PHILIPS

Data handbook

PHILIPS Electronic components and materials

Semiconductors

Part 7 December 1980

Microminiature semiconductors

for hybrid circuits

SEMICONDUCTORS

PART 7 - DECEMBER 1980

MICROMINIATURE SEMICONDUCTORS FOR HYBRID CIRCUITS

DATA HANDBOOK SYSTEM

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

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

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

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

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

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.

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

Part 1	**May 1980**	**IC1 05-80** **(SC5b 03-77)**	**Bipolar ICs for radio and audio equipment**
Part 2	**May 1980**	**IC2 05-80** **(SC5b 03-77)**	**Bipolar ICs for video equipment**
Part 5a	**November 1976**	**SC5a 11-76**	**Professional analogue integrated circuits**
Part 4	**October 1980**	**IC4 10-80** **(SC6 10-77)**	**Digital integrated circuits** LOCMOS HE4000B family
Part 6b	**August 1979**	**SC6b 08-79**	**ICs for digital systems in radio and television receivers**
Signetics integrated circuits			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**	**Assemblies for industrial use** 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**	**FM tuners, television tuners, surface acoustic wave filters**
Part 3b	**October 1978**	**CM3b 10-78**	**Loudspeakers**
Part 4a	**November 1978**	**CM4a 11-78**	**Soft Ferrites** Ferrites for radio, audio and television, beads and chokes, Ferroxcube potcores and square cores, Ferroxcube transformer cores
Part 4b	**February 1979**	**CM4b 02-79**	**Piezoelectric ceramics, permanent magnet materials**
Part 6	**April 1977**	**CM6 04-77**	**Electric motors and accessories** Small synchronous motors, stepper motors, miniature direct current motors
Part 7a	**January 1979**	**CM7a 01-79**	**Assemblies** Circuit blocks 40-series and CSA70 (L), counter modules 50-series, input/output devices
Part 8	**June 1979**	**CM8 06-79**	**Variable mains transformers**
Part 9	**August 1979**	**CM9 08-79**	**Piezoelectric quartz devices** Quartz crystal units, temperature compensated crystal oscillators
Part 10	**October 1980**	**C10 10-80**	**Connectors**
Part 11	**December 1979**	**CM11 12-79**	**Non-linear resistors** 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**	**Variable resistors and test switches**
Part 13	**December 1979**	**CM13 12-79**	**Fixed resistors**
Part 14	**April 1980**	**C14 04-80** **(CM2b 02-78)**	**Electrolytic and solid capacitors**
Part 15	**May 1980**	**C15 05-80** **(CM2b 02-78)**	**Film capacitors, ceramic capacitors, variable capacitors**

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.

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

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

P = Low-frequency power transistors

Sm = Small-signal transistors

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

* = 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

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

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 V_{CBO} V	V_{CEO} V	I_C mA	P_{tot} mW	h_{FE} min./max.	at I_C/V_{CE} mA/V	V_{CEsat} max. V	at I_C/I_B mA	f_T typ. MHz
P-N-P									
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				
N-P-N									
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 (*).

HIGH-FREQUENCY TRANSISTORS in SOT-23

type	RATINGS V_{CBO} V	V_{CEO} V	I_C mA	P_{tot} mW	h_{FE} min./max.	at I_C/V_{CE} mA/V	F typ. dB	at f MHz	f_T typ. MHz	C_{re} typ. pF
P-N-P										
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
N-P-N										
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 V_{CBO} V	V_{CEO} V	I_C mA	P_{tot} mW	h_{FE} min./max.	at I_C/V_{CE} mA/V	d_{im} typ. dB	at f MHz	f_T typ. GHz	C_{re} typ. pF
P-N-P										
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
N-P-N										
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

P-N-P-N	
BRY61	V_{GA} max. 70 V; I_A max. 175 mA; I_P = 5/1 μA; I_V = 30/50 μA

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

SWITCHING TRANSISTORS in SOT-23/SOT-89*

type	RATINGS V_{CBO} V	V_{CEO} V	I_C mA	P_{tot} mW	h_{FE} min./max.	at I_C/V_{CE} mA/V	V_{CEsat} max. V	at I_C/I_B mA/mA	t (max.) on/off ns	at I_C/I_B mA
P-N-P										
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	–	–
N-P-N										
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 $\pm V_{DS}$ V	$-V_{GSO}$ V	I_D mA	P_{tot} mW	$-I_{GSS}$ max. nA	I_{DSS} min./max. mA	$-V_{(P)GS}$ max. V	$\lvert y_{fs} \rvert$ min. mA/V	C_{rs} max. pF	V_n max. µF
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 (*).

VIDEO OUTPUT TRANSISTORS (SOT-89)

type	RATINGS V_{CBO} V	V_{CEO} V	I_C mA	P_{tot} mW	h_{FE} min./max.	at I_C/V_{CE} mA/V	V_{CEK} typ. V	at I_C mA	f_T min. MHz
P-N-P									
BF623	250	250	20	1000	50/–	25/20	20	25	60
N-P-N									
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	RATINGS V_{CBO} V	V_{CEO} V	I_C mA	P_{tot} mW	h_{FE} min./max.	at I_C/V_{CE} mA/V	V_{CEsat} max. V	at I_C/I_B mA	f_T typ. MHz
P-N-P									
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
N-P-N									
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 V_R V	I_F mA	t_{rr} max. ns	V_F max. (mV) at I_F = mA 10/100-150	C_d max. pF
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	r_D
	V	mA	nA	V	pF	V	typ.	Ω
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}	I_{ZRM}	I_{FRM}	V_F at I_F	
			%	mW	mA	mA	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

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	mark	reverse type mark	device type	SOT-23	SOT-89	nearest conventional type(s)	complement
BCW71;R	K1	K4	NPN	●		BC107A/BC547A	BCW69;R
BCW72;R	K2	K5	NPN	●		BC107B/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	●		BC107/BC547	
BCX70H	AH		NPN	●		BC107/BC547	
BCX70J	AJ		NPN	●		BC107/BC547	
BCX70K	AK		NPN	●		BC107/BC547	
BCX71G	BG		PNP	●		BC177/BC557	
BCX71H	BH		PNP	●		BC177/BC557	
BCX71J	BJ		PNP	●		BC177/BC557	
BCX71K	BK		PNP	●		BC177/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	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 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

mark	type no.
R4	BFR93R
R5	
R6	
R7	
R8	
R9	
S1	BBY31
S2	BBY40
S3	
S4	
S5	
S6	BF510
S7	BF511
S8	BF512
S9	BF513
T1	BCX17
T2	BCX18
T3	BSS63
T4	BCX17R
T5	BCX18R
T6	BSS63R
T7	BSR15
T71	BSR15R
T8	BSR16
T81	BSR16R
T9	
U1	BCX19
U2	BCX20
U3	BSS64
U4	BCX19R
U5	BCX20R
U6	BSS64R
U7	BSR13
U71	BSR13R
U8	BSR14
U81	BSR14R
U9	BSR17
U91	BSR17R
V1	BFT25
V2	
V3	
V4	BFT25R
V5	
V6	
V7	
V8	
V9	
W1	BFT92
W2	
W3	
W4	BFT92R
W5	
W6	
W7	
W8	
W9	
X1	BFT93
X2	
X3	
X4	BFT93R
X5	
X6	
X7	
X8	
X9	
Y1	BZX84-C11
Y2	-C12
Y3	-C13
Y4	-C15
Y5	-C16
Y6	BZX84-C18
Y7	-C20
Y8	-C22
Y9	-C24
Y10	-C27
Y11	BZX84-C30
Y12	-C33
Y13	-C36
Y14	-C39
Y15	-C43
Y16	BZX84-C47
Y17	-C51
Y18	-C56
Y19	-C62
Y20	-C68
Y21	BZX84-C75
Z1	-C4V7
Z2	-C5V1
Z3	-C5V6
Z4	-C6V2
Z5	BZX84-C6V8
Z6	-C7V5
Z7	-C8V2
Z8	-C9V1
Z9	-C10
Z11	BZX84-C2V4
Z12	-C2V7
Z13	-C3V0
Z14	-C3V3
Z15	-C3V6
Z16	BZX84-C3V9
Z17	-C4V3
Z18	
Z19	

SOT-89

mark	type no.
5Z1	BZX78-C5V1
5Z6	-C5V6
6Z2	-C6V2
6Z8	-C6V8
7Z5	-C7V5
8Z2	BZX78-C8V2
9Z1	-C9V1
10Z	-C10
11Z	-C11
12Z	-C12
13Z	BZX78-C13
15Z	-C15
16Z	-C16
18Z	-C18
20Z	-C20
22Z	BZX78-C22
24Z	-C24
27Z	-C27
30Z	-C30
33Z	-C33
36Z	BZX78-C36
39Z	-C39
43Z	-C43
47Z	-C47
51Z	-C51
56Z	BZX78-C56
62Z	-C62
68Z	-C68
75Z	-C75

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 ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
D. TRANSISTOR; power, audio frequency ($R_{th\ j\text{-}mb} \leqslant 15\ ^{o}C/W$)
E. DIODE; tunnel
F. TRANSISTOR; low power, high frequency ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
G. MULTIPLE OF DISSIMILAR DEVICES – MISCELLANEOUS; e.g. oscillator
H. DIODE; magnetic sensitive
L. TRANSISTOR; power, high frequency ($R_{th\ j\text{-}mb} \leqslant 15\ ^{o}C/W$)
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 ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
S. TRANSISTOR; low power, switching ($R_{th\ j\text{-}mb} > 15\ ^{o}C/W$)
T. CONTROL AND SWITCHING DEVICE; e.g. thyristor, power ($R_{th\ j\text{-}mb} \leqslant 15\ ^{o}C/W$)
U. TRANSISTOR; power, switching ($R_{th\ j\text{-}mb} \leqslant 15\ ^{o}C/W$)
X. DIODE: multiplier, e.g. varactor, step recovery
Y. DIODE; rectifying, booster
Z. DIODE; voltage reference or regulator (transient suppressor diode, with third letter W)

SERIAL NUMBER

Three figures, running from 100 to 999, for devices primarily intended for consumer equipment.
One letter (Z, Y, X, etc.) and two figures, running from 10 to 99, for devices primarily intended for industrial/professional equipment.
This letter has no fixed meaning except W, which is used for transient suppressor diodes.

VERSION LETTER

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

SUFFIX

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

1. VOLTAGE REFERENCE and VOLTAGE REGULATOR DIODES: *ONE LETTER and ONE NUMBER*
   The LETTER indicates the nominal tolerance of the Zener (regulation, working or reference) voltage
   A. 1% (according to IEC 63: series E96)
   B. 2% (according to IEC 63: series E48)
   C. 5% (according to IEC 63: series E24)
   D. 10% (according to IEC 63: series E12)
   E. 20% (according to IEC 63: series E6)
   The number denotes the typical operating (Zener) voltage related to the nominal current rating for the whole range.
   The letter 'V' is used instead of the decimal point.

2. TRANSIENT SUPPRESSOR DIODES: *ONE NUMBER*
   The NUMBER indicates the maximum recommended continuous reversed (stand-off) voltage V_R. The letter 'V' is used as above.

3. CONVENTIONAL and CONTROLLED AVALANCHE RECTIFIER DIODES and THYRISTORS: *ONE NUMBER*
   The NUMBER indicates the rated maximum repetitive peak reverse voltage (V_{RRM}) or the rated repetitive peak off-state voltage (V_{DRM}), whichever is the lower. Reversed polarity is indicated by letter R, immediately after the number.

4. RADIATION DETECTORS: *ONE NUMBER,* preceded by a hyphen (–)
   The NUMBER indicates the depletion layer in μm. The resolution is indicated by a version LETTER.

5. ARRAY OF RADIATION DETECTORS and GENERATORS: *ONE NUMBER,* preceded by a stroke (/).
   The NUMBER indicates how many basic devices are assembled into the array.

RATING SYSTEMS

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

DEFINITIONS OF TERMS USED

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

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

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

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

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

Note
Limiting conditions may be either maxima or minima.

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

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

ABSOLUTE MAXIMUM RATING SYSTEM

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

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

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

DESIGN MAXIMUM RATING SYSTEM

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

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

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

DESIGN CENTRE RATING SYSTEM

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

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

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

LETTER SYMBOLS FOR TRANSISTORS AND SIGNAL DIODES

based on IEC Publication 148

LETTER SYMBOLS FOR CURRENTS, VOLTAGES AND POWERS

Basic letters

The basic letters to be used are:

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

Lower-case basic letters shall be used for the representation of instantaneous values which vary with time.
In all other instances upper-case basic letters shall be used.

Subscripts

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

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

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

a) continuous (d.c.) values (without signal)

Example I_B

b) instantaneous total values

Example i_B

c) average total values

Example $I_{B(AV)}$

d) peak total values

Example I_{BM}

e) root-mean-square total values

Example $I_{B(RMS)}$

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

a) instantaneous values

Example i_b

b) root-mean-square values

Example $I_{b(rms)}$

c) peak values

Example I_{bm}

d) average values

Example $I_{b(av)}$

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

Additional rules for subscripts

Subscripts for currents

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

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

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

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

Subscripts for voltages

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

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

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

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

Subscripts for supply voltages or supply currents

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

Examples: V_{CC}, I_{EE}

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

Example : V_{CCE}

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

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

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

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

Subscripts for multiple devices

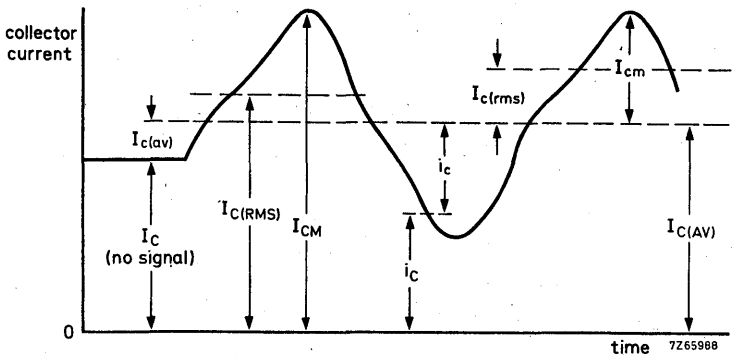
For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

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

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

Application of the rules

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



LETTER SYMBOLS FOR ELECTRICAL PARAMETERS

Definition

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

Basic letters

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

B, b = susceptance; imaginary part of an admittance

C = capacitance

G, g = conductance; real part of an admittance

H, h = hybrid parameter

L = inductance

R, r = resistance; real part of an impedance

X, x = reactance; imaginary part of an impedance

Y, y = admittance;

Z, z = impedance;

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

a) electrical parameters of external circuits and of circuits in which the device forms only a part;

b) all inductances and capacitances.

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

Subscripts

General subscripts

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

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

Examples: Z_S, h_f, h_F

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

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

R_E = d.c. value of the external emitter resistance.

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

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

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

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

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

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

Subscripts for four-pole matrix parameters

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

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

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

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

Distinction between real and imaginary parts

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

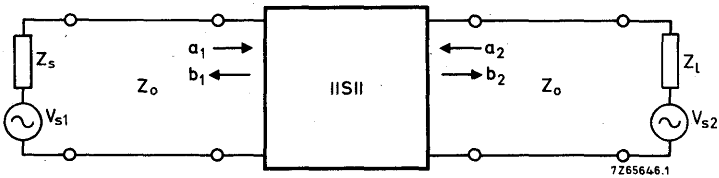
Examples: $Z_i = R_i + jX_i$
$y_{fe} = g_{fe} + jb_{fe}$

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

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

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.



$$a_1 = \frac{V_{i1}}{\sqrt{Z_o}} \qquad a_2 = \frac{V_{i2}}{\sqrt{Z_o}} \qquad ^{1)}$$

$$b_1 = \frac{V_{r1}}{\sqrt{Z_o}} \qquad b_2 = \frac{V_{r2}}{\sqrt{Z_o}}$$

Z_o = 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.

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 $Z_l = Z_o$ 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 $Z_s = Z_o$ 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 $Z_l = Z_o$ 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 $Z_s = Z_o$ 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 concentrally 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:

a. The temperature of the soldering bath should not exceed 280 °C.
b. The duration of the soldering cycle should not exceed 10 seconds.
c. 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.

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

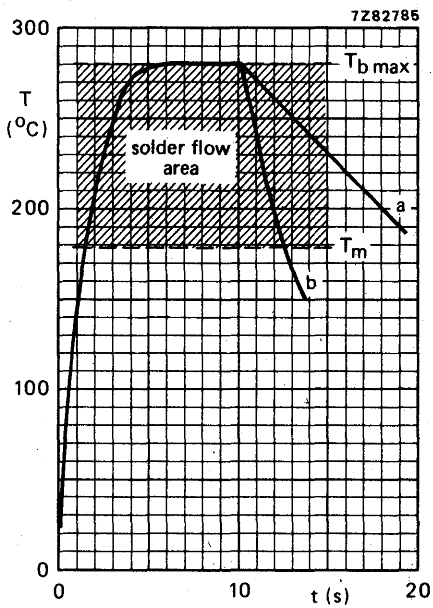


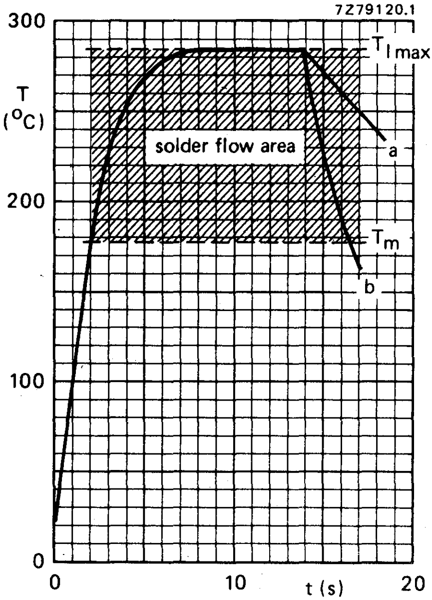
Fig. 1 Device temperature during *immersion* soldering.

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.

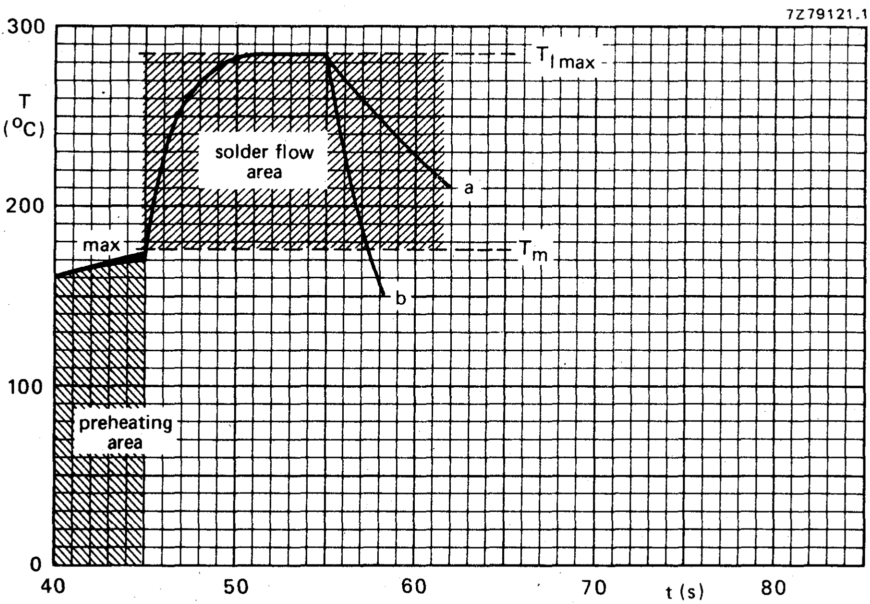


Fig. 3 Reflow soldering with preheating.

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

Dimensions in mm

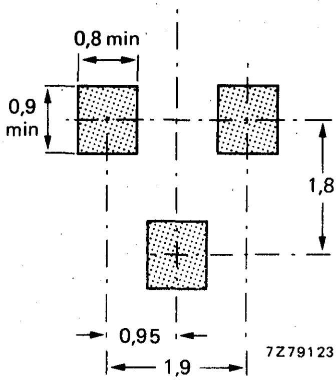


Fig. 4 SOT-23 pattern.

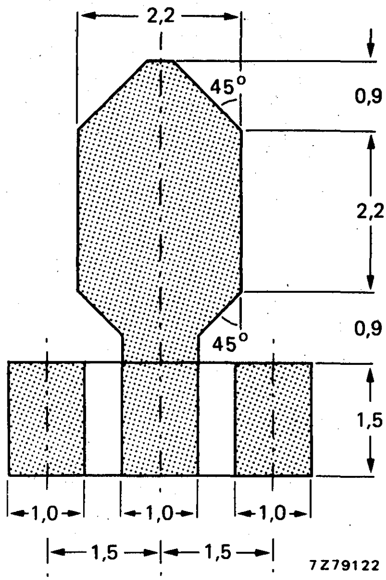


Fig. 5 SOT-89 pattern.

THERMAL CHARACTERISTICS OF SOT-23 ENVELOPES

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

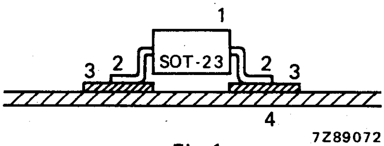


Fig. 1.

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).

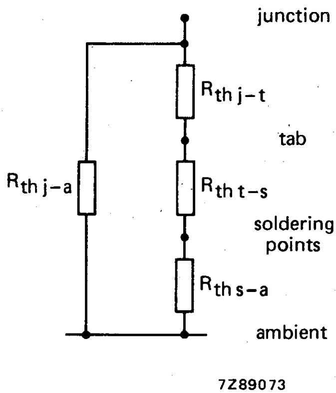


Fig. 2 Thermal behaviour of heat flow when the device is mounted on a substrate or printed circuit board.

$R_{th\ j\text{-}t}$ = Thermal resistance from junction to tab.

$R_{th\ t\text{-}s}$ = Thermal resistance from tab to soldering points.

$R_{th\ s\text{-}a}$ = Thermal resistance from soldering points to ambient.

$R_{th\ j\text{-}a}$ = 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.

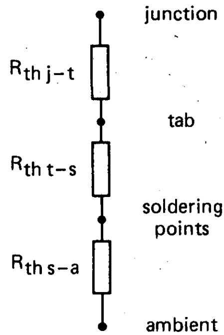


Fig. 3 Basic thermal model.

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.

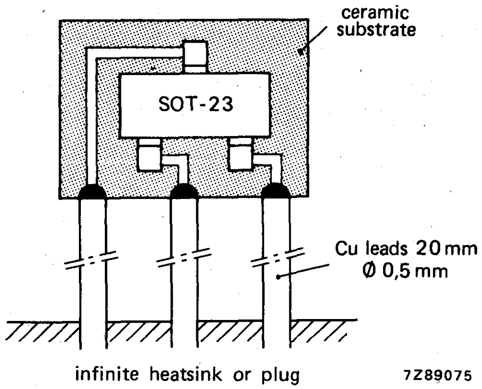


Fig. 4 Test circuit SOT-23 mounting conditions on a ceramic substrate.

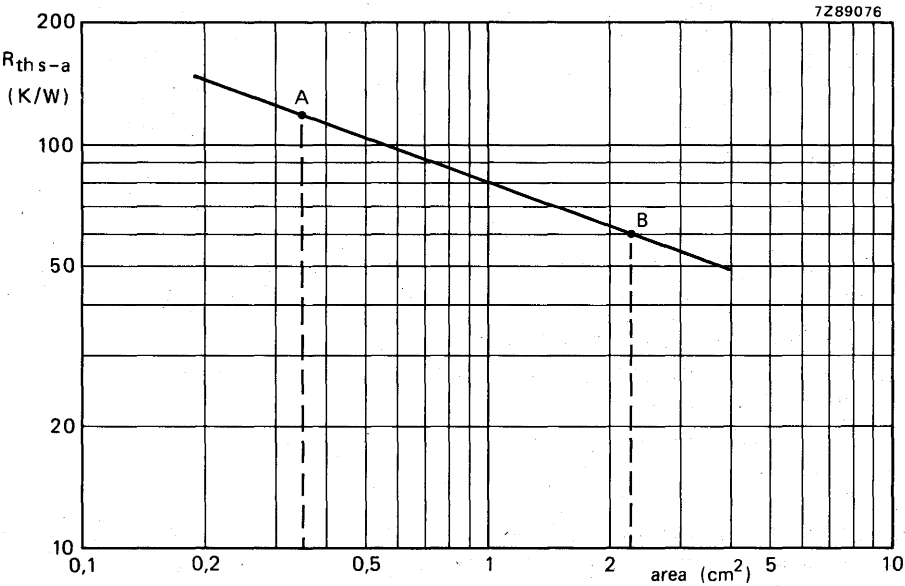


Fig. 5 Thermal resistance.

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:

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

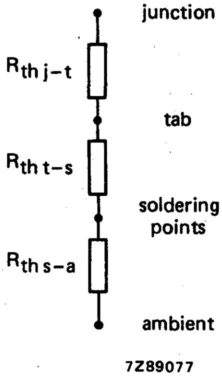


Fig. 6 Thermal model of SOT-23 envelopes with one crystal.

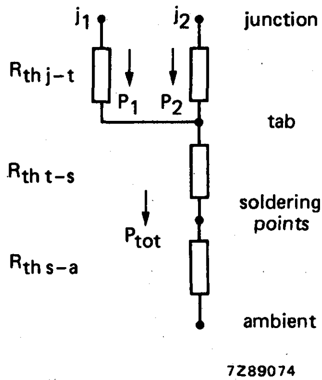


Fig. 7 Thermal model of SOT-23 envelopes with two crystals (double diode).

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

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

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

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

As mentioned on page 2:

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

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

$R_{th\ t\text{-}s}$ 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.

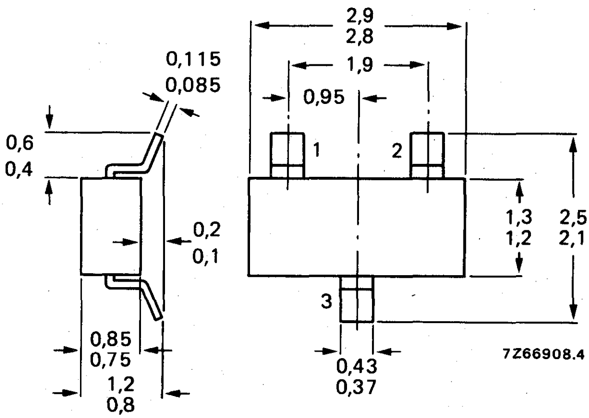
QUICK REFERENCE DATA

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 Ω; 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 Ω	Q_s	<	45	pC

MECHANICAL DATA

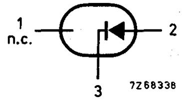
Dimensions in mm

Fig. 1 SOT-23.



Marking code

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 ▲ (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 *

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

Thermal resistance

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

CHARACTERISTICS

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 μA
V_R = 75 V	I_R	<	1 μA
V_R = 75 V; T_j = 150 °C	I_R	<	50 μA
Diode capacitance			
V_R = 0; f = 1 MHz	C_d	<	2 pF
Forward recovery voltage (see also Fig. 2) when switched to I_F = 10 mA; t_p = 20 ns	V_{fr}	<	1,75 V
Reverse recovery time (see also Fig. 3) when switched from I_F = 10 mA to I_R = 10 mA; R_L = 100 Ω; measured at I_R = 1 mA	t_{rr}	<	6 ns
Recovery charge (see also Fig. 4) when switched from I_F = 10 mA to V_R = 5 V; R_L = 500 Ω	Q_s	<	45 pC

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

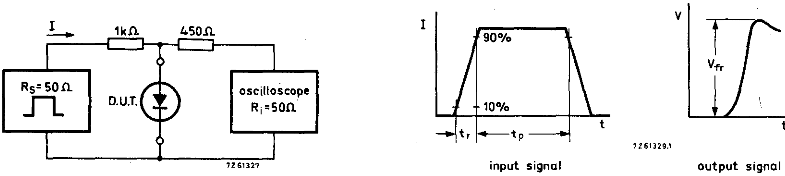


Fig. 2 Forward recovery voltage test circuit and waveforms.

Input signal: forward pulse rise time = t_r = 20 ns; forward current pulse duration t_p = 120 ns; duty factor = δ = 0,01.
Oscilloscope: rise time = t_r = 0,35 ns.
Circuit capacitance C ⩽ 1 pF (C = oscilloscope input capacitance + parasitic capacitance).

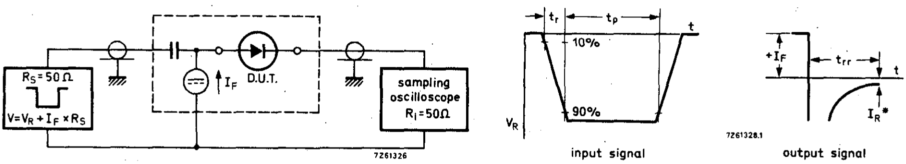


Fig. 3 Reverse recovery time test circuit and waveforms.

Input signal: reverse pulse rise time = t_r = 0,6 ns; reverse pulse duration = t_p = 100 ns; duty factor = δ = 0,05. * t_{rr} up to I_R = 1 mA.
Oscilloscope: rise time = t_r = 0,35 ns.
Circuit capacitance C ⩽ 1 pF (C = oscilloscope input capacitance + parasitic capacitance).

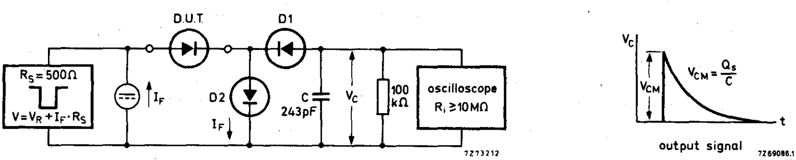


Fig. 4 Recovery charge test circuit and waveform.

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

Rise time of the reverse pulse	t_r	=	2 ns
Reverse pulse duration	t_p	=	400 ns
Duty factor	δ	=	0,02

Circuit capacitance C ⩽ 7 pF (C = oscilloscope input capacitance + parasitic capacitance).

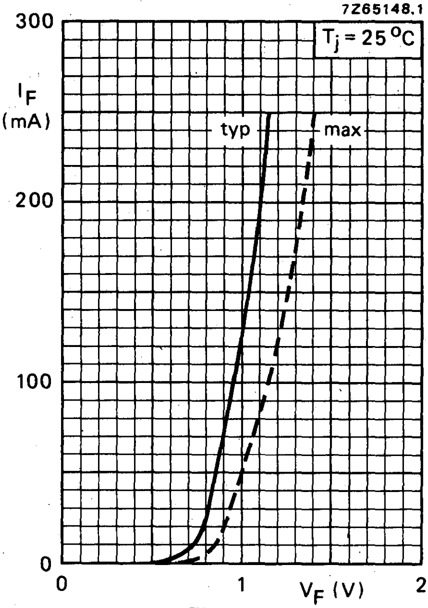


Fig. 5.

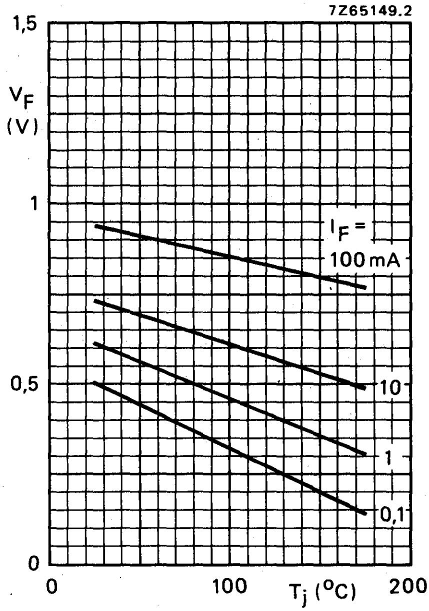


Fig. 6 Typical values.

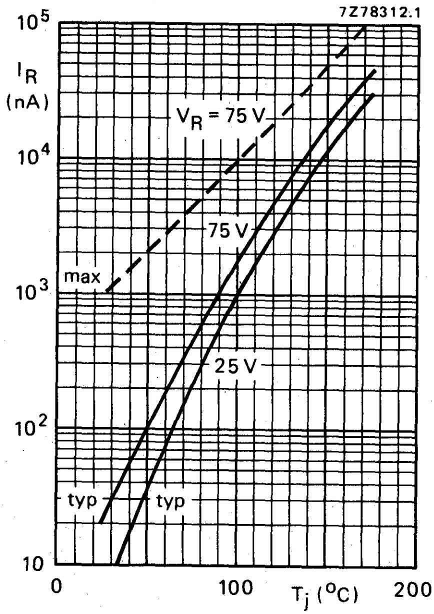


Fig. 7.

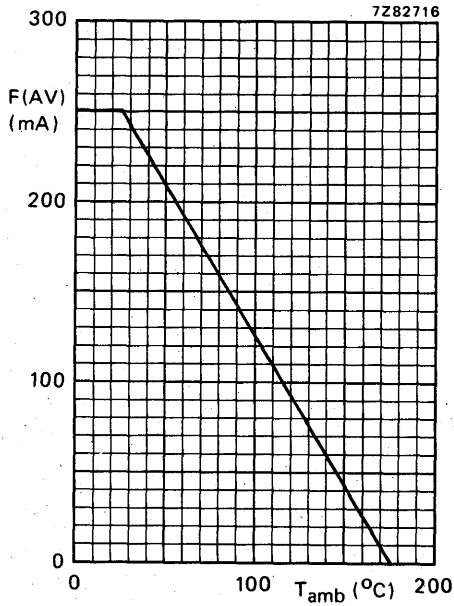


Fig. 8 Current derating curve.

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.

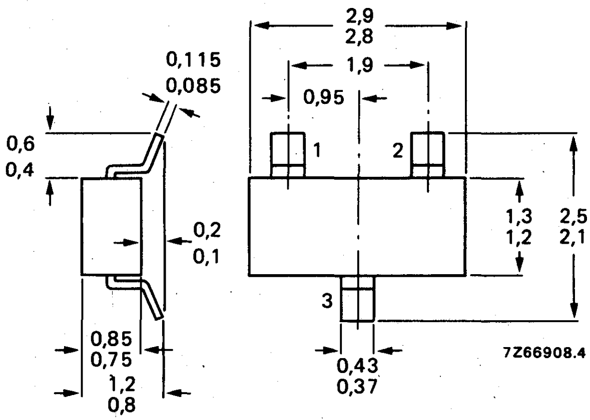
QUICK REFERENCE DATA

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	$R_{th\ j\text{-}a}$	=	0,62	K/mW
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 = 10 mA	V_F		750 to 830	mV
I_F = 100 mA	V_F		870 to 960	mV
Diode capacitance				
V_R = 0; f = 1 MHz	C_d	<	140	pF

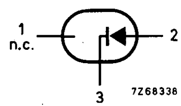
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.



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

CHARACTERISTICS

T_j = 25 °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	I_R	<	5	μA
Temperature coefficient I_F = 1 mA	S_F	typ.	−1,8	mV/K
Diode capacitance V_R = 0; f = 1 MHz	C_d	<	140	pF

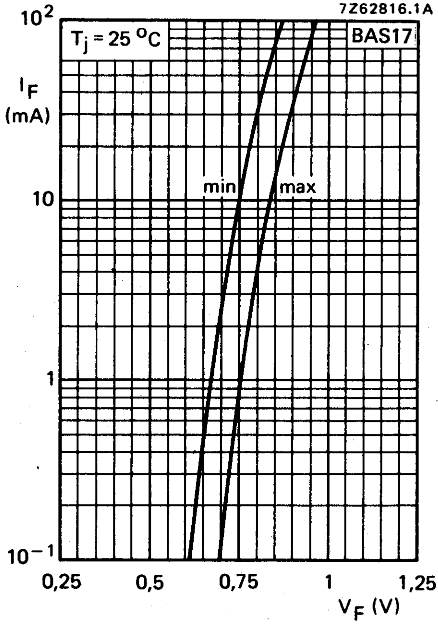


Fig. 2 Forward current as a function of forward voltage.

SILICON PLANAR EPITAXIAL HIGH-SPEED DIODES

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

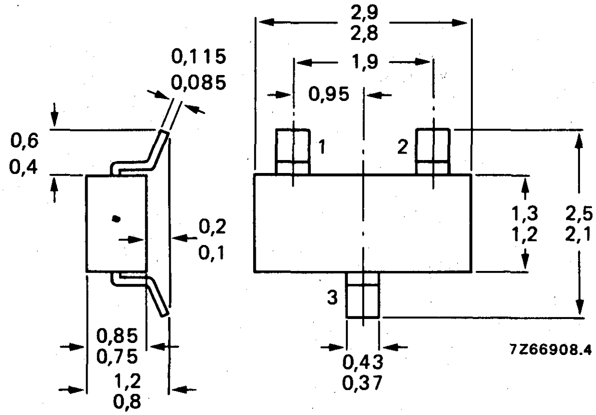
QUICK REFERENCE DATA

			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 Ω measured at I_R = 3 mA	t_{rr}	<		50		ns

MECHANICAL DATA

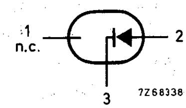
Dimensions in mm

Fig. 1 SOT-23.



Marking code

BAS19 = A8
BAS20 = A81
BAS21 = A82



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 °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	$R_{th\ j\text{-}a}$	=	0,62	°C/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Forward voltage				
I_F = 100 mA	V_F	<	1,0	V
I_F = 200 mA	V_F	<	1,25	V
Reverse breakdown voltage (1)				
BAS19; I_R = 100 μA	$V_{(BR)R}$	>	120	V
BAS20; I_R = 100 μA	$V_{(BR)R}$	>	200	V
BAS21; I_R = 100 μA (2)	$V_{(BR)R}$	>	250	V
Reverse current				
$V_R = V_{Rmax}$	I_R	<	100	nA
$V_R = V_{Rmax}$; T_j = 150 °C	I_R	<	100	μA
Differential resistance				
I_F = 10 mA	r_{diff}	typ.	5	Ω
Diode capacitance				
V_R = 0; f = 1 MHz	C_d	<	5	pF
Reverse recovery time (see Figs 2 and 3) when switched from I_F = 30 mA to I_R = 30 mA; R_L = 100 Ω; measured at I_R = 3 mA	t_{rr}	<	50	ns

(1) Measured under pulse conditions; Pulse time = $t_p \leq 0{,}3$ ms.
(2) At zero life time, measured under pulse conditions to avoid excessive dissipation and voltage limited to 275 V.

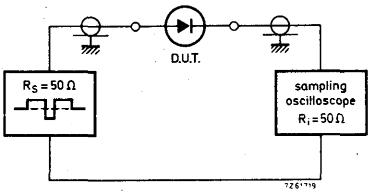


Fig. 2 Test circuit.

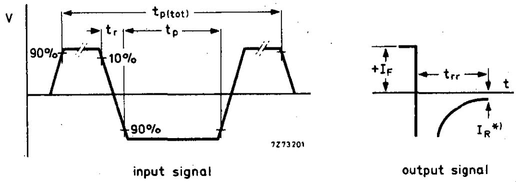


Fig. 3 Waveforms; I_R = 3 mA.

Input signal

total pulse duration	$t_{p(tot)}$	= 2 μs
duty factor	δ	= 0,0025
rise time of reverse pulse	t_r	= 0,6 ns
reverse pulse duration	t_p	= 100 ns

Oscilloscope

rise time	t_r	= 0,35 ns
circuit capacitance*	C	< 1 pF

*C = oscilloscope input capacitance + parasitic capacitance.

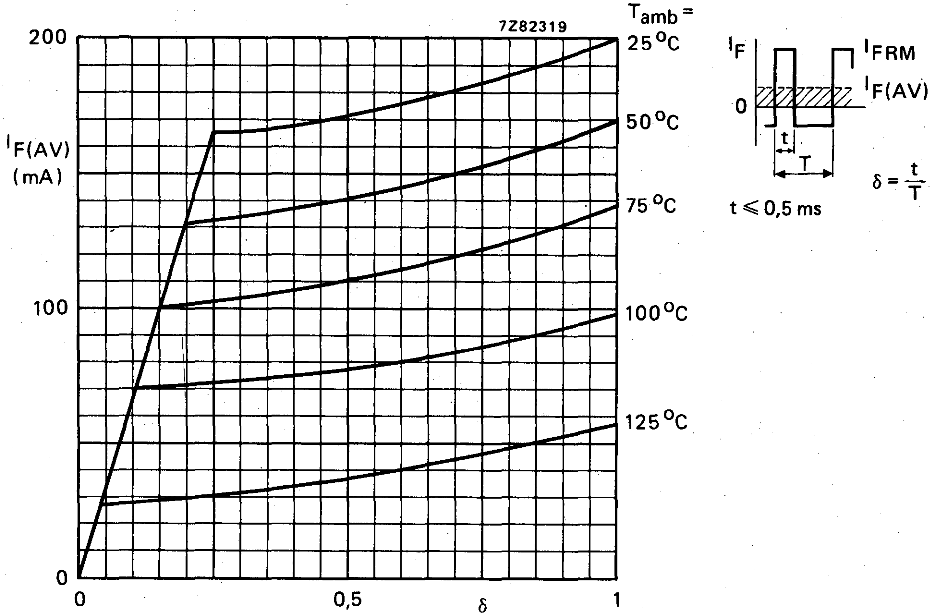


Fig. 4 BAS19; maximum permissible average rectified forward current for pulse operation as a function of the duty factor at V_R = 100 V.

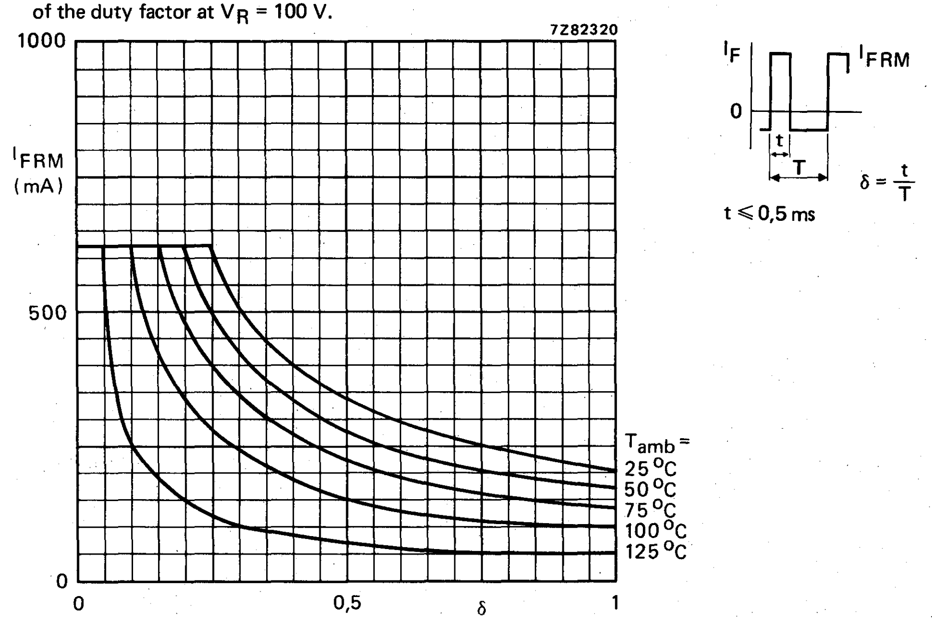
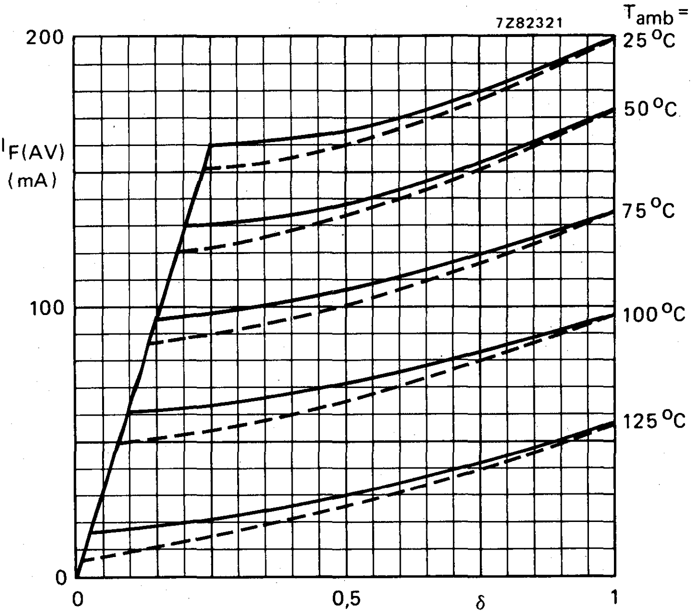


Fig. 5 BAS19; maximum permissible repetitive peak forward current for pulse operation as a function of the duty factor at V_R = 100 V.



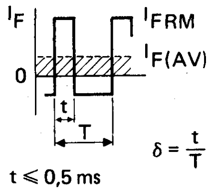
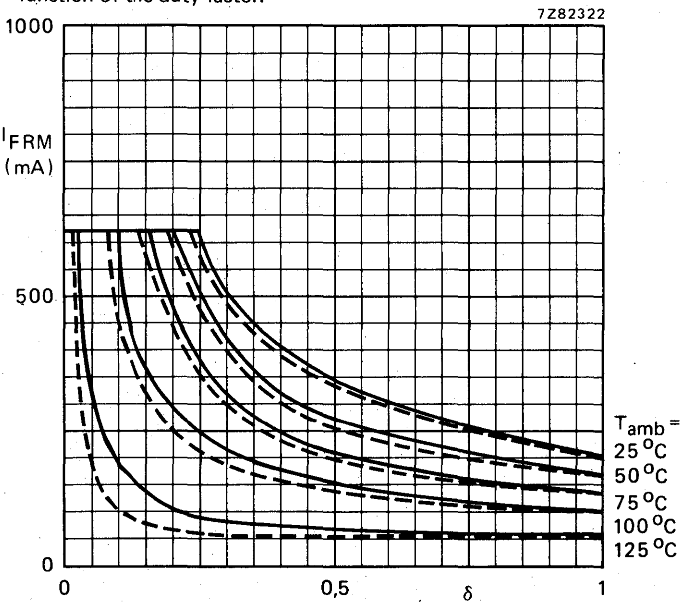


Fig. 6 BAS20/21; maximum permissible average rectified forward current for pulse operation as a function of the duty factor.



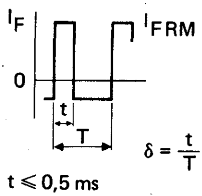


Fig. 7 BAS20/21; maximum permissible repetitive peak forward current for pulse operation as a function of the duty factor.

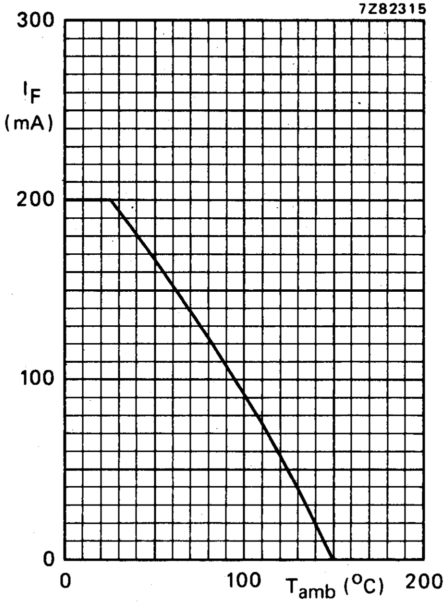


Fig. 8.

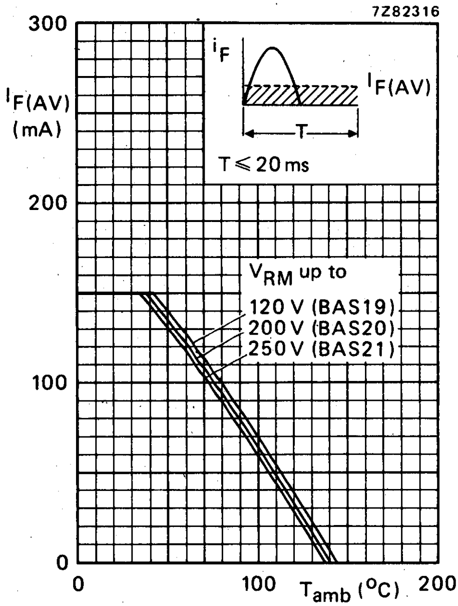


Fig. 9.

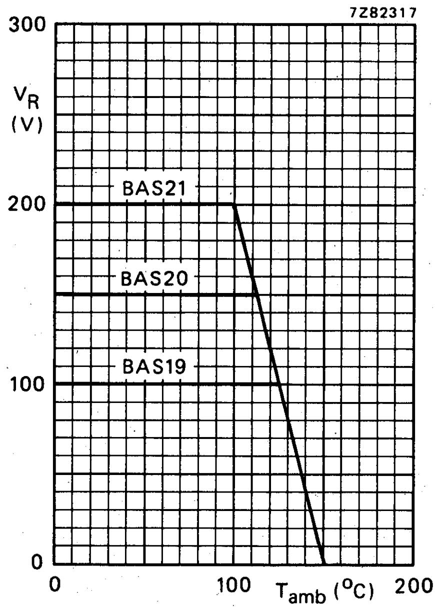


Fig. 10.

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.

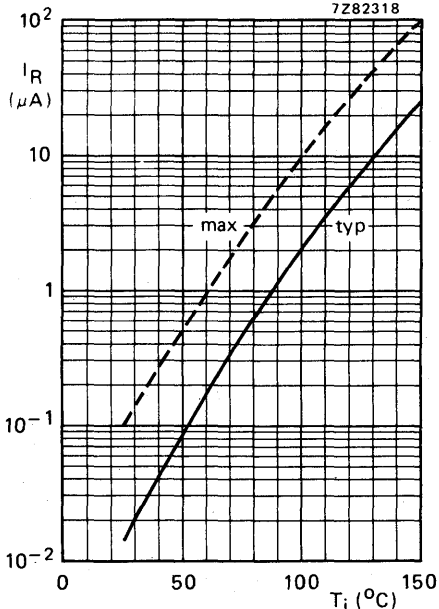


Fig. 11.

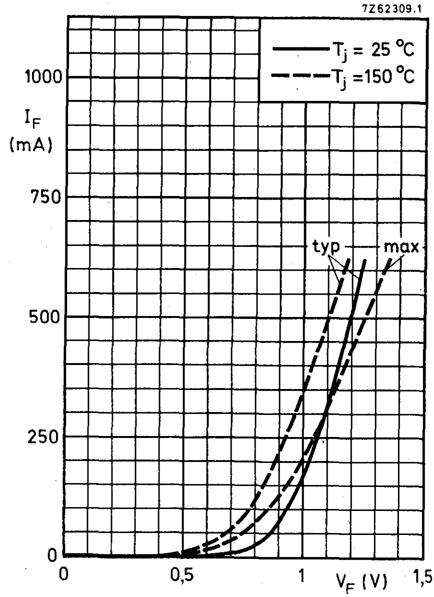


Fig. 12.

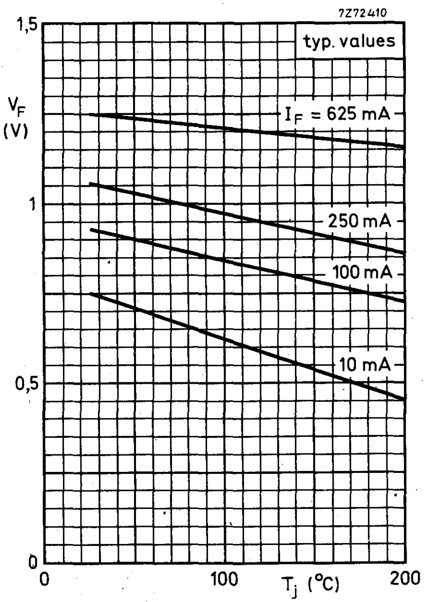


Fig. 13.

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.

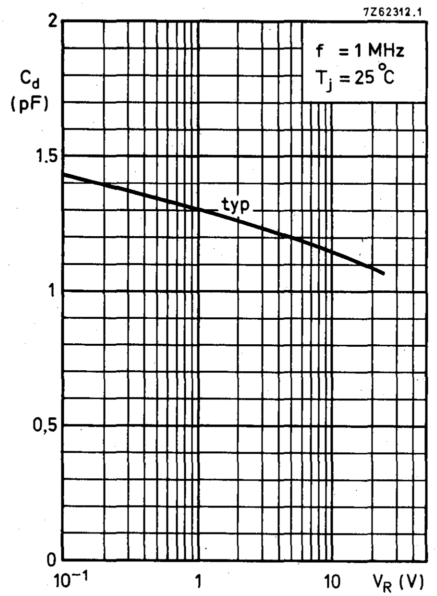

7Z62312.1
f = 1 MHz
T_j = 25 °C
C_d (pF)
2
1.5
1
0,5
0
typ
10^{-1}
1
10
V_R (V)

Fig. 14.

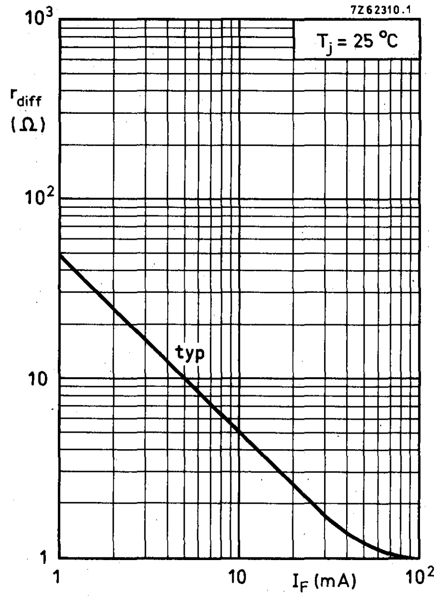

7Z62310.1
T_j = 25 °C
r_{diff} (Ω)
10^3
10^2
10
1
typ
1
10
I_F (mA)
10^2

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	^oC
Thermal resistance from junction to ambient	$R_{th\ j-a}$	=	0,62	$^oC/mW$
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

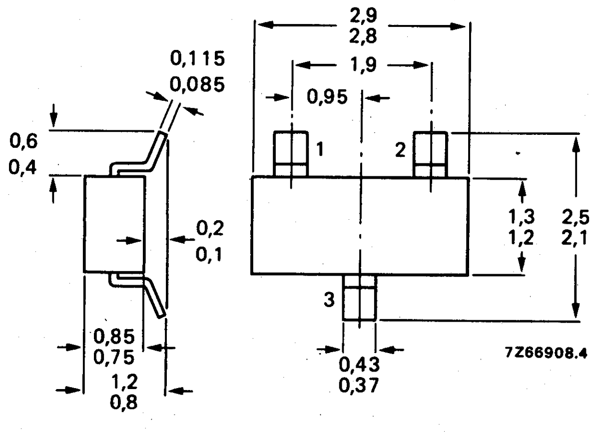
MECHANICAL DATA

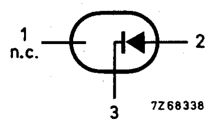
Dimensions in mm

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	$R_{th\ j-a}$	=	0,62 °C/mW

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Reverse current			
V_R = 3 V	I_R	<	0,25 μA
V_R = 3 V; T_{amb} = 60 °C	I_R	<	1,25 μA
Reverse breakdown voltage			
I_R = 10 μA	$V_{(BR)R}$	>	4 V
Forward voltage			
I_F = 0,1 mA	V_F	<	350 mV
I_F = 1,0 mA	V_F	<	450 mV
I_F = 10 mA	V_F	<	600 mV
Diode capacitance			
V_R = 0; f = 1 MHz	C_d	<	1,0 pF
Noise figure at f = 900 MHz *	F	<	8,0 dB
Series resistance at f = 1 kHz			
I_F = 5 mA	r_D	<	15 Ω

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

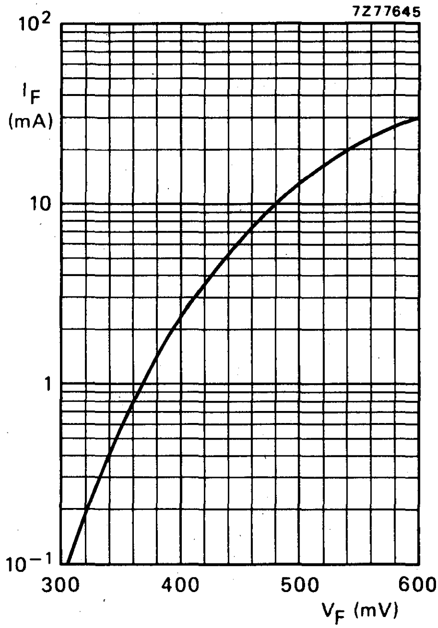


Fig. 2 Typical values.

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 1,0	pF pF
Series resistance at f = 200 MHz I_F = 5 mA	r_D	typ. <	0,5 0,7	Ω Ω

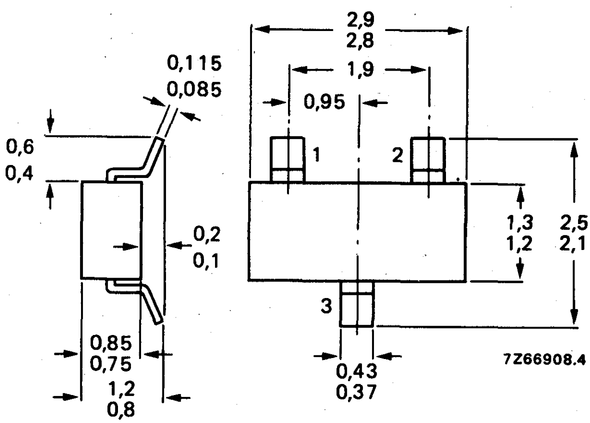
MECHANICAL DATA

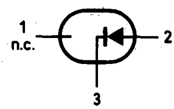
Dimensions in mm

Fig. 1 SOT-23.

Marking code

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	$R_{th\ j\text{-}a}$	=	0,62	°C/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 100 mA	V_F	<	1,2	V
Reverse current				
V_R = 20 V	I_R	<	100	nA
V_R = 20 V; T_j = 60 °C	I_R	<	1	μA
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	Ω
		<	0,7	Ω

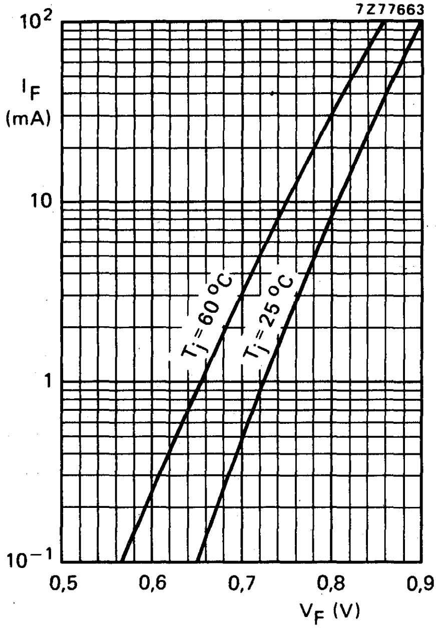


Fig. 2 Typical values.

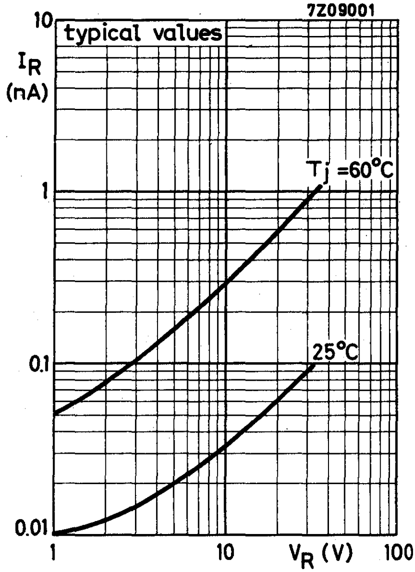


Fig. 3.

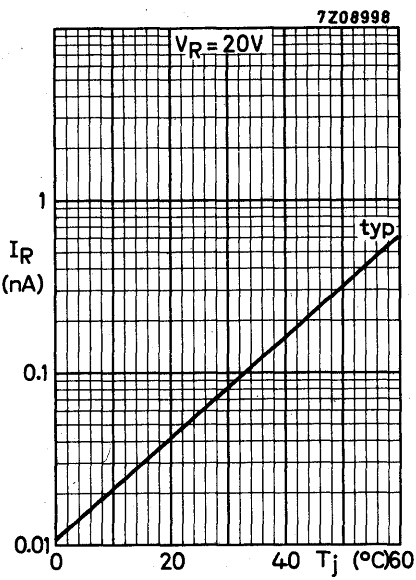


Fig. 4.

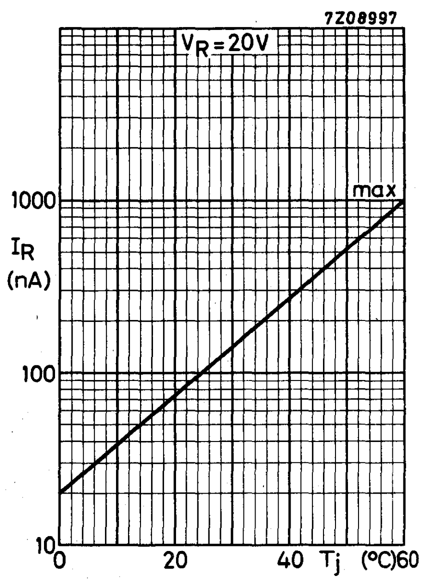


Fig. 5.

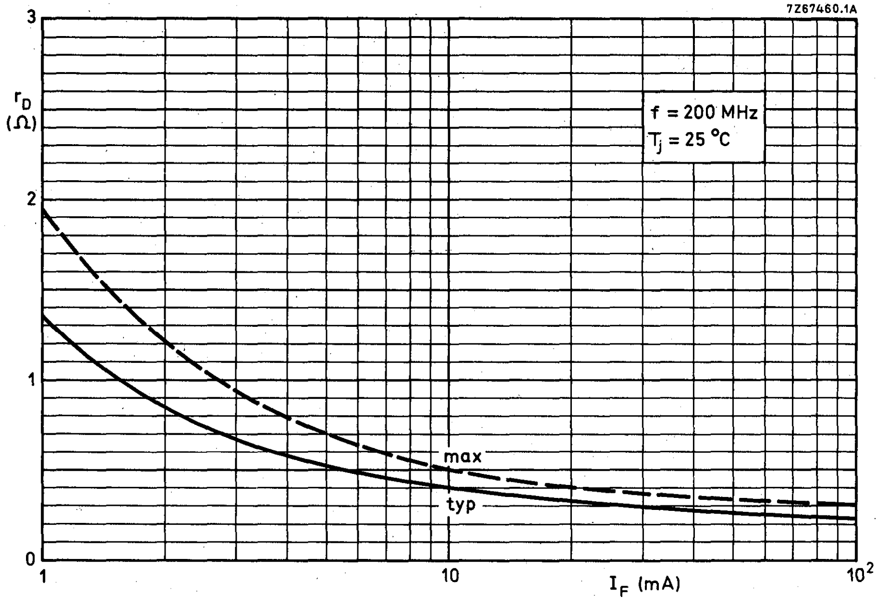


Fig. 6.

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)

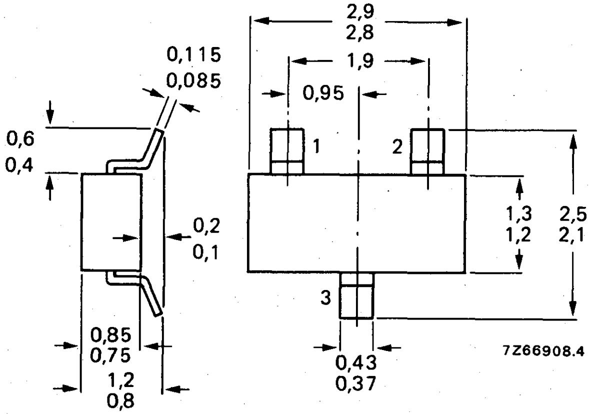
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward current	I_{FRM}	max.	250	mA
Junction temperature	T_j	max.	175	°C
Forward voltage at I_F = 50 mA	V_F	<	1,0	V
Reverse recovery time when switched from I_F = 10 mA to I_R = 10 mA; R_L = 100 Ω; 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 Ω	Q_s	<	45	pC

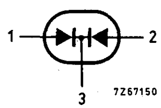
MECHANICAL DATA

Dimensions in mm

Marking code
BAV70 = A4

Fig. 1 SOT-23.





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▲ (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*

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

Thermal resistance

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

CHARACTERISTICS (per diode)

$T_j = 25\ ^oC$ 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; $T_j = 150\ ^oC$	I_R	<	60	µA
$V_R = 70$ V	I_R	<	5	µA
$V_R = 70$ V; $T_j = 150\ ^oC$	I_R	<	100	µA
Diode capacitance				
$V_R = 0$; f = 1 MHz	C_d	<	1,5	pF
Forward recovery voltage when switched to				
$I_F = 10$ mA; $t_r = 20$ ns	V_{fr}	<	1,75	V

▲ Measured under pulse conditions : pulse time $t_p \leqslant 0{,}5$ ms.
For sinusoidal operation $I_{F(AV)} = 150$ mA; averaging time $t_{(av)} \leqslant 1$ ms.

* See *Thermal characteristics* in chapter GENERAL.

**Mounted on a ceramic substrate of 7 mm x 5 mm x [illegible] mm.

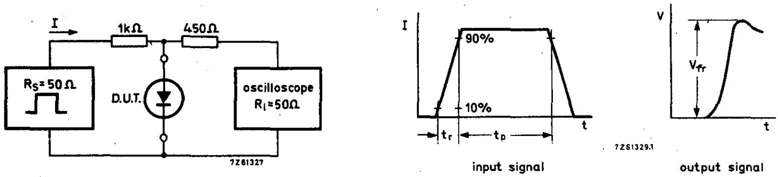


Fig. 2 Test circuit and waveforms; forward recovery voltage.

Input signal : Rise time of the forward pulse t_r = 20 ns; Forward current pulse duration t_p = 120 ns; Duty factor δ = 0,01

Oscilloscope : Rise time t_r = 0,35 ns

Circuit capacitance $C \leqslant 1$ 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 Ω;
measured at I_R = 1 mA — t_{rr} < 6 ns

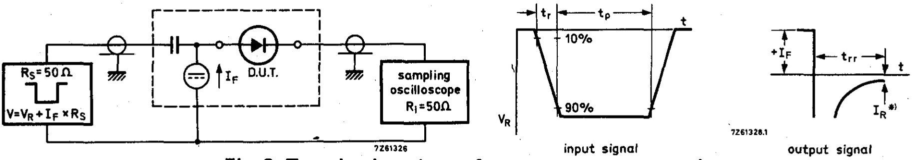


Fig. 3 Test circuit and waveforms; reverse recovery time.

*) I_R = 1 mA

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

Oscilloscope : Rise time t_r = 0,35 ns

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

Recovery charge when switched from
I_F = 10 mA to V_R = 5 V; R_L = 500 Ω — Q_s < 45 pC

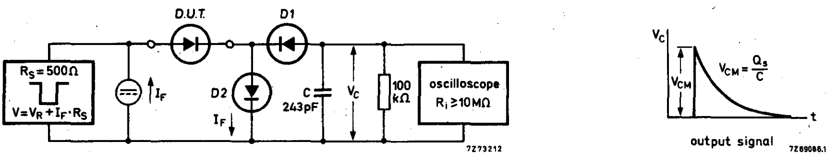


Fig. 4 Test circuit and waveform; recovery charge.

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 = δ = 0,02

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

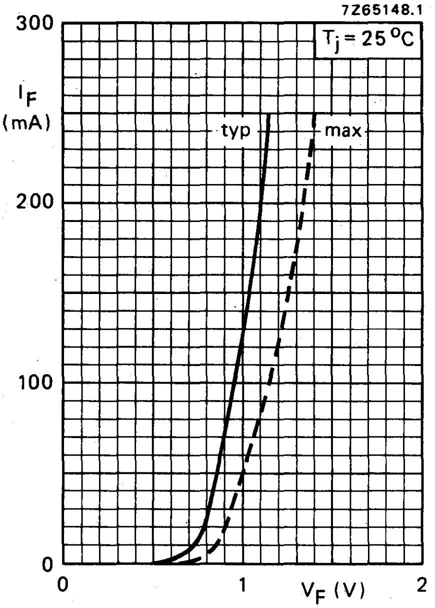


Fig. 5

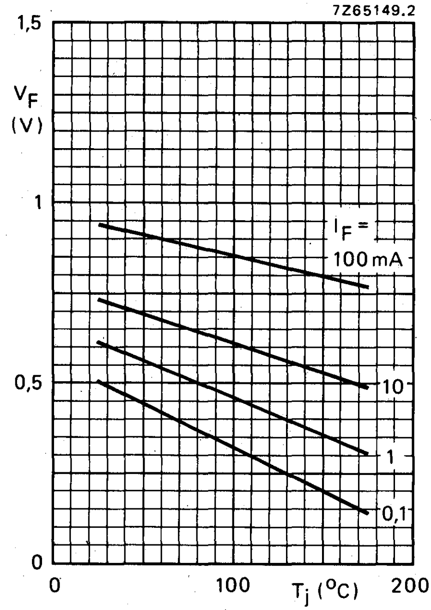


Fig. 6

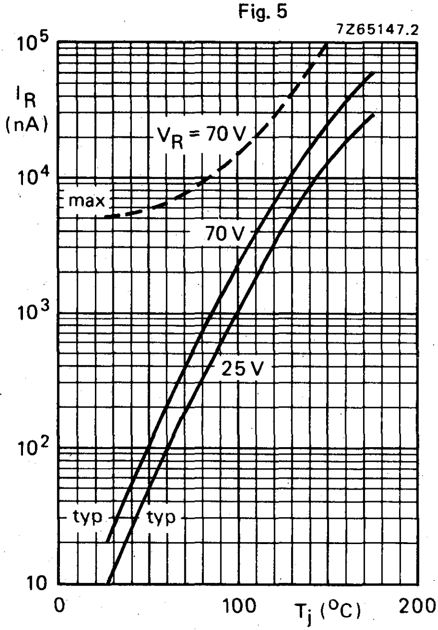


Fig. 7

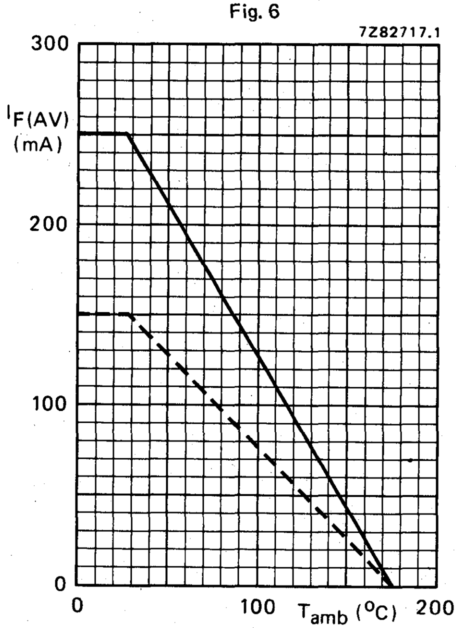


Fig. 8 ——— single diode
– – – – – double diode, equally loaded.

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)

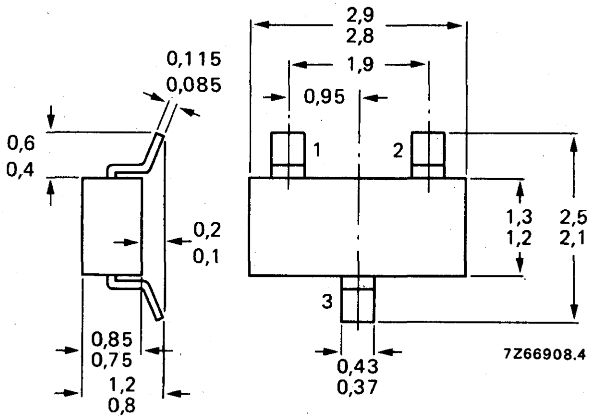
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward current	I_{FRM}	max.	250	mA
Junction temperature	T_j	max.	175	^oC ←
Forward voltage at I_F = 50 mA	V_F	<	1,0	V
Reverse recovery time when switched from I_F = 10 mA to I_R = 10 mA; R_L = 100 Ω; 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 Ω	Q_s	<	45	pC

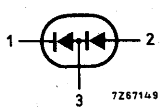
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.

Marking code
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 ▲ (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** *

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

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

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	50 K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260 K/W
From soldering points to ambient **	$R_{th\,s\text{-}a}$	=	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 µA
V_R = 70 V	I_R	<	2,5 µA
V_R = 70 V; T_j = 150 °C	I_R	<	50 µA
Diode capacitance			
V_R = 0; f = 1 MHz	C_d	<	1,5 pF
Forward recovery voltage when switched to			
I_F = 10 mA; t_r = 20 ns	V_{fr}	<	1,75 V

▲ 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

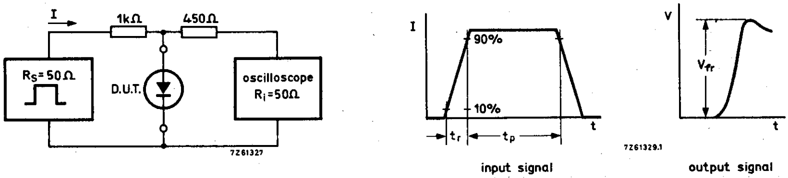


Fig. 2 Test circuit and waveforms; forward recovery voltage.

Input signal: Rise time of the forward pulse t_r = 20 ns;
Forward current pulse duration = t_p = 120 ns. Duty factor = δ = 0,01.
Oscilloscope: Rise time t_r = 0,35 ns.

Circuit capacitance C ⩽ 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 Ω; measured at I_R = 1 mA	t_{rr}	<	6 ns

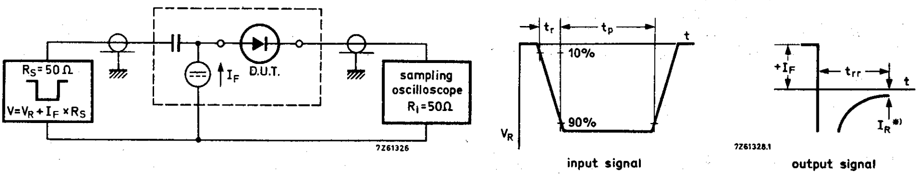


Fig. 3 Test circuit and waveforms; reverse recovery time.

Input signal: Rise time of the reverse pulse t_r = 0,6 ns
Reverse pulse duration t_p = 100 ns. Duty factor δ = 0,05.
Oscilloscope: Rise time t_r = 0,35 ns.

*) I_R = 1 mA

Circuit capacitance C ⩽ 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 Ω	Q_s	<	45 pC

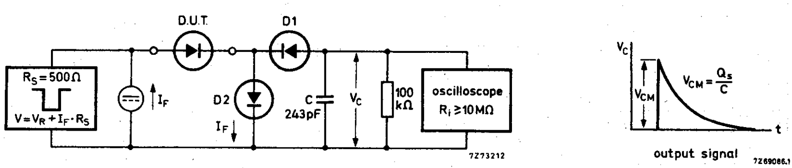


Fig. 4 Test and waveform; recovery charge.

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 δ = 0,02.

Citcuit capacitance C ⩽ 7 pF (C = oscilloscope input capacitance + parasitic capacitance).

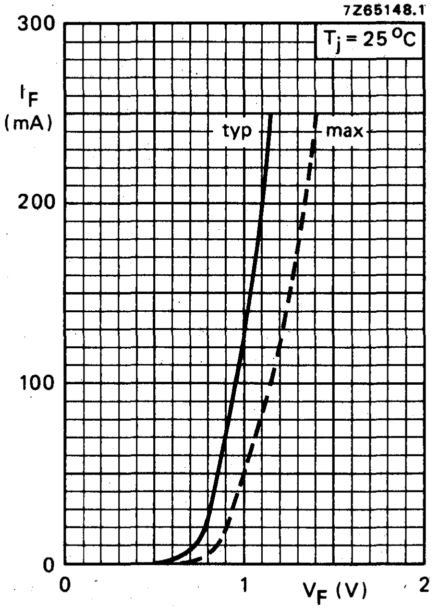


Fig. 5.

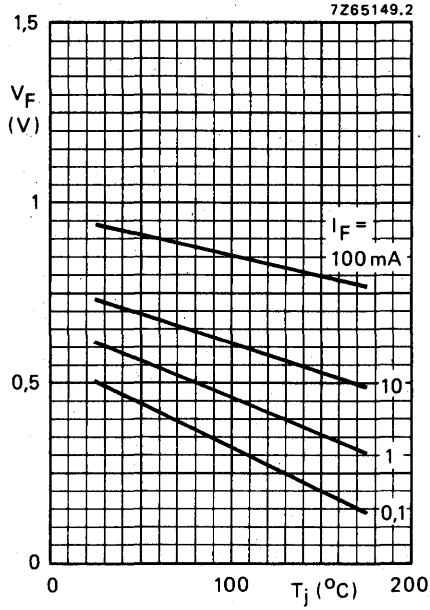


Fig. 6 Typical values.

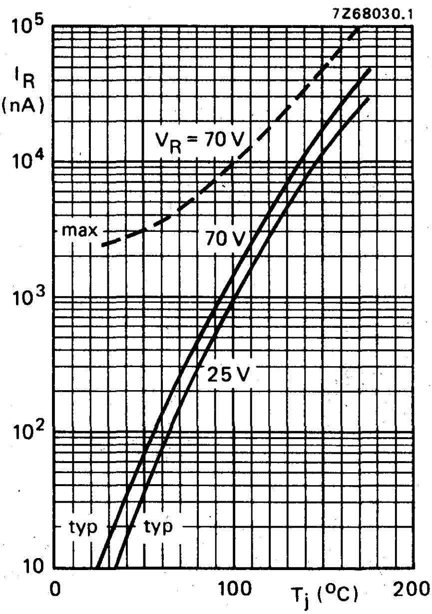


Fig. 7.

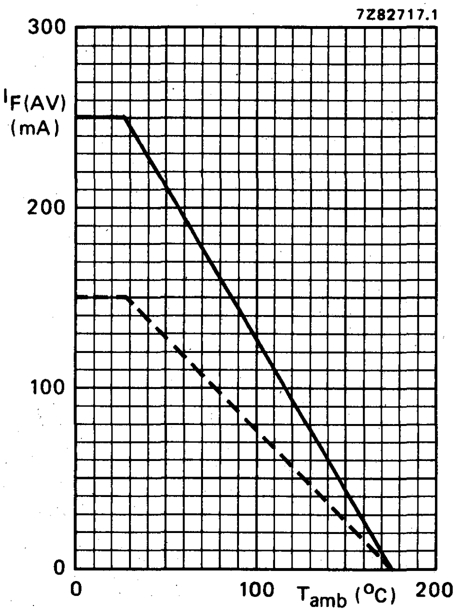


Fig. 8 ——— single diode
– – – – double diode; equally loaded.

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.

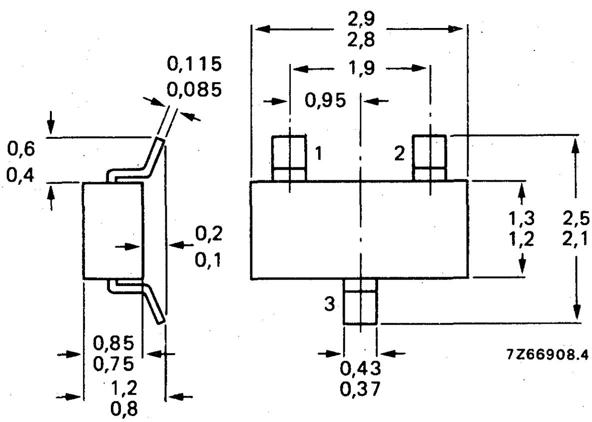
QUICK REFERENCE DATA (per diode)

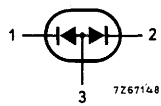
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward current	I_{FRM}	max.	250	mA
Junction temperature	T_j	max.	175	°C
Forward voltage at I_F = 50 mA	V_F	<	1,0	V
Reverse recovery time when switched from I_F = 10 mA to I_R = 10 mA; R_L = 100 Ω; 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 Ω	Q_s	<	45	pC

MECHANICAL DATA Dimensions in mm

Fig. 1 SOT-23.

Marking code
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 ▲ (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** *

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

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

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	50 K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	2 x 260 K/W
From soldering points to ambient **	$R_{th\,s\text{-}a}$	=	2 x 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 μA
V_R = 70 V	I_R	<	2,5 μA
V_R = 70 V; T_j = 150 °C	I_R	<	50 μA
Diode capacitance			
V_R = 0; f = 1 MHz	C_d	<	2 pF
Forward recovery voltage when switched to			
I_F = 10 mA; t_r = 20 ns	V_{fr}	<	1,75 V

▲ 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.

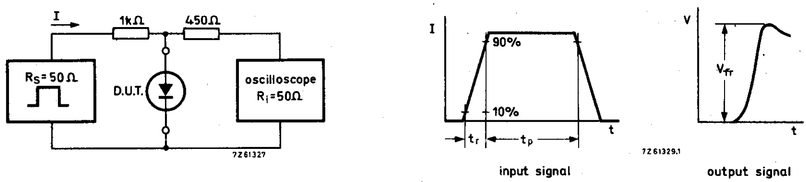


Fig. 2 Test circuit and waveforms; forward recovery voltage.

Input signal: Rise time of the forward pulse t_r = 20 ns
Forward current pulse duration t_p = 120 ns. Duty factor δ = 0,01
Oscilloscope: Rise time t_r = 0,35 ns.

Circuit capacitance $C \leqslant 1$ 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 Ω;
measured at I_R = 1 mA | t_{rr} | < | 6 ns

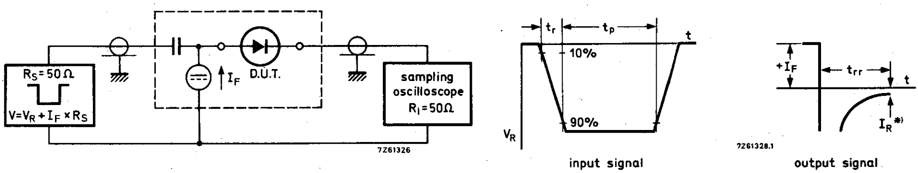


Fig. 3 Test circuit and waveforms; reverse recovery time.

*) I_R = 1 mA

Input signal: Rise time of the reverse pulse t_r = 0,6 ns
Reverse pulse duration t_p = 100 ns. Duty factor δ = 0,05.
Oscilloscope: Rise time t_r = 0,35 ns

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

Recovery charge when switched from
I_F = 10 mA to V_R = 5 V; R_L = 500 Ω | Q_s | < | 45 pC

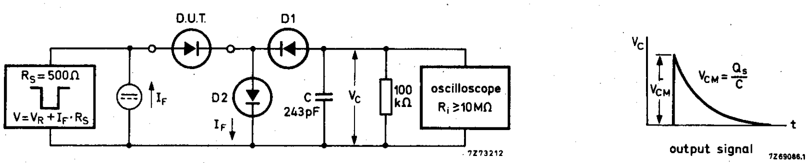


Fig. 4 Test circuit and waveform; recovery charge.

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 δ = 0,02

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

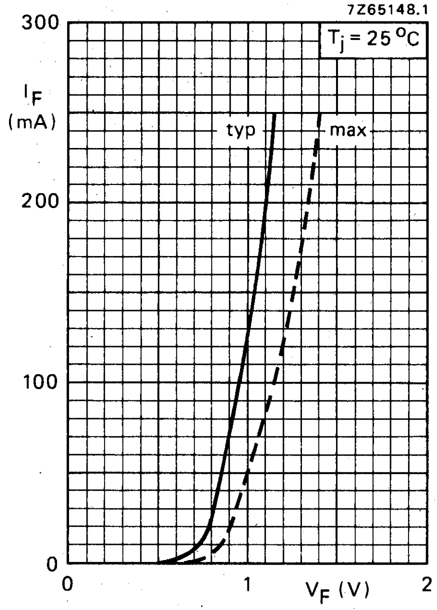


Fig. 5.

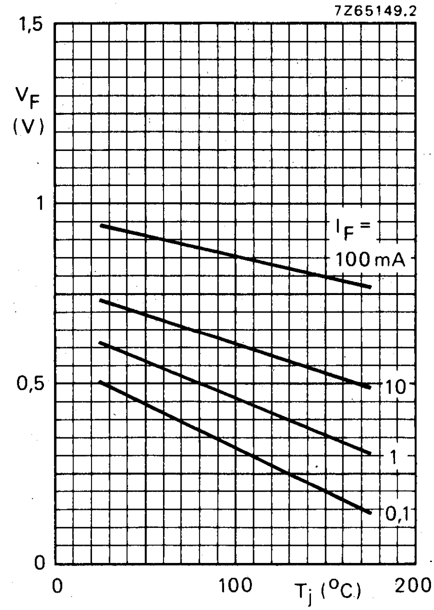


Fig. 6 Typical values.

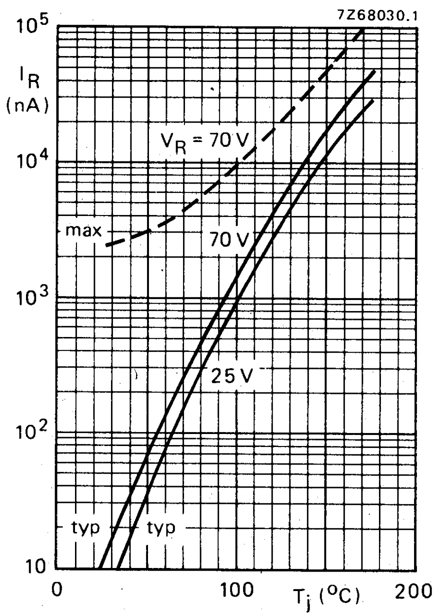


Fig. 7.

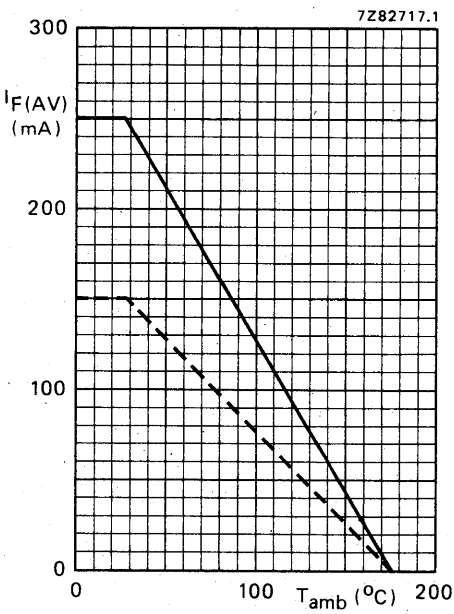


Fig. 8 ——— single diode;
– – – – double diode, equally loaded.

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.

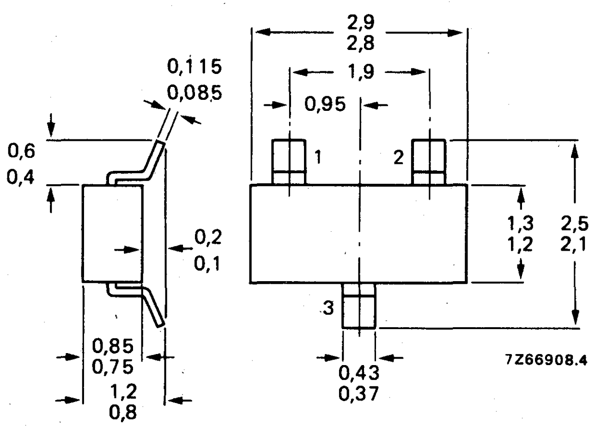
QUICK REFERENCE DATA

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	$\frac{C_d\ (V_R = 3\ V)}{C_d\ (V_R = 25\ V)}$	typ.	5
Series resistance at f = 470 MHz V_R = that value at which C_d = 9 pF	r_D	<	1,2 Ω

MECHANICAL DATA

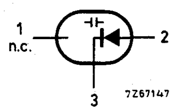
Dimensions in mm

Fig. 1 SOT-23.



Marking code

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	$R_{th\ j\text{-}a}$	=	0,62	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Reverse current

V_R = 28 V	I_R	<	50	nA
→ V_R = 28 V; T_j = 85 °C	I_R	<	1000	nA

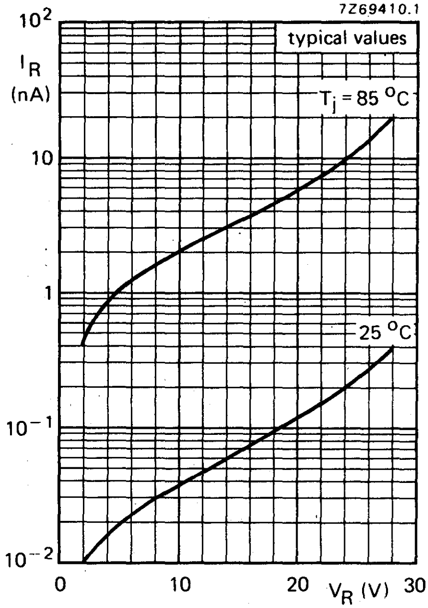
Diode capacitance at f = 1 MHz

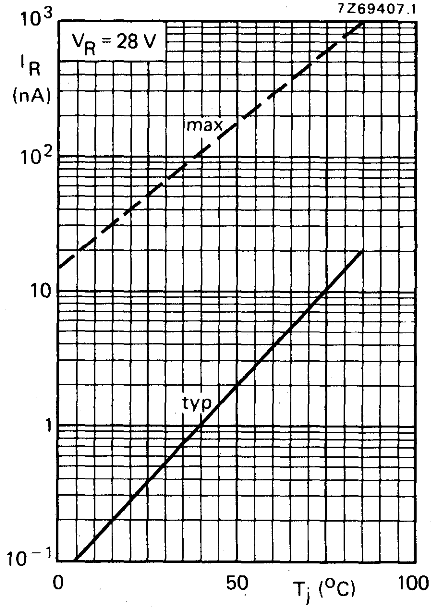
V_R = 1 V	C_d	typ.	17,5	pF
V_R = 3 V	C_d	typ.	11,5	pF
V_R = 25 V	C_d		1,8 to 2,8	pF

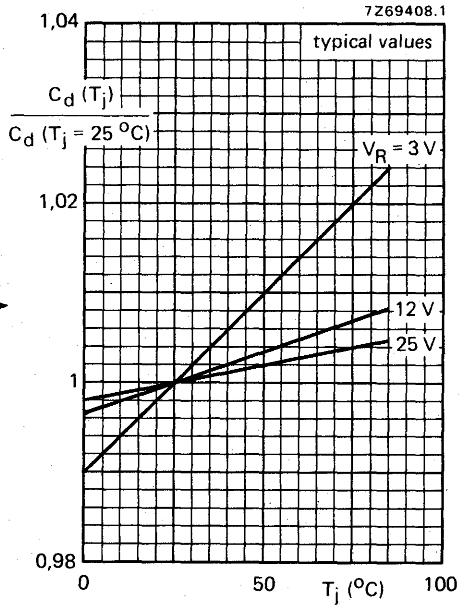
Capacitance ratio at f = 1 MHz	$\frac{C_d(V_R = 3\ V)}{C_d(V_R = 25\ V)}$	typ.	5	

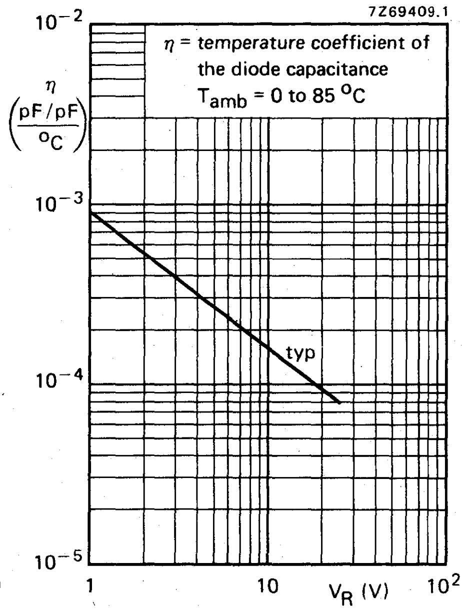
Series resistance

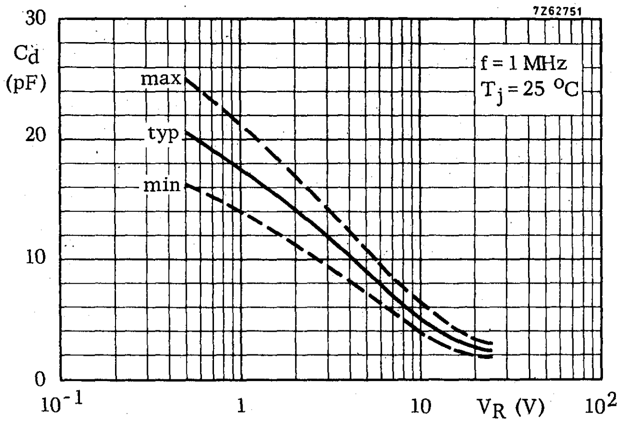
at f = 470 MHz and at that value of V_R at which C_d = 9 pF	r_D	<	1,2	Ω


7Z69410.1
typical values
I_R (nA)
T_j = 85 °C
25 °C
10^2
10
1
10^{-1}
10^{-2}
0
10
20
30
V_R (V)


7Z69407.1
V_R = 28 V
I_R (nA)
max
typ
10^3
10^2
10
1
10^{-1}
0
50
100
T_j (°C)


7Z69408.1
typical values
$\frac{C_d (T_j)}{C_d (T_j = 25\ °C)}$
V_R = 3 V
12 V
25 V
1,04
1,02
1
0,98
0
50
100
T_j (°C)


7Z69409.1
η = temperature coefficient of the diode capacitance
T_{amb} = 0 to 85 °C
η (pF/pF / °C)
typ
10^{-2}
10^{-3}
10^{-4}
10^{-5}
1
10
10^2
V_R (V)


7Z62751
30
20
10
0
C_d
(pF)
max
typ
min
f = 1 MHz
T_j = 25 °C
10^{-1}
1
10
V_R (V)
10^2

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

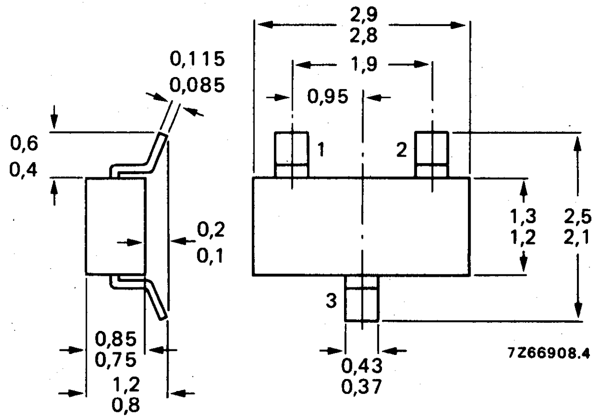
Continuous reverse voltage	V_R	max.	28 V
Reverse current at V_R = 28 V	I_R	<	50 nA
Diode capacitance at f = 1 MHz			
V_R = 3 V	C_d		26 to 32 pF
V_R = 25 V	C_d		4,3 to 6 pF
Capacitance ratio at f = 1 MHz	$\frac{C_d\ (V_R = 3\ V)}{C_d\ (V_R = 25\ V)}$		5 to 6,5
Series resistance at f = 200 MHz V_R is that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

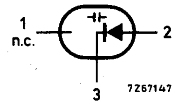
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.

Marking code
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 °C unless otherwise specified

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

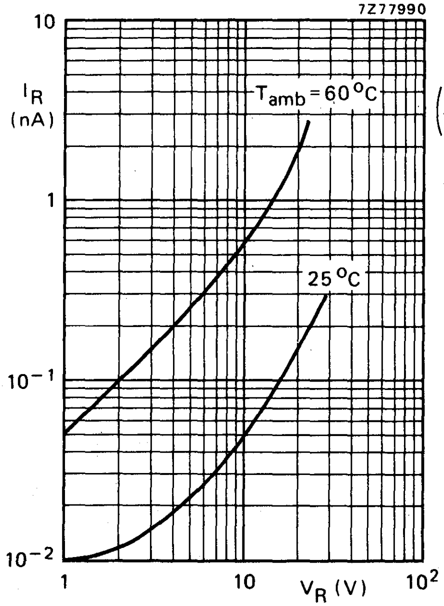


Fig. 2 Typical values

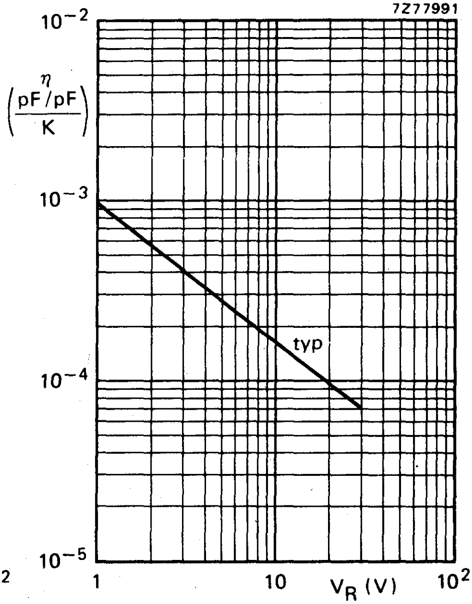


Fig. 3 Temperature coefficient of the diode capacitance; T_{amb} = 0 to 85 °C.

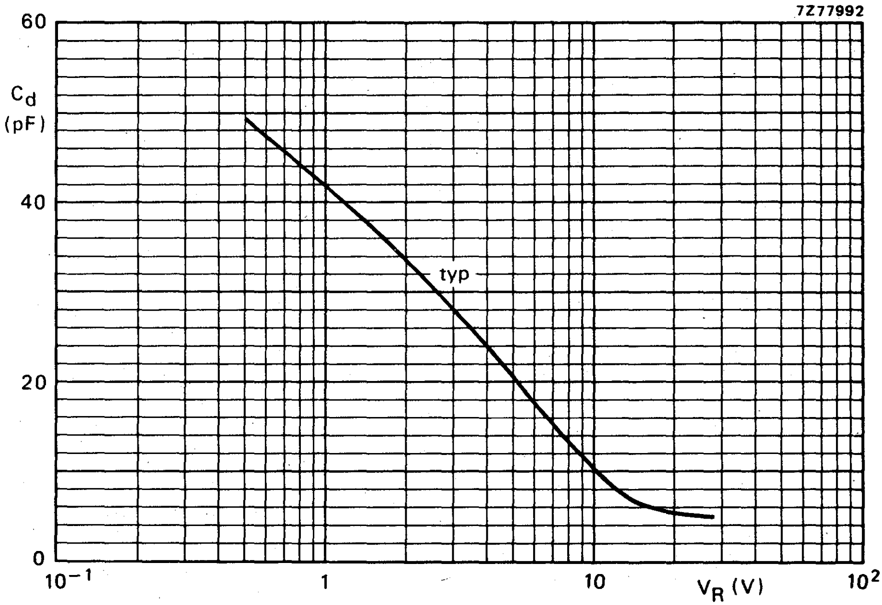


Fig. 4 f = 1 MHz; T_{amb} = 25 °C.

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.

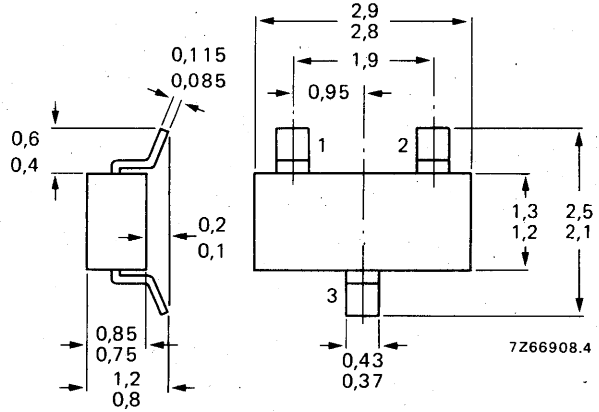
QUICK REFERENCE DATA

			BCF29 BCF29R	BCF30 BCF30R	
D.C. current gain at T_j = 25 °C; $-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	>	120	215	
		<	260	500	
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 °C	P_{tot}	max.	350		mW ←
Junction temperature	T_j	max.	175		°C ←
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 kΩ; $-I_C$ = 200 μA; $-V_{CE}$ = 5 V; f = 1 kHz; B = 200 Hz	F	<	4		dB

MECHANICAL DATA

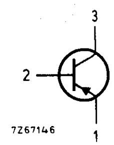
Dimensions in mm

Fig. 1 SOT-23.

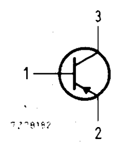


Marking code

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*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	50 K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	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
Saturation voltages			
$-I_C = 10$ mA; $-I_B = 0{,}5$ mA	$-V_{CEsat}$	typ.	80 mV
		<	300 mV
	$-V_{BEsat}$	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			BCF29 BCF29R	BCF30 BCF30R	
$-I_C = 10\ \mu A$; $-V_{CE} = 5$ V	h_{FE}	typ.	90	150	
$-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	>	120	215	
		<	260	500	
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	<	4		dB
		typ.	1		dB

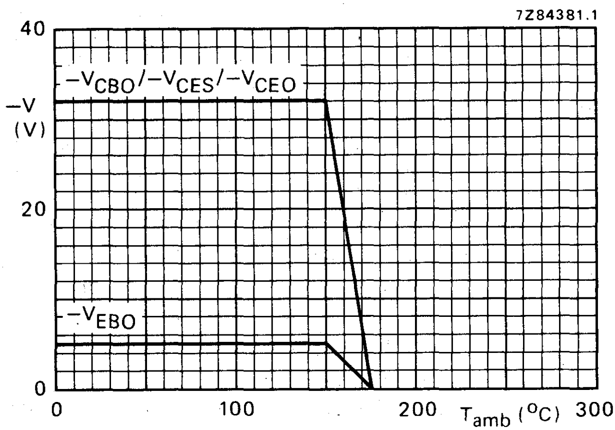


Fig. 2 Voltage derating curves.

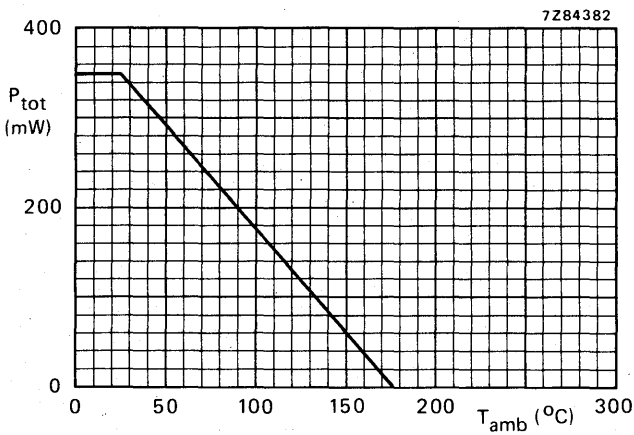


Fig. 3 Power derating curve.

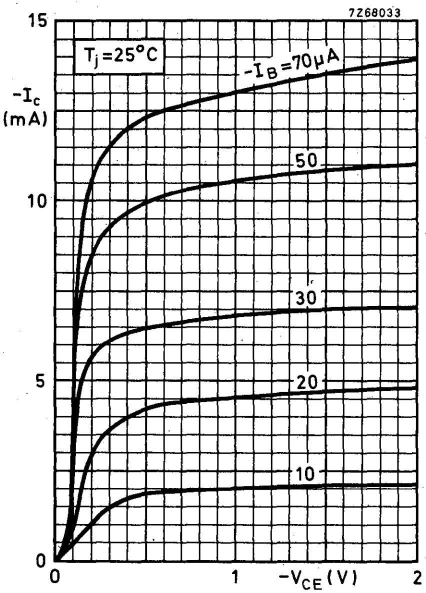


Fig. 4.

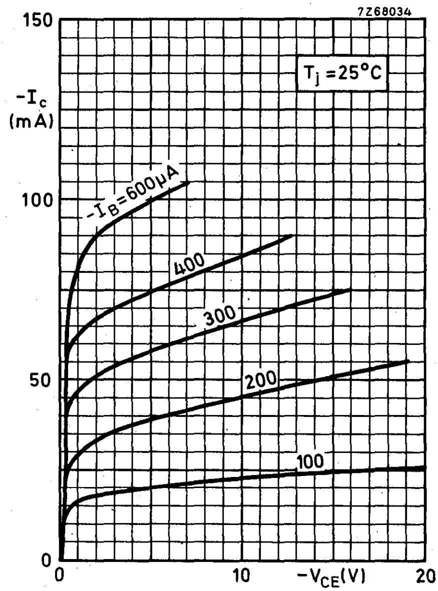


Fig. 5.

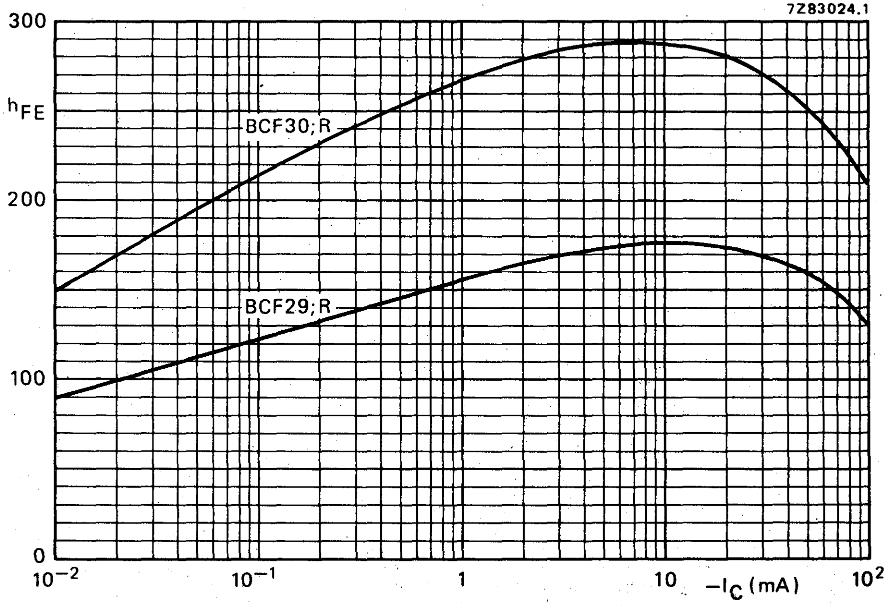


Fig. 6 Typical values of d.c. current gain. $-V_{CE} = 5$ V; $T_j = 25$ °C.

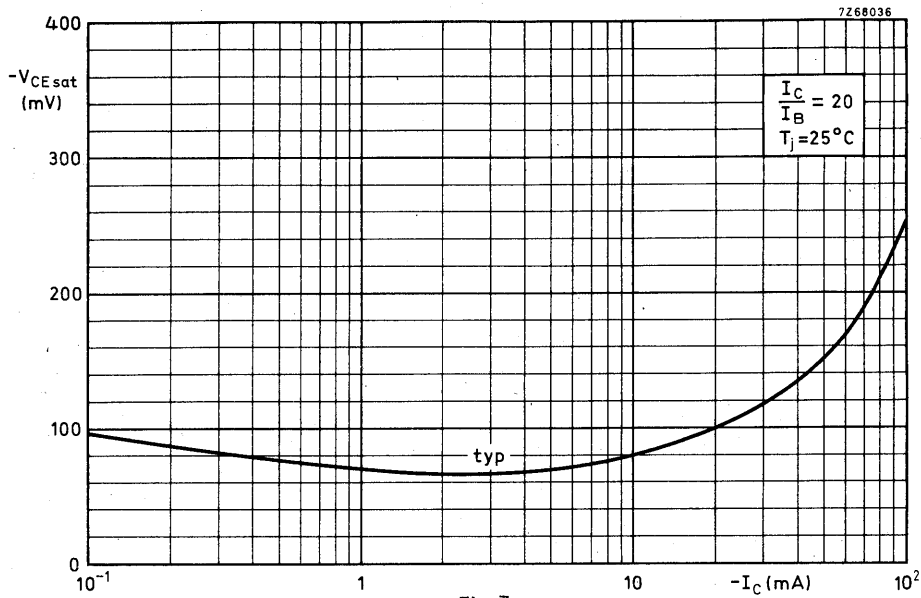

7Z68036
400
$-V_{CE sat}$
(mV)
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 7.

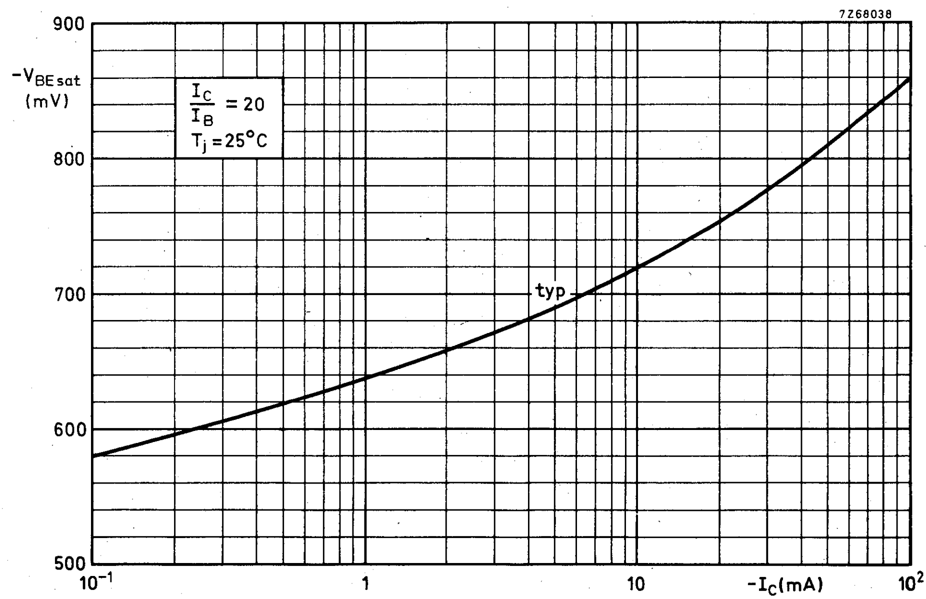

7Z68038
900
$-V_{BE sat}$
(mV)
800
700
600
500
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
$-I_C$(mA)
10^2

Fig. 8.

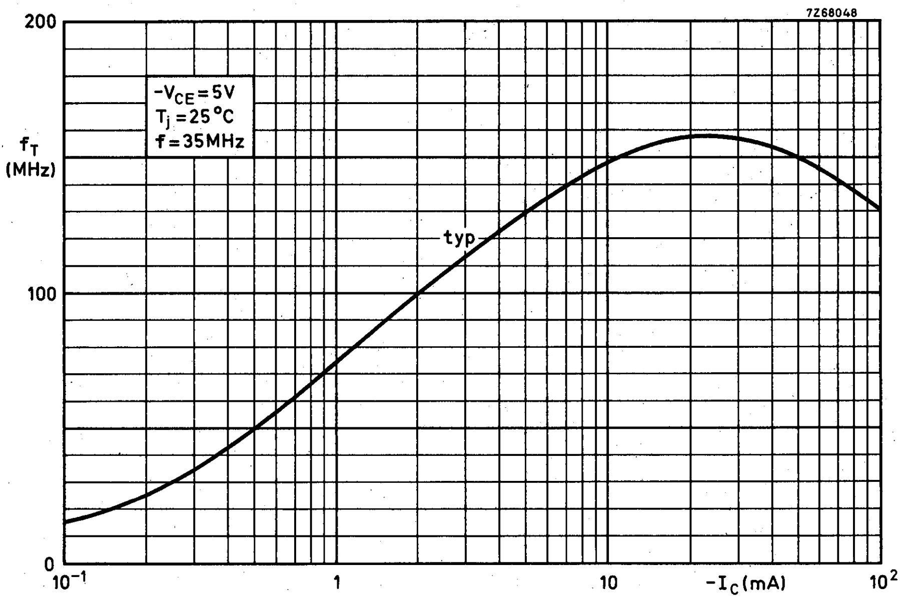

7Z68048
200
100
0
f_T
(MHz)
$-V_{CE} = 5V$
$T_j = 25\,°C$
f = 35MHz
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 9.

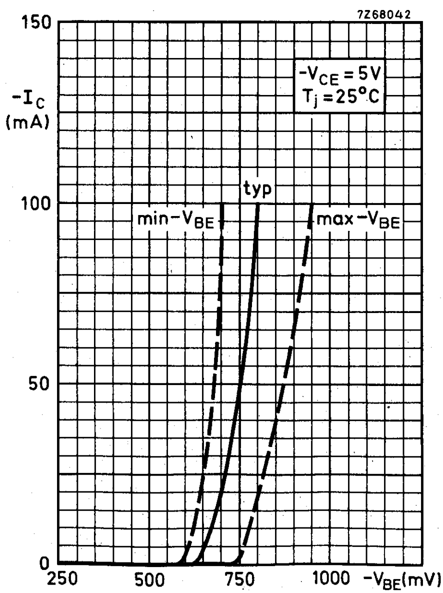

7Z68042
150
100
50
0
$-I_C$
(mA)
$-V_{CE} = 5V$
$T_j = 25°C$
typ
min $-V_{BE}$
max $-V_{BE}$
250
500
750
1000
$-V_{BE}$ (mV)

Fig. 10.

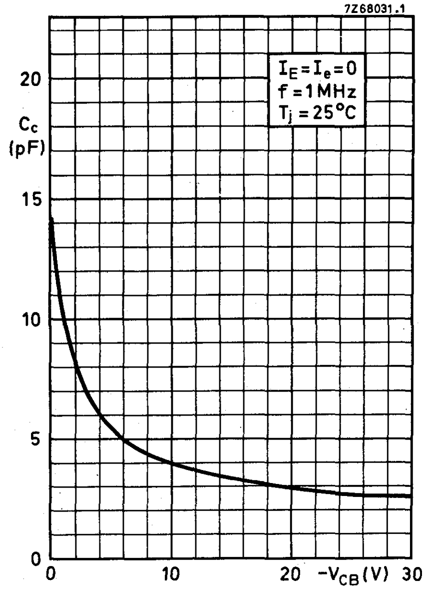

7Z68031.1
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25°C$
C_c (pF)
20
15
10
5
0
0
10
20
$-V_{CB}$ (V)
30

Fig. 11.

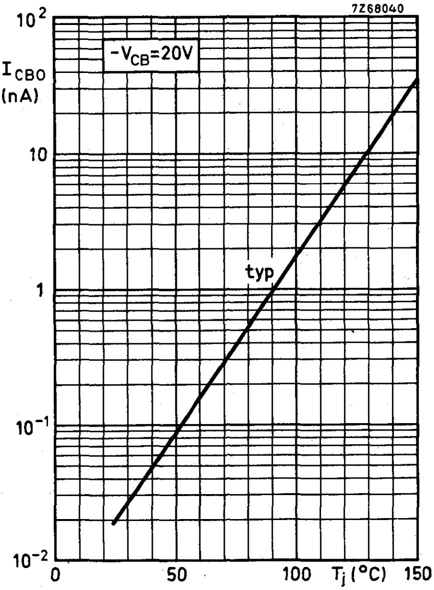

7Z68040
$-V_{CB}$ = 20V
$-I_{CBO}$ (nA)
10^2
10
1
10^{-1}
10^{-2}
typ
0
50
100
T_j (°C)
150

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.

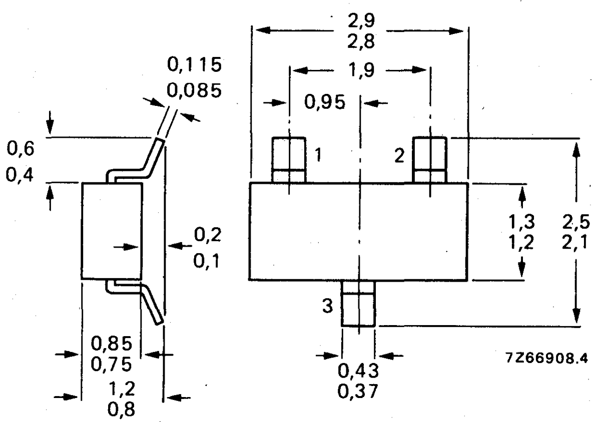
QUICK REFERENCE DATA

			BCF32 BCF32R	BCF33 BCF33R	
D.C. current gain at T_j = 25 °C I_C = 2 mA; V_{CE} = 5 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 °C	P_{tot}	max.	350		mW
Junction temperature	T_j	max.	175		°C
Transition frequency at f = 35 MHz I_C = 2 mA; V_{CE} = 5 V	f_T	typ.	300		MHz
Noise figure at R_S = 2 kΩ I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	<	4		dB

MECHANICAL DATA

Dimensions in mm

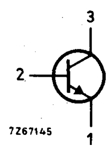
Fig. 1 SOT-23.



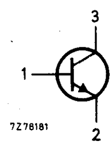
See also *Soldering recommendations*.

Marking code

BCF32 = D7
BCF33 = D8



BCF32R = D77
BCF33R = D81



RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	32	V
Collector-emitter voltage (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*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	50	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	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}		550 to 700	mV
Saturation voltages				
I_C = 10 mA; I_B = 0,5 mA	V_{CEsat}	typ.	120	mV
		<	250	mV
	V_{BEsat}	typ.	750	mV
I_C = 50 mA; I_B = 2,5 mA	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.

			BCF32 BCF32R	BCF33 BCF33R
D.C. current gain				
I_C = 10 μA; V_{CE} = 5 V	h_{FE}	typ.	150	270
		>	200	420
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	<	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 kΩ				
I_C = 200 μA; V_{CE} = 5 V				
f = 1 kHz; B = 200 Hz	F	<	4 dB	
		typ.	1,2 dB	

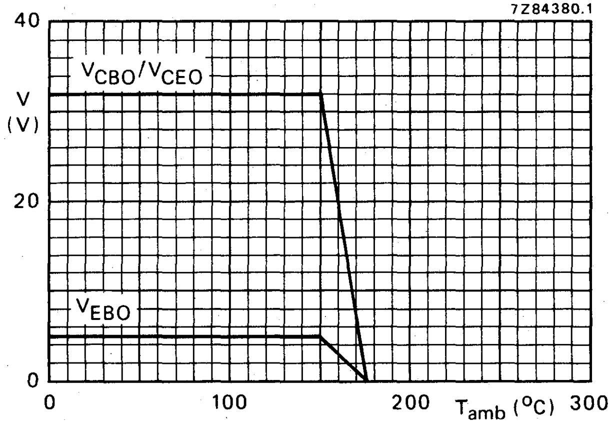


Fig. 2 Voltage derating curves.

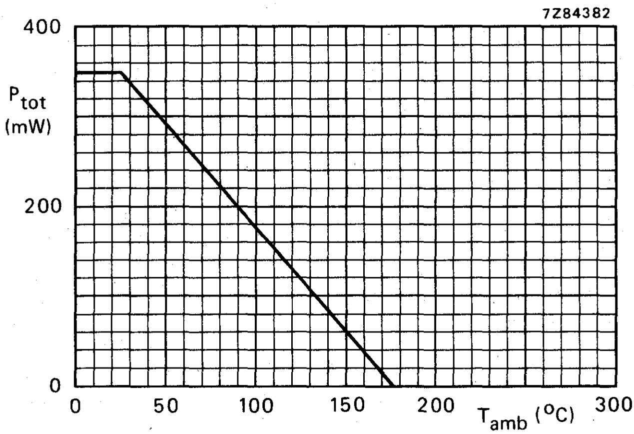


Fig. 3 Power derating curve.

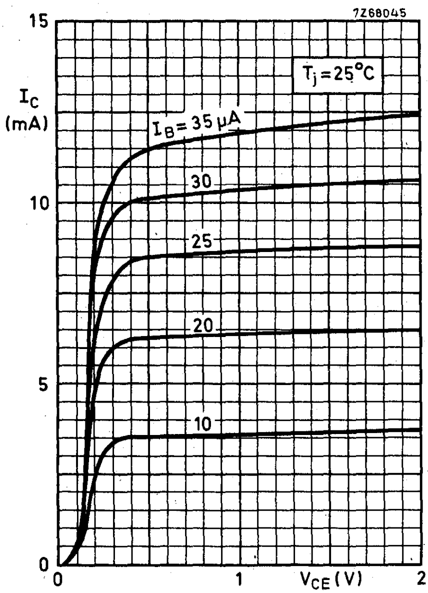


Fig. 4.

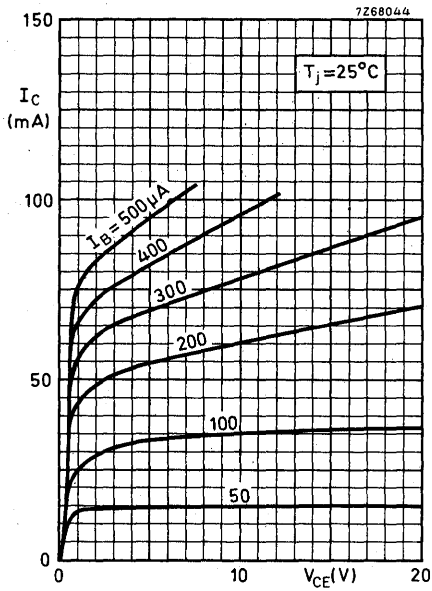


Fig. 5.

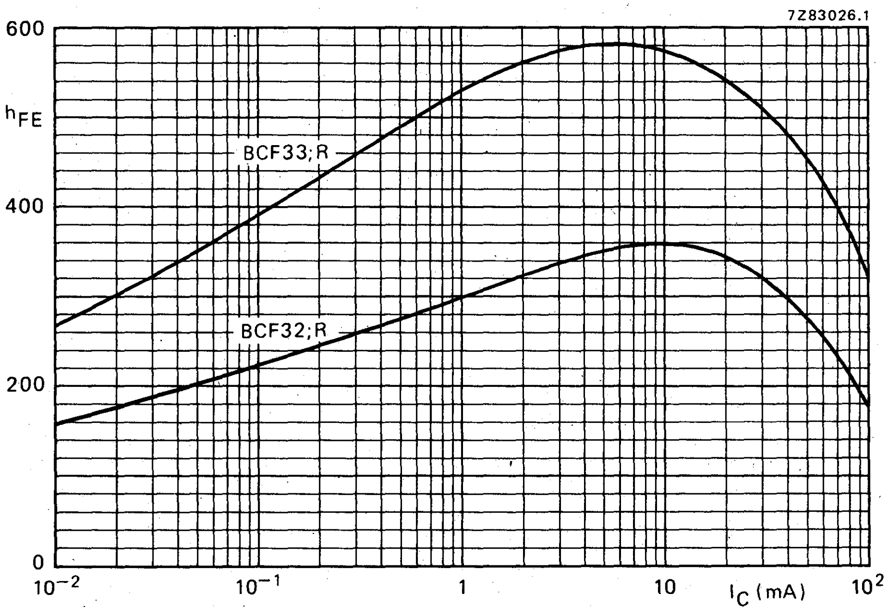


Fig. 6 Typical values d.c. current gain. V_{CE} = 5 V; T_j = 25 °C.

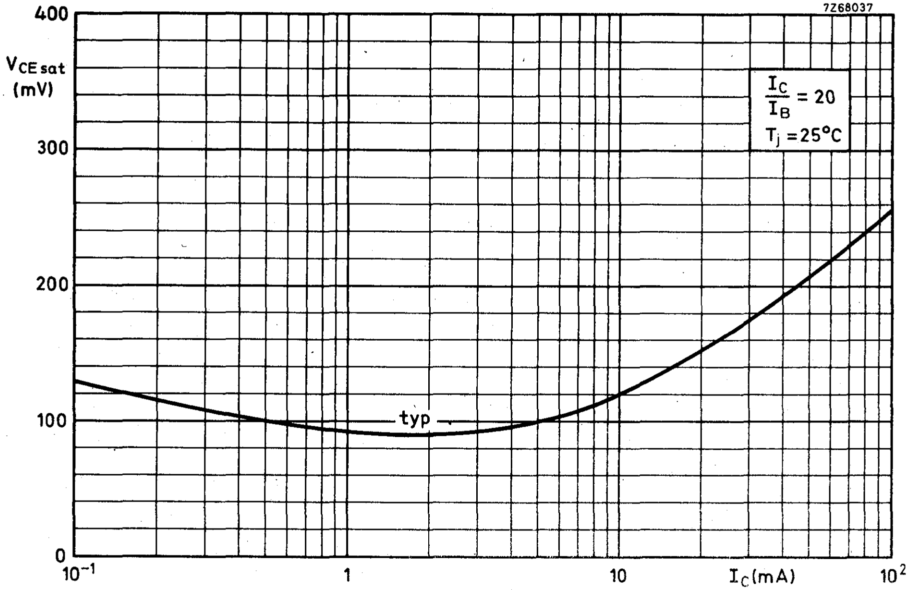

7Z68037
400
$V_{CE\,sat}$
(mV)
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25\,°C$
typ
10^{-1}
1
10
I_C (mA)
10^2

Fig. 7.

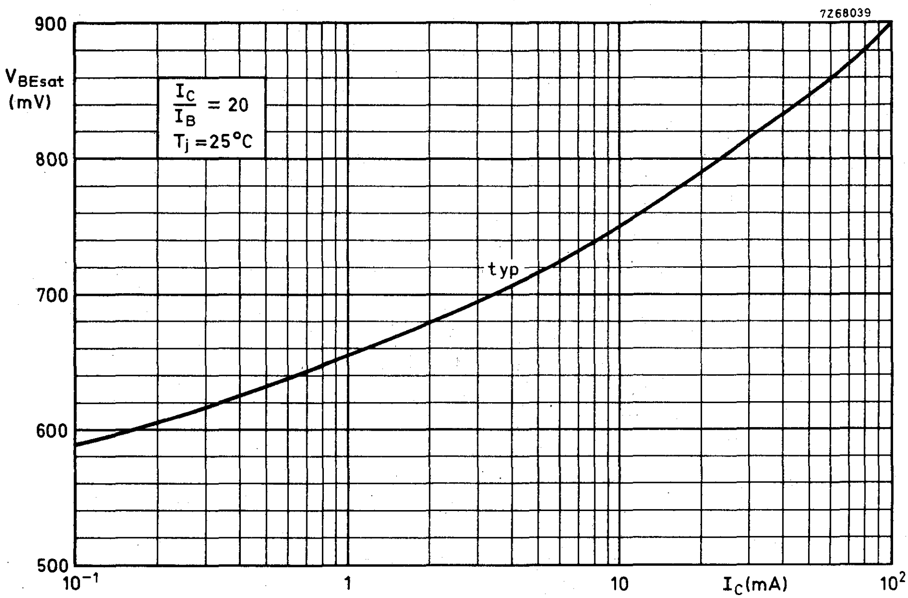

7Z68039
900
V_{BEsat}
(mV)
800
700
600
500
$\frac{I_C}{I_B} = 20$
$T_j = 25\,°C$
typ
10^{-1}
1
10
I_C (mA)
10^2

Fig. 8.

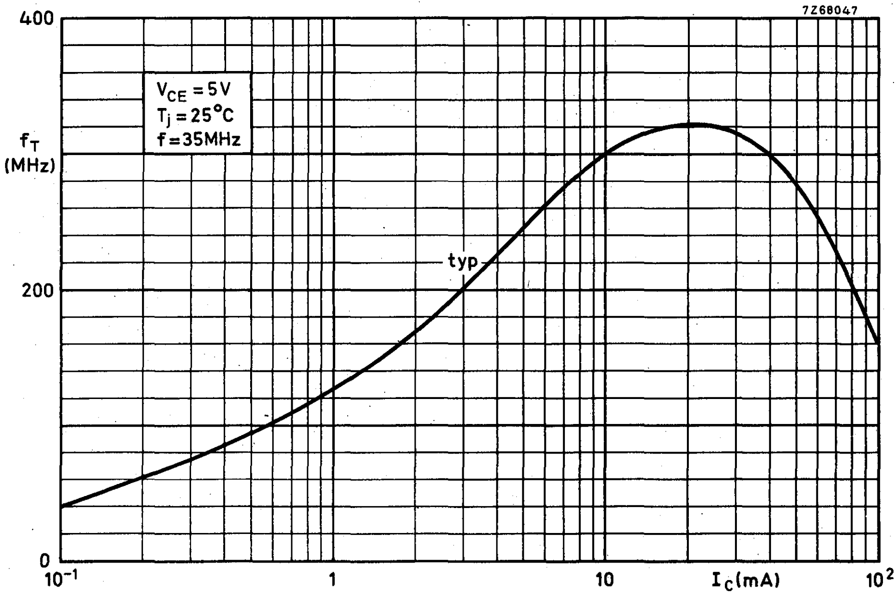

7Z68047
400
200
0
f_T
(MHz)
V_{CE} = 5 V
T_j = 25 °C
f = 35MHz
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 9.

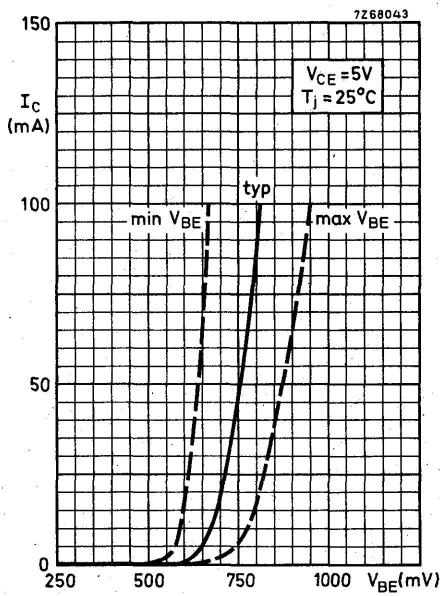

7Z68043
150
100
50
0
I_C
(mA)
V_{CE} = 5V
T_j = 25 °C
min V_{BE}
typ
max V_{BE}
250
500
750
1000
V_{BE}(mV)

Fig. 10.

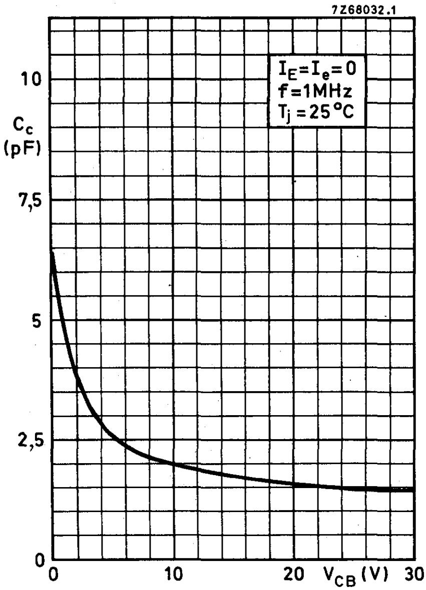

7Z68032.1
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25\,^\circ C$
C_c (pF)
10
7,5
5
2,5
0
0
10
20
V_{CB} (V)
30

Fig. 11.

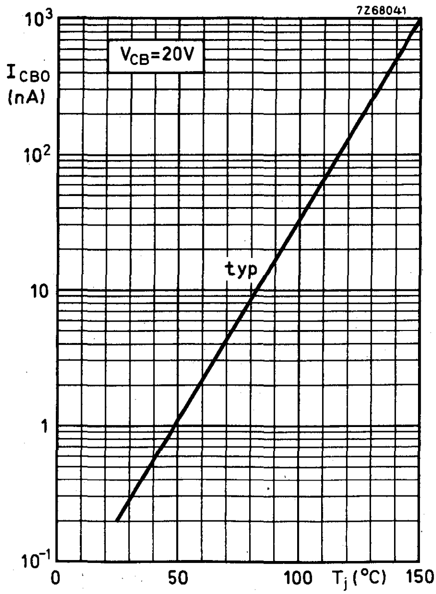

7Z68041
$V_{CB} = 20 V$
I_{CBO} (nA)
10^3
10^2
10
1
10^{-1}
typ
0
50
100
T_j (°C)
150

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.

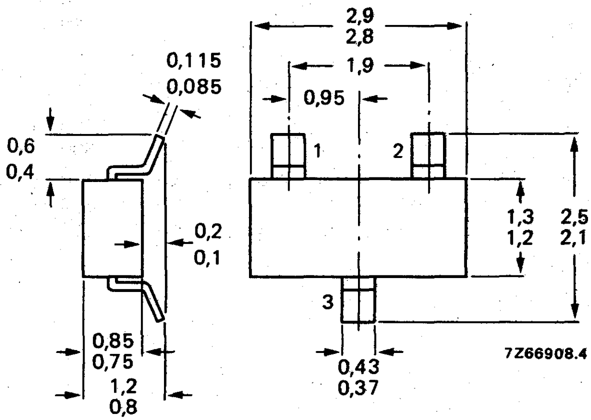
QUICK REFERENCE DATA

D.C. current gain at T_j = 25 °C $-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	> <	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 °C	P_{tot}	max.	350 mW
Junction temperature	T_j	max.	175 °C
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 kΩ $-I_C$ = 200 μA; $-V_{CE}$ = 5 V; f = 1 kHz; B = 200 Hz	F	<	4 dB

MECHANICAL DATA

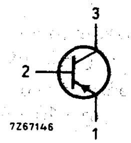
Dimensions in mm

Fig. 1 SOT-23.

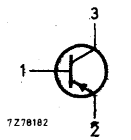


Marking code

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*

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

Thermal resistance

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

$I_E = 0$; $-V_{CB}$ = 20 V; T_j = 25 °C	$-I_{CBO}$	<	100	nA
T_j = 100 °C	$-I_{CBO}$	<	10	μA
Base-emitter voltage $-I_C$ = 2 mA; $-V_{CE}$ = 5 V; T_j = 25 °C	$-V_{BE}$		600 to 750	mV
Saturation voltages $-I_C$ = 10 mA; $-I_B$ = 0,5 mA	$-V_{CEsat}$	typ.	80	mV
		<	300	mV
	$-V_{BEsat}$	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			
$-I_C = 10\ \mu A$; $-V_{CE} = 5$ V	h_{FE}	typ.	150
$-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	> <	215 500
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	< typ.	4 dB 1 dB

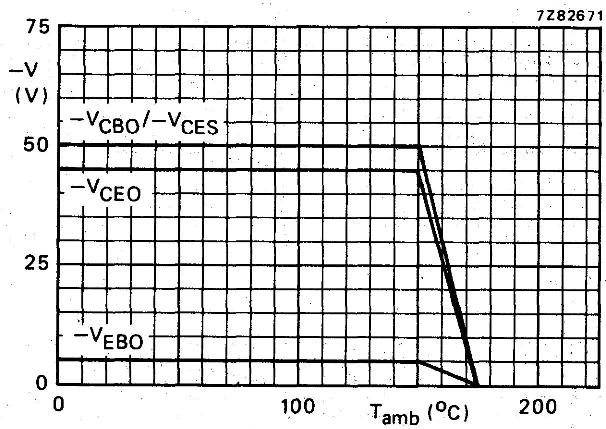


Fig. 2 Voltage derating curves.

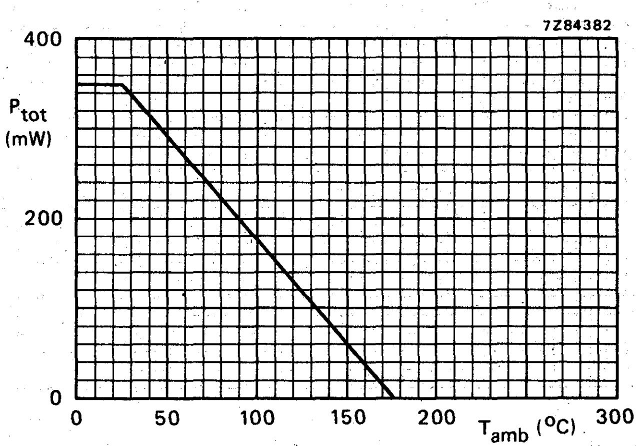


Fig. 3 Power derating curve.

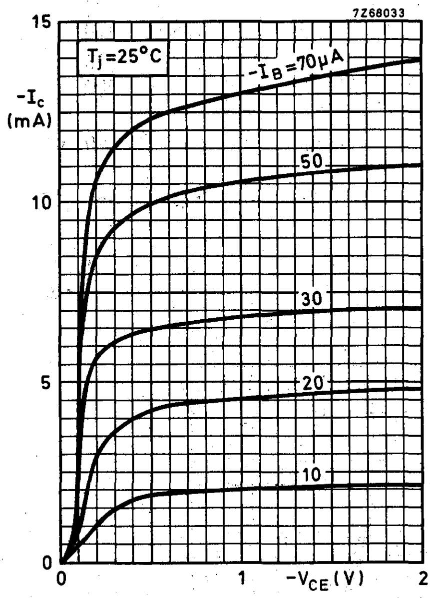


Fig. 4.

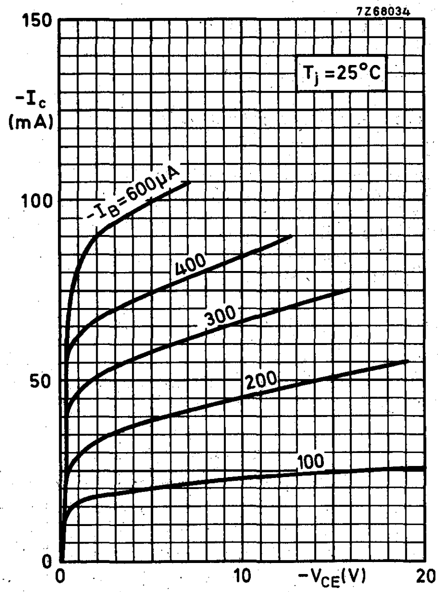


Fig. 5.

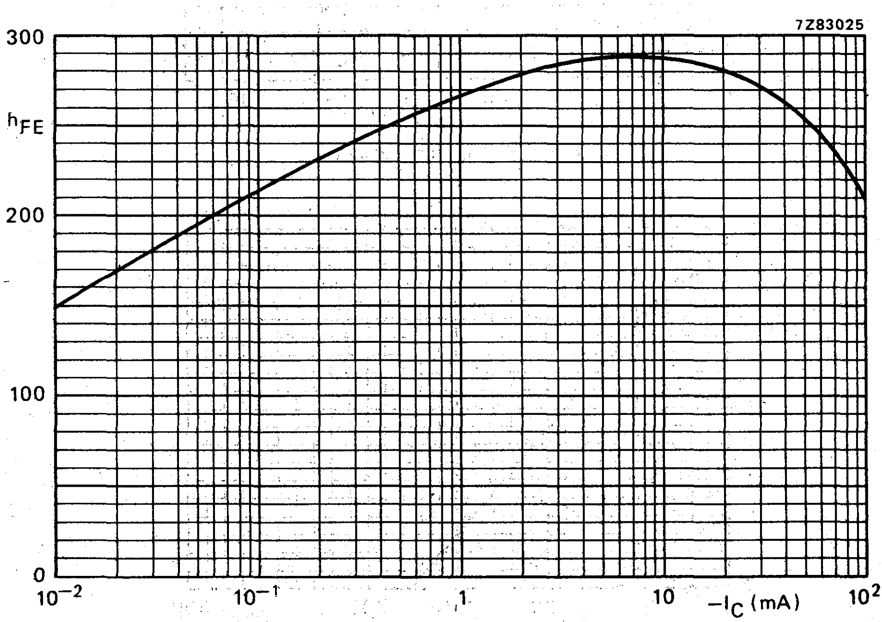


Fig. 6 Typical values of d.c. current gain. $-V_{CE}$ = 5 V; T_j = 25 °C.

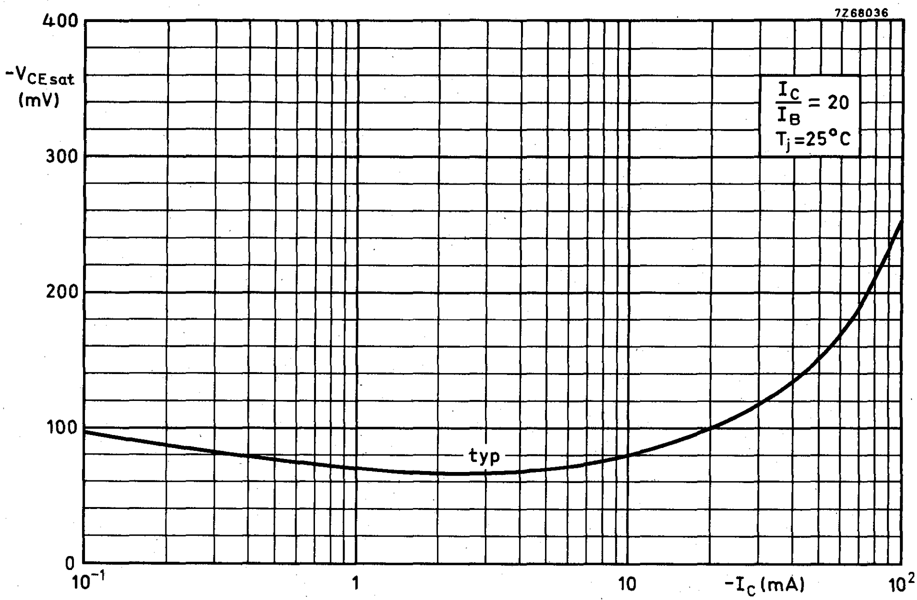

7Z68036
400
$-V_{CEsat}$
(mV)
300
200
100
0
$I_C/I_B = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 7.

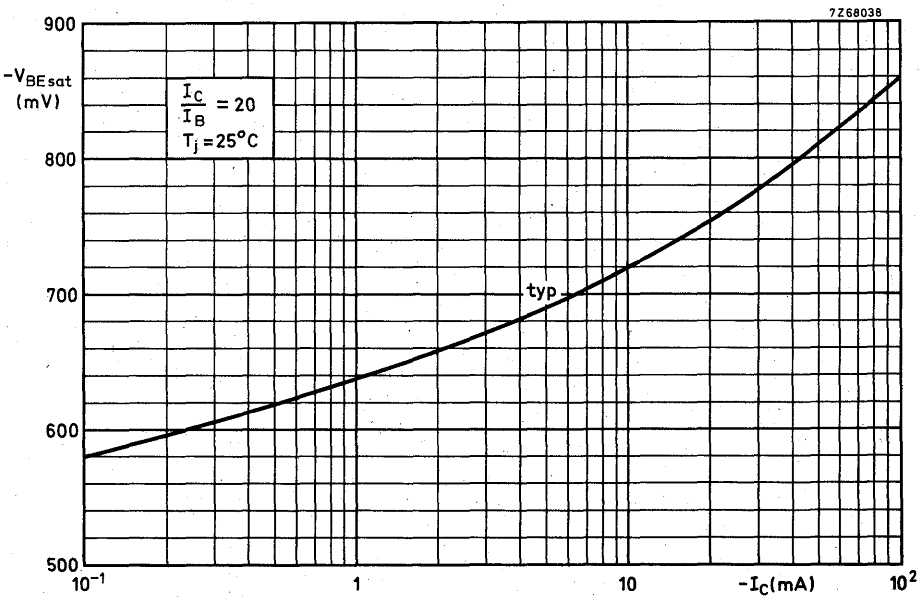

7Z68038
900
$-V_{BEsat}$
(mV)
800
700
600
500
$I_C/I_B = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
$-I_C$(mA)
10^2

Fig. 8.

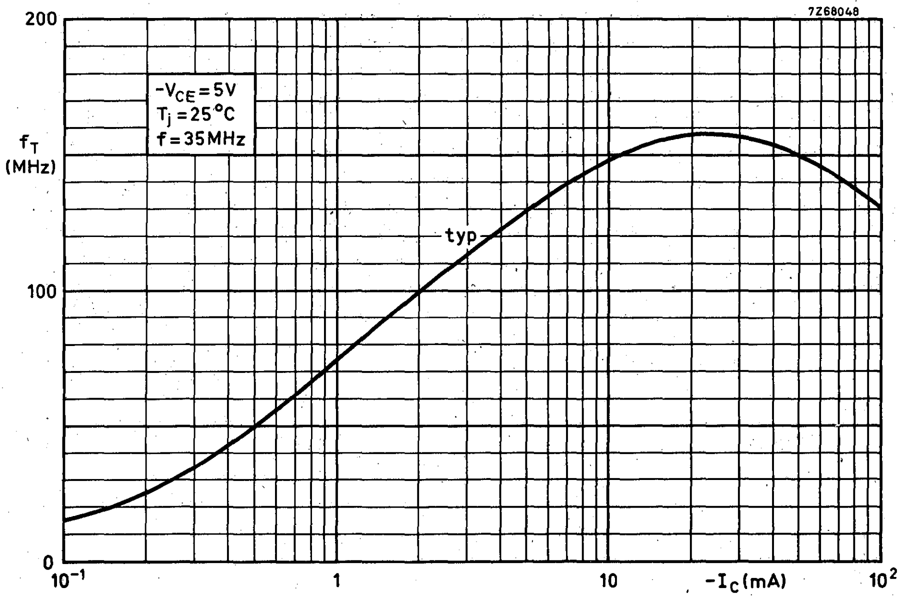

7Z68048
200
100
0
f_T
(MHz)
$-V_{CE} = 5V$
$T_j = 25°C$
f = 35 MHz
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 9.

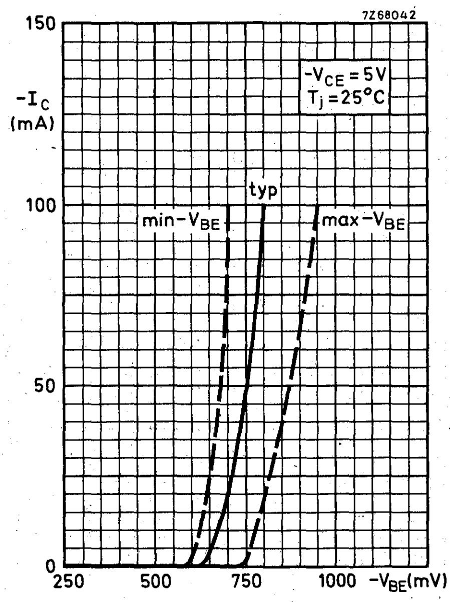

7Z68042
150
100
50
0
$-I_C$
(mA)
$-V_{CE} = 5V$
$T_j = 25°C$
typ
min $-V_{BE}$
max $-V_{BE}$
250
500
750
1000
$-V_{BE}$ (mV)

Fig. 10.

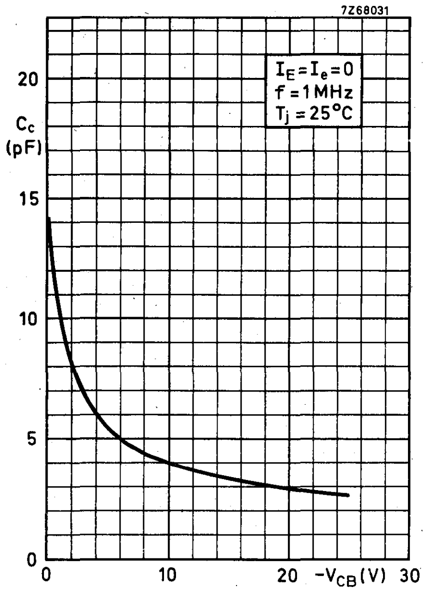

7Z68031
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25\,^\circ C$
C_c (pF)
0
5
10
15
20
0
10
20
$-V_{CB}$ (V)
30

Fig. 11.

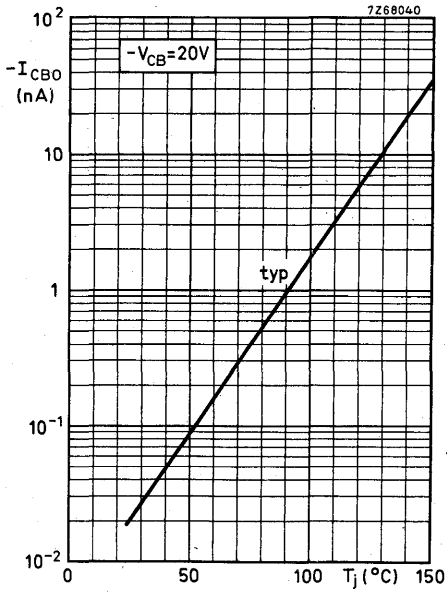

7Z68040
$-V_{CB} = 20V$
$-I_{CBO}$ (nA)
10^2
10
1
10^{-1}
10^{-2}
typ
0
50
100
T_j (°C)
150

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.

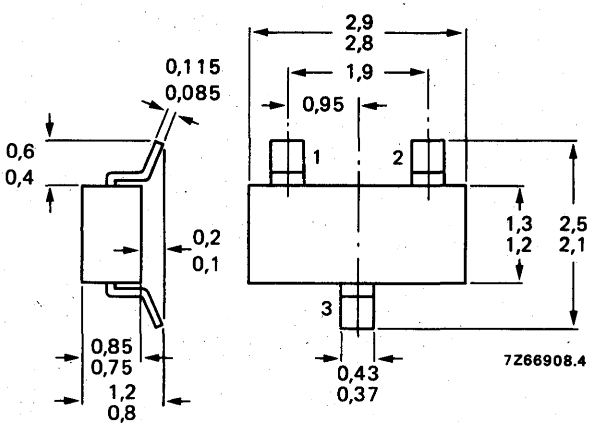
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	350 mW
Junction temperature	T_j	max.	175 °C
D.C. current gain at T_j = 25 °C I_C = 2 mA; V_{CE} = 5 V	h_{FE}	> <	420 800
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 kΩ I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	<	4 dB

MECHANICAL DATA

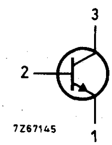
Dimensions in mm

Fig. 1 SOT-23.

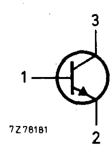


Marking code

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_{CBO}	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*

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

Thermal resistance.

From junction to tab	$R_{th\,j\text{-}t}$	=	50	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	120	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 = 100 °C	I_{CBO}	<	10	μA
Base emitter voltage				
I_C = 2 mA; V_{CE} = 5 V	V_{BE}	550 to 700		mV
Saturation voltages				
I_C = 10 mA; I_B = 0,5 mA	V_{CEsat}	typ.	120	mV
		<	250	mV
	V_{BEsat}	typ.	750	mV
I_C = 50 mA; I_B = 2,5 mA	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			
$I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	> <	420 800
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 $R_S = 2$ kΩ			
$I_C = 200$ μA; $V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	< typ.	4 dB 1,2 dB

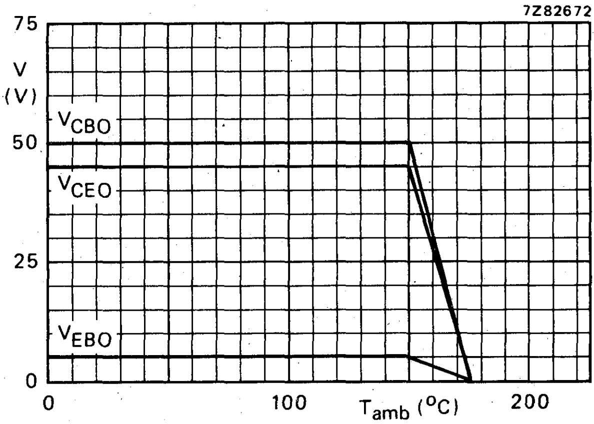


Fig. 2 Voltage derating curves.

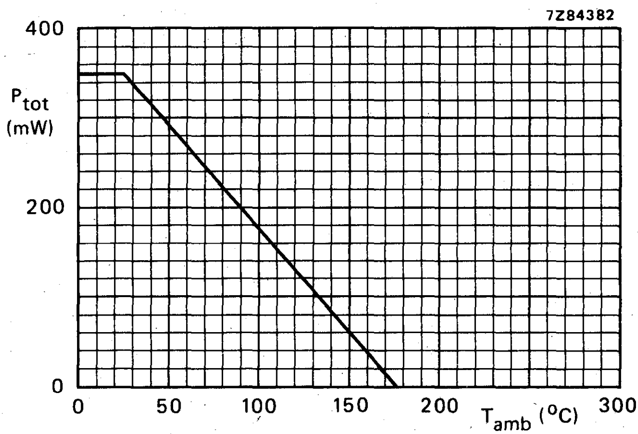


Fig. 3 Power derating curve.

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.

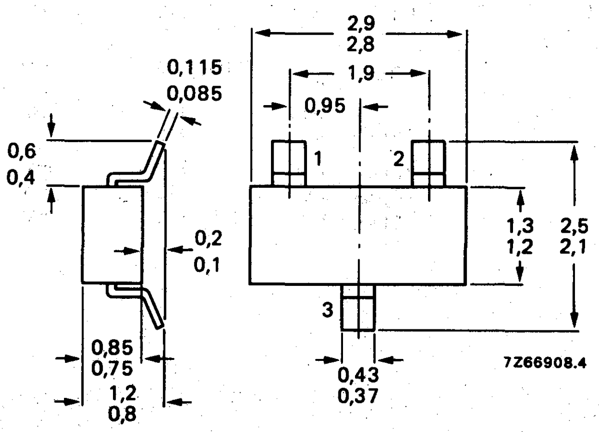
QUICK REFERENCE DATA

			BCV71 BCV71R	BCV72 BCV72R	
D.C. current gain at T_j = 25 °C I_C = 2 mA; V_{CE} = 5 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 °C	P_{tot}	max.	350		mW
Junction temperature	T_j	max.	175		°C
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 kΩ I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	<	10		dB

MECHANICAL DATA

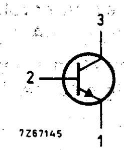
Dimensions in mm

Fig. 1 SOT-23.

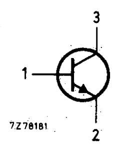


Marking code

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_{CBO}	max.	80	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*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	50	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	120	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 = 100 °C	I_{CBO}	<	10	µA
Base emitter voltage				
I_C = 2 mA; V_{CE} = 5 V	V_{BE}		550 to 700	mV
Saturation voltages				
I_C = 10 mA; I_B = 0,5 mA	V_{CEsat}	typ.	120	mV
		<	250	mV
	V_{BEsat}	typ.	750	mV
I_C = 50 mA; I_B = 2,5 mA	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 BCV71R	BCV72 BCV72R	
D.C. current gain					
I_C = 10 μA; 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 kΩ I_C = 200 μA; V_{CE} = 5 V f = 1 kHz; B = 200 Hz	F	<	10		dB

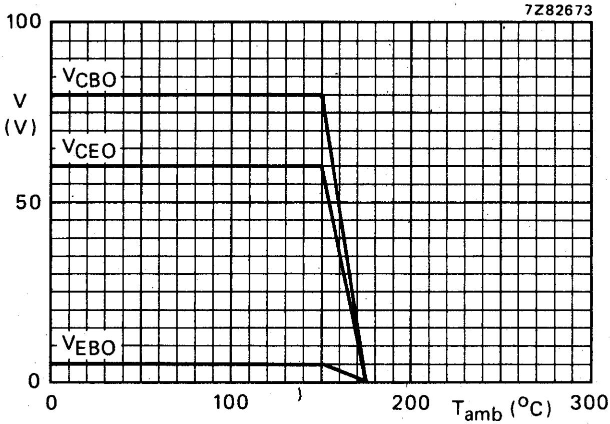


Fig. 2 Voltage derating curves.

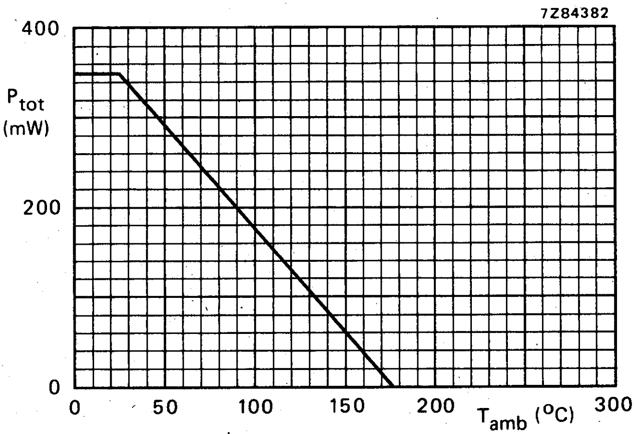


Fig. 3 Power derating curve.

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.

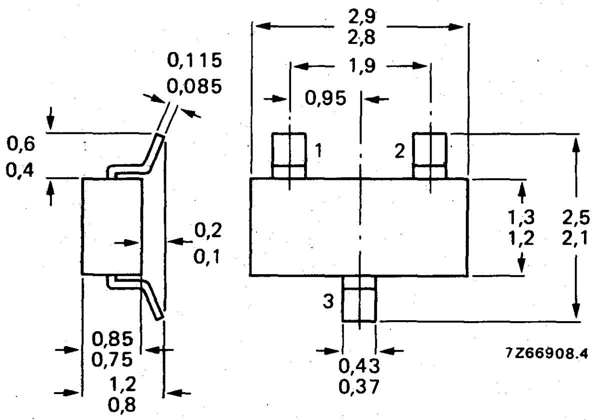
QUICK REFERENCE DATA

			BCW29 BCW29R	BCW30 BCW30R	
D.C. current gain at T_j = 25 °C; $-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	>	120	215	
		<	260	500	
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 °C	P_{tot}	max.	350		mW
Junction temperature	T_j	max.	175		°C
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 kΩ; $-I_C$ = 200 μA; $-V_{CE}$ = 5 V; f = 1 kHz; B = 200 Hz	F	<	10		dB

MECHANICAL DATA

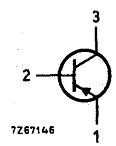
Dimensions in mm

Fig. 1 SOT-23.

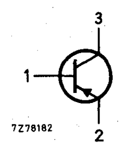


Marking code

BCW29 = C1
BCW30 = C2



BCW29R = C4
BCW30R = C5



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*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	50 K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	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
Saturation voltages			
$-I_C = 10$ mA; $-I_B = 0,5$ mA	$-V_{CEsat}$	typ.	80 mV
		<	300 mV
	$-V_{BEsat}$	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.

			BCW29 BCW29R	BCW30 BCW30R	
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}	>	120	215	
		<	260	500	
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

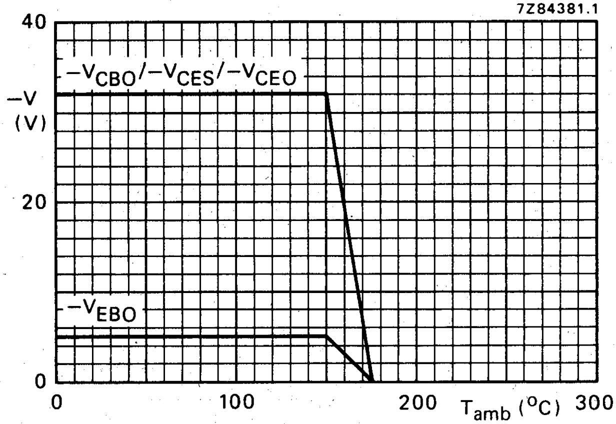


Fig. 2 Voltage derating curves.

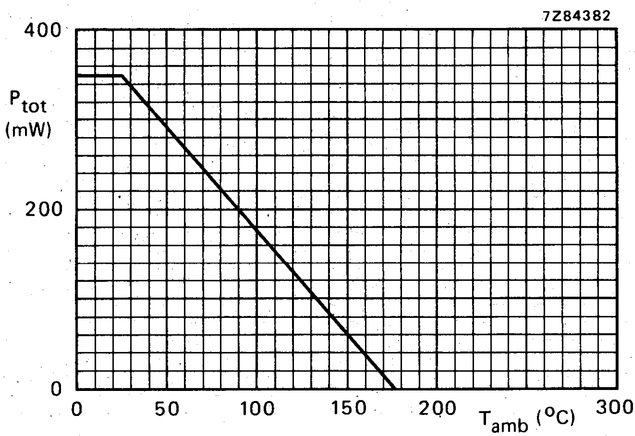


Fig. 3 Power derating curve.

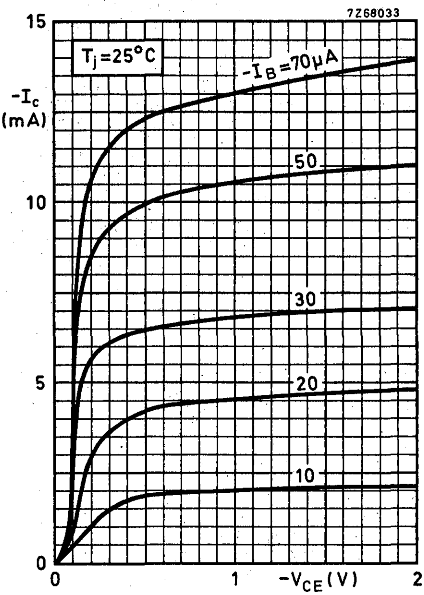


Fig. 4.

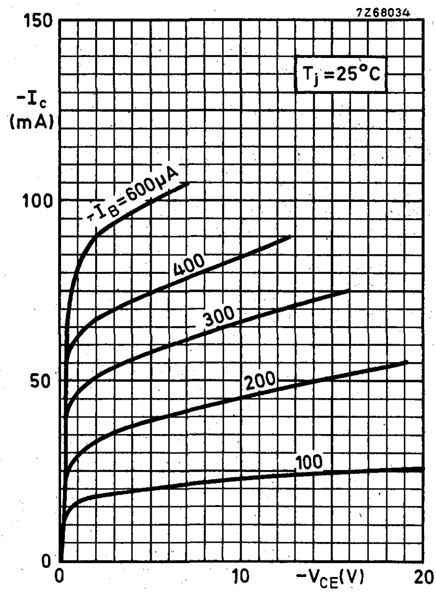


Fig. 5.

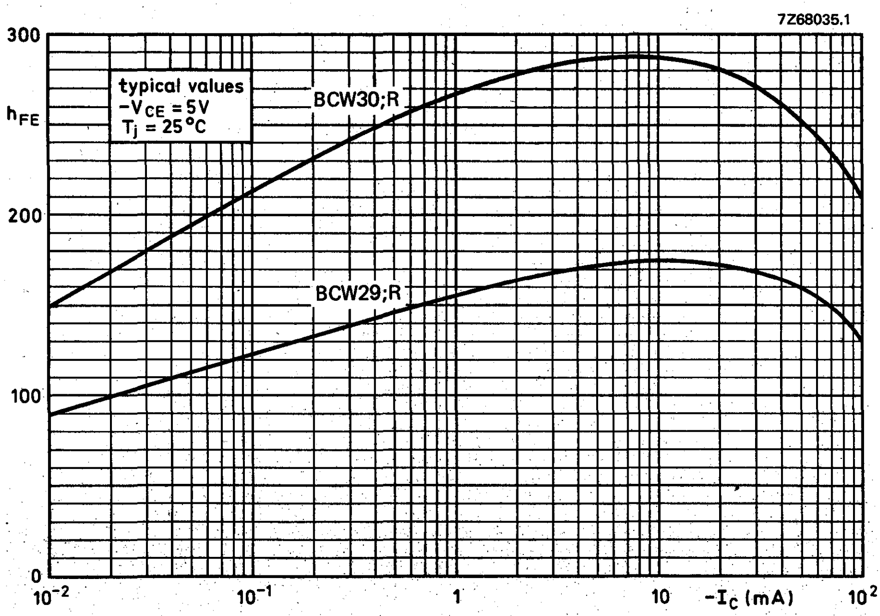


Fig. 6.

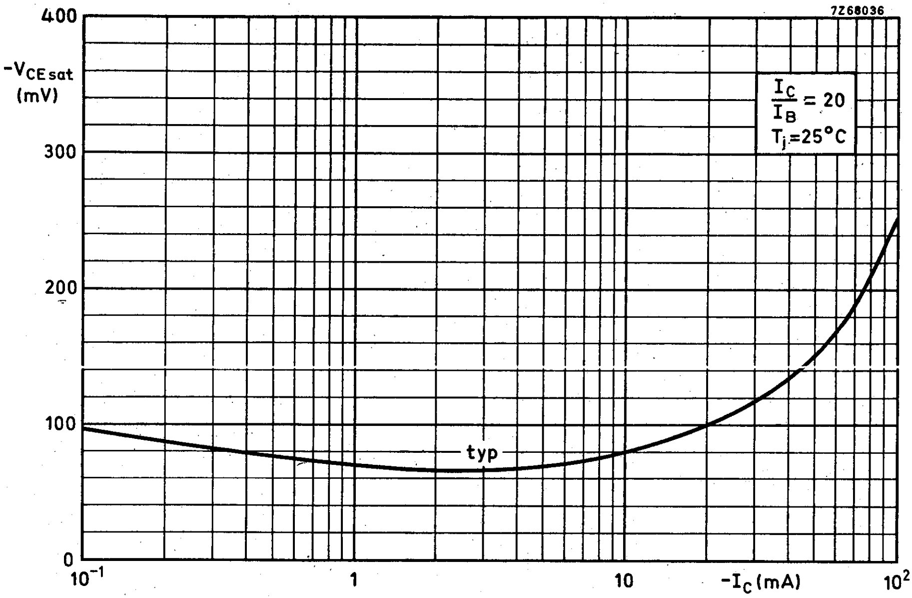

7Z68036
400
$-V_{CEsat}$
(mV)
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25\,°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 7.

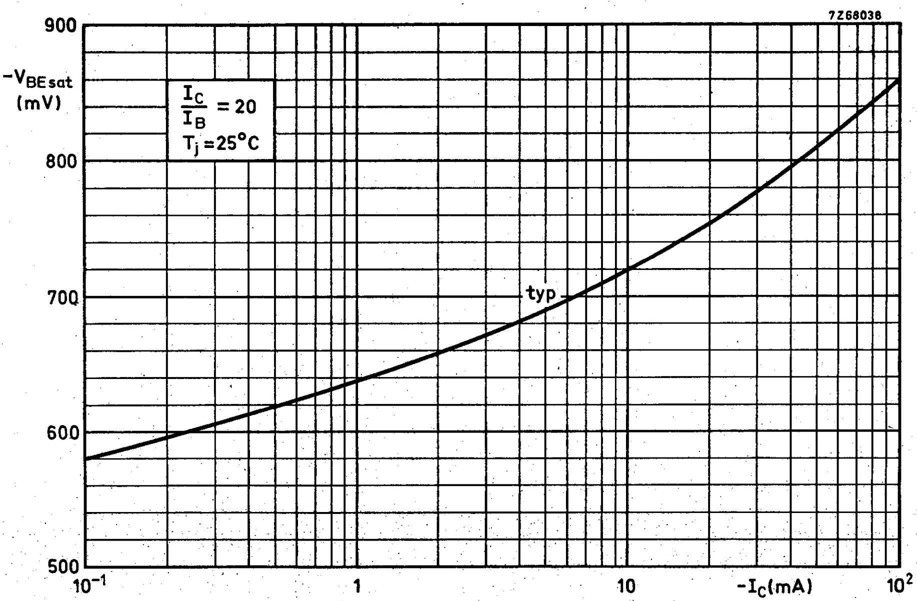

7Z68038
900
$-V_{BEsat}$
(mV)
800
700
600
500
$\frac{I_C}{I_B} = 20$
$T_j = 25\,°C$
typ
10^{-1}
1
10
$-I_C$(mA)
10^2

Fig. 8.

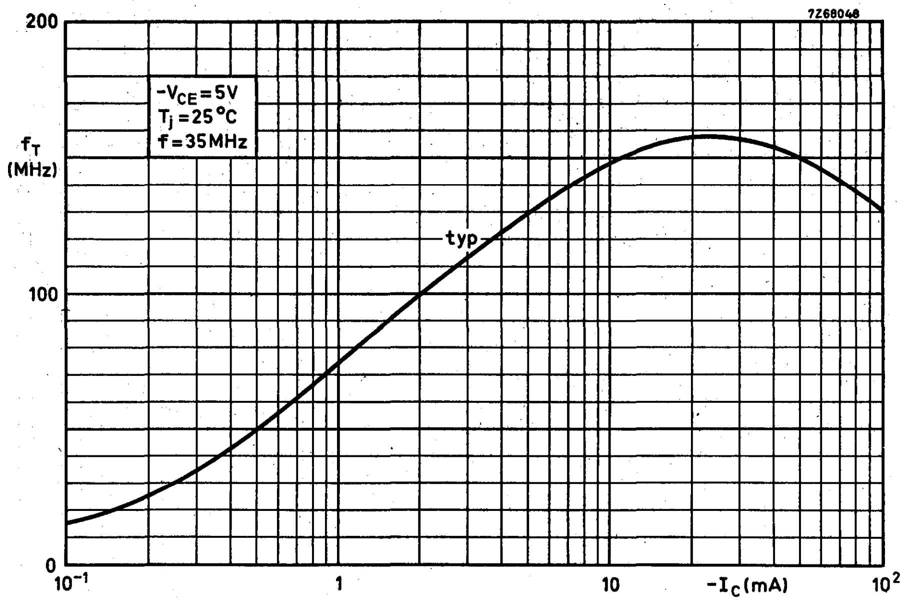

7Z68048
$-V_{CE} = 5 V$
$T_j = 25 °C$
$f = 35 MHz$
f_T (MHz)
typ
$-I_C$ (mA)
200
100
0
10^{-1}
1
10
10^2

Fig. 9.

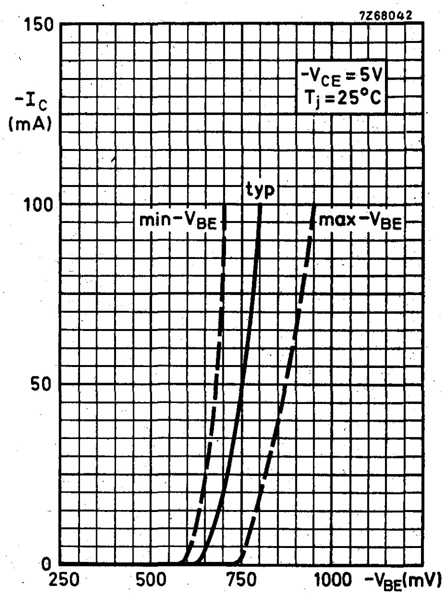

7Z68042
$-V_{CE} = 5 V$
$T_j = 25 °C$
$-I_C$ (mA)
min $-V_{BE}$
typ
max $-V_{BE}$
150
100
50
0
250
500
750
1000
$-V_{BE}$ (mV)

Fig. 10.

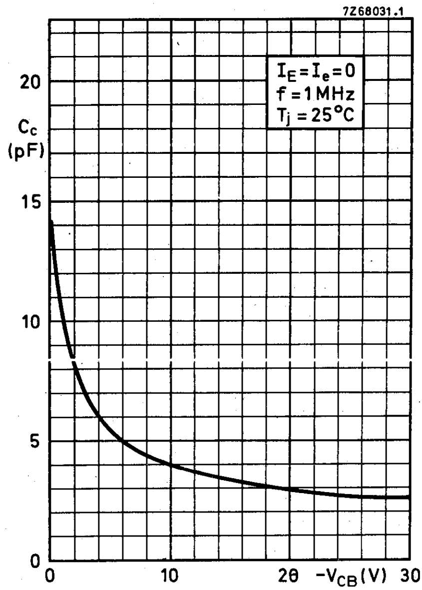

7Z68031.1
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25°C$
20
C_c
(pF)
15
10
5
0
0
10
20
$-V_{CB}$(V)
30

Fig. 11.

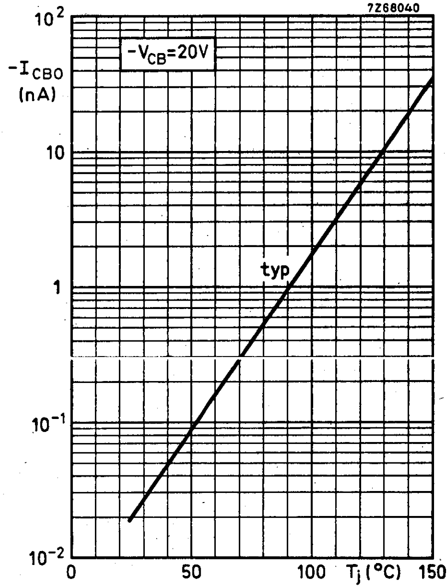

7Z68040
10^2
$-V_{CB}$=20V
$-I_{CBO}$
(nA)
10
1
typ
10^{-1}
10^{-2}
0
50
100
T_j (°C)
150

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.

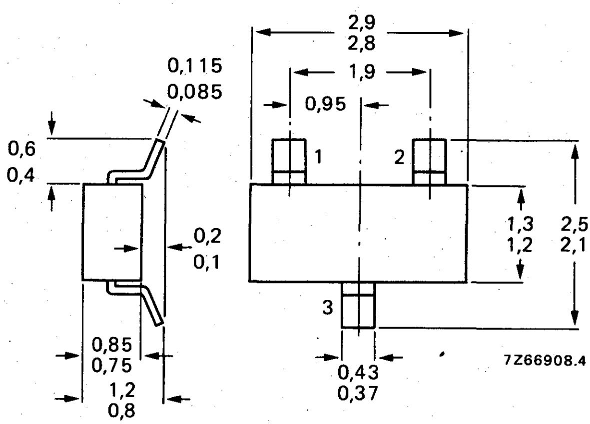
QUICK REFERENCE DATA

			BCW31 BCW31R	BCW32 BCW32R	BCW33 BCW33R	
D.C. current gain at T_j = 25 ^oC I_C = 2 mA; V_{CE} = 5 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 ^oC	P_{tot}	max.		350		mW
Junction temperature	T_j	max.		175		^oC
Transition frequency at f = 35 MHz I_C = 2 mA; V_{CE} = 5 V	f_T	typ.		300		MHz
Noise figure at R_S = 2 kΩ I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	<		10		dB

MECHANICAL DATA

Dimensions in mm

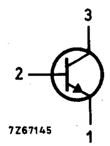
Fig. 1 SOT-23.



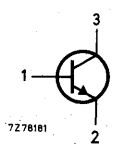
See also *Soldering recommendations.*

Marking code

BCW31 = D1
BCW32 = D2
BCW33 = D3



BCW31R = D4
BCW32R = D5
BCW32R = D6



RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	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*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	50 K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	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}		550 to 700 mV
Saturation voltages			
I_C 10 mA; $I_B = 0,5$ mA	V_{CEsat}	typ.	120 mV
		<	250 mV
	V_{BEsat}	typ.	750 mV
$I_C = 50$ mA; $I_B = 2,5$ mA	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			BCW31 BCW31R	BCW32 BCW32R	BCW33 BCW33R	
$I_C = 10\ \mu A$, $V_{CE} = 5$ V	h_{FE}	typ.	90	150	270	
$I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	> <	110 220	200 450	420 800	
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

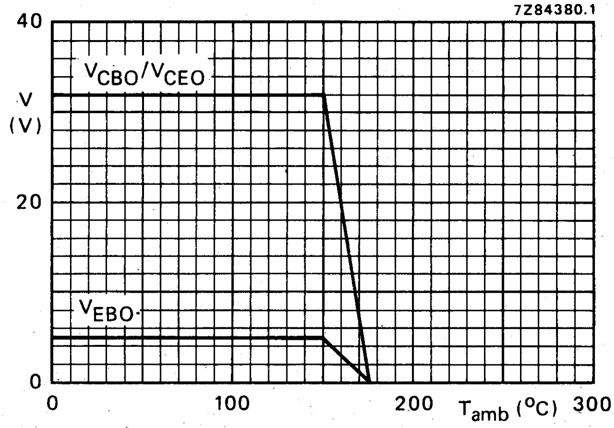


Fig. 2 Voltage derating curves.

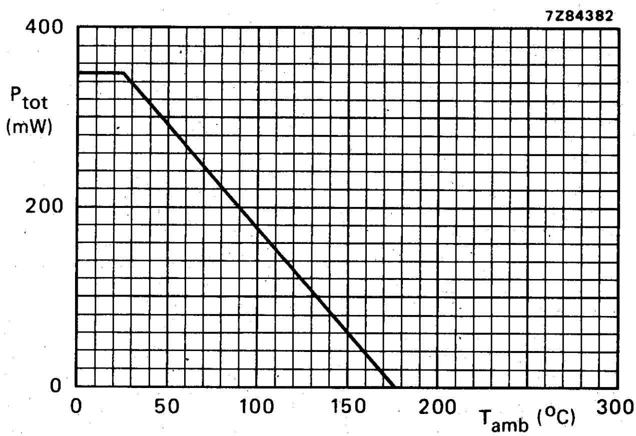


Fig. 3 Power derating curve.

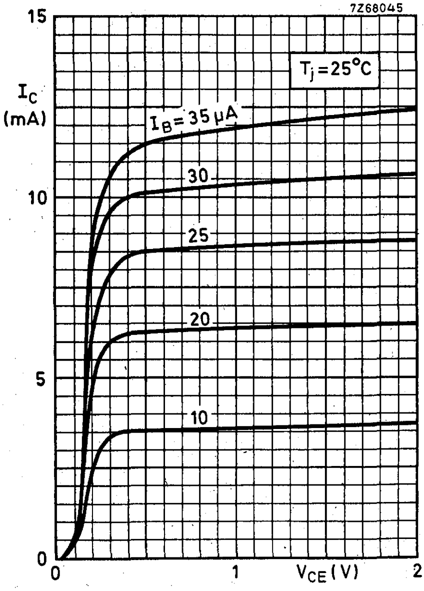


Fig. 4.

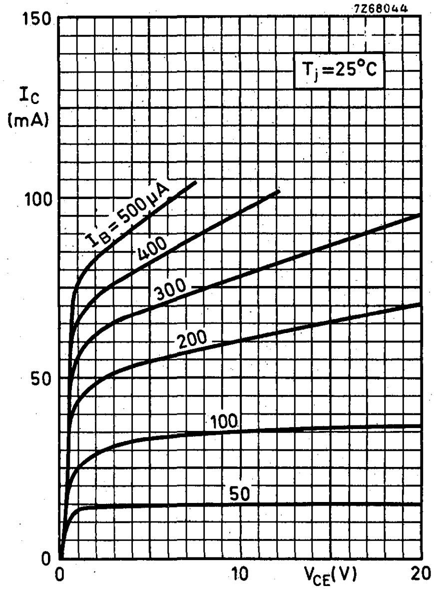


Fig. 5.

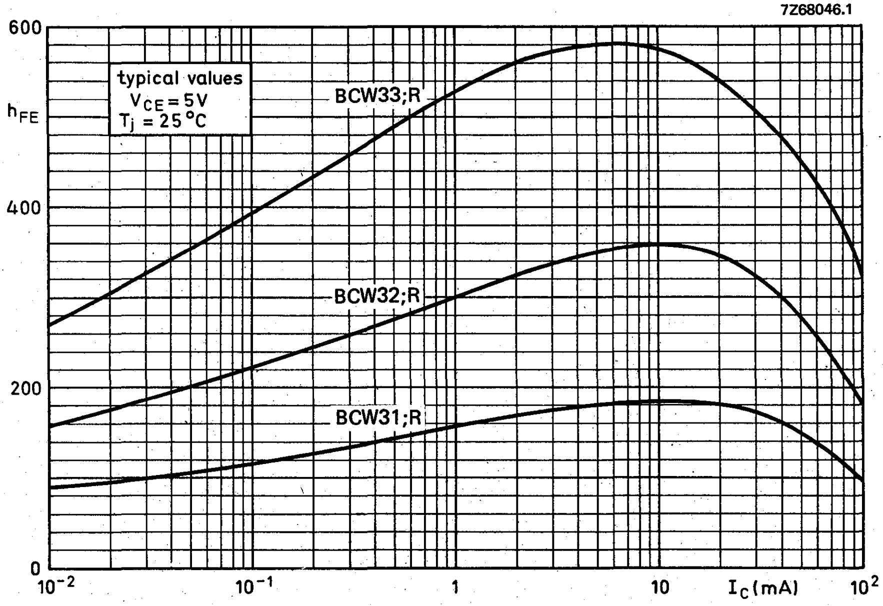


Fig. 6.

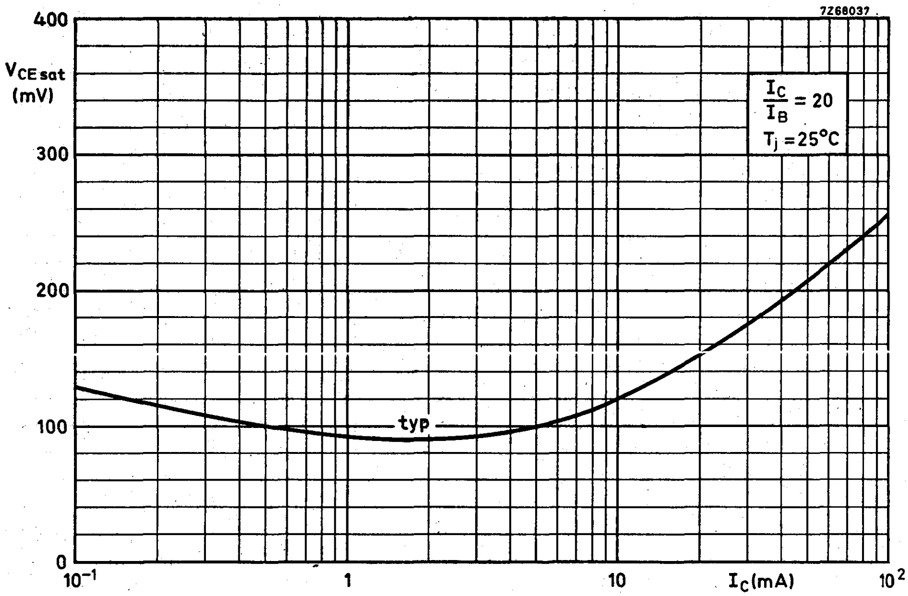

7Z68037
400
V_{CEsat} (mV)
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25 °C$
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 7.

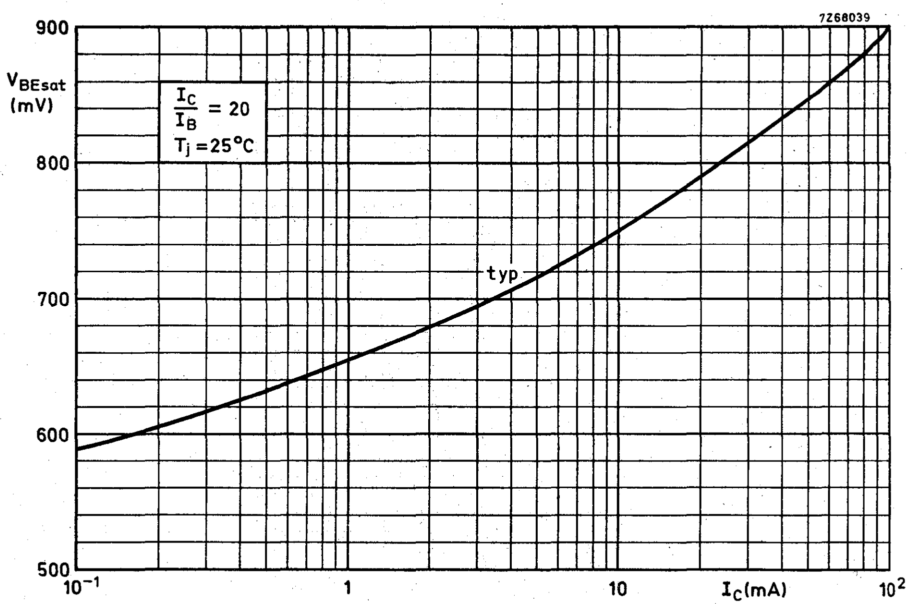

7Z68039
900
V_{BEsat} (mV)
800
700
600
500
$\frac{I_C}{I_B} = 20$
$T_j = 25 °C$
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 8.

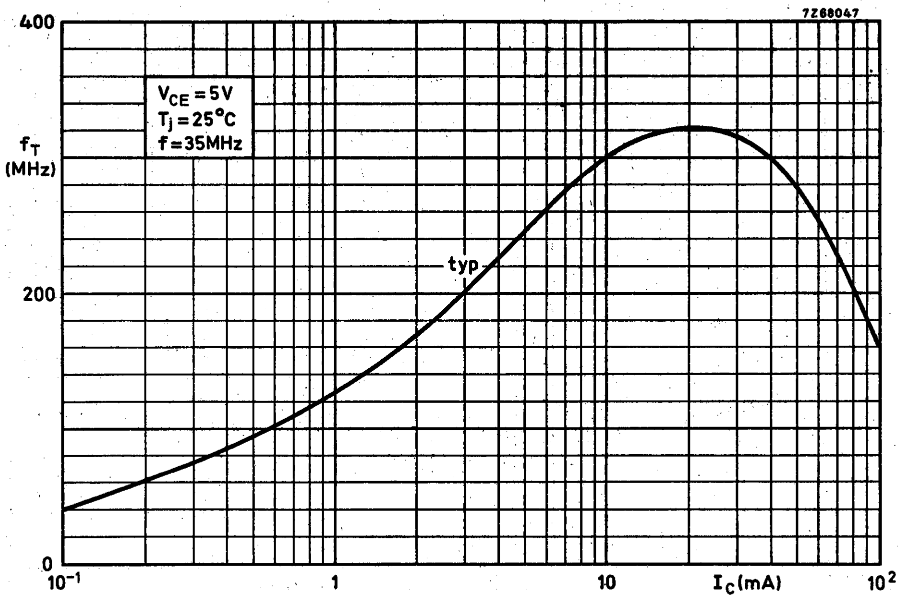

7Z68047
400
200
0
V_{CE} = 5 V
T_j = 25 °C
f = 35 MHz
f_T
(MHz)
typ
10^{-1}
1
10
I_C (mA)
10^2

Fig. 9.

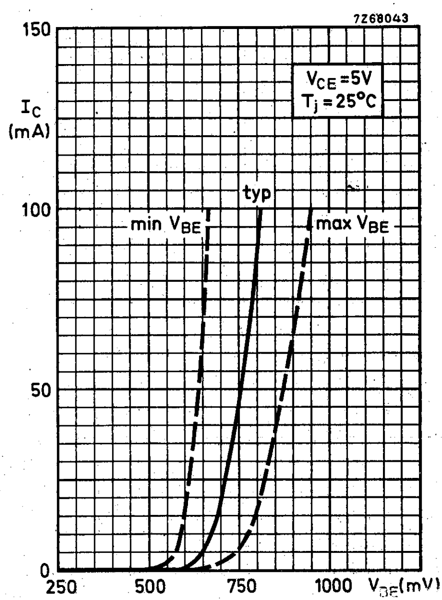

7Z68043
150
100
50
0
I_C
(mA)
V_{CE} = 5 V
T_j = 25 °C
min V_{BE}
typ
max V_{BE}
250
500
750
1000
V_{BE} (mV)

Fig. 10

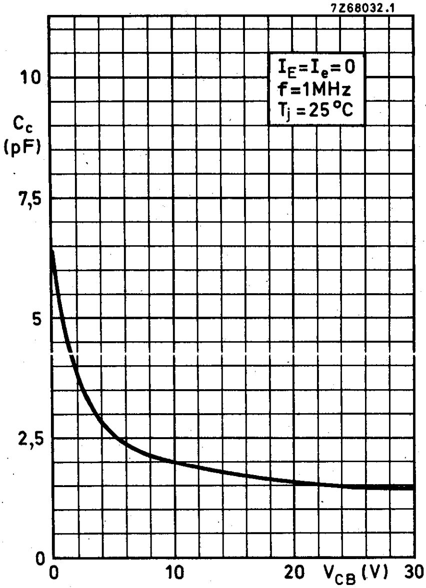

7Z68032.1
$I_E = I_e = 0$
f = 1MHz
$T_j = 25\,^\circ C$
C_c
(pF)
10
7,5
5
2,5
0
0
10
20
V_{CB} (V)
30

Fig. 11.

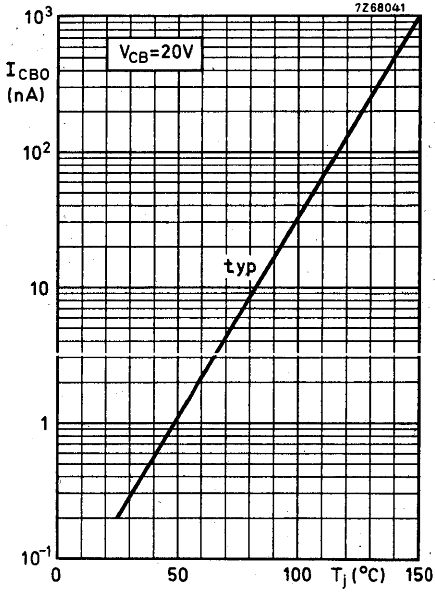

7Z68041
$V_{CB} = 20V$
I_{CBO}
(nA)
10^3
10^2
10
1
10^{-1}
typ
0
50
100
T_j (°C)
150

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 μA; B = 200 Hz	F	typ.	2	dB

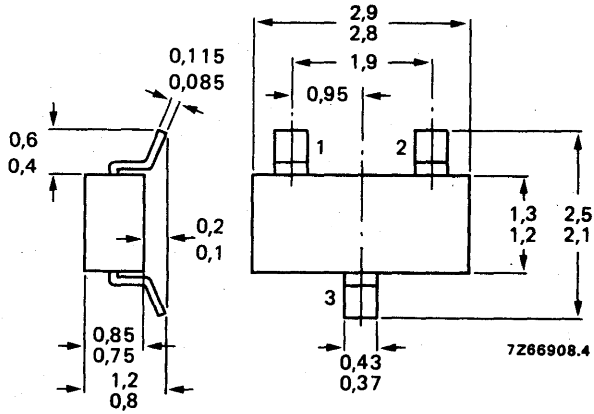
MECHANICAL DATA

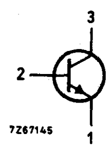
Dimensions in mm

Fig. 1 SOT-23.

Marking code

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*

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

Thermal resistance

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

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector-emitter cut-off current			
V_{BE} = 0; V_{CE} = 32 V	I_{CES}	<	20 nA
V_{BE} = 0; V_{CE} = 32 V; T_{amb} = 150 °C	I_{CES}	<	20 μA
Emitter-base cut-off current			
I_C = 0; V_{EB} = 4 V	I_{EBO}	<	20 nA
Saturation voltages			
at I_C = 10 mA; I_B = 0,25 mA	V_{CEsat}		0,05 to 0,35 V
	V_{BEsat}		0,6 to 0,85 V
at I_C = 50 mA; I_B = 1,25 mA	V_{CEsat}		0,1 to 0,55 V
	V_{BEsat}		0,7 to 1,05 V
Transition frequency at f = 100 MHz ▲			
I_C = 10 mA; V_{CE} = 5 V	f_T	>	125 MHz
		typ.	250 MHz
Collector capacitance at f = 1 MHz			
I_E = I_e = 0; V_{CB} = 10 V	C_c	<	4,5 pF
Emitter capacitance at f = 1 MHz			
I_C = I_c = 0; V_{EB} = 0,5 V	C_e	typ.	8 pF
Noise figure at R_S = 2 kΩ			
I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	typ.	2 dB
		<	6 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 V; I_C = 10 μA	h_{FE}	typ.	78	145	220	300	
		>	–	20	40	100	
		>	120	180	250	380	
V_{CE} = 5 V; I_C = 2 mA	h_{FE}	typ.	170	250	350	500	
		<	220	310	460	630	
V_{CE} = 1 V; I_C = 50 mA	h_{FE}	>	50	70	90	100	
Input impedance		>	1,6	2,5	3,2	4,5	kΩ
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{ie}	typ.	2,7	3,6	4,5	7,5	kΩ
		<	4,5	6,0	8,5	12,0	kΩ
Reverse voltage transfer ratio							
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{re}	typ.	1,5	2	2	3	10^{-4}
Small-signal current gain		>	125	175	250	350	
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{fe}	typ.	200	260	330	520	
		<	250	350	500	700	
Output admittance							
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{oe}	typ.	18	24	30	50	μA/V
		<	30	50	60	100	μA/V

Base-emitter voltage				
V_{CE} = 5 V; I_C = 2 mA	V_{BE}		0,55 to 0,75	V
		typ.	0,65	V
V_{CE} = 5 V; I_C = 10 μA	V_{BE}	typ.	0,52	V
V_{CE} = 1 V; I_C = 50 mA	V_{BE}	typ.	0,78	V

Switching times

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

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

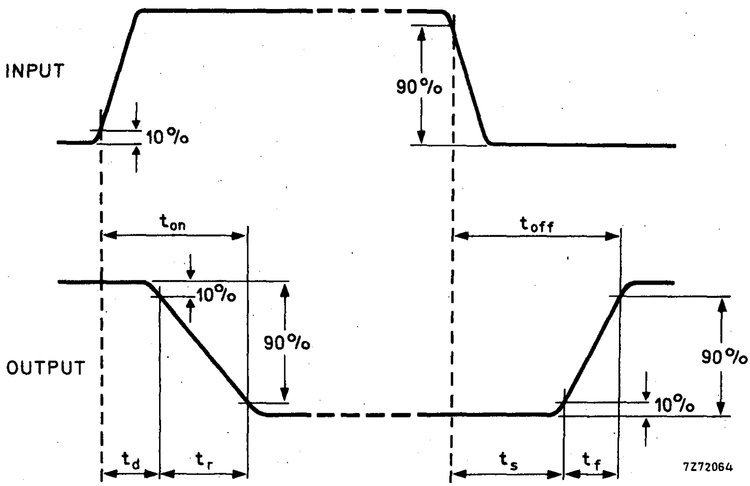


Fig. 2 Switching waveforms.

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 μA	F	typ.	2	dB

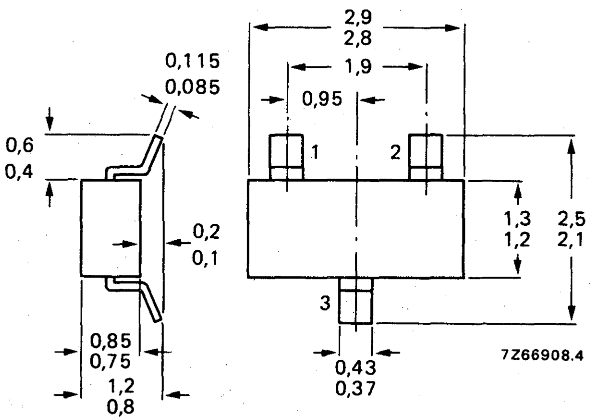
MECHANICAL DATA

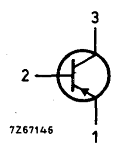
Fig. 1 SOT-23.

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*

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

Thermal resistance

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

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector-emitter cut-off current			
$V_{EB} = 0$; $-V_{CE} = 32$ V	$-I_{CES}$	<	20 nA
$V_{EB} = 0$; $-V_{CE} = 32$ V; $T_{amb} = 150$ °C	$-I_{CES}$	<	20 μA
Emitter-base cut-off current			
$I_C = 0$; $-V_{EB} = 4$ V	$-I_{EBO}$	<	20 nA
Saturation voltages			
$-I_C = 10$ mA; $-I_B = 0{,}25$ mA	$-V_{CEsat}$	0,06 to 0,25 V	
	$-V_{BEsat}$	0,6 to 0,85 V	
$-I_C = 50$ mA; $-I_B = 1{,}25$ mA	$-V_{CEsat}$	0,12 to 0,55 V	
	$-V_{BEsat}$	0,68 to 1,05 V	
Transition frequency at f = 100 MHz ▲			
$-V_{CE} = 5$ V; $-I_C = 10$ mA	f_T	typ.	180 MHz
Collector capacitance at f = 1 MHz			
$-V_{CB} = 10$ V; $I_E = I_e = 0$	C_c	<	6 pF
Emitter capacitance at f = 1 MHz			
$-V_{EB} = 0{,}5$ V; $I_C = I_c = 0$	C_e	typ.	11 pF
Noise figure at $R_S = 2$ kΩ			
$-V_{CE} = 5$ V; $-I_C = 200$ μA; B = 200 Hz	F	typ. < 	2 dB 6 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 V; $-I_C$ = 10 μA	h_{FE}	typ.	140	200	270	340	
		>	–	30	40	100	
		>	120	180	250	380	
$-V_{CE}$ = 5 V; $-I_C$ = 2 mA	h_{FE}	typ.	170	250	350	500	
		<	220	310	460	630	
$-V_{CE}$ = 1 V; $-I_C$ = 50 mA	h_{FE}	>	60	80	100	110	
Input impedance		>	1,6	2,5	3,2	4,5	kΩ
$-V_{CE}$ = 5 V; $-I_C$ = 2 mA; f = 1 kHz	h_{ie}	typ.	2,7	3,6	4,5	7,5	kΩ
		<	4,5	6,0	8,5	12,0	kΩ
Reverse voltage transfer ratio							
$-V_{CE}$ = 5 V; $-I_C$ = 2 mA; f = 1 kHz	h_{re}	typ.	1,5	2	2	3	10^{-4}
Small-signal current gain		>	125	175	250	350	
$-V_{CE}$ = 5 V; $-I_C$ = 2 mA; f = 1 kHz	h_{fe}	typ.	200	260	330	520	
		<	250	350	500	700	
Output admittance							
$-V_{CE}$ = 5 V; $-I_C$ = 2 mA; f = 1 kHz	h_{oe}	typ.	18	24	30	50	μA/V
		<	30	50	60	100	μA/V
Base-emitter voltage							
$-V_{CE}$ = 5 V; $-I_C$ = 2 mA	V_{BE}		0,6 to 0,75				V
		typ.	0,65				V
$-V_{CE}$ = 5 V; $-I_C$ = 10 μA	V_{BE}	typ.	0,55				V
$-V_{CE}$ = 1 V; $-I_C$ = 50 mA	V_{BE}	typ.	0,72				V

Switching times

$-I_{Con} = 10$ mA; $-I_{Bon} = I_{Boff} = 1$ mA
$-V_{CC} = 10$ 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

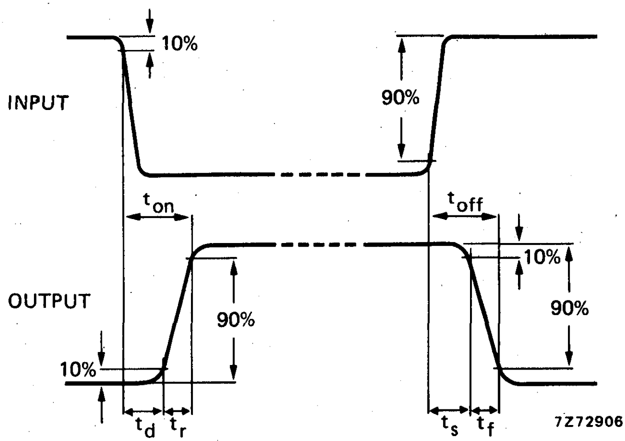


Fig. 2 Switching waveforms.

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.

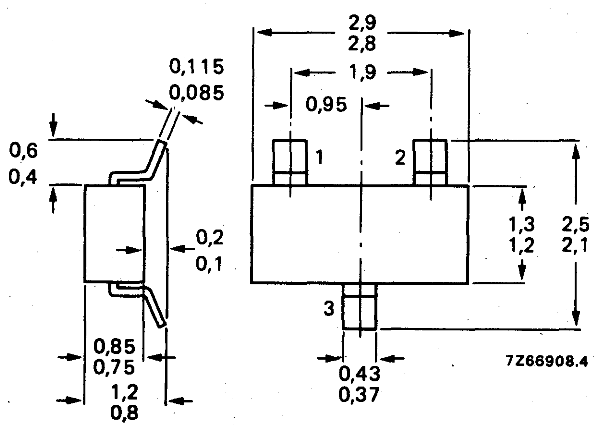
QUICK REFERENCE DATA

			BCW69 BCW69R	BCW70 BCW70R	
D.C. current gain at T_j = 25 °C; $-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	>	120	215	
		<	260	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 °C	P_{tot}	max.	350		mW
Junction temperature	T_j	max.	175		°C
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 kΩ; $-I_C$ = 200 µA; $-V_{CE}$ = 5 V; f = 1 kHz; B = 200 Hz	F	<	10		dB

MECHANICAL DATA

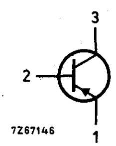
Dimensions in mm

Fig. 1 SOT-23.

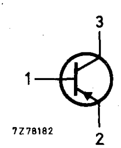


Marking code

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	$-V_{CBO}$	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*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	50	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	120	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; $T_j = 100$ °C	$-I_{CBO}$	<	10	µA
Base-emitter voltage				
$-I_C = 2$ mA; $-V_{CE} = 5$ V	$-V_{BE}$		600 to 750	mV
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.

			BCW69 BCW69R	BCW70 BCW70R	
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}	>	120	215	
		<	260	500	
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

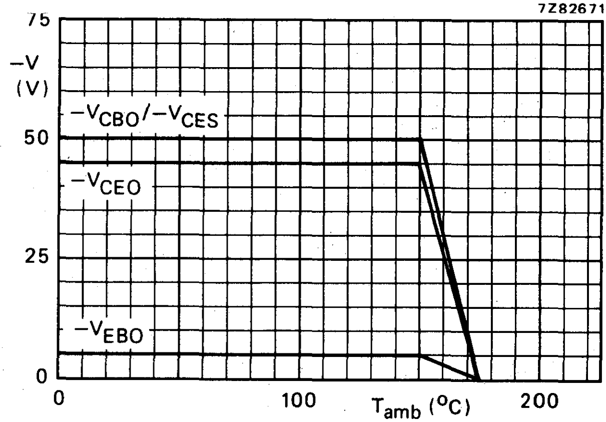


Fig. 2 Voltage derating curve.

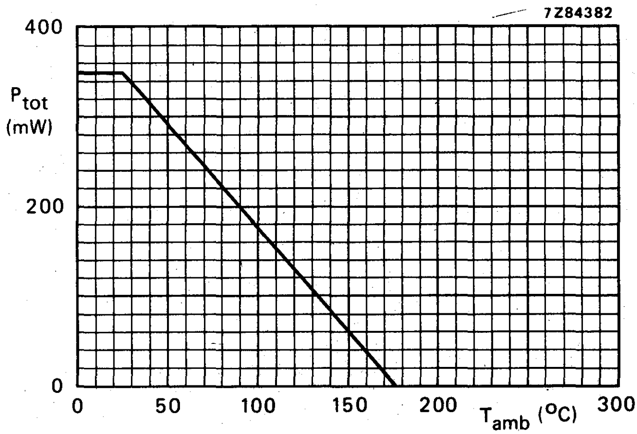


Fig. 3 Power derating curve.

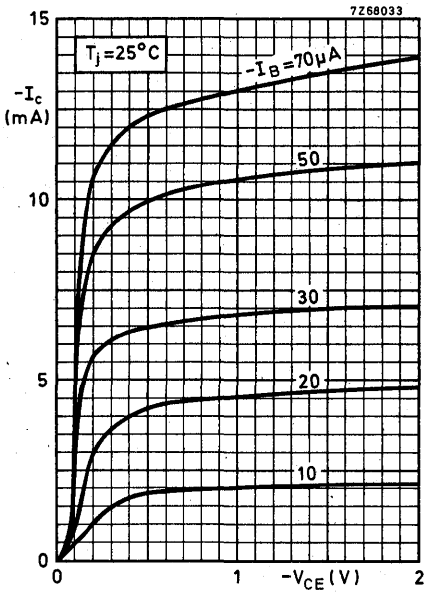


Fig. 4.

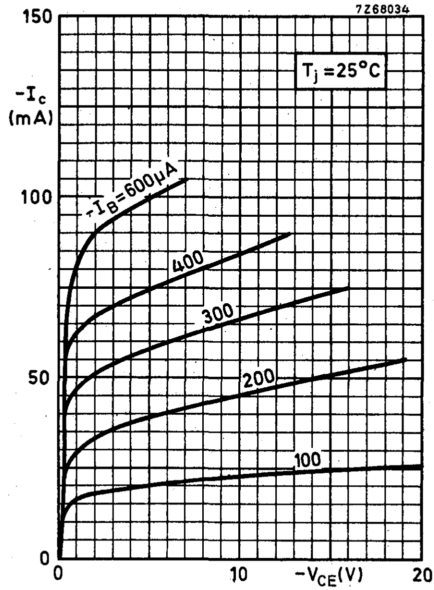


Fig. 5.

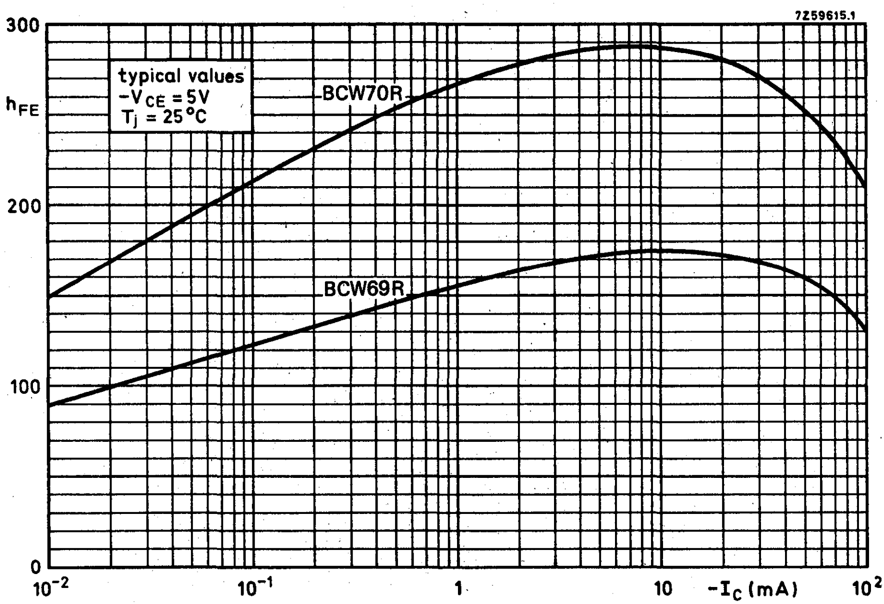


Fig. 6 D.C. current gain.

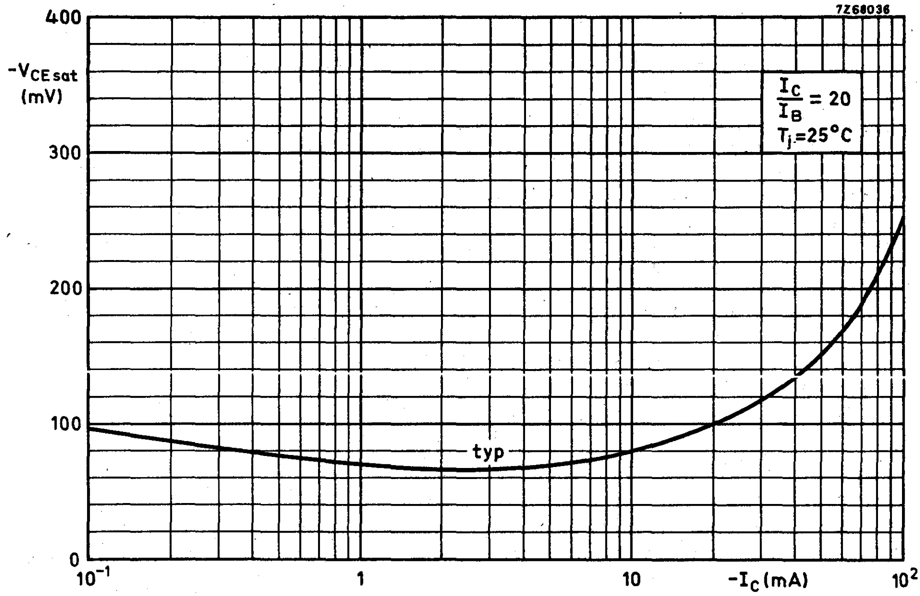

7Z68036
400
$-V_{CEsat}$
(mV)
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25\,°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 7.

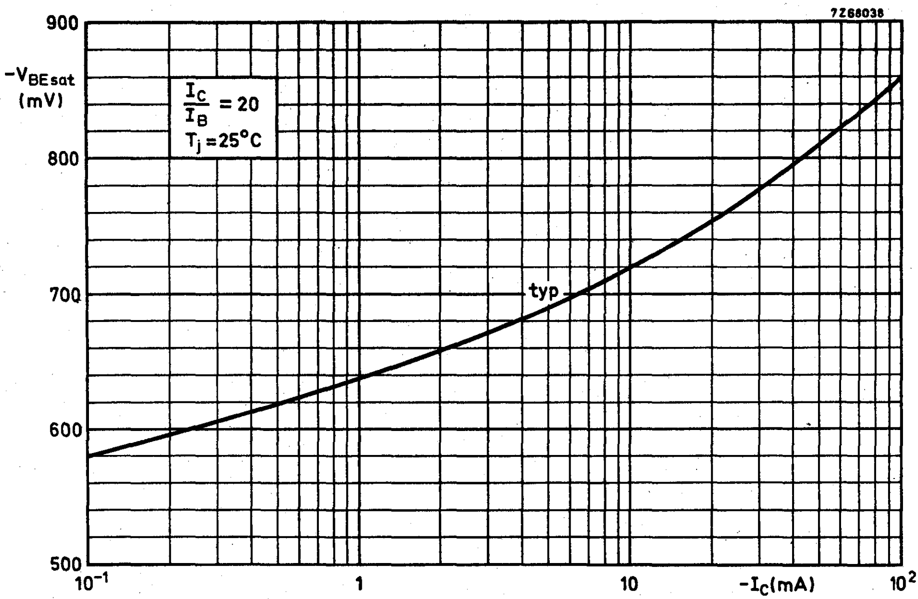

7Z68038
900
$-V_{BEsat}$
(mV)
800
700
600
500
$\frac{I_C}{I_B} = 20$
$T_j = 25\,°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 8.

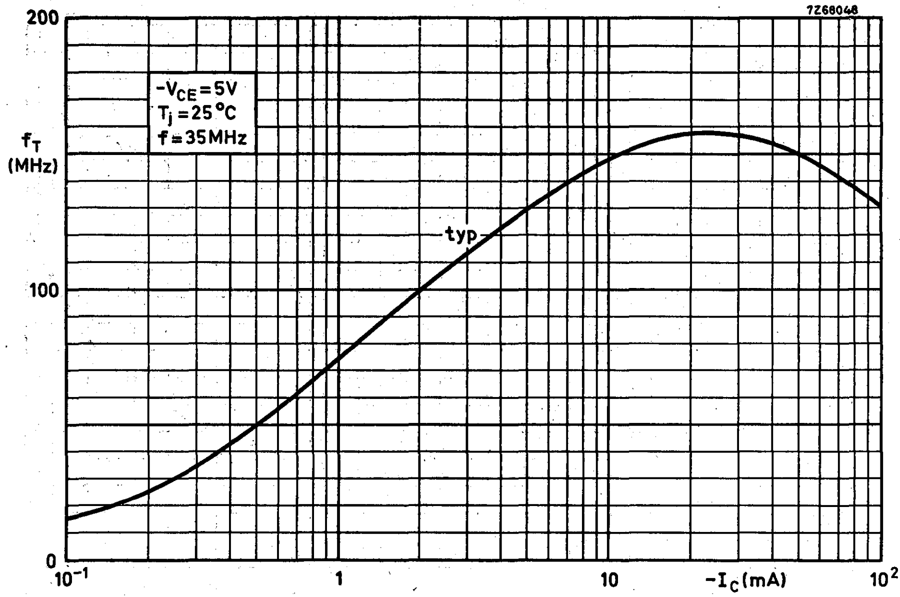

7Z68048
$-V_{CE} = 5V$
$T_j = 25°C$
f = 35MHz
f_T
(MHz)
200
100
0
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 9.

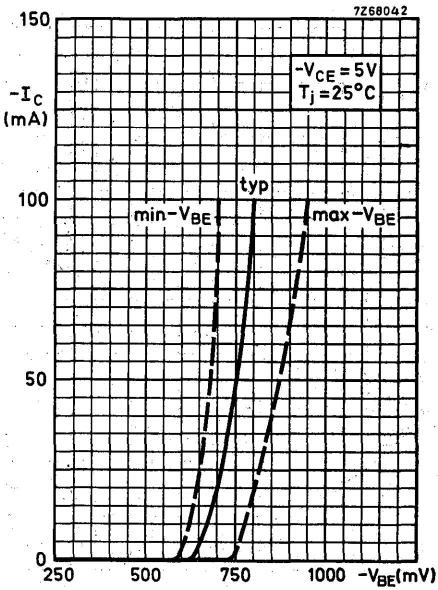

7Z68042
150
100
50
0
$-I_C$
(mA)
$-V_{CE} = 5V$
$T_j = 25°C$
typ
min$-V_{BE}$
max$-V_{BE}$
250
500
750
1000
$-V_{BE}$(mV)

Fig. 10.

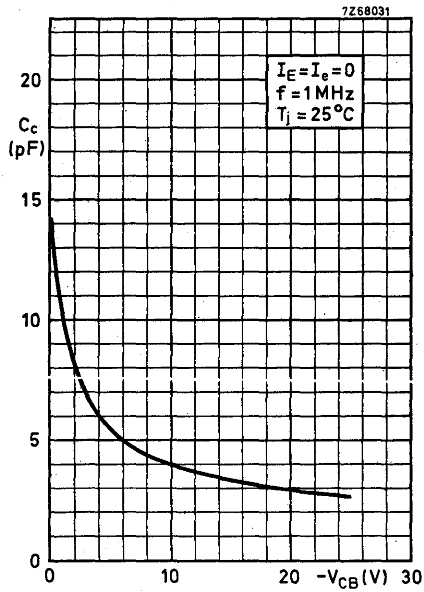

7Z68031
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
C_c (pF)
$-V_{CB}$ (V)
0
5
10
15
20
0
10
20
30

Fig. 11.

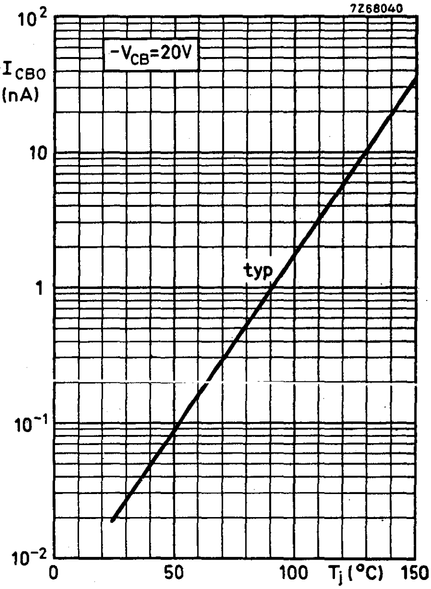

7Z68040
$-V_{CB}$ = 20V
$-I_{CBO}$ (nA)
typ
T_j (°C)
10^2
10
1
10^{-1}
10^{-2}
0
50
100
150

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.

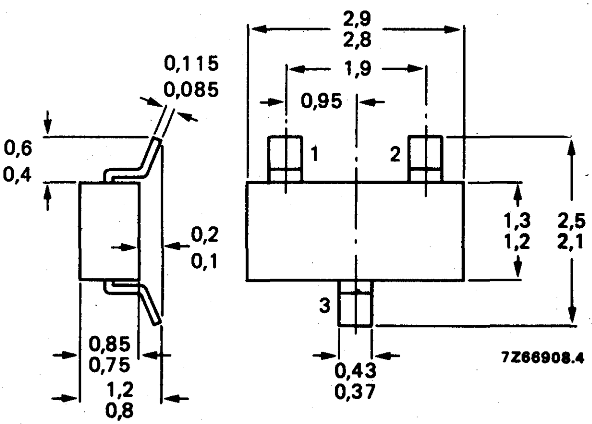
QUICK REFERENCE DATA

			BCW71 BCW71R	BCW72 BCW72R	
D.C. current gain at T_j = 25 °C		>	110	200	
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	<	220	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 °C	P_{tot}	max.	350		mW ←
Junction temperature	T_j	max.	175		°C ←
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 kΩ I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	<	10		dB

MECHANICAL DATA

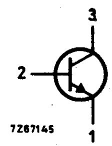
Dimensions in mm

Fig. 1 SOT-23.

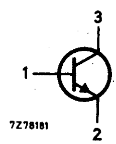


Marking code

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 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*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	50 K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	120 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 = 100 °C	I_{CBO}	<	10 μA
Base emitter voltage I_C = 2 mA; V_{CE} = 5 V	V_{BE}		550 to 700 mV
Saturation voltages			
I_C = 10 mA; I_B = 0,5 mA	V_{CEsat}	typ.	120 mV
		<	250 mV
	V_{BEsat}	typ.	750 mV
I_C = 50 mA; I_B = 2,5 mA	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.

			BCW71;R	BCW72;R	
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

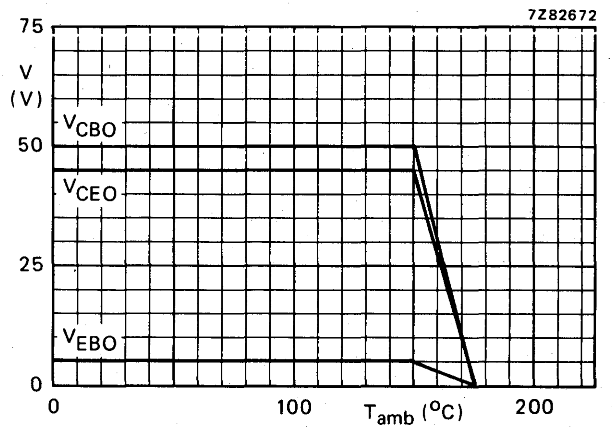


Fig. 2 Voltage derating curves.

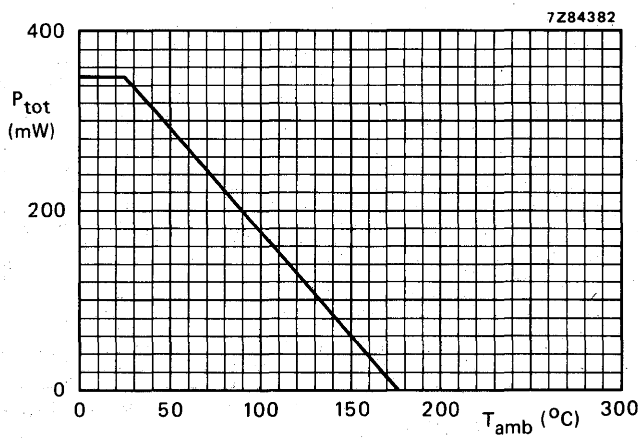


Fig. 3 Power derating curve.

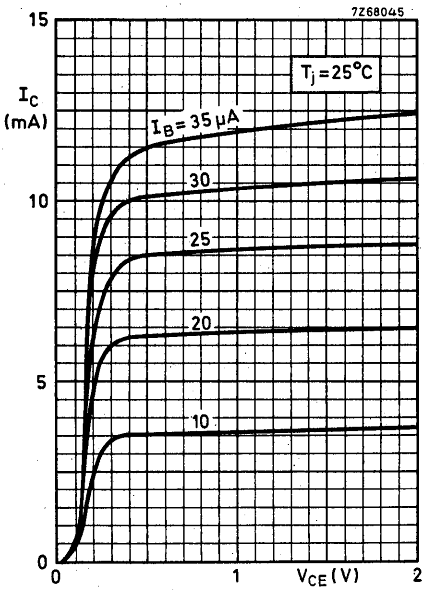


Fig. 4.

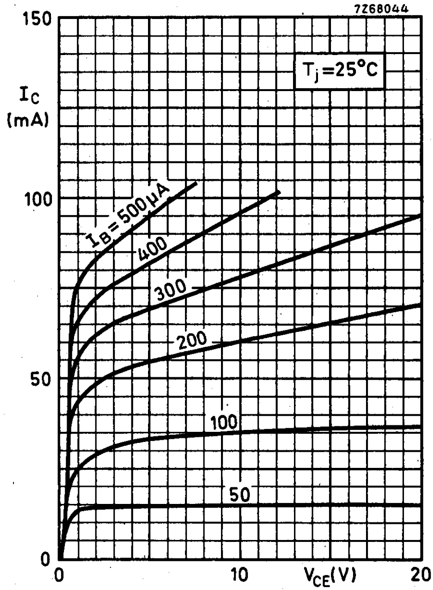


Fig.5.

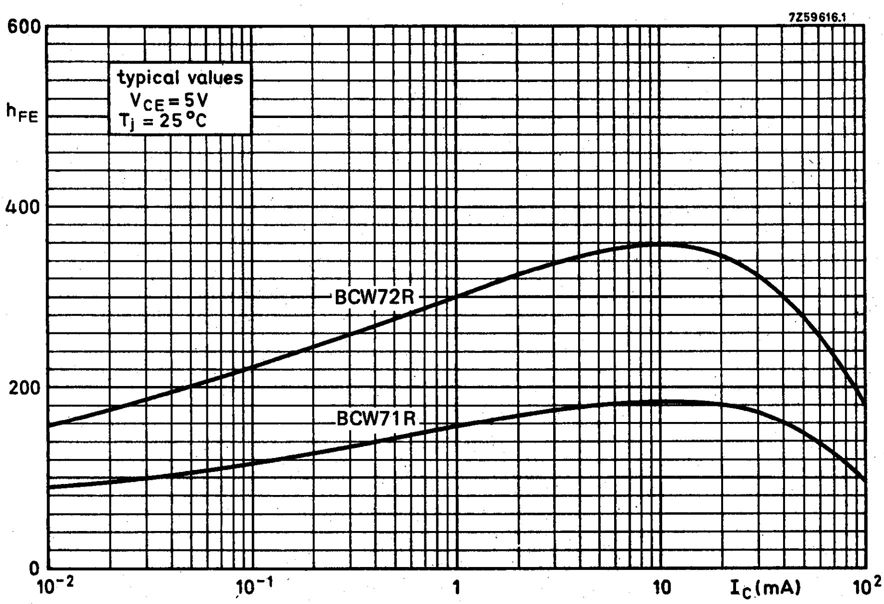


Fig. 6 D.C. current gain.

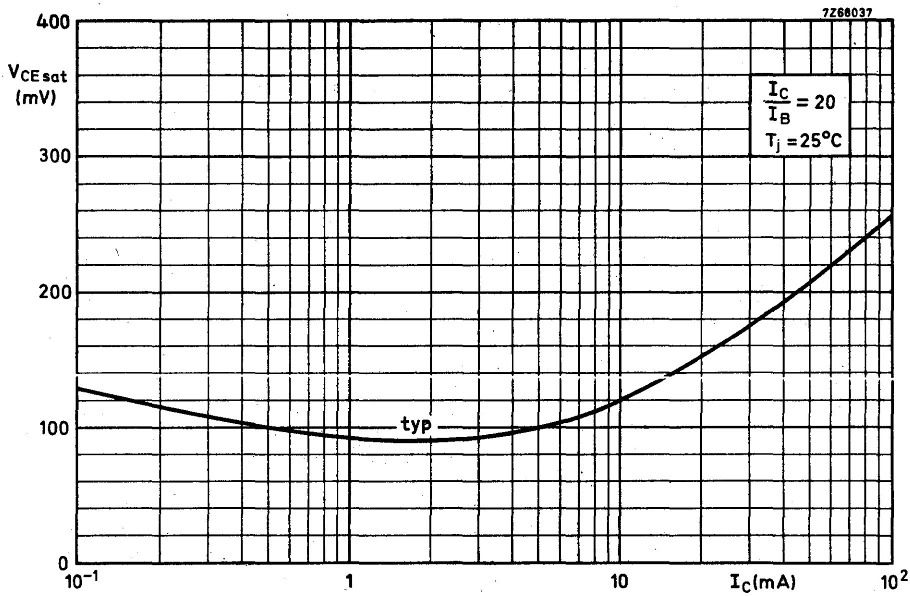

7Z68037
400
V_{CEsat} (mV)
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 7.

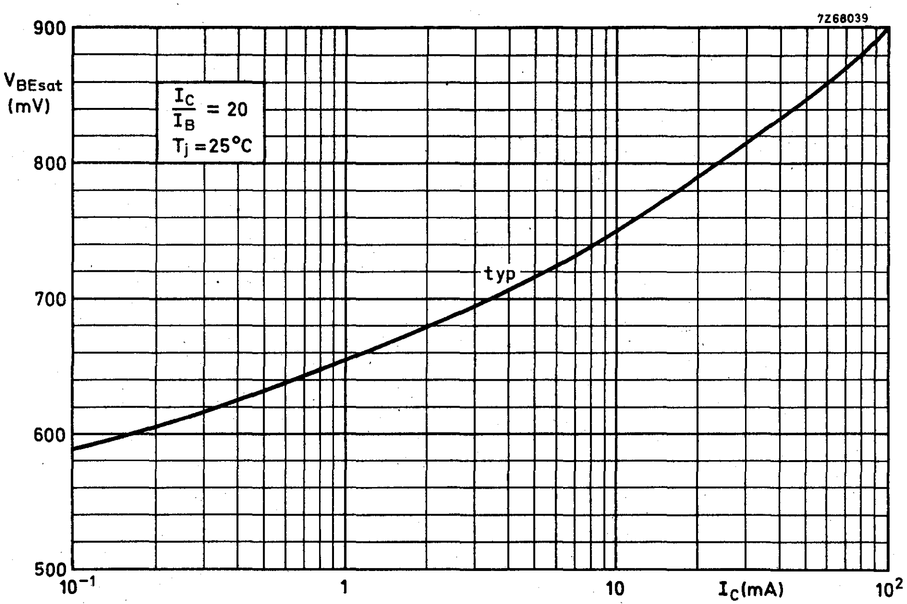

7Z68039
900
V_{BEsat} (mV)
800
700
600
500
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 8.

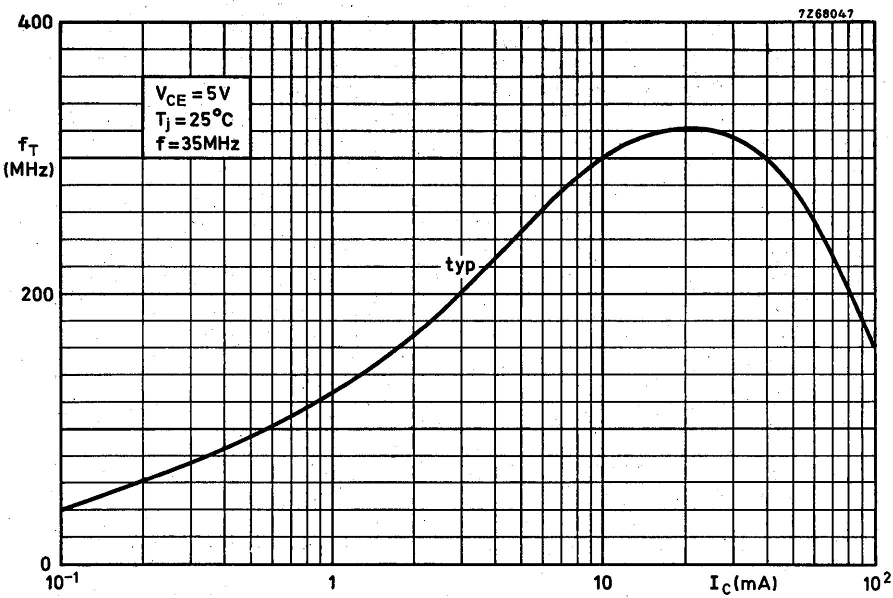

7Z68047
400
200
0
f_T
(MHz)
$V_{CE} = 5V$
$T_j = 25°C$
f = 35MHz
typ
10^{-1}
1
10
I_C (mA)
10^2

Fig. 9.

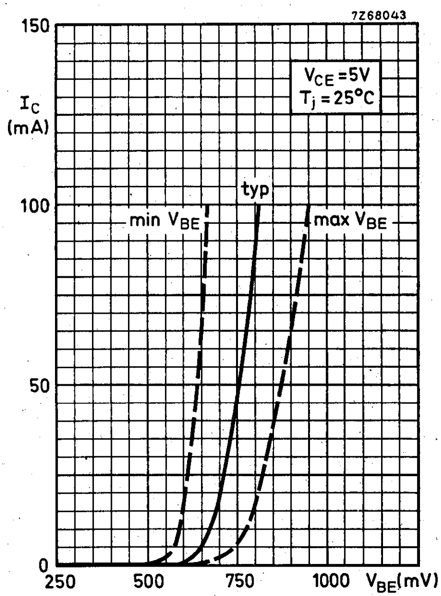

7Z68043
150
100
50
0
I_C
(mA)
$V_{CE} = 5V$
$T_j = 25°C$
typ
min V_{BE}
max V_{BE}
250
500
750
1000
V_{BE} (mV)

Fig. 10.

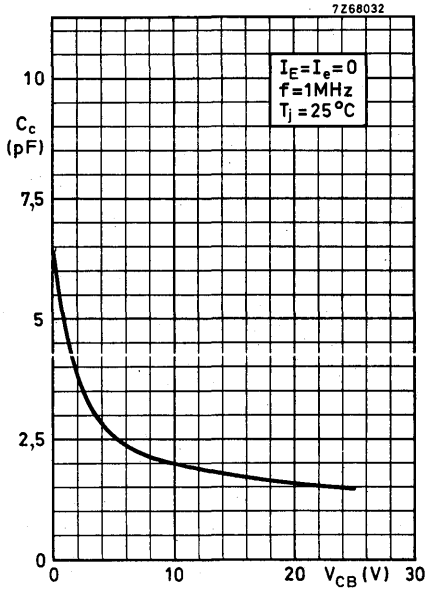

7Z68032
$I_E = I_e = 0$
f = 1MHz
$T_j = 25\,^{\circ}C$
C_c (pF)
10
7,5
5
2,5
0
0
10
20
V_{CB} (V)
30

Fig. 11.

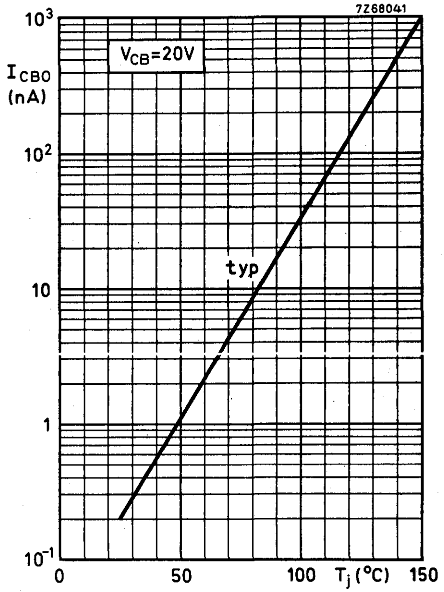

7Z68041
$V_{CB} = 20V$
I_{CBO} (nA)
10^3
10^2
10
1
10^{-1}
typ
0
50
100
T_j (°C)
150

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.

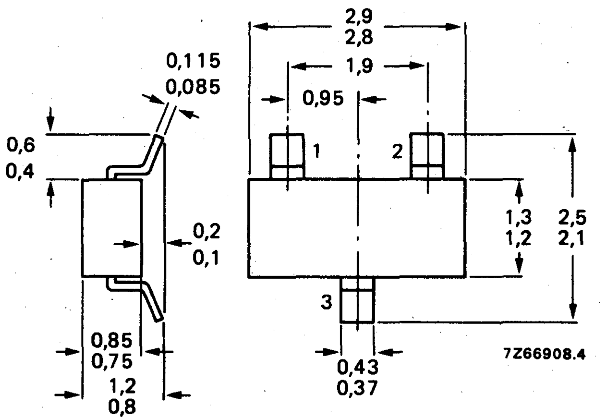
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	350 mW ←
Junction temperature	T_j	max.	175 °C ←
D.C. current gain at T_j = 25 °C I_C = 2 mA; V_{CE} = 5 V	h_{FE}	> <	420 800
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 kΩ I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	<	10 dB

MECHANICAL DATA

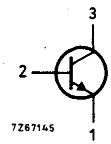
Dimensions in mm

Fig. 1 SOT-23.



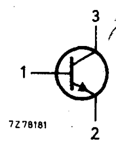
Marking code

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_{CBO}	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 $T_{amb} = 25\ ^oC$ 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		^oC
Junction temperature	T_j	max.	175	^oC

THERMAL CHARACTERISTICS*

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

Thermal resistance

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

CHARACTERISTICS

$T_j = 25\ ^oC$ 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; $T_j = 100\ ^oC$	I_{CBO}	<	10	µA
Base emitter voltage				
$I_C = 2$ mA; $V_{CE} = 5$ V	V_{BE}	550 to 700		mV
Saturation voltages				
$I_C = 10$ mA; $I_B = 0,5$ mA	V_{CEsat}	typ.	120	mV
		<	250	mV
	V_{BEsat}	typ.	750	mV
$I_C = 50$ mA; $I_B = 2,5$ mA	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 $I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	> <	420 800
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 $R_S = 2$ kΩ $I_C = 200$ μA; $V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10 dB

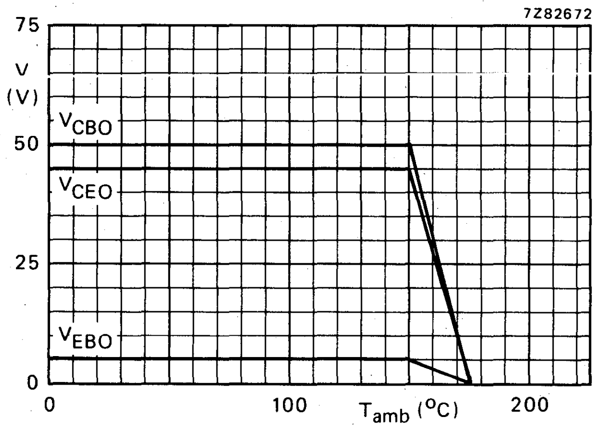


Fig. 2 Voltage derating curves.

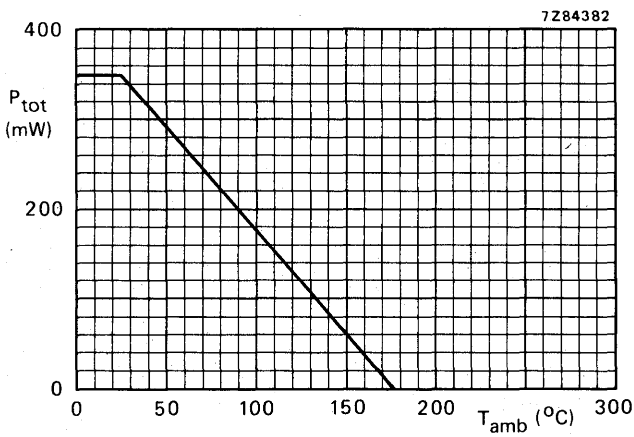


Fig. 3 Power derating curve.

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.

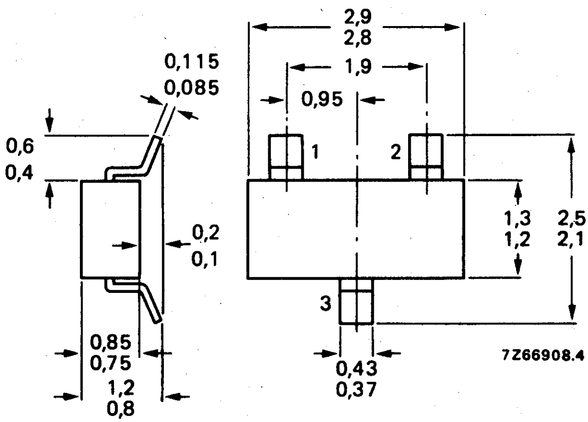
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	350	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C $-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	$>$ $<$	120 260	
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 kΩ $-I_C$ = 200 μA; $-V_{CE}$ = 5 V; f = 1 kHz; B = 200 Hz	F	$<$	10	dB

MECHANICAL DATA

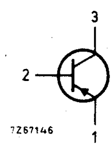
Dimensions in mm

Fig. 1 SOT-23.

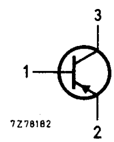


Marking code

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*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	50 K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	120 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 = 100 °C	$-I_{CBO}$	<	10 µA
Base-emitter voltage			
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V; T_j = 25 °C	$-V_{BE}$		600 to 750 mV
Saturation voltages			
$-I_C$ = 10 mA; $-I_B$ = 0,5 mA	$-V_{CEsat}$	typ.	80 mV
		<	300 mV
	$-V_{BEsat}$	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 μA; $-V_{CE}$ = 5 V	h_{FE}	typ.	90
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	> <	120 260
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 kΩ			
$-I_C$ = 200 μA; $-V_{CE}$ = 5 V f = 1 kHz; B = 200 Hz	F	<	10 dB

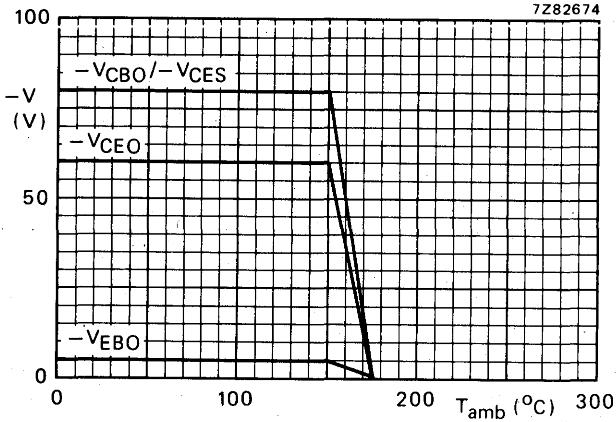


Fig. 2 Voltage derating curves.

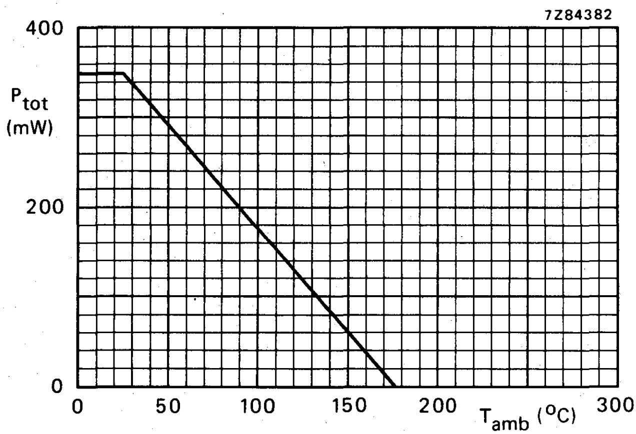


Fig. 3 Power derating curve.

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.

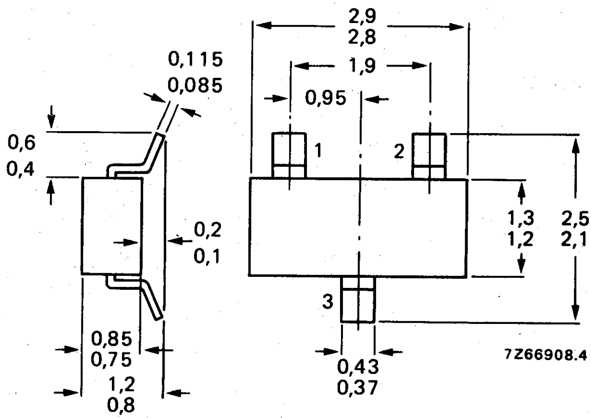
QUICK REFERENCE DATA

			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 °C	P_{tot}	max.	425		mW ←
Junction temperature	T_j	max.	175		°C ←
D.C. current gain $-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}		100 to 600		
Transition frequency $-I_C$ = 10 mA; $-V_{CE}$ = 5 V; f = 35 MHz	f_T	typ.	100		MHz

MECHANICAL DATA

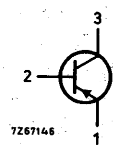
Dimensions in mm

Fig. 1 SOT-23.

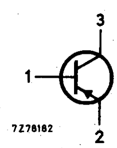


Marking code

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**

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	30	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
From soldering points to ambient*	$R_{th\ s\text{-}a}$	=	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 mA; $-V_{CE}$ = 1 V	h_{FE}	100 to 600
$-I_C$ = 300 mA; $-V_{CE}$ = 1 V	h_{FE}	> 70
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}	> 40
Transition frequency at f = 35 MHz		
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ. 100 MHz
Collector capacitance at f = 1 MHz		
$I_E = I_e = 0$; $-V_{CB}$ = 10 V	C_c	typ. 8 pF

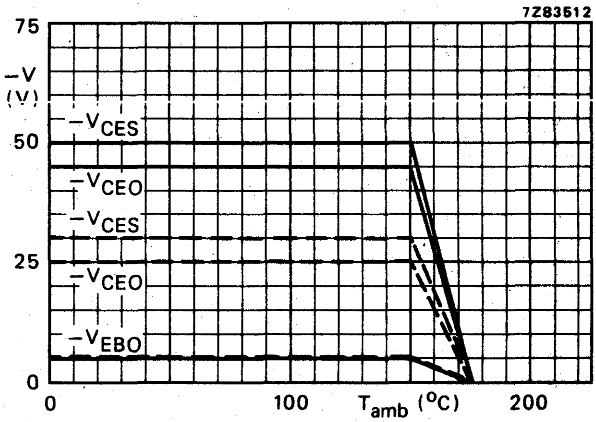


Fig. 2 Voltage derating curves. – – – BCX18; R ——— BCX17; R.

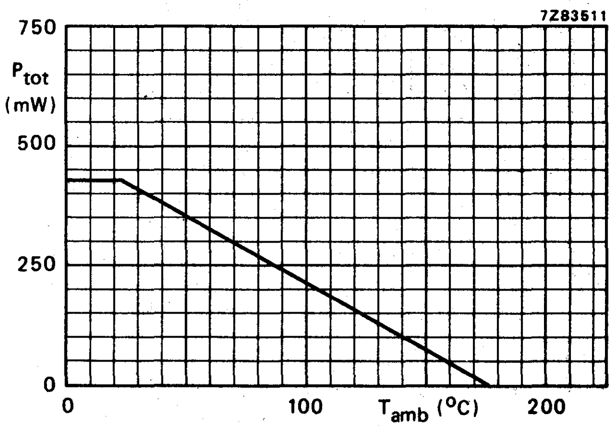


Fig. 3 Power derating curve.

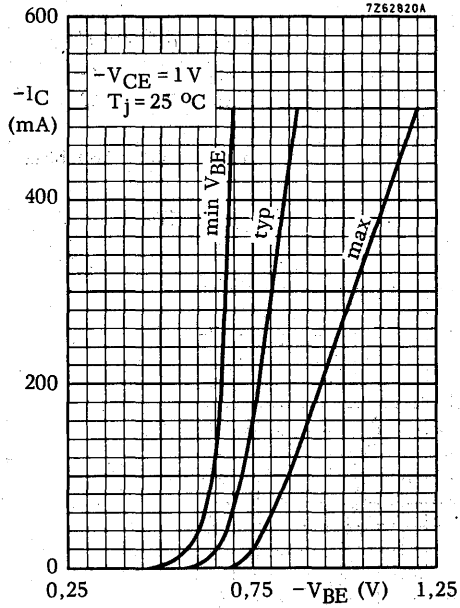


Fig. 4.

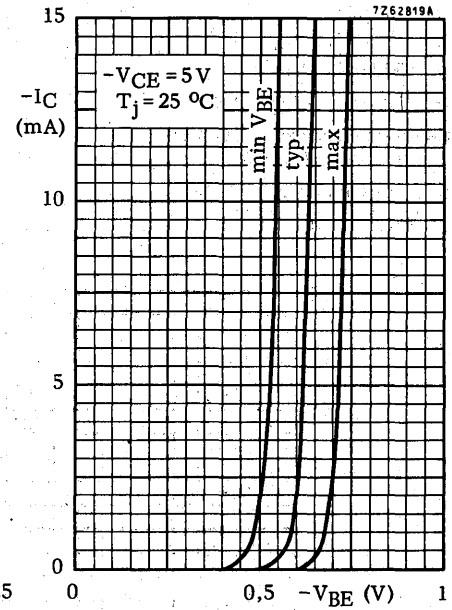


Fig. 5.

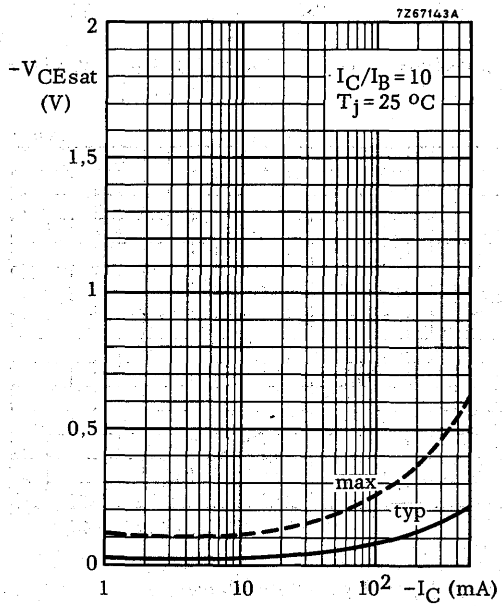


Fig. 6.

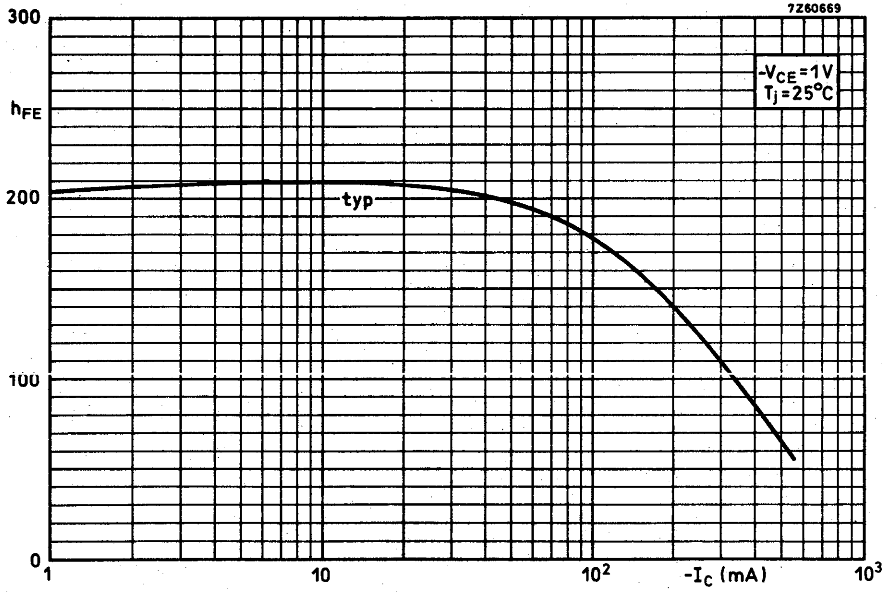

7Z60669
300
h_{FE}
200
100
0
1
10
10^2
$-I_C$ (mA)
10^3
$-V_{CE} = 1\,V$
$T_j = 25\,^oC$
typ

Fig. 7.

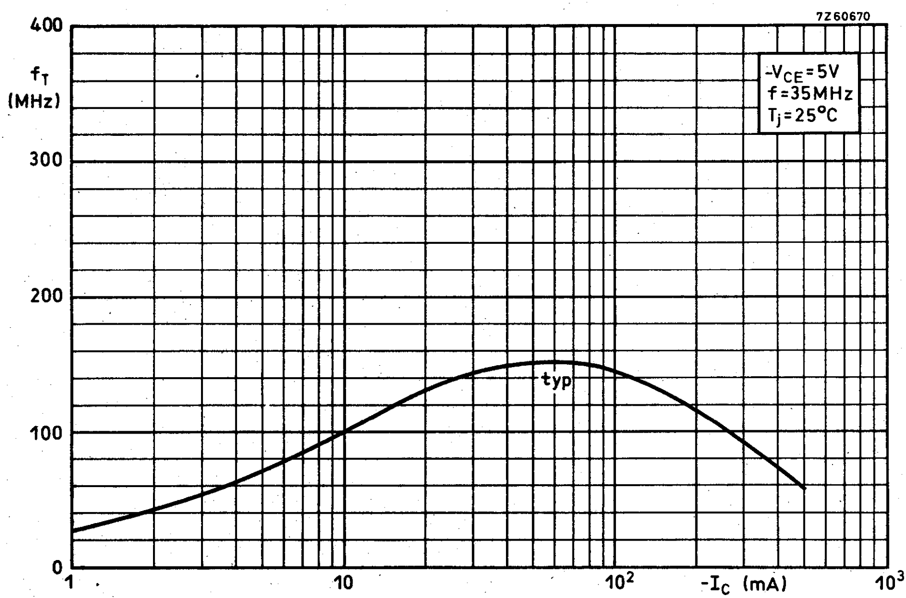

7Z60670
400
f_T
(MHz)
300
200
100
0
1
10
10^2
$-I_C$ (mA)
10^3
$-V_{CE} = 5\,V$
$f = 35\,MHz$
$T_j = 25\,^oC$
typ

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.

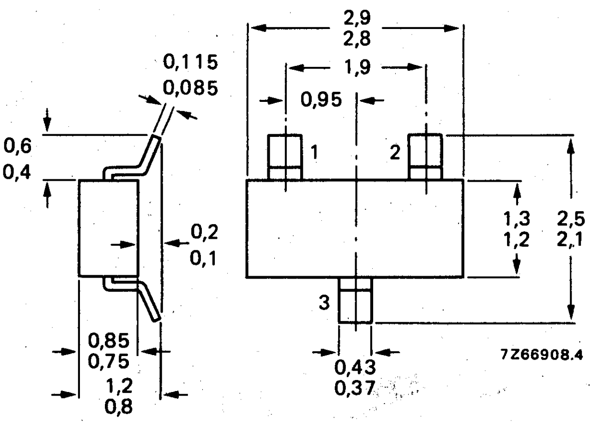
QUICK REFERENCE DATA

			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 °C	P_{tot}	max.	425		mW ←
Junction temperature	T_j	max.	175		°C ←
D.C. current gain I_C = 100 mA; V_{CE} = 1 V	h_{FE}		100 to 600		
Transition frequency I_C = 10 mA; V_{CE} = 5 V; f = 35 MHz	f_T	typ.	200		MHz

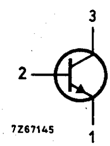
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.

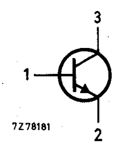


Marking code
BCX19 = U1
BCX20 = U2



←

BCX19R = U4
BCX20R = U5



See also *Soldering recommendations.*

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**

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	30	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260	K/W
From soldering points to ambient*	$R_{th\,s\text{-}a}$	=	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			
$I_C = 100$ mA; $V_{CE} = 1$ V	h_{FE}		100 to 600
$I_C = 300$ mA; $V_{CE} = 1$ V	h_{FE}	>	70
$I_C = 500$ mA; $V_{CE} = 1$ V	h_{FE}	>	40
Transition frequency at f = 35 MHz			
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	200 MHz
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	5 pF

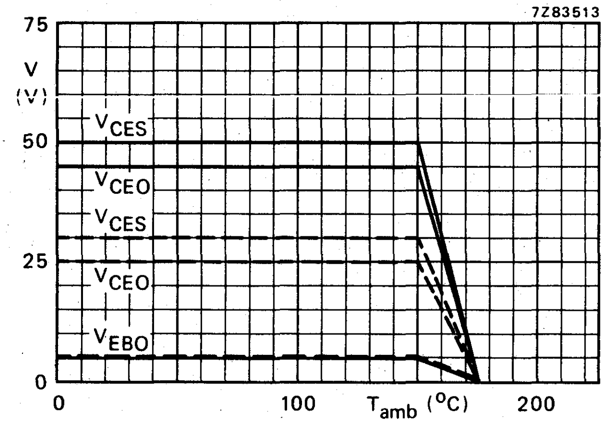


Fig. 2 Voltage derating curves. — — — BCX19; R/BCX20; R ———

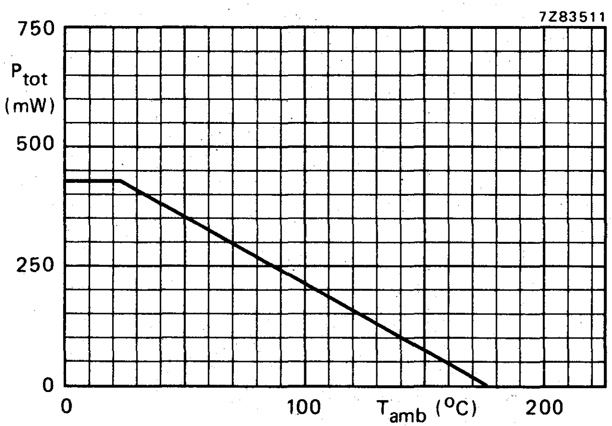


Fig. 3 Power derating curve.

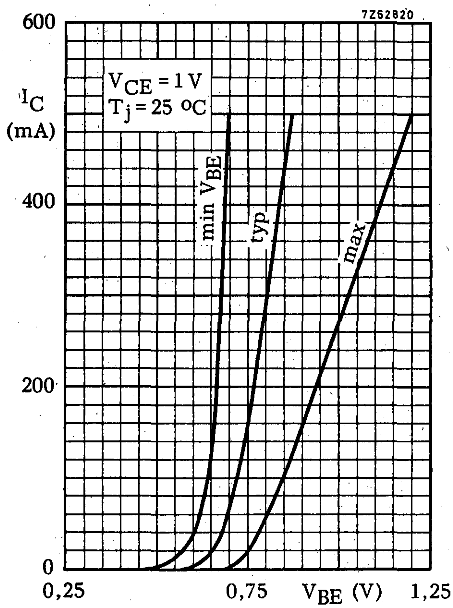


Fig. 4.

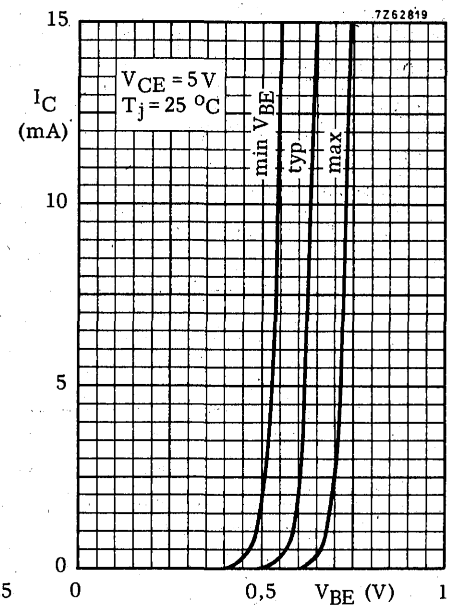


Fig. 5.

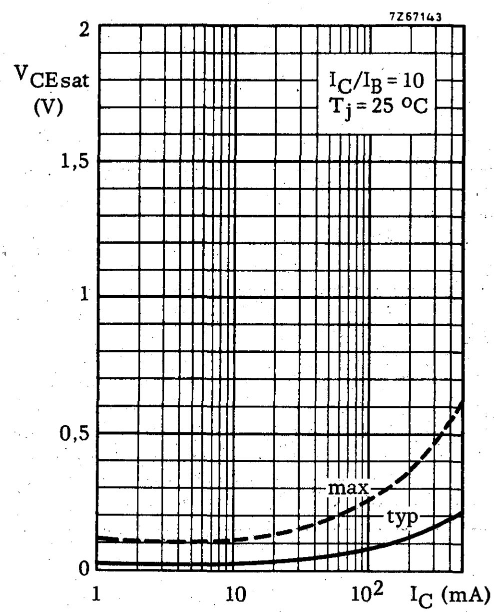


Fig. 6.

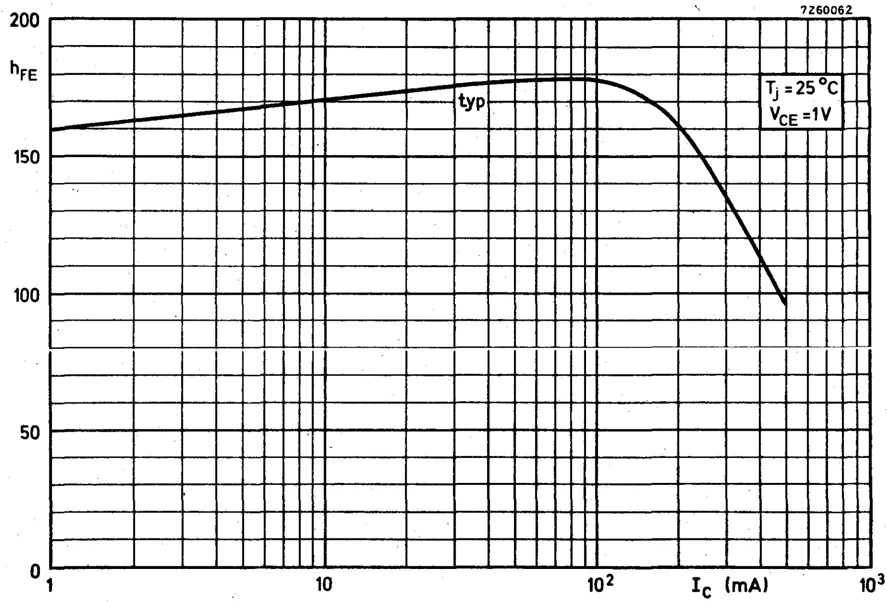

7Z60062
200
h_{FE}
150
100
50
0
1
10
10^2
I_C (mA)
10^3
typ
T_j = 25 °C
V_{CE} = 1V

Fig. 7.

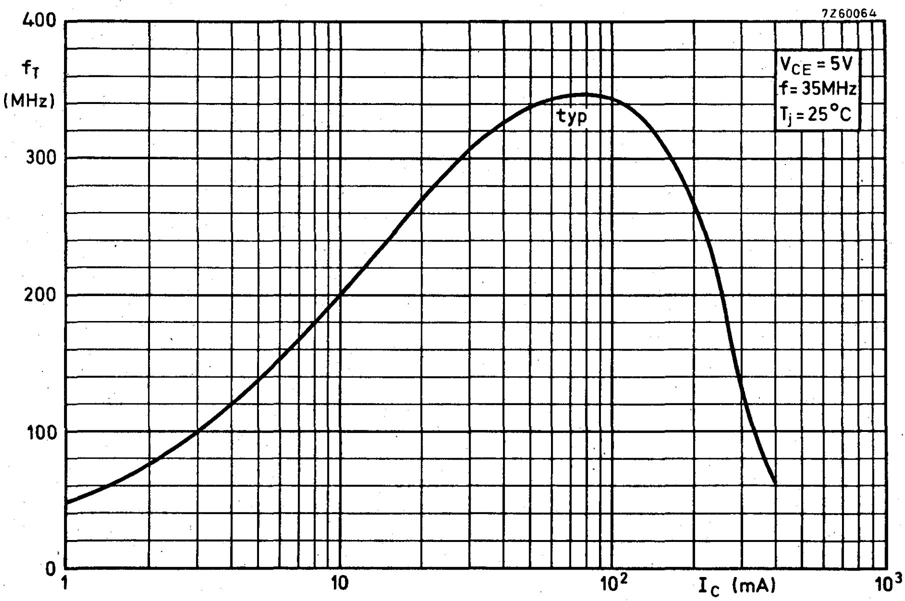

7Z60064
400
f_T
(MHz)
300
200
100
0
1
10
10^2
I_C (mA)
10^3
typ
V_{CE} = 5V
f = 35MHz
T_j = 25 °C

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.

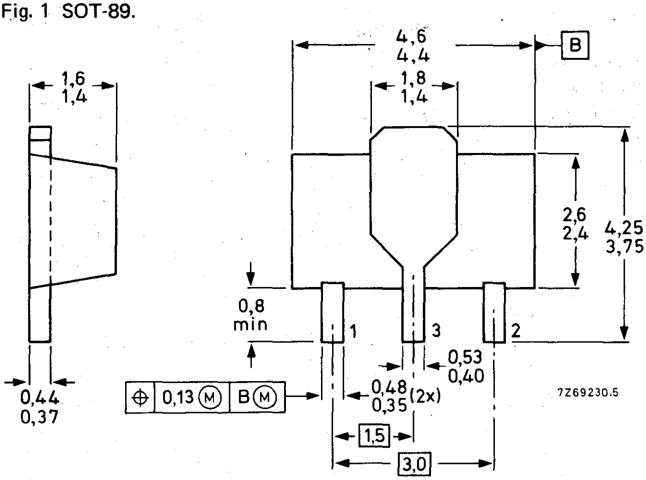
QUICK REFERENCE DATA

			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 kΩ)	$-V_{CER}$	max.	45	60	100	V
Collector current (peak value)	$-I_{CM}$	max.	1,5	1,5	1,5	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	1	1	1	W
Junction temperature	T_j	max.	150	150	150	°C
D.C. current gain $-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}	> <	40 250	40 160	40 160	
Transition frequency at f = 35 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	50	50	50	MHz

MECHANICAL DATA

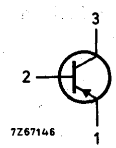
Dimensions in mm

Fig. 1 SOT-89.



Mark

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

Currrents				
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 °C mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	P_{tot}	max.	1,0	W

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

THERMAL RESISTANCE

From junction to collector tab	$R_{th\,j\text{-}tab}$	=	10	°C/W
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	$R_{th\,j\text{-}a}$	=	125	°C/W

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

Collector cut-off current

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

Emitter cut-off current

$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	10	μA

Base-emitter voltage

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

Saturation voltage

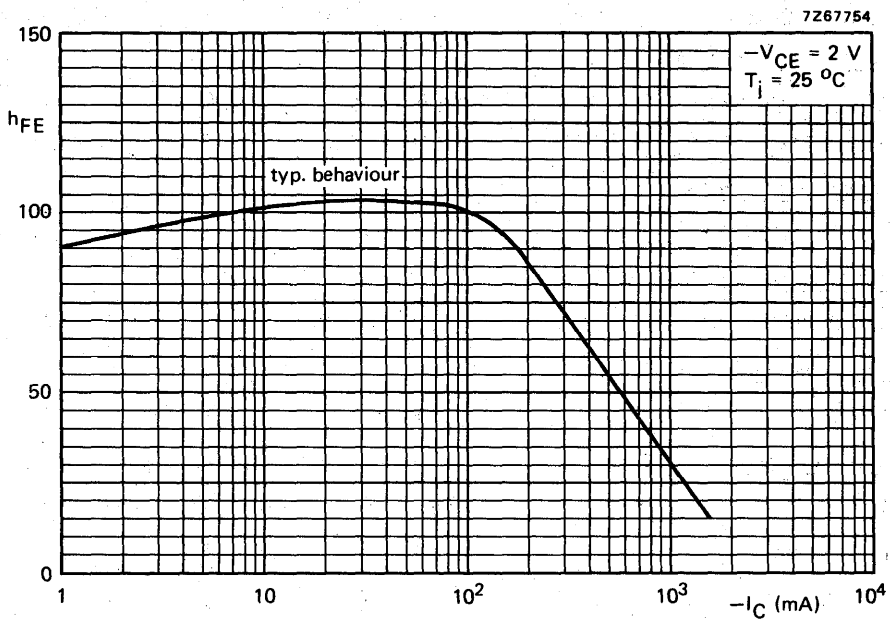
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	0,5	V

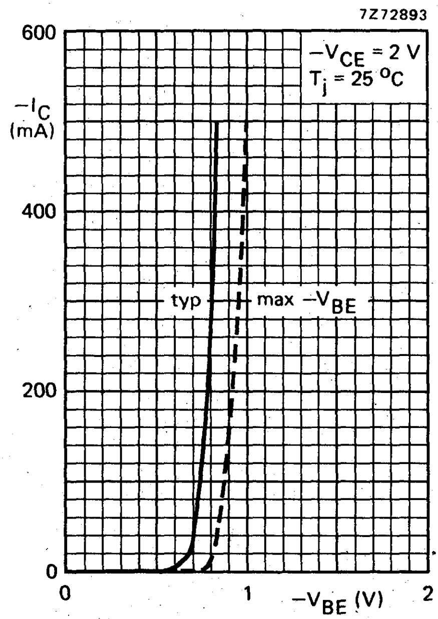
D.C. current gain

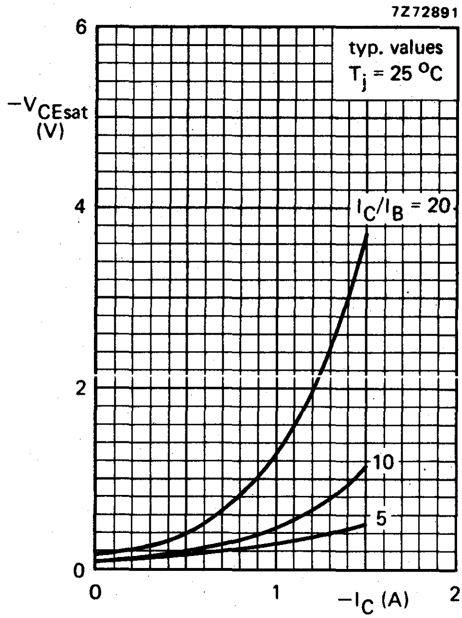
			BCX51	BCX52	BCX53
$-I_C = 5$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25	25	25
$-I_C = 150$ mA; $-V_{CE} = 2$ V	h_{FE}	>	40	40	40
		<	250	160	160
$-I_C = 500$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25	25	25

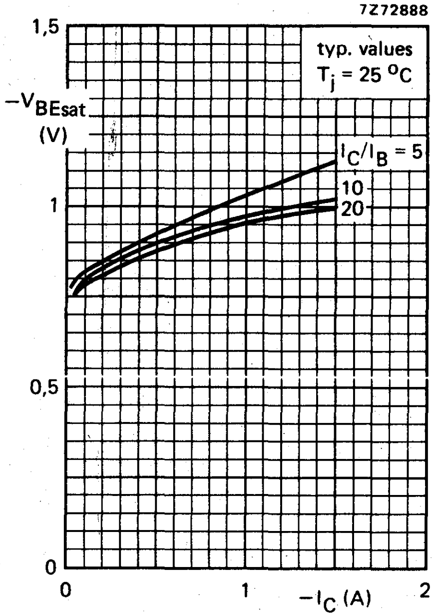
Transition frequency at f = 35 MHz

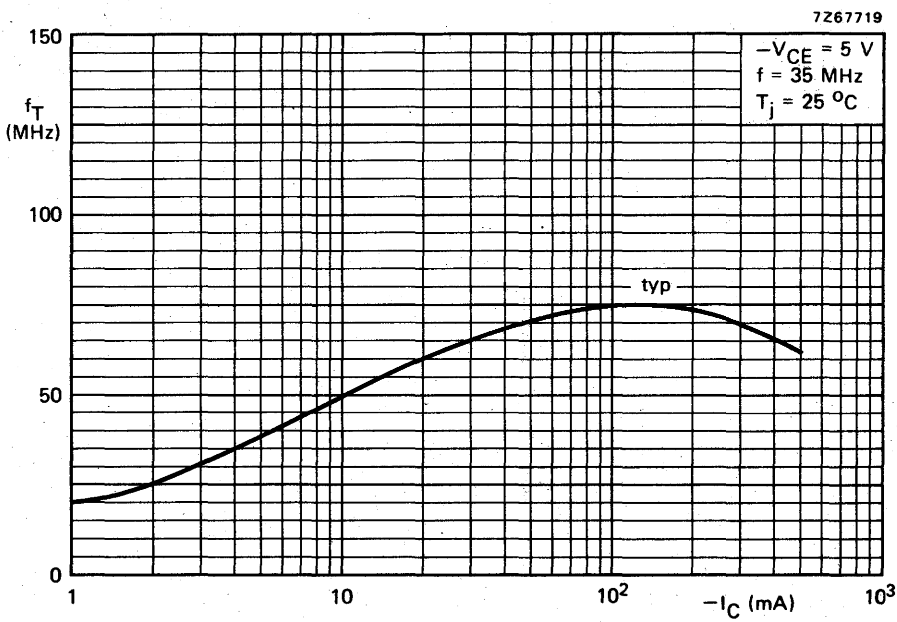
$-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	50	MHz


7Z67754
150
100
50
0
h_{FE}
$-V_{CE}$ = 2 V
T_j = 25 °C
typ. behaviour
1
10
10^2
10^3
10^4
$-I_C$ (mA)


7Z72893
600
400
200
0
$-I_C$
(mA)
$-V_{CE}$ = 2 V
T_j = 25 °C
typ
max $-V_{BE}$
0
1
2
$-V_{BE}$ (V)


7Z72891
typ. values
T_j = 25 °C
$-V_{CEsat}$ (V)
I_C/I_B = 20
10
5
0
2
4
6
0
1
2
$-I_C$ (A)


7Z72888
typ. values
T_j = 25 °C
$-V_{BEsat}$ (V)
I_C/I_B = 5
10
20
0
0,5
1
1,5
0
1
2
$-I_C$ (A)


7Z67719
$-V_{CE}$ = 5 V
f = 35 MHz
T_j = 25 °C
f_T (MHz)
typ
0
50
100
150
1
10
10^2
10^3
$-I_C$ (mA)

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.

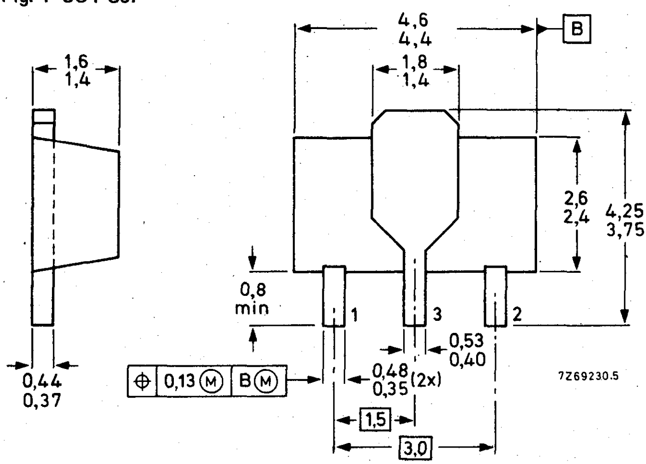
QUICK REFERENCE DATA

			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 kΩ)	V_{CER}	max.	45	60	100	V
Collector current (peak value)	I_{CM}	max.	1,5	1,5	1,5	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	1	1	1	W
Junction temperature	T_j	max.	150	150	150	°C
D.C. current gain I_C = 150 mA; V_{CE} = 2 V	h_{FE}	>	40	40	40	
		<	250	160	160	
Transition frequency at f = 35 MHz I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	130	130	130	MHz

MECHANICAL DATA

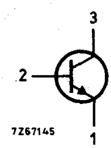
Dimensions in mm

Fig. 1 SOT-89.



Mark

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

Currents

Collector current (d.c.)	I_C	max.	1,0	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 °C mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	P_{tot}	max.	1,0	W

Temperatures

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

THERMAL RESISTANCE

From junction to collector tab	$R_{th\,j\text{-}tab}$	=	10	°C/W
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	$R_{th\,j\text{-}a}$	=	125	°C/W

CHARACTERISTICS

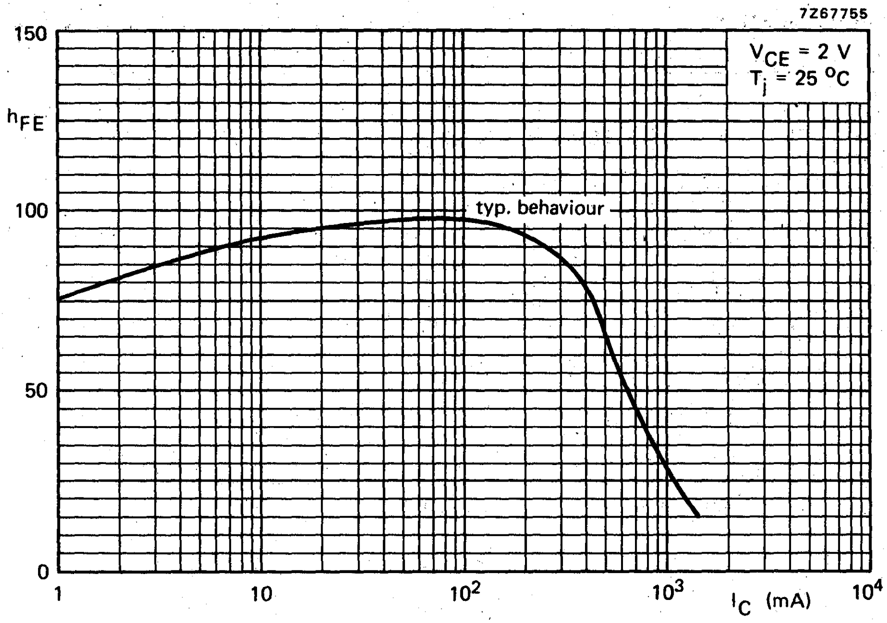
T_{amb} = 25 °C unless otherwise specified

Collector cut-off current					
$I_E = 0$; $V_{CB} = 30$ V	I_{CBO}	<	100		nA
$I_E = 0$; $V_{CB} = 30$ V; $T_j = 125$ °C	I_{CBO}	<	10		μA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10		μA
Base-emitter voltage					
$I_C = 500$ mA; $V_{CE} = 2$ V	V_{BE}	<	1		V
Saturation voltage					
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	0,5		V

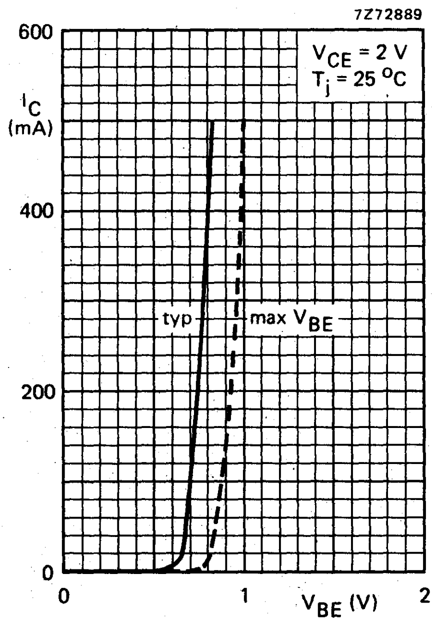
D.C. current gain

			BCX54	BCX55	BCX56
$I_C = 5$ mA; $V_{CE} = 2$ V	h_{FE}	>	25	25	25
$I_C = 150$ mA; $V_{CE} = 2$ V	h_{FE}	>	40	40	40
		<	250	160	160
$I_C = 500$ mA; $V_{CE} = 2$ V	h_{FE}	>	25	25	25

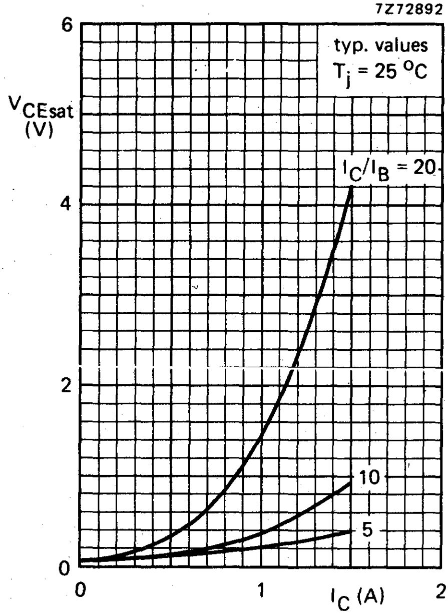
Transition frequency at f = 35 MHz				
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	130	MHz

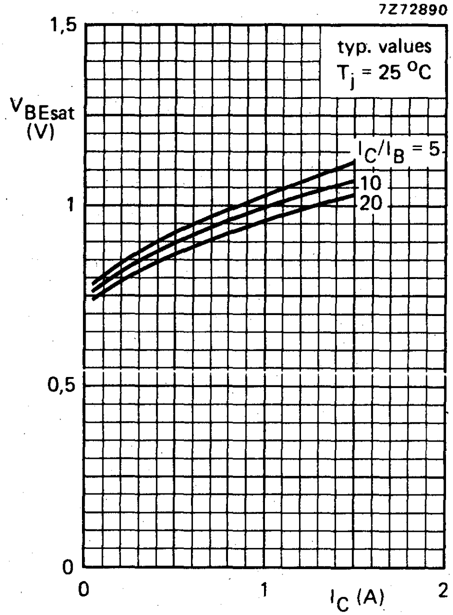


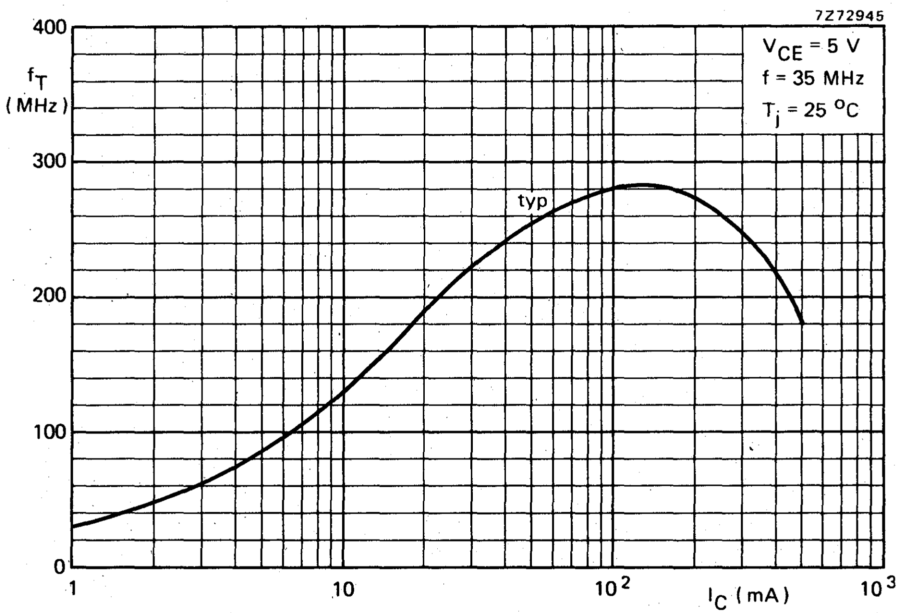
7Z67755
150
h_{FE}
100
50
0
1
10
10^2
10^3
10^4
I_C (mA)
V_{CE} = 2 V
T_j = 25 °C
typ. behaviour



7Z72889
600
I_C (mA)
400
200
0
0
1
2
V_{BE} (V)
V_{CE} = 2 V
T_j = 25 °C
typ
max V_{BE}


7Z72892
typ. values
T_j = 25 °C
V_{CEsat}
(V)
I_C/I_B = 20
10
5
6
4
2
0
0
1
2
I_C (A)


7Z72890
typ. values
T_j = 25 °C
V_{BEsat}
(V)
I_C/I_B = 5
10
20
1,5
1
0,5
0
0
1
2
I_C (A)


7Z72945
V_{CE} = 5 V
f = 35 MHz
T_j = 25 °C
f_T
(MHz)
typ
400
300
200
100
0
1
10
10^2
10^3
I_C (mA)

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.

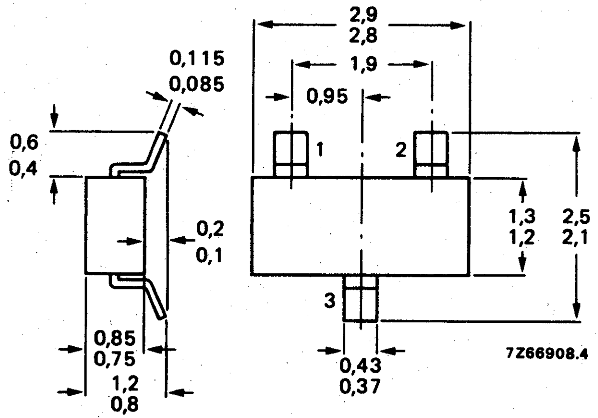
QUICK REFERENCE DATA

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 μA; B = 200 Hz	F	typ.	2	dB

MECHANICAL DATA

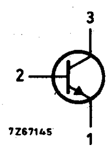
Dimensions in mm

Fig. 1 SOT-23.



Marking code

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*

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

Thermal resistance

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

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector-emitter cut-off current				
V_{BE} = 0; V_{CE} = 45 V	I_{CES}	<	20	nA
V_{BE} = 0; V_{CE} = 45 V; T_{amb} = 150 °C	I_{CES}	<	20	μA
Emitter-base cut-off current				
I_C = 0; V_{EB} = 4 V	I_{EBO}	<	20	nA
Saturation voltages				
at I_C = 10 mA; I_B = 0,25 mA	V_{CEsat}		0,05 to 0,35	V
	V_{BEsat}		0,6 to 0,85	V
at I_C = 50 mA; I_B = 1,25 mA	V_{CEsat}		0,1 to 0,55	V
	V_{BEsat}		0,7 to 1,05	V
Transition frequency at f = 100 MHz▲		>	125	MHz
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	250	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	<	4,5	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c$ = 0; V_{EB} = 0,5 V	C_e	typ.	8	pF
Noise figure at R_S = 2 kΩ		typ.	2	dB
I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	<	6	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 V; I_C = 10 μA	h_{FE}	typ.	78	145	220	300	
		>	–	20	40	100	
		>	120	180	250	380	
V_{CE} = 5 V; I_C = 2 mA	h_{FE}	typ.	170	250	350	500	
		<	220	310	460	630	
V_{CE} = 1 V; I_C = 50 mA	h_{FE}	>	50	70	90	100	
Input impedance		>	1,6	2,5	3,2	4,5	kΩ
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{ie}	typ.	2,7	3,6	4,5	7,5	kΩ
		<	4,5	6,0	8,5	12,0	kΩ
Reverse voltage transfer ratio							
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{re}	typ.	1,5	2	2	3	10^{-4}
Small-signal current gain		>	125	175	250	350	
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{fe}	typ.	200	260	330	520	
		<	250	350	500	700	
Output admittance							
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{oe}	typ.	18	24	30	50	μA/V
		<	30	50	60	100	μA/V
Base-emitter voltage							
V_{CE} = 5 V; I_C = 2 mA	V_{BE}		0,55 to 0,75				V
		typ.	0,65				V
V_{CE} = 5 V; I_C = 10 μA	V_{BE}	typ.	0,52				V
V_{CE} = 1 V; I_C = 50 mA	V_{BE}	typ.	0,78				V

Switching times

$I_{Con} = 10$ mA; $I_{Bon} = -I_{Boff} = 1$ mA
$V_{CC} = 10$ 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

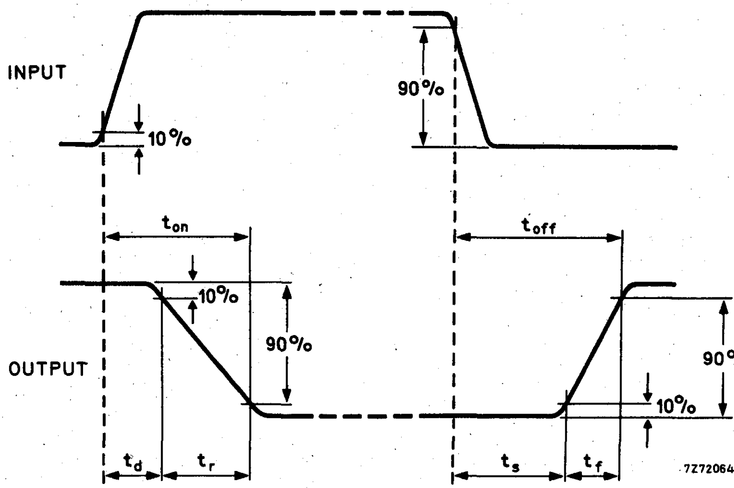


Fig. 2 Switching waveforms.

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 μA	F	typ.	2	dB

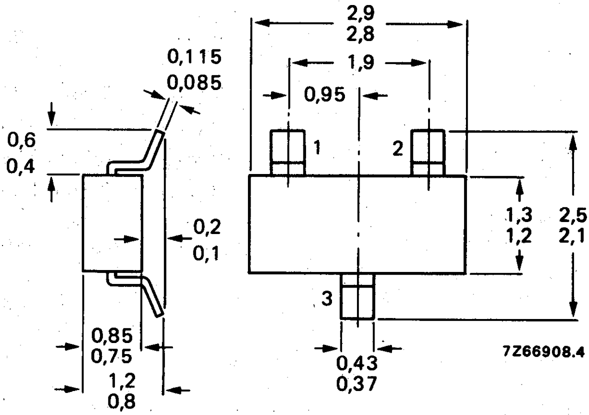
MECHANICAL DATA

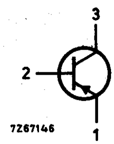
Dimensions in mm

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*

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

Thermal resistance

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

CHARACTERISTICS

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

Collector-emitter cut-off current			
$V_{EB} = 0$; $-V_{CE} = 45$ V	$-I_{CES}$	<	20 nA
$V_{EB} = 0$; $-V_{CE} = 45$ V; $T_{amb} = 150\ °C$	$-I_{CES}$	<	20 μA
Emitter-base cut-off current			
$I_C = 0$; $-V_{EB} = 4$ V	$-I_{EBO}$	<	20 nA
Saturation voltages			
$-I_C = 10$ mA; $-I_B = 0{,}25$ mA	$-V_{CEsat}$		0,06 to 0,25 V
	$-V_{BEsat}$		0,6 to 0,85 V
$-I_C = 50$ mA; $-I_B = 1{,}25$ mA	$-V_{CEsat}$		0,12 to 0,55 V
	$-V_{BEsat}$		0,68 to 1,05 V
Transition frequency at f = 100 MHz▲			
$-V_{CE} = 5$ V; $-I_C = 10$ mA	f_T	typ.	180 MHz
Collector capacitance at f = 1 MHz			
$-V_{CB} = 10$ V; $I_E = I_e = 0$	C_c	<	6 pF
Emitter capacitance at f = 1 MHz			
$-V_{EB} = 0{,}5$ V; $I_C = I_c = 0$	C_e	typ.	11 pF
Noise figure at $R_S = 2$ kΩ			
$-V_{CE} = 5$ V; $-I_C = 200$ μA; B = 200 Hz	F	typ. / <	2 dB / 6 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							
$-V_{CE} = 5$ V; $-I_C = 10\ \mu A$	h_{FE}	typ.	140	200	270	340	
		>	–	30	40	100	
		>	120	180	250	380	
$-V_{CE} = 5$ V; $-I_C = 2$ mA	h_{FE}	typ.	170	250	350	500	
		<	220	310	460	630	
$-V_{CE} = 1$ V; $-I_C = 50$ mA	h_{FE}	>	60	80	100	110	
Input impedance		>	1,6	2,5	3,2	4,5	kΩ
$-V_{CE} = 5$ V; $-I_C = 2$ mA; f = 1 kHz	h_{ie}	typ.	2,7	3,6	4,5	7,5	kΩ
		<	4,5	6,0	8,5	12,0	kΩ
Reverse voltage transfer ratio							
$-V_{CE} = 5$ V; $-I_C = 2$ mA; f = 1 kHz	h_{re}	typ.	1,5	2	2	3	10^{-4}
Small-signal current gain		>	125	175	250	350	
$-V_{CE} = 5$ V; $-I_C = 2$ mA; f = 1 kHz	h_{fe}	typ.	200	260	330	520	
		<	250	350	500	700	
Output admittance							
$-V_{CE} = 5$ V; $-I_C = 2$ mA; f = 1 kHz	h_{oe}	typ.	18	24	30	50	μA/V
		<	30	50	60	100	μA/V

Base-emitter voltage				
$-V_{CE} = 5$ V; $-I_C = 2$ mA	V_{BE}		0,6 to 0,75	V
		typ.	0,65	V
$-V_{CE} = 5$ V; $-I_C = 10\ \mu A$	V_{BE}	typ.	0,55	V
$-V_{CE} = 1$ V; $-I_C = 50$ mA	V_{BE}	typ.	0,72	V

Switching times

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

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

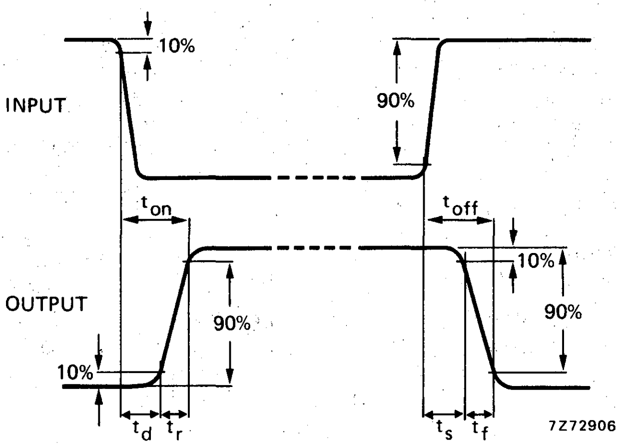


Fig. 2 Switching waveforms.

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 °C	P_{tot}	max.		300			mW
			BF510	511	512	513	
Drain current V_{DS} = 10 V; V_{GS} = 0	I_{DSS}	>	0,7	2,5	6	10	mA
		<	3,0	7,0	12	18	mA
Transfer admittance (common source) V_{DS} = 10 V; V_{GS} = 0; f = 1 kHz	$\|y_{fs}\|$	>	2,5	4	6	7	mA/V
Feedback capacitance V_{DS} = 10 V; V_{GS} = 0	C_{rs}	typ.	0,3	0,3	–	–	pF
V_{DS} = 10 V; I_D = 5 mA	C_{rs}	typ.	–	–	0,3	0,3	pF
Noise figure at optimum source admittance G_S = 1 mA/V; $-B_S$ = 3 mA/V; f = 100 MHz							
V_{DS} = 10 V; V_{GS} = 0	F	typ.	1,5	1,5	–	–	dB
V_{DS} = 10 V; I_D = 5 mA	F	typ.	–	–	1,5	1,5	dB

MECHANICAL DATA

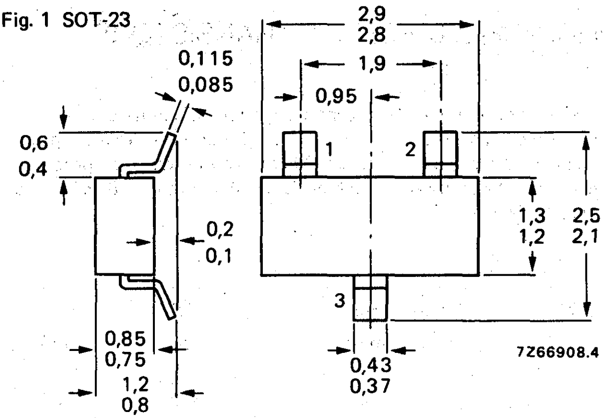
SOT-23 (see page 2).

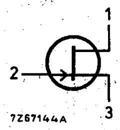
See also *Soldering recommendations.*

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23





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 °C **	P_{tot}	max.	300 mW
Storage temperature	T_{stg}	−65 to +175 °C	
Junction temperature	T_j	max.	175 °C

THERMAL CHARACTERISTICS *

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

Thermal resistance

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

			BF510	511	512	513	
Gate cut-off current $-V_{GS}$ = 0,2 V; V_{DS} = 0	$-I_{GSS}$	<	10	10	10	10	nA
Gate-drain breakdown voltage I_S = 0; $-I_D$ = 10 μA	$-V_{(BR)GDO}$	>	20	20	20	20	V
Drain current V_{DS} = 10 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 μA; V_{DS} = 10 V	$-V_{(P)GS}$	typ.	0,8	1,5	2,2	3	V

DYNAMIC CHARACTERISTICS

Measuring conditions (common source): V_{DS} = 10 V; V_{GS} = 0; T_{amb} = 25 °C for BF510 and BF511
V_{DS} = 10 V; I_D = 5 mA; T_{amb} = 25 °C for BF512 and BF513

y-parameters (common source)			BF510	511	512	513	
Input capacitance at f = 1 MHz	C_{is}	<	5	5	5	5	pF
Input conductance at f = 100 MHz	g_{is}	typ.	100	90	60	50	μA/V
Feedback capacitance at f = 1 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 kHz	$\|y_{fs}\|$	>	2,5	4,0	4,0	3,5	mA/V
V_{GS} = 0 instead of I_D = 5 mA	$\|y_{fs}\|$	>	–	–	6,0	7,0	mA/V
Transfer admittance at f = 100 MHz	$\|y_{fs}\|$	typ.	3,5	5,5	5,0	5,0	mA/V
Output capacitance at f = 1 MHz	C_{os}	<	3	3	3	3	pF
Output conductance at f = 1 MHz	g_{os}	<	60	80	100	120	μA/V
Output conductance at f = 100 MHz	g_{os}	typ.	35	55	70	90	μA/V
Noise figure at optimum source admittance G_S = 1 mA/V; $-B_S$ = 3 mA/V; f = 100 MHz	F	typ.	1,5	1,5	1,5	1,5	dB

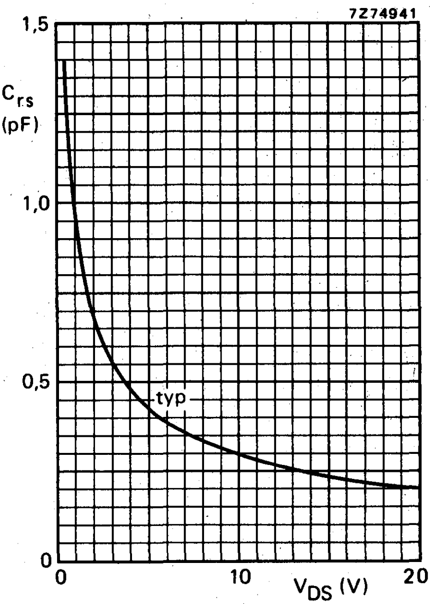


Fig. 2 $V_{GS} = 0$ for BF510 and BF511; $I_D = 5$ mA for BF512 and BF513; f = 1 MHz; $T_{amb} = 25$ °C.

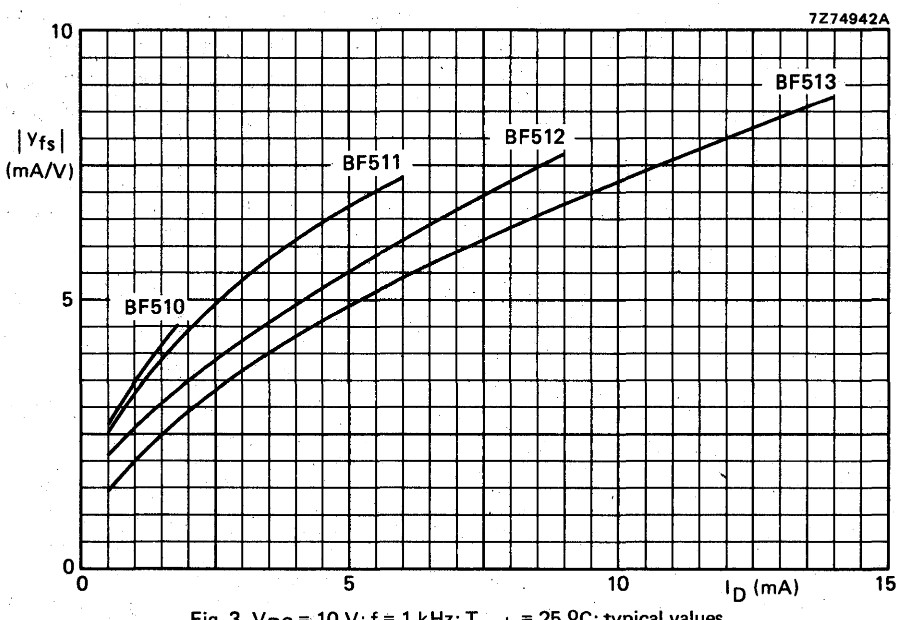


Fig. 3 $V_{DS} = 10$ V; f = 1 kHz; $T_{amb} = 25$ °C; typical values.

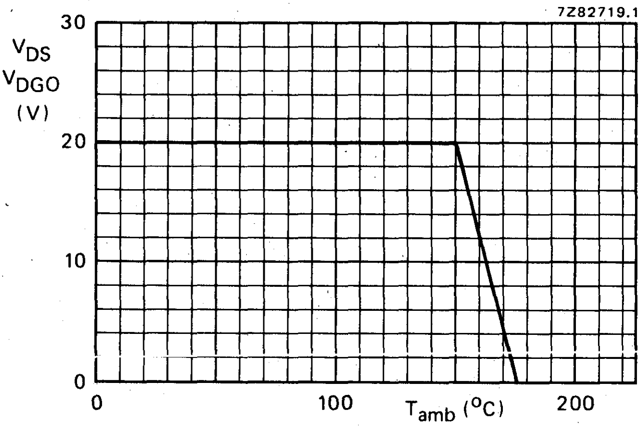


Fig. 4 Voltage derating curve.

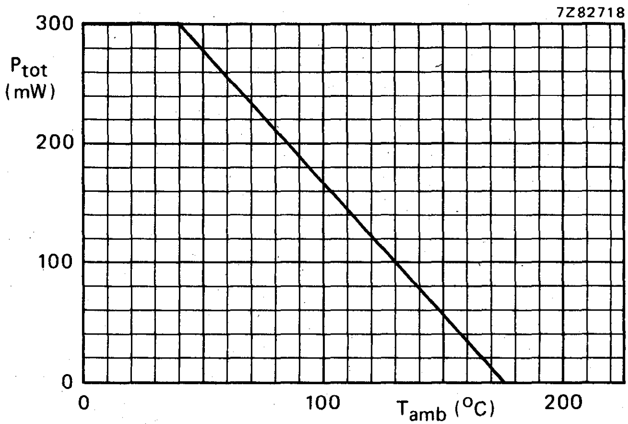


Fig. 5 Power derating curve.

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)	$-V_{CBO}$	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 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
D.C. current gain I_E = 1 mA; $-V_{CB}$ = 10 V	h_{FE}	>	25	
Transition frequency at f = 100 MHz I_E = 1 mA; $-V_{CB}$ = 10 V	f_T	typ.	350	MHz
Noise figure at f = 200 MHz I_E = 1 mA; $-V_{CB}$ = 10 V	F	typ.	5	dB

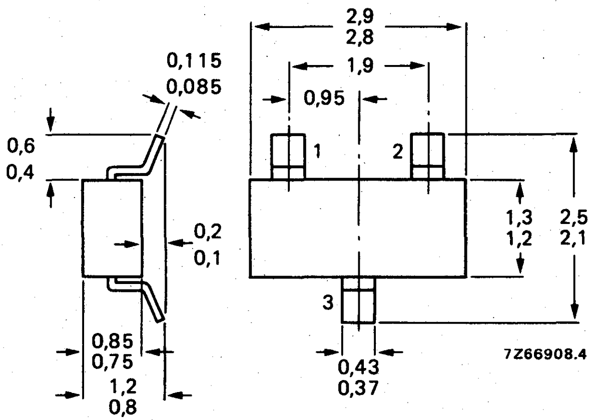
MECHANICAL DATA

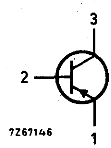
Dimensions in mm

Fig. 1 SOT-23.

Marking code

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 °C**	P_{tot}	max.	200	mW
Storage temperature	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	120	K/W

CHARACTERISTICS

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

Collector cut-off current $I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	<	50	nA
D.C. current gain $I_E = 1$ mA; $-V_{CB} = 10$ V	h_{FE}	>	25	
Transition frequency at f = 100 MHz $I_E = 1$ mA; $-V_{CB} = 10$ V	f_T	typ.	350	MHz
Noise figure at f = 200 MHz $I_E = 1$ mA; $-V_{CB} = 10$ V; $R_S = 50\ \Omega$	F	typ.	5	dB
Transducer gain (common base) at f = 200 MHz $I_E = 3$ mA; $-V_{CB} = 10$ V; $R_S = 60\ \Omega$; $R_L = 920\ \Omega$	G_{tr}	typ.	17,5	dB

* See *Thermal characteristics* in chapter GENERAL.
** Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

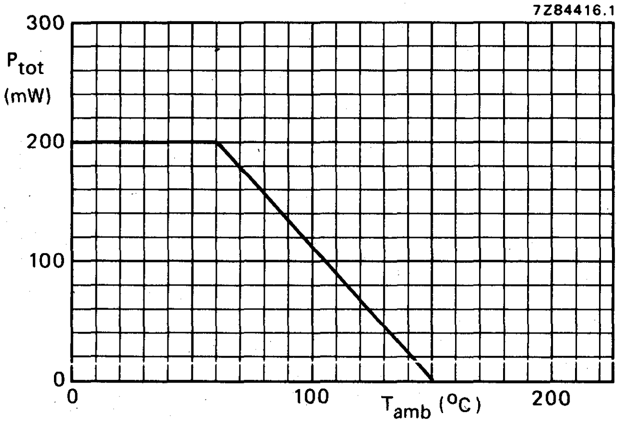


Fig. 2 Power derating curve.

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.

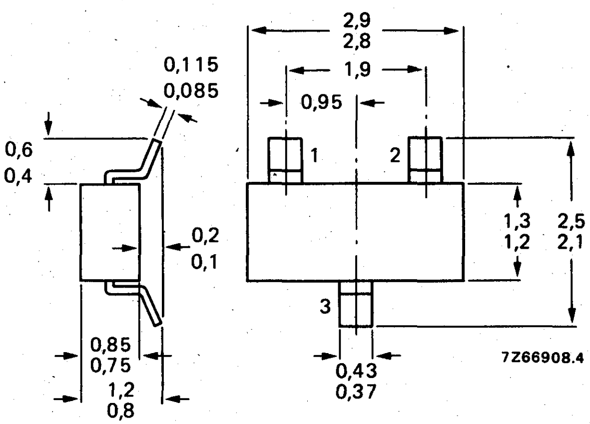
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	200 mW
Junction temperature	T_j	max.	150 °C
D.C. current gain at T_j = 25 °C $-I_C$ = 1 mA; $-V_{CE}$ = 10 V	h_{FE}	>	50
Transition frequency at f = 100 MHz $-I_C$ = 1 mA; $-V_{CE}$ = 10 V	f_T	typ.	325 MHz
Noise figure at R_S = 300 Ω $-I_C$ = 1 mA; $-V_{CE}$ = 10 V; f = 100 kHz	F	typ.	2 dB

MECHANICAL DATA

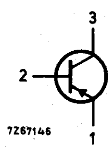
Dimensions in mm

Fig. 1 SOT-23

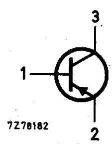


Marking code

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 °C **	P_{tot}	max.	200 mW
Storage temperature	T_{stg}		−55 to +150 °C
Junction temperature	T_j	max.	150 °C

THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60 K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	120 K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current $I_E = 0$; $-V_{CB} = 30$ V	$-I_{CBO}$	<	50 nA
Emitter cut-off current $I_C = 0$; $-V_{EB} = 3$ V	$-I_{EBO}$	<	100 µA
Base-emitter voltage $-I_C = 1$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	750 mV
D.C. current gain $-I_C = 1$ mA; $-V_{CE} = 10$ V	h_{FE}	>	50
Transition frequency at f = 100 MHz $-I_C = 1$ mA; $-V_{CE} = 10$ V	f_T	typ.	325 MHz
Feedback capacitance at f = 1 MHz $-I_C = 1$ mA; $-V_{CE} = 10$ V	C_{re}	typ.	0,5 pF
Noise figure at $R_S = 300\ \Omega$ $-I_C = 1$ mA; $-V_{CE} = 10$ V; f = 100 kHz	F	typ.	2 dB

* See *Thermal characteristics* in chapter GENERAL.
** Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

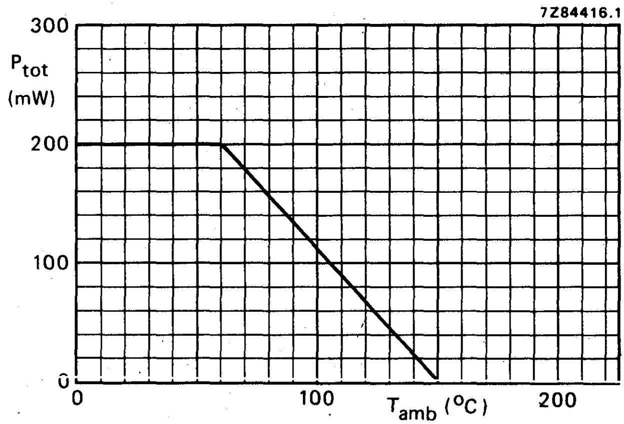


Fig. 2 Power derating curve.

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.

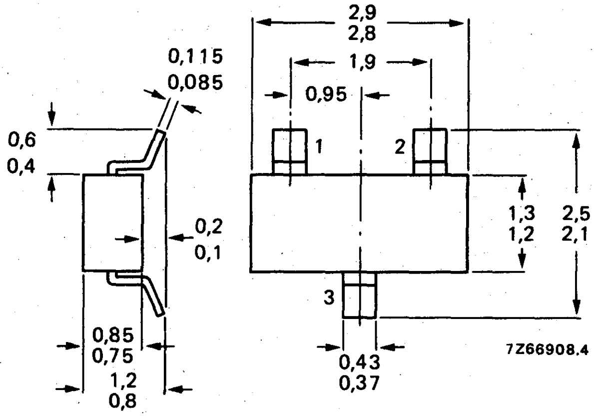
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	200 mW
Junction temperature	T_j	max.	150 °C
Transition frequency at f = 100 MHz I_E = 3 mA; $-V_{CB}$ = 10 V	f_T	typ.	900 MHz

MECHANICAL DATA

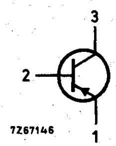
Dimensions in mm

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 °C**	P_{tot}	max.	200 mW
Storage temperature	T_{stg}		−65 to + 150 °C
Junction temperature	T_j	max.	150 °C

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60 K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	120 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
D.C. current gain $I_E = 3$ mA; $-V_{CB} = 10$ V	h_{FE}	> typ.	25 50
Transition frequency at f = 100 MHz $I_E = 3$ mA; $-V_{CB} = 10$ V	f_T	typ.	900 MHz
Feedback capacitance at f = 1 MHz $I_E = 1$ mA; $-V_{CB} = 10$ V	C_{re}	typ.	0,33 pF
Noise figure at f = 800 MHz $I_E = 3$ mA; $-V_{CB} = 10$ V; $R_S = 60\ \Omega$; $R_L = 500\ \Omega$	F	typ.	4,5 dB
Power gain at f = 800 MHz $I_E = 3$ mA; $-V_{CB} = 10$ V; $R_S = 60\ \Omega$; $R_L = 500\ \Omega$	G_{pb}	typ.	14,5 dB

* See *Thermal characteristics* in chapter GENERAL.

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

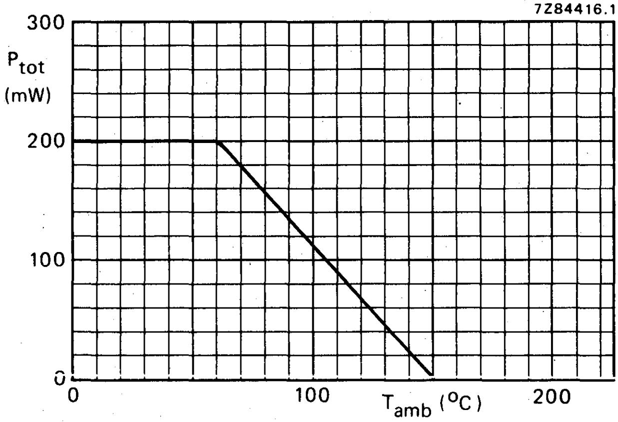


Fig. 2 Power derating curve.

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)	$-V_{CBO}$	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 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	150	°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 Ω; R_L = 500 Ω; T_{amb} = 25 °C	G_{tr}	typ.	16	dB
Noise figure (common base) I_E = 10 mA; $-V_{CB}$ = 10 V; f = 800 MHz R_S = 60 Ω; R_L = 500 Ω	F	typ.	4,5	dB

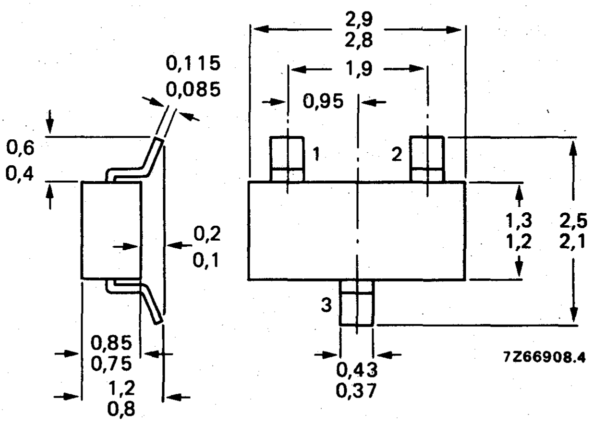
MECHANICAL DATA

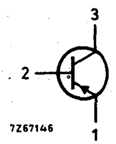
Dimensions in mm

Fig. 1 SOT-23.

Marking code

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	$-V_{CBO}$	max.	20 V
Collector-emitter voltage (open base) see Fig. 2	$-V_{CEO}$	max.	20 V
Emitter-base voltage (open collector) see Fig. 2	$-V_{EBO}$	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 °C**	P_{tot}	max.	150 mW
→ Storage temperature	T_{stg}	−65 to + 150 °C	
→ Junction temperature	T_j	max.	150 °C

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60 K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	120 K/W

CHARACTERISTICS

T_{amb} = 25 °C

Collector cut-off current $I_E = 0; -V_{CB} = 15$ V	$-I_{CBO}$	<	100 nA
Emitter cut-off current $I_C = 0; -V_{EB} = 1$ V	$-I_{EBO}$	<	100 nA
D.C. current gain $I_C = 10$ mA; $-V_{CE} = 10$ V	h_{FE}	>	20
Transition frequency at f = 100 MHz $I_E = 10$ mA; $-V_{CB} = 10$ V	f_T	typ.	1350 MHz
Feedback capacitance at f = 500 kHz $I_E = 7$ mA; $-V_{CB} = 10$ V	C_{re}	typ.	0,46 pF
$I_E = 0; -V_{CB} = 10$ V	C_{rb}	typ.	160 fF
Transducer gain (common base) $I_E = 10$ mA; $-V_{CB} = 10$ V; f = 800 MHz $R_S = 60\ \Omega$; $R_L = 500\ \Omega$	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

* See *Thermal characteristics* in chapter GENERAL.
** Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

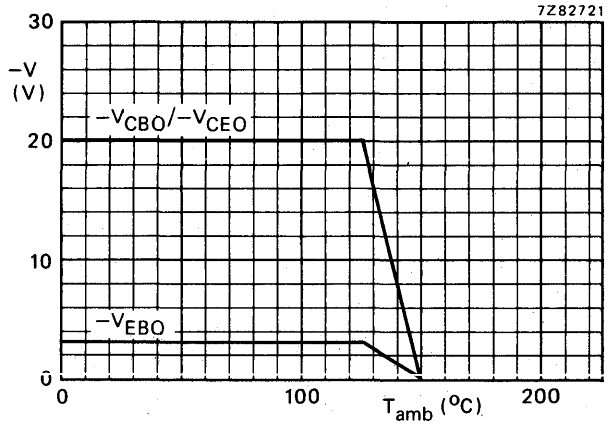


Fig. 2 Voltage derating curves.

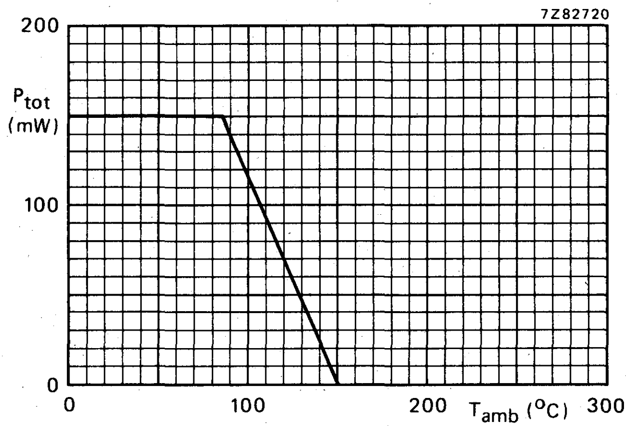


Fig. 3 Power derating curve.

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 °C	P_{tot}	max.	1 W
Junction temperature	T_j	max.	150 °C
D.C. current gain I_C = 25 mA; V_{CE} = 20 V	h_{FE}	>	50
Transition frequency at f = 35 MHz I_C = 10 mA; V_{CE} = 10 V	f_T	>	60 MHz
Feedback capacitance at f = 1 MHz I_C = 0; V_{CE} = 30 V	C_{re}	<	1,6 pF

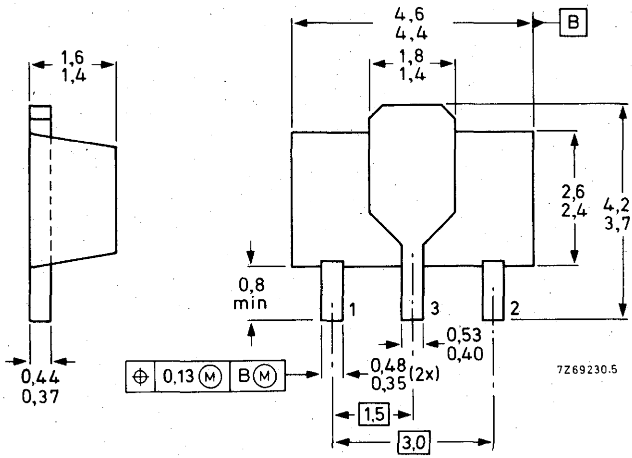
MECHANICAL DATA

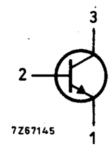
Dimensions in mm

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_{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 °C mounted on a ceramic substrate area = 2,5 cm^2; thickness = 0,7 mm	P_{tot}	max.	1	W
Storage temperature	T_{stg}		–65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to collector tab	$R_{th\ j\text{-}tab}$	=	25	°C/W
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm^2; thickness = 0,7 mm	$R_{th\ j\text{-}a}$	=	125	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = 200$ V	I_{CBO}	<	10 nA
$R_{BE} = 10$ kΩ; $V_{CE} = 200$ V; $T_j = 150$ °C	I_{CER}	<	50 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10 μA
Base-emitter voltage			
$I_C = 25$ mA; $V_{CE} = 20$ V	V_{BE}	typ.	0,73 V
D.C. current gain			
$I_C = 25$ mA; $V_{CE} = 20$ V	h_{FE}	>	50
High-frequency knee voltage at $T_j = 150$ °C *			
$I_C = 25$ mA	V_{CEK}	typ.	20 V
Transition frequency at f = 35 MHz			
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	>	60 MHz
Feedback capacitance at f = 1 MHz			
$I_C = 0$; $V_{CE} = 30$ V	C_{re}	<	1,6 pF
Feedback time constant at f = 10,7 MHz **			
$I_C = 10$ mA; $V_{CE} = 20$ V	$r_{bb'}C_{b'c}$	<	70 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 $V_{CE} = 50$ V. A further reduction of the collector-emitter voltage results in a rapid increase of the distortion of the signal.

** $r_{bb'}C_{b'c} = \frac{|h_{rb}|}{\omega}$.

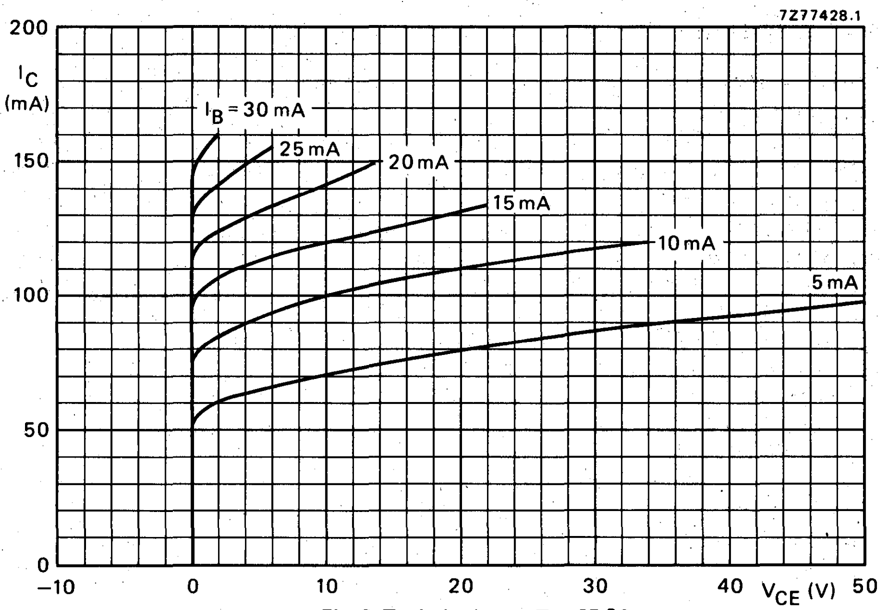


Fig. 2 Typical values at T_j = 25 °C.

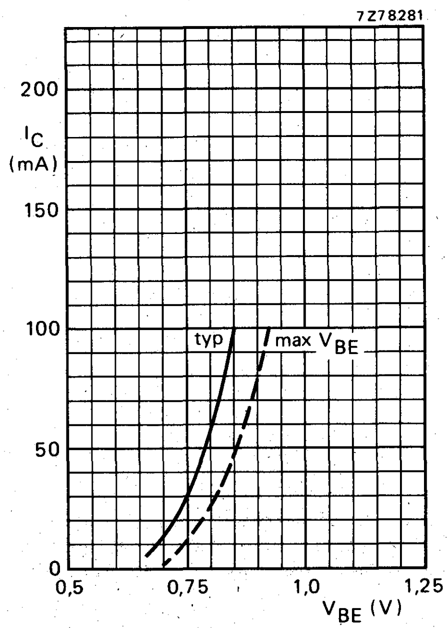


Fig. 3 V_{CE} = 20 V; T_j = 25 °C.

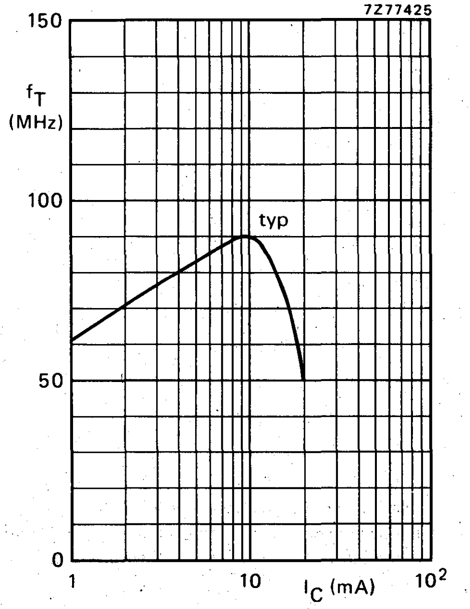


Fig. 4 V_{CE} = 10 V; T_j = 25 °C; f = 35 MHz.

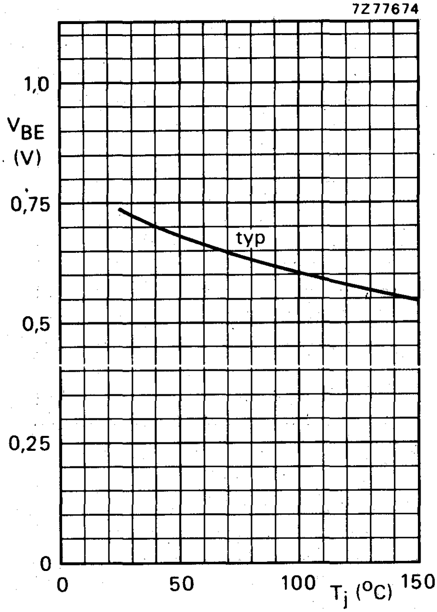


Fig. 5 I_C = 25 mA; V_{CE} = 20 V.

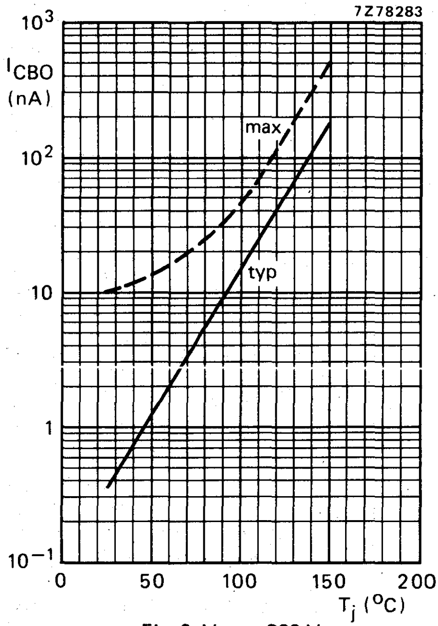


Fig. 6 V_{CB} = 200 V.

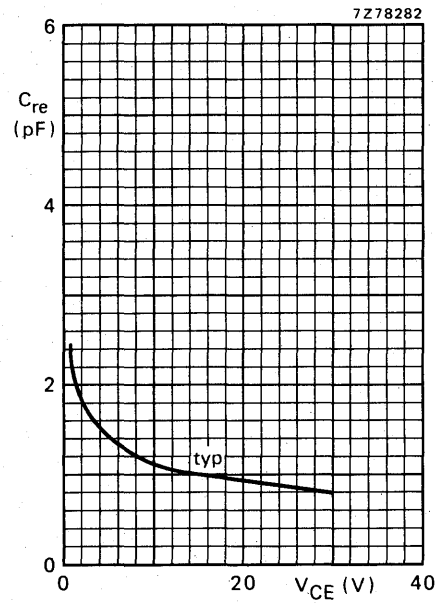


Fig. 7 I_C = 0; f = 1 MHz; T_j = 25 °C.

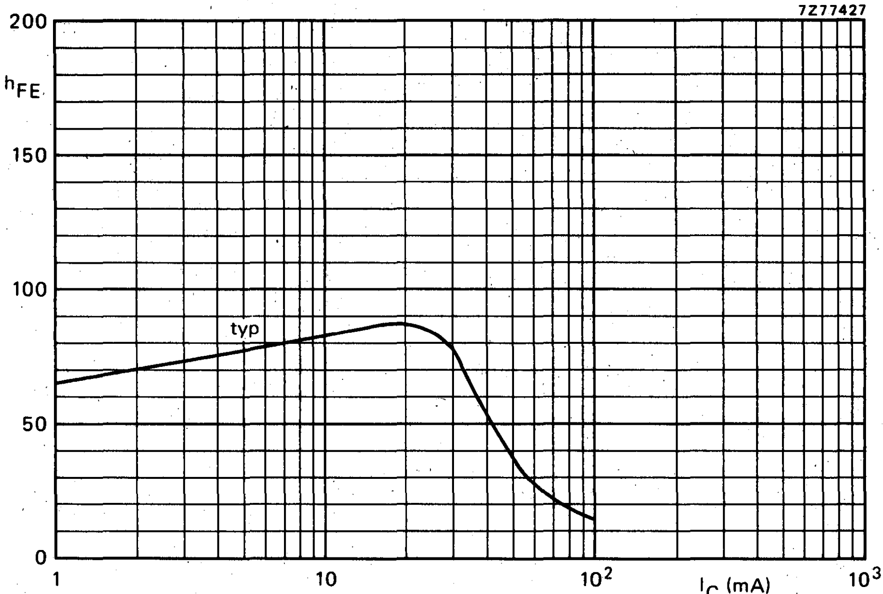


Fig. 8 V_{CE} = 20 V; T_j = 25 °C.

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 °C	P_{tot}	max.	1	W
Junction temperature	T_j	max.	150	°C
D.C. current gain $-I_C$ = 25 mA; $-V_{CE}$ = 20 V	h_{FE}	>	50	
Transition frequency at f = 35 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 10 V	f_T	>	60	MHz
Feedback capacitance at f = 1 MHz I_C = 0; $-V_{CE}$ = 30 V	C_{re}	<	1,6	pF

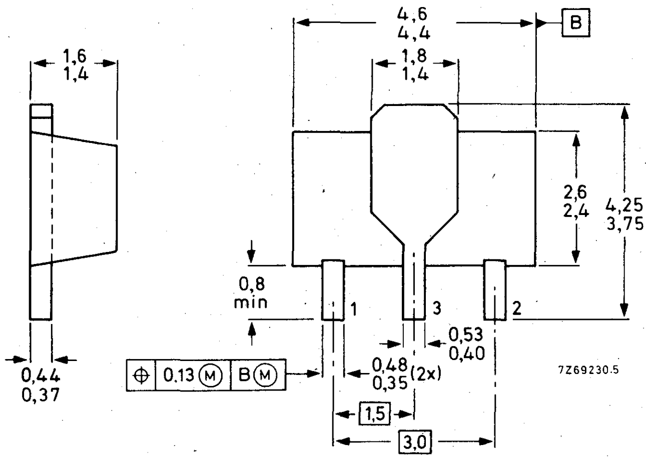
MECHANICAL DATA

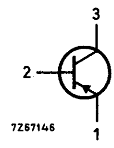
Dimensions in mm

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 °C mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	P_{tot}	max.	1	W
Storage temperature	T_{stg}		–65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to collector tab	$R_{th\ j\text{-}tab}$	=	25	°C/W
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	$R_{th\ j\text{-}a}$	=	125	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $-V_{CB}$ = 200 V	$-I_{CBO}$	<	10 nA
R_{BE} = 10 kΩ; $-V_{CE}$ = 200 V; T_j = 150 °C	$-I_{CER}$	<	50 μA
Emitter cut-off current			
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	10 μA
Base-emitter voltage			
$-I_C$ = 25 mA; $-V_{CE}$ = 20 V	$-V_{BE}$	typ.	0,75 V
D.C. current gain			
$-I_C$ = 25 mA; $-V_{CE}$ = 20 V	h_{FE}	>	50
High-frequency knee voltage at T_j = 150 °C *			
$-I_C$ = 25 mA	$-V_{CEK}$	typ.	20 V
Transition frequency at f = 35 MHz			
$-I_C$ = 10 mA; $-V_{CE}$ = 10 V	f_T	>	60 MHz
Feedback capacitance at f = 1 MHz			
$I_C = 0$; $-V_{CE}$ = 30 V	C_{re}	<	1,6 pF
Feedback time constant at f = 10,7 MHz **			
$-I_C$ = 10 mA; $-V_{CE}$ = 20 V	$r_{bb'}C_{b'c}$	<	70 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 V. A further reduction of the collector-emitter voltage results in a rapid increase of the distortion of the signal.

** $r_{bb'}C_{b'c} = \frac{|h_{rb}|}{\omega}$.

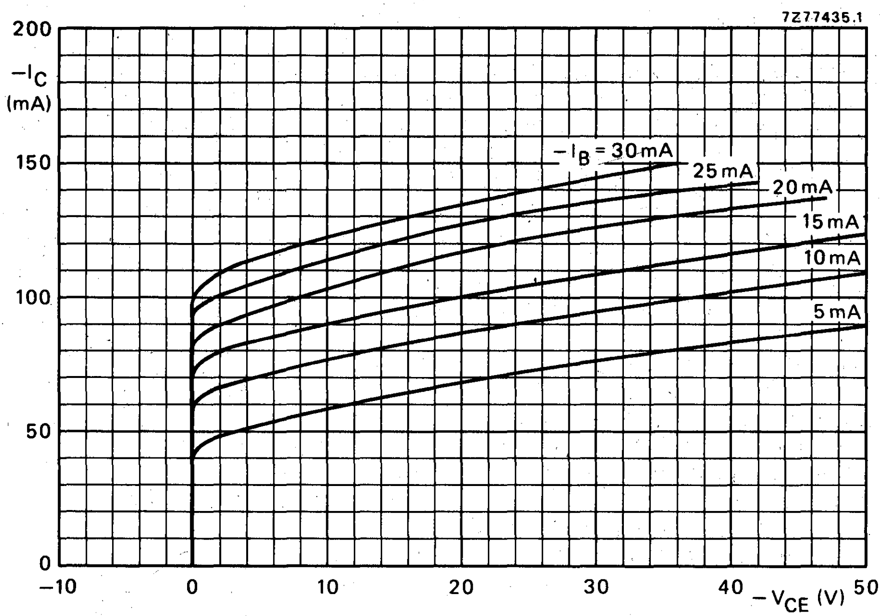


Fig. 2 Typical values at T_j = 25 °C.

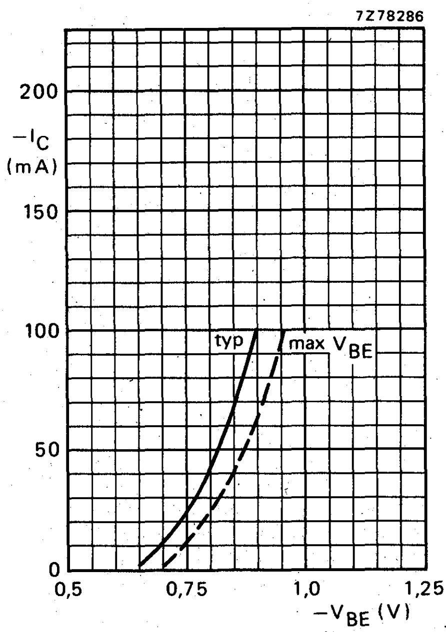


Fig. 3 $-V_{CE}$ = 20 V; T_j = 25 °C.

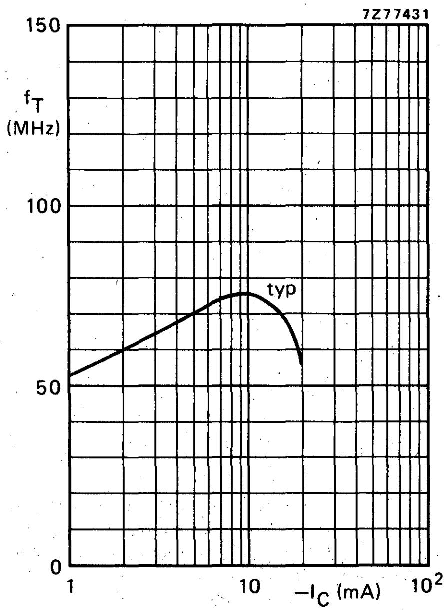


Fig. 4 $-V_{CE}$ = 10 V; T_j = 25 °C; f = 35 MHz.

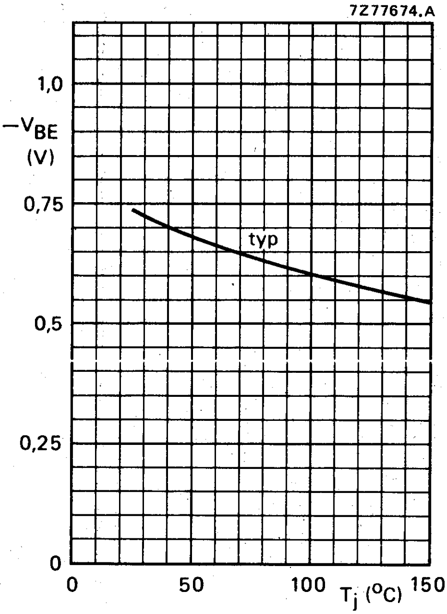


Fig. 5 $-I_C = 25$ mA; $-V_{CE} = 20$ V.

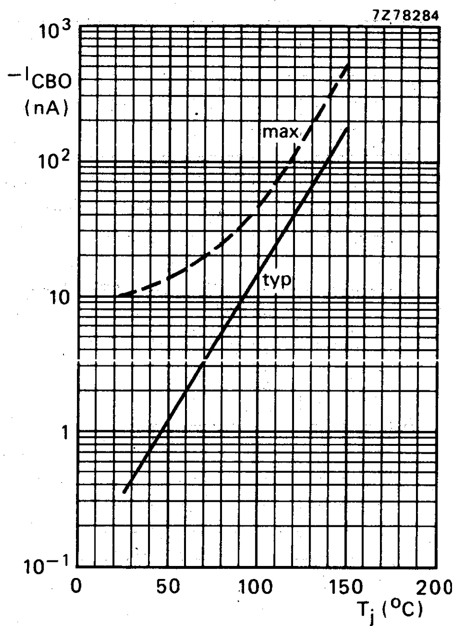


Fig. 6 $-V_{CB} = 200$ V.

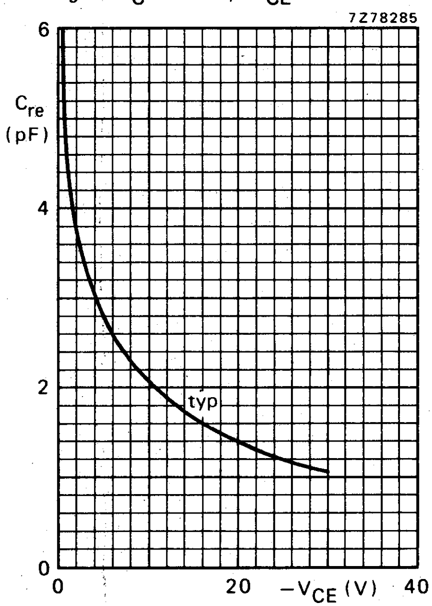


Fig. 7 $I_C = 0$; f = 1 MHz; $T_j = 25$ °C.

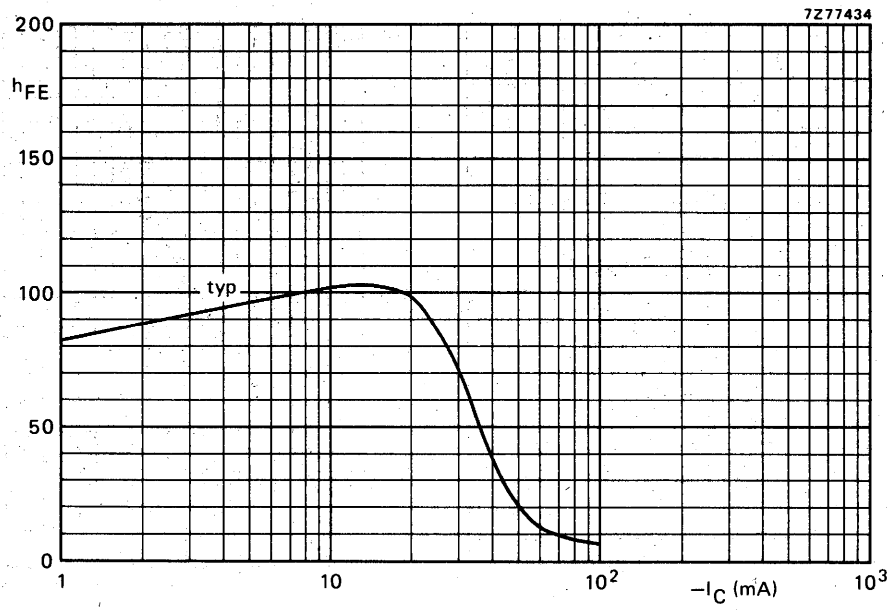


Fig. 8 $-V_{CE} = 20$ V; $T_j = 25$ °C.

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.

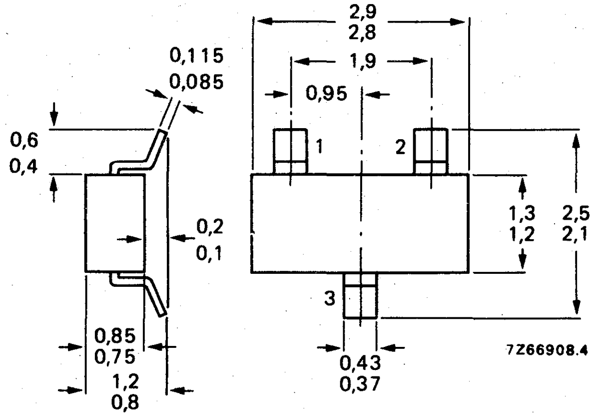
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	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 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 100 MHz I_E = 5 mA; $-V_{CB}$ = 10 V	f_T	typ.	650	MHz

MECHANICAL DATA

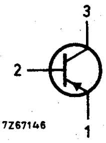
Dimensions in mm

Fig. 1 SOT-23.



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)	$-V_{CBO}$	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 °C **	P_{tot}	max.	200	mW
Storage temperature	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	120	K/W

CHARACTERISTICS

T_{amb} = 25 °C

Collector cut-off current $I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	<	50	nA
D.C. current gain $I_E = 3$ mA; $-V_{CE} = 10$ V	h_{FE}	>	30	
Transition frequency at f = 100 MHz $I_E = 5$ mA; $-V_{CB} = 10$ V	f_T	typ.	650	MHz
Feedback capacitance at f = 1 MHz $I_E = 1$ mA; $-V_{CB} = 10$ V	C_{re}	typ.	0,65	pF

* See *Thermal characteristics* in chapter GENERAL.

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

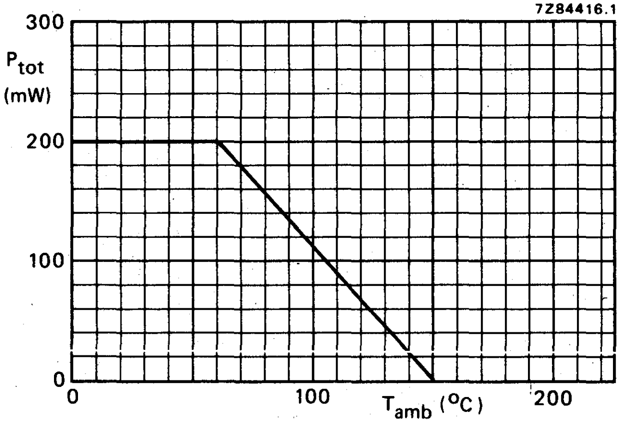


Fig. 2 Power derating curve.

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.

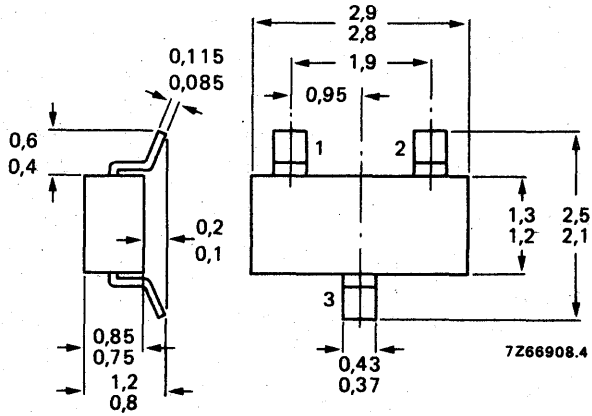
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 100 MHz I_E = 3 mA; $-V_{CB}$ = 10 V	f_T	typ.	900	MHz
Transducer gain (common base) I_E = 3 mA; $-V_{CB}$ = 10 V; f = 800 MHz R_S = 60 Ω; R_L = 500 Ω	G_{tr}	typ.	13	dB
Noise figure (common base) I_E = 3 mA; $-V_{CB}$ = 10 V; f = 800 MHz R_S = 60 Ω; R_L = 500 Ω	F	typ.	4	dB

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.



Marking code

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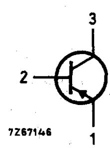


See also *Soldering recommendations*.

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.	3 V
Collector current (d.c.)	$-I_C$	max.	20 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*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60 K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	120 K/W

CHARACTERISTICS

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

Collector cut-off current $I_E = 0$; $-V_{CB} = 15$ V	$-I_{CBO}$	<	100 nA
D.C. current gain $-I_E = 3$ mA; $-V_{CB} = 10$ V	h_{FE}	> typ.	15 60
$-I_E = 7$ mA; $-V_{CB} = 4$ V	h_{FE}	>	10
Transition frequency at f = 100 MHz $I_E = 3$ mA; $-V_{CB} = 10$ V	f_T	typ.	900 MHz
$I_E = 7$ mA; $-V_{CB} = 5$ V	f_T	typ.	90 MHz
Feedback capacitance at f = 500 kHz $I_E = 1$ mA; $-V_{CB} = 10$ V	C_{re}	typ.	0,3 pF
$I_E = 0$; $-V_{CB} = 10$ V	C_{rb}	typ.	160 fF
Transducer gain (common base) $I_E = 3$ mA; $-V_{CB} = 10$ V; f = 800 MHz $R_S = 60\ \Omega$; $R_L = 500\ \Omega$	G_{tr}	typ.	13 dB
Noise figure (common base) $I_E = 3$ mA; $-V_{CB} = 10$ V; f = 800 MHz $R_S = 60\ \Omega$; $R_L = 500\ \Omega$	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.

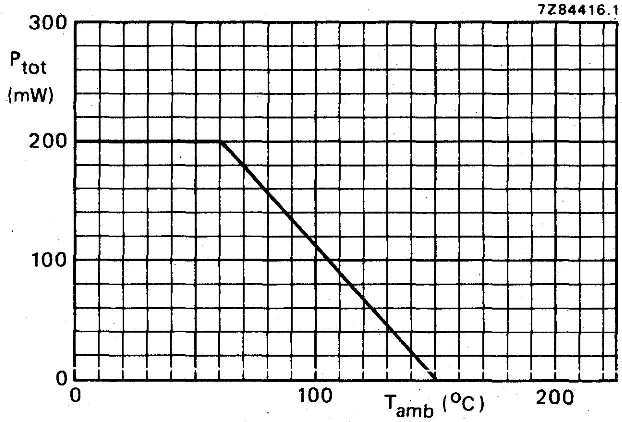


Fig. 2 Power derating curve.

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.

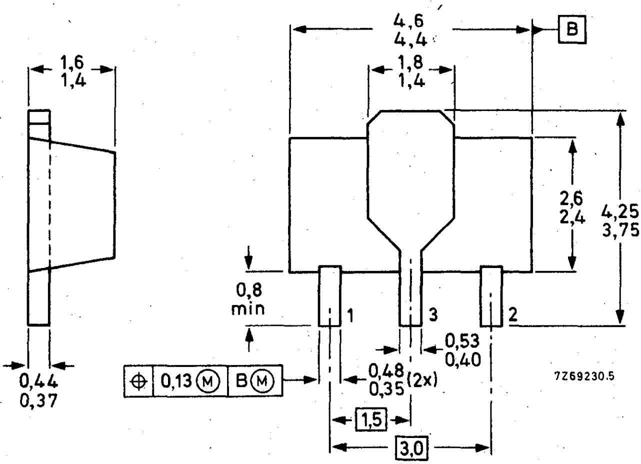
QUICK REFERENCE DATA

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

Fig. 1 SOT-89.



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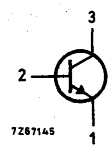


See also *Soldering recommendations.*

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} ≤ 50 Ω; 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 °C mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	P_{tot}	max.	1	W

Temperatures

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

THERMAL RESISTANCE

From junction to collector tab	$R_{th\,j-tab}$	=	30	°C/W
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	$R_{th\,j-a}$	=	125	°C/W

1) I_C = 10 mA.

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150\ ^oC$	I_{CBO}	<	20	μA
Saturation voltage				
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	<	0,5	V
D.C. current gain				
$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
$I_C = 150$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
Transition frequency at f = 500 MHz [1]				
$I_C = 150$ mA; $V_{CE} = 15$ V	f_T	typ.	1,2	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 15$ V	C_c	<	4	pF
Feedback capacitance at f = 1 MHz				
$I_C = 10$ mA; $V_{CE} = 15$ V; $T_{amb} = 25\ ^oC$	C_{re}	typ.	1,9	pF

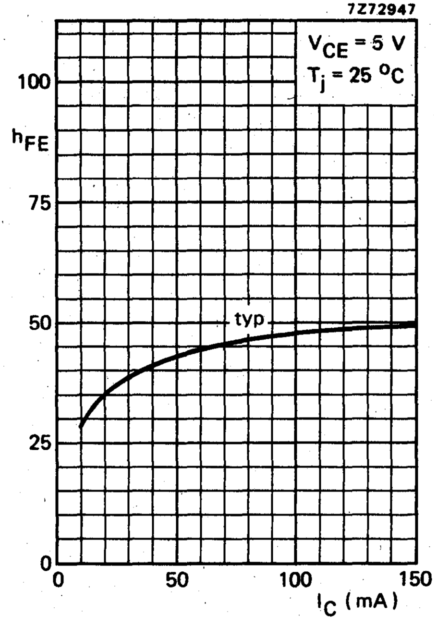
Max. unilateral power gain (s_{re} assumed to be zero)

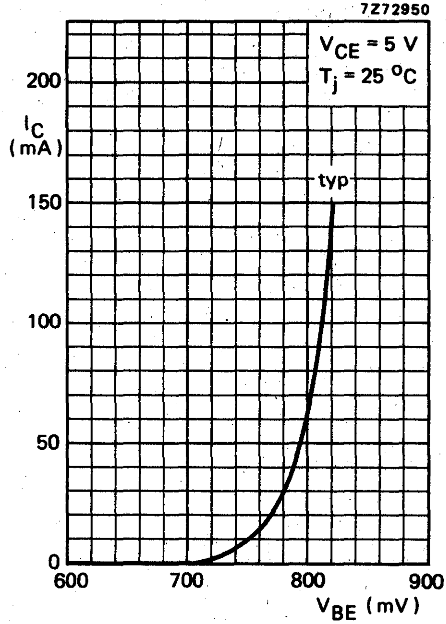
$$G_{UM}\ (\text{in dB}) = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

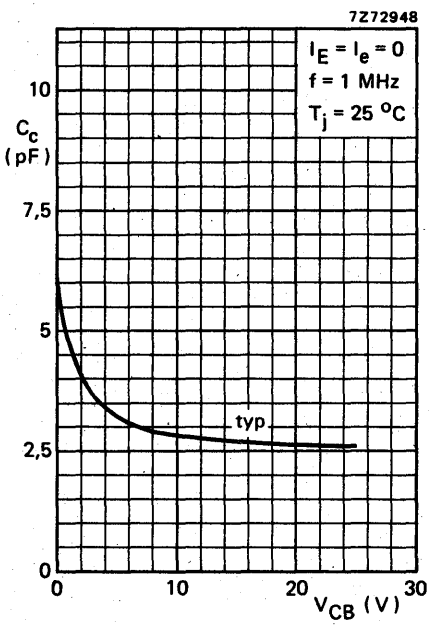
$I_C = 60$ mA; $V_{CE} = 15$ V; $T_{amb} = 25\ ^oC$;

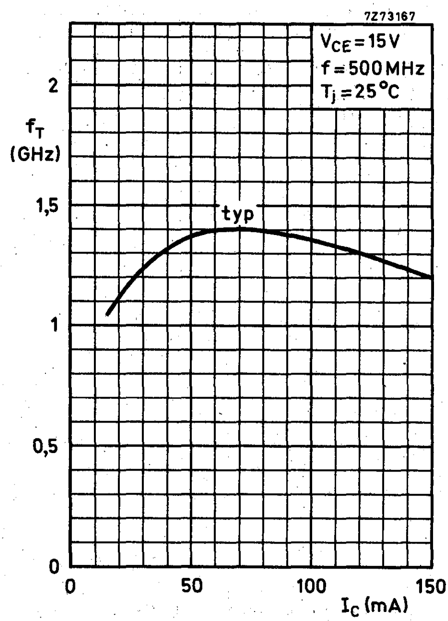
f = 200 MHz	G_{UM}	typ.	16	dB
f = 800 MHz	G_{UM}	typ.	6,5	dB

[1]) Measured under pulse conditions.


7Z72947
V_{CE} = 5 V
T_j = 25 °C
h_{FE}
100
75
50
25
0
typ
0
50
100
150
I_C (mA)


7Z72950
V_{CE} = 5 V
T_j = 25 °C
I_C (mA)
200
150
100
50
0
typ
600
700
800
900
V_{BE} (mV)


7Z72948
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
C_c (pF)
10
7,5
5
2,5
0
typ
0
10
20
30
V_{CB} (V)


7Z73167
V_{CE} = 15 V
f = 500 MHz
T_j = 25 °C
f_T (GHz)
2
1,5
1
0,5
0
typ
0
50
100
150
I_C (mA)

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.

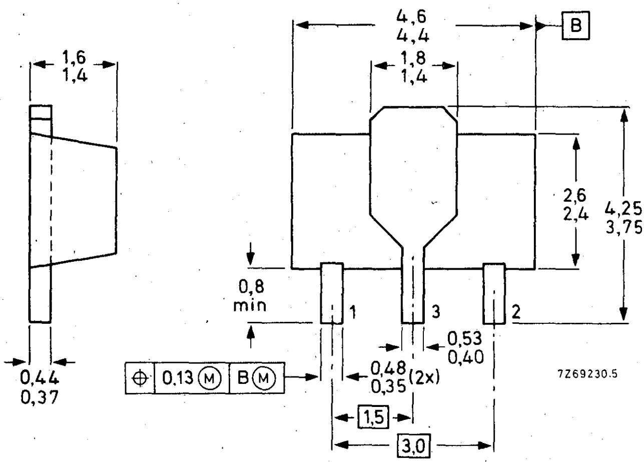
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	1	W
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz I_C = 100 mA; V_{CE} = 10 V	f_T	typ.	3,6	GHz
Feedback capacitance at f = 10,7 MHz I_C = 0; V_{CE} = 10 V	C_{re}	typ.	1,2	pF
Intermodulation distortion I_C = 80 mA; V_{CE} = 10 V; R_L = 75 Ω measured at $f_{(p+q-r)}$ = 793,25 MHz	d_{im}	<	−60	dB

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-89.



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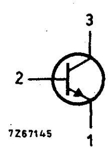


See also *Soldering recommendations.*

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 °C *	P_{tot}	max.	1	W
Storage temperature	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to collector tab	$R_{th\ j\text{-}tab}$	=	25	°C/W
From junction to ambient in free air *	$R_{th\ j\text{-}a}$	=	125	°C/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

D.C. current gain **				
I_C = 50 mA; V_{CE} = 10 V	h_{FE}	>	25	
I_C = 100 mA; V_{CE} = 10 V	h_{FE}	>	25	
Transition frequency at f = 500 MHz **				
I_C = 50 mA; V_{CE} = 10 V	f_T	typ.	3,2	GHz
I_C = 100 mA; V_{CE} = 10 V	f_T	typ.	3,6	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	2,0	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; V_{EB} = 0,5 V	C_e	typ.	11	pF
Feedback capacitance at f = 10,7 MHz				
$I_C = 0$; V_{CE} = 10 V	C_{re}	typ.	1,2	pF

* The device mounted on a ceramic substrate area = 2,5 cm^2; thickness = 0,7 mm.
** Measured under pulse conditions.

Intermodulation distortion (see Fig. 2)

I_C = 80 mA; V_{CE} = 10 V; R_L = 75 Ω
$V_p = V_o$ = 700 mV at f_p = 795,25 MHz
$V_q = V_o$ −6 dB at f_q = 803,25 MHz
$V_r = V_o$ −6 dB at f_r = 805,25 MHz
Measured at $f_{(p+q-r)}$ = 793,25 MHz d_{im} < −60 dB

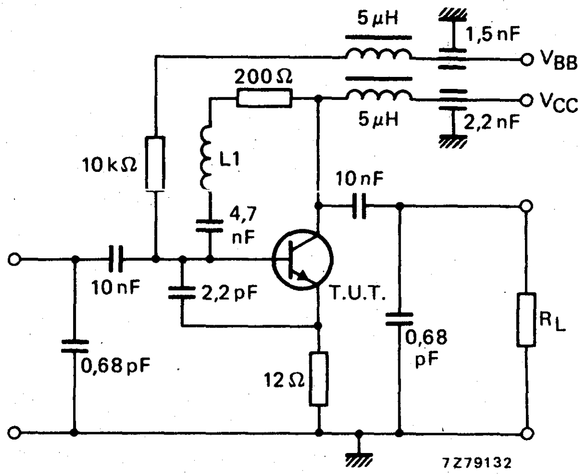


Fig. 2 MATV-test circuit (40–860 MHz).

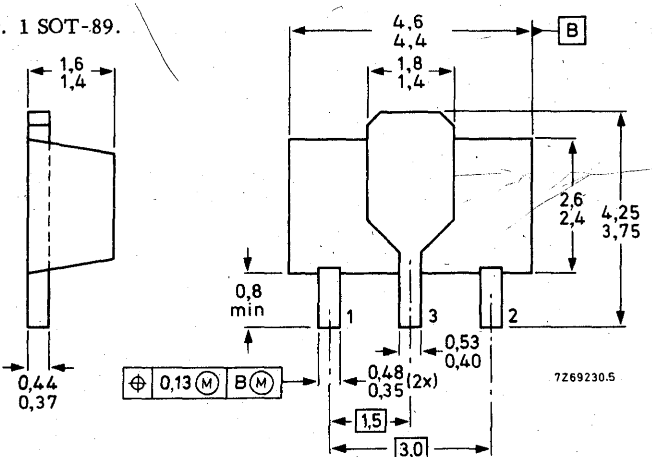
SILICON PLANAR EPITAXIAL TRANSISTOR

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 °C	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz I_C = 50 mA; V_{CE} = 10 V	f_T	typ.	5	GHz
Feedback capacitance at f = 1 MHz I_C = 10 mA; V_{CE} = 10 V; T_{amb} = 25 °C	C_{re}	typ.	1,3	pF
Noise figure at optimum source impedance I_C = 50 mA; V_{CE} = 10 V; f = 500 MHz; T_{amb} = 25 °C	F	typ.	3,3	dB

MECHANICAL DATA Dimensions in mm

Fig. 1 SOT-89.



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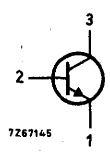


See also Soldering recommendations.

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

Voltages

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.	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^2; thickness = 0,7 mm	P_{tot}	max.	500	mW

Temperatures

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

THERMAL RESISTANCE

From junction to collector tab	$R_{th\,j-tab}$	=	40	°C/W
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm^2; thickness = 0,7 mm	$R_{th\,j-a}$	=	125	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$: $V_{CB} = 10$ V	I_{CBO}	<	100	nA
D.C. current gain [1]				
$I_C = 50$ mA; $V_{CE} = 10$ V	h_{FE}	>	25	
		typ.	50	
$I_C = 75$ mA; $V_{CE} = 10$ V	h_{FE}	>	25	
		typ.	52	
Transition frequency at f = 500 MHz [1]				
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	4,0	GHz
		typ.	5,0	GHz
$I_C = 75$ mA; $V_{CE} = 10$ V	f_T	>	4,4	GHz
		typ.	5,5	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	1,6	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0,5$ V	C_e	typ.	5,0	pF
Feedback capacitance at f = 1 MHz				
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = 25$ °C	C_{re}	typ.	1,3	pF
Noise figure at optimum source impedance				
$I_C = 50$ mA; $V_{CE} = 10$ V; f = 500 MHz; $T_{amb} = 25$ °C	F	typ.	3,3	dB

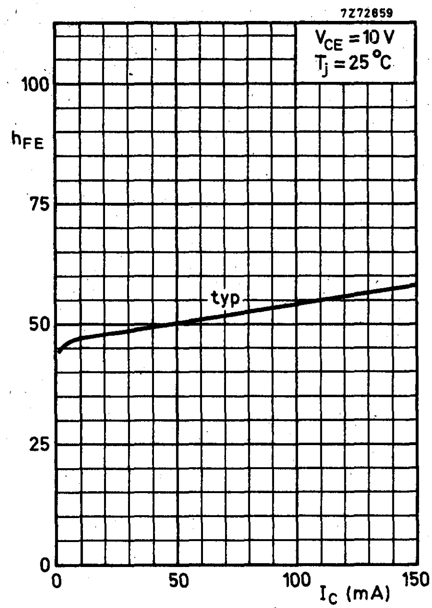
Max. unilateral power gain (s_{re} assumed to be zero)

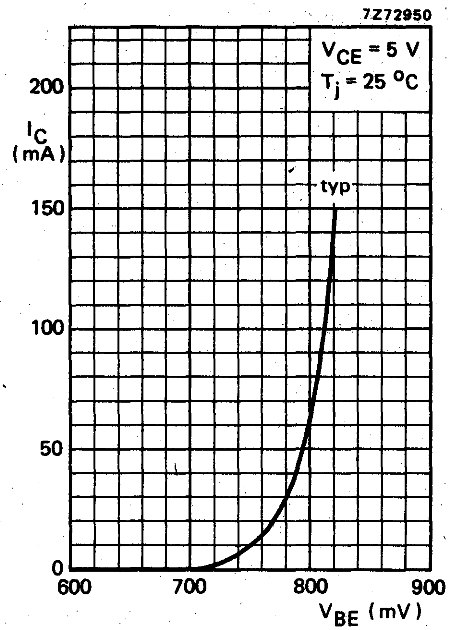
$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

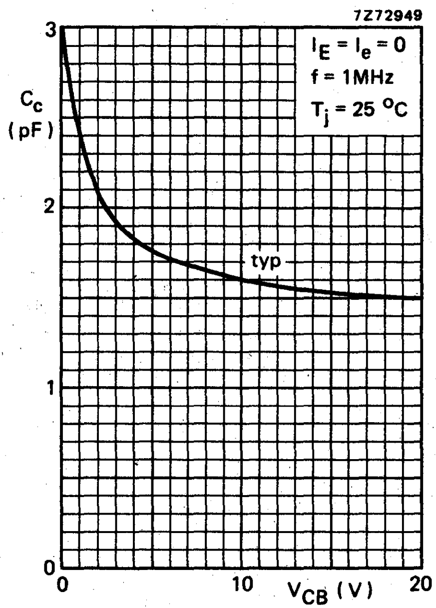
$I_C = 50$ mA; $V_{CE} = 10$ V; $T_{amb} = 25$ °C;

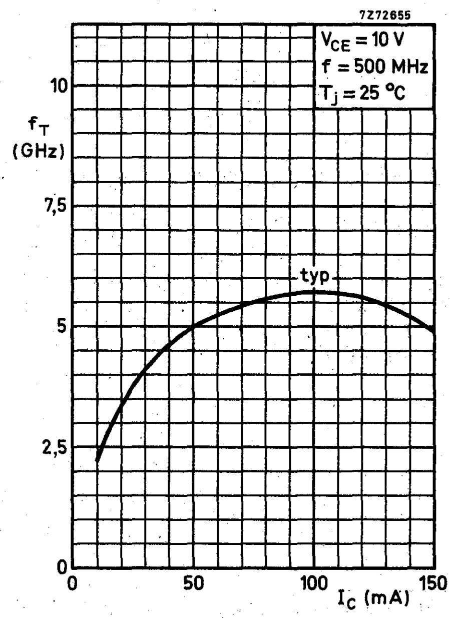
f = 200 MHz	G_{UM}	typ.	18,5	dB
f = 500 MHz	G_{UM}	typ.	11,5	dB
f = 800 MHz	G_{UM}	typ.	7,5	dB

1) Measured under pulse conditions.


7Z72659
V_{CE} = 10 V
T_j = 25 °C
100
h_{FE}
75
50
25
0
typ
0
50
100
150
I_C (mA)


7Z72950
V_{CE} = 5 V
T_j = 25 °C
200
I_C (mA)
150
100
50
0
typ
600
700
800
900
V_{BE} (mV)


7Z72949
$I_E = I_e = 0$
f = 1MHz
T_j = 25 °C
3
C_c (pF)
2
1
0
typ
0
10
20
V_{CB} (V)


7Z72655
V_{CE} = 10 V
f = 500 MHz
T_j = 25 °C
10
f_T (GHz)
7,5
5
2,5
0
typ
0
50
100
150
I_C (mA)

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

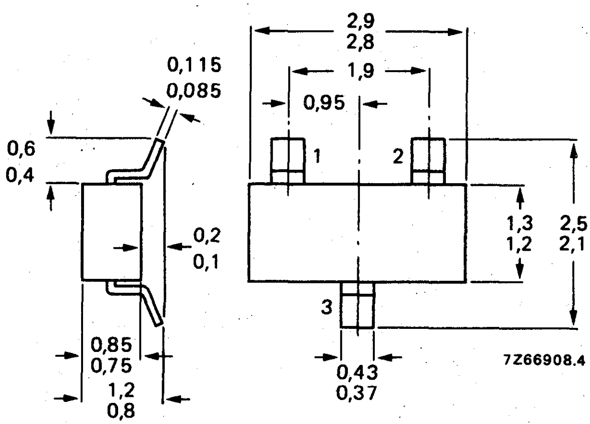
Drain-source voltage	$\pm V_{DS}$	max.	25		V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25		V
Total power dissipation up to T_{amb} = 65 °C	P_{tot}	max.	250		mW
			BFR30	BFR31	
Drain current V_{DS} = 10 V; V_{GS} = 0	I_{DSS}	> <	4 10	1 5	mA mA
Transfer admittance (common source) I_D = 1 mA; V_{DS} = 10 V; f = 1 kHz	$\lvert y_{fs} \rvert$	> <	1,0 4,0	1,5 4,5	mA/V mA/V

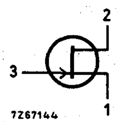
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.

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 °C**	P_{tot}	max.	250	mW
→ Storage temperature	T_{stg}		−65 to + 175	°C
→ Junction temperature	T_j	max.	175	°C

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	120	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BFR30	BFR31	
Gate cut-off current $-V_{GS}$ = 10 V; V_{DS} = 0	$-I_{GSS}$	<	0,2	0,2	nA
Drain current V_{DS} = 10 V; V_{GS} = 0	I_{DSS}	>	4	1	mA
		<	10	5	mA
Gate-source voltage I_D = 1 mA; V_{DS} = 10 V	$-V_{GS}$	>	0,7	0	V
		<	3,0	1,3	V
I_D = 50 μA; V_{DS} = 10 V	$-V_{GS}$	<	4,0	2,0	V
Gate-source cut-off voltage I_D = 0,5 nA; V_{DS} = 10 V	$-V_{(P)GS}$	<	5	2,5	V
y parameters					
Transfer admittance at f = 1 kHz; T_{amb} = 25 °C I_D = 1 mA; V_{DS} = 10 V	$\|y_{fs}\|$	>	1,0	1,5	mA/V
		<	4,0	4,5	mA/V
I_D = 200 μA; V_{DS} = 10 V	$\|y_{fs}\|$	>	0,5	0,75	mA/V
Output admittance at f = 1 kHz I_D = 1 mA; V_{DS} = 10 V	$\|y_{os}\|$	<	40	25	μA/V
I_D = 200 μA; V_{DS} = 10 V	$\|y_{os}\|$	<	20	15	μA/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)

			BFR30	BFR31	
Input capacitance at f = 1 MHz					
I_D = 1 mA; V_{DS} = 10 V	C_{is}	<	4	4	pF
I_D = 200 μA; V_{DS} = 10 V	C_{is}	<	4	4	pF
Feedback capacitance at f = 1 MHz; T_{amb} = 25 °C					
I_D = 1 mA; V_{DS} = 10 V	C_{rs}	<	1,5	1,5	pF
I_D = 200 μA; V_{DS} = 10 V	C_{rs}	<	1,5	1,5	pF
Equivalent noise voltage					
I_D = 200 μA; V_{DS} = 10 V B = 0,6 to 100 Hz	V_n	<	0,5	0,5	μV

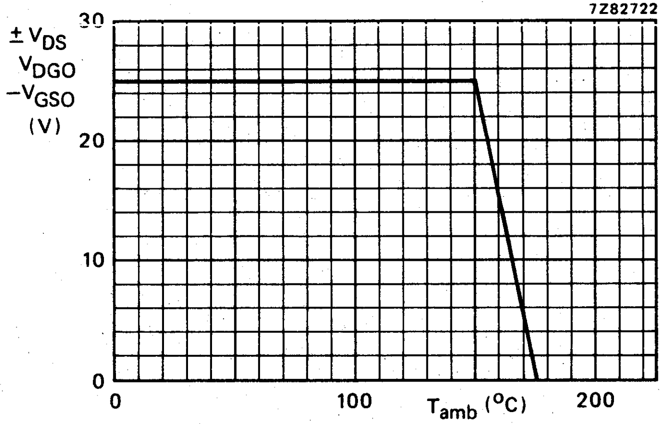


Fig. 2 Voltage derating curve.

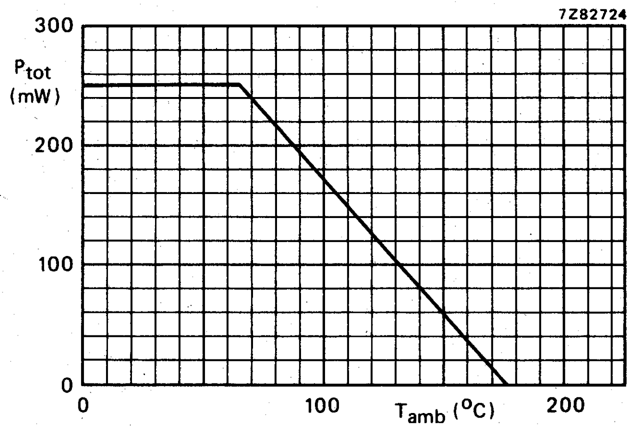
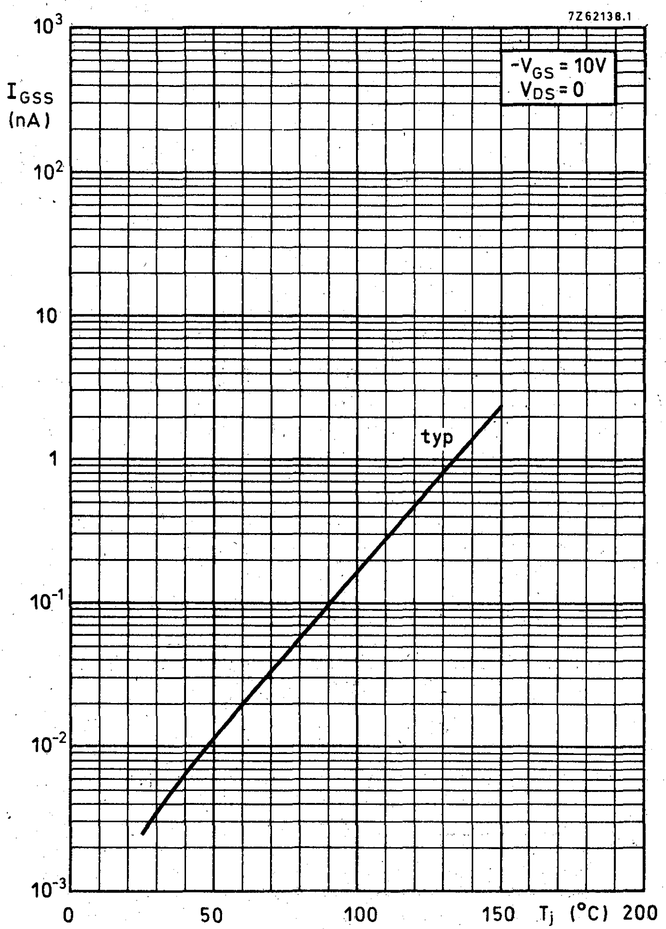
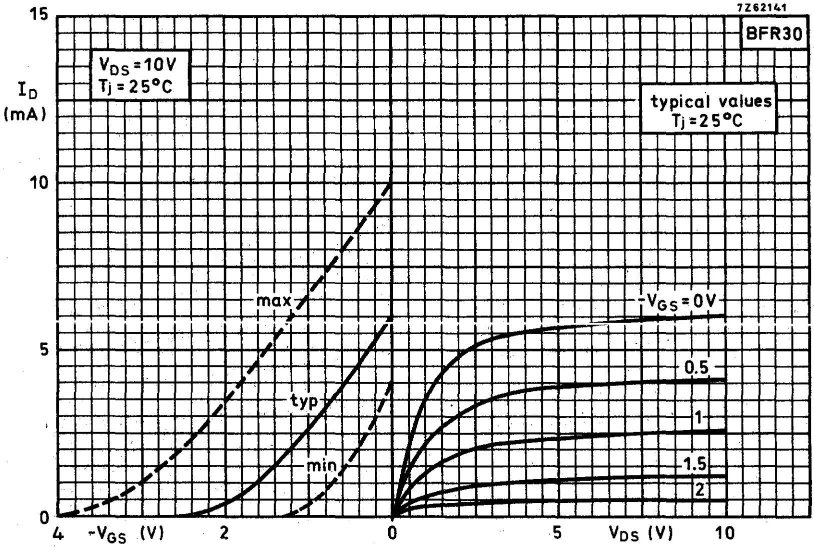
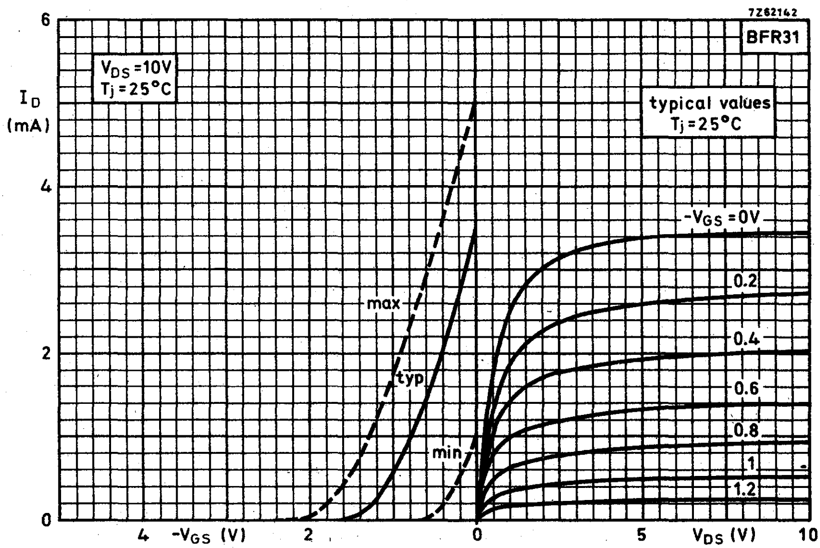
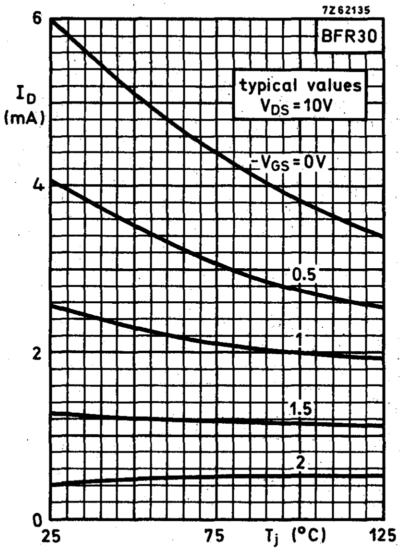


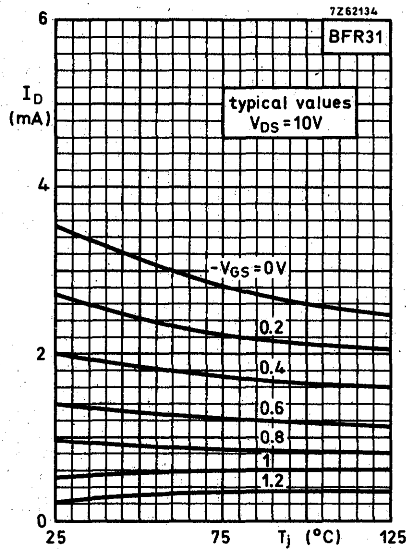
Fig. 3 Power derating curve.

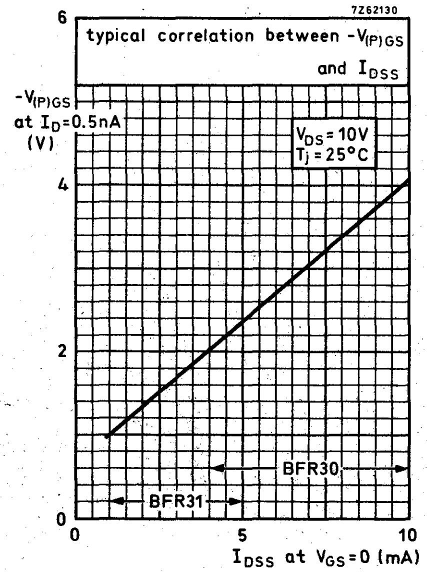

7Z62138.1
I_{GSS} (nA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
$-V_{GS} = 10V$
$V_{DS} = 0$
typ
0
50
100
150
200
T_j (°C)

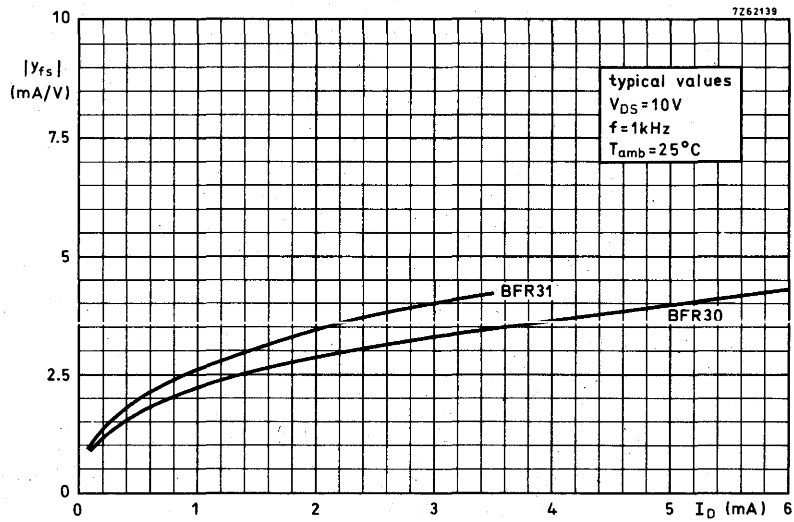

7Z62141
BFR30
V_{DS} = 10 V
T_j = 25 °C
I_D (mA)
typical values
T_j = 25 °C
max
typ
min
$-V_{GS}$ = 0 V
0.5
1
1.5
2
15
10
5
0
4
$-V_{GS}$ (V)
2
0
5
V_{DS} (V)
10

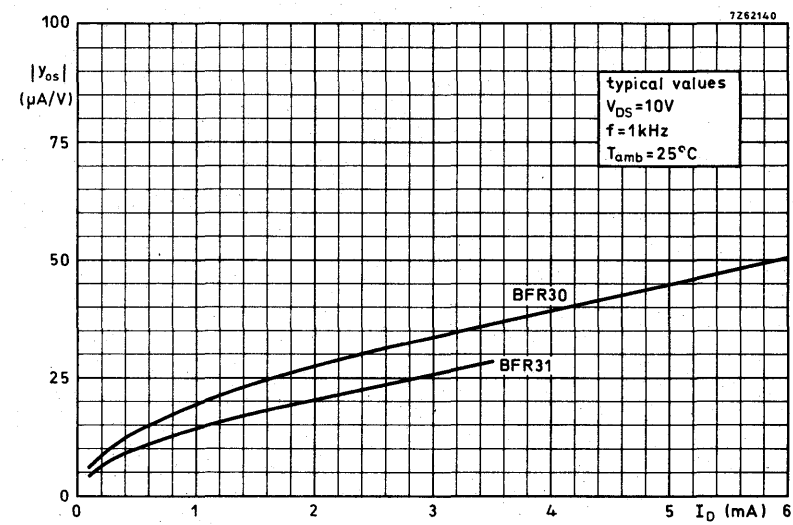

7Z62142
BFR31
V_{DS} = 10 V
T_j = 25 °C
I_D (mA)
typical values
T_j = 25 °C
$-V_{GS}$ = 0 V
0.2
0.4
0.6
0.8
1
1.2
max
typ
min
6
4
2
0
4
$-V_{GS}$ (V)
2
0
5
V_{DS} (V)
10

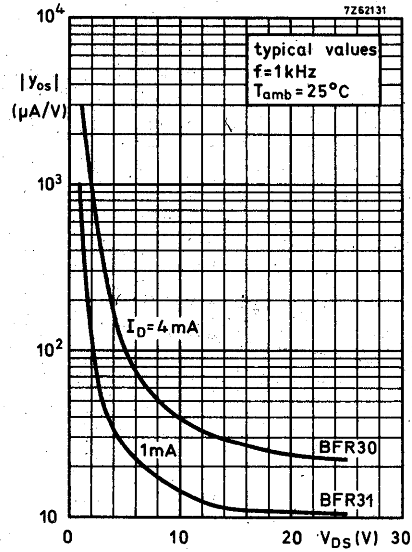

7Z62135
BFR30
typical values
V_{DS} = 10V
I_D (mA)
$-V_{GS}$ = 0V
0.5
1
1.5
2
T_j (°C)
0
2
4
6
25
75
125

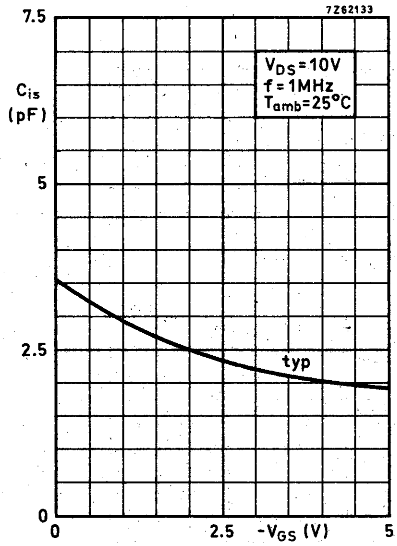

7Z62134
BFR31
typical values
V_{DS} = 10V
I_D (mA)
$-V_{GS}$ = 0V
0.2
0.4
0.6
0.8
1
1.2
T_j (°C)
0
2
4
6
25
75
125

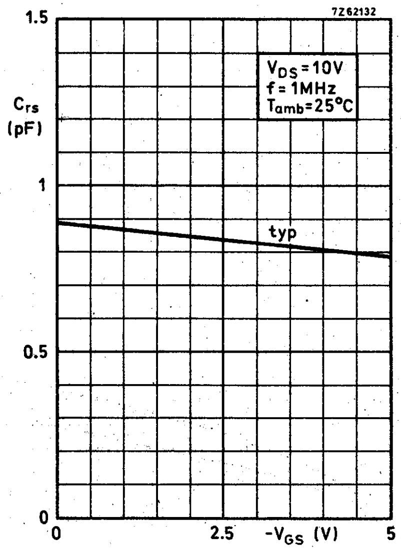

7Z62130
typical correlation between $-V_{(P)GS}$ and I_{DSS}
$-V_{(P)GS}$ at I_D = 0.5nA (V)
V_{DS} = 10V
T_j = 25°C
BFR30
BFR31
I_{DSS} at V_{GS} = 0 (mA)
0
2
4
6
5
10

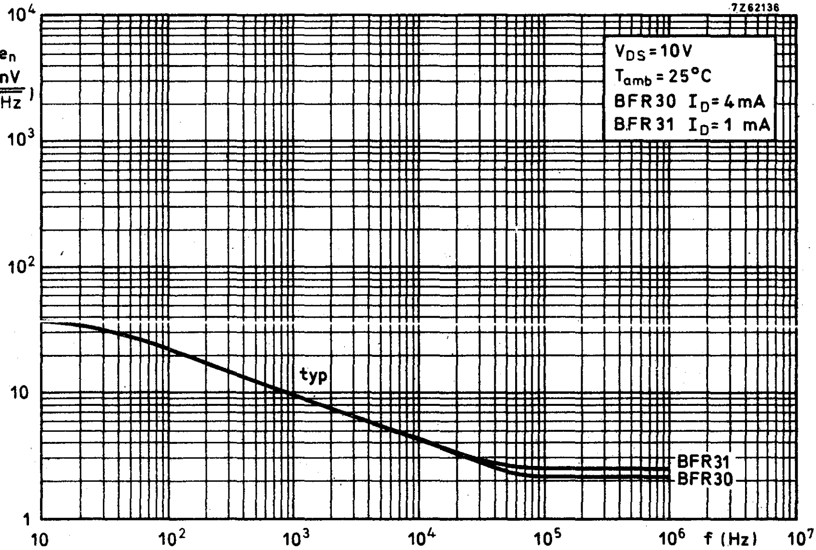

7Z62139
10
|yfs|
(mA/V)
7.5
5
2.5
0
typical values
VDS=10V
f=1kHz
Tamb=25°C
BFR31
BFR30
0
1
2
3
4
5
ID (mA)
6

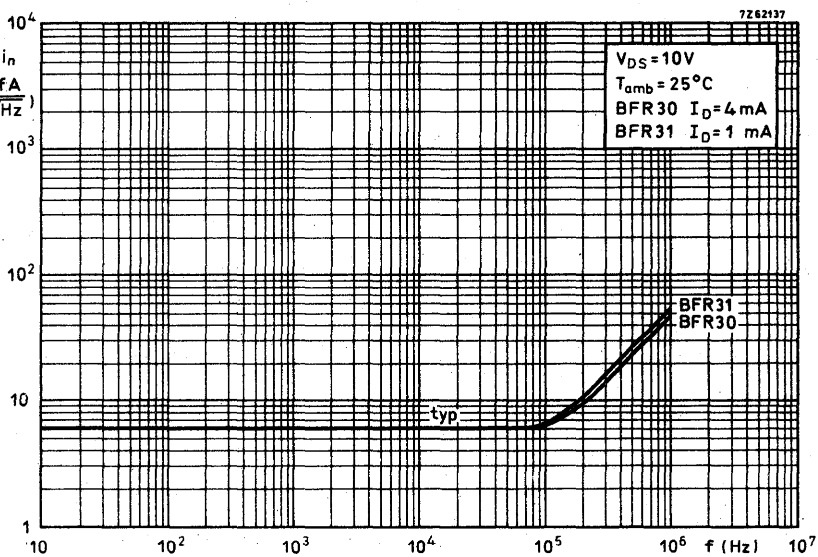

7Z62140
100
|yos|
(µA/V)
75
50
25
0
typical values
VDS=10V
f=1kHz
Tamb=25°C
BFR30
BFR31
0
1
2
3
4
5
ID (mA)
6


7Z62131
typical values
f=1kHz
T_{amb} = 25°C
$|y_{os}|$
(μA/V)
10^4
10^3
10^2
10
I_D=4mA
1mA
BFR30
BFR31
0
10
20
V_{DS} (V)
30


7Z62133
V_{DS}=10V
f=1MHz
T_{amb}=25°C
C_{is}
(pF)
7.5
5
2.5
0
typ
0
2.5
$-V_{GS}$ (V)
5


7Z62132
V_{DS}=10V
f=1MHz
T_{amb}=25°C
C_{rs}
(pF)
1.5
1
0.5
0
typ
0
2.5
$-V_{GS}$ (V)
5


7Z62136
e_n
nV
(√Hz)
V_DS = 10 V
T_amb = 25 °C
BFR30 I_D = 4 mA
BFR31 I_D = 1 mA
typ
BFR31
BFR30
10^4
10^3
10^2
10
1
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7


7Z62137
i_n
fA
(√Hz)
V_DS = 10 V
T_amb = 25 °C
BFR30 I_D = 4 mA
BFR31 I_D = 1 mA
typ
BFR31
BFR30
10^4
10^3
10^2
10
1
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7

SILICON PLANAR EPITAXIAL TRANSISTORS

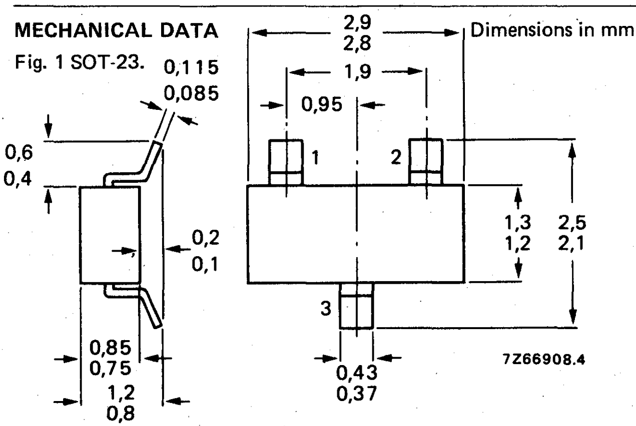
N-P-N multi-emitter transistor in a microminiature plastic envelope intended for application in thick and thin-film circuits. The transistor has very low intermodulation distortion and very high power gain. It is primarily intended for:
- Wideband vertical amplifiers in high speed oscilloscopes.
- Television distribution amplifiers.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	18	V
Collector-emitter voltage (open base)	V_{CEO}	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 Ω 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

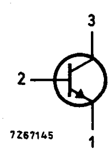
Fig. 1 SOT-23.



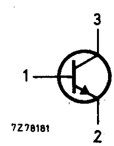
See also *Soldering recommendations.*

Marking code

BFR53 = N1



BFR53R = N4 ←



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*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	120	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<	50	nA
D.C. current gain ▲				
$I_C = 25$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
Transition frequency at f = 500 MHz ▲				
$I_C = 25$ mA; $V_{CE} = 5$ V	f_T	typ.	2,0	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	typ.	0,9	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0{,}5$ V	C_e	typ.	1,5	pF
Feedback capacitance at f = 1 MHz				
$I_C = 2$ mA; $V_{CE} = 5$ V; $T_{amb} = 25$ °C	$-C_{re}$	typ.	0,9	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 MHz ▲

I_C = 2 mA; V_{CE} = 5 V; T_{amb} = 25 °C

G_S = 20 mA/V; B_S is tuned — F < 5 dB

Max. unilateral power gain (s_{re} assumed to be zero)

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)\,(1 - |s_{oe}|^2)}$$

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 ▲

I_C = 30 mA; V_{CE} = 5 V; R_L = 37,5 Ω

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

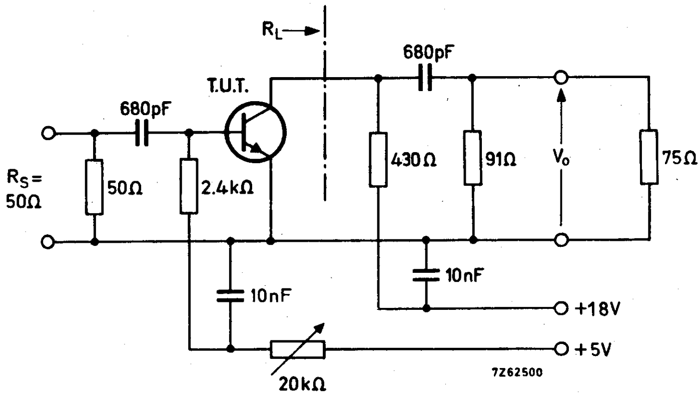


Fig. 2 Test circuit.

▲ Crystal mounted in a BFW30 envelope.

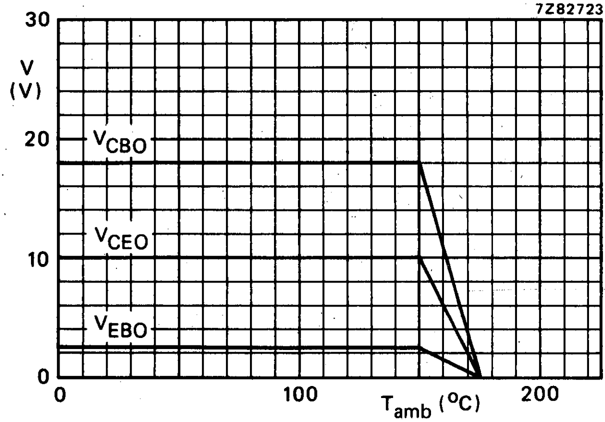


Fig. 3 Voltage derating curves.

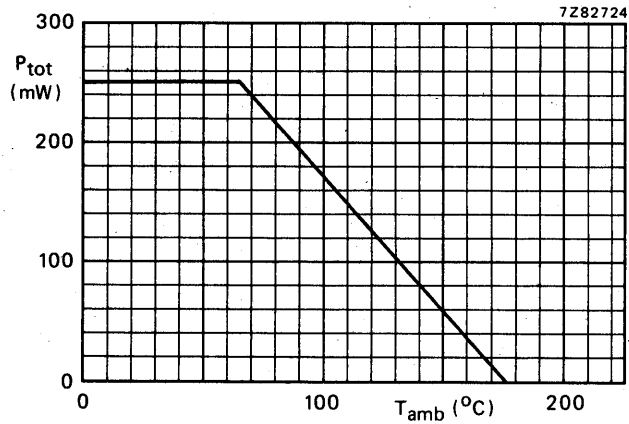
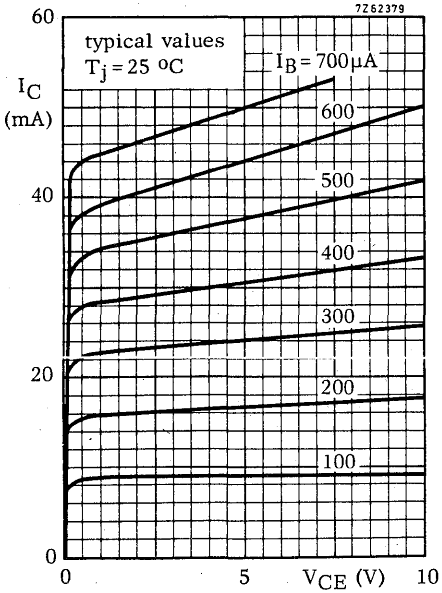
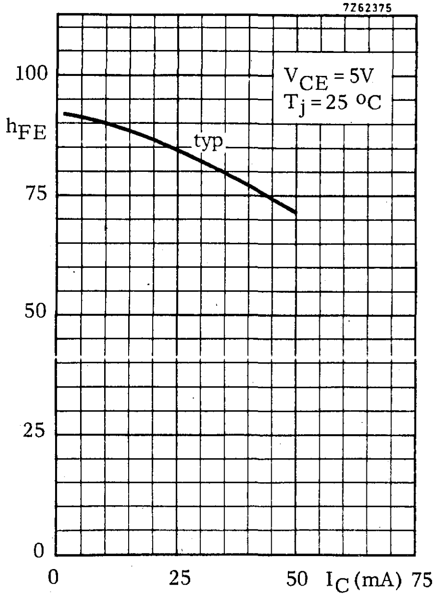
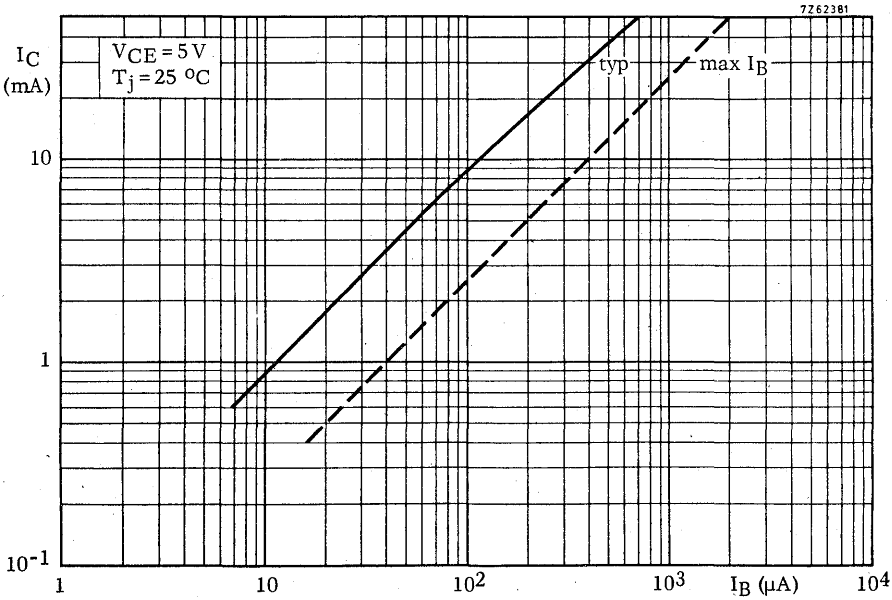
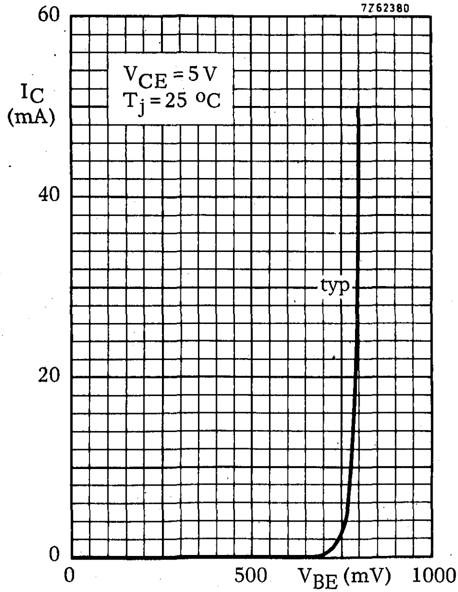


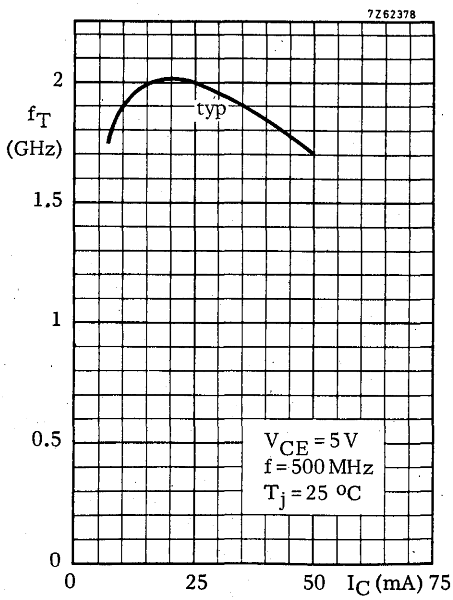
Fig. 4 Power derating curve.

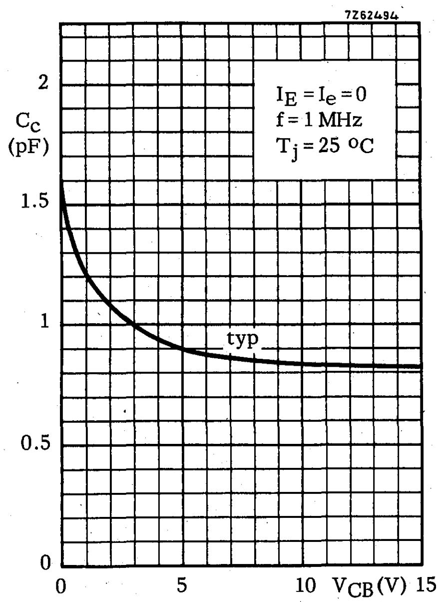

7Z62379
60
40
20
0
typical values
Tj = 25 °C
IC
(mA)
IB = 700 µA
600
500
400
300
200
100
0
5
VCE (V)
10


7Z62375
100
75
50
25
0
hFE
VCE = 5V
Tj = 25 °C
typ
0
25
50
IC (mA)
75

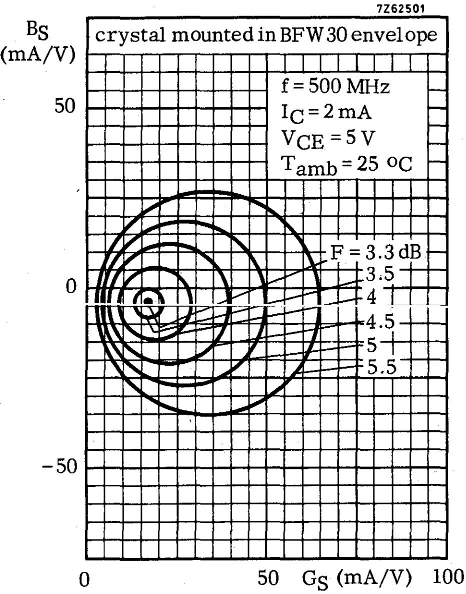

7Z62381
IC
(mA)
VCE = 5 V
Tj = 25 °C
typ
max IB
10
1
10-1
1
10
102
103
IB (µA)
104

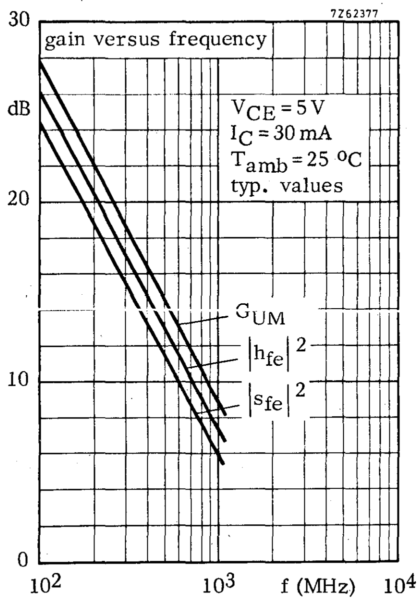

7Z62380
I_C (mA)
60
40
20
0
$V_{CE} = 5$ V
$T_j = 25$ °C
typ
0
500
V_{BE} (mV)
1000

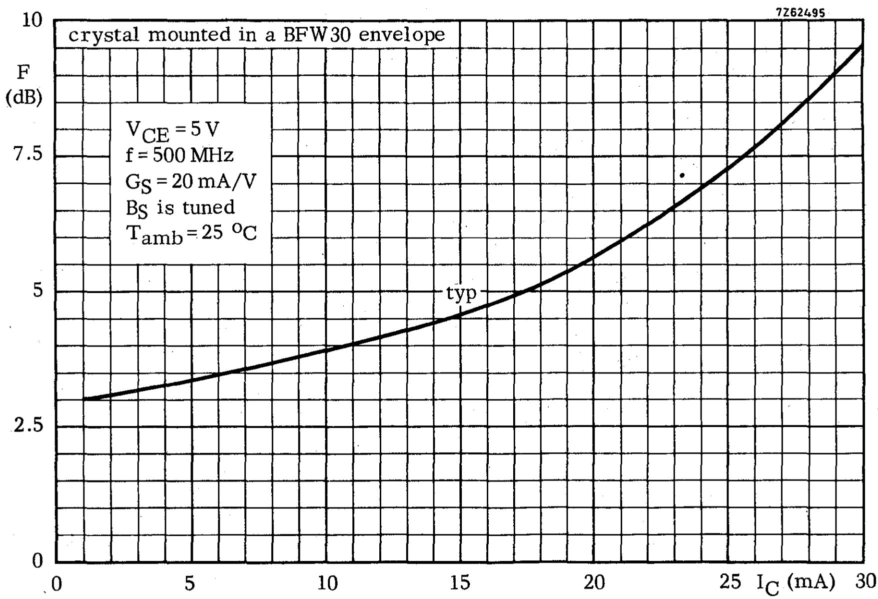

7Z62378
f_T (GHz)
2
1.5
1
0.5
0
typ
$V_{CE} = 5$ V
f = 500 MHz
$T_j = 25$ °C
0
25
50
I_C (mA) 75


7Z62494
C_c (pF)
2
1.5
1
0.5
0
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25$ °C
typ
0
5
10
V_{CB} (V) 15

circles of constant noise figure



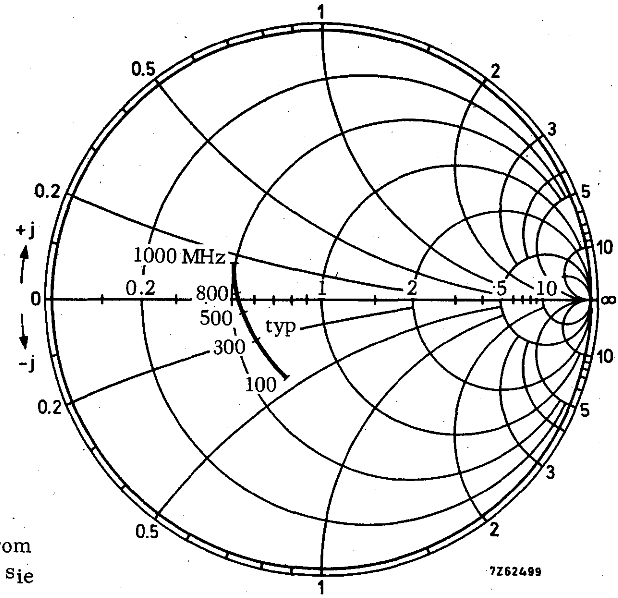




V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 °C

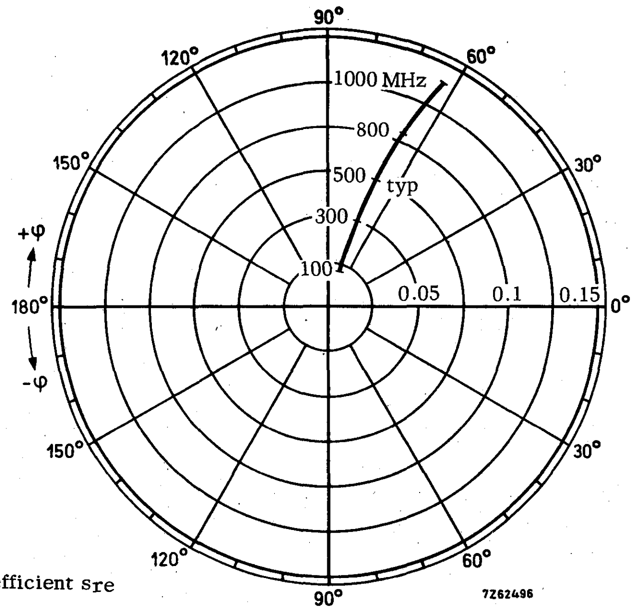


Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 °C

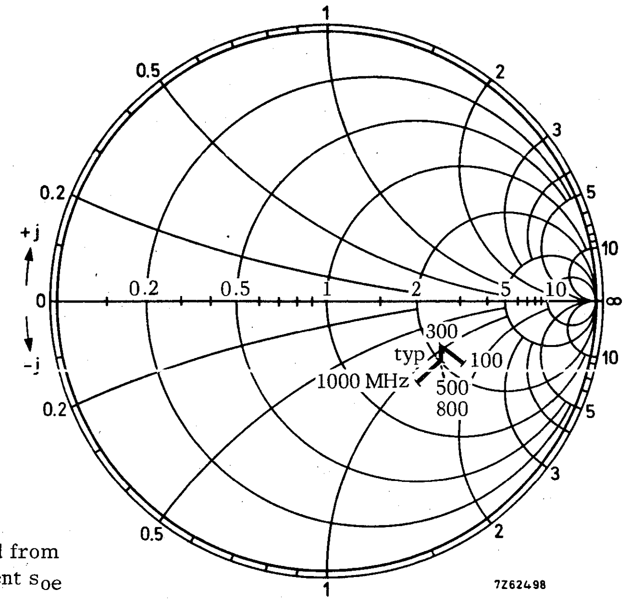


Reverse transmission coefficient s_{re}

V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 °C

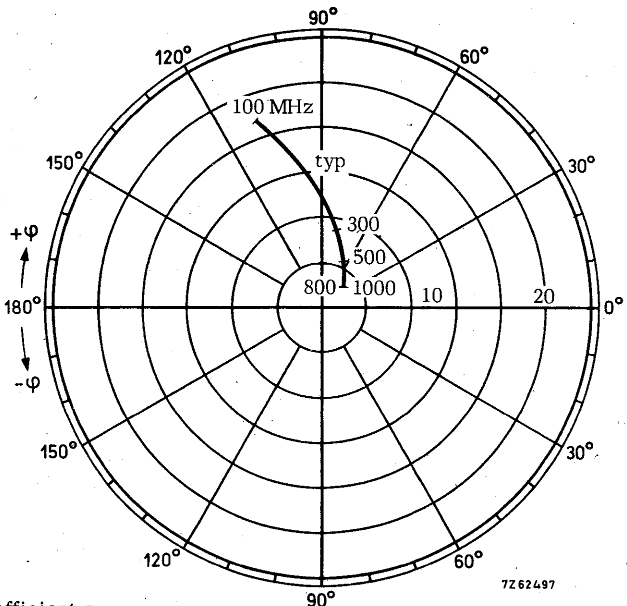


Output impedance derived from output reflection coefficient s_{oe} coordinates in ohm x 50

V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 °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 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.

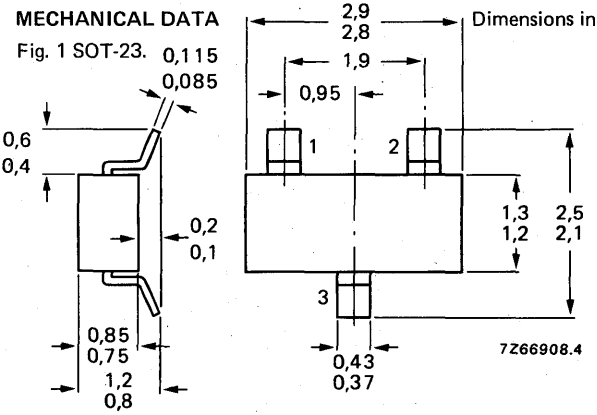
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz I_C = 14 mA; V_{CE} = 10 V	f_T	typ.	5	GHz
Feedback capacitance at f = 1 MHz I_C = 2 mA; V_{CE} = 10 V; T_{amb} = 25 °C	C_{re}	typ.	0,7	pF
Noise figure at optimum source impedance I_C = 2 mA; V_{CE} = 10 V; f = 500 MHz; T_{amb} = 25 °C	F	typ.	2,4	dB
Max. unilateral power gain (see page 3) I_C = 14 mA; V_{CE} = 10 V; f = 500 MHz; T_{amb} = 25 °C	G_{UM}	typ.	18	dB
Intermodulation distortion at T_{amb} = 25 °C I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; V_o = 150 mV $f_{(p+q-r)}$ = 493,25 MHz (see page 4)	d_{im}	typ.	−60	dB

MECHANICAL DATA

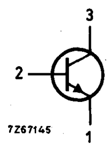
Fig. 1 SOT-23.

Dimensions in mm

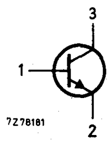


Marking code

BFR92 = P1



BFR92R = P4



See also *Soldering recommendations.*

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 °C **	P_{tot}	max.	200 mW
Storage temperature	T_{stg}	−65 to +150 °C	
Junction temperature	T_j	max.	150 °C

→ THERMAL CHARACTERISTICS *

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60 K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260 K/W
From soldering points to ambient **	$R_{th\ s\text{-}a}$	=	120 K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current $I_E = 0$; V_{CB} = 10 V	I_{CBO}	<	50 nA
D.C. current gain ▲ I_C = 14 mA; V_{CE} = 10 V	h_{FE}	> typ.	25 50
Transition frequency at f = 500 MHz ▲ I_C = 14 mA; V_{CE} = 10 V	f_T	typ.	5 GHz
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	0,75 pF
Emitter capacitance at f = 1 MHz $I_C = I_c = 0$; V_{EB} = 0,5 V	C_e	typ.	0,8 pF
Feedback capacitance at f = 1 MHz I_C = 2 mA; V_{CE} = 10 V; T_{amb} = 25 °C	C_{re}	typ.	0,7 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 mA; V_{CE} = 10 V; f = 500 MHz; T_{amb} = 25 °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 mA; V_{CE} = 10 V; f = 500 MHz; T_{amb} = 25 °C	G_{UM}	typ.	18 dB

Intermodulation distortion at T_{amb} = 25 °C

I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; V.S.W.R. < 2

$V_p = V_o$ = 150 mV at f_p = 495,25 MHz
$V_q = V_o$ −6 dB at f_q = 503,25 MHz
$V_r = V_o$ −6 dB at f_r = 505,25 MHz

Measured at $f_{(p+q-r)}$ = 493,25 MHz	d_{im}	typ.	−60 dB

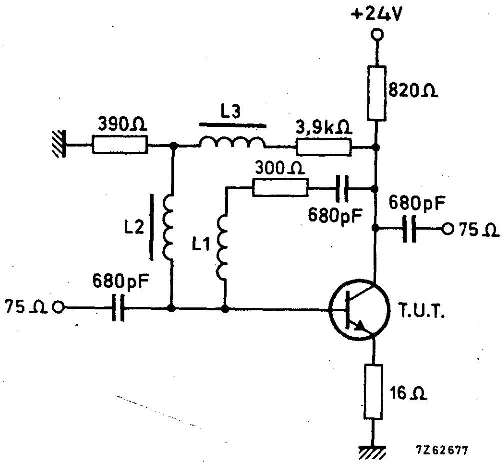


Fig. 2 Intermodulation test circuit.

L1 = 4 turns Cu wire (0,35 mm); winding pitch 1 mm; int. dia. 4 mm
L2 = L3 = 5 μH (code number: 3122 108 20150)

* Crystal mounted in a BFR90 envelope.

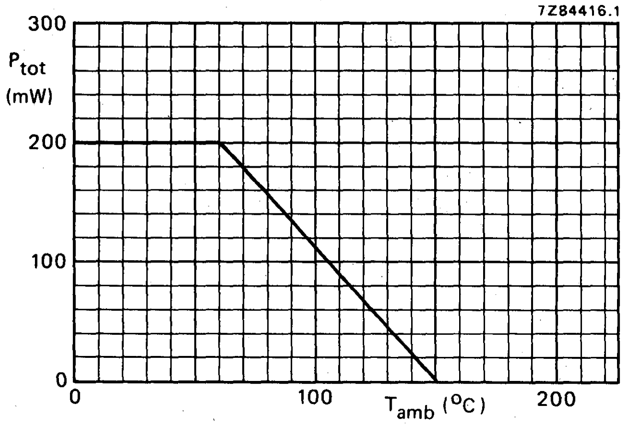
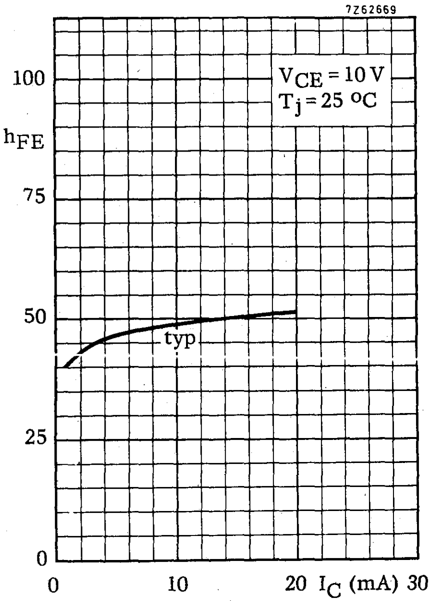
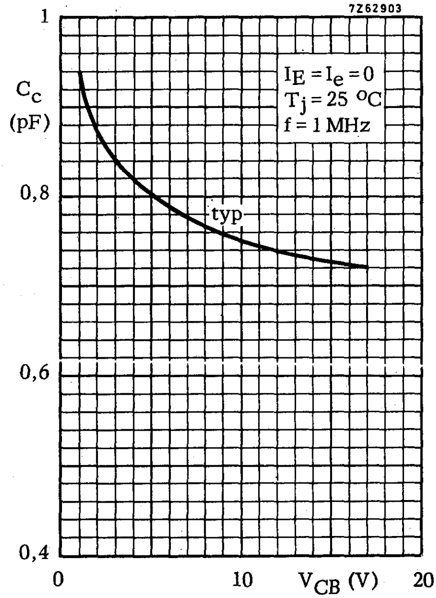
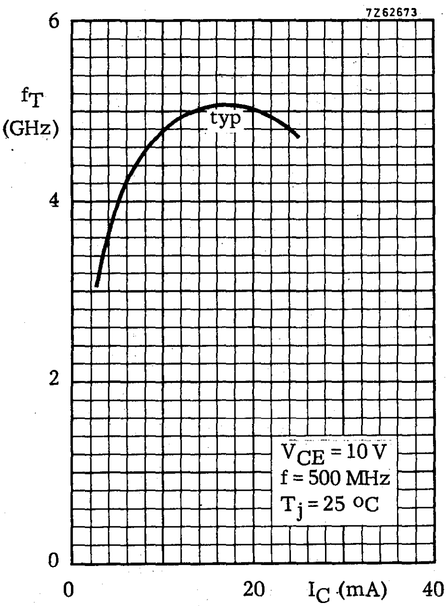
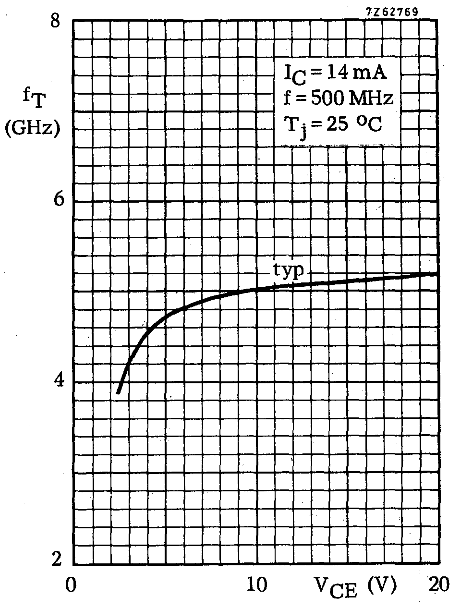


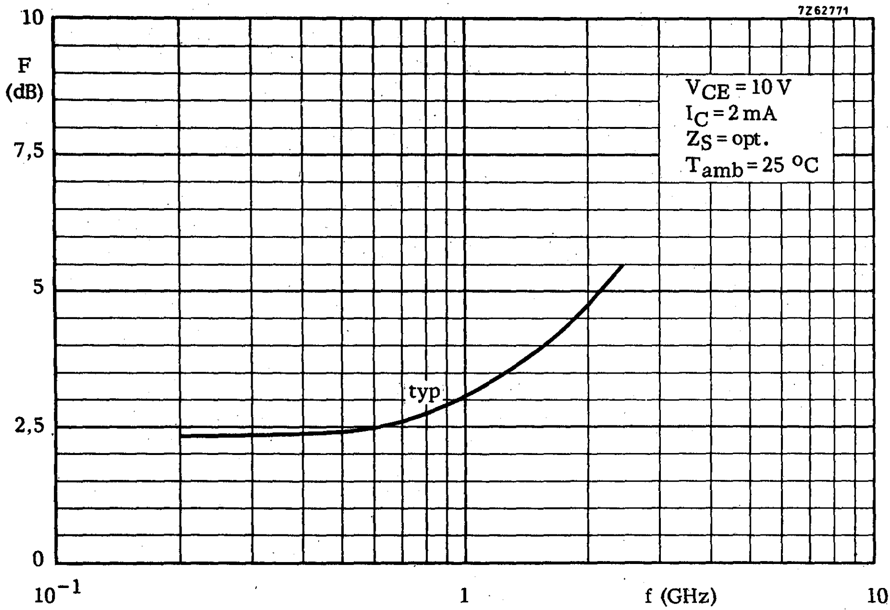
Fig. 3 Power derating curve.

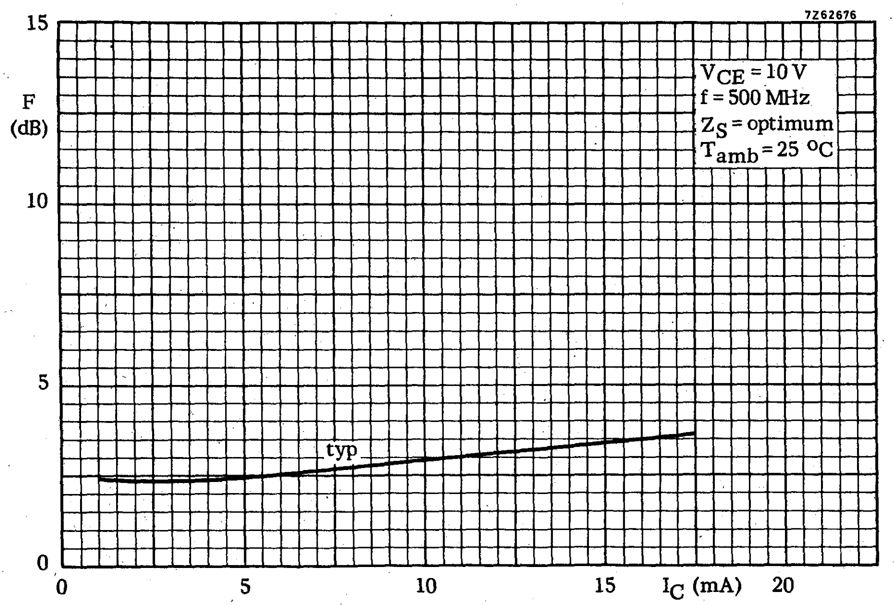

7Z62669
100
h_{FE}
75
50
25
0
0
10
20
I_C (mA)
30
V_{CE} = 10 V
T_j = 25 °C
typ

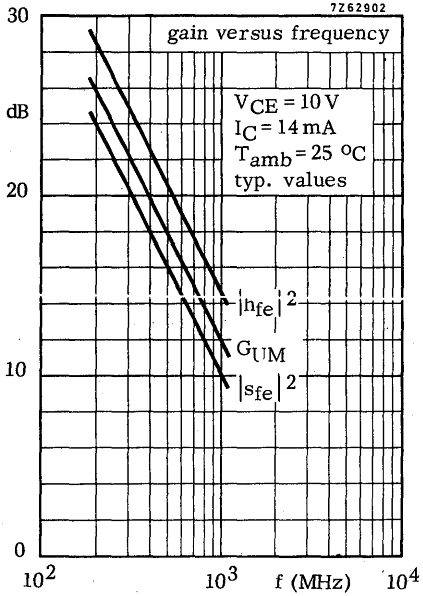

7Z62903
1
C_c
(pF)
0,8
0,6
0,4
0
10
V_{CB} (V)
20
$I_E = I_e = 0$
T_j = 25 °C
f = 1 MHz
typ


7Z62673
6
f_T
(GHz)
4
2
0
0
20
I_C (mA)
40
typ
V_{CE} = 10 V
f = 500 MHz
T_j = 25 °C

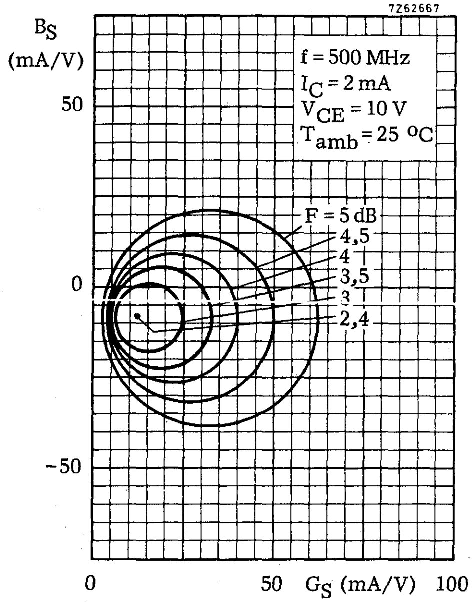

7Z62769
8
f_T
(GHz)
6
4
2
0
10
V_{CE} (V)
20
I_C = 14 mA
f = 500 MHz
T_j = 25 °C
typ


7Z62771
10
F
(dB)
7,5
5
2,5
0
VCE = 10 V
IC = 2 mA
ZS = opt.
Tamb = 25 °C
typ
10−1
1
f (GHz)
10


7Z62676
15
F
(dB)
10
5
0
VCE = 10 V
f = 500 MHz
ZS = optimum
Tamb = 25 °C
typ
0
5
10
15
IC (mA)
20



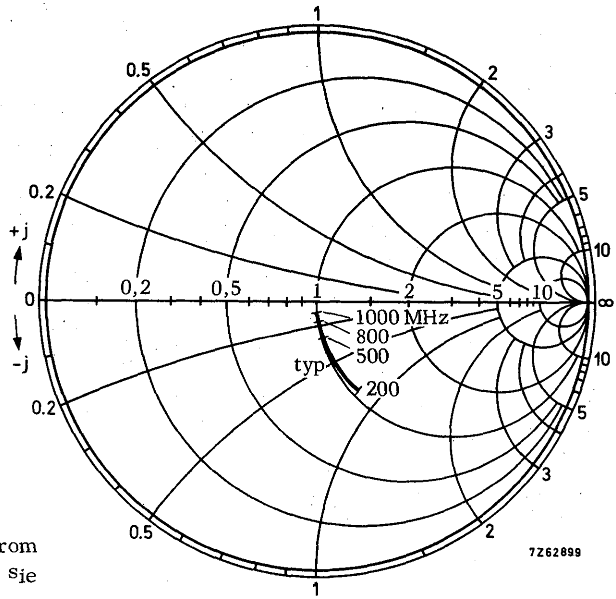
circles of constant noise figure



V_{CE} = 10 V

I_C = 14 mA

T_{amb} = 25 °C

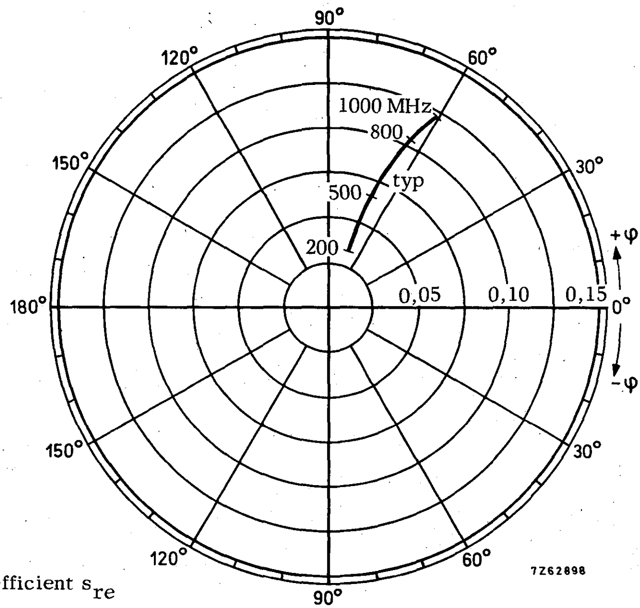


Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

V_{CE} = 10 V

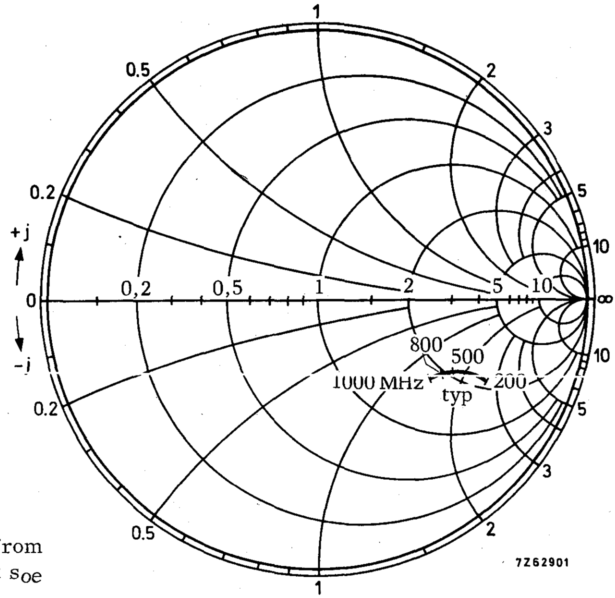
I_C = 14 mA

T_{amb} = 25 °C



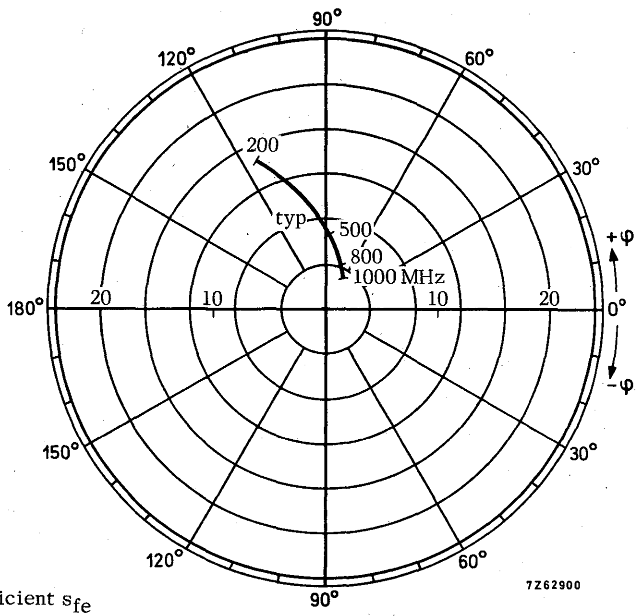
Reverse transmission coefficient s_{re}

V_{CE} = 10 V
I_C = 14 mA
T_{amb} = 25 ^oC



Output impedance derived from output reflection coefficient s_{oe} coordinates in ohm x 50

V_{CE} = 10 V
I_C = 14 mA
T_{amb} = 25 ^oC



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.

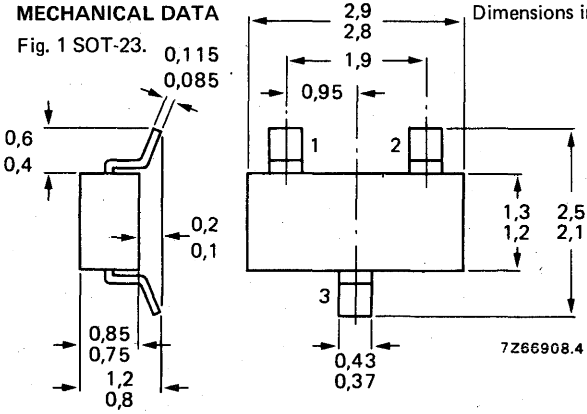
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz I_C = 30 mA; V_{CE} = 5 V	f_T	typ.	5	GHz
Feedback capacitance at f = 1 MHz I_C = 2 mA; V_{CE} = 5 V; T_{amb} = 25 °C	C_{re}	typ.	0,8	pF
Noise figure at optimum source impedance I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz; T_{amb} = 25 °C	F	typ.	1,9	dB
Max. unilateral power gain (see page 3) I_C = 30 mA; V_{CE} = 5 V; f = 500 MHz; T_{amb} = 25 °C	G_{UM}	typ.	16,5	dB
Intermodulation distortion at T_{amb} = 25 °C I_C = 30 mA; V_{CE} = 5 V; R_L = 75 Ω; V_o = 300 mV $f_{(p+q-r)}$ = 493,25 MHz (see page 4)	d_{im}	typ.	−60	dB

MECHANICAL DATA

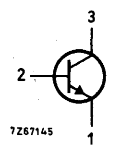
Fig. 1 SOT-23.

Dimensions in mm

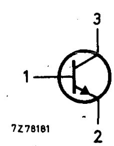


Marking code

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 °C**	P_{tot}	max.	200 mW
Storage temperature	T_{stg}		−65 to +150 °C
Junction temperature	T_j	max.	150 °C

→ THERMAL CHARACTERISTICS *

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60 K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260 K/W
From soldering points to ambient **	$R_{th\,s\text{-}a}$	=	120 K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current $I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<	50 nA
D.C. current gain ▲ $I_C = 30$ mA; $V_{CE} = 5$ V	h_{FE}	> typ.	25 50
Transition frequency at f = 500 MHz ▲ $I_C = 30$ mA; $V_{CE} = 5$ V	f_T	typ.	5 GHz
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	0,7 pF
Emitter capacitance at f = 1 MHz $I_C = I_c = 0$; $V_{EB} = 0{,}5$ V	C_e	typ.	1,8 pF
Feedback capacitance at f = 1 MHz $I_C = 2$ mA; $V_{CE} = 5$ V; $T_{amb} = 25$ °C	C_{re}	typ.	0,8 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 *			
$I_C = 2$ mA; $V_{CE} = 5$ V; f = 500 MHz; $T_{amb} = 25$ °C	F	typ.	1,9 dB
Max. unilateral power gain (s_{re} assumed to be zero)			

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

$I_C = 30$ mA; $V_{CE} = 5$ V; f = 500 MHz; $T_{amb} = 25$ °C	G_{UM}	typ.	16,5 dB
Intermodulation distortion at $T_{amb} = 25$ °C *			
$I_C = 30$ mA; $V_{CE} = 5$ V; $R_L = 75\ \Omega$; V.S.W.R. < 2			
$V_p = V_o = 300$ mV at $f_p = 495{,}25$ MHz			
$V_q = V_o - 6$ dB at $f_q = 503{,}25$ MHz			
$V_r = V_o - 6$ dB at $f_r = 505{,}25$ MHz			
Measured at $f_{(p+q-r)} = 493{,}25$ MHz	d_{im}	typ.	−60 dB

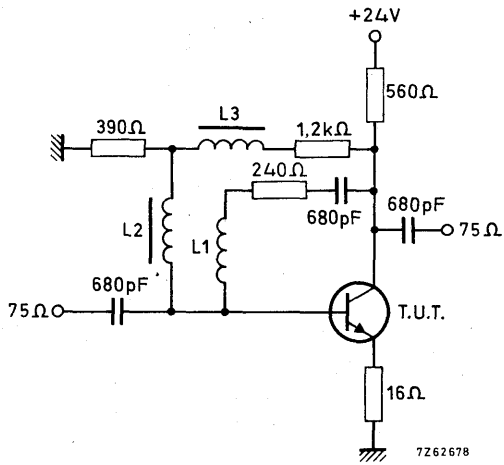


Fig. 2 Intermodulation test circuit.

L1 = 4 turns Cu wire (0,35); winding pitch 1 mm; int. dia. 4 mm
L2 and L3 5 μH (code number: 3122 108 20150)

* Crystal mounted in a BFR91 envelope.

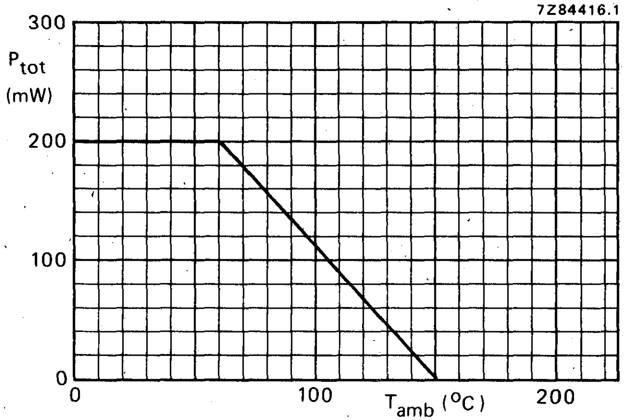
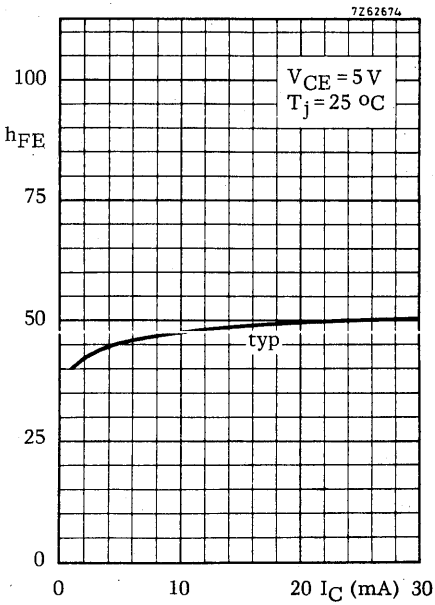
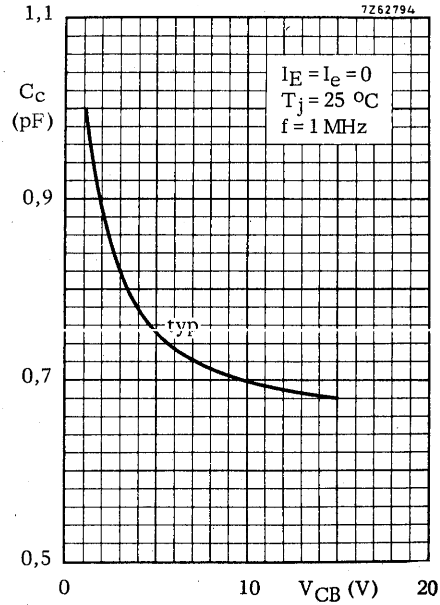
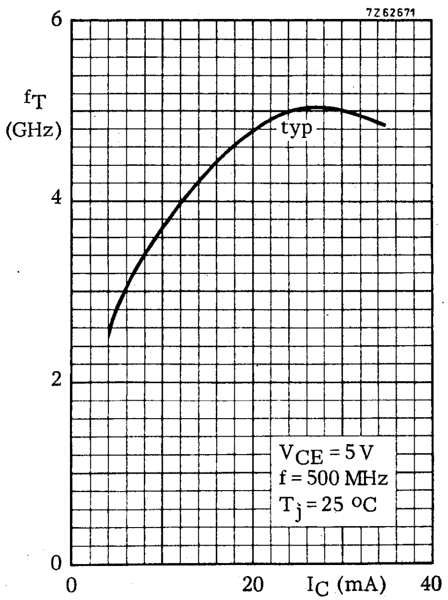
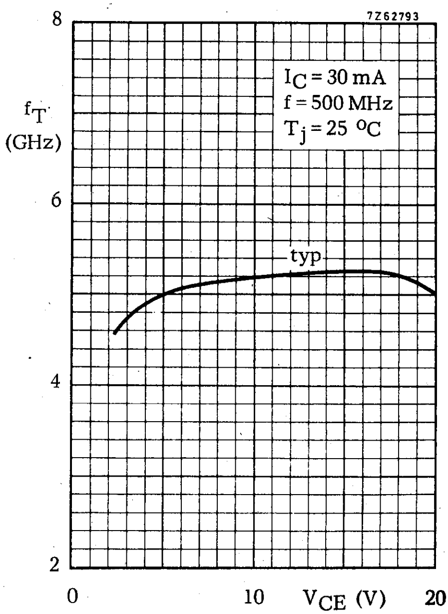


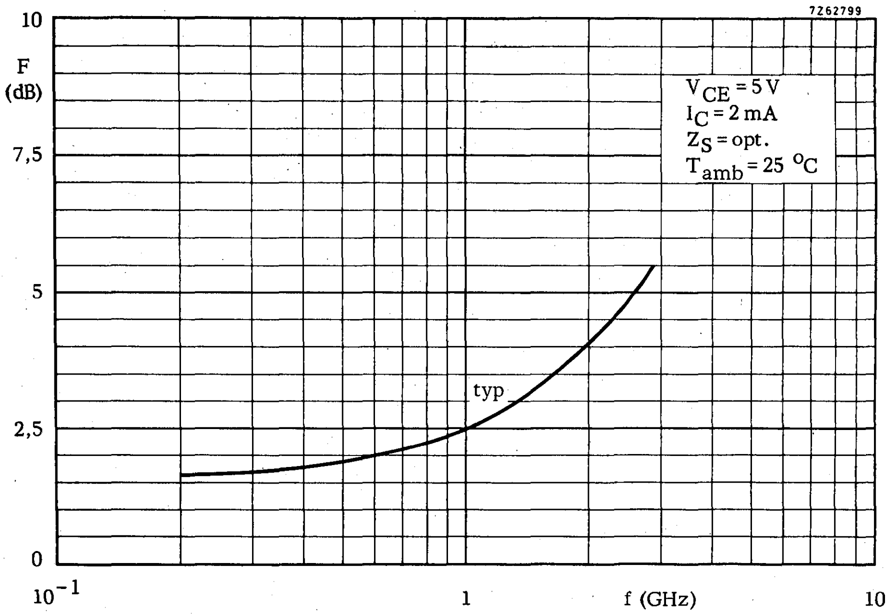
Fig. 3 Power derating curve.

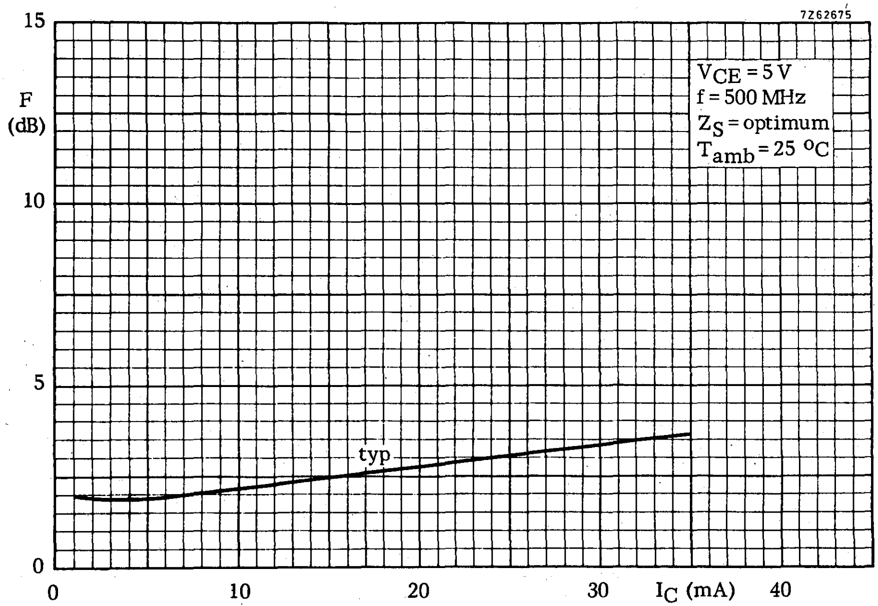

7Z62674
100
75
50
25
0
hFE
VCE = 5 V
Tj = 25 °C
typ
0
10
20 IC (mA) 30

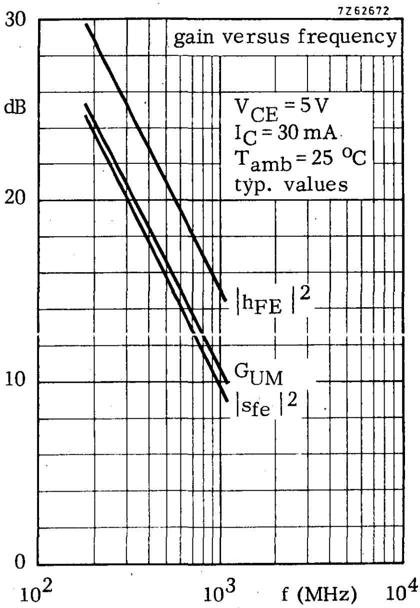

7Z62794
1,1
0,9
0,7
0,5
Cc
(pF)
IE = Ie = 0
Tj = 25 °C
f = 1 MHz
typ
0
10
VCB (V)
20


7Z62671
6
4
2
0
fT
(GHz)
typ
VCE = 5 V
f = 500 MHz
Tj = 25 °C
0
20
IC (mA)
40

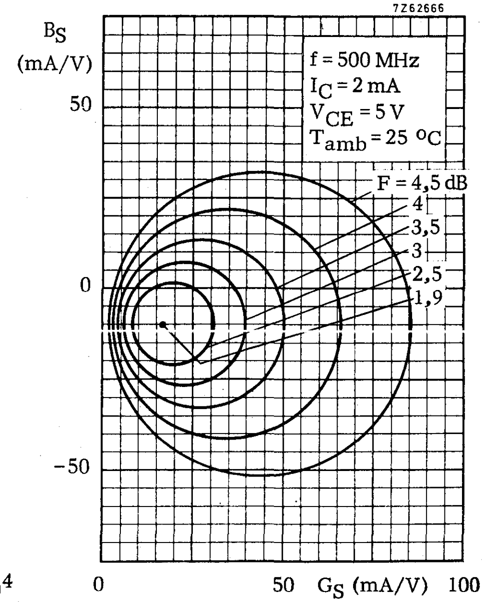

7Z62793
8
6
4
2
fT
(GHz)
IC = 30 mA
f = 500 MHz
Tj = 25 °C
typ
0
10
VCE (V)
20


7Z62799
10
F
(dB)
7,5
5
2,5
0
V_{CE} = 5 V
I_C = 2 mA
Z_S = opt.
T_{amb} = 25 °C
typ
10^{-1}
1
f (GHz)
10

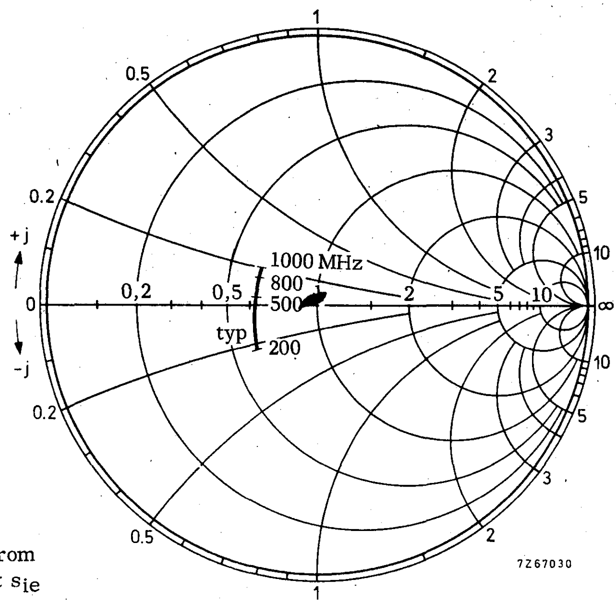

7Z62675
15
F
(dB)
10
5
0
V_{CE} = 5 V
f = 500 MHz
Z_S = optimum
T_{amb} = 25 °C
typ
0
10
20
30
I_C (mA)
40



circles of constant noise figure

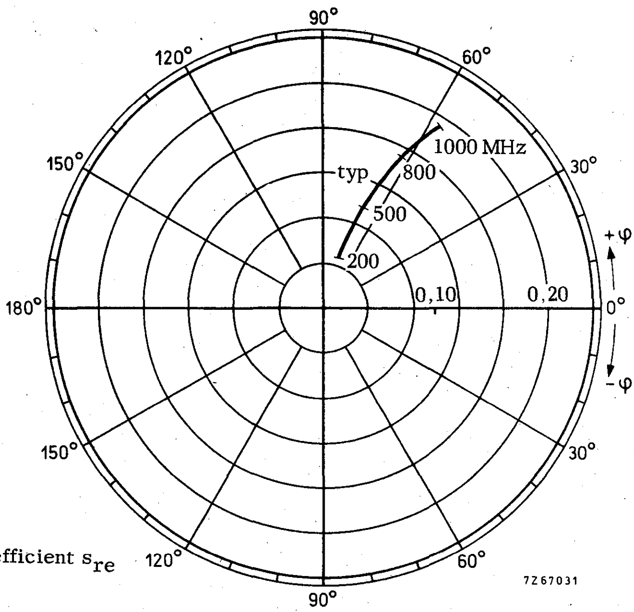


V_{CE} = 5 V
I_C = 30 mA
T_{amb} = 25 °C



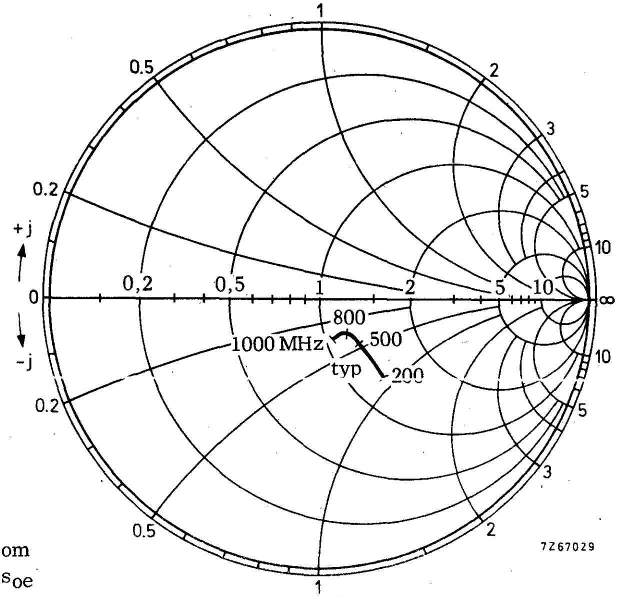
Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

V_{CE} = 5 V
I_C = 30 mA
T_{amb} = 25 °C



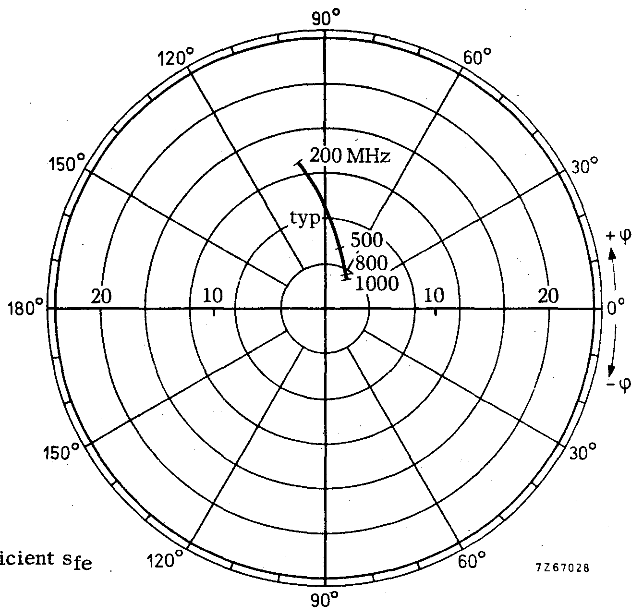
Reverse transmission coefficient s_{re}

V_{CE} = 5 V
I_C = 30 mA
T_{amb} = 25 °C



Output impedance derived from output reflection coefficient s_{oe} coordinates in ohm x 50

V_{CE} = 5 V
I_C = 30 mA
T_{amb} = 25 °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.

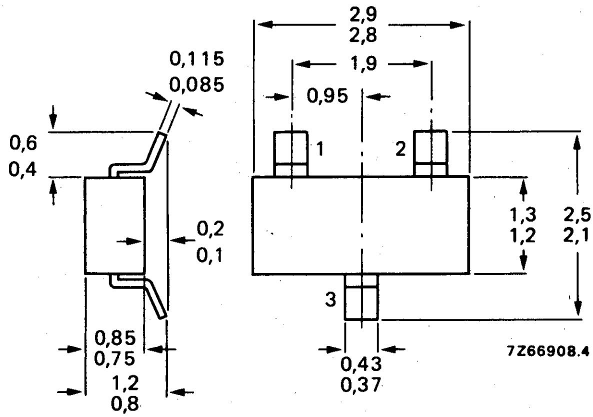
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain I_C = 2 mA; V_{CE} = 1 V	h_{FE}		20 to 150	
Transition frequency I_C = 25 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1,3	GHz
Noise figure I_C = 2 mA; V_{CE} = 5 V; R_S = 50 Ω; f = 500 MHz	F	typ.	4,5	dB

MECHANICAL DATA

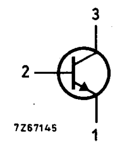
Dimensions in mm

Fig. 1 SOT-23.

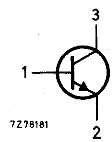


Marking code

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*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60 K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	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}		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	typ.	1,0 GHz
I_C = 25 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	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				
$I_C = I_c = 0$; $V_{EB} = 0,5$ V	C_e	<	2,0	pF
Feedback capacitance at f = 1 MHz				
$I_C = 1$ mA; $V_{CE} = 5$ V	$-C_{re}$	typ.	0,65	pF
Noise figure*				
$I_C = 2$ mA; $V_{CE} = 5$ V; f = 500 MHz; $R_S = 50\ \Omega$	F	typ.	4,5	dB
Intermodulation distortion				
$I_C = 10$ mA; $V_{CE} = 6$ V; $R_L = 37,5\ \Omega$; $T_{amb} = 25\ ^oC$ $V_o = 100$ 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.	−45	dB

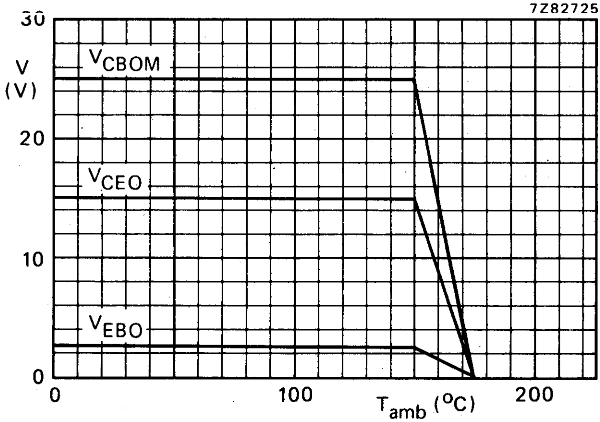


Fig. 2 Voltage derating curve.

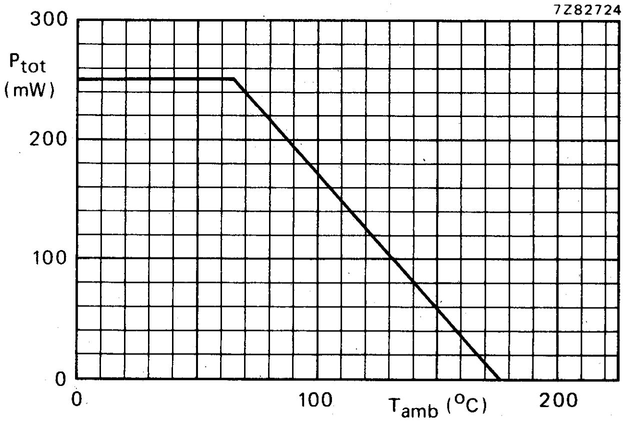
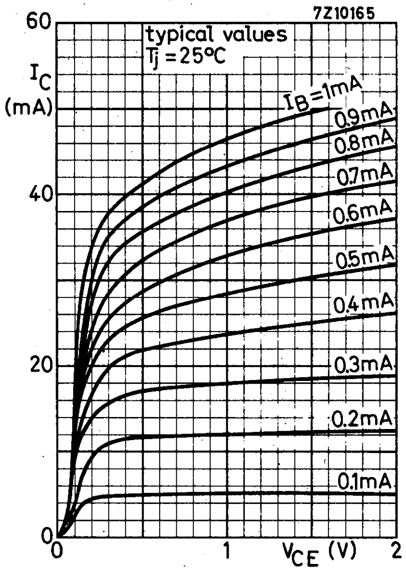
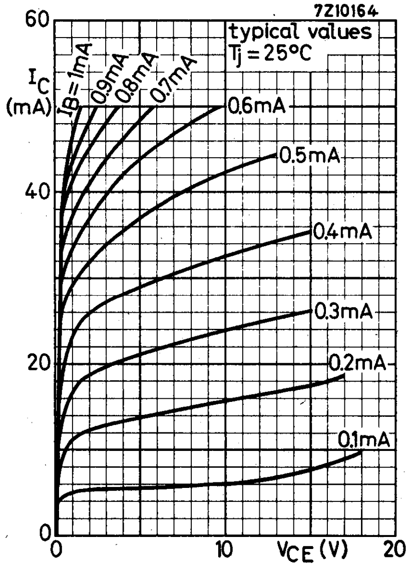
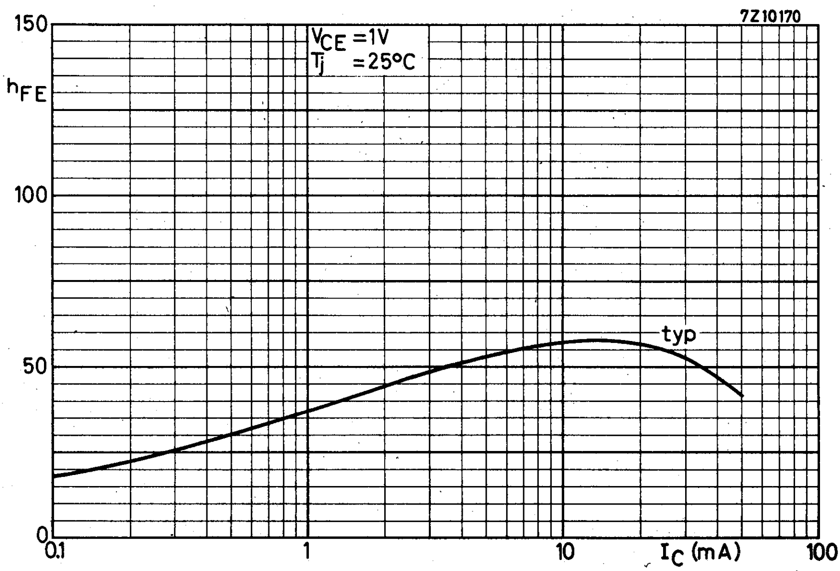


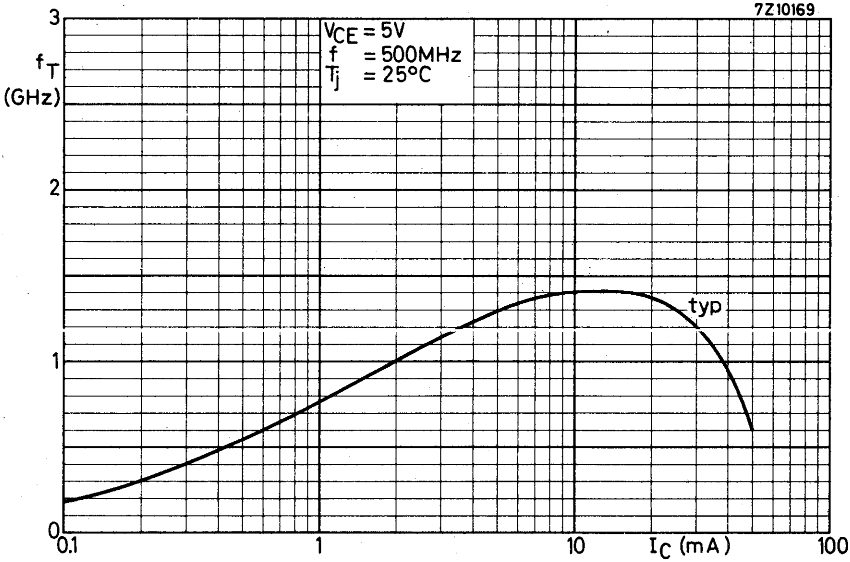
Fig. 3 Power derating curve.

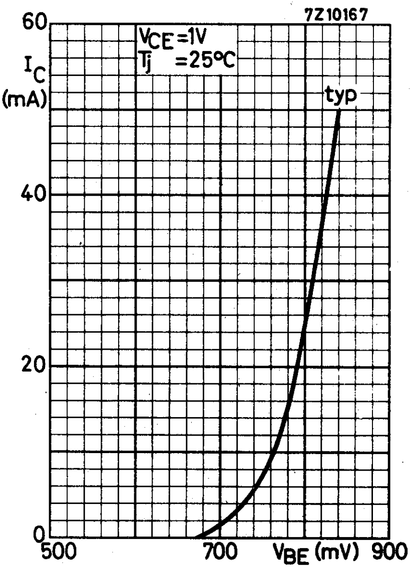
* Crystal mounted in a BFY90 envelope.

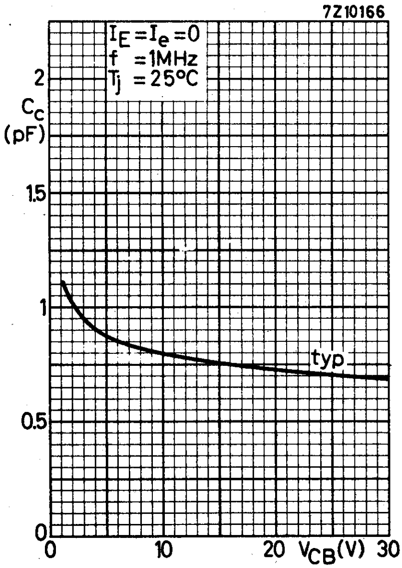

7Z10165
typical values
Tj = 25°C
IC
(mA)
IB=1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
VCE (V)

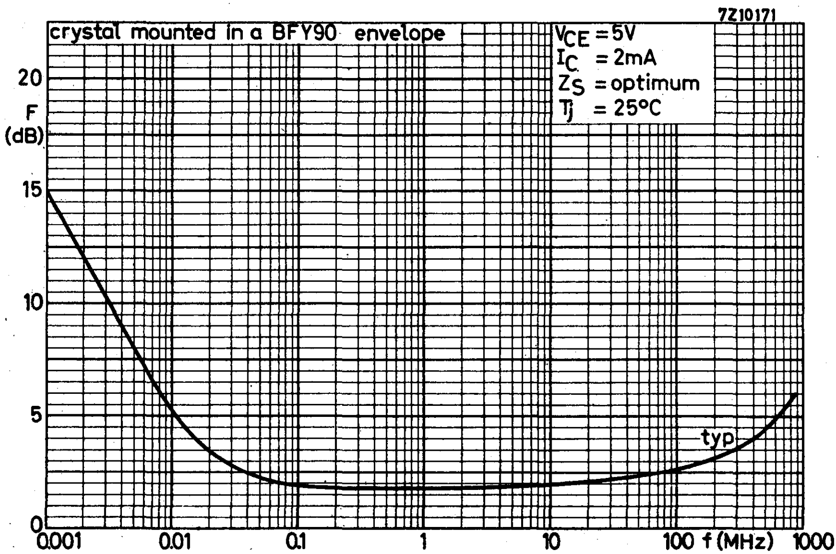

7Z10164
typical values
Tj = 25°C
IC
(mA)
IB=1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
VCE (V)

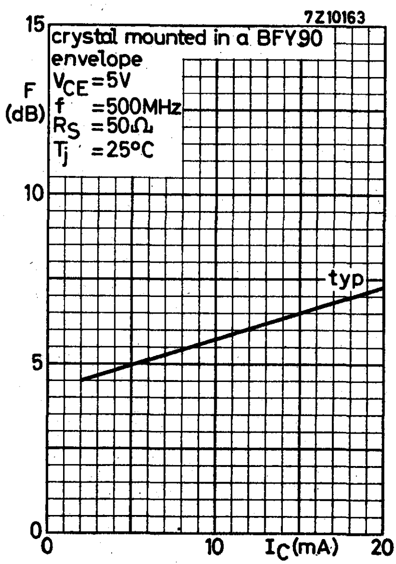

7Z10170
VCE = 1V
Tj = 25°C
hFE
typ
IC (mA)

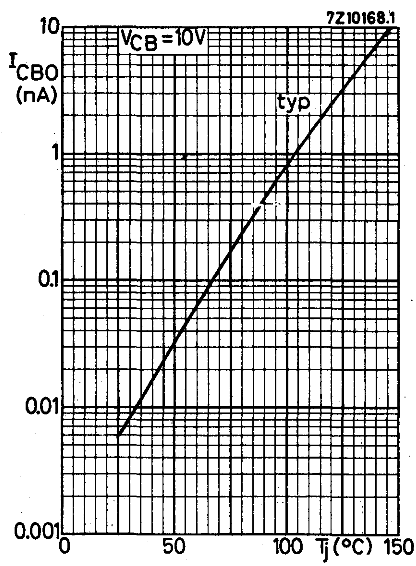

7Z10169
V_{CE} = 5V
f = 500MHz
T_j = 25°C
f_T (GHz)
3
2
1
0
0.1
1
10
100
I_C (mA)
typ


7Z10167
V_{CE} = 1V
T_j = 25°C
I_C (mA)
60
40
20
0
500
700
900
V_{BE} (mV)
typ


7Z10166
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
2
1.5
1
0.5
0
10
20
30
V_{CB} (V)
typ


7Z10171
crystal mounted in a BFY90 envelope
V_{CE} = 5V
I_C = 2mA
Z_S = optimum
T_j = 25°C
F (dB)
20
15
10
5
0
0.001
0.01
0.1
1
10
100
f (MHz)
1000
typ


7Z10163
crystal mounted in a BFY90 envelope
V_{CE} = 5V
f = 500MHz
R_S = 50Ω
T_j = 25°C
F (dB)
15
10
5
0
10
I_C (mA)
20
typ


7Z10168.1
V_{CB} = 10V
I_{CBO} (nA)
10
1
0.1
0.01
0.001
0
50
100
T_j (°C)
150
typ

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.

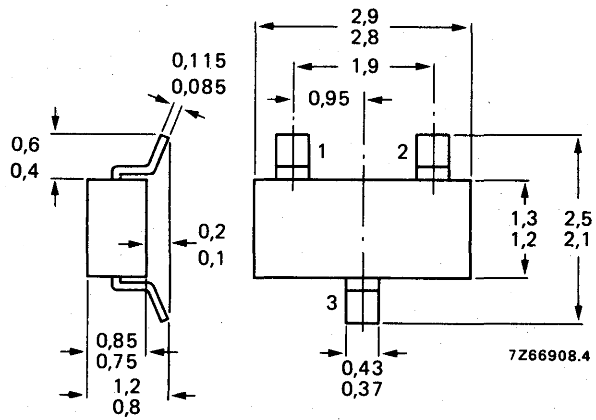
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	250		mW ←
Junction temperature	T_j	max.	175		°C ←
			BFS18 BFS18R	BFS19 BFS19R	
D.C. current gain I_C = 1 mA; V_{CE} = 10 V	h_{FE}		35 to 125	65 to 225	
Transition frequency at f = 100 MHz I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	200	260	MHz
Noise figure at f = 100 MHz I_C = 1 mA; V_{CE} = 10 V; G_S = 10 mΩ^{-1}	F	typ.	4		dB

MECHANICAL DATA

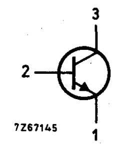
Dimensions in mm

Fig. 1 SOT-23.



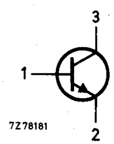
Marking code

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 $I_C = 2$ 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 $T_{amb} = 65$ °C**	P_{tot}	max.	250	mW
→ Storage temperature	T_{stg}		−65 to + 175	°C
→ Junction temperature	T_j	max.	175	°C

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	120	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; $T_j = 100$ °C	I_{CBO}	<	10		µA
Base-emitter voltage $I_C = 1$ mA; $V_{CE} = 10$ V	V_{BE}		0,65 to 0,74		V
			BFS18 BFS18R	BFS19 BFS19R	
D.C. current gain $I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}		35 to 125	65 to 225	
Transition frequency at f = 100 MHz $I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	200	260	MHz
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	1		pF
Feedback capacitance at f = 1 MHz $I_C = 1$ mA; $V_{CE} = 10$ V	$-C_{re}$	typ.	0,85		pF
Noise figure▲ $I_C = 1$ mA; $V_{CE} = 10$ V; $G_S = 10$ mΩ^{-1}; f = 100 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.

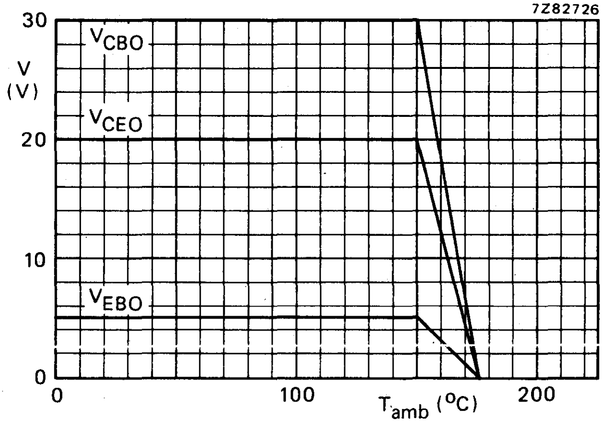


Fig. 2 Voltage derating curves.

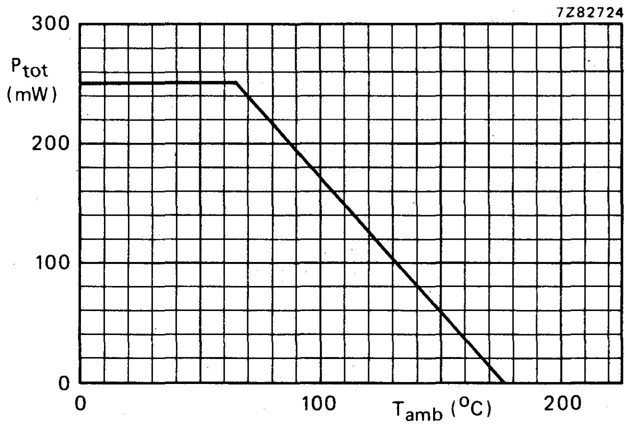
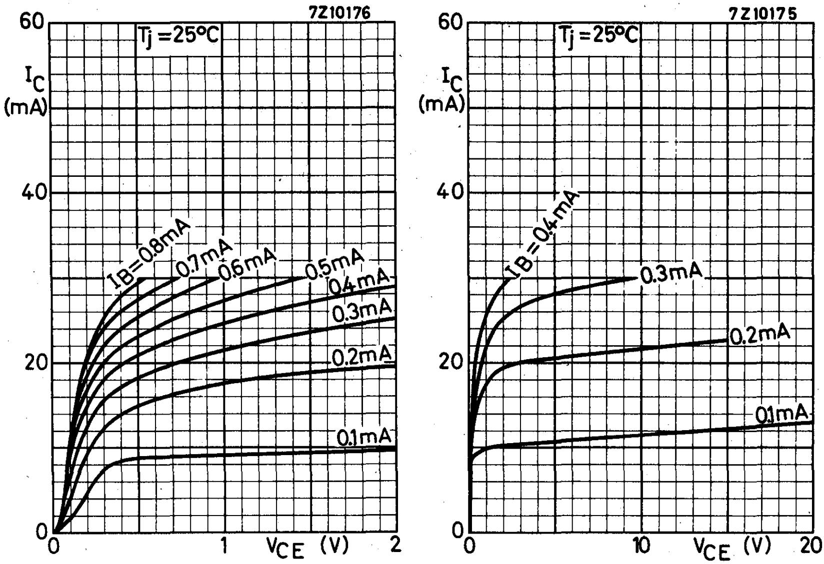
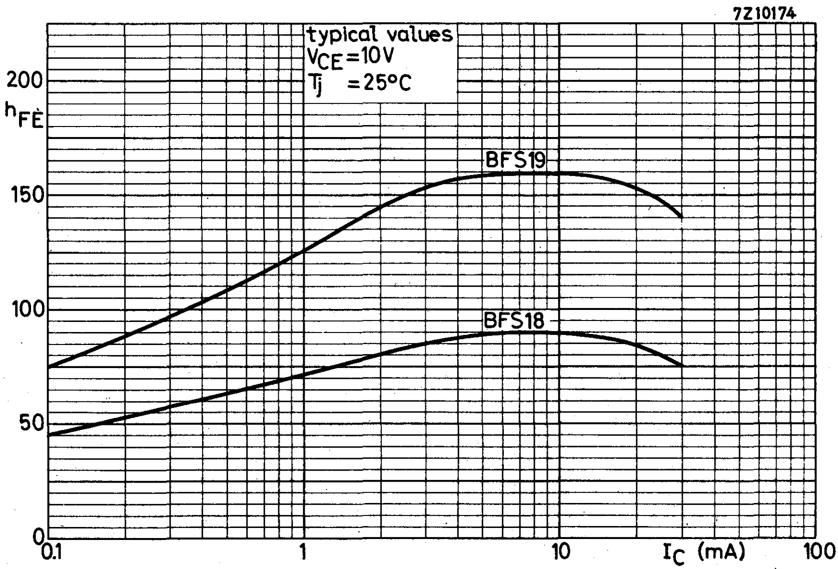
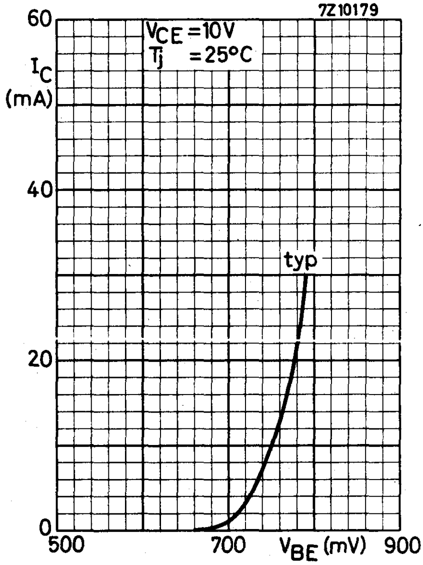


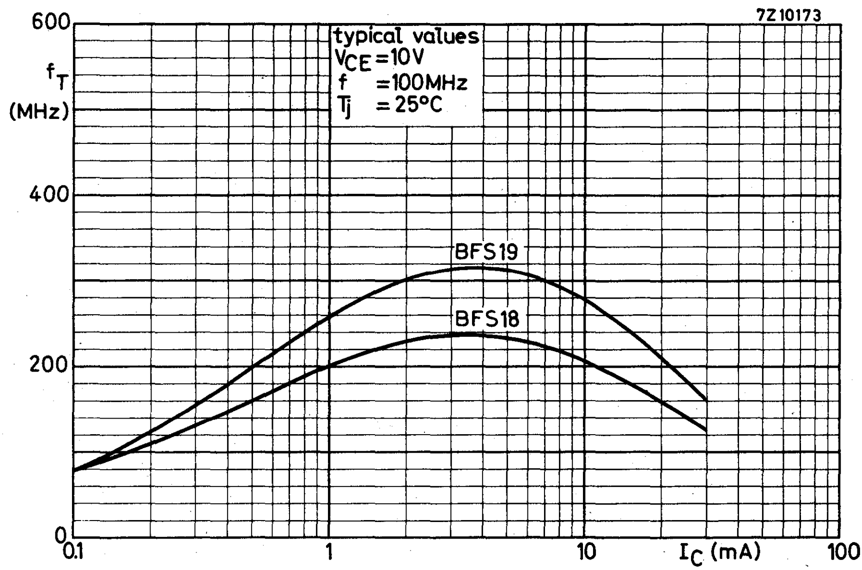
Fig. 3 Power derating curve.

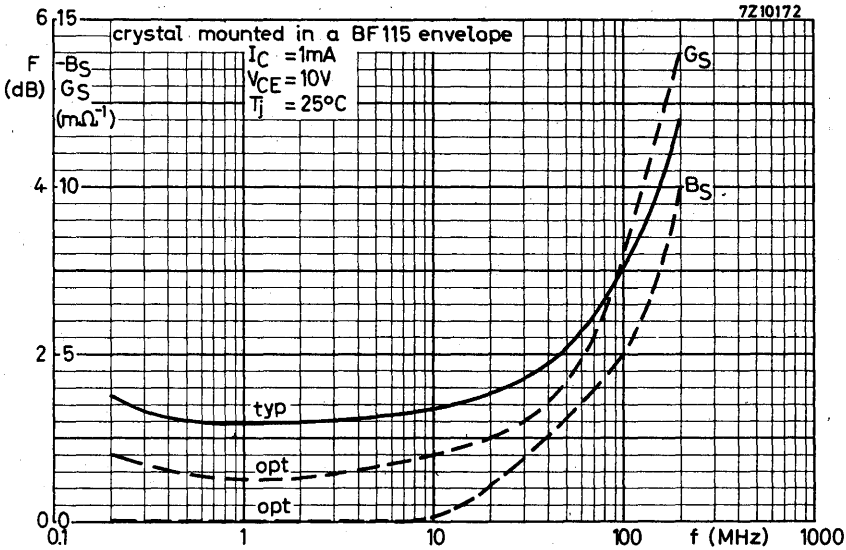
Typical behaviour of collector current versus collector-emitter voltage

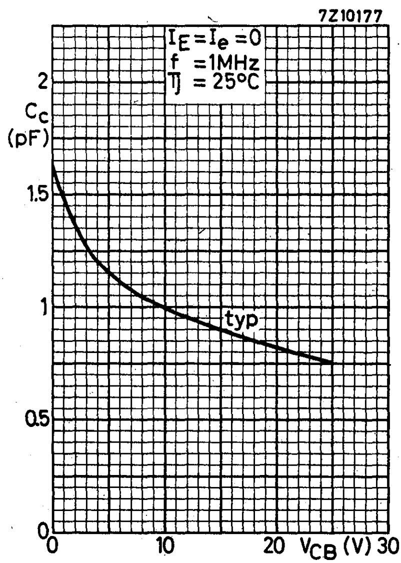


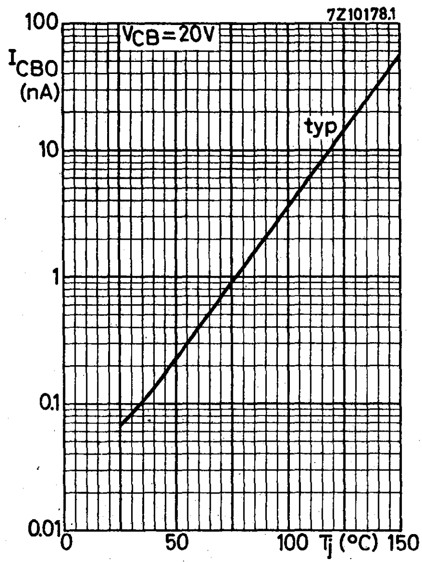



7Z10179
V_{CE} = 10 V
T_j = 25°C
I_C (mA)
60
40
20
0
typ
500
700
V_{BE} (mV)
900


7Z10173
typical values
V_{CE} = 10 V
f = 100 MHz
T_j = 25°C
f_T (MHz)
600
400
200
0
BFS19
BFS18
0.1
1
10
I_C (mA)
100


7Z10172
crystal mounted in a BF115 envelope
I_C = 1mA
V_{CE} = 10V
T_j = 25°C
F (dB)
$-B_S$
G_S
(mΩ⁻¹)
6 15
4 10
2 5
0 0
0.1
1
10
100
f (MHz)
1000
typ
opt
opt
G_S
B_S


7Z10177
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
2
1.5
1
0.5
0
0
10
20
V_{CB} (V)
30
typ


7Z10178.1
V_{CB} = 20V
I_{CBO} (nA)
100
10
1
0.1
0.01
0
50
100
T_j (°C)
150
typ

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.

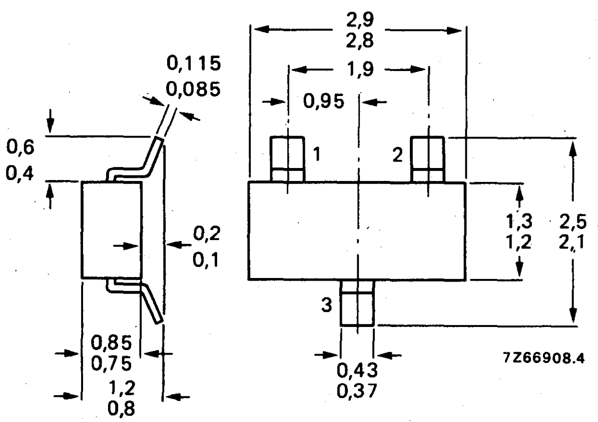
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain I_C = 7 mA; V_{CE} = 10 V	h_{FE}	>	40	
Transition frequency at f = 100 MHz I_C = 5 mA; V_{CE} = 5 V	f_T	typ.	450	MHz
Feedback capacitance at f = 1 MHz I_C = 1 mA; V_{CE} = 10 V	C_{re}	typ.	350	fF

MECHANICAL DATA

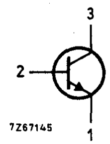
Dimensions in mm

Fig. 1 SOT-23.

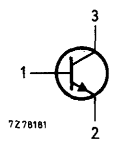


Marking code

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_{CBO}	max.	30 V
Collector-emitter voltage (open base) see Fig. 2 $I_C = 2$ 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 $T_{amb} = 65$ °C**	P_{tot}	max.	250 mW
→ Storage temperature	T_{stg}	−65 to	+175 °C
→ Junction temperature	T_j	max.	175 °C

→ THERMAL CHARACTERISTICS *

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60 K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260 K/W
From soldering points to ambient **	$R_{th\,s\text{-}a}$	=	120 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; $T_j = 100$ °C	I_{CBO}	<	10 μA
Base-emitter voltage			
$I_C = 7$ mA; $V_{CE} = 10$ V	V_{BE}	typ. <	740 mV 900 mV
D.C. current gain			
$I_C = 7$ mA; $V_{CE} = 10$ V	h_{FE}	> typ.	40 85
Transition frequency at f = 100 MHz			
$I_C = 5$ mA; $V_{CE} = 10$ V	f_T	> typ.	275 MHz 450 MHz
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	0,8 pF
Feedback capacitance at f = 1 MHz			
$I_C = 1$ mA; $V_{CE} = 10$ V	$-C_{re}$	typ.	350 fF

* See *Thermal characteristics* in chapter GENERAL.
** Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

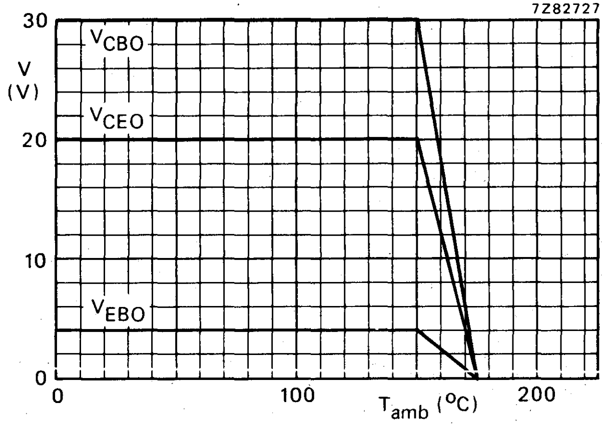


Fig. 2 Voltage derating curves.

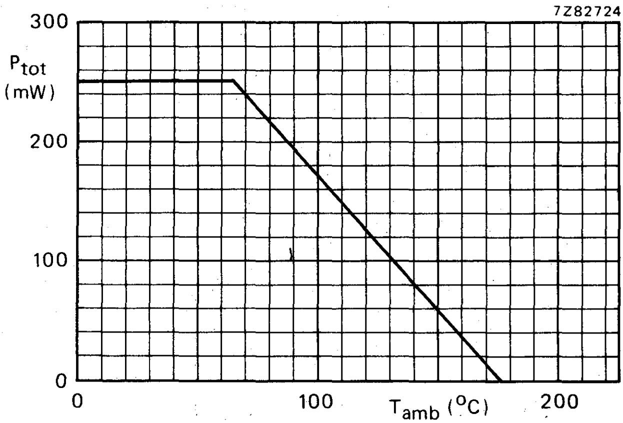
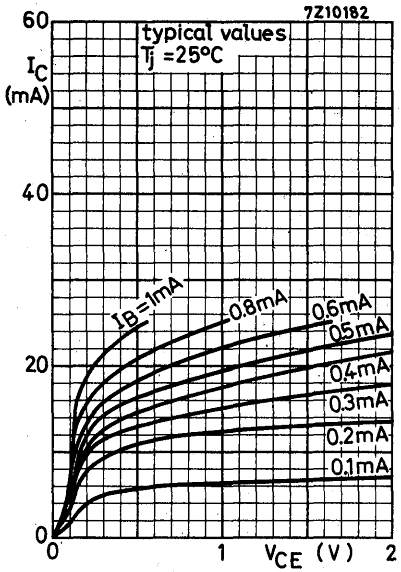
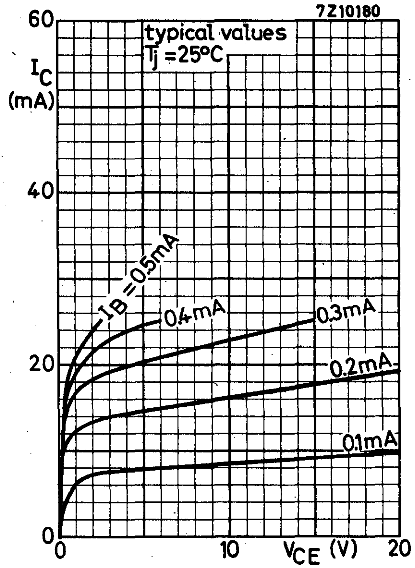
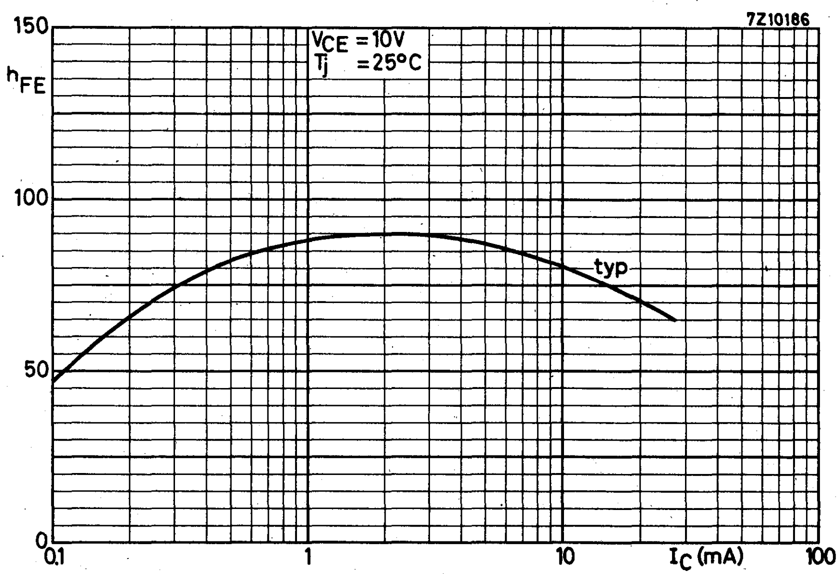
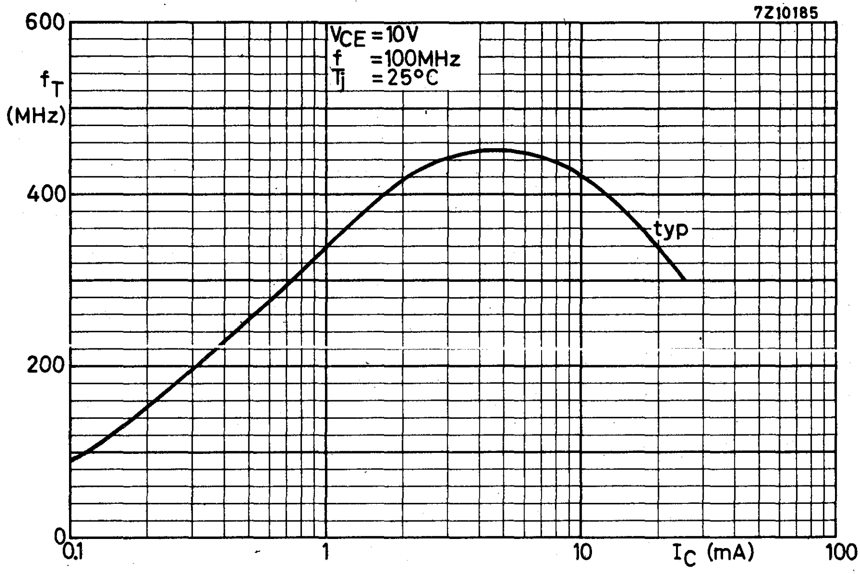


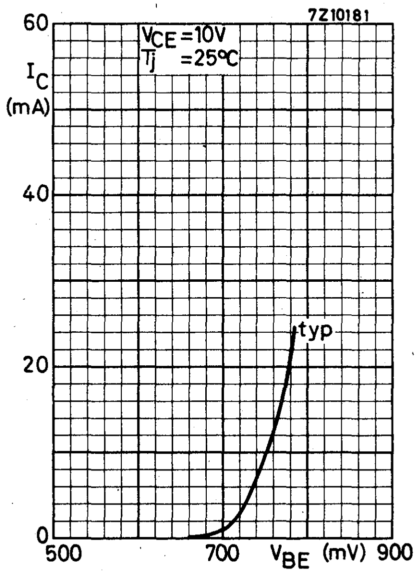
Fig. 3 Power derating curve.

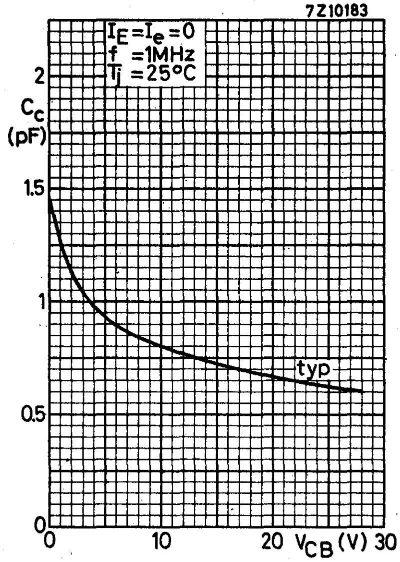

7Z10182
typical values
T_j = 25°C
I_C (mA)
60
40
20
0
I_B = 1mA
0.8mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
0
1
V_{CE} (V)
2

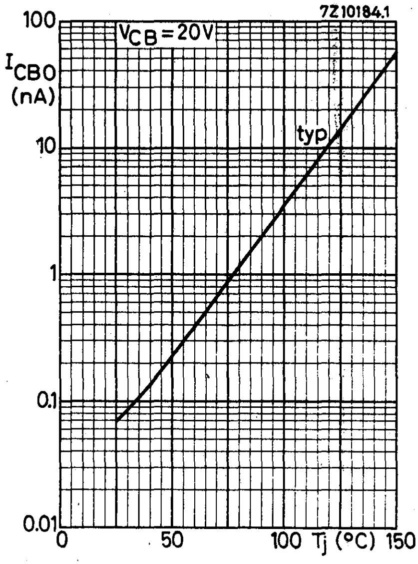

7Z10180
typical values
T_j = 25°C
I_C (mA)
60
40
20
0
I_B = 0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
0
10
V_{CE} (V)
20


7Z10186
V_{CE} = 10V
T_j = 25°C
h_{FE}
150
100
50
0
typ
0.1
1
10
I_C (mA)
100


7Z10185
600
f_T
(MHz)
400
200
0
V_{CE} = 10V
f = 100MHz
T_j = 25°C
typ
0.1
1
10
I_C (mA)
100


7Z10181
60
I_C
(mA)
40
20
0
V_{CE} = 10V
T_j = 25°C
typ
500
700
V_{BE} (mV)
900


7Z10183
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c
(pF)
2
1.5
1
0.5
0
0
10
20
V_{CB} (V)
30
typ


7Z10184.1
V_{CB} = 20V
I_{CBO}
(nA)
100
10
1
0.1
0.01
0
50
100
T_j (°C)
150
typ

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 μA – 1 mA); thanks to its high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

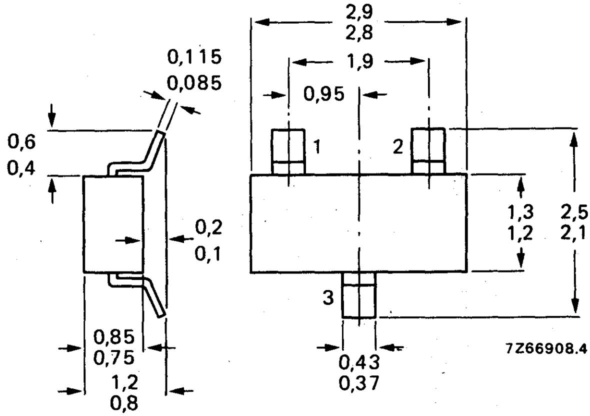
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	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 °C	P_{tot}	max.	50	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz I_C = 1 mA; V_{CE} = 1 V	f_T	typ.	2,3	GHz
Feedback capacitance at f = 1 MHz I_C = 1 mA; V_{CE} = 1 V; T_{amb} = 25 °C	C_{re}	<	0,45	pF
Noise figure at optimum source impedance I_C = 1 mA; V_{CE} = 1 V; f = 500 MHz; T_{amb} = 25 °C	F	typ.	3,8	dB
Max. unilateral power gain (see page 3) I_C = 1 mA; V_{CE} = 1 V; f = 500 MHz; T_{amb} = 25 °C	G_{UM}	typ.	18	dB

MECHANICAL DATA

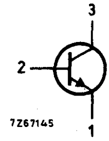
Dimensions in mm

Fig. 1 SOT-23.

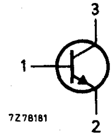


Marking code

BFT25 = V1



BFT25R = V4



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*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60 K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	120 K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; V_{CB} = 5 V	I_{CBO}	<	50 nA
D.C. current gain▲			
I_C = 10 μA; V_{CE} = 1 V	h_{FE}	<	20
		typ.	30
I_C = 1 mA; V_{CE} = 1 V	h_{FE}	<	20
		typ.	40
Saturation voltages			
I_C = 10 μA; I_B = 1 μA	V_{CEsat}	<	200 mV
	V_{BEsat}	<	750 mV
I_C = 1 mA; I_B = 0,1 mA	V_{CEsat}	<	175 mV
	V_{BEsat}	<	900 mV
Transition frequency at f = 500 MHz▲			
I_C = 1 mA; V_{CE} = 1 V	f_T	>	1,2 GHz
		typ.	2,3 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 MHz			
$I_E = I_e = 0$; $V_{CB} = 0,5$ V	C_c	<	0,6 pF
Emitter capacitance at f = 1 MHz			
$I_C = I_c = 0$; $V_{EB} = 0$	C_e	<	0,5 pF
Feedback capacitance at f = 1 MHz			
$I_C = 1$ mA; $V_{CE} = 1$ V; $T_{amb} = 25$ °C	C_{re}	<	0,45 pF
Noise figure at optimum source impedance			
$I_C = 0,1$ mA; $V_{CE} = 1$ V; f = 500 MHz; $T_{amb} = 25$ °C	F	typ.	5,5 dB
$I_C = 1$ mA; $V_{CE} = 1$ V; f = 500 MHz; $T_{amb} = 25$ °C	F	typ.	3,8 dB

Maximum unilateral power gain (s_{re} assumed to be zero)

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

$I_C = 1$ mA; $V_{CE} = 1$ V; f = 200 MHz; $T_{amb} = 25$ °C	G_{UM}	typ.	25 dB
$I_C = 1$ mA; $V_{CE} = 1$ V; f = 500 MHz; $T_{amb} = 25$ °C	G_{UM}	typ.	18 dB
$I_C = 1$ mA; $V_{CE} = 1$ V; f = 800 MHz; $T_{amb} = 25$ °C	G_{UM}	typ.	12 dB

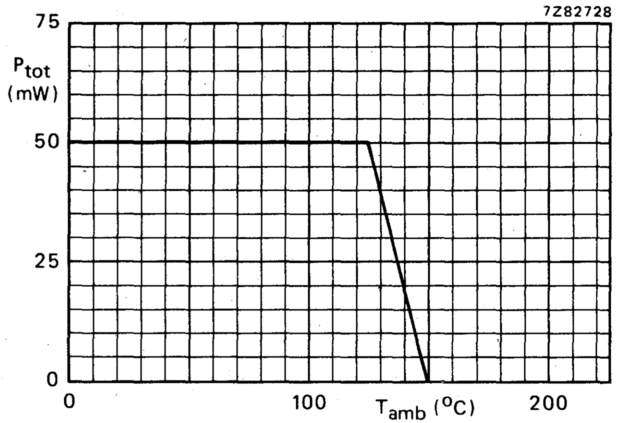
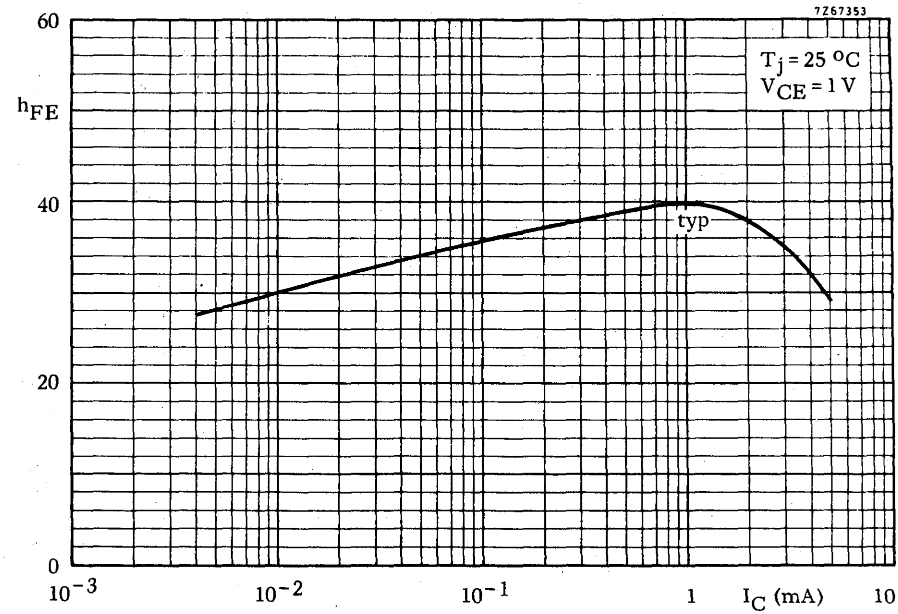
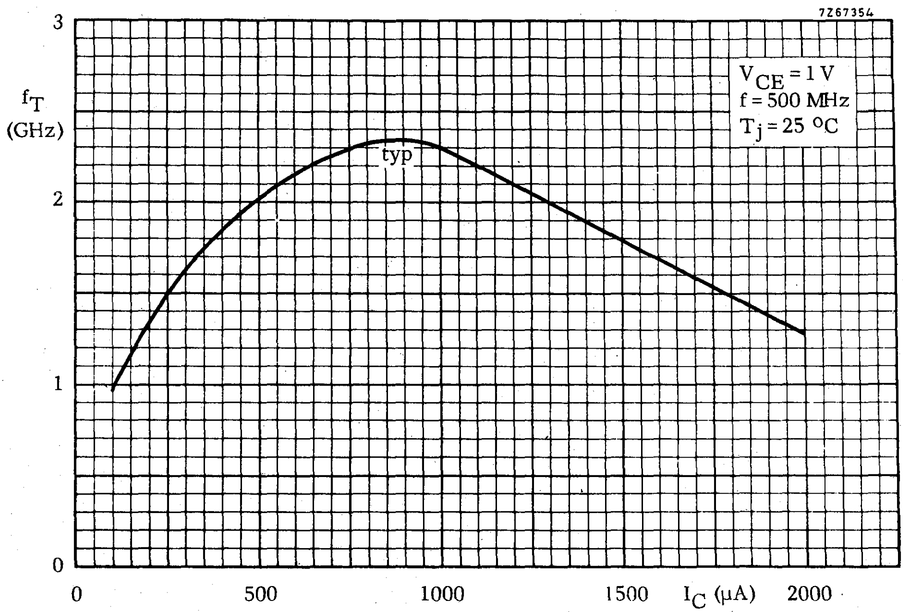
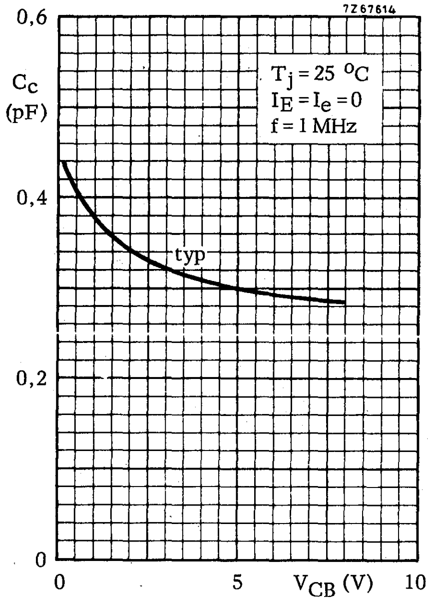


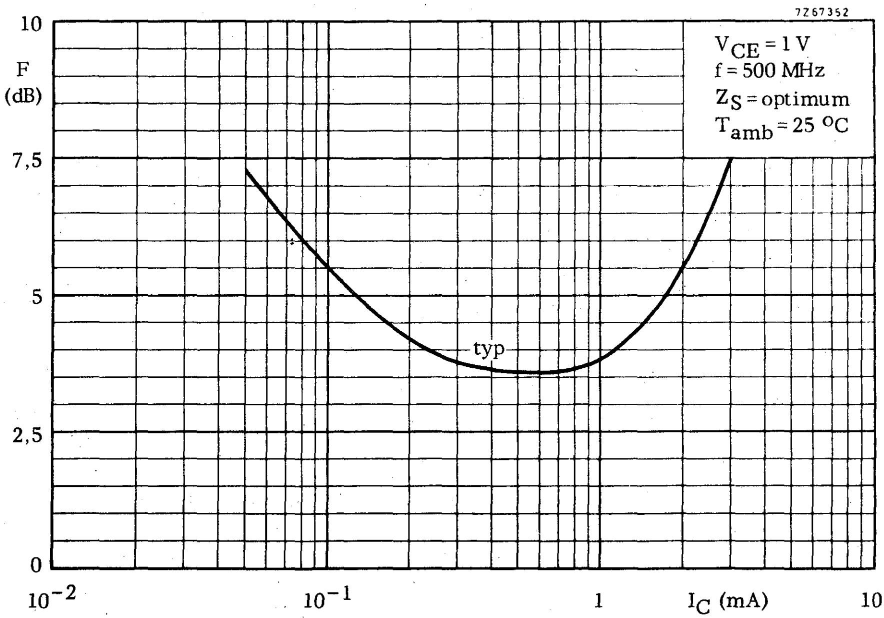
Fig. 2 Power derating curve.


7Z67353
60
h_{FE}
40
20
0
$T_j = 25\ ^oC$
$V_{CE} = 1\ V$
typ
10^{-3}
10^{-2}
10^{-1}
1
I_C (mA)
10


7Z67354
3
f_T
(GHz)
2
1
0
$V_{CE} = 1\ V$
f = 500 MHz
$T_j = 25\ ^oC$
typ
0
500
1000
1500
I_C (μA)
2000

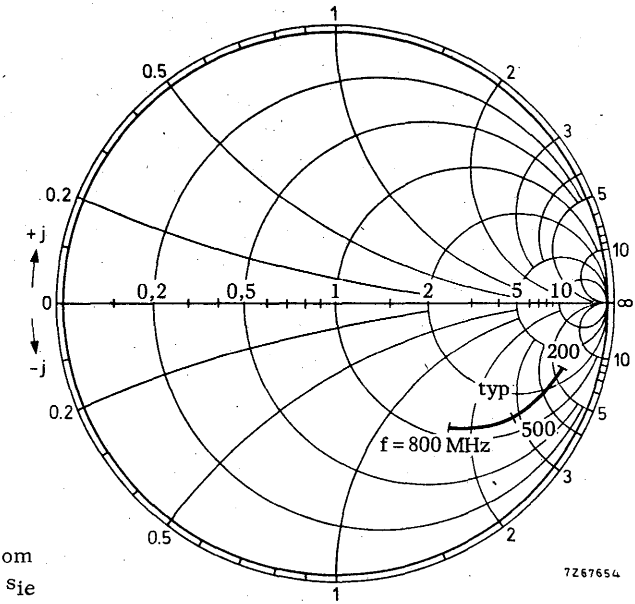


7Z67614
0,6
C_c
(pF)
$T_j = 25\ ^oC$
$I_E = I_e = 0$
f = 1 MHz
0,4
typ
0,2
0
0
5
V_{CB} (V)
10



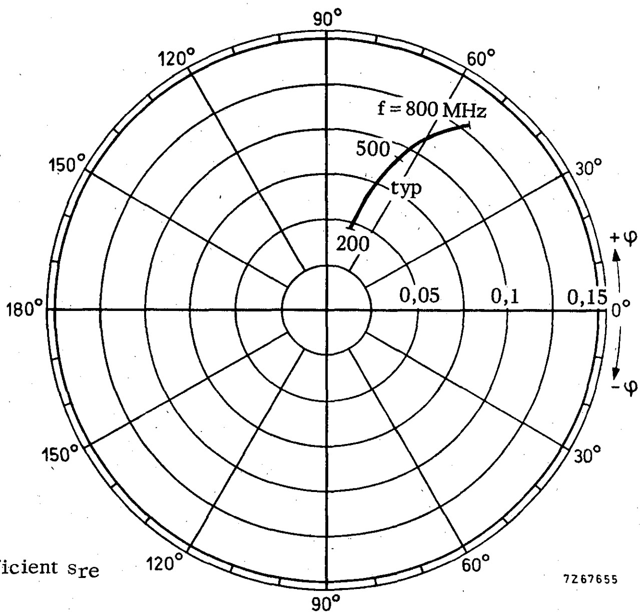
7Z67352
10
F
(dB)
$V_{CE} = 1\ V$
f = 500 MHz
Z_S = optimum
$T_{amb} = 25\ ^oC$
7,5
5
typ
2,5
0
10^{-2}
10^{-1}
1
I_C (mA)
10

V_{CE} = 1 V
I_C = 1 mA
T_{amb} = 25 °C



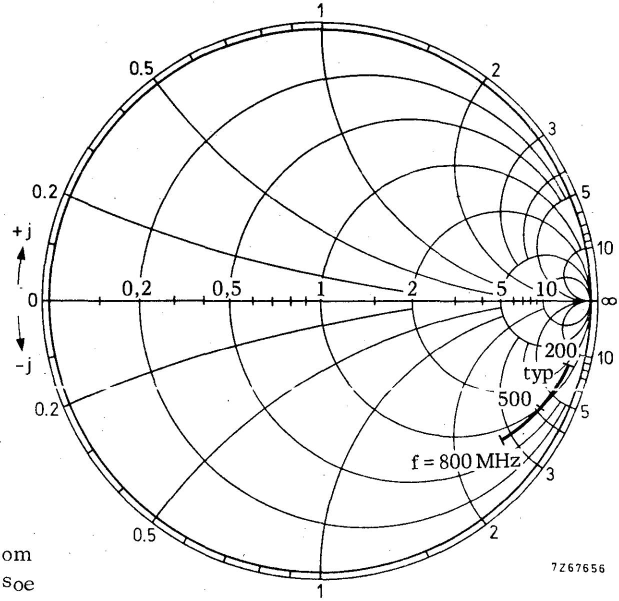
Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

V_{CE} = 1 V
I_C = 1 mA
T_{amb} = 25 °C



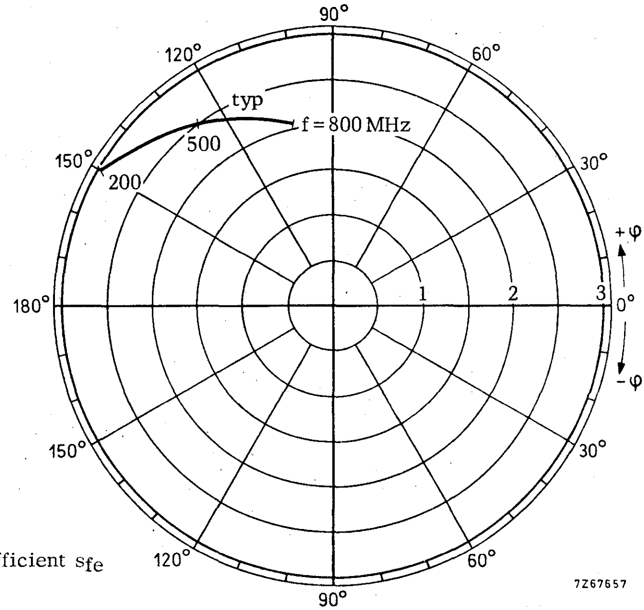
Reverse transmission coefficient s_{re}

V_{CE} = 1 V
I_C = 1 mA
T_{amb} = 25 °C



Output impedance derived from output reflection coefficient s_{oe} coordinates in ohm x 50

V_{CE} = 1 V
I_C = 1 mA
T_{amb} = 25 °C



Forward transmission coefficient s_{fe}

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.

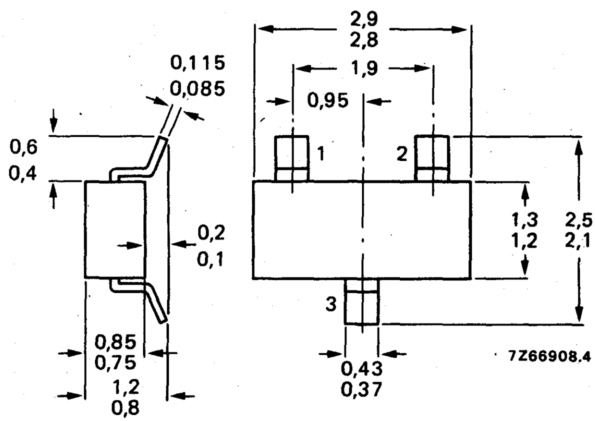
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	250 mW
Drain current V_{DS} = 10 V; V_{GS} = 0	I_{DSS}	> <	0,2 mA 1,5 mA
Transfer admittance (common source) I_D = 0,2 mA; V_{DS} = 10 V; f = 1 kHz	$\lvert y_{fs} \rvert$	>	0,5 mA/V
Equivalent noise voltage V_{DS} = 10 V; I_D = 200 μA; B = 0,6 to 100 Hz	V_n	<	0,5 μV

MECHANICAL DATA

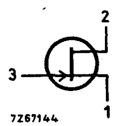
Dimensions in mm

Fig. 1 SOT-23.



Marking code

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 °C**	P_{tot}	max.	250	mW
→ Storage temperature	T_{stg}	–65 to +175		°C
→ Junction temperature	T_j	max.	175	°C

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	120	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Gate cut-off current $-V_{GS}$ = 10 V; V_{DS} = 0	$-I_{GSS}$	<	0,2	nA
Drain current ** V_{DS} = 10 V; V_{GS} = 0	I_{DSS}	> <	0,2 1,5	mA mA
Gate-source voltage I_D = 50 μA; V_{DS} = 10 V	$-V_{GS}$	> <	0,1 1,0	V V
Gate-source cut-off voltage I_D = 0,5 nA; V_{DS} = 10 V	$-V_{(P)GS}$	<	1,2	V
Y parameters at f = 1 kHz; V_{DS} = 10 V; V_{GS} = 0; T_{amb} = 25 °C				
Transfer admittance	$\lvert y_{fs}\rvert$	>	1,0	mA/V
Output admittance	$\lvert y_{os}\rvert$	<	10	μA/V
V_{DS} = 10 V; I_D = 200 μA;				
Transfer admittance	$\lvert y_{fs}\rvert$	>	0,5	mA/V
Output admittance	$\lvert y_{os}\rvert$	<	5	μA/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 MHz; V_{DS} = 10 V; V_{GS} = 0; T_{amb} = 25 °C	C_{is}	<	5 pF
Feedback capacitance at f = 1 MHz; V_{DS} = 10 V; V_{GS} = 0; T_{amb} = 25 °C	C_{rs}	<	1,5 pF
Equivalent noise voltage V_{DS} = 10 V; I_D = 200 μA; T_{amb} = 25 °C B = 0,6 to 100 Hz	V_n	<	0,5 μV

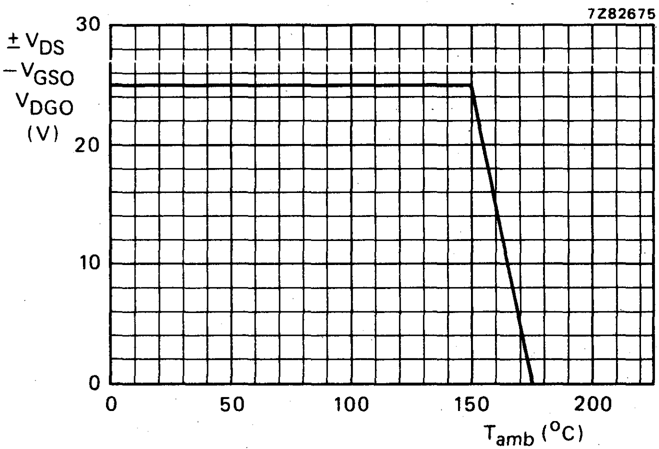


Fig. 2 Voltage derating curve.

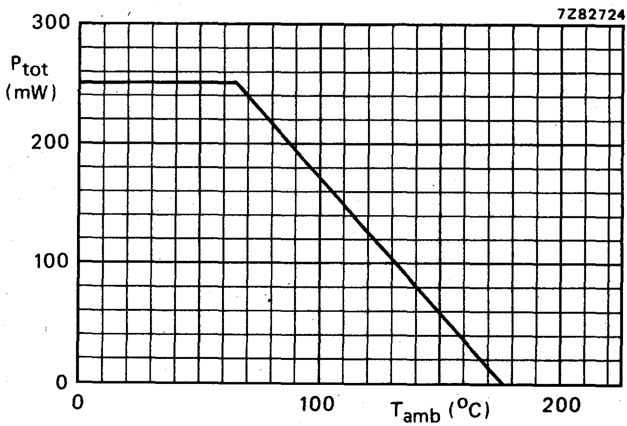


Fig. 3 Power derating curve.

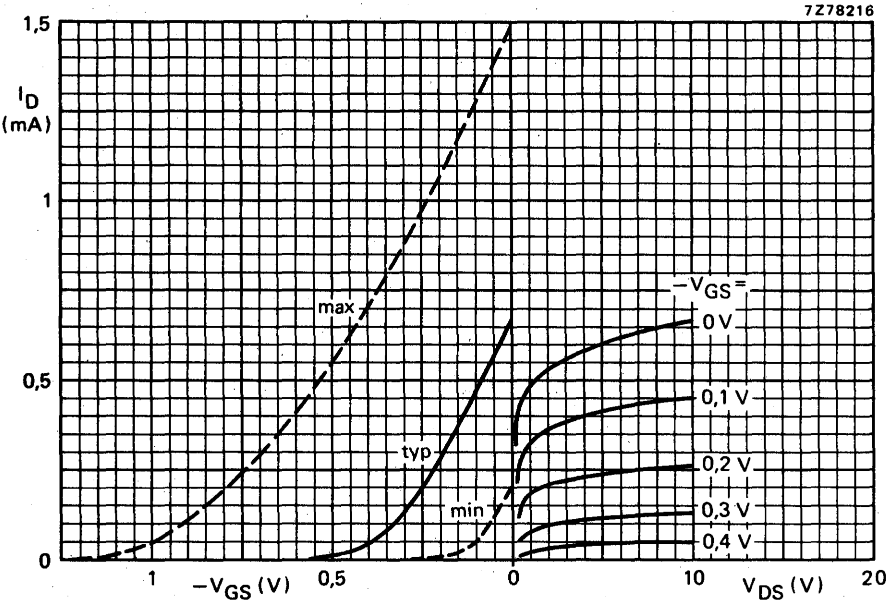


Fig. 4 Typical values. V_{DS} = 10 V; T_j = 25 °C.

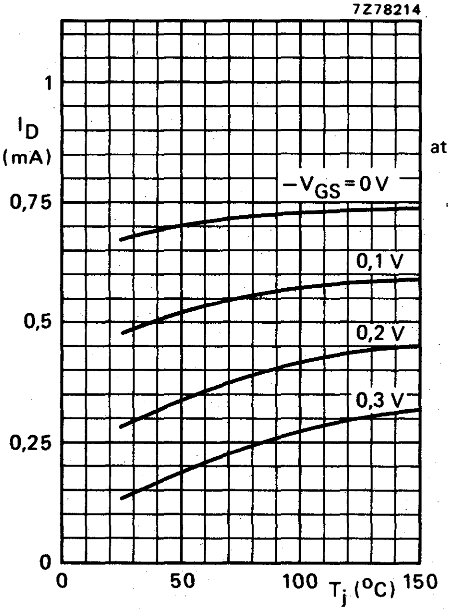


Fig. 5 Typical values. V_{DS} = 10 V.

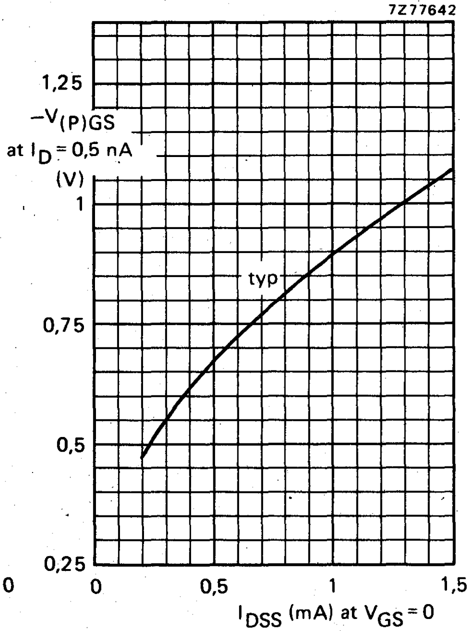


Fig. 6 Correlation between $-V_{(P)GS}$ and I_{DSS}. V_{DS} = 10 V; T_j = 25 °C.

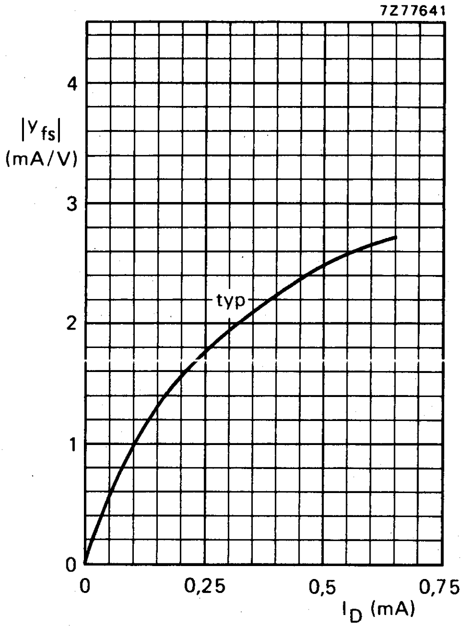


Fig. 7.

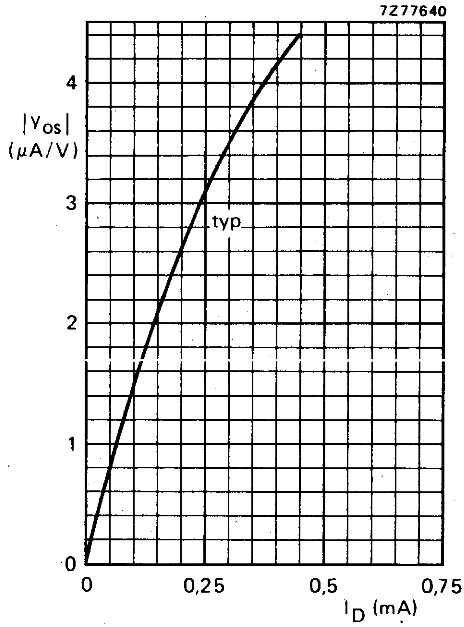


Fig. 8.

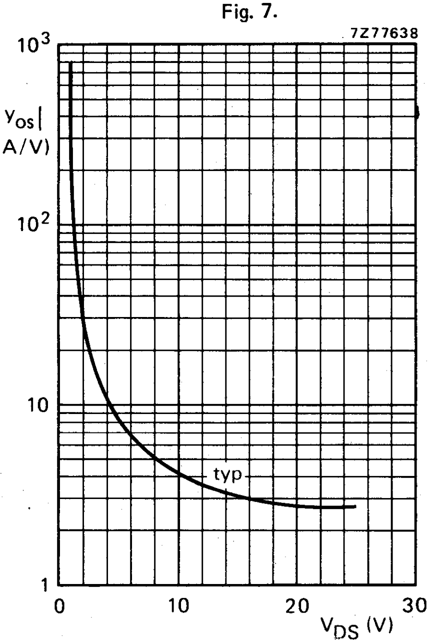


Fig. 9.

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.

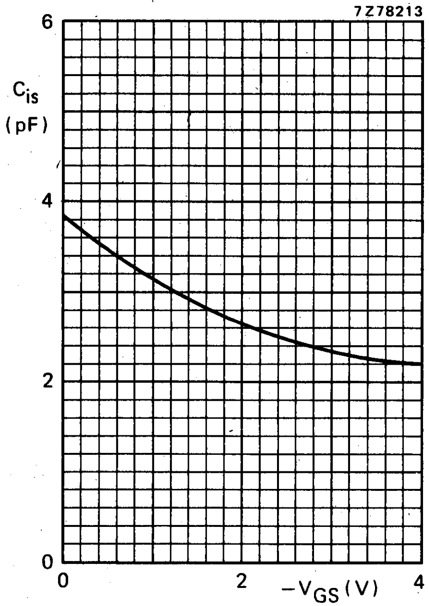


Fig. 10.

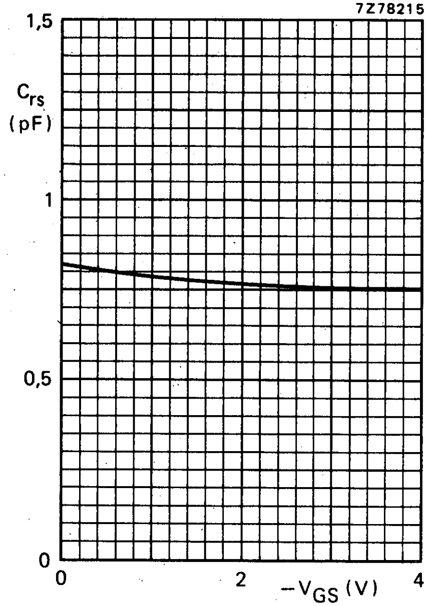


Fig. 11.

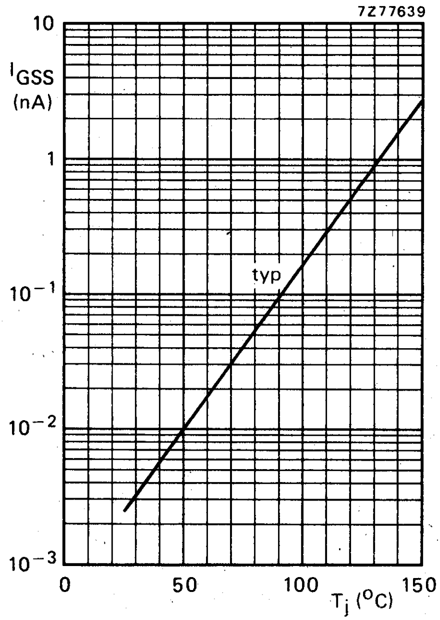


Fig. 12.

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.

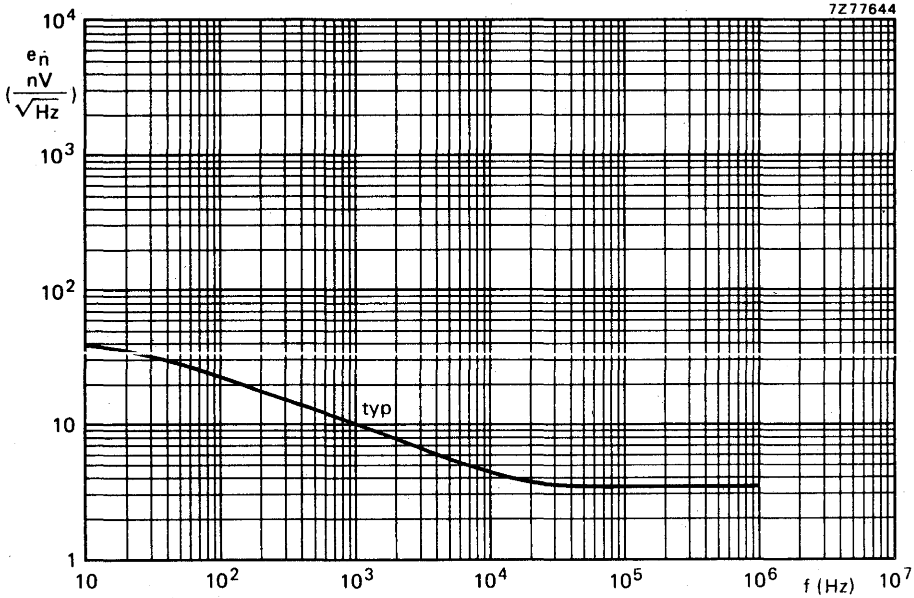


Fig. 13 V_{DS} = 10 V; I_D = 0,2 mA; T_{amb} = 25 °C.

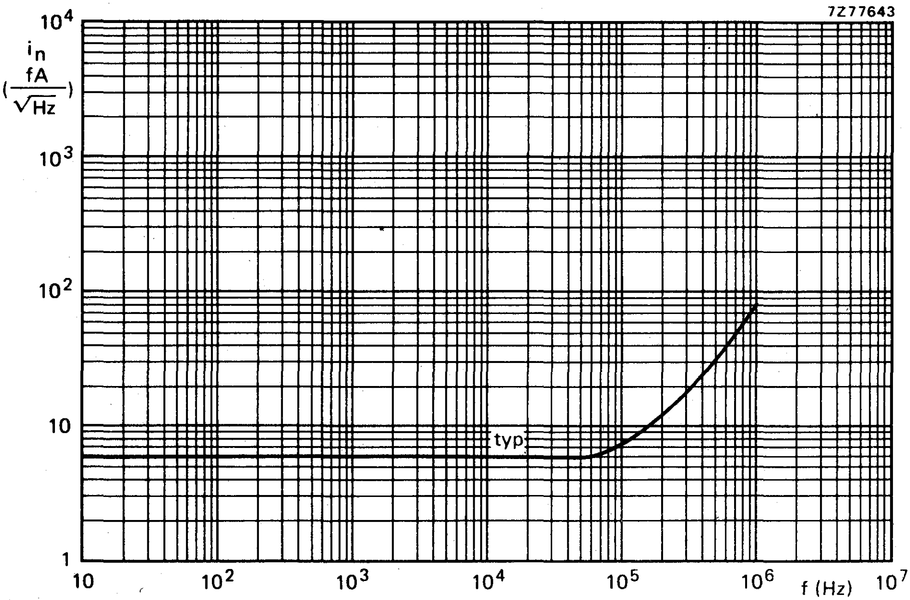


Fig. 14 V_{DS} = 10 V; I_D = 0,2 mA; T_{amb} = 25 °C.

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.

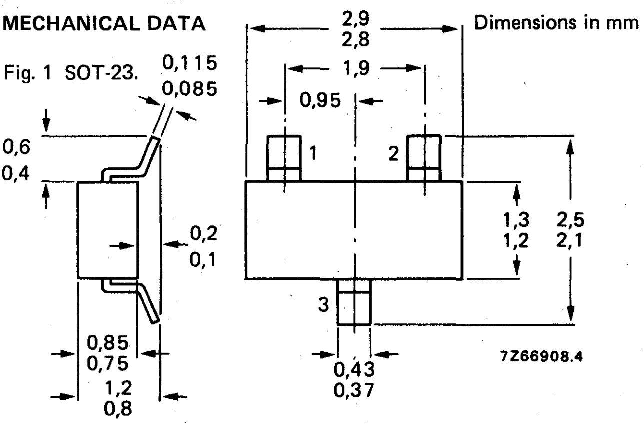
This type is complementary to BFR92.

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 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz $-I_C$ = 14 mA; $-V_{CE}$ = 10 V	f_T	typ.	5	GHz
Feedback capacitance at f = 1 MHz $-I_C$ = 2 mA; $-V_{CE}$ = 10 V; T_{amb} = 25 °C	C_{re}	typ.	0,7	pF
Noise figure at optimum source impedance $-I_C$ = 2 mA; $-V_{CE}$ = 10 V; f = 500 MHz; T_{amb} = 25 °C	F	typ.	2,7	dB
Max. unilateral power gain (see page 3) $-I_C$ = 14 mA; $-V_{CE}$ = 10 V; f = 500 MHz; T_{amb} = 25 °C	G_{UM}	typ.	18	dB
Intermodulation distortion at T_{amb} = 25 °C $-I_C$ = 14 mA; $-V_{CE}$ = 10 V; R_L = 75 Ω; V_o = 150 mV $f_{(p+q-r)}$ = 493,25 MHz (see page 3)	d_{im}	typ.	−60	dB

MECHANICAL DATA

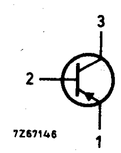
Fig. 1 SOT-23.



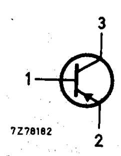
See also *Soldering recommendations.*

Marking code

BFT92 = W1



BFT92R = W4



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
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 *

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260	K/W
From soldering points to ambient **	$R_{th\,s\text{-}a}$	=	120	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current $I_E = 0; -V_{CB} = 10$ V	$-I_{CBO}$	<	50	nA
D.C. current gain * $-I_C = 14$ mA; $-V_{CE} = 10$ V	h_{FE}	> typ.	20 50	
Transition frequency at f = 500 MHz ▲ $-I_C = 14$ mA; $-V_{CE} = 10$ V	f_T	typ.	5	GHz
Collector capacitance at f = 1 MHz $I_E = I_e = 0; -V_{CB} = 10$ V	C_c	typ.	0,75	pF
Emitter capacitance at f = 1 MHz $I_C = I_c = 0; -V_{EB} = 0,5$ V	C_e	typ.	0,8	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 °C

Feedback capacitance at f = 1 MHz			
$-I_C$ = 2 mA; $-V_{CE}$ = 10 V	C_{re}	typ.	0,7 pF
Noise figure at optimum source impedance *			
$-I_C$ = 2 mA; $-V_{CE}$ = 10 V; f = 500 MHz	F	typ.	2,7 dB
Max. unilateral power gain (s_{re} assumed to be zero)			
$G_{UM}(\text{in dB}) = 10 \log \frac{\lvert s_{fe}\rvert^2}{(1-\lvert s_{ie}\rvert^2)(1-\lvert s_{oe}\rvert^2)}$			
$-I_C$ = 14 mA; $-V_{CE}$ = 10 V; f = 500 MHz	G_{UM}	typ.	18 dB
Intermodulation distortion *			
$-I_C$ = 14 mA; $-V_{CE}$ = 10 V; R_L = 75 Ω; VSWR < 2			
V_p = V_o = 150 mV at f_p = 495,25 MHz			
V_q = V_o −6 dB at f_q = 503,25 MHz			
V_r = V_o −6 dB at f_r = 505,25 MHz			
Measured at $f_{(p+q-r)}$ = 493,25 MHz	d_{im}	typ.	−60 dB

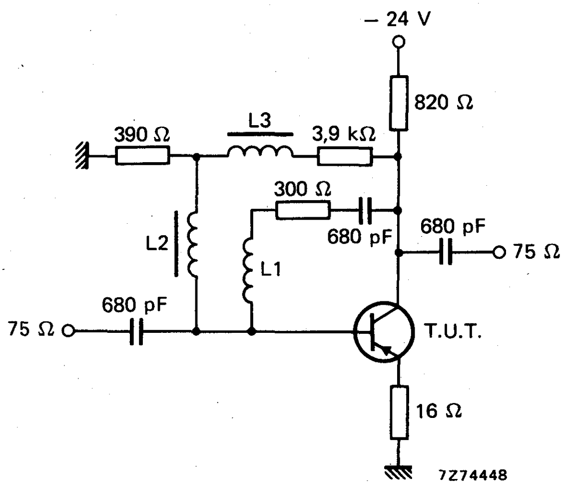


Fig. 2 Intermodulation test circuit.

L1 = 4 turns Cu wire (0,35 mm); winding pitch 1 mm; int. dia. 4 mm.
L2 = L3 = 5 μH (catalogue number: 3122 108 20150).

* Crystal mounted in SOT-37 envelope.

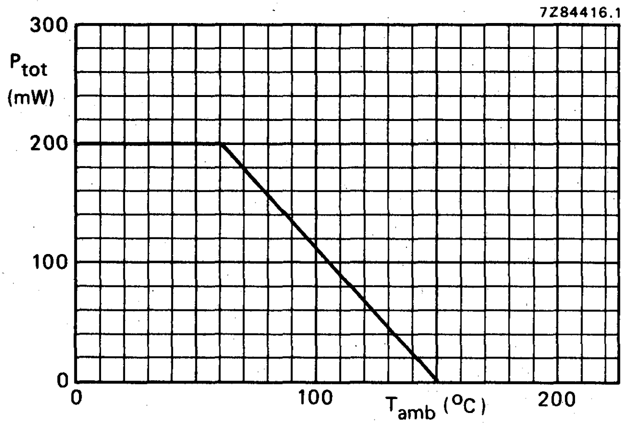


Fig. 3 Power derating curve.

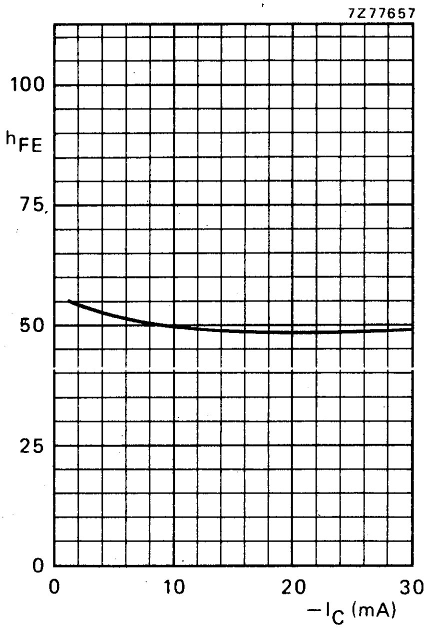


Fig. 4 $-V_{CE}$ = 10 V; T_j = 25 °C.

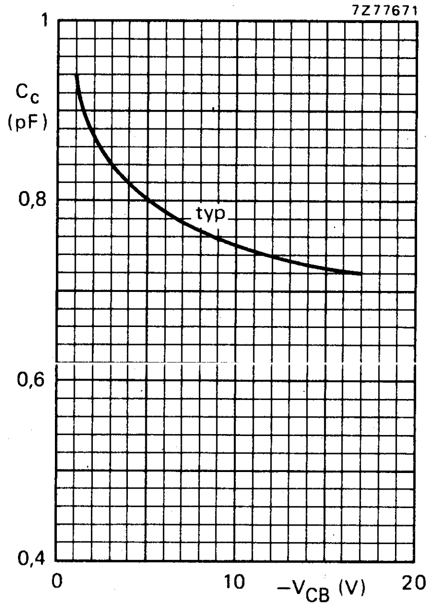


Fig. 5 $I_E = I_e = 0$; T_j = 25 °C; f = 1 MHz.

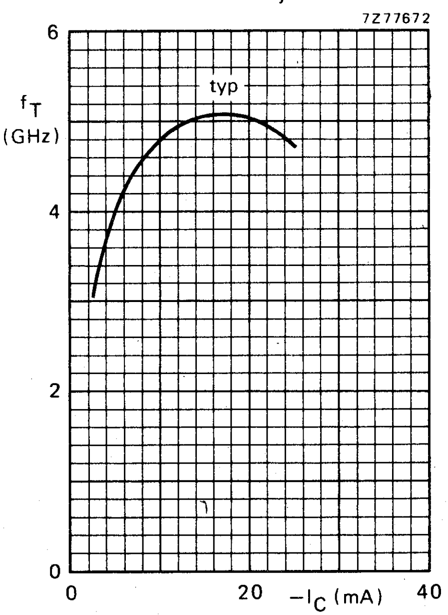


Fig. 6 $-V_{CE}$ = 10 V; f = 500 MHz; T_j = 25 °C.

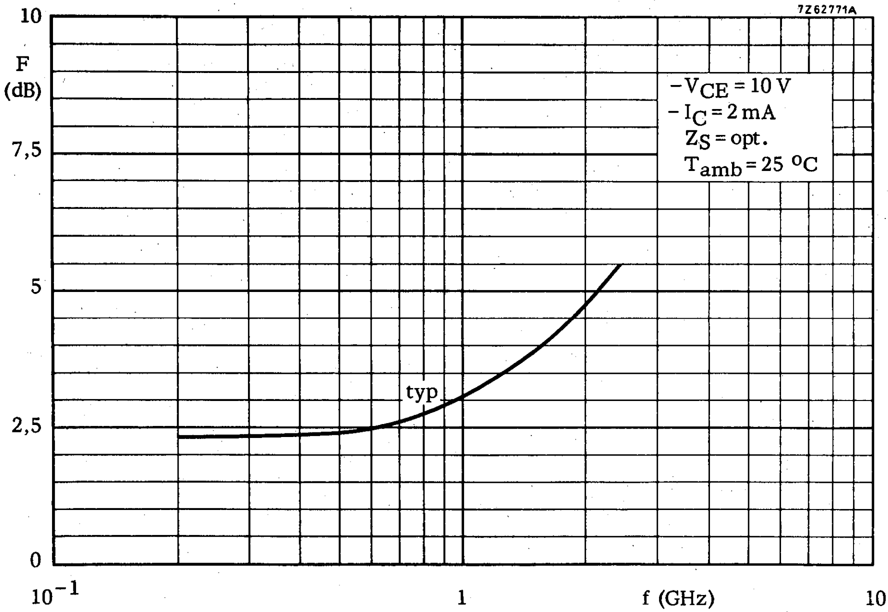

7Z62771A
10
F
(dB)
7,5
5
2,5
0
$-V_{CE} = 10$ V
$-I_C = 2$ mA
Z_S = opt.
$T_{amb} = 25$ °C
typ
10^{-1}
1
f (GHz)
10

Fig. 7.

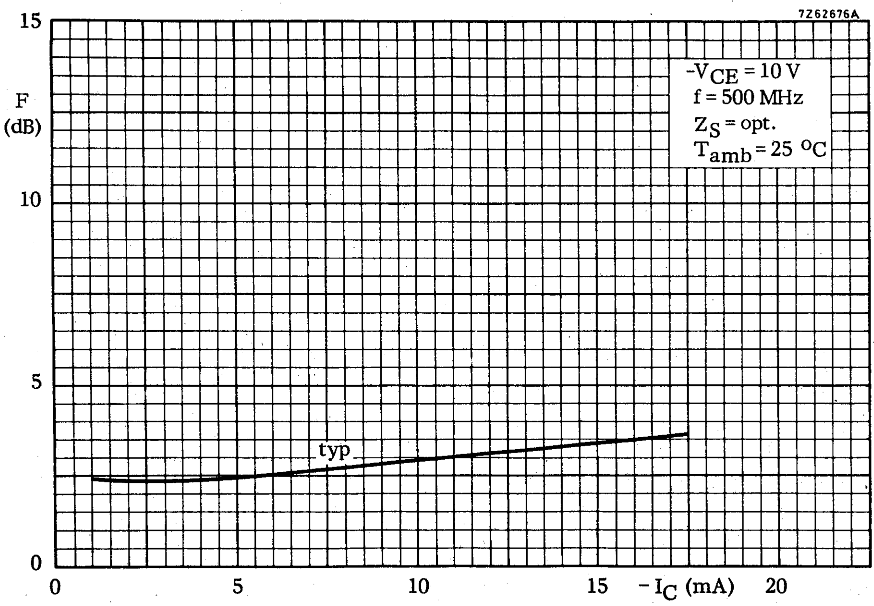

7Z62676A
15
F
(dB)
10
5
0
$-V_{CE} = 10$ V
f = 500 MHz
Z_S = opt.
$T_{amb} = 25$ °C
typ
0
5
10
15
$-I_C$ (mA)
20

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.

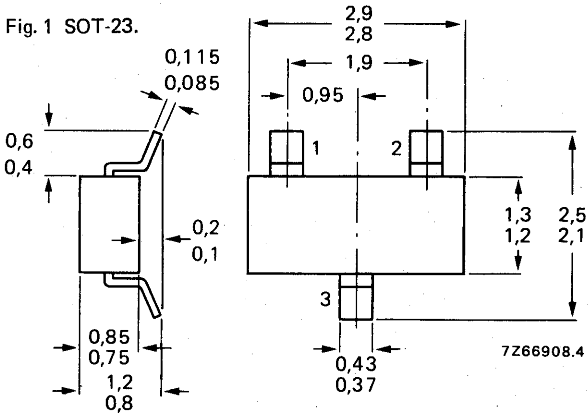
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 500 MHz $-I_C$ = 30 mA; $-V_{CE}$ = 5 V	f_T	typ.	5	GHz
Feedback capacitance at f = 1 MHz $-I_C$ = 2 mA; $-V_{CE}$ = 5 V; T_{amb} = 25 °C	C_{re}	typ.	1,0	pF
Noise figure at optimum source impedance $-I_C$ = 2 mA; $-V_{CE}$ = 5 V; f = 500 MHz; T_{amb} = 25 °C	F	typ.	2,4	dB
Max. unilateral power gain (see page 3) $-I_C$ = 30 mA; $-V_{CE}$ = 5 V; f = 500 MHz; T_{amb} = 25 °C	G_{UM}	typ.	16,5	dB
Intermodulation distortion at T_{amb} = 25 °C $-I_C$ = 30 mA; $-V_{CE}$ = 5 V; R_L = 75 Ω; V_o = 300 mV $f_{(p+q-r)}$ = 493,25 MHz (see page 3)	d_{im}	typ.	−60	dB

MECHANICAL DATA

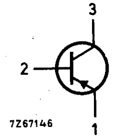
Dimensions in mm

Fig. 1 SOT-23.

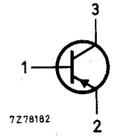


Marking code

BFT93 = X1



BFT93R = X4



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
Collector current (peak value; $f > 1$ MHz)	$-I_{CM}$	max.	50	mA
→ Total power dissipation up to $T_{amb} = 60\ ^oC$ **	P_{tot}	max.	200	mW
Storage temperature	T_{stg}	−65 to + 150		^oC
Junction temperature	T_j	max.	150	^oC

→ THERMAL CHARACTERISTICS *

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
From soldering points to ambient **	$R_{th\ s\text{-}a}$	=	120	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current $I_E = 0; -V_{CB} = 5$ V	$-I_{CBO}$	<	50	nA
D.C. current gain * $-I_C = 30$ mA; $-V_{CE} = 5$ V	h_{FE}	> typ.	20 50	
Transition frequency at f = 500 MHz ▲ $-I_C = 30$ mA; $-V_{CE} = 5$ V	f_T	typ.	5	GHz
Collector capacitance at f = 1 MHz $I_E = I_e = 0; -V_{CB} = 10$ V	C_c	typ.	0,95	pF
Emitter capacitance at f = 1 MHz $I_C = I_c = 0; -V_{EB} = 0,5$ V	C_e	typ.	1,8	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)

$T_{amb} = 25\ ^oC$

Feedback capacitance at f = 1 MHz			
$-I_C = 2$ mA; $-V_{CE} = 5$ V	C_{re}	typ.	1,0 pF
Noise figure at optimum source impedance *			
$-I_C = 2$ mA; $-V_{CE} = 5$ V; f = 500 MHz	F	typ.	2,4 dB
Max. unilateral power gain (s_{re} assumed to be zero)			
$G_{UM}(\text{in dB}) = 10 \log \frac{\|s_{fe}\|^2}{(1 - \|s_{ie}\|^2)(1 - \|s_{oe}\|^2)}$			
$-I_C = 30$ mA; $-V_{CE} = 5$ V; f = 500 MHz	G_{UM}	typ.	16,5 dB
Intermodulation distortion *			
$-I_C = 30$ mA; $-V_{CE} = 5$ V; $R_L = 75\ \Omega$; VSWR < 2			
$V_p = V_o = 300$ mV at $f_p = 495{,}25$ MHz			
$V_q = V_o - 6$ dB at $f_q = 503{,}25$ MHz			
$V_r = V_o - 6$ dB at $f_r = 505{,}25$ MHz			
Measured at $f_{(p+q-r)} = 493{,}25$ MHz	d_{im}	typ.	−60 dB

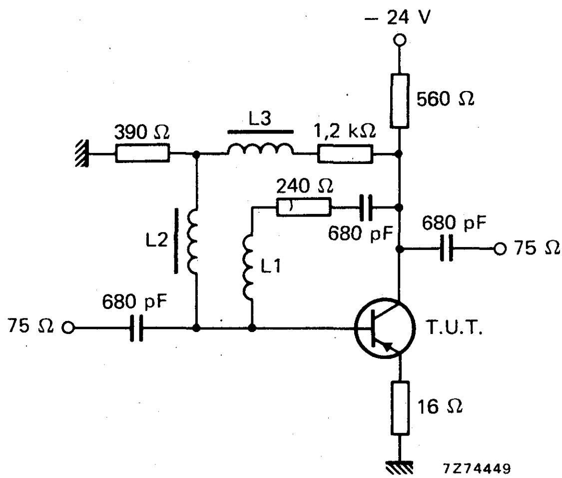


Fig. 2 Intermodulation test circuit.

L1 = 4 turns Cu wire (0,35); winding pitch 1 mm; int. dia. 4 mm.
L2 and L3 = 5 μH (catalogue number: 3122 108 20150).

* Crystal mounted in SOT-37 envelope.

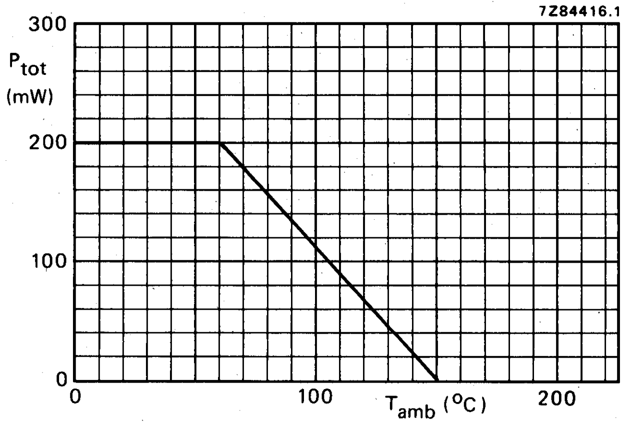


Fig. 3 Power derating curve.

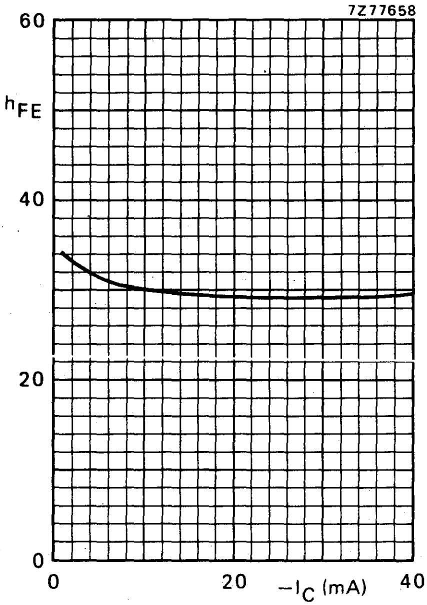


Fig. 4 $-V_{CE} = 5$ V; $T_j = 25$ °C.

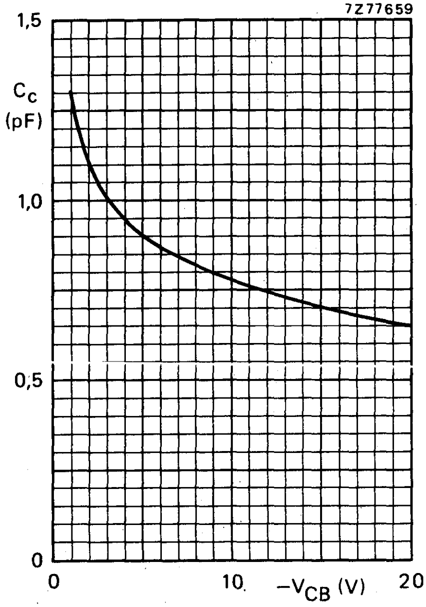


Fig. 5 $I_E = I_e = 0$; $T_j = 25$ °C; f = 1 MHz.

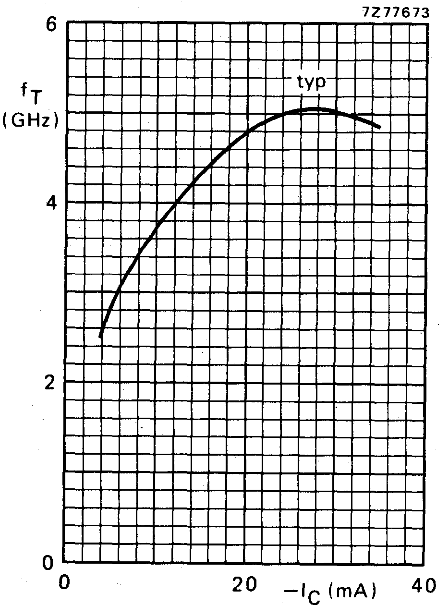


Fig. 6 $-V_{CE} = 5$ V; $T_j = 25$ °C; f = 500 MHz.

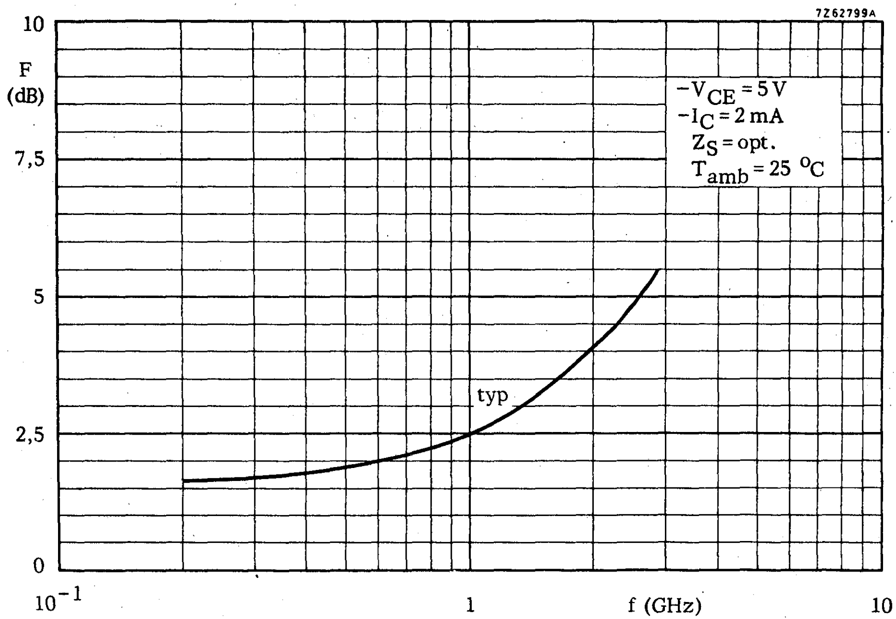

7Z62799A
10
F
(dB)
7,5
5
2,5
0
10^{-1}
1
f (GHz)
10
$-V_{CE} = 5$ V
$-I_C = 2$ mA
Z_S = opt.
$T_{amb} = 25$ °C
typ

Fig. 7.

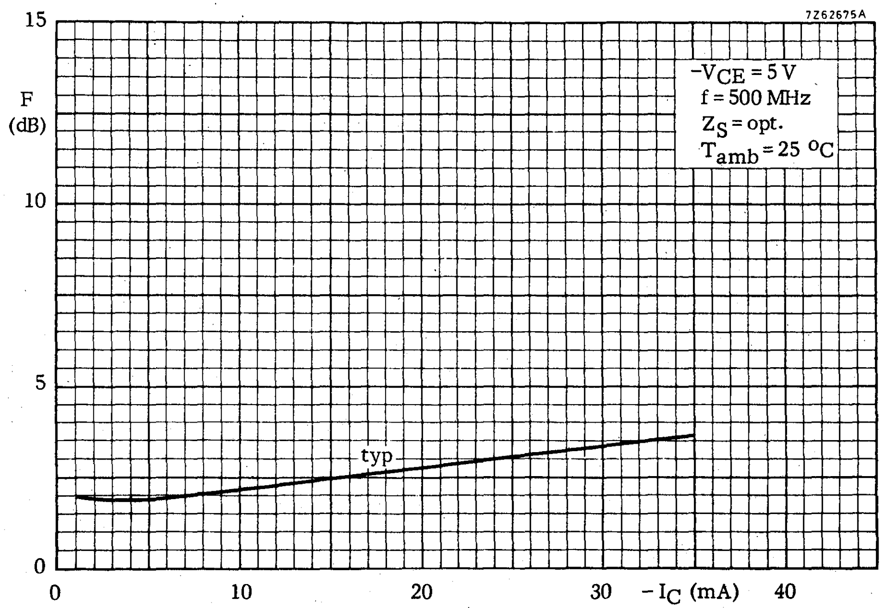

7Z62675A
15
F
(dB)
10
5
0
0
10
20
30
$-I_C$ (mA)
40
$-V_{CE} = 5$ V
f = 500 MHz
Z_S = opt.
$T_{amb} = 25$ °C
typ

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.

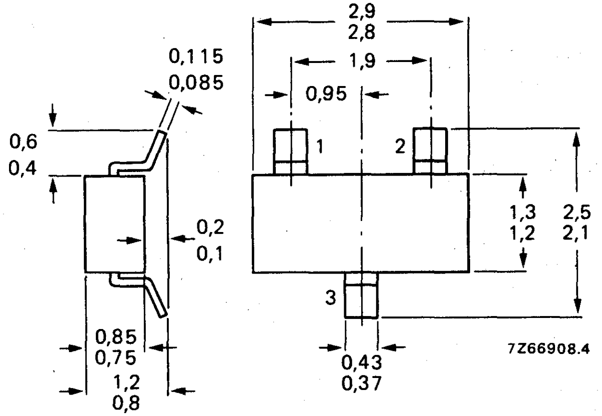
QUICK REFERENCE DATA

Gate-anode voltage	V_{GA}	max.	70	V
Anode current (d.c.) up to T_{amb} = 25 °C	I_A	max.	175	mA
Junction temperature	T_j	max.	150	°C
Peak point current V_S = 10 V; R_G = 10 kΩ	I_P	<	5	μA
Valley point current V_S = 10 V; R_G = 10 kΩ	I_V	>	30	μA

MECHANICAL DATA

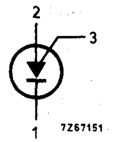
Dimensions in mm

Fig. 1 SOT-23.



Marking code

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 °C	I_A	max.	175	mA
Repetitive peak anode current t = 10 μs; δ = 0,01	I_{ARM}	max.	2,5	A
Non-repetitive peak anode current t = 10 μs; T_j = 150 °C	I_{ASM}	max.	3	A
Rate of rise of anode current up to I_A = 2,5 A	$\frac{dI_A}{dt}$	max.	20	A/μs
Storage temperature	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C
→ Total power dissipation up to T_{amb} = 25 °C**	P_{tot}	max.	275	mW

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	120	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Peak point current (see Figs 2, 3 and 4)				
V_S = 10 V; R_G = 10 kΩ	I_P	<	5	μA
V_S = 10 V; R_G = 1 MΩ	I_P	<	1	μA
Valley point current (see also Figs 2, 3 and 4)				
V_S = 10 V; R_G = 10 kΩ	I_V	>	30	μA
V_S = 10 V; R_G = 1 MΩ	I_V	<	50	μA
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

* See *Thermal characteristics* in chapter GENERAL.
** Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.

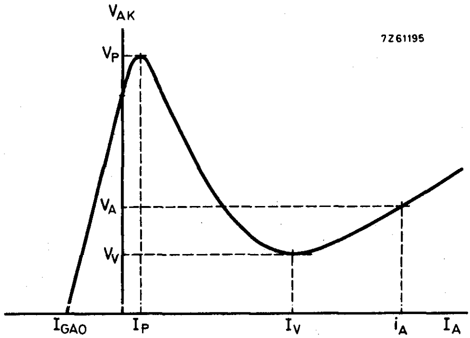


Fig. 2 See also Fig. 11.

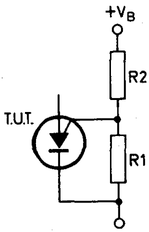


Fig. 3 BRY61 with "program" resistors R1 and R2.

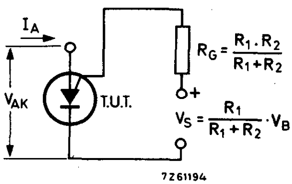


Fig. 4 Equivalent test circuit for characteristics testing.

Gate-anode leakage current (Fig. 5a) $I_K = 0$; $V_{GA} = 70$ V	I_{GAO}	<	10 nA
Gate-cathode leakage current (Fig. 5b) $V_{AK} = 0$; $V_{GK} = 70$ V	I_{GKS}	<	100 nA

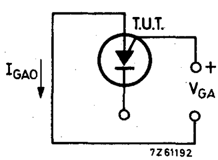


Fig. 5a.

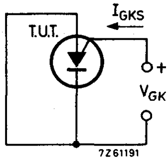


Fig. 5b.

Anode voltage			
I_A = 100 mA	V_A	<	1,4 V
I_A = 180 mA	V_A	<	1,6 V
Peak output voltage			
V_{AA} = 20 V; C = 200 nF (see Fig. 12)	V_{OM}	>	6 V
Rise time			
V_{AA} = 20 V; C = 10 nF (see Fig. 12)	t_r	<	80 ns

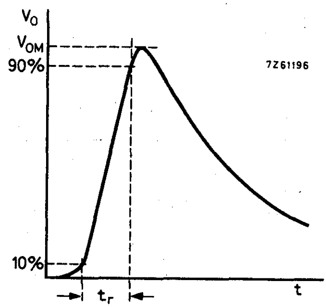


Fig. 6 Output voltage waveform.

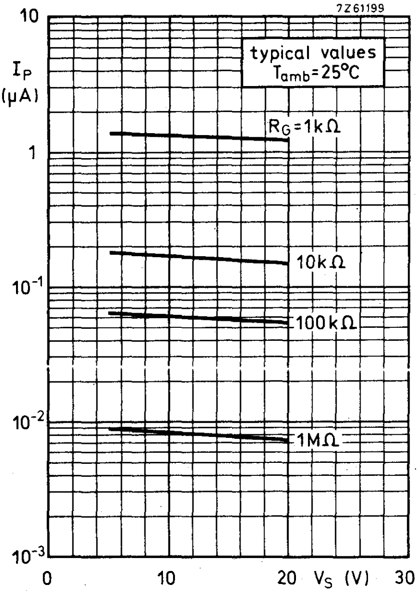


Fig. 8.

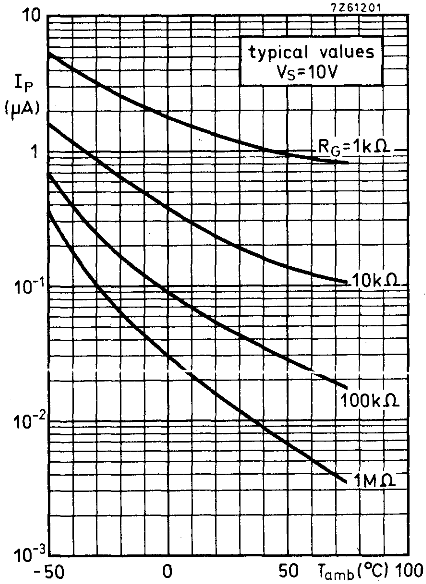


Fig. 9.

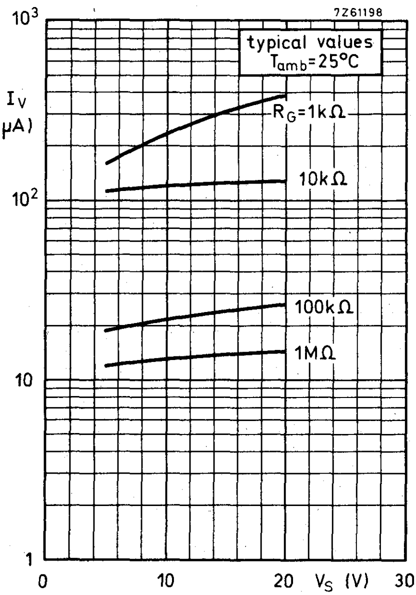


Fig. 10.

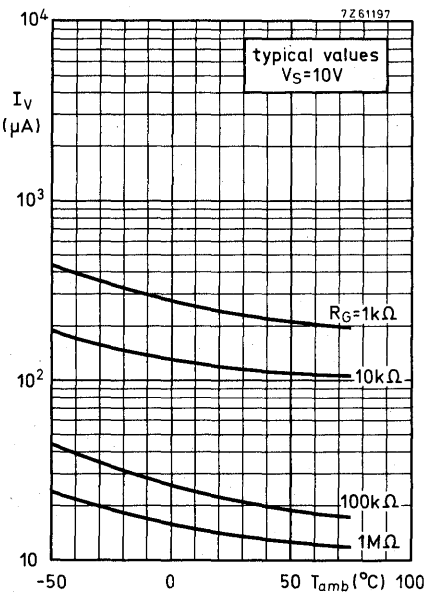


Fig. 11.

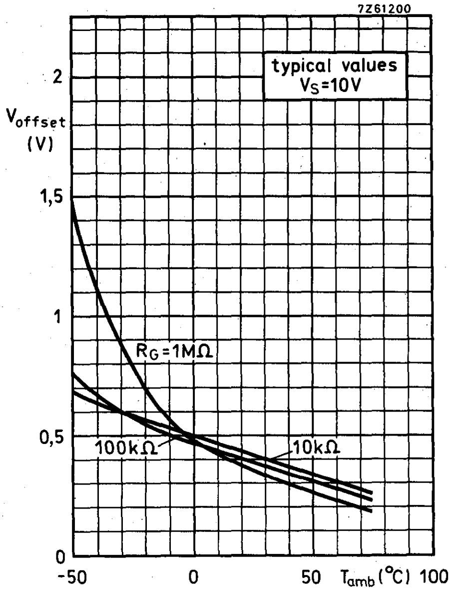

7Z61200
typical values
V_S=10V
V_{offset} (V)
2
1,5
1
0,5
0
R_G=1MΩ
100kΩ
10kΩ
-50
0
50
T_{amb} (°C)
100

Fig. 12.

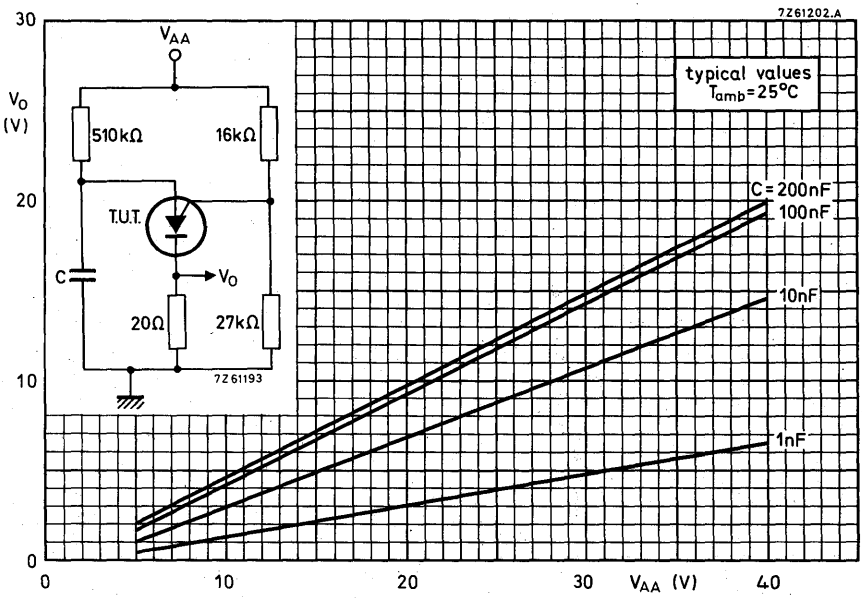

7Z61202.A
typical values
T_{amb}=25°C
V_O (V)
30
20
10
0
V_{AA}
510kΩ
16kΩ
T.U.T.
C
V_O
20Ω
27kΩ
7Z61193
C = 200nF
100nF
10nF
1nF
0
10
20
30
V_{AA} (V)
40

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.

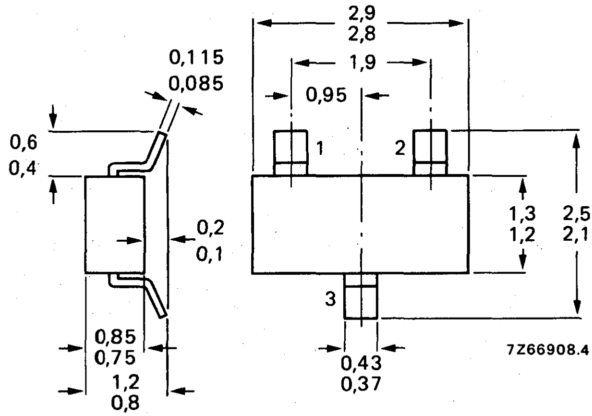
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain				
$-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	>	30	
$-I_C$ = 50 mA; $-V_{CE}$ = 1 V	h_{FE}		30 to 120	
Transition frequency at f = 500 MHz				
$-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	>	1,5	GHz
Turn-off time				
$-I_{Con}$ = 30 mA; $-I_{Bon}$ = $+I_{Boff}$ = 3,0 mA	t_{off}	<	30	ns

MECHANICAL DATA

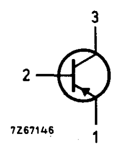
Dimensions in mm

Fig. 1 SOT-23.

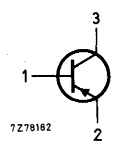


Marking code

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	$-V_{CBO}$	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 °C**	P_{tot}	max.	250	mW
→ Storage temperature	T_{stg}	–65 to + 175		°C
→ Junction temperature	T_j	max.	175	°C

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	120	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	<	50	nA
$I_E = 0$; $-V_{CB} = 10$ V; $T_{amb} = 125$ °C	$-I_{CBO}$	<	5	μA
$V_{BE} = 0$; $-V_{CE} = 10$ V	$-I_{CES}$	<	50	nA
Breakdown voltages				
$I_E = 0$; $-I_C = 10$ μA	$-V_{(BR)CBO}$	>	15	V
$V_{BE} = 0$; $-I_C = 10$ μA	$-V_{(BR)CES}$	>	15	V
$I_C = 0$; $-I_E = 100$ μA	$-V_{(BR)EBO}$	>	3	V
Collector-emitter sustaining voltage				
$I_B = 0$; $-I_C = 10$ mA	$-V_{CEOsust}$	>	15	V
Saturation voltages▲				
$-I_C = 10$ mA; $-I_B = 1$ mA	$-V_{CEsat}$	<	130	mV
	$-V_{BEsat}$		725 to 920	mV
$-I_C = 50$ mA; $-I_B = 5$ mA	$-V_{CEsat}$	<	190	mV
	$-V_{BEsat}$		800 to 1150	mV
$-I_C = 100$ mA; $-I_B = 10$ mA	$-V_{CEsat}$	<	450	mV
	$-V_{BEsat}$		900 to 1500	mV

▲ Measured under pulse conditions; $t_p = 300$ μs; $\delta = 0{,}01$.
* 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 mA; $-V_{CE}$ = 1 V	h_{FE}	>	30
$-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	>	30
$-I_C$ = 50 mA; $-V_{CE}$ = 1 V	h_{FE}		30 to 120
$-I_C$ = 50 mA; $-V_{CE}$ = 1 V; T_{amb} = 55 °C	h_{FE}	>	30
$-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}	>	20

Transition frequency at f = 500 MHz

$-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	>	1,5 GHz

Collector capacitance

$I_E = I_e = 0$; $-V_{CB}$ = 5 V	C_c	<	4,5 pF

Emitter capacitance

$I_C = I_c = 0$; $-V_{EB}$ = 0,5 V	C_e	<	6,0 pF

Switching times

Turn-on time	t_{on}	<	20 ns
Turn-off time	t_{off}	<	30 ns

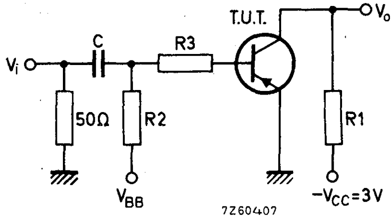


Fig. 2 Test circuit switching times.

Pulse generator

Pulse duration	t_p	=	400 ns
Rise time	t_r	<	1 ns
Output impedance	Z_o	=	50 Ω

Sampling scope

Rise time	t_r	<	1 ns
Input impedance	Z_i	=	100 kΩ

	V_i V	V_{BB} V	R1 Ω	R2 kΩ	R3 kΩ	$-I_{Con}$ mA	$-I_{Bon}$ mA	I_{Boff} mA	C μF
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 μs; δ = 0,01.

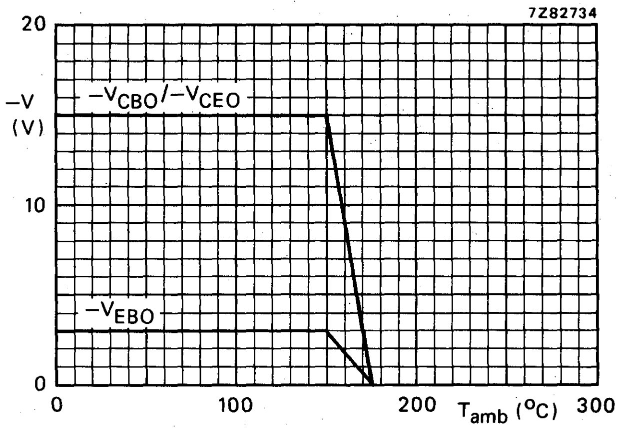


Fig. 3 Voltage derating curves.

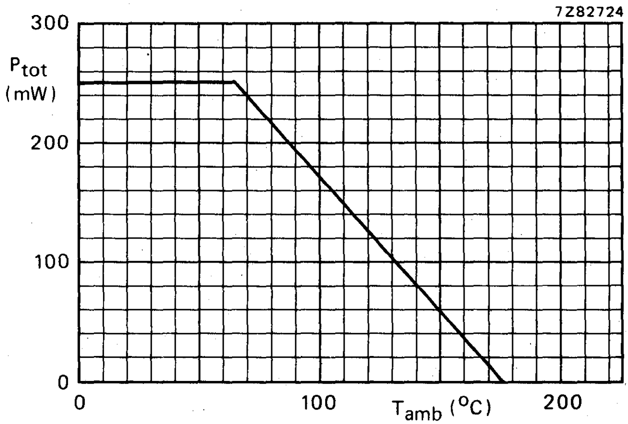


Fig. 4 Power derating curve.

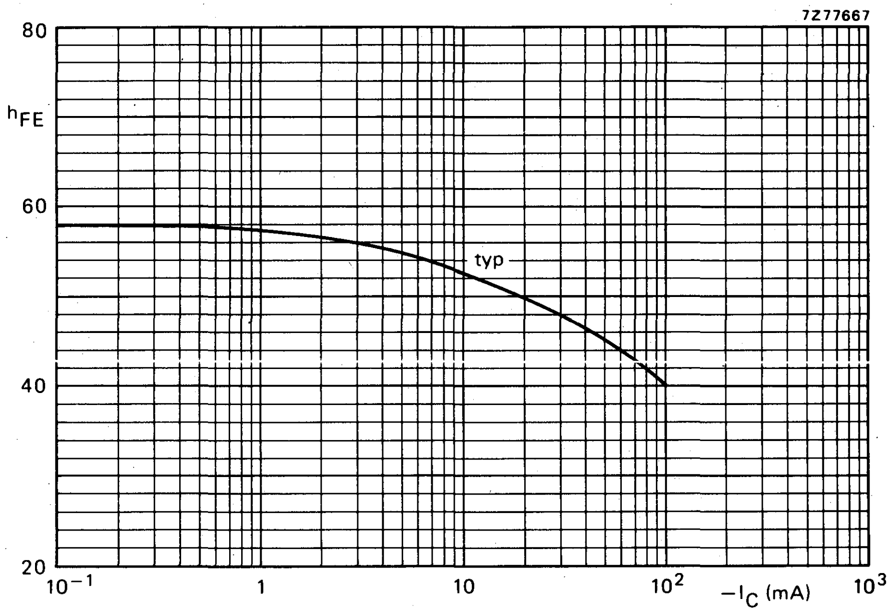


Fig. 5 $-V_{CE}$ = 1 V; T_{amb} = 25 °C.

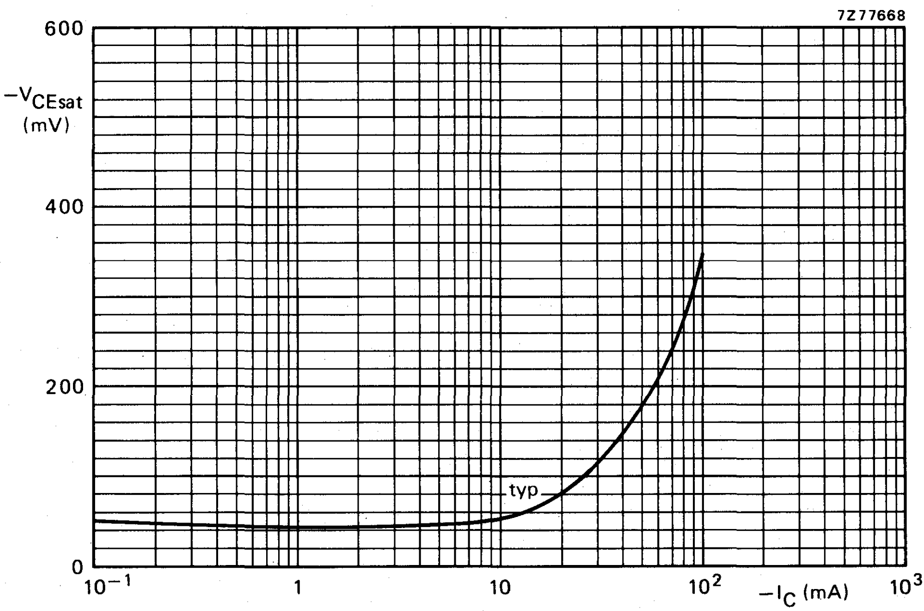


Fig. 6 V_{CEsat} as a function of I_C at I_C/I_B = 10.

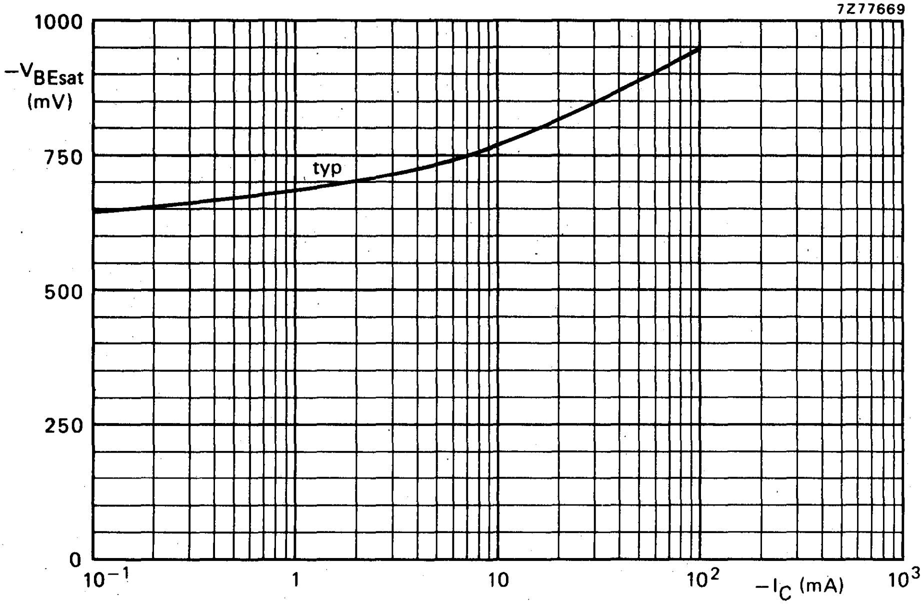


Fig. 7 V_{BEsat} as a function of I_C at $I_C/I_B = 10$.

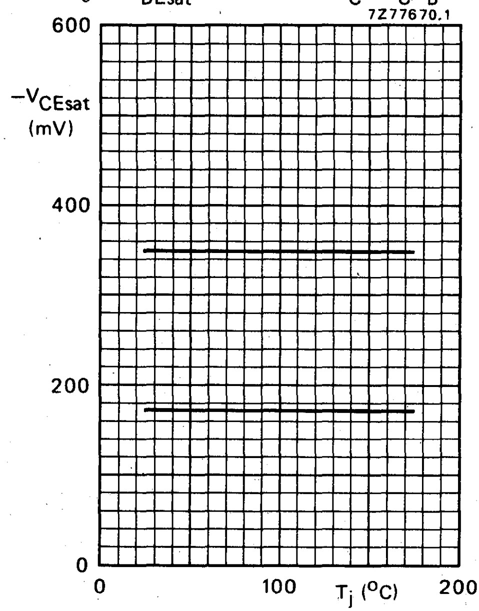


Fig. 8 V_{CEsat} as a function of T_j; typical values.
Upper graph at I_C = 100 mA; I_B = 10 mA. Lower graph at I_C = 50 mA and I_B = 5 mA.

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.

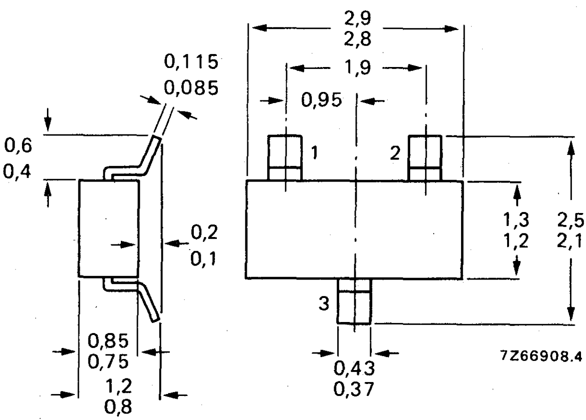
QUICK REFERENCE DATA

			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 °C	P_{tot}	max.	425		mW
Junction temperature	T_j	max.	175		°C
D.C. current gain					
I_C = 150 mA; V_{CE} = 10 V	h_{FE}		100 to 300		
I_C = 500 mA; V_{CE} = 10 V	h_{FE}	>	30	40	
Transition frequency at f = 100 MHz					
I_C = 20 mA; V_{CE} = 20 V	f_T	>	250	300	MHz

MECHANICAL DATA

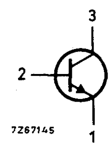
Dimensions in mm

Fig. 1 SOT-23.

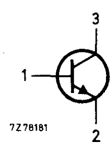


Marking code

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 °C	P_{tot}	max.	425		mW
Storage temperature	T_{stg}		–65 to + 175		°C
Junction temperature	T_j	max.	175		°C

THERMAL CHARACTERISTICS*

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

Thermal resistance

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BSR13; R	BSR14; R	
Collector cut-off current					
$I_E = 0$; V_{CB} = 50 V	I_{CBO}	<	30	–	nA
$I_E = 0$; V_{CB} = 60 V	I_{CBO}	<	–	10	nA
$I_E = 0$; V_{CB} = 50 V; T_j = 150 °C	I_{CBO}	<	10	–	µA
$I_E = 0$; V_{CB} = 60 V; T_j = 150 °C	I_{CBO}	<	–	10	µA
V_{EB} = 3 V; V_{CE} = 60 V	I_{CEX}	<	–	10	nA
Base current with reverse biased emitter junction V_{EB} = 3 V; V_{CE} = 60 V	I_{BEX}	<	–	20	nA
Emitter cut-off current $I_C = 0$; V_{EB} = 3 V	I_{EBO}	<	30	15	nA
Saturation voltages ▲					
I_C = 150 mA; I_B = 15 mA	V_{CEsat}	<	400	300	mV
	V_{BEsat}	<	1300	–	mV
	V_{BEsat}		–	0,6 to 1,2	V
I_C = 500 mA; I_B = 50 mA	V_{CEsat}	<	1600	1000	mV
	V_{BEsat}	<	2600	2000	mV

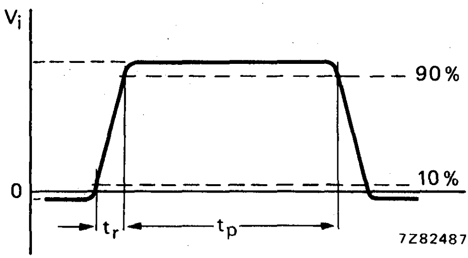
* See *Thermal characteristics* in chapter GENERAL.
** Device mounted on a ceramic substrate of 15 mm x 15 mm x 0,6 mm.
▲ Measured under pulsed conditions to avoid excessive dissipation $t_p \leqslant 300$ µs; $\delta \leqslant 0{,}02$.

D.C. current gain *				
$I_C = 0{,}1$ mA; $V_{CE} = 10$ V		h_{FE}	> 35	
$I_C = 1$ mA; $V_{CE} = 10$ V		h_{FE}	> 50	
$I_C = 10$ mA; $V_{CE} = 10$ V		h_{FE}	> 75	
$I_C = 150$ mA; $V_{CE} = 10$ V		h_{FE}	100 to 300	
$I_C = 150$ mA; $V_{CE} = 1$ V		h_{FE}	> 50	
$I_C = 500$ mA; $V_{CE} = 10$ V	BSR13; R	h_{FE}	> 30	
$I_C = 500$ mA; $V_{CE} = 10$ V	BSR14; R	h_{FE}	> 40	
Transition frequency at f = 100 MHz				
$I_C = 20$ mA; $V_{CE} = 20$ V	BSR13; R	f_T	> 250	MHz
$I_C = 20$ mA; $V_{CE} = 20$ V	BSR14; R	f_T	> 300	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V		C_c	< 8	pF
h parameters (common emitter) at f = 1 kHz				
$I_C = 1$ mA; $V_{CE} = 10$ V			BSR14;R	
input impedance		h_{ie}	2 to 8	kΩ
reverse voltage transfer ratio		h_{re}	< 8.10^{-4}	
small signal current gain		h_{fe}	50 to 300	
output admittance		h_{oe}	5 to 35	$\mu\Omega^{-1}$
$I_C = 10$ mA; $V_{CE} = 10$ V				
input impedance		h_{ie}	0,25 to 1,25	kΩ
reverse voltage transfer ratio		h_{re}	< 4.10^{-4}	
small signal current gain		h_{fe}	75 to 375	
output admittance		h_{oe}	25 to 200	$\mu\Omega^{-1}$

* Measured under pulsed conditions to avoid excessive dissipation; pulse duration $t_p \leqslant 300\ \mu s$; duty factor $\delta \leqslant 0{,}02$.

Switching times (between 10% and 90% levels)

		BSR14;R	
Turn-on time switched to I_C = 150 mA (see Fig. 2)			
delay time	t_d	< 10	ns
rise time	t_r	< 25	ns
Turn-off time switched from I_C = 150 mA (see Fig. 3)			
storage time	t_s	< 225	ns
fall time	t_f	< 60	ns



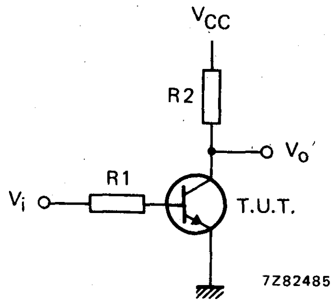
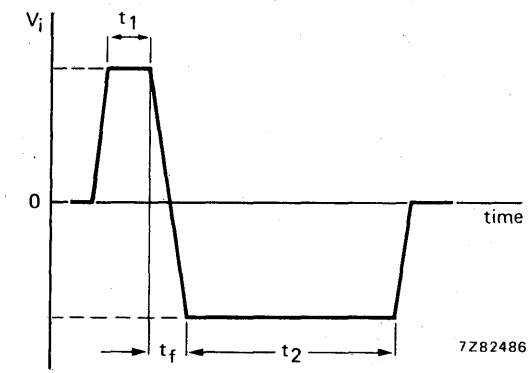


Fig. 2 Waveform and test circuit delay and rise time.

V_i = −0,5 to + 9,9 V; V_{CC} = 30 V; R1 = 619 Ω; R2 = 200 Ω.

Pulse generator:			
pulse duration	t_p	⩽	200 ns
rise time	t_r	⩽	2 ns
duty factor	δ	=	2 %

Oscilloscope:			
input impedance	Z_i	>	100 kΩ
input capacitance	C_i	<	12 pF
rise time	t_r	<	5 ns



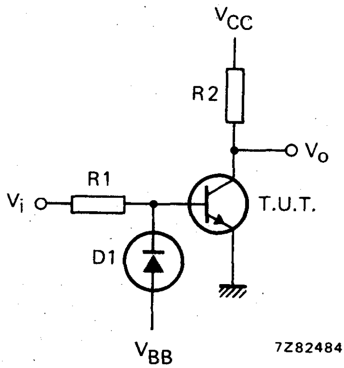


Fig. 3 Waveform and test circuit storage and fall time.

V_i = −13,8 to + 16,2 V; V_{CC} = 30 V; $-V_{BB}$ = 3 V; R1 = 1 kΩ; R2 = 200 Ω.

Pulse generator:			
fall time	t_f	<	5 ns
pulse time	t_1	=	100 μs
	t_2	=	500 μs

Oscilloscope:			
input impedance	Z_i	>	100 kΩ
input capacitance	C_i	<	12 pF
rise time	t_r	<	5 ns

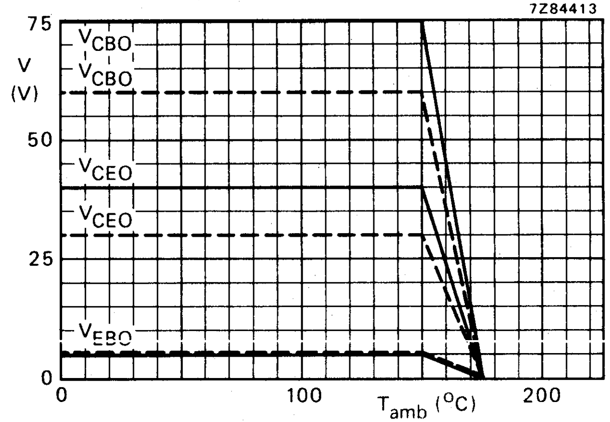


Fig. 4 Voltage derating curve.
– – – BSR13; R ——— BSR14; R.

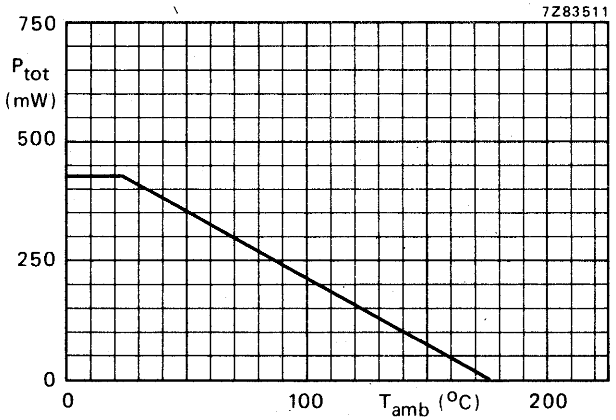


Fig. 5 Power derating curve.

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.

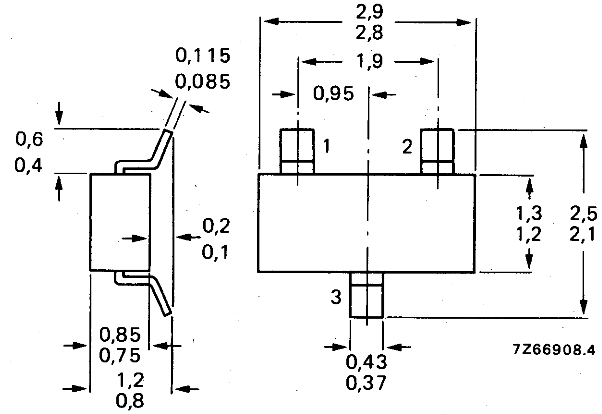
QUICK REFERENCE DATA

			BSR15; R	BSR16; R	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	60	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current (d.c.)	$-I_C$	max.	600		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	425		mW
Junction temperature	T_j	max.	175		°C
D.C. current gain $-I_C$ = 500 mA; $-V_{CE}$ = 10 V	h_{FE}	>	30	50	
Turn-off switching time $-I_{Con}$ = 150 mA; $-I_{Bon}$ = I_{Boff} = 15 mA	t_{off}	>	100		ns
Transition frequency at f = 100 MHz $-I_C$ = 50 mA; $-V_{CE}$ = 20 V	f_T	>	200		MHz

MECHANICAL DATA

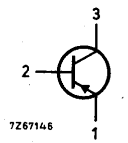
Dimensions in mm

Fig. 1 SOT-23.

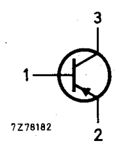


Marking code

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 °C**	P_{tot}	max.	425		mW
→ Storage temperature	T_{stg}		−65 to + 175		°C
→ Junction temperature	T_j	max.	175		°C

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BSR15; R	BSR16; R	
Collector cut-off current					
$I_E = 0$; $-V_{CB} = 50$ V	$-I_{CBO}$	<	20	10	nA
$I_E = 0$; $-V_{CB} = 50$ V; $T_j = 150$ °C	$-I_{CBO}$	<	20	10	µA
$-V_{EB} = 0,5$ V; $-V_{CE} = 30$ V	$-I_{CEX}$	<	50		nA
Base current with reverse biased emitter junction					
$-V_{EB} = 3$ V; $-V_{CE} = 30$ V	$-I_{BEX}$	<	50		nA
Saturation voltages ▲					
$-I_C = 150$ mA; $-I_B = 15$ mA	$-V_{CEsat}$	<	0,4		V
	$-V_{BEsat}$	<	1,3		V
$-I_C = 500$ mA; $-I_B = 50$ 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 $t_p \leqslant 300$ µs; duty factor $\delta \leqslant 0,02$.

			BSR15; R	BSR16; R	
D.C. current gain *					
$-I_C$ = 0,1 mA; $-V_{CE}$ = 10 V	h_{FE}	>	35	75	
$-I_C$ = 1 mA; $-V_{CE}$ = 10 V	h_{FE}	>	50	100	
$-I_C$ = 10 mA; $-V_{CE}$ = 10 V	h_{FE}	>	75	100	
$-I_C$ = 150 mA; $-V_{CE}$ = 10 V	h_{FE}		100 to 300		
$-I_C$ = 500 mA; $-V_{CE}$ = 10 V	h_{FE}	>	30	50	
Transition frequency at f = 100 MHz					
$-I_C$ = 50 mA; $-V_{CE}$ = 20 V; T_{amb} = 25 °C	f_T	>	200		MHz
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $-V_{CB}$ = 10 V	C_c	<	8		pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c = 0$; $-V_{EB}$ = 2 V	C_e	<	30		pF
Switching times (between 10% and 90% levels)					
Turn-on time when switched to					
$-I_C$ = 150 mA; $-I_B$ = 15 mA; (see Fig. 3)					
delay time	t_d	<	10		ns
rise time	t_r	<	40		ns
turn-on time ($t_d + t_r$)	t_{on}	<	45		ns
Turn-off time when switched from					
$-I_C$ = 150 mA; $-I_B$ = 15 mA					
to cut-off with + I_{BM} = 15 mA (see Fig. 4)					
storage time	t_s	<	80		ns
fall time	t_f	<	30		ns
turn-off time ($t_s + t_f$)	t_{off}	<	100		ns

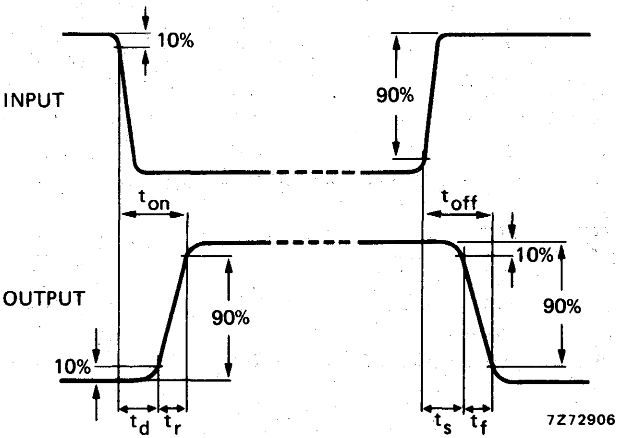


Fig. 2 Switching time waveforms.

* Measured under pulsed conditions to avoid excessive dissipation; pulse duration $t_p \leq 300\ \mu s$; duty factor $\delta \leq 0{,}02$.

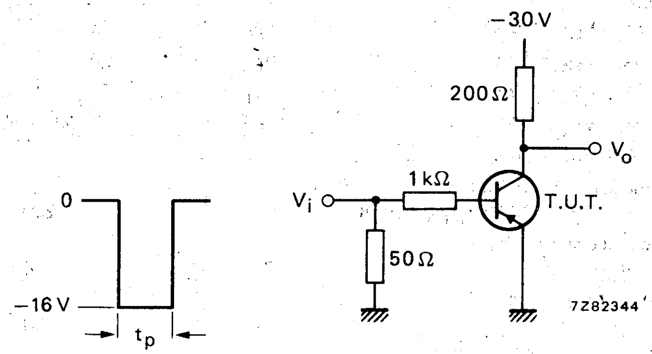


Fig. 3 Turn-on switching time test circuit.

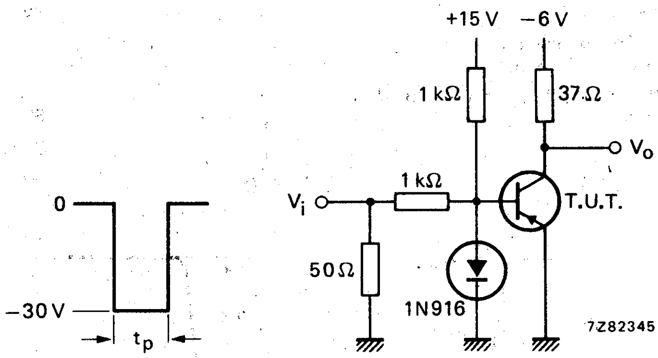


Fig. 4 Turn-off switching time test circuit.

Input pulse generator: Fig. 3 and Fig. 4	frequency	f	=	150	Hz
	pulse duration	t_p	=	200	ns
	rise time	t_r	⩽	2	ns
	output impedance	Z_o	=	50	Ω
Output oscilloscope: Fig. 3 and Fig. 4	rise time	t_r	⩽	5	ns
	input impedance	Z_i	=	10	MΩ

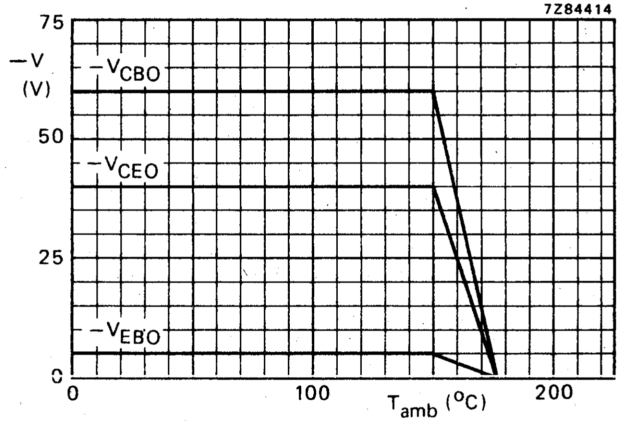


Fig. 5 Voltage derating curves BSR15; R.

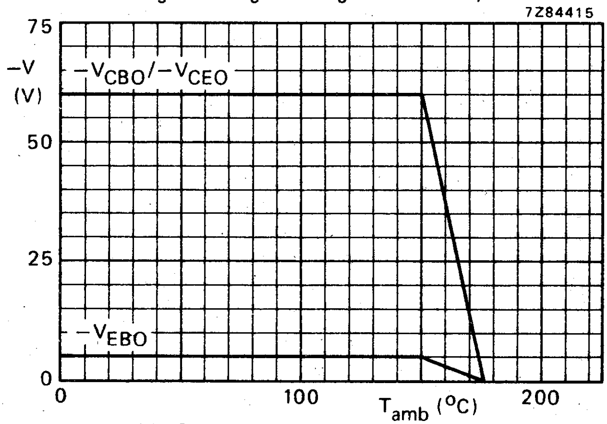


Fig. 6 Voltage derating curves BSR16; R.

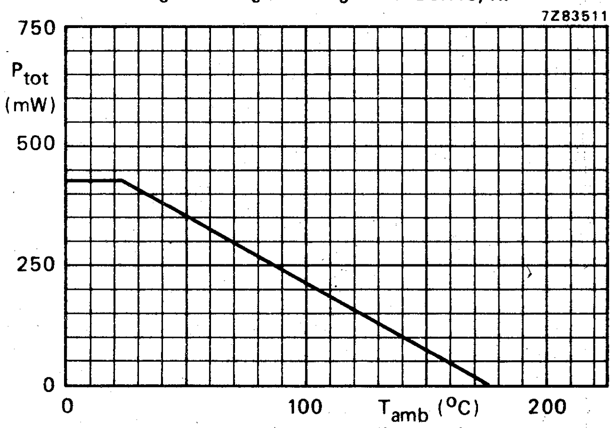


Fig. 7 Power derating curve BSR15; R/BSR16; R.

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.

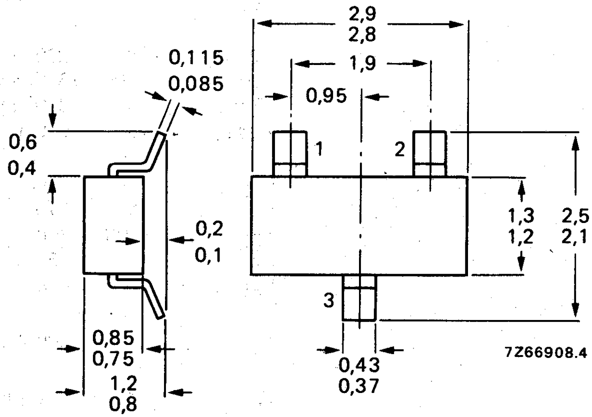
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	V
Collector current (d.c.)	I_C	max.	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	350	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain				
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	>	60	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	>	15	
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 20 V	f_T	>	300	MHz

MECHANICAL DATA

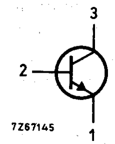
Dimensions in mm

Fig. 1 SOT-23.



Marking code

BSR17 = U9



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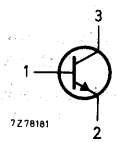


See also Soldering recommendations.

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 °C**	P_{tot}	max.	350	mW
Storage temperature	T_{stg}	–65 to + 175		°C
Junction temperature	T_j	max.	175	°C

THERMAL CHARACTERISTICS*

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

Thermal resistance

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

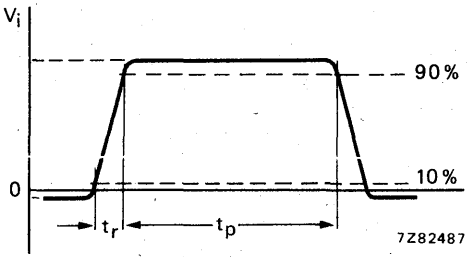
Collector cut-off current				
$I_E = 0$; $V_{CB} = 30$ V; $T_j = 150$ °C	I_{CBO}	<	5	µA
$V_{EB} = 3$ V; $V_{CE} = 30$ V	I_{CEX}	<	50	nA
Base current with reverse biased emitter junction				
$V_{EB} = 3$ V; $V_{CE} = 30$ V	I_{BEX}	<	50	nA
Saturation voltages▲				
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	<	200	mV
	V_{BEsat}	650 to 850		mV
$I_C = 50$ mA; $I_B = 5$ mA	V_{CEsat}	<	300	mV
	V_{BEsat}	<	950	mV
D.C. current gain▲				
$I_C = 0,1$ mA; $V_{CE} = 1$ V	h_{FE}	>	40	
$I_C = 1$ mA; $V_{CE} = 1$ V	h_{FE}	>	70	
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	100 to 300		
$I_C = 50$ mA; $V_{CE} = 1$ V	h_{FE}	>	60	
$I_C = 100$ mA; $V_{CE} = 1$ V	h_{FE}	>	15	
Transition frequency at f = 100 MHz				
$I_C = 10$ mA; $V_{CE} = 20$ V	f_T	>	300	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	4	pF

▲ Measured under pulsed conditions; pulse duration $t_p \leq 300$ µs; 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	t_d	<	35 ns
rise time	t_r	<	35 ns



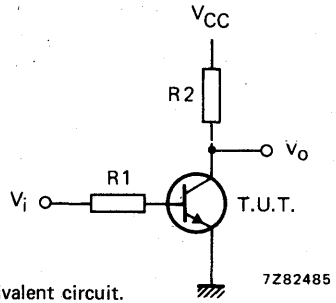
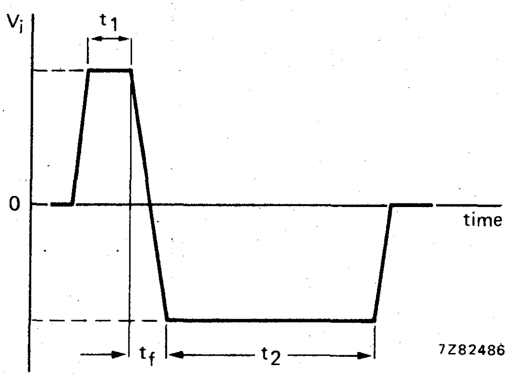


Fig. 2 Delay and rise time equivalent circuit.
$V_i = -0{,}5$ to $+ 10{,}6$ V; $V_{CC} = 3$ V; R1 = 10 kΩ; R2 = 275 Ω;
total shunt capacitance of test jig and connectors = $C_s \leqslant 4$ pF.
Pulse generator: pulse duration 300 ns; fall time < 1 ns; duty factor 2%.

Turn off time switched from
$I_C = 10$ mA; $I_{Bon} = -I_{Boff} = 1$ mA

storage time	t_s	<	200 ns
fall time	t_f	<	50 ns



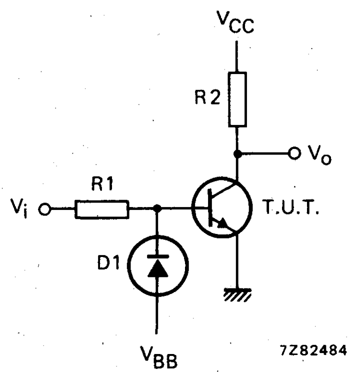


Fig. 3 Storage and fall time equivalent test circuit.
$V_i = -9{,}1$ to $+ 10{,}9$ V; $V_{CC} = 3$ V; $V_{BB} = 0$ V (ground); R1 = 10 kΩ; R2 = 275 Ω;
total shunt capacitance of test jig and connectors = $C_s \leqslant 4$ pF.
Pulse generator: pulse duration $t_1 = 10$ to 500 μs; fall time $t_f < 1$ ns; duty factor δ = 2%.

h parameters (common emitter)

I_C = 1 mA; V_{CE} = 10 V; f = 1 kHz

input impedance	h_{ie}	1 to 10 kΩ
reverse voltage transfer ratio	h_{re}	0,5 to 8 10^{-4}
small signal current gain	h_{fe}	100 to 400
output admittance	h_{oe}	1 to 40 μA/V

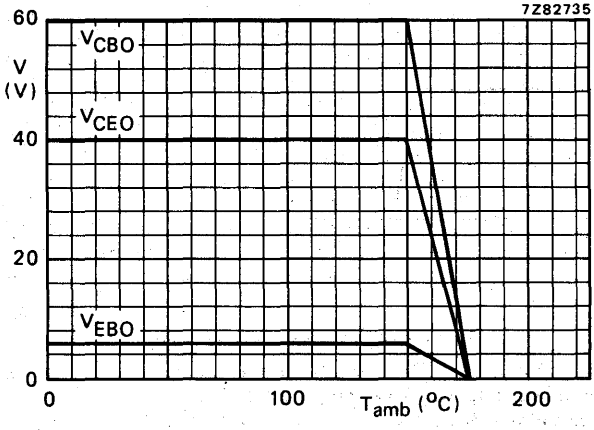


Fig. 4 Voltage derating curves.

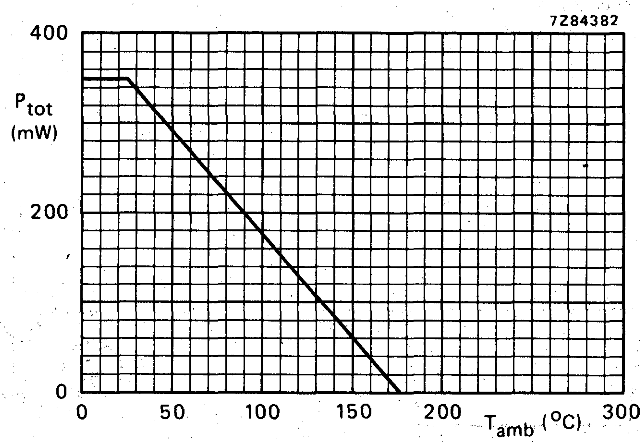


Fig. 5 Power derating curve.

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.

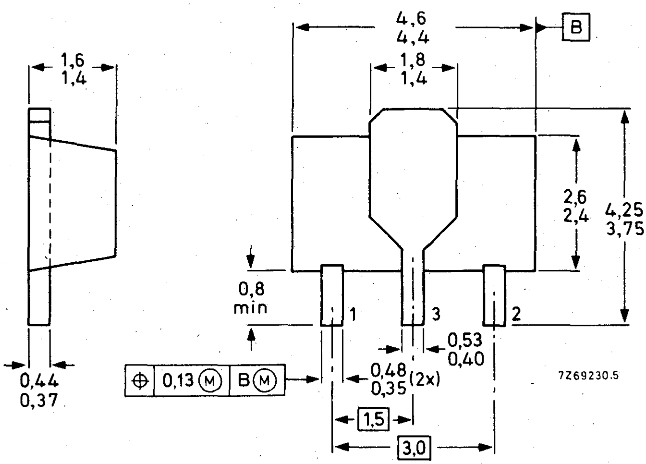
QUICK REFERENCE DATA

			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 °C	P_{tot}	max.	1	1	1	1	W
Junction temperature	T_j	max.	150	150	150	150	°C
D.C. current gain $-I_C$ = 100 mA; $-V_{CE}$ = 5 V	h_{FE}	>	40	100	40	100	
		<	120	300	120	300	
Transition frequency at f = 35 MHz $-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	>	100	100	100	100	MHz

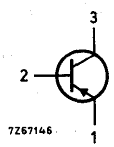
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-89.



Mark
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 °C mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	P_{tot}	max.	1	W
Temperatures				
Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to collector tab	$R_{th\ j\text{-}tab}$	=	10	°C/W
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	$R_{th\ j\text{-}a}$	=	125	°C/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			BSR30	BSR31	BSR32	BSR33	
Collector cut-off current							
$I_E = 0; -V_{CB} = 60$ V	$-I_{CBO}$	<	100				nA
$I_E = 0; -V_{CB} = 60$ V; $T_j = 150$ °C	$-I_{CBO}$	<	50				µA
Breakdown voltages			BSR30	BSR31	BSR32	BSR33	
$I_B = 0; -I_C = 10$ mA	$-V_{(BR)CEO}$	>	60	60	80	80	V
$V_{BE} = 0; -I_C = 10$ µA	$-V_{(BR)CES}$	>	70	70	90	90	V
$I_C = 0; -I_E = 10$ µA	$-V_{(BR)EBO}$	>	5	5	5	5	V
Saturation voltages *							
$-I_C = 150$ mA; $-I_B = 15$ mA	$-V_{CEsat}$	<	0,25	0,25	0,25	0,25	V
	$-V_{BEsat}$	<	1,0	1,0	1,0	1,0	V
$-I_C = 500$ mA; $-I_B = 50$ 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 *							
$-I_C = 100$ µA; $V_{CE} = 5$ V	h_{FE}	>	10	30	10	30	
$-I_C = 100$ mA; $V_{CE} = 5$ V	h_{FE}	>	40	100	40	100	
		<	120	300	120	300	
$-I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	30	50	30	50	
Transition frequency at f = 35 MHz							
$-I_C = 50$ mA; $-V_{CE} = 10$ V	f_T	>	100				MHz
Collector capacitance at f = 1 MHz							
$I_E = I_e = 0; -V_{CB} = 10$ V	C_c	<	20				pF
Emitter capacitance at f = 1 MHz							
$I_C = I_c = 0; -V_{EB} = 0,5$ V	C_e	<	120				pF

Switching times see page 4

* Measured under pulse conditions: $t_p = 300$ µs; $\delta < 0,01$.

CHARACTERISTICS (continued)

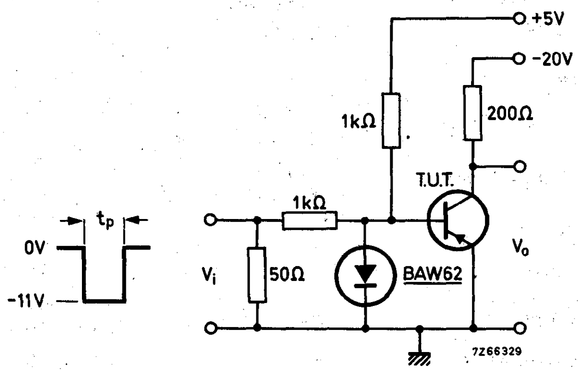
$T_{amb} = 25\ ^oC$

Switching times

$-I_{Con} = 100$ mA; $-I_{Bon} = +I_{Boff} = 5$ mA

Turn-on time	t_{on}	<	500	ns
Turn-off time	t_{off}	<	650	ns

Test circuit



Pulse generator:

Pulse duration	$t_p = 10\ \mu s$
Rise time	$t_r \leqslant 15$ ns
Fall time	$t_f \leqslant 15$ ns
Source impedance	$Z_S = 50\ \Omega$

Oscilloscope:

Rise time	$t_r \leqslant 15$ ns
Input impedance	$Z_I \geqslant 100\ k\Omega$

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.

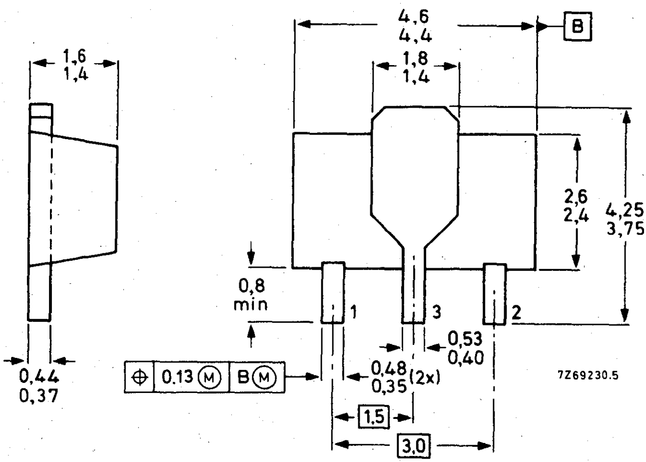
QUICK REFERENCE DATA

			BSR40	BSR41	BSR42	BSR43	
Collector-base voltage (open emitter)	V_{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 °C	P_{tot}	max.	1	1	1	1	W
Junction temperature	T_j	max.	150	150	150	150	°C
D.C. current gain I_C = 100 mA; V_{CE} = 5 V	h_{FE}	> <	40 120	100 300	40 120	100 300	
Transition frequency at f = 35 MHz I_C = 50 mA; V_{CE} = 10 V	f_T	>	100	100	100	100	MHz

MECHANICAL DATA

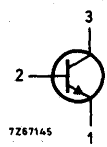
Dimensions in mm

Fig. 1 SOT-89.



Mark

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 °C mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	P_{tot}	max.	1	W

Temperatures

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

THERMAL RESISTANCE

From junction to collector tab	$R_{th\ j\text{-}tab}$	=	10	°C/W
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 m	$R_{th\ j\text{-}a}$	=	125	°C/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current								
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<		100			nA
$I_E = 0$; $V_{CB} = 60$ V; $T_j = 150$ °C	I_{CBO}	<		50			μA
Breakdown voltages			BSR40	BSR41	BSR42	BSR43	
$I_B = 0$; $I_C = 10$ mA	$V_{(BR)CEO}$	>	60	60	80	80	V
$V_{BE} = 0$; $I_C = 10$ μA	$V_{(BR)CES}$	>	70	70	90	90	V
$I_C = 0$; $I_E = 10$ μA	$V_{(BR)EBO}$	>	5	5	5	5	V
Saturation voltages *							
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0,25	0,25	0,25	0,25	V
	V_{BEsat}	<	1,0	1,0	1,0	1,0	V
$I_C = 500$ mA; $I_B = 50$ 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 *							
$I_C = 100$ μA; $V_{CE} = 5$ V	h_{FE}	>	10	30	10	30	
$I_C = 100$ mA; $V_{CE} = 5$ V	h_{FE}	>	40	100	40	100	
		<	120	300	120	300	
$I_C = 500$ mA; $V_{CE} = 5$ V	h_{FE}	>	30	50	30	50	
Transition frequency at f = 35 MHz							
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>		100			MHz
Collector capacitance at f = 1 MHz							
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<		12			pF
Emitter capacitance at f = 1 MHz							
$I_C = I_c = 0$; $V_{EB} = 0{,}5$ V	C_e	<		90			pF

Switching times see page 4

* Measured under pulse conditions: $t_p = 300$ μs; $\delta < 0{,}01$.

CHARACTERISTICS (continued)

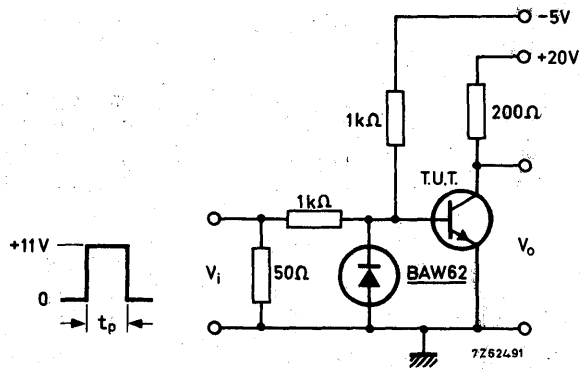
T_{amb} = 25 °C

Switching times

I_{Con} = 100 mA; $I_{Bon} = -I_{Boff}$ = 5 mA

Turn-on time	t_{on}	<	250	ns
Turn-off time	t_{off}	<	1000	ns

Test circuit



Pulse generator:

Pulse duration	t_p = 10 μs
Rise time	t_r ⩽ 15 ns
Fall time	t_f ⩽ 15 ns
Source impedance	Z_S = 50 Ω

Oscilloscope:

Rise time	t_r ⩽ 15 ns
Input impedance	Z_I ⩾ 100 kΩ

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.

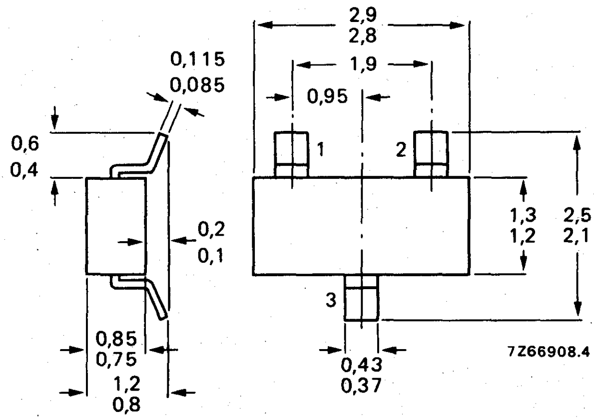
QUICK REFERENCE DATA

			BSR56	BSR57	BSR58	
Drain-source voltage	$\pm V_{DS}$	max.	40	40	40	V
Total power dissipation up to T_{amb} = 65 °C	P_{tot}	max.	250	250	250	mW
Drain current						
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	50	20	8	mA
		<	–	100	80	mA
Gate-source cut-off voltage						
V_{DS} = 15 V; I_D = 0,5 nA	$-V_{(P)GS}$	>	4	2	0,8	V
		<	10	6	4	V
Drain-source resistance (on) at f = 1 kHz						
I_D = 0; V_{GS} = 0	$r_{ds\ on}$	<	25	40	60	Ω
Feedback capacitance at f = 1 MHz						
$-V_{GS}$ = 10 V; V_{DS} = 0	C_{rs}	<	5	5	5	pF
Turn-off time						
V_{DD} = 10 V; V_{GS} = 0						
I_D = 20 mA; $-V_{GSM}$ = 10 V	t_{off}	<	25	–	–	ns
I_D = 10 mA; $-V_{GSM}$ = 6 V	t_{off}	<	–	50	–	ns
I_D = 5 mA; $-V_{GSM}$ = 4 V	t_{off}	<	–	–	100	ns

MECHANICAL DATA

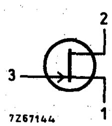
Dimensions in mm

Fig. 1 SOT-23.



Marking code

BSR56 = M4
BSR57 = M5
BSR58 = M6



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 °C	P_{tot}	max.	250 mW
→ Storage temperature	T_{stg}	−55 to + 175 °C	
→ Junction temperature	T_j	max.	175 °C

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60 K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260 K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	120 K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Gate-source cut-off current V_{DS} = 0 V; $-V_{GS}$ = 20 V	$-I_{GSS}$	<	1	nA
Drain cut-off current V_{DS} = 15 V; $-V_{GS}$ = 10 V	I_{DSX}	<	1	nA

			BSR56	BSR57	BSR58	
Drain current ▲ V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	50	20	8	mA
		<	–	100	80	mA
Gate-source breakdown voltage $-I_G$ = 1 μA; V_{DS} = 0	$-V_{(BR)GSS}$	>	40	40	40	V
Gate-source cut-off voltage I_D = 0,5 nA; V_{DS} = 15 V	$-V_{(P)GS}$	>	4	2	0,8	V
		<	10	6	4	V
Drain-source voltage (on) I_D = 20 mA; V_{GS} = 0	V_{DSon}	<	750	–	–	mV
I_D = 10 mA; V_{GS} = 0	V_{DSon}	<	–	500	–	mV
I_D = 5 mA; V_{GS} = 0	V_{DSon}	<	–	–	400	mV
Drain-source resistance (on) at f = 1 kHz I_D = 0; V_{GS} = 0	$r_{ds\,on}$	<	25	40	60	Ω

* See *Thermal characteristics* in chapter GENERAL.
** Mounted on a ceramic substrate of 7 mm x 5 mm x 0,6 mm.
▲ Measured under pulsed conditions; t_p = 100 ms; $\delta \leqslant 0{,}1$.

			BSR56	BSR57	BSR58	
Switching times*						
V_{DD} = 10 V; V_{GS} = 0						
Conditions I_D and $-V_{GSM}$	I_D	=	20	10	5	mA
	$-V_{GSM}$	=	10	6	4	V
Delay time	t_d	<	6	6	10	ns
Rise time	t_r	<	3	4	10	ns
Turn-off time	t_{off}	<	25	50	100	ns

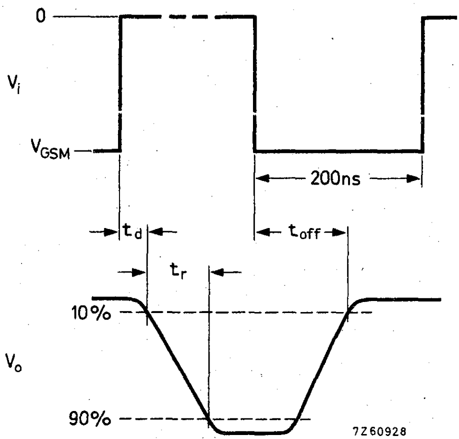


Fig. 2 Switching times waveforms.

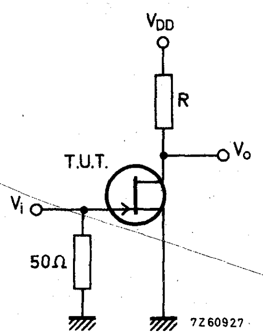


Fig. 3 Test circuit.

BSR56; R = 464 Ω
BSR57; R = 953 Ω
BSR58; R = 1910 Ω

Pulse generator

$t_r = t_f \leqslant 1$ ns
δ = 0,02
Z_o = 50 Ω

Oscilloscope

$t_r \leqslant 0{,}75$ ns
$R_i \geqslant$ 1 MΩ
$C_i \leqslant$ 2,5 pF

* Switching times measured on devices in SOT-18 envelope.

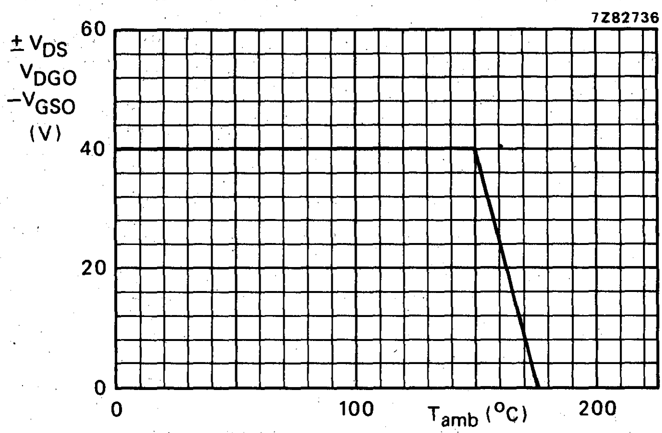


Fig. 4 Voltage derating curve.

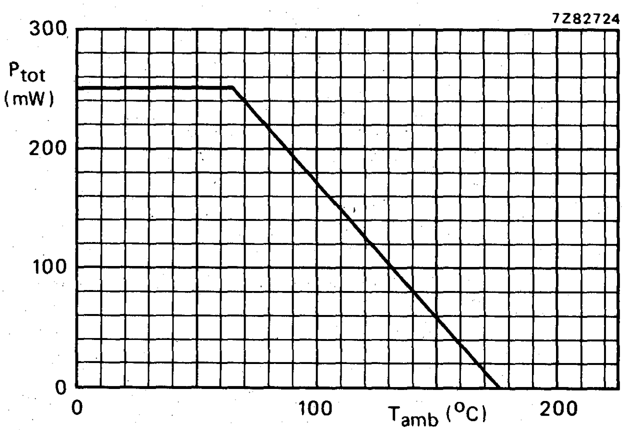


Fig. 5 Power derating curve.

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.

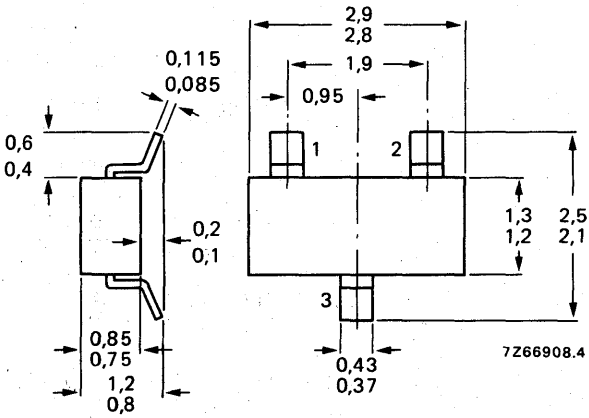
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	350	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C $-I_C$ = 25 mA; $-V_{CE}$ = 5 V	h_{FE}	>	30	
Transition frequency at f = 35 MHz $-I_C$ = 25 mA; $-V_{CE}$ = 5 V	f_T	> typ.	50 85	MHz MHz

MECHANICAL DATA

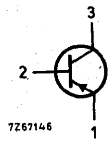
Dimensions in mm

Fig. 1 SOT-23.

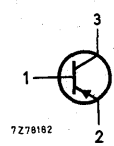


Marking code

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 $-I_C = 10\ \mu A$	$-V_{CBO}$	max.	110 V
Collector-emitter voltage (open base) see Fig. 6 $-I_C = 100\ \mu A$	$-V_{CEO}$	max.	100 V
Emitter-base voltage (open collector) see Fig. 6 $-I_E = 10\ \mu A$	$-V_{EBO}$	max.	6 V
Collector current (d.c.)	$-I_C$	max.	100 mA
Collector current (peak value)	$-I_{CM}$	max.	100 mA
Base current (peak value)	$-I_{BM}$	max.	100 mA
→ Total power dissipation up to $T_{amb} = 25\ ^oC$ **	P_{tot}	max.	350 mW
→ Storage temperature	T_{stg}	−65 to + 175	^oC
→ Junction temperature	T_j	max.	175 ^oC

→ THERMAL CHARACTERISTICS *

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

Thermal resistance

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

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current $I_E = 0; -V_{CB} = 90$ V	$-I_{CBO}$	<	100 nA
$I_E = 0; -V_{CB} = 90$ V; $T_j = 150\ ^oC$	$-I_{CBO}$	<	50 μA
Emitter cut-off current $I_C = 0; -V_{EB} = 6$ V	$-I_{EBO}$	<	200 nA
Saturation voltage $-I_C = 25$ mA; $-I_B = 2{,}5$ mA	$-V_{CEsat}$	<	250 mV
	$-V_{BEsat}$	<	900 mV
D.C. current gain $-I_C = 10$ mA; $-V_{CE} = 1$ V	h_{FE}	>	30
$-I_C = 25$ mA; $-V_{CE} = 1$ V	h_{FE}	>	30
Collector capacitance at f = 1 MHz $I_E = I_e = 0; -V_{CB} = 10$ V	C_c	typ.	3 pF
Transition frequency at f = 35 MHz $-I_C = 25$ mA; $-V_{CE} = 5$ V	f_T	>	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.

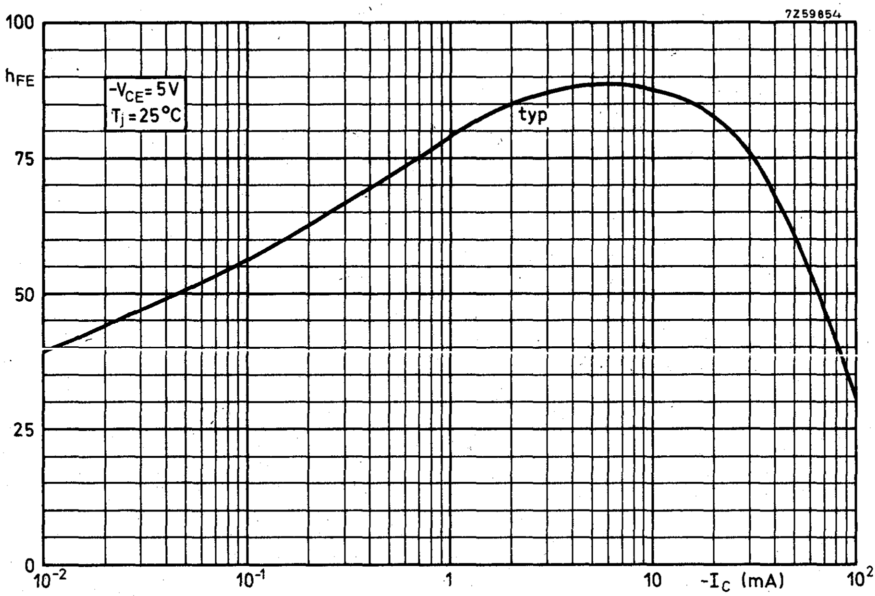

7Z59854
100
h_{FE}
75
50
25
0
$-V_{CE} = 5 V$
$T_j = 25 °C$
typ
10^{-2}
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 2.

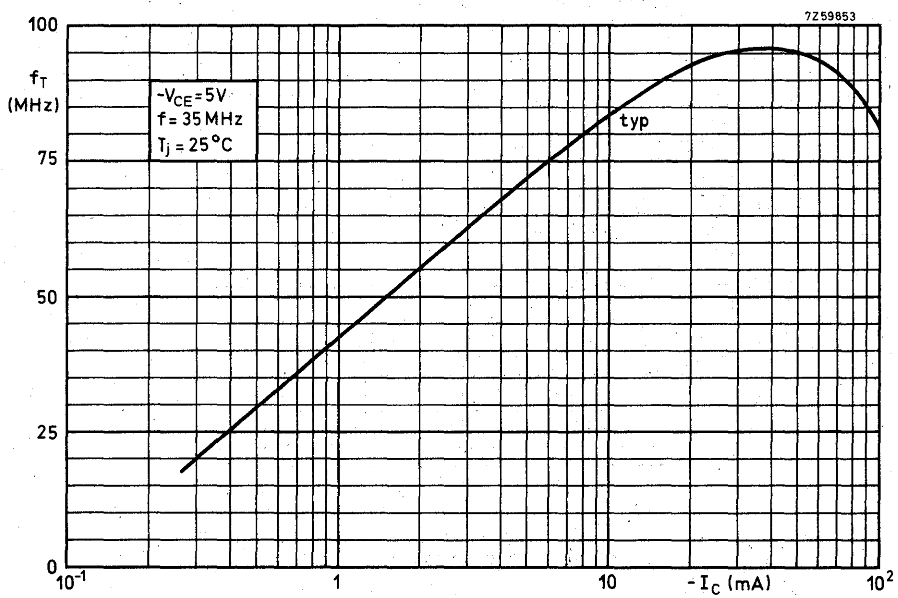

7Z59853
100
f_T
(MHz)
75
50
25
0
$-V_{CE} = 5 V$
f = 35 MHz
$T_j = 25 °C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 3.

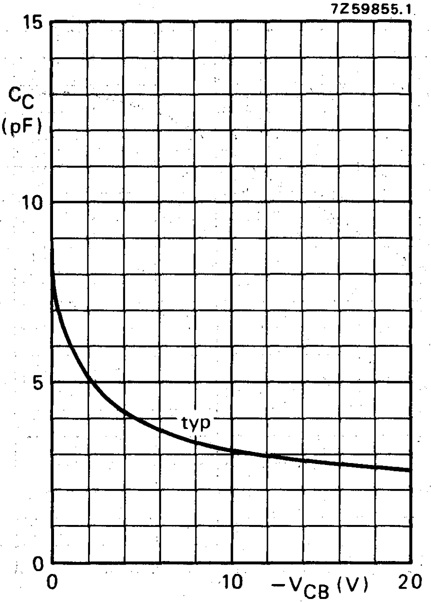


Fig. 4 Typical values collector capacitance as a function of collector-base voltage.
$I_E = I_e = 0$; $T_j = 25\ ^oC$; f = 1 MHz.

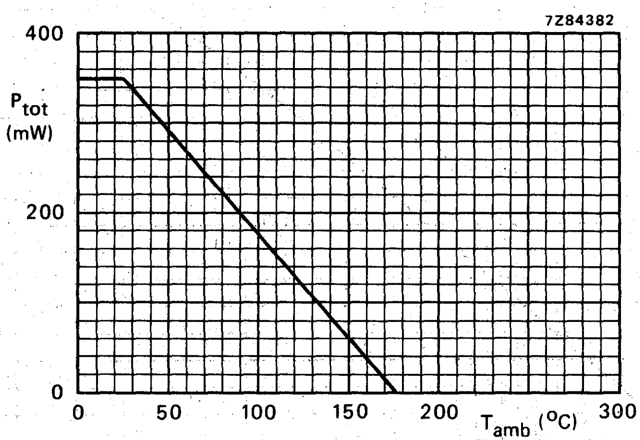


Fig. 5 Power derating curve.

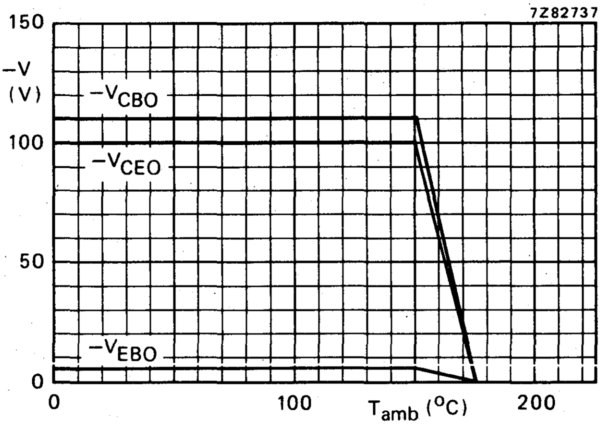


Fig. 6 Voltage derating curves.

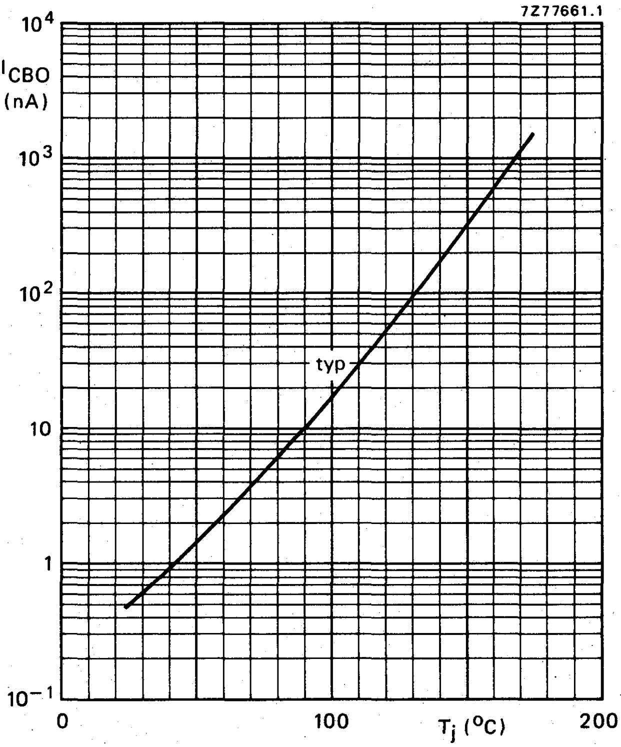


Fig. 7 Typical values collector-base currents as a function of the junction temperature at a collector-base voltage of 90 V.

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.

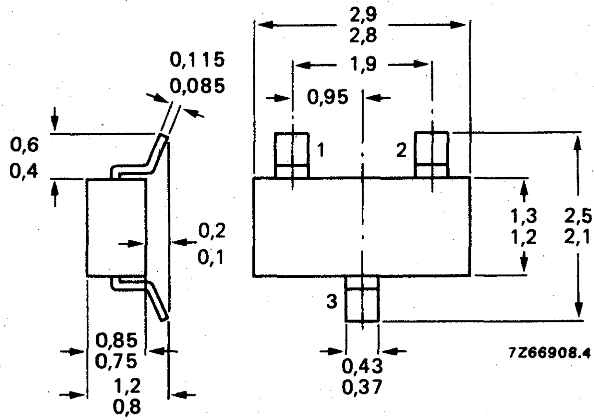
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	350	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain I_C = 10 mA; V_{CE} = 1 V; T_j = 25 °C	h_{FE}	$>$ typ.	20 80	
Transition frequency at f = 35 MHz I_C = 4 mA; V_{CE} = 10 V	f_T	$>$	60	MHz
Turn-off time I_C = 15 mA; I_{Bon} = $-I_{Boff}$ = 1 mA	t_{off}	$<$	1	μs

MECHANICAL DATA

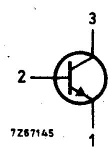
Dimensions in mm

Fig. 1 SOT-23.

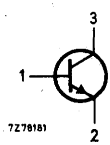


Marking code

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}	max.	120 V
Collector-emitter voltage (open base) see Fig. 2			
$I_C = 4$ mA	V_{CEO}	max.	80 V
Emitter-base voltage (open collector) see Fig. 2			
$I_E = 100\ \mu A$	V_{EBO}	max.	5 V
Collector current			
(d.c. or averaged over any 20 ms period)	I_C	max.	100 mA
Collector current (peak value)	I_{CM}	max.	250 mA
Base current (peak value)	I_{BM}	max.	100 mA
→ Total power dissipation up to $T_{amb} = 25\ ^oC$ **	P_{tot}	max.	350 mW
→ Storage temperature	T_{stg}	−65 to +175	^oC
→ Junction temperature	T_j	max.	175 ^oC

→ THERMAL CHARACTERISTICS *

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

Thermal resistance

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

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = 90$ V	I_{CBO}	<	100 nA
$I_E = 0$; $V_{CB} = 90$ V; $T_j = 150\ ^oC$	I_{CBO}	<	50 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	typ.	0,5 nA
		<	200 nA
Saturation voltages			
$I_C = 4$ mA; $I_B = 400\ \mu A$	V_{CEsat}	<	150 mV
	V_{BEsat}	<	1200 mV
$I_C = 50$ mA; $I_B = 15$ mA	V_{CEsat}	<	200 mV
D.C. current gain			
$I_C = 1$ mA; $V_{CE} = 1$ V	h_{FE}	typ.	60
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	>	20
		typ.	80
$I_C = 20$ mA; $V_{CE} = 1$ V	h_{FE}	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	> typ.	60 MHz 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 μs

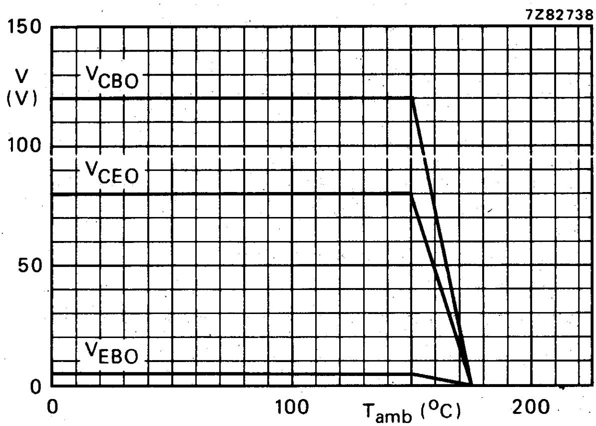


Fig. 2 Voltage derating curves.

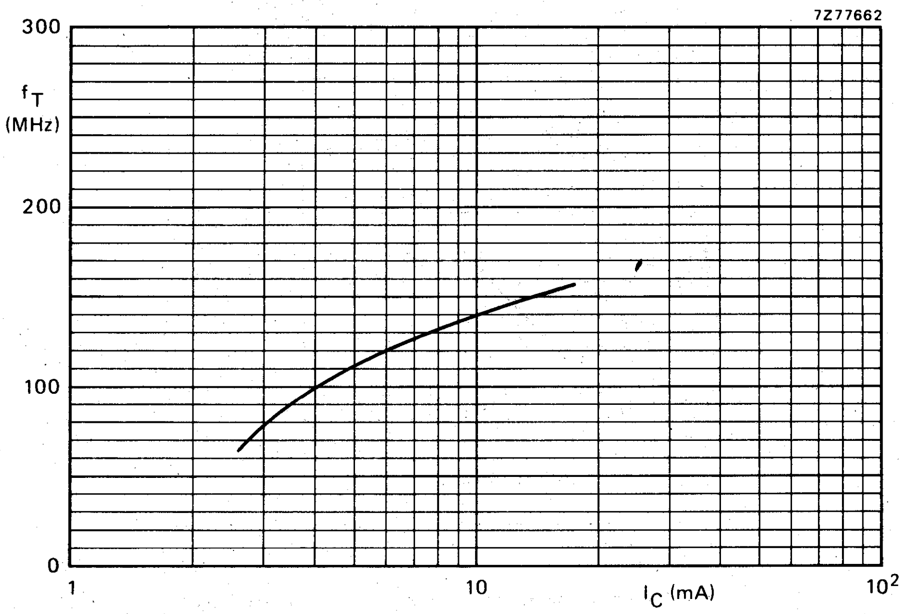


Fig. 3 Typical values transition frequency. V_{CE} = 10 V; f = 35 MHz; T_j = 25 °C.

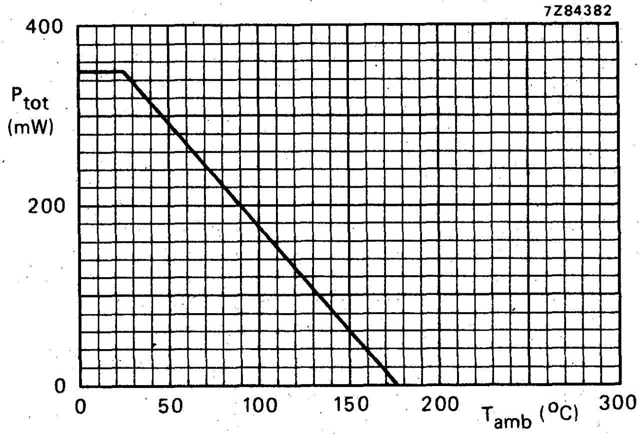


Fig. 4 Power derating curve.

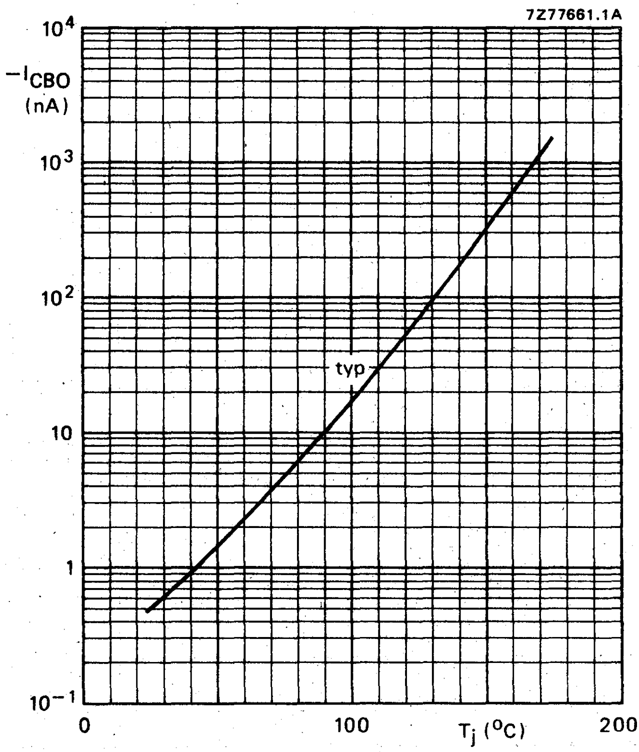


Fig. 5 Typical values collector-base current as a function of the junction temperature at a collector-base voltage of −90 V.

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.

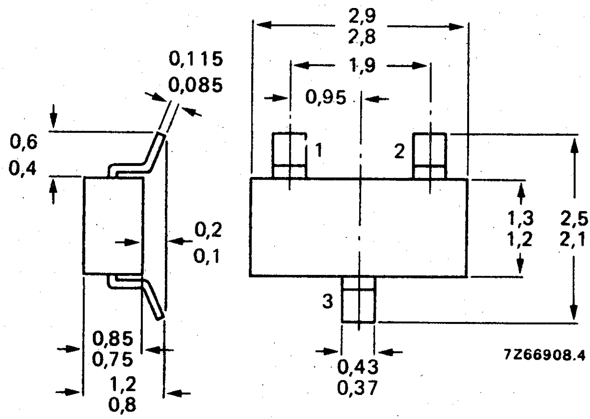
QUICK REFERENCE DATA

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 °C	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain				
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
Storage time				
$I_C = I_B = -I_{BM}$ = 10 mA	t_s	<	13	ns

MECHANICAL DATA

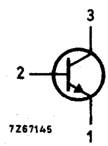
Dimensions in mm

Fig. 1 SOT-23.

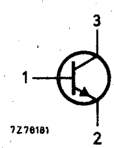


Marking code

BSV52 = B2



BSV52R = B4



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.	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*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	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	μA
Saturation voltages				
I_C = 10 mA; I_B = 300 μA	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 MHz $I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	4 pF
Emitter capacitance at f = 1 MHz $I_C = I_c = 0$; $V_{EB} = 1$ V	C_e	<	4,5 pF
Switching times Storage time $I_C = I_B = -I_{BM} = 10$ mA	t_s	<	13 ns
Turn on time when switched from $-V_{BE} = 1,5$ V to $I_C = 10$ mA; $I_B = 3$ mA	t_{on}	<	12 ns
Turn off time when switched from $I_C = 10$ mA; $I_B = 3$ mA to cut-off with $-I_{BM} = 1,5$ mA	t_{off}	<	18 ns

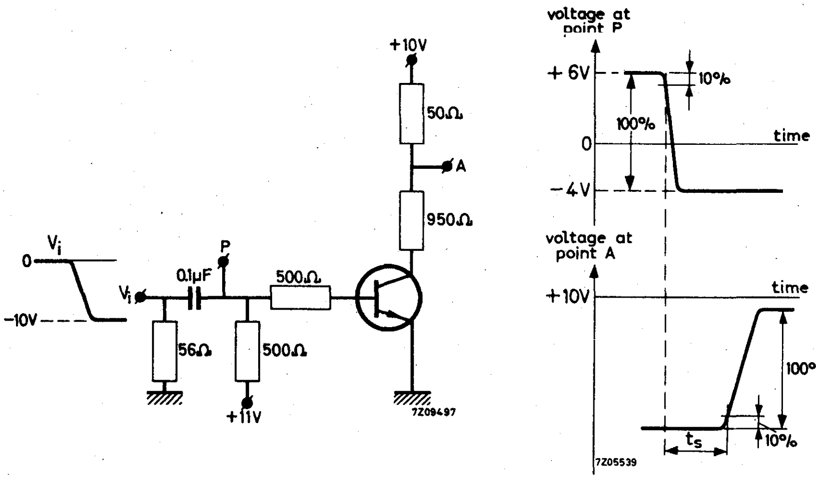


Fig. 2 Test circuit and waveform storage time.

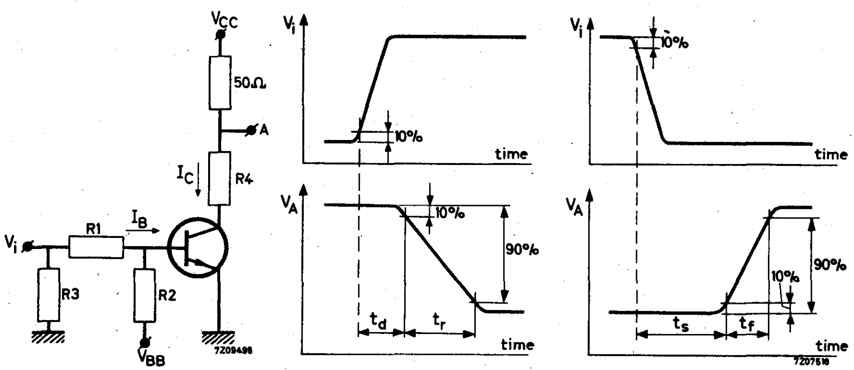


Fig. 3 Test circuit and waveforms turn on and turn off time.

Pulse generator:

Rise time	t_r	<	1 ns
Pulse duration	t	>	300 ns
Duty cycle	δ	<	0,02
Source impedance	R_S	=	50 Ω

Oscilloscope:

Input impedance	R_i	=	50 Ω
Rise time	t_r	<	1 ns

							turn on time			turn off time	
I_C mA	I_B mA	$-I_{BM}$ mA	V_{CC} V	R_1; R_2 kΩ	R_3 Ω	R_4 Ω	$-V_{BB}$ 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.

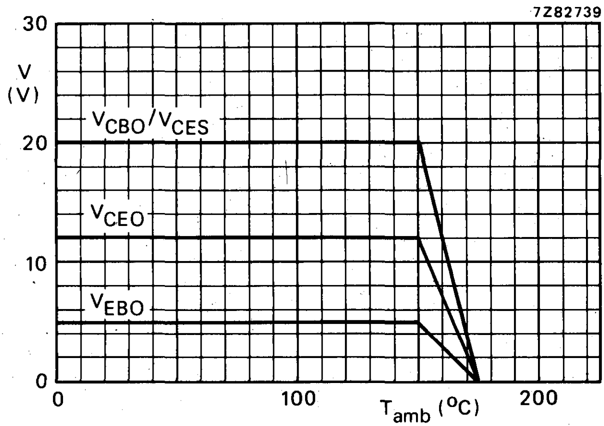


Fig. 4 Voltage derating curves.

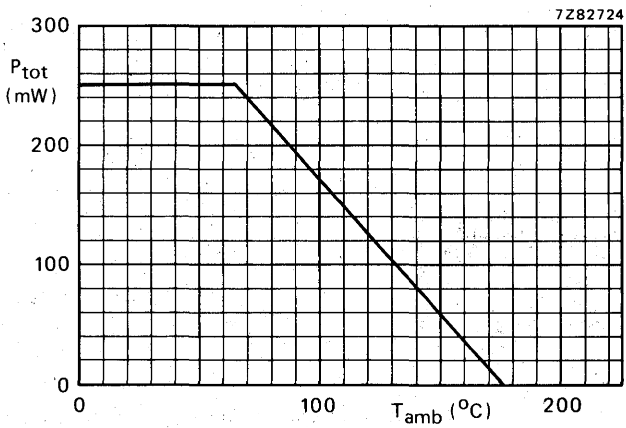
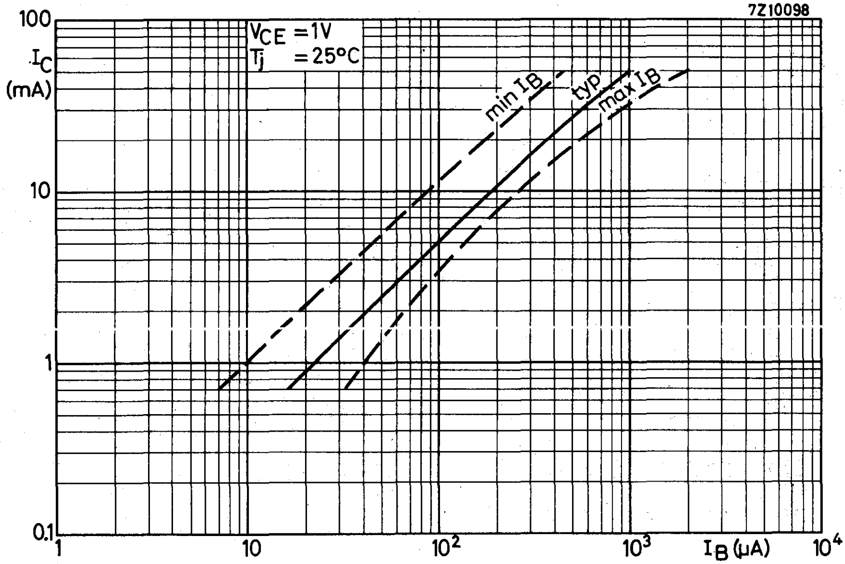
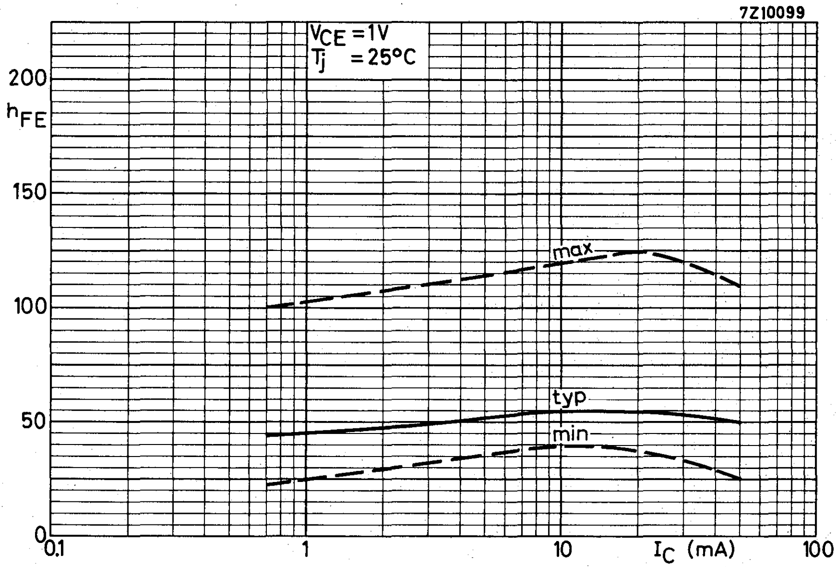
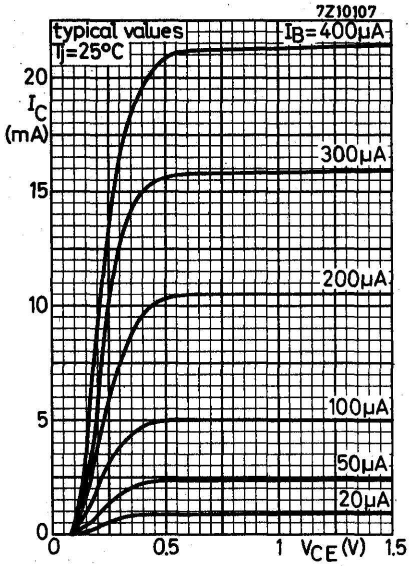
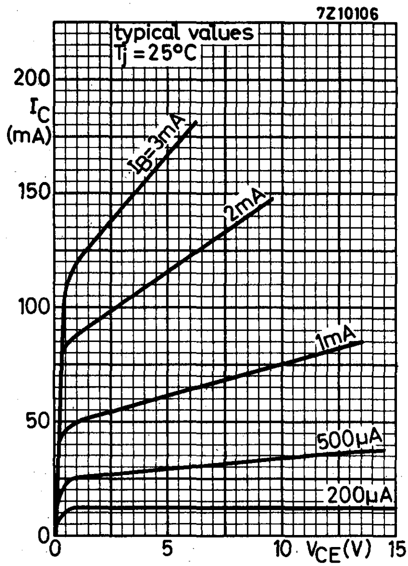


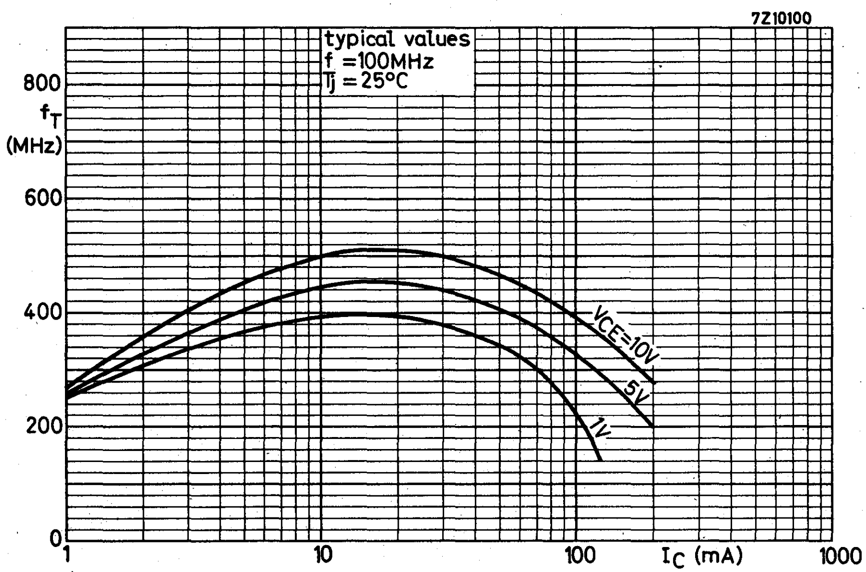
Fig. 5 Power derating curve.

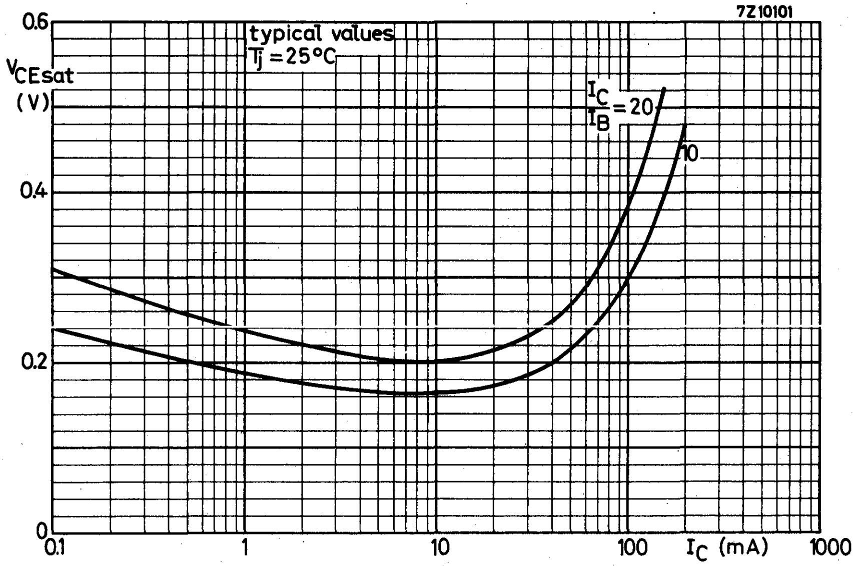

7Z10098
V_{CE} = 1V
T_j = 25°C
I_C (mA)
100
10
1
0.1
1
10
10^2
10^3
10^4
I_B (μA)
min IB
typ
max IB

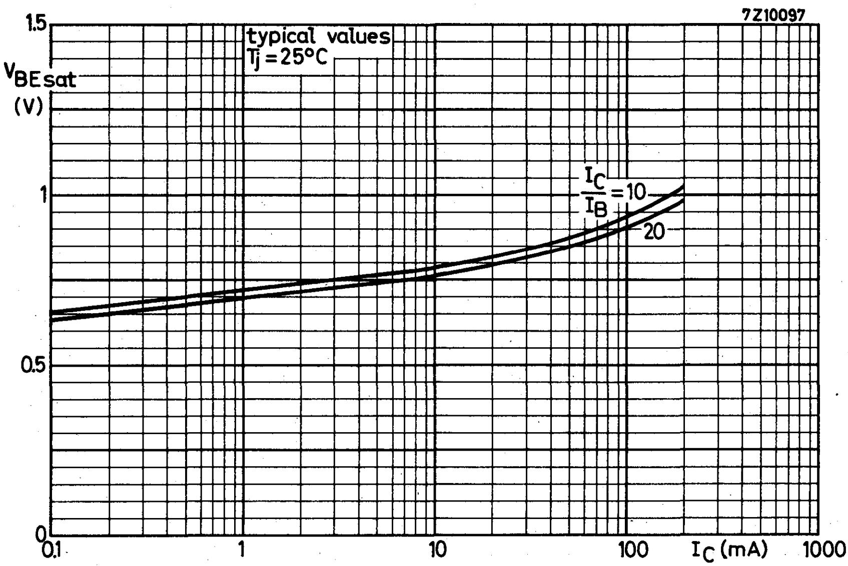

7Z10099
V_{CE} = 1V
T_j = 25°C
h_{FE}
200
150
100
50
0
0.1
1
10
100
I_C (mA)
max
typ
min

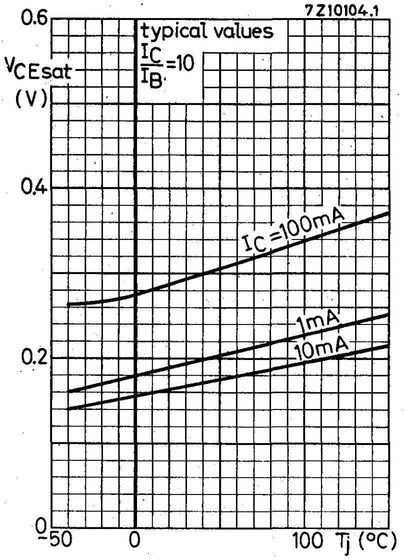

7Z10107
typical values
Tj=25°C
IB=400µA
300µA
200µA
100µA
50µA
20µA
IC (mA)
VCE (V)
0
5
10
15
20
0.5
1
1.5

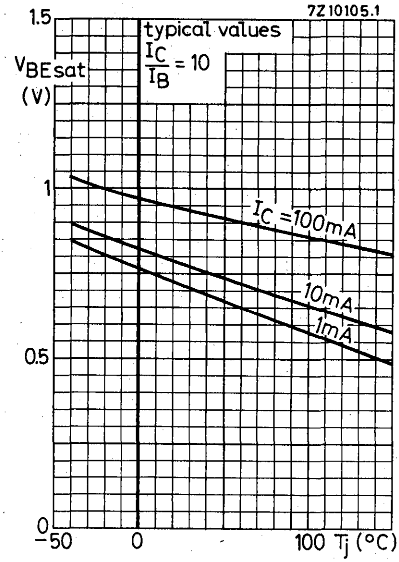

7Z10106
typical values
Tj=25°C
IB=3mA
2mA
1mA
500µA
200µA
IC (mA)
VCE (V)
0
50
100
150
200
5
10
15

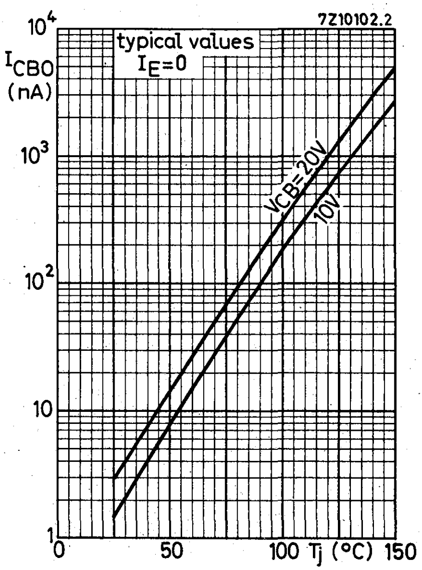

7Z10100
typical values
f =100MHz
Tj = 25°C
fT (MHz)
VCE=10V
5V
1V
IC (mA)
0
200
400
600
800
1
10
100
1000

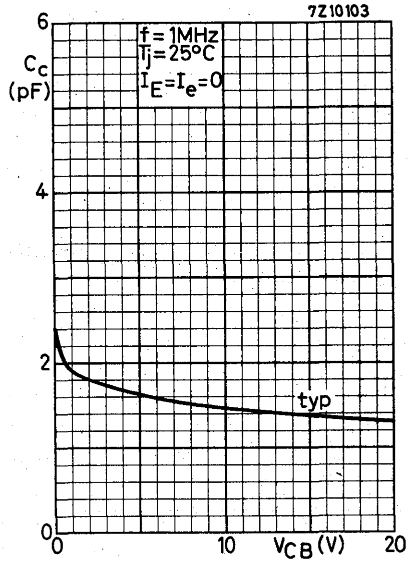

7Z10101
typical values
Tj = 25°C
VCEsat (V)
0.6
0.4
0.2
0
IC/IB = 20
10
0.1
1
10
100
IC (mA)
1000


7Z10097
typical values
Tj = 25°C
VBEsat (V)
1.5
1
0.5
0
IC/IB = 10
20
0.1
1
10
100
IC (mA)
1000


7Z10104.1
0.6
0.4
0.2
0
V_{CEsat}
(V)
typical values
$\frac{I_C}{I_B}=10$
$I_C=100mA$
1mA
10mA
−50
0
100
T_j (°C)


7Z10105.1
1.5
1
0.5
0
V_{BEsat}
(V)
typical values
$\frac{I_C}{I_B}=10$
$I_C=100mA$
10mA
1mA
−50
0
100
T_j (°C)


7Z10102.2
10^4
10^3
10^2
10
1
I_{CBO}
(nA)
typical values
$I_E=0$
$V_{CB}=20V$
10V
0
50
100
T_j (°C)
150


7Z10103
6
4
2
0
C_c
(pF)
f = 1MHz
$T_j=25°C$
$I_E=I_e=0$
typ
0
10
V_{CB} (V)
20

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 ±5% (international standard E24).

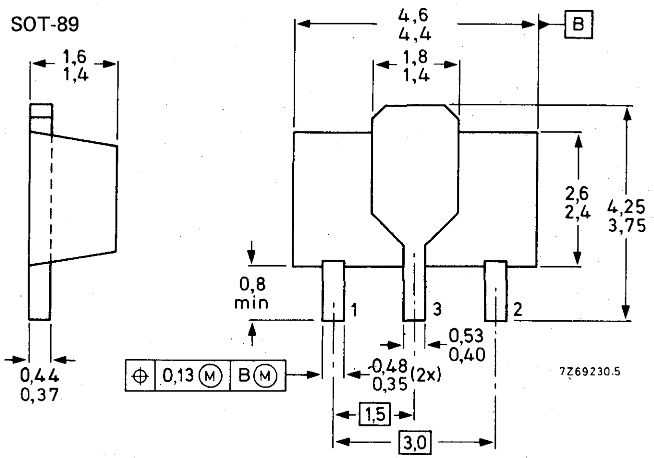
QUICK REFERENCE DATA

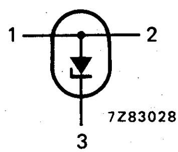
Working voltage range	V_Z	nom.	5,1 to 75	V
Working voltage tolerance (E24)			±5	%
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	1	W
Junction temperature	T_j	max.	150	°C

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-89





Marking code:

BZX78-C5V1 = 5Z1	BZX78-C12 = 12Z	BZX78-C33 = 33Z
C5V6 = 5Z6	C13 = 13Z	C36 = 36Z
C6V2 = 6Z2	C15 = 15Z	C39 = 39Z
C6V8 = 6Z8	C16 = 16Z	C43 = 43Z
C7V5 = 7Z5	C18 = 18Z	C47 = 47Z
C8V2 = 8Z2	C20 = 20Z	C51 = 51Z
C9V1 = 9Z1	C22 = 22Z	C56 = 56Z
C10 = 10Z	C24 = 24Z	C62 = 62Z
C11 = 11Z	C27 = 27Z	C68 = 68Z
	C30 = 30Z	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_{ZRMmax}		
Repetitive peak forward current	I_{FRM}	max.	400	mA
Total power dissipation * up to T_{amb} = 25 °C	P_{tot}	max.	1	W
Repetitive peak reverse power dissipation * up to T_{amb} = 145 °C; t_p = 100 μs; δ = 0,001	P_{ZRM}	max.	7,5	W
Non-repetitive peak reverse power dissipation * T_j = 25 °C prior to surge; t_p = 100 μs (see Fig. 7)	P_{ZSM}	max.	100	W
Storage temperature	T_{stg}	−65 to	+150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE (see also Fig. 6)

From junction to collector tab	$R_{th\,j\text{-}tab}$	=	10	K/W
From junction to ambient in free air *	$R_{th\,j\text{-}a}$	=	125	K/W

CHARACTERISTICS

T_j = 25 °C

Forward voltage at I_F = 0,2 A		V_F	<	1	V
Reverse current					
BZX78-C5V1	V_R = 2 V	I_R	<	10	μA
C5V6	V_R = 2 V	I_R	<	5	μA
C6V2	V_R = 2 V	I_R	<	3	μA
C6V8	V_R = 3 V	I_R	<	1,5	μA
C7V5	V_R = 3 V	I_R	<	0,6	μA
C8V2	V_R = 3 V	I_R	<	0,4	μA
C9V1	V_R = 5 V	I_R	<	0,3	μA
C10 to C75	V_R = 2/3 V_{Znom}	I_R	<	0,2	μA

* Device mounted on a ceramic substrate: area = 2,5 cm^2; thickness = 0,7 mm.

CHARACTERISTICS (continued)

$T_j = 25\ ^oC$

BZX78-.....	Working voltage V_Z (V)		Temperature coefficient S_Z (mV/K)			Differential resistance r_{diff} (Ω)		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

CHARACTERISTICS (continued)

T_j = 25 °C

BZX78-.....	Working voltage V_Z (V) at I_Z = 1 mA			Differential resistance r_{diff} (Ω) at I_Z = 1 mA		Working voltage V_Z (V) at I_Z = 100 mA			Differential resistance r_{diff} (Ω) at I_Z = 100 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 mA			at I_Z = 1 mA		at I_Z = 50 mA			at I_Z = 50 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

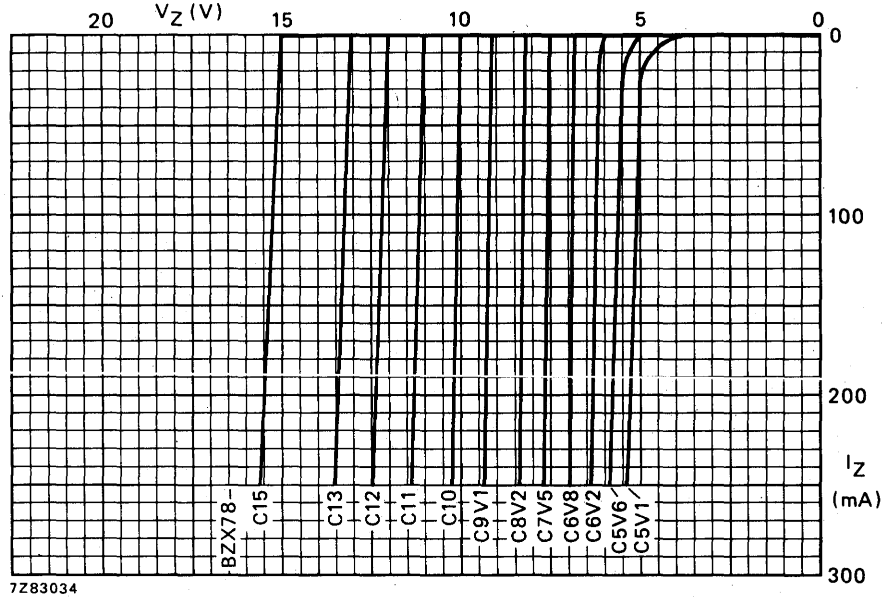


Fig. 2 Dynamic characteristics BZX78-C5V1 to C15; typical values at T_j = 25 °C.

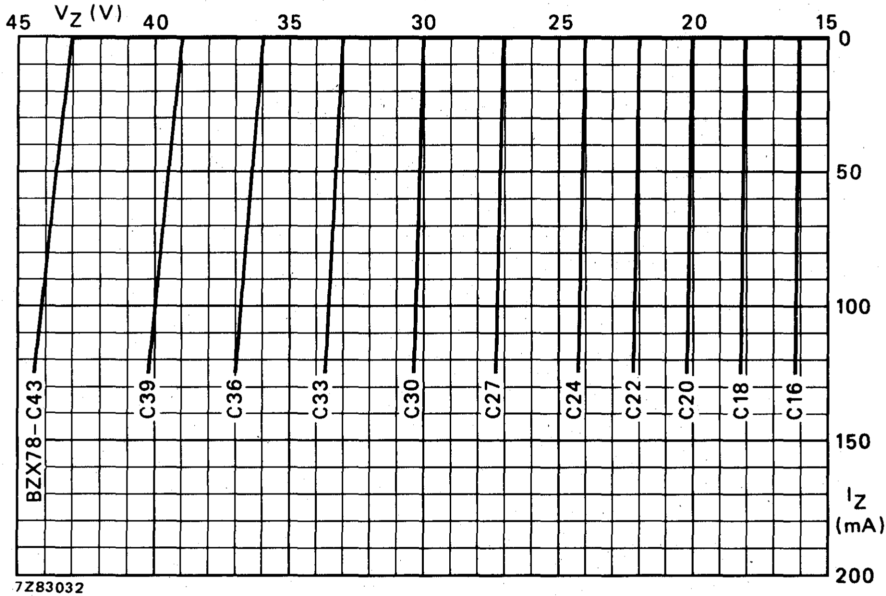


Fig. 3 Dynamic characteristics BZX78-C16 to C43. Typical values at T_j = 25 °C.

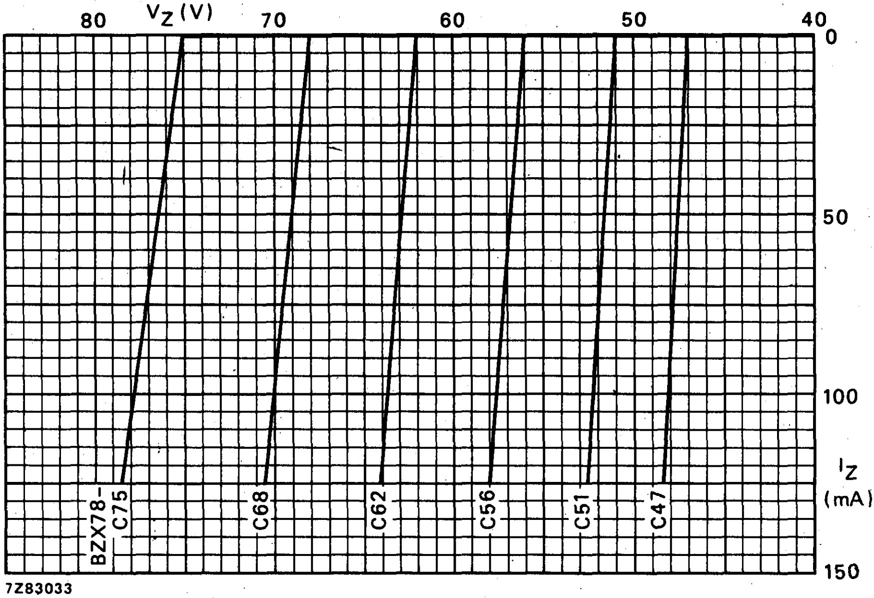


Fig. 4 Dynamic characteristics BZX78-C47 to C75. Typical values at T_j = 25 °C.

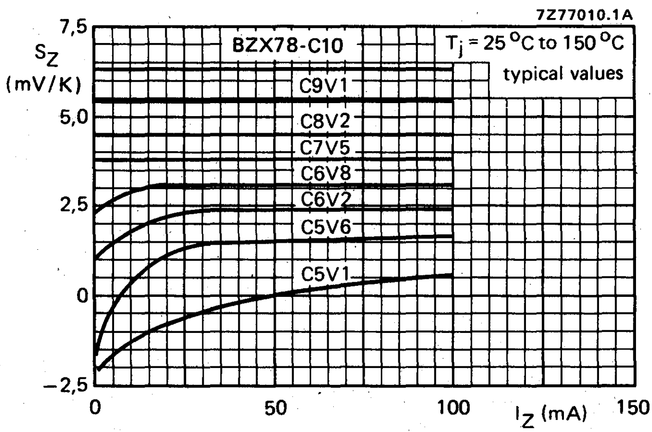


Fig. 5 Temperature coefficient as a function of working current.

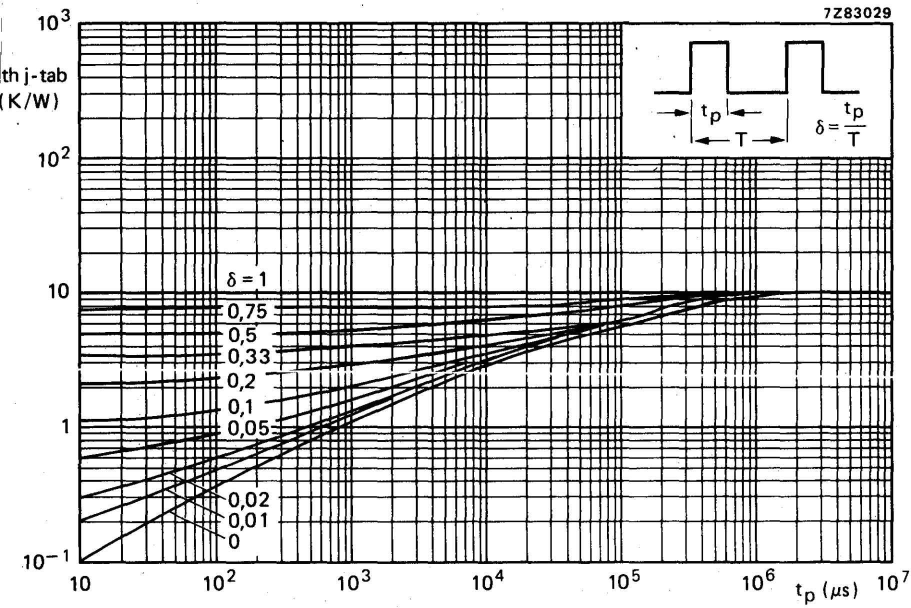


Fig. 6 Pulse power rating chart of BZX78 on a ceramic substrate.

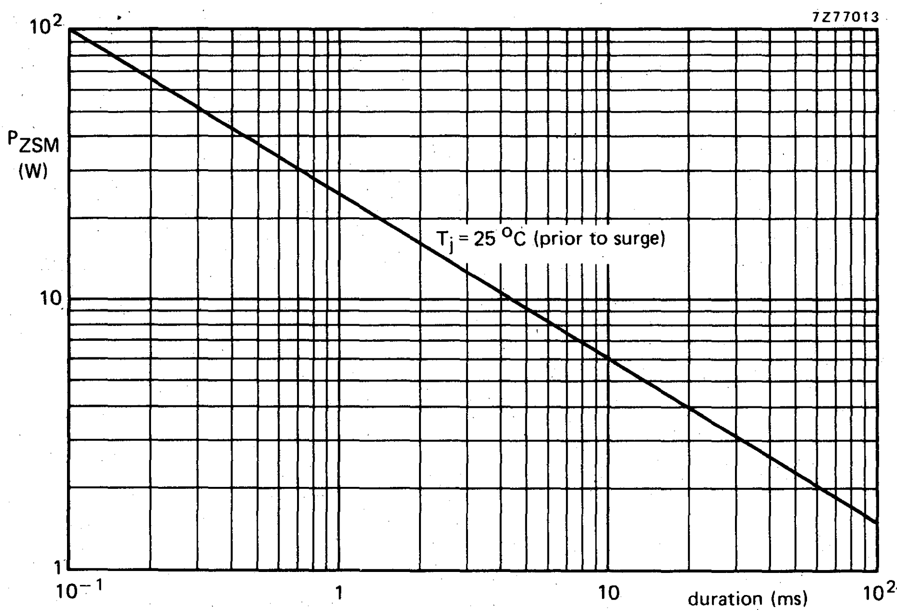


Fig. 7 Non-repetitive peak reverse power dissipation as a function of pulse duration.

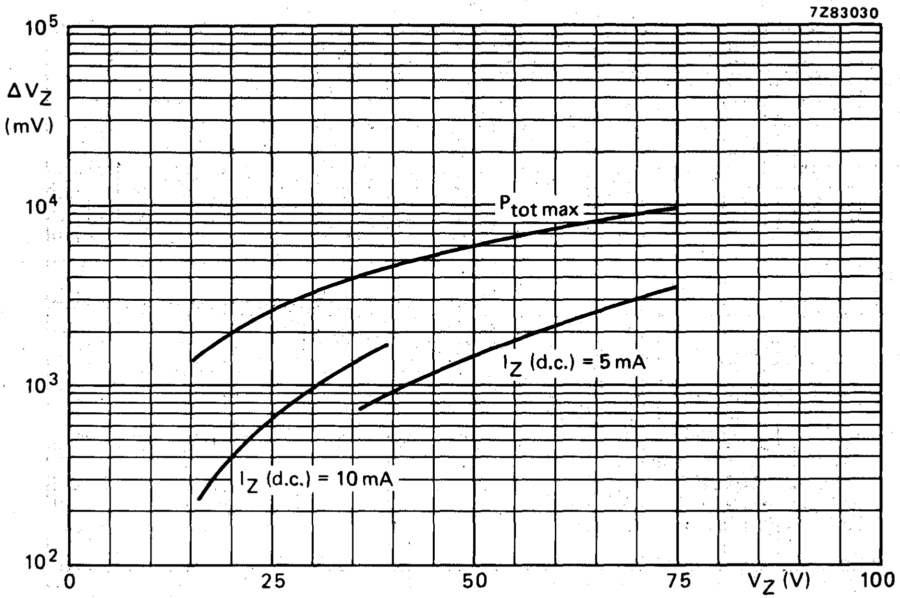


Fig. 8 Typical values at T_{amb} = 25 °C; device mounted on a ceramic substrate area = 2,5 cm^2; thickness = 0,7 mm.

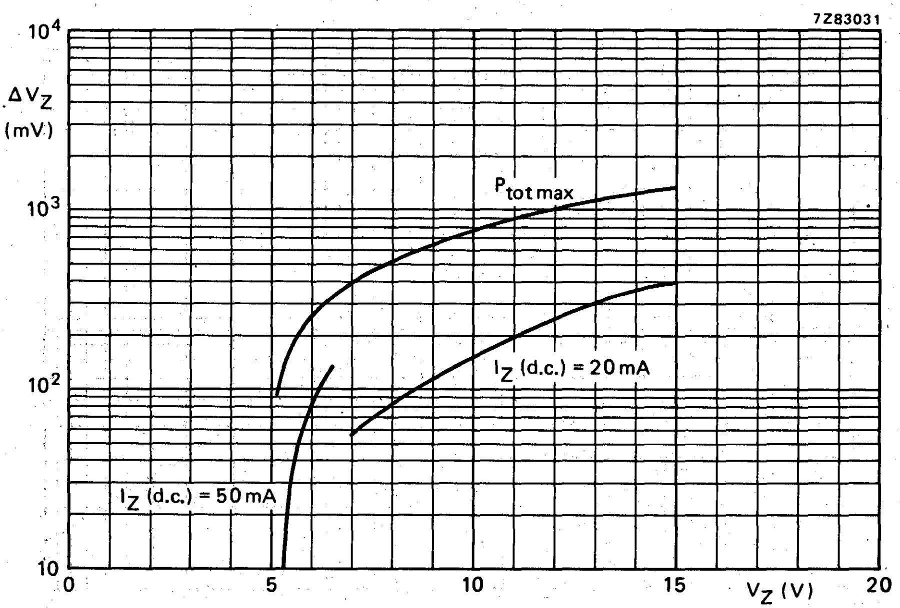


Fig. 9 Typical values at T_{amb} = 25 °C; device mounted on a ceramic substrate area = 2,5 cm^2; thickness = 0,7 mm.

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 ± 5%.

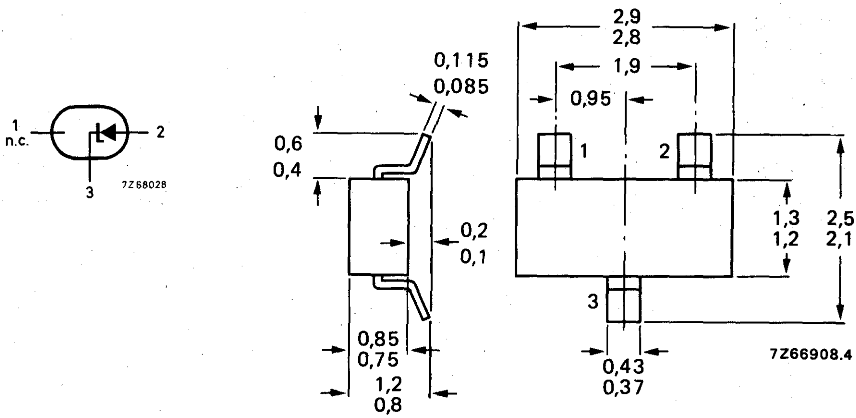
QUICK REFERENCE DATA

Working voltage range	V_Z	nom.	2,4 to 75	V
Working voltage tolerance			± 5	%
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	350	mW
Junction temperature	T_j	max.	175	°C

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.



See also *Soldering recommendations.*

Marking code

BZX84-C2V4 = Z11	BZX84-C5V6 = Z3	BZX84-C13 = Y3	BZX84-C33 = Y12
C2V7 = Z12	C6V2 = Z4	C15 = Y4	C36 = Y13
C3V0 = Z13	C6V8 = Z5	C16 = Y5	C39 = Y14
C3V3 = Z14	C7V5 = Z6	C18 = Y6	C43 = Y15
C3V6 = Z15	C8V2 = Z7	C20 = Y7	C47 = Y16
C3V9 = Z16	C9V1 = Z8	C22 = Y8	C51 = Y17
C4V3 = Z17	C10 = Z9	C24 = Y9	C56 = Y18
C4V7 = Z1	C11 = Y1	C27 = Y10	C62 = Y19
C5V1 = Z2	C12 = Y2	C30 = Y11	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 °C**	P_{tot}	max.	350 mW
Storage temperature	T_{stg}		−65 to + 175 °C
Junction temperature	T_j	max.	175 °C

THERMAL CHARACTERISTICS*

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

Thermal resistance

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Forward voltage

I_F = 10 mA		V_F	<	0,9 V

Reverse current

BZX84-C2V4	V_R = 1 V	I_R	<	50 μA
C2V7	V_R = 1 V	I_R	<	20 μA
C3V0	V_R = 1 V	I_R	<	10 μA
C3V3	V_R = 1 V	I_R	<	5 μA
C3V6	V_R = 1 V	I_R	<	5 μA
C3V9	V_R = 1 V	I_R	<	3 μA
C4V3	V_R = 1 V	I_R	<	3 μA
C4V7	V_R = 2 V	I_R	<	3 μA
C5V1	V_R = 2 V	I_R	<	2 μA
C5V6	V_R = 2 V	I_R	<	1 μA
C6V2	V_R = 4 V	I_R	<	3 μA
C6V8	V_R = 4 V	I_R	<	2 μA
C7V5	V_R = 5 V	I_R	<	1 μA
C8V2	V_R = 5 V	I_R	<	700 nA
C9V1	V_R = 6 V	I_R	<	500 nA
C10	V_R = 7 V	I_R	<	200 nA
C11	V_R = 8 V	I_R	<	100 nA
C12	V_R = 8 V	I_R	<	100 nA
C13	V_R = 8 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 V_Z (V) at I_{Ztest} = 5 mA		differential resistance r_{diff} (Ω) at I_{Ztest} = 5 mA		temperature coefficient S_Z (mV/°C) at I_{Ztest} = 5 mA			diode capacitance C_d(pF); f = 1 MHz 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-....	working voltage V_Z (V)			differential resistance r_{diff} (Ω)		working voltage V_Z (V)			differential resistance r_{diff} (Ω)	
	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

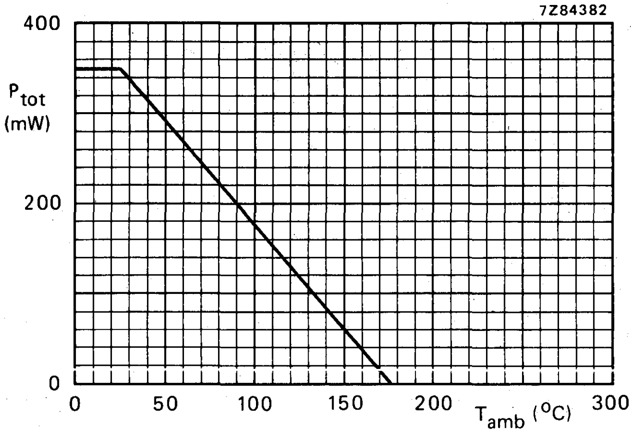


Fig. 2 Power derating curve.

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.
$\Delta T = P_{tot} \times R_{th\ j\text{-}a} = I_Z \times V_{Z\ dyn} \times R_{th\ j\text{-}a}$.
Following $\Delta V_Z = I_Z \times V_{Z\ dyn} \times R_{th\ j\text{-}a} \times S_Z$ and the model will be:

$$V_{Z\ stat} = V_{Z\ dyn} + I_Z \times V_{Z\ dyn} \times R_{th\ j\text{-}a} \times S_Z$$

Calculating example

BZX84-C24 mounted on a ceramic substrate of 7 x 5 x 0,6 mm; at I_Z = 7 mA.

$$V_{Z\ stat} = 24 + \left(\frac{7}{1000} \times 24 \times \frac{430}{1000} \times 20{,}3\right)$$

$$= 24 + 1{,}47 = 25{,}47\ \text{V}.$$

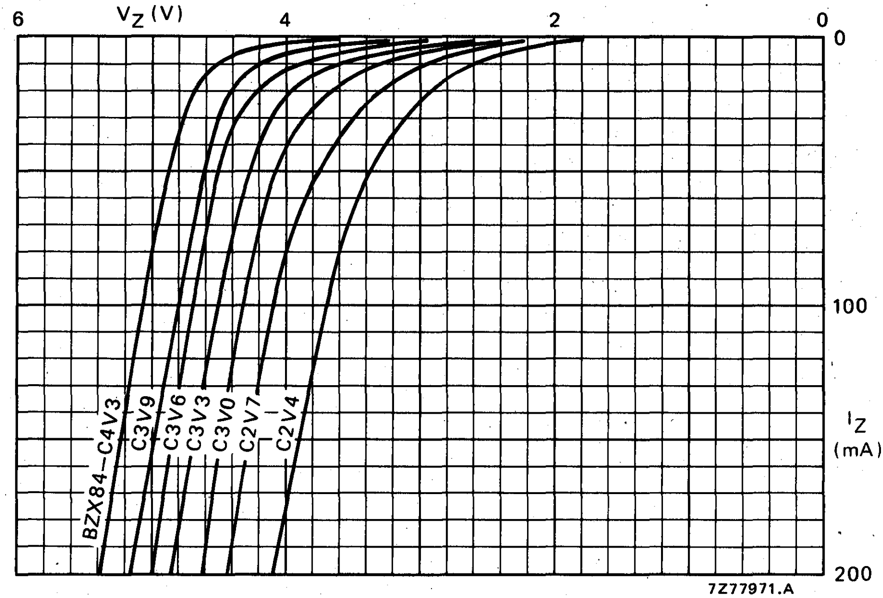


Fig. 3 Dynamic characteristics; typical values; T_j = 25 °C.

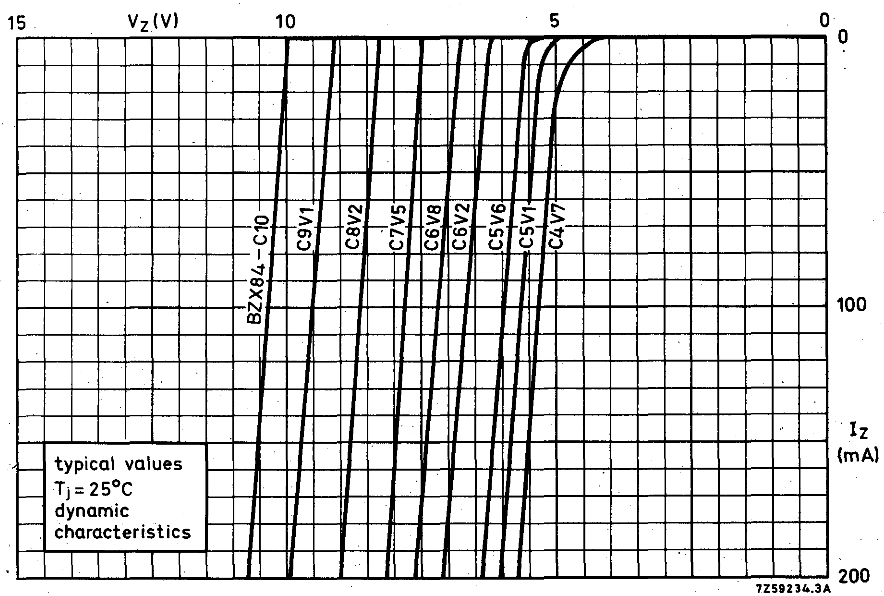


Fig. 4 Dynamic characteristics; typical values; T_j = 25 °C.

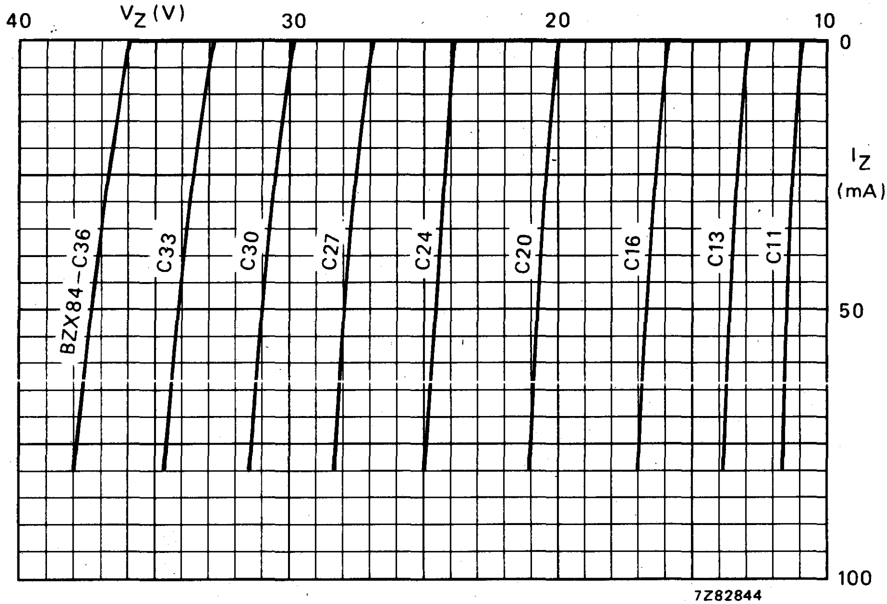


Fig. 5 Dynamic characteristics; typical values; T_j = 25 °C.

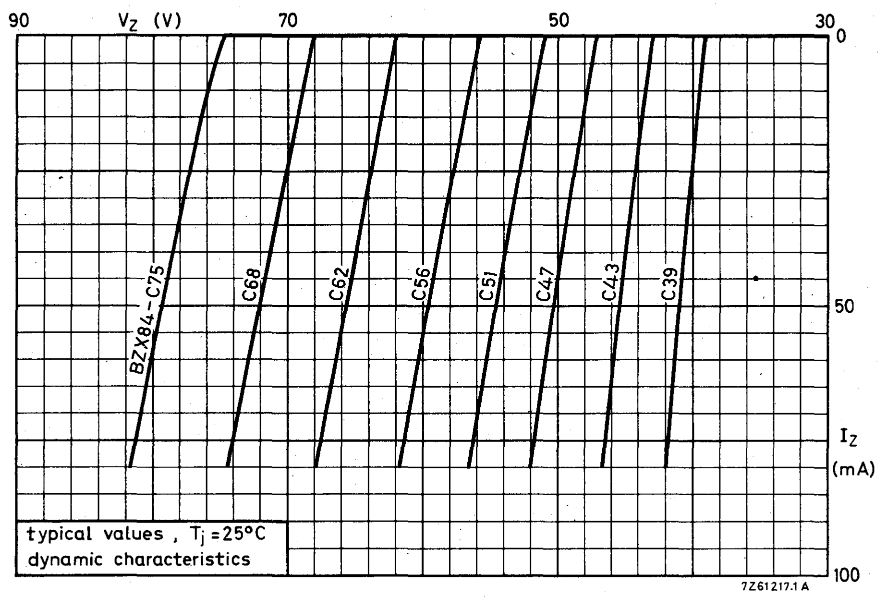


Fig. 6 Dynamic characteristics; typical values; T_j = 25 °C.

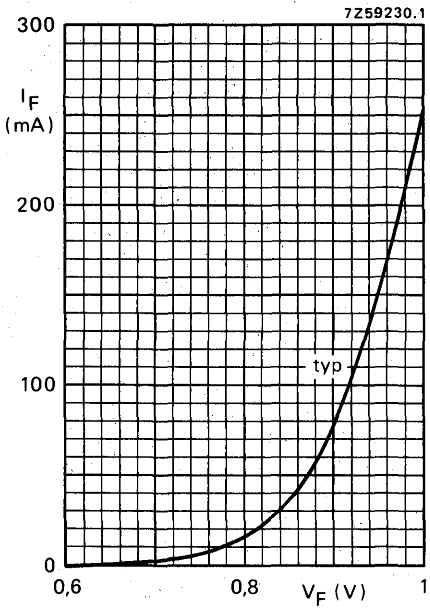


Fig. 7 Typical values at T_j = 25 °C.

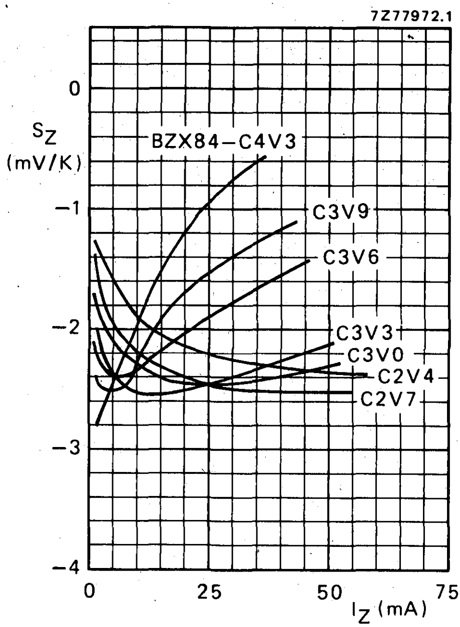


Fig. 8 Typical values; T_j = 25 to 175 °C.

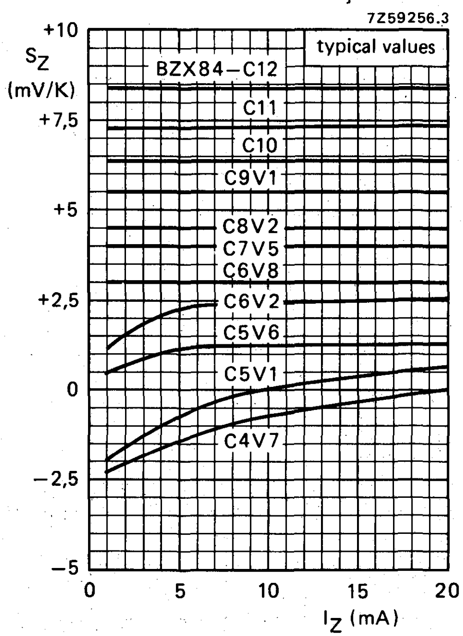


Fig. 9 Typical values; T_j = 25 to 175 °C.

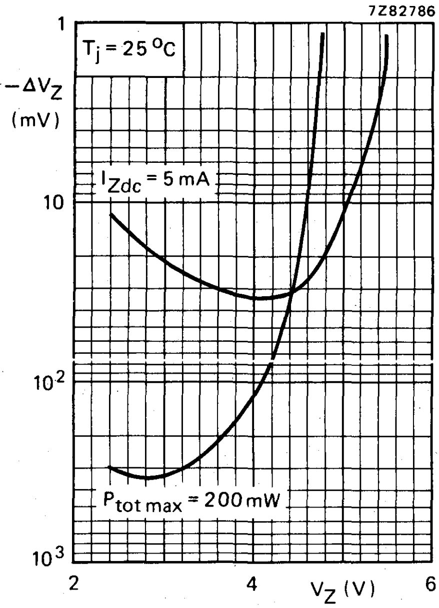


Fig. 10.

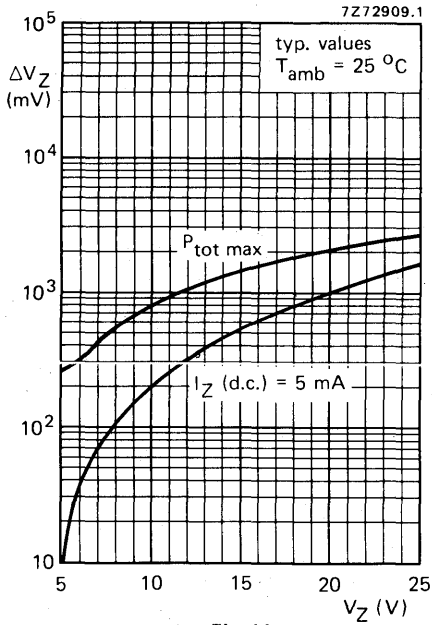


Fig. 11.

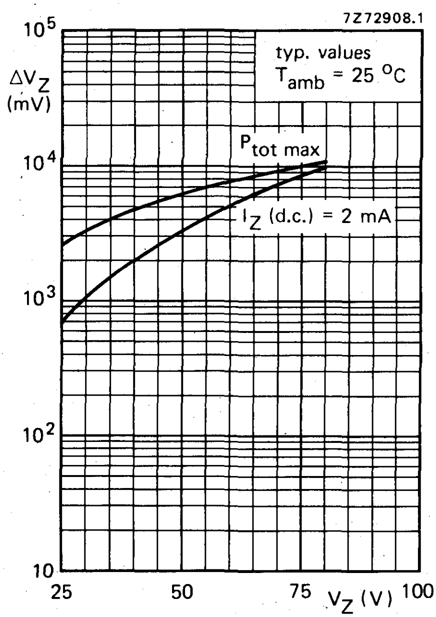


Fig. 12.

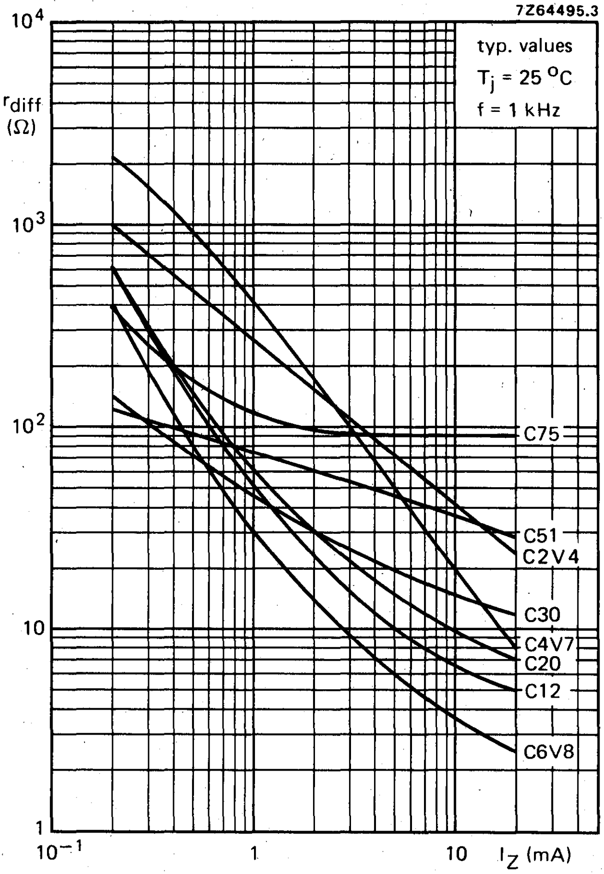

7Z64495.3
typ. values
T_j = 25 °C
f = 1 kHz
r_{diff} (Ω)
10^4
10^3
10^2
10
1
10^{-1}
1
10
I_Z (mA)
C75
C51
C2V4
C30
C4V7
C20
C12
C6V8

Fig. 13.

NOTES

NOTES

NOTES

MICROMINIATURE SEMICONDUCTORS FOR HYBRID CIRCUITS

SELECTION GUIDE

TYPE NUMBER SURVEY

GENERAL

SOLDERING RECOMMENDATIONS
THERMAL CHARACTERISTICS

DEVICE DATA

Argentina: FAPESA I.y.C., Av. Crovara 2550, Tablada, Prov. de BUENOS AIRES, Tel. 652-7438/7478.
Australia: PHILIPS INDUSTRIES HOLDINGS LTD., Elcoma Division, 67 Mars Road, LANE COVE, 2066, N.S.W., Tel. 427 08 88.
Austria: ÖSTERREICHISCHE PHILIPS BAUELEMENTE Industrie G.m.b.H., Triester Str. 64, A-1101 WIEN, Tel. 62 91 11.
Belgium: M.B.L.E., 80, rue des Deux Gares, B-1070 BRUXELLES, Tel. 523 00 00.
Brazil: IBRAPE, Caixa Postal 7383, Av. Brigadeiro Faria Lima, 1735 SAO PAULO, SP, Tel. (011) 211-2600.
Canada: PHILIPS ELECTRONICS LTD., Electron Devices Div., 601 Milner Ave., SCARBOROUGH, Ontario, M1B 1M8, Tel. 292-5161.
Chile: PHILIPS CHILENA S.A., Av. Santa Maria 0760, SANTIAGO, Tel. 39-40 01.
Colombia: SADAPE S.A., P.O. Box 9805, Calle 13, No. 51 + 39, BOGOTA D.E. 1., Tel. 600 600.
Denmark: MINIWATT A/S, Emdrupvej 115A, DK-2400 KØBENHAVN NV., Tel. (01) 69 16 22.
Finland: OY PHILIPS AB, Elcoma Division, Kaivokatu 8, SF-00100 HELSINKI 10, Tel. 1 72 71.
France: R.T.C. LA RADIOTECHNIQUE-COMPELEC, 130 Avenue Ledru Rollin, F-75540 PARIS 11, Tel. 355-44-99.
Germany: VALVO, UB Bauelemente der Philips G.m.b.H., Valvo Haus, Burchardstrasse 19, D-2 HAMBURG 1, Tel. (040) 3296-1.
Greece: PHILIPS S.A. HELLENIQUE, Elcoma Division, 52, Av. Syngrou, ATHENS, Tel. 915 311.
Hong Kong: PHILIPS HONG KONG LTD., Elcoma Div., 15/F Philips Ind. Bldg., 24-28 Kung Yip St., KWAI CHUNG, Tel. 12-24 51 21.
India: PEICO ELECTRONICS & ELECTRICALS LTD., Ramon House, 169 Backbay Reclamation, BOMBAY 400020, Tel. 295144.
Indonesia: P.T. PHILIPS-RALIN ELECTRONICS, Elcoma Div., Panim Bank Building, 2nd Fl., Jl. Jend. Sudirman, P.O. Box 223, JAKARTA, Tel. 716 131.
Ireland: PHILIPS ELECTRICAL (IRELAND) LTD., Newstead, Clonskeagh, DUBLIN 14, Tel. 69 33 55.
Italy: PHILIPS S.p.A., Sezione Elcoma, Piazza IV Novembre 3, I-20124 MILANO, Tel. 2-6994.
Japan: NIHON PHILIPS CORP., Shuwa Shinagawa Bldg., 26-33 Takanawa 3-chome, Minato-ku, TOKYO (108), Tel. 448-5611.
(IC Products) SIGNETICS JAPAN, LTD, TOKYO, Tel. (03)230-1521.
Korea: PHILIPS ELECTRONICS (KOREA) LTD., Elcoma Div., Philips House, 260-199 Itaewon-dong, Yongsan-ku, C.P.O. Box 3680, SEOUL, Tel. 794-4202.
Malaysia: PHILIPS MALAYSIA SDN. BERHAD, Lot 2, Jalan 222, Section 14, Petaling Jaya, P.O.B. 2163, KUALA LUMPUR, Selangor, Tel. 77 44 11.
Mexico: ELECTRONICA S.A. de C.V., Varsovia No. 36, MEXICO 6, D.F., Tel. 533-11-80.
Netherlands: PHILIPS NEDERLAND B.V., Afd. Elonco, Boschdijk 525, 5600 PB EINDHOVEN, Tel. (040) 79 33 33.
New Zealand: PHILIPS ELECTRICAL IND. LTD., Elcoma Division, 2 Wagener Place, St. Lukes, AUCKLAND, Tel. 867 119.
Norway: NORSK A/S PHILIPS, Electronica, Sørkedalsveien 6, OSLO 3, Tel. 46 38 90.
Peru: CADESA, Rocca de Vergallo 247, LIMA 17, Tel. 62 85 99.
Philippines: PHILIPS INDUSTRIAL DEV. INC., 2246 Pasong Tamo, P.O. Box 911, Makati Comm. Centre, MAKATI-RIZAL 3116, Tel. 86-89-51 to 59.
Portugal: PHILIPS PORTUGESA S.A.R.L., Av. Eng. Duharte Pacheco 6, LISBOA 1, Tel. 68 31 21.
Singapore: PHILIPS PROJECT DEV. (Singapore) PTE LTD., Elcoma Div., Lorong 1, Toa Payoh, SINGAPORE 1231, Tel. 25 38 811.
South Africa: EDAC (Pty.) Ltd., 3rd Floor Rainer House, Upper Railway Rd. & Ove St., New Doornfontein, JOHANNESBURG 2001, Tel. 614-2362/9.
Spain: COPRESA S.A., Balmes 22, BARCELONA 7, Tel. 301 63 12.
Sweden: A.B. ELCOMA, Lidingövägen 50, S-115 84 STOCKHOLM 27, Tel. 08/67 97 80.
Switzerland: PHILIPS A.G., Elcoma Dept., Allmendstrasse 140-142, CH-8027 ZÜRICH, Tel. 01/43 22 11.
Taiwan: PHILIPS TAIWAN LTD., 3rd Fl., San Min Building, 57-1, Chung Shan N. Rd, Section 2, P.O. Box 22978, TAIPEI, Tel. 5513101-5.
Thailand: PHILIPS ELECTRICAL CO. OF THAILAND LTD., 283 Silom Road, P.O. Box 961, BANGKOK, Tel. 233-6330-9.
Turkey: TÜRK PHILIPS TICARET A.S., EMET Department, Inonu Cad. No. 78-80, ISTANBUL, Tel. 43 59 10.
United Kingdom: MULLARD LTD., Mullard House, Torrington Place, LONDON WC1E 7HD, Tel. 01-580 6633.
United States: (Active devices & Materials) AMPEREX SALES CORP., Providence Pike, SLATERSVILLE, R.I. 02876, Tel. (401) 762-9000.
(Passive devices) MEPCO/ELECTRA INC., Columbia Rd., MORRISTOWN, N.J. 07960, Tel. (201) 539-2000.
(IC Products) SIGNETICS CORPORATION, 811 East Arques Avenue, SUNNYVALE, California 94086, Tel. (408) 739-7700.
Uruguay: LUZILECTRON S.A., Avda Rondeau 1576, piso 5, MONTEVIDEO, Tel. 91 43 21.
Venezuela: IND. VENEZOLANAS PHILIPS S.A., Elcoma Dept., A. Ppal de los Ruices, Edif. Centro Colgate, CARACAS, Tel. 36 05 11.

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