ

MECHANICAL DATA

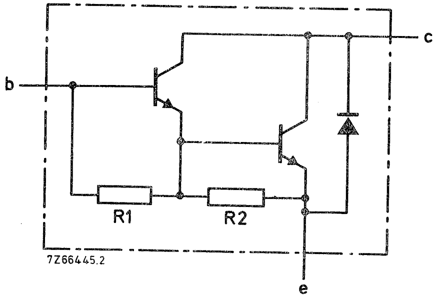
Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.



R_1 typ. 4 kΩ
R_2 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_{CBO}	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 *

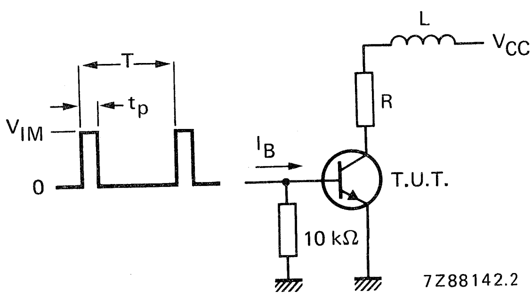
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2 K/W
From junction to ambient	$R_{th\ j\text{-}a}$	=	70 K/W

* 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 °C unless otherwise specified

Collector-emitter breakdown voltage			
$I_B = 0$; $I_C = 10$ mA	$V_{(BR)CEO}$	>	130 V
Collector cut-off current			
$I_E = 0$; $V_{CB} = 100$ V	I_{CBO}	<	0,2 mA
$I_E = 0$; $V_{CB} = 60$ V; $T_j = 150$ °C	I_{CBO}	<	2 mA
$I_B = 0$; $V_{CE} = 60$ V	I_{CEO}	<	50 µA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	5 mA
D.C. current gain (note 1)			
$I_C = 50$ mA; $V_{CE} = 3$ V	h_{FE}	>	100
$I_C = 250$ mA; $V_{CE} = 3$ V	h_{FE}		500 to 3000
$I_C = 3$ A; $V_{CE} = 3$ V	h_{FE}	>	500
$I_C = 8$ A; $V_{CE} = 3$ V	h_{FE}		typ.1800
Base-emitter voltage (notes 1 and 2)			
$I_C = 3$ A; $V_{CE} = 3$ V	V_{BE}	<	3 V
Collector-emitter saturation voltage (note 1)			
$I_C = 1$ A; $I_B = 2$ mA	V_{CEsat}	<	1,5 V
$I_C = 3$ A; $I_B = 12$ mA	V_{CEsat}	<	2 V
Forward voltage collector-emitter diode			
$I_F = 0{,}1$ A	V_F	<	0,9 V
$I_F = 8$ A	V_F	typ.	1,2 V
Turn-off breakdown energy with inductive load (Fig. 3)	$E_{(BR)}$	>	100 mJ



L	=	0,6 H
V_{CCmax}	=	60 V
t_p	=	0,3 s
T	=	12 s
$R_s = R_L + R$	=	100 Ω
T_{amb}	=	100 °C

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

1. Measured under pulse conditions: $t_p < 300$ µs, $\delta < 2\%$.
2. V_{BE} decreases by about 3,6 mV/K with increasing temperature.

Switching times
(between 10% and 90% levels)
I_{Con} = 3 A; I_{Bon} = $-I_{Boff}$ = 12 mA

turn-on time	t_{on}	typ.	1	μs
turn-off time	t_{off}	typ.	5	μs

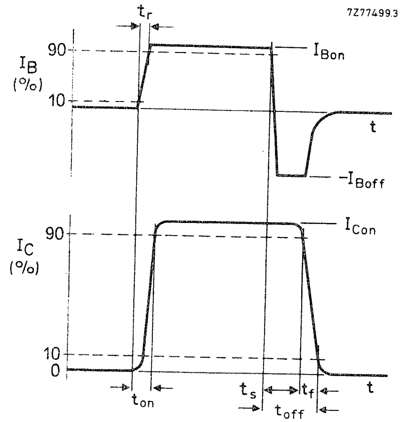
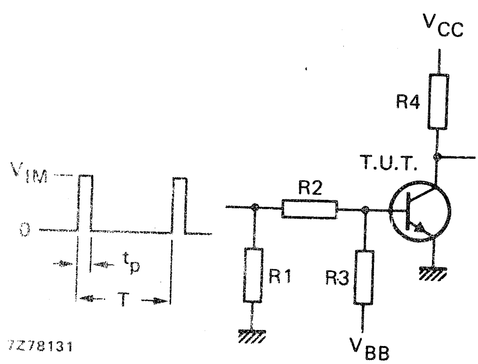


Fig. 4 Switching times waveforms.



V_{IM}	=	10	V
V_{CC}	=	10	V
$-V_{BB}$	=	4	V
R1	=	56	Ω
R2	=	410	Ω
R3	=	560	Ω
R4	=	3	Ω
$t_r = t_f$	=	15	ns
t_p	=	10	μs
T	=	500	μs

Fig. 5 Switching times test circuit.

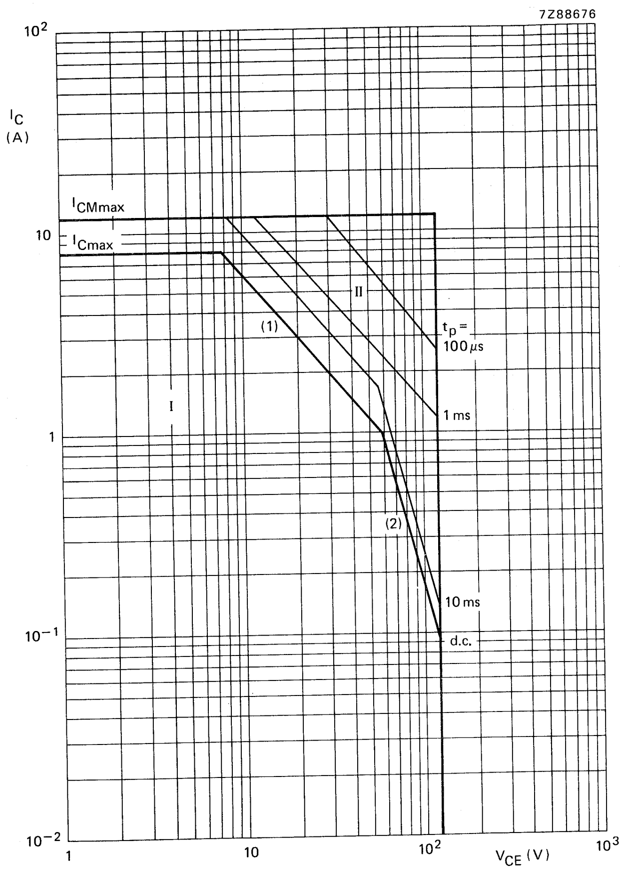


Fig. 6 Safe Operating ARea, $T_{mb} \leqslant 25$ °C.

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).

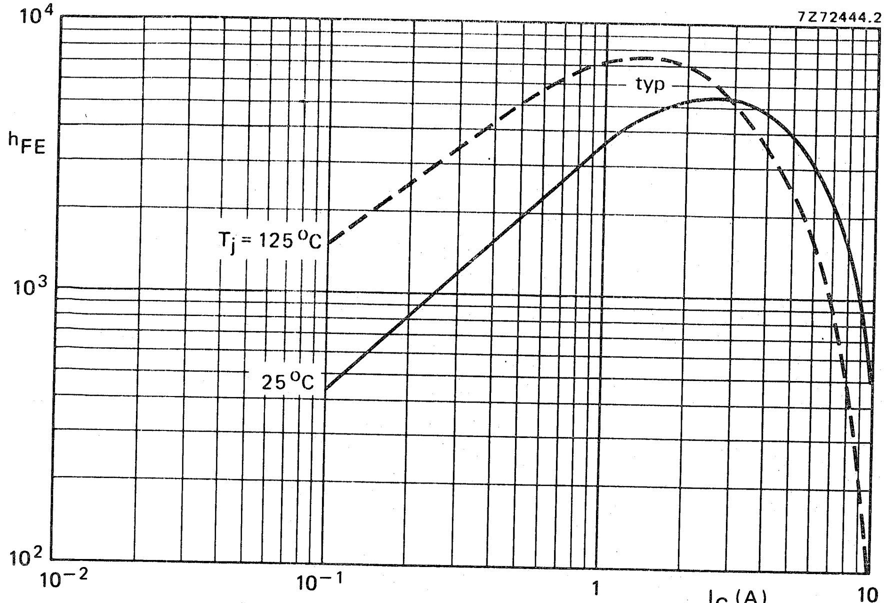


Fig. 7 Typical d.c. current gain. V_{CE} = 3 V.

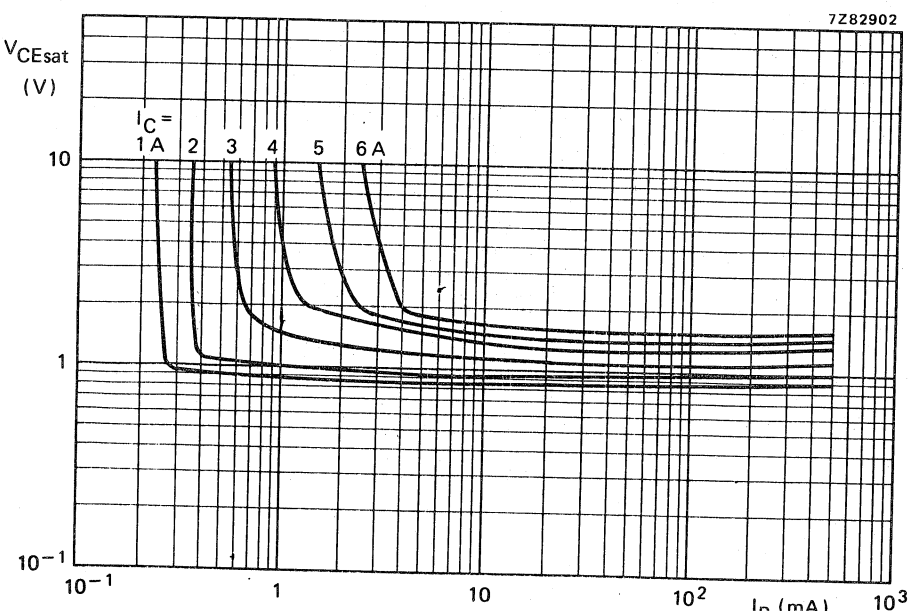


Fig. 8 Typical values collector-emitter saturation voltage. T_j = 25 °C.

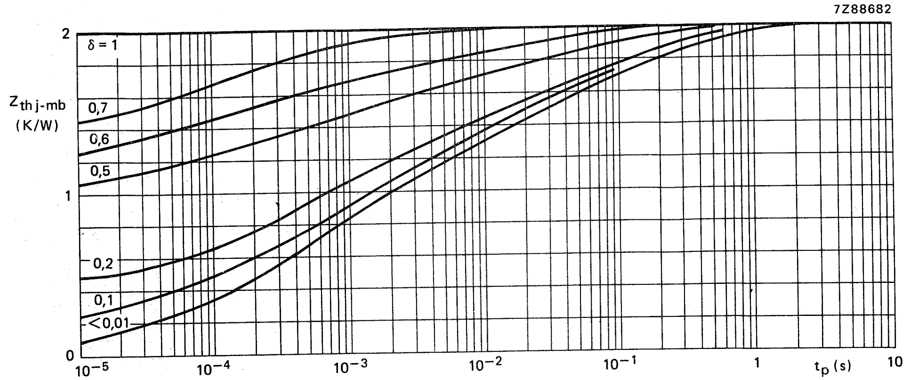


Fig. 9 Pulse power rating chart.

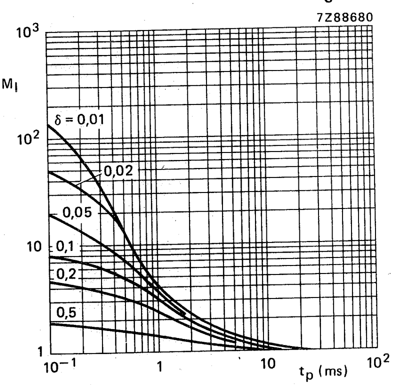


Fig. 10 SB current multiplying factor at V_{CEO} = 120 V.

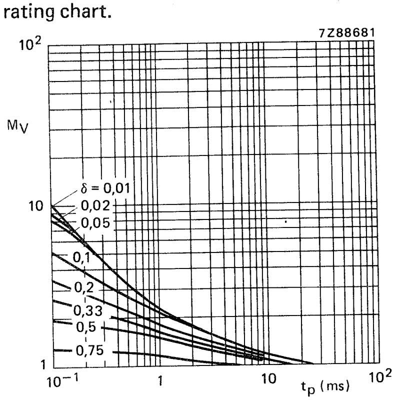


Fig. 11 SB voltage multiplying factor at the $I_{C\,max}$ level.

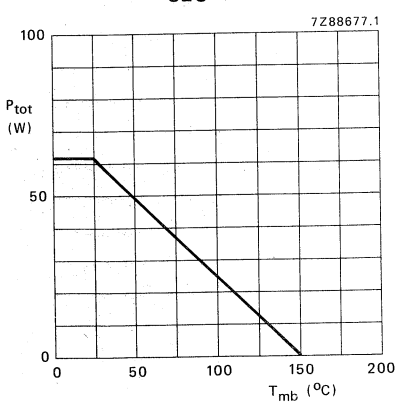


Fig. 12 Power derating curve.

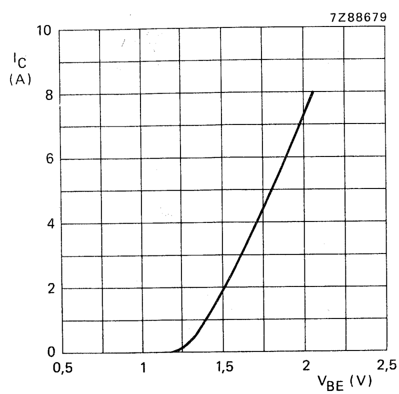


Fig. 13 Typical collector current as a function of base emitter voltage at V_{CE} = 3 V; T_{amb} = 25 °C.

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.

QUICK REFERENCE DATA

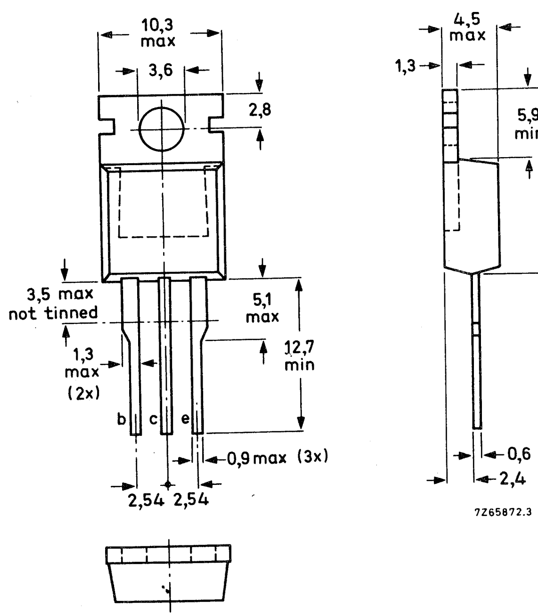
			BDT29	A	B	C	
Collector-base voltage	V_{CBO}	max.	40	60	80	100	V
Collector-emitter voltage	V_{CEO}	max.	40	60	80	100	V
Collector current (peak value)	I_{CM}	max.		3			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		30			W
Junction temperature	T_j	max.		150			°C
D.C. current gain							
I_C = 200 mA; V_{CE} = 4 V	h_{FE}	>		40			
I_C = 1 A; V_{CE} = 4 V	h_{FE}			15 to 75			
Transition frequency at f = 1 MHz							
I_C = 200 mA; V_{CE} = 10 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)

			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 °C	P_{tot}	max.	30				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BDT29; A	BDT29B; C	
Collector cut-off current					
$I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	<	0,3	—	mA
$I_B = 0$; $V_{CE} = 60$ V	I_{CEO}	<	—	0,3	mA
$V_{BE} = 0$; $V_{CE} = V_{CEOmax}$	I_{CES}	<	0,2		mA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	1		mA
D.C. current gain*					
$I_C = 200$ mA; $V_{CE} = 4$ V	h_{FE}	>	40		
$I_C = 1$ A; $V_{CE} = 4$ V	h_{FE}		15 to 75		
Base-emitter voltage**					
$I_C = 1$ A; $V_{CE} = 4$ V	V_{BE}	<	1,3		V
Collector-emitter saturation voltage*					
$I_C = 1$ A; $I_B = 0,125$ A	V_{CEsat}	<	0,7		V

			BDT29	A	B	C	
Collector-emitter breakdown voltage*							
$I_B = 0$; $I_C = 30$ mA	$V_{(BR)CEO}$	>	40	60	80	100	V
Small-signal current gain							
$I_C = 0,2$ A; $V_{CE} = 10$ V; f = 1 kHz	$\|h_{fe}\|$	>	20				
Turn off breakdown energy							
L = 20 mH; $I_{CC} = 1,8$ A	$E_{(BR)}$	>	32				mJ

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

Transition frequency at f = 1 MHz I_C = 0,2 A; V_{CE} = 10 V	f_T	>	3 MHz
Switching times (between 10% and 90% levels) I_{Con} = 1 A; I_{Bon} = $-I_{Boff}$ = 0,1 A			
Turn-on time	t_{on}	typ.	0,3 μs
Turn-off time	t_{off}	typ.	1 μs

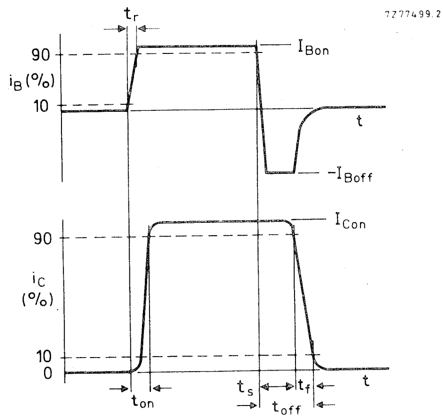
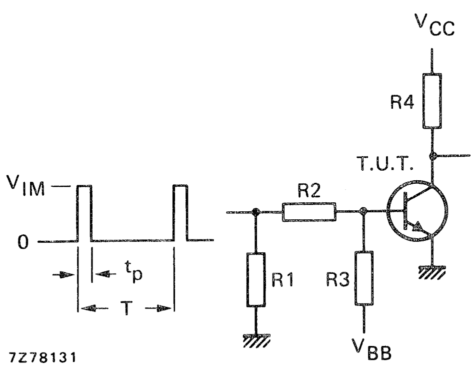


Fig. 2 Switching times waveforms.



V_{IM}	=	16 V
V_{CC}	=	20 V
$-V_{BB}$	=	6,4 V
R1	=	82 Ω
R2	=	82 Ω
R3	=	82 Ω
R4	=	20 Ω
$t_r = t_f$	⩽	15 ns
t_p	=	20 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

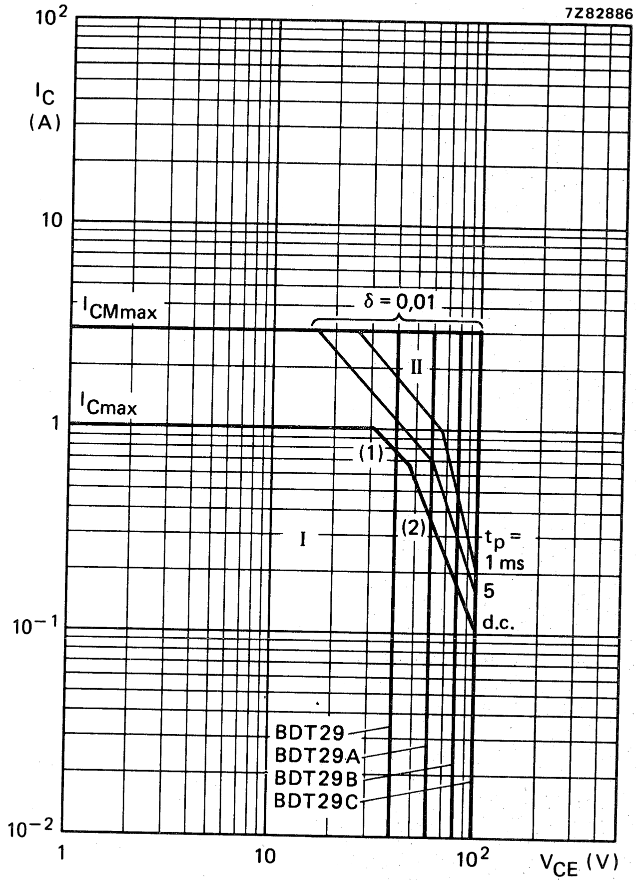


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

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.

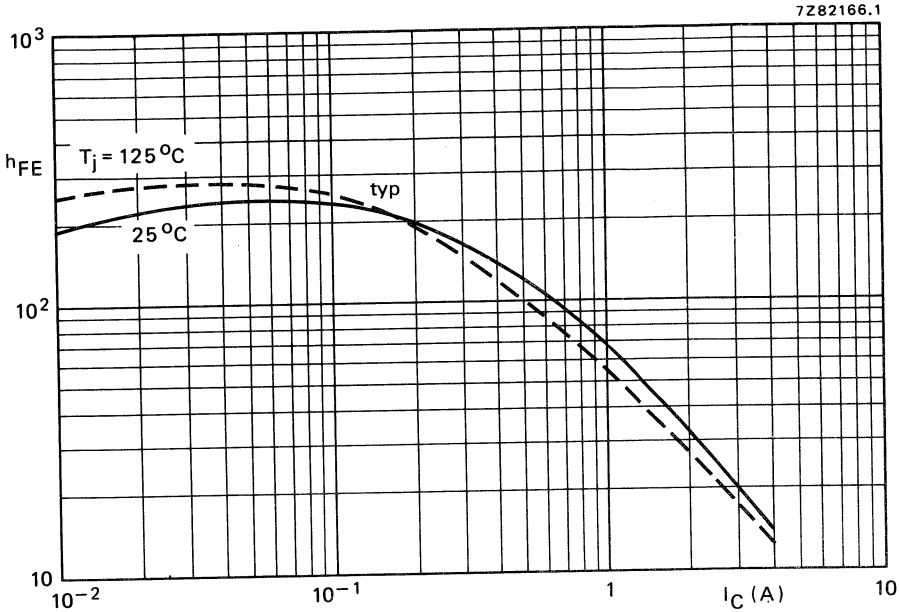


Fig. 5 Typical static forward current transfer ratio as a function of the collector current. $V_{CE} = 4$ V.

SILICON EPITAXIAL BASE POWER TRANSISTORS

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

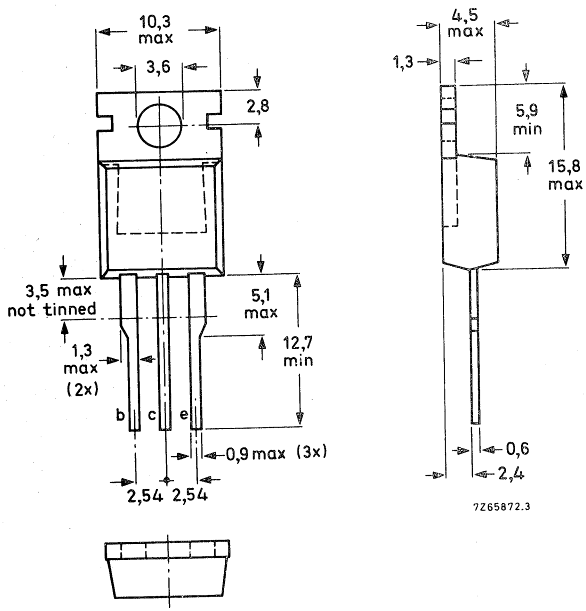
			BDT30	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	40	60	80	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	40	60	80	100	V
Collector current (d.c.)	$-I_{CM}$	max.	3				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	30				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 1 A; $-V_{CE}$ = V	h_{FE}		15 to 75				
Transition frequency $-I_C$ = 200 mA; $-V_{CE}$ = 10 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)

			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 °C	P_{tot}	max.	30				W
Storage temperature	T_{stg}		−65 to +150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,17	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BDT30;A	BDT30B;C	
Collector cut-off current					
$-I_B = 0$; $-V_{CE} = 30$ V	$-I_{CEO}$	<	0,3	–	mA
$-I_B = 0$; $-V_{CE} = 60$ V	$-I_{CEO}$	<	–	0,3	mA
$-V_{BE} = 0$; $-V_{CE} = -V_{CEOmax}$	$-I_{CES}$	<	0,2		mA
Emitter cut-off current					
$I_C = 0$; $-V_{EB} = 5$V	$-I_{EBO}$	<	1		mA
D.C. current gain*					
$-I_C = 200$ mA; $-V_{CE} = 4$ V	h_{FE}	>	40		
$-I_C = 1$ A; $-V_{CE} = 4$ V	h_{FE}		15 to 75		
Base-emitter voltage*					
$-I_C = 1$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	1,3		V
Collector-emitter saturation voltage*					
$-I_C = 1$ A; $-I_B = 0,125$ A	$-V_{CEsat}$	<	0,7		V

			BDT30	A	B	C	
Collector-emitter breakdown voltage* $I_B = 0$; $-I_C = 30$ mA	$-V_{(BR)CEO}$	>	40	60	80	100	
Small-signal current gain $-I_C = 0,2$ A; $-V_{CE} = 10$ V; f = 1 kHz	$\|h_{fe}\|$	>	20				
Turn off breakdown energy L = 20 mH; $I_{CC} = 1,22$ A	$E_{(BR)}$	>	15				mJ

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

Transition frequency at f = 1 MHz $-I_C$ = 200 mA; $-V_{CE}$ = 10 V	f_T	>	3 MHz
Switching times $-I_{Con}$ = 1 A; $-I_{Bon}$ = I_{Boff} = 0,1 A			
turn-on time	t_{on}	typ.	0,3 μs
turn-off time	t_{off}	typ.	1 μs

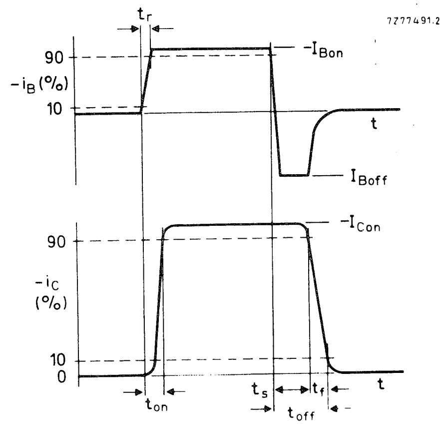
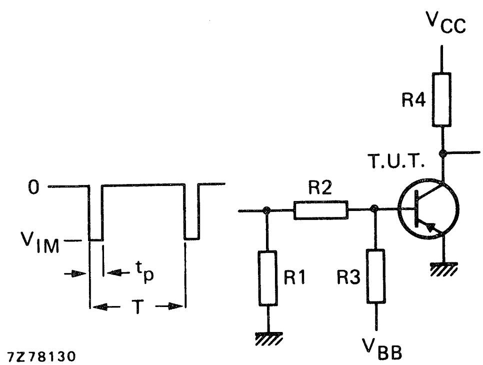


Fig. 2 Switching times waveforms.



$-V_{IM}$	=	16 V
$-V_{CC}$	=	20 V
$+V_{BB}$	=	6,4 V
R1	=	82 Ω
R2	=	82 Ω
R3	=	82 Ω
R4	=	20 Ω
$t_r = t_f$	=	15 ns
t_p	=	20 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

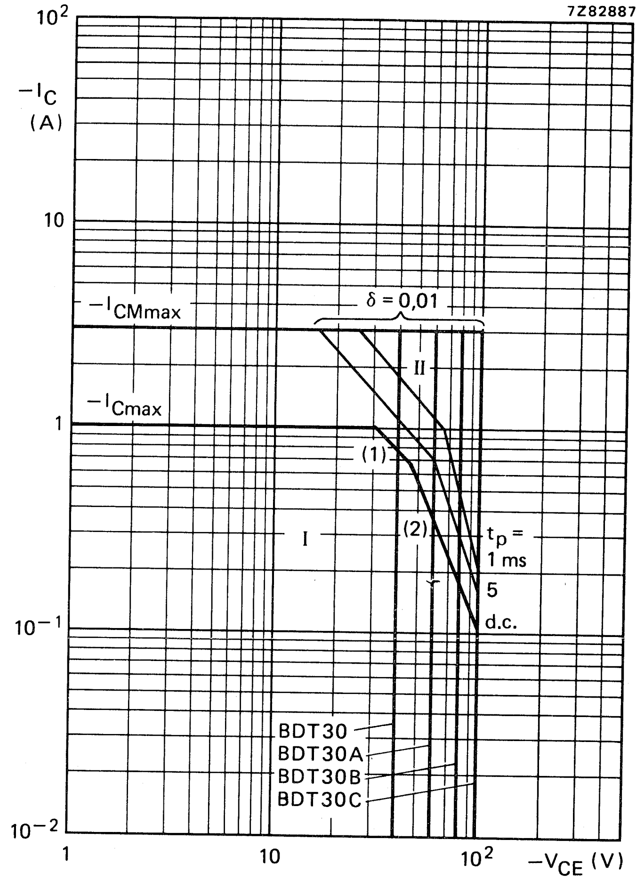


Fig. 4 Safe Operating ARea; $T_{mb} = 25\ ^oC$.

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.

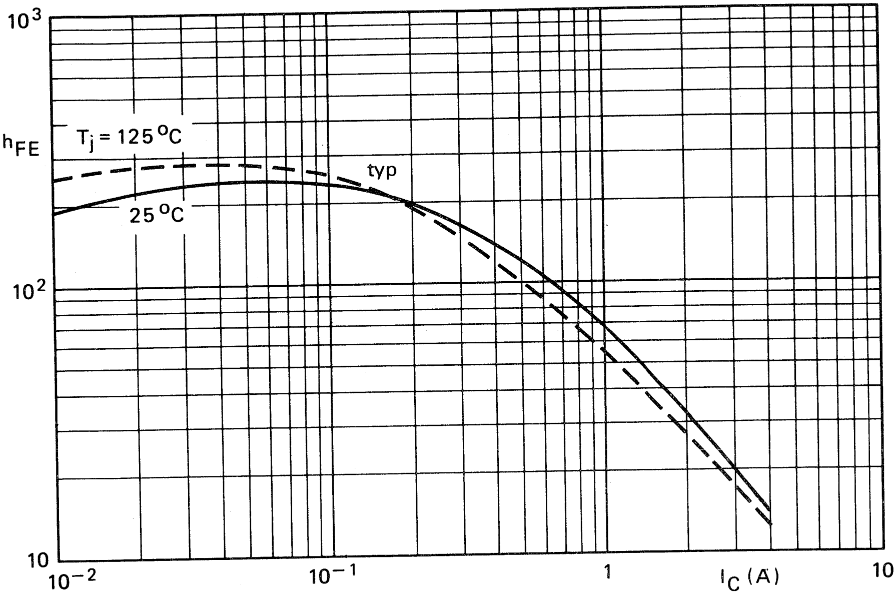


Fig. 5 Typical static forward current transfer ratio as a function of the collector current. $-V_{CE} = 4$ V.

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.

QUICK REFERENCE DATA

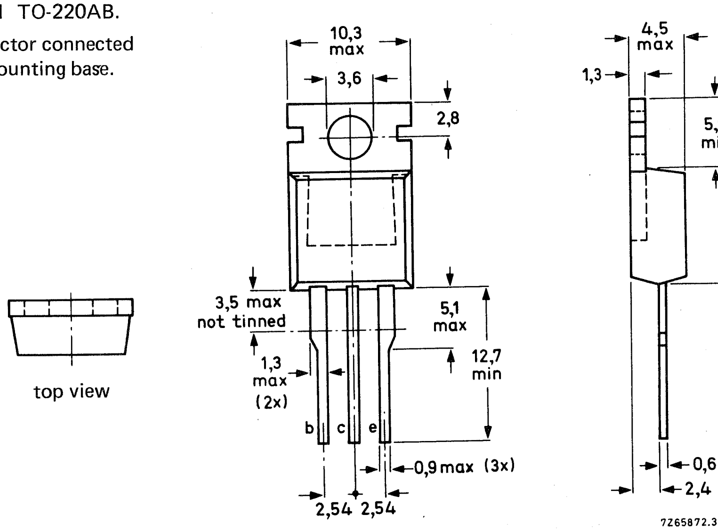
			BDT31	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	40	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Collector current (d.c.)	I_C	max.		3			A
Collector current (peak value)	I_{CM}	max.		5			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		40			W
Junction temperature	T_j	max.		150			°C
D.C. current gain							
I_C = 1 A; V_{CE} = 4 V	h_{FE}	>		25			
I_C = 3 A; V_{CE} = 4 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)

			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 °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	$R_{th\ j\text{-}mb}$	=	3,12	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BDT31; A	BDT31B; C	
Collector cut-off current					
I_B = 0; V_{CE} = 30 V	I_{CEO}	<	0,3	–	mA
I_B = 0; V_{CE} = 60 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 V	I_{EBO}	<	1		mA
D.C. current gain *					
I_C = 1 A; V_{CE} = 4 V	h_{FE}	>	25		
I_C = 3 A; V_{CE} = 4 V	h_{FE}		10 to 50		
Base-emitter voltage * **					
I_C = 3 A; V_{CE} = 4 V	V_{BE}	<	1,8		V
Collector-emitter saturation voltage *					
I_C = 3 A; I_B = 0,375 A	V_{CEsat}	<	1,2		V

			BDT31	A	B	C	
Collector-emitter breakdown voltage *							
I_B = 0; I_C = 30 mA	$V_{(BR)CEO}$	>	40	60	80	100	V
Small-signal current transfer ratio							
I_C = 0,5 A; V_{CE} = 10 V; f = 1 kHz	$\|h_{fe}\|$	>		20			
I_C = 0,5 A; V_{CE} = 10 V; f = 1 MHz	$\|h_{fe}\|$	>		3			
Turn-off breakdown energy							
L = 20 mH; I_{CC} = 1,8 A	$E_{(BR)}$	>		32			mJ

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

Switching times
(between 10% and 90% levels)
$I_{Con} = 1$ A; $I_{Bon} = -I_{Boff} = 0,1$ A

Turn-on time	t_{on}	typ.	0,3 μs
Turn-off time	t_{off}	typ.	1 μs

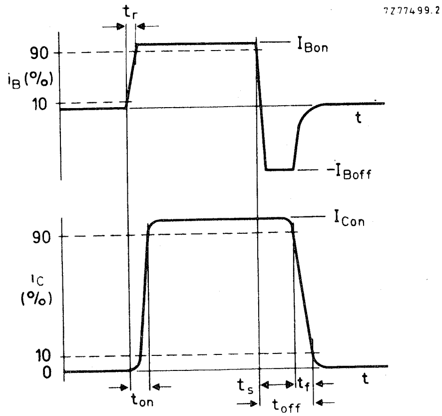
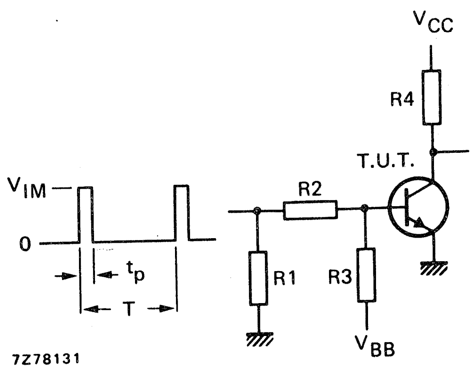


Fig. 2 Switching times waveforms.



V_{IM}	=	30 V
V_{CC}	=	20 V
$-V_{BB}$	=	3 V
R1	=	56 Ω
R2	=	150 Ω
R3	=	33 Ω
R4	=	20 Ω
$t_r = t_f$	=	15 ns
t_p	=	20 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

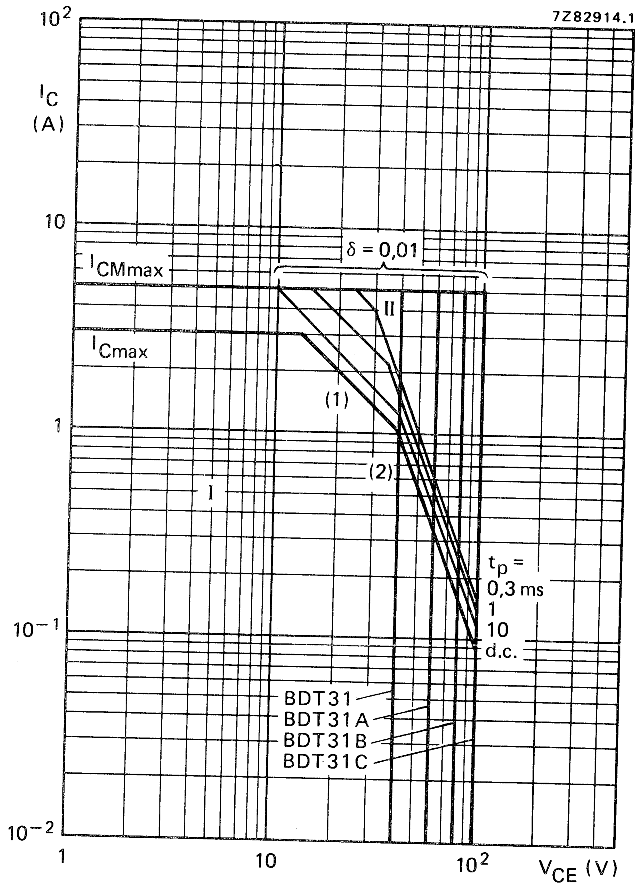


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

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).

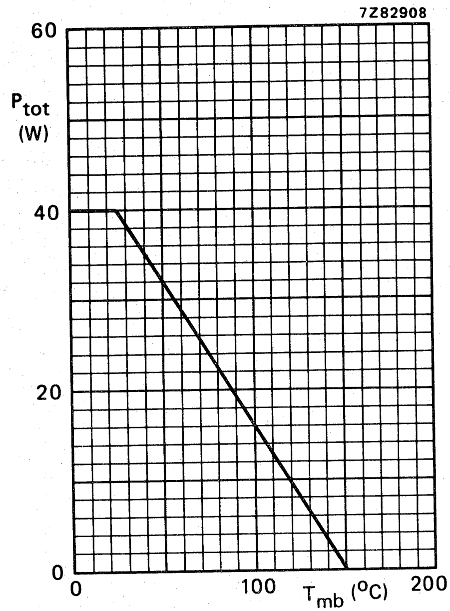


Fig. 5 Power derating curve.

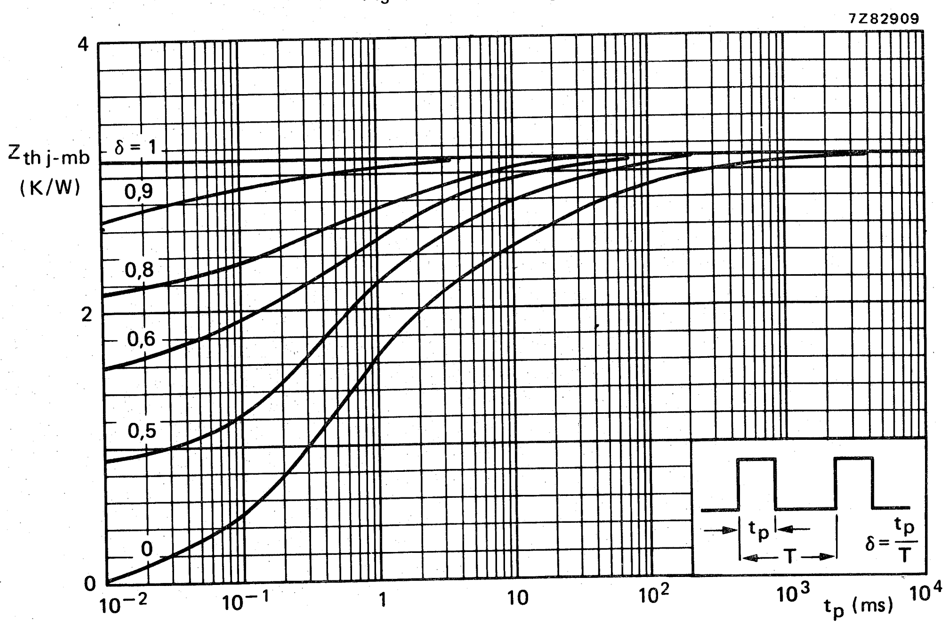


Fig. 6 Pulse power rating chart.

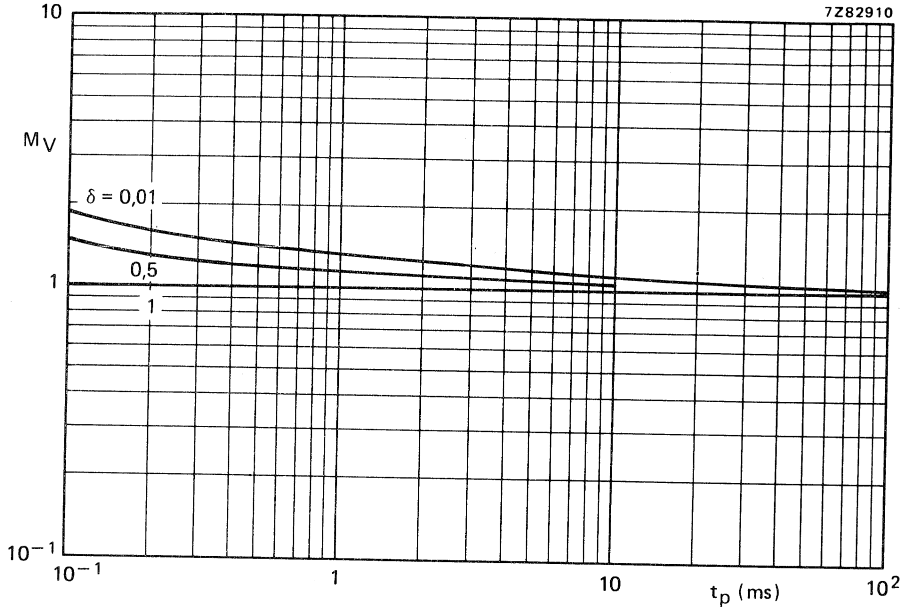


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

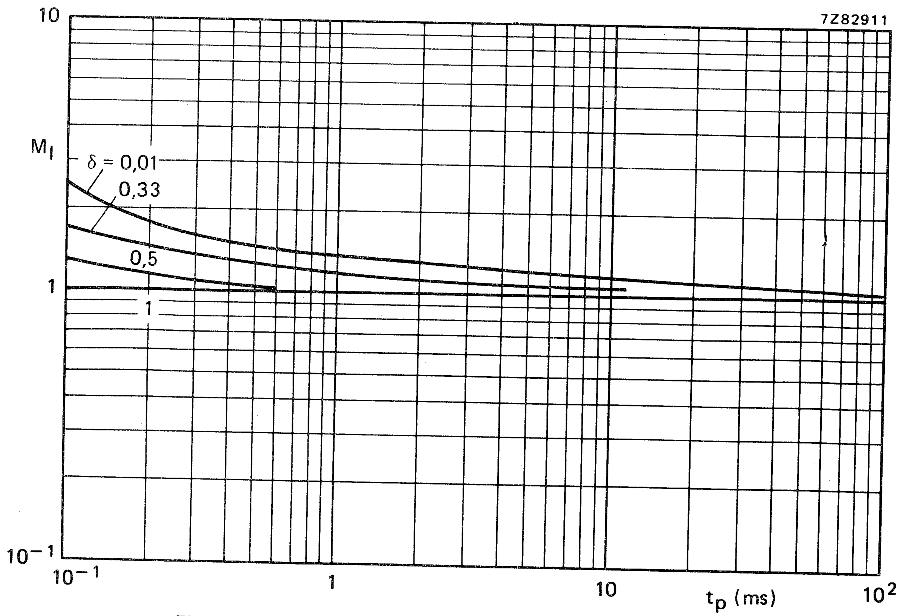


Fig. 8 S.B. current multiplying factor at the V_{CEOmax} level.

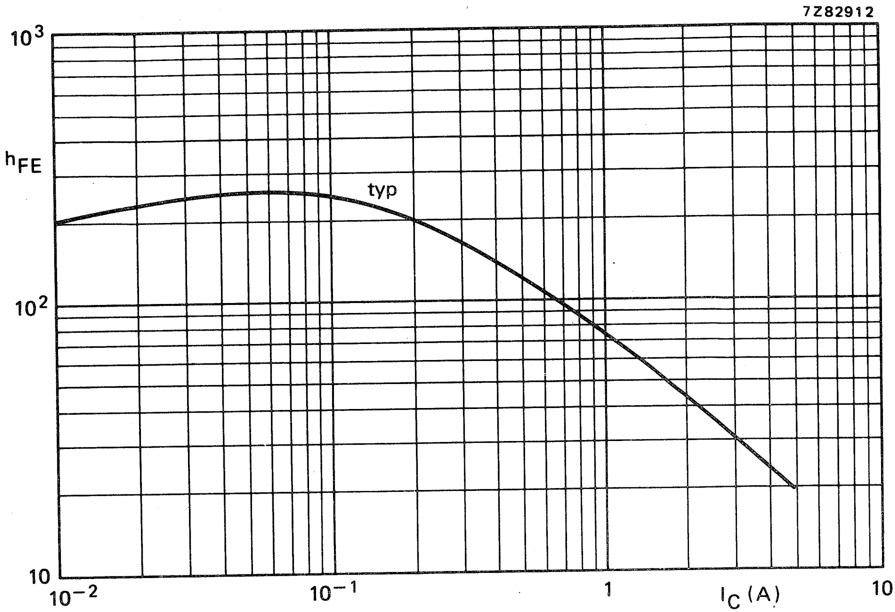


Fig. 9 Typical values d.c. current gain at V_{CE} = 4 V.

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

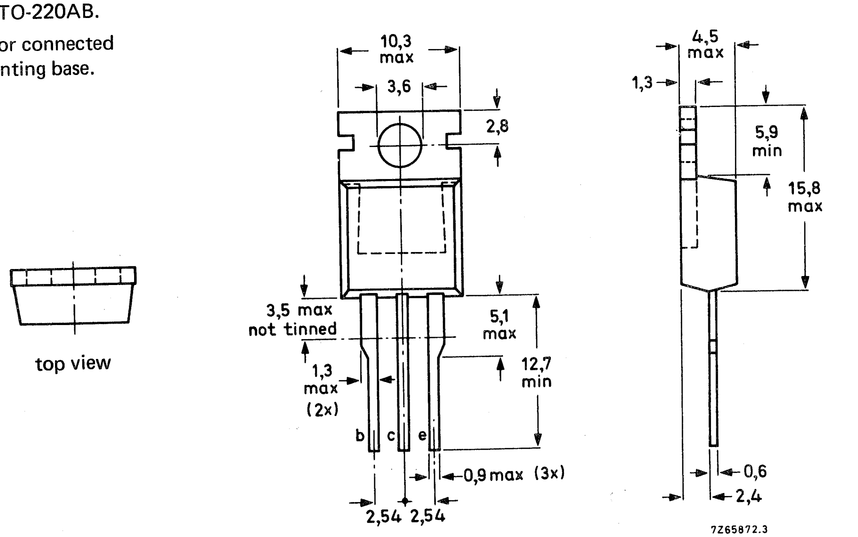
			BDT32	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	100	V
Collector current (d.c.)	$-I_C$	max.			3		A
Collector current (peak value)	$-I_{CM}$	max.			5		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.			40		W
Junction temperature	T_j	max.			150		°C
D.C. current gain							
$-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	>			25		
$-I_C$ = 3 A; $-V_{CE}$ = 4 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)

			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 °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	$R_{th\ j\text{-}mb}$	=	3,12	K/W
from junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BDT32; A	B; C	
Collector cut-off current					
$I_B = 0$; $-V_{CE}$ = 30 V	$-I_{CEO}$	<	0,3		mA
$I_B = 0$; $-V_{CE}$ = 60 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 V	$-I_{EBO}$	<	1		mA
D.C. current gain *					
$-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	>	25		
$-I_C$ = 3 A; $-V_{CE}$ = 4 V	h_{FE}		10 to 50		
Base-emitter voltage * **					
$-I_C$ = 3 A; $-V_{CE}$ = 4 V	$-V_{BE}$	<	1,8		V
Collector-emitter saturation voltage					
$-I_C$ = 3 A; $-I_B$ = 0,375 A	$-V_{CEsat}$	<	1,2		V

			BDT32	A	B	C	
Collector-emitter breakdown voltage *							
$I_B = 0$; $-I_C$ = 30 mA	$-V_{(BR)CEO}$	>	40	60	80	100	V
Small signal current transfer ratio							
$-I_C$ = 0,5 A; $-V_{CE}$ = 10 V; f = 1 kHz	$\|h_{fe}\|$	>		20			
$-I_C$ = 0,5 A; $-V_{CE}$ = 10 V; f = 1 MHz	$\|h_{fe}\|$	>		3			
Turn-off breakdown energy							
L = 20 mH; I_{CC} = 1,22 A	$E_{(BR)}$	>		15			mJ

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

Switching times
(between 10% and 90% levels)
$-I_{Con} = 1$ A; $-I_{Bon} = I_{Boff} = 0,1$ A

Turn-on time	t_{on}	typ.	0,3 μs
Turn-off time	t_{off}	typ.	1 μs

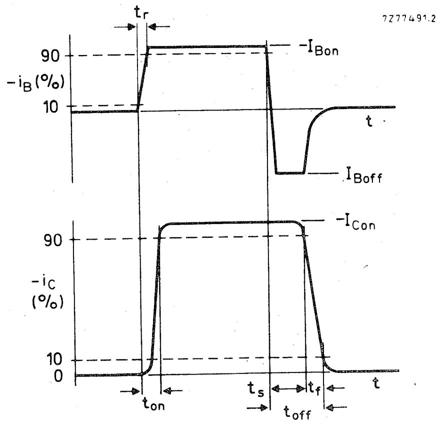
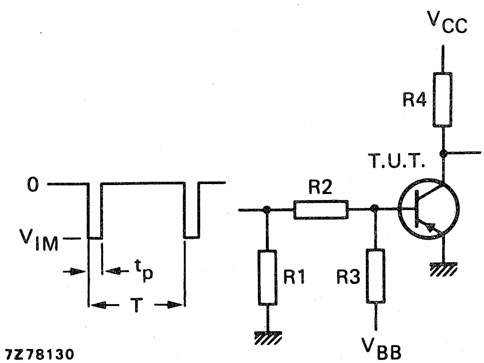


Fig. 2 Switching times waveforms.



$-V_{IM}$	=	30 V
$-V_{CC}$	=	20 V
V_{BB}	=	3 V
R_1	=	56 Ω
R2	=	150 Ω
R3	=	33 Ω
R4	=	20 Ω
$t_r = t_f$	⩽	15 ns
t_p	=	20 μs
T	=	500 μs

Fig. 3 Switching times test circuit.

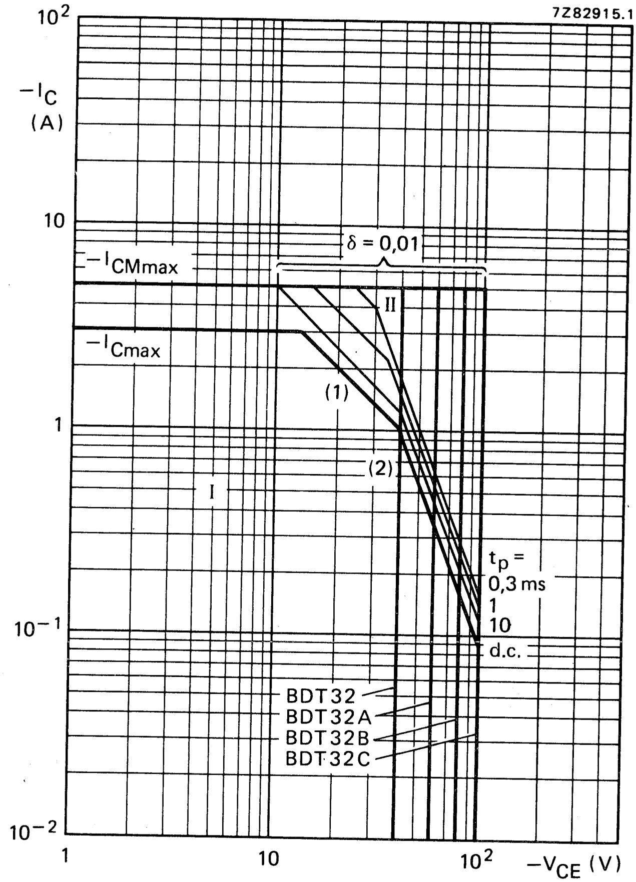


Fig. 4 Safe Operating ARea; $T_{mb} \leqslant 25\ ^oC$.

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).

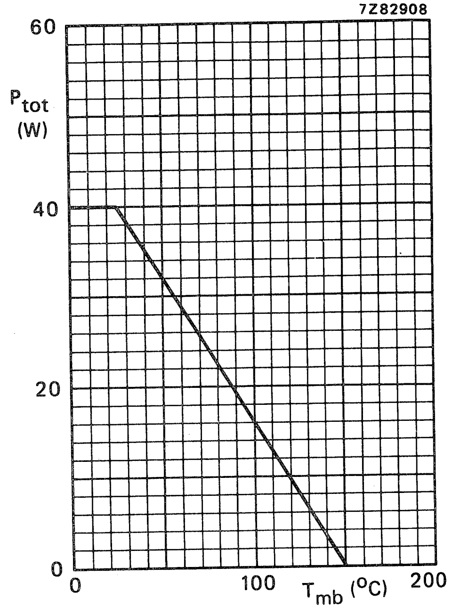


Fig. 5 Power derating curve.

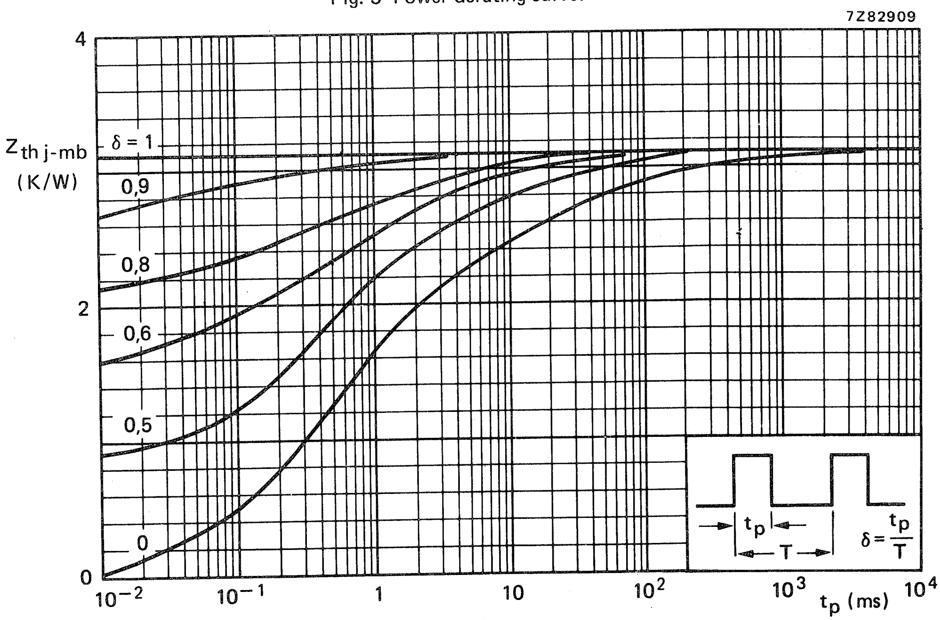


Fig. 6 Pulse power rating chart.

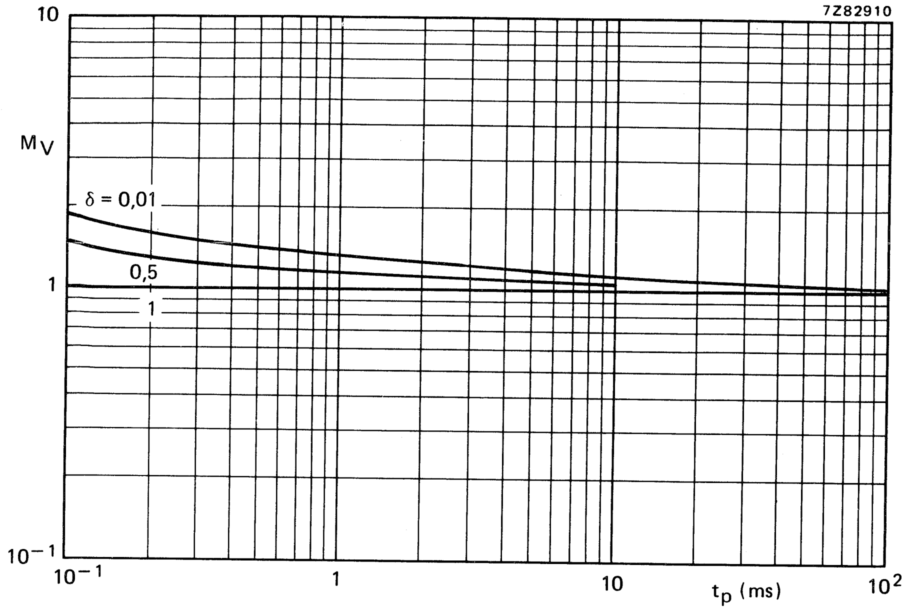


Fig. 7 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

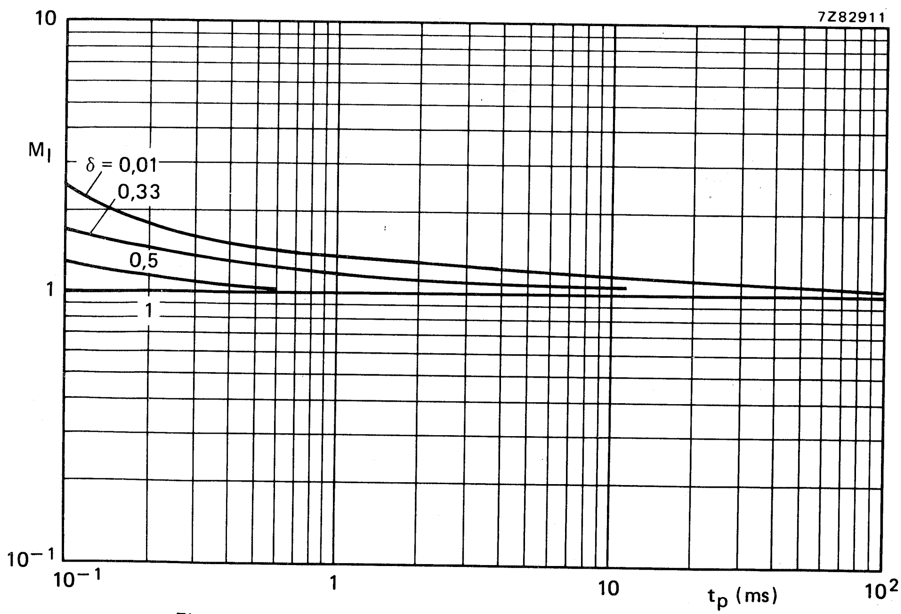


Fig. 8 S.B. current multiplying factor at the $-V_{CEOmax}$ level.

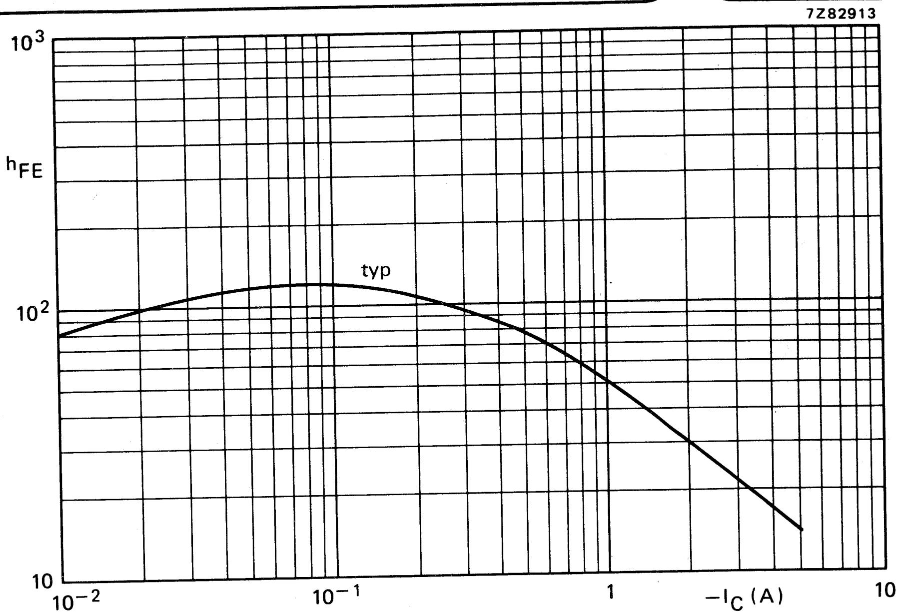


Fig. 9 Typical d.c. current gain at $-V_{CE} = 4$ V; $T_j = 25$ °C.

SILICON EPITAXIAL BASE POWER TRANSISTORS

N-P-N silicon transistors in a plastic envelope intended for use in general purpose amplifier and switching applications.

QUICK REFERENCE DATA

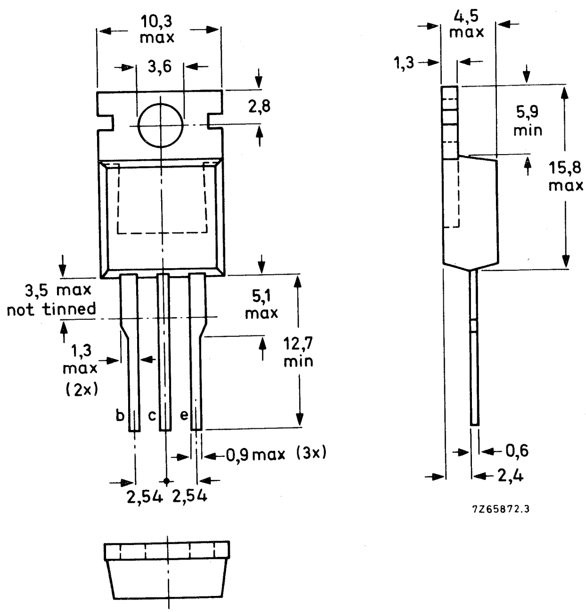
			BDT41	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	40	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	100	V
Collector current (d.c.)	I_C	max.		6			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		65			W
Junction temperature	T_j	max.		150			°C
D.C. current gain I_C = 3 A; V_{CE} = 4 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 °C	P_{tot}	max.	65				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BDT41;A	B;C	
Collector cut-off current					
I_B = 0; V_{CE} = 30 V	I_{CEO}	<	0,7	–	mA
I_B = 0; V_{CE} = 60 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 V	I_{EBO}	<	1		mA
D.C. current gain*					
I_C = 0,3 A; V_{CE} = 4 V	h_{FE}	>	30		
I_C = 3 A; V_{CE} = 4 V	h_{FE}		15 to 75		
Base-emitter voltage**					
I_C = 6 A; V_{CE} = 4 V	V_{BE}	<	2		V
Collector-emitter saturation voltage*					
I_C = 6 A; I_B = 0,6 A	V_{CEsat}	<	1,5		V

			BDT41	A	B	C	
Collector-emitter breakdown voltage*							
I_B = 0; I_C = 30 mA	$V_{(BR)CEO}$	>	40	60	80	100	V
Small-signal current transfer ratio							
I_C = 0,5 A; V_{CE} = 10 V; f = 1 kHz	$\|h_{fe}\|$	>	20				
Transition frequency at f = 1 MHz							
I_C = 0,5 A; V_{CE} = 10 V	f_T	>	3				MHz

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

Turn-off breakdown energy with inductive load (Fig. 4) $-I_{Boff} = 0$; $I_{CC} = 2{,}5$ A	$E_{(BR)}$	>	62,5 mJ
Switching times (between 10% and 90% levels) $I_{Con} = 6$ A; $I_{Bon} = -I_{Boff} = 0{,}6$ A			
Turn-on time	t_{on}	typ.	0,6 μs
Turn-off time	t_{off}	typ.	1 μs

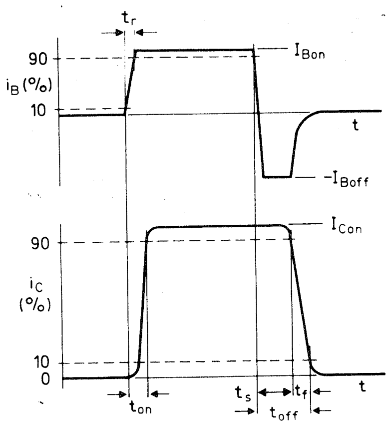
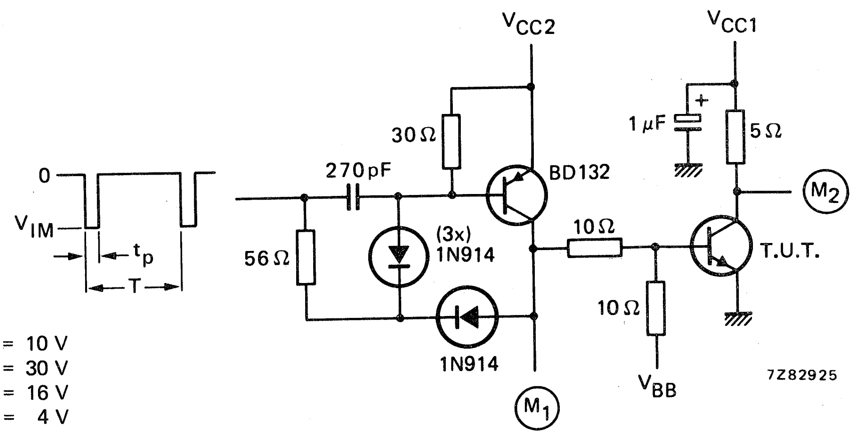


Fig. 2 Switching times waveforms.



$-V_{IM}$ = 10 V
V_{CC1} = 30 V
V_{CC2} = 16 V
$-V_{BB}$ = 4 V
$t_r = t_f$ = 15 ns
t_p = 20 μs
δ ⩽ 2 %

Fig. 3 Switching times test circuit.
Adjust V_{CC2} so that the input to M_1 = 14 V.

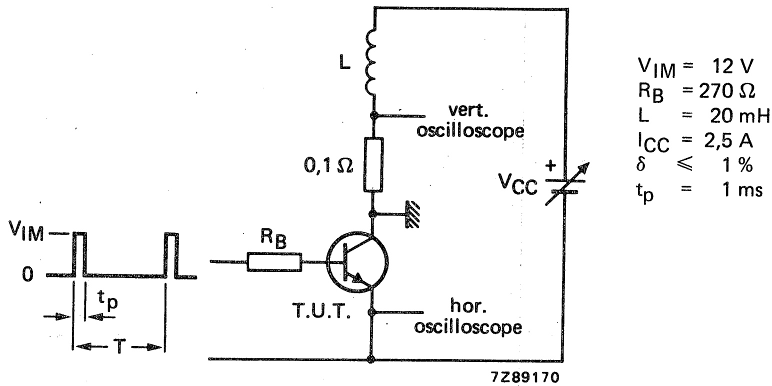


Fig. 4 Test circuit for turn-off breakdown energy.

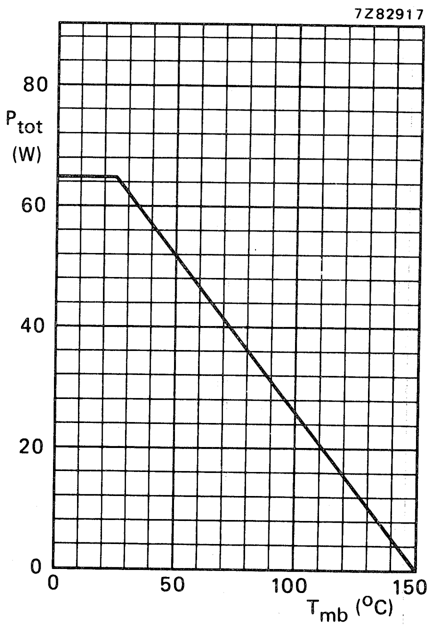


Fig. 5 Power derating curve.

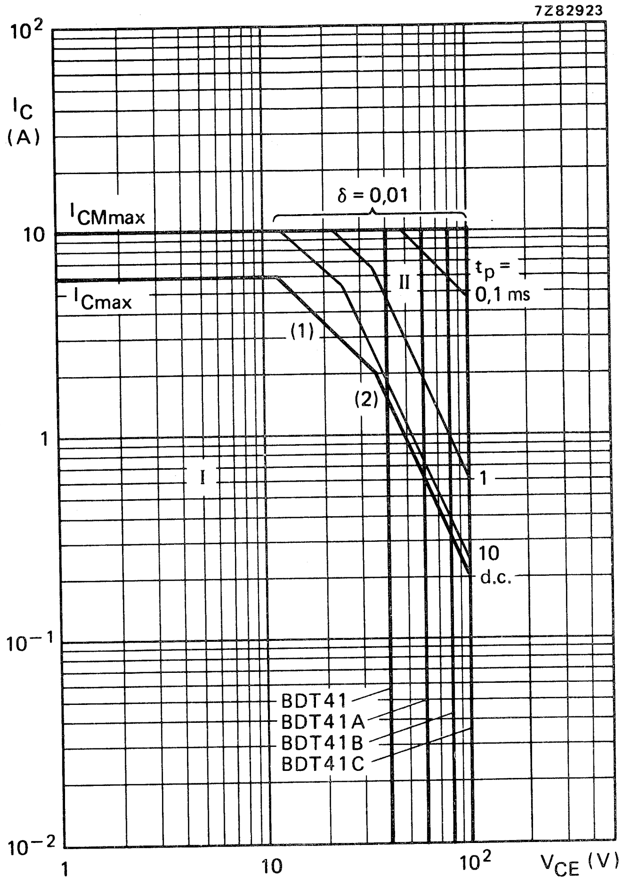


Fig. 6 Safe Operating ARea, $T_{mb} = 25\ ^oC$.

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).

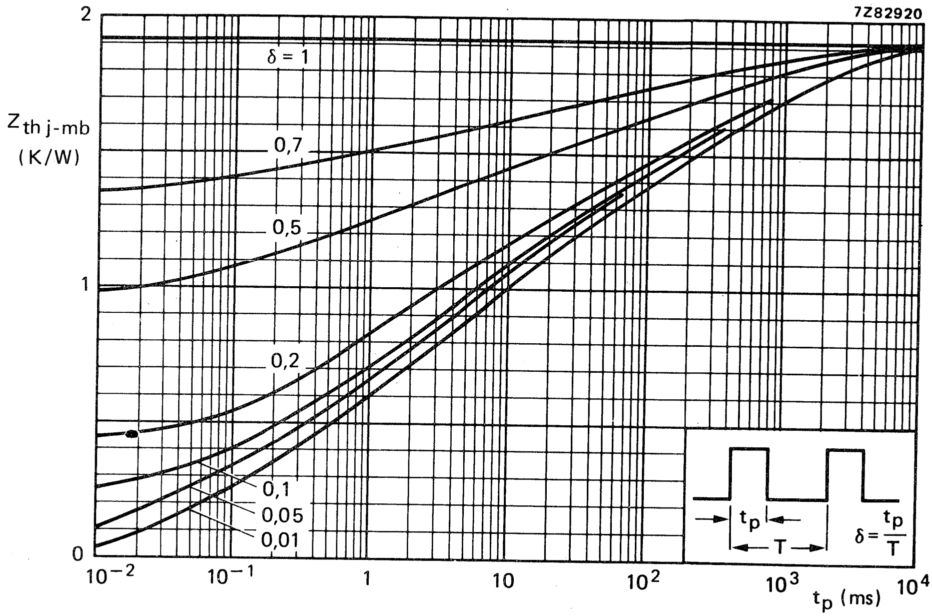


Fig. 7 Pulse power rating chart.

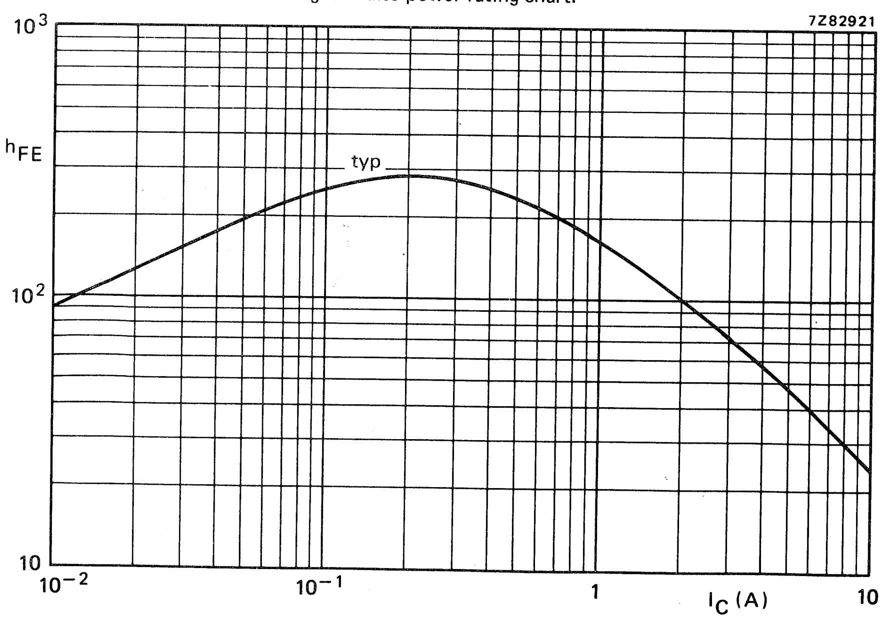


Fig. 8 D.C. current gain at V_{CE} = 4 V; T_j = 25 °C.

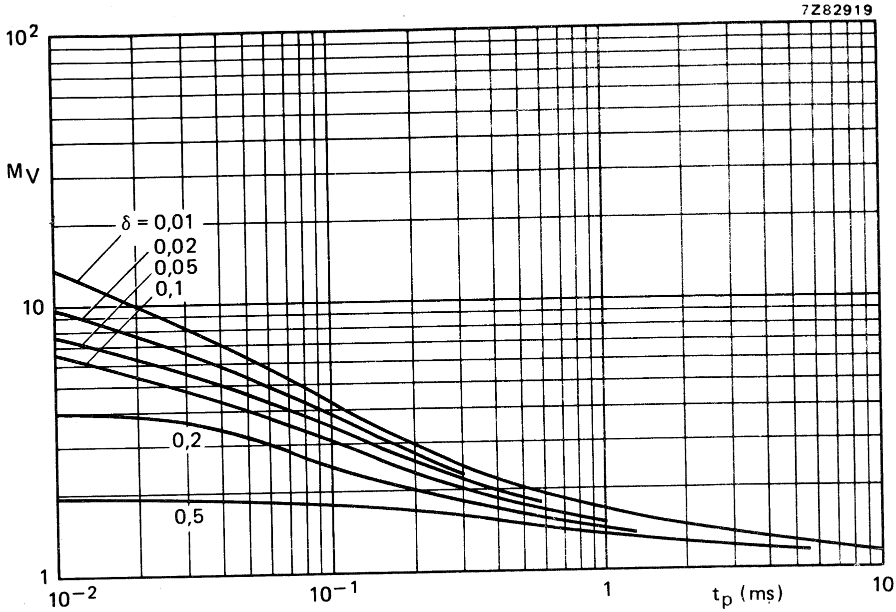


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

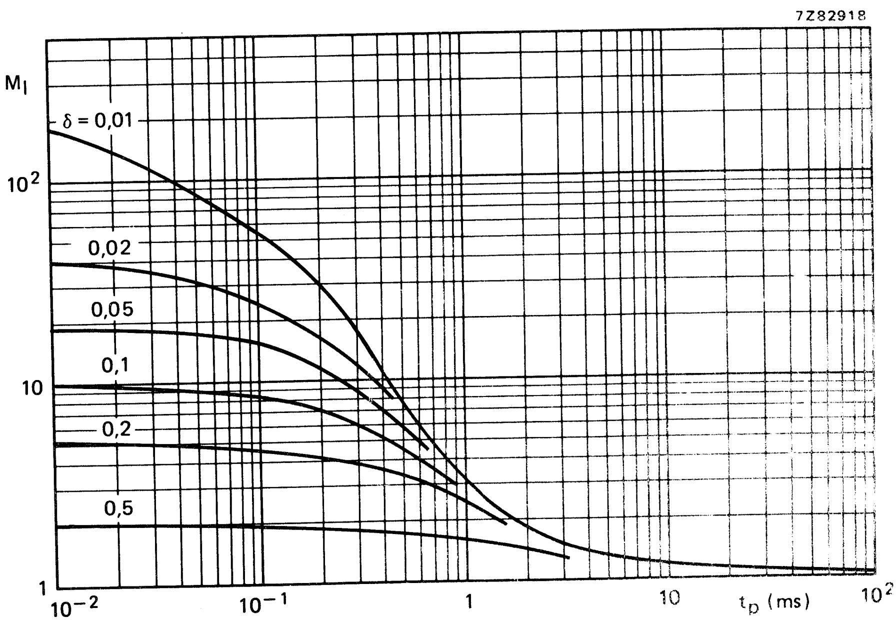


Fig. 10 S.B. current multiplying factor at the V_{CEOmax} level.

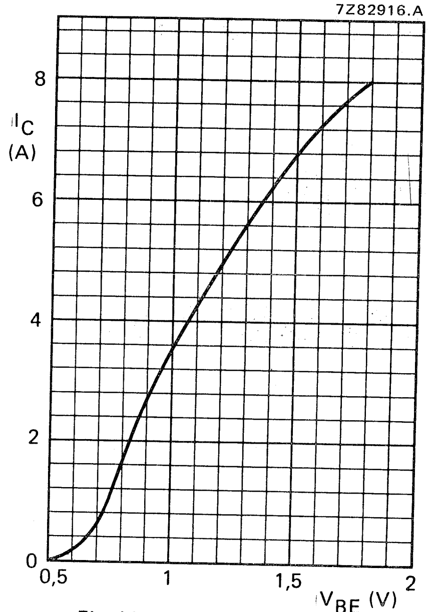


Fig. 11 Typical collector current.
V_{CE} = 4 V; T_j = 25 °C.

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

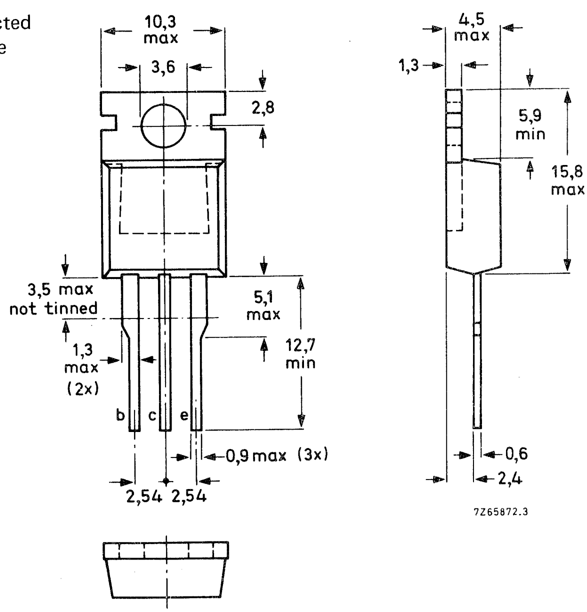
			BDT42	A	B	C	
Collector-base voltage	$-V_{CBO}$	max.	40	60	80	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	40	60	80	100	V
Collector current (d.c.)	$-I_C$	max.		6			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		65			W
Junction temperature	T_j	max.		150			°C
D.C. current gain $-I_C$ = 3 A; $-V_{CE}$ = 4 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)

			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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	65				W
Storage temperature	T_{stg}		−65 to + 150				^oC
Junction temperature	T_j	max.	150				^oC

THERMAL RESISTANCE

From junction to mouting base	$R_{th\ j\text{-}mb}$	=	1,92	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

			BDT42;A	B;C	
Collector cut-off current					
$I_B = 0$; $-V_{CE} = 30$ V	$-I_{CEO}$	<	0,7	–	mA
$I_B = 0$; $-V_{CE} = 60$ V	$-I_{CEO}$	<	–	0,7	mA
$V_{BE} = 0$; $-V_{CE} = -V_{CEOmax}$	$-I_{CES}$	<	0,4		mA
Emitter cut-off current					
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	1		mA
D.C. current gain*					
$-I_C = 300$ mA; $-V_{CE} = 4$ V	h_{FE}	>	30		
$-I_C = 3$ A; $-V_{CE} = 4$ V	h_{FE}		15 to 75		
Base-emitter voltage**					
$-I_C = 6$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	2		V
Collector-emitter saturation voltage*					
$-I_C = 6$ A; $-I_B = 0,6$ A	$-V_{CEsat}$	<	1,5		V

			BDT42	A	B	C	
Collector-emitter breakdown voltage*							
$I_B = 0$; $-I_C = 30$ mA	$-V_{(BR)CEO}$	>	40	60	80	100	V
Transition frequency at f = 1 MHz							
$-I_C = 500$ mA; $-V_{CE} = 10$ V	f_T	>	3				MHz
Small signal current transfer ratio							
$-I_C = 0,5$ A; $-V_{CE} = 10$ V; f = 1 kHz	$\lvert h_{fe} \rvert$	>	20				

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

Turn-off breakdown energy with inductive load (Fig. 5)			
$I_{Boff} = 0$; $-I_{CC} = 2,5$ A	$E_{(BR)}$	>	62,5 mJ
Switching times			
$-I_{Con} = 6$ A; $-I_{Bon} = I_{Boff} = 0,6$ A			
turn-on time	t_{on}	typ.	0,4 μs
turn-off time	t_{off}	typ.	0,7 μs

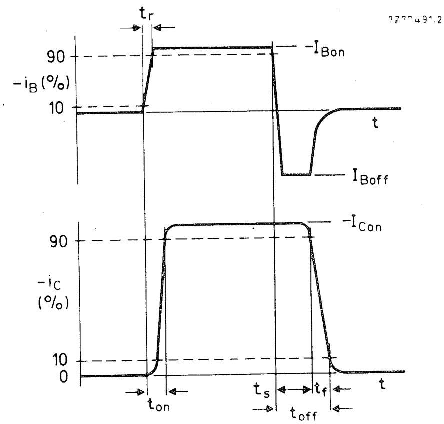
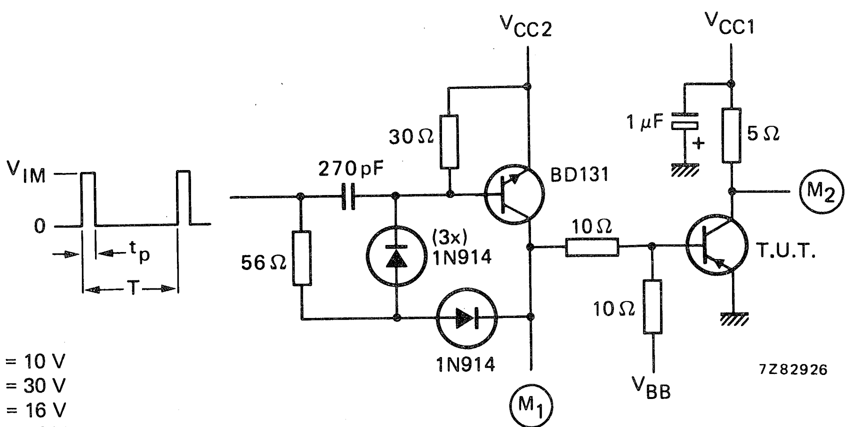


Fig. 2 Switching times waveforms.



$V_{IM} = 10$ V
$-V_{CC1} = 30$ V
$-V_{CC2} = 16$ V
$V_{BB} = 4$ V
$t_r = t_f = 15$ ns
$t_p = 20$ μs
$\delta \leqslant 2$ %

Fig. 3 Switching times test circuit.
Adjust V_{CC2} so that the input to M1 = 14 V.

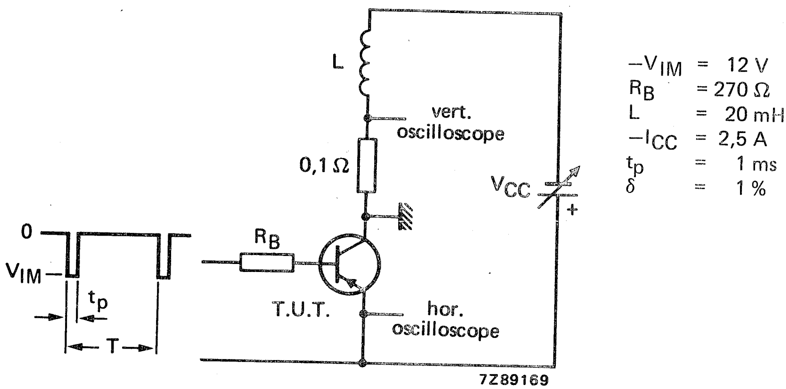


Fig. 4 Test circuit for turn-off breakdown energy.

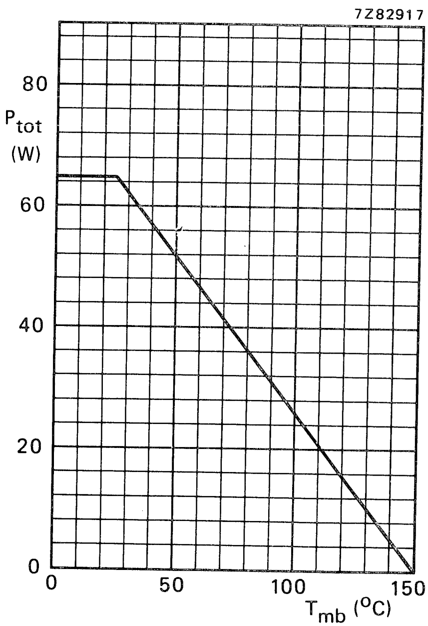


Fig. 5 Power derating curve.

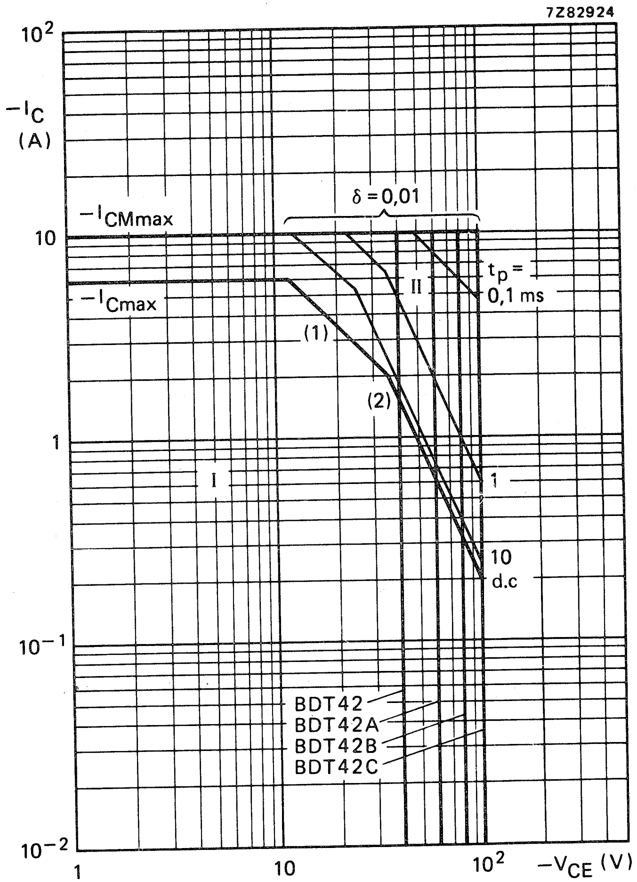


Fig. 6 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

(2) $P_{tot\,max}$ and $P_{peak\,max}$ lines.

(3) Second breakdown limits independent of temperature.

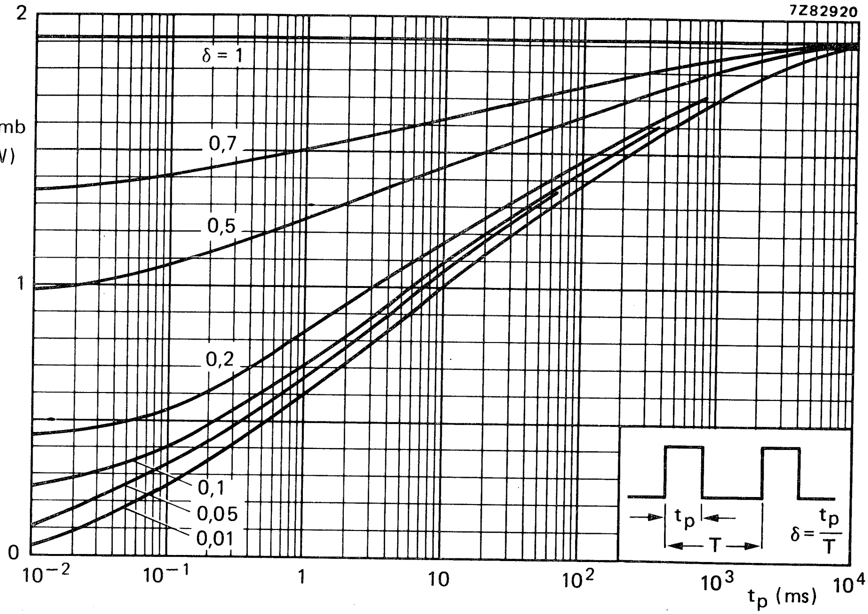


Fig. 7 Pulse power rating chart.

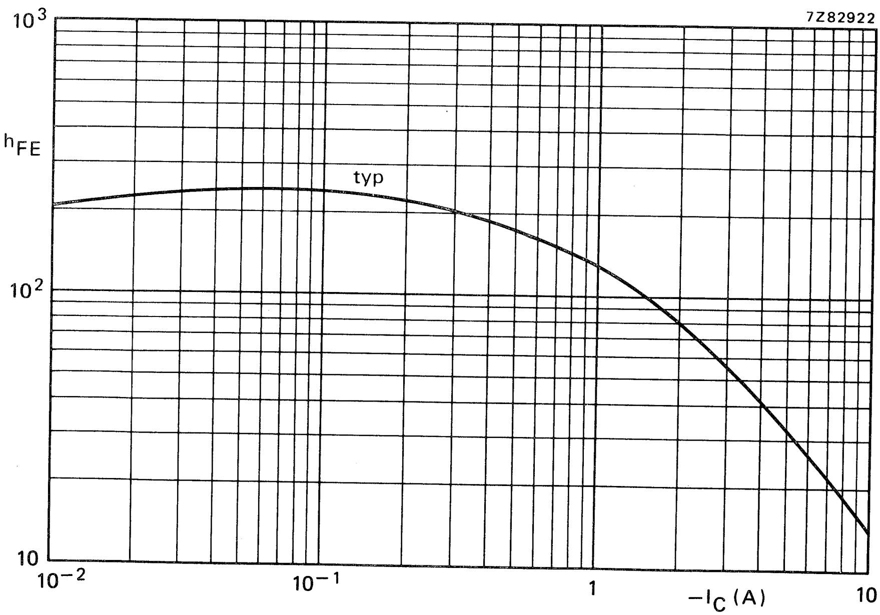


Fig. 8 Typical values d.c. current gain. $-V_{CE} = 4$ V; $T_j = 25$ °C.

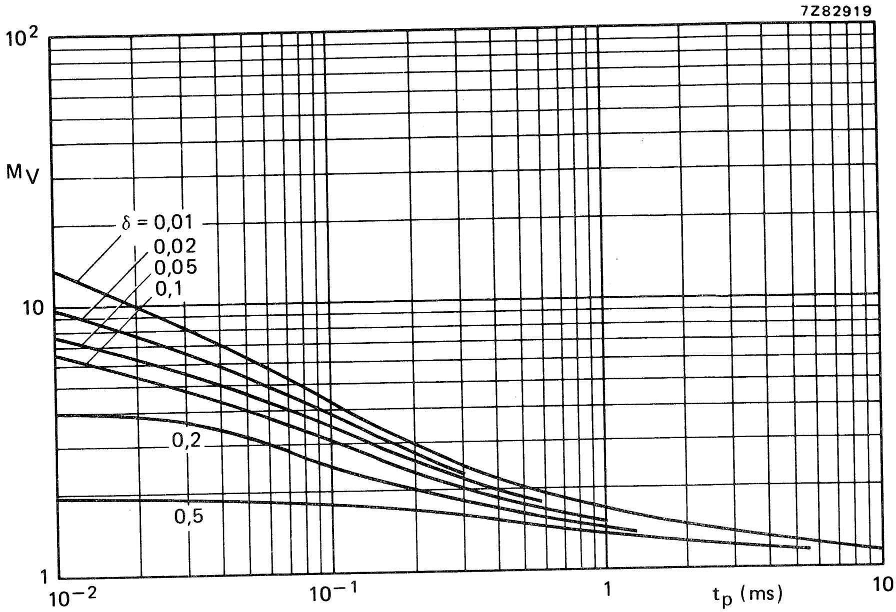


Fig. 9 Second breakdown voltage multiplying factor at the I_{Cmax} level.

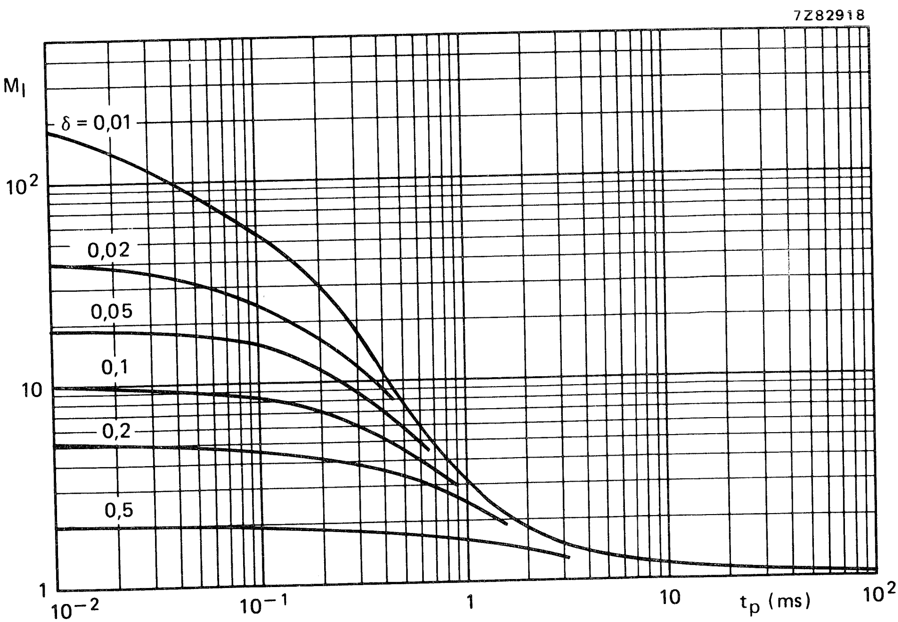


Fig. 10 Second breakdown current multiplying factor at the V_{CEOmax} level.

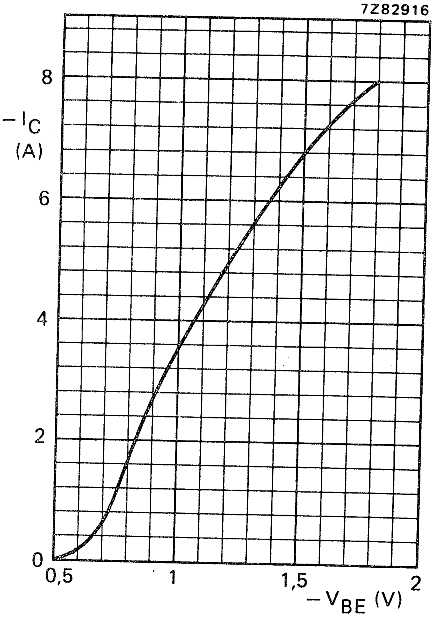


Fig. 11 Typical collector current.
$-V_{CE} = 4$ V; $T_j = 25$ °C.

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.

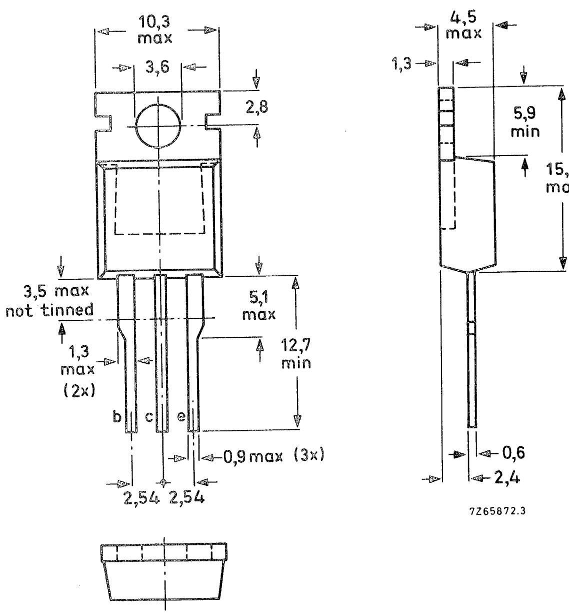
QUICK REFERENCE DATA

			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 °C	P_{tot}	max.		50			W
Junction temperature	T_j	max.		150			°C
D.C. current gain $-I_C$ = 0,5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.		2200			

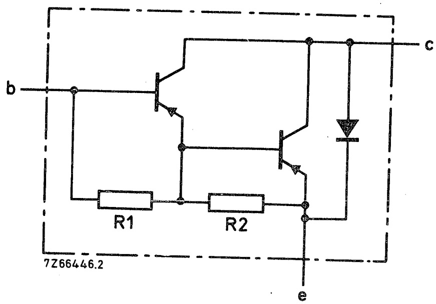
MECHANICAL DATA

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)	$-V_{CBO}$	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 °C	P_{tot}	max.		50			W
Storage temperature	T_{stg}			−65 to + 150			°C
Junction temperature*	T_j	max.		150			°C

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,5	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	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 °C unless otherwise specified.

Collector cut-off current			
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,2 mA
$I_E = 0$; $-V_{CB} = -½V_{CBOmax}$; T_j = 150 °C	$-I_{CBO}$	<	2 mA
$I_B = 0$; $-V_{CE} = -½V_{CEOmax}$	$-I_{CEO}$	<	1 mA
Emitter cut-off current			
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	5 mA
Forward bias second-breakdown collector current			
$-V_{CE}$ = 50 V; t = 0,1 s; non-repetitive (without heatsink); T_{amb} = 25 °C	$-I_{(SB)}$	>	1 A
D.C. current gain*			
$-I_C$ = 0,5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	2200 ←
$-I_C$ = 1,5 A; $-V_{CE}$ = 3 V	h_{FE}	>	750
$-I_C$ = 4 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	650 ←
Base-emitter voltage			
$-I_C$ = 1,5 A; $-V_{CE}$ = 3 V	$-V_{BE}$	<	2,5 V
Collector-emitter saturation voltage*			
$-I_C$ = 1,5 A; $-I_B$ = 6 mA	$-V_{CEsat}$	<	2,5 V
Cut-off frequency			
$-I_C$ = 1,5 A; $-V_{CE}$ = 3 V	f_{hfe}	>	25 kHz
Small-signal current gain at f = 1 MHz			
$-I_C$ = 1,5 A; $-V_{CE}$ = 3 V	h_{fe}	>	10

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

CHARACTERISTICS (continued)

Diode, forward voltage			
I_F = 1,5 A	V_F	<	2 V
I_F = 4 A	V_F	typ.	2,1 V
Switching times (between 10% and 90% levels)			
$-I_{Con}$ = 1,5 A; $-I_{Bon}$ = I_{Boff} = 6 mA; $-V_{CC}$ = 30 V			
→ turn-on time	t_{on}	typ.	0,3 μs
		<	1,5 μs
turn-off time	t_{off}	typ.	1,5 μs
		<	5 μs

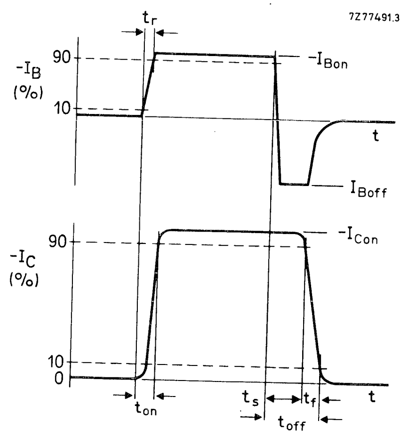
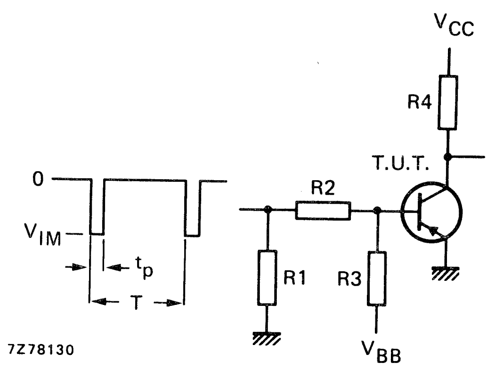


Fig. 3 Switching times waveforms.



$-V_{IM}$	=	12 V
$-V_{CC}$	=	30 V
$+V_{BB}$	=	3 V
R1	=	56 Ω
R2	=	1 kΩ
R3	=	680 Ω
R4	=	22 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

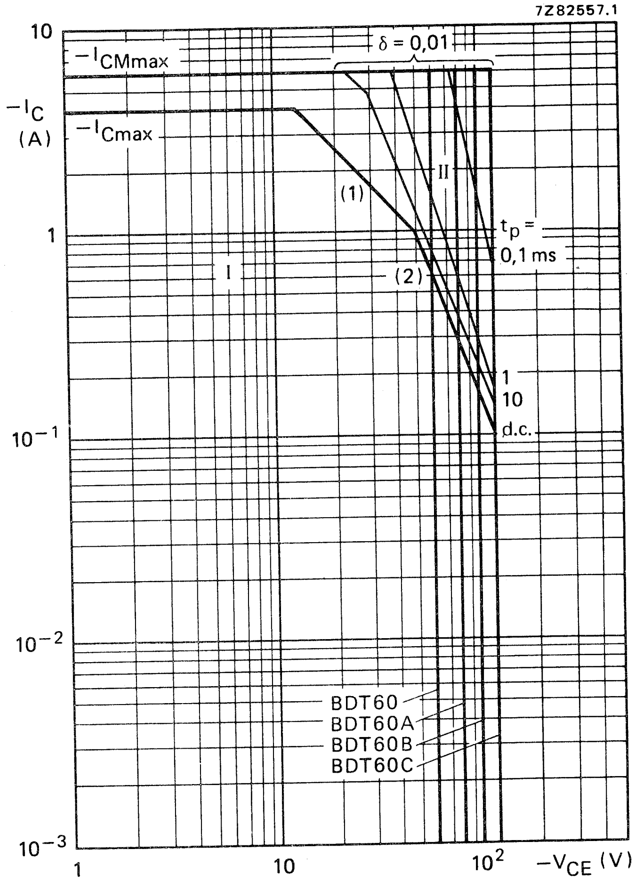


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

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).

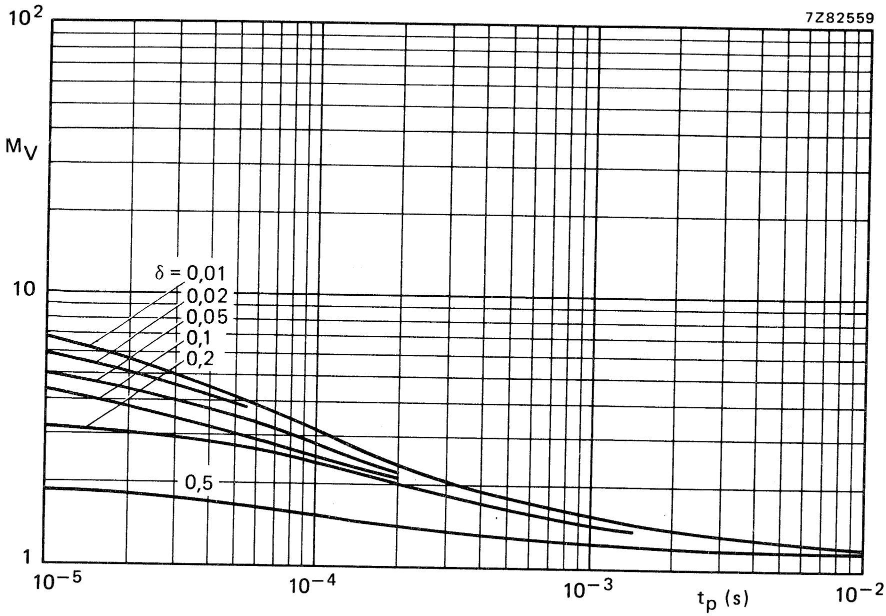


Fig. 6 Second-breakdown voltage multiplying factor at the $I_{C\,max}$ level.

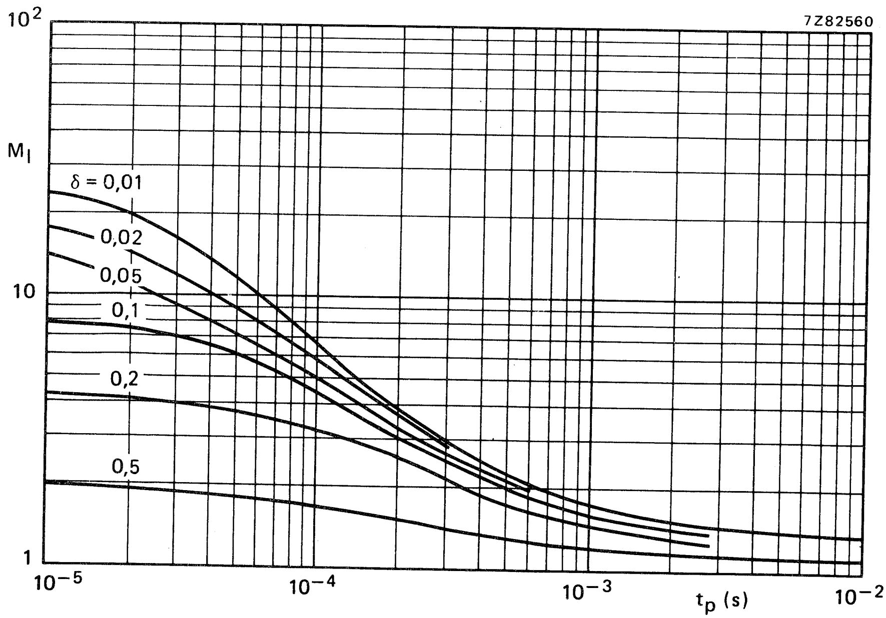


Fig. 7 Second-breakdown current multiplying factor at the $V_{CEO\,max}$ level.

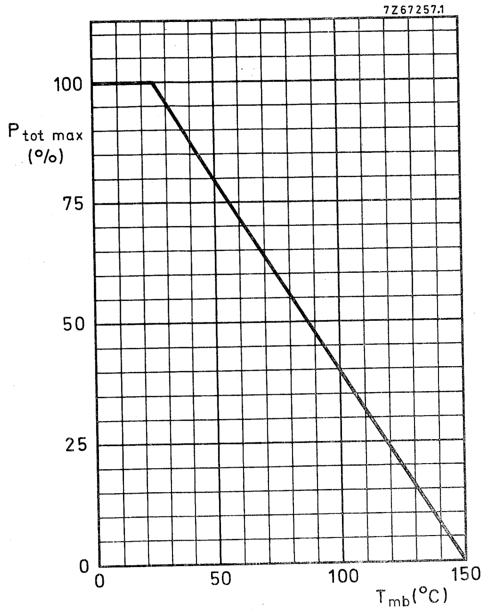


Fig. 8 Power derating curve.

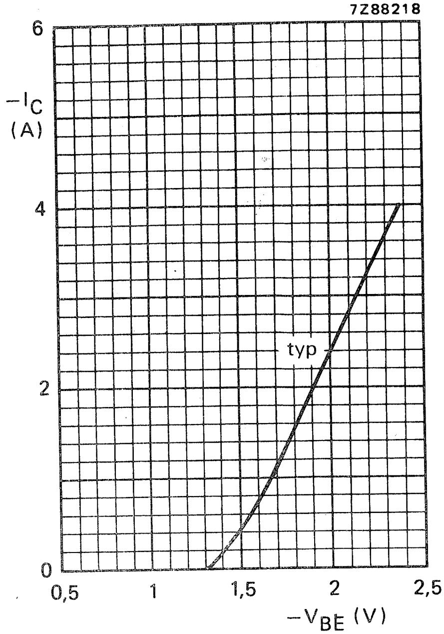


Fig. 9 $-V_{CE} = 3$ V; $T_j = 25$ °C.

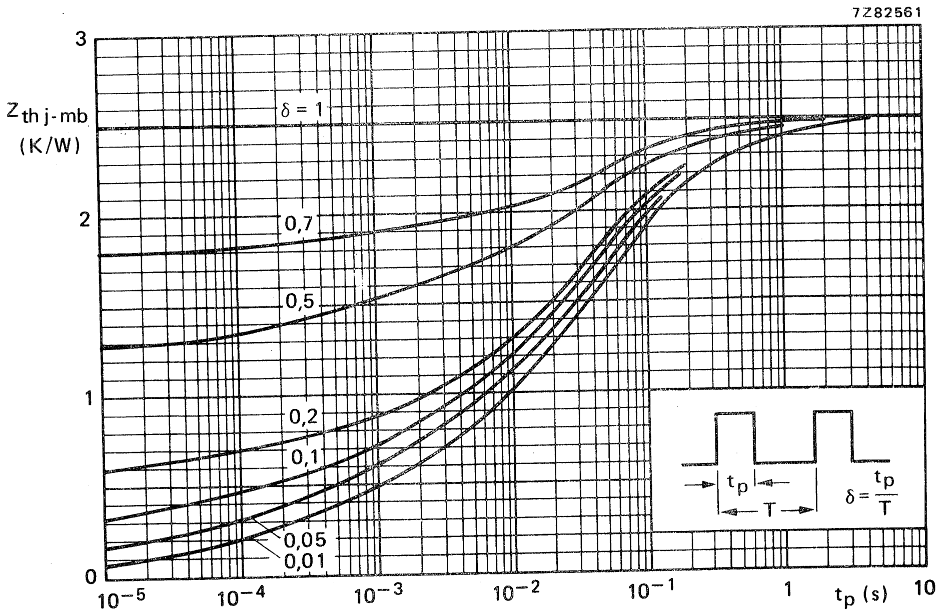


Fig. 10 Pulse power rating chart.

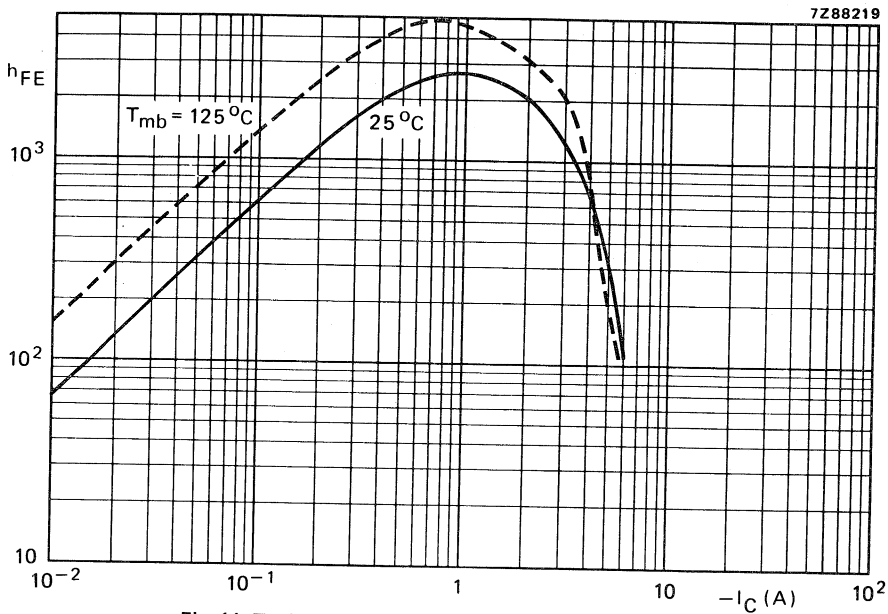


Fig. 11 Typical d.c. current gain. $-V_{CE} = 3$ V.

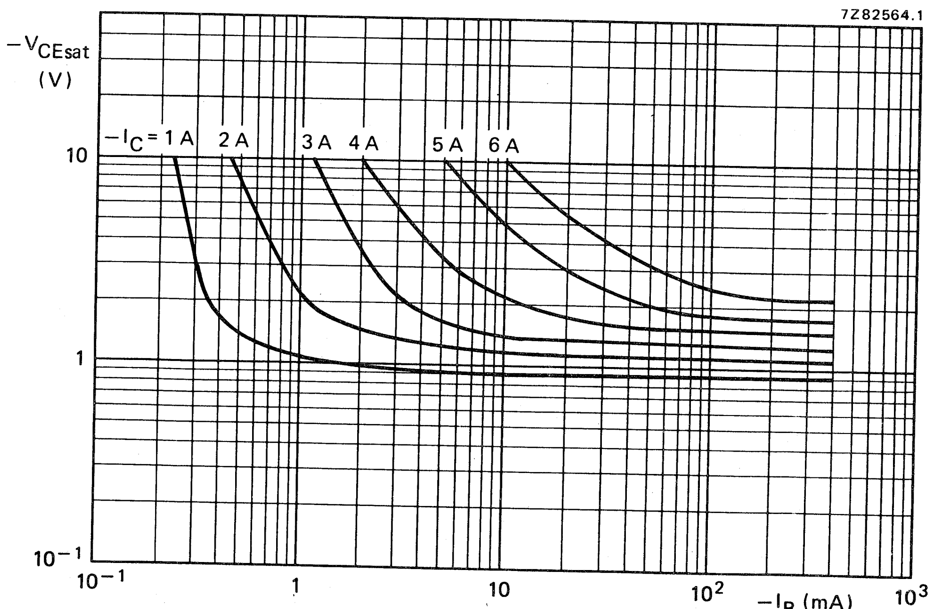


Fig. 12 Typical values collector-emitter saturation voltage at T_{mb} = 25 °C.

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

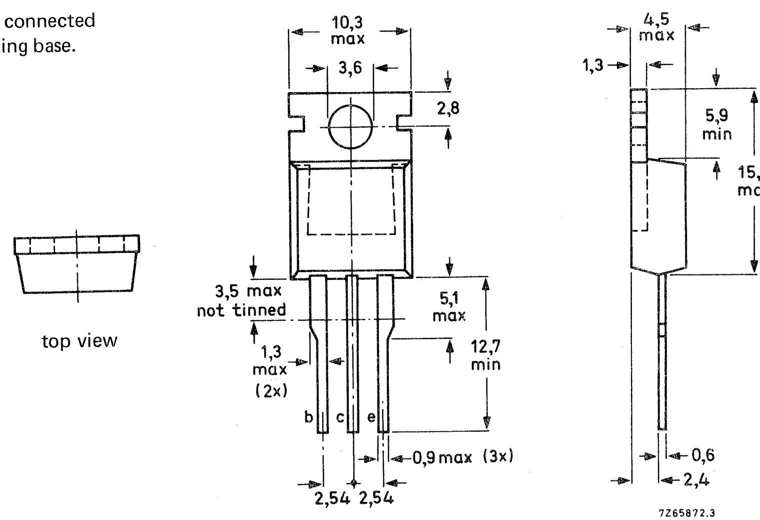
			BDT61	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (d.c.)	I_C	max.			4		A
Collector current (peak value)	I_{CM}	max.			6		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.			50		W
Junction temperature	T_j	max.			150		°C
D.C. current gain I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.			2200		

MECHANICAL DATA

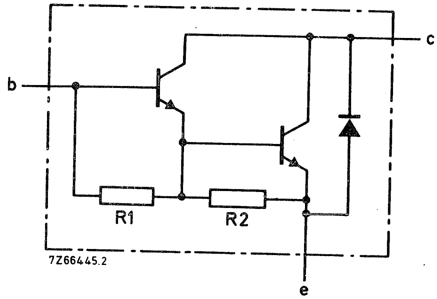
Dimensions in mm

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)

			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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	50	W
Storage temperature	T_{stg}		−65 to + 150	^oC
Junction temperature *	T_j	max.	150	^oC

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,5	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	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 °C unless otherwise specified

Collector cut-off current			
I_E = 0; V_{CB} = V_{CBOmax}	I_{CBO}	<	0,2 mA
I_E = 0; V_{CB} = ½V_{CBOmax}; T_j = 150 °C	I_{CBO}	<	2 mA
I_B = 0; V_{CE} = ½V_{CEOmax}	I_{CEO}	<	1 mA
Emitter cut-off current			
I_C = 0; V_{EB} = 5 V	I_{EBO}	<	5 mA
Forward-bias second-breakdown collector current			
V_{CE} = 50 V; t = 0,1 s; non-repetitive (without heatsink); T_{amb} = 25 °C	$I_{(SB)}$	>	1 A
D.C. current gain *			
I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.	2200
I_C = 1,5 A; V_{CE} = 3 V	h_{FE}	>	750
I_C = 4 A; V_{CE} = 3 V	h_{FE}	typ.	1500
Base-emitter voltage *			
I_C = 1,5 A; V_{CE} = 3 V	V_{BE}	<	2,5 V
Collector-emitter saturation voltage *			
I_C = 1,5 A; I_B = 6 mA	V_{CEsat}	<	2,5 V
Turn-off breakdown energy with inductive load (Fig. 3)			
$-I_{Boff}$ = 0; L = 5 mH; I_{CC} = 3,2 A	$E_{(BR)}$	>	25 mJ
Small-signal current gain at f = 1 MHz			
I_C = 1,5 A; V_{CE} = 3 V	h_{fe}	>	10
Cut-off frequency			
I_C = 1,5 A; V_{CE} = 3 V	f_{hfe}	typ.	25 kHz

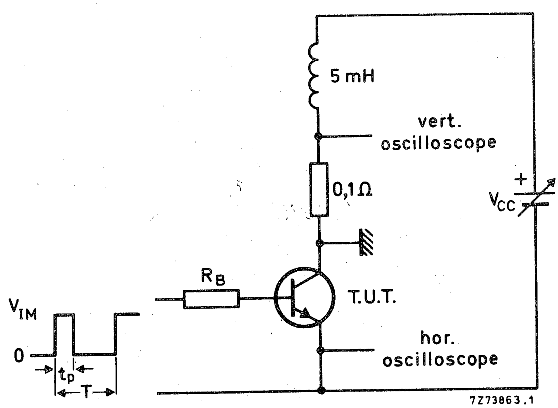


Fig. 3 Turn-off breakdown energy with inductive load.

V_{IM} = 12 V; R_B = 270 Ω; $\delta = \frac{t_p}{T}$ x 100% = 1%; I_{CC} = 3,2 A.

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

CHARACTERISTICS (continued)

Diode, forward voltage			
I_F = 1,5 A	V_F	<	2 V
I_F = 4 A	V_F	typ.	2,1 V
Switching times (between 10% and 90% levels) I_{Con} = 1,5 A; I_{Bon} = $-I_{Boff}$ = 6 mA			
turn-on time	t_{on}	typ.	0,8 µs
		<	2 µs
turn-off time	t_{off}	typ.	4,5 µs
		<	8 µs

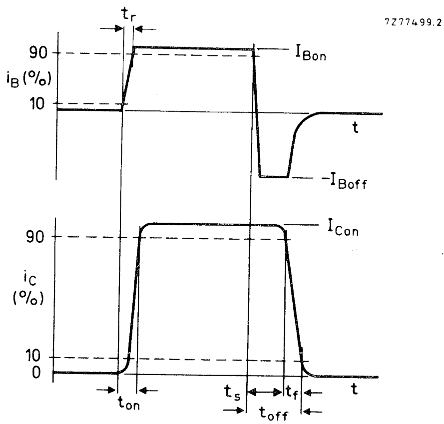


Fig. 4 Switching times waveforms.

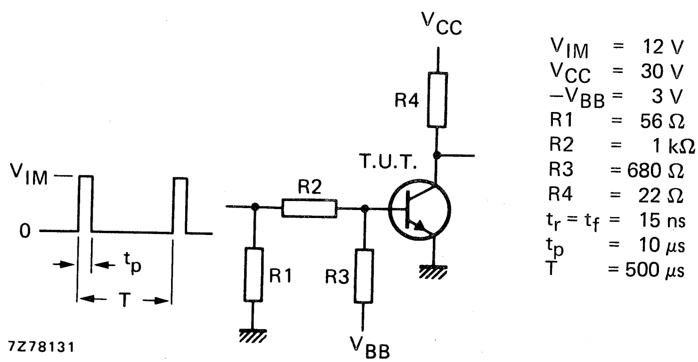


Fig. 5 Switching times test circuit.

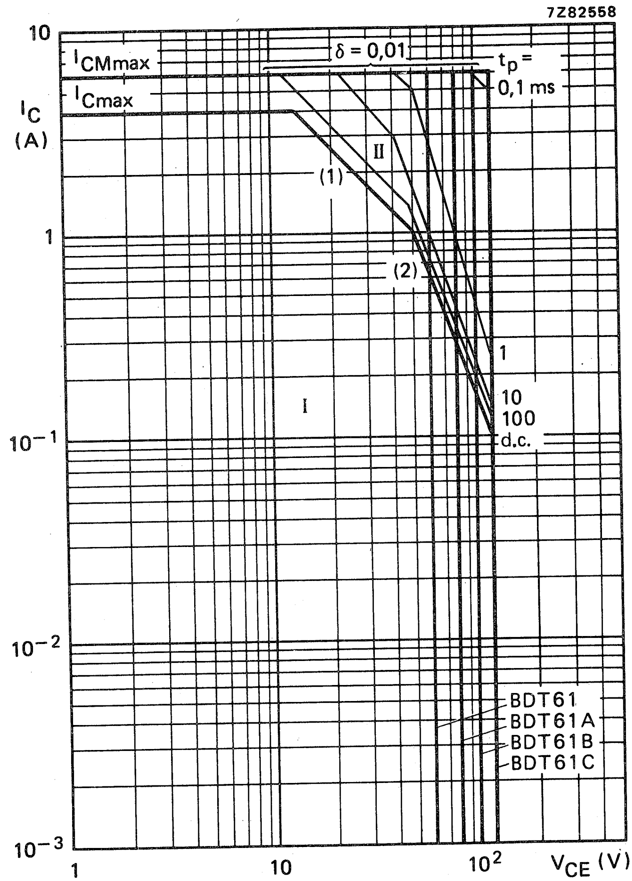


Fig. 6 Safe Operating ARea; T_{mb} = 25 °C.

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).

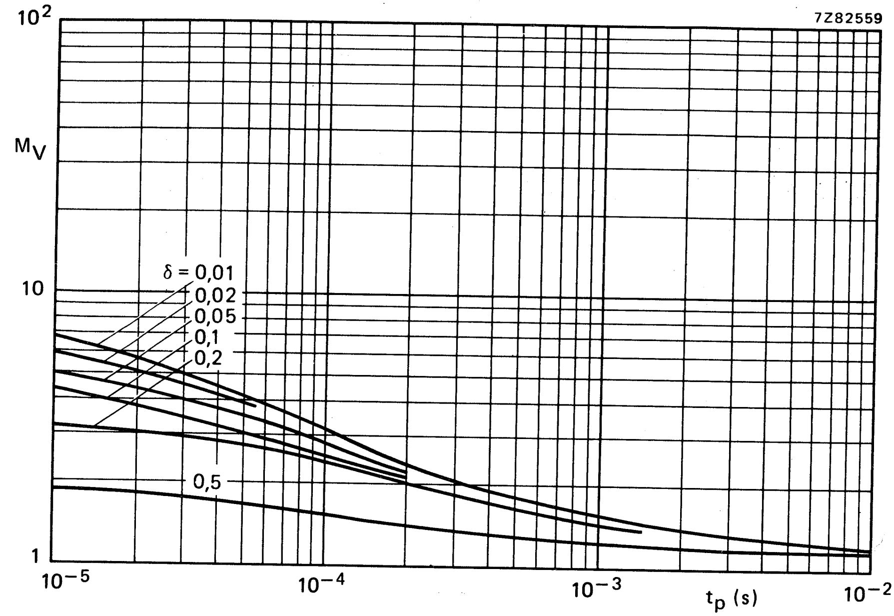


Fig. 7 Second breakdown voltage multiplying factor at the I_{Cmax} level.

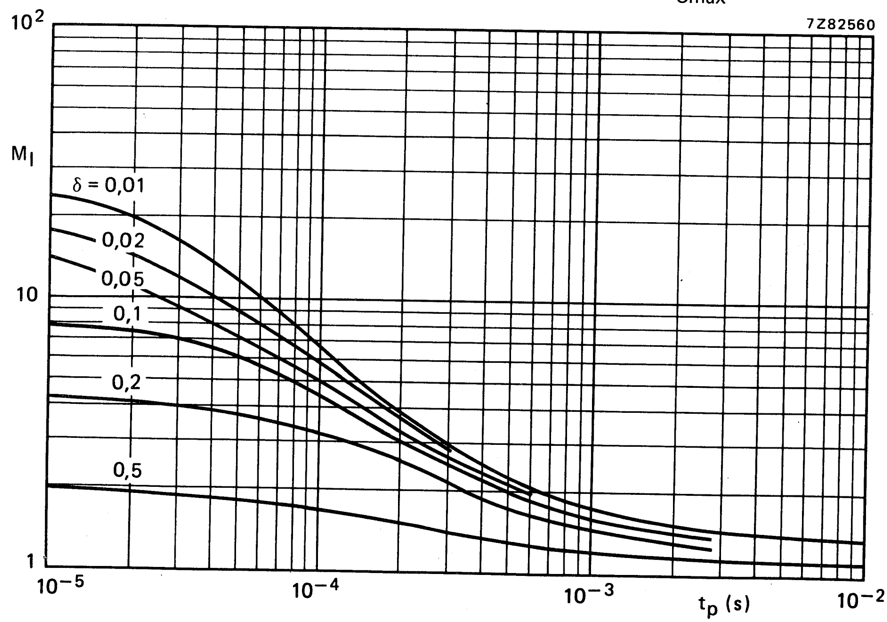


Fig. 8 Second breakdown current multiplying factor at the V_{CEOmax} level.

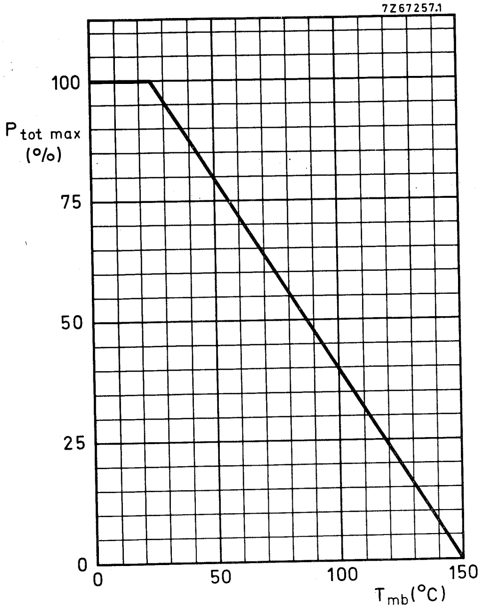


Fig. 9 Power derating curve.

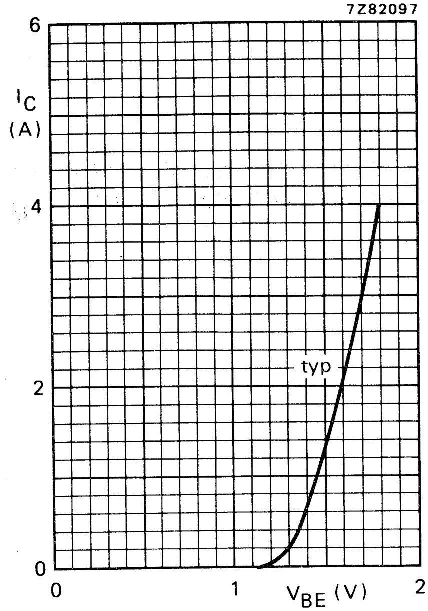


Fig. 10 V_{CE} = 3 V; T_j = 25 °C.

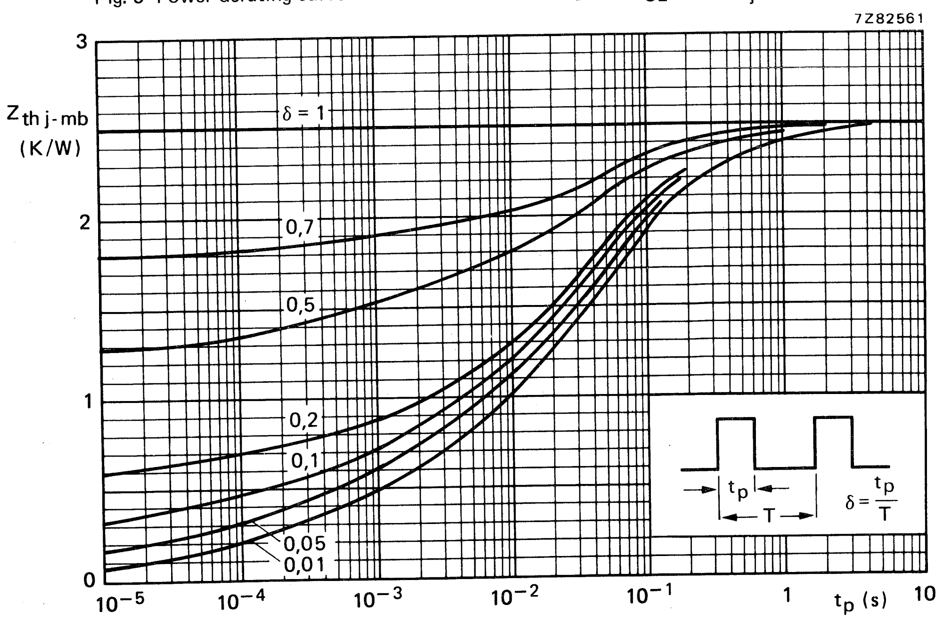


Fig. 11 Pulse power rating chart.

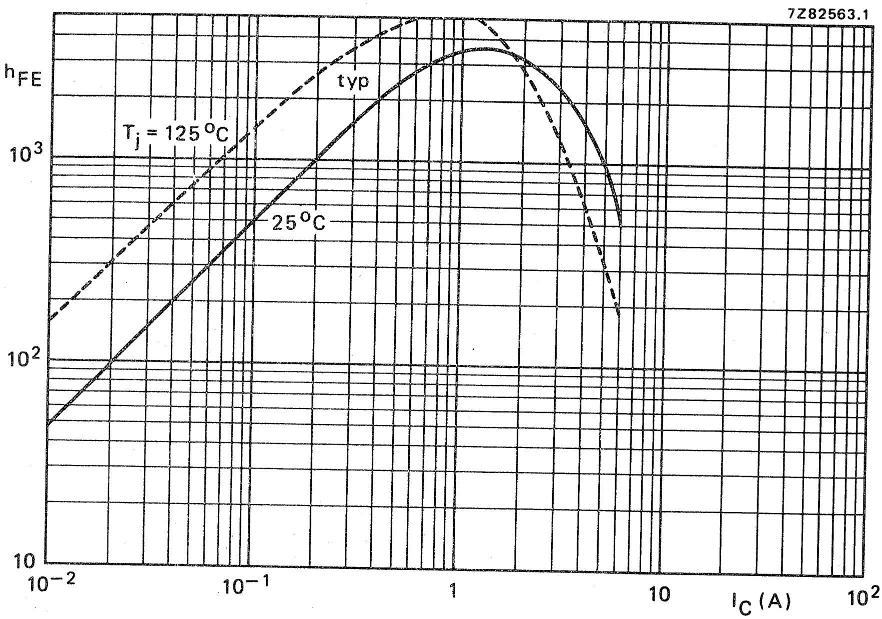


Fig. 12 Typical d.c. current gain. V_{CE} = 3 V.

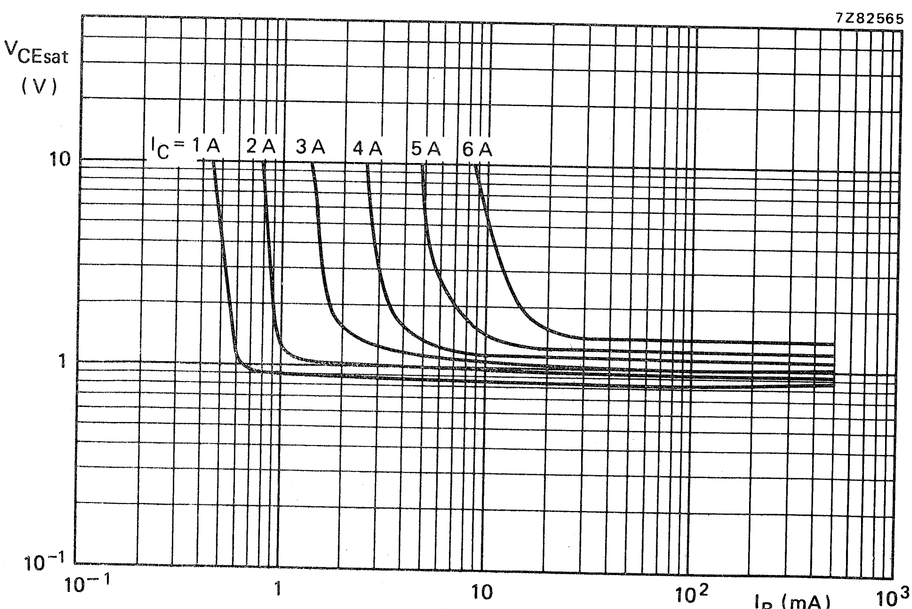


Fig. 13 Typical values collector-emitter saturation voltage at T_{mb} = 25 °C.

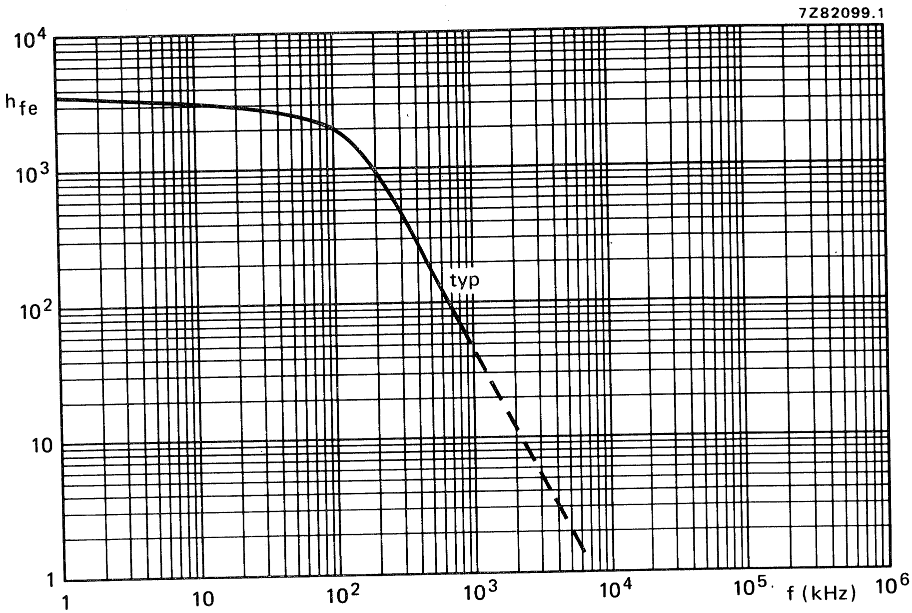


Fig. 14 Small signal current gain. I_C = 1,5 A; V_{CE} = 3 V; T_j = 25 °C.

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.

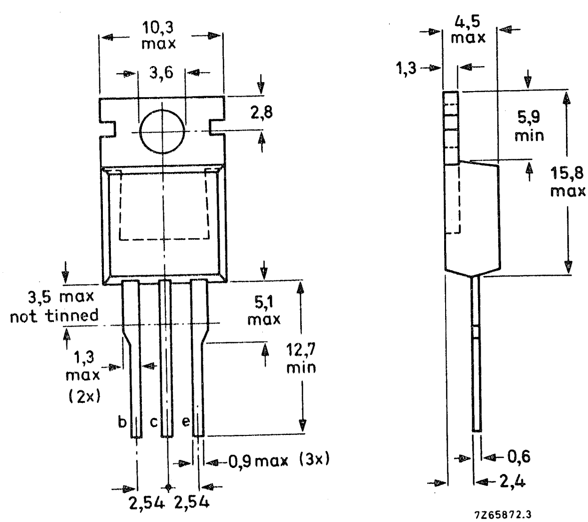
QUICK REFERENCE DATA

			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; δ = 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		

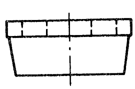
MECHANICAL DATA

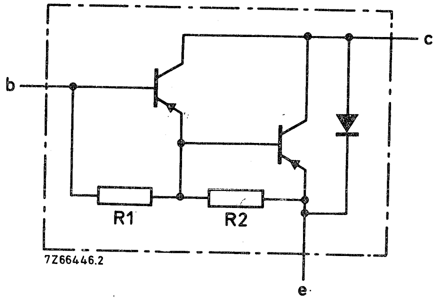
Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.





R1 typ. 4 kΩ
R2 typ. 60 Ω

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; δ = 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	$R_{th\ j\text{-}mb}$	=	1,39	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	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 °C unless otherwise specified.

Collector cut-off current			
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,2 mA
$I_E = 0$; $-V_{CB} = -\frac{1}{2}V_{CBOmax}$; T_j = 150 °C	$-I_{CBO}$	<	2 mA
$I_B = 0$; $-V_{CE} = -\frac{1}{2}V_{CEOmax}$	$-I_{CEO}$	<	0,5 mA
Emitter cut-off current			
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	5 mA
Forward bias second-breakdown collector current			
$-V_{CE} = 40$ V; t = 0,1 s; non-repetitive (without heatsink)			
BDT62	$I_{(SB)}$	>	0,45 A
BDT62A, B and C	$I_{(SB)}$	>	1,4 A
D.C. current gain*			
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE}	>	1000
$-I_C = 10$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	200
Base-emitter voltage*			
$-I_C = 3$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5 V
Collector-emitter saturation voltage*			
$-I_C = 3$ A; $-I_B = 12$ mA	$-V_{CEsat}$	<	2 V
$-I_C = 8$ A; $-I_B = 80$ mA	$-V_{CEsat}$	<	2,5 V
Cut-off frequency			
$-I_C = 3$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	100 kHz
Collector capacitance			
$-V_{CB} = 10$ V; f = 1 MHz	C_{ob}	typ.	100 pF
D.C. current gain ratio of matched complementary pairs			
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE1}/h_{FE2}	<	2,5
Small-signal current gain at f = 1 MHz			
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{fe}	>	25

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

CHARACTERISTICS (continued)

Diode, forward voltage $I_F = 3$ A	V_F	<	2 V
Switching times (between 10% and 90% levels) $-I_{Con} = 3$ A; $-I_{Bon} = I_{Boff} = 12$ mA			
turn-on time	t_{on}	typ.	0,5 μs
turn-off time	t_{off}	typ.	2,5 μs

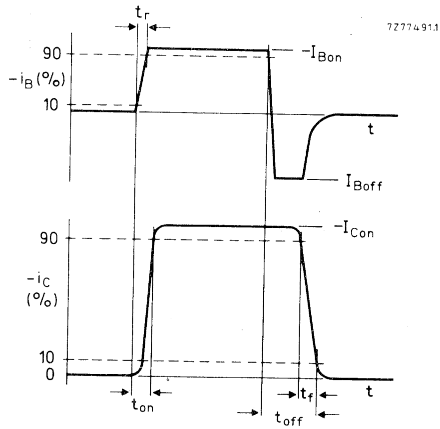
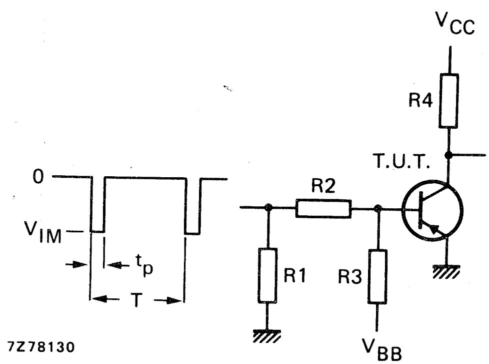


Fig. 3 Switching times waveforms.



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

Fig. 4 Switching times test circuit.

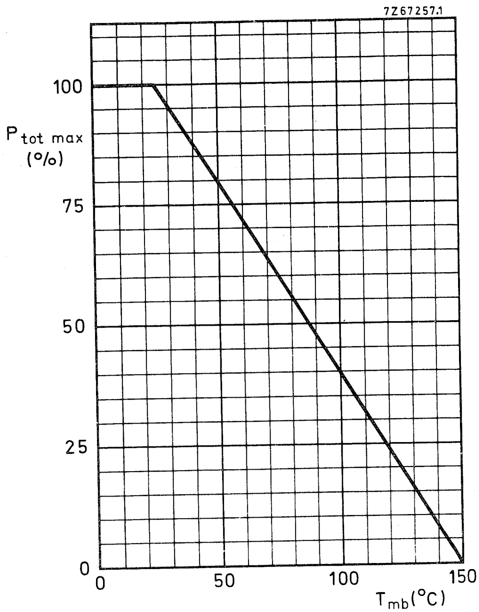


Fig. 5 Power derating curve.

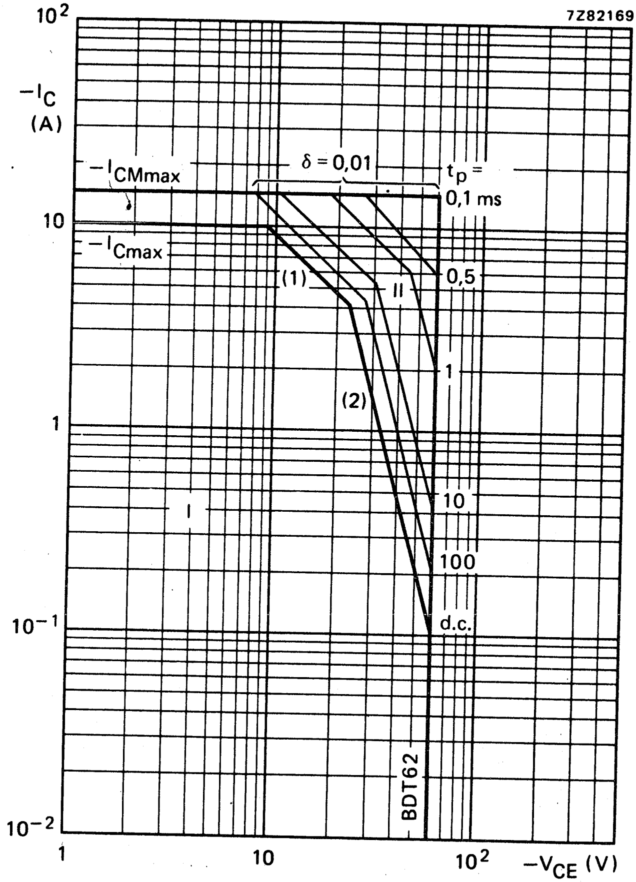


Fig. 6 Safe Operating ARea BDT62; T_{mb} = 25 °C.

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).

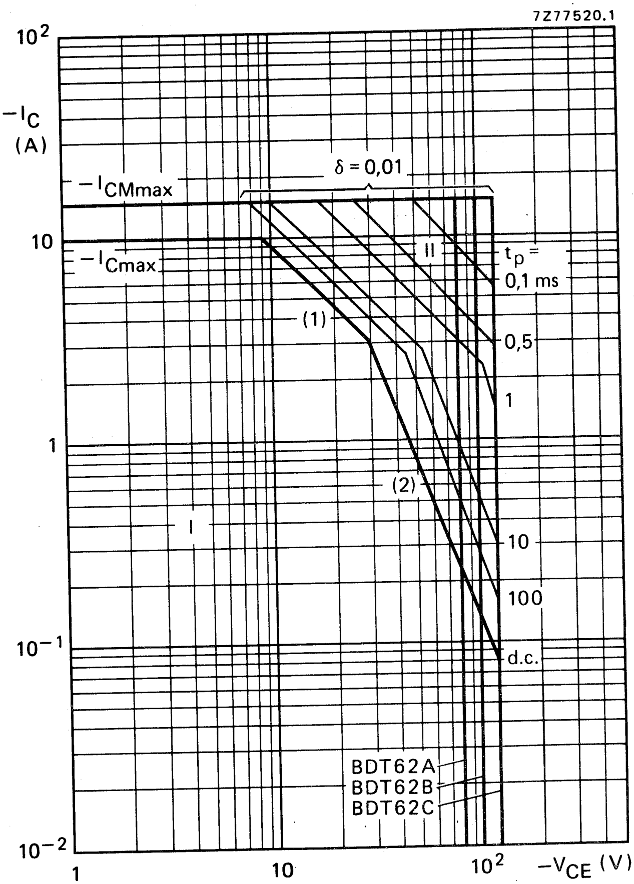


Fig. 7 Safe Operating ARea BDT62A; 62B and 62C; T_{mb} = 25 °C.

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

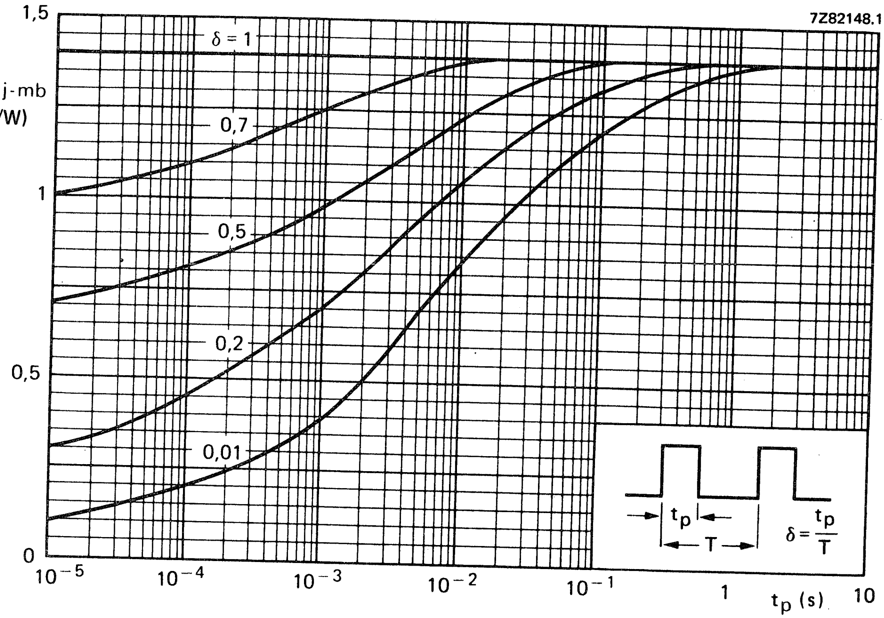


Fig. 8 Pulse power rating chart.

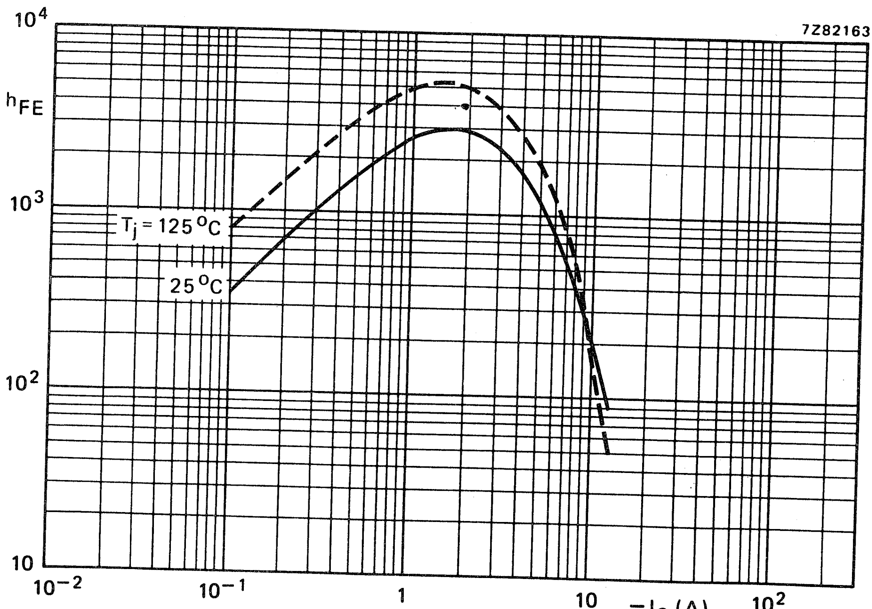


Fig. 9 Typical d.c. current gain at $-V_{CE} = 3$ V.

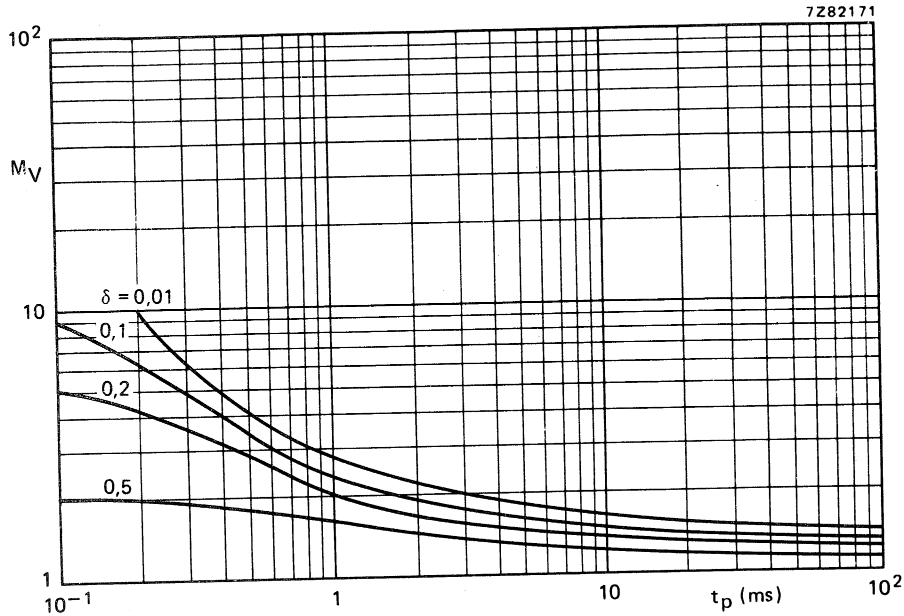


Fig. 10 S.B. voltage multiplying factor at the $I_{C\,max}$ level.

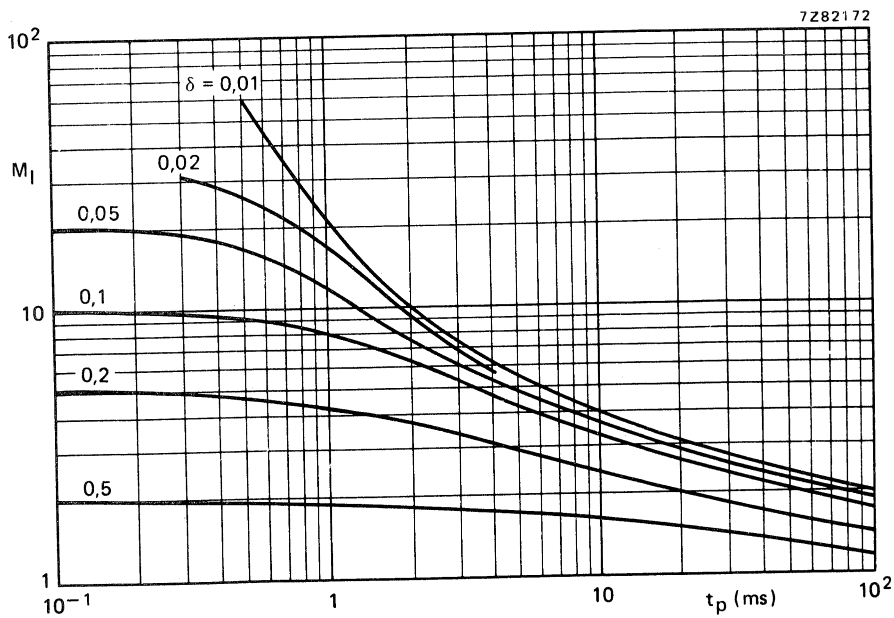


Fig. 11 S.B. current multiplying factor at the $V_{CEO\,max}$ level.

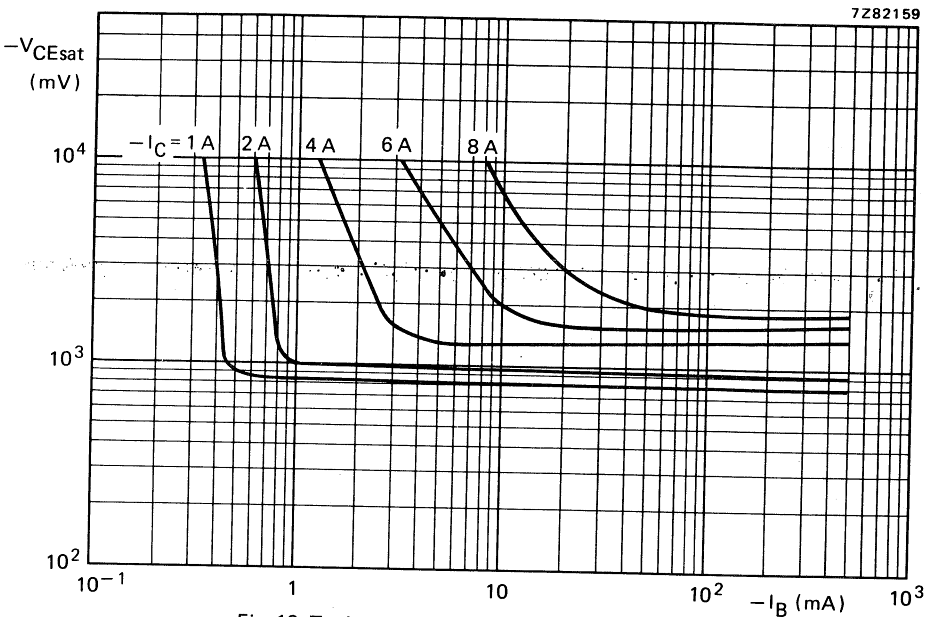


Fig. 12 Typical collector-emitter saturation voltage.

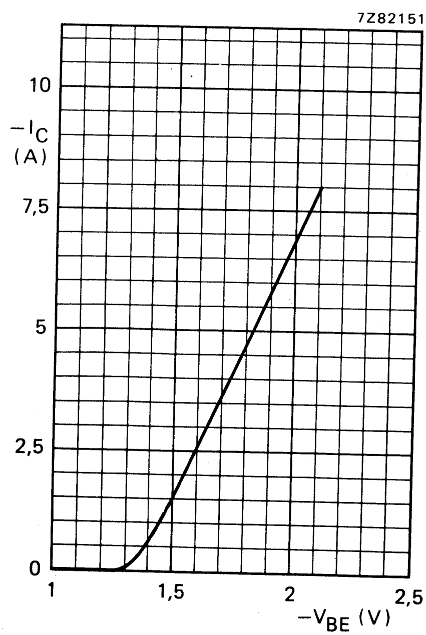


Fig. 13 Typical base emitter voltage as a function of the collector current.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-220 plastic envelope. P-N-P complements are BDT62, BDT62A; BDT62B and BDT62C.

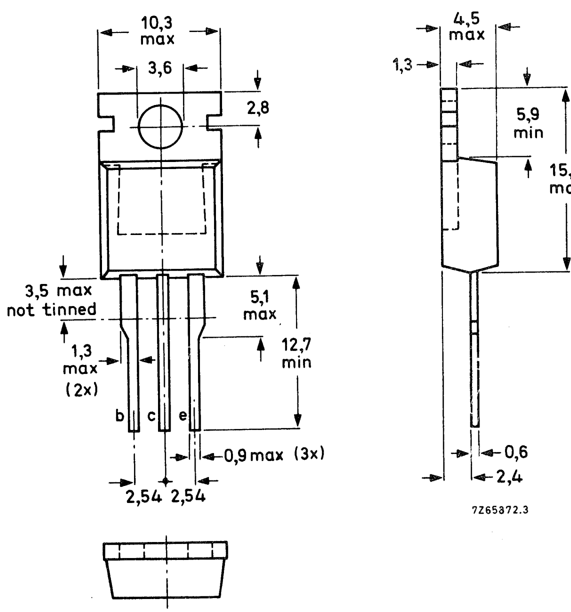
QUICK REFERENCE DATA

			BDT63	A	B	C	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (d.c.)	I_C	max.		10			A
Collector current (peak value) t_p = 0,3 ms; δ = 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			

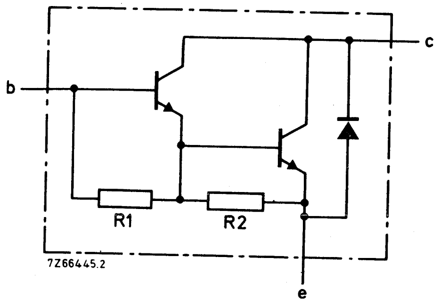
MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.



R1 typ. 8 kΩ
R2 typ. 100 Ω

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; δ = 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	$R_{th\ j\text{-}mb}$	=	1,39	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	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 °C unless otherwise specified.

Collector cut-off current			
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	0,2 mA
$I_E = 0$; $V_{CB} = \frac{1}{2}V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	2 mA
$I_B = 0$; $V_{CE} = \frac{1}{2}V_{CEOmax}$	I_{CEO}	<	0,5 mA
Emitter cut-off current			
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5 mA
Forward-bias second-breakdown collector current			
V_{CE} = 60 V; t = 0,1 s; non-repetitive (without heatsink)	$I_{(SB)}$	>	1,5 A ←
D.C. current gain*			
I_C = 3 A; V_{CE} = 3 V	h_{FE}	>	1000
I_C = 10 A; V_{CE} = 3 V	h_{FE}	typ.	3000
Base-emitter voltage*			
I_C = 3 A; V_{CE} = 3 V	V_{BE}	<	2,5 V
Collector-emitter saturation voltage*			
I_C = 3 A; I_B = 12 mA	V_{CEsat}	<	2 V
I_C = 8 A; I_B = 80 mA	V_{CEsat}	<	2,5 V
Diode, forward voltage			
I_F = 3 A	V_F	<	2 V
Turn-off breakdown energy with inductive load (Fig. 6)			
$-I_{Boff} = 0$; L = 5 mH	$E_{(BR)}$	>	100 mJ
Small-signal current gain at f = 1 MHz			
I_C = 3 A; V_{CE} = 3 V	h_{fe}	>	25
Cut-off frequency			
I_C = 3 A; V_{CE} = 3 V	f_{hfe}	typ.	50 kHz
Collector capacitance			
V_{CB} = 10 V; f = 1 MHz	C_{ob}	typ.	100 pF
D.C. current gain ratio of matched complementary pairs			
I_C = 3 A; V_{CE} = 3 V	h_{FE1}/h_{FE2}	<	2,5

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

CHARACTERISTICS (continued)

Switching times
(between 10% and 90% levels)
$I_{Con} = 3$ A; $I_{Bon} = -I_{Boff} = 12$ mA

turn-on time	t_{on}	typ.	1 µs
		<	2,5 µs
turn-off time	t_{off}	typ.	5 µs
		<	10 µs

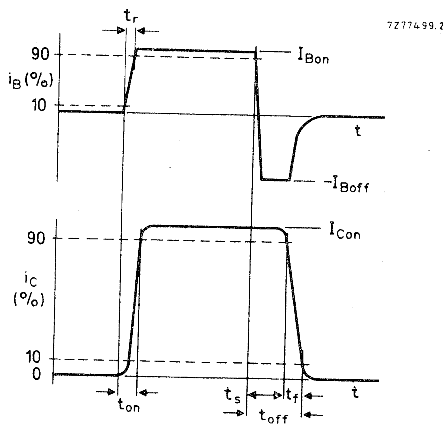
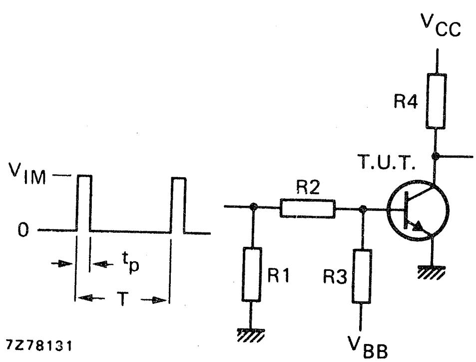


Fig. 3 Switching times waveforms.



V_{IM}	=	10 V
V_{CC}	=	10 V
$-V_{BB}$	=	4 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	3 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 µs
T	=	500 µs

Fig. 4 Switching times test circuit.

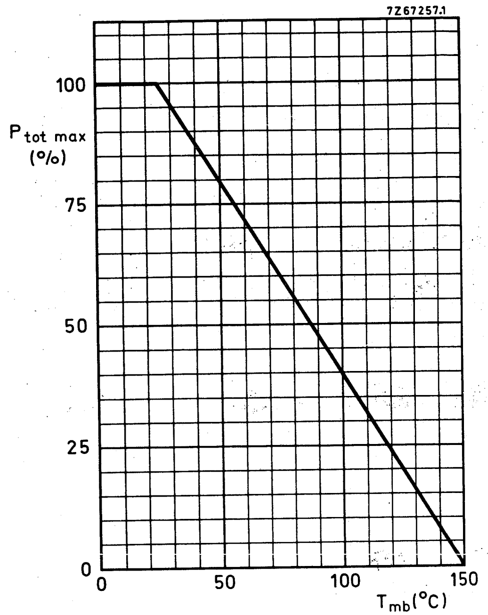


Fig. 5 Power derating curve.

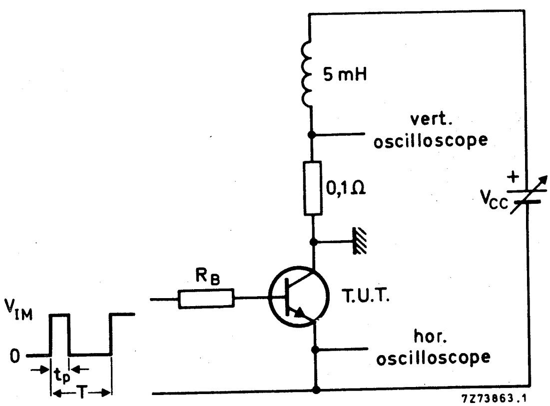


Fig. 6 Turn-off breakdown energy with inductive load.
V_{IM} = 12 V; R_B = 270 Ω; $\delta = \frac{t_p}{T} \times 100\% = 1\%$; I_{CC} = 6,3 A.

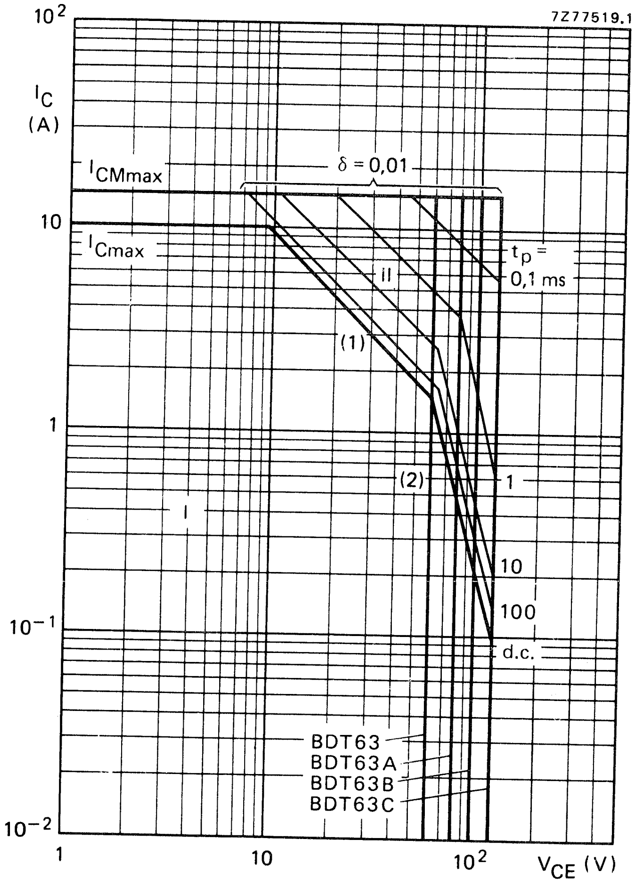


Fig. 7 Safe Operating ARea; T_{mb} = 25 °C.

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

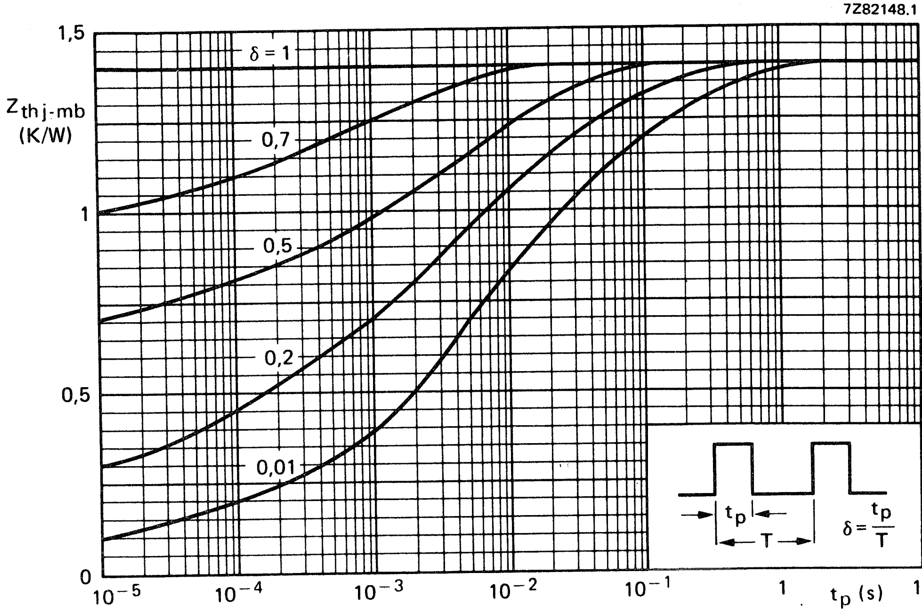


Fig. 8 Pulse power rating chart.

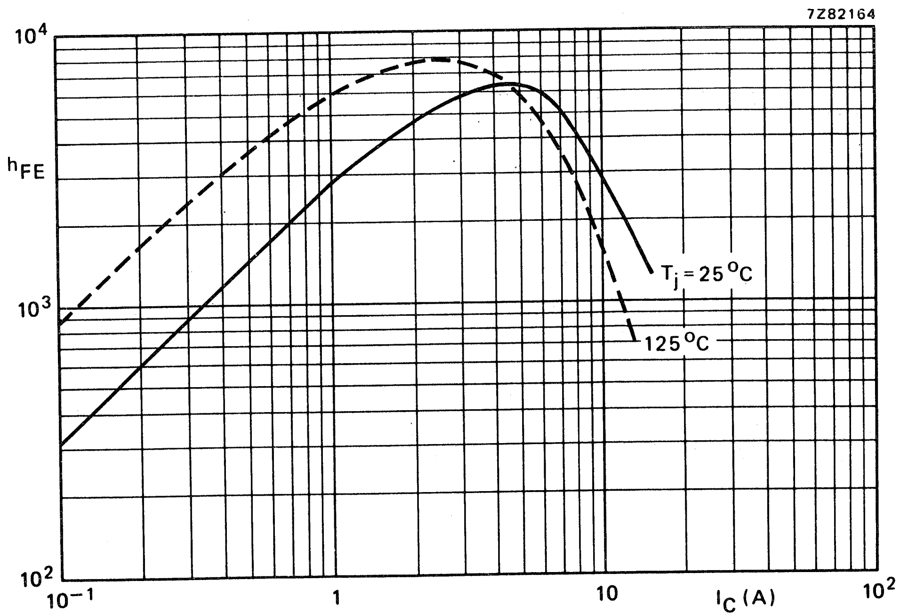


Fig. 9 Typical d.c. current gain at V_{CE} = 3 V.

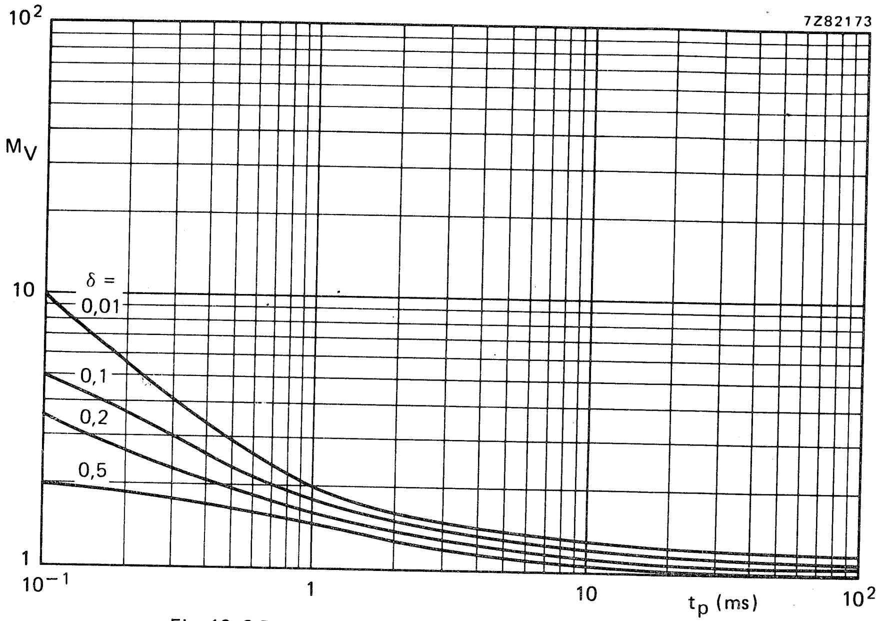


Fig. 10 S.B. voltage multiplying factor at the $I_{C\,max}$ level.

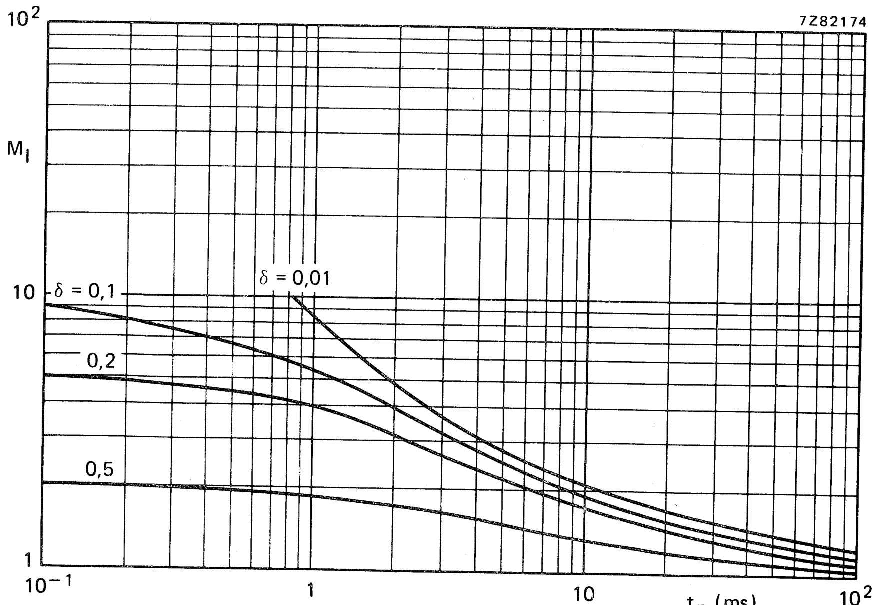


Fig. 11 S.B. current multiplying factor at V_{CEO} level = 60 V and 100 V.

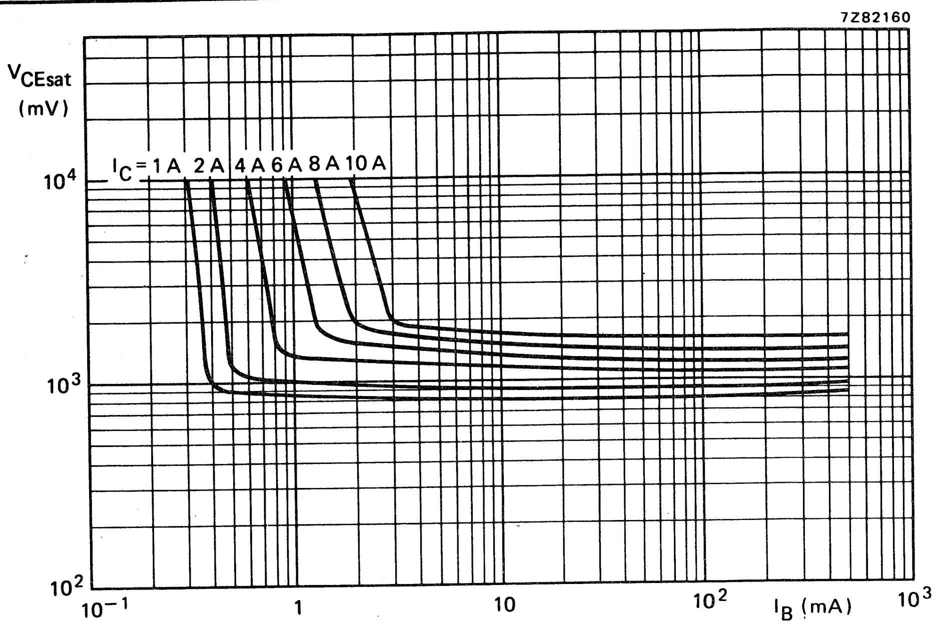


Fig. 12 Typical collector-emitter saturation voltage.

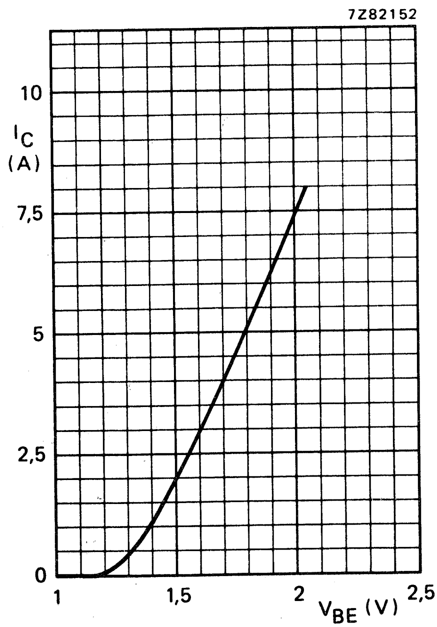


Fig. 13 Typical base-emitter voltage as a function of the collector current.

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

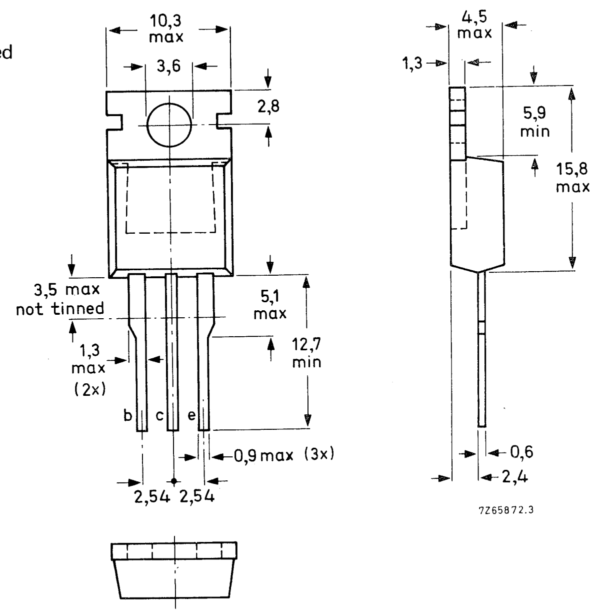
			BDT64	64A	64B	64C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V
Collector current (peak value)	$-I_{CM}$	max.	20				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125				W
Junction temperature	T_j	max.	150				°C
D.C. current gain $-I_C$ = 5 A; $-V_{CE}$ = 4 V	h_{FE}	>	1000				

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

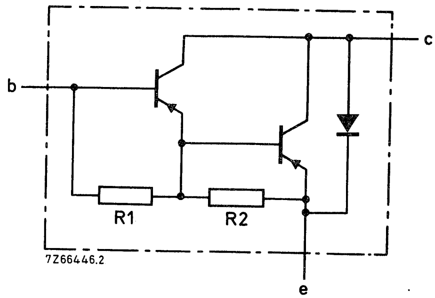


Fig. 2 Circuit diagram. R1 typ. 3 kΩ; R2 typ. 45 Ω.

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 °C	P_{tot}	max.	125				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off current			
$-V_{CB} = -V_{CBOmax}$; $I_E = 0$	$-I_{CBO}$	<	0,4 mA
$I_E = 0$; $-V_{CB} = -½\,V_{CBOmax}$; T_j = 150 °C	$-I_{CBO}$	<	2 mA
$I_B = 0$; $-V_{CE} = -½\,V_{CEOmax}$	$-I_{CEO}$	<	1 mA
Emitter cut-off current			
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	5 mA
D.C. current gain*			
$-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	typ.	1500
$-I_C$ = 5 A; $-V_{CE}$ = 4 V	h_{FE}	>	1000
$-I_C$ = 12 A; $-V_{CE}$ = 4 V	h_{FE}	typ.	750
Base-emitter voltage			
$-I_C$ = 5 A; $-V_{CE}$ = 4 V	$-V_{BE}$	<	2,5 V
Collector-emitter saturation voltage*			
$-I_C$ = 5 A; $-I_B$ = 20 mA	$-V_{CEsat}$	<	2 V
$-I_C$ = 10 A; $-I_B$ = 100 mA	$-V_{CEsat}$	<	3 V
Diode, forward voltage			
I_F = 5 A	V_F	<	2 V
I_F = 12 A	V_F	typ.	2 V
Collector capacitance at f = 1 MHz			
$-V_{CB}$ = 10 V; $I_E = I_e = 0$	C_c	typ.	200 pF
Second breakdown collector current non-repetitive; without heatsink			
$-V_{CE}$ = 60 V; t_p = 0,1 s	$-I_{SB}$	>	2 A
Switching times (see Figs 3 and 4)			
$-I_{Con}$ = 5 A; $-I_{Bon} = I_{Boff}$ = 20 mA			
$-V_{CC}$ = 30 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 A; $-V_{CE}$ = 3 V; f = 1 MHz	$\|h_{fe}\|$	typ.	40

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

CHARACTERISTICS (continued)

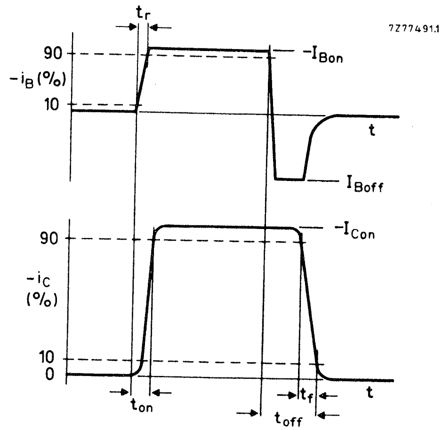
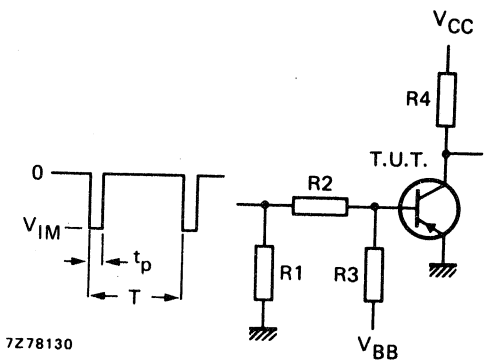


Fig. 3 Switching times waveforms.



$-V_{IM}$	=	15 V
$-V_{CC}$	=	30 V
V_{BB}	=	4 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	6 Ω
$t_r = t_f$	=	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

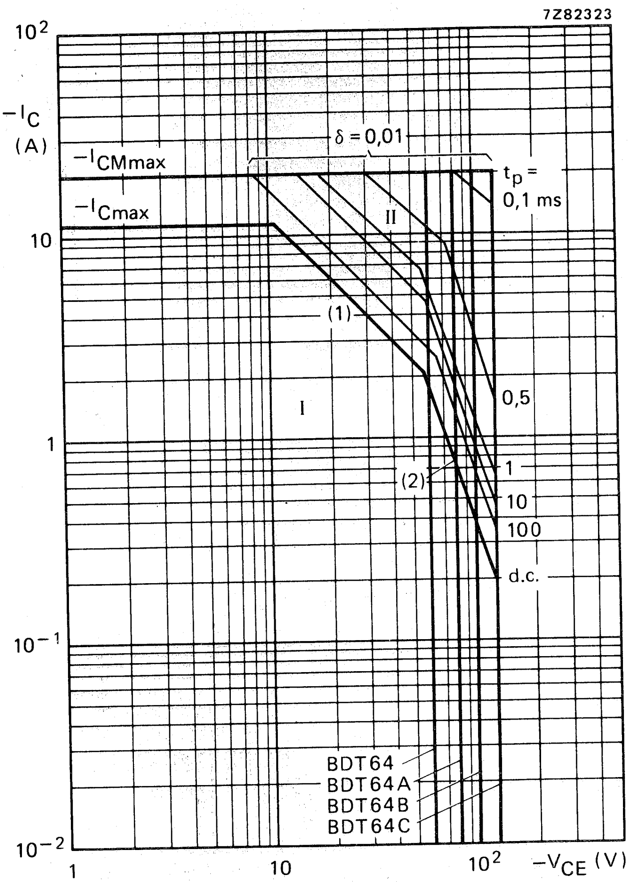


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

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).

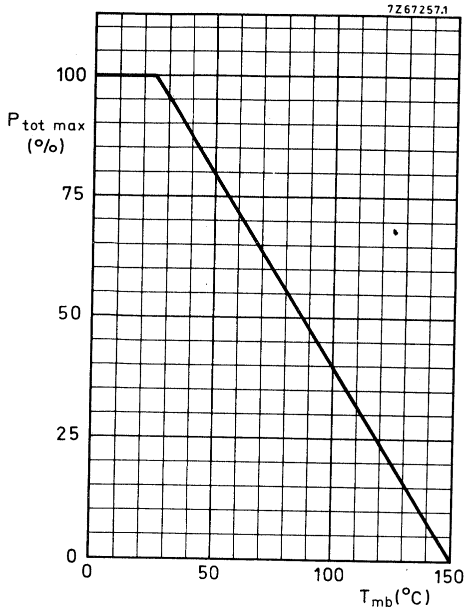


Fig. 6 Power derating curve.

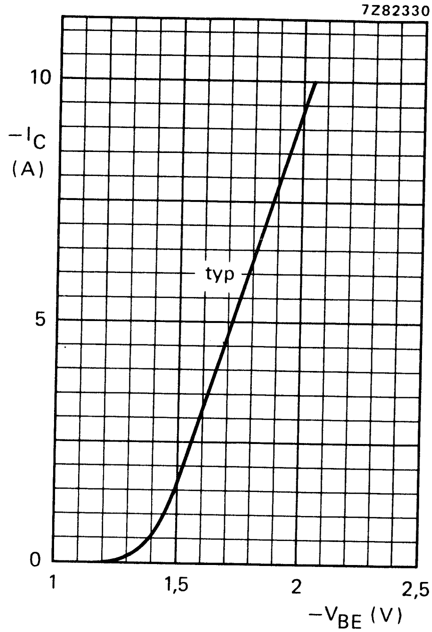


Fig. 7 $-V_{CE} = 3$ V; $T_{amb} = 25$ °C.

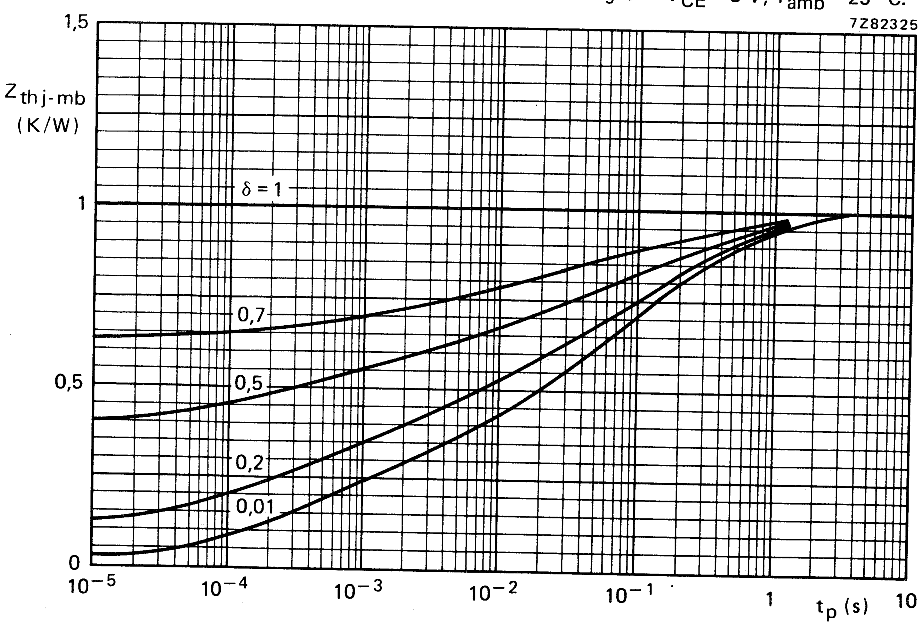


Fig. 8 Pulse power rating chart.

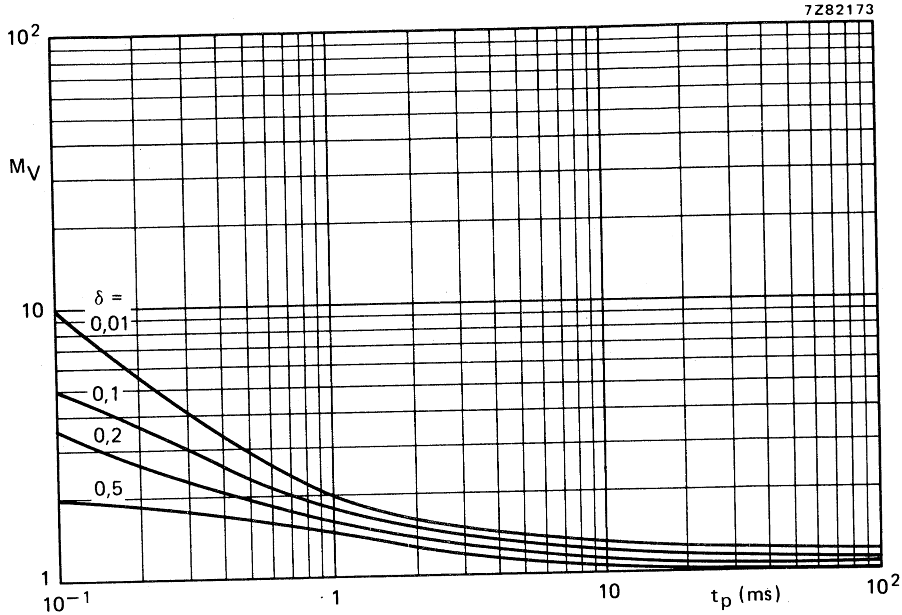


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

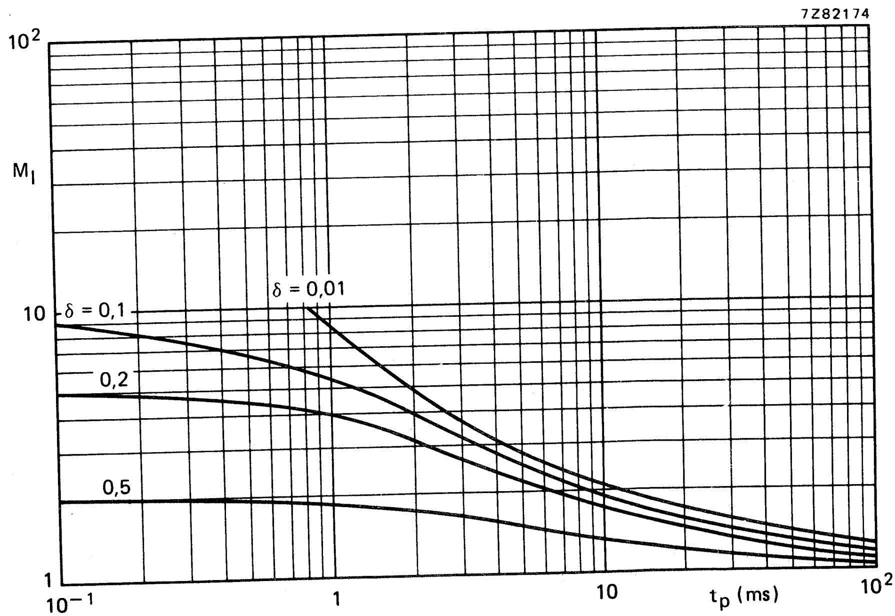


Fig. 10 S.B. current multiplying factor at the V_{CEOmax} level.

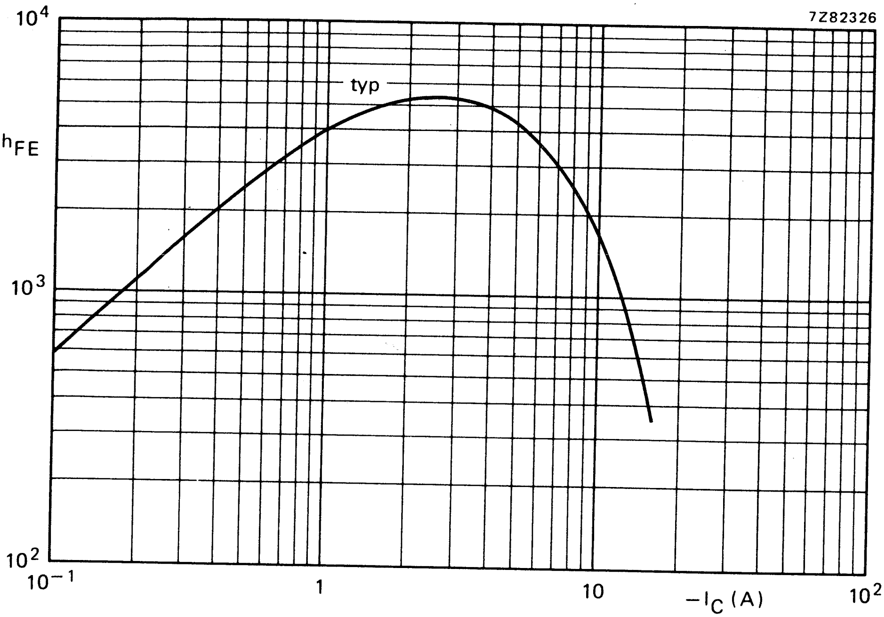


Fig. 11 D.C. current gain. $-V_{CE} = 3$ V; $T_j = 25$ °C.

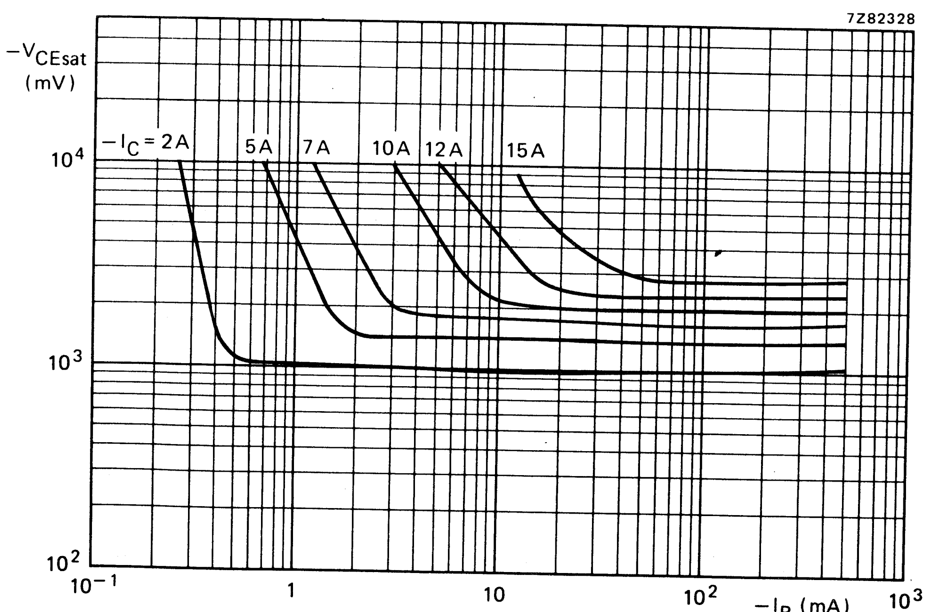


Fig. 12 Typical collector-emitter saturation voltages.

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

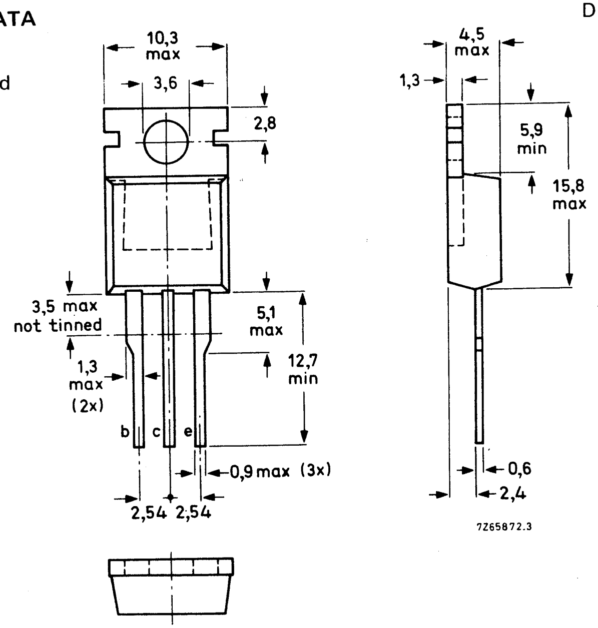
			BDT65	65A	65B	65C	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V
Collector current (peak value)	I_{CM}	max.	20				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	125				W
Junction temperature	T_j	max.	150				°C
D.C. current gain I_C = 5 A; V_{CE} = 4 V	h_{FE}	>	1000				

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

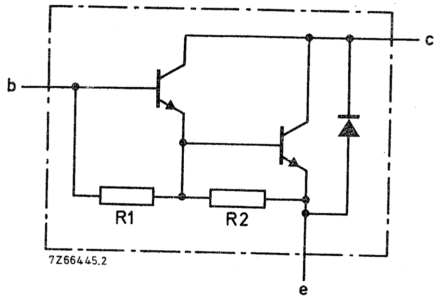


Fig. 2 Circuit diagram. R1 typ. 5 kΩ; R2 typ. 80 Ω.

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 °C	P_{tot}	max.	125				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base $R_{th\ j\text{-}mb}$ = 1 K/W

CHARACTERISTICS

T_j = 25 °C, unless otherwise specified

Collector cut-off current			
$V_{CB} = V_{CBOmax}$; I_E = o	I_{CBO}	<	0,4 mA
$V_{CB} = ½V_{CBOmax}$; I_E = 0; T_j = 150 °C	I_{CBO}	<	2 mA
I_B = 0; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	<	1 mA
Emitter cut-off current			
I_C = 0; V_{EB} = 5 V	I_{EBO}	<	5 mA
D.C. current gain*			
I_C = 1 A; V_{CE} = 4 V	h_{FE}	typ.	1500
I_C = 5 A; V_{CE} = 4 V	h_{FE}	>	1000
I_C = 12 A; V_{CE} = 4 V	h_{FE}	typ.	1000
Base-emitter voltage			
I_C = 5 A; V_{CE} = 4 V	V_{BE}	<	2,5 V
Collector-emitter saturation voltage*			
I_C = 5 A; I_B = 20 mA	V_{CEsat}	<	2 V
I_C = 10 A; I_B = 100 mA	V_{CEsat}	<	3 V
Diode, forward voltage			
I_F = 5 A	V_F	<	2 V
I_F = 12 A	V_F	typ.	2 V
Collector capacitance at f = 1 MHz			
V_{CB} = 10 V; $I_E = I_e$ = 0	C_c	typ.	200 pF
Second-breakdown collector current non-repetitive; without heatsink V_{CE} = 60 V; t_p = 0,1 s	I_{SB}	>	2 A
Turn-off breakdown energy with inductive load; $-I_{Boff}$ = 0; I_{CM} = 6,3 A L = 5 mH (see Fig. 3)	$E_{(BR)}$	>	100 mJ
Switching times (see Figs 4 and 5) I_{Con} = 5 A; $I_{Bon} = -I_{Boff}$ = 20 mA			
turn-on time	t_{on}	typ. <	1 µs 2,5 µs
turn-off time	t_{off}	typ. <	6,0 µs 10 µs
Small-signal current gain			
I_C = 5 A; V_{CE} = 3 V; f = 1 MHz	$\|h_{fe}\|$	typ.	20

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

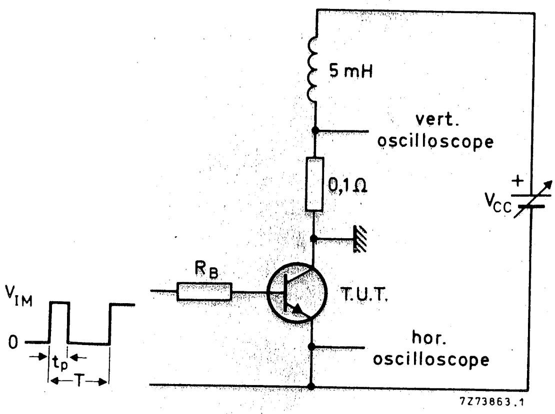


Fig. 3 Test circuit for turn-off breakdown energy.
V_{IM} = 12 V; R_B = 270 Ω;
t_p = 1 ms; δ = 1%.

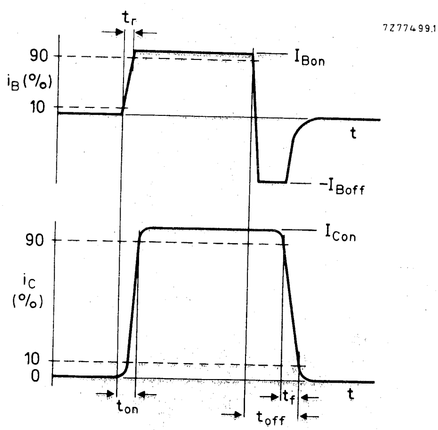
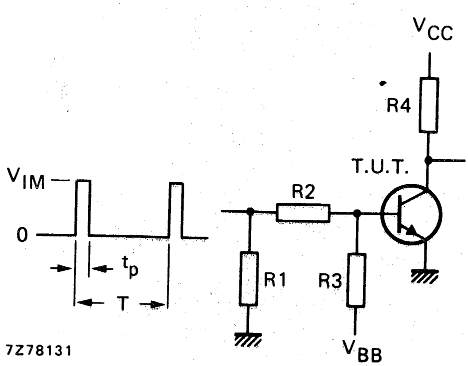


Fig. 4 Switching times waveforms.



V_{CC} = 30 V
V_{IM} = 15 V
$-V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 6 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 5 Switching times test circuit.

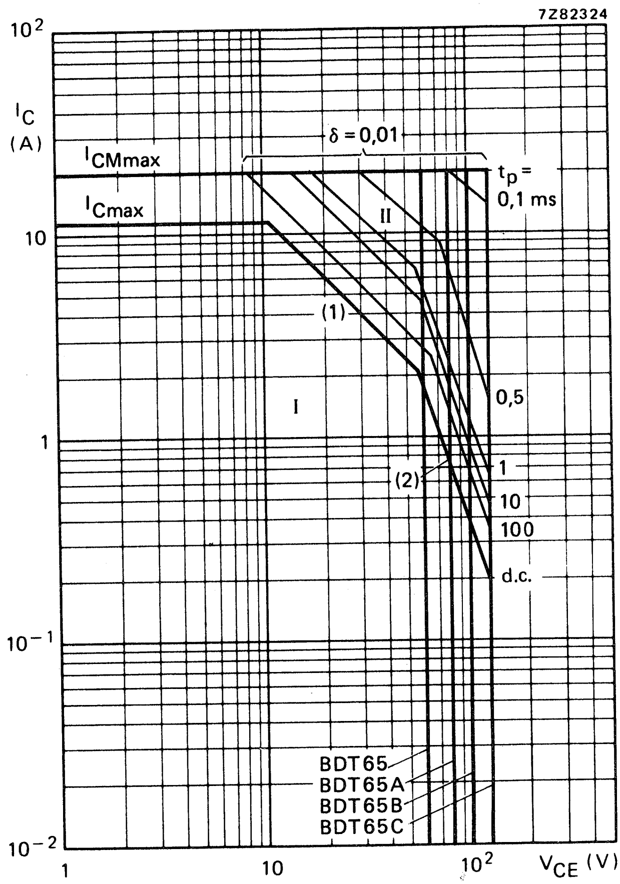


Fig. 6 Safe Operating ARea; T_{mb} = 25 °C.

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).

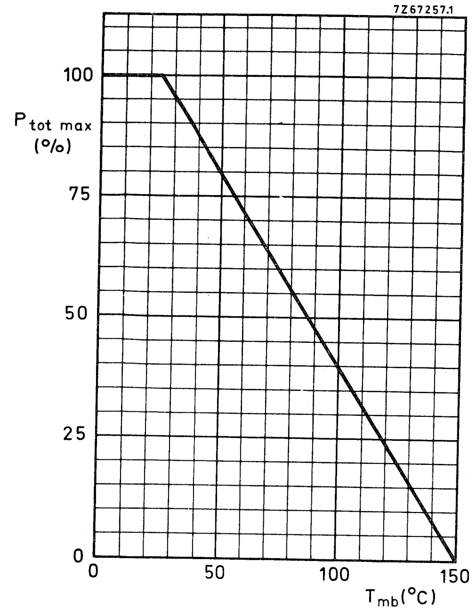


Fig. 7 Power derating curve.

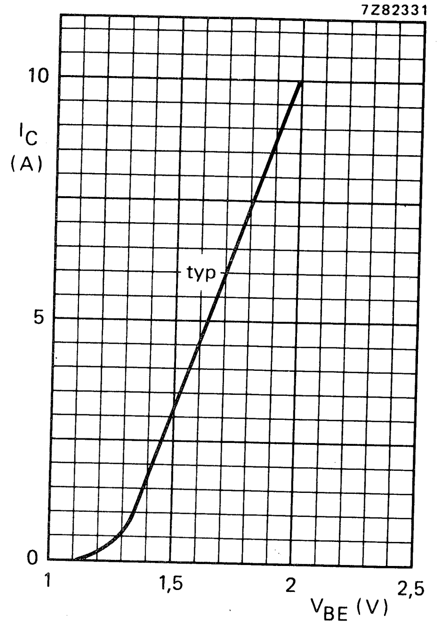


Fig. 8 Base-emitter voltage as a function of collector current. V_{CE} = 3 V; T_{amb} = 25 °C.

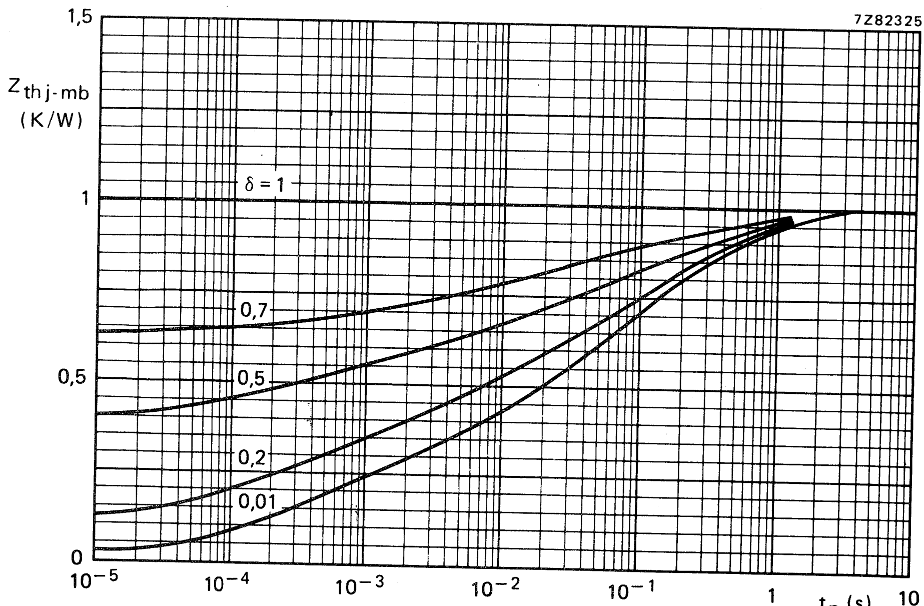


Fig. 9 Pulse power rating chart.

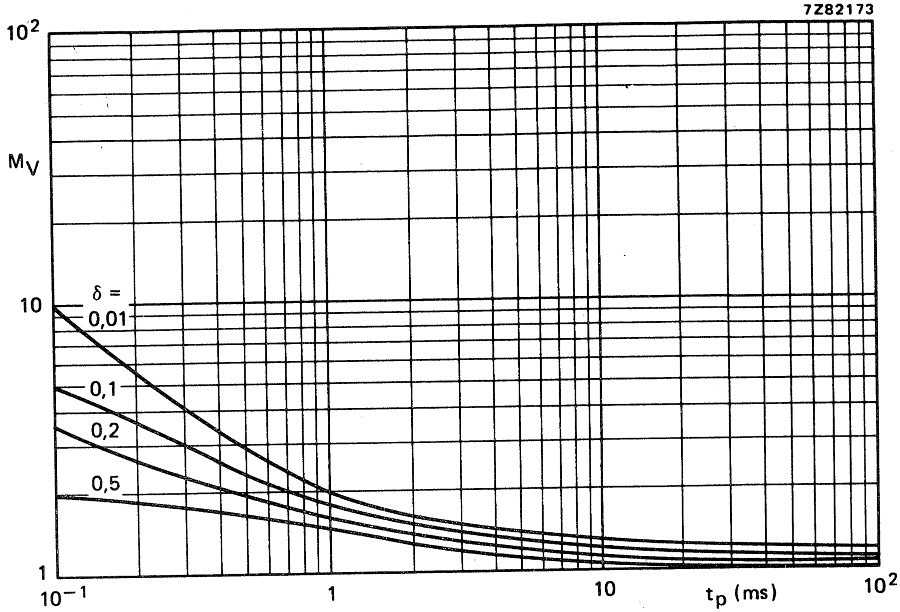


Fig. 10 S.B. voltage multiplying factor at the I_{Cmax} level.

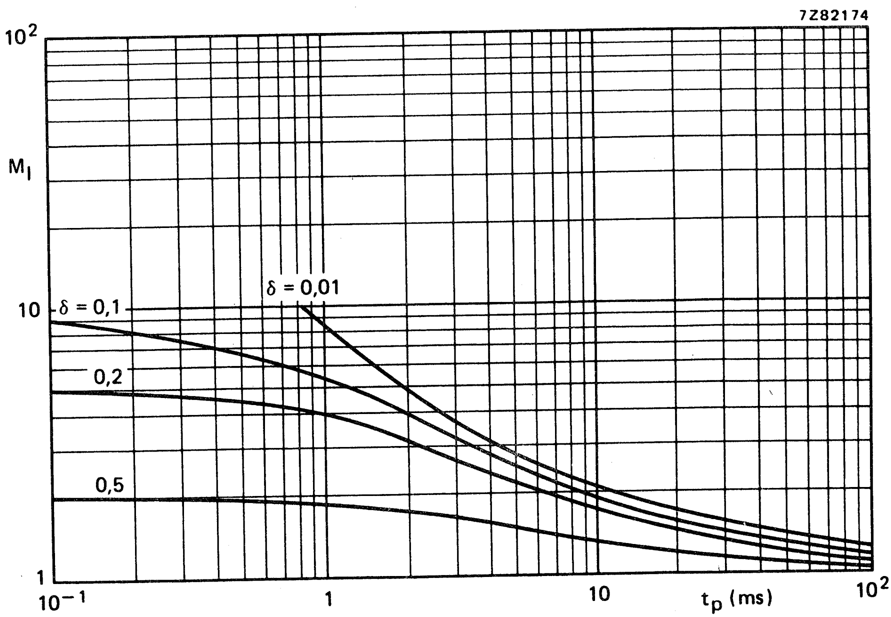


Fig. 11 S.B. current multiplying factor at the V_{CEOmax} level.

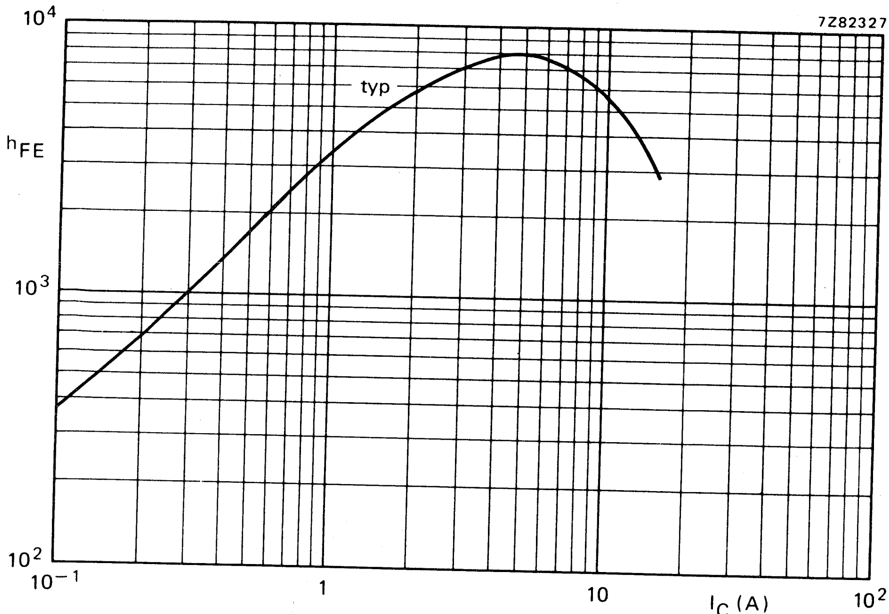


Fig. 12 Typical d.c. current gain as a function of collector current; V_{CE} = 3 V; T_j = 25 °C.

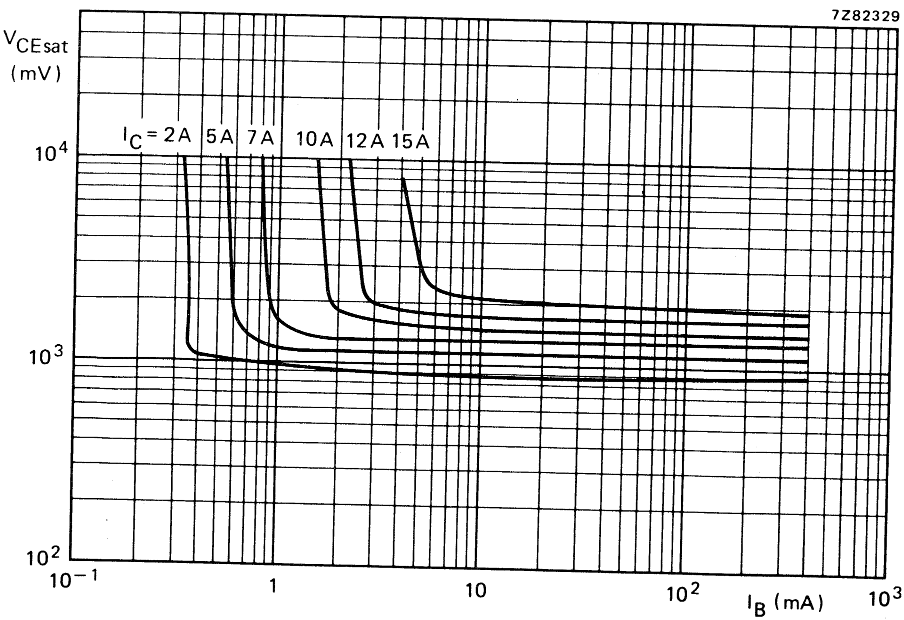


Fig. 13 Typical collector-emitter saturation voltages.

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

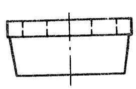
			BDT91	BDT93	BDT95	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (d.c.)	I_C	max.		10		A
Collector current (peak value)	I_{CM}	max.		20		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		90		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
I_C = 4 A; V_{CE} = 4 V	h_{FE}			20 to 200		
I_C = 10 A; V_{CE} = 4 V	h_{FE}	>		5		
Transition frequency						
I_C = 0,5 A; V_{CE} = 10 V	f_T	>		4		MHz

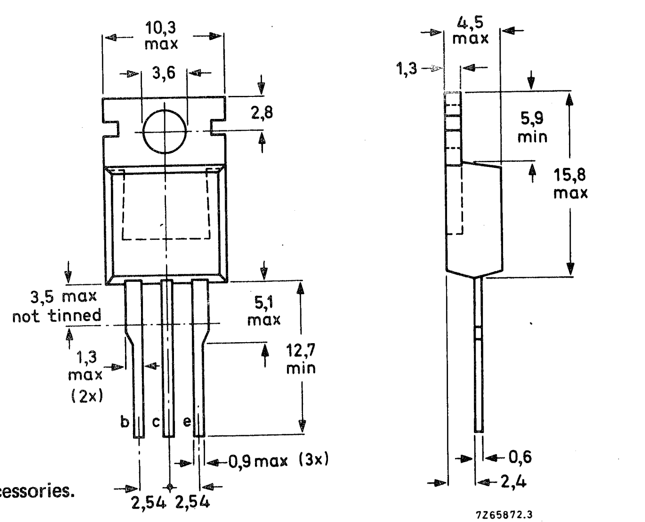
MECHANICAL DATA

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)

			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 °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	$R_{th\ j\text{-}mb}$	=	1,4	K/W
From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	0,1	mA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 150 °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 V	I_{EBO}	<	1	mA
D.C. current gain (note 1)				
I_C = 4 A; V_{CE} = 4 V	h_{FE}		20 to 200	
I_C = 10 A; V_{CE} = 4 V	h_{FE}	>	5	
Base-emitter voltage (notes 1 and 2)				
I_C = 4 A; V_{CE} = 4 V	V_{BE}	<	1,6	V
Collector-emitter saturation voltage (note 1)				
I_C = 4 A; I_B = 0,4 A	V_{CEsat}	<	1	V
I_C = 10 A; I_B = 3,3 A	V_{CEsat}	<	3	V
Transition frequency at f = 1 MHz				
I_C = 0,5 A; V_{CE} = 10 V	f_T	>	4	MHz
Cut-off frequency				
I_C = 0,5 A; V_{CE} = 10 V	f_{hfe}	>	20	kHz

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

Second-breakdown collector current V_{CE} = 60 V; t_p = 0,1 s	$I_{(SB)}$	>	1,5 A
Switching times (between 10% and 90% levels) I_{Con} = 4 A; I_{Bon} = $-I_{Boff}$ = 0,4 A			
Turn-on time	t_{on}	typ. <	0,5 μs 1 μs
Turn-off time	t_{off}	typ. <	2 μs 4 μs

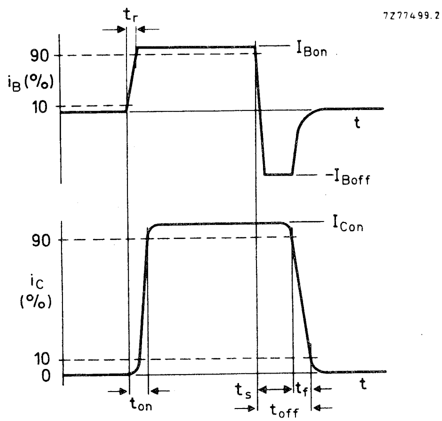


Fig. 2 Switching times waveforms.

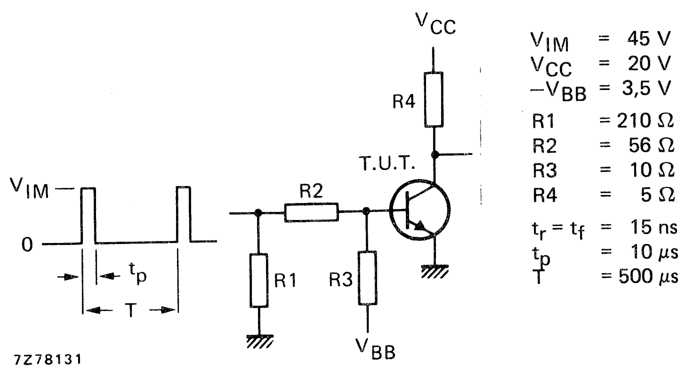


Fig. 3 Switching times test circuit.

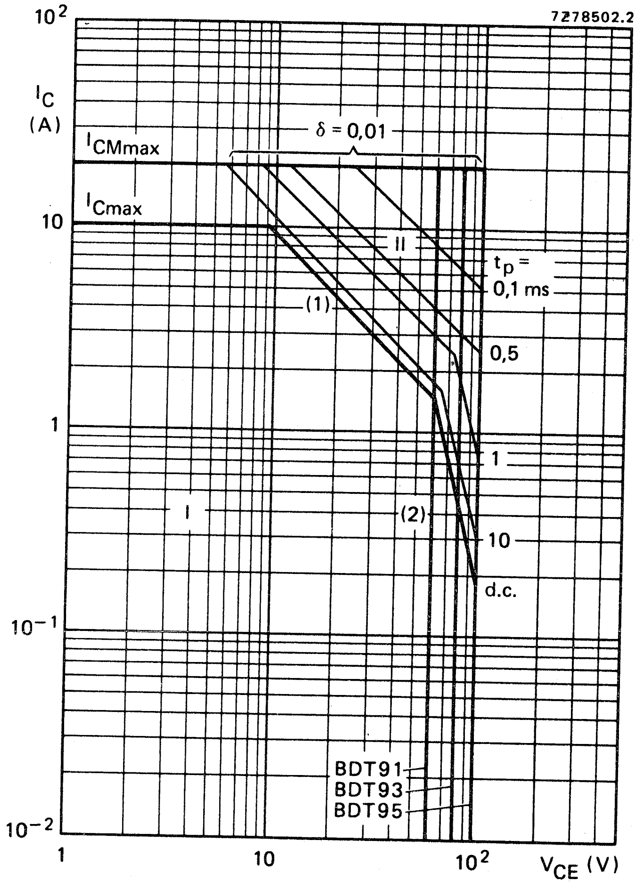


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

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).

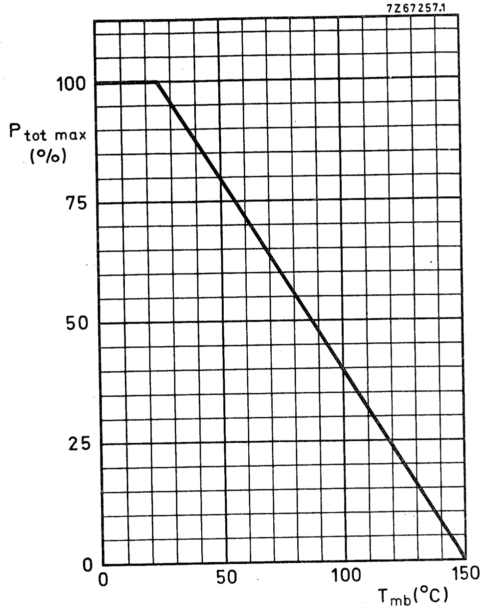


Fig. 5 Power derating curve.

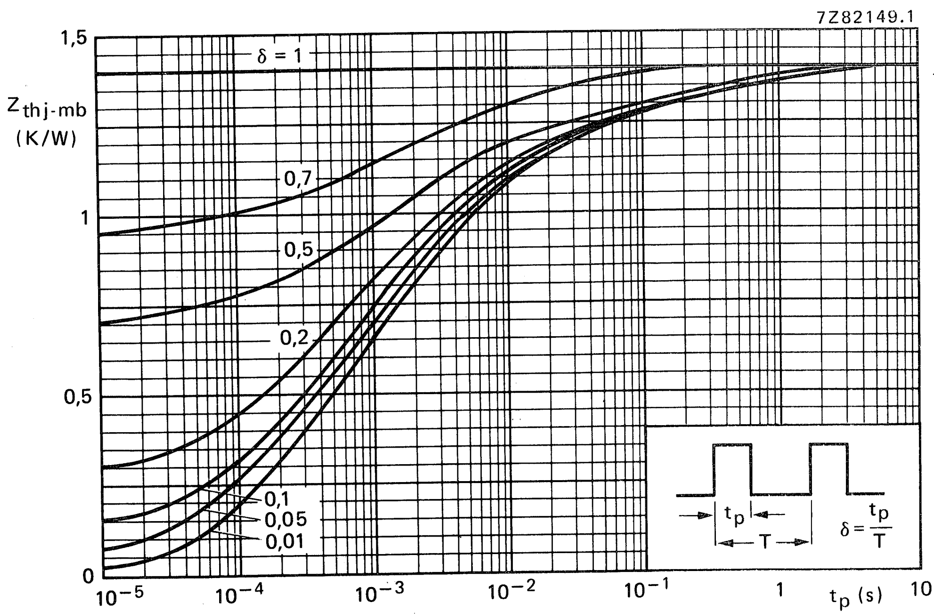


Fig. 6 Pulse power rating chart.

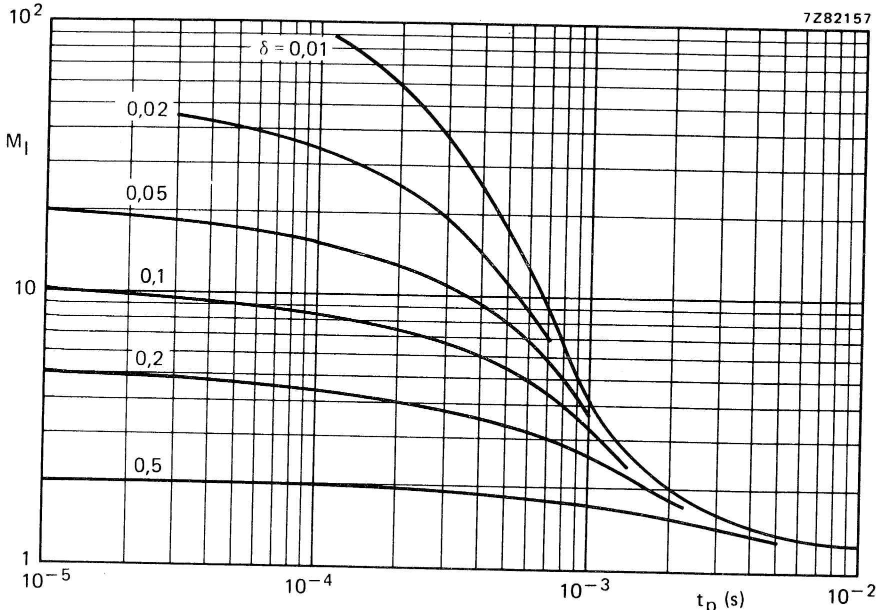


Fig. 7 S.B. current multiplying factor at the V_{CEOmax} level.

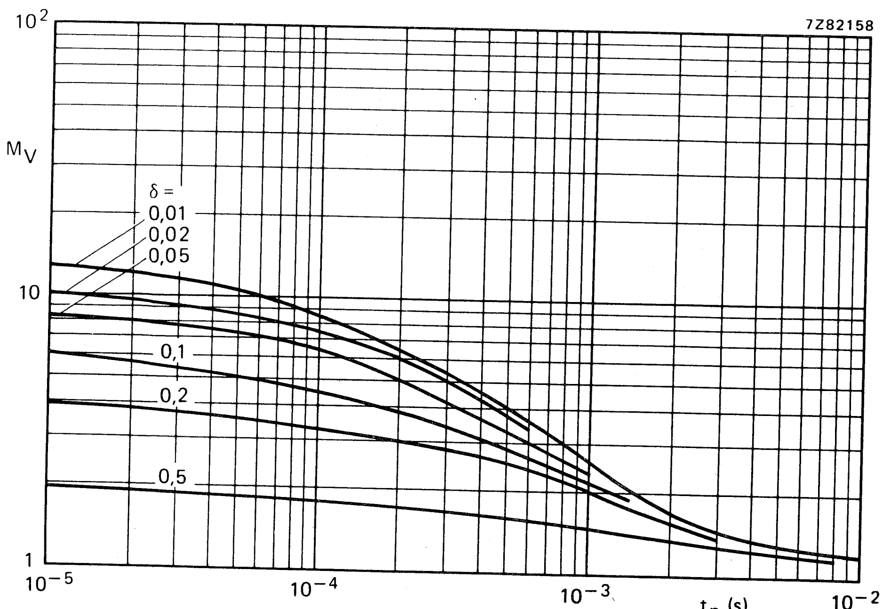


Fig. 8 S.B. voltage multiplying factor at the I_{Cmax} level.

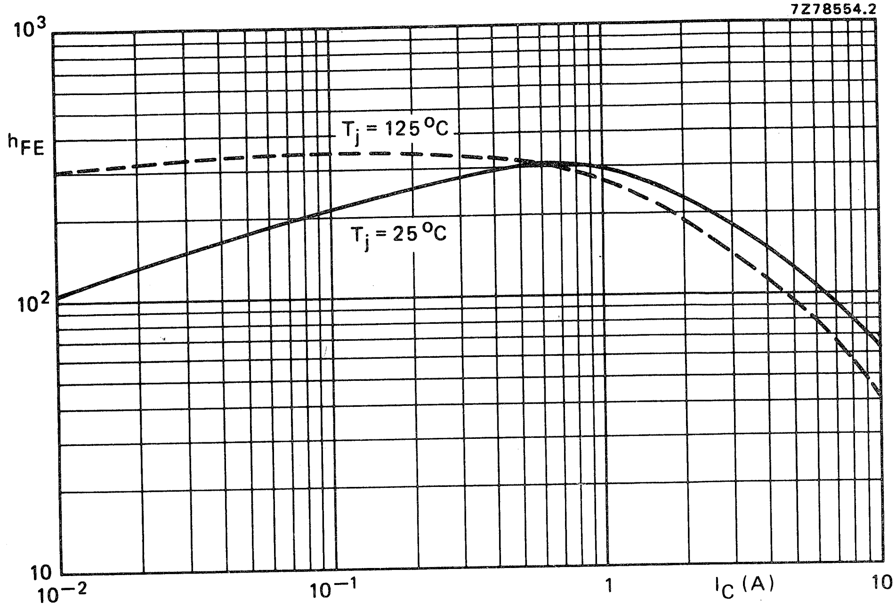


Fig. 9 Typical d.c. current gain at V_{CE} = 4 V.

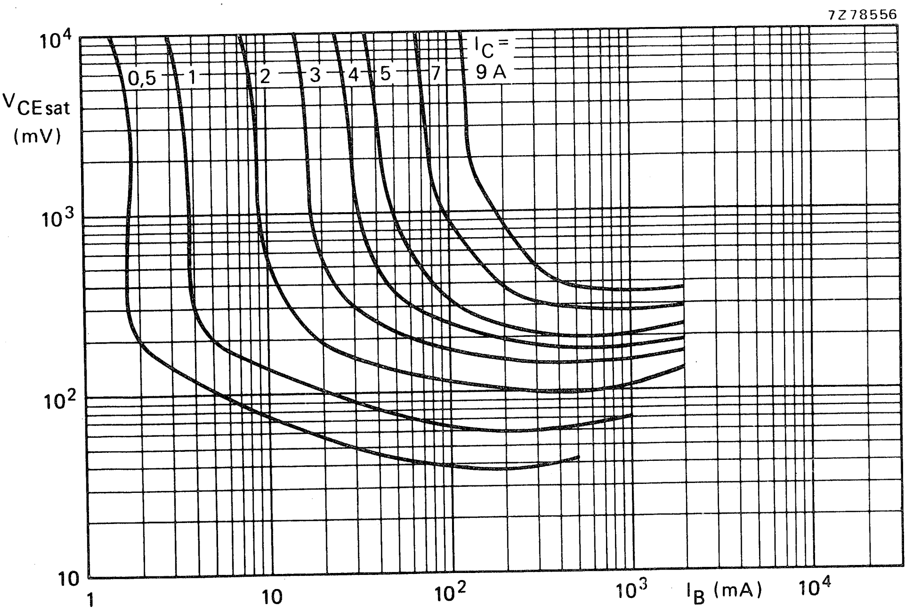


Fig. 10 Typical collector-emitter saturation voltage. T_{mb} = 25 ^oC.

SILICON EPITAXIAL BASE POWER TRANSISTORS

P-N-P transistors in a plastic envelope intended for use in audio output stages and general amplifier and switching applications.
N-P-N complements are BDT91, BDT93 and BDT95.

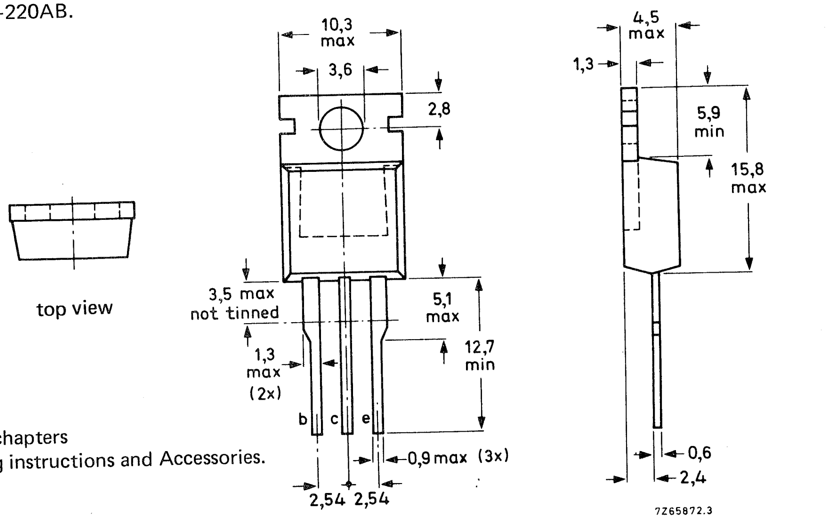
QUICK REFERENCE DATA

			BDT92	BDT94	BDT96	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Collector current (d.c.)	$-I_C$	max.		10		A
Collector current (peak value)	$-I_{CM}$	max.		20		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		90		W
Junction temperature	T_j	max.		150		°C
D.C. current gain						
$-I_C$ = 4 A; $-V_{CE}$ = 4 V	h_{FE}			20 to 200		
$-I_C$ = 10 A; $-V_{CE}$ = 4 V	h_{FE}	>		5		
Transition frequency						
$-I_C$ = 0,5 A; $-V_{CE}$ = 10 V	f_T	>		4		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



See also chapters
Mounting instructions and Accessories.

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 °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	$R_{th\ j\text{-}mb}$	=	1,4	K/W
→ From junction to ambient (in free air)	$R_{th\ j\text{-}a}$	=	70	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,1	mA
$I_E = 0; -V_{CB} = -½V_{CBOmax}; T_j = 150\ °C$	$-I_{CBO}$	<	5	mA
$I_B = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CEO}$	<	1	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 7$ V	$-I_{EBO}$	<	1	mA
D.C. current gain (note 1)				
$-I_C = 4$ A; $-V_{CE} = 4$ V	h_{FE}		20 to 200	
$-I_C = 10$ A; $-V_{CE} = 4$ V	h_{FE}	>	5	
Base-emitter voltage (notes 1 and 2)				
$-I_C = 4$ A; $-V_{CE} = 4$ V	$-V_{BE}$	<	1,6	V
Collector-emitter saturation voltage (note 1)				
$-I_C = 4$ A; $-I_B = 0,4$ A	$-V_{CEsat}$	<	1	V
$-I_C = 10$ A; $-I_B = 3,3$ A	$-V_{CEsat}$	<	3	V
Transition frequency at f = 1 MHz				
$-I_C = 0,5$ A; $-V_{CE} = 10$ V	f_T	>	4	MHz
Cut-off frequency				
$-I_C = 0,5$ A; $-V_{CE} = 10$ V	f_{hfe}	>	20	kHz
→ D.C. current gain ratio of matched pairs				
BDT91/92; $-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE1}/h_{FE2}	<	2,5	

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

Second-breakdown collector current $-V_{CE} = 60$ V; $t_p = 0{,}1$ s	$-I_{(SB)}$	>	1,5 A
Switching times (between 10% and 90% levels) $-I_{Con} = 4$ A; $-I_{Bon} = + I_{Boff} = 0{,}4$ A			
Turn-on time	t_{on}	typ. <	0,5 μs 1,5 μs
Turn-off time	t_{off}	typ. <	1 μs 3 μs

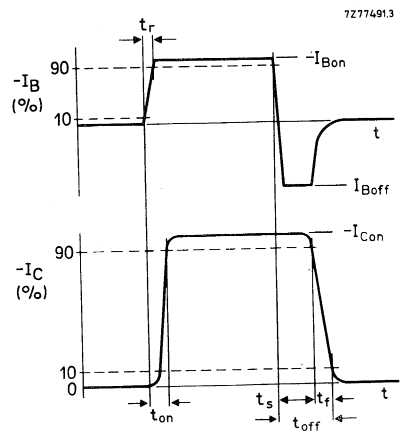
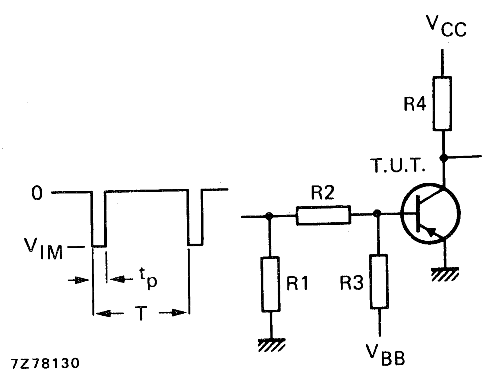


Fig. 2 Switching times waveforms.



$-V_{IM}$ = 45 V
$-V_{CC}$ = 20 V
V_{BB} = 3,5 V
R1 = 210 Ω
R2 = 56 Ω
R3 = 10 Ω
R4 = 5 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 3 Switching times test circuit.

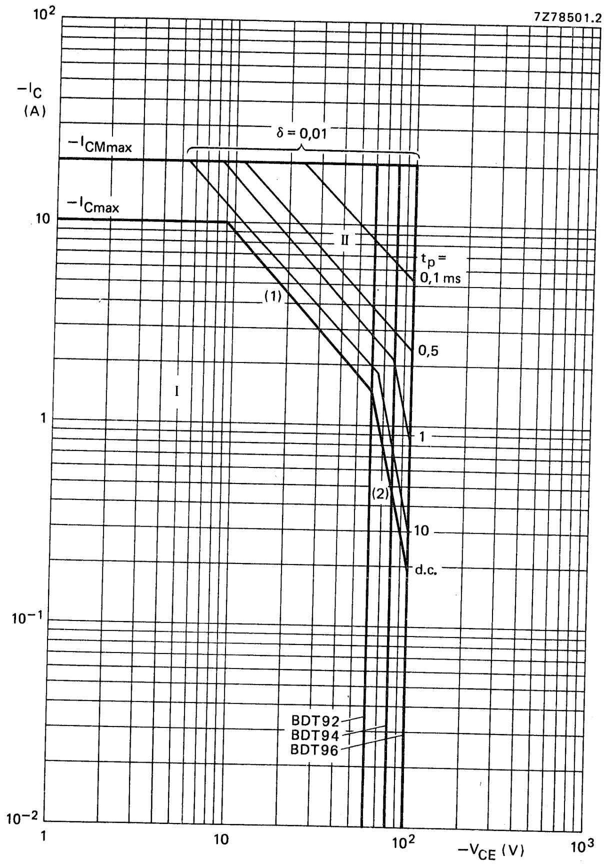


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

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).

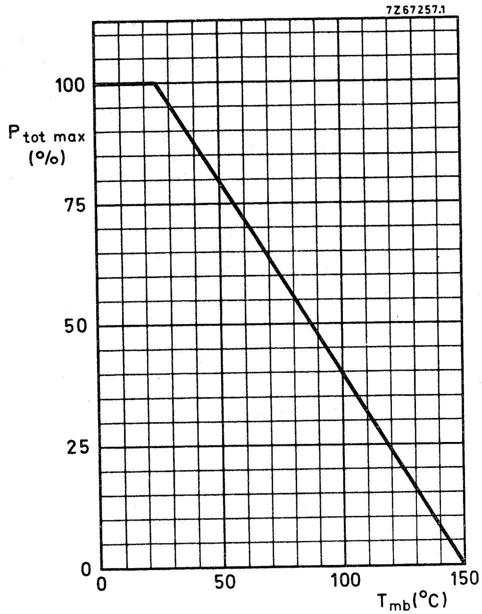


Fig. 5 Power derating curve.

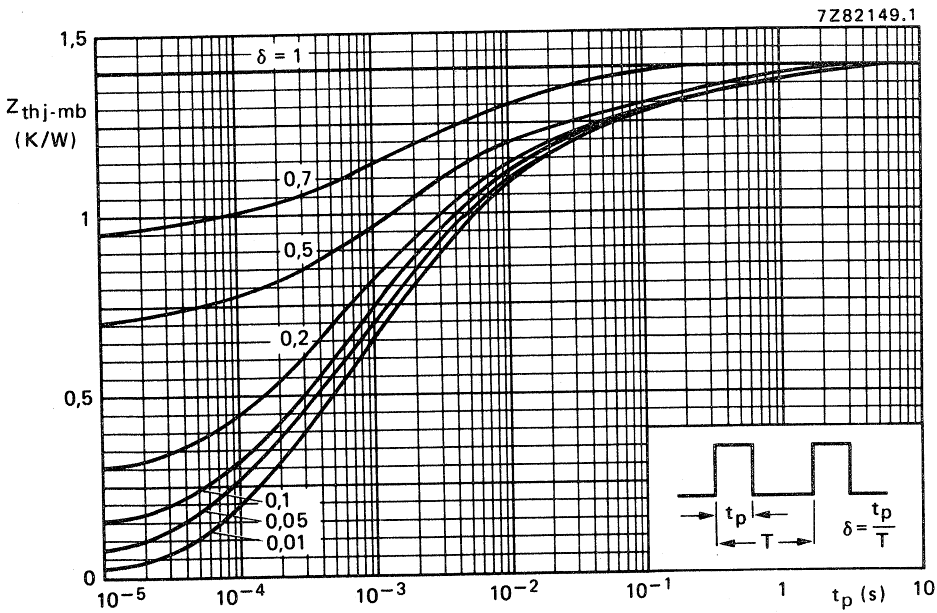


Fig. 6 Pulse power rating chart.

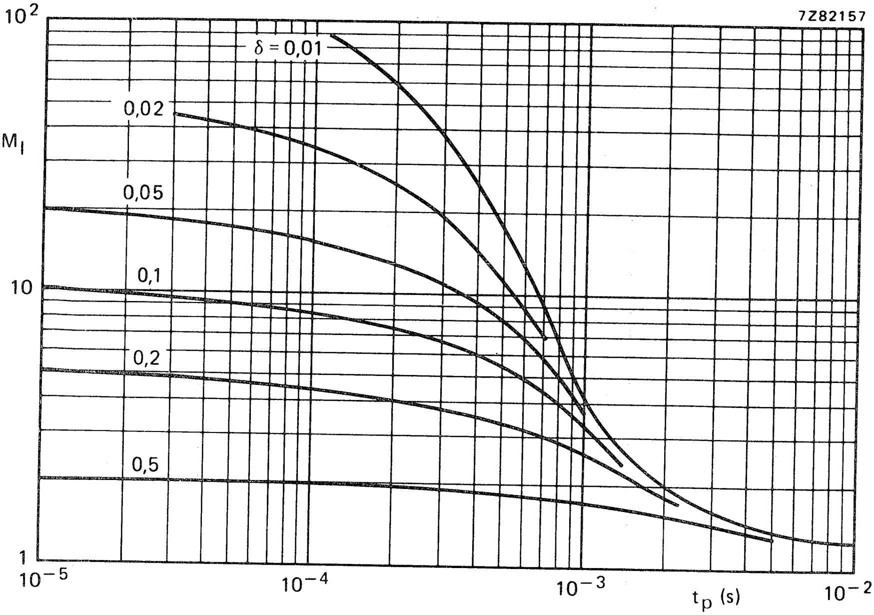


Fig. 7 S.B. current multiplying factor at the V_{CEOmax} level.

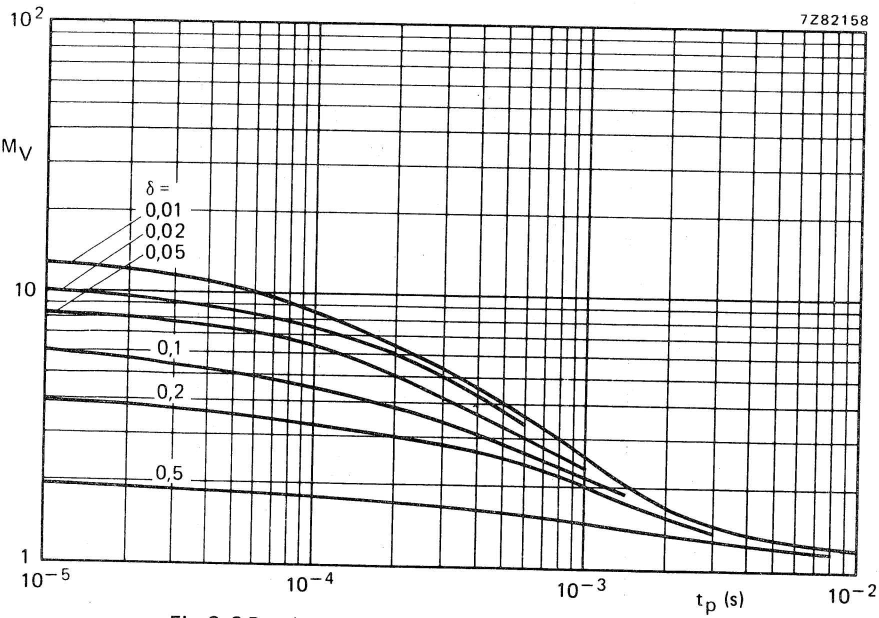


Fig. 8 S.B. voltage multiplying factor at the I_{Cmax} level.

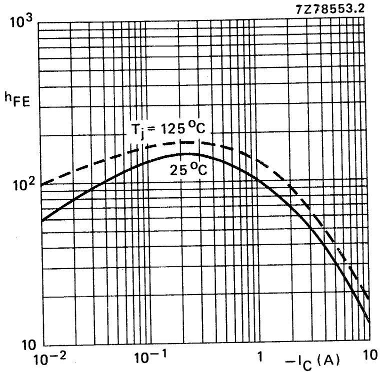


Fig. 9 Typical d.c. current gain at $-V_{CE} = 4$ V.

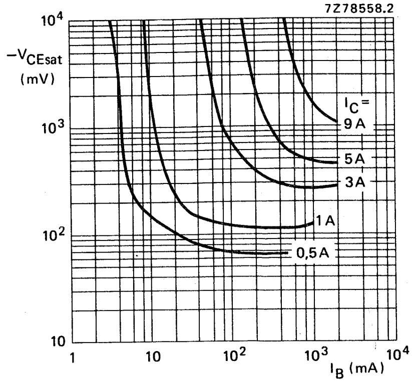


Fig. 10 Typical collector-emitter saturation voltage. $T_{mb} = 25\ ^oC$.

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

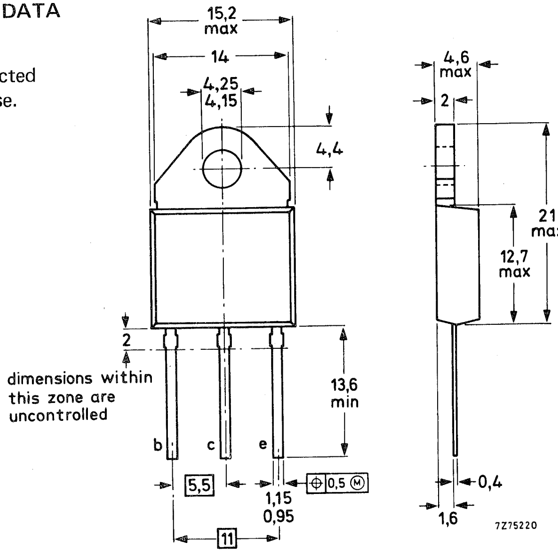
			BDV64	A	B	C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (peak value)	$-I_{CM}$	max.		20			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		125			W
Junction temperature	T_j	max.		150			°C
D.C. current gain							
$-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	typ.		1500			
$-I_C$ = 5 A; $-V_{CE}$ = 4 V	h_{FE}	>		1000			
Cut-off frequency							
$-I_C$ = 5 A; $-V_{CE}$ = 4 V	f_{hfe}	typ.		100			kHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

CIRCUIT DIAGRAM

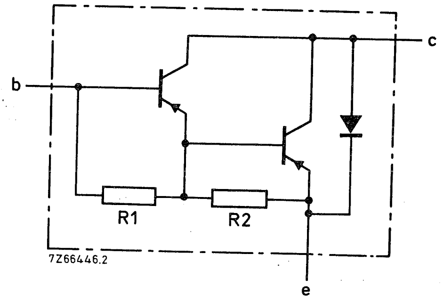


Fig. 2.
R1 typical 5 kΩ
R2 typical 80 Ω.

RATINGS

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

			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 °C	P_{tot}	max.	125	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C*

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	K/W*

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off currents				
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	400	µA
$I_E = 0; -V_{CB} = -½V_{CBOmax}; T_j = 150$ °C	$-I_{CBO}$	<	2	mA
$I_B = 0; -V_{CE} = -½V_{CEOmax}$	$-I_{CEO}$	<	1	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 5$ 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 °C unless otherwise specified.

D.C. current gain*			
$-I_C$ = 1 A; $-V_{CE}$ = 4 V	h_{FE}	typ.	1500
$-I_C$ = 5 A; $-V_{CE}$ = 4 V	h_{FE}	>	1000
$-I_C$ = 10 A; $-V_{CE}$ = 4 V	h_{FE}	typ.	1000
Base-emitter voltage*			
$-I_C$ = 5 A; $-V_{CE}$ = 4 V	$-V_{BE}$	<	2,5 V**
Collector-emitter saturation voltage*			
$-I_C$ = 5 A; $-I_B$ = 20 mA	$-V_{CEsat}$	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; $-V_{CB}$ = 10 V	C_c	typ.	200 pF
Cut-off frequency			
$-I_C$ = 5 A; $-V_{CE}$ = 4 V	f_{hfe}	typ.	100 kHz
Diode, forward voltage			
I_F = 5 A	V_F	typ.	1,8 V
I_F = 12 A	V_F	typ.	2 V
Switching times (see also Fig. 4)			
$-I_{Con}$ = 5 A; $-I_{Bon}$ = I_{Boff} = 20 mA; V_{CC} = −16 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

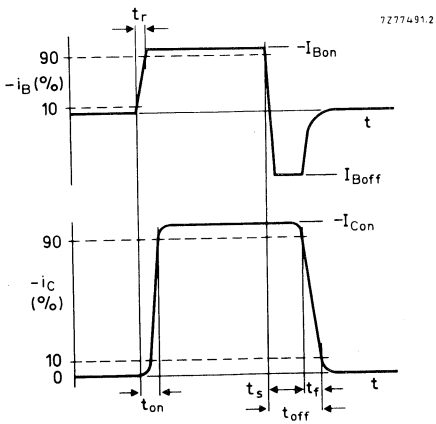
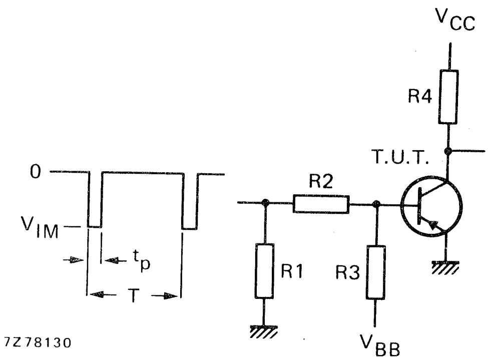


Fig. 3 Waveforms.

* Measured under pulse conditions: t_p < 300 μs; δ < 2%.
**$-V_{BE}$ decreases by about 3,6 mV/K with increasing temperature.



$-V_{IM}$ = 16,5 V
$-V_{CC}$ = 16 V
V_{BB} = 6,5 V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 3 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 4 Switching times test circuit.

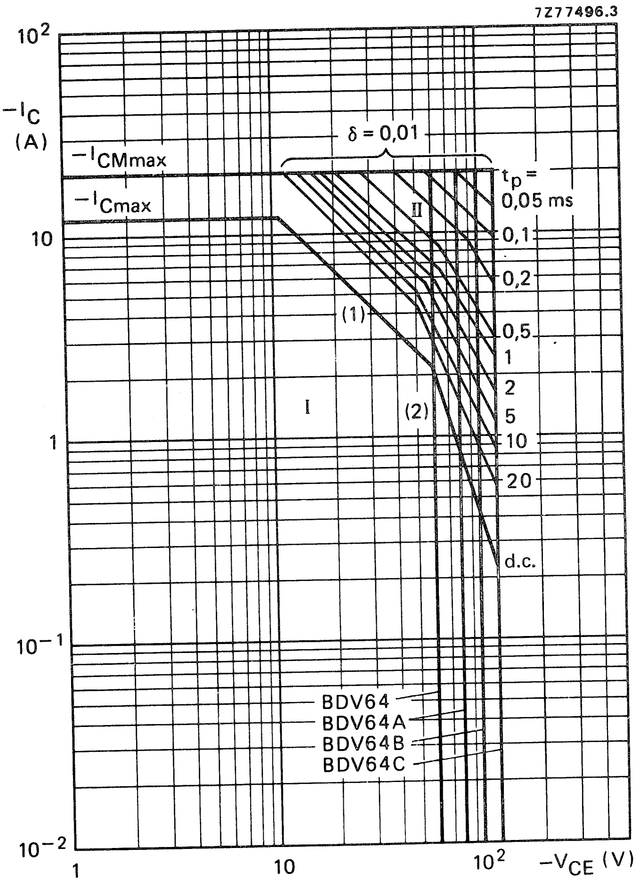


Fig. 5 Safe Operating ARea; $T_{mb} \leq 25$ °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

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

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

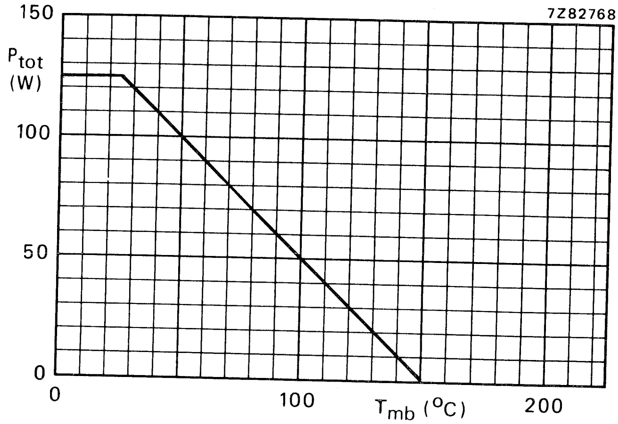


Fig. 6 Power derating curve.

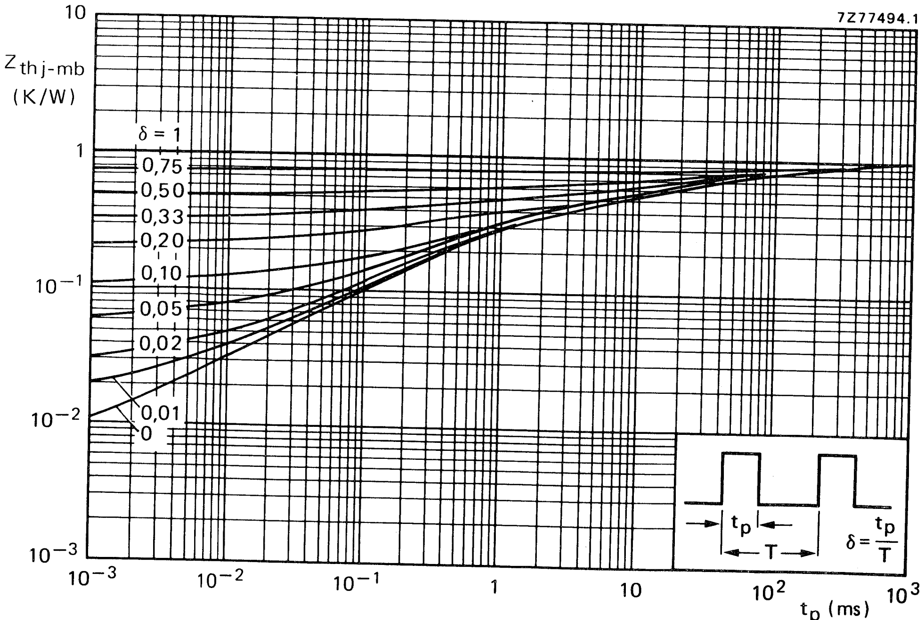


Fig. 7 Pulse power rating chart.

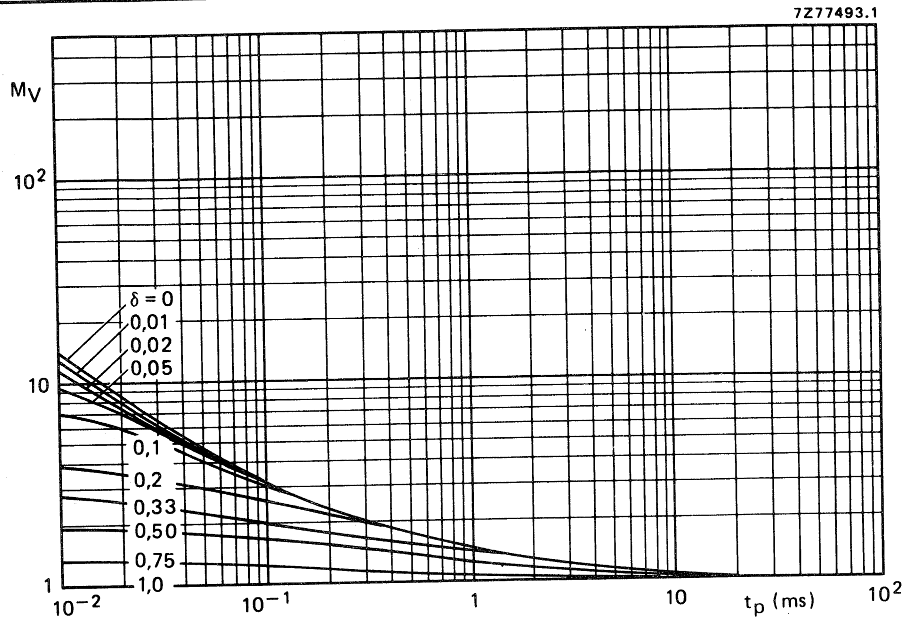


Fig. 8 S.B. voltage multiplying factor at the $-I_{Cmax}$ level.

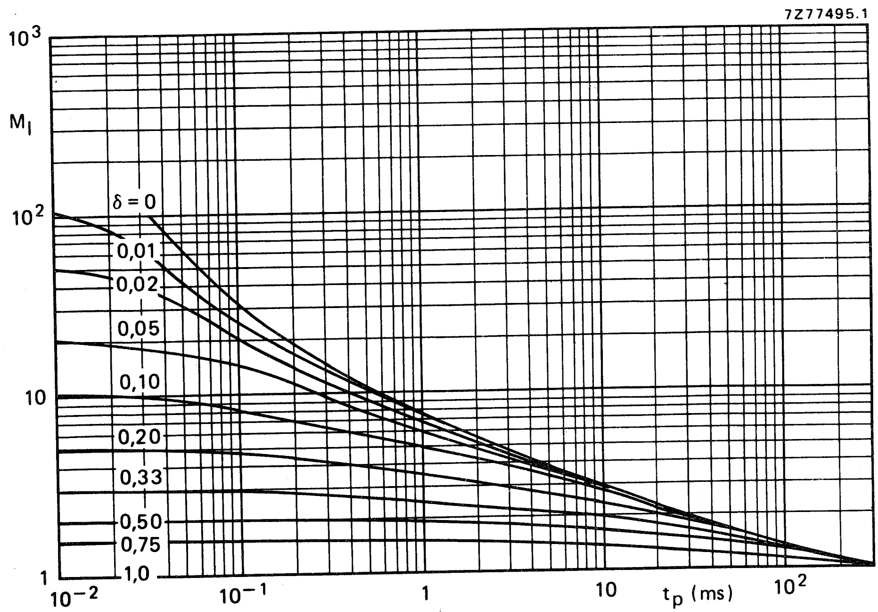


Fig. 9 S.B. current multiplying factor at the $-V_{CEOmax}$ level (100 V).

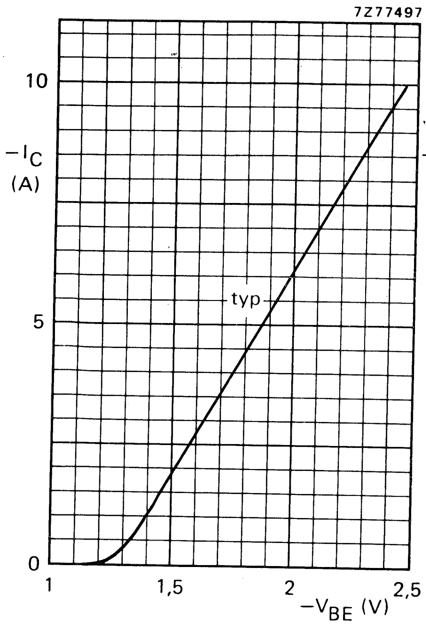


Fig. 10 $-V_{CE} = 4$ V; $T_j = 25$ °C.

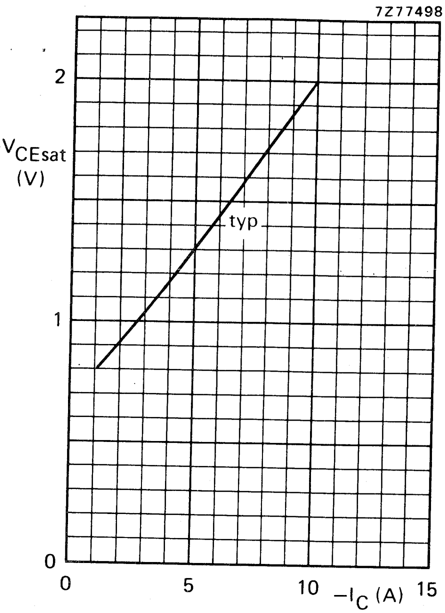


Fig. 11 $-I_C/I_B = 250$; $T_j = 25$ °C.

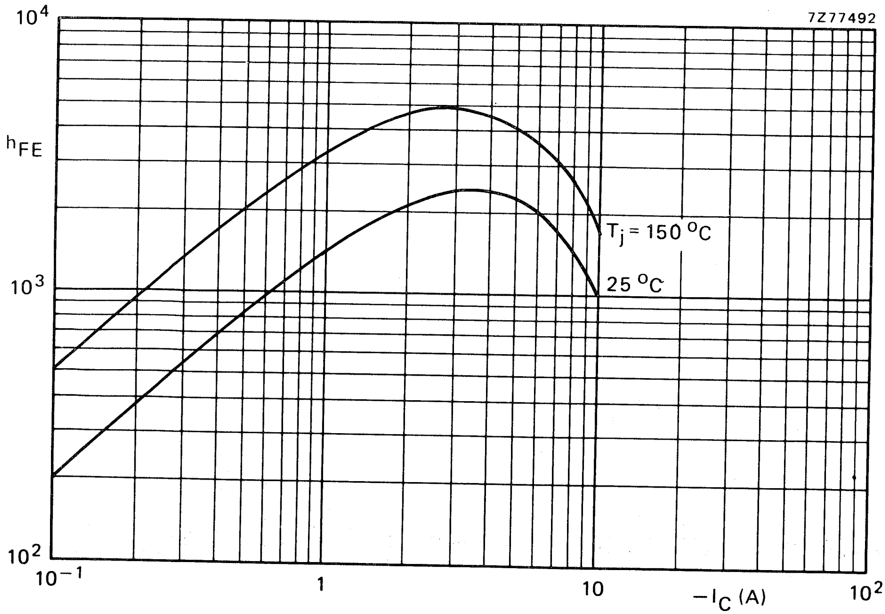


Fig. 12 Typical values; $-V_{CE} = 4$ V.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications. P-N-P complements are BDV64, 64B and 64C.

QUICK REFERENCE DATA

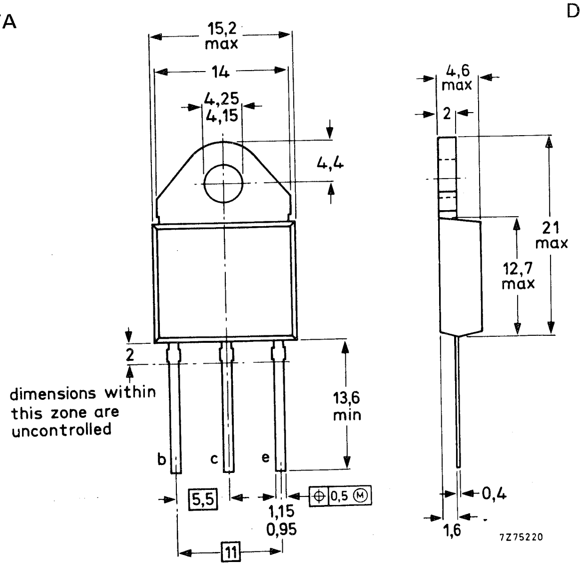
			BDV65	A	B	C	
Collector-base voltage (open emitter	V_{CBO}	max.	60	80	100	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.		20			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		125			W
Junction temperature	T_j	max.		150			°C
D.C. current gain							
I_C = 1 A; V_{CE} = 4 V	h_{FE}	typ.		1500			
I_C = 5 A; V_{CE} = 4 V	h_{FE}	>		1000			
Cut-off frequency							
I_C = 5 A; V_{CE} = 4 V	f_{hfe}	typ.		70			kHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting-base.



See also chapters Mounting instructions and Accessories .

CIRCUIT DIAGRAM

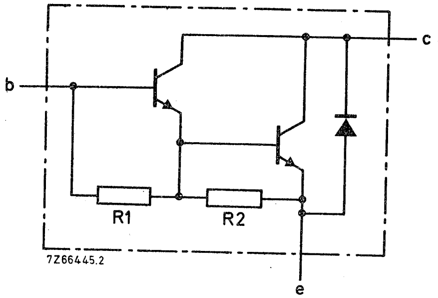


Fig. 2.
R1 typical 5 kΩ
R2 typical 80 Ω.

RATINGS

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

			BDV65	A	B	C	
Collector-base voltage (open emitter)	V_{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 °C	P_{tot}	max.	125				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature	T_j	max.	150				°C*

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$ =	1	K/W*

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off currents				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	400	μA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	2	mA
$I_B = 0$; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	<	1	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 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 °C unless otherwise specified.

D.C. current gain*			
I_C = 1 A; V_{CE} = 4 V	h_{FE}	typ.	1500
I_C = 5 A; V_{CE} = 4 V	h_{FE}	>	1000
I_C = 10 A; V_{CE} = 4 V	h_{FE}	typ.	1750
Base-emitter voltage*			
I_C = 5 A; V_{CE} = 4 V	V_{BE}	<	2,5 V**
Collector-emitter saturation voltage*			
I_C = 5 A; I_B = 20 mA	V_{CEsat}	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	typ.	150 pF
Cut-off frequency			
I_C = 5 A; V_{CE} = 4 V	f_{hfe}	typ.	70 kHz
Diode, forward voltage			
I_F = 5 A	V_F	typ.	1,2 V
I_F = 12 A	V_F	typ.	2 V
Switching times (see also Fig. 4)			
I_{Con} = 5 A; $I_{Bon} = -I_{Boff}$ = 20 mA; V_{CC} = 16 V			
Turn-on time	t_{on}	typ.	1 μs
Fall time	t_f	typ.	3 μs
Turn-off time	t_{off}	typ.	6 μs

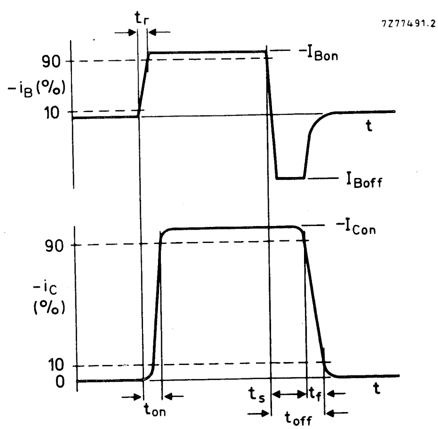
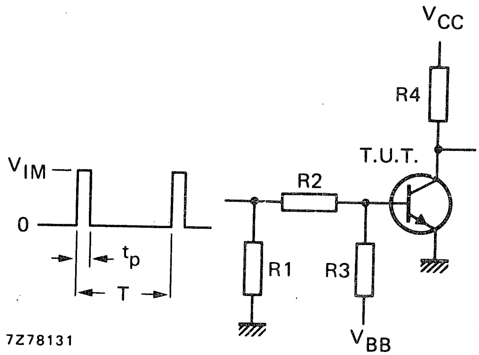


Fig. 3 Waveforms showing t_{on}; $t_s + t_f = t_{off}$.

* Measured under pulse conditions: t_p < 300 μs; δ < 2%.
** V_{BE} decreases by about 3,6 mV/K with increasing temperature.



V_{IM}	= 16,5 V
V_{CC}	= 16 V
V_{BB}	−6,5 V
R1	= 56 Ω
R2	= 410 Ω
R3	= 560 Ω
R4	= 3 Ω
$t_r = t_f$	= 15 ns
t_p	= 10 μs
T	= 500 μs

Fig. 4 Switching times test circuit.

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

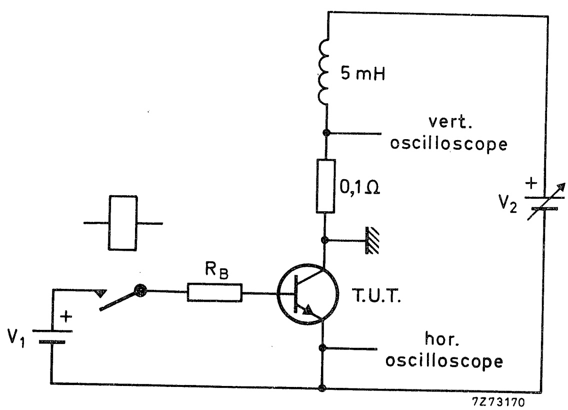


Fig. 5 Test circuit; V_1 = 12 V; R_B = 270 Ω.

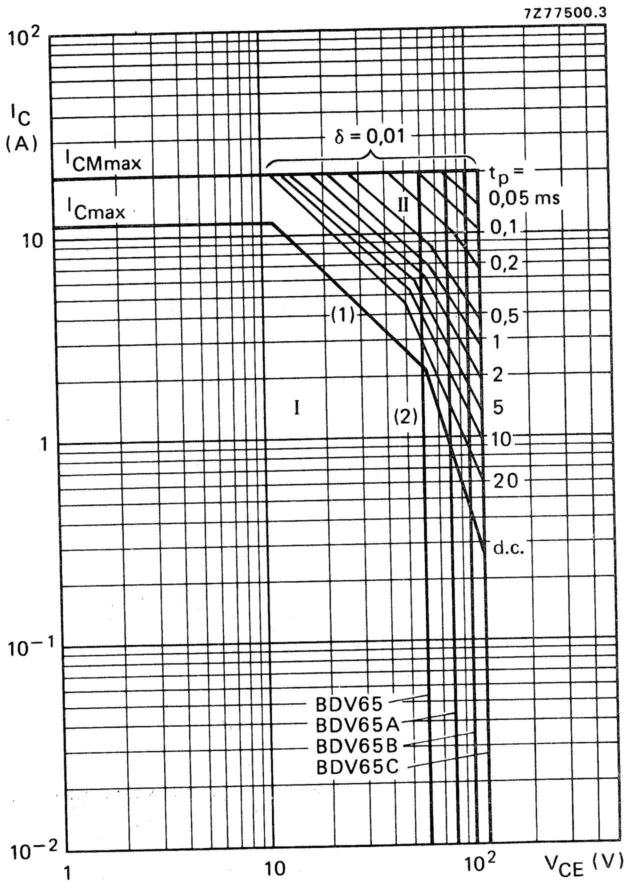


Fig. 6 Safe Operating ARea; $T_{mb} \leqslant 25\ ^oC$.

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).

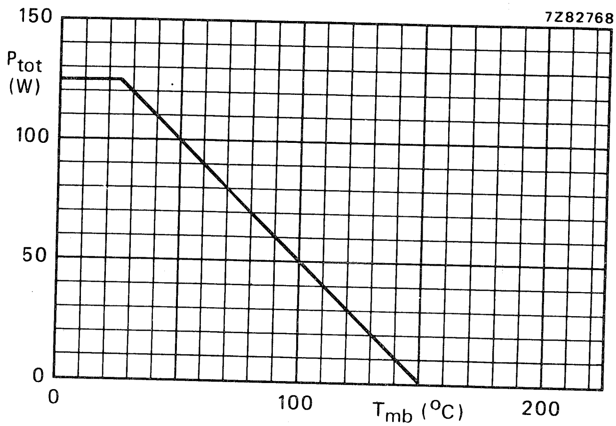


Fig. 7 Power derating curve.

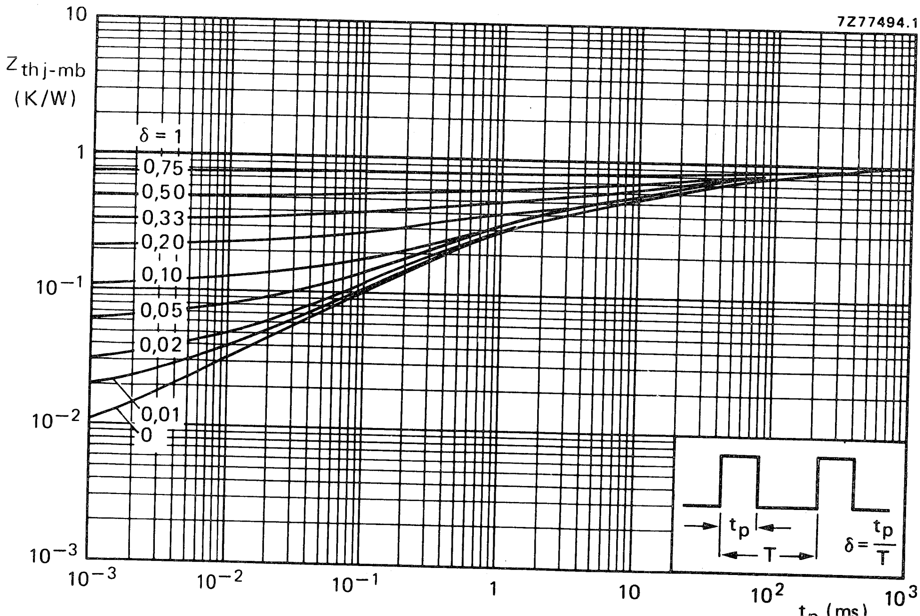


Fig. 8 Pulse power rating chart.

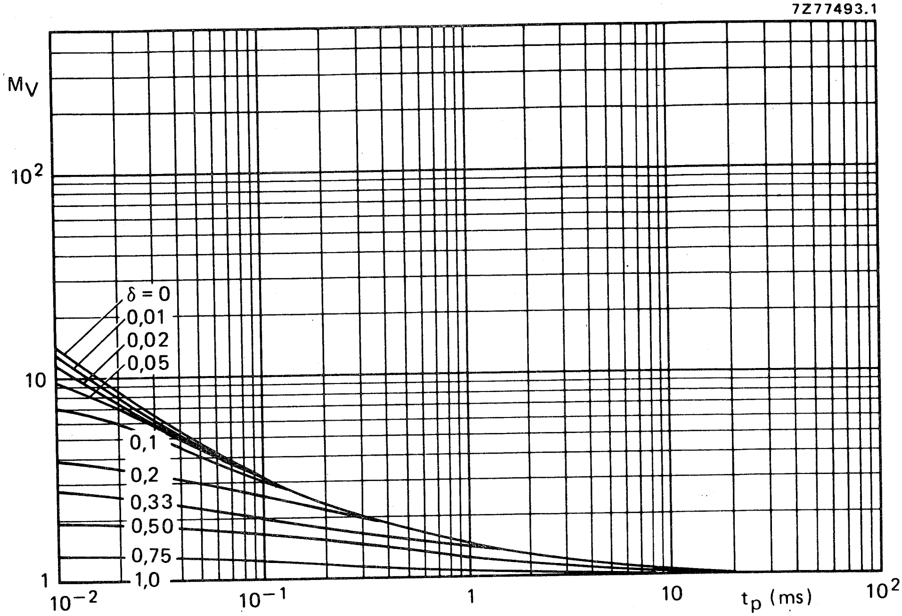


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

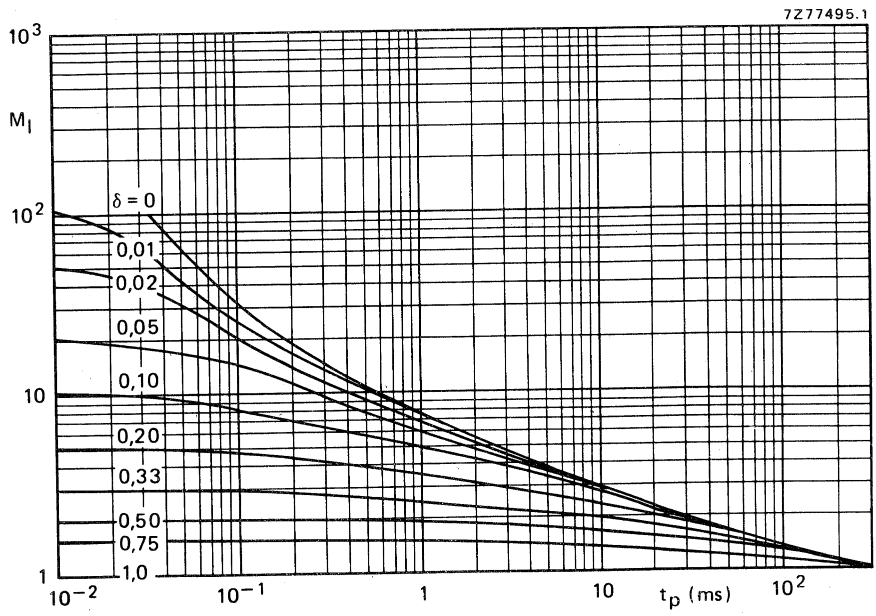


Fig. 10 S.B. current multiplying factor at the V_{CEOmax} level (100 V).

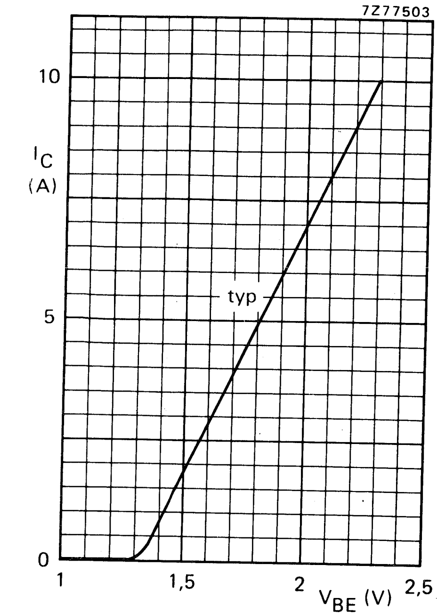


Fig. 11 V_{CE} = 4 V; T_j = 25 °C.

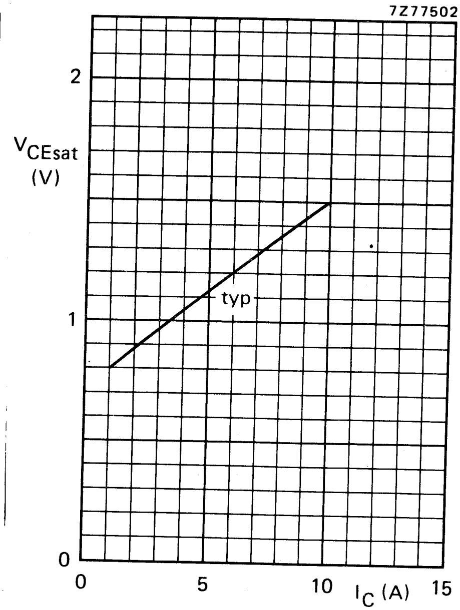


Fig. 12 I_C/I_B = 250; T_j = 25 °C.

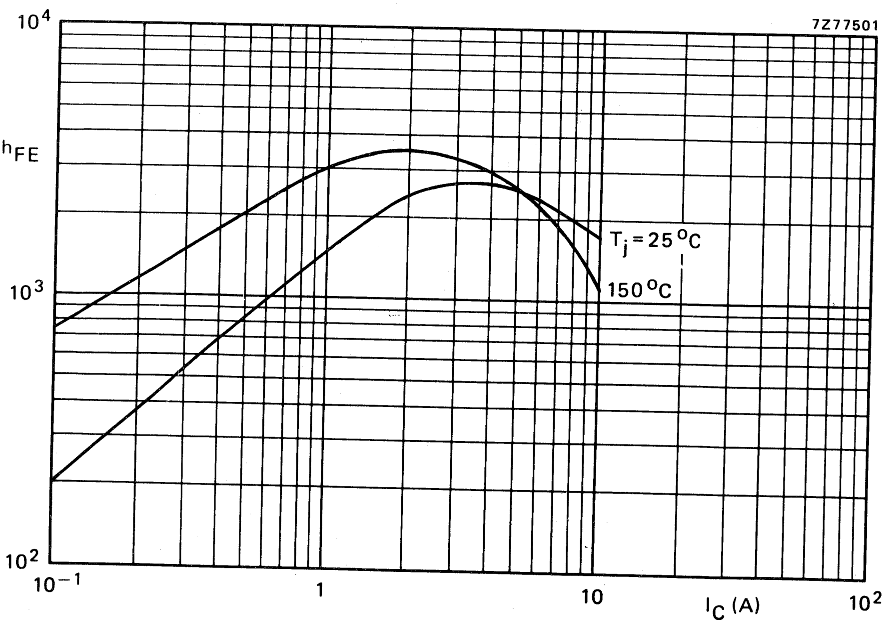


Fig. 13 Typical values; V_{CE} = 4 V.

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

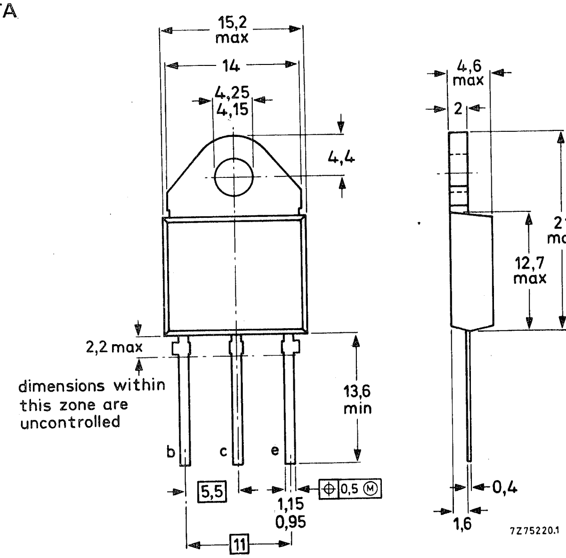
			BDV66A	B	C	D	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	100	120	140	160	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	80	100	120	150	V
Collector current (peak value)	$-I_{CM}$	max.	20				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	200				W
Junction temperature	T_j	max.	150				°C
D.C. current gain							
$-I_C$ = 1 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	3000				
$-I_C$ = 10 A; $-V_{CE}$ = 3 V	h_{FE}	>	1000				
Cut-off frequency							
$-I_C$ = 5 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.	60				kHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



See also chapters Mounting instructions and Accessories.

CIRCUIT DIAGRAM

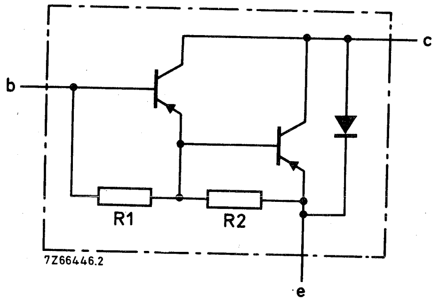


Fig. 2.
R1 typical 3 kΩ
R2 typical 80 Ω

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 °C	P_{tot}	max.	200				W
Storage temperature	T_{stg}		−65 to + 150				°C
Junction temperature*	T_j	max.	150				°C

THERMAL RESISTANCE

From junction to mounting base*	$R_{th\ j\text{-}mb}$	=	0,625	K/W

CHARACTERISTICS

T_j = 25 °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 °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 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*			
$-I_C = 1$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	3000
$-I_C = 10$ A; $-V_{CE} = 3$ V	h_{FE}	>	1000
$-I_C = 16$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	1000
Base-emitter voltage**			
$-I_C = 10$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5 V
Collector-emitter saturation voltage*			
$-I_C = 10$ A; $-I_B = 40$ mA	$-V_{CEsat}$	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	typ.	300 pF
Cut-off frequency			
$-I_C = 5$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	60 kHz
Diode, forward voltage			
$I_F = 10$ A	V_F	<	3 V
D.C. current gain ratio of matched complementary pairs			
$-I_C = 10$ A; $-V_{CE} = 3$ V	h_{FE1}/h_{FE2}	<	2,5
Small-signal current gain			
$-I_C = 5$ A; $-V_{CE} = 3$ V; f = 1 MHz	h_{fe}	typ.	40
Switching times			
$-I_{Con} = 10$ A; $-I_{Bon} = I_{Boff} = 40$ mA; $V_{CC} = -12$ V			
Turn-on time	t_{on}	typ.	1 µs
Turn-off time	t_{off}	typ.	3,5 µs

DEVELOPMENT SAMPLE DATA

* Measured under pulse conditions: $t_p < 300$ µs; $\delta < 2\%$.
** $-V_{BE}$ decreases by about 3,6 mV/K with increasing temperature.

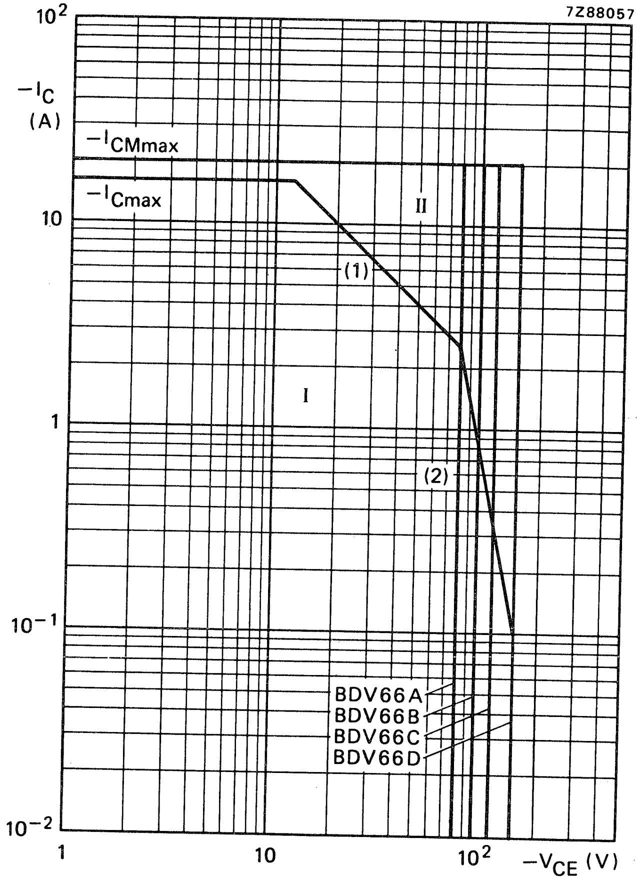


Fig. 3 Safe Operating ARea; $T_{mb} \leq 25$ °C.

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).

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

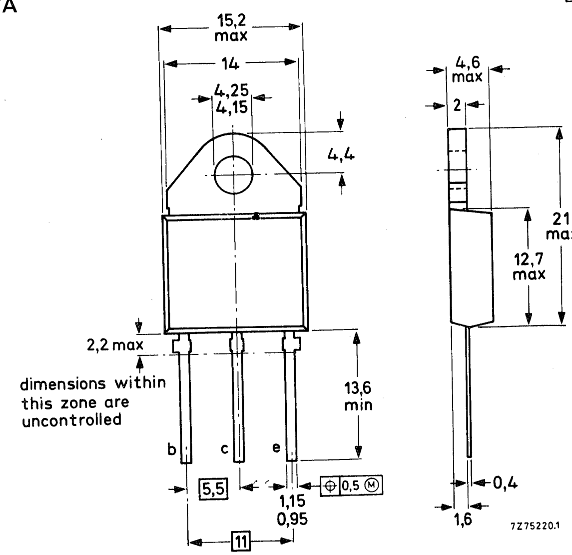
			BDV67A	B	C	D	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	120	140	160	V
Collector-emitter voltage (open base)	V_{CEO}	max.	80	100	120	150	V
Collector current (peak value)	I_{CM}	max.	20				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	200				W
Junction temperature	T_j	max.	150				°C
D.C. current gain							
I_C = 1 A; V_{CE} = 3 V	h_{FE}	typ.	3000				
I_C = 10 A; V_{CE} = 3 V	h_{FE}	>	1000				
Cut-off frequency							
I_C = 5 A; V_{CE} = 3 V	f_{hfe}	typ.	60				kHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting-base.



See also chapters Mounting instructions and Accessories.

CIRCUIT DIAGRAM

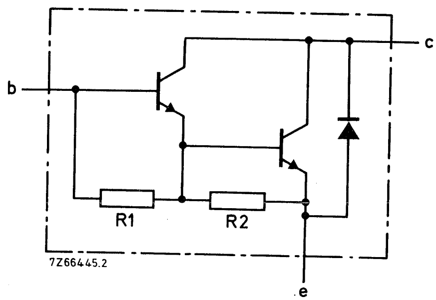


Fig. 2.
R1 typical 3 kΩ
R2 typical 80 Ω

RATINGS

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

			BDV67A	B	C	D	
Collector-base voltage (open emitter)	V_{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 °C	P_{tot}	max.	200	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature*	T_j	max.	150	°C

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0,625	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off currents				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	1	mA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 150 °C	I_{CBO}	<	4	mA
$I_B = 0$; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	<	3	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 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 A; V_{CE} = 3 V	h_{FE}	typ.	3000
I_C = 10 A; V_{CE} = 3 V	h_{FE}	>	1000
I_C = 16 A; V_{CE} = 3 V	h_{FE}	typ.	1000
Base-emitter voltage** I_C = 10 A; V_{CE} = 3 V	V_{BE}	<	2,5 V
Collector-emitter saturation voltage* I_C = 10 A; I_B = 40 mA	V_{CEsat}	<	2 V
Collector capacitance at f = 1 MHz $I_E = I_e$ = 0; V_{CB} = 10 V	C_c	typ.	300 pF
Cut-off frequency I_C = 5 A; V_{CE} = 3 V	f_{hfe}	typ.	60 kHz
Diode, forward voltage I_F = 10 A	V_F	<	3 V
D.C. current gain ratio of matched complementary pairs I_C = 10 A; V_{CE} = 3 V	h_{FE1}/h_{FE2}	<	2,5
Small-signal current gain I_C = 5 A; V_{CE} = 3 V; f = 1 MHz	h_{fe}	typ.	40
Turn-off breakdown energy with inductive load (see also Fig. 3). I_{Con} = 6,3 A; $-I_{Boff}$ = 0; t_p = 1 ms; T = 100 ms	$E_{(BR)}$	>	150 mJ
Switching times I_{Con} = 10 A; $I_{Bon} = -I_{Boff}$ = 40 mA; V_{CC} = 12 V			
Turn-on time	t_{on}	typ.	1 μs
Turn-off time	t_{off}	typ.	3,5 μs

DEVELOPMENT SAMPLE DATA

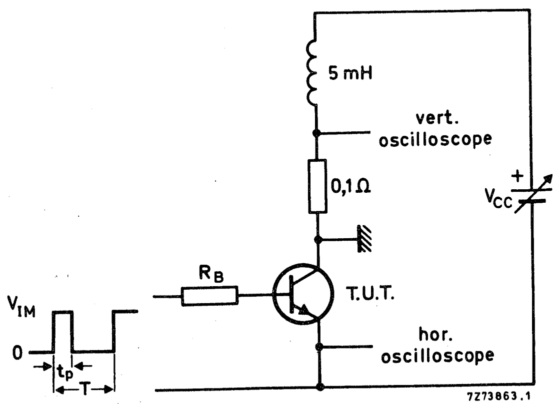


Fig. 3 Test circuit; V_1 = 12 V; R_B = 270 Ω.

* Measured under pulse conditions: $t_p < 300$ μs; $\delta < 2\%$.
** V_{BE} decreases by about 3,6 mV/K with increasing temperature.

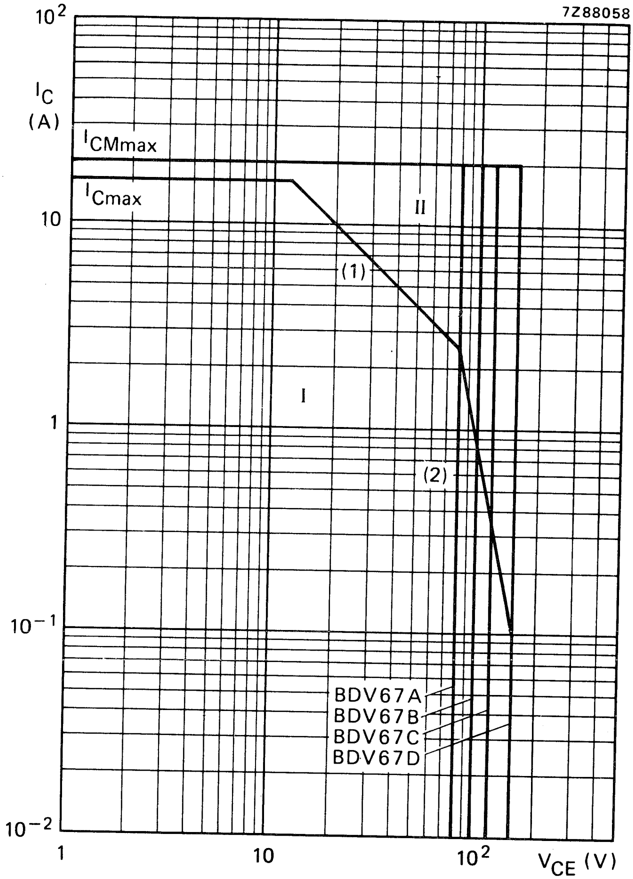


Fig. 4 Safe Operating ARea; $T_{mb} \leqslant 25\ ^oC$.

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

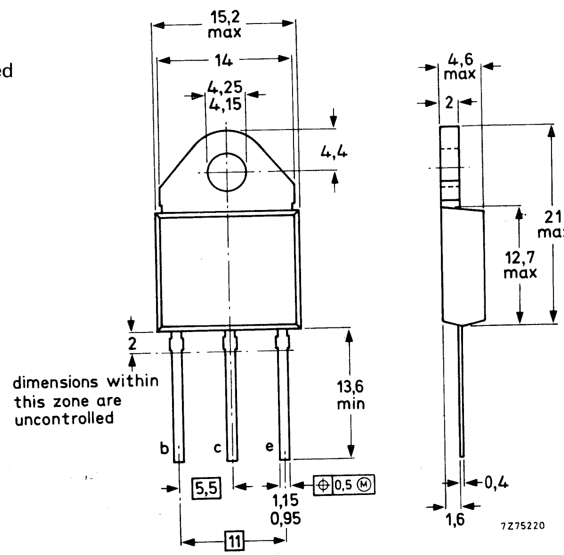
			BDV91	BDV93	BDV95	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (peak value)	I_{CM}	max.		20		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		100		W
Junction temperature	T_j	max.		150		°C
D.C. current gain I_C = 4 A; V_{CE} = 4 V	h_{FE}	>		20		
Transition frequency I_C = 0,5 A; V_{CE} = 10 V	f_T	>		3		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



See chapters Mounting Instructions SOT-93 and Accessories.

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 °C	P_{tot}	max.		100		W
Storage temperature	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,25	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents				
$I_E = 0$; $V_{CB} = V_{CBO\,max}$	I_{CBO}	<	0,1	mA
$I_E = 0$; $V_{CB} = ½V_{CBO\,max}$; T_j = 150 °C	I_{CBO}	<	1	mA
$I_B = 0$; $V_{CE} = V_{CEO\,max}$	I_{CEO}	<	1	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 7 V	I_{EBO}	<	1	mA
D.C. current gain				
I_C = 4 A; V_{CE} = 4 V	h_{FE}	>	20	
I_C = 10 A; V_{CE} = 4 V	h_{FE}	>	5	
Collector-emitter saturation voltage				
I_C = 4 A; I_B = 0,4 A	$V_{CE\,sat}$	<	1	V
I_C = 10 A; I_B = 3,3 A	$V_{CE\,sat}$	<	3	V
Base-emitter saturation voltage				
I_C = 4 A; I_B = 0,4 A	$V_{BE\,sat}$	<	1,6	V
Base-emitter voltage				
I_C = 4 A; V_{CE} = 4 V	V_{BE}	<	1,6	V

CHARACTERISTICS (continued)

Transition frequency			
I_C = 0,5 A; V_{CE} = 10 V	f_T	>	3 MHz
Switching times (between 10% and 90% levels)			
I_{Con} = 4 A; I_{Bon} = $-I_{Boff}$ = 0,4 A; V_{CC} = 30 V			
Turn-on time	t_{on}	typ.	0,5 μs
Turn-off time	t_{off}	typ.	2,0 μs
Fall time	t_f	typ.	0,7 μs

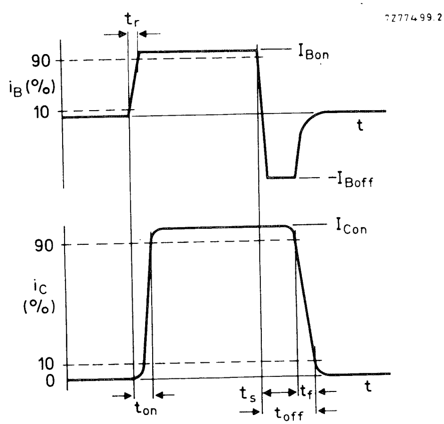


Fig. 2 Switching times waveforms.

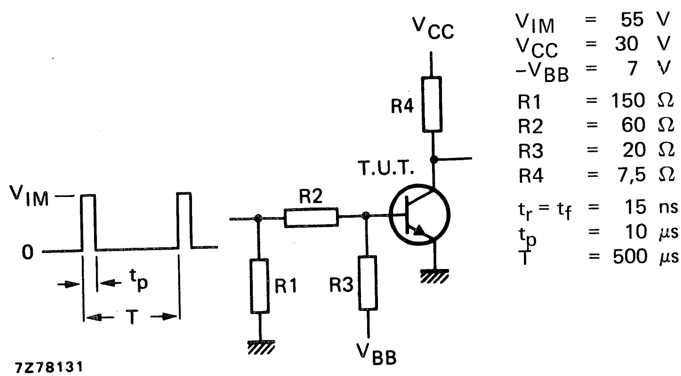


Fig. 3 Switching times test circuit.

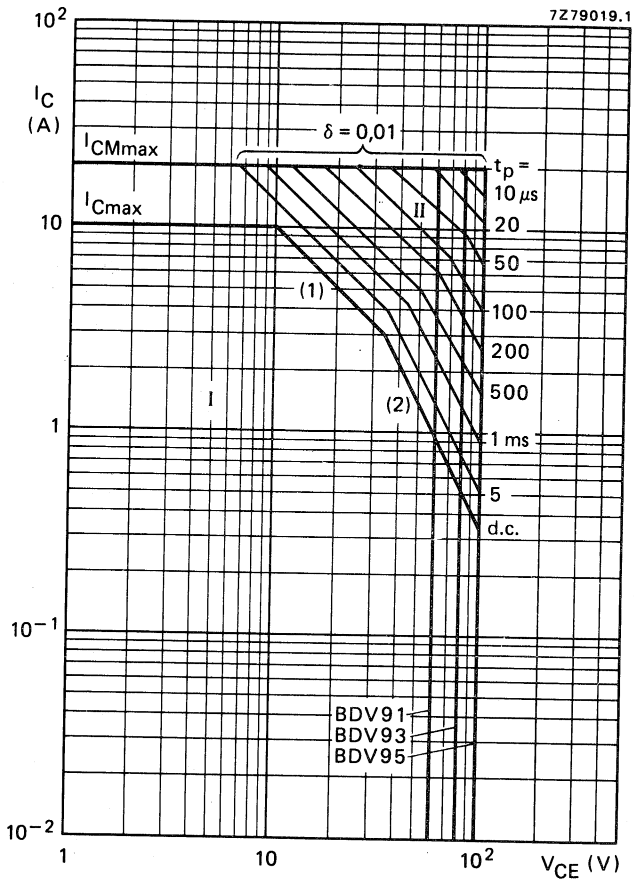


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

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.

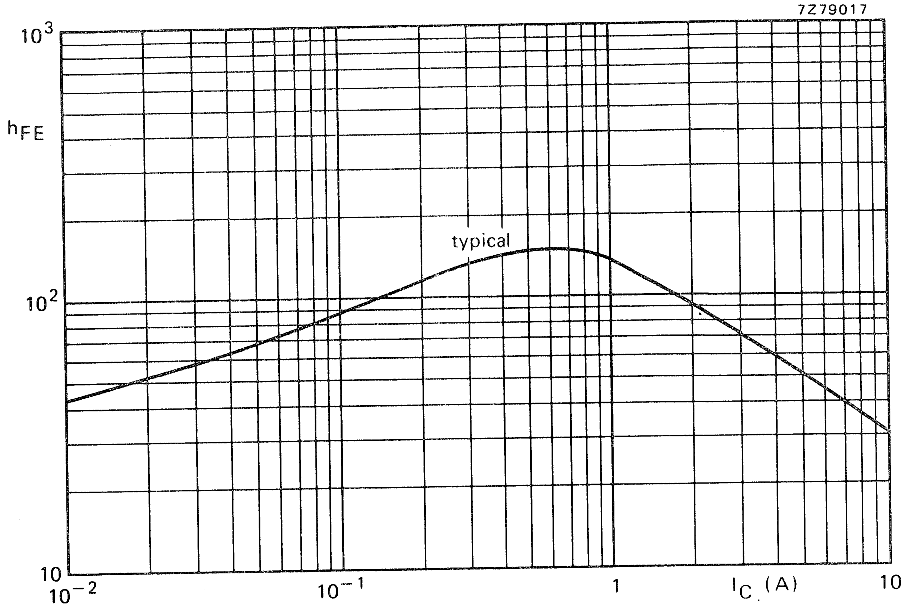


Fig. 5 $V_{CE} = 4$ V; $T_j = 25$ °C.

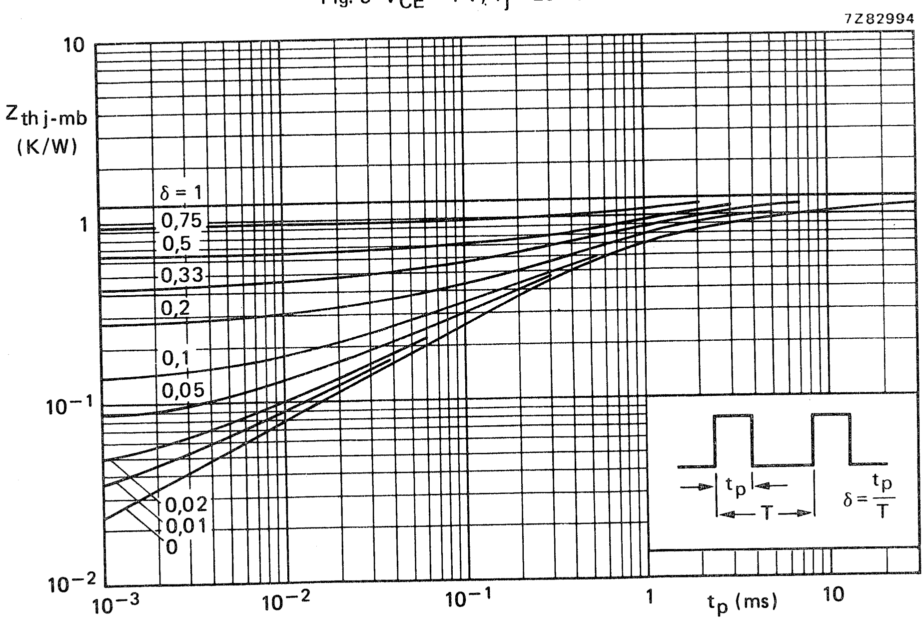


Fig. 6 Pulse power rating chart.

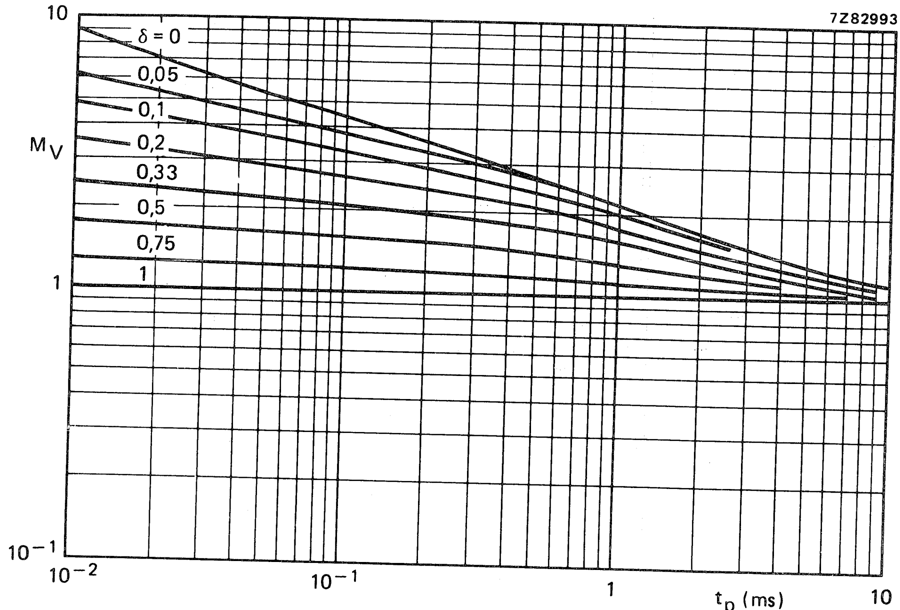


Fig. 7 Second-breakdown voltage multiplying factor at the I_{Cmax} level.

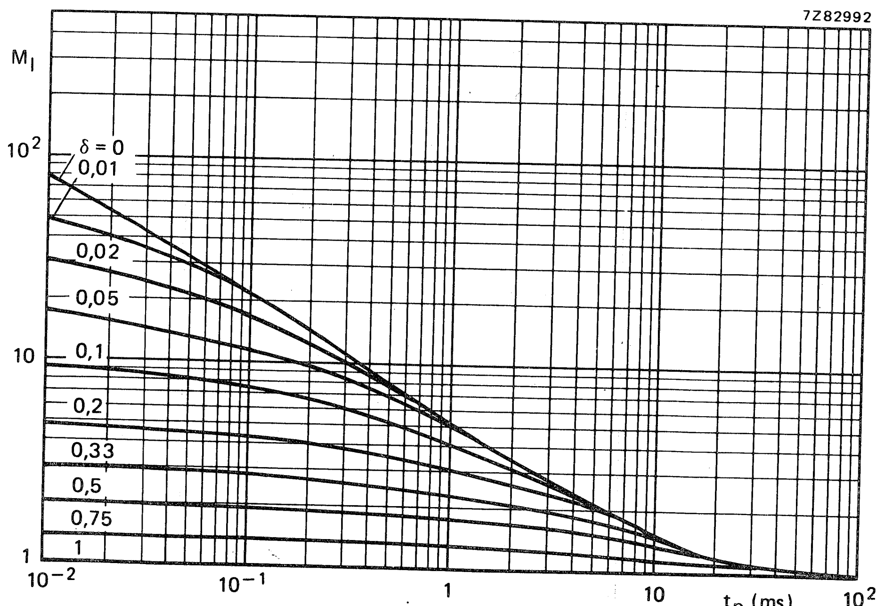


Fig. 8 Second-breakdown current multiplying factor at the V_{CEOmax} level.

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

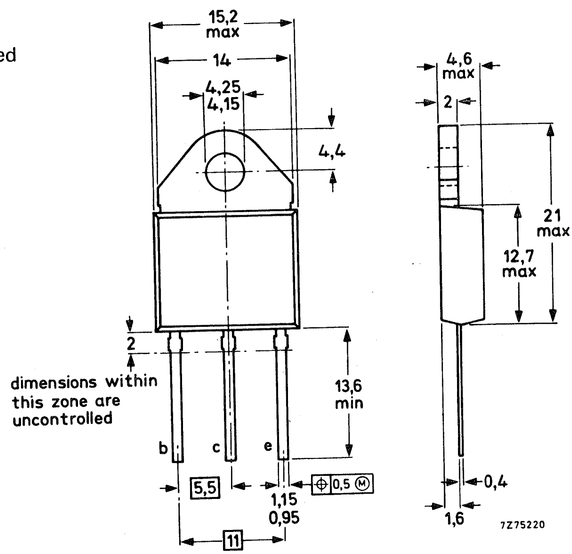
			BDV92	BDV94	BDV96	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Collector current (peak value)	$-I_{CM}$	max.		20		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		100		W
Junction temperature	T_j	max.		150		°C
D.C. current gain $-I_C$ = 4 A; $-V_{CE}$ = 4 V	h_{FE}	>		20		
Transition frequency $-I_C$ = 0,5 A; $-V_{CE}$ = 10 V	f_T	>		4		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-93.

Collector connected to mounting base.



See chapters Mounting Instructions SOT-93 and Accessories.

RATINGS

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

			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
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 °C	P_{tot}	max.		100		W
Storage temperature	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$ =	1,25	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off currents				
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,1	mA
$I_E = 0$; $-V_{CB} = -½V_{CBOmax}$; T_j = 150 °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 V	$-I_{EBO}$	<	1	mA
D.C. current gain				
$-I_C$ = 4 A; $-V_{CE}$ = 4 V	h_{FE}	>	20	
$-I_C$ = 10 A; $-V_{CE}$ = 4 V	h_{FE}	>	5	
Collector-emitter saturation voltage				
$-I_C$ = 4 A; $-I_B$ = 0,4 A	$-V_{CEsat}$	<	1	V
$-I_C$ = 10 A; $-I_B$ = 3,3 A	$-V_{CEsat}$	<	3	V
Base-emitter saturation voltage				
$-I_C$ = 4 A; $-I_B$ = 0,4 A	$-V_{BEsat}$	<	1,6	V
Base-emitter voltage				
$-I_C$ = 4 A; $-V_{CE}$ = 4 V	$-V_{BE}$	<	1,6	V

CHARACTERISTICS (continued)

Transition frequency $-I_C = 0,5$ A; $-V_{CE} = 10$ V	f_T	>	4 MHz
Switching times (between 10% and 90% levels) $-I_{Con} = 4$ A; $-I_{Bon} = I_{Boff} = 0,4$ A; $-V_{CC} = 30$ V			
Turn-on time	t_{on}	typ.	0,3 μs
Turn-off time	t_{off}	typ.	0,7 μs
Fall time	t_f	typ.	0,3 μs

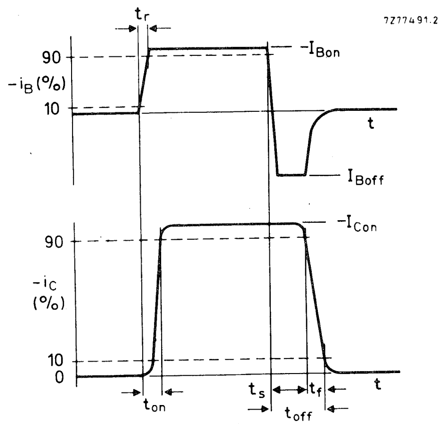
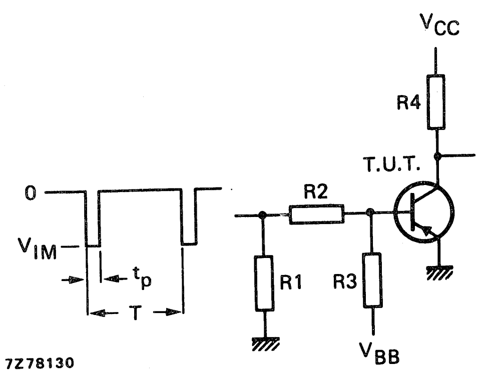


Fig. 2 Switching times waveforms.



$-V_{IM}$	=	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

Fig. 3 Switching times test circuit.

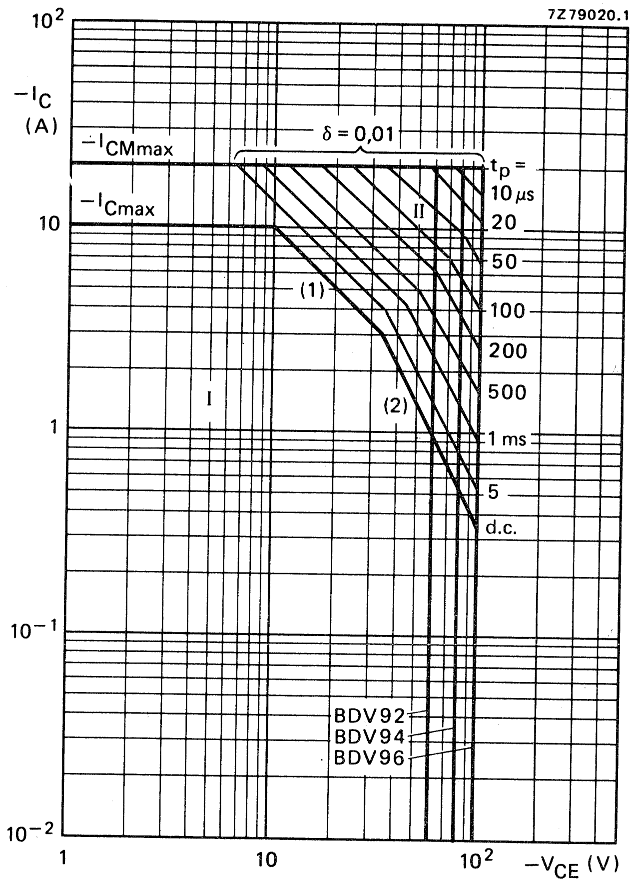


Fig. 4 Safe Operating ARea; T_{mb} = 25 °C.

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.

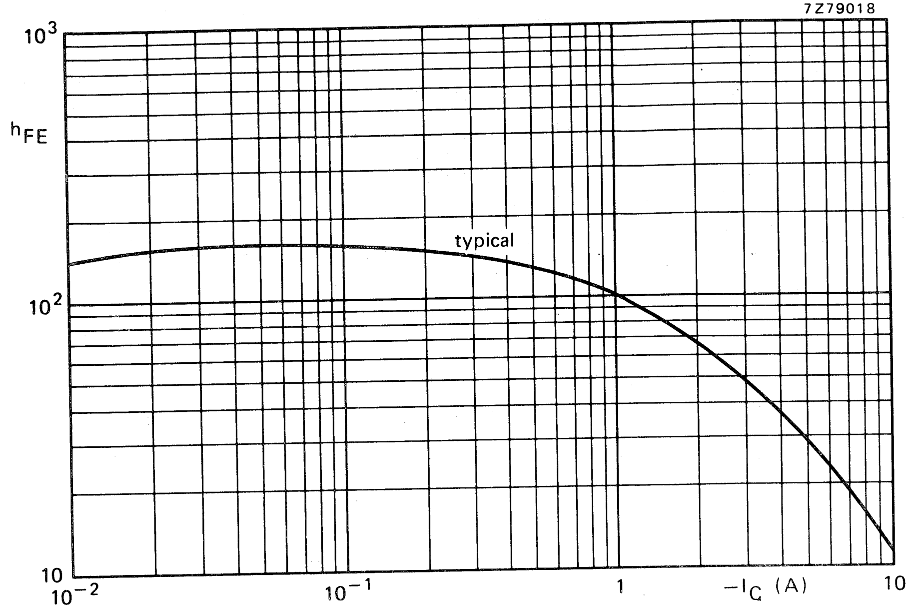


Fig. 5 $-V_{CE}$ = 4 V; T_j = 25 °C.

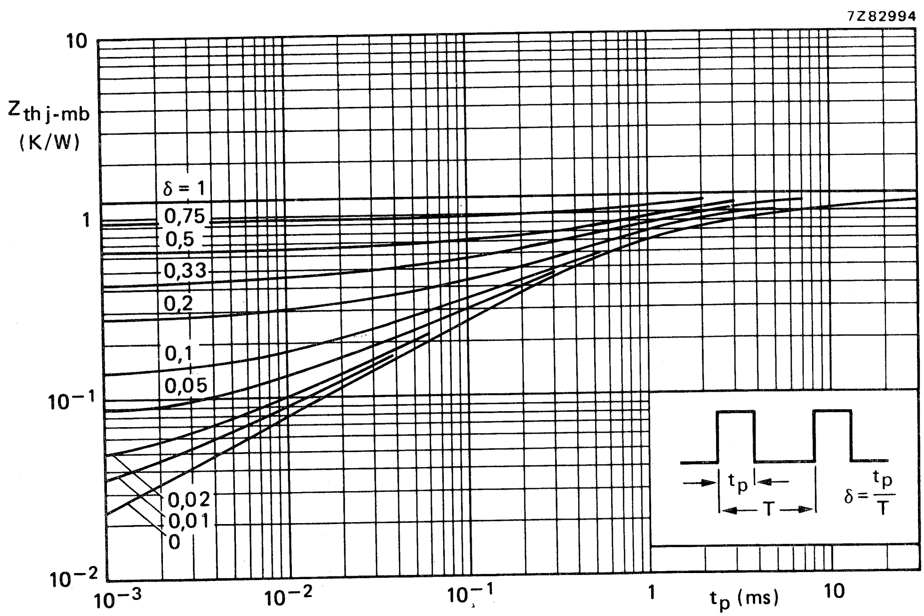


Fig. 6 Pulse power rating chart.

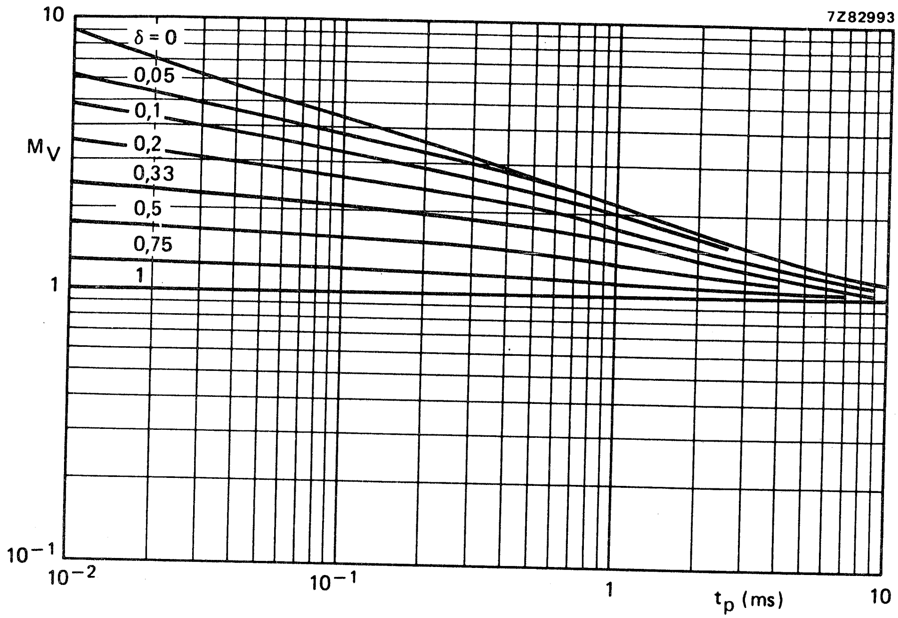


Fig. 7 Second-breakdown voltage multiplying factor at the I_{Cmax} level.

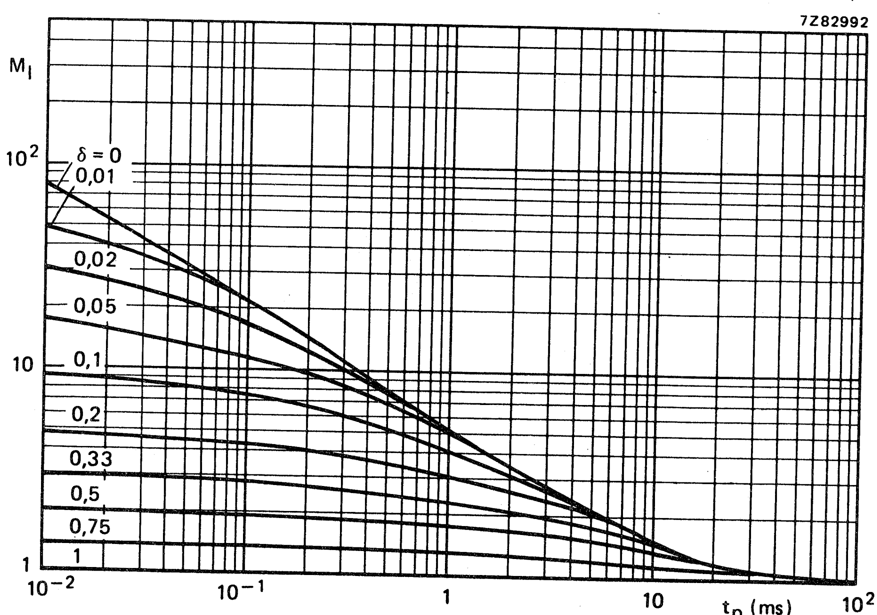


Fig. 8 Second-breakdown current multiplying factor at the V_{CEOmax} level.

SILICON 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 bounding;
- gold silicon eutectic chip bond;
- glass-passivated chip;
- silicone plastic

P-N-P complements are BDW56, BDW58 and BDW60.

QUICK REFERENCE DATA

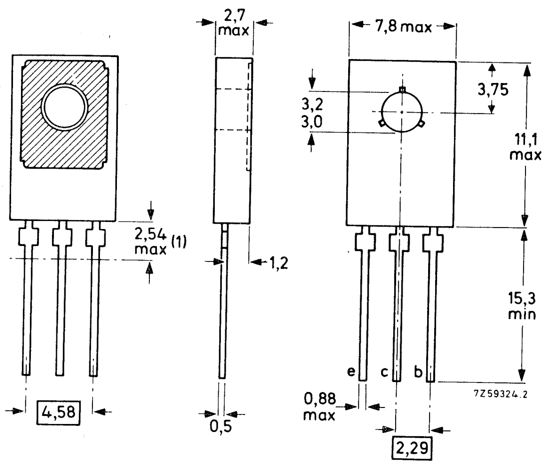
			BDW55	BDW57	BDW59	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	60	100	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	V_{CER}	max.	45	60	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	80	V
Collector current (peak value)	I_{CM}	max.		1,5		A
Total power dissipation up to T_{mb} = 95 °C	P_{tot}	max.		8		W
Junction temperature	T_j	max.		175		°C
D.C. current gain I_C = 150 mA; V_{CE} = 2 V	h_{FE}	>		40 to 250		
Transition frequency I_C = 50 mA; V_{CE} = 5 V	f_T	typ.		250		MHz

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 kΩ)	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 °C	P_{tot}	max.		8		W
Storage temperature	T_{stg}			−65 to +175		°C
Junction temperature	T_j	max.		175		°C

THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off current			
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	100 nA
$I_E = 0$; V_{CB} = 30, 45, 70 V (resp.); T_j = 150 °C	I_{CBO}	<	10 μA
Emitter cut-off current			
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	10 μA
Base-emitter voltage			
I_C = 500 mA; V_{CE} = 2 V	V_{BE}	<	1 V
Collector-emitter saturation voltage			
I_C = 500 mA; I_B = 50 mA	V_{CEsat}	<	0,5 V
D.C. current gain			
I_C = 5 mA; V_{CE} = 2 V	h_{FE}	>	25
I_C = 150 mA; V_{CE} = 2 V	h_{FE}		40 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
Switching times (see also Figs 2 and 3)			
I_{Con} = 150 mA; $I_{Bon} = -I_{Boff}$ = 15 mA; V_{CC} = 10,2 V			
Turn-on delay time	t_d	typ.	30 ns
Turn-on rise time	t_r	typ.	30 ns
Turn-off storage time	t_s	typ.	500 ns
Turn-off fall time	t_f	typ.	80 ns

CHARACTERISTICS (continued)

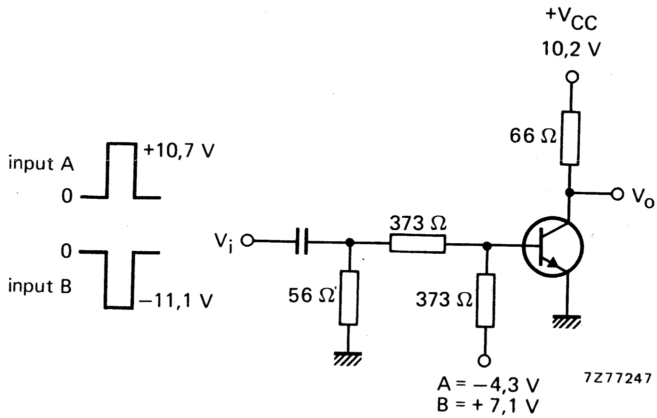


Fig. 2 Test circuit for measuring switching times.

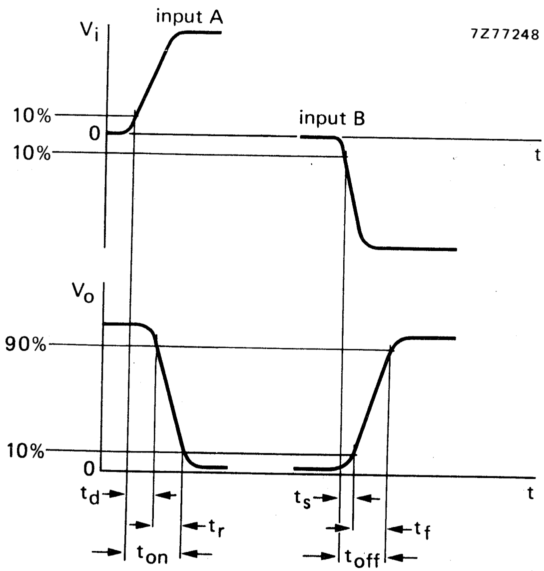


Fig. 3 Switching times waveforms.

Equipment

pulse generator; rise time = 1 ns.
double-beam or dual-trace oscilloscope; rise time < 5 ns.

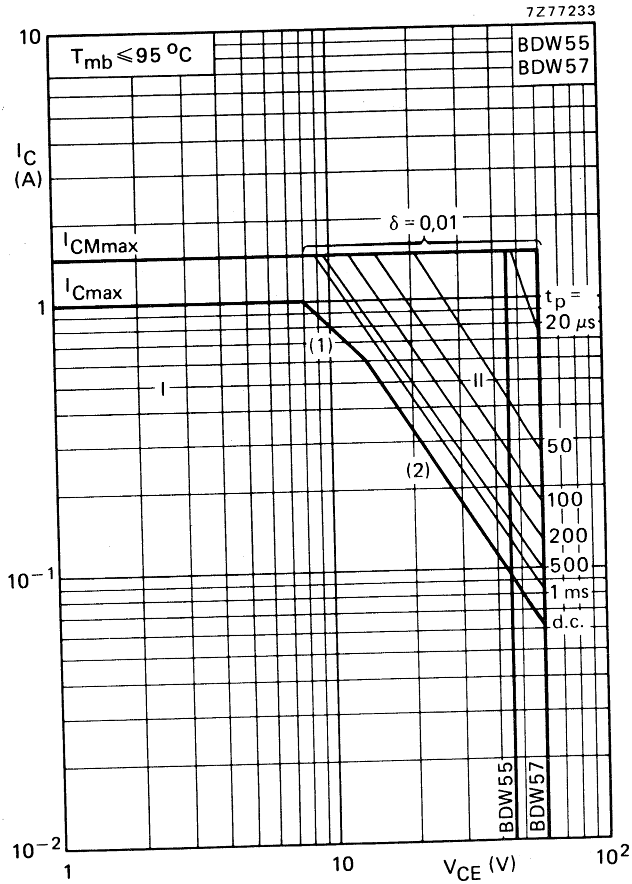


Fig. 4 Safe Operating ARea.

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).

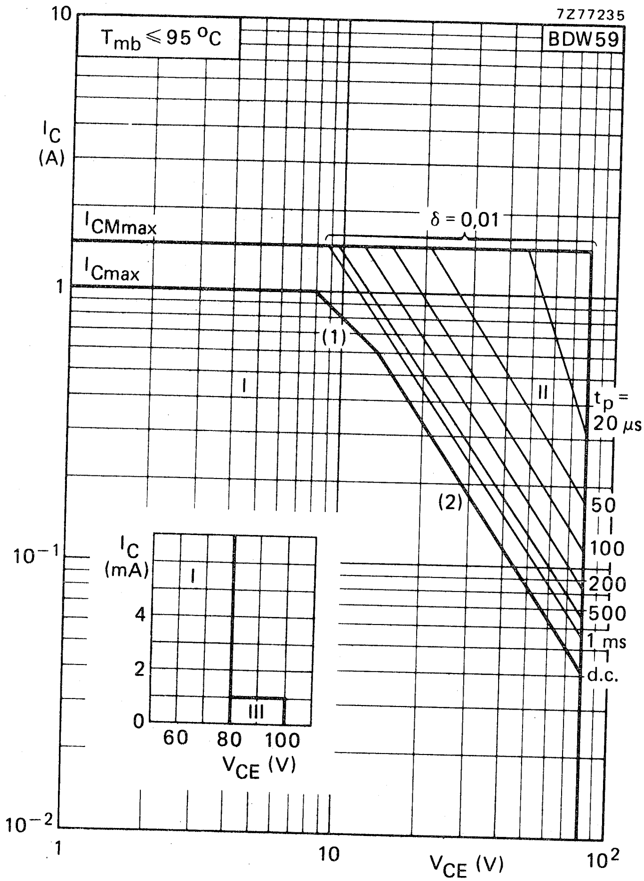


Fig. 5 Safe Operating ARea.

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

(1) $P_{tot\,max}$ and $P_{tot\,peak\,max}$ lines.
(2) Second-breakdown limits (independent of temperature).

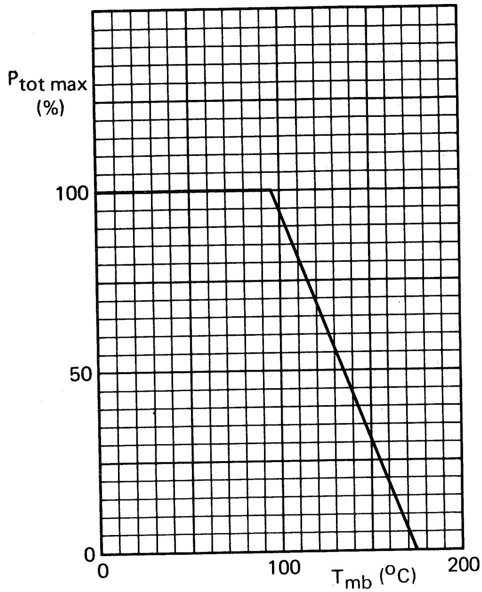

7Z77232
$P_{tot\ max}$ (%)
100
50
0
0
100
T_{mb} (°C)
200

Fig. 6.

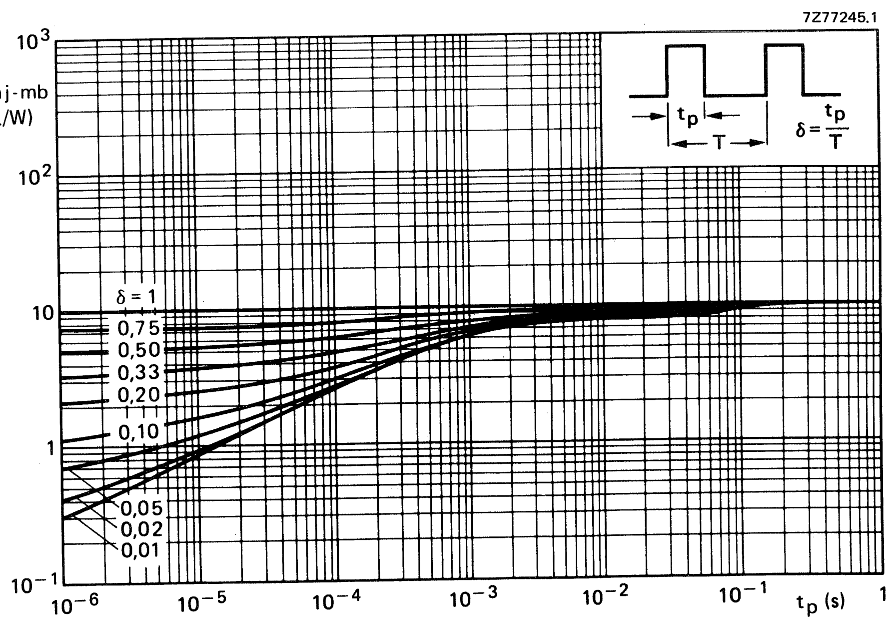

7Z77245.1
$Z_{th\ j\text{-}mb}$ (K/W)
10^3
10^2
10
1
10^{-1}
t_p
T
$\delta = \frac{t_p}{T}$
$\delta = 1$
0,75
0,50
0,33
0,20
0,10
0,05
0,02
0,01
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
t_p (s)
1

Fig. 7.

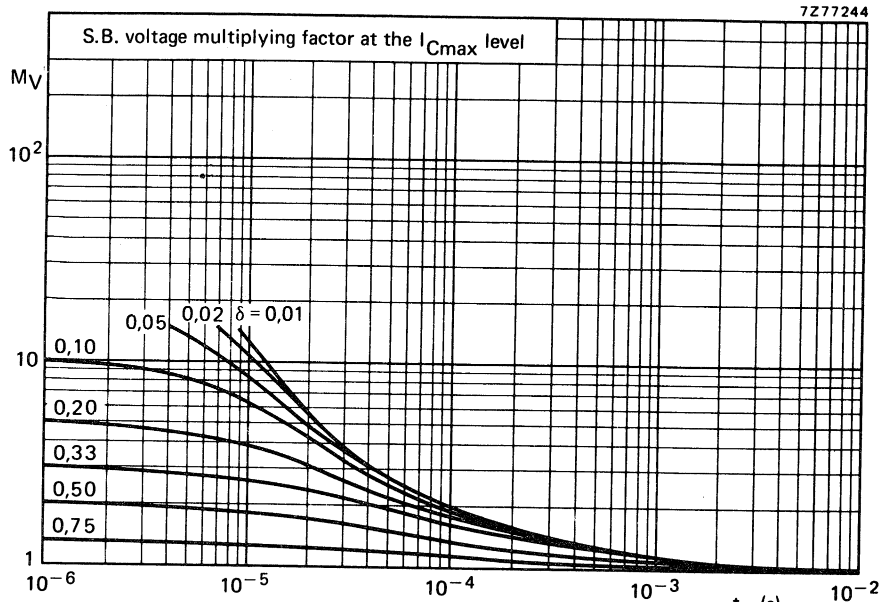

7Z77244
S.B. voltage multiplying factor at the I_{Cmax} level
M_V
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
t_p (s)

Fig. 8.

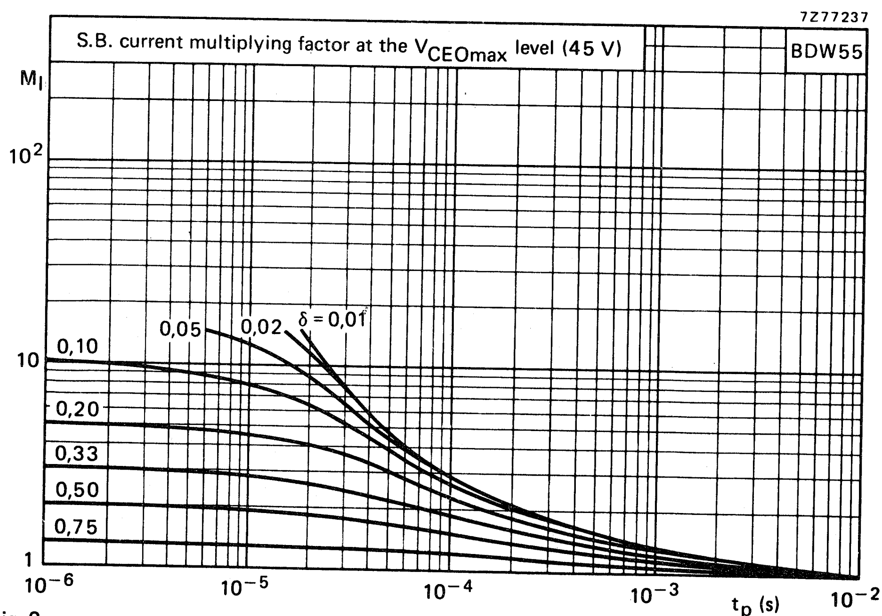

7Z77237
S.B. current multiplying factor at the V_{CEOmax} level (45 V)
BDW55
M_I
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
t_p (s)

Fig. 9.

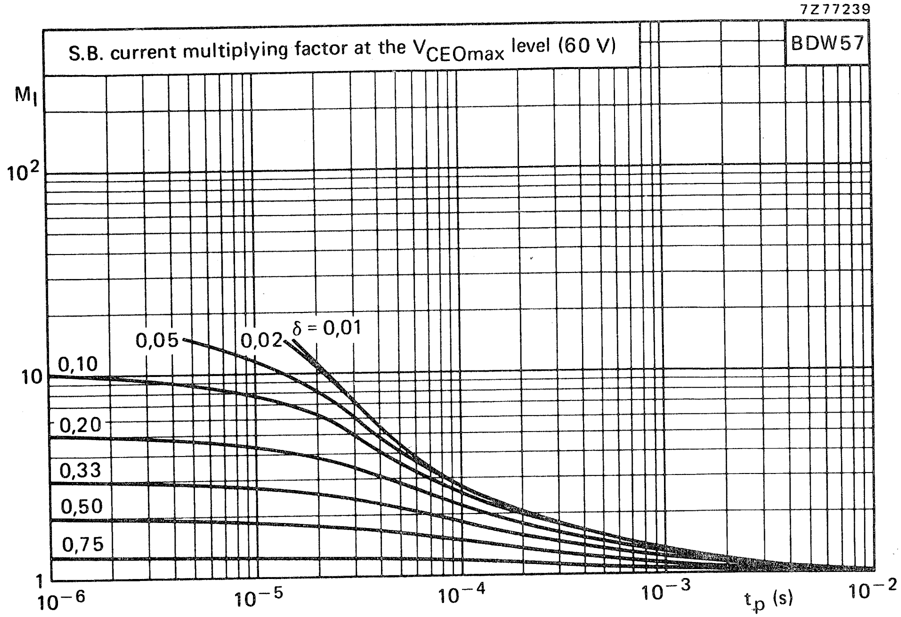

7Z77239
S.B. current multiplying factor at the V_{CEOmax} level (60 V)
BDW57
M_I
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 10.

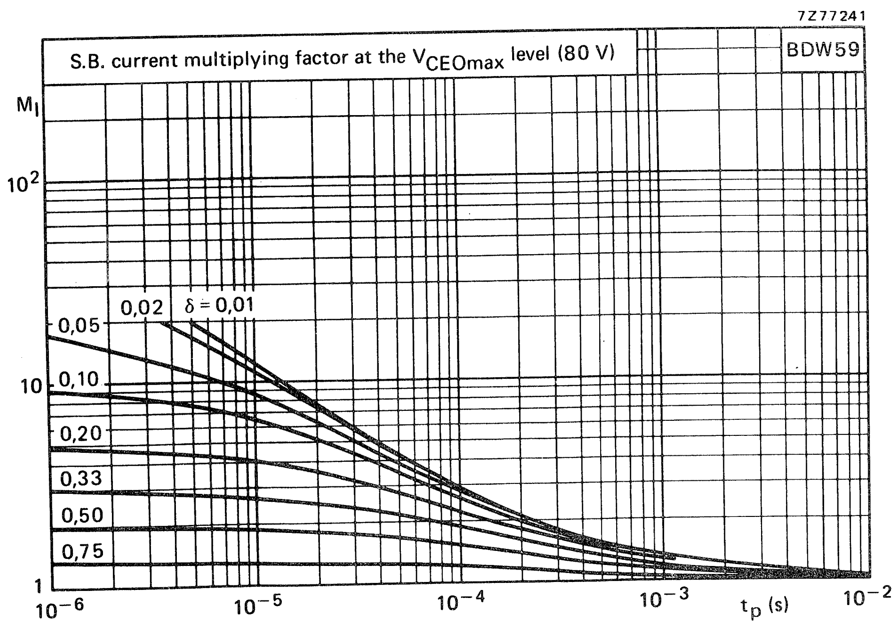

7Z77241
S.B. current multiplying factor at the V_{CEOmax} level (80 V)
BDW59
M_I
10^2
10
1
0,02
δ = 0,01
0,05
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 11.

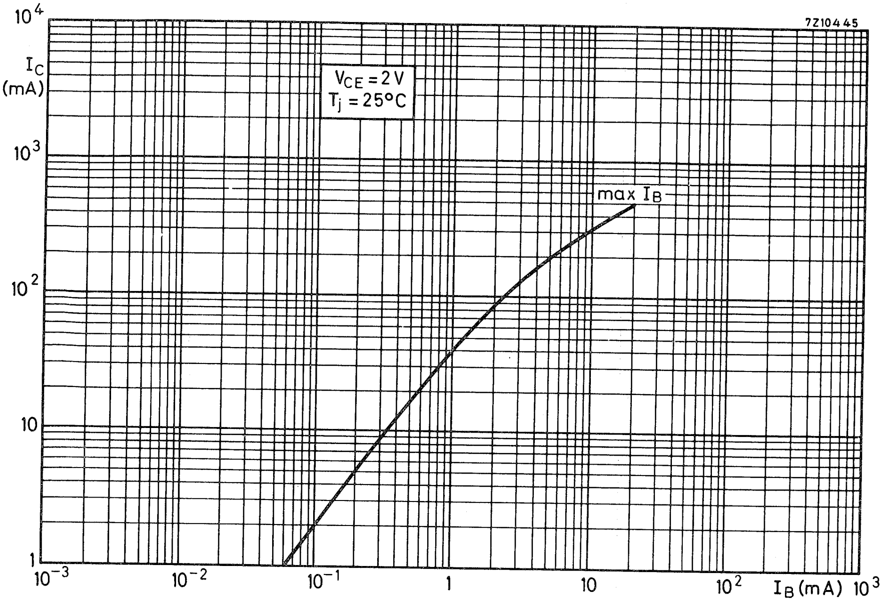

7Z10445
I_C (mA)
10^4
10^3
10^2
10
1
$V_{CE} = 2$ V
$T_j = 25$°C
max I_B
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
I_B (mA)
10^3

Fig. 12.

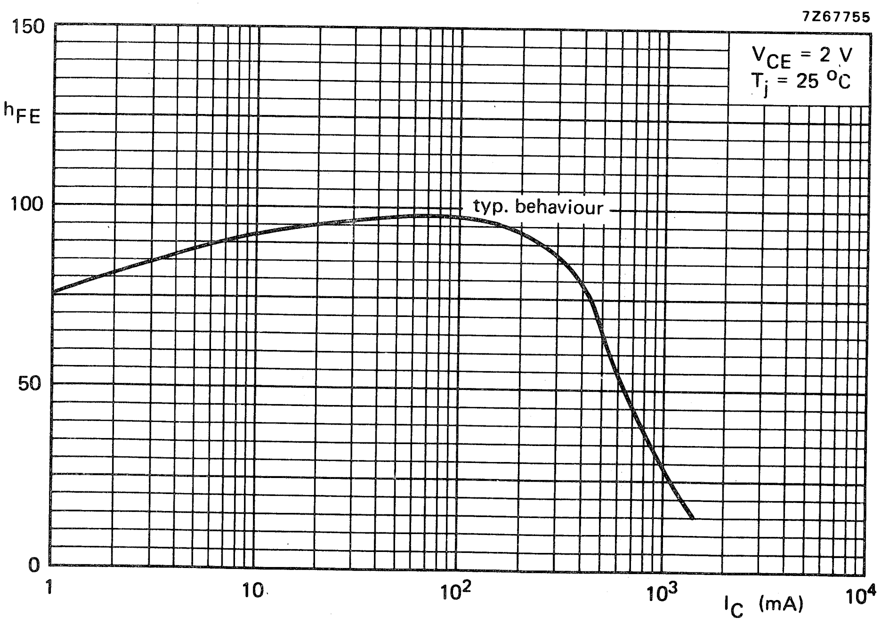

7Z67755
h_{FE}
150
100
50
0
$V_{CE} = 2$ V
$T_j = 25$ °C
typ. behaviour
1
10
10^2
10^3
I_C (mA)
10^4

Fig. 13.

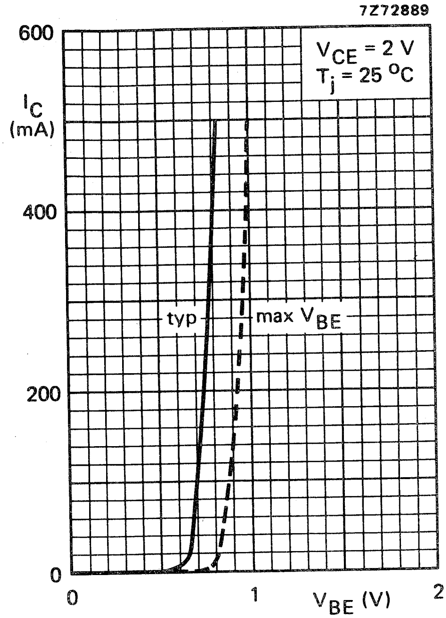


Fig. 14.

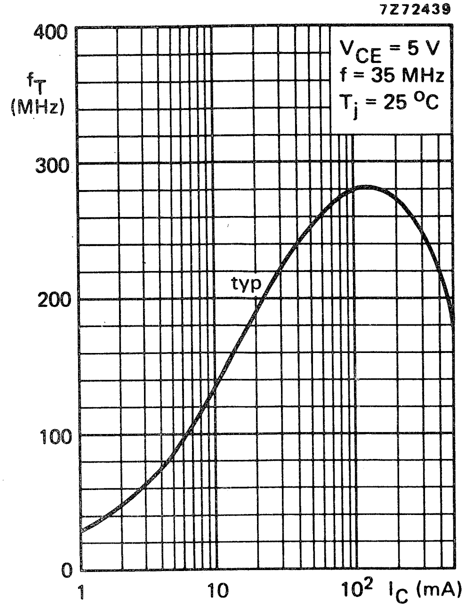


Fig. 15.

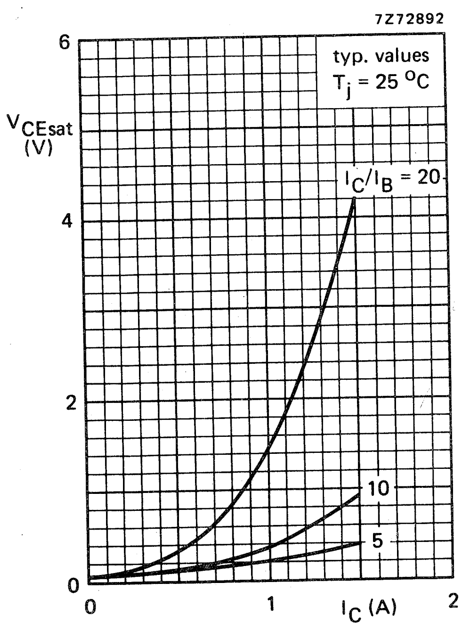


Fig. 16.

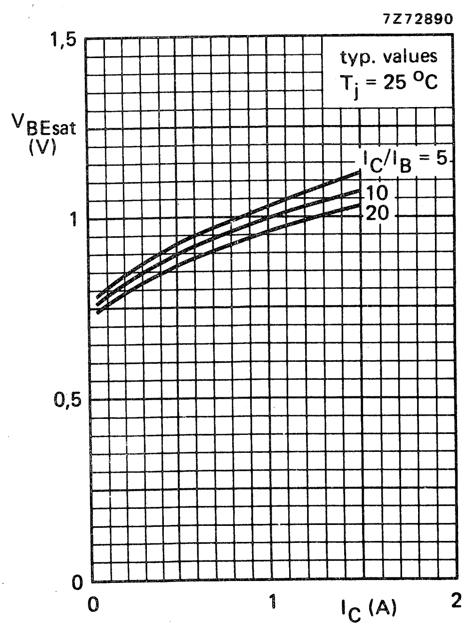


Fig. 17.

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 bounding;
- gold silicon eutectic chip bond;
- glass-passivated chip;
- silicone plastic.

N-P-N complements are BDW55, BDW57 and BDW59.

QUICK REFERENCE DATA

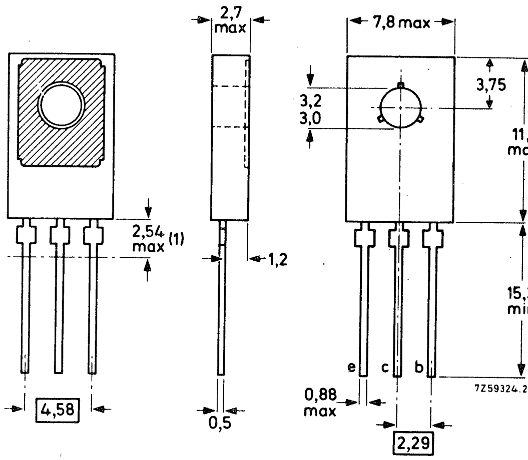
			BDW56	BDW58	BDW60	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector current (peak value)	$-I_{CM}$	max.		1,5		A
Total power dissipation up to T_{mb} = 95 °C	P_{tot}	max.		8		W
Junction temperature	T_j	max.		175		°C
D.C. current gain $-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}	>		40 to 250		
Transition frequency $-I_C$ = 50 mA; $-V_{CE}$ = 5 V	f_T	typ.		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)

			BDW56	BDW58	BDW60	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	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 °C	P_{tot}	max.		8		W
Storage temperature	T_{stg}			-65 to +175		°C
Junction temperature	T_j	max.		175		°C

THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Collector cut-off current			
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	100 nA
$I_E = 0; -V_{CB}$ = 30, 45, 70 V (resp.); T_j = 150 °C	$-I_{CBO}$	<	10 μA
Emitter cut-off current			
$I_C = 0; -V_{EB}$ = 5 V	$-I_{EBO}$	<	10 μA
Base-emitter voltage			
$-I_C$ = 500 mA; $-V_{CE}$ = 2 V	$-V_{BE}$	<	1 V
Collector-emitter saturation voltage			
$-I_C$ = 500 mA; $-I_B$ = 50 mA	$-V_{CEsat}$	<	0,5 V
D.C. current gain			
$-I_C$ = 5 mA; $-V_{CE}$ = 2 V	h_{FE}	>	25
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}		40 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.	75 MHz
Switching times (see also Figs 2 and 3)			
$-I_{Con}$ = 150 mA; $-I_{Bon} = I_{Boff}$ = 15 mA;			
$-V_{CC}$ = 10,2 V			
Turn-on delay time	t_d	typ.	30 ns
Turn-on rise time	t_r	typ.	40 ns
Turn-off storage time	t_s	typ.	500 ns
Turn-off fall time	t_f	typ.	80 ns

CHARACTERISTICS (continued)

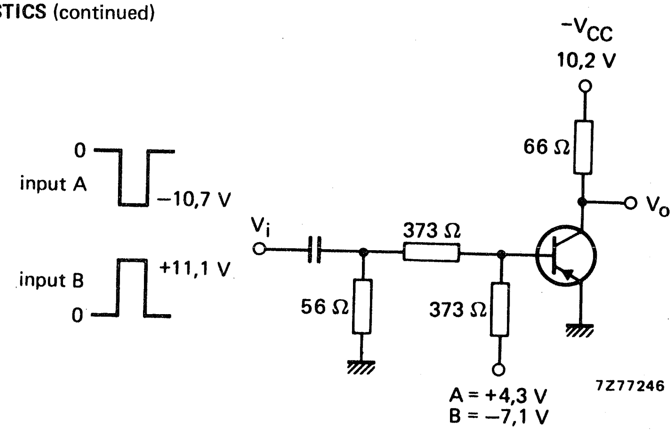


Fig. 2 Test circuit for measuring switching times.

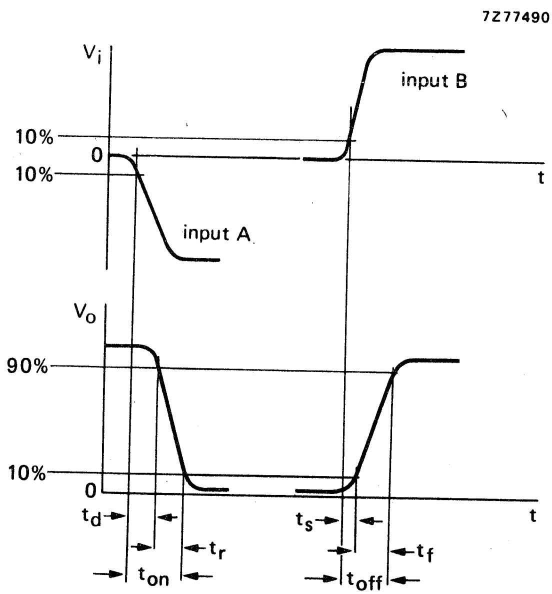


Fig. 3 Switching time waveforms.

Equipment

pulse generator; rise time = 1 ns.
double-beam or dual-trace oscilloscope; rise time < 5 ns.

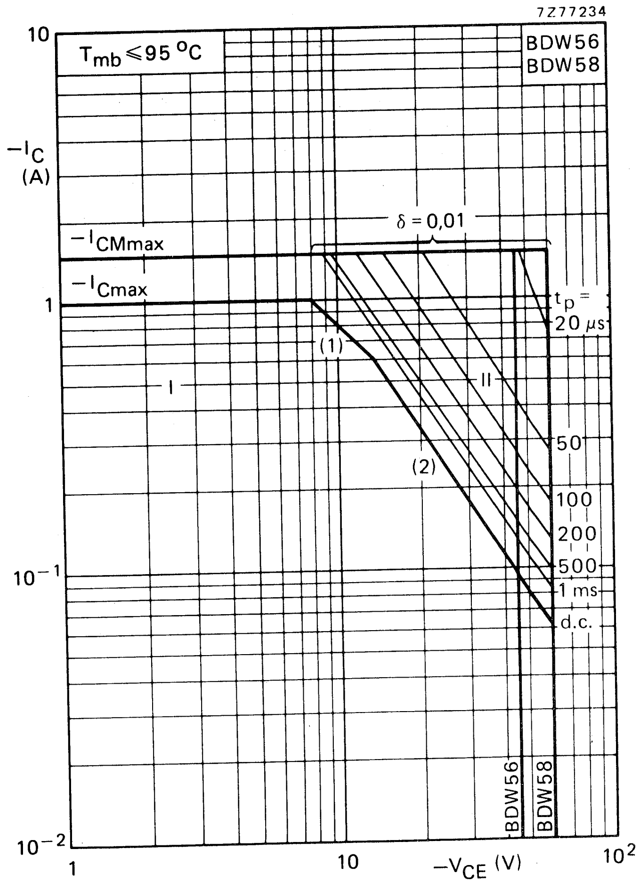


Fig. 4 Safe Operating ARea.

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).

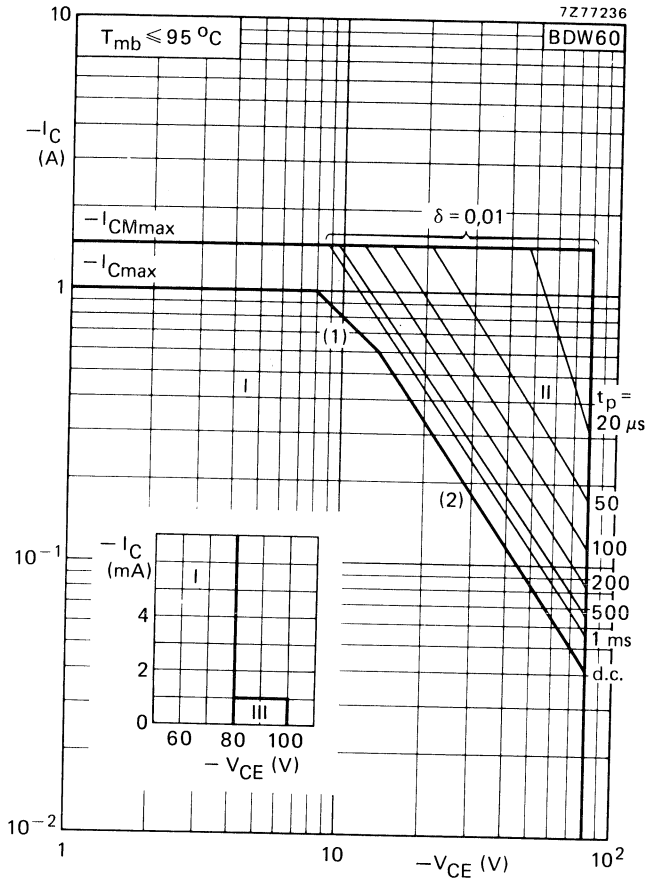


Fig. 5 Safe Operating ARea.

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

(1) $P_{tot\,max}$ and $P_{tot\,peak\,max}$ lines
(2) Second-breakdown limits (independent of temperature).

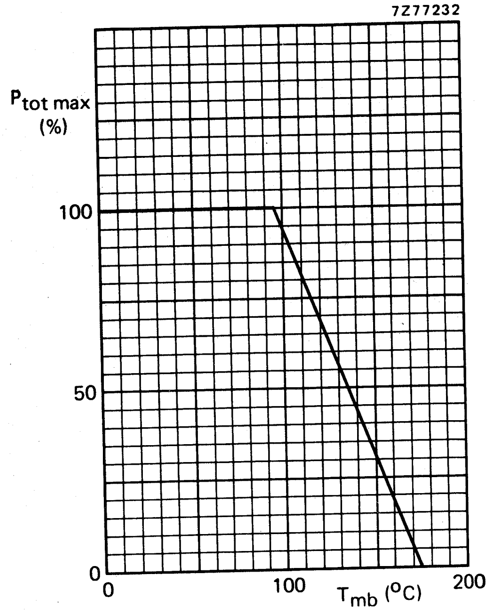

7Z77232
$P_{tot\,max}$ (%)
100
50
0
0
100
T_{mb} (°C)
200

Fig. 6.

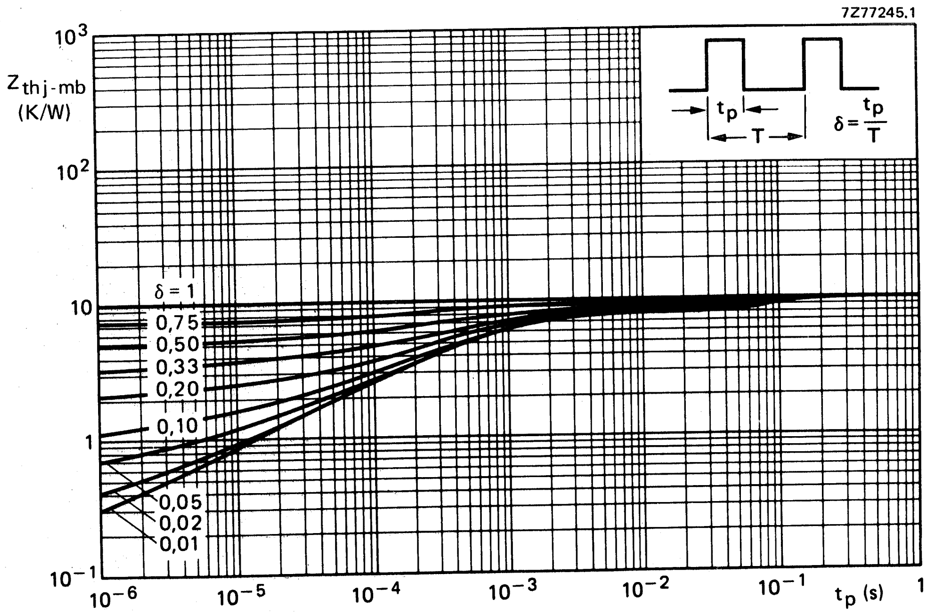

7Z77245.1
10^3
$Z_{th\,j\text{-}mb}$ (K/W)
10^2
10
1
10^{-1}
δ = 1
0,75
0,50
0,33
0,20
0,10
0,05
0,02
0,01
t_p
T
$\delta = \frac{t_p}{T}$
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
t_p (s)
1

Fig. 7.

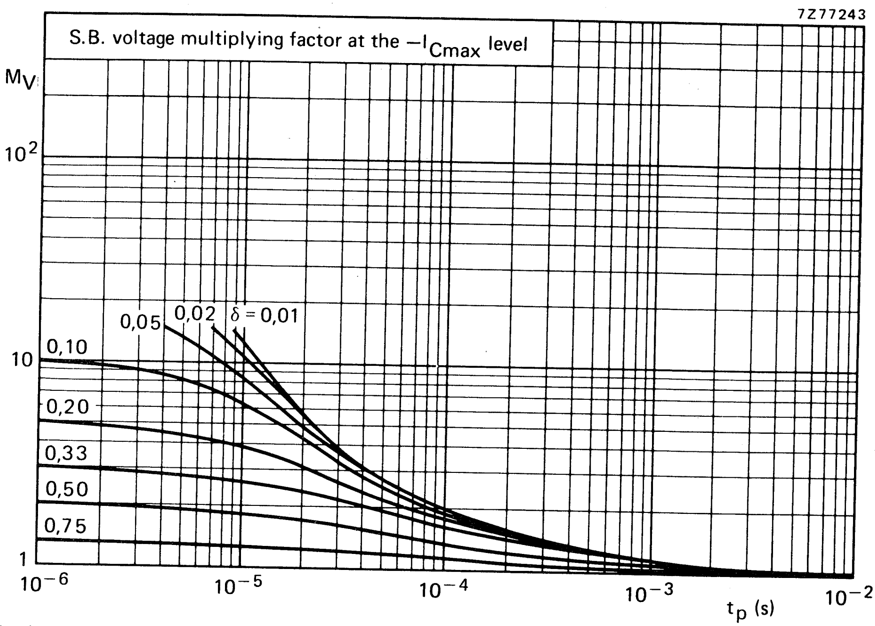

7Z77243
S.B. voltage multiplying factor at the $-I_{Cmax}$ level
M_V
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 8.

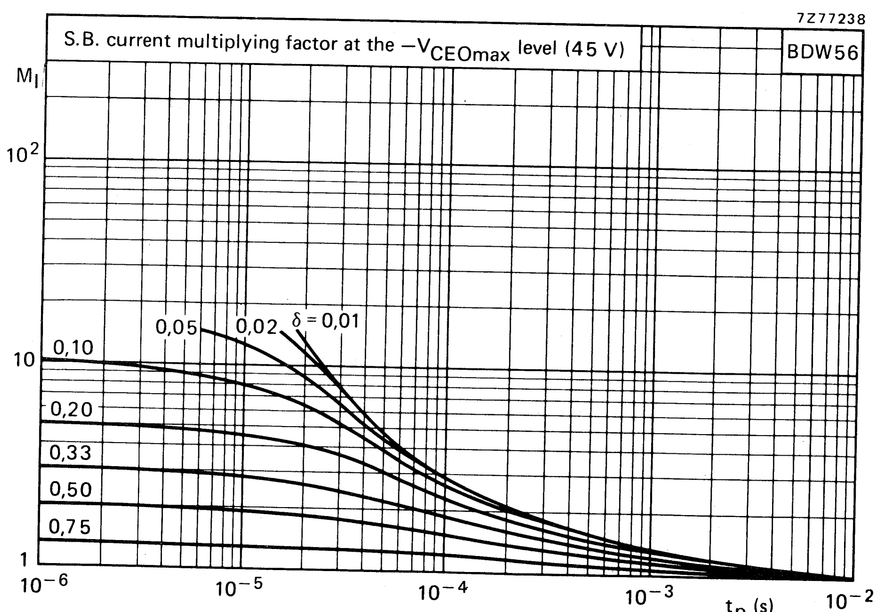

7Z77238
S.B. current multiplying factor at the $-V_{CEOmax}$ level (45 V)
BDW56
M_I
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 9.

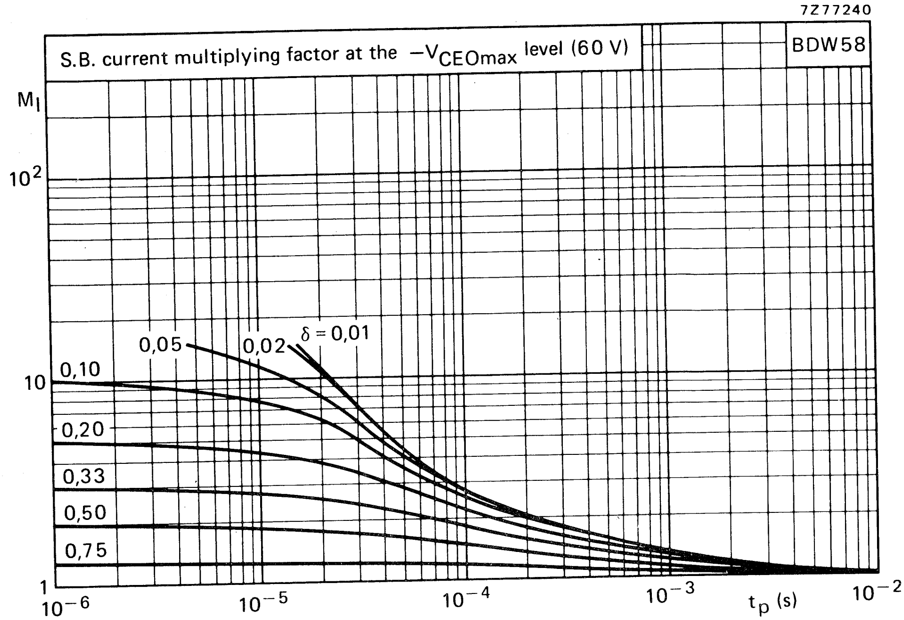

7Z77240
S.B. current multiplying factor at the $-V_{CEOmax}$ level (60 V)
BDW58
M_I
10^2
10
1
0,05
0,02
δ = 0,01
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 10.

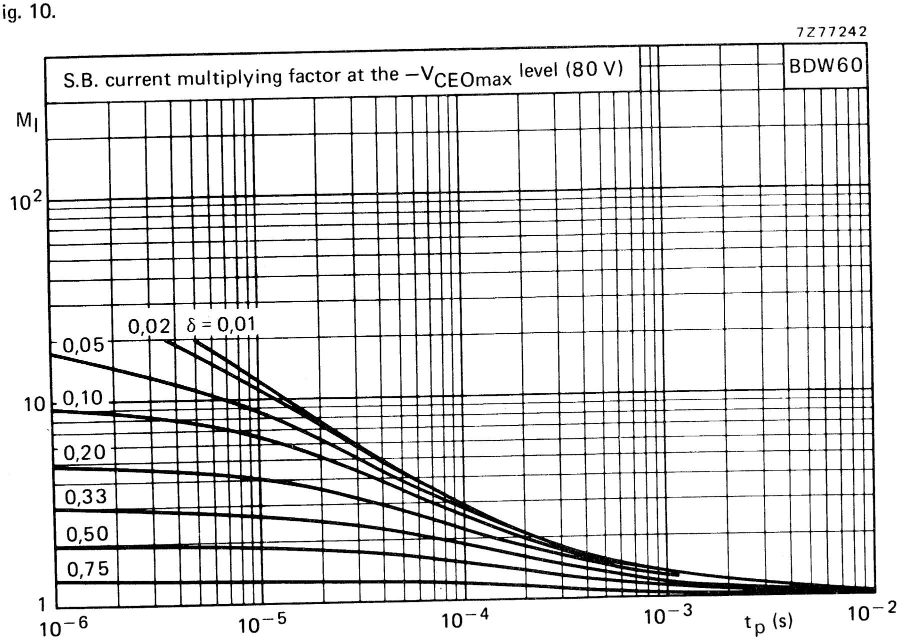

7Z77242
S.B. current multiplying factor at the $-V_{CEOmax}$ level (80 V)
BDW60
M_I
10^2
10
1
0,02
δ = 0,01
0,05
0,10
0,20
0,33
0,50
0,75
10^{-6}
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}

Fig. 11.

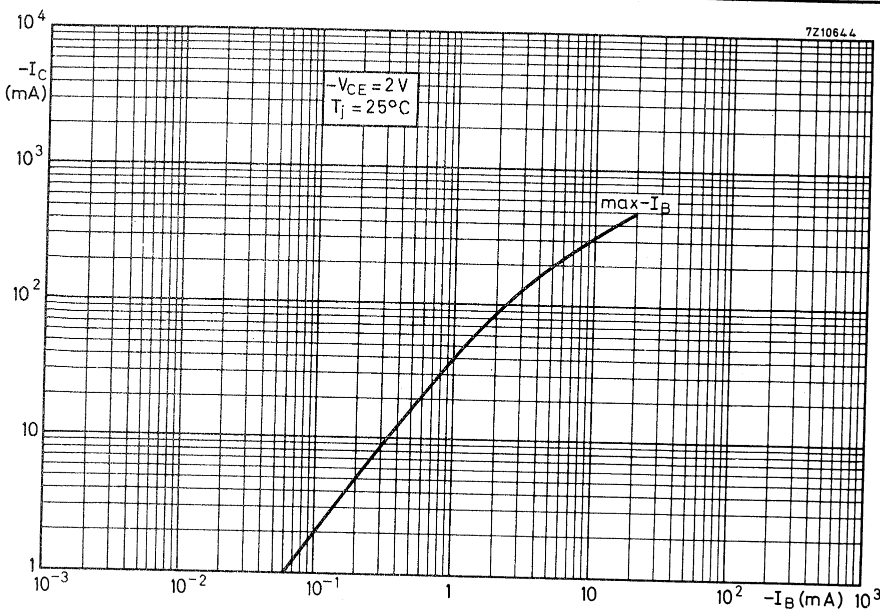

7Z10644
$-I_C$ (mA)
10^4
10^3
10^2
10
1
$-V_{CE} = 2$ V
$T_j = 25°C$
max-I_B
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
$-I_B$ (mA)
10^3

Fig. 12.

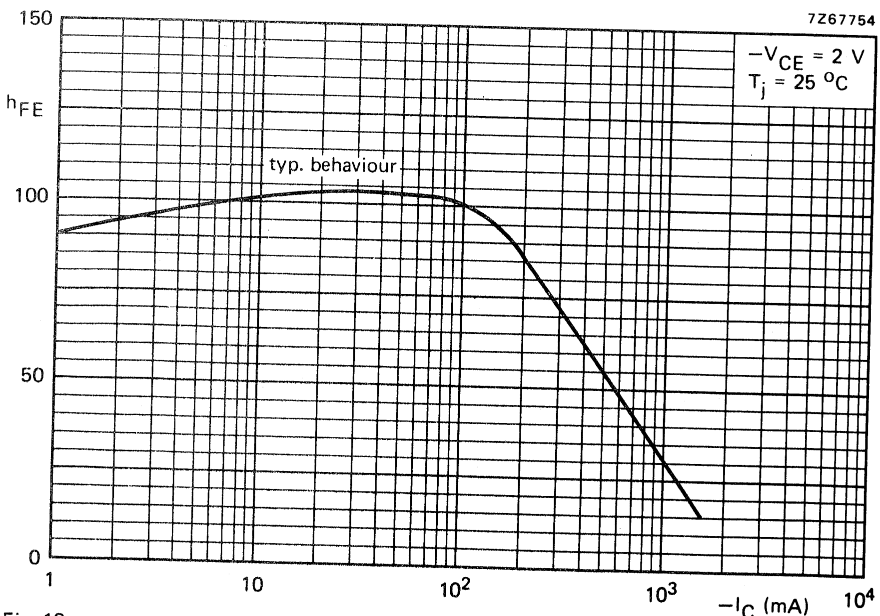

7Z67754
h_{FE}
150
100
50
0
$-V_{CE} = 2$ V
$T_j = 25$ °C
typ. behaviour
1
10
10^2
10^3
$-I_C$ (mA)
10^4

Fig. 13.

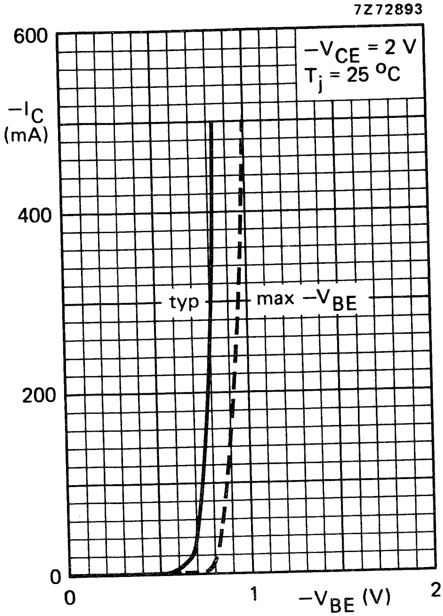


Fig. 14.

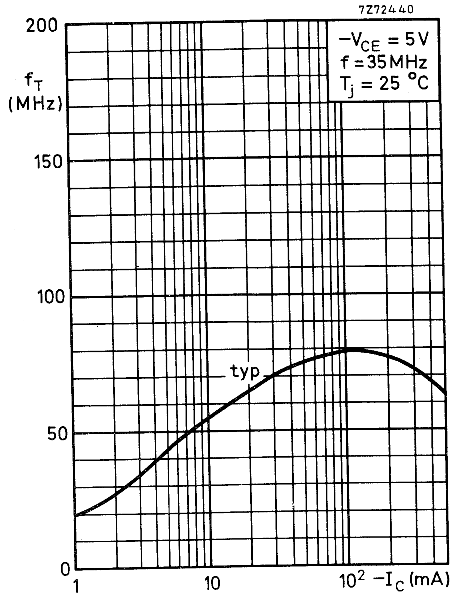


Fig. 15.

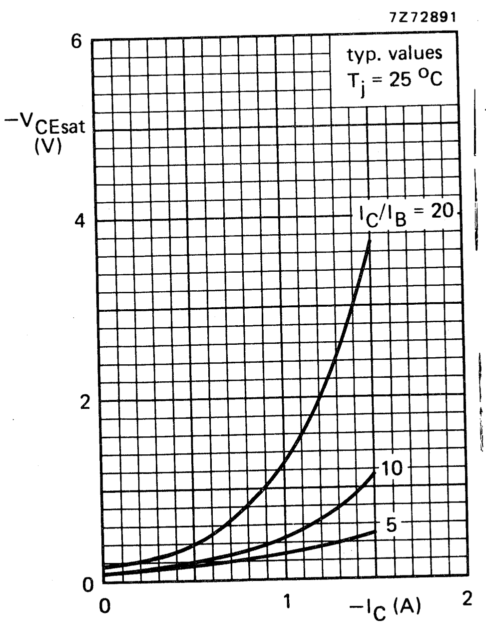


Fig. 16.

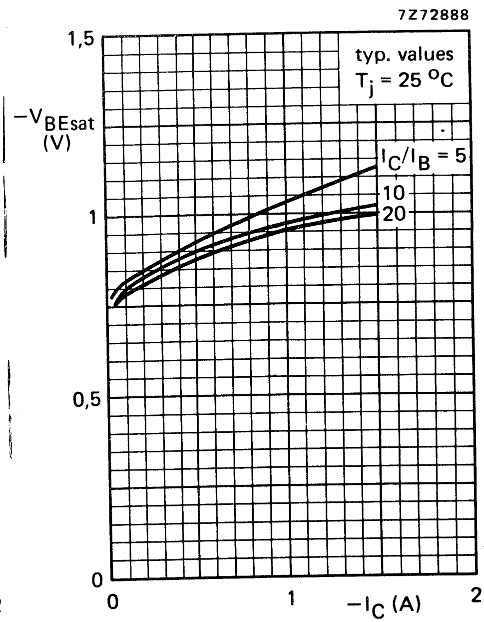


Fig. 17.

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

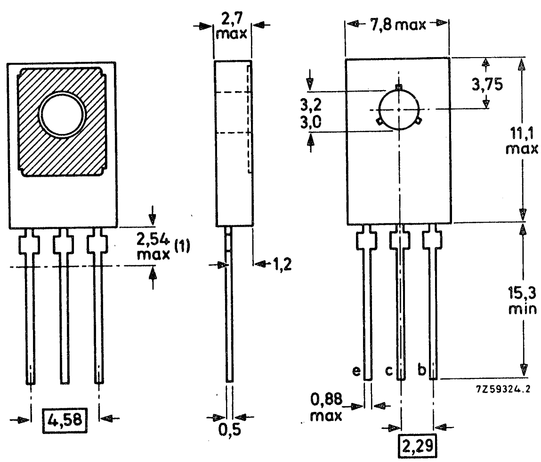
			BDX35	BDX36	BDX37	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	120	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	60	80	V
Collector current (peak value)	I_{CM}	max.	10	10	10	A
Total power dissipation up to T_{mb} = 75 °C	P_{tot}	max.	15	15	15	W
D.C. current gain I_C = 0,5 A; V_{CE} = 10 V	h_{FE}	>	45	45	45	
Collector-emitter saturation voltage I_C = 5 A; I_B = 0,5 A	V_{CEsat}	<	0,9	0,7	0,9	V
Turn-off time I_{Con} = 5 A; I_{Bon} = $-I_{Boff}$ = 0,5 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 $T_{mb} = 75\ ^oC$	P_{tot}	max.	15	W
up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	1,25	W
Storage temperature	T_{stg}		−65 to + 150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 80 V	BDX35	I_{CBO}	<	10 μA
I_E = 0; V_{CB} = 80 V; T_j = 100 °C	BDX35	I_{CBO}	<	50 μA
I_E = 0; V_{CB} = 100 V	BDX36/37	I_{CBO}	<	10 μA
I_E = 0; V_{CB} = 100 V; T_j = 100 °C	BDX36/37	I_{CBO}	<	50 μA
Emitter cut-off current				
I_C = 0; V_{EB} = 4 V		I_{EBO}	typ.	5 nA
			<	10 μA
I_C = 0; V_{EB} = 5 V		I_{EBO}	<	1 mA
D.C. current gain		h_{FE}		45 to 450
I_C = 0,5 A; V_{CE} = 10 V	BDX35/36	h_{FE}	typ.	130
	BDX37	h_{FE}	typ.	80
Collector-emitter saturation voltage				
I_C = 5 A; I_B = 0,5 A	BDX35/37	V_{CEsat}	<	0,9 V
	BDX36	V_{CEsat}	<	0,7 V
I_C = 7 A; I_B = 0,7 A	BDX35/37	V_{CEsat}	<	1,2 V
I_C = 10 A; I_B = 1 A	BDX36	V_{CEsat}	<	1,5 V
Base-emitter saturation voltage				
I_C = 5 A; I_B = 0,5 A		V_{BEsat}	<	1,6 V
I_C = 7 A; I_B = 0,7 A	BDX35/37	V_{BEsat}	<	1,8 V
I_C = 10 A; I_B = 1 A	BDX36	V_{BEsat}	<	2,2 V
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 10 V		C_c	typ.	40 pF
			<	60 pF
Transition frequency at f = 35 MHz				
I_C = 0,5 A; V_{CE} = 5 V; T_{amb} = 25 °C		f_T	typ.	100 MHz
Switching times (between 10% and 90% levels)				
I_{Con} = 1 A; I_{Bon} = $-I_{Boff}$ = 0,1 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 A; I_{Bon} = $-I_{Boff}$ = 0,2 A				
turn-on time		t_{on}	<	80 ns
turn-off time		t_{off}	typ.	0,45 μs
			<	0,7 μs
I_{Con} = 5 A; I_{Bon} = $-I_{Boff}$ = 0,5 A				
turn-on time		t_{on}	typ.	180 ns
			<	300 ns
turn-off time		t_{off}	typ.	320 ns
			<	500 ns

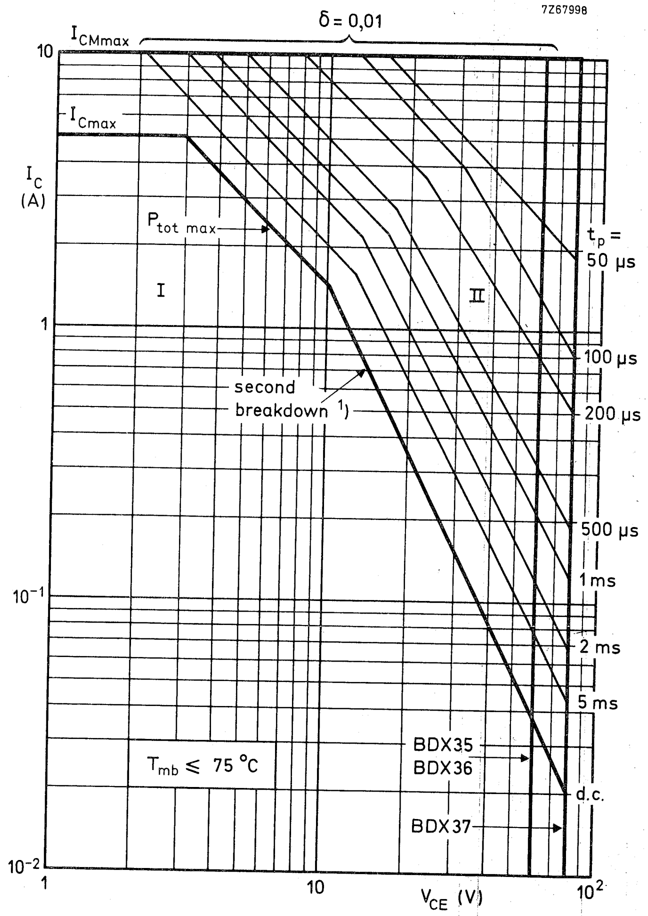


Fig. 2 Safe Operating Area with the transistor forward biased.
I Region of permissible d.c. operation
II Permissible extension for repetitive pulse operation.

1) Independent of temperature.

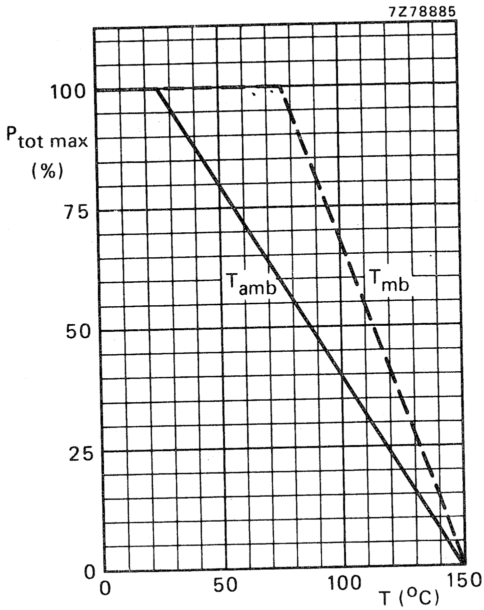


Fig. 3 Power derating curve.

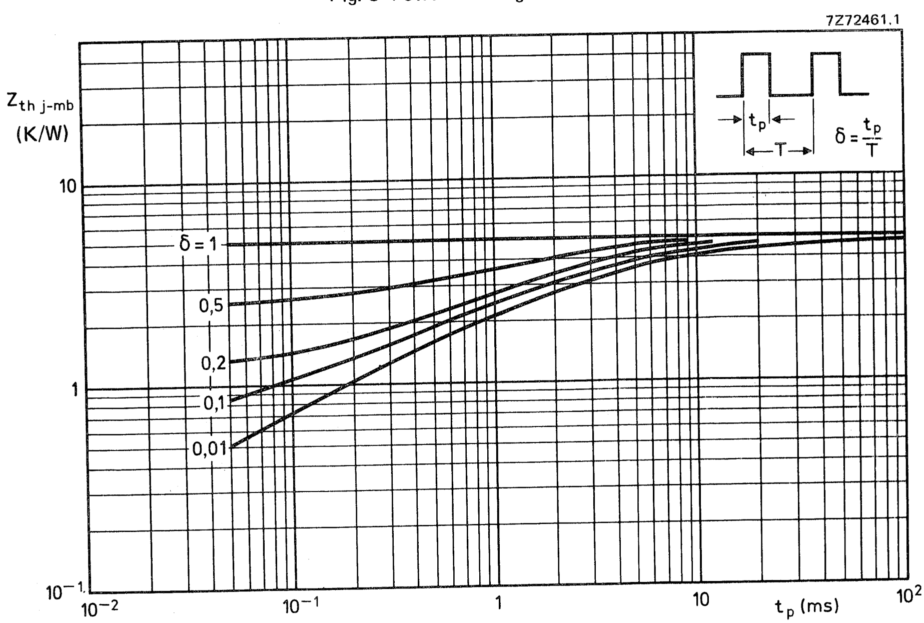


Fig. 4 Pulse power rating chart.

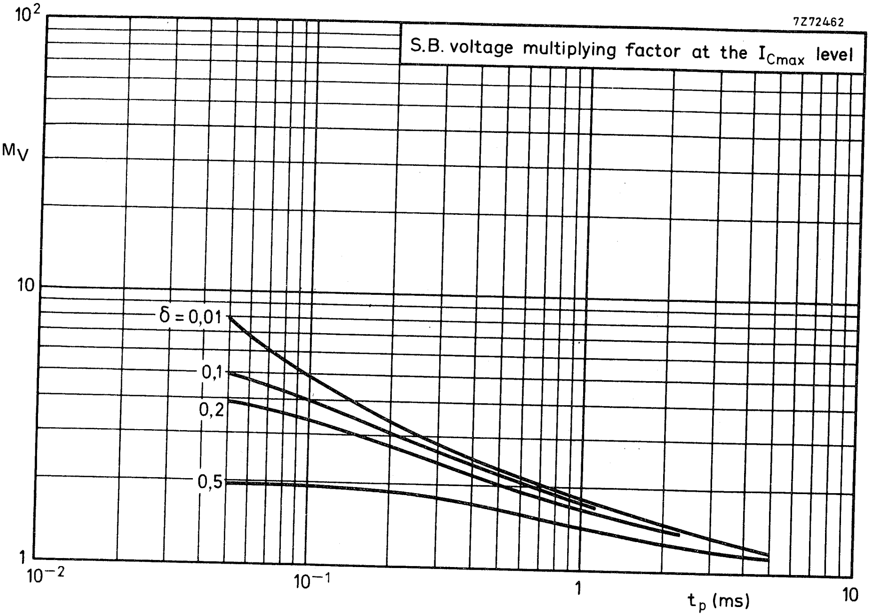


Fig. 5 S.B. voltage multiplying factor at the I_{Cmax} level.

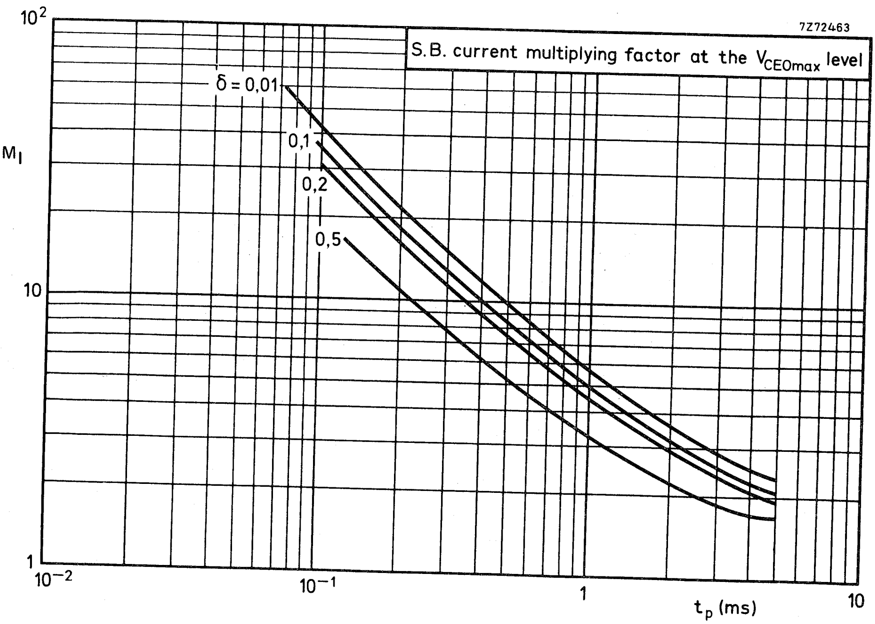


Fig. 6 S.B. current multiplying factor at the V_{CEOmax} level.

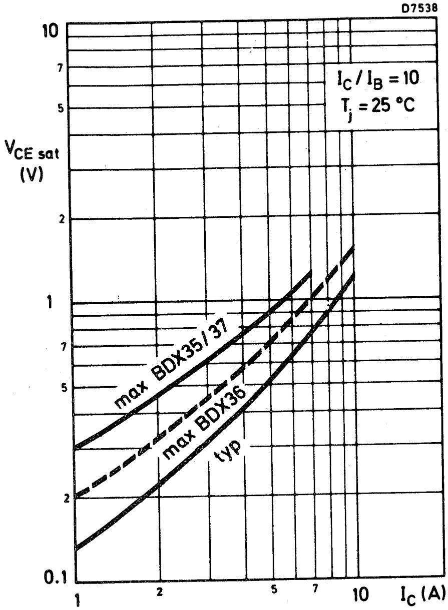


Fig. 7 Collector-emitter saturation voltage as a function of the collector current.

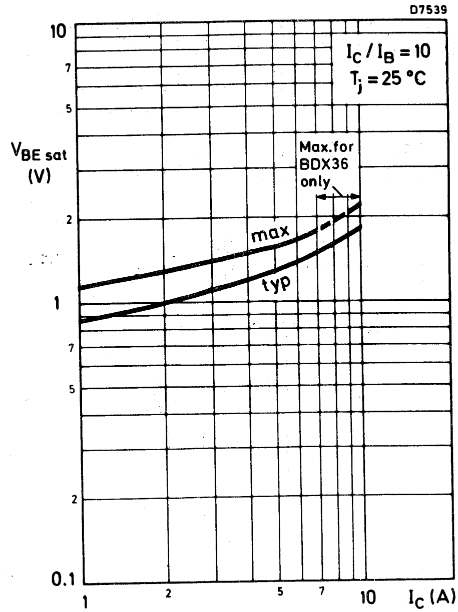


Fig. 8 Base-emitter saturation voltage as a function of the collector current.

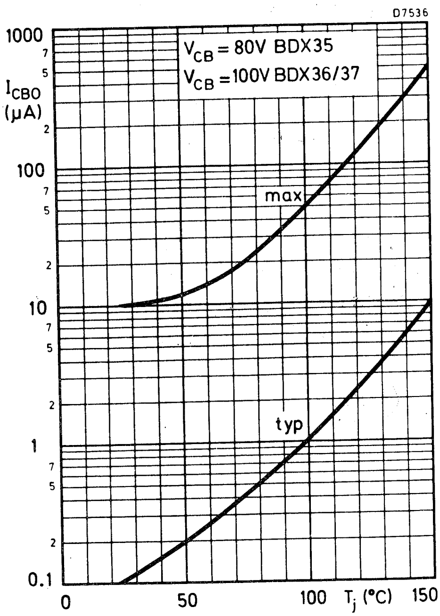


Fig. 9 Collector-base current with an open emitter as a function of junction temperature.

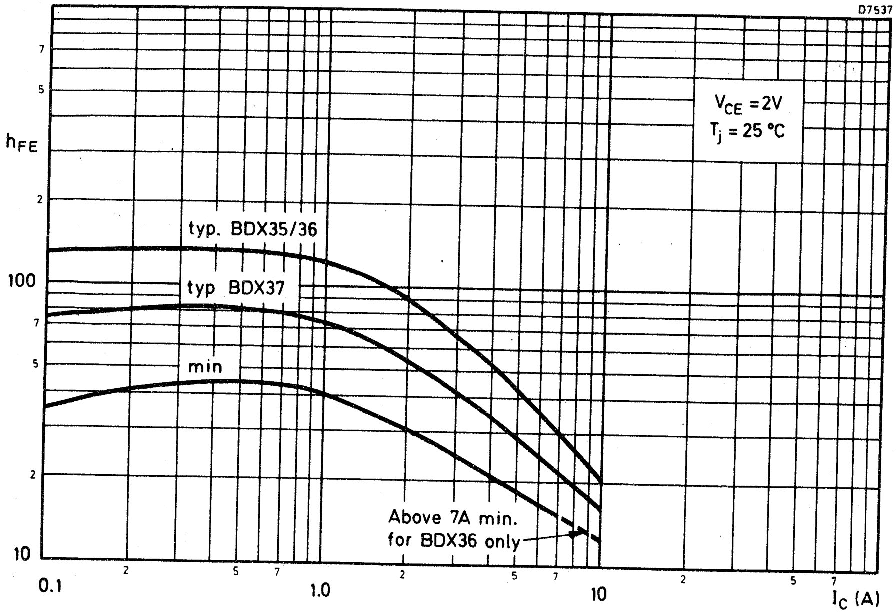


Fig. 10 D.C. current gain as a function of collector current.

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

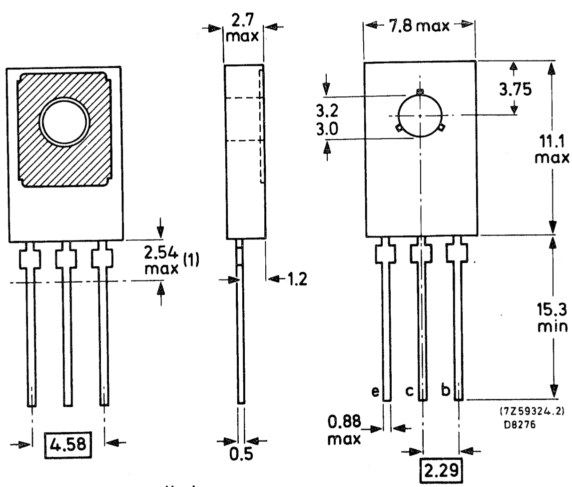
			BDX42	BDX43	BDX44	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage	V_{CER}	max.	45	60	80	V
Collector current	I_C	max.	1	1	1	A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.	1,25	1,25	1,25	W
up to T_{mb} = 100 °C	P_{tot}	max.	5	5	5	W
D.C. current gain						
I_C = 500 mA; V_{CE} = 10 V	h_{FE}	>	2000	2000	2000	
Collector-emitter saturation voltage						
I_C = 1 A; I_B = 1 mA	V_{CEsat}	<	–	1,6	–	V
I_C = 1 A; I_B = 4 mA	V_{CEsat}	<	1,6	–	1,6	V
Turn-off time						
I_C = 500 mA; $I_{Bon} = -I_{Boff}$ = 0,5 mA	t_{off}	typ.	1500	1500	1500	ns

MECHANICAL DATA

Dimensions in mm

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.

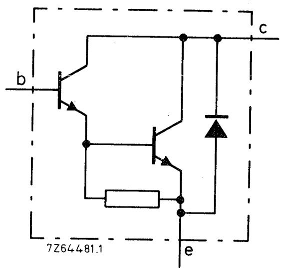


Fig. 2 Circuit diagram.

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 °C	P_{tot}	max.		1,25		W
up to T_{mb} = 100 °C	P_{tot}	max.		5		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature **	T_j	max.		150		°C

THERMAL RESISTANCE **

From junction to ambient	$R_{th\ j\text{-}a}$	=	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	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 °C unless otherwise specified

Collector cut-off current				
V_{BE} = 0; V_{CE} = 45 V	BDX42	I_{CES}	<	10 μA
V_{BE} = 0; V_{CE} = 60 V	BDX43	I_{CES}	<	10 μA
V_{BE} = 0; V_{CE} = 80 V	BDX44	I_{CES}	<	10 μA
Emitter cut-off current				
I_C = 0; V_{EB} = 4 V		I_{EBO}	<	10 μA
D.C. current gain				
I_C = 150 mA; V_{CE} = 10 V		h_{FE}	>	1000
I_C = 500 mA; V_{CE} = 10 V		h_{FE}	>	2000
Collector-emitter saturation voltage				
I_C = 500 mA; I_B = 0,5 mA		V_{CEsat}	<	1,3 V
I_C = 1 A; I_B = 1 mA	BDX43	V_{CEsat}	<	1,6 V
I_C = 1 A; I_B = 4 mA	BDX42, 44	V_{CEsat}	<	1,6 V
I_C = 500 mA; I_B = 0,5 mA; T_j = 150 °C		V_{CEsat}	<	1,3 V
I_C = 1 A; I_B = 1 mA; T_j = 150 °C	BDX43	V_{CEsat}	<	1,8 V
I_C = 1 A; I_B = 4 mA; T_j = 150 °C	BDX42, 44	V_{CEsat}	<	1,6 V
Base-emitter saturation voltage				
I_C = 500 mA; I_B = 0,5 mA		V_{BEsat}	<	1,9 V
I_C = 1 A; I_B = 1 mA	BDX43	V_{BEsat}	<	2,2 V
I_C = 1 A; I_B = 4 mA	BDX42, 44	V_{BEsat}	<	2,2 V
Small signal current gain				
I_C = 500 mA; V_{CE} = 5 V; f = 35 MHz		h_{fe}	typ.	10
Switching times (see also Fig. 3 and Fig. 4)				
I_C = 500 mA; I_{Bon} = $-I_{Boff}$ = 0,5 mA				
Turn-on time		t_{on}	typ.	400 ns
Turn-off time		t_{off}	typ.	1500 ns
I_C = 1 A; I_{Bon} = $-I_{Boff}$ = 1 mA				
Turn-on time		t_{on}	typ.	400 ns
Turn-off time		t_{off}	typ.	1500 ns

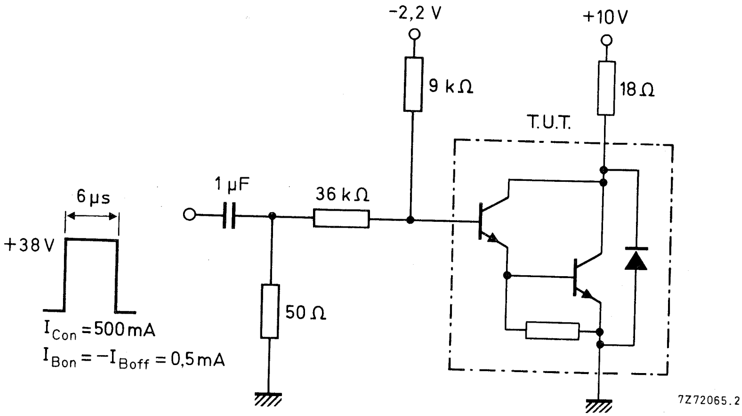


Fig. 3 Test circuit for 500 mA switching.

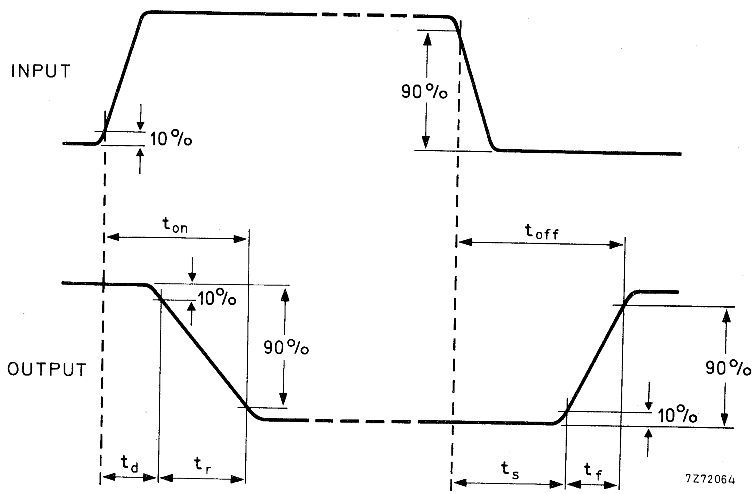


Fig. 4 Switching waveforms.

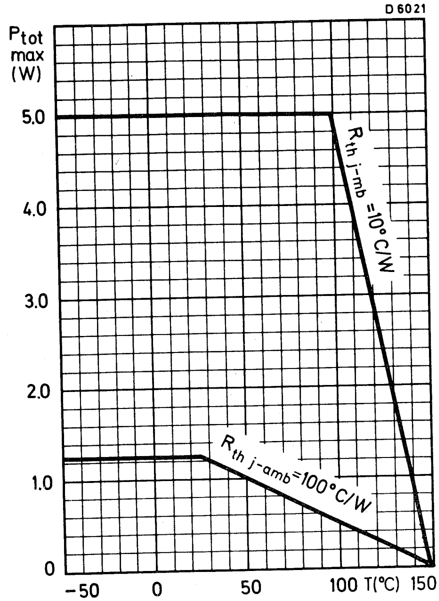


Fig. 5.

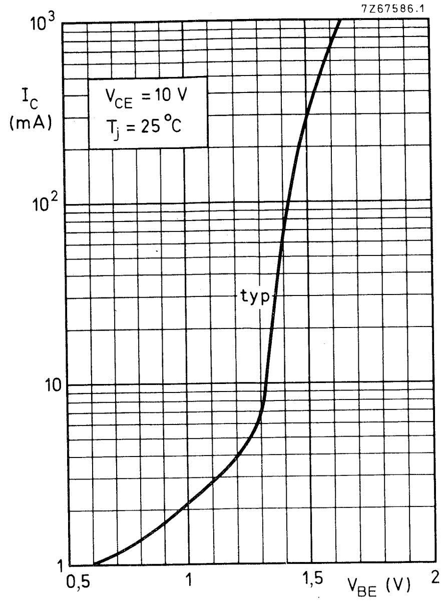


Fig. 6.

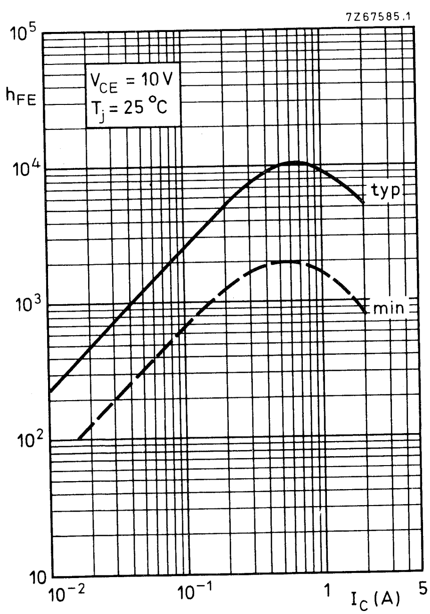


Fig. 7.

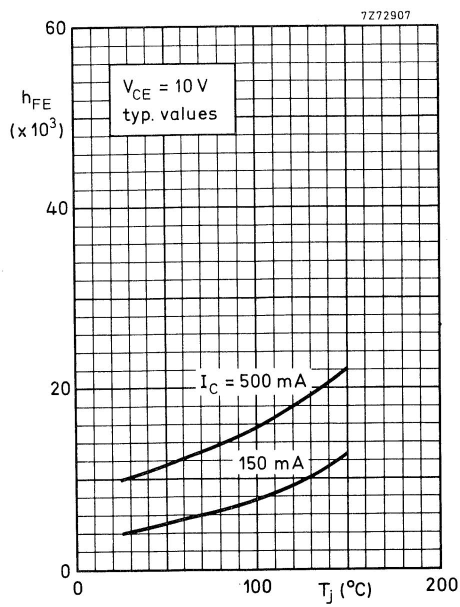


Fig. 8.

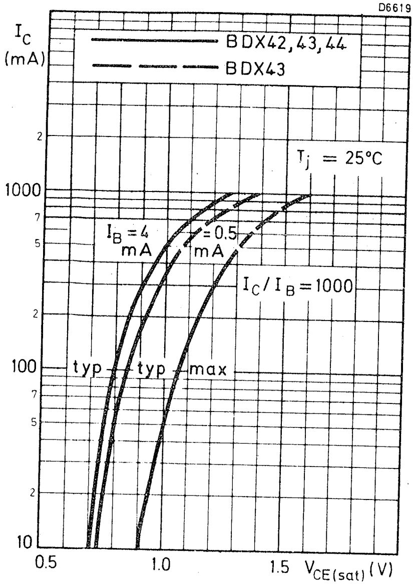


Fig. 9.

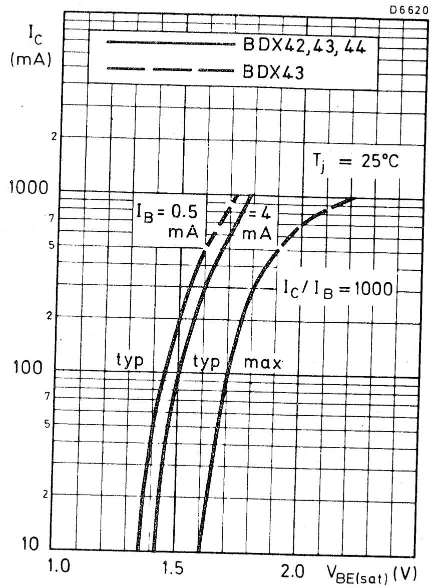


Fig. 10.

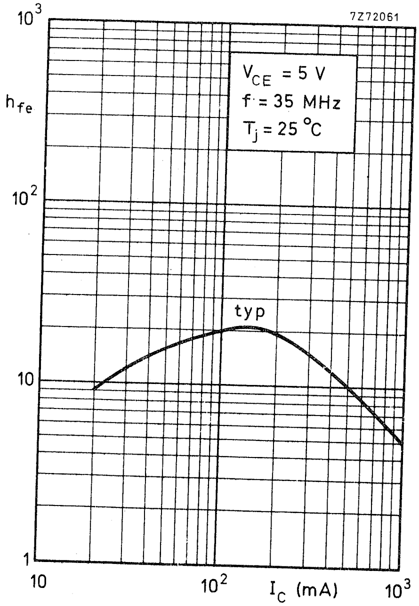


Fig. 11.

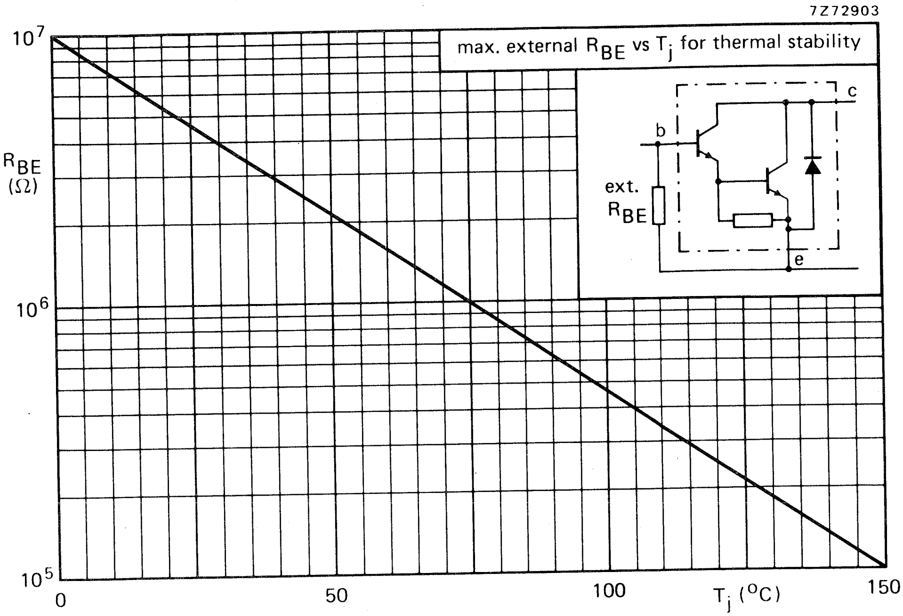

7Z72903
max. external R_{BE} vs T_j for thermal stability
10^7
R_{BE} (Ω)
10^6
10^5
0
50
100
150
T_j (°C)
c
b
ext.
R_{BE}
e

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

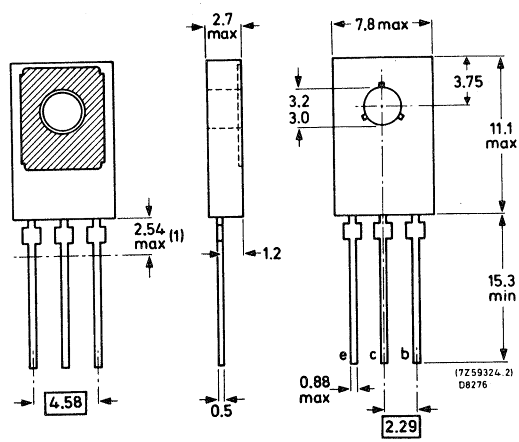
			BDX45	BDX46	BDX47	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage	$-V_{CER}$	max.	45	60	80	V
Collector current	$-I_C$	max.	1	1	1	A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.	1,25	1,25	1,25	W
up to T_{mb} = 100 °C	P_{tot}	max.	5	5	5	W
D.C. current gain						
$-I_C$ = 500 mA; $-V_{CE}$ = 10 V	h_{FE}	>	2000	2000	2000	
Collector-emitter saturation voltage						
$-I_C$ = 1 A; $-I_B$ = 1 mA	$-V_{CEsat}$	<	–	1,6	–	V
$-I_C$ = 1 A; $-I_B$ = 4 mA	$-V_{CEsat}$	<	1,6	–	1,6	V
Turn-off time						
$-I_C$ = 500 mA; $-I_{Bon}$ = I_{Boff} = 0,5 mA	t_{off}	typ.	1500	1500	1500	ns

MECHANICAL DATA

Dimensions in mm

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.

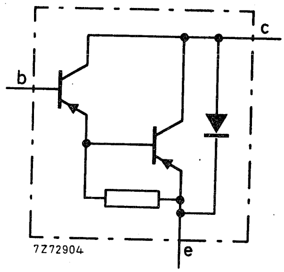


Fig. 2 Circuit diagram.

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 °C	P_{tot}	max.		1,25		W
up to T_{mb} = 100 °C	P_{tot}	max.		5		W
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature**	T_j	max.		150		°C

THERMAL RESISTANCE **

From junction to ambient	$R_{th\ j\text{-}a}$	=	100	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	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 °C unless otherwise specified

Collector cut-off current				
V_{BE} = 0; $-V_{CE}$ = 45 V	BDX45	$-I_{CES}$	<	10 μA
V_{BE} = 0; $-V_{CE}$ = 60 V	BDX46	$-I_{CES}$	<	10 μA
V_{BE} = 0; $-V_{CE}$ = 80 V	BDX47	$-I_{CES}$	<	10 μA
Emitter cut-off current				
I_C = 0; V_{EB} = 4 V		$-I_{EBO}$	<	10 μA
D.C. current gain				
$-I_C$ = 150 mA; $-V_{CE}$ = 10 V		h_{FE}	>	1000
$-I_C$ = 500 mA; $-V_{CE}$ = 10 V		h_{FE}	>	2000
Collector-emitter saturation voltage				
$-I_C$ = 500 mA; $-I_B$ = 0,5 mA		$-V_{CEsat}$	<	1,3 V
$-I_C$ = 1 A; $-I_B$ = 1 mA	BDX46	$-V_{CEsat}$	<	1,6 V
$-I_C$ = 1 A; $-I_B$ = 4 mA	BDX45, 47	$-V_{CEsat}$	<	1,6 V
$-I_C$ = 500 mA; $-I_B$ = 0,5 mA; T_j = 150 °C		$-V_{CEsat}$	<	1,3 V
$-I_C$ = 1 A; $-I_B$ = 1 mA; T_j = 150 °C	BDX46	$-V_{CEsat}$	<	1,8 V
$-I_C$ = 1 A; $-I_B$ = 4 mA; T_j = 150 °C	BDX45, 47	$-V_{CEsat}$	<	1,6 V
Base-emitter saturation voltage				
$-I_C$ = 500 mA; $-I_B$ = 0,5 mA		$-V_{BEsat}$	<	1,9 V
$-I_C$ = 1 A; $-I_B$ = 1 mA	BDX46	$-V_{BEsat}$	<	2,2 V
$-I_C$ = 1 A; $-I_B$ = 4 mA	BDX45, 47	$-V_{BEsat}$	<	2,2 V
Small signal current gain				
$-I_C$ = 500 mA; $-V_{CE}$ = 5 V, f = 35 MHz		h_{fe}	typ.	10
Switching times (see also Fig. 3 and Fig. 4)				
$-I_C$ = 500 mA; $-I_{Bon}$ = I_{Boff} = 0,5 mA				
Turn-on time		t_{on}	typ.	400 ns
Turn-off time		t_{off}	typ.	1500 ns
$-I_C$ = 1 A; $-I_{Bon}$ = I_{Boff} = 1 mA				
Turn-on time		t_{on}	typ.	400 ns
Turn-off time		t_{off}	typ.	1500 ns

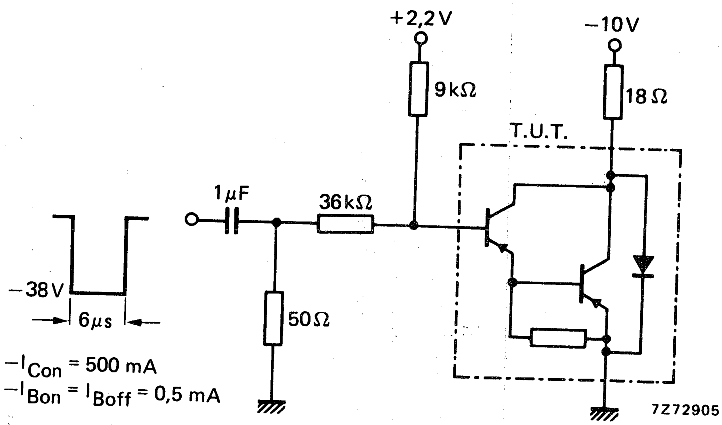


Fig. 3 Test circuit for 500 mA switching.

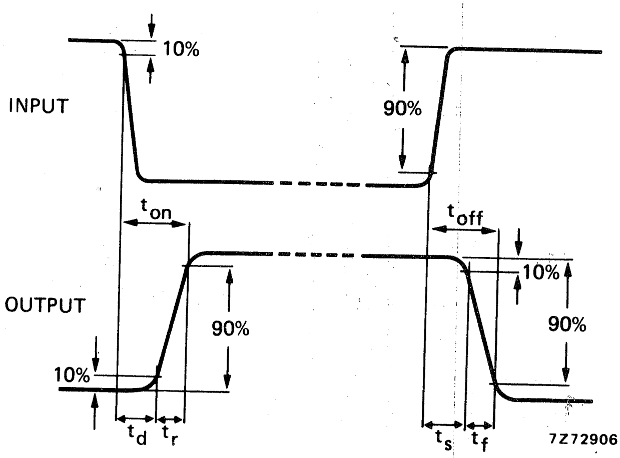


Fig. 4 Switching waveforms.

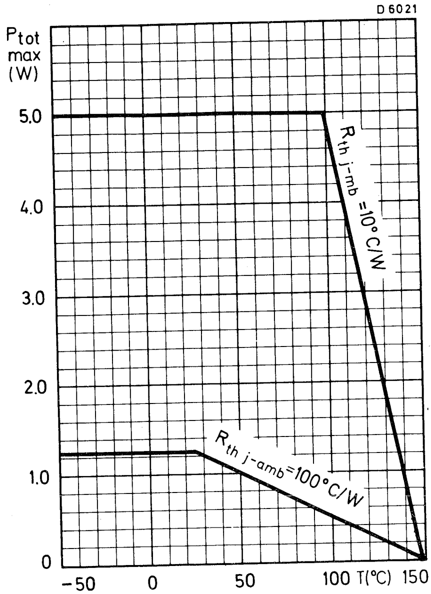


Fig. 5.

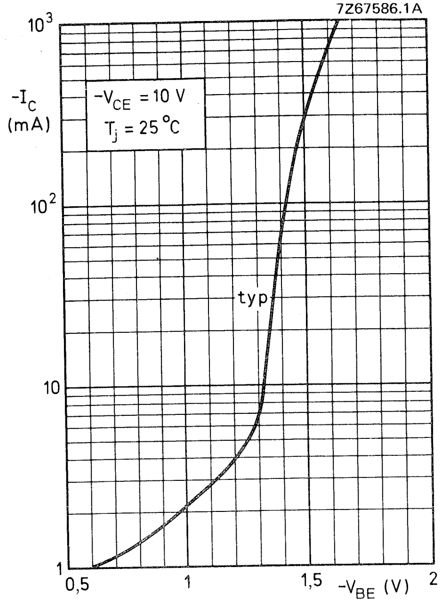


Fig. 6.

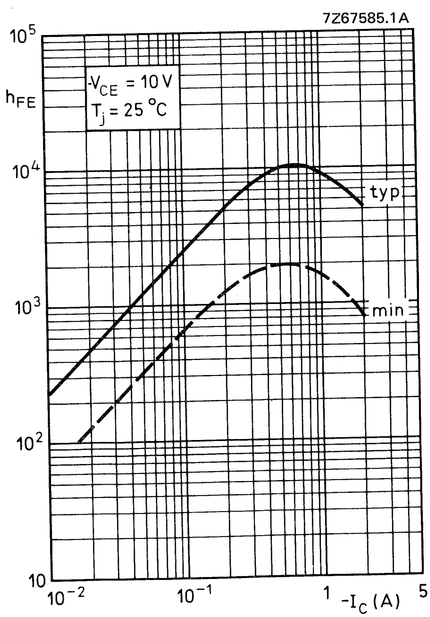


Fig. 7.

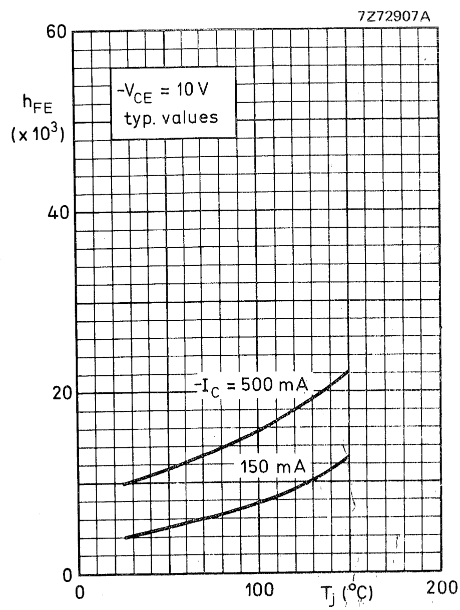


Fig. 8.

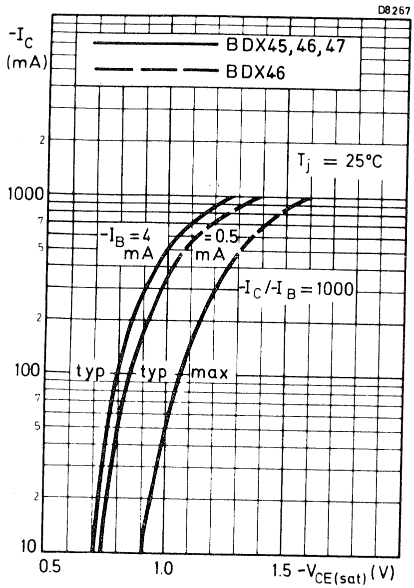


Fig. 9.

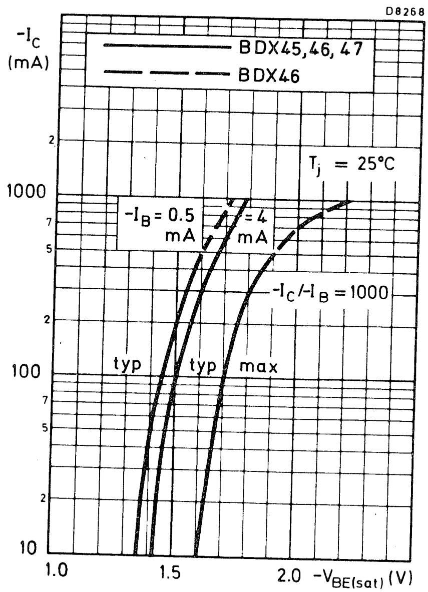


Fig. 10.

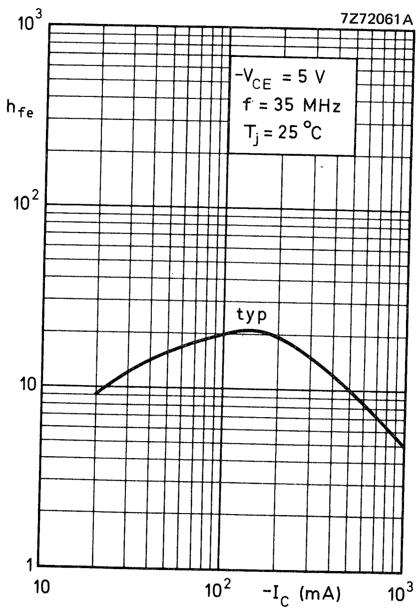


Fig. 11.

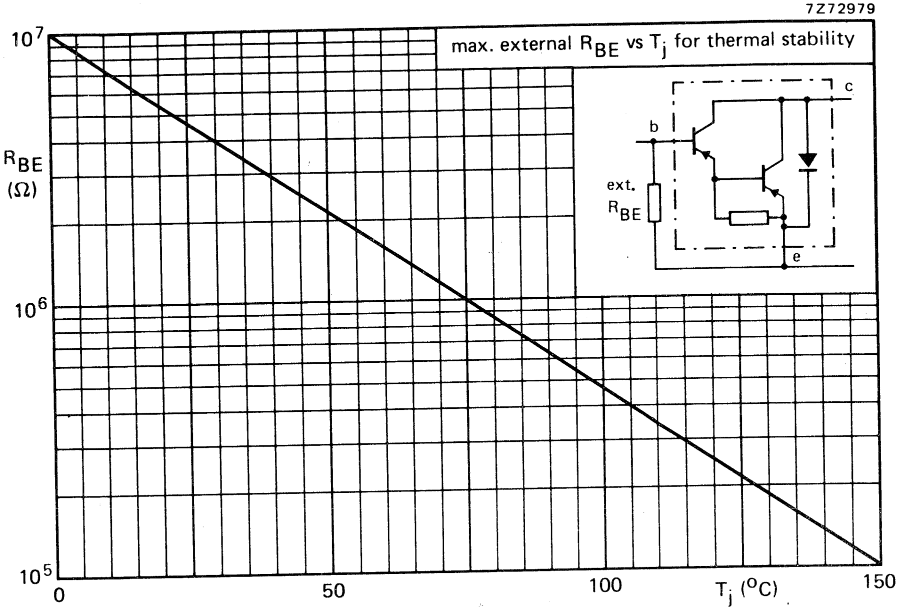

7Z72979
max. external R_{BE} vs T_j for thermal stability
10^7
R_{BE}
(Ω)
10^6
10^5
0
50
100
150
T_j (°C)
b
c
e
ext.
R_{BE}

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.

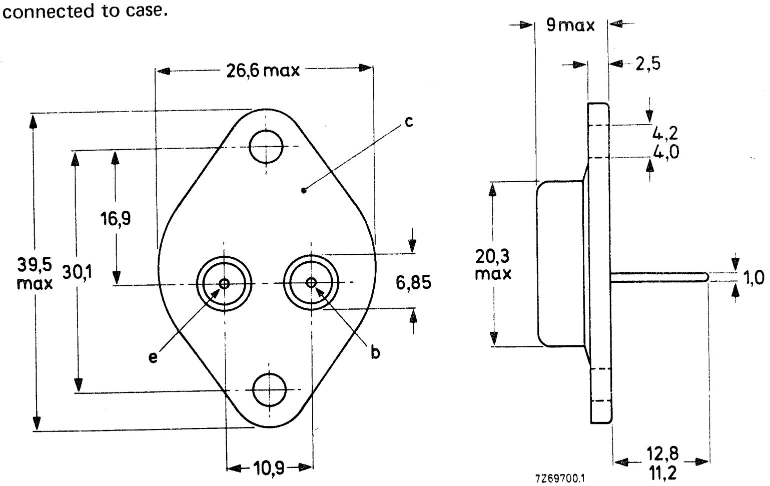
QUICK REFERENCE DATA

			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 °C	P_{tot}	max.		90			W
Junction temperature	T_j	max.		200			°C
D.C. current gain							
$-I_C$ = 0,5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.		1500			
$-I_C$ = 3,0 A; $-V_{CE}$ = 3 V	h_{FE}	>		1000			
Cut-off frequency							
$-I_C$ = 3 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.		100			kHz

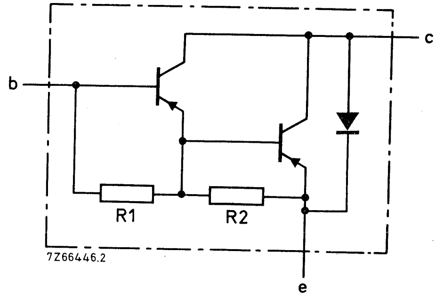
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.
Collector connected to case.



See also chapters Mounting instructions and Accessories.



R_1 typ. 6 kΩ
R_2 typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

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

			BDX62	62A	62B	62C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V
Collector current (d.c.)	$-I_C$	max.	8				A
Collector current (peak value)	$-I_{CM}$	max.	12				A
Base current (d.c.)	$-I_B$	max.	150				mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	90				W
Storage temperature	T_{stg}		−65 to +200				°C
Junction temperature*	T_j	max.	200				°C

THERMAL RESISTANCE*

From junction to mounting base $R_{th\ j\text{-}mb}$ = 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 °C unless otherwise specified.

Collector cut-off current			
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,2 mA
$I_E = 0$; $-V_{CB} = 40$ V; $T_j = 200$ °C; BDX62 $I_E = 0$; $-V_{CB} = 50$ V; $T_j = 200$ °C; BDX62A $I_E = 0$; $-V_{CB} = 60$ V; $T_j = 200$ °C; BDX62B $I_E = 0$; $-V_{CB} = 70$ V; $T_j = 200$ °C; BDX62C	$-I_{CBO}$	<	2 mA
$I_B = 0$; $-V_{CE} = -½V_{CEO}$	$-I_{CEO}$	<	0,5 mA
Emitter cut-off current			
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	5 mA
D.C. current gain (note 1)			
$-I_C = 0,5$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	1500
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE}	>	1000
$-I_C = 8$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	750
Base-emitter voltage (notes 1 and 2)			
$-I_C = 3$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5 V
Collector-emitter saturation voltage (note 1)			
$-I_C = 3$ A; $-I_B = 12$ mA	$-V_{CEsat}$	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	typ.	100 pF
Cut-off frequency			
$-I_C = 3$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	100 kHz
Small-signal current gain			
$-I_C = 3$ A; $-V_{CE} = 3$ V; f = 1 MHz	h_{fe}	typ.	100

Notes
1. Measured under pulse conditions: $t_p < 300$ μs, $\delta < 2\%$.
2. $-V_{BE}$ decreases by about 3,6 mV/K with increasing temperature.

CHARACTERISTICS (continued)

Switching times
(between 10% and 90% levels)

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

turn-on time	t_{on}	typ.	0,5 μs
turn-off time	t_{off}	typ.	2,5 μs

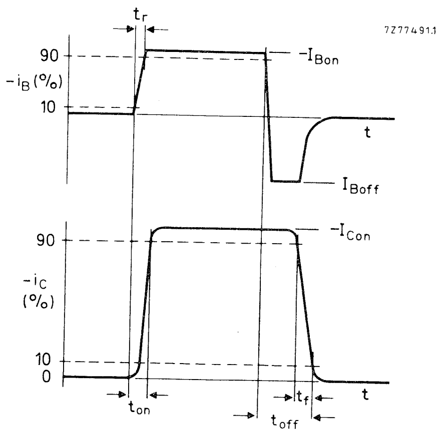


Fig. 3 Switching times waveforms.

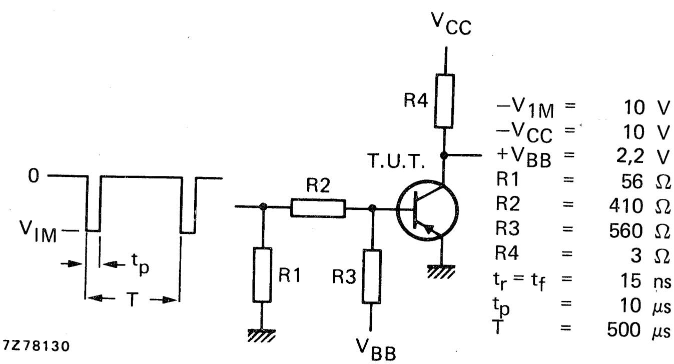


Fig. 4 Switching times test circuit.

Diode forward voltage

$I_F = 3$ A — V_F typ. 1,8 V

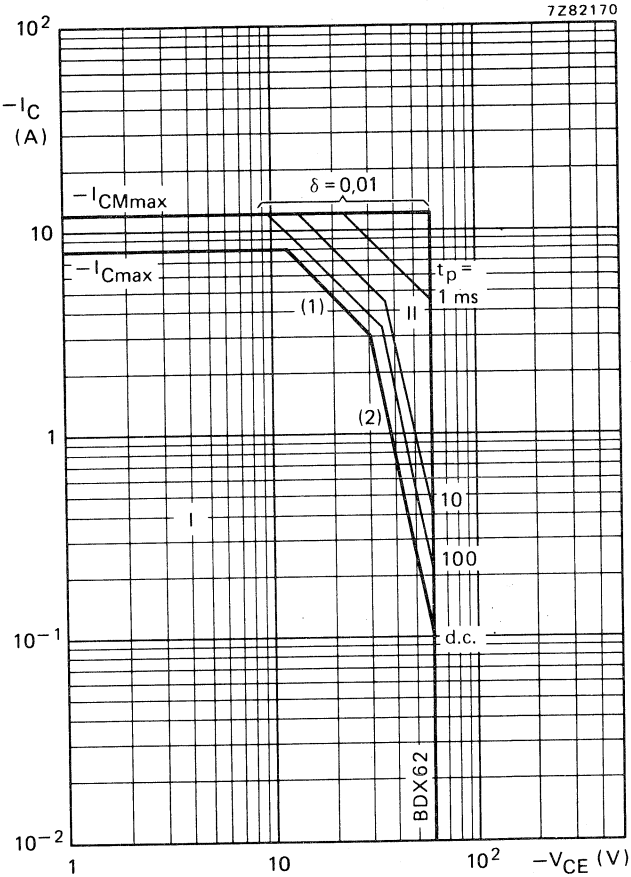


Fig. 5 Safe Operating ARea; $T_{mb} = 25\ ^{o}C$.

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).

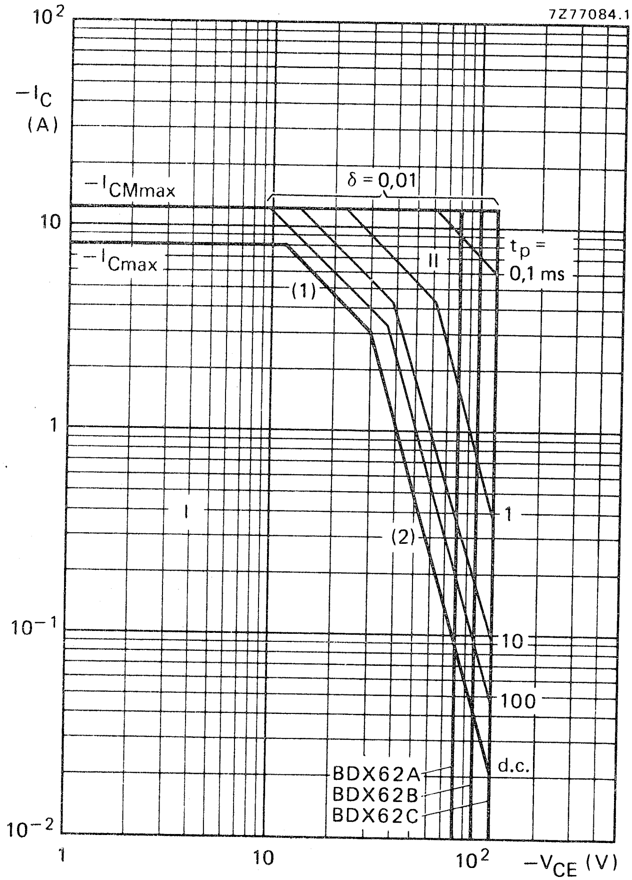


Fig. 6 Safe Operating ARea; T_{mb} = 25 °C.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

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

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

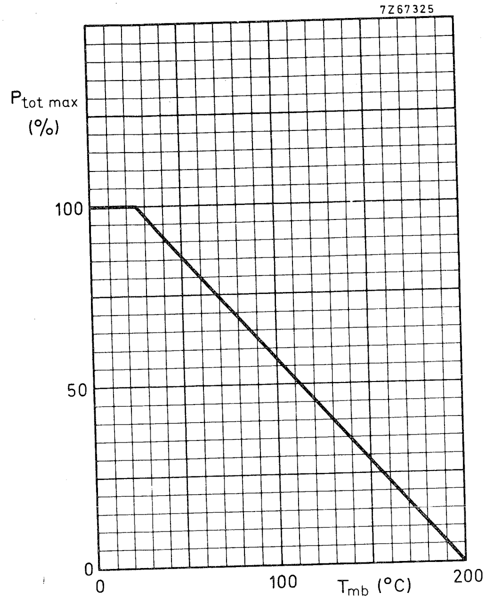


Fig. 7 Power derating curve.

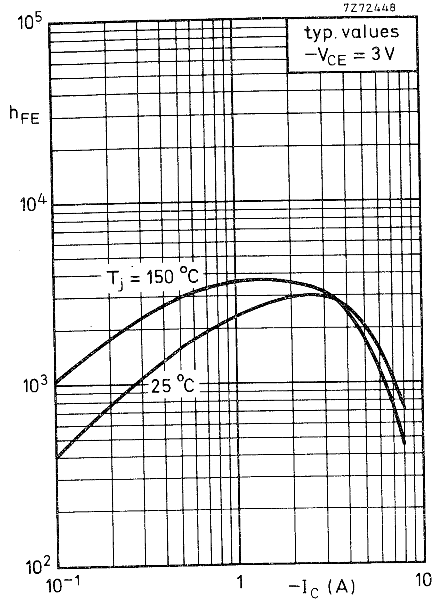


Fig. 8 D.C. current gain.

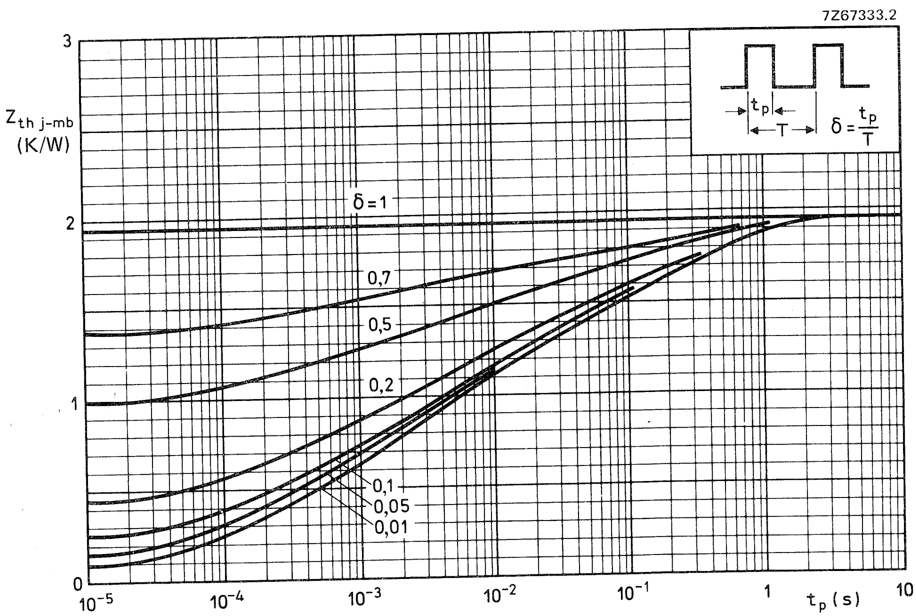


Fig. 9 Pulse power rating chart.

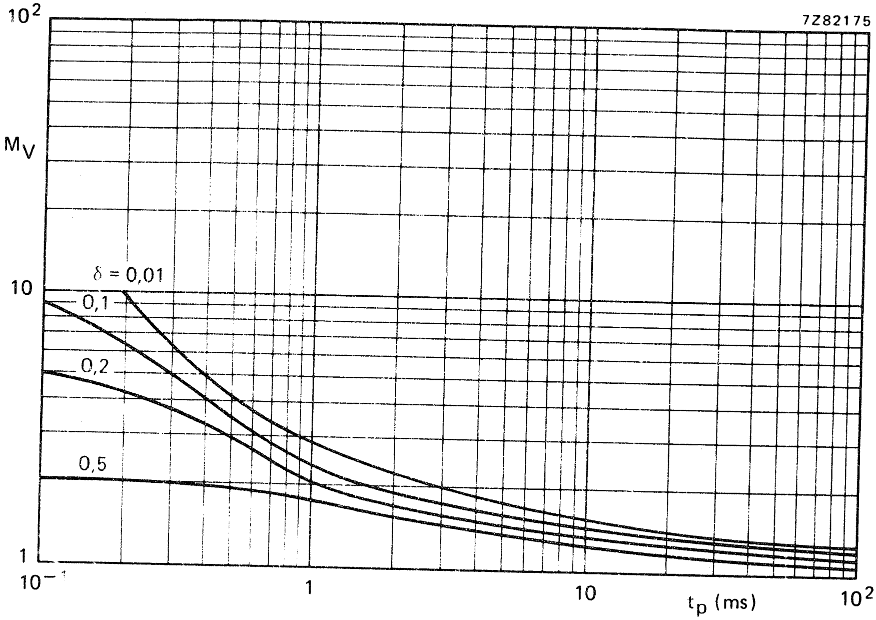


Fig. 10 S.B. voltage multiplying factor at the I_{Cmax} level.

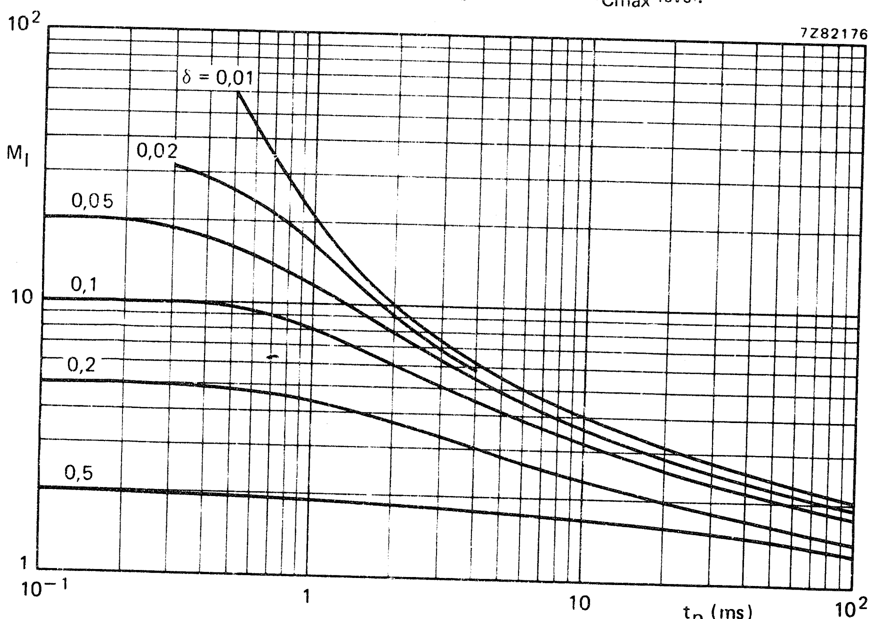


Fig. 11 S.B. current multiplying factor at the V_{CEO} 100 V and 60 V level.

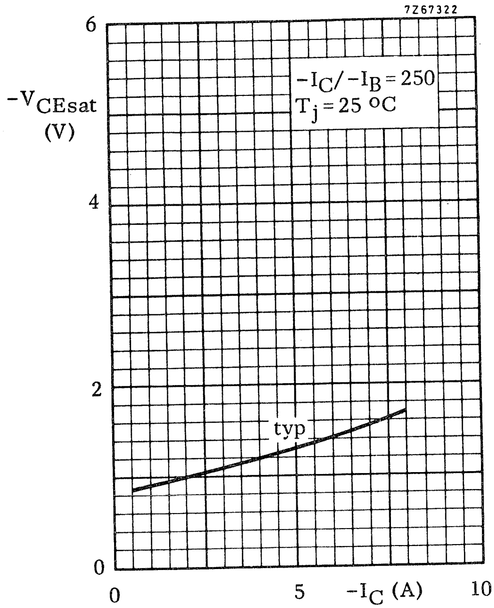


Fig. 12.

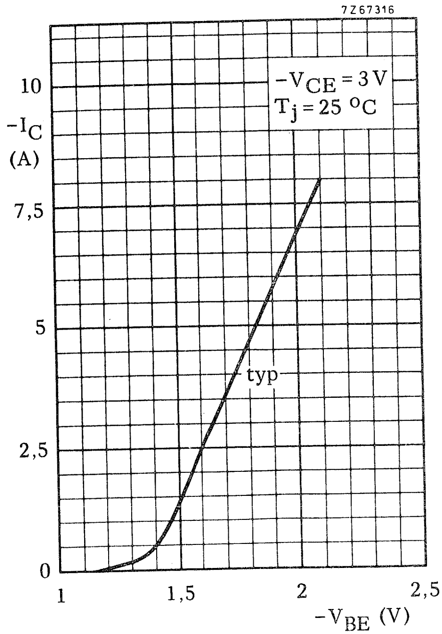


Fig. 13.

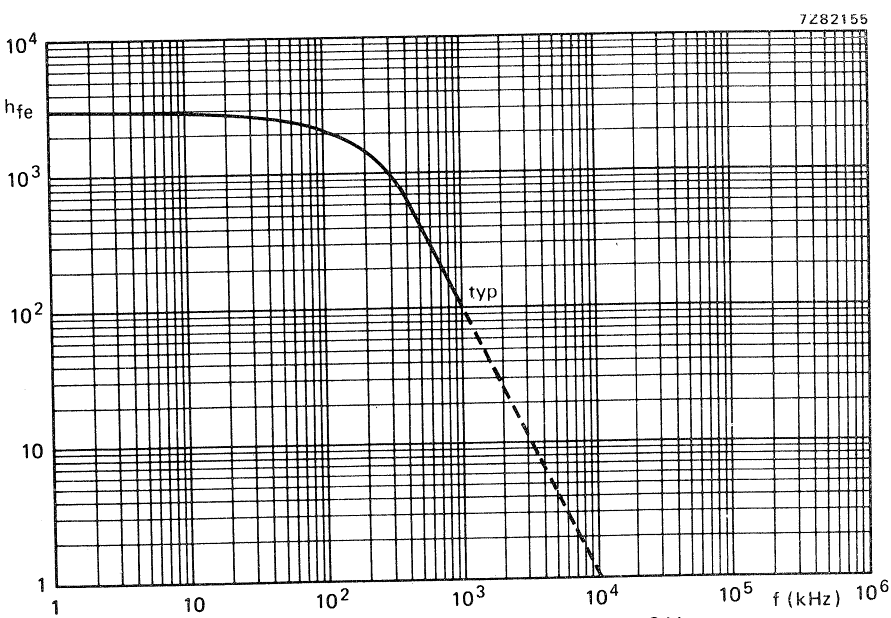


Fig. 14 Small signal current gain at $-I_C = 3$ A; $-V_{CE} = 3$ V.

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.

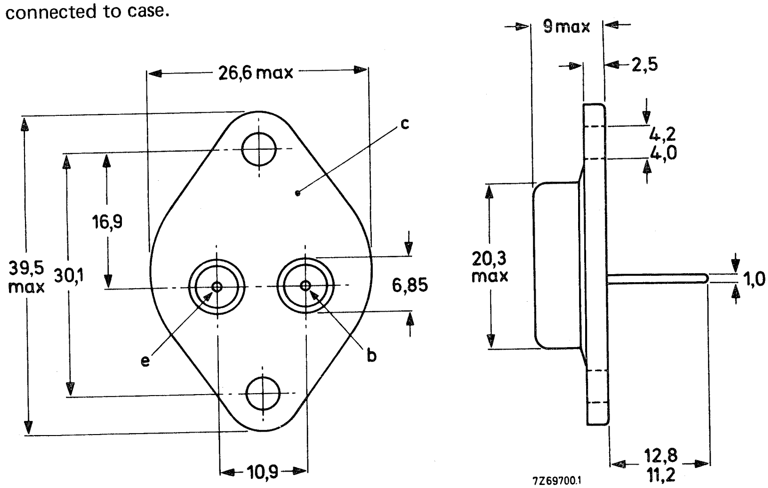
QUICK REFERENCE DATA

			BDX63	63A	63B	63C	
Collector-base voltage (open emitter)	V_{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 °C	P_{tot}	max.		90			W
Junction temperature	T_j	max.		200			°C
D.C. current gain I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.		2500			
I_C = 3,0 A; V_{CE} = 3 V	h_{FE}	>		1000			
Cut-off frequency I_C = 3 A; V_{CE} = 3 V	f_{hfe}	typ.		100			kHz

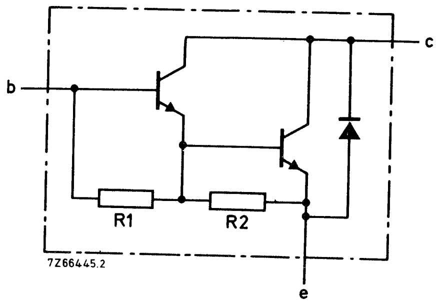
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.
Collector connected to case.



See also chapters Mounting Instructions and Accessories.



R1 typ. 8 kΩ
R2 typ. 100 Ω

Fig. 2 Circuit diagram.

RATINGS

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

			BDX63	63A	63B	63C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open-base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V
Collector current (d.c.)	I_C	max.	8				A
Collector current (peak value)	I_{CM}	max.	12				A
Base current (d.c.)	I_B	max.	150				mA
Total power dissipation up to T_{mb} = 25 °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	$R_{th\ j\text{-}mb}$	=	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 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = V_{CEOmax}$	I_{CBO}	<	0,2 mA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 200 °C	I_{CBO}	<	2 mA
$I_B = 0$; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	<	0,5 mA
Emitter cut-off current			
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5 mA
D.C. current gain (note 1)			
I_C = 0,5 A; V_{CE} = 3 V	h_{FE}	typ.	2500
I_C = 3 A; V_{CE} = 3 V	h_{FE}	>	1000
I_C = 8 A; V_{CE} = 3 V	h_{FE}	typ.	2600
Base-emitter voltage (notes 1 and 2)			
I_C = 3 A; V_{CE} = 3 V	V_{BE}	<	2,5 V
Collector-emitter saturation voltage (note 1)			
I_C = 3 A; I_B = 12 mA	V_{CEsat}	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	100 pF
Cut-off frequency			
I_C = 3 A; V_{CE} = 3 V	f_{hfe}	typ.	100 kHz
Turn-off breakdown energy with inductive load (Fig. 4)			
$-I_{Boff} = 0$; I_{Con} = 4,5 A; t_p = 1 ms; T = 100 ms	$E_{(BR)}$	>	50 mJ
Small signal current gain			
I_C = 3 A; V_{CE} = 3 V; f = 1 MHz	$\|h_{fe}\|$	typ.	100
Diode, forward voltage			
I_F = 3 A	V_F	typ.	1,2 V

Notes
1. Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.
2. V_{BE} decreases by about 3,6 mV/K with increasing temperature.

CHARACTERISTICS (continued)

Switching times
(between 10% and 90% levels)
I_{Con} = 3 A; I_{Bon} = $-I_{Boff}$ = 12 mA

turn-on time	t_{on}	typ.	0,5 μs
turn-off time	t_{off}	typ.	5 μs

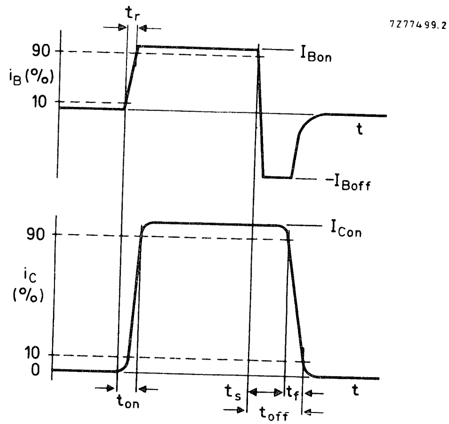
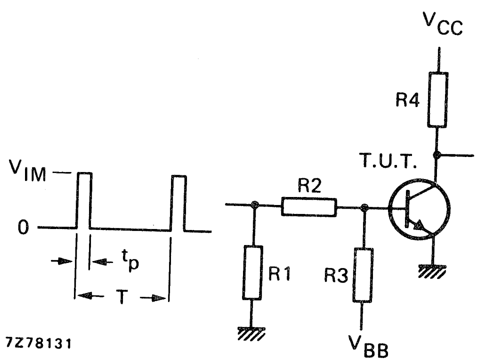


Fig. 3 Switching time waveforms.



V_{IM}	=	10 V
V_{CC}	=	10 V
V_{BB}	=	−4 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	3 Ω
$t_r = t_f$	⩽	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

Diode, forward voltage I_F = 3 A	V_F	typ. 1,2 V

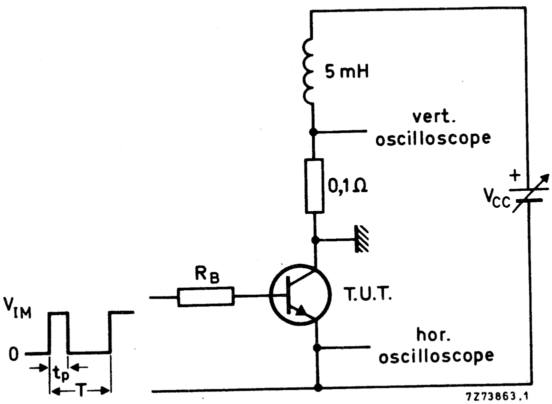


Fig. 5 Test circuit for turn-off breakdown energy.
V_{IM} = 12 V; R_B = 270 Ω; I_{CC} = 4,5 A; t_p = 1 ms; δ = 1%.

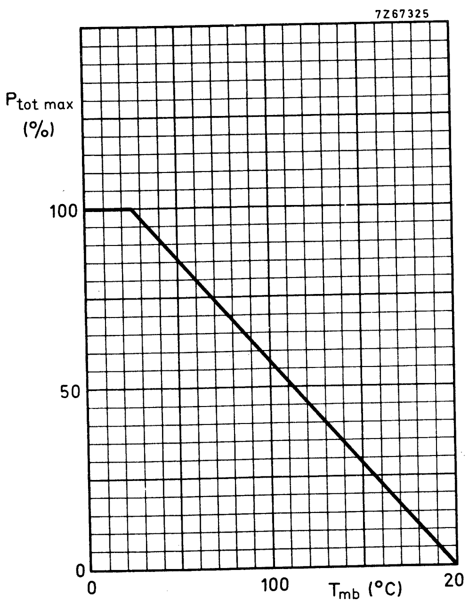


Fig. 6 Power derating curve.

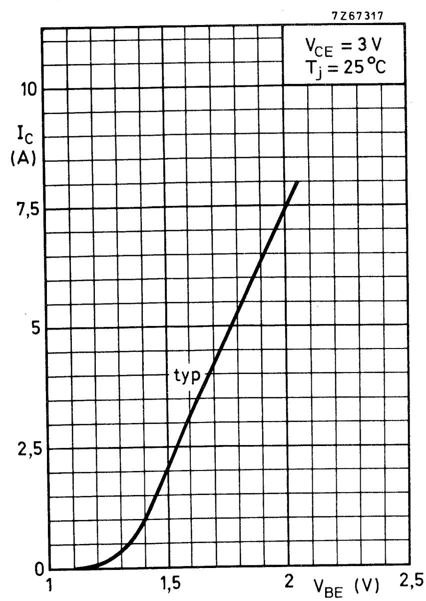


Fig. 7.

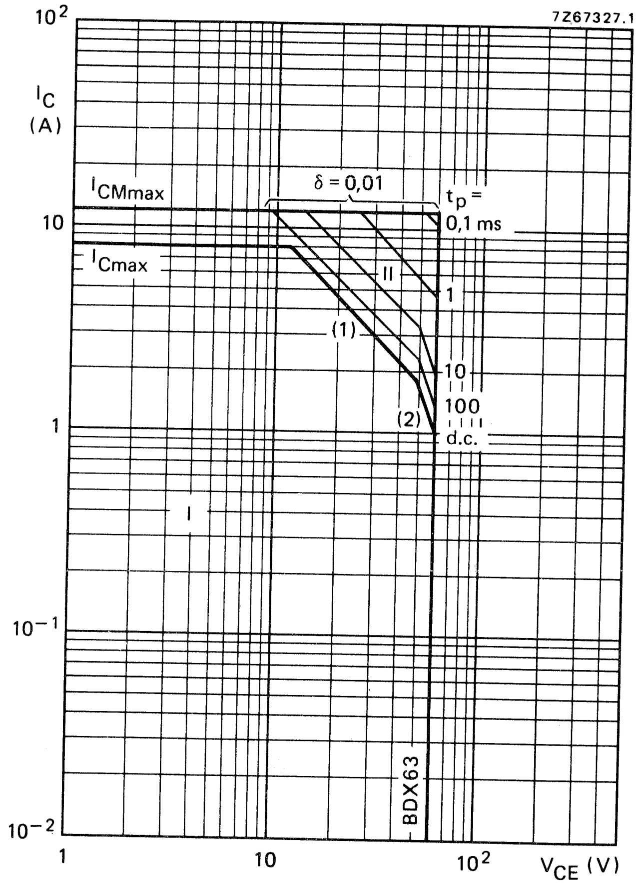


Fig. 8 Safe Operating ARea, $T_{mb} \leq 25\ ^oC$.

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).

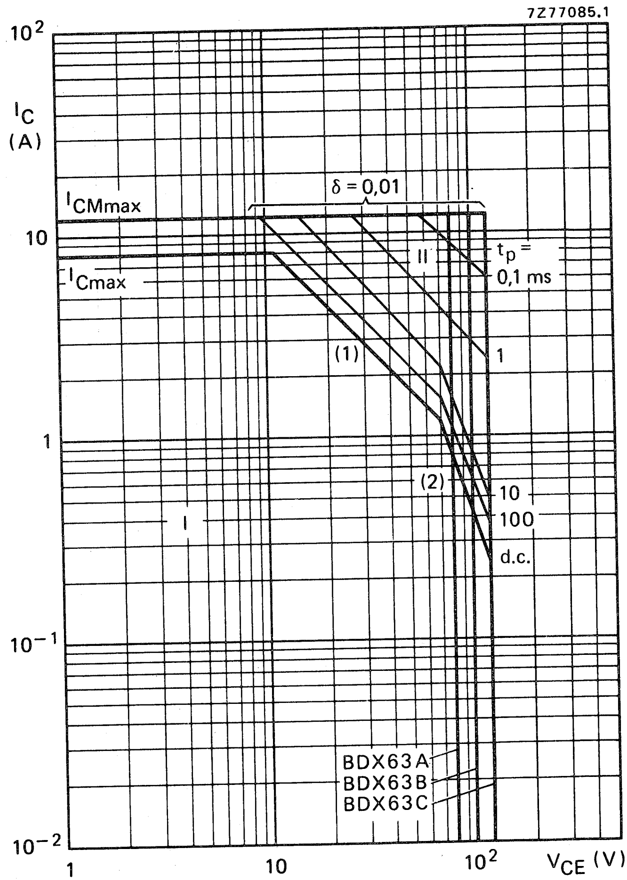


Fig. 9 Safe Operating ARea, $T_{mb} \leqslant 25\ ^oC$.

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).

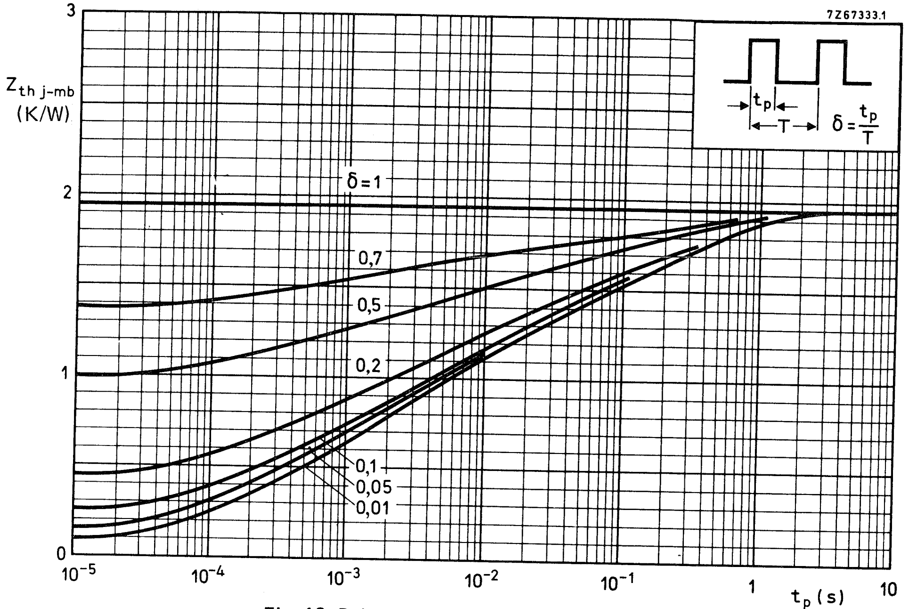


Fig. 10 Pulse power rating chart.

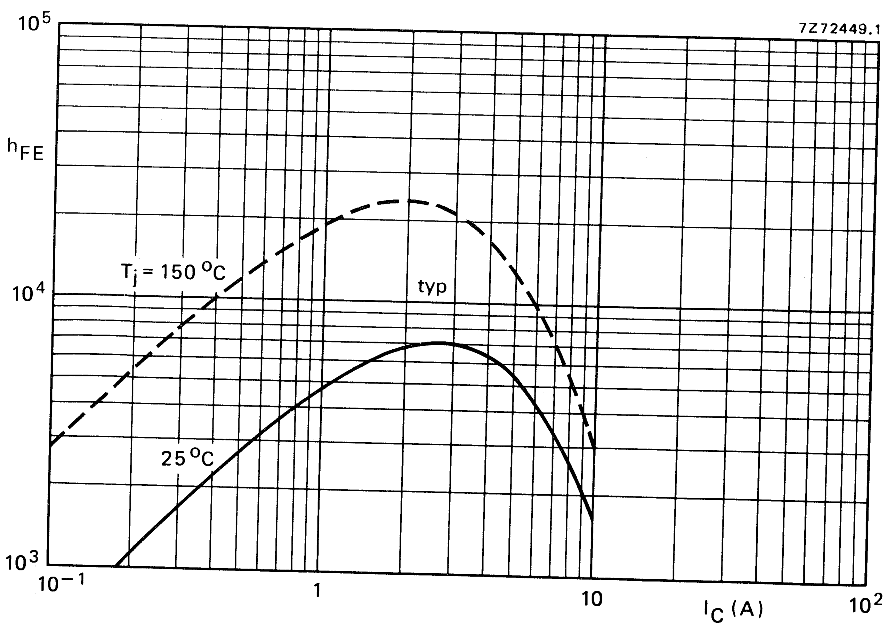


Fig. 11 Typical values d.c. current gain at V_{CE} = 3 V.

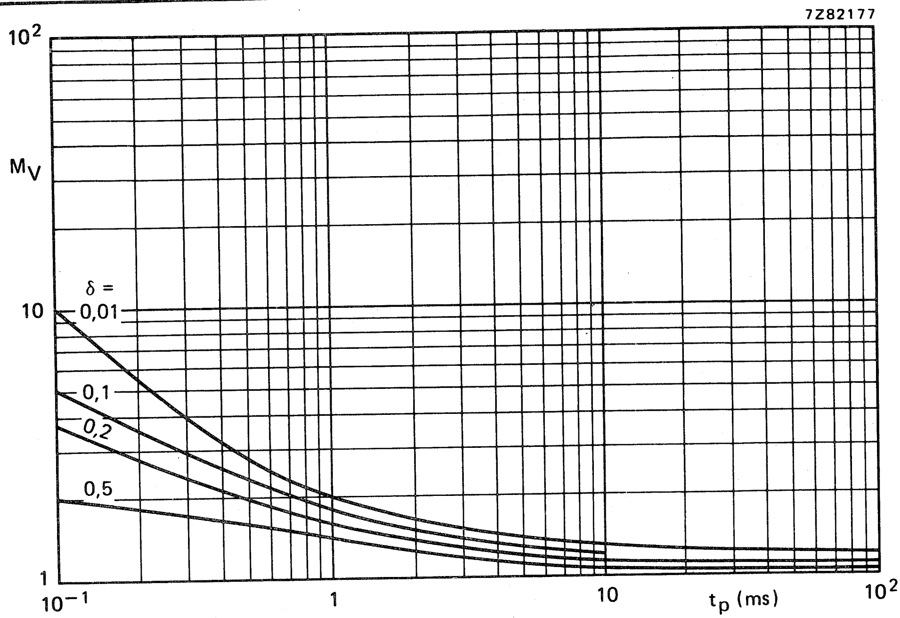


Fig. 12 S.B. voltage multiplying factor at the I_{Cmax} level.

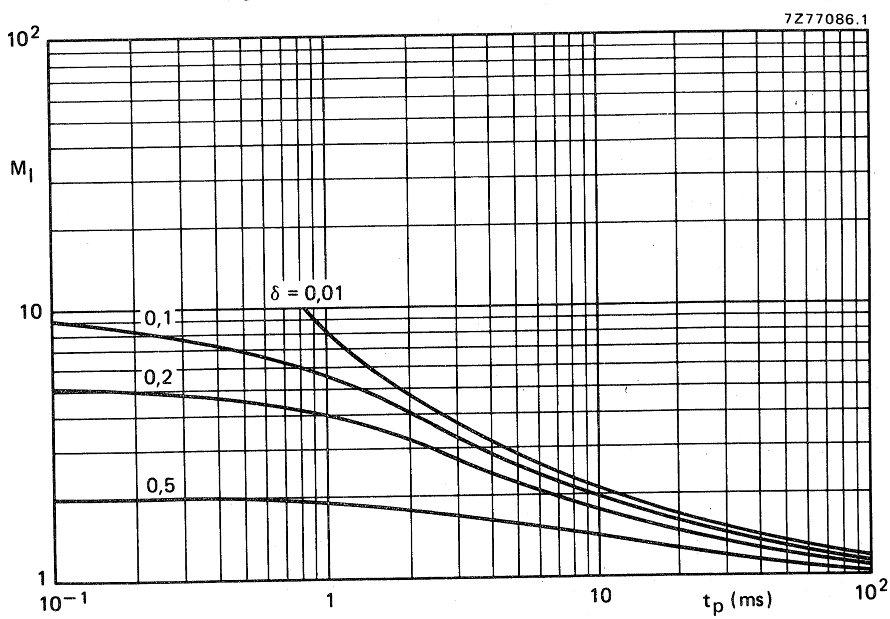


Fig. 13 S.B. current multiplying factor at the V_{CEO} 100 V and 60 V level.

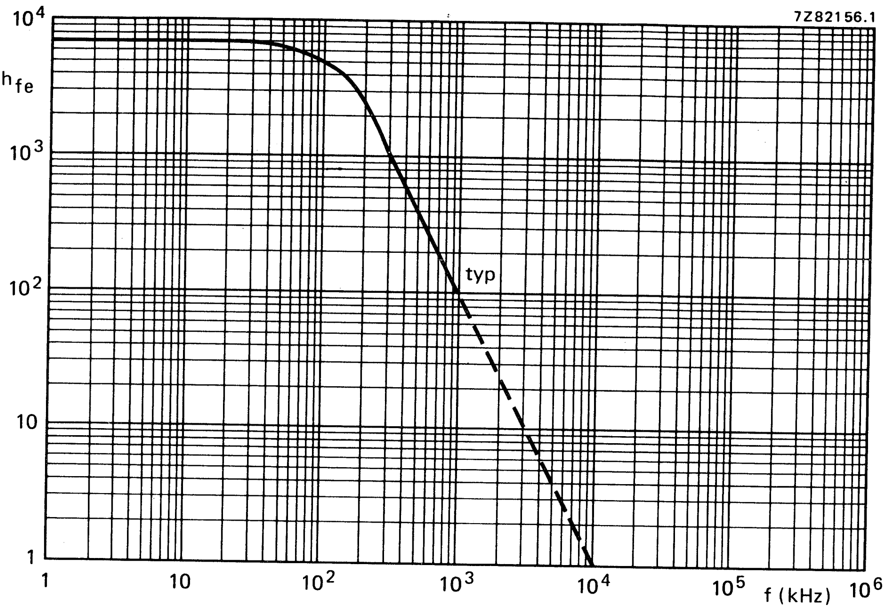


Fig. 14 Small-signal current gain at I_C = 3 A; V_{CE} = 3 V.

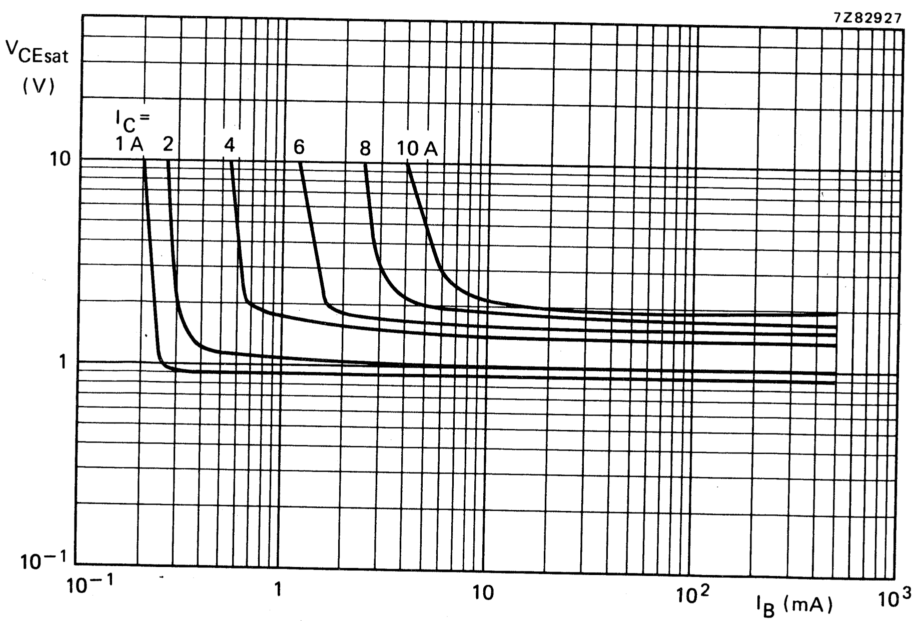


Fig. 15 Typical values collector-emitter saturation voltage at T_j = 25 °C.

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

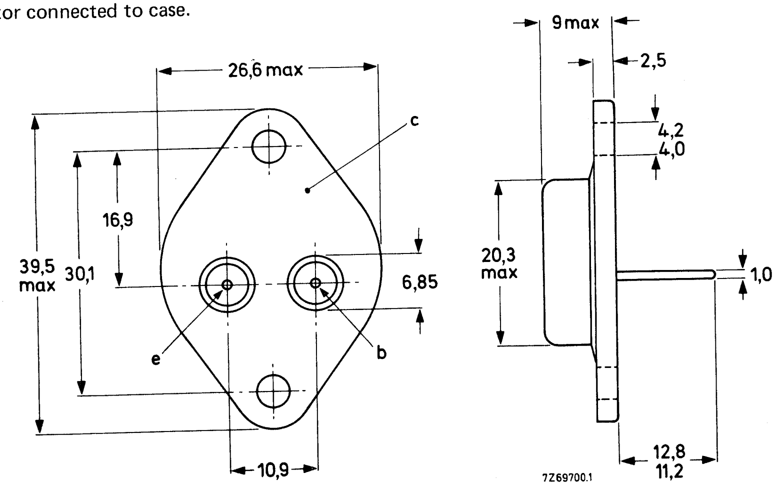
			BDX64	64A	64B	64C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (peak value)	$-I_{CM}$	max.		16			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		117			W
Junction temperature	T_j	max.		200			°C
D.C. current gain $-I_C$ = 1 A; $-V_{CE}$ = 3 V	h_{FE}	typ.		1500			
$-I_C$ = 5 A; $-V_{CE}$ = 3 V	h_{FE}	>		1000			
Cut-off frequency $-I_C$ = 5 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.		80			kHz

MECHANICAL DATA

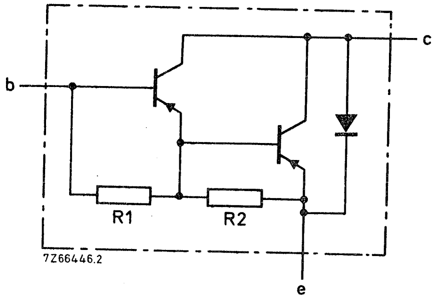
Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting instructions and Accessories.



R1 typ. 5 kΩ
R2 typ. 80 Ω

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 $T_{mb} = 25\ ^oC$	P_{tot}	max.	117				W
Storage temperature	T_{stg}		−65 to + 200				^oC
Junction temperature*	T_j	max.	200				^oC

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	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 °C unless otherwise specified

Collector cut-off current			
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,4 mA
$I_E = 0; -V_{CB} = 40$ V; $T_j = 200$ °C: BDX64 $I_E = 0; -V_{CB} = 50$ V; $T_j = 200$ °C: BDX64A $I_E = 0; -V_{CB} = 60$ V; $T_j = 200$ °C: BDX64B $I_E = 0; -V_{CB} = 70$ V; $T_j = 200$ °C: BDX64C	$-I_{CBO}$	<	3 mA
$I_B = 0; -V_{CE} = -\frac{1}{2} V_{CEOmax}$	$-I_{CEO}$	<	1 mA
Emitter cut-off current			
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	5 mA
D.C. current gain (note 1)			
$-I_C = 1$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	1500
$-I_C = 5$ A; $-V_{CE} = 3$ V	h_{FE}	>	1000
$-I_C = 12$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	750
Base-emitter voltage (notes 1 and 2)			
$-I_C = 5$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5 V
Collector-emitter saturation voltage (note 1)			
$-I_C = 5$ A; $-I_B = 20$ mA	$-V_{CEsat}$	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0; -V_{CB} = 10$ V	C_c	typ.	200 pF
Cut-off frequency			
$-I_C = 5$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	80 kHz
Small-signal current gain			
$-I_C = 5$ A; $-V_{CE} = 3$ V; f = 1 MHz	h_{fe}	typ.	30

Notes

1. Measured under pulse conditions: $t_p < 300$ μs, $\delta < 2\%$.
2. $-V_{BE}$ decreases by about 3,6 mV/K with increasing temperature.

CHARACTERISTICS (continued)

Diode, forward voltage			
$I_F = 5$ A	V_F	<	1,8 V
Switching times (between 10% and 90% levels)			
$-I_{Con} = 5$ A; $-I_{Bon} = I_{Boff} = 20$ mA			
turn-on time	t_{on}	typ.	1 μs
turn-off time	t_{off}	typ.	2,5 μs

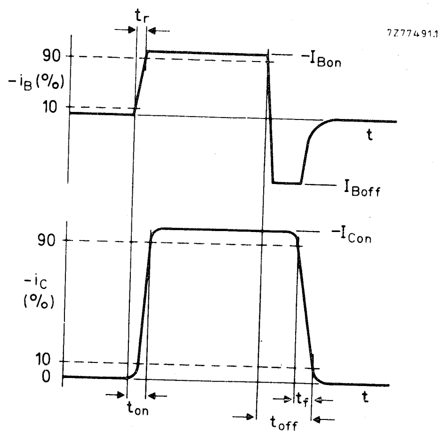
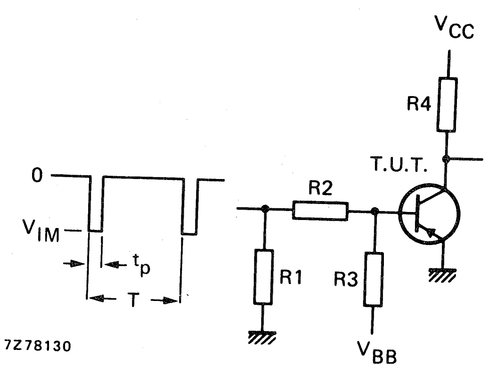


Fig. 3 Switching times waveforms.



$-V_{IM}$	=	16,5 V
$-V_{CC}$	=	16 V
$+V_{BB}$	=	6,5 V
R1	=	56 Ω
R2	=	410 Ω
R3	=	560 Ω
R4	=	3 Ω
$t_r = t_f$	⩽	15 ns
t_p	=	10 μs
T	=	500 μs

Fig. 4 Switching times test circuit.

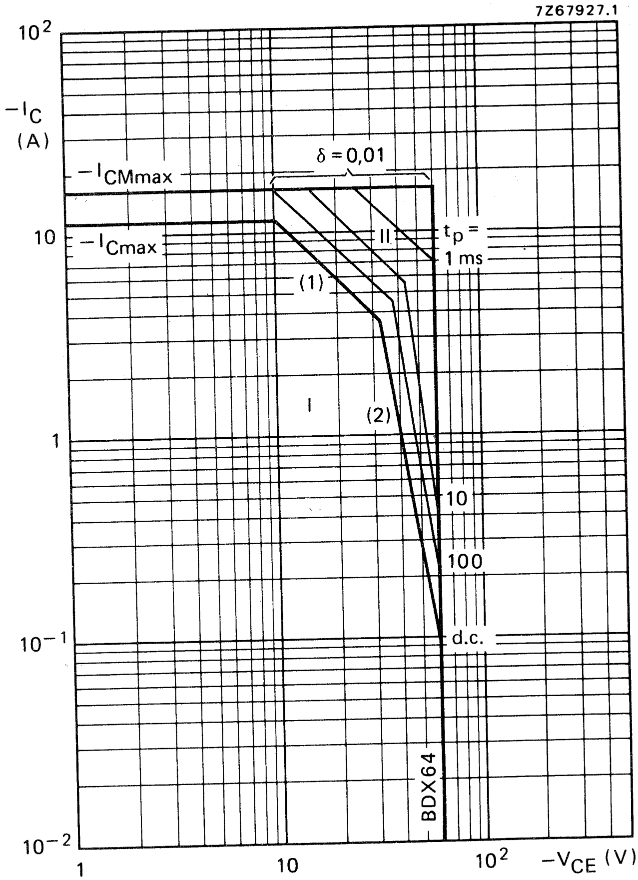


Fig. 5 Safe Operating ARea; $T_{mb} \leq 25\ ^{o}C$.

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).

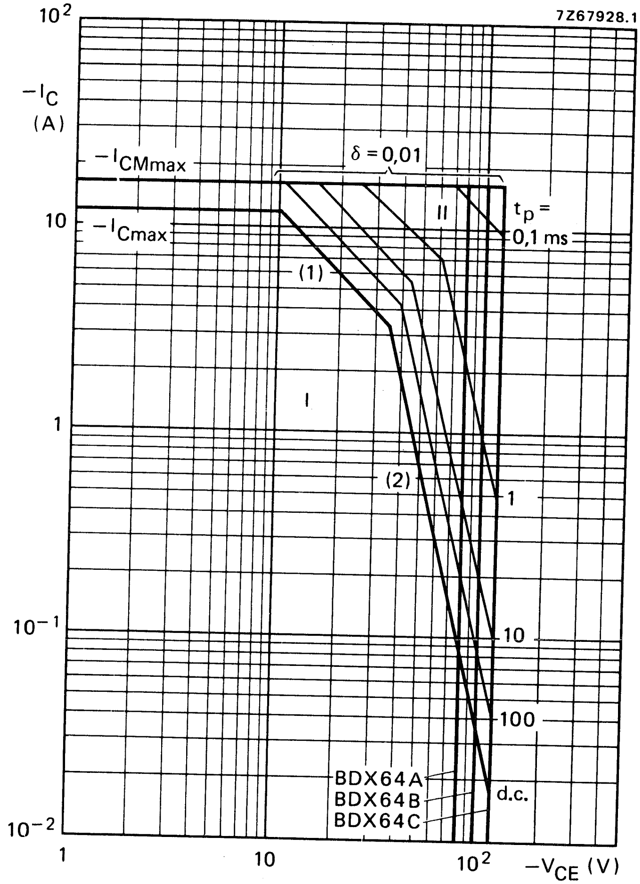


Fig. 6 Safe Operating ARea; $T_{mb} \leqslant 25$ °C.

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 (indepenedent of temperature).

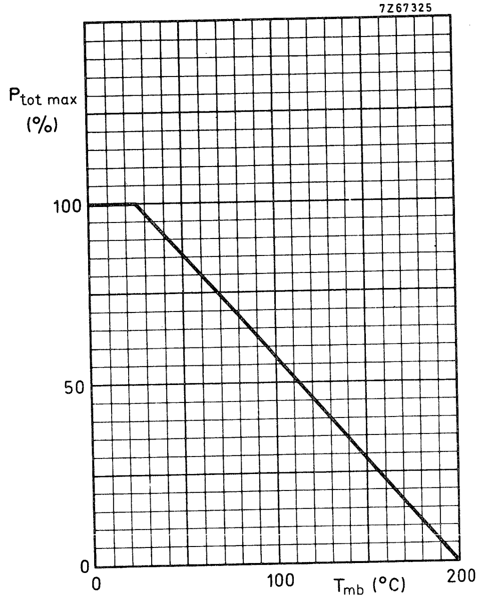


Fig. 7 Power derating curve.

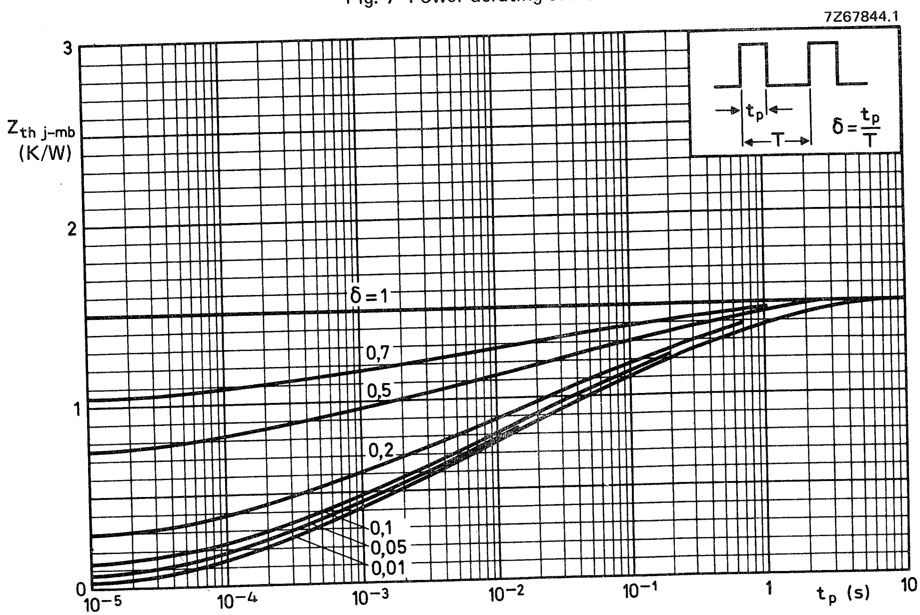


Fig. 8 Pulse power rating chart.

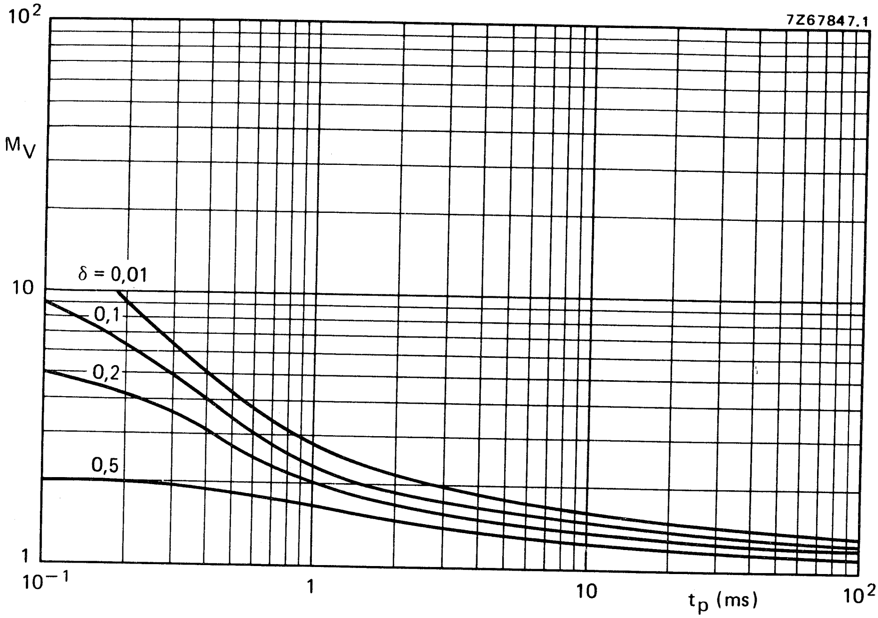


Fig. 9 S.B. voltage multiplying factor at the $-I_{C\,max}$ level.

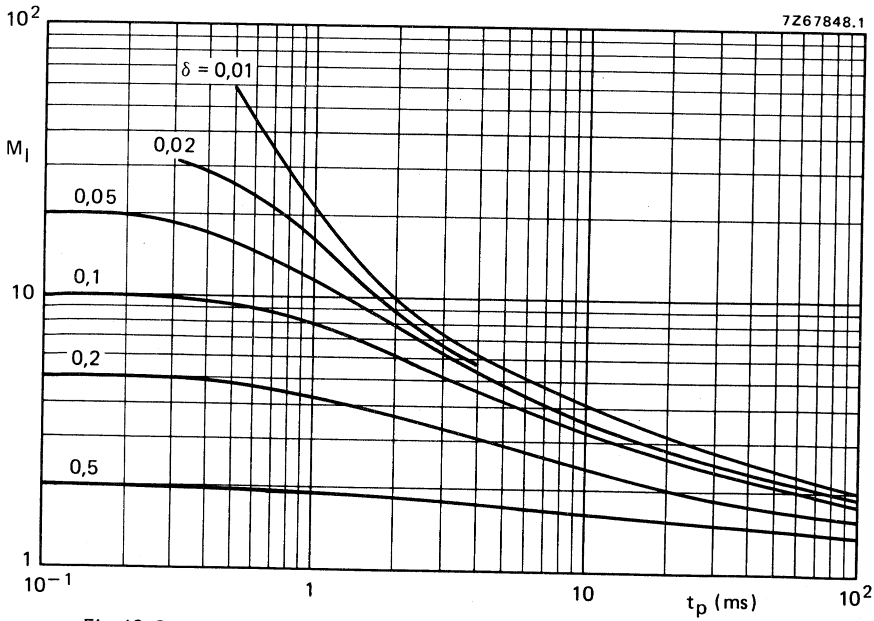


Fig. 10 S.B. current multiplying factor at $-V_{CEO}$ 100 V and 60 V level.

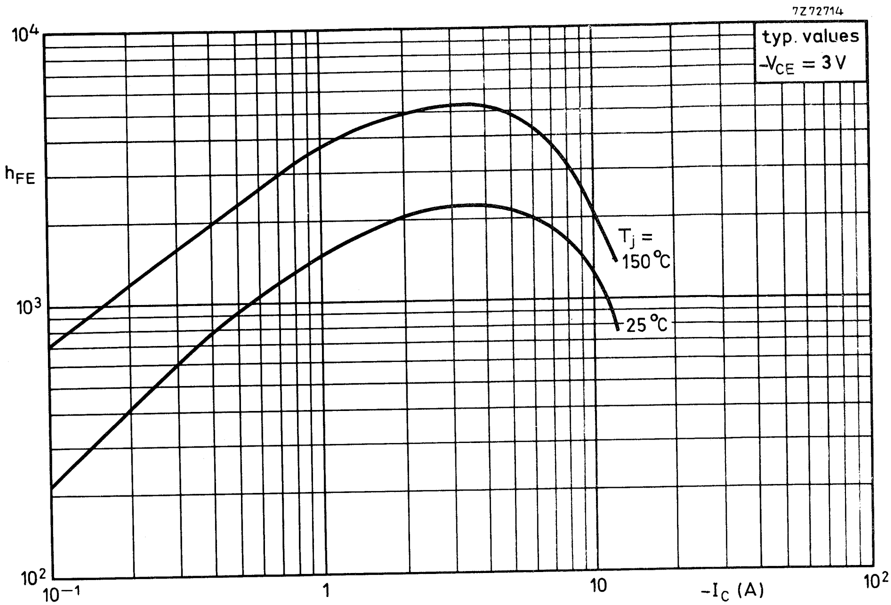


Fig. 11 D.C. current gain.

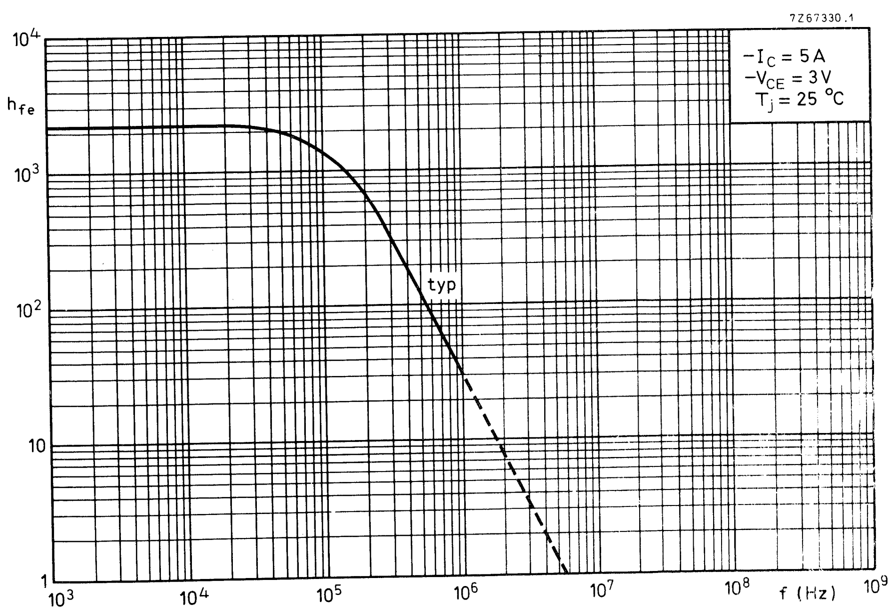


Fig. 12 Small-signal current gain.

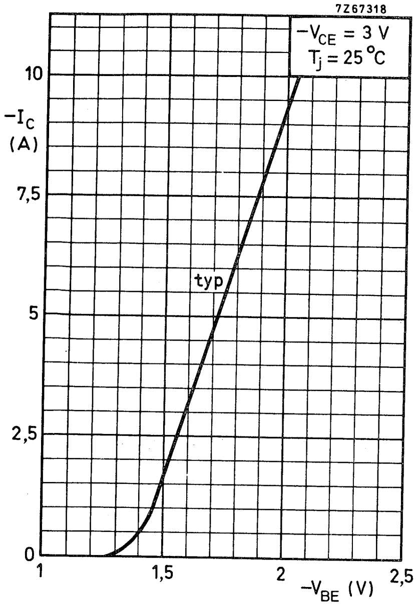


Fig. 13 Typical collector current.

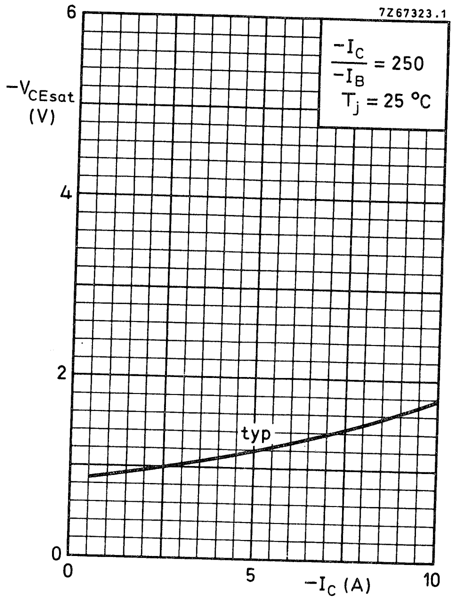


Fig. 14 Typical collector-emitter saturation voltage.

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-3 envelope. P-N-P complements are BDX64, BDX64A, BDX64B and BDX64C.

QUICK REFERENCE DATA

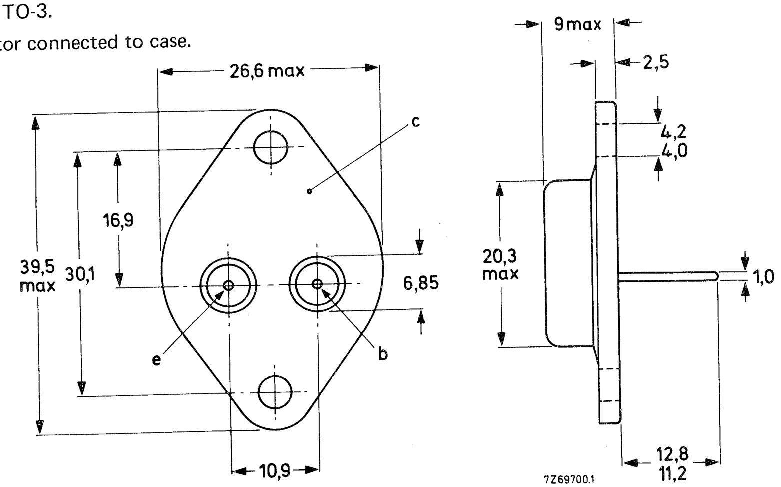
			BDX65	65A	65B	65C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.		16			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		117			W
Junction temperature	T_j	max.		200			°C
D.C. current gain I_C = 1 A; V_{CE} = 3 V	h_{FE}	typ.		3300			
I_C = 5 A; V_{CE} = 3 V	h_{FE}	>		1000			
Cut-off frequency I_C = 5 A; V_{CE} = 3 V	f_{hfe}	typ.		50			kHz

MECHANICAL DATA

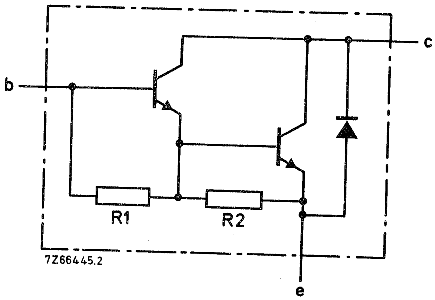
Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting instructions and Accessories.



R1 typ. 5 kΩ
R2 typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

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

			BDX65	65A	65B	65C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	5	V

Collector current (d.c.)	I_C	max.	12	A
Collector current (peak value)	I_{CM}	max.	16	A
Base current (d.c.)	I_B	max.	200	mA
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	117	W
Storage temperature	T_{stg}		−65 to + 200	°C
Junction temperature*	T_j	max.	200	°C

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	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 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = V_{CEOmax}$	I_{CBO}	<	0,4 mA
$I_E = 0$; $V_{CB} = ½ V_{CBOmax}$; T_j = 200 °C	I_{CBO}	<	3 mA
$I_B = 0$; $V_{CE} = ½ V_{CEOmax}$	I_{CEO}	<	1 mA
Emitter cut-off current			
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5 mA
D.C. current gain (note 1)			
I_C = 1 A; V_{CE} = 3 V	h_{FE}	typ.	3300
I_C = 5 A; V_{CE} = 3 V	h_{FE}	>	1000
I_C = 12 A; V_{CE} = 3 V	h_{FE}	typ.	3700
Base-emitter voltage (notes 1 and 2)			
I_C = 5 A; V_{CE} = 3 V	V_{BE}	<	2,5 V
Collector-emitter saturation voltage (note 1)			
I_C = 5 A; I_B = 20 mA	V_{CEsat}	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	200 pF
Cut-off frequency			
I_C = 5 A; V_{CE} = 3 V	f_{hfe}	typ.	50 kHz
Turn-off breakdown energy with inductive load (Fig. 5)			
$-I_{Boff} = 0$; I_{CC} = 6,3 A	$E_{(BR)}$	>	100 mJ

Notes
1. Measured under pulse conditions: $t_p < 300\ \mu s$, $\delta < 2\%$.
2. V_{BE} decreases by about 3,6 mV/K with increasing temperature.

CHARACTERISTICS (continued)

Diode, forward voltage			
I_F = 5 A	V_F	typ.	1,2 V
Switching times (between 10% and 90% levels)			
I_{Con} = 5 A; I_{Bon} = $-I_{Boff}$ = 20 mA			
Turn-on time	t_{on}	typ.	1 μs
Turn-off time	t_{off}	typ.	6 μs

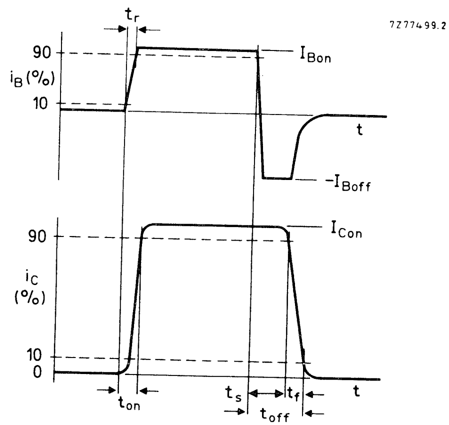
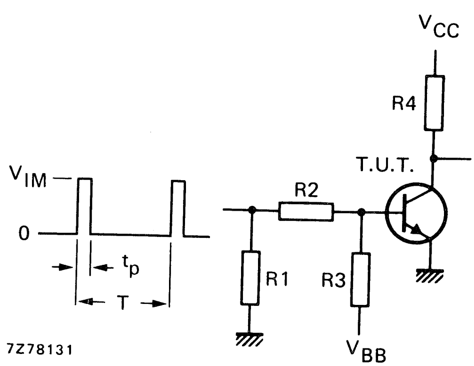


Fig. 3 Switching times waveforms.



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

Fig. 4 Switching times test circuit.

CHARACTERISTICS (continued)

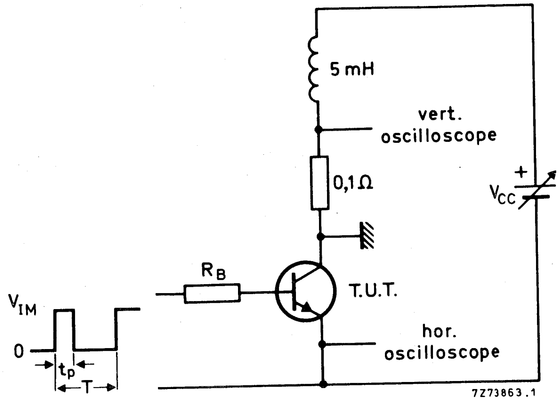


Fig. 5 Test circuit for turn-off breakdown energy. V_{IM} = 12 V; R_B = 270 Ω; I_{CC} = 6,3 A; δ = 1%.

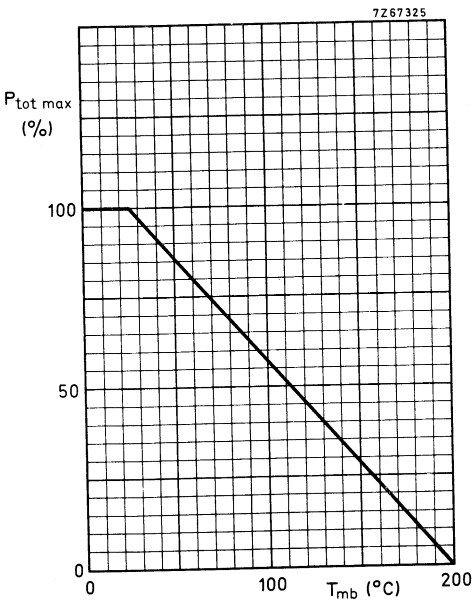


Fig. 6 Power derating curve.

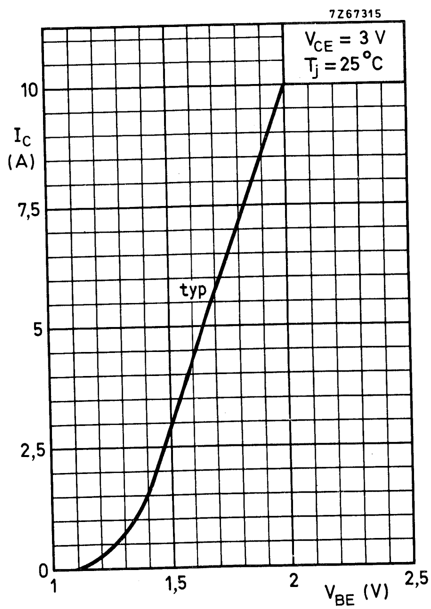


Fig. 7 Typical collector current.

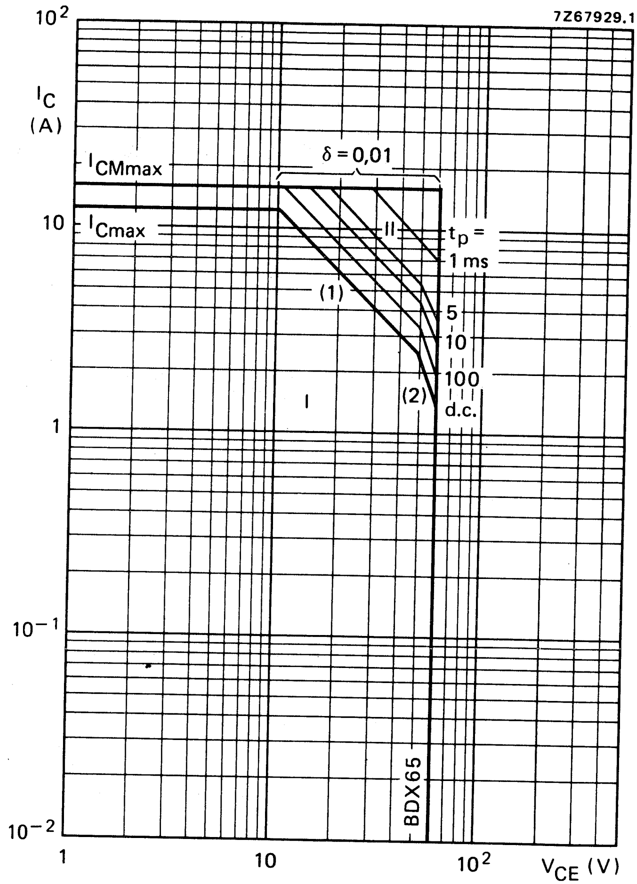


Fig. 8 Safe Operating ARea at $T_{mb} \leq 25\ ^oC$ of BDX65.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

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

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

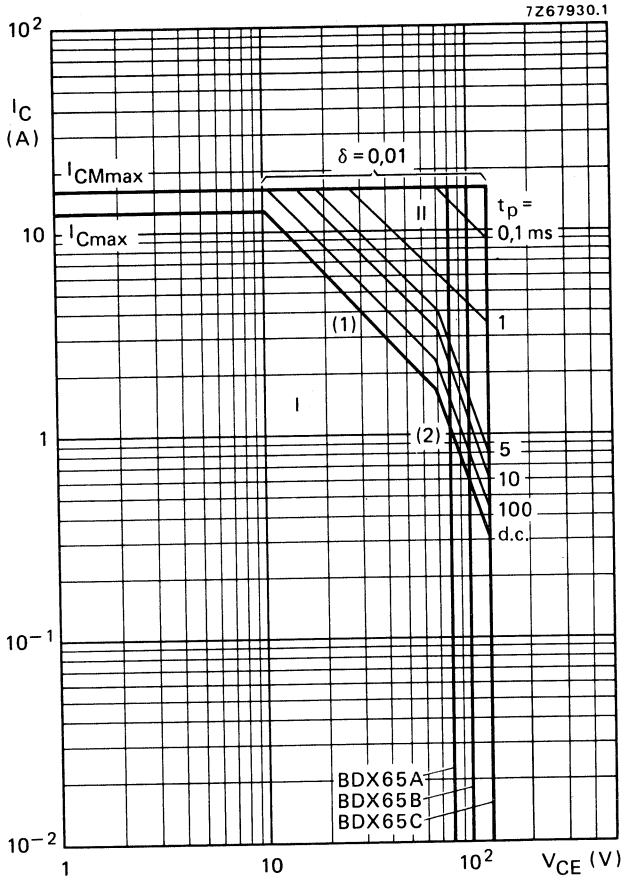


Fig. 9 Safe Operating ARea at $T_{mb} \leq 25$ °C.

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).

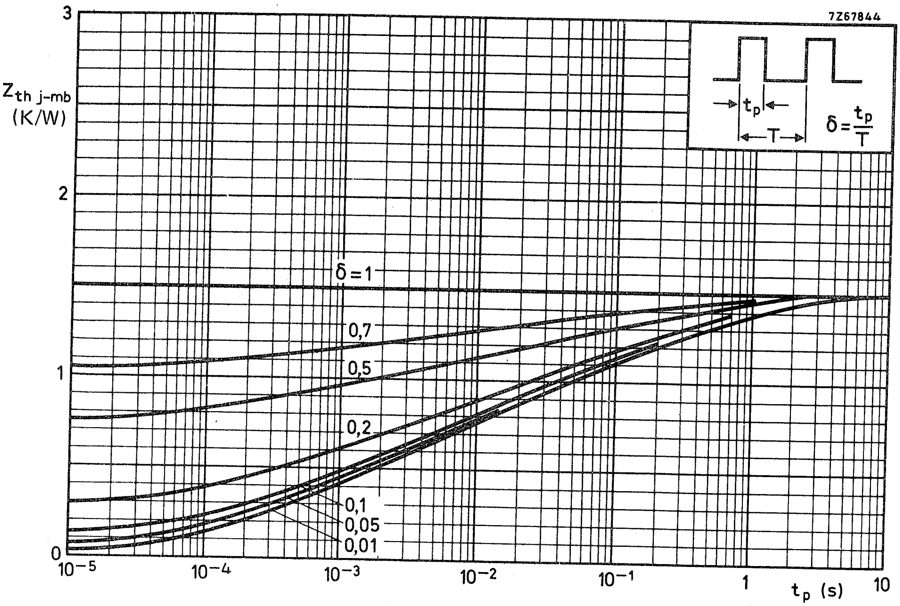


Fig. 10 Pulse power rating chart.

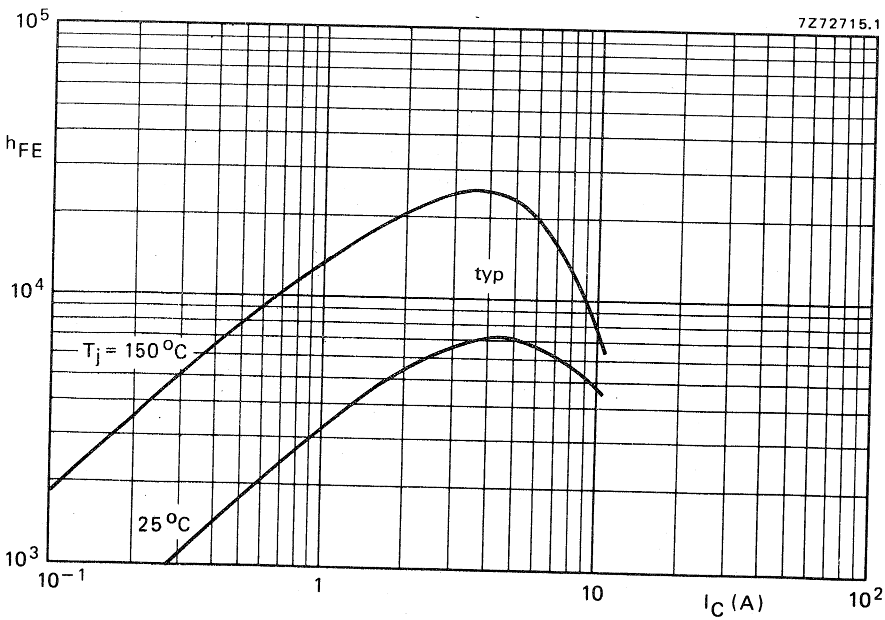


Fig. 11 Typical d.c. current gain at V_{CE} = 3 V.

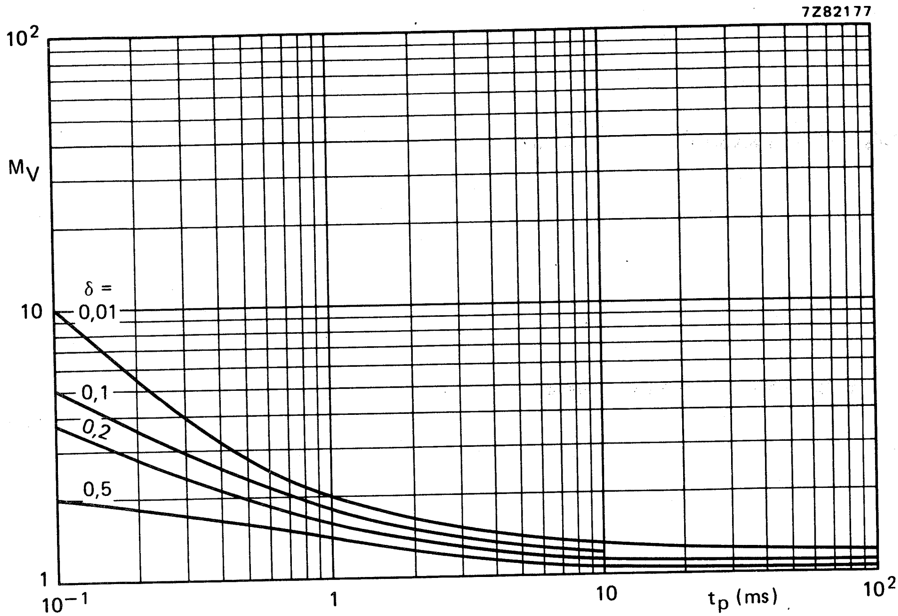


Fig. 12 S.B. voltage multiplying factor at the I_{Cmax} level.

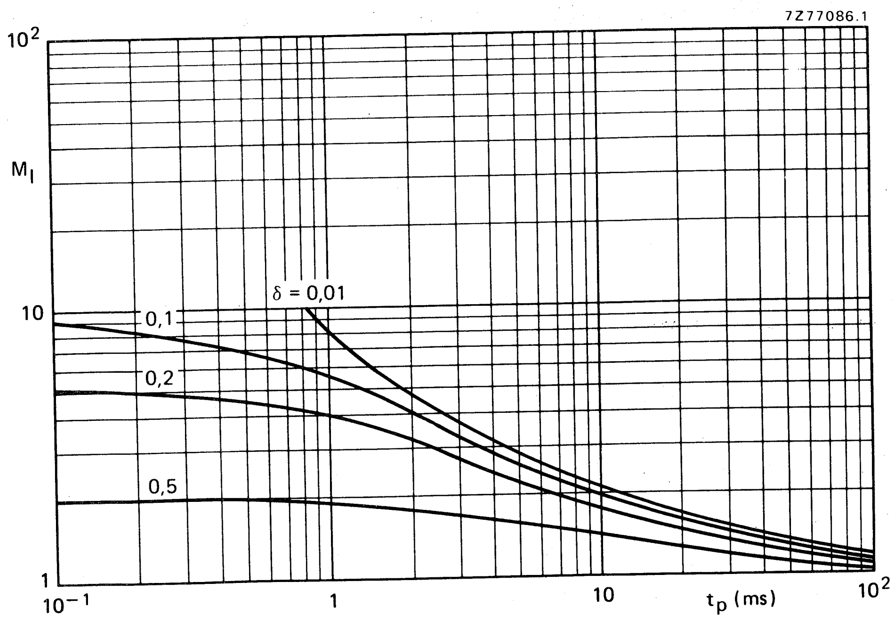


Fig. 13 S.B. current multiplying factor at V_{CEO} 100 V and 60 V level.

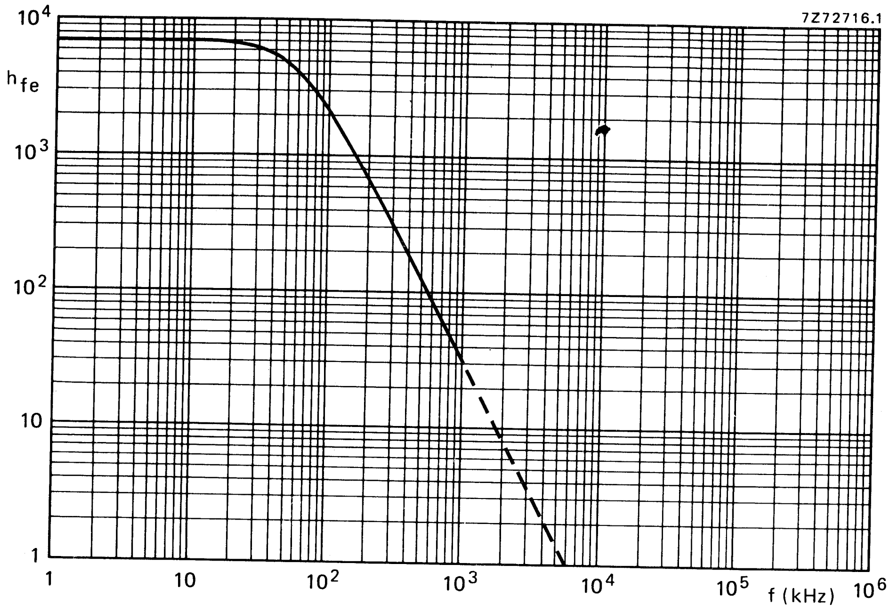


Fig. 14 Typical small-signal current gain, I_C = 5 A; V_{CE} = 3 V; T_j = 25 °C.

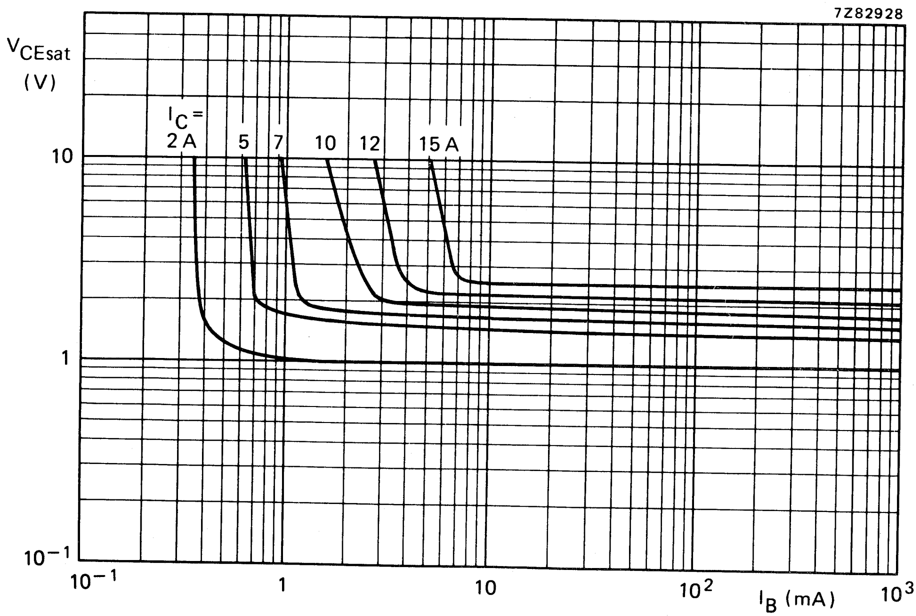


Fig. 15 Typical values collector-emitter saturation voltage. T_{amb} = 25 °C.

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 BDX67, BDX67A, BDX67B and BDX67C.

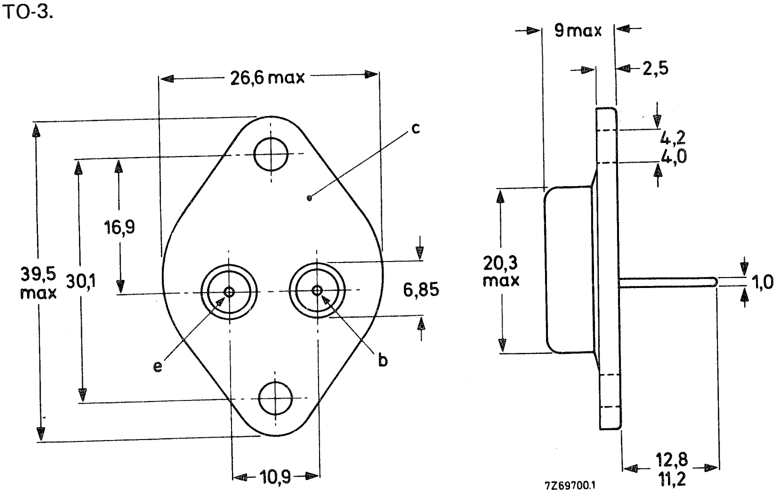
QUICK REFERENCE DATA

			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 °C	P_{tot}	max.		150			W
Junction temperature	T_j	max.		200			°C
D.C. current gain $-I_C$ = 1 A; $-V_{CE}$ = 3 V	h_{FE}	typ.		2000			
$-I_C$ = 10 A; $-V_{CE}$ = 3 V	h_{FE}	>		1000			
Cut-off frequency $-I_C$ = 5 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.		60			kHz

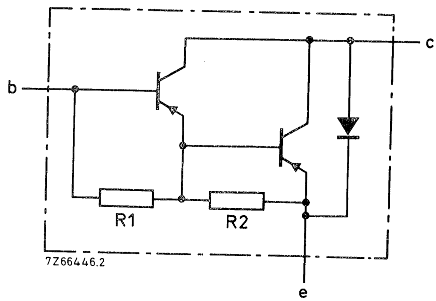
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-3.



See also chapters Mounting instructions and Accessories.



R1 typ. 3 kΩ
R2 typ. 80 Ω

Fig. 2 Circuit diagram.

RATINGS

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

			BDX66	66A	66B	66C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open-base)	$-V_{CEO}$	max.	60	80	100	120	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	5	V
Collector current (d.c.)	$-I_C$	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 °C	P_{tot}	max.		150			W
Storage temperature	T_{stg}			−65 to +200			°C
Junction temperature*	T_j	max.		200			°C

THERMAL RESISTANCE *

From junction to mounting base $R_{th\ j\text{-}mb}$ = 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 °C unless otherwise specified.

Collector cut-off current			
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	1 mA
$I_E = 0$; $-V_{CB} = 40$ V; $T_j = 200$ °C; BDX66 $I_E = 0$; $-V_{CB} = 50$ V; $T_j = 200$ °C; BDX66A $I_E = 0$; $-V_{CB} = 60$ V; $T_j = 200$ °C; BDX66B $I_E = 0$; $-V_{CB} = 70$ V; $T_j = 20$ °C; BDX66C	$-I_{CBO}$	<	5 mA
$I_B = 0$; $-V_{CE} = -½V_{CEOmax}$	$-I_{CEO}$	<	3 mA
Emitter cut-off current			
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	5 mA
D.C. current gain *			
$-I_C = 1$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	2000
$-I_C = 10$ A; $-V_{CE} = 3$ V	h_{FE}	>	1000
$-I_C = 16$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	1000
Base-emitter voltage *			
$-I_C = 10$ A; $-V_{CE} = 3$ V	$-V_{BE}$	<	2,5 V
Collector-emitter saturation voltage *			
$-I_C = 10$ A; $-I_B = 40$ mA	$-V_{CEsat}$	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	typ.	300 pF
Cut-off frequency			
$-I_C = 5$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.	60 kHz
Small-signal current gain			
$-I_C = 5$ A; $-V_{CE} = 3$ V; f = 1 MHz	h_{fe}	typ.	50
Diode, forward voltage			
$I_F = 10$ A	V_F	typ.	2 V

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

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

Switching times
(between 10% and 90% levels)

$-I_{Con}$ = 10 A; $-I_{Bon}$ = I_{Boff} = 40 mA

turn-on time	t_{on}	typ.	1 μs
turn-off time	t_{off}	typ.	3,5 μs

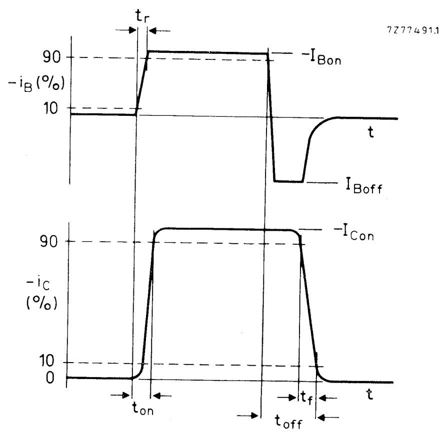


Fig. 3 Switching times waveforms.

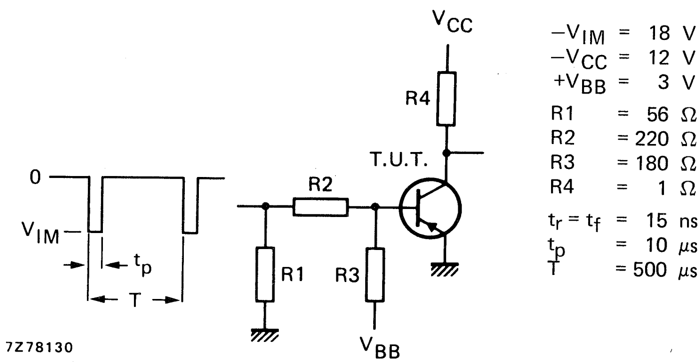


Fig. 4 Switching times test circuit.

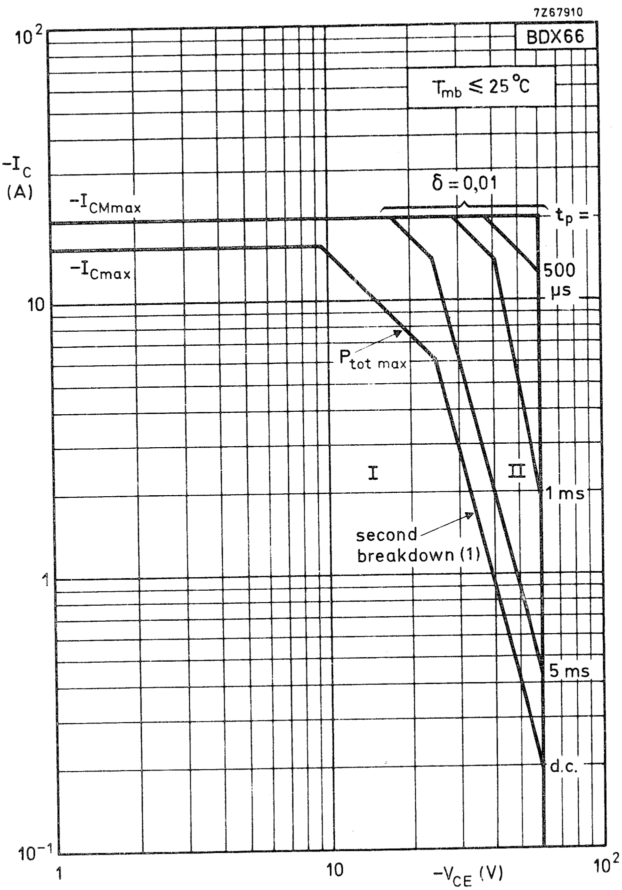


Fig. 5 Safe Operating ARea with the transistor forward biased.

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

(1) Independent of temperature.

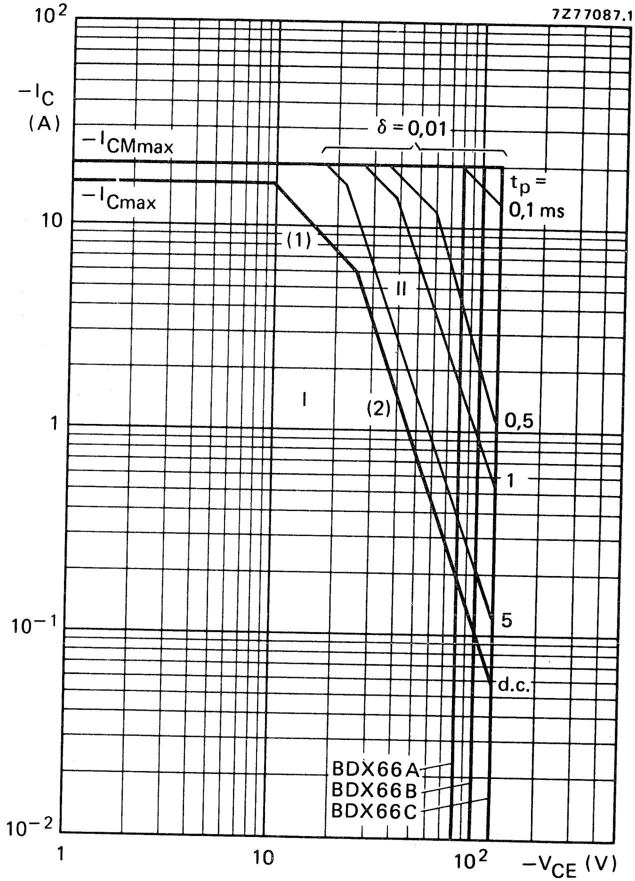


Fig. 6 Safe Operating ARea.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

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

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

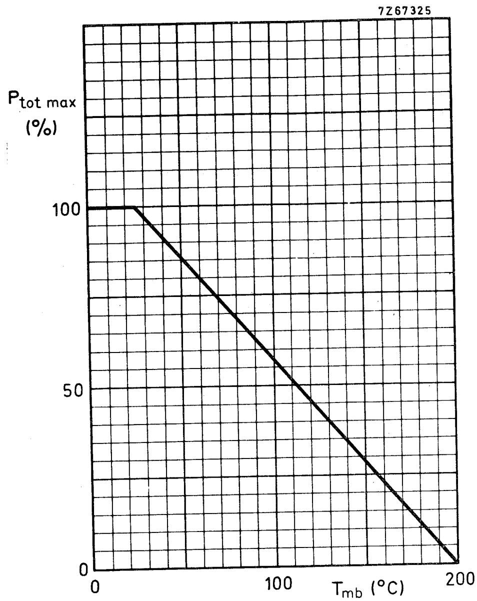


Fig. 7 Power derating curve.

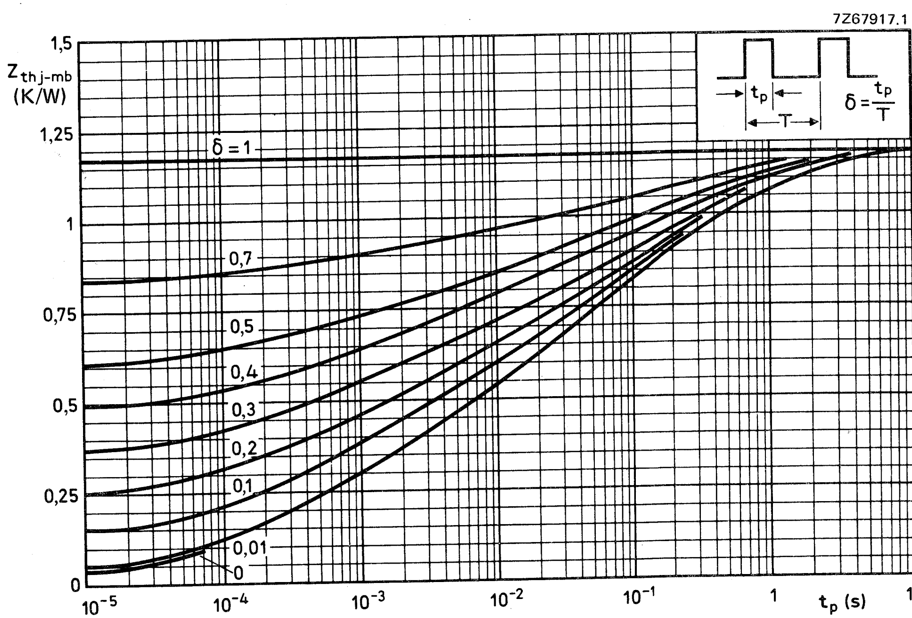


Fig. 8 Pulse power rating chart.

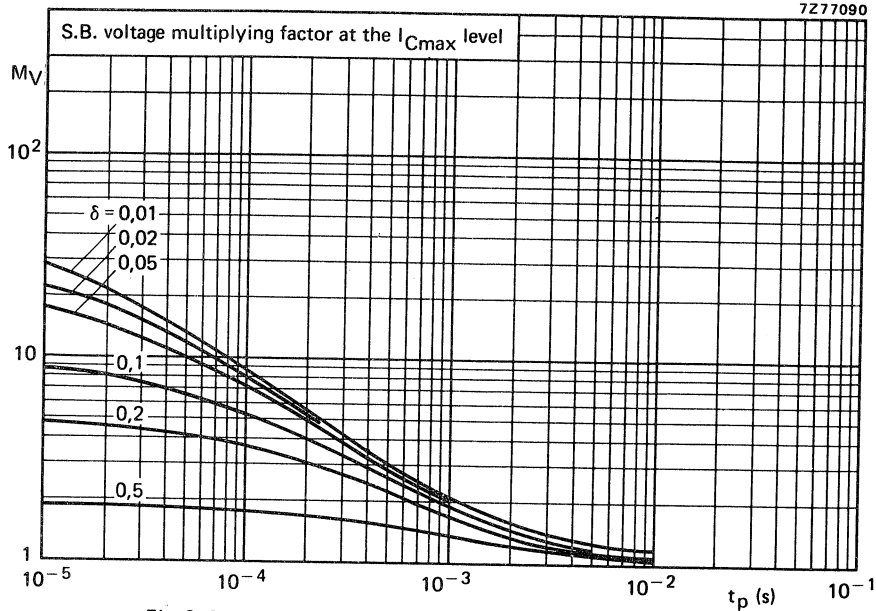


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

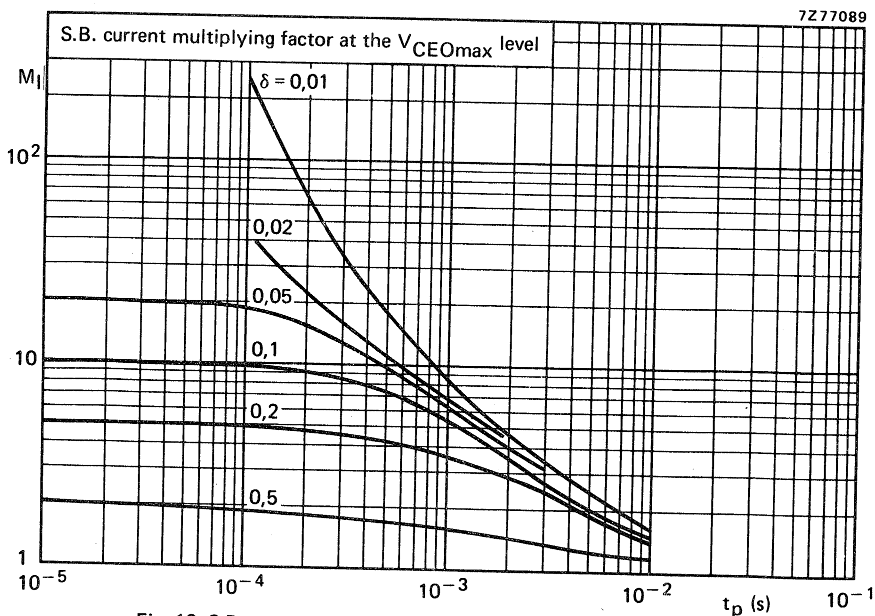


Fig. 10 S.B. current multiplying factor at the V_{CEOmax} level.

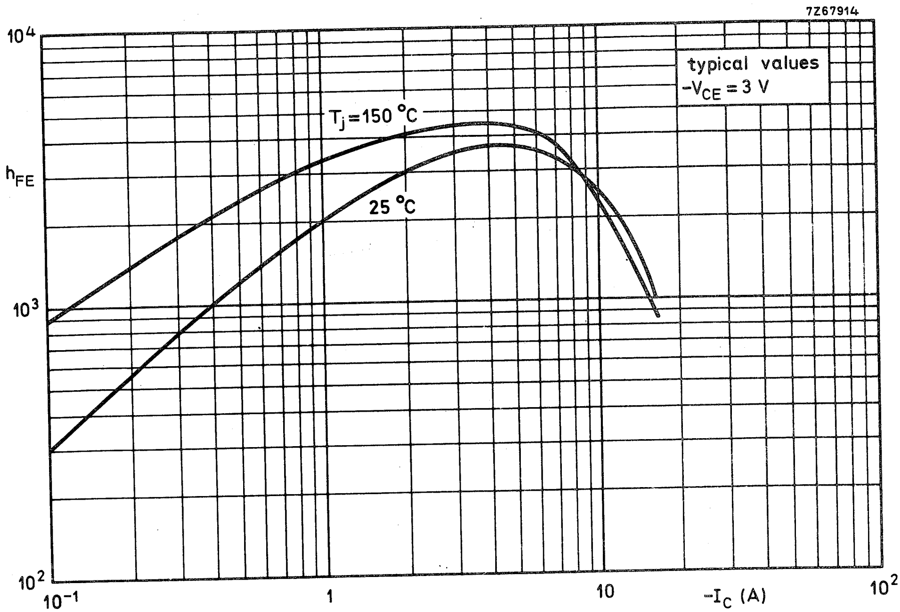


Fig. 11 D.C. current gain.

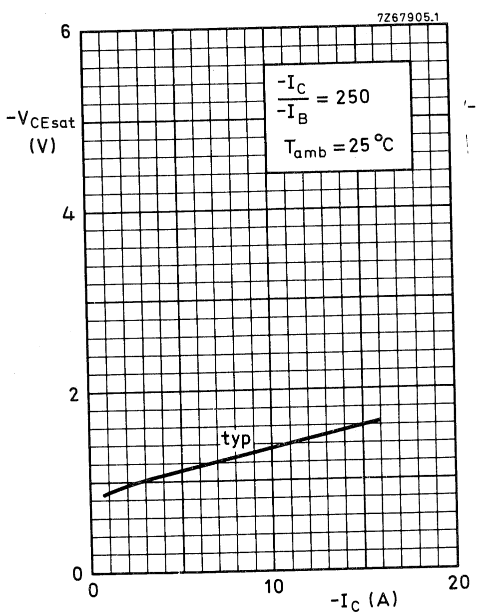


Fig. 12 Collector-emitter saturation voltage.

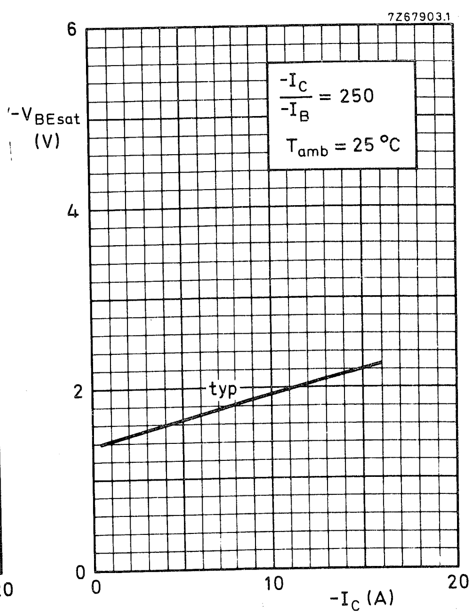


Fig. 13 Base-emitter saturation voltage.

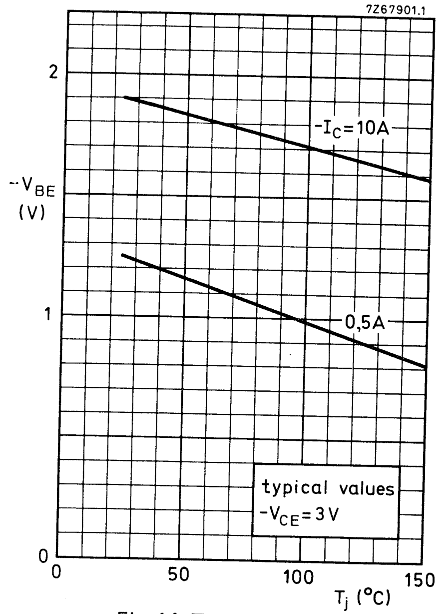


Fig. 14 Typical base-emitter voltage.

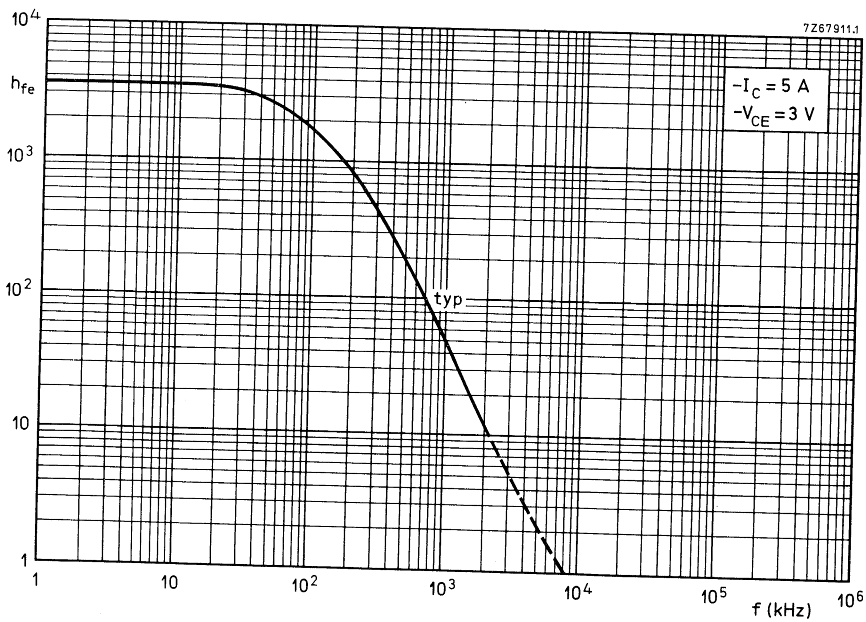


Fig. 15 Small-signal current gain.

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

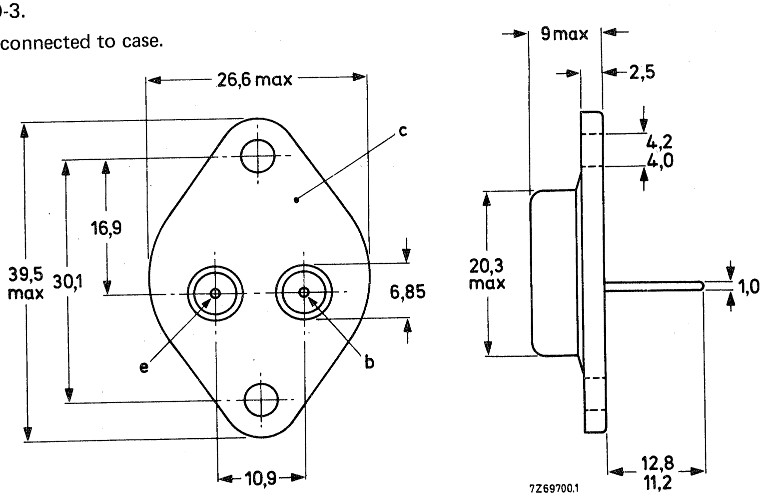
			BDX67	67A	67B	67C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.		20			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		150			W
Junction temperature	T_j	max.		200			°C
D.C. current gain I_C = 1 A; V_{CE} = 3 V	h_{FE}	typ.		5200			
I_C = 10 A; V_{CE} = 3 V	h_{FE}	>		1000			
Cut-off frequency I_C = 5 A; V_{CE} = 3 V	f_{hfe}	typ.		50			kHz

MECHANICAL DATA

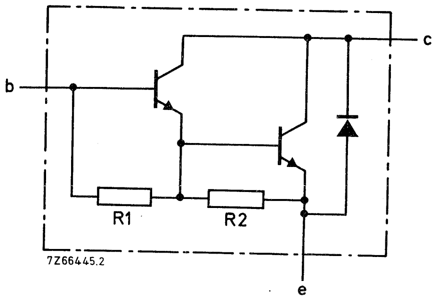
Dimensions in mm

Fig. 1 TO-3.

Collector connected to case.



See also chapters Mounting Instructions and Accessories.



R1 typ. 3 kΩ
R2 typ. 80 Ω

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 °C	P_{tot}	max.	150	W
Storage temperature	T_{stg}		−65 to + 200	°C
Junction temperature *	T_j	max.	200	°C

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	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 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = V_{CEOmax}$	I_{CBO}	<	1 mA
$I_E = 0$; $V_{CB} = ½ V_{CBOmax}$; T_j = 200 °C	I_{CBO}	<	5 mA
$I_B = 0$; $V_{CE} = ½ V_{CEOmax}$	I_{CEO}	<	3 mA
Emitter-cut-off current			
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	5 mA
D.C. current gain *			
I_C = 1 A; V_{CE} = 3 V	h_{FE}	typ.	5200
I_C = 10 A; V_{CE} = 3 V	h_{FE}	>	1000
I_C = 16 A; V_{CE} = 3 V	h_{FE}	typ.	4000
Base-emitter voltage *			
I_C = 10 A; V_{CE} = 3 V	V_{BE}	<	2,5 V
Collector-emitter saturation voltage *			
I_C = 10 A; I_B = 40 mA	V_{CEsat}	<	2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	300 pF
Cut-off frequency			
I_C = 5 A; V_{CE} = 3 V	f_{hfe}	typ.	50 kHz
Turn-off breakdown energy with inductive load			
$-I_{Boff} = 0$; I_{CC} = 7,8 A; see Fig. 5	$E_{(BR)}$	>	150 mJ
Small-signal current gain			
I_C = 5 A; V_{CE} = 3 V; f = 1 MHz	h_{fe}	typ.	20
Diode, forward voltage			
I_F = 10 A	V_F	typ.	2,5 V

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

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

Switching times
(between 10% and 90% levels)
I_{Con} = 10 A; I_{Bon} = $-I_{Boff}$ = 40 mA;

turn-on time	t_{on}	typ.	1 µs
turn-off time	t_{off}	typ.	3,5 µs

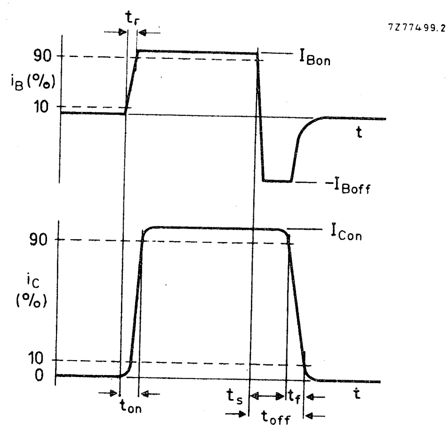
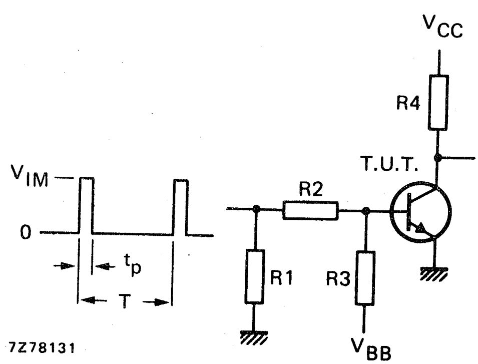


Fig. 3 Switching times waveforms.



V_{IM}	=	18 V
V_{CC}	=	12 V
V_{BB}	=	−3 V
R1	=	56 Ω
R2	=	220 Ω
R3	=	180 Ω
R4	=	1 Ω
$t_r = t_f$	≤	15 ns
t_p	=	10 µs
T	=	500 µs

Fig. 4 Switching times test circuit.

CHARACTERISTICS (continued)

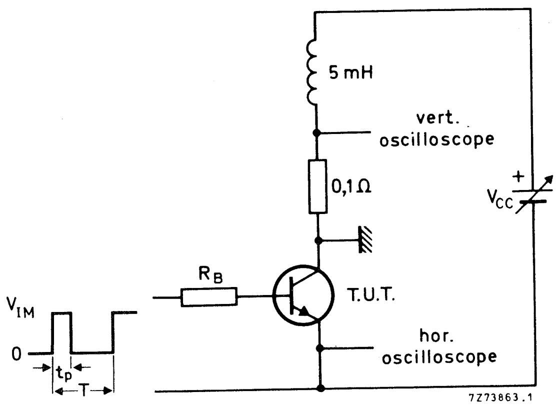


Fig. 5 Test circuit for turn-off breakdown energy. V_{IM} = 12 V; R_B = 270 Ω; I_{CC} = 7,8 A; t_p = 1 ms; δ = 1%.

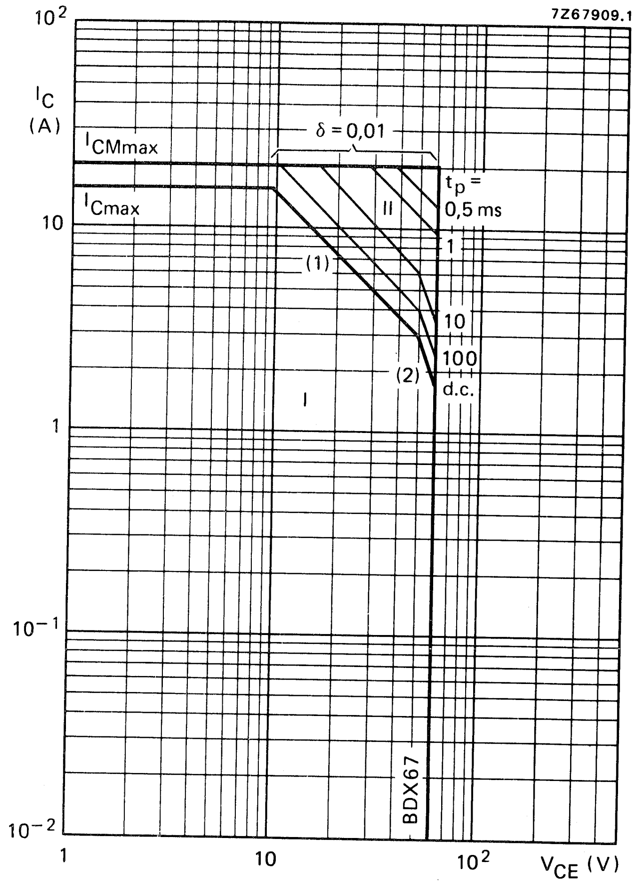


Fig. 6 Safe Operating ARea at T_{mb} = 25 °C of BDX67.

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).

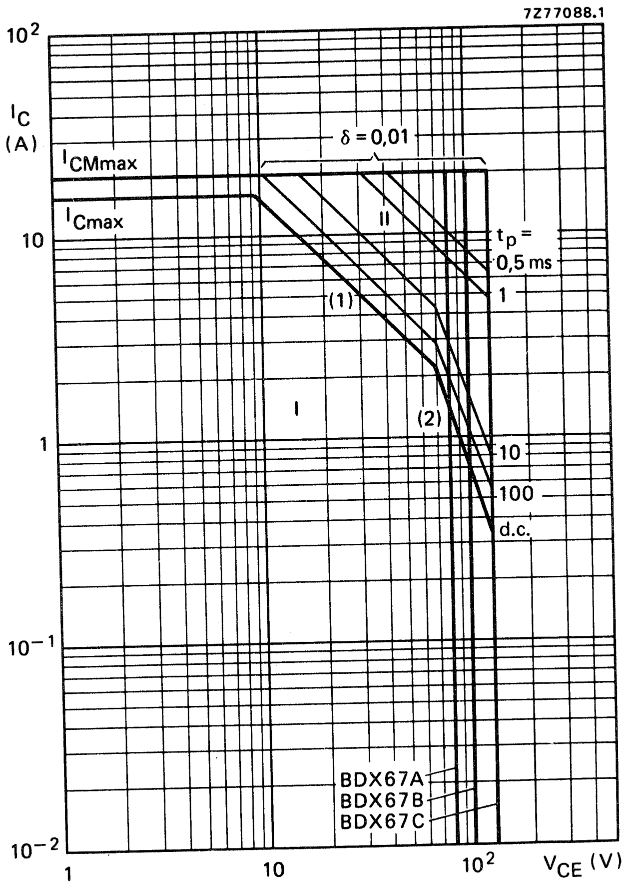


Fig. 7 Safe Operating ARea at T_{mb} = 25 °C.

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).

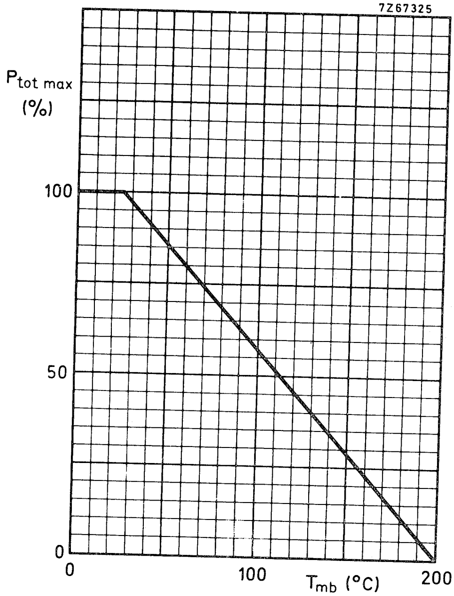


Fig. 8 Power derating curve.

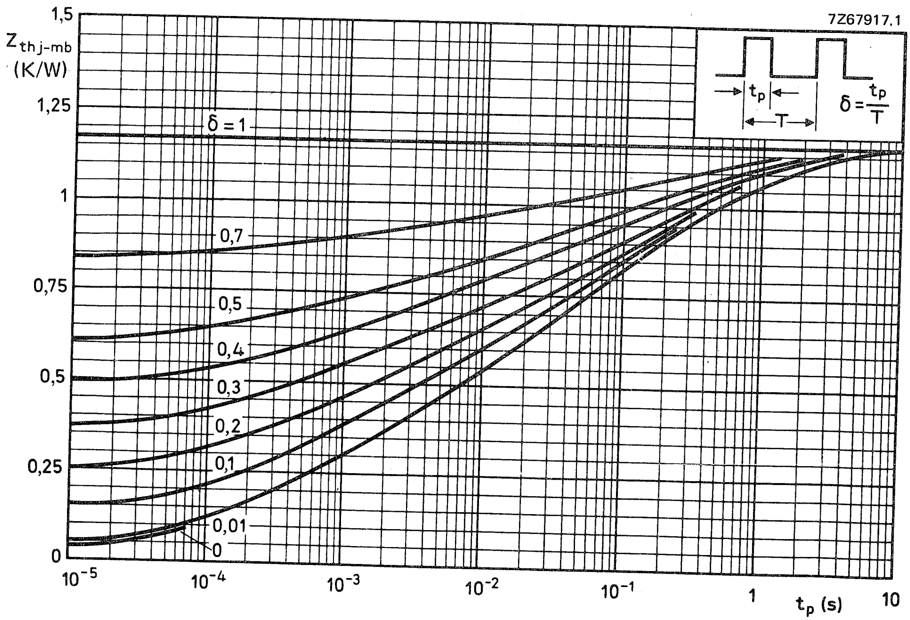


Fig. 9 Pulse power rating chart.

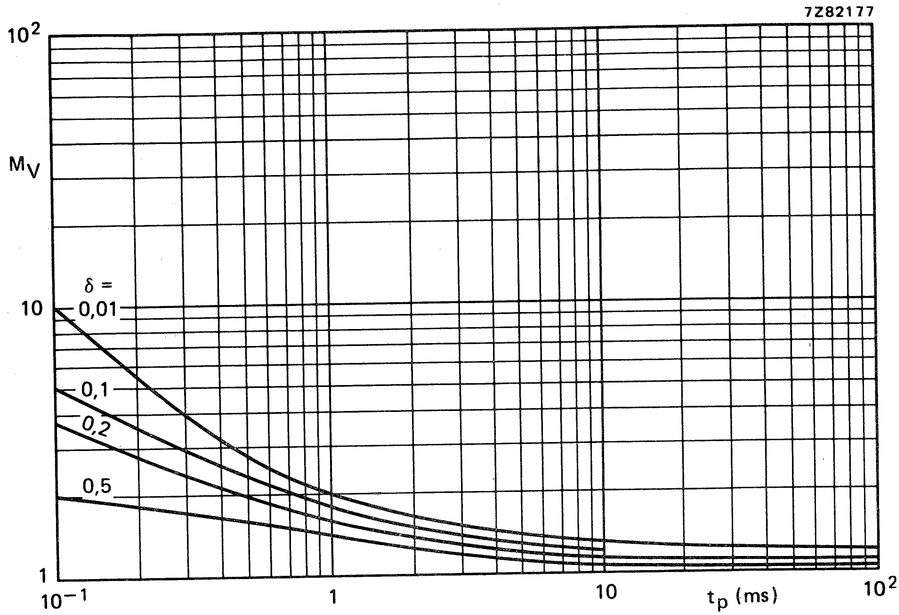


Fig. 10 S.B. voltage multiplying factor at the I_{Cmax} level.

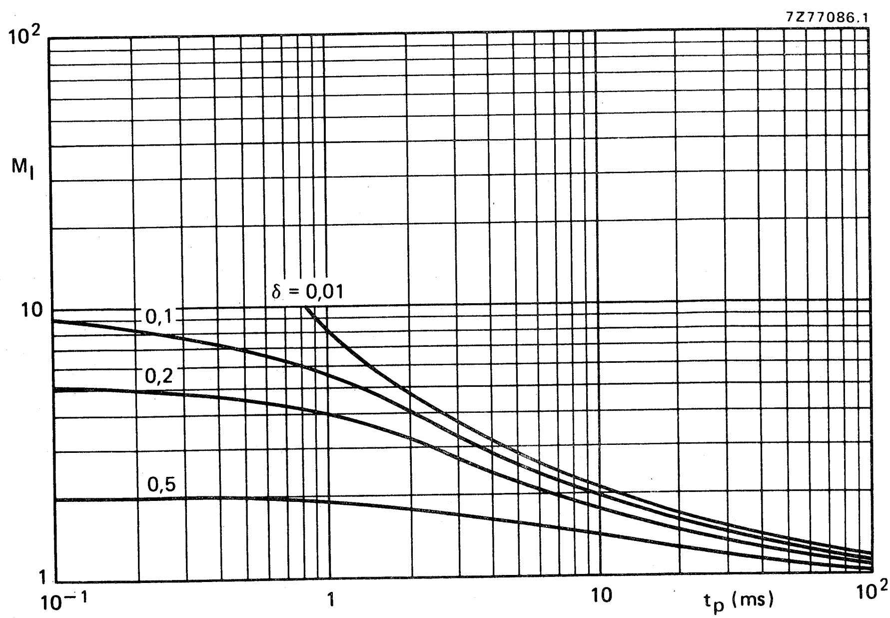


Fig. 11 S.B. current multiplying factor at the V_{CEOmax} level.

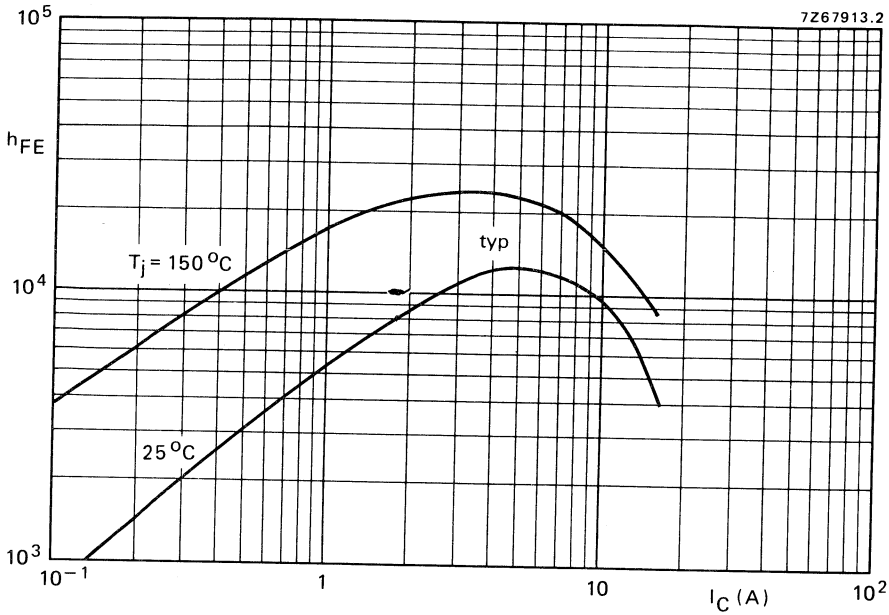


Fig. 12 D.C. current gain.

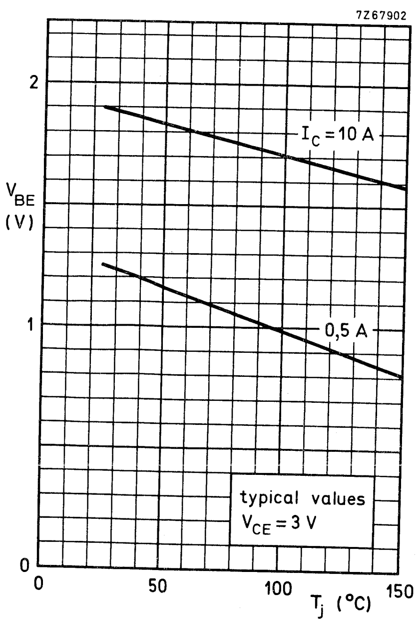


Fig. 13 Typical base-emitter voltage.

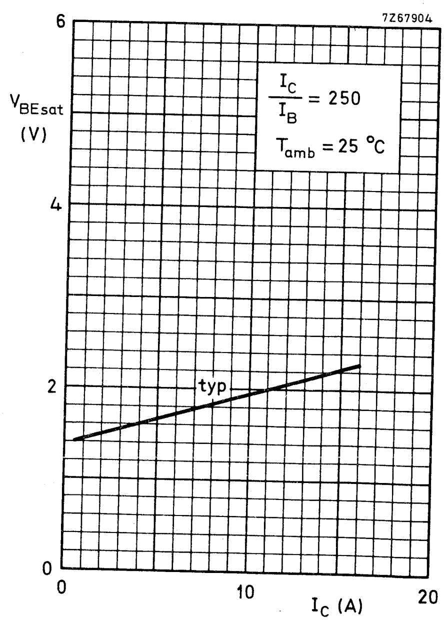


Fig. 14 Base-emitter saturation voltage.

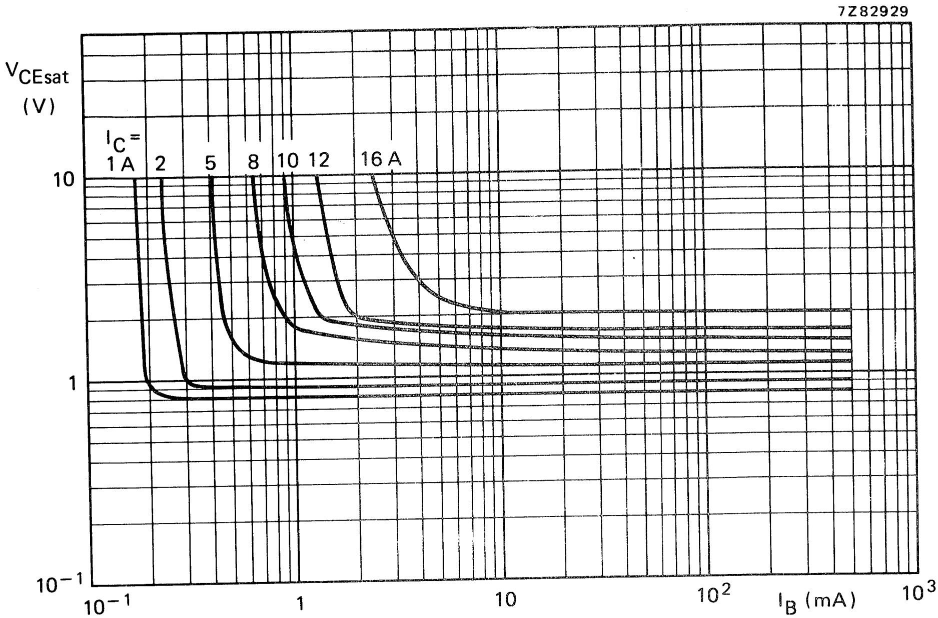


Fig. 15 Typical values collector-emitter saturation voltage at T_j = 25 °C.

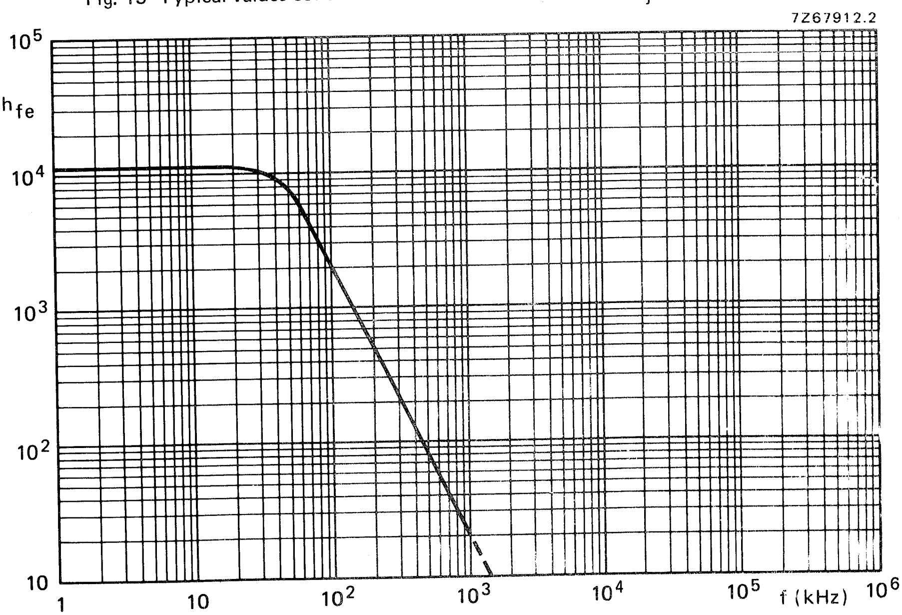


Fig. 16 Small-signal current gain, I_C = 5 A; V_{CE} = 3 V.

DARLINGTON POWER TRANSISTORS

P-N-P Darlingtons 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

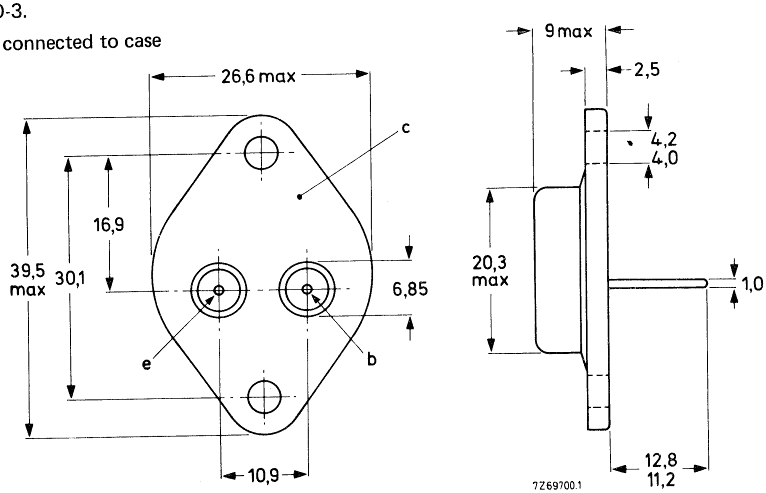
			BDX68	68A	68B	68C	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (peak value)	$-I_{CM}$	max.		40			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		200			W
Junction temperature	T_j	max.		200			°C
D.C. current gain							
$-I_C$ = 5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.		3000			
$-I_C$ = 20 A; $-V_{CE}$ = 3 V	h_{FE}	>		1000			
Cut-off frequency							
$-I_C$ = 10 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.		60			kHz

MECHANICAL DATA

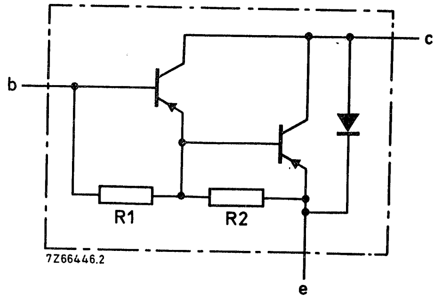
Dimensions in mm

Fig. 1 TO-3.

Collector connected to case



See also chapters Mounting instructions and Accessories.



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)

			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 °C	P_{tot}	max.	200				W
Storage temperature	T_{stg}		−65 to + 200				°C
Junction temperature*	T_j	max.	200				°C

THERMAL RESISTANCE *

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	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 °C unless otherwise specified

Collector cut-off current				
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	2	mA
$I_E = 0; -V_{CB} = -½V_{CBOmax}$; T_j = 200 °C	$-I_{CBO}$	<	10	mA
$I_B = 0; -V_{CE} = -½V_{CEOmax}$	$-I_{CEO}$	<	6	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	10	mA
D.C. current gain*				
$-I_C$ = 5 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	3000	
$-I_C$ = 20 A; $-V_{CE}$ = 3 V	h_{FE}	>	1000	
$-I_C$ = 30 A; $-V_{CE}$ = 3 V	h_{FE}	typ.	1000	
Base-emitter voltage*				
$-I_C$ = 20 A; $-V_{CE}$ = 3 V	$-V_{BE}$	<	2,5	V
Collector-emitter saturation voltage*				
$-I_C$ = 20 A; $-I_B$ = 80 mA	$-V_{CEsat}$	<	2	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0; -V_{CB}$ = 10 V	C_c	typ.	600	pF
Cut-off frequency				
$-I_C$ = 10 A; $-V_{CE}$ = 3 V	f_{hfe}	typ.	60	kHz
Small-signal current gain				
$-I_C$ = 10 A; $-V_{CE}$ = 3 V; f = 1 MHz	h_{fe}	typ.	20	
Diode, forward voltage				
I_F = 20 A	V_F	typ.	2,0	V
Switching times (between 10% and 90% levels)				
$-I_{Con}$ = 20 A; $-I_{Bon} = I_{Boff}$ = 80 mA				
turn-on time	t_{on}	typ.	1	μs
turn-off time	t_{off}	typ.	3,5	μs

DEVELOPMENT SAMPLE DATA

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

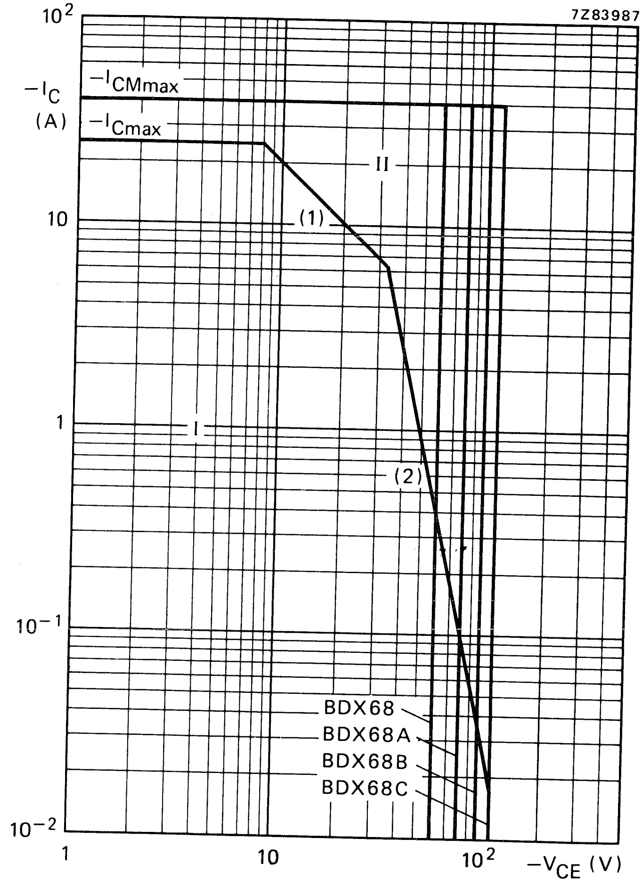


Fig. 3 Safe Operating ARea.

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 Darlingtons 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

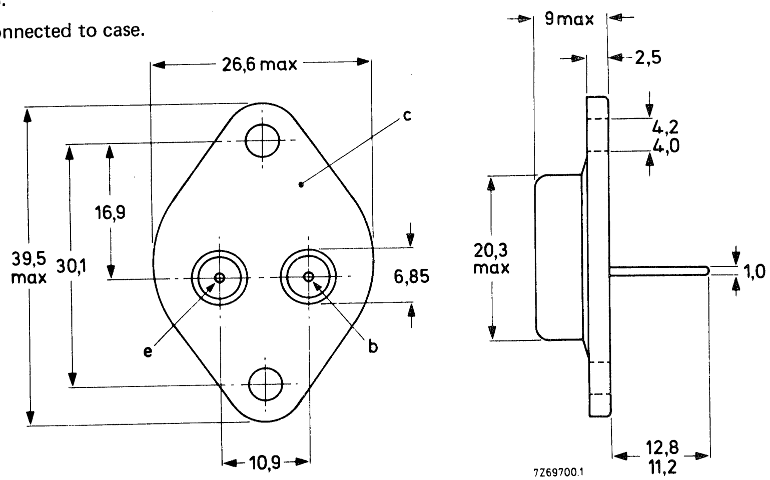
			BDX69	69A	69B	69C	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.	40				A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	200				W
Junction temperature	T_j	max.	200				°C
D.C. current gain I_C = 5 A; V_{CE} = 3 V	h_{FE}	typ.	3000				
I_C = 20 A; V_{CE} = 3 V	h_{FE}	>	1000				
Cut-off frequency I_C = 10 A; V_{CE} = 3 V	f_{hfe}	typ.	50				kHz

MECHANICAL DATA

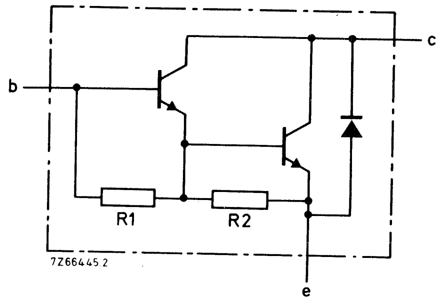
Dimensions in mm

Fig. 1 TO.3.

Collector connected to case.



See also chapters Mounting Instructions and Accessories in l.f. power transistor handbook.



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 °C	P_{tot}	max.	200	W
Storage temperature	T_{stg}		−65 to + 200	°C
Junction temperature*	T_j	max.	200	°C

THERMAL RESISTANCE*

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	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 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	2	mA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 200 °C	I_{CBO}	<	10	mA
$I_B = 0$; $V_{CE} = ½V_{CEOmax}$	I_{CEO}	<	6	mA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	10	mA
D.C. current gain*				
I_C = 5 A; V_{CE} = 3 V	h_{FE}	typ.	3000	
I_C = 20 A; V_{CE} = 3 V	h_{FE}	>	1000	
I_C = 30 A; V_{CE} = 3 V	h_{FE}	typ.	4000	
Base-emitter voltage*				
I_C = 20 A; V_{CE} = 3 V	V_{BE}	<	2,5	V
Collector-emitter saturation voltage*				
I_C = 20 A; I_B = 80 mA	V_{CEsat}	<	2	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	600	pF
Cut-off frequency				
I_C = 10 A; V_{CE} = 3 V	f_{hfe}	typ.	50	kHz
Small-signal current gain				
I_C = 10 A; V_{CE} = 3 V; f = 1 MHz	h_{fe}	typ.	20	
Diode, forward voltage				
I_F = 20 A	V_F	typ.	2,5	V
Switching times (between 10% and 90% levels)				
I_{Con} = 20 A; $I_{Bon} = -I_{Boff}$ = 80 mA				
turn-on time	t_{on}	typ.	1	μs
turn-off time	t_{off}	typ.	3,5	μs

DEVELOPMENT SAMPLE DATA

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

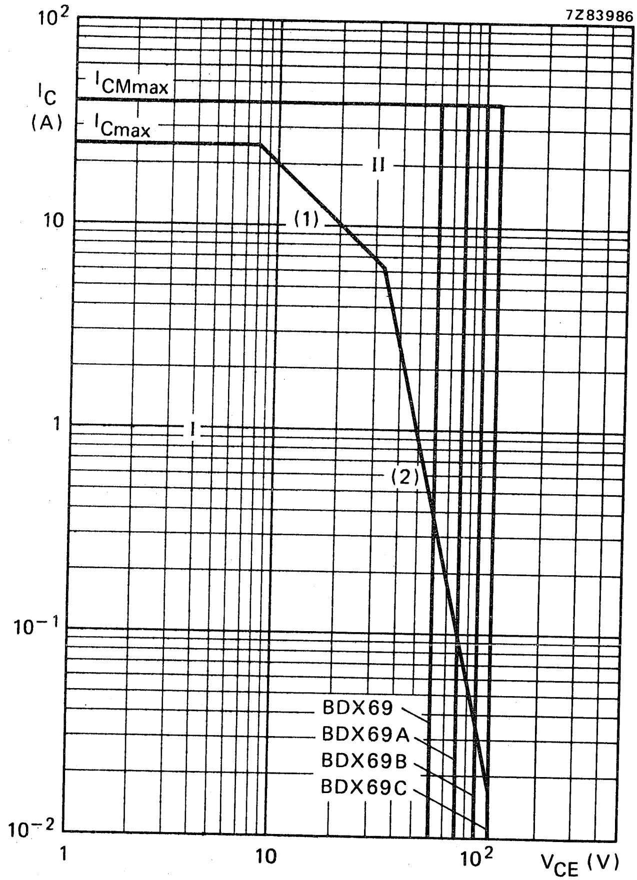


Fig. 3 Safe Operating ARea at T_{mb} = 25 °C.

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 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

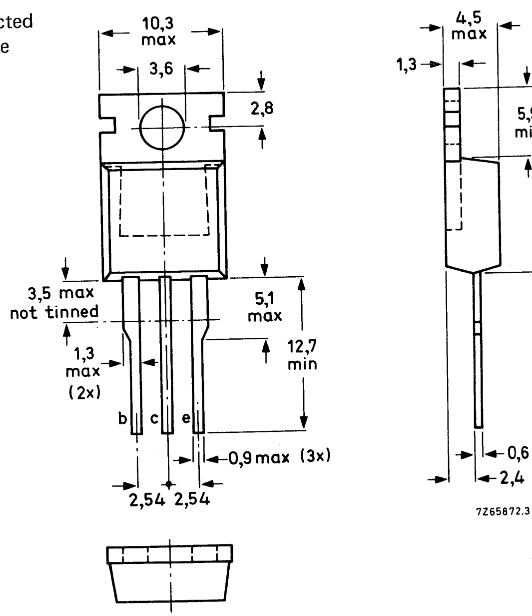
Collector-emitter voltage (open base)	V_{CEO}	max.	80	V
Collector-base voltage (open emitter)	V_{CBO}	max.	100	V
Collector current (d.c.)	I_C	max.	8	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	60	W
D.C. current gain I_C = 2 A; V_{CE} = 2 V	h_{FE}	>	30	
Cut-off frequency I_C = 0,3 A; V_{CE} = 3 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_{CBO}	max.	100 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, $t_p \leqslant 10$ ms)	I_{CM}	max.	12 A
Collector current (surge) ($t_p \leqslant 2$ 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	$R_{th\ j\text{-}mb}$	=	2,08 K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	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
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 voltages			
$I_C = 2$ A; $I_B = 0{,}2$ A	V_{CEsat}	<	0,6 V
$I_C = 3$ A; $I_B = 0{,}3$ A	V_{CEsat}	<	1 V
$I_C = 6$ A; $I_B = 0{,}6$ A	V_{CEsat}	<	1,5 V
$I_C = 6$ A; $I_B = 0{,}6$ A	V_{BEsat}	<	2 V
D.C. current gain*			
$I_C = 2$ 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; $t_p \leqslant 300\ \mu s$; $\delta \leqslant 2\%$.

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 μs
Turn-off time	t_{off}	typ.	4 μs

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

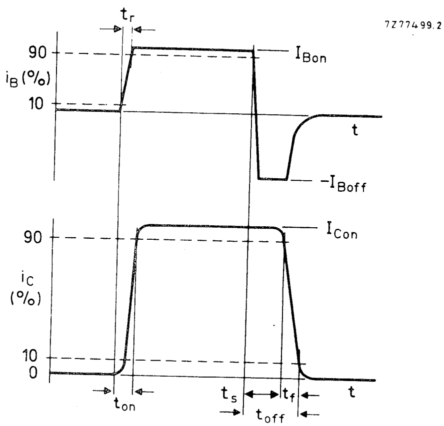


Fig. 2 Switching times waveforms.

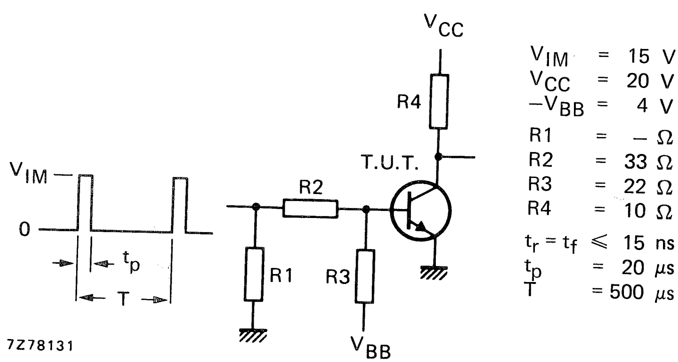


Fig. 3 Switching times test circuit.

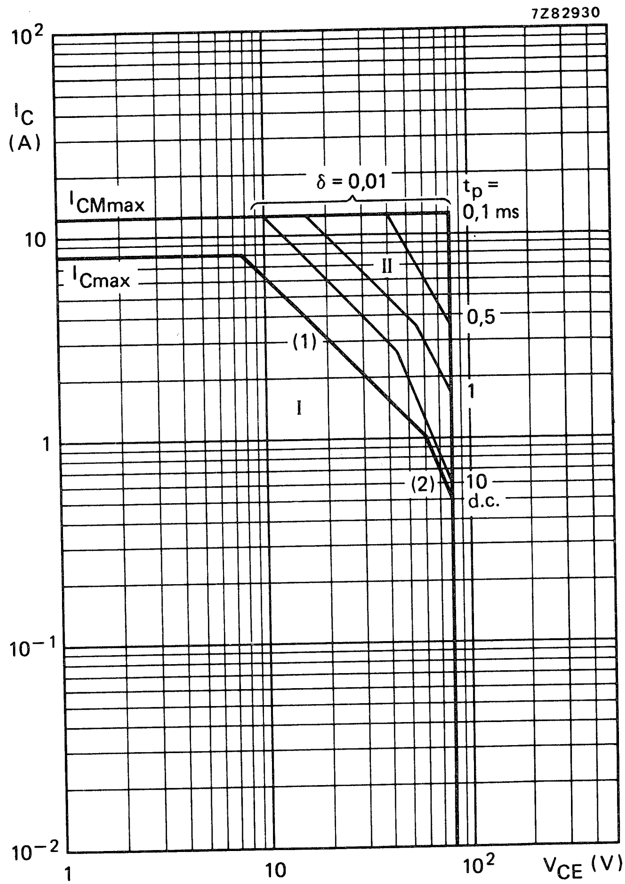


Fig. 4 Safe Operating ARea at $T_{mb} \leqslant 25\ ^{o}C$.

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).

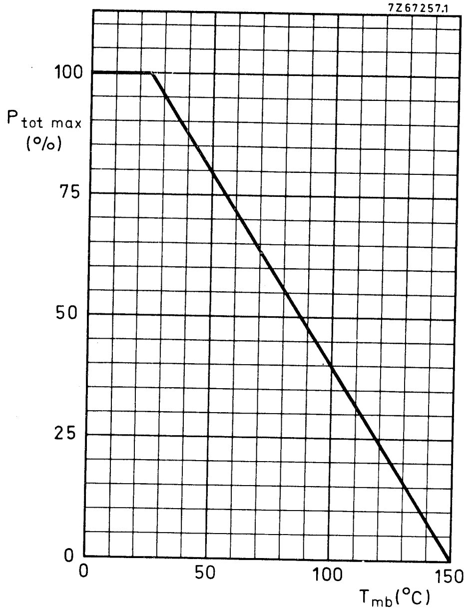


Fig. 5 Power derating curve.

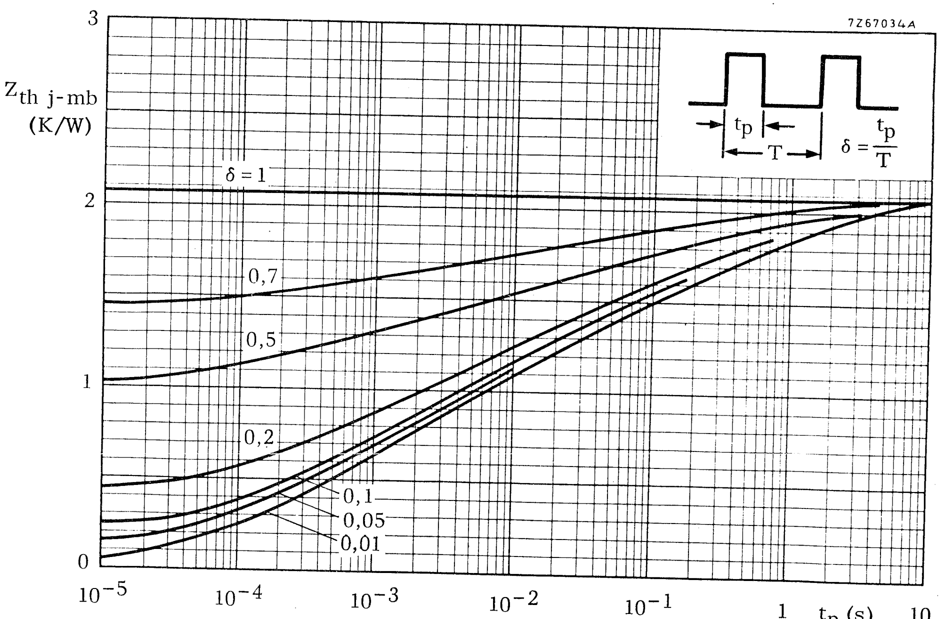


Fig. 6 Pulse power rating chart.

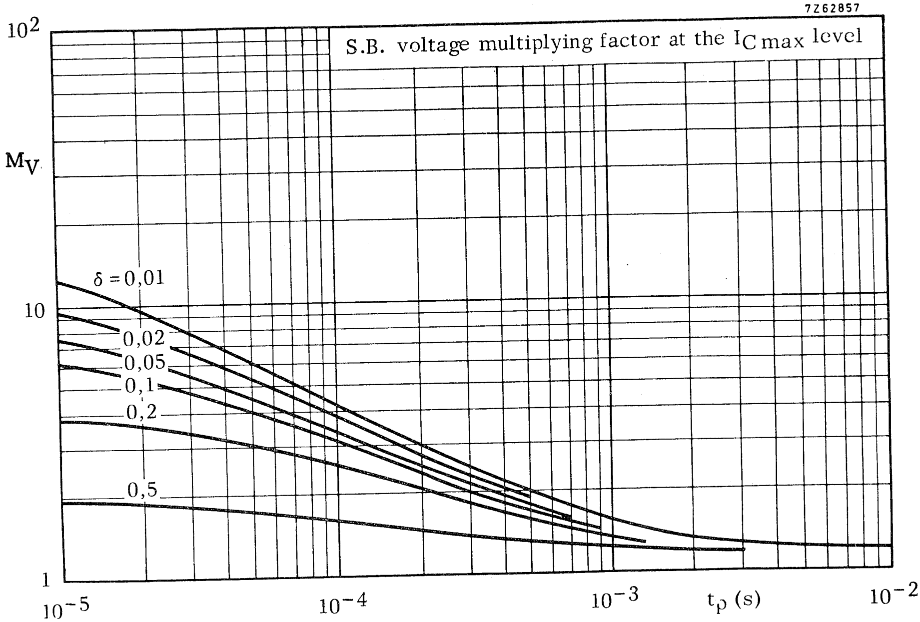


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

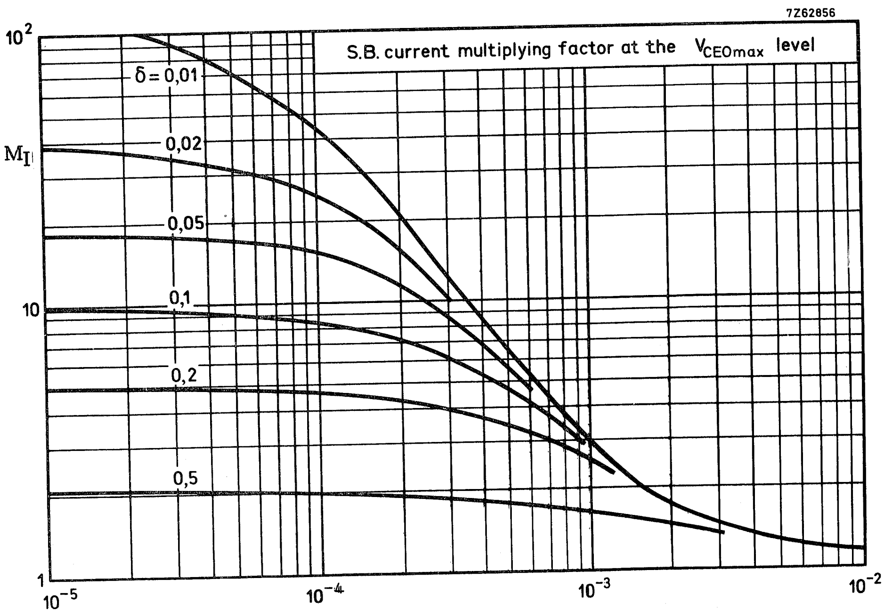


Fig. 8 S.B. current multiplying factor at the V_{CEOmax} level.

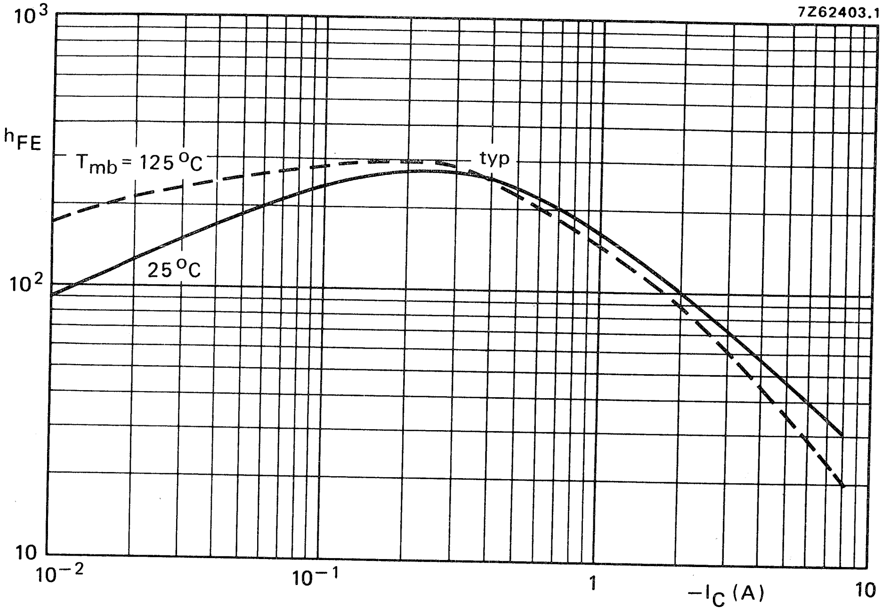


Fig. 9 D.C. current gain at V_{CE} = 2 V.

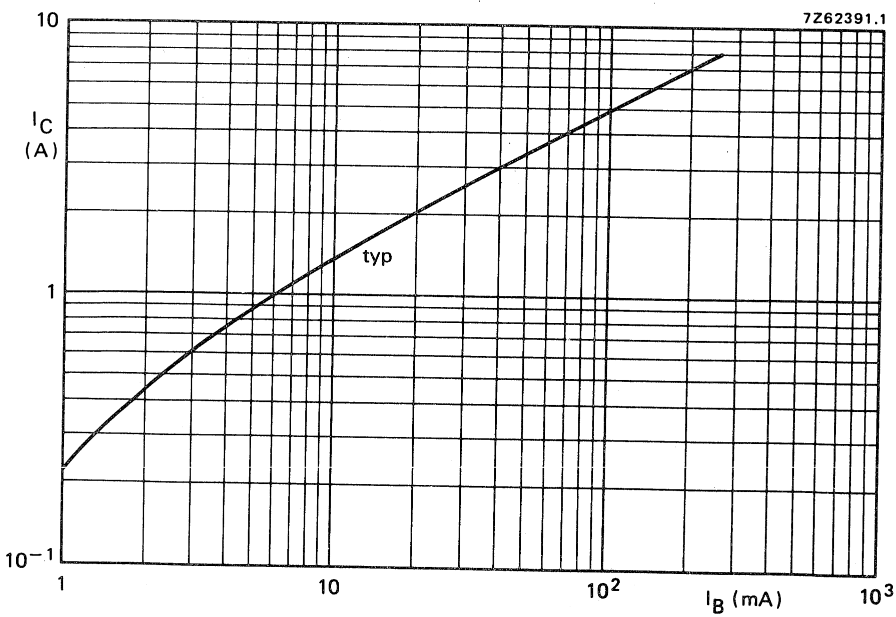


Fig. 10 Typical collector current. T_j = 25 °C; V_{CE} = 2 V.

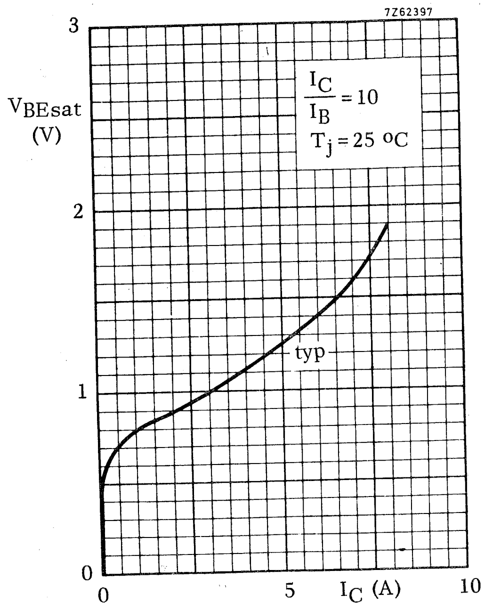


Fig. 11 Base-emitter saturation voltage.

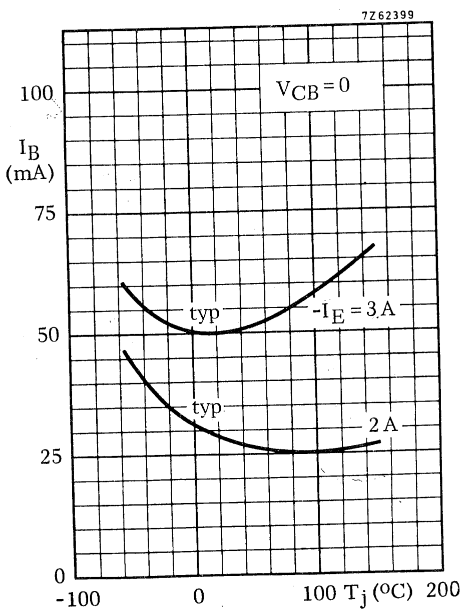


Fig. 12 Base current.

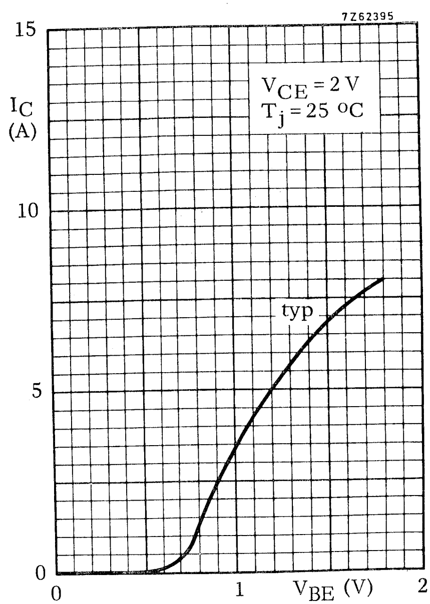


Fig. 13 Collector current.

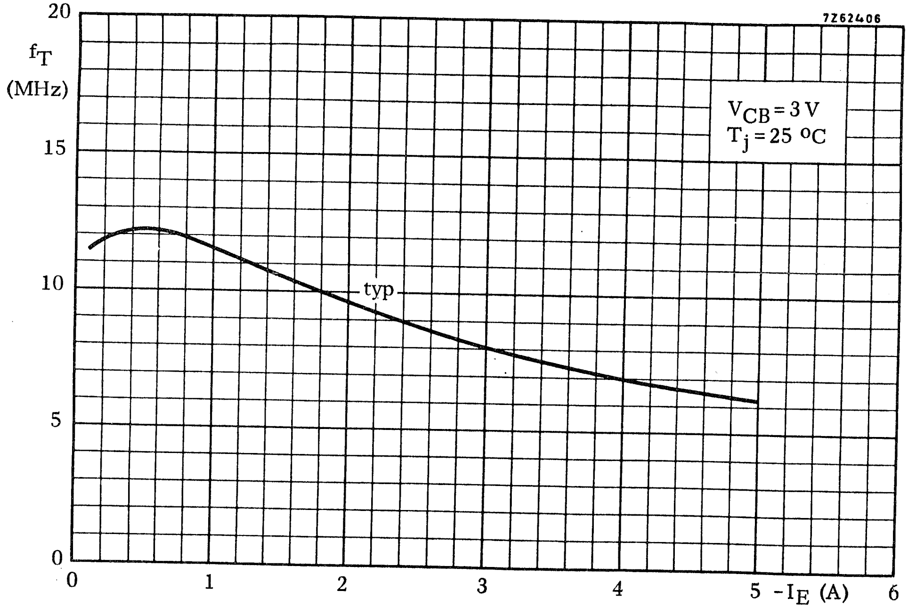


Fig. 14 Typical values transition frequency at $V_{CB} = 3$ V; $T_j = 25$ °C.

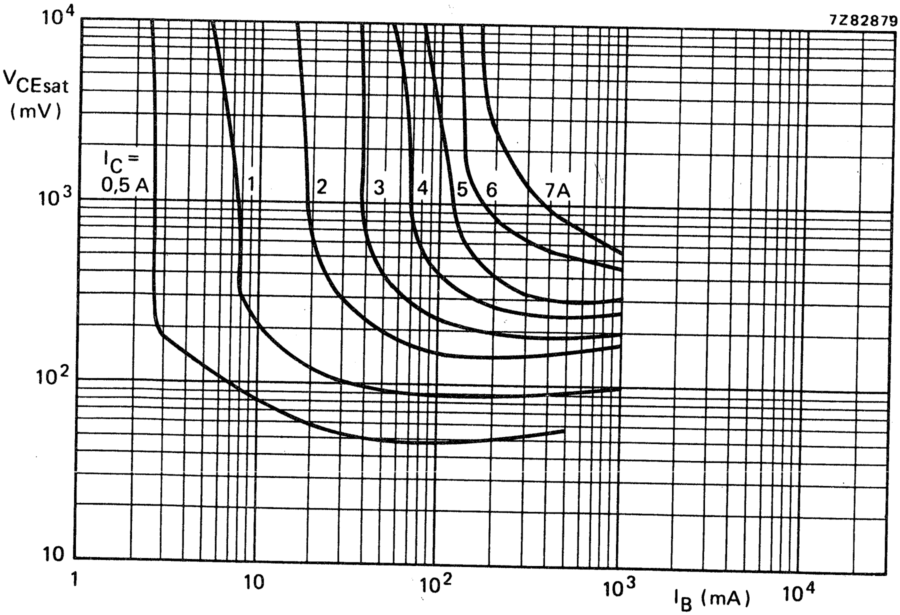


Fig. 15 Typical values collector-emitter saturation voltage at $T_j = 25$ °C.

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

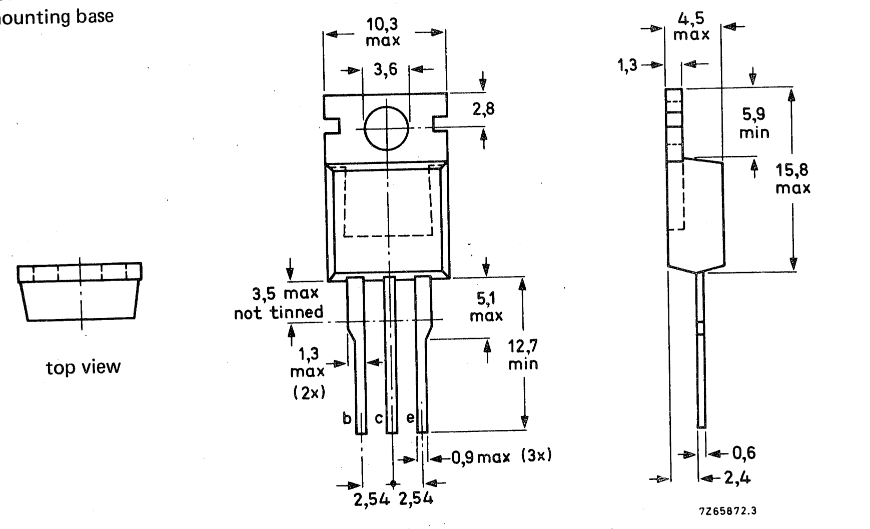
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	80 V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80 V
Collector current (d.c.)	$-I_C$	max.	8 A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	60 W
D.C. current gain $-I_C$ = 2 A; $-V_{CE}$ = 2 V	h_{FE}	>	30
Cut-off frequency $-I_C$ = 0,3 A; $-V_{CE}$ = 3 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, $t_p \leqslant 10$ ms)	$-I_{CM}$	max.	12 A
Collector current (surge) $t_p \leqslant 2$ 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	$R_{th\ j\text{-}mb}$	=	2,08 K/W
From junction to mounting base in free air	$R_{th\ j\text{-}a}$	=	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
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	$-V_{CEsat}$	<	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: $t_p < 300\ \mu s$, $\delta < 2\%$.

Collector-emitter breakdown voltage* $-I_C = 0{,}2$ A; $I_B = 0$	$V_{(BR)CEO}$	>	80 V
D.C. current gain* $-I_C = 2$ A; $-V_{CE} = 2$ V	h_{FE}	>	30
Cut-off frequency $-I_C = 0{,}3$ A; $-V_{CE} = 3$ V	f_{hfe}	>	25 kHz
Transition frequency at f = 1 MHz $-I_E = 0{,}3$ A; $-V_{CB} = 3$ V	f_T	>	7 MHz ←
Forward bias second-breakdown collector current $-V_{CE} = 50$ V; $t_p = 0{,}1$ s; $T_{amb} = 25$ °C	$I_{(SB)}$	>	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 µs
turn-off time	t_{off}	typ.	2 µs

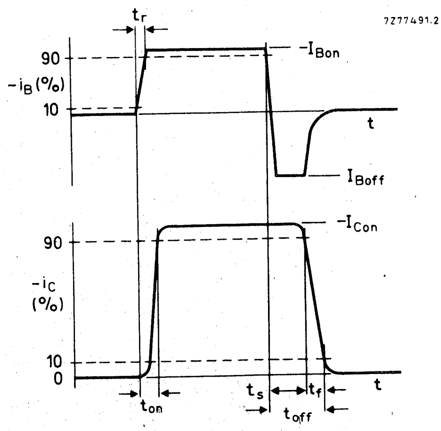


Fig. 2 Switching times waveforms.

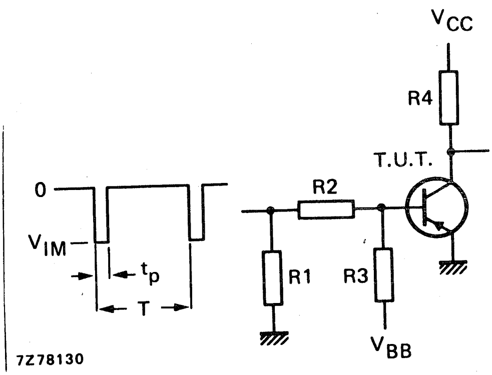


Fig. 3 Switching times test circuit.

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

* Measured under pulse conditions $t_p \leqslant 300$ µs; $\delta \leqslant 2\%$.

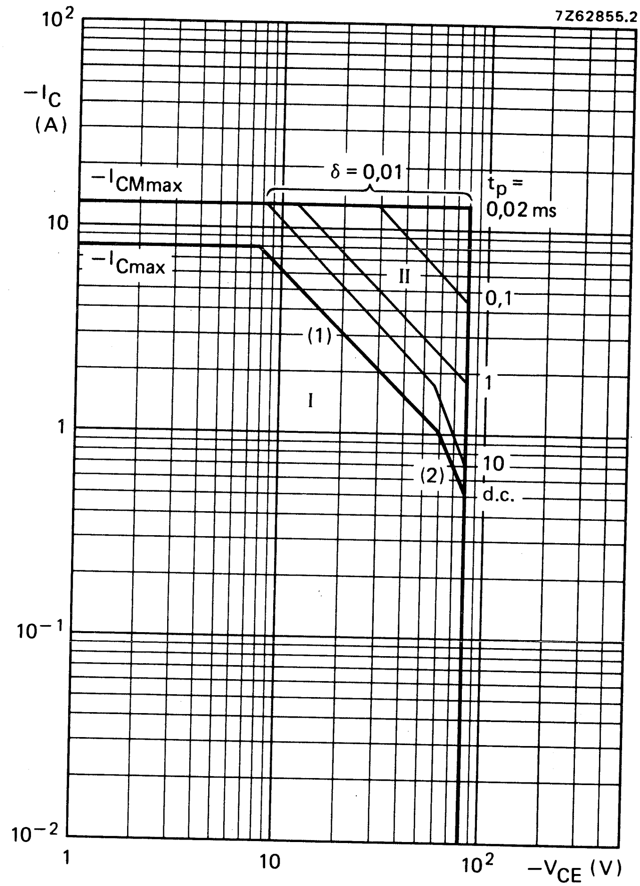


Fig. 4 Safe Operating ARea at $T_{mb} \leqslant 25$ °C.

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).

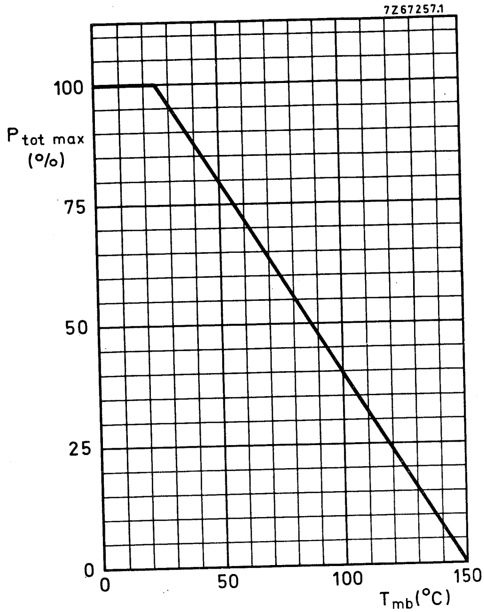


Fig. 5 Power derating curve.

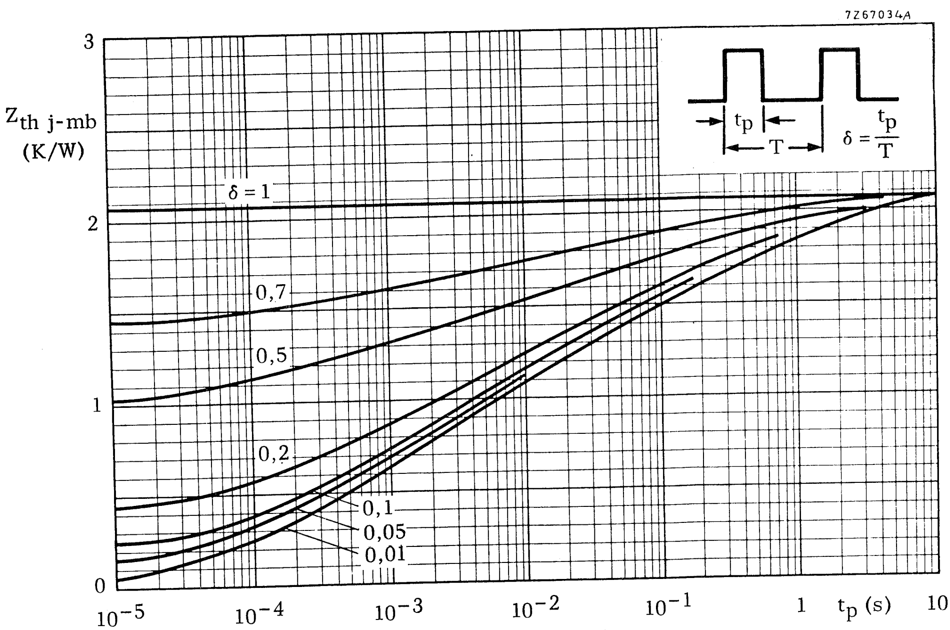


Fig. 6 Pulse power rating chart.

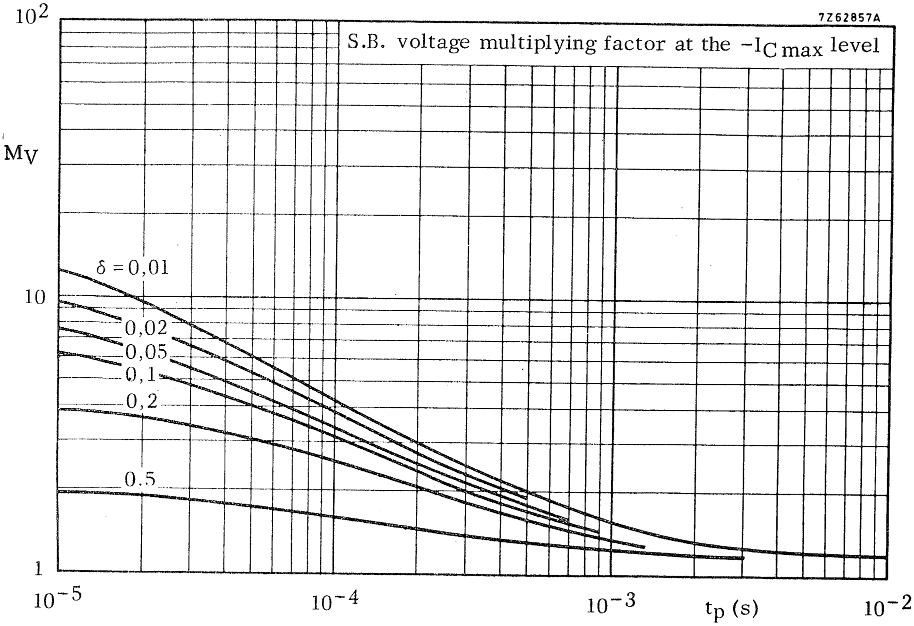


Fig. 7 S.B. voltage multiplying factor at the $-I_{C\,max}$ level.

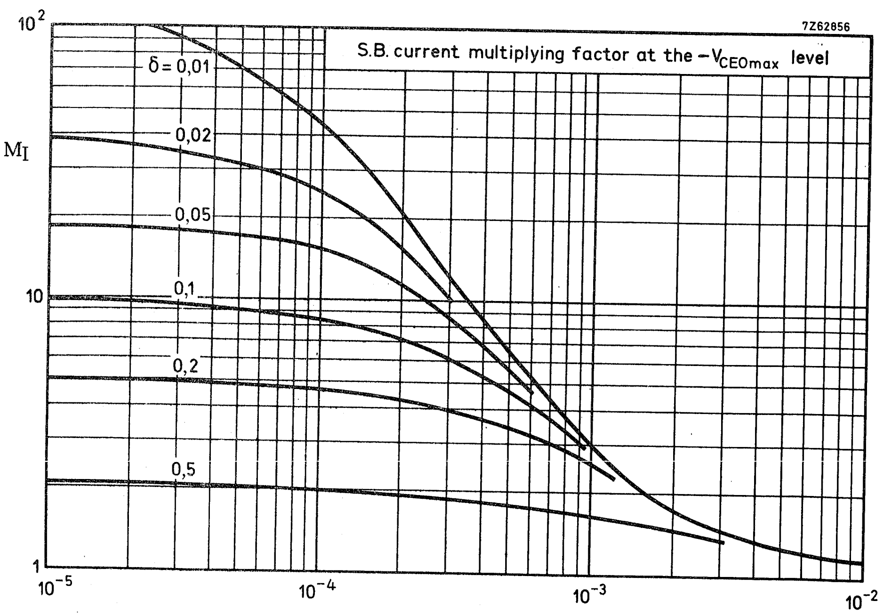


Fig. 8 S.B. current multiplying factor at the $-V_{CEO\,max}$ level.

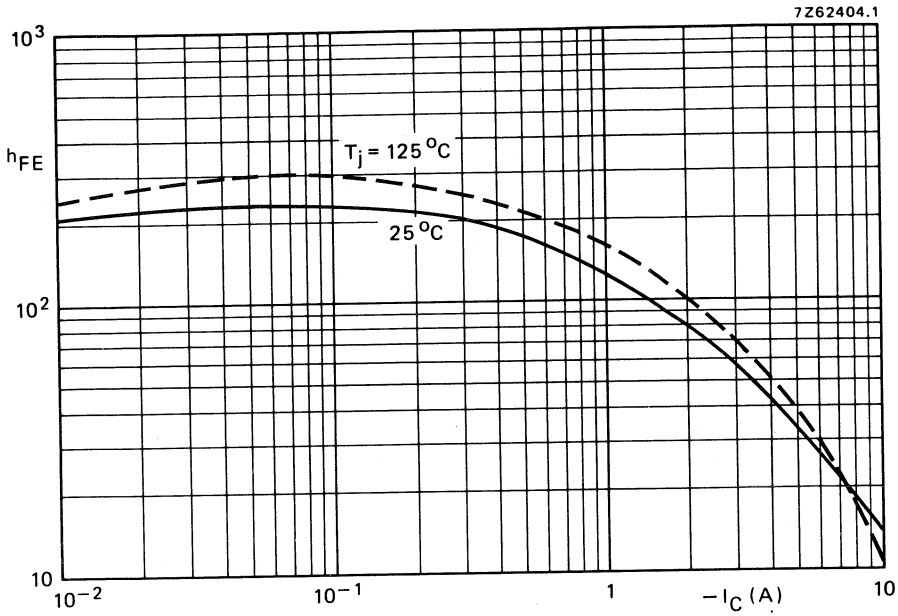


Fig. 9 D.C. current gain at $-V_{CE} = 2$ V.

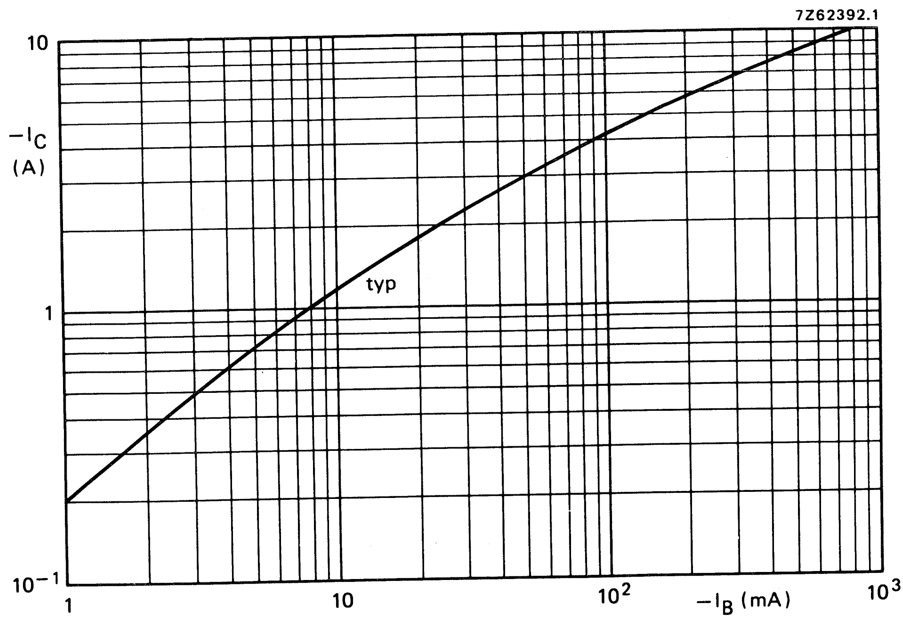


Fig. 10 Typical values collector current. $-V_{CE} = 2$ V; $T_j = 25\ ^oC$.

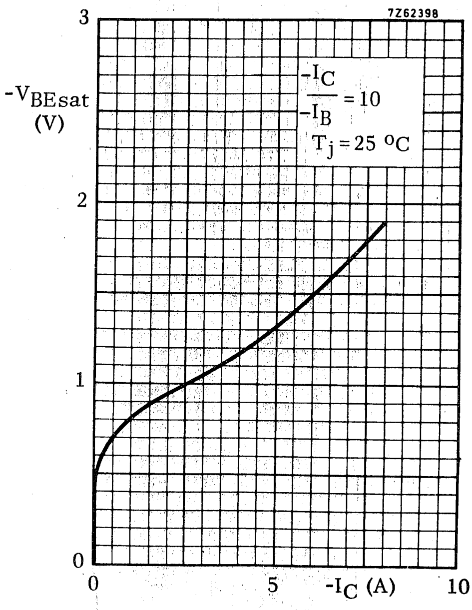


Fig. 11 Base-emitter saturation voltage.

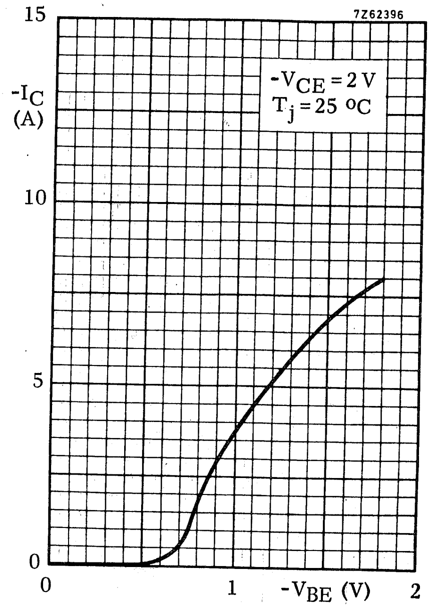


Fig. 12 Collector current.

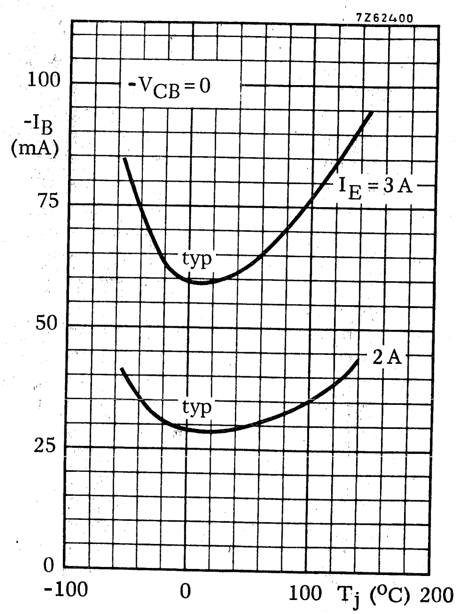


Fig. 13.

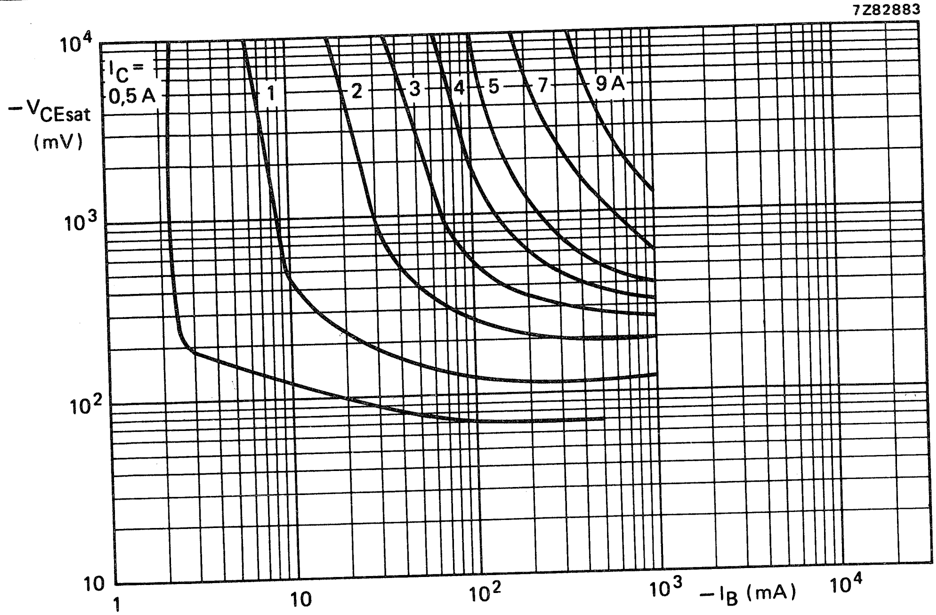


Fig. 14 Typical values collector-emitter saturation voltage at T_j = 25 °C.

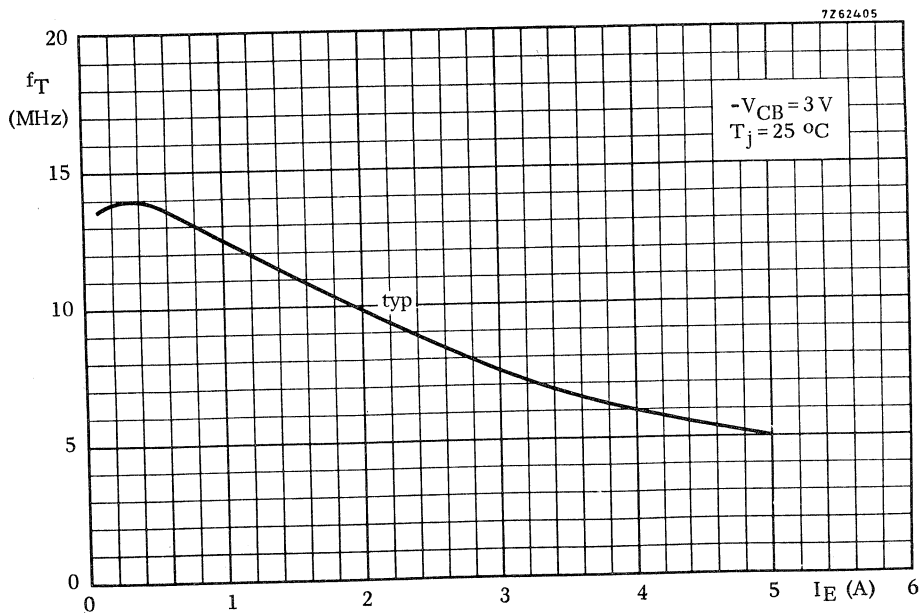


Fig. 15.

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

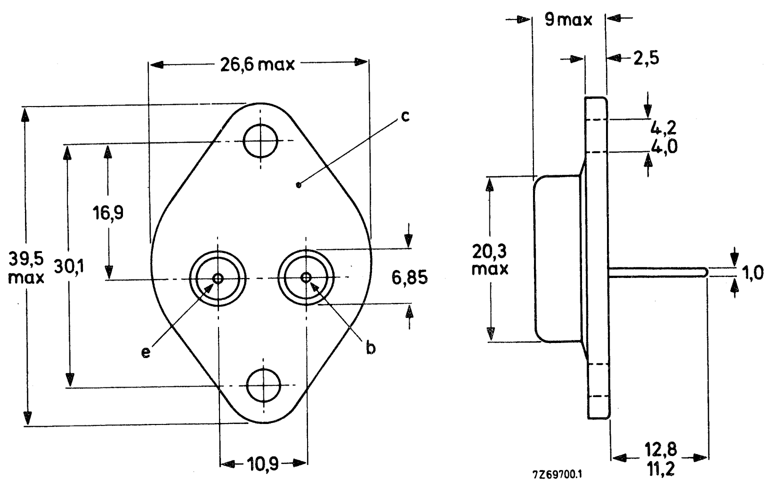
			BDX91	BDX93	BDX95	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	V
Collector current (peak value)	I_{CM}	max.		12		A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		90		W
Junction temperature	T_j	max.		200		^oC
D.C. current gain $I_C = 3$ A; $V_{CE} = 2$ V	h_{FE}	>		20		
Transition frequency $I_C = 1$ A; $V_{CE} = 10$ 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 °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	$R_{th\ j\text{-}mb}$	=	1,94	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<	0,1	mA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; T_j = 200 °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 V	I_{EBO}	<	1	mA
D.C. current gain*				
I_C = 3 A; V_{CE} = 2 V	h_{FE}	>	20	
I_C = 5 A; V_{CE} = 2 V	h_{FE}	>	10	
Base-emitter voltage*				
I_C = 3 A; V_{CE} = 2 V	V_{BE}	<	1,4	V
Collector-emitter saturation voltage*				
I_C = 3 A; I_B = 0,3 A	V_{CEsat}	<	0,8	V
I_C = 5 A; I_B = 1 A	V_{CEsat}	<	1	V
Base-emitter saturation voltage*				
I_C = 3 A; I_B = 0,3 A	V_{BEsat}	<	1,5	V
I_C = 5 A; I_B = 1 A	V_{BEsat}	<	2	V

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

Small-signal current gain at f = 1 kHz I_C = 0,5 A; V_{CE} = 10 V	h_{fe}	>		40		
Transition frequency I_C = 1 A; V_{CE} = 10 V	f_T	>		4		MHz
			BDX91	BDX93	BDX95	
Collector-emitter breakdown voltage* I_C = 100 mA	$V_{(BR)CEO}$	>	60	80	100	V
Switching times (between 10% and 90% levels) I_{Con} = 3 A; I_{Bon} = $-I_{Boff}$ = 0,3 A						
Turn-on time	t_{on}	typ.		0,2		μs
		<		1		μs
Turn-off time	t_{off}	typ.		1,2		μs
		<		2		μs

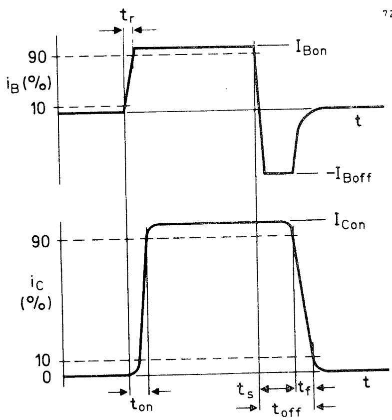
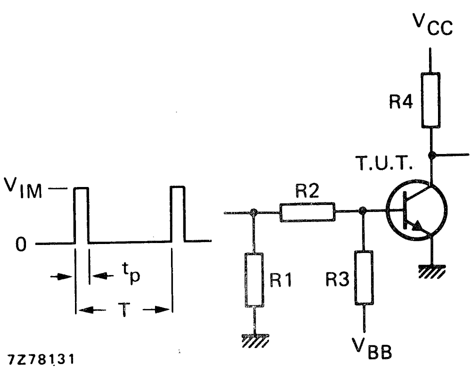


Fig. 2 Switching times waveforms.



V_{IM} = 55 V
V_{CC} = 30 V
$-V_{BB}$ = 5 V
R1 = 150 Ω
R2 = 82 Ω
R3 = 20 Ω
R4 = 10 Ω
$t_r = t_f \leqslant$ 15 ns
t_p = 10 μs
T = 500 μs

Fig. 3 Switching times test circuit.

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

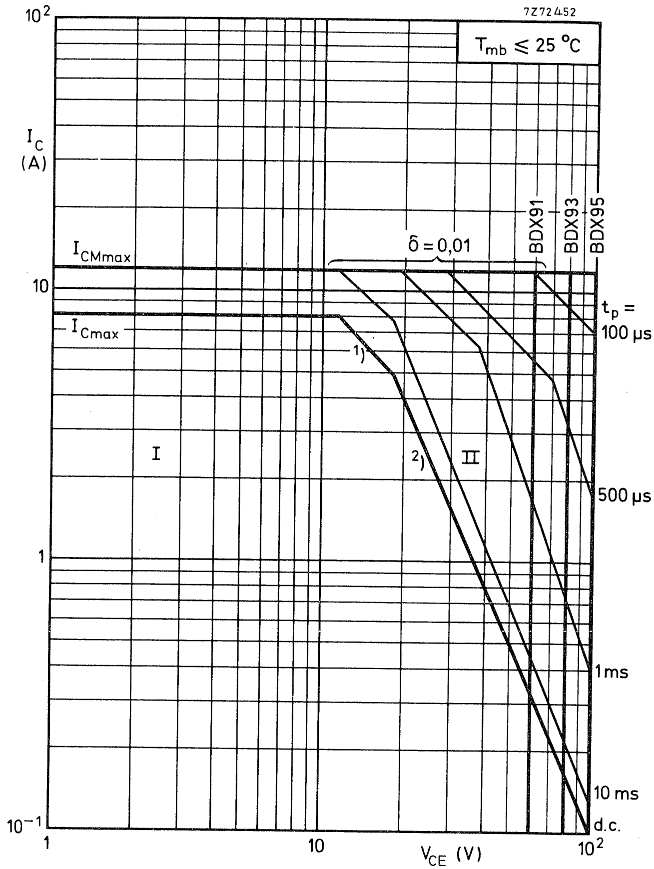


Fig. 4 Safe Operating ARea at $T_{mb} \leqslant 25$ °C.

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).

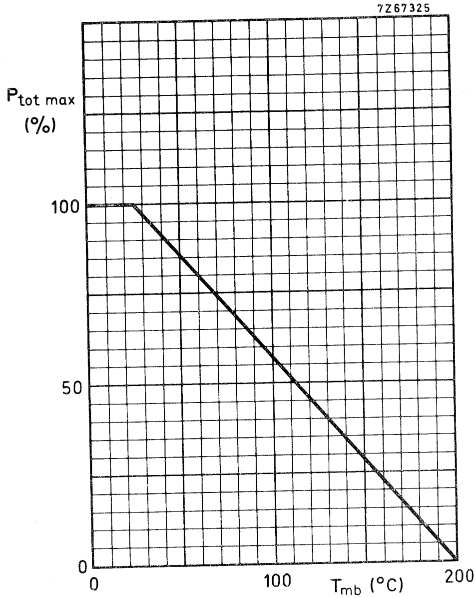


Fig. 5 Power derating curve

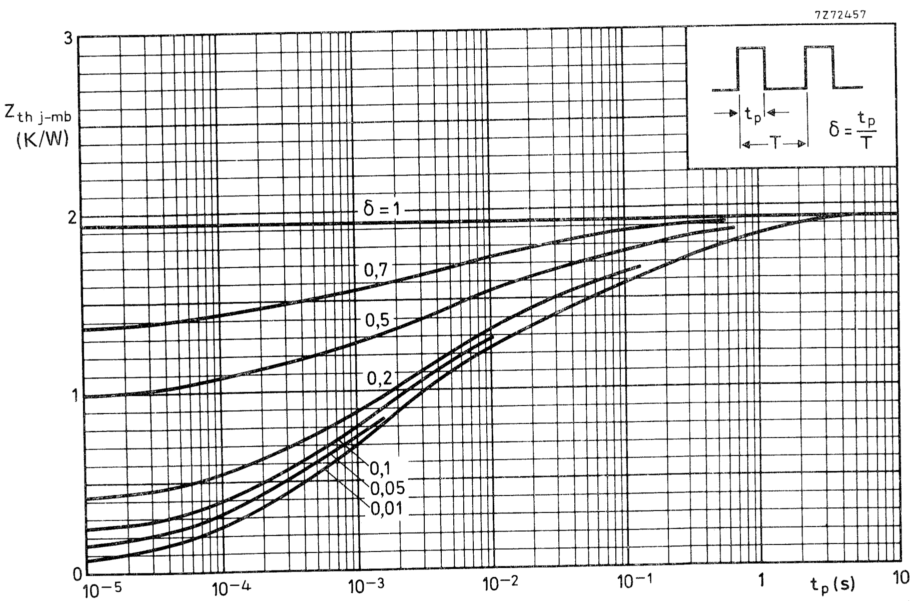


Fig. 6 Pulse power rating chart.

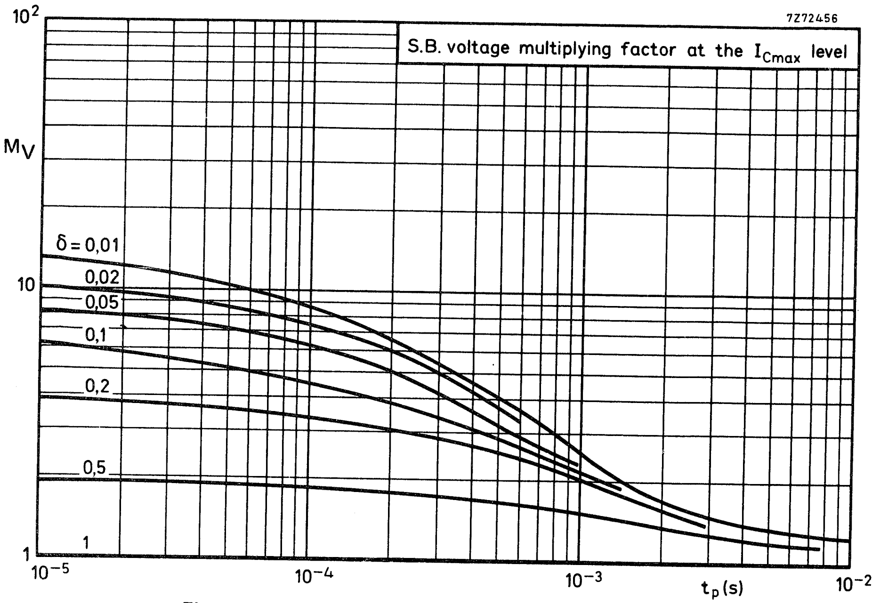


Fig. 7 S.B. voltage multiplying factor at the I_{Cmax} level.

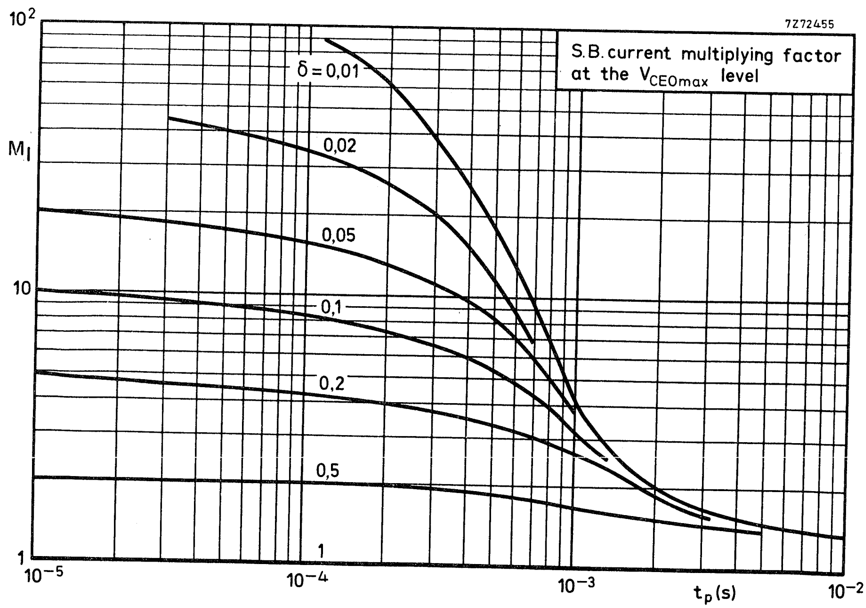


Fig. 8 S.B. current multiplying factor at the V_{CEOmax} level.

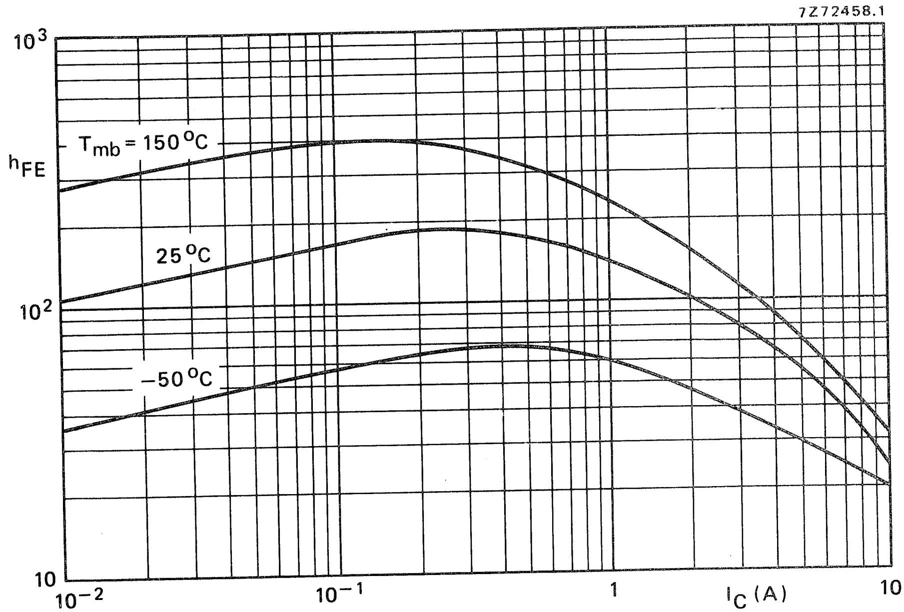


Fig. 9 D.C. current gain at V_{CE} = 2 V; T_j = 25 °C.

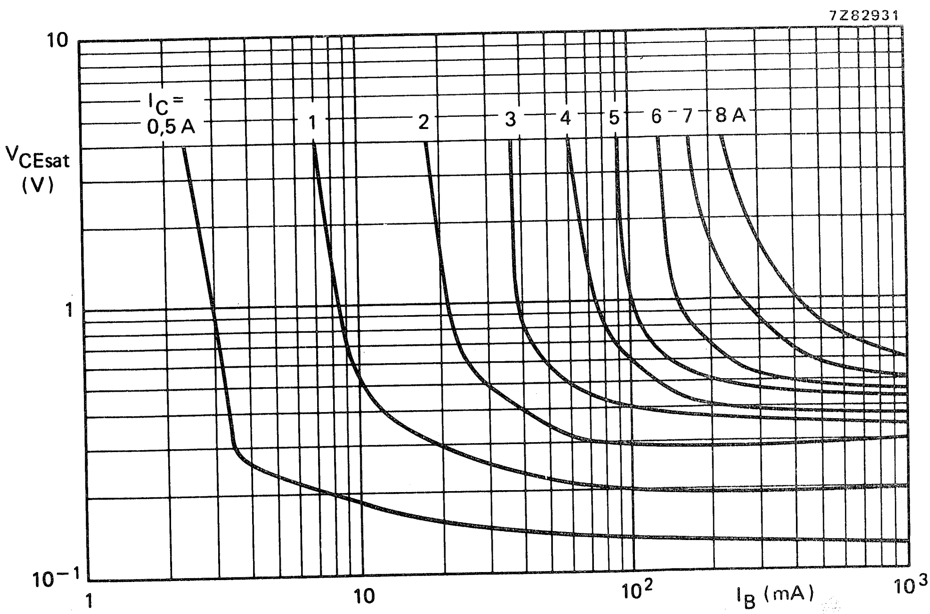


Fig. 10 Typical values collector-emitter saturation voltage.

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.

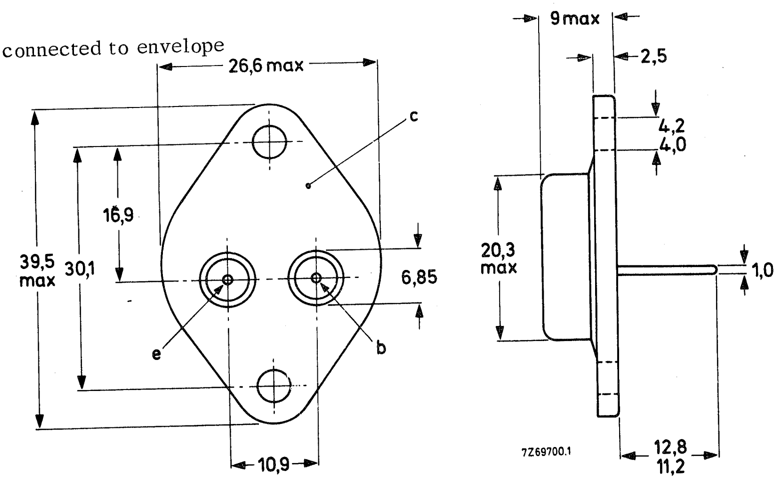
QUICK REFERENCE DATA

			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 $T_{mb} = 25\ ^oC$	P_{tot}	max.		90		W
Junction temperature	T_j	max.		200		^oC
D.C. current gain $-I_C = 3$ A; $-V_{CE} = 2$ V	h_{FE}	>		20		
Transition frequency $-I_C = 1$ A; $-V_{CE} = 10$ V	f_T	>		4		MHz

MECHANICAL DATA

Dimensions in mm

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)

Voltages

			BDX92	BDX94	BDX96	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V

Currents

Collector current (d.c.)	$-I_C$	max.	8	A
Collector current (peak value)	$-I_{CM}$	max.	12	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	90	W

Temperatures

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0, 1	mA
$I_E = 0$; $-V_{CB} = 30$ V; $T_j = 200$ °C: BDX92 $I_E = 0$; $-V_{CB} = 40$ V; $T_j = 200$ °C: BDX94 $I_E = 0$; $-V_{CB} = 50$ V; $T_j = 200$ °C: BDX96	$-I_{CBO}$	<	2	mA
$I_B = 0$; $-V_{CE} = -V_{CEOmax}$	$-I_{CEO}$	<	1	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	1	mA
D.C. current gain [1]				
$-I_C = 3$ A; $-V_{CE} = 2$ V	h_{FE}	>	20	
$-I_C = 5$ A; $-V_{CE} = 2$ V	h_{FE}	>	10	
Base-emitter voltage [1]				
$-I_C = 3$ A; $-V_{CE} = 2$ V	$-V_{BE}$	<	1, 4	V
Collector-emitter saturation voltage [1]				
$-I_C = 3$ A; $-I_B = 0,3$ A	$-V_{CEsat}$	<	0, 8	V
$-I_C = 5$ A; $-I_B = 1$ A	$-V_{CEsat}$	<	1	V
Base-emitter saturation voltage [1]				
$-I_C = 3$ A; $-I_B = 0,3$ A	$-V_{BEsat}$	<	1, 5	V
$-I_C = 5$ A; $-I_B = 1$ A	$-V_{BEsat}$	<	2	V
Small-signal current gain at f = 1 kHz				
$-I_C = 0,5$ A; $-V_{CE} = 10$ V	h_{fe}	>	40	
Transition frequency				
$-I_C = 1$ A; $-V_{CE} = 10$ V	f_T	>	4	MHz

[1]) Measured under pulse conditions: $t_p < 300$ µs, $\delta < 2\%$.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

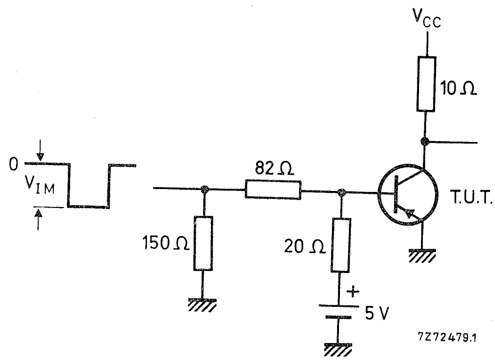
Switching times (between 10% and 90% levels)

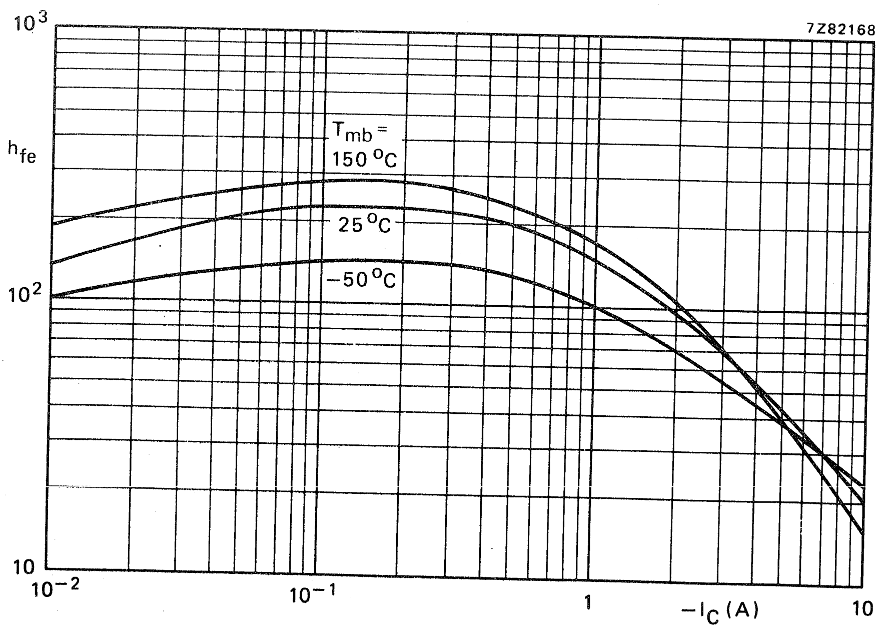
$-I_{Con}$ = 3 A; $-I_{Bon}$ = I_{Boff} = 0, 3 A; V_{CC} = −30 V

Turn-on time	t_{on}	typ.	0, 2	μs
		<	1	μs
Turn-off time	t_{off}	typ.	1	μs
		<	2	μs

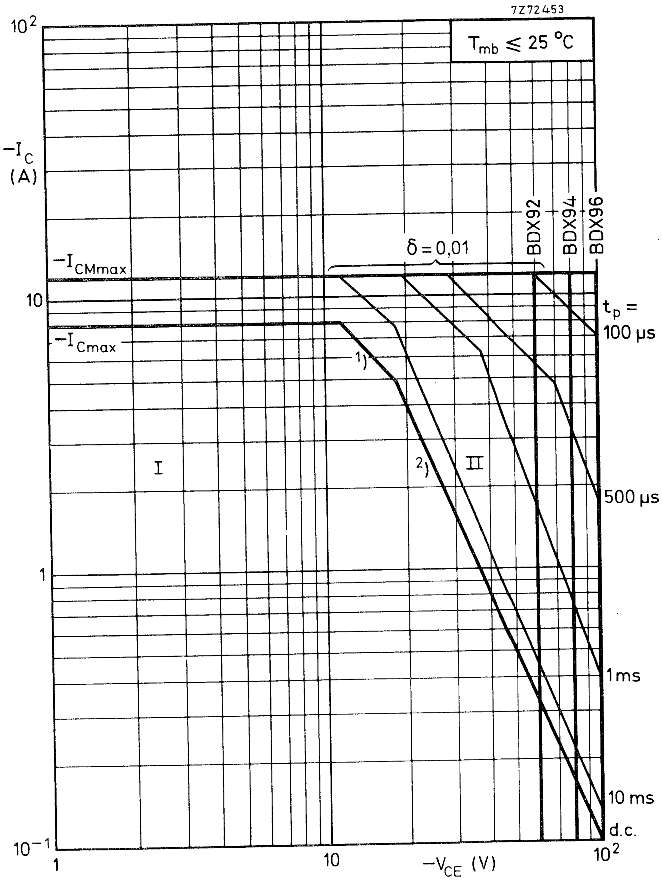
Test circuit

V_{IM} = 55 V
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs





Typical small-signal current gain as a function of collector current; $-V_{CE}$ = 2 V.



Safe Operating ARea with the transistor forward biased

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

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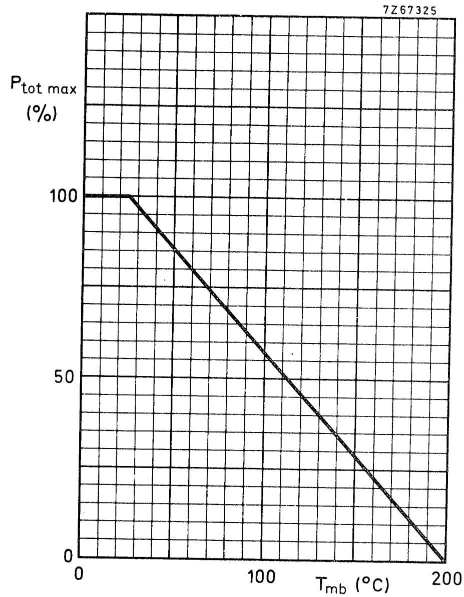
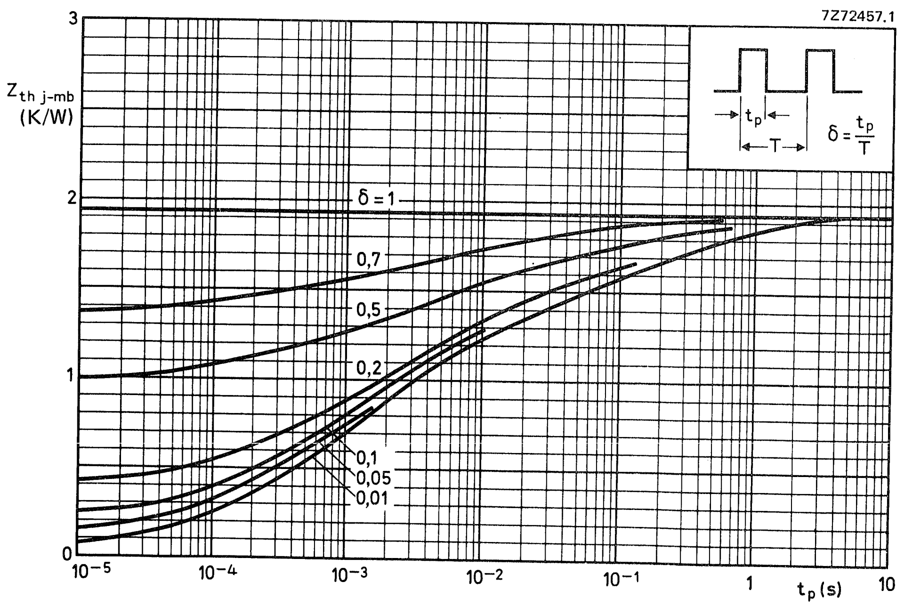
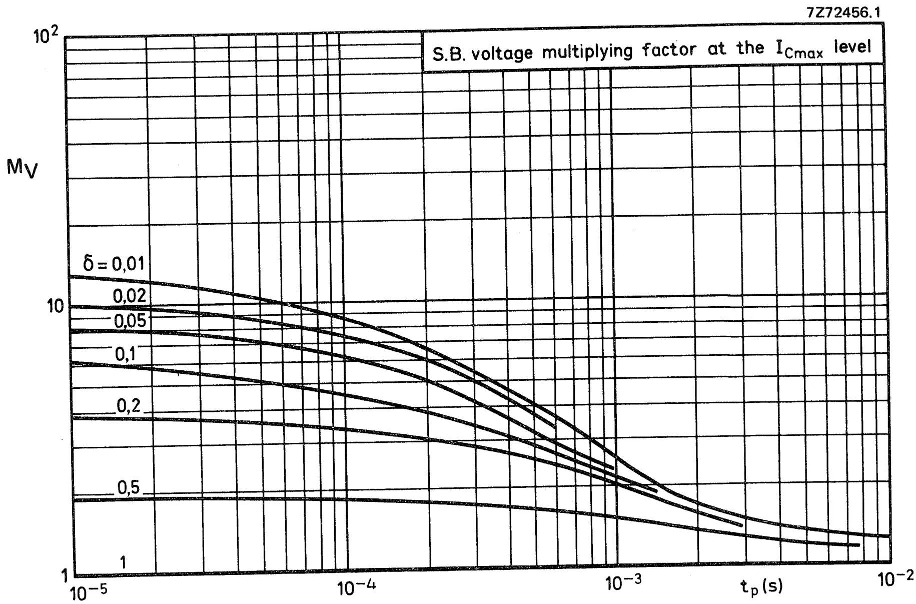
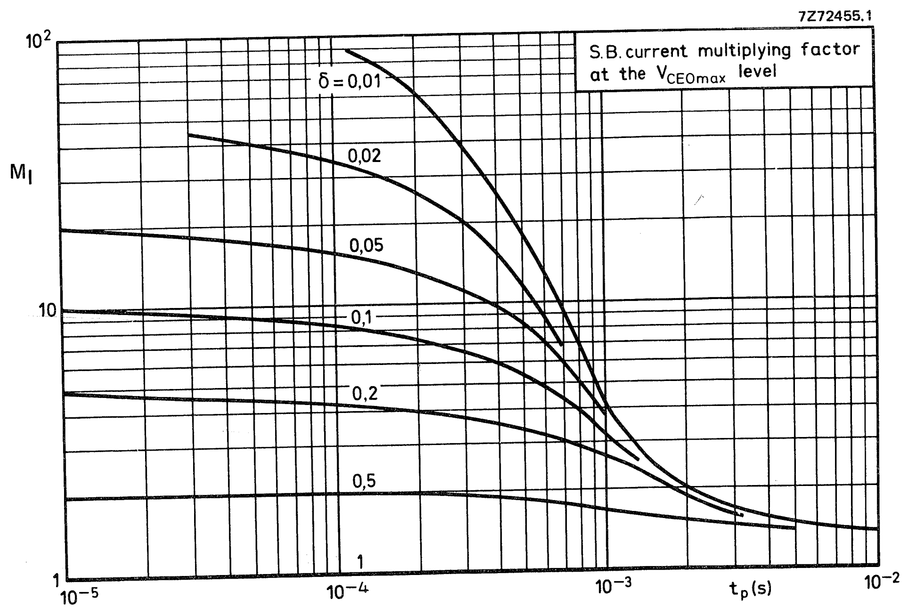
[1]) $P_{tot\ max}$ and $P_{peak\ max}$ lines.

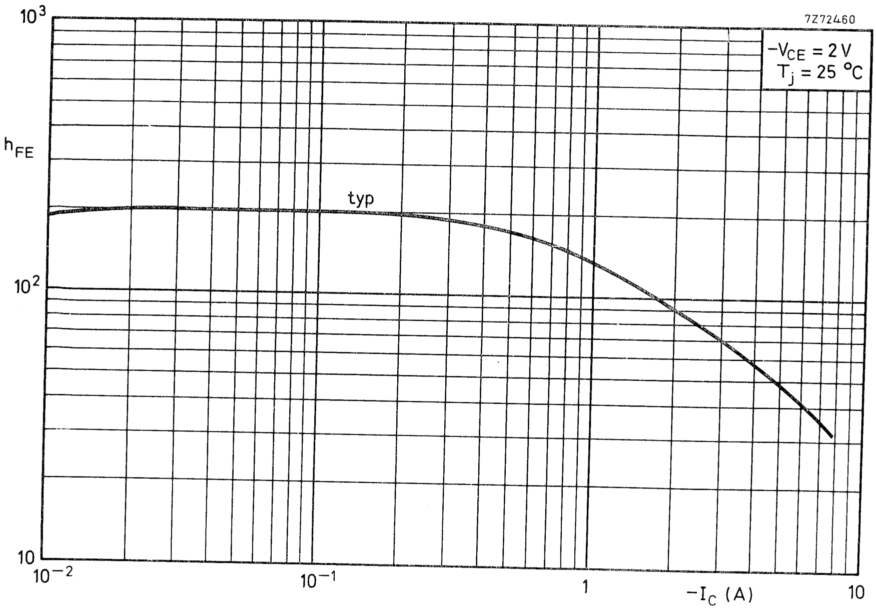
[2]) Second-breakdown limits (independent of temperature).

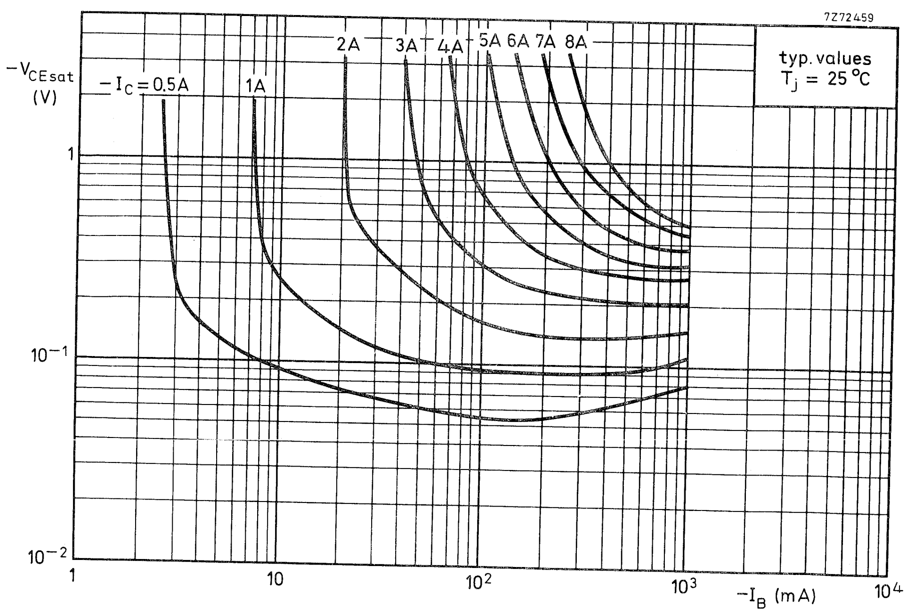

7Z67325
P tot max
(%)
100
50
0
0
100
T mb (°C)
200


7Z72457.1
Z th j-mb
(K/W)
3
2
1
0
t p
T
δ = t p / T
δ = 1
0,7
0,5
0,2
0,1
0,05
0,01
10⁻⁵
10⁻⁴
10⁻³
10⁻²
10⁻¹
1
t p (s)
10


7Z72456.1
S.B. voltage multiplying factor at the I_{Cmax} level
M_V
10^2
10
1
δ = 0,01
0,02
0,05
0,1
0,2
0,5
1
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}


7Z72455.1
S.B. current multiplying factor at the V_{CEOmax} level
M_I
10^2
10
1
δ = 0,01
0,02
0,05
0,1
0,2
0,5
1
10^{-5}
10^{-4}
10^{-3}
t_p (s)
10^{-2}


7Z72460
$-V_{CE}$ = 2 V
T_j = 25 °C
h_{FE}
typ
10^3
10^2
10
10^{-2}
10^{-1}
1
10
$-I_C$ (A)


7Z72459
typ. values
T_j = 25 °C
$-V_{CEsat}$ (V)
$-I_C$ = 0.5A
1A
2A
3A
4A
5A
6A
7A
8A
1
10^{-1}
10^{-2}
1
10
10^2
10^3
10^4
$-I_B$ (mA)

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

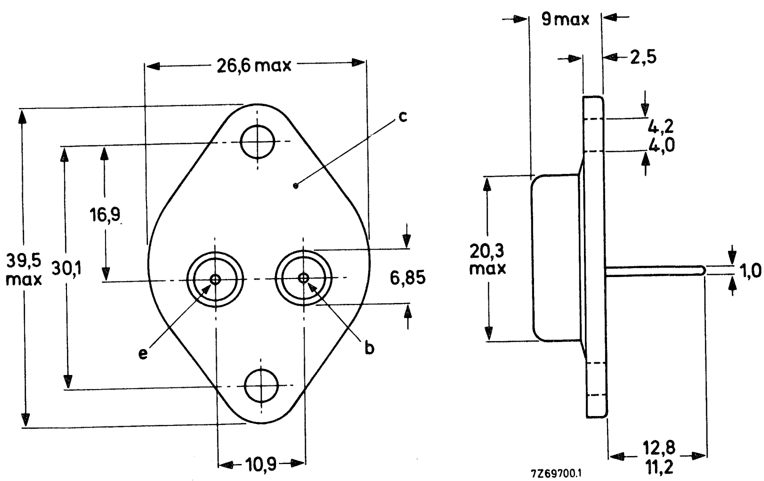
			BDY90	BDY91	BDY92	
Collector-base voltage (open emitter)	V_{CBO}	max.	120	100	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	100	80	60	V
Collector current (peak value)	I_{CM}	max.		15		A
Total power dissipation up to $T_{mb} = 70\ ^oC$	P_{tot}	max.		40		W
Collector-emitter saturation voltage $I_C = 10$ A; $I_B = 1$ A	V_{CEsat}	<		1		V
Fall time $I_C = 5$ A; $I_B = -I_{BM} = 0{,}5$ A; $V_{CC} = 30$ V	t_f	<		0,2		μs
Transition frequency at f = 5 MHz $I_C = 0{,}5$ A; $V_{CE} = 5$ 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	$R_{th\ j\text{-}mb}$	=	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};	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			
$I_C = 1$ A; $V_{CE} = 2$ V	h_{FE}	>	35
$I_C = 5$ A; $V_{CE} = 5$ V	h_{FE}		30 to 120
$I_C = 10$ 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			
$I_C = 5$ A; $I_B = -I_{BM} = 0{,}5$ A; $V_{CC} = 30$ V	t_{on}	<	0,35 μs
Turn off time			
$I_C = 5$ A; $I_B = -I_{BM} = 0{,}5$ A; $V_{CC} = 30$ V storage time	t_s	<	1,3 μs
fall time	t_f	<	0,2 μs

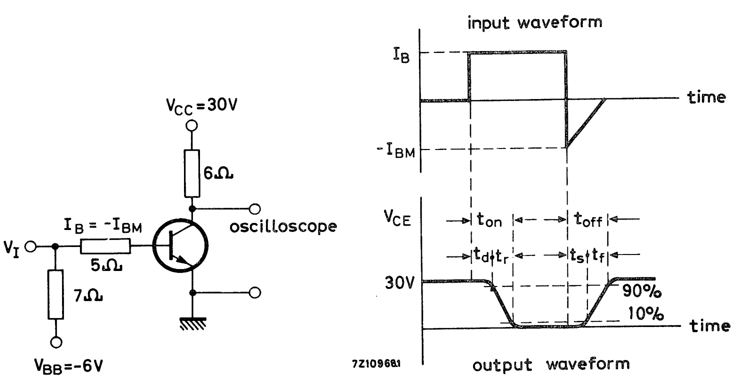


Fig. 2 Test circuit and waveforms.

Pulse generator:

Rise time	t_r	<	50 ns
Fall time	t_f	<	50 ns
Pulse duration	t_p	=	20 μs
Duty cycle	δ	=	0,02

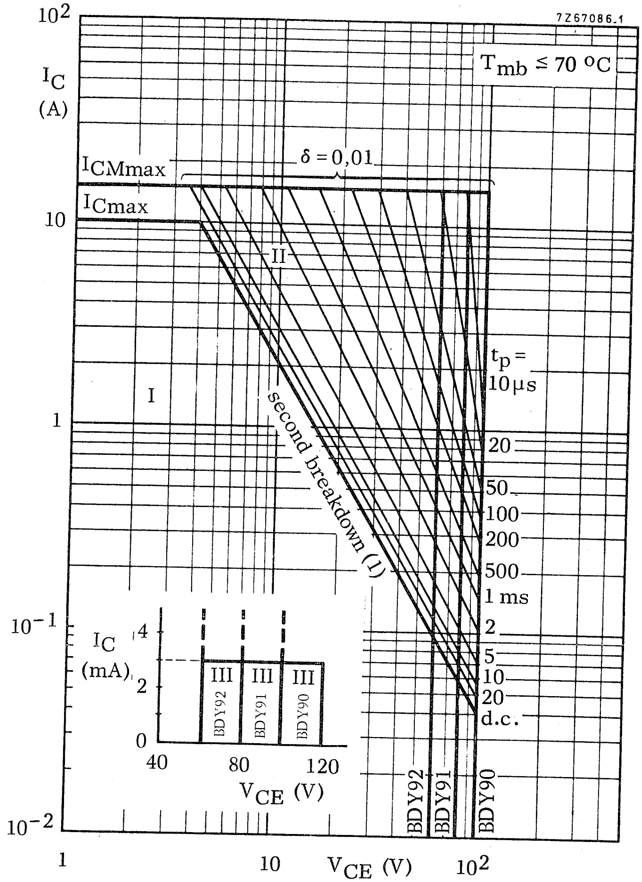


Fig. 3 Safe Operating ARea (Regions I and II forward biased).

I Region of permissible d.c. operation

II Permissible extension for repetitve pulse operation

III Repetitive pulse operation in this region is allowable, provided $-V_{BE} \geqslant 1{,}5$ V

(1) Independent of temperature

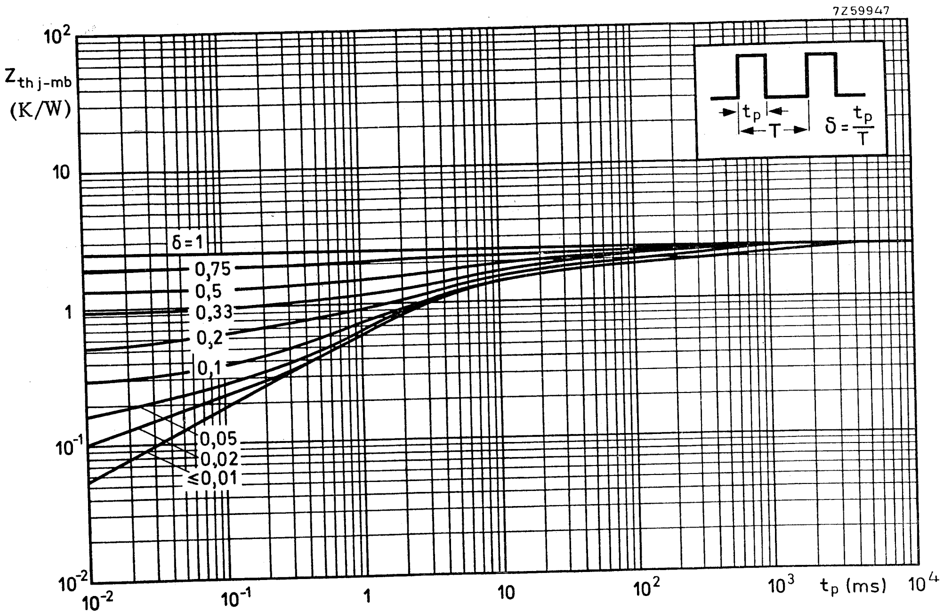


Fig. 4 Pulse power rating chart.

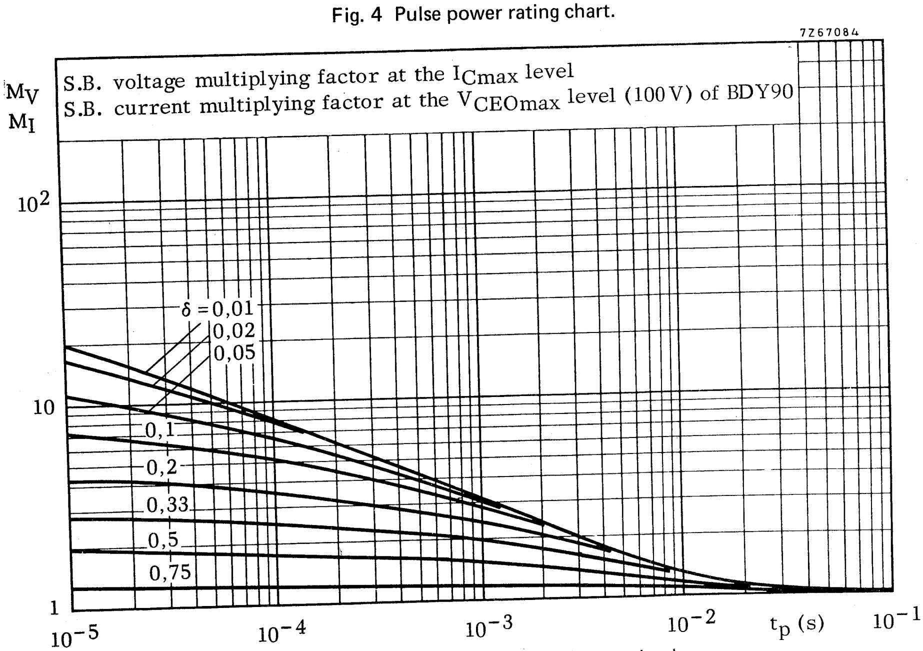


Fig. 5 S.B. voltage multiplying factor at the I_C max level.
S.B. current multiplying factor at the BDY90 V_{CEOmax} level (100 V).

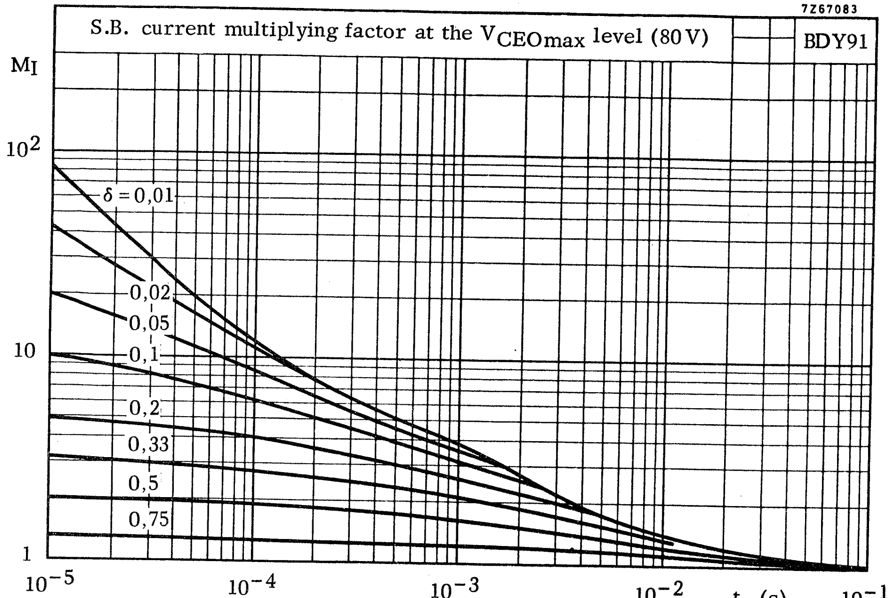


Fig. 6 S.B. current multiplying factor.

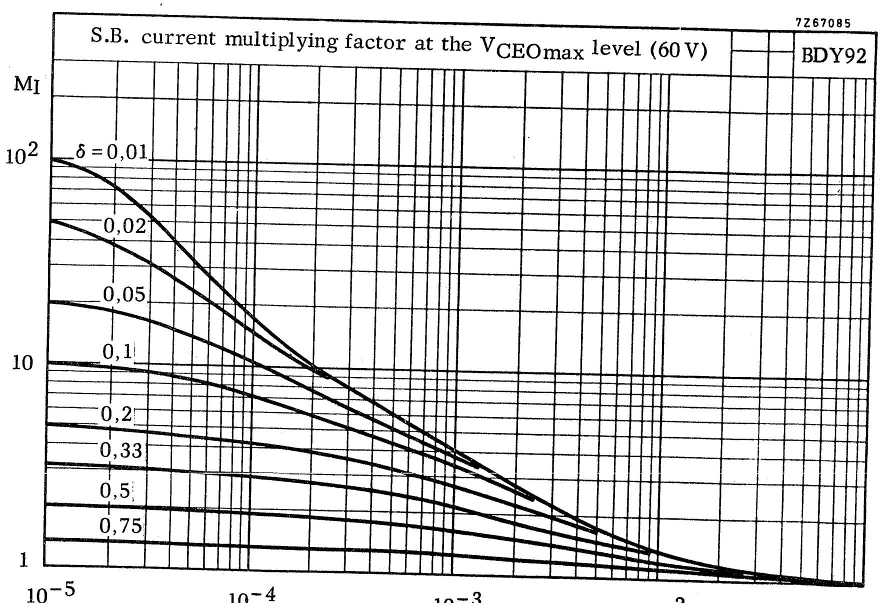


Fig. 7 S.B. current multiplying factor.

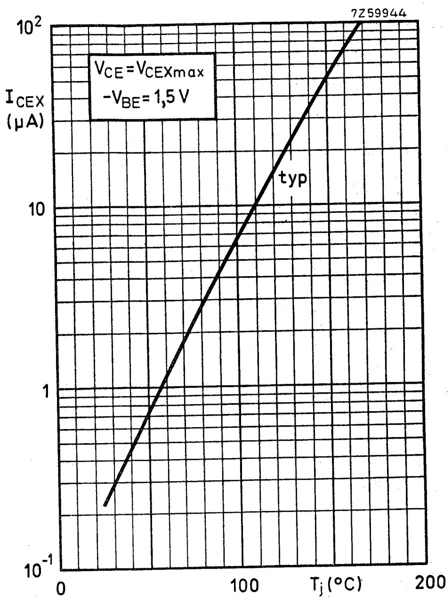


Fig. 8 Collector-emitter current.

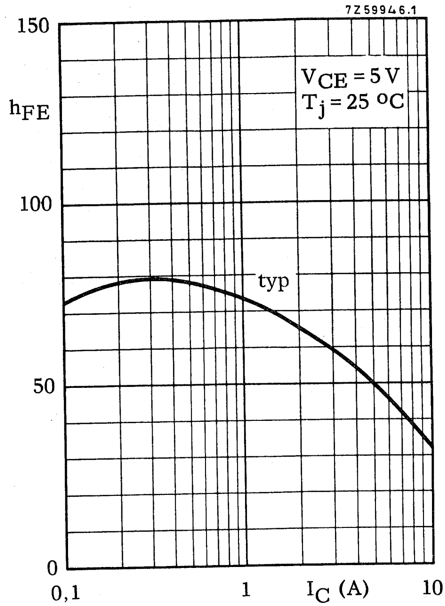


Fig. 9 D.C. current gain.

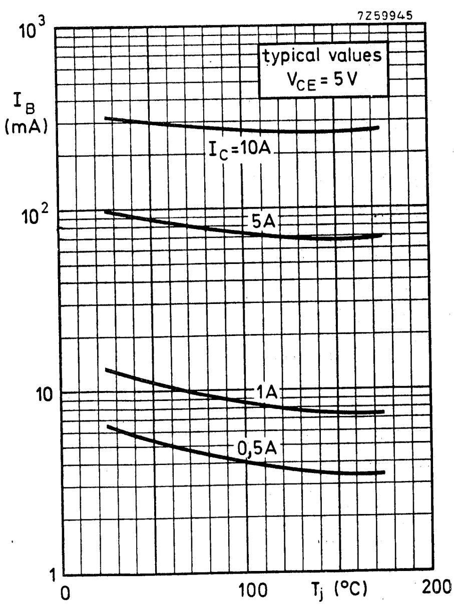


Fig. 10 Typical base current.

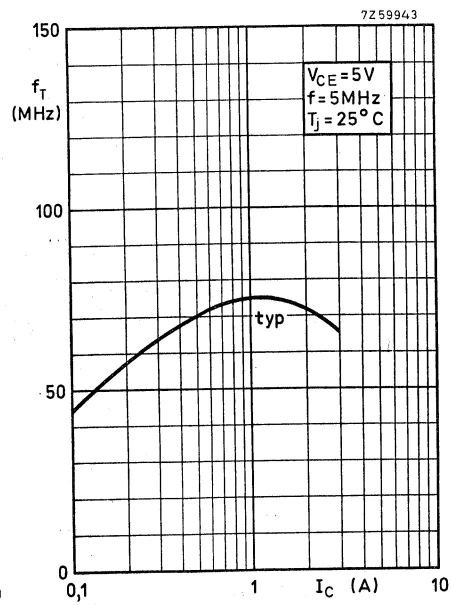


Fig. 11 Transition frequency.

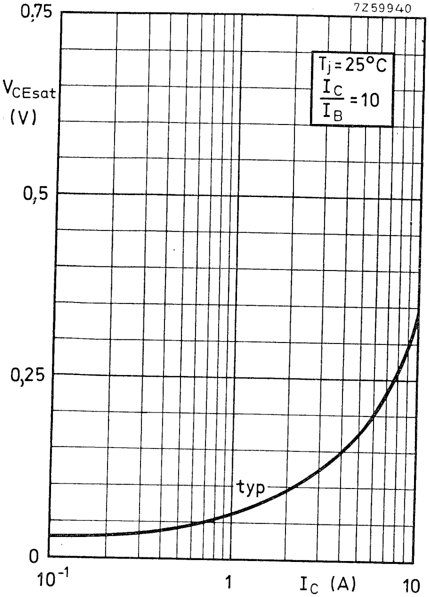


Fig. 12 Collector-emitter saturation voltage as a function of collector current.

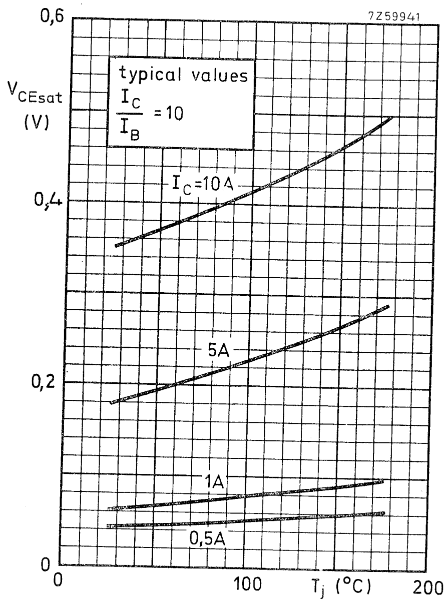


Fig. 13 Collector-emitter saturation voltage as a function of junction temperature.

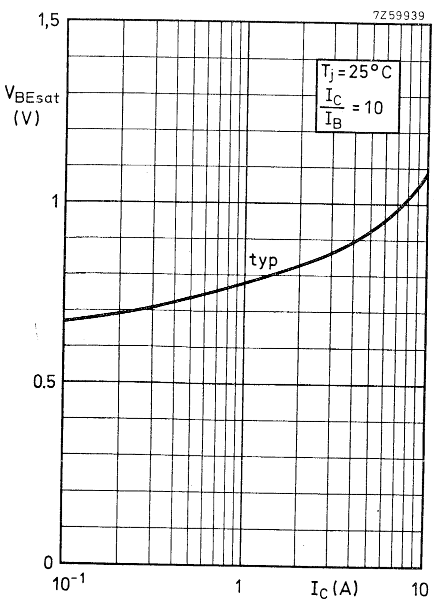


Fig. 14 Typical base-emitter saturation voltage.

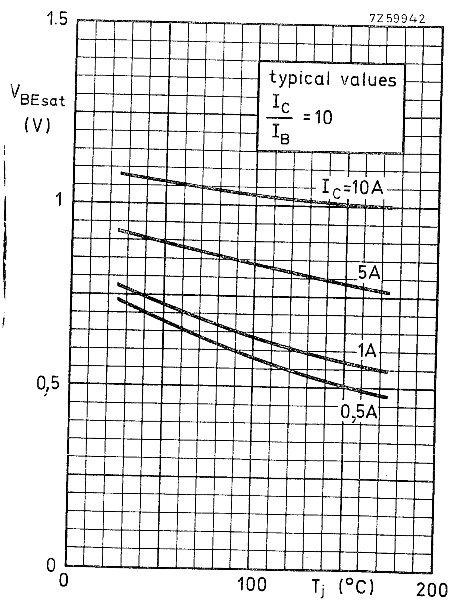


Fig. 15 Typical base-emitter saturation voltage.

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

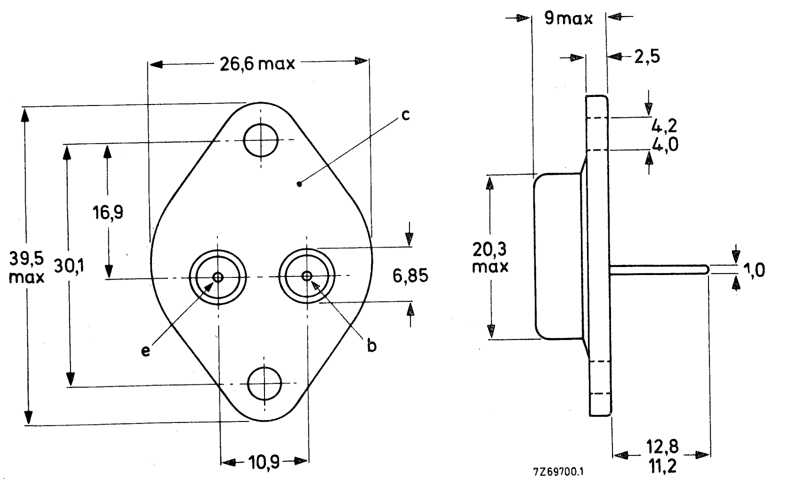
Collector-base voltage (open emitter)	V_{CBO}	max.	120 V
Collector-emitter voltage (open base)	V_{CEO}	max.	100 V
Collector current (peak value)	I_{CM}	max.	15 A
Total power dissipation up to T_{mb} = 70 °C	P_{tot}	max.	40 W
Collector-emitter saturation voltage I_C = 12 A; I_B = 1,2 A	V_{CEsat}	<	1,0 V
Fall time I_C = 5,0 A; $I_B = -I_{BM}$ = 0,5 A; V_{CC} = 30 V	t_f	<	0,2 μs
Transition frequency at f = 5 MHz I_C = 0,5 A; V_{CE} = 5 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	$R_{th\ j\text{-}mb}$	=	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 A; $I_B = -I_{BM}$ = 0,5 A; V_{CC} = 30 V — t_{on} < 0,35 µs

Turn off time

I_C = 5 A; $I_B = -I_{BM}$ = 0,5 A; V_{CC} = 30 V

storage time	t_s	<	1,3 µs
fall time	t_f	<	0,2 µs

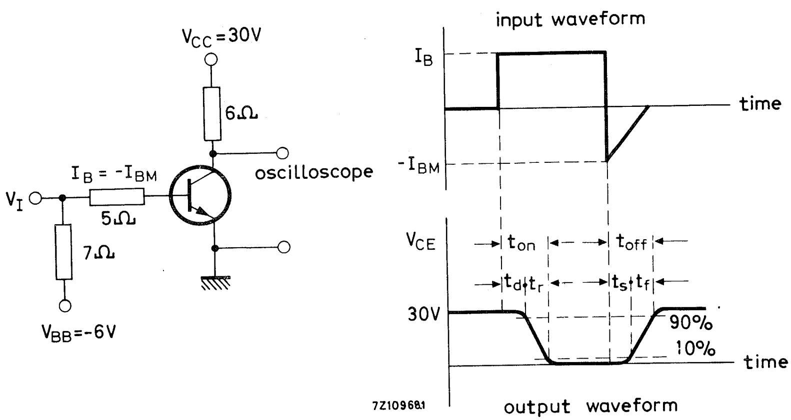


Fig. 2 Test circuit and waveforms.

Pulse generator:

Rise time	t_r	<	50	ns	Pulse duration	t_p	=	20 µs
Fall time	t_f	<	50	ns	Duty factor	δ	=	0,02

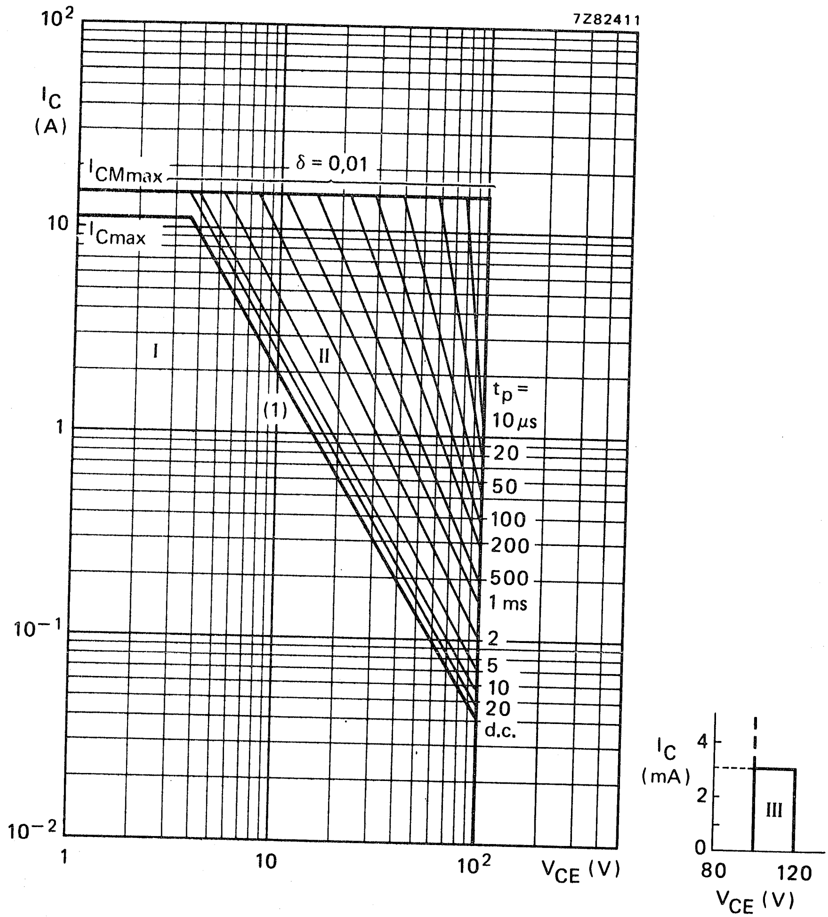


Fig. 3 Safe Operating ARea (regions I and II forward biased). $T_{mb} \leqslant 70\ ^oC$.

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation

III Repetitive pulse operation in this region is permissible, provided $-V_{BE} \geqslant 1{,}5$ V

(1) Second breakdown limits (independent of temperature)

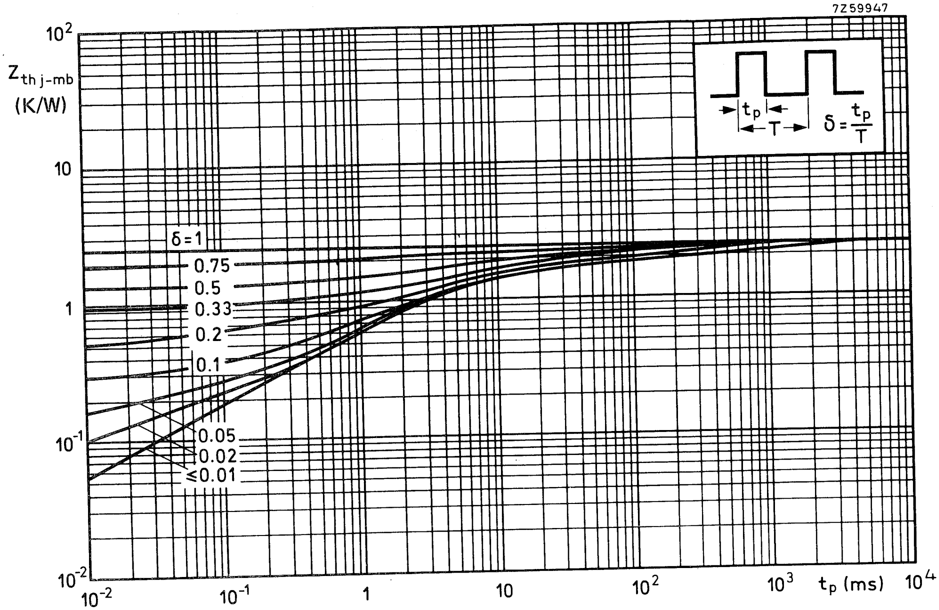


Fig. 4.

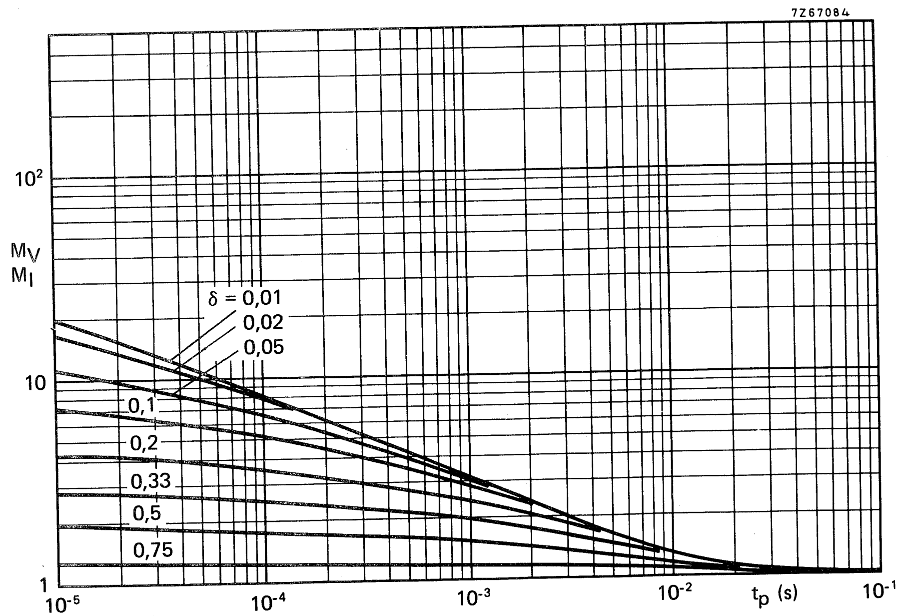


Fig. 5 SB voltage multiplying factor at I_{Cmax} level and SB current multiplying factor at V_{CEOmax} level.

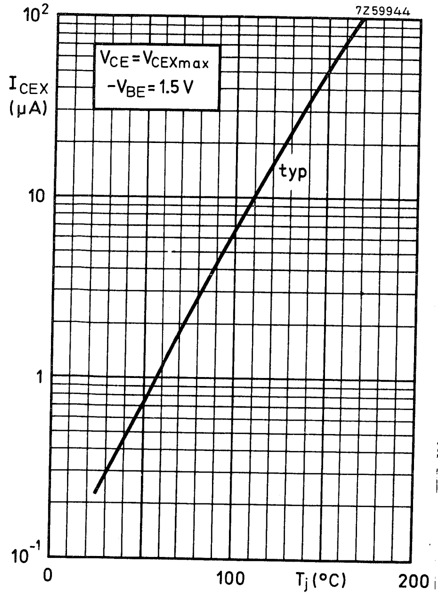


Fig. 6 Collector-emitter current as a function of junction temperature.

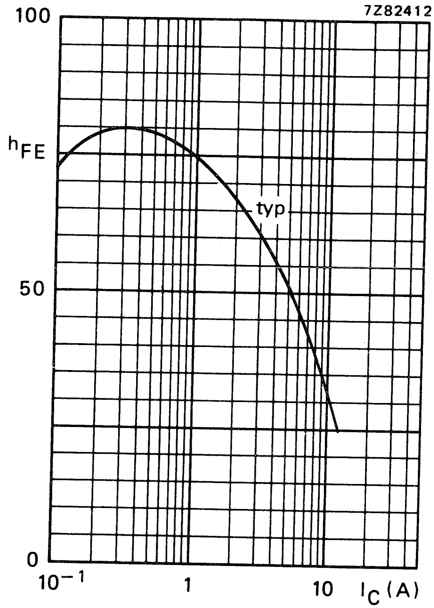


Fig. 7 D.C. current gain at $V_{CE} = 5$ V and $T_j = 25$ °C.

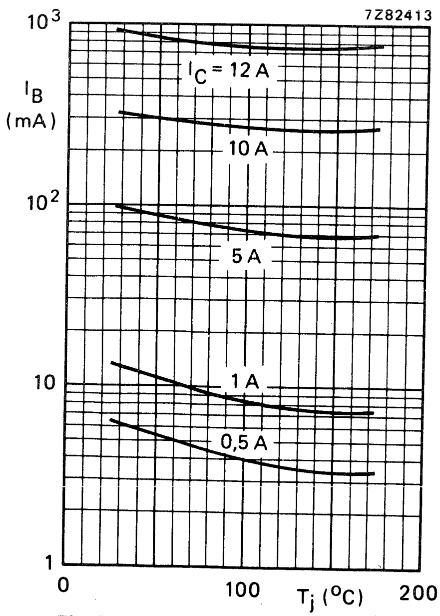


Fig. 8 Typical base current at $V_{CE} = 5$ V.

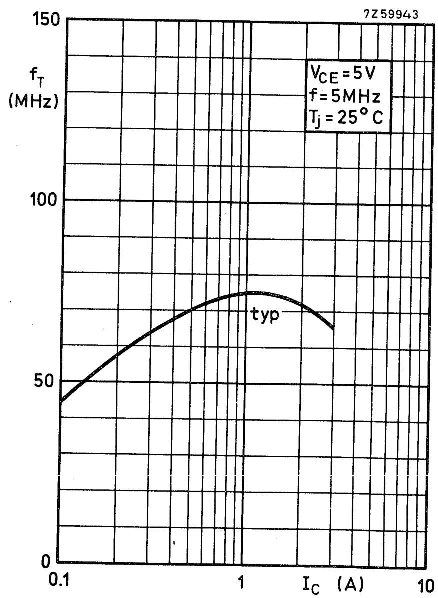


Fig. 9 Transition frequency as a function of the collector current.

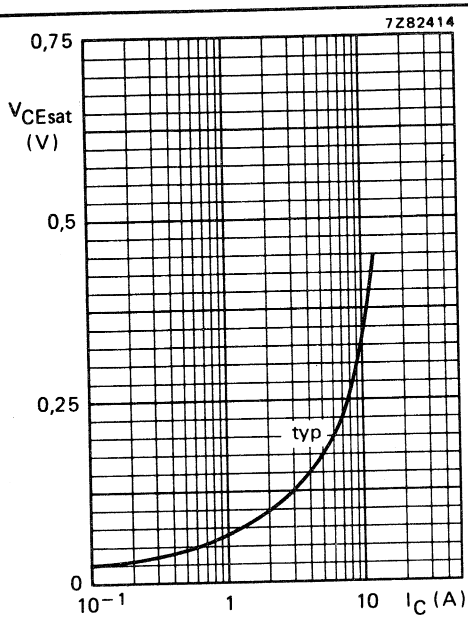


Fig. 10 Collector-emitter saturation voltage at $I_C/I_B = 10$; $T_j = 25$ °C.

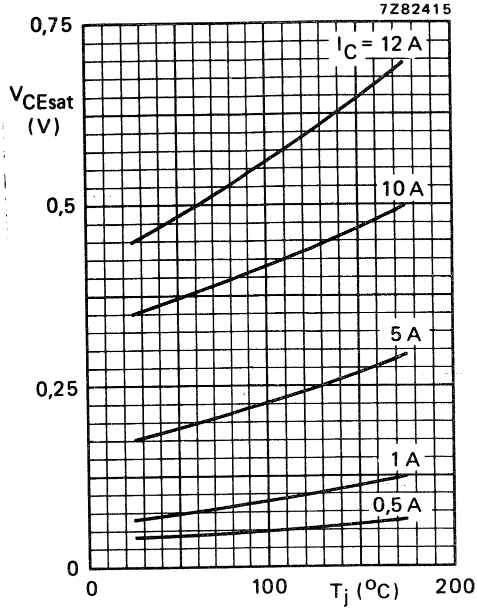


Fig. 11 Typical collector-emitter saturation voltage at $I_C/I_B = 10$.

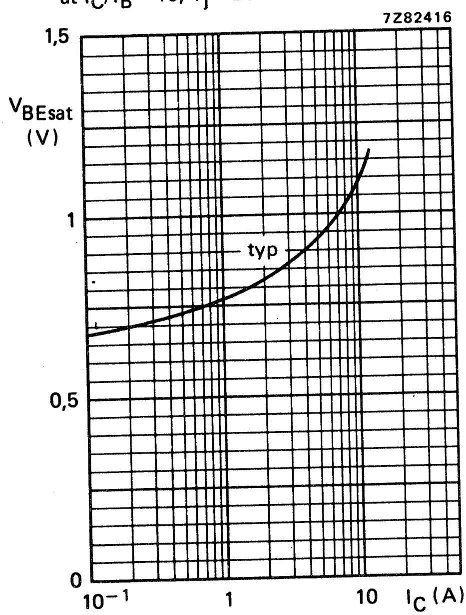


Fig. 12 Typical base-emitter saturation voltage at $I_C/I_B = 10$ and $T_j = 25$ °C.

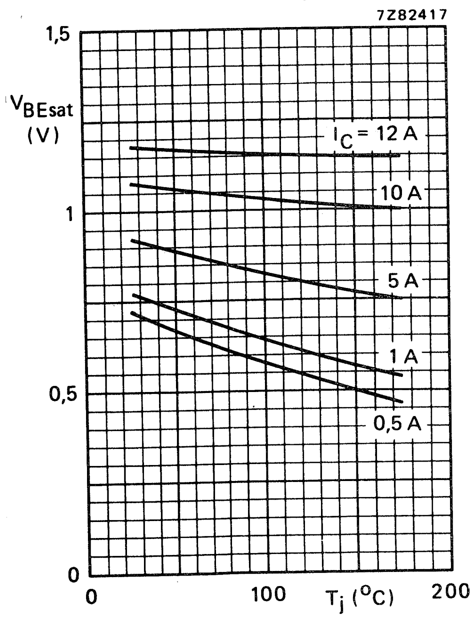


Fig. 13 Typical base-emitter saturation voltage at $I_C/I_B = 10$.

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

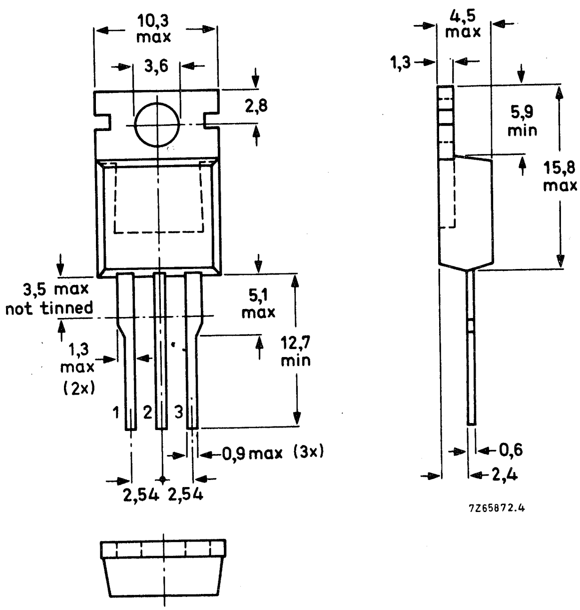
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60 V
Collector current (d.c.)	$-I_C$	max.	10 A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	75 W
Transition frequency at f = 1 MHz $-I_C$ = 0,5 A; $-V_{CE}$ = 10 V	f_T	>	2 MHz

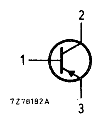
MECHANICAL DATA

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	$R_{th\ j\text{-}mb}$	=	1,67 K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	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
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: $t_p < 300$ μs, $\delta < 2\%$.

Switching times

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

turn-on time	t_{on}	<	1 μs
turn-off time	t_{off}	<	2 μs

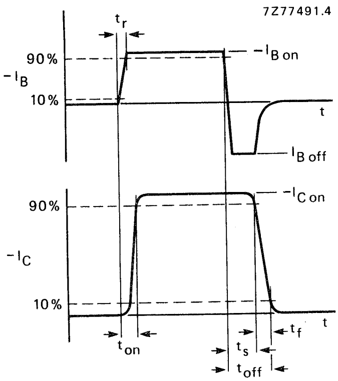


Fig. 2 Switching times waveforms.

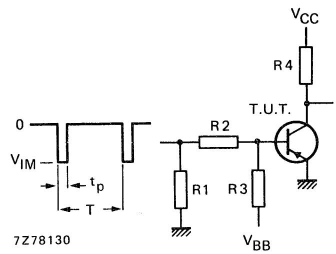


Fig. 3 Switching times test circuit.

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

DEVELOPMENT SAMPLE DATA

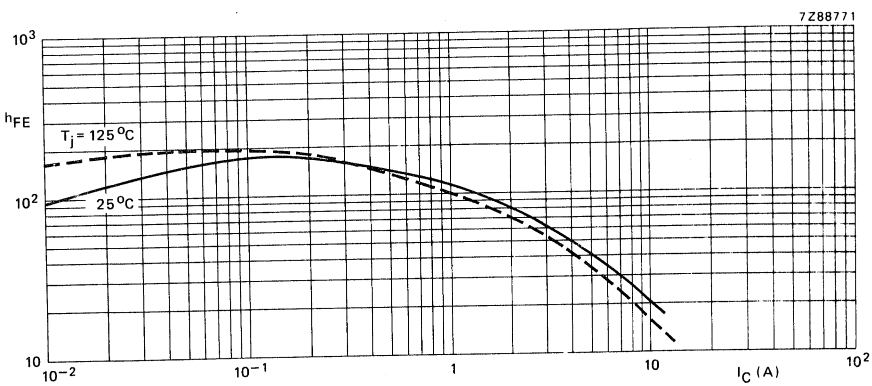


Fig. 4 Typical values d.c. current gain at $-V_{CE} = 2$ V.

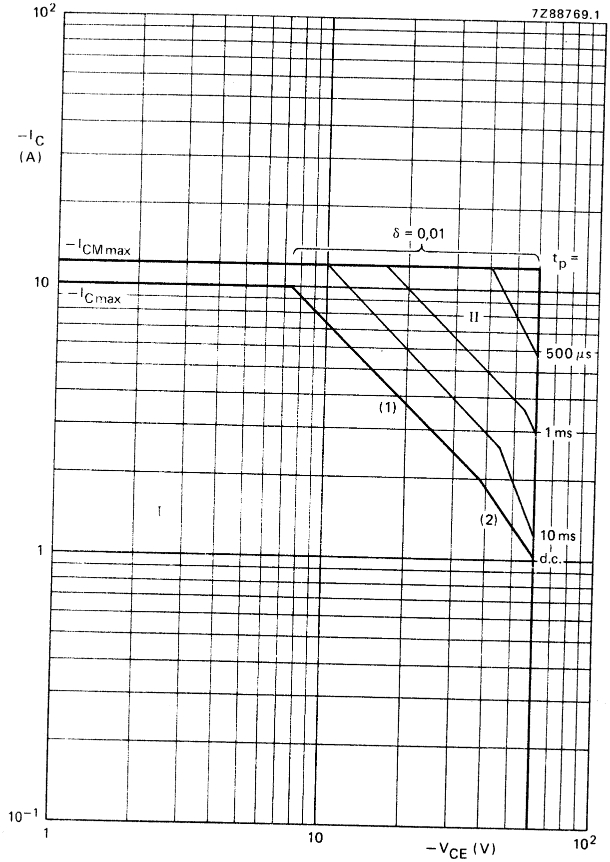


Fig. 5 Safe Operating ARea; T_{mb} = 25 °C.

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 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

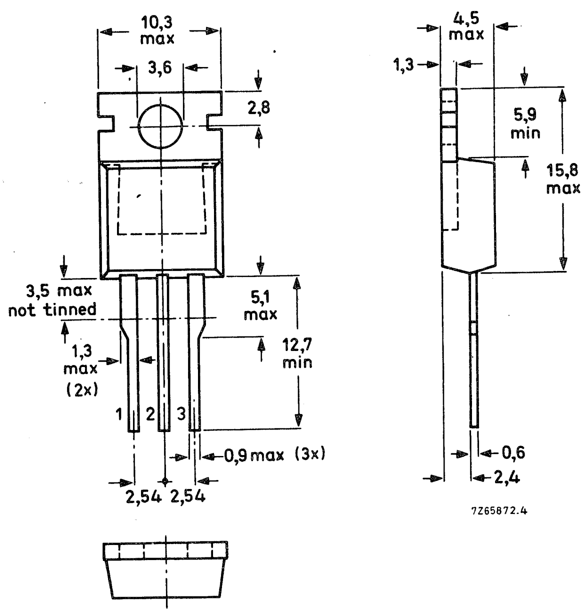
Collector-emitter voltage (open base)	V_{CEO}	max.	60 V
Collector current (d.c.)	I_C	max.	10 A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	75 W
Transition frequency at f = 1 MHz I_C = 0,5 A; V_{CE} = 10 V	f_T	>	2 MHz

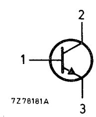
MECHANICAL DATA

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 $T_{mb} = 25\ ^oC$	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	$R_{th\ j\text{-}mb}$	=	1,67 K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	70 K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ 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; $T_j = 150\ ^oC$	I_{CBO}	<	5 mA
$V_{CE} = 70$ V; $V_{BE} = -1{,}5$ V	I_{CEX}	<	1 mA
$V_{CE} = 70$ V; $V_{BE} = -1{,}5$ V; $T_j = 150\ ^oC$	I_{CEX}	<	5 mA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	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: $t_p < 300\ \mu s$, $\delta < 2\%$.

Switching times

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

Turn-on time	t_{on}	<	1 μs
Turn-off time	t_{off}	<	4 μs

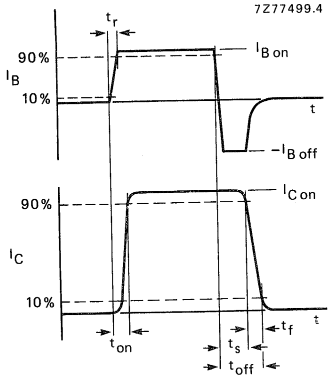


Fig. 2 Switching time waveforms.

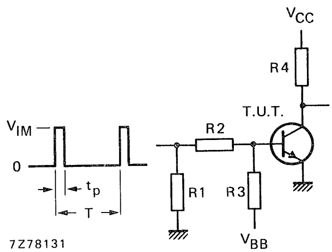


Fig. 3 Switching times test circuit.

$V_{IM} = 15$ V		R3	= 22 Ω
$V_{CC} = 20$ V		R4	= 10 Ω
$V_{BB} = -4$ V		$t_r = t_f \leqslant$	15 ns
R1 = none		t_p	20 μs
R2 = 33 Ω		T	= 500 μs

DEVELOPMENT SAMPLE DATA

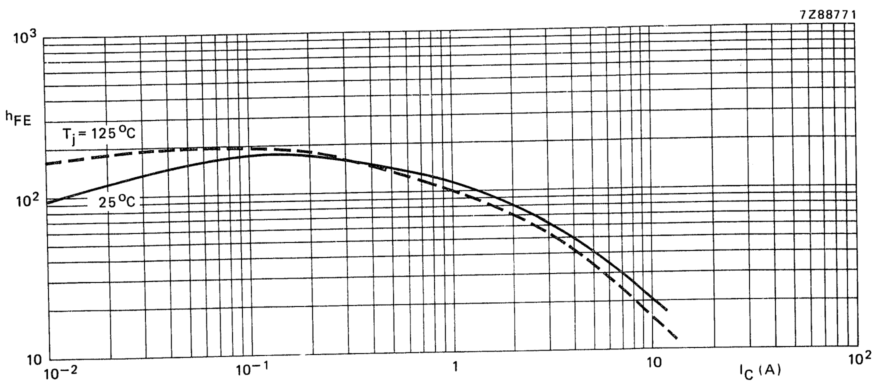


Fig. 4 Typical values d.c. current gain at $V_{CE} = 2$ V.

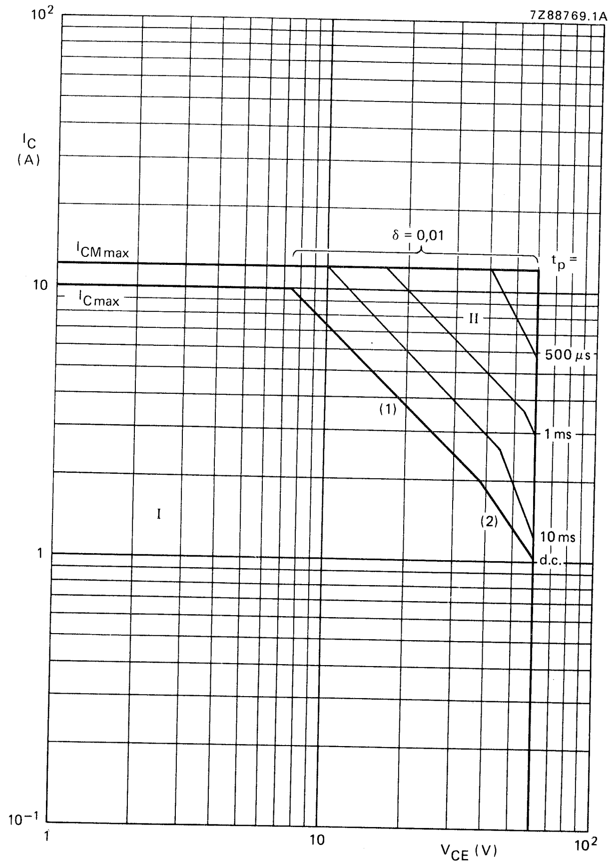


Fig. 5 Safe Operating ARea, $T_{mb} \leqslant 25$ °C.

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).

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.

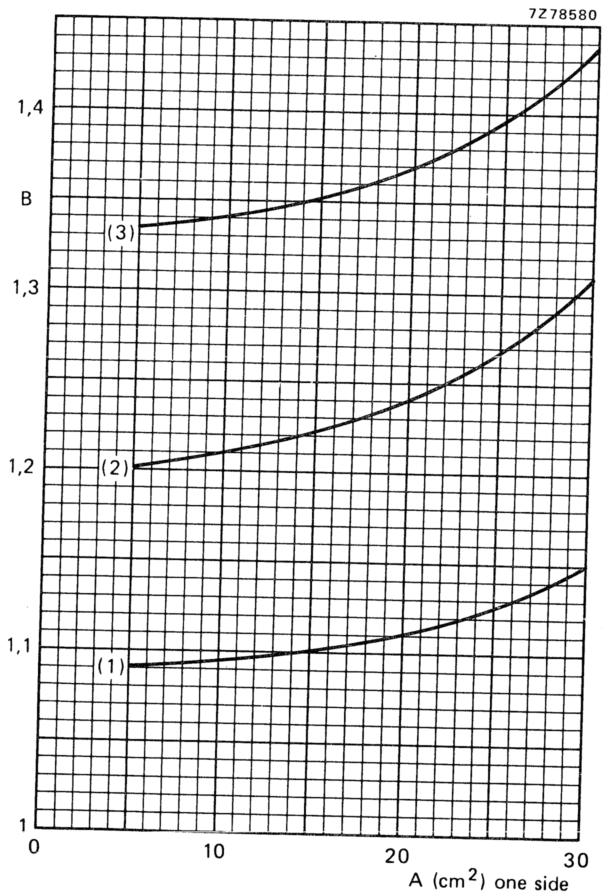


Fig. 1 Multiplication factor (B) as a function of heatsink area (A).
(1) 1 mm blackened aluminium.
(2) 1,5 mm unblackened aluminium.
(3) 1 mm unblackened aluminium.

MOUNTING INSTRUCTIONS
FOR TO-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^{o} tolerance for M2,5 thread and within 2^{o} 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 ($R_{th\ mb\text{-}h}$) 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.

Thermal data

From mounting base to heatsink

	$R_{th\ mb\text{-}h}$ (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 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 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).

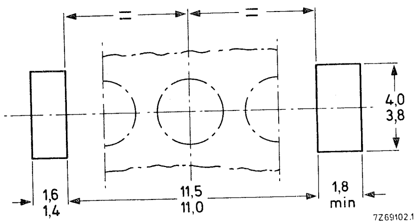


Fig. 1 Heatsink requirements.

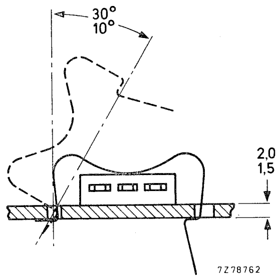


Fig. 2 Mounting spring clip.

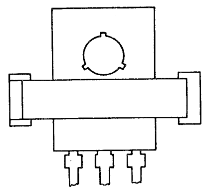


Fig. 3 Position of transistor (top view).

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.

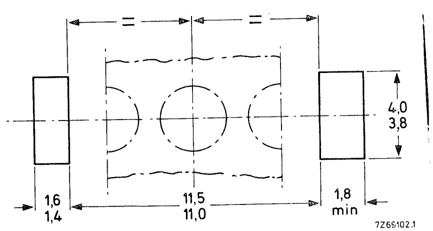


Fig. 4 Heatsink requirements.

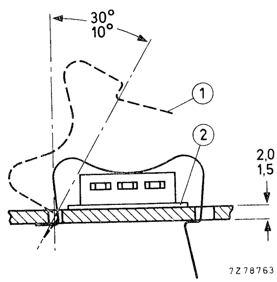


Fig. 5 Mounting.
(1) spring clip 56353.
(2) insulator 56354.

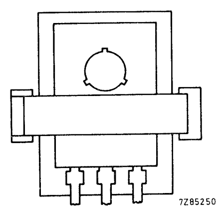


Fig. 6 Position of transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Dimensions in mm

Direct mounting with screw and spacing washer

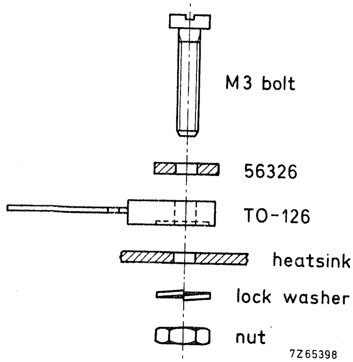


Fig. 7 Assembly through heatsink with nut.

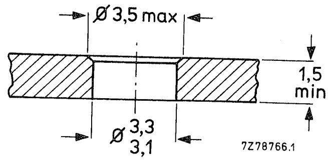


Fig. 8 Heatsink requirements.

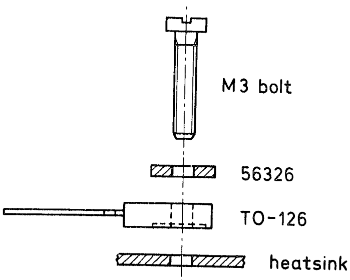


Fig. 9 Assembly into tapped heatsink.

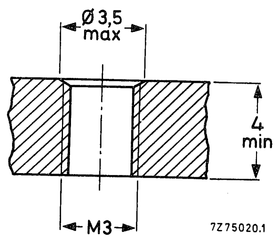


Fig. 10 Heatsink requirements.

INSTRUCTIONS FOR SCREW MOUNTING

Insulated mounting with 56326, 56387a and 56387b (up to 300 V)

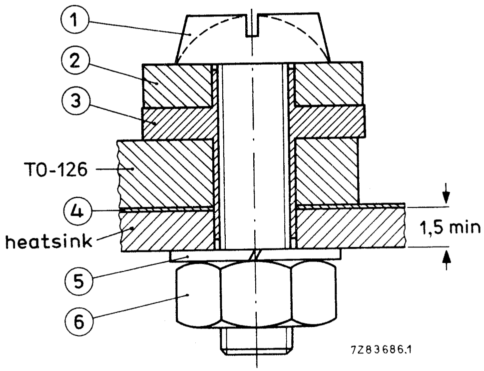


Fig. 15 Assembly through heatsink with nut.

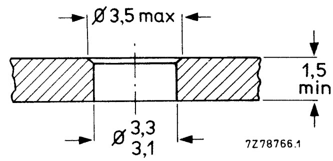


Fig. 16 Heatsink requirements.

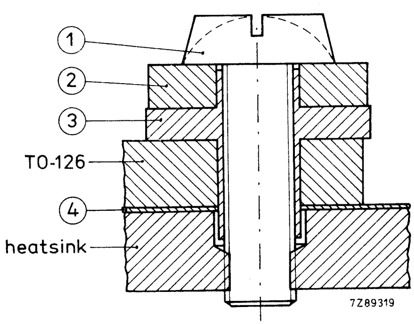


Fig. 17 Assembly with tapped heatsink.

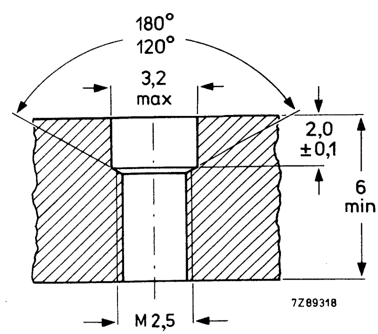


Fig. 18 Heatsink requirements.

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 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 ($R_{th\ mb\text{-}h}$) 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 $R_{th\ mb\text{-}h}$ 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-rivetted 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

From mounting base to heatsink			clip mounting	screw mounting	
with heatsink compound, direct mounting	$R_{th\ mb\text{-}h}$	=	0,3	0,5	K/W
without heatsink compound, direct mounting	$R_{th\ mb\text{-}h}$	=	1,4	1,4	K/W
with heatsink compound and 0,1 mm maximum mica washer	$R_{th\ mb\text{-}h}$	=	2,2	–	K/W
with heatsink compound and 0,25 mm maximum alumina insulator	$R_{th\ mb\text{-}h}$	=	0,8	–	K/W
with heatsink compound and 0,05 mm mica washer					
insulated up to 500 V	$R_{th\ mb\text{-}h}$	=	–	1,4	K/W
insulated up to 800 V/1000 V	$R_{th\ mb\text{-}h}$	=	–	1,6	K/W
without heatsink compound and 0,05 mm mica washer					
insulated up to 500 V	$R_{th\ mb\text{-}h}$	=	–	3,0	K/W
insulated up to 800 V/1000 V	$R_{th\ mb\text{-}h}$	=	–	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 $T_{j\ max} \leqslant 175$ °C, soldering temperature $T_{sld\ max} = 275$ °C.
Devices with $T_{j\ max} \leqslant 110$ °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).

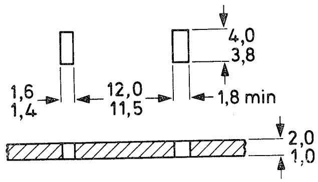


Fig. 1 Heatsink requirements.

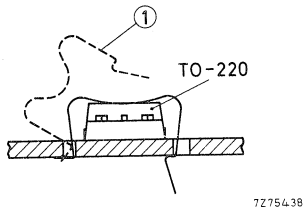


Fig. 2 Mounting.
(1) spring clip 56363.

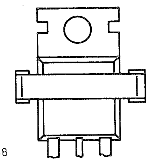


Fig. 2a Position of transistor (top view).

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.

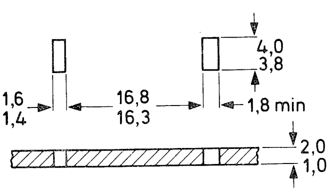


Fig. 3 Heatsink requirements.

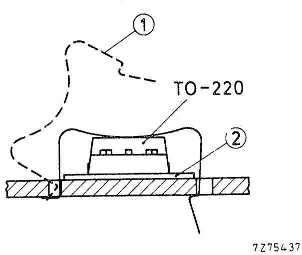


Fig. 4 Mounting.
(1) spring clip 56364.
(2) insulator 56369 or 56367.

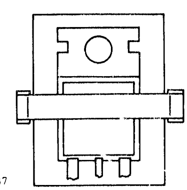


Fig. 4a Position of transistor (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Dimensions in mm

Direct mounting with screw and spacing washer

- *through heatsink with nut*

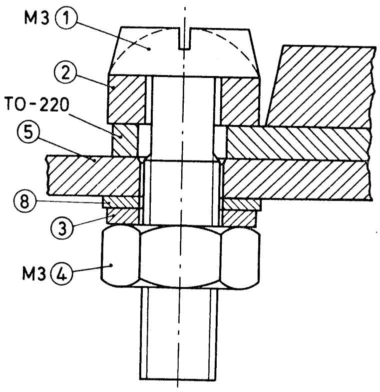


Fig. 5 Assembly.

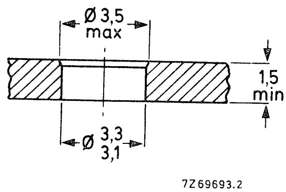


Fig. 6 Heatsink requirements.

(1) M3 screw.
(2) rectangular washer (56360a).
(3) lock washer.
(4) M3 nut.
(5) heatsink.
(8) plain washer.

- *into tapped heatsink*

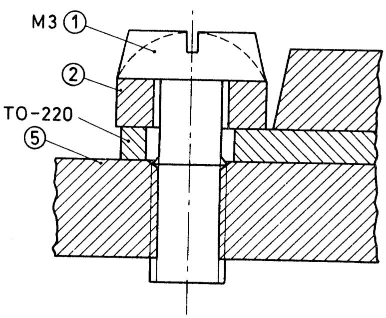


Fig. 7 Assembly.

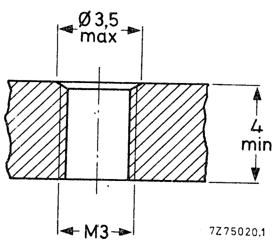


Fig. 8 Heatsink requirements.

(1) M3 screw.
(2) rectangular washer 56360a.
(5) heatsink.

Dimensions in mm

Insulated mounting with screw and spacing washer
(not recommended where mounting tab is on mains voltage)

- *through heatsink with nut*

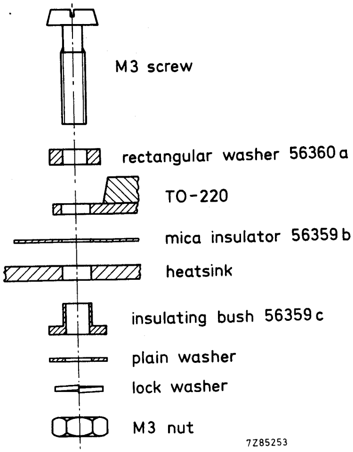


Fig. 9 Insulated screw mounting with rectangular washer. Known as a "bottom mounting".

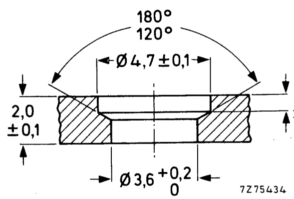


Fig. 10 Heatsink requirements for 500 V insulation.

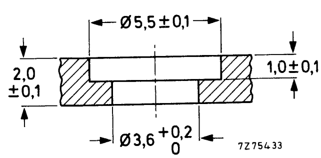


Fig. 11 Heatsink requirements for 800 V insulation.

- *into tapped heatsink*

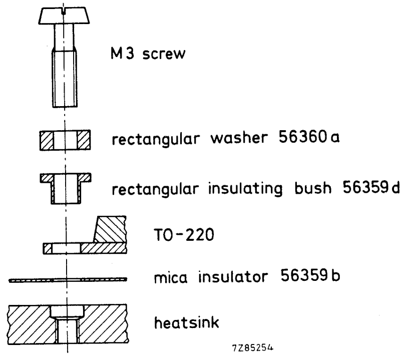


Fig. 12 Insulated screw mounting with rectangular washer into tapped heatsink. Known as a "top mounting".

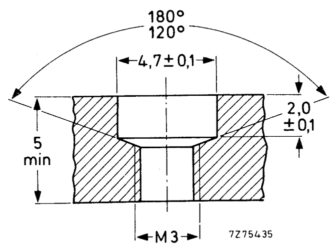


Fig. 13 Heatsink requirements for 500 V insulation.

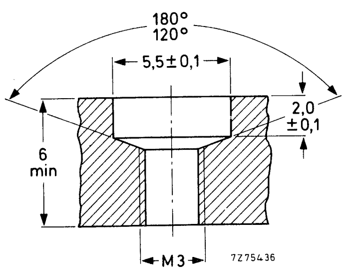


Fig. 14 Heatsink requirements for 1000 V insulation.

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.

N.B.: Data on accessories are given in chapter Accessories.

Soldering

Recommendations for devices with a maximum junction temperature rating ≤ 175 °C:

a. Dip or wave soldering

Maximum permissible solder temperature is 260 °C at a distance from the body of > 5 mm and for a total contact time with soldering bath or waves of < 7 s.

b. Hand soldering

Maximum permissible temperature is 275 °C at a distance from the body of > 3 mm and for a total contact time with the soldering iron of < 5 s.

The body of the device must not touch anything with a temperature > 200 °C.

It is not permitted to solder the metal tab of the device to a heatsink, otherwise the junction temperature rating will be exceeded.

Avoid any force on body and leads during or after soldering; do not correct the position of the device or of its leads after soldering.

Thermal data

			clip mounting	screw mounting
Thermal resistance from mounting base to heatsink				
direct mounting				
with heatsink compound	$R_{th\ mb-h}$	=	0,3	0,3 K/W
without heatsink compound	$R_{th\ mb-h}$	=	1,5	0,8 K/W
with 0,05 mm mica washer				
with heatsink compound	$R_{th\ mb-h}$	=	0,8	0,8 K/W
without heatsink compound	$R_{th\ mb-h}$	=	3,0	2,2 K/W

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56379

1. Place the device on the heatsink, applying heatsink compound to the mounting base.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 20° to the vertical (see Fig. 1b).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 1(c)).

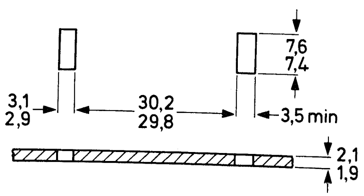


Fig. 1a Heatsink requirements.

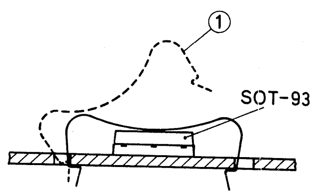


Fig. 1b Mounting.
(1) = spring clip 56379.

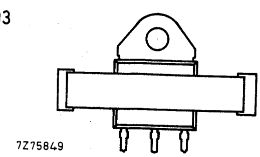


Fig. 1c Position of the device.

Insulated mounting with clip 56379

With the mica 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.

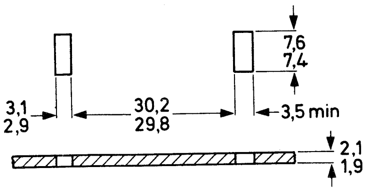


Fig. 2a Heatsink requirements.

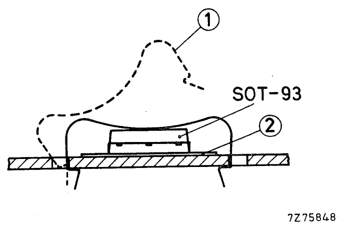


Fig. 2b Mounting.
(1) = spring clip 56379
(2) = insulator 56378

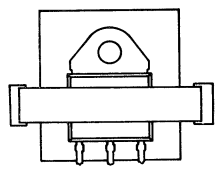


Fig. 2c Position of the device.

INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting

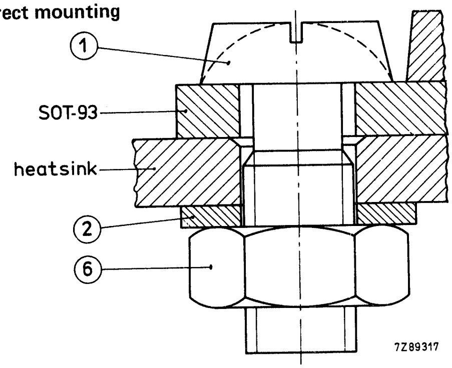


Fig. 3a Assembly through heatsink with nut.

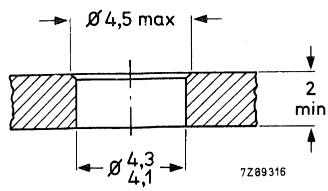


Fig. 3b Heatsink requirements.

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.

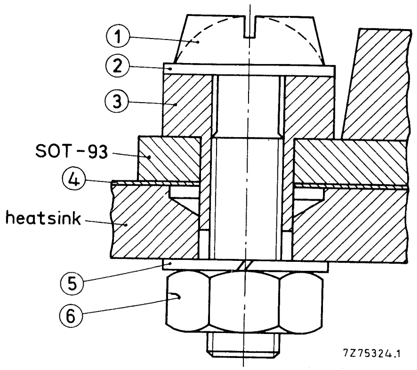


Fig. 4 Assembly.
See also Fig. 9.

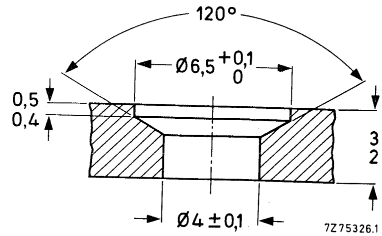


Fig. 5 Heatsink requirements up to 800 V insulation.

(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
(4) mica insulator (56368a)
(5) lock washer
(6) M3 nut

Insulated screw mounting with tapped hole; up to 800 V.

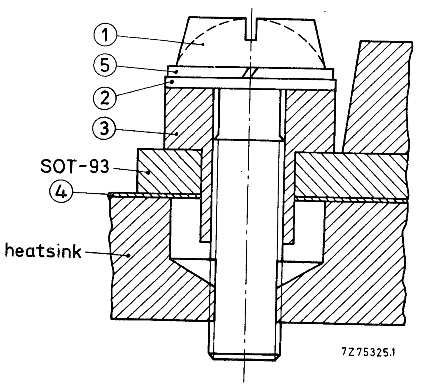


Fig. 6 Assembly.
See also Fig. 9.

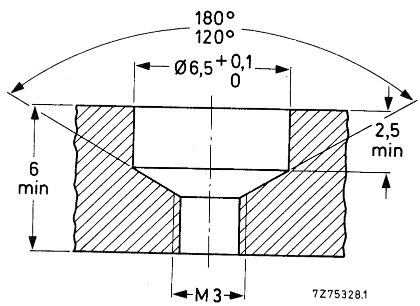


Fig. 7 Heatsink requirements up to 800 V insulation.

(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

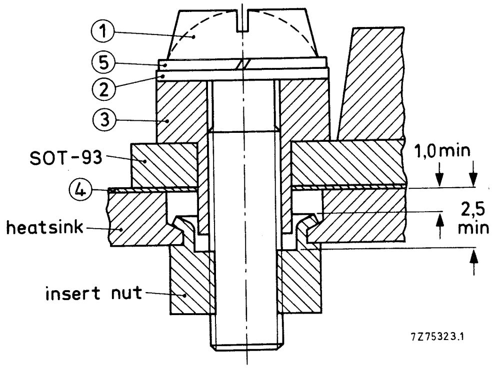


Fig. 8 Assembly and heatsink requirements for 500 V insulation. See also Fig. 3.

(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
(4) mica insulator (56368a)
(5) lock washer

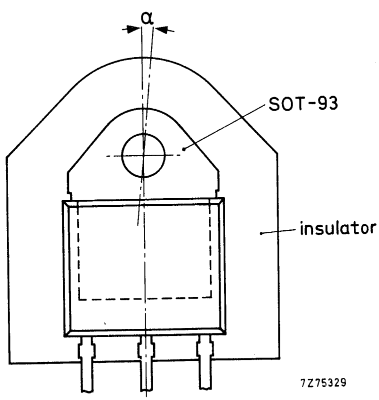


Fig. 9 Mica insulator.

The axial deviation (α) between SOT-93 and mica should not exceed 5°.

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)

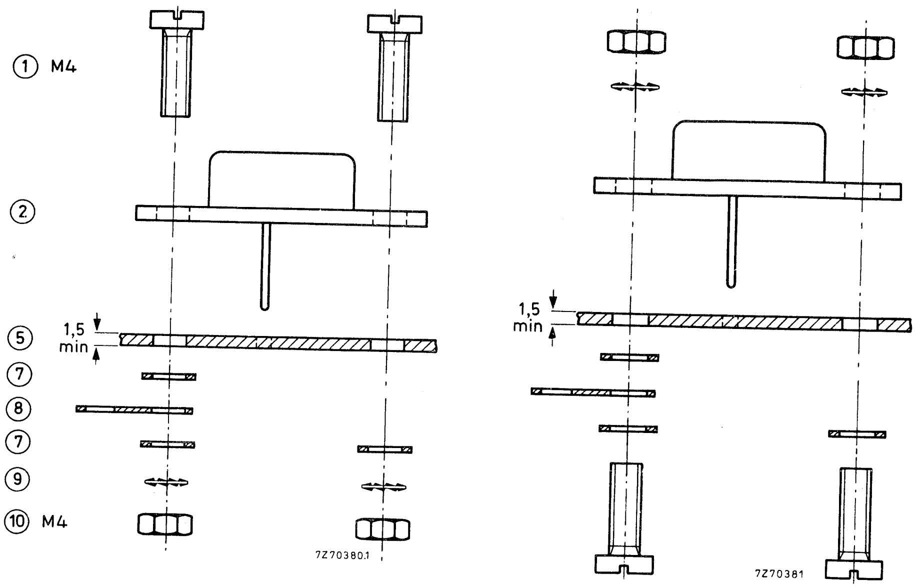
Thermal data

The thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) 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	Insulated mounting 2000 V mica	
From mounting base to heatsink					
without heatsink compound	$R_{th\ mb\text{-}h}$	0,6	1,0	1,25	K/W
with heatsink compound	$R_{th\ mb\text{-}h}$	0,1	0,3	0,5	K/W

INSTRUCTIONS FOR DIRECT MOUNTING

The transistors should be mounted with M4 screws, see Figs 1 and 2. Minimum heatsink thickness (for good heat transfer) 1,5 mm. Hole pattern: Fig. 3.
A heatsink with tapped holes or insert nuts can also be used, but a torque washer is necessary between metal washer and transistor. See Fig. 4.



Figs 1 and 2. Direct mounting with nuts.

Legend
(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

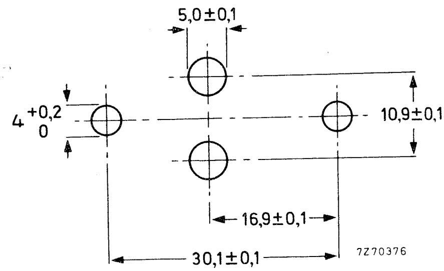


Fig. 3 Hole pattern for direct mounting with nuts.

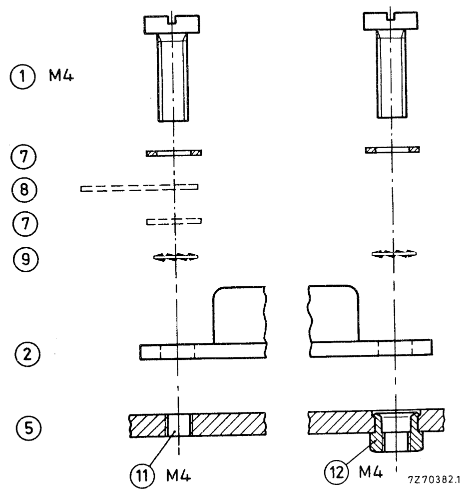


Fig. 4 Direct mounting with tapped holes or insert nuts.

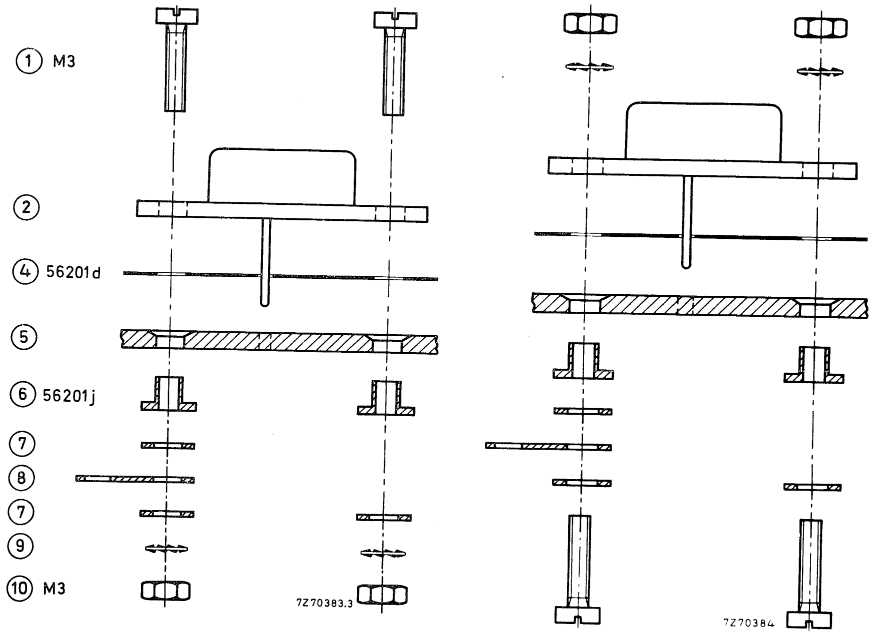
MOUNTING INSTRUCTIONS FOR UP TO 500 V INSULATION

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.

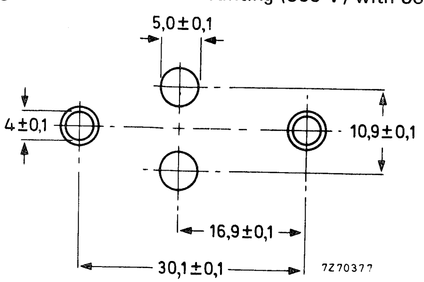


Fig. 7 Hole pattern for 500 V insulation, nut fastening.

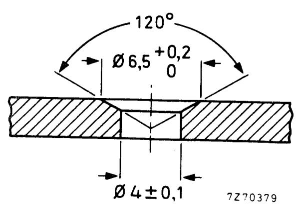


Fig. 8 Shape of hole for 500 V insulation, nut fastening.

For legend see page 732.

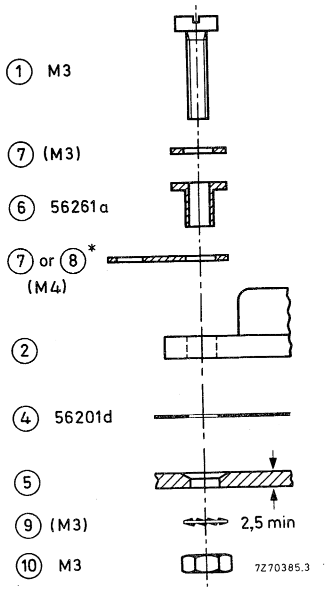


Fig. 9 Insulated mounting (500 V) with nuts.

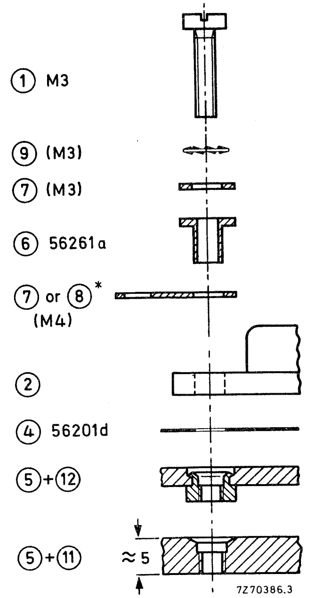


Fig. 10 Insulated mounting (500 V) with tapped holes or insert nuts.

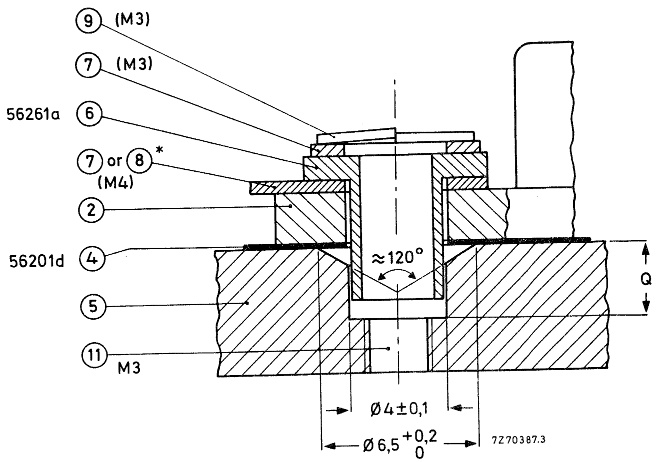


Fig. 11 Assembly (partial) for Fig. 10 - tapped holes.
Q minimum 2,5 mm.

For legend see page 732.

* Thickness approximately 0,6 mm, outer diameter 7,5 mm.

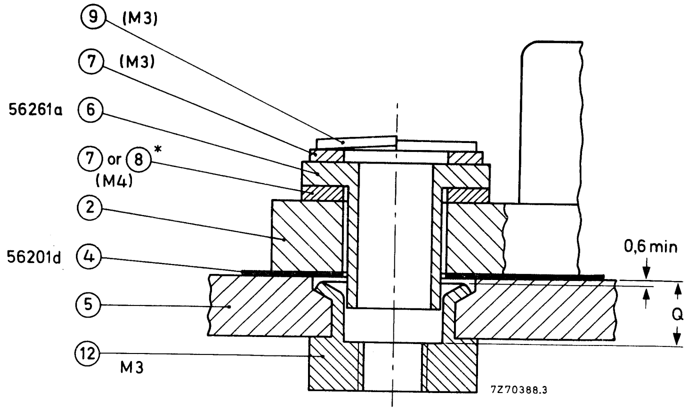


Fig. 12 Assembly (partial) for Fig. 10 - insert nuts Q minimum 2,5 mm.

For legend see page 732.

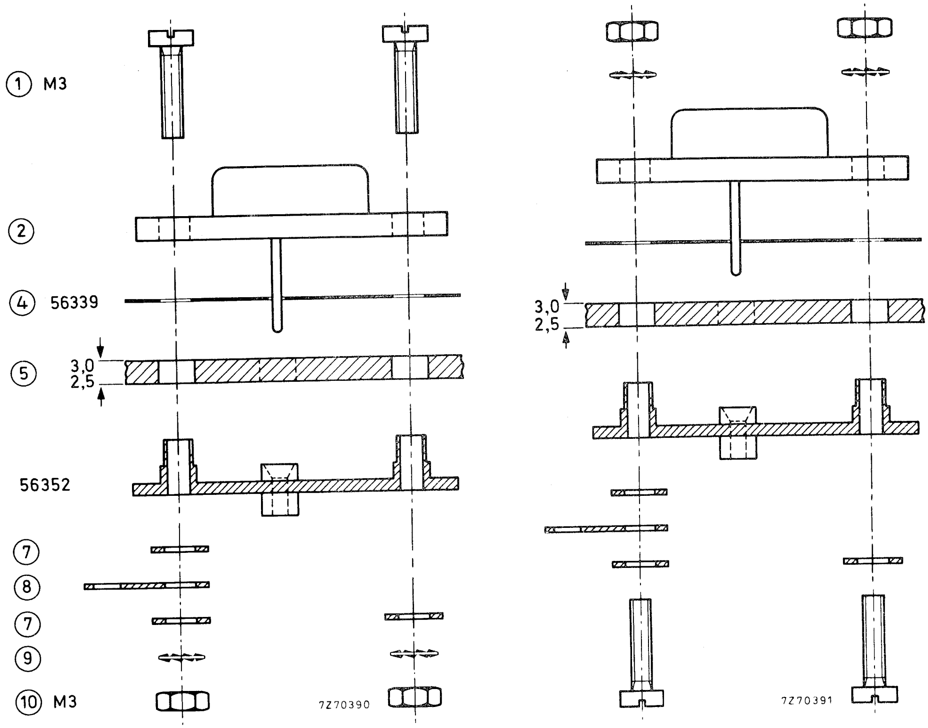
Dimensions in mm

* 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).

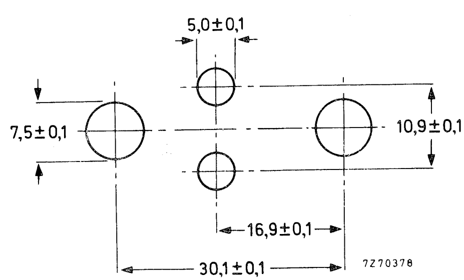


Fig. 15 Hole pattern for Figs 13 and 14.

For legend see page 732.

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)	56360a	M3				
up to 800 V			56359b	56359c	56360a	M3
up to 1000 V			56359b	56359d	56360a	M3
SOT-93	–	M4	56368a	56368b		M3
TO-3 (SOT-3)	–	M4				
up to 500 V			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.

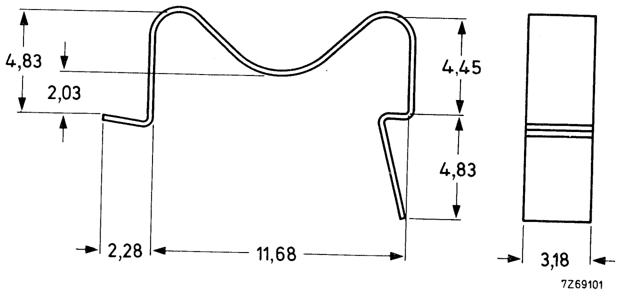
Mounting TO-126 and SOT-82 envelopes.

56353

CLIP
for TO-126 and SOT-82 envelopes

MECHANICAL DATA
Material: high carbon spring steel

Dimensions in mm



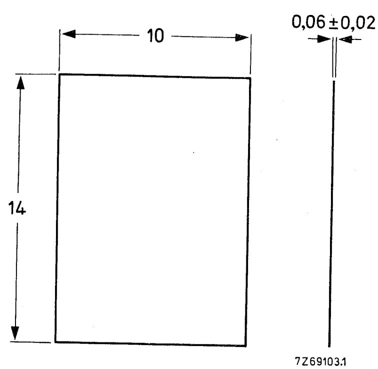
Spring clip suitable for heatsink of 1,5 to 2 mm.

56354

MICA INSULATOR
for TO-126 and SOT-82 envelopes

MECHANICAL DATA

Dimensions in mm



Mounting of TO-126 envelopes

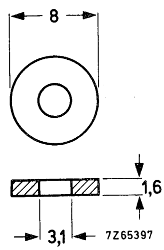
56326 WASHER

for direct mounting of TO-126 envelopes

MECHANICAL DATA

Dimensions in mm

Material: brass, nickel plated

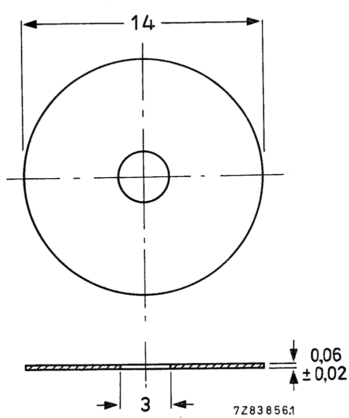


56387a MICA WASHER

for insulated screw mounting of TO-126 envelopes (up to 300 V)

MECHANICAL DATA

Dimensions in mm



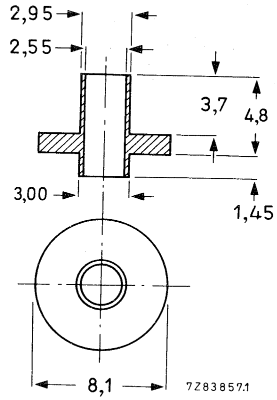
56387b INSULATING BUSH

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

Clip mounting TO-220 envelopes

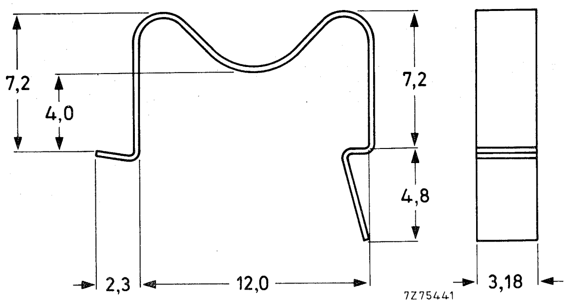
56363 SPRING CLIP

for direct mounting of TO-220 envelopes

MECHANICAL DATA

Dimensions in mm

Material: steel, zinc-chromate passivated.



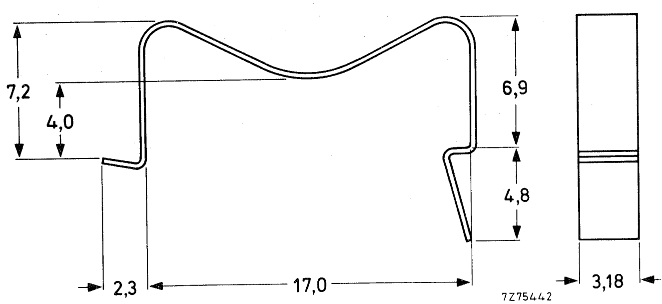
56364 SPRING CLIP

for insulated mounting of TO-220 envelopes

MECHANICAL DATA

Dimensions in mm

Material: steel, zinc-chromate passivated.



to be used in conjunction with **56367** or **56369.**

Clip mounting TO-220 envelopes

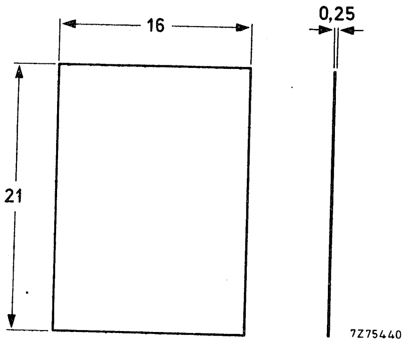
56367 ALUMINA INSULATOR

for insulated clip mounting of TO-220 envelopes (up to 2 kV)

MECHANICAL DATA

Dimensions in mm

Material: 96-alumina.



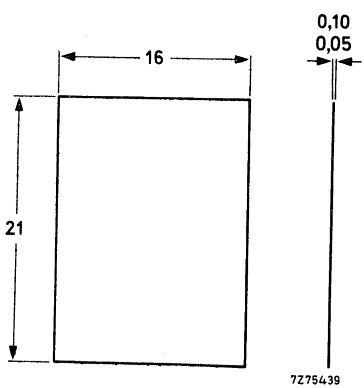
* Because alumina is brittle, extreme care must be taken when mounting devices not to crack the alumina, particularly when used without heatsink compound.

56369 MICA INSULATOR

for insulated clip mounting of TO-220 envelopes (up to 2 kV)

MECHANICAL DATA

Dimensions in mm



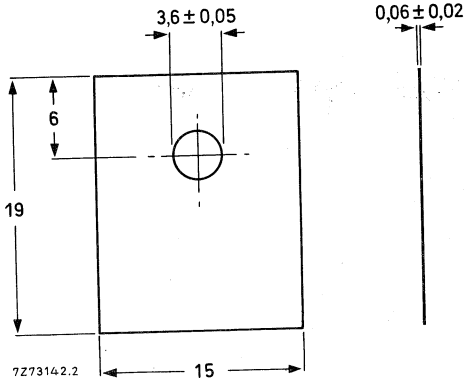
Mounting TO-220 envelopes

56359b MICA WASHER

for TO-220 envelopes (up to 1000 V)

MECHANICAL DATA

Dimensions in mm



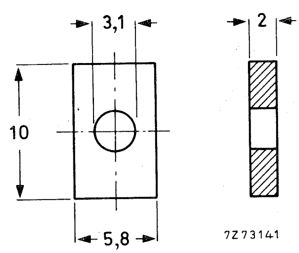
56360a RECTANGULAR WASHER

for direct and insulated mounting of TO-220 envelopes

MECHANICAL DATA

Material: brass; nickel plated

Dimensions in mm



Mounting TO-220 envelopes

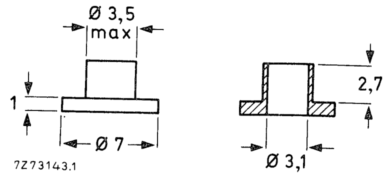
56359c INSULATING BUSH

for TO-220 envelopes (up to 800 V)

MECHANICAL DATA

Material: polyester

Dimensions in mm



TEMPERATURE

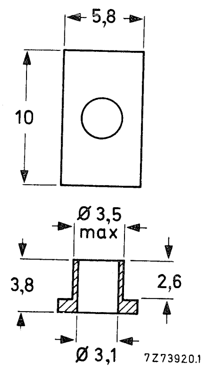
Maximum permissible temperature T_{max} = 150 °C

56359d RECTANGULAR INSULATING BUSH

for TO-220 envelopes (up to 1000 V)

MECHANICAL DATA

Dimensions in mm



TEMPERATURE

Maximum permissible temperature T_{max} = 150 °C

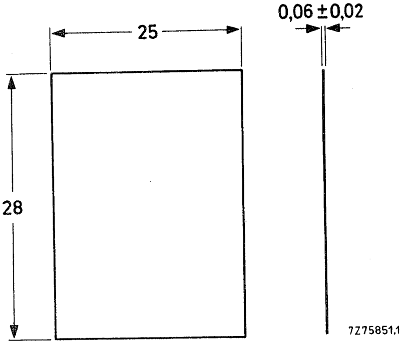
Clip mounting of SOT-93 envelopes

56378 MICA INSULATOR

for SOT-93 clip mounting (up to 1500 V)

MECHANICAL DATA

Dimensions in mm



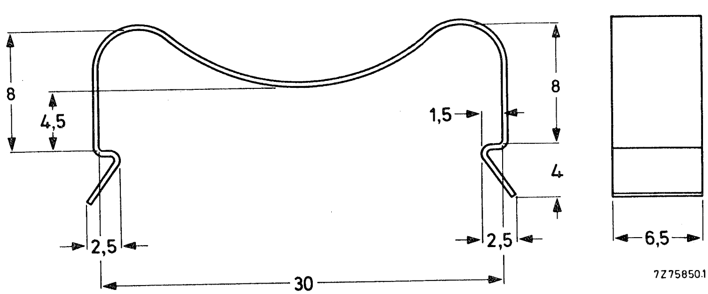
56379 SPRING CLIP

for direct and insulated mounting of SOT-93 envelopes

MECHANICAL DATA

Dimensions in mm

Material:
CrNi steel NLN-939;
thickness 0,4 ± 0,04.



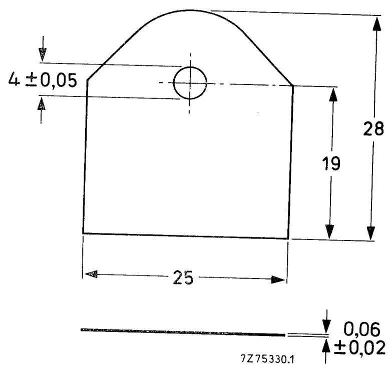
Screw mounting of SOT-93 envelopes

56368a MICA INSULATOR

for insulated screw mounting of SOT-93 envelopes (up to 800 V)

MECHANICAL DATA

Dimensions in mm



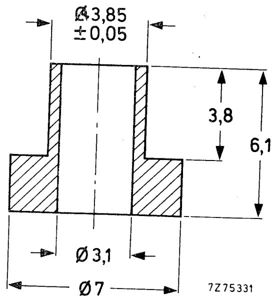
56368b INSULATING BUSH

for insulated screw mounting of SOT-93 envelopes (up to 800 V)

MECHANICAL DATA

Material: polyester

Dimensions in mm



TEMPERATURE

Maximum permissible temperature $T_{max} = 150\ ^oC$

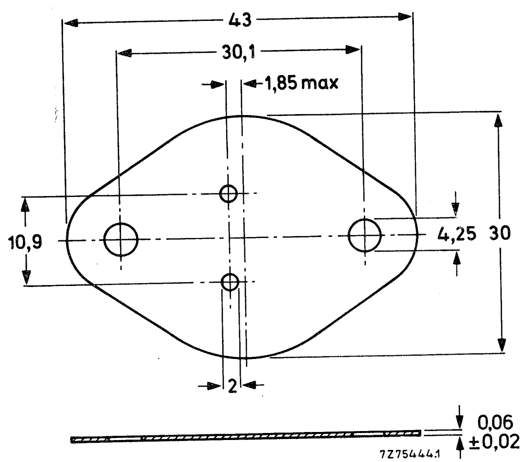
Mounting TO-3 envelopes

56201d MICA WASHER

Mica washer for up to 500 V insulation of **TO-3** envelopes.

MECHANICAL DATA

Dimensions in mm



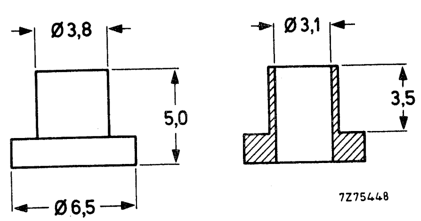
56201j 2 INSULATING BUSHES

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 °C

Mounting TO-3 envelopes

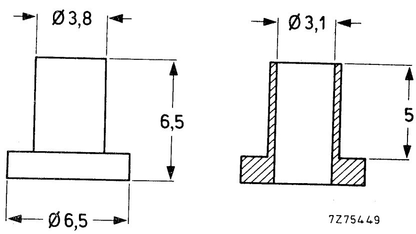
56261a — 2 INSULATING BUSHES

Two insulating bushes for up to 500 V insulation of **TO-3** envelopes.

MECHANICAL DATA

Material: polyester

Dimensions in mm



TEMPERATURE

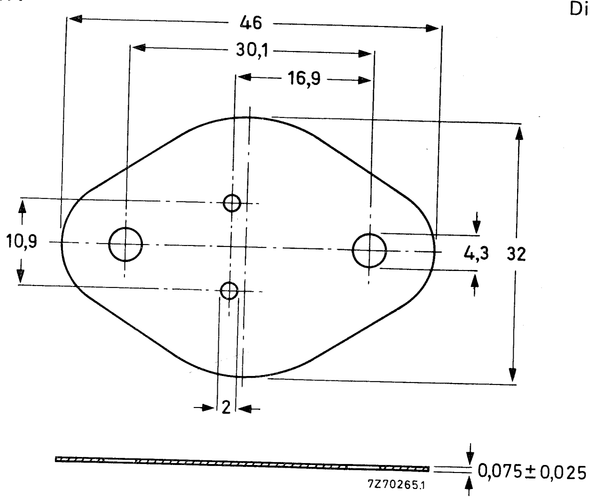
Maximum permissible temperature — T_{max} 150 °C

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

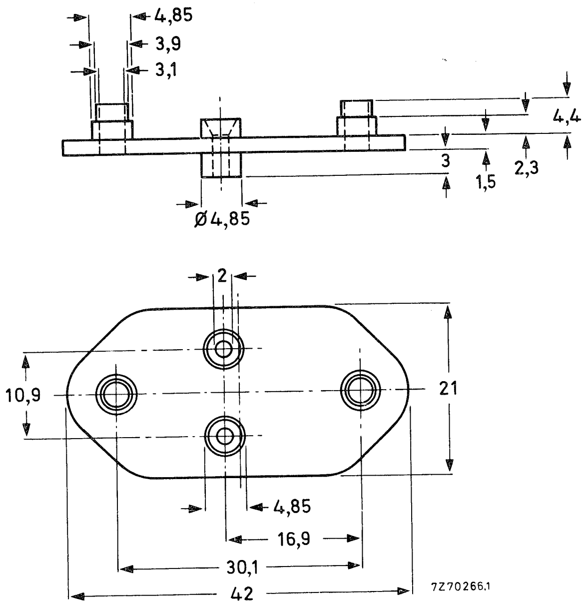
56352 MOUNTING SUPPORT

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 °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

			OM931	OM961
Sinusoidal output power for $d_{tot} < 0,2$ %				
f = 20 Hz to 20 kHz				
$R_L = 4\,\Omega$	P_o		> 30 W at ± 23 V	> 60 W at ± 31 V
$R_L = 8\,\Omega$	P_o		> 30 W at ± 26 V	> 60 W at ± 35 V
Total harmonic distortion				
$P_o = 1$ W; f = 1 kHz	d_{tot}	typ.	0,02	0,02 %

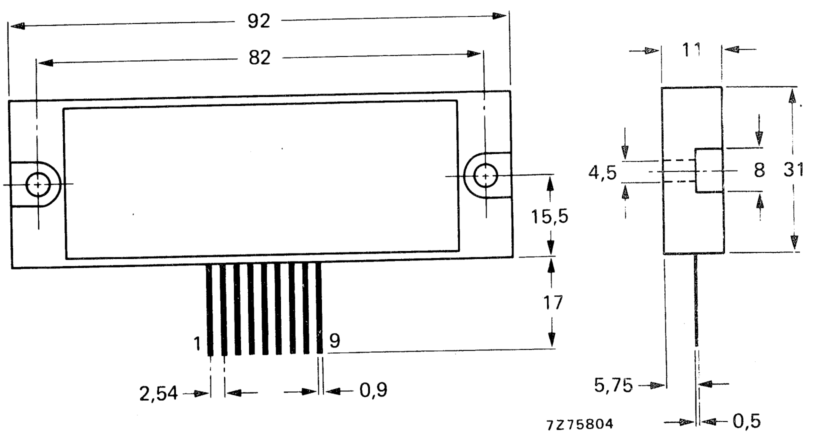


Fig. 1 Outline; dimensions in mm.

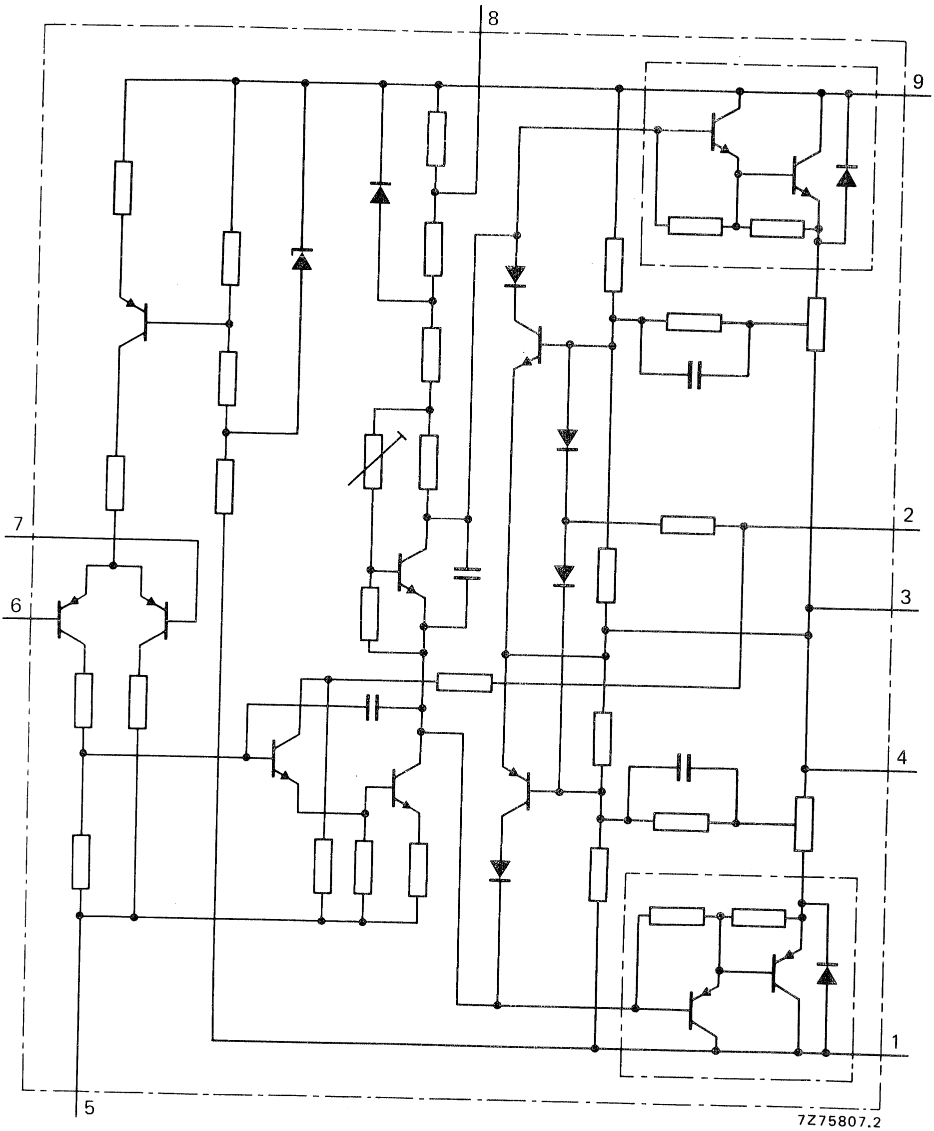


Fig. 2 Circuit diagram.

RATINGS

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

Symmetrical supply voltage	OM931	V_S	max.	±40 V
	OM961	V_S	max.	±45 V
Operating mounting base temperature		T_{mb}	max.	95 °C
Storage temperature		T_{stg}		−30 to +100 °C

CHARACTERISTICS

Mounted on a heatsink with $R_{th\ h\text{-}a}$ = 1,4 K/W (OM931) and $R_{th\ h\text{-}a}$ = 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 Ω	P_o	>	30	–	60	–	W*
R_L = 8 Ω	P_o	>	–	30	–	60	W*
Clipping level at f = 1 kHz; R_L = 4 Ω; 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	d_{im}	typ.	0,05		0,05		%
P_o = rated value	d_{im}	typ.	0,1		0,1		%
Input sensitivity for P_o = rated value	V_i	typ.	0,7	1	1	1,4	V

Input impedance determined by input circuitry	R_i	typ.	10 kΩ
Open loop gain	G_o	typ.	80 dB
Closed loop gain	G_c	typ.	24 dB
Frequency response P_o = rated value −10 dB (−1 dB)	f		30 Hz to 40 kHz
Power bandwidth (−3 dB)	f_p		20 Hz to 40 kHz
Signal-to-noise ratio (unweighted) P_o = 50 mW; wide band	S/N	typ.	75 dB
Signal-to-noise ratio (weighted) P_o = 50 mW; A-curve	S/N	typ.	87 dB
D.C. output offset voltage	V_{off}	typ.	±20 mV
Ripple rejection	RR	⩾	65 dB
Output impedance	R_o	typ.	0,05 Ω

* P_o is stated as rated value.

APPLICATION INFORMATION

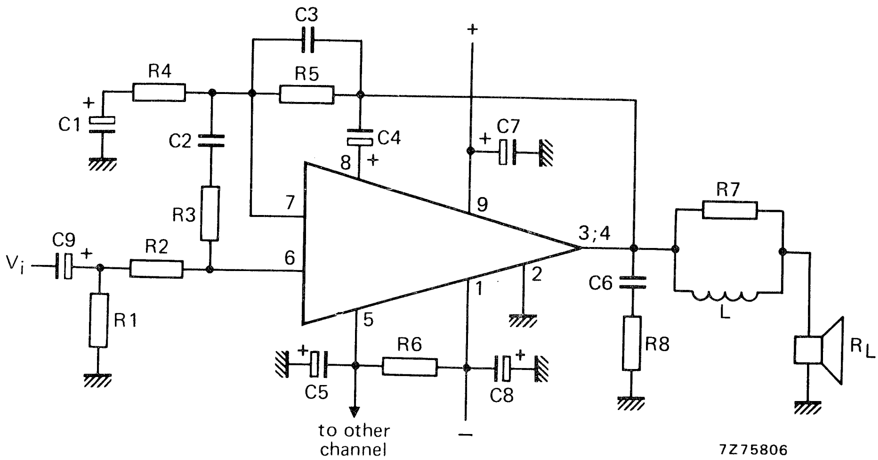


Fig. 3 Example of an amplifier with external components.

List of components:

R1 = 10 kΩ (0,25 W)	C1 = 47 μF (10 V)	L = 4 μH
R2 = 4,7 kΩ (0,25 W)	C2 = 270 pF (10%)	R_L = 4 or 8 Ω
R3 = 300 Ω (0,25 W)	C3 = 120 pF (10%)	
R4 = 680 Ω (0,25 W)	C4 = 100 μF	
R5 = 10 kΩ (0,25 W)	C5 = 470 μF	
R6 = 22 Ω (0,5 W)	C6 = 100 nF	
R7 = 2,2 Ω (0,25 W)	C7 = 10 μF (63 V)	
R8 = 10 Ω (0,5 W)	C8 = 10 μF (63 V)	
	C9 = 1 μF (63 V)	

MOUNTING RECOMMENDATIONS

The modules are delivered with leads in SIL (single in-line) but leads may also be bent to DIL (dual in-line).

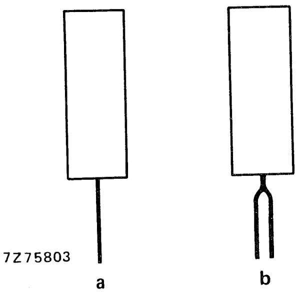
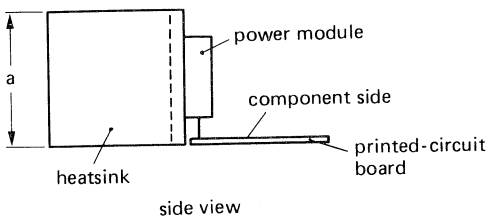


Fig. 4:
a. Single in-line (SIL) leads.
b. Dual in-line (DIL) leads.



Thermal resistance values from heatsink to ambient for various heatsink lengths (a):

$R_{th\ h\text{-}a}$ = 1,4 K/W: a = 50 mm
$R_{th\ h\text{-}a}$ = 1,0 K/W: a = 75 mm
$R_{th\ h\text{-}a}$ = 0,8 K/W: a = 90 mm

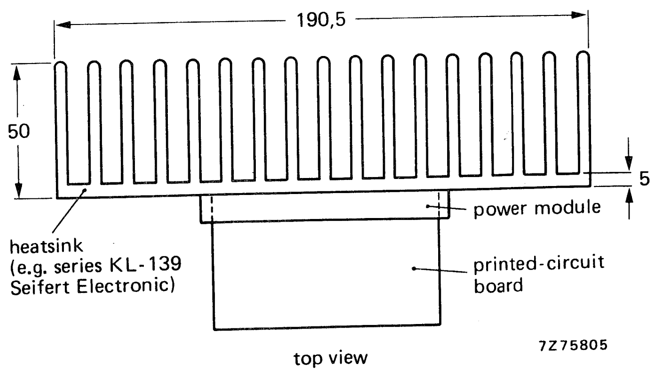


Fig. 5 Example of a heatsink to be used for the module; dimensions in mm.

PRINTED-CIRCUIT BOARDS for OM931 and OM961

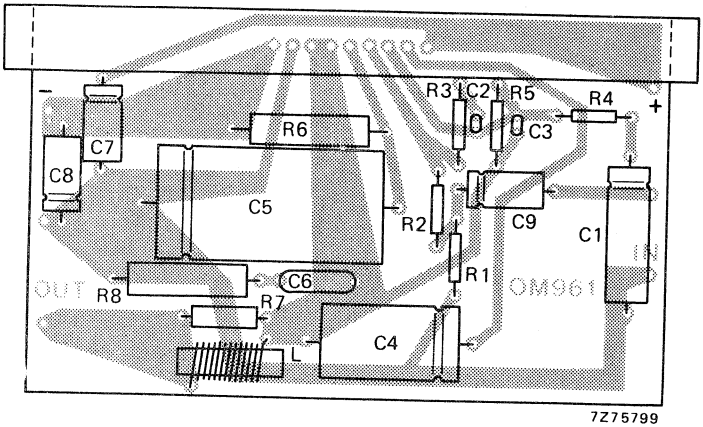


Fig. 6 Component side of SIL-version showing component layout.

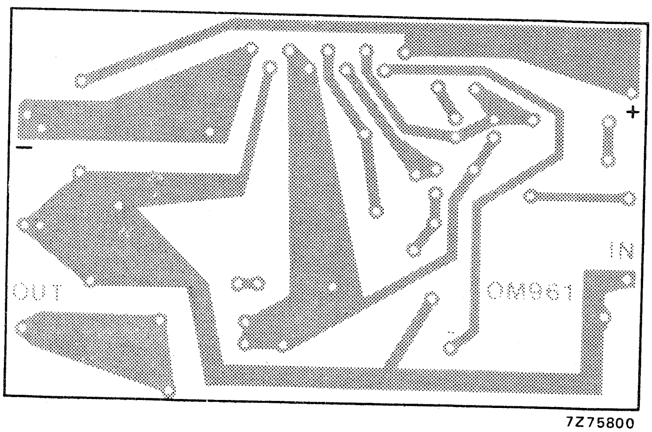


Fig. 7 Component side of DIL-version; for component layout see Fig. 6.

Dimensions in mm

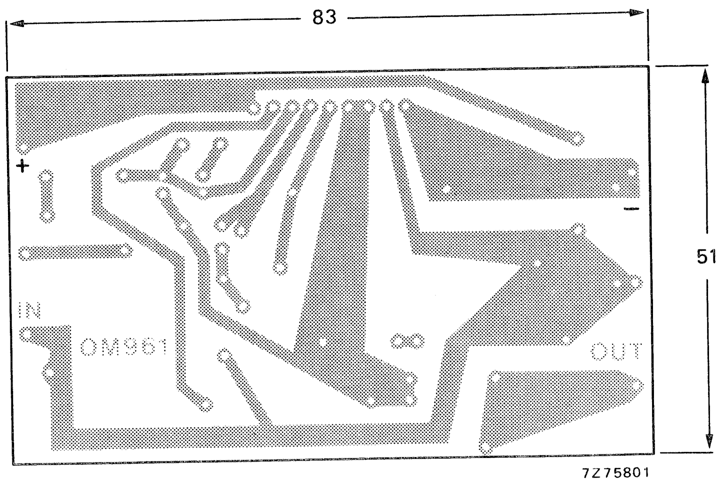


Fig. 8 Track side of SIL-version.

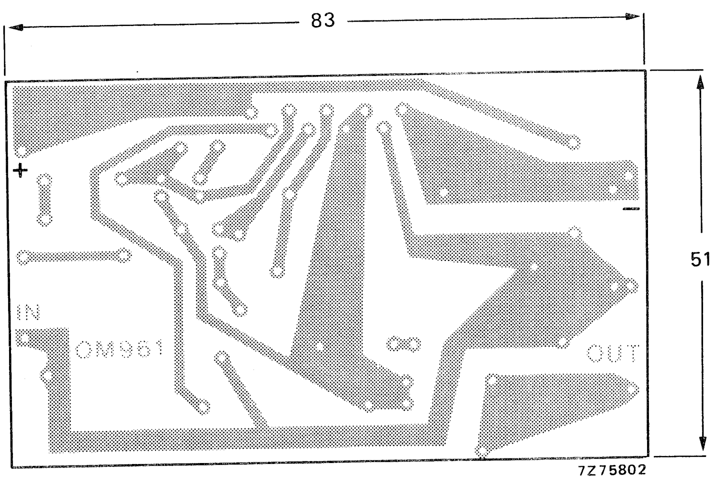


Fig. 9 Track side of DIL-version.

NOTES

NOTES

LOW-FREQUENCY POWER TRANSISTORS

TYPE NUMBER SURVEY
SELECTION GUIDE

GENERAL

TRANSISTOR DATA

MOUNTING INSTRUCTIONS

ACCESSORIES

HYBRID MODULES

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