SEMICONDUCTORS

PART 7 - APRIL 1983

MICROMINIATURE SEMICONDUCTORS FOR HYBRID CIRCUITS

DATA HANDBOOK SYSTEM

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

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

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

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

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

ELECTRON TUBES (BLUE SERIES)

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

SEMICONDUCTORS (RED SERIES)

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

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

S2 **Power diodes, thyristors, triacs**
Rectifier diodes, voltage regulator diodes (> 1,5 W), rectifier stacks, thyristors, triacs

S3 **Small-signal transistors**

S4 **Low-frequency power transistors and hybrid IC modules**

S5 **Field-effect transistors**

S6 **R.F. power transistors and modules**

S7 **Microminiature semiconductors for hybrid circuits**

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

S9 Taken into handbook T11 of the blue series

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

INTEGRATED CIRCUITS (PURPLE SERIES)

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

IC1 **Bipolar ICs for radio and audio equipment**

IC2 **Bipolar ICs for video equipment**

IC3 **ICs for digital systems in radio, audio and video equipment**

IC4 **Digital integrated circuits**
LOCMOS HE4000B family

IC5 **Digital integrated circuits – ECL**
ECL10 000 (GX family), ECL100 000 (HX family), dedicated designs

IC6 **Professional analogue integrated circuits**

IC7 **Signetics bipolar memories**

IC8 **Signetics analogue circuits**

IC9 **Signetics TTL logic**

IC10* **Signetics Integrated Fuse Logic (IFL)**

IC11* **Microprocessors, microcomputers and peripheral circuitry**

* This handbook will be available later this year.

COMPONENTS AND MATERIALS (GREEN SERIES)

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

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

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

C3 **Loudspeakers**

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

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

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

C7 **Variable capacitors**

C8 **Variable mains transformers**

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

C10 **Connectors**

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

C12 **Variable resistors and test switches**

C13 **Fixed resistors**

C14 **Electrolytic and solid capacitors**

C15 **Film capacitors, ceramic capacitors**

C16 **Piezoelectric ceramics, permanent magnet materials**

SEMICONDUCTOR INDEX

INDEX OF TYPE NUMBERS

Data Handbooks S1 to S10

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

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

* = series
FET = Field-effect transistors
Mm = Microminiature semiconductors for hybrid circuits
P = Low-frequency power transistors
Sm = Small-signal transistors

P = Low-frequency power transistors

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

PDT = Photodiodes or transistors
RFP = R.F. power transistors and modules
RT = Tripler
ThM = Thyristor Modules
WBM = Wideband hybrid IC modules
WBT = Wideband hybrid IC modules

* = series
FET = Field-effect transistors
Mm = Microminiature semiconductors for hybrid circuits
P = Low-frequency power transistors
PDT = Photodiodes or transistors
Sm = Small-signal transistors
Th = Thyristors
Tri = Triacs

* = series
D = Displays
GD = Germanium diodes
I = Infrared devices
LED = Light emitting diodes
Mm = Microminiature semiconductors for hybrid circuits
P = Low-frequency power transistors
Ph = Photoconductive devices

PhC = Photocouplers
R = Rectifier diodes
Sm = Small-signal transistors
St = Rectifier stacks
TS = Transient suppressor diodes
Vrf = Voltage reference diodes
Vrg = Voltage regulator diodes
WBM = Wideband hybrid IC modules

FET = Field-effect transistors
I = Infrared devices
PDT = Photodiodes or transistors
R = Rectifier diodes
RFP = R.F. power transistors and modules
SD = Small-signal diodes
Sm = Small-signal transistors
Vrf = Voltage reference diodes
WBT = Wideband hybrid IC modules

A = Accessories
DH = Diecast heatsinks
HE = Heatsink extrusions

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									
BC807	45	45	500	310	100/600	100/1	0,70	500/50	100
BC808	25	25	500	310					
BC856	65	65	100	200	75/475	2/5	0,30	10/0,5	150
BC857	45	45	100	200	75/475	2/5	0,30	10/0,5	150
BC858	30	30	100	200	75/800	2/5	0,30	10/0,5	150
BC859	30	30	100	200	125/800	2/5	0,30	10/0,5	150
BC860	45	45	100	200	125/800	2/5	0,30	10/0,5	150
BC869*	20	20	1000	1000	85/375	500/1	0,50	1000/100	60
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				

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

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
N-P-N									
BC817	45	45	500	310	100/600	100/1	0,70	500/50	200
BC818	25	25	500	310					
BC846	65	65	100	200	220/800	2/5	0,25	10/0,5	300
BC847	45	45	100	200					
BC848	30	30	100	200					
BC849	30	30	100	200	450/800	2/5	0,25	10/0,5	300
BC850	45	45	100	200					
BC868*	20	20	1000	1000	85/375	500/1	0,50	1000/100	60
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	F 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
BFR92A;R	20	15	25	200	40/–	14/10	60	793,25	5,0	0,35
BFR93;R	15	12	35	200	25/–	30/5	60	493,25	5,0	0,8
BFR93A;R	15	12	35	250	40/–	30/5	60	793,25	5,0	0,6
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

* 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								
BSR18;R	40	40	200	250	50/150	10/1	0,40	50/5	70/250	10/1
BSR18A;R	40	40	200	250	100/300	10/1	0,4	50/5	70/300	10/1
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	–	–
BST60*	60	45	500	1000	1000/–	150/10	1,3	500/0,5	400/1500	500/0,5
BST61*	80	60								
BST62*	100	80								
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	50/150	10/1	0,3	50/5	70/225	10/1
BSR17A;R	60	40	200	350	100/300	10/1	0,3	50/5	70/250	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
BST50*	60	45	500	1000	1000/–	150/10	1,3	500/50	400/1500	500/0,5
BST51*	80	60	500	1000						
BST52*	100	80	500	1000						

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

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

HIGH VOLTAGE 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 min. MHz
P-N-P									
BF621*	300	–	20	1000	50/–	25/20	0,8	30/5	60
BF623*	250	250	20	1000	50/–	25/20	0,8	30/5	60
BF821	300	–	50	310	50/–	25/20	0,8	30/5	60
BF823	250	250	50	310	50/–	25/20	0,8	30/5	60
BST15*	200	200	1000	1000	30/150	50/10	2,5	50/5	15
BST16*	350	300	1000	1000	30/120	50/10	2,0	50/5	15
N-P-N									
BF620*	300	–	20	1000	50/–	25/20	0,6	30/5	60
BF622*	250	250	20	1000	50/–	25/20	0,6	30/5	60
BF820	300	–	50	310	50/–	25/20	0,6	30/5	60
BF822	250	250	50	310	50/–	25/20	0,6	30/5	60

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

FIELD-EFFECT TRANSISTOR in SOT-23/SOT-143*

type	RATINGS $\pm V_{DS}$ V	$-V_{GSO}$ V	I_D mA	P_{tot} mW	$-I_{DSS}$ max. nA	I_{DSS} min./max. mA	$-V_{(P)GS}$ max. V	$\|y_{fs}\|$ 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		
BF989*	20	–	20	200	50	2/20	2,7	9,5	0,025	–
BF990*	18	–	30	200	25	–	1,3	17	0,025	–
BF991*	20	–	20	200	50	4/25	2,5	10	0,020	–
BF992*	20	–	40	200	25	–	1,3	20	0,04	–
BF994*	20	–	30	200	50	2/20	2,5	15	0,025	–
BF996*	20	–	30	200	50	2/20	2,5	15	0,025	–
BFR30	25	25	10	250	0,2	4/10	5	1	1,5	0,5
BFR31						1/5	2,5	1,5		
BFR101A*	30	30	10	200	5	0,2/1,5	1,0	1,2	–	–
BFR101B*	30	30	10	200	5	1/5	2,5	2,5	–	–
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			

TRIGGER DEVICES

P-N-P-N	case	V_{GA} max. V	I_A max. mA	I_P μA	I_V μA
BRY61	SOT-23	70	175	5/1	30/50
BRY62	SOT-143	70	175	–	–

* Types in SOT-143 package are denoted by an asterisk (*).

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
BAT 18	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 V_R V	I_F mA	CHARACTERISTICS C_d at V_R pF	V	C_d ratio at V_R = 3/25 at f = 1 MHz	r_D Ω
BBY31	28	20	1,8 – 2,8	25	typ. 5	< 1,2
BBY40	28	20	4,3 – 6	25	5 to 5,6	< 0,6

VOLTAGE REGULATOR DIODES

type	case	range (V)	voltage tolerance %	P_{tot} mW	I_{ZRM} mA	I_{FRM} mA	max. V_F at I_F V	mA
BZV49	SOT-89	2,4 to 75	5	1000	–**	250	1	50
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}.

NOTES

TYPE NUMBER SURVEY

Numerical index
Conversion conventional types
Marking and marking code
Packing

NUMERICAL TYPE LIST

type number	SOT-23	SOT-89	SOT-143	marking type	marking reverse type	device type	nearest conventional type(s)	complement
BAS16	o	–	–	A6		diode	BAW62, 1N4148	
BAS17	o	–	–	A91		diode	BA314	
BAS19	o	–	–	A8		diode	BAV19	
BAS20	o	–	–	A81		diode	BAV20	
BAS21	o	–	–	A82		diode	BAV21	
BAT17	o	–	–	A3		diode	BA481	
BAT18	o	–	–	A2		diode	BA243, BA482	
BAV70	o	–	–	A4		diode	BAW62, 1N4148 (double)	
BAV99	o	–	–	A7		diode	BAW62, 1N4148 (double)	
BAW56	o	–	–	A1		diode	BAW62, 1N4148 (double)	
BBY31	o	–	–	S1		diode	BB405	
BBY40	o	–	–	S2		diode	BB809	
BC807-16	o	–	–	5A	5AR	PNP	BC327-16	BC817-16
-25	o	–	–	5B	5BR	PNP	-25	-25
-40	o	–	–	5C	5CR	PNP	-40	-40
BC808-16	o	–	–	5E	5ER	PNP	BC328-16	BC818-16
-25	o	–	–	5F	5FR	PNP	-25	-25
-40	o	–	–	5G	5GR	PNP	-40	-40
BC817-16	o	–	–	6A	6AR	NPN	BC337-16	BC807-16
-25	o	–	–	6B	6BR	NPN	-25	-25
BC817-40	o	–	–	6C	6CR	NPN	BC337-40	BC807-40
BC818-16	o	–	–	6E	6ER	NPN	BC338-16	BC808-16
-25	o	–	–	6F	6FR	NPN	-25	-25
-40	o	–	–	6G	6GR	NPN	-40	-40
BC846A	o	–	–	1A	1AR	NPN	BC546A	BC856
BC846B	o	–	–	1B	1BR	NPN	BC546B	
BC847A	o	–	–	1E	1ER	NPN	BC547, BC107	BC857
BC847B	o	–	–	1F	1FR	NPN		
BC847C	o	–	–	1G	1GR	NPN		
BC848A	o	–	–	1J	1JR	NPN	BC548, BC108	BC858
BC848B	o	–	–	1K	1KR	NPN	BC548, BC108	BC858
BC848C	o	–	–	1L	1LR	NPN		
BC849B	o	–	–	2B	2BR	NPN	BC549, BC109	BC859
BC849C	o	–	–	2C	2CR	NPN		
BC850B	o	–	–	2F	2FR	NPN	BC550B, BCY79	BC860

type number	SOT-23	SOT-89	SOT-143	marking type	marking reverse type	device type	nearest conventional type(s)	complement
BC850C	o	–	–	2G	2GR	NPN	BC550C, BCY79	
BC856A	o	–	–	3A	3AR	PNP	BC556	BC846
BC856B	o	–	–	3B	3BR	PNP		
BC857A	o	–	–	3E	3ER	PNP	BC557, BC177	BC847
BC857B	o	–	–	3F	3FR	PNP		
BC858A	o	–	–	3J	3JR	PNP	BC558, BC178	BC848
BC858B	o	–	–	3K	3KR	PNP		
BC858C	o	–	–	3L	3LR	PNP		
BC859A	o	–	–	4A	4AR	PNP	BC559, BC179, BCY78	BC849
BC859B	o	–	–	4B	4BR	PNP		
BC859C	o	–	–	4C	4CR	PNP		
BC860A	o	–	–	4E	4ER	PNP	BC560, BCY79	BC850
BC860B	o	–	–	4F	4FR	PNP		
BC860C	o	–	–	4G	4GR	PNP		
BC868	–	o	–	BC868		NPN	BC368	BC869
BC869	–	o	–	BC869		PNP	BC369	BC868
BCF29	o	–	–	C7	C77	PNP	BC559A, BCY78, BC179	
BCF30	o	–	–	C8	C9	PNP	BC559B, BCY78	BCF32
BCF32	o	–	–	D7	D77	NPN	BC549B, BCY58, BC109	BCF30
BCF33	o	–	–	D8	D81	NPN	BC549C, BCY58	
BCF70	o	–	–	H7	H71	PNP	BC560B, BCY79	
BCF81	o	–	–	K9	K91	NPN	BC550C	
BCV71	o	–	–	K7	K71	NPN	BC546A	
BCV72	o	–	–	K8	K81	NPN	BC546B	
BCW29	o	–	–	C1	C4	PNP	BC178A, BC558A	BCW31
BCW30	o	–	–	C2	C5	PNP	BC178B, BC558B	BCW32
BCW31	o	–	–	D1	D4	NPN	BC108A, BC548A	BCW29
BCW32	o	–	–	D2	D5	NPN	BC108B, BC548B	BCW30
BCW33	o	–	–	D3	D6	NPN	BC108C, BC548C	
BCW60A	o	–	–	AA		NPN	BC548A	BCW61A
BCW60B	o	–	–	AB		NPN	BC548B	BCW61B
BCW60C	o	–	–	AC		NPN	BC548B	BCW61C
BCW60D	o	–	–	AD		NPN	BC548C	BCW61D
BCW61A	o	–	–	BA		PNP	BC558A	BCW60A
BCW61B	o	–	–	BB		PNP	BC558B	BCW60B
BCW61C	o	–	–	BC		PNP	BC558B	BCW60C
BCW61D	o	–	–	BD		PNP	BC558C	BCW60D
BCW69	o	–	–	H1	H4	PNP	BC557A	BCW71
BCW70	o	–	–	H2	H5	PNP	BC557B	BCW72
BCW71	o	–	–	K1	K4	NPN	BC547A	BCW69

type number	SOT-23	SOT-89	SOT-143	marking type	marking reverse type	device type	nearest conventional type(s)	complement
BCW72	o	–	–	K2	K5	NPN	BC547B	BCW70
BCW81	o	–	–	K3	K31	NPN	BC547C	
BCW89	o	–	–	H3	H31	PNP	BC556A	
BCX17	o	–	–	T1	T4	PNP	BC327	BCX19
BCX18	o	–	–	T2	T5	PNP	BC328	BCX20
BCX19	o	–	–	U1	U4	NPN	BC337	BCX17
BCX20	o	–	–	U2	U5	NPN	BC338	BCX18
BCX51	–	o	–	BCX51		PNP	BC636	BCX54
BCX52	–	o	–	BCX52		PNP	BC638	BCX55
BCX53	–	o	–	BCX53		PNP	BC640	BCX56
BCX54	–	o	–	BCX54		NPN	BC635	BCX51
BCX55	–	o	–	BCX55		NPN	BC637	BCX52
BCX56	–	o	–	BCX56		NPN	BC639	BCX53
BCX70G	o	–	–	AG		NPN	BC107, BC547	BCX71G
BCX70H	o	–	–	AH		NPN	BC107, BC547	BCX71H
BCX70J	o	–	–	AJ		NPN	BC107, BC547	BCX71J
BCX70K	o	–	–	AK		NPN	BC107, BC547	BCX71K
BCX71G	o	–	–	BG		PNP	BC177, BC557	BCX70G
BCX71H	o	–	–	BH		PNP	BC177, BC557	BCX70H
BCX71J	o	–	–	BJ		PNP	BC177, BC557	BCX70J
BCX71K	o	–	–	BK		PNP	BC177, BC557	BCX70K
BF510	o	–	–	S6		FET	BF410A	
BF511	o	–	–	S7		FET	BF410B	
BF512	o	–	–	S8		FET	BF410C	
BF513	o	–	–	S9		FET	BF410D	
BF536	o	–	–	G3		PNP	BF936	
BF550	o	–	–	G2	G5	PNP	BF450	
BF569	o	–	–	G6		PNP	BF970	
BF579	o	–	–	G7		PNP	BF979	
BF620	–	o	–	BF620		NPN	BF420	BF621
BF621	–	o	–	BF621		PNP	BF421	BF620
BF622	–	o	–	BF622		NPN	BF422	BF623
BF623	–	o	–	BF623		PNP	BF423	BF622
BF660	o	–	–	G8	G81	PNP	BF606A	
BF767	o	–	–	G9		PNP	BF967	
BF820	o	–	–	1V		NPN	BF420	BF821
BF821	o	–	–	1W		PNP	BF421	BF820
BF822	o	–	–	1X		NPN	BF422	BF823
BF823	o	–	–	1Y		PNP	BF423	BF822
BF989	–	–	o	M89		FET	BF960	

type number	SOT-23	SOT-89	SOT-143	marking type	marking reverse type	device type	nearest conventional type(s)	complement
BF990	–	–	o	M90		FET	BF980	
BF991	–	–	o	M91		FET	BF981	
BF992	–	–	o	M8		FET	BF982	
BF994	–	–	o	M94		FET	BF964	
BF996	–	–	o	M96		FET	BF966	
BFQ17	–	o	–	BFQ17		NPN	BFW16A	
BFQ18A	–	o	–	BFQ18A		NPN	BFQ34	
BFQ19	–	o	–	BFQ19		NPN	BFR96	
BFR30	o	–	–	M1		FET	BFW11, BF245	
BFR31	o	–	–	M2		FET	BFW12, BF245	
BFR53	o	–	–	N1	N4	NPN	BFW30, BFW93	
BFR92	o	–	–	P1	P4	NPN	BFR90	BFT92
BFR92A	o	–	–	P2	P5	NPN	BFR90	
BFR93	o	–	–	R1	R4	NPN	BFR91	BFT93
BFR93A	o	–	–	R2	R5	NPN	BFR91	
BFR101A	–	–	o	M97		FET	----	
BFR101B	–	–	o	M98		FET	----	
BFS17	o	–	–	E1	E4	NPN	BFY90, BFW92	
BFS18	o	–	–	F1	F4	NPN	BF185, BF495	
BFS19	o	–	–	F2	F5	NPN	BF184, BF494	
BFS20	o	–	–	G1	G4	NPN	BF199	
BFT25	o	–	–	V1	V4	NPN	BFT24	
BFT46	o	–	–	M3		FET	BFW13, BF245	
BFT92	o	–	–	W1	W4	PNP	BFQ51; 52	BFR92
BFT93	o	–	–	X1	X4	PNP	BFQ23; 24	BFR93
BRY61	o	–	–	A5		PNPN	BRY56	
BRY62	–	–	o	A51		PNPN	BRY39	
BSR12	o	–	–	B5	B8	PNP	2N2894A	BSV52
BSR13	o	–	–	U7	U71	NPN	2N2222	
BSR14	o	–	–	U8	U81	NPN	2N2222A	
BSR15	o	–	–	T7	T71	PNP	2N2907	
BSR16	o	–	–	T8	T81	PNP	2N2907A	
BSR17	o	–	–	U9	U91	NPN	2N3903	BSR18
BSR17A	o	–	–	U92	U93	NPN	2N3904	BSR18A
BSR18	o	–	–	T9	T91	PNP	2N3905	BSR17
BSR18A	o	–	–	T92	T93	PNP	2N3906	BSR17A
BSR30	–	o	–	BSR30		PNP	2N4030	BSR40
BSR31	–	o	–	BSR31		PNP	2N4031	BSR41
BSR32	–	o	–	BSR32		PNP	2N4032	BSR42
BSR33	–	o	–	BSR33		PNP	2N4033	BSR43

type number	SOT-23	SOT-89	SOT-143	marking type	marking reverse type	device type	nearest conventional type(s)	complement
BSR40	–	o	–	BSR40		NPN	BSX46-6	BSR30
BSR41	–	o	–	BSR41		NPN	BSX46-16	BSR31
BSR42	–	o	–	BSR42		NPN	2N3020	BSR32
BSR43	–	o	–	BSR43		NPN	2N3019	BSR33
BSR56	o	–	–	M4		FET	2N4856	
BSR57	o	–	–	M5		FET	2N4857	
BSR58	o	–	–	M6		FET	2N4858	
BSS63	o	–	–	T3	T6	PNP	BSS68	BSS64
BSS64	o	–	–	U3	U6	NPN	BSS38	BSS63
BST15	–	o	–	BST15		PNP	2N5415	
BST16	–	o	–	BST16		PNP	2N5416	
BST50	–	o	–	BST50		NPN	BSR50	
BST51	–	o	–	BST51		NPN	BSR51	
BST52	–	o	–	BST52		NPN	BSR52	
BST60	–	o	–	BST60		PNP	BSR60	
BST61	–	o	–	BST61		PNP	BSR61	
BST62	–	o	–	BST62		PNP	BSR62	
BSV52	o	–	–	B2	B4	NPN	PH2369, BSX20	BSR12
BZV49	–	o	–	*		diode	BZV85	
BZX84	o	–	–	*		diode	BZX55, BZX79	

* For marking of these types see next page.

type	BZV49- SOT-89	BZX84- SOT-23
device type	diode	diode
nearest conventional type	BZV85 series	BZX79 series
type number suffix	mark	mark
C2V4	2Y4	Z11
C2V7	2Y7	Z12
C3V0	3Y0	Z13
C3V3	3Y3	Z14
C3V6	3Y6	Z15
C3V9	3Y9	Z16
C4V3	4Y3	Z17
C4V7	4Y7	Z1
C5V1	5Y1	Z2
C5V6	5Y6	Z3
C6V2	6Y2	Z4
C6V8	6Y8	Z5
C7V5	7Y5	Z6
C8V2	8Y2	Z7
C9V1	9Y1	Z8
C10	10Y	Z9
C11	11Y	Y1
C12	12Y	Y2
C13	13Y	Y3
C15	15Y	Y4
C16	16Y	Y5
C18	18Y	Y6
C20	20Y	Y7
C22	22Y	Y8
C24	24Y	Y9
C27	27Y	Y10
C30	30Y	Y11
C33	33Y	Y12
C36	36Y	Y13
C39	39Y	Y14
C43	43Y	Y15
C47	47Y	Y16
C51	51Y	Y17
C56	56Y	Y18
C62	62Y	Y19
C68	68Y	Y20
C75	75Y	Y21

CONVERSION LIST

conventional to microminiature type

conventional type	microminiature type	conventional type	microminiature type	conventional type	microminiature type
BA243	BAT18	BC328	BC808	BC556	BC856
BA314	BAS17		BCX18	BC556A	BCW89
BA481	BAT17	BC337	BC817	BC557	BC857
BA482	BAT18		BCX19		BCX71
BAV19	BAS19	BC338	BC818	BC557A	BCW69
BAV20	BAS20	BC338	BCX20	BC557B	BCW70
BAV21	BAS21	BC368	BC868	BC558	BC858
BAW62	BAS16	BC369	BC869	BC558A	BCW29
	BAV70	BC546	BC846		BCW61A
BAW62	BAV99	BC546A	BCV71	BC558B	BCW30
BAW62	BAW56	BC546B	BCV72	BC558B	BCW61B
BB405	BBY31	BC547	BC847		BCW61C
BB809	BBY40	BC547A	BCW71	BC558C	BCW61D
BC107	BC847	BC547B	BCW72	BC559	BC859
	BCX70	BC547C	BCW81	BC559A	BCF29
BC108	BC848	BC547	BCX70	BC559B	BCF30
BC108A	BCW31	BC548	BC848	BC560	BC860
BC108B	BCW32	BC548A	BCW31	BC560B	BCF70
BC108C	BCW33		BCW60A	BC635	BCX54
BC109	BC849	BC548B	BCW32	BC636	BCX51
BC109	BCF32	BC548B	BCW60B	BC637	BCX55
BC177	BC857		BCW60C	BC638	BCX52
BC177	BCX71	BC548C	BCW33	BC639	BCX56
BC178	BC858		BCW60D	BC640	BCX53
BC178A	BCW29	BC549	BC849	BCY58	BCF32
BC178B	BCW30	BC549B	BCF32	BCY58	BCF33
BC179	BC859	BC549C	BCF33	BCY78	BC859A
BC179	BCF29	BC550B	BC850B	BCY78	BCF29
BC327	BC807	BC550C	BC850C		BCF30
	BCX17	BC550C	BCF81	BCY79	BC850B

conventional type	microminiature type	conventional type	microminiature type	conventional type	microminiature type
BCY79	BC860	BF979	BF579	BSS68	BSS63
	BCF70	BF980	BF990	BSX20	BSV52
BF184	BFS18	BF981	BF991	BSX46-6	BSR40
BF185	BFS19	BF982	BF992	BSX46-16	BSR41
BF199	BFS20	BFQ23	BFT93	BZX55	BZX84
BF245	BFR30	BFQ24	BFT93	BZX79	BZX84
	BFR31	BFQ34	BFQ18A	BZV85	BZV49
BF245	BFT46	BFQ51	BFT92	PH2369	BSV52
BF410A	BF510	BFQ52	BFT92	1N4148	BAS16
BF410B	BF511	BFR90	BFR92; A	1N4148	BAV70
BF410C	BF512	BFR91	BFR93; A	1N4148	BAV99
BF410D	BF513	BFR96	BFQ19		BAW56
BF420	BF620	BFT24	BFT25	2N2222	BSR13
	BF820	BFW11	BFR30	2N2222A	BSR14
BF421	BF621	BFW12	BFR31	2N2894A	BSR12
BF421	BF821	BFW13	BFT46	2N2907	BSR15
BF422	BF622	BFW16A	BFQ17	2N2907A	BSR16
BF422	BF822	BFW30	BFR53	2N3019	BSR43
BF423	BF623	BFW92	BFS17	2N3020	BSR42
	BF823	BFW93	BFR53	2N3903	BSR17
BF450	BF550	BFY90	BFS17	2N3904	BSR17A
BF494	BFS19	BRY39	BRY62	2N3905	BSR18
BF495	BFS18	BRY56	BRY61	2N3906	BSR18A
BF606A	BF660	BSR50	BST50	2N4030	BSR30
BF936	BF536	BSR51	BST51	2N4031	BSR31
BF960	BF989	BSR52	BST52	2N4032	BSR32
BF964	BF994	BSR60	BST60	2N4033	BSR33
BF966	BF996	BSR61	BST61	2N4856	BSR56
BF967	BF767	BSR62	BST62	2N4857	BSR57
BF970	BF569	BSS38	BSS64	2N4858	BSR58
				2N5415	BST15
				2N5416	BST16

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 BZV-49 series.

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
A51	BRY62	C4	BCW29R	F9		M1	BFR30
A6	BAS16	C5	BCW30R	G1	BFS20	M2	BFR31
A7	BAV99	C6		G2	BF550	M3	BFT46
A8	BAS19	C7	BCF29	G3	BF536	M4	BSR56
A81	BAS20	C77	BCF29R	G4	BFS20R	M5	BSR57
A82	BAS21	C8	BCF30	G5	BF550R	M6	BSR58
A9		C9	BCF30R	G6	BF569	M7	
A91	BAS17	D1	BCW31	G7	BF579	M8	BF992
AA	BCW60A	D2	BCW32	G8	BF660	M89	BF989
AB	BCW60B	D3	BCW33	G81	BF660R	M9	
AC	BCW60C	D4	BCW31R	G9	BF767	M90	BF990
AD	BCW60D	D5	BCW32R	H1	BCW69	M91	BF991
AG	BCX70G	D6	BCW33R	H2	BCW70	M94	BF994
AH	BCX70H	D7	BCF32	H3	BCW89	M96	BF996
AJ	BCX70J	D77	BCF32R	H31	BCW89R	M97	BFR101A
AK	BCX70K	D8	BCF33	H4	BCW69R	M98	BFR101B
B1		D81	BCF33R	H5	BCW70R	N1	BFR53
B2	BSV52	D9		H6		N2	
B3		E1	BFS17	H7	BCF70	N3	
B4	BSV52R	E2		H71	BCF70R	N4	BFR53R
B5	BSR12	E3		H8		N5	
B6		E4	BFS17R	H9		N6	
B7		E5		K1	BCW71	N7	
B8	BSR12R	E6		K2	BCW72	N8	
BA	BCW61A	E7		K3	BCW81	N9	
BB	BCW61B	E8		K31	BCW81R	P1	BFR92
BC	BCW61C	E9		K4	BCW71R	P2	BFR92A
BD	BCW61D	F1	BFS18	K5	BCW72R	P3	
BG	BCX71G	F2	BFS19	K6		P4	BFR92R
BH	BCX71H	F3		K7	BCV71	P5	BFR92AR

mark	type no.	mark	type no.	mark	type no.	mark	type no.
P6		U5	BCX20R	Y4	BZX84-C15	1F	BC847B
P7		U6	BSS64R	Y5	-C16	1FR	BC847BR
P8		U7	BSR13	Y6	-C18	1G	BC847C
P9		U71	BSR13R	Y7	-C20	1GR	BC847CR
R1	BFR93	U8	BSR14	Y8	-C22	1J	BC848A
R2	BFR93A	U81	BSR14R	Y9	BZX84-C24	1JR	BC848AR
R3		U9	BSR17	Y10	-C27	1K	BC848B
R4	BFR93R	U91	BSR17R	Y11	-C30	1KR	BC848BR
R5	BFR93AR	U92	BSR17A	Y12	-C33	1L	BC848C
R6		U93	BSR17AR	Y13	-C36	1LR	BC848CR
R7		V1	BFT25	Y14	BZX84-C39	1V	BF820
R8		V2		Y15	-C43	1W	BF821
R9		V3		Y16	-C47	1X	BF822
S1	BBY31	V4	BFT25R	Y17	-C51	1Y	BF823
S2	BBY40	V5		Y18	-C56	2B	BC849B
S3		V6		Y19	BZX84-C62	2BR	BC849BR
S4		V7		Y20	-C68	2C	BC849C
S5		V8		Y21	-C75	2CR	BC849CR
S6	BF510	V9		Z1	BZX84-C4V7	2F	BC850B
S7	BF511	W1	BFT92	Z2	-C5V1	2FR	BC850BR
S8	BF512	W2		Z3	BZX84-C5V6	2G	BC850C
S9	BF513	W3		Z4	-C6V2	2GR	BC850CR
T1	BCX17	W4	BFT92R	Z5	-C6V8	2Y4	BZV49-C2V4
T2	BCX18	W5		Z6	-C7V5	2Y7	BZV49-C2V7
T3	BSS63	W6		Z7	-C8V2	3A	BC856A
T4	BCX17R	W7		Z8	BZX84-C9V1	3AR	BC856AR
T5	BCX18R	W8		Z9	-C10	3B	BC856B
T6	BSS63R	W9		Z11	-C2V4	3BR	BC856BR
T7	BSR15	X1	BFT93	Z12	-C2V7	3E	BC857A
T71	BSR15R	X2		Z13	-C3V0	3ER	BC857AR
T8	BSR16	X3		Z14	BZX84-C3V3	3F	BC857B
T81	BSR16R	X4	BFT93R	Z15	-C3V6	3FR	BC857BR
T9	BSR18	X5		Z16	-C3V9	3J	BC858A
T91	BSR18R	X6		Z17	-C4V3	3JR	BC858AR
T92	BSR18A	X7		1A	BC846A	3K	BC858B
T93	BSR18AR	X8		1AR	BC846AR	3KR	BC858BR
U1	BCX19	X9		1B	BC846B	3L	BC858C
U2	BCX20	Y1	BZX84-C11	1BR	BC846BR	3LR	BC858CR
U3	BSS64	Y2	-C12	1E	BC847A	3Y0	BZV49-C3V0
U4	BCX19R	Y3	-C13	1ER	BC847AR	3Y3	BZV49-C3V3

mark	type no.	mark	type no.	mark	type no.	mark	type no.
3Y6	BZV49-C3V6	5C	BC807-40	6G	BC818-40	36Y	BZV49-C36
3Y9	BZV49-C3V6	5CR	BC807-40R	6GR	BC818-40R	39Y	BZV49-C39
4A	BC859A	5E	BC808-16	6Y2	BZV49-C6V2	43Y	BZV49-C43
4AR	BC859AR	5ER	BC808-16R	6Y8	-C6V8	47Y	BZV49-C47
4B	BC859B	5F	BC808-25	7Y5	-C7V5	51Y	BZV49-C51
4BR	BC859BR	5FR	BC808-25R	8Y2	BZV49-C8V2	56Y	BZV49-C56
4C	BC859C	5G	BC808-40	9Y1	-C9V1	62Y	BZV49-C62
4CR	BC859CR	5GR	BC808-40R	10Y	-C10	68Y	BZV49-C68
4E	BC860A	5Y1	BZV49-C5V1	11Y	-C11	75Y	BZV49-C75
4ER	BC860AR	5Y6	BZV49-C5V6	12Y	-C12		
4F	BC860B	6A	BC817-16	13Y	BZV49-C13		
4FR	BC860BR	6AR	BC817-16R	15Y	-C15		
4G	BC860C	6B	BC817-25	16Y	-C16		
4GR	BC860CR	6BR	BC817-25R	18Y	-C18		
4Y3	BZV49-C4V3	6C	BC817-40	20Y	-C20		
4Y7	BZV49-C4V7	6CR	BC817-40R	22Y	BZV49-C22		
5A	BC807-16	6E	BC818-16	24Y	BZV49-C24		
5AR	BC807-16R	6ER	BC818-16R	27Y	BZV49-C27		
5B	BC807-25	6F	BC818-25	30Y	BZV49-C30		
5BR	BC807-25R	6FR	BC818-25R	33Y	BZV49-C33		

TAPE AND REEL SPECIFICATION

Semiconductors in SOT-23 and SOT-143 encapsulations can be delivered in reel packing for automatic placement on hybrid circuits and printed circuit boards. The devices are placed with the mounting side downwards in compartments.

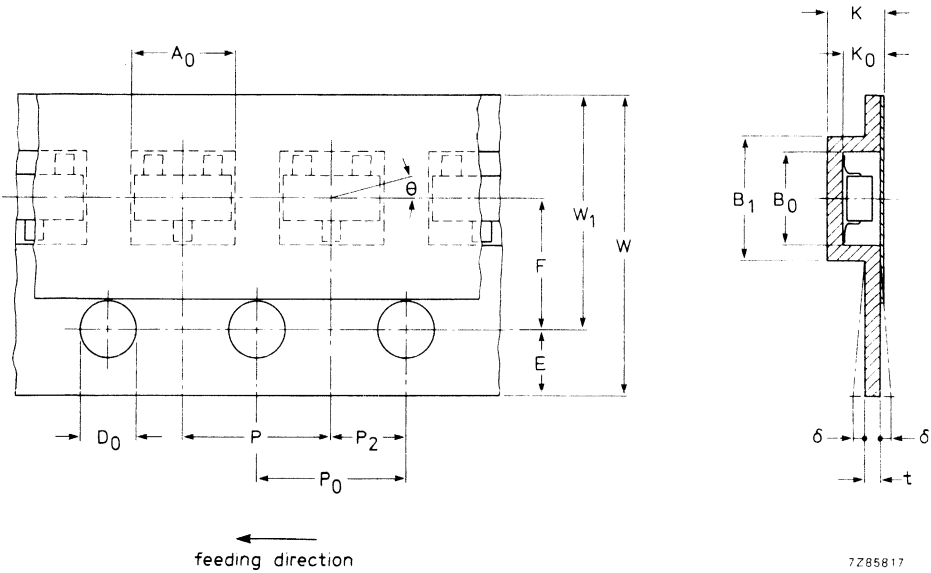


Fig. 1 Configuration of bandolier. Dimensions in mm.

Compartment			tol.
length	A_0	2,85	+ 0,2
width	B_0	2,35	+ 0,2
depth	K_0	0,95	+ 0,2
width outside	B_1	3,3	max.
pitch	P	4,0	± 0,1
deviation	Θ	15^o	max.
Sprocket hole			
diameter	D_0	1,5	+ 0,1
pitch	P_0	4,0	± 0,1
distance	E	1,75	± 0,1
cumulative (10) pitch error		± 0,1	

Centre line dimensions			tol.
length direction	P_2	2,0	± 0,05
width direction	F	3,5	± 0,05
Fixing tape			
width	W_1	5,5	± 0,25
thickness	—	0,1	max.
Carrier tape			
width	W	8,0	± 0,2
bending	δ	0,3	max.
thickness	t	0,4	max.
Overall thickness	K	1,5	max.

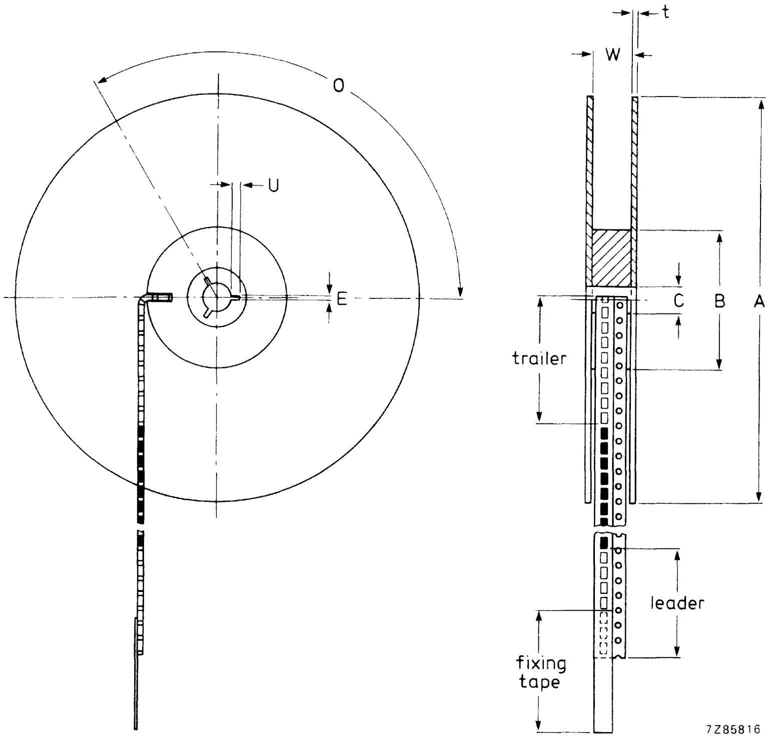


Fig. 2 Configuration of reel and flange (dimensions in mm).

Flange			tol.
diameter	A	180	+0 −2
thickness	t	1,5	+0,5 −0,1
space between flanges	W	9,5	± 0,5

Hub			tol.
diameter	B	62	± 1,5
spindle hole	C	12,75	+0,15 −0
key slit			
width	E	2	± 0,5
depth	U	4	± 0,5
location	O	120	degrees

Amount of devices per reel

The bandolier of a 180 mm reel contains minimally 3000 devices with a maximum of 15 vacant compartments (0,5%). Three consecutive empty places might be found provided this gap is followed by 6 consecutive devices.

The carrier tape (leader) starts with at least 50 empty positions (200 mm); the covering foil minimum 200 mm. To be able to fix the carrier tape a 20 to 50 mm self-adhesive tape is applied.

At the end of the bandolier (trailer) 10 empty positions (40 mm) and 40 mm foil. To be fixed a 20 to 50 mm self-adhesive tape is attached.

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 ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
D. TRANSISTOR; power, audio frequency ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)
E. DIODE; tunnel
F. TRANSISTOR; low power, high frequency ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
G. MULTIPLE OF DISSIMILAR DEVICES – MISCELLANEOUS; e.g. oscillator
H. DIODE; magnetic sensitive
L. TRANSISTOR; power, high frequency ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)
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 ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
S. TRANSISTOR; low power, switching ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
T. CONTROL AND SWITCHING DEVICE; e.g. thyristor, power ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)
U. TRANSISTOR; power, switching ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)
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.

→ * When these serial numbers are exhausted the serial number for consumer types may be extended to four figures, and that for industrial types to three figures.

TRANSISTOR RATINGS

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

Transistor voltage ratings

Collector to base voltage ratings

V_{CBmax} — The maximum permissible instantaneous voltage between collector and base terminals. The collector voltage is negative with respect to base in PNP transistors and positive with respect to base in NPN types.

V_{CBmax} $(I_E = 0)$ — The maximum permissible instantaneous voltage between collector and base terminals, when the emitter terminal is open circuited.

Emitter to base voltage ratings

V_{EBmax} — The maximum permissible instantaneous reverse voltage between emitter and base terminal. The emitter voltage is negative with respect to base for PNP transistor and positive with respect to base for NPN types.

V_{EBmax} $(I_C = 0)$ — The maximum permissible instantaneous reverse voltage between emitter and base terminals when the collector terminal is open circuited.

Collector to emitter voltage ratings

V_{CEmax} — The maximum permissible instantaneous voltage between collector and emitter terminals. The collector voltage is negative with respect to emitter in PNP transistors and positive with respect to emitter in NPN types. This rating is very dependent on circuit conditions and collector current and it is necessary to refer to the curve of V_{CE} versus I_C for the appropriate circuit condition in order to obtain the correct rating.

V_{CEmax} (Cut-off) — The maximum permissible instantaneous voltage between collector and emitter terminals when the emitter current is reduced to zero by means of a reverse emitter base voltage, i.e. the base voltage is normally positive with respect to emitter for PNP transistor and negative with respect to emitter for NPN types.

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

V_{CEmax} $(I_C = x\ mA)$ — The maximum permissible instantaneous voltage between collector and emitter terminals when the collector current is at a high value, often the max. rated value.

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

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

This curve is divided into two areas:

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

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

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

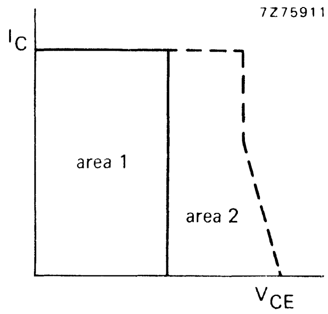


Fig. 1.

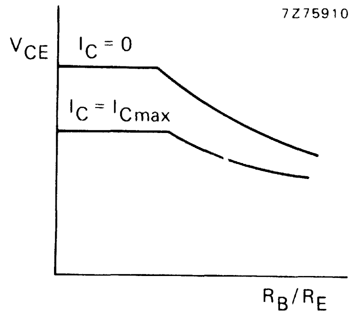


Fig. 2.

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

Transistor current ratings

Collector current ratings

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

Emitter current ratings

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

Base current ratings

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

Transistor power ratings

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

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

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

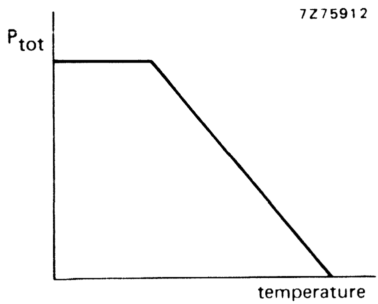


Fig. 3.

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

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

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

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

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

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

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

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

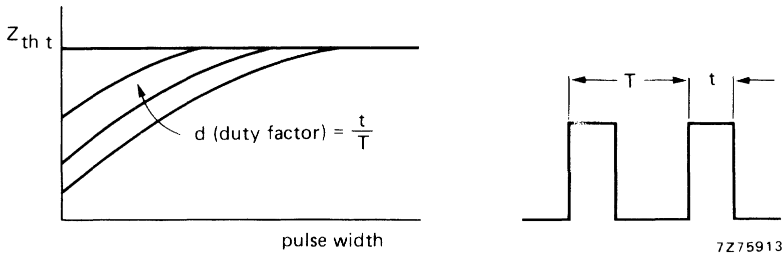


Fig. 4.

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

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

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

Temperature ratings

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

RATING SYSTEMS

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

DEFINITIONS OF TERMS USED

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

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

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

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

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

Note
Limiting conditions may be either maxima or minima.

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

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

ABSOLUTE MAXIMUM RATING SYSTEM

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

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

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

DESIGN MAXIMUM RATING SYSTEM

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

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

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

DESIGN CENTRE RATING SYSTEM

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

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

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

LETTER SYMBOLS FOR TRANSISTORS AND SIGNAL DIODES

based on IEC Publication 148

LETTER SYMBOLS FOR CURRENTS, VOLTAGES AND POWERS

Basic letters

The basic letters to be used are:

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

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

Subscripts

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

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

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

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

b) instantaneous total values
Example i_B

c) average total values
Example $I_{B(AV)}$

d) peak total values
Example I_{BM}

e) root-mean-square total values
Example $I_{B(RMS)}$

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

a) instantaneous values
Example i_b

b) root-mean-square values
Example $I_{b(rms)}$

c) peak values
Example I_{bm}

d) average values
Example $I_{b(av)}$

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

Additional rules for subscripts

Subscripts for currents

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

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

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

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

Subscripts for voltages

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

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

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

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

Subscripts for supply voltages or supply currents

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

Examples: V_{CC}, I_{EE}

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

Example : V_{CCE}

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

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

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

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

Subscripts for multiple devices

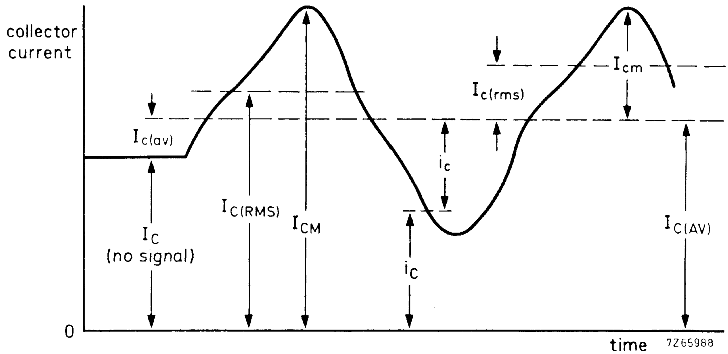
For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

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

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

Application of the rules

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



LETTER SYMBOLS FOR ELECTRICAL PARAMETERS

Definition

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

Basic letters

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

B, b = susceptance; imaginary part of an admittance

C = capacitance

G, g = conductance; real part of an admittance

H, h = hybrid parameter

L = inductance

R, r = resistance; real part of an impedance

X, x = reactance; imaginary part of an impedance

Y, y = admittance;

Z, z = impedance;

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

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

b) all inductances and capacitances.

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

Subscripts

General subscripts

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

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

Examples: Z_S, h_f, h_F

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

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

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

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

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

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

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

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

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

Subscripts for four-pole matrix parameters

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

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

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

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

Distinction between real and imaginary parts

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

Examples: $Z_i = R_i + jX_i$

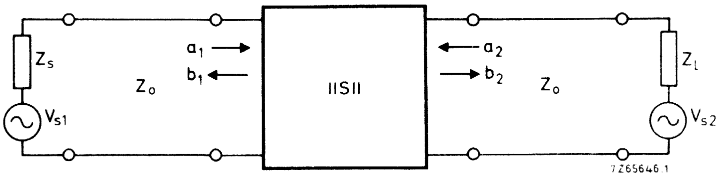
$y_{fe} = g_{fe} + jb_{fe}$

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

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

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.



$$a_1 = \frac{V_{i1}}{\sqrt{Z_0}} \qquad a_2 = \frac{V_{i2}}{\sqrt{Z_0}} \qquad {}^{1)}$$

$$b_1 = \frac{V_{r1}}{\sqrt{Z_0}} \qquad b_2 = \frac{V_{r2}}{\sqrt{Z_0}}$$

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

V_i = incident voltage

V_r = reflected (generated) voltage

The four-pole equations for s-parameters are:

$$b_1 = s_{11}a_1 + s_{12}a_2$$
$$b_2 = s_{21}a_1 + s_{22}a_2$$

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

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

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

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

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

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

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, SOT-143 AND SOT-89 ENVELOPES

SOT-23, SOT-143 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 SOT-23, SOT-143 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, SOT-143 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.

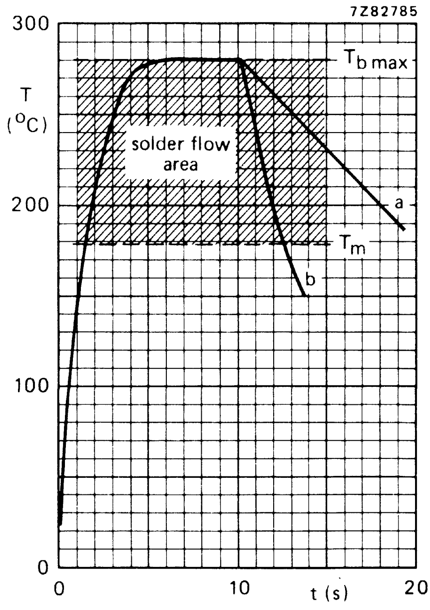
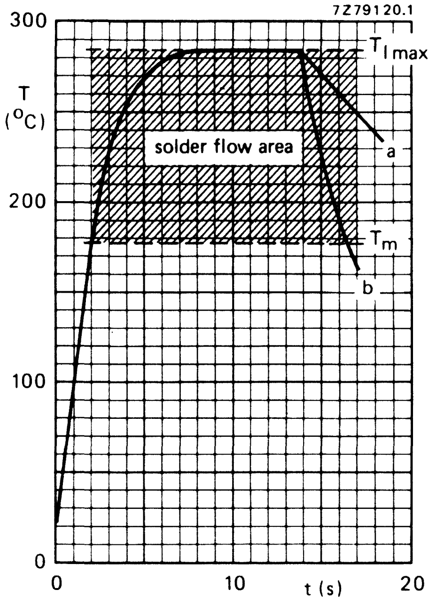


Fig. 1 Device temperature during *immersion* soldering.

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.

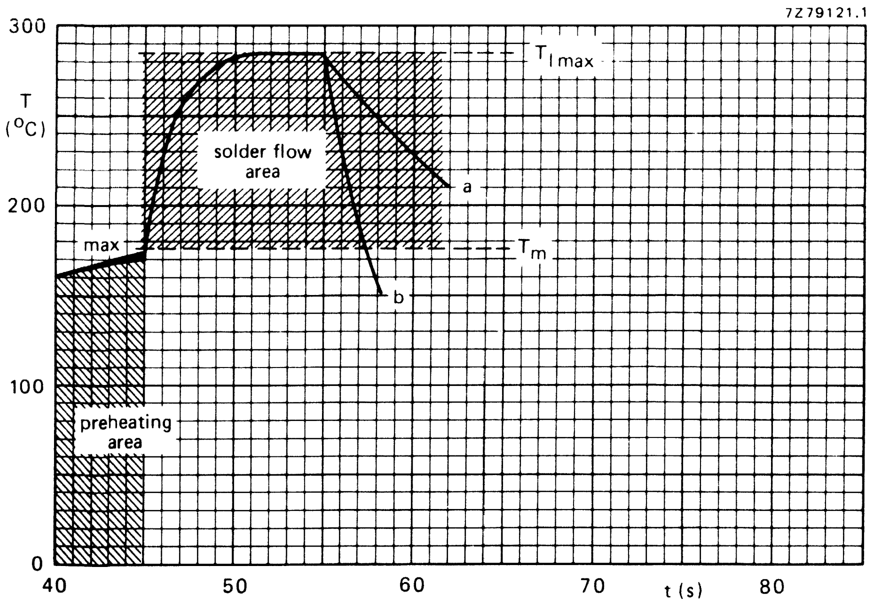


Fig. 3 Reflow soldering with preheating.

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

Dimensions in mm

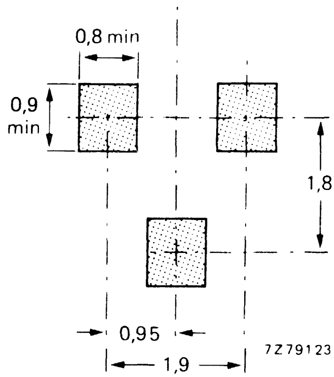


Fig. 4 SOT-23 pattern.

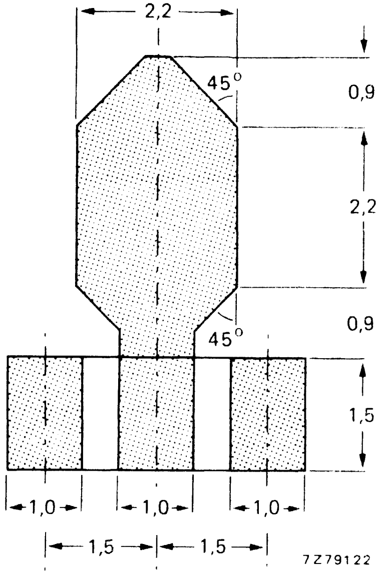


Fig. 5 SOT-89 pattern.

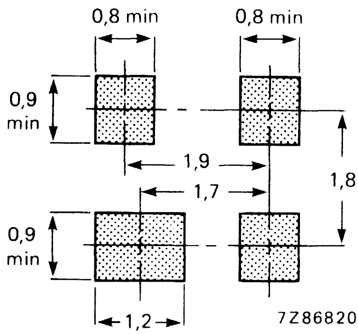


Fig. 6 SOT-143 pattern.

THERMAL CHARACTERISTICS OF SOT-23 AND SOT-143 ENVELOPES

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

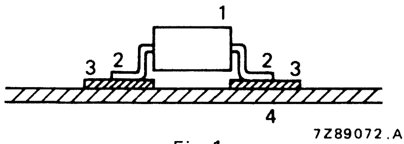


Fig. 1.

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).

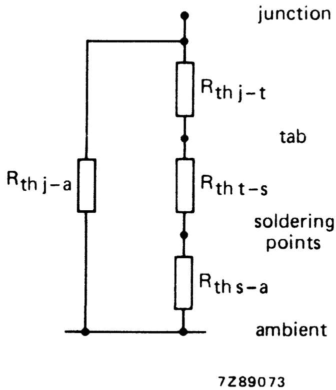


Fig. 2 Thermal behaviour of heat flow when the device is mounted on a substrate or printed circuit board.

$R_{th\,j\text{-}t}$ = 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.

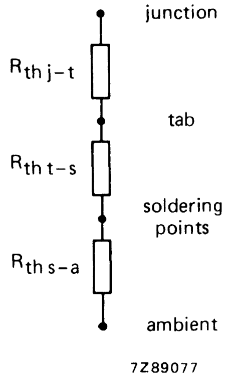


Fig. 3 Basic thermal model.

Heat transfer from junction to tab

This is an internal heat transfer and has been measured. In general it is:

for high-frequency transistors, low-power diodes and (MOS) FETs	60 K/W
for low-frequency and switching transistors	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 with $P_{tot} < 350$ mW	280 K/W
for types of semiconductors in this envelope with $P_{tot} < 425$ mW	260 K/W
for types of semiconductors in a SOT-143 envelope this value is	310 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 and SOT-143 encapsulations.

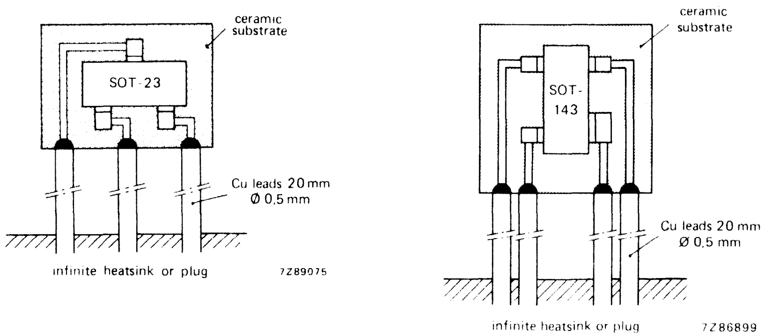


Fig. 4 Test circuits SOT-23 and SOT-143 mounting conditions on a ceramic substrate.

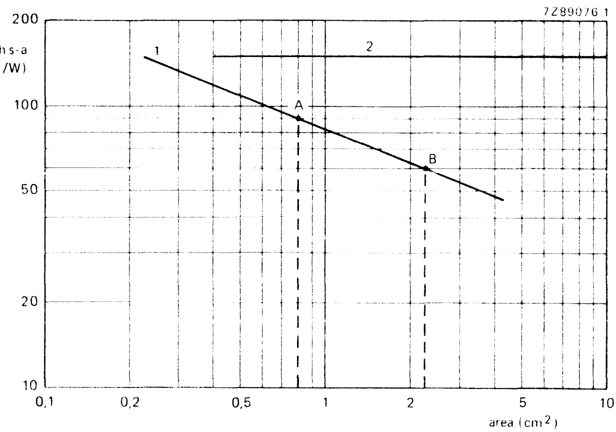


Fig. 5 Heat transfer from soldering points to ambient.

1. Ceramic substrate

Point A on the curve in Fig. 5 is for an area of the ceramic substrate of 8 mm x 10 mm x 0,7 mm for the maximum rating of all high-frequency, low-frequency and switching transistors and also for all diodes.

Point B on the curve in Fig. 5 is for an area of the ceramic substrate of 15 mm x 15 mm x 0,7 mm for the maximum rating of low-frequency medium-power semiconductors.

2. Printed circuit board

$R_{th\ s\text{-}a}$ = 150 K/W for SOT-23 and SOT-143 envelopes mounted on a printed circuit board.

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:

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

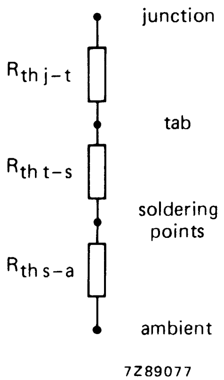


Fig. 6 Thermal model of SOT-23 envelopes with one crystal.

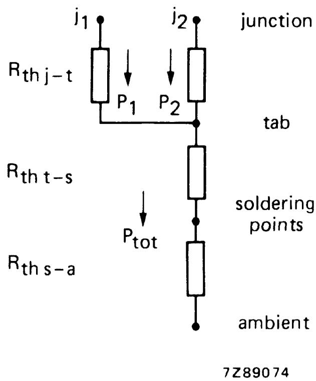


Fig. 7 Thermal model of SOT-23 envelopes with two crystals (double diode).

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

$$T_{tab} = P_{tot} \cdot (R_{th\ t\text{-}s} + R_{th\ s\text{-}a}) + T_{amb} = P_{tot}\,(280 + 90) + T_{amb}$$

$$T_{j1} = (P_1 \times R_{th\ j\text{-}t}) + T_{tab} = P_1 \cdot 60 + T_{tab}$$

$$T_{j2} = (P_2 \times R_{th\ j\text{-}t}) + T_{tab} = P_2 \cdot 60 + T_{tab}$$

As mentioned on page 2:

$R_{th\ j\text{-}t}$ for diodes is 60 K/W.

$R_{th\ s\text{-}a}$ (area 8 mm x 10 mm x 0,7 mm) = 90 K/W.

$R_{th\ t\text{-}s}$ for all semiconductors in SOT-23 = 280 K/W.

Thus:

$$T_{j1} = 60\,P_1 + 370\,P_{tot} + T_{amb}.$$

$$T_{j2} = 60\,P_2 + 370\,P_{tot} + T_{amb}.$$

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.

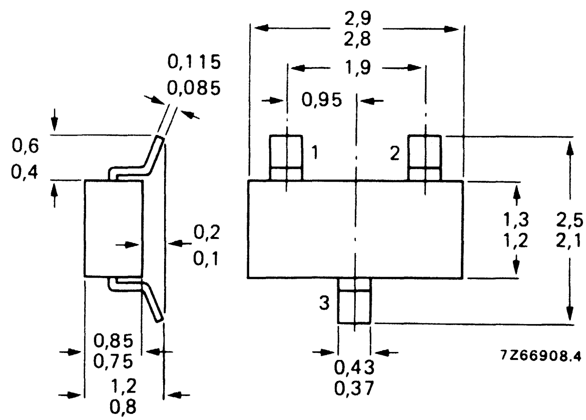
QUICK REFERENCE DATA

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	^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

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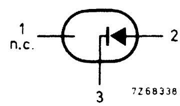


See also *Soldering recommendations.*

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) up to T_{amb} = 25 °C**	$I_{F(AV)}$	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	$R_{th\,j\text{-}t}$	=	60	K/W
→ From tab to soldering points	$R_{th\,t\text{-}s}$	=	280	K/W
→ From soldering points to ambient **	$R_{th\,s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 mm.

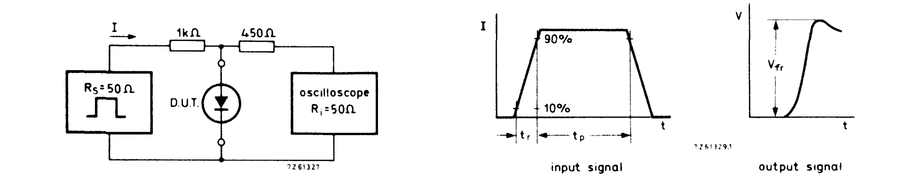


Fig. 2 Forward recovery voltage test circuit and waveforms.

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

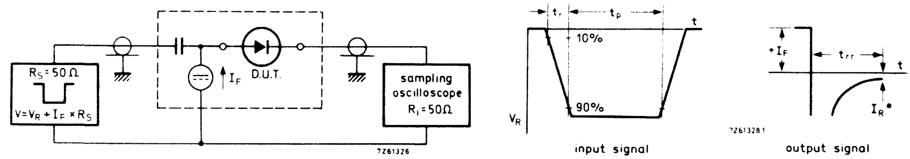


Fig. 3 Reverse recovery time test circuit and waveforms.

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

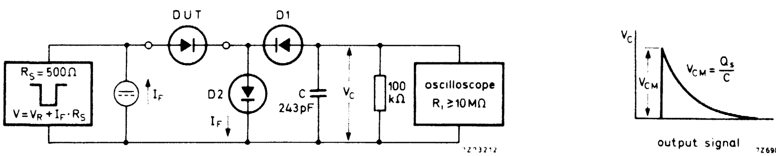


Fig. 4 Recovery charge test circuit and waveform.

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

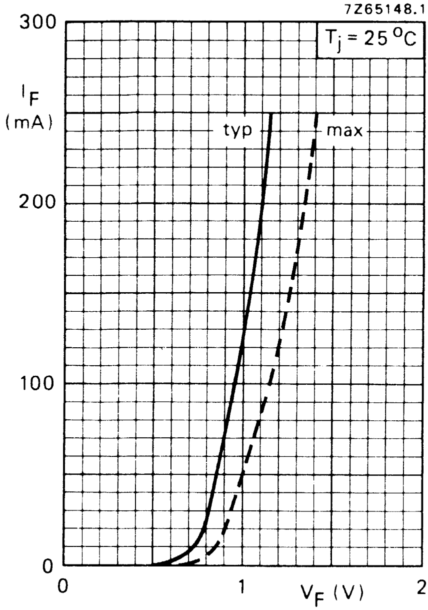


Fig. 5.

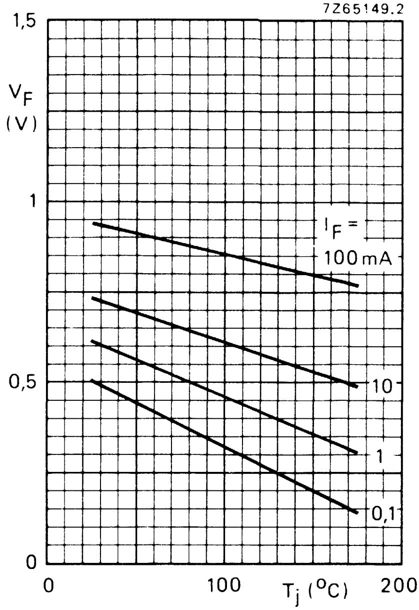


Fig. 6 Typical values.

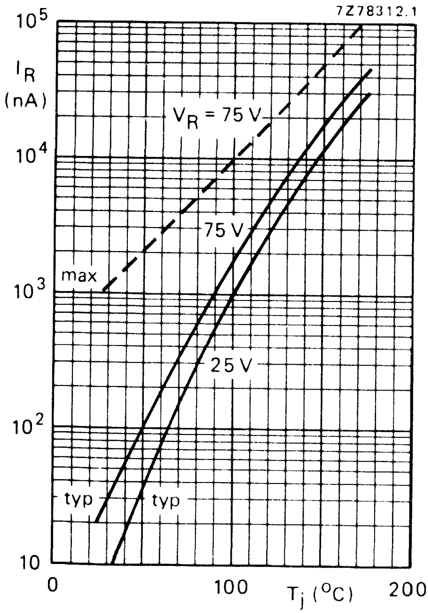


Fig. 7.

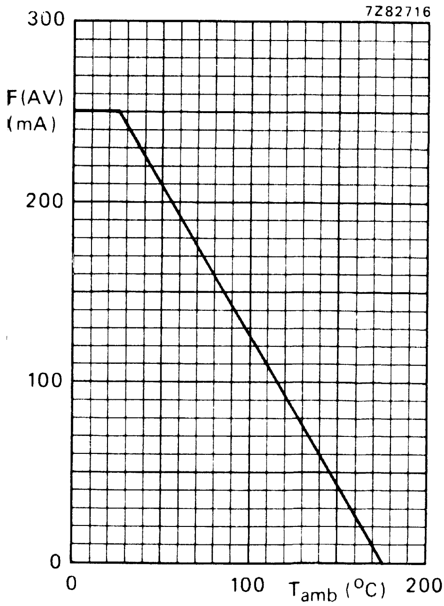


Fig. 8 Current derating curve.

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.

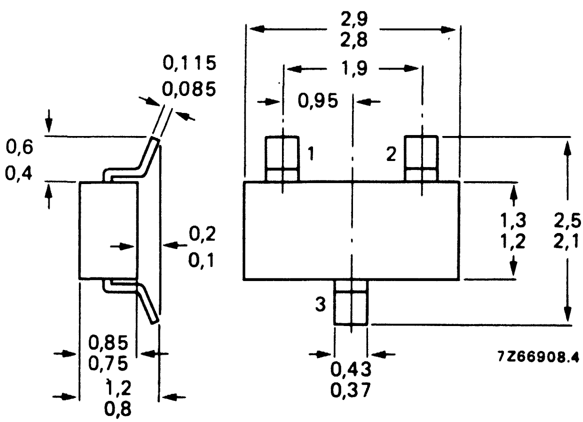
QUICK REFERENCE DATA

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

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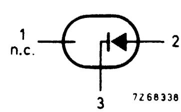


See also chapter *Soldering Recommendations*.

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 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	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	K/W

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

* See *Thermal characteristics* in chapter GENERAL.

** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

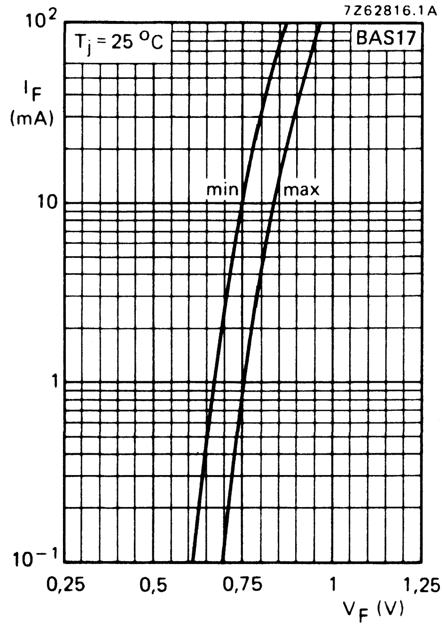


Fig. 2 Forward current as a function of forward voltage.

SILICON PLANAR EPITAXIAL HIGH-SPEED DIODES

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

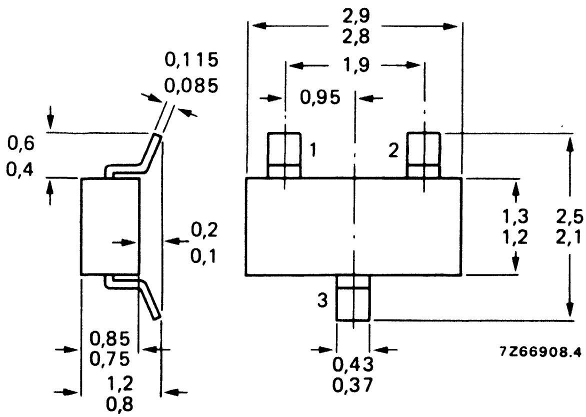
QUICK REFERENCE DATA

			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		^oC
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

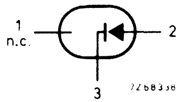
Fig. 1 SOT-23.

Dimensions in mm



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.) up to T_{amb} = 25 °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 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	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	K/W

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

(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.
* See *Thermal characteristics* in chapter GENERAL.
** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

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; $R_L = 100\ \Omega$; measured at $I_R = 3$ mA	t_{rr}	<	50 ns

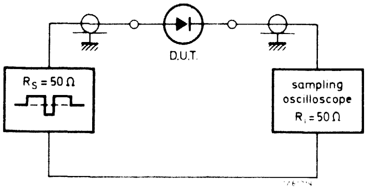


Fig. 2 Test circuit.

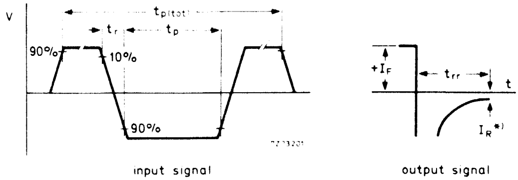


Fig. 3 Waveforms; $I_R = 3$ mA.

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.

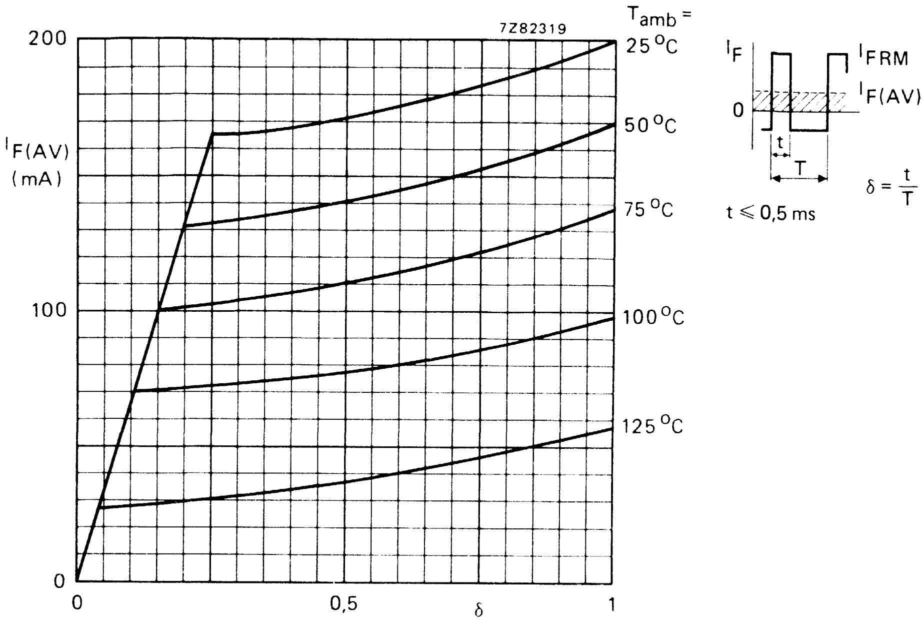


Fig. 4 BAS19; maximum permissible average rectified forward current for pulse operation as a function of the duty factor at V_R = 100 V.

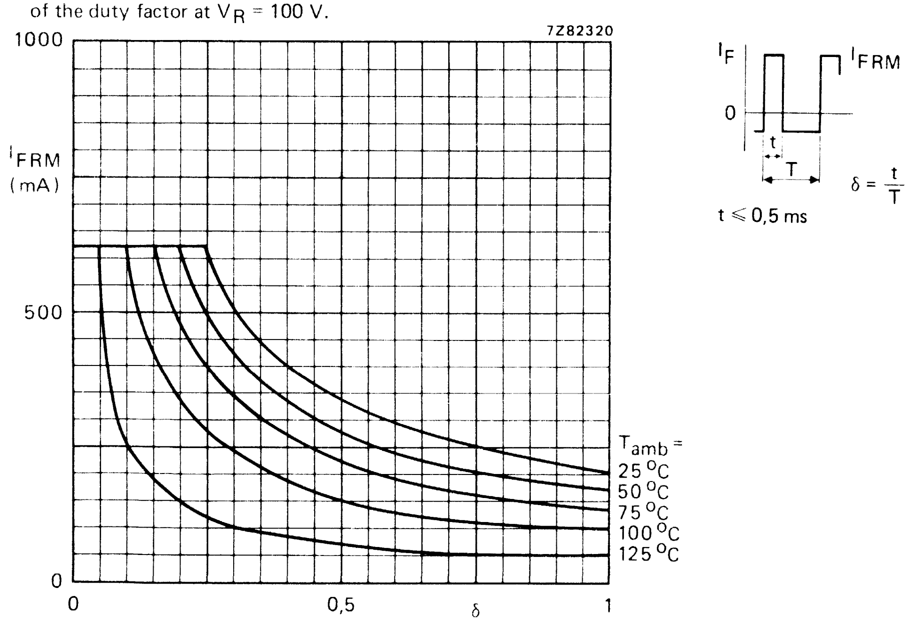


Fig. 5 BAS19; maximum permissible repetitive peak forward current for pulse operation as a function of the duty factor at V_R = 100 V.

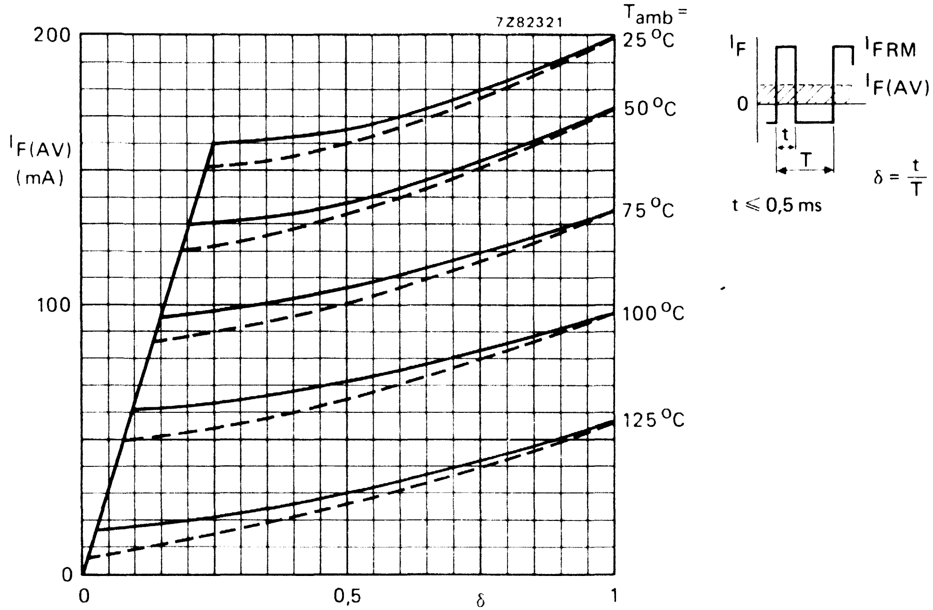


Fig. 6 BAS20/21; maximum permissible average rectified forward current for pulse operation as a function of the duty factor.

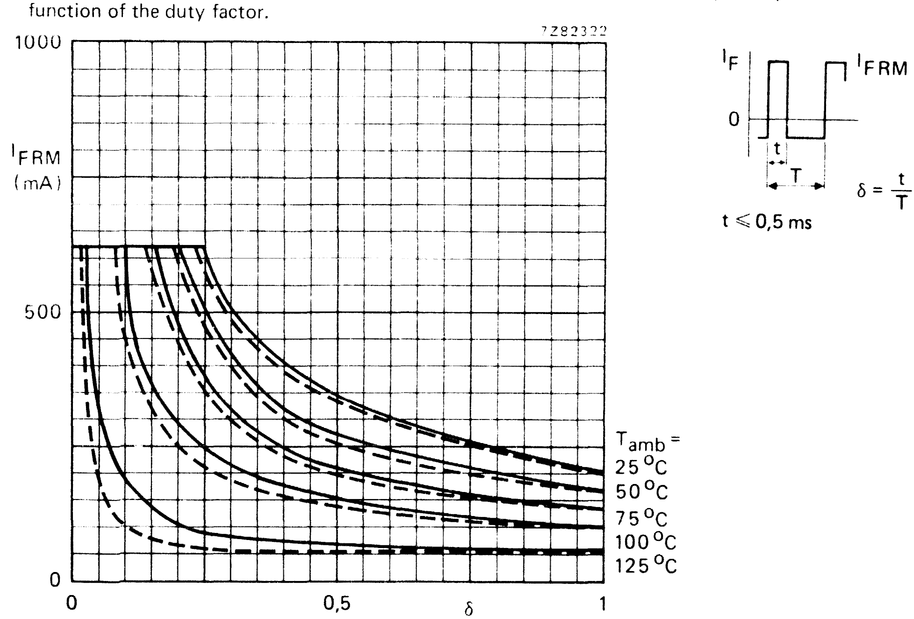


Fig. 7 BAS20/21; maximum permissible repetitive peak forward current for pulse operation as a function of the duty factor.

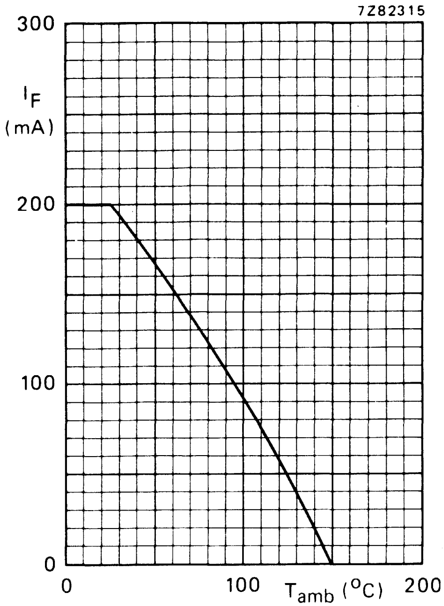


Fig. 8.

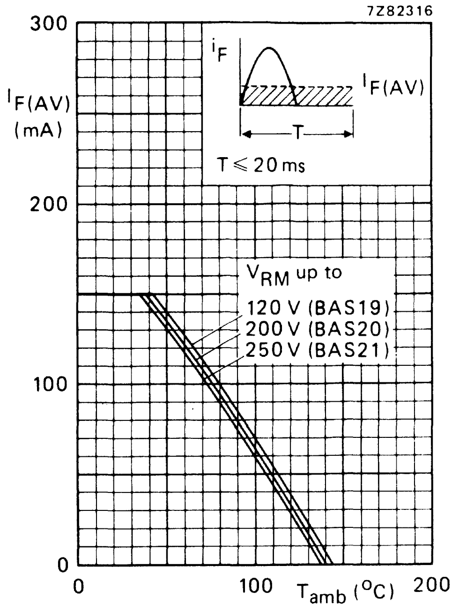


Fig. 9.

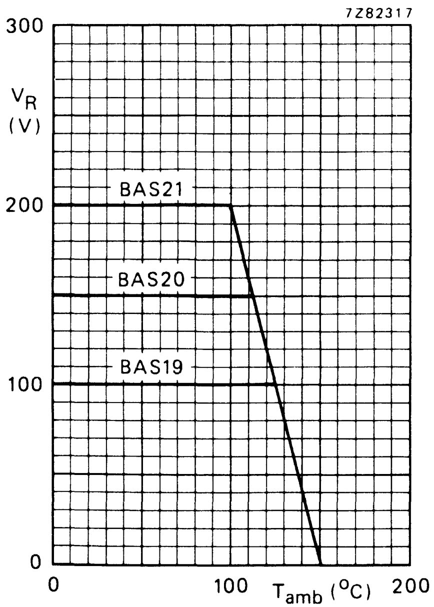


Fig. 10.

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.

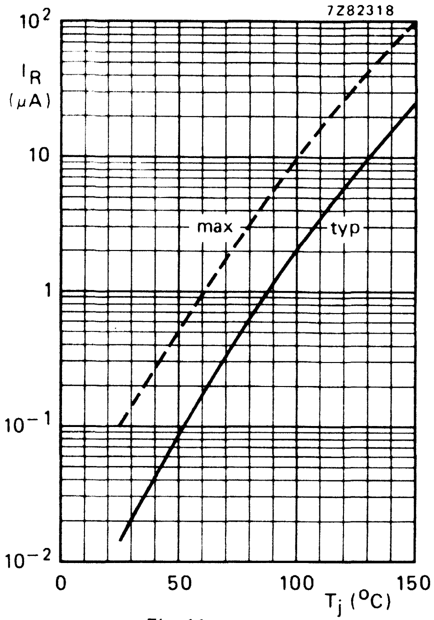


Fig. 11.

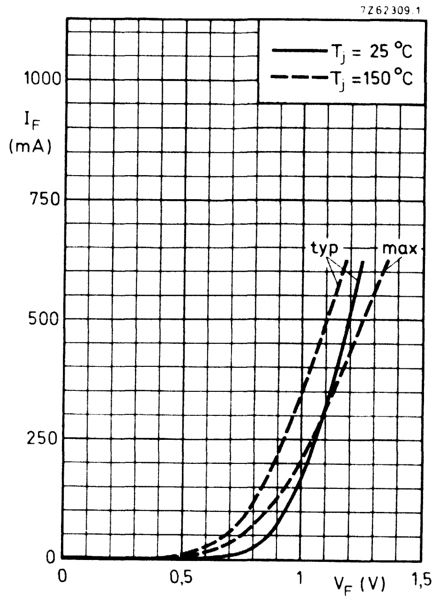


Fig. 12.

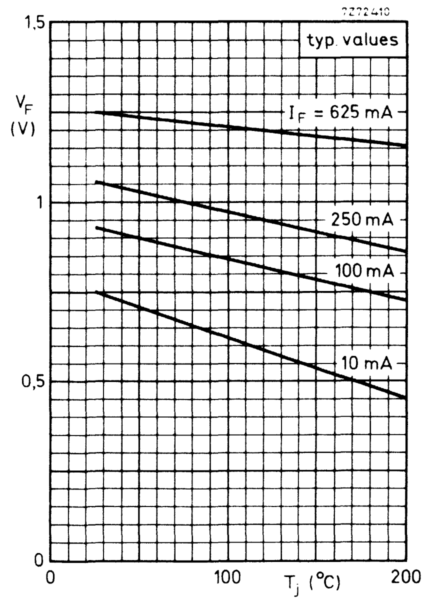


Fig. 13.

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.

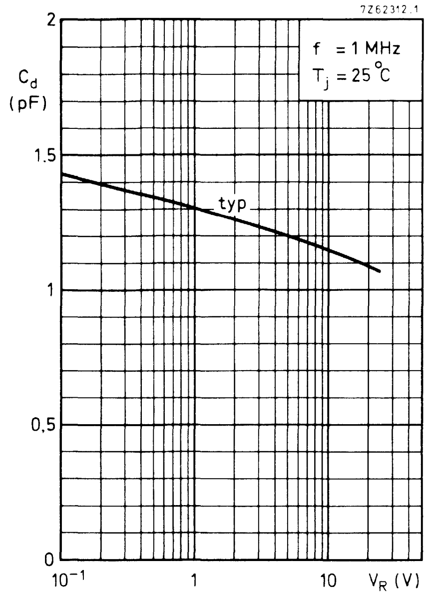

7Z62312.1
f = 1 MHz
T_j = 25 °C
C_d (pF)
2
1.5
1
0,5
0
typ
10^{-1}
1
10
V_R (V)

Fig. 14.

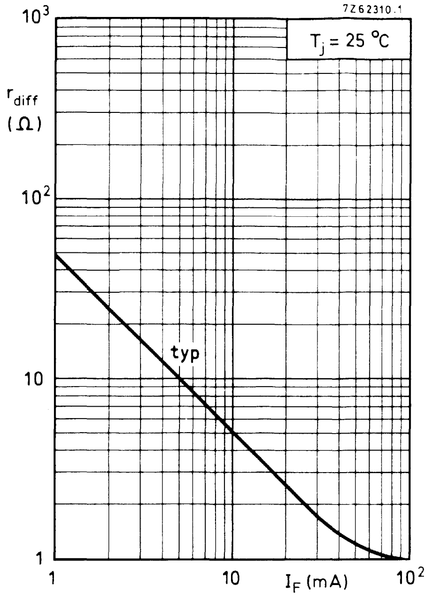

7Z62310.1
T_j = 25 °C
r_{diff} (Ω)
10^3
10^2
10
1
typ
1
10
I_F (mA)
10^2

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	°C
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

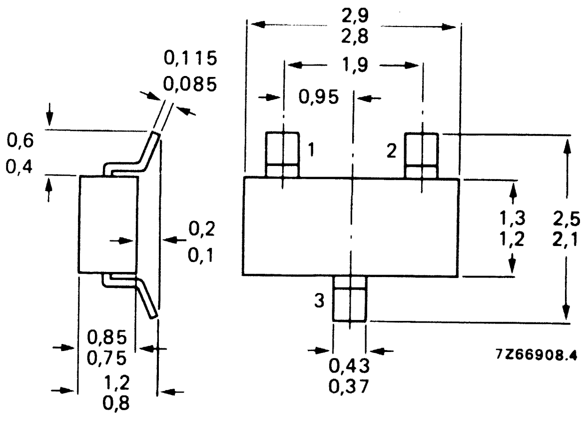
MECHANICAL DATA

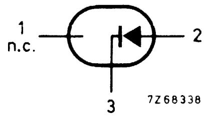
Dimensions in mm

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 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	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	K/W

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

* See *Thermal characteristics* in chapter GENERAL.

→ ** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

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

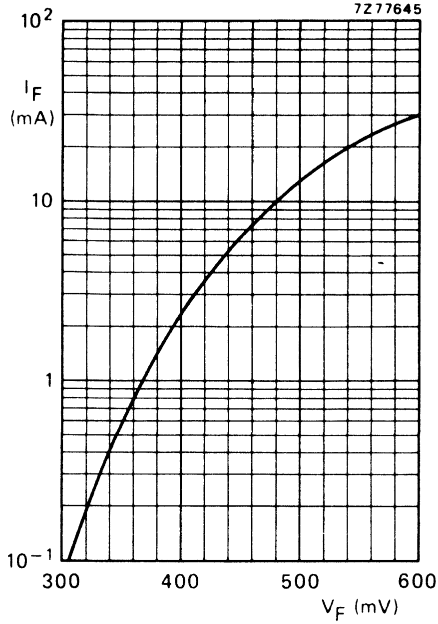


Fig. 2 Typical values.

SILICON PLANAR DIODE

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

QUICK REFERENCE DATA

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

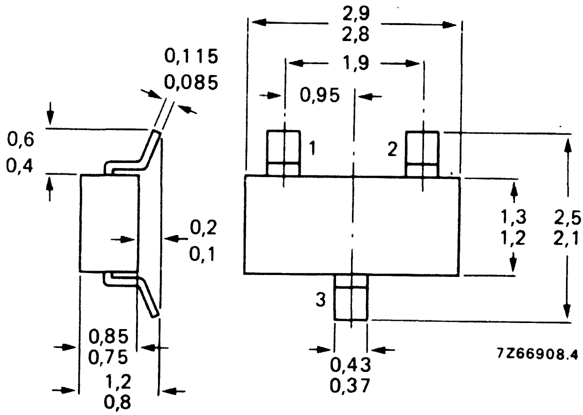
MECHANICAL DATA

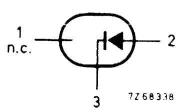
Dimensions in mm

Fig. 1 SOT-23.

Marking code

BAT18 = A2





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 + 125 °C
Junction temperature	T_j	max.	125 °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	$R_{th\ t\text{-}s}$	=	280 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90 K/W

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		typ.	0,8 pF
V_R = 20 V	C_d	<	1,0 pF
Series resistance at f = 200 MHz		typ.	0,5 Ω
I_F = 5 mA	r_D	<	0,7 Ω

* See *Thermal characteristics* in chapter GENERAL.
** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

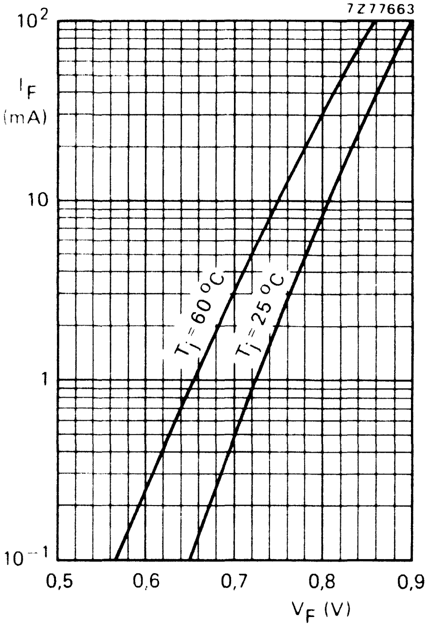


Fig. 2 Typical values.

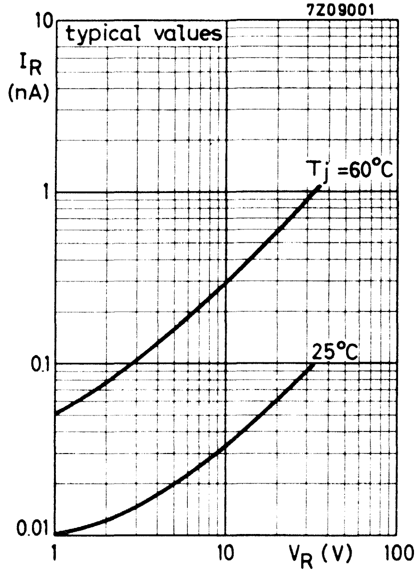


Fig. 3.

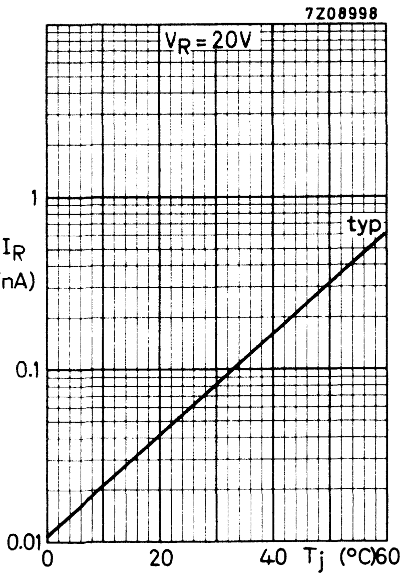


Fig. 4.

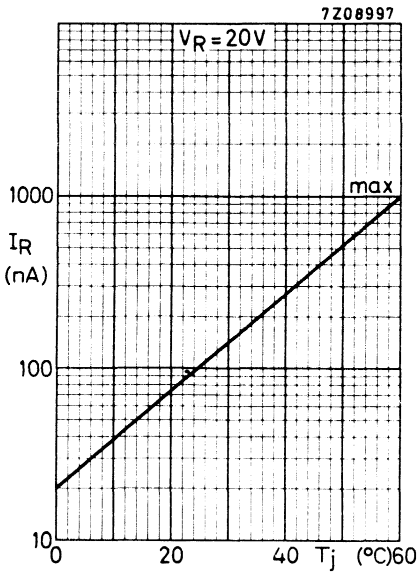


Fig. 5.

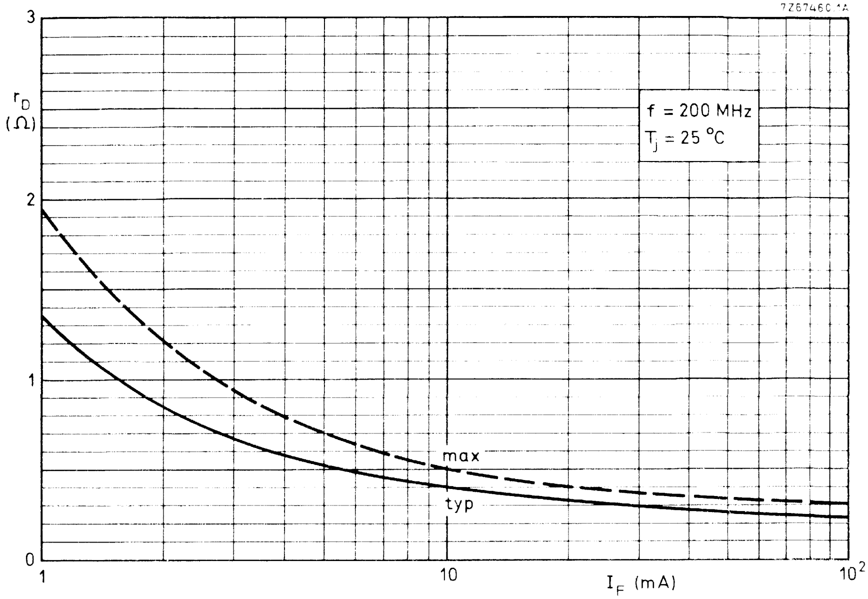


Fig. 6.

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)

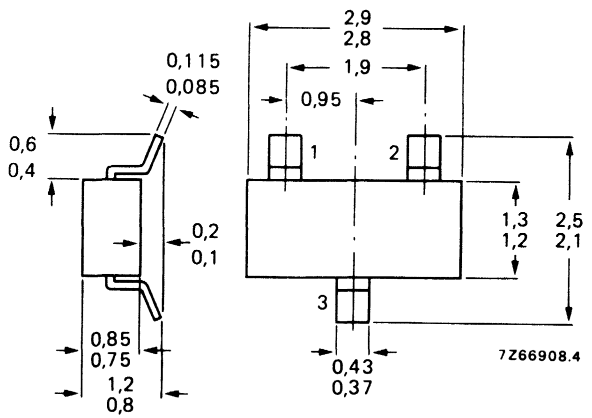
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward current	I_{FRM}	max.	250	mA
Junction temperature	T_j	max.	175	°C
Forward voltage at I_F = 50 mA	V_F	<	1,0	V
Reverse recovery time when switched from I_F = 10 mA to I_R = 10 mA; R_L = 100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

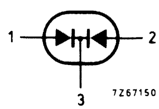
MECHANICAL DATA Dimensions in mm

Fig. 1 SOT-23.

Marking code

BAV70 = A4





See also *Soldering recommendations.*

RATINGS (per diode)

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

Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Average rectified forward current▲ (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	$R_{th\ j\text{-}t}$	=	60	K/W
→ From tab to soldering points	$R_{th\ t\text{-}s}$	=	280	K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	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	<	60	μA
V_R = 70 V	I_R	<	5	μA
V_R = 70 V; T_j = 150 °C	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 $t_p \leq 0{,}5$ 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 8 mm x 10 mm x 0,7 mm.

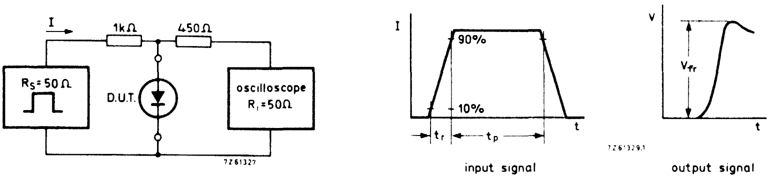


Fig. 2 Test circuit and waveforms; forward recovery voltage.

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

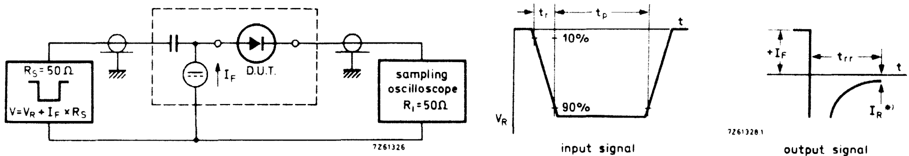


Fig. 3 Test circuit and waveforms; reverse recovery time.

*) 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

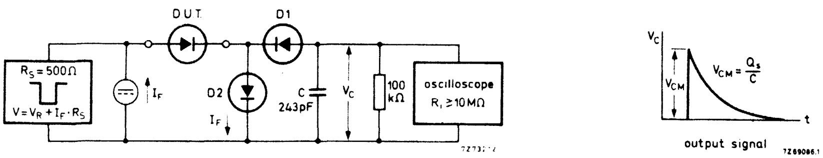


Fig. 4 Test circuit and waveform; recovery charge.

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)

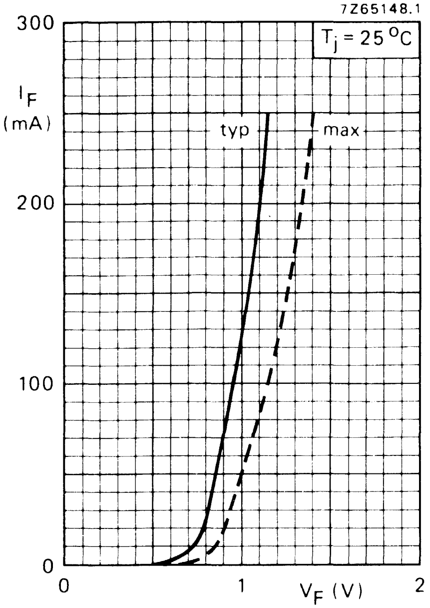


Fig. 5

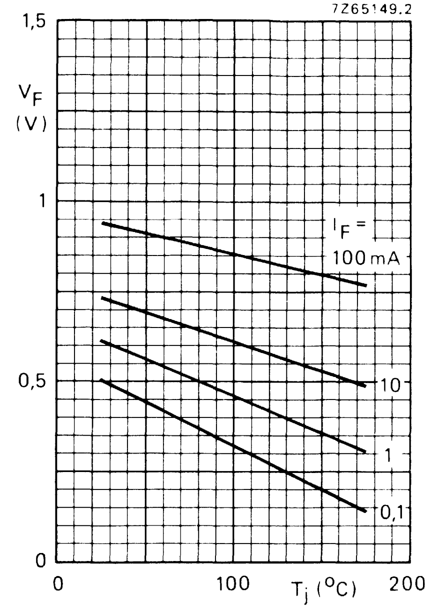


Fig. 6

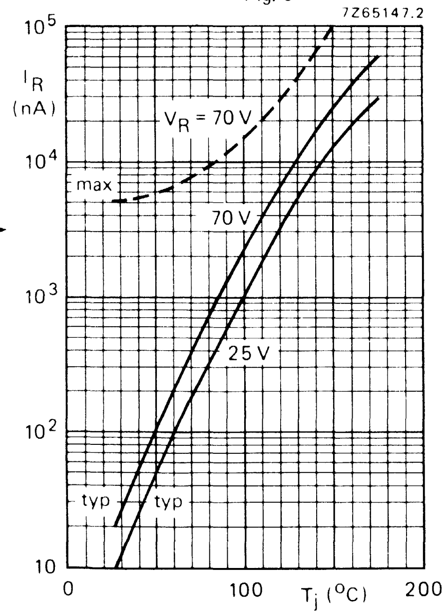


Fig. 7

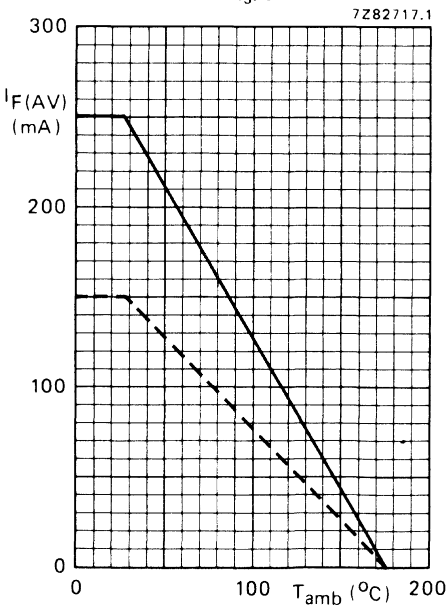


Fig. 8 ——— single diode
— — — — — double diode, equally loaded.

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)

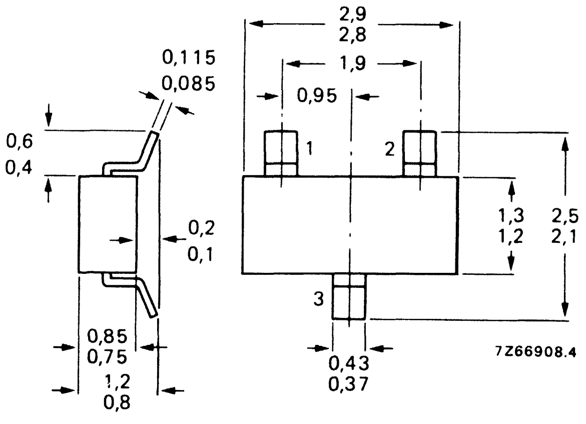
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward current	I_{FRM}	max.	250	mA
Junction temperature	T_j	max.	175	^oC
Forward voltage at I_F = 50 mA	V_F	<	1,0	V
Reverse recovery time when switched from I_F = 10 mA to I_R = 10 mA; R_L = 100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

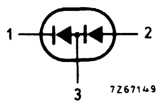
MECHANICAL DATA Dimensions in mm

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	$R_{th\,j\text{-}t}$	=	60	K/W
→ From tab to soldering points	$R_{th\,t\text{-}s}$	=	280	K/W
→ From soldering points to ambient **	$R_{th\,s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 mm.

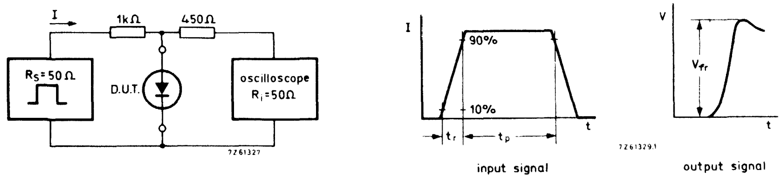


Fig. 2 Test circuit and waveforms; forward recovery voltage.

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

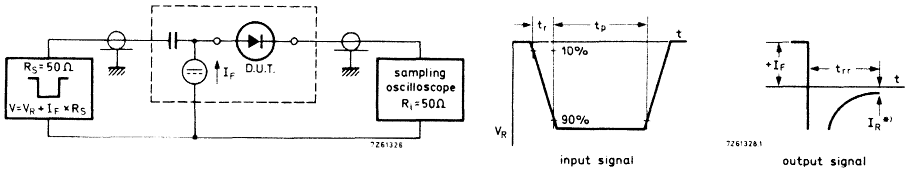


Fig. 3 Test circuit and waveforms; reverse recovery time.

Input signal: Rise time of the reverse pulse t_r = 0,6 ns $\quad$ *) I_R = 1 mA
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 $\quad Q_s \quad < \quad 45$ pC

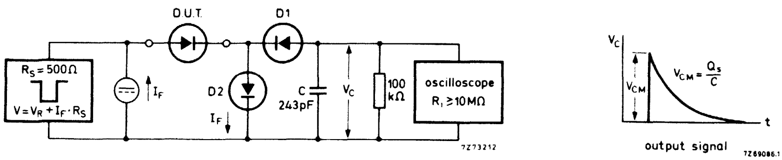


Fig. 4 Test and waveform; recovery charge.

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

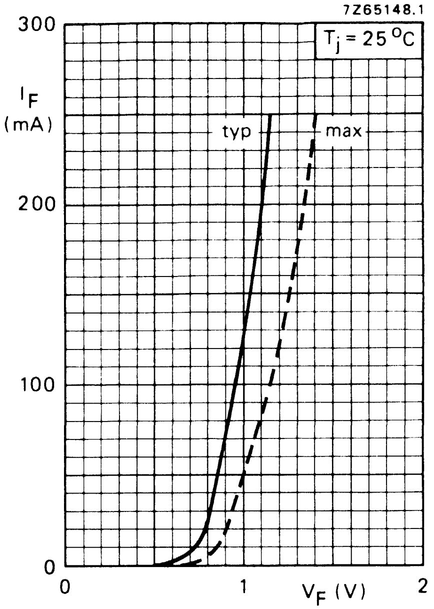


Fig. 5.

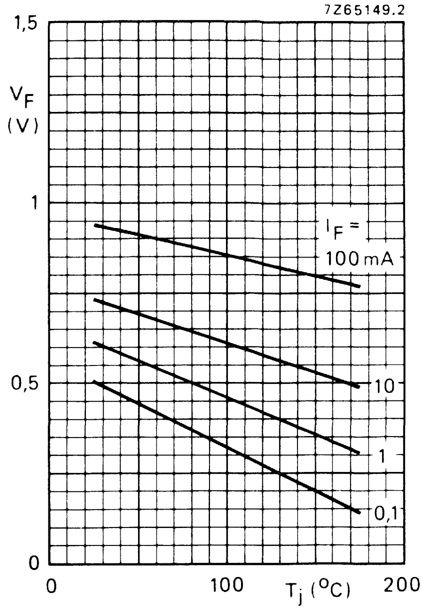


Fig. 6 Typical values.

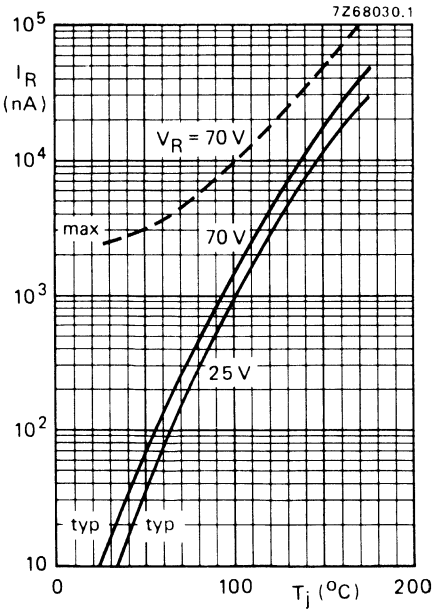


Fig. 7.

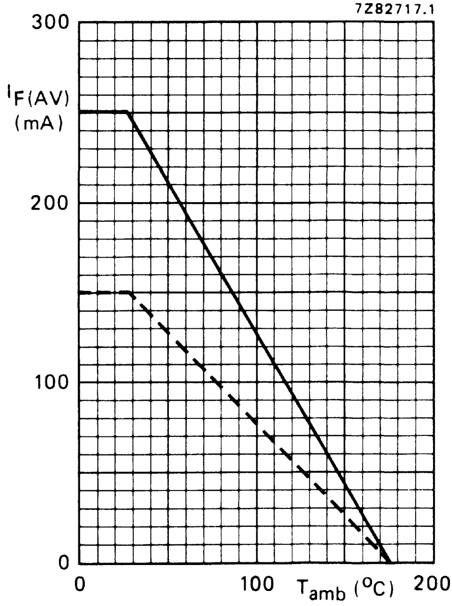


Fig. 8 ——— single diode
– – – – double diode; equally loaded.

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)

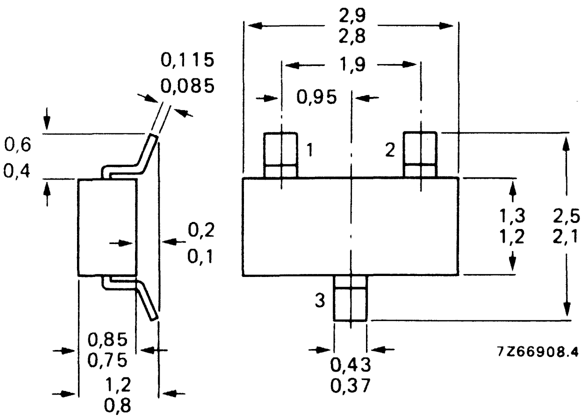
Continuous reverse voltage	V_R	max.	70	V
Repetitive peak reverse voltage	V_{RRM}	max.	70	V
Repetitive peak forward current	I_{FRM}	max.	250	mA
Junction temperature	T_j	max.	175	°C
Forward voltage at I_F = 50 mA	V_F	<	1,0	V
Reverse recovery time when switched from I_F = 10 mA to I_R = 10 mA; R_L = 100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

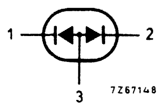
MECHANICAL DATA Dimensions in mm

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	$R_{th\ j\text{-}t}$	=	60	K/W
→ From tab to soldering points	$R_{th\ t\text{-}s}$	=	2 x 280	K/W
→ From soldering points to ambient **	$R_{th\ s\text{-}a}$	=	2 x 90	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 8 mm x 10 mm x 0,7 mm.

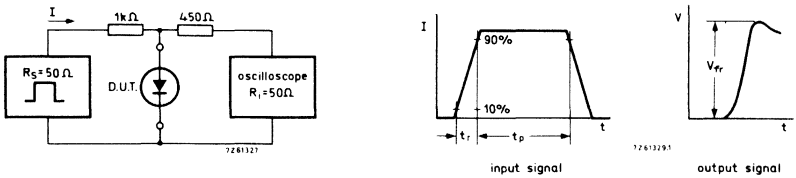


Fig. 2 Test circuit and waveforms; forward recovery voltage.

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

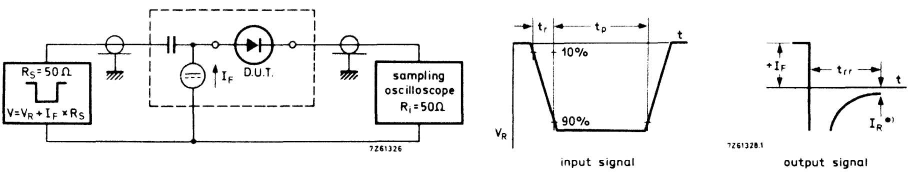


Fig. 3 Test circuit and waveforms; reverse recovery time.

*) 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 ⩽ 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

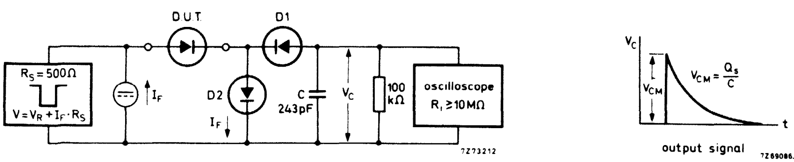


Fig. 4 Test circuit and waveform; recovery charge.

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

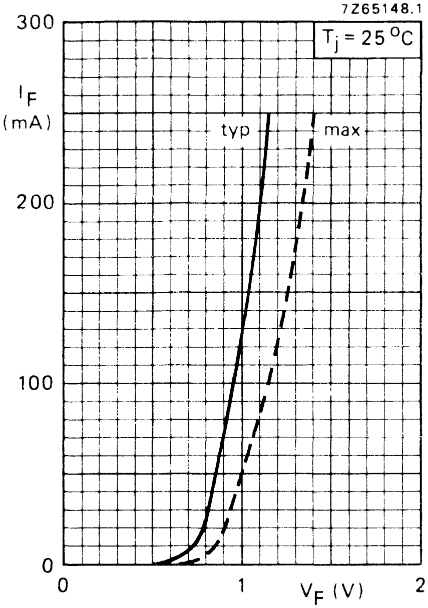


Fig. 5.

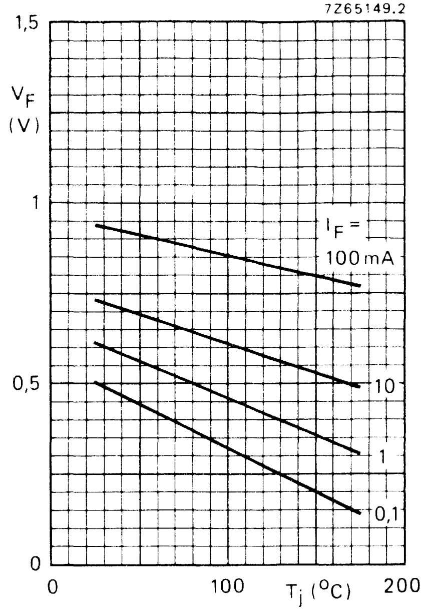


Fig. 6 Typical values.

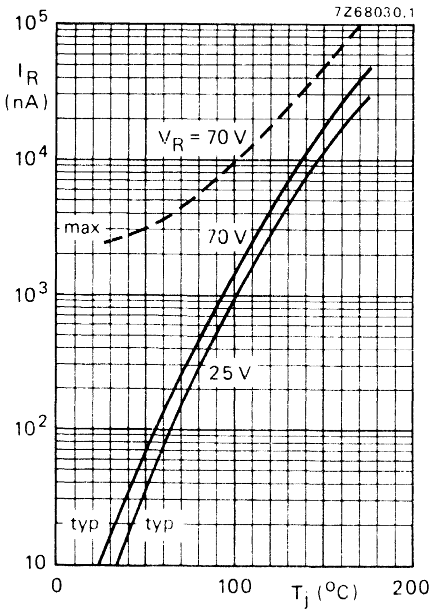


Fig. 7.

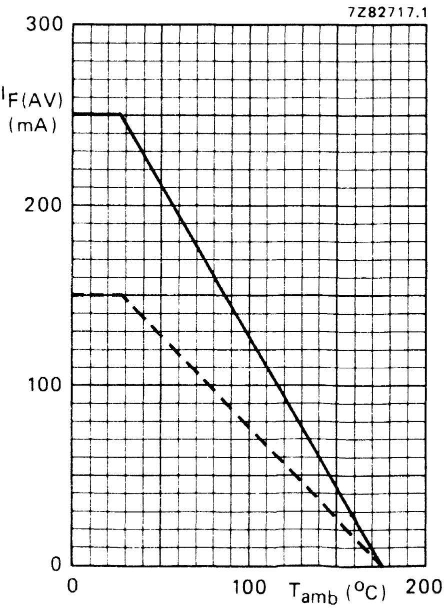


Fig. 8 ——— single diode;
– – – – double diode, equally loaded.

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.

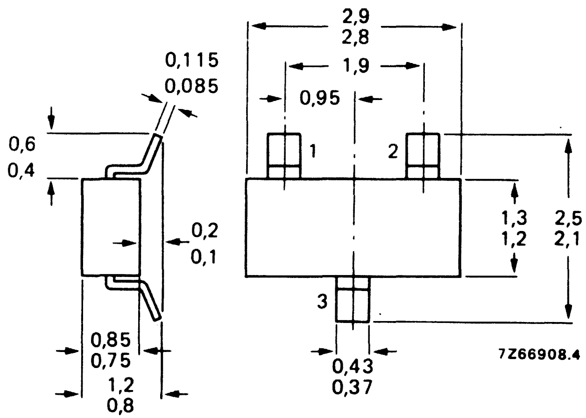
QUICK REFERENCE DATA

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

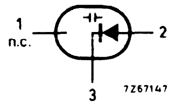
Dimensions in mm

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 CHARACTERISTICS*

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

Thermal resistance

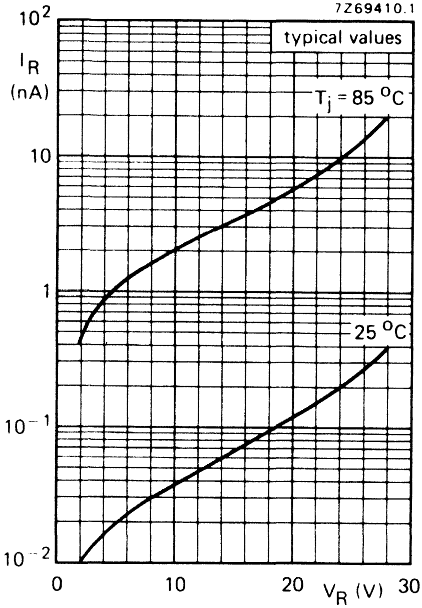
From junction to tab	$R_{th\ j\text{-}t}$	=	60 K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	280 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90 K/W

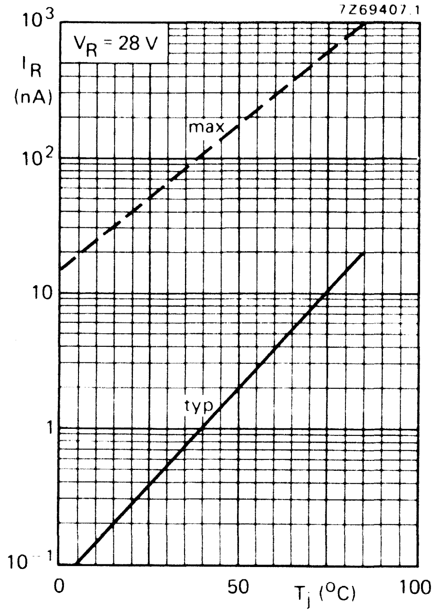
CHARACTERISTICS

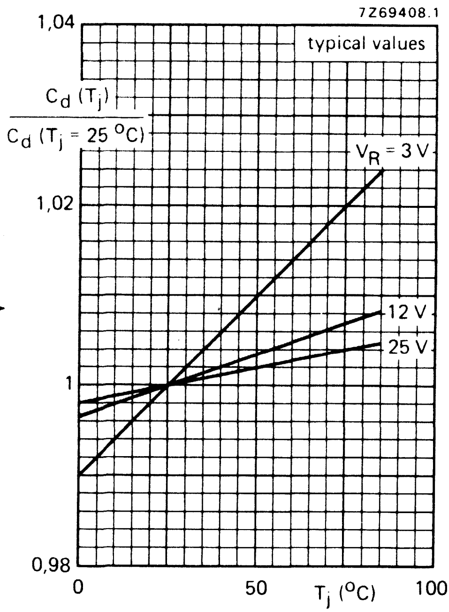
T_j = 25 °C unless otherwise specified

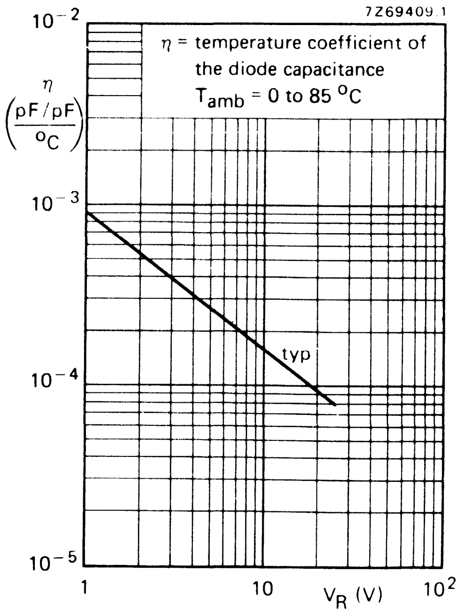
Reverse current			
V_R = 28 V	I_R	<	50 nA
V_R = 28 V; T_j = 85 °C	I_R	<	1000 nA
Diode capacitance at f = 1 MHz			
V_R = 1 V	C_d	typ.	17,5 pF
V_R = 3 V	C_d	typ.	11,5 pF
V_R = 25 V	C_d		1,8 to 2,8 pF
Capacitance ratio at f = 1 MHz	$\frac{C_d\ (V_R = 3\ V)}{C_d\ (V_R = 25\ V)}$	typ.	5
Series resistance at f = 470 MHz and at that value of V_R at which C_d = 9 pF	r_D	<	1,2 Ω

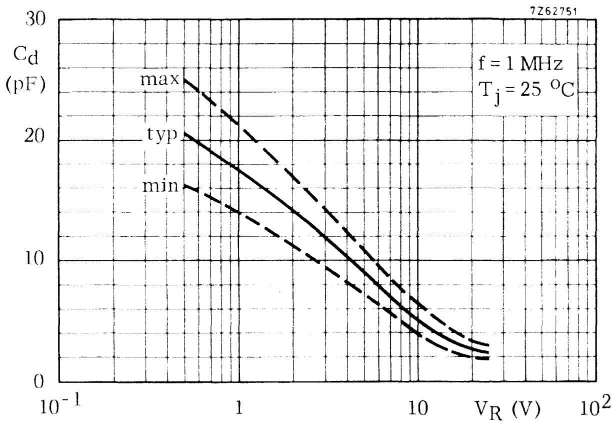
* See *Thermal characteristics* in chapter GENERAL.
→ ** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.


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


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


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


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


7Z62751
30
20
10
0
Cd
(pF)
max
typ
min
f = 1 MHz
Tj = 25 °C
10^-1
1
10
VR (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

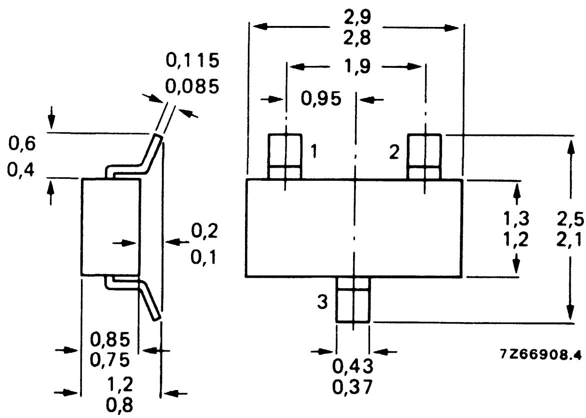
MECHANICAL DATA

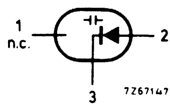
Dimensions in mm

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

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	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	K/W

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

* See *Thermal characteristics* in chapter GENERAL.

** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

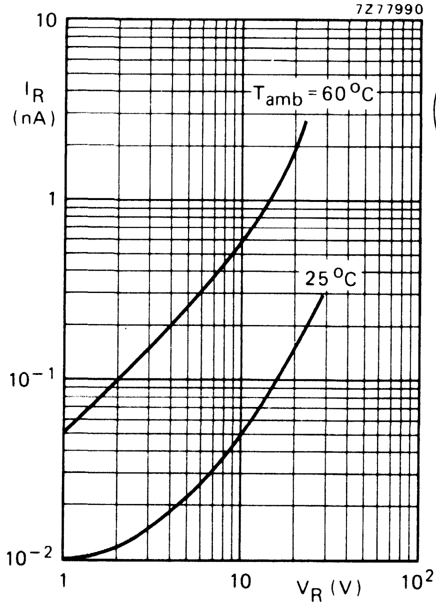


Fig. 2 Typical values

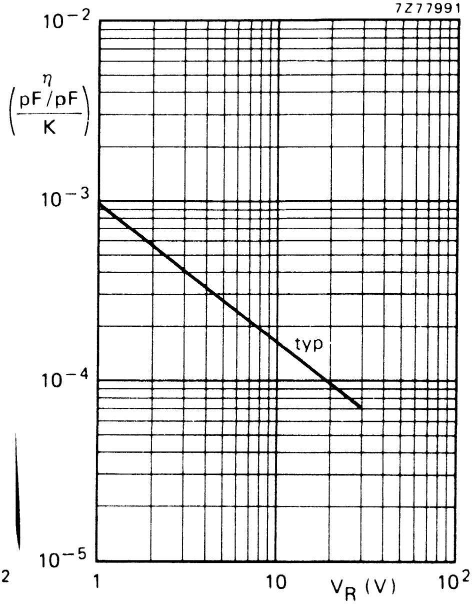


Fig. 3 Temperature coefficient of the diode capacitance; T_{amb} = 0 to 85 °C.

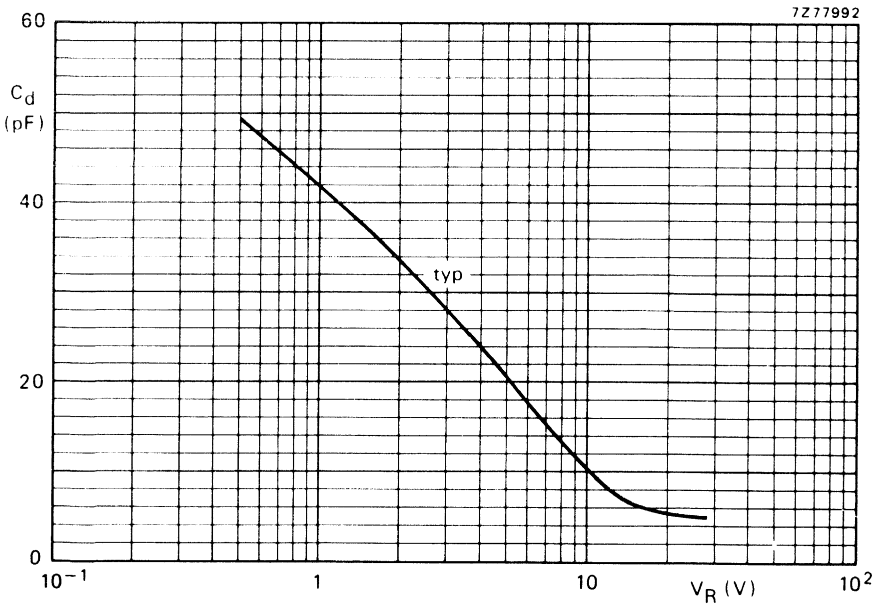


Fig. 4 f = 1 MHz; T_{amb} = 25 °C.

DEVELOPMENT SAMPLE DATA

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors, in a SOT-23 plastic envelope for use in driver and output stages of audio amplifiers in thick and thin-film hybrid circuits.

N-P-N complements are BC817; R and BC818; R respectively.

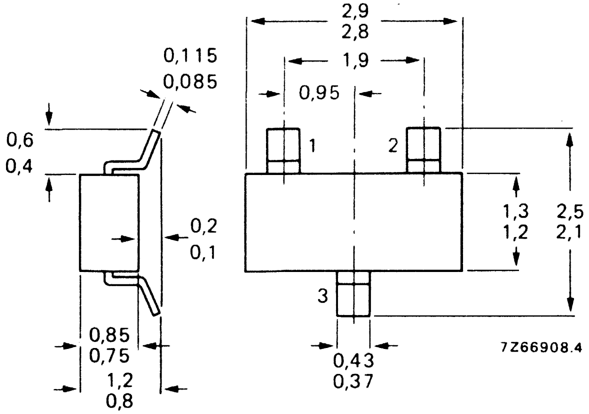
QUICK REFERENCE DATA

			BC807; R	BC808; 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} = 35 ^oC	P_{tot}	max.	310		mW
Junction temperature	T_j	max.	150		^oC
Transition frequency at f = 35 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	100		MHz

MECHANICAL DATA

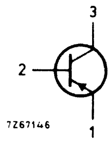
Dimensions in mm

Fig. 1 SOT-23.

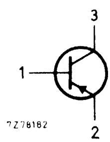


Marking code

BC807-16 = 5 A
-25 = 5 B
-40 = 5 C
BC808-16 = 5 E
-25 = 5 F
-40 = 5 G



BC807-16R = 5 AR
-25R = 5 BR
-40R = 5 CR
BC808-16R = 5 ER
-25R = 5 FR
-40R = 5 GR



See also *Soldering recommendations* in Microminiature Semiconductor handbook.

RATINGS

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

			BC807; R	BC808; R	
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	50	30	V
Collector-emitter voltage (open base) $-I_C$ = 10 mA	$-V_{CEO}$	max.	45	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	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 at T_{amb} = 35 °C *	P_{tot}	max.	310	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	$R_{th\,j\text{-}t}$	=	50	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	260	K/W
From soldering points to ambient *	$R_{th\,s\text{-}a}$	=	60	K/W

* Mounted on a ceramic substrate of 15 mm x 15 mm x 0,7 mm.
** See *Thermal characteristics* in chapter GENERAL.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $-V_{CB} = 20$ V; T_j = 25 °C	$-I_{CBO}$	<	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	$-V_{CEsat}$	<	700 mV
D.C. current gain			
$-I_C = 500$ mA; $-V_{CE} = 1$ V	h_{FE}	>	40
$-I_C = 100$ mA; $-V_{CE} = 1$ V; BC807; BC808	h_{FE}		100 to 600
BC807-16, BC808-16	h_{FE}		100 to 250
BC807-25, BC808-25	h_{FE}		160 to 400
BC807-40, BC808-40	h_{FE}		250 to 600
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
D.C. current gain ratio of complementary matched pairs			
$\lvert I_C \rvert = 100$ mA; $\lvert V_{CE} \rvert = 1$ V	h_{FE1}/h_{FE2}	typ. <	1,25 1,40

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

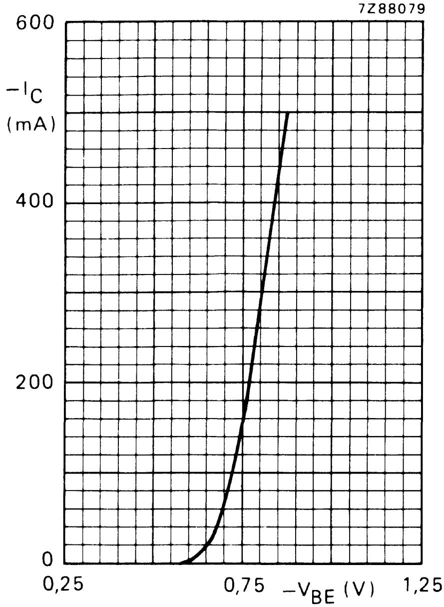


Fig. 2 $-V_{CE}$ = 1 V; T_j = 25 °C.
Typical values.

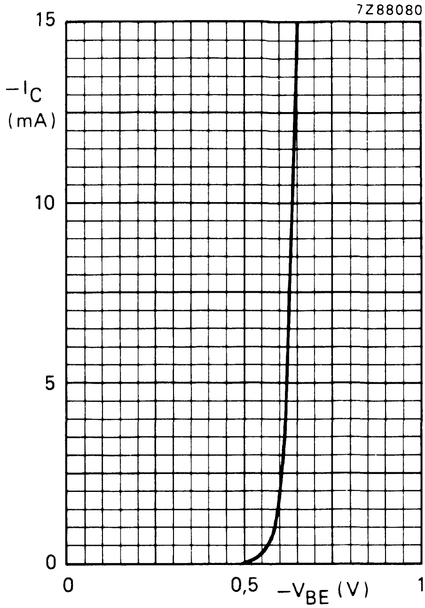


Fig. 3 $-V_{CE}$ = 5 V; T_j = 25 °C.
Typical values.

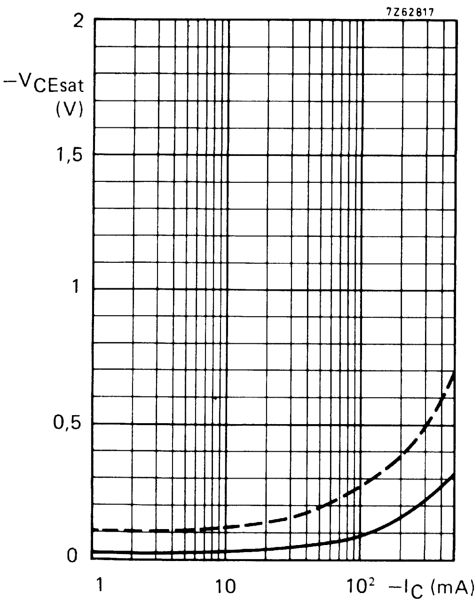


Fig. 4 ---- max. values, —— typical values.

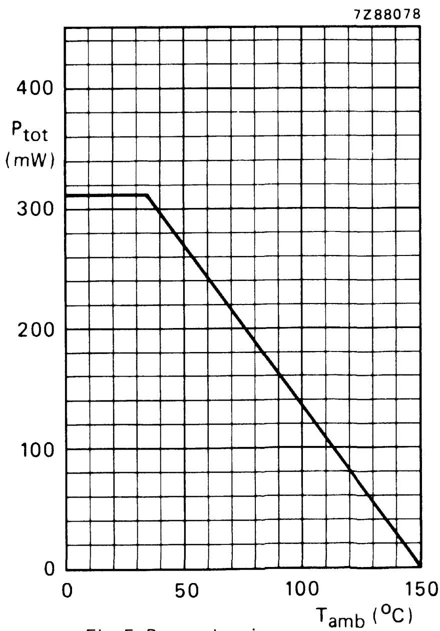


Fig. 5. Power derating curve.

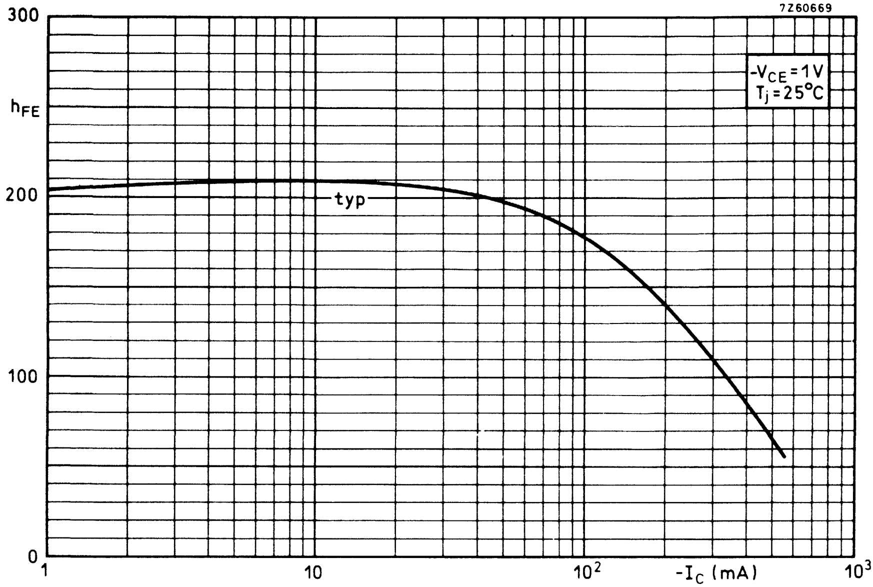


Fig. 6 D.C. current gain.

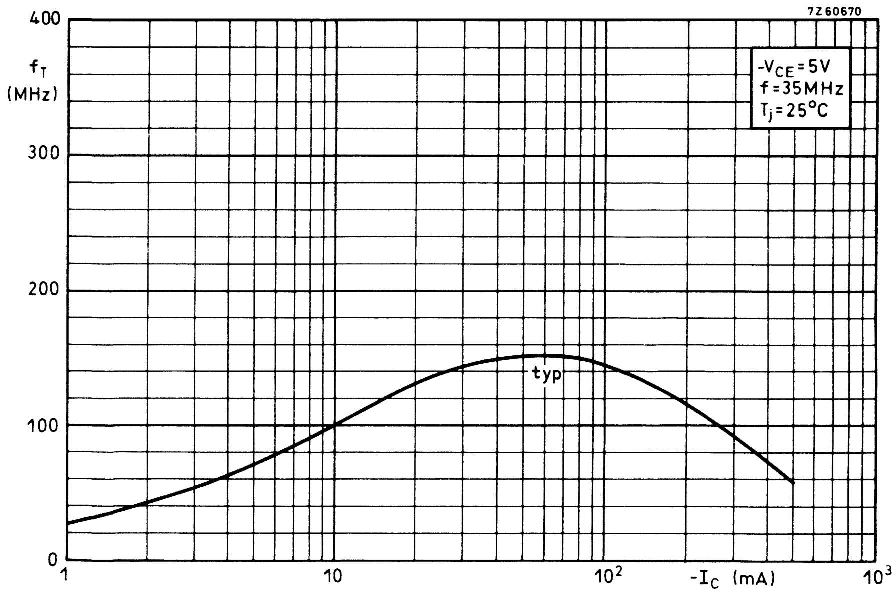


Fig. 7 Typical values transition frequency.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors, in a SOT-23 plastic envelope for use in driver and output stages of audio amplifiers in thick and thin-film hybrid circuits.

P-N-P complements are BC807; R and BC808; R respectively.

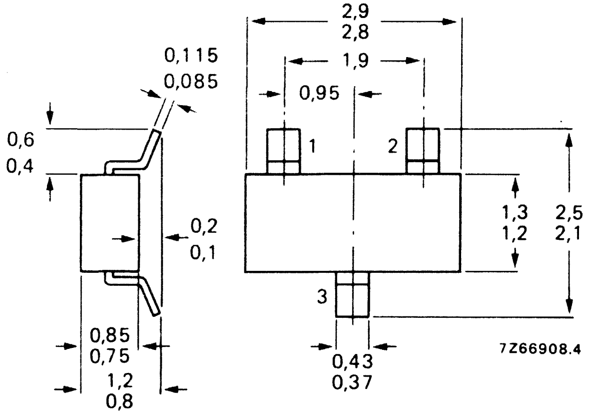
QUICK REFERENCE DATA

			BC817; R	BC818; 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} = 35 °C	P_{tot}	max.	310		mW
Junction temperature	T_j	max.	150		°C
Transition frequency at f = 35 MHz I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	200		MHz

MECHANICAL DATA

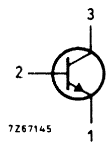
Dimensions in mm

Fig. 1 SOT-23.

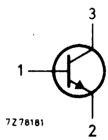


Marking code

BC817-16 = 6 A
-25 = 6 B
-40 = 6 C
BC818-16 = 6 E
-25 = 6 F
-40 = 6 G



BC817-16R = 6 AR
-25R = 6 BR
-40R = 6 CR
BC818-16R = 6 ER
-25R = 6 FR
-40R = 6 GR



See also *Soldering recommendations* in Microminiature Semiconductor handbook.

RATINGS

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

			BC817; R	BC818; R	
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	50	30	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	45	25	V
Emitter-base voltage (open collector)	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} = 35 °C	P_{tot}	max.	310		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	$R_{th\ j\text{-}t}$	=	50	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
From soldering points to ambient *	$R_{th\ s\text{-}a}$	=	60	K/W

* Mounted on a ceramic substrate of 15 mm x 15 mm x 0,7 mm.
** See *Thermal characteristics* in chapter GENERAL.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 25$ °C	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}	<	700 mV
D.C. current gain			
$I_C = 500$ mA; $V_{CE} = 1$ V	h_{FE}	>	40
$I_C = 100$ mA; $V_{CE} = 1$ V; BC817; BC818	h_{FE}		100 to 600
BC817-16, BC818-16	h_{FE}		100 to 250
BC817-25, BC818-25	h_{FE}		160 to 400
BC817-40, BC818-40	h_{FE}		250 to 600
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
D.C. current gain ratio of matched complementary pairs complementary pairs			
$\|I_C\| = 100$ mA; $\|V_{CE}\| = 1$ V	h_{FE1}/h_{FE2}	typ.	1,25
		<	1,40

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

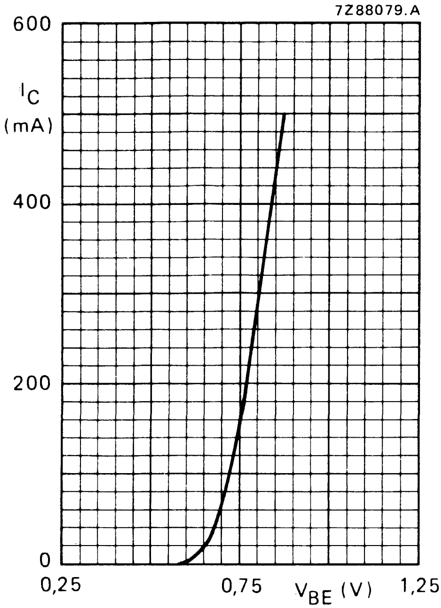


Fig. 2 V_{CE} = 1 V; T_j = 25 °C. Typical values.

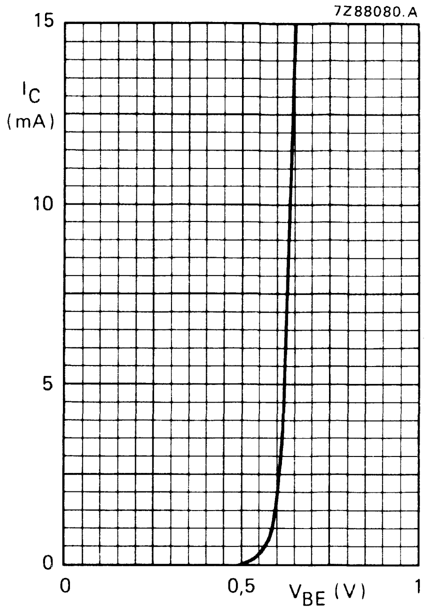


Fig. 3 V_{CE} = 5 V; T_j = 25 °C. Typical values.

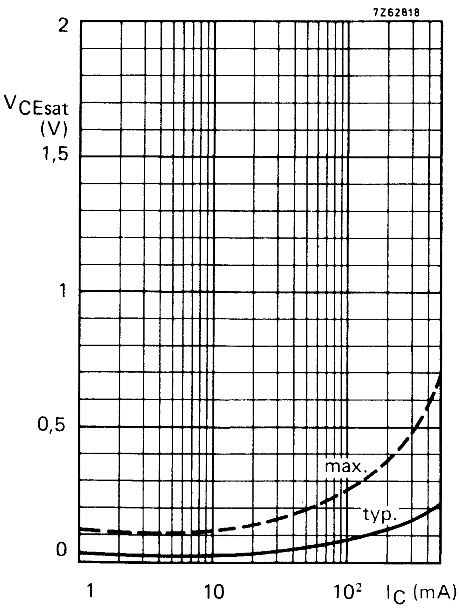


Fig. 4 I_C/I_B = 10; T_j = 25 °C.

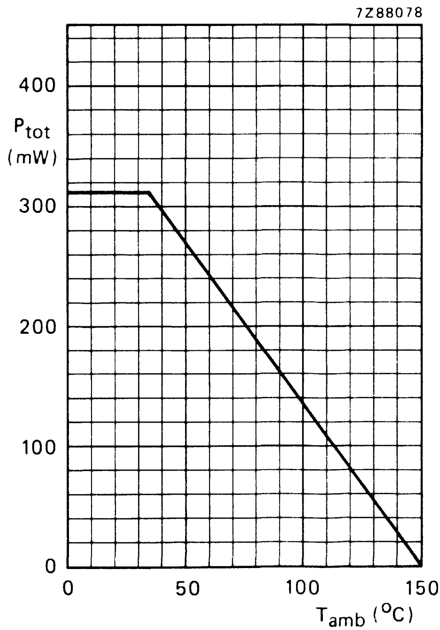


Fig. 5 Power derating curve.

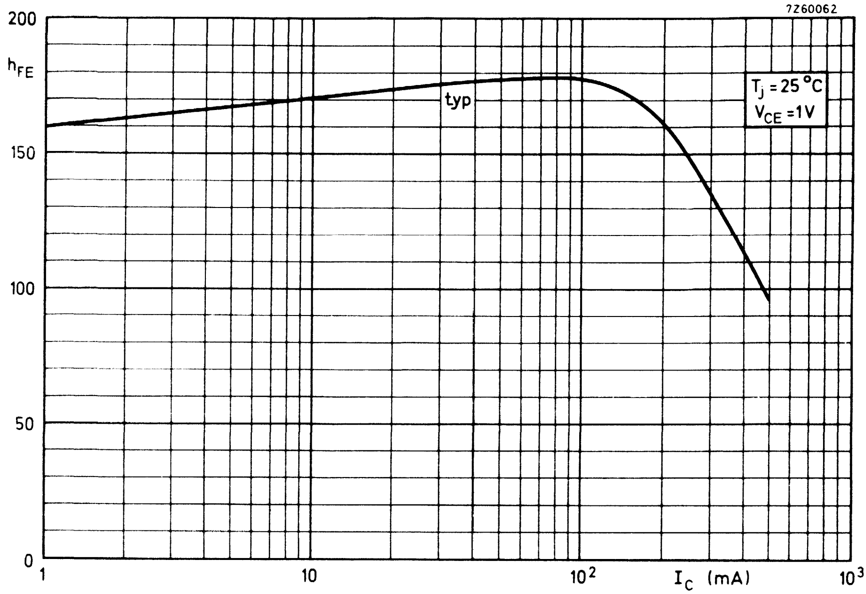


Fig. 6 D.C. current gain.

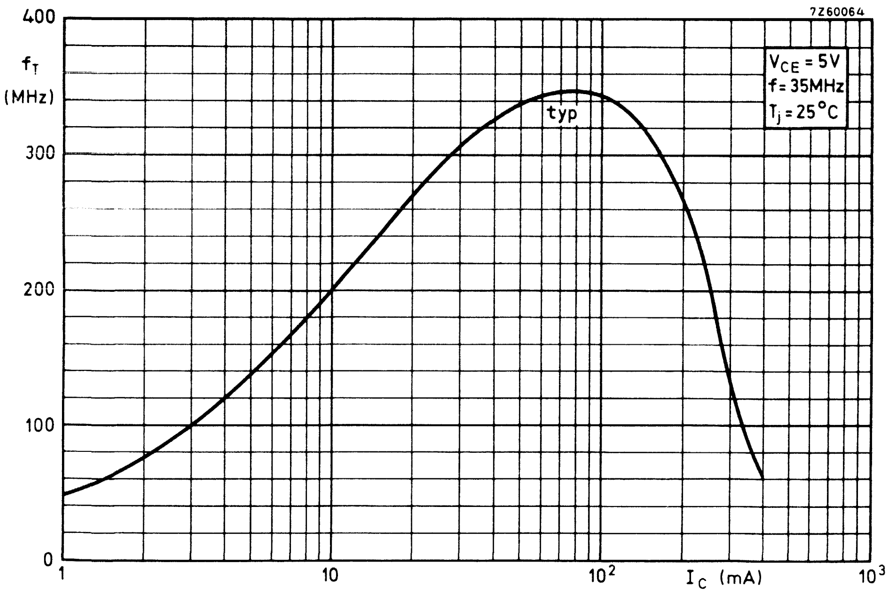


Fig. 7 Typical values transition frequency.

SILICON PLANAR EPITAXIAL TRANSISTORS

General purpose n-p-n transistors in a plastic SOT-23 variant, especially suitable for use in driver stages of audio amplifiers in thick and thin-film hybrid circuits.

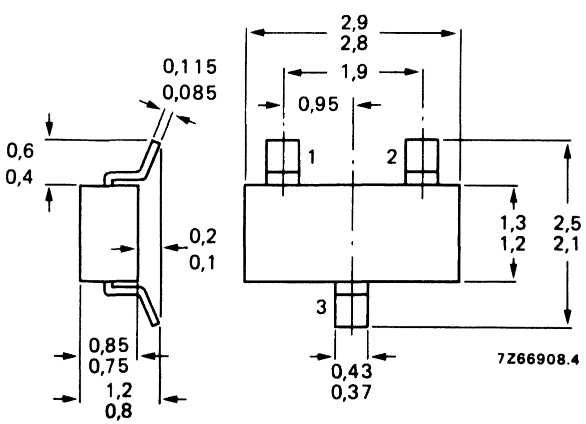
QUICK REFERENCE DATA

			BC846; R	BC847; R	BC848; R	
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	80	50	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	65	45	30	V
Collector current (peak value)	I_{CM}	max.	200	200	200	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	200	200	200	mW
Junction temperature	T_j	max.	150	150	150	°C
Small-signal current gain I_C = 2 mA; V_{CE} = 5 V; f = 1 kHz	h_{fe}	>	125	125	125	
		<	500	900	900	
Transition frequency I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	300	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.	2	2	2	dB

MECHANICAL DATA

Dimensions in mm

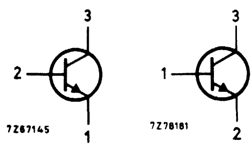
Fig. 1 SOT-23.



Marking code

		type	reverse
BC846A	=	1A	1AR
B	=	1B	1BR
BC847A	=	1E	1ER
B	=	1F	1FR
C	=	1G	1GR
BC848A	=	1J	1JR
B	=	1K	1KR
C	=	1L	1LR

type : reverse:



See also *Soldering recommendations* in Microminiature Semiconductor handbook.

RATINGS

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

			BC846; R	BC847; R	BC848; R	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	50	30	V
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	80	50	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	65	45	30	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	6	5	V

Collector current (d.c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	200	mA
Emitter current (peak value)	$-I_{EM}$	max.	200	mA
Base current (peak value)	I_{BM}	max.	200	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**

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient*	$R_{th\ s\text{-}a}$	=	90	K/W

* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.
** See *Thermal characteristics* in chapter GENERAL in handbook Microminiature Semiconductors.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 30 V	I_{CBO}	<	15	nA
I_E = 0; V_{CB} = 30 V; T_j = 150 °C	I_{CBO}	<	5	μA
Base-emitter voltage*				
I_C = 2 mA; V_{CE} = 5 V	V_{BE}	typ.	660	mV
		580 to	700	mV
I_C = 10 mA; V_{CE} = 5 V	V_{BE}	<	770	mV
Saturation voltage**				
I_C = 10 mA; I_B = 0,5 mA	V_{CEsat}	typ.	90	mV
		<	250	mV
	V_{BEsat}	typ.	700	mV
I_C = 100 mA; I_B = 5 mA	V_{CEsat}	typ.	200	mV
		<	600	mV
	V_{BEsat}	typ.	900	mV
Knee voltage				
I_C = 10 mA; I_B = value for which I_C = 11 mA at V_{CE} = 1 V	V_{CEK}	typ.	300	mV
		<	600	mV

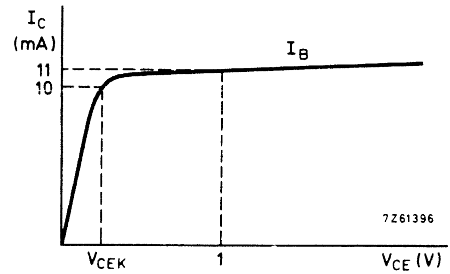


Fig. 2.

Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	typ.	2,5	pF
		<	4,5	pF
Transition frequency at f = 35 MHz				
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	MHz

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

** V_{BEsat} decreases by about 1,7 mV/K with increasing temperature.

			BC846	BC847	BC848	
Small signal current gain at f = 1 kHz						
I_C = 2 mA; V_{CE} = 5 V	h_{fe}	>	125	125	125	
		<	500	900	900	
Noise figure at R_S = 2 kΩ						
I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	typ.	2	2	2	dB
		<	10	10	10	dB

			BC846A BC847A BC848A	BC846B BC847B BC848B	BC847C BC848C	
D.C. current gain						
I_C = 10 μA; V_{CE} = 5 V	h_{FE}	typ.	90	150	270	
		>	110	200	420	
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	typ.	180	290	520	
		<	220	450	800	
h parameters at f = 1 kHz (common emitter)						
I_C = 2 mA; V_{CE} = 5 V						
		>	1,6	3,2	6	kΩ
Input impedance	h_{ie}	typ.	2,7	4,5	8,7	kΩ
		<	4,5	8,5	15	kΩ
Reverse voltage transfer ratio	h_{re}	typ.	1,5	2	3	10^{-4}
		>	125	240	450	
Small signal current gain	h_{fe}	typ.	220	330	600	
		<	260	500	900	
Output admittance	h_{oe}	typ.	18	30	60	μA/V
		<	30	60	110	μA/V

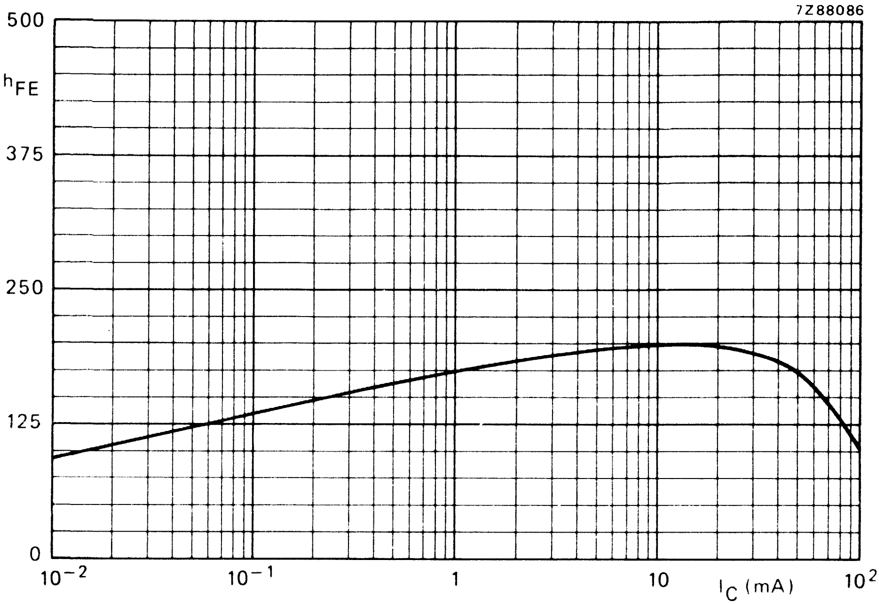


Fig. 3 Typical D.C. current gain for A-selections. V_{CE} = 5 V; T_j = 25 °C.

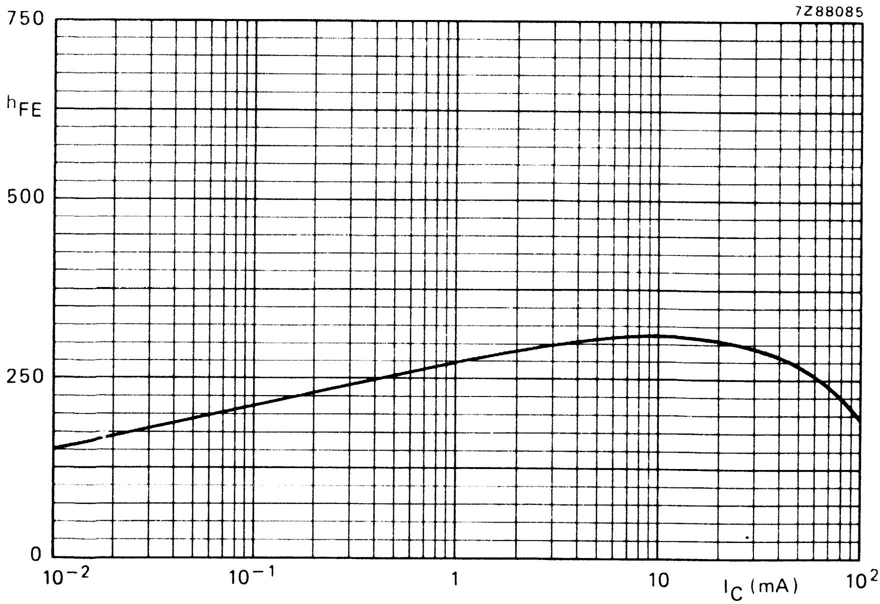


Fig. 4 Typical D.C. current gain for B-selections. V_{CE} = 5 V; T_j = 25 °C.

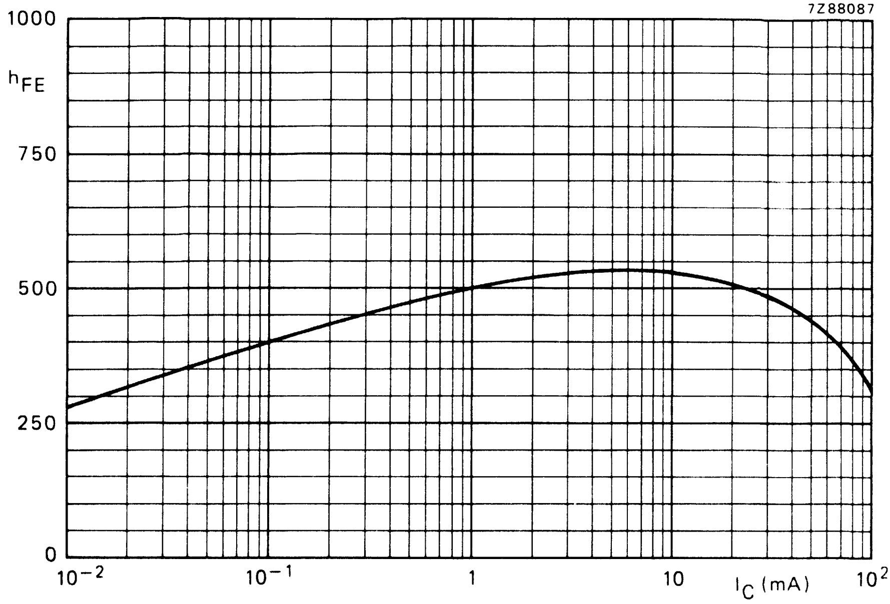


Fig. 5 Typical D.C. current gain for C-selections. V_{CE} = 5 V; T_j = 25 °C.

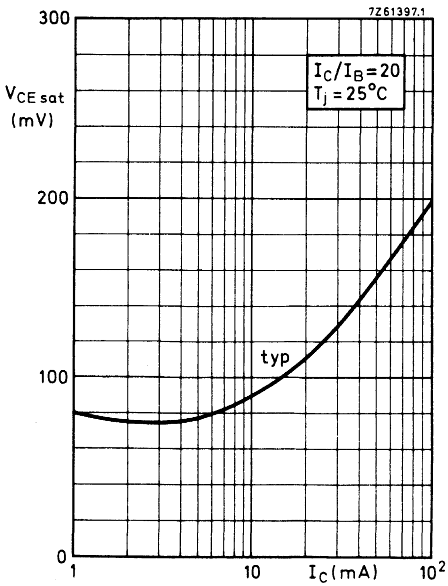


Fig. 6 Typical values.

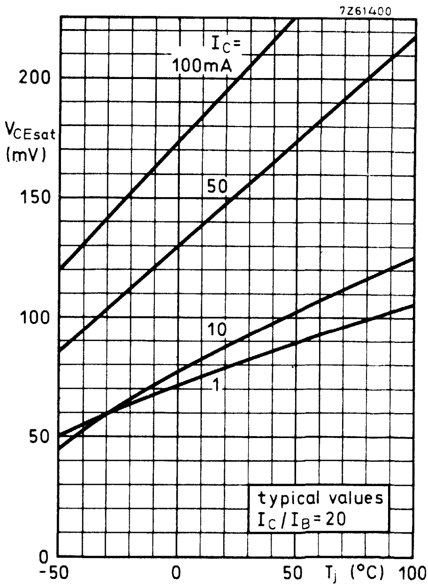


Fig. 7 Typical values.

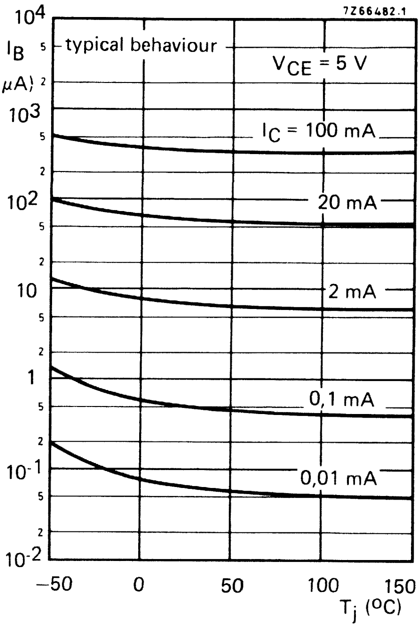


Fig. 8 Typical behaviour of base current versus junction temperature.

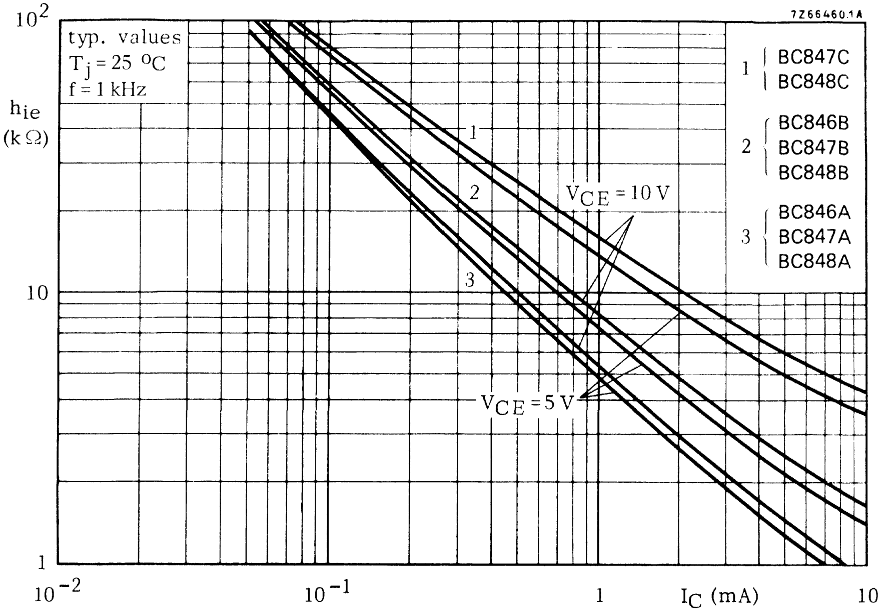


Fig. 9 Input impedance. 1 = C selections; 2 = B selections; 3 = A selections.

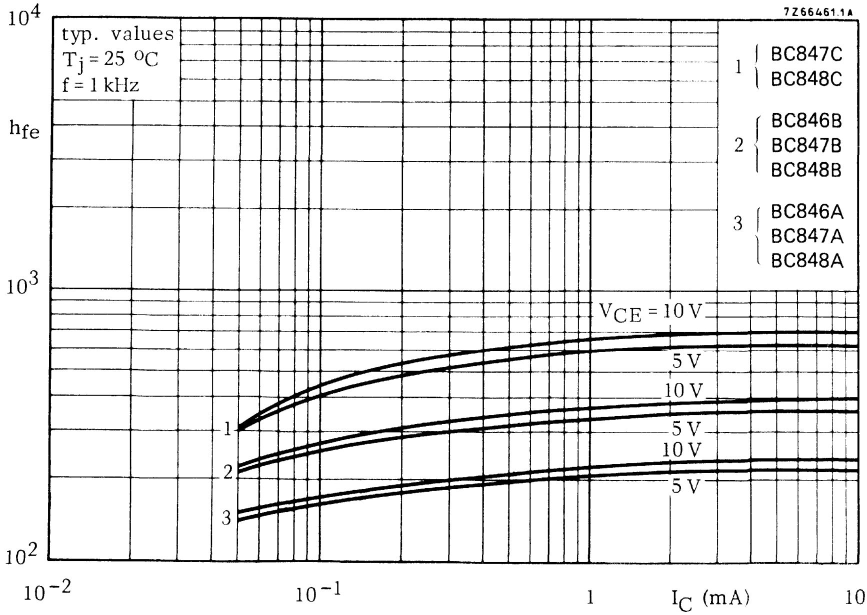


Fig. 10 Small signal current gain. 1 = C-; 2 = B- and 3 = A-selections.

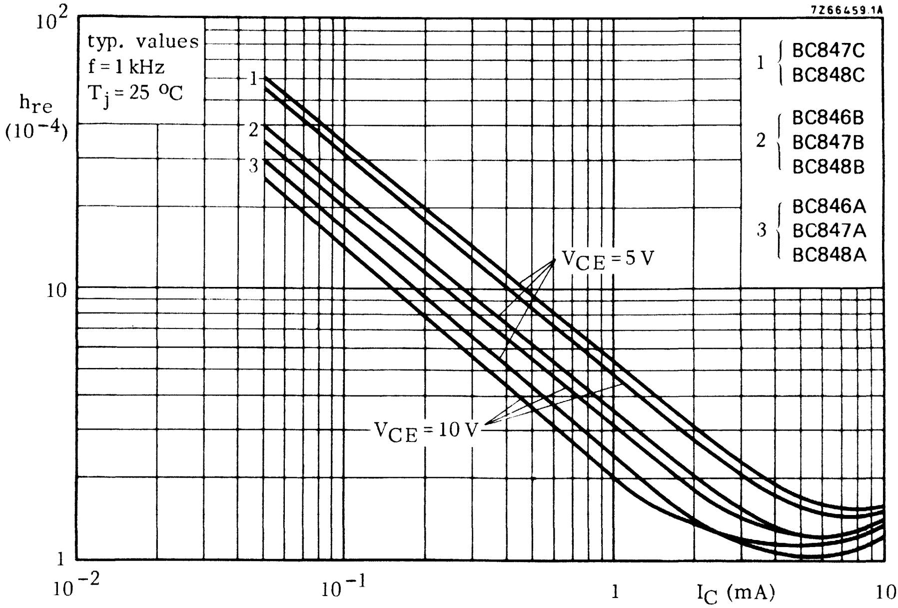


Fig. 11 Reverse voltage transfer ratio. 1 = C-; 2 = B- and 3 = A-selections.

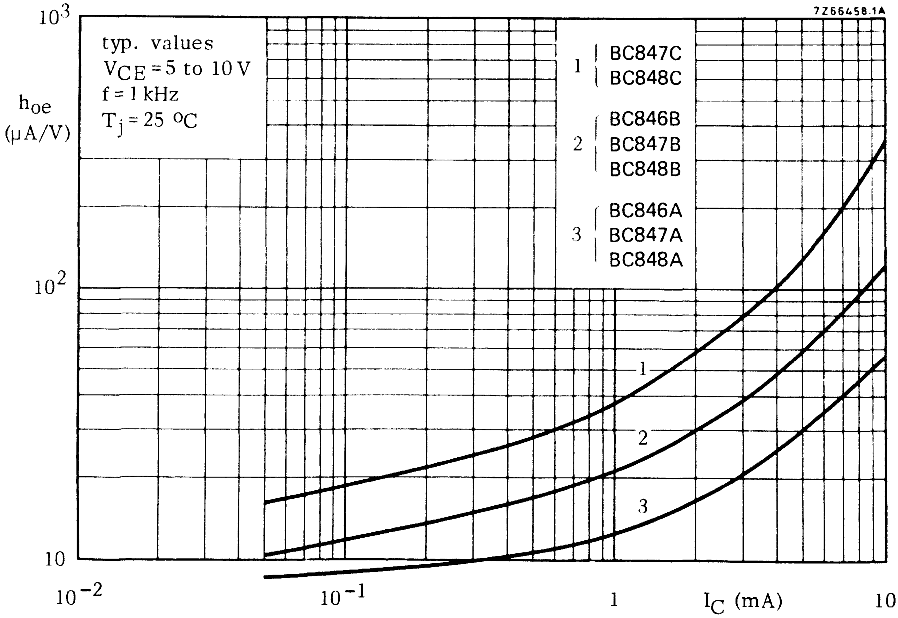


Fig. 12 Output admittance. 1 = C-; 2 = B- and 3 = A-selections.

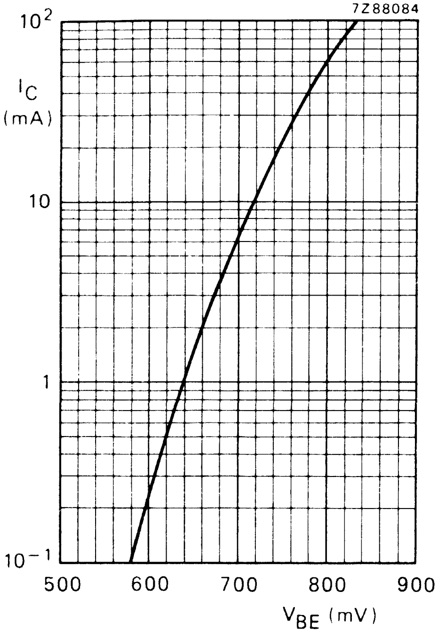


Fig. 13 Typical values at V_{CE} = 5 V; T_j = 25 °C.

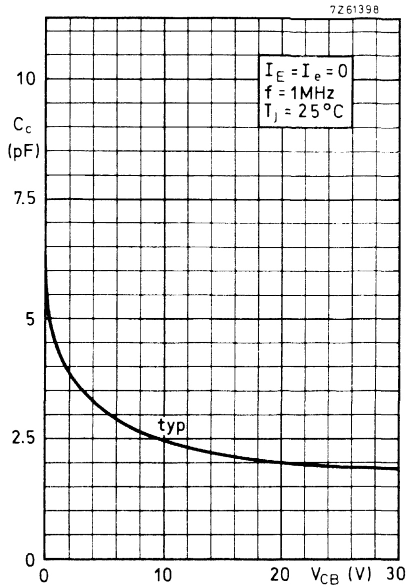


Fig. 14 Typical values.

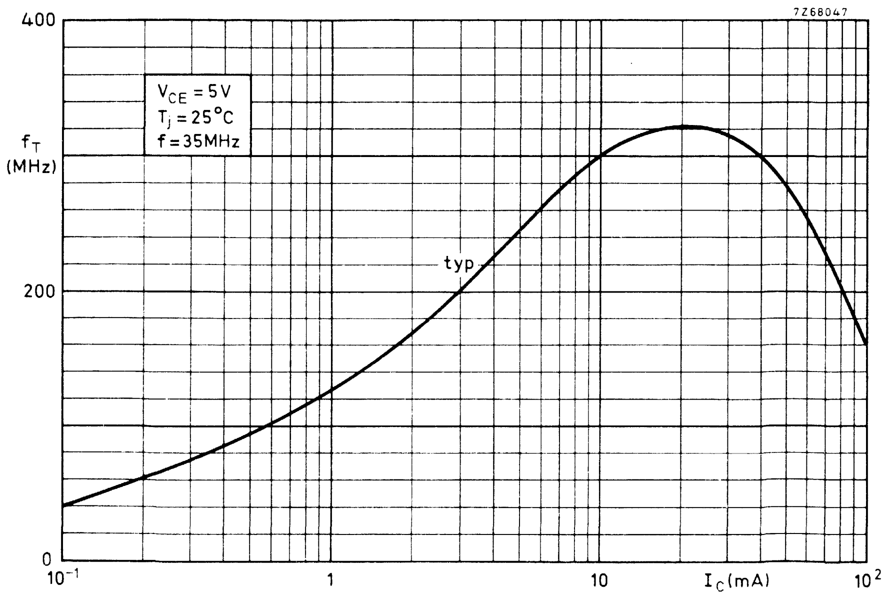


Fig. 15 Typical values transition frequency.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a plastic SOT-23 envelope, primarily intended for low-noise input stages in tape recorders, hi-fi amplifiers and other audio-frequency equipment in thick and thin-film hybrid circuits.

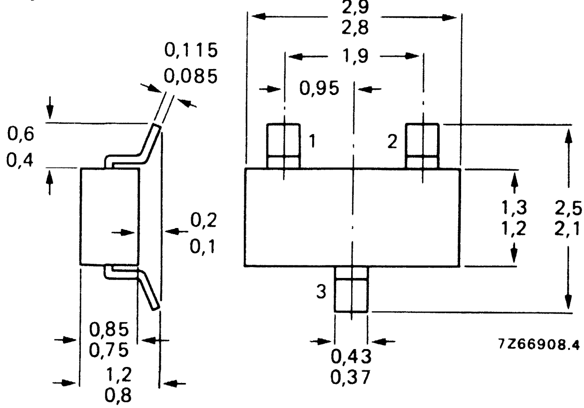
QUICK REFERENCE DATA

			BC849; R	BC850; R	
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	30	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	45	V
Collector current (peak value)	I_{CM}	max.	200	200	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	200	200	mW
Junction temperature	T_j	max.	150	150	°C
Small-signal current gain					
I_C = 2 mA; V_{CE} = 5 V; f = 1 kHz	h_{fe}	>	240	240	
		<	900	900	
Transition frequency					
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	300	MHz
Noise figure at R_S = 2 kΩ					
I_C = 200 μA; V_{CE} = 5 V					
f = 30 Hz to 15 kHz	F	typ.	1,4	1,4	dB
		<	4	3	dB
f = 1 kHz; B = 200 Hz	F	typ.	1,2	1	dB
f = 10 Hz to 50 Hz (equivalent noise voltage)	V_n	<	–	0,135	μV

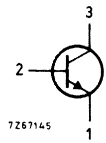
MECHANICAL DATA

Dimensions in mm

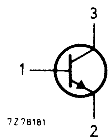
Fig. 1 SOT-23.



Marking code



BC849B = 2B
BC849C = 2C
BC850B = 2F
BC850C = 2G



BC849BR = 2BR
BC849CR = 2CR
BC850BR = 2FR
BC850CR = 2GR

See also *Soldering recommendations* in Microminiature Semiconductor handbook.

RATINGS

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

			BC849; R	BC850; R	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	50	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	30	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	V

Collector current (d.c.)	I_C	max.	100	mA
Collector current (peak value)	I_{CM}	max.	200	mA
Emitter current (peak value)	$-I_{EM}$	max.	200	mA
Base current (peak value)	I_{BM}	max.	200	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	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	K/W

* See *Thermal characteristics* in chapter GENERAL in Microminiature Semiconductor handbook.
** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = 30$ V	I_{CBO}	<	15 nA
$I_E = 0$; $V_{CB} = 30$ V; $T_j = 150$ °C	I_{CBO}	<	5 μA
Base emitter voltage*			
$I_C = 2$ mA; $V_{CE} = 5$ V	V_{BE}	typ.	660 mV
			580 to 700 mV
$I_C = 10$ mA; $V_{CE} = 5$ V	V_{BE}	<	770 mV
Saturation voltages**			
$I_C = 10$ mA; $I_B = 0{,}5$ mA	V_{CEsat}	typ.	90 mV
		<	250 mV
	V_{BEsat}	typ.	700 mV
$I_C = 100$ mA; $I_B = 5$ mA	V_{CEsat}	typ.	200 mV
		<	600 mV
	V_{BEsat}	typ.	900 mV
Knee voltage			
$I_C = 10$ mA; I_B = value for which $I_C = 11$ mA at $V_{CE} = 1$ V	V_{CEK}	typ.	300 mV
		<	600 mV

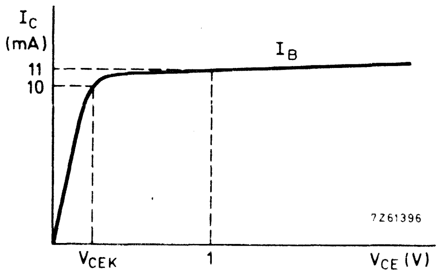


Fig. 2 Knee voltage waveform.

Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	2,5 pF
		<	4,5 pF
Transition frequency at f = 35 MHz			
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	300 MHz

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

** V_{BEsat} decreases by about 1,7 mV/K with increasing temperature.

			BC849; R	BC850; R	
Small signal current gain at f = 1 kHz					
I_C = 2 mA; V_{CE} = 5 V	h_{fe}	>	240	240	
		<	900	900	
Noise figure at R_S = 2 kΩ					
I_C = 200 μA; V_{CE} = 5 V					
f = 30 Hz to 15 kHz	F	typ.	1,4	1,4	dB
		<	4	3	dB
f = 1 kHz; B = 200 Hz	F	typ.	1,2	1	dB
		<	4	4	dB
Equivalent noise voltage at R_S = 2 kΩ					
I_C = 200 μA; V_{CE} = 5 V					
f = 10 Hz to 50 Hz; T_{amb} = 25 °C	V_n	max.	–	0,135	μV

			B-selections	C-selections	
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}	typ.	290	520	
		<	450	800	
h parameters at f = 1 kHz (common emitter)					
I_C = 2 mA, V_{CE} = 5 V					
		>	3,2	6	kΩ
Input impedance	h_{ie}	typ.	4,5	8,7	kΩ
		<	8,5	15	kΩ
Reverse voltage transfer ratio	h_{re}	typ.	2	3	10^{-4}
		>	240	450	
Small signal current gain	h_{fe}	typ.	330	600	
		<	500	900	
Output admittance	h_{oe}	typ.	30	60	μA/V
		<	60	110	μA/V

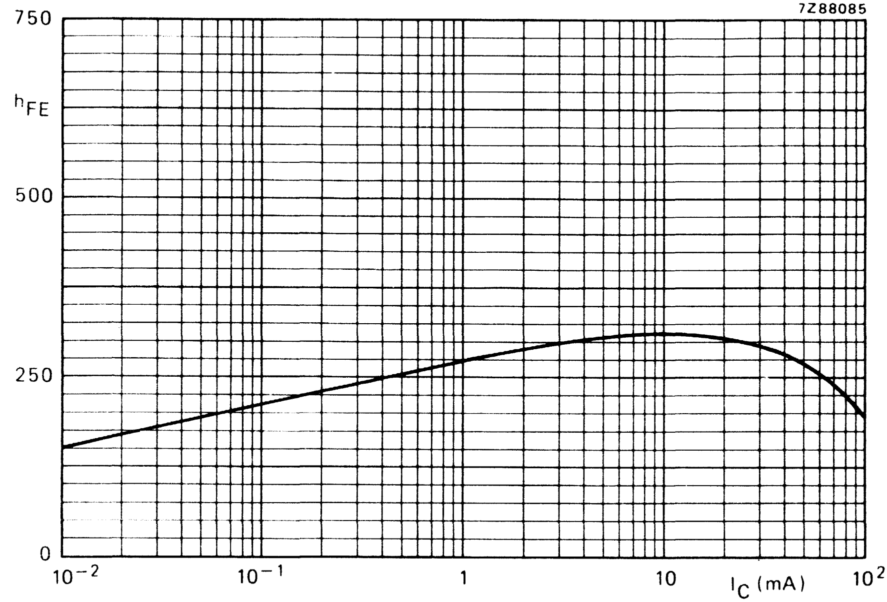


Fig. 3 Typical D.C. current gain B selections. V_{CE} = 5 V; T_j = 25 °C.

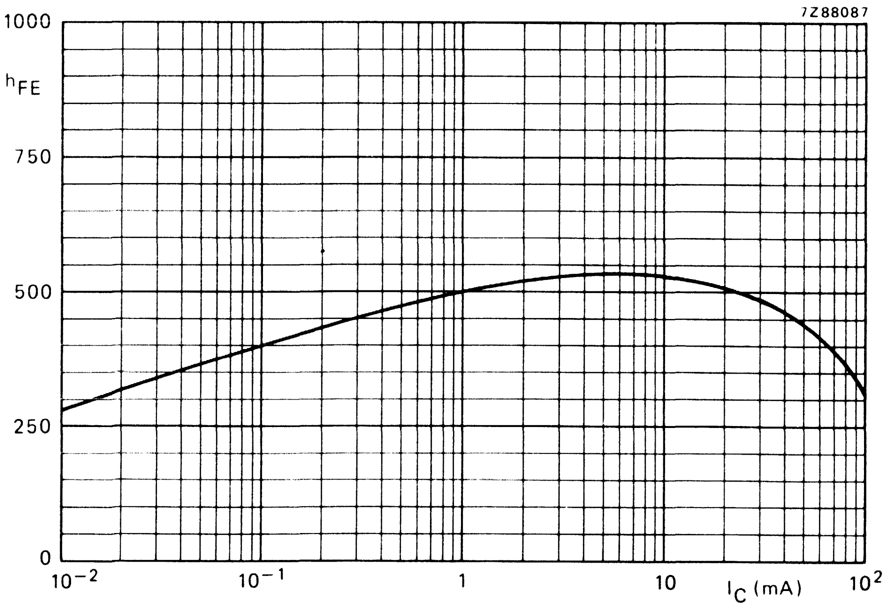


Fig. 4 Typical D.C. current gain C selections. V_{CE} = 5 V; T_j = 25 °C.

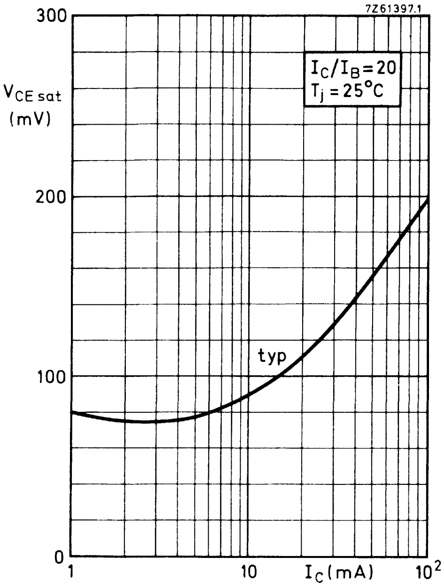


Fig. 5 Typical values.

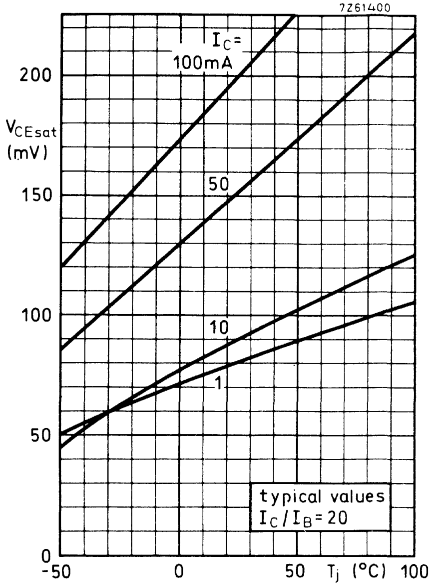


Fig. 6 Typical values; $I_C/I_B = 20$.

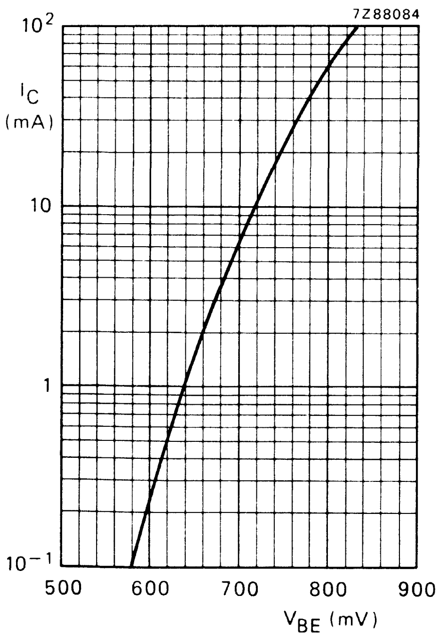


Fig. 7 Typical values V_{BE}. V_{CE} = 5 V; T_j = 25 °C.

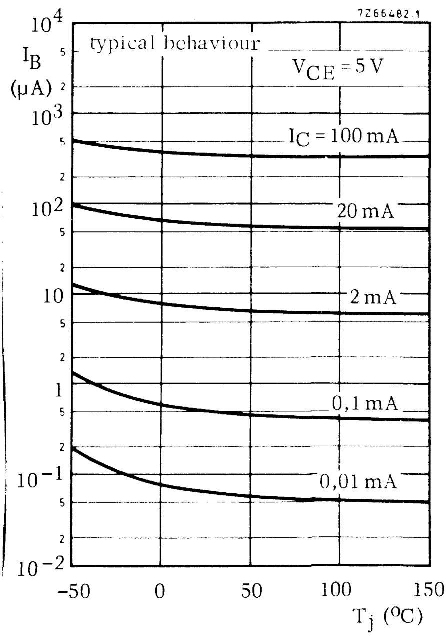


Fig. 8 Typical values.

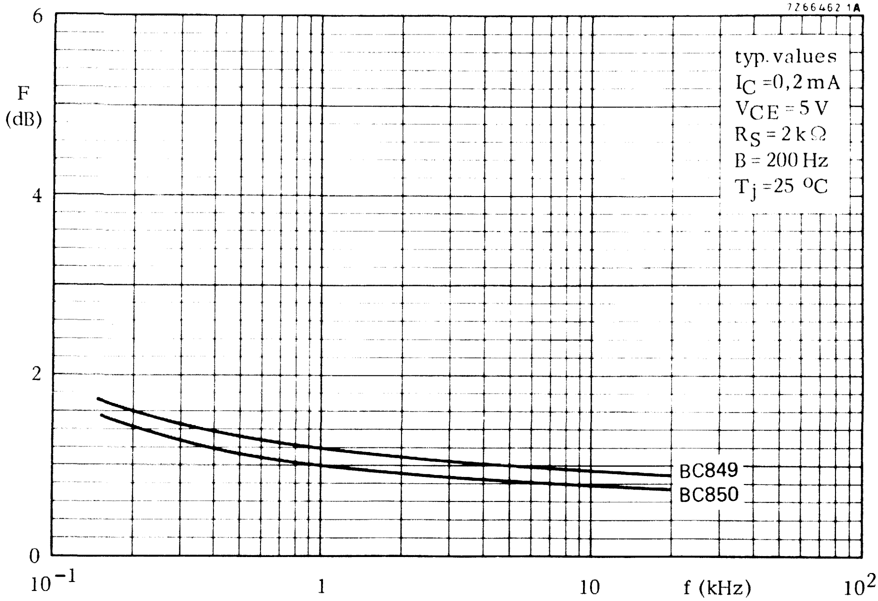

7Z66462 1A
F
(dB)
6
4
2
0
typ. values
I_C = 0,2 mA
V_{CE} = 5 V
R_S = 2 kΩ
B = 200 Hz
T_j = 25 °C
BC849
BC850
10^{-1}
1
10
f (kHz)
10^2

Fig. 9.

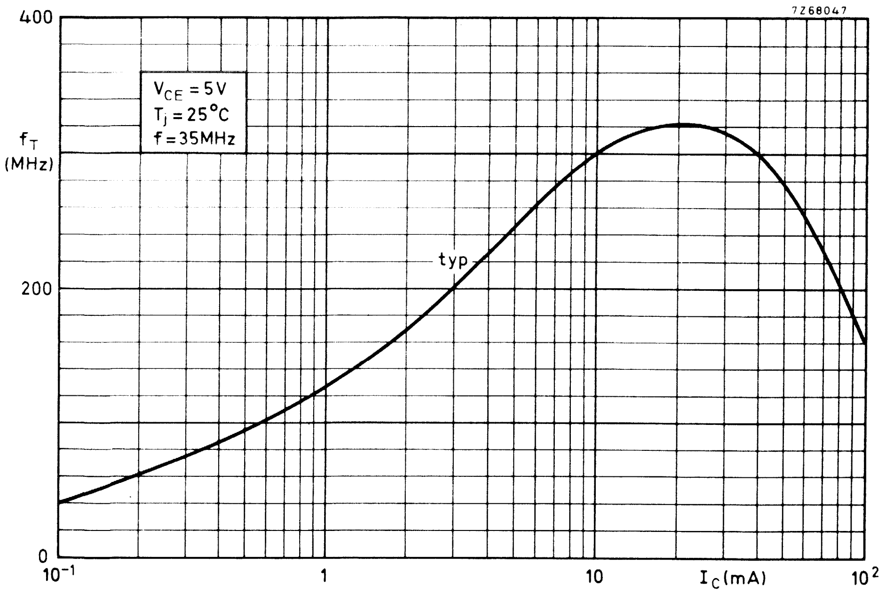

7Z68047
f_T
(MHz)
400
200
0
V_{CE} = 5 V
T_j = 25 °C
f = 35 MHz
typ
10^{-1}
1
10
I_C (mA)
10^2

Fig. 10.

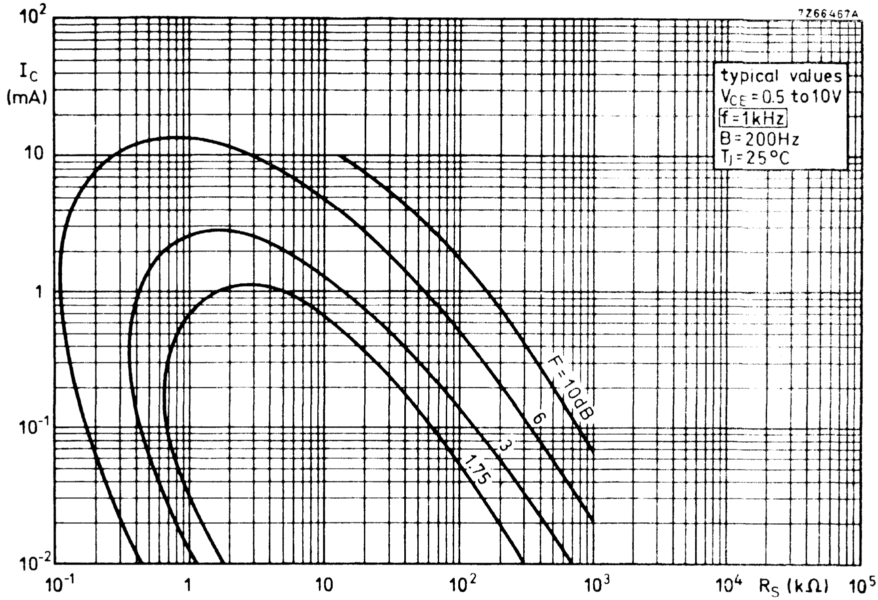


Fig. 11 Curves of constant noise figure for BC849.

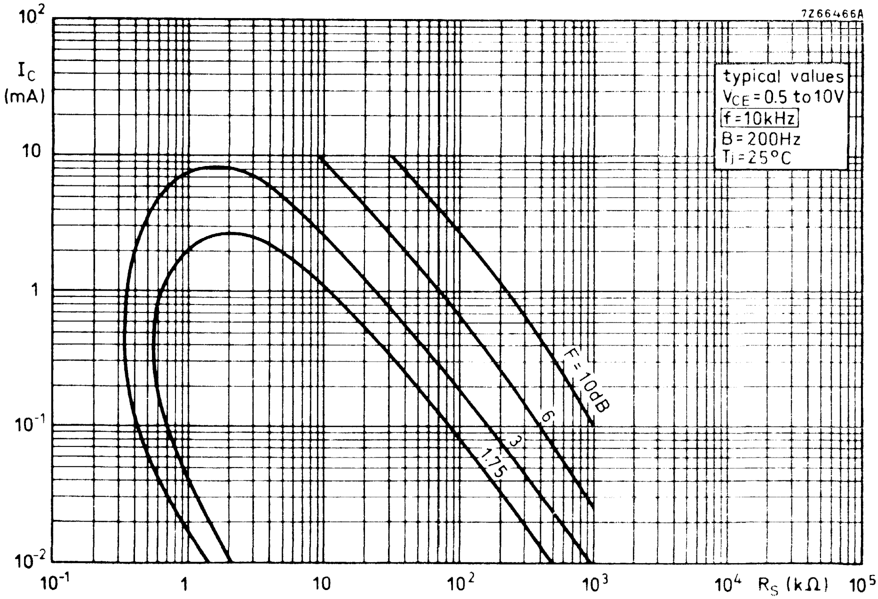


Fig. 12 Curves of constant noise figure for BC849.

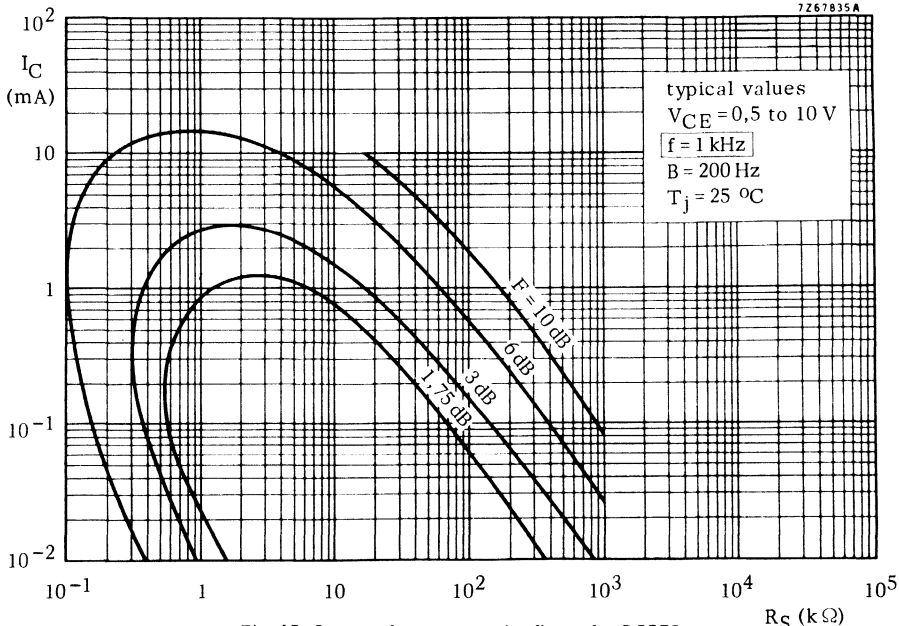


Fig. 13 Curves of constant noise figure for BC850.

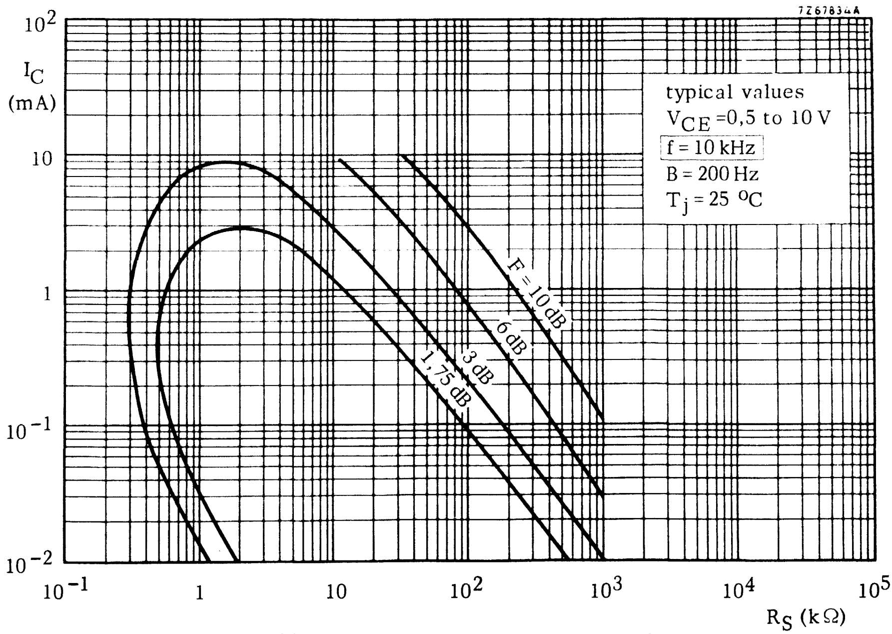


Fig. 14 Curves of constant noise figure for BC850.

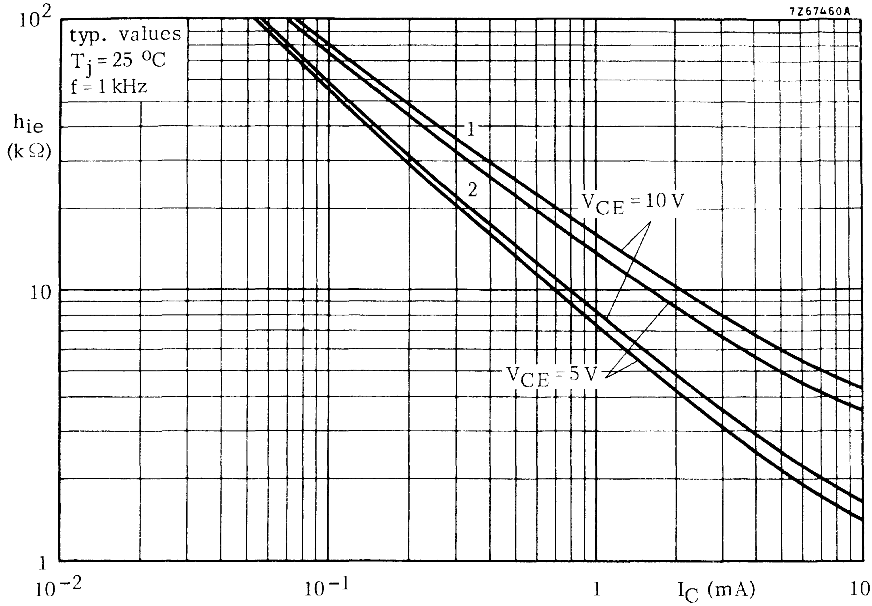


Fig. 15 Typical values. 1 = C selections; 2 = B selections.

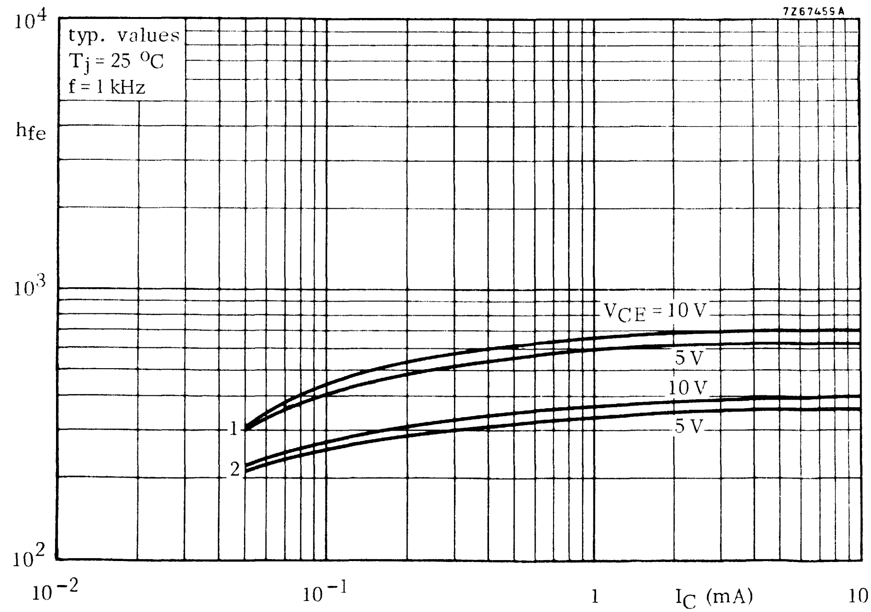


Fig. 16 Typical values. 1 = C selections; 2 = B selections.

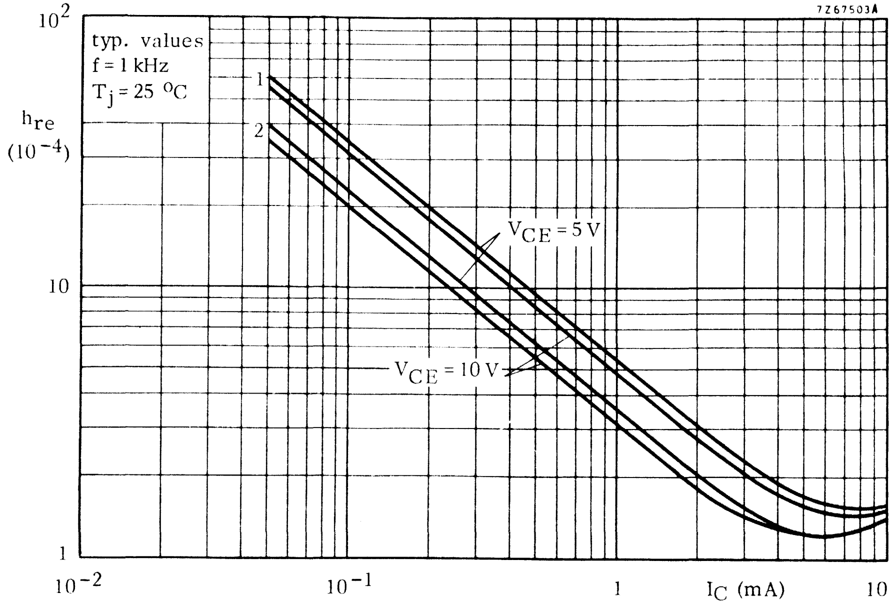


Fig. 17 Typical values. 1 = C selections; 2 = B selections.

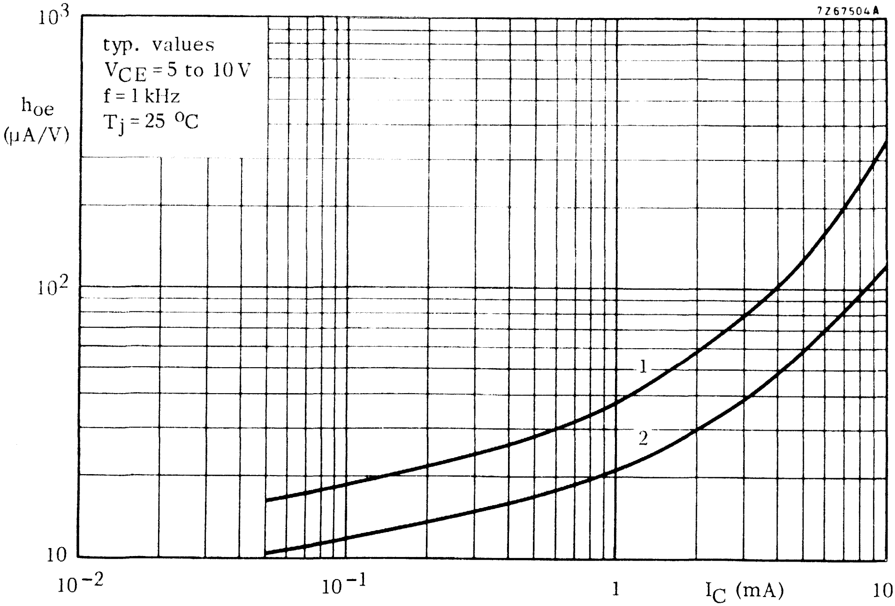


Fig. 18 Typical values. 1 = C selections; 2 = B selections.

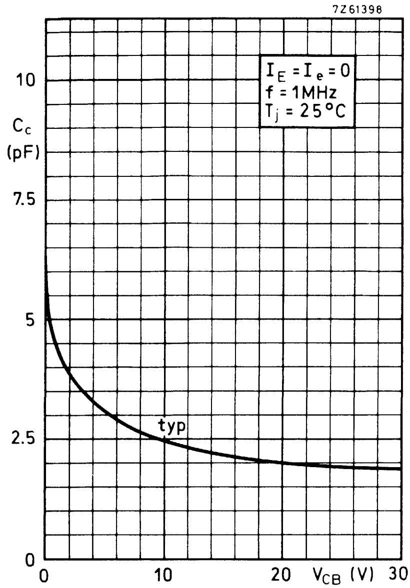


Fig. 19 Typical values.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors, in a SOT-23 plastic envelope for use in driver and output stages of audio amplifiers in thick and thin-film circuits.

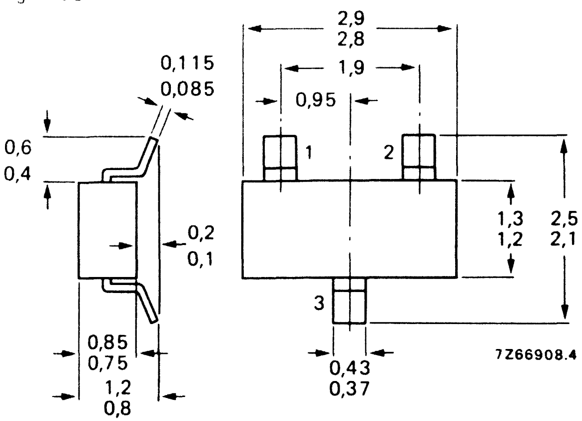
QUICK REFERENCE DATA

			BC856; R	BC857; R	BC858; R	
Collector-emitter voltage (+ V_{BE} = 1 V)	$-V_{CEX}$	max.	80	50	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	65	45	30	V
Collector current (peak value)	$-I_{CM}$	max.		200		mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.		200		mW
Junction temperature	T_j	max.		150		°C
Small-signal current gain $-I_C$ = 2 mA; $-V_{CE}$ = 5 V; f = 1 kHz	h_{fe}			75 to 900		
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

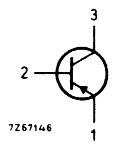
MECHANICAL DATA

Dimensions in mm

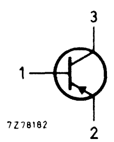
Fig. 1 SOT-23.



Marking code



BC856A = 3A
B = 3B
BC857A = 3E
B = 3F
BC858A = 3J
B = 3K
C = 3L



BC856AR = 3AR
BR = 3BR
BC857AR = 3ER
BR = 3FR
BC858AR = 3JR
BC = 3KR
CR = 3LR

See also *Soldering recommendations* in Microminiature Semiconductor handbook.

RATINGS

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

			BC856; R	BC857; R	BC858; R	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	50	30	V
Collector-emitter voltage ($+V_{BE}$ = 1 V)	$-V_{CEX}$	max.	80	50	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	65	45	30	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V
Collector current (d.c.)	$-I_C$	max.		100		mA
Collector current (peak value)	$-I_{CM}$	max.		200		mA
Emitter current (peak value)	I_{EM}	max.		200		mA
Base current (peak value)	$-I_{BM}$	max.		200		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*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB}$ = 30 V; T_j 25 °C	$-I_{CBO}$	typ.	1	nA
		<	15	nA
T_j = 150 °C	$-I_{CBO}$	<	4	μA
Base-emitter voltage▲				
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	$-V_{BE}$	typ.	650	mV
			600 to 750	mV
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	$-V_{BE}$	<	820	mV

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

* See *Thermal characteristics* in chapter GENERAL in Microminiature Semiconductor handbook.

** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

Saturation voltages *

$-I_C$ = 10 mA; $-I_B$ = 0,5 mA	$-V_{CEsat}$	typ.	75	mV
		<	300	mV
	$-V_{BEsat}$	typ.	700	mV
$-I_C$ = 100 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	typ.	250	mV
		<	650	mV
	$-V_{BEsat}$	typ.	850	mV

Knee voltage

$-I_C$ = 10 mA; $-I_B$ = value for which $-I_C$ = 11 mA at $-V_{CE}$ = 1 V	$-V_{CEK}$	typ.	250	mV
		<	600	mV

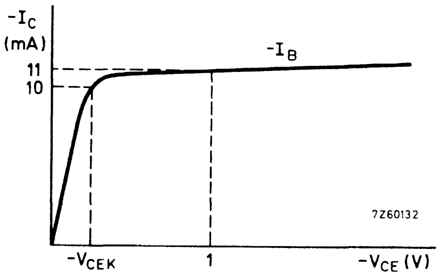


Fig. 2 Knee voltage waveform.

Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $-V_{CB}$ = 10 V		C_c	typ.	4,5	pF
Transition frequency at f = 35 MHz					
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V		f_T	typ.	150	MHz
Small-signal current gain at f = 1 kHz					
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V		h_{fe}		75 to 900	
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
			<	10	dB
D.C. current gain					
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	BC856/857	h_{FE}		75 to 475	
	BC858	h_{FE}		75 to 800	
	BC856A/857A/858A	h_{FE}		125 to 250	
	BC856B/857B/858B	h_{FE}		220 to 475	
	BC858C	h_{FE}		420 to 800	

* $-V_{BEsat}$ decreases by about 1,7 mV/K with increasing temperature.

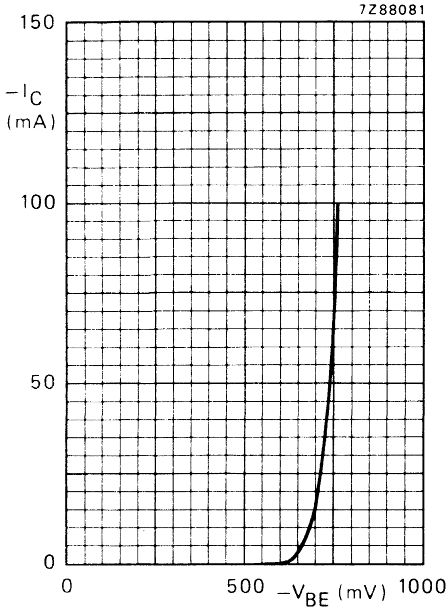


Fig. 3 Typical values. $-V_{CE}$ = 5 V; T_j = 25 °C.

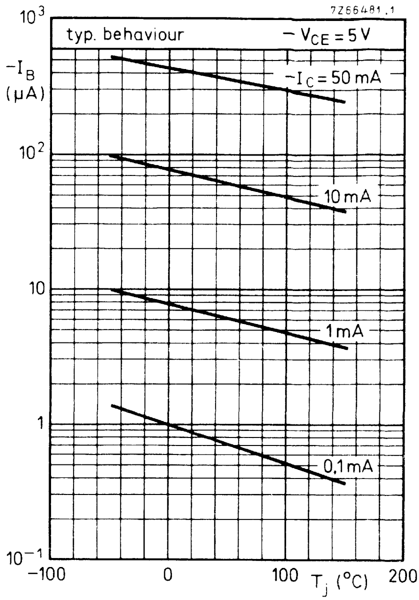


Fig. 4 Typical values.

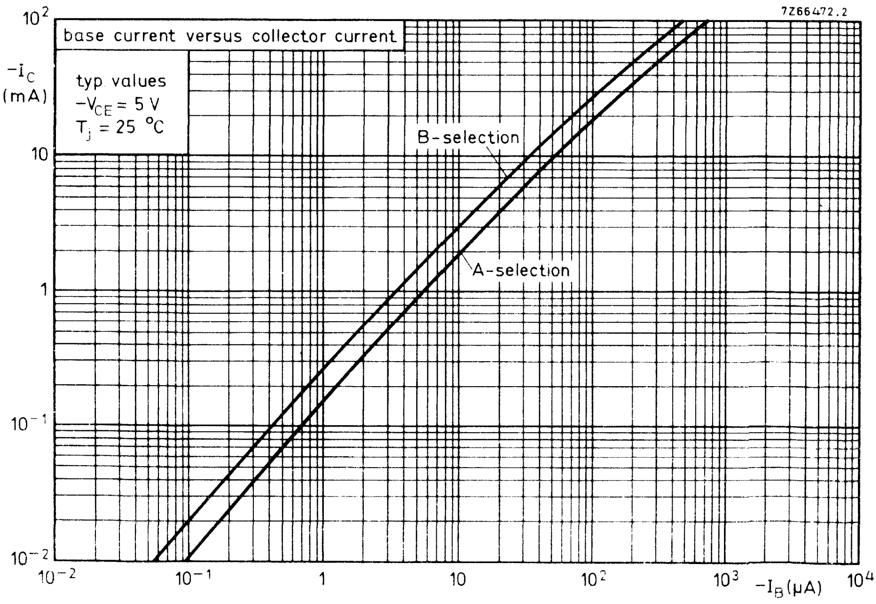


Fig. 5.

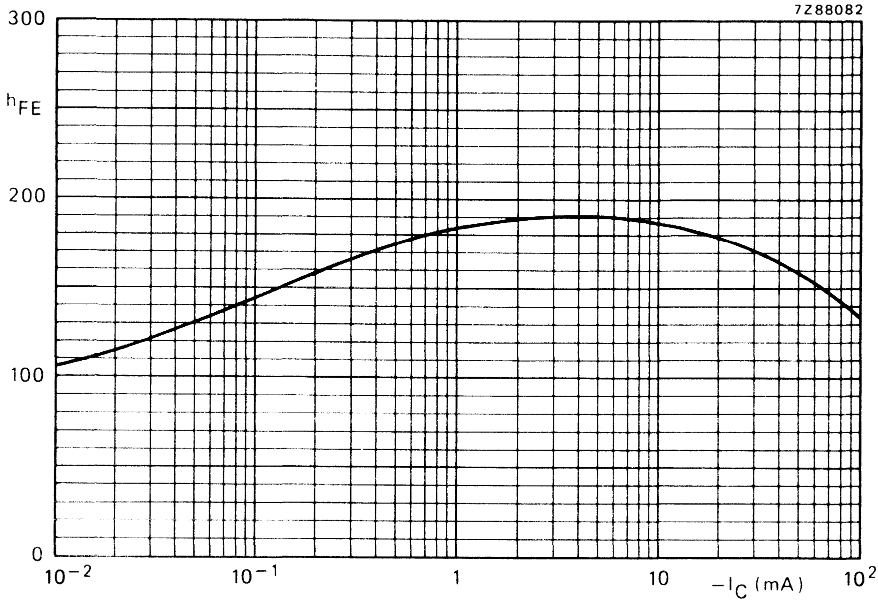


Fig. 6 Typical values D.C. current gain A-selections. $-V_{CE}$ = 5 V; T_j = 25 °C.

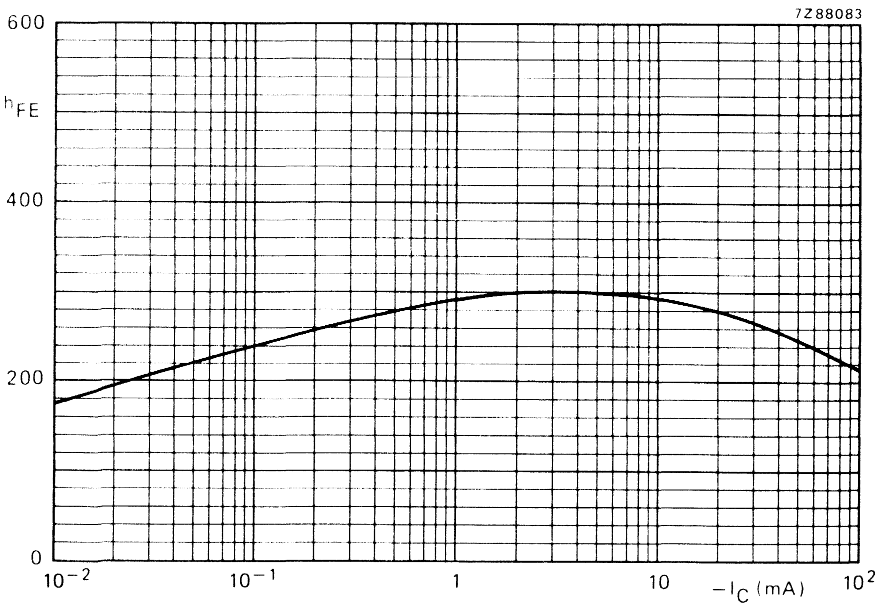


Fig. 7 Typical values D.C. current gain B-selections. $-V_{CE}$ = 5 V; T_j = 25 °C.

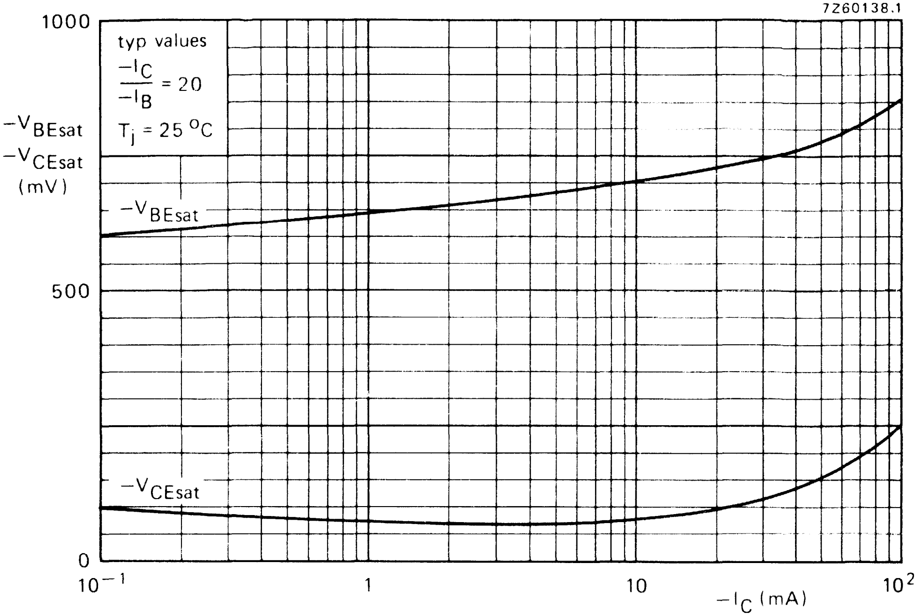


Fig. 8 Typical values base-emitter and collector-emitter saturation voltage.

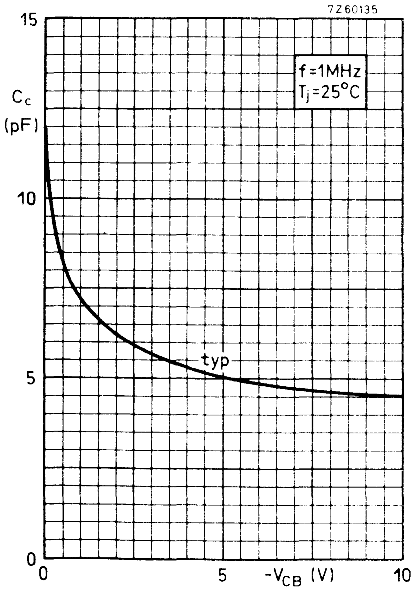


Fig. 9 Typical values.

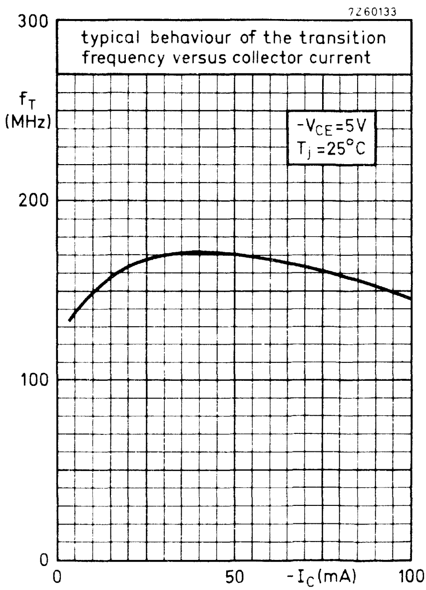


Fig. 10 Typical values. f = 35 MHz.

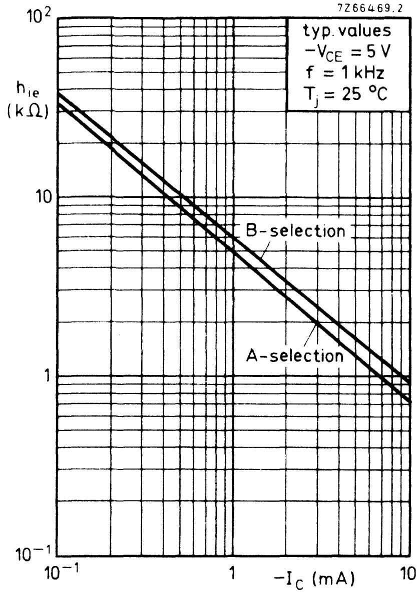


Fig. 11.

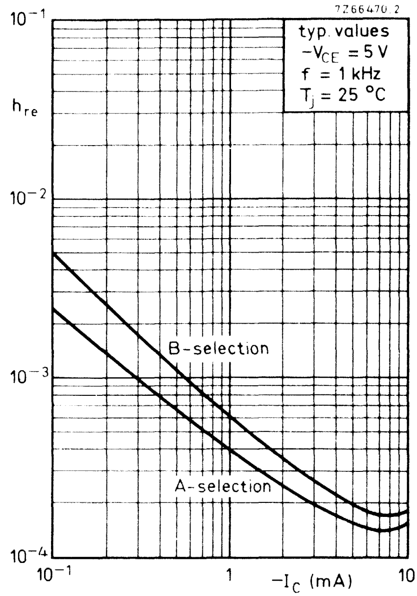


Fig. 12.

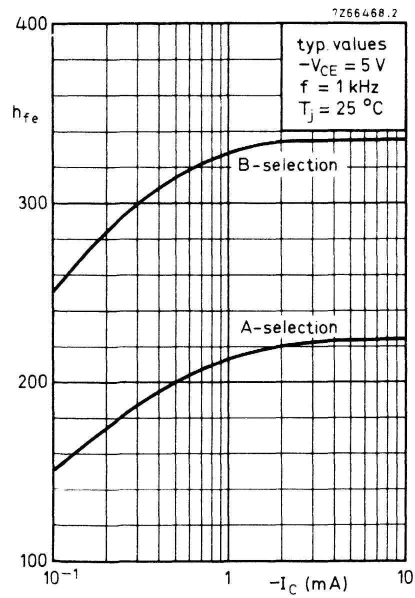


Fig. 13.

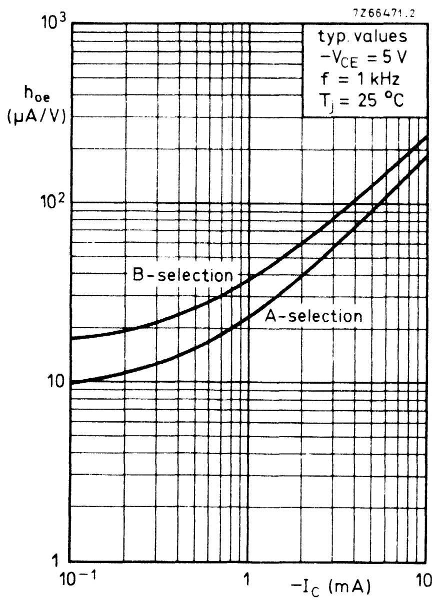


Fig. 14.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in a plastic SOT-23 envelope, primarily intended for low-noise input stages in tape recorders, hi-fi amplifiers and other audio frequency equipment in thick and thin-film hybrid circuits.

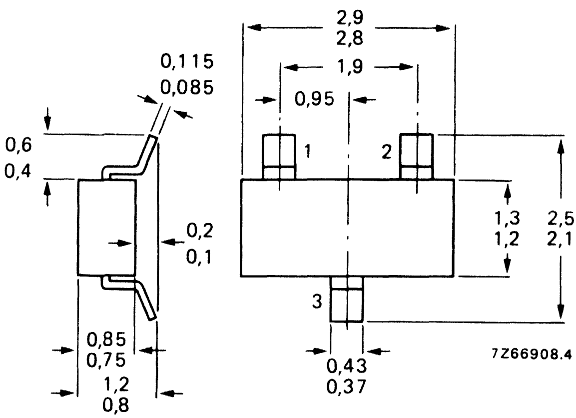
QUICK REFERENCE DATA

			BC859; R	BC860; R	
Collector-emitter voltage (+ V_{BE} = 1 V)	$-V_{CEX}$	max.	30	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30	45	V
Collector current (peak value)	$-I_{CM}$	max.	200	200	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	200	200	mW
Junction temperature	T_j	max.	150	150	°C
Small-signal current gain $-I_C$ = 2 mA; $-V_{CE}$ = 5 V; f = 1 kHz	h_{fe}	> <	125 900	125 900	
Transition frequency $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	150	150	MHz
Noise figure at R_S = 2 kΩ $-I_C$ = 200 μA; $-V_{CE}$ = 5 V f = 30 Hz to 15 kHz	F	typ. <	1,2 4	1 3	dB dB
f = 1 kHz; B = 200 Hz	F	<	4	4	dB

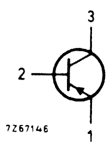
MECHANICAL DATA

Dimensions in mm

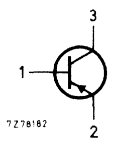
Fig. 1 SOT-23.



Marking code



BC859A = 4A
B = 4B
C = 4C
BC860A = 4E
B = 4F
C = 4G



BC859AR = 4AR
BR = 4BR
CR = 4CR
BC860AR = 4ER
BR = 4FR
CR = 4GR

See also *Soldering recommendations* in Microminiature Semiconductor handbook.

RATINGS

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

			BC859; R	BC860; R	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	50	V
Collector-emitter voltage (+ V_{BE} = 1 V)	$-V_{CEX}$	max.	30	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30	45	V
Emitter-base voltage (open collector)	$-V_{CBO}$	max.	5	5	V

Collector current (d.c.)	$-I_C$	max.	100	mA
Collector current (peak value)	$-I_{CM}$	max.	200	mA
Emitter current (peak value)	I_{EM}	max.	200	mA
Base current (peak value)	$-I_{BM}$	max.	200	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	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $-V_{CB}$ = 30 V; T_j = 25 °C	$-I_{CBO}$	typ.	1	nA
		<	15	nA
T_j = 150 °C	$-I_{CBO}$	<	4	μA

Base-emitter voltage ▲

$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	$-V_{BE}$	typ.	650	mV
			600 to 750	mV
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	$-V_{BE}$	<	820	mV

* See *Thermal characteristics* in chapter GENERAL in Microminiature Semiconductor handbook.
** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.
▲ $-V_{BE}$ decreases by about 2 mV/K with increasing temperature.

Saturation voltages*

$-I_C$ = 10 mA; $-I_B$ = 0,5 mA	$-V_{CEsat}$	typ.	75	mV
		<	300	mV
	$-V_{BEsat}$	typ.	700	mV
$-I_C$ = 100 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	typ.	250	mV
		<	650	mV
	$-V_{BEsat}$	typ.	850	mV

Knee voltage

$-I_C$ = 10 mA; $-I_B$ = value for which $-I_C$ = 11 mA at $-V_{CE}$ = 1 V	$-V_{CEK}$	typ.	250	mV
		<	600	mV

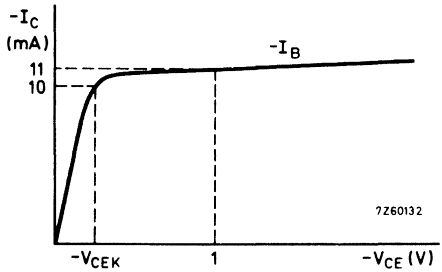


Fig. 2.

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; $-V_{CB}$ = 10 V	C_c	typ.	4,5	pF

Transition frequency at f = 35 MHz

$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	150	MHz

Small-signal current gain at f = 1 kHz

$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{fe}	125 to 900

Noise figure at R_S = 2 kΩ

$-I_C$ = 200 μA; $-V_{CE}$ = 5 V

			BC859	BC860	
f = 30 Hz to 15 kHz	F	typ.	1,2	1	dB
		<	4	3	dB
f = 1 kHz; B = 200 Hz	F	typ.	1	1	dB
		<	4	4	dB

Equivalent noise voltage at R_S = 2 kΩ

			BC859	BC860	
$-I_C$ = 200 μA; $-V_{CE}$ = 5 V f = 10 Hz to 50 Hz; T_{amb} = 25 °C	V_n	<	–	0,11	μV

D.C. current gain

$-I_C$ = 2 mA; $-V_{CE}$ = 5 V; total range	h_{FE}	125 to 800
A selections	h_{FE}	125 to 250
B selections	h_{FE}	220 to 475
C selections	h_{FE}	420 to 800

* $-V_{BEsat}$ decreases by about 1,7 mV/K with increasing temperature.

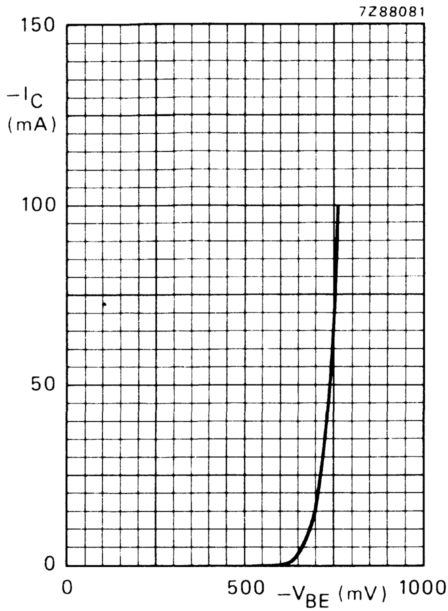


Fig. 3 Typical values. $-V_{CE}$ = 5 V; T_j = 25 °C.

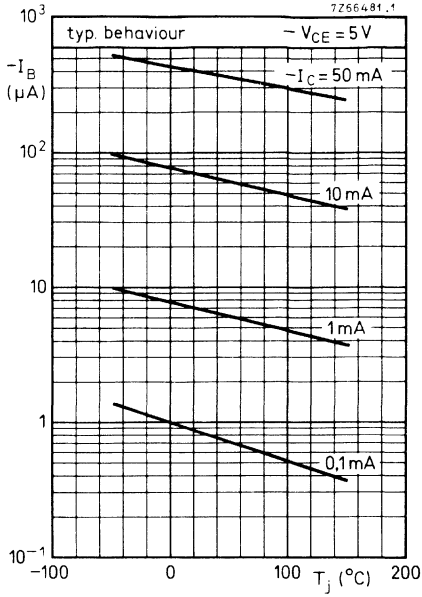


Fig. 4 Typical values.

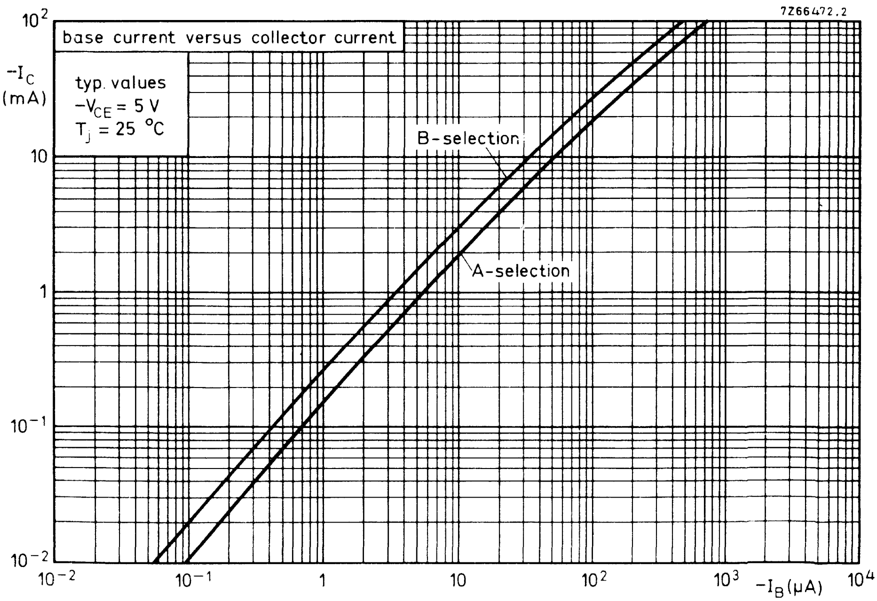


Fig. 5.

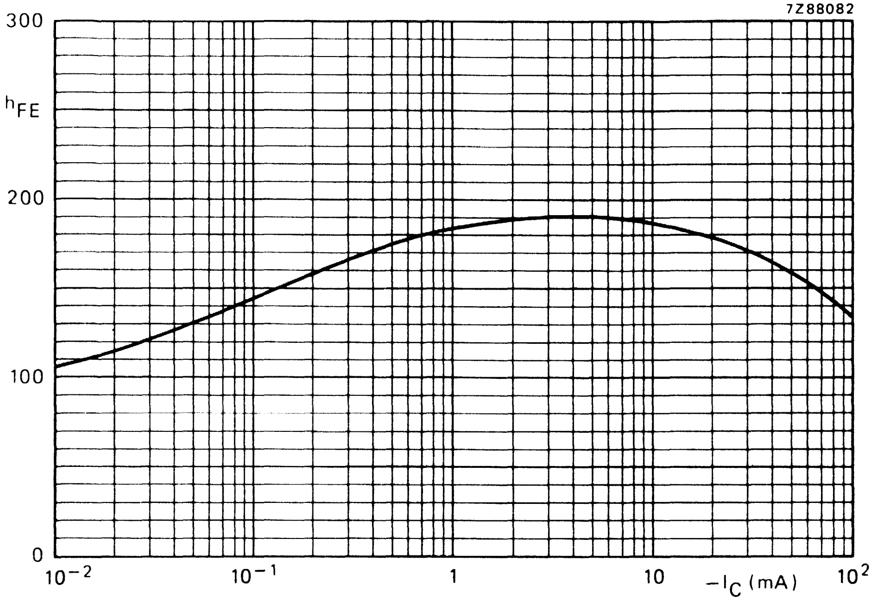


Fig. 6 Typical values. D.C. current gain A-selections. $-V_{CE}$ = 5 V; T_j = 25 °C.

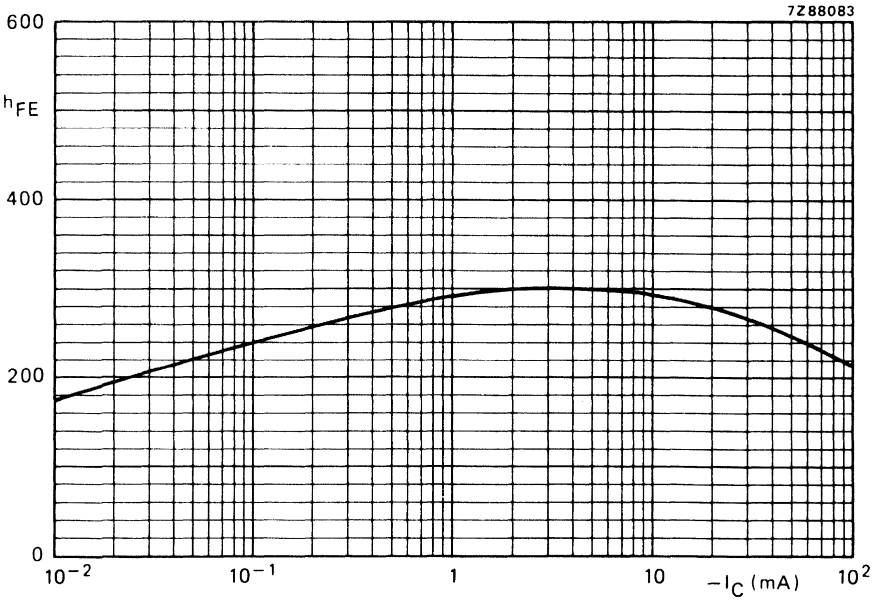


Fig. 7 Typical values. D.C. current gain B-selections. $-V_{CE}$ = 5 V; T_j = 25 °C.

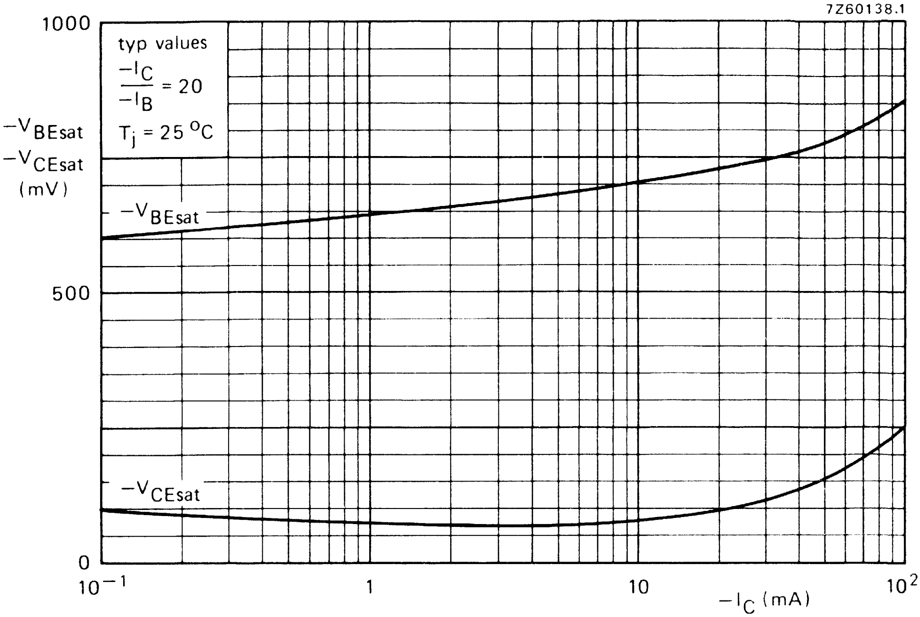


Fig. 8 Typical values base-emitter and collector-emitter saturation voltage.

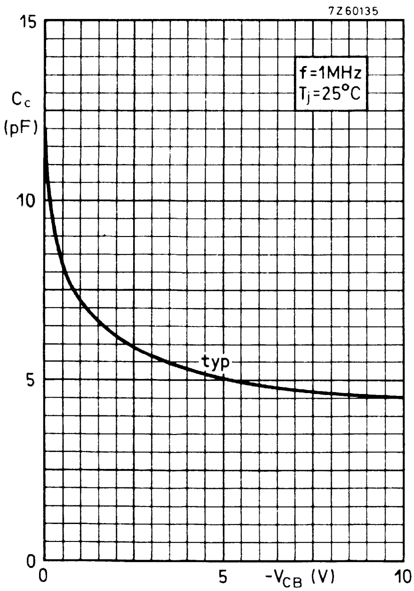


Fig. 9 Typical values.

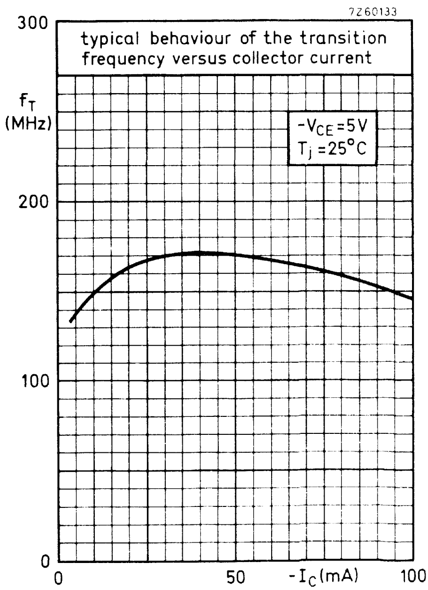


Fig. 10 Typical values. f = 35 MHz.

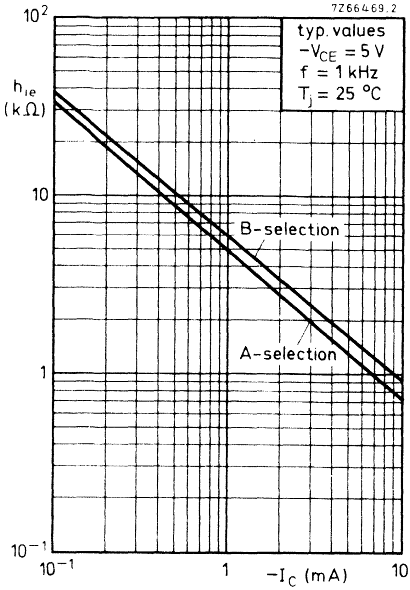


Fig. 11 Typical values.

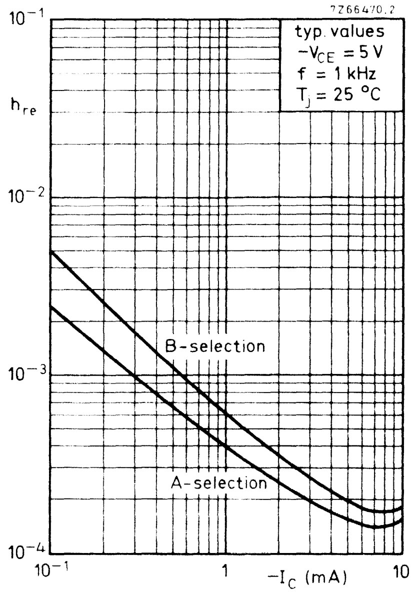


Fig. 12 Typical values.

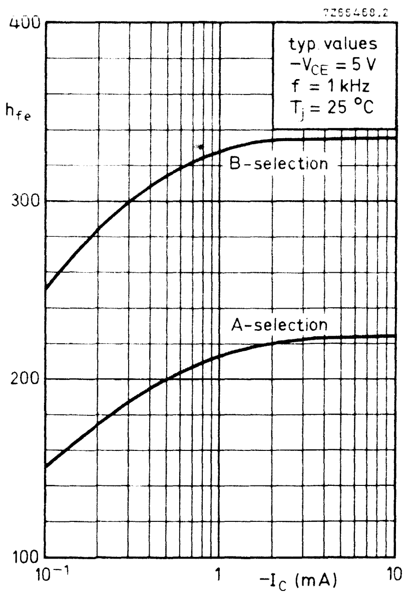


Fig. 13 Typical values.

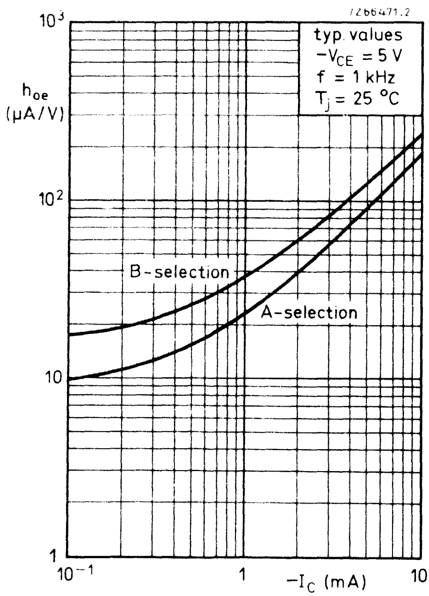


Fig. 14 Typical values.

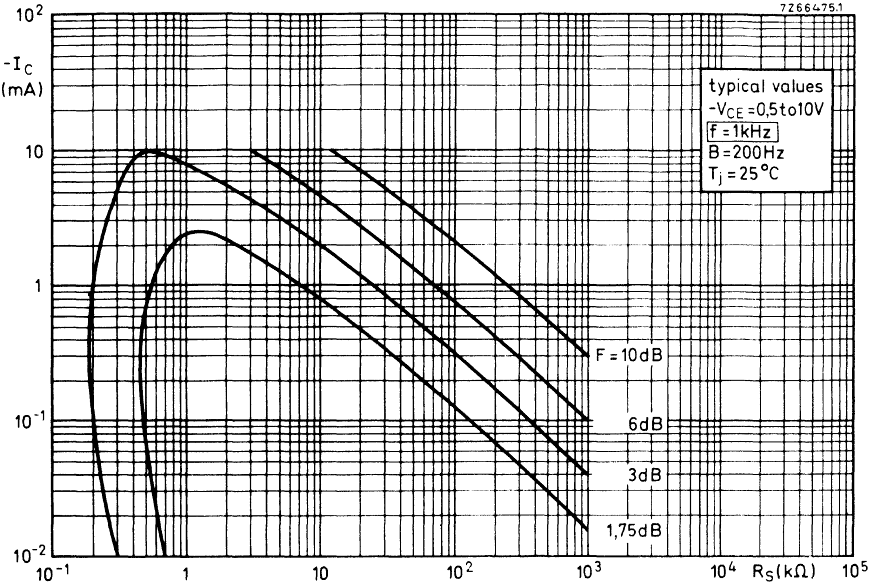


Fig. 15 Curves of constant noise figure at f = 1 kHz.

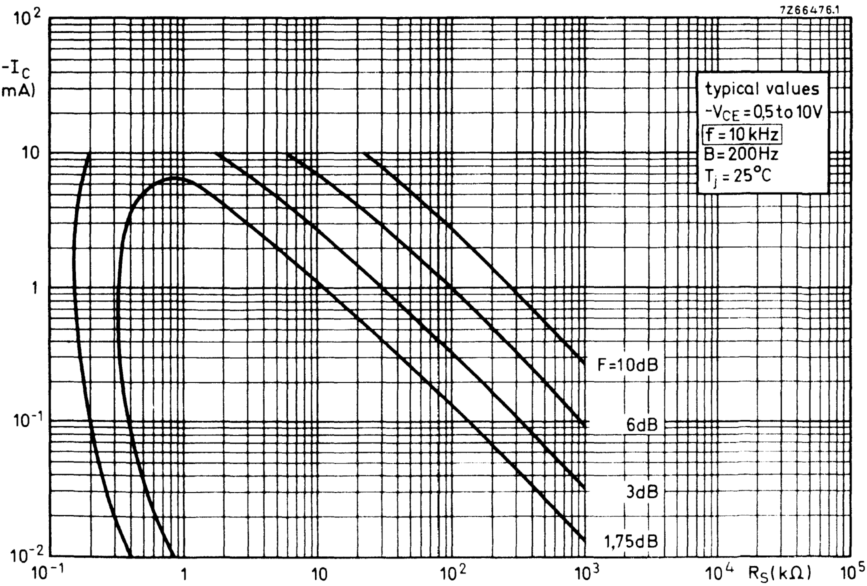


Fig. 16 Curves of constant noise figure at f = 10 kHz.

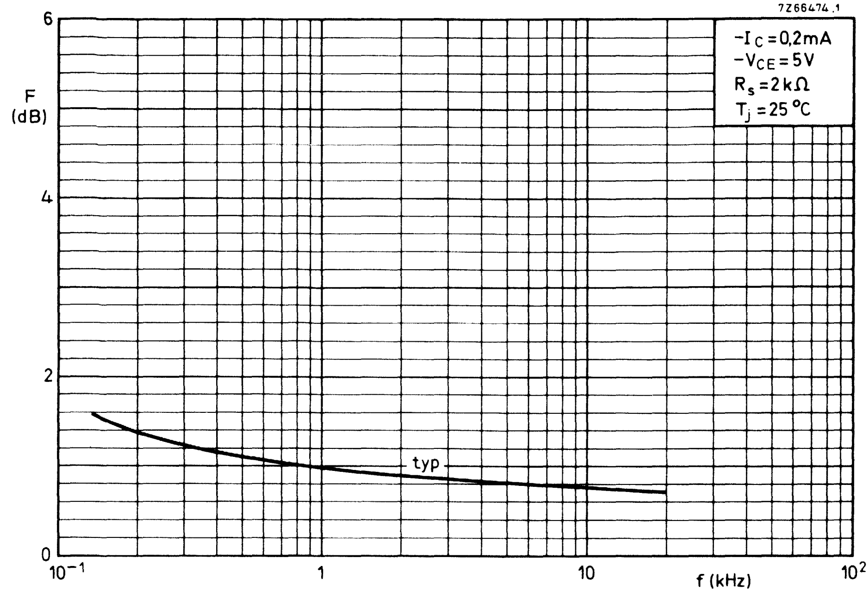


Fig. 17 Typical values noise figure.

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a microminiature plastic envelope intended for low-voltage, high-current l.f. applications. BC868/BC869 is the matched complementary pair suitable for class-B audio output stages up to 3 W.

QUICK REFERENCE DATA

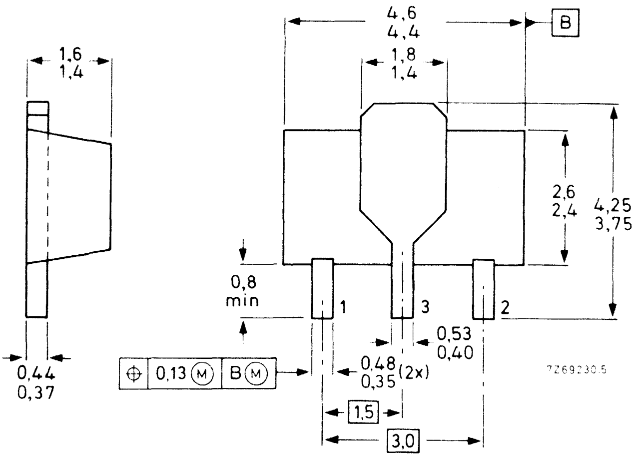
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (peak value)	I_{CM}	max.	2	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	1	W
Junction temperature	T_j	max.	150	°C
D.C. current gain I_C = 500 mA; V_{CE} = 1 V	h_{FE}		85 to 375	
Transition frequency at f = 35 MHz I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	60	MHz

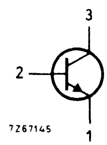
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-89.

Mark
BC868





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.	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c.)	I_C	max.	1	A
Collector current (peak value)	I_{CM}	max.	2	A
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.	1	W
Storage temperature	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 25 V	I_{CBO}	<	10	μA
I_E = 0; V_{CB} = 25 V; T_j = 150 °C	I_{CBO}	<	1	mA
Emitter cut-off current				
I_C = 0; V_{EB} = 5 V	I_{EBO}	<	10	μA
Base-emitter voltage				
I_C = 5 mA; V_{CE} = 10 V	V_{BE}	typ.	0,62	V
I_C = 1 A; V_{CE} = 1 V	V_{BE}	<	1	V
Collector-emitter saturation voltage				
I_C = 1 A; I_B = 100 mA	V_{CEsat}	<	0,5	V
D.C. current gain				
I_C = 5 mA; V_{CE} = 10 V	h_{FE}	>	50	
I_C = 500 mA; V_{CE} = 1 V	h_{FE}		85 to 375	
I_C = 1 A; V_{CE} = 1 V	h_{FE}	>	60	
Collector capacitance at f = 450 kHz				
I_E = I_e = 0; V_{CB} = 5 V	C_c	typ.	27	pF
Cut-off frequency				
I_C = 10 mA; V_{CE} = 5 V	f_{hfe}	typ.	400	kHz
Transition frequency at f = 35 MHz				
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	60	MHz
D.C. current gain ratio of matched pair BC868/BC869				
$\lvert I_C \rvert$ = 500 mA; $\lvert V_{CE} \rvert$ = 1 V	h_{FE1}/h_{FE2}	<	1,4	

* Mounted on a ceramic substrate, area = 2,5 cm^2, thickness = 0,7 mm.

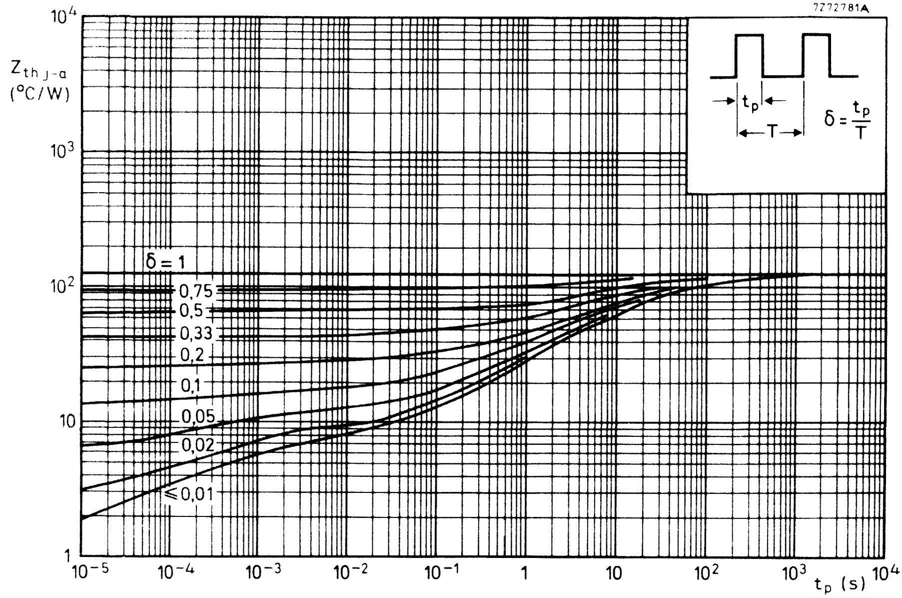


Fig. 2 Pulse power rating chart.

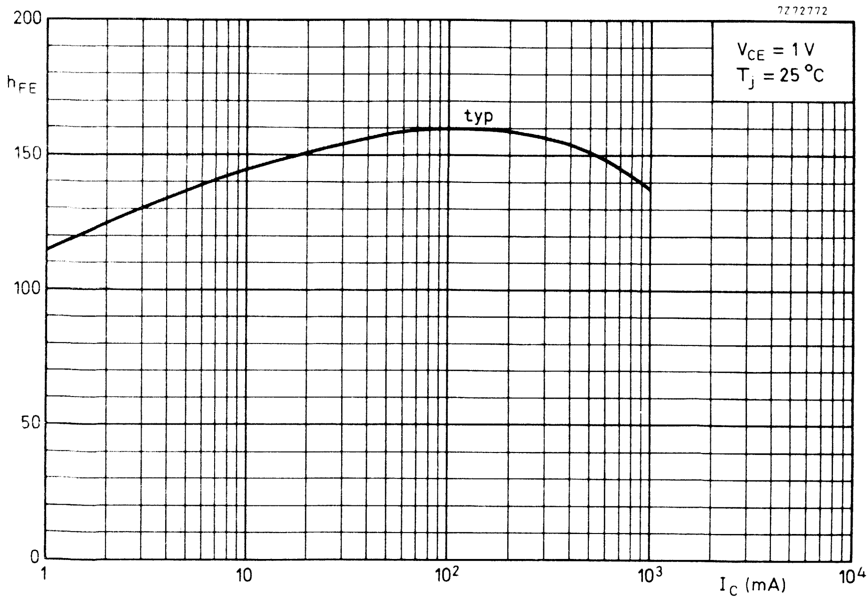


Fig. 3 D.C. current gain.

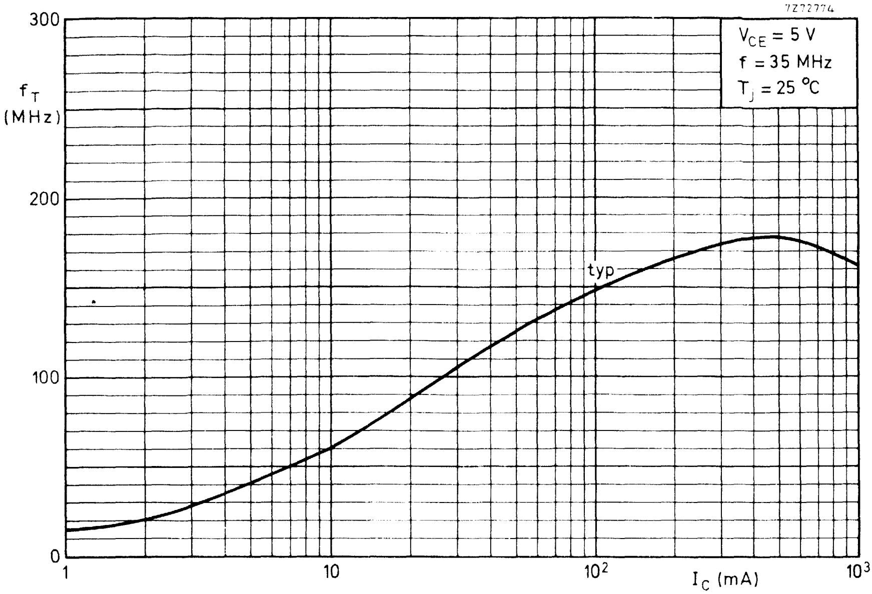


Fig. 4 Typical values transition frequency as a function of collector current.

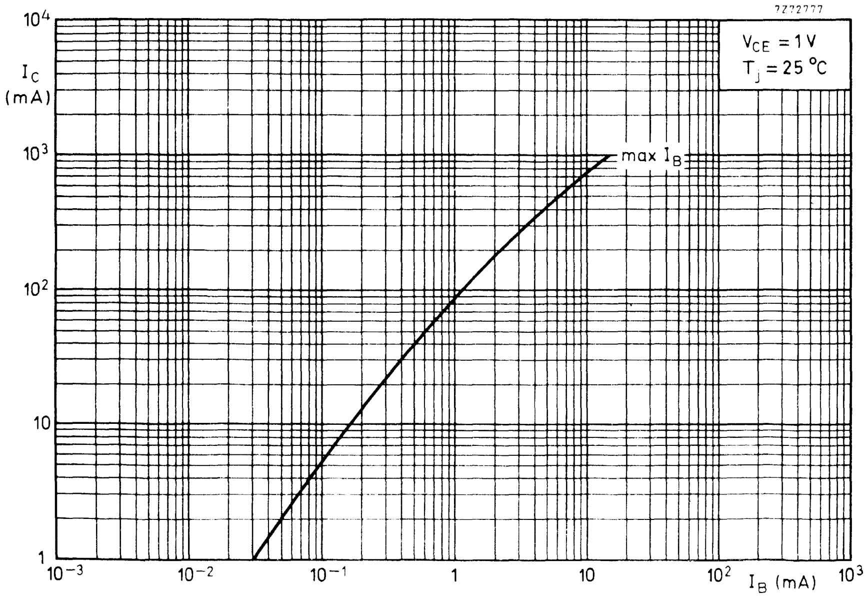


Fig. 5 Typical values collector current as a function of maximum base current.

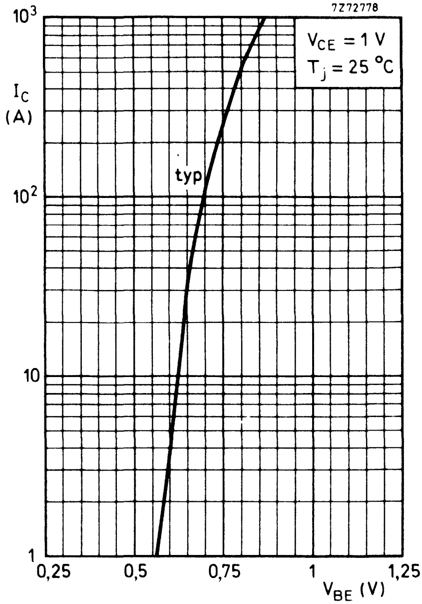


Fig. 6 Typical values collector current as a function of base-emitter voltage.

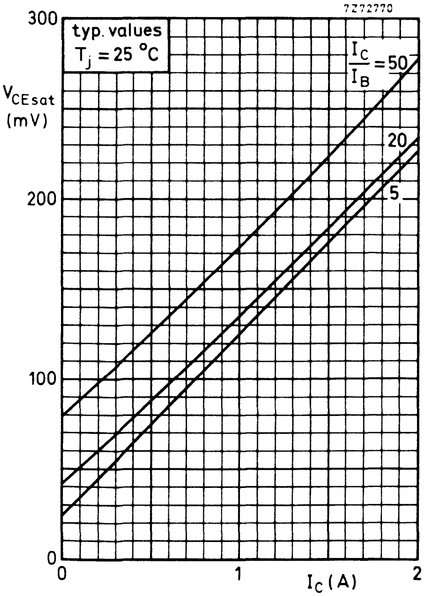


Fig. 7 Collector-emitter saturation voltage as a function of collector current.

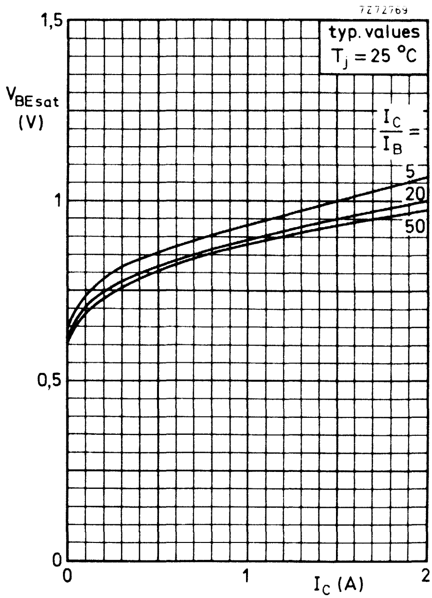


Fig. 8 Base-emitter saturation voltage as a function of collector current.

SILICON PLANAR EPITAXIAL TRANSISTOR

P-N-P transistor in a plastic microminiature envelope, intended for low-voltage, high-current l.f. applications. BC868/BC869 is the matched complementary pair suitable for class-B audio output stages up to 3 W.

QUICK REFERENCE DATA

Collector-emitter voltage ($V_{BE} = 0$)	$-V_{CES}$	max.	25	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Collector current (peak value)	$-I_{CM}$	max.	2	A
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	1	W
Junction temperature	T_j	max.	150	^oC
D.C. current gain $-I_C = 500$ mA; $-V_{CE} = 1$ V	h_{FE}		85 to 375	
Transition frequency at f = 35 MHz $-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	60	MHz

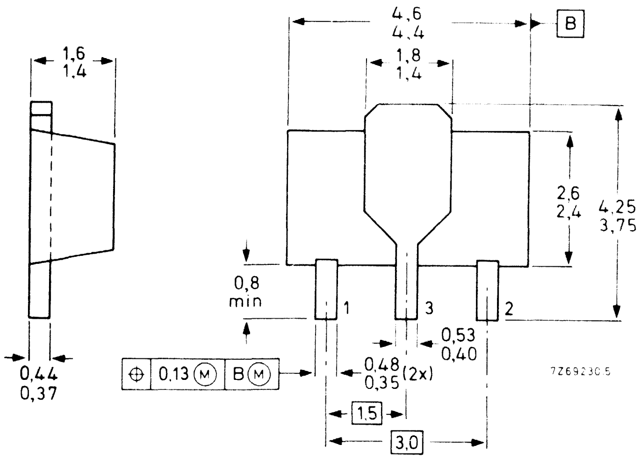
MECHANICAL DATA

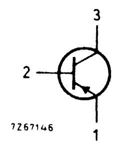
Dimensions in mm

Fig. 1 SOT-89.

Mark

BC869





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.	25	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V
Collector current (d.c.)	$-I_C$	max.	1	A
Collector current (peak value)	$-I_{CM}$	max.	2	A
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.	1	W
Storage temperature	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; $-V_{CB}$ = 25 V	$-I_{CBO}$	<	10	μA
I_E = 0; $-V_{CB}$ = 25 V; T_j = 150 °C	$-I_{CBO}$	<	1	mA
Emitter cut-off current				
I_C = 0; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	10	μA
Base-emitter voltage				
$-I_C$ = 5 mA; $-V_{CE}$ = 10 V	$-V_{BE}$	typ.	0,62	V
$-I_C$ = 1 A; $-V_{CE}$ = 1 V	$-V_{BE}$	<	1	V
Collector-emitter saturation voltage				
$-I_C$ = 1 A; $-I_B$ = 100 mA	$-V_{CEsat}$	<	0,5	V
D.C. current gain				
$-I_C$ = 5 mA; $-V_{CE}$ = 10 V	h_{FE}	>	50	
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}	85 to 375		
$-I_C$ = 1 A; $-V_{CE}$ = 1 V	h_{FE}	>	60	
Collector capacitance at f = 450 kHz				
$I_E = I_e$ = 0; $-V_{CB}$ = 5 V	C_c	typ.	45	pF
Cut-off frequency				
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_{hfe}	typ.	350	kHz
Transition frequency at f = 35 MHz				
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	60	MHz
D.C. current gain ratio of matched pair BC868/BC869				
$\|I_C\|$ = 500 mA; $\|V_{CE}\|$ = 1 V	h_{FE1}/h_{FE2}	<	1,4	

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

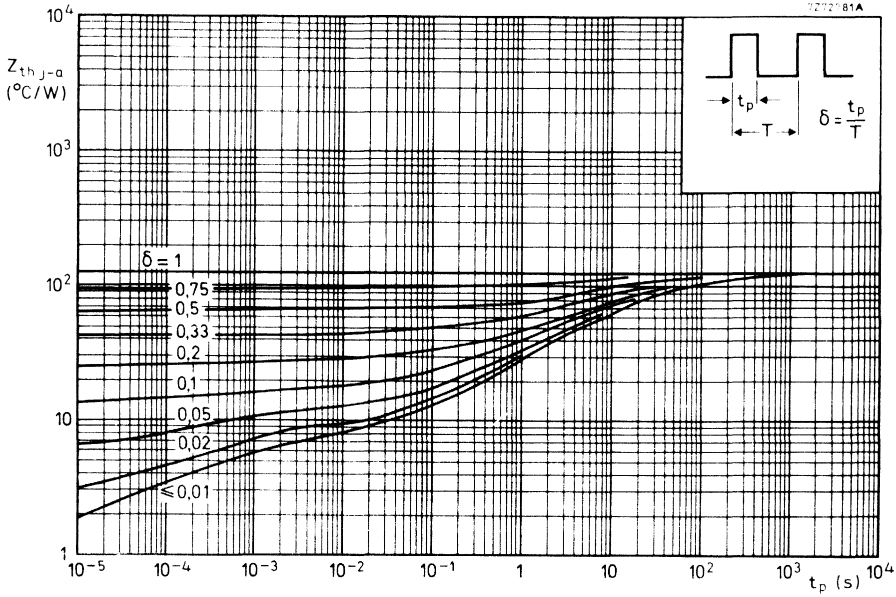


Fig. 2 Pulse power rating chart.

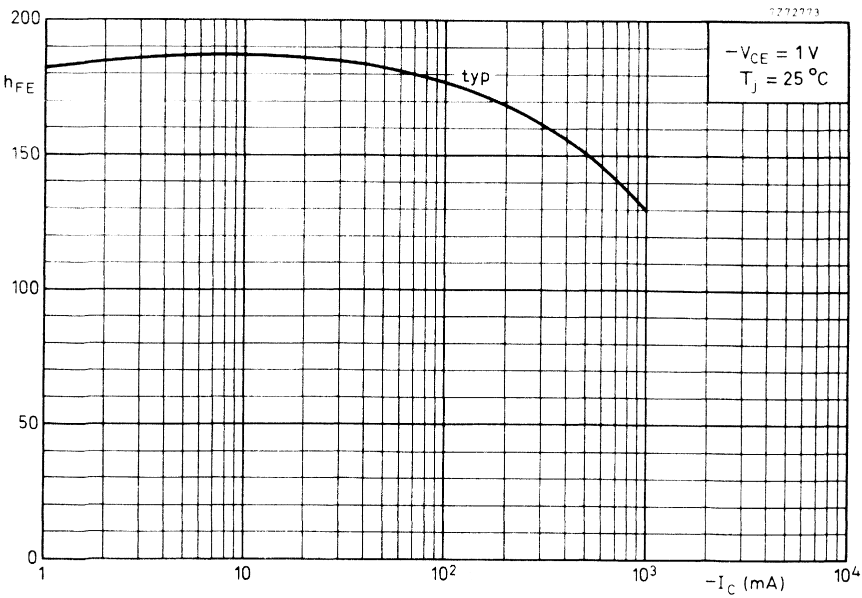


Fig. 3 D.C. current gain.

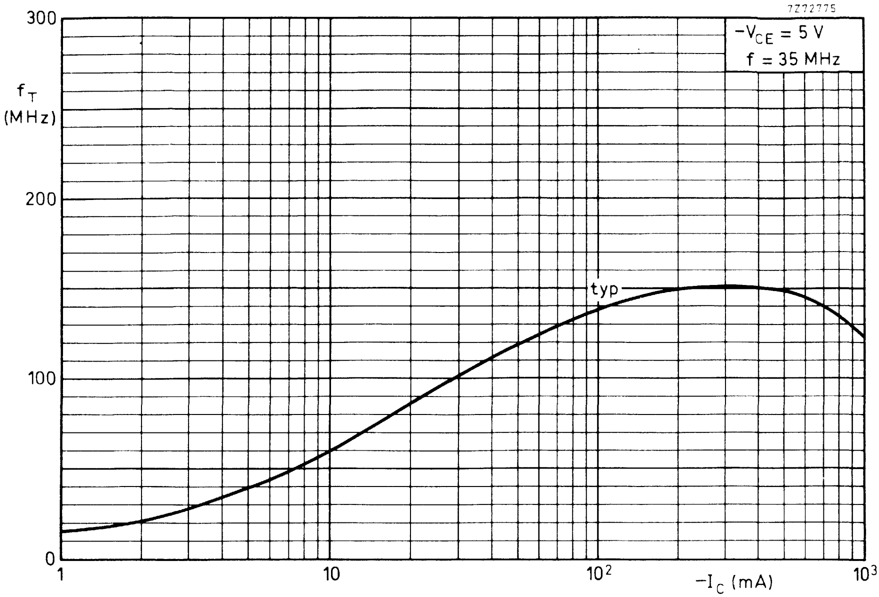


Fig. 4 Typical values transition frequency as a function of collector current.

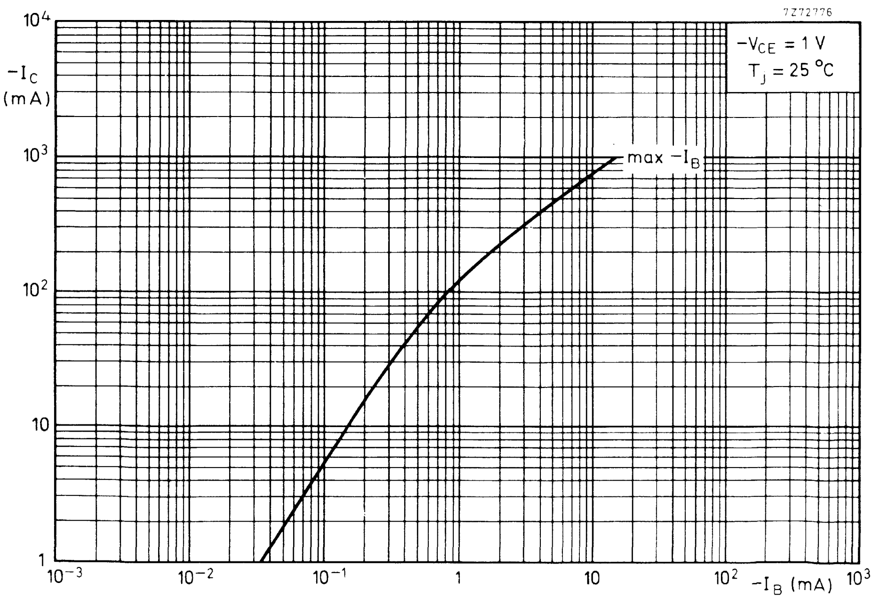


Fig. 5 Typical values collector current as a function of maximum base current.

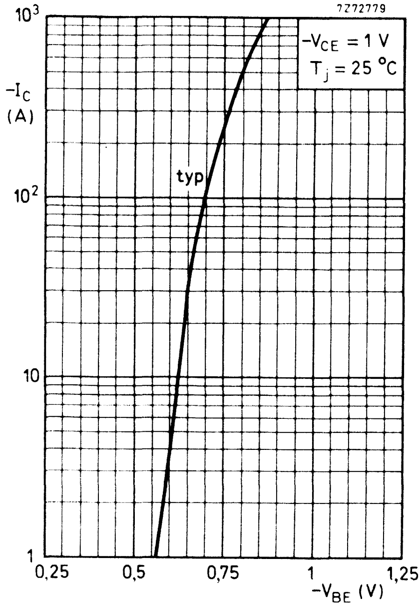


Fig. 6 Typical values collector current as a function of base-emitter voltage.

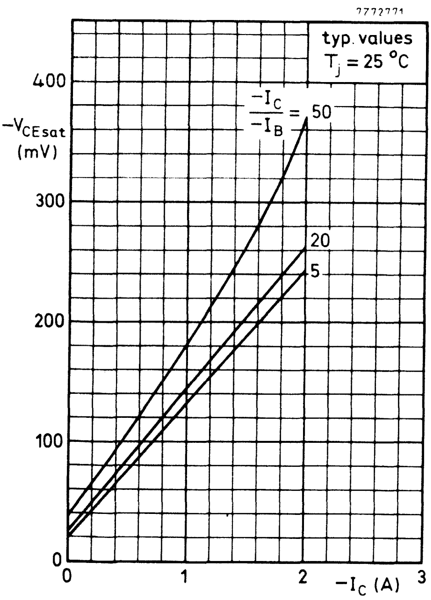


Fig. 7 Collector-emitter saturation voltage as a function of collector current.

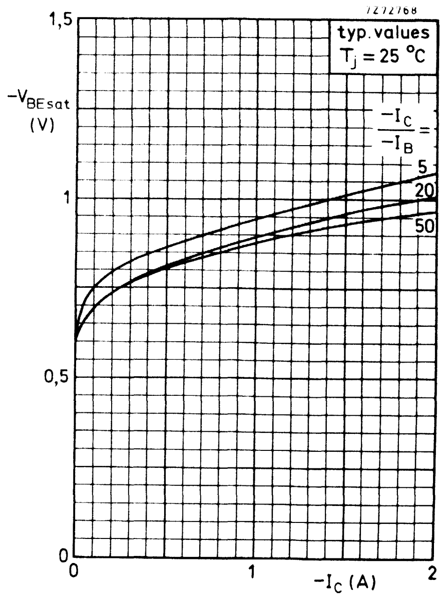


Fig. 8 Base-emitter saturation voltage as a function of collector current.

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.

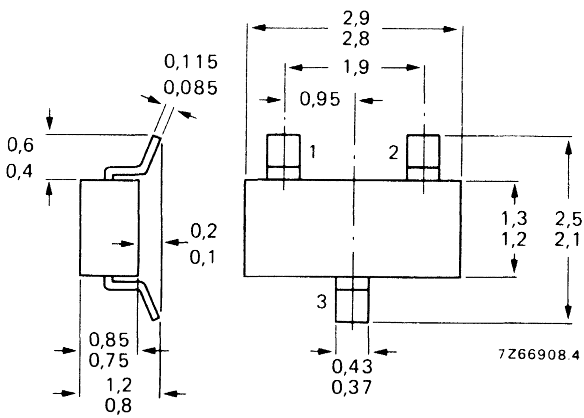
QUICK REFERENCE DATA

			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

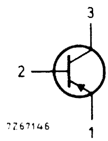
Dimensions in mm

Fig. 1 SOT-23.

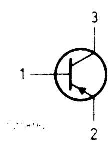


Marking code

BCF29 = C7
BCF30 = C8



BCF29R = C77
BCF30R = C9



See also *Soldering recommendations.*

RATINGS

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32 V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32 V
Collector-emitter voltage (open base) $-I_C$ = 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**	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	$R_{th\,t\text{-}s}$	=	280 K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90 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 mV; $-I_B$ = 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 8 mm x 10 mm x 0,7 mm.

D.C. current gain

			BCF29 BCF29R	BCF30 BCF30R	
$-I_C$ = 10 μA; $-V_{CE}$ = 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 kΩ $-I_C$ = 200 μA; $-V_{CE}$ = 5 V f = 1 kHz; B = 200 Hz	F	<	4		dB
		typ.	1		dB

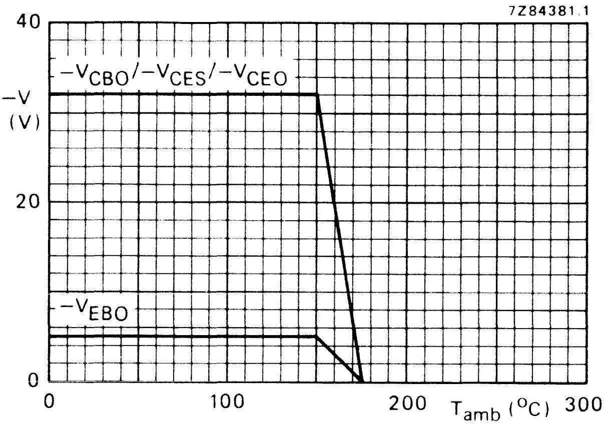


Fig. 2 Voltage derating curves.

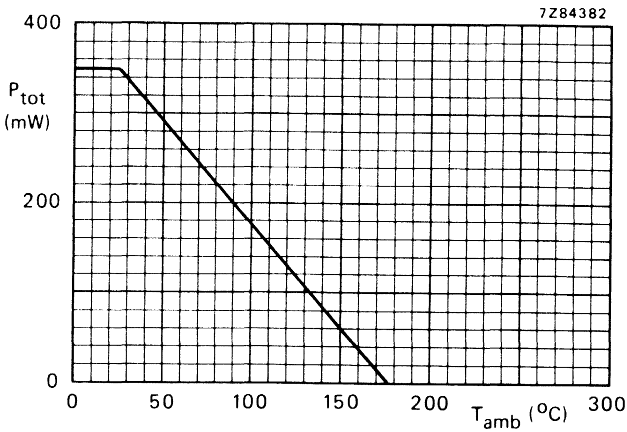


Fig. 3 Power derating curve.

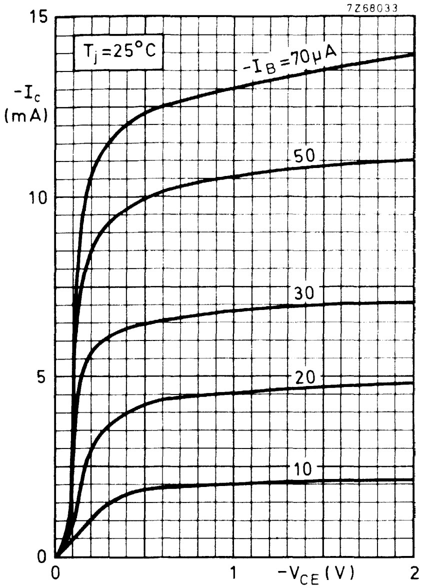


Fig. 4.

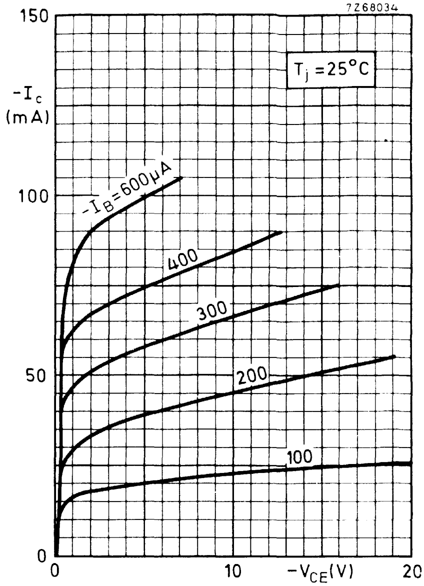


Fig. 5.

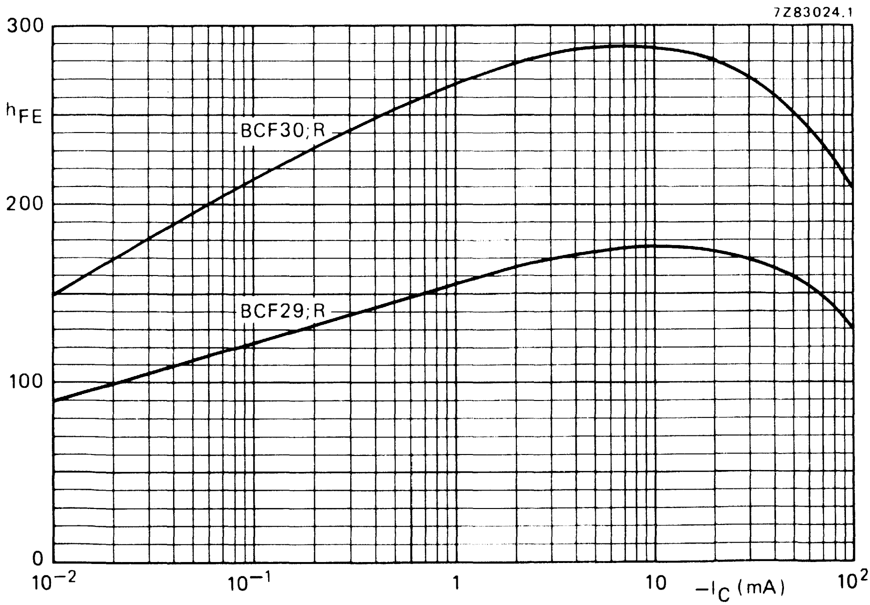


Fig. 6 Typical values of d.c. current gain. $-V_{CE}$ = 5 V; T_j = 25 °C.

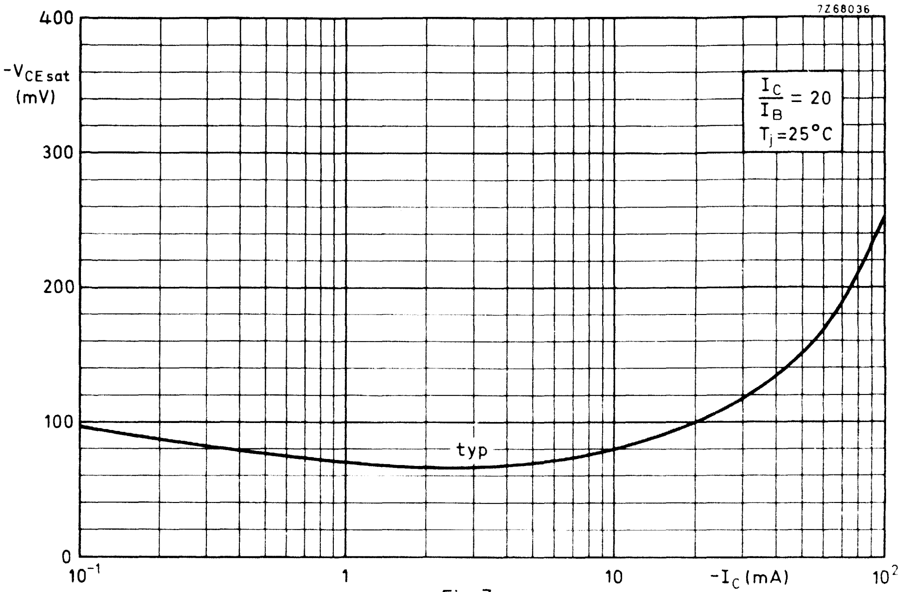

7Z68036
400
$-V_{CEsat}$
(mV)
300
200
100
0
10^{-1}
1
10
$-I_C$ (mA)
10^2
$\frac{I_C}{I_B} = 20$
$T_j = 25\,°C$
typ

Fig. 7.

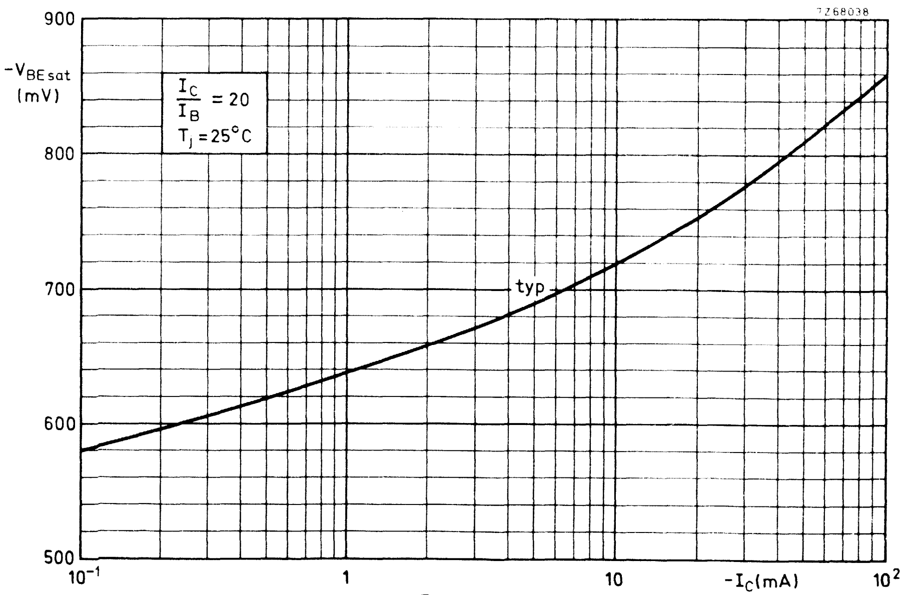

7Z68038
900
$-V_{BEsat}$
(mV)
800
700
600
500
10^{-1}
1
10
$-I_C$(mA)
10^2
$\frac{I_C}{I_B} = 20$
$T_j = 25\,°C$
typ

Fig. 8.

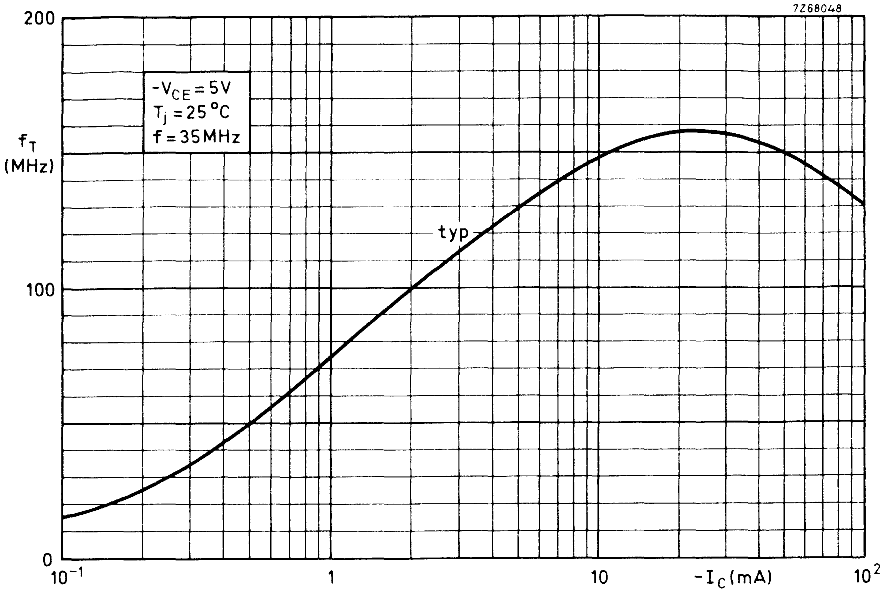

7Z68048
200
100
0
f_T
(MHz)
$-V_{CE} = 5V$
$T_j = 25\,°C$
f = 35 MHz
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 9.

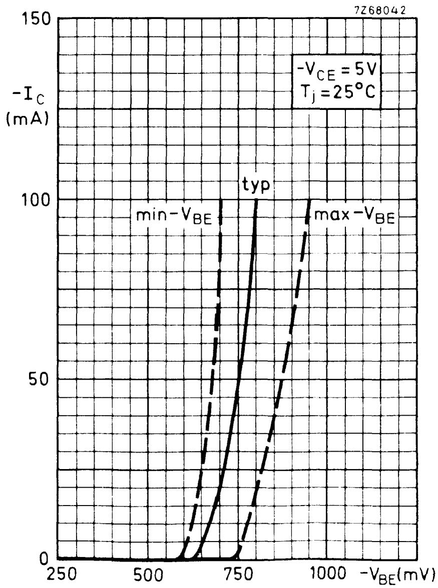

7Z68042
150
100
50
0
$-I_C$
(mA)
$-V_{CE} = 5V$
$T_j = 25°C$
typ
min $-V_{BE}$
max $-V_{BE}$
250
500
750
1000
$-V_{BE}$(mV)

Fig. 10.

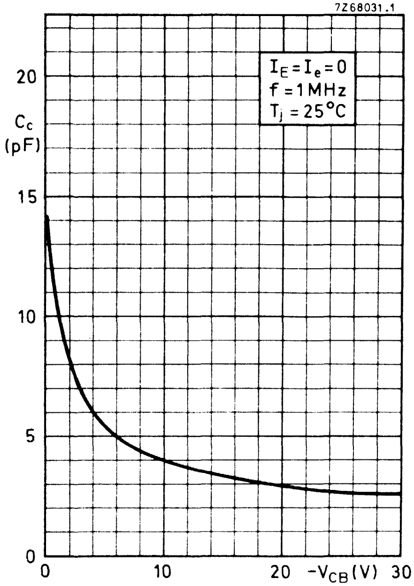

7Z68031.1
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
C_c (pF)
$-V_{CB}$ (V)
0
5
10
15
20
0
10
20
30

Fig. 11.

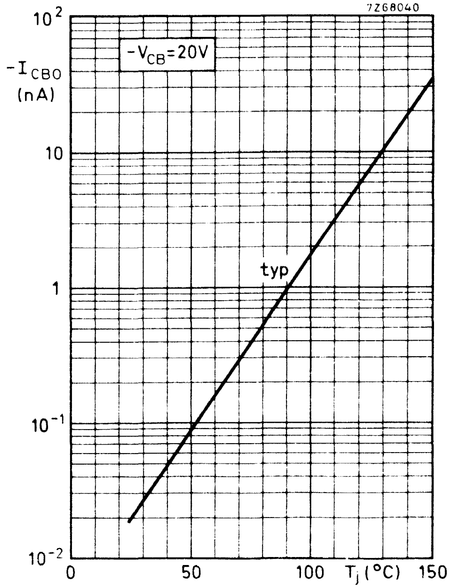

7Z68040
$-V_{CB}$ = 20 V
$-I_{CBO}$ (nA)
typ
T_j (°C)
10^2
10
1
10^{-1}
10^{-2}
0
50
100
150

Fig. 12.

SILICON PLANAR EPITAXIAL TRANSISTORS

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

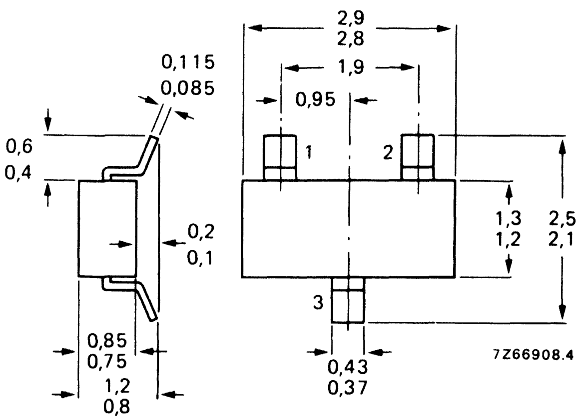
QUICK REFERENCE DATA

			BCF32 BCF32R	BCF33 BCF33R	
D.C. current gain at T_j = 25 °C; I_C = 2 mA; V_{CE} = 5 V	h_{FE}	>	200	420	
		<	450	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

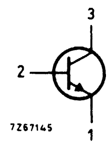
Fig. 1 SOT-23.



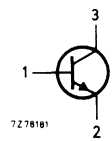
See also *Soldering recommendations*.

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 dissipatation 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	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ 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; $T_j = 100\ ^oC$	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 8 mm x 10 mm x 0,7 mm.

			BCF32 BCF32R	BCF33 BCF33R
D.C. current gain				
$I_C = 10\ \mu A$; $V_{CE} = 5$ V	h_{FE}	typ.	150	270
$I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	>	200	420
		<	450	800
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	4,0 pF	
Transition frequency at f = 35 MHz $I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	300 MHz	
Noise figure at $R_S = 2\ k\Omega$ $I_C = 200\ \mu A$; $V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	4 dB	
		typ.	1,2 dB	

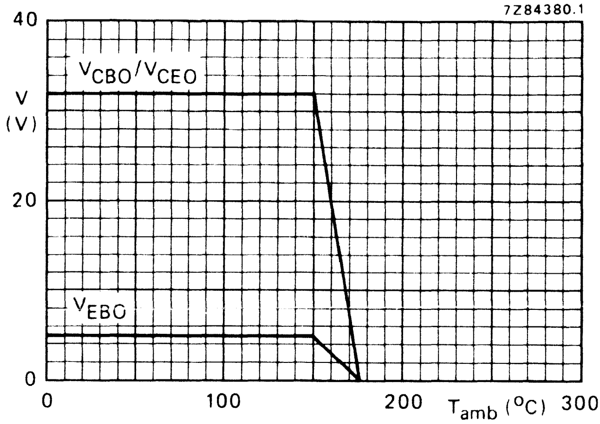


Fig. 2 Voltage derating curves.

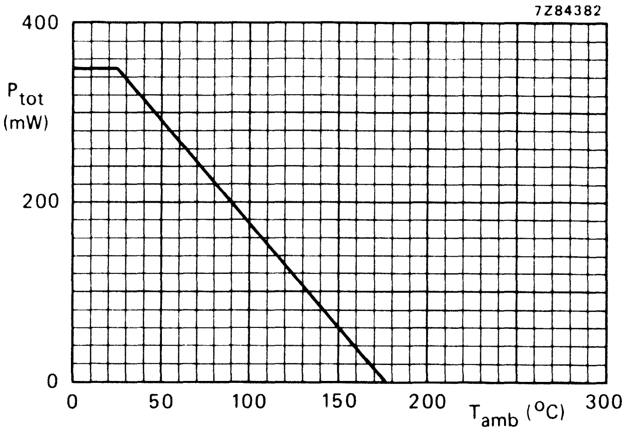


Fig. 3 Power derating curve.

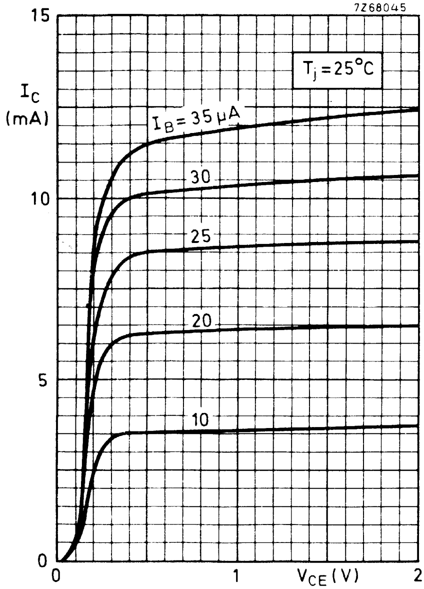


Fig. 4.

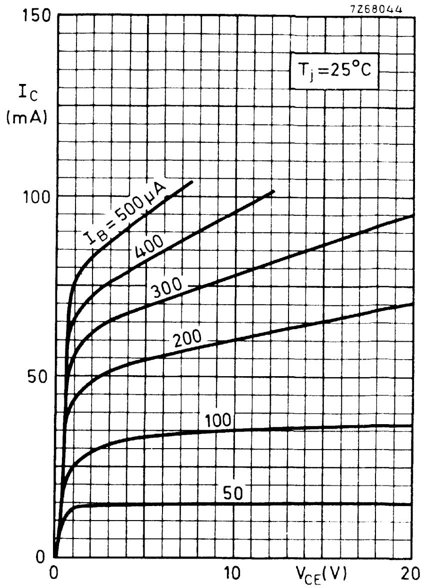


Fig. 5.

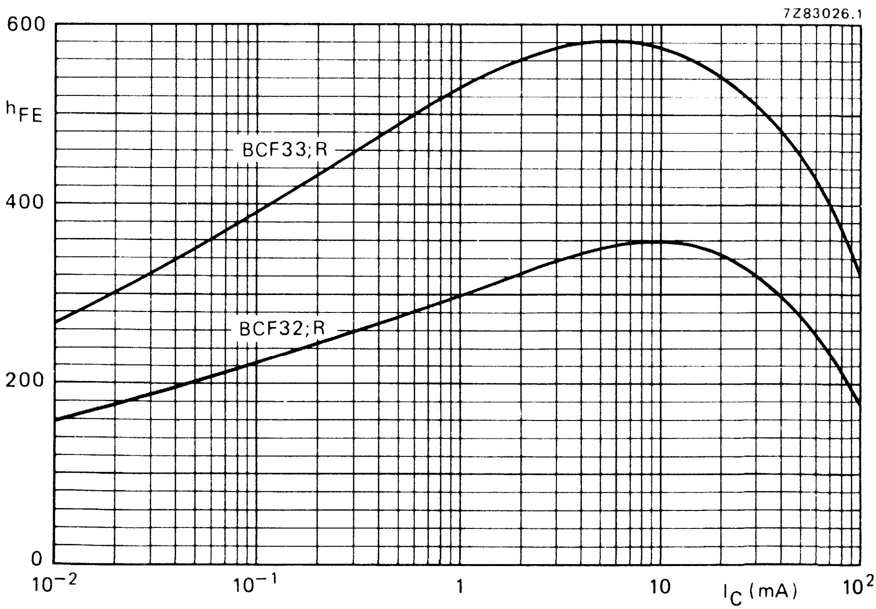


Fig. 6 Typical values d.c. current gain. $V_{CE} = 5$ V; $T_j = 25$ °C.

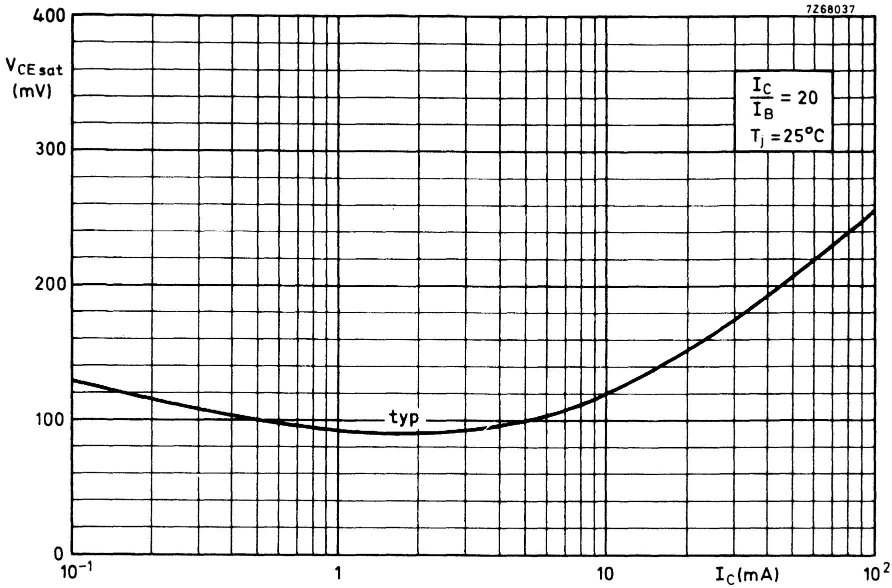

7Z68037
400
300
200
100
0
V_{CEsat}
(mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 7.

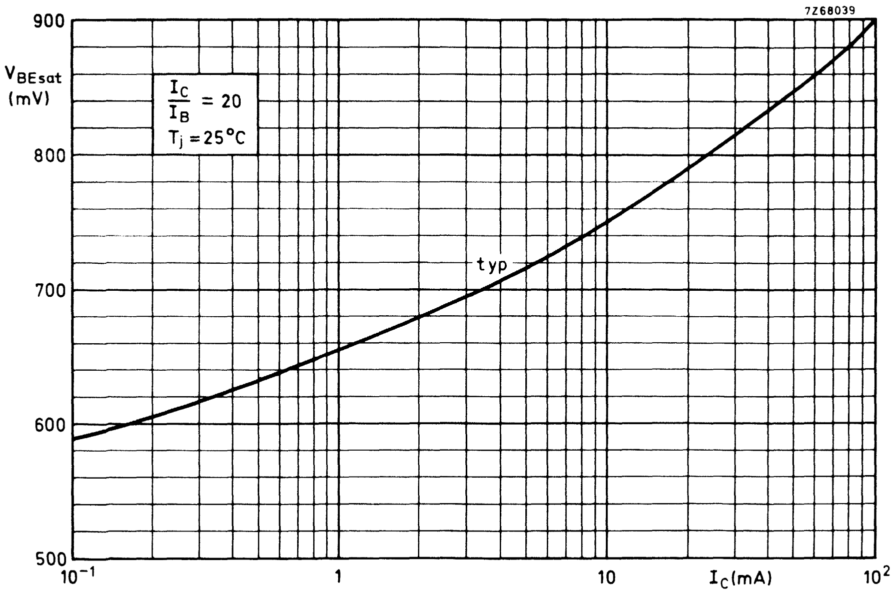

7Z68039
900
800
700
600
500
V_{BEsat}
(mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 8.

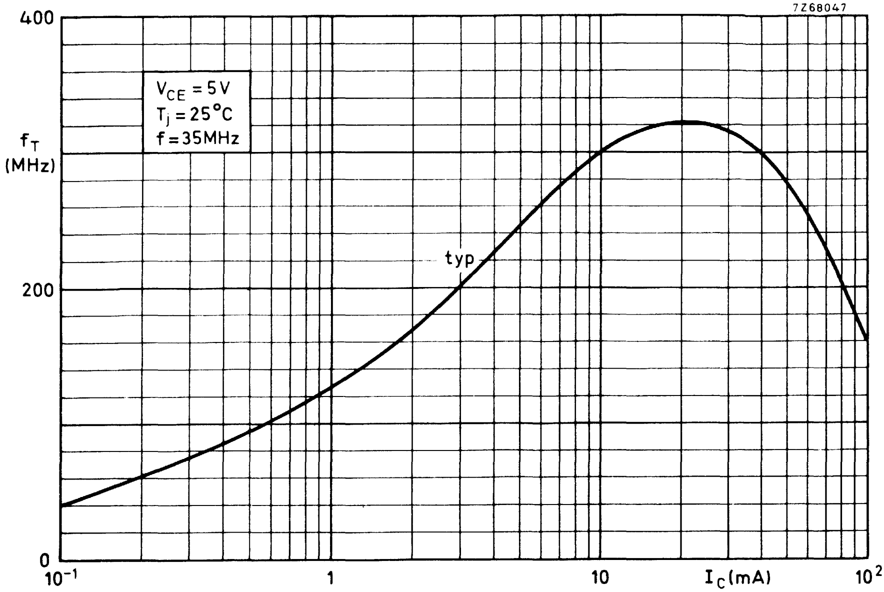

7Z68047
400
200
0
f_T
(MHz)
V_{CE} = 5 V
T_j = 25 °C
f = 35 MHz
typ
10^{-1}
1
10
I_C (mA)
10^2

Fig. 9.

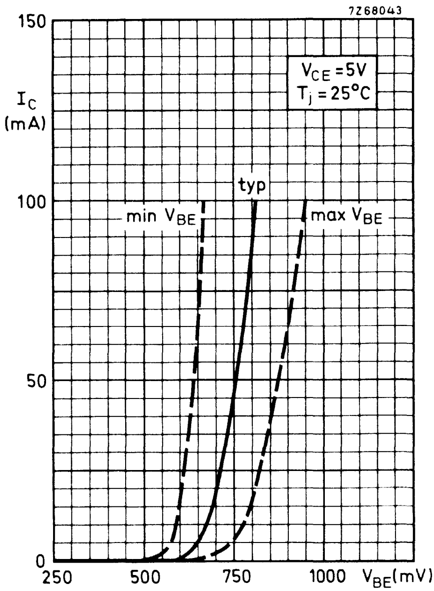

7Z68043
150
100
50
0
I_C
(mA)
V_{CE} = 5 V
T_j = 25 °C
typ
min V_{BE}
max V_{BE}
250
500
750
1000
V_{BE} (mV)

Fig. 10.

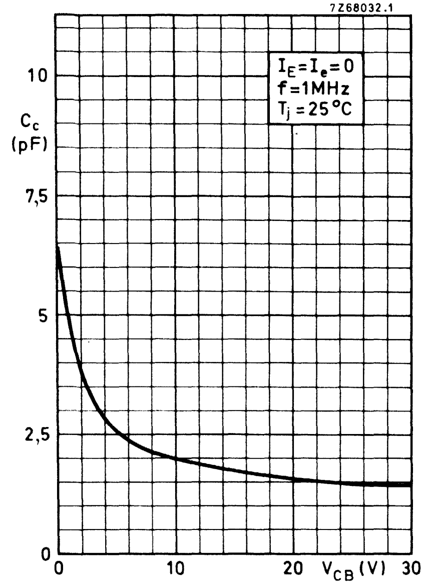

7Z68032.1
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25\ ^\circ C$
C_c (pF)
10
7,5
5
2,5
0
0
10
20
V_{CB} (V)
30

Fig. 11.

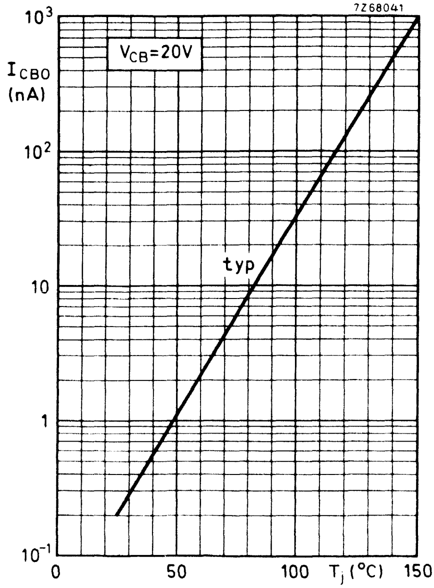

7Z68041
$V_{CB} = 20 V$
I_{CBO} (nA)
10^3
10^2
10
1
10^{-1}
typ
0
50
100
T_j (°C)
150

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.

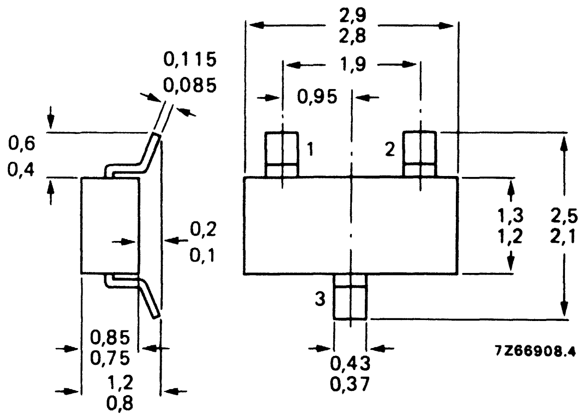
QUICK REFERENCE DATA

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

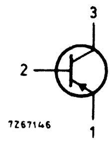
Dimensions in mm

Fig. 1 SOT-23.

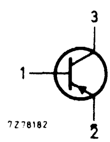


Marking code

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

→ THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	50	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 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

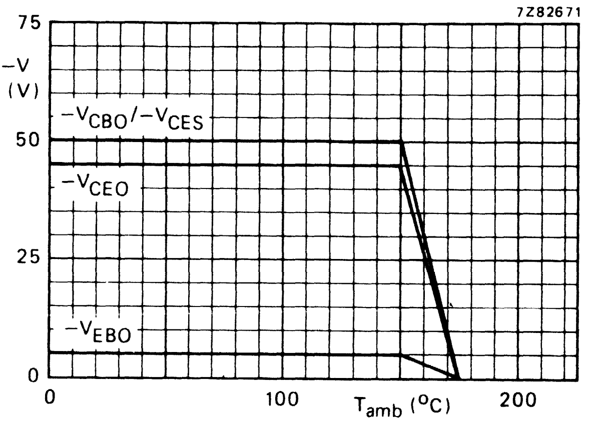


Fig. 2 Voltage derating curves.

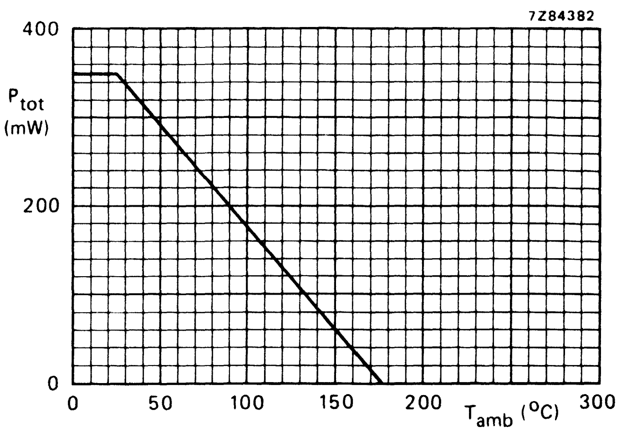


Fig. 3 Power derating curve.

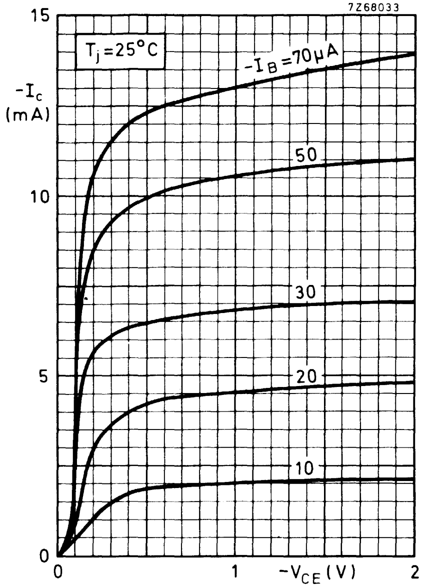


Fig. 4.

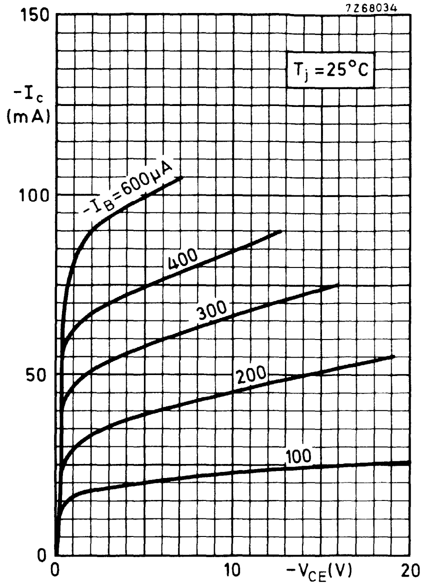


Fig. 5.

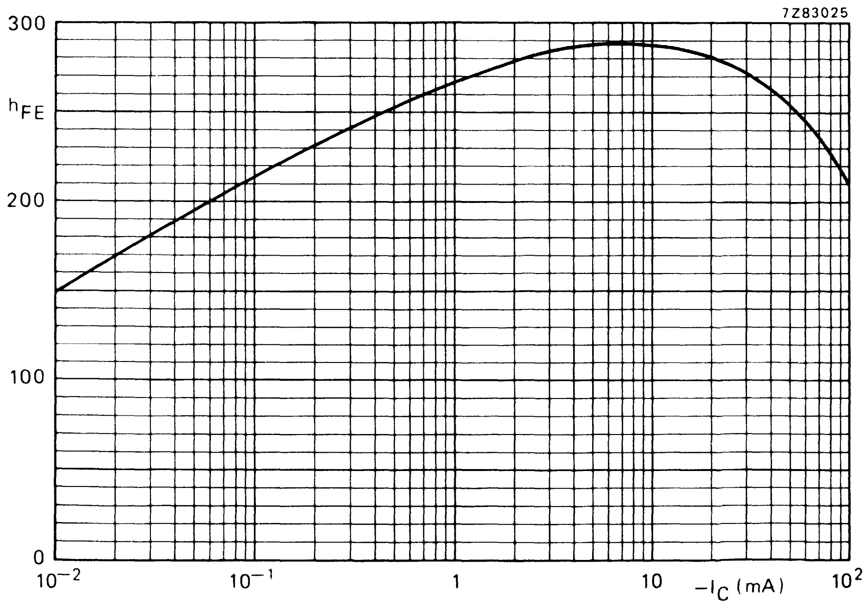


Fig. 6 Typical values of d.c. current gain. $-V_{CE} = 5$ V; $T_j = 25$ °C.

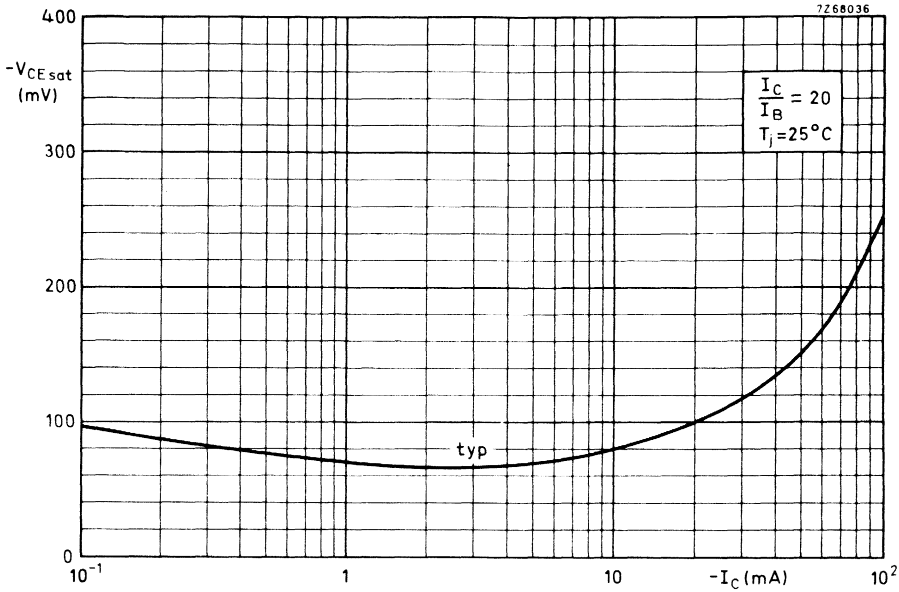

7Z68036
400
$-V_{CEsat}$
(mV)
300
200
100
0
10^{-1}
1
10
$-I_C$ (mA)
10^2
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ

Fig. 7.

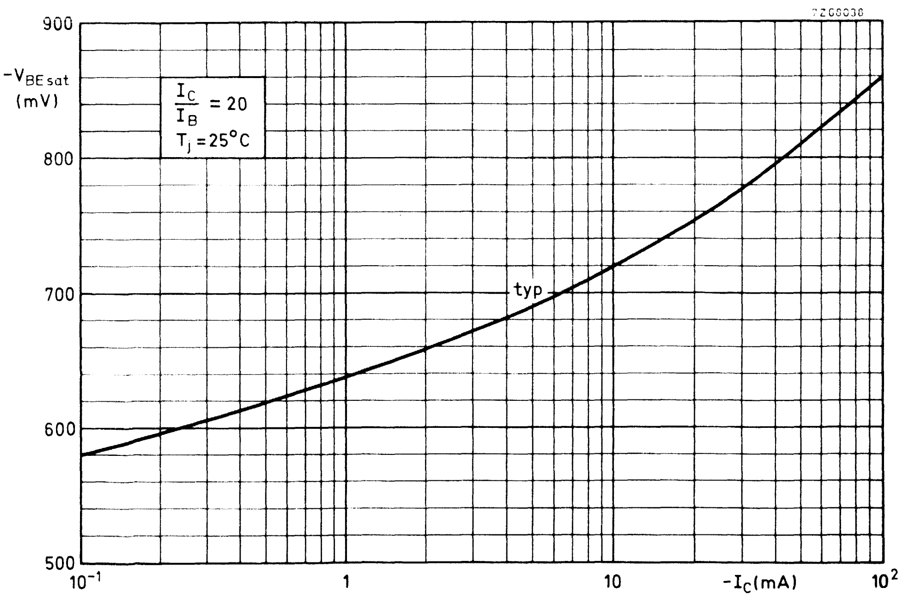

900
$-V_{BEsat}$
(mV)
800
700
600
500
10^{-1}
1
10
$-I_C$(mA)
10^2
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ

Fig. 8.

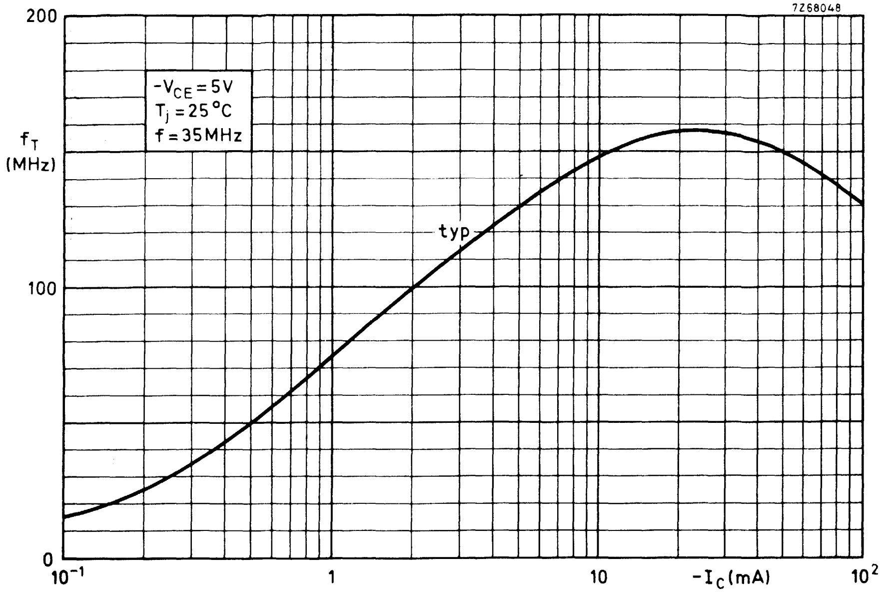

7Z68048
200
100
0
f_T
(MHz)
$-V_{CE} = 5V$
$T_j = 25°C$
f = 35MHz
typ
10^{-1}
1
10
$-I_C$(mA)
10^2

Fig. 9.

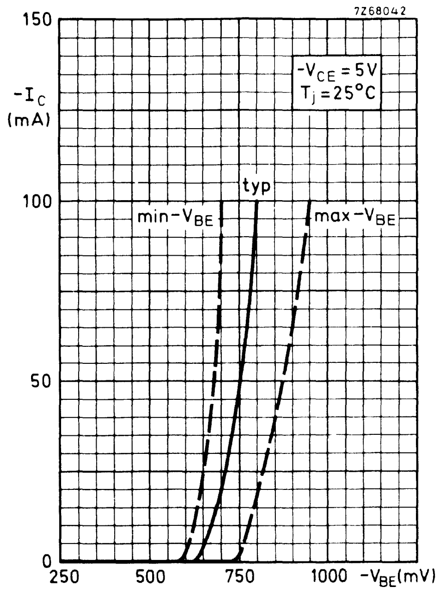

7Z68042
150
100
50
0
$-I_C$
(mA)
$-V_{CE} = 5V$
$T_j = 25°C$
typ
min $-V_{BE}$
max $-V_{BE}$
250
500
750
1000
$-V_{BE}$(mV)

Fig. 10.

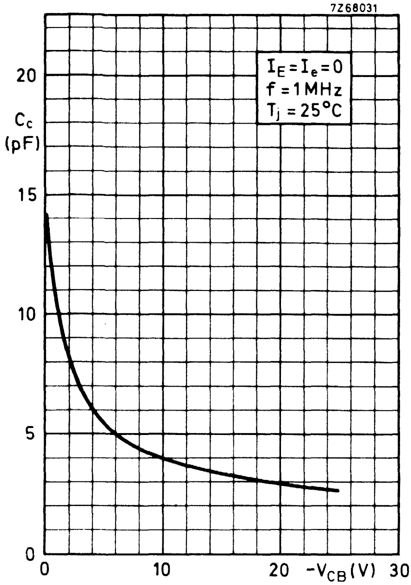

7Z68031
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
C_c (pF)
0
5
10
15
20
0
10
20
$-V_{CB}$ (V)
30

Fig. 11.

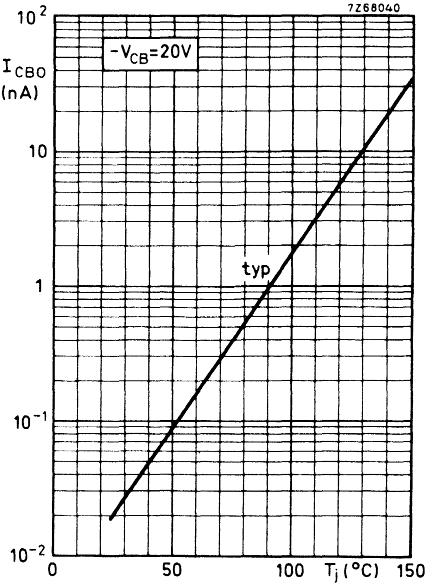

7Z68040
$-V_{CB}$ = 20V
$-I_{CBO}$ (nA)
10^2
10
1
10^{-1}
10^{-2}
typ
0
50
100
T_j (°C)
150

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.

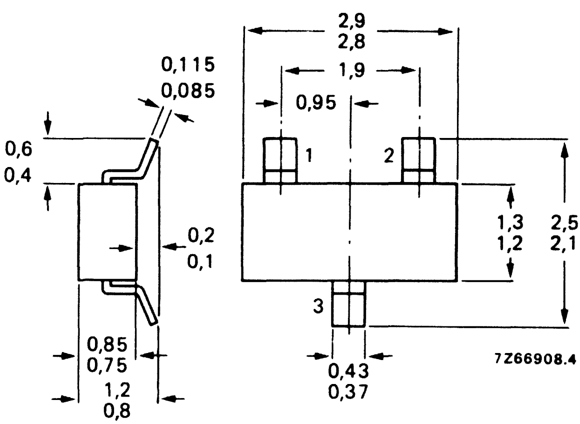
QUICK REFERENCE DATA

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

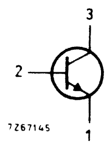
Dimensions in mm

Fig. 1 SOT-23.

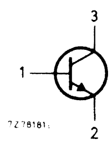


Marking code

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 $T_{amb} = 25\ ^oC$**	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	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 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

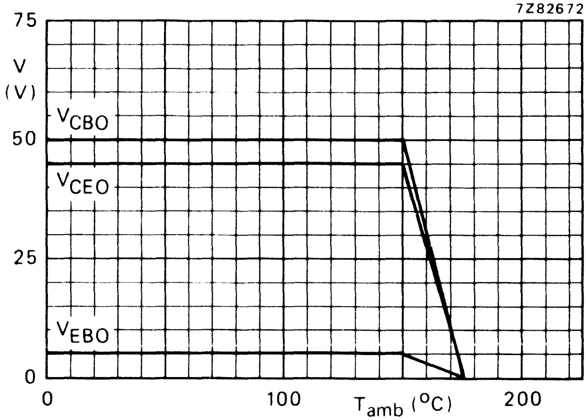


Fig. 2 Voltage derating curves.

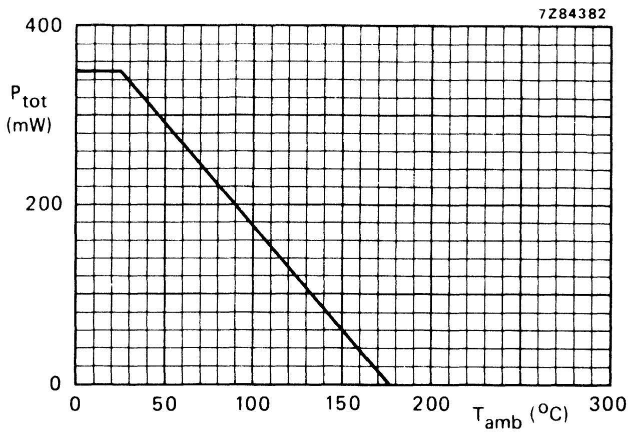


Fig. 3 Power derating curve.

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.

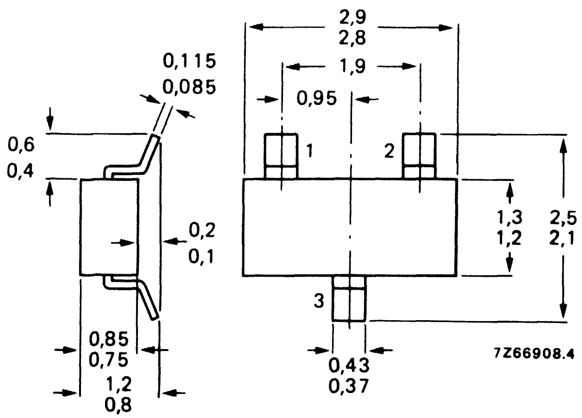
QUICK REFERENCE DATA

			BCV71 BCV71R	BCV72 BCV72R	
D.C. current gain at T_j = 25 °C; I_C = 2 mA; V_{CE} = 5 V	h_{FE}	>	110	200	
		<	220	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

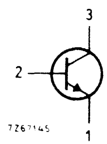
Dimensions in mm

Fig. 1 SOT-23.

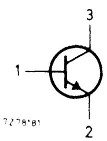


Marking code

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**	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	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 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

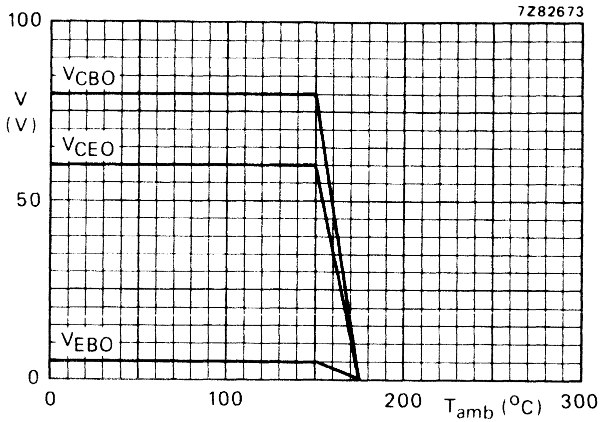


Fig. 2 Voltage derating curves.

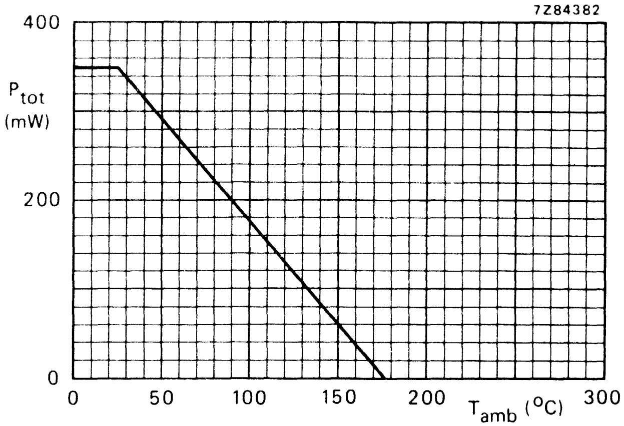


Fig. 3 Power derating curve.

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.

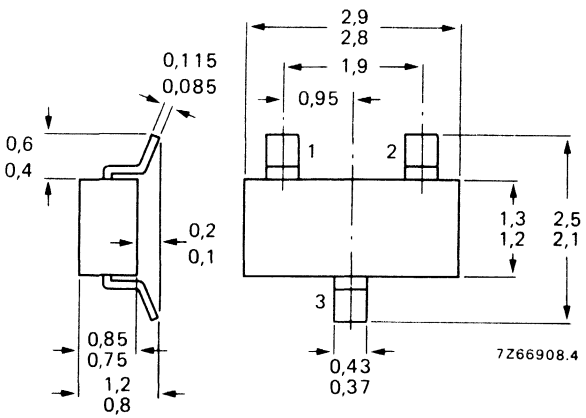
QUICK REFERENCE DATA

			BCW29 BCW29R	BCW30 BCW30R	
D.C. current gain at $T_j = 25\ ^oC$ $-I_C = 2$ 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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	350		mW
Junction temperature	T_j	max.	175		^oC
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

MECHANICAL DATA

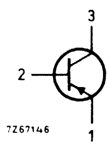
Dimensions in mm

Fig. 1 SOT-23.

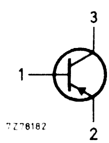


Marking code

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**	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	$R_{th\ t\text{-}s}$	=	280 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90 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 8 mm x 10 mm x 0,7 mm.

			BCW29 BCW29R	BCW30 BCW30R	
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}	>	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 kΩ $-I_C$ = 200 μA; $-V_{CE}$ = 5 V f = 1 kHz; B = 200 Hz	F	<	10		dB

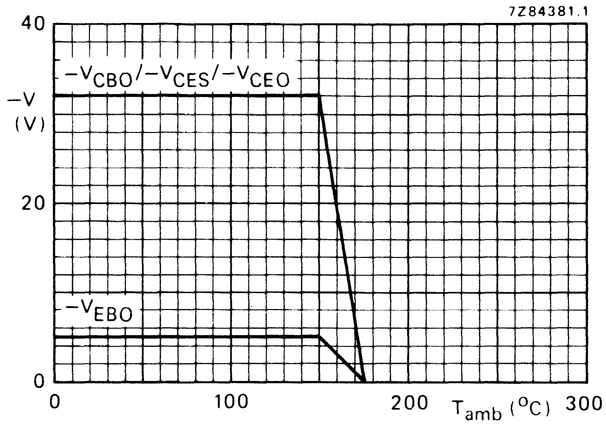


Fig. 2 Voltage derating curves.

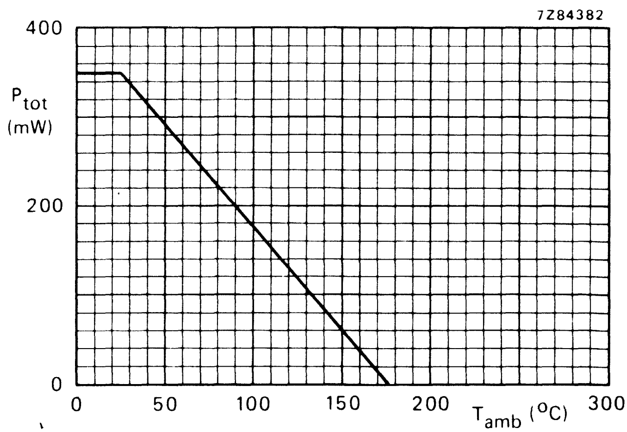


Fig. 3 Power derating curve.

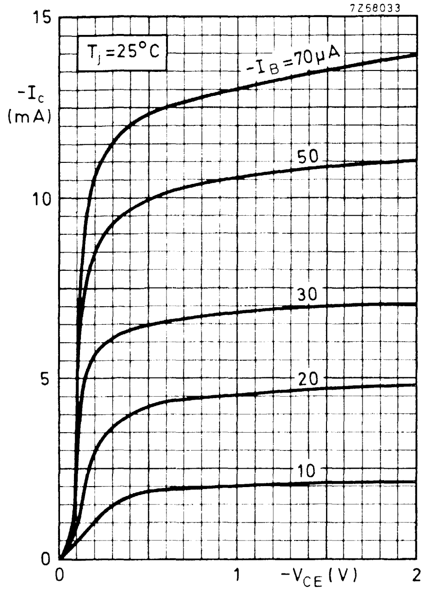


Fig. 4.

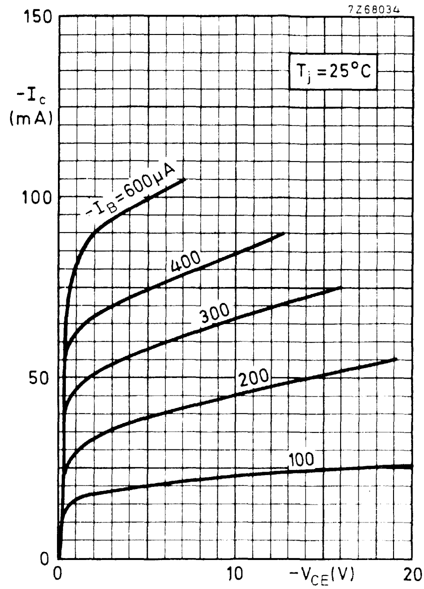


Fig. 5.

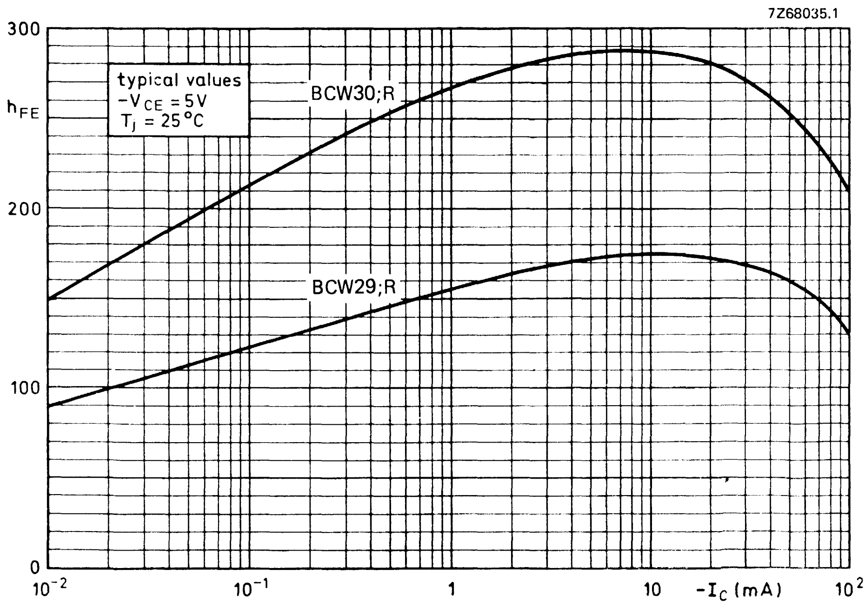


Fig. 6.

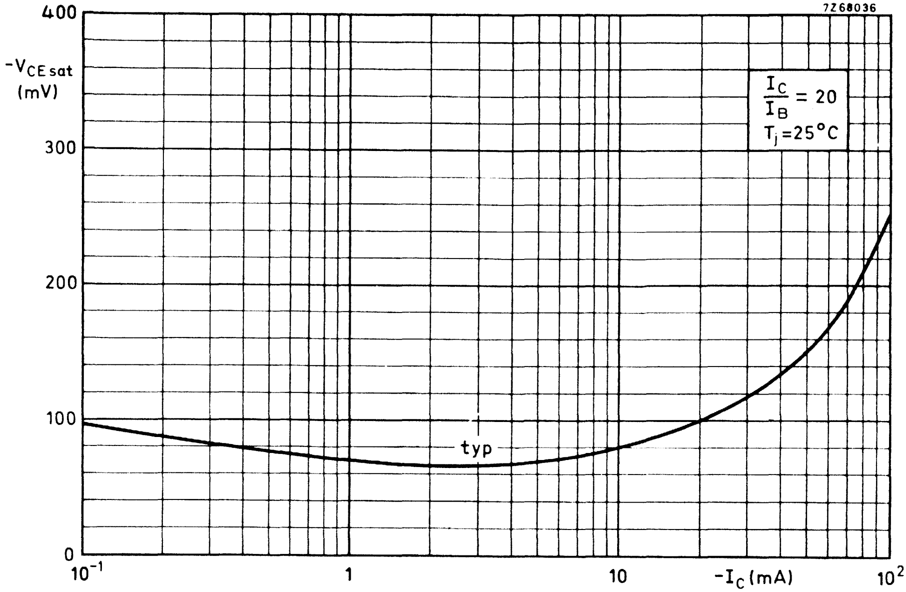

7Z68036
400
300
200
100
0
$-V_{CE sat}$ (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 7.

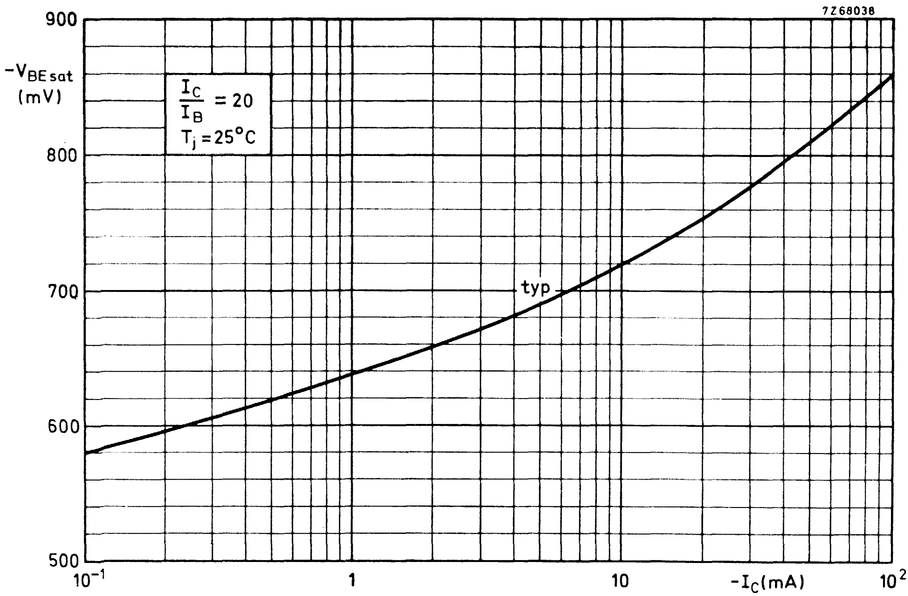

7Z68038
900
800
700
600
500
$-V_{BE sat}$ (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 8.

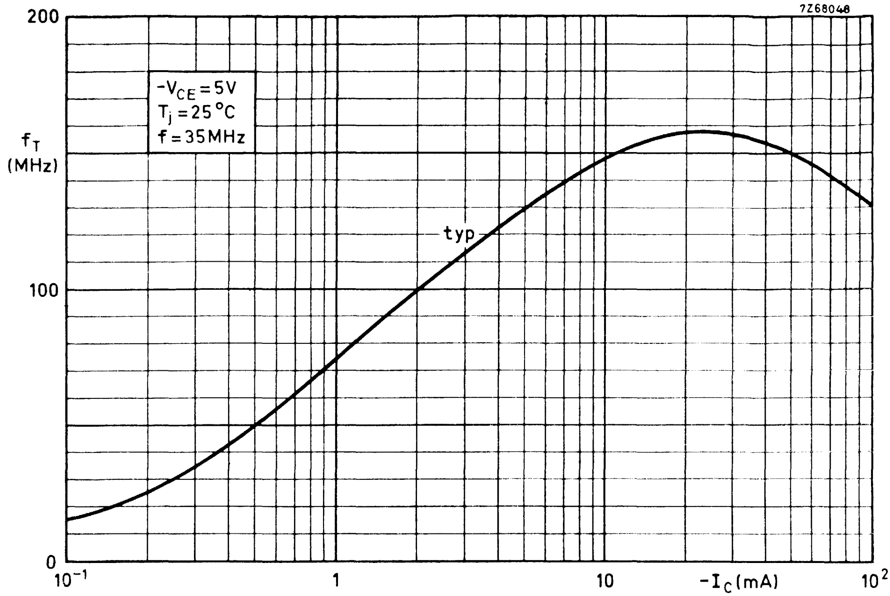

7Z68048
$-V_{CE} = 5V$
$T_j = 25\,°C$
$f = 35MHz$
f_T
(MHz)
200
100
0
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 9.

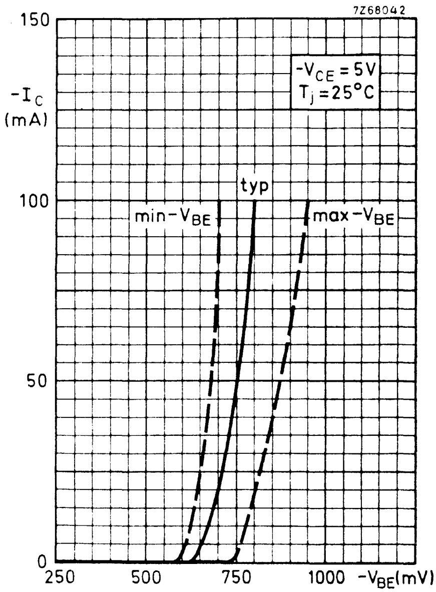

7Z68042
$-V_{CE} = 5V$
$T_j = 25\,°C$
$-I_C$
(mA)
150
100
50
0
typ
min-V_{BE}
max-V_{BE}
250
500
750
1000
$-V_{BE}$(mV)

Fig. 10.

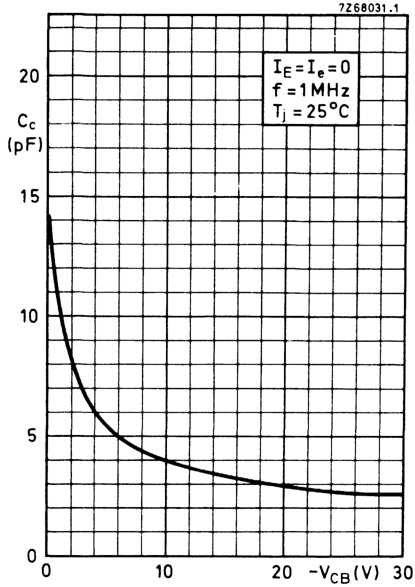

7Z68031.1
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
C_c
(pF)
20
15
10
5
0
0
10
20
$-V_{CB}$ (V)
30

Fig. 11.

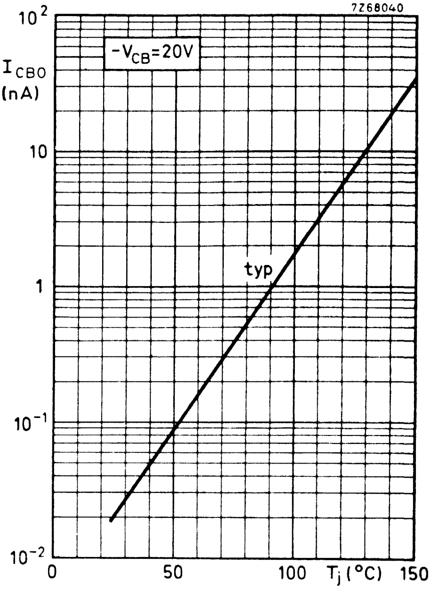

7Z68040
$-V_{CB}$ = 20 V
$-I_{CBO}$
(nA)
10^2
10
1
10^{-1}
10^{-2}
typ
0
50
100
T_j (°C)
150

Fig. 12.

SILICON PLANAR EPITAXIAL TRANSISTORS

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

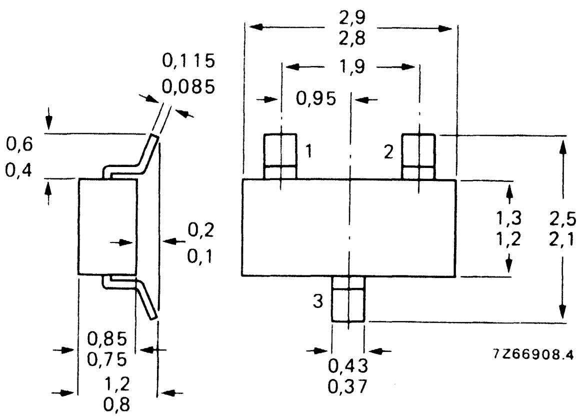
QUICK REFERENCE DATA

			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

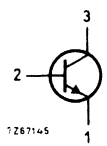
Dimensions in mm

Fig. 1 SOT-23.

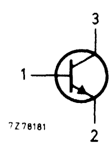


Marking code

BCW31 = D1
BCW32 = D2
BCW33 = D3



BCW31R = D4
BCW32R = D5
BCW33R = D6



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 (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**	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	$R_{th\ t\text{-}s}$	=	280 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90 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 8 mm x 10 mm x 0,7 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	200	420	
		<	220	450	800	
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<		4,0		pF
Transition frequency at f = 35 MHz $I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.		300		MHz
Noise figure at $R_S = 2\ k\Omega$ $I_C = 200\ \mu A$; $V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<		10		dB

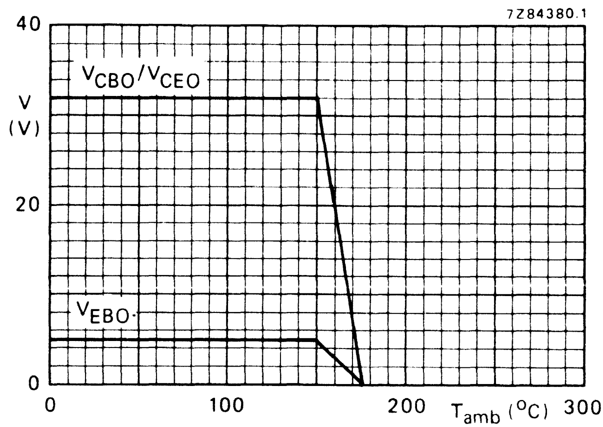


Fig. 2 Voltage derating curves.

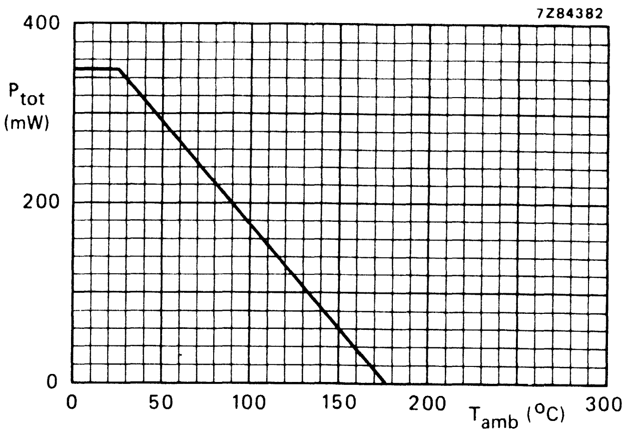


Fig. 3 Power derating curve.

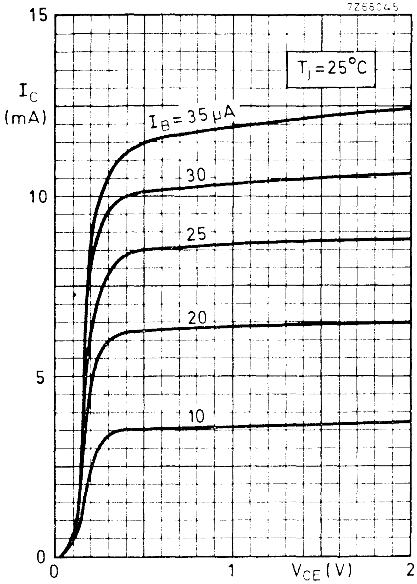


Fig. 4.

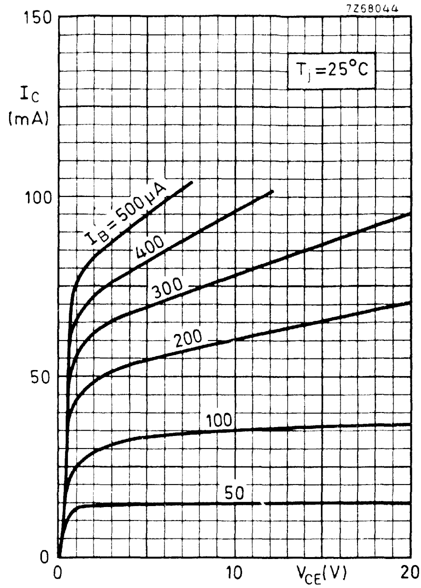


Fig. 5.

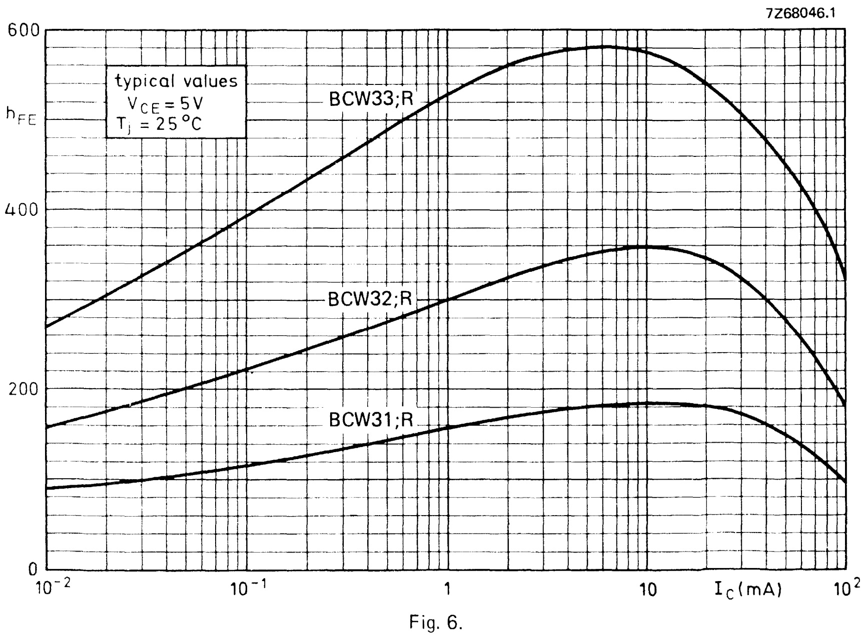


Fig. 6.

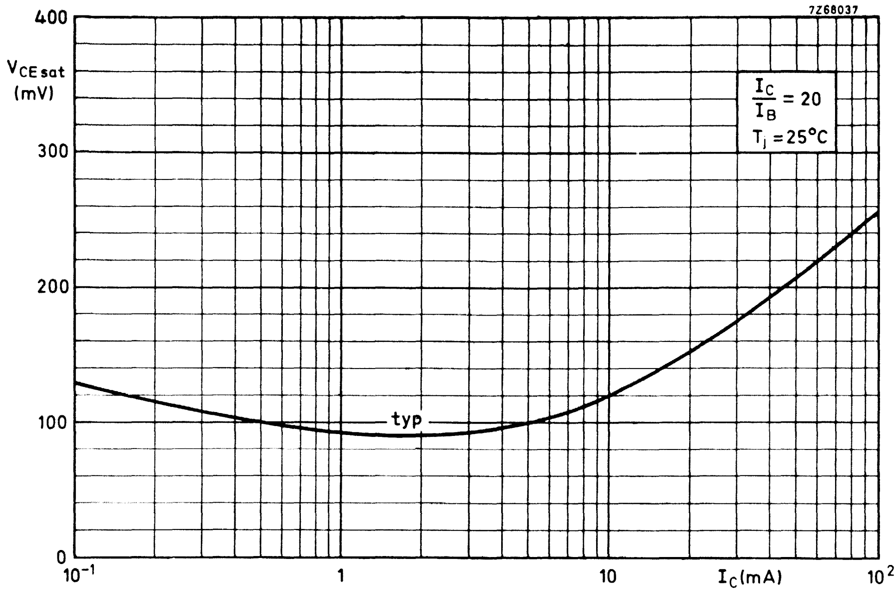

7Z68037
400
300
200
100
0
V_{CEsat} (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 7.

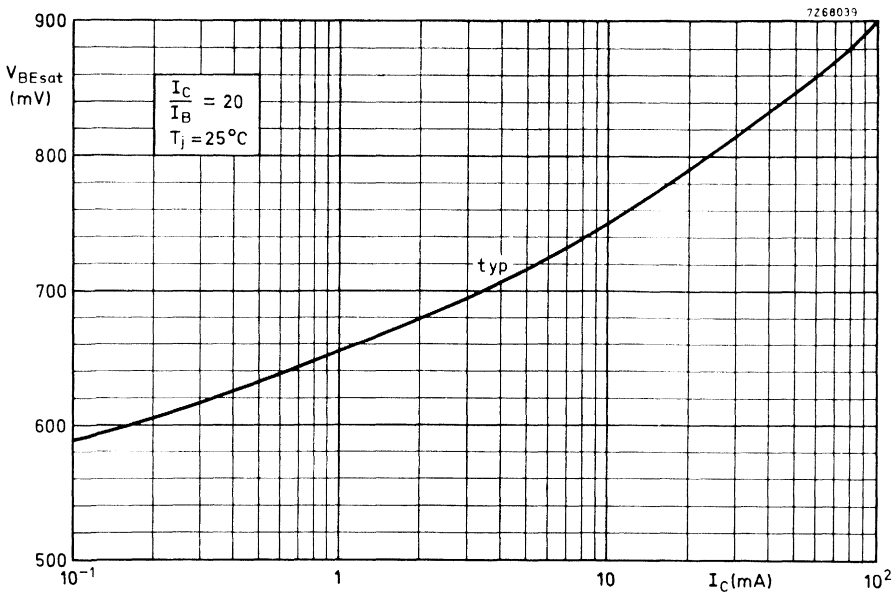

7Z68039
900
800
700
600
500
V_{BEsat} (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 8.

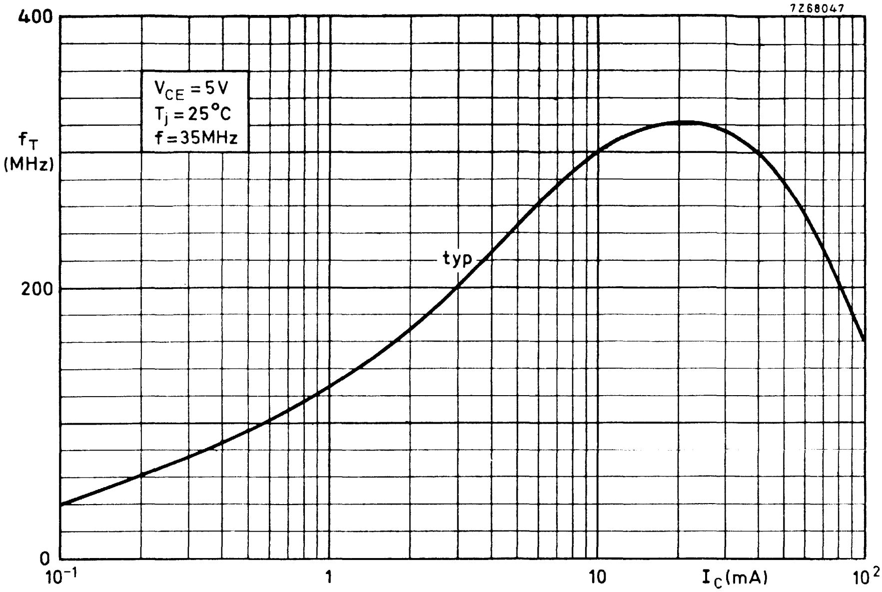

7Z68047
400
200
0
f_T
(MHz)
$V_{CE} = 5V$
$T_j = 25°C$
f = 35MHz
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 9.

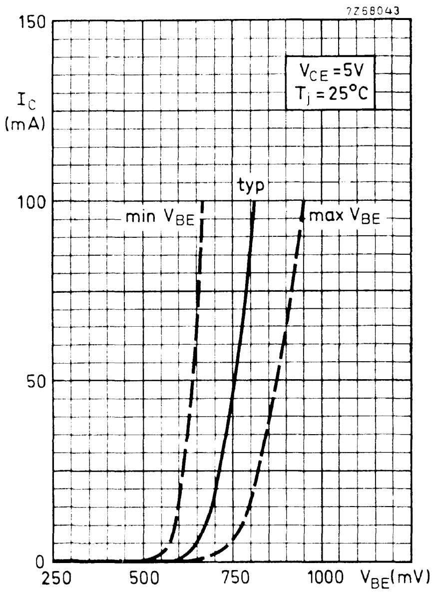

7Z68043
150
100
50
0
I_C
(mA)
$V_{CE} = 5V$
$T_j = 25°C$
typ
min V_{BE}
max V_{BE}
250
500
750
1000
V_{BE}(mV)

Fig. 10.

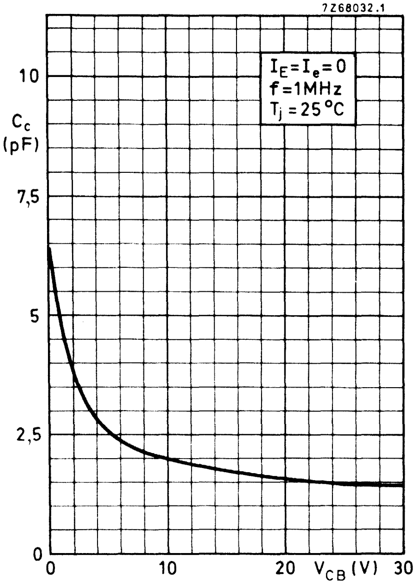

7Z68032.1
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25\,^{\circ}C$
C_c (pF)
10
7,5
5
2,5
0
0
10
20
V_{CB} (V)
30

Fig. 11.

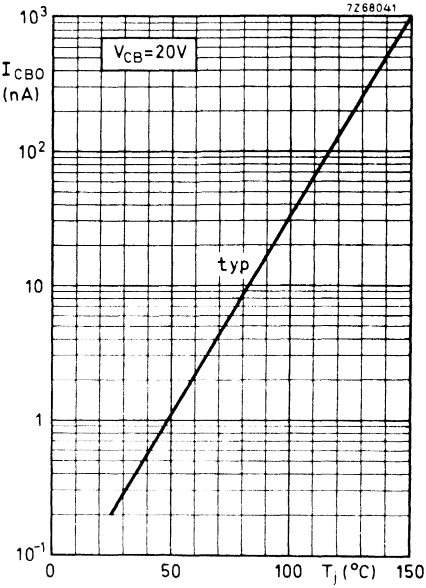

7Z68041
$V_{CB} = 20\,V$
I_{CBO} (nA)
10^3
10^2
10
1
10^{-1}
typ
0
50
100
T_j (°C)
150

Fig. 12.

SILICON PLANAR EPITAXIAL TRANSISTORS

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

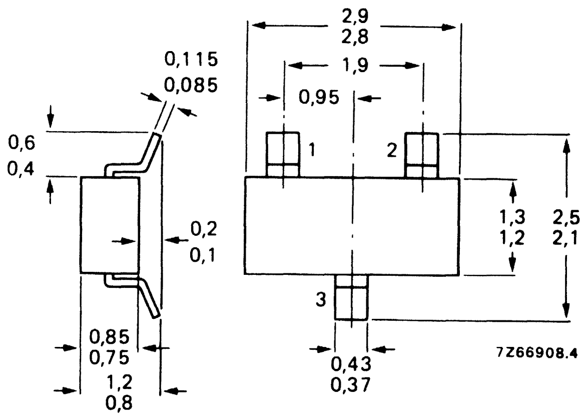
MECHANICAL DATA

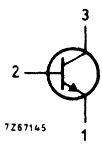
Dimensions in mm

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 up to T_{amb} = 100 °C**	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	$R_{th\ t\text{-}s}$	=	280 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90 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 8 mm x 10 mm x 0,7 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	
V_{CE} = 5 V; I_C = 2 mA	h_{FE}	>	120	180	250	380	
		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							
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{ie}	>	1,6	2,5	3,2	4,5	kΩ
		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							
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{fe}	>	125	175	250	350	
		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

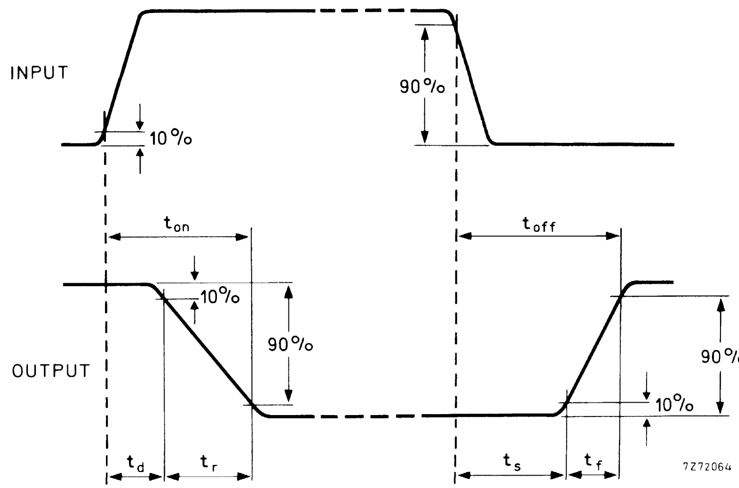


Fig. 2 Switching waveforms.

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	^{o}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

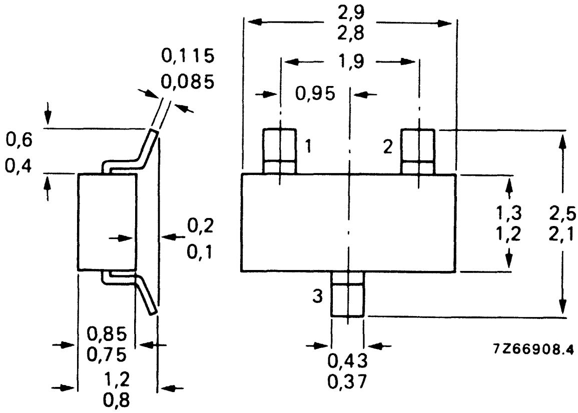
MECHANICAL DATA

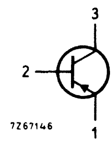
Dimensions in mm

Fig. 1 SOT-23.

Marking code

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 up to T_{amb} = 100 °C**	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	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 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 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

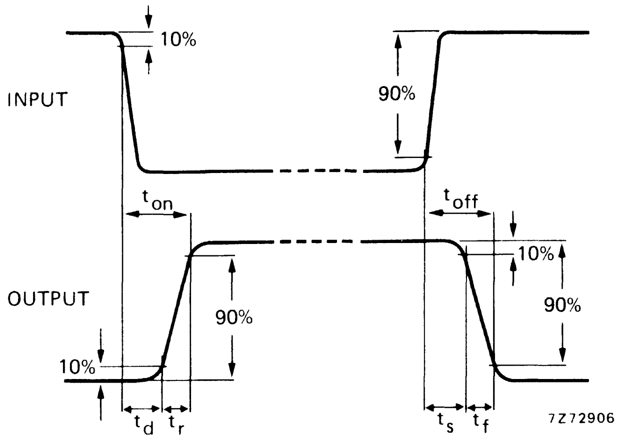


Fig. 2 Switching waveforms.

SILICON PLANAR EPITAXIAL TRANSISTORS

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

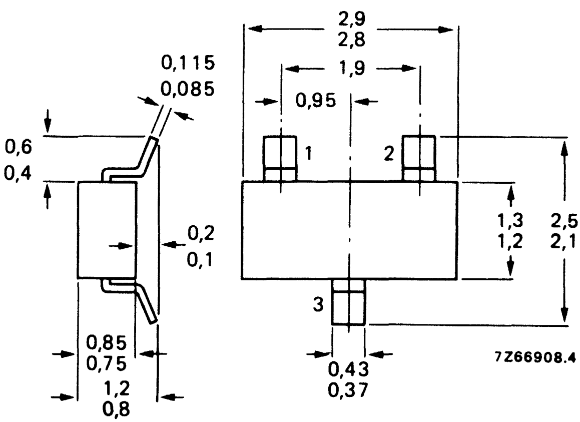
QUICK REFERENCE DATA

			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

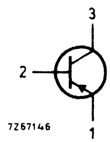
Dimensions in mm

Fig. 1 SOT-23.

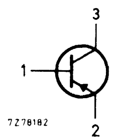


Marking code

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

THERMAL CHARACTERISTICS*

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

→ **Thermal resistance**

From junction to tab	$R_{th\,j\text{-}t}$	=	50 K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	280 K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90 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 8 mm x 10 mm x 0,7 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

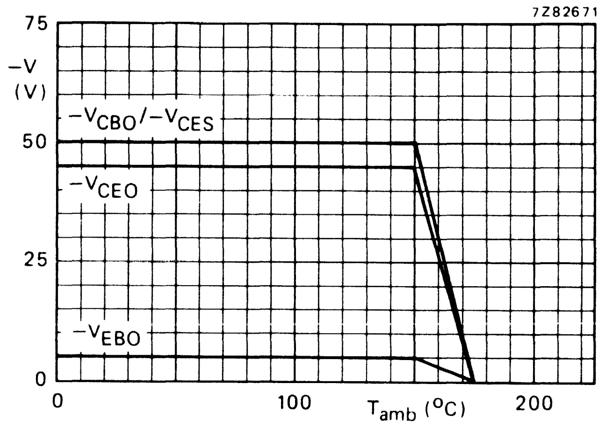


Fig. 2 Voltage derating curve.

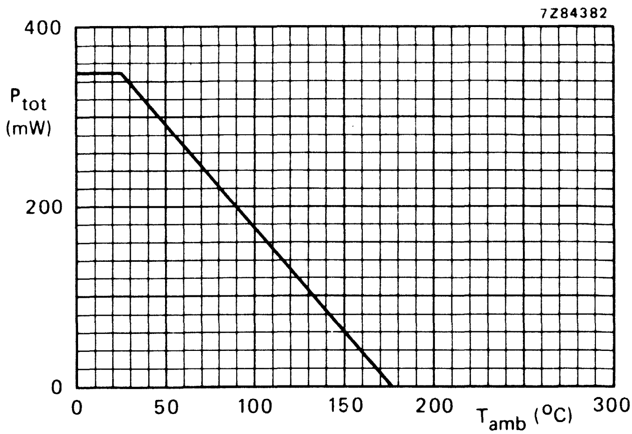


Fig. 3 Power derating curve.

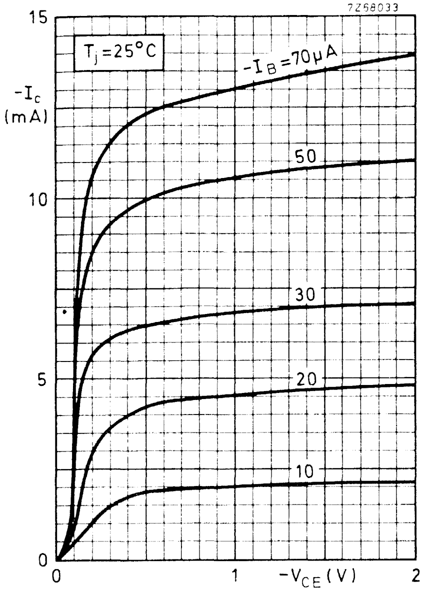


Fig. 4.

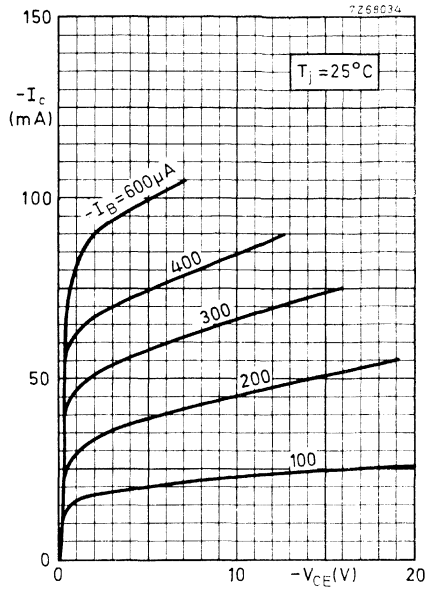


Fig. 5.

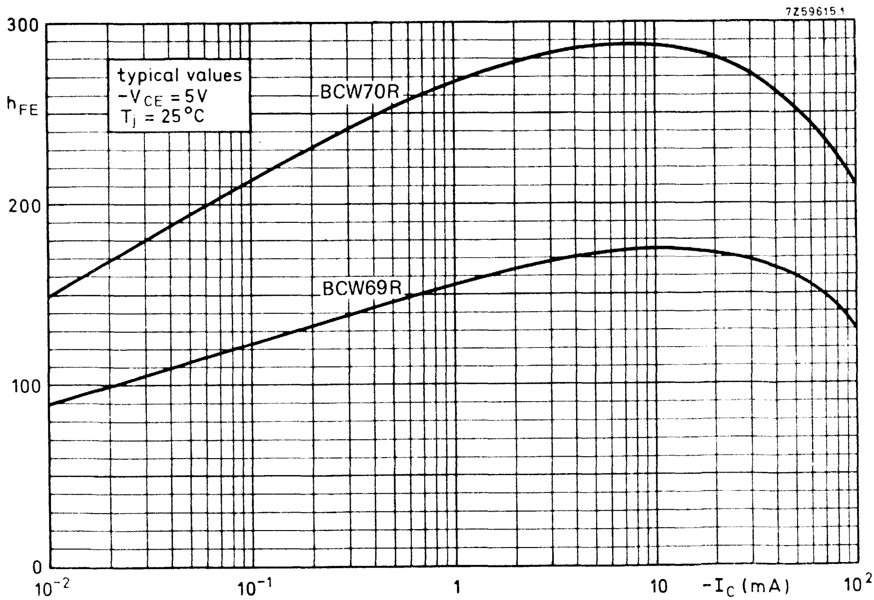


Fig. 6 D.C. current gain.

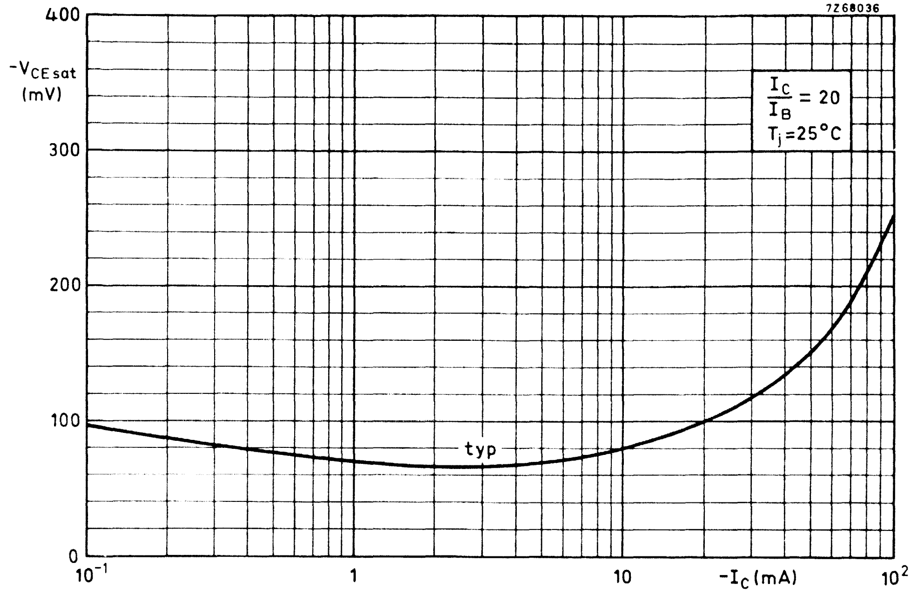

7Z68036
400
300
200
100
0
$-V_{CEsat}$ (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25\,^\circ C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 7.

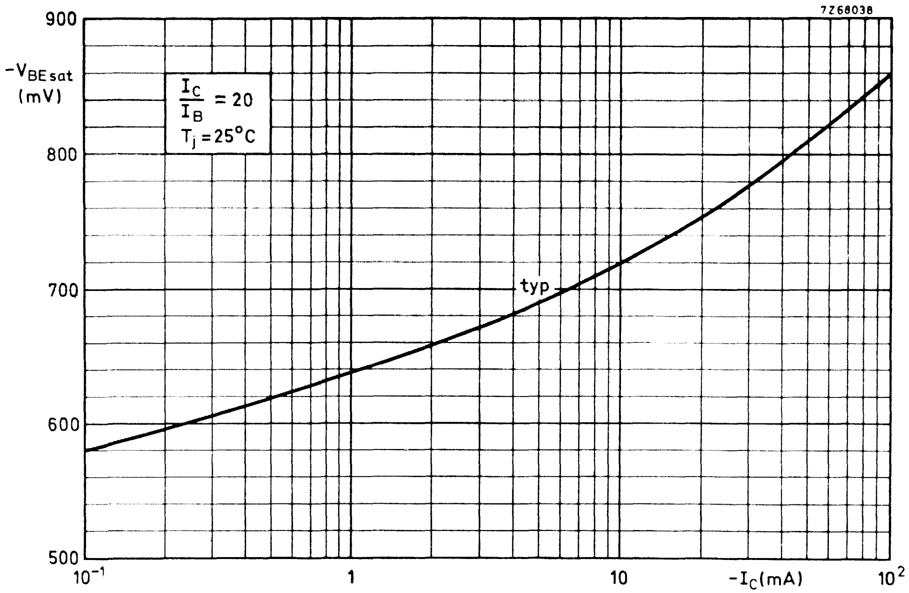

7Z68038
900
800
700
600
500
$-V_{BEsat}$ (mV)
$\frac{I_C}{I_B} = 20$
$T_j = 25\,^\circ C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 8.

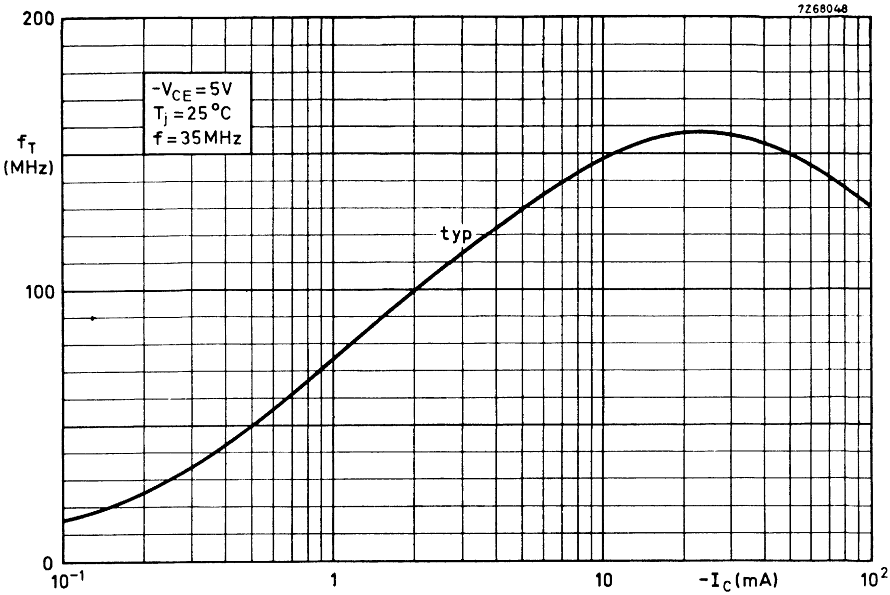

7Z68048
$-V_{CE} = 5V$
$T_j = 25°C$
$f = 35MHz$
f_T (MHz)
typ
200
100
0
10^{-1}
1
10
$-I_C$(mA)
10^2

Fig. 9.

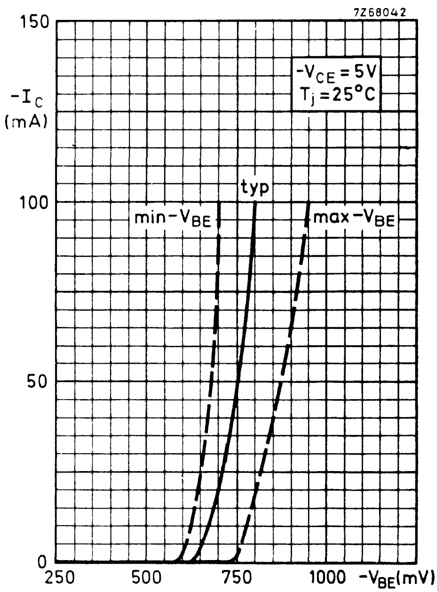

7Z68042
$-V_{CE} = 5V$
$T_j = 25°C$
$-I_C$ (mA)
typ
min $-V_{BE}$
max $-V_{BE}$
150
100
50
0
250
500
750
1000
$-V_{BE}$(mV)

Fig. 10.

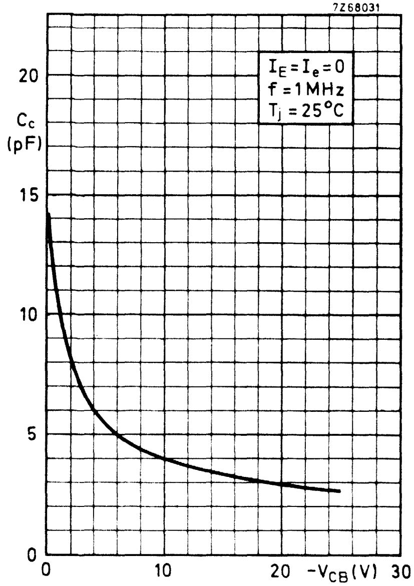

7Z68031
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
C_c (pF)
20
15
10
5
0
0
10
20
$-V_{CB}$ (V)
30

Fig. 11.

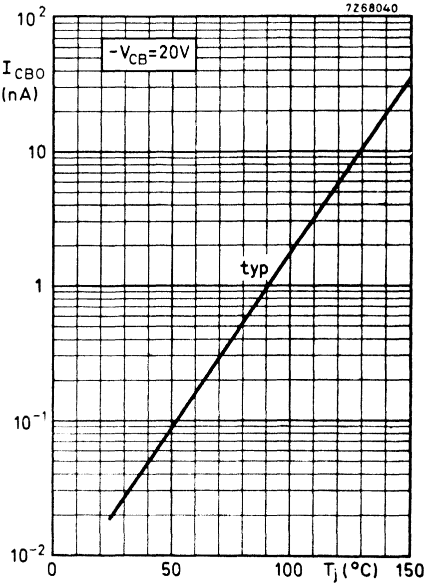

7Z68040
$-V_{CB}$ = 20 V
$-I_{CBO}$ (nA)
10^2
10
1
10^{-1}
10^{-2}
typ
0
50
100
T_j (°C)
150

Fig. 12.

SILICON PLANAR EPITAXIAL TRANSISTORS

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

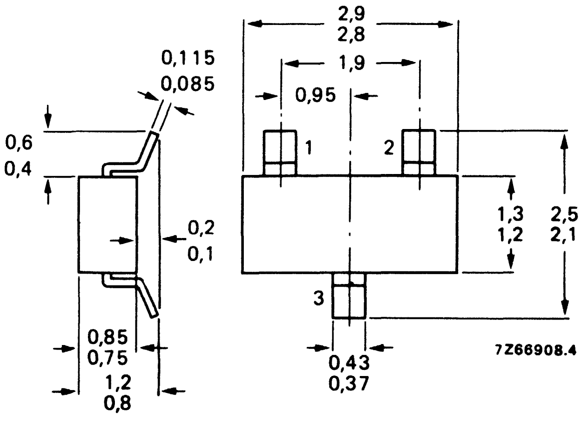
QUICK REFERENCE DATA

			BCW71 BCW71R	BCW72 BCW72R	
D.C. current gain at $T_j = 25\ ^oC$ $I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	> <	110 220	200 450	
Collector-base voltage (open emitter)	V_{CBO}	max.	50		V
Collector-emitter voltage (open base)	V_{CEO}	max.	45		V
Collector current (peak value)	I_{CM}	max.	200		mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	350		mW ←
Junction temperature	T_j	max.	175		^oC ←
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

MECHANICAL DATA

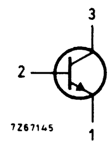
Dimensions in mm

Fig. 1 SOT-23.

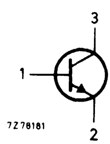


Marking code

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**	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	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 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

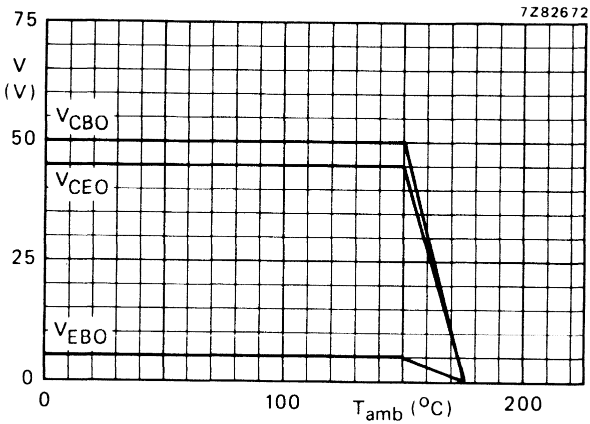


Fig. 2 Voltage derating curves.

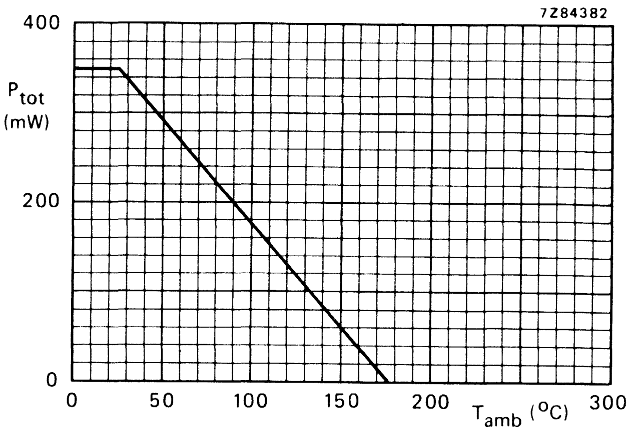


Fig. 3 Power derating curve.

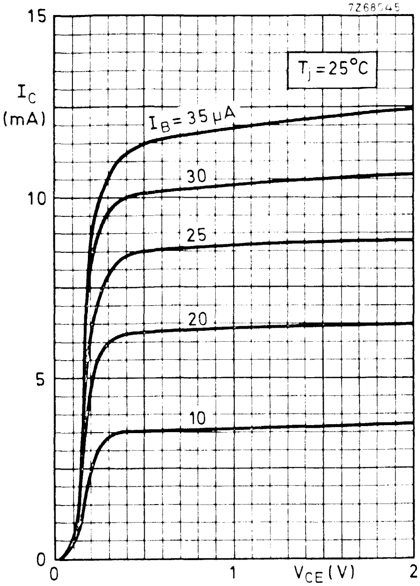


Fig. 4.

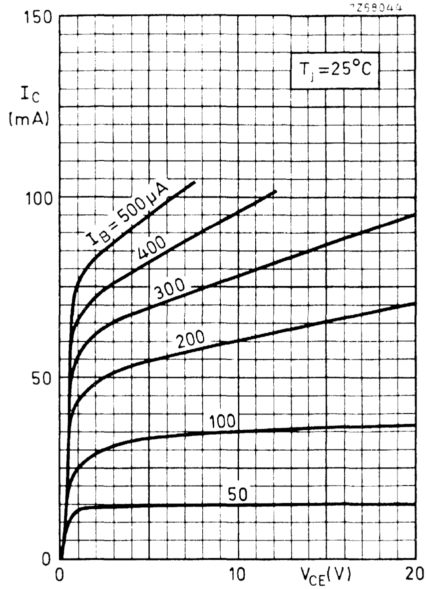


Fig.5.

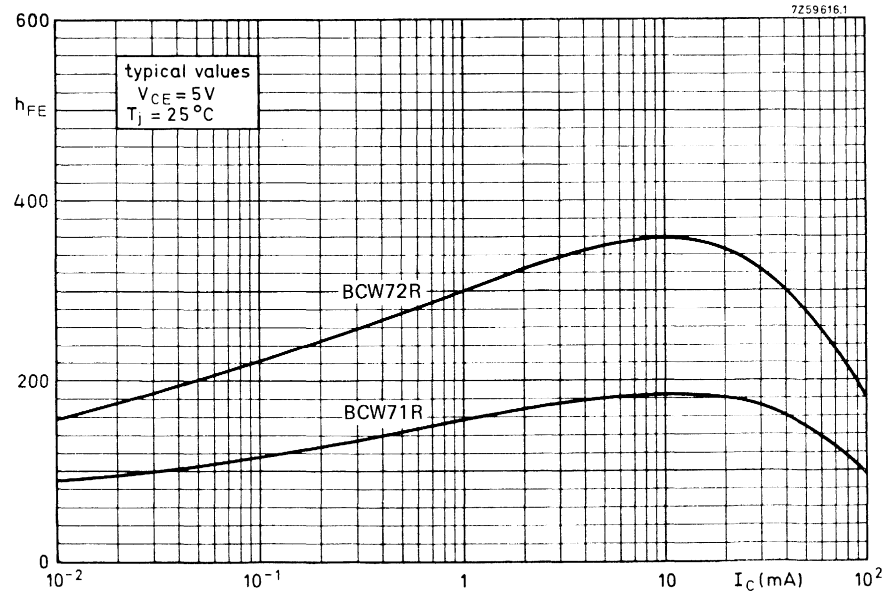


Fig. 6 D.C. current gain.

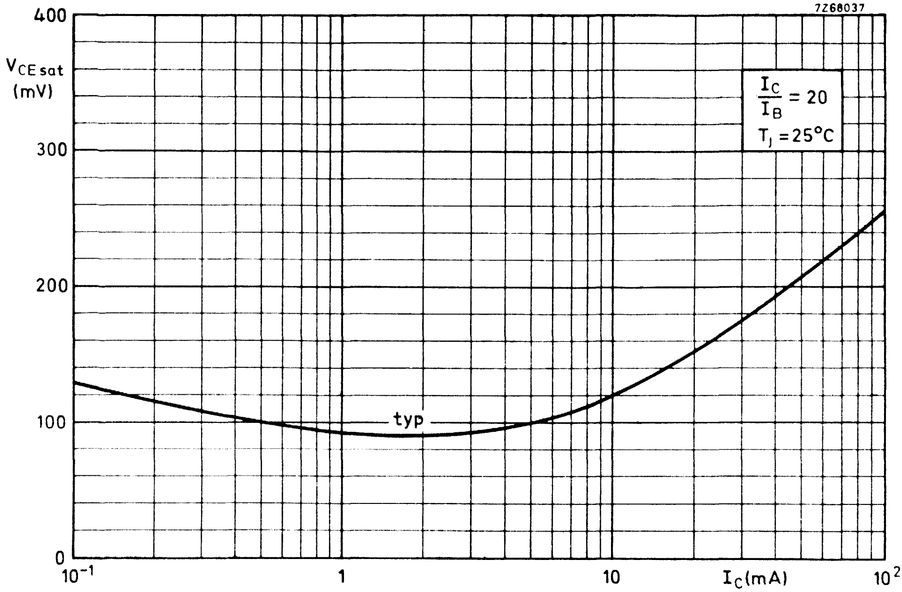

7Z68037
400
V_{CEsat}
(mV)
300
200
100
0
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 7.

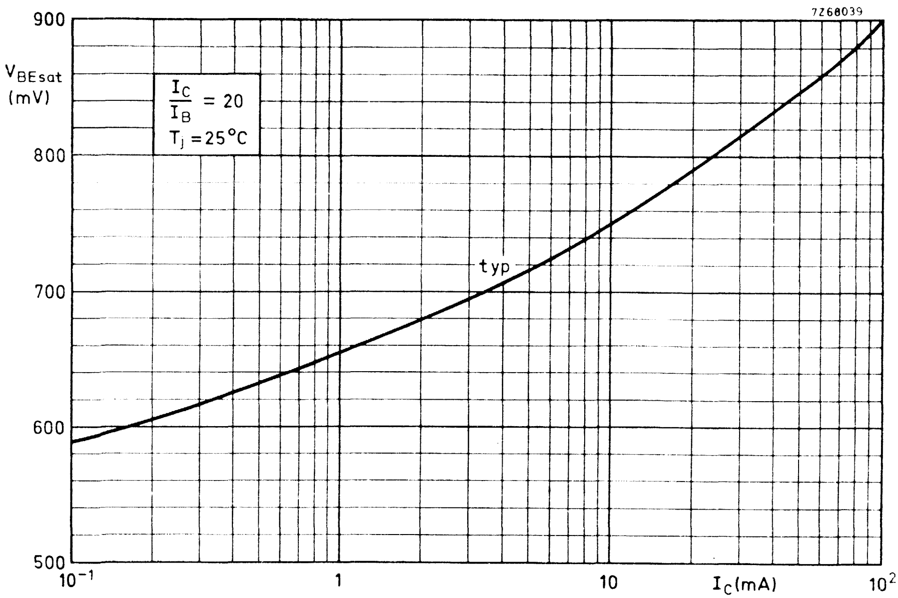

7Z68039
900
V_{BEsat}
(mV)
800
700
600
500
$\frac{I_C}{I_B} = 20$
$T_j = 25°C$
typ
10^{-1}
1
10
I_C(mA)
10^2

Fig. 8.

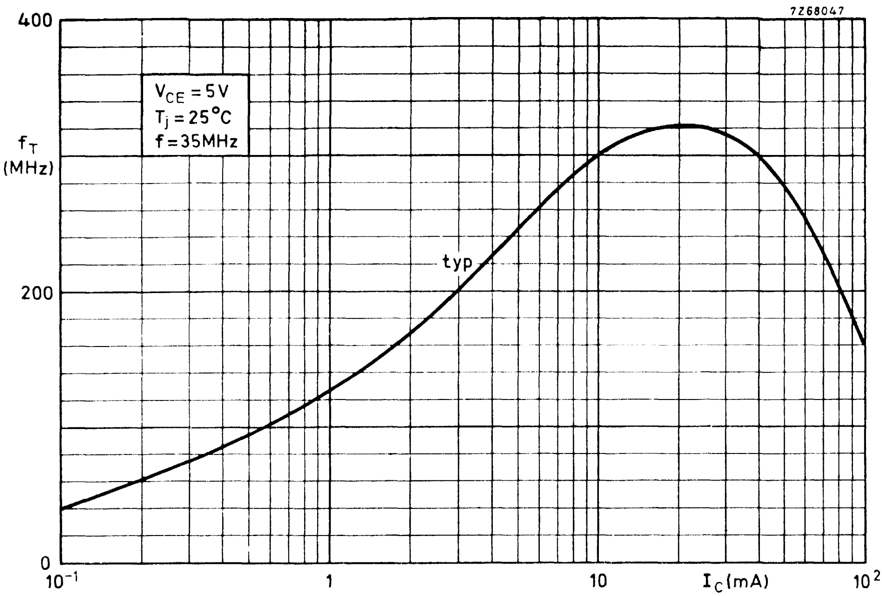

7Z68047
400
200
0
f_T
(MHz)
$V_{CE} = 5V$
$T_j = 25°C$
f = 35MHz
typ
10^{-1}
1
10
I_C (mA)
10^2

Fig. 9.

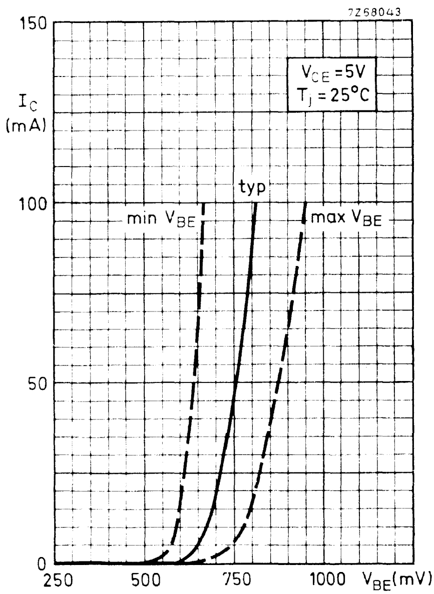

7Z68043
150
100
50
0
I_C
(mA)
$V_{CE} = 5V$
$T_j = 25°C$
typ
min V_{BE}
max V_{BE}
250
500
750
1000
V_{BE} (mV)

Fig. 10.

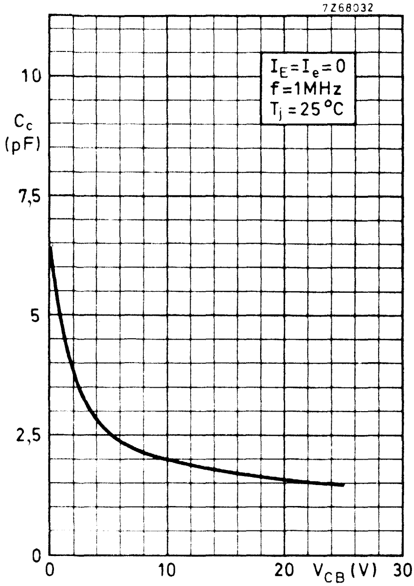

7Z68032
$I_E = I_e = 0$
f = 1 MHz
$T_j = 25\,^{\circ}C$
C_c (pF)
10
7,5
5
2,5
0
0
10
20
V_{CB} (V)
30

Fig. 11.

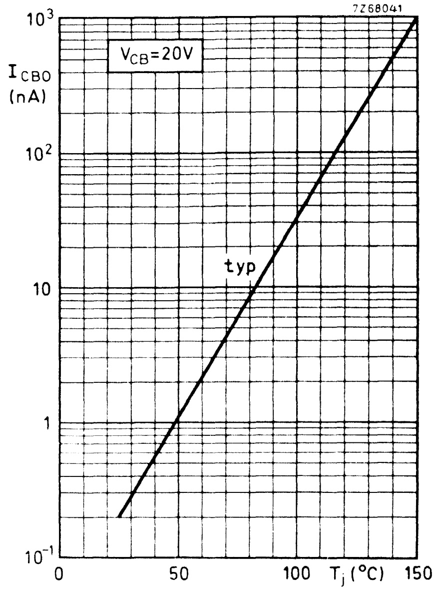

7Z68041
$V_{CB} = 20V$
I_{CBO} (nA)
10^3
10^2
10
1
10^{-1}
typ
0
50
100
T_j (°C)
150

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.

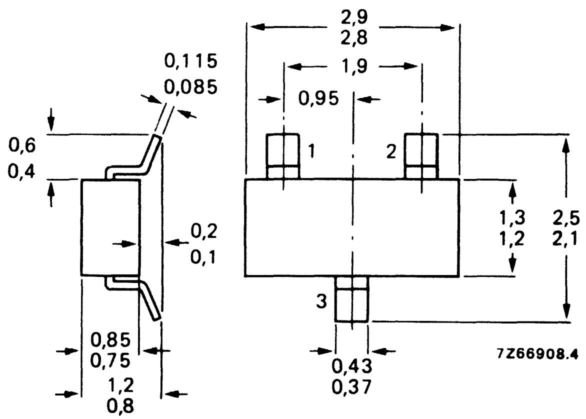
QUICK REFERENCE DATA

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

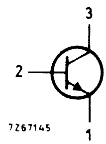
Dimensions in mm

Fig. 1 SOT-23.

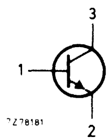


Marking code

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

THERMAL CHARACTERISTICS*

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

→ **Thermal resistance**

From junction to tab	$R_{th\ j\text{-}t}$	=	50	K/W
From tab to soldering points	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 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

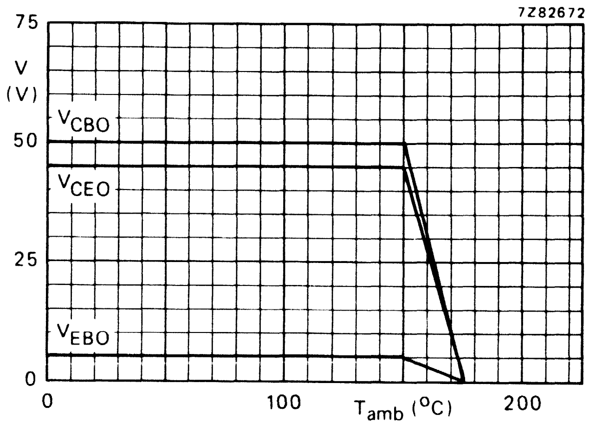


Fig. 2 Voltage derating curves.

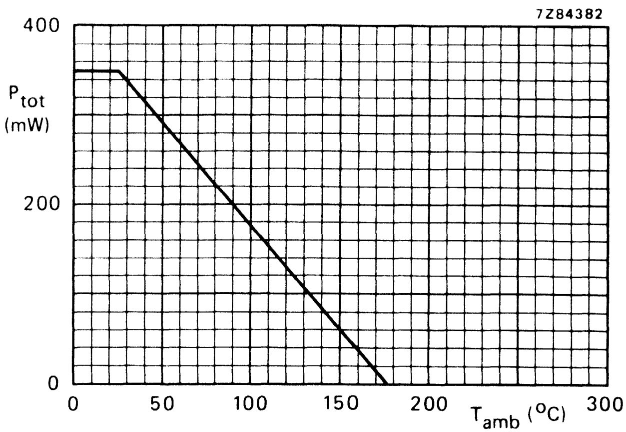


Fig. 3 Power derating curve.

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.

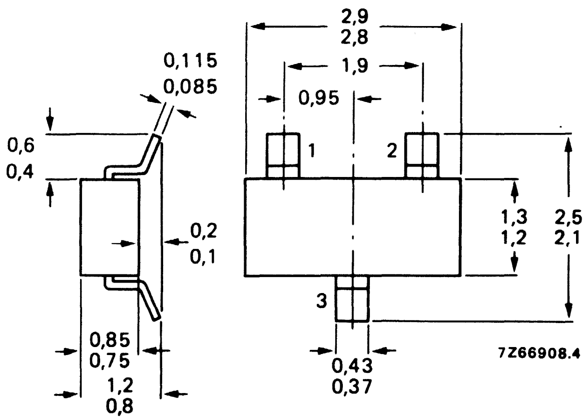
QUICK REFERENCE DATA

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

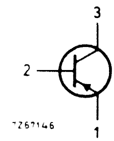
Dimensions in mm

Fig. 1 SOT-23.

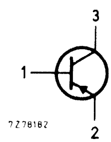


Marking code

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**	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	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 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

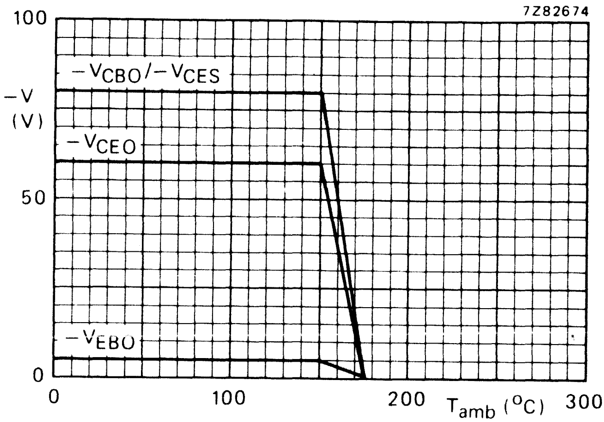


Fig. 2 Voltage derating curves.

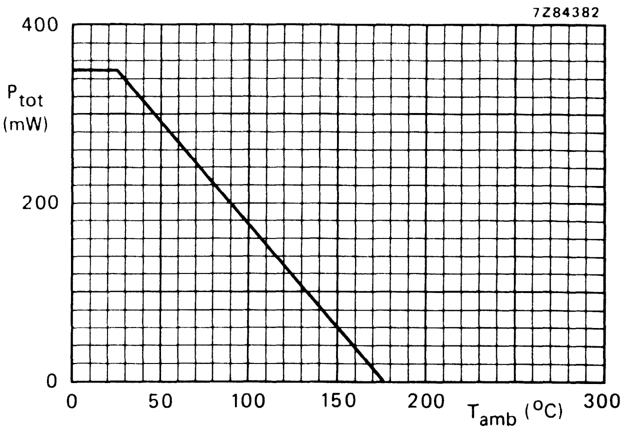


Fig. 3 Power derating curve.

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.

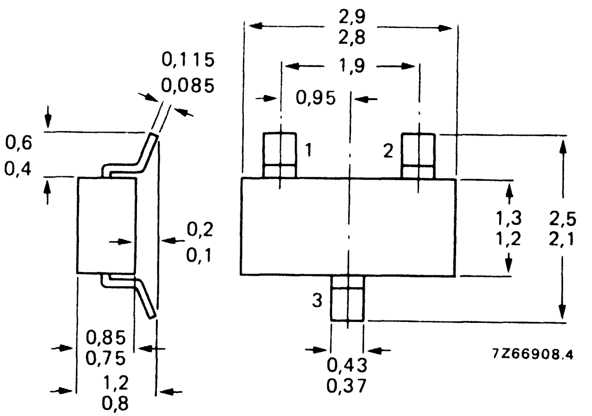
QUICK REFERENCE DATA

			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

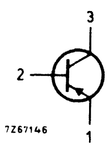
Dimensions in mm

Fig. 1 SOT-23.

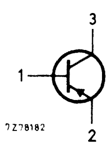


Marking code

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

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 ^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 = 150 ^oC	$-I_{CBO}$	<	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 0,7 mm.

** See *Thermal characteristics* in chapter GENERAL.

▲ $-V_{BE}$ decreases by about 2 mV/^oC 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

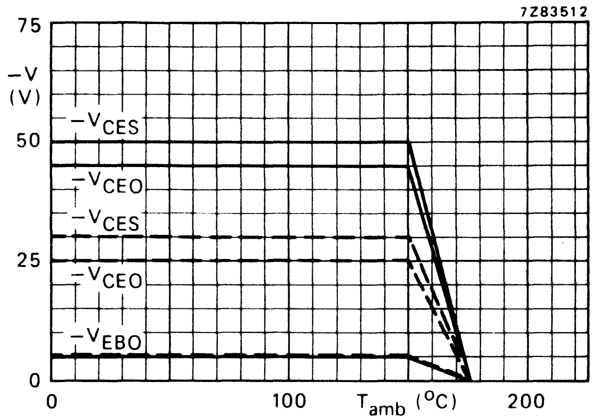


Fig. 2 Voltage derating curves. — — — BCX18; R ——— BCX17; R.

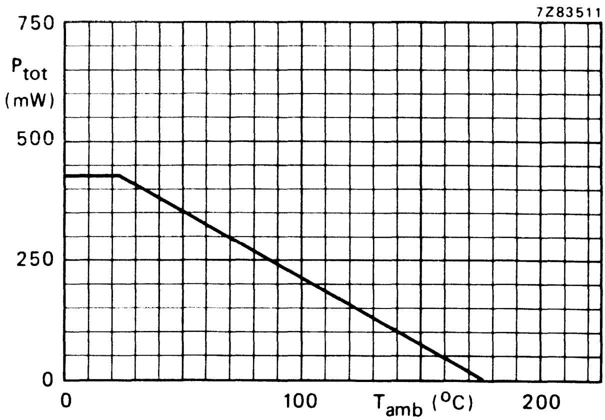


Fig. 3 Power derating curve.

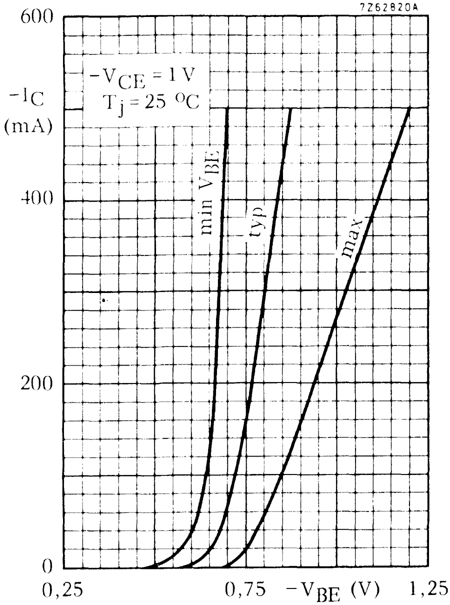


Fig. 4.

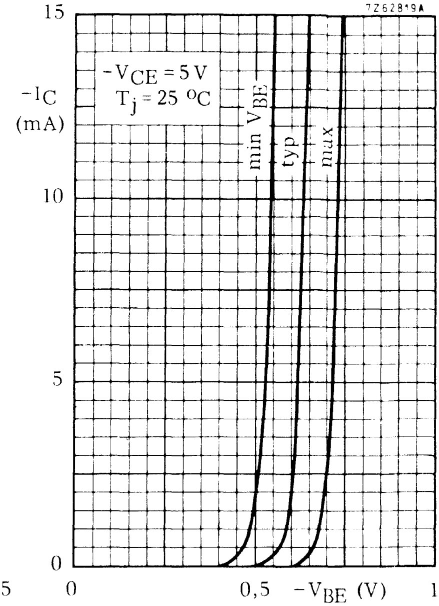


Fig. 5.

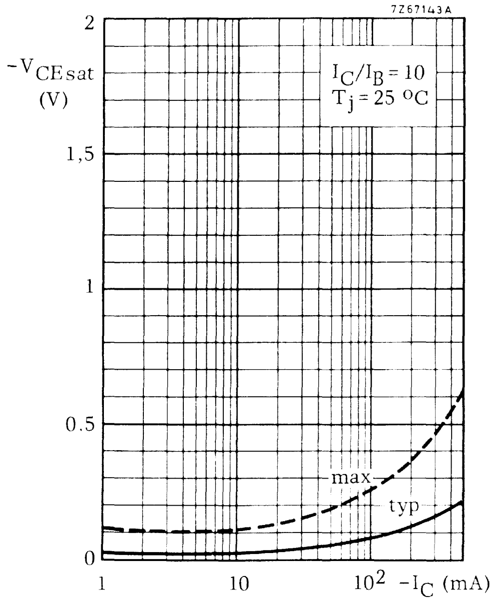


Fig. 6.

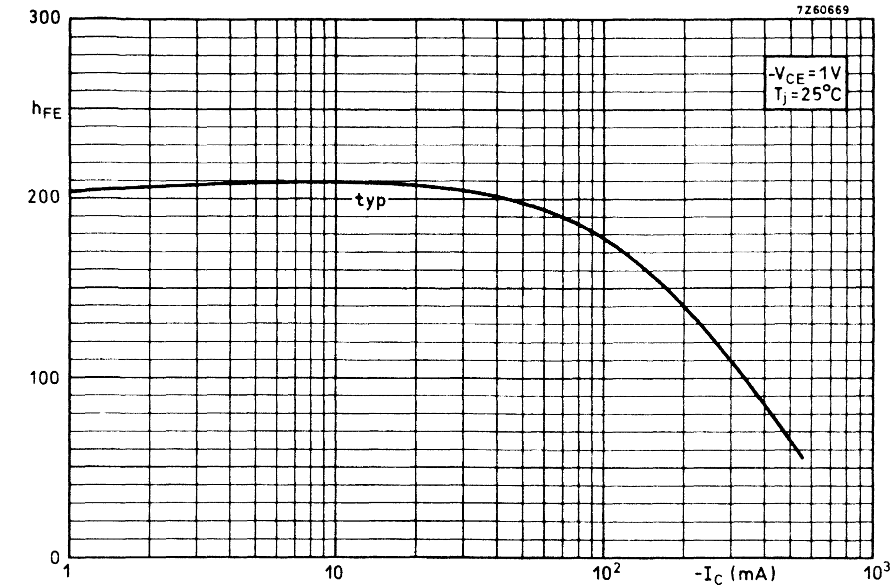

7Z60669
300
h_{FE}
200
100
0
1
10
10^2
$-I_C$ (mA)
10^3
$-V_{CE}$ = 1 V
T_j = 25 °C
typ

Fig. 7.

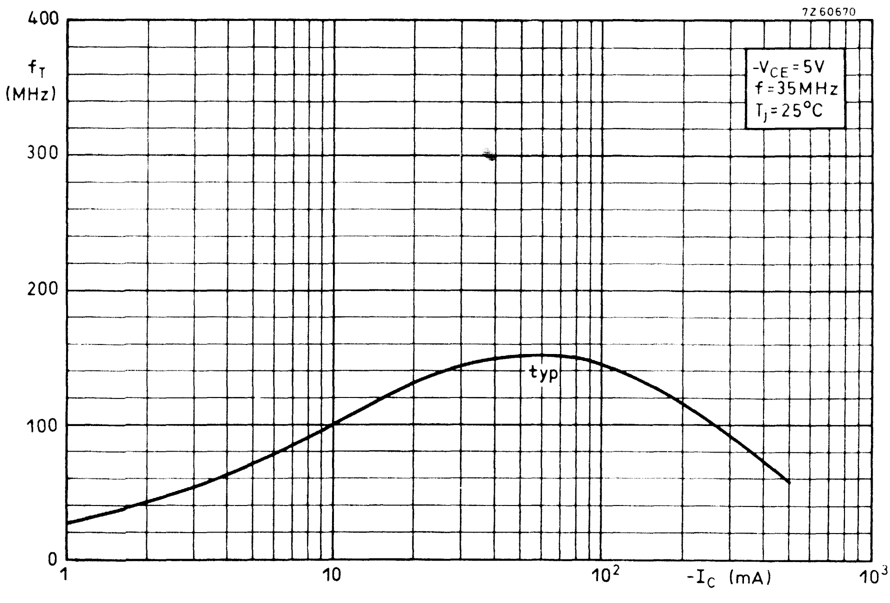

7Z60670
400
f_T
(MHz)
300
200
100
0
1
10
10^2
$-I_C$ (mA)
10^3
$-V_{CE}$ = 5 V
f = 35 MHz
T_j = 25 °C
typ

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.

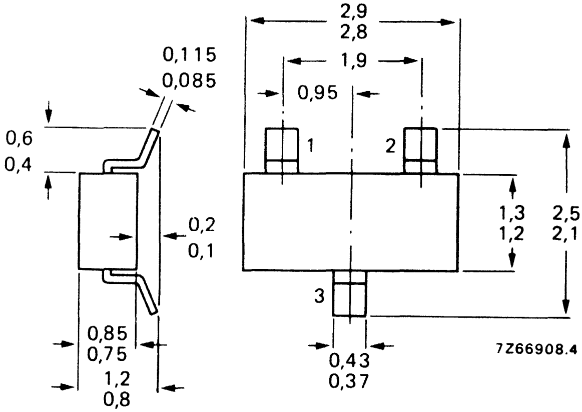
QUICK REFERENCE DATA

			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

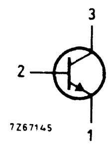
Dimensions in mm

Fig. 1 SOT-23.

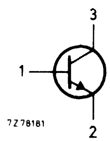


Marking code

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 0,7 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

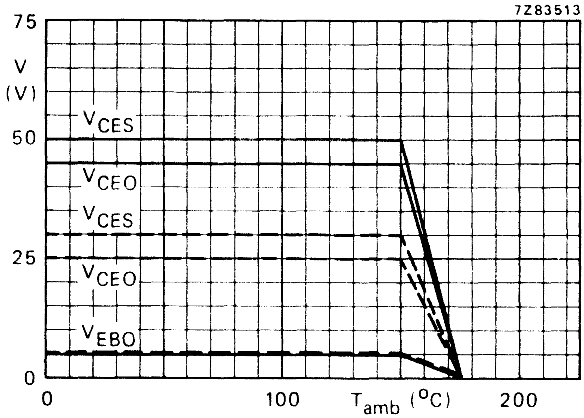


Fig. 2 Voltage derating curves. – – – BCX19; R/BCX20; R ——— .

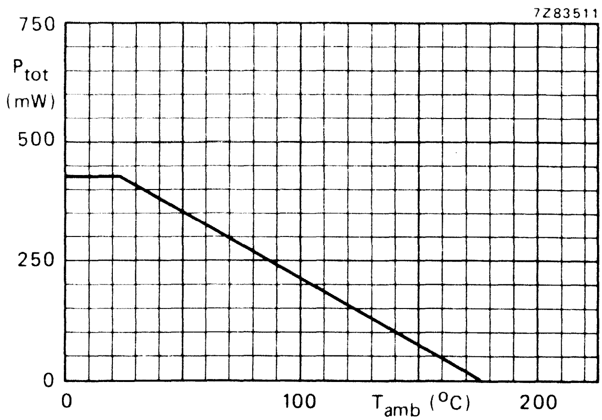


Fig. 3 Power derating curve.

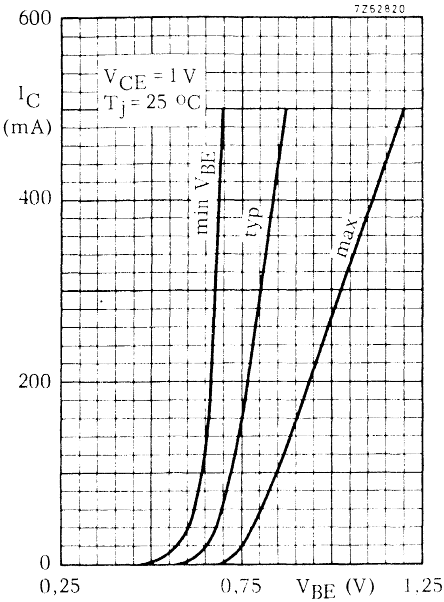


Fig. 4.

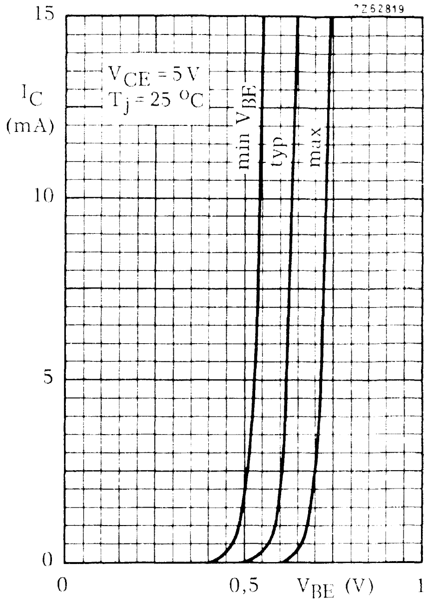


Fig. 5.

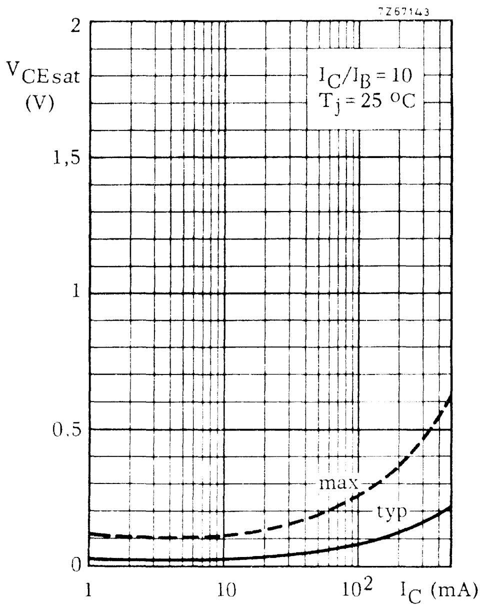


Fig. 6.

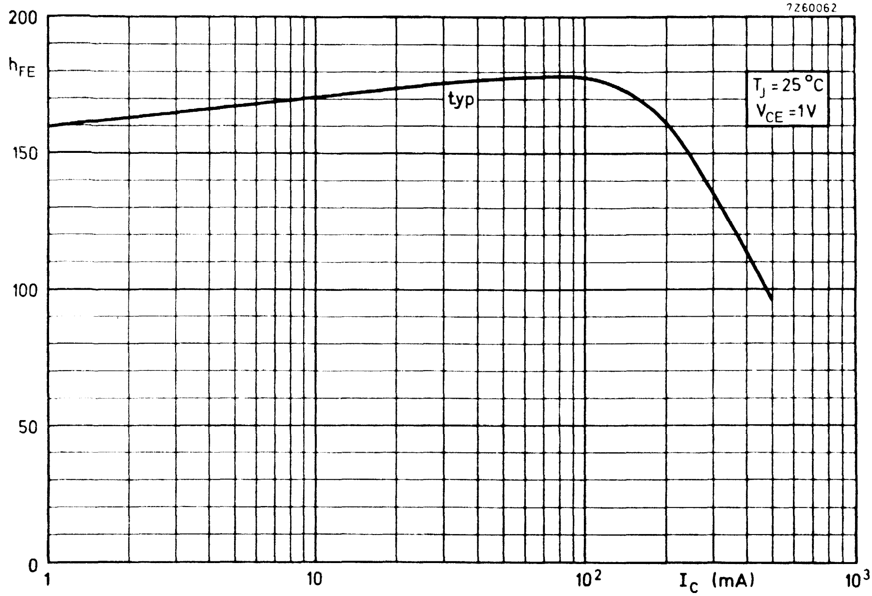

7Z60062
200
h_{FE}
150
100
50
0
typ
$T_j = 25\,^{\circ}C$
$V_{CE} = 1V$
1
10
10^2
I_C (mA)
10^3

Fig. 7.

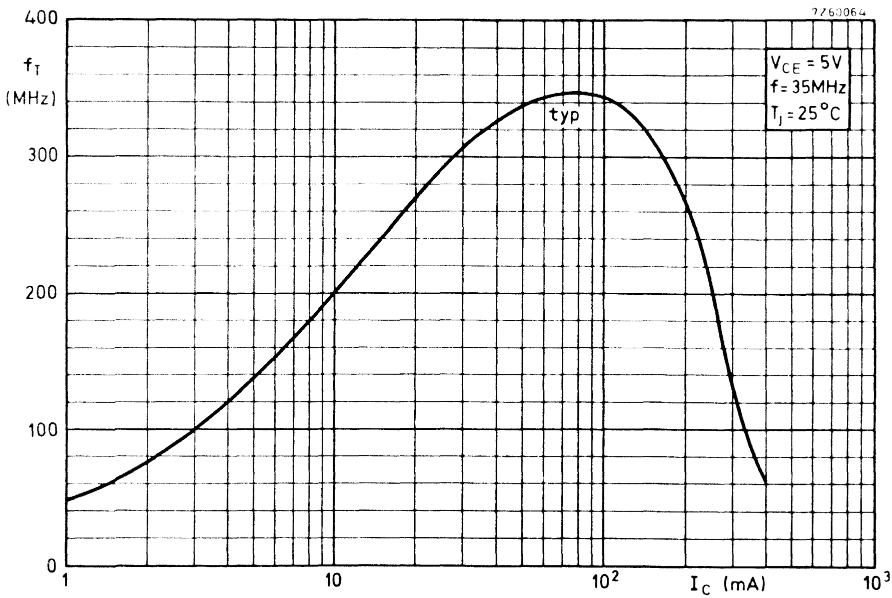

7Z60064
400
f_T
(MHz)
300
200
100
0
typ
$V_{CE} = 5V$
f = 35MHz
$T_j = 25\,^{\circ}C$
1
10
10^2
I_C (mA)
10^3

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.

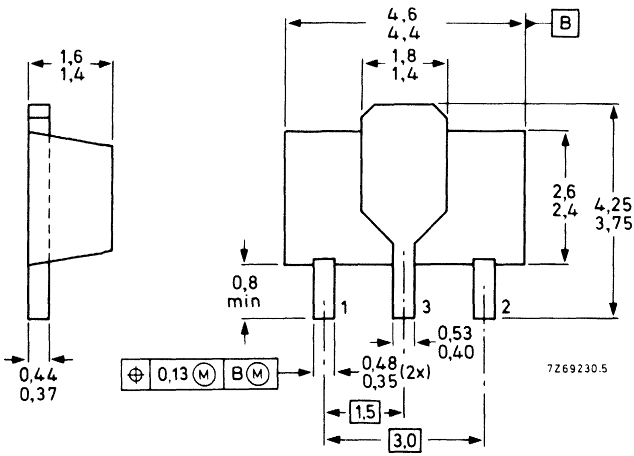
QUICK REFERENCE DATA

			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	40	40	
		<	250	160	160	
Transition frequency at f = 35 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	50	50	50	MHz

MECHANICAL DATA

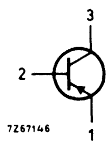
Dimensions in mm

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

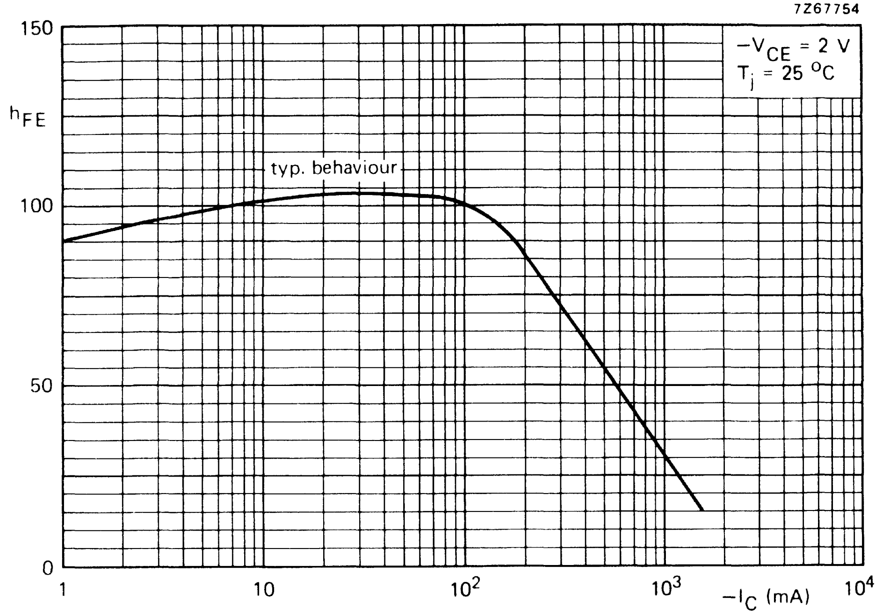
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

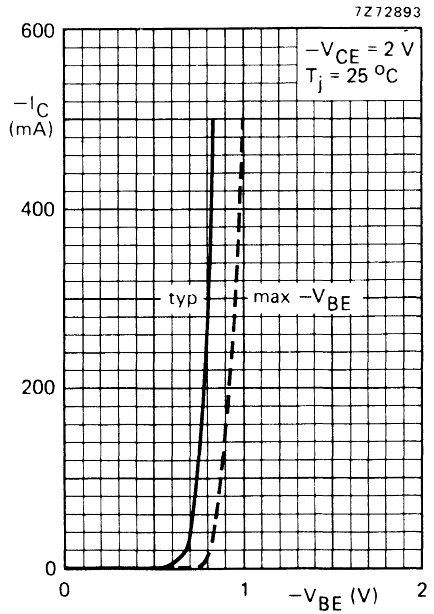
THERMAL RESISTANCE

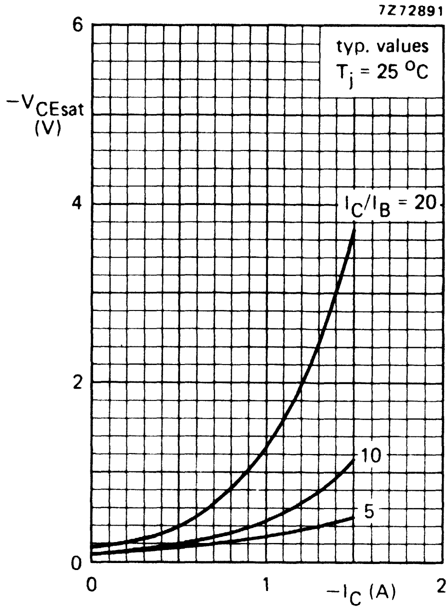
→ From junction to collector tab	$R_{th\,j\text{-}tab}$ =	10	°C/W
From junction to ambient in free air mounted on a ceramic substrate area = 2.5 cm²; thickness = 0,7 mm	$R_{th\,j\text{-}a}$ =	125	°C/W

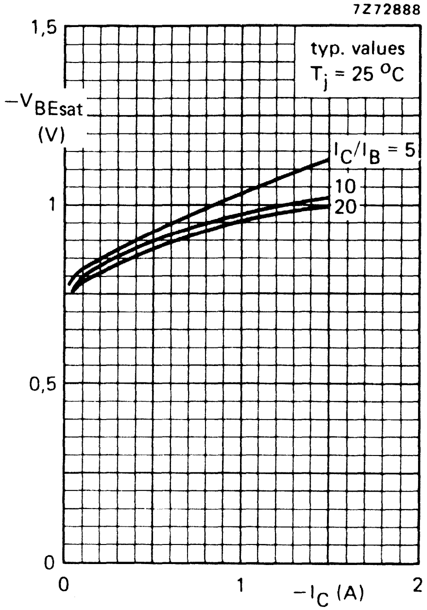
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

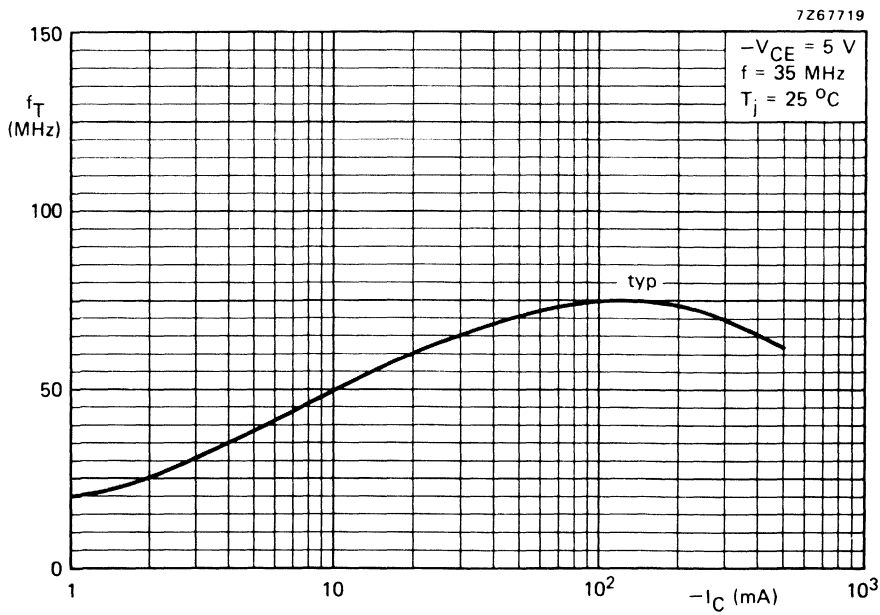
Collector cut-off current						
$I_E = 0$; $-V_{CB} = 30$ V	$-I_{CBO}$	<	100			nA
$I_E = 0$; $-V_{CB} = 30$ V; $T_j = 125$ °C	$-I_{CBO}$	<	10			μA
Emitter cut-off current						
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	10			μA
Base-emitter voltage						
$-I_C = 500$ mA; $-V_{CE} = 2$ V	$-V_{BE}$	<	1			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}
typ. behaviour
$-V_{CE}$ = 2 V
T_j = 25 °C
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)
6
4
2
0
I_C/I_B = 20
10
5
0
1
2
$-I_C$ (A)


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


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

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.

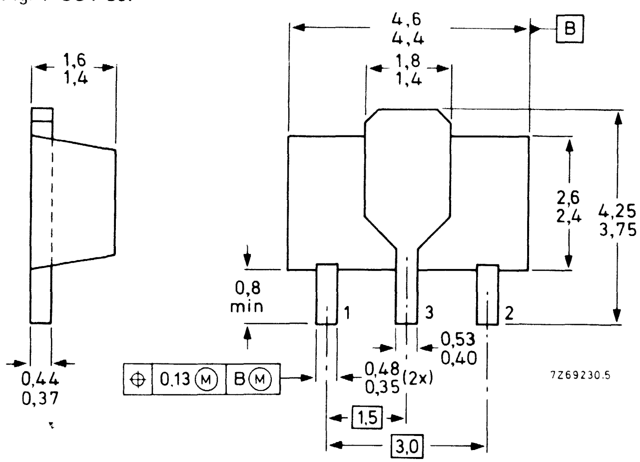
QUICK REFERENCE DATA

			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

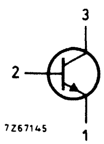
Dimensions in mm

Fig. 1 SOT-89.



Mark

BCX54
BCX55
BCX56



See also *Soldering recommendations.*

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

			BCX54	BCX55	BCX56	
Voltages						
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

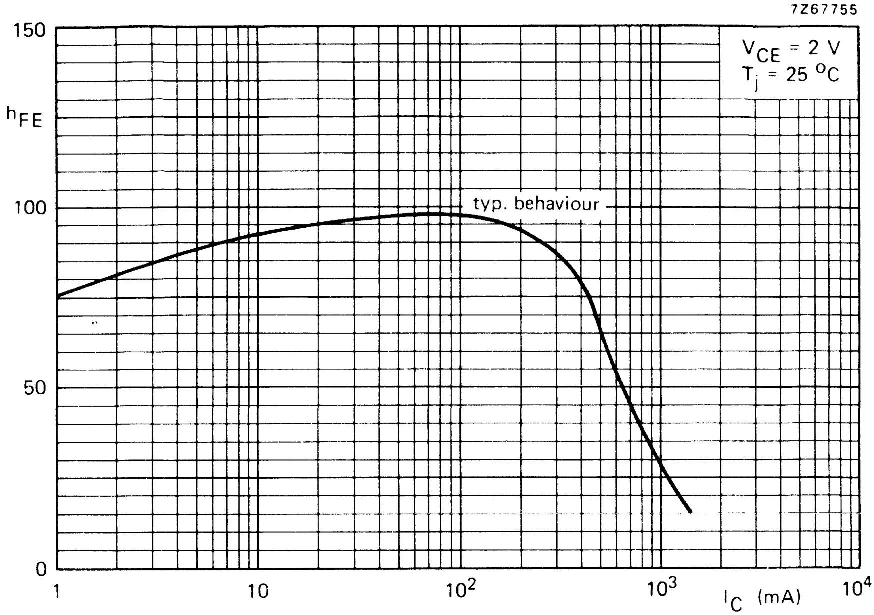
THERMAL RESISTANCE

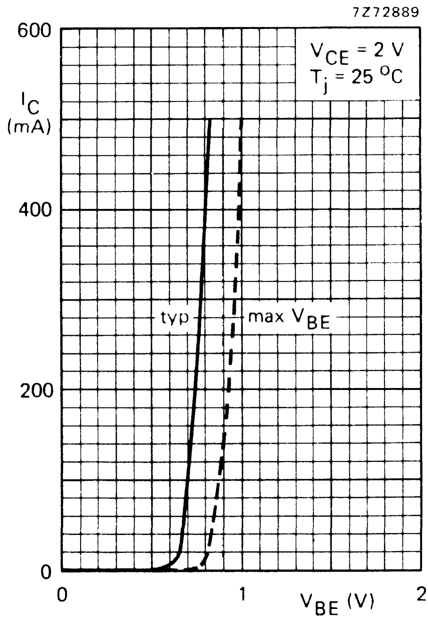
→ From junction to collector tab	$R_{th\,j\text{-}tab}$	=	10	°C/W
From junction to ambient in free air mounted on a ceramic substrate area = 2,5 cm²; thickness = 0,7 mm	$R_{th\,j\text{-}a}$	=	125	°C/W

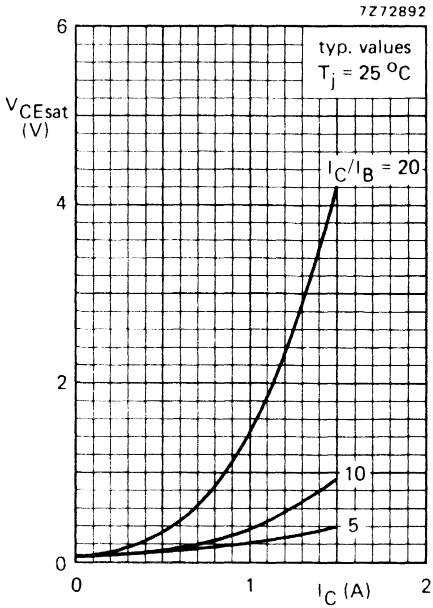
CHARACTERISTICS

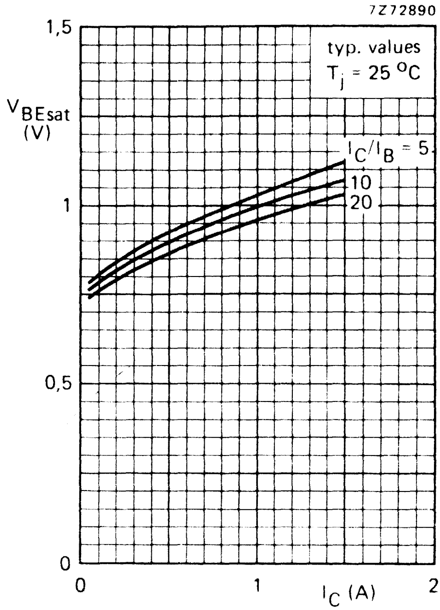
T_{amb} = 25 °C unless otherwise specified

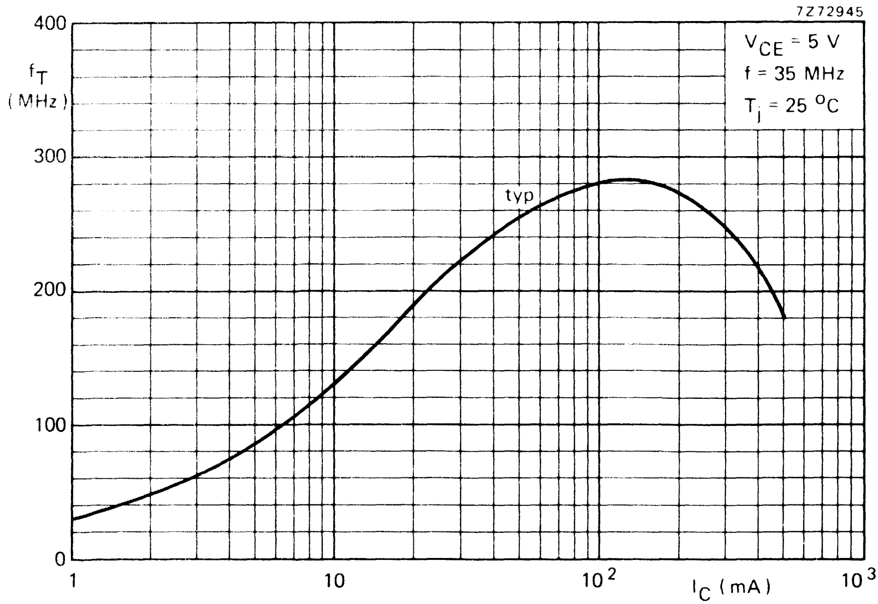
Collector cut-off current						
$I_E = 0$; $V_{CB} = 30$ V	I_{CBO}	<	100			nA
$I_E = 0$; $V_{CB} = 30$ V; $T_j = 125$ °C	I_{CBO}	<	10			μA
Emitter cut-off current						
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10			μA
Base-emitter voltage						
$I_C = 500$ mA; $V_{CE} = 2$ V	V_{BE}	<	1			V
Saturation voltage						
$I_C = 500$ 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
hFE
100
50
0
1
10
10^2
10^3
10^4
IC (mA)
VCE = 2 V
Tj = 25 oC
typ. behaviour


7Z72889
600
IC
(mA)
400
200
0
0
1
2
VBE (V)
VCE = 2 V
Tj = 25 oC
typ
max VBE


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.

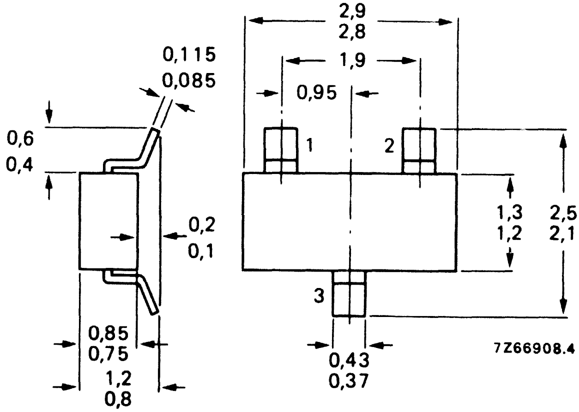
QUICK REFERENCE DATA

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	^oC
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

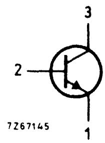
Dimensions in mm

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 up to T_{amb} = 100 °C**	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	$R_{th\ t\text{-}s}$	=	280	K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 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	
V_{CE} = 5 V; I_C = 2 mA	h_{FE}	>	120	180	250	380	
		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							
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{ie}	>	1,6	2,5	3,2	4,5	kΩ
		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							
V_{CE} = 5 V; I_C = 2 mA; f = 1 kHz	h_{fe}	>	125	175	250	350	
		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

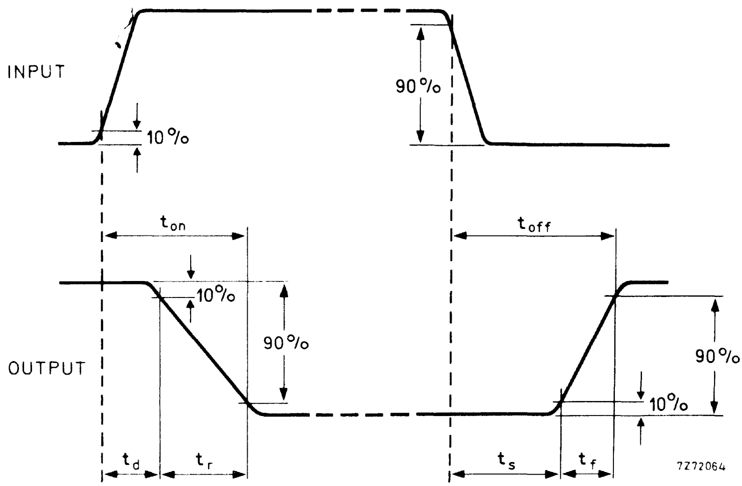


Fig. 2 Switching waveforms.

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.	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

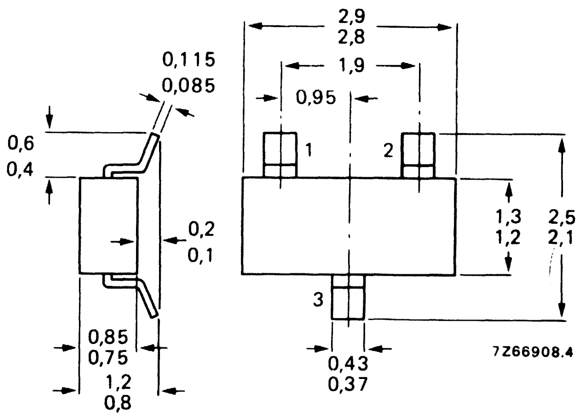
MECHANICAL DATA

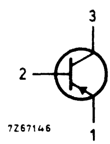
Dimensions in mm

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 up to T_{amb} = 100 °C**	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	$R_{th\ t\text{-}s}$	=	280	K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 mm.

▲ Measured under pulse conditions.

			G	H	J	K	
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			0,6 to 0,75				V
$-V_{CE}$ = 5 V; $-I_C$ = 2 mA	V_{BE}	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

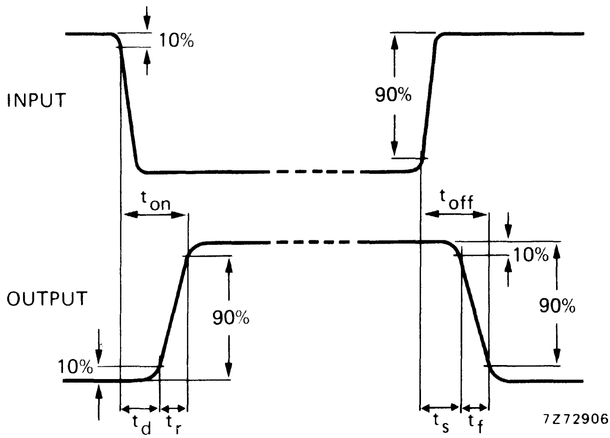


Fig. 2 Switching waveforms.

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} = 65 °C	P_{tot}	max.		250			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

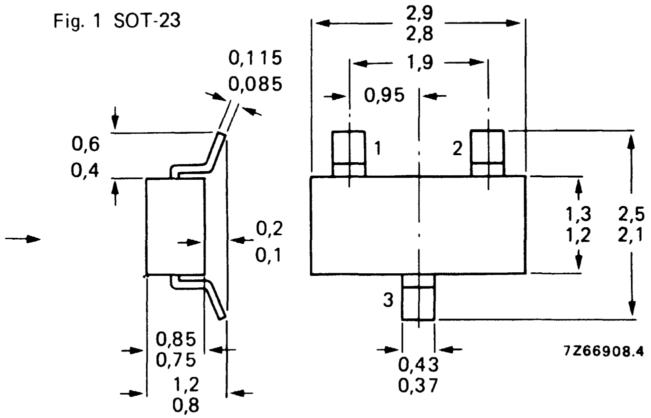
SOT-23 (see page 2).

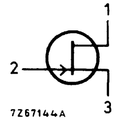
See also *Soldering recommendations.*

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} = 60 °C **	P_{tot}	max.	250	mW
Storage temperature	T_{stg}	−65 to +175		°C
Junction temperature	T_j	max.	175	°C

→ THERMAL CHARACTERISTICS *

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60	K/W
From tab to soldering points	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient **	$R_{th\,s\text{-}a}$	=	90	K/W

* See *Thermal characteristics* in chapter GENERAL.
** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 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

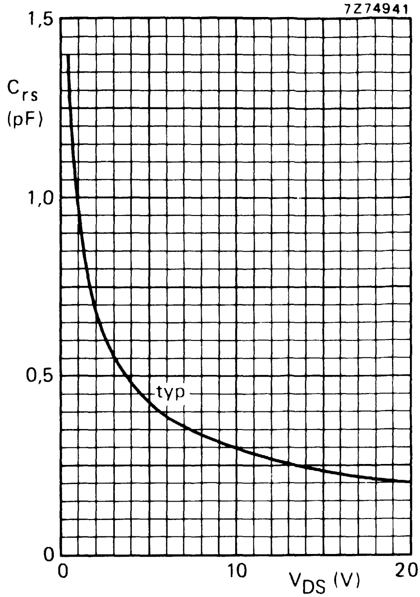


Fig. 2 V_{GS} = 0 for BF510 and BF511;
I_D = 5 mA for BF512 and BF513;
f = 1 MHz; T_{amb} = 25 °C.

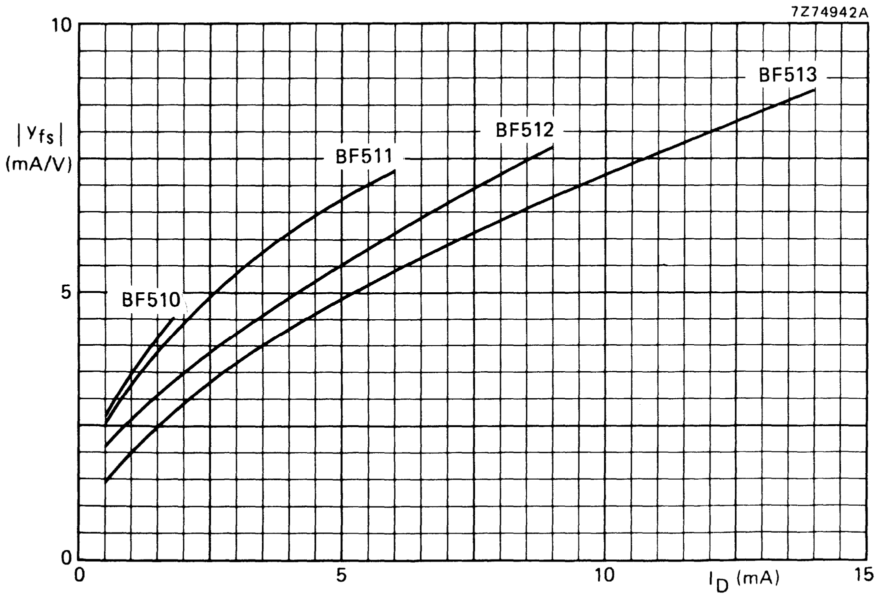


Fig. 3 V_{DS} = 10 V; f = 1 kHz; T_{amb} = 25 °C; typical values.

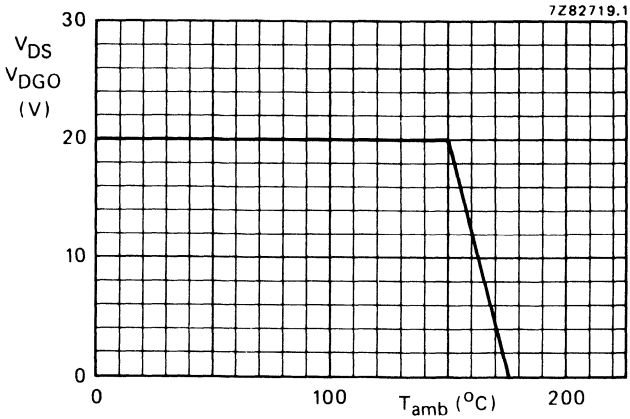


Fig. 4 Voltage derating curve.

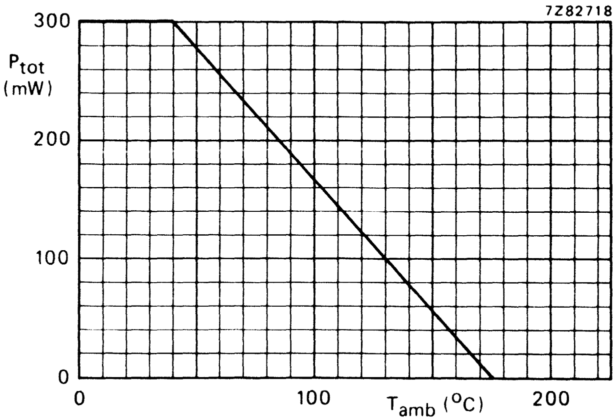


Fig. 5 Power derating curve.

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

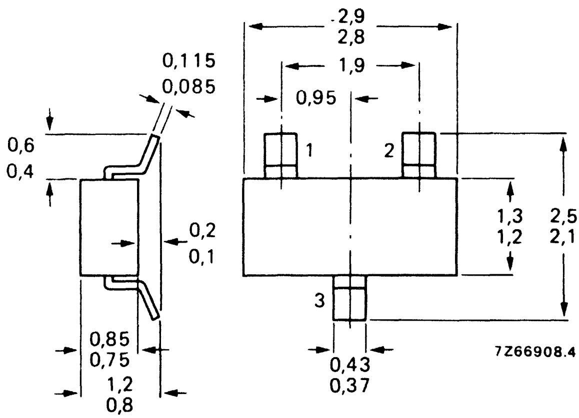
MECHANICAL DATA

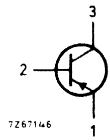
Dimensions in mm

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	$R_{th\ t\text{-}s}$	=	280	K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 mm.

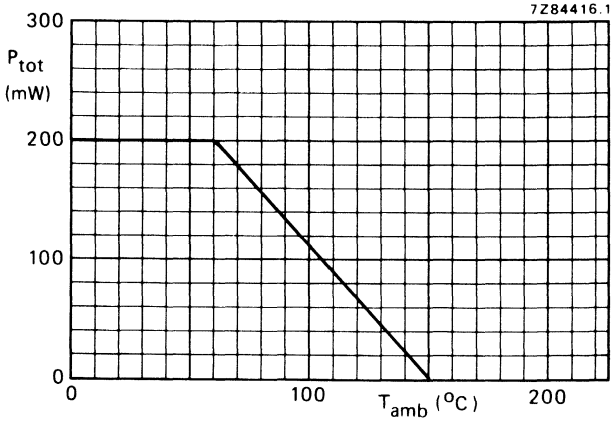


Fig. 2 Power derating curve.

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.

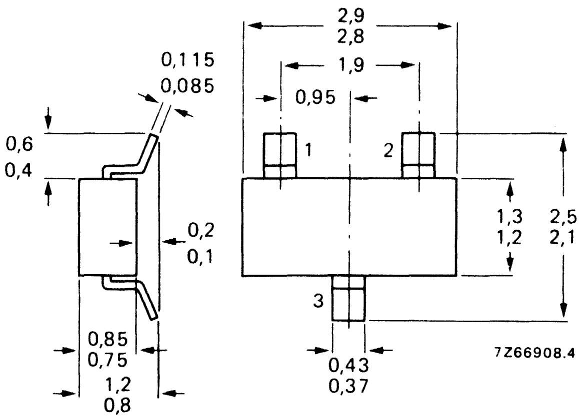
QUICK REFERENCE DATA

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

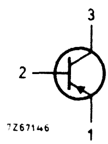
Dimensions in mm

Fig. 1 SOT-23

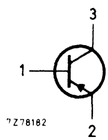


Marking code

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	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 mm.

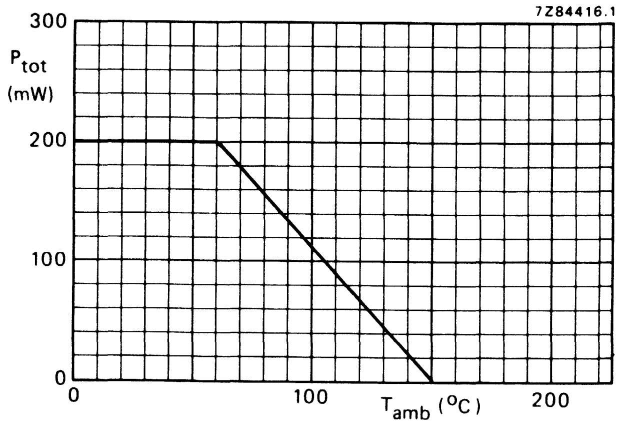


Fig. 2 Power derating curve.

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.

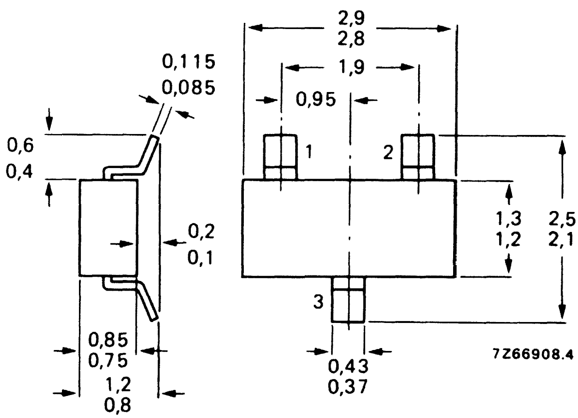
QUICK REFERENCE DATA

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

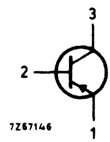
Dimensions in mm

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	$R_{th\ t\text{-}s}$	=	280	K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 mm.

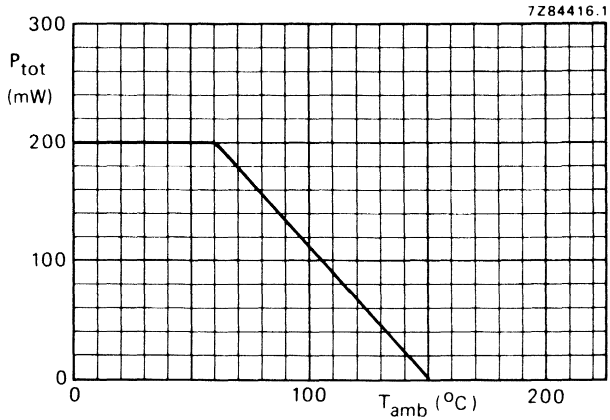


Fig. 2 Power derating curve.

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

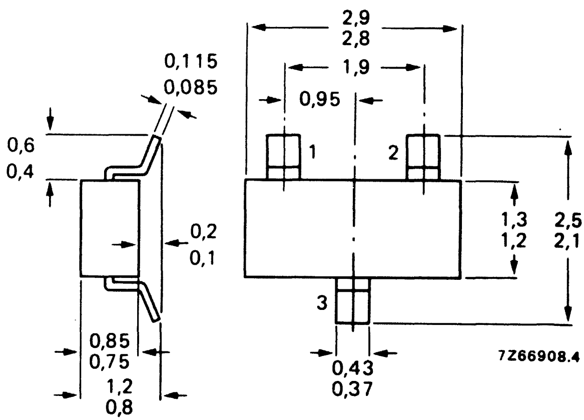
MECHANICAL DATA

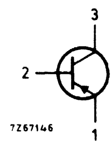
Dimensions in mm

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	$R_{th\ t\text{-}s}$	=	280 K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90 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 8 mm x 10 mm x 0,7 mm.

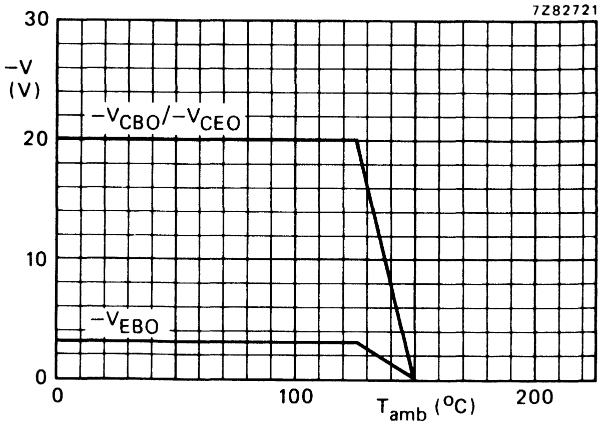


Fig. 2 Voltage derating curves.

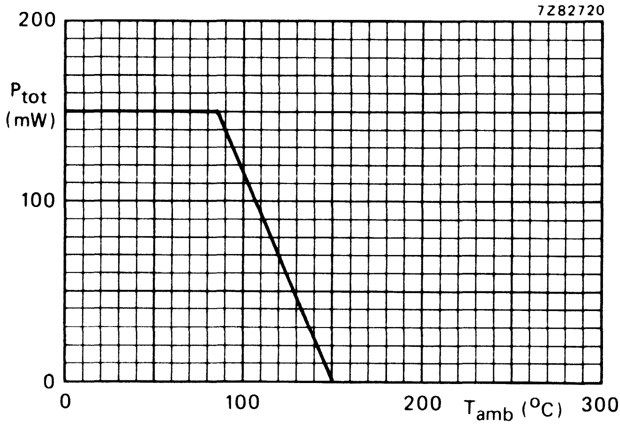


Fig. 3 Power derating curve.

SILICON EPITAXIAL TRANSISTORS

- **For video output stages**

N-P-N transistors in a microminiature plastic envelope intended for class-B video output stages in colour television receivers.

P-N-P complements are BF621 and BF623 respectively.

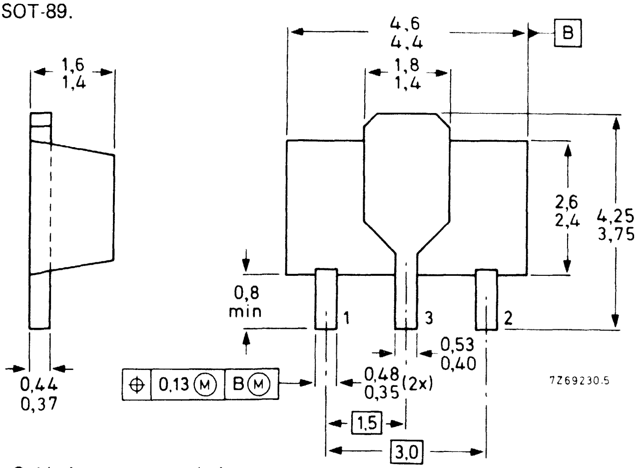
QUICK REFERENCE DATA

			BF620	BF622	
Collector-base voltage (open emitter)	V_{CBO}	max.	300	250	V
Collector-emitter voltage (open base)	V_{CEO}	max.	–	250	V
Collector-emitter voltage (R_{BE} = 2,7 kΩ)	V_{CER}	max.	300	–	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

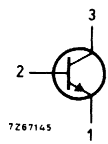
Dimensions in mm

Fig. 1 SOT-89.



Mark

BF620
BF622



See also *Soldering recommendations*.

RATINGS

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

			BF620	BF622	
Collector-base voltage (open emitter)	V_{CBO}	max.	300	250	V
Collector-emitter voltage (open base)	V_{CEO}	max.	–	250	V
Collector-emitter voltage (R_{BE} = 2,7 kΩ)	V_{CER}	max.	300	–	V

Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c.)	I_C	max.	50	mA
Collector current (peak value)	I_{CM}	max.	100	mA
Total power dissipation up to T_{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	K/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	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BF620	BF622	
Collector cut-off current I_E = 0; V_{CB} = 200 V	I_{CBO}	<	10	10	nA
Collector-emitter voltage R_{BE} = 2,7 kΩ; V_{CE} = 250 V	I_{CER}	<	50	–	nA
R_{BE} = 2,7 kΩ; V_{CE} = 200 V; T_j = 150 °C	I_{CER}	<	10	10	μA

Saturation voltage I_C = 30 mA; I_B = 5 mA	$V_{CE\ sat}$	<	0,6	V
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

* See *Thermal characteristics.*

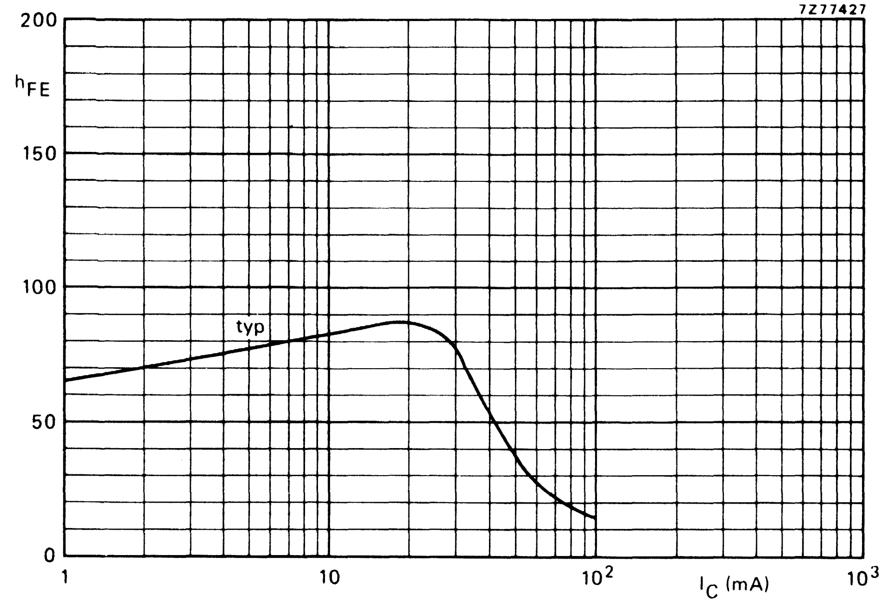


Fig. 2 Typical values at V_{CE} = 20 V; T_j = 25 °C.

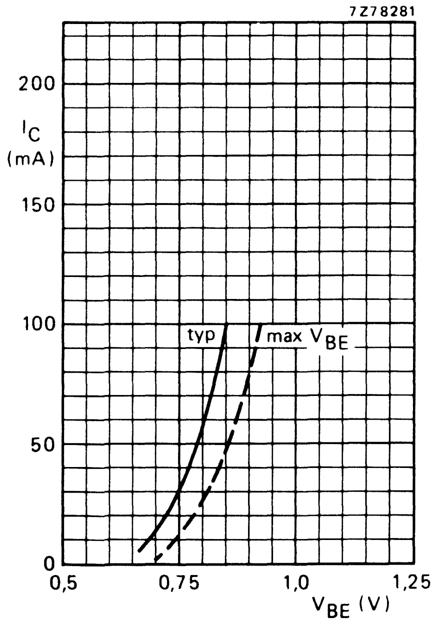


Fig. 3 V_{CE} = 20 V; T_j = 25 °C.

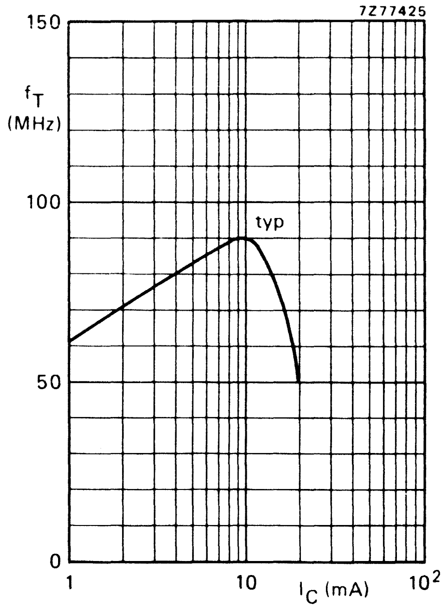


Fig. 4 V_{CE} = 10 V; T_j = 25 °C; f = 35 MHz.

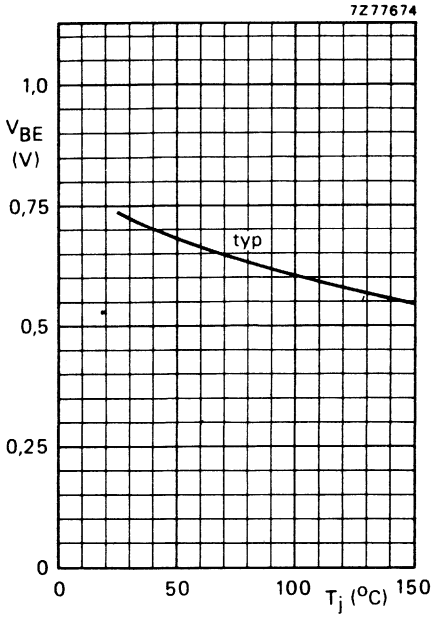


Fig. 5 I_C = 25 mA; V_{CE} = 20 V.

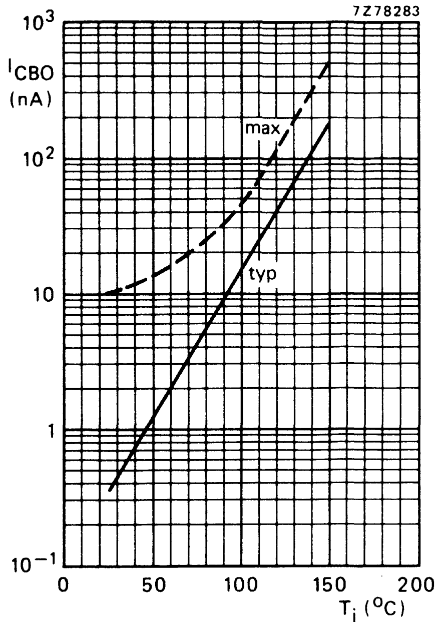


Fig. 6 V_{CB} = 200 V.

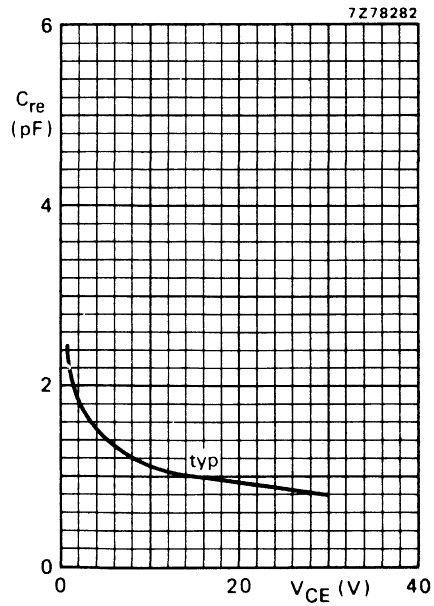


Fig. 7 I_C = 0; f = 1 MHz; T_j = 25 °C.

SILICON EPITAXIAL TRANSISTORS

- **For video output stages**

P-N-P transistors in a microminiature plastic envelope intended for application in class-B video output stages in colour television receivers.

N-P-N complements are BF620 and BF622 respectively.

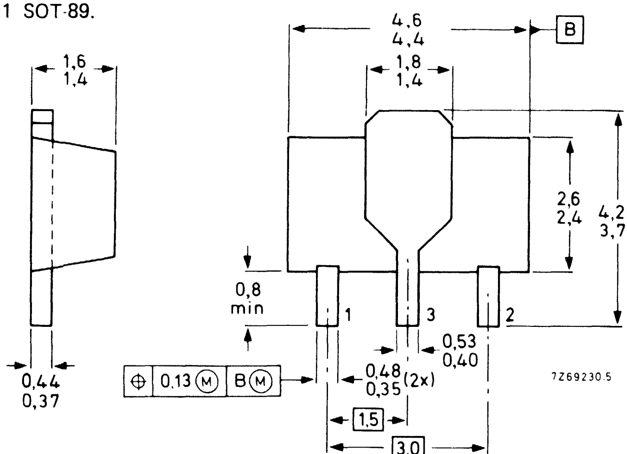
QUICK REFERENCE DATA

			BF621	BF623	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	300	250	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	–	250	V
Collector-emitter voltage (R_{BE} = 2,7 kΩ)	$-V_{CER}$	max.	300	–	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

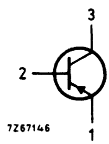
Dimensions in mm

Fig. 1 SOT-89.



Mark

BF621
BF623



See also *Soldering recommendations.*

RATINGS

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

			BF621	BF623	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	300	250	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	–	250	V
Collector-emitter voltage (R_{BE} = 2,7 kΩ)	$-V_{CER}$	max.	300	–	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current (d.c.)	$-I_C$	max.	50		mA
Collector current (peak value)	$-I_{CM}$	max.	100		mA
Total power dissipation up to T_{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	K/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	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BF621	BF623	
Collector cut-off current I_E = 0; $-V_{CB}$ = 200 V	$-I_{CBO}$	<	10	10	nA
Collector-emitter voltage R_{BE} = 2,7 kΩ; $-V_{CE}$ = 250 V	$-I_{CER}$	<	50	–	nA
R_{BE} = 2,7 kΩ; $-V_{CE}$ = 200 V; T_j = 150 °C	$-I_{CER}$	<	10	10	μA
Saturation voltage $-I_C$ = 30 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	<	0,8		V
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

* See *Thermal characteristics*.

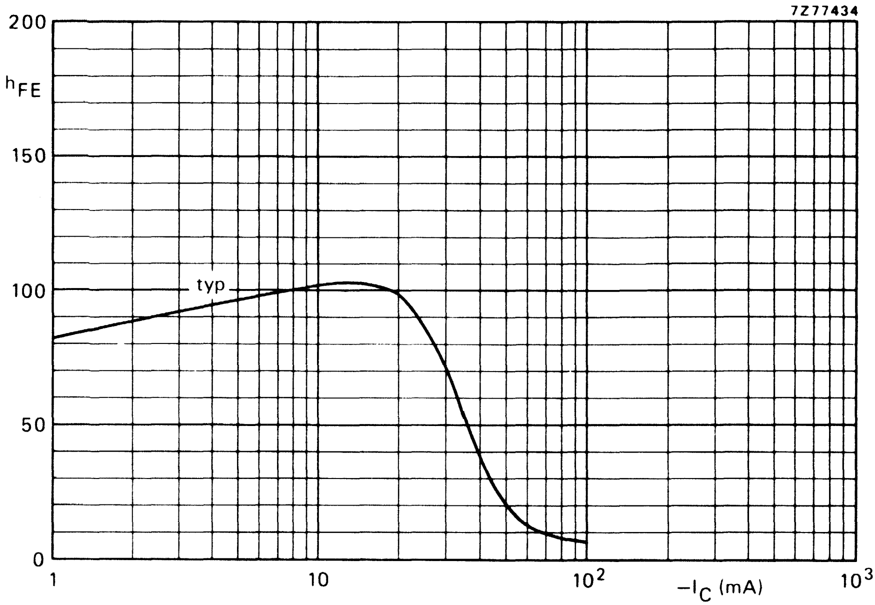


Fig. 2 Typical values at $-V_{CE}$ = 20 V; T_j = 25 °C.

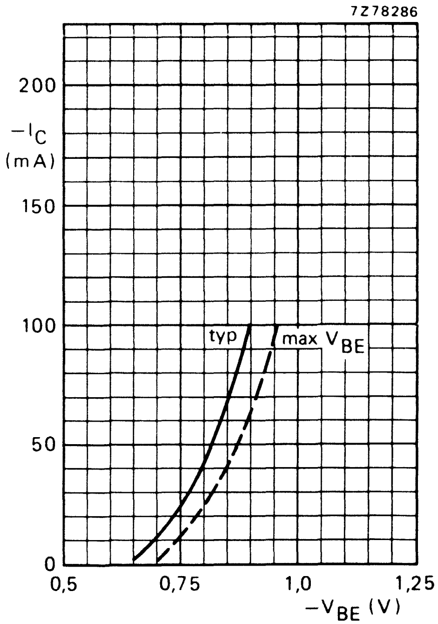


Fig. 3 $-V_{CE}$ = 20 V; T_j = 25 °C.

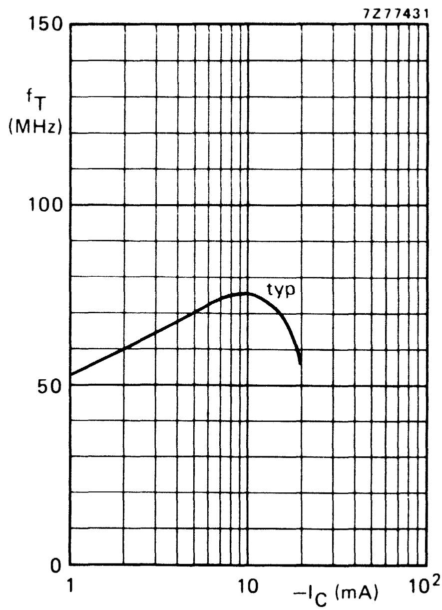


Fig. 4 $-V_{CE}$ = 10 V; T_j = 25 °C; f = 35 MHz.

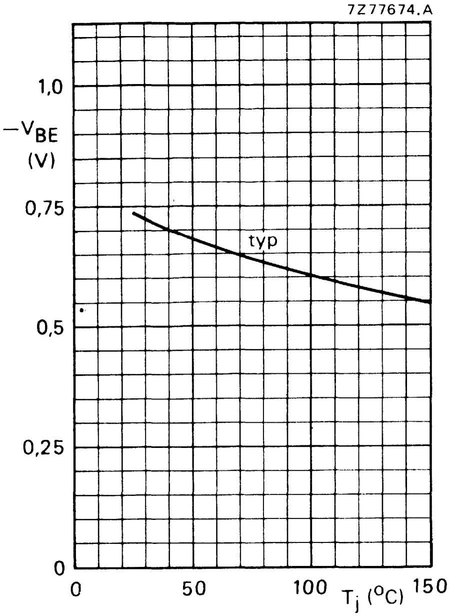


Fig. 5 $-I_C$ = 25 mA; $-V_{CE}$ = 20 V.

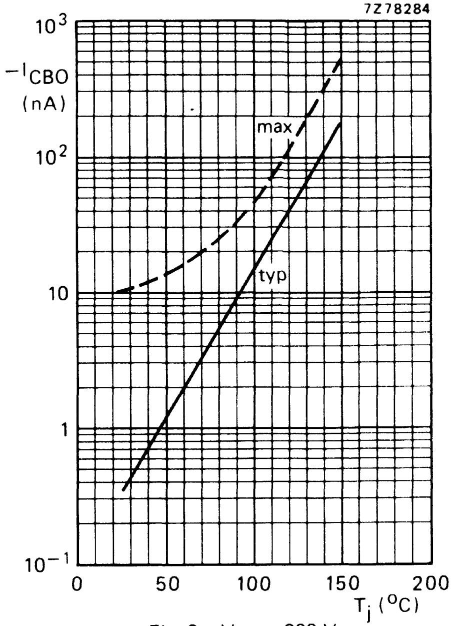


Fig. 6 $-V_{CB}$ = 200 V.

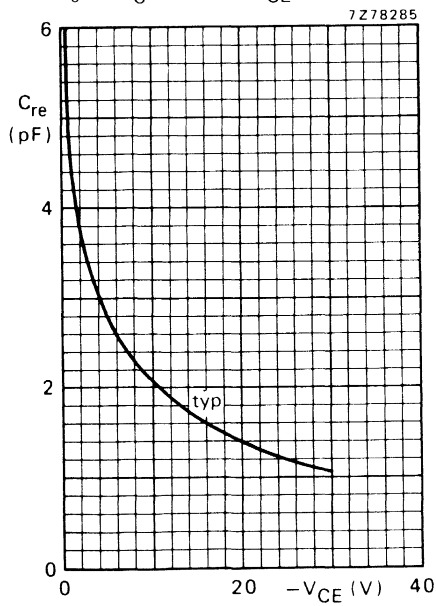


Fig. 7 I_C = 0; f = 1 MHz; T_j = 25 °C.

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.

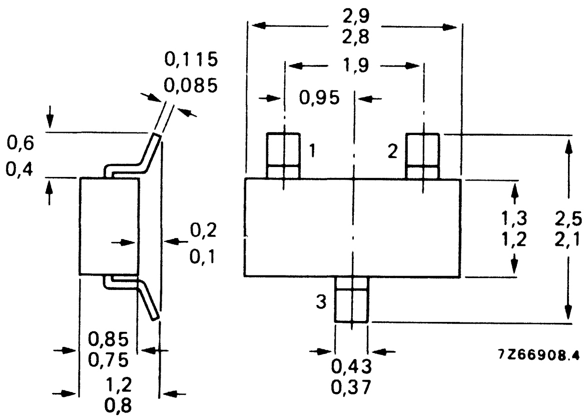
QUICK REFERENCE DATA

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

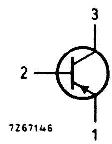
Dimensions in mm

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	$R_{th\,t\text{-}s}$	=	280 K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90 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 8 mm x 10 mm x 0,7 mm.

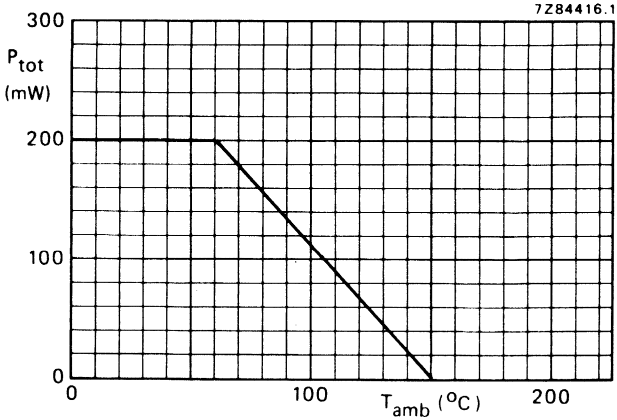


Fig. 2 Power derating curve.

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

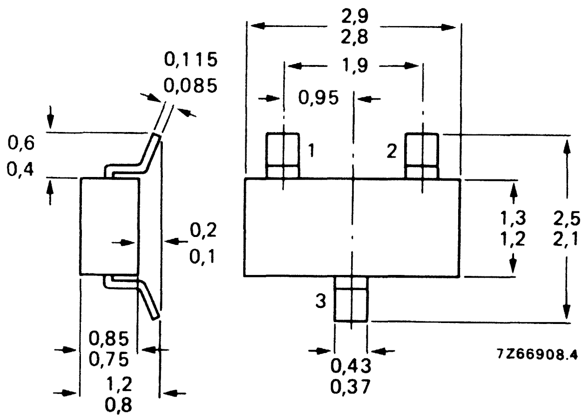
MECHANICAL DATA

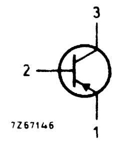
Dimensions in mm

Fig. 1 SOT-23.

Marking code

BF767 = G9





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	$R_{th\ t\text{-}s}$	=	280 K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90 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}	>	15
		typ.	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 8 mm x 10 mm x 0,7 mm.

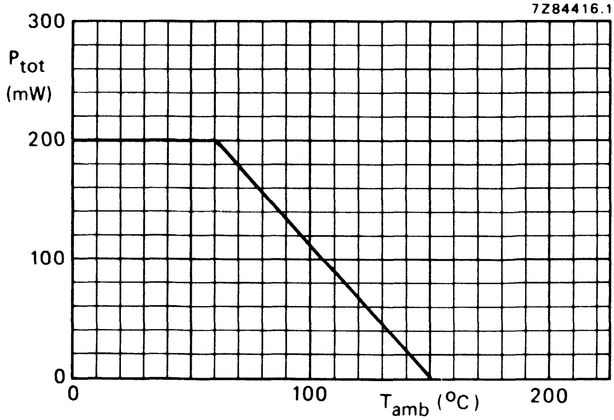


Fig. 2 Power derating curve.

SILICON EPITAXIAL TRANSISTORS

N-P-N transistors in a microminiature plastic envelope intended for application in thick and thin-film circuits. Primarily intended for use in telephony and professional communication equipment. P-N-P components are BF821, BF823 respectively.

QUICK REFERENCE DATA

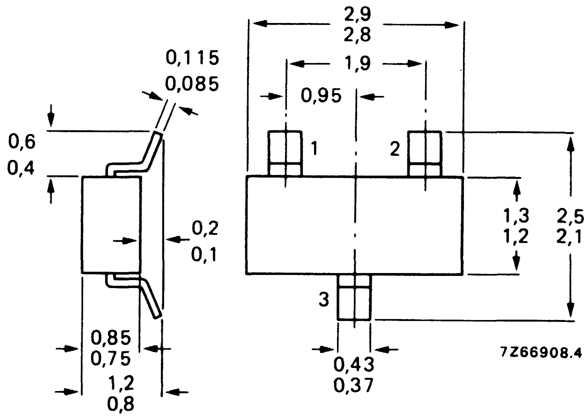
			BF820	BF822	
Collector-base voltage (open emitter)	V_{CBO}	max.	300	250	V
Collector-emitter voltage (open base)	V_{CEO}	max.	--	250	V
Collector-emitter voltage (R_{BE} = 2,7 kΩ)	V_{CER}	max.	300	–	V
Collector current (peak value)	I_{CM}	max.	100		mA
Total power dissipation up to T_{amb} = 35 °C	P_{tot}	max.	310		mW
Junction temperature	T_j	max.	150		°C
D.C. current gain I_C = 25 mA; V_{CE} = 20 V	h_{FE}	>	50		
Feedback capacitance at f = 1 MHz I_C = 0; V_{CE} = 30 V	C_{re}	<	1,6		pF
Transition frequency at f = 35 MHz I_C = 10 mA; V_{CE} = 10 V	f_T	>	60		MHz

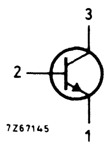
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.

Mark
BF820 = 1 V
BF822 = 1 X





See also *Soldering recommendations* in Microminiature Semiconductor handbook.

RATINGS

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

			BF820	BF822	
Collector-base voltage (open emitter)	V_{CBO}	max.	300	250	V
Collector-emitter voltage (open base)	V_{CEO}	max.	–	250	V
Collector-emitter voltage (R_{BE} = 2,7 kΩ)	V_{CER}	max.	300	–	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5		V
Collector current (d.c.)	I_C	max.	50		mA
Collector current (peak value)	I_{CM}	max.	100		mA
Total power dissipation* up to T_{amb} = 35 °C	P_{tot}	max.	310		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	$R_{th\ j\text{-}t}$	=	50	K/W
from tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
from soldering points to ambient*	$R_{th\ s\text{-}a}$	=	60	K/W

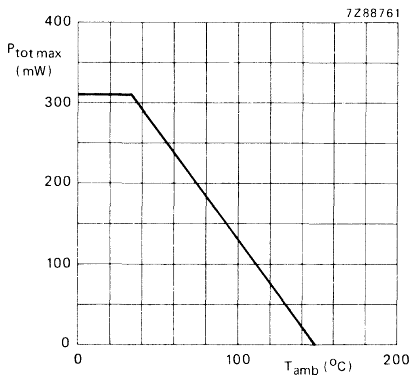


Fig. 2 Power derating curve.

* Mounted on a ceramic substrate: area = 2,5 cm²; thickness = 0,7 mm.
** See *Thermal characteristics.*

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BF820	BF822	
Collector cut-off current					
I_E = 0; V_{CB} = 200 V	I_{CBO}	<	10	10	nA
Collector-emitter voltage					
R_{BE} = 2,7 kΩ; V_{CE} = 250 V	I_{CER}	<	50	50	nA
R_{BE} = 2,7 kΩ; V_{CE} = 200 V; T_j = 150 °C	I_{CER}	<	10	10	μA
Saturation voltage					
I_C = 30 mA; I_B = 5 mA	$V_{CE\,sat}$	<	0,6		V
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

DEVELOPMENT SAMPLE DATA

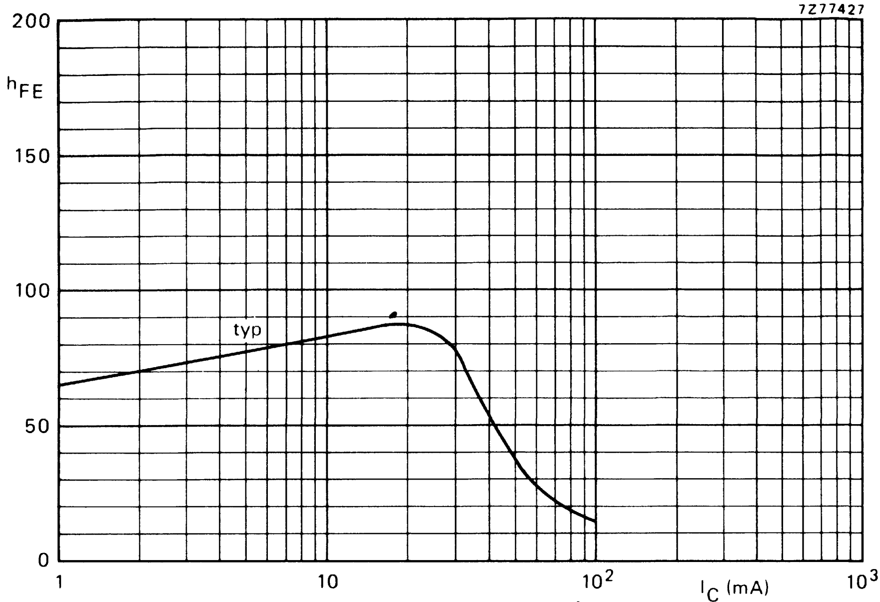


Fig. 3 V_{CE} = 20 V; T_j = 25 °C.

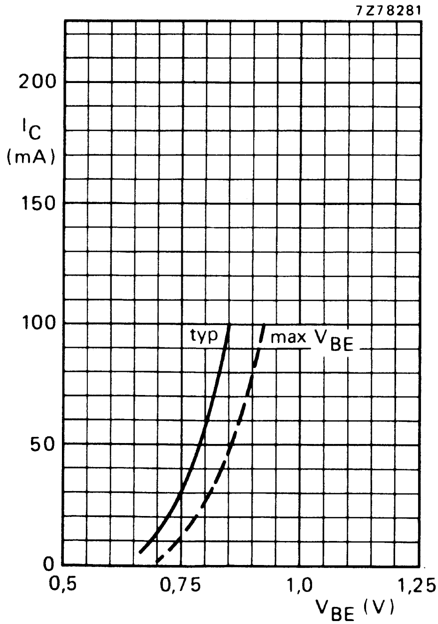


Fig. 4 V_{CE} = 20 V; T_j = 25 °C.

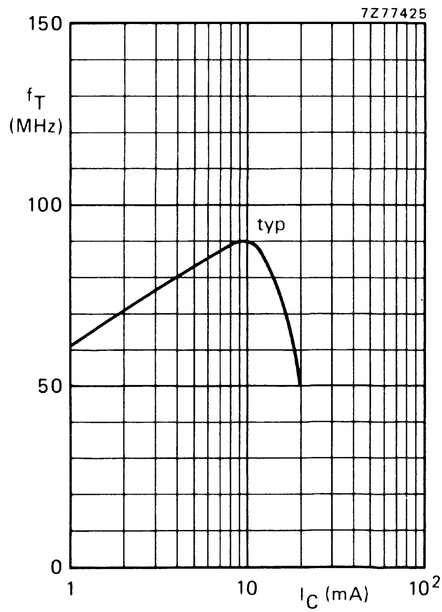


Fig. 5 V_{CE} = 10 V; T_j = 25 °C, f = 35 MHz.

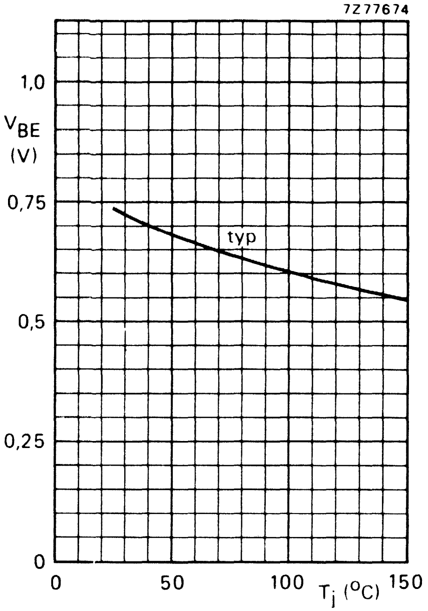


Fig. 6 I_C = 25 mA; V_{CE} = 20 V.

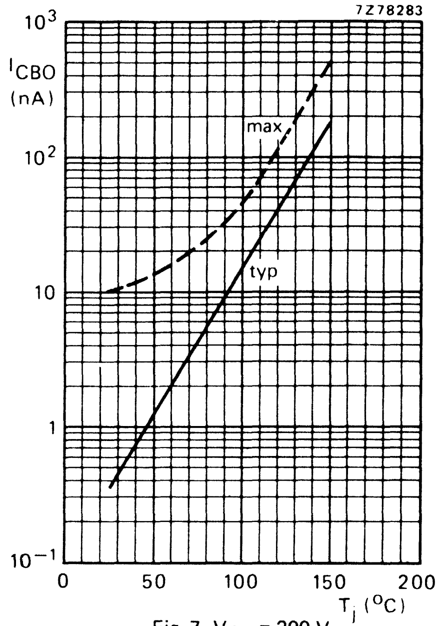


Fig. 7 V_{CB} = 200 V.

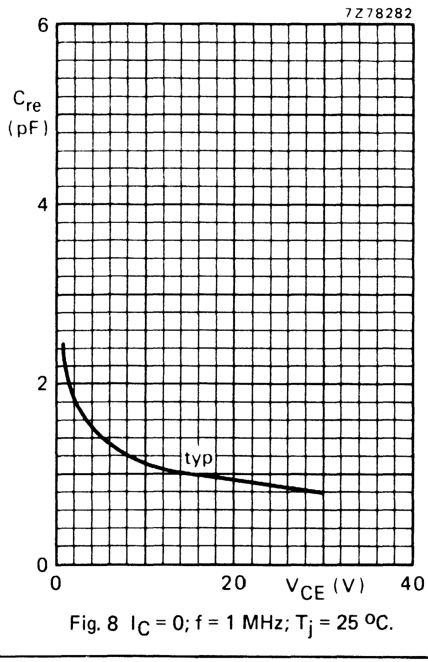


Fig. 8 I_C = 0; f = 1 MHz; T_j = 25 °C.

SILICON EPITAXIAL TRANSISTORS

P-N-P transistors in a microminiature plastic envelope intended for application in thick and thin-film circuits. Primarily intended for use in telephony and professional communication equipment. N-P-N complements are BF820, BF822 respectively.

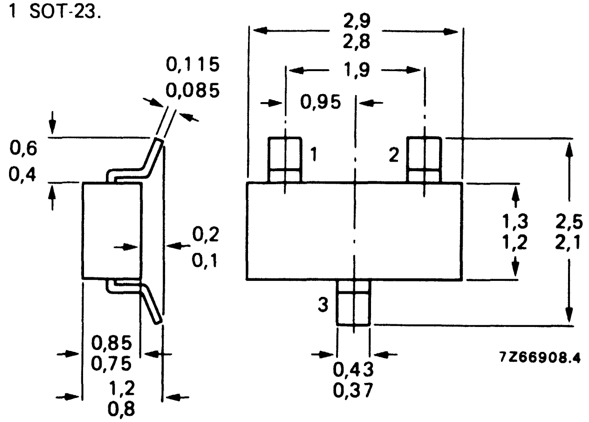
QUICK REFERENCE DATA

			BF821	BF823	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	300	250	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	–	250	V
Collector-emitter voltage (R_{BE} = 2,7 kΩ)	$-V_{CER}$	max.	300	–	V
Collector current (peak value)	$-I_{CM}$	max.	100		mA
Total power dissipation up to T_{amb} = 35 °C	P_{tot}	max.	310		mW
Junction temperature	T_j	max.	150		°C
D.C. current gain $-I_C$ = 25 mA; $-V_{CE}$ = 20 V	h_{FE}	>	50		
Feedback capacitance at f = 1 MHz $-I_C$ = 0; $-V_{CE}$ = 30 V	C_{re}	<	1,6		pF
Transition frequency at f = 35 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 10 V	f_T	>	60		MHz

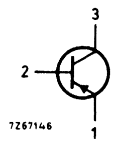
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.



Mark
BF821 = 1W
BF823 = 1Y



See also *Soldering recommendations.*

RATINGS

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

			BF821	BF823	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	300	250	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	–	250	V
Collector-emitter voltage (R_{BE} = 2,7 kΩ)	$-V_{CER}$	max.	300	–	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current (d.c.)	$-I_C$	max.	50		mA
Collector current (peak value)	$-I_{CM}$	max.	100		mA
Total power dissipation* up to T_{amb} = 35 °C	P_{tot}	max.	310		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	$R_{th\ j\text{-}t}$	=	50	K/W
from tab to soldering points	$R_{th\ t\text{-}s}$	=	260	K/W
from soldering points to ambient*	$R_{th\ s\text{-}a}$	=	60	K/W

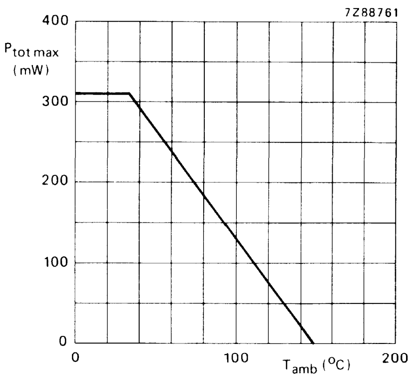


Fig. 2 Power derating curve.

* Mounted on a ceramic substrate: area = 2,5 cm²; thickness = 0,7 mm.
** See *Thermal characteristics.*

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BF821	BF823	
Collector cut-off current					
$I_E = 0$; $-V_{CB} = 200$ V	$-I_{CBO}$	<	10	10	nA
Collector-emitter voltage					
$R_{BE} = 2,7$ kΩ; $-V_{CE} = 250$ V	$-I_{CER}$	<	50	50	nA
$R_{BE} = 2,7$ kΩ; $-V_{CE} = 200$ V; $T_j = 150$ °C	$-I_{CER}$	<	10	10	μA
Saturation voltage					
$-I_C = 30$ mA; $-I_B = 5$ mA	$-V_{CEsat}$	<	0,8		V
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

DEVELOPMENT SAMPLE DATA

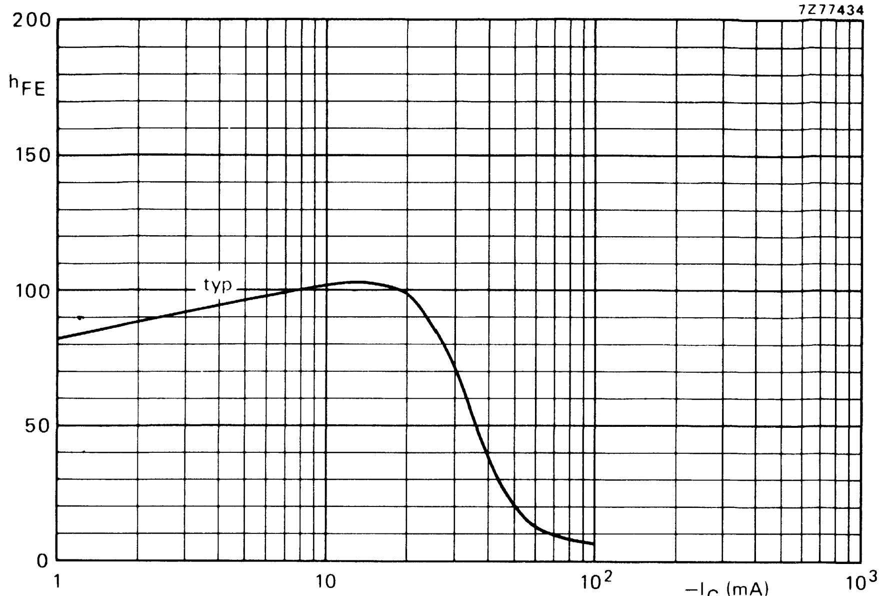


Fig. 3 D.C. current gain. $-V_{CE}$ = 20 V; T_j = 25 °C.

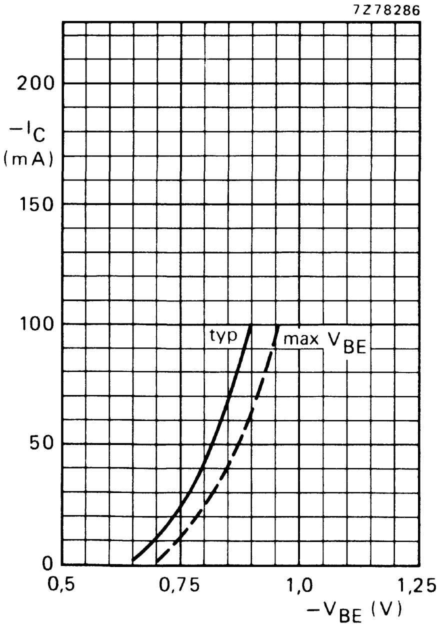


Fig. 4 $-V_{CE}$ = 20 V; T_j = 25 °C.

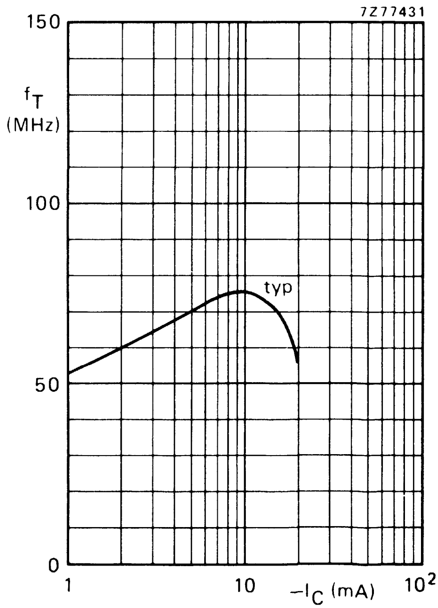


Fig. 5 $-V_{CE}$ = 10 V; T_j = 25 °C; f = 35 MHz.

DEVELOPMENT SAMPLE DATA

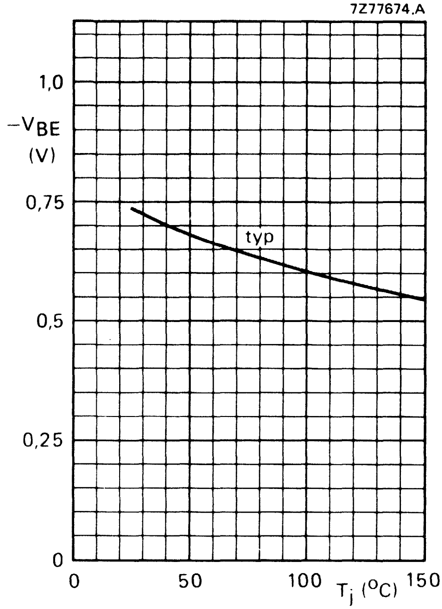


Fig. 6 $-I_C$ = 25 mA; $-V_{CE}$ = 20 V.

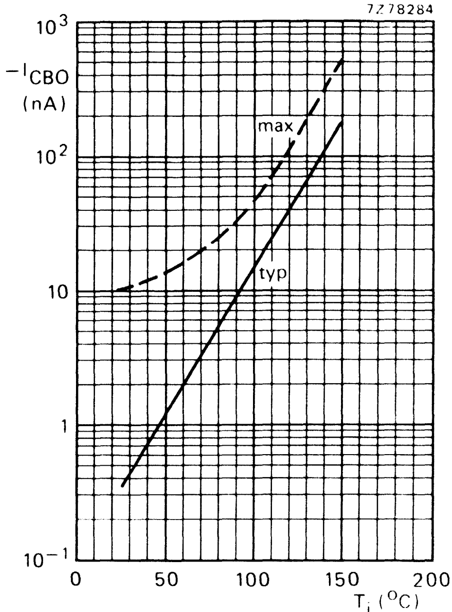


Fig. 7 $-V_{CB}$ = 200 V.

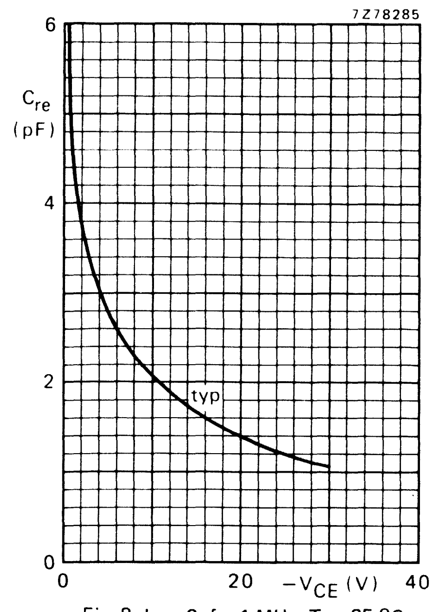


Fig. 8 I_C = 0; f = 1 MHz; T_j = 25 °C.

SILICON N-CHANNEL DUAL GATE MOS-FET

Depletion type field-effect transistor in a plastic SOT-143 microminiature envelope with source and substrate interconnected. This MOS-FET tetrode is intended for use in u.h.f. applications in television tuners. The device is also suitable for use in professional communication equipment.

The device is protected against excessive input voltage surges by integrated back-to-back diodes between gates and source.

QUICK REFERENCE DATA

Drain-source voltage	V_{DS}	max.	20	V
Drain current (peak value)	I_{DM}	max.	30	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transfer admittance at f = 1 kHz I_D = 7 mA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V	$\lvert y_{fs} \rvert$	typ.	12	mA/V
Feedback capacitance at f = 1 MHz I_D = 7 mA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V	C_{rs}	typ.	25	fF
Noise figure at G_S = 2 mA/V I_D = 7 mA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V; f = 800 MHz	F	typ.	2,8	dB

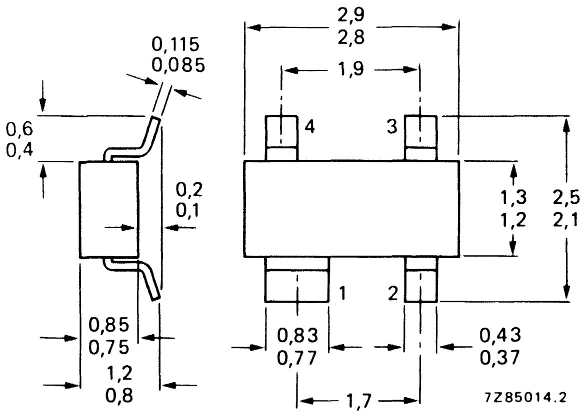
MECHANICAL DATA

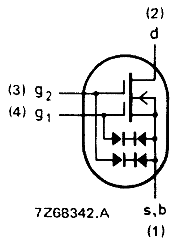
Dimensions in mm

Fig. 1 SOT-143.

Marking code

BF989 = M89





See also *Soldering recommendations* in handbook Microminiature Semiconductors.

RATINGS

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

Drain-source voltage	V_{DS}	max.	20 V
Drain current (d.c. or average)	I_D	max.	20 mA
Drain current (peak value)	I_{DM}	max.	30 mA
Gate 1 - source current	$\pm I_{G1\text{-}S}$	max.	10 mA
Gate 2 - source current	$\pm I_{G2\text{-}S}$	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 RESISTANCE

From junction to ambient in free air*	$R_{th\ j\text{-}a}$	=	460 K/W

STATIC CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Gate cut-off currents			
$\pm V_{G1\text{-}S}$ = 5 V; $V_{G2\text{-}S} = V_{DS} = 0$	$\pm I_{G1\text{-}SS}$	<	50 nA
$\pm V_{G2\text{-}S}$ = 5 V; $V_{G1\text{-}S} = V_{DS} = 0$	$\pm I_{G2\text{-}SS}$	<	50 nA
Drain current			
V_{DS} = 10 V; $V_{G1\text{-}S}$ = 0; + $V_{G2\text{-}S}$ = 4 V; T_j = 25 °C	I_{DSS}		2 to 20 mA
Gate-source breakdown voltages			
$\pm I_{G1\text{-}SS}$ = 10 mA; $V_{G2\text{-}S} = V_{DS} = 0$	$\pm V_{(BR)G1\text{-}SS}$		6 to 20 V
$\pm I_{G2\text{-}SS}$ = 10 mA; $V_{G1\text{-}S} = V_{DS} = 0$	$\pm V_{(BR)G2\text{-}SS}$		6 to 20 V
Gate-source cut-off voltages			
I_D = 20 μA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V	$-V_{(P)G1\text{-}S}$	<	2,7 V
I_D = 20 μA; V_{DS} = 10 V; $V_{G1\text{-}S}$ = 0	$-V_{(P)G2\text{-}S}$	<	2,7 V

DYNAMIC CHARACTERISTICS

Measuring conditions (common source): I_D = 7 mA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V; T_{amb} = 25 °C

Transfer admittance at f = 1 kHz	$\lvert y_{fs} \rvert$	>	9,5 mA/V
		typ.	12 mA/V
Input capacitance at gate 1; f = 1 MHz	$C_{ig1\text{-}s}$	typ.	1,8 pF
Input capacitance at gate 2; f = 1 MHz	$C_{ig2\text{-}s}$	typ.	1,0 pF
Feedback capacitance at f = 1 MHz	C_{rs}	typ.	25 fF
Output capacitance at f = 1 MHz	C_{os}	typ.	0,9 pF
Noise figure at G_S = 2 mA/V			
f = 200 MHz	F	typ.	1,6 dB
f = 800 MHz	F	typ.	2,8 dB

* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0,6 mm.

SILICON N-CHANNEL DUAL GATE MOS-FET

Depletion type field-effect transistor in a plastic microminiature envelope with source and substrate interconnected, intended for u.h.f. applications, such as u.h.f. television tuners and professional communication equipment.

This MOS-FET tetrode is protected against excessive input voltage surges by integrated back-to-back diodes between gates and source.

QUICK REFERENCE DATA

Drain-source voltage	V_{DS}	max.	18	V
Drain current (average)	$I_{D(AV)}$	max.	30	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transfer admittance at f = 1 kHz I_D = 10 mA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V	$\lvert y_{fs} \rvert$	typ.	21	mA/V
Feedback capacitance at f = 1 MHz I_D = 10 mA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V	C_{rs}	typ.	25	fF
Noise figure at optimum source admittance I_D = 10 mA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V; f = 800 MHz	F	typ.	2,8	dB

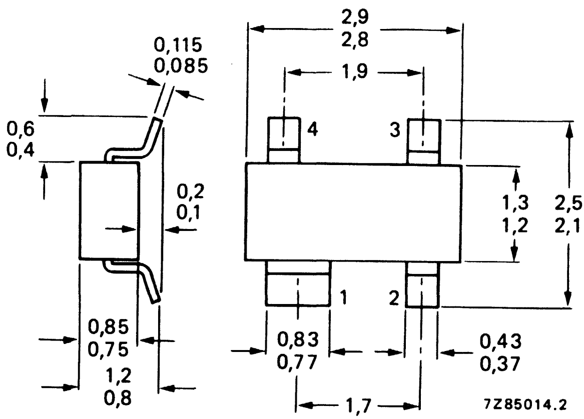
MECHANICAL DATA

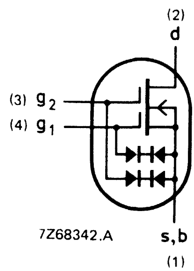
Dimensions in mm

Fig. 1 SOT-143.

Marking code

BF990 = M90





See also *Soldering recommendations.*

RATINGS

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

Drain-source voltage	V_{DS}	max.	18 V
Drain current (average)	$I_{D(AV)}$	max.	30 mA
Gate 1 source current	$\pm I_{G1-S}$	max.	10 mA
Gate 2 source current	$\pm I_{G2-S}$	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 RESISTANCE

From junction to ambient in free air*	$R_{th\,j\text{-}a}$	=	460 K/W

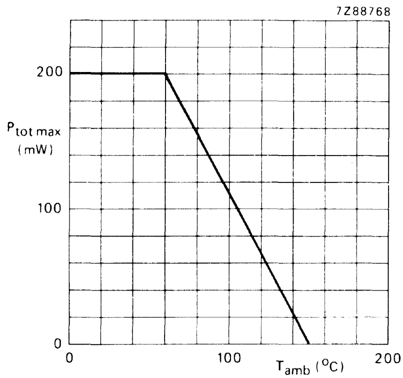


Fig. 2 Power derating curve.

* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

STATIC CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Gate cut-off currents			
gate 1; $\pm V_{G1\text{-}S}$ = 7 V; $V_{G2\text{-}S} = V_{DS} = 0$	$\pm I_{G1\text{-}SS}$	<	25 nA
gate 2; $\pm V_{G2\text{-}S}$ = 7 V; $V_{G1\text{-}S} = V_{DS} = 0$	$\pm I_{G2\text{-}SS}$	<	25 nA
Gate-source breakdown voltages			
gate 1; $\pm I_{G1\text{-}SS}$ = 10 mA; $V_{G2\text{-}S} = V_{DS} = 0$	$\pm V_{(BR)G1\text{-}SS}$	>	8 V
gate 2; $\pm I_{G2\text{-}SS}$ = 10 mA; $V_{G1\text{-}S} = V_{DS} = 0$	$\pm V_{(BR)G2\text{-}SS}$	>	8 V
Gate-source cut-off voltages			
gate 1; I_D = 20 μA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V	$-V_{(P)G1\text{-}S}$	<	1,3 V
gate 2; I_D = 20 μA; V_{DS} = 10 V; $V_{G1\text{-}S}$ = 0	$-V_{(P)G2\text{-}S}$	<	1,1 V

DYNAMIC CHARACTERISTICS

Measuring conditions (common source): I_D = 10 mA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V; T_{amb} = 25 °C

Transfer admittance at f = 1 kHz	$\lvert y_{fs} \rvert$	> typ.	17 mA/V 21 mA/V
Input capacitance at gate 1; f = 1 MHz	$C_{ig1\text{-}s}$	typ.	3 pF
Input capacitance at gate 2; f = 1 MHz	$C_{ig2\text{-}s}$	typ.	1,4 pF
Feedback capacitance at f = 1 MHz	C_{rs}	typ.	25 fF
Output capacitance at f = 1 MHz	C_{os}	typ.	1,2 pF
Noise figure at f = 800 MHz; G_S = 5 mA/V	F	typ.	2,8 dB

SILICON N-CHANNEL DUAL GATE MOS-FET

Depletion type field-effect transistor in a plastic SOT-143 microminiature envelope with source and substrate interconnected. This MOS-FET tetrode is intended for use in v.h.f. applications, such as v.h.f. television tuners and f.m. tuners. The device is also suitable for use in professional communication equipment.

The device is protected against excessive input voltage surges by integrated back-to-back diodes between gates and source.

QUICK REFERENCE DATA

Drain-source voltage	V_{DS}	max.	20	V
Drain current	I_D	max.	20	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transfer admittance at f = 1 kHz I_D = 10 mA; V_{DS} = 10 V; + V_{G2-S} = 4 V	$\|y_{fs}\|$	typ.	14	mA/V
Feedback capacitance at f = 1 MHz I_D = 10 mA; V_{DS} = 10 V; + V_{G2-S} = 4 V	C_{rs}	typ.	20	fF
Noise figure at optimum source admittance I_D = 10 mA; V_{DS} = 10 V; + V_{G2-S} = 4 V; f = 200 MHz	F	typ.	0,7	dB

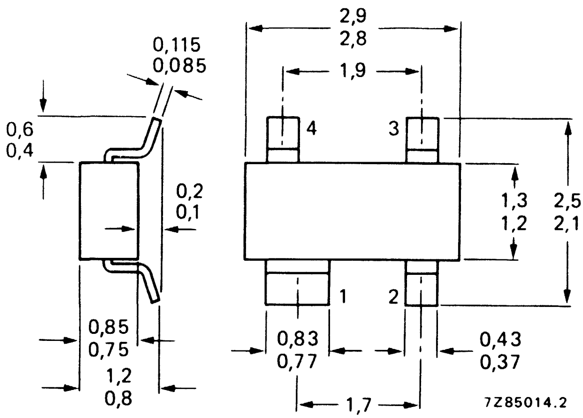
MECHANICAL DATA

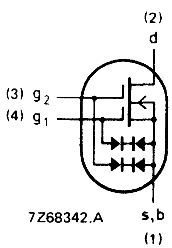
Dimensions in mm

Fig. 1 SOT-143.

Marking code

BF991 = M91





See also *Soldering recommendations* in handbook Microminiature Semiconductors.

RATINGS

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

Drain-source voltage	V_{DS}	max.	20 V
Drain current (d.c. or average)	I_D	max.	20 mA
Drain current (peak value)	I_{DM}	max.	30 mA
Gate 1 - source current	$\pm I_{G1\text{-}S}$	max.	10 mA
Gate 2 - source current	$\pm I_{G2\text{-}S}$	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 RESISTANCE

From junction to ambient in free air*	$R_{th\ j\text{-}a}$	=	460 K/W

STATIC CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Gate cut-off currents			
$\pm V_{G1\text{-}S}$ = 5 V; $V_{G2\text{-}S} = V_{DS}$ = 0	$\pm I_{G1\text{-}SS}$	<	50 nA
$\pm V_{G2\text{-}S}$ = 5 V; $V_{G1\text{-}S} = V_{DS}$ = 0	$\pm I_{G2\text{-}SS}$	<	50 nA
Drain current			
V_{DS} = 10 V; $V_{G1\text{-}S}$ = 0; + $V_{G2\text{-}S}$ = 4 V; T_j = 25 °C	I_{DSS}		4 to 25 mA
Gate-source breakdown voltages			
$\pm I_{G1\text{-}SS}$ = 10 mA; $V_{G2\text{-}S} = V_{DS}$ = 0	$\pm V_{(BR)G1\text{-}SS}$	>	6 V
$\pm I_{G2\text{-}SS}$ = 10 mA; $V_{G1\text{-}S} = V_{DS}$ = 0	$\pm V_{(BR)G2\text{-}SS}$	>	6 V
Gate-source cut-off voltages			
I_D = 20 μA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V	$-V_{(P)G1\text{-}S}$	<	2,5 V
I_D = 20 μA; V_{DS} = 10 V; $V_{G1\text{-}S}$ = 0	$-V_{(P)G2\text{-}S}$	<	2,5 V

DYNAMIC CHARACTERISTICS

Measuring conditions (common source): I_D = 10 mA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V; T_{amb} = 25 °C

Transfer admittance at f = 1 kHz	$\lvert y_{fs} \rvert$	>	10 mA/V
		typ.	14 mA/V
Input capacitance at gate 1; f = 1 MHz	$C_{ig1\text{-}s}$	typ.	2,1 pF
Input capacitance at gate 2; f = 1 MHz	$C_{ig2\text{-}s}$	typ.	1,0 pF
Feedback capacitance at f = 1 MHz	C_{rs}	typ.	20 fF
Output capacitance at f = 1 MHz	C_{os}	typ.	1,1 pF
Noise figure			
f = 100 MHz; G_S = 1 mA/V	F	typ.	0,7 dB
		<	1,7 dB
f = 200 MHz; G_S = 2 mA/V	F	typ.	1,0 dB
		<	2,0 dB
Transducer gain **			
f = 100 MHz; G_S = 1 mA/V; G_L = 0,5 mA/V	G_{tr}	typ.	29 dB
f = 200 MHz; G_S = 2 mA/V; G_L = 0,5 mA/V	G_{tr}	typ.	26 dB

* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0,6 mm.

** Crystal mounted in a SOT-103 envelope.

SILICON N-CHANNEL DUAL GATE MOS-FET

Depletion type field-effect transistor in a plastic SOT-143 microminiature envelope with source and substrate interconnected. This MOS-FET tetrode is intended for use in v.h.f. applications, such as v.h.f. television tuners, FM tuners with a 12 volt supply voltage. The device is also suitable for use in professional communication equipment.

The device is protected against excessive input voltage surges by integrated back-to-back diodes between gates and source.

QUICK REFERENCE DATA

Drain-source voltage	V_{DS}	max.	20	V
Drain current	I_D	max.	40	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transfer admittance at f = 1 kHz I_D = 15 mA; V_{DS} = 10 V; + V_{G2-S} = 4 V	$\|y_{fs}\|$	typ.	25	mA/V
Feedback capacitance at f = 1 MHz I_D = 15 mA; V_{DS} = 10 V; + V_{G2-S} = 4 V	C_{rs}	typ.	30	fF
Noise figure at G_S = 2 mA/V I_D = 15 mA; V_{DS} = 10 V; + V_{G2-S} = 4 V; f = 200 MHz	F	typ.	1,2	dB

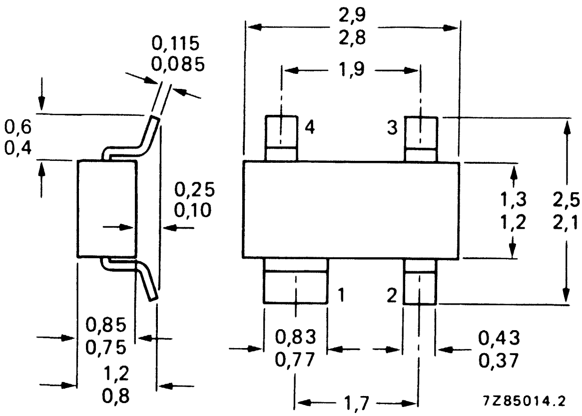
MECHANICAL DATA

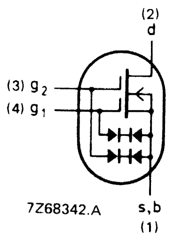
Dimensions in mm

Fig. 1 SOT-143.

Marking code

BF992 = M8





See also *Soldering recommendations* in handbook Microminiature Semiconductors.

RATINGS

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

Drain-source voltage	V_{DS}	max.	20	V
Drain current (d.c. or average)	I_D	max.	40	mA
Gate 1 - source current	$\pm I_{G1\text{-}S}$	max.	10	mA
Gate 2 - source current	$\pm I_{G2\text{-}S}$	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 RESISTANCE

From junction to ambient in free air*	$R_{th\ j\text{-}a}$	=	460	K/W

STATIC CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Gate cut-off currents				
$\pm V_{G1\text{-}S}$ = 7 V; $V_{G2\text{-}S} = V_{DS}$ = 0	$\pm I_{G1\text{-}SS}$	<	25	nA
$\pm V_{G2\text{-}S}$ = 7 V; $V_{G1\text{-}S} = V_{DS}$ = 0	$\pm I_{G2\text{-}SS}$	<	25	nA
Gate-source breakdown voltages				
$\pm I_{G1\text{-}SS}$ = 10 mA; $V_{G2\text{-}S} = V_{DS}$ = 0	$\pm V_{(BR)G1\text{-}SS}$	>	8	V
$\pm I_{G2\text{-}SS}$ = 10 mA; $V_{G1\text{-}S} = V_{DS}$ = 0	$\pm V_{(BR)G2\text{-}SS}$	>	8	V
Gate-source cut-off voltages				
I_D = 20 μA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V	$-V_{(P)G1\text{-}S}$		0,2 to 1,3	V
I_D = 20 μA; V_{DS} = 10 V; $V_{G1\text{-}S}$ = 0	$-V_{(P)G2\text{-}S}$		0,2 to 1,1	V

DYNAMIC CHARACTERISTICS

Measuring conditions (common source): I_D = 15 mA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V; T_{amb} = 25 °C

Transfer admittance at f = 1 kHz	$\lvert y_{fs} \rvert$	>	20	mA/V
		typ.	25	mA/V
Input capacitance at gate 1; f = 1 MHz	$C_{ig1\text{-}s}$	typ.	4	pF
Input capacitance at gate 2; f = 1 MHz	$C_{ig2\text{-}s}$	typ.	1,7	pF
Feedback capacitance at f = 1 MHz	C_{rs}	typ.	30	fF
		<	40	fF
Output capacitance at f = 1 MHz	C_{os}	typ.	2	pF
Noise figure at f = 200 MHz; G_S = 2 mA/V	F	typ.	1,2	dB

* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0,6 mm.

SILICON N-CHANNEL DUAL GATE MOS-FET

Depletion type field-effect transistor in a plastic microminiature envelope with source and substrate interconnected, intended for u.h.f. and v.h.f. applications, such as u.h.f./v.h.f. television tuners and professional communication equipment.

This MOS-FET tetrode is protected against excessive input voltage surges by integrated back-to-back diodes between gates and source.

QUICK REFERENCE DATA

Drain-source voltage	V_{DS}	max.	20	V
Drain current (average)	$I_{D(AV)}$	max.	30	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transfer admittance at f = 1 kHz I_D = 10 mA; V_{DS} = 15 V; + $V_{G2\text{-}S}$ = 4 V	$\lvert y_{fs} \rvert$	typ.	17	mA/V
Feedback capacitance at f = 1 MHz I_D = 10 mA; V_{DS} = 15 V; + $V_{G2\text{-}S}$ = 4 V	C_{rs}	typ.	25	fF
Noise figure at optimum source admittance I_D = 10 mA; V_{DS} = 15 V; + $V_{G2\text{-}S}$ = 4 V; f = 200 MHz	F	typ.	1,5	dB

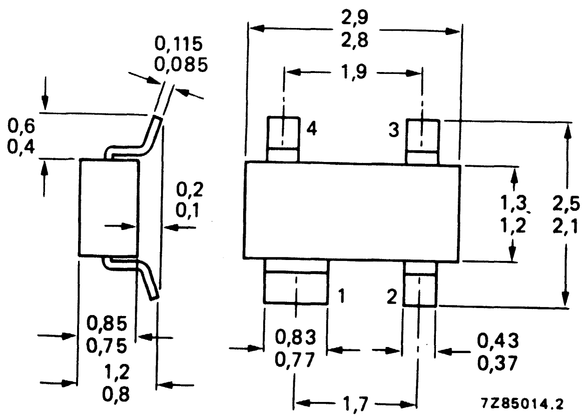
MECHANICAL DATA

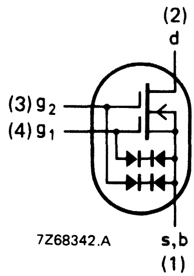
Dimensions in mm

Fig. 1 SOT-143.

Marking code

BF994 = M94





See also *Soldering recommendations.*

RATINGS

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

Drain-source voltage	V_{DS}	max.	20	V
Drain current (average)	$I_{D(AV)}$	max.	30	mA
Gate 1 source current	$\pm I_{G1-S}$	max.	10	mA
Gate 2 source current	$\pm I_{G2-S}$	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 RESISTANCE

From junction to ambient in free air*	$R_{th\ j-a}$	=	460	K/W

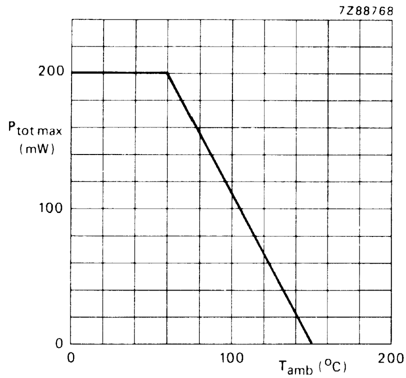


Fig. 2 Power derating curve.

* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0,6 mm.

STATIC CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Gate cut-off currents			
gate 1; $\pm V_{G1\text{-}S}$ = 5 V; $V_{G2\text{-}S} = V_{DS}$ = 0	$\pm I_{G1\text{-}SS}$	<	50 nA
gate 2; $\pm V_{G2\text{-}S}$ = 5 V; $V_{G1\text{-}S} = V_{DS}$ = 0	$\pm I_{G2\text{-}SS}$	<	50 nA
Gate-source breakdown voltages			
gate 1; $\pm I_{G1\text{-}SS}$ = 10 mA; $V_{G2\text{-}S} = V_{DS}$ = 0	$\pm V_{(BR)G1\text{-}SS}$		6 to 20 V
gate 2; $\pm I_{G2\text{-}SS}$ = 10 mA; $V_{G1\text{-}S} = V_{DS}$ = 0	$\pm V_{(BR)G2\text{-}SS}$		6 to 20 V
Gate-source cut-off voltages			
gate 1; I_D = 20 μA; V_{DS} = 15 V; + $V_{G2\text{-}S}$ = 4 V	$-V_{(P)G1\text{-}S}$	<	2,5 V
gate 2; I_D = 20 μA; V_{DS} = 15 V; $V_{G1\text{-}S}$ = 0	$-V_{(P)G2\text{-}S}$	<	2,0 V
Drain-source cut-off voltage V_{DS} = 15 V; $V_{G2\text{-}S}$ = 4 V	I_{DSS}		2 to 20 mA

DYNAMIC CHARACTERISTCS

Measuring conditions (common source): I_D = 10 mA; V_{DS} = 15 V; + $V_{G2\text{-}S}$ = 4 V; T_{amb} = 25 °C

Transfer admittance at f = 1 kHz	$\|y_{fs}\|$	>	15 mA/V
		typ.	17 mA/V
Input capacitance at gate 1; f = 1 MHz	$C_{ig1\text{-}s}$	typ.	2,5 pF
Input capacitance at gate 2; f = 1 MHz	$C_{ig2\text{-}s}$	typ.	1,2 pF
Feedback capacitance at f = 1 MHz	C_{rs}	typ.	25 fF
Output capacitance at f = 1 MHz	C_{os}	typ.	1,0 pF
Noise figure at f = 200 MHz; G_S = 2 mA/V	F	typ.	1,5 dB
		<	2,8 dB
Power gain at G_S = 2 mA/V, G_L = 0,5 mA/V, f = 200 MHz	G_p	typ.	25 dB

DEVELOPMENT SAMPLE DATA

SILICON N-CHANNEL DUAL GATE MOS-FET

Depletion type field-effect transistor in a plastic microminiature envelope, with source and substrate interconnected, intended for u.h.f. applications, such as television tuners and professional communication equipment.

This MOS-FET tetrode is protected against excessive input voltage surges by integrated back-to-back diodes between gates and source.

QUICK REFERENCE DATA

Drain-source voltage	V_{DS}	max.	20	V
Drain current (average)	$I_{D(AV)}$	max.	30	mA
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	150	°C
Transfer admittance at f = 1 kHz				
I_D = 10 mA; V_{DS} = 15 V; + $V_{G2\text{-}S}$ = 4 V	$\|y_{fs}\|$	typ.	17	mA/V
Feedback capacitance at f = 1 MHz				
I_D = 10 mA; V_{DS} = 15 V; + $V_{G2\text{-}S}$ = 4 V	C_{rs}	typ.	25	fF
Noise figure at optimum source admittance				
I_D = 10 mA; V_{DS} = 10 V; + $V_{G2\text{-}S}$ = 4 V; f = 800 MHz	F	typ.	2,8	dB
I_D = 10 mA; V_{DS} = 15 V; + $V_{G2\text{-}S}$ = 4 V; f = 200 MHz	F	typ.	1,5	dB

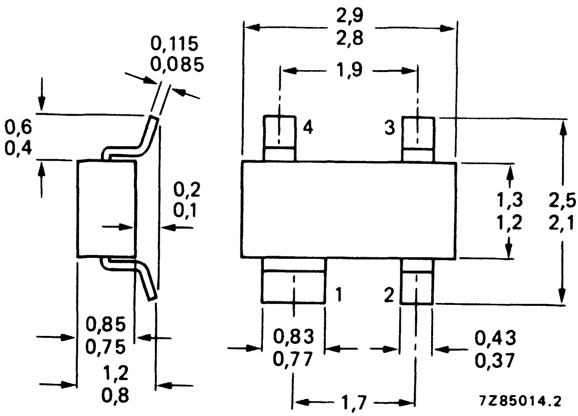
MECHANICAL DATA

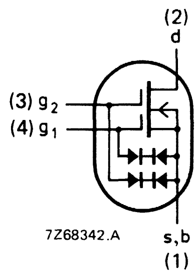
Dimensions in mm

Fig. 1 SOT-143.

Marking code

BF996 = M96





See also *Soldering recommendations.*

RATINGS

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

Drain-source voltage	V_{DS}	max.	20 V
Drain current (average)	$I_{D(AV)}$	max.	30 mA
Gate 1 source current	$\pm I_{G1\text{-}S}$	max.	10 mA
Gate 2 source current	$\pm I_{G2\text{-}S}$	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 RESISTANCE

From junction to ambient in free air*	$R_{th\ j\text{-}a}$	=	460 K/W

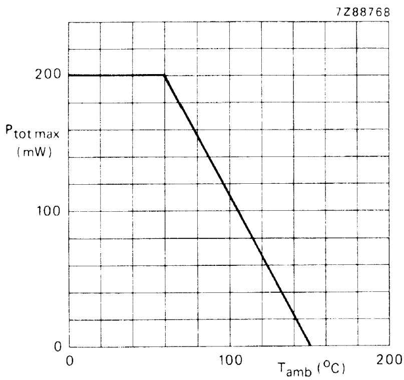


Fig. 2 Power derating curve.

* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0,6 mm.

STATIC CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Gate cut-off currents			
gate 1; $\pm V_{G1-S}$ = 5 V; $V_{G2-S} = V_{DS}$ = 0	$\pm I_{G1-SS}$	<	50 nA
gate 2; $\pm V_{G2-S}$ = 5 V; $V_{G1-S} = V_{DS}$ = 0	$\pm I_{G2-SS}$	<	50 nA
Gate-source breakdown voltages			
gate 1; $\pm I_{G1-SS}$ = 10 mA; $V_{G2-S} = V_{DS}$ = 0	$\pm V_{(BR)G1-SS}$		6 to 20 V
gate 2; $\pm I_{G2-SS}$ = 10 mA; $V_{G1-S} = V_{DS}$ = 0	$\pm V_{(BR)G2-SS}$		6 to 20 V
Gate-source cut-off voltages			
gate 1; I_D = 20 μA; V_{DS} = 15 V; + V_{G2-S} = 4 V	$-V_{(P)G1-S}$	<	2,5 V
gate 2; I_D = 20 μA; V_{DS} = 15 V; V_{G1-S} = 0	$-V_{(P)G2-S}$	<	2,0 V
Drain-source cut-off voltage V_{DS} = 15 V; V_{G2-S} = 4 V	I_{DSS}		2 to 20 mA

DYNAMIC CHARACTERISTICS

Measuring conditions (common source): I_D = 10 mA; V_{DS} = 15 V; + V_{G2-S} = 4 V; T_{amb} = 25 °C

Transfer admittance at f = 1 kHz	$\lvert y_{fs} \rvert$	>	15 mA/V
		typ.	17 mA/V
Input capacitance at gate 1; f = 1 MHz	C_{ig1-s}	typ.	2,2 pF
Input capacitance at gate 2; f = 1 MHz	C_{ig2-s}	typ.	1,1 pF
Feedback capacitance at f = 1 MHz	C_{rs}	typ.	25 fF
Output capacitance at f = 1 MHz	C_{os}	typ.	0,8 pF
Noise figure			
at G_S = 2 mA/V, f = 200 MHz	F	typ.	1,5 dB
at G_S = 2 mA/V, f = 800 MHz	F	typ.	2,8 dB
		<	3,9 dB
Power gain			
G_S = 2 mA/V, G_L = 0,5 mA/V, f = 200 MHz	G_p	typ.	25 dB
G_S = 2 mA/V, G_L = 1,0 mA/V, f = 800 MHz	G_p	typ.	18 dB

DEVELOPMENT SAMPLE DATA

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.

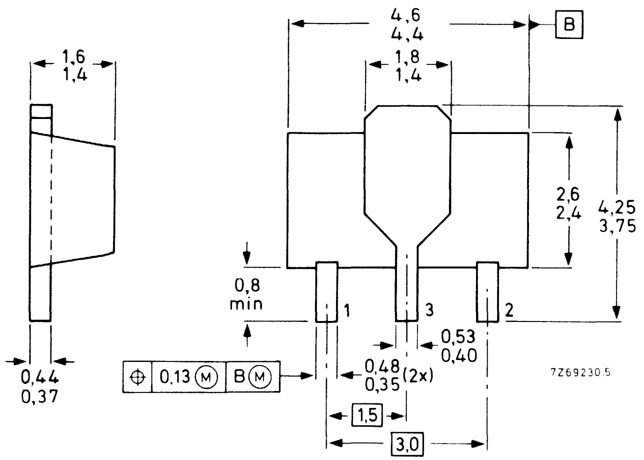
QUICK REFERENCE DATA

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

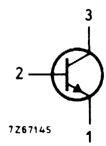
Dimensions in mm

Fig. 1 SOT-89.



Mark

BFQ17



See also *Soldering recommendations*.

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

Voltages

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	40	V	
Collector-emitter voltage ($R_{BE} \leq 50\ \Omega$; peak value)	V_{CERM}	max.	40	V	1)
Collector-emitter voltage (open base)	V_{CEO}	max.	25	V	1)
Emitter-base voltage (open collector)	V_{EBO}	max.	2	V	

Currents

Collector current (d.c.)	I_C	max.	150	mA
Collector current (peak value; f > 1 MHz)	I_{CM}	max.	300	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a ceramic substrate area = 2,5 cm^2; 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 cm^2; thickness = 0,7 mm	$R_{th\,j-a}$	=	125	°C/W

1) I_C = 10 mA.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

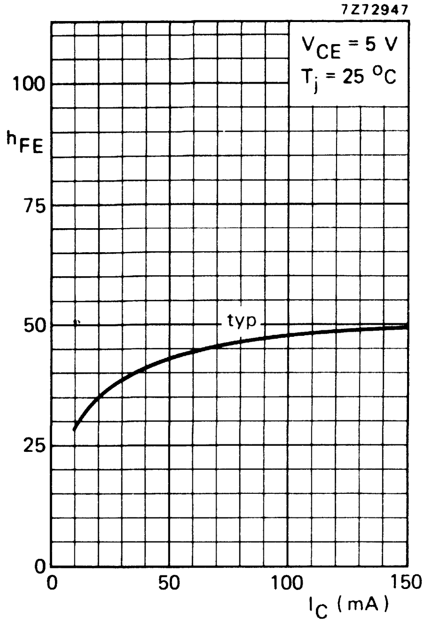
Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	<	20	μA
Saturation voltage				
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	<	0,5	V
D.C. current gain				
$I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
$I_C = 150$ mA; $V_{CE} = 5$ V	h_{FE}	>	25	
Transition frequency at f = 500 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; $T_{amb} = 25$ °C	C_{re}	typ.	1,9	pF

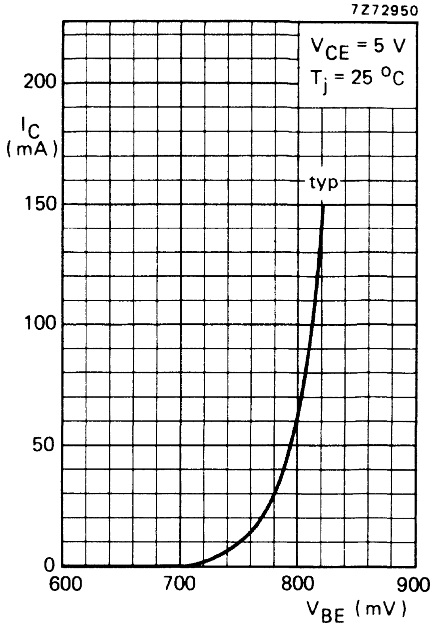
Max. unilateral power gain (s_{re} assumed to be zero)

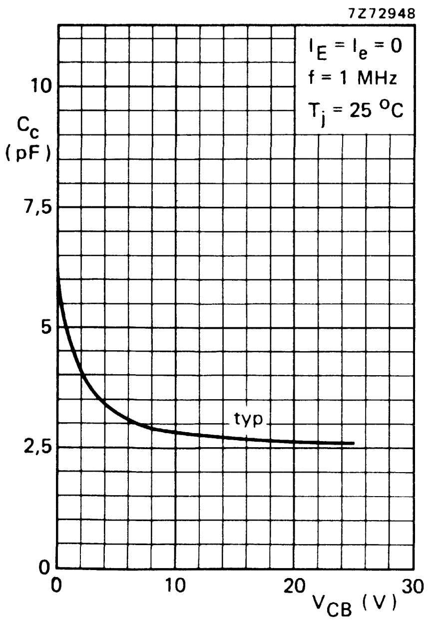
$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{fe}|^2}{(1 - |s_{ie}|^2)(1 - |s_{oe}|^2)}$$

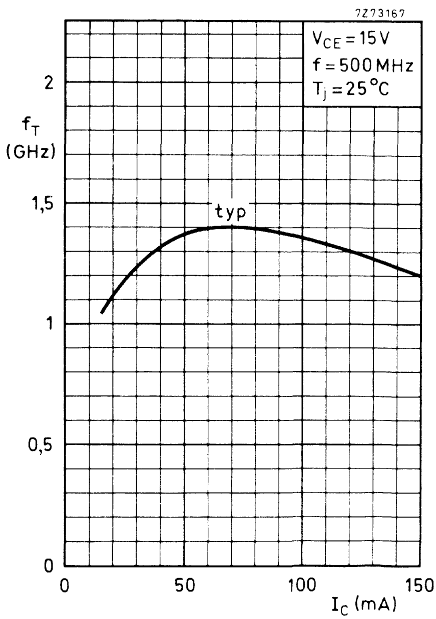
$I_C = 60$ mA; $V_{CE} = 15$ V; $T_{amb} = 25$ °C;				
f = 200 MHz	G_{UM}	typ.	16	dB
f = 800 MHz	G_{UM}	typ.	6,5	dB

[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.

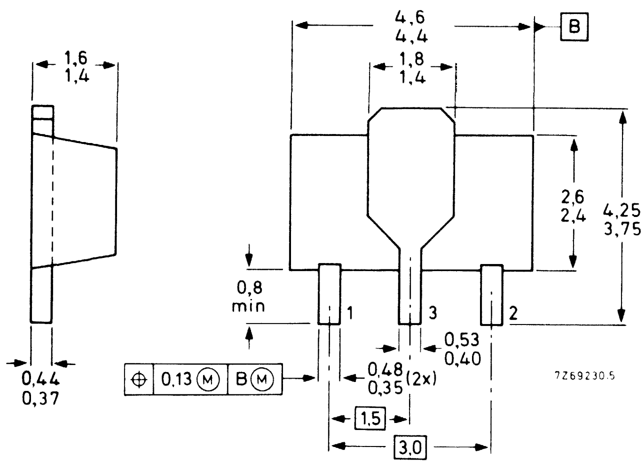
QUICK REFERENCE DATA

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

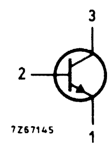
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-89.



Mark
BFQ18A



See also *Soldering recommendations.*

RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	2	V
Collector current (d.c.)	I_C	max.	150	mA
Total power dissipation up to T_{amb} = 25 °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

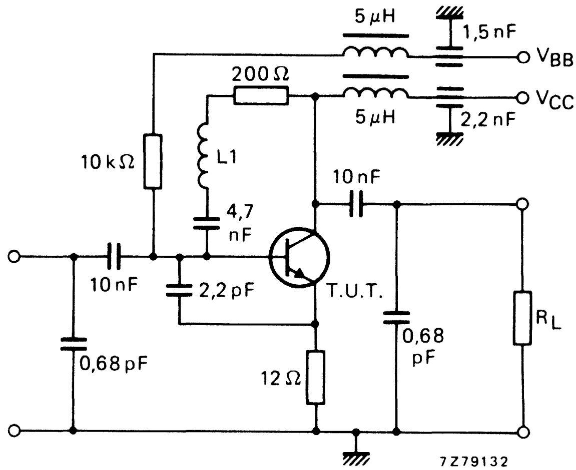


Fig. 2 MATV-test circuit (40–860 MHz).

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.

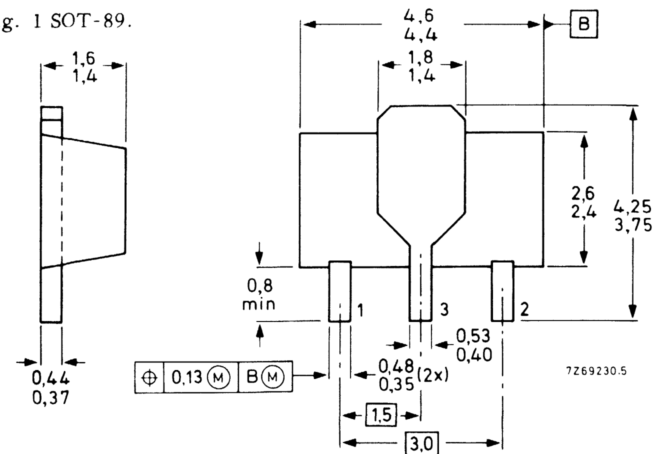
QUICK REFERENCE DATA

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

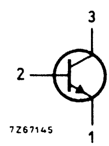
Dimensions in mm

Fig. 1 SOT-89.



Mark

BFQ19



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

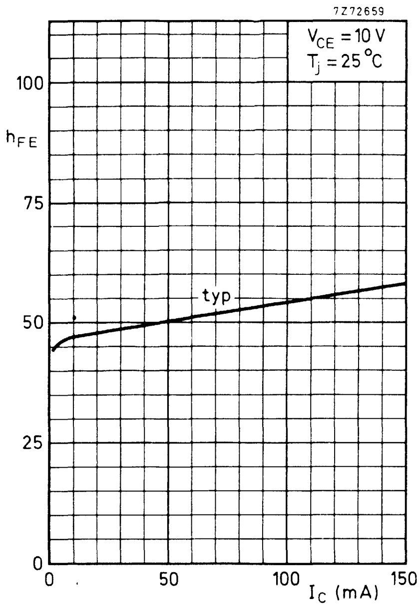
Collector cut-off current				
I_E = 0: V_{CB} = 10 V	I_{CBO}	<	100	nA
D.C. current gain [1]				
I_C = 50 mA: V_{CE} = 10 V	h_{FE}	>	25	
		typ.	50	
I_C = 75 mA: V_{CE} = 10 V	h_{FE}	>	25	
		typ.	52	
Transition frequency at f = 500 MHz [1]				
I_C = 50 mA: V_{CE} = 10 V	f_T	>	4,0	GHz
		typ.	5,0	GHz
I_C = 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

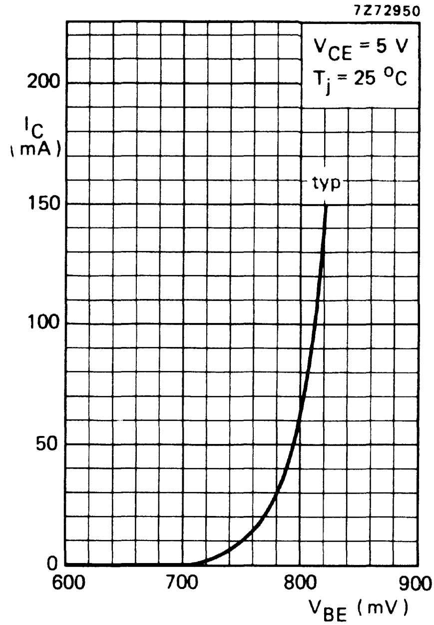
Max. unilateral power gain (s_{re} assumed to be zero)

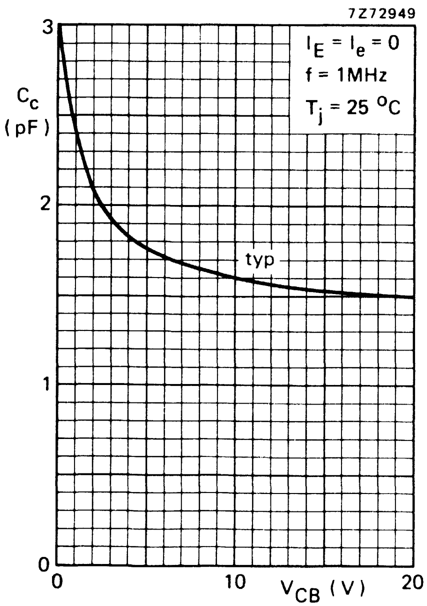
$$G_{UM}\ (\text{in dB}) = 10 \log \frac{|s_{fe}|^2}{(1-|s_{ie}|^2)(1-|s_{oe}|^2)}$$

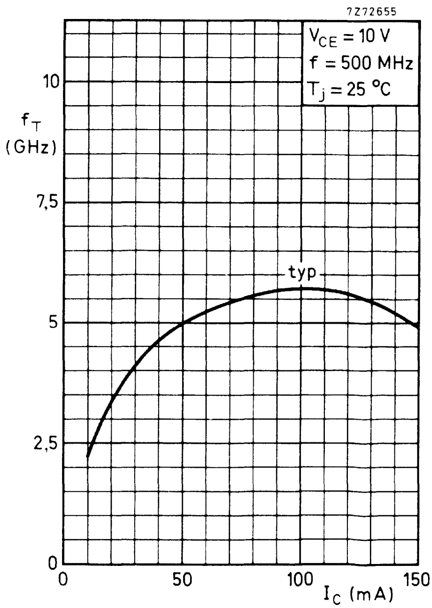
I_C = 50 mA; V_{CE} = 10 V; T_{amb} = 25 °C:				
f = 200 MHz	G_{UM}	typ.	18,5	dB
f = 500 MHz	G_{UM}	typ.	11,5	dB
f = 800 MHz	G_{UM}	typ.	7,5	dB

[1] Measured under pulse conditions.


7Z72659
V_{CE} = 10 V
T_j = 25 °C
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)


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


7Z72655
V_{CE} = 10 V
f = 500 MHz
T_j = 25 °C
f_T
(GHz)
10
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

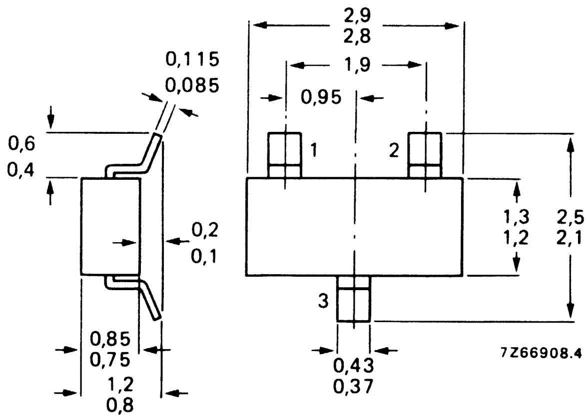
			BFR30	BFR31	
Drain-source voltage	$\pm V_{DS}$	max.	25		V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25		V
Total power dissipation up to T_{amb} = 65 °C	P_{tot}	max.	250		mW
Drain current V_{DS} = 10 V; V_{GS} = 0	I_{DSS}	>	4	1	mA
		<	10	5	mA
Transfer admittance (common source) I_D = 1 mA; V_{DS}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

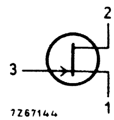
MECHANICAL DATA

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	$R_{th\ t\text{-}s}$	=	280	K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	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 10	1 5	mA mA
Gate-source voltage I_D = 1 mA; V_{DS} = 10 V	$-V_{GS}$	> <	0,7 3,0	0 1,3	V 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	$\lvert y_{fs}\rvert$	> <	1,0 4,0	1,5 4,5	mA/V mA/V
I_D = 200 μA; V_{DS} = 10 V	$\lvert y_{fs}\rvert$	>	0,5	0,75	mA/V
Output admittance at f = 1 kHz I_D = 1 mA; V_{DS} = 10 V	$\lvert y_{os}\rvert$	<	40	25	μA/V
I_D = 200 μA; V_{DS} = 10 V	$\lvert y_{os}\rvert$	<	20	15	μA/V

* See *Thermal characteristics* in chapter GENERAL.
→ ** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 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

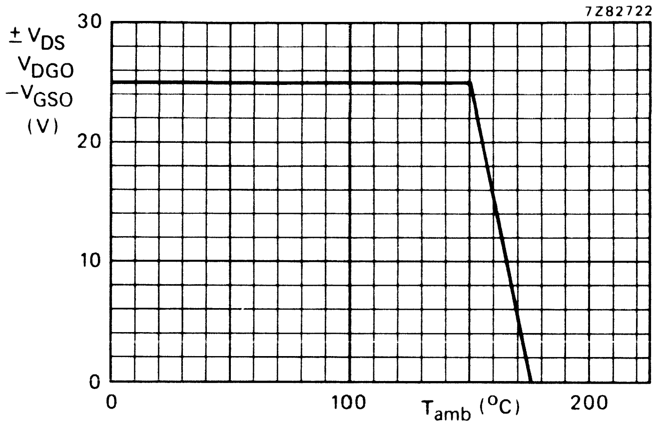


Fig. 2 Voltage derating curve.

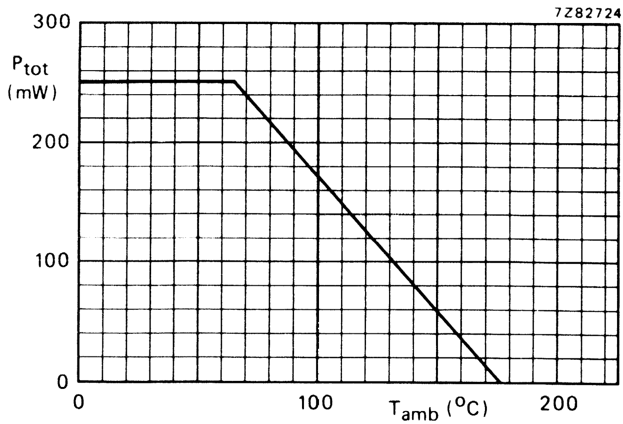


Fig. 3 Power derating curve.

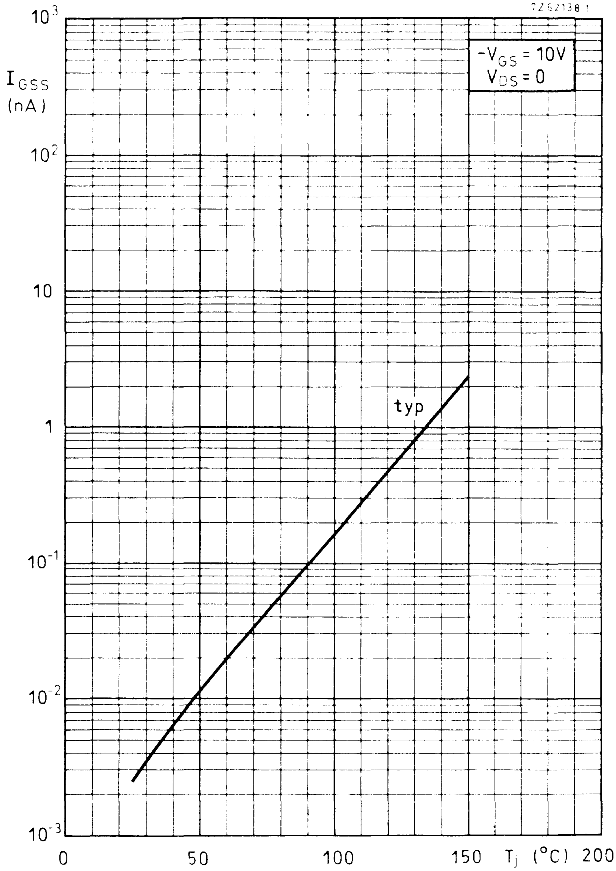

7Z62138.1
10^3
I_{GSS} (nA)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
$-V_{GS} = 10V$
$V_{DS} = 0$
typ
0
50
100
150
T_j (°C)
200

Fig. 4.

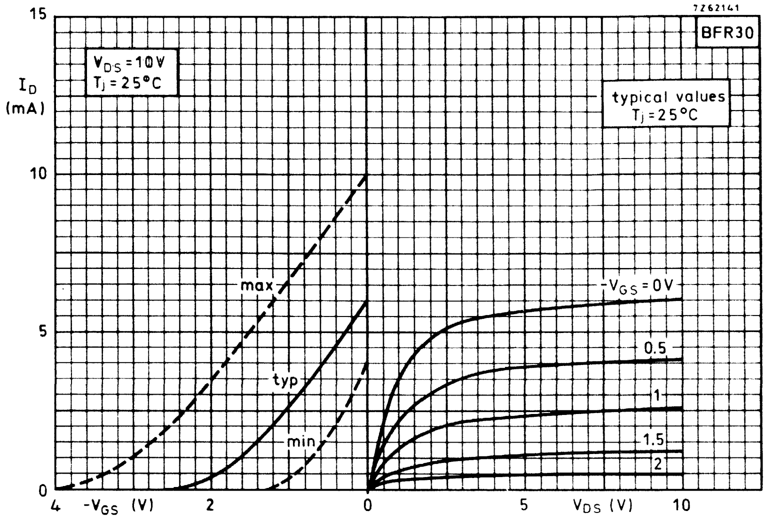

7Z62141
BFR30
V_{DS} = 10 V
T_j = 25 °C
I_D (mA)
typical values
T_j = 25 °C
max
typ
min
$-V_{GS}$ = 0 V
0.5
1
1.5
2
15
10
5
0
4
$-V_{GS}$ (V)
2
0
5
V_{DS} (V)
10

Fig. 5.

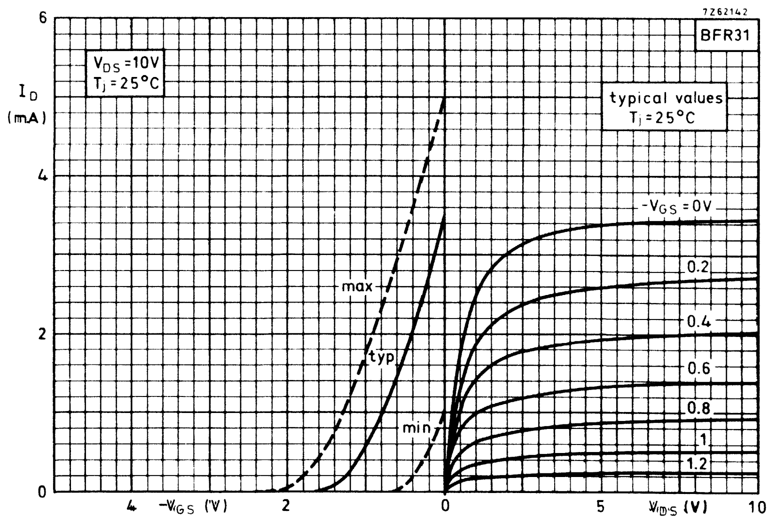

7Z62142
BFR31
V_{DS} = 10 V
T_j = 25 °C
I_D (mA)
typical values
T_j = 25 °C
max
typ
min
$-V_{GS}$ = 0 V
0.2
0.4
0.6
0.8
1
1.2
6
4
2
0
4
$-V_{GS}$ (V)
2
0
5
V_{DS} (V)
10

Fig. 6.

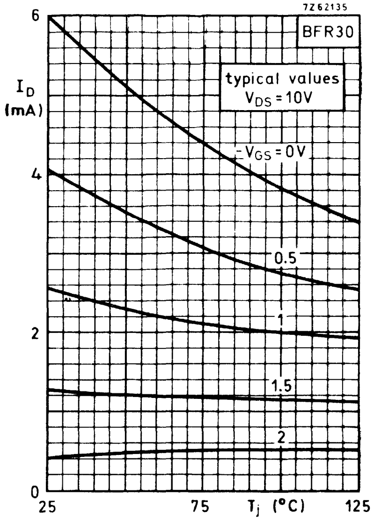


Fig. 7.

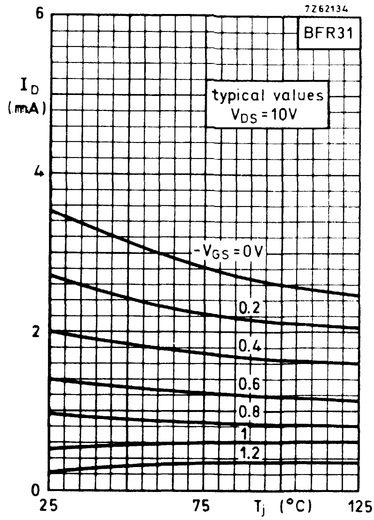


Fig. 8.

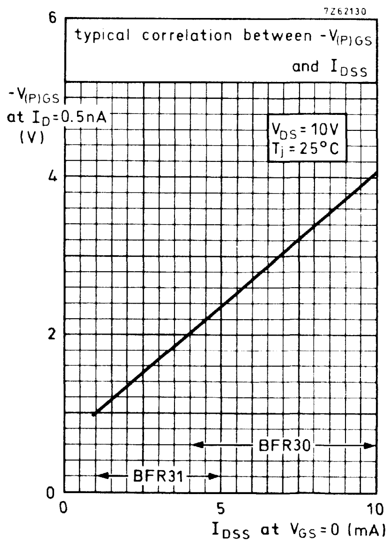


Fig. 9.

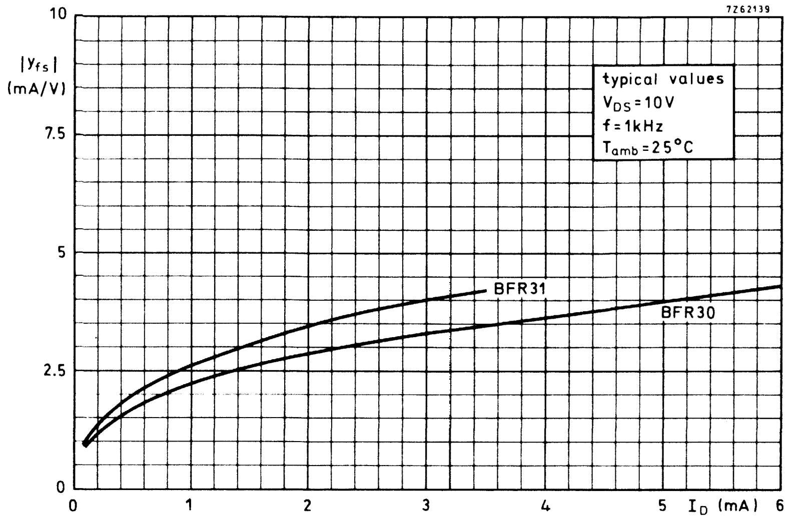

7Z62139
10
|yfs|
(mA/V)
7.5
5
2.5
0
0
1
2
3
4
5
ID (mA)
6
typical values
VDS = 10V
f = 1kHz
Tamb = 25°C
BFR31
BFR30

Fig. 10.

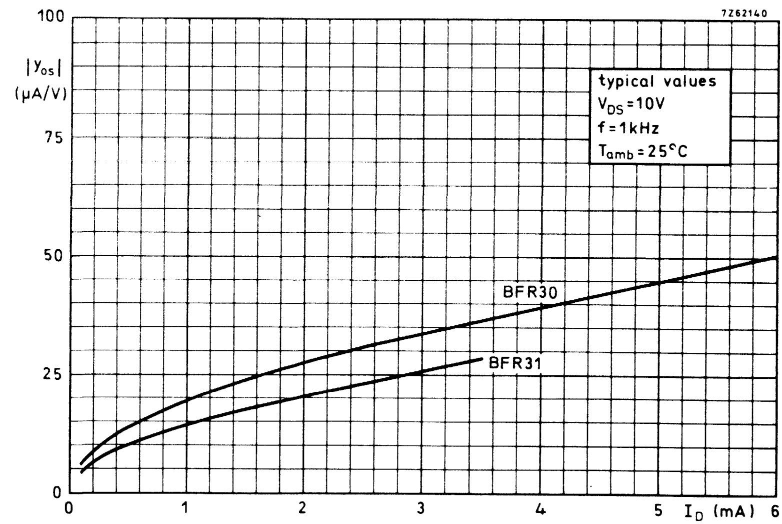

7Z62140
100
|yos|
(μA/V)
75
50
25
0
0
1
2
3
4
5
ID (mA)
6
typical values
VDS = 10V
f = 1kHz
Tamb = 25°C
BFR30
BFR31

Fig. 11.

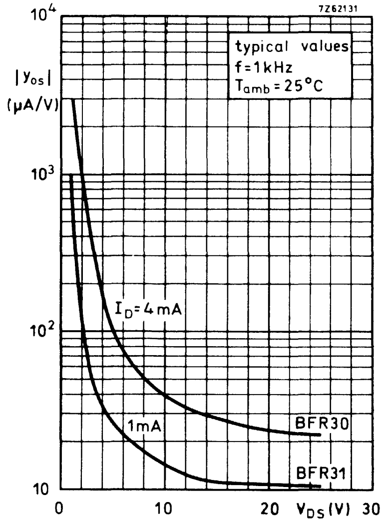


Fig. 12.

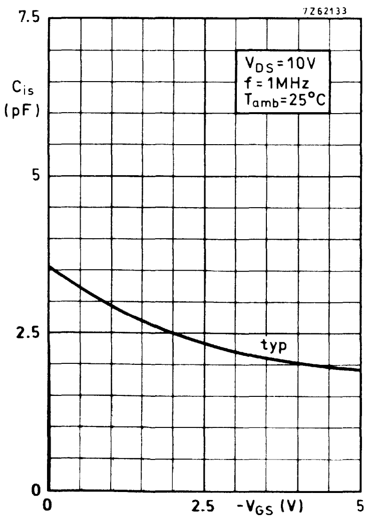


Fig. 13.

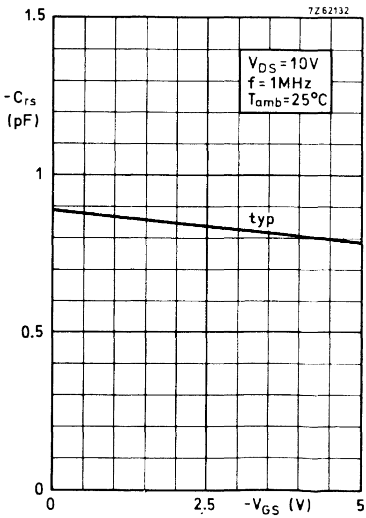


Fig. 14.

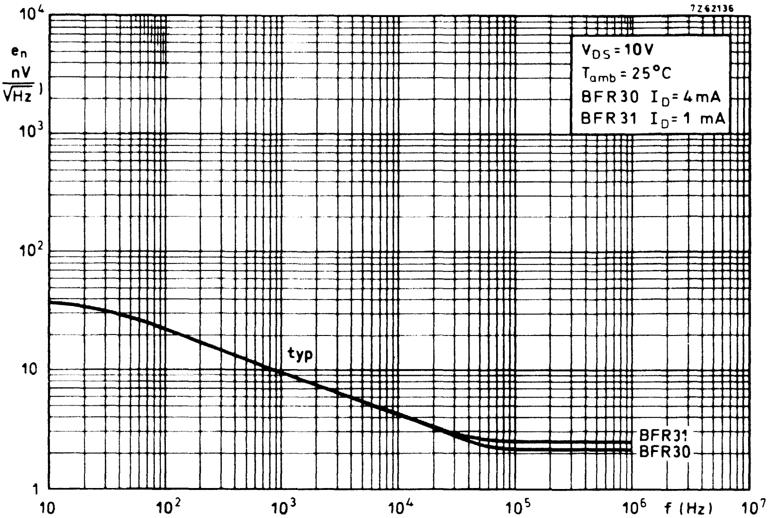

7Z62136
e_n
$\frac{nV}{\sqrt{Hz}}$
10^4
10^3
10^2
10
1
V_{DS} = 10 V
T_{amb} = 25 °C
BFR30 I_D = 4 mA
BFR31 I_D = 1 mA
typ
BFR31
BFR30
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7

Fig. 15.

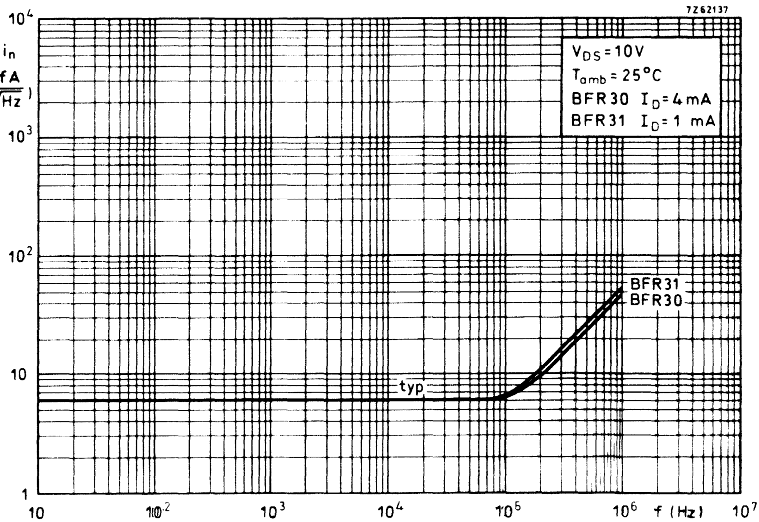

7Z62137
i_n
$\frac{fA}{\sqrt{Hz}}$
10^4
10^3
10^2
10
1
V_{DS} = 10 V
T_{amb} = 25 °C
BFR30 I_D = 4 mA
BFR31 I_D = 1 mA
typ
BFR31
BFR30
10
10^2
10^3
10^4
10^5
10^6
f (Hz)
10^7

Fig. 16.

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.

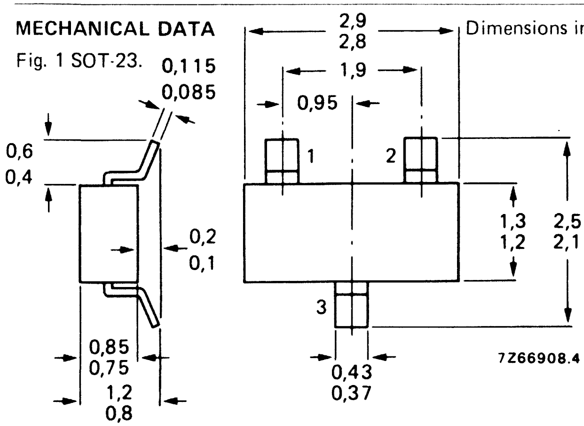
QUICK REFERENCE DATA

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.

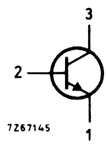
Dimensions in mm



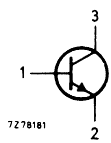
See also *Soldering recommendations.*

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

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	$R_{th\ t\text{-}s}$	=	280	K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	K/W

CHARACTERISTICS

T_j = 25 ^oC 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; $T_{amb} = 25$ ^oC	$-C_{re}$	typ.	0,9	pF

▲ Measured under pulse conditions.
* See *Thermal characteristics* in chapter GENERAL.
→ ** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 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

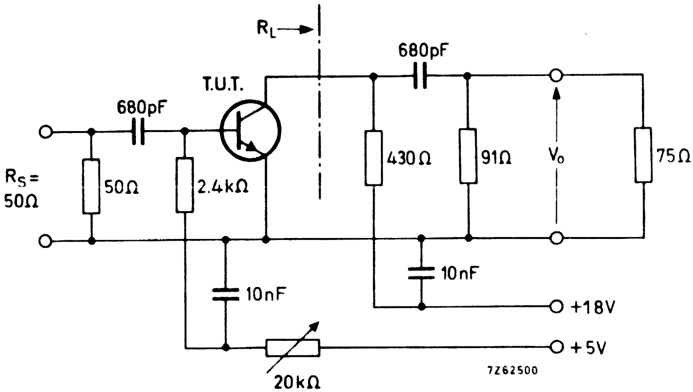


Fig. 2 Test circuit.

▲ Crystal mounted in a BFW30 envelope.

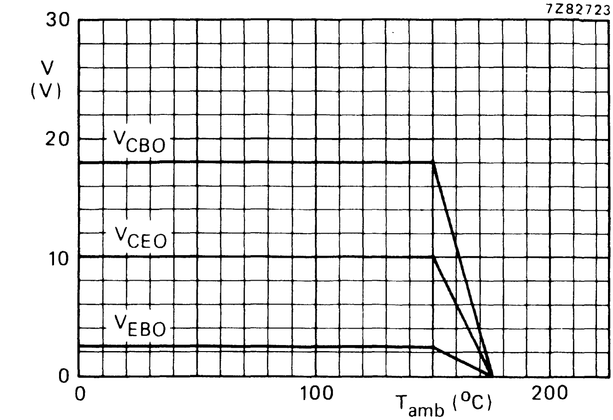


Fig. 3 Voltage derating curves.

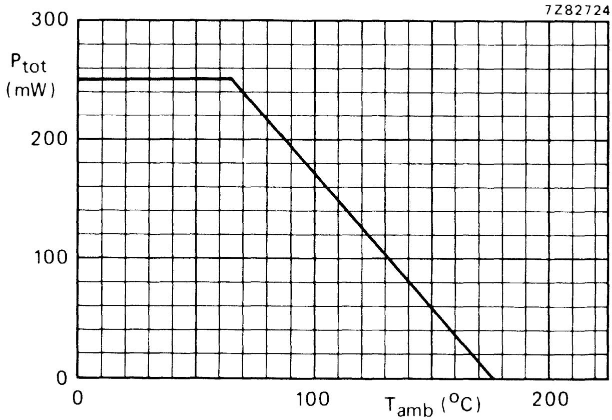
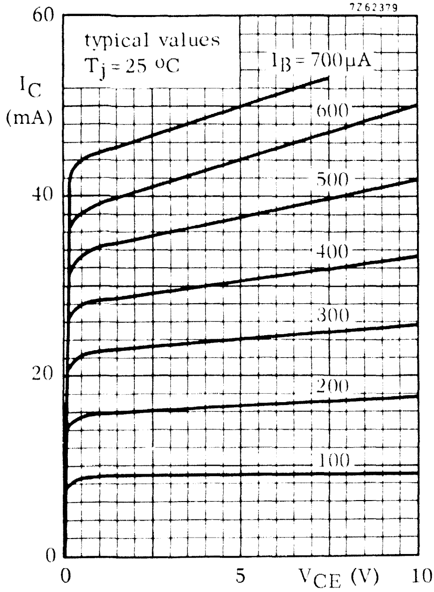
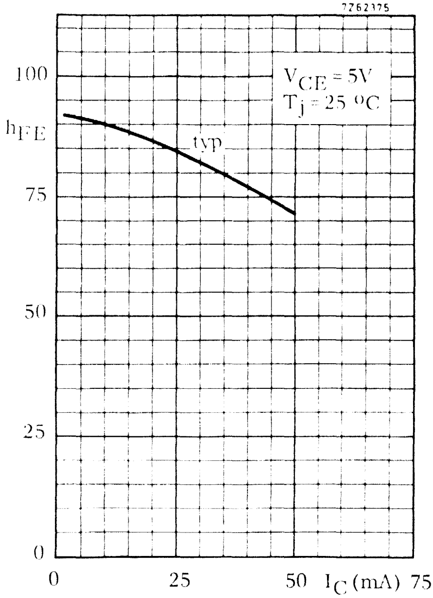
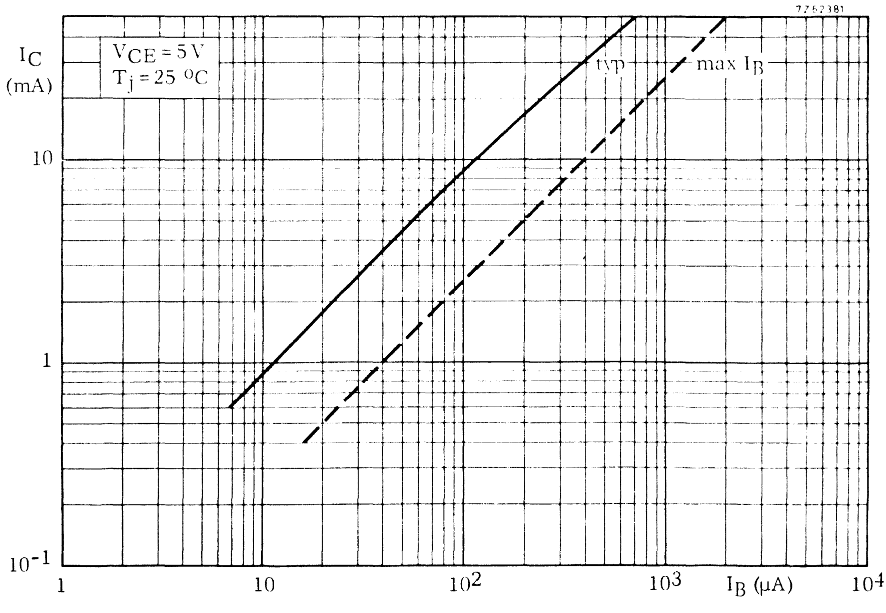
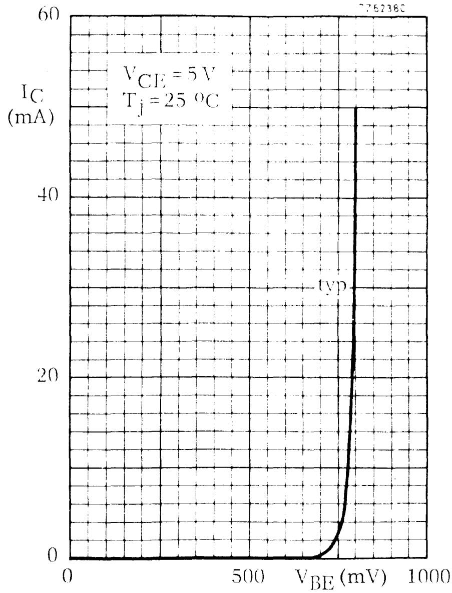


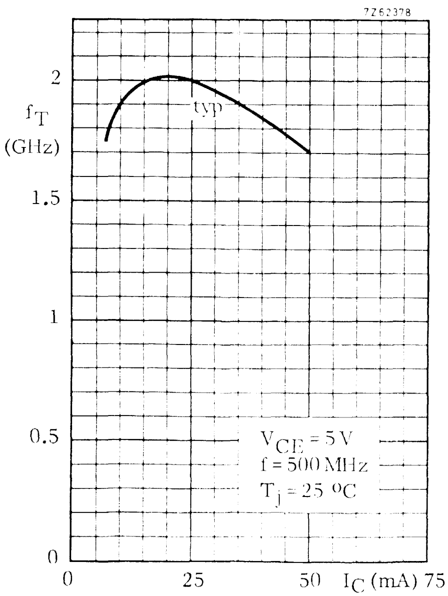
Fig. 4 Power derating curve.

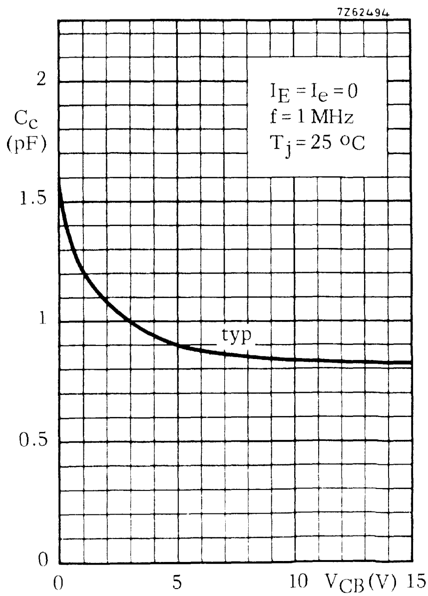

7Z62379
typical values
T_j = 25 °C
I_B = 700 µA
600
500
400
300
200
100
I_C (mA)
60
40
20
0
0
5
V_{CE} (V)
10


7Z62375
V_{CE} = 5V
T_j = 25 °C
typ
h_{FE}
100
75
50
25
0
0
25
50
I_C (mA)
75

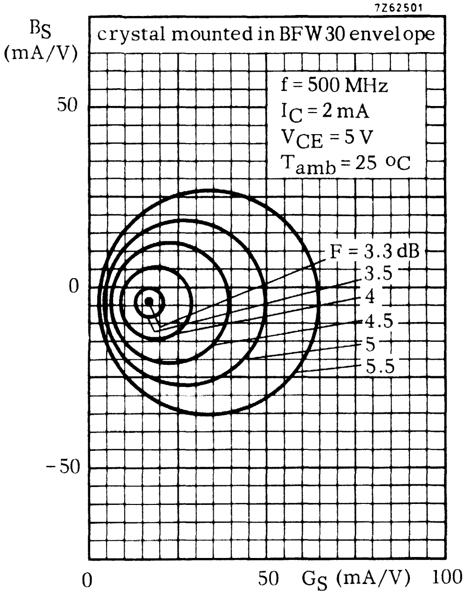

7Z62381
V_{CE} = 5 V
T_j = 25 °C
typ
max I_B
I_C (mA)
10
1
10^{-1}
1
10
10^2
10^3
I_B (µA)
10^4

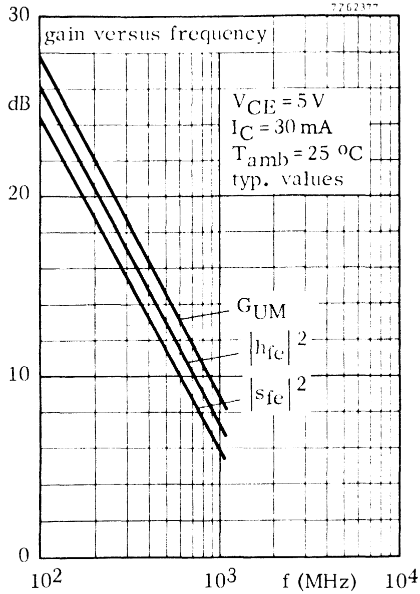

7Z62380
I_C
(mA)
60
40
20
0
V_{CE} = 5 V
T_j = 25 °C
typ
0
500
V_{BE} (mV)
1000

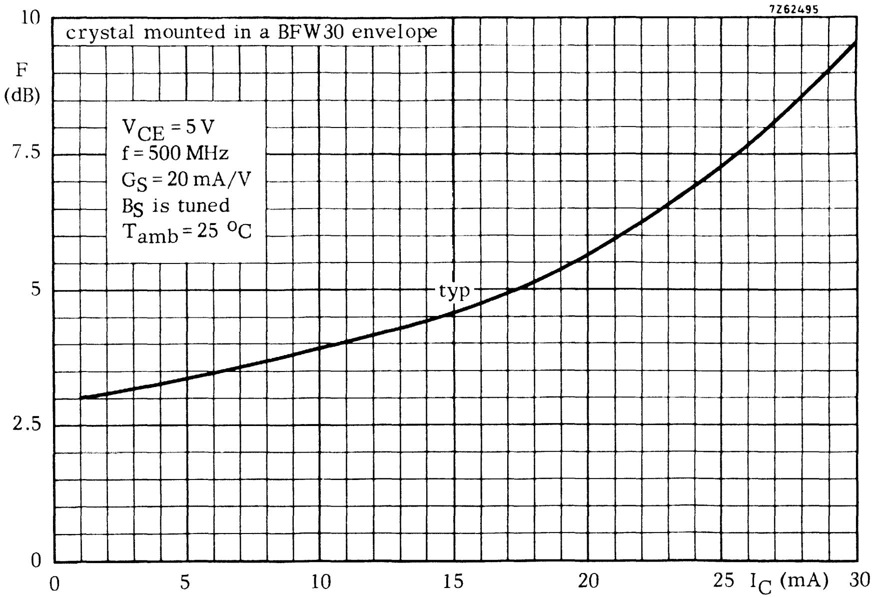

7Z62378
f_T
(GHz)
2
1.5
1
0.5
0
typ
V_{CE} = 5 V
f = 500 MHz
T_j = 25 °C
0
25
50
I_C (mA) 75


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



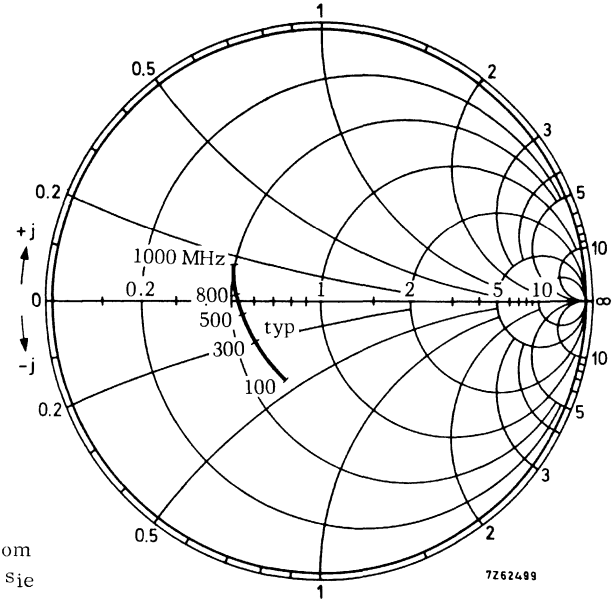




$V_{CE} = 5$ V

$I_C = 30$ mA

$T_{amb} = 25\ ^oC$

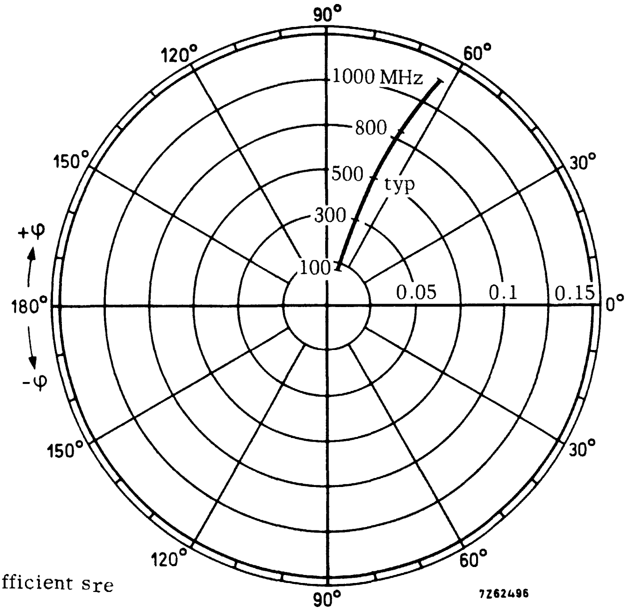


Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

$V_{CE} = 5$ V

$I_C = 30$ mA

$T_{amb} = 25\ ^oC$

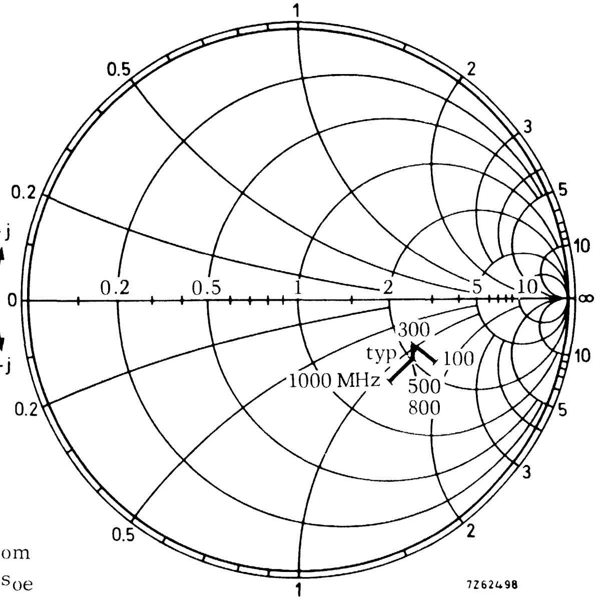


→ Reverse transmission coefficient s_{re}

V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 ^oC

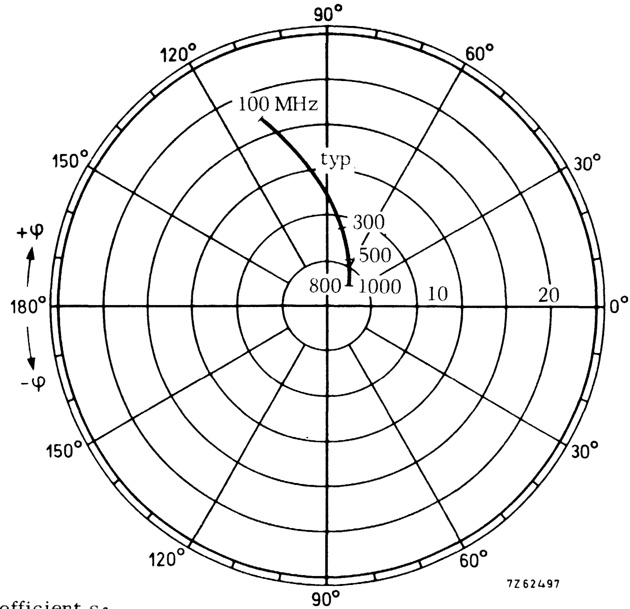


Output impedance derived from output reflection coefficient s_{oe} coordinates in ohm x 50

V_{CE} = 5 V

I_C = 30 mA

T_{amb} = 25 ^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 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.

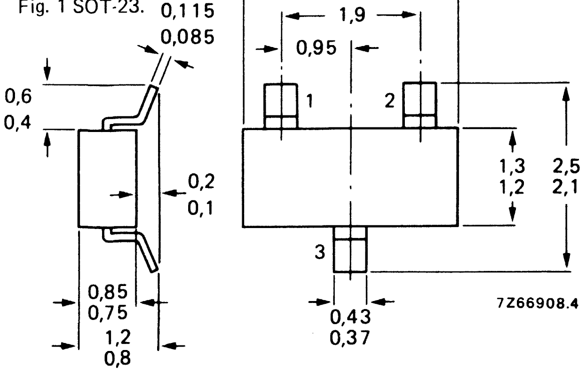
QUICK REFERENCE DATA

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.

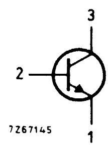
Dimensions in mm



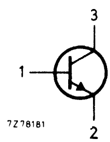
See also *Soldering recommendations.*

Marking code

BFR92 = P1



BFR92R = P4



RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	2,0	V
Collector current (d.c.)	I_C	max.	25	mA
Total power dissipation up to T_{amb} = 60 °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	$R_{th\ t\text{-}s}$	=	280	K/W
→ From soldering points to ambient **	$R_{th\ s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 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} (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; 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

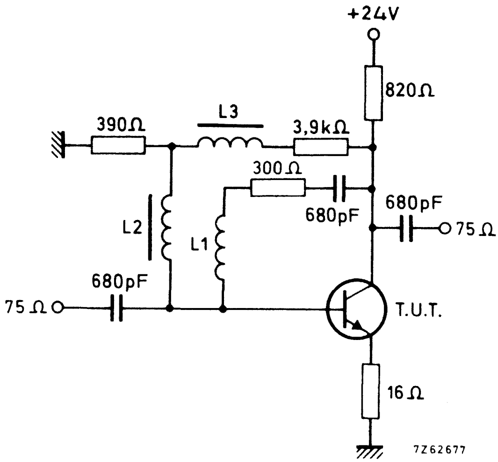


Fig. 2 Intermodulation test circuit.

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.

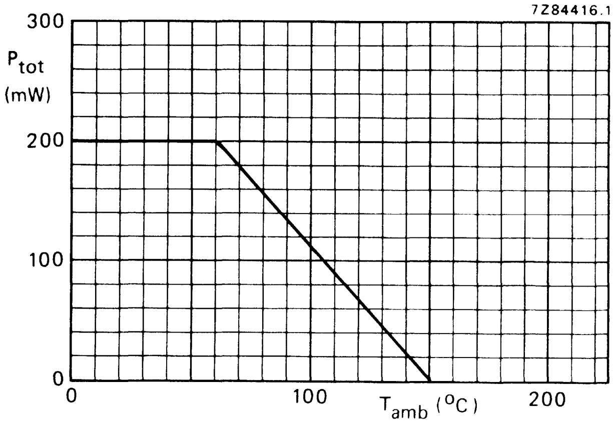
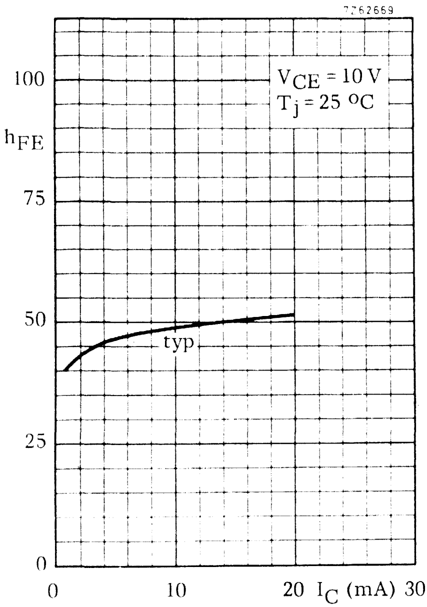
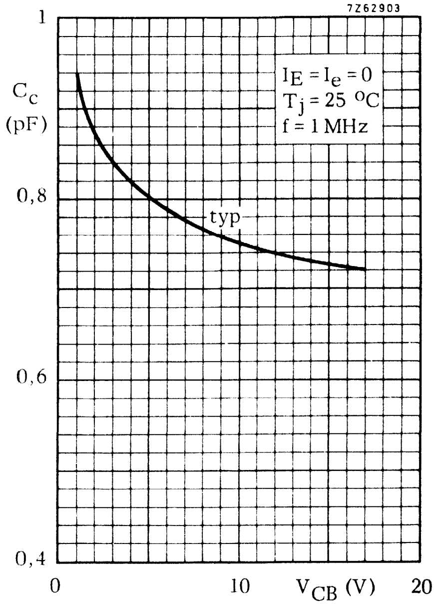
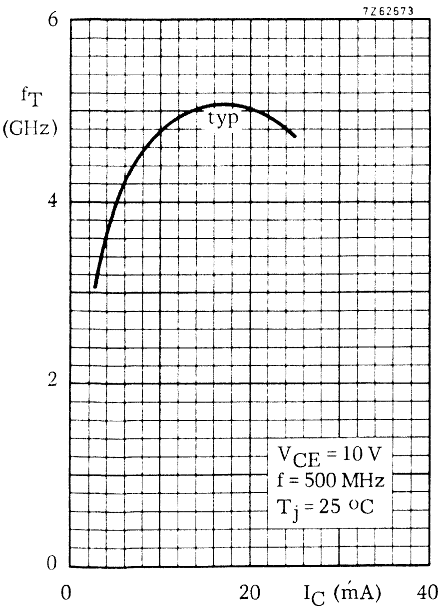
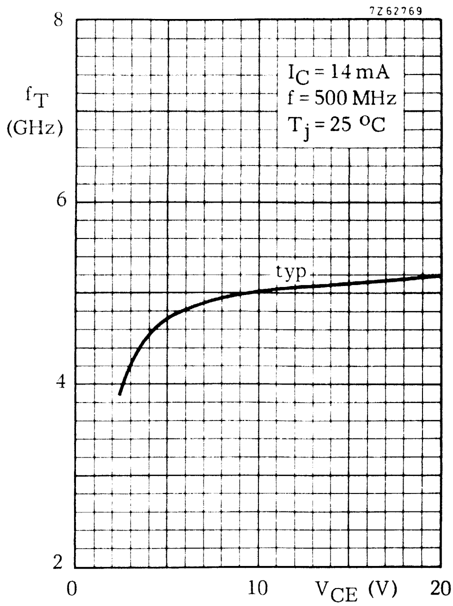


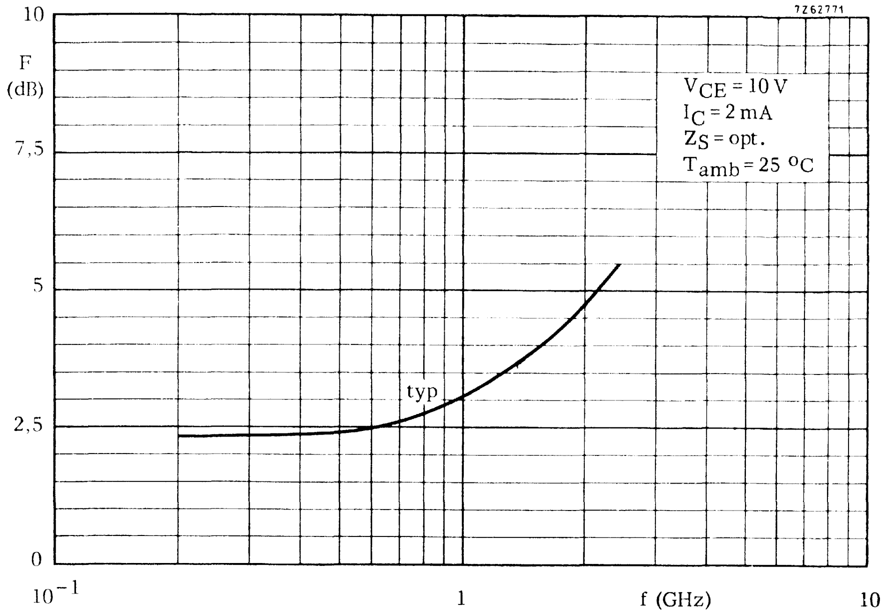
Fig. 3 Power derating curve.

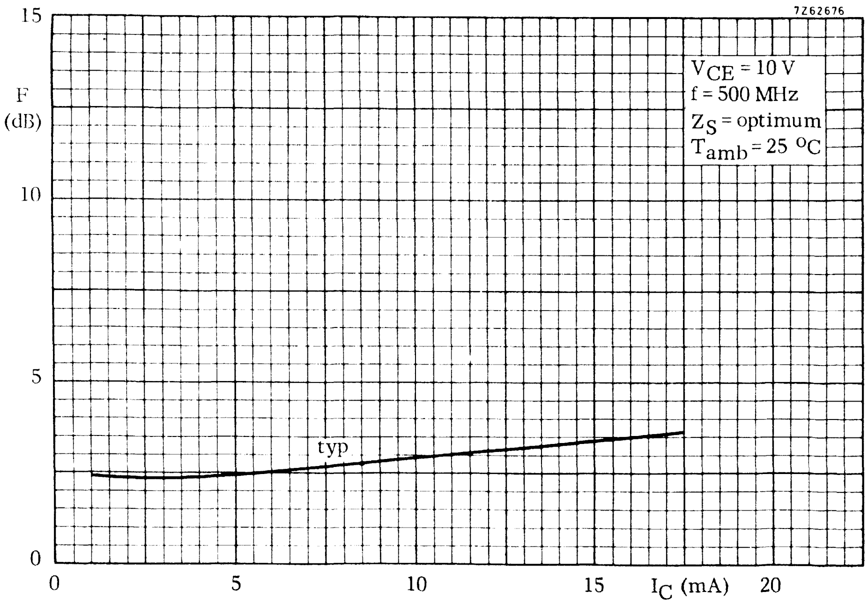

7Z62669
V_{CE} = 10 V
T_j = 25 °C
h_{FE}
typ
100
75
50
25
0
0
10
20
I_C (mA)
30

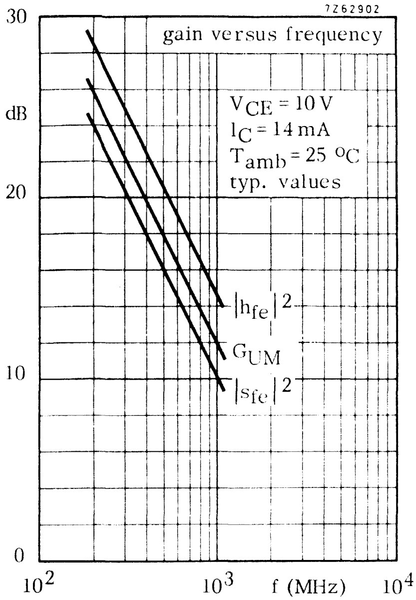

7Z62903
I_E = I_e = 0
T_j = 25 °C
f = 1 MHz
C_c
(pF)
typ
1
0,8
0,6
0,4
0
10
V_{CB} (V)
20


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

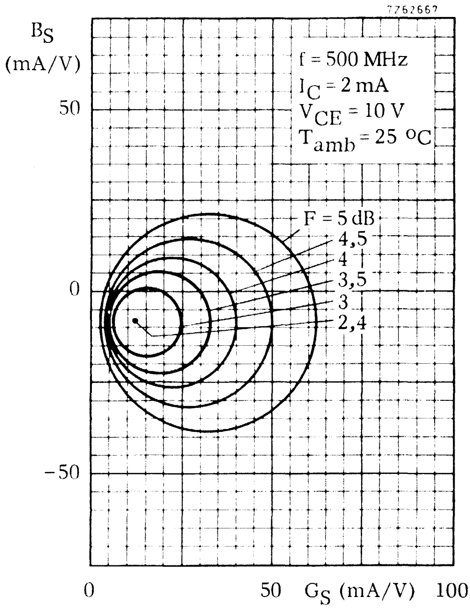

7Z62769
I_C = 14 mA
f = 500 MHz
T_j = 25 °C
f_T
(GHz)
typ
8
6
4
2
0
10
V_{CE} (V)
20


7Z62771
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

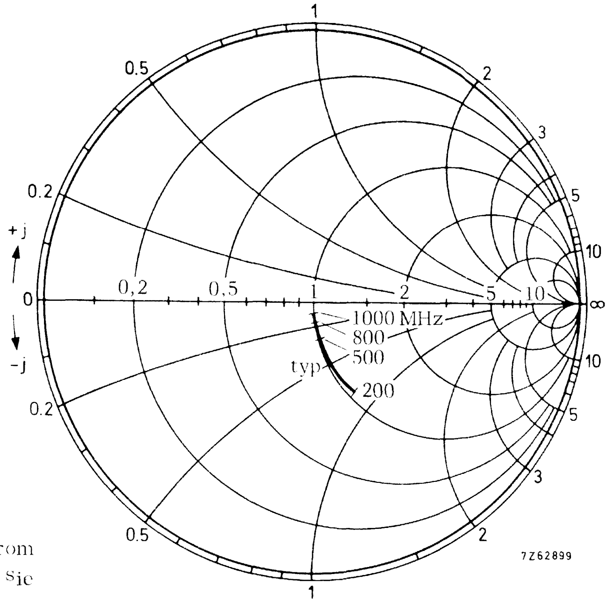

7Z62676
15
F
(dB)
10
5
0
V_{CE} = 10 V
f = 500 MHz
Z_S = optimum
T_{amb} = 25 °C
typ
0
5
10
15
I_C (mA)
20



circles of constant noise figure

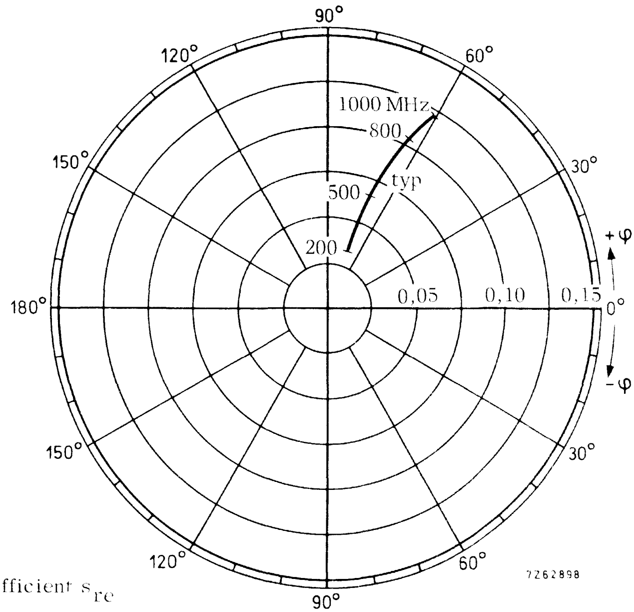


V_{CE} = 10 V
I_C = 14 mA
T_{amb} = 25 °C



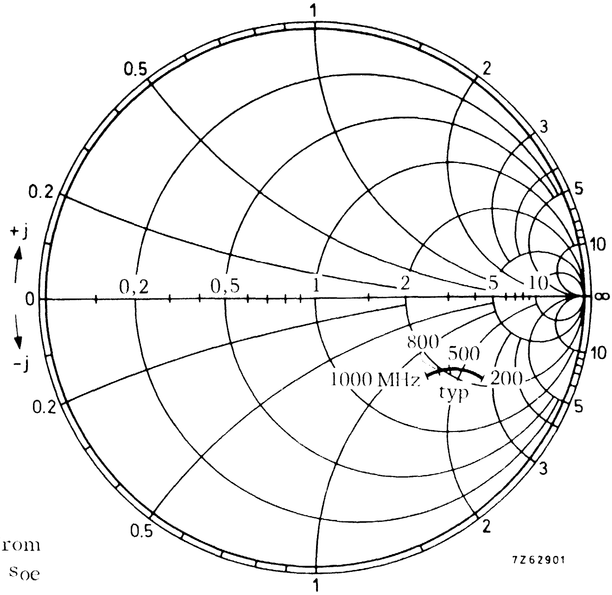
Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

V_{CE} = 10 V
I_C = 14 mA
T_{amb} = 25 °C



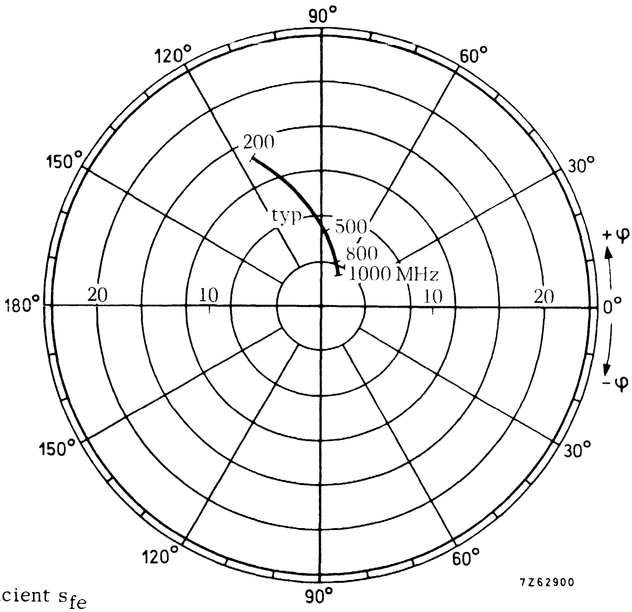
→ Reverse transmission coefficient s_{re}

V_{CE} = 10 V
I_C = 14 mA
T_{amb} = 25 °C



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 °C



→ Forward transmission coefficient s_{fe}

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a micro miniature plastic envelope. They are primarily intended for use in v.h.f./u.h.f. broadband amplifiers. The transistors feature:

- low noise;
- low intermodulation distortion;
- high power gain;

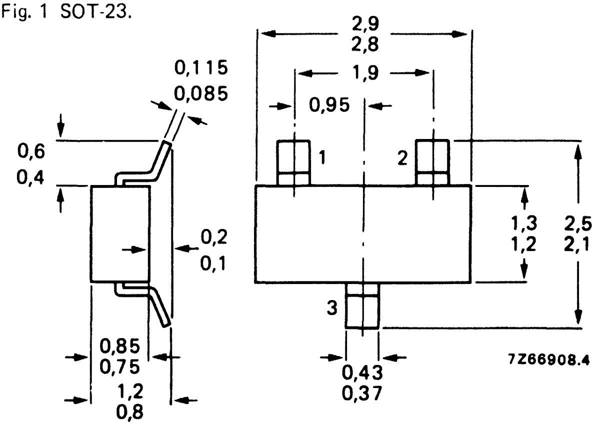
QUICK REFERENCE DATA

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 = 0; V_{CE} = 10 V; T_{amb} = 25 °C	C_{re}	typ.	0,35	pF
Noise figure at R_S = 60 Ω I_C = 4 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C	F	typ.	1,8	dB
Output voltage at d_{im} = −60 dB (see Fig. 2) I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C $f_{(p+q-r)}$ = 793,25 MHz	V_o	typ.	150	mV

MECHANICAL DATA

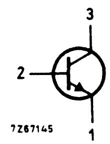
Dimensions in mm

Fig. 1 SOT-23.

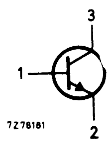


Marking code

BFR92A = P2



BFR92AR = P5



See also *Soldering recommendations* in handbook Microminiature Semiconductors.

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	$R_{th\,t\text{-}s}$	=	280 K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90 K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current $I_E = 0$; V_{CB} = 10 V	I_{CBO}	<	60 nA
D.C. current gain▲ I_C = 14 mA; V_{CE} = 10 V	h_{FE}	> typ.	40 90
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.	0,6 pF
Emitter capacitance at f = 1 MHz $I_C = I_c = 0$; V_{EB} = 0,5 V	C_e	typ.	1,2 pF
Feedback capacitance at f = 1 MHz $I_C = 0$; V_{CE} = 10 V; T_{amb} = 25 °C	C_{re}	typ.	0,35 pF
Noise figure at T_{amb} = 25 °C I_C = 4 mA; V_{CE} = 10 V; R_S = 60 Ω; f = 800 MHz	F	typ.	1,8 dB

Maximum unilateral power gain (s_{re} assumed to be zero)
See Figs 11 to 15

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

I_C = 14 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C	G_{UM}	typ.	15,5 dB

* See *Thermal characteristics* in chapter GENERAL in handbook Microminiature Semiconductors.
** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.
▲ Measured under pulse conditions.

Output voltage at d_{im} = −60 dB (see Figs 2 and 17)*
(DIN 45004B, par. 6.3: 3-tone)
I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; VSWR < 2; T_{amb} = 25 °C
$V_p = V_o$ at d_{im} = −60 dB; f_p = 795,25 MHz
$V_q = V_o$ −6 dB ; f_q = 803,25 MHz
$V_r = V_o$ −6 dB ; f_r = 805,25 MHz
Measured at $f_{(p+q-r)}$ = 793,25 MHz | V_o typ. 150 mV

Second harmonic distortion (see Figs 2 and 18)*
I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; VSWR < 2; T_{amb} = 25 °C
V_p = 60 mV at f_p = 250 MHz
V_q = 60 mV at f_q = 560 MHz
measured at $f_{(p+q)}$ = 810 MHz | d_2 typ. −50 dB

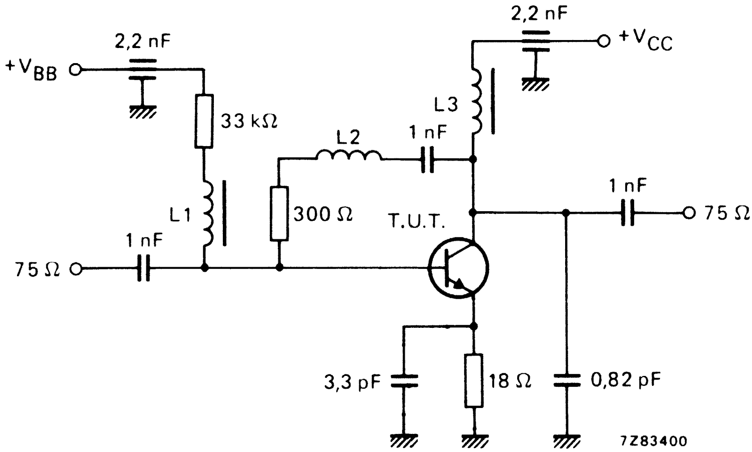


Fig. 2 Intermodulation distortion and second harmonic distortion MATV test circuit.

L1 = L3 = 5 μH micro choke
L2 = 3 turns Cu wire (0,4 mm); internal diameter 3 mm; winding pitch 1 mm

* Measured on same crystal in a SOT-37 envelope (BFR90A).

s-parameters (common emitter)

V_{CE} V	I_C mA	f MHz	s_{ie}	s_{re}	s_{fe}	s_{oe}
		40	0,88/ −8,9°	0,009/83,6°	6,7/174,2°	1,00/ −2,7°
		100	0,86/ −21,9°	0,022/78,3°	6,5/164,2°	0,98/ −6,6°
		200	0,80/ −42,2°	0,041/69,0°	6,0/149,2°	0,94/−12,2°
5	2	500	0,61/ −87,2°	0,073/54,9°	4,2/119,1°	0,81/−20,2°
		800	0,48/−117,4°	0,086/52,7°	3,1/100,5°	0,74/−22,9°
		1000	0,44/−133,8°	0,092/54,2°	2,6/ 91,4°	0,71/−24,2°
		1200	0,41/−147,6°	0,099/57,5°	2,2/ 84,3°	0,70/−25,7°
		40	0,75/ −14,4°	0,008/81,8°	14,4/170,2°	0,99/ −4,9°
		100	0,70/ −34,0°	0,020/74,2°	13,3/155,3°	0,94/−11,2°
		200	0,60/ −61,7°	0,034/65,0°	10,9/135,8°	0,84/−17,9°
5	5	500	0,40/−111,1°	0,057/61,1°	6,2/106,9°	0,67/−21,9°
		800	0,32/−139,7°	0,074/65,5°	4,2/ 92,4°	0,62/−22,2°
		1000	0,30/−153,2°	0,086/68,2°	3,4/ 85,3°	0,61/−22,8°
		1200	0,29/−166,2°	0,100/70,9°	2,9/ 79,6°	0,60/−24,0°
		40	0,61/ −21,1°	0,008/79,7°	22,9/165,2°	0,97/ −7,3°
		100	0,54/ −48,5°	0,017/71,4°	19,8/145,8°	0,88/−15,5°
		200	0,42/ −82,1°	0,028/65,2°	14,4/124,7°	0,74/−20,8°
5	10	500	0,30/−132,3°	0,050/69,0°	7,1/ 99,6°	0,59/−20,5°
		800	0,26/−158,0°	0,072/73,7°	4,7/ 87,8°	0,56/−20,3°
		1000	0,25/−168,3°	0,088/75,2°	3,8/ 82,2°	0,56/−20,9°
		1200	0,25/−179,3°	0,104/76,6°	3,2/ 77,5°	0,55/−22,1°
		40	0,53/ −26,0°	0,007/78,6°	27,7/162,4°	0,96/ −8,7°
		100	0,45/ −58,1°	0,016/70,5°	22,6/140,7°	0,85/−17,2°
		200	0,36/ −94,4°	0,025/66,6°	15,6/119,7°	0,70/−21,0°
5	14	500	0,27/−142,8°	0,049/72,5°	7,3/ 96,9°	0,57/−19,1°
		800	0,25/−166,0°	0,072/76,5°	4,7/ 86,1°	0,55/−19,1°
		1000	0,24/−174,8°	0,088/77,4°	3,8/ 80,5°	0,55/−19,9°
		1200	0,24/ 174,8°	0,105/78,4°	3,2/ 76,2°	0,54/−21,3°
		40	0,45/ −33,1°	0,007/77,0°	32,3/158,8°	0,94/−10,1°
		100	0,38/ −71,8°	0,015/69,5°	24,7/135,0°	0,80/−18,4°
		200	0,31/−110,6°	0,023/68,3°	16,0/114,6°	0,66/−20,1°
5	20	500	0,26/−154,5°	0,047/75,5°	7,2/ 94,3°	0,56/−17,3°
		800	0,25/−174,2°	0,071/78,7°	4,7/ 84,3°	0,55/−17,8°
		1000	0,25/ 178,5°	0,088/79,3°	3,7/ 79,1°	0,54/−18,9°
		1200	0,26/ 169,9°	0,104/80,0°	3,2/ 74,9°	0,54/−20,5°

s-parameters (common emitter)

V_{CE} V	I_C mA	f MHz	s_{ie}	s_{re}	s_{fe}	s_{oe}
		40	0,89/ −8,7°	0,008/83,6°	6,8/174,4°	1,00/ −2,5°
		100	0,86/ −21,2°	0,021/78,5°	6,5/164,6°	0,98/ −6,1°
		200	0,80/ −40,9°	0,038/69,5°	6,0/149,6°	0,94/−11,3°
10	2	500	0,61/ −85,3°	0,069/55,8°	4,3/119,8°	0,82/−18,7°
		800	0,48/−115,4°	0,081/53,8°	3,1/101,2°	0,75/−21,3°
		1000	0,44/−131,4°	0,086/55,5°	2,6/ 92,1°	0,73/−22,5°
		1200	0,40/−145,6°	0,093/58,9°	2,2/ 85,0°	0,72/−23,9°
		40	0,77/ −13,6°	0,008/81,8°	14,2/170,5°	0,99/ −4,5°
		100	0,73/ −32,3°	0,019/74,7°	13,2/155,8°	0,95/−10,3°
		200	0,62/ −58,8°	0,032/65,6°	11,0/136,8°	0,85/−16,6°
10	5	500	0,41/−107,2°	0,054/61,4°	6,3/107,7°	0,69/−20,4°
		800	0,32/−135,9°	0,071/65,9°	4,2/ 92,9°	0,64/−20,8°
		1000	0,30/−150,0°	0,082/68,6°	3,5/ 86,1°	0,63/−21,3°
		1200	0,28/−162,9°	0,095/71,5°	2,9/ 80,5°	0,62/−22,4°
		40	0,66/ −19,4°	0,007/80,1°	22,5/165,9°	0,97/ −6,6°
		100	0,58/ −44,7°	0,017/71,8°	19,5/147,0°	0,90/−14,1°
		200	0,45/ −76,2°	0,027/65,4°	14,5/126,0°	0,76/−19,3°
10	10	500	0,29/−125,1°	0,049/68,7°	7,2/100,6°	0,62/−19,2°
		800	0,24/−151,8°	0,070/73,5°	4,7/ 88,8°	0,59/−19,0°
		1000	0,24/−162,9°	0,084/75,2°	3,8/ 82,6°	0,58/−19,7°
		1200	0,23/−174,8°	0,099/76,8°	3,2/ 78,3°	0,58/−20,9°
		40	0,60/ −23,2°	0,007/78,6°	27,2/163,0°	0,96/ −7,9°
		100	0,51/ −52,5°	0,016/70,6°	22,6/141,8°	0,86/−15,8°
		200	0,38/ −86,2°	0,025/66,4°	15,7/120,7°	0,72/−19,6°
10	14	500	0,26/−134,3°	0,047/72,0°	7,5/ 97,8°	0,60/−18,0°
		800	0,22/−159,3°	0,069/76,2°	4,8/ 86,8°	0,57/−18,0°
		1000	0,22/−169,0°	0,085/77,3°	3,9/ 81,3°	0,57/−18,7°
		1200	0,22/ 179,8°	0,100/78,5°	3,3/ 76,8°	0,57/−20,1°
		40	0,54/ −28,2°	0,007/77,4°	31,7/159,9°	0,95/ −9,1°
		100	0,45/ −61,7°	0,015/69,5°	24,7/136,8°	0,82/−16,8°
		200	0,33/ −97,5°	0,023/67,5°	16,3/116,2°	0,68/−18,8°
10	20	500	0,24/−143,7°	0,046/74,4°	7,4/ 95,3°	0,59/−16,4°
		800	0,22/−166,4°	0,069/78,0°	4,8/ 85,2°	0,57/−16,9°
		1000	0,22/−174,7°	0,084/78,7°	3,8/ 80,1°	0,57/−17,8°
		1200	0,22/ 176,3°	0,100/79,7°	3,3/ 76,0°	0,57/−19,4°

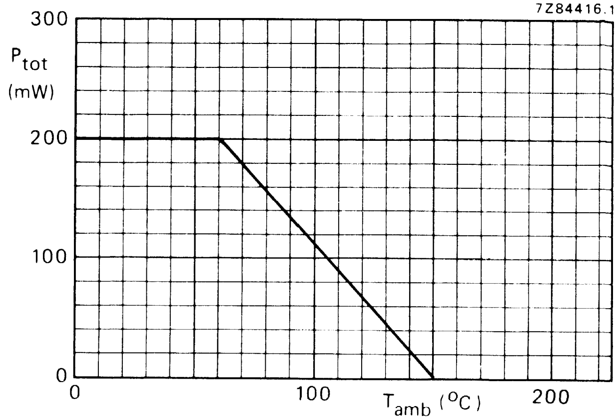


Fig. 3 Power derating curve.

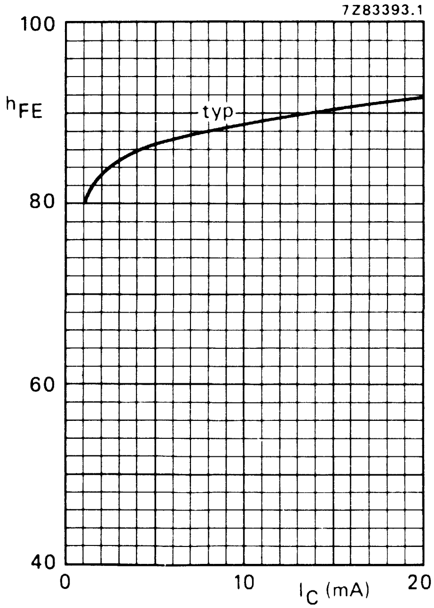


Fig. 4 V_{CE} = 10 V; T_j = 25 °C.

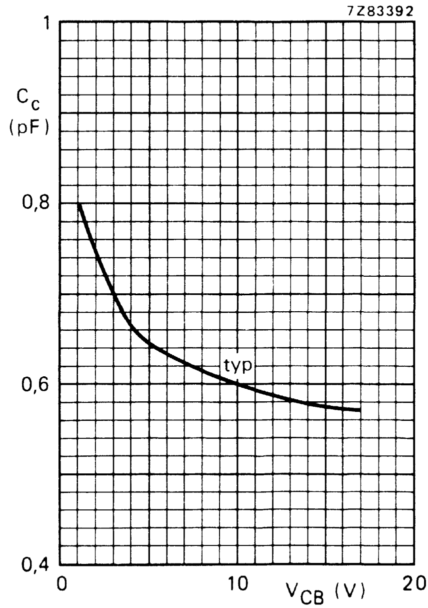


Fig. 5 I_E = I_e = 0; f = 1 MHz; T_j = 25 °C.

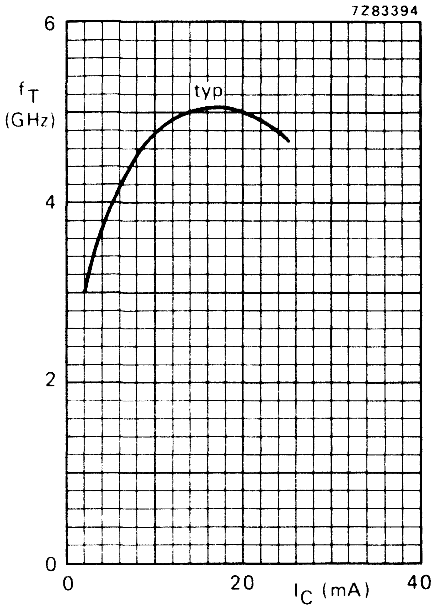


Fig. 6 V_{CE} = 10 V; f = 500 MHz; T_j = 25 °C.

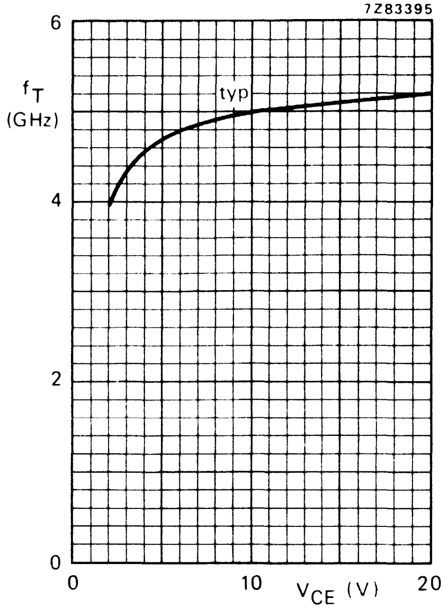


Fig. 7 I_C = 14 mA; f = 500 MHz; T_j = 25 °C.

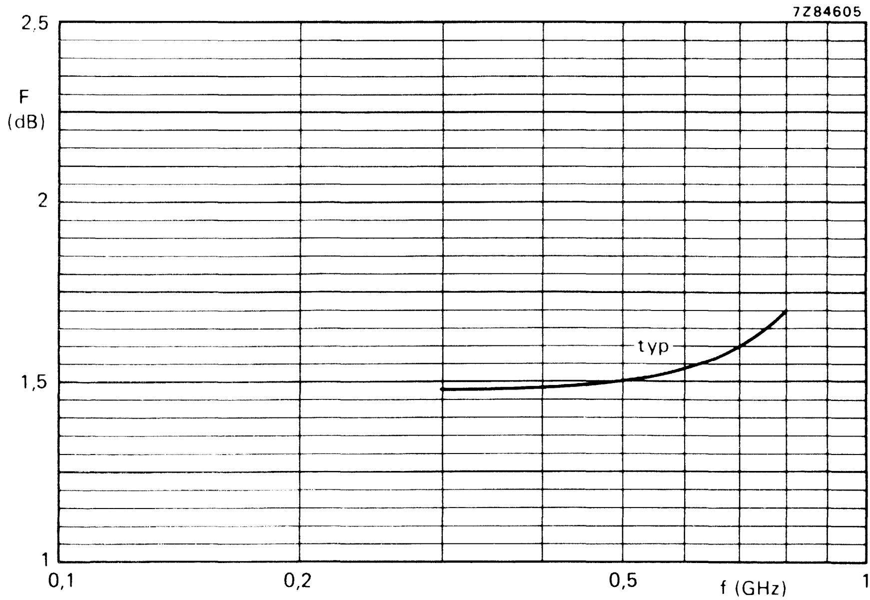


Fig. 8 V_{CE} = 10 V; I_C = 4 mA; Z_S = optimum; T_{amb} = 25 °C.

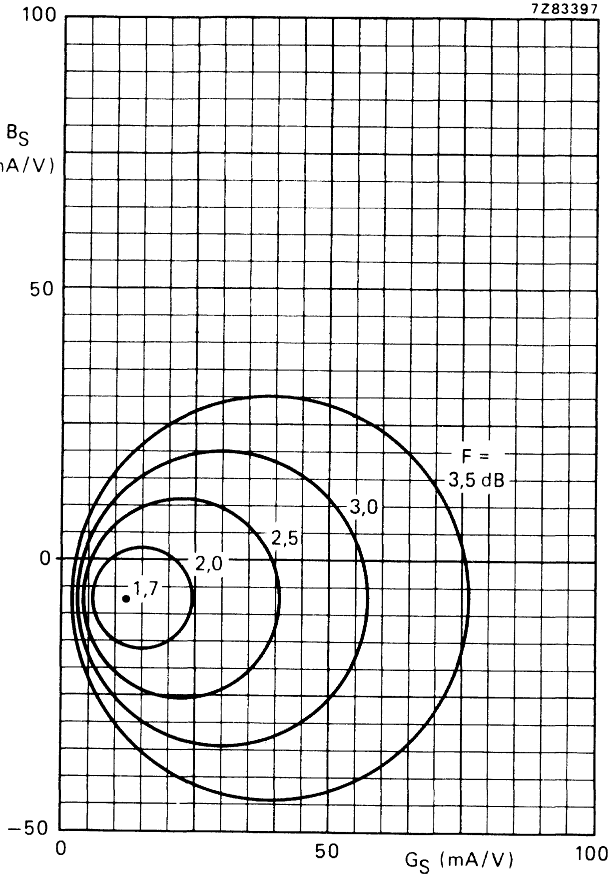


Fig. 9 Circles of constant noise figure.
V_{CE} = 10 V; I_C = 4 mA; f = 800 MHz; T_{amb} = 25 °C; typical values.

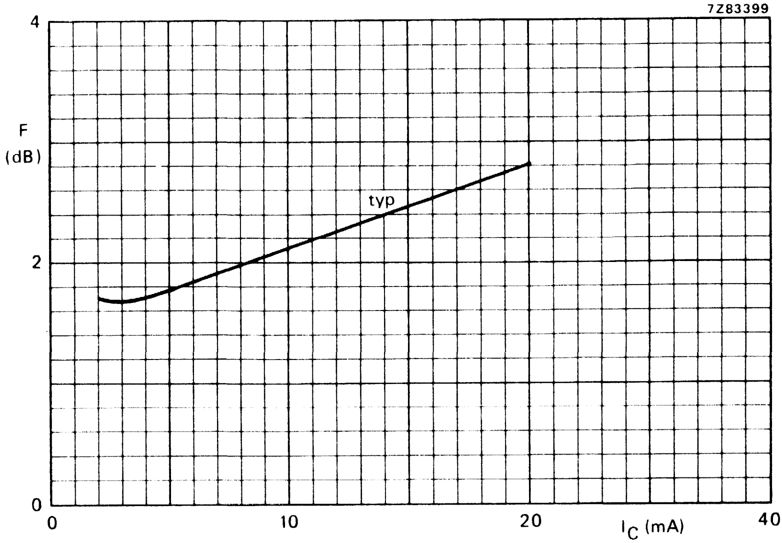


Fig. 10 V_{CE} = 10 V; f = 800 MHz; Z_S = optimum; T_{amb} = 25 °C.

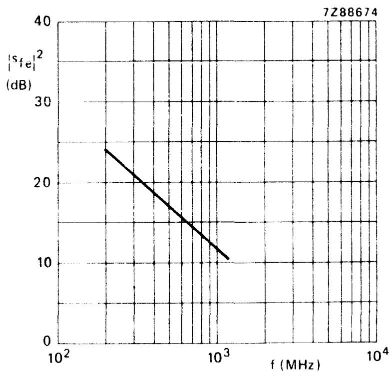


Fig. 11 V_{CE} = 10 V; I_C = 14 mA; T_{amb} = 25 °C.

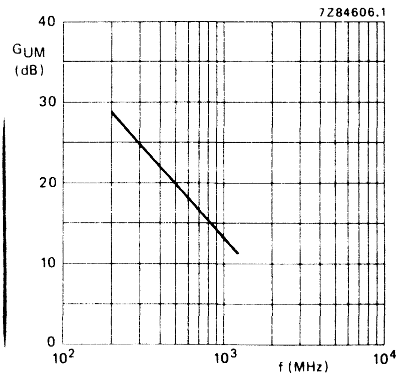


Fig. 12 V_{CE} = 10 V; I_C = 14 mA; T_{amb} = 25 °C.

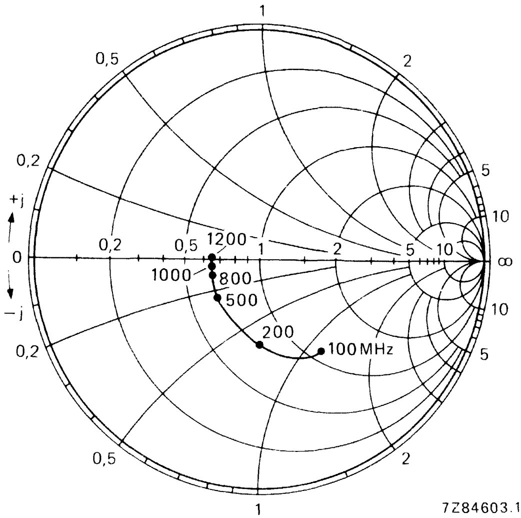


Fig. 13 Input impedance derived from input reflection coefficient s_{ie} co-ordinates in ohm x 50.
V_{CE} = 10 V; I_C = 14 mA; T_{amb} = 25 °C.

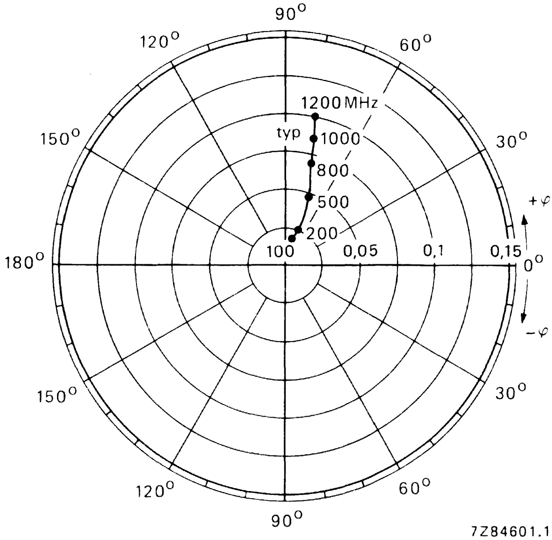


Fig. 14 Reverse transmission coefficient s_{re}.
V_{CE} = 10 V; I_C = 14 mA; T_{amb} = 25 °C.

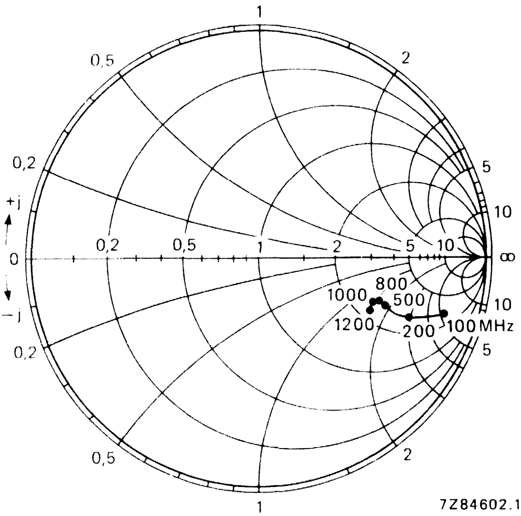


Fig. 15 Output impedance derived from output reflection coefficient s_{oe} co-ordinates in ohm x 50.
V_{CE} = 10 V; I_C = 14 mA; T_{amb} = 25 °C.

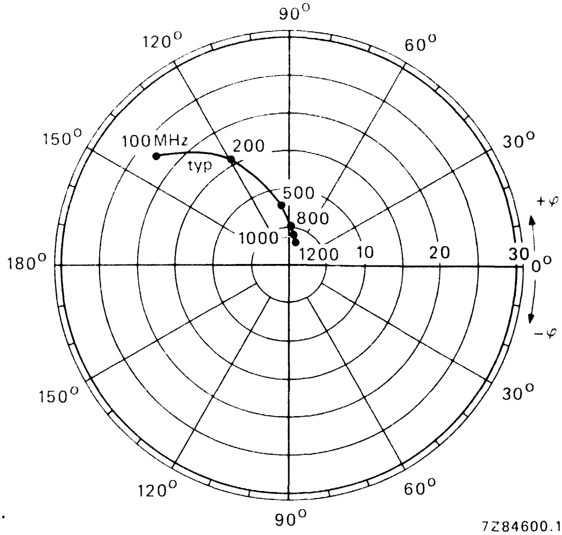


Fig. 16 Forward transmission coefficient s_{fe}.
V_{CE} = 10 V; I_C = 14 mA; T_{amb} = 25 °C.

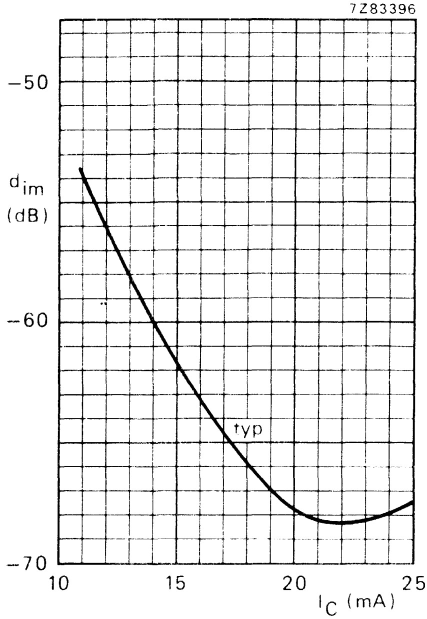


Fig. 17 V_{CE} = 10 V; V_o = 43,5 dBmV = 150 mV; $f_{(p+q-r)}$ = 793,25 MHz; T_{amb} = 25 °C; measured in MATV test circuit (see Fig. 2)

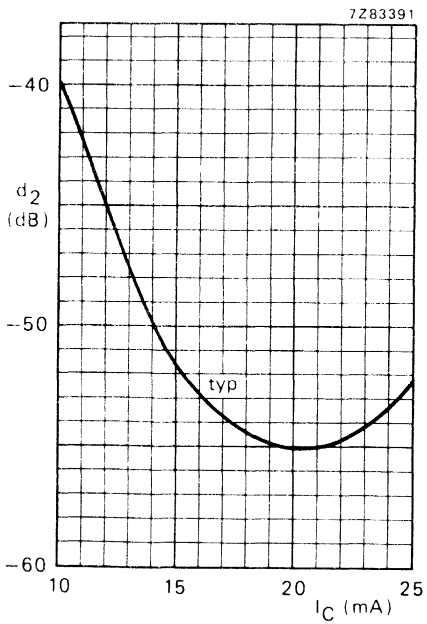


Fig. 18 V_{CE} = 10 V; V_o = 60 mV; $f_{(p+q)}$ = 810 MHz; T_{amb} = 25 °C; measured in MATV test circuit (see Fig. 2).

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.

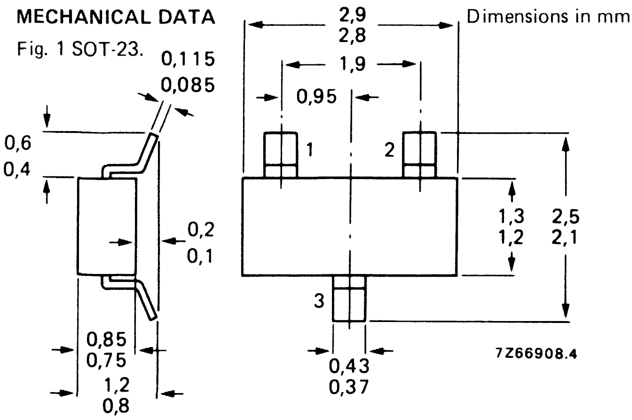
QUICK REFERENCE DATA

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

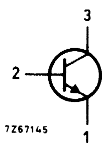
Fig. 1 SOT-23.

Dimensions in mm

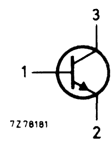


Marking code

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	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient **	$R_{th\,s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 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 Ω; 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

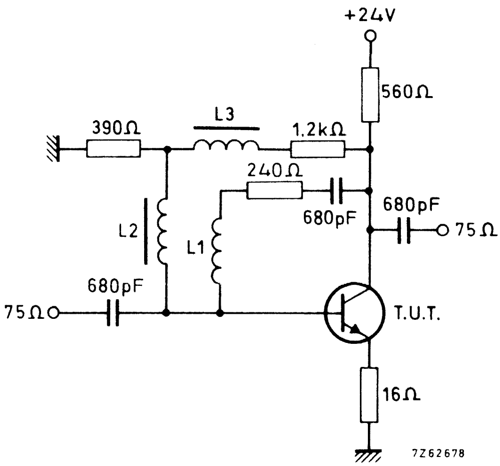


Fig. 2 Intermodulation test circuit.

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.

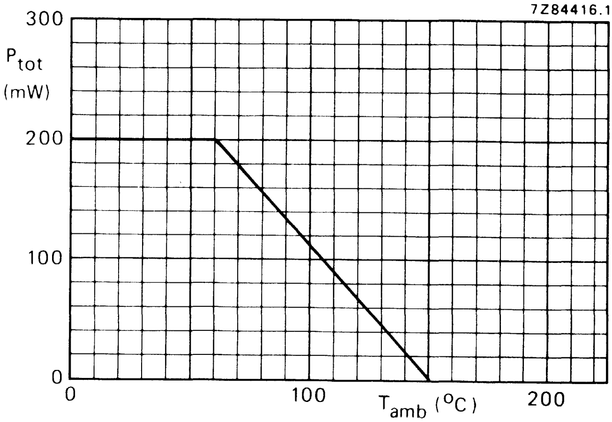
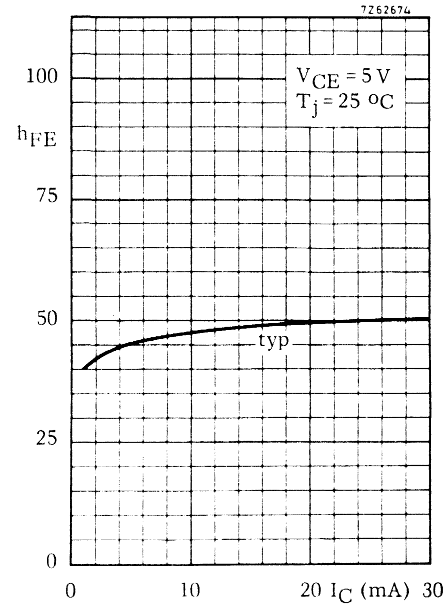
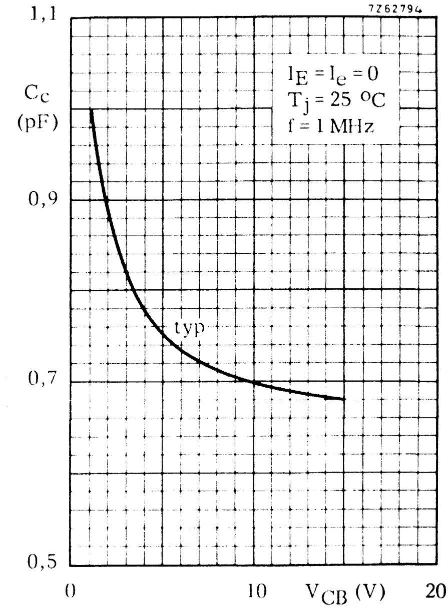
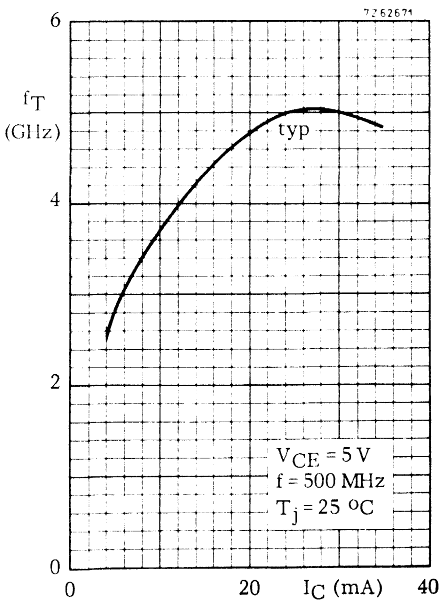
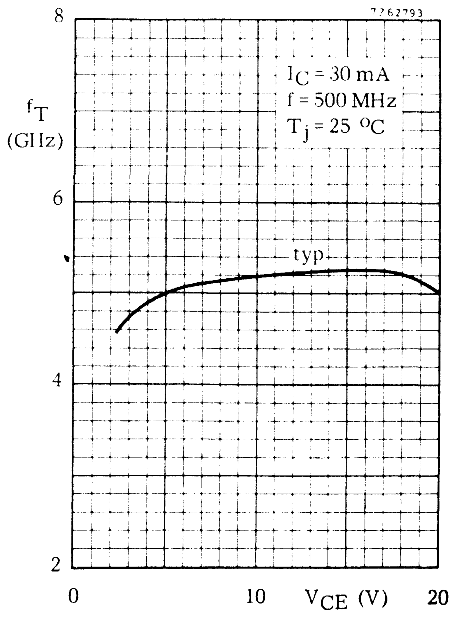


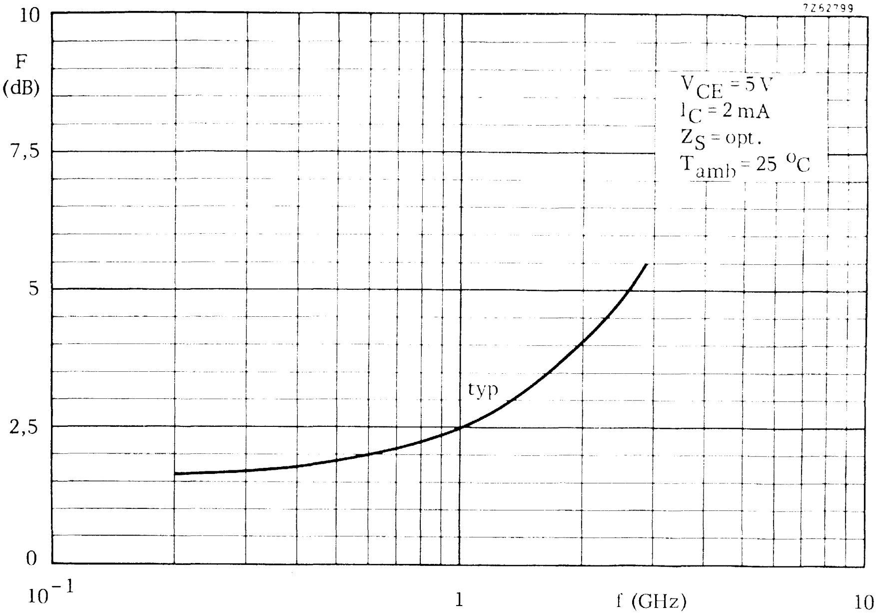
Fig. 3 Power derating curve.

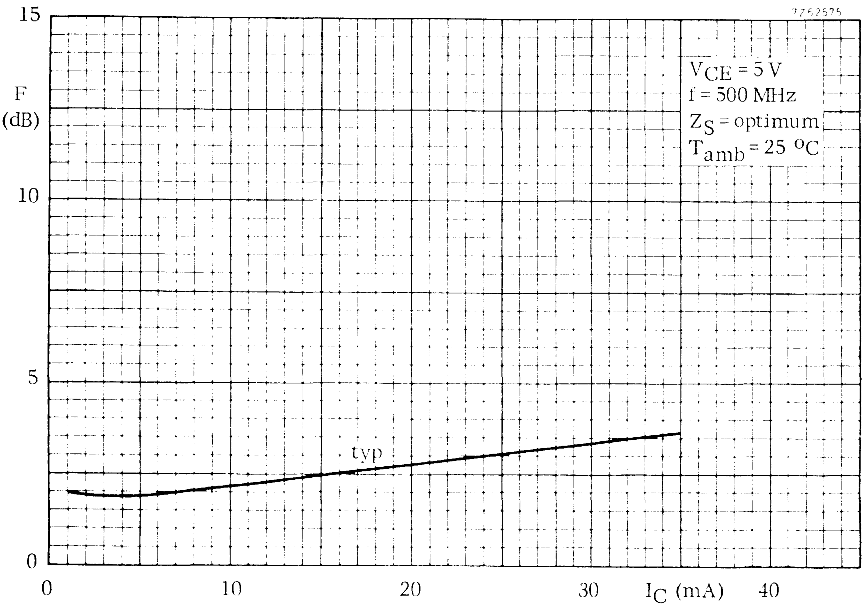

7Z62674
100
75
50
25
0
hFE
VCE = 5 V
Tj = 25 °C
typ
0
10
20
IC (mA)
30

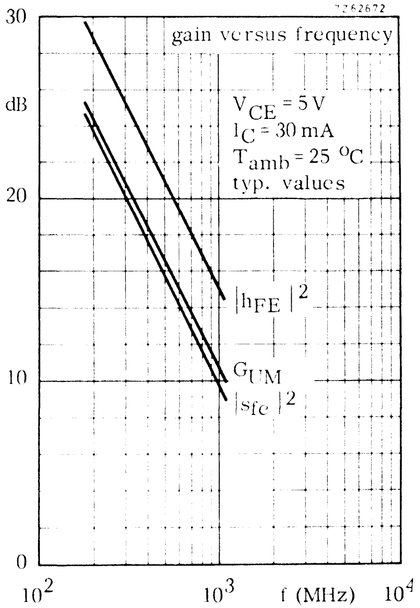

7Z62794
1,1
0,9
0,7
0,5
Cc
(pF)
IE = Ie = 0
Tj = 25 °C
f = 1 MHz
typ
0
10
VCB (V)
20


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

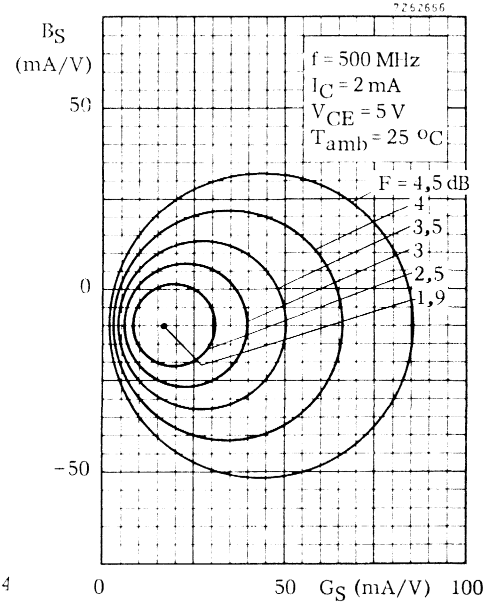

7Z62793
8
6
4
2
fT
(GHz)
IC = 30 mA
f = 500 MHz
Tj = 25 °C
typ
0
10
VCE (V)
20


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

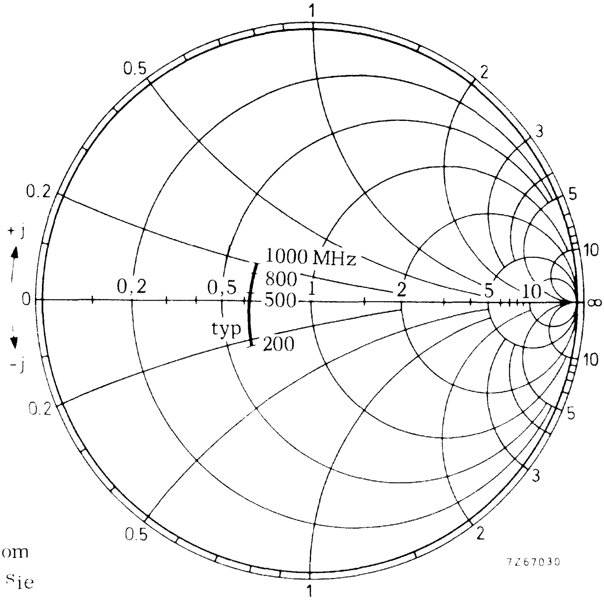

7Z62575
15
F
(dB)
10
5
0
V_{CE} = 5 V
f = 500 MHz
Z_S = optimum
T_{amb} = 25 °C
typ
0
10
20
30
I_C (mA)
40



circles of constant noise figure

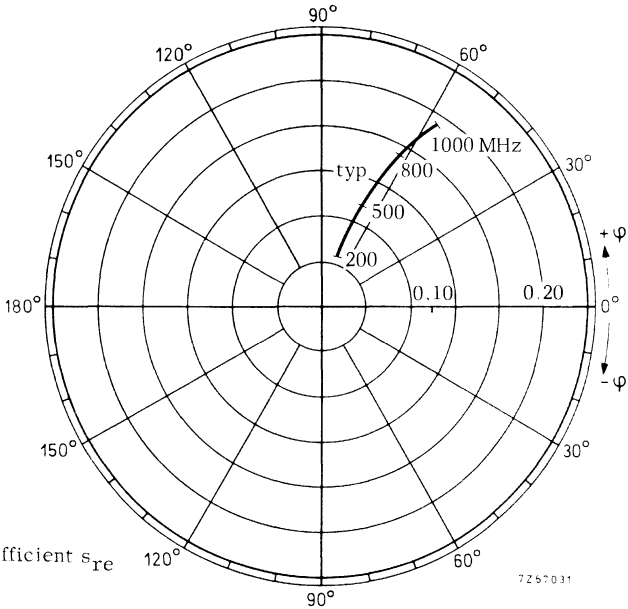


V_{CE} = 5 V
I_C = 30 mA
T_{amb} = 25 °C



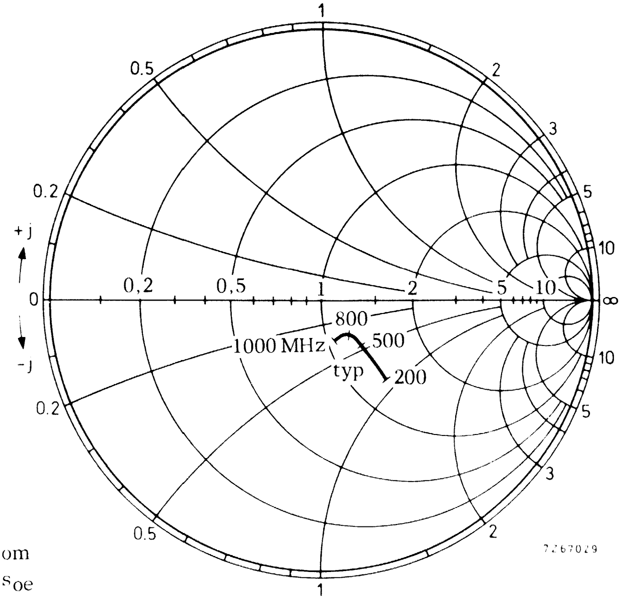
Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

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



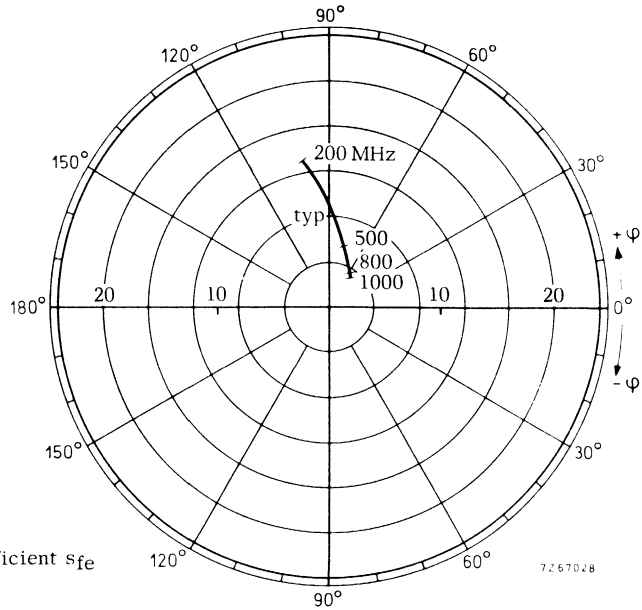
Reverse transmission coefficient s_{re}

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 TRANSISTORS

N-P-N transistors in a microminiature plastic envelope. They are primarily intended for use in v.h.f./u.h.f. broadband amplifiers. The transistors feature:

- low noise;
- very low intermodulation distortion;
- high power gain;

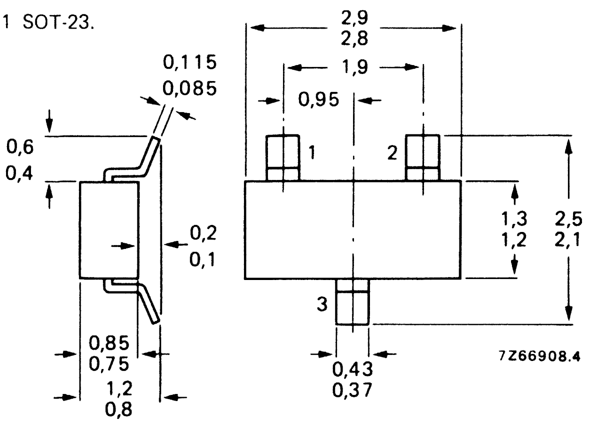
QUICK REFERENCE DATA

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} = 45 °C	P_{tot}	max.	250	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 = 0; V_{CE} = 5 V; T_{amb} = 25 °C	C_{re}	typ.	0,6	pF
Noise figure at optimum source impedance I_C = 4 mA; V_{CE} = 8 V; f = 800 MHz	F	typ.	1,6	dB
Output voltage at d_{im} = −60 dB (see Fig. 2) I_C = 30 mA; V_{CE} = 8 V; R_L = 75 Ω; T_{amb} = 25 °C $f_{(p+q-r)}$ = 793,25 MHz	V_o	typ.	425	mV

MECHANICAL DATA

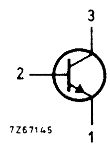
Dimensions in mm

Fig. 1 SOT-23.

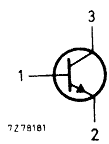


Marking code

BFR93A = R2



BFR93AR = R5



See also *Soldering recommendations* in handbook Microminiature Semiconductors.

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} = 45 °C**	P_{tot}	max.	250	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	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90	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▲ $I_C = 30$ mA; $V_{CE} = 5$ V	h_{FE}	> typ.	40 90	
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 $I_E = I_e = 0$; $V_{CB} = 5$ 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.	1,9	pF
Feedback capacitance at f = 1 MHz $I_C = 0$; $V_{CE} = 5$ V; $T_{amb} = 25$ °C	C_{re}	typ.	0,6	pF
Noise figure at optimum source impedance▲ $I_C = 4$ mA; $V_{CE} = 8$ V; f = 800 MHz	F	typ.	1,6	dB
$I_C = 30$ mA; $V_{CE} = 8$ V; f = 800 MHz	F	typ.	2,3	dB

Maximum unilateral power gain (s_{re} assumed to be zero)
See Figs 10 to 15

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

$I_C = 30$ mA; $V_{CE} = 8$ V; f = 800 MHz; $T_{amb} = 25$ °C	G_{UM}	typ.	14	dB

▲ Measured under pulse conditions.
* See *Thermal characteristics* in chapter GENERAL in handbook Microminiature semiconductors.
** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

Output voltage at d_{im} = −60 dB (see Figs 2 and 16)*			
(DIN 45004B, par. 6.3: 3-tone)			
I_C = 30 mA; V_{CE} = 8 V; R_L = 75 Ω; T_{amb} = 25 °C			
$V_p = V_o$ at d_{im} = −60 dB; f_p = 795,25 MHz			
$V_q = V_o$ −6 dB ; f_q = 803,25 MHz			
$V_r = V_o$ −6 dB ; f_r = 805,25 MHz			
Measured at $f_{(p+q-r)}$ = 793,25 MHz	V_o	typ.	425 mV
Second harmonic distortion (see Figs 2 and 17)*			
I_C = 30 mA; V_{CE} = 8 V; R_L = 75 Ω; T_{amb} = 25 °C			
V_p = 200 mV at f_p = 250 MHz			
V_q = 200 mV at f_q = 560 MHz			
measured at $f_{(p+q)}$ = 810 MHz	d_2	typ.	−50 dB

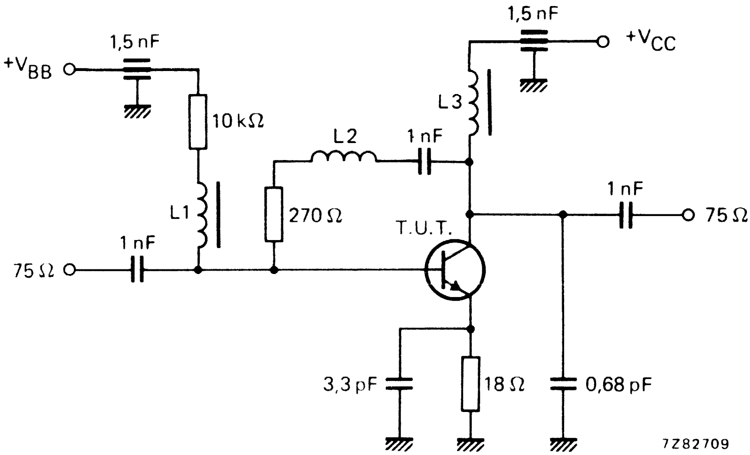


Fig. 2 Intermodulation distortion and second harmonic distortion MATV test circuit.

L1 = L3 = 5 μH micro choke
L2 = 3 turns Cu wire (0,4 mm); internal diameter 3 mm; winding pitch 1 mm.

* Measured on same crystal in a SOT-37 envelope (BFR91A).

s-parameters (common emitter)

V_{CE} V	I_C mA	f MHz	s_{ie}	s_{re}	s_{fe}	s_{oe}
		40	0,89/ −12,4°	0,016/82,3°	7,0/171,8°	0,88/ −4,8°
		100	0,87/ −30,1°	0,038/74,2°	6,7/160,1°	0,96/−11,3°
		200	0,80/ −56,3°	0,067/61,8°	6,0/142,3°	0,88/−20,1°
5	2	500	0,64/−109,5°	0,106/44,3°	3,8/110,6°	0,69/−31,9°
		800	0,57/−140,3°	0,116/41,8°	2,7/ 91,5°	0,60/−35,5°
		1000	0,54/−154,5°	0,119/43,9°	2,2/ 82,8°	0,58/−38,0°
		1200	0,53/−166,6°	0,124/48,2°	1,9/ 75,1°	0,56/−40,2°
		40	0,77/ −19,9°	0,015/79,4°	15,1/166,8°	0,97/ −8,8°
		100	0,72/ −46,9°	0,033/68,6°	13,5/149,7°	0,89/−19,6°
		200	0,62/ −81,4°	0,053/57,0°	10,5/128,5°	0,73/−30,3°
5	5	500	0,48/−134,4°	0,079/52,6°	5,5/100,5°	0,51/−37,3°
		800	0,45/−159,8°	0,099/57,8°	3,6/ 85,6°	0,44/−37,9°
		1000	0,44/−170,8°	0,114/61,0°	3,0/ 78,8°	0,42/−39,3°
		1200	0,43/ 179,8°	0,131/64,2°	2,5/ 72,9°	0,41/−40,9°
		40	0,63/ −29,7°	0,013/76,5°	24,4/161,0°	0,95/−13,5°
		100	0,56/ −66,2°	0,028/64,8°	20,0/139,4°	0,80/−17,8°
		200	0,47/−105,4°	0,042/57,8°	13,6/118,0°	0,59/−37,3°
5	10	500	0,41/−152,0°	0,070/62,6°	6,4/ 94,8°	0,39/−39,0°
		800	0,39/−171,7°	0,099/67,6°	4,1/ 82,7°	0,35/−38,2°
		1000	0,39/ 179,6°	0,119/69,1°	3,4/ 76,7°	0,34/−39,1°
		1200	0,39/ 171,6°	0,140/70,5°	2,8/ 71,5°	0,33/−40,7°
		40	0,47/ −44,2°	0,012/73,8°	35,2/154,0°	0,90/−19,2°
		100	0,42/ −90,7°	0,023/63,9°	25,4/129,3°	0,68/−35,0°
		200	0,39/−129,4°	0,034/62,9°	15,6/109,7°	0,47/−41,0°
5	20	500	0,37/−165,1°	0,067/70,5°	6,8/ 90,9°	0,32/−38,4°
		800	0,37/ 179,5°	0,101/73,2°	4,4/ 80,3°	0,29/−37,4°
		1000	0,36/ 173,0°	0,124/73,4°	3,6/ 75,4°	0,29/−38,3°
		1200	0,37/ 166,2°	0,148/73,6°	3,0/ 70,3°	0,28/−40,0°
		40	0,39/ −56,3°	0,011/72,3°	40,8/149,5°	0,86/−22,5°
		100	0,38/−106,8°	0,021/64,5°	27,4/124,0°	0,61/−37,9°
		200	0,37/−141,6°	0,032/66,4°	16,0/105,8°	0,41/−41,1°
5	30	500	0,37/−171,0°	0,067/73,5°	6,9/ 88,9°	0,29/−36,6°
		800	0,37/ 175,9°	0,102/75,2°	4,4/ 79,1°	0,27/−36,0°
		1000	0,36/ 170,0°	0,126/74,8°	3,6/ 74,2°	0,27/−37,1°
		1200	0,37/ 163,9°	0,150/74,6°	3,0/ 69,5°	0,27/−39,0°

s-parameters (common emitter)

V_{CE} V	I_C mA	f MHz	s_{ie}	s_{re}	s_{fe}	s_{oe}
		40	0,90/ −12,2°	0,015/82,1°	6,9/171,7°	0,99/ −4,8°
		100	0,88/ −29,2°	0,036/74,5°	6,6/160,4°	0,96/−10,8°
		200	0,81/ −54,7°	0,064/62,4°	5,9/143,1°	0,89/−19,2°
8	2	500	0,64/−107,0°	0,103/44,9°	3,8/111,5°	0,71/−30,6°
		800	0,56/−138,1°	0,112/42,1°	2,7/ 92,2°	0,62/−34,1°
		1000	0,54/−152,6°	0,116/44,1°	2,3/ 83,6°	0,60/−36,4°
		1200	0,52/−165,2°	0,120/48,5°	1,9/ 75,9°	0,58/−38,6°
		40	0,78/ −19,2°	0,014/79,4°	14,8/166,9°	0,98/ −8,6°
		100	0,73/ −44,6°	0,032/69,0°	13,5/150,4°	0,90/−18,7°
		200	0,63/ −78,1°	0,051/57,5°	10,5/129,4°	0,75/−28,9°
8	5	500	0,48/−131,2°	0,077/52,5°	5,6/101,3°	0,53/−35,7°
		800	0,44/−157,3°	0,096/57,7°	3,7/ 86,3°	0,46/−36,2°
		1000	0,42/−168,3°	0,110/61,0°	3,0/ 79,5°	0,44/−37,5°
		1200	0,42/−178,3°	0,126/64,3°	2,6/ 73,6°	0,43/−39,0°
		40	0,66/ −27,7°	0,013/76,7°	24,0/161,5°	0,95/−12,9°
		100	0,58/ −62,0°	0,027/65,4°	19,9/140,4°	0,81/−26,3°
		200	0,48/−100,1°	0,041/58,0°	13,8/119,0°	0,61/−35,5°
8	10	500	0,40/−148,2°	0,068/62,2°	6,5/ 95,4°	0,42/−37,0°
		800	0,38/−169,1°	0,096/67,4°	4,2/ 83,0°	0,37/−36,2°
		1000	0,37/−178,3°	0,116/69,0°	3,4/ 77,4°	0,36/−37,0°
		1200	0,37/ 173,6°	0,136/70,5°	2,9/ 72,5°	0,35/−38,5°
		40	0,53/ −39,6°	0,012/73,8°	34,7/154,8°	0,91/−18,1°
		100	0,45/ −83,0°	0,023/63,9°	25,6/130,5°	0,70/−33,2°
		200	0,39/−122,0°	0,034/62,2°	15,9/110,6°	0,49/−39,0°
8	20	500	0,35/−161,3°	0,066/69,7°	7,0/ 91,4°	0,34/−36,2°
		800	0,35/−177,9°	0,098/72,7°	4,5/ 80,7°	0,31/−35,1°
		1000	0,34/ 175,2°	0,121/73,1°	3,7/ 75,8°	0,31/−36,0°
		1200	0,34/ 168,3°	0,143/73,4°	3,1/ 71,2°	0,30/−37,5°
		40	0,47/ −48,0°	0,011/72,2°	40,3/150,8°	0,87/−20,9°
		100	0,41/ −95,5°	0,021/63,8°	27,5/125,4°	0,63/−35,7°
		200	0,36/−132,8°	0,032/64,9°	16,4/106,8°	0,44/−38,9°
8	30	500	0,35/−166,6°	0,065/72,3°	7,1/ 89,6°	0,32/−34,4°
		800	0,34/ 178,8°	0,100/74,4°	4,5/ 79,7°	0,30/−33,6°
		1000	0,34/ 172,7°	0,122/74,4°	3,7/ 74,7°	0,30/−34,7°
		1200	0,34/ 166,0°	0,145/74,3°	3,1/ 70,3°	0,29/−36,5°

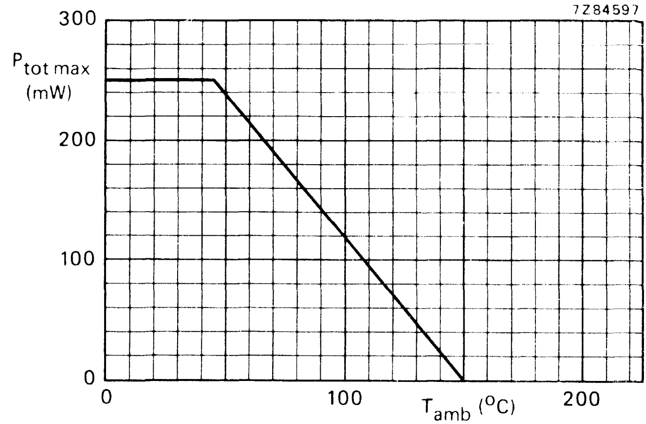


Fig. 3 Power derating curve.

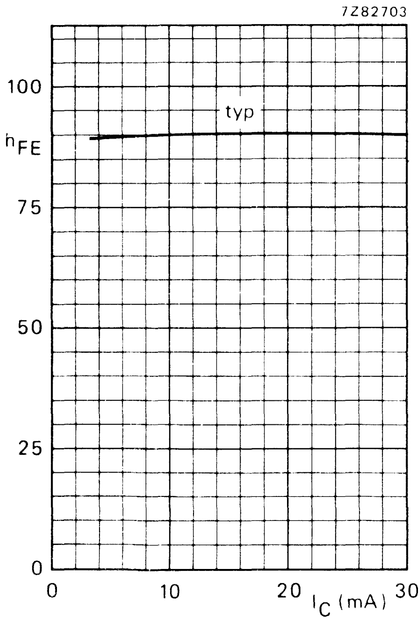


Fig. 4 V_{CE} = 5 V; T_j = 25 °C.

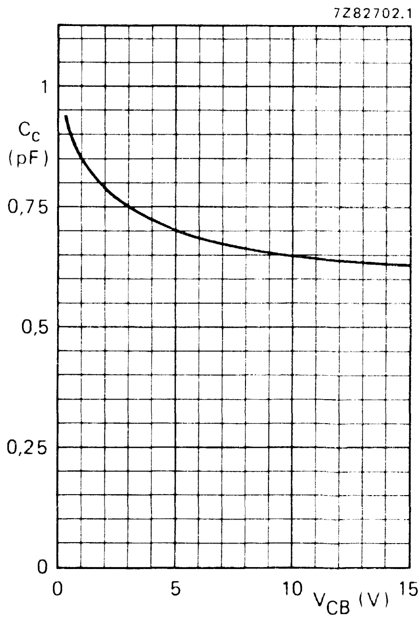


Fig. 5 Typical values collector capacitance $I_E = I_e = 0$; f = 1 MHz; T_j = 25 °C.

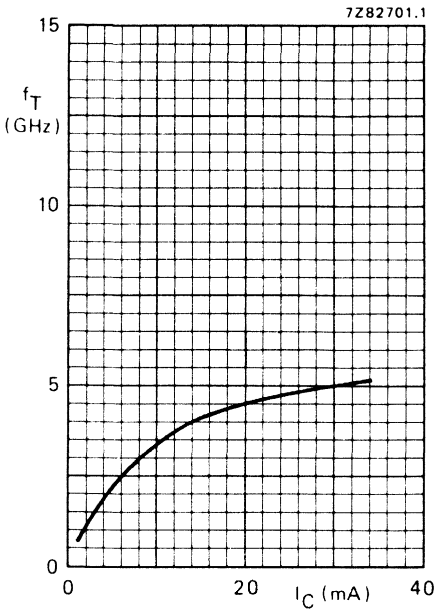


Fig. 6 Typical values transition frequency at V_{CE} = 5 V; f = 500 MHz; T_j = 25 °C.

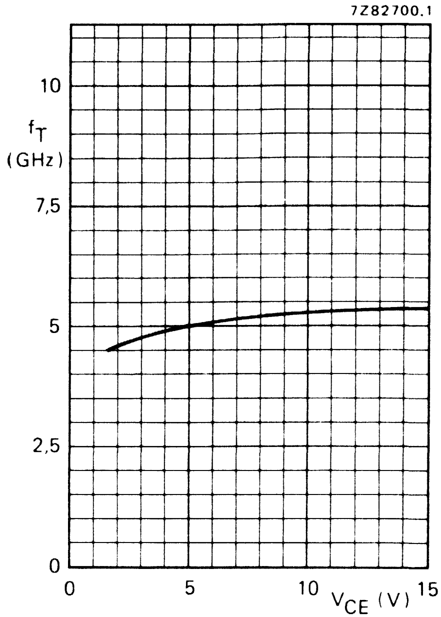


Fig. 7 Typical values transition frequency at I_C = 30 mA; f = 500 MHz; T_j = 25 °C.

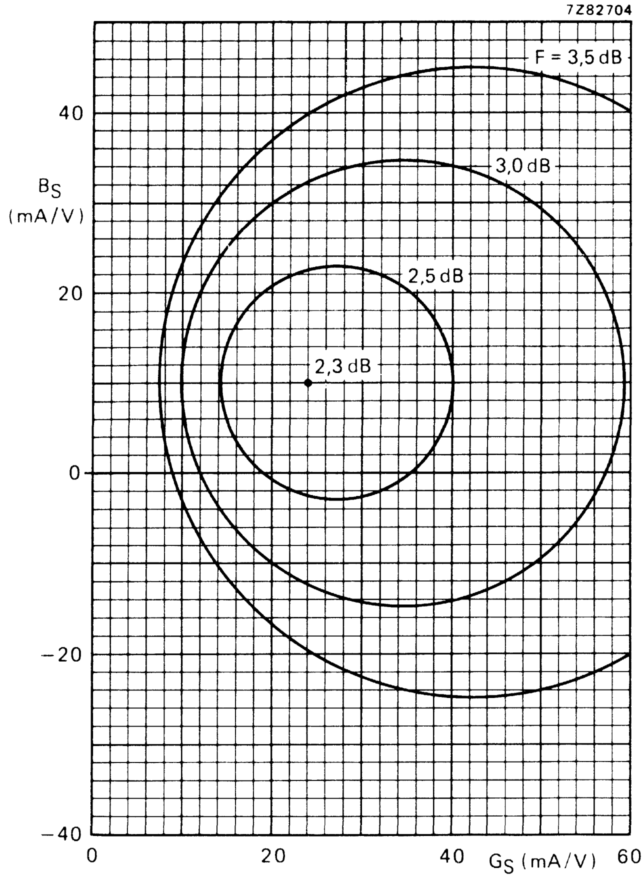


Fig. 8 Circles of constant noise figure.
V_{CE} = 8 V; I_C = 30 mA; f = 800 MHz;
T_{amb} = 25 °C; typical values.

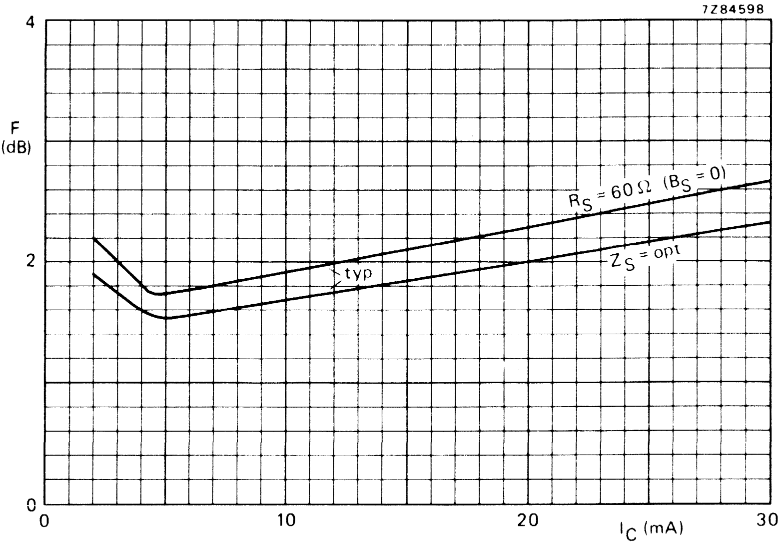


Fig. 9 V_{CE} = 8 V; f = 800 MHz; T_{amb} = 25 °C.

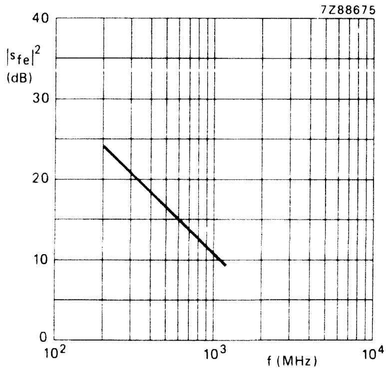


Fig. 10 Typical values forward transmission coefficient as a function of frequency. V_{CE} = 8 V; I_C = 30 mA; T_{amb} = 25 °C.

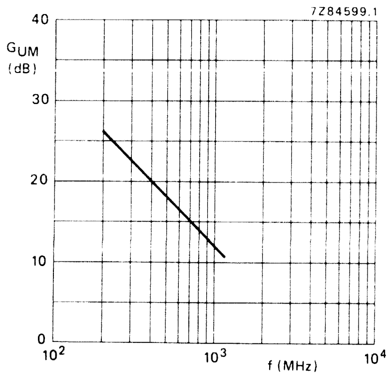


Fig. 11 Typical values unilateral power power gain as a function of frequency. V_{CE} = 8 V; I_C = 30 mA; T_{amb} = 25 °C.

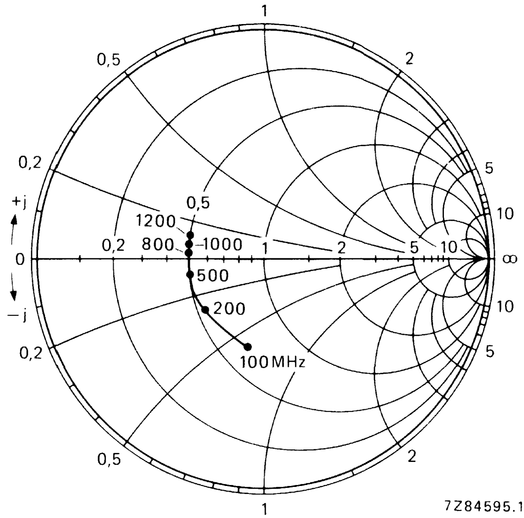


Fig. 12 Input impedance derived from input reflection coefficient s_{ie} co-ordinates in ohm x 50.
V_{CE} = 8 V; I_C = 30 mA; T_{amb} = 25 °C.

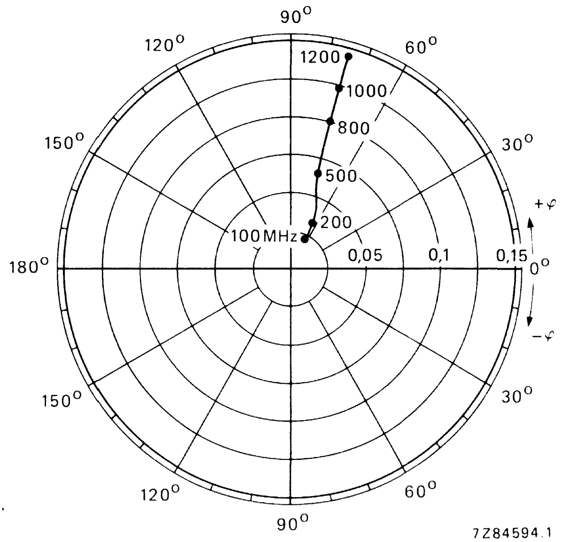


Fig. 13 Reverse transmission coefficient s_{re}.
V_{CE} = 8 V; I_C = 30 mA; T_{amb} = 25 °C.

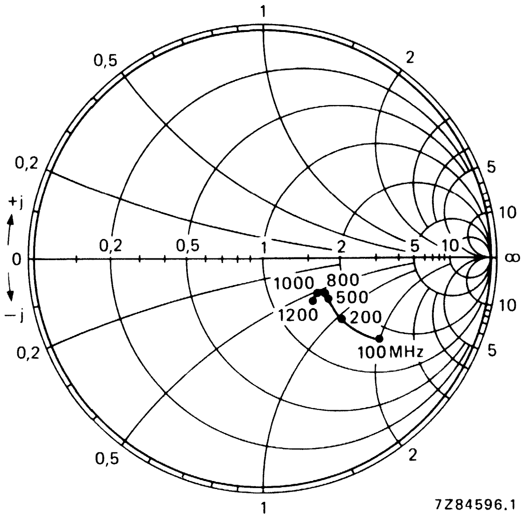


Fig. 14 Output impedance derived from output reflection coefficient s_{oe} co-ordinates in ohm x 50.
V_{CE} = 8 V; I_C = 30 mA; T_{amb} = 25 °C.

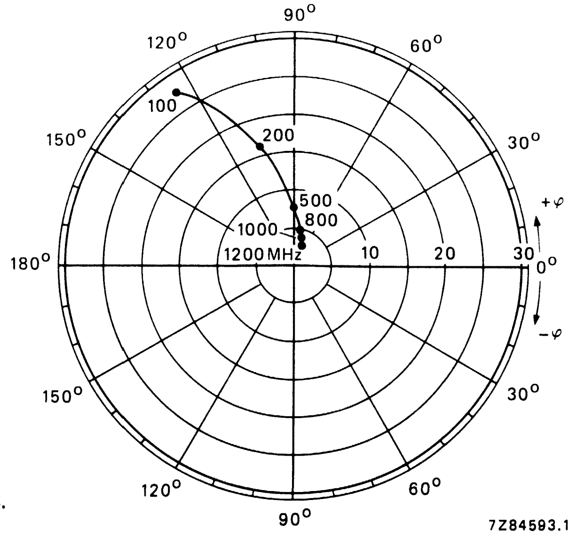


Fig. 15 Forward transmission coefficient s_{fe}.
V_{CE} = 8 V; I_C = 30 mA; T_{amb} = 25 °C.

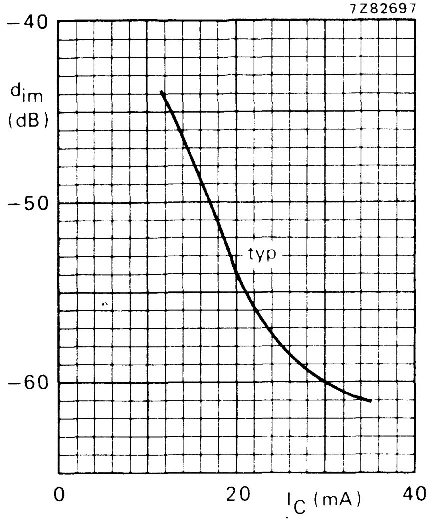


Fig. 16 V_{CE} = 8 V; V_o = 425 mV = 52,6 dBmV; $f_{(p+q-r)}$ = 793,25 MHz; T_{amb} = 25 °C; measured in MATV test circuit (see Fig. 2).

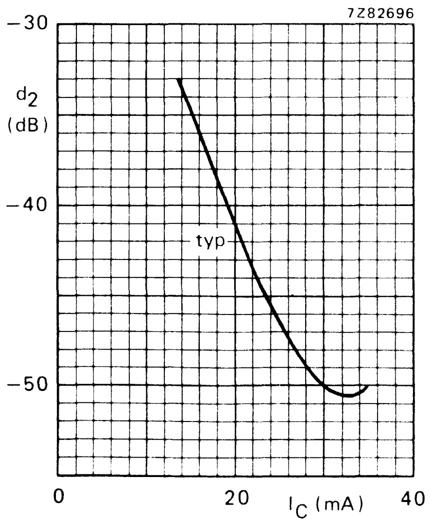


Fig. 17 V_{CE} = 8 V; V_o = 200 mV = 46 dBmV; $f_{(p+q)}$ = 810 MHz; T_{amb} = 25 °C; measured in MATV test circuit (see Fig. 2).

N-CHANNEL JUNCTION FIELD-EFFECT TRANSISTOR

Symmetrical n-channel silicon junction field-effect transistor, designed primarily for use as a source follower with the input protected against successive voltage surges by a forward and reverse integrated diode.

QUICK REFERENCE DATA

Drain-source voltage	$\pm V_{DS}$	max.	30	V
Gate-source voltage (open drain)	$-V_{GS}$	max.	30	V
Total power dissipation up to T_{amb} = 60 °C	P_{tot}	max.	200	mW
Drain current				
V_{DS} = 6 V; V_{GS} = 0: BFR101A	I_{DSS}		0,2 to 1,5	mA
V_{DS} = 6 V; V_{GS} = 0: BFR101B	I_{DSS}		1,0 to 5,0	mA
Transfer admittance (common source)				
V_{DS} = 6 V; V_{GS} = 0; f = 1 kHz: BFR101A	$\lvert y_{fs} \rvert$	>	1,2	mA/V
V_{DS} = 6 V; V_{GS} = 0; f = 1 kHz: BFR101B	$\lvert y_{fs} \rvert$	>	2,5	mA/V

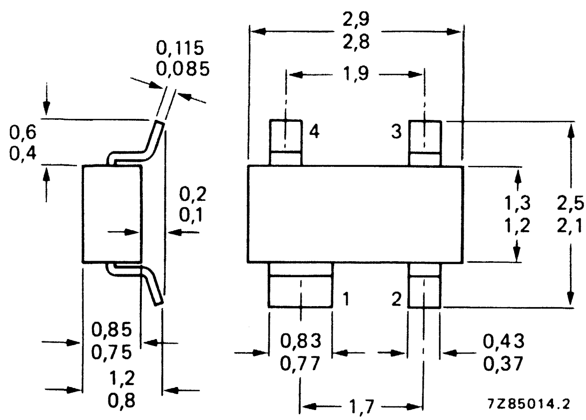
MECHANICAL DATA

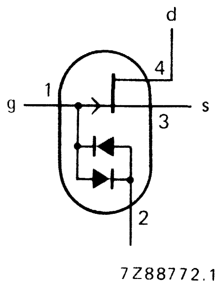
Dimensions in mm

Fig. 1 SOT-143.

Marking code

BFR101A = M97
BFR101B = M98





See also *Soldering recommendations.*

RATINGS

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

Drain-source voltage	$\pm V_{DS}$	max.	30 V
Drain-gate voltage (open source)	V_{DGO}	max.	30 V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30 V
Drain current (d.c.)	I_D	max.	20 mA
Gate current (d.c.)	I_G	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 RESISTANCE

From junction to ambient in free air*	$R_{th\ j\text{-}a}$	=	460 K/W

CHARACTERISTICS with source connected to case for all measurements

T_{amb} = 25 °C unless otherwise specified

		BFR101A	BFR101B
Gate leakage current V_{DS} = 6 V; I_D = 10 μA	$-I_G$	< 5	5 nA
Drain current* V_{DS} = 6 V; V_{GS} = 0	I_{DSS}	0,2 to 1,5	1 to 5 mA
Gate-source cut-off voltage V_{DS} = 6 V; I_D = 1 μA	$-V_{(P)GS}$	0,2 to 1	0,5 to 2,5 V
Small-signal common-source characteristics V_{DS} = 6 V; V_{GS} = 0			
Transfer admittance* f = 1 kHz	$\lvert y_{fs} \rvert$	> 1,2	2,5 mA/V
Output admittance at f = 1 kHz**	$\lvert y_{os} \rvert$	typ. 10	50 μA/V
Input capacitance at f = 1 MHz diodes not connected	C_{is}	< 5	5 pF
Diode capacitance V_D = 0; source and drain not connected	C_d	typ. 0,7	0,7 pF
Diode forward voltage $\pm I_F$ = 10 mA	V_F	0,7 to 1,2	0,7 to 1,2 V

* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0,6 mm.

** Measured under pulse conditions: t_p = 100 ms; $\delta \leqslant 0,1$.

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.

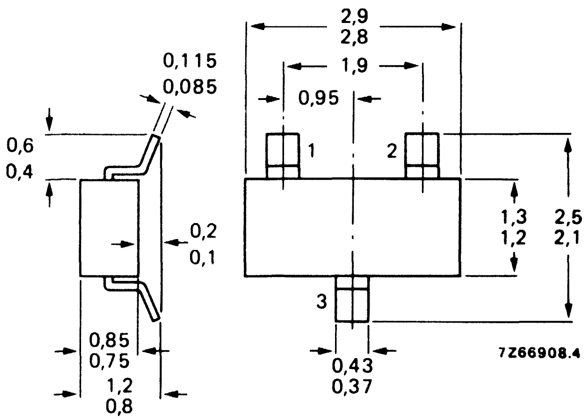
QUICK REFERENCE DATA

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

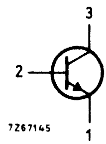
Dimensions in mm

Fig. 1 SOT-23.

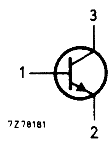


Marking code

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	$R_{th\ t\text{-}s}$	=	280 K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90 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 8 mm x 10 mm x 0,7 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

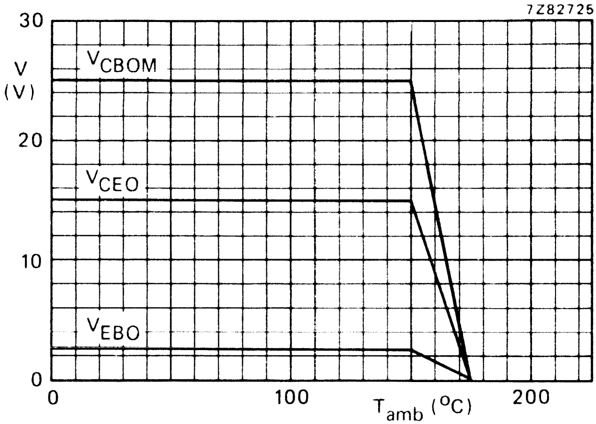


Fig. 2 Voltage derating curve.

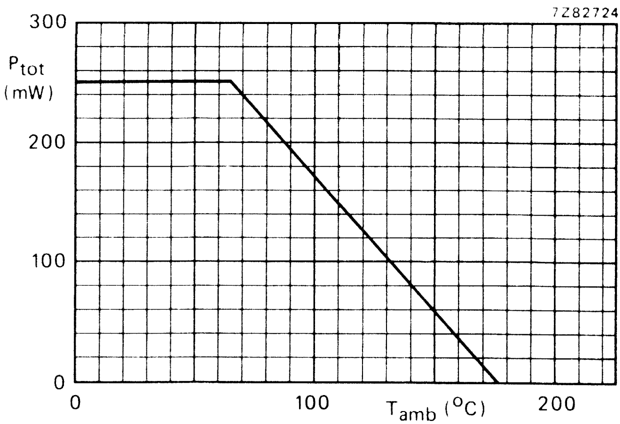
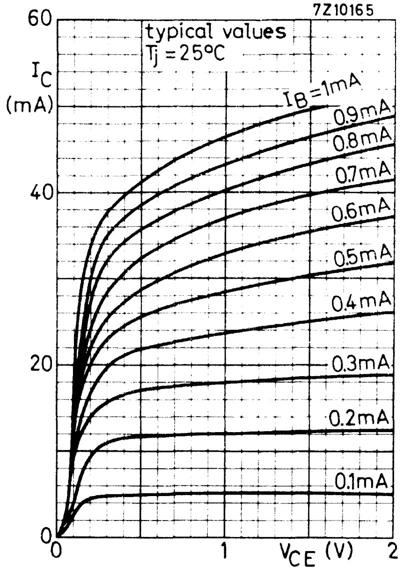
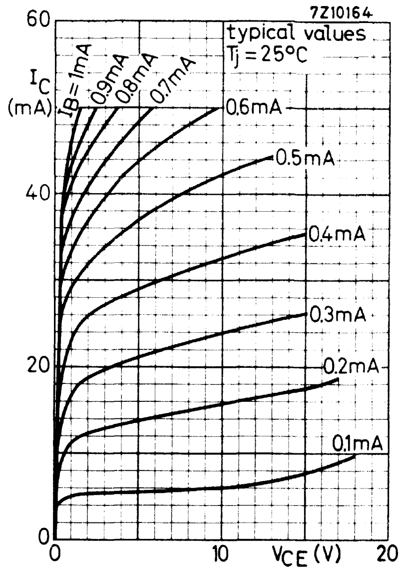
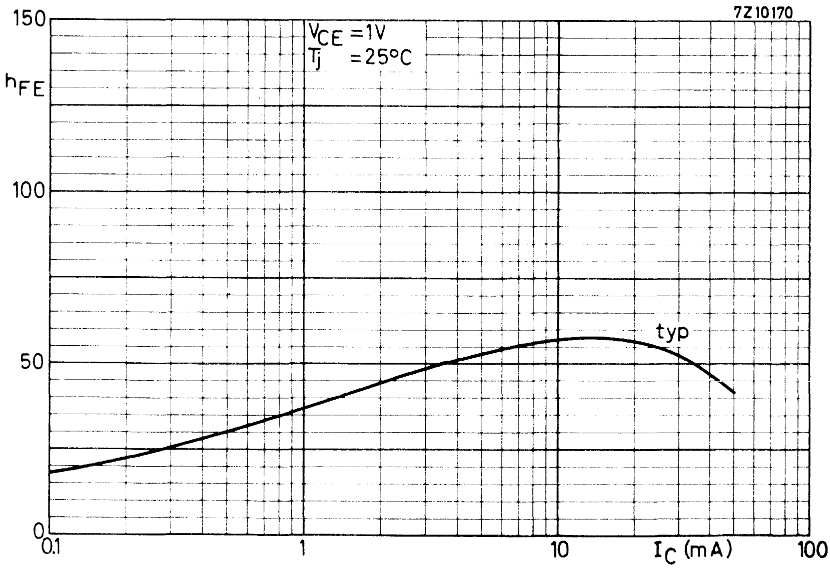


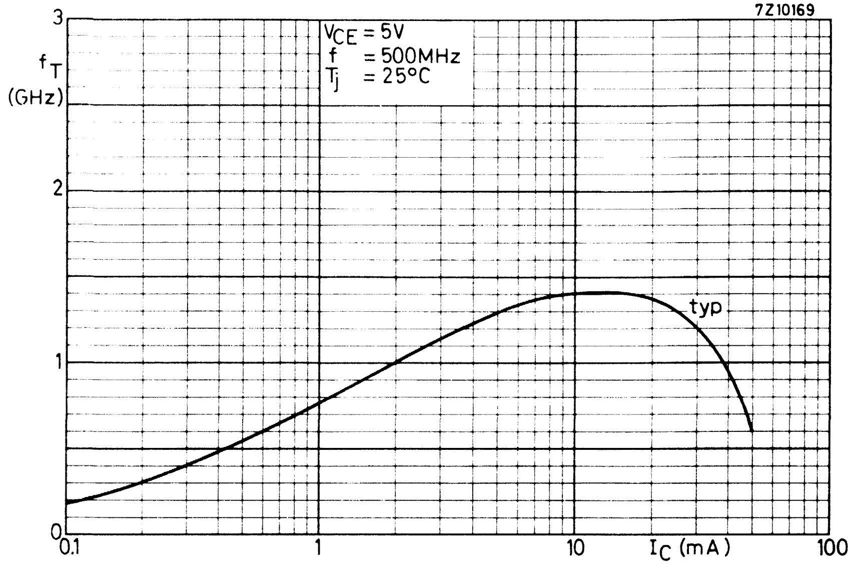
Fig. 3 Power derating curve.

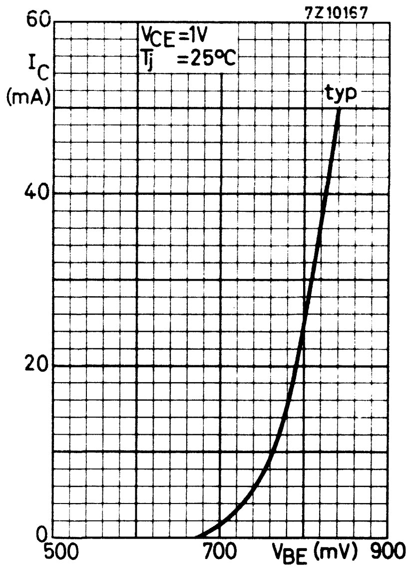
* Crystal mounted in a BFY90 envelope.


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)
60
40
20
0
0
1
2


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)
60
40
20
0
0
10
20


7Z10170
VCE = 1V
Tj = 25°C
hFE
typ
IC (mA)
150
100
50
0
0.1
1
10
100


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


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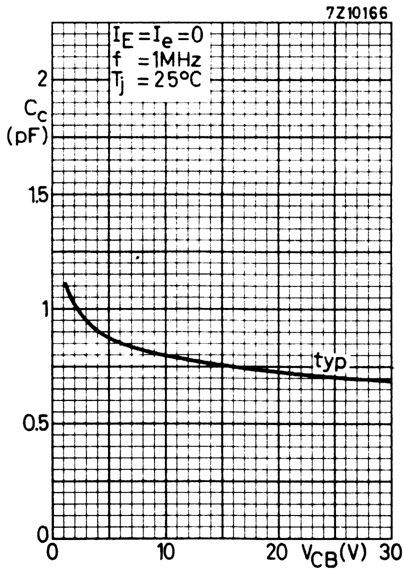
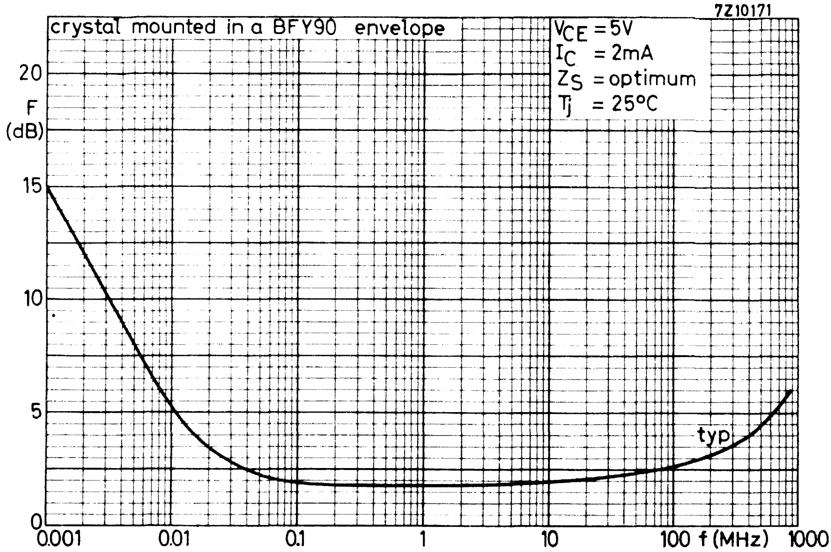
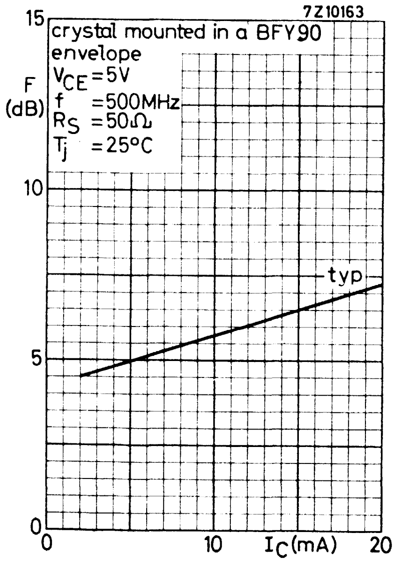
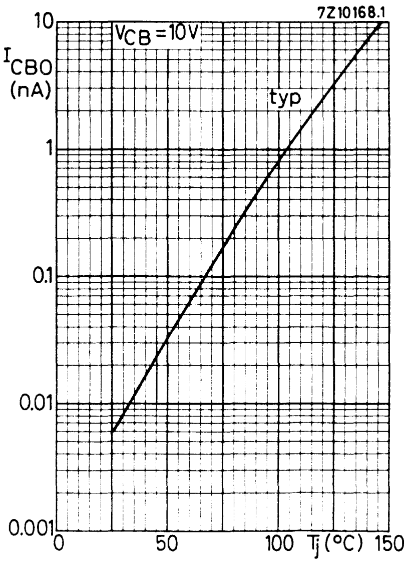
T_j =25°C
I_C (mA)
typ
V_{BE} (mV)
0
20
40
60
500
700
900


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


7Z10171
crystal mounted in a BFY90 envelope
VCE = 5V
IC = 2mA
ZS = optimum
Tj = 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
VCE = 5V
f = 500MHz
RS = 50Ω
Tj = 25°C
F (dB)
15
10
5
0
0
10
IC (mA)
20
typ


7Z10168.1
VCB = 10V
ICBO (nA)
10
1
0.1
0.01
0.001
0
50
100
Tj (°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.

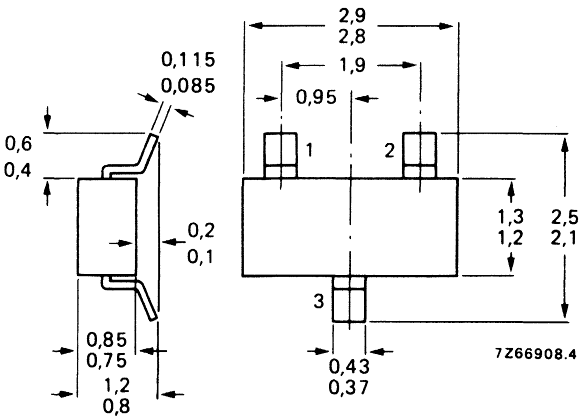
QUICK REFERENCE DATA

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} = 40 °C	P_{tot}	max.	250		mW
Junction temperature	T_j	max.	150		°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

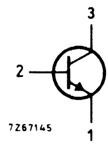
Dimensions in mm

Fig. 1 SOT-23.

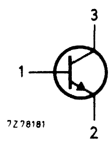


Marking code

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} = 40 °C**	P_{tot}	max.	250	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

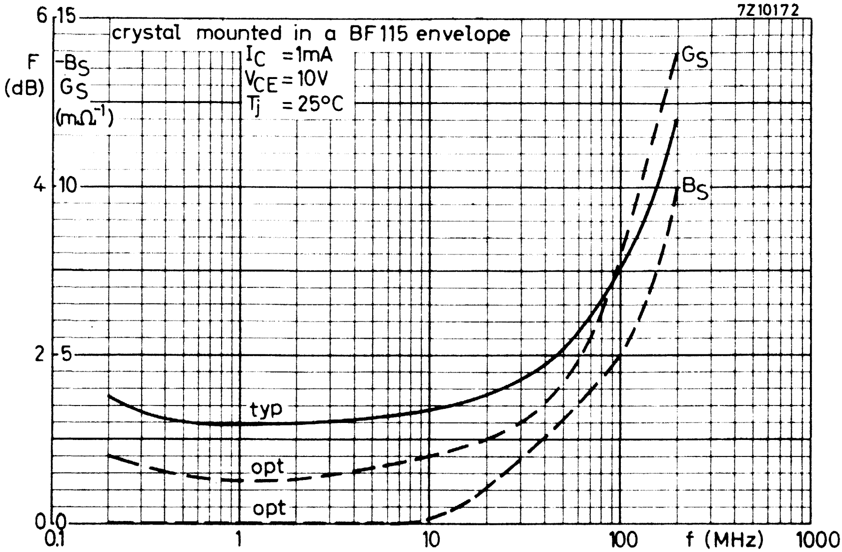
From junction to tab	$R_{th\ j\text{-}t}$	=	60	K/W
→ From tab to soldering points	$R_{th\ t\text{-}s}$	=	280	K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	K/W

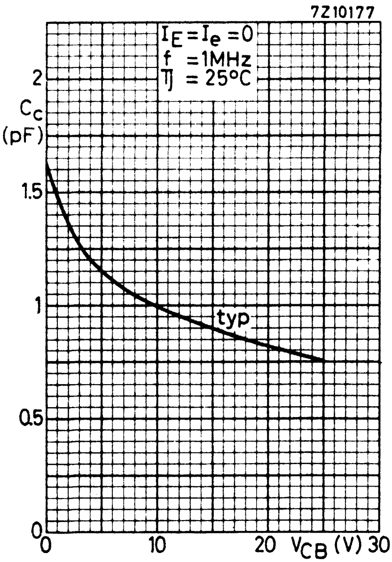
CHARACTERISTICS

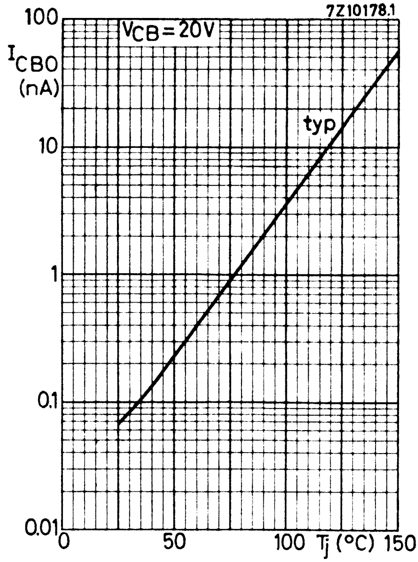
T_j = 25 °C unless otherwise specified

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

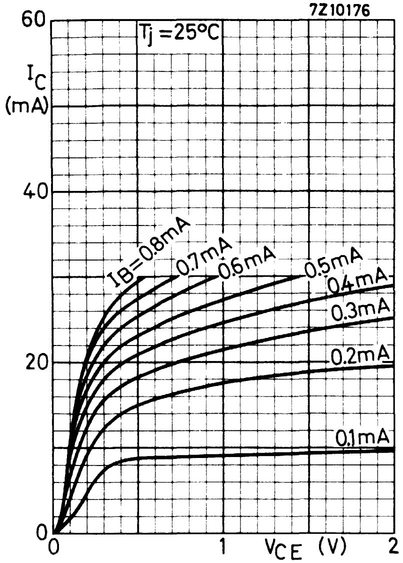
* See *Thermal characteristics* in chapter GENERAL.
** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.
▲ Crystal mounted in a BF115 envelope.

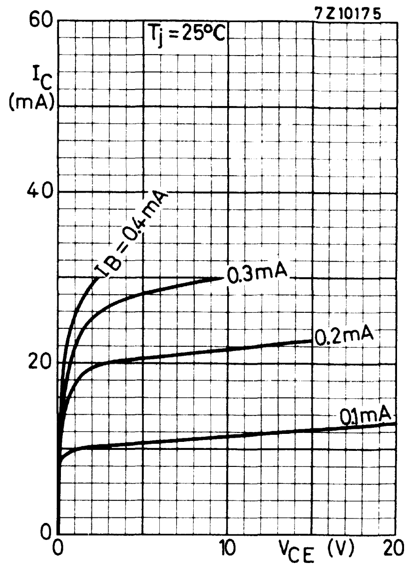

7Z10172
crystal mounted in a BF115 envelope
IC = 1mA
VCE = 10V
Tj = 25°C
F
(dB)
-BS
GS
(mΩ-1)
6
4
2
0
15
10
5
0
GS
BS
typ
opt
opt
0.1
1
10
100
f (MHz)
1000

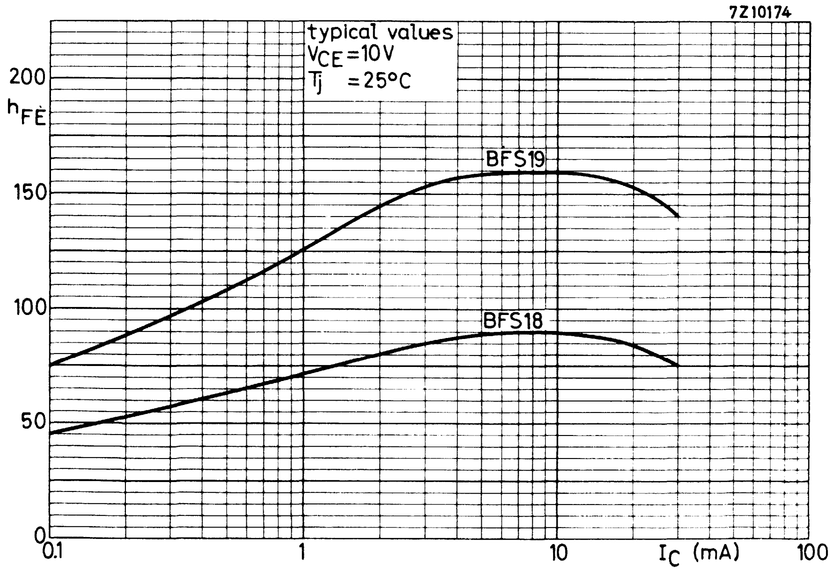

7Z10177
IE = Ie = 0
f = 1MHz
Tj = 25°C
Cc
(pF)
2
1.5
1
0.5
0
typ
0
10
20
VCB (V)
30


7Z10178.1
VCB = 20V
ICBO
(nA)
100
10
1
0.1
0.01
typ
0
50
100
Tj (°C)
150

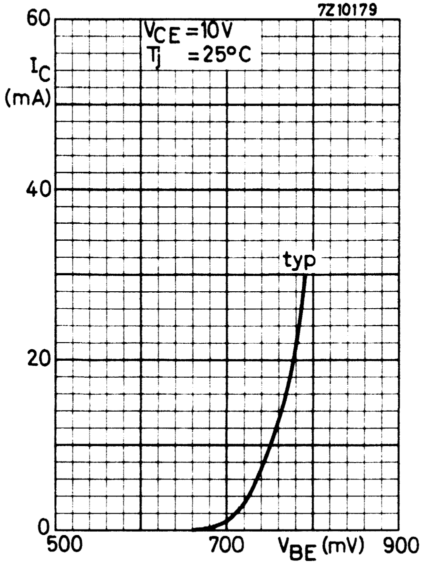
Typical behaviour of collector current versus collector-emitter voltage

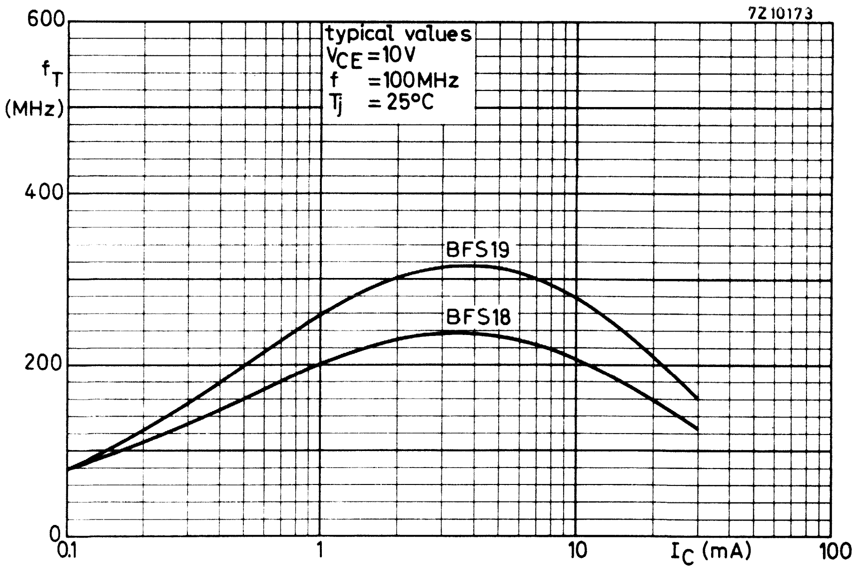






February 1969


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


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

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.

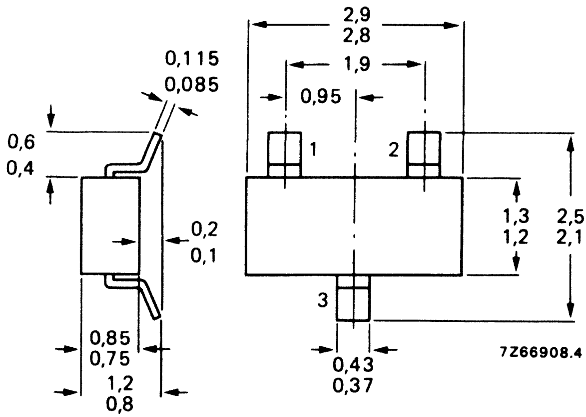
QUICK REFERENCE DATA

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} = 40 °C	P_{tot}	max.	250	mW ←
Junction temperature	T_j	max.	150	°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

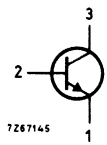
Dimensions in mm

Fig. 1 SOT-23.

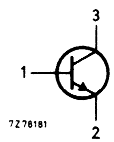


Marking code

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} = 40 °C**	P_{tot}	max.	250	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	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient **	$R_{th\,s\text{-}a}$	=	90	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}	>	40	
		typ.	85	
Transition frequency at f = 100 MHz				
I_C = 5 mA; V_{CE} = 10 V	f_T	>	275	MHz
		typ.	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 8 mm x 10 mm x 0,7 mm.

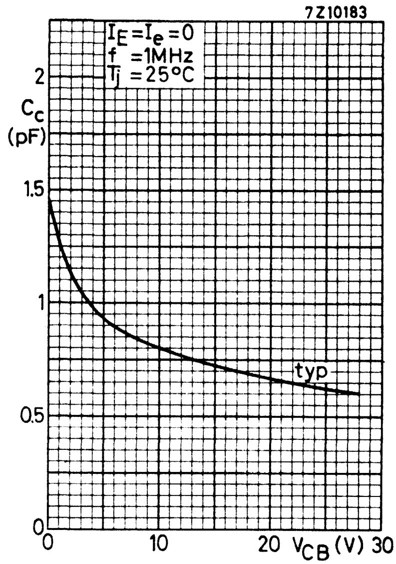


Fig. 2 Voltage derating curves.

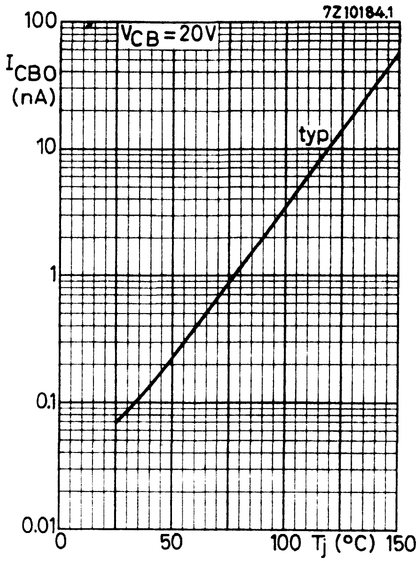
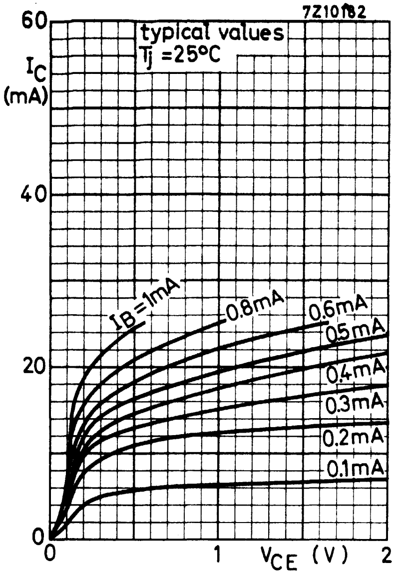
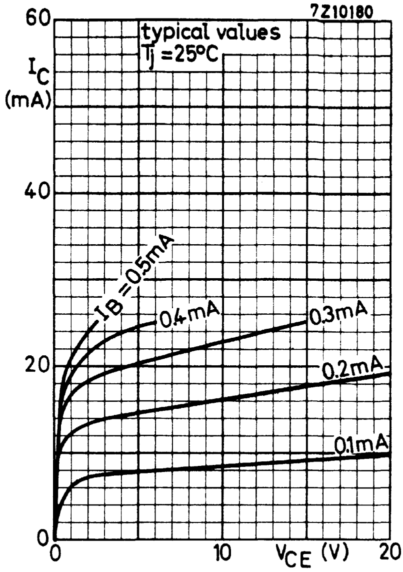
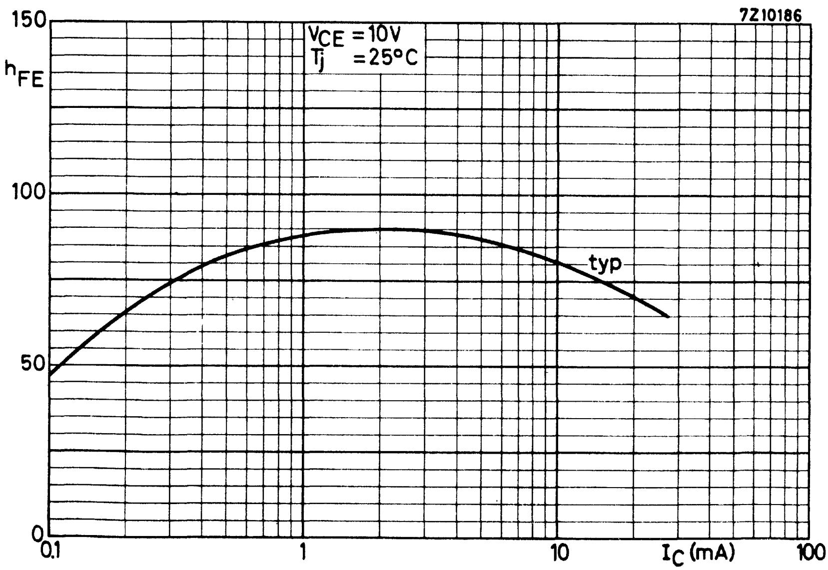
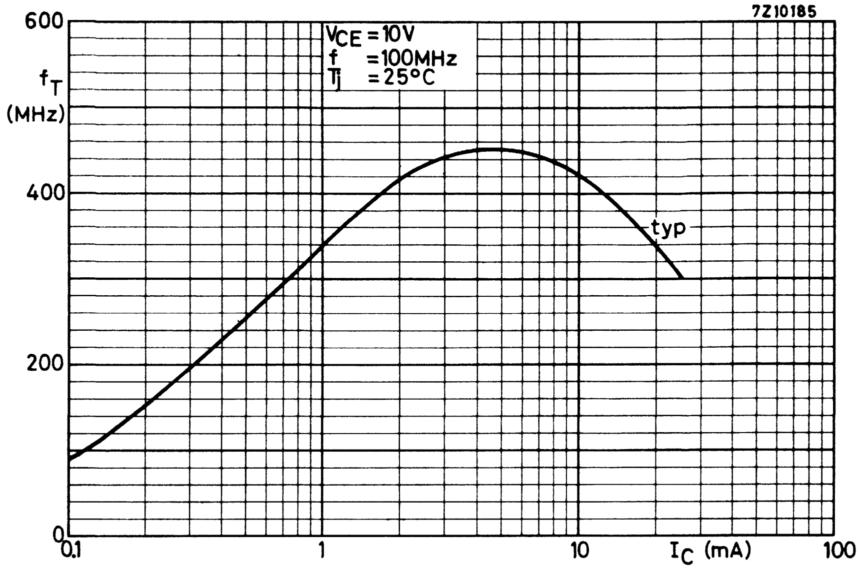


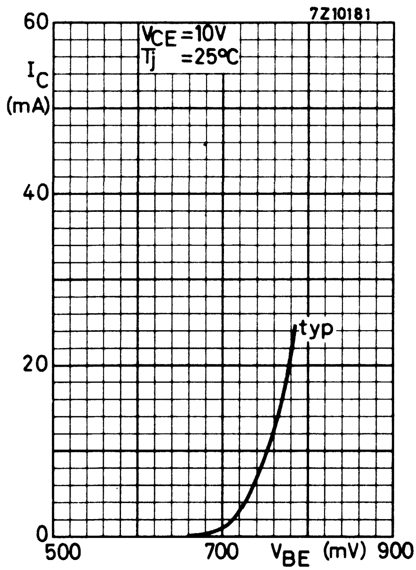
Fig. 3 Power derating curve.


7Z10182
typical values
Tj =25°C
IC (mA)
IB=1mA
0.8mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
VCE (V)


7Z10180
typical values
Tj =25°C
IC (mA)
IB=0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
VCE (V)


7Z10186
VCE =10V
Tj =25°C
hFE
typ
IC (mA)


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


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

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.

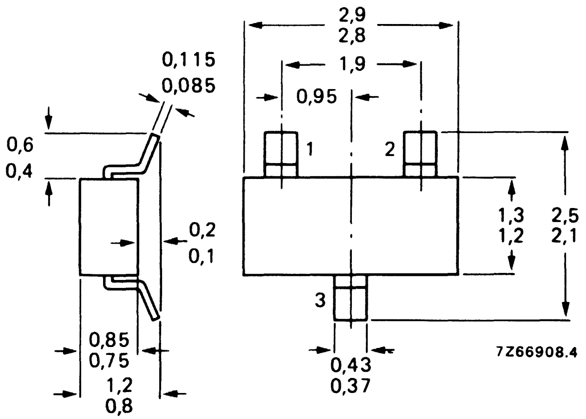
QUICK REFERENCE DATA

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.	6,5	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

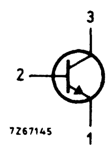
Dimensions in mm

Fig. 1 SOT-23.

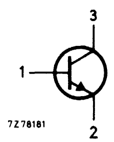


Marking code

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.	6,5	mA
→ Collector current (peak value; f > 1 MHz)	I_{CM}	max.	10	mA
Total power dissipation up to T_{amb} = 125 °C**	P_{tot}	max.	50	mW
Storage temperature	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL CHARACTERISTICS*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60	K/W
→ From tab to soldering points	$R_{th\,t\text{-}s}$	=	280	K/W
→ From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90	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▲ $I_C = 10\ \mu A$; $V_{CE} = 1$ V	h_{FE}	< typ.	20 30	
$I_C = 1$ mA; $V_{CE} = 1$ V	h_{FE}	< typ.	20 40	
Saturation voltages $I_C = 10\ \mu A$; $I_B = 1\ \mu A$	V_{CEsat} V_{BEsat}	< <	200 750	mV mV
$I_C = 1$ mA; $I_B = 0{,}1$ mA	V_{CEsat} V_{BEsat}	< <	175 900	mV mV
Transition frequency at f = 500 MHz▲ $I_C = 1$ mA; $V_{CE} = 1$ V	f_T	> typ.	1,2 2,3	GHz GHz

* See *Thermal characteristics* in chapter GENERAL.
→ ** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 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

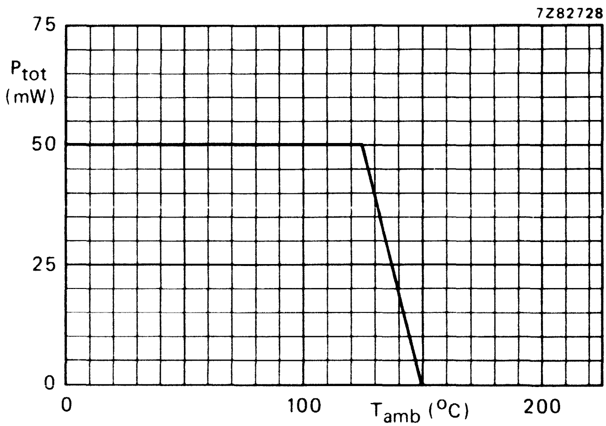
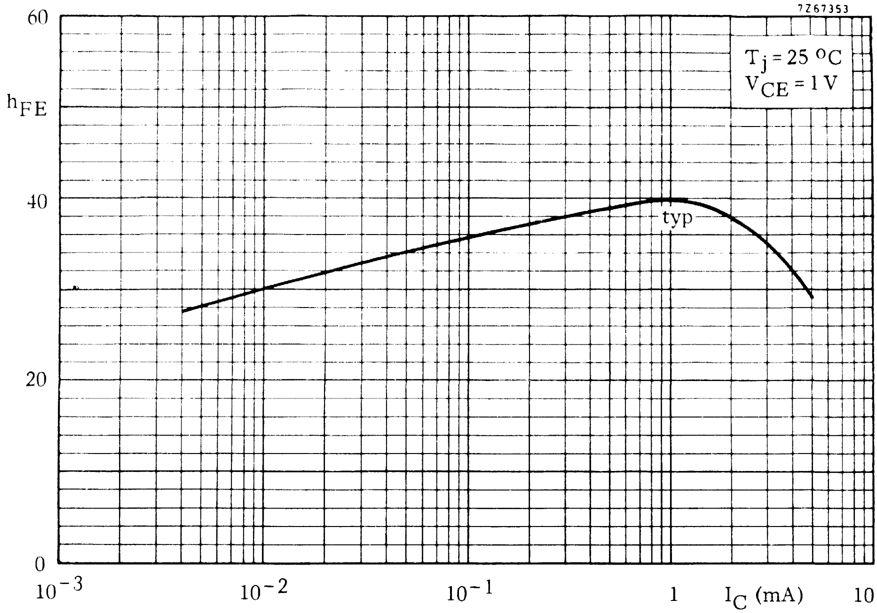
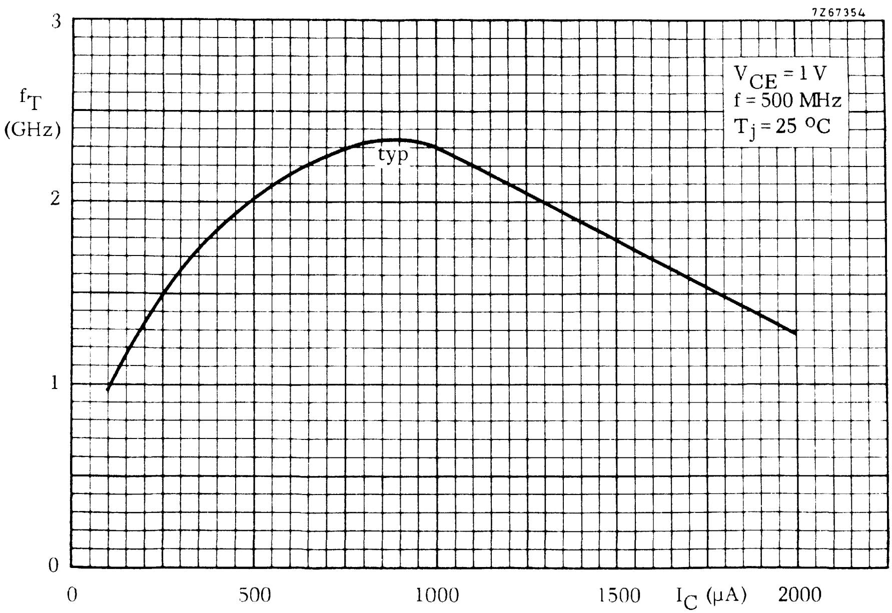
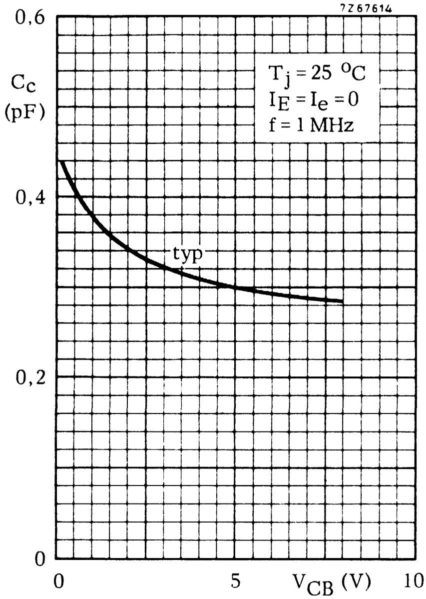
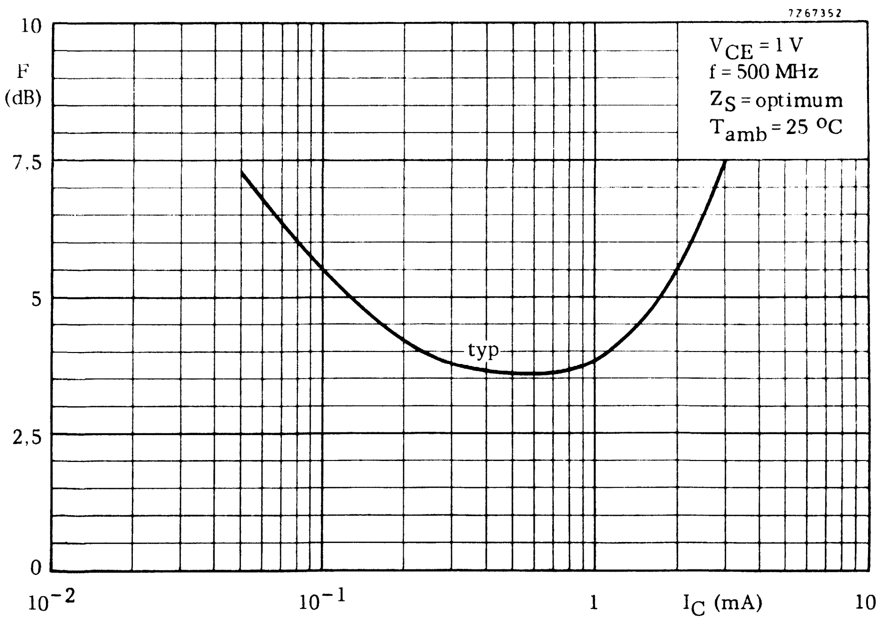


Fig. 2 Power derating curve.

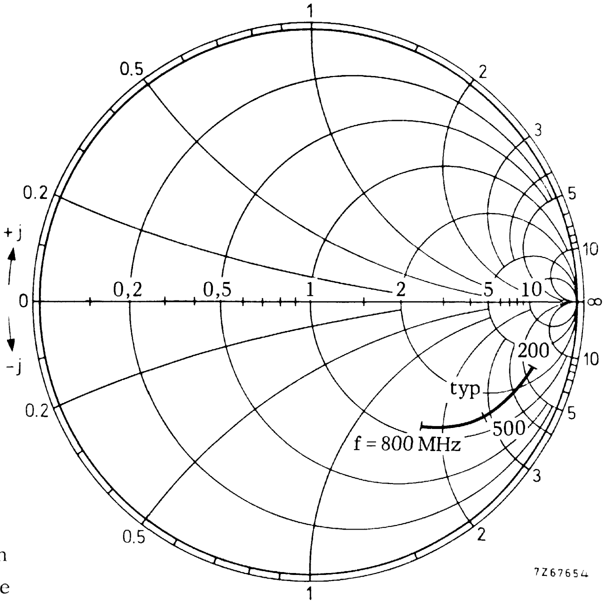

7Z67353
60
40
20
0
h_{FE}
$T_j = 25\ ^oC$
$V_{CE} = 1\ V$
typ
10^{-3}
10^{-2}
10^{-1}
1
I_C (mA)
10


7Z67354
3
2
1
0
f_T
(GHz)
$V_{CE} = 1\ V$
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

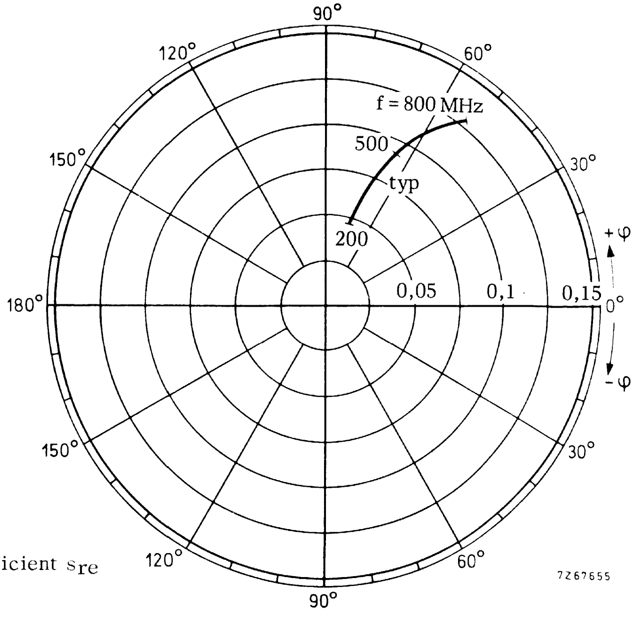

7Z67352
10
F
(dB)
$V_{CE} = 1$ V
f = 500 MHz
Z_S = optimum
$T_{amb} = 25\ ^oC$
7,5
5
typ
2,5
0
10^{-2}
10^{-1}
1
I_C (mA)
10

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



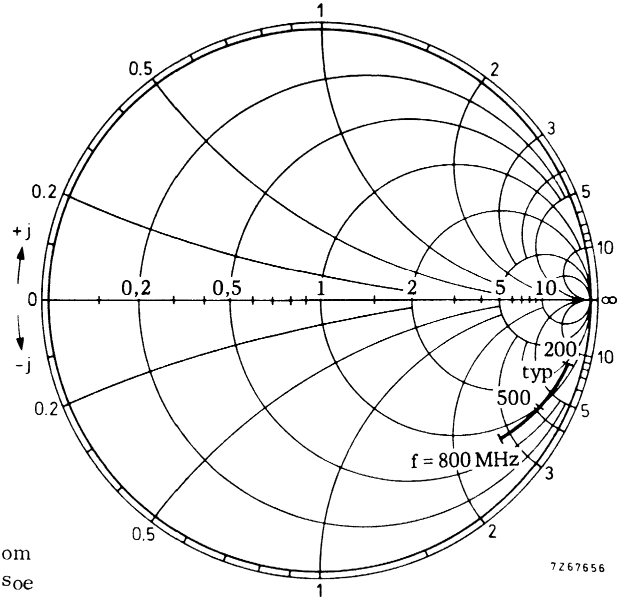
Input impedance derived from input reflection coefficient s_{ie} coordinates in ohm x 50

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



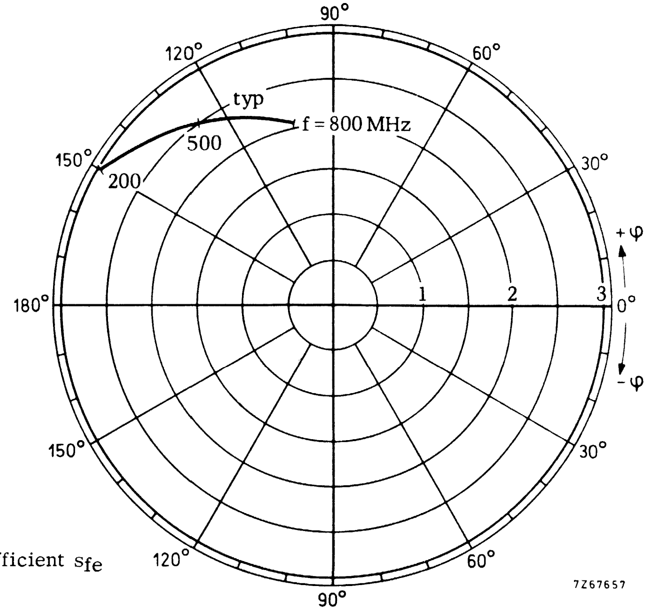
Reverse transmission coefficient s_{re}

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 1,5	mA 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

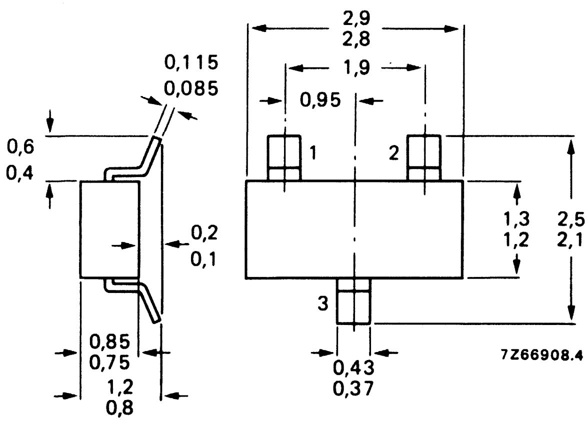
MECHANICAL DATA

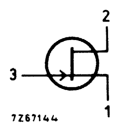
Dimensions in mm

Marking code

Fig. 1 SOT-23.

BFT46 = M3





See also *Soldering recommendations.*

RATINGS

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

Drain-source voltage	$\pm V_{DS}$	max.	25	V
Drain-gate voltage (open source)	V_{DGO}	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V
Drain current	I_D	max.	10	mA
Gate current	I_G	max.	5	mA
Total power dissipation up to T_{amb} = 65 °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	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 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

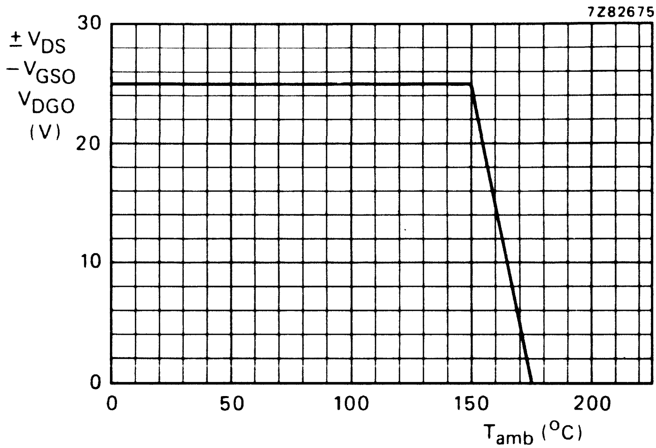


Fig. 2 Voltage derating curve.

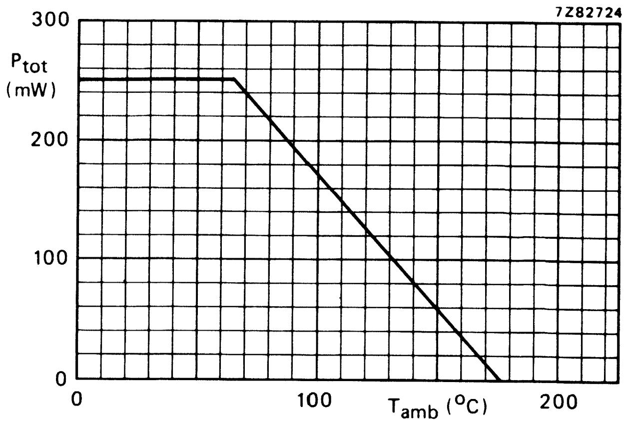


Fig. 3 Power derating curve.

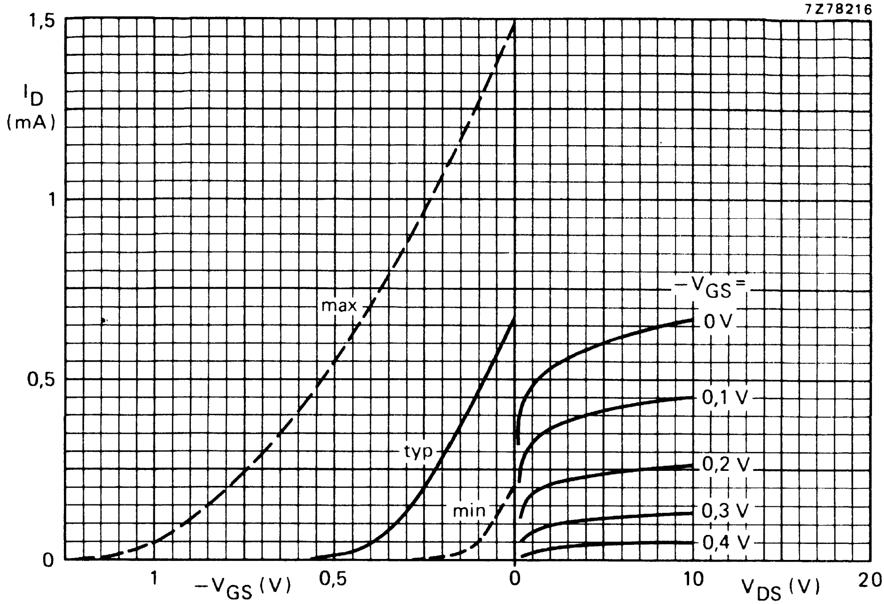


Fig. 4 Typical values. V_{DS} = 10 V; T_j = 25 °C.

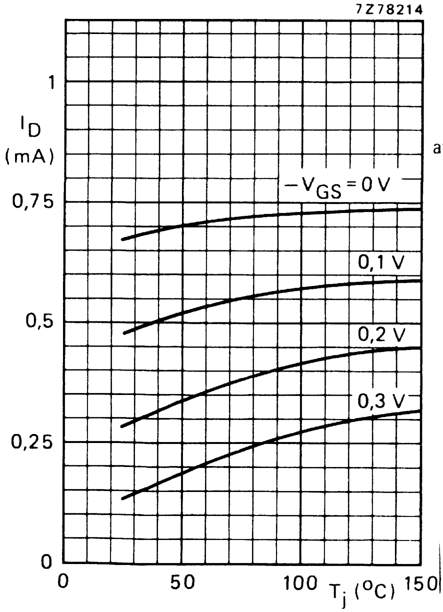


Fig. 5 Typical values. V_{DS} = 10 V.

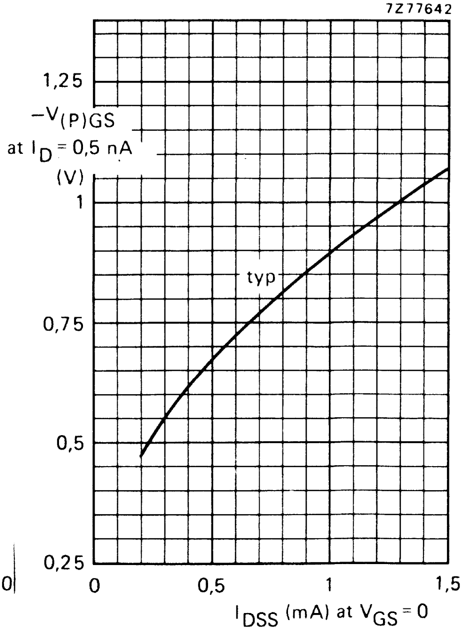


Fig. 6 Correlation between $-V_{(P)GS}$ and I_{DSS}. V_{DS} = 10 V; T_j = 25 °C.

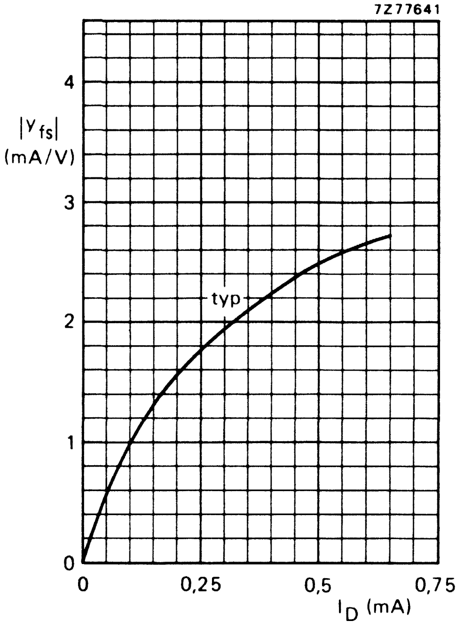


Fig. 7.

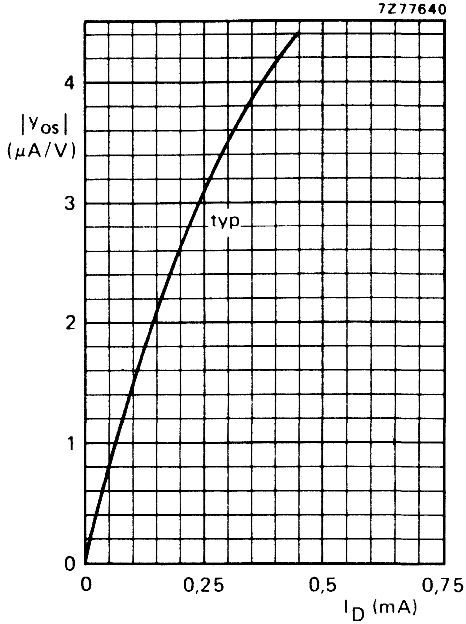


Fig. 8.

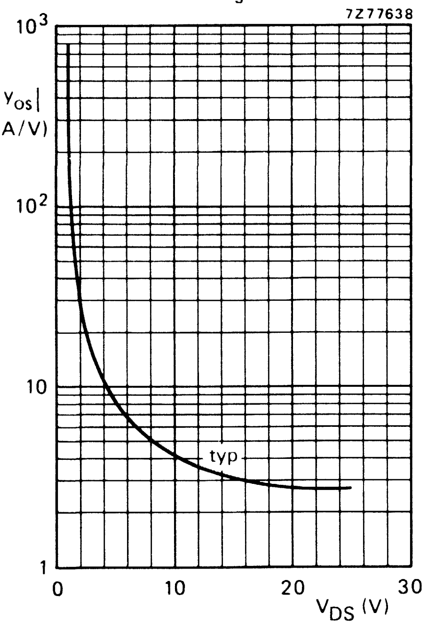


Fig. 9.

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.

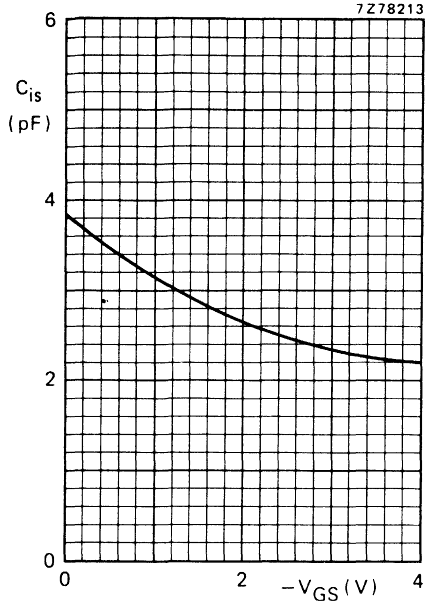


Fig. 10.

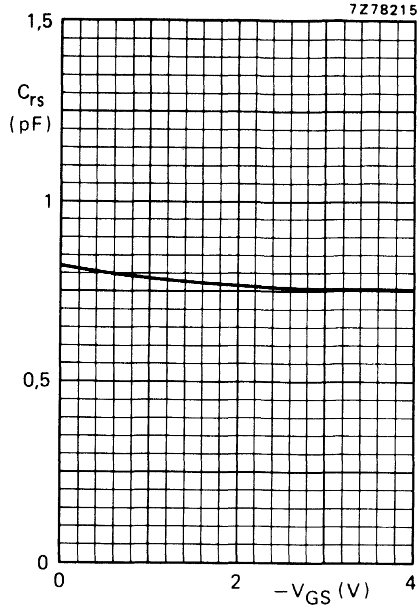


Fig. 11.

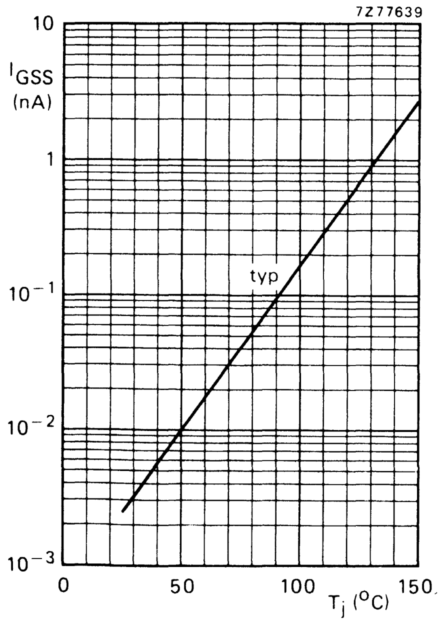


Fig. 12.

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.

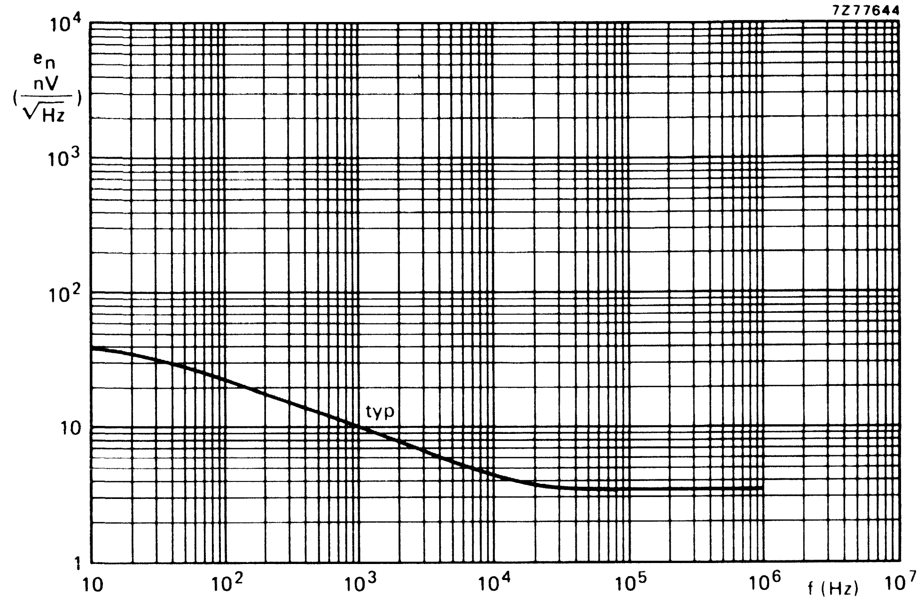


Fig. 13 V_{DS} = 10 V; I_D = 0,2 mA; T_{amb} = 25 °C.

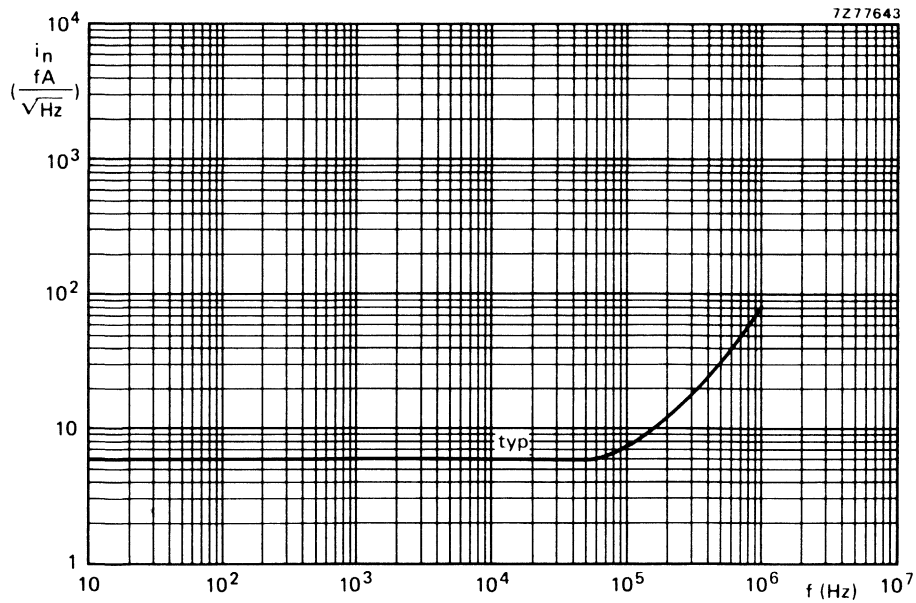


Fig. 14 V_{DS} = 10 V; I_D = 0,2 mA; T_{amb} = 25 °C.

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.

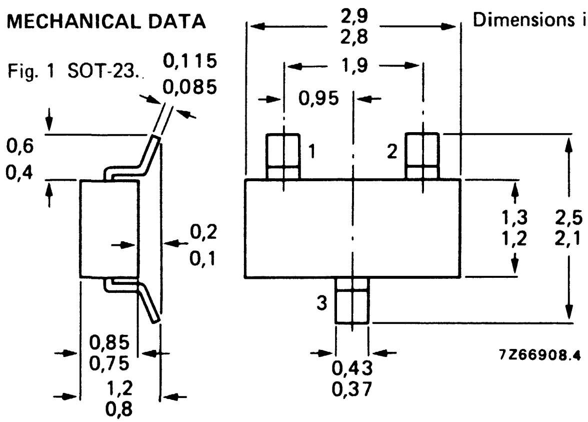
QUICK REFERENCE DATA

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.

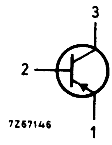
Dimensions in mm



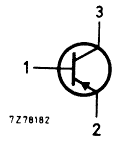
See also *Soldering recommendations.*

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 $T_{amb} = 60\ ^oC$ **	P_{tot}	max.	200	mW
Storage temperature	T_{stg}	−65 to +150		^oC
Junction temperature	T_j	max.	150	^oC

THERMAL CHARACTERISTICS *

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	60	K/W
→ From tab to soldering points	$R_{th\ t\text{-}s}$	=	280	K/W
→ From soldering points to ambient **	$R_{th\ s\text{-}a}$	=	90	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ 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 8 mm x 10 mm x 0,7 mm.

CHARACTERISTICS (continued)

$T_{amb} = 25\ ^oC$

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; $R_L = 75\ \Omega$; 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

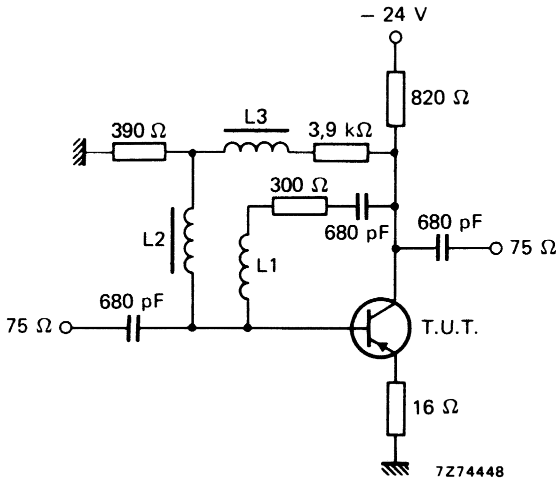


Fig. 2 Intermodulation test circuit.

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.

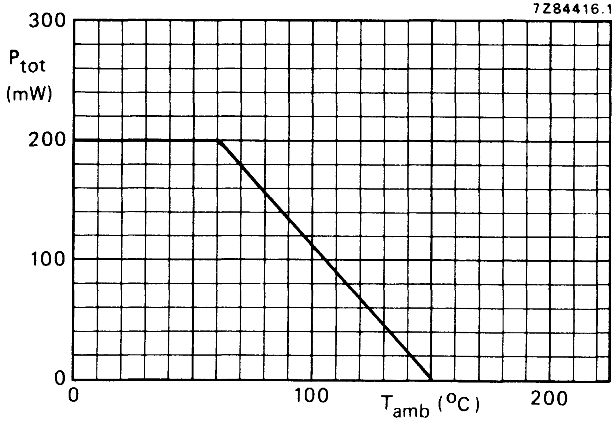


Fig. 3 Power derating curve.

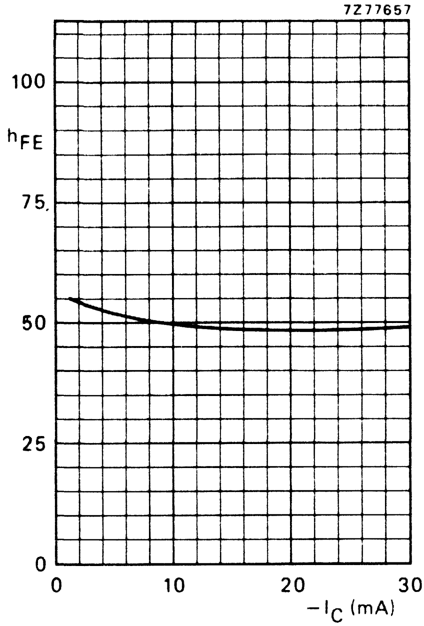


Fig. 4 $-V_{CE}$ = 10 V; T_j = 25 °C.

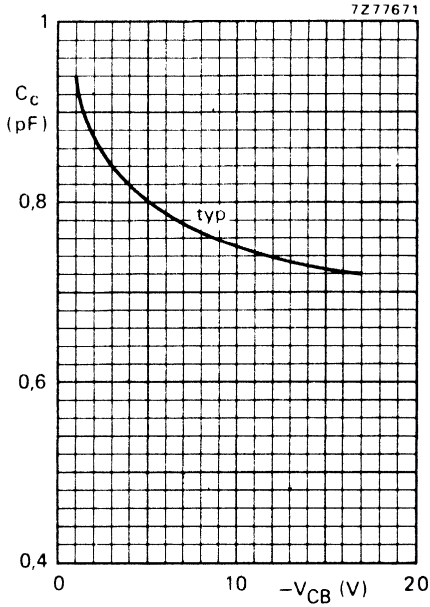


Fig. 5 $I_E = I_e = 0$; T_j = 25 °C; f = 1 MHz.

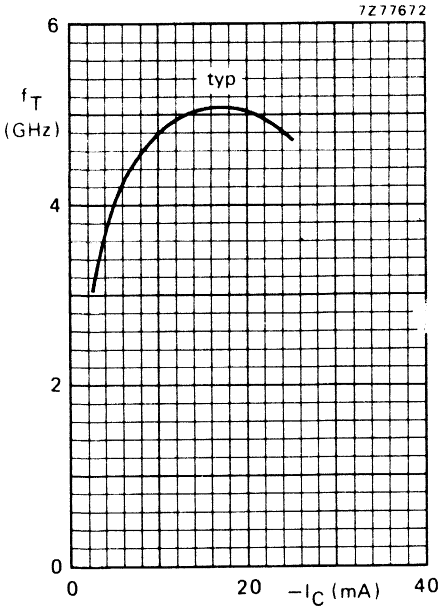


Fig. 6 $-V_{CE}$ = 10 V; f = 500 MHz; T_j = 25 °C.

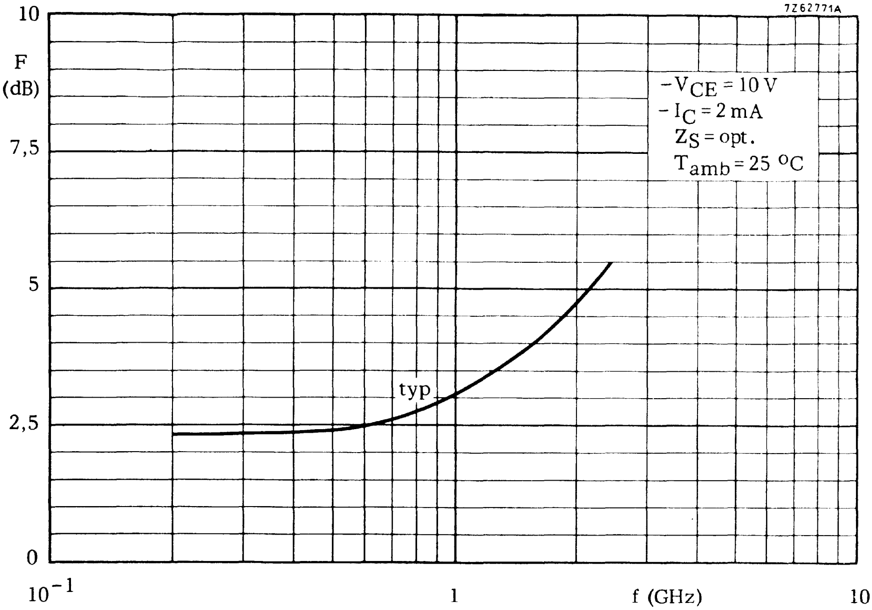

7Z62771A
10
F
(dB)
7,5
5
2,5
0
−V_CE = 10 V
− I_C = 2 mA
Z_S = opt.
T_amb = 25 °C
typ
10^−1
1
f (GHz)
10

Fig. 7.

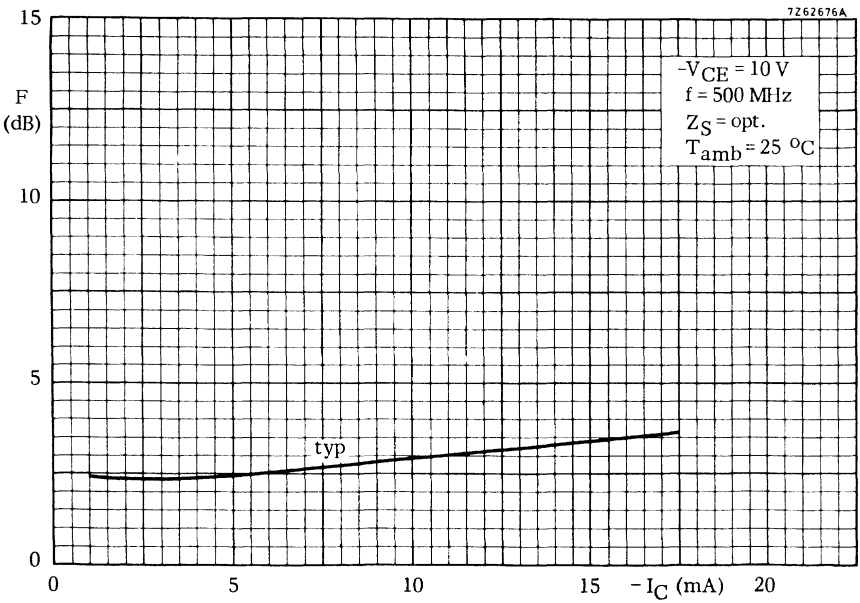

7Z62676A
15
F
(dB)
10
5
0
−V_CE = 10 V
f = 500 MHz
Z_S = opt.
T_amb = 25 °C
typ
0
5
10
15
− I_C (mA)
20

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.

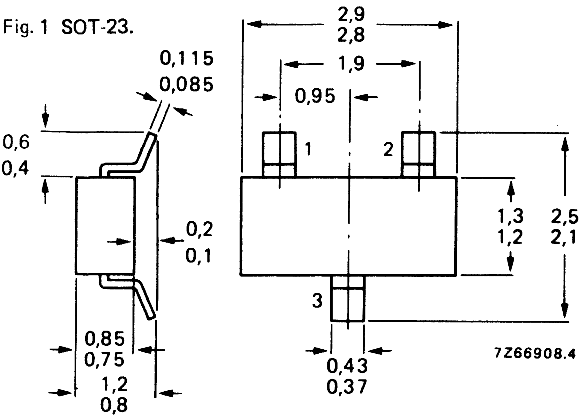
QUICK REFERENCE DATA

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

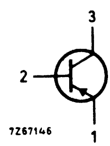
Dimensions in mm

Fig. 1 SOT-23.

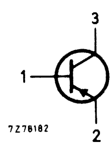


Marking code

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 °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	$R_{th\,t\text{-}s}$	=	280	K/W
From soldering points to ambient **	$R_{th\,s\text{-}a}$	=	90	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 * $-I_C = 30$ 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 8 mm x 10 mm x 0,7 mm.

CHARACTERISTICS (continued)

T_{amb} = 25 °C

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)			
$G_{UM}(\text{in dB}) = 10 \log \frac{\lvert s_{fe}\rvert^2}{(1-\lvert s_{ie}\rvert^2)(1-\lvert s_{oe}\rvert^2)}$			
$-I_C$ = 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 Ω; 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

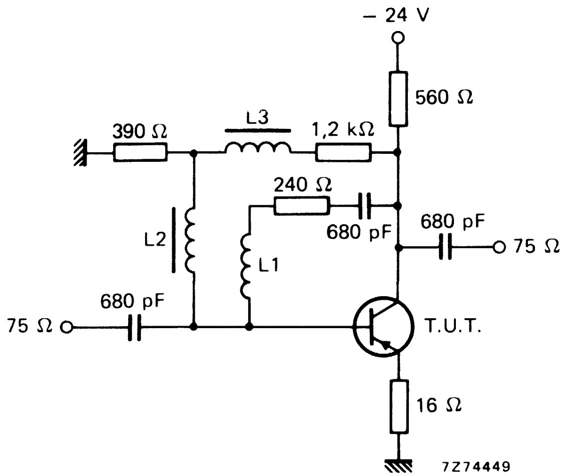


Fig. 2 Intermodulation test circuit.

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.

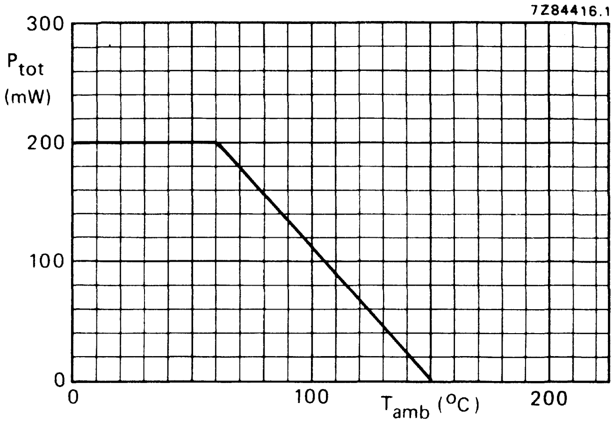


Fig. 3 Power derating curve.

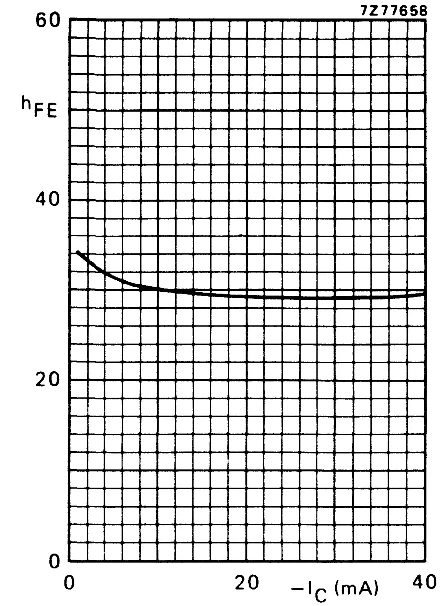


Fig. 4 $-V_{CE}$ = 5 V; T_j = 25 °C.

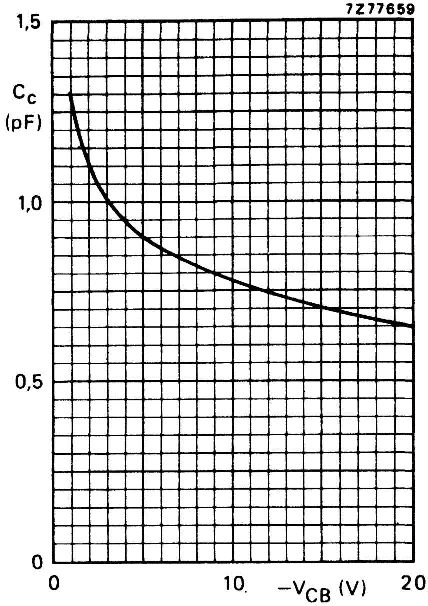


Fig. 5 $I_E = I_e = 0$; T_j = 25 °C; f = 1 MHz.

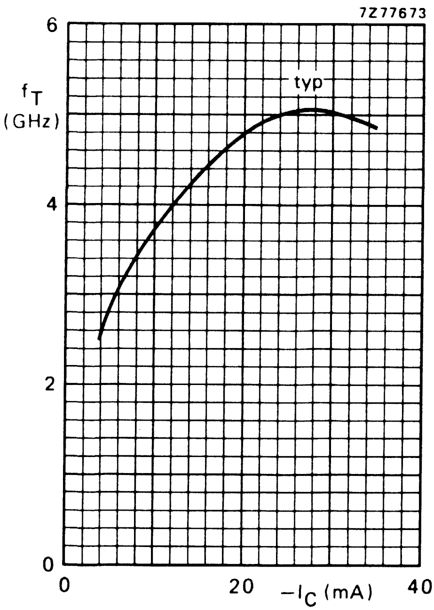


Fig. 6 $-V_{CE}$ = 5 V; T_j = 25 °C; f = 500 MHz.

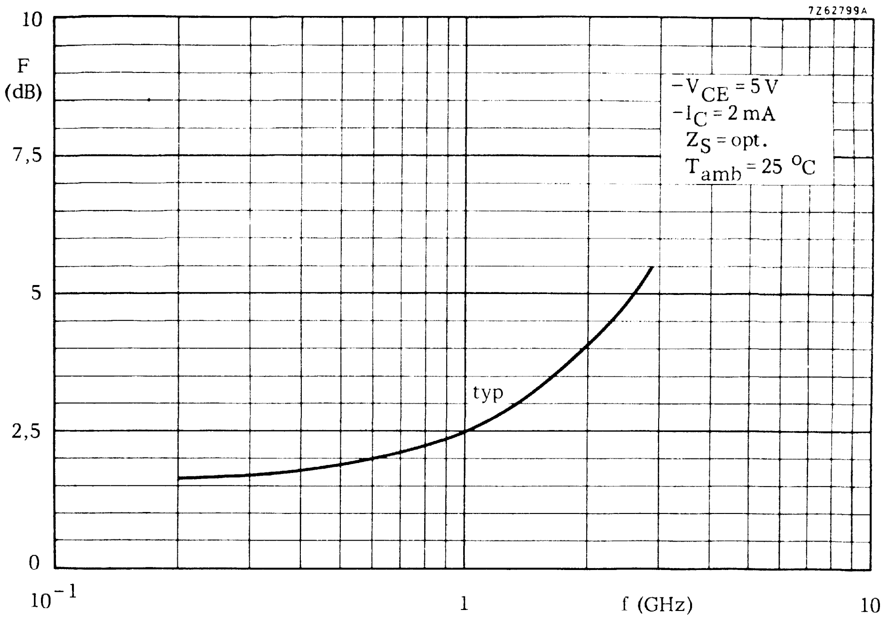

7Z62799A
F
(dB)
10
7,5
5
2,5
0
typ
$-V_{CE} = 5$ V
$-I_C = 2$ mA
Z_S = opt.
$T_{amb} = 25$ °C
10^{-1}
1
f (GHz)
10

Fig. 7.

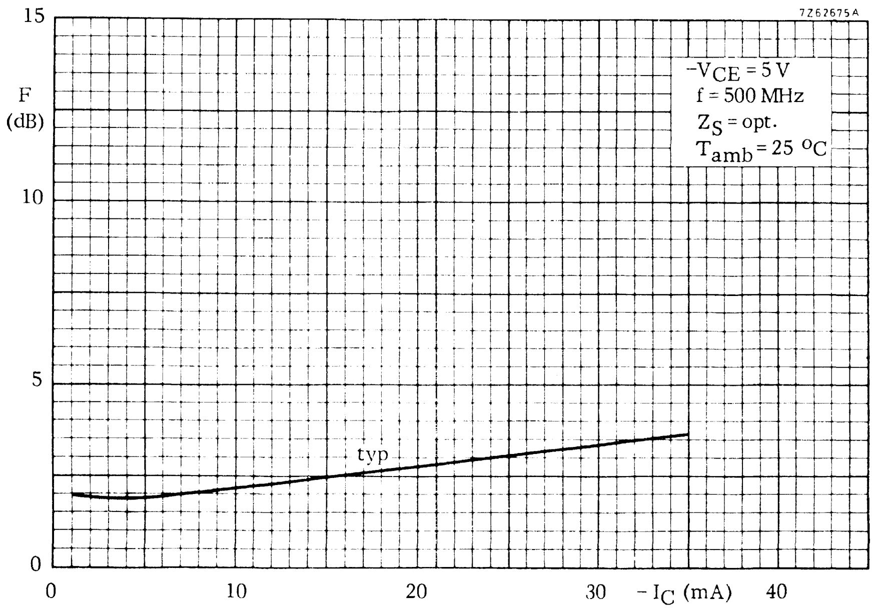

7Z62675A
F
(dB)
15
10
5
0
typ
$-V_{CE} = 5$ V
f = 500 MHz
Z_S = opt.
$T_{amb} = 25$ °C
0
10
20
30
$-I_C$ (mA)
40

Fig. 8.

PROGRAMMABLE UNIJUNCTION TRANSISTOR

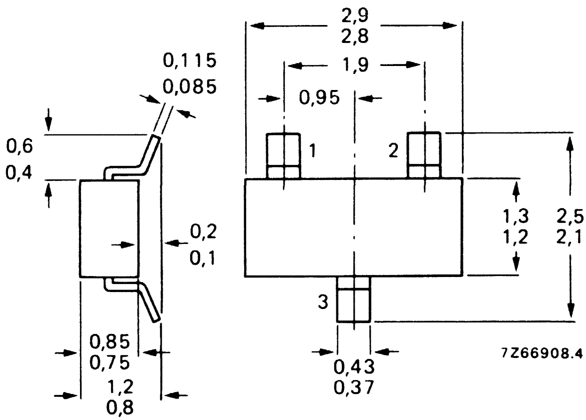
Planar p-n-p-n trigger device in a microminiature plastic envelope intended for applications in thick and thin-film circuits. It is intended for use in switching applications such as motor control, oscillators, relay replacement, timers, pulse shaper, trigger device etc.

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

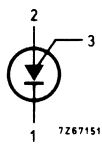
MECHANICAL DATA Dimensions in mm

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	$R_{th\,t\text{-}s}$	=	280	K/W
→ From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 mm.

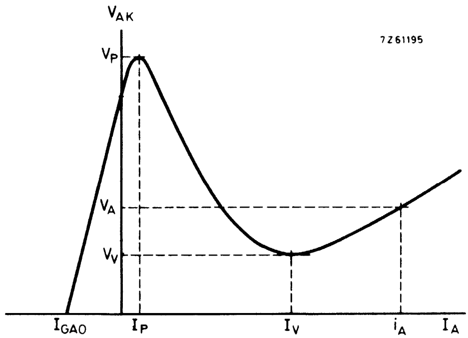


Fig. 2 See also Fig. 11.

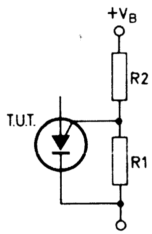


Fig. 3 BRY61 with "program" resistors R1 and R2.

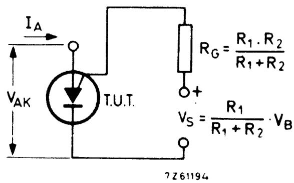


Fig. 4 Equivalent test circuit for characteristics testing.

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

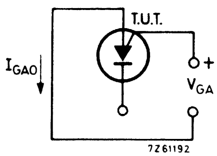


Fig. 5a.

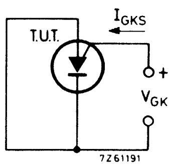


Fig. 5b.

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

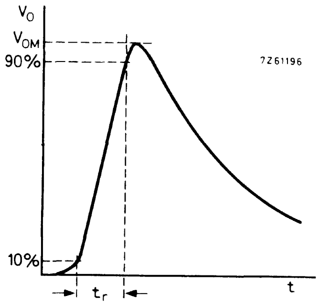


Fig. 6 Output voltage waveform.

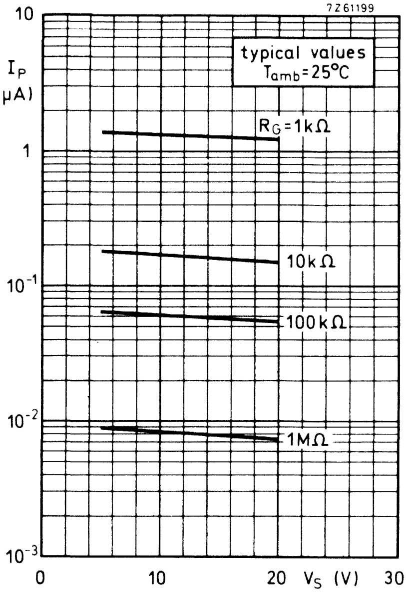


Fig. 7.

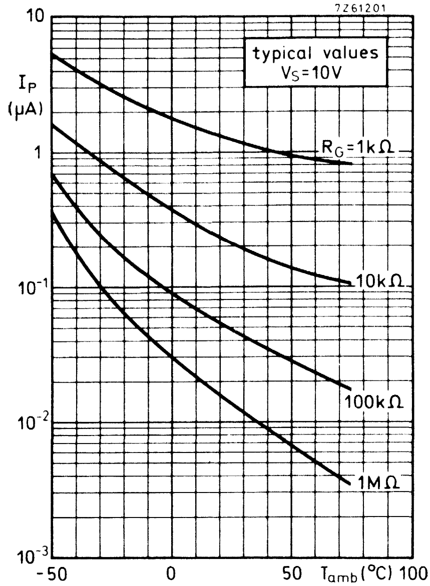


Fig. 8.

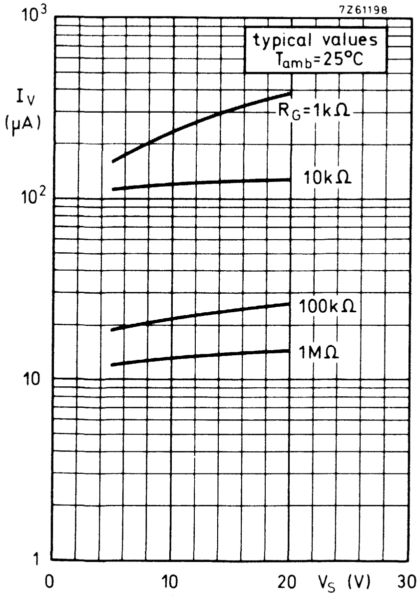


Fig. 9.

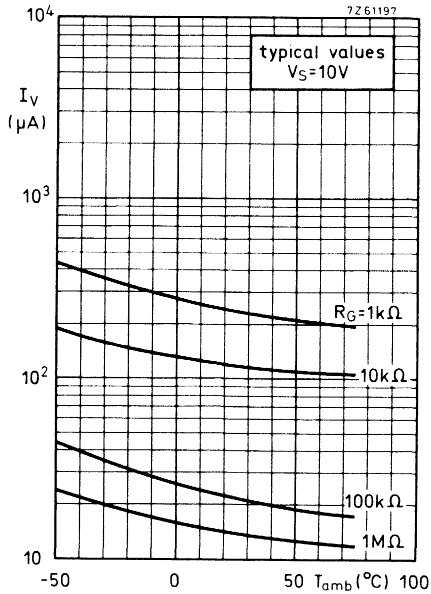


Fig. 10.

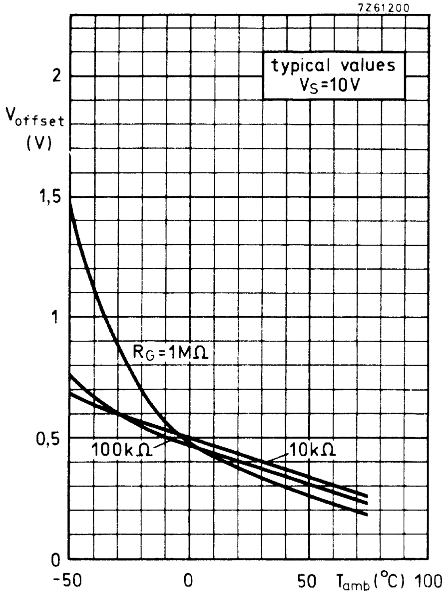

7Z61200
typical values
V_S=10V
V_{offset}
(V)
2
1,5
1
0,5
0
R_G=1MΩ
100kΩ
10kΩ
-50
0
50
T_{amb} (°C)
100

Fig. 11.

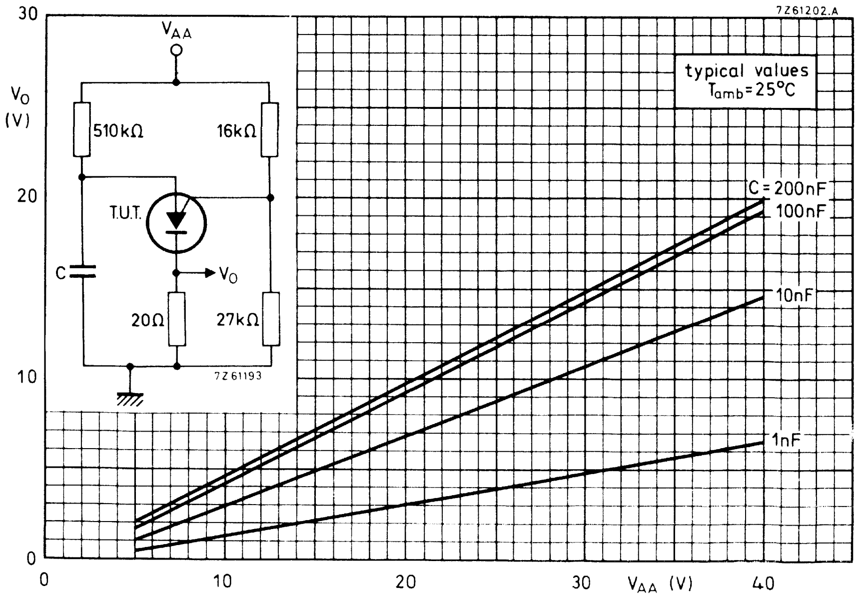

7Z61202.A
typical values
T_{amb}=25°C
V_O
(V)
30
20
10
0
V_{AA}
510kΩ
16kΩ
T.U.T.
C
V_O
20Ω
27kΩ
7Z61193
C = 200nF
100nF
10nF
1nF
0
10
20
30
V_{AA} (V)
40

Fig. 12.

SILICON P-N-P-N PLANAR TETRODE THYRISTOR

Planar p-n-p-n trigger device in a microminiature plastic envelope. It is intended for use as a programmable trigger device (SCS = silicon controlled switch).

QUICK REFERENCE DATA

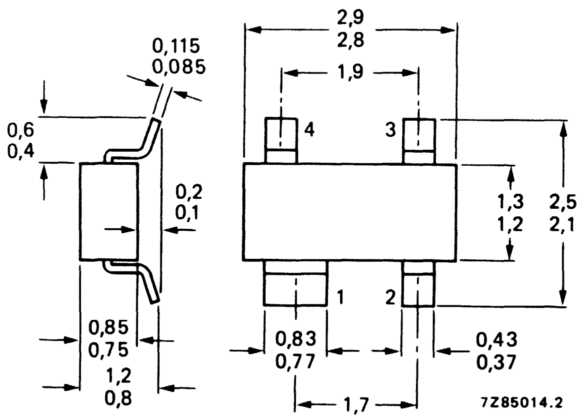
Anode gate – cathode voltage	$V_{ga\text{-}kR}$	max.	70	V
Anode gate – anode voltage (open cathode)	$V_{ga\text{-}aO}$	max.	70	V
Average anode current	$I_{A(AV)}$	max.	175	mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	275	mW
Junction temperature	T_j	max.	150	°C
Gate-controlled turn-on time $R_{gk\text{-}k}$ = 1 kΩ	t_{gt}	<	0,25	μs
Circuit-commutated turn-off time $R_{gk\text{-}k}$ = 1 kΩ	t_q	<	5	μs

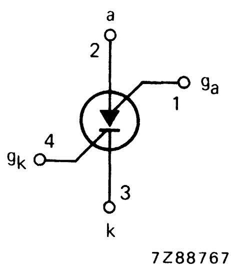
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-143.

Marking code
BRY62 = A51





See also *Soldering recommendations*.

RATINGS

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

Transistor 1 (T1)

Collector-base voltage (open emitter)	V_{CBO}	max.	70 V
Collector-emitter voltage (R_{BE} = 10 kΩ)	V_{CEO}	max.	70 V
Emitter-collector voltage (I_{C1} = 0)	V_{EBO}	max.	5 V
Average collector current	$I_{C(AV)}$	max.	175 mA ▲
Collector current (peak value)	I_{CM}	max.	**
Average emitter current	$I_{E(AV)}$	max.	175 mA
Emitter current (peak value) t_p = 10 μs; δ = 1%	I_{EM}	max.	2,5 A

Transistor 2 (T2)

Collector-base voltage (I_{E2} = 0)	$-V_{CBO}$	max.	70 V
Collector-emitter voltage (I_{B2} = 0)	$-V_{CEO}$	max.	70 V
Emitter-base voltage (I_{C2} = 0)	$-V_{EBO}$	max.	70 V
Emitter current (average)	$I_{E(AV)}$	max.	175 mA
Emitter current (peak value) t_p = 10 μs; δ = 1%	I_{EM}	max.	2,5 A
Reverse gate to cathode voltage	$V_{ga\text{-}kR}$	max.	70 V
Gate to anode voltage (open cathode)	$V_{ga\text{-}aO}$	max.	70 V
Gate to cathode voltage (open anode)	$V_{gk\text{-}kO}$	max.	5 V
Average anode current	$I_{A(AV)}$	max.	175 mA
Anode current (peak value) t_p = 10 μs; δ = 1%	I_{AM}	max.	2,5 A
Anode gate current (average)	$I_{GA(AV)}$	max.	175 mA
Anode gate current (peak value)	I_{GAM}	max.	**
Total power dissipation at T_{amb} = 25 °C*	P_{tot}	max.	275 mW
Junction temperature	T_j	max.	150 °C
Storage temperature	T_{stg}		−65 to + 150 °C

THERMAL RESISTANCE

From junction to ambient*	$R_{th\ j\text{-}a}$	=	450 K/W

* Device mounted on a ceramic substrate of 15 mm x 15 mm x 0,5 mm.

** During switching on, the device can withstand the discharge of a capacitor of maximum value of 500 pF. This capacitor is charged when the transistor is in cut-off condition, with a collector supply voltage of 160 V and a series resistance of 100 kΩ.

▲ Provided the I_E rating is not exceeded.

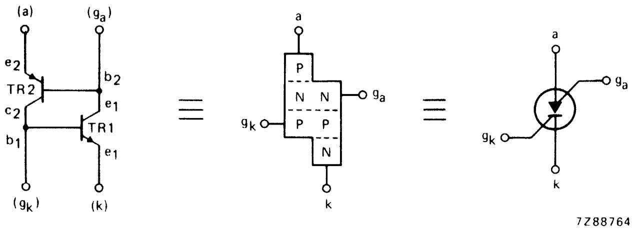


Fig. 2 Circuit diagram.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

Transistor 1 (TR1)

Collector-emitter cut-off current			
V_{CE} = 70 V; R_{BE} = 10 kΩ	I_{CER}	<	100 nA
V_{CE} = 70 V; R_{BE} = 10 kΩ; T_j = 150 °C	I_{CER}	<	10 μA
Emitter cut-off current			
V_{EB} = 5 V; I_C = 0; T_j = 150 °C	I_{EBO}	<	10 μA
Saturation voltages			
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	<	0,5 V
	V_{BEsat}	<	0,9 V
D.C. current gain			
V_{CE} = 2 V; I_C = 10 mA	h_{FE}	>	50
Collector capacitance			
V_{CB} = 20 V; I_E = I_e = 0	C_c	<	5 pF
Emitter capacitance			
V_{EB} = 1 V; I_C = I_c = 0	C_e	<	25 pF

Transistor 2 (TR2)

Collector-emitter cut-off current			
$-V_{CE}$ = 70 V; I_B = 0; T_j = 150 °C	$-I_{CE}$	<	10 μA
Emitter cut-off current			
$-V_{EB}$ = 70 V; I_C = I_c = 0; T_j = 150 °C	$-I_{EB}$	<	10 μA
D.C. current gain			
V_{CB} = 0 V; I_E = 1 mA	h_{FE}	>	0,25

THYRISTOR

Anode to cathode

On-state voltage

I_A = 50 mA; I_{ga} = 0; $R_{gk\text{-}k}$ = 10 kΩ	V_T	<	1,4 V
I_A = 1 mA; I_{ga} = 10 mA; $R_{gk\text{-}k}$ = 10 kΩ	V_T	<	1,2 V

Holding current

I_{ga} = 10 mA; $-V_{gk}$ = 2 V; $R_{gk\text{-}k}$ = 10 Ω	I_H	<	1 mA

Switching characteristics

Gate-controlled turn-on time ($t_{gt} = t_d + t_r$)
when switched from V_{gk} = −0,5 V to 4,5 V

at $R_{gk\text{-}k}$ = 1 kΩ	t_{gt}	<	0,25 μs
at $R_{gk\text{-}k}$ = 10 kΩ	t_{gt}	<	1,5 μs

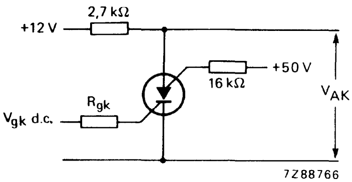


Fig. 3 Switching times test circuit.
The pulse time of V_{gk} can be adjusted in such a way that the broken line in Fig. 4 disappears, which means that the thyristor starts triggering.

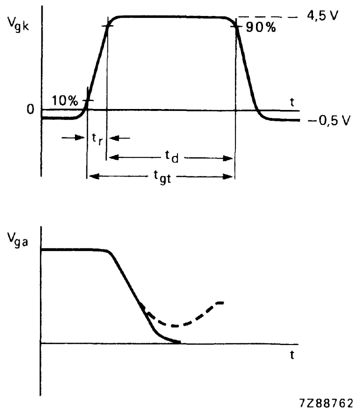


Fig. 4 Switching times waveforms.

Turn-off time (Figs 5 and 6)

R_{gk} = 1 kΩ	t_q	<	5 μs
R_{gk} = 10 kΩ	t_q	<	8 μs
R_{gk} = 10 kΩ; T_j = 125 °C	t_q	<	15 μs

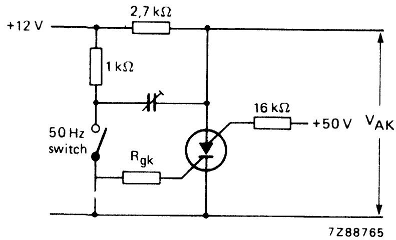


Fig. 5 Switching times test circuit.

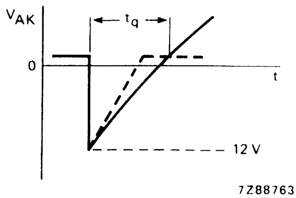


Fig. 6 Switching times waveforms.

The capacitor can be adjusted in such a way that the broken line disappears, which means that the thyristor will not trigger any more.

DEVELOPMENT SAMPLE DATA

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.

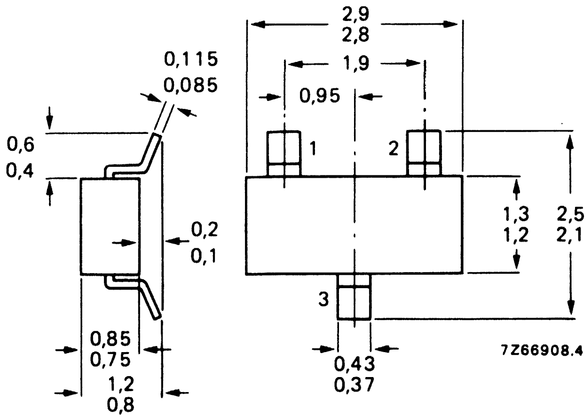
QUICK REFERENCE DATA

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

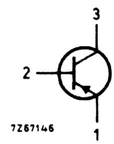
Dimensions in mm

Fig. 1 SOT-23.

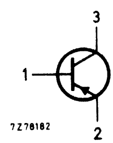


Marking code

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	$R_{th\,t\text{-}s}$	=	280	K/W
→ From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90	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; δ = 0,01.
* See *Thermal characteristics* in chapter GENERAL.
→ ** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 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

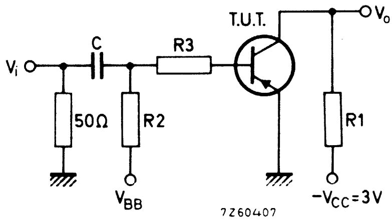


Fig. 2 Test circuit switching times.

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.

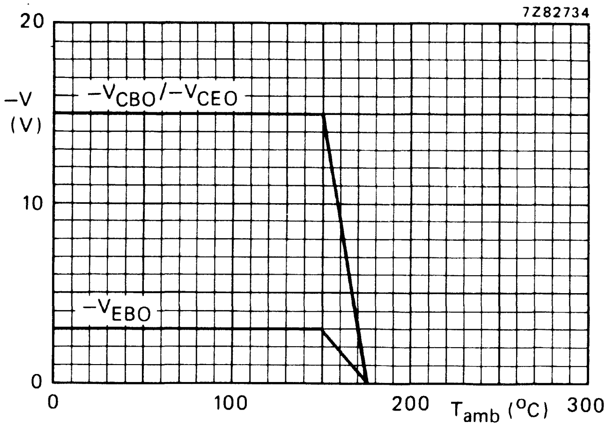


Fig. 3 Voltage derating curves.

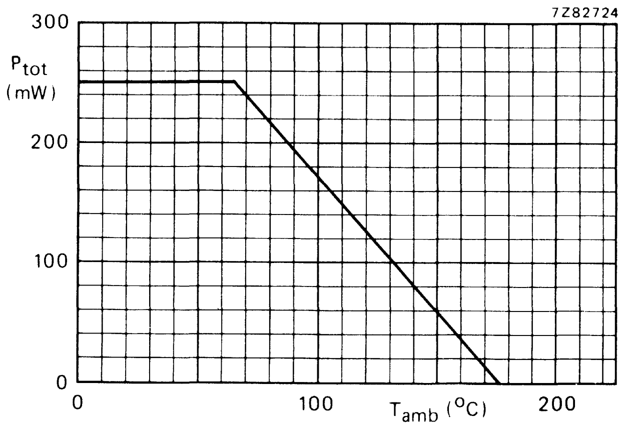


Fig. 4 Power derating curve.

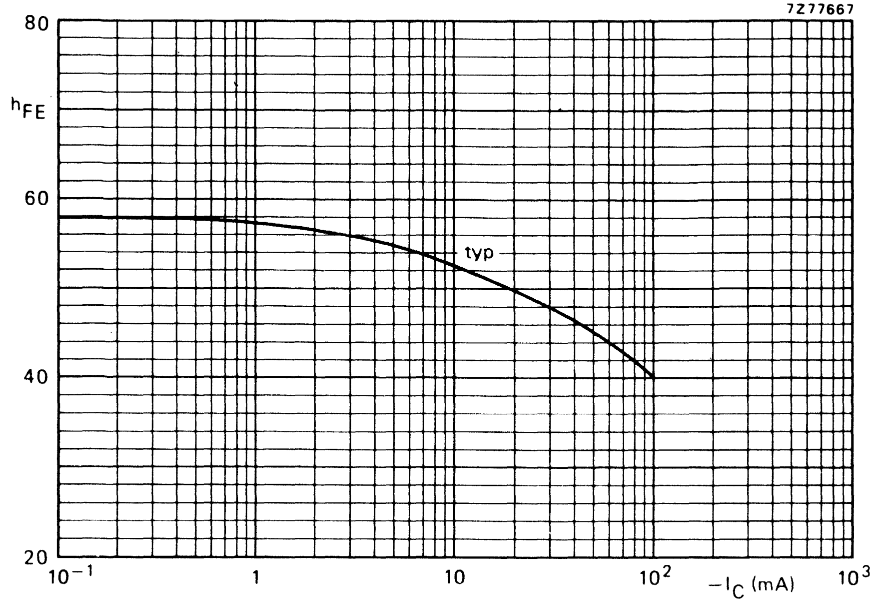


Fig. 5 $-V_{CE} = 1$ V; $T_{amb} = 25$ °C.

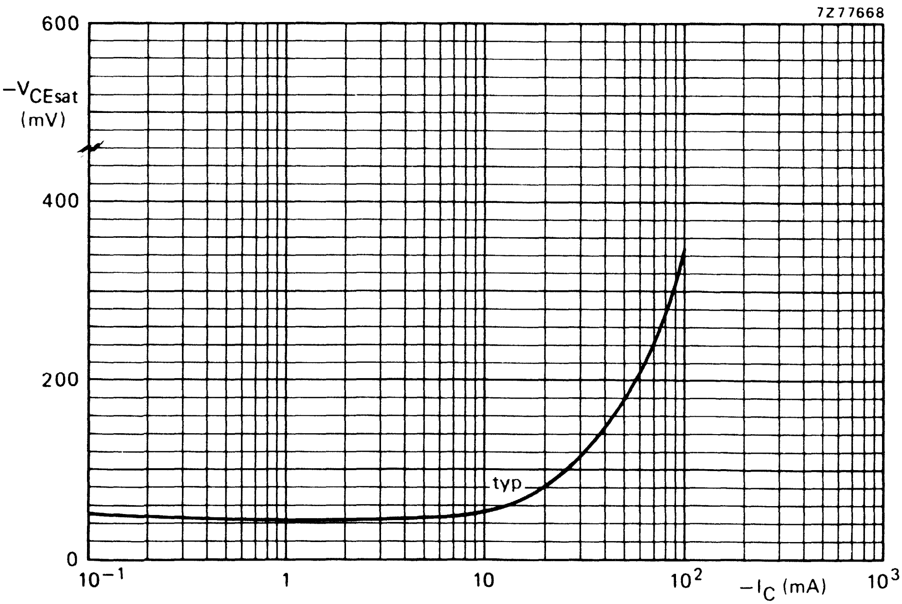


Fig. 6 V_{CEsat} as a function of I_C at $I_C/I_B = 10$.

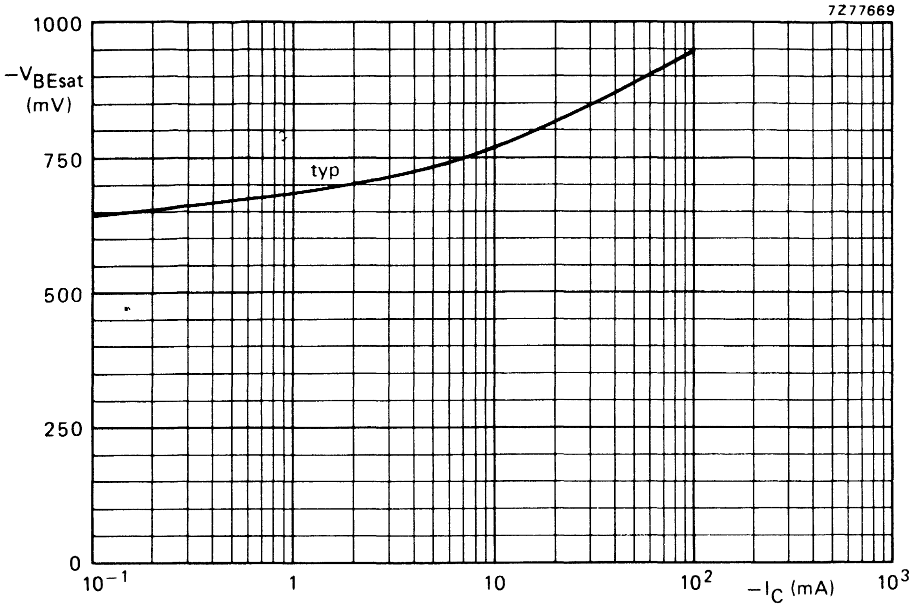


Fig. 7 V_{BEsat} as a function of I_C at $I_C/I_B = 10$.

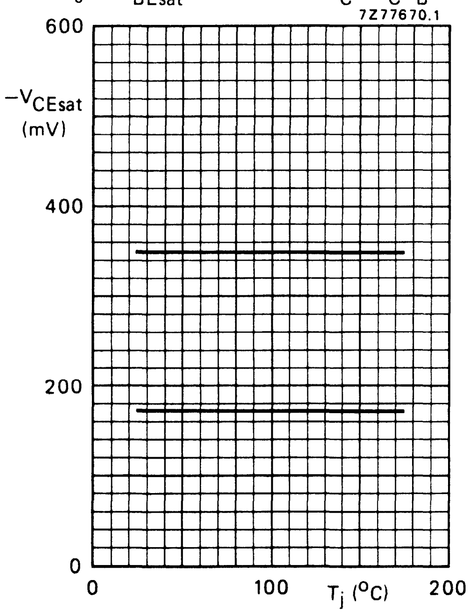


Fig. 8 V_{CEsat} as a function of T_j; typical values.
Upper graph at I_C = 100 mA; I_B = 10 mA. Lower graph at I_C = 50 mA and I_B = 5 mA.

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.

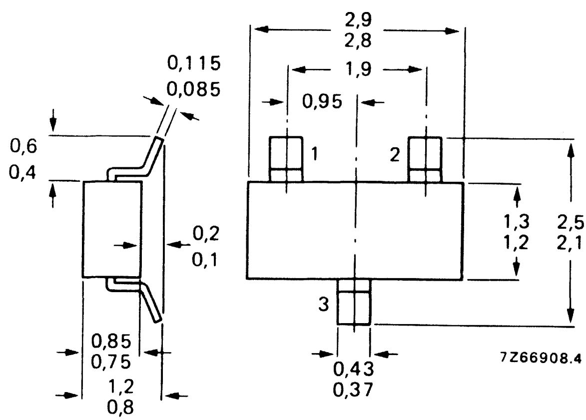
QUICK REFERENCE DATA

			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

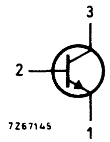
Dimensions in mm

Fig. 1 SOT-23.

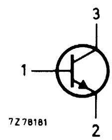


Marking code

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 0,7 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

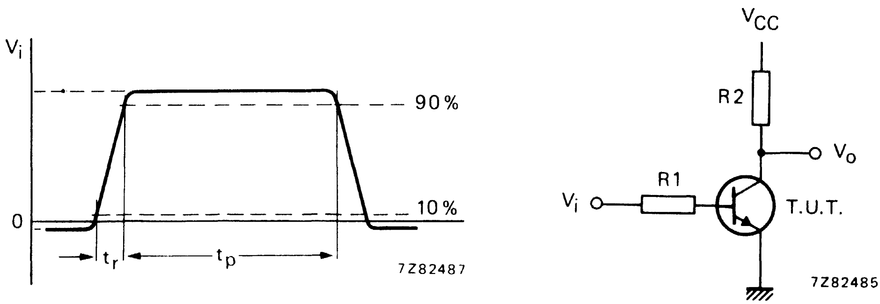


Fig. 2 Waveform and test circuit delay and rise time.

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

Pulse generator:				Oscilloscope:			
pulse duration	t_p	⩽	200 ns	input impedance	Z_i	>	100 kΩ
rise time	t_r	⩽	2 ns	input capacitance	C_i	<	12 pF
duty factor	δ	=	2 %	rise time	t_r	<	5 ns

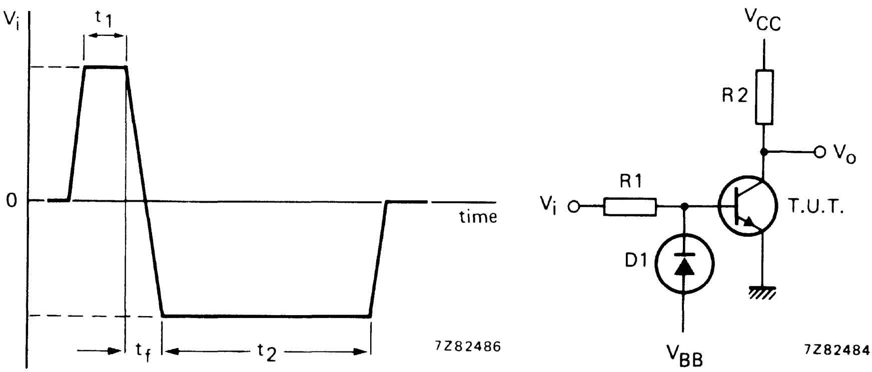


Fig. 3 Waveform and test circuit storage and fall time.

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

Pulse generator:				Oscilloscope:			
fall time	t_f	<	5 ns	input impedance	Z_i	>	100 kΩ
pulse time	t_1	=	100 μs	input capacitance	C_i	<	12 pF
	t_2	=	500 μs	rise time	t_r	<	5 ns

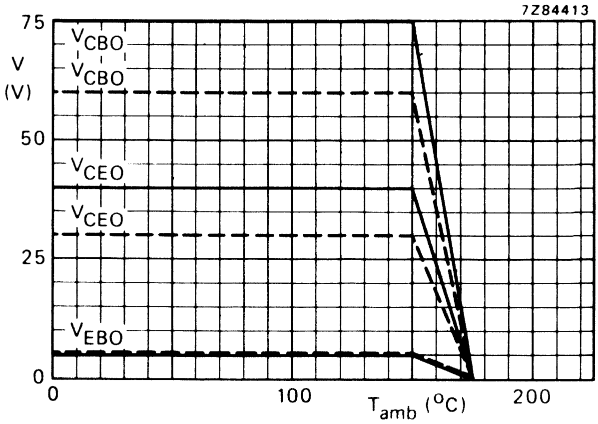


Fig. 4 Voltage derating curve.
– – – BSR13; R ——— BSR14; R.

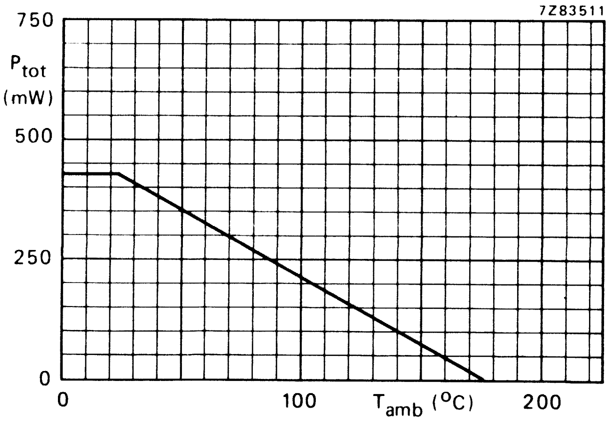


Fig. 5 Power derating curve.

DEVELOPMENT SAMPLE DATA

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.

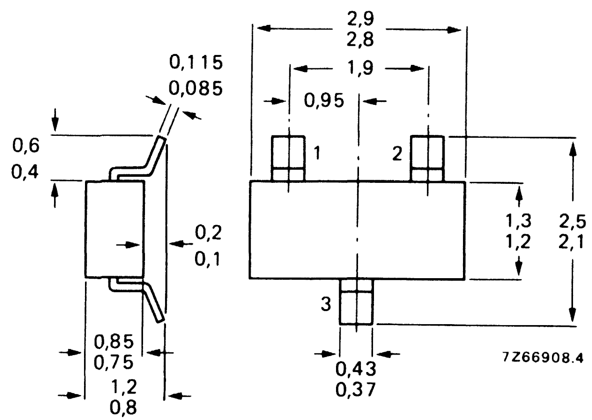
QUICK REFERENCE DATA

			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

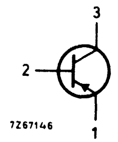
Dimensions in mm

Fig. 1 SOT-23.

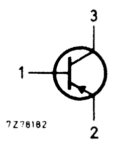


Marking code

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 0,7 mm.

▲ Measured under pulsed conditions to avoid excessive dissipation pulse duration $t_p \leqslant 300\ \mu s$; 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

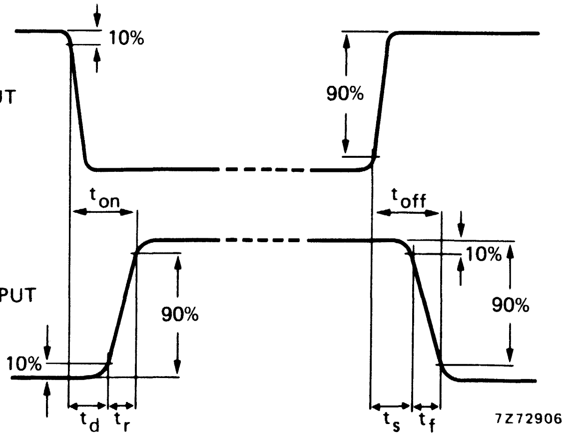


Fig. 2 Switching time waveforms.

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

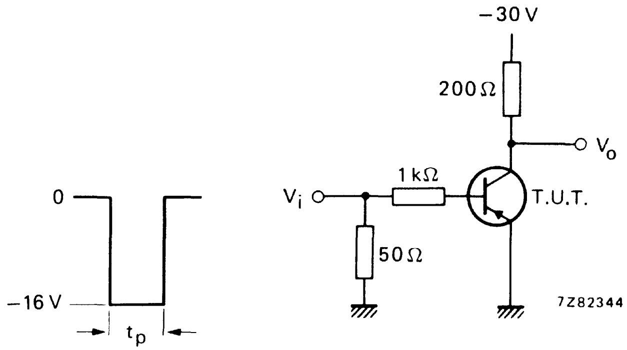


Fig. 3 Turn-on switching time test circuit.

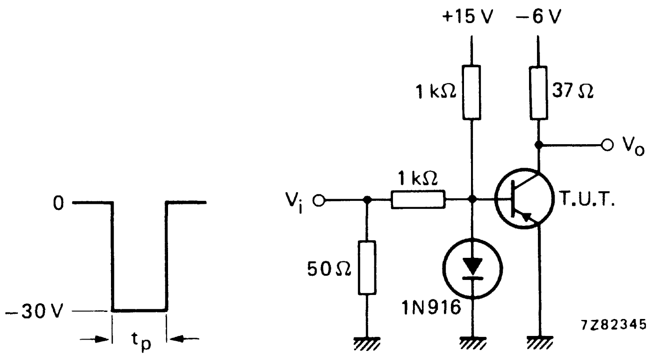


Fig. 4 Turn-off switching time test circuit.

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

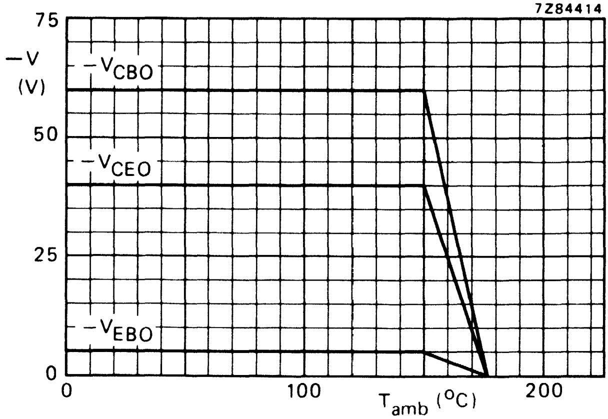


Fig. 5 Voltage derating curves BSR15; R.

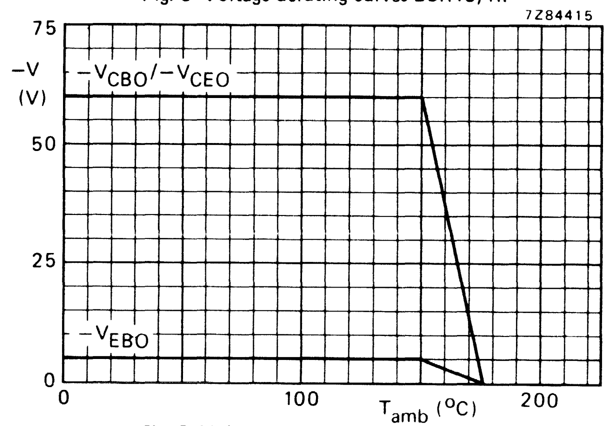


Fig. 6 Voltage derating curves BSR16; R.

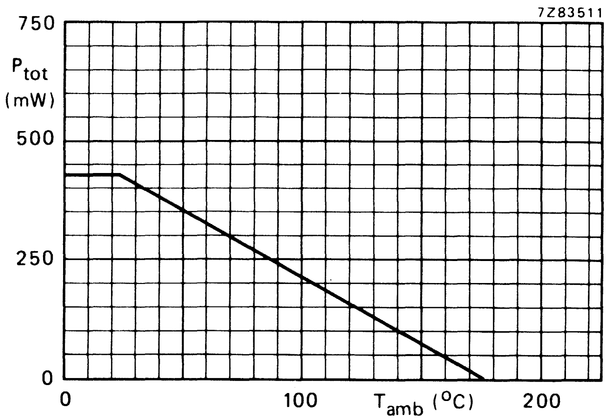


Fig. 7 Power derating curve BSR15; R/BSR16; R.

DEVELOPMENT SAMPLE DATA

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon transistor in a microminiature plastic envelope intended for switching and linear applications in thick and thin-film circuits.

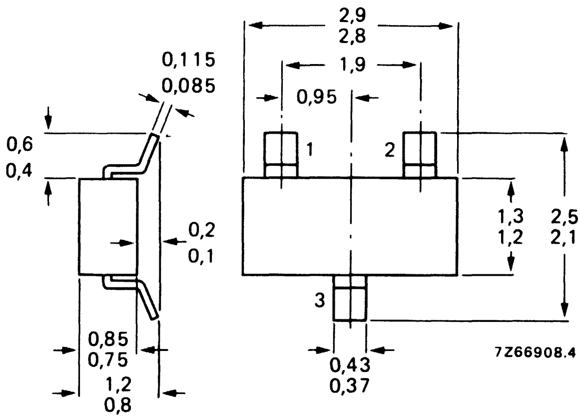
QUICK REFERENCE DATA

Collector-base voltage (open emitter)		V_{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.	150	°C
D.C. current gain					
I_C = 10 mA; V_{CE} = 1 V	BSR17;R	h_{FE}		50 to 150	
I_C = 10 mA; V_{CE} = 1 V	BSR17A;R	h_{FE}		100 to 300	
Transition frequency at f = 500 MHz					
I_C = 10 mA; V_{CE} = 20 V	BSR17;R	f_T	>	250	MHz
I_C = 10 mA; V_{CE} = 20 V	BSR17A;R	f_T	>	300	MHz

MECHANICAL DATA

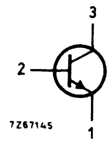
Dimensions in mm

Fig. 1 SOT-23

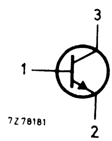


Marking code

BSR17 = U9
BSR17A = U92



BSR17R = U91
BSR17AR = U93



See also *Soldering recommendations.*

RATINGS

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

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
Power dissipation up to T_{amb} = 25 °C**	P_{tot}	max.	350	mW
Storage temperature	T_{stg}	−55 to +	150	°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	$R_{th\ t\text{-}s}$	=	280	K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

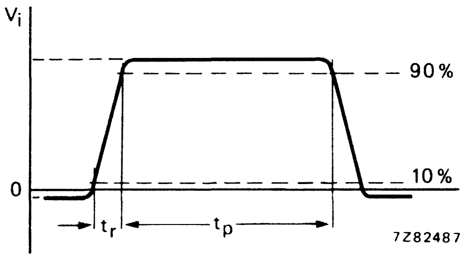
Collector cut-off current				
$I_E = 0$; V_{CB} = 30 V; T_j = 150 °C	I_{CBO}	<	5	μA
V_{EB} = 3 V; V_{CE} = 30 V	I_{CEX}	<	50	nA
Base current with reverse biased emitter junction				
V_{EB} = 3 V; V_{CE} = 30 V	I_{BEX}	<	50	nA
Saturation voltages▲				
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	<	200	mV
	V_{BEsat}	650 to	850	mV
I_C = 50 mA; I_B = 5 mA	V_{CEsat}	<	300	mV
	V_{BEsat}	<	950	mV
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} = 0,5 V	C_e	<	8	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 8 mm x 10 mm x 0,7 mm.

		BSR17	BSR17A
D.C. current gain*			
I_C = 0,1 mA; V_{CE} = 1 V	h_{FE}	> 20	40
I_C = 1 mA; V_{CE} = 1 V	h_{FE}	> 35	70
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	> 50 < 150	100 300
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	> 30	60
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	> 15	30
Transition frequency at f = 100 MHz			
I_C = 10 mA; V_{CE} = 20 V	f_T	> 250	300 MHz
h-parameters (common emitter)			
I_C = 1 mA; V_{CE} = 10 V; f = 1 kHz			
Input impedance	h_{ie}	1 to 8	1 to 10 kΩ
Reverse voltage transfer ratio	h_{re}	0,1 to 5	0,5 to 8 10^{-4}
Small-signal current gain	h_{fe}	50 to 200	100 to 400
Output admittance	h_{oe}	1 to 40	1 to 40 μA/V

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



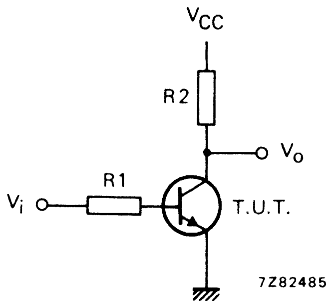
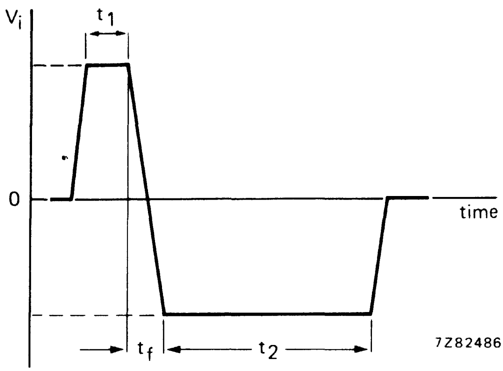


Fig. 2 Delay and rise time equivalent circuit.
V_i = −0,5 to +10,6 V; V_{CC} = 3 V; R1 = 10 kΩ; R2 = 275 Ω;
total shunt capacitance of test jig and connectors = $C_s \leq 4$ pF.
Pulse generator: pulse duration 300 ns; fall time < 1 ns; duty factor 2%.

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

		BSR17	BSR17A
storage time	t_s	< 175	200 ns
fall time	t_f	< 50	50 ns



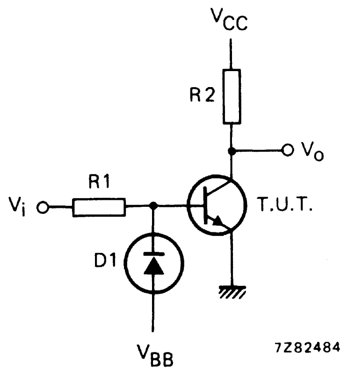


Fig. 3 Storage and fall time equivalent test circuit.
V_i = −9,1 to + 10,9 V; V_{CC} = 3 V; V_{BB} = 0 V (ground); R1 = 10 kΩ; R2 = 275 Ω;
total shunt capacitance of test jig and connectors = $C_s \leq 4$ pF.
Pulse generator: pulse duration t_1 = 10 to 500 μs; fall time t_f < 1 ns; duty factor δ = 2%.

SILICON LOW-POWER SWITCHING TRANSISTORS

P-N-P silicon transistor in a microminiature plastic envelope, intended for switching and linear applications in thick and thin-film circuits.

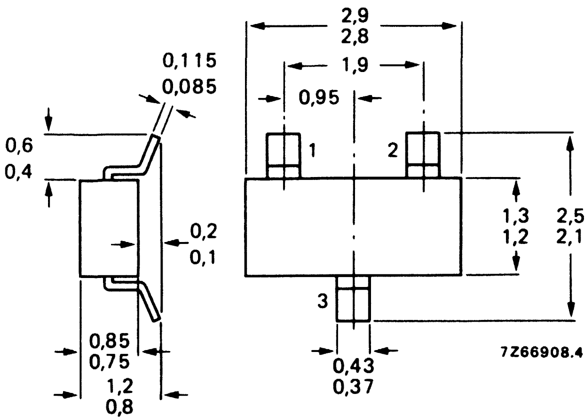
QUICK REFERENCE DATA

Collector-base voltage (open emitter)		$-V_{CBO}$	max.	40 V
Collector-emitter voltage (open base)		$-V_{CEO}$	max.	40 V
Collector current (d.c.)		$-I_C$	max.	200 mA
Total power dissipation up to T_{amb} = 65 °C		P_{tot}	max.	250 mW
Junction temperature		T_j	max.	150 °C
D.C. current gain				
$-I_C$ = 10 mA; $-V_{CE}$ = 1 V	BSR18; R	h_{FE}		50 to 150
$-I_C$ = 10 mA; $-V_{CE}$ = 1 V	BSR18A; R	h_{FE}		100 to 300
Transition frequency at f = 500 MHz				
$-I_C$ = 10 mA; $-V_{CE}$ = 20 V	BSR18; R	f_T	>	200 MHz
$-I_C$ = 10 mA; $-V_{CE}$ = 20 V	BSR18A; R	f_T	>	250 MHz

MECHANICAL DATA

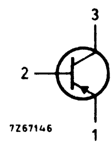
Dimensions in mm

Fig. 1 SOT-23.

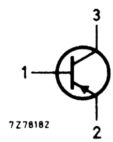


Marking code

BSR18 = T9
BSR18A = T92



BSR18R = T91
BSR18AR = T93



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.	5 V
Collector current (d.c.)	$-I_C$	max.	200 mA
Total power dissipation up to $T_{amb} \leqslant 65\ ^oC$	P_{tot}	max.	200 mW
Storage temperature	T_{stg}	−55 to + 150	^oC
Junction temperature	T_j	max.	150 ^oC

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	$R_{th\ t\text{-}s}$	=	280 K/W
From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90 K/W

CHARACTERISTICS

$T_{amb} = 25\ ^oC$ 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	$-I_{EBO}$	<	50 nA
Breakdown voltages			
$I_E = 0$; $-I_C = 10\ \mu A$	$-V_{(BR)CBO}$	>	40 V
$I_B = 0$; $-I_C = 1$ mA	$-V_{(BR)CBO}$	>	40 V
$I_C = 0$; $-I_E = 10\ \mu A$	$-V_{(BR)EBO}$	>	5 V
Saturation voltages ▲			
$-I_C = 10$ mA; $-I_B = 1$ mA	$-V_{CEsat}$	<	250 mV
	$-V_{BEsat}$		650 to 850 mV
$-I_C = 50$ mA; $-I_B = 5$ mA	$-V_{CEsat}$	<	400 mV
	$-V_{BEsat}$	<	950 mV
Collector capacitance at f = 100 kHz			
$I_E = I_e = 0$; $-V_{CB} = 5$ V	C_c	<	4,5 pF
Emitter capacitance at f = 100 kHz			
$I_C = I_c = 0$; $-V_{EB} = 0,5$ V	C_e	<	10 pF

* See *Thermal characteristics* in chapter GENERAL.
** Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.
▲ Measured under pulse conditions; $t_p = 300\ \mu s$; $\delta = 0,01$.

			BSR18	BSR18A
D.C. current gain*				
$-I_C$ = 0,1 mA; $-V_{CE}$ = 1 V	h_{FE}	>	30	60
$-I_C$ = 1,0 mA; $-V_{CE}$ = 1 V	h_{FE}	>	40	80
$-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}		50 to 150	100 to 300
$-I_C$ = 50 mA; $-V_{CE}$ = 1 V	h_{FE}	>	30	60
$-I_C$ =100 mA; $-V_{CE}$ = 1 V	h_{FE}	>	15	30
Transition frequency at f = 100 MHz				
$-I_C$ = 10 mA; $-V_{CE}$ = 20 V	f_T	>	200	250 MHz
Noise figure at R_S = 1 kΩ				
$-I_C$ = 100 μA; $-V_{CE}$ = 5 V				
f = 10 to 15 700 Hz	F	<	5	4 dB
h parameters (common emitter) at f = 1 kHz				
$-I_C$ = 1 mA; $-V_{CE}$ = 10 V				
input impedance	h_{ie}		0,5 to 8	2 to 12 kΩ
reverse voltage transfer ratio	h_{re}		$0{,}1$ to 5.10^{-4}	1 to 10.10^{-4}
small signal current gain	h_{fe}		50 to 200	100 to 400
output admittance	h_{oe}		1 to 40	3 to 60 $\mu\Omega^{-1}$
Switching times (between 10% and 90% levels)				
$-I_C$ = 10 mA; $-I_{Bon}$ = $+I_{Boff}$ = 1 mA				
delay time	t_d	<		35 ns
rise time	t_r	<		35 ns

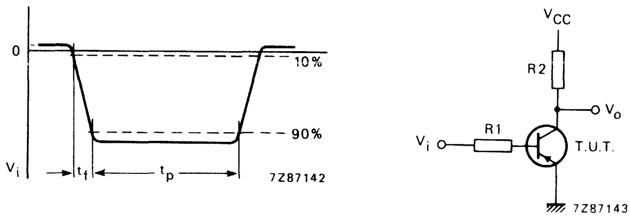
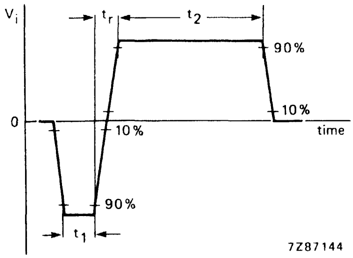


Fig. 2 Waveform and test circuit delay and rise time.
V_i = +0,5 to −10,6 V; $-V_{CC}$ = 3 V; R1 = 10 kΩ; R2 = 275 Ω.
Total shunt capacitance of test jig and connectors = $C_s \leqslant 4$ pF.
Pulse generator: pulse duration 300 ns; fall time < 1 ns; duty factor 2%.

			BSR18	BSR18A	
Switching times (between 10% and 90% levels)					
$-I_C = 10$ mA, $-I_{Bon} = I_{Boff} = 1$ mA					
storage time	t_s	<	200	225	ns
fall time	t_r	<	60	75	ns



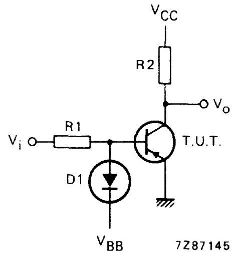


Fig. 3 Waveform and test circuit fall and storage time.
$V_i = -9{,}1$ to $+10{,}9$ V; $V_{CC} = 3$ V; $V_{BB} = 0$ V (ground); R1 = 10 kΩ; R2 = 275 Ω; D1 = 1N916.
Total shunt capacitance of test jig and connectors = $C_s \leq 4$ pF.
Pulse generator: pulse duration $t_1 = 10$ to 500 μs; rise time $t_r < 1$ ns; duty factor $\delta = 2\%$.

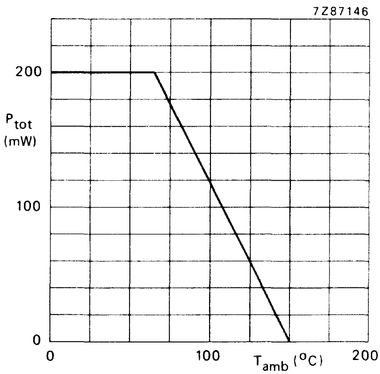


Fig. 4 Power derating curve.

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.

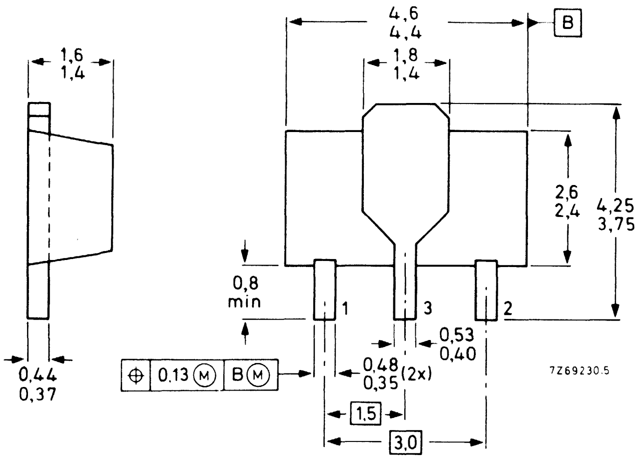
QUICK REFERENCE DATA

			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

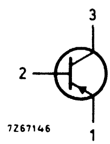
Dimensions in mm

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 ^oC mounted on a ceramic substrate area = 2,5 cm^2; thickness = 0,7 mm	P_{tot}	max.	1	W

Temperatures

Storage temperature	T_{stg}		−65 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to collector tab	$R_{th\ j\text{-}tab}$	=	10	$^oC/W$
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	$^oC/W$

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							
$I_B = 0; -I_C = 10$ 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

DEVELOPMENT SAMPLE DATA

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

CHARACTERISTICS (continued)

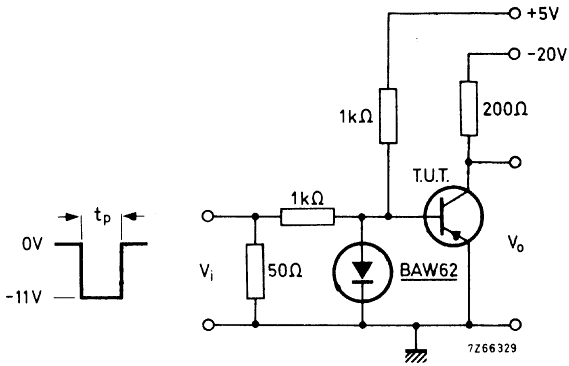
T_{amb} = 25 °C

Switching times

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

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

Test circuit



Pulse generator:		Oscilloscope:	
Pulse duration	t_p = 10 μs	Rise time	$t_r \leqslant 15$ ns
Rise time	$t_r \leqslant 15$ ns	Input impedance	$Z_I \geqslant 100$ kΩ
Fall time	$t_f \leqslant 15$ ns		
Source impedance	Z_S = 50 Ω		

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.

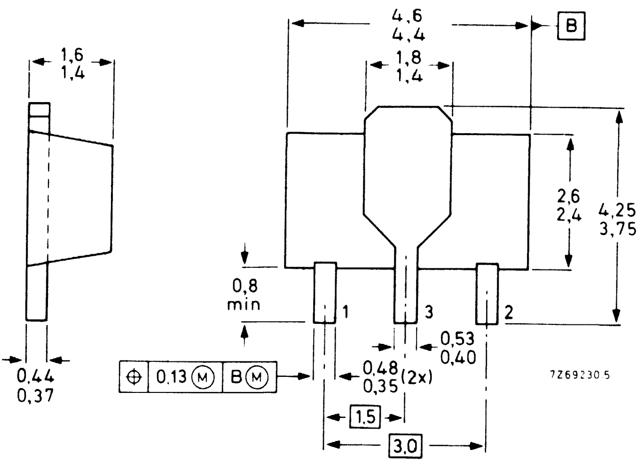
QUICK REFERENCE DATA

			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

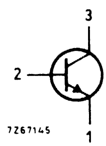
Dimensions in mm

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

			BSR40	BSR41	BSR42	BSR43	
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							
$I_B = 0$; $I_C = 10$ 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)

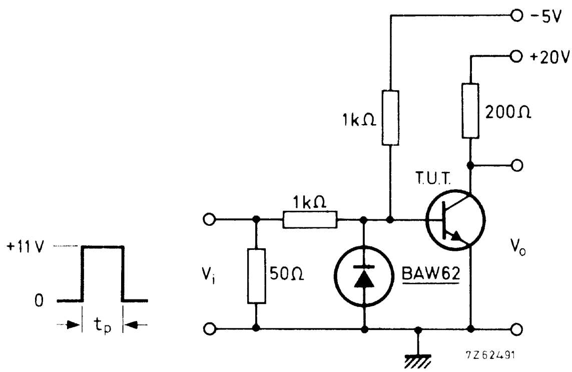
$T_{amb} = 25\ ^oC$

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	$t_p = 10\ \mu s$
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	$Z_I \geqslant 100\ k\Omega$

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.

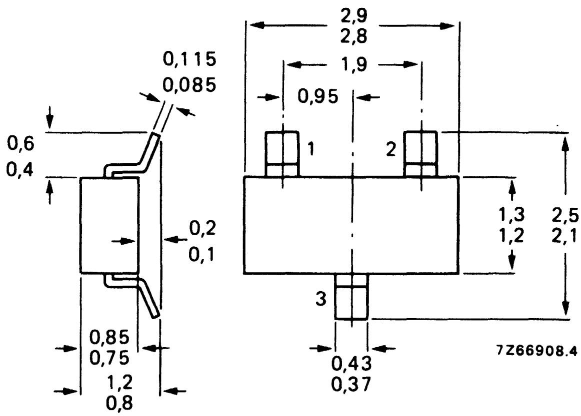
QUICK REFERENCE DATA

			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

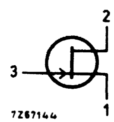
Dimensions in mm

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	$R_{th\,t\text{-}s}$	=	280 K/W
From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90 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 8 mm x 10 mm x 0,7 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

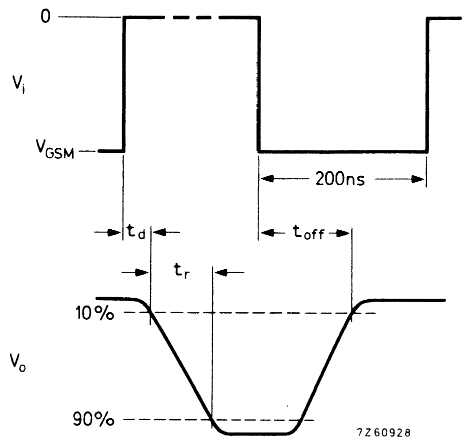


Fig. 2 Switching times waveforms.

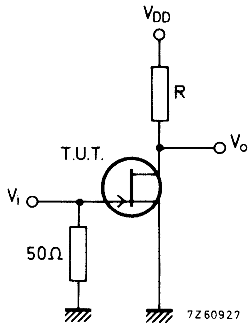


Fig. 3 Test circuit.

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.

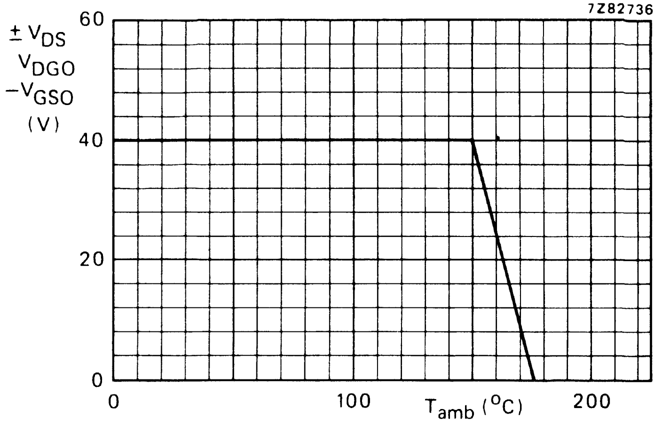


Fig. 4 Voltage derating curve.

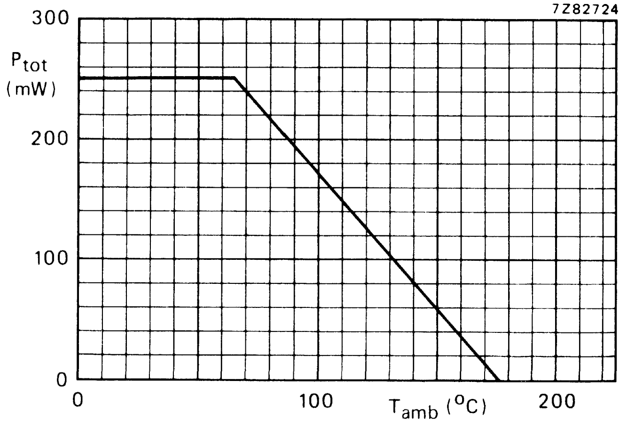


Fig. 5 Power derating curve.

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.

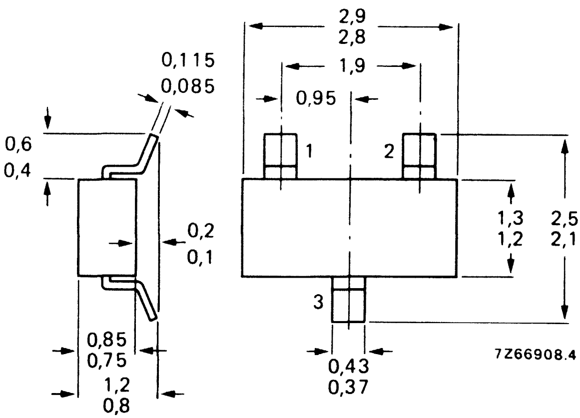
QUICK REFERENCE DATA

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	>	50	MHz
		typ.	85	MHz

MECHANICAL DATA

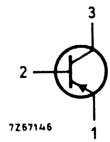
Dimensions in mm

Fig. 1 SOT-23.

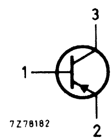


Marking code

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 *

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	50	K/W
→ From tab to soldering points	$R_{th\ t\text{-}s}$	=	280	K/W
→ From soldering points to ambient **	$R_{th\ s\text{-}a}$	=	90	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 8 mm x 10 mm x 0,7 mm.

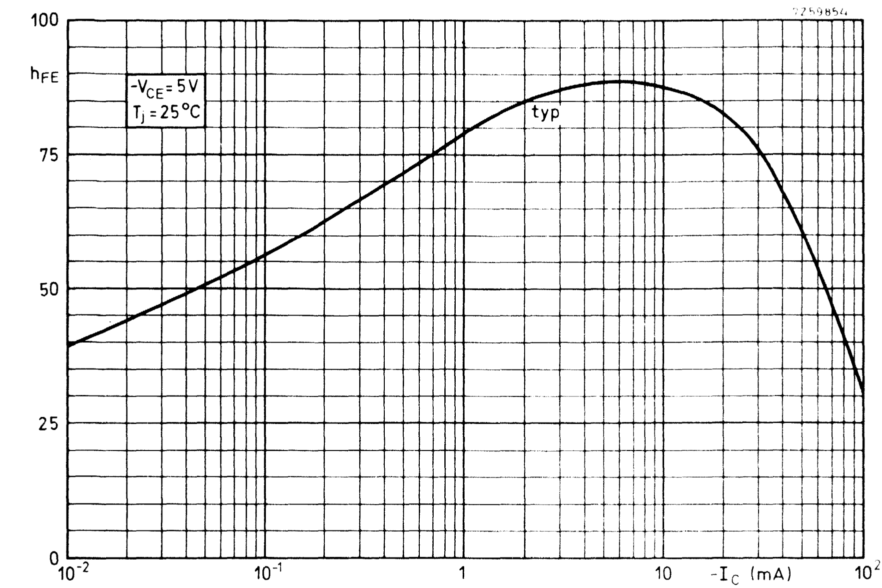

7259854
100
h_{FE}
75
50
25
0
$-V_{CE} = 5$ V
$T_j = 25$ °C
typ
10^{-2}
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 2.

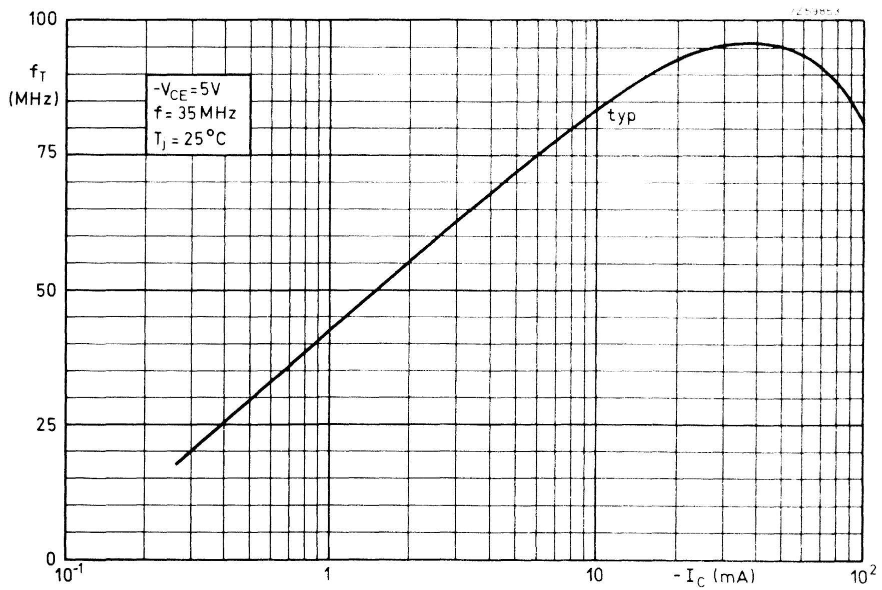

100
f_T
(MHz)
75
50
25
0
$-V_{CE} = 5$ V
f = 35 MHz
$T_j = 25$ °C
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 3.

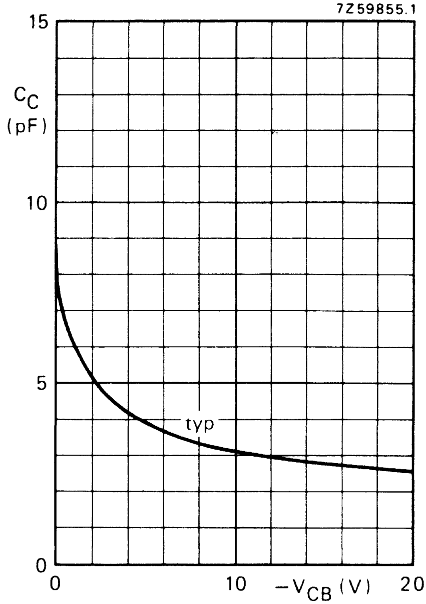


Fig. 4 Typical values collector capacitance as a function of collector-base voltage.
$I_E = I_e = 0$; $T_j = 25$ °C; f = 1 MHz.

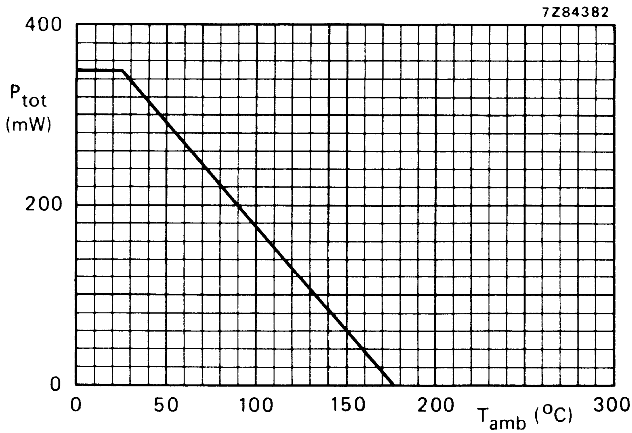


Fig. 5 Power derating curve.

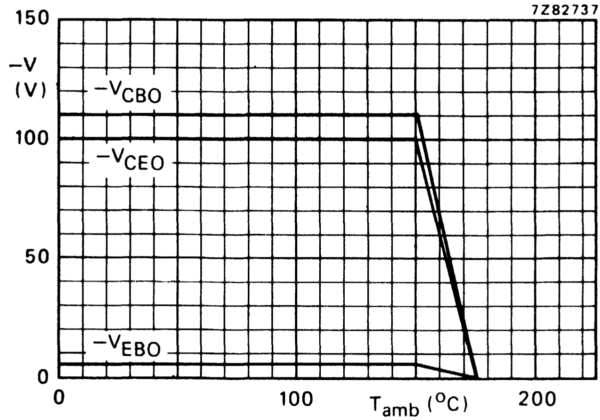


Fig. 6 Voltage derating curves.

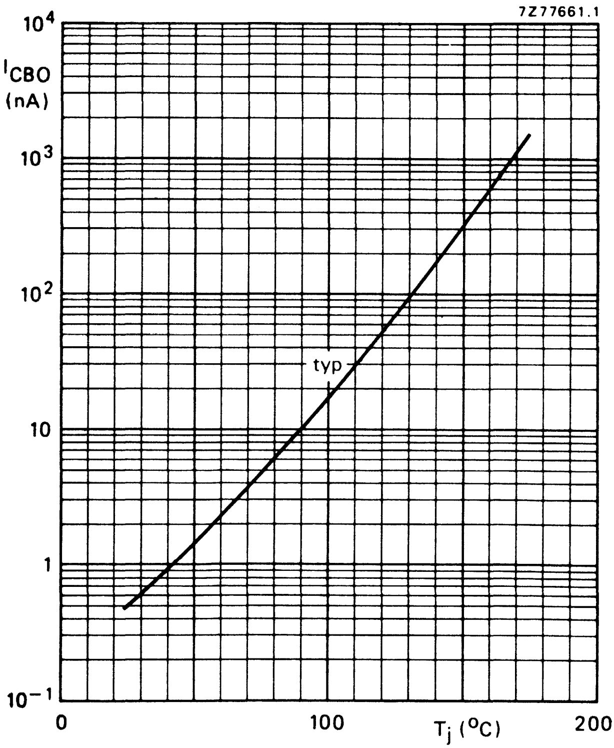


Fig. 7 Typical values collector-base currents as a function of the junction temperature at a collector-base voltage of 90 V.

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.

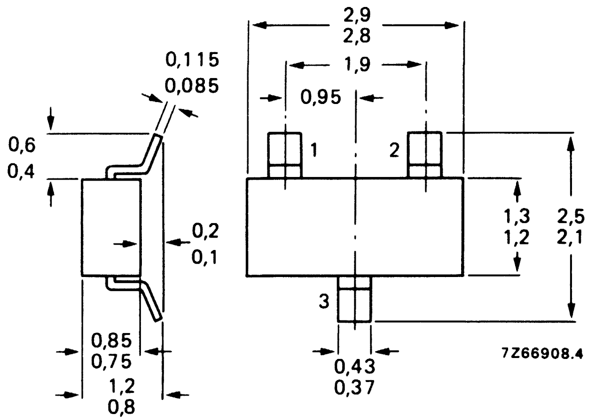
QUICK REFERENCE DATA

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

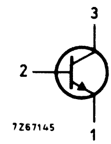
Dimensions in mm

Fig. 1 SOT-23.

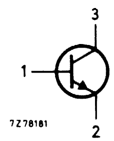


Marking code

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 *

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

Thermal resistance

From junction to tab	$R_{th\ j\text{-}t}$	=	50 K/W
→ From tab to soldering points	$R_{th\ t\text{-}s}$	=	280 K/W
→ From soldering points to ambient **	$R_{th\ s\text{-}a}$	=	90 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} V_{BEsat}	< <	150 mV 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}	> typ.	20 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 8 mm x 10 mm x 0,7 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

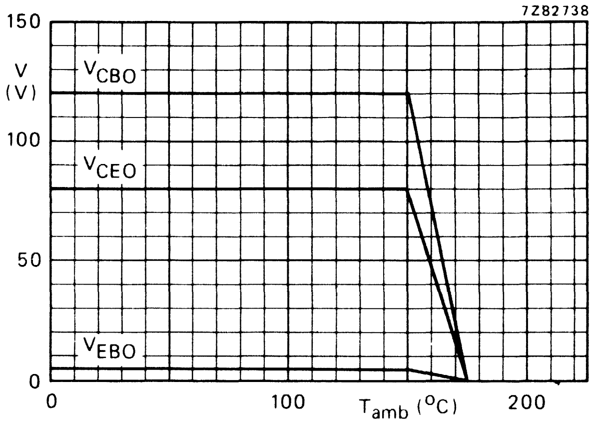


Fig. 2 Voltage derating curves.

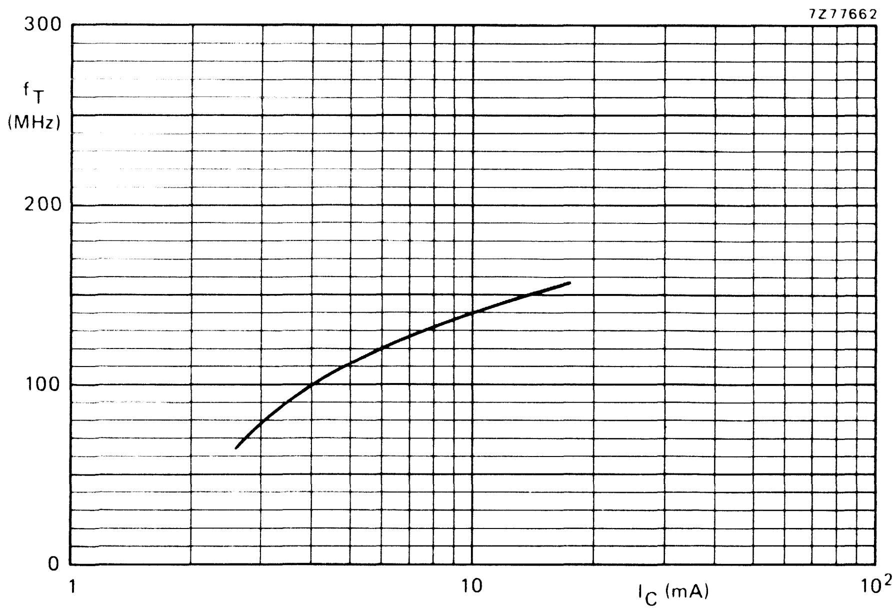


Fig. 3 Typical values transition frequency. V_{CE} = 10 V; f = 35 MHz; T_j = 25 °C.

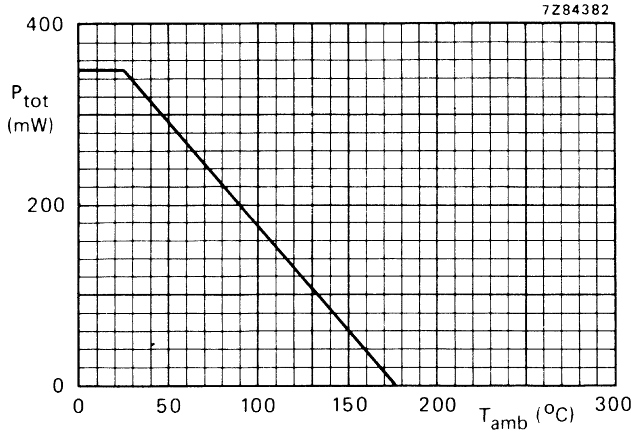


Fig. 4 Power derating curve.

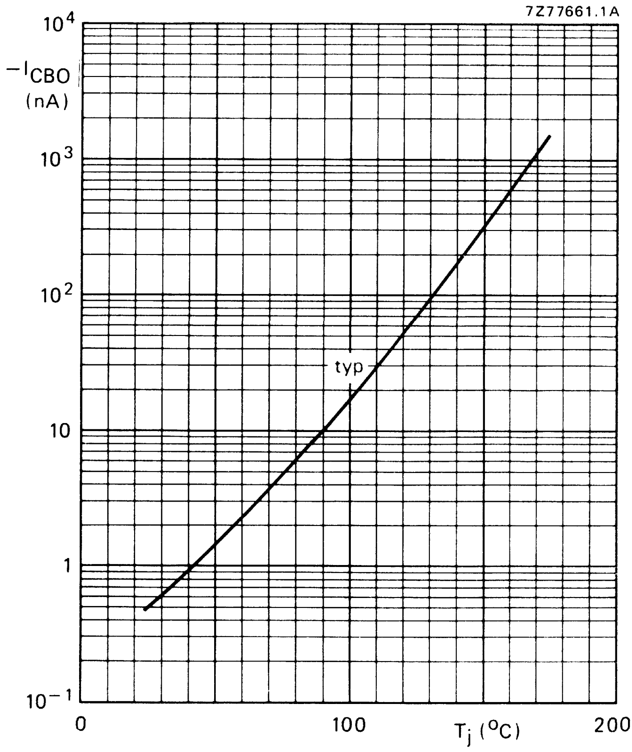


Fig. 5 Typical values collector-base current as a function of the junction temperature at a collector-base voltage of −90 V.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in miniature plastic envelopes intended for use in amplifier and switching applications.

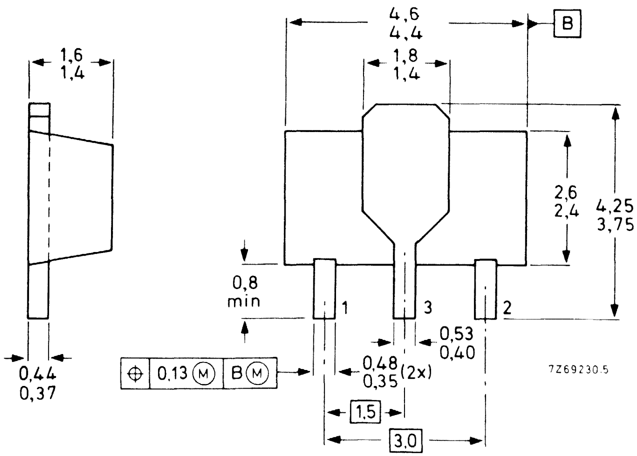
QUICK REFERENCE DATA

			BST15	BST16	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	200	350	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	200	300	V
Collector current (d.c.)	$-I_C$	max.	1		A
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 $-V_{CE}$ = 10 V; $-I_C$ = 50 mA	h_{FE}		30 to 150	30 to 120	
Transition frequency $-V_{CE}$ = 10 V; $-I_C$ = 10 mA	f_T	>	15		MHz

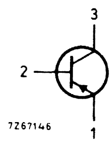
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-89.



Mark
BST15
BST16



See also *Soldering Recommendations* in Microminiature Semiconductors handbook.

RATINGS

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

			BST15	BST16	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	200	350	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	200	300	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	4	6	V
Collector current (d.c.)	$-I_C$	max.	1		A
Base current	$-I_B$	max.	0,5		A
Total power dissipation up to T_{amb} = 25 °C*	P_{tot}	max.	1		W
Junction temperature	T_j	max.	150		°C
Storage temperature	T_{stg}		−65 to 150		°C

THERMAL RESISTANCE

from junction to ambient*	$R_{th\ j\text{-}mb}$	=	125	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BST15	BST16	
Collector cut-off current					
$I_E = 0$; $-V_{CB}$ = 175 V	$-I_{CBO}$	<	1	–	μA
$I_E = 0$; $-V_{CB}$ = 280 V	$-I_{CBO}$	<	–	1	μA
$I_B = 0$; $-V_{CE}$ = 150 V	$-I_{CEO}$	<	50	–	μA
$I_B = 0$; $-V_{CE}$ = 250 V	$-I_{CEO}$	<	–	50	μA
Emitter cut-off current					
$I_C = 0$; $-V_{EB}$ = 4 V	$-I_{EBO}$	<	20	–	μA
$I_C = 0$; $-V_{EB}$ = 6 V	$-I_{EBO}$	<	–	20	μA
Collector-emitter breakdown voltage					
$I_B = 0$; $-I_C$ = 50 mA; L = 25 mH	$-V_{(BR)CEO}$	>	200	300	V
Collector-emitter saturation voltage					
$-I_C$ = 50 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	<	2,5	2,0	V
D.C. current gain					
$-V_{CE}$ = 10 V; $-I_C$ = 50 mA	h_{FE}		30 to 150	30 to 120	
Transition frequency at f = 30 MHz					
$-I_C$ = 10 mA; $-V_{CE}$ = 10 V	f_T	>	15		MHz
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $-V_{CB}$ = 10 V	C_c	<	15		pF

* Mounted on an area of 2,5 cm^2 of a ceramic substrate; thickness 0,7 mm.

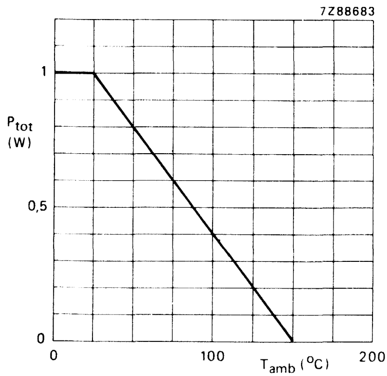


Fig. 2 Power derating curve.

N-P-N SILICON PLANAR DARLINGTON TRANSISTORS

Silicon n-p-n planar Darlington transistors for industrial switching applications, e.g. print hammer, solenoid, relay and lamp driving. Encapsulated in a microminiature SOT-89 envelope.

P-N-P complements are BST60, 61, 62 respectively.

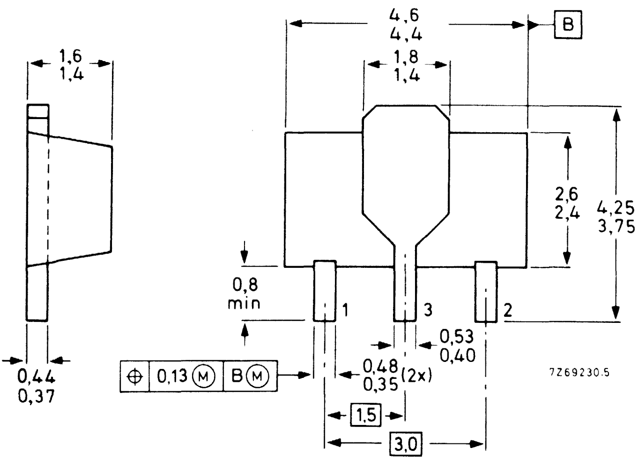
QUICK REFERENCE DATA

			BST50	BST51	BST52	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage	V_{CER}	max.	45	60	80	V
Collector current	I_C	max.	0,5	0,5	0,5	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		1		W
D.C. current gain I_C = 500 mA; V_{CE} = 10 V	h_{FE}	>		2000		
Collector-emitter saturation voltage I_C = 500 mA; I_B = 0,5 mA	V_{CEsat}	<		1,3		V
Turn-off time I_C = 500 mA; $I_{Bon} = -I_{Boff}$ = 0,5 mA	t_{off}	typ.		1500		ns

MECHANICAL DATA

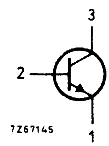
Dimensions in mm

Fig. 1 SOT-89.



Mark

BST50
BST51
BST52



See also *Soldering recommendations*.

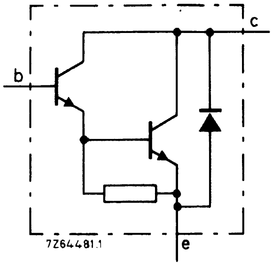


Fig. 2 Circuit diagram.

RATINGS

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

			BST50	BST51	BST52	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage*	V_{CER}	max.	45	60	80	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5		V
Collector current (d.c.)	I_C	max.		0,5		A
Collector current (peak)	I_{CM}	max.		1,5		A
Base current (d.c.)	I_B	max.		0,1		A
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 ambient▲	$R_{th\,j\text{-}a}$	=	125	K/W
From junction to tab	$R_{th\,j\text{-}tab}$	=	10	K/W

* External R_{BE} not to exceed value shown in Fig. 5.
** Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.
▲ Device mounted on a ceramic substrate; area = 2,5 cm^2, thickness = 0,7 mm.

DEVELOPMENT SAMPLE DATA

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$V_{BE} = 0$; $V_{CE} = V_{CER}max$	I_{CES}	<	10 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	<	10 μA
D.C. current gain*			
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}	>	1000
$I_C = 500$ mA; $V_{CE} = 10$ V	h_{FE}	>	2000
Collector-emitter saturation voltage			
$I_C = 500$ mA; $I_B = 0,5$ mA	V_{CEsat}	<	1,3 V
$I_C = 500$ mA; $I_B = 0,5$ mA; $T_j = 150$ °C	V_{CEsat}	<	1,3 V
Base-emitter saturation voltage			
$I_C = 500$ mA; $I_B = 0,5$ mA	V_{BEsat}	<	1,9 V
Switching times (see also Fig. 3 and Fig. 4)			
$I_C = 500$ mA; $I_{Bon} = -I_{Boff} = 0,5$ mA			
Turn-on time	t_{on}	typ.	400 ns
Turn-off time	t_{off}	typ.	1500 ns

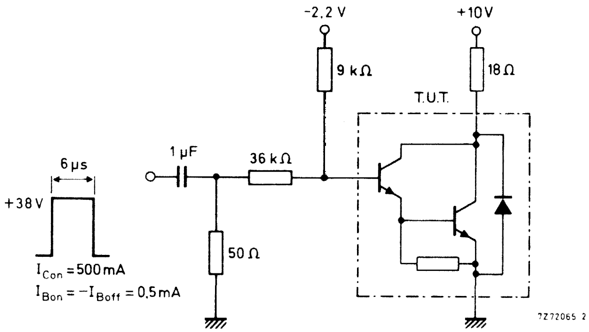


Fig. 3 Switching times test circuit.

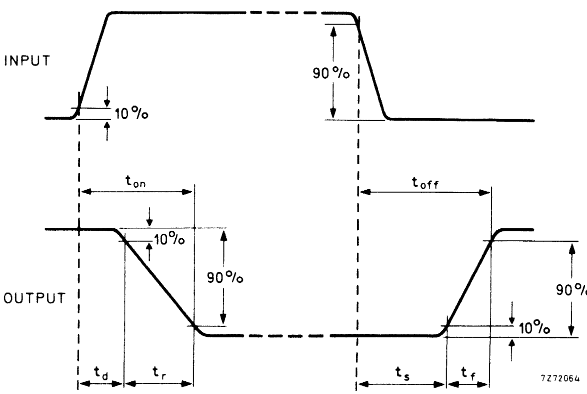


Fig. 4 Switching times waveform.

* Measured under pulsed conditions.

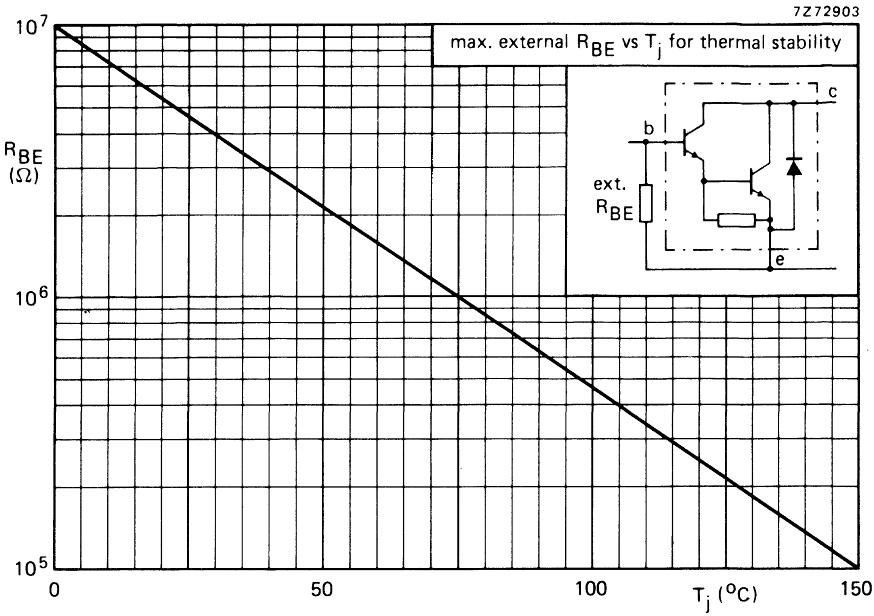


Fig. 5 Maximum values external R_{BE} as a function of junction temperature.

P-N-P SILICON PLANAR DARLINGTON TRANSISTORS

Silicon p-n-p planar Darlington transistors for industrial switching applications, e.g. print hammer, solenoid, relay and lamp driving. Encapsulated in a microminiature plastic SOT-89 envelope.

N-P-N complements are BST50, BST51 and BST52 respectively.

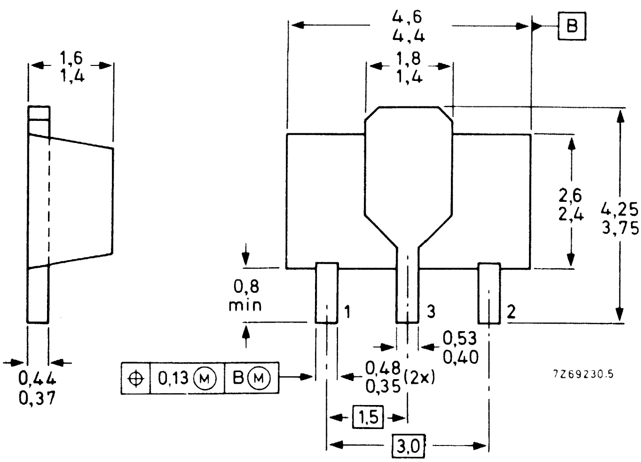
QUICK REFERENCE DATA

			BST60	BST61	BST62	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage	$-V_{CER}$	max.	45	60	80	V
Collector current	$-I_C$	max.	0,5	0,5	0,5	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		1		W
D.C. current gain $-I_C$ = 500 mA; $-V_{CE}$ = 10 V	h_{FE}	>		2000		
Collector-emitter saturation voltage $-I_C$ = 0,5 A; $-I_B$ = 0,5 mA	$-V_{CEsat}$	<		1,3		V
Turn-off time $-I_C$ = 500 mA; $-I_{Bon}$ = I_{Boff} = 0,5 mA	t_{off}	typ.		1500		ns

MECHANICAL DATA

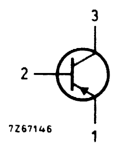
Dimensions in mm

Fig. 1 SOT-89.



Mark

BST60
BST61
BST62



See also *Soldering recommendations*.

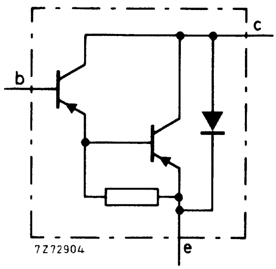


Fig. 2 Circuit diagram.

RATINGS

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

			BST60	BST61	BST62	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage*	$-V_{CER}$	max.	45	60	80	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5		V
Collector current (d.c.)	$-I_C$	max.		0,5		A
Collector current (peak)	$-I_{CM}$	max.		1,5		A
Base current (d.c.)	$-I_B$	max.		0,1		A
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 ambient▲	$R_{th\,j\text{-}a}$	=	125	K/W
From junction to tab	$R_{th\,j\text{-}tab}$	=	10	K/W

* External R_{BE} not to exceed value shown in Fig. 5.
** Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.
▲ Device mounted on a ceramic substrate area 2,5 cm^2, thickness = 0,7 mm.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
V_{BE} = 0; $-V_{CE} = -V_{CER}max$	$-I_{CES}$	<	10 μA
Emitter cut-off current			
I_C = 0; V_{EB} = 4 V	$-I_{EBO}$	<	10 μA
D.C. current gain*			
$-I_C$ = 150 mA; $-V_{CE}$ = 10 V	h_{FE}	>	1000
$-I_C$ = 500 mA; $-V_{CE}$ = 10 V	h_{FE}	>	2000
Collector-emitter saturation voltage			
$-I_C$ = 500 mA; $-I_B$ = 0,5 mA	$-V_{CEsat}$	<	1,3 V
$-I_C$ = 500 mA; $-I_B$ = 0,5 mA; T_j = 150 °C	$-V_{CEsat}$	<	1,3 V
Base-emitter saturation voltage			
$-I_C$ = 500 mA; $-I_B$ = 0,5 mA	$-V_{BEsat}$	<	1,9 V
Switching times (see also Fig. 3 and Fig. 4)			
$-I_C$ = 500 mA; $-I_{Bon} = -I_{Boff}$ = 0,5 mA			
Turn-on time	t_{on}	typ.	400 ns
Turn-off time	t_{off}	typ.	1500 ns

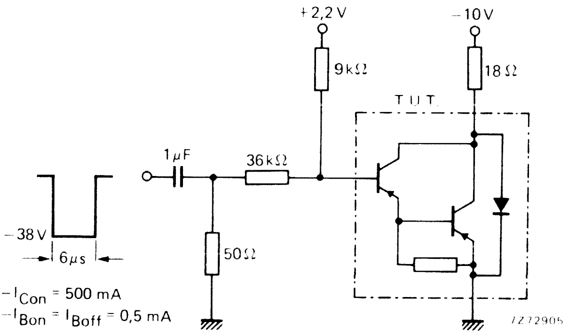


Fig. 3 Switching times test circuit.

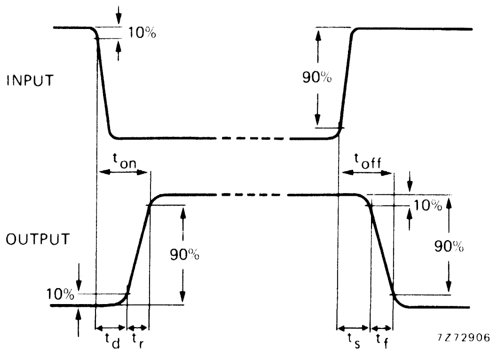


Fig. 4 Switching times waveform.

* Measured under pulsed conditions.

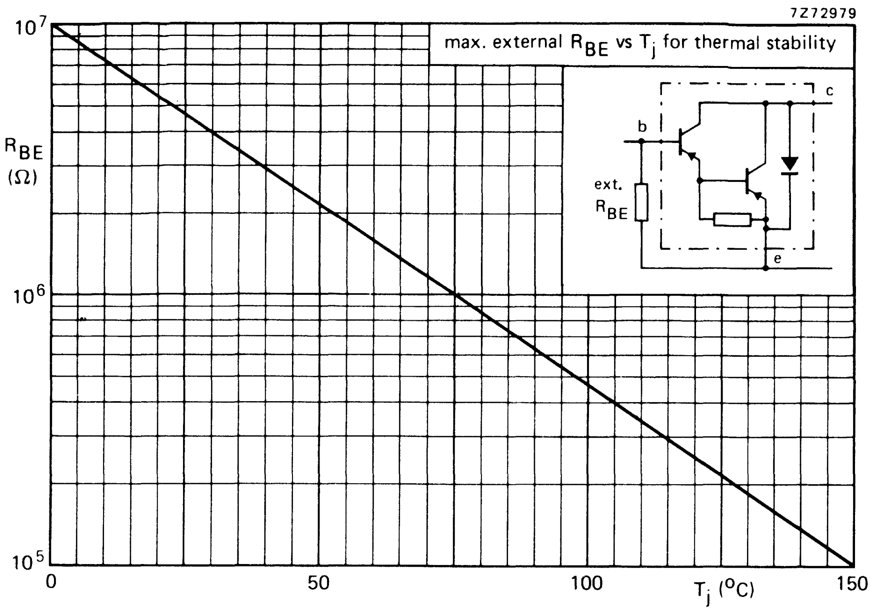


Fig. 5 Maximum values external R_{BE} as a function of junction temperature.

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.

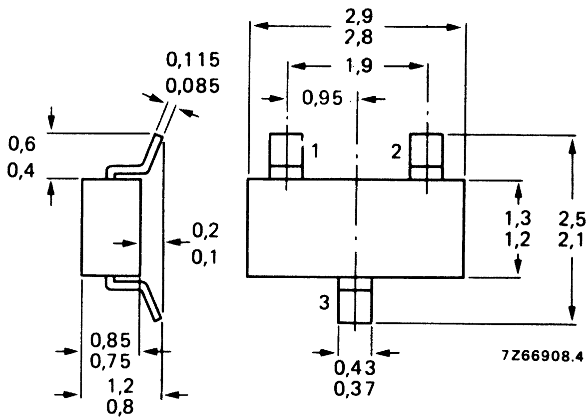
QUICK REFERENCE DATA

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		>	400	MHz
I_C = 10 mA; V_{CE} = 10 V	f_T	typ.	500	MHz
Storage time				
$I_C = I_B = -I_{BM}$ = 10 mA	t_s	<	13	ns

MECHANICAL DATA

Dimensions in mm

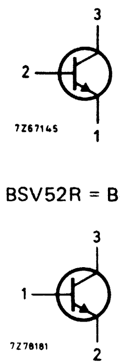
Fig. 1 SOT-23.



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*

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

Thermal resistance

From junction to tab	$R_{th\,j\text{-}t}$	=	60 K/W
→ From tab to soldering points	$R_{th\,t\text{-}s}$	=	280 K/W
→ From soldering points to ambient**	$R_{th\,s\text{-}a}$	=	90 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 8 mm x 10 mm x 0,7 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

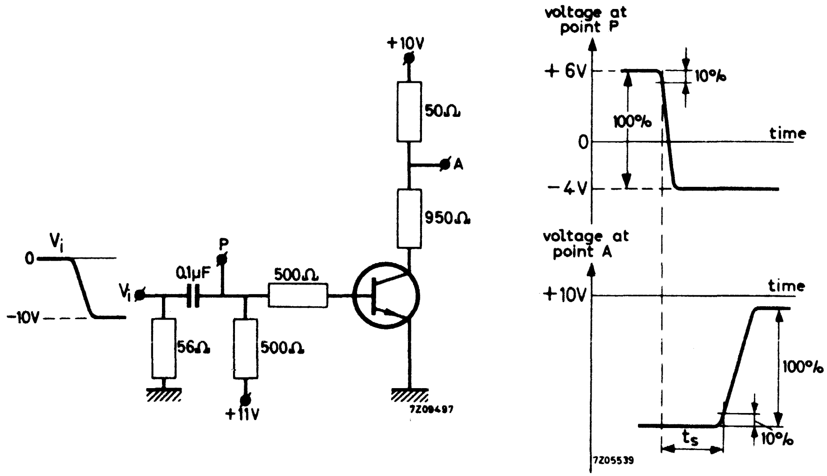


Fig. 2 Test circuit and waveform storage time.

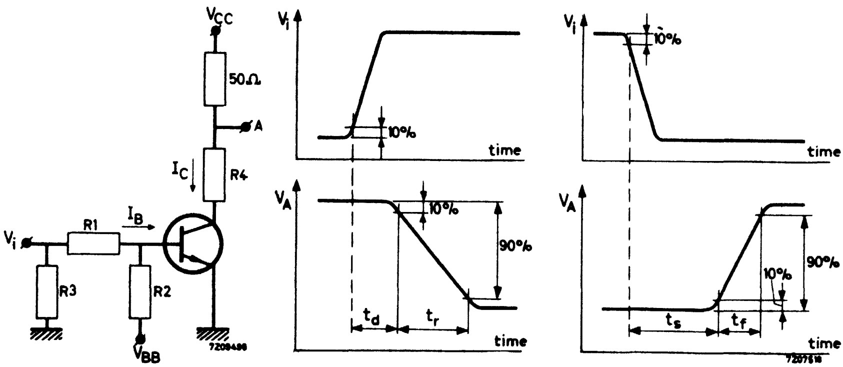


Fig. 3 Test circuit and waveforms turn on and turn off time.

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.

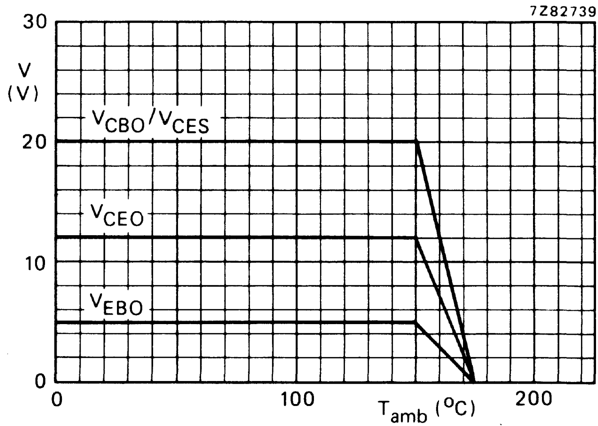


Fig. 4 Voltage derating curves.

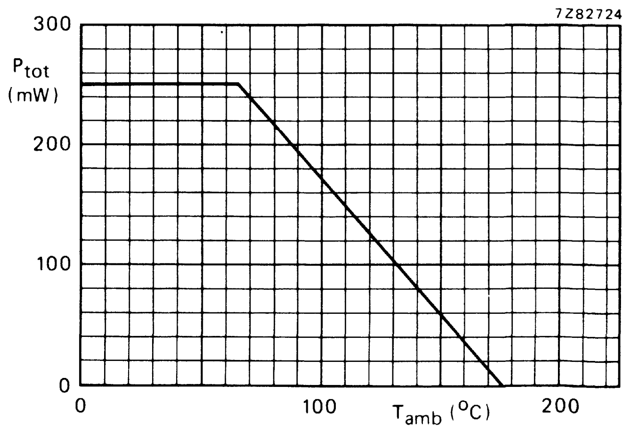
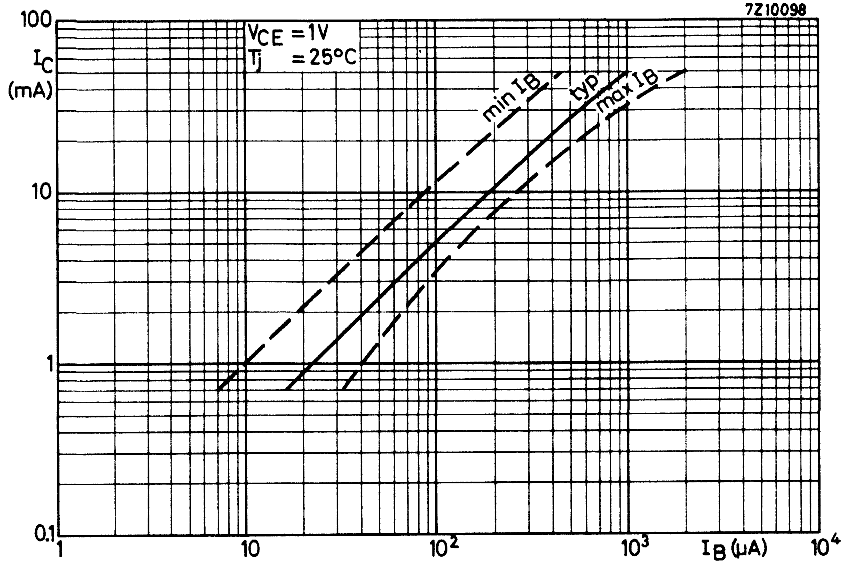
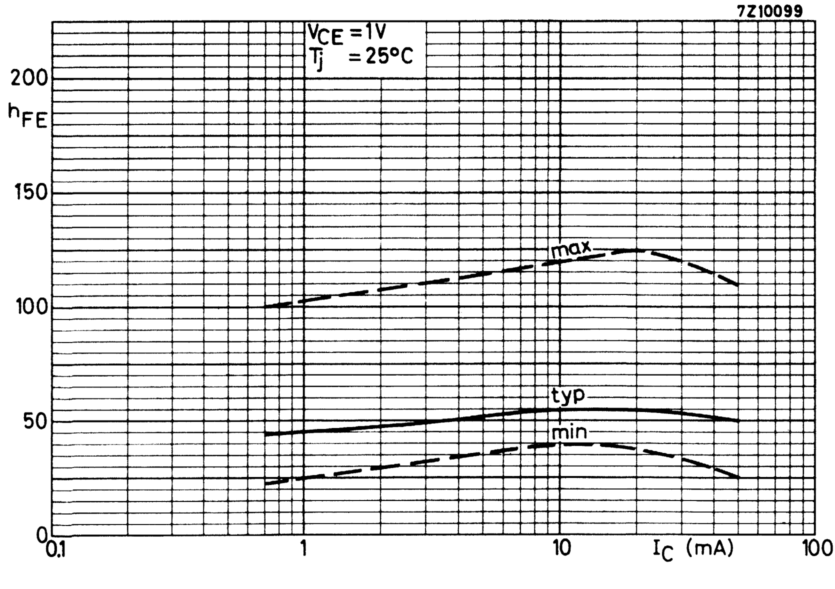
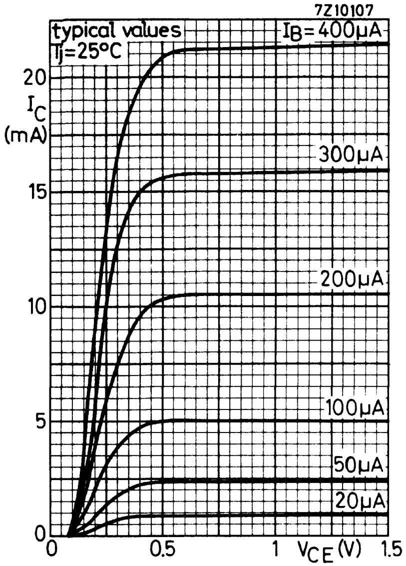
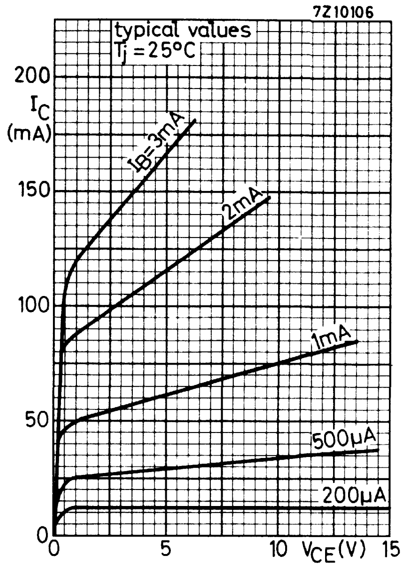


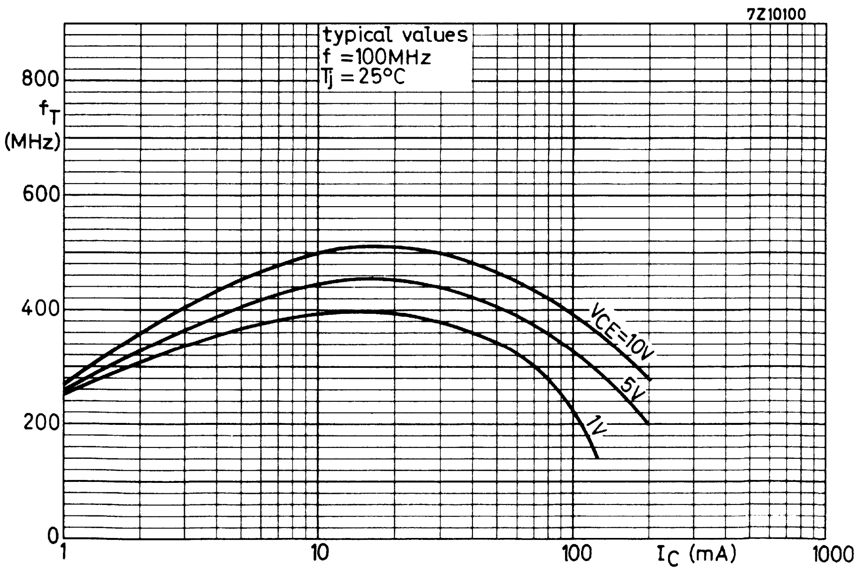
Fig. 5 Power derating curve.

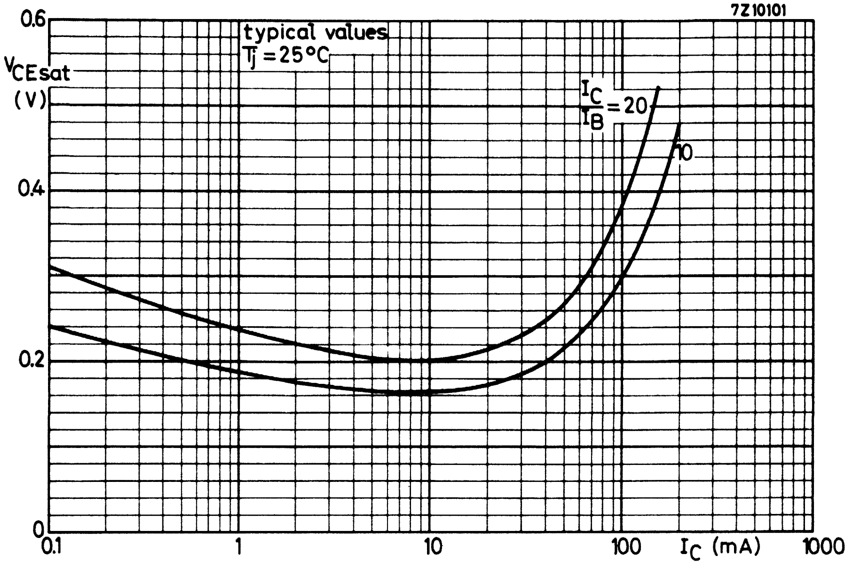

7Z10098
V_{CE} = 1V
T_j = 25°C
I_C (mA)
100
10
1
0.1
1
10
10^2
10^3
10^4
I_B (µA)
min I_B
typ
max I_B

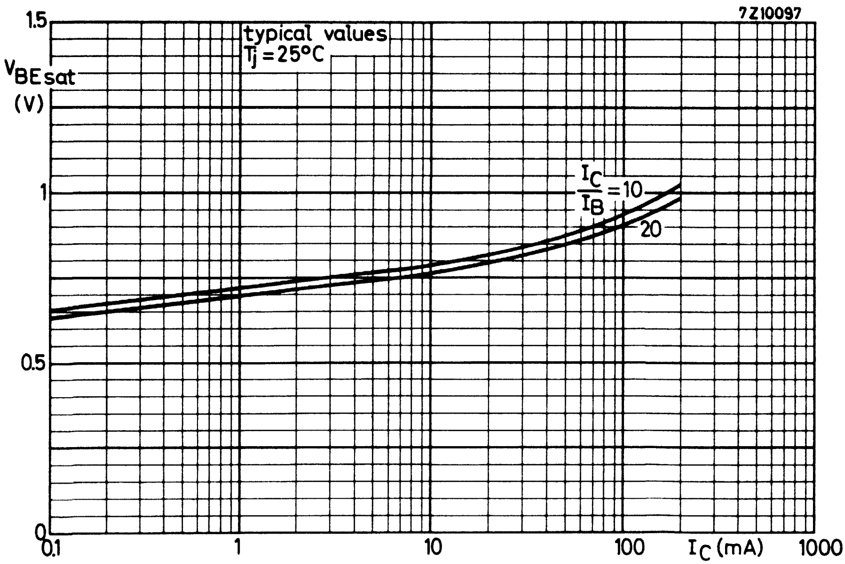

7Z10099
V_{CE} = 1V
T_j = 25°C
h_{FE}
200
150
100
50
0
0.1
1
10
100
I_C (mA)
max
typ
min

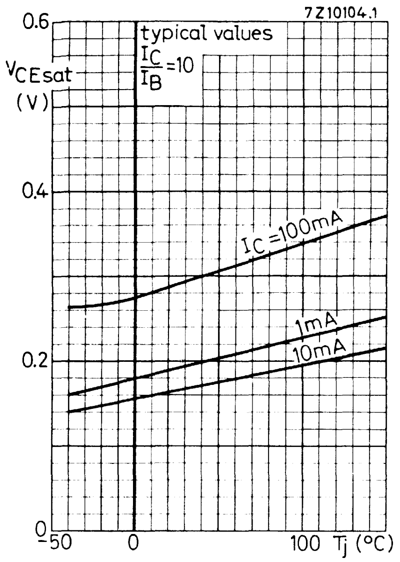

7Z10107
typical values
Tj=25°C
IB=400µA
300µA
200µA
100µA
50µA
20µA
20
15
10
5
0
IC
(mA)
0
0.5
1
VCE (V)
1.5

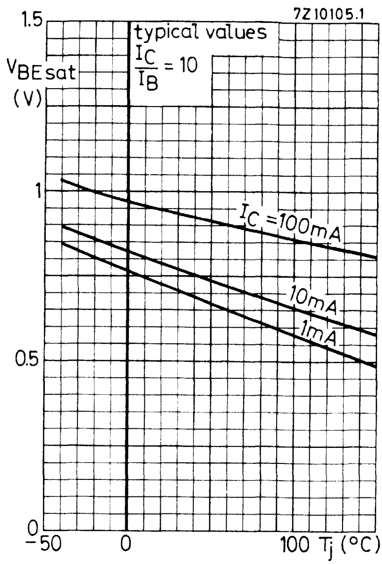

7Z10106
typical values
Tj=25°C
IB=3mA
2mA
1mA
500µA
200µA
200
150
100
50
0
IC
(mA)
0
5
10
VCE (V)
15

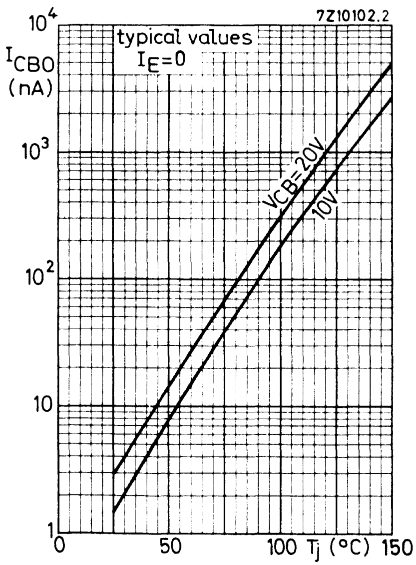

7Z10100
typical values
f =100MHz
Tj =25°C
VCE=10V
5V
1V
800
600
400
200
0
fT
(MHz)
1
10
100
IC (mA)
1000

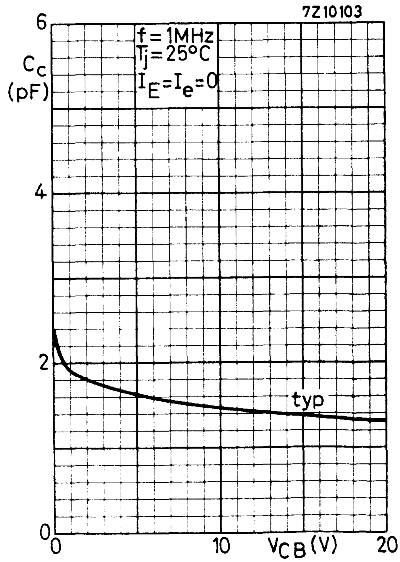

7Z10101
0.6
0.4
0.2
0
V_{CEsat}
(V)
typical values
$T_j = 25\,°C$
$\frac{I_C}{I_B} = 20$
10
0.1
1
10
100
I_C (mA)
1000


7Z10097
1.5
1
0.5
0
V_{BEsat}
(V)
typical values
$T_j = 25\,°C$
$\frac{I_C}{I_B} = 10$
20
0.1
1
10
100
I_C (mA)
1000


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


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


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


7Z10103
f = 1MHz
T_j = 25°C
$I_E=I_e=0$
C_c (pF)
typ
6
4
2
0
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 2,4 V to 75 V with a tolerance of ± 5% (international standard E24 range).

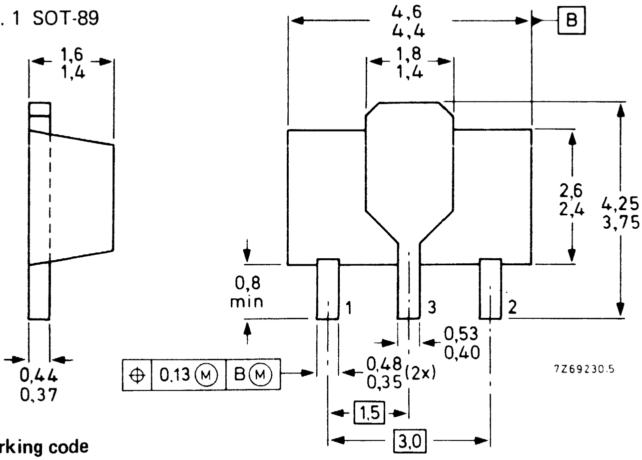
QUICK REFERENCE DATA

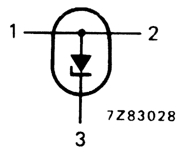
Working voltage range	V_Z	nom.	2,4 to 75	V
Working voltage tolerance (E24 range)			±5	%
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	1	W
Junction temperature	T_j	max.	150	°C

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-89





Marking code

BZV49- C2V4 = 2Y4	C5V1 = 5Y1	C12 = 12Y	C33 = 33Y
C2V7 = 2Y7	C5V6 = 5Y6	C13 = 13Y	C36 = 36Y
C3V0 = 3Y0	C6V2 = 6Y2	C15 = 15Y	C39 = 39Y
C3V3 = 3Y3	C6V8 = 6Y8	C16 = 16Y	C43 = 43Y
C3V6 = 3Y6	C7V5 = 7Y5	C18 = 18Y	C47 = 47Y
C3V9 = 3Y9	C8V2 = 8Y2	C20 = 20Y	C51 = 51Y
C4V3 = 4Y3	C9V1 = 9Y1	C22 = 22Y	C56 = 56Y
C4V7 = 4Y7	C10 = 10Y	C24 = 24Y	C62 = 62Y
	C11 = 11Y	C27 = 27Y	C68 = 68Y
		C30 = 30Y	C75 = 75Y

RATINGS

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

Repetitive peak forward current	I_{FRM}	max.	250 mA
Average forward current (averaged over any 20 ms period)	$I_{F(AV)}$	max.	250 mA
Working current (d.c.)	I_Z	limited by $P_{tot\ max}$	
Total power dissipation * up to T_{amb} = 25 °C	P_{tot}	max.	1 W
Non-repetitive peak reverse power dissipation * T_j = 25 °C; t_p = 100 μs	P_{ZSM}	max.	40 W
Storage temperature	T_{stg}		−65 to +150 °C
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

From junction to collector tab	$R_{th\ j\text{-}tab}$	=	15 K/W
From junction to ambient in free air *	$R_{th\ j\text{-}a}$	=	125 K/W

CHARACTERISTICS

T_j = 25 °C

Forward voltage I_F = 50 mA		V_F	<	1,0 V
Reverse current				
BZV49- 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 to C13	V_R = 8 V	I_R	<	100 nA
C15 to C75	V_R = 0,7 V_{Znom}	I_R	<	50 nA

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

T_j = 25 °C

E24 logarithmic range (tolerance ± 5%)

BZV49-...	working voltage V_Z (V) at I_{Ztest} = 5 mA min.	max.	differential resistance r_{diff} (Ω) at I_{Ztest} = 5 mA typ.	max.	temperature coefficient S_Z (mV/K) at I_{Ztest} = 5 mA min.	typ.	max.	diode capacitance C_d(pF); f = 1 MHz V_R = 0 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_{Ztest} = 2 mA		at I_{Ztest} = 2 mA		at I_{Ztest} = 2 mA				
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

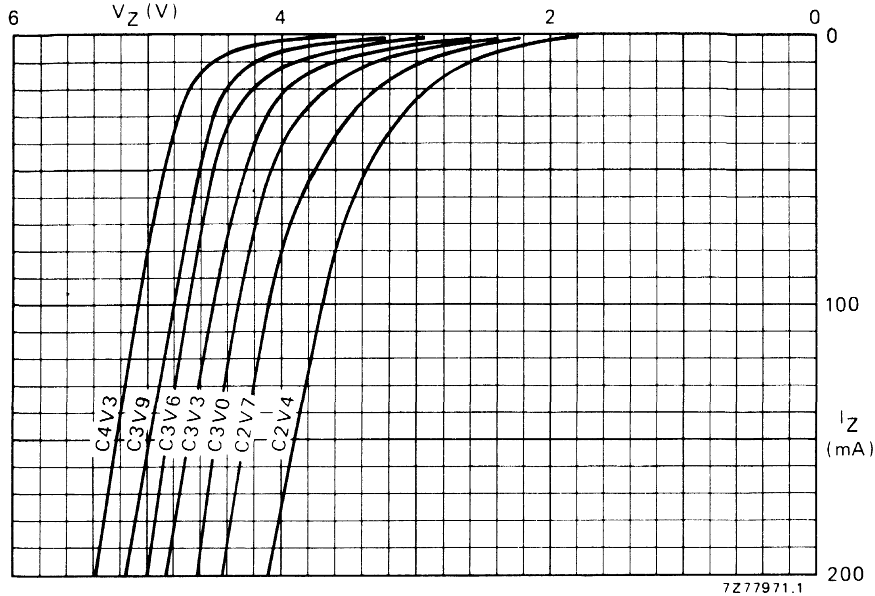


Fig. 2 Dynamic characteristics; typical values; T_j = 25 °C.

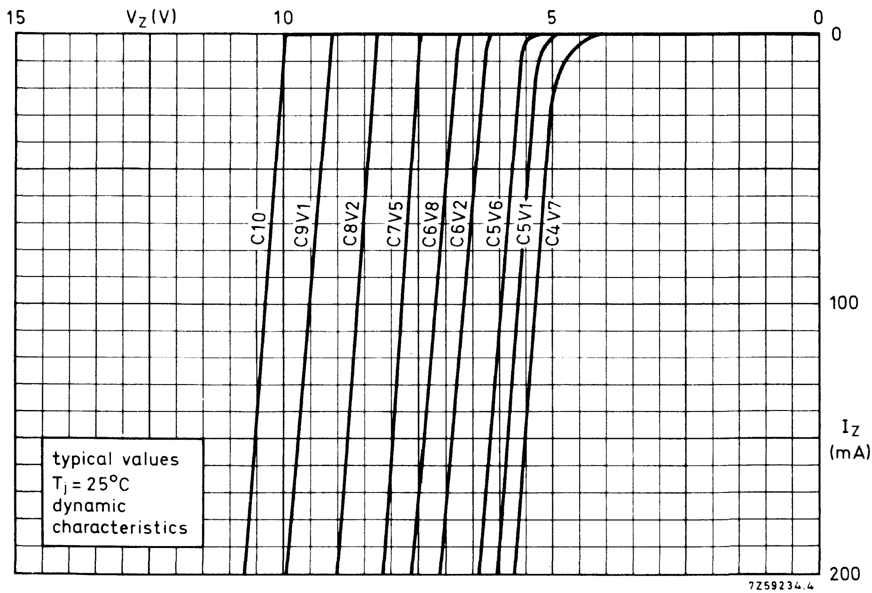


Fig. 3 Dynamic characteristics; typical values at T_j = 25 °C.

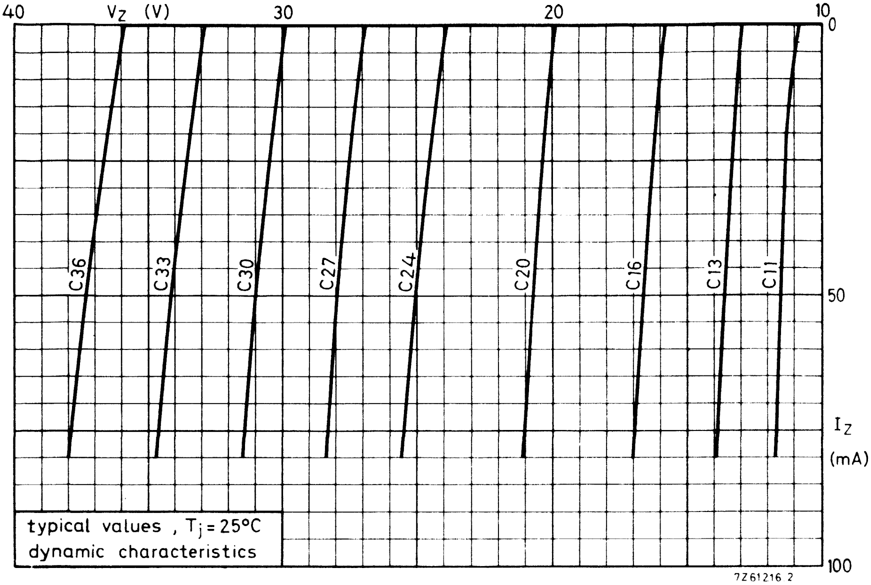


Fig. 4 Dynamic characteristics; typical values; T_j = 25 °C.

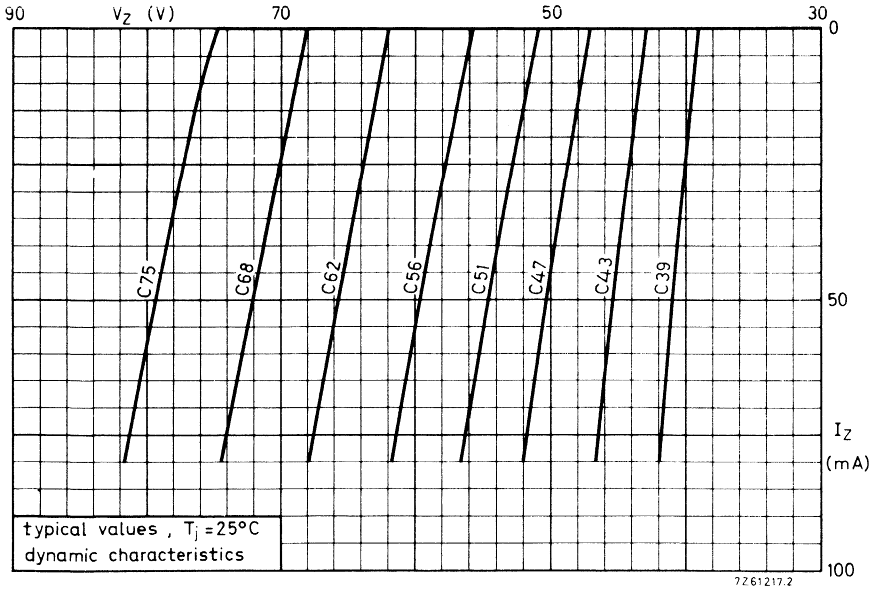


Fig. 5 Dynamic characteristics; typical values at T_j = 25 °C.

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 page 3 and can be derived from the typical dynamic characteristic curves (Figs 2, 3, 4 and 5)
$\Delta V_Z = \Delta T \times S_Z$. 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

BZV49-C24 mounted on a ceramic substrate of 7 x 5 x 0,6 mm; at I_Z = 7 mA.

$$V_{Z\ stat} = 24 + \left(\frac{7}{1000} \times 24 \times \frac{125}{1000} \times 20{,}3\right)$$

$$= 24 + 0{,}4 = 24{,}4\ \text{V}.$$

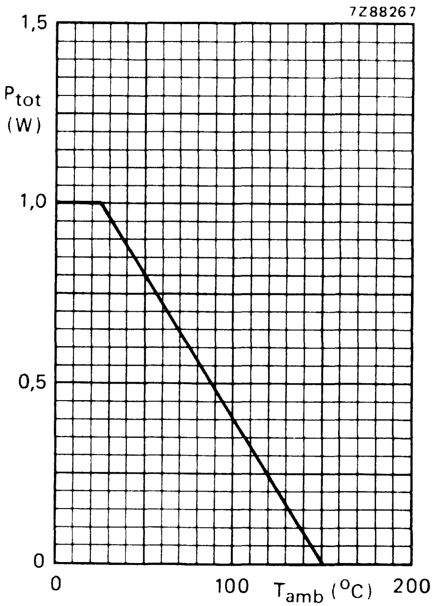


Fig. 6 Power derating curve.

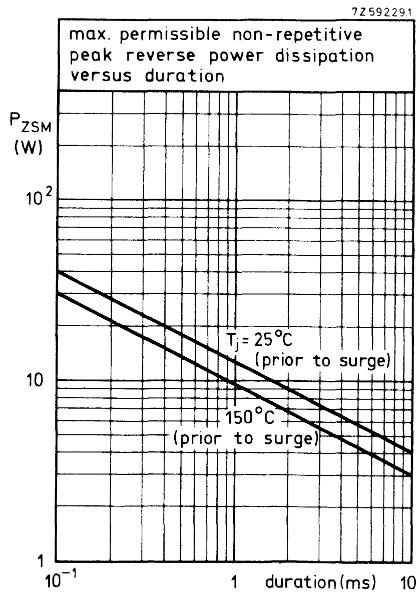


Fig. 7.

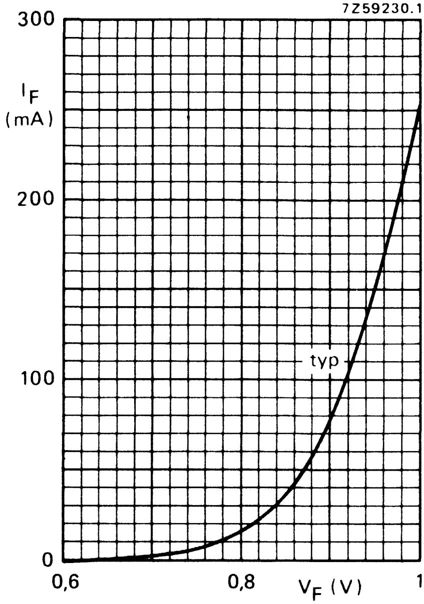


Fig. 8 $T_j = 25\ ^oC$.

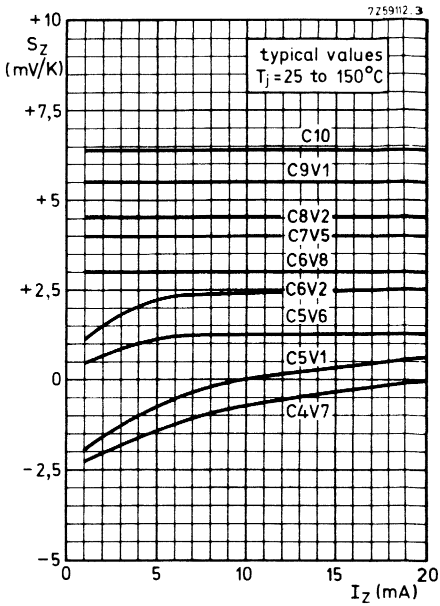


Fig. 9.

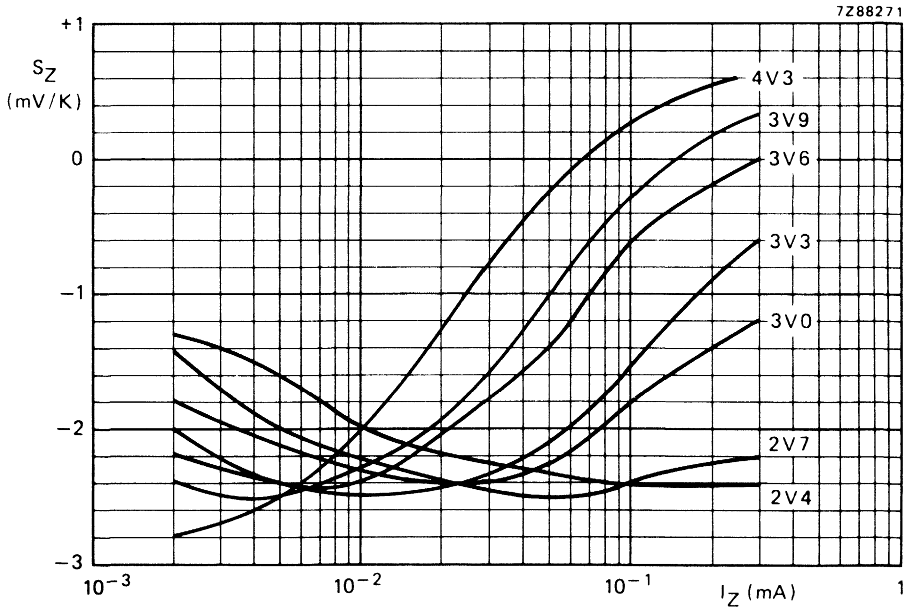


Fig. 10 Typical values temperature coefficient.

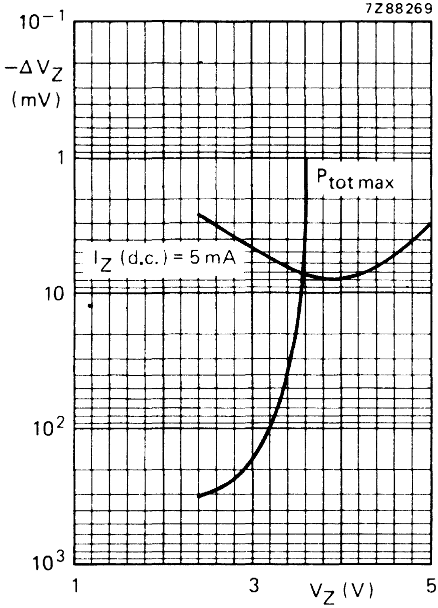


Fig. 11 Typical change of working voltage; T_j = 25 °C.

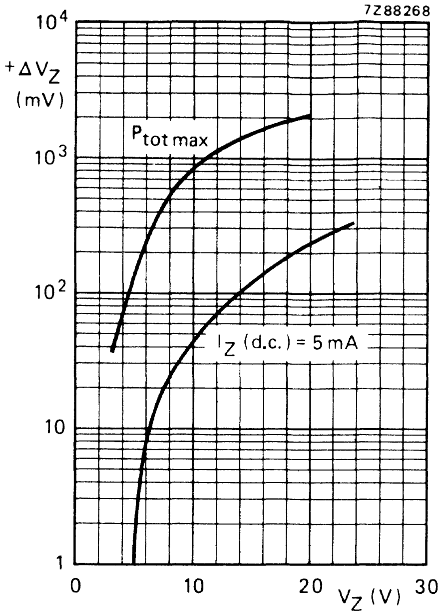


Fig. 12 Typical change of working voltage; T_{amb} = 25 °C.

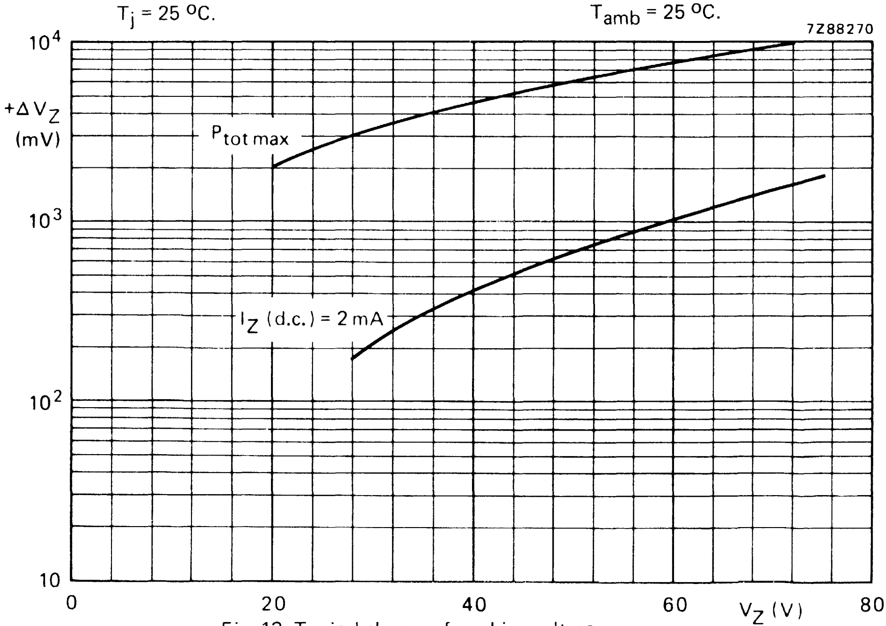


Fig. 13 Typical change of working voltage.

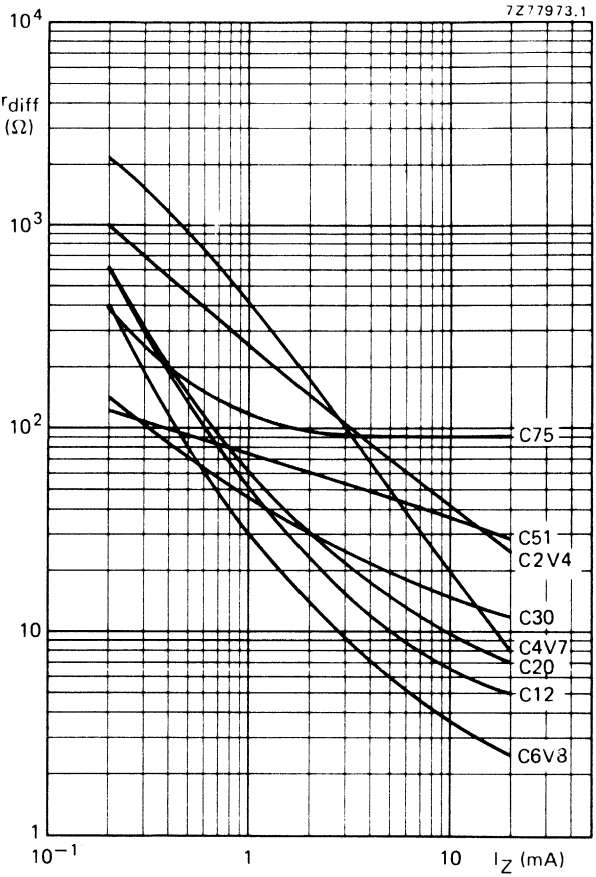


Fig. 14 Typical values; T_j = 25 °C; f = 1 kHz.

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%.

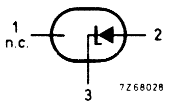
QUICK REFERENCE DATA

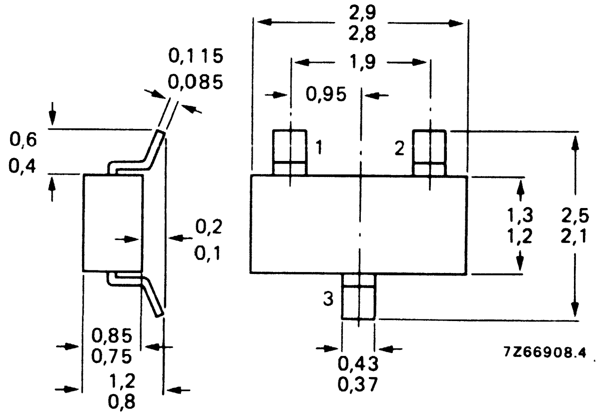
Working voltage range	V_Z	nom.	2,4 to 75	V
Working voltage tolerance			± 5	%
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	350	mW
Junction temperature	T_j	max.	175	°C

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	$R_{th\ t\text{-}s}$	=	280 K/W
→ From soldering points to ambient**	$R_{th\ s\text{-}a}$	=	90 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 8 mm x 10 mm x 0,7 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) at I_Z = 1 mA			differential resistance r_{diff} (Ω) at I_Z = 1 mA		working voltage V_Z (V) at I_Z = 20 mA			differential resistance r_{diff} (Ω) 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

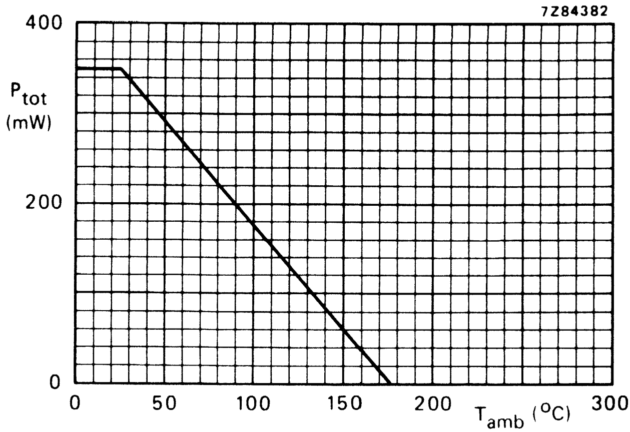


Fig. 2 Power derating curve.

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.

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

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

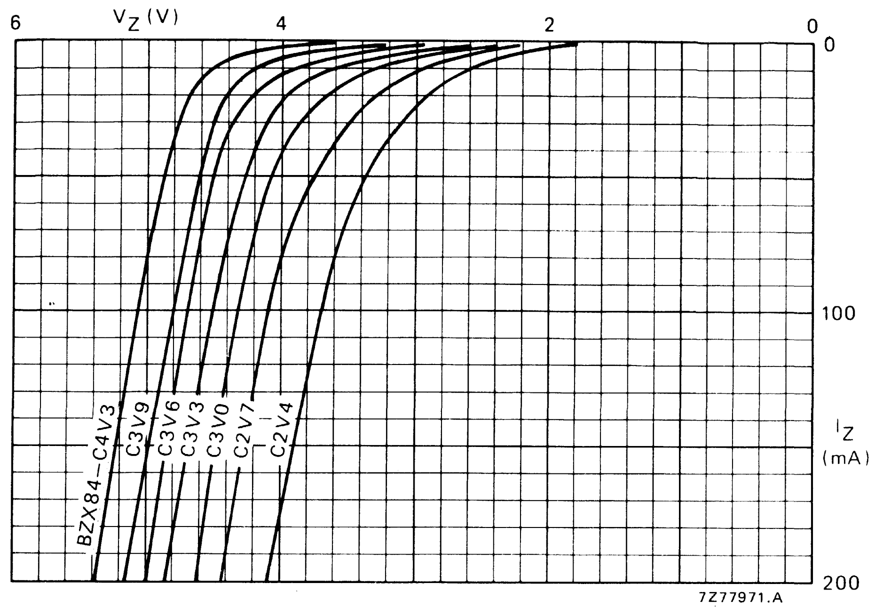


Fig. 3 Dynamic characteristics; typical values; T_j = 25 °C.

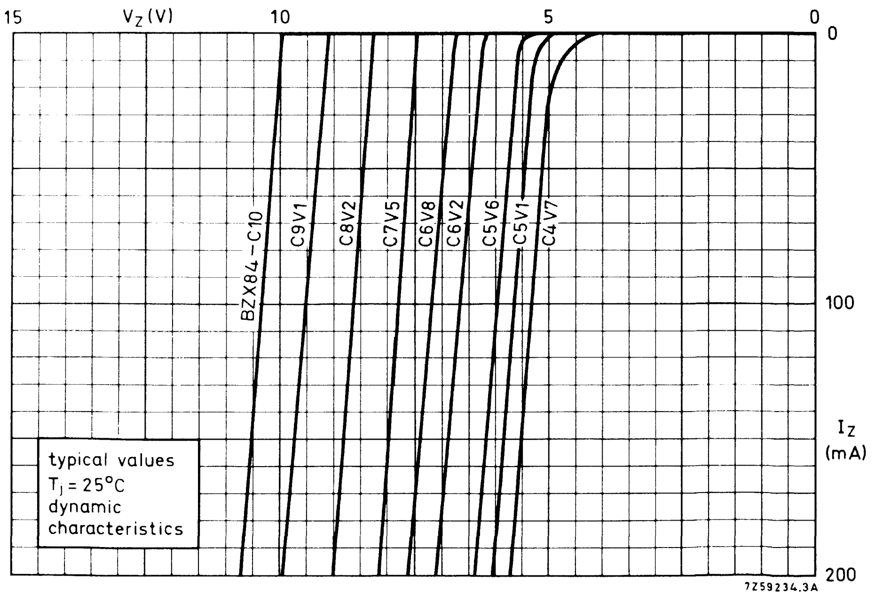


Fig. 4 Dynamic characteristics; typical values; T_j = 25 °C.

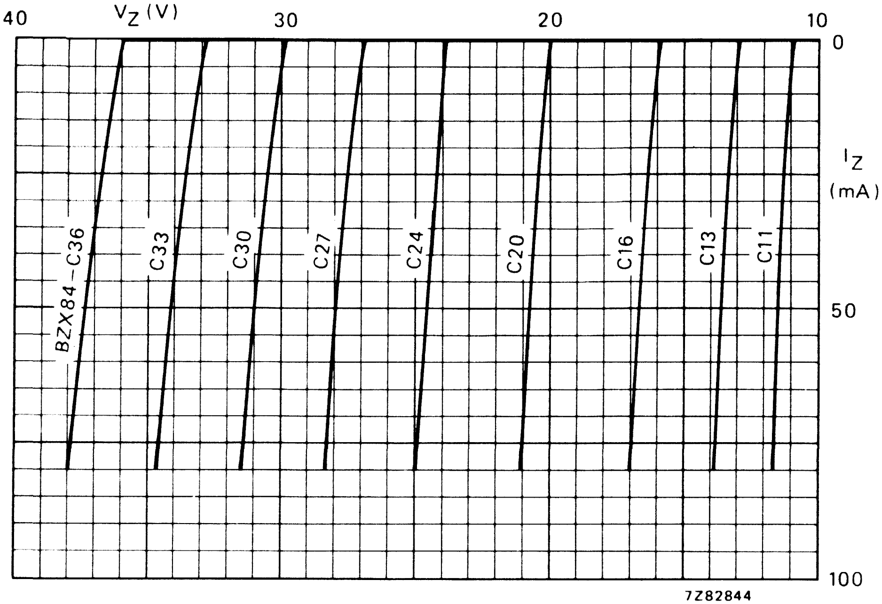


Fig. 5 Dynamic characteristics; typical values; T_j = 25 °C.

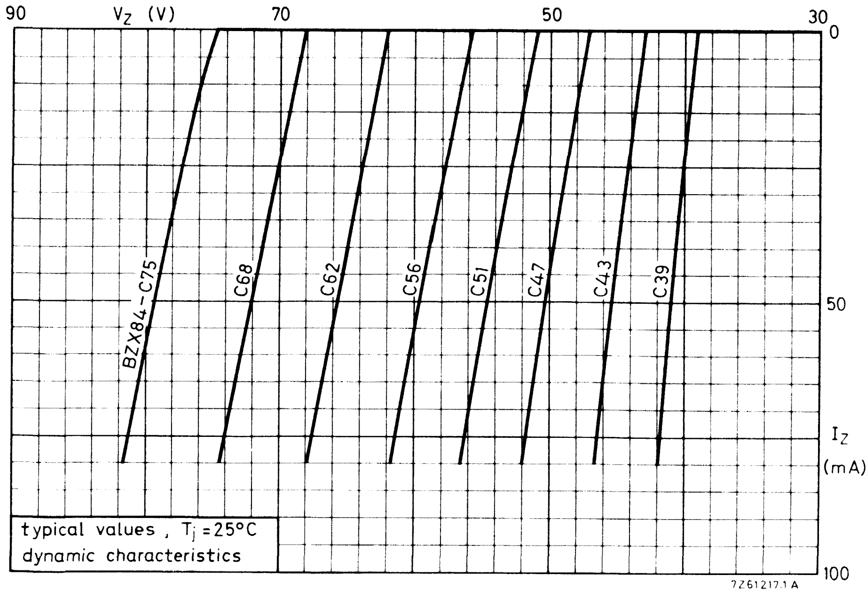


Fig. 6 Dynamic characteristics; typical values; T_j = 25 °C.

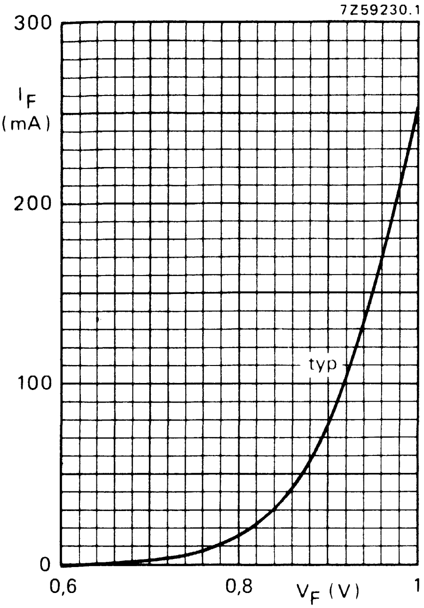


Fig. 7 Typical values at T_j = 25 °C.

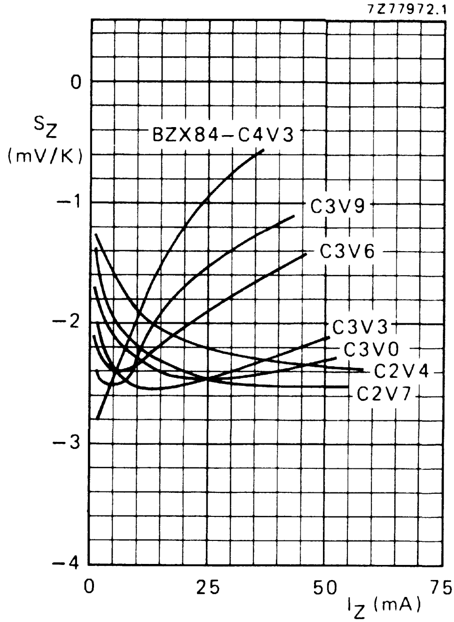


Fig. 8 Typical values; T_j = 25 to 175 °C.

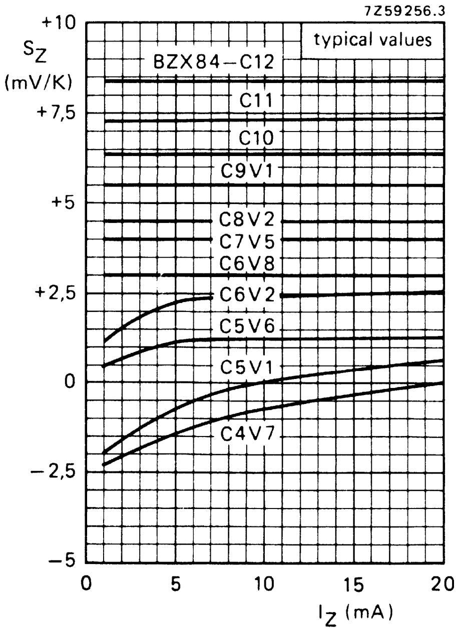


Fig. 9 Typical values; T_j = 25 to 175 °C.

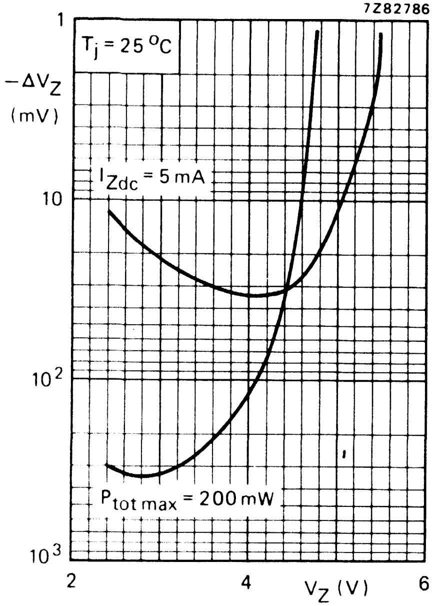


Fig. 10.

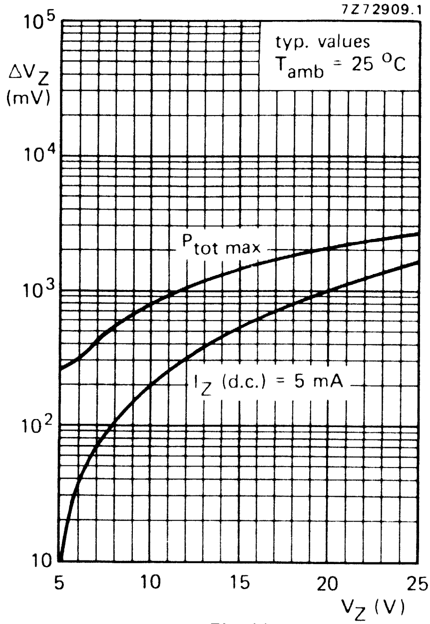


Fig. 11.

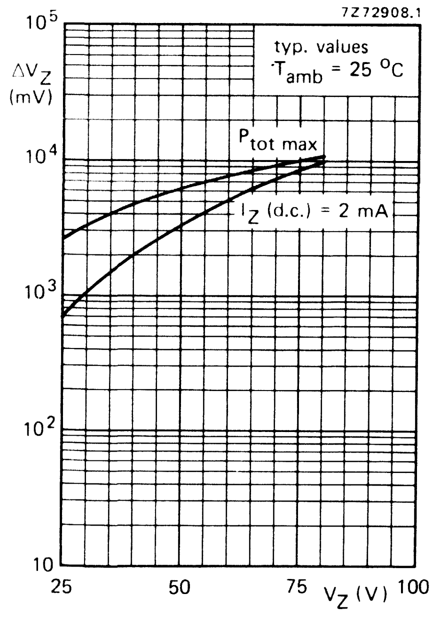


Fig. 12.

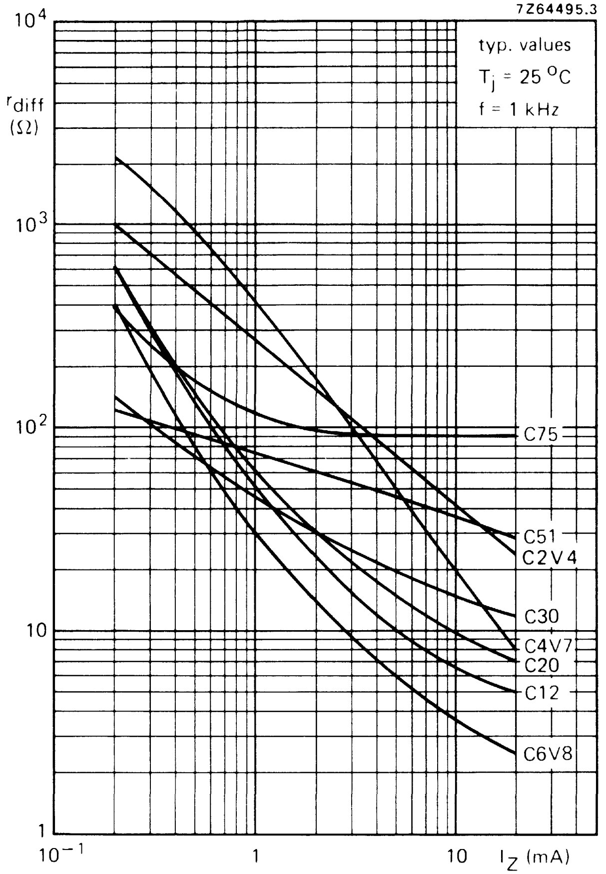

7Z64495.3
typ. values
T_j = 25 °C
f = 1 kHz
r_{diff} (Ω)
10^4
10^3
10^2
10
1
10^{-1}
1
10
I_Z (mA)
C75
C51
C2V4
C30
C4V7
C20
C12
C6V8

Fig. 13.

NOTES

NOTES

NOTES

MICROMINIATURE SEMICONDUCTORS FOR HYBRID CIRCUITS

SELECTION GUIDE

TYPE NUMBER SURVEY

GENERAL

SOLDERING RECOMMENDATIONS
THERMAL CHARACTERISTICS

DEVICE DATA