

# SEMICONDUCTORS

PART 7 - DECEMBER 1980

## MICROMINIATURE SEMICONDUCTORS FOR HYBRID CIRCUITS

DATA HANDBOOK SYSTEM  
SEMICONDUCTOR INDEX

SELECTION GUIDE

TYPE NUMBER SURVEY

GENERAL

SOLDERING RECOMMENDATIONS  
THERMAL CHARACTERISTICS

DEVICE DATA





## DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, sub-assemblies and materials; it is made up of 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.

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## ELECTRON TUBES (BLUE SERIES)

Starting in 1980, new part numbers and corresponding codes are being introduced. The former code of the preceding issue is given in brackets under the new code.

<b>Part 1</b>	<b>February 1980</b>	<b>T1 02-80</b> <b>(ET1a 12-75)</b>	<b>Tubes for r.f. heating</b>
<b>Part 2</b>	<b>April 1980</b>	<b>T2 04-80</b> <b>(ET1b 08-77)</b>	<b>Transmitting tubes for communications</b>
<b>Part 2b</b>	<b>May 1978</b>	<b>ET2b 05-78</b>	<b>Microwave semiconductors and components</b> Gunn, Impatt and noise diodes, mixer and detector diodes, backward diodes, varactor diodes, Gunn oscillators, sub-assemblies, circulators and isolators.
<b>Part 3</b>	<b>June 1980</b>	<b>T3 06-80</b> <b>(ET2a 11-77)</b>	<b>Klystrons, travelling-wave tubes, microwave diodes</b>
<b>Part 3</b>	<b>January 1975</b>	<b>ET3 01-75</b>	<b>Special Quality tubes, miscellaneous devices</b>
<b>Part 4</b>	<b>September 1980</b>	<b>T4 09-80</b> <b>(ET2a 11-77)</b>	<b>Magnetrons</b>
<b>Part 5a</b>	<b>October 1979</b>	<b>ET5a 10-79</b>	<b>Cathode-ray tubes</b> Instrument tubes, monitor and display tubes, C.R. tubes for special applications.
<b>Part 5b</b>	<b>December 1978</b>	<b>ET5b 12-78</b>	<b>Camera tubes and accessories, image intensifiers</b>
<b>Part 6</b>	<b>July 1980</b>	<b>T6 07-80</b> <b>(ET6 01-77)</b>	<b>Geiger-Müller tubes</b>
<b>Part 7a</b>	<b>March 1977</b>	<b>ET7a 03-77</b>	<b>Gas-filled tubes</b> Thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes.
<b>Part 7b</b>	<b>May 1979</b>	<b>ET7b 05-79</b>	<b>Gas-filled tubes</b> Segment indicator tubes, indicator tubes, switching diodes, dry reed contact units.
<b>Part 8</b>	<b>July 1979</b>	<b>ET8 07-79</b>	<b>Picture tubes and components</b> Colour TV picture tubes, black and white TV picture tubes, monitor tubes, components for colour television, components for black and white television.
<b>Part 9</b>	<b>June 1980</b>	<b>T9 06-80</b> <b>(ET9 03-78)</b>	<b>Photo and electron multipliers</b> Photomultiplier tubes, phototubes, single channel electron multipliers, channel electron multiplier plates.



## SEMICONDUCTORS (RED SERIES)

Starting in 1980, new part numbers and corresponding codes are being introduced. The former code of the preceding issue is given in brackets under the new code.

Part 1	March 1980	S1 03-80 (SC1b 05-77)	Diodes Small-signal germanium diodes, small-signal silicon diodes, special diodes, voltage regulator diodes (< 1,5 W), voltage reference diodes, tuner diodes, rectifier diodes
Part 2	May 1980	S2 05-80 (SC1a 08-78)	Power diodes, thyristors, triacs Rectifier diodes, voltage regulator diodes (> 1,5 W), rectifier stacks, thyristors, triacs
Part 2	June 1979	SC2 06-79	Low-frequency power transistors
Part 3	January 1978	SC3 01-78	High-frequency, switching and field-effect transistors*
Part 3	April 1980	S3 04-80 (SC2 11-77, partly) (SC3 01-78, partly)	Small-signal transistors
Part 4a	December 1978	SC4a 12-78	Transmitting transistors and modules
Part 4b	September 1978	SC4b 09-78	Devices for optoelectronics Photosensitive diodes and transistors, light-emitting diodes, photocouplers, infrared sensitive devices, photoconductive devices
Part 5	October 1980	S5 10-80 (SC3 01-78)	Field-effect transistors
Part 7	December 1980	S7 12-80 (SC4c 07-78)	Discrete semiconductors for hybrid circuits

\* Wideband transistors will be transferred to S10. The old book SC3 01-78 should be kept until then.

## INTEGRATED CIRCUITS (PURPLE SERIES)

Starting in 1980, new part numbers and corresponding codes are being introduced. The former code of the preceding issue is given in brackets under the new code. Books with the purple cover will replace existing red covered editions as each is revised.

<b>Part 1</b>	<b>May 1980</b>	<b>IC1 05-80 (SC5b 03-77)</b>	<b>Bipolar ICs for radio and audio equipment</b>
<b>Part 2</b>	<b>May 1980</b>	<b>IC2 05-80 (SC5b 03-77)</b>	<b>Bipolar ICs for video equipment</b>
<b>Part 5a</b>	<b>November 1976</b>	<b>SC5a 11-76</b>	<b>Professional analogue integrated circuits</b>
<b>Part 4</b>	<b>October 1980</b>	<b>IC4 10-80 (SC6 10-77)</b>	<b>Digital integrated circuits</b> LOC MOS HE4000B family
<b>Part 6b</b>	<b>August 1979</b>	<b>SC6b 08-79</b>	<b>ICs for digital systems in radio and television receivers</b>
<b>Signetics integrated circuits</b>			Bipolar and MOS memories 1979 Bipolar and MOS microprocessors 1978 Analogue circuits 1979 Logic - TTL 1978

## COMPONENTS AND MATERIALS (GREEN SERIES)

Starting in 1980, new part numbers and corresponding codes are being introduced. The former code of the preceding issue is given in brackets under the new code.

Part 1	July 1979	CM1 07-79	<b>Assemblies for industrial use</b> PLC modules, high noise immunity logic FZ/30 series, NORbits 60-series, 61-series, 90-series, input devices, hybrid integrated circuits, peripheral devices
Part 3a	September 1978	CM3a 09-78	<b>FM tuners, television tuners, surface acoustic wave filters</b>
Part 3b	October 1978	CM3b 10-78	<b>Loudspeakers</b>
Part 4a	November 1978	CM4a 11-78	<b>Soft Ferrites</b> Ferrites for radio, audio and television, beads and chokes, Ferroxcube potcores and square cores, Ferroxcube transformer cores
Part 4b	February 1979	CM4b 02-79	<b>Piezoelectric ceramics, permanent magnet materials</b>
Part 6	April 1977	CM6 04-77	<b>Electric motors and accessories</b> Small synchronous motors, stepper motors, miniature direct current motors
Part 7a	January 1979	CM7a 01-79	<b>Assemblies</b> Circuit blocks 40-series and CSA70 (L), counter modules 50-series, input/output devices
Part 8	June 1979	CM8 06-79	<b>Variable mains transformers</b>
Part 9	August 1979	CM9 08-79	<b>Piezoelectric quartz devices</b> Quartz crystal units, temperature compensated crystal oscillators
Part 10	October 1980	C10 10-80	<b>Connectors</b>
Part 11	December 1979	CM11 12-79	<b>Non-linear resistors</b> Voltage dependent resistors (VDR), light dependent resistors (LDR), negative temperature coefficient thermistors (NTC), positive temperature coefficient thermistors (PTC)
Part 12	November 1979	CM12 11-79	<b>Variable resistors and test switches</b>
Part 13	December 1979	CM13 12-79	<b>Fixed resistors</b>
Part 14	April 1980	C14 04-80 (CM2b 02-78)	<b>Electrolytic and solid capacitors</b>
Part 15	May 1980	C15 05-80 (CM2b 02-78)	<b>Film capacitors, ceramic capacitors, variable capacitors</b>







SEMICONDUCTER INDEX







## INDEX OF TYPE NUMBERS

Data Handbooks S1 to S7

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

type no.	part	section	type no.	part	section	type no.	part	section
AA119	S1	PC	BAS21	S7	Mm	BB110G	S1	T
AAZ13	S1	GB	BAT17	S7	Mm	BB119	S1	T
AAZ15	S1	GB	BAT18	S7	Mm	BB204B	S1	T
AAZ17	S1	GB	BAV10	S1	WD	BB204G	S1	T
AAZ18	S1	GB	BAV18	S1	WD	BB212	S1	T
BA182	S1	T	BAV19	S1	WD	BB405B	S1	T
BA220	S1	WD	BAV20	S1	WD	BB405G	S1	T
BA221	S1	WD	BAV21	S1	WD	BBY31	S7	Mm
BA223	S1	T	BAV45	S1	Sp	BBY40	S7	Mm
BA243	S1	T	BAV70	S7	Mm	BC107	S3	Sm
BA244	S1	T	BAV99	S7	Mm	BC108	S3	Sm
BA280	S1	T	BAW56	S7	Mm	BC109	S3	Sm
BA314	S1	Vrg	BAW62	S1	WD	BC140	S3	Sm
BA315	S1	Vrg	BAX12	S1	WD	BC141	S3	Sm
BA316	S1	WD	BAX12A	S1	WD	BC146	S3	Sm
BA317	S1	WD	BAX13	S1	WD	BC147	S3	Sm
BA318	S1	WD	BAX14A	S1	WD	BC148	S3	Sm
BA379	S1	T	BAX16	S1	WD	BC149	S3	Sm
BA482	S1	T	BAX17	S1	WD	BC157	S3	Sm
BA483	S1	T	BAX18A	S1	WD	BC158	S3	Sm
BAS11	S1	WD	BB105B	S1	T	BC159	S3	Sm
BAS16	S7	Mm	BB105G	S1	T	BC160	S3	Sm
BAS17	S7	Mm	BB106	S1	T	BC161	S3	Sm
BAS19	S7	Mm	BB109G	S1	T	BC177	S3	Sm
BAS20	S7	Mm	BB110B	S1	T	BC178	S3	Sm

GB = Germanium gold bonded diodes  
Mm = Microminiature semiconductors  
for hybrid circuits  
PC = Germanium point contact diodes

Sm = Small-signal transistors  
Sp = Special diodes  
T = Tuner diodes  
Vrg = Voltage regulator diodes  
WD = Silicon whiskerless diodes

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type no.	part	section	type no.	part	section	type no.	part	section
BC179	S3	Sm	BCW31;R	S7	Mm	BD135	SC2	P
BC200	S3	Sm	BCW32;R	S7	Mm	BD136	SC2	P
BC264A	S5	FET	BCW33;R	S7	Mm	BD137	SC2	P
BC264B	S5	FET	BCW60*	S7	Mm	BD138	SC2	P
BC264C	S5	FET	BCW61*	S7	Mm	BD139	SC2	P
			BCW69;R	S7	Mm			
BC264D	S5	FET	BCW70;R	S7	Mm	BD140	SC2	P
BC327	S3	Sm	BCW71;R	S7	Mm	BD181	SC2	P
BC328	S3	Sm	BCW72;R	S7	Mm	BD182	SC2	P
BC337	S3	Sm	BCW81;R	S7	Mm	BD183	SC2	P
BC338	S3	Sm	BCW89;R	S7	Mm	BD201	SC2	P
			BCX17;R	S7	Mm			
BC368	S3	Sm	BCX18;R	S7	Mm	BD202	SC2	P
BC369	S3	Sm	BCX19;R	S7	Mm	BD203	SC2	P
BC375	S3	Sm	BCX20;R	S7	Mm	BD204	SC2	P
BC376	S3	Sm	BCX51	S7	Mm	BD226	SC2	P
BC546	S3	Sm	BCX52	S7	Mm	BD227	SC2	P
			BCX53	S7	Mm			
BC547	S3	Sm	BCX54	S7	Mm	BD228	SC2	P
BC548	S3	Sm	BCX55	S7	Mm	BD229	SC2	P
BC549	S3	Sm	BCX56	S7	Mm	BD230	SC2	P
BC550	S3	Sm	BCX70*	S7	Mm	BD231	SC2	P
BC556	S3	Sm	BCX71*	S7	Mm	BD232	SC2	P
BC557	S3	Sm	BCY30A	S3	Sm	BD233	SC2	P
BC558	S3	Sm	BCY31A	S3	Sm	BD234	SC2	P
BC559	S3	Sm	BCY32A	S3	Sm	BD235	SC2	P
BC560	S3	Sm	BCY33A	S3	Sm	BD236	SC2	P
BC635	S3	Sm	BCY34A	S3	Sm	BD237	SC2	P
BC636	S3	Sm	BCY56	S3	Sm	BD238	SC2	P
BC637	S3	Sm	BCY57	S3	Sm	BD291	SC2	P
BC638	S3	Sm	BCY58	S3	Sm	BD292	SC2	P
BC639	S3	Sm	BCY59	S3	Sm	BD293	SC2	P
BC640	S3	Sm	BCY70	S3	Sm	BD294	SC2	P
BCF29;R	S7	Mm	BCY71	S3	Sm	BD295	SC2	P
BCF30;R	S7	Mm	BCY72	S3	Sm	BD296	SC2	P
BCF32;R	S7	Mm	BCY78	S3	Sm	BD329	SC2	P
BCF33;R	S7	Mm	BCY79	S3	Sm	BD330	SC2	P
BCF70;R	S7	Mm	BCY87	S3	Sm	BD331	SC2	P
BCF81;R	S7	Mm	BCY88	S3	Sm	BD332	SC2	P
BCV71;R	S7	Mm	BCY89	S3	Sm	BD333	SC2	P
BCV72;R	S7	Mm	BD131	SC2	P	BD334	SC2	P
BCW29;R	S7	Mm	BD132	SC2	P	BD335	SC2	P
BCW30;R	S7	Mm	BD133	SC2	P	BD336	SC2	P

\* = Series  
FET = Field-effect transistors

Mm = Microminiature semiconductors  
for hybrid circuits

type no.	part	section	type no.	part	section	type no.	part	section
BD337	SC2	P	BD947	SC2	P	BDX62A	SC2	P
BD338	SC2	P	BD948	SC2	P	BDX62B	SC2	P
BD433	SC2	P	BD949	SC2	P	BDX62C	SC2	P
BD434	SC2	P	BD950	SC2	P	BDX63 SC2	P	P
BD435	SC2	P	BD951	SC2	P	BDX63A	SC2	P
BD436	SC2	P	BD952	SC2	P	BDX63B	SC2	P
BD437	SC2	P	BD953	SC2	P	BDX63C	SC2	P
BD438	SC2	P	BD954	SC2	P	BDX64	SC2	P
BD645	SC2	P	BD955	SC2	P	BDX64A	SC2	P
BD646	SC2	P	BD956	SC2	P	BDX64B	SC2	P
BD647	SC2	P	BDT62	SC2	P	BDX64C	SC2	P
BD648	SC2	P	BDT62A	SC2	P	BDX65	SC2	P
BD649	SC2	P	BDT62B	SC2	P	BDX65A	SC2	P
BD650	SC2	P	BDT62C	SC2	P	BDX65B	SC2	P
BD651	SC2	P	BDT63	SC2	P	BDX65C	SC2	P
BD652	SC2	P	BDT63A	SC2	P	BDX66	SC2	P
BD675	SC2	P	BDT63B	SC2	P	BDX66A	SC2	P
BD676	SC2	P	BDT63C	SC2	P	BDX66B	SC2	P
BD677	SC2	P	BDT91	SC2	P	BDX66C	SC2	P
BD678	SC2	P	BDT92	SC2	P	BDX67	SC2	P
BD679	SC2	P	BDT93	SC2	P	BDX67A	SC2	P
BD680	SC2	P	BDT94	SC2	P	BDX67B	SC2	P
BD681	SC2	P	BDT95	SC2	P	BDX67C	SC2	P
BD682	SC2	P	BDT96	SC2	P	BDX77	SC2	P
BD683	SC2	P	BDV64	SC2	P	BDX78	SC2	P
BD684	SC2	P	BDV64A	SC2	P	BDX91	SC2	P
BD933	SC2	P	BDV64B	SC2	P	BDX92	SC2	P
BD934	SC2	P	BDV65	SC2	P	BDX93	SC2	P
BD935	SC2	P	BDV65A	SC2	P	BDX94	SC2	P
BD936	SC2	P	BDV65B	SC2	P	BDX95	SC2	P
BD937	SC2	P	BDX35	SC2	P	BDX96	SC2	P
BD938	SC2	P	BDX36	SC2	P	BDY20	SC2	P
BD939	SC2	P	BDX37	SC2	P	BDY90	SC2	P
BD940	SC2	P	BDX42	SC2	P	BDY91	SC2	P
BD941	SC2	P	BDX43	SC2	P	BDY92	SC2	P
BD942	SC2	P	BDX44	SC2	P	BDY93	SC2	P
BD943	SC2	P	BDX45	SC2	P	BDY94	SC2	P
BD944	SC2	P	BDX46	SC2	P	BDY96	SC2	P
BD945	SC2	P	BDX47	SC2	P	BDY97	SC2	P
BD946	SC2	P	BDX62	SC2	P	BF115	S3	Sm

P = Low-frequency power transistors

Sm = Small-signal transistors

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type no.	part	section	type no.	part	section	type no.	part	section
BF180	S3	Sm	BF469	SC2	P	BFQ32	SC3	HFSW
BF181	S3	Sm	BF470	SC2	P	BFQ34	SC3	HFSW
BF182	S3	Sm	BF471	SC2	P	BFQ42	4a	Tra
BF183	S3	Sm	BF472	SC2	P	BFQ43	4a	Tra
BF194	S3	Sm	BF480	S3	Sm	BFR29	S5	FET
BF195	S3	Sm	BF494	S3	Sm	BFR30	S7	Mm
BF196	S3	Sm	BF495	S3	Sm	BFR31	S7	Mm
BF197	S3	Sm	BF496	S3	Sm	BFR49	SC3	HFSW
BF198	S3	Sm	BF510	S7	Mm	BFR53;R	S7	Mm
BF199	S3	Sm	BF511	S7	Mm	BFR54	S3	Sm
BF200	S3	Sm	BF512	S7	Mm	BFR64	SC3	HFSW
BF240	S3	Sm	BF513	S7	Mm	BFR65	SC3	HFSW
BF241	S3	Sm	BF536	S7	Mm	BFR84	S5	FET
BF245A	S5	FET	BF550;R	S7	Mm	BFR90	SC3	HFSW
BF245B	S5	FET	BF569	S7	Mm	BFR91	SC3	HFSW
BF245C	S5	FET	BF579	S7	Mm	BFR92;R	S7	Mm
BF246A	S5	FET	BF622	S7	Mm	BFR93;R	S7	Mm
BF246B	S5	FET	BF623	S7	Mm	BFR94	SC3	HFSW
BF246C	S5	FET	BF660;R	S7	Mm	BFR95	SC3	HFSW
BF256A	S5	FET	BF767	S7	Mm	BFR96	SC3	HFSW
BF256B	S5	FET	BF926	S3	Sm	BFS17;R	S7	Mm
BF256C	S5	FET	BF936	S3	Sm	BFS18;R	S7	Mm
BF324	S3	Sm	BF939	S3	Sm	BFS19;R	S7	Mm
BF336	S3	Sm	BF960	S5	FET	BFS20;R	S7	Mm
BF337	S3	Sm	BF967	S3	Sm	BFS21	S5	FET
BF338	S3	Sm	BF970	S3	Sm	BFS21A	S5	FET
BF362	S3	Sm	BF979	S3	Sm	BFS22A	4a	Tra
BF363	S3	Sm	BF981	S5	FET	BFS23A	4a	Tra
BF410A	S5	FET	BFQ10	S5	FET	BFS28	S5	FET
BF410B	S5	FET	BFQ11	S5	FET	BFT24	SC3	HFSW
BF410C	S5	FET	BFQ12	S5	FET	BFT25;R	S7	Mm
BF410D	S5	FET	BFQ13	S5	FET	BFT44	S3	Sm
BF419	SC2	P	BFQ14	S5	FET	BFT45	S3	Sm
BF422	S3	Sm	BFQ15	S5	FET	BFT46	S7	Mm
BF423	S3	Sm	BFQ16	S5	FET	BFT92;R	S7	Mm
BF450	S3	Sm	BFQ17	S7	Mm	BFT93;R	S7	Mm
BF451	S3	Sm	BFQ18A	S7	Mm	BFW10	S5	FET
BF457	SC2	P	BFQ19	S7	Mm	BFW11	S5	FET
BF458	SC2	P	BFQ23	SC3	HFSW	BFW12	S5	FET
BF459	SC2	P	BFQ24	SC3	HFSW	BFW13	S5	FET

FET = Field-effect transistors  
HFSW = High-frequency and switching transistors

Mm = Microminiature semiconductors  
for hybrid circuits

P = Low-frequency power transistors

type no.	part	section	type no.	part	section	type no.	part	section
BFW16A	SC3	HFSW	BLW60C	4a	Tra	BLY89C	4a	Tra
BFW17A	SC3	HFSW	BLW64	4a	Tra	BLY90	4a	Tra
BFW30	SC3	HFSW	BLW75	4a	Tra	BLY91A	4a	Tra
BFW45	SC3	HFSW	BLW76	4a	Tra	BLY91C	4a	Tra
BFW61	S5	FET	BLW77	4a	Tra	BLY92A	4a	Tra
BFW92	SC3	HFSW	BLW78	4a	Tra	BLY92C	4a	Tra
BFW93	SC3	HFSW	BLW79	4a	Tra	BLY93A	4a	Tra
BFX29	S3	Sm	BLW80	4a	Tra	BLY93C	4a	Tra
BFX30	S3	Sm	BLW81	4a	Tra	BLY94	4a	Tra
BFX34	S3	Sm	BLW82	4a	Tra	BPW22	4b	PDT
BFX84	S3	Sm	BLW83	4a	Tra	BPW34	4b	PDT
BFX85	S3	Sm	BLW84	4a	Tra	BPX25	4b	PDT
BFX86	S3	Sm	BLW85	4a	Tra	BPX29	4b	PDT
BFX87	S3	Sm	BLW86	4a	Tra	BPX40	4b	PDT
BFX88	S3	Sm	BLW87	4a	Tra	BPX41	4b	PDT
BFX89	SC3	HFSW	BLW95	4a	Tra	BPX42	4b	PDT
BFY50	S3	Sm	BLW98	4a	Tra	BPX47A	4b	PDT
BFY51	S3	Sm	BLX13	4a	Tra	BPX70	4b	PDT
BFY52	S3	Sm	BLX13C	4a	Tra	BPX71	4b	PDT
BFY55	S3	Sm	BLX14	4a	Tra	BPX72	4b	PDT
BFY90	SC3	HFSW	BLX15	4a	Tra	BPX94	4b	PDT
BGY22	4a	Tra	BLX39	4a	Tra	BPX95B	4b	PDT
BGY22A	4a	Tra	BLX65	4a	Tra	BR100/03	S2	Th
BGY23	4a	Tra	BLX66	4a	Tra	BR101	S3	Sm
BGY23A	4a	Tra	BLX67	4a	Tra	BRY39P	S3	Sm
BGY32	4a	Tra	BLX68	4a	Tra	BRY39S	S3	Sm
BGY33	4a	Tra	BLX69A	4a	Tra	BRY39T	S2	Th
BGY35	4a	Tra	BLX91A	4a	Tra	BRY39T	S3	Sm
BGY36	4a	Tra	BLX92A	4a	Tra	BRY56	S3	Sm
BGY37	SC3	HFSW	BLX93A	4a	Tra	BRY61	S7	Mm
BLV10	4a	Tra	BLX94A	4a	Tra	BSR12;R	S7	Mm
BLV11	4a	Tra	BLX95	4a	Tra	BSR13;R	S7	Mm
BLV20	4a	Tra	BLX96	4a	Tra	BSR14;R	S7	Mm
BLV21	4a	Tra	BLX97	4a	Tra	BSR15;R	S7	Mm
BLW29	4a	Tra	BLX98	4a	Tra	BSR16;R	S7	Mm
BLW31	4a	Tra	BLY87A	4a	Tra	BSR17;R	S7	Mm
BLW32	4a	Tra	BLY87C	4a	Tra	BSR30	S7	Mm
BLW33	4a	Tra	BLY88A	4a	Tra	BSR31	S7	Mm
BLW34	4a	Tra	BLY88C	4a	Tra	BSR32	S7	Mm
BLW60	4a	Tra	BLY89A	4a	Tra			

PDT = Photodiodes or transistors  
Sm = Small-signal transistors

Th = Thyristors  
Tra = Transmitting transistors and modules

# INDEX

type no.	part	section	type no.	part	section	type no.	part	section
BSR33	S7	Mm	BSX46	S3	Sm	BU209A	SC2	P
BSR40	S7	Mm	BSX47	S3	Sm	BU326	SC2	P
BSR41	S7	Mm	BSX59	S3	Sm	BU326A	SC2	P
BSR42	S7	Mm	BSX60	S3	Sm	BU426	SC2	P
BSR43	S7	Mm	BSX61	S3	Sm	BU426A	SC2	P
BSR50	S3	Sm	BSY95A	S3	Sm	BU433	SC2	P
BSR51	S3	Sm	BT136 *	S2	Tri	BUW84	SC2	P
BSR52	S3	Sm	BT137 *	S2	Tri	BUW85	SC2	P
BSR56	S7	Mm	BT138 *	S2	Tri	BUX80	SC2	P
BSR57	S7	Mm	BT139 *	S2	Tri	BUX81	SC2	P
BSR58	S7	Mm	BT151 *	S2	Th	BUX82	SC2	P
BSR60	S3	Sm	BT152 *	S2	Th	BUX83	SC2	P
BSR61	S3	Sm	BT153	S2	Th	BUX84	SC2	P
BSR62	S3	Sm	BT154	S2	Th	BUX85	SC2	P
BSS38	S3	Sm	BTW23 *	S2	Th	BUX86	SC2	P
BSS50	S3	Sm	BTW24 *	S2	Th	BUX87	SC2	P
BSS51	S3	Sm	BTW30S*	S2	Th	BY126M	S1	R
BSS52	S3	Sm	BTW31W*	S2	Th	BY127M	S1	R
BSS60	S3	Sm	BTW33 *	S2	Th	BY164	S2	R
BSS61	S3	Sm	BTW34 *	S2	Tri	BY179	S2	R
BSS62	S3	Sm	BTW38 *	S2	Th	BY184	S1	R
BSS63;R	S7	Mm	BTW40 *	S2	Th	BY206	S1	R
BSS64;R	S7	Mm	BTW41 *	S2	Tri	BY207	S1	R
BSS68	S3	Sm	BTW42 *	S2	Th	BY208 *	S1	R
BSV15	S3	Sm	BTW43 *	S2	Tri	BY210	S1	R
BSV16	S3	Sm	BTW45 *	S2	Th	BY223	S2	R
BSV17	S3	Sm	BTW47 *	S2	Th	BY224 *	S2	R
BSV52;R	S7	Mm	BTW92 *	S2	Th	BY225 *	S2	R
BSV64	S3	Sm	BTX18 *	S2	Th	BY226	S1	R
BSV78	S5	FET	BTX94 *	S2	Tri	BY227	S1	R
BSV79	S5	FET	BTY79 *	S2	Th	BY228	S1	R
BSV80	S5	FET	BTY87 *	S2	Th	BY229 *	S2	R
BSV81	S5	FET	BTY91 *	S2	Th	BY256	S2	R
BSW66A	S3	Sm	BU126	SC2	P	BY257	S2	R
BSW67A	S3	Sm	BU133	SC2	P	BY260 *	S2	R
BSW68A	S3	Sm	BU204	SC2	P	BY261 *	S2	R
BSX19	S3	Sm	BU205	SC2	P	BY277 *	S2	R
BSX20	S3	Sm	BU206	SC2	P	BY409	S1	R
BSX21	S3	Sm	BU207A	SC2	P	BY409A	S1	R
BSX45	S3	Sm	BU208A	SC2	P	BY438	S1	R

\* = series

FET = Field-effect transistors

GB = Germanium gold bonded diodes

I = Infrared devices

LED = Light-emitting diodes

Mm = Microminiature semiconductors  
for hybrid circuits

P = Low-frequency power transistors

PC = Germanium point contact diodes

Ph = Photoconductive devices

type no.	part	section	type no.	part	section	type no.	part	section
BY448	S1	R	BYX55 *	S1	R	CNY42	4b	PhC
BY458	S1	R	BYX56 *	S2	R	CNY43	4b	PhC
BY476	S1	R	BYX71 *	S2	R	CNY44	4b	PhC
BY477	S1	R	BYX90	S1	R	CNY46	4b	PhC
BY478	S1	R	BYX91 *	S1	R	CNY47	4b	PhC
BY509	S1	R	BYX94	S1	R	CNY47A	4b	PhC
BYV21 *	S2	R	BYX96 *	S2	R	CNY48	4b	PhC
BYV30 *	S2	R	BYX97 *	S2	R	CQY11B	4b	LED
BYV92 *	S2	R	BYX98 *	S2	R	CQY11C	4b	LED
BYV95A	S1	R	BYX99 *	S2	R	CQY24A	4b	LED
BYV95B	S1	R	BZV10	S1	Vrf	CQY46A	4b	LED
BYV95C	S1	R	BZV11	S1	Vrf	CQY47A	4b	LED
BYV96D, E	S1	R	BZV12	S1	Vrf	CQY49B	4b	LED
BYW19*	S2	R	BZV13	S1	Vrf	CQY49C	4b	LED
BYW25	S2	R	BZV14	S1	Vrf	CQY50	4b	LED
BYW29 *	S2	R	BZV15 *	S2	Vrg	CQY52	4b	LED
BYW30 *	S2	R	BZV46	S1	Vrg	CQY54	4b	LED
BYW31 *	S2	R	BZV85	S1	Vrg	CQY58	4b	LED
BYW54	S1	R	BZW10	S2	TS	CQY88	4b	LED
BYW55	S1	R	BZW70 *	S2	TS	CQY89	4b	LED
BYW56	S1	R	BZW86 *	S2	TS	CQY94	4b	LED
BYW92 *	S2	R	BZW91 *	S2	TS	CQY95	4b	LED
BYW95A	S1	R	BZX61 *	S1	Vrg	CQY96	4b	LED
BYW95B	S1	R	BZX70 *	S2	Vrg	CQY97	4b	LED
BYW95C	S1	R	BZX78 *	S7	Mm	OA47	S1	GB
BYW96D, E	S1	R	BZX79 *	S1	Vrg	OA90	S1	PC
BYX10	S1	R	BZX84 *	S7	Mm	OA91	S1	PC
BYX22 *	S2	R	BZX87 *	S1	Vrg	OA95	S1	PC
BYX25 *	S2	R	BZX90	S1	Vrf	OA200	S1	WD
BYX30 *	S2	R	BZX91	S1	Vrf	OA202	S1	WD
BYX32 *	S2	R	BZX92	S1	Vrf	OM931	SC2	P
BYX36 *	S1	R	BZX93	S1	Vrf	OM961	SC2	P
BYX38 *	S2	R	BZX94	S1	Vrf	ORP10	4b	I
BYX39 *	S2	R	BZY88 *	S1	Vrg	ORP13	4b	I
BYX42 *	S2	R	BZY91 *	S2	Vrg	ORP23	4b	Ph
BYX45 *	S2	R	BZY93 *	S2	Vrg	ORP52	4b	Ph
BYX46 *	S2	R	BZY95 *	S2	Vrg	ORP60	4b	Ph
BYX49 *	S2	R	BZY96 *	S2	Vrg	ORP61	4b	Ph
BYX50 *	S2	R	CNY22	4b	PhC	ORP62	4b	Ph
BYX52 *	S2	R	CNY23	4b	PhC	ORP66	4b	Ph

PhC = Photocouplers  
 R = Rectifier diodes  
 Sm = Small-signal transistors  
 St = Rectifier stacks  
 Th = Thyristors

Tri = Triacs  
 TS = Transient suppressor diodes  
 Vrf = Voltage reference diodes  
 Vrg = Voltage regulator diodes  
 WD = Silicon whiskerless diodes

# INDEX

type no.	part	section	type no.	part	section	type no.	part	section
ORP68	4b	Ph	SD306	S5	FET	2N1613	S3	Sm
ORP69	4b	Ph	1N821	S1	Vrf	2N1711	S3	Sm
OSB9110	S2	St	1N823	S1	Vrf	2N1893	S3	Sm
OSB9210	S2	St	1N825	S1	Vrf	2N2218	S3	Sm
OSB9310	S2	St	1N827	S1	Vrf	2N2218A	S3	Sm
OSB9410	S2	St	1N829	S1	Vrf	2N2219	S3	Sm
OSM9110	S2	St	1N914	S1	WD	2N2219A	S3	Sm
OSM9210	S2	St	1N916	S1	WD	2N2221	S3	Sm
OSM9310	S2	St	1N3879	S2	R	2N2221A	S3	Sm
OSM9410	S2	St	1N3880	S2	R	2N2222	S3	Sm
OSM9510	S2	St	1N3881	S2	R	2N2222A	S3	Sm
OSM9511	S2	St	1N3882	S2	R	2N2297	S3	Sm
OSM9512	S2	St	1N3889	S2	R	2N2368	S3	Sm
OSS9110	S2	St	1N3890	S2	R	2N2369	S3	Sm
OSS9210	S2	St	1N3891	S2	R	2N2369A	S3	Sm
OSS9310	S2	St	1N3892	S2	R	2N2483	S3	Sm
OSS9410	S2	St	1N3899	S2	R	2N2484	S3	Sm
PH2369	S3	Sm	1N3900	S2	R	2N2904	S3	Sm
RPY58A	4b	Ph	1N3901	S2	R	2N2904A	S3	Sm
RPY71	4b	Ph	1N3902	S2	R	2N2905	S3	Sm
RPY76A	4b	I	1N3903	S2	R	2N2905A	S3	Sm
RPY82	4b	Ph	1N3909	S2	R	2N2906	S3	Sm
RPY84	4b	Ph	1N3910	S2	R	2N2906A	S3	Sm
RPY85	4b	Ph	1N3911	S2	R	2N2907	S3	Sm
RPY86	4b	I	1N3912	S2	R	2N2907A	S3	Sm
RPY87	4b	I	1N3913	S2	R	2N3019	S3	Sm
RPY88	4b	I	1N4001			2N3020	S3	Sm
RPY89	4b	I	to 4007	S1	R	2N3053	S3	Sm
SD205	S5	FET	1N4148	S1	WD	2N3055	SC2	P
SD210	S5	FET	1N4150	S1	WD	2N3375	4a	Tra
SD211	S5	FET	1N4151	S1	WD	2N3439	S3	Sm
SD212	S5	FET	1N4154	S1	WD	2N3440	S3	Sm
SD213	S5	FET	1N4446	S1	WD	2N3442	SC2	P
SD214	S5	FET	1N4448	S1	WD	2N3553	4a	Tra
SD215	S5	FET	1N5060	S1	R	2N3632	4a	Tra
SD217	S5	FET	1N5061	S1	R	2N3822	S5	FET
SD220	S5	FET	1N5062	S1	R	2N3823	S5	FET
SD222	S5	FET	2N918	SC3	HFSW	2N3866	4a	Tra
SD226	S5	FET	2N929	S3	Sm	2N3903	S3	Sm
SD304	S5	FET	2N930	S3	Sm	2N3904	S3	Sm

A = Accessories  
 DH = Diecast heatsinks  
 FET = Field-effect transistors

HE = Heatsink extrusions  
 HFSW = High-frequency and switching transistors  
 I = Infrared devices



type no.	part	section	type no.	part	section	type no.	part	section
2N3924	4a	Tra	56230	S2	HE	56348	S2	DH
2N3926	4a	Tra	56231	S2	HE	56349	S2	DH
2N3927	4a	Tra	56233	S2	A	56350	S2	DH
2N3966	S5	FET	56234	S2	A	56352	SC2	A
2N4030	S3	Sm	56245	S3, 4a	A	56353	SC2	A
2N4031	S3	Sm	56246	S2, S3	A	56354	SC2	A
2N4032	S3	Sm	56253	S2	DH	56359b	SC2	A
2N4033	S3	Sm	56256	S2	DH	56359c	SC2	A
2N4091	S5	FET	56261a	SC2	A	56359d	SC2	A
2N4092	S5	FET	56262A	S2	A	56360a	SC2	A
2N4093	S5	FET	56264A	S2	A	56363	S2, SC2	A
2N4123	S3	Sm	56268	S2	DH	56364	S2, SC2	A
2N4124	S3	Sm	56271	S2	DH	56366	S2	A
2N4347	SC2	P	56278	S2	DH	56367	S2, SC2	A
2N4391	S5	FET	56280	S2	DH	56368a	SC2	A
2N4392	S5	FET	56290	S2	HE	56368b	SC2	A
2N4393	S5	FET	56293	S2	HE	56369	S2, SC2	A
2N4427	4a	Tra	56295	S2	A	56378	SC2	A
2N4856	S5	FET	56312	S2	DH	56379	SC2	A
2N4857	S5	FET	56313	S2	DH			
2N4858	S5	FET	56314	S2	DH			
2N4859	S5	FET	56315	S2	DH			
2N4860	S5	FET	56316	S2	A			
2N4861	S5	FET	56317	S2	A			
2N5415	S3	Sm	56318	S2	DH			
2N5416	S3	Sm	56319	S2	DH			
61SV	4b	I	56326	SC2	A			
56201c	SC2	A	56333	SC2	A			
56201d	SC2	A	56334	S2	DH			
56201j	SC2	A	56339	SC2	A			

P = Low-frequency power transistors  
 Ph = Photoconductive devices  
 R = Rectifier diodes  
 Sm = Small-signal transistors

St = Rectifier stacks  
 Tra = Transmitting transistors and modules  
 Vrf = Voltage reference diodes  
 WD = Silicon whiskerless diodes







SELECTION GUIDE





GENERAL PURPOSE TRANSISTORS in SOT-23/SOT-89\*

type	RATINGS				h <sub>FE</sub>		V <sub>CEsat</sub>		f <sub>T</sub> typ. MHz
	V <sub>CB0</sub> V	V <sub>CEO</sub> V	I <sub>C</sub> mA	P <sub>tot</sub> mW	min./max. at I <sub>C</sub> /V <sub>CE</sub> mA/V		max. at I <sub>C</sub> /I <sub>B</sub> V mA		
<b>P-N-P</b>									
BCW29;R	32	32	100	350	120/260	2/5	0,30	10/0,5	150
BCW30;R					215/500				
BCW61A	32	32	200	150	120/220	2/5	0,25	10/0,25	180
BCW61B					180/310				
BCW61C					250/460				
BCW61D					380/630				
BCW69R	50	45	100	350	120/260	2/5	0,30	10/0,5	150
BCW70;R					215/500				
BCW89;R	80	60			120/260				
BCX17;R	50	45	500	425	100/600	100/1	0,62	500/50	100
BCX18;R	30	25							
BCX51*	45	45	1000	1000	40/250	150/2	0,50	500/60	50
BCX52*	60	60			40/160				
BCX53*	100	80			40/160				
BCX71G	45	45	200	150	120/220	2/5	0,25	10/0,25	180
BCX71H					180/310				
BCX71J					250/460				
BCX71K					380/630				
<b>N-P-N</b>									
BCV71	80	60	100	350	110/220	2/5	0,25	10/0,5	300
BCV72					200/450				
BCW31;R	32	32	100	350	110/220	2/5	0,25	10/0,5	300
BCW32;R					200/450				
BCW33;R					420/800				
BCW60A	32	32	200	150	120/220	2/5	0,35	10/0,25	250
BCW60B					180/310				
BCW60C					250/460				
BCW60D					380/630				
BCW71;R	50	45	100	350	110/220	2/5	0,25	10/0,5	300
BCW72;R					220/450				
BCW81;R					420/800				
BCX19;R	50	45	500	425	100/600	100/1	0,62	500/50	200
BCX20;R	30	25							
BCX54*	45	45	1000	1000	45/250	150/2	0,50	500/50	130
BCX55*	60	60			40/160				
BCX56*	100	80			40/160				
BCX70G	45	45	200	150	120/220	2/5	0,35	10/0,25	250
BCX70H					180/310				
BCX70J					250/460				
BCX70K					380/630				

\* Types in SOT-89 package are denoted by an asterisk (\*).

# SELECTION GUIDE

## HIGH-FREQUENCY TRANSISTORS in SOT-23

type	RATINGS				h <sub>FE</sub>		F		f <sub>T</sub>	C <sub>re</sub>
	V <sub>CB0</sub> V	V <sub>CEO</sub> V	I <sub>C</sub> mA	P <sub>tot</sub> mW	min./max. at I <sub>C</sub> /V <sub>CE</sub> mA/V		typ. at f dB	MHz	typ. MHz	typ. pF
<b>P-N-P</b>										
BF536	30	30	25	200	25/-	1/10	5	200	350	-
BF550;R	40	40	25	200	50/-	1/10	2	0,1	325	0,5
BF569	40	35	30	200	25/-	3/10	4,5	800	900	0,33
BF579	20	20	25	150	20/-	10/10	4,5	800	1350	0,46
BF660	40	30	25	200	30/-	3/10	-	-	650	0,65
BF767	30	30	20	200	15/-	3/10	4	800	900	0,3
<b>N-P-N</b>										
BFS18;R	30	20	30	250	35/125	1/10	4	100	200	0,85
BFS19;R	30	20	30	250	65/225	1/10	4	100	260	0,85
BFS20;R	30	20	25	250	40/85	7/10	-	-	450	0,35

## BROAD-BAND TRANSISTORS in SOT-23/SOT-89\*

type	RATINGS				h <sub>FE</sub>		d <sub>im</sub>		f <sub>T</sub>	C <sub>re</sub>
	V <sub>CB0</sub> V	V <sub>CEO</sub> V	I <sub>C</sub> mA	P <sub>tot</sub> mW	min./max. at I <sub>C</sub> /V <sub>CE</sub> mA/V		typ. at f dB	MHz	typ. GHz	typ. pF
<b>P-N-P</b>										
BFT92;R	20	15	25	200	20/-	14/10	60	493,25	5	0,7
BFT93;R	15	12	35	200	20/-	30/5	60	493,25	5	1,0
<b>N-P-N</b>										
BFQ17*	40	25	150	1000	25/-	150/5	-	-	1,2	1,9
BFQ18A*	25	15	150	1000	25/-	100/10	60	793,25	3,6	1,2
BFQ19*	20	15	75	500	25/-	75/10	-	-	5,0	1,3
BFR53;R	18	10	50	250	25/-	50/5	60	217,0	2,0	0,9
BFR92;R	20	15	25	200	25/-	14/10	60	493,25	5,0	0,7
BFR93;R	15	12	35	200	25/-	30/5	60	493,25	5,0	0,8
BFS17;R	25	15	25	250	20/150	2/1	45	217	1,3	0,65
BFT25;R	8	5	2,5	50	20/-	1/1	-	-	2,3	0,45

## TRIGGER DEVICE in SOT-23

<b>P-N-P-N</b>	
BRY61	V <sub>GA</sub> max. 70 V; I <sub>A</sub> max. 175 mA; I <sub>p</sub> = 5/1 μA; I <sub>V</sub> = 30/50 μA

\* Types in SOT-89 package are denoted by an asterisk (\*).



## SWITCHING TRANSISTORS in SOT-23/SOT-89\*

type	RATINGS				hFE		V <sub>CEsat</sub>		t (max.)	
	V <sub>CBO</sub> V	V <sub>CEO</sub> V	I <sub>C</sub> mA	P <sub>tot</sub> mW	min./max.	at I <sub>C</sub> /V <sub>CE</sub> mA/V	max. at I <sub>C</sub> /I <sub>B</sub> V	mA/mA	on/off at I <sub>C</sub> /I <sub>B</sub> ns	mA
<b>P-N-P</b>										
BSR12;R	15	15	100	250	30/120	50/1	0,45	100/10	20/30	30/3
BSR15;R	60	40	600	425	100/300	150/10	1,6	500/50	45/100	150/15
BSR16;R	60	60								
BSR30*	70	60	1000	1000	40/120	100/5	0,5	500/50	500/650	100/5
BSR31*	70	60			100/300					
BSR32*	90	80			40/120					
BSR33*	90	80			100/300					
BSS63;R	110	100	100	350	30/-	25/1	0,25	25/2,5	-	-
<b>N-P-N</b>										
BSR13;R	60	30	800	425	100/300	150/10	1,6	500/50	35/285	150/-
BSR14;R	75	40					1,0			
BSR17;R	60	40	200	350	100/300	10/1	0,3	50/5	-/250	10/1
BSR40*	70	60	1000	1000	40/120	100/5	0,5	500/50	250/1000	100/5
BSR41*					100/300					
BSR42*	90	80	1000	1000	40/120	100/5	0,5	500/50	250/1000	100/5
BSR43*					100/300					
BSS64;R	120	80	100	350	20/80	10/1	0,2	50/15	/1000	15/1
BSV52;R	20	12	100	250	40/120	10/1	0,4	50/5	12/18	10/3

## FIELD-EFFECT TRANSISTORS in SOT-23

type	RATINGS				-I <sub>GSS</sub> max. nA	I <sub>DSS</sub> min./max. mA	-V(P)GS max. V	y <sub>fs</sub>   min. mA/V	C <sub>rs</sub> max. pF	V <sub>n</sub> max. μF
	±V <sub>DS</sub> V	-V <sub>GSO</sub> V	I <sub>D</sub> mA	P <sub>tot</sub> mW						
BF510	20	-	30	300	10	0,7/3,0	0,8	2,5	0,4	-
BF511						2,5/7,0	1,5	4		
BF512						6/12	2,2	6		
BF513						10/18	3	7		
BFR30	25	25	10	250	0,2	4/10	5	1	1,5	0,5
BFR31						1/5	2,5	1,5		
BFT46	25	25	10	250	0,2	0,2/1,5	1,0	1,0	1,5	0,5
BSR56	40	40	-	250	1	50/-	10	-	5	-
BSR57						20/100	6			
BSR58						8/80	4			

\* Types in SOT-89 package are denoted by an asterisk (\*).

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## VIDEO OUTPUT TRANSISTORS (SOT-89)

type	$V_{CBO}$ V	RATINGS			$h_{FE}$ min./max. at $I_C/V_{CE}$		$V_{CEK}$ typ. at $I_C$		$f_T$ min. MHz
		$V_{CEO}$ V	$I_C$ mA	$P_{tot}$ mW	mA/V		V mA		
<b>P-N-P</b> BF623	250	250	20	1000	50/-	25/20	20	25	60
<b>N-P-N</b> BF622	250	250	20	1000	50/-	25/20	20	25	60

## LOW NOISE TRANSISTORS in SOT-23 ( $F < 4$ dB at $f = 1$ kHz; $B = 200$ Hz)

type	$V_{CBO}$ V	RATINGS			$h_{FE}$ min./max. at $I_C/V_{CE}$		$V_{CEsat}$ max. at $I_C/I_B$		$f_T$ typ. MHz
		$V_{CEO}$ V	$I_C$ mA	$P_{tot}$ mW	mA/V		V mA		
<b>P-N-P</b>									
BCF29	32	32	100	350	120/260	2/5	0,3	10/0,5	150
BCF30	32	32	100	350	215/500	2/5	0,3	10/0,5	150
BCF70	50	45	100	350	215/500	2/5	0,3	10/0,5	150
<b>N-P-N</b>									
BCF32	32	32	100	350	200/450	2/5	0,25	10/0,5	300
BCF33	32	32	100	350	420/800	2/5	0,25	10/0,5	300
BCF81	50	45	100	350	420/800	2/5	0,25	10/0,5	300

## DIODES (SOT-23)

type	description	RATINGS		$t_{rr}$ max. ns	$V_F$ max. (mV) at $I_F =$ mA 10/100-150	$C_d$ max. pF
		$V_R$ V	$I_F$ mA			
BAS16	high-speed switch	75	250	6	855/- - 1250	2
BAS17	low-voltage stabilizer	-	250	-	830/960 -	140
BAS19	high-speed switch	100	200	50	- /1000 -	5
BAS20	high-speed switch	150	200	50	- /1000 -	5
BAS21	high speed switch	200	200	50	- /1000 -	5
BAT17	Schottky barrier	4	30	-	600/- -	1
BAT18	band switch	35	100	-	/1200 -	1
BAV70	common cathode double diode	70	250	6	855/- - 1250	1,5
BAV99	two diodes in series	70	250	6	855/- - 1250	1,5
BAW56	common anode double diode	70	250	6	855/- - 1250	2

VARIABLE CAPACITANCE DIODES (SOT-23)

type	RATINGS		CHARACTERISTICS					
	$V_R$	$I_F$	$I_R$ at $V_R$		$C_d$ at $V_R$		capacitance ratio typ.	$r_D$ $\Omega$
	V	mA	nA	V	pF	V		
BBY31	28	20	< 50	28	typ. 17,5 typ. 11,5 1,8 – 2,8	1 3 25	5	< 1,2
BBY40	28	20	< 50	28	26 – 32 4,3 – 6	3 25	5 to 5,6	< 0,6

VOLTAGE REGULATOR DIODES

type	case	range (V)	voltage tolerance %	$P_{tot}$ mW	$I_{ZRM}$ mA	$I_{FRM}$ mA	$V_F$ at $I_F$	
							V	mA
BZX78	SOT-89	5,1 to 75	5	1000	– **	400	1	200
BZX84	SOT-23	2,4 to 75	5 *	350	250	250	0,9	10



\* Types with 2% voltage tolerance available on request.

\*\*  $I_{ZRM}$  limited by  $P_{ZRMmax}$ .



**TYPE NUMBER SURVEY**

**Numerical index**  
**Conversion conventional types**  
**Marking and marking code**



# TYPE NUMBER SURVEY

## NUMERICAL TYPE LIST

type number	mark	reverse type mark	device type	SOT-23	SOT-89	nearest conventional type(s)	complement
BAS16	A6		D	●		BAW62/1N4148	
BAS17	A91		D	●		BA314	
BAS19	A8		D	●		BAV19	
BAS20	A81		D	●		BAV20	
BAS21	A82		D	●		BAV21	
BAT17	A3		D	●		BA280	
BAT18	A2		D	●		BA182/BA243/BA482	
BAV70	A4		D	●		BAW62/1N4148 (double)	
BAV99	A7		D	●		BAW62/1N4148 (double)	
BAW56	A1		D	●		BAW62/1N4148 (double)	
BBY31	S1		D	●		BB105G/BB405G	
BBY40	S2		D	●		BB109G/BB809	
BCF29;R	C7	C77	PNP	●		BC559A/BCY78/BC179	
BCF30;R	C8	C9	PNP	●		BC559B/BCY78	
BCF32;R	D7	D77	NPN	●		BC549B/BCY58/BC109	
BCF33;R	D8	D81	NPN	●		BC549C/BCY58	
BCF70;R	H7	H71	PNP	●		BC560B/BCY79	
BCF81;R	K9	K91	NPN	●		BC550C	
BCV71;R	K7	K71	NPN	●		BC546A	
BCV72;R	K8	K81	NPN	●		BC546B	
BCW29;R	C1	C4	PNP	●		BC178A/BC558A	BCW31;R
BCW30;R	C2	C5	PNP	●		BC178B/BC558B	BCW32;R
BCW31;R	D1	D4	NPN	●		BC108A/BC548A	BCW29;R
BCW32;R	D2	D5	NPN	●		BC108B/BC548B	BCW30;R
BCW33;R	D3	D6	NPN	●		BC108C/BC548C	
BCW60A	AA		NPN	●		BC108/BC548	
BCW60B	AB		NPN	●		BC108/BC548	
BCW60C	AC		NPN	●		BC108/BC548	
BCW60D	AD		NPN	●		BC108/BC548	
BCW61A	BA		PNP	●		BC178/BC558	
BCW61B	BB		PNP	●		BC178/BC558	
BCW61C	BC		PNP	●		BC178/BC558	
BCW61D	BD		PNP	●		BC178/BC558	
BCW69;R	H1	H4	PNP	●		BC177A/BC557A	BCW71;R
BCW70;R	H2	H5	PNP	●		BC177B/BC557B	BCW72;R

# TYPE NUMBER SURVEY

type number	mark	reverse type mark	device type	SOT-23	SOT-89	nearest conventional type(s)	complement
BCW71;R	K1	K4	NPN	●		BC 107A/BC547A	BCW69;R
BCW72;R	K2	K5	NPN	●		BC 107B/BC547B	BCW70;R
BCW81;R	K3	K31	NPN	●		BC547C	
BCW89;R	H3	H31	PNP	●		BC556A	
BCX17;R	T1	T4	PNP	●		BC327	BCX19;R
BCX18;R	T2	T5	PNP	●		BC328	BCX20;R
BCX19;R	U1	U4	NPN	●		BC337	BCX17;R
BCX20;R	U2	U5	NPN	●		BC338	BCX18;R
BCX51			PNP		●	BC636	BCX54
BCX52			PNP		●	BC638	BCX55
BCX53			PNP		●	BC640	BCX56
BCX54			NPN		●	BC635	BCX51
BCX55			NPN		●	BC637	BCX52
BCX56			NPN		●	BC639	BCX53
BCX70G	AG		NPN	●		BC 107/BC547	
BCX70H	AH		NPN	●		BC 107/BC547	
BCX70J	AJ		NPN	●		BC 107/BC547	
BCX70K	AK		NPN	●		BC 107/BC547	
BCX71G	BG		PNP	●		BC 177/BC557	
BCX71H	BH		PNP	●		BC 177/BC557	
BCX71J	BJ		PNP	●		BC 177/BC557	
RCX71K	BK		PNP	●		BC 177/BC557	
BF510	S6		FET	●		BF410A	
BF511	S7		FET	●		BF410B	
BF512	S8		FET	●		BF410C	
BF513	S9		FET	●		BF410D	
BF536	G3		PNP	●		BF936	
BF550;R	G2	G5	PNP	●		BF450	
BF569	G6		PNP	●		BF970	
BF579	G7		PNP	●		BF979	
BF622			NPN		●	BF422	BF623
BF623			PNP		●	BF423	BF622
BF660;R	G8	G81	PNP	●		BF606A	
BF767	G9		PNP	●		BF967	
BFQ17			NPN		●	BFW16A	
BFQ18A			NPN		●	BFQ34	
BFQ19			NPN		●	BFR96	
BFR30	M1		FET	●		BFW11/BF245	
BFR31	M2		FET	●		BFW12/BF245	
BFR53;R	N1	N4	NPN	●		BFW30/BFW93	
BFR92;R	P1	P4	NPN	●		BFR90	BFT92;R
BFR93;R	R1	R4	NPN	●		BFR91	BFT93;R
BFS17;R	E1	E4	NPN	●		BFY90/BFW92	
BFS18;R	F1	F4	NPN	●		BF185/BF495	
BFS19;R	F2	F5	NPN	●		BF184/BF494	



# TYPE NUMBER SURVEY

type number	mark	reverse type mark	device type	SOT-23	SOT-89	nearest conventional type(s)	complement
BFS20;R	G1	G4	NPN	●		BF199	
BFT25;R	V1	V4	NPN	●		BFT24	
BFT46	M3		FET	●		BFW13/BF245	
BFT92;R	W1	W4	PNP	●		BFQ51/52	BFR92;R
BFT93;R	X1	X4	PNP	●		BFQ23/24	BFR93;R
BRY61	A5		PNPN	●		BRY56/BRY39PUT	
BSR12;R	B5	B8	PNP	●		2N2894A	BSV52
BSR13;R	U7	U71	NPN	●		2N2222	
BSR14;R	U8	U81	NPN	●		2N2222A	
BSR15;R	T7	T71	PNP	●		2N2907	
BSR16;R	T8	T81	PNP	●		2N2907A	
BSR17;R	U9	U91	NPN	●		2N3904	
BSR30			PNP		●		BSR40
BSR31			PNP		●	BSV16/17	BSR41
BSR32			PNP		●	2N4030 to 4033	BSR42
BSR33			PNP		●		BSR43
BSR40			NPN		●		BSR30
BSR41			NPN		●	BSX46/47	BSR31
BSR42			NPN		●	2N3019/3020	BSR32
BSR43			NPN		●		
BSR56	M4		FET	●		2N4856	
BSR57	M5		FET	●		2N4857	
BSR58	M6		FET	●		2N4858	
BSS63;R	T3	T6	PNP	●		BSS68	BSS64;R
BSS64;R	U3	U6	NPN	●		BSS38	BSS63;R
BSV52;R	B2	B4	NPN	●		BSX20/2N2369	BSR12





# TYPE NUMBER SURVEY

type device type nearest conventional type	BZX78- SOT-89 diode BZX87 series	BZX84- SOT-23 diode BZX79 series
type number suffix	mark	mark
C2V4	-	Z11
C2V7	-	Z12
C3V0	-	Z13
C3V3	-	Z14
C3V6	-	Z15
C3V9	-	Z16
C4V3	-	Z17
C4V7	-	Z1
C5V1	5Z1	Z2
C5V6	5Z6	Z3
C6V2	6Z2	Z4
C6V8	6Z8	Z5
C7V5	7Z5	Z6
C8V2	8Z2	Z7
C9V1	9Z1	Z8
C10	10Z	Z9
C11	11Z	Y1
C12	12Z	Y2
C13	13Z	Y3
C15	15Z	Y4
C16	16Z	Y5
C18	18Z	Y6
C20	20Z	Y7
C22	22Z	Y8
C24	24Z	Y9
C27	27Z	Y10
C30	30Z	Y11
C33	33Z	Y12
C36	36Z	Y13
C39	39Z	Y14
C43	43Z	Y15
C47	47Z	Y16
C51	51Z	Y17
C56	56Z	Y18
C62	62Z	Y19
C68	68Z	Y20
C75	75Z	Y21



CONVERSION LIST

conventional type	microminiature type	conventional type	microminiature type	conventional type	microminiature type
BA182	BAT18	BC546B	BCF72	BF410A	BF510
BA243	BAT18	BC547A	BCW71	BF410B	BF511
BA280	BAT17	BC547B	BCW72	BF410C	BF512
BA314	BAS17	BC547C	BCW81	BF410D	BF513
BAV19	BAS19	BC548A	BCW31	BF422	BF622
BAV20	BAS20	BC548B	BCW32	BF423	BF623
BAV21	BAS21	BC548C	BCW33	BF450	BF550
BAW62	BAS16	BC549B	BCF32	BF494	BFS19
	BAV70	BC549C	BCF33	BF495	BFS18
	BAV99	BC550C	BCF81	BF606A	BF660
	BAW56	BC556A	BCW89	BF936	BF536
BB105G	BBY31	BC557A	BCW69	BF967	BF767
BB109	BBY40	BC557B	BCW70	BF970	BF569
BC107A	BCW71	BC558A	BCW29	BF979	BF579
BC107B	BCW72	BC558B	BCW30	BFQ23	BFT93
BC108A	BCW31	BC559A	BCF29	BFQ24	BFT93
BC108B	BCW32	BC559B	BCF30	BFQ34	BFQ18A
BC108C	BCW33	BC560B	BCF70	BFR90	BFR92
BC109	BCF32	BC635	BCX54	BFR91	BFR93
BC177A	BCW69	BC636	BCX51	BFR96	BFQ19
BC177B	BCW70	BC637	BCX55	BFT24	BFT25
BC178A	BCW29	BC638	BCX52	BFW11	BFR30
BC178B	BCW30	BC639	BCX56	BFW12	BFR31
BC179	BCF29	BC640	BCX53	BFW13	BFT46
BC327	BCX17	BCY58	BCF32/33	BFW16A	BFQ17
BC328	BCX18	BCY78	BCF29/30	BFW30	BFR53
BC337	BCX19	BCY79	BCF29/30	BFW92	BFS17
BC338	BCX20	BF184	BCF70	BFW93	BFR53
BC369	BCX69	BF185	BFS19	BFY90	BFS17
BC546A	BCF71	BF199	BFS18	BRY39 (PUT)	BRY61

conventional type	microminiature type	conventional type	microminiature type	conventional type	microminiature type
BRY56	BRY61	2N2222A	BSR14	2N3019	BSR43
BSS38	BSS64	2N2369	BSV52	2N3020	BSR42
BSS68	BSS63	2N2894A	BSR12	2N3904	BSR17
BSV16	BSR30-33	2N2907	BSR15	2N3906	BSR18
BSV17	BSR30-33	2N2907A	BSR16	2N4030	BSR30
BSX20	BSV52	1N4148	BAS16	2N4031	BSR32
BSX46	BSR40-43		BAV70	2N4032	BSR31
BSX47	BSR40-43		BAV99	2N4033	BSR33
BZX87	BZX78		BAW56	2N4856	BSR56
BZX79	BZX84	2N2222	BSR13	2N4857	BSR57
				2N4858	BSR58



MARKING LIST

Types in SOT-23 envelopes are marked with a code as listed below. The actual type number and date code are on the packing.

Types in SOT-89 usually have the type number marked in full on the envelope. An exception to this is the BZX78 series. These envelopes are coded as indicated opposite.

SOT-23

mark	type no.	mark	type no.	mark	type no.	mark	type no.
A1	BAW56	BJ	BCX71J	F4	BFS18R	K71	BCV71R
A2	BAT18	BK	BCX71K	F5	BFS19R	K8	BCV72
A3	BAT17	C1	BCW29	F6		K81	BCV72R
A4	BAV70	C2	BCW30	F7		K9	BCF81
A5	BRY61	C3		F8		K91	BCF81R
A6	BAS16	C4	BCW29R	F9		M1	BFR30
A7	BAV99	C5	BCW30R	G1	BFS20	M2	BFR31
A8	BAS19	C6		G2	BF550	M3	BFT46
A81	BAS20	C7	BCF29	G3	BF536	M4	BSR56
A82	BAS21	C77	BCF29R	G4	BFS20R	M5	BSR57
A9		C8	BCF30	G5	BF550R	M6	BSR58
A91	BAS17	C9	BCF30R	G6	BF569	M7	
AA	BCW60A	D1	BCW31	G7	BF579	M8	
AB	BCW60B	D2	BCW32	G8	BF660	M9	
AC	BCW60C	D3	BCW33	G81	BF660R	N1	BFR53
AD	BCW60D	D4	BCW31R	G9	BF767	N2	
AG	BCX70G	D5	BCW32R	H1	BCW69	N3	
AH	BCX70H	D6	BCW33R	H2	BCW70	N4	BFR53R
AJ	BCX70J	D7	BCF32	H3	BCW89	N5	
AK	BCX70K	D77	BCF32R	H31	BCW89R	N6	
B1		D8	BCF33	H4	BCW69R	N7	
B2	BSV52	D81	BCF33R	H5	BCW70R	N8	
B3		D9		H6		N9	
B4	BSV52R	E1	BFS17	H7	BCF70	P1	BFR92
B5	BSR12	E2		H71	BCF70R	P2	
B6		E3		H8		P3	
B7		E4	BFS17R	H9		P4	BFR92R
B8	BSR12R	E5		K1	BCW71	P5	
B9		E6		K2	BCW72	P6	
BA	BCW61A	E7		K3	BCW81	P7	
BB	BCW61B	E8		K31	BCW81R	P8	
BC	BCW61C	E9		K4	BCW71R	P9	
BD	BCW61D	F1	BFS18	K5	BCW72R	R1	BFR93
BG	BCX71G	F2	BFS19	K6		R2	
BH	BCX71H	F3		K7	BCV71	R3	



## SOT-23

## SOT-89

SOT-23		SOT-89		SOT-89	
mark	type no.	mark	type no.	mark	type no.
R4	BFR93R	V3		Y16	BZX84-C47
R5		V4	BFT25R	Y17	-C51
R6		V5		Y18	-C56
R7		V6		Y19	-C62
R8		V7		Y20	-C68
R9		V8		Y21	BZX84-C75
S1	BBY31	V9		Z1	-C4V7
S2	BBY40	W1	BFT92	Z2	-C5V1
S3		W2		Z3	-C5V6
S4		W3		Z4	-C6V2
S5		W4	BFT92R	Z5	BZX84-C6V8
S6	BF510	W5		Z6	-C7V5
S7	BF511	W6		Z7	-C8V2
S8	BF512	W7		Z8	-C9V1
S9	BF513	W8		Z9	-C10
T1	BCX17	W9		Z10	BZX84-C2V4
T2	BCX18	X1	BFT93	Z12	-C2V7
T3	BSS63	X2		Z13	-C3V0
T4	BCX17R	X3		Z14	-C3V3
T5	BCX18R	X4	BFT93R	Z15	-C3V6
T6	BSS63R	X5		Z16	BZX84-C3V9
T7	BSR15	X6		Z17	-C4V3
T71	BSR15R	X7		Z18	
T8	BSR16	X8		Z19	
T81	BSR16R	X9			
T9		Y1	BZX84-C11		
U1	BCX19	Y2	-C12	56Z	BZX78-C56
U2	BCX20	Y3	-C13	62Z	-C62
U3	BSS64	Y4	-C15	68Z	-C68
U4	BCX19R	Y5	-C16	75Z	-C75
U5	BCX20R	Y6	BZX84-C18		
U6	BSS64R	Y7	-C20		
U7	BSR13	Y8	-C22		
U71	BSR13R	Y9	-C24		
U8	BSR14	Y10	-C27		
U81	BSR14R	Y11	BZX84-C30		
U9	BSR17	Y12	-C33		
U91	BSR17R	Y13	-C36		
V1	BFT25	Y14	-C39		
V2		Y15	-C43		





GENERAL

**Pro Electron Type designation**  
**Rating Systems**  
**Letter Symbols**  
**S-parameters**







PRO ELECTRON TYPE DESIGNATION CODE  
FOR SEMICONDUCTOR DEVICES

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

A basic type number consists of:

*TWO LETTERS FOLLOWED BY A SERIAL NUMBER*

**FIRST LETTER**

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

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

**SECOND LETTER**

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

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

## SERIAL NUMBER

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

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

## VERSION LETTER

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

## SUFFIX

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

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

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

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

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

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

### 2. TRANSIENT SUPPRESSOR DIODES: *ONE NUMBER*

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

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

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

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

The NUMBER indicates the depletion layer in  $\mu\text{m}$ . The resolution is indicated by a version LETTER.

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

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

## RATING SYSTEMS

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

### DEFINITIONS OF TERMS USED

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

#### Note

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

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

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

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

#### Note

Limiting conditions may be either maxima or minima.

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

#### Note

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

### ABSOLUTE MAXIMUM RATING SYSTEM

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

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

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

## DESIGN MAXIMUM RATING SYSTEM

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

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

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

## DESIGN CENTRE RATING SYSTEM

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

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

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

# LETTER SYMBOLS FOR TRANSISTORS AND SIGNAL DIODES

based on IEC Publication 148

## LETTER SYMBOLS FOR CURRENTS, VOLTAGES AND POWERS

### Basic letters

The basic letters to be used are:

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

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

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

### Subscripts

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

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

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

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

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

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

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

**Additional rules for subscripts**

Subscripts for currents

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

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

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

Examples:  $I_F, I_R, i_F, I_{f(rms)}$

Subscripts for voltages

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

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

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

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

Subscripts for supply voltages or supply currents

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

Examples:  $V_{CC}$ ,  $I_{EE}$

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

Example:  $V_{CCE}$

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

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

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

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

Subscripts for multiple devices

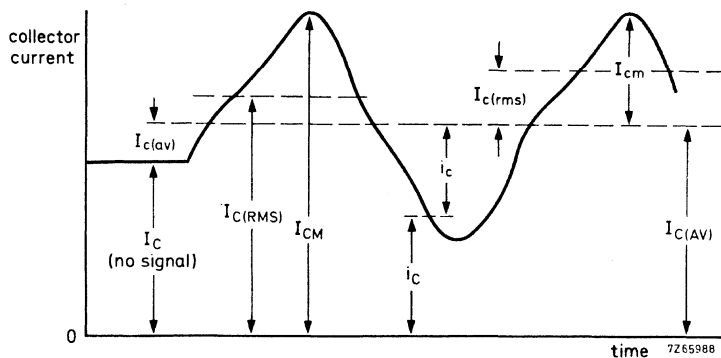
For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

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

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

Application of the rules

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



LETTER SYMBOLS FOR ELECTRICAL PARAMETERS

Definition

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

Basic letters

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

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



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

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

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

### Subscripts

#### General subscripts

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

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

Examples:  $Z_S$ ,  $h_f$ ,  $h_F$

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

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

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

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

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

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

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

Examples:  $h_{FE}$ ,  $Y_{RE}$ ,  $h_{fe}$

Subscripts for four-pole matrix parameters

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

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

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

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

**Distinction between real and imaginary parts**

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

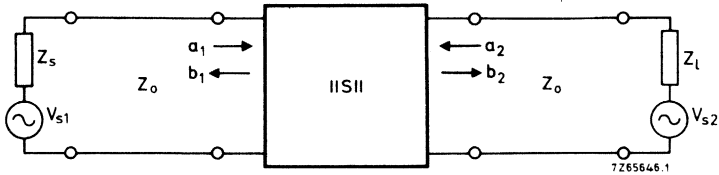
Examples:  $Z_i = R_i + jX_i$   
 $y_{fe} = g_{fe} + jb_{fe}$

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

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

## SCATTERING PARAMETERS

In distinction to the conventional h, y and z-parameters, s-parameters relate to travelling wave conditions. The figure below shows a two-port network with the incident and reflected waves  $a_1$ ,  $b_1$ ,  $a_2$  and  $b_2$ .



$$\begin{aligned}
 a_1 &= \frac{V_{i1}}{\sqrt{Z_0}} & a_2 &= \frac{V_{i2}}{\sqrt{Z_0}} \\
 b_1 &= \frac{V_{r1}}{\sqrt{Z_0}} & b_2 &= \frac{V_{r2}}{\sqrt{Z_0}}
 \end{aligned}
 \quad 1)$$

$Z_0$  = characteristic impedance of the transmission line in which the two-port is connected.

$V_i$  = incident voltage

$V_r$  = reflected (generated) voltage

The four-pole equations for s-parameters are:

$$b_1 = s_{11}a_1 + s_{12}a_2$$

$$b_2 = s_{21}a_1 + s_{22}a_2$$

Using the subscripts i for 11, r for 12, f for 21 and o for 22, it follows that:

$$s_i = s_{11} = \left. \frac{b_1}{a_1} \right|_{a_2 = 0}$$

$$s_r = s_{12} = \left. \frac{b_1}{a_2} \right|_{a_1 = 0}$$

$$s_f = s_{21} = \left. \frac{b_2}{a_1} \right|_{a_2 = 0}$$

$$s_o = s_{22} = \left. \frac{b_2}{a_2} \right|_{a_1 = 0}$$

1) The squares of these quantities have the dimension of power.

## S-PARAMETERS

The s-parameters can be named and expressed as follows:

$s_i = s_{11}$  = Input reflection coefficient.

The complex ratio of the reflected wave and the incident wave at the input, under the conditions  $Z_1 = Z_0$  and  $V_{s2} = 0$ .

$s_r = s_{12}$  = Reverse transmission coefficient.

The complex ratio of the generated wave at the input and the incident wave at the output, under the conditions  $Z_s = Z_0$  and  $V_{s1} = 0$ .

$s_f = s_{21}$  = Forward transmission coefficient.

The complex ratio of the generated wave at the output and the incident wave at the input, under the conditions  $Z_1 = Z_0$  and  $V_{s2} = 0$ .

$s_o = s_{22}$  = Output reflection coefficient.

The complex ratio of the reflected wave and the incident wave at the output, under the conditions  $Z_s = Z_0$  and  $V_{s1} = 0$ .

SOLDERING RECOMMENDATIONS  
THERMAL CHARACTERISTICS





## SOLDERING RECOMMENDATIONS SOT-23 AND SOT-89

SOT-23 and SOT-89 devices are ideally suited for placement onto thick and thin film substrates and printed circuit boards.

To assure reliable and consistent connections particular attention should be paid to:

### 1. Flux

A non-active flux is recommended. Where active fluxes are employed, great care in subsequent substrate cleaning must be exercised.

### 2. Metal-alloy solder or solder paste

Correct choice of solder alloy or solder paste to be employed e.g. 62% Sn, 36% Pb, 2% Ag or 60% Sn/40% Pb. Any paste used should contain at least 85% metal dry weight.

### 3. Soldering temperature

This will vary according to the actual method employed.

## REFLOW SOLDERING

The preferred technique for mounting microminiature components on hybrid thick and thin-film is the method of reflow soldering.

The tags of both SOT-23 and SOT-89 envelopes are pre-tinned and the best results are obtained if a similar solder is applied to the corresponding soldering areas on the substrate. This can be done by either dipping the substrate in a solder bath or by screen printing a solder paste.

The maximum temperature of the leads or tab during the soldering cycle should not exceed 285 °C. The most economic method of soldering is a process in which all different components are soldered simultaneously for example SOT-23 or SOT-89 devices, capacitors and resistors.

Having first been fluxed, all components are positioned on the substrate. The slight adhesive force of the flux is sufficient to keep the components in place. Solder paste contains a flux and has therefore good inherent adhesive properties which eases positioning of the components.

With the components in position the substrate is heated to a point where the solder begins to flow. This can be done on a heating plate or on a conveyor belt running through an infrared tunnel. The maximum allowed temperature of the plastic body of a device must be kept below 280 °C during the soldering cycle. For further temperature behaviour during the soldering process see Figs 2 and 3.

The surface tension of the liquid solder tends to draw the tags of the device towards the centre of the soldering area and has thus a correcting effect on slight mispositionings. However, if the layout leaves something to be desired the same effect can result in undesirable shifts; particularly if the soldering areas on the substrate and the components are not concentrically arranged. This problem can be solved using a standard contact pattern, which leaves sufficient scope for the self-positioning effect (see Figs 4 and 5).

After cooling the connections may be visually inspected and, where necessary, repaired with a light soldering iron. Finally any remaining flux must be removed carefully.



### IMMERSION SOLDERING

Where a complete substrate or printed circuit board is immersed in solder:

- The temperature of the soldering bath should not exceed 280 °C.
- The duration of the soldering cycle should not exceed 10 seconds.
- Forced cooling may be applied (see Fig. 1).

### HAND SOLDERING

It is possible to solder microminiature devices with a light hand-held soldering iron, but this method has obvious drawbacks and should therefore be restricted to laboratory use and/or incidental repairs on production circuits.

- It is time-consuming and expensive.
- The device cannot be positioned accurately and therefore the connecting tags may come into contact with the substrate and damage it.
- There is a great risk of breaking either substrate or even internal connections inside the encapsulation.
- The envelope may be damaged by the iron.

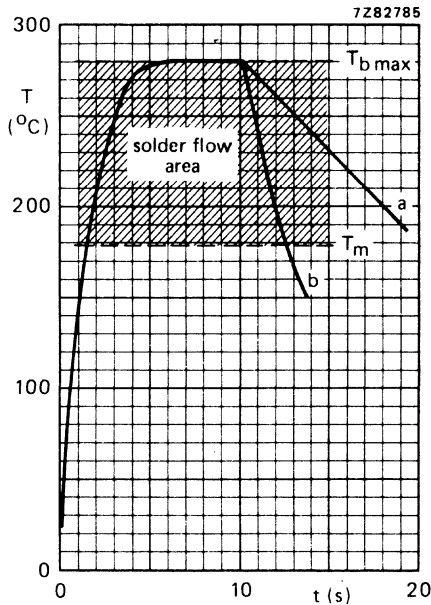


Fig. 1 Device temperature during immersion soldering.

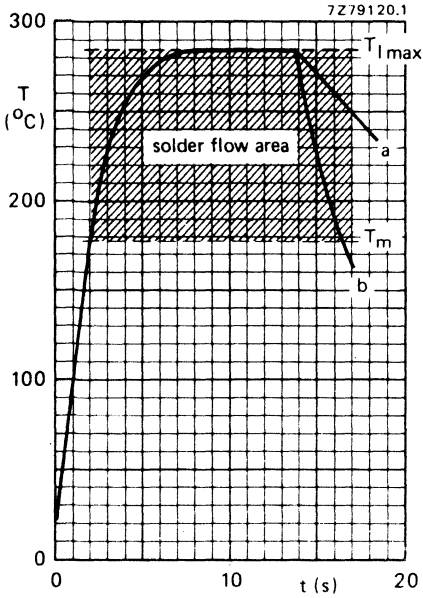
Maximum time of immersion in soldering bath is 10 seconds at an ambient temperature of 25 °C.

a = free convection cooling; b = forced cooling.

$T_{b \max}$  = maximum bath temperature (280 °C).

$T_m$  = melting temperature of solder (179 °C).





a = free convection cooling.  
 b = permissible forced cooling.  
 $T_{l\ max}$  = Maximum lead or tab temperature = 285 °C.  
 $T_m$  = Melting point of the solder is 179 °C.  
 $T_{amb}$  = 25 °C.

Time of heat supply:  
 without preheating max. 14 s  
 with preheating max. 10 s  
 Maximum time of preheating 45 s

Fig. 2 Reflow soldering without preheating.

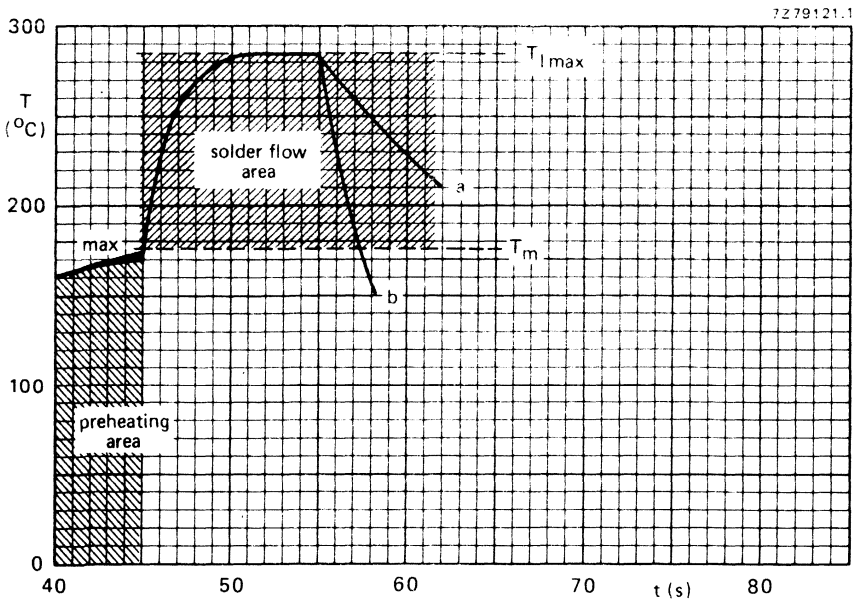


Fig. 3 Reflow soldering with preheating.

Minimum required dimensions of metal  
connection pads on hybrid thick and thin-film  
substrates.

Dimensions in mm

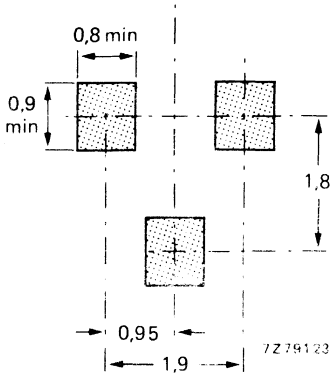


Fig. 4 SOT-23 pattern.

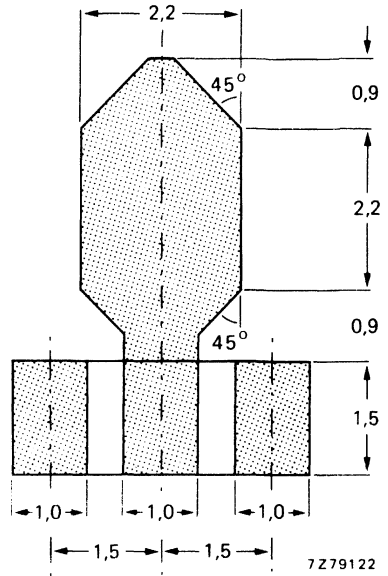


Fig. 5 SOT-89 pattern.



## THERMAL CHARACTERISTICS OF SOT-23 ENVELOPES

The heat generated in a semiconductor chip normally flows by various paths to the surroundings (ambient).

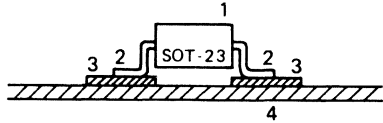
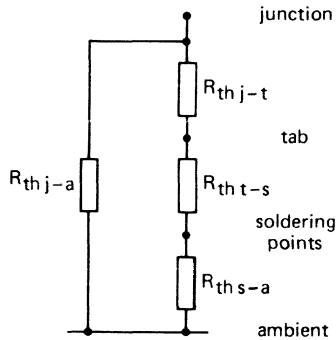


Fig. 1.

7Z89072

1. Heat radiation from the envelope to ambient (1).  
This heat transfer can be neglected when the envelope is mounted on a substrate or printed circuit board.
2. Heat transmission via leads (2) soldering points (3) and substrate (4).



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Fig. 2 Thermal behaviour of heat flow when the device is mounted on a substrate or printed circuit board.

- $R_{th\ j-t}$  = Thermal resistance from junction to tab.  
 $R_{th\ t-s}$  = Thermal resistance from tab to soldering points.  
 $R_{th\ s-a}$  = Thermal resistance from soldering points to ambient.  
 $R_{th\ j-a}$  = Thermal resistance from junction to ambient.

### Heat transfer directly from envelope to ambient

This depends on the difference between the temperatures of envelope and the surroundings. When the device is mounted on a substrate or printed circuit board direct heat flow can usually be neglected in relation to the heat flow via leads and substrate. Thus the thermal model can be as in Fig. 3.

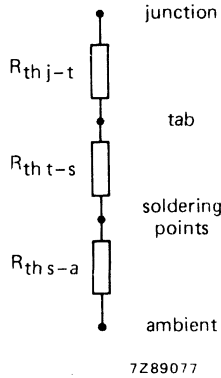


Fig. 3 Basic thermal model.

### Heat transfer from junction to tab

This is an internal heat transfer and has been measured for SOT-23 envelopes. In general it is:

- for high-frequency transistors 60 K/W
- for low-frequency and switching transistors and also for low power diodes 50 K/W
- for low-frequency medium-power transistors 30 K/W

### Heat transfer from tab to soldering points

This value has also been measured for SOT-23 and for all types of semiconductors in this envelope is 260 K/W

### Heat transfer from soldering points to ambient

This depends on the shape and material of tracks and substrate. In figures 4 and 5 standard mounting conditions are given to set up the maximum power ratings for SOT-23 encapsulation.

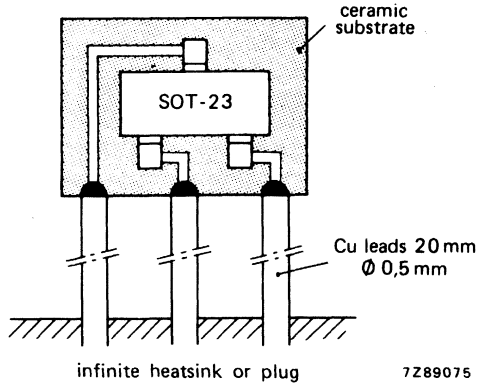


Fig. 4 Test circuit SOT-23 mounting conditions on a ceramic substrate.

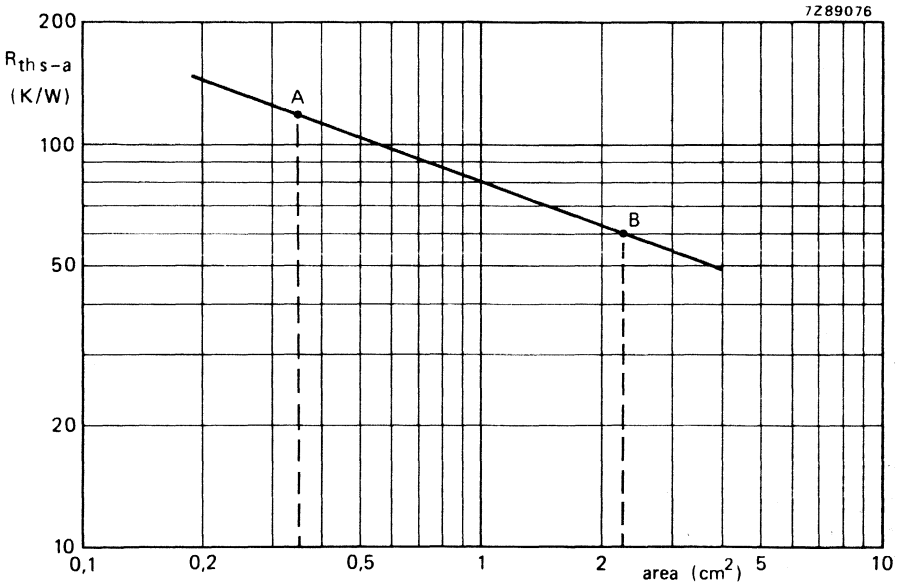


Fig. 5 Thermal resistance.

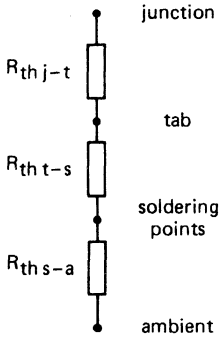
Point A on the curve in Fig. 5 is for an area of the ceramic substrate of 7 mm x 5 mm x 0,6 mm for the maximum rating of all high-frequency, low-frequency and switching transistors and also for all diodes in SOT-23 encapsulation.

Point B on the curve in Fig. 5 is for an area of the ceramic substrate of 15 mm x 15 mm x 0,6 mm for the maximum rating of low-frequency medium-power semiconductors.

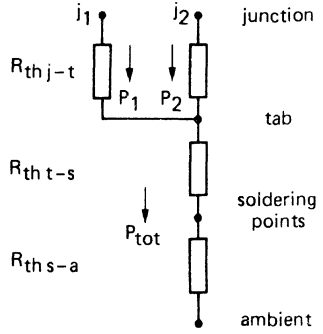
The values for the thermal resistance from junction to tab, and tab to soldering points, are mentioned on page 2 and Fig. 5.

The formula for devices in SOT-23 with one crystal can be generalized:

$$T_j = P (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$



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Fig. 6 Thermal model of SOT-23 envelopes with one crystal.

Fig. 7 Thermal model of SOT-23 envelopes with two crystals (double diode).

The formulae for devices with two crystals (double diodes) are:

$$T_{tab} = P_{tot} \cdot (R_{th\ t-s} + R_{th\ s-a}) + T_{amb} = P_{tot} (260 + 120) + T_{amb}$$

$$T_{j1} = (P_1 \times R_{th\ j-t}) + T_{tab} = P_1 \cdot 50 + T_{tab}$$

$$T_{j2} = (P_2 \times R_{th\ j-t}) + T_{tab} = P_2 \cdot 50 + T_{tab}$$

As mentioned on page 2:

$R_{th\ j-t}$  for diodes is 50 K/W.

$R_{th\ s-a}$  (area 7 mm x 5 mm x 0,6 mm) = 120 K/W.

$R_{th\ t-s}$  for all semiconductors in SOT-23 = 260 K/W.

Thus:

$$T_{j1} = 50 P_1 + 380 P_{tot} + T_{amb}$$

$$T_{j2} = 50 P_2 + 380 P_{tot} + T_{amb}$$

DEVICE DATA







## SILICON PLANAR EPITAXIAL HIGH-SPEED DIODE

Silicon epitaxial high-speed diode in a microminiature plastic envelope. It is intended for high-speed switching in hybrid thick and thin-film circuits.

### QUICK REFERENCE DATA

Continuous reverse voltage	$V_R$	max.	75 V
Repetitive peak reverse voltage	$V_{RRM}$	max.	85 V
Repetitive peak forward current	$I_{FRM}$	max.	250 mA
Junction temperature	$T_j$	max.	175 °C
Forward voltage at $I_F = 50$ mA	$V_F$	<	1,0 V
Reverse recovery time when switched from $I_F = 10$ mA to $I_R = 10$ mA; $R_L = 100$ $\Omega$ ; measured at $I_R = 1$ mA	$t_{rr}$	<	6 ns
Recovery charge when switched from $I_F = 10$ mA to $V_R = 5$ V; $R_L = 500$ $\Omega$	$Q_s$	<	45 pC

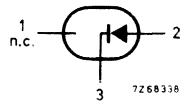
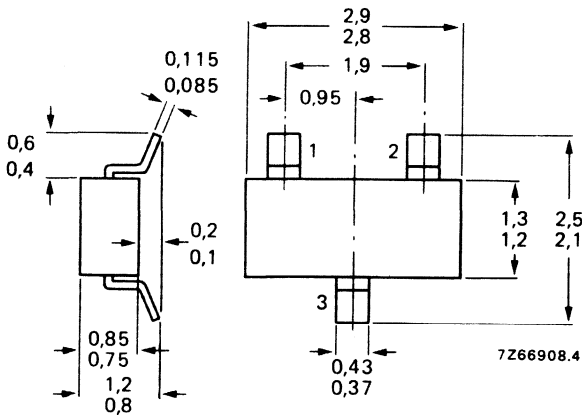
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BAS16 = A6



See also *Soldering recommendations*.

## RATINGS

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

Continuous reverse voltage	$V_R$	max.	75 V
Repetitive peak reverse voltage	$V_{RRM}$	max.	85 V
Average rectified forward current <sup>▲</sup> (averaged over any 20 ms period)	$I_{F(AV)}$	max.	250 mA
Forward current (d.c.)	$I_F$	max.	250 mA
Repetitive peak forward current	$I_{FRM}$	max.	250 mA
→ Storage temperature	$T_{stg}$	-65 to +175	°C
→ Junction temperature	$T_j$	max.	175 °C

## → THERMAL CHARACTERISTICS \*

$$T_j = P_x (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

### Thermal resistance

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient **	$R_{th\ s-a}$	=	120 K/W

## CHARACTERISTICS

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

### Forward voltage

$I_F = 1\text{ mA}$	$V_F$	<	715 mV
$I_F = 10\text{ mA}$	$V_F$	<	855 mV
$I_F = 50\text{ mA}$	$V_F$	<	1000 mV
$I_F = 150\text{ mA}$	$V_F$	<	1250 mV

### Reverse current

$V_R = 25\text{ V}; T_j = 150\text{ °C}$	$I_R$	<	30 $\mu\text{A}$
$V_R = 75\text{ V}$	$I_R$	<	1 $\mu\text{A}$
$V_R = 75\text{ V}; T_j = 150\text{ °C}$	$I_R$	<	50 $\mu\text{A}$

### Diode capacitance

$V_R = 0; f = 1\text{ MHz}$	$C_d$	<	2 pF
-----------------------------	-------	---	------

### Forward recovery voltage (see also Fig. 2)

when switched to $I_F = 10\text{ mA}; t_p = 20\text{ ns}$	$V_{fr}$	<	1,75 V
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### Reverse recovery time (see also Fig. 3)

when switched from $I_F = 10\text{ mA}$ to $I_R = 10\text{ mA};$ $R_L = 100\ \Omega$ ; measured at $I_R = 1\text{ mA}$	$t_{rr}$	<	6 ns
---	----------	---	------

### Recovery charge (see also Fig. 4)

when switched from $I_F = 10\text{ mA}$ to $V_R = 5\text{ V};$ $R_L = 500\ \Omega$	$Q_s$	<	45 pC
---	-------	---	-------

▲ Measured under pulse conditions.  $t_p \leq 0,5\text{ ms}$ .  $I_{F(AV)} = 150\text{ mA}$ ,  $t_{(av)} \leq 1\text{ ms}$ , for sinusoidal operation.

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

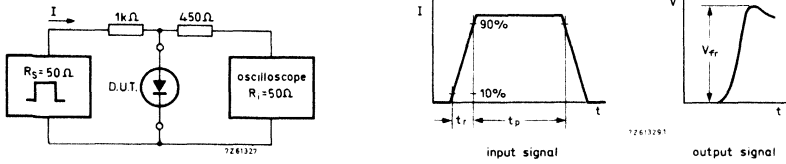


Fig. 2 Forward recovery voltage test circuit and waveforms.

Input signal: forward pulse rise time =  $t_r = 20$  ns; forward current pulse duration  $t_p = 120$  ns; duty factor =  $\delta = 0,01$ .

Oscilloscope: rise time =  $t_r = 0,35$  ns.

Circuit capacitance  $C \leq 1$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance).

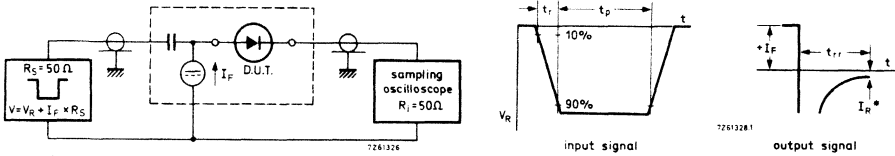


Fig. 3 Reverse recovery time test circuit and waveforms.

Input signal: reverse pulse rise time =  $t_r = 0,6$  ns; reverse pulse duration =  $t_p = 100$  ns; duty factor =  $\delta = 0,05$ . \*  $t_{rr}$  up to  $I_R = 1$  mA.

Oscilloscope: rise time =  $t_r = 0,35$  ns.

Circuit capacitance  $C \leq 1$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance).

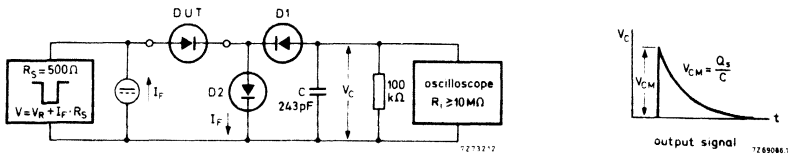


Fig. 4 Recovery charge test circuit and waveform.

D1 = BAW62; D2 = diode with minority carrier life time at 10 mA:  $< 200$  ps

Input signal

Rise time of the reverse pulse

Reverse pulse duration

Duty factor

$$\begin{aligned}
 t_r &= 2 \text{ ns} \\
 t_p &= 400 \text{ ns} \\
 \delta &= 0,02
 \end{aligned}$$

Circuit capacitance  $C \leq 7$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance).

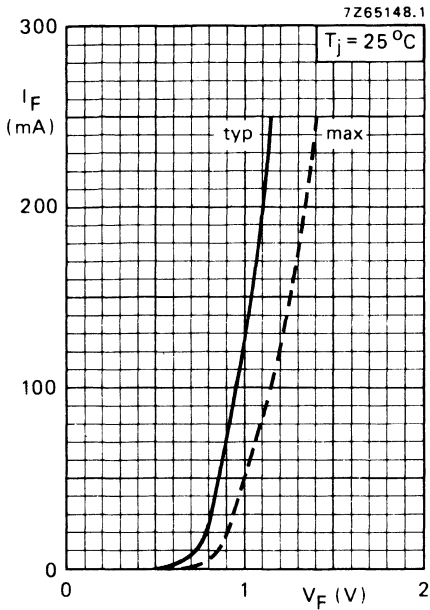


Fig. 5.

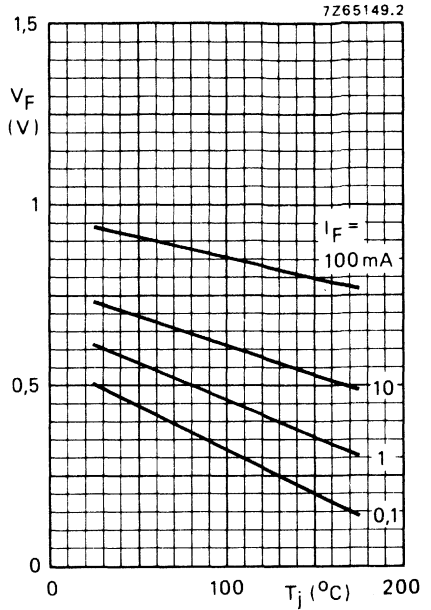


Fig. 6 Typical values.

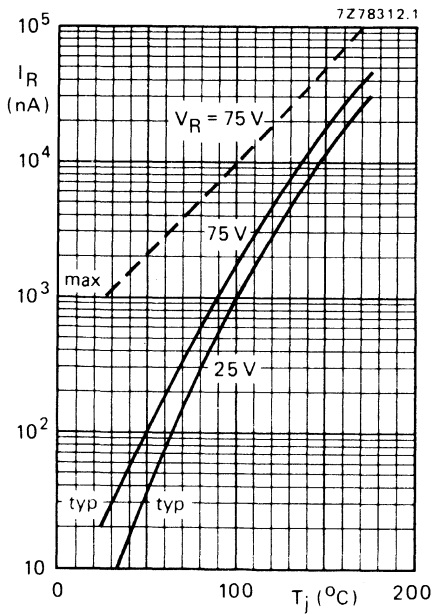


Fig. 7.

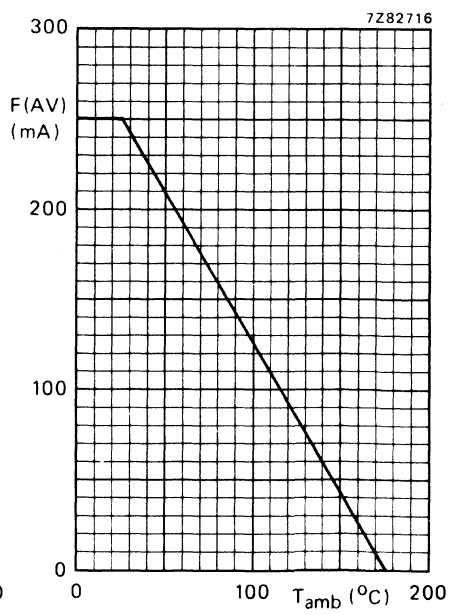


Fig. 8 Current derating curve.

## LOW VOLTAGE STABISTOR

Silicon planar epitaxial diode in SOT-23 envelope. This diode is intended for low voltage stabilizing e.g. bias stabilizer in class-B output stages, clipping, clamping and meter protection.

### QUICK REFERENCE DATA

Repetitive peak forward current	$I_{FRM}$	max.	250 mA
Storage temperature	$T_{stg}$	-65 to + 150 °C	
Junction temperature	$T_j$	max.	150 °C
Thermal resistance from junction to ambient	$R_{th j-a}$	=	0,62 K/mW
Forward voltage	$V_F$		
$I_F = 0,1$ mA	$V_F$		610 to 690 mV
$I_F = 1,0$ mA	$V_F$		680 to 760 mV
$I_F = 10$ mA	$V_F$		750 to 830 mV
$I_F = 100$ mA	$V_F$		870 to 960 mV
Diode capacitance	$C_d$	<	140 pF
$V_R = 0$ ; $f = 1$ MHz			

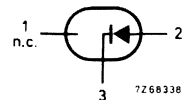
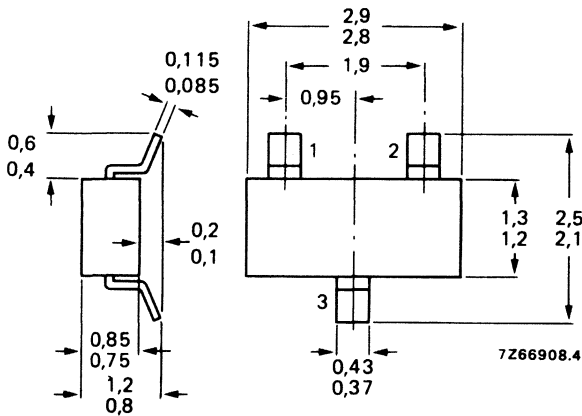
### MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BAS17 = A91



See also chapter *Soldering Recommendations*.

**RATINGS**

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

Repetitive peak forward current	$I_{FRM}$	max.	250 mA
Storage temperature	$T_{stg}$		-65 to + 150 °C
Junction temperature	$T_j$	max.	150 °C

**THERMAL RESISTANCE**

From junction to ambient in free air mounted on a ceramic substrate of 7 mm x 5 mm x 0,5 mm

$$R_{th\ j-a} = 0,62\ K/mW$$

**CHARACTERISTICS**

$T_j = 25\ ^\circ C$  unless otherwise specified

Forward voltage

$I_F = 0,1\ mA$	$V_F$	610 to 690 mV
$I_F = 1,0\ mA$	$V_F$	680 to 760 mV
$I_F = 5,0\ mA$	$V_F$	730 to 810 mV
$I_F = 10\ mA$	$V_F$	750 to 830 mV
$I_F = 100\ mA$	$V_F$	870 to 960 mV

Reverse current

$$V_R = 4\ V \quad I_R < 5\ \mu A$$

Temperature coefficient

$$I_F = 1\ mA \quad S_F\ \text{typ.}\ -1,8\ mV/K$$

Diode capacitance

$$V_R = 0; f = 1\ MHz \quad C_d < 140\ pF$$



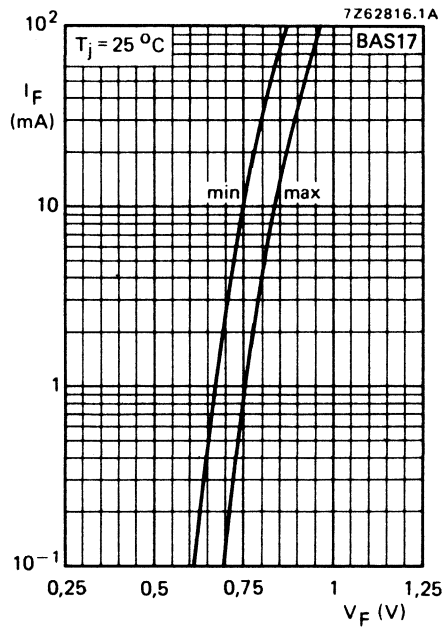


Fig. 2 Forward current as a function of forward voltage.







## SILICON PLANAR EPITAXIAL HIGH-SPEED DIODES

Silicon epitaxial high-speed diodes in a microminiature plastic envelope. They are intended for switching and general purposes.

### QUICK REFERENCE DATA

			BAS19	BAS20	BAS21	
Continuous reverse voltage	$V_R$	max.	100	150	200	V
Repetitive peak reverse voltage	$V_{RRM}$	max.	120	200	250	V
Repetitive peak forward current	$I_{FRM}$	max.		625		mA
Junction temperature	$T_j$	max.		150		°C
Forward voltage at $I_F = 100$ mA	$V_F$	<		1		V
Reverse recovery time when switched from $I_F = 30$ mA to $I_R = 30$ mA; $R_L = 100 \Omega$ measured at $I_R = 3$ mA	$t_{rr}$	<		50		ns

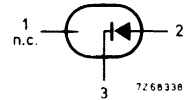
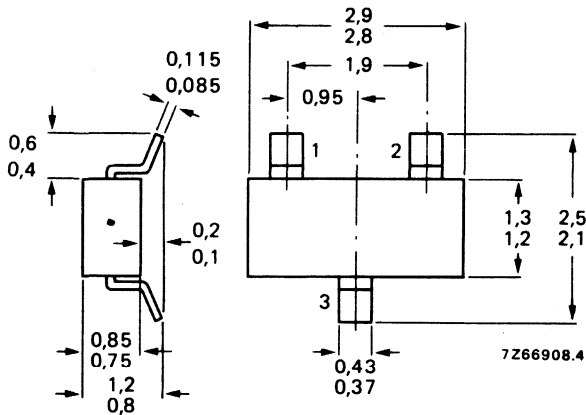
### MECHANICAL DATA

Dimensions in mm

### Marking code

BAS19 = A8  
 BAS20 = A81  
 BAS21 = A82

Fig. 1 SOT-23.



See also *Soldering recommendations*.

**RATINGS**

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

		BAS19	BAS20	BAS21	
Continuous reverse voltage	$V_R$	max. 100	150	200	V
Repetitive peak reverse peak	$V_{RRM}$	max. 120	200	250	V
Average rectified forward current (1) (averaged over any 20 ms period)	$I_F(AV)$	max.	200		mA
Forward current (d.c.)	$I_F$	max.	200		mA
Repetitive peak forward current	$I_{FRM}$	max.	625		mA
Storage temperature	$T_{stg}$		-65 to + 150		°C
Junction temperature	$T_j$	max.	150		°C
Total power dissipation up to $T_{amb} = 25\text{ °C}$	$P_{tot}$	max.	200		mW

**THERMAL RESISTANCE**

From junction to ambient  
mounted on a ceramic substrate  
of 7 mm x 5 mm x 0,5 mm

$R_{th\ j-a}$	=	0,62 °C/mW
---------------	---	------------

**CHARACTERISTICS**

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

Forward voltage

$I_F = 100\text{ mA}$

$I_F = 200\text{ mA}$

$V_F$	<	1,0 V
$V_F$	<	1,25 V

Reverse breakdown voltage (1)

BAS19;  $I_R = 100\text{ }\mu\text{A}$

BAS20;  $I_R = 100\text{ }\mu\text{A}$

BAS21;  $I_R = 100\text{ }\mu\text{A}$  (2)

$V_{(BR)R}$	>	120 V
$V_{(BR)R}$	>	200 V
$V_{(BR)R}$	>	250 V

Reverse current

$V_R = V_{Rmax}$

$V_R = V_{Rmax}$ ;  $T_j = 150\text{ °C}$

$I_R$	<	100 nA
$I_R$	<	100 $\mu\text{A}$

Differential resistance

$I_F = 10\text{ mA}$

$r_{diff}$	typ.	5 $\Omega$
------------	------	------------

Diode capacitance

$V_R = 0$ ;  $f = 1\text{ MHz}$

$C_d$	<	5 pF
-------	---	------

Reverse recovery time (see Figs 2 and 3)

when switched from  $I_F = 30\text{ mA}$  to  $I_R = 30\text{ mA}$ ;

$R_L = 100\text{ }\Omega$ ; measured at  $I_R = 3\text{ mA}$

$t_{rr}$	<	50 ns
----------	---	-------

(1) Measured under pulse conditions; Pulse time =  $t_p \leq 0,3\text{ ms}$ .

(2) At zero life time, measured under pulse conditions to avoid excessive dissipation and voltage limited to 275 V.

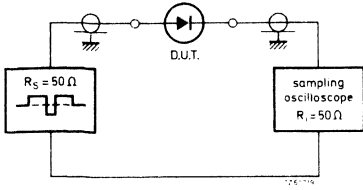


Fig. 2 Test circuit.

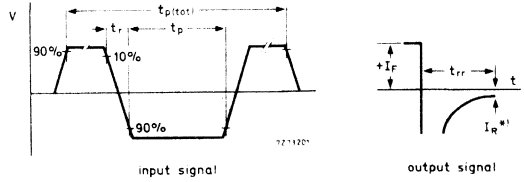


Fig. 3 Waveforms;  $I_R = 3 \text{ mA}$ .

**Input signal**

total pulse duration	$t_p(\text{tot}) = 2 \mu\text{s}$
duty factor	$\delta = 0,0025$
rise time of reverse pulse	$t_r = 0,6 \text{ ns}$
reverse pulse duration	$t_p = 100 \text{ ns}$

**Oscilloscope**

rise time	$t_r = 0,35 \text{ ns}$
circuit capacitance*	$C < 1 \text{ pF}$

\*C = oscilloscope input capacitance + parasitic capacitance.

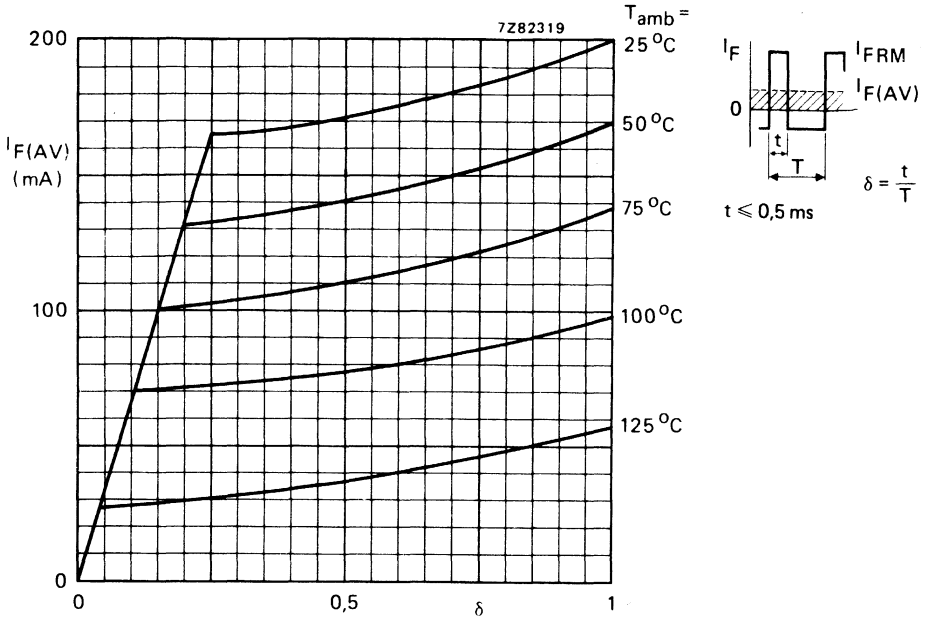


Fig. 4 BAS19; maximum permissible average rectified forward current for pulse operation as a function of the duty factor at  $V_R = 100 \text{ V}$ .

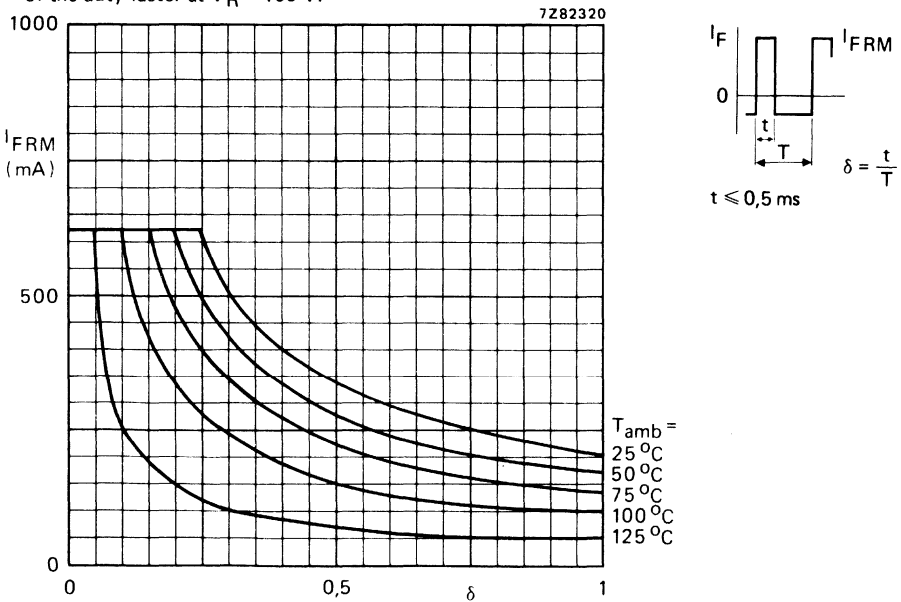


Fig. 5 BAS19; maximum permissible repetitive peak forward current for pulse operation as a function of the duty factor at  $V_R = 100 \text{ V}$ .

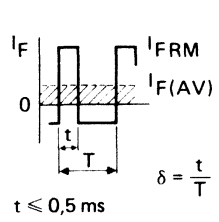
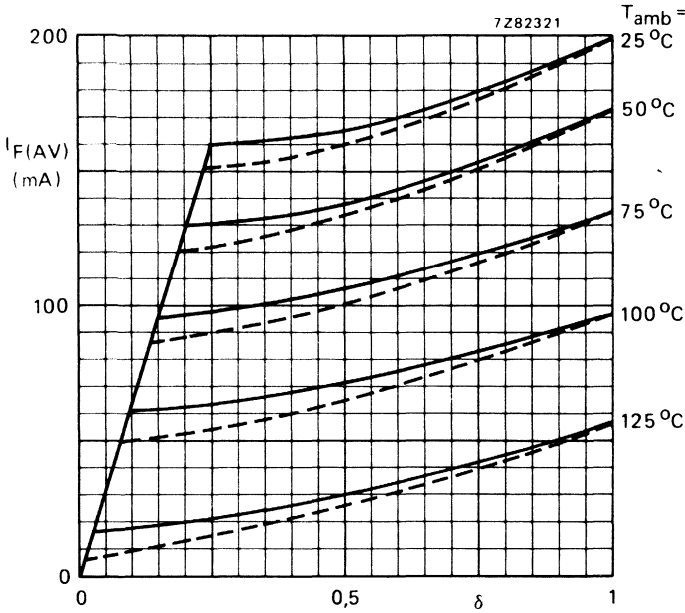


Fig. 6 BAS20/21; maximum permissible average rectified forward current for pulse operation as a function of the duty factor.

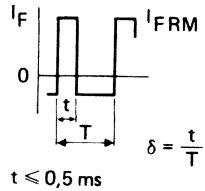
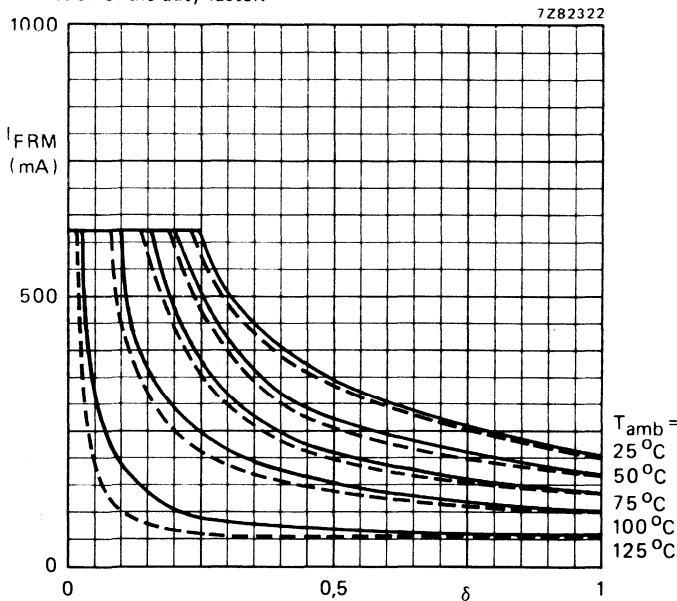


Fig. 7 BAS20/21; maximum permissible repetitive peak forward current for pulse operation as a function of the duty factor.

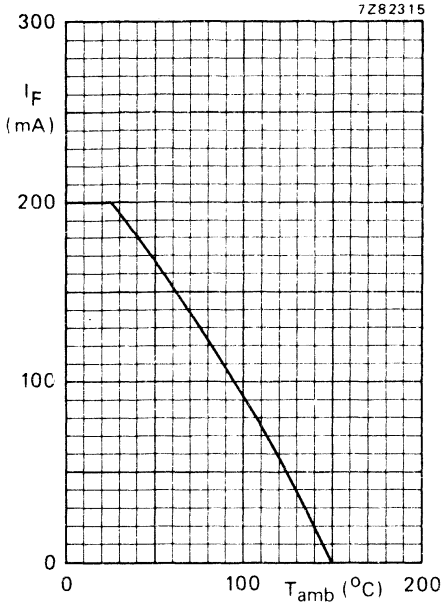


Fig. 8.

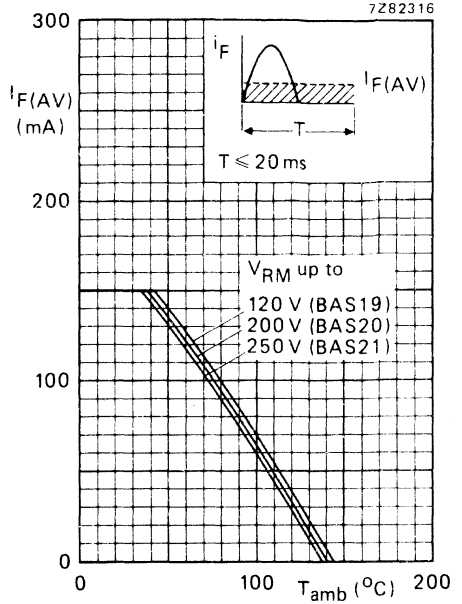


Fig. 9.

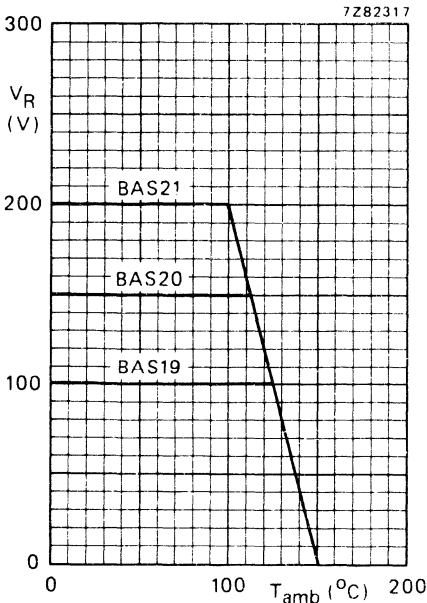


Fig. 10.

Fig. 8 Maximum permissible continuous forward current as a function of the ambient temperature.

Fig. 9 Maximum permissible average rectified forward current as a function of the ambient temperature.

Fig. 10 Maximum permissible continuous reverse voltage as a function of the ambient temperature.

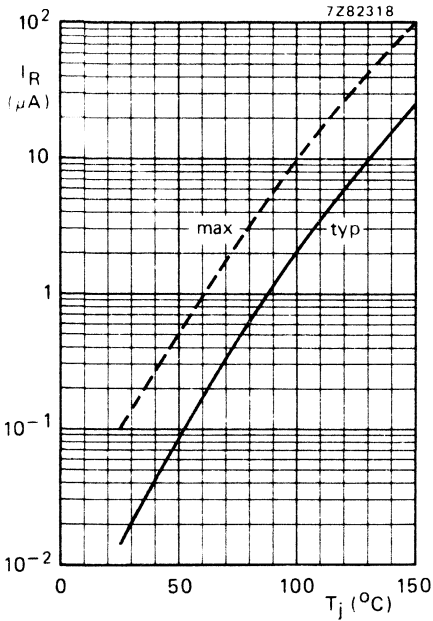


Fig. 11.

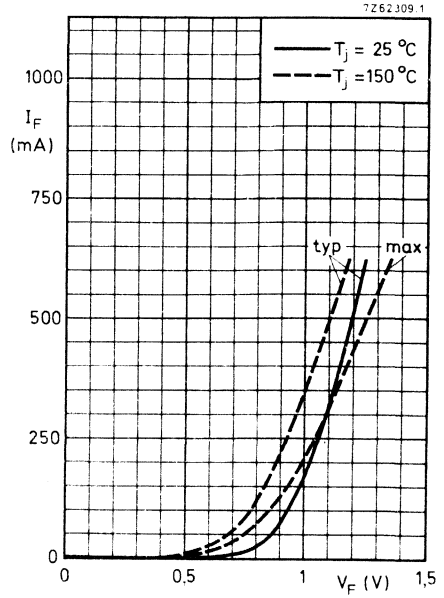


Fig. 12.

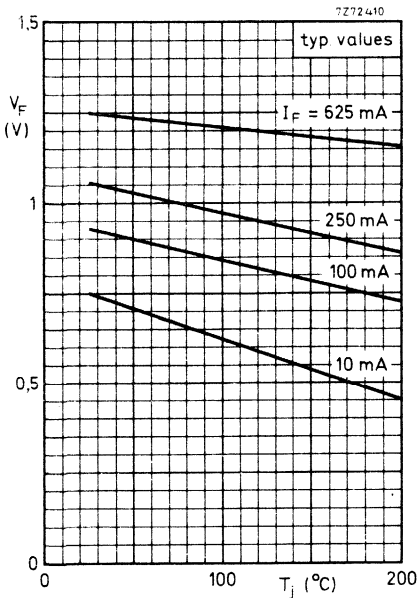


Fig. 13.

Fig. 11 Continuous reverse current as a function of the junction temperature.

Fig. 12 Forward current as a function of forward voltage.

Fig. 13 Forward voltage as a function of the junction temperature.

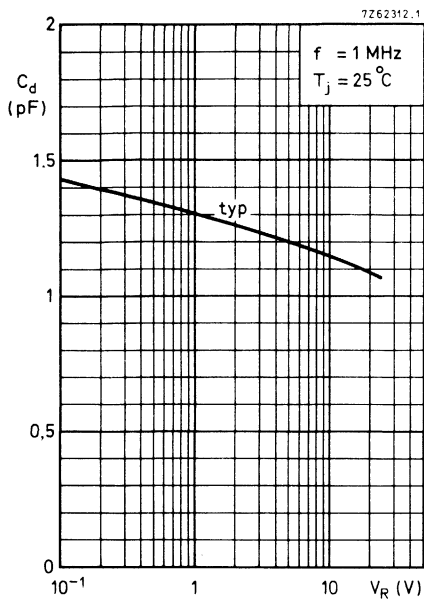


Fig. 14.

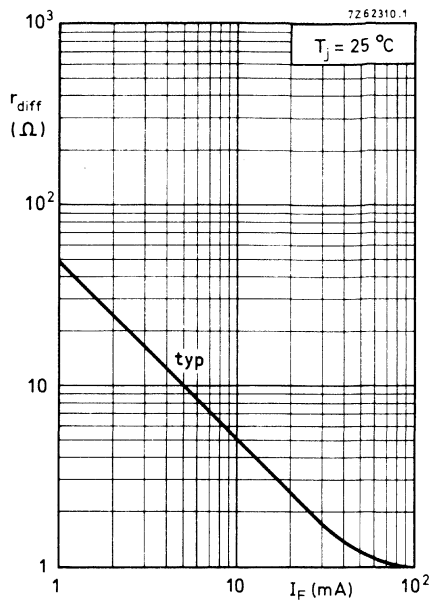


Fig. 15.





## SCHOTTKY BARRIER DIODE

Silicon epitaxial diode in a microminiature plastic envelope. Intended for u.h.f. mixer and fast switching applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

Continuous reverse voltage	$V_R$	max.	4 V
Forward current (d.c.)	$I_F$	max.	30 mA
Junction temperature	$T_j$	max.	100 °C
Thermal resistance from junction to ambient	$R_{thj-a}$	=	0,62 °C/mW
Forward voltage at $I_F = 10$ mA	$V_F$	<	600 mV
Diode capacitance at $V_R = 0$ ; $f = 1$ MHz	$C_d$	<	1,0 pF
Noise figure at $f = 900$ MHz	F	<	8,0 dB

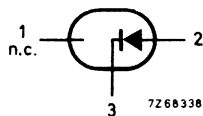
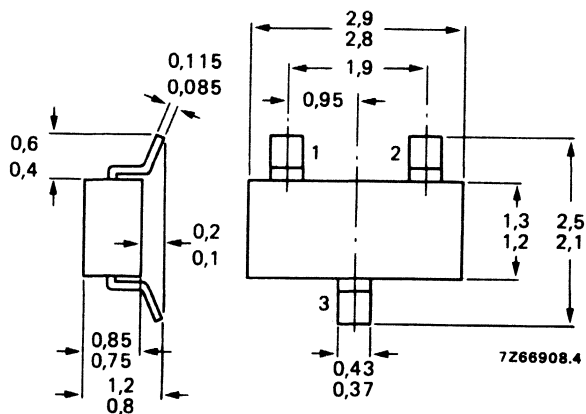
### MECHANICAL DATA

Dimensions in mm

Marking code

BAT17 = A3

Fig.1 SOT-23.



See also *Soldering recommendations*.

## RATINGS

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

Continuous reverse voltage	$V_R$	max.	4 V
Forward current (d.c.)	$I_F$	max.	30 mA
Storage temperature	$T_{stg}$		-65 to +100 °C
Junction temperature	$T_j$	max.	100 °C

## THERMAL RESISTANCE

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0,5 mm

$$R_{thj-a} = 0,62 \text{ } ^\circ\text{C/mW}$$

## CHARACTERISTICS

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

Reverse current

$$V_R = 3 \text{ V}$$

$$I_R < 0,25 \text{ } \mu\text{A}$$

$$V_R = 3 \text{ V}; T_{amb} = 60 \text{ } ^\circ\text{C}$$

$$I_R < 1,25 \text{ } \mu\text{A}$$

Reverse breakdown voltage

$$I_R = 10 \text{ } \mu\text{A}$$

$$V_{(BR)R} > 4 \text{ V}$$

Forward voltage

$$I_F = 0,1 \text{ mA}$$

$$V_F < 350 \text{ mV}$$

$$I_F = 1,0 \text{ mA}$$

$$V_F < 450 \text{ mV}$$

$$I_F = 10 \text{ mA}$$

$$V_F < 600 \text{ mV}$$

Diode capacitance

$$V_R = 0; f = 1 \text{ MHz}$$

$$C_d < 1,0 \text{ pF}$$

Noise figure at  $f = 900 \text{ MHz}$  \*

$$F < 8,0 \text{ dB}$$

Series resistance at  $f = 1 \text{ kHz}$

$$I_F = 5 \text{ mA}$$

$$r_D < 15 \text{ } \Omega$$

\* The local oscillator is adjusted for a diode current of 2 mA. I.F. amplifier noise  $F_{if} = 1,5 \text{ dB}$ ;  $f = 35 \text{ MHz}$ .

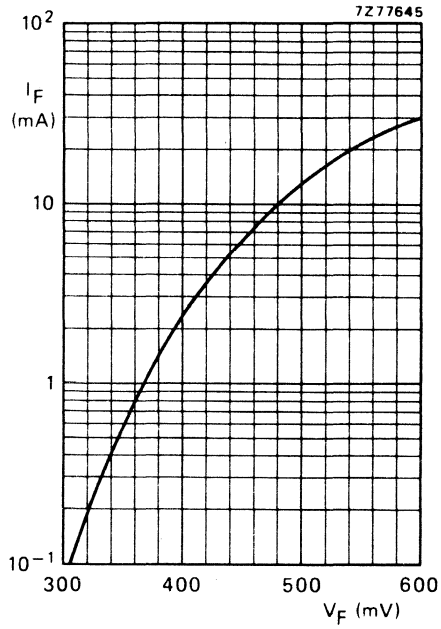


Fig. 2 Typical values.





## SILICON PLANAR DIODE

Switching diode in a microminiature plastic envelope. Intended for thick and thin-film circuits.

### QUICK REFERENCE DATA

Continuous reverse voltage	$V_R$	max.	35 V
Forward current (d.c.)	$I_F$	max.	100 mA
Junction temperature	$T_j$	max.	100 °C
Diode capacitance at $f = 1$ MHz $V_R = 20$ V	$C_d$	typ. <	0,8 pF 1,0 pF
Series resistance at $f = 200$ MHz $I_F = 5$ mA	$r_D$	typ. <	0,5 $\Omega$ 0,7 $\Omega$

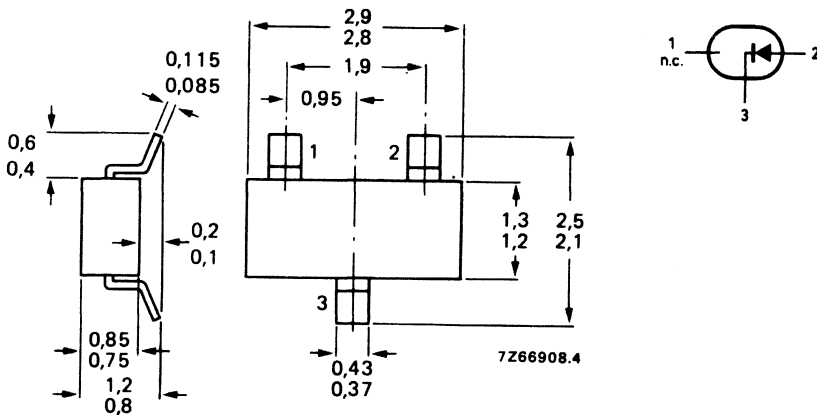
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BAT18 = A2



See also *Soldering recommendations*.

## RATINGS

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

Continuous reverse voltage	$V_R$	max.	35 V
Forward current (d.c.)	$I_F$	max.	100 mA
Storage temperature	$T_{stg}$		-55 to +100 °C
Junction temperature	$T_j$	max.	100 °C

## THERMAL RESISTANCE

From junction to ambient mounted on a ceramic substrate of 7 mm x 5 mm x 0,5 mm

$$R_{th\ j-a} = 0,62\text{ }^{\circ}\text{C/mW}$$

## CHARACTERISTICS

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

Forward voltage at $I_F = 100\text{ mA}$	$V_F$	<	1,2 V
Reverse current	$I_R$	<	100 nA
$V_R = 20\text{ V}$	$I_R$	<	1 $\mu\text{A}$
$V_R = 20\text{ V}; T_j = 60\text{ }^{\circ}\text{C}$			
Diode capacitance at $f = 1\text{ MHz}$	$C_d$	typ.	0,8 pF
$V_R = 20\text{ V}$		<	1,0 pF
Series resistance at $f = 200\text{ MHz}$	$r_D$	typ.	0,5 $\Omega$
$I_F = 5\text{ mA}$		<	0,7 $\Omega$



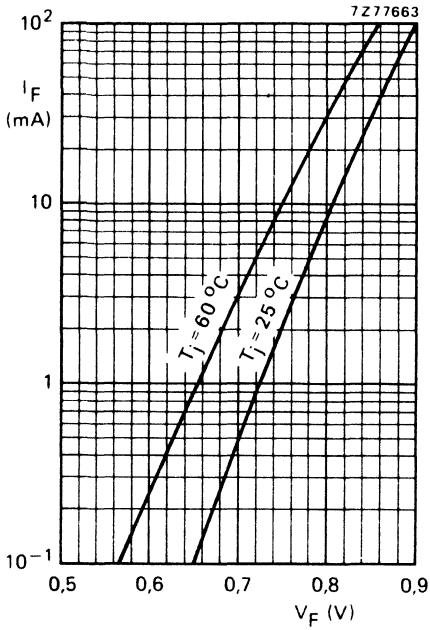


Fig. 2 Typical values.

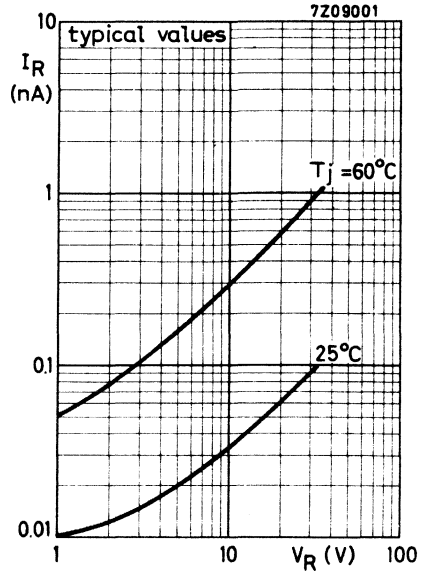


Fig. 3.

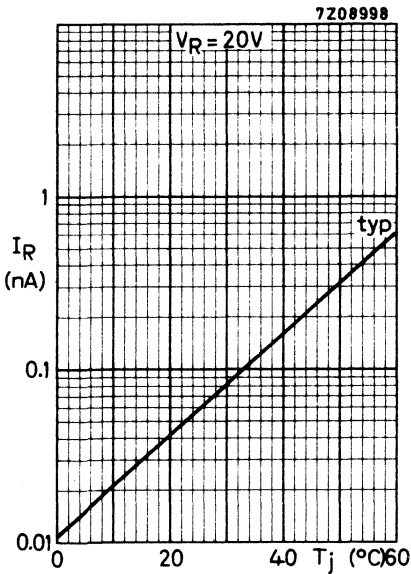


Fig. 4.

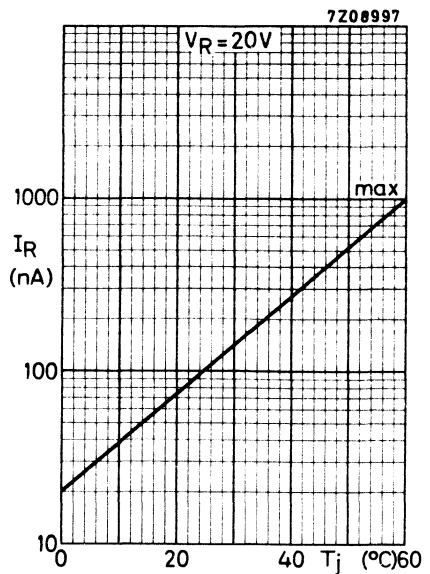


Fig. 5.



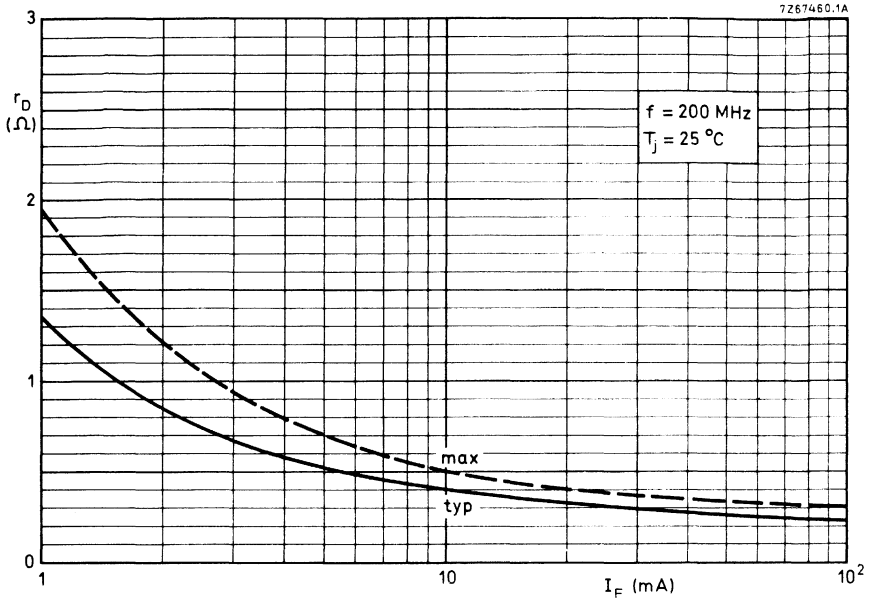


Fig. 6.





## SILICON PLANAR EPITAXIAL HIGH-SPEED DIODES

The BAV70 consists of two diodes in a microminiature plastic envelope. The cathodes are commoned and the unit is intended for high-speed switching in thick and thin-film circuits.

### QUICK REFERENCE DATA (per diode)

Continuous reverse voltage	$V_R$	max.	70 V	
Repetitive peak reverse voltage	$V_{RRM}$	max.	70 V	
Repetitive peak forward current	$I_{FRM}$	max.	250 mA	←
Junction temperature	$T_j$	max.	175 °C	←
Forward voltage at $I_F = 50$ mA	$V_F$	<	1,0 V	←
Reverse recovery time when switched from $I_F = 10$ mA to $I_R = 10$ mA; $R_L = 100 \Omega$ ; measured at $I_R = 1$ mA	$t_{rr}$	<	6 ns	
Recovery charge when switched from $I_F = 10$ mA to $V_R = 5$ V; $R_L = 500 \Omega$	$Q_s$	<	45 pC	

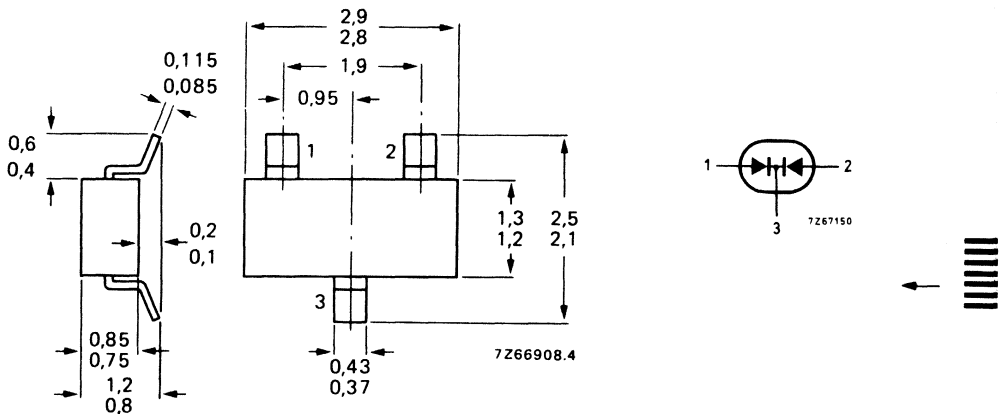
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BAV70 = A4



See also *Soldering recommendations*.

## RATINGS (per diode)

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

Continuous reverse voltage	$V_R$	max.	70 V
Repetitive peak reverse voltage	$V_{RRM}$	max.	70 V
Average rectified forward current <sup>▲</sup> → (averaged over any 20 ms period)	$I_{F(AV)}$	max.	250 mA
→ Forward current (d.c.)	$I_F$	max.	250 mA
→ Repetitive peak forward current	$I_{FRM}$	max.	250 mA
→ Storage temperature	$T_{stg}$	-65 to +	175 °C
→ Junction temperature	$T_j$	max.	175 °C

## THERMAL CHARACTERISTICS\*

→  $T_{j1} = P_1 (R_{th\ j-t}) + T_{tab}$   
 $T_{j2} = P_2 (R_{th\ j-t}) + T_{tab}$   
 $T_{tab} = P_{tot} (R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$

### Thermal resistance

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

## CHARACTERISTICS (per diode)

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

### Forward voltage

$I_F = 1\text{ mA}$	$V_F$	<	715 mV
$I_F = 10\text{ mA}$	$V_F$	<	855 mV
$I_F = 50\text{ mA}$	$V_F$	<	1000 mV
$I_F = 150\text{ mA}$	$V_F$	<	1250 mV

### Reverse current

$V_R = 25\text{ V}; T_j = 150\text{ °C}$	$I_R$	<	60 $\mu\text{A}$
$V_R = 70\text{ V}$	$I_R$	<	5 $\mu\text{A}$
$V_R = 70\text{ V}; T_j = 150\text{ °C}$	$I_R$	<	100 $\mu\text{A}$

### Diode capacitance

$V_R = 0; f = 1\text{ MHz}$	$C_d$	<	1,5 pF
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### Forward recovery voltage when switched to

$I_F = 10\text{ mA}; t_r = 20\text{ ns}$	$V_{fr}$	<	1,75 V
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▲ Measured under pulse conditions : pulse time  $t_p \leq 0,5\text{ ms}$ .

For sinusoidal operation  $I_{F(AV)} = 150\text{ mA}$ ; averaging time  $t_{(av)} \leq 1\text{ ms}$ .

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm.

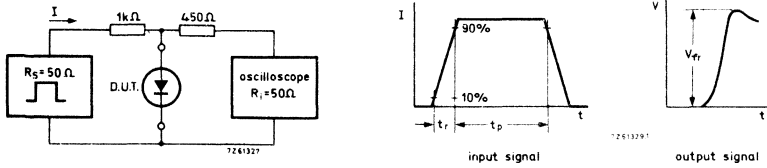


Fig. 2 Test circuit and waveforms; forward recovery voltage.

Input signal : Rise time of the forward pulse  $t_r = 20$  ns; Forward current pulse duration  $t_p = 120$  ns;

Duty factor  $\delta = 0,01$

Oscilloscope : Rise time  $t_r = 0,35$  ns

Circuit capacitance  $C \leq 1$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance)

Reverse recovery time when switched from  $I_F = 10$  mA to  $I_R = 10$  mA;  $R_L = 100 \Omega$ ;  
measured at  $I_R = 1$  mA

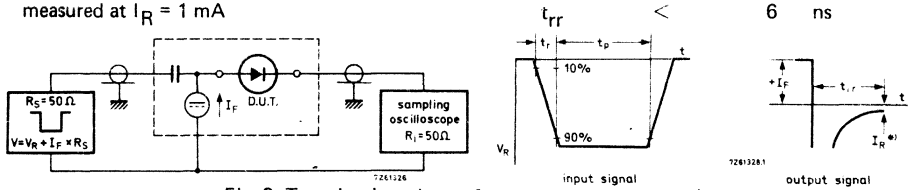


Fig. 3 Test circuit and waveforms; reverse recovery time.

Input signal : Rise time of the reverse pulse  $t_r = 0,6$  ns; reverse pulse duration  $t_p = 100$  ns; duty factor  $\delta = 0,05$

Oscilloscope : Rise time  $t_r = 0,35$  ns

Circuit capacitance  $C \leq 1$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance)

Recovery charge when switched from

$I_F = 10$  mA to  $V_R = 5$  V;  $R_L = 500 \Omega$

$Q_s < 45$  pC

\*)  $I_R = 1$  mA

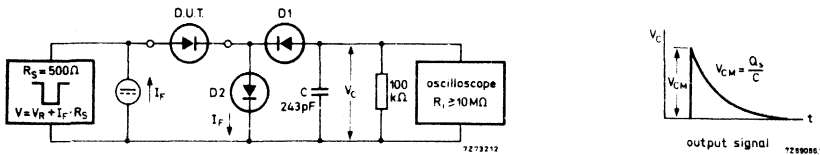


Fig. 4 Test circuit and waveform; recovery charge.

D1 = BAW62

D2 = diode with minority carrier life time at 10 mA:  $< 200$  ps

Input signal : Rise time of the reverse pulse =  $t_r = 2$  ns; Reverse pulse duration =  $t_p = 400$  ns;

Duty factor =  $\delta = 0,02$

Circuit capacitance  $C \leq 7$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance)

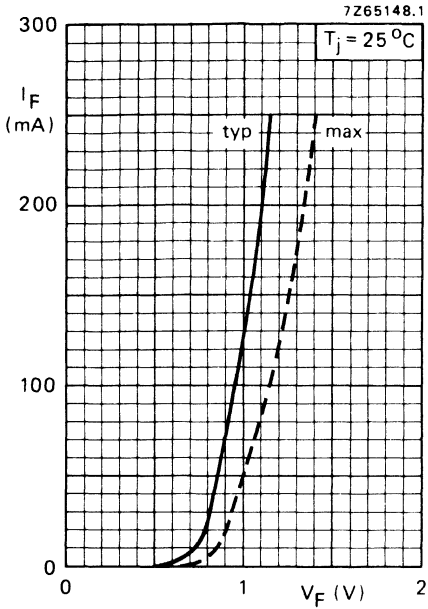


Fig. 5

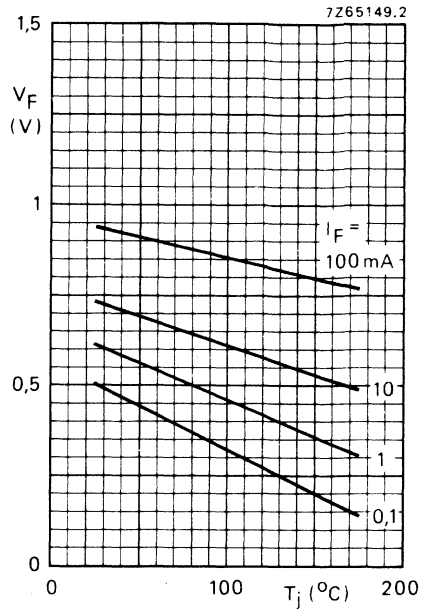


Fig. 6

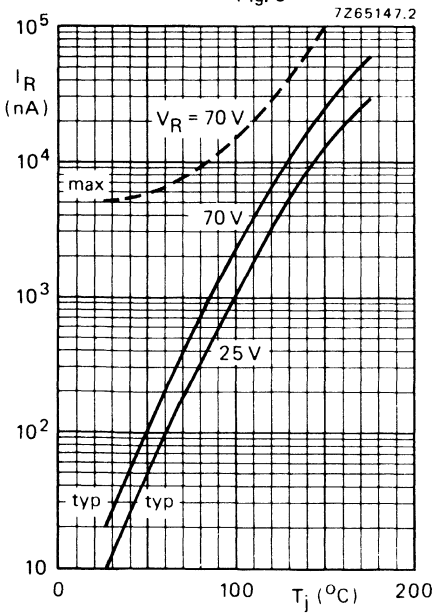


Fig. 7

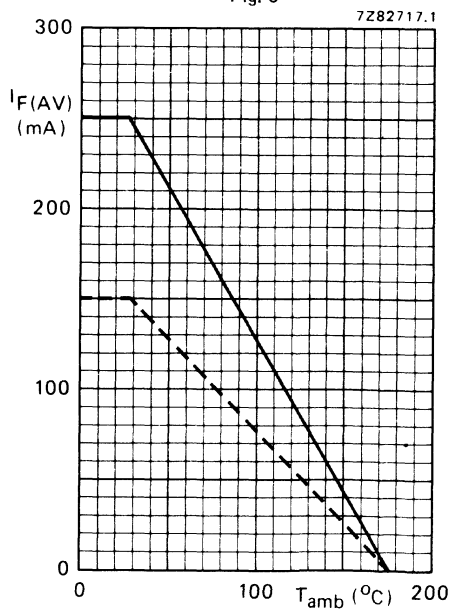


Fig. 8 — single diode  
----- double diode, equally loaded.

## SILICON PLANAR EPITAXIAL HIGH-SPEED DIODES

The BAV99 consists of two diodes in a microminiature plastic envelope. The diodes are connected in series and the unit is intended for high-speed switching in thick and thin-film circuits.

### QUICK REFERENCE DATA (per diode)

Continuous reverse voltage	$V_R$	max.	70 V	
Repetitive peak reverse voltage	$V_{RRM}$	max.	70 V	
Repetitive peak forward current	$I_{FRM}$	max.	250 mA	
Junction temperature	$T_j$	max.	175 °C	←
Forward voltage at $I_F = 50$ mA	$V_F$	<	1,0 V	
Reverse recovery time when switched from $I_F = 10$ mA to $I_R = 10$ mA; $R_L = 100 \Omega$ ; measured at $I_R = 1$ mA	$t_{rr}$	<	6 ns	
Recovery charge when switched from $I_F = 10$ mA to $V_R = 5$ V; $R_L = 500 \Omega$	$Q_s$	<	45 pC	

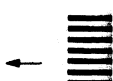
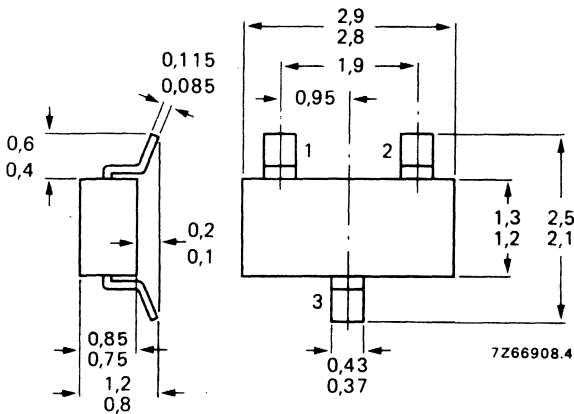
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BAV99 = A7



See also *Soldering recommendations*.

## RATINGS (per diode)

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

Continuous reverse voltage	$V_R$	max.	70 V
Repetitive peak reverse voltage	$V_{RRM}$	max.	70 V
Average rectified forward current <sup>▲</sup> (averaged over any 20 ms period)	$I_{F(AV)}$	max.	250 mA
Forward current (d.c.)	$I_F$	max.	250 mA
Repetitive peak forward current	$I_{FRM}$	max.	250 mA
→ Storage temperature	$T_{stg}$		-65 to +175 °C
→ Junction temperature	$T_j$	max.	175 °C

## → THERMAL CHARACTERISTICS \*

$$T_{j1} = P_1 (R_{th j-t}) + T_{tab}$$

$$T_{j2} = P_2 (R_{th j-t}) + T_{tab}$$

$$T_{tab} = P_{tot} (R_{th t-s} + R_{th s-a}) + T_{amb}$$

### Thermal resistance

From junction to tab	$R_{th j-t}$	=	50 K/W
From tab to soldering points	$R_{th t-s}$	=	260 K/W
From soldering points to ambient **	$R_{th s-a}$	=	120 K/W

## CHARACTERISTICS (per diode)

$T_j = 25$  °C unless otherwise specified

### Forward voltage

$I_F = 1$ mA	$V_F$	<	715 mV
$I_F = 10$ mA	$V_F$	<	855 mV
$I_F = 50$ mA	$V_F$	<	1000 mV
$I_F = 150$ mA	$V_F$	<	1250 mV

### Reverse current

$V_R = 25$ V; $T_j = 150$ °C	$I_R$	<	30 $\mu$ A
$V_R = 70$ V	$I_R$	<	2,5 $\mu$ A
$V_R = 70$ V; $T_j = 150$ °C	$I_R$	<	50 $\mu$ A

### Diode capacitance

$V_R = 0$ ; $f = 1$ MHz	$C_d$	<	1,5 pF
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### Forward recovery voltage when switched to

$I_F = 10$ mA; $t_r = 20$ ns	$V_{fr}$	<	1,75 V
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<sup>▲</sup> Measured under pulse conditions: pulse time  $t_p \leq 0,5$  ms.

For sinusoidal operation  $I_{F(AV)} = 150$  mA; averaging time  $t_{(av)} \leq 1$  ms.

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm

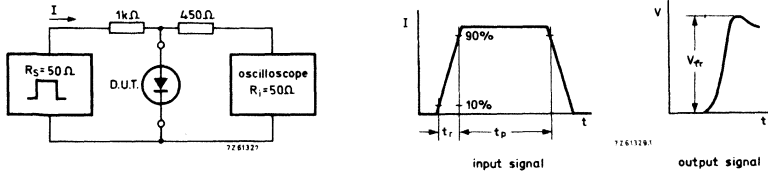


Fig. 2 Test circuit and waveforms; forward recovery voltage.

Input signal: Rise time of the forward pulse  $t_r = 20$  ns;  
 Forward current pulse duration =  $t_p = 120$  ns. Duty factor =  $\delta = 0,01$ .  
 Oscilloscope: Rise time  $t_r = 0,35$  ns.  
 Circuit capacitance  $C \leq 1$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance).  
 Reverse recovery time when switched from  
 $I_F = 10$  mA to  $I_R = 10$  mA;  $R_L = 100 \Omega$ ;  
 measured at  $I_R = 1$  mA

$$t_{rr} < 6 \text{ ns}$$

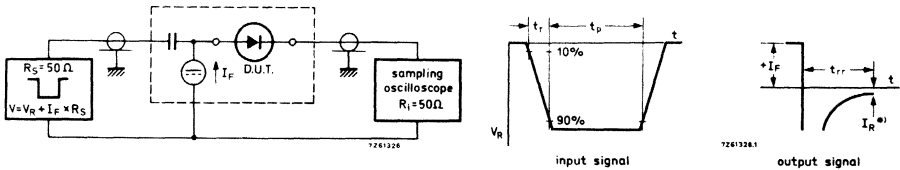


Fig. 3 Test circuit and waveforms; reverse recovery time.

Input signal: Rise time of the reverse pulse  $t_r = 0,6$  ns  
 Reverse pulse duration  $t_p = 100$  ns. Duty factor  $\delta = 0,05$ .  
 Oscilloscope: Rise time  $t_r = 0,35$  ns.  
 Circuit capacitance  $C \leq 1$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance).  
 Recovery charge when switched from  
 $I_F = 10$  mA to  $V_R = 5$  V;  $R_L = 500 \Omega$

\*)  $I_R = 1$  mA

$$Q_s < 45 \text{ pC}$$

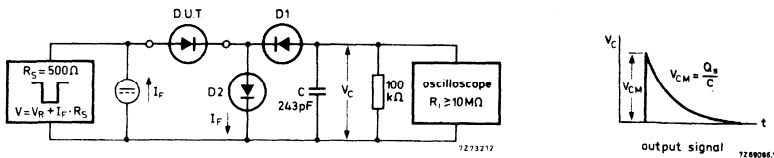


Fig. 4 Test and waveform; recovery charge.

$D2 =$  diode with minority carrier life time at 10 mA:  $< 200$  ps;  $D1 =$  BAV62.  
 Input signal: Rise time of the reverse pulse  $t_r = 2$  ns  
 Reverse pulse duration  $t_p = 400$  ns. Duty factor  $\delta = 0,02$ .  
 Circuit capacitance  $C \leq 7$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance).

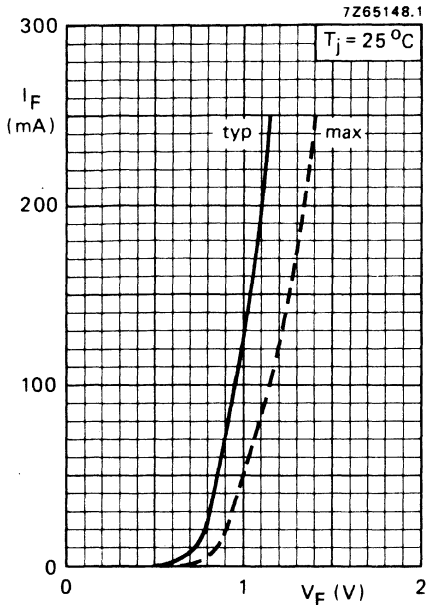


Fig. 5.

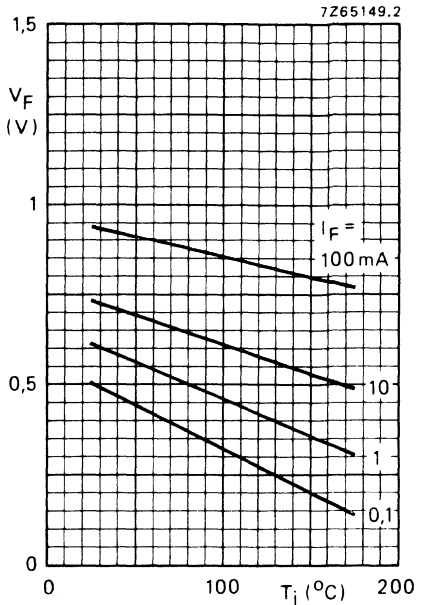


Fig. 6 Typical values.

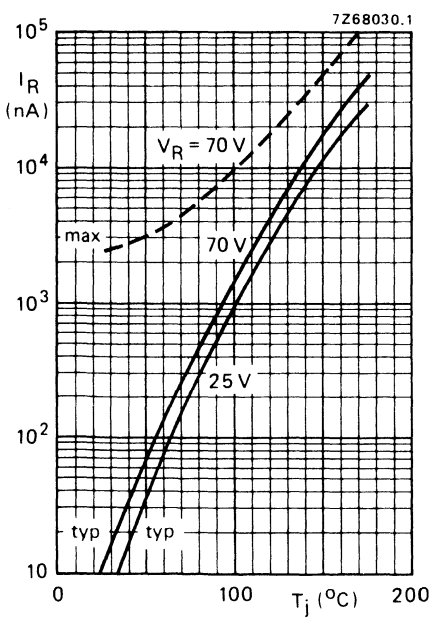


Fig. 7.

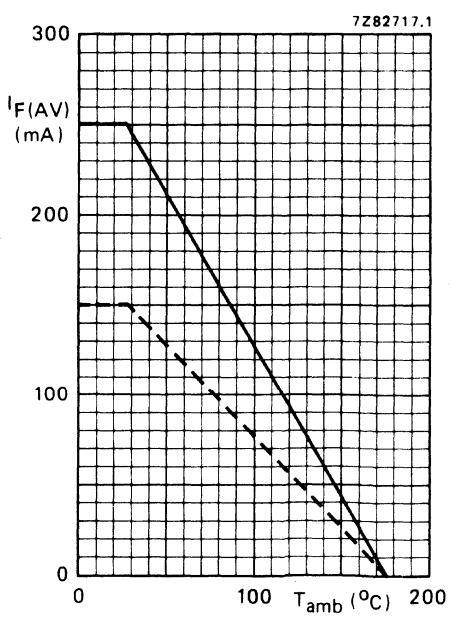


Fig. 8 — single diode  
 - - - double diode; equally loaded.



## SILICON PLANAR EPITAXIAL HIGH-SPEED DIODES

The BAW56 consists of two diodes in a microminiature plastic envelope. The anodes are commoned and the unit is intended for high-speed switching in thick and thin-film circuits.

## QUICK REFERENCE DATA (per diode)

Continuous reverse voltage	$V_R$	max.	70 V
Repetitive peak reverse voltage	$V_{RRM}$	max.	70 V
Repetitive peak forward current	$I_{FRM}$	max.	250 mA
Junction temperature	$T_j$	max.	175 °C ←
Forward voltage at $I_F = 50$ mA	$V_F$	<	1,0 V
Reverse recovery time when switched from $I_F = 10$ mA to $I_R = 10$ mA; $R_L = 100 \Omega$ ; measured at $I_R = 1$ mA	$t_{rr}$	<	6 ns
Recovery charge when switched from $I_F = 10$ mA to $V_R = 5$ V; $R_L = 500 \Omega$	$Q_s$	<	45 pC

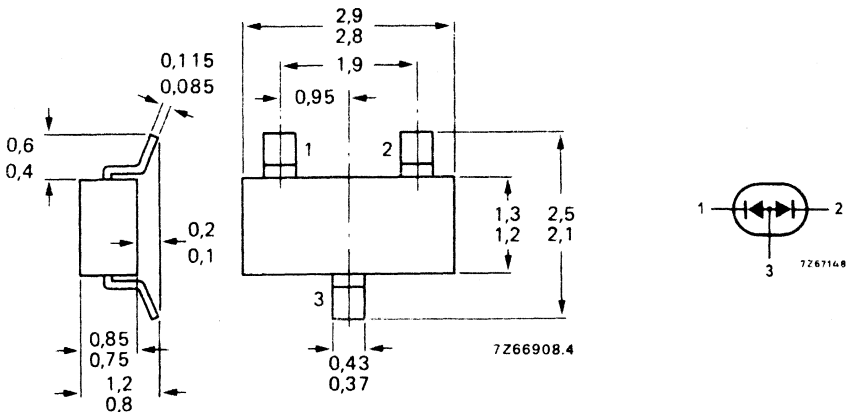
## MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BAW56 = A1



See also *Soldering recommendations*.

**RATINGS** (per diode)

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

Continuous reverse voltage	$V_R$	max.	70 V
Repetitive peak reverse voltage	$V_{RRM}$	max.	70 V
Average rectified forward current <sup>▲</sup> (averaged over any 20 ms period)	$I_{F(AV)}$	max.	250 mA
Forward current (d.c.)	$I_F$	max.	250 mA
Repetitive peak forward current	$I_{FRM}$	max.	250 mA
→ Storage temperature	$T_{stg}$		-65 to +175 °C
→ Junction temperature	$T_j$	max.	175 °C

→ **THERMAL CHARACTERISTICS \***

$$T_{j1} = P_1 (R_{th\ j-t}) + T_{tab}$$

$$T_{j2} = P_2 (R_{th\ j-t}) + T_{tab}$$

$$T_{tab} = P_{tot} (R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	2 x 260 K/W
From soldering points to ambient **	$R_{th\ s-a}$	=	2 x 120 K/W

**CHARACTERISTICS** (per diode) $T_j = 25\text{ °C}$  unless otherwise specified

## Forward voltage

$I_F = 1\text{ mA}$	$V_F$	<	715 mV
$I_F = 10\text{ mA}$	$V_F$	<	855 mV
$I_F = 50\text{ mA}$	$V_F$	<	1000 mV
$I_F = 150\text{ mA}$	$V_F$	<	1250 mV

## Reverse current

$V_R = 25\text{ V}; T_j = 150\text{ °C}$	$I_R$	<	30 $\mu\text{A}$
$V_R = 70\text{ V}$	$I_R$	<	2,5 $\mu\text{A}$
$V_R = 70\text{ V}; T_j = 150\text{ °C}$	$I_R$	<	50 $\mu\text{A}$

## Diode capacitance

$V_R = 0; f = 1\text{ MHz}$	$C_d$	<	2 pF
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## Forward recovery voltage when switched to

$I_F = 10\text{ mA}; t_r = 20\text{ ns}$	$V_{fr}$	<	1,75 V
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▲ Measured under pulse conditions: pulse time  $t_p \leq 0,5\text{ ms}$ .For sinusoidal operation  $I_{F(AV)} = 150\text{ mA}$ ; averaging time  $t_{(av)} \leq 1\text{ ms}$ .\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

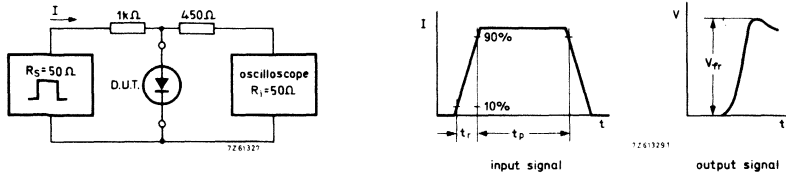


Fig. 2 Test circuit and waveforms; forward recovery voltage.

Input signal: Rise time of the forward pulse  $t_r = 20$  ns  
 Forward current pulse duration  $t_p = 120$  ns. Duty factor  $\delta = 0,01$   
 Oscilloscope: Rise time  $t_r = 0,35$  ns.  
 Circuit capacitance  $C \leq 1$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance)  
 Reverse recovery time when switched from  
 $I_F = 10$  mA to  $I_R = 10$  mA;  $R_L = 100 \Omega$ ;  
 measured at  $I_R = 1$  mA

$$t_{rr} < 6 \text{ ns}$$

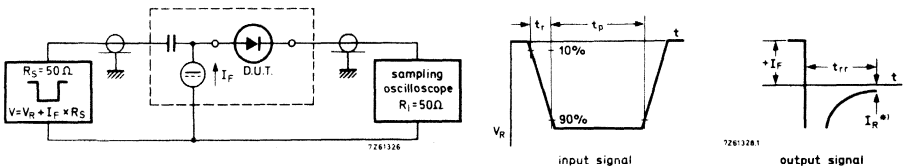


Fig. 3 Test circuit and waveforms; reverse recovery time.

Input signal: Rise time of the reverse pulse  $t_r = 0,6$  ns  
 Reverse pulse duration  $t_p = 100$  ns. Duty factor  $\delta = 0,05$ .  
 Oscilloscope: Rise time  $t_r = 0,35$  ns  
 Circuit capacitance  $C \leq 1$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance)  
 Recovery charge when switched from  
 $I_F = 10$  mA to  $V_R = 5$  V;  $R_L = 500 \Omega$

$$Q_s < 45 \text{ pC}$$

\*)  $I_R = 1$  mA

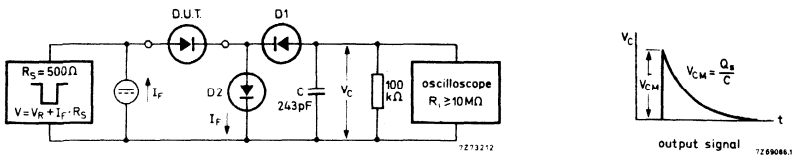


Fig. 4 Test circuit and waveform; recovery charge.

D2 = diode with minority carrier life time at 10 mA:  $< 200$  ps. D1 = BAW62.

Input signal: Rise time of the reverse pulse  $t_r = 2$  ns  
 Reverse pulse duration  $t_p = 400$  ns. Duty factor  $\delta = 0,02$

Circuit capacitance  $C \leq 7$  pF ( $C =$  oscilloscope input capacitance + parasitic capacitance).

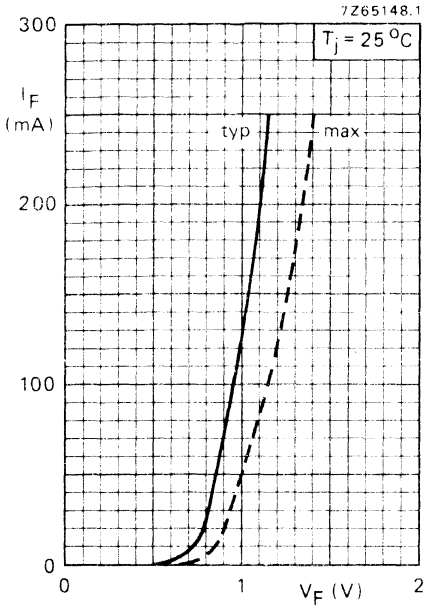


Fig. 5.

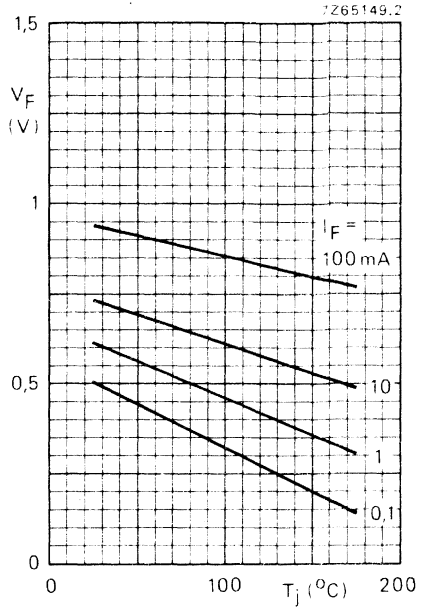


Fig. 6 Typical values.

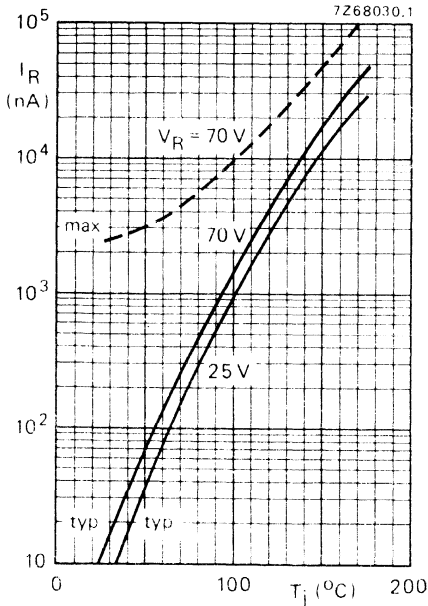


Fig. 7.

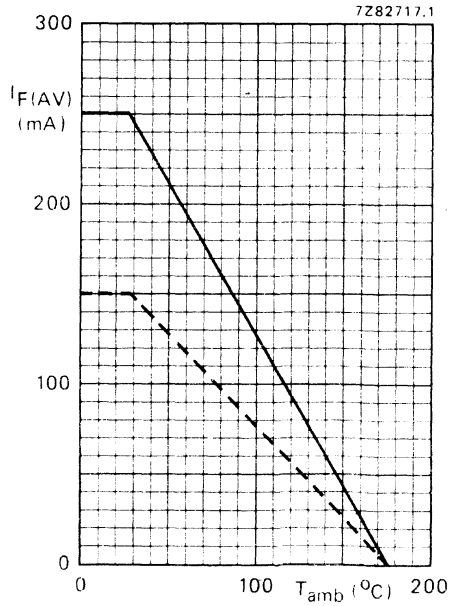


Fig. 8 ——— single diode;  
 - - - - - double diode, equally loaded.

## VARIABLE CAPACITANCE DIODE

Silicon planar variable capacitance diode in a microminiature envelope. It is intended for electronic tuning applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

Reverse voltage	$V_R$	max.	28 V
Reverse current at $V_R = 28$ V	$I_R$	<	50 nA
Diode capacitance at $f = 1$ MHz $V_R = 25$ V	$C_d$		1,8 to 2,8 pF
Capacitance ratio at $f = 1$ MHz	$\frac{C_d(V_R = 3\text{ V})}{C_d(V_R = 25\text{ V})}$	typ.	5
Series resistance at $f = 470$ MHz $V_R =$ that value at which $C_d = 9$ pF	$r_D$	<	1,2 $\Omega$

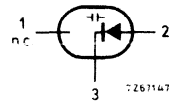
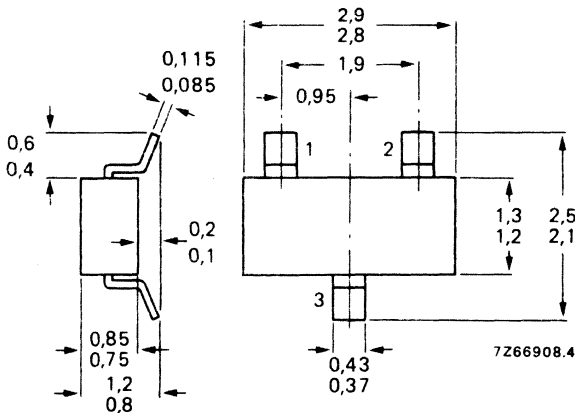
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BBY31 = S1



See also *Soldering recommendations*.

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

Continuous reverse voltage	$V_R$	max.	28	V
Reverse voltage (peak value)	$V_{RM}$	max.	30	V
Forward current (d.c.)	$I_F$	max.	20	mA
Storage temperature	$T_{stg}$		-65 to +100	°C
→ Operating junction temperature	$T_j$	max.	85	°C

**THERMAL RESISTANCE**

From junction to ambient  
 mounted on a ceramic substrate of  
 7 mm x 5 mm x 0,5 mm

$$R_{th\ j-a} = 0,62 \text{ °C/mW}$$

**CHARACTERISTICS**

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

Reverse current

$V_R = 28 \text{ V}$	$I_R$	<	50	nA
→ $V_R = 28 \text{ V}; T_j = 85 \text{ °C}$	$I_R$	<	1000	nA

Diode capacitance at f = 1 MHz

$V_R = 1 \text{ V}$	$C_d$	typ.	17,5	pF
$V_R = 3 \text{ V}$	$C_d$	typ.	11,5	pF
$V_R = 25 \text{ V}$	$C_d$		1,8 to 2,8	pF

Capacitance ratio at f = 1 MHz

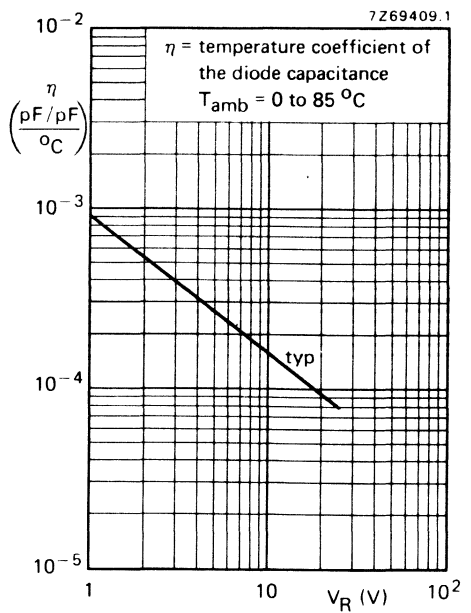
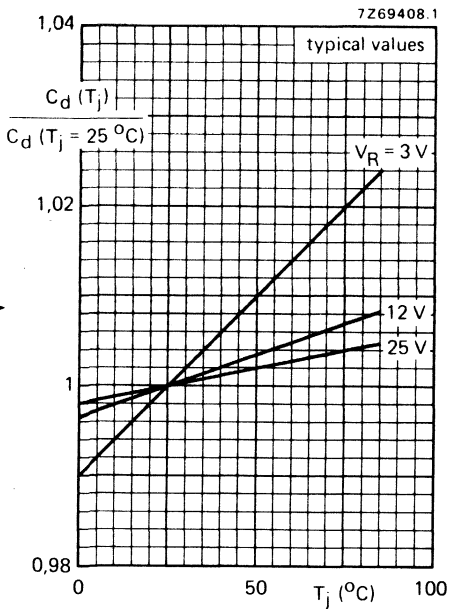
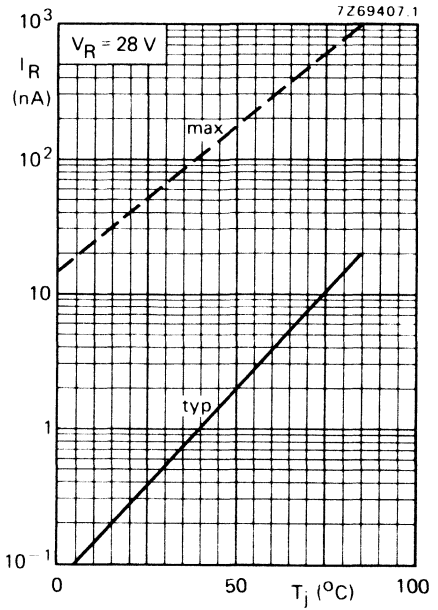
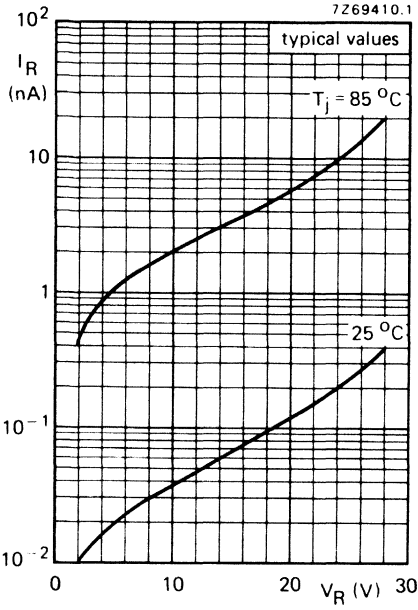
$$\frac{C_d(V_R = 3 \text{ V})}{C_d(V_R = 25 \text{ V})} \text{ typ. } 5$$

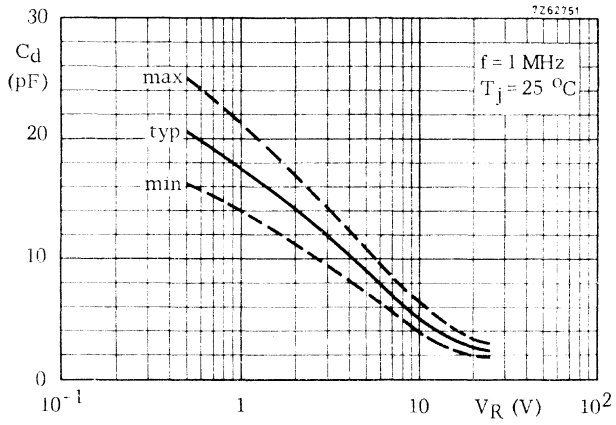
Series resistance

at f = 470 MHz and at that value  
 of  $V_R$  at which  $C_d = 9 \text{ pF}$

$$r_D < 1,2 \text{ } \Omega$$









# DEVELOPMENT SAMPLE DATA

This information is derived from development samples made available for evaluation. It does not form part of our data handbook system and does not necessarily imply that the device will go into production

BBY40

## SILICON PLANAR VARIABLE CAPACITANCE DIODE

The BBY40 is a variable capacitance diode in a plastic envelope intended for electronic tuning in v.h.f. television tuners with extended band I (FCC and OIRT-norm).

### QUICK REFERENCE DATA

Continuous reverse voltage	$V_R$	max.	28 V
Reverse current at $V_R = 28$ V	$I_R$	<	50 nA
Diode capacitance at $f = 1$ MHz	$V_R = 3$ V	$C_d$	26 to 32 pF
	$V_R = 25$ V	$C_d$	4,3 to 6 pF
Capacitance ratio at $f = 1$ MHz		$\frac{C_d(V_R = 3\text{ V})}{C_d(V_R = 25\text{ V})}$	5 to 6,5
Series resistance at $f = 200$ MHz	$r_D$	<	0,6 $\Omega$
$V_R$ is that value at which $C_d = 25$ pF			

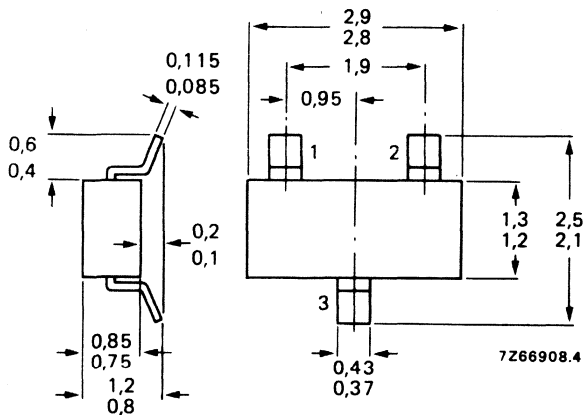
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BBY40 = S2



See also *Soldering recommendations.*

## RATINGS

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

Continuous reverse voltage	$V_R$	max.	28 V
Reverse voltage (repetitive peak value)	$V_{RRM}$	max.	30 V
Forward current (d.c.)	$I_F$	max.	20 mA
Storage temperature	$T_{stg}$		-55 to + 100 °C
Operating junction temperature	$T_j$	max.	85 °C

## CHARACTERISTICS

$T_{amb} = 25\text{ °C}$  unless otherwise specified

Reverse current		typ.	0,1 nA
$V_R = 28\text{ V}$	$I_R$	<	50 nA
$V_R = 28\text{ V}; T_{amb} = 60\text{ °C}$	$I_R$	<	500 nA
Diode capacitance at $f = 1\text{ MHz}$			
$V_R = 3\text{ V}$	$C_d$		26 to 32 pF
$V_R = 25\text{ V}$	$C_d$		4,3 to 6 pF
Capacitance ratio at $f = 1\text{ MHz}$	$\frac{C_d(V_R = 3\text{ V})}{C_d(V_R = 25\text{ V})}$		5 to 6,5
Series resistance at $f = 200\text{ MHz}$		typ.	0,4 $\Omega$
$V_R$ is that value at which $C_d = 25\text{ pF}$	$r_D$	<	0,6 $\Omega$



DEVELOPMENT SAMPLE DATA

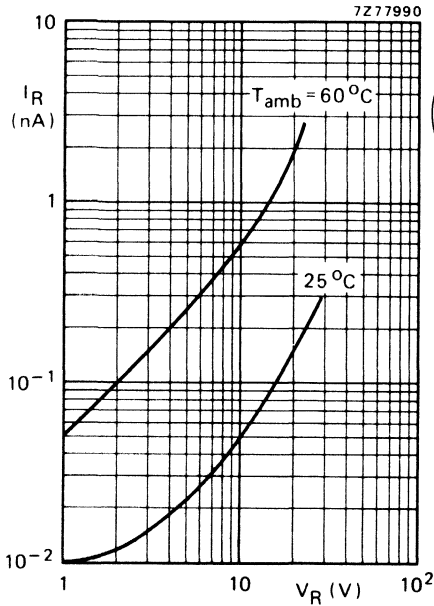


Fig. 2 Typical values

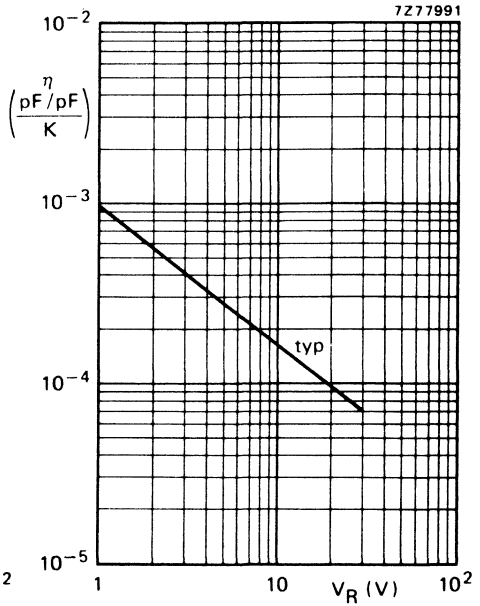


Fig. 3 Temperature coefficient of the diode capacitance;  $T_{amb} = 0$  to  $85\text{ }^\circ\text{C}$ .

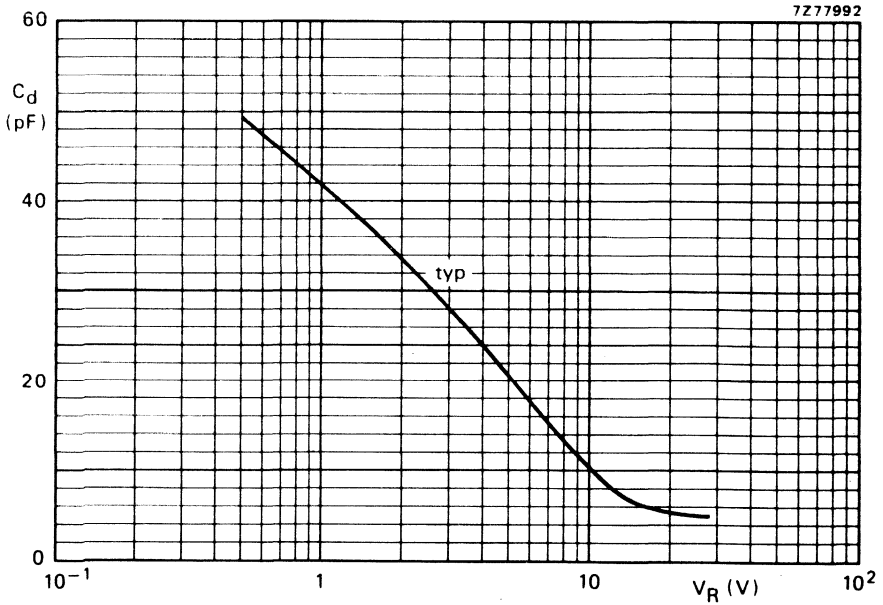


Fig. 4  $f = 1\text{ MHz}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ .





## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors, in a microminiature plastic envelope, intended for low level, low noise general purpose applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

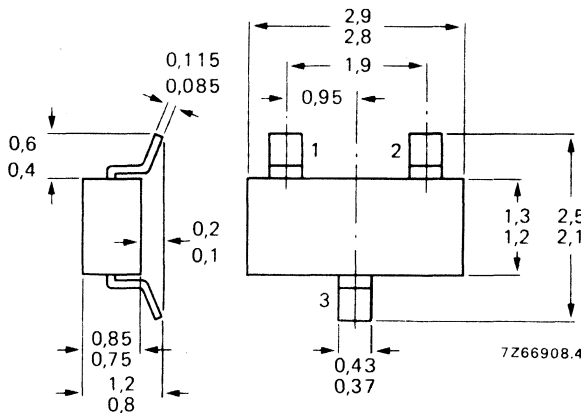
		BCF29 BCF29R	BCF30 BCF30R	
D.C. current gain at $T_j = 25\text{ }^\circ\text{C}$ $-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}$	$h_{FE}$	> 120 < 260	215 500	
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	32	32	V ←
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	32	32	V ←
Collector current (peak value)	$-I_{CM}$ max.	200	200	mA ←
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$ max.	350	350	mW ←
Junction temperature	$T_j$ max.	175	175	$^\circ\text{C}$ ←
Transition frequency at $f = 35\text{ MHz}$ $-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	$f_T$ typ.	150	150	MHz
Noise figure at $R_S = 2\text{ k}\Omega$ $-I_C = 200\text{ }\mu\text{A}; -V_{CE} = 5\text{ V};$ $f = 1\text{ kHz}; B = 200\text{ Hz}$	F	< 4	4	dB

### MECHANICAL DATA

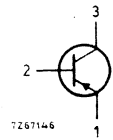
Fig. 1 SOT-23.

Dimensions in mm

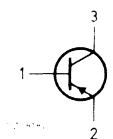
Marking code



BCF29 = C7  
BCF30 = C8



BCF29R = C77  
BCF30R = C9



See also *Soldering recommendations*.

→ RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

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)			
$-I_C = 2$ mA	$-V_{CEO}$	max.	32 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V
Collector current (d.c.)	$-I_C$	max.	100 mA
Collector current (peak value)	$-I_{CM}$	max.	200 mA
Total power dissipation up to $T_{amb} = 25$ °C mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm	$P_{tot}$	max.	350 mW
Storage temperature	$T_{stg}$		-65 to +175 °C
Junction temperature	$T_j$	max.	175 °C

→ THERMAL CHARACTERISTICS\*

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

$T_j = 25$  °C unless otherwise specified

→ Collector cut-off current

$I_E = 0; -V_{CB} = 32$ V	$-I_{CBO}$	<	100 nA
$I_E = 0; -V_{CB} = 32$ V; $T_j = 100$ °C	$-I_{CBO}$	<	10 μA

Base-emitter voltage

$-I_C = 2$ mA; $-V_{CE} = 5$ V	$-V_{BE}$		600 to 750 mV
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Saturation voltages

	$-V_{CEsat}$	typ.	80 mV
$-I_C = 10$ mA; $-I_B = 0,5$ mA		<	300 mV
	$-V_{BEsat}$	typ.	720 mV
	$-V_{CEsat}$	typ.	150 mV
$-I_C = 50$ mA; $-I_B = 2,5$ mA	$-V_{BEsat}$	typ.	810 mV

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

D.C. current gain

$-I_C = 10 \mu A; -V_{CE} = 5 V$

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

Collector capacitance at  $f = 1 MHz$

$I_E = I_e = 0; -V_{CB} = 10 V$

Transition frequency at  $f = 35 MHz$

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

Noise figure at  $R_S = 2 k\Omega$

$-I_C = 200 \mu A; -V_{CE} = 5 V$

$f = 1 kHz; B = 200 Hz$

		BCF29 BCF29R	BCF30 BCF30R	
$h_{FE}$	typ.	90	150	
$h_{FE}$	>	120	215	
$h_{FE}$	<	260	500	
$C_c$	<	7,0	pF	
$f_T$	typ.	150	MHz	
F	<	4	dB	
	typ.	1	dB	

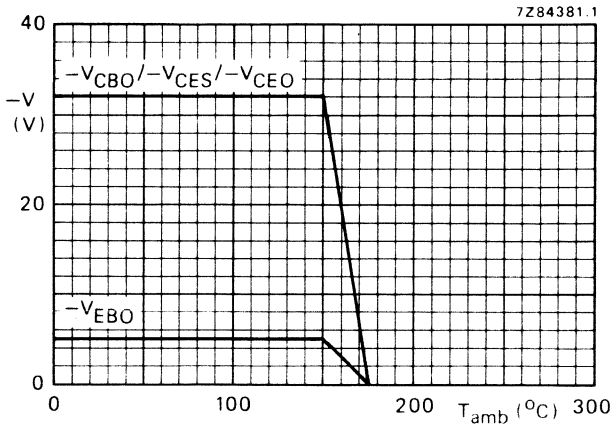


Fig. 2 Voltage derating curves.

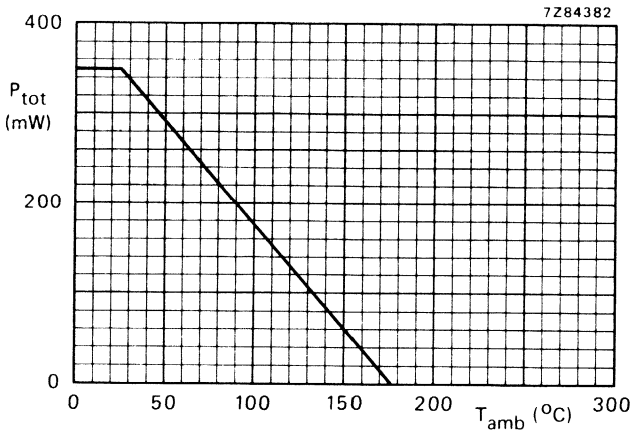


Fig. 3 Power derating curve.

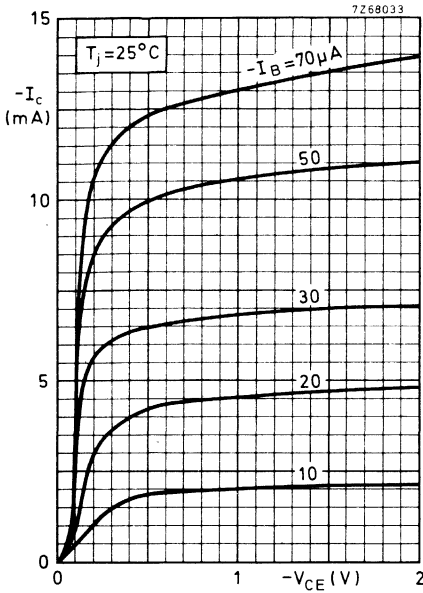


Fig. 4.

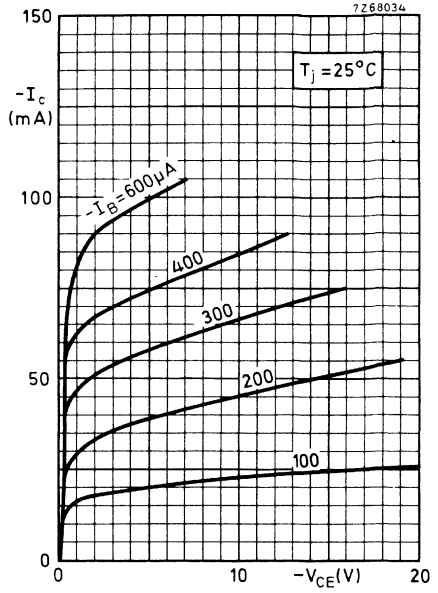


Fig. 5.

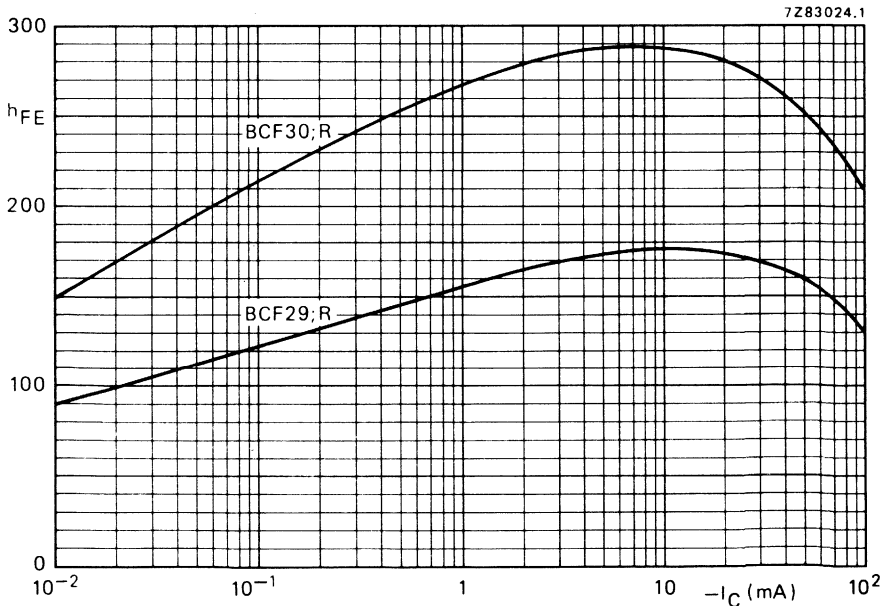


Fig. 6 Typical values of d.c. current gain.  $-V_{CE} = 5\text{ V}$ ;  $T_j = 25^\circ\text{C}$ .



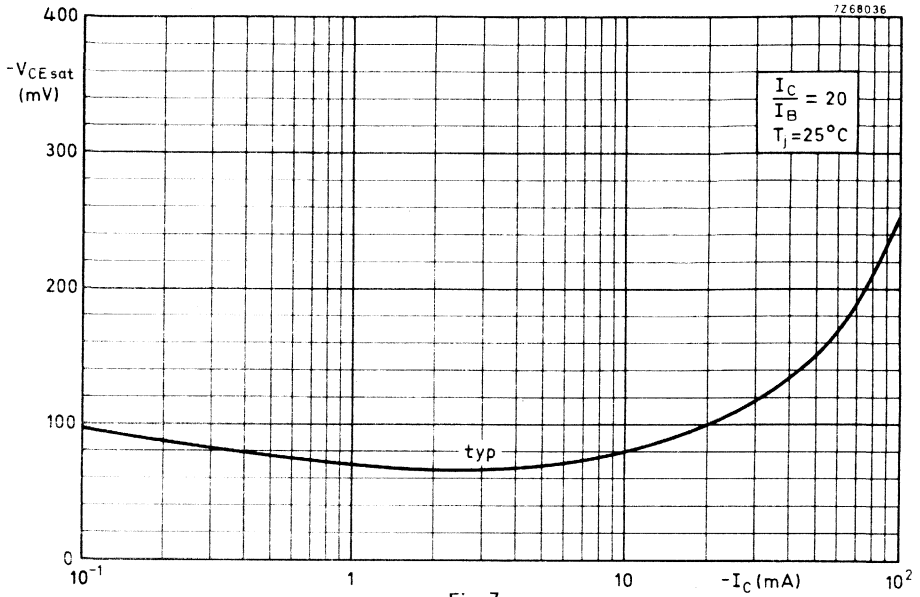


Fig. 7.

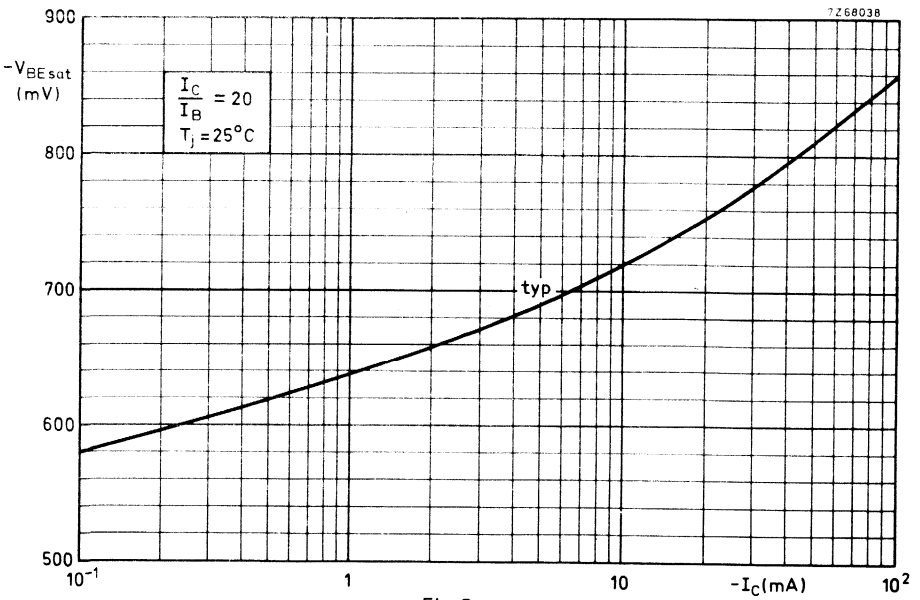


Fig. 8.

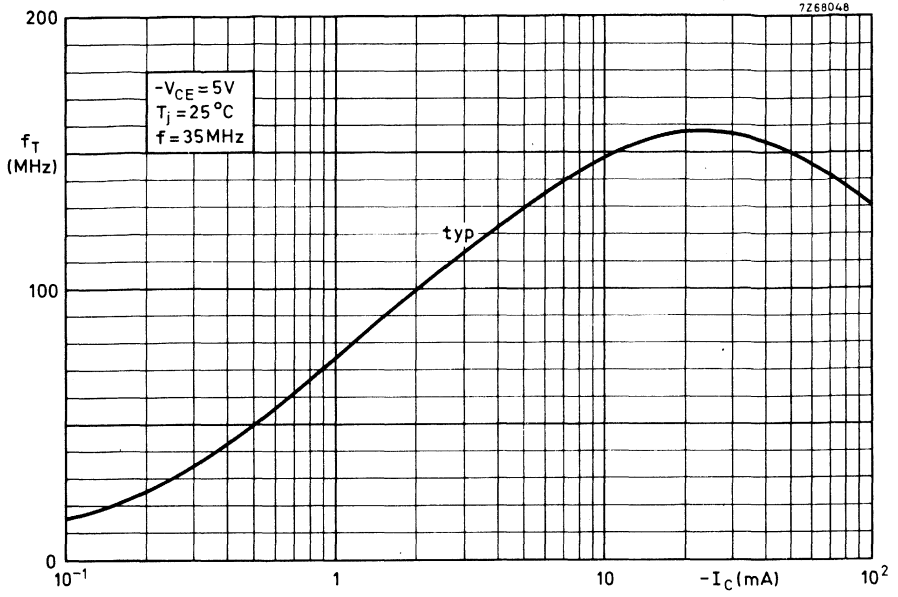


Fig. 9.

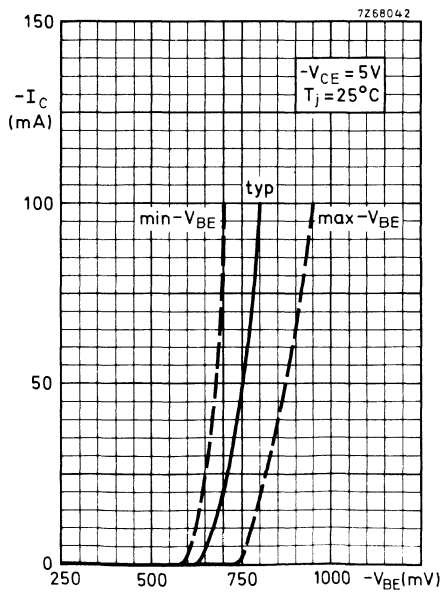


Fig. 10.

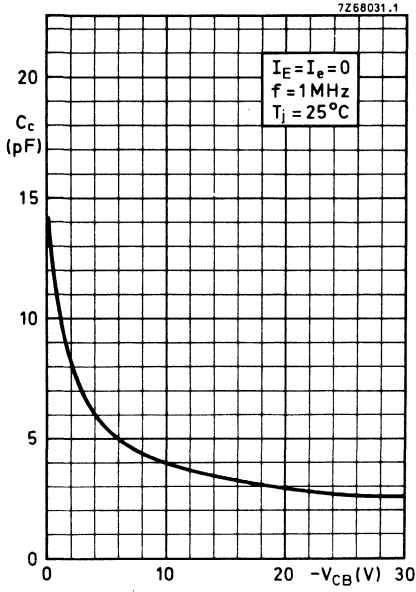


Fig. 11.

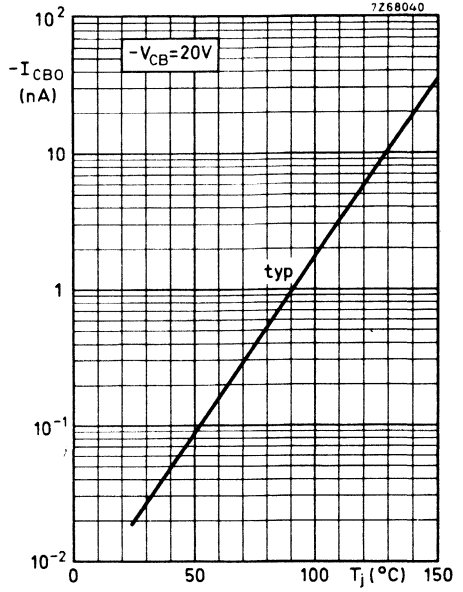


Fig. 12.





## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a microminiature plastic envelope. They are intended for low level, low noise general purpose applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

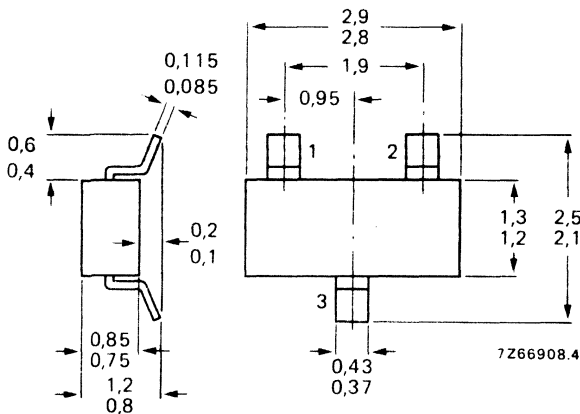
		BCF32 BCF32R	BCF33 BCF33R	
D.C. current gain at $T_j = 25\text{ }^\circ\text{C}$ $I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$	$h_{FE}$	> 200 < 450	420 800	
Collector-base voltage (open emitter)	$V_{CBO}$	max. 32	V	←
Collector-emitter voltage (open base)	$V_{CEO}$	max. 32	V	←
Collector current (peak value)	$I_{CM}$	max. 200	mA	
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max. 350	mW	←
Junction temperature	$T_j$	max. 175	$^\circ\text{C}$	←
Transition frequency at $f = 35\text{ MHz}$ $I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$	$f_T$	typ. 300	MHz	
Noise figure at $R_S = 2\text{ k}\Omega$ $I_C = 200\text{ }\mu\text{A}; V_{CE} = 5\text{ V};$ $f = 1\text{ kHz}; B = 200\text{ Hz}$	F	< 4	dB	

### MECHANICAL DATA

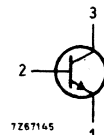
Dimensions in mm

Marking code

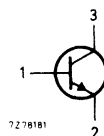
Fig. 1 SOT-23.



BCF32 = D7  
BCF33 = D8



BCF32R = D77  
BCF33R = D81



See also *Soldering recommendations*.

→ RATINGS

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

Collector-base voltage (open emitter)	$V_{CB0}$	max.	32 V
Collector-emitter voltage (open base) $I_C = 2 \text{ mA}$	$V_{CE0}$	max.	32 V
Emitter-base voltage (open collector)	$V_{EB0}$	max.	5 V
Collector current (d.c.)	$I_C$	max.	100 mA
Collector current (peak value)	$I_{CM}$	max.	200 mA
Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm	$P_{tot}$	max.	350 mW
Storage temperature	$T_{stg}$		-65 to + 175 $^\circ\text{C}$
Junction temperature	$T_j$	max.	175 $^\circ\text{C}$

→ THERMAL CHARACTERISTICS\*

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

→ Collector cut-off current

$I_E = 0; V_{CB} = 32 \text{ V}$	$I_{CB0}$	<	100 nA
$I_E = 0; V_{CB} = 32 \text{ V}; T_j = 100 \text{ }^\circ\text{C}$	$I_{CB0}$	<	10 $\mu\text{A}$

Base-emitter voltage

$I_C = 2 \text{ mA}; V_{CE} = 5 \text{ V}$	$V_{BE}$		550 to 700 mV
--	----------	--	---------------

Saturation voltages

$I_C = 10 \text{ mA}; I_B = 0,5 \text{ mA}$	$V_{CEsat}$	typ.	120 mV
		<	250 mV

$I_C = 50 \text{ mA}; I_B = 2,5 \text{ mA}$	$V_{BEsat}$	typ.	750 mV
	$V_{CEsat}$	typ.	210 mV
	$V_{BEsat}$	typ.	850 mV

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

D.C. current gain

$I_C = 10 \mu A; V_{CE} = 5 V$

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

Collector capacitance at  $f = 1 MHz$

$I_E = I_b = 0; V_{CB} = 10 V$

Transition frequency at  $f = 35 MHz$

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

Noise figure at  $R_S = 2 k\Omega$

$I_C = 200 \mu A; V_{CE} = 5 V$

$f = 1 kHz; B = 200 Hz$

		BCF32 BCF32R	BCF33 BCF33R
$h_{FE}$	typ.	150	270
	$>$	200	420
$h_{FE}$	$<$	450	800
$C_c$	$<$	4,0 pF	
$f_T$	typ.	300 MHz	
F	$<$	4 dB	
	typ.	1,2 dB	

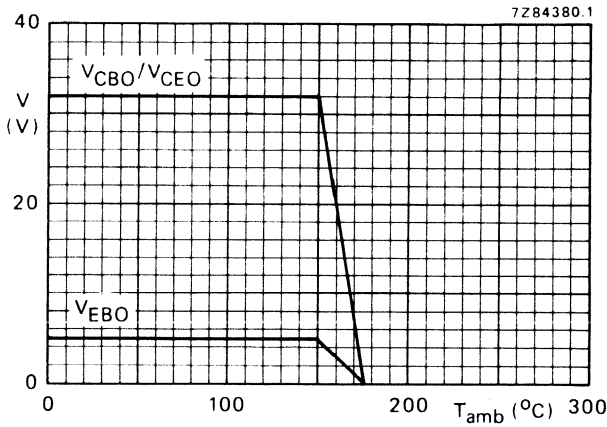


Fig. 2 Voltage derating curves.

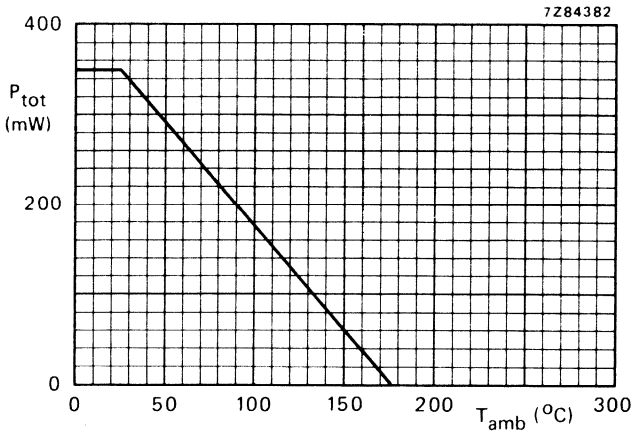


Fig. 3 Power derating curve.

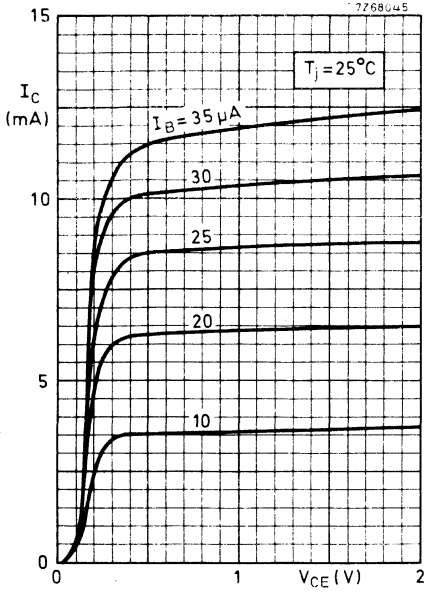


Fig. 4.

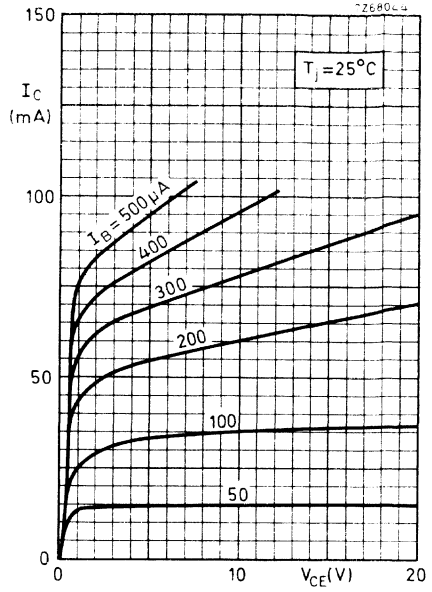


Fig. 5.

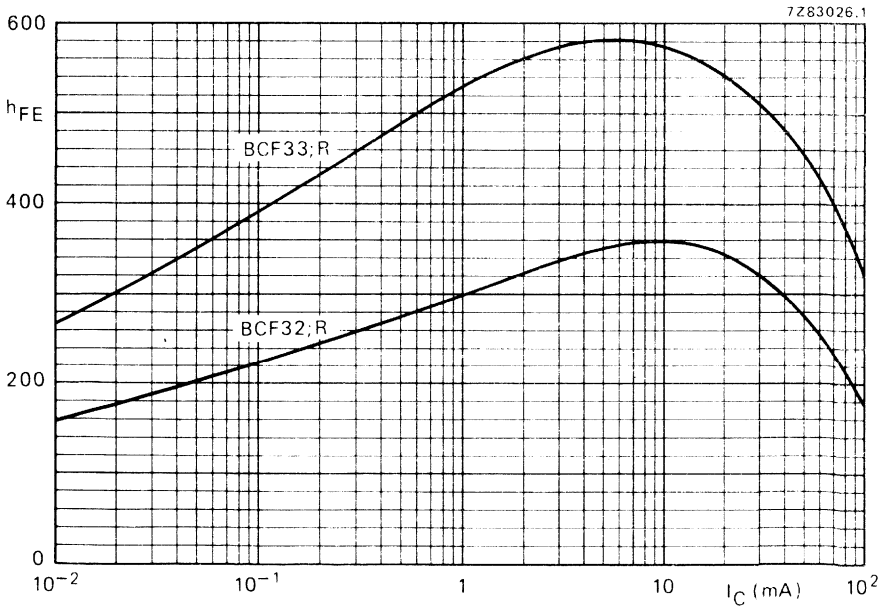


Fig. 6 Typical values d.c. current gain.  $V_{CE} = 5 \text{ V}$ ;  $T_j = 25^\circ\text{C}$ .



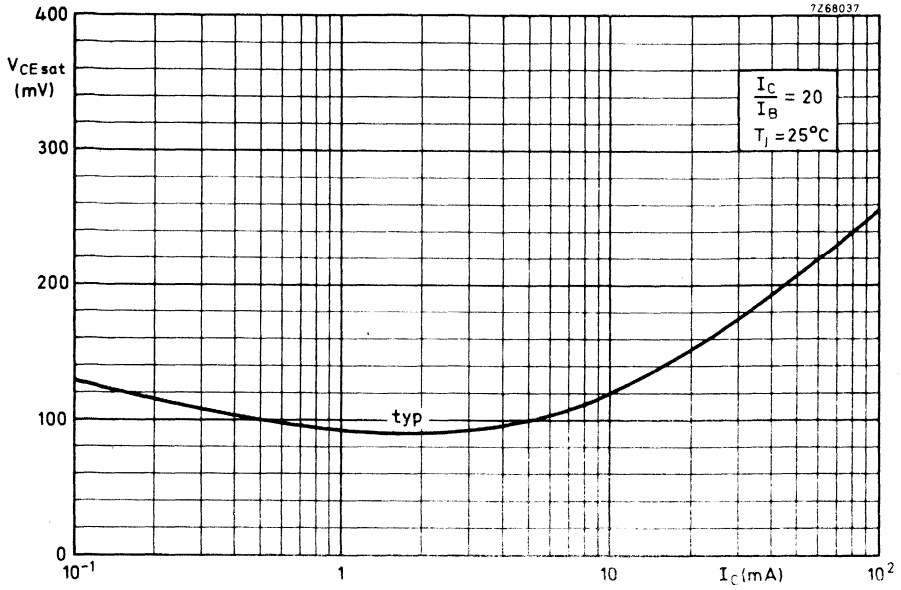


Fig. 7.

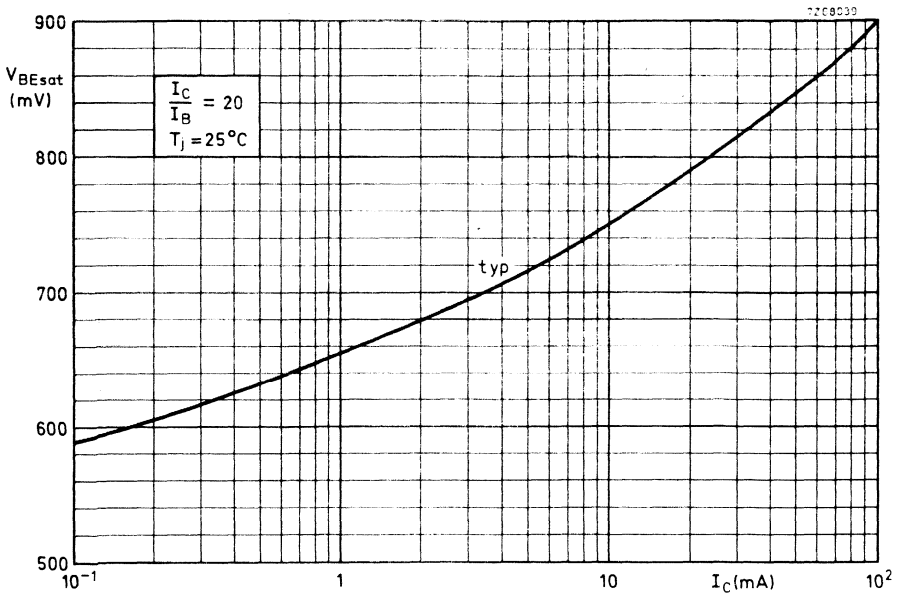


Fig. 8.

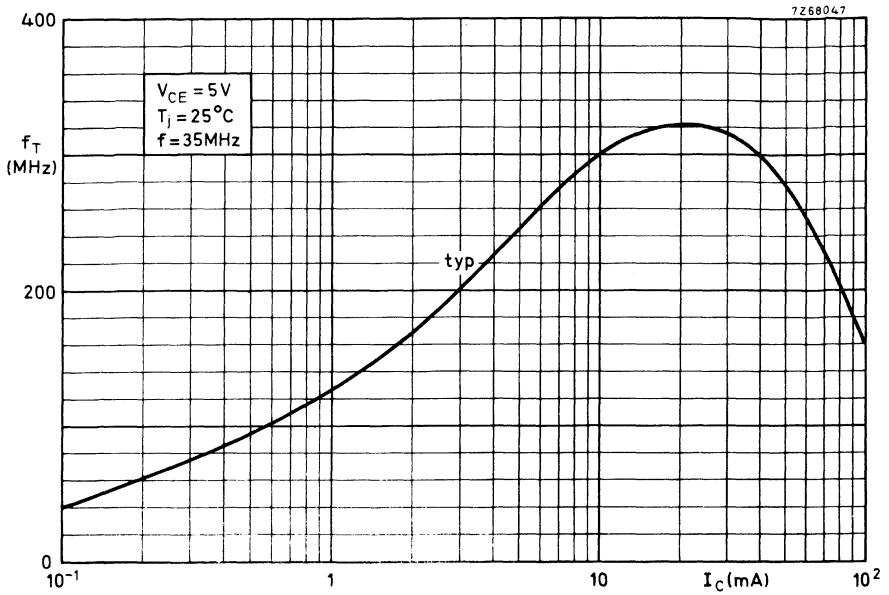


Fig. 9.

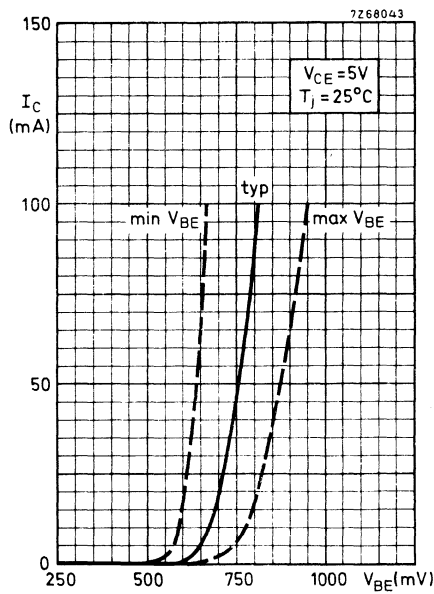


Fig. 10.

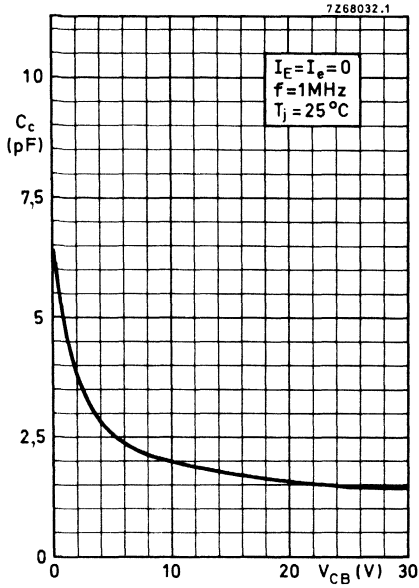


Fig. 11.

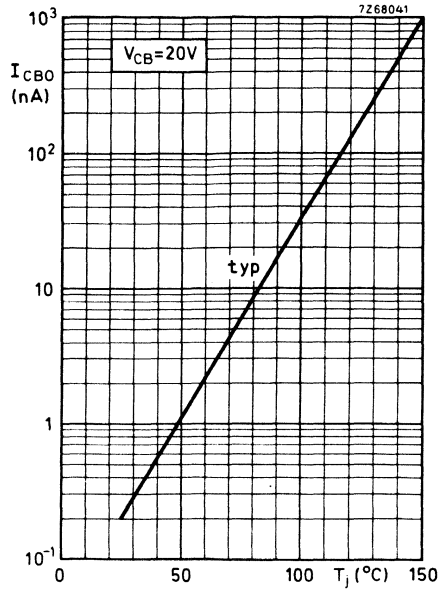


Fig. 12.





## SILICON PLANAR EPITAXIAL TRANSISTORS

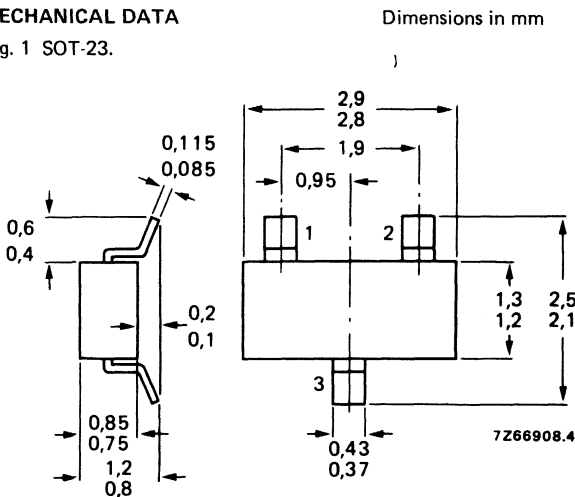
P-N-P transistors, in a microminiature plastic envelope, intended for low level, low noise applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

D.C. current gain at $T_j = 25\text{ }^\circ\text{C}$ $-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}$	$h_{FE}$	$>$	215	
		$<$	500	
Collector-base voltage (open emitter)	$-V_{CB0}$	max.	50 V	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45 V	
Collector current (peak value)	$-I_{CM}$	max.	200 mA	
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max.	350 mW	←
Junction temperature	$T_j$	max.	175 $^\circ\text{C}$	←
Transition frequency at $f = 35\text{ MHz}$ $-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	$f_T$	typ.	150 MHz	
Noise figure at $R_S = 2\text{ k}\Omega$ $-I_C = 200\text{ }\mu\text{A}; -V_{CE} = 5\text{ V};$ $f = 1\text{ kHz}; B = 200\text{ Hz}$	F	$<$	4 dB	

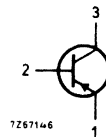
### MECHANICAL DATA

Fig. 1 SOT-23.

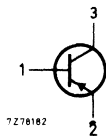


### Marking code

BCF70 = H7



BCF70R = H71



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) see Fig. 2	$-V_{CBO}$	max.	50 V
Collector-emitter voltage ( $V_{BE} = 0$ ) see Fig. 2	$-V_{CES}$	max.	50 V
Collector-emitter voltage (open base) see Fig. 2			
$-I_C = 2$ mA	$-V_{CEO}$	max.	45 V
Emitter-base voltage (open collector) see Fig. 2	$-V_{EBO}$	max.	5 V
Collector current (d.c.)	$-I_C$	max.	100 mA
Collector current (peak value)	$-I_{CM}$	max.	200 mA
Total power dissipation up to $T_{amb} = 25$ °C mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm	$P_{tot}$	max.	350 mW
Storage temperature	$T_{stg}$		-65 to +175 °C
Junction temperature	$T_j$	max.	175 °C

**→ THERMAL CHARACTERISTICS\***

$$T_j = P_x (R_{th j-t} + R_{th t-s} + R_{th s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th j-t}$	=	50 K/W
From tab to soldering points	$R_{th t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th s-a}$	=	120 K/W

**CHARACTERISTICS** $T_j = 25$  °C unless otherwise specified

$$I_E = 0; -V_{CB} = 20 \text{ V}; T_j = 25 \text{ °C}$$

$$T_j = 100 \text{ °C}$$

$-I_{CBO}$	<	100 nA
$-I_{CBO}$	<	10 $\mu$ A

Base-emitter voltage

$$-I_C = 2 \text{ mA}; -V_{CE} = 5 \text{ V}; T_j = 25 \text{ °C}$$

$-V_{BE}$		600 to 750 mV
-----------	--	---------------

Saturation voltages

$$-I_C = 10 \text{ mA}; -I_B = 0,5 \text{ mA}$$

$-V_{CEsat}$	typ.	80 mV
	<	300 mV

$$-I_C = 50 \text{ mA}; -I_B = 2,5 \text{ mA}$$

$-V_{BEsat}$	typ.	720 mV
$-V_{CEsat}$	typ.	150 mV
$-V_{BEsat}$	typ.	810 mV

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

D.C. current gain

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

$h_{FE}$  typ. 150

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

$h_{FE}$  > 215  
< 500

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

$I_E = I_e = 0; -V_{CB} = 10 \text{ V}$

$C_c$  < 7,0 pF

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

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

$f_T$  typ. 150 MHz

Noise figure at  $R_S = 2 \text{ k}\Omega$

$-I_C = 200 \mu\text{A}; -V_{CE} = 5 \text{ V}$

$f = 1 \text{ kHz}; B = 200 \text{ Hz}$

$F$  < 4 dB  
typ. 1 dB

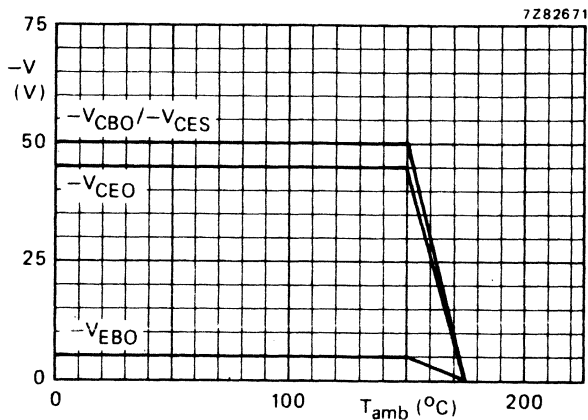


Fig. 2 Voltage derating curves.

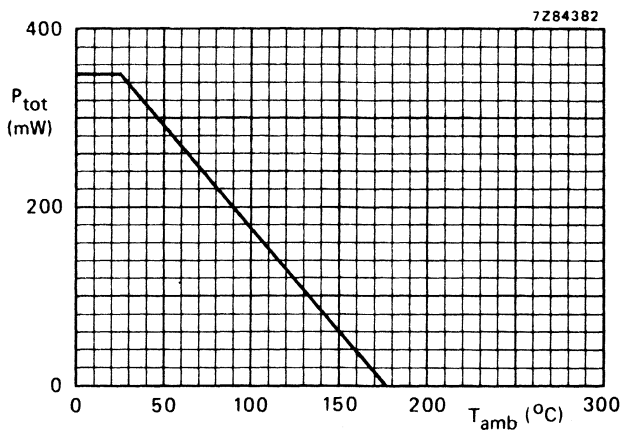


Fig. 3 Power derating curve.

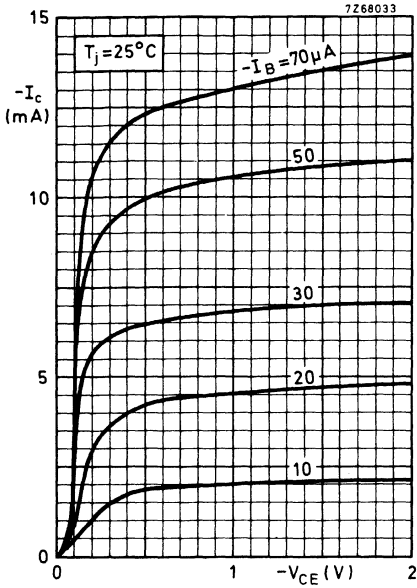


Fig. 4.

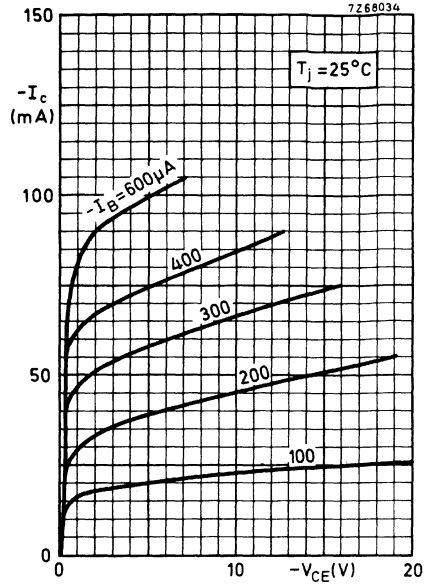


Fig. 5.

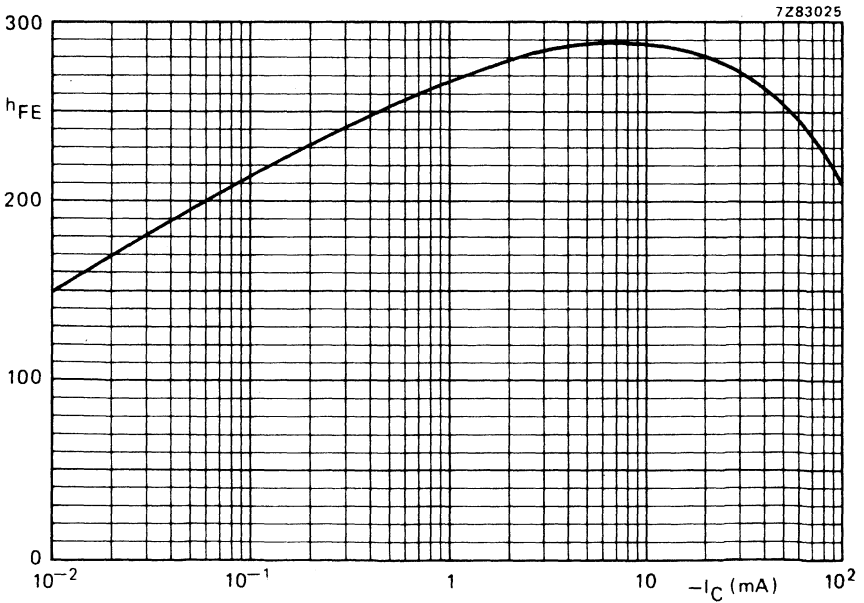


Fig. 6 Typical values of d.c. current gain.  $-V_{CE} = 5 \text{ V}$ ;  $T_j = 25^\circ\text{C}$ .



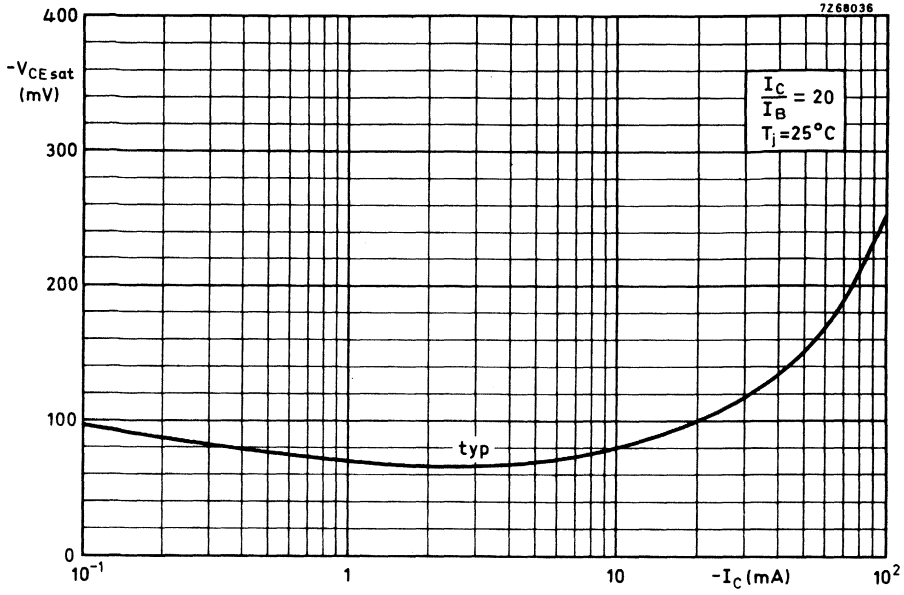


Fig. 7.

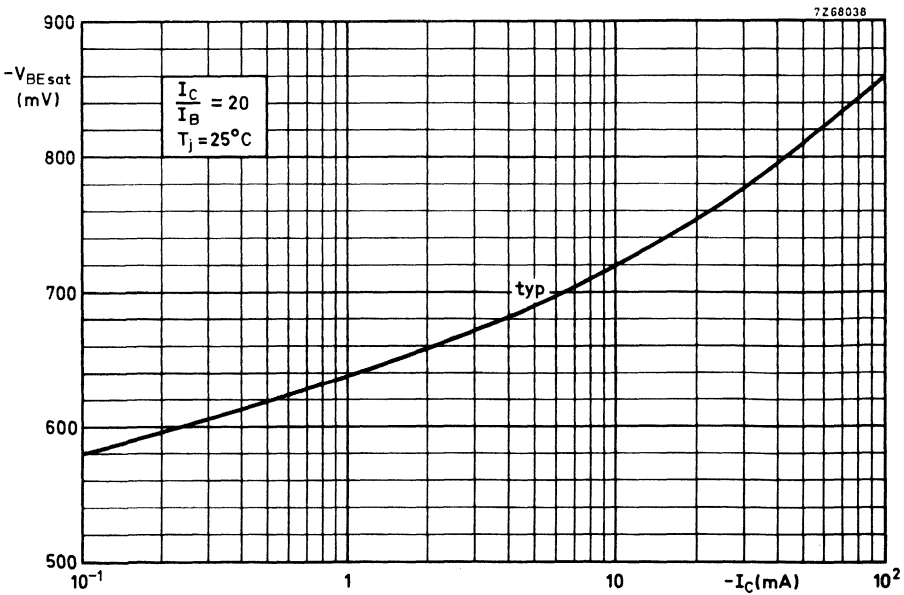


Fig. 8.

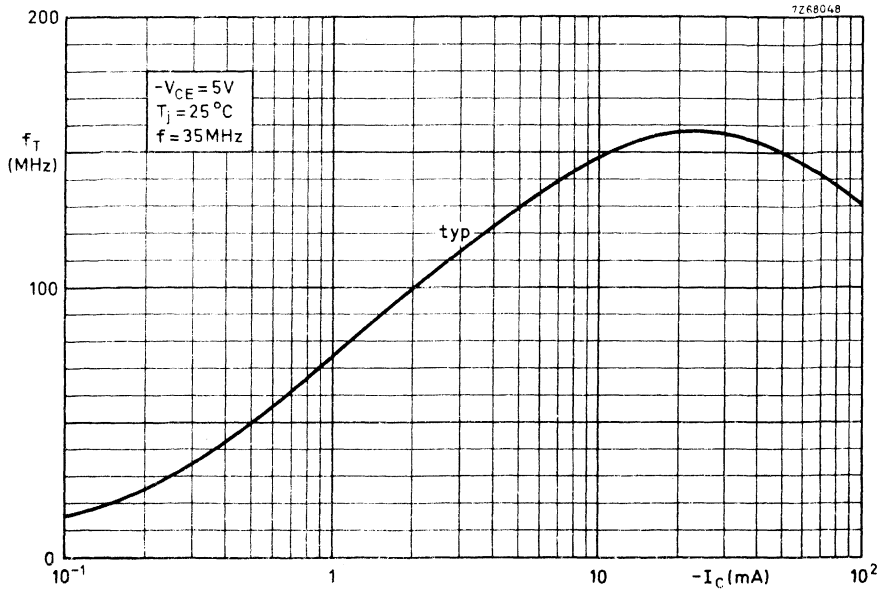


Fig. 9.

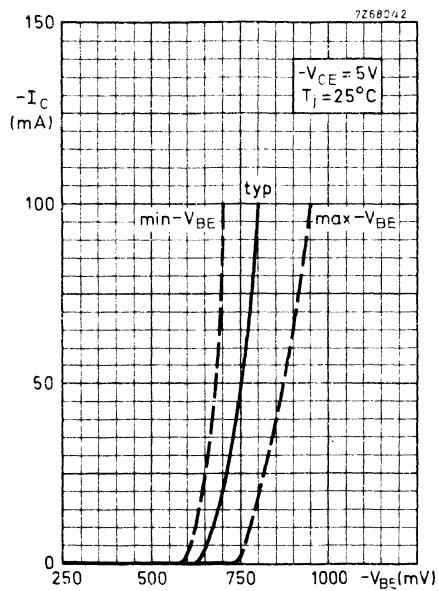


Fig. 10.

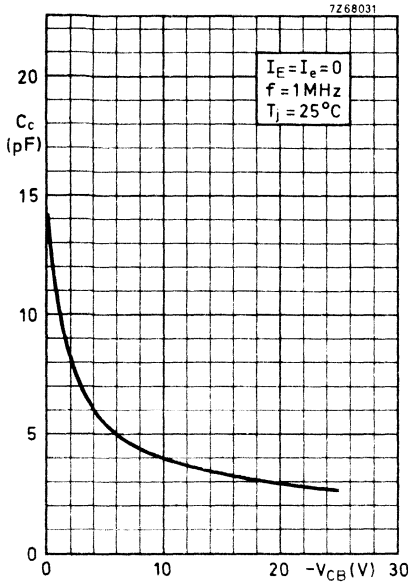


Fig. 11.

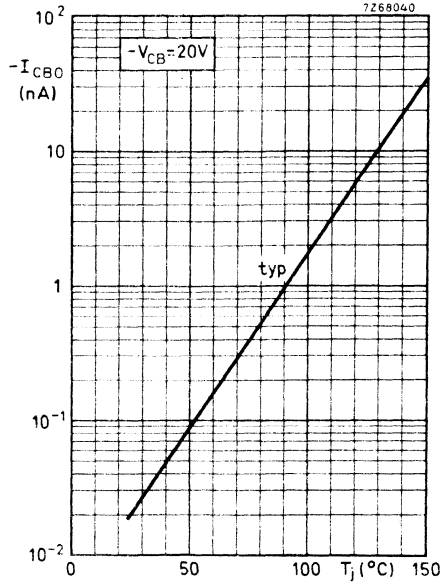


Fig. 12.





## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors, in a microminiature plastic envelope, intended for low level, low noise general purpose applications in thick and thin-film circuits.

## QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CBO}$	max.	50 V	
Collector-emitter voltage (open base)	$V_{CEO}$	max.	45 V	
Collector current (peak value)	$I_{CM}$	max.	200 mA	
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	350 mW	←
Junction temperature	$T_j$	max.	175 $^{\circ}\text{C}$	←
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$ $I_C = 2\text{ mA}$ ; $V_{CE} = 5\text{ V}$	$h_{FE}$	>	420	
		<	800	
Transition frequency at $f = 35\text{ MHz}$ $I_C = 10\text{ mA}$ ; $V_{CE} = 5\text{ V}$	$f_T$	typ.	300 MHz	
Noise figure at $R_S = 2\text{ k}\Omega$ $I_C = 200\text{ }\mu\text{A}$ ; $V_{CE} = 5\text{ V}$ ; $f = 1\text{ kHz}$ ; $B = 200\text{ Hz}$	F	<	4 dB	

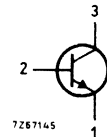
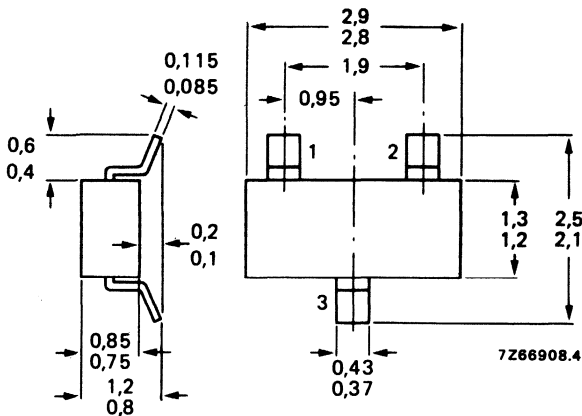
## MECHANICAL DATA

Dimensions in mm

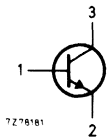
Marking code

Fig. 1 SOT-23.

BCF81 = K9



BCF81R = K91



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) see Fig. 2	$V_{CB0}$	max.	50 V
Collector-emitter voltage (open base) see Fig. 2 $I_C = 2 \text{ mA}$	$V_{CEO}$	max.	45 V
Emitter-base voltage (open collector) see Fig. 2	$V_{EBO}$	max.	5 V
Collector current (d.c.)	$I_C$	max.	100 mA
Collector current (peak value)	$I_{CM}$	max.	200 mA
Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm	$P_{tot}$	max.	350 mW
Storage temperature	$T_{stg}$		-65 to + 175 $^\circ\text{C}$
Junction temperature	$T_j$	max.	175 $^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P_x (R_{th j-t} + R_{th t-s} + R_{th s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th j-t}$	=	50 K/W
From tab to soldering points	$R_{th t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th s-a}$	=	120 K/W

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

Collector cut-off current

$I_E = 0; V_{CB} = 20 \text{ V}$

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

$I_E = 0; V_{CB} = 20 \text{ V}; T_j = 100 \text{ }^\circ\text{C}$

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

Base emitter voltage

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

$V_{BE} \quad 550 \text{ to } 700 \text{ mV}$

Saturation voltages

$I_C = 10 \text{ mA}; I_B = 0,5 \text{ mA}$

$V_{CEsat} \quad \text{typ. } 120 \text{ mV}$   
 $V_{CEsat} < 250 \text{ mV}$

$I_C = 50 \text{ mA}; I_B = 2,5 \text{ mA}$

$V_{BEsat} \quad \text{typ. } 750 \text{ mV}$   
 $V_{CEsat} \quad \text{typ. } 210 \text{ mV}$   
 $V_{BEsat} \quad \text{typ. } 850 \text{ mV}$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

D.C. current gain

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

$h_{FE}$	$>$	420
	$<$	800

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

$I_E = I_e = 0; V_{CB} = 10 \text{ V}$

$C_C$	$<$	4,0 pF
-------	-----	--------

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

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

$f_T$	typ.	300 MHz
-------	------	---------

Noise figure at  $R_G = 2 \text{ k}\Omega$ 

$I_C = 200 \mu\text{A}; V_{CE} = 5 \text{ V}$

$f = 1 \text{ kHz}; B = 200 \text{ Hz}$

$F$	$<$	4 dB
	typ.	1,2 dB

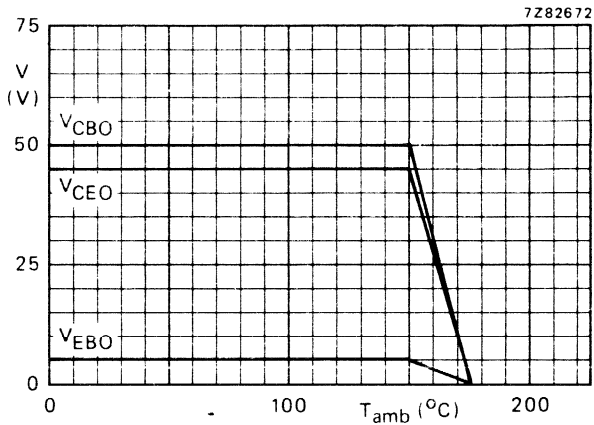


Fig. 2 Voltage derating curves.

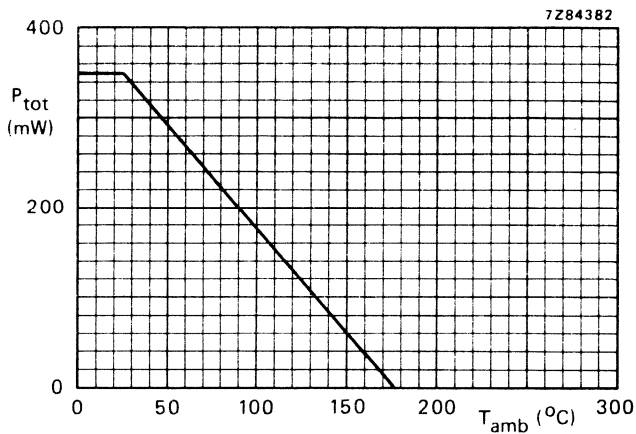


Fig. 3 Power derating curve.





## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors, in a microminiature plastic envelope, intended for low level general purpose applications in thick and thin-film circuits.

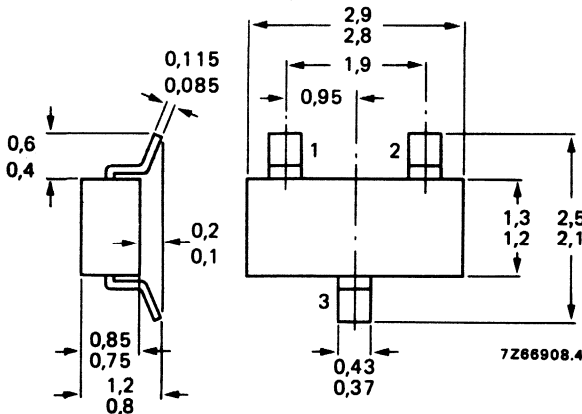
### QUICK REFERENCE DATA

		BCV71 BCV71R	BCV72 BCV72R	
D.C. current gain at $T_j = 25\text{ }^\circ\text{C}$ $I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$	$h_{FE}$	> 110 < 220	200 450	
Collector-base voltage (open emitter)	$V_{CBO}$	max. 80	V	←
Collector-emitter voltage (open base)	$V_{CEO}$	max. 60	V	
Collector current (peak value)	$I_{CM}$	max. 200	mA	
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max. 350	mW	←
Junction temperature	$T_j$	max. 175	$^\circ\text{C}$	←
Transition frequency at $f = 35\text{ MHz}$ $I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$	$f_T$	typ. 300	MHz	
Noise figure at $R_S = 2\text{ k}\Omega$ $I_C = 200\text{ }\mu\text{A}; V_{CE} = 5\text{ V};$ $f = 1\text{ kHz}; B = 200\text{ Hz}$	F	< 10	dB	

### MECHANICAL DATA

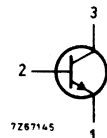
Fig. 1 SOT-23.

Dimensions in mm

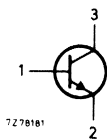


### Marking code

BCV71 = K7  
BCV72 = K8



BCV71R = K71  
BCV72R = K81



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) see Fig. 2	$V_{CB0}$	max.	80	V
Collector-emitter voltage (open base) see Fig. 2 $I_C = 2 \text{ mA}$	$V_{CEO}$	max.	60	V
Emitter-base voltage (open collector) see Fig. 2	$V_{EBO}$	max.	5	V
Collector current (d.c.)	$I_C$	max.	100	mA
Collector current (peak value)	$I_{CM}$	max.	200	mA
Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ mounted on a ceramic substrate of → 7 mm x 5 mm x 0,6 mm	$P_{tot}$	max.	350	mW
→ Storage temperature	$T_{stg}$		-65 to + 175	$^\circ\text{C}$
→ Junction temperature	$T_j$	max.	175	$^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P_x (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	50	K/W
From tab to soldering points	$R_{th\ t-s}$	=	260	K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120	K/W

**CHARACTERISTICS**

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

Collector cut-off current $I_E = 0; V_{CB} = 20 \text{ V}$	$I_{CB0}$	<	100	nA
$I_E = 0; V_{CB} = 20 \text{ V}; T_j = 100 \text{ }^\circ\text{C}$	$I_{CBO}$	<	10	$\mu\text{A}$
Base emitter voltage $I_C = 2 \text{ mA}; V_{CE} = 5 \text{ V}$	$V_{BE}$		550 to 700	mV
Saturation voltages $I_C = 10 \text{ mA}; I_B = 0,5 \text{ mA}$	$V_{CEsat}$	typ.	120	mV
		<	250	mV
$I_C = 50 \text{ mA}; I_B = 2,5 \text{ mA}$	$V_{BEsat}$	typ.	750	mV
	$V_{CEsat}$	typ.	210	mV
	$V_{BEsat}$	typ.	850	mV

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

		BCV71		BCV72	
		BCV71R		BCV72R	
D.C. current gain					
$I_C = 10 \mu A; V_{CE} = 5 V$	$h_{FE}$	typ.	90	150	
$I_C = 2 mA; V_{CE} = 5 V$	$h_{FE}$	>	110	200	
		<	220	450	
Collector capacitance at $f = 1 MHz$					
$I_E = I_e = 0; V_{CB} = 10 V$	$C_c$	<	4,0		pF
Transition frequency at $f = 35 MHz$					
$I_C = 10 mA; V_{CE} = 5 V$	$f_T$	typ.	300		MHz
Noise figure at $R_S = 2 k\Omega$					
$I_C = 200 \mu A; V_{CE} = 5 V$					
$f = 1 kHz; B = 200 Hz$	F	<	10		dB

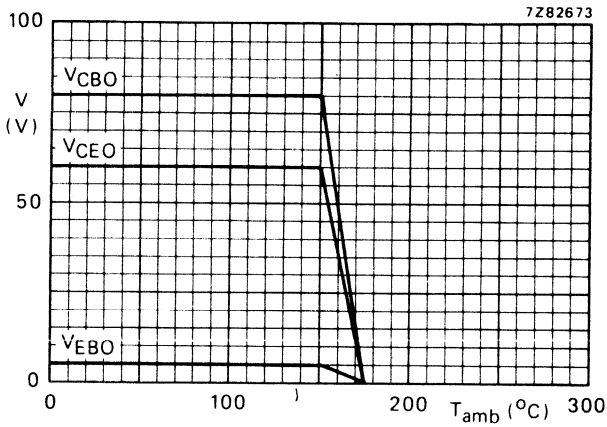


Fig. 2 Voltage derating curves.

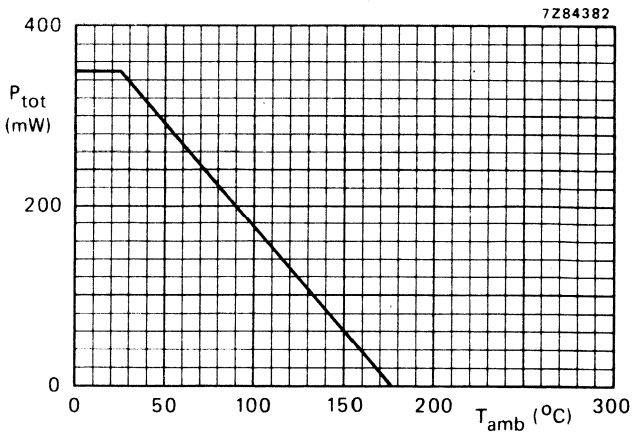


Fig. 3 Power derating curve.



## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors, in a microminiature plastic envelope, intended for low level general purpose applications in thick and thin-film circuits.

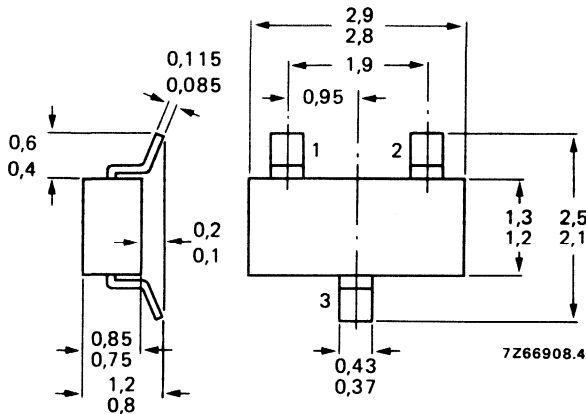
### QUICK REFERENCE DATA

		BCW29 BCW29R		BCW30 BCW30R	
				120	215
D.C. current gain at $T_j = 25\text{ }^\circ\text{C}$ $-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}$	$h_{FE}$	>		<	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32		V ←
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	32		V ←
Collector current (peak value)	$-I_{CM}$	max.	200		mA
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max.	350		mW ←
Junction temperature	$T_j$	max.	175		$^\circ\text{C}$ ←
Transition frequency at $f = 35\text{ MHz}$ $-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	$f_T$	typ.	150		MHz
Noise figure at $R_S = 2\text{ k}\Omega$ $-I_C = 200\text{ }\mu\text{A}; -V_{CE} = 5\text{ V};$ $f = 1\text{ kHz}; B = 200\text{ Hz}$	F	<	10		dB

### MECHANICAL DATA

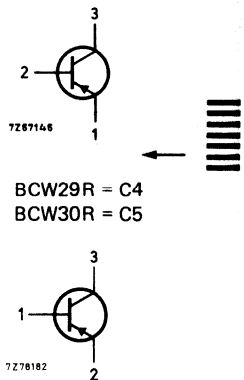
Dimensions in mm

Fig. 1 SOT-23.



### Marking code

BCW29 = C1  
BCW30 = C2



See also *Soldering recommendations*.

→ RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Collector-base voltage (open emitter)	$-V_{CB0}$	max.	32 V
Collector-emitter voltage ( $V_{BE} = 0$ )	$-V_{CES}$	max.	32 V
Collector-emitter voltage (open base) $-I_C = 2$ mA	$-V_{CEO}$	max.	32 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V
Collector current (d.c.)	$-I_C$	max.	100 mA
Collector current (peak value)	$-I_{CM}$	max.	200 mA
Total power dissipation up to $T_{amb} = 25$ °C mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm	$P_{tot}$	max.	350 mW
Storage temperature	$T_{stg}$		-65 to +175 °C
Junction temperature	$T_j$	max.	175 °C

→ THERMAL CHARACTERISTICS\*

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

$T_j = 25$  °C unless otherwise specified

→ Collector cut-off current

$I_E = 0; -V_{CB} = 32$ V	$-I_{CBO}$	<	100 nA
$I_E = 0; -V_{CB} = 32$ V; $T_j = 100$ °C	$-I_{CBO}$	<	10 $\mu$ A

Base-emitter voltage

$-I_C = 2$ mA; $-V_{CE} = 5$ V	$-V_{BE}$		600 to 750 mV
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Saturation voltages

$-I_C = 10$ mA; $-I_B = 0,5$ mA	$-V_{CEsat}$	typ.	80 mV
		<	300 mV
$-I_C = 50$ mA; $-I_B = 2,5$ mA	$-V_{BEsat}$	typ.	720 mV
	$-V_{CEsat}$	typ.	150 mV
	$-V_{BEsat}$	typ.	810 mV

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

D.C. current gain

$-I_C = 10 \mu A; -V_{CE} = 5 V$

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

Collector-capacitance at  $f = 1 MHz$

$I_E = I_e = 0; -V_{CB} = 10 V$

Transition frequency at  $f = 35 MHz$

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

Noise figure at  $R_S = 2 k\Omega$

$-I_C = 200 \mu A; -V_{CE} = 5 V$

$f = 1 kHz; B = 200 Hz$

	BCW29 BCW29R	BCW30 BCW30R	
$h_{FE}$	typ. 90	150	
$h_{FE}$	> 120	215	
$h_{FE}$	< 260	500	
$C_c$	<	7,0	pF
$f_T$	typ.	150	MHz
F	<	10	dB

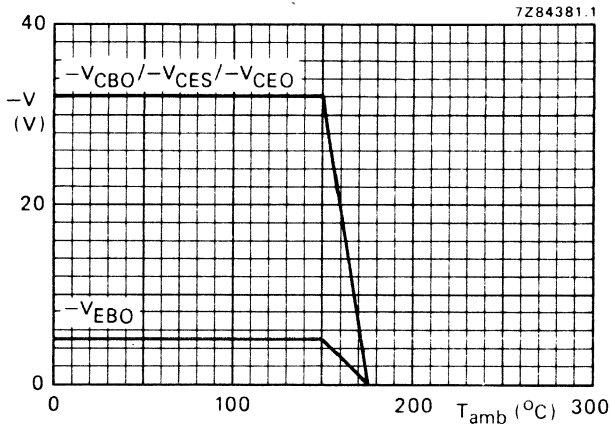


Fig. 2 Voltage derating curves.

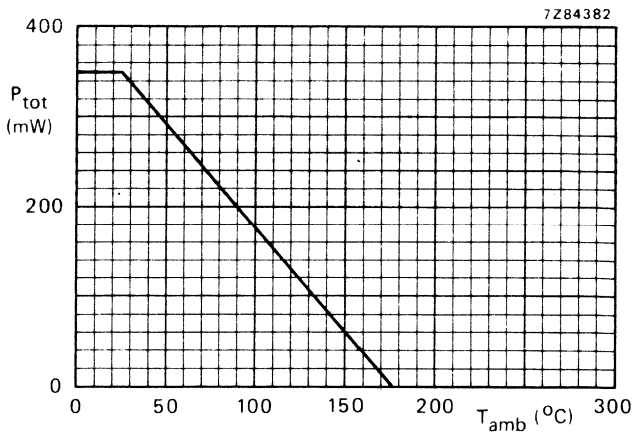


Fig. 3 Power derating curve.

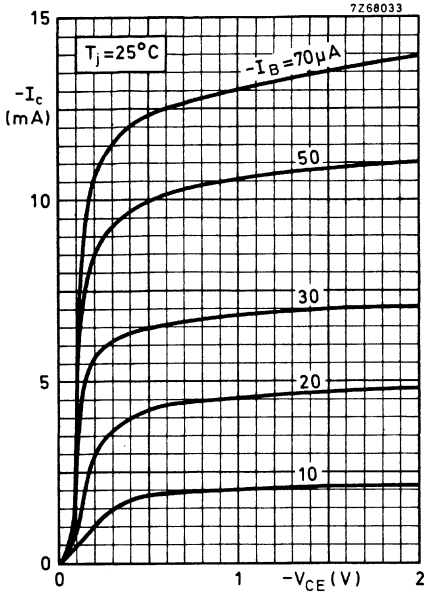


Fig. 4.

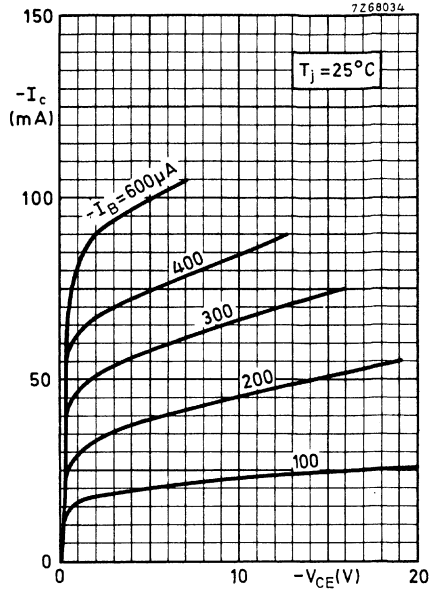


Fig. 5.

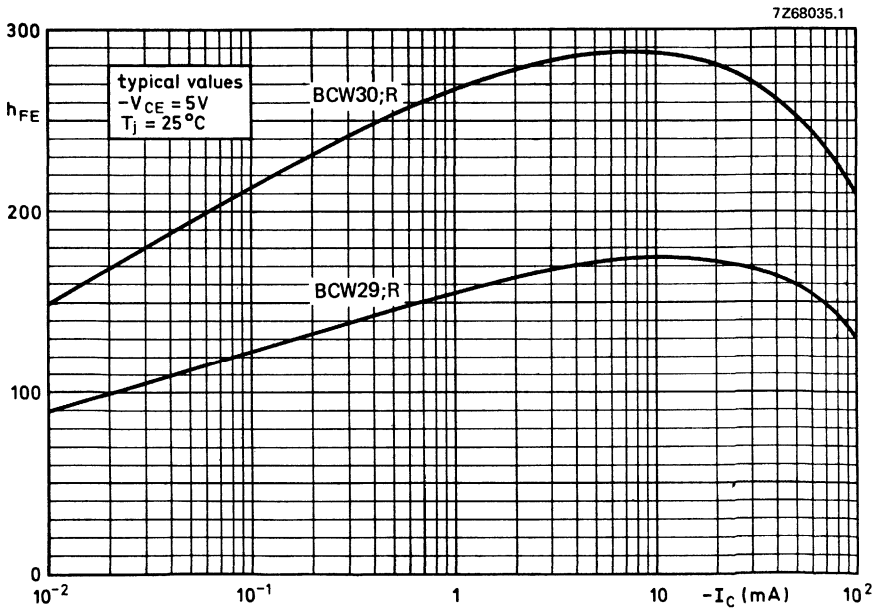


Fig. 6.



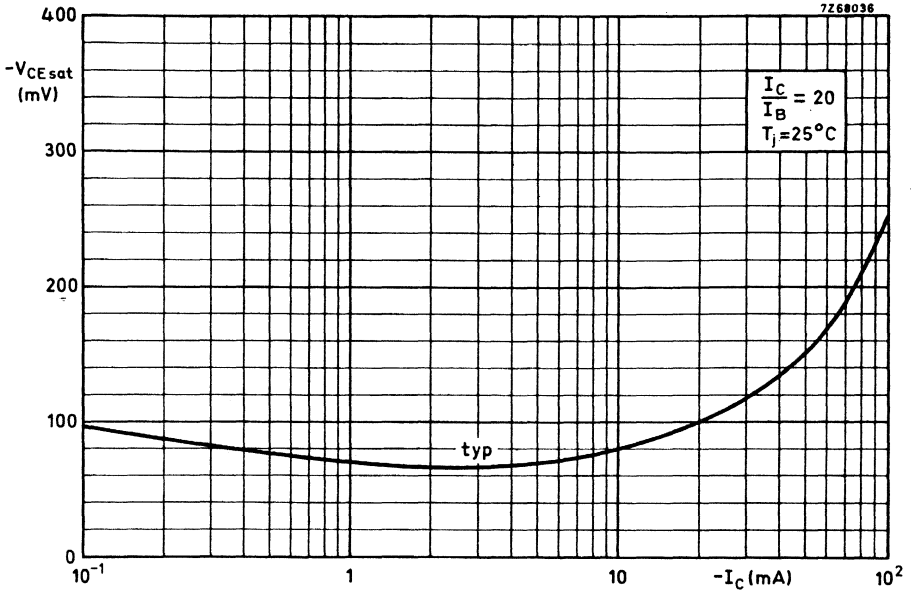


Fig. 7.

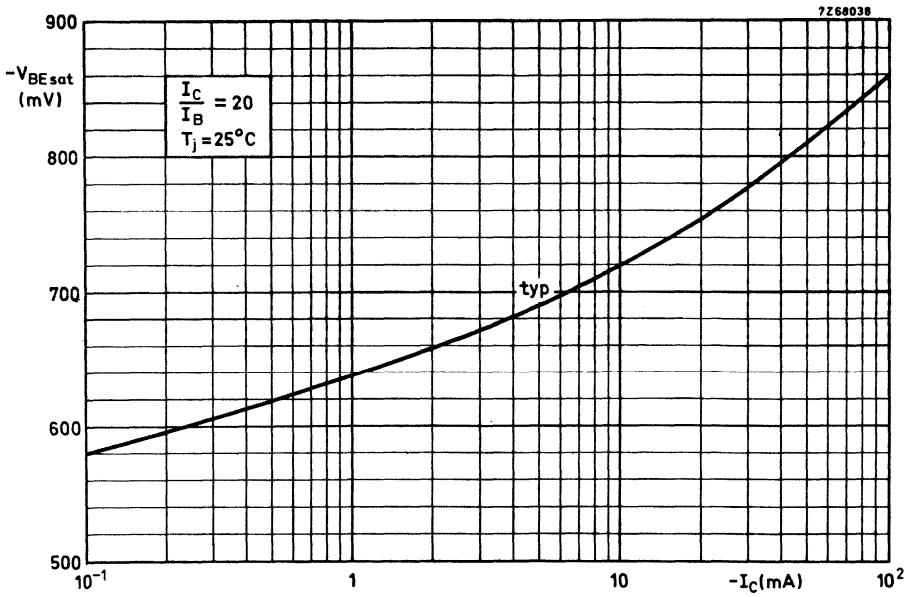


Fig. 8.

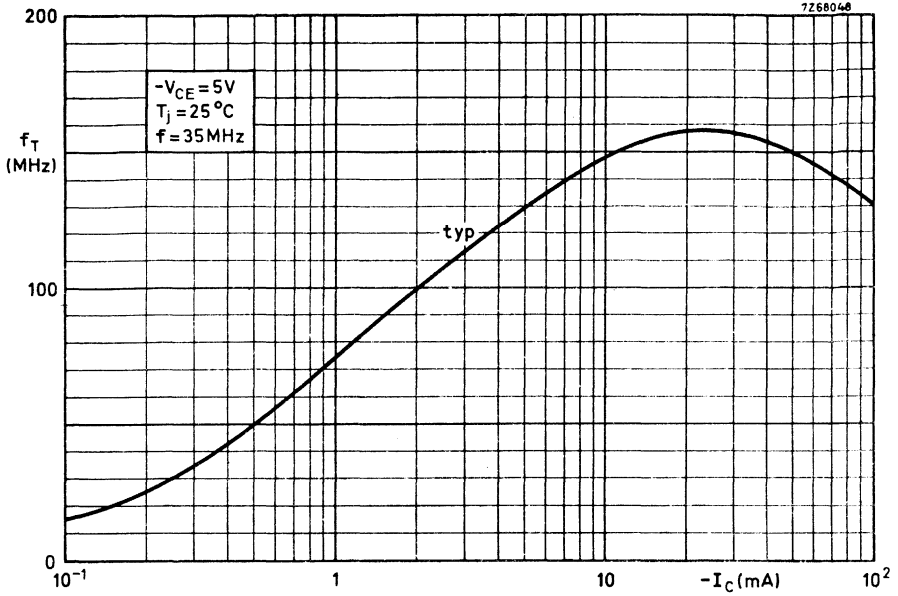


Fig. 9.

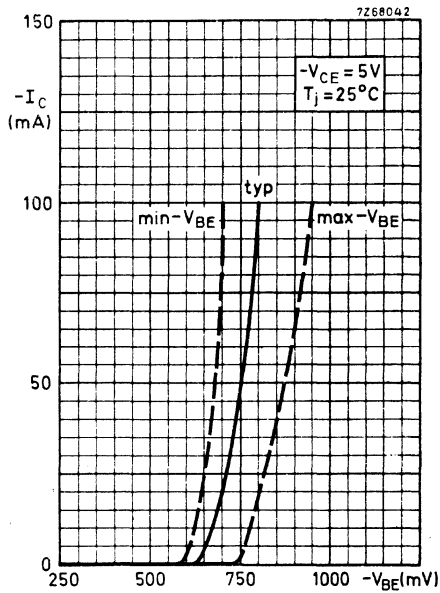


Fig. 10.

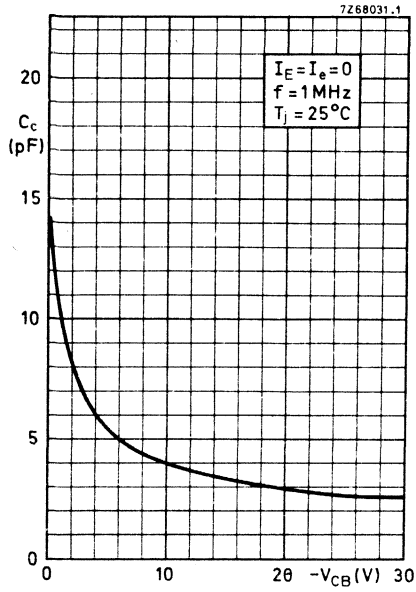


Fig. 11.

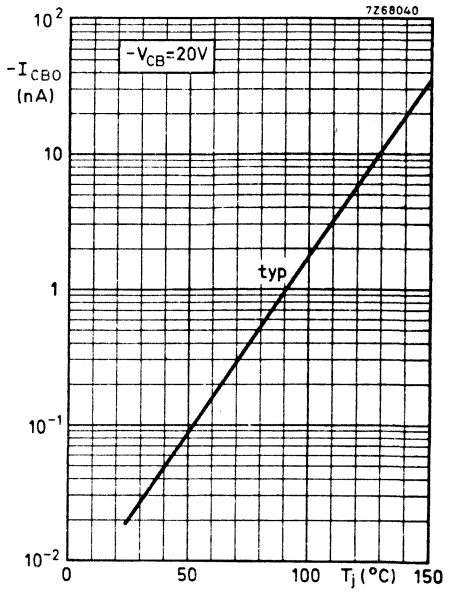


Fig. 12.





## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a microminiature plastic envelope. They are intended for low level general purpose applications in thick and thin-film circuits.

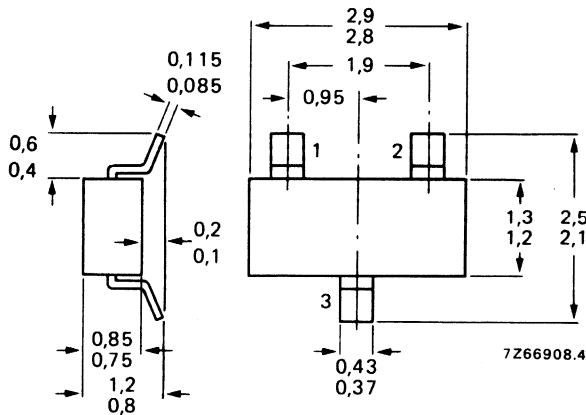
### QUICK REFERENCE DATA

			BCW31 BCW31R	BCW32 BCW32R	BCW33 BCW33R
D.C. current gain at $T_j = 25\text{ }^\circ\text{C}$ $I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$	$h_{FE}$	$>$ $<$	110 220	200 450	420 800
Collector-base voltage (open emitter)	$V_{CBO}$	max.		32	V
Collector-emitter voltage (open base)	$V_{CEO}$	max.		32	V
Collector current (peak value)	$I_{CM}$	max.		200	mA
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max.		350	mW ←
Junction temperature	$T_j$	max.		175	$^\circ\text{C}$ ←
Transition frequency at $f = 35\text{ MHz}$ $I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$	$f_T$	typ.		300	MHz
Noise figure at $R_S = 2\text{ k}\Omega$ $I_C = 200\text{ }\mu\text{A}; V_{CE} = 5\text{ V};$ $f = 1\text{ kHz}; B = 200\text{ Hz}$	F	$<$		10	dB

### MECHANICAL DATA

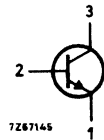
Fig. 1 SOT-23.

Dimensions in mm

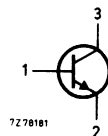


### Marking code

BCW31 = D1  
BCW32 = D2  
BCW33 = D3



BCW31R = D4  
BCW32R = D5  
BCW32R = D6



See also *Soldering recommendations*.

→ RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC134)

Collector-base voltage (open emitter)	$V_{CB0}$	max.	32 V
Collector-emitter voltage (open base) $I_C = 2 \text{ mA}$	$V_{CEO}$	max.	32 V
Emitter-base voltage (open collector)	$V_{EBO}$	max.	5 V
Collector current (d.c.)	$I_C$	max.	100 mA
Collector current (peak value)	$I_{CM}$	max.	200 mA
Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm	$P_{tot}$	max.	350 mW
Storage temperature	$T_{stg}$		-65 to +175 $^\circ\text{C}$
Junction temperature	$T_j$	max.	175 $^\circ\text{C}$

→ THERMAL CHARACTERISTICS\*

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

→ Collector cut-off current

$I_E = 0; V_{CB} = 32 \text{ V}$   $I_{CBO} < 100 \text{ nA}$

$I_E = 0; V_{CB} = 32 \text{ V}; T_j = 100 \text{ }^\circ\text{C}$   $I_{CBO} < 10 \text{ } \mu\text{A}$

Base-emitter voltage

$I_C = 2 \text{ mA}; V_{CE} = 5 \text{ V}$   $V_{BE} = 550 \text{ to } 700 \text{ mV}$

Saturation voltages

$I_C = 10 \text{ mA}; I_B = 0,5 \text{ mA}$   $V_{CEsat} \text{ typ. } 120 \text{ mV}$   
 $V_{CEsat} < 250 \text{ mV}$

$I_C = 50 \text{ mA}; I_B = 2,5 \text{ mA}$   $V_{BEsat} \text{ typ. } 750 \text{ mV}$

$I_C = 50 \text{ mA}; I_B = 2,5 \text{ mA}$   $V_{CEsat} \text{ typ. } 210 \text{ mV}$   
 $V_{BEsat} \text{ typ. } 850 \text{ mV}$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

D.C. current gain

$I_C = 10 \mu A; V_{CE} = 5 V$

$h_{FE}$  typ.

BCW31 BCW31R	BCW32 BCW32R	BCW33 BCW33R
90	150	270
$>$	110	420
$<$	220	800

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

$h_{FE}$   
 $>$   
 $<$

110	200	420
220	450	800

Collector capacitance at  $f = 1 MHz$

$I_E = I_e = 0; V_{CB} = 10 V$

$C_c$

$<$	4,0	pF
-----	-----	----

Transition frequency at  $f = 35 MHz$

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

$f_T$

typ.	300	MHz
------	-----	-----

Noise figure at  $R_S = 2 k\Omega$

$I_C = 200 \mu A; V_{CE} = 5 V$

$f = 1 kHz; B = 200 Hz$

F

$<$	10	dB
-----	----	----

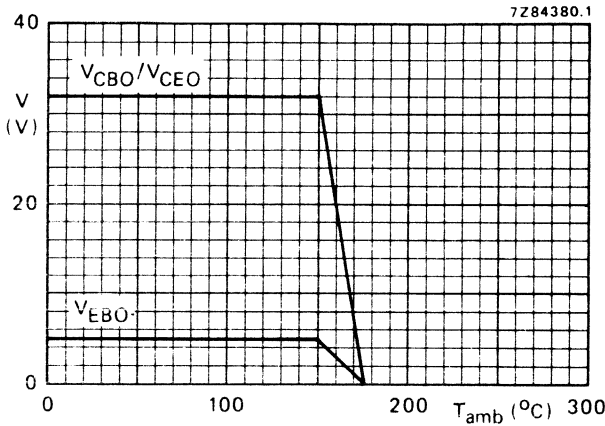


Fig. 2 Voltage derating curves.

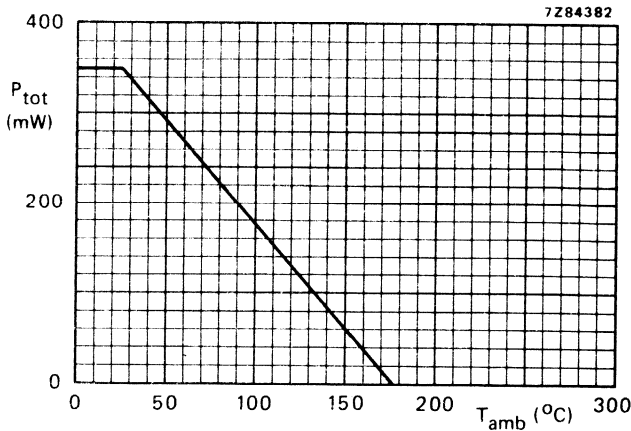


Fig. 3 Power derating curve.

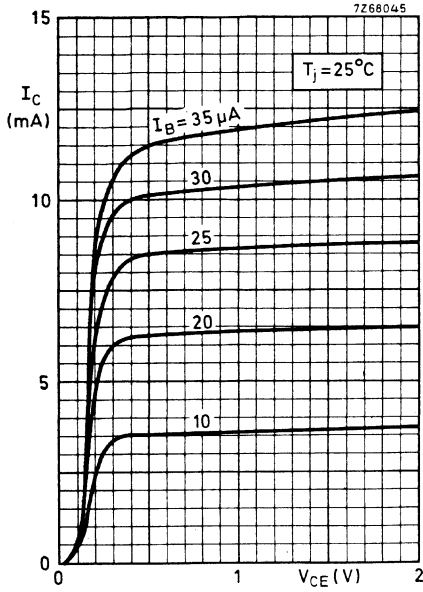


Fig. 4.

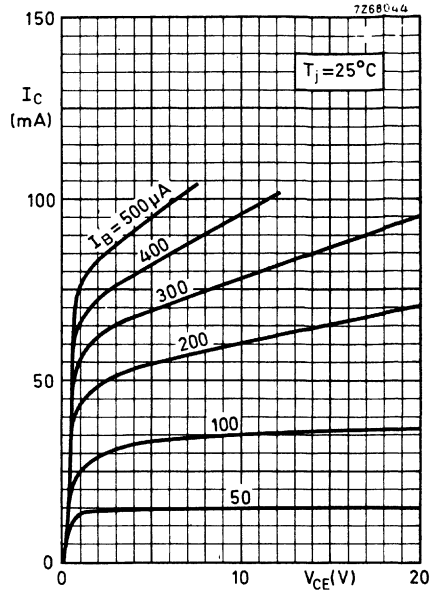


Fig. 5.

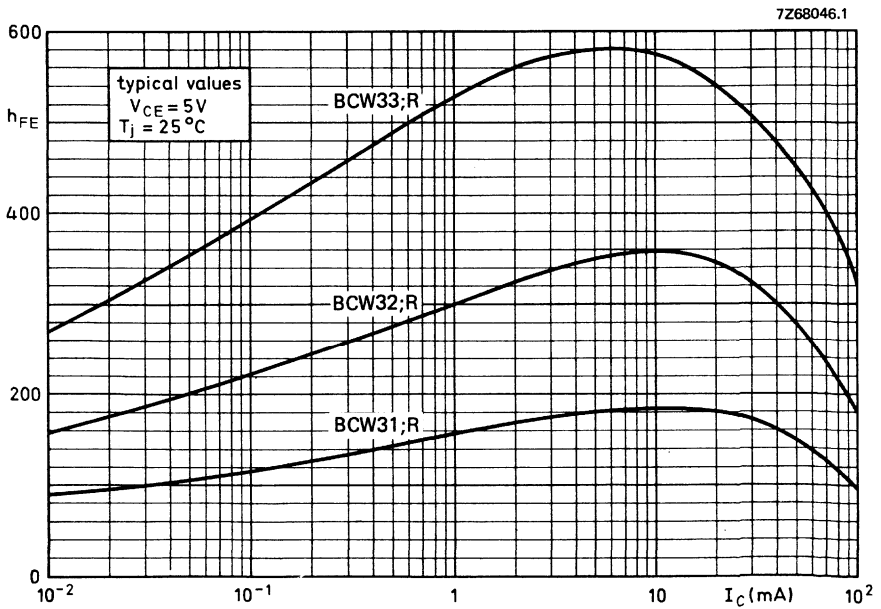


Fig. 6.



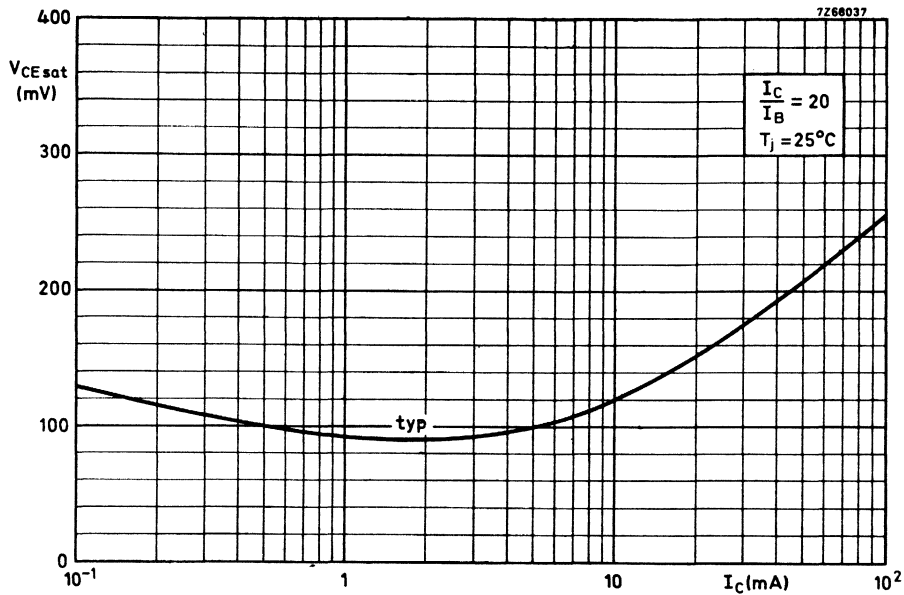


Fig. 7.

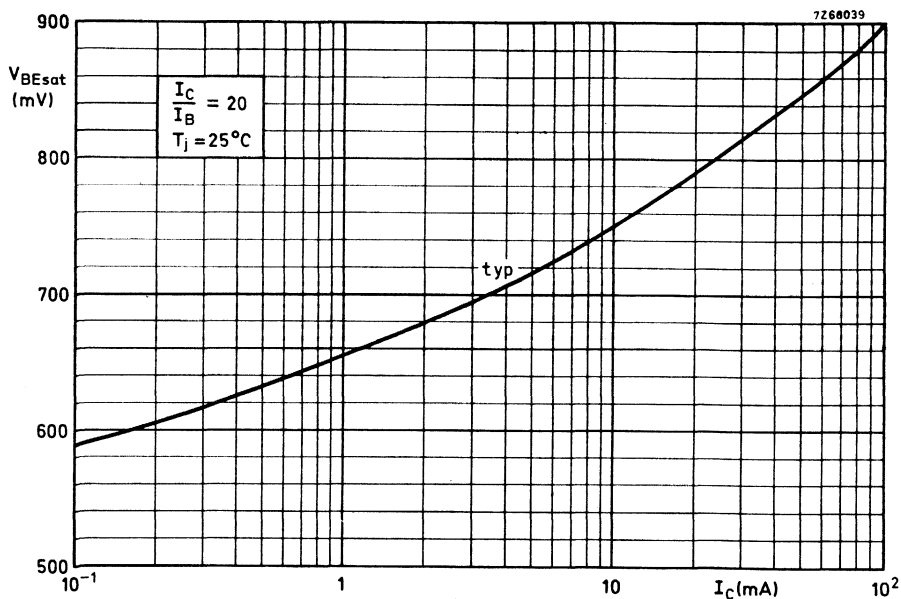


Fig. 8.

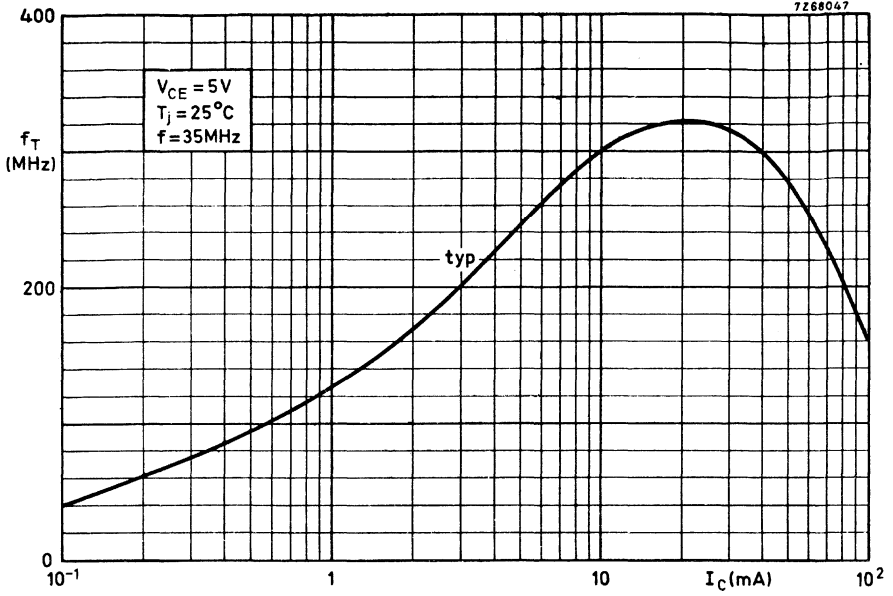


Fig. 9.

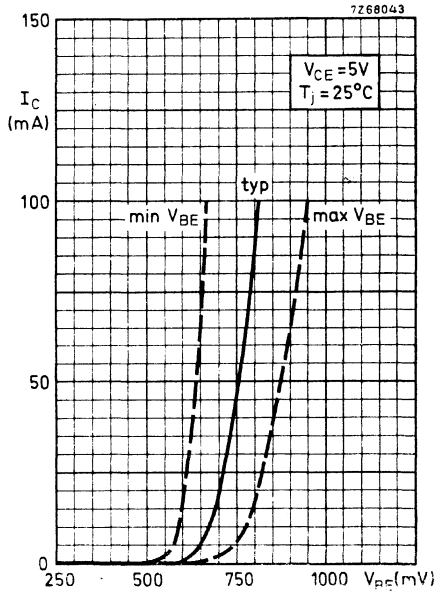


Fig. 10

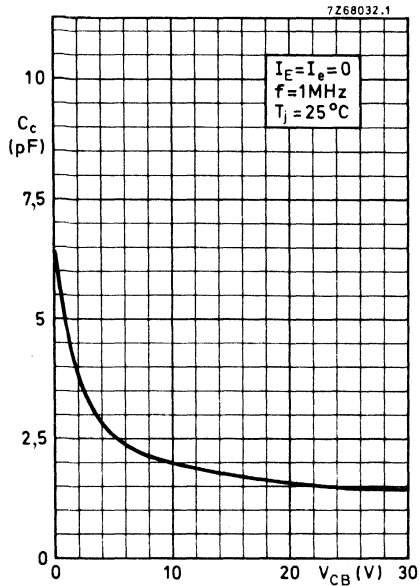


Fig. 11.

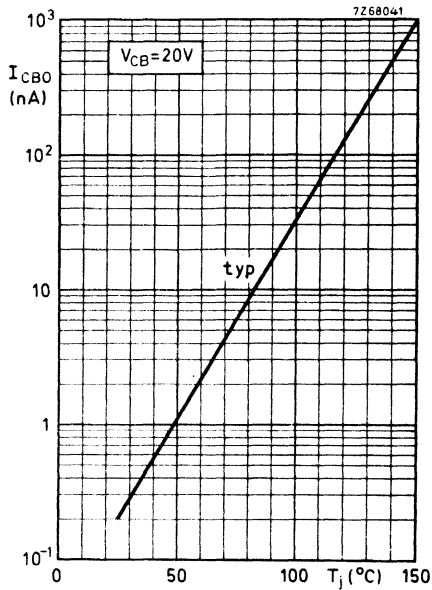


Fig. 12.





## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon transistors, in a microminiature plastic envelope, intended for low level, low noise, low frequency purpose applications in hybrid circuits.

### QUICK REFERENCE DATA

Collector-emitter voltage ( $V_{BE} = 0$ )	$V_{CES}$	max.	32 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	32 V
Collector current (d.c.)	$I_C$	max.	200 mA
Total power dissipation	$P_{tot}$	max.	150 mW
Junction temperature	$T_j$	max.	150 °C
Transition frequency at $f = 100$ MHz $V_{CE} = 5$ V; $I_C = 10$ mA	$f_T$	typ.	250 MHz
Noise figure at $f = 1$ kHz $V_{CE} = 5$ V; $I_C = 200 \mu A$ ; $B = 200$ Hz	F	typ.	2 dB

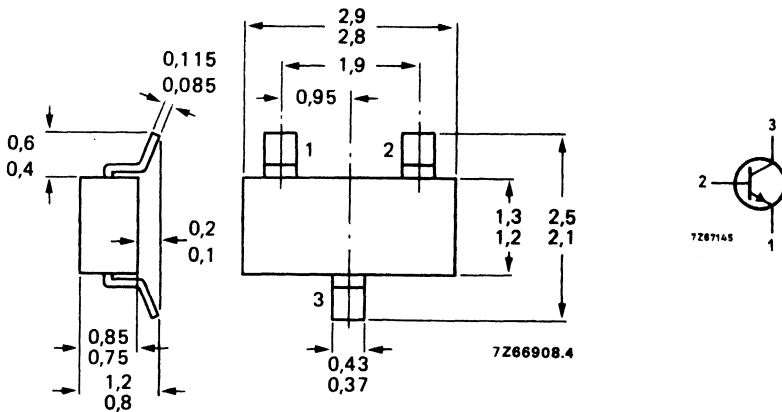
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BCW60A = AA  
BCW60B = AB  
BCW60C = AC  
BCW60D = AD



See also *Soldering recommendations*.

## RATINGS

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

Collector-emitter voltage ( $V_{BE} = 0$ )	$V_{CES}$	max.	32 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	32 V
Emitter-base voltage (open collector)	$V_{EBO}$	max.	5 V
Collector current (d.c.)	$I_C$	max.	200 mA
Base current	$I_B$	max.	50 mA
Total power dissipation**	$P_{tot}$	max.	150 mW
Storage temperature	$T_{stg}$		-55 to + 125 °C
Junction temperature	$T_j$	max.	150 °C

## THERMAL CHARACTERISTICS\*

$$T_j = P_x (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

### Thermal resistance

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

## CHARACTERISTICS

$T_{amb} = 25$  °C unless otherwise specified

Collector-emitter cut-off current

$$V_{BE} = 0; V_{CE} = 32\text{ V}$$

$$I_{CES} < 20\text{ nA}$$

$$V_{BE} = 0; V_{CE} = 32\text{ V}; T_{amb} = 150\text{ °C}$$

$$I_{CES} < 20\text{ }\mu\text{A}$$

Emitter-base cut-off current

$$I_C = 0; V_{EB} = 4\text{ V}$$

$$I_{EBO} < 20\text{ nA}$$

Saturation voltages

$$\text{at } I_C = 10\text{ mA}; I_B = 0,25\text{ mA}$$

$$V_{CEsat} \quad 0,05\text{ to }0,35\text{ V}$$

$$V_{BEsat} \quad 0,6\text{ to }0,85\text{ V}$$

$$\text{at } I_C = 50\text{ mA}; I_B = 1,25\text{ mA}$$

$$V_{CEsat} \quad 0,1\text{ to }0,55\text{ V}$$

$$V_{BEsat} \quad 0,7\text{ to }1,05\text{ V}$$

Transition frequency at  $f = 100$  MHz ▲

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

$$f_T > 125\text{ MHz}$$

$$\text{typ. } 250\text{ MHz}$$

Collector capacitance at  $f = 1$  MHz

$$I_E = I_e = 0; V_{CB} = 10\text{ V}$$

$$C_C < 4,5\text{ pF}$$

Emitter capacitance at  $f = 1$  MHz

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

$$C_e \text{ typ. } 8\text{ pF}$$

Noise figure at  $R_S = 2\text{ k}\Omega$

$$I_C = 200\text{ }\mu\text{A}; V_{CE} = 5\text{ V}; f = 1\text{ kHz}; B = 200\text{ Hz}$$

$$F \text{ typ. } 2\text{ dB}$$

$$< 6\text{ dB}$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

▲ Measured under pulse conditions.

		A	B	C	D	
D.C. current gain	$V_{CE} = 5 \text{ V}; I_C = 10 \mu\text{A}$	$h_{FE}$ typ.	78	145	220	300
		$h_{FE} >$	—	20	40	100
	$V_{CE} = 5 \text{ V}; I_C = 2 \text{ mA}$	$h_{FE} >$	120	180	250	380
		$h_{FE}$ typ.	170	250	350	500
	$V_{CE} = 1 \text{ V}; I_C = 50 \text{ mA}$	$h_{FE} <$	220	310	460	630
		$h_{FE} >$	50	70	90	100
Input impedance	$V_{CE} = 5 \text{ V}; I_C = 2 \text{ mA}; f = 1 \text{ kHz}$	$h_{FE} >$	1,6	2,5	3,2	4,5 k $\Omega$
		$h_{ie}$ typ.	2,7	3,6	4,5	7,5 k $\Omega$
		$h_{ie} <$	4,5	6,0	8,5	12,0 k $\Omega$
Reverse voltage transfer ratio	$V_{CE} = 5 \text{ V}; I_C = 2 \text{ mA}; f = 1 \text{ kHz}$	$h_{re}$ typ.	1,5	2	2	3 $10^{-4}$
Small-signal current gain	$V_{CE} = 5 \text{ V}; I_C = 2 \text{ mA}; f = 1 \text{ kHz}$	$h_{re} >$	125	175	250	350
		$h_{fe}$ typ.	200	260	330	520
		$h_{fe} <$	250	350	500	700
Output admittance	$V_{CE} = 5 \text{ V}; I_C = 2 \text{ mA}; f = 1 \text{ kHz}$	$h_{oe}$ typ.	18	24	30	50 $\mu\text{A/V}$
		$h_{oe} <$	30	50	60	100 $\mu\text{A/V}$
Base-emitter voltage						
	$V_{CE} = 5 \text{ V}; I_C = 2 \text{ mA}$	$V_{BE}$ typ.	0,55 to 0,75		V	
	$V_{CE} = 5 \text{ V}; I_C = 10 \mu\text{A}$	$V_{BE}$ typ.	0,65		V	
	$V_{CE} = 5 \text{ V}; I_C = 10 \mu\text{A}$	$V_{BE}$ typ.	0,52		V	
	$V_{CE} = 1 \text{ V}; I_C = 50 \text{ mA}$	$V_{BE}$ typ.	0,78		V	



Switching times

$I_{Con} = 10 \text{ mA}$ ;  $I_{Bon} = -I_{Boff} = 1 \text{ mA}$   
 $V_{CC} = 10 \text{ V}$ ;  $R_L = 990 \Omega$

turn-on time ( $t_d + t_r$ )

$t_{on}$  typ. 85 ns  
 < 150 ns

turn-off time ( $t_s + t_f$ )

$t_{off}$  typ. 480 ns  
 < 800 ns

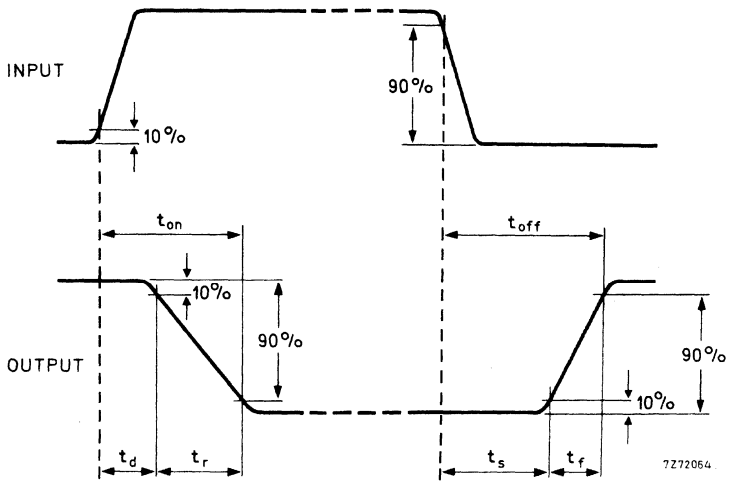


Fig. 2 Switching waveforms.





## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P silicon transistors, in a microminiature plastic envelope, intended for low level, low noise, low frequency purpose applications in hybrid circuits.

### QUICK REFERENCE DATA

Collector-emitter voltage ( $V_{BE} = 0$ )	$-V_{CES}$	max.	32 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	32 V
Collector current (d.c.)	$-I_C$	max.	200 mA
Total power dissipation	$P_{tot}$	max.	150 mW
Junction temperature	$T_j$	max.	150 °C
Transition frequency at $f = 100$ MHz $-V_{CE} = 5$ V; $-I_C = 10$ mA	$f_T$	typ.	180 MHz
Noise figure at $f = 1$ kHz $-V_{CE} = 5$ V; $-I_C = 200$ $\mu$ A	F	typ.	2 dB

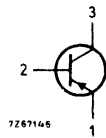
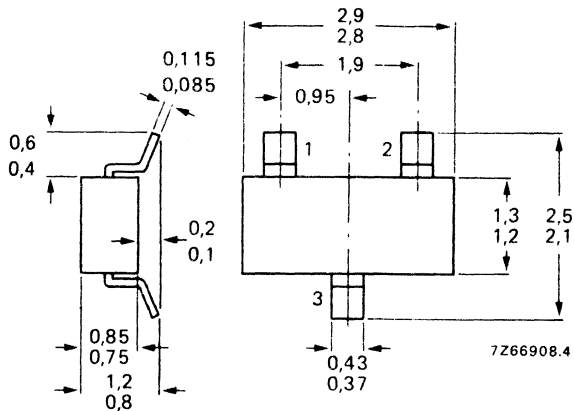
### MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BCW61A = BA  
BCW61B = BB  
BCW61C = BC  
BCW61D = BD



See also *Soldering recommendations*.

## RATINGS

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

Collector-emitter voltage ( $V_{BE} = 0$ )	$-V_{CES}$	max.	32 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	32 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V
Collector current (d.c.)	$-I_C$	max.	200 mA
Base current	$-I_B$	max.	50 mA
Total power dissipation**	$P_{tot}$	max.	150 mW
Storage temperature	$T_{stg}$		-55 to + 125 °C
Junction temperature	$T_j$	max.	150 °C

## THERMAL CHARACTERISTICS\*

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

### Thermal resistance

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

## CHARACTERISTICS

$T_{amb} = 25$  °C unless otherwise specified

Collector-emitter cut-off current

$$V_{EB} = 0; -V_{CE} = 32\text{ V}$$

$$-I_{CES} < 20\text{ nA}$$

$$V_{EB} = 0; -V_{CE} = 32\text{ V}; T_{amb} = 150\text{ °C}$$

$$-I_{CES} < 20\text{ }\mu\text{A}$$

Emitter-base cut-off current

$$I_C = 0; -V_{EB} = 4\text{ V}$$

$$-I_{EBO} < 20\text{ nA}$$

Saturation voltages

$$-I_C = 10\text{ mA}; -I_B = 0,25\text{ mA}$$

$$-V_{CEsat} \quad 0,06\text{ to }0,25\text{ V}$$

$$-V_{BEsat} \quad 0,6\text{ to }0,85\text{ V}$$

$$-I_C = 50\text{ mA}; -I_B = 1,25\text{ mA}$$

$$-V_{CEsat} \quad 0,12\text{ to }0,55\text{ V}$$

$$-V_{BEsat} \quad 0,68\text{ to }1,05\text{ V}$$

Transition frequency at  $f = 100\text{ MHz}$  ▲

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

$$f_T \quad \text{typ.} \quad 180\text{ MHz}$$

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

$$-V_{CB} = 10\text{ V}; I_E = I_e = 0$$

$$C_c < 6\text{ pF}$$

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

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

$$C_e \quad \text{typ.} \quad 11\text{ pF}$$

Noise figure at  $R_S = 2\text{ k}\Omega$

$$-V_{CE} = 5\text{ V}; -I_C = 200\text{ }\mu\text{A}; B = 200\text{ Hz}$$

$$F \quad \text{typ.} \quad 2\text{ dB}$$

$$< 6\text{ dB}$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

▲ Measured under pulse conditions.

		A	B	C	D
D.C. current gain					
$-V_{CE} = 5 \text{ V}; -I_C = 10 \mu\text{A}$	$h_{FE}$ typ.	140	200	270	340
	>	—	30	40	100
	>	120	180	250	380
$-V_{CE} = 5 \text{ V}; -I_C = 2 \text{ mA}$	$h_{FE}$ typ.	170	250	350	500
	<	220	310	460	630
$-V_{CE} = 1 \text{ V}; -I_C = 50 \text{ mA}$	$h_{FE}$ >	60	80	100	110
Input impedance	>	1,6	2,5	3,2	4,5 k $\Omega$
$-V_{CE} = 5 \text{ V}; -I_C = 2 \text{ mA}; f = 1 \text{ kHz}$	$h_{ie}$ typ.	2,7	3,6	4,5	7,5 k $\Omega$
	<	4,5	6,0	8,5	12,0 k $\Omega$
Reverse voltage transfer ratio					
$-V_{CE} = 5 \text{ V}; -I_C = 2 \text{ mA}; f = 1 \text{ kHz}$	$h_{re}$ typ.	1,5	2	2	3 $10^{-4}$
Small-signal current gain	>	125	175	250	350
$-V_{CE} = 5 \text{ V}; -I_C = 2 \text{ mA}; f = 1 \text{ kHz}$	$h_{fe}$ typ.	200	260	330	520
	<	250	350	500	700
Output admittance					
$-V_{CE} = 5 \text{ V}; -I_C = 2 \text{ mA}; f = 1 \text{ kHz}$	$h_{oe}$ typ.	18	24	30	50 $\mu\text{A}/\text{V}$
	<	30	50	60	100 $\mu\text{A}/\text{V}$
Base-emitter voltage					
$-V_{CE} = 5 \text{ V}; -I_C = 2 \text{ mA}$	$V_{BE}$ typ.	0,6 to 0,75			V
		0,65			V
$-V_{CE} = 5 \text{ V}; -I_C = 10 \mu\text{A}$	$V_{BE}$ typ.	0,55			V
$-V_{CE} = 1 \text{ V}; -I_C = 50 \text{ mA}$	$V_{BE}$ typ.	0,72			V



Switching times

$-I_{Con} = 10 \text{ mA}; -I_{Bon} = I_{Boff} = 1 \text{ mA}$   
 $-V_{CC} = 10 \text{ V}; R_L = 990 \Omega$

turn-on time ( $t_d + t_r$ )

$t_{on}$  typ. 85 ns  
 < 150 ns

turn-off time ( $t_s + t_f$ )

$t_{off}$  typ. 480 ns  
 < 800 ns

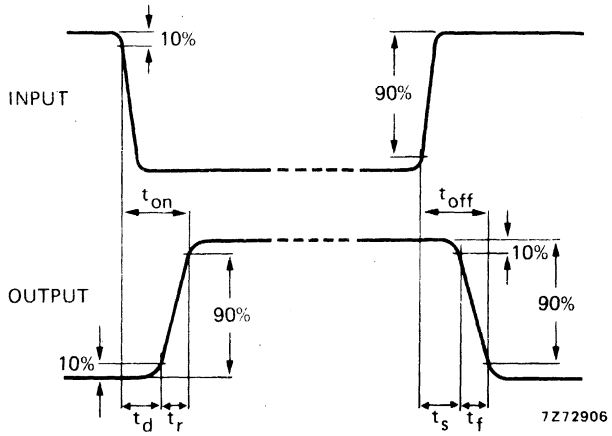


Fig. 2 Switching waveforms.



## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors, in a microminiature plastic envelope, intended for low level general purpose applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

		BCW69 BCW69R	BCW70 BCW70R	
D.C. current gain at $T_j = 25\text{ }^\circ\text{C}$ $-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}$	$h_{FE}$	120 260	215 500	
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	50		V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	45		V
Collector current (peak value)	$-I_{CM}$ max.	200		mA
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$ max.	350		mW ←
Junction temperature	$T_j$ max.	175		$^\circ\text{C}$ ←
Transition frequency at $f = 35\text{ MHz}$ $-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	$f_T$ typ.	150		MHz
Noise figure at $R_S = 2\text{ k}\Omega$ $-I_C = 200\text{ }\mu\text{A}; -V_{CE} = 5\text{ V};$ $f = 1\text{ kHz}; B = 200\text{ Hz}$	F	<	10	dB

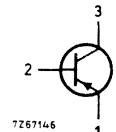
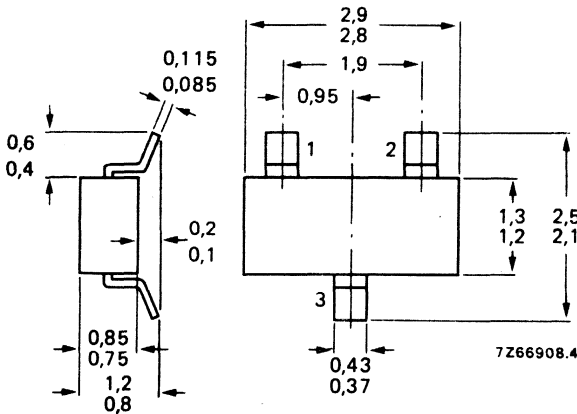
### MECHANICAL DATA

Fig. 1 SOT-23.

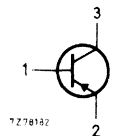
Dimensions in mm

Marking code

BCW69 = H1  
BCW70 = H2



BCW69R = H4  
BCW70R = H5



See also *Soldering recommendations*.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC134)

Collector-base voltage (open emitter) see Fig. 2	$-V_{CB0}$	max.	50 V
Collector-emitter voltage ( $V_{BE} = 0$ ) see Fig. 2	$-V_{CES}$	max.	50 V
Collector-emitter voltage (open base) see Fig. 2			
$-I_C = 2$ mA	$-V_{CEO}$	max.	45 V
Emitter-base voltage (open collector) see Fig. 2	$-V_{EBO}$	max.	5 V
Collector current (d.c.)	$-I_C$	max.	100 mA
Collector current (peak value)	$-I_{CM}$	max.	200 mA
Total power dissipation up to $T_{amb} = 25$ °C mounted on a ceramic substrate of			
→ 7 mm x 5 mm x 0,6 mm	$P_{tot}$	max.	350 mW
→ Storage temperature	$T_{stg}$		-65 to + 175 °C
→ Junction temperature	$T_j$	max.	175 °C

→ **THERMAL CHARACTERISTICS\***

$$T_j = P_x (R_{th j-t} + R_{th t-s} + R_{th s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th j-t}$	=	50 K/W
From tab to soldering points	$R_{th t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th s-a}$	=	120 K/W

**CHARACTERISTICS**

$T_j = 25$  °C unless otherwise specified

Collector cut-off current

$I_E = 0; -V_{CB} = 20$ V	$-I_{CB0}$	<	100 nA
---------------------------	------------	---	--------

$I_E = 0; -V_{CB} = 20$ V; $T_j = 100$ °C	$-I_{CBO}$	<	10 $\mu$ A
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Base-emitter voltage

$-I_C = 2$ mA; $-V_{CE} = 5$ V	$-V_{BE}$		600 to 750 mV
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Saturation voltages

	$-V_{CEsat}$	typ.	80 mV
		<	300 mV

$-I_C = 10$ mA; $-I_B = 0,5$ mA	$-V_{BEsat}$	typ.	720 mV
---------------------------------	--------------	------	--------

$-I_C = 50$ mA; $-I_B = 2,5$ mA	$-V_{CEsat}$	typ.	150 mV
---------------------------------	--------------	------	--------

	$-V_{BEsat}$	typ.	810 mV
--	--------------	------	--------

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

D.C. current gain

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

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

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

$I_E = I_e = 0; -V_{CB} = 10 \text{ V}$

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

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

Noise figure at  $R_S = 2 \text{ k}\Omega$

$-I_C = 200 \mu\text{A}; -V_{CE} = 5 \text{ V}$

$f = 1 \text{ kHz}; B = 200 \text{ Hz}$

	BCW69 BCW69R	BCW70 BCW70R
$h_{FE}$ typ.	90	150
$h_{FE} >$	120	215
$h_{FE} <$	260	500
$C_c$	7,0 pF	
$f_T$ typ.	150	MHz
F	10 dB	

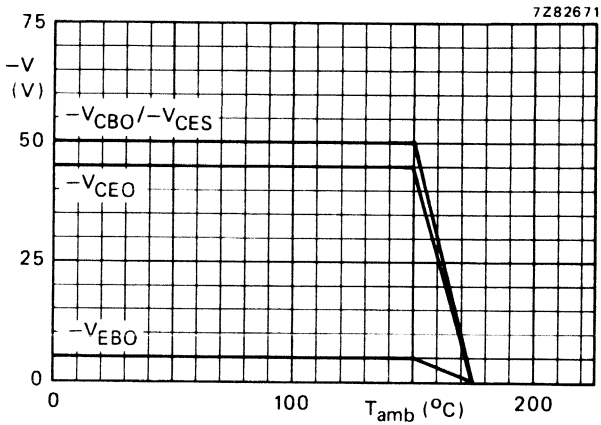


Fig. 2 Voltage derating curve.

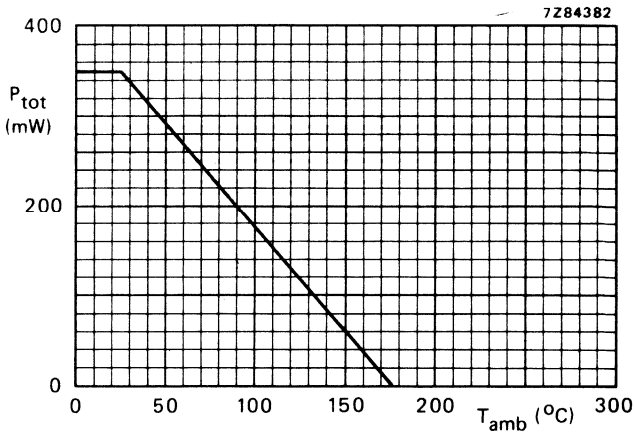


Fig. 3 Power derating curve.

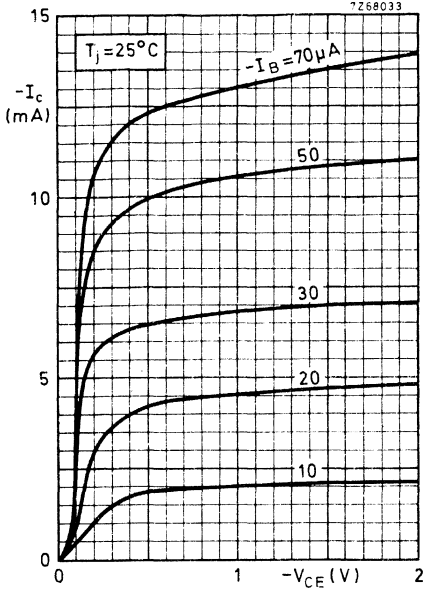


Fig. 4.

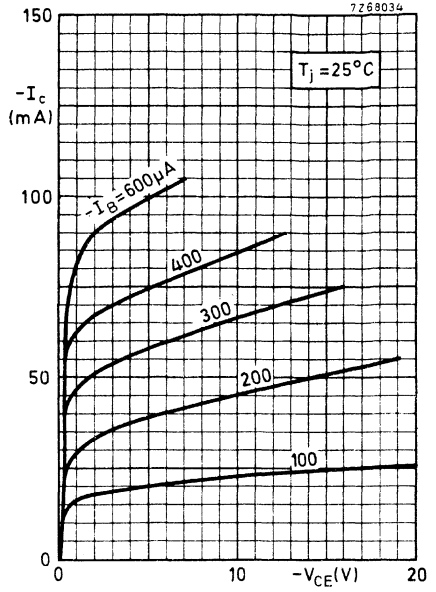


Fig. 5.

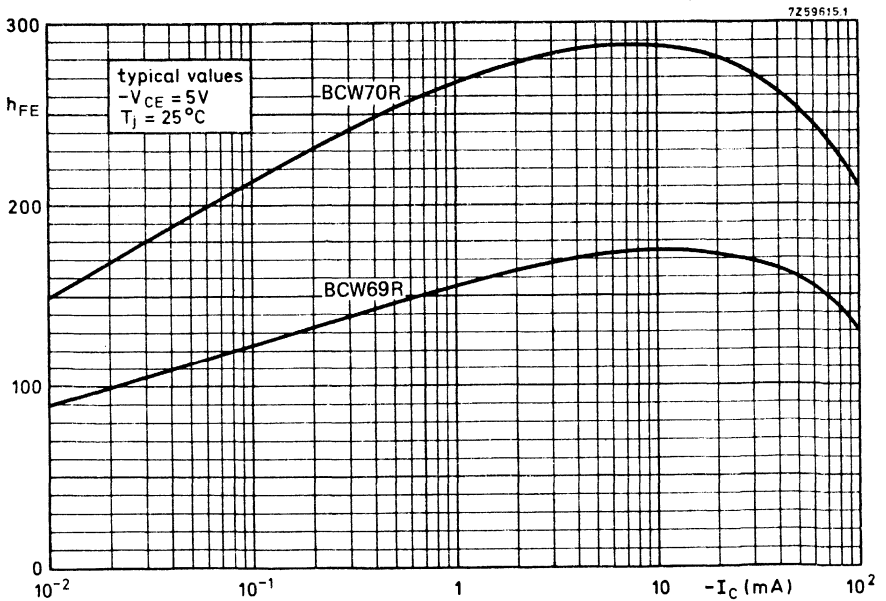


Fig. 6 D.C. current gain.



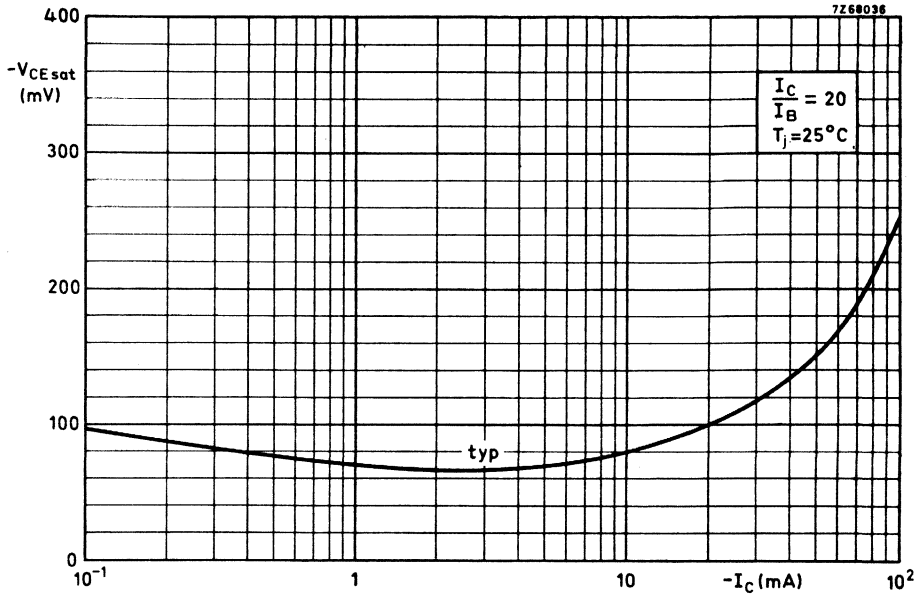


Fig. 7.

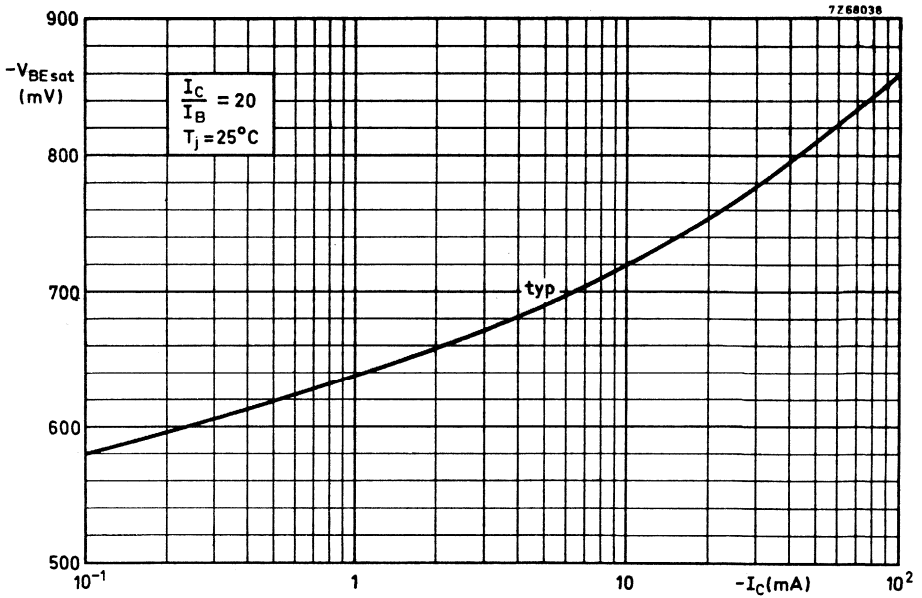


Fig. 8.

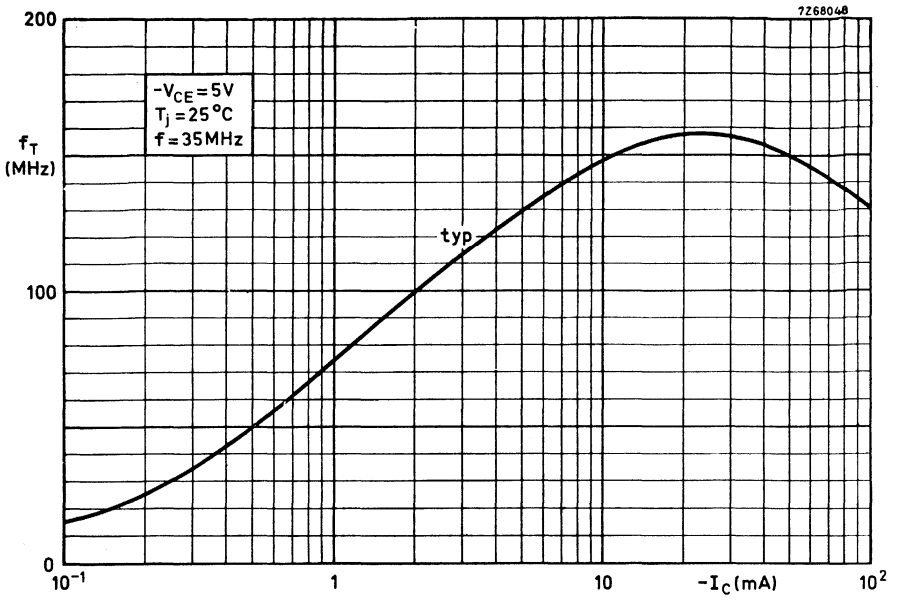


Fig. 9.

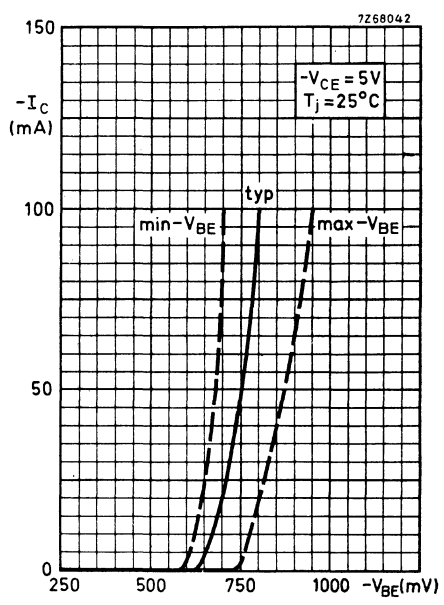


Fig. 10.

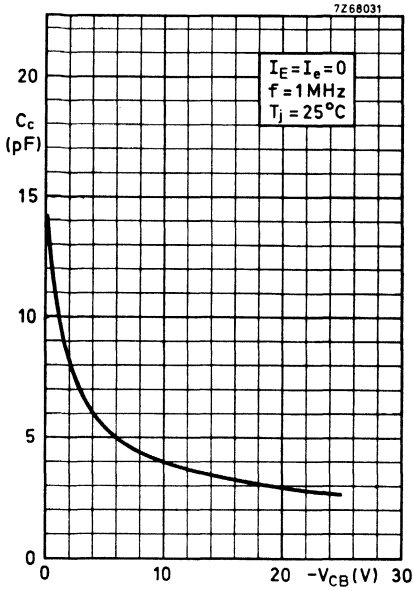


Fig. 11.

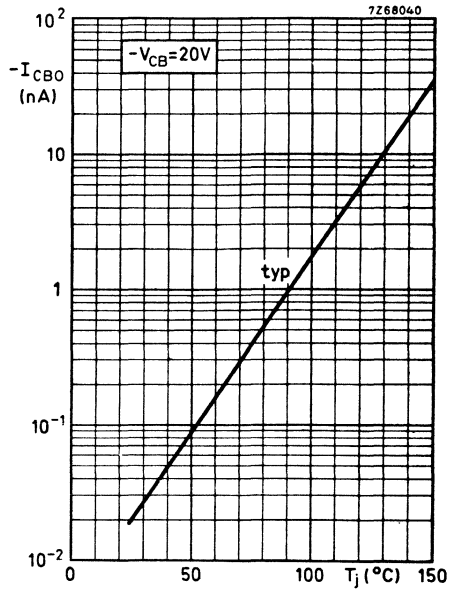


Fig. 12.





## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors, in a microminiature plastic envelope, intended for low level general purpose applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

		BCW71 BCW71R	BCW72 BCW72R	
D.C. current gain at $T_j = 25\text{ }^\circ\text{C}$ $I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$	$h_{FE}$	> 110 < 220	> 200 < 450	
Collector-base voltage (open emitter)	$V_{CBO}$	max. 50	V	
Collector-emitter voltage (open base)	$V_{CEO}$	max. 45	V	
Collector current (peak value)	$I_{CM}$	max. 200	mA	
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max. 350	mW	←
Junction temperature	$T_j$	max. 175	$^\circ\text{C}$	←
Transition frequency at $f = 35\text{ MHz}$ $I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$	$f_T$	typ. 300	MHz	
Noise figure at $R_S = 2\text{ k}\Omega$ $I_C = 200\text{ }\mu\text{A}; V_{CE} = 5\text{ V};$ $f = 1\text{ kHz}; B = 200\text{ Hz}$	F	< 10	dB	

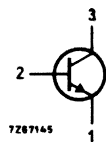
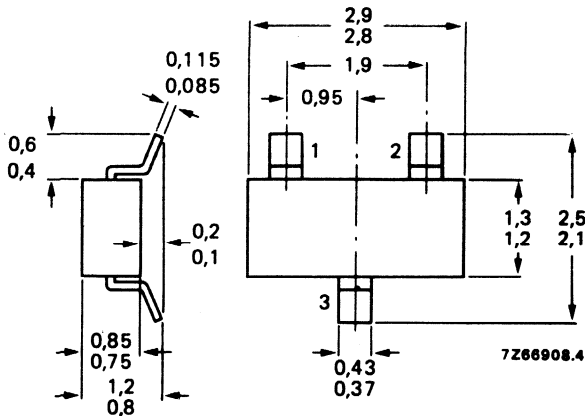
### MECHANICAL DATA

Dimensions in mm

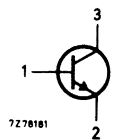
### Marking code

Fig. 1 SOT-23.

BCW71 = K1  
BCW72 = K2



BCW71R = K4  
BCW72R = K5



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) see Fig. 2	$V_{CBO}$	max.	50 V
Collector-emitter voltage (open base) see Fig. 2 $I_C = 2 \text{ mA}$	$V_{CEO}$	max.	45 V
Emitter-base voltage (open collector) see Fig. 2	$V_{EBO}$	max.	5 V
Collector current (d.c.)	$I_C$	max.	100 mA
Collector current (peak value)	$I_{CM}$	max.	200 mA
Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm	$P_{tot}$	max.	350 mW
Storage temperature	$T_{stg}$		-65 to +175 $^\circ\text{C}$
Junction temperature	$T_j$	max.	175 $^\circ\text{C}$

**THERMAL CHARACTERISTICS\***

$$T_j = P_x (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Collector cut-off current

$I_E = 0; V_{CB} = 20 \text{ V}$   $I_{CBO} < 100 \text{ nA}$

$I_E = 0; V_{CB} = 20 \text{ V}; T_j = 100 \text{ }^\circ\text{C}$   $I_{CBO} < 10 \text{ } \mu\text{A}$

Base emitter voltage

$I_C = 2 \text{ mA}; V_{CE} = 5 \text{ V}$   $V_{BE} \quad 550 \text{ to } 700 \text{ mV}$

Saturation voltages

$I_C = 10 \text{ mA}; I_B = 0,5 \text{ mA}$   $V_{CEsat} \quad \text{typ. } 120 \text{ mV}$

$V_{CEsat} < 250 \text{ mV}$

$I_C = 50 \text{ mA}; I_B = 2,5 \text{ mA}$   $V_{BEsat} \quad \text{typ. } 750 \text{ mV}$

$V_{CEsat} \quad \text{typ. } 210 \text{ mV}$

$V_{BEsat} \quad \text{typ. } 850 \text{ mV}$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

D.C. current gain

$I_C = 10 \mu A; V_{CE} = 5 V$

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

Collector capacitance at  $f = 1 MHz$

$I_E = I_e = 0; V_{CB} = 10 V$

Transition frequency at  $f = 35 MHz$

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

Noise figure at  $R_S = 2 k\Omega$

$I_C = 200 \mu A; V_{CE} = 5 V$

$f = 1 kHz; B = 200 Hz$

$h_{FE}$  typ.

$h_{FE} >$

$h_{FE} <$

$C_c <$

$f_T$  typ.

$F <$

	BCW71;R	BCW72;R
$h_{FE}$ typ.	90	150
$h_{FE} >$	110	200
$h_{FE} <$	220	450

4,0 pF

300 MHz

10 dB

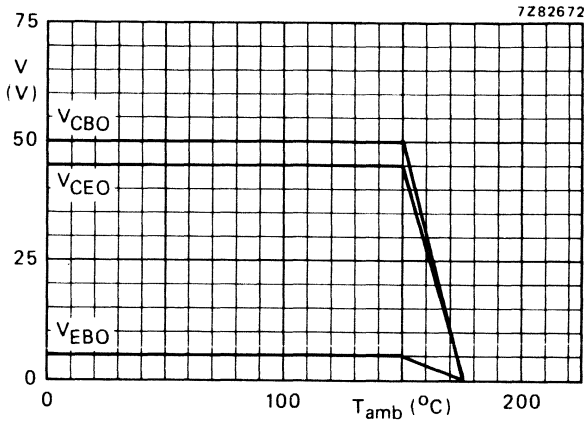


Fig. 2 Voltage derating curves.

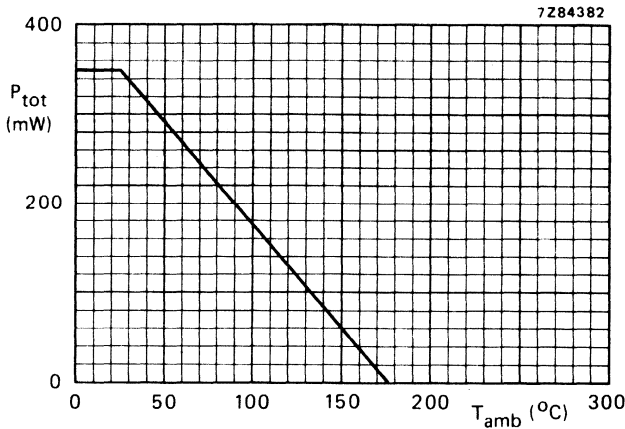


Fig. 3 Power derating curve.

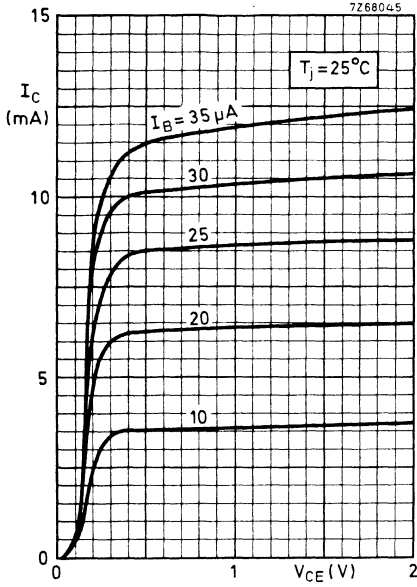


Fig. 4.

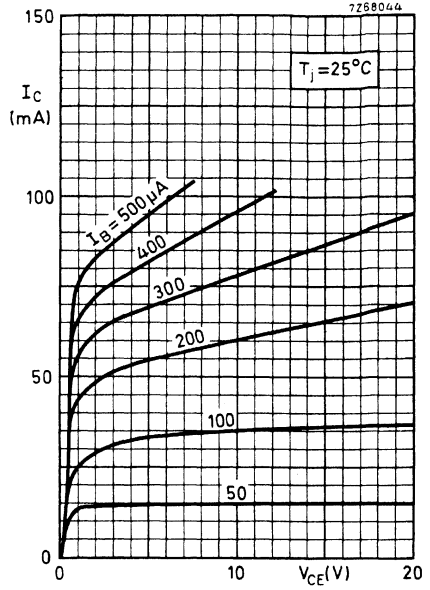


Fig. 5.

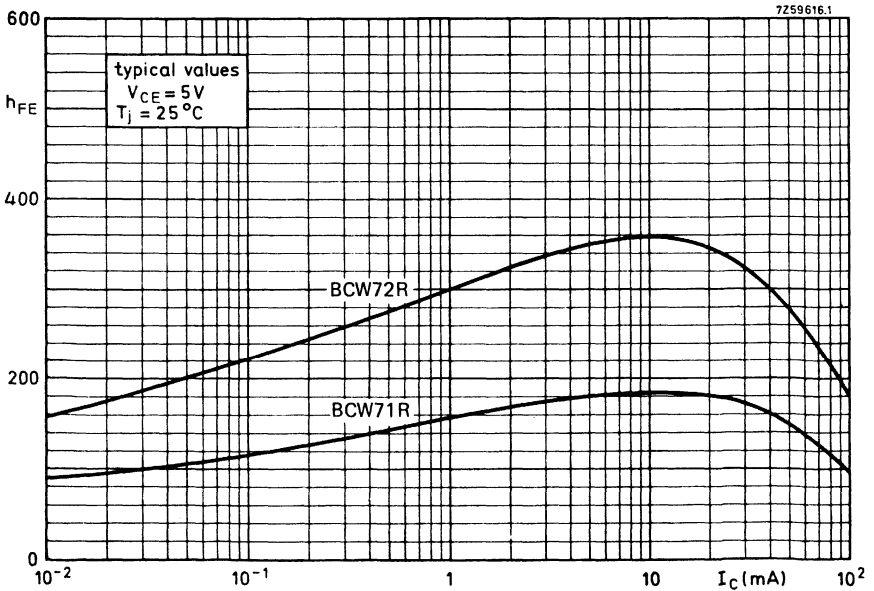


Fig. 6 D.C. current gain.



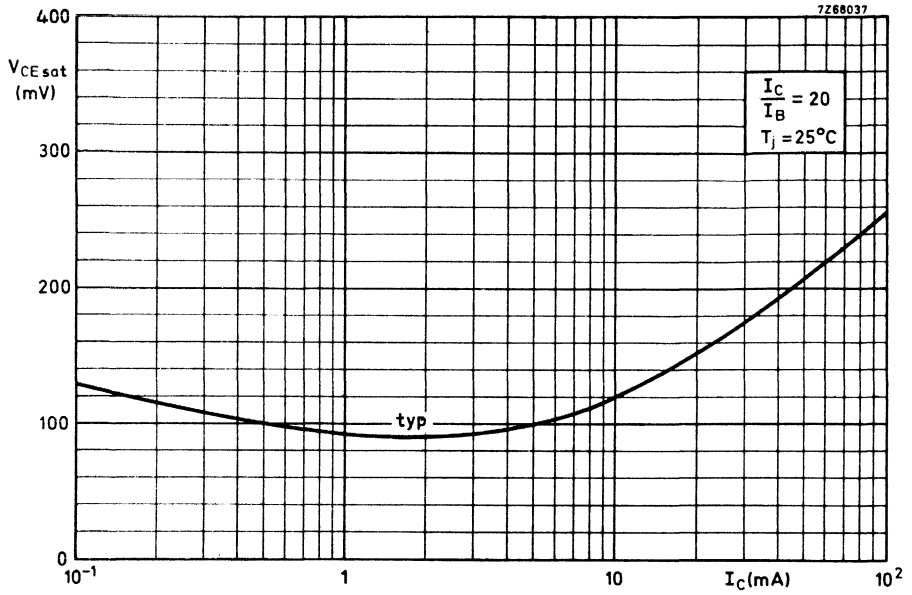


Fig. 7.

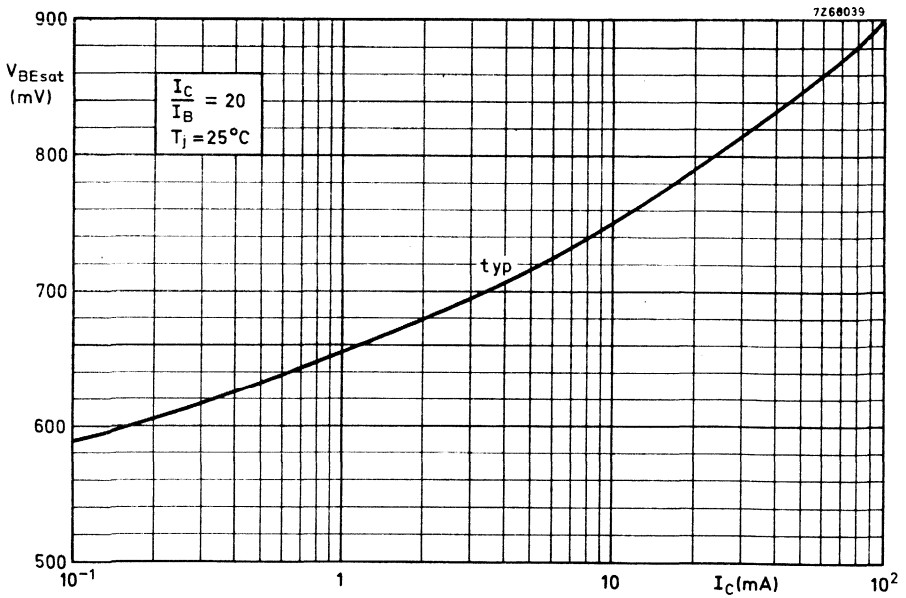


Fig. 8.

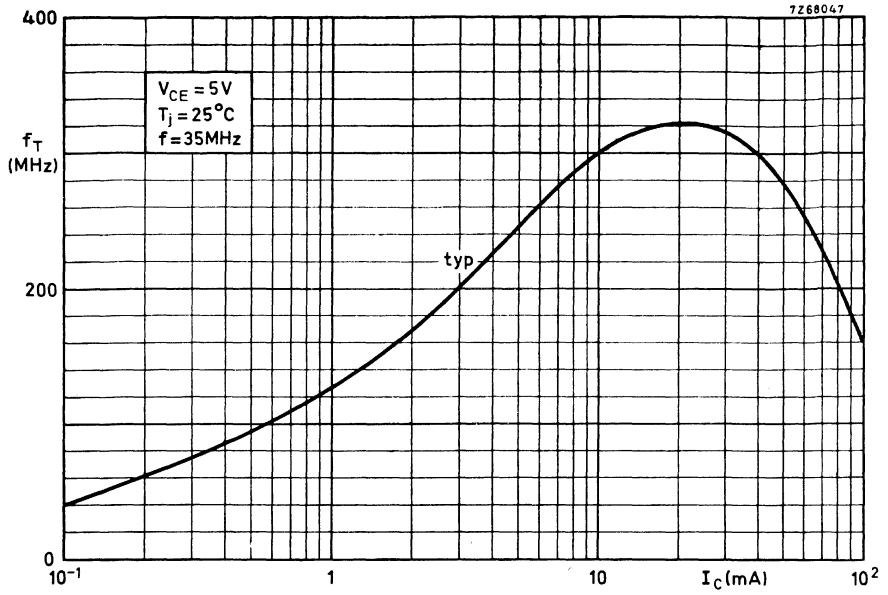


Fig. 9.

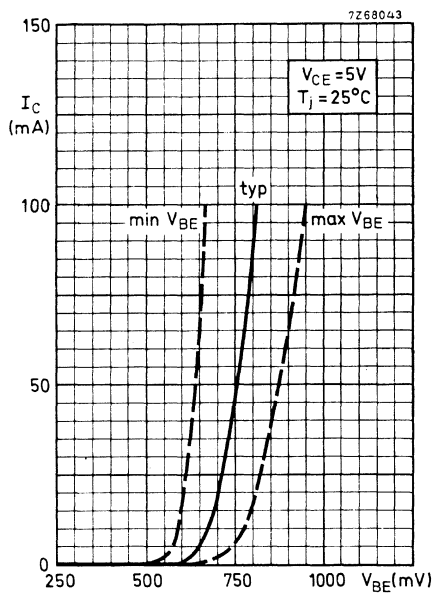


Fig. 10.

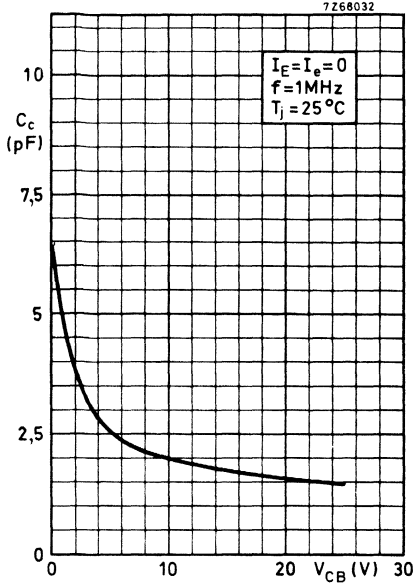


Fig. 11.

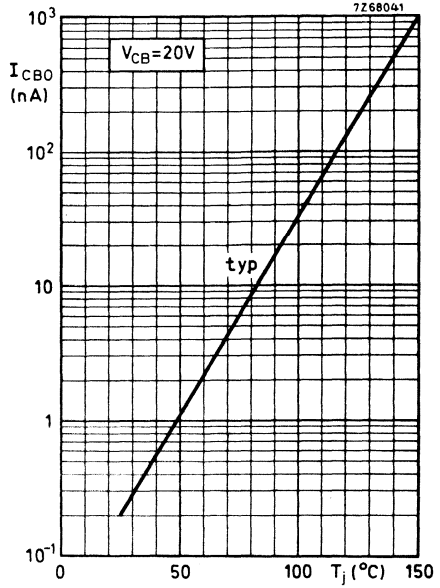


Fig. 12.





## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors, in a microminiature plastic envelope, intended for low level general purpose applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CBO}$	max.	50 V	
Collector-emitter voltage (open base)	$V_{CEO}$	max.	45 V	
Collector current (peak value)	$I_{CM}$	max.	200 mA	
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	350 mW	←
Junction temperature	$T_j$	max.	175 $^{\circ}\text{C}$	←
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$ $I_C = 2\text{ mA}; V_{CE} = 5\text{ V}$	$h_{FE}$	>	420	
		<	800	
Transition frequency at $f = 35\text{ MHz}$ $I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$	$f_T$	typ.	300 MHz	
Noise figure at $R_S = 2\text{ k}\Omega$ $I_C = 200\text{ }\mu\text{A}; V_{CE} = 5\text{ V};$ $f = 1\text{ kHz}; B = 200\text{ Hz}$	F	<	10 dB	

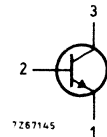
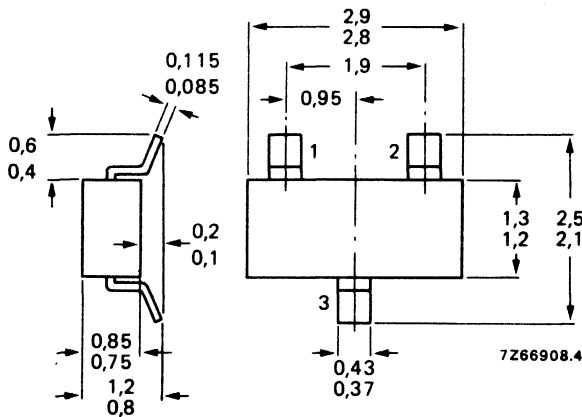
### MECHANICAL DATA

Fig. 1 SOT-23.

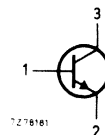
Dimensions in mm

Marking code

BCW81 = K3



BCW81R = K31



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) see Fig. 2	$V_{CB0}$	max.	50 V
Collector-emitter voltage (open base) see Fig. 2 $I_C = 2 \text{ mA}$	$V_{CEO}$	max.	45 V
Emitter-base voltage (open collector) see Fig. 2	$V_{EBO}$	max.	5 V
Collector current (d.c.)	$I_C$	max.	100 mA
Collector current (peak value)	$I_{CM}$	max.	200 mA
Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ mounted on a ceramic substrate of → 7 mm x 5 mm x 0,6 mm	$P_{tot}$	max.	350 mW
→ Storage temperature	$T_{stg}$		-65 to + 175 $^\circ\text{C}$
→ Junction temperature	$T_j$	max.	175 $^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P_x (R_{th j-t} + R_{th t-s} + R_{th s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th j-t}$	=	50 K/W
From tab to soldering points	$R_{th t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Collector cut-off current

$$I_E = 0; V_{CB} = 20 \text{ V} \quad I_{CBO} < 100 \text{ nA}$$

$$I_E = 0; V_{CB} = 20 \text{ V}; T_j = 100 \text{ }^\circ\text{C} \quad I_{CBO} < 10 \text{ } \mu\text{A}$$

Base emitter voltage

$$I_C = 2 \text{ mA}; V_{CE} = 5 \text{ V} \quad V_{BE} \quad 550 \text{ to } 700 \text{ mV}$$

Saturation voltages

$$I_C = 10 \text{ mA}; I_B = 0,5 \text{ mA} \quad V_{CEsat} \quad \text{typ. } 120 \text{ mV}$$

$$I_C = 50 \text{ mA}; I_B = 2,5 \text{ mA} \quad V_{CEsat} < 250 \text{ mV}$$

$$V_{BEsat} \quad \text{typ. } 750 \text{ mV}$$

$$V_{CEsat} \quad \text{typ. } 210 \text{ mV}$$

$$V_{BEsat} \quad \text{typ. } 850 \text{ mV}$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

D.C. current gain

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

$h_{FE} > 420$   
 $h_{FE} < 800$

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

$I_E = I_e = 0; V_{CB} = 10 \text{ V}$

$C_c < 4,0 \text{ pF}$

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

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

$f_T \text{ typ. } 300 \text{ MHz}$

Noise figure at  $R_S = 2 \text{ k}\Omega$

$I_C = 200 \text{ }\mu\text{A}; V_{CE} = 5 \text{ V}$

$f = 1 \text{ kHz}; B = 200 \text{ Hz}$

$F < 10 \text{ dB}$

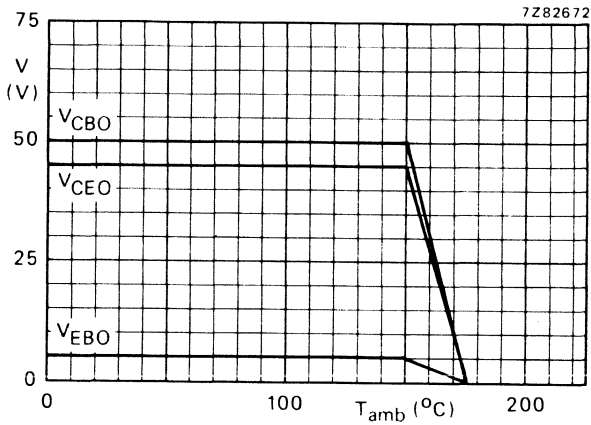


Fig. 2 Voltage derating curves.

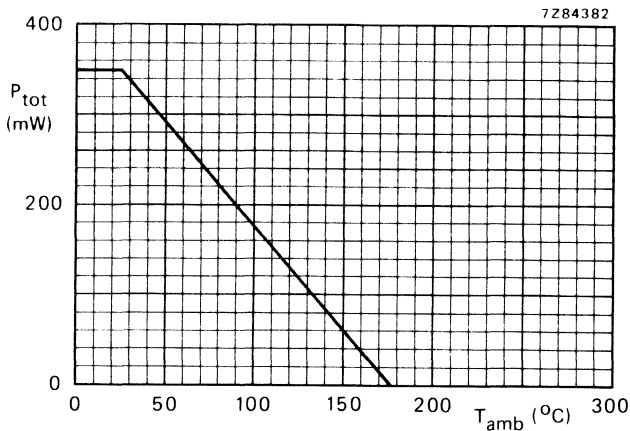


Fig. 3 Power derating curve.





## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors, in a microminiature plastic envelope, intended for low level general purpose applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80 V	←
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60 V	
Collector current (peak value)	$-I_{CM}$	max.	200 mA	
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	350 mW	←
Junction temperature	$T_j$	max.	175 $^{\circ}\text{C}$	←
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$ $-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}$	$h_{FE}$	>	120	
		<	260	
Transition frequency at $f = 35\text{ MHz}$ $-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	$f_T$	typ.	150 MHz	
Noise figure at $R_G = 2\text{ k}\Omega$ $-I_C = 200\text{ }\mu\text{A}; -V_{CE} = 5\text{ V};$ $f = 1\text{ kHz}; B = 200\text{ Hz}$	$F$	<	10 dB	

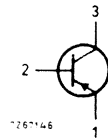
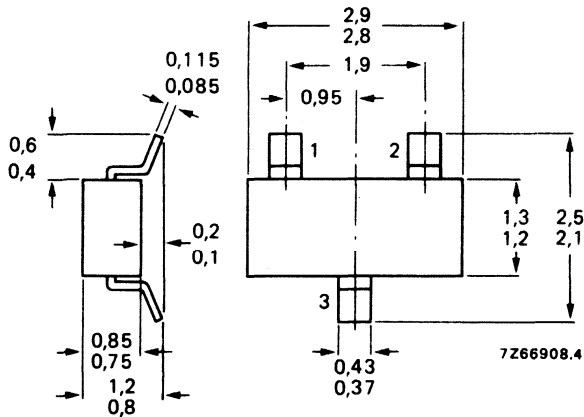
### MECHANICAL DATA

Dimensions in mm

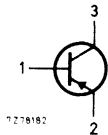
Marking code

Fig. 1 SOT-23.

BCW89 = H3



BCW89R = H31



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) see Fig. 2	$-V_{CBO}$	max.	80 V
Collector-emitter voltage ( $V_{BE} = 0$ ) see Fig. 2	$-V_{CES}$	max.	60 V
Collector-emitter voltage (open base) see Fig. 2			
$-I_C = 2$ mA	$-V_{CEO}$	max.	60 V
Emitter-base voltage (open collector) see Fig. 2	$-V_{EBO}$	max.	5 V
Collector current (d.c.)	$-I_C$	max.	100 mA
Collector current (peak value)	$-I_{CM}$	max.	200 mA
Total power dissipation up to $T_{amb} = 25$ °C mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm	$P_{tot}$	max.	350 mW
→ Storage temperature	$T_{stg}$		-65 to + 175 °C
→ Junction temperature	$T_j$	max.	175 °C

→ **THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

$T_j = 25$  °C unless otherwise specified

Collector cut-off current

$$I_E = 0; -V_{CB} = 20\text{ V} \quad -I_{CBO} < 100\text{ nA}$$

$$I_E = 0; -V_{CB} = 20\text{ V}; T_j = 100\text{ °C} \quad -I_{CBO} < 10\text{ }\mu\text{A}$$

Base-emitter voltage

$$-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}; T_j = 25\text{ °C} \quad -V_{BE} = 600\text{ to }750\text{ mV}$$

Saturation voltages

$$-I_C = 10\text{ mA}; -I_B = 0,5\text{ mA} \quad -V_{CEsat} \text{ typ. } 80\text{ mV}$$

$$-I_C = 10\text{ mA}; -I_B = 0,5\text{ mA} \quad -V_{CEsat} < 300\text{ mV}$$

$$-I_C = 50\text{ mA}; -I_B = 2,5\text{ mA} \quad -V_{BEsat} \text{ typ. } 720\text{ mV}$$

$$-I_C = 50\text{ mA}; -I_B = 2,5\text{ mA} \quad -V_{CEsat} \text{ typ. } 150\text{ mV}$$

$$-I_C = 50\text{ mA}; -I_B = 2,5\text{ mA} \quad -V_{BEsat} \text{ typ. } 810\text{ mV}$$



\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

D.C. current gain

$-I_C = 10 \mu A; -V_{CE} = 5 V$

$h_{FE}$  typ. 90

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

$h_{FE} > 120$   
 $h_{FE} < 260$

Collector capacitance at  $f = 1 MHz$

$I_E = I_e = 0; -V_{CB} = 10 V$

$C_c < 7,0 pF$

Transition frequency at  $f = 35 MHz$

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

$f_T$  typ. 150 MHz

Noise figure at  $R_S = 2 k\Omega$

$-I_C = 200 \mu A; -V_{CE} = 5 V$

$f = 1 kHz; B = 200 Hz$

$F < 10 dB$

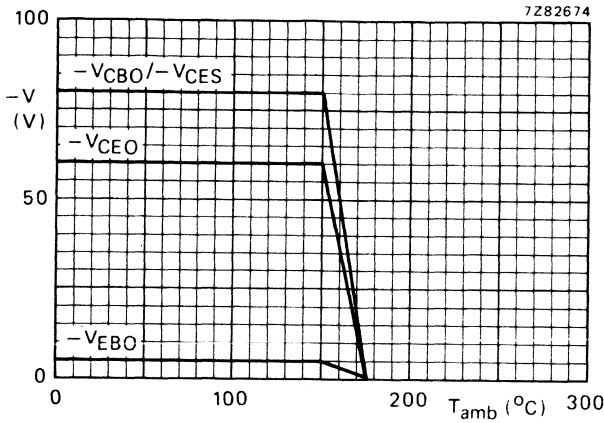


Fig. 2 Voltage derating curves.

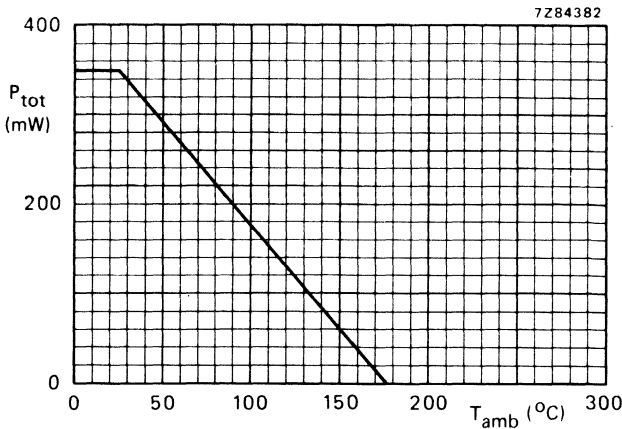


Fig. 3 Power derating curve.



## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors, in a SOT-23 plastic envelope, intended for application in thick and thin-film circuits. These transistors are intended for general purposes as well as saturated switching and driver applications for industrial service.

N-P-N complements are BCX19; 19R and BCX20; 20R respectively.

### QUICK REFERENCE DATA

		BCX17 BCX17R	BCX18 BCX18R	
Collector-emitter voltage ( $V_{BE} = 0$ )	$-V_{CES}$ max.	50	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	45	25	V
Collector current (peak value)	$-I_{CM}$ max.	1000		mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	$P_{tot}$ max.	425		mW ←
Junction temperature	$T_j$ max.	175		$^{\circ}\text{C}$ ←
D.C. current gain $-I_C = 100\text{ mA}; -V_{CE} = 1\text{ V}$	$h_{FE}$	100 to 600		
Transition frequency $-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}; f = 35\text{ MHz}$	$f_T$ typ.	100		MHz

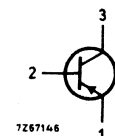
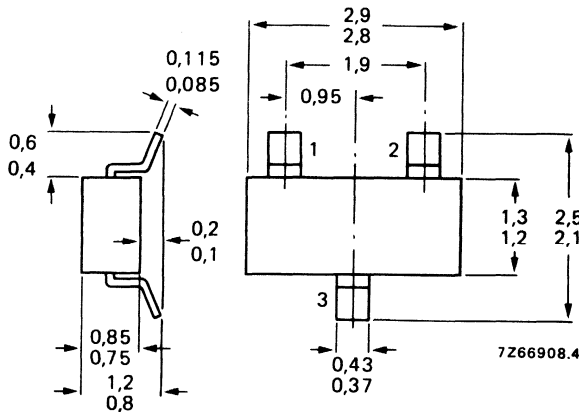
### MECHANICAL DATA

Dimensions in mm

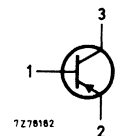
### Marking code

Fig. 1 SOT-23.

BCX17 = T1  
BCX18 = T2



BCX17R = T4  
BCX18R = T5



See also *Soldering recommendations*.

**RATINGS**

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

		BCX17; R		BCX18; R	
Collector-emitter voltage ( $V_{BE} = 0$ ) (see Fig. 2)	$-V_{CES}$	max.	50	30	V
Collector-emitter voltage (open base) $-I_C = 10$ mA (see Fig. 2)	$-V_{CEO}$	max.	45	25	V
Emitter-base voltage (open collector) (see Fig. 2)	$-V_{EBO}$	max.	5	5	V
Collector current (d.c.)	$-I_C$	max.	500		mA
Collector current (peak value)	$-I_{CM}$	max.	1000		mA
Emitter current (peak value)	$I_{EM}$	max.	1000		mA
Base current (d.c.)	$-I_B$	max.	100		mA
Base current (peak value)	$-I_{BM}$	max.	200		mA
→ Total power dissipation up to $T_{amb} = 25$ °C*	$P_{tot}$	max.	425		mW
→ Storage temperature	$T_{stg}$		-65 to + 175		°C
→ Junction temperature	$T_j$	max.	175		°C

→ **THERMAL CHARACTERISTICS\*\***

$$T_j = P (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	30	K/W
From tab to soldering points	$R_{th\ t-s}$	=	260	K/W
From soldering points to ambient*	$R_{th\ s-a}$	=	60	K/W

**CHARACTERISTICS**

$T_j = 25$  °C unless otherwise specified

Collector cut-off current $I_E = 0; -V_{CB} = 20$ V	$-I_{CBO}$	<	100	nA
$I_E = 0; -V_{CB} = 20$ V; $T_j = 150$ °C	$-I_{CBO}$	<	5	μA
Emitter cut-off current $I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	<	10	μA
Base-emitter voltage ▲ $-I_C = 500$ mA; $-V_{CE} = 1$ V	$-V_{BE}$	<	1,2	V
Saturation voltage $-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	620	mV

\* Mounted on a ceramic substrate of 15 mm x 15 mm x 0,6 mm.

\*\* See *Thermal characteristics* in chapter GENERAL.

▲  $-V_{BE}$  decreases by about 2 mV/°C with increasing temperature.

D.C. current gain

$-I_C = 100 \text{ mA}; -V_{CE} = 1 \text{ V}$

$-I_C = 300 \text{ mA}; -V_{CE} = 1 \text{ V}$

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

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

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

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

$I_E = I_e = 0; -V_{CB} = 10 \text{ V}$

$h_{FE} \quad 100 \text{ to } 600$

$h_{FE} \quad > \quad 70$

$h_{FE} \quad > \quad 40$

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

$C_C \quad \text{typ.} \quad 8 \text{ pF}$

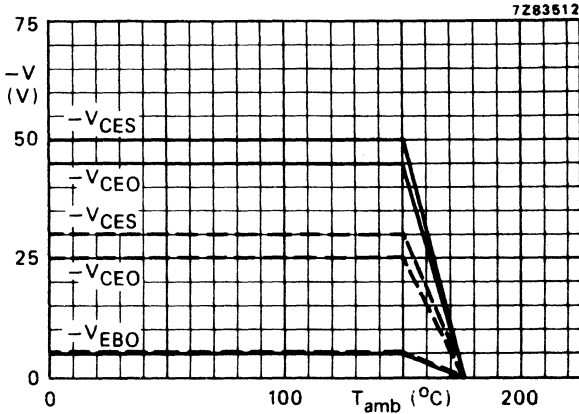


Fig. 2 Voltage derating curves. --- BCX18; R — BCX17; R.

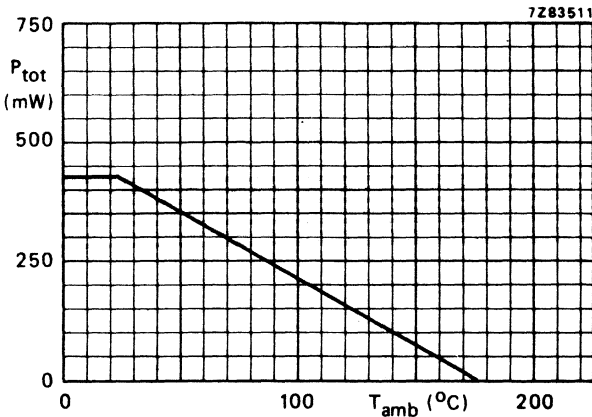


Fig. 3 Power derating curve.

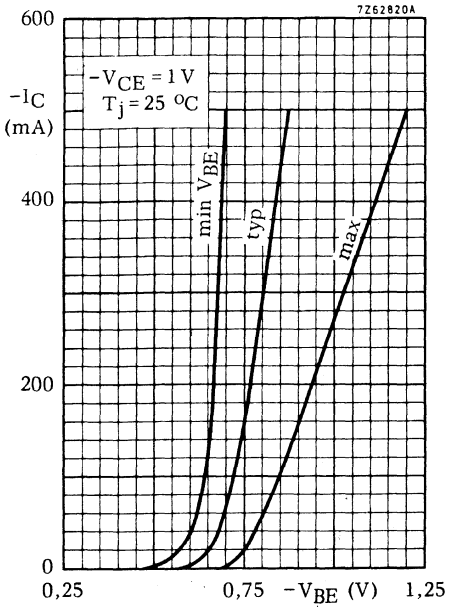


Fig. 4.

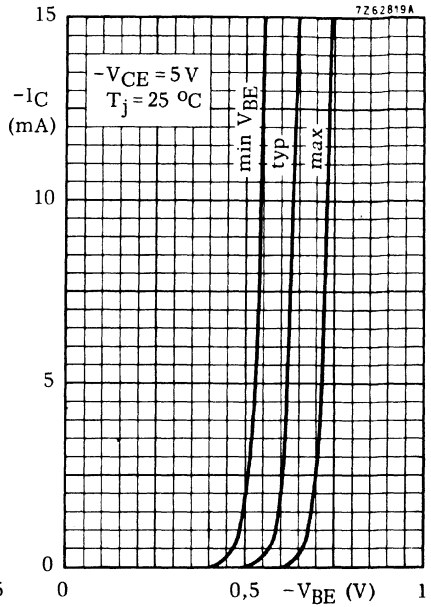


Fig. 5.

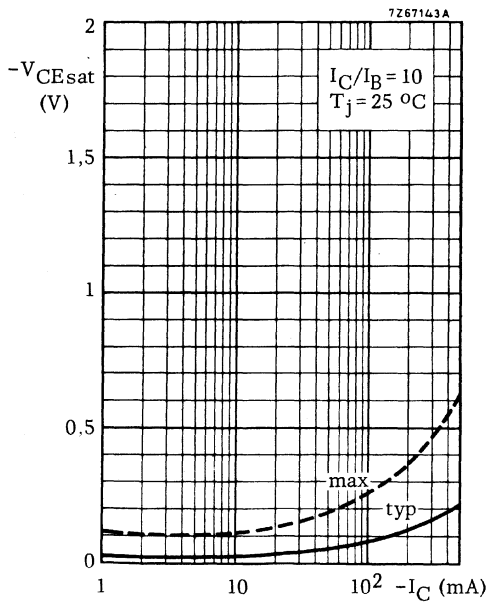


Fig. 6.



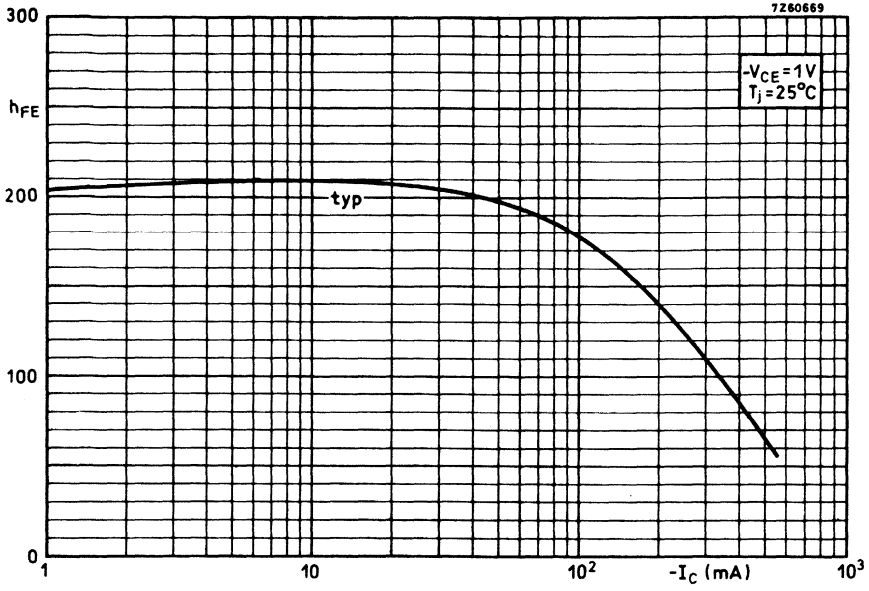


Fig. 7.

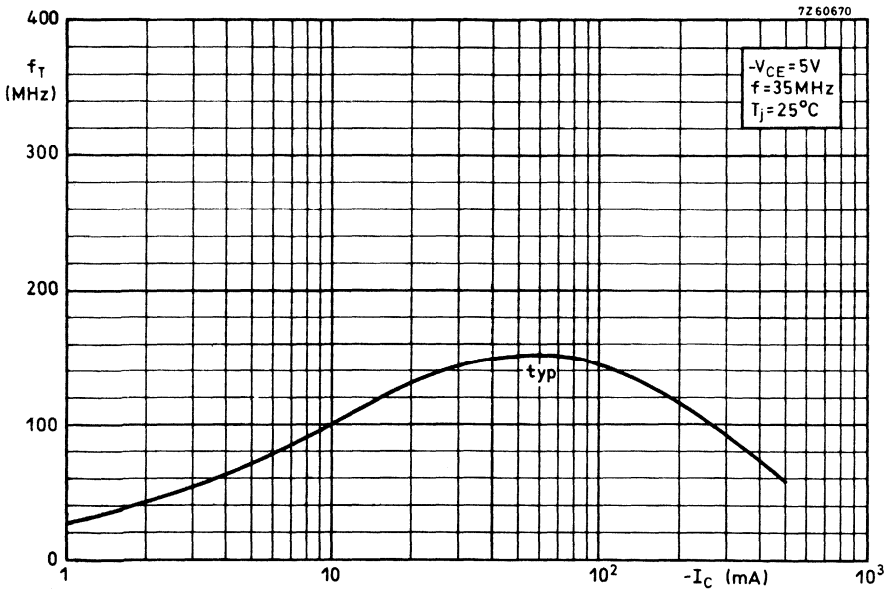


Fig. 8.



## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors, in a SOT-23 plastic envelope, intended for application in thick and thin-film circuits. These transistors are intended for general purposes as well as saturated switching and driver applications for industrial service.

P-N-P complements are BCX17; 17R and BCX18; 18R respectively.

### QUICK REFERENCE DATA

		BCX19; R	BCX20; R	
Collector-emitter voltage ( $V_{BE} = 0$ )	$V_{CES}$ max.	50	30	V
Collector-emitter voltage (open base)	$V_{CEO}$ max.	45	25	V
Collector current (peak value)	$I_{CM}$ max.	1000		mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	$P_{tot}$ max.	425		mW ←
Junction temperature	$T_j$ max.	175		$^{\circ}\text{C}$ ←
D.C. current gain $I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE}$	100 to 600		
Transition frequency $I_C = 10\text{ mA}; V_{CE} = 5\text{ V}; f = 35\text{ MHz}$	$f_T$ typ.	200		MHz

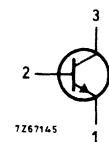
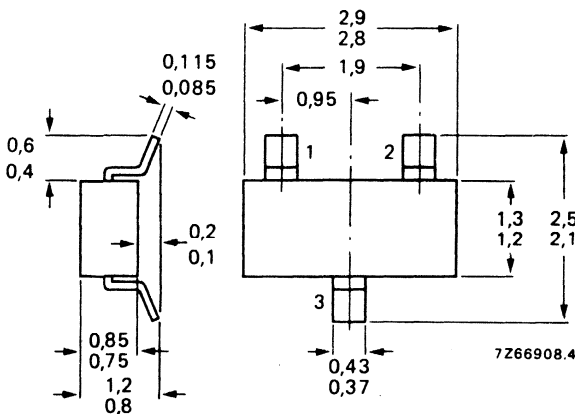
### MECHANICAL DATA

Dimensions in mm

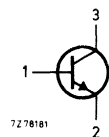
Marking code

Fig. 1 SOT-23.

BCX19 = U1  
BCX20 = U2



BCX19R = U4  
BCX20R = U5



See also *Soldering recommendations*.

# BCX19; R BCX20; R

## RATINGS

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

			BCX19; R	BCX20; R	
Collector-emitter voltage ( $V_{BE} = 0$ ) (see Fig. 2)	$V_{CES}$	max.	50	30	V
Collector-emitter voltage (open base) $I_C = 10$ mA (see Fig. 2)	$V_{CEO}$	max.	45	25	V
Emitter-base voltage (open collector) (see Fig. 2)	$V_{EBO}$	max.	5	5	V
Collector current (d.c.)	$I_C$	max.	500		mA
Collector current (peak value)	$I_{CM}$	max.	1000		mA
Emitter current (peak value)	$-I_{EM}$	max.	1000		mA
Base current (d.c.)	$I_B$	max.	100		mA
Base current (peak value)	$I_{BM}$	max.	200		mA
→ Total power dissipation up to $T_{amb} = 25$ °C*	$P_{tot}$	max.	425		mW
→ Storage temperature	$T_{stg}$		-65 to + 175		°C
→ Junction temperature	$T_j$	max.	175		°C

## → THERMAL CHARACTERISTICS\*\*

$$T_j = P (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

### Thermal resistance

From junction to tab	$R_{th\ j-t}$	=	30	K/W
From tab to soldering points	$R_{th\ t-s}$	=	260	K/W
From soldering points to ambient*	$R_{th\ s-a}$	=	60	K/W

## CHARACTERISTICS

$T_j = 25$  °C unless otherwise specified

Collector cut-off current

$$I_E = 0; V_{CB} = 20\text{ V} \quad I_{CBO} < \begin{matrix} 100 \\ 5 \end{matrix} \quad \begin{matrix} \text{nA} \\ \mu\text{A} \end{matrix}$$

$$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150\text{ °C} \quad I_{CBO} < \begin{matrix} 100 \\ 5 \end{matrix} \quad \begin{matrix} \text{nA} \\ \mu\text{A} \end{matrix}$$

Emitter cut-off current

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

Base emitter voltage ▲

$$I_C = 500\text{ mA}; V_{CE} = 1\text{ V} \quad V_{BE} < \begin{matrix} 1.2 \\ 1.2 \end{matrix} \quad \begin{matrix} \text{V} \\ \text{V} \end{matrix}$$

Saturation voltage

$$I_C = 500\text{ mA}; I_B = 50\text{ mA} \quad V_{CEsat} < \begin{matrix} 620 \\ 620 \end{matrix} \quad \begin{matrix} \text{mV} \\ \text{mV} \end{matrix}$$

\* Mounted on a ceramic substrate of 15 mm x 15 mm x 0,6 mm.

\*\* See *Thermal characteristics* in chapter GENERAL.

▲  $V_{BE}$  decreases by about 2 mV/°C with increasing temperature.

D.C. current gain

$I_C = 100 \text{ mA}; V_{CE} = 1 \text{ V}$

$I_C = 300 \text{ mA}; V_{CE} = 1 \text{ V}$

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

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

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

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

$I_E = I_e = 0; V_{CB} = 10 \text{ V}$

$h_{FE} \quad 100 \text{ to } 600$

$h_{FE} \quad > \quad 70$

$h_{FE} \quad > \quad 40$

$f_T \quad \text{typ.} \quad 200 \text{ MHz}$

$C_c \quad \text{typ.} \quad 5 \text{ pF}$

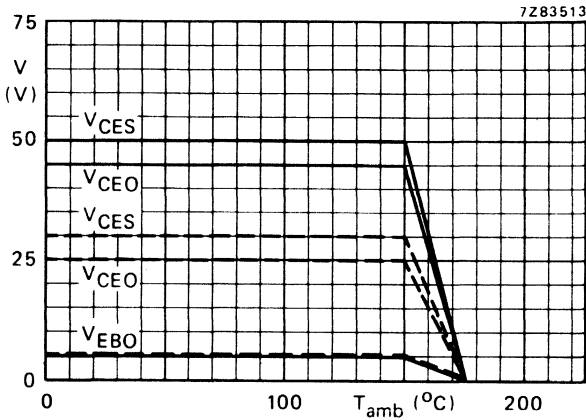


Fig. 2 Voltage derating curves. --- BCX19; R/BCX20; R ———

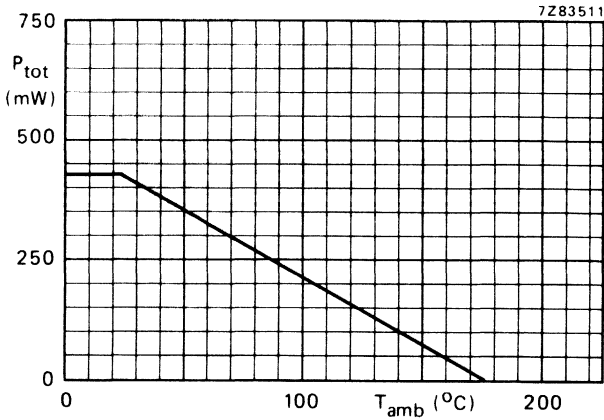


Fig. 3 Power derating curve.

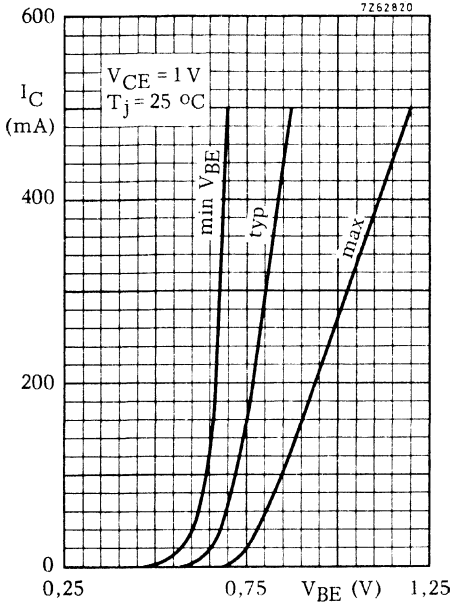


Fig. 4.

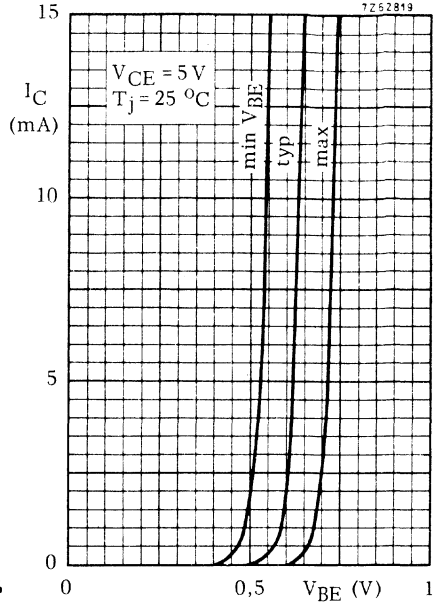


Fig. 5.

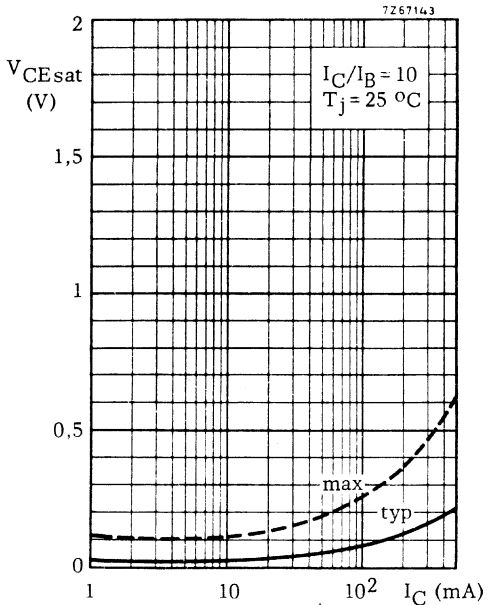


Fig. 6.



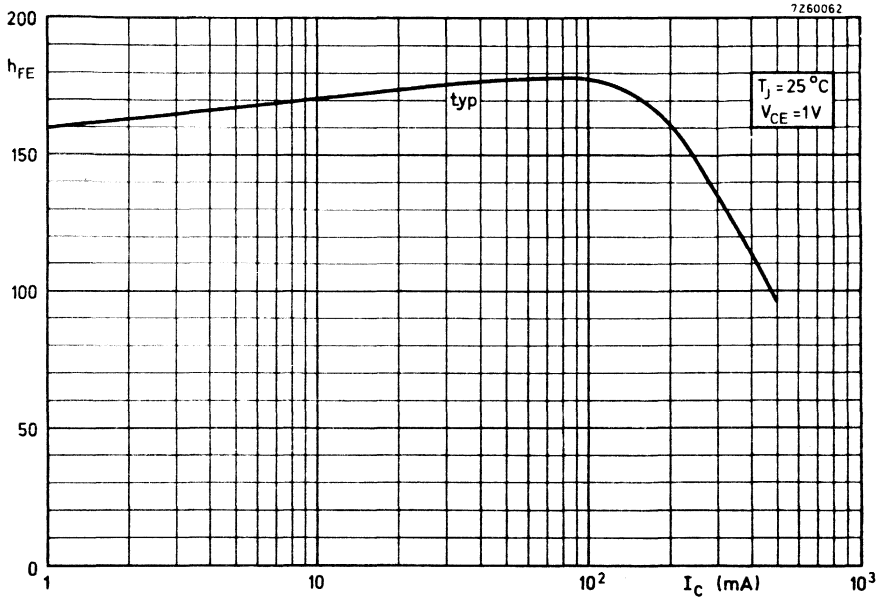


Fig. 7.

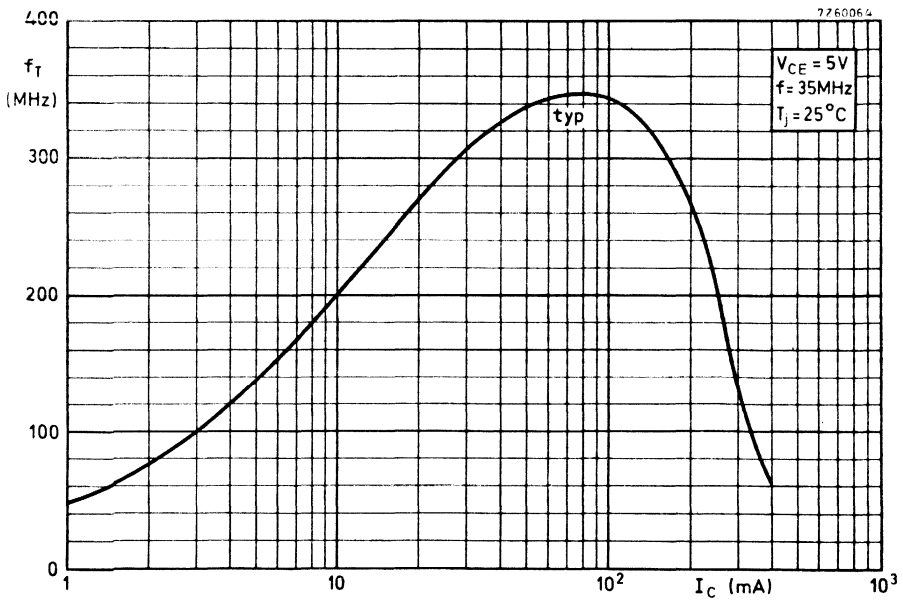


Fig. 8.





## SILICON PLANAR EPITAXIAL TRANSISTORS

Medium power p-n-p transistors in a miniature plastic envelope intended for applications in thick and thin-film circuits. These transistors are intended for general purposes as well as for use in driver stages of audio amplifiers.

N-P-N complements are BCX54, BCX55 and BCX56 respectively.

### QUICK REFERENCE DATA

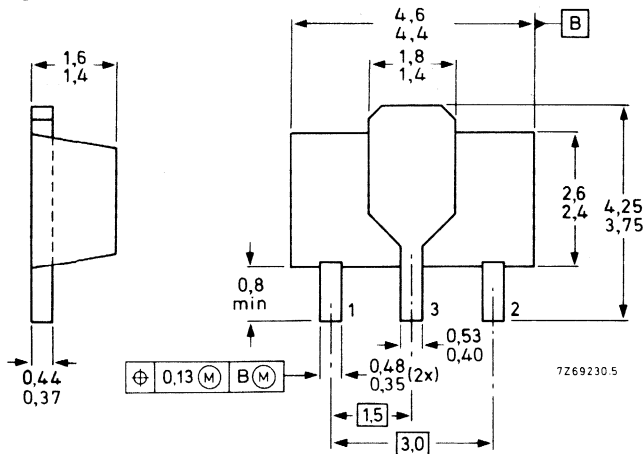
		BCX51	BCX52	BCX53
Collector-base voltage (open emitter)	$-V_{CBO}$	max. 45	60	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 45	60	80 V
Collector-emitter voltage ( $R_{BE} = 1 \text{ k}\Omega$ )	$-V_{CER}$	max. 45	60	100 V
Collector current (peak value)	$-I_{CM}$	max. 1,5	1,5	1,5 A
Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	$P_{tot}$	max. 1	1	1 W
Junction temperature	$T_j$	max. 150	150	150 $^\circ\text{C}$
D.C. current gain	$h_{FE}$	$> 40$ $< 250$	40 160	40 160
Transition frequency at $f = 35 \text{ MHz}$	$f_T$	typ. 50	50	50 MHz

### MECHANICAL DATA

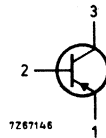
Dimensions in mm

Mark

Fig. 1 SOT-89.



BCX51  
BCX52  
BCX53



See also *Soldering recommendations.*

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

Voltages

			BCX51	BCX52	BCX53	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80	V
Collector-emitter voltage ( $R_{BE} = 1 \text{ k}\Omega$ )	$-V_{CER}$	max.	45	60	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V

Currents

Collector current (d. c.)	$-I_C$	max.		1,0		A
Collector current (peak value)	$-I_{CM}$	max.		1,5		A
Base current (d. c.)	$-I_B$	max.		0,1		A
Base current (peak value)	$-I_{BM}$	max.		0,2		A

Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ mounted on a ceramic substrate area = 2,5 cm <sup>2</sup> ; thickness = 0,7 mm						
	$P_{tot}$	max.		1,0		W

Temperatures

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

**THERMAL RESISTANCE**

From junction to collector tab	$R_{th j-tab} =$			10		$^\circ\text{C/W}$
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm <sup>2</sup> ; thickness = 0,7 mm	$R_{th j-a} =$			125		$^\circ\text{C/W}$

**CHARACTERISTICS**

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

Collector cut-off current

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

Emitter cut-off current

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

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

Saturation voltage

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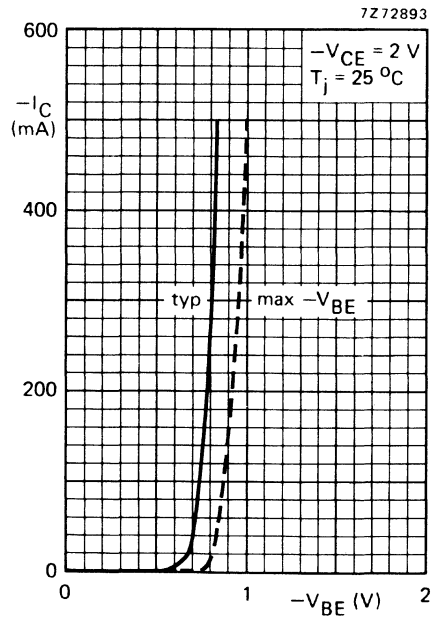
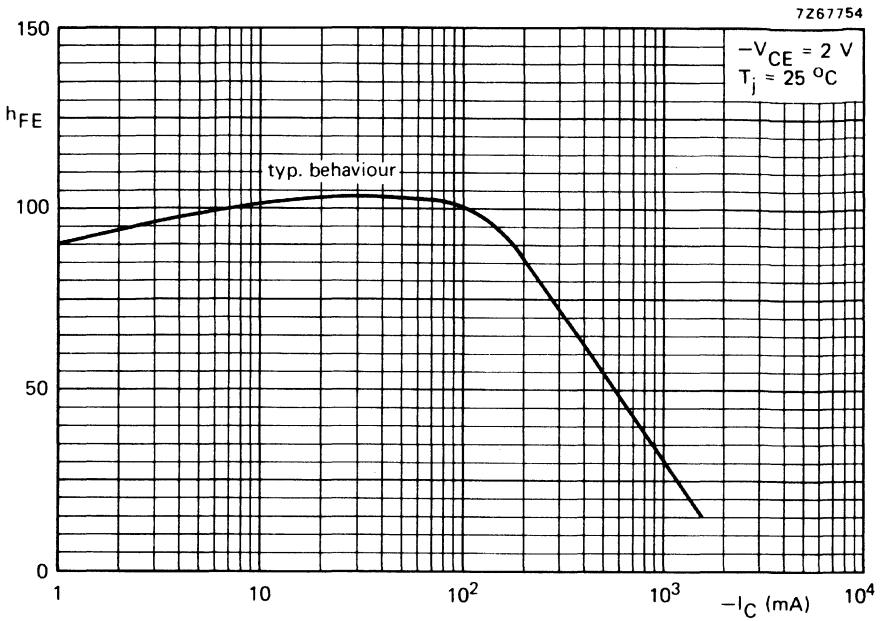
D. C. current gain

		BCX51	BCX52	BCX53
$-I_C = 5\text{ mA}; -V_{CE} = 2\text{ V}$	$h_{FE}$	> 25	25	25
$-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$	$h_{FE}$	> 40	40	40
		< 250	160	160
$-I_C = 500\text{ mA}; -V_{CE} = 2\text{ V}$	$h_{FE}$	> 25	25	25

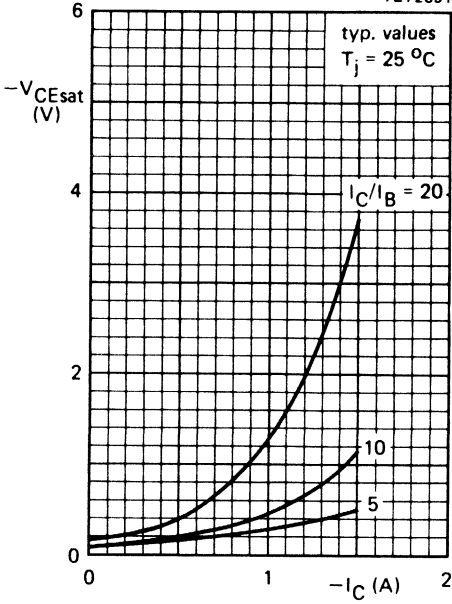
Transition frequency at  $f = 35\text{ MHz}$

$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$	$f_T$	typ.	50	MHz
---	-------	------	----	-----

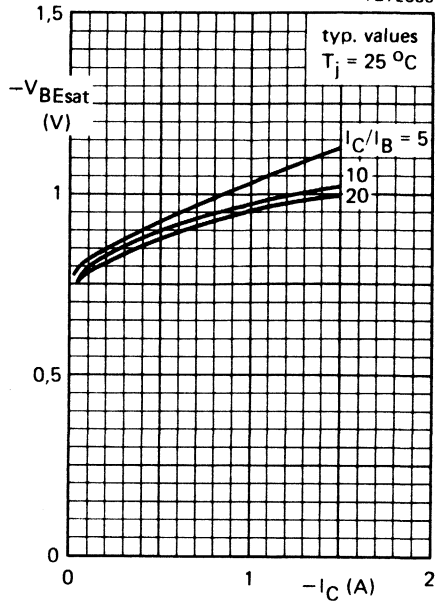




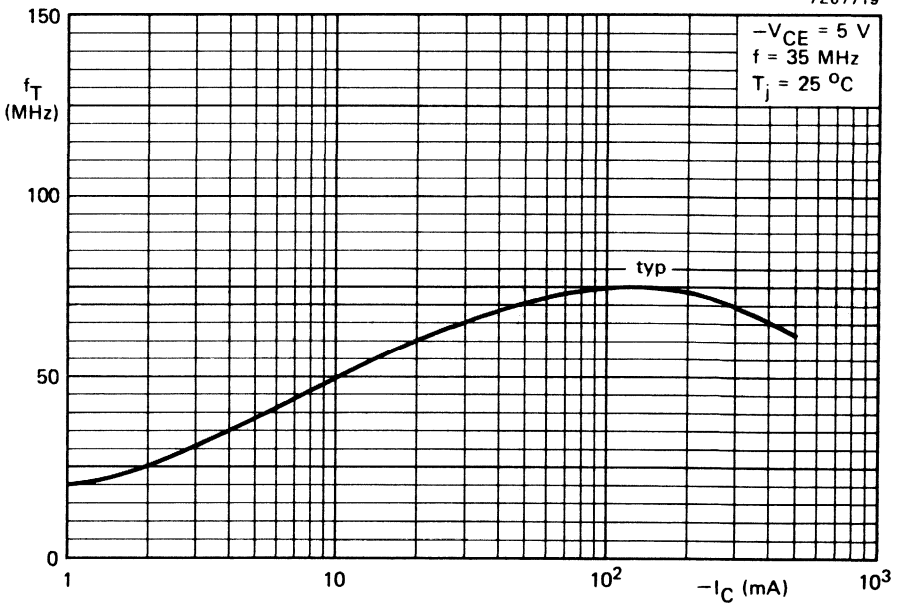
7Z72891



7Z72888



7Z67719





## SILICON PLANAR EPITAXIAL TRANSISTORS

Medium power n-p-n transistors in a miniature plastic envelope intended for applications in thick and thin-film circuits. These transistors are intended for general purposes as well as for use in driver stages of audio amplifiers.

P-N-P complements are BCX51, BCX52 and BCX53 respectively.

### QUICK REFERENCE DATA

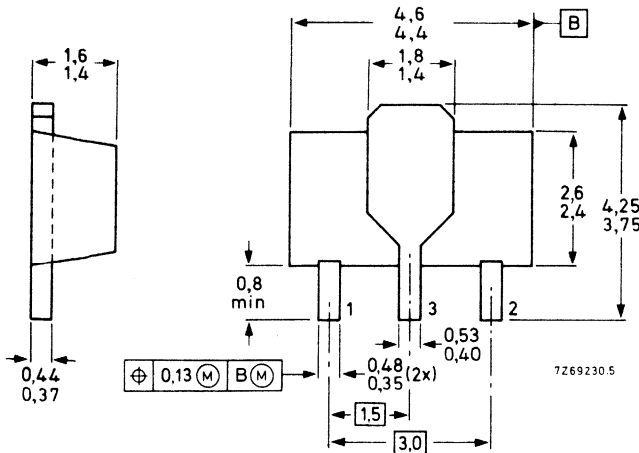
		BCX54	BCX55	BCX56
Collector-base voltage (open emitter)	$V_{CBO}$ max.	45	60	100 V
Collector-emitter voltage (open base)	$V_{CEO}$ max.	45	60	80 V
Collector-emitter voltage ( $R_{BE} = 1 \text{ k}\Omega$ )	$V_{CER}$ max.	45	60	100 V
Collector current (peak value)	$I_{CM}$ max.	1,5	1,5	1,5 A
Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$	$P_{tot}$ max.	1	1	1 W
Junction temperature	$T_j$ max.	150	150	150 $^\circ\text{C}$
D.C. current gain				
$I_C = 150 \text{ mA}; V_{CE} = 2 \text{ V}$	$h_{FE} >$	40	40	40
	$h_{FE} <$	250	160	160
Transition frequency at $f = 35 \text{ MHz}$				
$I_C = 10 \text{ mA}; V_{CE} = 5 \text{ V}$	$f_T$ typ.	130	130	130 MHz

### MECHANICAL DATA

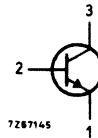
Dimensions in mm

Mark

Fig. 1 SOT-89.



BCX54  
BCX55  
BCX56



See also *Soldering recommendations*.

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

Voltages

		BCX54	BCX55	BCX56	
Collector-base voltage (open emitter)	$V_{CBO}$	max. 45	60	100	V
Collector-emitter voltage (open base)	$V_{CEO}$	max. 45	60	80	V
Collector-emitter voltage ( $R_{BE} = 1 \text{ k}\Omega$ )	$V_{CER}$	max. 45	60	100	V
Emitter-base voltage (open collector)	$V_{EBO}$	max. 5	5	5	V

Currents

Collector current (d.c.)	$I_C$	max.	1,0	A
Collector current (peak value)	$I_{CM}$	max.	1,5	A
Base current (d.c.)	$I_B$	max.	0,1	A
Base current (peak value)	$I_{BM}$	max.	0,2	A

Power dissipation

Total power dissipation up to  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 mounted on a ceramic substrate  
 area = 2,5 cm<sup>2</sup>; thickness = 0,7 mm

$P_{tot}$	max.	1,0	W
-----------	------	-----	---

Temperatures

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

**THERMAL RESISTANCE**

From junction to collector tab  $R_{thj-tab} = 10 \text{ }^\circ\text{C/W}$

From junction to ambient in free air  
 mounted on a ceramic substrate  
 area = 2,5 cm<sup>2</sup>; thickness = 0,7 mm  $R_{thj-a} = 125 \text{ }^\circ\text{C/W}$





**CHARACTERISTICS**

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

Collector cut-off current

$I_E = 0; V_{CB} = 30\text{ V}$   $I_{CBO} < 100\text{ nA}$

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

Emitter cut-off current

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

Base-emitter voltage

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

Saturation voltage

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

D. C. current gain

$I_C = 5\text{ mA}; V_{CE} = 2\text{ V}$   $h_{FE} > \begin{array}{|c|c|c|} \hline \text{BCX54} & \text{BCX55} & \text{BCX56} \\ \hline 25 & 25 & 25 \\ \hline \end{array}$

$I_C = 150\text{ mA}; V_{CE} = 2\text{ V}$   $h_{FE} > \begin{array}{|c|c|c|} \hline 40 & 40 & 40 \\ \hline \end{array}$

$I_C = 500\text{ mA}; V_{CE} = 2\text{ V}$   $h_{FE} < \begin{array}{|c|c|c|} \hline 250 & 160 & 160 \\ \hline \end{array}$

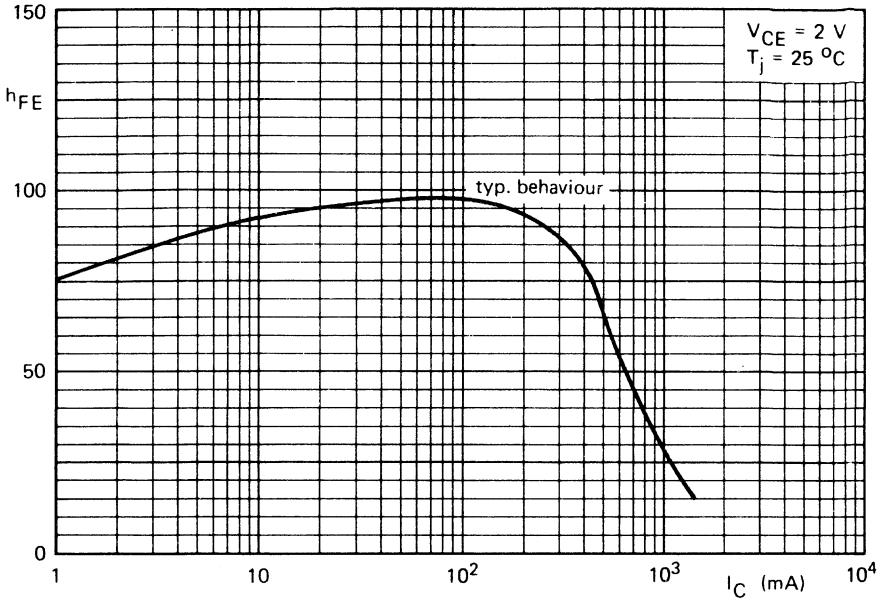
$I_C = 500\text{ mA}; V_{CE} = 2\text{ V}$   $h_{FE} > \begin{array}{|c|c|c|} \hline 25 & 25 & 25 \\ \hline \end{array}$

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

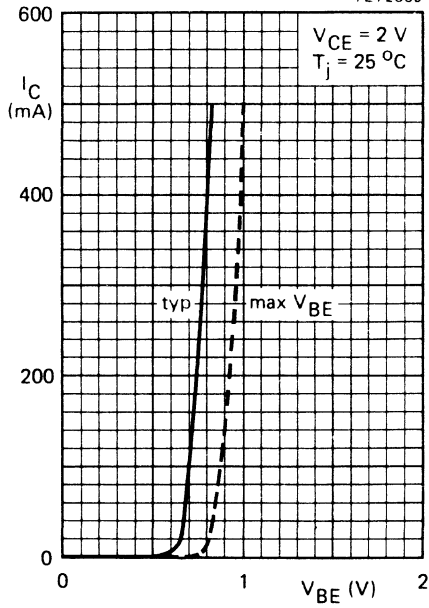
$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$   $f_T \text{ typ. } 130\text{ MHz}$

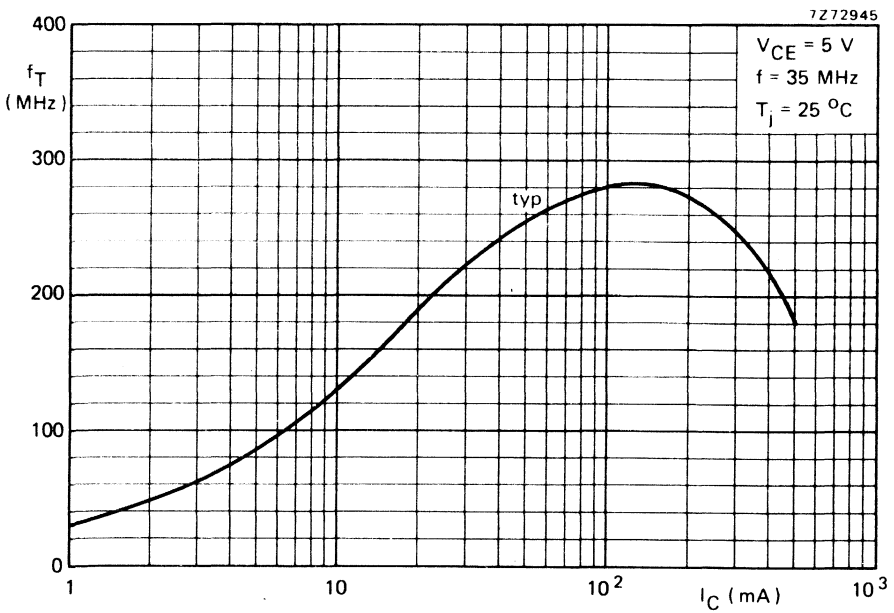
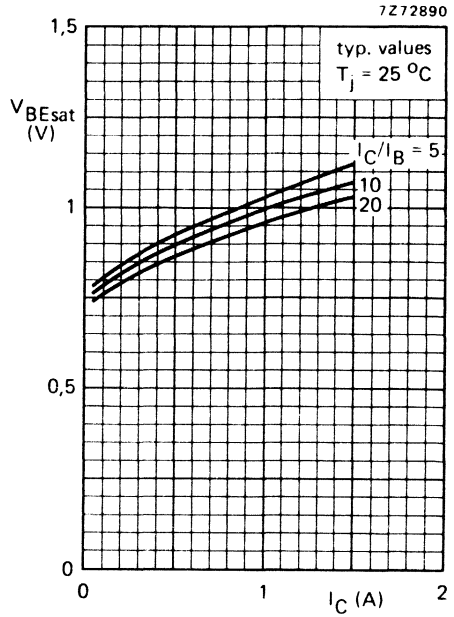
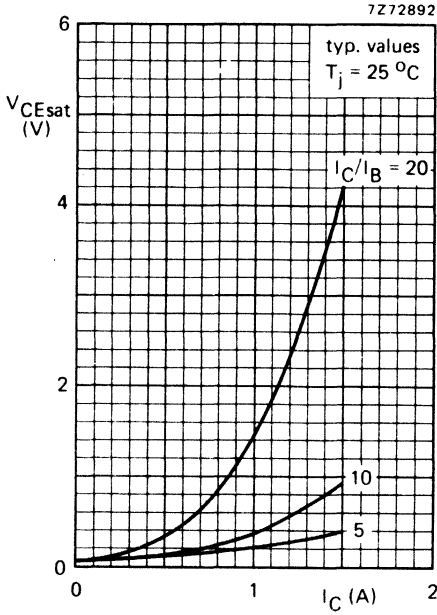


7267755



7272889







## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon transistors, in a microminiature plastic envelope, intended for low level, low noise, low frequency purpose applications in hybrid circuits.

### QUICK REFERENCE DATA

Collector-emitter voltage ( $V_{BE} = 0$ )	$V_{CES}$	max.	45 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	45 V
Collector current (d.c.)	$I_C$	max.	200 mA
Total power dissipation	$P_{tot}$	max.	150 mW
Junction temperature	$T_j$	max.	150 °C
Transition frequency at $f = 100$ MHz $V_{CE} = 5$ V; $I_C = 10$ mA	$f_T$	typ.	250 MHz
Noise figure at $f = 1$ kHz $V_{CE} = 5$ V; $I_C = 200$ $\mu$ A; $B = 200$ Hz	F	typ.	2 dB

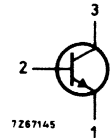
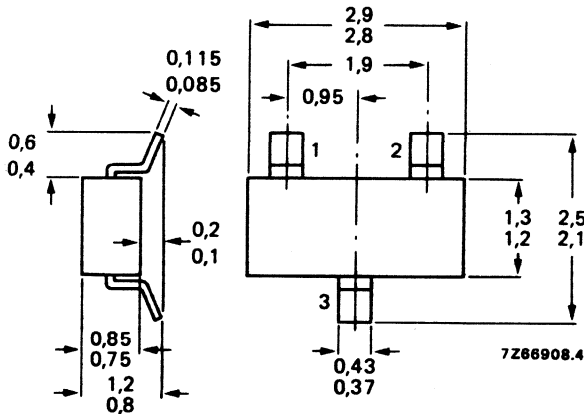
### MECHANICAL DATA

Dimensions in mm

### Marking code

Fig. 1 SOT-23.

BCX70G = AG  
BCX70H = AH  
BCX70J = AJ  
BCX70K = AK



See also *Soldering recommendations*.

## RATINGS

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

Collector-emitter voltage ( $V_{BE} = 0$ )	$V_{CES}$	max.	45 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	45 V
Emitter-base voltage (open collector)	$V_{EBO}$	max.	5 V
Collector current (d.c.)	$I_C$	max.	200 mA
Base current	$I_B$	max.	50 mA
Total power dissipation**	$P_{tot}$	max.	150 mW
Storage temperature	$T_{stg}$		-55 to + 125 °C
Junction temperature	$T_j$	max.	150 °C

## THERMAL CHARACTERISTICS\*

$$T_j = P_x (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

### Thermal resistance

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

## CHARACTERISTICS

$T_{amb} = 25$  °C unless otherwise specified

Collector-emitter cut-off current

$$V_{BE} = 0; V_{CE} = 45\text{ V}$$

$$I_{CES} < 20\text{ nA}$$

$$V_{BE} = 0; V_{CE} = 45\text{ V}; T_{amb} = 150\text{ °C}$$

$$I_{CES} < 20\text{ }\mu\text{A}$$

Emitter-base cut-off current

$$I_C = 0; V_{EB} = 4\text{ V}$$

$$I_{EBO} < 20\text{ nA}$$

Saturation voltages

$$\text{at } I_C = 10\text{ mA}; I_B = 0,25\text{ mA}$$

$$V_{CEsat} \quad 0,05\text{ to }0,35\text{ V}$$

$$V_{BEsat} \quad 0,6\text{ to }0,85\text{ V}$$

$$\text{at } I_C = 50\text{ mA}; I_B = 1,25\text{ mA}$$

$$V_{CEsat} \quad 0,1\text{ to }0,55\text{ V}$$

$$V_{BEsat} \quad 0,7\text{ to }1,05\text{ V}$$

Transition frequency at  $f = 100$  MHz ▲

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

$$f_T > 125\text{ MHz}$$

$$\text{typ. } 250\text{ MHz}$$

Collector capacitance at  $f = 1$  MHz

$$I_E = I_e = 0; V_{CB} = 10\text{ V}$$

$$C_C < 4,5\text{ pF}$$

Emitter capacitance at  $f = 1$  MHz

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

$$C_e \text{ typ. } 8\text{ pF}$$

Noise figure at  $R_S = 2\text{ k}\Omega$

$$I_C = 200\text{ }\mu\text{A}; V_{CE} = 5\text{ V}; f = 1\text{ kHz}; B = 200\text{ Hz}$$

$$F \text{ typ. } 2\text{ dB}$$

$$< 6\text{ dB}$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

▲ Measured under pulse conditions.

		G	H	J	K
D.C. current gain $V_{CE} = 5\text{ V}; I_C = 10\ \mu\text{A}$	$h_{FE}$ typ.	78	145	220	300
	$h_{FE} >$	—	20	40	100
$V_{CE} = 5\text{ V}; I_C = 2\text{ mA}$	$h_{FE} >$	120	180	250	380
	$h_{FE}$ typ.	170	250	350	500
$V_{CE} = 1\text{ V}; I_C = 50\text{ mA}$	$h_{FE} <$	220	310	460	630
	$h_{FE} >$	50	70	90	100
Input impedance $V_{CE} = 5\text{ V}; I_C = 2\text{ mA}; f = 1\text{ kHz}$	$h_{ie} >$	1,6	2,5	3,2	4,5 k $\Omega$
	$h_{ie}$ typ.	2,7	3,6	4,5	7,5 k $\Omega$
Reverse voltage transfer ratio $V_{CE} = 5\text{ V}; I_C = 2\text{ mA}; f = 1\text{ kHz}$	$h_{re} <$	4,5	6,0	8,5	12,0 k $\Omega$
	$h_{re}$ typ.	1,5	2	2	3 $10^{-4}$
Small-signal current gain $V_{CE} = 5\text{ V}; I_C = 2\text{ mA}; f = 1\text{ kHz}$	$h_{fe} >$	125	175	250	350
	$h_{fe}$ typ.	200	260	330	520
Output admittance $V_{CE} = 5\text{ V}; I_C = 2\text{ mA}; f = 1\text{ kHz}$	$h_{oe} <$	250	350	500	700
	$h_{oe}$ typ.	18	24	30	50 $\mu\text{A/V}$
Base-emitter voltage $V_{CE} = 5\text{ V}; I_C = 2\text{ mA}$	$V_{BE} <$	30	50	60	100 $\mu\text{A/V}$
	$V_{BE}$ typ.	0,55 to 0,75			V
$V_{CE} = 5\text{ V}; I_C = 10\ \mu\text{A}$	$V_{BE}$ typ.	0,65			V
	$V_{BE}$ typ.	0,52			V
$V_{CE} = 1\text{ V}; I_C = 50\text{ mA}$	$V_{BE}$ typ.	0,78			V



Switching times

$I_{Con} = 10 \text{ mA}$ ;  $I_{Bon} = -I_{Boff} = 1 \text{ mA}$   
 $V_{CC} = 10 \text{ V}$ ;  $R_L = 990 \Omega$

turn-on time ( $t_d + t_r$ )

$t_{on}$  typ. 85 ns  
 < 150 ns

turn-off time ( $t_s + t_f$ )

$t_{off}$  typ. 480 ns  
 < 800 ns

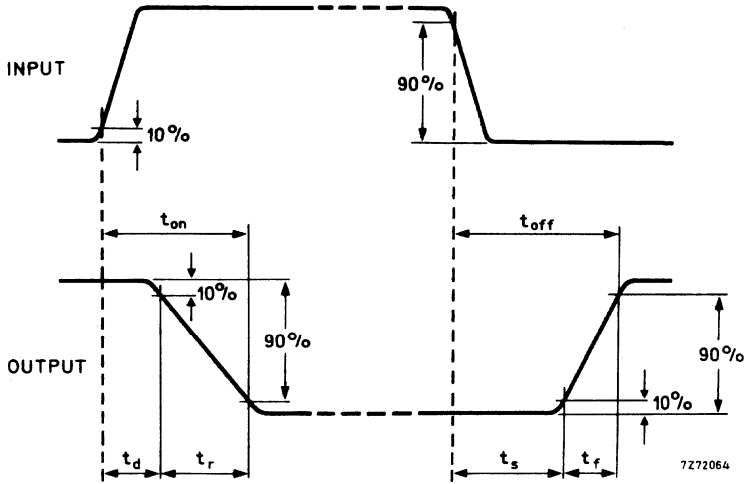


Fig. 2 Switching waveforms.





## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P silicon transistors, in a microminiature plastic envelope, intended for low level, low noise, low frequency purpose applications in hybrid circuits.

### QUICK REFERENCE DATA

Collector-emitter voltage ( $V_{BE} = 0$ )	$-V_{CES}$	max.	45 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45 V
Collector current (d.c.)	$-I_C$	max.	200 mA
Total power dissipation	$P_{tot}$	max.	150 mW
Junction temperature	$T_j$	max.	150 °C
Transition frequency at $f = 100$ MHz $-V_{CE} = 5$ V; $-I_C = 10$ mA	$f_T$	typ.	180 MHz
Noise figure at $f = 1$ kHz $-V_{CE} = 5$ V; $-I_C = 200$ $\mu$ A	F	typ.	2 dB

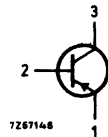
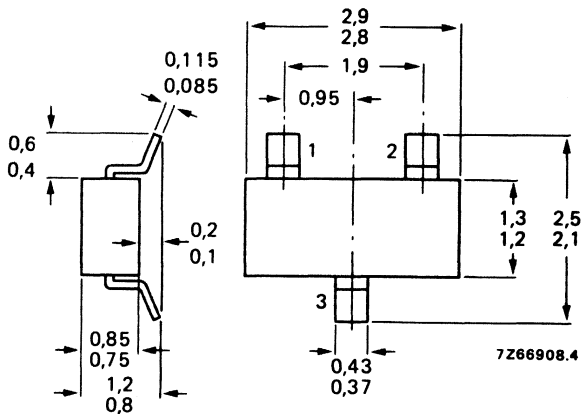
### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.

### Marking code

BCX71G = BG  
BCX71H = BH  
BCX71J = BJ  
BCX71K = BK



See also *Soldering recommendations*.

## RATINGS

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

Collector-emitter voltage ( $V_{BE} = 0$ )	$-V_{CES}$	max.	45 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V
Collector current (d.c.)	$-I_C$	max.	200 mA
Base current	$-I_B$	max.	50 mA
Total power dissipation**	$P_{tot}$	max.	150 mW
Storage temperature	$T_{stg}$		-55 to + 125 °C
Junction temperature	$T_j$	max.	150 °C

## THERMAL CHARACTERISTICS\*

$$T_j = P_x (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

### Thermal resistance

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

## CHARACTERISTICS

$T_{amb} = 25$  °C unless otherwise specified

Collector-emitter cut-off current

$$V_{EB} = 0; -V_{CE} = 45\text{ V}$$

$$-I_{CES} < 20\text{ nA}$$

$$V_{EB} = 0; -V_{CE} = 45\text{ V}; T_{amb} = 150\text{ °C}$$

$$-I_{CES} < 20\text{ }\mu\text{A}$$

Emitter-base cut-off current

$$I_C = 0; -V_{EB} = 4\text{ V}$$

$$-I_{EBO} < 20\text{ nA}$$

Saturation voltages

$$-I_C = 10\text{ mA}; -I_B = 0,25\text{ mA}$$

$$-V_{CEsat} \quad 0,06\text{ to }0,25\text{ V}$$

$$-V_{BEsat} \quad 0,6\text{ to }0,85\text{ V}$$

$$-I_C = 50\text{ mA}; -I_B = 1,25\text{ mA}$$

$$-V_{CEsat} \quad 0,12\text{ to }0,55\text{ V}$$

$$-V_{BEsat} \quad 0,68\text{ to }1,05\text{ V}$$

Transition frequency at  $f = 100\text{ MHz}$  ▲

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

$$f_T \quad \text{typ.} \quad 180\text{ MHz}$$

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

$$-V_{CB} = 10\text{ V}; I_E = I_e = 0$$

$$C_c < 6\text{ pF}$$

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

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

$$C_e \quad \text{typ.} \quad 11\text{ pF}$$

Noise figure at  $R_S = 2\text{ k}\Omega$

$$-V_{CE} = 5\text{ V}; -I_C = 200\text{ }\mu\text{A}; B = 200\text{ Hz}$$

$$F \quad \text{typ.} \quad 2\text{ dB}$$

$$< 6\text{ dB}$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

▲ Measured under pulse conditions.

		A	B	C	D
D.C. current gain					
	$-V_{CE} = 5\text{ V}; -I_C = 10\ \mu\text{A}$				
$h_{FE}$	typ.	140	200	270	340
	>	—	30	40	100
$-V_{CE} = 5\text{ V}; -I_C = 2\text{ mA}$					
$h_{FE}$	typ.	120	180	250	380
	>	170	250	350	500
$-V_{CE} = 1\text{ V}; -I_C = 50\text{ mA}$					
$h_{FE}$	typ.	220	310	460	630
	>	60	80	100	110
Input impedance					
	$-V_{CE} = 5\text{ V}; -I_C = 2\text{ mA}; f = 1\text{ kHz}$				
$h_{ie}$	typ.	1,6	2,5	3,2	4,5 k $\Omega$
	>	2,7	3,6	4,5	7,5 k $\Omega$
$h_{ie}$	typ.	4,5	6,0	8,5	12,0 k $\Omega$
	<				
Reverse voltage transfer ratio					
	$-V_{CE} = 5\text{ V}; -I_C = 2\text{ mA}; f = 1\text{ kHz}$				
$h_{re}$	typ.	1,5	2	2	3 $10^{-4}$
	>				
Small-signal current gain					
	$-V_{CE} = 5\text{ V}; -I_C = 2\text{ mA}; f = 1\text{ kHz}$				
$h_{fe}$	typ.	125	175	250	350
	>	200	260	330	520
$h_{fe}$	typ.	250	350	500	700
	<				
Output admittance					
	$-V_{CE} = 5\text{ V}; -I_C = 2\text{ mA}; f = 1\text{ kHz}$				
$h_{oe}$	typ.	18	24	30	50 $\mu\text{A/V}$
	<	30	50	60	100 $\mu\text{A/V}$
Base-emitter voltage					
	$-V_{CE} = 5\text{ V}; -I_C = 2\text{ mA}$				
$V_{BE}$	typ.	0,6 to 0,75			V
	>	0,65			V
$-V_{CE} = 5\text{ V}; -I_C = 10\ \mu\text{A}$					
$V_{BE}$	typ.	0,55			V
	>	0,72			V
$-V_{CE} = 1\text{ V}; -I_C = 50\text{ mA}$					
$V_{BE}$	typ.	0,72			V
	>				



Switching times

$-I_{Con} = 10 \text{ mA}; -I_{Bon} = I_{Boff} = 1 \text{ mA}$   
 $-V_{CC} = 10 \text{ V}; R_L = 990 \Omega$

turn-on time ( $t_d + t_r$ )	$t_{on}$	typ. 85 ns < 150 ns
turn-off time ( $t_s + t_f$ )	$t_{off}$	typ. 480 ns < 800 ns

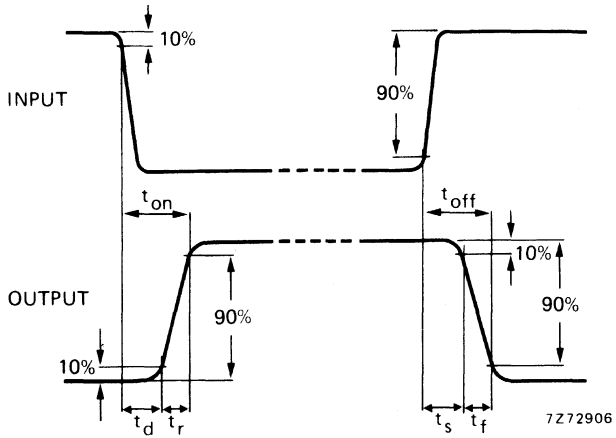


Fig. 2 Switching waveforms.



## N-CHANNEL SILICON FIELD-EFFECT TRANSISTORS

Asymmetrical N-channel planar epitaxial junction field-effect transistors in the miniature plastic envelope intended for applications up to the v.h.f. range in hybrid thick and thin-film circuits. Special features are the low feedback capacitance and the low noise figure. These features make the product very suitable for applications such as the r.f. stages in f.m. portables (BF510), car radios (BF511) and mains radios (BF512) or the mixer stage (BF513).

## QUICK REFERENCE DATA

Drain-source voltage	$V_{DS}$	max.	20	V	
Drain current (d.c. or average)	$I_D$	max.	30	mA	
Total power dissipation up to $T_{amb} = 40\text{ }^\circ\text{C}$	$P_{tot}$	max.	300	mW	
			BF510	511	512
Drain current $V_{DS} = 10\text{ V}; V_{GS} = 0$	$I_{DSS}$	$>$	0,7	2,5	6
		$<$	3,0	7,0	12
Transfer admittance (common source) $V_{DS} = 10\text{ V}; V_{GS} = 0; f = 1\text{ kHz}$	$ y_{fs} $	$>$	2,5	4	6
Feedback capacitance $V_{DS} = 10\text{ V}; V_{GS} = 0$	$C_{rs}$	typ.	0,3	0,3	—
$V_{DS} = 10\text{ V}; I_D = 5\text{ mA}$	$C_{rs}$	typ.	—	—	0,3
Noise figure at optimum source admittance $G_S = 1\text{ mA/V}; -B_S = 3\text{ mA/V}; f = 100\text{ MHz}$	F	typ.	1,5	1,5	—
$V_{DS} = 10\text{ V}; V_{GS} = 0$	F	typ.	—	—	1,5
$V_{DS} = 10\text{ V}; I_D = 5\text{ mA}$	F	typ.	—	—	1,5

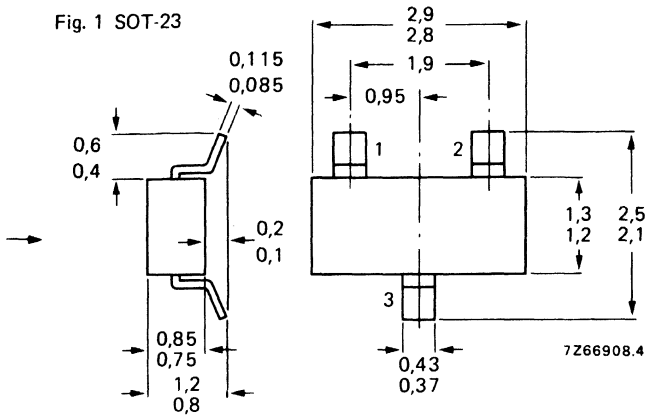
## MECHANICAL DATA

SOT-23 (see page 2).

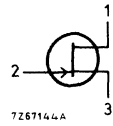
See also *Soldering recommendations*.

**MECHANICAL DATA**

Fig. 1 SOT-23



Dimensions in mm



**Marking code**

- BF510 = S6
- BF511 = S7
- BF512 = S8
- BF513 = S9

**RATINGS**

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

→ Drain-source voltage see Fig. 4	$V_{DS}$	max.	20 V
→ Drain-gate voltage (open source) see Fig. 4	$V_{DGO}$	max.	20 V
→ Drain current (d.c. or average)	$I_D$	max.	30 mA
→ Gate current	$\pm I_G$	max.	10 mA
→ Total power dissipation up to $T_{amb} = 40\text{ °C}^{**}$	$P_{tot}$	max.	300 mW
→ Storage temperature	$T_{stg}$		-65 to +175 °C
→ Junction temperature	$T_j$	max.	175 °C

→ **THERMAL CHARACTERISTICS \***

$$T_j = P_x (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient **	$R_{th\ s-a}$	=	120 K/W

\* See *Thermal characteristics* in chapter GENERAL.  
 \*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

## STATIC CHARACTERISTICS

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

			BF510	511	512	513
Gate cut-off current $-V_{GS} = 0,2\text{ V}; V_{DS} = 0$	$-I_{GSS}$	<	10	10	10	10 nA
Gate-drain breakdown voltage $I_S = 0; -I_D = 10\text{ }\mu\text{A}$	$-V_{(BR)GDO}$	>	20	20	20	20 V
Drain current $V_{DS} = 10\text{ V}; V_{GS} = 0$	$I_{DSS}$	>	0,7	2,5	6	10 mA
		<	3,0	7,0	12	18 mA
Gate-source cut-off voltage $I_D = 10\text{ }\mu\text{A}; V_{DS} = 10\text{ V}$	$-V_{(P)GS}$	typ.	0,8	1,5	2,2	3 V

## DYNAMIC CHARACTERISTICS

Measuring conditions (common source):  $V_{DS} = 10\text{ V}; V_{GS} = 0; T_{amb} = 25\text{ }^{\circ}\text{C}$  for BF510 and BF511  
 $V_{DS} = 10\text{ V}; I_D = 5\text{ mA}; T_{amb} = 25\text{ }^{\circ}\text{C}$  for BF512 and BF513

## y-parameters (common source)

			BF510	511	512	513
Input capacitance at $f = 1\text{ MHz}$	$C_{is}$	<	5	5	5	5 pF
Input conductance at $f = 100\text{ MHz}$	$g_{is}$	typ.	100	90	60	50 $\mu\text{A/V}$
Feedback capacitance at $f = 1\text{ MHz}$	$C_{rs}$	typ.	0,3	0,3	0,3	0,3 pF
		<	0,4	0,4	0,4	0,4 pF
Transfer admittance at $f = 1\text{ kHz}$ $V_{GS} = 0$ instead of $I_D = 5\text{ mA}$	$ y_{fs} $	>	2,5	4,0	4,0	3,5 mA/V
		>	—	—	6,0	7,0 mA/V
Transfer admittance at $f = 100\text{ MHz}$	$ y_{fs} $	typ.	3,5	5,5	5,0	5,0 mA/V
Output capacitance at $f = 1\text{ MHz}$	$C_{os}$	<	3	3	3	3 pF
Output conductance at $f = 1\text{ MHz}$	$g_{os}$	<	60	80	100	120 $\mu\text{A/V}$
Output conductance at $f = 100\text{ MHz}$	$g_{os}$	typ.	35	55	70	90 $\mu\text{A/V}$
Noise figure at optimum source admittance $G_S = 1\text{ mA/V}; -B_S = 3\text{ mA/V};$ $f = 100\text{ MHz}$	F	typ.	1,5	1,5	1,5	1,5 dB

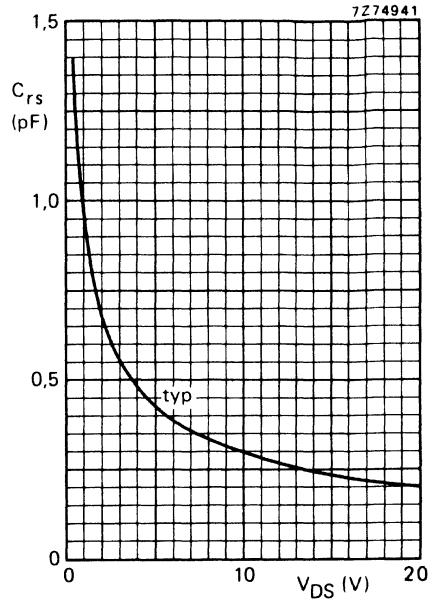


Fig. 2  $V_{GS} = 0$  for BF510 and BF511;  
 $I_D = 5$  mA for BF512 and BF513;  
 $f = 1$  MHz;  $T_{amb} = 25$  °C.

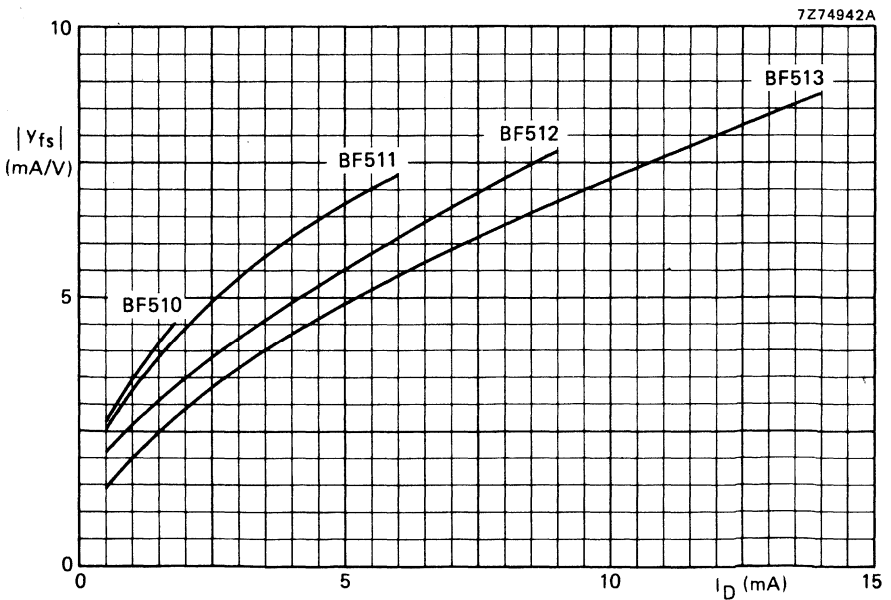


Fig. 3  $V_{DS} = 10$  V;  $f = 1$  kHz;  $T_{amb} = 25$  °C; typical values.





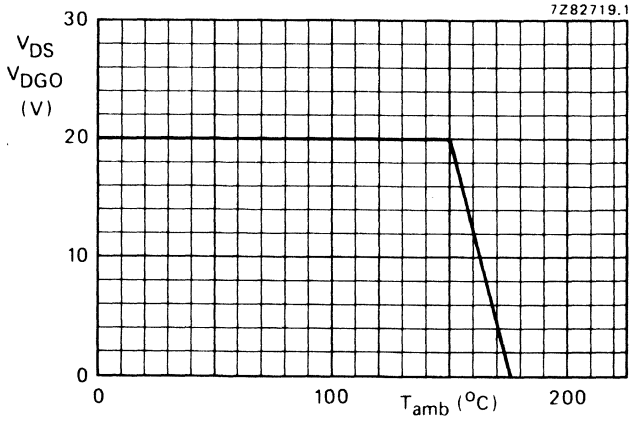


Fig. 4 Voltage derating curve.

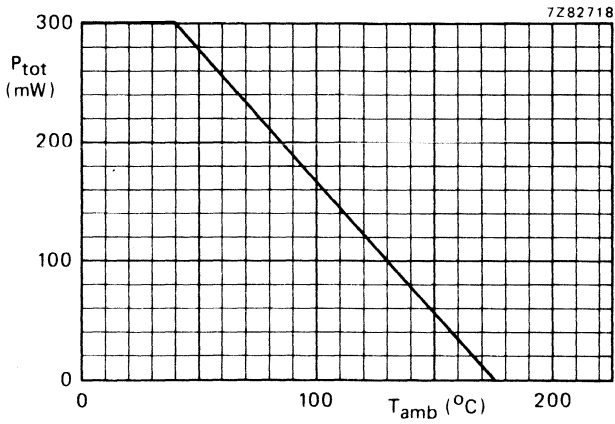


Fig. 5 Power derating curve.





## SILICON PLANAR TRANSISTOR

P-N-P transistor in a microminiature plastic envelope. Primarily intended for use as mixer in v.h.f. tuners. Also suitable as r.f. amplifier and oscillator in f.m. tuners.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CB0}$	max.	30 V	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30 V	
Collector current (d.c.)	$-I_C$	max.	25 mA	
Total power dissipation up to $T_{amb} = 60\text{ }^\circ\text{C}$	$P_{tot}$	max.	200 mW	←
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$	←
D.C. current gain	$h_{FE}$	>	25	
Transition frequency at $f = 100\text{ MHz}$	$f_T$	typ.	350 MHz	
Noise figure at $f = 200\text{ MHz}$	F	typ.	5 dB	

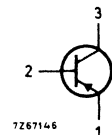
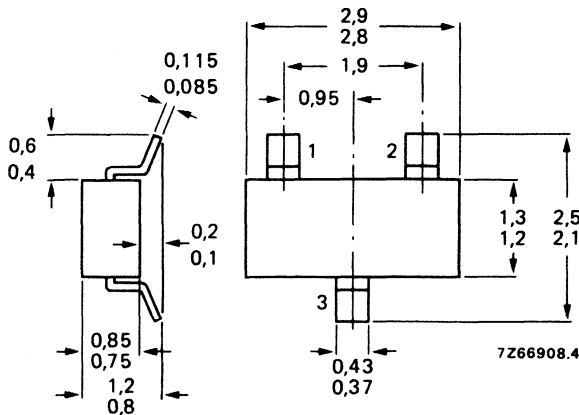
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BF536 = G3



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	4 V
Collector current (d.c.)	$-I_C$	max.	25 mA
→ Total power dissipation up to $T_{amb} = 60\text{ }^\circ\text{C}^{**}$	$P_{tot}$	max.	200 mW
Storage temperature	$T_{stg}$		-65 to + 150 °C
Junction temperature	$T_j$	max.	150 °C

→ **THERMAL CHARACTERISTICS\***

$$T_j = P (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

$T_{amb} = 25\text{ }^\circ\text{C}$ ; unless otherwise specified

Collector cut-off current

$$I_E = 0; -V_{CB} = 20\text{ V} \quad -I_{CBO} < 50\text{ nA}$$

D.C. current gain

$$I_E = 1\text{ mA}; -V_{CB} = 10\text{ V} \quad h_{FE} > 25$$

Transition frequency at  $f = 100\text{ MHz}$

$$I_E = 1\text{ mA}; -V_{CB} = 10\text{ V} \quad f_T \text{ typ. } 350\text{ MHz}$$

Noise figure at  $f = 200\text{ MHz}$

$$I_E = 1\text{ mA}; -V_{CB} = 10\text{ V}; R_S = 50\ \Omega \quad F \text{ typ. } 5\text{ dB}$$

Transducer gain (common base) at  $f = 200\text{ MHz}$

$$I_E = 3\text{ mA}; -V_{CB} = 10\text{ V}; R_S = 60\ \Omega; R_L = 920\ \Omega \quad G_{tr} \text{ typ. } 17,5\text{ dB}$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

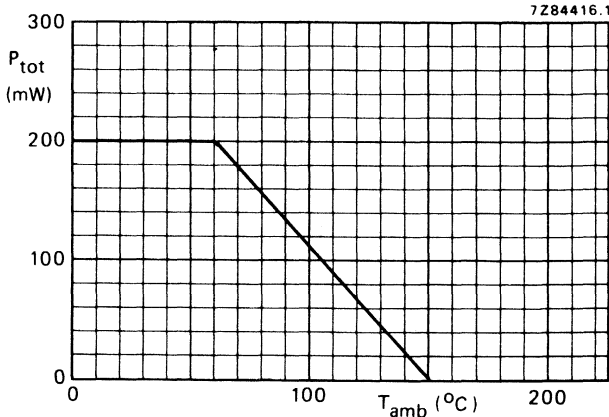


Fig. 2 Power derating curve.





## SILICON PLANAR EPITAXIAL TRANSISTOR

P-N-P transistor, in a microminiature plastic envelope, intended for applications in thick and thin-film circuits. This transistor is primarily intended for use in i. f. detection applications.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40 V
Collector current (d.c.)	$-I_C$	max.	25 mA
Total power dissipation up to $T_{amb} = 60\text{ }^\circ\text{C}$	$P_{tot}$	max.	200 mW
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$
D.C. current gain at $T_j = 25\text{ }^\circ\text{C}$ $-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$	$h_{FE}$	>	50
Transition frequency at $f = 100\text{ MHz}$ $-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$	$f_T$	typ.	325 MHz
Noise figure at $R_S = 300\text{ }\Omega$ $-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}; f = 100\text{ kHz}$	F	typ.	2 dB

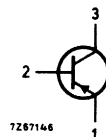
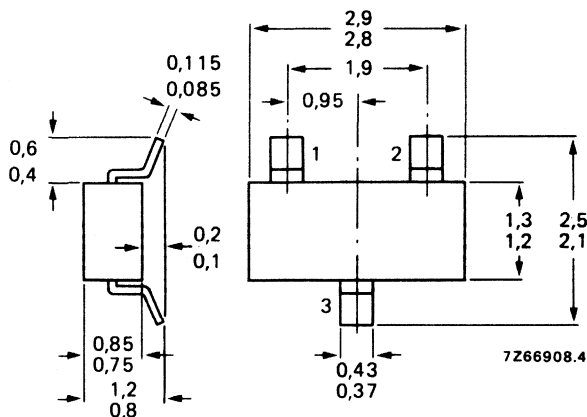
### MECHANICAL DATA

Dimensions in mm

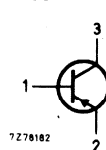
Marking code

Fig. 1 SOT-23

BF550 = G2



BF550R = G5



See also *Soldering Recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	4 V
Collector current (d.c.)	$-I_C$	max.	25 mA
→ Total power dissipation up to $T_{amb} = 60\text{ }^\circ\text{C}$ **	$P_{tot}$	max.	200 mW
Storage temperature	$T_{stg}$		-55 to +150 $^\circ\text{C}$
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Collector cut-off current

$$I_E = 0; -V_{CB} = 30\text{ V} \quad -I_{CBO} < 50\text{ nA}$$

Emitter cut-off current

$$I_C = 0; -V_{EB} = 3\text{ V} \quad -I_{EBO} < 100\text{ }\mu\text{A}$$

Base-emitter voltage

$$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V} \quad -V_{BE} \text{ typ. } 750\text{ mV}$$

D.C. current gain

$$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V} \quad h_{FE} > 50$$

Transition frequency at  $f = 100\text{ MHz}$

$$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V} \quad f_T \text{ typ. } 325\text{ MHz}$$

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

$$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V} \quad C_{re} \text{ typ. } 0,5\text{ pF}$$

Noise figure at  $R_S = 300\text{ }\Omega$

$$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}; f = 100\text{ kHz} \quad F \text{ typ. } 2\text{ dB}$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.



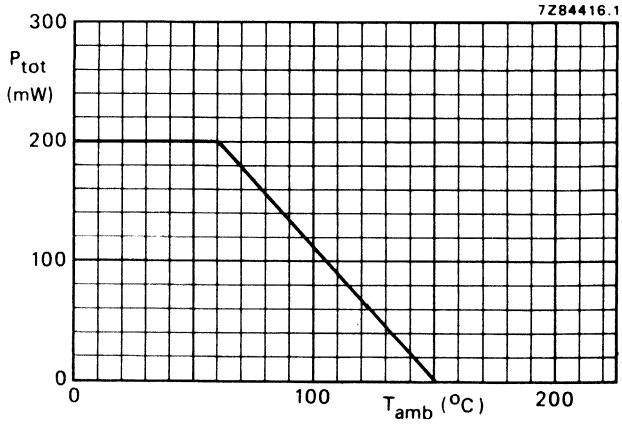


Fig. 2 Power derating curve.





## SILICON PLANAR EPITAXIAL TRANSISTOR

P-N-P transistor in a microminiature plastic envelope, intended for applications in thick and thin-film circuits such as self-oscillating mixer in u.h.f. tuners in conjunction with bipolar transistors or with MOS fets.

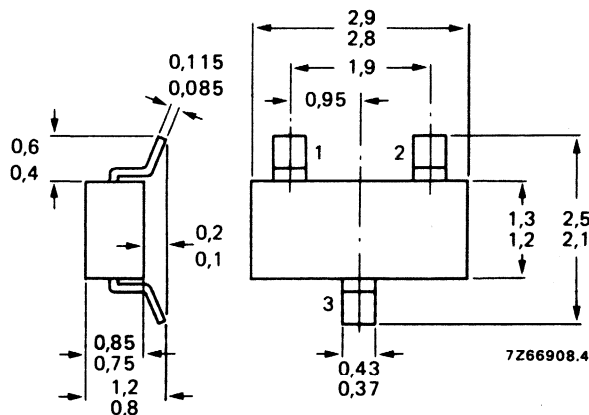
### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	35 V
Collector current (d.c.)	$-I_C$	max.	30 mA
Total power dissipation up to $T_{amb} = 60\text{ }^\circ\text{C}$	$P_{tot}$	max.	200 mW
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$
Transition frequency at $f = 100\text{ MHz}$ $I_E = 3\text{ mA}; -V_{CB} = 10\text{ V}$	$f_T$	typ.	900 MHz

### MECHANICAL DATA

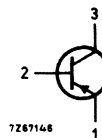
Dimensions in mm

Fig. 1 SOT-23



Marking code

BF569 = G6



See also Soldering Recommendations.

**RATINGS**

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	35 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	3 V
Collector current (d.c.)	$-I_C$	max.	30 mA
→ Total power dissipation up to $T_{amb} = 60\text{ }^\circ\text{C}^{**}$	$P_{tot}$	max.	200 mW
Storage temperature	$T_{stg}$		-65 to +150 $^\circ\text{C}$
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Collector cut-off current

$$I_E = 0; -V_{CB} = 20\text{ V} \quad -I_{CBO} < 100\text{ nA}$$

D.C. current gain

$$I_E = 3\text{ mA}; -V_{CB} = 10\text{ V} \quad h_{FE} > \begin{matrix} 25 \\ \text{typ. } 50 \end{matrix}$$

Transition frequency at  $f = 100\text{ MHz}$

$$I_E = 3\text{ mA}; -V_{CB} = 10\text{ V} \quad f_T \text{ typ. } 900\text{ MHz}$$

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

$$I_E = 1\text{ mA}; -V_{CB} = 10\text{ V} \quad C_{re} \text{ typ. } 0,33\text{ pF}$$

Noise figure at  $f = 800\text{ MHz}$

$$I_E = 3\text{ mA}; -V_{CB} = 10\text{ V}; R_S = 60\ \Omega; R_L = 500\ \Omega \quad F \text{ typ. } 4,5\text{ dB}$$

Power gain at  $f = 800\text{ MHz}$

$$I_E = 3\text{ mA}; -V_{CB} = 10\text{ V}; R_S = 60\ \Omega; R_L = 500\ \Omega \quad G_{pb} \text{ typ. } 14,5\text{ dB}$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

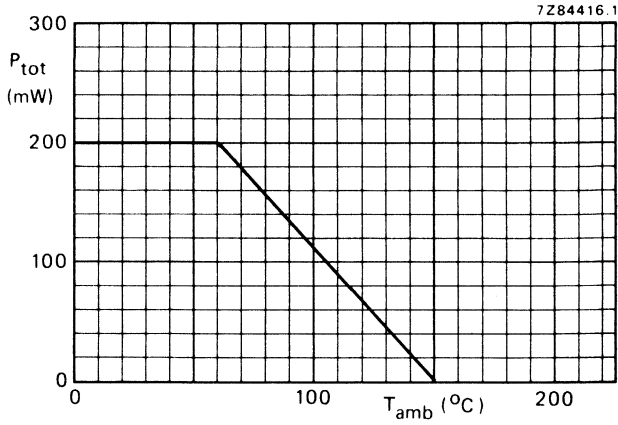


Fig. 2 Power derating curve.





## SILICON PLANAR TRANSISTOR

P-N-P transistor in a microminiature envelope primarily intended for u.h.f. applications in thick and thin-film circuits.

## QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CB0}$	max.	20 V	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20 V	
Collector current	$-I_C$	max.	25 mA	
Total power dissipation up to $T_{amb} = 85^\circ\text{C}$	$P_{tot}$	max.	150 mW	←
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$	←
Transition frequency at $f = 100$ MHz $I_E = 10$ mA; $-V_{CB} = 10$ V	$f_T$	typ.	1350 MHz	
Transducer gain (common base) $I_E = 10$ mA; $-V_{CB} = 10$ V; $f = 800$ MHz $R_S = 60 \Omega$ ; $R_L = 500 \Omega$ ; $T_{amb} = 25^\circ\text{C}$	$G_{tr}$	typ.	16 dB	
Noise figure (common base) $I_E = 10$ mA; $-V_{CB} = 10$ V; $f = 800$ MHz $R_S = 60 \Omega$ ; $R_L = 500 \Omega$	F	typ.	4,5 dB	

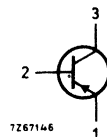
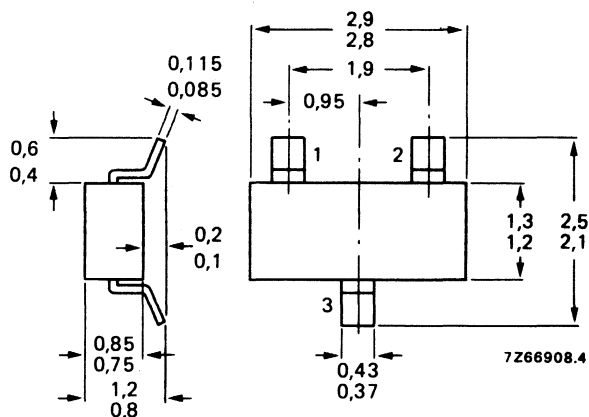
## MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BF579 = G7



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) see Fig. 2	$-V_{CB0}$	max.	20 V
Collector-emitter voltage (open base) see Fig. 2	$-V_{CE0}$	max.	20 V
Emitter-base voltage (open collector) see Fig. 2	$-V_{EB0}$	max.	3 V
Collector current	$-I_C$	max.	25 mA
Base current (d.c.)	$-I_B$	max.	10 mA
→ Total power dissipation up to $T_{amb} = 85\text{ }^\circ\text{C}^{**}$	$P_{tot}$	max.	150 mW
→ Storage temperature	$T_{stg}$		$-65$ to $+150\text{ }^\circ\text{C}$
→ Junction temperature	$T_j$	max.	$150\text{ }^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Collector cut-off current

$$I_E = 0; -V_{CB} = 15\text{ V} \quad -I_{CBO} < 100\text{ nA}$$

Emitter cut-off current

$$I_C = 0; -V_{EB} = 1\text{ V} \quad -I_{EBO} < 100\text{ nA}$$

D.C. current gain

$$I_C = 10\text{ mA}; -V_{CE} = 10\text{ V} \quad h_{FE} > 20$$

Transition frequency at  $f = 100\text{ MHz}$

$$I_E = 10\text{ mA}; -V_{CB} = 10\text{ V} \quad f_T \text{ typ. } 1350\text{ MHz}$$

Feedback capacitance at  $f = 500\text{ kHz}$

$$I_E = 7\text{ mA}; -V_{CB} = 10\text{ V} \quad C_{re} \text{ typ. } 0,46\text{ pF}$$

$$I_E = 0; -V_{CB} = 10\text{ V} \quad C_{rb} \text{ typ. } 160\text{ fF}$$

Transducer gain (common base)

$$I_E = 10\text{ mA}; -V_{CB} = 10\text{ V}; f = 800\text{ MHz} \quad G_{tr} \text{ typ. } 16\text{ dB}$$

$$R_S = 60\ \Omega; R_L = 500\ \Omega$$

Noise figure (common base)

$$I_E = 10\text{ mA}; -V_{CB} = 10\text{ V}; f = 800\text{ MHz} \quad F \text{ typ. } 4,5\text{ dB}$$

$$R_S = 60\ \Omega; R_L = 500\ \Omega$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.



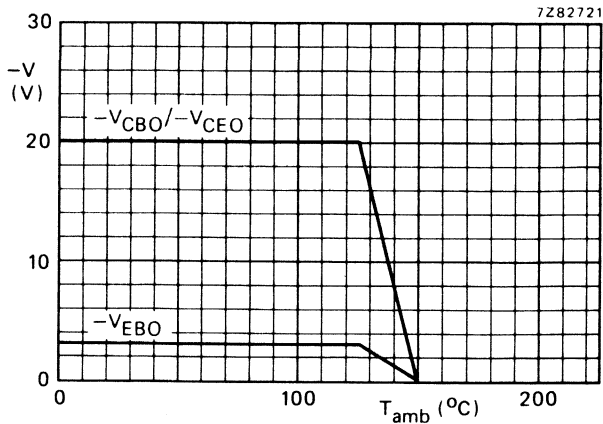


Fig. 2 Voltage derating curves.

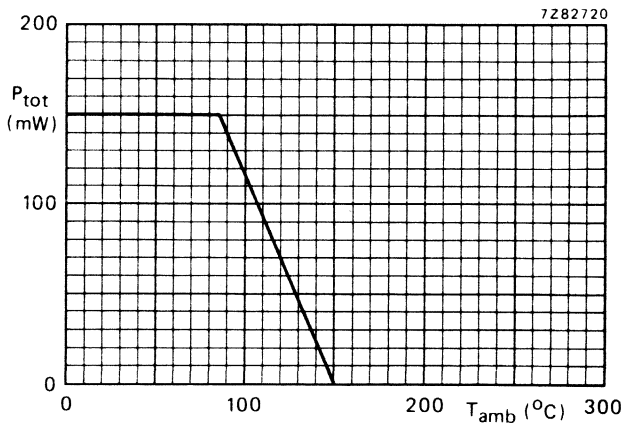


Fig. 3 Power derating curve.





## SILICON EPITAXIAL TRANSISTOR

- for video output stages

N-P-N transistor in a miniature plastic envelope intended for application in thick and thin-film circuits. This device is intended for class-B video output stages in colour television receivers.

P-N-P complement is BF623.

## QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CBO}$	max.	250 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	250 V
Collector current (peak value)	$I_{CM}$	max.	100 mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	1 W
Junction temperature	$T_j$	max.	150 $^{\circ}\text{C}$
D.C. current gain			
$I_C = 25\text{ mA}; V_{CE} = 20\text{ V}$	$h_{FE}$	>	50
Transition frequency at $f = 35\text{ MHz}$			
$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	$f_T$	>	60 MHz
Feedback capacitance at $f = 1\text{ MHz}$			
$I_C = 0; V_{CE} = 30\text{ V}$	$C_{re}$	<	1,6 pF

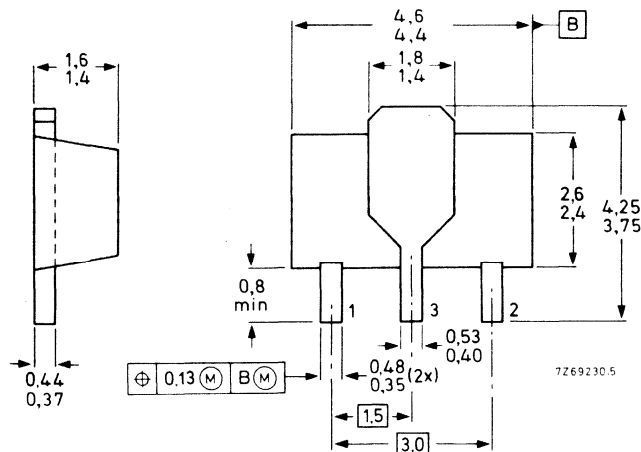
## MECHANICAL DATA

Dimensions in mm

Mark

Fig. 1 SOT-89.

BF622



See also *Soldering recommendations*.

## RATINGS

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

Collector-base voltage (open emitter)	$V_{CB0}$	max.	250 V
Collector-emitter voltage (open base)	$V_{CE0}$	max.	250 V
Emitter-base voltage (open collector)	$V_{EB0}$	max.	5 V
Collector current (d.c.)	$I_C$	max.	20 mA
Collector current (peak value)	$I_{CM}$	max.	100 mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ mounted on a ceramic substrate area = 2,5 cm <sup>2</sup> ; thickness = 0,7 mm	$P_{tot}$	max.	1 W
Storage temperature	$T_{stg}$		-65 to +150 $^{\circ}\text{C}$
Junction temperature	$T_j$	max.	150 $^{\circ}\text{C}$

## THERMAL RESISTANCE

From junction to collector tab	$R_{th\ j-tab}$	=	25 $^{\circ}\text{C}/\text{W}$
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm <sup>2</sup> ; thickness = 0,7 mm	$R_{th\ j-a}$	=	125 $^{\circ}\text{C}/\text{W}$

## CHARACTERISTICS

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

Collector cut-off current

$$I_E = 0; V_{CB} = 200\text{ V}$$

$$I_{CBO} < 10\text{ nA}$$

$$R_{BE} = 10\text{ k}\Omega; V_{CE} = 200\text{ V}; T_j = 150\text{ }^\circ\text{C}$$

$$I_{CER} < 50\text{ }\mu\text{A}$$

Emitter cut-off current

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

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

Base-emitter voltage

$$I_C = 25\text{ mA}; V_{CE} = 20\text{ V}$$

$$V_{BE} \text{ typ. } 0,73\text{ V}$$

D.C. current gain

$$I_C = 25\text{ mA}; V_{CE} = 20\text{ V}$$

$$h_{FE} > 50$$

High-frequency knee voltage at  $T_j = 150\text{ }^\circ\text{C}$  \*

$$I_C = 25\text{ mA}$$

$$V_{CEK} \text{ typ. } 20\text{ V}$$

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

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

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

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

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

$$C_{re} < 1,6\text{ pF}$$

Feedback time constant at  $f = 10,7\text{ MHz}$  \*\*

$$I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$$

$$r_{bb'}C_{b'c} < 70\text{ ps}$$

\* The high-frequency knee voltage of a transistor is that value of the collector-emitter voltage at which the small-signal gain, measured in a practical circuit, has dropped to 80% of the gain at  $V_{CE} = 50\text{ V}$ . A further reduction of the collector-emitter voltage results in a rapid increase of the distortion of the signal.

$$** r_{bb'}C_{b'c} = \frac{|h_{rb}|}{\omega}$$

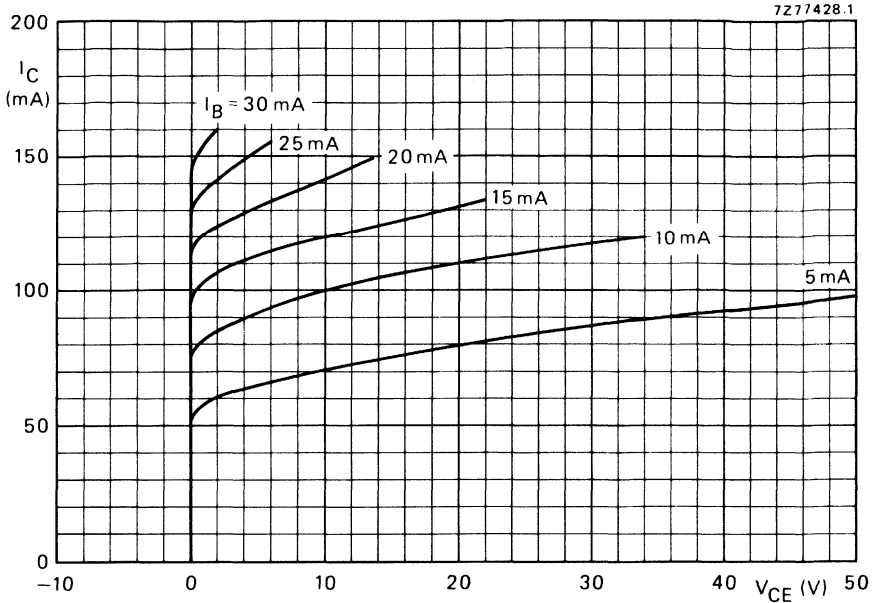


Fig. 2 Typical values at  $T_j = 25^\circ\text{C}$ .

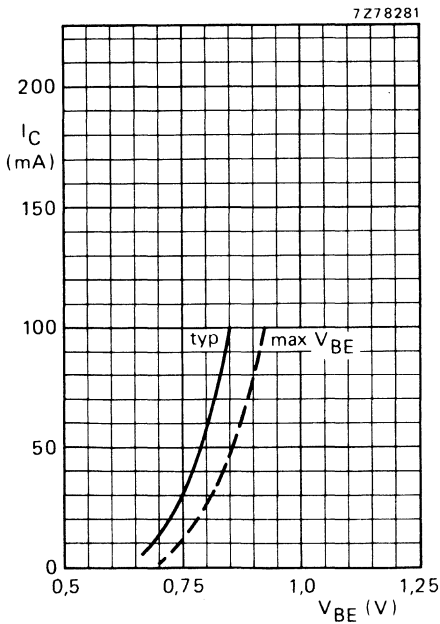


Fig. 3  $V_{CE} = 20\text{ V}$ ;  $T_j = 25^\circ\text{C}$ .

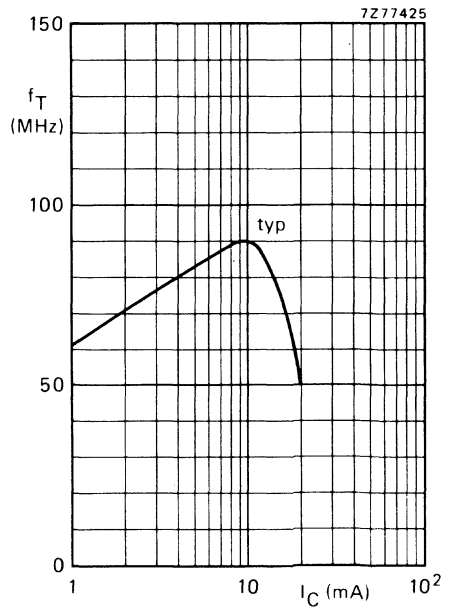


Fig. 4  $V_{CE} = 10\text{ V}$ ;  $T_j = 25^\circ\text{C}$ ;  $f = 35\text{ MHz}$ .

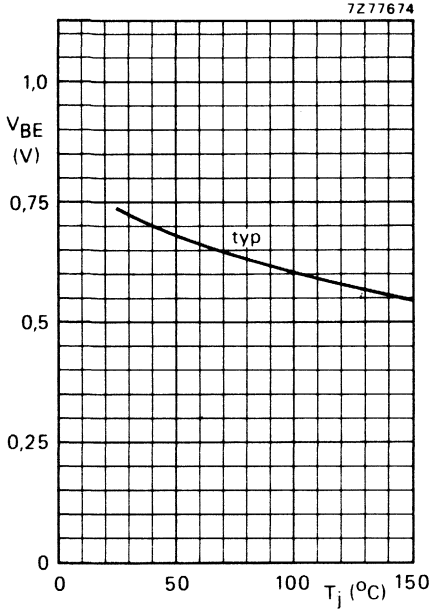


Fig. 5  $I_C = 25 \text{ mA}$ ;  $V_{CE} = 20 \text{ V}$ .

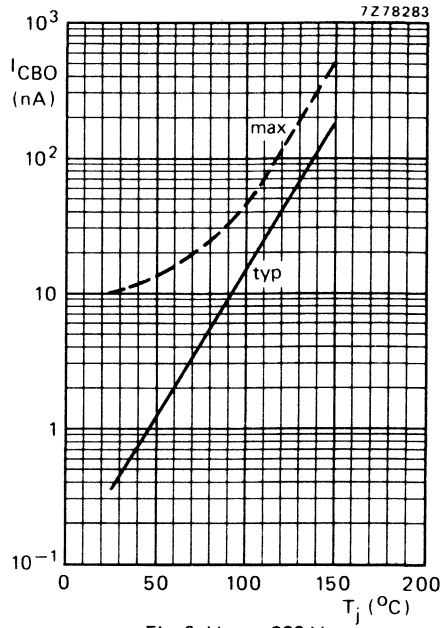


Fig. 6  $V_{CB} = 200 \text{ V}$ .

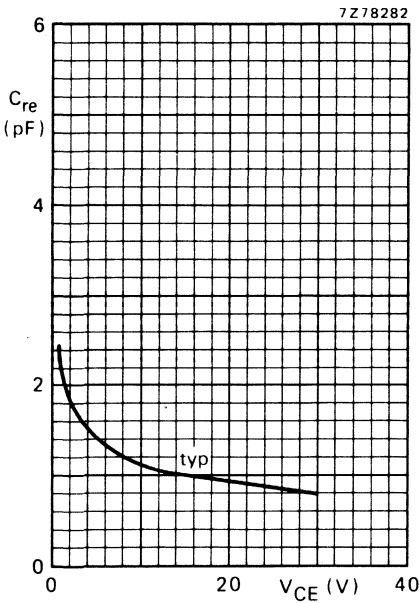


Fig. 7  $I_C = 0$ ;  $f = 1 \text{ MHz}$ ;  $T_j = 25 \text{ }^{\circ}\text{C}$ .



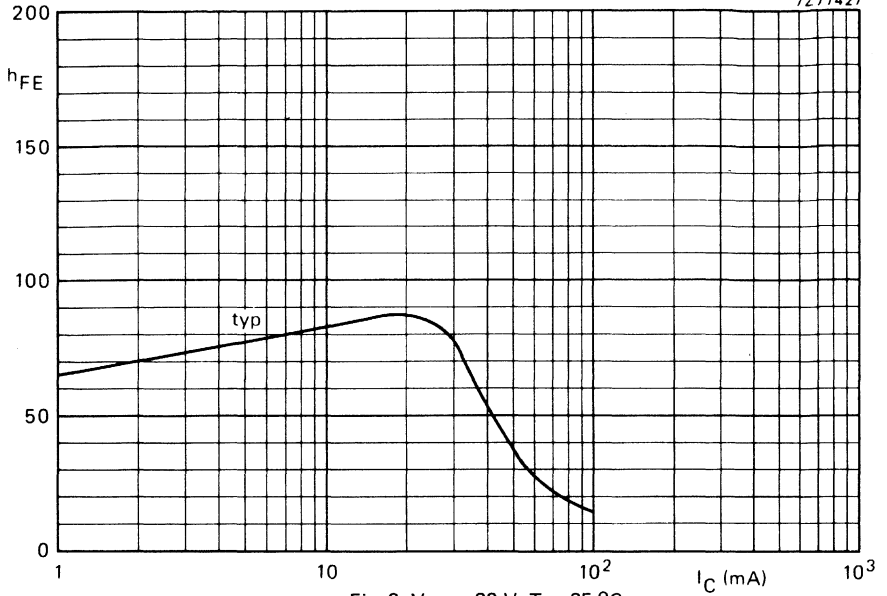


Fig. 8  $V_{CE} = 20 V; T_j = 25 ^\circ C.$





## SILICON EPITAXIAL TRANSISTOR

- for video output stages

P-N-P transistor in a miniature plastic envelope intended for application in thick and thin-film circuits. This device is intended for class-B video output stages in colour television receivers.

N-P-N complement is BF622.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	250 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	250 V
Collector current (peak value)	$-I_{CM}$	max.	100 mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	1 W
Junction temperature	$T_j$	max.	150 $^{\circ}\text{C}$
D.C. current gain $-I_C = 25\text{ mA}; -V_{CE} = 20\text{ V}$	$h_{FE}$	>	50
Transition frequency at $f = 35\text{ MHz}$ $-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$	$f_T$	>	60 MHz
Feedback capacitance at $f = 1\text{ MHz}$ $I_C = 0; -V_{CE} = 30\text{ V}$	$C_{re}$	<	1,6 pF

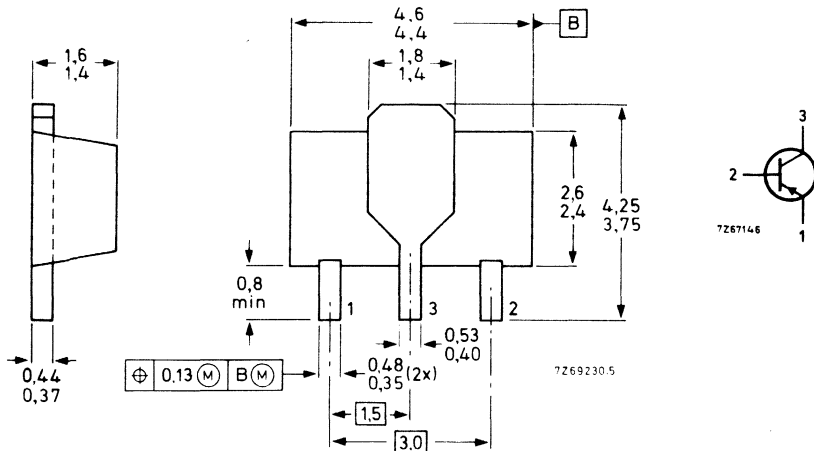
### MECHANICAL DATA

Dimensions in mm

Mark

Fig. 1 SOT-89.

BF623



See also *Soldering recommendations.*

## RATINGS

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	250 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	250 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5 V
Collector current (d.c.)	$-I_C$	max.	20 mA
Collector current (peak value)	$-I_{CM}$	max.	100 mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ mounted on a ceramic substrate area = 2,5 cm <sup>2</sup> ; thickness = 0,7 mm	$P_{tot}$	max.	1 W
Storage temperature	$T_{stg}$		-65 to +150 $^{\circ}\text{C}$
Junction temperature	$T_j$	max.	150 $^{\circ}\text{C}$

## THERMAL RESISTANCE

From junction to collector tab	$R_{th\ j-tab}$	=	25 $^{\circ}\text{C}/\text{W}$
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm <sup>2</sup> ; thickness = 0,7 mm	$R_{th\ j-a}$	=	125 $^{\circ}\text{C}/\text{W}$

## CHARACTERISTICS

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

Collector cut-off current

$$I_E = 0; -V_{CB} = 200\text{ V}$$

$$-I_{CBO} < 10\text{ nA}$$

$$R_{BE} = 10\text{ k}\Omega; -V_{CE} = 200\text{ V}; T_j = 150\text{ }^\circ\text{C}$$

$$-I_{CER} < 50\text{ }\mu\text{A}$$

Emitter cut-off current

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

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

Base-emitter voltage

$$-I_C = 25\text{ mA}; -V_{CE} = 20\text{ V}$$

$$-V_{BE} \text{ typ. } 0,75\text{ V}$$

D.C. current gain

$$-I_C = 25\text{ mA}; -V_{CE} = 20\text{ V}$$

$$h_{FE} > 50$$

High-frequency knee voltage at  $T_j = 150\text{ }^\circ\text{C}$  \*

$$-I_C = 25\text{ mA}$$

$$-V_{CEK} \text{ typ. } 20\text{ V}$$

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

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

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

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

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

$$C_{re} < 1,6\text{ pF}$$

Feedback time constant at  $f = 10,7\text{ MHz}$  \*\*

$$-I_C = 10\text{ mA}; -V_{CE} = 20\text{ V}$$

$$r_{bb}'C_{b'c} < 70\text{ ps}$$



\* The high-frequency knee voltage of a transistor is that value of the collector-emitter voltage at which the small-signal gain, measured in a practical circuit, has dropped to 80% of the gain at  $-V_{CE} = 50\text{ V}$ . A further reduction of the collector-emitter voltage results in a rapid increase of the distortion of the signal.

$$** r_{bb}'C_{b'c} = \frac{|h_{rb}|}{\omega}$$

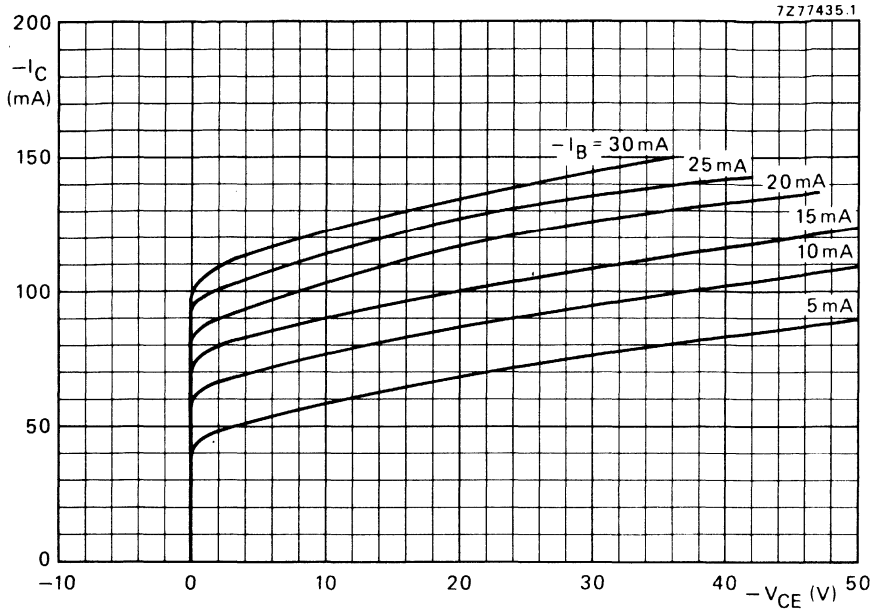


Fig. 2 Typical values at  $T_j = 25^\circ\text{C}$ .

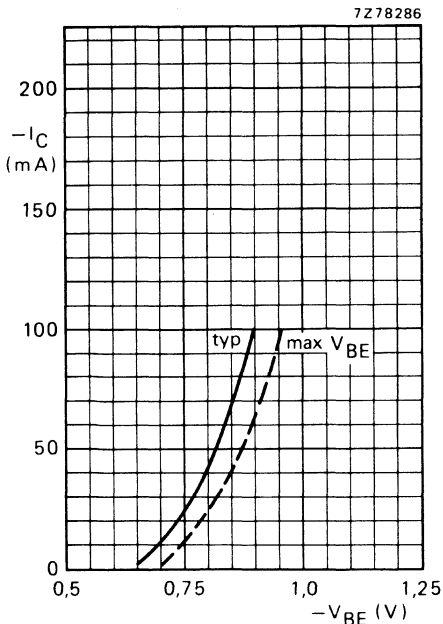


Fig. 3  $-V_{CE} = 20\text{ V}$ ;  $T_j = 25^\circ\text{C}$ .

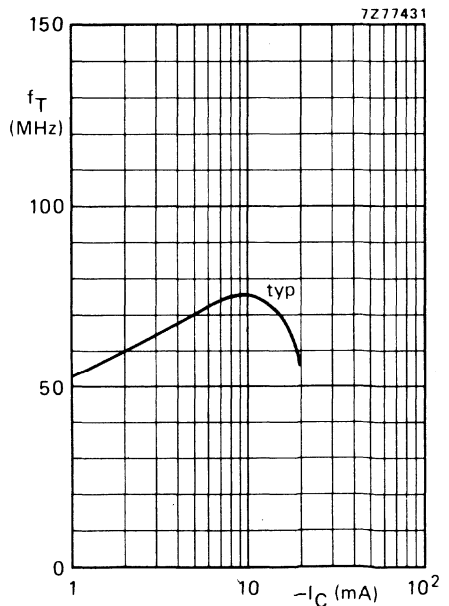


Fig. 4  $-V_{CE} = 10\text{ V}$ ;  $T_j = 25^\circ\text{C}$ ;  $f = 35\text{ MHz}$ .

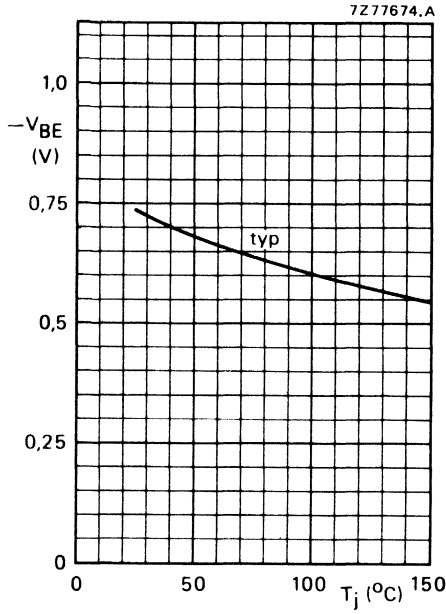


Fig. 5  $-I_C = 25 \text{ mA}$ ;  $-V_{CE} = 20 \text{ V}$ .

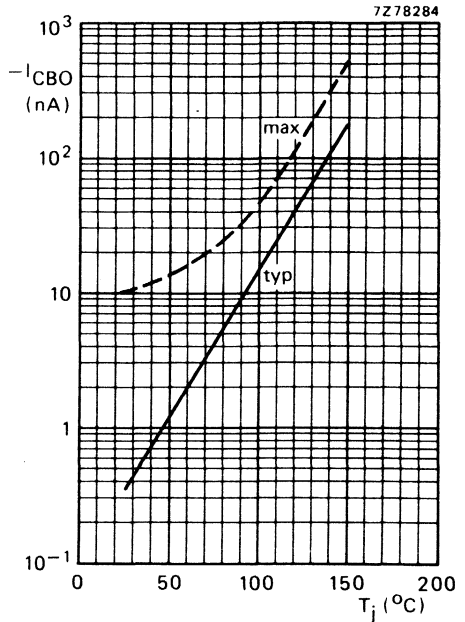


Fig. 6  $-V_{CB} = 200 \text{ V}$ .

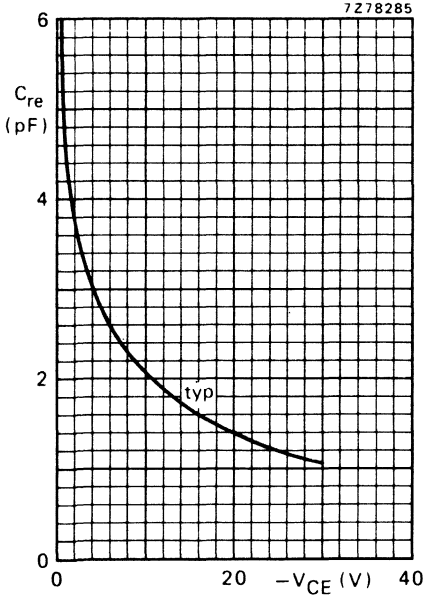


Fig. 7  $I_C = 0$ ;  $f = 1 \text{ MHz}$ ;  $T_j = 25 \text{ }^{\circ}\text{C}$ .



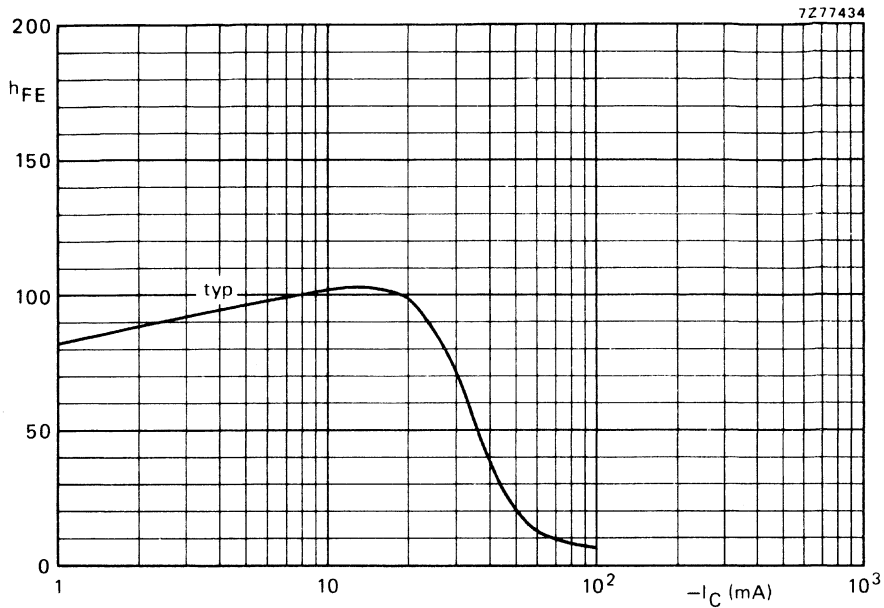


Fig. 8  $-V_{CE} = 20$  V;  $T_j = 25$  °C.



## SILICON PLANAR TRANSISTOR

P-N-P transistor, in a microminiature plastic envelope; intended for use as oscillator in v.h.f. tuners with extended frequency range and/or in conjunction with MOS-FETs in thick and thin-film circuits.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CB0}$	max.	40 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30 V
Collector current (peak value)	$-I_{CM}$	max.	25 mA
Total power dissipation up to $T_{amb} = 60\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	200 mW
Junction temperature	$T_j$	max.	150 $^{\circ}\text{C}$
Transition frequency at $f = 100\text{ MHz}$ $I_E = 5\text{ mA}$ ; $-V_{CB} = 10\text{ V}$	$f_T$	typ.	650 MHz

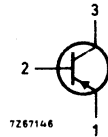
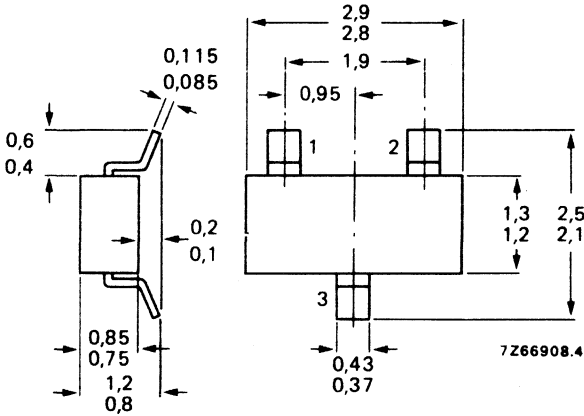
### MECHANICAL DATA

Fig. 1 SOT-23.

Dimensions in mm

Marking code

BF660 = G8



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter)	$-V_{CB0}$	max.	40 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	4 V
Collector current (peak value)	$-I_{CM}$	max.	25 mA
Base current (d.c.)	$-I_B$	max.	10 mA
→ Total power dissipation up to $T_{amb} = 60\text{ }^\circ\text{C}^{**}$	$P_{tot}$	max.	200 mW
Storage temperature	$T_{stg}$		-65 to + 150 $^\circ\text{C}$
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Collector cut-off current

$I_E = 0; -V_{CB} = 20\text{ V}$	$-I_{CB0}$	<	50 nA
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D.C. current gain

$I_E = 3\text{ mA}; -V_{CE} = 10\text{ V}$	$h_{FE}$	>	30
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Transition frequency at  $f = 100\text{ MHz}$

$I_E = 5\text{ mA}; -V_{CB} = 10\text{ V}$	$f_T$	typ.	650 MHz
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Feedback capacitance at  $f = 1\text{ MHz}$

$I_E = 1\text{ mA}; -V_{CB} = 10\text{ V}$	$C_{re}$	typ.	0,65 pF
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\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.



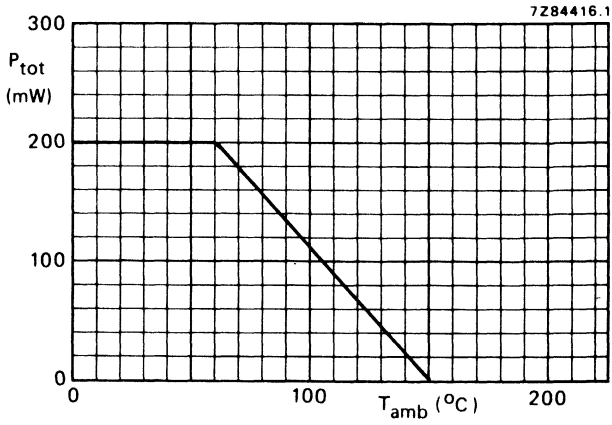


Fig. 2 Power derating curve.





## SILICON PLANAR TRANSISTOR

P-N-P transistor in a microminiature plastic envelope, primarily intended for application as gain controlled amplifier e.g. in v.h.f. and u.h.f. television tuners in thick and thin-film circuits.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30 V	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30 V	
Collector current (d.c.)	$-I_C$	max.	20 mA	
Total power dissipation up to $T_{amb} = 60\text{ }^\circ\text{C}$	$P_{tot}$	max.	200 mW	←
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$	
Transition frequency at $f = 100\text{ MHz}$ $I_E = 3\text{ mA}; -V_{CB} = 10\text{ V}$	$f_T$	typ.	900 MHz	
Transducer gain (common base) $I_E = 3\text{ mA}; -V_{CB} = 10\text{ V}; f = 800\text{ MHz}$ $R_S = 60\ \Omega; R_L = 500\ \Omega$	$G_{tr}$	typ.	13 dB	
Noise figure (common base) $I_E = 3\text{ mA}; -V_{CB} = 10\text{ V}; f = 800\text{ MHz}$ $R_S = 60\ \Omega; R_L = 500\ \Omega$	F	typ.	4 dB	

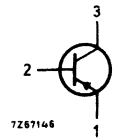
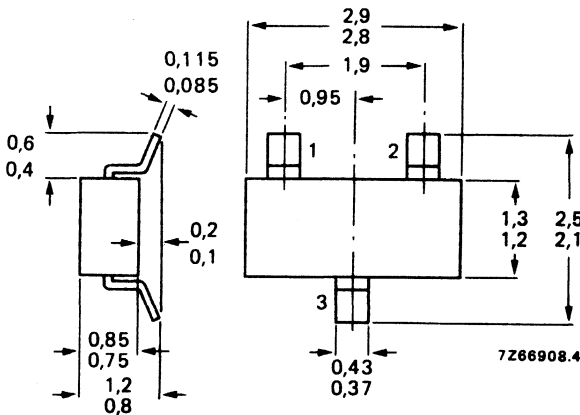
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BF767 = G9



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter)	$-V_{CB0}$	max.	30 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	3 V
Collector current (d.c.)	$-I_C$	max.	20 mA
→ Total power dissipation up to $T_{amb} = 60\text{ }^\circ\text{C}^{**}$	$P_{tot}$	max.	200 mW
Storage temperature	$T_{stg}$		-65 to + 150 $^\circ\text{C}$
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

$T_{amb} = 25\text{ }^\circ\text{C}$ ; unless otherwise specified

Collector cut-off current

$$I_E = 0; -V_{CB} = 15\text{ V} \quad -I_{CB0} < 100\text{ nA}$$

D.C. current gain

$$-I_E = 3\text{ mA}; -V_{CB} = 10\text{ V} \quad h_{FE} > \begin{matrix} 15 \\ \text{typ. } 60 \end{matrix}$$

$$-I_E = 7\text{ mA}; -V_{CB} = 4\text{ V} \quad h_{FE} > 10$$

Transition frequency at  $f = 100\text{ MHz}$

$$I_E = 3\text{ mA}; -V_{CB} = 10\text{ V} \quad f_T \text{ typ. } 900\text{ MHz}$$

$$I_E = 7\text{ mA}; -V_{CB} = 5\text{ V} \quad f_T \text{ typ. } 90\text{ MHz}$$

Feedback capacitance at  $f = 500\text{ kHz}$

$$I_E = 1\text{ mA}; -V_{CB} = 10\text{ V} \quad C_{re} \text{ typ. } 0,3\text{ pF}$$

$$I_E = 0; -V_{CB} = 10\text{ V} \quad C_{rb} \text{ typ. } 160\text{ fF}$$

Transducer gain (common base)

$$I_E = 3\text{ mA}; -V_{CB} = 10\text{ V}; f = 800\text{ MHz} \\ R_S = 60\ \Omega; R_L = 500\ \Omega \quad G_{tr} \text{ typ. } 13\text{ dB}$$

Noise figure (common base)

$$I_E = 3\text{ mA}; -V_{CB} = 10\text{ V}; f = 800\text{ MHz} \\ R_S = 60\ \Omega; R_L = 500\ \Omega \quad F \text{ typ. } 4\text{ dB}$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

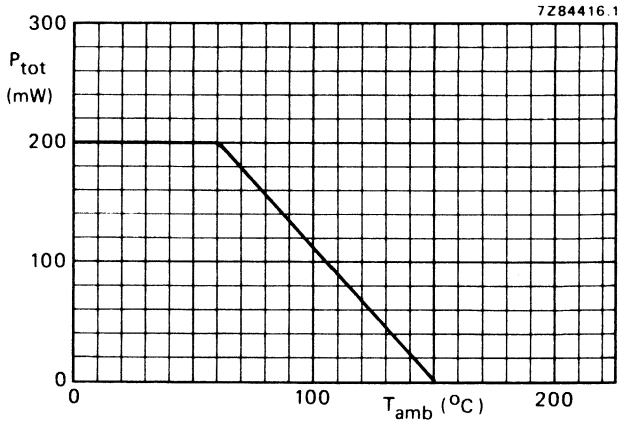


Fig. 2 Power derating curve.





## SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N multi-emitter transistor in a miniature plastic envelope intended for application in thick and thin-film circuits. The transistor has extremely good intermodulation properties and a high power gain. It is primarily intended for:

- Output and driver stages of channel and band serial amplifiers with high output power for bands I, II, III and IV/V (40–860 MHz).
- Output and driver stages of wideband amplifiers.

### QUICK REFERENCE DATA

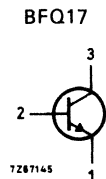
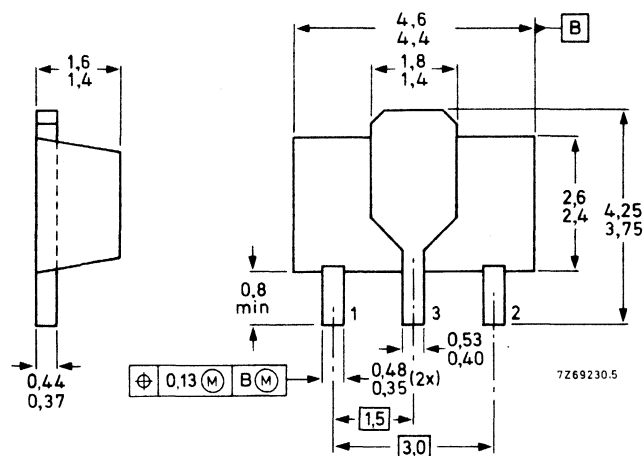
Collector-base voltage (open emitter; peak value)	$V_{CBOM}$	max.	40 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	25 V
Collector current (peak value; $f > 1$ MHz)	$I_{CM}$	max.	300 mA
Total power dissipation up to $T_{amb} = 25$ °C	$P_{tot}$	max.	1 W
Junction temperature	$T_j$	max.	150 °C
Transition frequency at $f = 500$ MHz $I_C = 150$ mA; $V_{CE} = 15$ V	$f_T$	typ.	1,2 GHz
Feedback capacitance at $f = 1$ MHz $I_C = 10$ mA; $V_{CE} = 15$ V; $T_{amb} = 25$ °C	$C_{re}$	typ.	1,9 pF

### MECHANICAL DATA

Dimensions in mm

Mark

Fig. 1 SOT-89.



See also *Soldering recommendations*.

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

Voltages

Collector-base voltage (open emitter; peak value)	$V_{CBOM}$	max.	40	V
Collector-emitter voltage ( $R_{BE} \leq 50 \Omega$ ; peak value)	$V_{CERM}$	max.	40	V 1)
Collector-emitter voltage (open base)	$V_{CEO}$	max.	25	V 1)
Emitter-base voltage (open collector)	$V_{EBO}$	max.	2	V

Currents

Collector current (d.c.)	$I_C$	max.	150	mA
Collector current (peak value; $f > 1$ MHz)	$I_{CM}$	max.	300	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ mounted on a ceramic substrate area = 2,5 cm <sup>2</sup> ; thickness = 0,7 mm	$P_{tot}$	max.	1	W
--	-----------	------	---	---

Temperatures

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

**THERMAL RESISTANCE**

From junction to collector tab	$R_{th j-tab}$	=	30	$^\circ\text{C/W}$ ←
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm <sup>2</sup> ; thickness = 0,7 mm	$R_{th j-a}$	=	125	$^\circ\text{C/W}$

1)  $I_C = 10$  mA.



**CHARACTERISTICS**

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

Collector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150\text{ }^\circ\text{C}$

$I_{CBO} < 20\text{ }\mu\text{A}$

Saturation voltage

$I_C = 100\text{ mA}; I_B = 10\text{ mA}$

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

D.C. current gain

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

$h_{FE} > 25$

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

$h_{FE} > 25$

Transition frequency at  $f = 500\text{ MHz}$  1)

$I_C = 150\text{ mA}; V_{CE} = 15\text{ V}$

$f_T$  typ. 1,2 GHz

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

$I_E = I_e = 0; V_{CB} = 15\text{ V}$

$C_c < 4\text{ pF}$

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

$I_C = 10\text{ mA}; V_{CE} = 15\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$

$C_{re}$  typ. 1,9 pF

Max. unilateral power gain ( $s_{re}$  assumed to be zero)

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

$I_C = 60\text{ mA}; V_{CE} = 15\text{ V}; T_{amb} = 25\text{ }^\circ\text{C};$

$f = 200\text{ MHz}$

$f = 800\text{ MHz}$

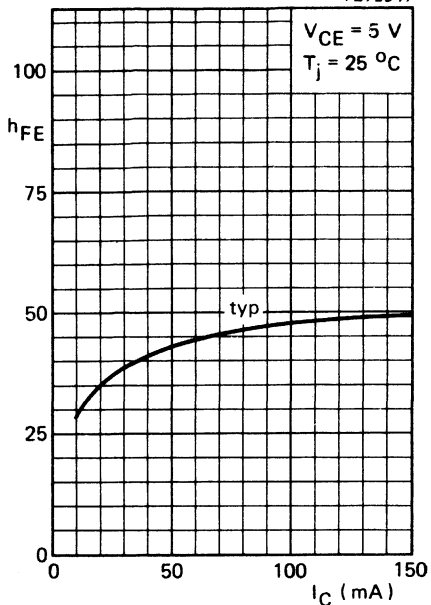
$G_{UM}$  typ. 16 dB

$G_{UM}$  typ. 6,5 dB

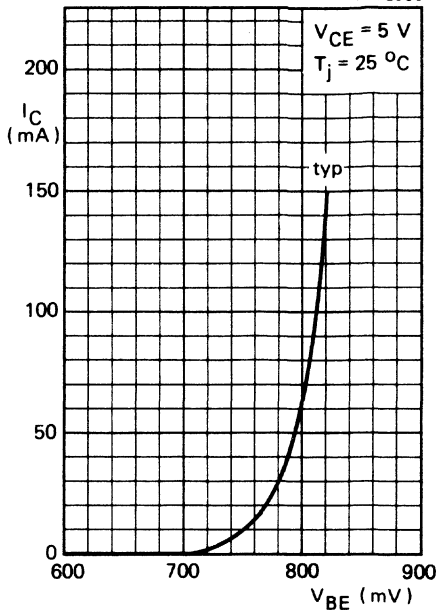


1) Measured under pulse conditions.

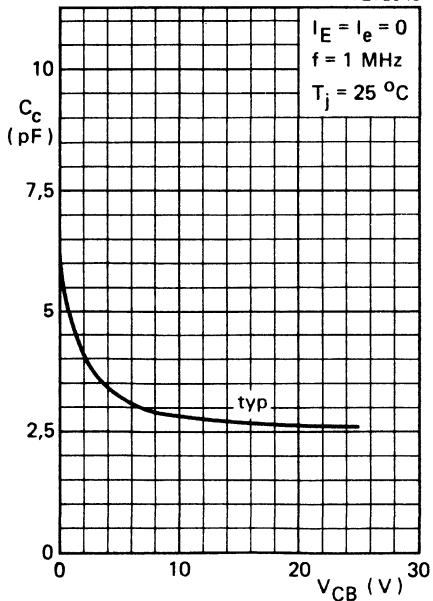
7Z72947



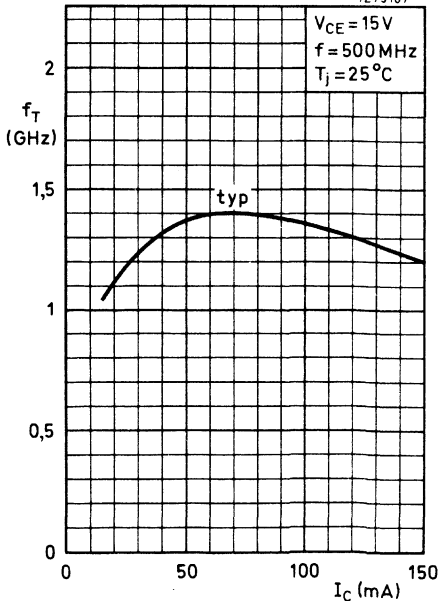
7Z72950



7Z72948



7Z73167



## SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a miniature plastic envelope intended for application in thick and thin-film circuits. It is primarily intended for MATV purposes.

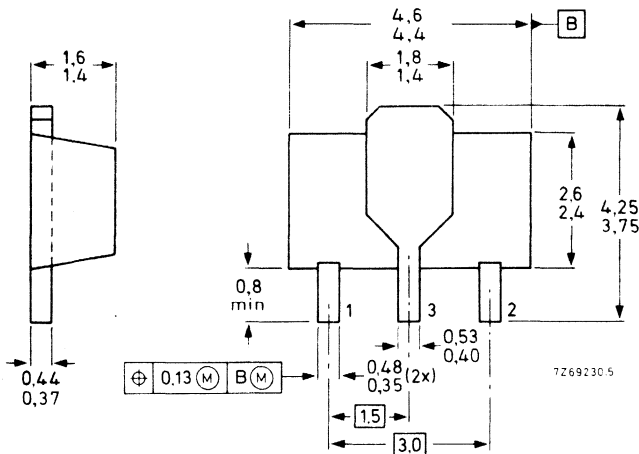
### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CBO}$	max.	25 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	15 V
Collector current (d.c.)	$I_C$	max.	150 mA
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max.	1 W
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$
Transition frequency at $f = 500\text{ MHz}$ $I_C = 100\text{ mA}$ ; $V_{CE} = 10\text{ V}$	$f_T$	typ.	3,6 GHz
Feedback capacitance at $f = 10,7\text{ MHz}$ $I_C = 0$ ; $V_{CE} = 10\text{ V}$	$C_{re}$	typ.	1,2 pF
Intermodulation distortion $I_C = 80\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $R_L = 75\text{ }\Omega$ measured at $f_{(p+q-r)} = 793,25\text{ MHz}$	$d_{im}$	<	-60 dB

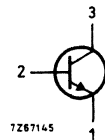
### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-89.



Mark  
BFQ18A



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter)	$V_{CBO}$	max.	25 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	15 V
Emitter-base voltage (open collector)	$V_{EBO}$	max.	2 V
Collector current (d.c.)	$I_C$	max.	150 mA
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$ *	$P_{tot}$	max.	1 W
Storage temperature	$T_{stg}$		-65 to + 150 $^\circ\text{C}$
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$

**THERMAL RESISTANCE**

From junction to collector tab	$R_{th\ j-tab}$	=	25 $^\circ\text{C/W}$
From junction to ambient in free air *	$R_{th\ j-a}$	=	125 $^\circ\text{C/W}$

**CHARACTERISTICS**

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

D.C. current gain \*\*

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE}$	>	25
$I_C = 100\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE}$	>	25

Transition frequency at  $f = 500\text{ MHz}$  \*\*

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	$f_T$	typ.	3,2 GHz
$I_C = 100\text{ mA}; V_{CE} = 10\text{ V}$	$f_T$	typ.	3,6 GHz

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

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	$C_C$	typ.	2,0 pF
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Emitter capacitance at  $f = 1\text{ MHz}$

$I_C = I_c = 0; V_{EB} = 0,5\text{ V}$	$C_e$	typ.	11 pF
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Feedback capacitance at  $f = 10,7\text{ MHz}$

$I_C = 0; V_{CE} = 10\text{ V}$	$C_{re}$	typ.	1,2 pF
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\* The device mounted on a ceramic substrate area = 2,5 cm<sup>2</sup>; thickness = 0,7 mm.

\*\* Measured under pulse conditions.

Intermodulation distortion (see Fig. 2)

$I_C = 80 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ ;  $R_L = 75 \Omega$   
 $V_p = V_o = 700 \text{ mV}$  at  $f_p = 795,25 \text{ MHz}$   
 $V_q = V_o - 6 \text{ dB}$  at  $f_q = 803,25 \text{ MHz}$   
 $V_r = V_o - 6 \text{ dB}$  at  $f_r = 805,25 \text{ MHz}$   
 Measured at  $f_{(p+q-r)} = 793,25 \text{ MHz}$

$d_{im} < -60 \text{ dB}$

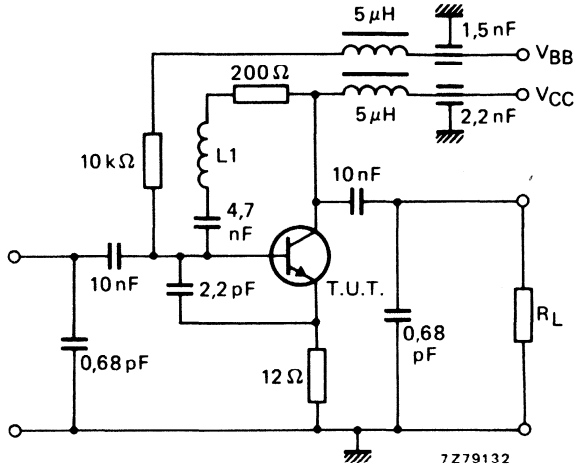


Fig. 2 MATV-test circuit (40–860 MHz).





## SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a miniature plastic envelope intended for application in thick- and thin-film circuits.

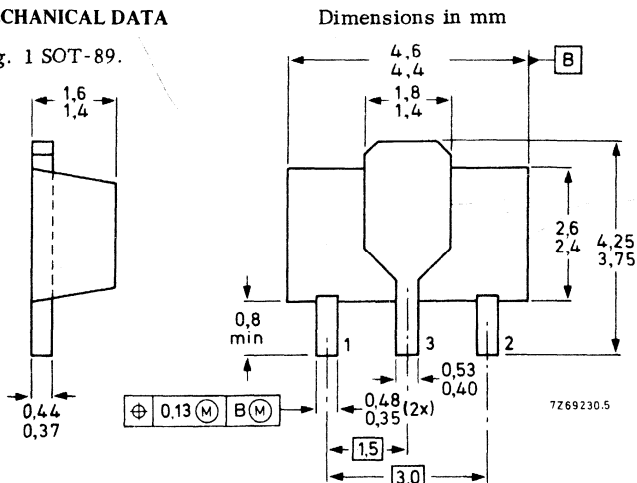
It is primarily intended for use in u.h.f. and microwave amplifiers such as in aerial amplifiers, radar systems, oscilloscopes, spectrum analysers etc.

The transistor features very low intermodulation distortion and high power gain. Thanks to its very high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	$V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	15 V
Collector current (d.c.)	$I_C$	max.	75 mA
Total power dissipation up to $T_{amb} = 87,5\text{ }^\circ\text{C}$	$P_{tot}$	max.	500 mW
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$
Transition frequency at $f = 500\text{ MHz}$ $I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	$f_T$	typ.	5 GHz
Feedback capacitance at $f = 1\text{ MHz}$ $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$	$C_{re}$	typ.	1,3 pF
Noise figure at optimum source impedance $I_C = 50\text{ mA}; V_{CE} = 10\text{ V}; f = 500\text{ MHz}; T_{amb} = 25\text{ }^\circ\text{C}$	F	typ.	3,3 dB

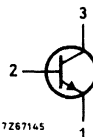
### MECHANICAL DATA

Fig. 1 SOT-89.



### Mark

BFQ19



See also Soldering recommendations.

**RATINGS** Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

Collector-base voltage (open emitter)	$V_{CB0}$	max.	20	V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	15	V
Emitter-base voltage (open collector)	$V_{EBO}$	max.	3,0	V

Currents

Collector current (d.c.)	$I_C$	max.	75	mA
Collector current (peak value); $f > 1$ MHz	$I_{CM}$	max.	150	mA

Power dissipation

Total power dissipation up to $T_{amb} = 87,5$ °C mounted on a ceramic substrate area = $2,5$ cm <sup>2</sup> ; thickness = $0,7$ mm	$P_{tot}$	max.	500	mW
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Temperatures

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

**THERMAL RESISTANCE**

From junction to collector tab	$R_{thj-tab}$	=	40	°C/W
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From junction to ambient in free air mounted on a ceramic substrate area = $2,5$ cm <sup>2</sup> ; thickness = $0,7$ mm	$R_{thj-a}$	=	125	°C/W
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**CHARACTERISTICS** $T_j = 25\text{ }^\circ\text{C}$  unless otherwise specifiedCollector cut-off current

$I_E = 0; V_{CB} = 10\text{ V}$	$I_{CBO}$	<	100	nA
---------------------------------	-----------	---	-----	----

D. C. current gain 1)

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE}$	>	25	
		typ.	50	

$I_C = 75\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE}$	>	25	
		typ.	52	

Transition frequency at  $f = 500\text{ MHz}$  1)

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	$f_T$	>	4,0	GHz
		typ.	5,0	GHz

$I_C = 75\text{ mA}; V_{CE} = 10\text{ V}$	$f_T$	>	4,4	GHz
		typ.	5,5	GHz

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

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	$C_c$	typ.	1,6	pF
---------------------------------------	-------	------	-----	----

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

$I_C = I_c = 0; V_{EB} = 0,5\text{ V}$	$C_e$	typ.	5,0	pF
--	-------	------	-----	----

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

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$	$C_{re}$	typ.	1,3	pF
--	----------	------	-----	----

Noise figure at optimum source impedance

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}; f = 500\text{ MHz}; T_{amb} = 25\text{ }^\circ\text{C}$	F	typ.	3,3	dB
--	---	------	-----	----

Max. unilateral power gain ( $s_{re}$  assumed to be zero)

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{1e}|^2)(1 - |s_{oe}|^2)}$$

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = 25\text{ }^\circ\text{C};$

$f = 200\text{ MHz}$

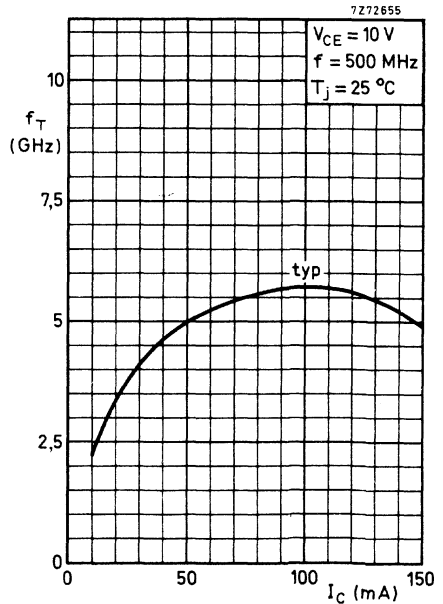
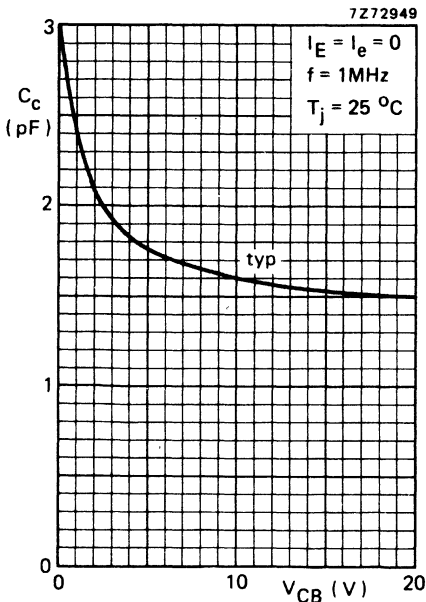
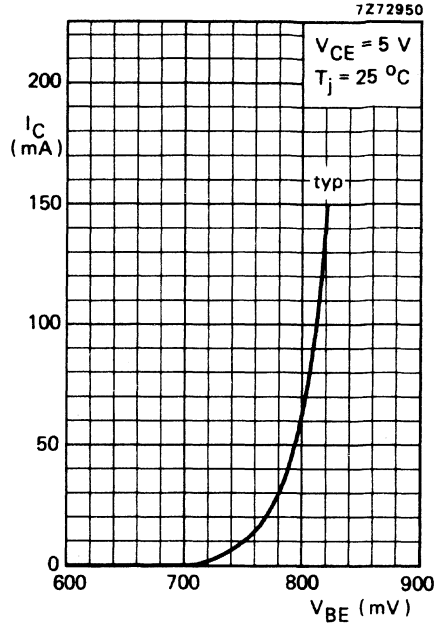
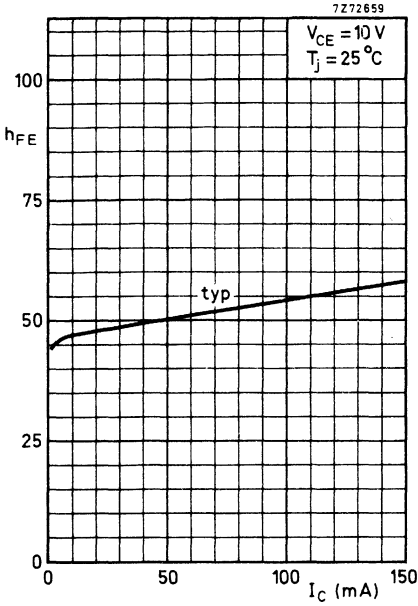
$f = 500\text{ MHz}$

$f = 800\text{ MHz}$

GUM	typ.	18,5	dB
GUM	typ.	11,5	dB
GUM	typ.	7,5	dB



1) Measured under pulse conditions.



## N-CHANNEL SILICON FIELD-EFFECT TRANSISTORS

Planar epitaxial junction field effect transistor in a microminiature plastic envelope. It is intended for low level general purpose amplifiers in thick and thin-film circuits.

### QUICK REFERENCE DATA

Drain-source voltage	$\pm V_{DS}$	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V
Total power dissipation up to $T_{amb} = 65\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	250	mW
<b>BFR30   BFR31</b>				
Drain current $V_{DS} = 10\text{ V}; V_{GS} = 0$	$I_{DSS}$	$>$	4	1 mA
		$<$	10	5 mA
Transfer admittance (common source) $I_D = 1\text{ mA}; V_{DS} = 10\text{ V}; f = 1\text{ kHz}$	$ y_{fs} $	$>$	1,0	1,5 mA/V
		$<$	4,0	4,5 mA/V

### MECHANICAL DATA

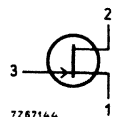
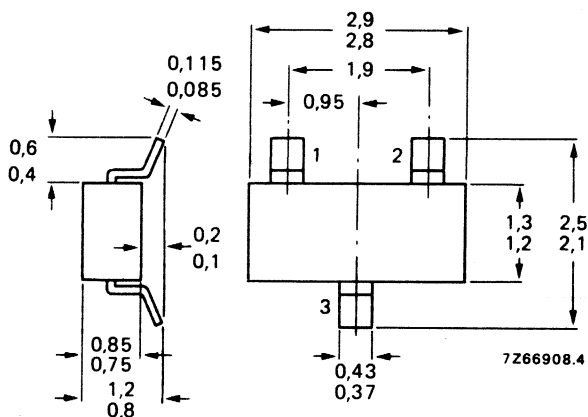
Fig. 1 SOT-23.

Dimensions in mm

Marking code

BFR30 = M1

BFR31 = M2



See also *Soldering recommendations*.

**RATINGS**

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

Drain-source voltage see Fig. 2	$\pm V_{DS}$	max.	25	V
Drain-gate voltage (open source) see Fig. 2	$V_{DGO}$	max.	25	V
Gate-source voltage (open drain) see Fig. 2	$-V_{GSO}$	max.	25	V
Drain current	$I_D$	max.	10	mA
Gate current	$I_G$	max.	5	mA
→ Total power dissipation up to $T_{amb} = 65\text{ }^\circ\text{C}^{**}$	$P_{tot}$	max.	250	mW
→ Storage temperature	$T_{stg}$		-65 to + 175	$^\circ\text{C}$
→ Junction temperature	$T_j$	max.	175	$^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60	K/W
From tab to soldering points	$R_{th\ t-s}$	=	260	K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120	K/W

**CHARACTERISTICS**

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

			BFR30	BFR31	
Gate cut-off current					
$-V_{GS} = 10\text{ V}; V_{DS} = 0$	$-I_{GSS}$	<	0,2	0,2	nA
Drain current					
$V_{DS} = 10\text{ V}; V_{GS} = 0$	$I_{DSS}$	>	4	1	mA
		<	10	5	mA
Gate-source voltage					
$I_D = 1\text{ mA}; V_{DS} = 10\text{ V}$	$-V_{GS}$	>	0,7	0	V
		<	3,0	1,3	V
$I_D = 50\text{ }\mu\text{A}; V_{DS} = 10\text{ V}$	$-V_{GS}$	<	4,0	2,0	V
Gate-source cut-off voltage					
$I_D = 0,5\text{ nA}; V_{DS} = 10\text{ V}$	$-V_{(P)GS}$	<	5	2,5	V

**y parameters**

Transfer admittance at  $f = 1\text{ kHz}; T_{amb} = 25\text{ }^\circ\text{C}$

$I_D = 1\text{ mA}; V_{DS} = 10\text{ V}$	$ y_{fs} $	>	1,0	1,5	mA/V
		<	4,0	4,5	mA/V
$I_D = 200\text{ }\mu\text{A}; V_{DS} = 10\text{ V}$	$ y_{fs} $	>	0,5	0,75	mA/V
Output admittance at $f = 1\text{ kHz}$					
$I_D = 1\text{ mA}; V_{DS} = 10\text{ V}$	$ y_{os} $	<	40	25	$\mu\text{A/V}$
$I_D = 200\text{ }\mu\text{A}; V_{DS} = 10\text{ V}$	$ y_{os} $	<	20	15	$\mu\text{A/V}$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

y parameters (continued)

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

$I_D = 1 \text{ mA}; V_{DS} = 10 \text{ V}$

$I_D = 200 \mu\text{A}; V_{DS} = 10 \text{ V}$

Feedback capacitance at  $f = 1 \text{ MHz}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

$I_D = 1 \text{ mA}; V_{DS} = 10 \text{ V}$

$I_D = 200 \mu\text{A}; V_{DS} = 10 \text{ V}$

Equivalent noise voltage

$I_D = 200 \mu\text{A}; V_{DS} = 10 \text{ V}$

$B = 0,6 \text{ to } 100 \text{ Hz}$

		BFR30	BFR31	
$C_{is}$	<	4	4	pF
$C_{is}$	<	4	4	pF
$C_{rs}$	<	1,5	1,5	pF
$C_{rs}$	<	1,5	1,5	pF
$V_n$	<	0,5	0,5	$\mu\text{V}$

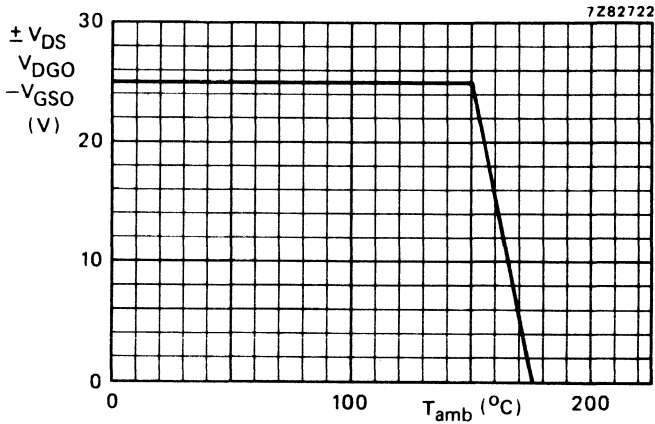


Fig. 2 Voltage derating curve.

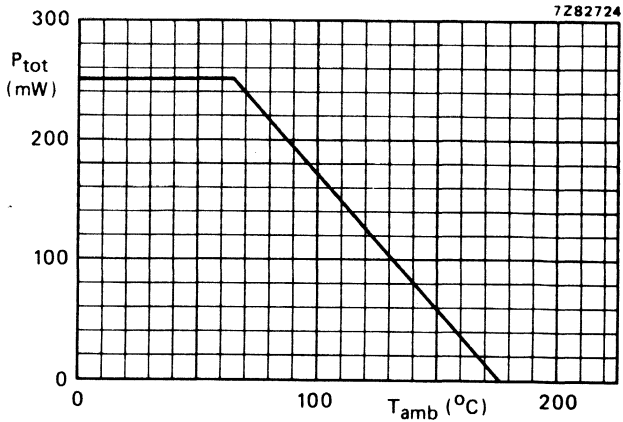
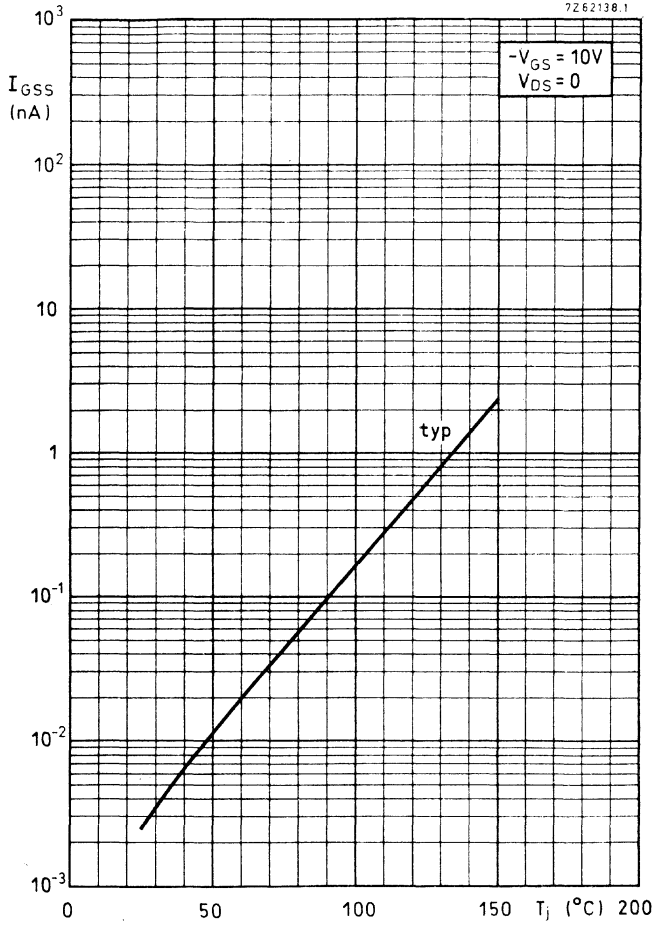
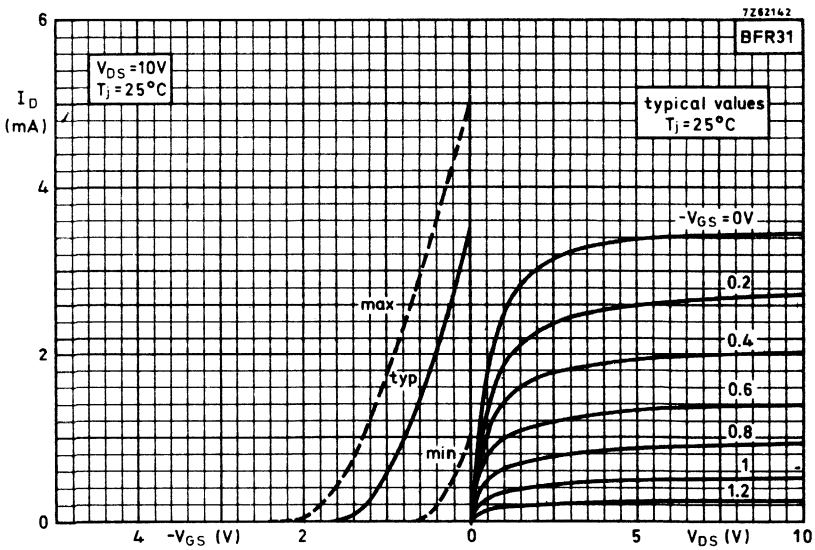
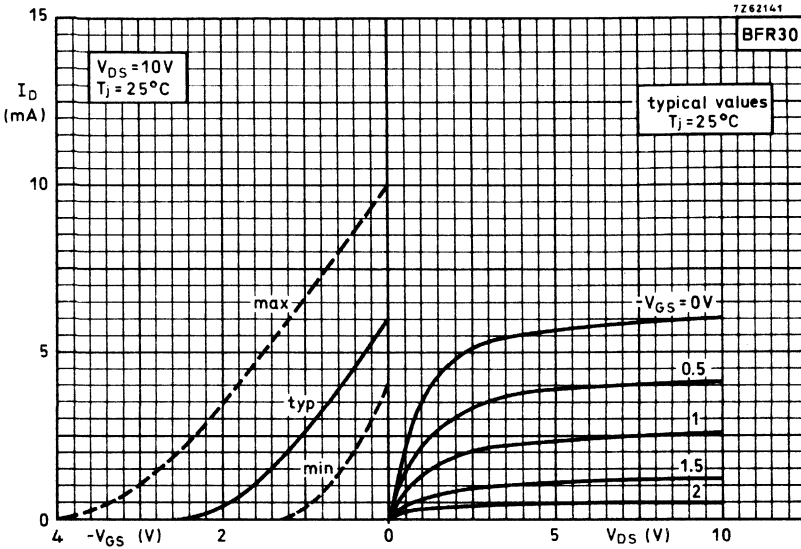
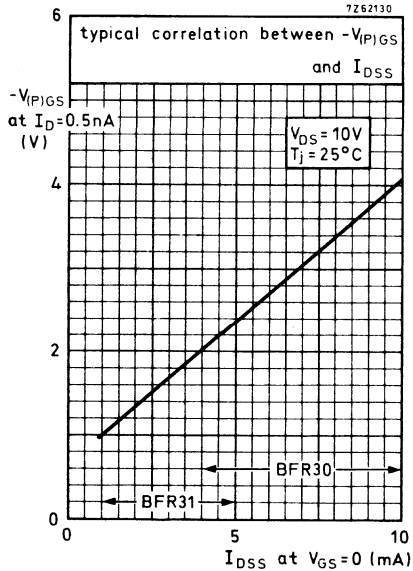
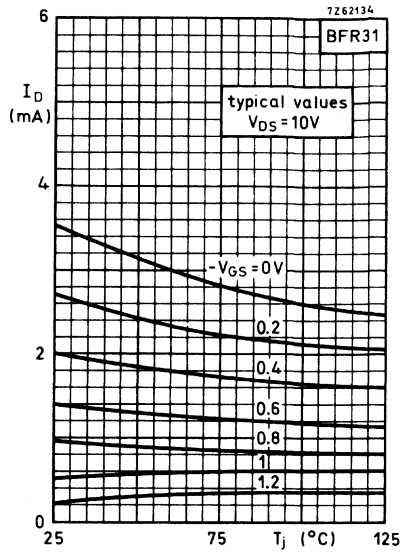
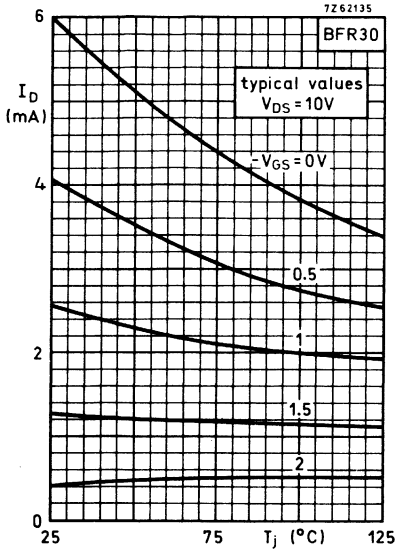


Fig. 3 Power derating curve.

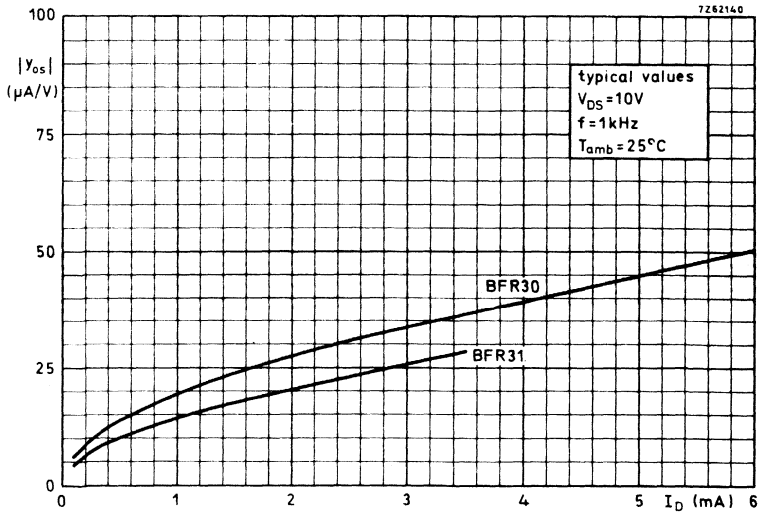
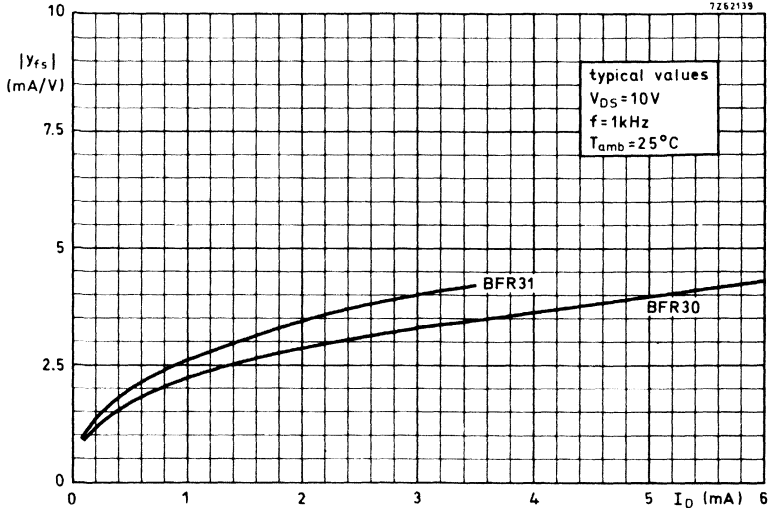




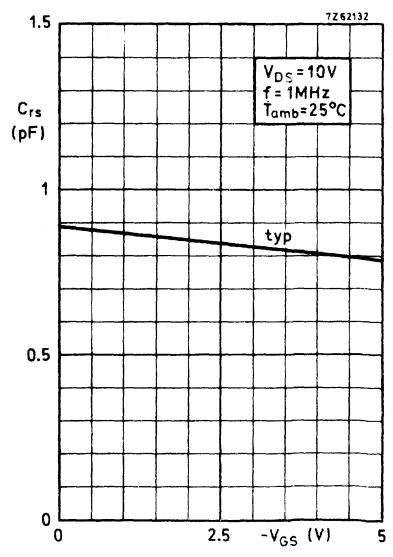
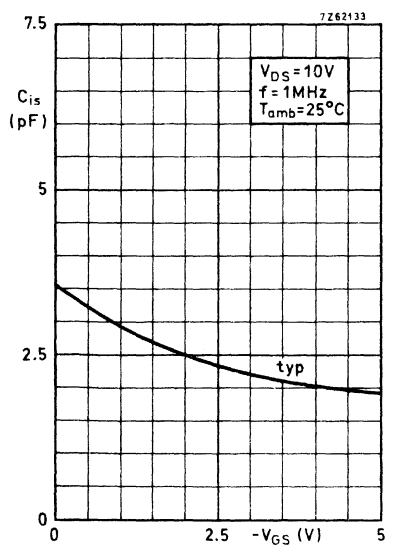
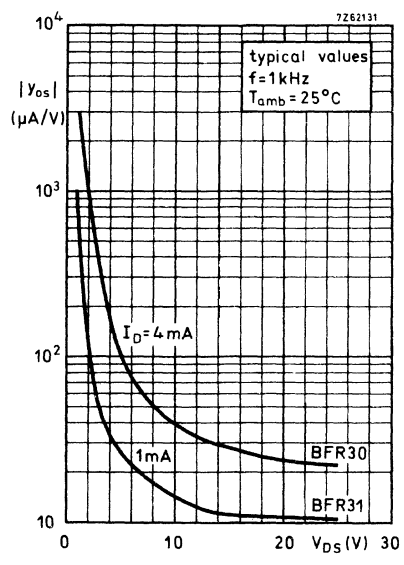
# BFR30; BFR31

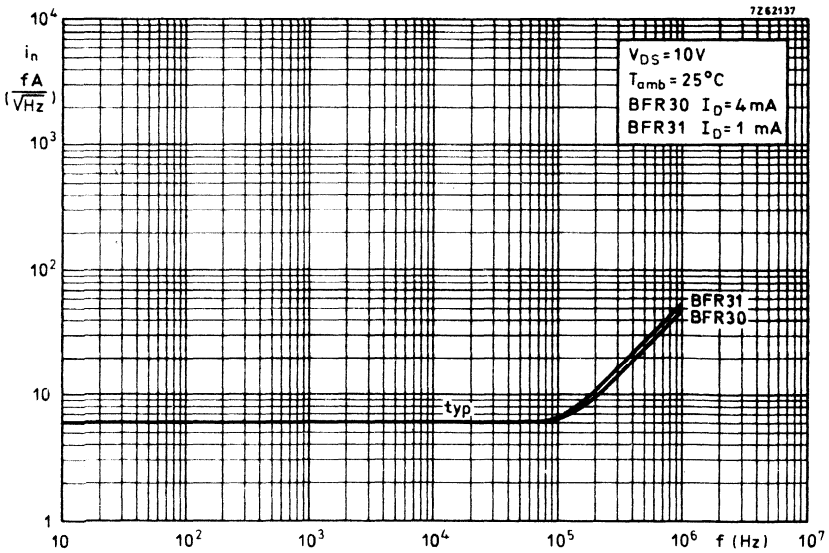
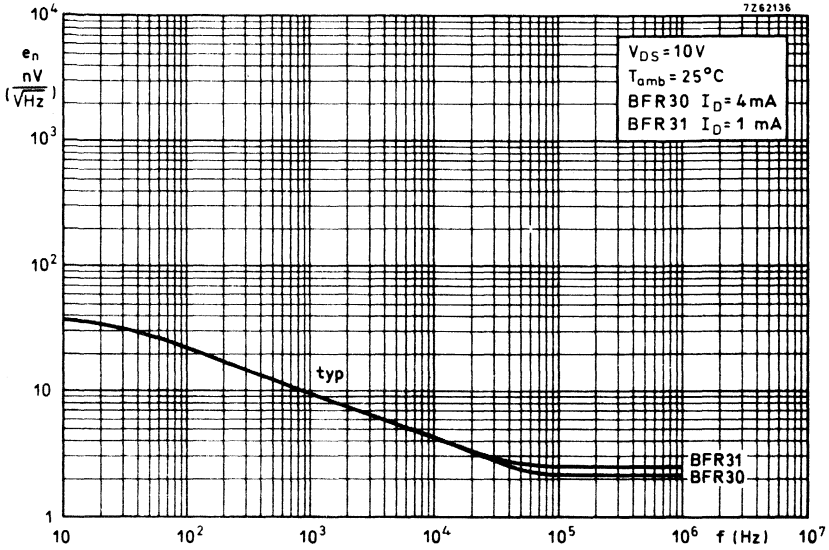






# BFR30; BFR31







## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N multi-emitter transistor in a microminiature plastic envelope intended for application in thick and thin-film circuits. The transistor has very low intermodulation distortion and very high power gain. It is primarily intended for:

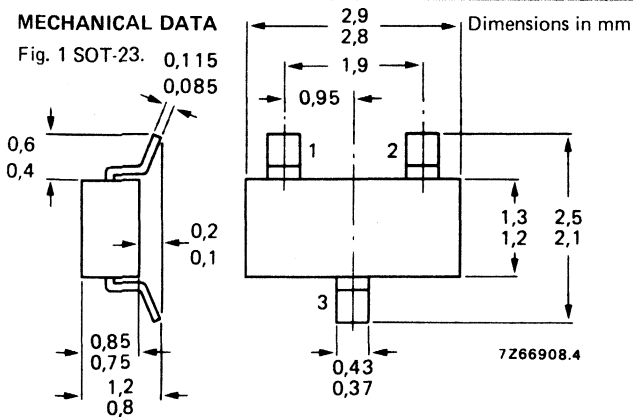
- Wideband vertical amplifiers in high speed oscilloscopes.
- Television distribution amplifiers.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CB0}$	max.	18 V	
Collector-emitter voltage (open base)	$V_{CE0}$	max.	10 V	
Collector current (peak value; $f > 1$ MHz)	$I_{CM}$	max.	100 mA	
Total power dissipation up to $T_{amb} = 65$ °C	$P_{tot}$	max.	250 mW	←
Junction temperature	$T_j$	max.	175 °C	←
Feedback capacitance at $f = 1$ MHz $I_C = 2$ mA; $V_{CE} = 5$ V; $T_{amb} = 25$ °C	$-C_{re}$	typ.	0,9 pF	
Transition frequency at $f = 500$ MHz $I_C = 25$ mA; $V_{CE} = 5$ V	$f_T$	typ.	2,0 GHz	
Max. unilateral power gain (see page 3) $I_C = 30$ mA; $V_{CE} = 5$ V; $f = 200$ MHz; $T_{amb} = 25$ °C	$G_{UM}$	typ.	22 dB	
$I_C = 30$ mA; $V_{CE} = 5$ V; $f = 800$ MHz; $T_{amb} = 25$ °C	$G_{UM}$	typ.	10,5 dB	
Intermodulation distortion at $T_{amb} = 25$ °C $I_C = 30$ mA; $V_{CE} = 5$ V; $R_L = 37,5$ $\Omega$ $V_o = 100$ mV at $f_p = 183$ MHz $V_o = 100$ mV at $f_q = 200$ MHz measured at $f(2q-p) = 217$ MHz	$d_{im}$	typ.	-60 dB	

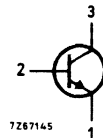
### MECHANICAL DATA

Fig. 1 SOT-23.

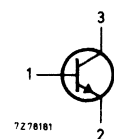


### Marking code

BFR53 = N1



BFR53R = N4



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) see Fig. 3	$V_{CBO}$	max.	18 V
Collector-emitter voltage (open base) see Fig. 3	$V_{CEO}$	max.	10 V
Emitter-base voltage (open collector) see Fig. 3	$V_{EBO}$	max.	2,5 V
Collector current (d.c.)	$I_C$	max.	50 mA
Collector current (peak value: $f > 1$ MHz)	$I_{CM}$	max.	100 mA
Total power dissipation up to $T_{amb} = 65$ °C**	$P_{tot}$	max.	250 mW
Storage temperature	$T_{stg}$		-65 to +175 °C
Junction temperature	$T_j$	max.	175 °C

→ **THERMAL CHARACTERISTICS\***

$$T_j = P_x (R_{th j-t} + R_{th t-s} + R_{th s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th j-t}$	=	60 K/W
From tab to soldering points	$R_{th t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th s-a}$	=	120 K/W

**CHARACTERISTICS**

$T_j = 25$  °C unless otherwise specified

Collector cut-off current

$$I_E = 0; V_{CB} = 10 \text{ V} \quad I_{CBO} < 50 \text{ nA}$$

D.C. current gain ▲

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

$$I_C = 50 \text{ mA}; V_{CE} = 5 \text{ V} \quad h_{FE} > 25$$

Transition frequency at  $f = 500$  MHz ▲

$$I_C = 25 \text{ mA}; V_{CE} = 5 \text{ V} \quad f_T \text{ typ. } 2,0 \text{ GHz}$$

Collector capacitance at  $f = 1$  MHz

$$I_E = I_e = 0; V_{CB} = 5 \text{ V} \quad C_c \text{ typ. } 0,9 \text{ pF}$$

Emitter capacitance at  $f = 1$  MHz

$$I_C = I_c = 0; V_{EB} = 0,5 \text{ V} \quad C_e \text{ typ. } 1,5 \text{ pF}$$

Feedback capacitance at  $f = 1$  MHz

$$I_C = 2 \text{ mA}; V_{CE} = 5 \text{ V}; T_{amb} = 25 \text{ °C} \quad -C_{re} \text{ typ. } 0,9 \text{ pF}$$

▲ Measured under pulse conditions.

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.



Noise figure at  $f = 500 \text{ MHz}$  <sup>▲</sup>

$I_C = 2 \text{ mA}$ ;  $V_{CE} = 5 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

$G_S = 20 \text{ mA/V}$ ;  $B_S$  is tuned

F < 5 dB

Max. unilateral power gain ( $s_{re}$  assumed to be zero)

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{fe}|^2)(1 - |s_{oe}|^2)}$$

$I_C = 30 \text{ mA}$ ;  $V_{CE} = 5 \text{ V}$ ;  $f = 200 \text{ MHz}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

$G_{UM}$  typ. 22 dB

$I_C = 30 \text{ mA}$ ;  $V_{CE} = 5 \text{ V}$ ;  $f = 800 \text{ MHz}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

$G_{UM}$  typ. 10,5 dB

Intermodulation distortion <sup>▲</sup>

$I_C = 30 \text{ mA}$ ;  $V_{CE} = 5 \text{ V}$ ;  $R_L = 37,5 \text{ } \Omega$

$V_o = 100 \text{ mV}$  at  $f_p = 183 \text{ MHz}$

$V_o = 100 \text{ mV}$  at  $f_q = 200 \text{ MHz}$

Measured at  $f(2q - p) = 217 \text{ MHz}$

$d_{im}$  typ. -60 dB

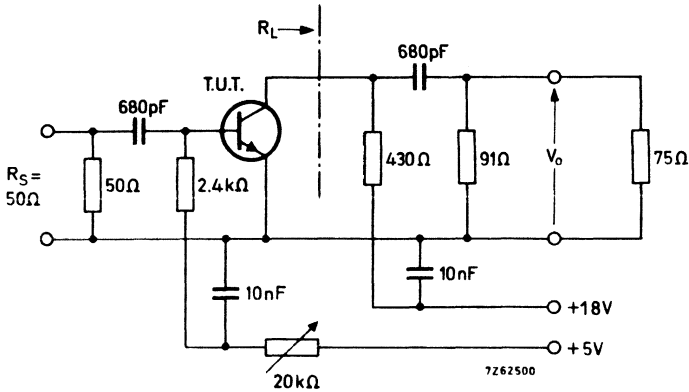


Fig. 2 Test circuit.

<sup>▲</sup> Crystal mounted in a BFW30 envelope.

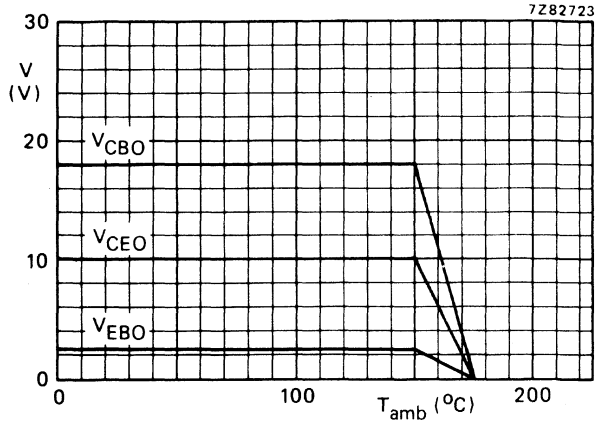


Fig. 3 Voltage derating curves.

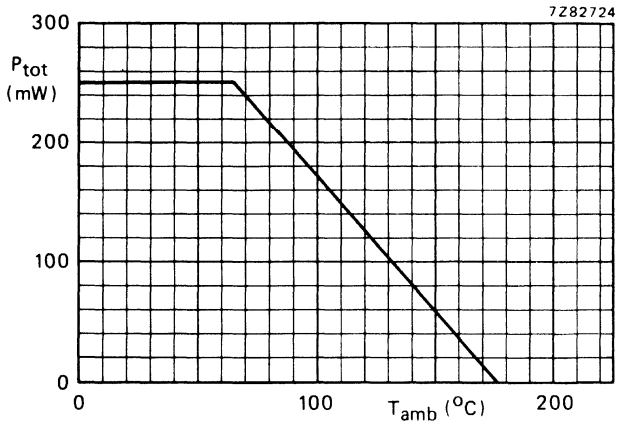
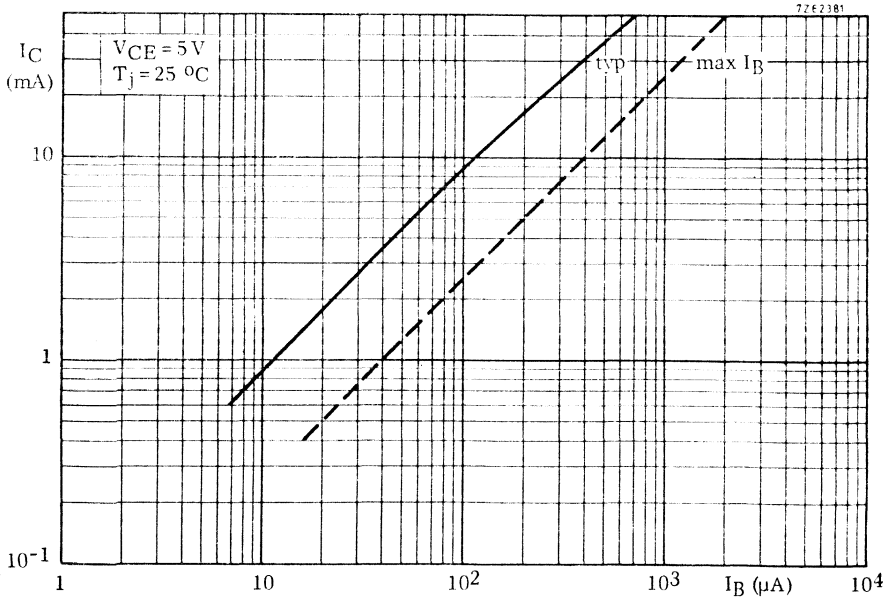
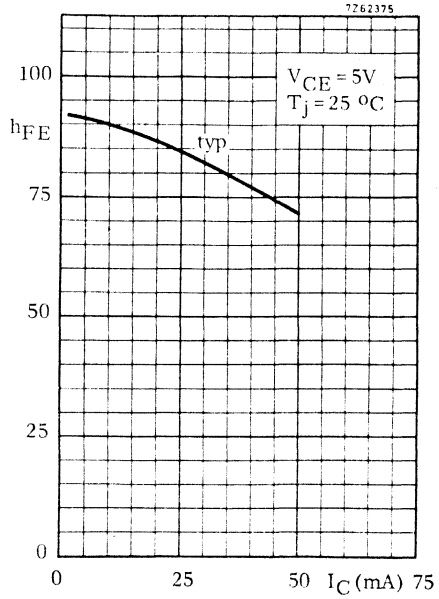
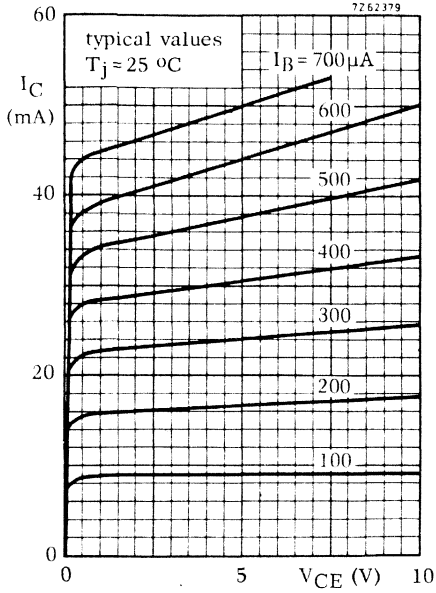
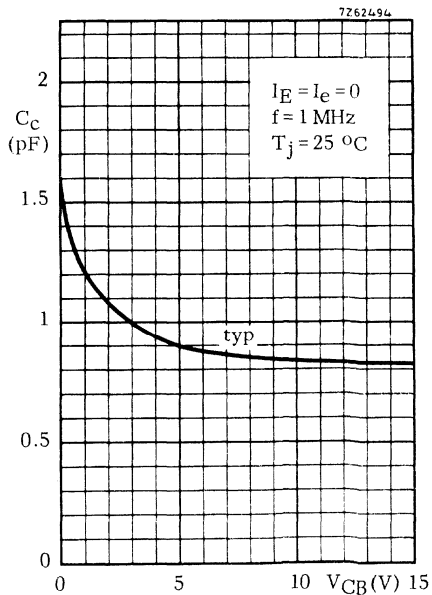
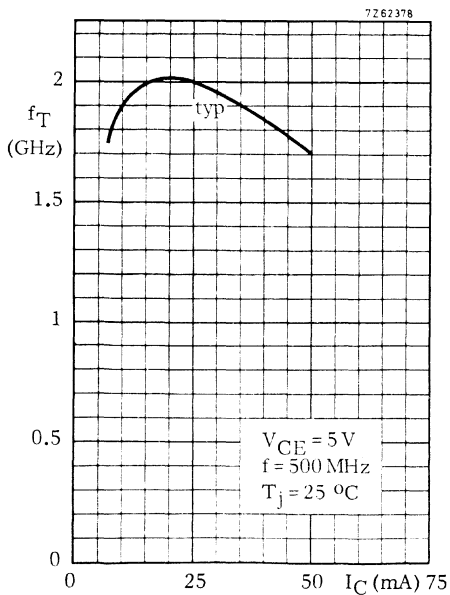
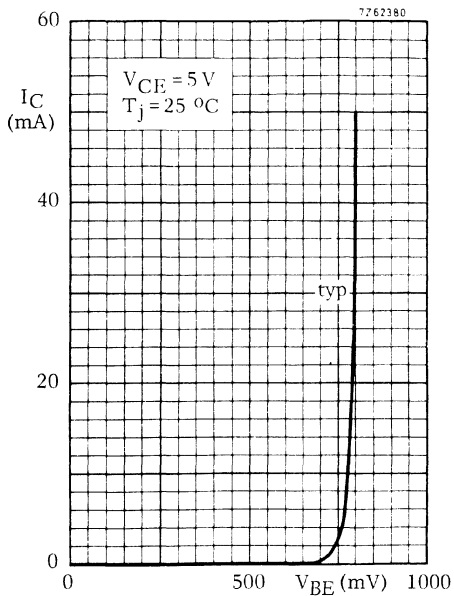


Fig. 4 Power derating curve.

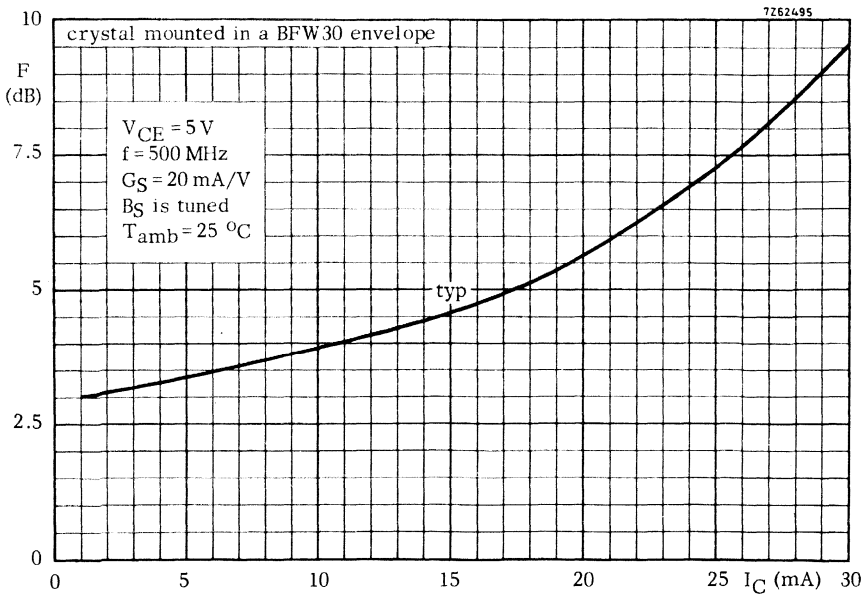
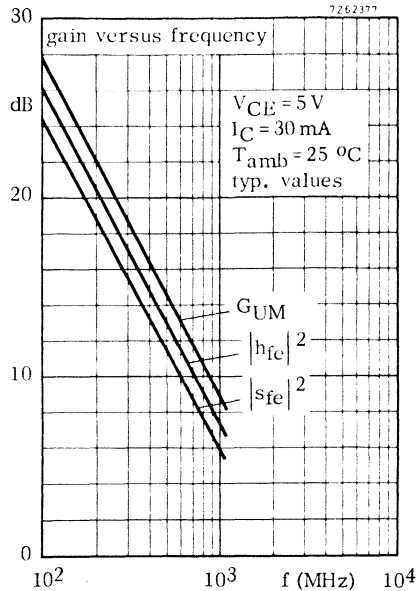
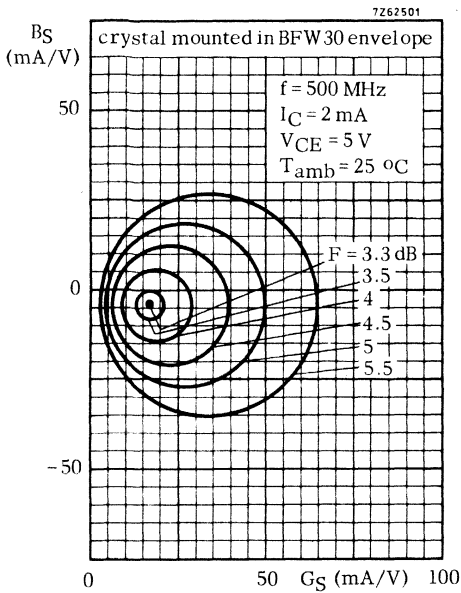






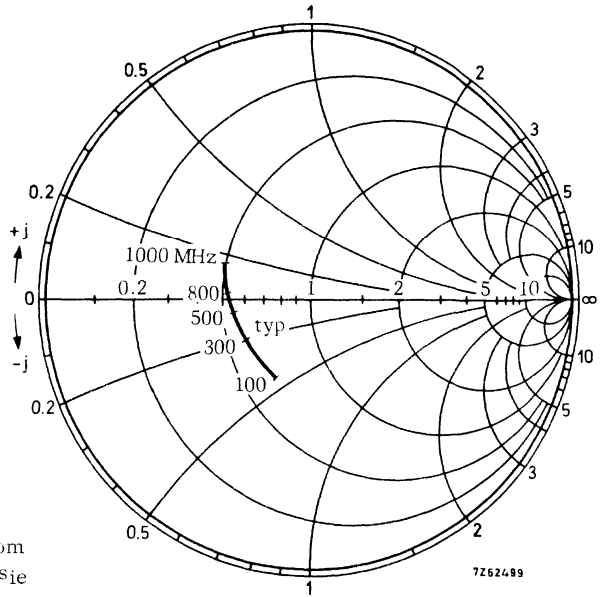


circles of constant noise figure



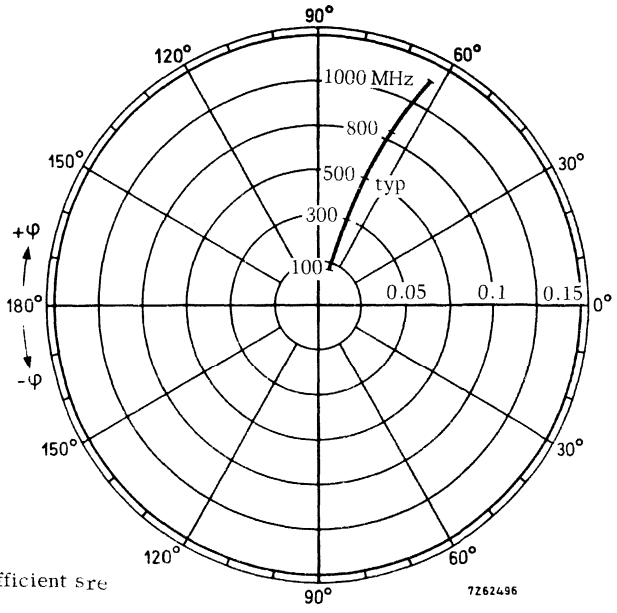
# BFR53

$V_{CE} = 5 \text{ V}$   
 $I_C = 30 \text{ mA}$   
 $T_{amb} = 25 \text{ }^\circ\text{C}$



Input impedance derived from input reflection coefficient  $s_{ie}$  coordinates in ohm x 50

$V_{CE} = 5 \text{ V}$   
 $I_C = 30 \text{ mA}$   
 $T_{amb} = 25 \text{ }^\circ\text{C}$

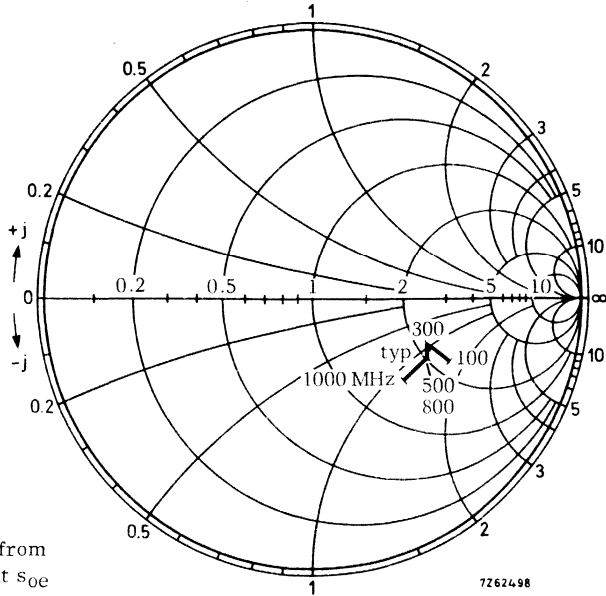


Reverse transmission coefficient  $s_{re}$

$V_{CE} = 5 \text{ V}$

$I_C = 30 \text{ mA}$

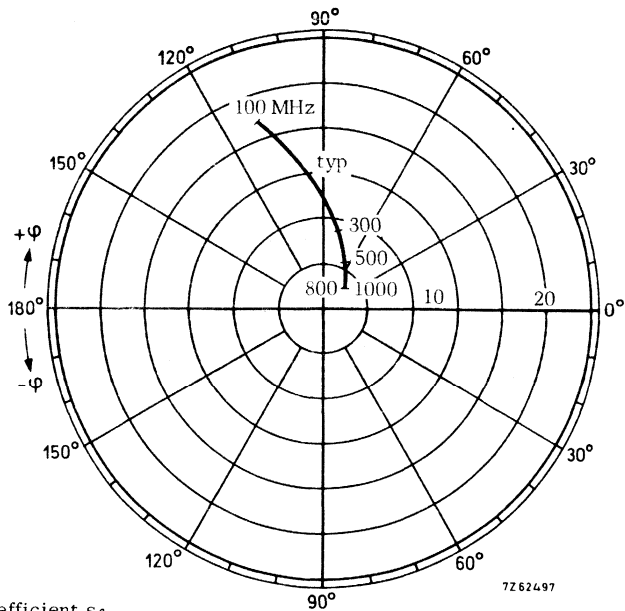
$T_{amb} = 25 \text{ }^\circ\text{C}$



$V_{CE} = 5 \text{ V}$

$I_C = 30 \text{ mA}$

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





## SILICON PLANAR EPITAXIAL TRANSISTORS

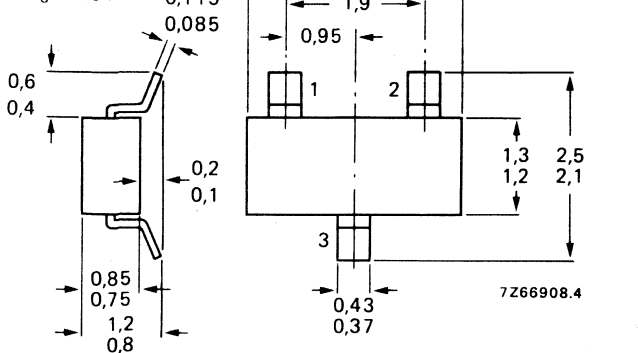
N-P-N transistor in a microminiature plastic envelope. It is primarily intended for use in u.h.f. and microwave amplifiers in thick and thin-film circuits, such as in aerial amplifiers, radar systems, oscilloscopes, spectrum analysers etc. The transistor features low intermodulation distortion and high power gain; thanks to its very high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	15 V
Collector current (d.c.)	$I_C$	max.	25 mA
Total power dissipation up to $T_{amb} = 60\text{ }^\circ\text{C}$	$P_{tot}$	max.	200 mW
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$
Transition frequency at $f = 500\text{ MHz}$ $I_C = 14\text{ mA}$ ; $V_{CE} = 10\text{ V}$	$f_T$	typ.	5 GHz
Feedback capacitance at $f = 1\text{ MHz}$ $I_C = 2\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$	$C_{re}$	typ.	0,7 pF
Noise figure at optimum source impedance $I_C = 2\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 500\text{ MHz}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$	F	typ.	2,4 dB
Max. unilateral power gain (see page 3) $I_C = 14\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 500\text{ MHz}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$	G <sub>UM</sub>	typ.	18 dB
Intermodulation distortion at $T_{amb} = 25\text{ }^\circ\text{C}$ $I_C = 14\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $R_L = 75\text{ }\Omega$ ; $V_O = 150\text{ mV}$ $f_{(p+q-r)} = 493,25\text{ MHz}$ (see page 4)	dim	typ.	-60 dB

### MECHANICAL DATA

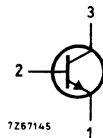
Fig. 1 SOT-23.



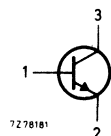
See also *Soldering recommendations*.

### Marking code

BFR92 = P1



BFR92R = P4



**RATINGS**

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

Collector-base voltage (open emitter)	$V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	15 V
Emitter-base voltage (open collector)	$V_{EBO}$	max.	2,0 V
Collector current (d.c.)	$I_C$	max.	25 mA
→ Total power dissipation up to $T_{amb} = 60\text{ °C}$ **	$P_{tot}$	max.	200 mW
Storage temperature	$T_{stg}$		-65 to +150 °C
Junction temperature	$T_j$	max.	150 °C

→ **THERMAL CHARACTERISTICS \***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient **	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Collector cut-off current

$$I_E = 0; V_{CB} = 10\text{ V}$$

$$I_{CBO} < 50\text{ nA}$$

D.C. current gain ▲

$$I_C = 14\text{ mA}; V_{CE} = 10\text{ V}$$

$$h_{FE} > 25$$

typ. 50

Transition frequency at  $f = 500\text{ MHz}$ ▲

$$I_C = 14\text{ mA}; V_{CE} = 10\text{ V}$$

$$f_T \text{ typ. } 5\text{ GHz}$$

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

$$I_E = I_e = 0; V_{CB} = 10\text{ V}$$

$$C_c \text{ typ. } 0,75\text{ pF}$$

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

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

$$C_e \text{ typ. } 0,8\text{ pF}$$

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

$$I_C = 2\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = 25\text{ °C}$$

$$C_{re} \text{ typ. } 0,7\text{ pF}$$

▲ Measured under pulse conditions.

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.



Noise figure at optimum source impedance \*

$$I_C = 2 \text{ mA}; V_{CE} = 10 \text{ V}; f = 500 \text{ MHz}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$$

F typ. 2,4 dB

Max. unilateral power gain ( $s_{re}$  assumed to be zero)

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

$$I_C = 14 \text{ mA}; V_{CE} = 10 \text{ V}; f = 500 \text{ MHz}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$$

G<sub>UM</sub> typ. 18 dBIntermodulation distortion at  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ 

$$I_C = 14 \text{ mA}; V_{CE} = 10 \text{ V}; R_L = 75 \text{ } \Omega; \text{V.S.W.R.} < 2$$

$$V_p = V_o = 150 \text{ mV at } f_p = 495,25 \text{ MHz}$$

$$V_q = V_o - 6 \text{ dB at } f_q = 503,25 \text{ MHz}$$

$$V_r = V_o - 6 \text{ dB at } f_r = 505,25 \text{ MHz}$$

$$\text{Measured at } f_{(p+q-r)} = 493,25 \text{ MHz}$$

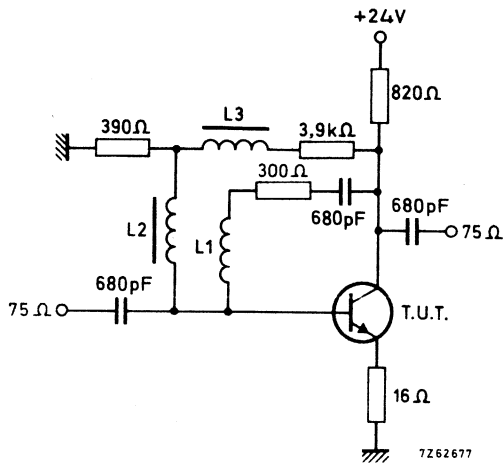
d<sub>im</sub> typ. -60 dB

Fig. 2 Intermodulation test circuit.

L1 = 4 turns Cu wire (0,35 mm); winding pitch 1 mm; int. dia. 4 mm

L2 = L3 = 5  $\mu\text{H}$  (code number: 3122 108 20150)

\* Crystal mounted in a BFR90 envelope.

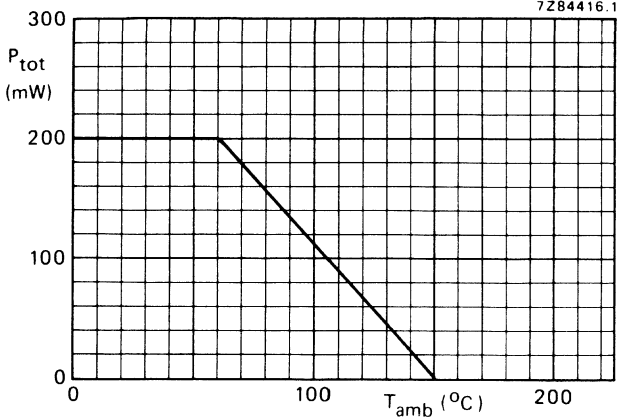
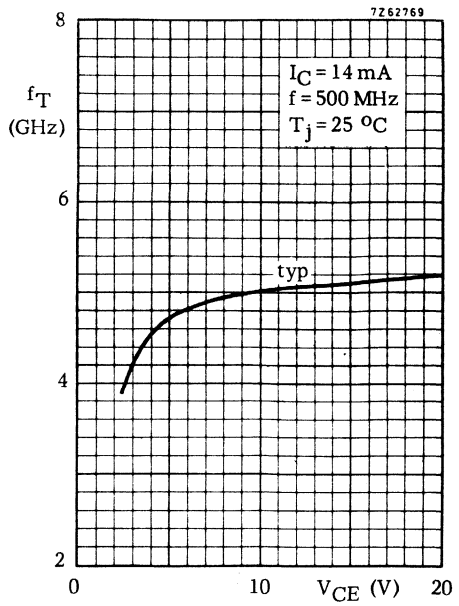
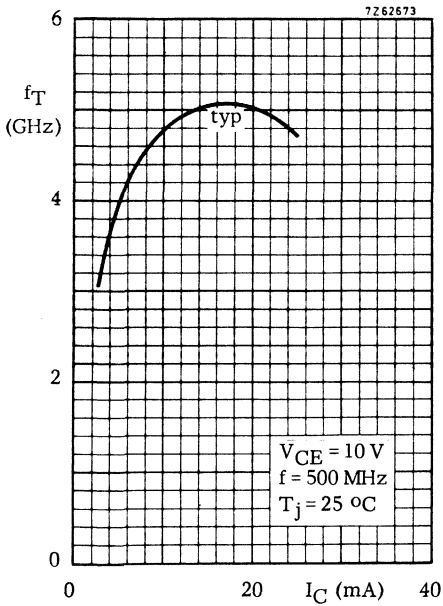
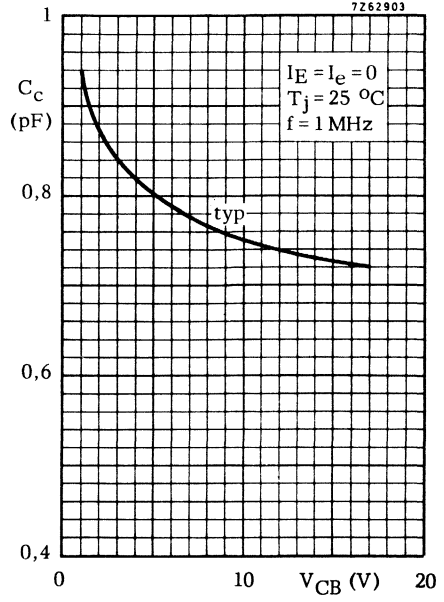
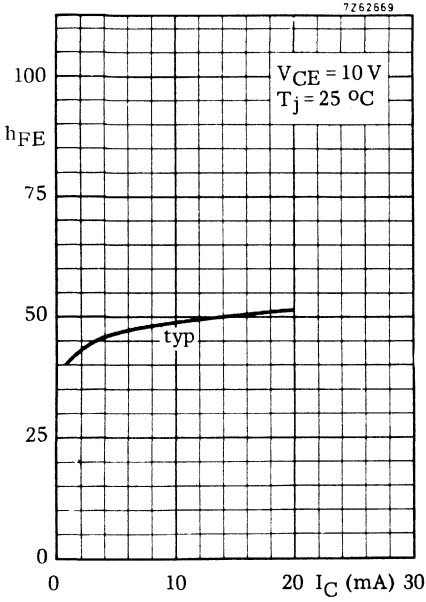
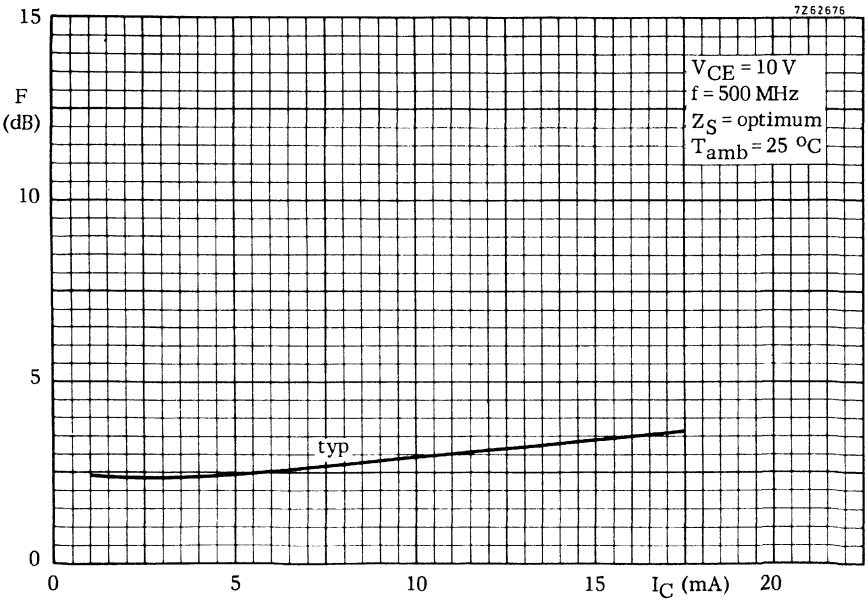
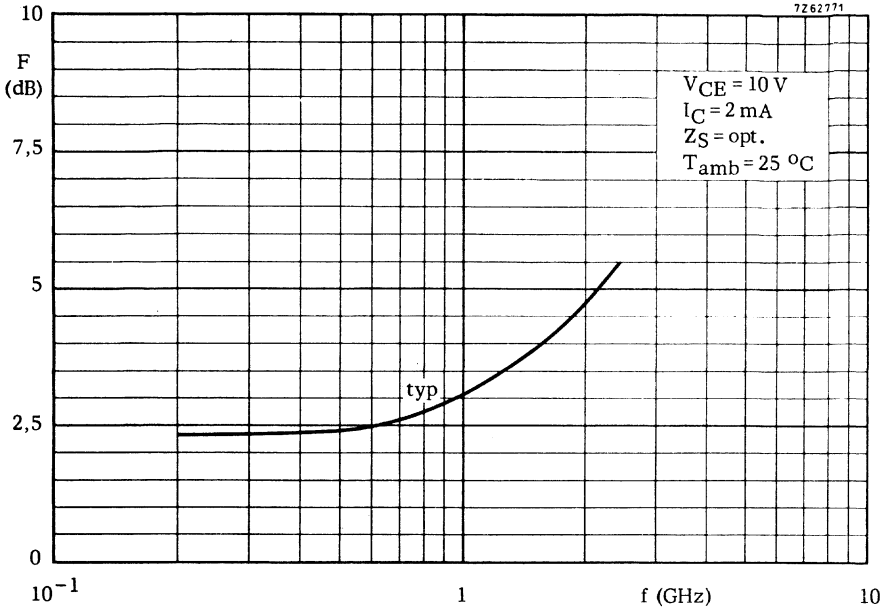
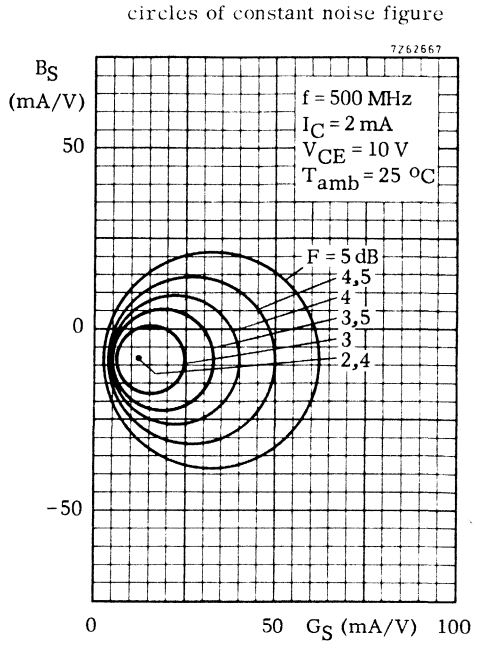
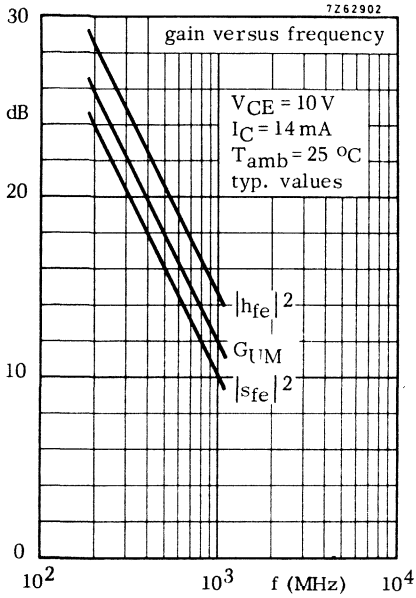


Fig. 3 Power derating curve.

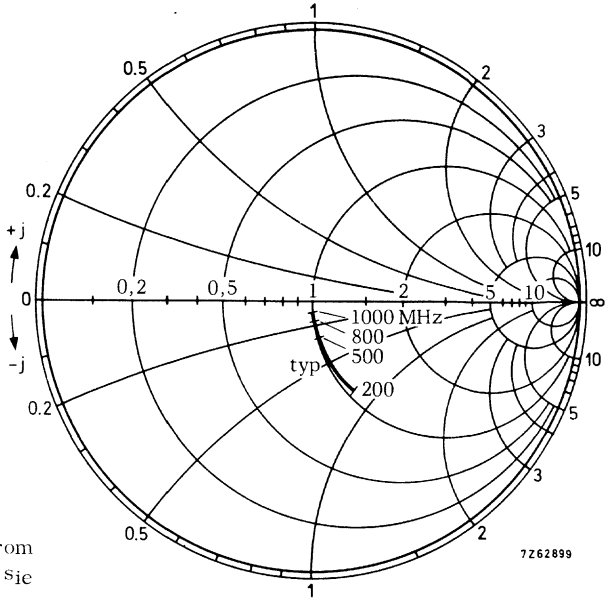






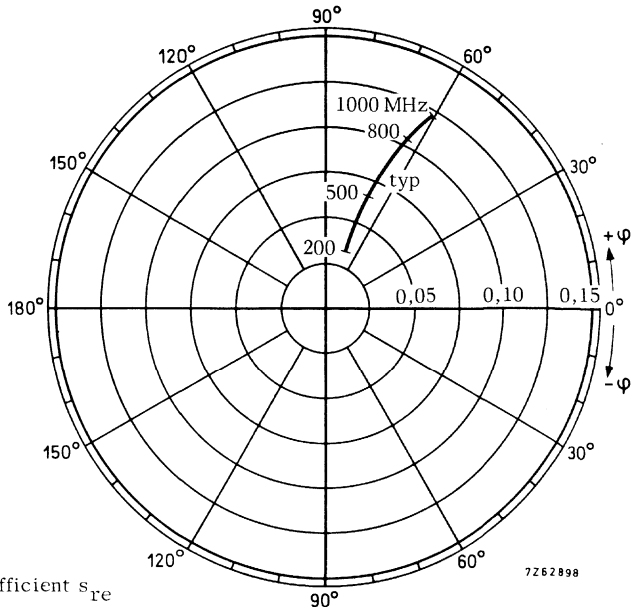


$V_{CE} = 10\text{ V}$   
 $I_C = 14\text{ mA}$   
 $T_{amb} = 25\text{ }^\circ\text{C}$



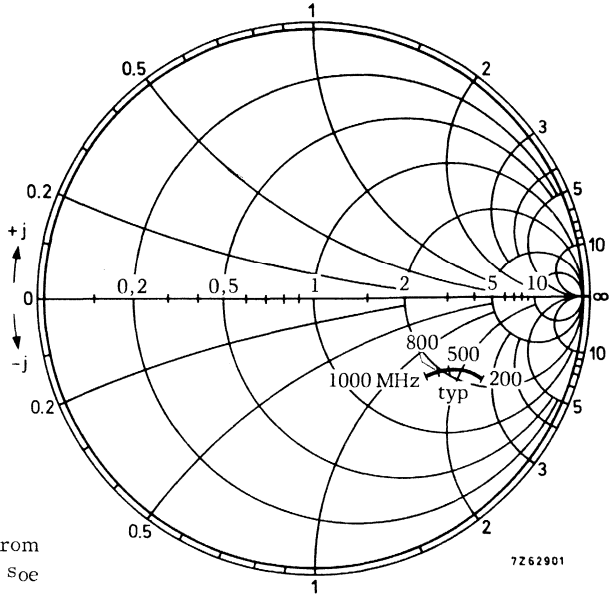
Input impedance derived from  
input reflection coefficient  $s_{ie}$   
coordinates in ohm x 50

$V_{CE} = 10\text{ V}$   
 $I_C = 14\text{ mA}$   
 $T_{amb} = 25\text{ }^\circ\text{C}$



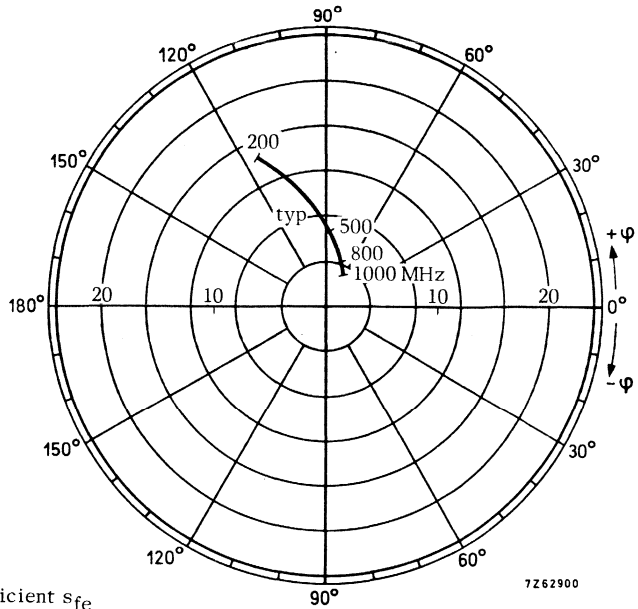
Reverse transmission coefficient  $s_{re}$

$V_{CE} = 10\text{ V}$   
 $I_C = 14\text{ mA}$   
 $T_{amb} = 25\text{ }^\circ\text{C}$



Output impedance derived from output reflection coefficient  $s_{oe}$  coordinates in ohm x 50

$V_{CE} = 10\text{ V}$   
 $I_C = 14\text{ mA}$   
 $T_{amb} = 25\text{ }^\circ\text{C}$



Forward transmission coefficient  $s_{fe}$





## SILICON PLANAR EPITAXIAL TRANSISTORS

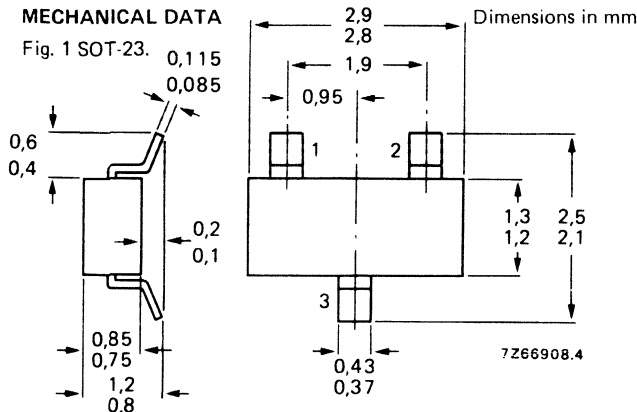
N-P-N transistor in a microminiature plastic envelope. It is primarily intended for use in u.h.f. and microwave amplifiers in thick and thin-film circuits, such as in aerial amplifiers, radar systems, oscilloscopes, spectrum analysers etc. The transistor features very low intermodulation distortion and high power gain; thanks to its very high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CBO}$	max.	15 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	12 V
Collector current (d.c.)	$I_C$	max.	35 mA
Total power dissipation up to $T_{amb} = 60\text{ }^\circ\text{C}$	$P_{tot}$	max.	200 mW
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$
Transition frequency at $f = 500\text{ MHz}$ $I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$	$f_T$	typ.	5 GHz
Feedback capacitance at $f = 1\text{ MHz}$ $I_C = 2\text{ mA}$ ; $V_{CE} = 5\text{ V}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$	$C_{re}$	typ.	0,8 pF
Noise figure at optimum source impedance $I_C = 2\text{ mA}$ ; $V_{CE} = 5\text{ V}$ ; $f = 500\text{ MHz}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$	F	typ.	1,9 dB
Max. unilateral power gain (see page 3) $I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$ ; $f = 500\text{ MHz}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$	$G_{UM}$	typ.	16,5 dB
Intermodulation distortion at $T_{amb} = 25\text{ }^\circ\text{C}$ $I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$ ; $R_L = 75\text{ }\Omega$ ; $V_o = 300\text{ mV}$ $f_{(p+q-r)} = 493,25\text{ MHz}$ (see page 4)	$d_{im}$	typ.	-60 dB

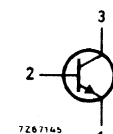
### MECHANICAL DATA

Fig. 1 SOT-23.

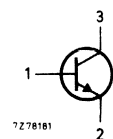


### Marking code

BFR93 = R1



BFR93R = R4



See also *Soldering recommendations.*

**RATINGS**

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

Collector-base voltage (open emitter)	$V_{CBO}$	max.	15 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	12 V
Emitter-base voltage (open collector)	$V_{EBO}$	max.	2,0 V
Collector current (d.c.)	$I_C$	max.	35 mA
→ Total power dissipation up to $T_{amb} = 60\text{ °C}^{**}$	$P_{tot}$	max.	200 mW
Storage temperature	$T_{stg}$		-65 to +150 °C
Junction temperature	$T_j$	max.	150 °C

→ **THERMAL CHARACTERISTICS \***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient **	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Collector cut-off current

$$I_E = 0; V_{CB} = 10\text{ V}$$

$$I_{CBO} < 50\text{ nA}$$

D.C. current gain ▲

$$I_C = 30\text{ mA}; V_{CE} = 5\text{ V}$$

$$h_{FE} > \begin{matrix} 25 \\ \text{typ. } 50 \end{matrix}$$

Transition frequency at  $f = 500\text{ MHz}$  ▲

$$I_C = 30\text{ mA}; V_{CE} = 5\text{ V}$$

$$f_T \text{ typ. } 5\text{ GHz}$$

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

$$I_E = I_e = 0; V_{CB} = 10\text{ V}$$

$$C_c \text{ typ. } 0,7\text{ pF}$$

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

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

$$C_e \text{ typ. } 1,8\text{ pF}$$

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

$$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}; T_{amb} = 25\text{ °C}$$

$$C_{re} \text{ typ. } 0,8\text{ pF}$$

▲ Measured under pulse conditions.

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

Noise figure at optimum source impedance \*

$$I_C = 2 \text{ mA}; V_{CE} = 5 \text{ V}; f = 500 \text{ MHz}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$$

F typ. 1,9 dB

Max. unilateral power gain ( $s_{re}$  assumed to be zero)

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

$$I_C = 30 \text{ mA}; V_{CE} = 5 \text{ V}; f = 500 \text{ MHz}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$$

GUM typ. 16,5 dB

Intermodulation distortion at  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$  \*

$$I_C = 30 \text{ mA}; V_{CE} = 5 \text{ V}; R_L = 75 \text{ } \Omega; \text{V.S.W.R.} < 2$$

$$V_p = V_o = 300 \text{ mV at } f_p = 495,25 \text{ MHz}$$

$$V_q = V_o - 6 \text{ dB at } f_q = 503,25 \text{ MHz}$$

$$V_r = V_o - 6 \text{ dB at } f_r = 505,25 \text{ MHz}$$

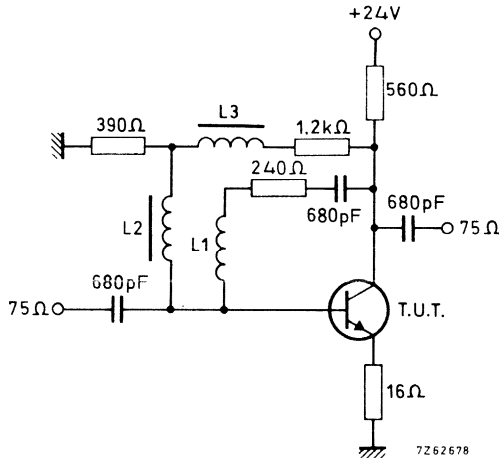
Measured at  $f_{(p+q-r)} = 493,25 \text{ MHz}$  $d_{im}$  typ. -60 dB

Fig. 2 Intermodulation test circuit.

L1 = 4 turns Cu wire (0,35); winding pitch 1 mm; int. dia. 4 mm

L2 and L3 5  $\mu$ H (code number: 3122 108 20150)

\* Crystal mounted in a BFR91 envelope.

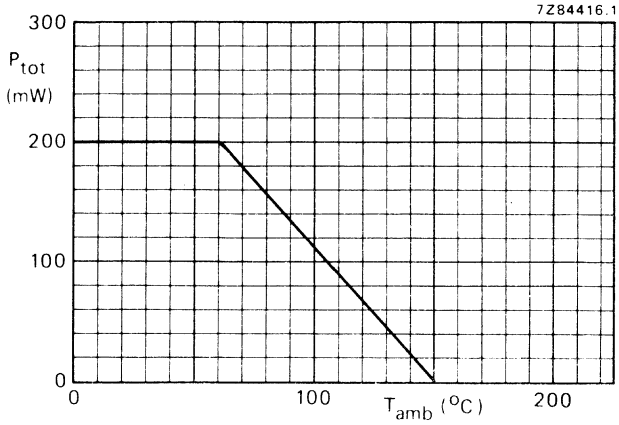
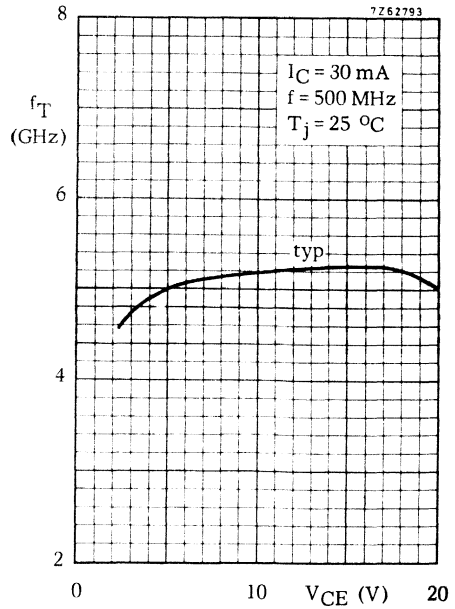
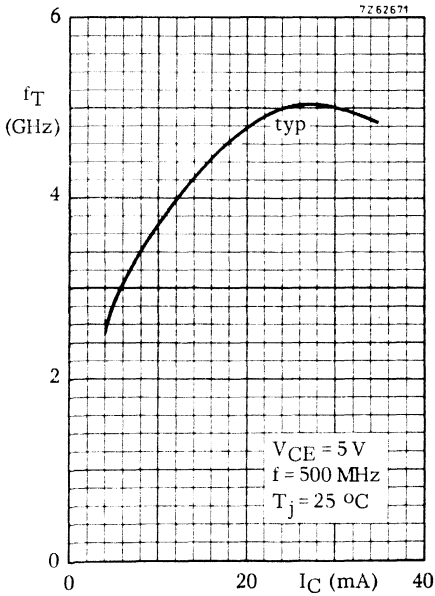
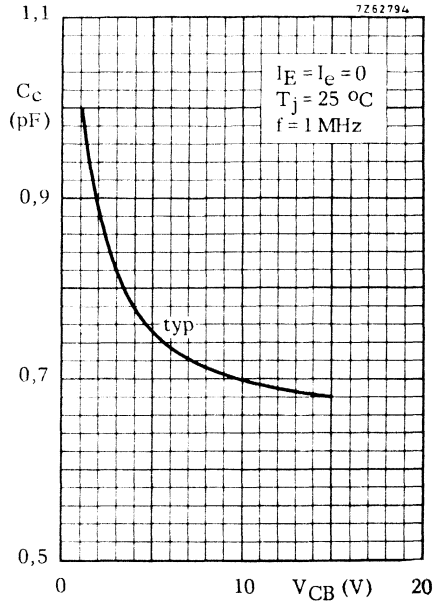
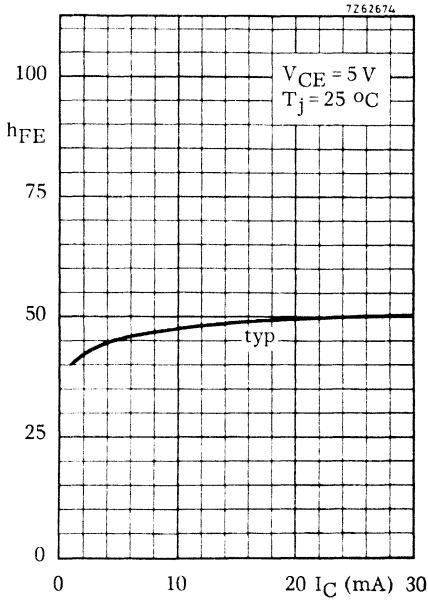
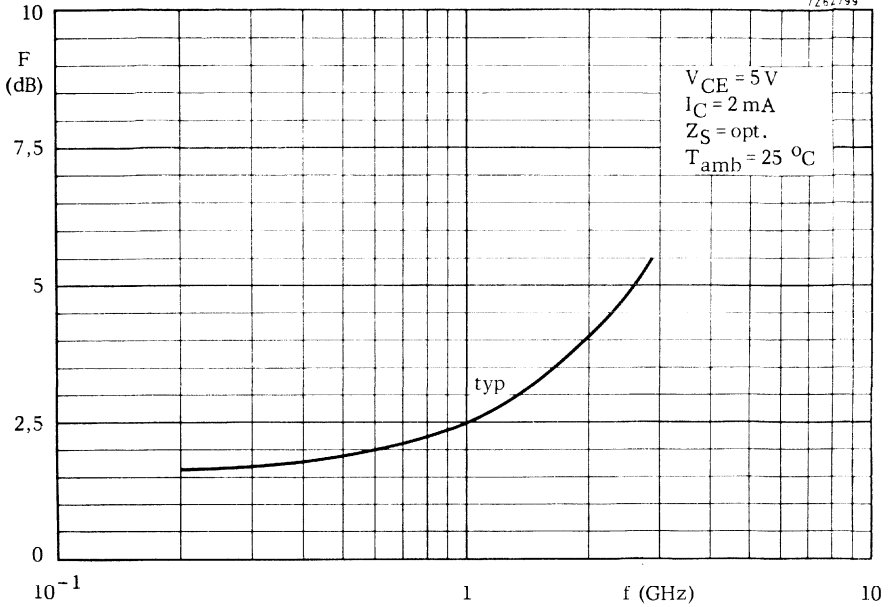


Fig. 3 Power derating curve.

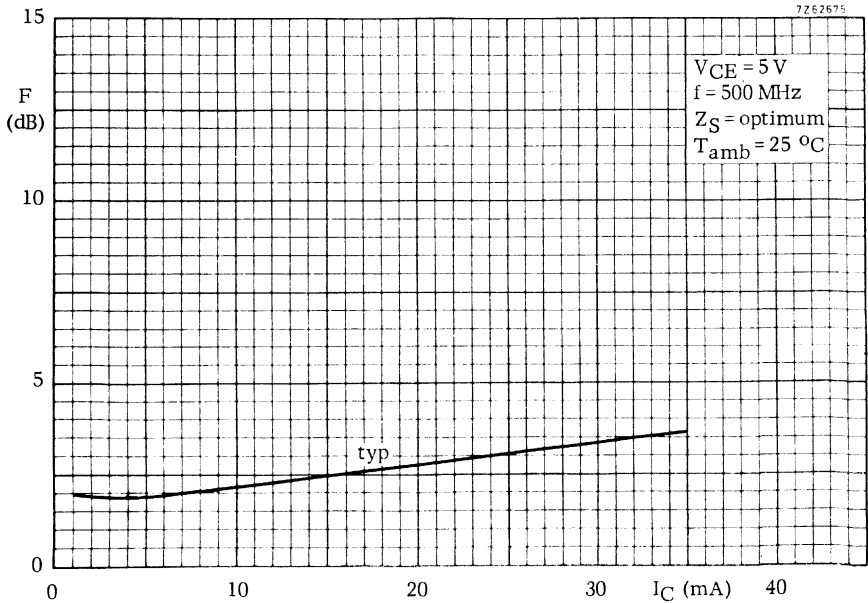


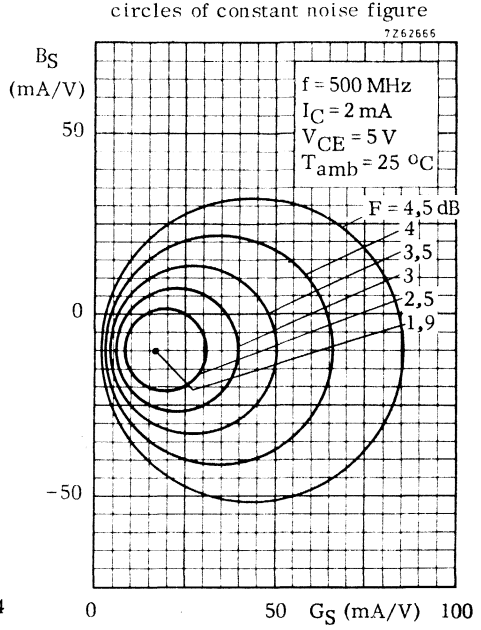
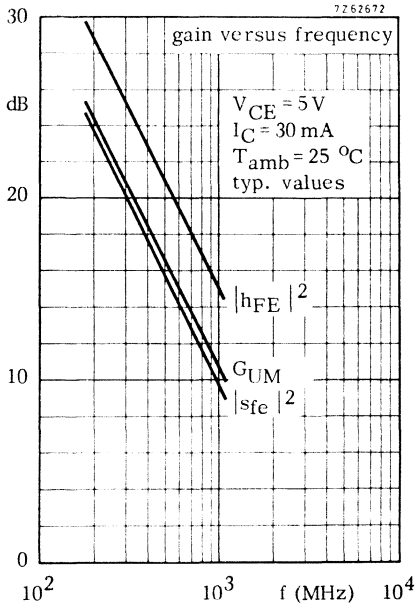


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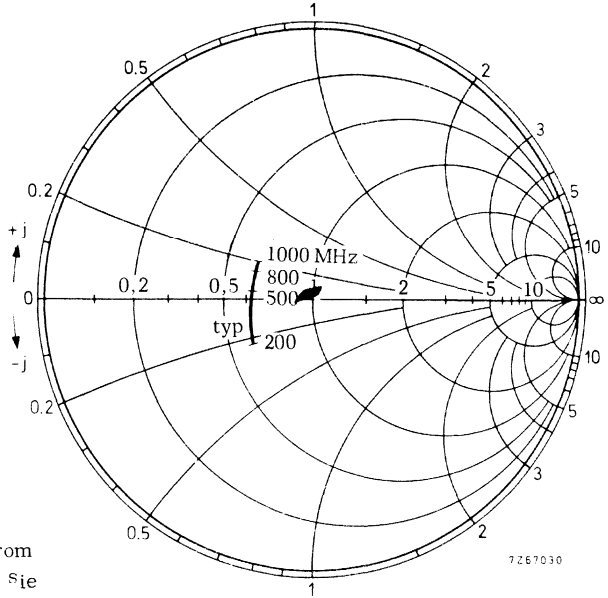


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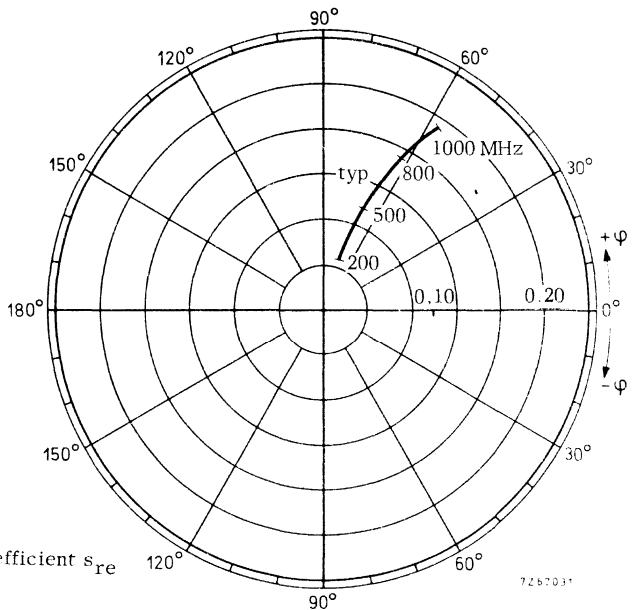


$V_{CE} = 5 \text{ V}$   
 $I_C = 30 \text{ mA}$   
 $T_{amb} = 25 \text{ }^\circ\text{C}$



Input impedance derived from  
input reflection coefficient  $s_{ie}$   
coordinates in ohm x 50

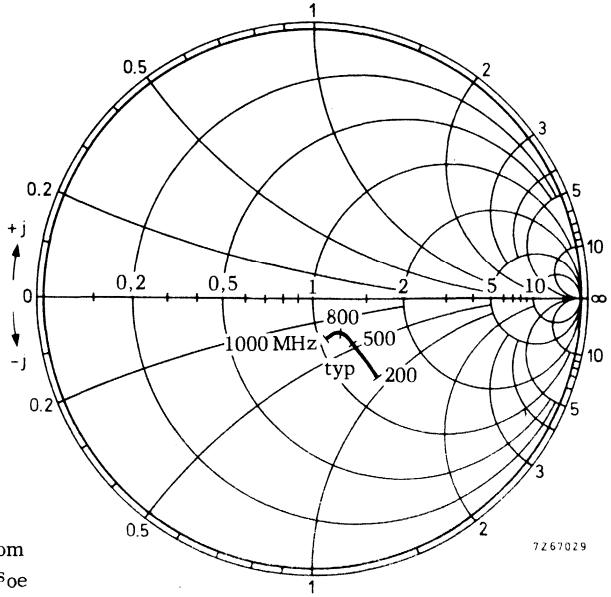
$V_{CE} = 5 \text{ V}$   
 $I_C = 30 \text{ mA}$   
 $T_{amb} = 25 \text{ }^\circ\text{C}$



Reverse transmission coefficient  $s_{re}$

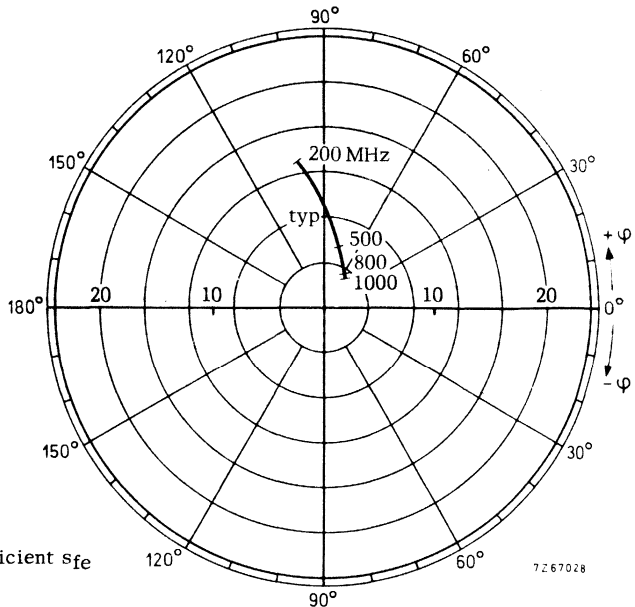


$V_{CE} = 5\text{ V}$   
 $I_C = 30\text{ mA}$   
 $T_{amb} = 25\text{ }^\circ\text{C}$



Output impedance derived from output reflection coefficient  $s_{oe}$  coordinates in ohm x 50

$V_{CE} = 5\text{ V}$   
 $I_C = 30\text{ mA}$   
 $T_{amb} = 25\text{ }^\circ\text{C}$



Forward transmission coefficient  $s_{fe}$



## SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a microminiature plastic envelope. It is intended for a wide range of v.h.f. and u.h.f. applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter; peak value)	$V_{CBOM}$ max.	25 V	
Collector-emitter voltage (open base)	$V_{CEO}$ max.	15 V	
Collector current (peak value)	$I_{CM}$ max.	50 mA	
Total power dissipation up to $T_{amb} = 65\text{ }^{\circ}\text{C}$	$P_{tot}$ max.	250 mW	←
Junction temperature	$T_j$ max.	175 $^{\circ}\text{C}$	←
D.C. current gain $I_C = 2\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE}$	20 to 150	
Transition frequency $I_C = 25\text{ mA}; V_{CE} = 5\text{ V}; f = 500\text{ MHz}$	$f_T$ typ.	1,3 GHz	
Noise figure $I_C = 2\text{ mA}; V_{CE} = 5\text{ V}; R_S = 50\text{ }\Omega; f = 500\text{ MHz}$	F typ.	4,5 dB	

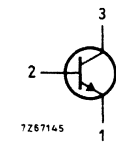
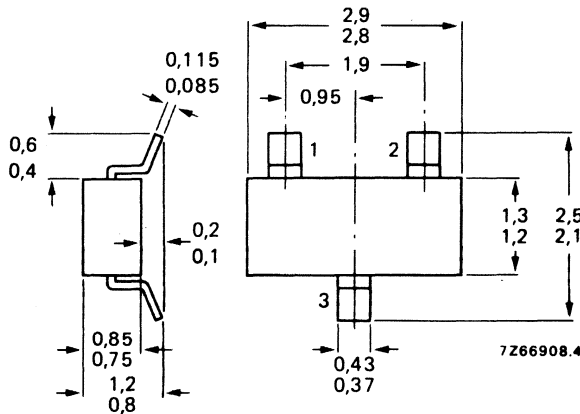
### MECHANICAL DATA

Dimensions in mm

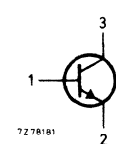
Marking code

Fig. 1 SOT-23.

BFS17 = E1



BFS17R = E4



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter; peak value)	$V_{CBOM}$	max.	25 V
Collector-emitter voltage (open base) $I_C = 10$ mA	$V_{CEO}$	max.	15 V
Emitter-base voltage (open collector)	$V_{EBO}$	max.	2,5 V
Collector current (d.c.)	$I_C$	max.	25 mA
Collector current (peak value)	$I_{CM}$	max.	50 mA
→ Total power dissipation up to $T_{amb} = 65$ °C**	$P_{tot}$	max.	250 mW
→ Storage temperature	$T_{stg}$		-65 to + 175 °C
→ Junction temperature	$T_j$	max.	175 °C

→ **THERMAL CHARACTERISTICS\***

$$T_j = P (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

$T_j = 25$  °C unless otherwise specified

Collector cut-off current

$$I_E = 0; V_{CB} = 10$$
 V

$$I_{CBO} < 10$$
 nA

$$I_E = 0; V_{CB} = 10$$
 V;  $T_j = 100$  °C

$$I_{CBO} < 10$$
 μA

D.C. current gain

$$I_C = 2$$
 mA;  $V_{CE} = 1$  V

$$h_{FE} \quad 20$$
 to 150

$$I_C = 25$$
 mA;  $V_{CE} = 1$  V

$$h_{FE} > 20$$

Transition frequency

$$I_C = 2$$
 mA;  $V_{CE} = 5$  V;  $f = 500$  MHz

$$f_T \quad \text{typ.} \quad 1,0$$
 GHz

$$I_C = 25$$
 mA;  $V_{CE} = 5$  V;  $f = 500$  MHz

$$f_T \quad \text{typ.} \quad 1,3$$
 GHz

Collector capacitance at  $f = 1$  MHz

$$I_E = I_e = 0; V_{CB} = 10$$
 V

$$C_c < 1,5$$
 pF

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

Emitter capacitance at  $f = 1$  MHz

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

$$C_e < 2,0 \text{ pF}$$

Feedback capacitance at  $f = 1$  MHz

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

$$-C_{re} \text{ typ. } 0,65 \text{ pF}$$

Noise figure\*

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

$$f = 500 \text{ MHz}; R_S = 50 \Omega$$

$$F \text{ typ. } 4,5 \text{ dB}$$

Intermodulation distortion

$$I_C = 10 \text{ mA}; V_{CE} = 6 \text{ V}; R_L = 37,5 \Omega; T_{amb} = 25 \text{ }^\circ\text{C}$$

$$V_o = 100 \text{ mV at } f_p = 183 \text{ MHz}$$

$$V_o = 100 \text{ mV at } f_q = 200 \text{ MHz}$$

measured at  $f(2q-p) = 217 \text{ MHz}$

$$d_{im} \text{ typ. } -45 \text{ dB}$$

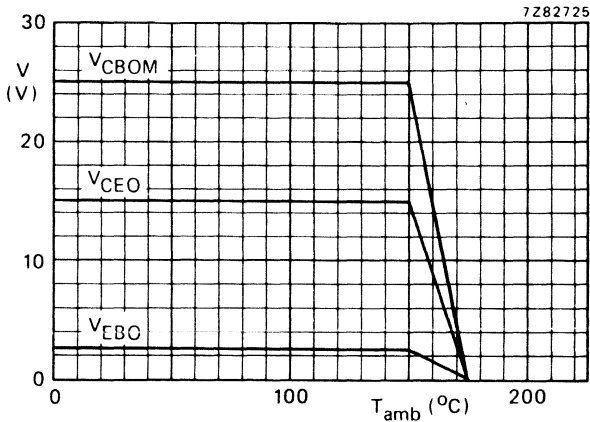


Fig. 2 Voltage derating curve.

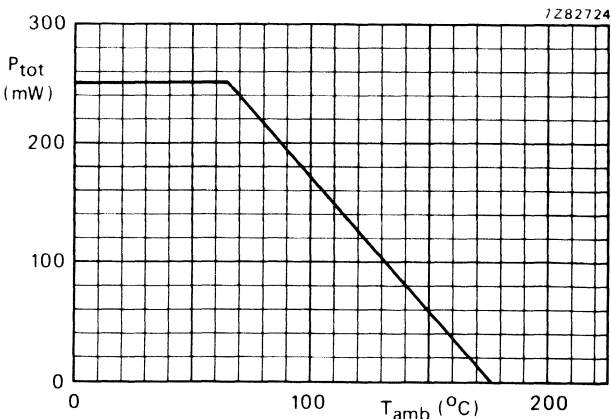
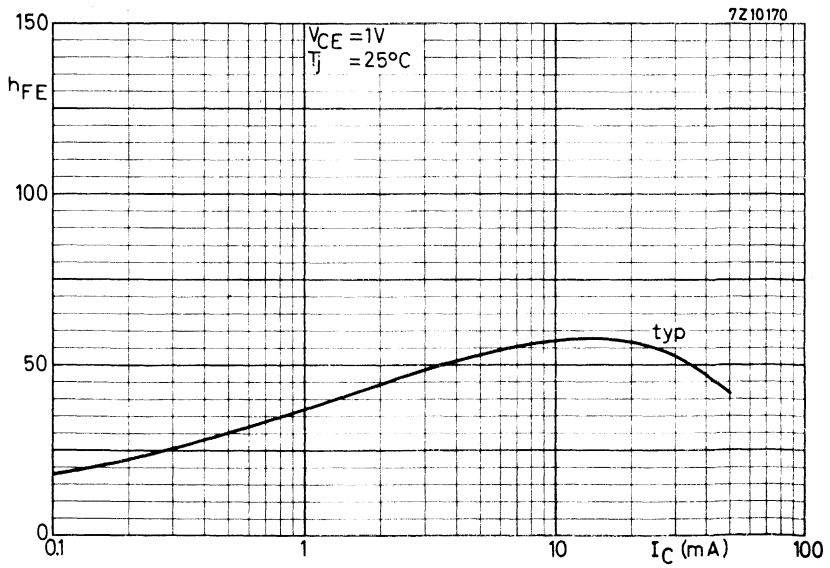
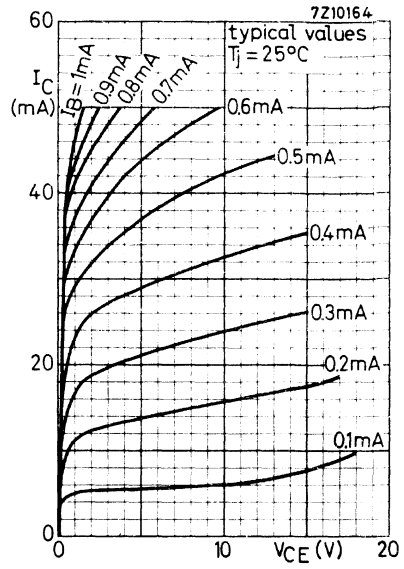
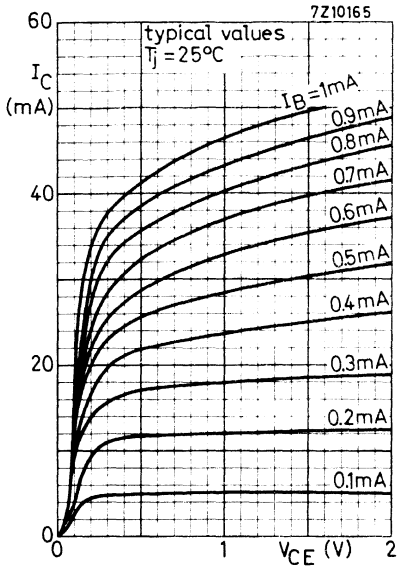
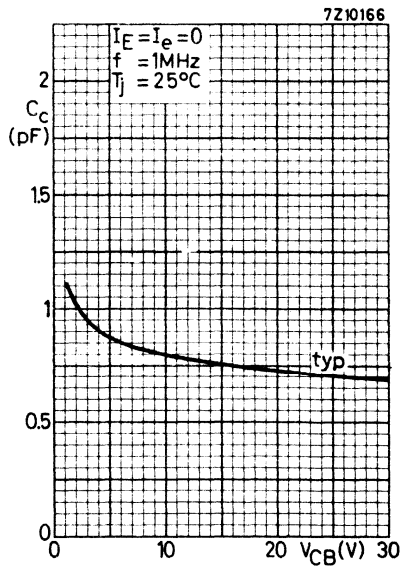
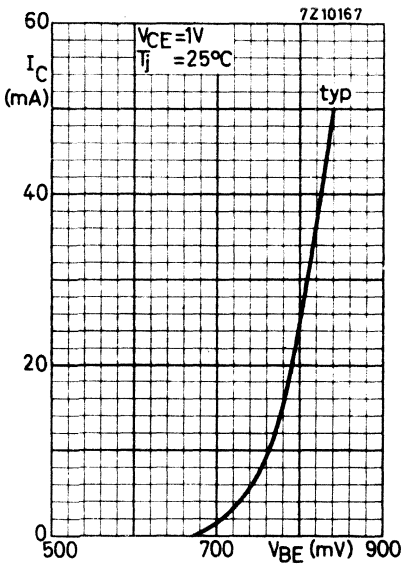
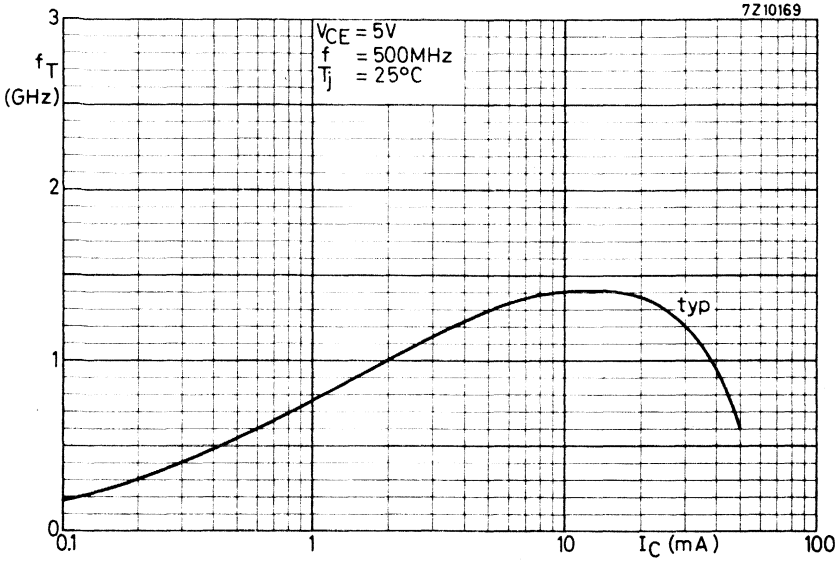
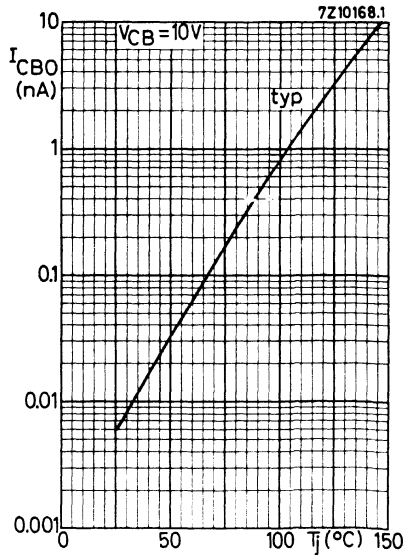
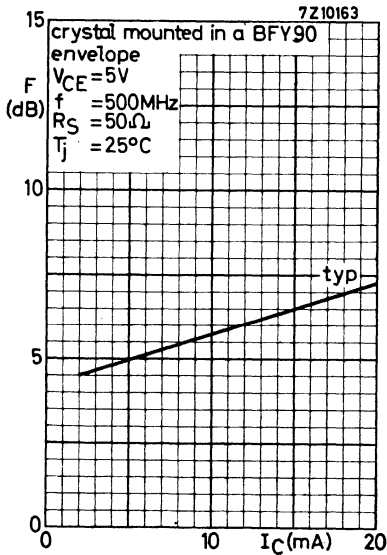
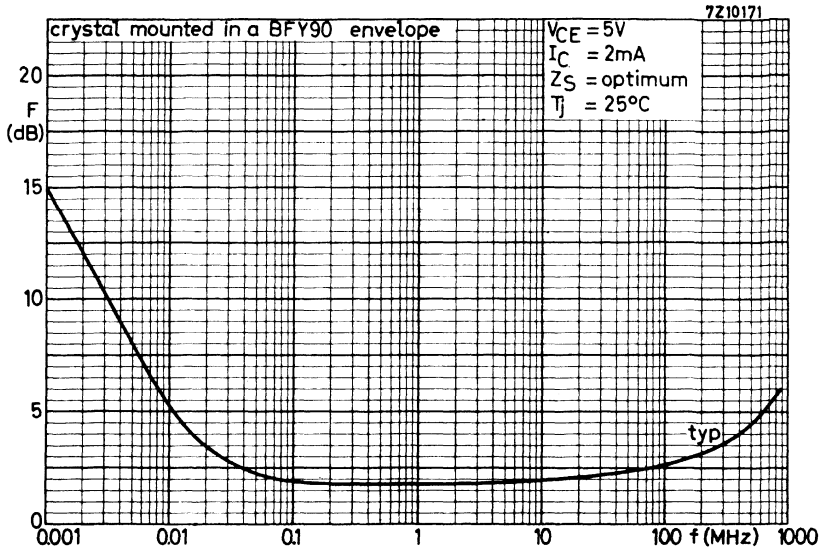


Fig. 3 Power derating curve.

\* Crystal mounted in a BFY90 envelope.









## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a microminiature plastic envelope. They are intended for general purpose and h.f. applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CBO}$	max.	30	V	
Collector-emitter voltage (open base)	$V_{CEO}$	max.	20	V	
Collector current (d.c.)	$I_C$	max.	30	mA	
Total power dissipation up to $T_{amb} = 65\text{ }^\circ\text{C}$	$P_{tot}$	max.	250	mW	←
Junction temperature	$T_j$	max.	175	$^\circ\text{C}$	←
D.C. current gain					
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE}$		BFS18 BFS18R	BFS19 BFS19R	
			35 to 125	65 to 225	
Transition frequency at $f = 100\text{ MHz}$					
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$	$f_T$	typ.	200	260	MHz
Noise figure at $f = 100\text{ MHz}$					
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}; G_S = 10\text{ m}\Omega^{-1}$	F	typ.	4		dB

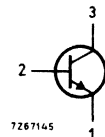
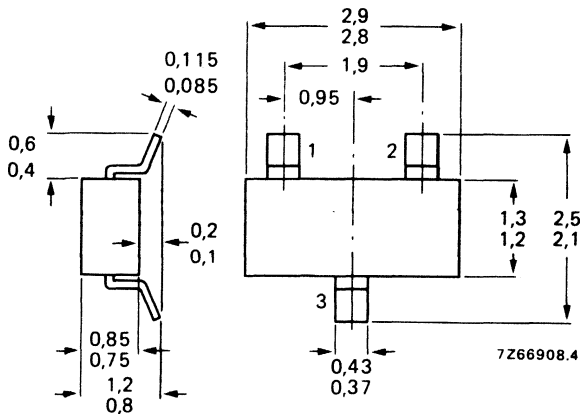
### MECHANICAL DATA

Dimensions in mm

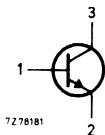
Marking code

Fig. 1 SOT-23.

BFS18 = F1  
BFS19 = F2



BFS18R = F4  
BFS19R = F5



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) See Fig. 2	$V_{CBO}$	max.	30	V
Collector-emitter voltage (open base) See Fig. 2 $I_C = 2 \text{ mA}$	$V_{CEO}$	max.	20	V
Emitter-base voltage (open collector) See Fig. 2	$V_{EBO}$	max.	5	V
Collector current (d.c.)	$I_C$	max.	30	mA
Collector current (peak value)	$I_{CM}$	max.	30	mA
→ Total power dissipation up to $T_{amb} = 65 \text{ }^\circ\text{C}^{**}$	$P_{tot}$	max.	250	mW
→ Storage temperature	$T_{stg}$		-65 to +175	$^\circ\text{C}$
→ Junction temperature	$T_j$	max.	175	$^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P (R_{th j-t} + R_{th t-s} + R_{th s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th j-t}$	=	60	K/W
From tab to soldering points	$R_{th t-s}$	=	260	K/W
From soldering points to ambient**	$R_{th s-a}$	=	120	K/W

**CHARACTERISTICS**

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

Collector cut-off current $I_E = 0; V_{CB} = 20 \text{ V}$	$I_{CBO}$	<	100	nA				
$I_E = 0; V_{CB} = 20 \text{ V}; T_j = 100 \text{ }^\circ\text{C}$	$I_{CBO}$	<	10	$\mu\text{A}$				
Base-emitter voltage $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	$V_{BE}$		0,65 to 0,74	V				
			<table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>BFS18</td> <td>BFS19</td> </tr> <tr> <td>BFS18R</td> <td>BFS19R</td> </tr> </table>	BFS18	BFS19	BFS18R	BFS19R	
BFS18	BFS19							
BFS18R	BFS19R							
D.C. current gain $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	$h_{FE}$		35 to 125	65 to 225				
Transition frequency at $f = 100 \text{ MHz}$ $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	$f_T$	typ.	200	260 MHz				
Collector capacitance at $f = 1 \text{ MHz}$ $I_E = I_e = 0; V_{CB} = 10 \text{ V}$	$C_c$	typ.	1	pF				
Feedback capacitance at $f = 1 \text{ MHz}$ $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	$-C_{re}$	typ.	0,85	pF				
Noise figure▲ $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V};$ $G_S = 10 \text{ m}\Omega^{-1}; f = 100 \text{ MHz}$	F	typ.	4	dB				

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

▲ Crystal mounted in a BF115 envelope.

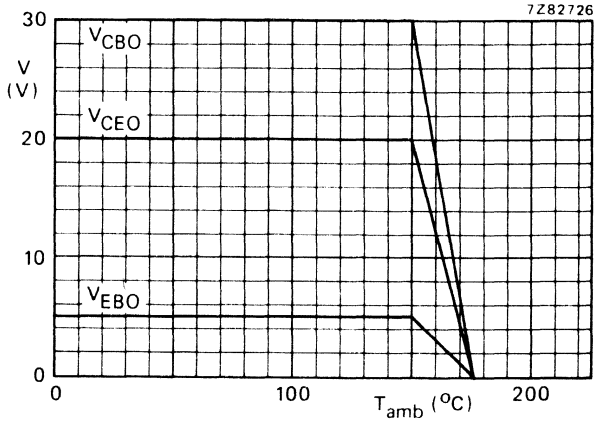


Fig. 2 Voltage derating curves.

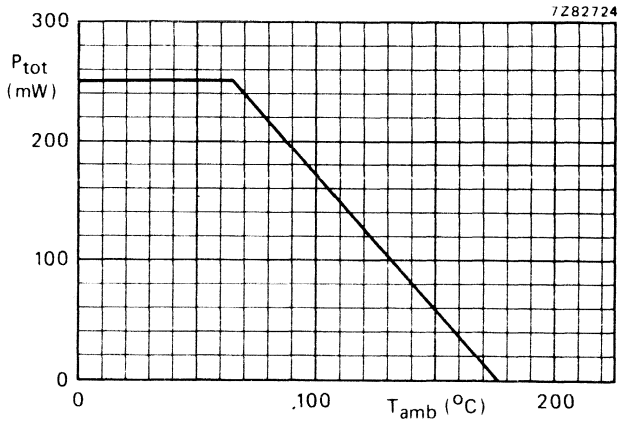
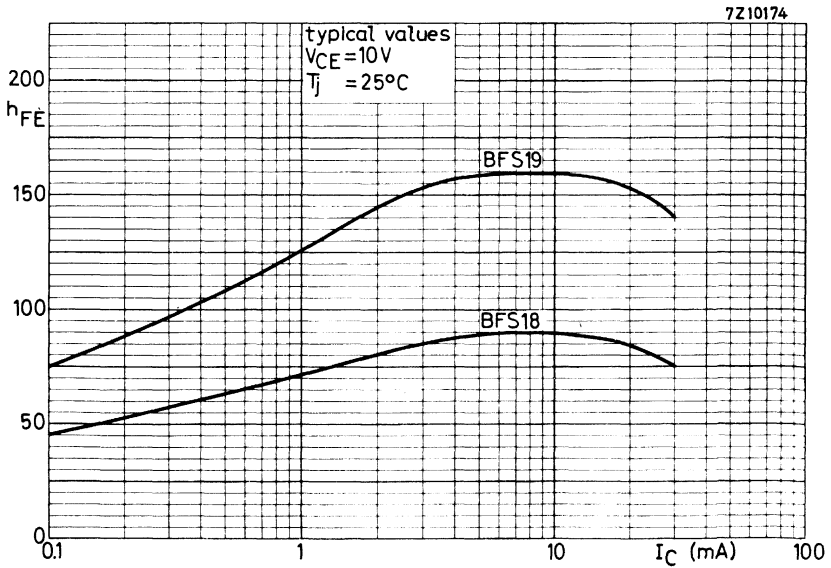
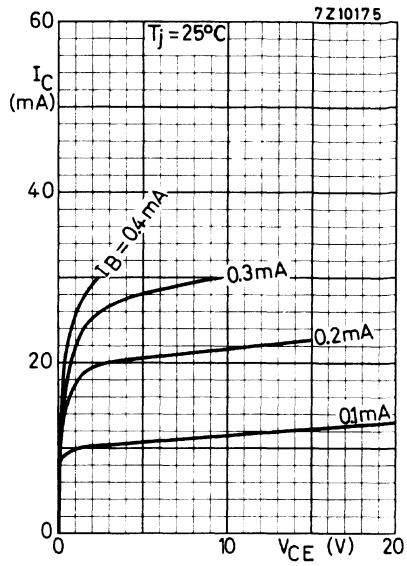
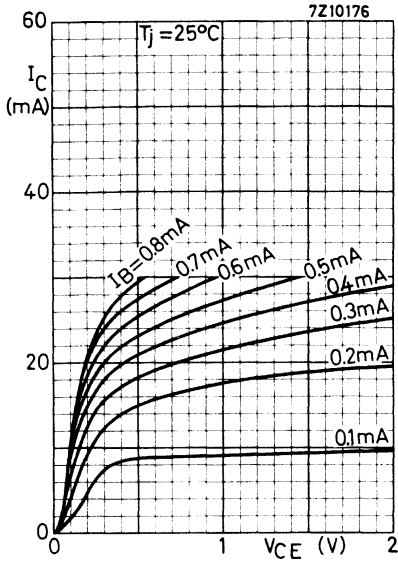
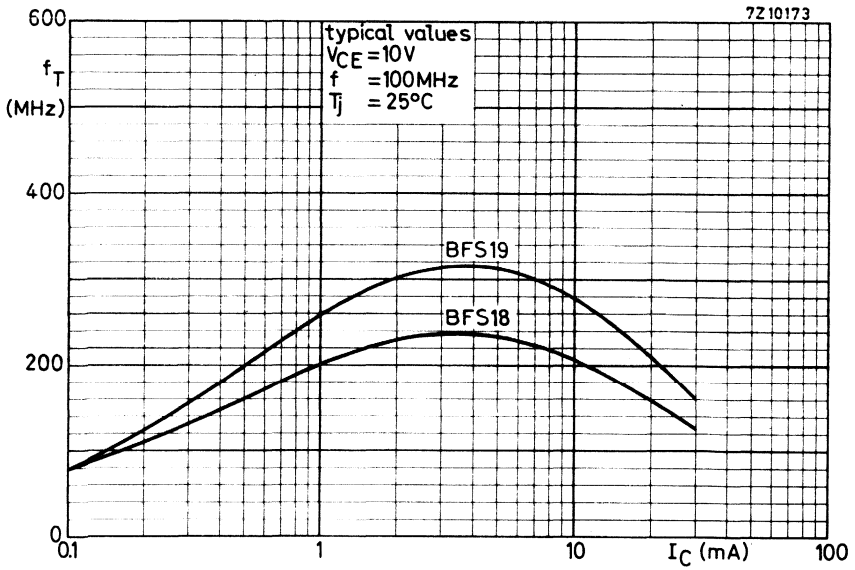
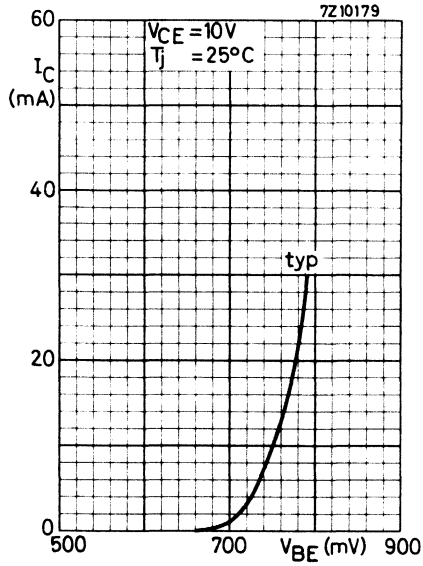


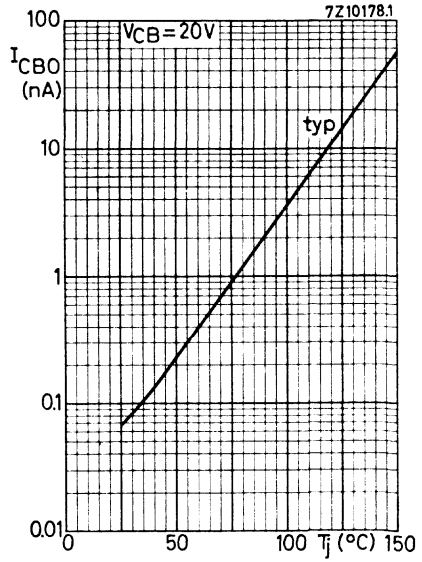
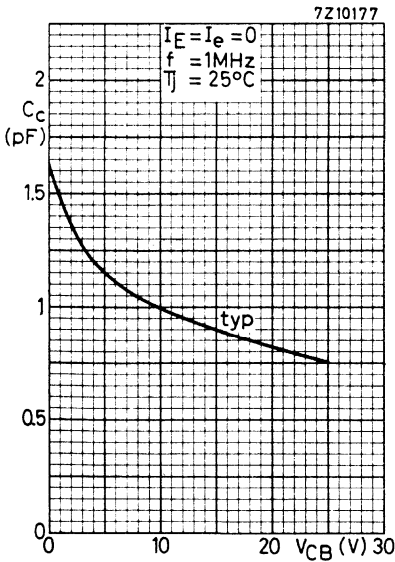
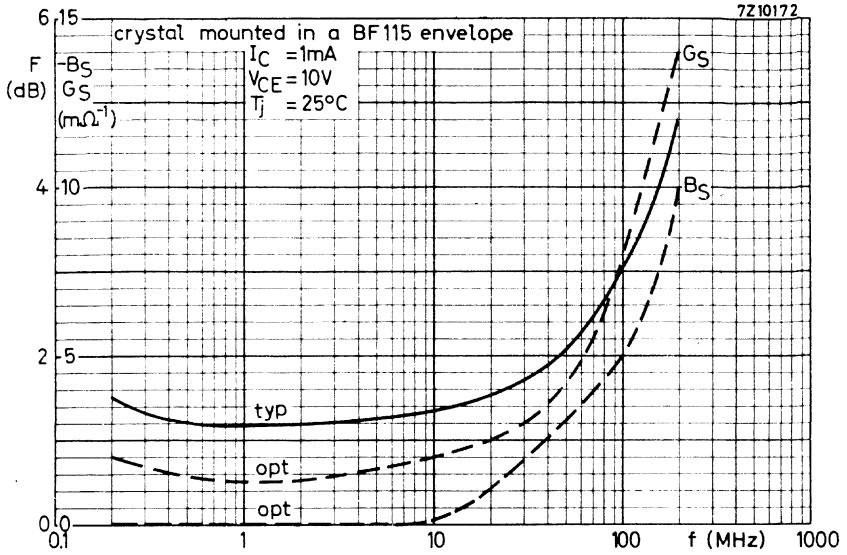
Fig. 3 Power derating curve.

**BFS18**  
**BFS19**

Typical behaviour of collector current versus collector-emitter voltage







## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistor in a microminiature plastic envelope. It has a very low feedback capacitance and is intended for i.f. and v.h.f. applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

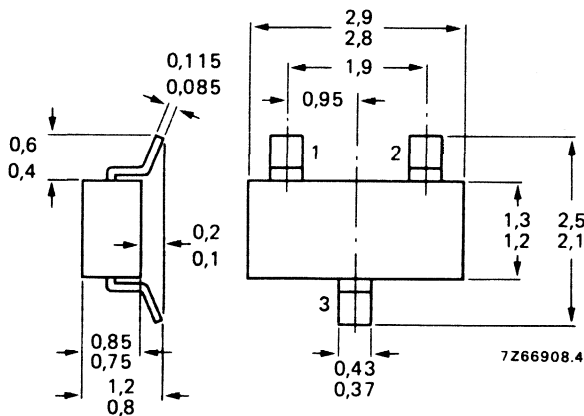
Collector-base voltage (open emitter)	$V_{CBO}$	max.	30 V	
Collector-emitter voltage (open base)	$V_{CEO}$	max.	20 V	
Collector current (d.c.)	$I_C$	max.	25 mA	
Total power dissipation up to $T_{amb} = 65\text{ }^\circ\text{C}$	$P_{tot}$	max.	250 mW	←
Junction temperature	$T_j$	max.	175 $^\circ\text{C}$	←
D.C. current gain	$h_{FE}$	>	40	
Transition frequency at $f = 100\text{ MHz}$	$f_T$	typ.	450 MHz	
Feedback capacitance at $f = 1\text{ MHz}$	$C_{re}$	typ.	350 fF	
$I_C = 7\text{ mA}; V_{CE} = 10\text{ V}$				
$I_C = 5\text{ mA}; V_{CE} = 5\text{ V}$				
$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$				

### MECHANICAL DATA

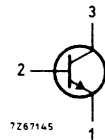
Fig. 1 SOT-23.

Dimensions in mm

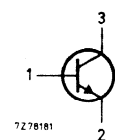
Marking code



BFS20 = G1



BFS20R = G4



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) see Fig. 2	$V_{CB0}$	max.	30 V
Collector-emitter voltage (open base) see Fig. 2 $I_C = 2 \text{ mA}$	$V_{CEO}$	max.	20 V
Emitter-base voltage (open collector) see Fig. 2	$V_{EBO}$	max.	4 V
Collector current (d.c.)	$I_C$	max.	25 mA
Collector current (peak value)	$I_{CM}$	max.	25 mA
→ Total power dissipation up to $T_{amb} = 65 \text{ }^\circ\text{C}^{**}$	$P_{tot}$	max.	250 mW
→ Storage temperature	$T_{stg}$		-65 to +175 $^\circ\text{C}$
→ Junction temperature	$T_j$	max.	175 $^\circ\text{C}$

→ **THERMAL CHARACTERISTICS \***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient **	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Collector cut-off current

$I_E = 0; V_{CB} = 20 \text{ V}$	$I_{CBO}$	<	100 nA
$I_E = 0; V_{CB} = 20 \text{ V}; T_j = 100 \text{ }^\circ\text{C}$	$I_{CBO}$	<	10 $\mu\text{A}$

Base-emitter voltage

$I_C = 7 \text{ mA}; V_{CE} = 10 \text{ V}$	$V_{BE}$	typ.	740 mV
		<	900 mV

D.C. current gain

$I_C = 7 \text{ mA}; V_{CE} = 10 \text{ V}$	$h_{FE}$	>	40
		typ.	85

Transition frequency at  $f = 100 \text{ MHz}$

$I_C = 5 \text{ mA}; V_{CE} = 10 \text{ V}$	$f_T$	>	275 MHz
		typ.	450 MHz

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

$I_E = I_e = 0; V_{CB} = 10 \text{ V}$	$C_c$	typ.	0,8 pF
--	-------	------	--------

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

$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$	$-C_{re}$	typ.	350 fF
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\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.



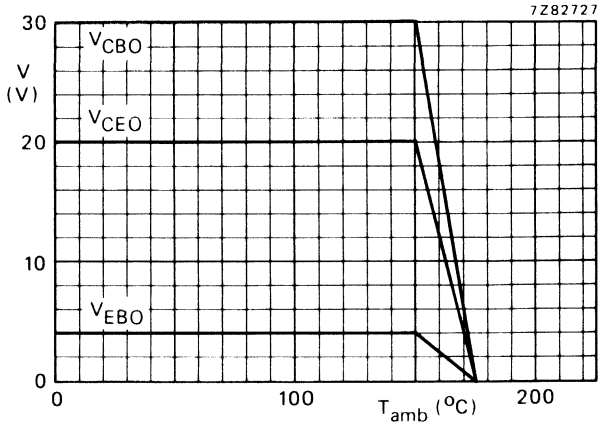


Fig. 2 Voltage derating curves.

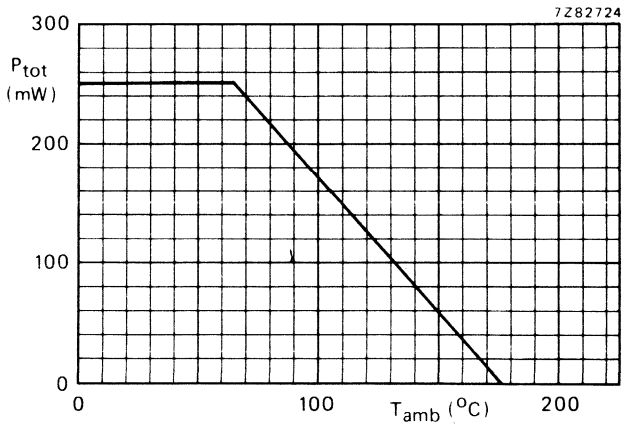
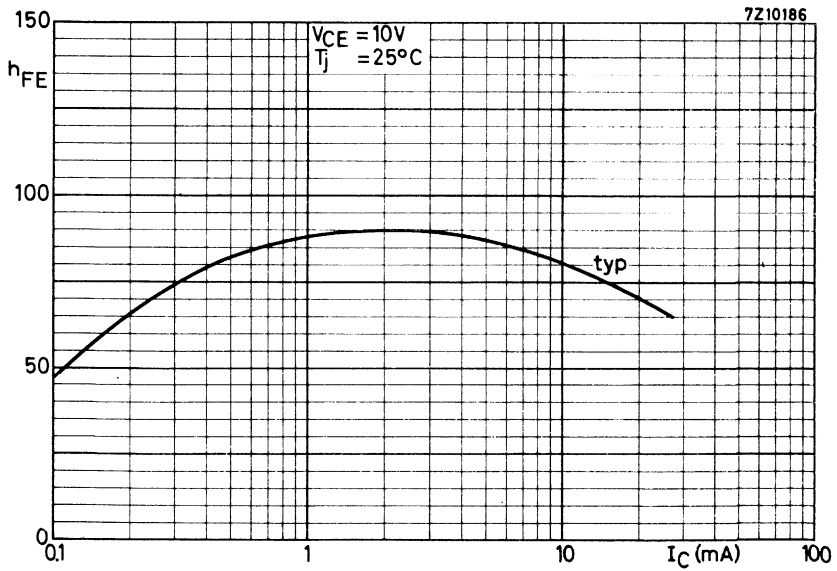
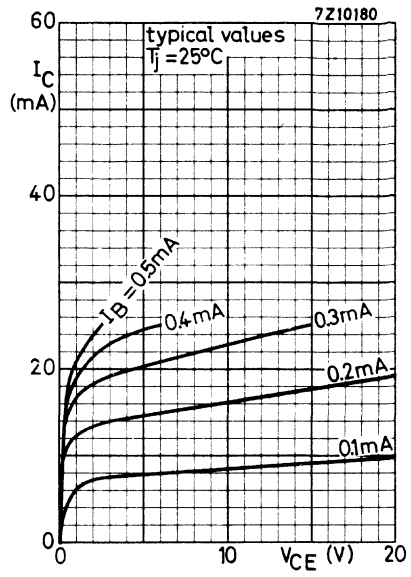
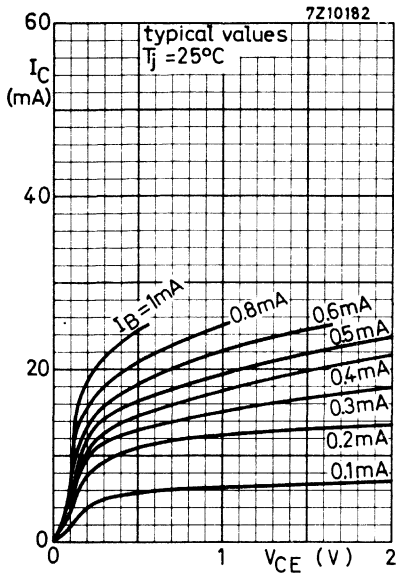
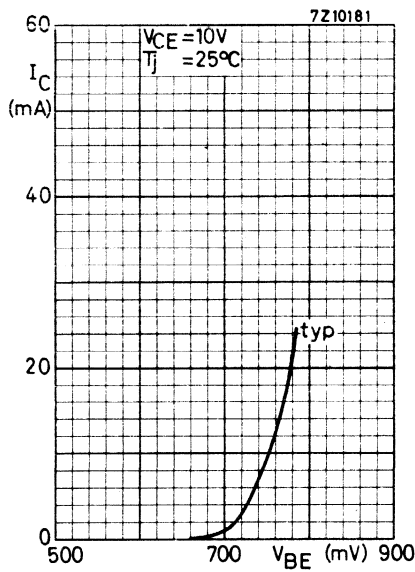
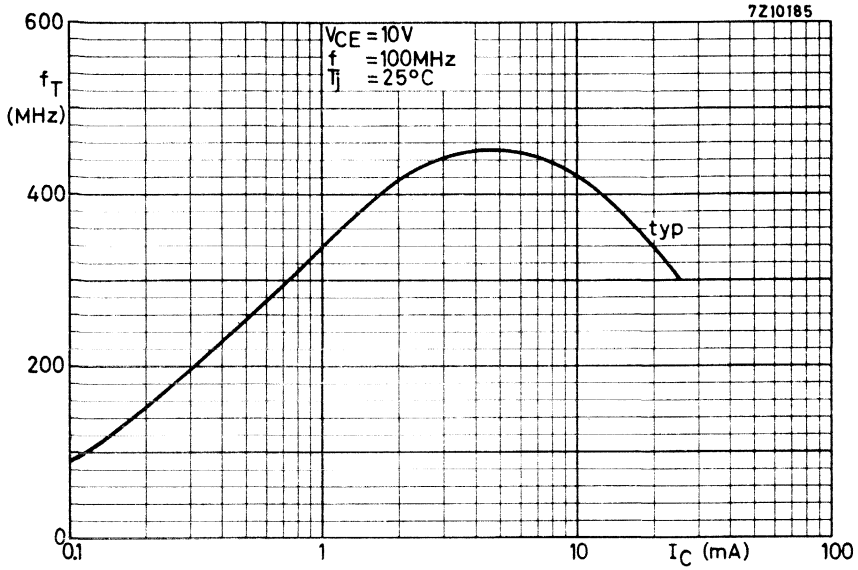
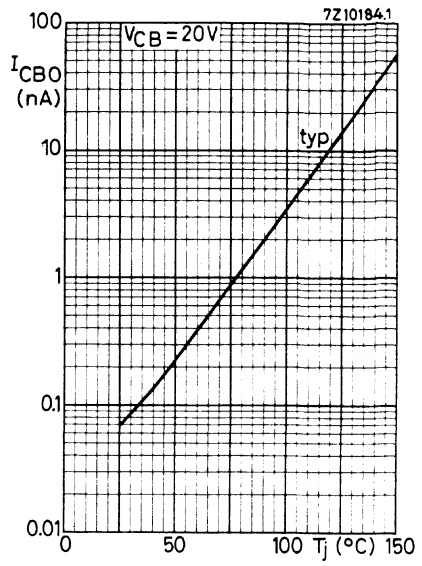
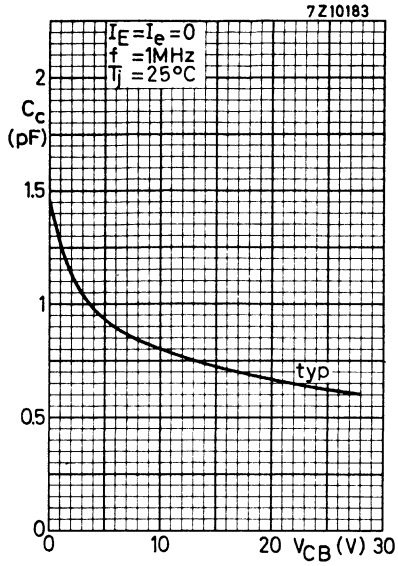


Fig. 3 Power derating curve.







## SILICON PLANAR EPITAXIAL TRANSISTORS

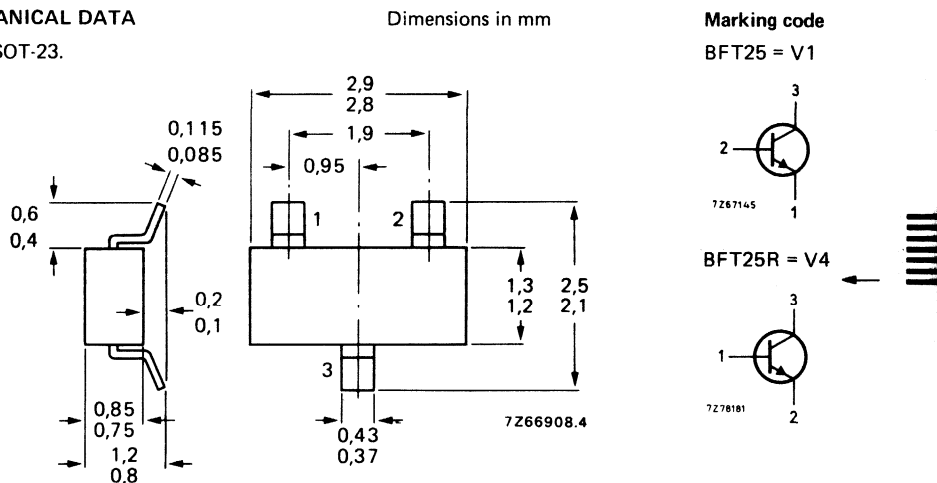
N-P-N transistor in a microminiature plastic envelope, primarily intended for use in u.h.f. low power amplifiers in thick and thin-film circuits, such as in pocket phones, paging systems, etc. The transistor features low current consumption ( $100 \mu\text{A} - 1 \text{ mA}$ ); thanks to its high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CB0}$	max.	8 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	5 V
Collector current (d.c.)	$I_C$	max.	2,5 mA
Total power dissipation up to $T_{amb} = 125 \text{ }^\circ\text{C}$	$P_{tot}$	max.	50 mW
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$
Transition frequency at $f = 500 \text{ MHz}$ $I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}$	$f_T$	typ.	2,3 GHz
Feedback capacitance at $f = 1 \text{ MHz}$ $I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$	$C_{re}$	<	0,45 pF
Noise figure at optimum source impedance $I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 500 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	F	typ.	3,8 dB
Max. unilateral power gain (see page 3) $I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 500 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	$G_{UM}$	typ.	18 dB

### MECHANICAL DATA

Fig. 1 SOT-23.



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter)	$V_{CBO}$	max.	8 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	5 V
Emitter-base voltage (open collector)	$V_{EBO}$	max.	2 V
Collector current (d.c.)	$I_C$	max.	2,5 mA
Collector current (peak value; $f > 1$ MHz)	$I_{CM}$	max.	5,0 mA
Total power dissipation up to $T_{amb} = 125$ °C**	$P_{tot}$	max.	50 mW
Storage temperature	$T_{stg}$		-65 to + 150 °C
Junction temperature	$T_j$	max.	150 °C

**THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

$T_j = 25$  °C unless otherwise specified

Collector cut-off current

$$I_E = 0; V_{CB} = 5\text{ V} \quad I_{CBO} < 50\text{ nA}$$

D.C. current gain▲

$$I_C = 10\ \mu\text{A}; V_{CE} = 1\text{ V} \quad h_{FE} < 20$$

$$I_C = 1\text{ mA}; V_{CE} = 1\text{ V} \quad h_{FE} \text{ typ. } 30$$

$$I_C = 1\text{ mA}; V_{CE} = 1\text{ V} \quad h_{FE} < 20$$

$$I_C = 1\text{ mA}; V_{CE} = 1\text{ V} \quad h_{FE} \text{ typ. } 40$$

Saturation voltages

$$I_C = 10\ \mu\text{A}; I_B = 1\ \mu\text{A} \quad V_{CEsat} < 200\text{ mV}$$

$$I_C = 10\ \mu\text{A}; I_B = 1\ \mu\text{A} \quad V_{BEsat} < 750\text{ mV}$$

$$I_C = 1\text{ mA}; I_B = 0,1\text{ mA} \quad V_{CEsat} < 175\text{ mV}$$

$$I_C = 1\text{ mA}; I_B = 0,1\text{ mA} \quad V_{BEsat} < 900\text{ mV}$$

Transition frequency at  $f = 500$  MHz▲

$$I_C = 1\text{ mA}; V_{CE} = 1\text{ V} \quad f_T > 1,2\text{ GHz}$$

$$I_C = 1\text{ mA}; V_{CE} = 1\text{ V} \quad f_T \text{ typ. } 2,3\text{ GHz}$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

▲ Measured under pulse conditions.

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

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

$C_c < 0,6 \text{ pF}$

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

$$I_C = I_c = 0; V_{EB} = 0$$

$C_e < 0,5 \text{ pF}$

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

$$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$$

$C_{re} < 0,45 \text{ pF}$

Noise figure at optimum source impedance

$$I_C = 0,1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 500 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$$

$F \text{ typ. } 5,5 \text{ dB}$

$$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 500 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$$

$F \text{ typ. } 3,8 \text{ dB}$

Maximum unilateral power gain ( $s_{re}$  assumed to be zero)

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

$$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 200 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$$

$G_{UM} \text{ typ. } 25 \text{ dB}$

$$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 500 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$$

$G_{UM} \text{ typ. } 18 \text{ dB}$

$$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 800 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$$

$G_{UM} \text{ typ. } 12 \text{ dB}$

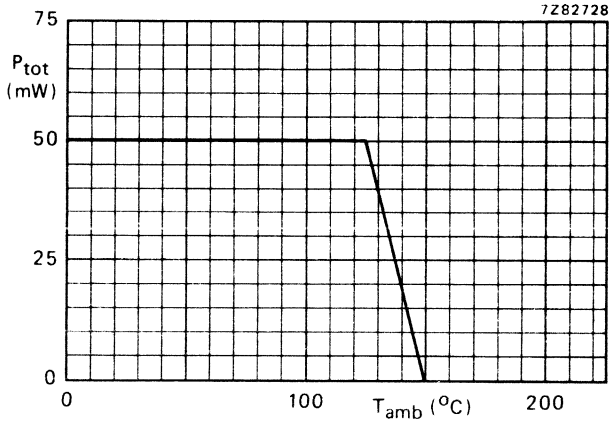
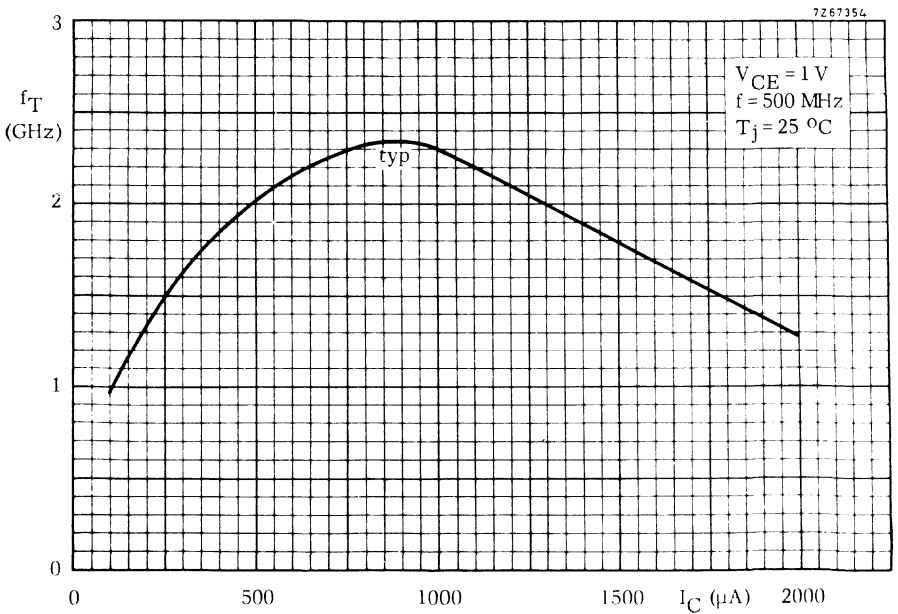
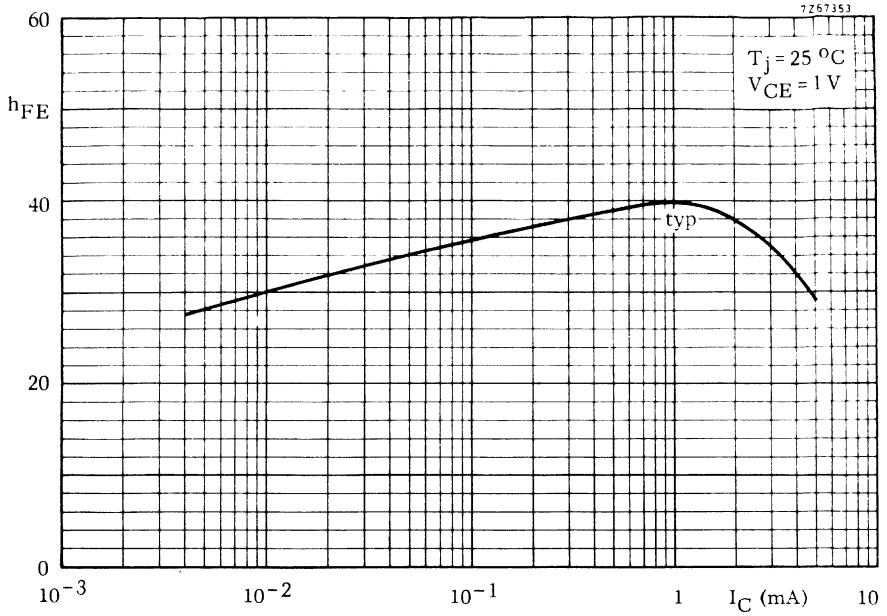
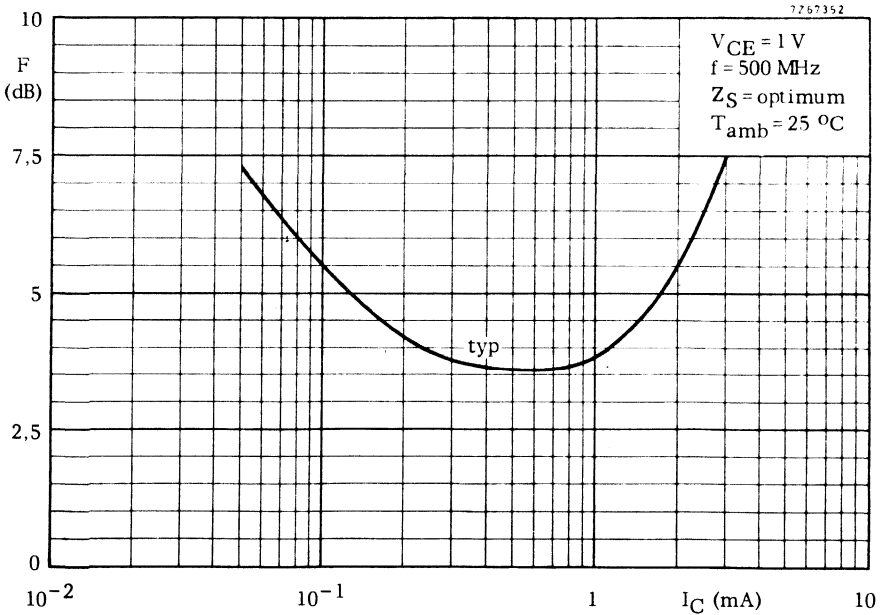
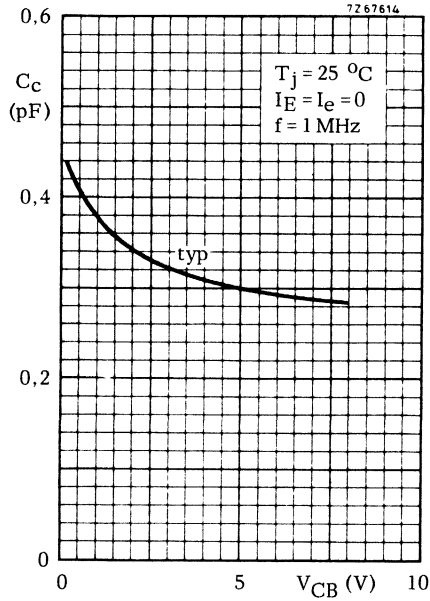


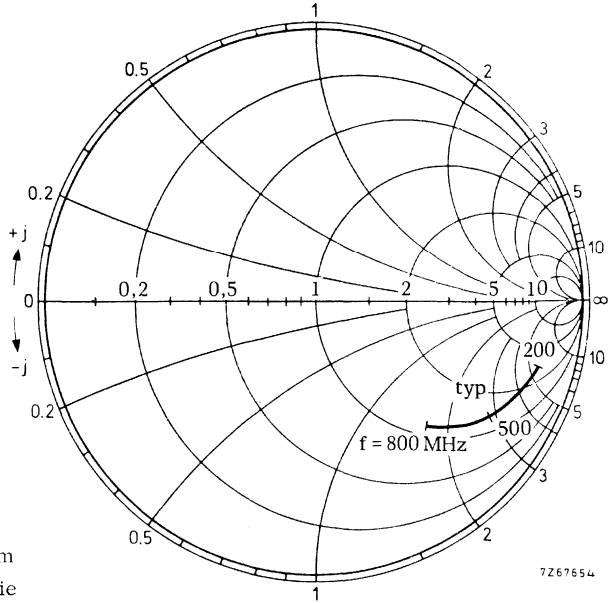
Fig. 2 Power derating curve.







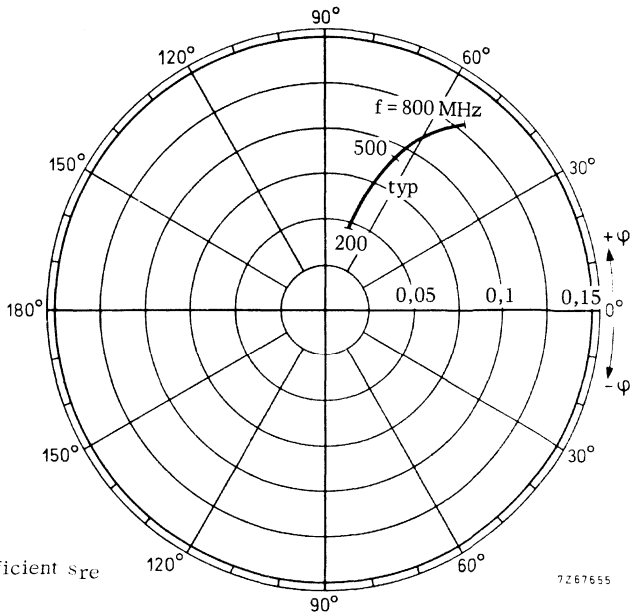
$V_{CE} = 1\text{ V}$   
 $I_C = 1\text{ mA}$   
 $T_{amb} = 25\text{ }^\circ\text{C}$



7267654

Input impedance derived from  
input reflection coefficient  $s_{ie}$   
coordinates in ohm x 50

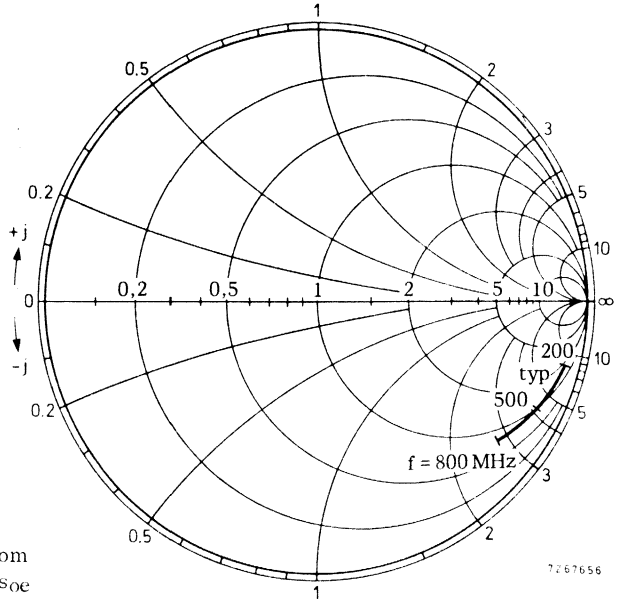
$V_{CE} = 1\text{ V}$   
 $I_C = 1\text{ mA}$   
 $T_{amb} = 25\text{ }^\circ\text{C}$



7267655

Reverse transmission coefficient  $s_{re}$

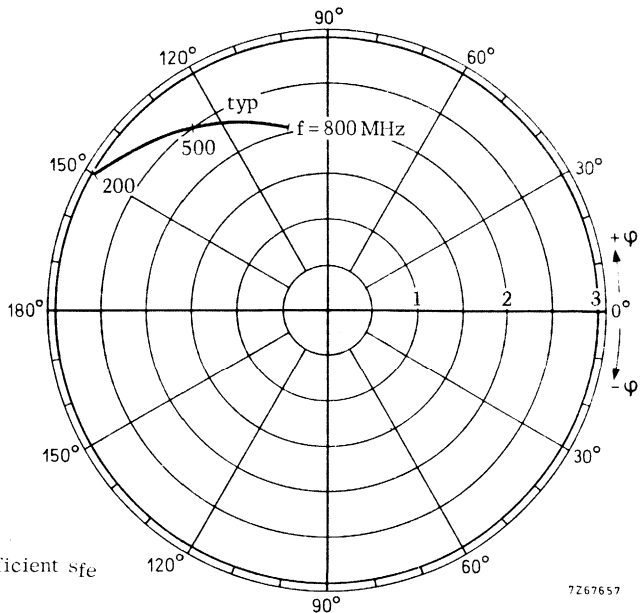
$V_{CE} = 1\text{ V}$   
 $I_C = 1\text{ mA}$   
 $T_{amb} = 25\text{ }^\circ\text{C}$



Output impedance derived from output reflection coefficient  $s_{oe}$  coordinates in ohm x 50

7267656

$V_{CE} = 1\text{ V}$   
 $I_C = 1\text{ mA}$   
 $T_{amb} = 25\text{ }^\circ\text{C}$



Forward transmission coefficient  $s_{fe}$

7267657



## N-CHANNEL SILICON FET

N-channel silicon epitaxial planar junction field-effect transistor in a microminiature plastic envelope. The transistor is intended for low level general purpose amplifiers in thick and thin-film circuits.

### QUICK REFERENCE DATA

Drain-source voltage	$\pm V_{DS}$	max.	25 V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25 V
Total power dissipation up to $T_{amb} = 65\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	250 mW
Drain current $V_{DS} = 10\text{ V}; V_{GS} = 0$	$I_{DSS}$	>	0,2 mA
		<	1,5 mA
Transfer admittance (common source) $I_D = 0,2\text{ mA}; V_{DS} = 10\text{ V}; f = 1\text{ kHz}$	$ y_{fs} $	>	0,5 mA/V
		<	
Equivalent noise voltage $V_{DS} = 10\text{ V}; I_D = 200\text{ }\mu\text{A}; B = 0,6\text{ to }100\text{ Hz}$	$V_n$	<	0,5 $\mu\text{V}$
		>	

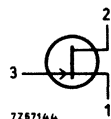
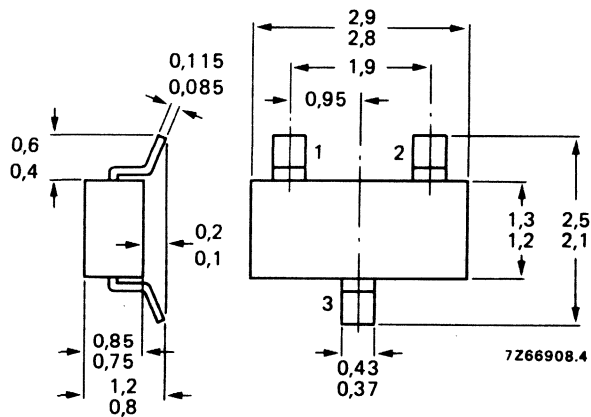
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BFT46 = M3



See also *Soldering recommendations*.

**RATINGS**

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

Drain-source voltage	$\pm V_{DS}$	max.	25 V
Drain-gate voltage (open source)	$V_{DGO}$	max.	25 V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25 V
Drain current	$I_D$	max.	10 mA
Gate current	$I_G$	max.	5 mA
→ Total power dissipation up to $T_{amb} = 65\text{ }^\circ\text{C}^{**}$	$P_{tot}$	max.	250 mW
→ Storage temperature	$T_{stg}$		-65 to +175 $^\circ\text{C}$
→ Junction temperature	$T_j$	max.	175 $^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a} = \frac{T_j - T_{amb}}{P}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Gate cut-off current

$$-V_{GS} = 10\text{ V}; V_{DS} = 0 \quad -I_{GSS} < 0,2\text{ nA}$$

Drain current \*\*

$$V_{DS} = 10\text{ V}; V_{GS} = 0 \quad I_{DSS} > 0,2\text{ mA}$$

Gate-source voltage

$$I_D = 50\text{ }\mu\text{A}; V_{DS} = 10\text{ V} \quad -V_{GS} > 0,1\text{ V}$$

Gate-source cut-off voltage

$$I_D = 0,5\text{ nA}; V_{DS} = 10\text{ V} \quad -V_{(P)GS} < 1,2\text{ V}$$

Y parameters at  $f = 1\text{ kHz}$ ;

$$V_{DS} = 10\text{ V}; V_{GS} = 0; T_{amb} = 25\text{ }^\circ\text{C}$$

Transfer admittance

$$|Y_{fs}| > 1,0\text{ mA/V}$$

Output admittance

$$|Y_{os}| < 10\text{ }\mu\text{A/V}$$

$$V_{DS} = 10\text{ V}; I_D = 200\text{ }\mu\text{A};$$

Transfer admittance

$$|Y_{fs}| > 0,5\text{ mA/V}$$

Output admittance

$$|Y_{os}| < 5\text{ }\mu\text{A/V}$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

Input capacitance at  $f = 1 \text{ MHz}$ ;

$V_{DS} = 10 \text{ V}$ ;  $V_{GS} = 0$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

$C_{is} < 5 \text{ pF}$

Feedback capacitance at  $f = 1 \text{ MHz}$ ;

$V_{DS} = 10 \text{ V}$ ;  $V_{GS} = 0$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

$C_{rs} < 1,5 \text{ pF}$

Equivalent noise voltage

$V_{DS} = 10 \text{ V}$ ;  $I_D = 200 \text{ }\mu\text{A}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

$B = 0,6 \text{ to } 100 \text{ Hz}$

$V_n < 0,5 \text{ }\mu\text{V}$

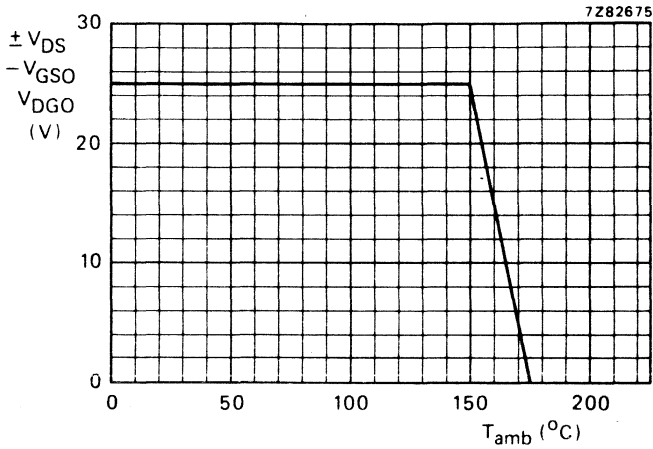


Fig. 2 Voltage derating curve.

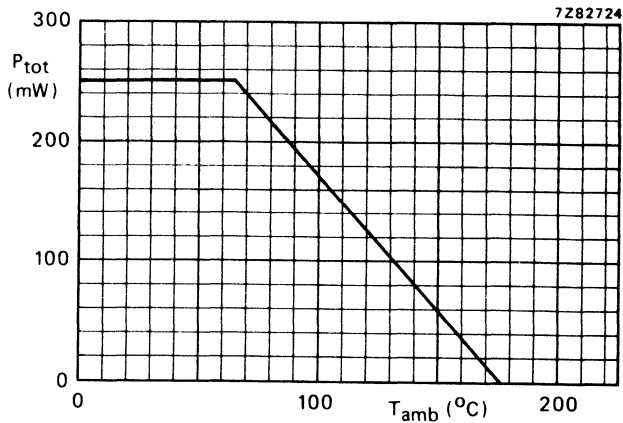
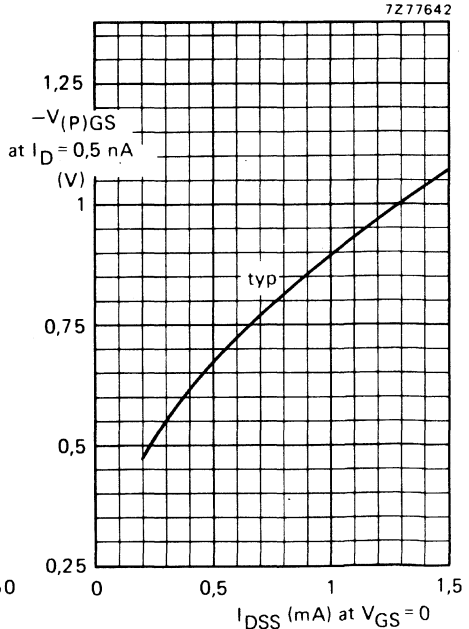
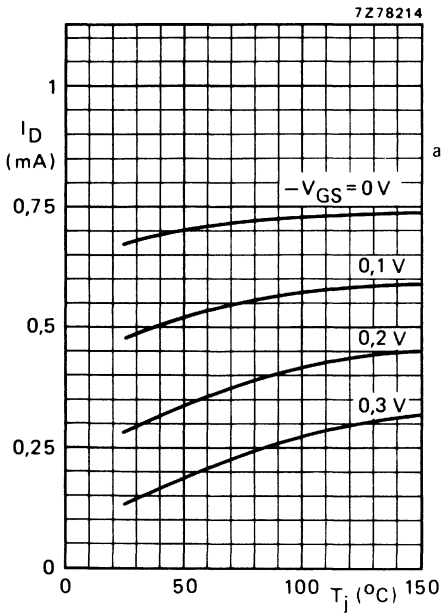
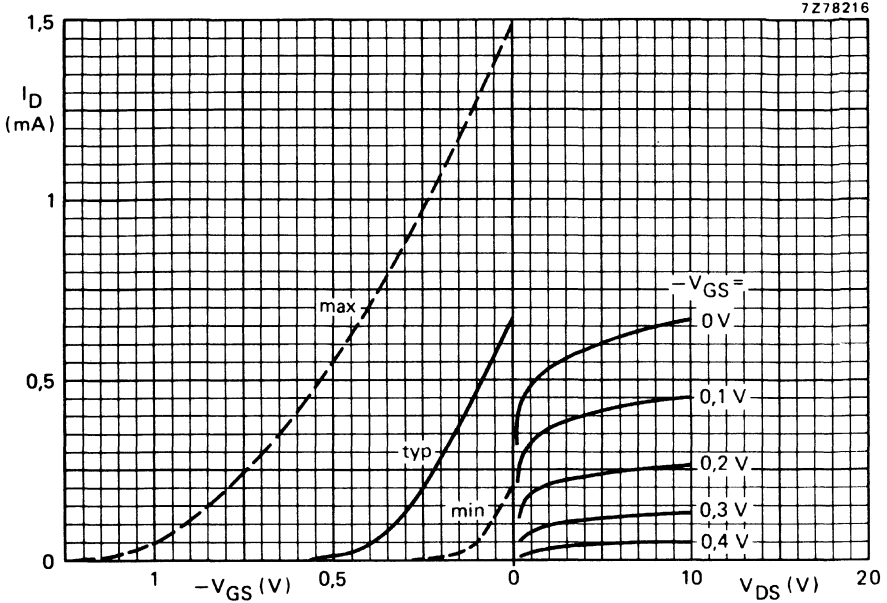


Fig. 3 Power derating curve.





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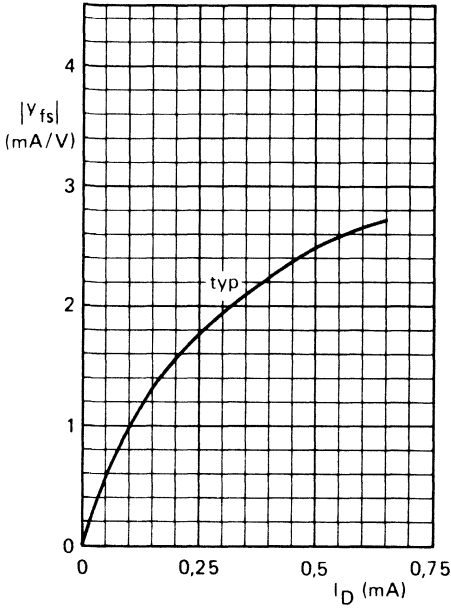


Fig. 7.

7277640

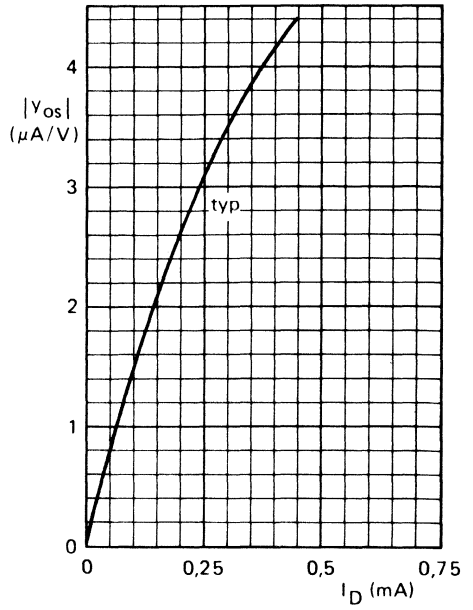


Fig. 8.

7277638

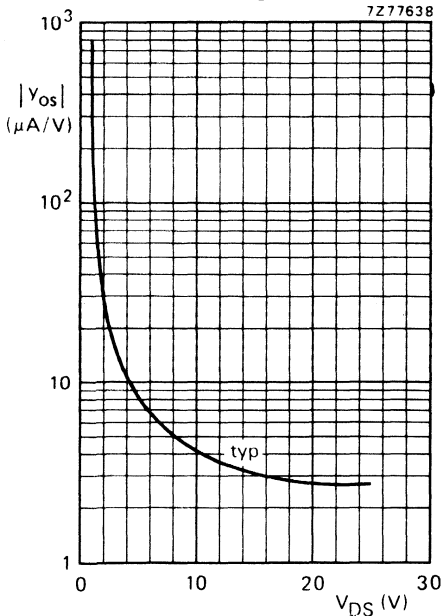


Fig. 9.

Fig. 7  $|Y_{fs}|$  versus  $I_D$ .  
 $V_{DS} = 10$  V;  $f = 1$  kHz;  $T_{amb} = 25$  °C.

Fig. 8  $|Y_{os}|$  versus  $I_D$ .  
 $V_{DS} = 10$  V;  $f = 1$  kHz;  $T_{amb} = 25$  °C.

Fig. 9  $|Y_{os}|$  versus  $V_{DS}$ .  
 $I_D = 0,4$  mA;  $f = 1$  kHz;  $T_{amb} = 25$  °C.



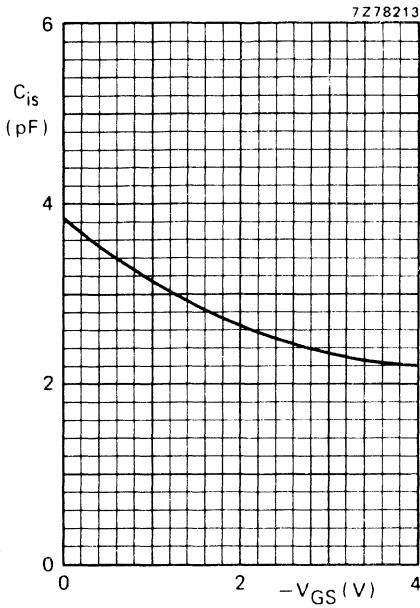


Fig. 10.

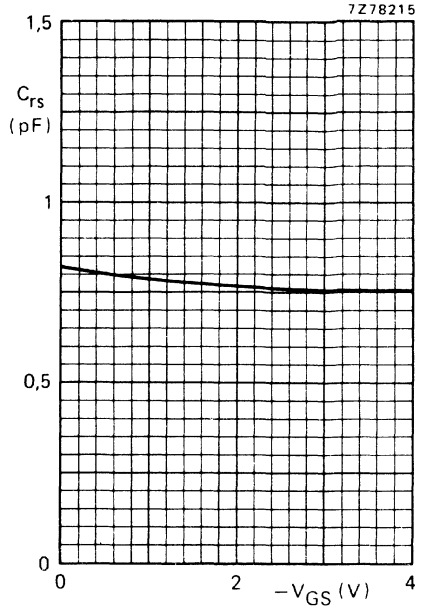


Fig. 11.

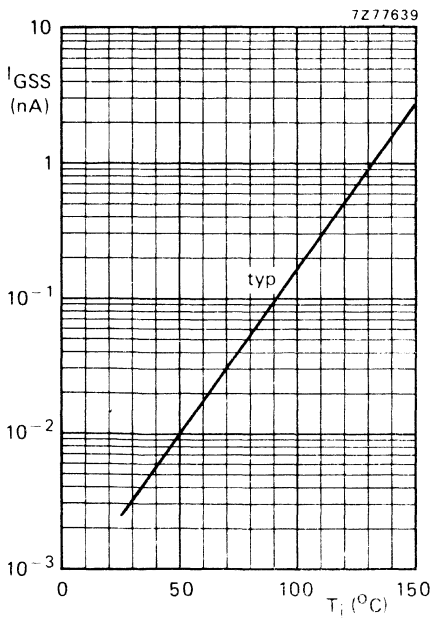


Fig. 12.

Fig. 10 Typical values.  
 $V_{DS} = 10$  V,  $T_{amb} = 25$  °C.

Fig. 11 Typical values.  
 $V_{DS} = 10$  V,  $T_{amb} = 25$  °C.

Fig. 12  $I_{GSS}$  versus  $T_j$ .  
 $-V_{GSS} = 10$  V;  $V_{DS} = 0$ .

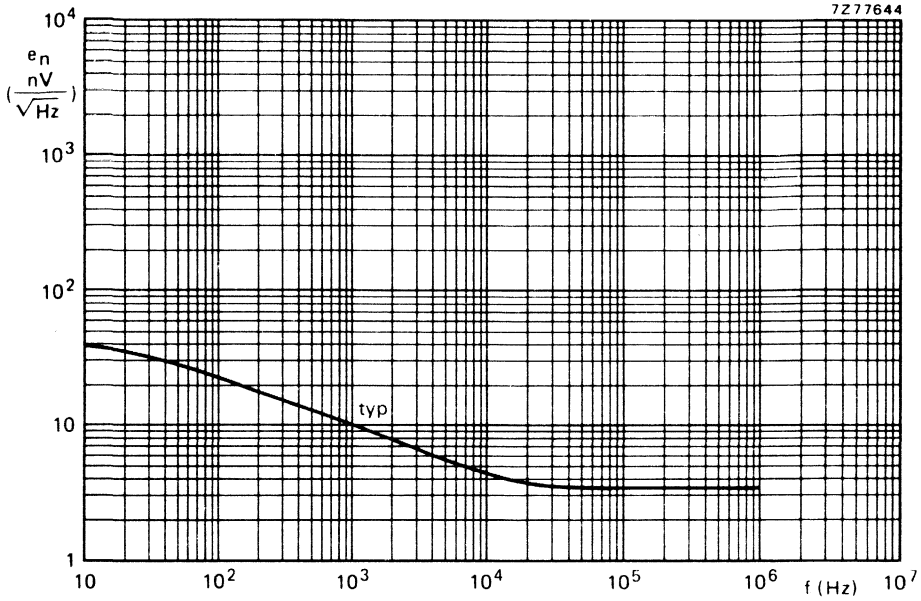


Fig. 13  $V_{DS} = 10 V$ ;  $I_D = 0,2 mA$ ;  $T_{amb} = 25 ^\circ C$ .

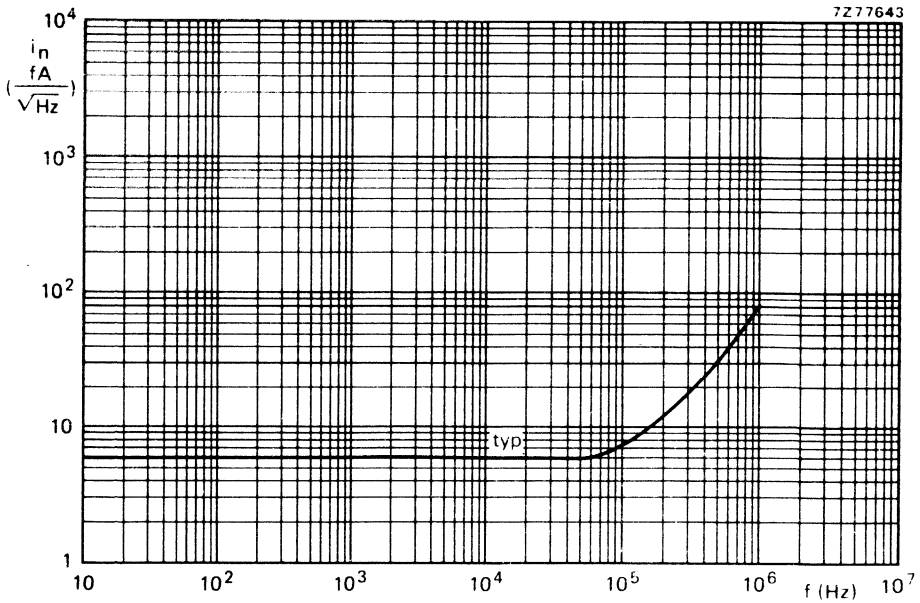


Fig. 14  $V_{DS} = 10 V$ ;  $I_D = 0,2 mA$ ;  $T_{amb} = 25 ^\circ C$ .

**RATINGS**

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

Collector-base voltage (open emitter)	$-V_{CB0}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	2,0 V
Collector current (d.c.)	$-I_C$	max.	25 mA
Collector current (peak value; $f > 1$ MHz)	$-I_{CM}$	max.	35 mA
→ Total power dissipation up to $T_{amb} = 60$ °C **	$P_{tot}$	max.	200 mW
Storage temperature	$T_{stg}$		-65 to + 150 °C
Junction temperature	$T_j$	max.	150 °C

→ **THERMAL CHARACTERISTICS \***

$$T_j = P (R_{th j-t} + R_{th t-s} + R_{th s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th j-t}$	=	60 K/W
From tab to soldering points	$R_{th t-s}$	=	260 K/W
From soldering points to ambient **	$R_{th s-a}$	=	120 K/W

**CHARACTERISTICS**

$T_j = 25$  °C unless otherwise specified

Collector cut-off current

$$I_E = 0; -V_{CB} = 10 \text{ V} \quad -I_{CB0} < 50 \text{ nA}$$

D.C. current gain \*

$$-I_C = 14 \text{ mA}; -V_{CE} = 10 \text{ V} \quad h_{FE} > \begin{matrix} 20 \\ \text{typ.} \\ 50 \end{matrix}$$

Transition frequency at  $f = 500$  MHz <sup>▲</sup>

$$-I_C = 14 \text{ mA}; -V_{CE} = 10 \text{ V} \quad f_T \text{ typ. } 5 \text{ GHz}$$

Collector capacitance at  $f = 1$  MHz

$$I_E = I_e = 0; -V_{CB} = 10 \text{ V} \quad C_c \text{ typ. } 0,75 \text{ pF}$$

Emitter capacitance at  $f = 1$  MHz

$$I_C = I_c = 0; -V_{EB} = 0,5 \text{ V} \quad C_e \text{ typ. } 0,8 \text{ pF}$$



▲ Measured under pulse conditions.

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

**CHARACTERISTICS** (continued) $T_{amb} = 25\text{ }^{\circ}\text{C}$ Feedback capacitance at  $f = 1\text{ MHz}$  $-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$  $C_{re}$  typ. 0,7 pF

Noise figure at optimum source impedance \*

 $-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}; f = 500\text{ MHz}$ 

F typ. 2,7 dB

Max. unilateral power gain ( $s_{re}$  assumed to be zero)

$$G_{UM}(\text{in dB}) = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

 $-I_C = 14\text{ mA}; -V_{CE} = 10\text{ V}; f = 500\text{ MHz}$  $G_{UM}$  typ. 18 dB

Intermodulation distortion \*

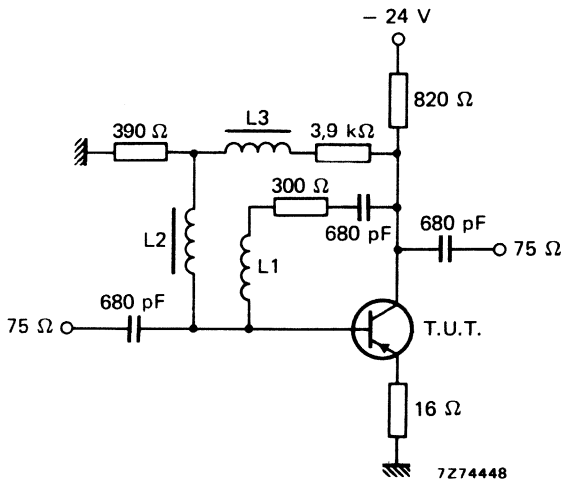
 $-I_C = 14\text{ mA}; -V_{CE} = 10\text{ V}; R_L = 75\text{ }\Omega; \text{VSWR} < 2$  $V_p = V_o = 150\text{ mV}$  at  $f_p = 495,25\text{ MHz}$  $V_q = V_o - 6\text{ dB}$  at  $f_q = 503,25\text{ MHz}$  $V_r = V_o - 6\text{ dB}$  at  $f_r = 505,25\text{ MHz}$ Measured at  $f_{(p+q-r)} = 493,25\text{ MHz}$  $d_{im}$  typ. -60 dB

Fig. 2 Intermodulation test circuit.

L1 = 4 turns Cu wire (0,35 mm); winding pitch 1 mm; int. dia. 4 mm.

L2 = L3 = 5  $\mu\text{H}$  (catalogue number: 3122 108 20150).

\* Crystal mounted in SOT-37 envelope.

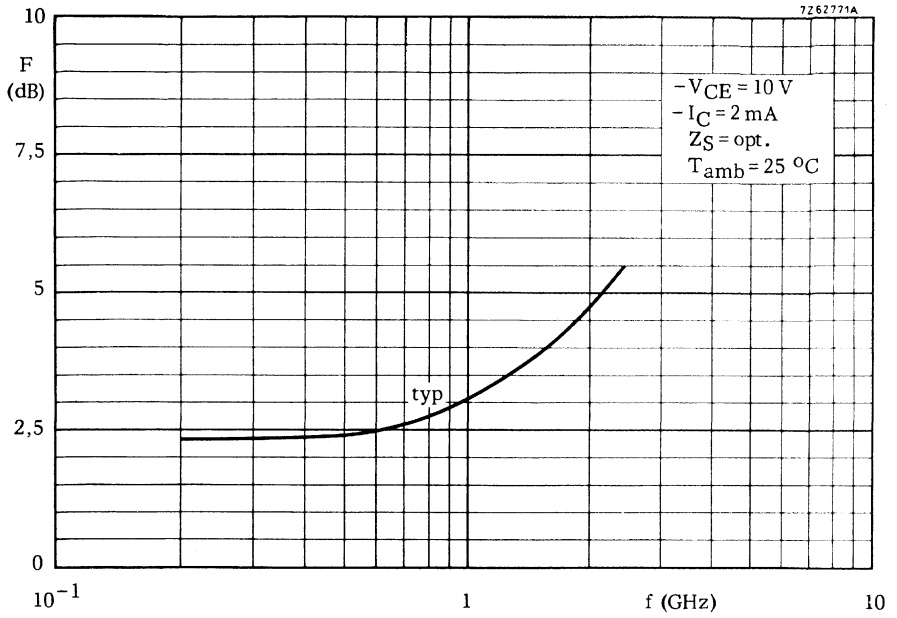


Fig. 7.

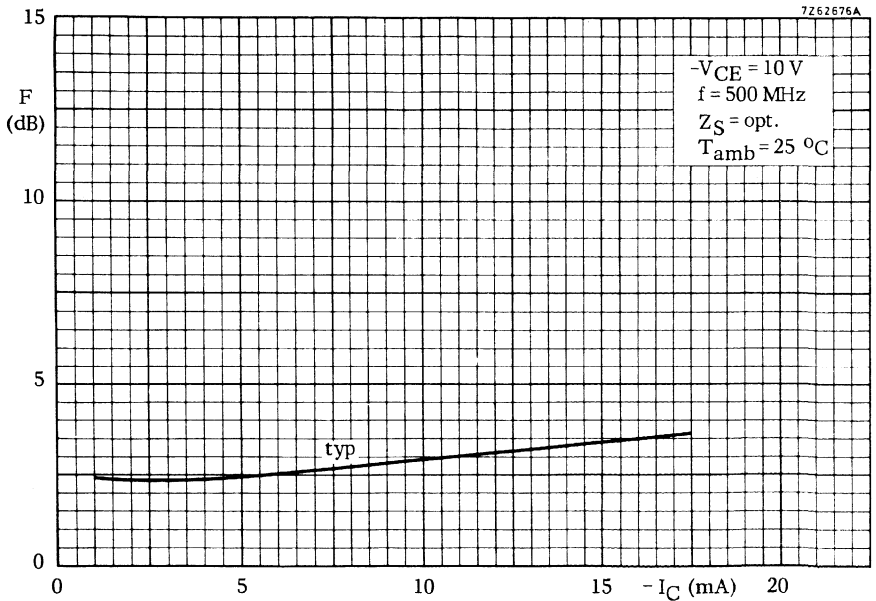


Fig. 8.

## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistor in a microminiature plastic envelope. It is primarily intended for use in u.h.f. and microwave amplifiers in thick and thin-film circuits, such as in aerial amplifiers, radar systems, oscilloscopes, spectrum analysers, etc.

The transistor features low intermodulation distortion and high power gain; thanks to its very high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

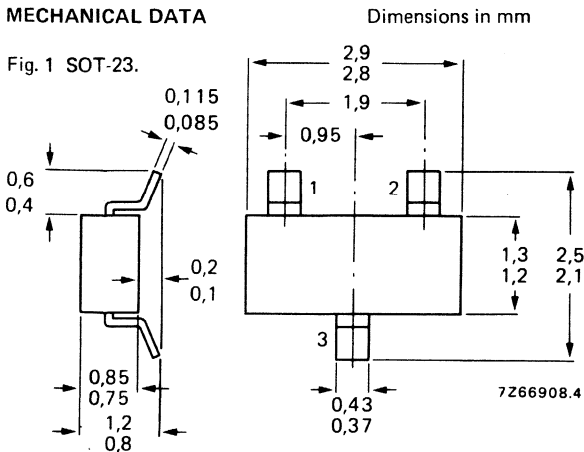
This type is complementary to BFR93.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	12 V
Collector current (d.c.)	$-I_C$	max.	35 mA
Total power dissipation up to $T_{amb} = 60^\circ\text{C}$	$P_{tot}$	max.	200 mW
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$
Transition frequency at $f = 500\text{ MHz}$ $-I_C = 30\text{ mA}; -V_{CE} = 5\text{ V}$	$f_T$	typ.	5 GHz
Feedback capacitance at $f = 1\text{ MHz}$ $-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}; T_{amb} = 25^\circ\text{C}$	$C_{re}$	typ.	1,0 pF
Noise figure at optimum source impedance $-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}; f = 500\text{ MHz}; T_{amb} = 25^\circ\text{C}$	F	typ.	2,4 dB
Max. unilateral power gain (see page 3) $-I_C = 30\text{ mA}; -V_{CE} = 5\text{ V}; f = 500\text{ MHz}; T_{amb} = 25^\circ\text{C}$	$G_{UM}$	typ.	16,5 dB
Intermodulation distortion at $T_{amb} = 25^\circ\text{C}$ $-I_C = 30\text{ mA}; -V_{CE} = 5\text{ V}; R_L = 75\ \Omega; V_o = 300\text{ mV}$ $f_{(p+q-r)} = 493,25\text{ MHz}$ (see page 3)	$d_{im}$	typ.	-60 dB

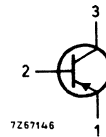
### MECHANICAL DATA

Fig. 1 SOT-23.

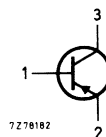


### Marking code

BFT93 = X1



BFT93R = X4



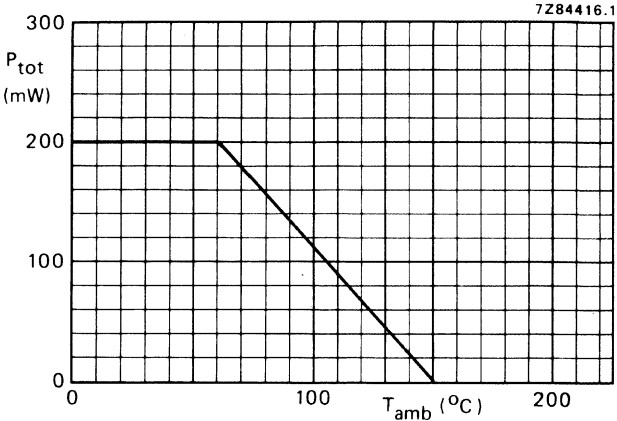


Fig. 3 Power derating curve.





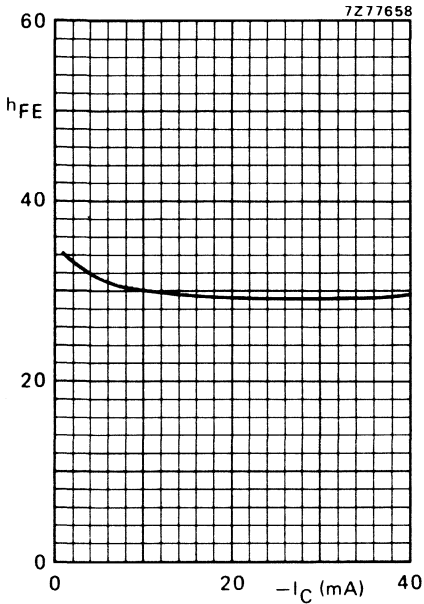


Fig. 4  $-V_{CE} = 5$  V;  $T_j = 25$  °C.

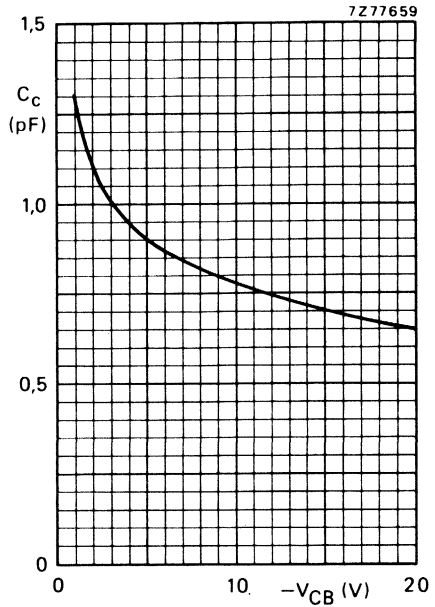


Fig. 5  $I_E = I_e = 0$ ;  $T_j = 25$  °C;  $f = 1$  MHz.

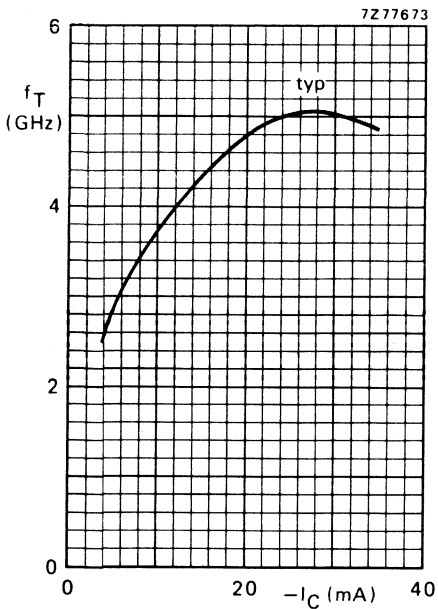


Fig. 6  $-V_{CE} = 5$  V;  $T_j = 25$  °C;  $f = 500$  MHz.



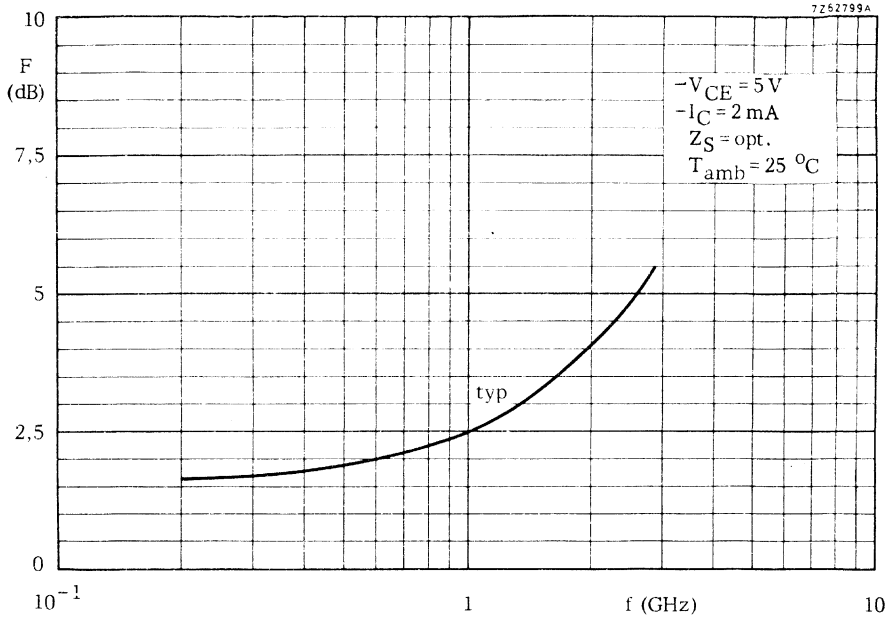


Fig. 7.

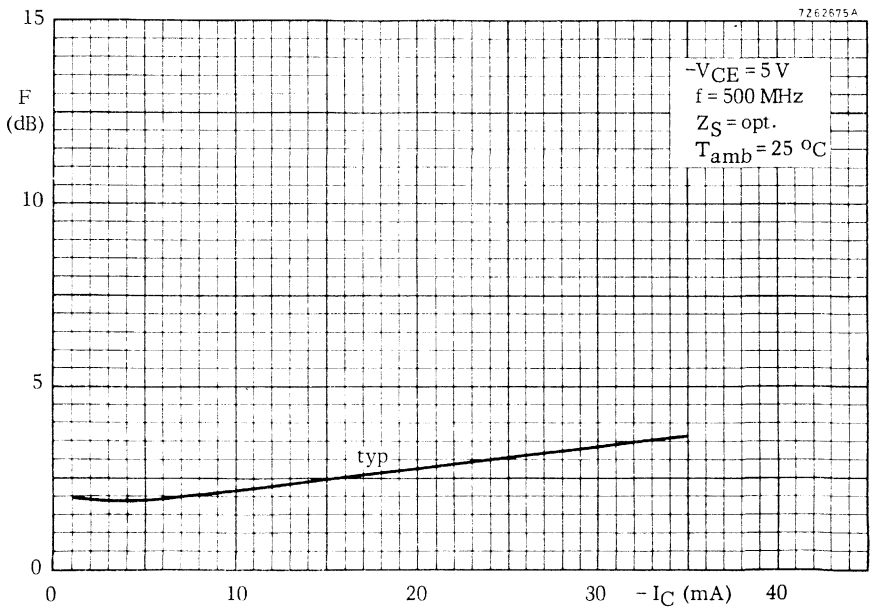


Fig. 8.

## PROGRAMMABLE UNIJUNCTION TRANSISTOR

Planar p-n-p-n trigger device in a microminiature plastic envelope intended for applications in thick and thin-film circuits. It is intended for use in switching applications such as motor control, oscillators, relay replacement, timers, pulse shaper, trigger device etc.

### QUICK REFERENCE DATA

Gate-anode voltage	$V_{GA}$	max.	70 V
Anode current (d.c.) up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	$I_A$	max.	175 mA
Junction temperature	$T_j$	max.	150 $^{\circ}\text{C}$
Peak point current $V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$	$I_p$	<	5 $\mu\text{A}$
Valley point current $V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$	$I_v$	>	30 $\mu\text{A}$

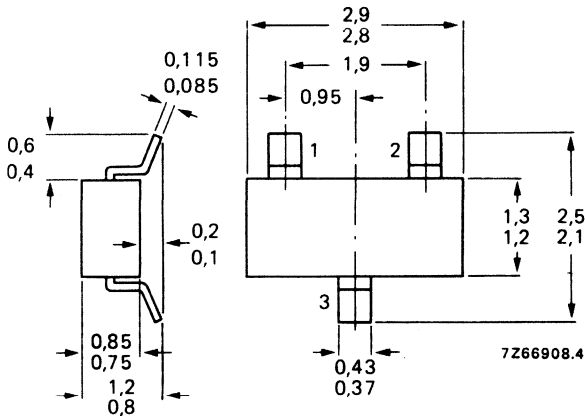
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BRY61 = A5



See also *Soldering Recommendations*.

**RATINGS**

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

Gate-anode voltage	$V_{GA}$	max.	70 V
→ Anode current (d.c.) up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	$I_A$	max.	175 mA
Repetitive peak anode current $t = 10\text{ }\mu\text{s}; \delta = 0,01$	$I_{ARM}$	max.	2,5 A
Non-repetitive peak anode current $t = 10\text{ }\mu\text{s}; T_j = 150\text{ }^{\circ}\text{C}$	$I_{ASM}$	max.	3 A
Rate of rise of anode current up to $I_A = 2,5\text{ A}$	$\frac{dI_A}{dt}$	max.	20 A/ $\mu\text{s}$
Storage temperature	$T_{stg}$		-65 to +150 $^{\circ}\text{C}$
Junction temperature	$T_j$	max.	150 $^{\circ}\text{C}$
→ Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}^{**}$	$P_{tot}$	max.	275 mW

→ **THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Peak point current (see Figs 2, 3 and 4)

$V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$	$I_p$	<	5 $\mu\text{A}$
$V_S = 10\text{ V}; R_G = 1\text{ M}\Omega$	$I_p$	<	1 $\mu\text{A}$

Valley point current (see also Figs 2, 3 and 4)

$V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$	$I_V$	>	30 $\mu\text{A}$
$V_S = 10\text{ V}; R_G = 1\text{ M}\Omega$	$I_V$	<	50 $\mu\text{A}$

Offset voltage (see Fig. 12)

$I_A = 0$ (for $V_p$ see Fig. 2; for $V_S$ see Fig. 4)	$V_{offset}$	=	$V_p - V_S$ V
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\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.



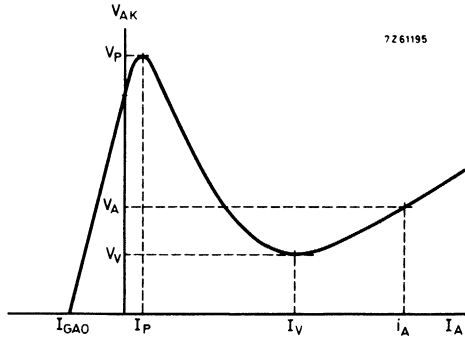


Fig. 2 See also Fig. 11.

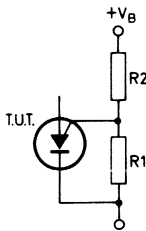


Fig. 3 BRY61 with "program" resistors  $R_1$  and  $R_2$ .

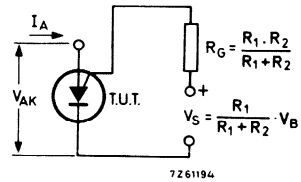


Fig. 4 Equivalent test circuit for characteristics testing.

Gate-anode leakage current (Fig. 5a)

$$I_K = 0; V_{GA} = 70 \text{ V}$$

Gate-cathode leakage current (Fig. 5b)

$$V_{AK} = 0; V_{GK} = 70 \text{ V}$$

$$I_{GAO} < 10 \text{ nA}$$

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

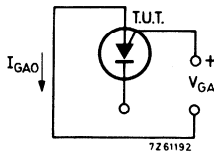


Fig. 5a.

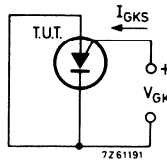


Fig. 5b.

Anode voltage

$I_A = 100 \text{ mA}$

$I_A = 180 \text{ mA}$

$V_A < 1,4 \text{ V}$

$V_A < 1,6 \text{ V}$

Peak output voltage

$V_{AA} = 20 \text{ V}; C = 200 \text{ nF}$  (see Fig. 12)

$V_{OM} > 6 \text{ V}$

Rise time

$V_{AA} = 20 \text{ V}; C = 10 \text{ nF}$  (see Fig. 12)

$t_r < 80 \text{ ns}$

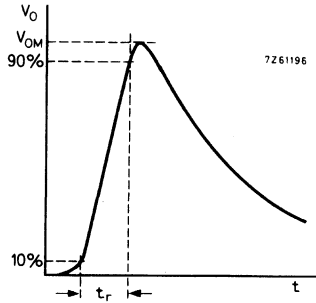


Fig. 6 Output voltage waveform.



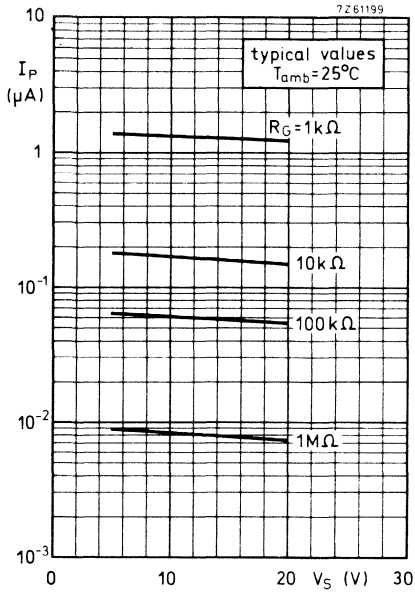


Fig. 8.

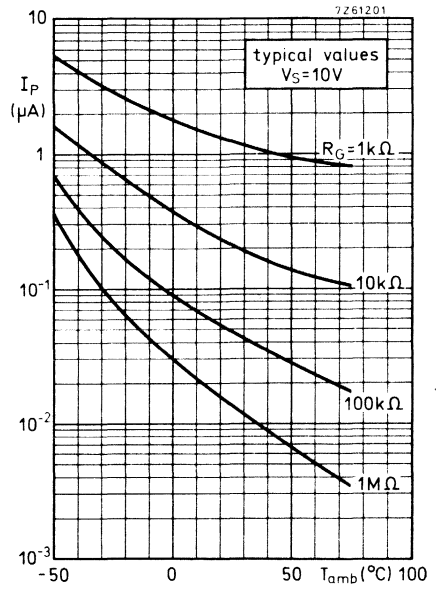


Fig. 9.

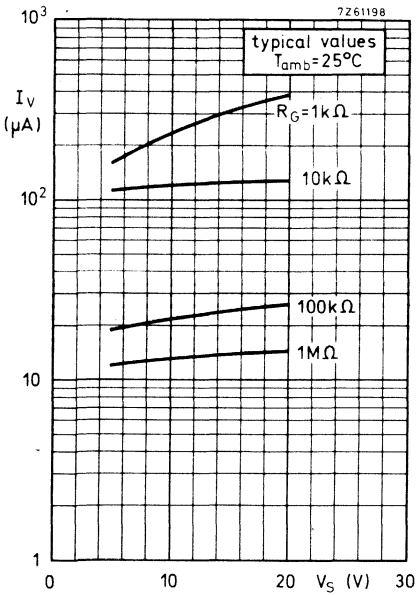


Fig. 10.

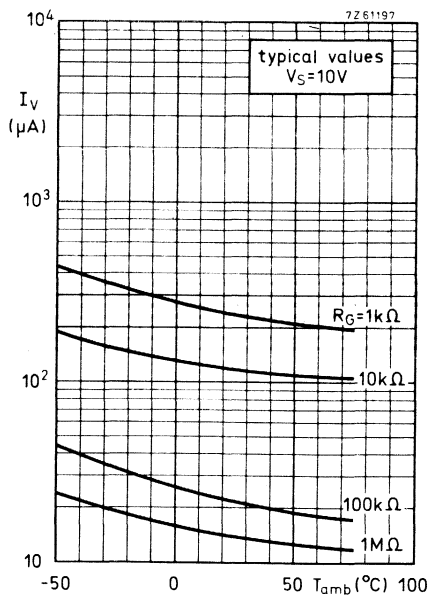


Fig. 11.

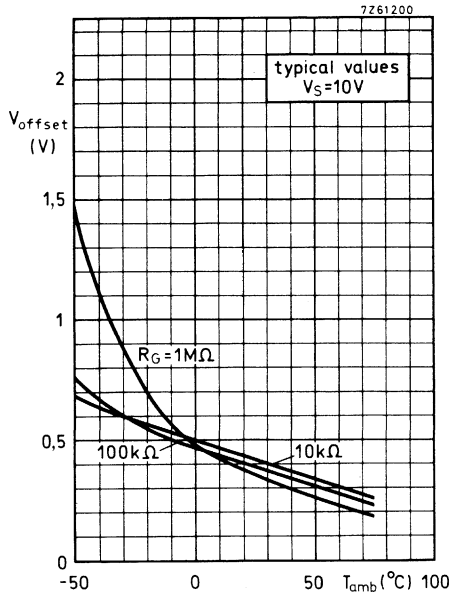


Fig. 12.

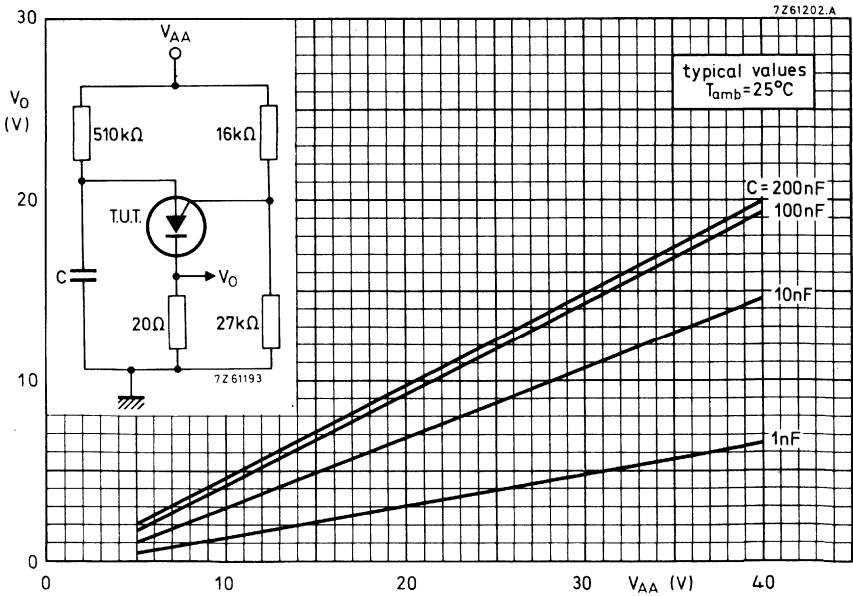


Fig. 13.



## SILICON LOW-POWER SWITCHING TRANSISTORS

P-N-P silicon transistor in a microminiature plastic envelope. It is intended for high-speed, saturated switching applications for industrial service in thick and thin-film circuits.

### QUICK REFERENCE DATA

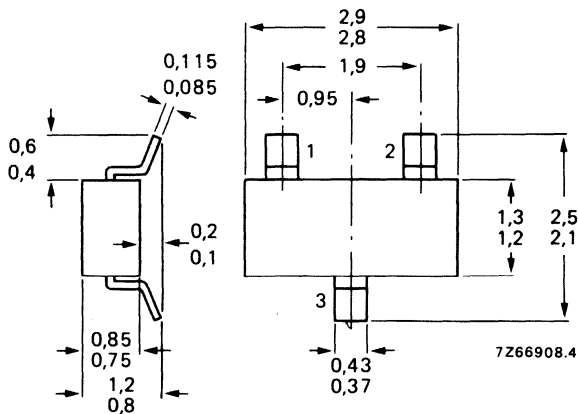
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15 V	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15 V	
Collector current (peak value)	$-I_{CM}$	max.	200 mA	
Total power dissipation up to $T_{amb} = 65^{\circ}\text{C}$	$P_{tot}$	max.	250 mW	←
Junction temperature	$T_j$	max.	$175^{\circ}\text{C}$	←
D.C. current gain				
$-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$	$h_{FE}$	>	30	
$-I_C = 50\text{ mA}; -V_{CE} = 1\text{ V}$	$h_{FE}$		30 to 120	
Transition frequency at $f = 500\text{ MHz}$				
$-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$	$f_T$	>	1,5 GHz	
Turn-off time				
$-I_{Con} = 30\text{ mA}; -I_{Bon} = +I_{Boff} = 3,0\text{ mA}$	$t_{off}$	<	30 ns	

### MECHANICAL DATA

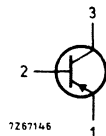
Dimensions in mm

### Marking code

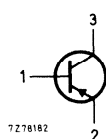
Fig. 1 SOT-23.



BSR12 = B5



BSR12R = B8



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) See Fig. 3	$-V_{CB0}$	max.	15 V
Collector-emitter voltage (open base) See Fig. 3	$-V_{CEO}$	max.	15 V
Emitter-base voltage (open collector) See Fig. 3	$-V_{EBO}$	max.	3 V
Collector current (d.c.)	$-I_C$	max.	100 mA
Collector current (peak value)	$-I_{CM}$	max.	200 mA
→ Total power dissipation up to $T_{amb} = 65\text{ }^\circ\text{C}^{**}$	$P_{tot}$	max.	250 mW
→ Storage temperature	$T_{stg}$		$-65\text{ to }+175\text{ }^\circ\text{C}$
→ Junction temperature	$T_j$	max.	175 $^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P_x (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Collector cut-off current

$I_E = 0; -V_{CB} = 10\text{ V}$	$-I_{CB0}$	<	50 nA
$I_E = 0; -V_{CB} = 10\text{ V}; T_{amb} = 125\text{ }^\circ\text{C}$	$-I_{CB0}$	<	5 $\mu\text{A}$
$V_{BE} = 0; -V_{CE} = 10\text{ V}$	$-I_{CES}$	<	50 nA

Breakdown voltages

$I_E = 0; -I_C = 10\text{ }\mu\text{A}$	$-V_{(BR)CBO}$	>	15 V
$V_{BE} = 0; -I_C = 10\text{ }\mu\text{A}$	$-V_{(BR)CES}$	>	15 V
$I_C = 0; -I_E = 100\text{ }\mu\text{A}$	$-V_{(BR)EBO}$	>	3 V

Collector-emitter sustaining voltage

$I_B = 0; -I_C = 10\text{ mA}$	$-V_{CEO\text{sust}}$	>	15 V
--------------------------------	-----------------------	---	------

Saturation voltages $\blacktriangle$

$-I_C = 10\text{ mA}; -I_B = 1\text{ mA}$	$-V_{CE\text{sat}}$	<	130 mV
	$-V_{BE\text{sat}}$		725 to 920 mV
$-I_C = 50\text{ mA}; -I_B = 5\text{ mA}$	$-V_{CE\text{sat}}$	<	190 mV
	$-V_{BE\text{sat}}$		800 to 1150 mV
$-I_C = 100\text{ mA}; -I_B = 10\text{ mA}$	$-V_{CE\text{sat}}$	<	450 mV
	$-V_{BE\text{sat}}$		900 to 1500 mV

$\blacktriangle$  Measured under pulse conditions;  $t_p = 300\text{ }\mu\text{s}$ ;  $\delta = 0,01$ .

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

D.C. current gain \*

$-I_C = 1 \text{ mA}; -V_{CE} = 1 \text{ V}$	$h_{FE}$	$>$	30
$-I_C = 10 \text{ mA}; -V_{CE} = 1 \text{ V}$	$h_{FE}$	$>$	30
$-I_C = 50 \text{ mA}; -V_{CE} = 1 \text{ V}$	$h_{FE}$	$>$	30 to 120
$-I_C = 50 \text{ mA}; -V_{CE} = 1 \text{ V}; T_{amb} = 55 \text{ }^\circ\text{C}$	$h_{FE}$	$>$	30
$-I_C = 100 \text{ mA}; -V_{CE} = 1 \text{ V}$	$h_{FE}$	$>$	20

Transition frequency at  $f = 500 \text{ MHz}$

$-I_C = 50 \text{ mA}; -V_{CE} = 10 \text{ V}$	$f_T$	$>$	1,5 GHz
--	-------	-----	---------

Collector capacitance

$I_E = I_e = 0; -V_{CB} = 5 \text{ V}$	$C_c$	$<$	4,5 pF
--	-------	-----	--------

Emitter capacitance

$I_C = I_c = 0; -V_{EB} = 0,5 \text{ V}$	$C_e$	$<$	6,0 pF
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Switching times

Turn-on time	$t_{on}$	$<$	20 ns
Turn-off time	$t_{off}$	$<$	30 ns

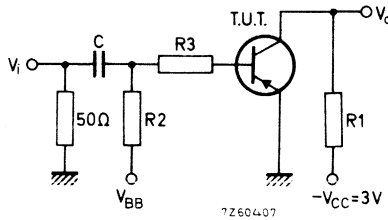


Fig. 2 Test circuit switching times.

Pulse generator

Pulse duration	$t_p = 400 \text{ ns}$
Rise time	$t_r < 1 \text{ ns}$
Output impedance	$Z_o = 50 \text{ } \Omega$

Sampling scope

Rise time	$t_r < 1 \text{ ns}$
Input impedance	$Z_i = 100 \text{ k} \Omega$

	$V_i$ V	$V_{BB}$ V	$R_1$ $\Omega$	$R_2$ k $\Omega$	$R_3$ k $\Omega$	$-I_{Con}$ mA	$-I_{Bon}$ mA	$I_{Boff}$ mA	$C$ $\mu\text{F}$
$t_{on}$	-6,85	0	94	1,0	2,0	30	3,0	-	0,1
$t_{off}$	11,7	-9,85	94	1,0	2,0	30	3,0	3,0	0,1

\* Measured under pulse conditions;  $t_p = 300 \text{ } \mu\text{s}$ ;  $\delta = 0,01$ .

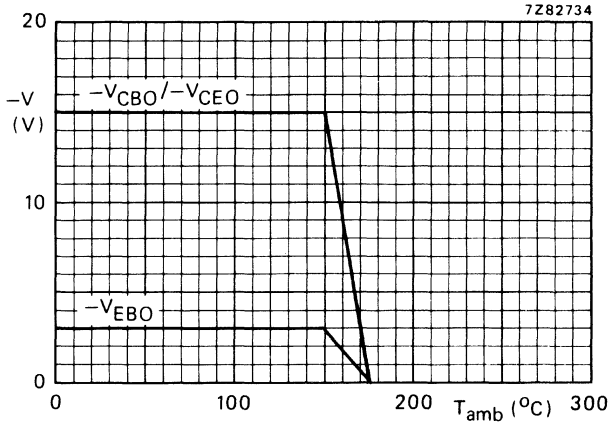


Fig. 3 Voltage derating curves.

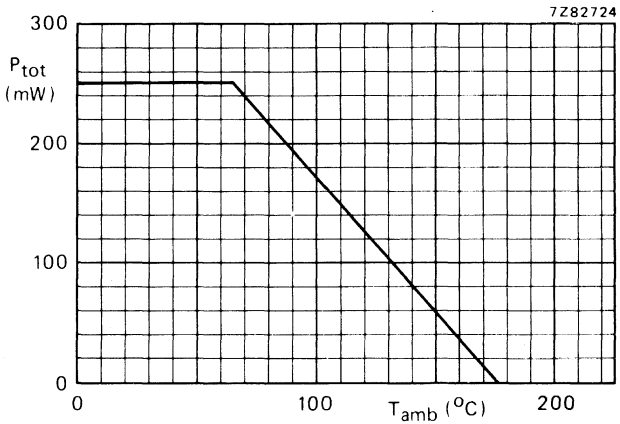


Fig. 4 Power derating curve.

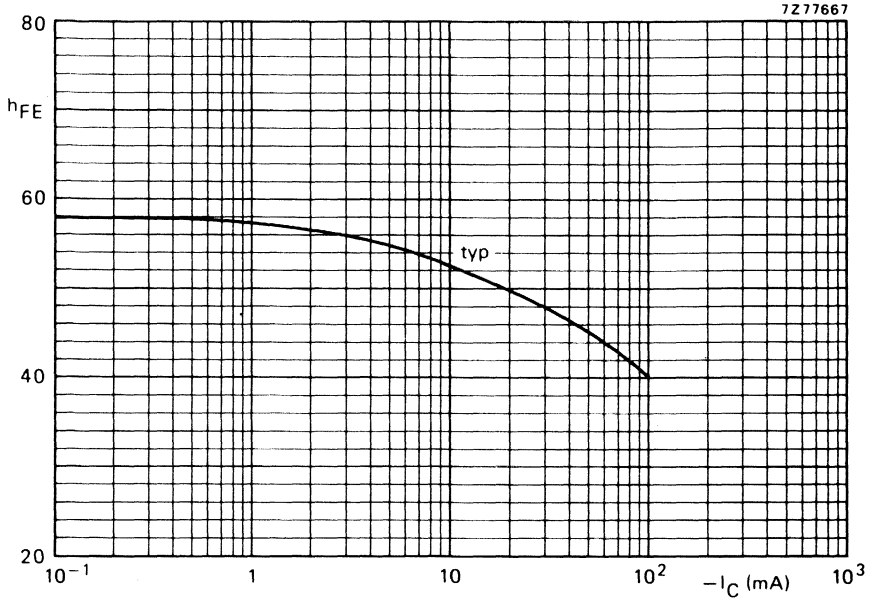


Fig. 5  $-V_{CE} = 1$  V;  $T_{amb} = 25$  °C.

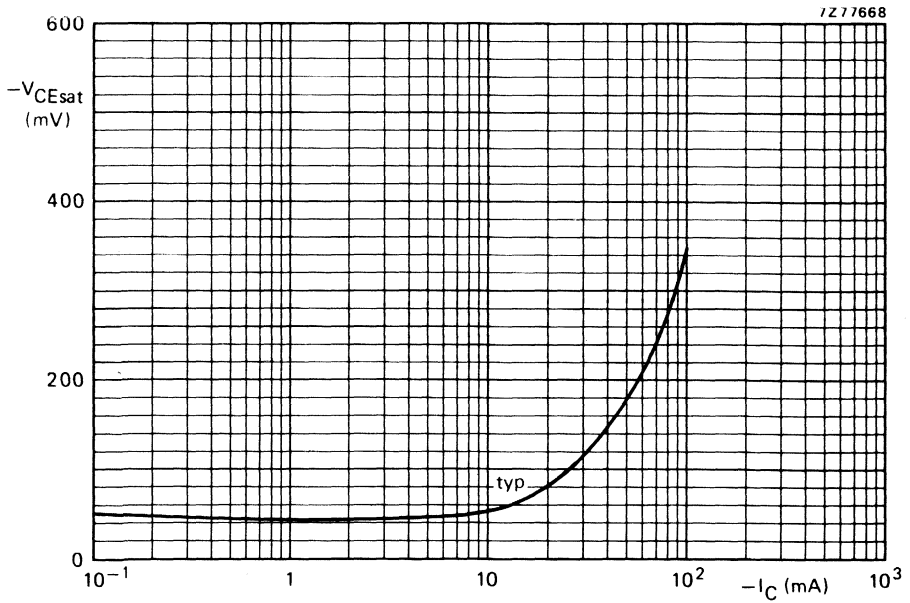


Fig. 6  $V_{CEsat}$  as a function of  $I_C$  at  $I_C/I_B = 10$ .

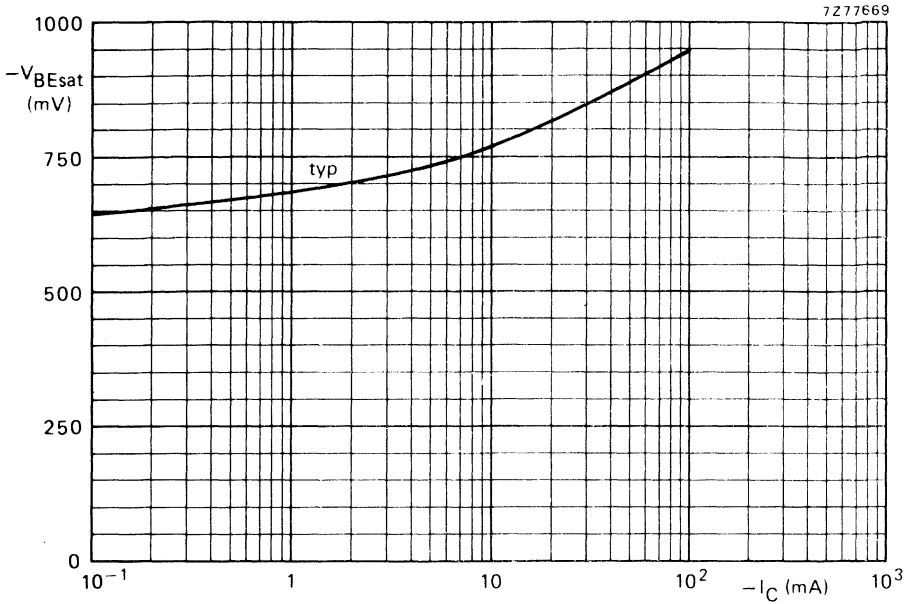


Fig. 7  $V_{BEsat}$  as a function of  $I_C$  at  $I_C/I_B = 10$ .

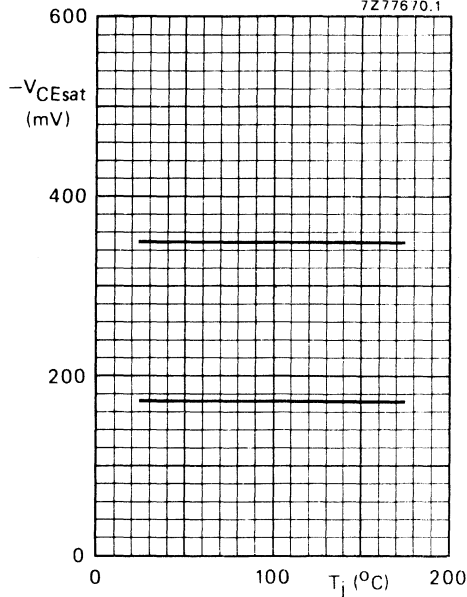


Fig. 8  $V_{CEsat}$  as a function of  $T_j$ ; typical values.

Upper graph at  $I_C = 100$  mA;  $I_B = 10$  mA. Lower graph at  $I_C = 50$  mA and  $I_B = 5$  mA.

# DEVELOPMENT SAMPLE DATA

This information is derived from development samples made available for evaluation. It does not necessarily imply that the device will go into regular production.

BSR13;R  
BSR14;R

## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon transistors, in a microminiature plastic envelope intended for switching and linear applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

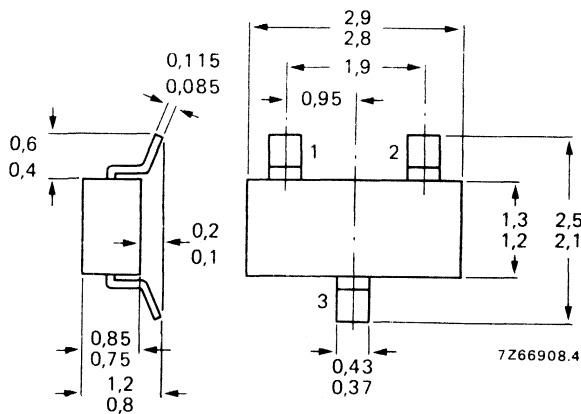
		BSR13;R		BSR14;R	
Collector-base voltage (open emitter)	$V_{CBO}$	max.	60	75	V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	30	40	V
Emitter-base voltage (open collector)	$V_{EBO}$	max.	5	6	V
Collector current (d.c.)	$I_C$	max.	800		mA
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	$P_{tot}$	max.	425		mW ←
Junction temperature	$T_j$	max.	175		$^\circ\text{C}$ ←
D.C. current gain			100 to 300		
$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE}$		30		40
$I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$	$h_{FE}$	>			
Transition frequency at $f = 100\text{ MHz}$					
$I_C = 20\text{ mA}; V_{CE} = 20\text{ V}$	$f_T$	>	250		300 MHz

### MECHANICAL DATA

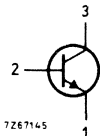
Dimensions in mm

Marking code

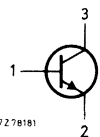
Fig. 1 SOT-23.



BSR13 = U7  
BSR14 = U8



BSR13R = U71  
BSR14R = U81



See also Soldering recommendations.

**RATINGS**

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

			BSR13; R	BSR14; R	
Collector-base voltage (open emitter) see Fig. 4	$V_{CBO}$	max.	60	75	V
Collector-emitter voltage (open base) see Fig. 4	$V_{CEO}$	max.	30	40	V
Emitter-base voltage (open collector) see Fig. 4	$V_{EBO}$	max.	5	6	V
Collector current (d.c.)	$I_C$	max.	800		mA
Total power dissipation**					
→ up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max.	425		mW
→ Storage temperature	$T_{stg}$		-65 to +175		$^\circ\text{C}$
→ Junction temperature	$T_j$	max.	175		$^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	30	K/W
From tab to soldering points	$R_{th\ t-s}$	=	260	K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	60	K/W

**CHARACTERISTICS**

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

			BSR13; R	BSR14; R	
Collector cut-off current					
$I_E = 0; V_{CB} = 50\text{ V}$	$I_{CBO}$	<	30	—	nA
$I_E = 0; V_{CB} = 60\text{ V}$	$I_{CBO}$	<	—	10	nA
$I_E = 0; V_{CB} = 50\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$I_{CBO}$	<	10	—	$\mu\text{A}$
$I_E = 0; V_{CB} = 60\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$I_{CBO}$	<	—	10	$\mu\text{A}$
$V_{EB} = 3\text{ V}; V_{CE} = 60\text{ V}$	$I_{CEX}$	<	—	10	nA
Base current					
with reverse biased emitter junction					
$V_{EB} = 3\text{ V}; V_{CE} = 60\text{ V}$	$I_{BEX}$	<	—	20	nA
Emitter cut-off current					
$I_C = 0; V_{EB} = 3\text{ V}$	$I_{EBO}$	<	30	15	nA
Saturation voltages ▲					
$I_C = 150\text{ mA}; I_B = 15\text{ mA}$	$V_{CEsat}$	<	400	300	mV
	$V_{BEsat}$	<	1300	—	mV
	$V_{BEsat}$		—	0,6 to 1,2	V
$I_C = 500\text{ mA}; I_B = 50\text{ mA}$	$V_{CEsat}$	<	1600	1000	mV
	$V_{BEsat}$	<	2600	2000	mV

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Device mounted on a ceramic substrate of 15 mm x 15 mm x 0,6 mm.

▲ Measured under pulsed conditions to avoid excessive dissipation  $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0,02$ .



## D.C. current gain \*

 $I_C = 0,1 \text{ mA}; V_{CE} = 10 \text{ V}$  $h_{FE} > 35$  $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$  $h_{FE} > 50$  $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$  $h_{FE} > 75$  $I_C = 150 \text{ mA}; V_{CE} = 10 \text{ V}$  $h_{FE} 100 \text{ to } 300$  $I_C = 150 \text{ mA}; V_{CE} = 1 \text{ V}$  $h_{FE} > 50$  $I_C = 500 \text{ mA}; V_{CE} = 10 \text{ V}$  BSR13; R $h_{FE} > 30$  $I_C = 500 \text{ mA}; V_{CE} = 10 \text{ V}$  BSR14; R $h_{FE} > 40$ Transition frequency at  $f = 100 \text{ MHz}$  $I_C = 20 \text{ mA}; V_{CE} = 20 \text{ V}$  BSR13; R $f_T > 250 \text{ MHz}$  $I_C = 20 \text{ mA}; V_{CE} = 20 \text{ V}$  BSR14; R $f_T > 300 \text{ MHz}$ Collector capacitance at  $f = 1 \text{ MHz}$  $I_E = I_e = 0; V_{CB} = 10 \text{ V}$  $C_c < 8 \text{ pF}$ h parameters (common emitter) at  $f = 1 \text{ kHz}$  $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$ BSR14;R

input impedance

 $h_{ie} 2 \text{ to } 8 \text{ k}\Omega$ 

reverse voltage transfer ratio

 $h_{re} < 8 \cdot 10^{-4}$ 

small signal current gain

 $h_{fe} 50 \text{ to } 300$ 

output admittance

 $h_{oe} 5 \text{ to } 35 \mu\Omega^{-1}$  $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$ 

input impedance

 $h_{ie} 0,25 \text{ to } 1,25 \text{ k}\Omega$ 

reverse voltage transfer ratio

 $h_{re} < 4 \cdot 10^{-4}$ 

small signal current gain

 $h_{fe} 75 \text{ to } 375$ 

output admittance

 $h_{oe} 25 \text{ to } 200 \mu\Omega^{-1}$ 

DEVELOPMENT SAMPLE DATA

\* Measured under pulsed conditions to avoid excessive dissipation; pulse duration  $t_p \leq 300 \mu\text{s}$ ; duty factor  $\delta \leq 0,02$ .

Switching times (between 10% and 90% levels)

Turn-on time switched to  $I_C = 150 \text{ mA}$  (see Fig. 2)

delay time  
rise time

BSR14;R	
$t_d$	< 10 ns
$t_r$	< 25 ns

Turn-off time switched from  $I_C = 150 \text{ mA}$  (see Fig. 3)

storage time  
fall time

$t_s$	< 225 ns
$t_f$	< 60 ns

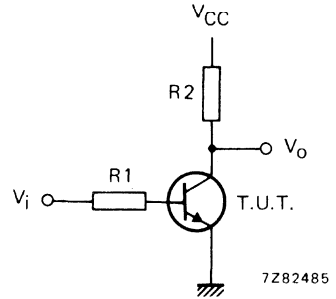
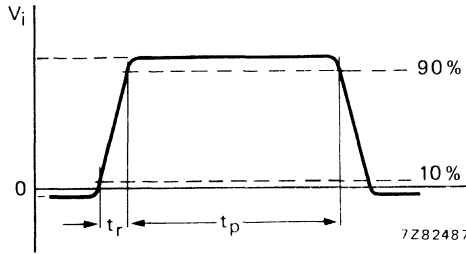


Fig. 2 Waveform and test circuit delay and rise time.

$V_i = -0,5 \text{ to } +9,9 \text{ V}$ ;  $V_{CC} = 30 \text{ V}$ ;  $R_1 = 619 \Omega$ ;  $R_2 = 200 \Omega$ .

Pulse generator:

pulse duration	$t_p \leq 200 \text{ ns}$
rise time	$t_r \leq 2 \text{ ns}$
duty factor	$\delta = 2 \%$

Oscilloscope:

input impedance	$Z_i > 100 \text{ k}\Omega$
input capacitance	$C_i < 12 \text{ pF}$
rise time	$t_r < 5 \text{ ns}$

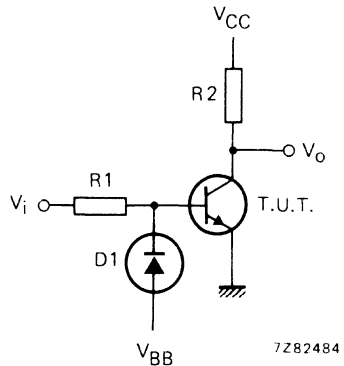
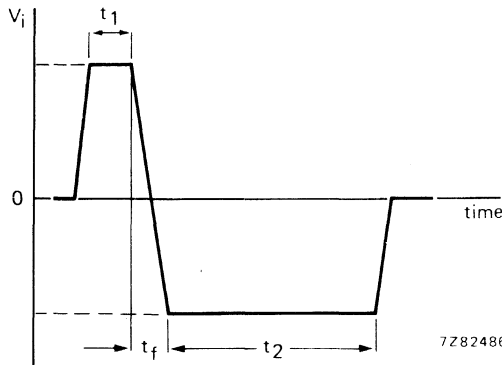


Fig. 3 Waveform and test circuit storage and fall time.

$V_i = -13,8 \text{ to } +16,2 \text{ V}$ ;  $V_{CC} = 30 \text{ V}$ ;  $-V_{BB} = 3 \text{ V}$ ;  $R_1 = 1 \text{ k}\Omega$ ;  $R_2 = 200 \Omega$ .

Pulse generator:

fall time	$t_f < 5 \text{ ns}$
pulse time	$t_1 = 100 \mu\text{s}$
	$t_2 = 500 \mu\text{s}$

Oscilloscope:

input impedance	$Z_i > 100 \text{ k}\Omega$
input capacitance	$C_i < 12 \text{ pF}$
rise time	$t_r < 5 \text{ ns}$

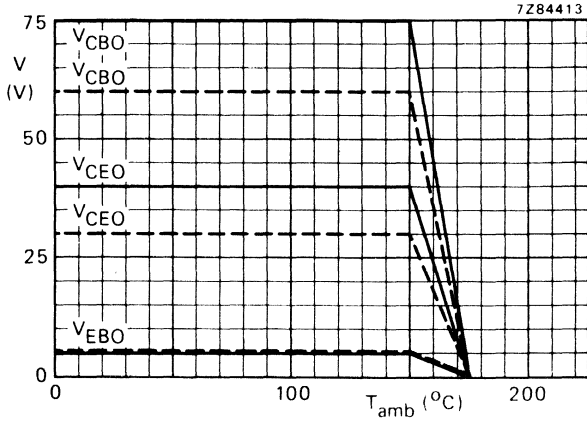


Fig. 4 Voltage derating curve.  
--- BSR13; R — BSR14; R.

DEVELOPMENT SAMPLE DATA

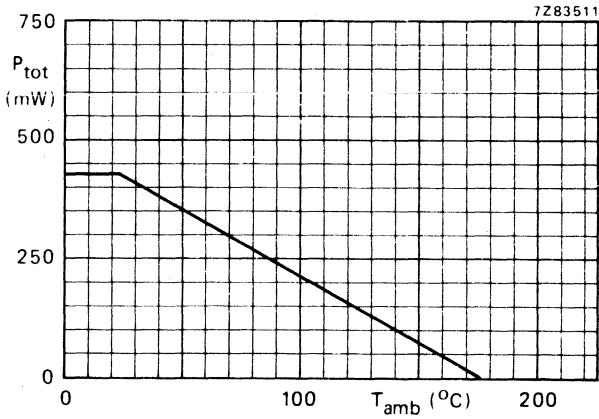


Fig. 5 Power derating curve.



# DEVELOPMENT SAMPLE DATA

This information is derived from development samples made available for evaluation. It does not necessarily imply that the device will go into regular production.

BSR15; R  
BSR16; R

## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P silicon transistors, in a microminiature plastic envelope, intended for medium power switching and general purpose amplifier applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

		BSR15; R	BSR16; R	
Collector-base voltage (open emitter)	$-V_{CB0}$	max. 60	60	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max. 40	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max. 5	5	V
Collector current (d.c.)	$-I_C$	max. 600	600	mA ←
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max. 425	425	mW ←
Junction temperature	$T_j$	max. 175	175	$^\circ\text{C}$ ←
D.C. current gain				
$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$	$h_{FE}$	> 30	50	
Turn-off switching time				
$-I_{Con} = 150\text{ mA}; -I_{Bon} = I_{Boff} = 15\text{ mA}$	$t_{off}$	> 100	100	ns
Transition frequency at $f = 100\text{ MHz}$				
$-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}$	$f_T$	> 200	200	MHz

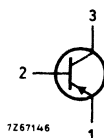
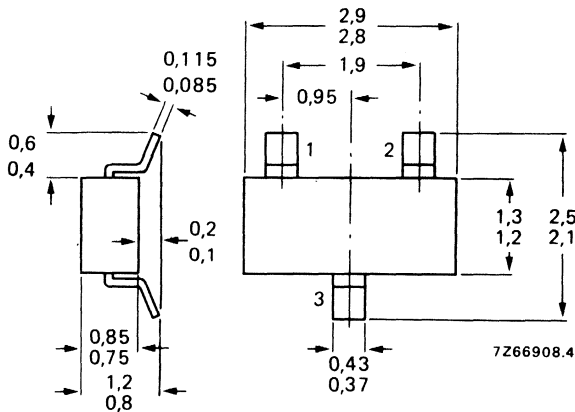
### MECHANICAL DATA

Dimensions in mm

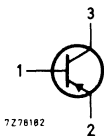
### Marking code

Fig. 1 SOT-23.

BSR15 = T7  
BSR16 = T8



BSR15R = T71  
BSR16R = T81



See also Soldering recommendations.

**RATINGS**

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

		BSR15; R	BSR16; R	
Collector-base voltage (open emitter) See Figs 5 and 6	$-V_{CBO}$ max.	60	60	V
Collector-emitter voltage (open base) See Figs 5 and 6	$-V_{CEO}$ max.	40	60	V
Emitter-base voltage (open collector) See Figs 5 and 6	$-V_{EBO}$ max.	5	5	V
Collector current (d.c.)	$-I_C$ max.	600		mA
→ Power dissipation up to $T_{amb} = 25\text{ °C}^{**}$	$P_{tot}$ max.	425		mW
→ Storage temperature	$T_{stg}$	-65 to +175		°C
→ Junction temperature	$T_j$ max.	175		°C

→ **THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$ =	30	K/W
From tab to soldering points	$R_{th\ t-s}$ =	260	K/W
From soldering points to ambient**	$R_{th\ s-a}$ =	60	K/W

**CHARACTERISTICS**

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

		BSR15; R	BSR16; R	
Collector cut-off current				
$I_E = 0; -V_{CB} = 50\text{ V}$	$-I_{CBO} <$	20	10	nA
$I_E = 0; -V_{CB} = 50\text{ V}; T_j = 150\text{ °C}$	$-I_{CBO} <$	20	10	μA
$-V_{EB} = 0,5\text{ V}; -V_{CE} = 30\text{ V}$	$-I_{CEX} <$		50	nA
Base current				
with reverse biased emitter junction				
$-V_{EB} = 3\text{ V}; -V_{CE} = 30\text{ V}$	$-I_{BEX} <$		50	nA
Saturation voltages ▲				
$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$	$-V_{CEsat} <$		0,4	V
	$-V_{BEsat} <$		1,3	V
$-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$	$-V_{CEsat} <$		1,6	V
	$-V_{BEsat} <$		2,6	V

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Device mounted on a ceramic substrate of 15 mm x 15 mm x 0,6 mm.

▲ Measured under pulsed conditions to avoid excessive dissipation pulse duration  $t_p \leq 300\text{ μs}$ ; duty factor  $\delta \leq 0,02$ .

D.C. current gain \*

- I<sub>C</sub> = 0,1 mA; -V<sub>CE</sub> = 10 V
- I<sub>C</sub> = 1 mA; -V<sub>CE</sub> = 10 V
- I<sub>C</sub> = 10 mA; -V<sub>CE</sub> = 10 V
- I<sub>C</sub> = 150 mA; -V<sub>CE</sub> = 10 V
- I<sub>C</sub> = 500 mA; -V<sub>CE</sub> = 10 V

	BSR15; R	BSR16; R
h <sub>FE</sub> >	35	75
h <sub>FE</sub> >	50	100
h <sub>FE</sub> >	75	100
h <sub>FE</sub>	100 to 300	
h <sub>FE</sub> >	30	50

Transition frequency at f = 100 MHz

- I<sub>C</sub> = 50 mA; -V<sub>CE</sub> = 20 V; T<sub>amb</sub> = 25 °C

f <sub>T</sub> >	200	MHz
------------------	-----	-----

Collector capacitance at f = 1 MHz

- I<sub>E</sub> = I<sub>e</sub> = 0; -V<sub>CB</sub> = 10 V

C <sub>c</sub> <	8	pF
------------------	---	----

Emitter capacitance at f = 1 MHz

- I<sub>C</sub> = I<sub>c</sub> = 0; -V<sub>EB</sub> = 2 V

C <sub>e</sub> <	30	pF
------------------	----	----

Switching times (between 10% and 90% levels)

Turn-on time when switched to

- I<sub>C</sub> = 150 mA; -I<sub>B</sub> = 15 mA; (see Fig. 3)

delay time

t <sub>d</sub> <	10	ns
------------------	----	----

rise time

t <sub>r</sub> <	40	ns
------------------	----	----

turn-on time (t<sub>d</sub> + t<sub>r</sub>)

t <sub>on</sub> <	45	ns
-------------------	----	----

Turn-off time when switched from

- I<sub>C</sub> = 150 mA; -I<sub>B</sub> = 15 mA
- to cut-off with +I<sub>BM</sub> = 15 mA (see Fig. 4)

storage time

t <sub>s</sub> <	80	ns
------------------	----	----

fall time

t <sub>f</sub> <	30	ns
------------------	----	----

turn-off time (t<sub>s</sub> + t<sub>f</sub>)

t <sub>off</sub> <	100	ns
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DEVELOPMENT SAMPLE DATA

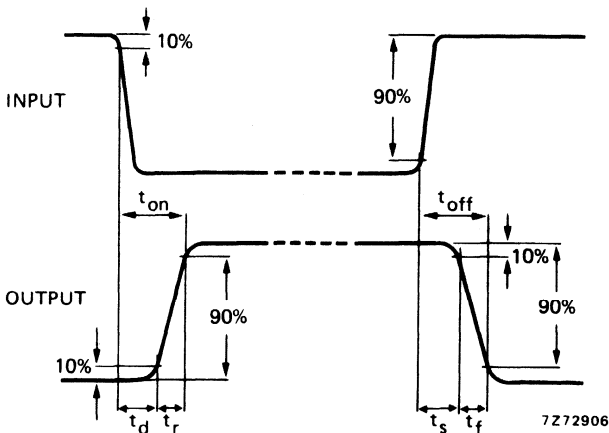


Fig. 2 Switching time waveforms.

\* Measured under pulsed conditions to avoid excessive dissipation; pulse duration t<sub>p</sub> ≤ 300 μs; duty factor δ ≤ 0,02.

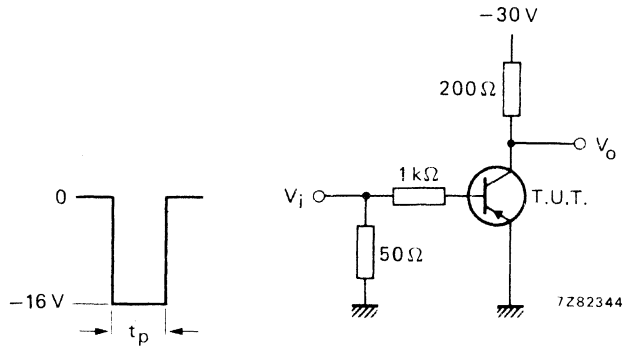


Fig. 3 Turn-on switching time test circuit.

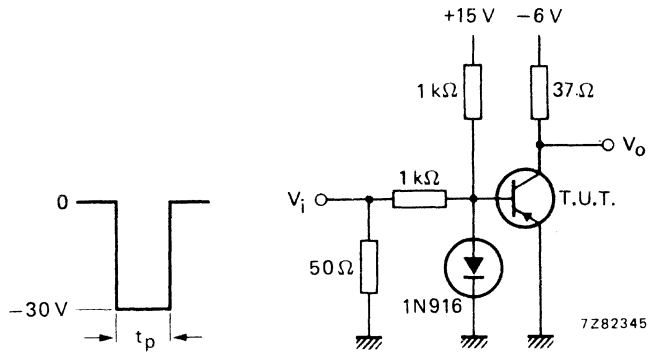


Fig. 4 Turn-off switching time test circuit.

Input pulse generator:  
Fig. 3 and Fig. 4

frequency  
pulse duration  
rise time  
output impedance

$f = 150$  Hz  
 $t_p = 200$  ns  
 $t_r \leq 2$  ns  
 $Z_o = 50$  Ω

Output oscilloscope:  
Fig. 3 and Fig. 4

rise time  
input impedance

$t_r \leq 5$  ns  
 $Z_i = 10$  MΩ



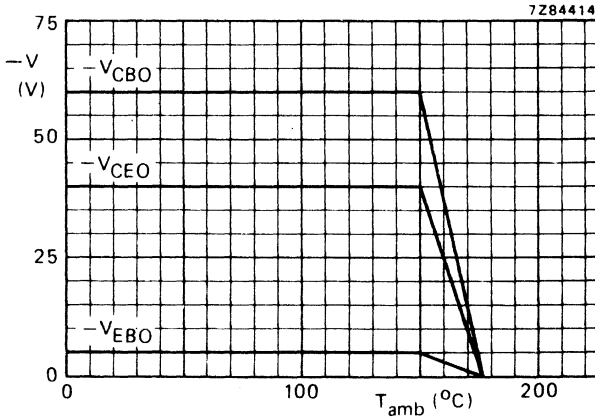


Fig. 5 Voltage derating curves BSR15; R.

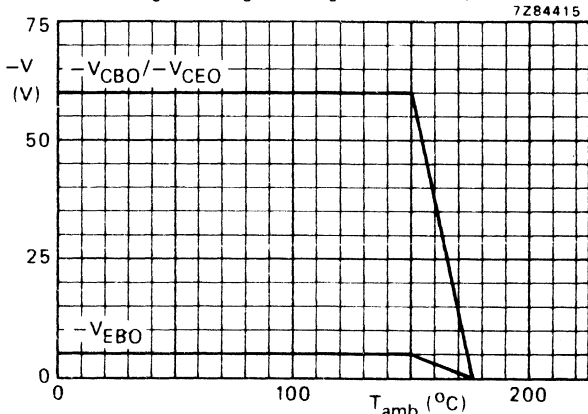


Fig. 6 Voltage derating curves BSR16; R.

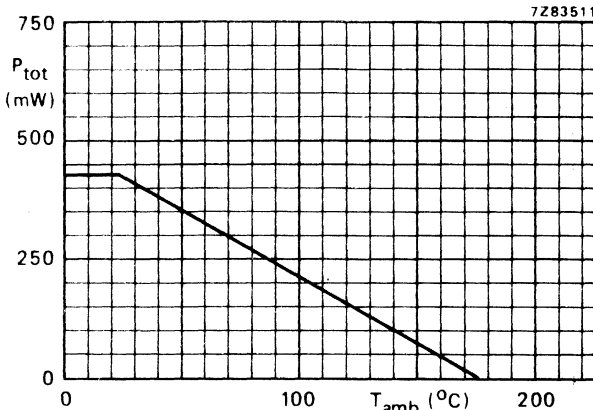


Fig. 7 Power derating curve BSR15; R/BSR16; R.

DEVELOPMENT SAMPLE DATA



## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon transistor in a microminiature plastic envelope intended for switching and linear applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CB0}$	max.	60 V	
Collector-emitter voltage (open base)	$V_{CE0}$	max.	40 V	
Emitter-base voltage (open collector)	$V_{EB0}$	max.	6 V	
Collector current (d.c.)	$I_C$	max.	200 mA	
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max.	350 mW	←
Junction temperature	$T_j$	max.	175 $^\circ\text{C}$	←
D.C. current gain				
$I_C = 50\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE}$	>	60	
$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE}$	>	15	
Transition frequency at $f = 100\text{ MHz}$				
$I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$	$f_T$	>	300 MHz	

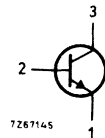
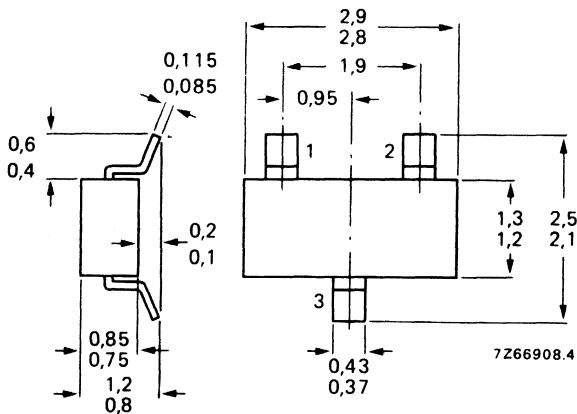
### MECHANICAL DATA

Dimensions in mm

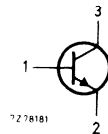
Marking code

Fig. 1 SOT-23.

BSR17 = U9



BSR17R = U91



See also Soldering recommendations.

**RATINGS**

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

Collector-base voltage (open emitter) See Fig. 4	$V_{CBO}$	max.	60 V
Collector-emitter voltage (open base) See Fig. 4	$V_{CEO}$	max.	40 V
Emitter base voltage (open collector) See Fig. 4	$V_{EBO}$	max.	6 V
Collector current (d.c.)	$I_C$	max.	200 mA
→ Power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}^{**}$	$P_{tot}$	max.	350 mW
→ Storage temperature	$T_{stg}$		-65 to +175 $^\circ\text{C}$
→ Junction temperature	$T_j$	max.	175 $^\circ\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P_x (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Collector cut-off current

$I_E = 0; V_{CB} = 30\text{ V}; T_j = 150\text{ }^\circ\text{C}$	$I_{CBO}$	<	5 $\mu\text{A}$
$V_{EB} = 3\text{ V}; V_{CE} = 30\text{ V}$	$I_{CEX}$	<	50 nA

Base current

with reverse biased emitter junction $V_{EB} = 3\text{ V}; V_{CE} = 30\text{ V}$	$I_{BEX}$	<	50 nA
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Saturation voltages<sup>▲</sup>

$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	$V_{CEsat}$	<	200 mV
	$V_{BEsat}$		650 to 850 mV
$I_C = 50\text{ mA}; I_B = 5\text{ mA}$	$V_{CEsat}$	<	300 mV
	$V_{BEsat}$	<	950 mV

D.C. current gain<sup>▲</sup>

$I_C = 0,1\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE}$	>	40
$I_C = 1\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE}$	>	70
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE}$		100 to 300
$I_C = 50\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE}$	>	60
$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE}$	>	15

Transition frequency at  $f = 100\text{ MHz}$

$I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$	$f_T$	>	300 MHz
--	-------	---	---------

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

$I_E = I_e = 0; V_{CB} = 5\text{ V}$	$C_c$	<	4 pF
--------------------------------------	-------	---	------

▲ Measured under pulsed conditions; pulse duration  $t_p \leq 300\text{ }\mu\text{s}$ ; duty factor  $\delta \leq 0,02$ .

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

Emitter capacitance at  $f = 1$  MHz  
 $I_C = I_c = 0$ ;  $V_{EB} = 0,5$  V

$C_e < 8$  pF

Switching times (between 10% and 90% levels)

Turn on time switched to  
 $I_C = 10$  mA;  $I_B = 1$  mA;  $V_{EB} = 0,5$  V  
 delay time  
 rise time

$t_d < 35$  ns  
 $t_r < 35$  ns

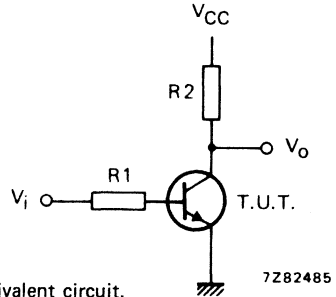
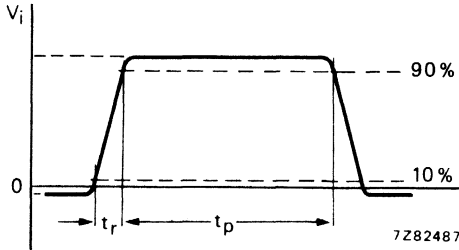


Fig. 2 Delay and rise time equivalent circuit.

$V_i = -0,5$  to  $+10,6$  V;  $V_{CC} = 3$  V;  $R_1 = 10$  k $\Omega$ ;  $R_2 = 275$   $\Omega$ ;  
 total shunt capacitance of test jig and connectors =  $C_s \leq 4$  pF.  
 Pulse generator: pulse duration 300 ns; fall time  $< 1$  ns; duty factor 2%.

Turn off time switched from  
 $I_C = 10$  mA;  $I_{Bon} = -I_{Boff} = 1$  mA  
 storage time  
 fall time

$t_s < 200$  ns  
 $t_f < 50$  ns

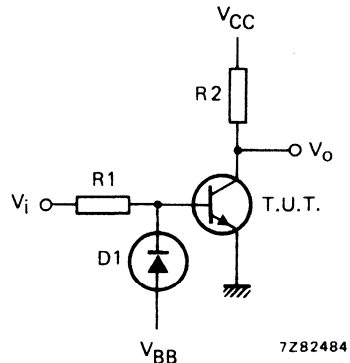
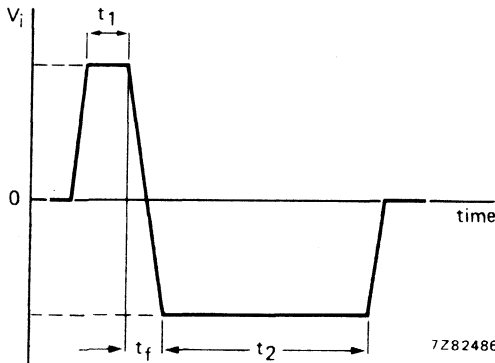


Fig. 3 Storage and fall time equivalent test circuit.

$V_i = -9,1$  to  $+10,9$  V;  $V_{CC} = 3$  V;  $V_{BB} = 0$  V (ground);  $R_1 = 10$  k $\Omega$ ;  $R_2 = 275$   $\Omega$ ;  
 total shunt capacitance of test jig and connectors =  $C_s \leq 4$  pF.  
 Pulse generator: pulse duration  $t_1 = 10$  to 500  $\mu$ s; fall time  $t_f < 1$  ns; duty factor  $\delta = 2\%$ .

BSR17  
BSR17R

h parameters (common emitter)

$I_C = 1 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ ;  $f = 1 \text{ kHz}$

input impedance

reverse voltage transfer ratio

small signal current gain

output admittance

$h_{ie}$

$h_{re}$

$h_{fe}$

$h_{oe}$

1 to 10  $k\Omega$

0,5 to 8  $10^{-4}$

100 to 400

1 to 40  $\mu A/V$

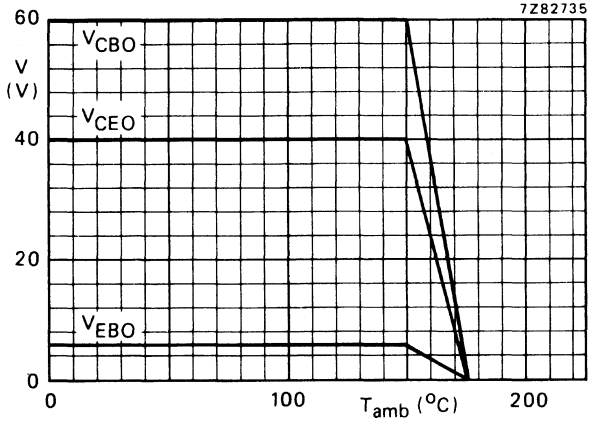


Fig. 4 Voltage derating curves.

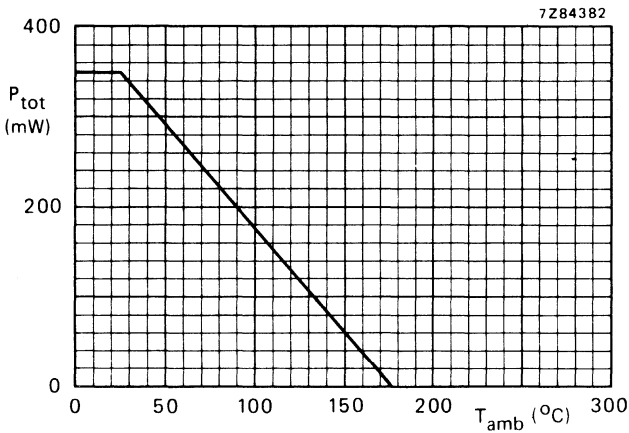


Fig. 5 Power derating curve.



# DEVELOPMENT SAMPLE DATA

This information is derived from development samples made available for evaluation. It does not form part of our data handbook system and does not necessarily imply that the device will go into production

BSR30 to 33

## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in miniature plastic envelopes intended for application in thick and thin-film circuits. They are intended for use in telephony and general industrial applications.

### QUICK REFERENCE DATA

		BSR30	BSR31	BSR32	BSR33
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	70	70	90	90 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	60	80	80 V
Collector current (d.c.)	$-I_C$ max.	1	1	1	1 A
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	$P_{tot}$ max.	1	1	1	1 W
Junction temperature	$T_j$ max.	150	150	150	150 $^\circ\text{C}$
D.C. current gain					
$-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$	$h_{FE}$	$> 40$	100	40	100
		$< 120$	300	120	300
Transition frequency at $f = 35\text{ MHz}$					
$-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$	$f_T$	$> 100$	100	100	100 MHz

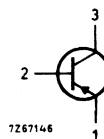
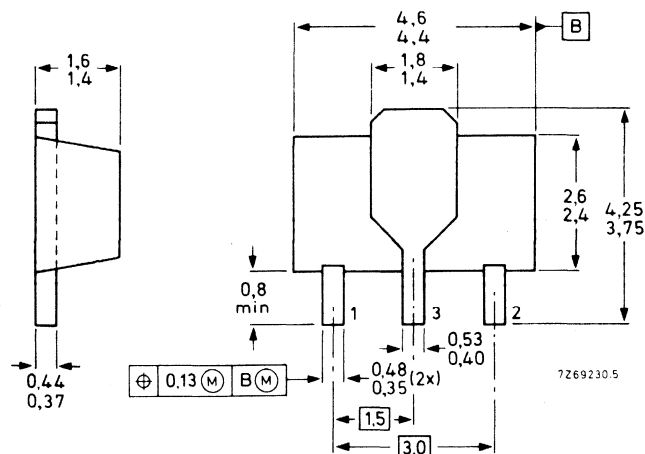
### MECHANICAL DATA

Dimensions in mm

Mark

Fig. 1 SOT-89.

BSR30  
BSR31  
BSR32  
BSR33



See also *Soldering recommendations.*

**RATINGS**

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

**Voltages**

		BSR30	BSR31	BSR32	BSR33
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	70	70	90	90 V
Collector-emitter voltage (open base)	$-V_{CEO}$ max.	60	60	80	80 V
Emitter-base voltage (open collector)	$-V_{EBO}$ max.	5	5	5	5 V

**Currents**

Collector current (d.c.)	$-I_C$ max.			1	A
Base current (d.c.)	$-I_B$ max.			0,1	A

**Power dissipation**Total power dissipation up to  $T_{amb} = 25\text{ }^{\circ}\text{C}$ 

mounted on a ceramic substrate

area =  $2,5\text{ cm}^2$ ; thickness =  $0,7\text{ mm}$ 

$P_{tot}$ max.		1	W
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**Temperatures**

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

**THERMAL RESISTANCE**

From junction to collector tab	$R_{th\ j-tab} =$	10	$^{\circ}\text{C/W}$
From junction to ambient in free air mounted on a ceramic substrate area = $2,5\text{ cm}^2$ ; thickness = $0,7\text{ mm}$	$R_{th\ j-a} =$	125	$^{\circ}\text{C/W}$



**CHARACTERISTICS**

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

**Collector cut-off current**

$I_E = 0; -V_{CB} = 60\text{ V}$	$-I_{CBO}$	<	100	nA
$I_E = 0; -V_{CB} = 60\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$	$-I_{CBO}$	<	50	$\mu\text{A}$

**Breakdown voltages**

			BSR30	BSR31	BSR32	BSR33	
$I_B = 0; -I_C = 10\text{ mA}$	$-V_{(BR)CEO}$	>	60	60	80	80	V
$V_{BE} = 0; -I_C = 10\text{ }\mu\text{A}$	$-V_{(BR)CES}$	>	70	70	90	90	V
$I_C = 0; -I_E = 10\text{ }\mu\text{A}$	$-V_{(BR)EBO}$	>	5	5	5	5	V

**Saturation voltages \***

$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$	$-V_{CEsat}$	<	0,25	0,25	0,25	0,25	V
	$-V_{BEsat}$	<	1,0	1,0	1,0	1,0	V
$-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$	$-V_{CEsat}$	<	0,5	0,5	0,5	0,5	V
	$-V_{BEsat}$	<	1,2	1,2	1,2	1,2	V

**D.C. current gain \***

$-I_C = 100\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$	$h_{FE}$	>	10	30	10	30
$-I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$	$h_{FE}$	>	40	100	40	100
	$h_{FE}$	<	120	300	120	300
$-I_C = 500\text{ mA}; V_{CE} = 5\text{ V}$	$h_{FE}$	>	30	50	30	50

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

$-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$	$f_T$	>	100	MHz
--	-------	---	-----	-----

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

$I_E = I_e = 0; -V_{CB} = 10\text{ V}$	$C_c$	<	20	pF
--	-------	---	----	----

**Emitter capacitance at  $f = 1\text{ MHz}$**

$I_C = I_c = 0; -V_{EB} = 0,5\text{ V}$	$C_e$	<	120	pF
---	-------	---	-----	----

Switching times see page 4

DEVELOPMENT SAMPLE DATA



\* Measured under pulse conditions:  $t_p = 300\text{ }\mu\text{s}; \delta < 0,01$ .

**CHARACTERISTICS** (continued)

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

**Switching times**

$-I_{Con} = 100\text{ mA}; -I_{Bon} = +I_{Boff} = 5\text{ mA}$

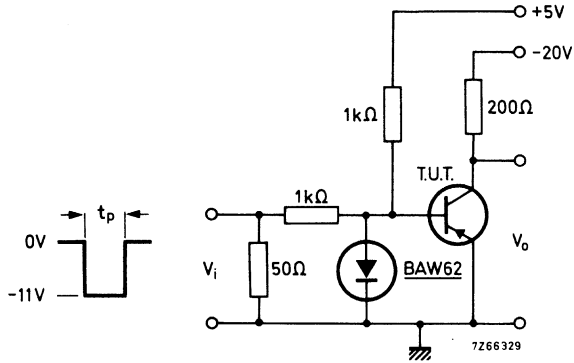
Turn-on time

$t_{on} < 500\text{ ns}$

Turn-off time

$t_{off} < 650\text{ ns}$

Test circuit



Pulse generator:

Pulse duration  $t_p = 10\text{ }\mu\text{s}$   
 Rise time  $t_r \leq 15\text{ ns}$   
 Fall time  $t_f \leq 15\text{ ns}$   
 Source impedance  $Z_S = 50\text{ }\Omega$

Oscilloscope:

Rise time  $t_r \leq 15\text{ ns}$   
 Input impedance  $Z_I \geq 100\text{ k}\Omega$



## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in miniature plastic envelopes intended for application in thick and thin-film circuits. They are intended for use in telephony and general industrial applications.

## QUICK REFERENCE DATA

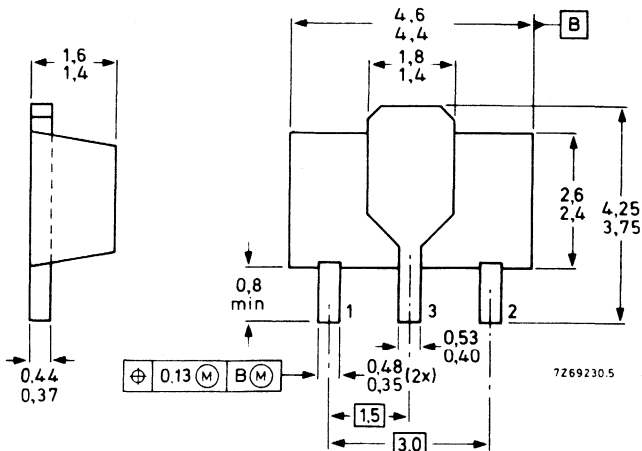
		BSR40	BSR41	BSR42	BSR43
Collector-base voltage (open emitter)	$V_{CB0}$ max.	70	70	90	90 V
Collector-emitter voltage (open base)	$V_{CEO}$ max.	60	60	80	80 V
Collector current (d.c.)	$I_C$ max.	1	1	1	1 A
Total power dissipation up to $T_{amb} = 25^\circ\text{C}$	$P_{tot}$ max.	1	1	1	1 W
Junction temperature	$T_j$ max.	150	150	150	150 $^\circ\text{C}$
D.C. current gain	$h_{FE}$	> 40	100	40	100
$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$		< 120	300	120	300
Transition frequency at $f = 35\text{ MHz}$	$f_T$	> 100	100	100	100 MHz
$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$					

## MECHANICAL DATA

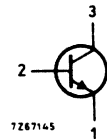
Dimensions in mm

Mark

Fig. 1 SOT-89.



BSR40  
BSR41  
BSR42  
BSR43



**RATINGS**

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

**Voltages**

			BSR40	BSR41	BSR42	BSR43
Collector-base voltage (open emitter)	$V_{CBO}$	max.	70	70	90	90 V
Collector-emitter voltage (open base)	$V_{CEO}$	max.	60	60	80	80 V
Emitter-base voltage (open collector)	$V_{EBO}$	max.	5	5	5	5 V

**Currents**

Collector current (d.c.)	$I_C$	max.			1	A
Base current (d.c.)	$I_B$	max.			0,1	A

**Power dissipation**

Total power dissipation up to  $T_{amb} = 25\text{ }^{\circ}\text{C}$   
 mounted on a ceramic substrate

area =  $2,5\text{ cm}^2$ ; thickness =  $0,7\text{ mm}$

$P_{tot}$	max.			1	W
-----------	------	--	--	---	---

**Temperatures**

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

**THERMAL RESISTANCE**

From junction to collector tab	$R_{th\ j-tab}$	=			10	$^{\circ}\text{C/W}$
From junction to ambient in free air mounted on a ceramic substrate area = $2,5\text{ cm}^2$ ; thickness = $0,7\text{ m}$	$R_{th\ j-a}$	=			125	$^{\circ}\text{C/W}$

## CHARACTERISTICS

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

## Collector cut-off current

$I_E = 0; V_{CB} = 60\text{ V}$	$I_{CBO}$	<	100	nA
$I_E = 0; V_{CB} = 60\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$	$I_{CBO}$	<	50	$\mu\text{A}$

## Breakdown voltages

			BSR40	BSR41	BSR42	BSR43	
$I_B = 0; I_C = 10\text{ mA}$	$V_{(BR)CEO}$	>	60	60	80	80	V
$V_{BE} = 0; I_C = 10\text{ }\mu\text{A}$	$V_{(BR)CES}$	>	70	70	90	90	V
$I_C = 0; I_E = 10\text{ }\mu\text{A}$	$V_{(BR)EBO}$	>	5	5	5	5	V

## Saturation voltages \*

$I_C = 150\text{ mA}; I_B = 15\text{ mA}$	$V_{CEsat}$	<	0,25	0,25	0,25	0,25	V
	$V_{BEsat}$	<	1,0	1,0	1,0	1,0	V
$I_C = 500\text{ mA}; I_B = 50\text{ mA}$	$V_{CEsat}$	<	0,5	0,5	0,5	0,5	V
	$V_{BEsat}$	<	1,2	1,2	1,2	1,2	V

## D.C. current gain \*

$I_C = 100\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$	$h_{FE}$	>	10	30	10	30
		>	40	100	40	100
$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$	$h_{FE}$	<	120	300	120	300
		>	30	50	30	50

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

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$	$f_T$	>	100	MHz
--	-------	---	-----	-----

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

$I_E = I_e = 0; V_{CB} = 10\text{ V}$	$C_C$	<	12	pF
---------------------------------------	-------	---	----	----

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

$I_C = I_c = 0; V_{EB} = 0,5\text{ V}$	$C_e$	<	90	pF
--	-------	---	----	----

Switching times see page 4

\* Measured under pulse conditions:  $t_p = 300\text{ }\mu\text{s}; \delta < 0,01$ .

**CHARACTERISTICS (continued)**

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

**Switching times**

$I_{Con} = 100\text{ mA}; I_{Bon} = -I_{Boff} = 5\text{ mA}$

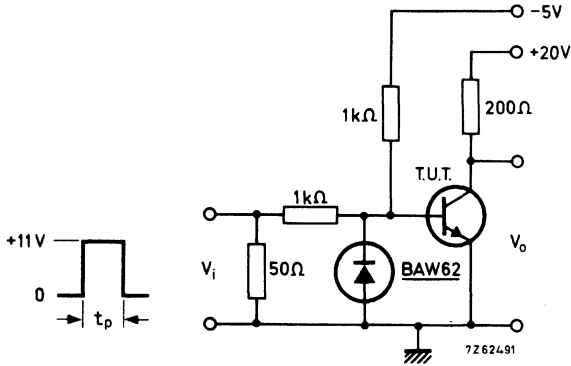
Turn-on time

$t_{on} < 250\text{ ns}$

Turn-off time

$t_{off} < 1000\text{ ns}$

Test circuit



Pulse generator:

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

Rise time  $t_r \leq 15\text{ ns}$

Fall time  $t_f \leq 15\text{ ns}$

Source impedance  $Z_S = 50\text{ }\Omega$

Oscilloscope:

Rise time  $t_r \leq 15\text{ ns}$

Input impedance  $Z_I \geq 100\text{ k}\Omega$



## N-CHANNEL FETS

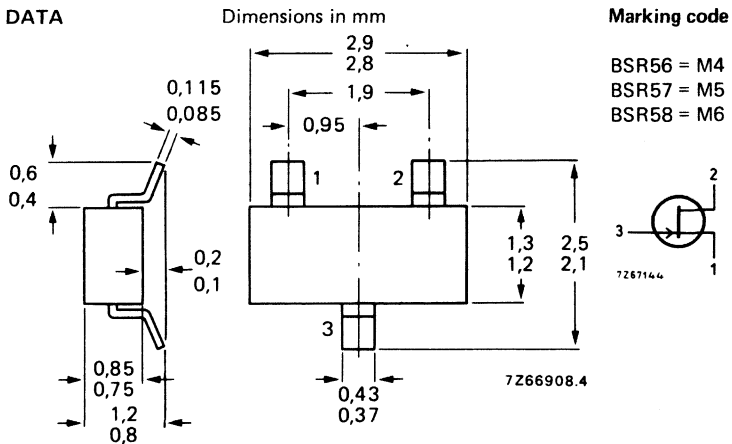
Silicon n-channel depletion type junction field-effect transistors in a plastic microminiature envelope intended for application in thick and thin-film circuits. The transistors are intended for low-power, chopper or switching applications in industrial service.

### QUICK REFERENCE DATA

		BSR56	BSR57	BSR58
Drain-source voltage	$\pm V_{DS}$	max. 40	40	40 V
Total power dissipation up to $T_{amb} = 65\text{ }^{\circ}\text{C}$	$P_{tot}$	max. 250	250	250 mW
Drain current $V_{DS} = 15\text{ V}; V_{GS} = 0$	$I_{DSS}$	$> 50$	20	8 mA
		$< -$	100	80 mA
Gate-source cut-off voltage $V_{DS} = 15\text{ V}; I_D = 0,5\text{ nA}$	$-V(P)_{GS}$	$> 4$	2	0,8 V
		$< 10$	6	4 V
Drain-source resistance (on) at $f = 1\text{ kHz}$ $I_D = 0; V_{GS} = 0$	$r_{ds\ on}$	$< 25$	40	60 $\Omega$
Feedback capacitance at $f = 1\text{ MHz}$ $-V_{GS} = 10\text{ V}; V_{DS} = 0$	$C_{rs}$	$< 5$	5	5 pF
Turn-off time $V_{DD} = 10\text{ V}; V_{GS} = 0$	$I_D = 20\text{ mA}; -V_{GSM} = 10\text{ V}$	$t_{off} < 25$	—	— ns
	$I_D = 10\text{ mA}; -V_{GSM} = 6\text{ V}$	$t_{off} < -$	50	— ns
	$I_D = 5\text{ mA}; -V_{GSM} = 4\text{ V}$	$t_{off} < -$	—	100 ns

### MECHANICAL DATA

Fig. 1 SOT-23.



See also *Soldering Recommendations*.

**RATINGS**

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

Drain-source voltage (See Fig. 4)	$\pm V_{DS}$	max.	40 V
Drain-gate voltage (See Fig. 4)	$V_{DGO}$	max.	40 V
Gate-source voltage (See Fig. 4)	$-V_{GSO}$	max.	40 V
Forward gate current	$I_{GF}$	max.	50 mA
→ Total power dissipation up to $T_{amb} = 65\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	250 mW
→ Storage temperature	$T_{stg}$		$-55\text{ to }+175\text{ }^{\circ}\text{C}$
→ Junction temperature	$T_j$	max.	175 $^{\circ}\text{C}$

→ **THERMAL CHARACTERISTICS\***

$$T_j = P (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th\ j-t}$	=	60 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

**CHARACTERISTICS**

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

Gate-source cut-off current

$$V_{DS} = 0\text{ V}; -V_{GS} = 20\text{ V} \quad -I_{GSS} < 1\text{ nA}$$

Drain cut-off current

$$V_{DS} = 15\text{ V}; -V_{GS} = 10\text{ V} \quad I_{DSX} < 1\text{ nA}$$

			BSR56	BSR57	BSR58
Drain current $\Delta$ $V_{DS} = 15\text{ V}; V_{GS} = 0$	$I_{DSS}$	$>$	50	20	8 mA
		$<$	—	100	80 mA
Gate-source breakdown voltage $-I_G = 1\text{ }\mu\text{A}; V_{DS} = 0$	$-V_{(BR)GSS}$	$>$	40	40	40 V
Gate-source cut-off voltage $I_D = 0,5\text{ nA}; V_{DS} = 15\text{ V}$	$-V_{(P)GS}$	$>$	4	2	0,8 V
		$<$	10	6	4 V
Drain-source voltage (on) $I_D = 20\text{ mA}; V_{GS} = 0$ $I_D = 10\text{ mA}; V_{GS} = 0$ $I_D = 5\text{ mA}; V_{GS} = 0$	$V_{DSon}$	$<$	750	—	— mV
		$<$	—	500	— mV
		$<$	—	—	400 mV
Drain-source resistance (on) at $f = 1\text{ kHz}$ $I_D = 0; V_{GS} = 0$	$r_{ds\ on}$	$<$	25	40	60 $\Omega$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

$\Delta$  Measured under pulsed conditions;  $t_p = 100\text{ ms}; \delta \leq 0,1$ .



Switching times\*

$V_{DD} = 10\text{ V}; V_{GS} = 0$

Conditions  $I_D$  and  $-V_{GSM}$

Delay time

Rise time

Turn-off time

$I_D$   
 $-V_{GSM}$

$t_d$

$t_r$

$t_{off}$

=

=

<

<

<

BSR56

BSR57

BSR58

20

10

5 mA

10

6

4 V

6

6

10 ns

3

4

10 ns

25

50

100 ns

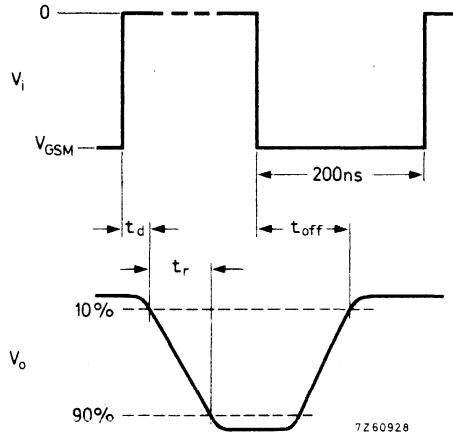


Fig. 2 Switching times waveforms.

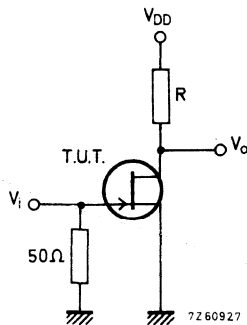


Fig. 3 Test circuit.

BSR56;  $R = 464\ \Omega$   
BSR57;  $R = 953\ \Omega$   
BSR58;  $R = 1910\ \Omega$

**Pulse generator**

$t_r = t_f \leq 1\text{ ns}$   
 $\delta = 0,02$   
 $Z_o = 50\ \Omega$

**Oscilloscope**

$t_r \leq 0,75\text{ ns}$   
 $R_i \geq 1\text{ M}\Omega$   
 $C_i \leq 2,5\text{ pF}$

\* Switching times measured on devices in SOT-18 envelope.

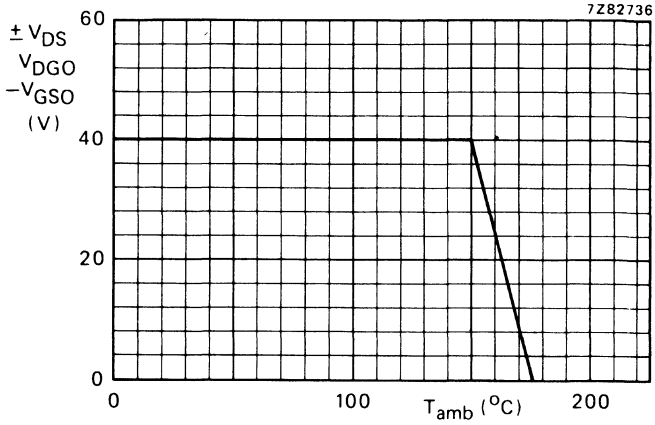


Fig. 4 Voltage derating curve.

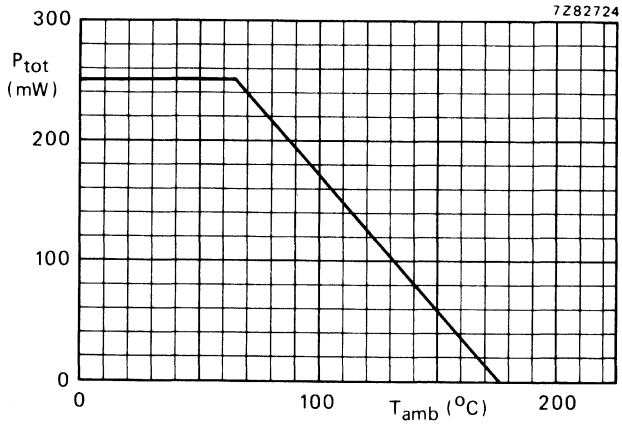


Fig. 5 Power derating curve.



## HIGH VOLTAGE P-N-P TRANSISTORS

Silicon planar epitaxial transistor in a microminiature plastic envelope intended for application in thick and thin-film circuits. This transistor is intended for high voltage general purpose and switching applications.

### QUICK REFERENCE DATA

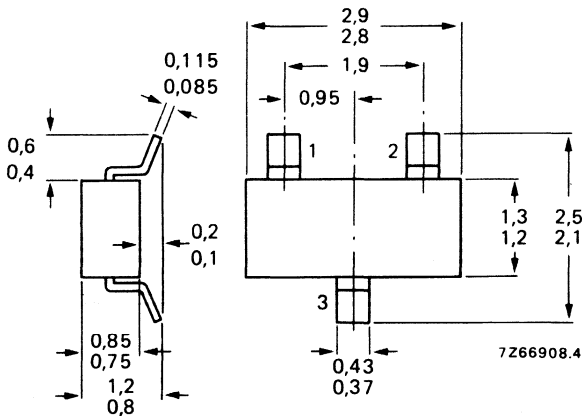
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	110 V	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	100 V	
Collector current (peak value)	$-I_{CM}$	max.	100 mA	
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	350 mW	←
Junction temperature	$T_j$	max.	175 $^{\circ}\text{C}$	←
D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$ $-I_C = 25\text{ mA}; -V_{CE} = 5\text{ V}$	$h_{FE}$	>	30	
Transition frequency at $f = 35\text{ MHz}$ $-I_C = 25\text{ mA}; -V_{CE} = 5\text{ V}$	$f_T$	>	50 MHz	
		typ.	85 MHz	

### MECHANICAL DATA

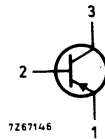
Dimensions in mm

### Marking code

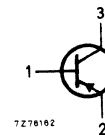
Fig. 1 SOT-23.



BSS63 = T3



BSS63R = T6



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) see Fig. 6 -I <sub>C</sub> = 10 μA	-V <sub>CBO</sub> max.	110 V
Collector-emitter voltage (open base) see Fig. 6 -I <sub>C</sub> = 100 μA	-V <sub>CEO</sub> max.	100 V
Emitter-base voltage (open collector) see Fig. 6 -I <sub>E</sub> = 10 μA	-V <sub>EBO</sub> max.	6 V
Collector current (d.c.)	-I <sub>C</sub> max.	100 mA
Collector current (peak value)	-I <sub>CM</sub> max.	100 mA
Base current (peak value)	-I <sub>BM</sub> max.	100 mA
→ Total power dissipation up to T <sub>amb</sub> = 25 °C **	P <sub>tot</sub> max.	350 mW
→ Storage temperature	T <sub>stg</sub>	-65 to + 175 °C
→ Junction temperature	T <sub>j</sub> max.	175 °C

→ **THERMAL CHARACTERISTICS \***

$$T_j = P_x (R_{th j-t} + R_{th t-s} + R_{th s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	R <sub>th j-t</sub> =	50 K/W
From tab to soldering points	R <sub>th t-s</sub> =	260 K/W
From soldering points to ambient **	R <sub>th s-a</sub> =	120 K/W

**CHARACTERISTICS**

T<sub>j</sub> = 25 °C unless otherwise specified

Collector cut-off current I <sub>E</sub> = 0; -V <sub>CB</sub> = 90 V	-I <sub>CBO</sub> <	100 nA
I <sub>E</sub> = 0; -V <sub>CB</sub> = 90 V; T <sub>j</sub> = 150 °C	-I <sub>CBO</sub> <	50 μA
Emitter cut-off current I <sub>C</sub> = 0; -V <sub>EB</sub> = 6 V	-I <sub>EBO</sub> <	200 nA
Saturation voltage -I <sub>C</sub> = 25 mA; -I <sub>B</sub> = 2,5 mA	-V <sub>CEsat</sub> <	250 mV
	-V <sub>BEsat</sub> <	900 mV
D.C. current gain -I <sub>C</sub> = 10 mA; -V <sub>CE</sub> = 1 V	h <sub>FE</sub> >	30
-I <sub>C</sub> = 25 mA; -V <sub>CE</sub> = 1 V	h <sub>FE</sub> >	30
Collector capacitance at f = 1 MHz I <sub>E</sub> = I <sub>B</sub> = 0; -V <sub>CB</sub> = 10 V	C <sub>c</sub> typ.	3 pF
Transition frequency at f = 35 MHz -I <sub>C</sub> = 25 mA; -V <sub>CE</sub> = 5 V	f <sub>T</sub> >	50 MHz
	typ.	85 MHz

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

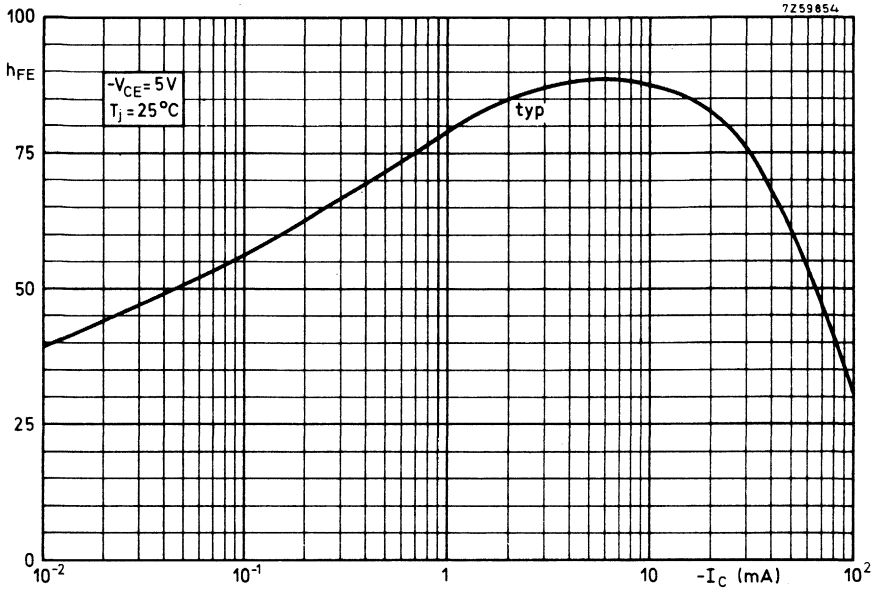


Fig. 2.

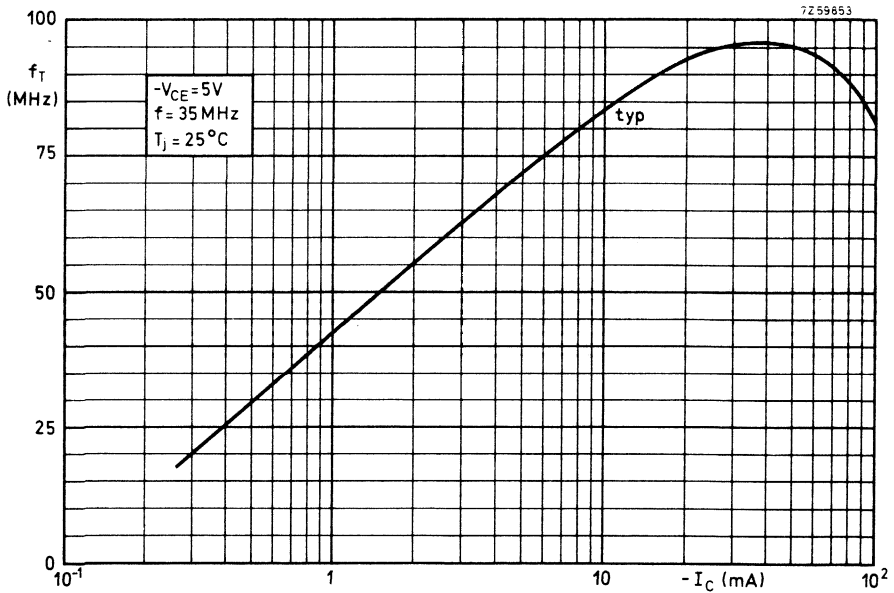


Fig. 3.

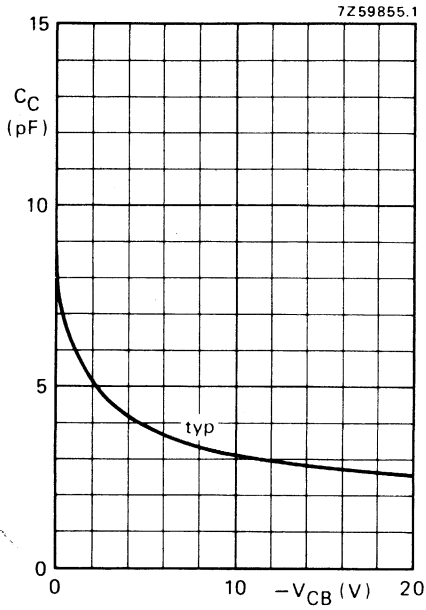


Fig. 4 Typical values collector capacitance as a function of collector-base voltage.  
 $I_E = I_e = 0$ ;  $T_j = 25^\circ\text{C}$ ;  $f = 1\text{ MHz}$ .

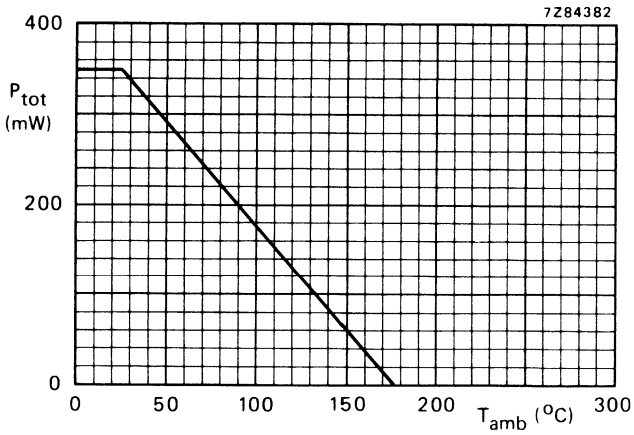


Fig. 5 Power derating curve.

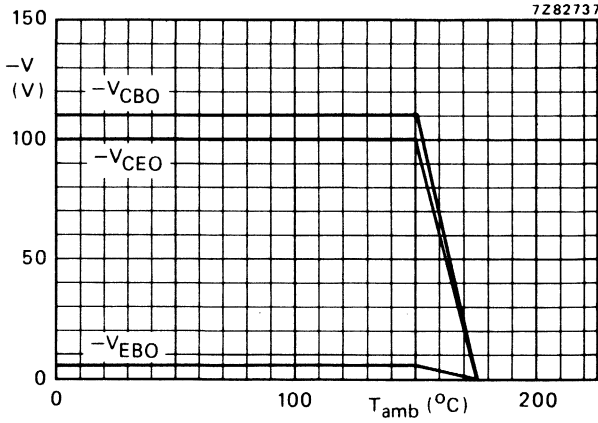


Fig. 6 Voltage derating curves.

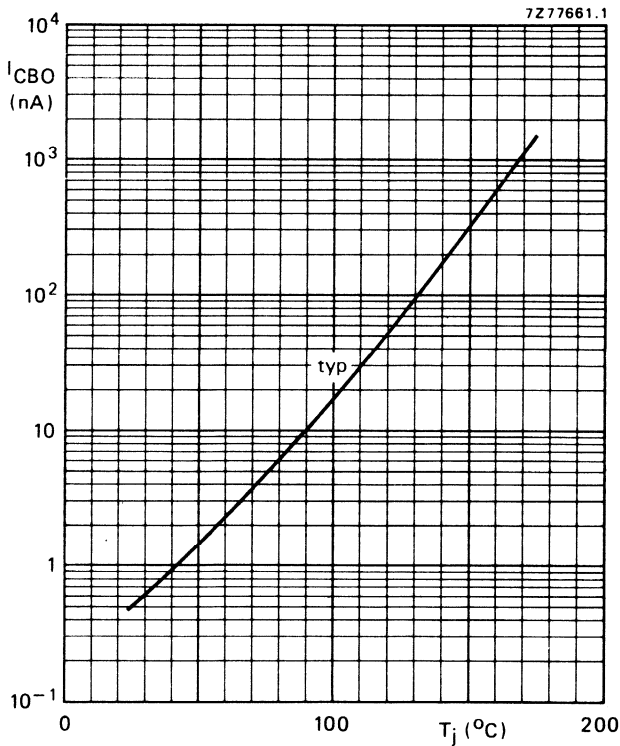


Fig. 7 Typical values collector-base currents as a function of the junction temperature at a collector-base voltage of 90 V.





## HIGH VOLTAGE N-P-N TRANSISTORS

Silicon planar epitaxial transistor in a microminiature plastic envelope intended for application in thick and thin-film circuits. This transistor is intended for high-voltage general purpose and switching applications.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CBO}$	max.	120 V	
Collector-emitter voltage (open base)	$V_{CEO}$	max.	80 V	
Collector current (peak value)	$I_{CM}$	max.	250 mA	
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	350 mW	←
Junction temperature	$T_j$	max.	175 $^{\circ}\text{C}$	←
D.C. current gain				
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}; T_j = 25\text{ }^{\circ}\text{C}$	$h_{FE}$	>	20	
		typ.	80	
Transition frequency at $f = 35\text{ MHz}$				
$I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$	$f_T$	>	60 MHz	
Turn-off time				
$I_C = 15\text{ mA}; I_{Bon} = -I_{Boff} = 1\text{ mA}$	$t_{off}$	<	1 $\mu\text{s}$	

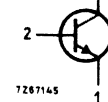
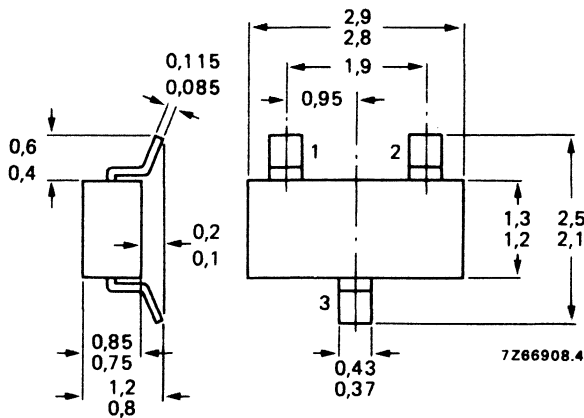
### MECHANICAL DATA

Dimensions in mm

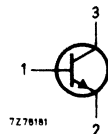
Marking code

Fig. 1 SOT-23.

BSS64 = U3



BSS64R = U6



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) see Fig. 2

$$I_C = 100 \mu A$$

$$V_{CBO} \text{ max. } 120 \text{ V}$$

Collector-emitter voltage (open base) see Fig. 2

$$I_C = 4 \text{ mA}$$

$$V_{CEO} \text{ max. } 80 \text{ V}$$

Emitter-base voltage (open collector) see Fig. 2

$$I_E = 100 \mu A$$

$$V_{EBO} \text{ max. } 5 \text{ V}$$

Collector current

(d.c. or averaged over any 20 ms period)

$$I_C \text{ max. } 100 \text{ mA}$$

Collector current (peak value)

$$I_{CM} \text{ max. } 250 \text{ mA}$$

Base current (peak value)

$$I_{BM} \text{ max. } 100 \text{ mA}$$

→ Total power dissipation up to  $T_{amb} = 25 \text{ }^\circ\text{C}$  \*\*

$$P_{tot} \text{ max. } 350 \text{ mW}$$

→ Storage temperature

$$T_{stg} -65 \text{ to } +175 \text{ }^\circ\text{C}$$

→ Junction temperature

$$T_j \text{ max. } 175 \text{ }^\circ\text{C}$$

→ **THERMAL CHARACTERISTICS \***

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab

$$R_{th\ j-t} = 50 \text{ K/W}$$

From tab to soldering points

$$R_{th\ t-s} = 260 \text{ K/W}$$

From soldering points to ambient \*\*

$$R_{th\ s-a} = 120 \text{ K/W}$$

**CHARACTERISTICS**

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

Collector cut-off current

$$I_E = 0; V_{CB} = 90 \text{ V}$$

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

$$I_E = 0; V_{CB} = 90 \text{ V}; T_j = 150 \text{ }^\circ\text{C}$$

$$I_{CBO} < 50 \mu A$$

Emitter cut-off current

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

$$I_{EBO} \text{ typ. } 0,5 \text{ nA}$$

$$< 200 \text{ nA}$$

Saturation voltages

$$I_C = 4 \text{ mA}; I_B = 400 \mu A$$

$$V_{CEsat} < 150 \text{ mV}$$

$$V_{BEsat} < 1200 \text{ mV}$$

$$I_C = 50 \text{ mA}; I_B = 15 \text{ mA}$$

$$V_{CEsat} < 200 \text{ mV}$$

D.C. current gain

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

$$h_{FE} \text{ typ. } 60$$

$$I_C = 10 \text{ mA}; V_{CE} = 1 \text{ V}$$

$$h_{FE} > 20$$

$$\text{typ. } 80$$

$$I_C = 20 \text{ mA}; V_{CE} = 1 \text{ V}$$

$$h_{FE} \text{ typ. } 55$$

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

Transition frequency at  $f = 35$  MHz  
 $I_C = 4$  mA;  $V_{CE} = 10$  V

$f_T > 60$  MHz  
 typ. 100 MHz

Collector capacitance at  $f = 1$  MHz  
 $I_E = I_e = 0$ ;  $V_{CB} = 10$  V

$C_c$  typ. 3 pF  
 $< 5$  pF

Turn-off switching time

$I_{Con} = 15$  mA;  $I_{Bon} = -I_{Boff} = 1$  mA

$t_{off} < 1$   $\mu$ s

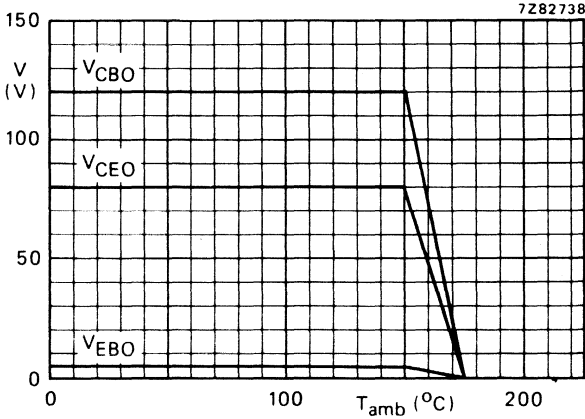


Fig. 2 Voltage derating curves.

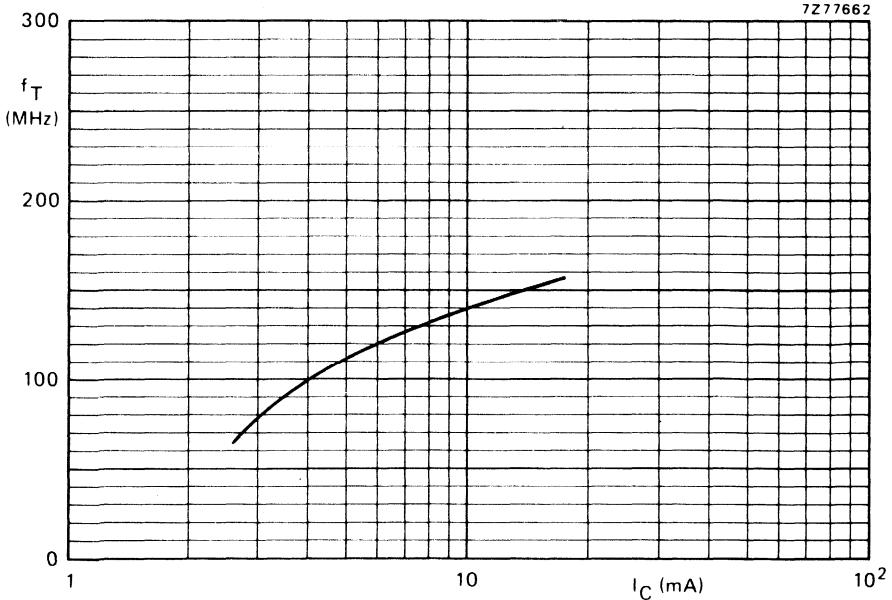


Fig. 3 Typical values transition frequency.  $V_{CE} = 10$  V;  $f = 35$  MHz;  $T_j = 25$  °C.

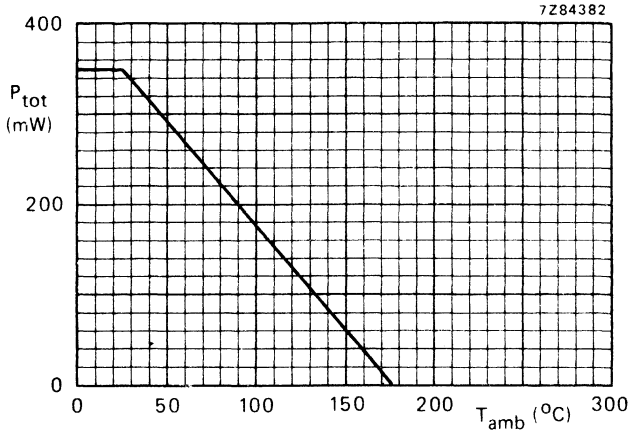


Fig. 4 Power derating curve.

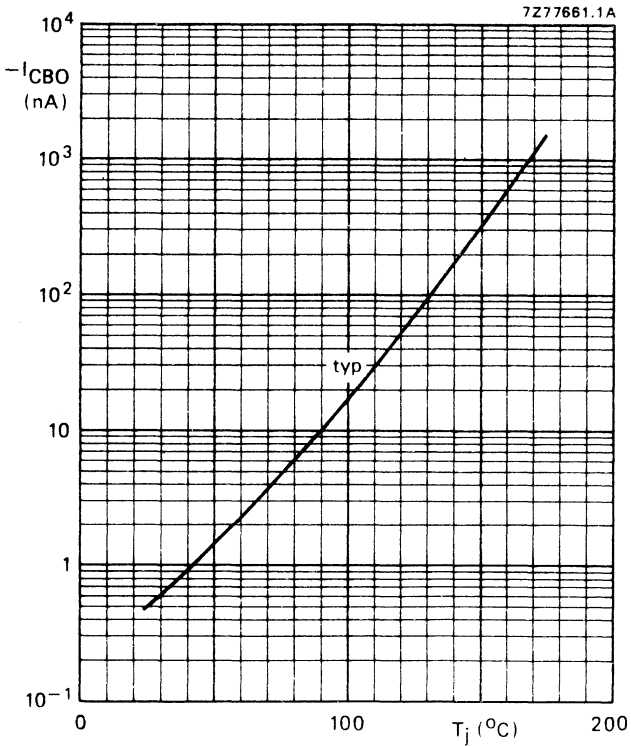


Fig. 5 Typical values collector-base current as a function of the junction temperature at a collector-base voltage of  $-90$  V.

## SILICON PLANAR EPITAXIAL TRANSISTORS

• High-speed switching

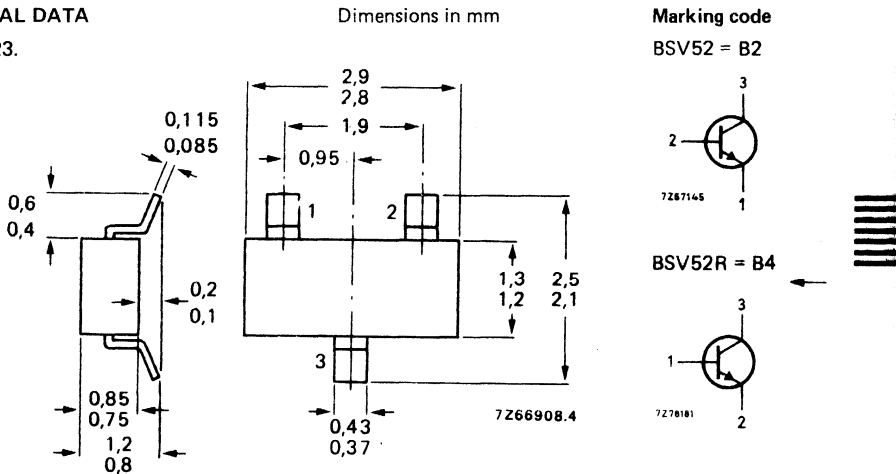
N-P-N transistor in a microminiature plastic envelope. It is intended for very high-speed saturated switching in thick and thin-film circuits.

### QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$V_{CBO}$	max.	20 V	
Collector-emitter voltage ( $V_{BE} = 0$ )	$V_{CES}$	max.	20 V	
Collector-emitter voltage (open base)	$V_{CEO}$	max.	12 V	
Collector current (peak value)	$I_{CM}$	max.	200 mA	
Total power dissipation up to $T_{amb} = 65\text{ }^{\circ}\text{C}$	$P_{tot}$	max.	250 mW	←
Junction temperature	$T_j$	max.	175 $^{\circ}\text{C}$	←
D.C. current gain				
$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE}$		40 to 120	
$I_C = 50\text{ mA}; V_{CE} = 1\text{ V}$	$h_{FE}$	>	25	
Transition frequency at $f = 100\text{ MHz}$				
$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$	$f_T$	>	400 MHz	
		typ.	500 MHz	
Storage time				
$I_C = I_B = -I_{BM} = 10\text{ mA}$	$t_s$	<	13 ns	

### MECHANICAL DATA

Fig. 1 SOT-23.



See also *Soldering recommendations*.

**RATINGS**

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

Collector-base voltage (open emitter) See Fig. 4	$V_{CB0}$	max.	20 V
Collector-emitter voltage ( $V_{BE} = 0$ ) See Fig. 4	$V_{CES}$	max.	20 V
Collector-emitter voltage (open base) $I_C = 10$ mA (see Fig. 4)	$V_{CEO}$	max.	12 V
Emitter-base voltage (open collector) See Fig. 4	$V_{EBO}$	max.	5 V
Collector current (d.c.)	$I_C$	max.	100 mA
Collector current (peak value)	$I_{CM}$	max.	200 mA
Total power dissipation up to $T_{amb} = 65$ °C **	$P_{tot}$	max.	250 mW
Storage temperature	$T_{stg}$		-65 to + 175 °C
Junction temperature	$T_j$	max.	175 °C

**THERMAL CHARACTERISTICS\***

$$T_j = P \times (R_{th j-t} + R_{th t-s} + R_{th s-a}) + T_{amb}$$

**Thermal resistance**

From junction to tab	$R_{th j-t}$	=	60 K/W
From tab to soldering points	$R_{th t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th s-a}$	=	120 K/W

**CHARACTERISTICS**

$T_j = 25$  °C unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = 10$ V	$I_{CBO}$	<	100 nA
$I_E = 0; V_{CB} = 10$ V; $T_j = 125$ °C	$I_{CBO}$	<	5 $\mu$ A

Saturation voltages

$I_C = 10$ mA; $I_B = 300$ $\mu$ A	$V_{CEsat}$	<	300 mV
$I_C = 10$ mA; $I_B = 1$ mA	$V_{CEsat}$	<	250 mV
	$V_{BEsat}$		700 to 850 mV
$I_C = 50$ mA; $I_B = 5$ mA	$V_{CEsat}$	<	400 mV
	$V_{BEsat}$	<	1200 mV

D.C. current gain

$I_C = 1$ mA; $V_{CE} = 1$ V	$h_{FE}$	>	25
$I_C = 10$ mA; $V_{CE} = 1$ V	$h_{FE}$		40 to 120
$I_C = 50$ mA; $V_{CE} = 1$ V	$h_{FE}$	>	25

Transition frequency at  $f = 100$  MHz

$I_C = 10$ mA; $V_{CE} = 10$ V	$f_T$	>	400 MHz
		typ.	500 MHz

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

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

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

$$C_c < 4 \text{ pF}$$

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

$$I_C = I_c = 0; V_{EB} = 1 \text{ V}$$

$$C_e < 4,5 \text{ pF}$$

Switching times

Storage time  $I_C = I_B = -I_{BM} = 10 \text{ mA}$

$$t_s < 13 \text{ ns}$$

Turn on time when switched from

$-V_{BE} = 1,5 \text{ V}$  to  $I_C = 10 \text{ mA}; I_B = 3 \text{ mA}$

$$t_{on} < 12 \text{ ns}$$

Turn off time when switched from

$I_C = 10 \text{ mA}; I_B = 3 \text{ mA}$

to cut-off with  $-I_{BM} = 1,5 \text{ mA}$

$$t_{off} < 18 \text{ ns}$$

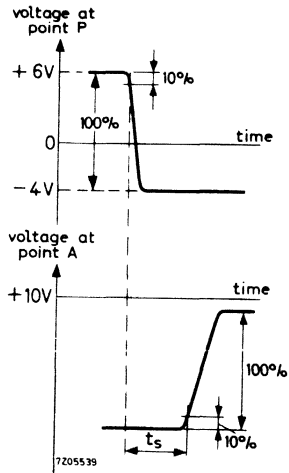
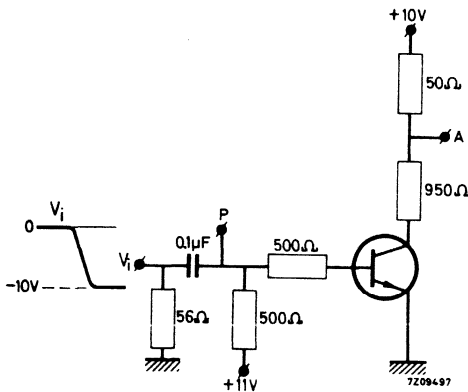


Fig. 2 Test circuit and waveform storage time.

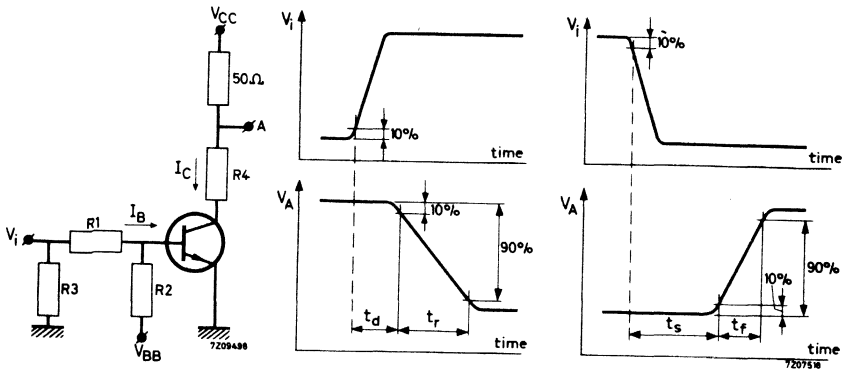


Fig. 3 Test circuit and waveforms turn on and turn off time.

# BSV52 BSV52R

Pulse generator:

Rise time  $t_r < 1 \text{ ns}$

Pulse duration  $t > 300 \text{ ns}$

Duty cycle  $\delta < 0,02$

Source impedance  $R_S = 50 \Omega$

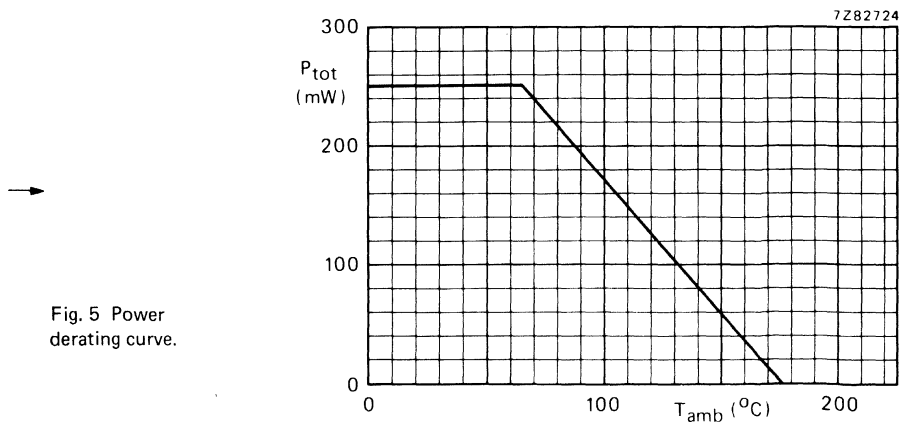
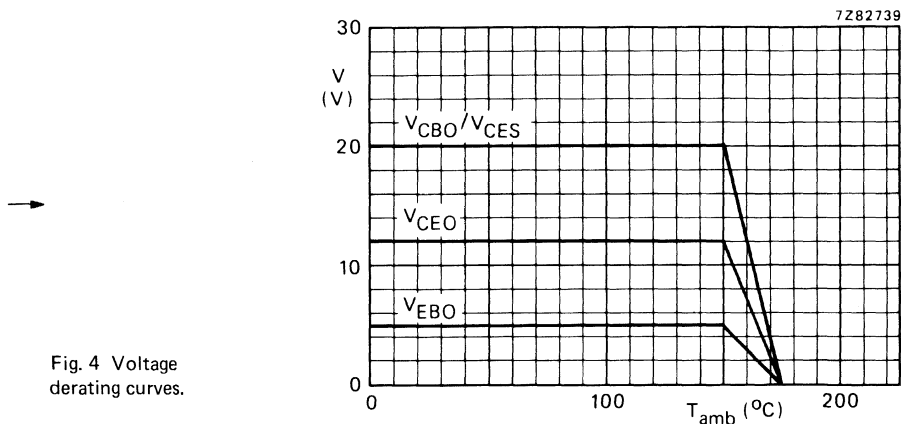
Oscilloscope:

Input impedance  $R_i = 50 \Omega$

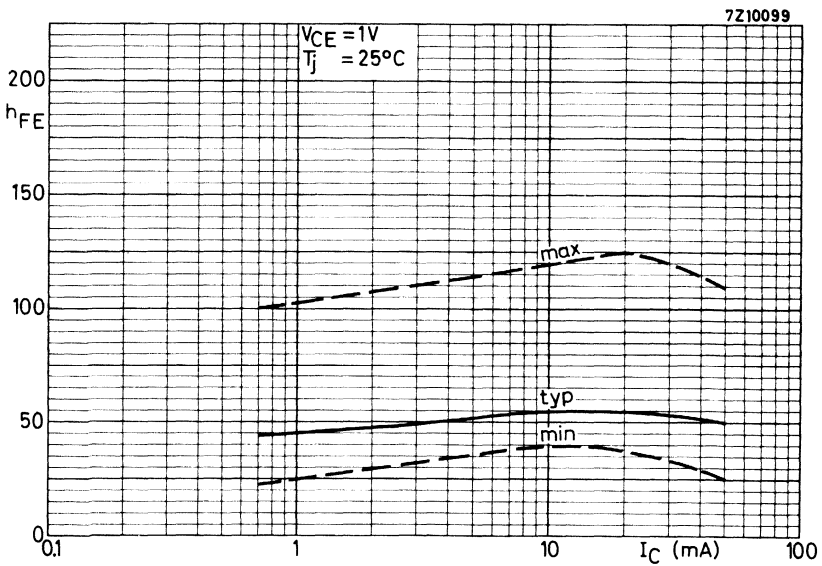
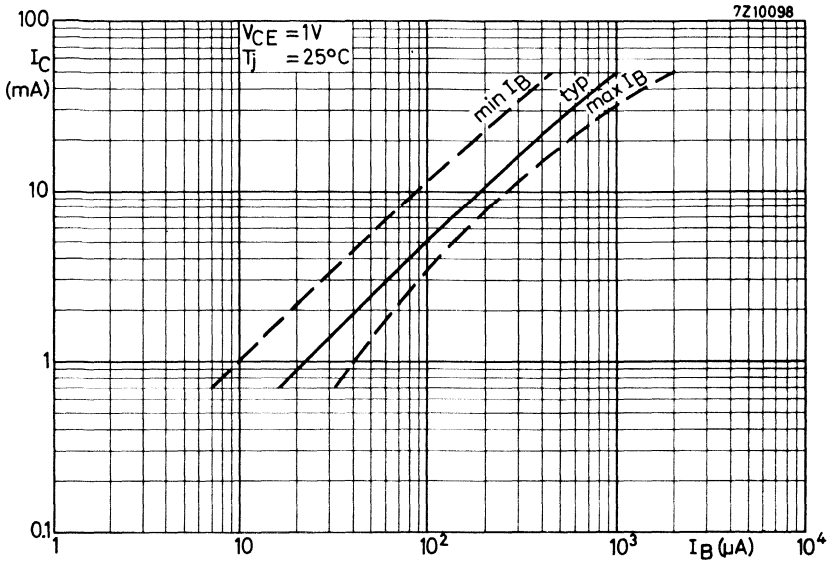
Rise time  $t_r < 1 \text{ ns}$

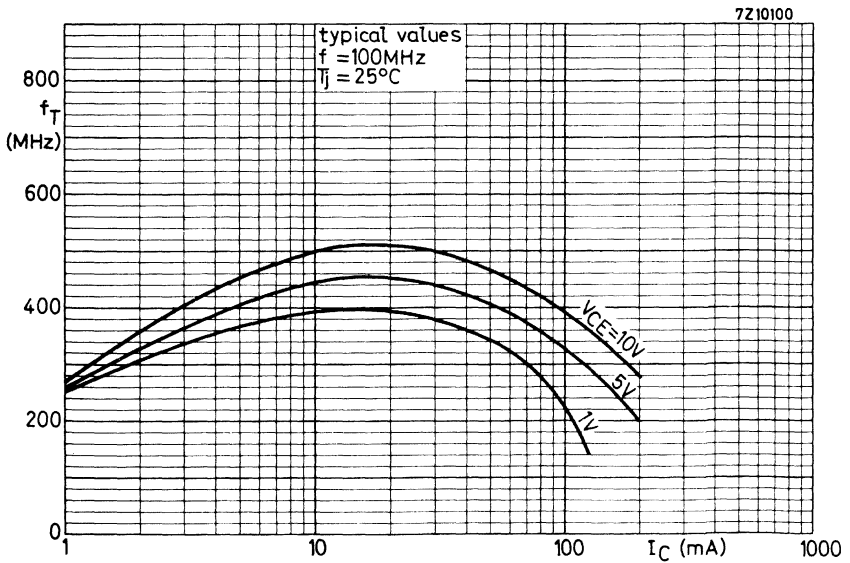
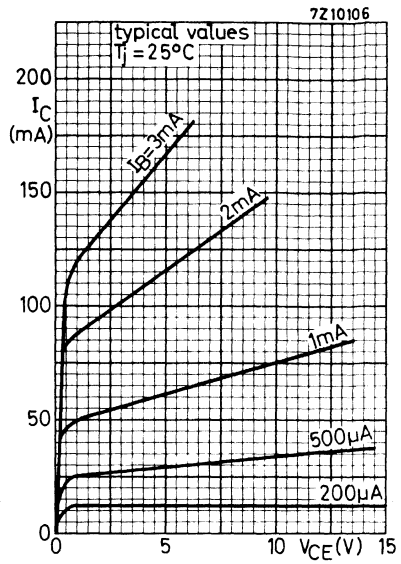
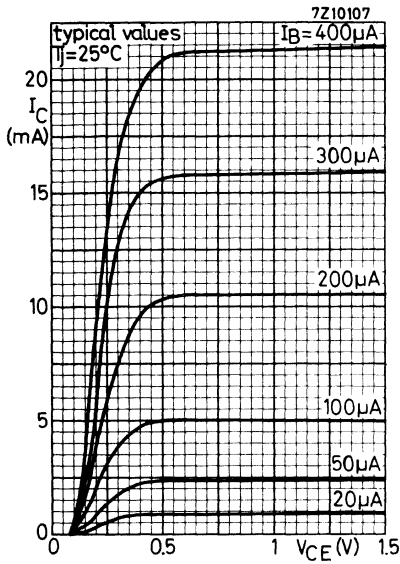
$I_C$ mA	$I_B$ mA	$-I_{BM}$ mA	$V_{CC}$ V	$R_1; R_2$ k $\Omega$	$R_3$ $\Omega$	$R_4$ $\Omega$	turn on time		turn off time		
							$-V_{BB}$ V	$-V_{BE}$ V	$V_i$ V	$V_{BB}$ V	$-V_i$ V
10	3	1,5	3	3,3	50	220	3,0	1,5	15	12,0	15

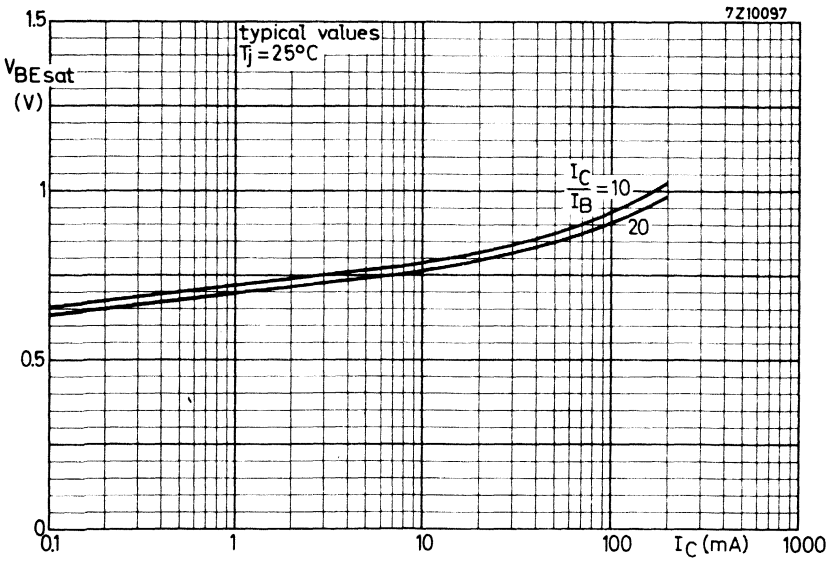
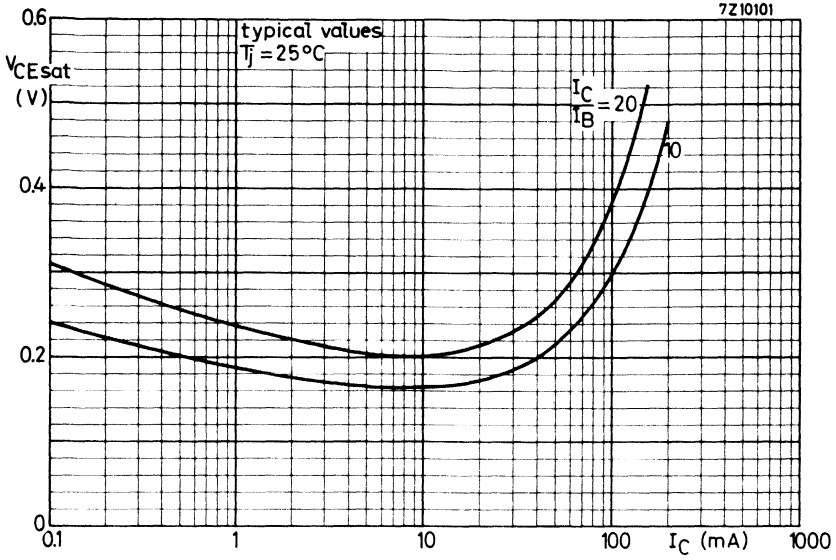
$-I_{BM}$  is the reverse current that can flow during switching off. The indicated  $-I_{BM}$  is determined and limited by the applied cut-off voltage and series resistance.

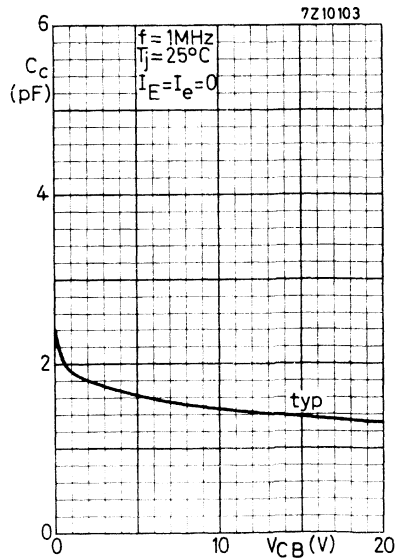
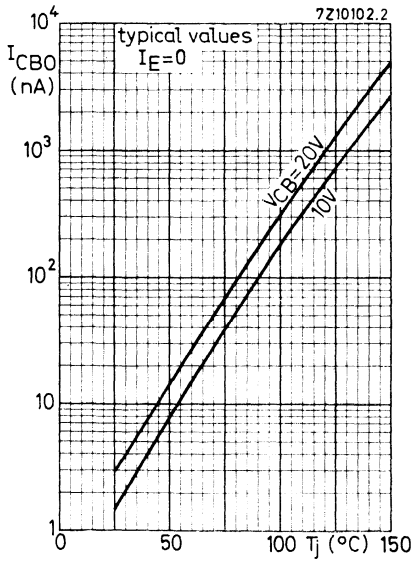
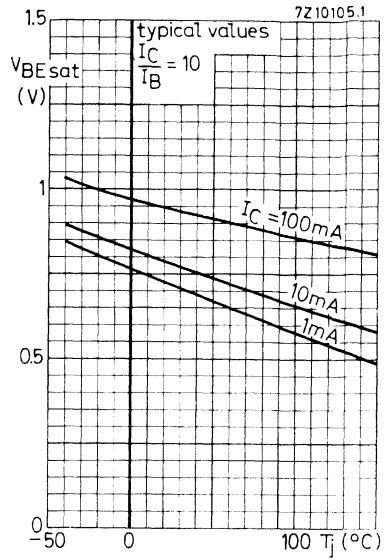
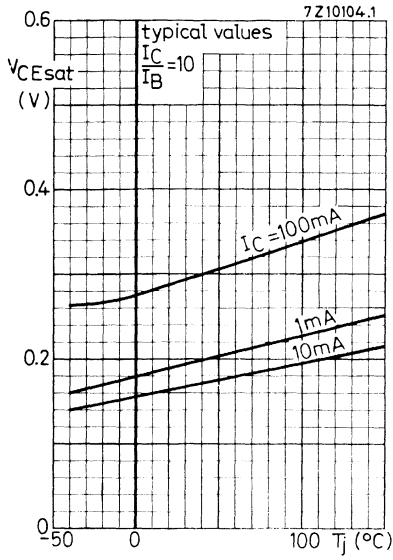












## SILICON PLANAR VOLTAGE REGULATOR DIODES

Silicon planar voltage regulator diodes, in a SOT-89 plastic envelope, intended for stabilization applications in thick and thin-film circuits.

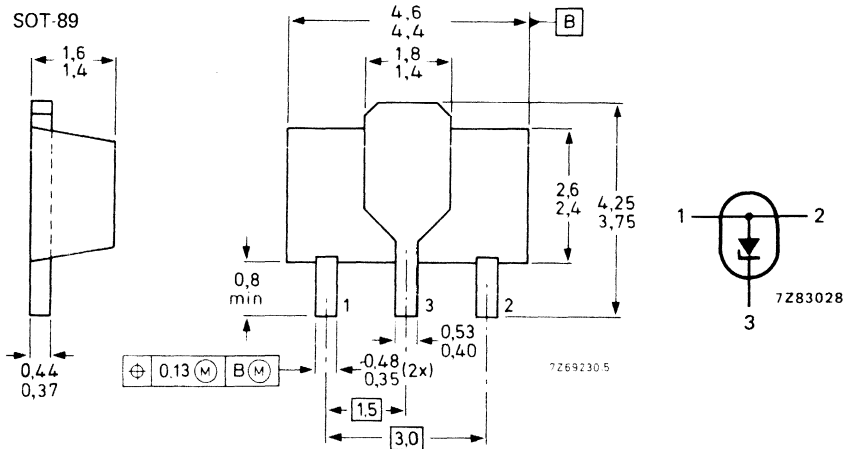
The series covers the normalized range of nominal working voltages from 5,1 V to 75 V with a tolerance of  $\pm 5\%$  (international standard E24).

### QUICK REFERENCE DATA

Working voltage range	$V_Z$	nom.	5,1 to 75 V
Working voltage tolerance (E24)			$\pm 5\%$
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max.	1 W
Junction temperature	$T_j$	max.	150 $^\circ\text{C}$

### MECHANICAL DATA

Fig. 1 SOT-89



### Marking code:

BZX78-C5V1 = 5Z1  
 C5V6 = 5Z6  
 C6V2 = 6Z2  
 C6V8 = 6Z8  
 C7V5 = 7Z5  
 C8V2 = 8Z2  
 C9V1 = 9Z1  
 C10 = 10Z  
 C11 = 11Z

BZX78-C12 = 12Z  
 C13 = 13Z  
 C15 = 15Z  
 C16 = 16Z  
 C18 = 18Z  
 C20 = 20Z  
 C22 = 22Z  
 C24 = 24Z  
 C27 = 27Z  
 C30 = 30Z

BZX78-C33 = 33Z  
 C36 = 36Z  
 C39 = 39Z  
 C43 = 43Z  
 C47 = 47Z  
 C51 = 51Z  
 C56 = 56Z  
 C62 = 62Z  
 C68 = 68Z  
 C75 = 75Z

See also *Soldering recommendations* in Handbook Microminiatures.

## RATINGS

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

Working current (d.c.)	$I_Z$	limited by $P_{tot\ max}$
Repetitive peak working current	$I_{ZRM}$	limited by $P_{ZRM\ max}$
Repetitive peak forward current	$I_{FRM}$	max. 400 mA
Total power dissipation * up to $T_{amb} = 25\ ^\circ C$	$P_{tot}$	max. 1 W
Repetitive peak reverse power dissipation * up to $T_{amb} = 145\ ^\circ C$ ; $t_p = 100\ \mu s$ ; $\delta = 0,001$	$P_{ZRM}$	max. 7,5 W
Non-repetitive peak reverse power dissipation * $T_j = 25\ ^\circ C$ prior to surge; $t_p = 100\ \mu s$ (see Fig. 7)	$P_{ZSM}$	max. 100 W
Storage temperature	$T_{stg}$	-65 to +150 $^\circ C$
Junction temperature	$T_j$	max. 150 $^\circ C$

## THERMAL RESISTANCE (see also Fig. 6)

From junction to collector tab	$R_{th\ j-tab}$	=	10 K/W
From junction to ambient in free air *	$R_{th\ j-a}$	=	125 K/W

## CHARACTERISTICS

$T_j = 25\ ^\circ C$

Forward voltage at  $I_F = 0,2\ A$

$$V_F < 1\ V$$

Reverse current

BZX78-C5V1	} $V_R = 2\ V$	$I_R$	<	10 $\mu A$
C5V6		$I_R$	<	5 $\mu A$
C6V2		$I_R$	<	3 $\mu A$
C6V8	} $V_R = 3\ V$	$I_R$	<	1,5 $\mu A$
C7V5		$I_R$	<	0,6 $\mu A$
C8V2		$I_R$	<	0,4 $\mu A$
C9V1	$V_R = 5\ V$	$I_R$	<	0,3 $\mu A$
C10 to C75	$V_R = 2/3\ V_{Znom}$	$I_R$	<	0,2 $\mu A$

\* Device mounted on a ceramic substrate: area = 2,5 cm<sup>2</sup>; thickness = 0,7 mm.

## CHARACTERISTICS (continued)

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

BZX78.....	Working voltage $V_Z$ (V)		Temperature coefficient $S_Z$ (mV/K)			Differential resistance $r_{\text{diff}}$ ( $\Omega$ )		Diode capacitance $C_d$ (pF) at $f = 1$ MHz	
	at $I_Z = 50$ mA		at $I_Z = 50$ mA			at $I_Z = 50$ mA		$V_R = 0$	
	min.	max.	min.	typ.	max.	typ.	max.	typ.	max.
C5V1	4,8	5,4	-1,5	0	1,5	4	10	200	250
C5V6	5,2	6,0	-0,2	1,5	2,5	2	5	180	225
C6V2	5,8	6,6	1,5	2,4	3,3	1,5	3	350	400
	at $I_Z = 20$ mA		at $I_Z = 20$ mA			at $I_Z = 20$ mA			
C6V8	6,4	7,2	2,2	3,1	3,9	1	3	300	350
C7V5	7,0	7,9	2,8	3,8	4,7	1	3	270	310
C8V2	7,7	8,7	3,5	4,5	5,5	1,5	4	250	280
C9V1	8,5	9,6	4,3	5,4	6,5	2	4	210	250
C10	9,4	10,6	5,2	6,3	7,5	2	5	190	230
C11	10,4	11,6	6,2	7,4	8,6	3	5	170	220
C12	11,4	12,7	7,2	8,4	9,8	3	6	165	200
C13	12,4	14,1	8,2	9,4	11,2	3	7	165	200
C15	13,8	15,6	9,6	11,4	12,8	4	10	160	190
	at $I_Z = 10$ mA		at $I_Z = 10$ mA			at $I_Z = 10$ mA			
C16	15,3	17,1	11,1	12,5	14,4	4	10	140	180
C18	16,8	19,1	12,6	14,5	16,6	5	15	120	160
C20	18,8	21,2	14,6	16,6	18,8	5	15	110	150
C22	20,8	23,3	16,6	18,6	20,9	5	20	100	135
C24	22,8	25,6	18,6	20,7	23,4	6	20	95	130
C27	25,1	28,9	21,0	23,8	26,8	7	25	90	120
C30	28	32	23,8	26,9	30,6	8	25	80	110
C33	31	35	26,6	30,0	34,2	10	30	75	95
C36	34	38	29,6	33,4	38,0	10	35	70	90
	at $I_Z = 5$ mA		at $I_Z = 5$ mA			at $I_Z = 5$ mA			
C39	37	41	32,6	37,0	41,6	15	40	65	80
C43	40	46	36,0	41,6	47,6	15	50	62	75
C47	44	50	40,4	46,1	52,6	20	60	60	75
C51	48	54	44,6	51,0	57,6	30	70	55	70
C56	52	60	49,2	56,6	64,8	35	80	52	65
C62	58	66	56,0	63,4	72,0	40	90	50	60
C68	64	72	62,4	70,4	79,2	45	110	46	58
C75	70	79	69,2	78,4	88,0	45	125	44	55



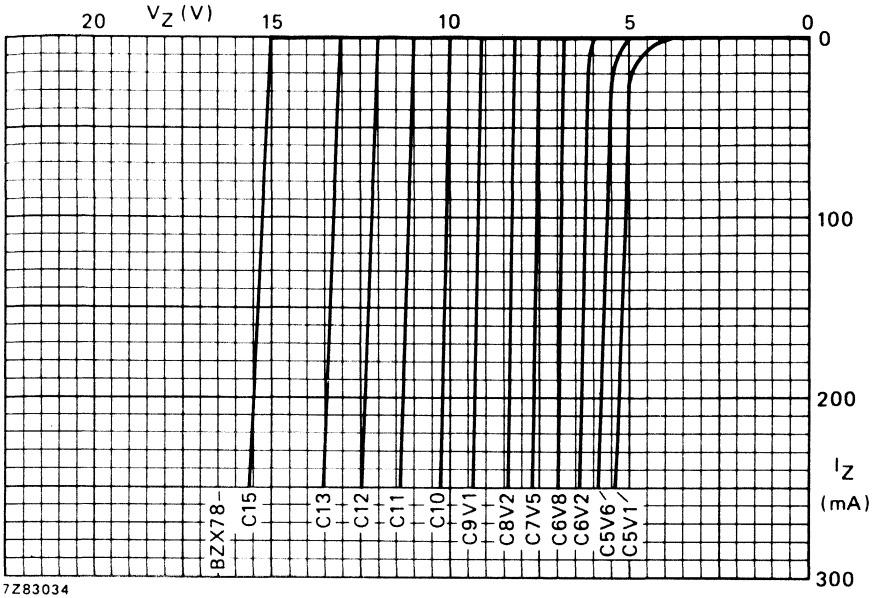
# BZX78 SERIES

## CHARACTERISTICS (continued)

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

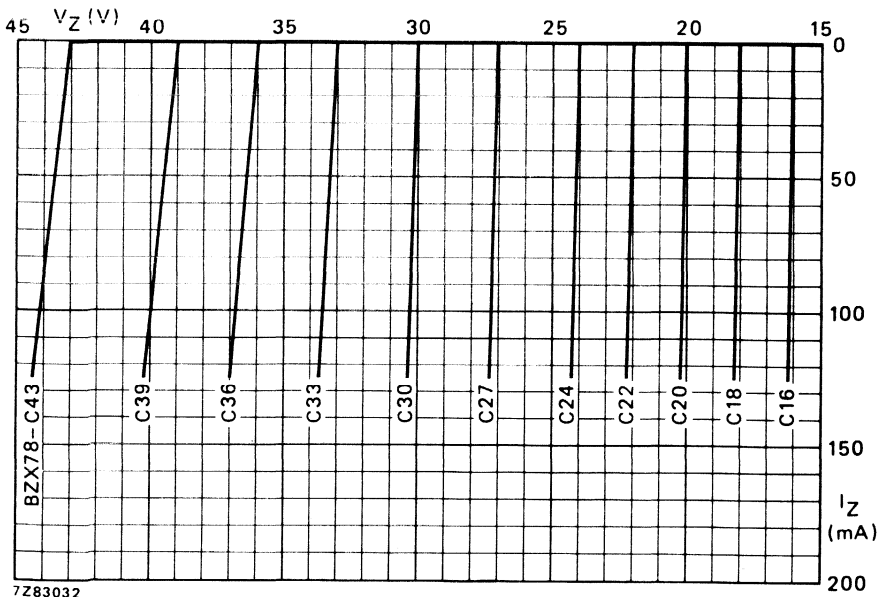
BZX78- . . . .	Working voltage			Differential resistance		Working voltage			Differential resistance	
	$V_Z$ (V)			$r_{\text{diff}}$ ( $\Omega$ )		$V_Z$ (V)			$r_{\text{diff}}$ ( $\Omega$ )	
	at $I_Z = 1\text{ mA}$			at $I_Z = 1\text{ mA}$		at $I_Z = 100\text{ mA}$			at $I_Z = 100\text{ mA}$	
	min.	nom.	max.	typ.	max.	min.	nom.	max.	typ.	max.
C5V1	3,3	3,8	4,3	425	500	4,9	5,2	5,5	1,2	2,5
C5V6	4,1	5,3	5,8	400	500	5,3	5,7	6,1	1,0	2,0
C6V2	5,6	6,0	6,5	40	200	5,9	6,3	6,7	0,8	2,0
C6V8	6,3	6,7	7,1	40	120	6,5	6,9	7,3	0,6	2,0
C7V5	6,9	7,4	7,8	20	100	7,1	7,6	8,0	0,5	1,5
C8V2	7,6	8,1	8,6	20	100	7,8	8,3	8,8	0,5	1,5
C9V1	8,4	9,0	9,6	25	100	8,6	9,2	9,8	0,8	2,0
C10	9,3	9,9	10,5	30	120	9,5	10,1	10,8	0,8	2,0
C11	10,3	10,9	11,5	30	120	10,5	11,1	11,8	0,8	2,0
C12	11,2	11,9	12,6	30	150	11,5	12,1	12,9	1,0	2,0
C13	12,2	12,9	14,0	30	150	12,5	13,1	14,3	1,2	2,5
C15	13,6	14,9	15,4	30	150	13,9	15,1	15,8	1,2	2,5
	at $I_Z = 1\text{ mA}$			at $I_Z = 1\text{ mA}$		at $I_Z = 50\text{ mA}$			at $I_Z = 50\text{ mA}$	
C16	15,2	15,9	17,0	30	150	15,4	16,1	17,3	1,2	3,0
C18	16,7	17,9	19,0	30	150	16,9	18,1	19,3	2,0	5,0
C20	18,7	19,9	21,1	30	150	19,0	20,2	21,5	2,5	6,0
C22	20,7	21,9	23,2	30	150	21,0	22,2	23,7	2,5	6,0
C24	22,6	23,9	25,5	30	150	23,0	24,2	26,0	3,0	8,0
C27	24,9	26,9	28,8	30	150	25,3	27,2	29,2	4,0	8,0
C30	27,8	29,9	31,9	30	150	28,2	30,2	32,5	4,0	8,0
C33	29,8	32,9	34,9	30	150	31,2	33,3	35,5	5,0	10
C36	33,8	35,9	37,9	30	150	34,2	36,3	38,5	5,0	10
C39	36,8	38,9	40,9	40	150	37,5	39,5	42,0	6,0	12
C43	39,8	42,9	45,9	50	150	40,5	43,5	47,0	8	15
C47	43,8	46,9	49,9	55	200	44,5	47,5	51,0	10	20
C51	47,8	50,9	53,8	60	200	48,5	51,8	55,5	12	25
C56	51,8	55,9	59,8	60	200	52,5	56,8	61,5	15	30
C62	57,6	61,8	65,8	70	200	58,5	62,8	67,5	16	30
C68	63,5	67,6	71,7	80	225	65,0	69,0	74,0	18	35
C75	69,3	74,5	78,6	100	250	73,0	77,5	84,0	20	35





7Z83034

Fig. 2 Dynamic characteristics BZX78-C5V1 to C15; typical values at  $T_j = 25^\circ\text{C}$ .



7Z83032

Fig. 3 Dynamic characteristics BZX78-C16 to C43. Typical values at  $T_j = 25^\circ\text{C}$ .

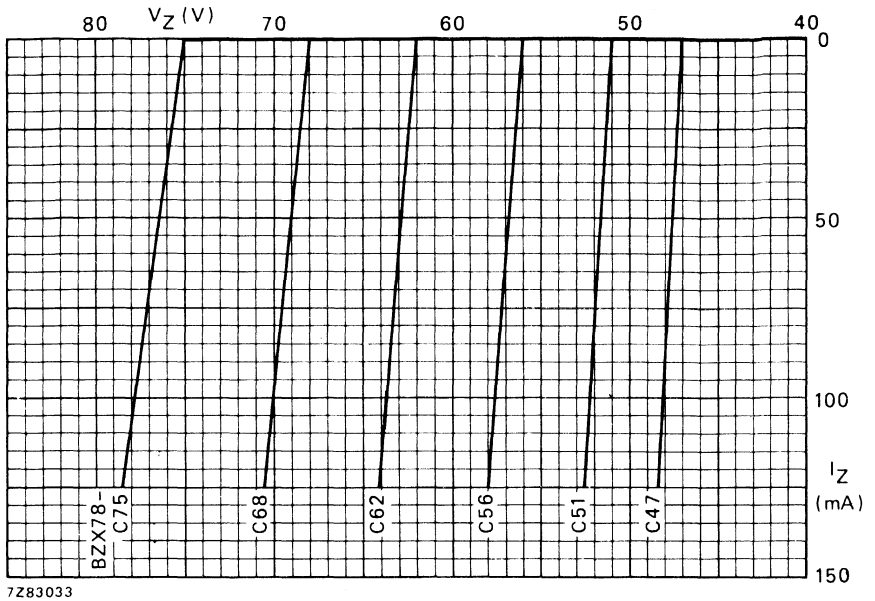


Fig. 4 Dynamic characteristics BZX78-C47 to C75. Typical values at  $T_j = 25^\circ\text{C}$ .

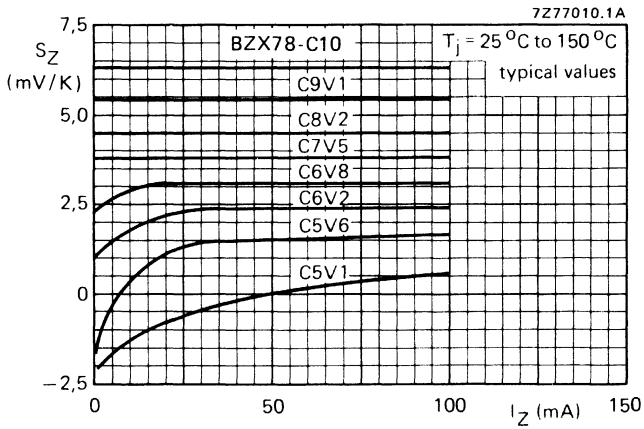


Fig. 5 Temperature coefficient as a function of working current.

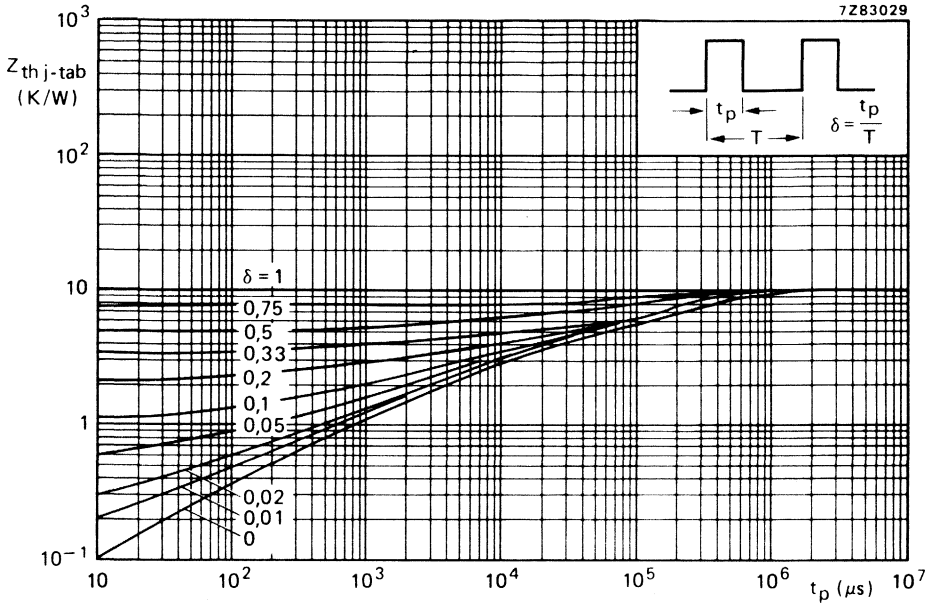


Fig. 6 Pulse power rating chart of BZX78 on a ceramic substrate.

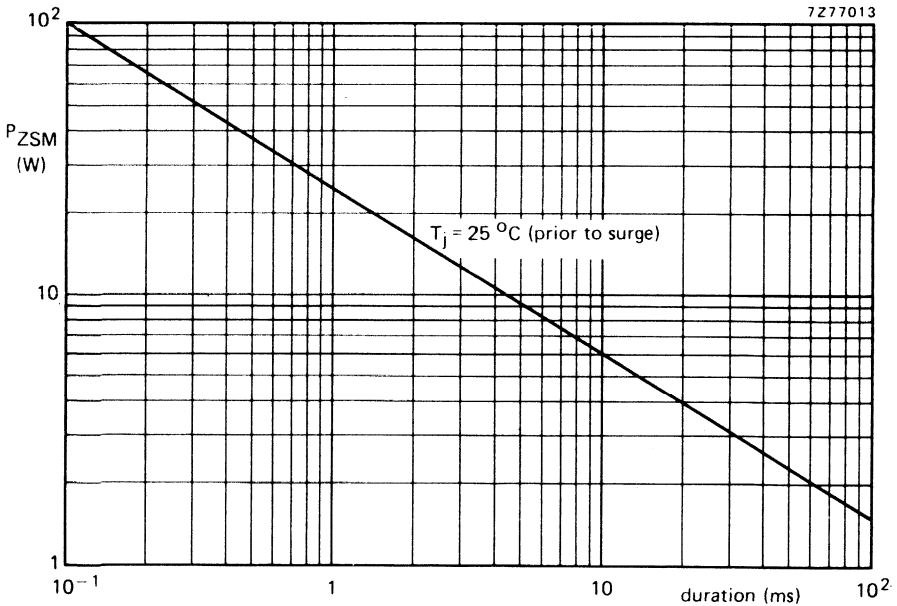


Fig. 7 Non-repetitive peak reverse power dissipation as a function of pulse duration.

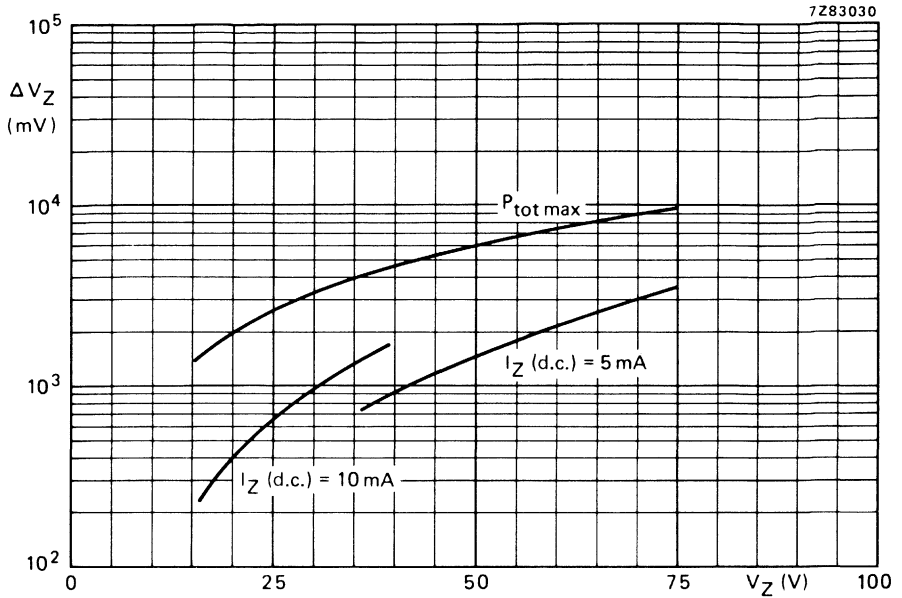


Fig. 8 Typical values at  $T_{amb} = 25\ ^\circ C$ ; device mounted on a ceramic substrate area =  $2,5\ cm^2$ ; thickness =  $0,7\ mm$ .

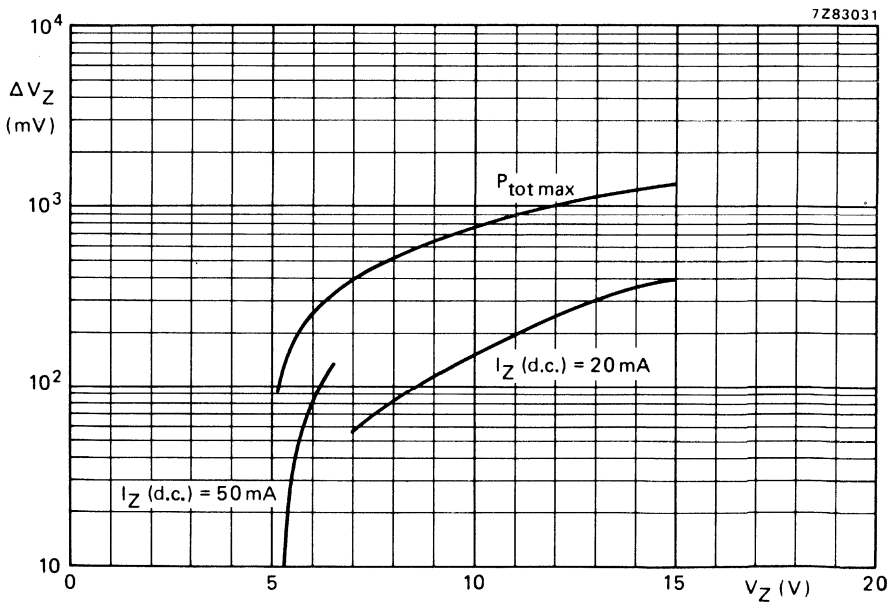


Fig. 9 Typical values at  $T_{amb} = 25\ ^\circ C$ ; device mounted on a ceramic substrate area =  $2,5\ cm^2$ ; thickness =  $0,7\ mm$ .

## SILICON PLANAR VOLTAGE REGULATOR DIODES

Low power general purpose voltage regulator diodes in a microminiature plastic envelope intended for application in thick and thin-film circuits. The series covers the normalized range of nominal working voltages from 2,4 V to 75 V with a working voltage tolerance of  $\pm 5\%$ .

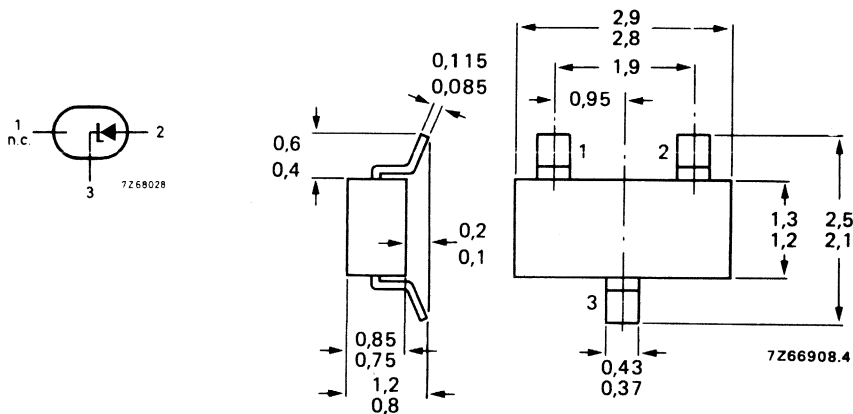
### QUICK REFERENCE DATA

Working voltage range	$V_Z$	nom.	2,4 to 75 V
Working voltage tolerance			$\pm 5\%$
Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$	$P_{tot}$	max.	350 mW
Junction temperature	$T_j$	max.	175 $^\circ\text{C}$

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.



See also *Soldering recommendations*.

### Marking code

BZX84-C2V4 = Z11  
 C2V7 = Z12  
 C3V0 = Z13  
 C3V3 = Z14  
 C3V6 = Z15  
 C3V9 = Z16  
 C4V3 = Z17  
 C4V7 = Z1  
 C5V1 = Z2

BZX84-C5V6 = Z3  
 C6V2 = Z4  
 C6V8 = Z5  
 C7V5 = Z6  
 C8V2 = Z7  
 C9V1 = Z8  
 C10 = Z9  
 C11 = Y1  
 C12 = Y2

BZX84-C13 = Y3  
 C15 = Y4  
 C16 = Y5  
 C18 = Y6  
 C20 = Y7  
 C22 = Y8  
 C24 = Y9  
 C27 = Y10  
 C30 = Y11

BZX84-C33 = Y12  
 C36 = Y13  
 C39 = Y14  
 C43 = Y15  
 C47 = Y16  
 C51 = Y17  
 C56 = Y18  
 C62 = Y19  
 C68 = Y20  
 C75 = Y21



## RATINGS

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

Repetitive peak forward current	$I_{FRM}$	max.	250 mA
Repetitive peak working current	$I_{ZRM}$	max.	250 mA
Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}^{**}$	$P_{tot}$	max.	350 mW
Storage temperature	$T_{stg}$		-65 to + 175 $^{\circ}\text{C}$
Junction temperature	$T_j$	max.	175 $^{\circ}\text{C}$

## THERMAL CHARACTERISTICS\*

$$T_j = P \times (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

### Thermal resistance

From junction to tab	$R_{th\ j-t}$	=	50 K/W
From tab to soldering points	$R_{th\ t-s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s-a}$	=	120 K/W

## CHARACTERISTICS

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

Forward voltage

$$I_F = 10\text{ mA}$$

$$V_F < 0,9\text{ V}$$

Reverse current

BZX84-C2V4	$V_R = 1\text{ V}$	$I_R <$	50 $\mu\text{A}$
C2V7	$V_R = 1\text{ V}$	$I_R <$	20 $\mu\text{A}$
C3V0	$V_R = 1\text{ V}$	$I_R <$	10 $\mu\text{A}$
C3V3	$V_R = 1\text{ V}$	$I_R <$	5 $\mu\text{A}$
C3V6	$V_R = 1\text{ V}$	$I_R <$	5 $\mu\text{A}$
C3V9	$V_R = 1\text{ V}$	$I_R <$	3 $\mu\text{A}$
C4V3	$V_R = 1\text{ V}$	$I_R <$	3 $\mu\text{A}$
C4V7	$V_R = 2\text{ V}$	$I_R <$	3 $\mu\text{A}$
C5V1	$V_R = 2\text{ V}$	$I_R <$	2 $\mu\text{A}$
C5V6	$V_R = 2\text{ V}$	$I_R <$	1 $\mu\text{A}$
C6V2	$V_R = 4\text{ V}$	$I_R <$	3 $\mu\text{A}$
C6V8	$V_R = 4\text{ V}$	$I_R <$	2 $\mu\text{A}$
C7V5	$V_R = 5\text{ V}$	$I_R <$	1 $\mu\text{A}$
C8V2	$V_R = 5\text{ V}$	$I_R <$	700 nA
C9V1	$V_R = 6\text{ V}$	$I_R <$	500 nA
C10	$V_R = 7\text{ V}$	$I_R <$	200 nA
C11	$V_R = 8\text{ V}$	$I_R <$	100 nA
C12	$V_R = 8\text{ V}$	$I_R <$	100 nA
C13	$V_R = 8\text{ V}$	$I_R <$	100 nA
C15 to C75	$V_R = 0,7 V_{Znom}$	$I_R <$	50 nA

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Device mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

BZX84....	working voltage		differential resistance		temperature coefficient			diode capacitance	
	$V_Z$ (V)		$r_{diff}$ ( $\Omega$ )		$S_Z$ (mV/ $^{\circ}$ C)			$C_d$ (pF); $f = 1$ MHz	
	at $I_{Ztest} = 5$ mA		at $I_{Ztest} = 5$ mA		at $I_{Ztest} = 5$ mA			$V_R = 0$	
	min.	max.	typ.	max.	min.	typ.	max.	typ.	max.
C2V4	2,2	2,6	70	100	-3,5	-1,6	0	375	450
C2V7	2,5	2,9	75	100	-3,5	-2,0	0	350	450
C3V0	2,8	3,2	80	95	-3,5	-2,1	0	350	450
C3V3	3,1	3,5	85	95	-3,5	-2,4	0	325	450
C3V6	3,4	3,8	85	90	-3,5	-2,4	0	300	450
C3V9	3,7	4,1	85	90	-3,5	-2,5	0	300	450
C4V3	4,0	4,6	80	90	-3,5	-2,5	0	275	450
C4V7	4,4	5,0	50	80	-3,5	-1,4	0,2	130	180
C5V1	4,8	5,4	40	60	-2,7	-0,8	1,2	110	160
C5V6	5,2	6,0	15	40	-2,0	1,2	2,5	95	140
C6V2	5,8	6,6	6	10	0,4	2,3	3,7	90	130
C6V8	6,4	7,2	6	15	1,2	3,0	4,5	85	110
C7V5	7,0	7,9	6	15	2,5	4,0	5,3	80	100
C8V2	7,7	8,7	6	15	3,2	4,6	6,2	75	95
C9V1	8,5	9,6	6	15	3,8	5,5	7,0	70	90
C10	9,4	10,6	8	20	4,5	6,4	8,0	70	90
C11	10,4	11,6	10	20	5,4	7,4	9,0	65	85
C12	11,4	12,7	10	25	6,0	8,4	10,0	65	85
C13	12,4	14,1	10	30	7,0	9,4	11,0	60	80
C15	13,8	15,6	10	30	9,2	11,4	13,0	55	75
C16	15,3	17,1	10	40	10,4	12,4	14,0	52	75
C18	16,8	19,1	10	45	12,4	14,4	16,0	47	70
C20	18,8	21,2	15	55	14,4	16,4	18,0	36	60
C22	20,8	23,3	20	55	16,4	18,4	20,0	34	60
C24	22,8	25,6	25	70	18,4	20,4	22,0	33	55
	at $I_Z = 2$ mA		at $I_Z = 2$ mA		at $I_Z = 2$ mA				
	min.	max.	typ.	max.	min.	typ.	max.	typ.	max.
C27	25,1	28,9	25	80	21,4	23,4	25,3	30	50
C30	28,0	32,0	30	80	24,4	26,6	29,4	27	50
C33	31,0	35,0	35	80	27,4	29,7	33,4	25	45
C36	34,0	38,0	35	90	30,4	33,0	37,4	23	45
C39	37,0	41,0	40	130	33,4	36,4	41,2	21	45
C43	40,0	46,0	45	150	37,6	41,2	46,6	21	40
C47	44,0	50,0	50	170	42,0	46,1	51,8	19	40
C51	48,0	54,0	60	180	46,6	51,0	57,2	19	40
C56	52,0	60,0	70	200	52,2	57,0	63,8	18	40
C62	58,0	66,0	80	215	58,8	64,4	71,6	17	35
C68	64,0	72,0	90	240	65,6	71,7	79,8	17	35
C75	70,0	79,0	95	255	73,4	80,2	88,6	16,5	35

# BZX84 SERIES

BZX84.....	working voltage			differential resistance		working voltage			differential resistance	
	$V_Z$ (V)			$r_{diff}$ ( $\Omega$ )		$V_Z$ (V)			$r_{diff}$ ( $\Omega$ )	
	at $I_Z = 1$ mA			at $I_Z = 1$ mA		at $I_Z = 20$ mA			at $I_Z = 20$ mA	
	min.	nom.	max.	typ.	max.	min.	nom.	max.	typ.	max.
C2V4	1,7	1,9	2,1	275	600	2,6	2,9	3,2	25	50
C2V7	1,9	2,2	2,4	300	600	3,0	3,3	3,6	25	50
C3V0	2,1	2,4	2,7	325	600	3,3	3,6	3,9	25	50
C3V3	2,3	2,6	2,9	350	600	3,6	3,9	4,2	20	40
C3V6	2,7	3,0	3,3	375	600	3,9	4,2	4,5	20	40
C3V9	2,9	3,2	3,5	400	600	4,1	4,4	4,7	15	30
C4V3	3,3	3,6	4,0	410	600	4,4	4,7	5,1	15	30
C4V7	3,7	4,2	4,7	425	500	4,5	5,0	5,4	8	15
C5V1	4,2	4,7	5,3	400	480	5,0	5,4	5,9	6	15
C5V6	4,8	5,4	6,0	80	400	5,2	5,7	6,3	4	10
C6V2	5,6	6,1	6,6	40	150	5,8	6,3	6,8	3	6
C6V8	6,3	6,7	7,2	30	80	6,4	6,9	7,4	2,5	6
C7V5	6,9	7,4	7,9	30	80	7,0	7,6	8,0	2,5	6
C8V2	7,6	8,1	8,7	40	80	7,7	8,3	8,8	3	6
C9V1	8,4	9,0	9,6	40	100	8,5	9,2	9,7	4	8
C10	9,3	9,9	10,6	50	150	9,4	10,1	10,7	4	10
C11	10,2	10,9	11,6	50	150	10,4	11,1	11,8	5	10
C12	11,2	11,9	12,7	50	150	11,4	12,1	12,9	5	10
C13	12,3	12,9	14,0	50	170	12,5	13,1	14,2	5	15
C15	13,7	14,9	15,5	50	200	13,9	15,1	15,7	6	20
C16	15,2	15,9	17,0	50	200	15,4	16,1	17,2	6	20
C18	16,7	17,9	19,0	50	225	16,9	18,1	19,2	6	20
C20	18,7	19,9	21,1	60	225	18,9	20,1	21,4	7	20
C22	20,7	21,9	23,2	60	250	20,9	22,1	23,4	7	25
C24	22,7	23,9	25,5	60	250	22,9	24,1	25,7	7	25
	at $I_Z = 0,1$ mA			at $I_Z = 0,5$ mA		at $I_Z = 10$ mA			at $I_Z = 10$ mA	
	min.	nom.	max.	typ.	max.	min.	nom.	max.	typ.	max.
C27	25,0	26,9	28,9	65	300	25,2	27,1	29,3	10	45
C30	27,8	29,9	32,0	70	300	28,1	30,1	32,4	15	50
C33	30,8	32,9	35,0	75	325	31,1	33,1	35,4	20	55
C36	33,8	35,9	38,0	80	350	34,1	36,1	38,4	25	60
C39	36,7	38,9	41,0	80	350	37,1	39,1	41,5	25	70
C43	39,7	42,9	46,0	85	375	40,1	43,1	46,5	25	80
C47	43,7	46,8	50,0	85	375	44,1	47,1	50,5	30	90
C51	47,6	50,8	54,0	90	400	48,1	51,1	54,6	35	100
C56	51,5	55,7	60,0	100	425	52,1	56,1	60,8	45	110
C62	57,4	61,7	66,0	120	450	58,2	62,1	67,0	60	120
C68	63,4	67,7	72,0	150	475	64,2	68,2	73,2	75	130
C75	69,4	74,7	79,0	170	500	70,3	75,3	80,2	90	140



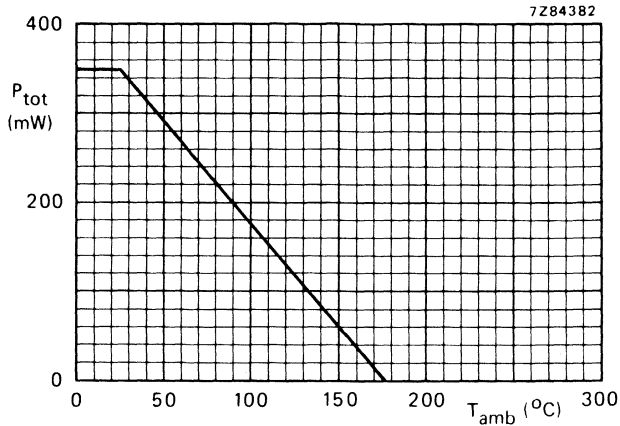


Fig. 2 Power derating curve.

**Model for calculating the static working voltage ( $V_Z$  stat).**

This model can be derived from  $V_Z$  stat =  $V_Z$  dyn +  $\Delta V_Z$  of which  $V_Z$  dyn is given in the tables on pages 3 and 4 and can be derived from the typical dynamic characteristic curves on pages 6 and 7.

$\Delta V_Z = \Delta T \times S_Z$ . For  $S_Z$  see tables and graphs  $S_Z$  versus  $T_j$ .

$\Delta T = P_{tot} \times R_{th\ j-a} = I_Z \times V_Z$  dyn  $\times R_{th\ j-a}$ .

Following  $\Delta V_Z = I_Z \times V_Z$  dyn  $\times R_{th\ j-a} \times S_Z$  and the model will be:

$$V_Z \text{ stat} = V_Z \text{ dyn} + I_Z \times V_Z \text{ dyn} \times R_{th\ j-a} \times S_Z$$

**Calculating example**

BZX84-C24 mounted on a ceramic substrate of 7 x 5 x 0,6 mm; at  $I_Z = 7$  mA.

$$V_Z \text{ stat} = 24 + \left( \frac{7}{1000} \times 24 \times \frac{430}{1000} \times 20,3 \right)$$

$$= 24 + 1,47 = 25,47 \text{ V.}$$



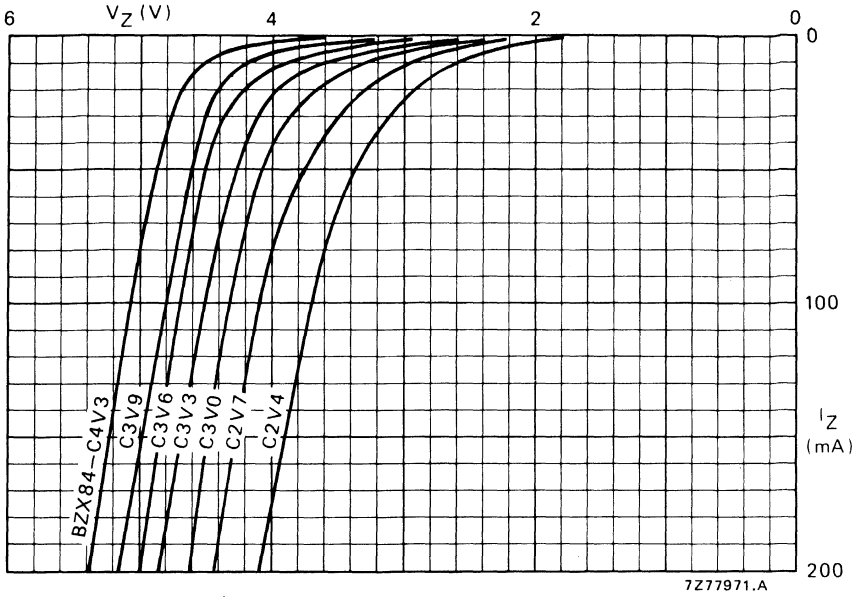


Fig. 3 Dynamic characteristics; typical values;  $T_j = 25^\circ\text{C}$ .

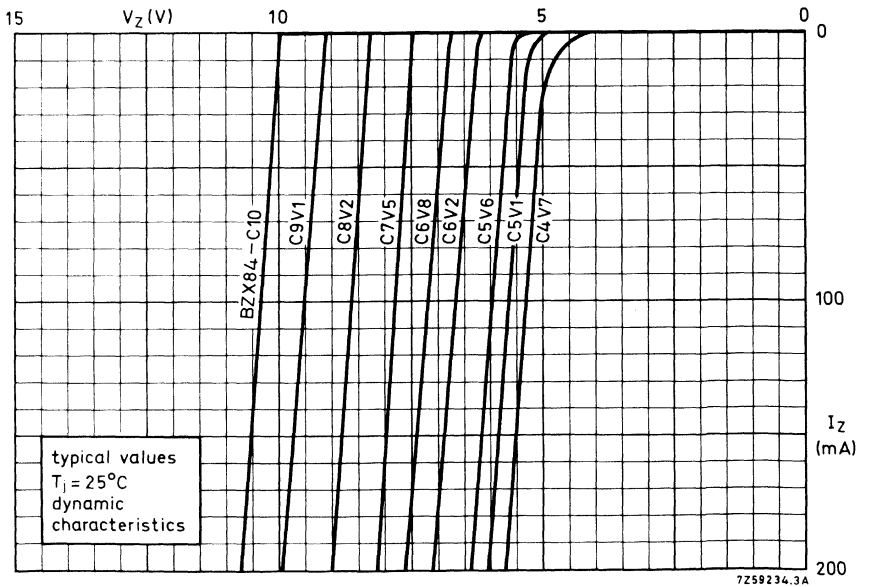


Fig. 4 Dynamic characteristics; typical values;  $T_j = 25^\circ\text{C}$ .

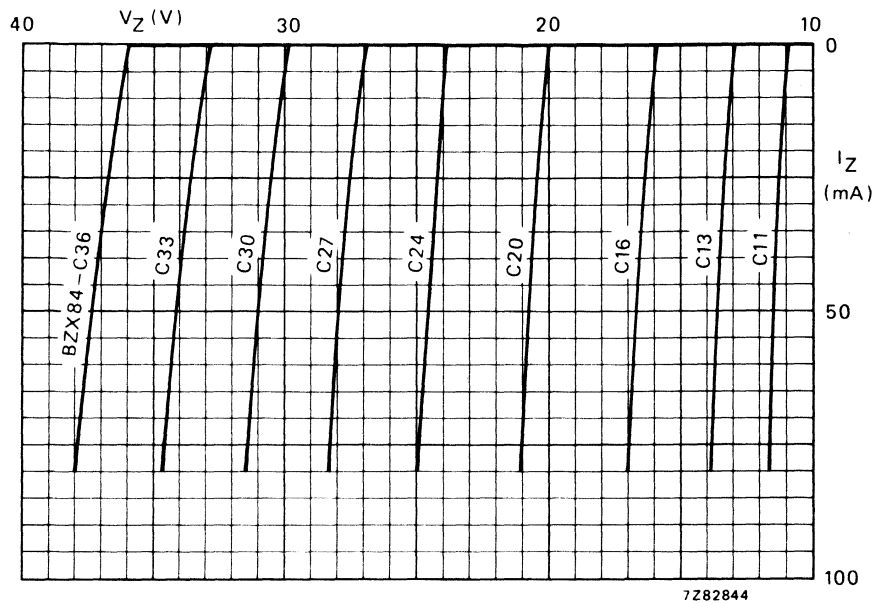


Fig. 5 Dynamic characteristics; typical values;  $T_j = 25^\circ\text{C}$ .

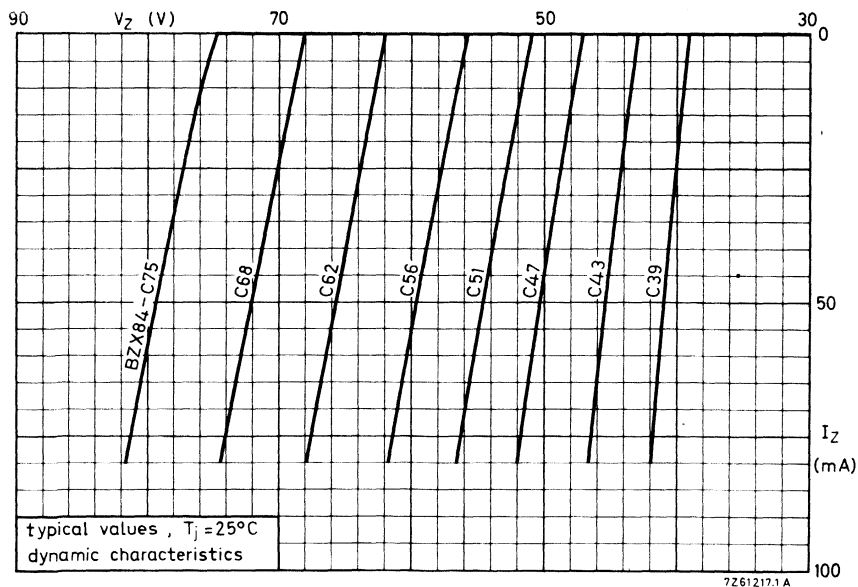


Fig. 6 Dynamic characteristics; typical values;  $T_j = 25^\circ\text{C}$ .

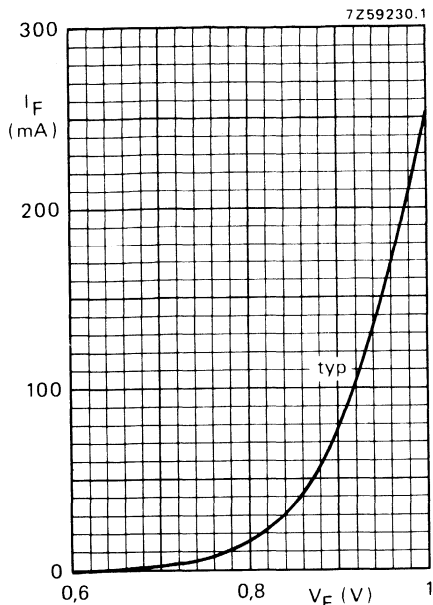


Fig. 7 Typical values at  $T_j = 25^\circ\text{C}$ .

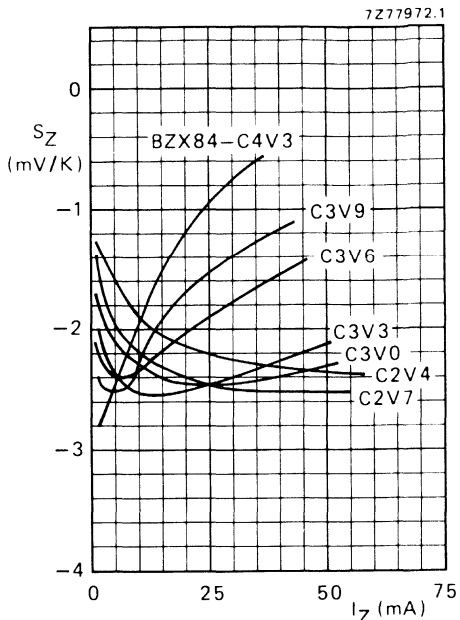


Fig. 8 Typical values;  $T_j = 25$  to  $175^\circ\text{C}$ .

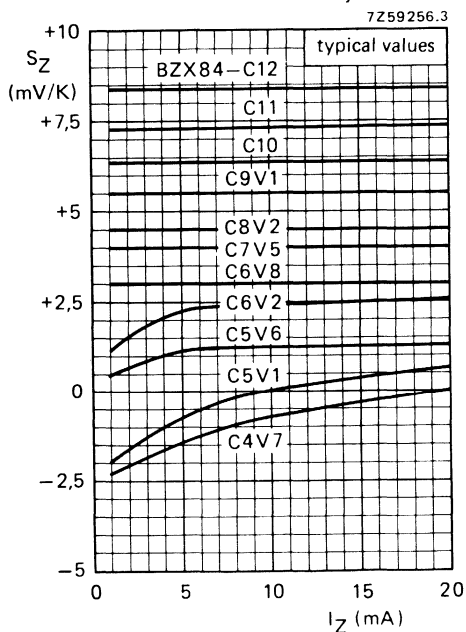


Fig. 9 Typical values;  $T_j = 25$  to  $175^\circ\text{C}$ .

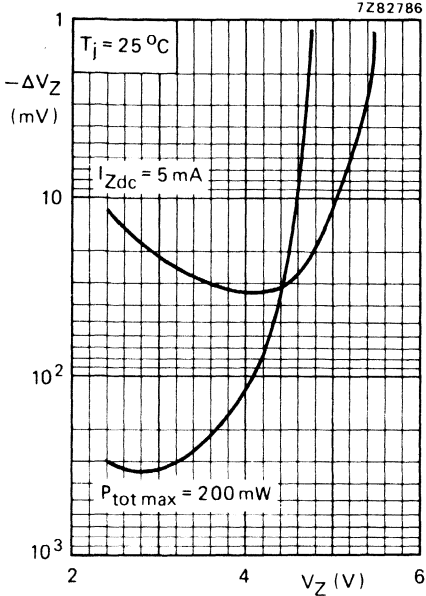


Fig. 10.

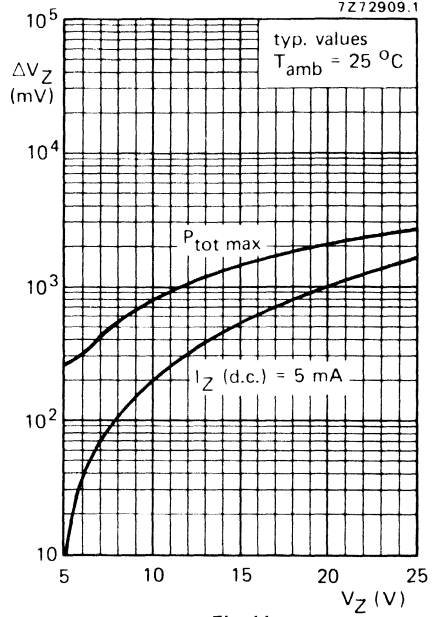


Fig. 11.

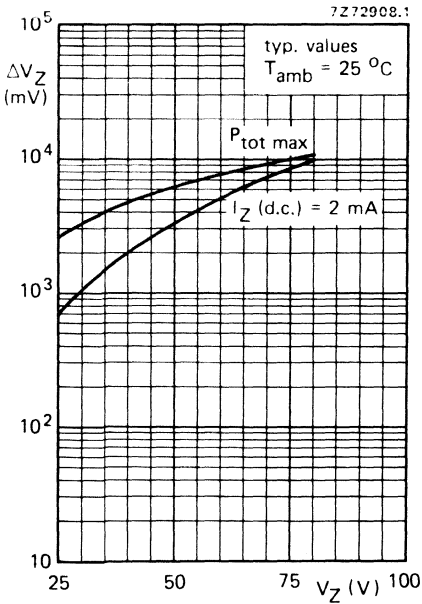


Fig. 12.



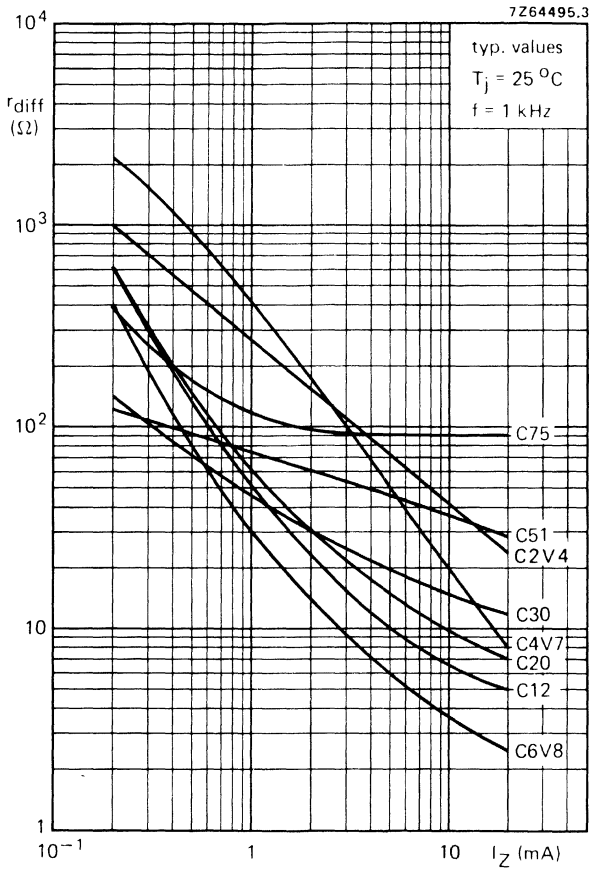


Fig. 13.



NOTES



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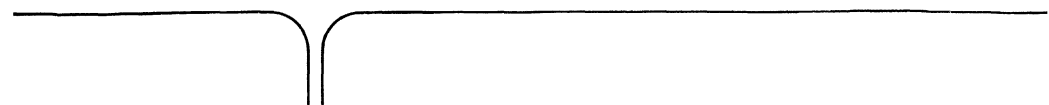




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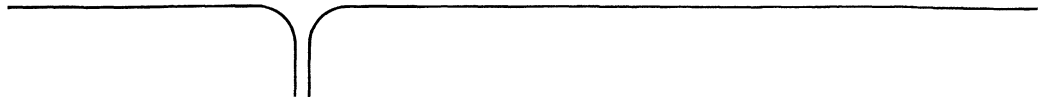
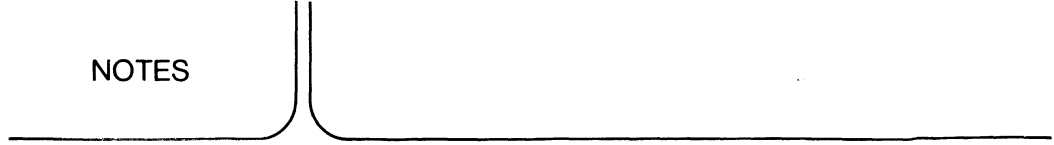


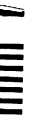
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# MICROMINIATURE SEMICONDUCTORS FOR HYBRID CIRCUITS




SELECTION GUIDE



TYPE NUMBER SURVEY



GENERAL



SOLDERING RECOMMENDATIONS  
THERMAL CHARACTERISTICS



DEVICE DATA