DISCRETE SEMICONDUCTORS

Small- signal Transistors

BOOK SC04 1991

Philips Semiconductors

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Small-signal transistors

Contents

SELECTION GUIDE

Small-signal transistors

Selection guide

Transistors for audio and general purpose applications

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE} (h_{fe})	at I_C (mA)	f_T (MHz) typ.	F (dB) typ.	REMARKS	PAGE
BC107	npn	TO-18	45	100	300	25	(125-500)	2	> 300	2		69
BC108	npn	TO-18	20	100	300	25	(125-900)	2	> 300	2		
BC109	npn	TO-18	20	100	300	25	(240-900)	2	> 300	1.2	low-noise type	
BC140	npn	TO-39	40	1000	3700	45 (note 1)	40-250	100	> 50			83
BC141	npn	TO-39	60	1000	3700	45 (note 1)	40-250	100	> 50			
BC160	pnp	TO-39	40	1000	3700	45 (note 1)	40-250	100	> 50			87
BC161	pnp	TO-39	60	1000	3700	45 (note 1)	40-250	100	> 50			
BC177	pnp	TO-18	45	100	300	25	(75-260)	2	150	-		91
BC178	pnp	TO-18	25	100	300	25	(125-500)	2	150	-		
BC179	pnp	TO-18	20	100	300	25	(125-500)	2	150	1.2	low-noise type	
BC327	pnp	TO-92	45	500	800	25	100-600	100	100	-	driver and output stage	103
BC327A	pnp	TO-92	60	500	800	25	100-600	100	100	-	driver and output stage	
BC328	pnp	TO-92	25	500	800	25	100-600	100	100	-	driver and output stage	
BC337	npn	TO-92	45	500	800	25	100-600	100	100	-	driver and output stage	109
BC337A	npn	TO-92	60	500	800	25	100-600	100	100	-	driver and output stage	
BC338	npn	TO-92	25	500	800	25	100-600	100	100	-	driver and output stage	
BC368	npn	TO-92	20	1000	800	25	85-375	500	60	-	class-B audio output stage	115
BC369	pnp	TO-92	20	1000	800	25	85-375	500	60	-	class-B audio output stage	123
BC375	npn	TO-92	20	1000	800	25	60-340	150	150	-	output stage	131
BC376	pnp	TO-92	20	1000	800	25	60-340	150	150	-	output stage	133
BC516	pnp	TO-92	30	400	625	25	> 30 000	20	220	-	Darlington transistors	135
BC517	npn	TO-92	30	400	625	25	> 30 000	20	220	-	Darlington transistors	137
BC546	npn	TO-92	65	100	500	25	(110-450)	2	300	2	driver stage audio amplifier	139
BC547	npn	TO-92	45	100	500	25	(110-800)	2	300	2	driver stage audio amplifier	
BC548	npn	TO-92	30	100	500	25	(110-800)	2	300	2	driver stage audio amplifier	
BC549	npn	TO-92	30	100	500	25	(240-800)	2	300	1.4	low-noise stage	149
BC550	npn	TO-92	45	100	500	25	(240-800)	2	300	1.4	low-noise stage	
BC556	pnp	TO-92	65	100	500	25	(75-475)	2	150	2	driver stage audio amplifier	161
BC557	pnp	TO-92	45	100	500	25	(75-800)	2	150	2	driver stage audio amplifier	
BC558	pnp	TO-92	30	100	500	25	(75-800)	2	150	2	driver stage audio amplifier	

Note

1. T_{case}.

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE} (h_{fe})	at I_C (mA)	f_T (MHz) typ.	F (dB) typ.	REMARKS	PAGE
BC559	pnp	TO-92	30	100	500	25	(125-800)	2	150	1.2	low-noise type	167
BC560	pnp	TO-92	45	100	500	25	(125-800)	2	150	1	low-noise type	
BC617	npn	TO-92	40	1000	625	25	> 4000	1	155	-	driver stage	175
BC618	npn	TO-92	55	1000	625	25	> 2000	1	155	-	driver stage	
BC635	npn	TO-92	45	1000	1000	25	40-250	150	130	-	driver stage	177
BC637	npn	TO-92	60	1000	1000	25	40-160	150	130	-	driver stage	
BC639	npn	TO-92	80	1000	1000	25	40-160	150	130	-	driver stage	
BC636	pnp	TO-92	45	1000	1000	25	40-250	150	50	-	driver stage	183
BC638	pnp	TO-92	60	1000	1000	25	40-250	150	50	-	driver stage	
BC640	pnp	TO-92	80	1000	1000	25	40-250	150	50	-	driver stage	
BC875	npn	TO-92	45	1000	800	25	> 1000	150	200	-	driver stage	189
BC877	npn	TO-92	60	1000	800	25	> 1000	150	200	-	driver stage	
BC879	npn	TO-92	80	1000	800	25	> 1000	150	200	-	driver stage	
BC876	pnp	TO-92	45	1000	800	25	> 1000	150	200	-	driver stage	193
BC878	pnp	TO-92	60	1000	800	25	> 1000	150	200	-	driver stage	
BC880	pnp	TO-92	80	1000	800	25	> 1000	150	200	-	driver stage	
BCX22	npn	TO-18	125	800	450	25	63	100	100	-		197
BCX23	pnp	TO-18	125	800	450	25	63	100	100	-		201
BCY56	npn	TO-18	45	100	300	25	100-450	2	85	1.5	low-noise type	213
BCY57	npn	TO-18	20	100	300	25	200-800	2	100	1.5	low-noise type	
BCY58	npn	TO-18	32	200	330	45	(125-700)	2	> 150	2	switching	217
BCY59	npn	TO-18	45	200	330	45	(125-700)	2	> 150	2	switching	
BCY70	pnp	TO-18	40	200	350	25	> 100	10	450	2.0	low-noise type	231
BCY71	pnp	TO-18	45	200	350	25	> 100	10	450	0.8	low-noise type	
BCY72	pnp	TO-18	25	200	350	25	> 100	10	450	2.0	low-noise type	
BCY78	pnp	TO-18	32	200	345	45	(125-700)	2	180	2	switching	247
BCY79	pnp	TO-18	45	200	345	45	(125-700)	2	180	2	switching	
BCY87	pnp	TO-71	40	30	150	25	100-450	0.05	> 10	< 3	pre-stages of	255
BCY88	pnp	TO-71	40	30	150	25	100-450	0.05	> 10	< 4	differential amplifier	
BCY89 (note 1)	pnp	TO-71	40	30	150	25	100-450	0.05	> 10	< 4	long-tailed pairs	
JA100	pnp	TO-92	25	100	500	25	90-600	1	130	< 10	centre collector	607
JA101	pnp	TO-92	45	100	500	25	90-600	1	130	< 10	centre collector	
JC327	pnp	TO-92	45	1000	800	25	100-600	100	100		centre collector	611
JC327A	pnp	TO-92	60	1000	800	25	100-600	100	100		centre collector	
JC328	pnp	TO-92	25	1000	800	25	100-600	100	100		centre collector	

Note

1. Dual transistors for differential amplifiers.

Small-signal transistors

Selection guide

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE} (h_{fe})	at I_C (mA)	f_T (MHz) typ.	F (dB) typ.	REMARKS	PAGE
JC337	npn	TO-92	45	1000	800	25	100-600	100	100		centre collector	615
JC337A	npn	TO-92	60	1000	800	25	100-600	100	100		centre collector	
JC338	npn	TO-92	25	1000	800	25	100-600	100	100		centre collector	
JC500	npn	TO-92	25	100	500	25	90-600	1	130	< 10	centre collector	619
JC501	npn	TO-92	45	100	500	25	90-600	1	130	< 10	centre collector	
JC546	npn	TO-92	65	100	500	25	110-450	2	300	2	centre-collector	623
JC547	npn	TO-92	45	100	500	25	110-800	2	300	2	centre-collector	
JC548	npn	TO-92	30	100	500	25	110-800	2	300	2	centre-collector	
JC549	npn	TO-92	30	200	500	25	200-800	2	300	1.4	centre collector	633
JC550	npn	TO-92	45	200	500	25	200-800	2	300	1.4	centre collector	
JC556	pnp	TO-92	65	100	500	25	75-475	2	200	2	centre-collector	637
JC557	pnp	TO-92	45	100	500	25	75-800	2	200	2	centre-collector	
JC558	pnp	TO-92	30	100	500	25	75-800	2	200	2	centre-collector	
JC559	pnp	TO-92	30	200	500	25	125-800	2	200	1.2	centre collector	641
JC560	pnp	TO-92	45	200	500	25	125-800	2	200	1	centre collector	
MPS3702	pnp	TO-92	25	600	625	25	60-300	50	100	-		653
MPS3703	pnp	TO-92	30	600	625	25	30-150	50	100	-		
MPS3704	npn	TO-92	30	600	625	25	100-300	50	100	-		655
MPS3705	npn	TO-92	30	600	625	25	50-150	50	100	-		
MPS3706	npn	TO-92	20	600	625	25	30-600	50	100	-		
MPS6513	npn	TO-92	30	100	625	25	> 60	100	-	-		665
MPS6514	npn	TO-92	25	100	625	25	> 90	100	-	-		
MPS6515	npn	TO-92	25	100	625	25	> 150	100	-	-		
MPS6517	pnp	TO-92	40	100	625	25	> 60	100	-	-		667
MPS6518	pnp	TO-92	40	100	625	25	> 90	100	-	-		
MPS6519	pnp	TO-92	25	100	625	25	> 150	100	-	-		
MPS6520	npn	TO-92	25	100	625	25	200-400	2	-	< 3	low-noise amplifier	669
MPS6521	npn	TO-92	25	100	625	25	300-600	2	-	< 3	low-noise amplifier	
MPS6522	pnp	TO-92	25	100	625	25	200-400	2	-	< 3	low-noise amplifier	671
MPS6523	pnp	TO-92	25	100	625	25	400-600	2	-	< 3	low-noise amplifier	
MPS6531	npn	TO-92	40	30	625	25	90-270	100	-	-		673
MPS6532	npn	TO-92	40	30	625	25	> 30	100	-	-		

Small-signal transistors

Selection guide

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE} (h_{fe})	at I_C (mA)	f_T (MHz) typ.	F (dB) typ.	REMARKS	PAGE
MPS6534	pnp	TO-92	40	30	625	25	90-270	100	-	-		675
MPS6535	pnp	TO-92	40	30	625	25	> 30	100	-	-		
MPSA05	npn	TO-92	60	500	625	25	> 50	10	> 100	-	driver stage	677
MPSA06	npn	TO-92	80	500	625	25	> 50	10	> 100	-	driver stage	
MPSA55	pnp	TO-92	60	500	625	25	> 50	100	> 50	-	driver stage	685
MPSA56	pnp	TO-92	80	500	625	25	> 50	100	> 50	-	driver stage	
2N930	npn	TO-18	45	30	300	25	100-350 150-600	10	80	2.5 2.0	low-level, low-noise amplifier	749
2N2483	npn	TO-18	60	50 (note 1)	360	25	< 500	10	80	4	low-level, low-noise amplifier	793
2N2484	npn	TO-18	60	50 (note 1)	360	25	< 800	10	80	3	low-level, low-noise amplifier	
2N4030	pnp	TO-39	60	1000	800	25	40-120	100	> 100	-	large-signal, low-noise, low-power	843
2N4031	pnp	TO-39	80	1000	800	25	40-120	100	> 100	-	large-signal, low-noise, low-power	
2N4032	pnp	TO-39	60	1000	800	25	100-300	100	> 150	-	large-signal, low-noise, low-power	
2N4033	pnp	TO-39	80	1000	800	25	100-300	100	> 150	-	large-signal, low-noise, low-power	
2N4123	npn	TO-92	30	200	350	25	(50-200)	-	> 250	6	small-signal, low-power	849
2N4124	npn	TO-92	25	200	350	25	(120-480)	-	> 300	5	small-signal, low-power	
2N4125	pnp	TO-92	30	200	350	25	(50-200)	2	> 200	5	small-signal, low-power	851
2N4126	pnp	TO-92	25	200	350	25	(120-480)	2	> 250	4	small-signal, low-power	
2N4400	npn	TO-92	40	600	625	25	50-150	100	> 200	-	driver stage	853
2N4401	npn	TO-92	40	600	625	25	100-300	100	> 250	-	driver stage	
2N4402	pnp	TO-92	40	600	625	25	50-150	150	> 150	-	driver stage	857
2N4403	pnp	TO-92	40	600	625	25	100-300	150	> 200	-	driver stage	
2N5086	pnp	TO-92	50	50	625	25	150	1	> 40	3	low-noise	861
2N5087	pnp	TO-92	50	50	625	25	250	1	> 40	2	low-noise	861
2N5088	npn	TO-92	30	50	625	25	350	1	> 50	3	low-noise	865

Note

1. I_{CM}.

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE} (h_{fe})	at I_C (mA)	f_T (MHz) typ.	F (dB) typ.	REMARKS	PAGE
2N5680	pnp	TO-39	120	1000	1000	25	40-150	250	30	100		879
2PA733	pnp	TO-92	50	100	500	25	90-600	1	> 100	6		889
2PA1015	pnp	TO-92	50	150	500	25	120-400	2	> 80	1		891
2PA1015L	pnp	TO-92	50	150	500	25	120-400	2	> 80	0.2		
2PC945	npn	TO-92	50	100	500	25	90-600	1	> 150	15		893
2PC1815	npn	TO-92	50	150	500	25	120-700	2	> 80	1		895
2PC1815L	npn	TO-92	50	150	500	25	120-700	2	> 80	0.2		

Transistors for HF applications

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE}	at I_C (mA)	C_{re} (pF) typ.	f_T (MHz) typ.	F (dB) typ.	at f (MHz)	REMARKS	PAGE
BF198	npn	TO-92	30	25	500	25	> 10	15	0.20	400	3	35	gain-controlled TV IF amp.	263
BF199	npn	TO-92	25	25	500	25	> 38	7	0.30	550	-	-	output video IF amp.	277
BF240	npn	TO-92	40	25	250	25	67-220	1	0.34	380	3.5	0.2	AM mixers and IF amp. in AM/FM receivers	283
BF241	npn	TO-92	40	25	250	25	36-125	1	0.34	350	3.5	0.2	AM mixers and IF amp. in AM/FM receivers	
BF324	pnp	TO-92	30	25	250	45	typ. 50	4	0.10 (note 1)	450	3	100	RF stages in FM front-ends	287
BF370	npn	TO-92	15	100	500	25	> 40	10	1.6	> 500	-	-	large signal, IF amp.	293
BF450	pnp	TO-92	40	25	250	45	62-200	1	0.35	325	2	100	mixer stages in AM receivers and IF stages for AM/FM	309
BF451	pnp	TO-92	40	25	250	45	30-90	1	0.35	325	2	100	mixer stages in AM receivers and IF stages for AM/FM	
BF494	npn	TO-92	20	30	300	25	typ. 115	1	0.85	260	4	100	osc., IF amp. in AM/FM receivers	321
BF495	npn	TO-92	20	30	300	25	typ. 67	1	0.85	200	4	100	FM tuners, IF amp. in AM/FM receivers and AM input stages car radios	329
BF496	npn	TO-92	20	20	300	75	> 12	2	0.80	> 550	2	100	gain-controlled VHF amp.	337
BF926	pnp	TO-92	20	25	250	45	> 30	1	0.5	350	5	200	mixer/osc. in VHF/UHF	341

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE}	at I_C (mA)	C_{re} (pF) typ.	f_T (MHz) typ.	F (dB) typ.	at f (MHz)	REMARKS	PAGE
BF970	pnp	SOT37	35	30	160	55	> 25	3	0.475	900	4.7	800	self-osc. UHF mixer stage	343
BF970A	pnp	SOT37	40	30	160	55	> 25	3	-	900	4.7	800		345
BF979	pnp	SOT37	20	30 (note 1)	140	55	> 20	10	0.65	1350	4.5	800	RF stages in UHF tuners	347
BFR54	npn	TO-92	15	500 (note 2)	500	25	> 40	10	-	> 500	-	-	frequency multipliers	351
JF494	npn	TO-92	20	30	300	25	67-220	1	1	260	-	-		645

Transistors for switching applications

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE}	at I_C (mA)	f_T (MHz) typ.	t_{off} (ns) max.	at I_C (mA)	REMARKS	PAGE
BCX58 BCX59	npn npn	TO-92 TO-92	32 45	200 200	450 450	25 25	- -	- -	> 125 > 125	- -	- -		205
BCX78 BCX79	pnp pnp	TO-92 TO-92	32 45	200 200	450 450	25 25	- -	- -	> 200 > 200	- -	- -		209
BCY58 BCY59	npn npn	TO-18 TO-18	32 45	200 200	330 330	45 45	80-1000 80-1000	10 10	280 280	800 800	10 10		217
BCY65	npn	TO-18	60	200	330	45	200-330	2	≥ 125	800	10		227
BCY70 BCY71 BCY72	pnp pnp pnp	TO-18 TO-18 TO-18	40 45 25	200 200 200	350 350 350	25 25 25	> 100 > 100 > 100	10 10 10	450 450 450	420 - 420	10 - 10	BCY71 is low-noise version	231
BCY78 BCY79	pnp pnp	TO-18 TO-18	32 45	200 200	345 345	45 45	80-1000 80-1000	10 10	180 180	800 800	10 10	amplifying and switching amplifying and switching	247

Notes

1. C_{br}.
2. I_{CM}.

Small-signal transistors

Selection guide

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE}	at I_C (mA)	f_T (MHz) typ.	t_{off} (ns) max.	at I_C (mA)	REMARKS	PAGE
BFT44	pnp	TO-39	300	500	5000	50 (note 1)	50-150	10	70	125	500		359
BFT45	pnp	TO-39	250	500	5000	50 (note 1)	50-150	10	70	125	500		
BFX29	pnp	TO-39	60	600	600	25	> 50	10	> 100	150	-		367
BFX30	pnp	TO-39	65	600	600	25	50-200	10	-	240	-		381
BFX34	npn	TO-39	60	2000	5000	25 (note 1)	40-150	2000	> 70	1200	5000	inverter and switching regulators	393
BFX84	npn	TO-39	60	1	800	25	> 30	150	> 50	360	-		399
BFX85	npn	TO-39	60	1	800	25	> 70	150	> 50	360	-		
BFX87	pnp	TO-39	50	10	600	25	> 40	10	> 100	150	-		419
BFX88	pnp	TO-39	40	10	600	25	> 40	10	> 100	150	-		
BFY50	npn	TO-39	35	1000	5000	50 (note 1)	typ. 112	150	140	360	150	general purpose	433
BFY51	npn	TO-39	30	1000	5000	50 (note 1)	typ. 123	150	160	360	150	general purpose	
BFY52	npn	TO-39	20	1000	5000	50 (note 1)	typ. 142	150	185	360	150	general purpose	
BFY55	npn	TO-39	35	1000	800	25	40-120	150	> 60	-	-		453
BSR50	npn	TO-92	45 (note 1)	1000	800	25	> 2000	500	-	1500	500	Darlington transistor	487
BSR51	npn	TO-92	60 (note 1)	1000	800	25	> 2000	500	-	1500	500	Darlington transistor	
BSR52	npn	TO-92	80 (note 1)	1000	800	25	> 2000	500	-	1500	500	Darlington transistor	
BSR60	pnp	TO-92	45 (note 1)	1000	800	25	> 2000	500	-	1500	500	Darlington transistor	493
BSR61	pnp	TO-92	60 (note 1)	1000	800	25	> 2000	500	-	1500	500	Darlington transistor	
BSR62	pnp	TO-92	80 (note 1)	1000	800	25	> 2000	500	-	1500	500	Darlington transistor	
BSS38	npn	TO-92	100	100	500	25	> 20	4	> 60	1000	15	driver for numerical indicator tube	499

Note

1. T_{case}.

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE}	at I_C (mA)	f_T (MHz) typ.	t_{off} (ns) max.	at I_C (mA)	REMARKS	PAGE
BSS50	npn	TO-39	45 (note 1)	1000	5000	25 (note 2)	> 2000	500	-	1000	500	Darlington transistor	503
BSS51	npn	TO-39	60 (note 1)	1000	5000	25 (note 2)	> 2000	500	-	1000	500	Darlington transistor	
BSS52	npn	TO-39	80 (note 1)	1000	5000	25 (note 2)	> 2000	500	-	1000	500	Darlington transistor	
BSS60	pnp	TO-39	45 (note 1)	1000	5000	25 (note 2)	> 2000	500	-	1500	500	Darlington transistor	511
BSS61	pnp	TO-39	60 (note 1)	1000	5000	25 (note 2)	> 2000	500	-	1500	500	Darlington transistor	
BSS62	pnp	TO-39	80 (note 1)	1000	5000	25 (note 2)	> 2000	500	-	1500	500	Darlington transistor	
BSS68	pnp	TO-92	100	100	500	25	> 30	25	> 50	-	-	general purpose	519
BSV15	pnp	TO-39	40	1000	5000	25 (note 1)	40-250	100	> 50	650	100	general purpose	523
BSV16	pnp	TO-39	60	1000	5000	25 (note 1)	40-250	100	> 50	650	100	general purpose	
BSV17	pnp	TO-39	80	1000	5000	25 (note 1)	40-250	100	> 50	650	100	general purpose	
BSV64	npn	TO-39	60	2000	5000	50 (note 1)	> 40	2000	100	1200	5000	high-current saturation characteristics	533
BSW66A	npn	TO-39	100	1000	5000	25 (note 1)	> 30	500	130	900	500	general purpose	539
BSW67A	npn	TO-39	120	1000	5000	25 (note 1)	> 30	500	130	900	500	general purpose	
BSW68A	npn	TO-39	150	1000	5000	25 (note 1)	> 30	500	130	900	500	general purpose	
BSX20	npn	TO-18	15	500 (note 2)	360	25	40-120	10	> 500	18	-	high-speed saturated switching and HF amplifier applications	547
BSX32	npn	TO-39	40	1000	800	25	30-60	10	> 300	60	500		563
BSX45	npn	TO-39	40	1000	6250	25 (note 1)	40-250	100	> 50	850	100	general purpose	567
BSX46	npn	TO-39	60	1000	6250	25 (note 1)	40-250	100	> 50	850	100	general purpose	
BSX47	npn	TO-39	80	1000	6250	25 (note 1)	40-160	100	> 50	850	100	general purpose	
BSX49	npn	TO-18	40	600	1000	45	25-40	100	400	50	150	general purpose	579

Notes

1. T_{case}.
2. I_{CM}.

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE}	at I_C (mA)	f_T (MHz) typ.	t_{off} (ns) max.	at I_C (mA)	REMARKS	PAGE
BSX59	npn	TO-39	45	1000	800	25	30-90	500	450	60	500	very high speed core-driving purposes	583
BSX60	npn	TO-39	30	1000	800	25	30-90	500	475	70	500	very high speed core-driving purposes	
BSX61	npn	TO-39	45	1000	800	25	30-90	500	475	100	500	very high speed core-driving purposes	
BSX62	npn	TO-39	40	3000	875	25	63-160	1000	70	1500	100		595
BSX63	npn	TO-39	60	3000	875	25	100-250	1000	70	1500	100		
BSY95A	npn	TO-18	15	200	300	25	50-200	10	200	-	-		603
MPS3904	npn	TO-92	40	200	625	25	100-300	10	300	90	10		657
MPS3906	pnp	TO-92	40	200	625	25	100-300	10	300	90	10		661
MPSA13	npn	TO-92	30	500	625	25	> 5000	10	> 125	-	-	Darlington transistor	679
MPSA14	npn	TO-92	30	500	625	25	> 10 000	10	> 125	-	-	Darlington transistor	
MPSA25	npn	TO-92	40	500	500	25	> 10 000	-	220	-	-		681
MPSA26	npn	TO-92	50	500	500	25	> 10 000	-	220	-	-		
MPSA27	npn	TO-92	60	500	500	25	> 10 000	-	220	-	-		
MPSA42	npn	TO-92	300	500	625	25	> 40	30	> 50	-	-	high voltage, HF	683
MPSA43	npn	TO-92	200	500	625	25	> 40	30	> 50	-	-	high voltage, HF	
MPSA63	pnp	TO-92	30	500	625	25	> 5000	10	> 125	-	-	Darlington transistor	687
MPSA64	pnp	TO-92	30	500	625	25	> 10 000	10	> 125	-	-	Darlington transistor	
MPSA75	pnp	TO-92	40	500	500	25	> 10 000	-	220	-	-		689
MPSA76	pnp	TO-92	50	500	500	25	> 10 000	-	220	-	-		
MPSA77	pnp	TO-92	60	500	500	25	> 10 000	-	220	-	-		
MPSA92	pnp	TO-92	300	500	625	25	> 25	30	> 50	-	-	high voltage, HF	691
MPSA93	pnp	TO-92	200	500	625	25	> 25	30	> 50	-	-	high voltage, HF	
PH2222	npn	TO-92	30	800	625	25	> 75	10	> 250	285	150		699
PH2222A	npn	TO-92	40	800	625	25	> 75	10	> 300	285	150		
PH2369	npn	TO-92	15	500 (note 1)	500	25	40-120	10	> 500	18	10		703

Note

1. I_{CM}.

Small-signal transistors

Selection guide

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE}	at I_C (mA)	f_T (MHz) typ.	t_{off} (ns) max.	at I_C (mA)	REMARKS	PAGE
PH2907	pnp	TO-92	40	600	625	25	100-300	150	> 200	100	150		713
PH2907A	pnp	TO-92	60	600	625	25	100-300	150	> 200	100	150		
PH5415	pnp	TO-92	200	1000	625	25	30-150	50	> 15	-	-	high-voltage switching	717
PH5416	pnp	TO-92	300	1000	625	25	30-120	50	> 15	-	-	high-voltage switching	
PMBS3904	npn	TO-92	40	200	300	25	100-300	10	300	-	-		719
PMBS3906	pnp	TO-92	40	200	300	25	100-300	10	250	-	-		723
PN2222	npn	TO-92	30	600	625	25	100-300	150	> 250	285	150		727
PN2222A	npn	TO-92	40	600	625	25	100-300	150	> 250	285	150		
PN2369	npn	TO-92	15	600	625	25	40-120	10	-	18	10		731
PN2369A	npn	TO-92	15	600	625	25	40-120	10	-	18	10		
PN2907	pnp	TO-92	40	600	625	25	100-300	150	> 200	100	150		735
PN2907A	pnp	TO-92	60	600	625	25	100-300	150	> 200	100	150		
PN3439	npn	TO-92	350	1000	625	25	> 30	2	> 70	-	-	high voltage	739
PN3440	npn	TO-92	250	1000	625	25	> 40	20	> 70	-	-	high voltage	
PN5415	pnp	TO-92	200	1000	625	25	30-150	50	> 15	-	-	high voltage	741
PN5416	pnp	TO-92	300	1000	625	25	30-120	50	> 15	-	-	high voltage	
2N1613	npn	TO-39	(50)	500 (note 1)	800	25	40-120	150	> 60	-	-	DC and high-speed amplifiers	753
2N1711	npn	TO-39	(50)	1000 (note 1)	800	25	100-300	150	> 70	-	-		761
2N1893	npn	TO-39	80	500	3000	25 (note 2)	40-120	150	> 50	-	-		765
2N2219	npn	TO-39	30	800	800	25	100-300	150	> 250	285	150	high-speed switching	769
2N2219A	npn	TO-39	40	800	800	25	100-300	150	> 300	285	150	high-speed switching	
2N2222	npn	TO-18	30	800	500	25	100-300	150	250	285	150	high-speed switching	775
2N2222A	npn	TO-18	40	800	500	25	100-300	150	300	285	150	high-speed switching	

Notes

1. I_{CM}.
2. T_{case}.

Small-signal transistors

Selection guide

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE}	at I_C (mA)	f_T (MHz) typ.	t_{off} (ns) max.	at I_C (mA)	REMARKS	PAGE
2N2297	npn	TO-39	35	1000	800	25	40-120	150	> 60	-	-		781
2N2369	npn	TO-18	15	500 (note 1)	360	25	40-120	10	> 500	18	10	very high speed saturated switching	785
2N2369A	npn	TO-18	15	200	360	25	> 40	10	> 500	18	10	very high speed saturated switching	789
2N2894A	pnp	TO-18	12	200	1200	25	40-150	30	800	35	30		801
2N2904	pnp	TO-39	40	600	600	25	40-120	150	> 200	100	150	high-speed switching and driver applications	807
2N2904A	pnp	TO-39	60	600	600	25	40-120	150	> 200	100	150	high-speed switching and driver applications	
2N2905	pnp	TO-39	40	600	600	25	100-300	150	> 200	100	150	high-speed switching and driver applications	815
2N2905A	pnp	TO-39	60	600	600	25	100-300	150	> 200	100	150	high-speed switching and driver applications	
2N2906	pnp	TO-18	40	600	400	25	40-120	150	> 200	100	150	high-speed switching and driver applications	819
2N2906A	pnp	TO-18	60	600	400	25	40-120	150	> 200	100	150	high-speed switching and driver applications	
2N2907	pnp	TO-18	40	600	400	25	100-300	150	> 200	100	150	high-speed switching and driver applications	823
2N2907A	pnp	TO-18	60	600	400	25	100-300	150	> 200	100	150	high-speed switching and driver applications	
2N3019	npn	TO-39	80	1000	800	25	100-300	150	> 100	-	-	amplifiers and medium-speed switching	827
2N3020	npn	TO-39	80	1000	800	25	40-120	150	> 80	-	-	amplifiers and medium-speed switching	
2N3053	npn	TO-39	40	700	5000	(25)	50-250	150	> 100	-	-	medium-speed switching	831
2N3439	npn	TO-39	400	1000	625	25	> 30	2	> 70	-	-		833
2N3440	npn	TO-39	300	1000	625	25	> 40	20	> 70	-	-		
2N3904	npn	TO-92	40	200	350	25	100-300	10	> 300	250	10	high-speed saturated switching	835

Note

1. T_{case}.

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE}	at I_C (mA)	f_T (MHz) typ.	t_{off} (ns) max.	at I_C (mA)	REMARKS	PAGE
2N3906	pnp	TO-92	40	200	350	25	100-300	10	> 250	300	10		839
2N4030	pnp	TO-39	60	1000	800	25	> 25	500	> 100	400	500	large signal, low-noise, low-power	843
2N4031	pnp	TO-39	80	1000	800	25	> 25	500	> 100	400	500	large signal, low-noise, low-power	843
2N4032	pnp	TO-39	60	1000	800	25	> 70	500	> 150	400	500	large signal, low-noise, low-power	843
2N4033	pnp	TO-39	80	1000	800	25	> 70	500	> 150	400	500	large signal, low-noise, low-power	843
2N4036	pnp	TO-39	90	1000	7000	25	20-200	150	-	700	-		847
2N5400	pnp	TO-92	120	600	625	25	> 40	10	> 100	-	-	high-voltage switching	867
2N5401	pnp	TO-92	150	600	625	25	> 60	10	> 100	-	-	high-voltage switching	867
2N5415	pnp	TO-39	200	1000	1000	50	30-150	50	> 15	850 (note 1)	50	high-voltage general purpose amplifier applications	871
2N5416	pnp	TO-39	300	1000	1000	50	30-120	50	> 15	850 (note 1)	50	high-voltage general purpose amplifier applications	871
2N5550	npn	TO-92	140	60	625	25	> 60	10	> 100	-	-	high-voltage switching	875
2N5551	npn	TO-92	160	60	625	25	> 80	10	> 100	-	-	high-voltage switching	875

Note

1. Typical value.

Transistors for high voltage applications

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE}	at I_C (mA)	C_{re} (pF)	f_T (MHz)	REMARKS	PAGE
BF420	npn	TO-92	300 (note 1)	50	830	25	> 50	25	1.0	> 60	class-B video output	297
BF421	pnp	TO-92	300 (note 1)	50	830	25	> 50	25	1.1	> 60	class-B video output	303
BF422	npn	TO-92	250	50	830	25	> 50	25	1.0	> 60	class-B video output	297
BF423	pnp	TO-92	250	50	830	25	> 50	25	1.1	> 60	class-B video output	303
BF483	npn	TO-92	250	100	830	25	> 50	25	1.4	> 70	video output	313
BF485	npn	TO-92	300	100	830	25	> 50	25	1.4	> 70	video output	
BF487	npn	TO-92	350	100	830	25	> 50	25	1.4	> 70	video output	
BF484	pnp	TO-92	250	100	830	25	> 50	25	1.6	> 70		317
BF486	pnp	TO-92	300	100	830	25	> 50	25	1.6	> 70		
BF488	pnp	TO-92	350	100	830	25	> 50	25	1.6	> 70		
MPSA42	pnp	TO-92	300	500	625	25	> 40	30	-	> 50	high voltage, switching	683
MPSA43	pnp	TO-92	200	500	625	25	> 40	30	-	> 50	high voltage, switching	
MPSA92	pnp	TO-92	300	500	625	25	> 25	30	-	> 50	high voltage, switching	691
MPSA93	pnp	TO-92	200	500	625	25	> 25	30	-	> 50	high voltage, switching	
PH5415	pnp	TO-92	200	1000	625	25	30-150	50	-	> 15	high voltage, switching	717
PH5416	pnp	TO-92	300	1000	625	25	30-120	50	-	> 15	high voltage, switching	
PN3439	npn	TO-92	350	1000	625	25	> 30	2	-	> 70		739
PN3440	npn	TO-92	250	1000	625	25	> 40	20	-	> 70		
PN5415	npn	TO-92	200	1000	625	25	30-150	50	-	> 15		741
PN5416	pnp	TO-92	200	1000	625	25	30-120	50	-	> 15		
2N3439	npn	TO-92	400	1000	625	25	> 30	2	-	> 70		833
2N3440	npn	TO-92	300	1000	625	25	> 40	20	-	> 70		
2N5400	pnp	TO-92	120	600	625	25	> 40	10	-	> 100	high voltage, switching	867
2N5401	pnp	TO-92	150	600	625	25	> 60	10	-	> 100	high voltage, switching	

Note

1. V_{CER}.

TYPE NUMBER	POLARITY	ENVELOPE	V_{CEO} (V)	I_C (mA)	P_{tot} (mW)	at T_{amb} (°C)	h_{FE}	at I_C (mA)	C_{re} (pF)	f_T (MHz)	REMARKS	PAGE
2N5415	pnp	TO-39	200	1000	1000	50	30-150	50	-	> 15	high voltage, general purpose and amplifier	871
2N5416	pnp	TO-39	300	1000	1000	50	30-120	50	-	> 15	high voltage, general purpose and amplifier	871
2N5550	npn	TO-92	140	60	625	25	> 60	10	-	> 100	high voltage, switching	875
2N5551	npn	TO-92	160	60	625	25	> 80	10	-	> 100	high voltage, switching	875

P-N-P-N DEVICES

Programmable unijunction transistors

TYPE NUMBER	ENVELOPE	V_{GA} (V)	I_A (mA)	I_{ARM} (A)	dI_A/dt (A/µs)	I_P (µA) max.	I_V (µA) min.	t_r (ns) max.	REMARKS	PAGE
BRY39	TO-72	70	175	2.5	20	5	25	80	characteristics measured with R_G = 10 kΩ	469
BRY56	TO-92	70	175	2.5	20	5	2	80		483
2N6027	TO-92	40	200	-	-	5	70	80	characteristics measured	883
2N6028	TO-92	40	200	-	-	1	25	80	characteristics measured	883

Silicon controlled switches

TYPE NUMBER	ENVELOPE	V_{CBO} (V)	I_E (mA)	I_{ERM} (A)	P_{tot} (mW)	at T_{amb} (°C)	V_{AK} (V) max.	I_H (mA) max.	t_{on} (µs) max.	t_q (µs) max.	REMARKS	PAGE
BR101	TO-72	50	175	2.5	275	25	1.4	1.0	-	-	characteristics measured with R_G = 10 kΩ	465
BRY39	TO-72	70	175	2.5	275	25	1.4	1.0	1.5	8		475

TYPE NUMBER SURVEY

(alphanumerical)

Small-signal transistors

Type number survey

In this alphanumeric list we present all small-signal transistors mentioned in this handbook.

TYPE NUMBER	PAGE	TYPE NUMBER	PAGE	TYPE NUMBER	PAGE	TYPE NUMBER	PAGE
BC107	69	BCY56	213	BR101	465	JC550	633
BC108	69	BCY57	213	BRY39(P)	469	JC556	637
BC109	69	BCY58	217	BRY39(S)	475	JC557	637
BC140	83	BCY59	217			JC558	637
BC141	83	BCY65	227	BRY56	483	JC559	641
BC160	87	BCY70	231	BSR50	487	JC560	641
BC161	87	BCY71	231	BSR51	487	JF494	645
BC177	91	BCY72	231	BSR52	487	MPS3702	653
BC178	91	BCY78	247	BSR60	493	MPS3703	653
BC179	91	BCY79	247	BSR61	493	MPS3704	655
BC327	103	BCY87	255	BSR62	493	MPS3705	655
BC327A	103	BCY88	255	BSS38	499	MPS3706	655
BC328	103	BCY89	255	BSS50	503	MPS3904	657
BC337	109	BF198	263	BSS51	503	MPS3906	661
BC337A	109	BF199	277	BSS52	503	MPS6513	665
BC338	109	BF240	283	BSS60	511	MPS6514	665
BC368	115	BF241	283	BSS61	511	MPS6515	665
BC369	123	BF324	287	BSS62	511	MPS6517	667
BC375	131	BF370	293	BSS68	519	MPS6518	667
BC376	133	BF420	297	BSV15	523	MPS6519	667
BC516	135	BF421	303	BSV16	523	MPS6520	669
BC517	137	BF422	297	BSV17	523	MPS6521	669
BC546	139	BF423	303	BSV64	533	MPS6522	671
BC547	139	BF450	309	BSW66A	539	MPS6523	671
BC548	139	BF451	309	BSW67A	539	MPS6531	673
BC549	149	BF483	313	BSW68A	539	MPS6532	673
BC550	149	BF484	317	BSX20	547	MPS6534	675
BC556	161	BF485	313	BSX32	563	MPS6535	675
BC557	161	BF486	317	BSX45	567	MPSA05	677
BC558	161	BF487	313	BSX46	567	MPSA06	677
BC559	167	BF488	317	BSX47	567	MPSA13	679
BC560	167	BF494	321	BSX49	579	MPSA14	679
BC617	175	BF495	329	BSX59	583	MPSA25	681
BC618	175	BF496	337	BSX60	583	MPSA26	681
BC635	177	BF926	341	BSX61	583	MPSA27	681
BC636	183	BF970	343	BSX62	595	MPSA42	683
BC637	177	BF970A	345	BSX63	595	MPSA43	683
BC638	183	BF979	347	BSY95A	603	MPSA55	685
BC639	177	BFR54	351	JA100	607	MPSA56	685
BC640	183	BFT44	359	JA101	607	MPSA63	687
BC875	189	BFT45	359	JC327	611	MPSA64	687
BC876	193	BFX29	367	JC327A	611	MPSA75	689
BC877	189	BFX30	381	JC328	611	MPSA76	689
BC878	193	BFX34	393	JC337	615	MPSA77	689
BC879	189	BFX84	399	JC337A	615	MPSA92	691
BC880	193	BFX85	399	JC338	615	MPSA93	691
BCX22	197	BFX87	419	JC500	619	OM200/S2	693
BCX23	201	BFX88	419	JC501	619	PH2222	699
BCX58	205	BFY50	433	JC546	623	PH2222A	699
BCX59	205	BFY51	433	JC547	623	PH2369	703
BCX78	209	BRY52	433	JC548	623	PH2907	713
BCX79	209	BFY55	453	JC549	633	PH2907A	713

Small-signal transistors

Type number survey

CONVERSION LIST

CONVERSION LIST

(conventional type number to SMD type number)

conven.[1]	micro.[2]	conven.[1]	micro.[2]	conven.[1]	micro.[2]
BA243	BAT18	BC177	BC857	BC546B	BC846B
BA314	BAS17		BCW69/70		BCV72
BA480	BAT17	BC177A	BC857A	BC547	BC847
BA481	BAT17		BCW69		BCW71/72/81
BA482	BA682	BC177B	BC857B	BC547A	BC847A
BA483	BA683		BCW70		BCW71
BAT85	BAT54	BC178	BC858	BC547B	BC847B
	BAT74		BCW29/30		BCW72
BAV10	BAS56	BC178A	BC858A	BC547C	BC847C
BAV18	BAV100		BCW29		BCW81
BAV19	BAS19	BC178B	BC858B	BC548	BC848
	BAV101		BCW30		BCW31-33
BAV20	BAS20	BC179	BC859	BC548A	BC848A
	BAV102		BCF29/30		BCW31
BAV21	BAS21	BC179A	BC859A	BC548B	BC848B
BAW62	BAS16		BCF29		BCW32
	BAS28	BC179B	BC859B	BC548C	BC848C
	BAS32		BCF30		BCW33
	BAV70	BC200/01	BC859B	BC549	BC849
	BAV99		BCF29		BCF32-33
	BAW56	BC200/02	BC859B/C	BC549B	BC849B
BAX12	BAS29		BCF29/30		BCF32
	BAS31	BC200/03	BC859C	BC549C	BC849C
	BAS35		BCF30		BCF33
BB405	BBY31	BC327	BC807	BC550	BC850
BB809	BBY40		BCX17		BCF81
BC107	BC847	BC327-16	BC807-16	BC550B	BC850B
	BCW71/72	BC327-25	BC807-25	BC550C	BC850C
BC107A	BC847A	BC327-40	BC807-40	BC556	BC856
	BCW71	BC327A			BCW89
BC107B	BC847B	BC328	BC808	BC556A	BC856A
	BCW72	BC328-16	BC808-16		BCW89
BC108	BC848	BC328-25	BC808-25	BC556B	BC856B
	BCW31-33	BC328-40	BC808-40	BC557	BC857
BC108A	BC848A	BC337	BC817		BCW69/70
	BCW31		BCX19	BC557A	BC857A
BC108B	BC848B	BC337-16	BC817-16		BCW69
	BCW32	BC337-25	BC817-25	BC557B	BC857B
BC109	BC849	BC337-40	BC817-40		BCW70
	BCF32/33	BC338	BC818	BC557C	BC857C
BC109B	BC849B		BCX20	BC558	BC858
	BCF32	BC338-16	BC818-16		BCW29/30
BC109C	BC849C	BC338-25	BC818-25	BC558A	BC858A
	BCFC33	BC338-40	BC818-40		BCW29
BC146/01	BC849B	BC368	BC868	BC558B	BC858B
	BCF32	BC369	BC869		BCW30
BC146/02	BC849B/C	BC516	BCV26	BC558C	BC858C
	BCF32/33	BC517	BCV27	BC559	BC859
BC146/03	BC849C	BC546	BC846		BCF29/30
	BCF33		BCV71/72	BC559A	BC859A
BC156	BCV26	BC546A	BC846A		BCF29
BC157	BCV27		BCV71		

[1] = *conventional type*
[2] = *microminiature type*

conven.[1]	micro.[2]
BSV17-10	BSR32/33
	BSP32/33
BSX20	BSV52
BSX45	BSR40/41
	BSP40/41
BSX45-6	BSR40
	BSP40
BSX45-10	BSR40/41
	BSP40/41
BSX45-16	BSR41
	BSP41
BSX46	BSR40/41
	BSP40/41
BSX46-6	BSR40
	BSP40
BSX46-10	BSR40/41
BSX46-16	BSR41
BSX47	BSR42/43
BSX47-6	BSR42
BSX47-10	BSR42-43
BSY95A	BSV52
BZX55	BZX84
BZX79	BZX84
	BZV55
BZV85	BZV49
MPS6513	BC848A
MPS6514	BC848A
MPS6515	BC848B
MPS6517	BC858A
MPS6518	BC858A
MPS6519	BC858B
MPS6520	BC859B
MPS6521	BC859C
MPS6522	BC859B
MPS6523	BC859C
MPSA05	PMBTA05
MPSA06	PMBTA06
MPSA13	PMBTA13
MPSA14	PMBTA14
MPSA42	PMBTA42
MPSA43	PMBTA43
MPSA55	PMBTA55
MPSA56	PMBTA56
MPSA63	PMBTA63
MPSA64	PMPTA64
MPSA92	PMBTA92
MPSA93	PMBTA93
PH2222	BSR13
PH2222A	BSR14
PH2369	BSV52
PH2907	BSR15

conven.[1]	micro.[2]
PH2907A	BSR16
PN2222	PMBT2222
	BSR13
PN2222A	PMBT 2222A
	BSR14
PN2369	PMBT 2369
	BSV52
PN2369A	PMBT 2369A
PN2907	PMBT2907
	BSR15
PM2907A	PMBT2907A
	BSR16
PN3439	BST39
	BSP19
PN3440	BST40
	BSP20
PN5415	BST15
	BSP15
PN5416	BST16
	BSP16
1N4148	BAS16
	BAV90
	BAV99
	BAW56
1N5225B	PMLL5225B
to	to
1N5267B	PMLL5267B
2N894A	BSR12
2N929	BC850
2N930	BNC850
	BCF81
2N1613	BDSR40
2N1711	BSR41
2N1893	BSR42
2N2219	BSR13
2N2219A	BSR14
2N2222	BSR13
	PMBT2222
2N2222A	BSR14
	PMBT2222A
2N2297	BSR40
2N2368	BSV52
2N2369	BSV52
2N2369A	BSV52
2N2483	BC850B
2N2484	BC850B/C
2N2905	BSR15
2N2905A	BSR16
2N2907	BSR15
	PMBT2907
2N2907A	BSR16
	PMBT2907A

conven.[1]	micro.[2]
2N3019	BSR43
2N3020	BSR42
2N3053	BSR40/41
2N3904	BSR17A
	PMBT3904
2N3906	BSR18A
	PMBT3906
2N4030	BSR30
2N4031	BSR32
2N4032	BSR31
2N4033	BSR33
2N4124	BSR18 A
2N4400	PMBT4400
2N4401	PMBT4401
2N4402	PMBT4402
2N4403	PMBT4403
2N4856	BSR56
2N4857	BSR57
2N4858	BSR58
2N5086	PMBT5086
2N5087	PMBT5087
2N5088	PMBT5088
2N5415	BST15
2N5416	BST16
2N6428	PMBT6428
2N6429	PMBT6429

[1] = *conventional type*
[2] = *microminiature type*

CONVERSION LIST

conven.[1]	micro.[2]
BF419	BST40
BF420	BF620
	BF720
	BF820
BF421	BF621
	BF721
	BF821
BF422	BF622
	BF722
	BF822
BF423	BF623
	BF723
	BF823
BF450	BF550
BF457	BST40
BF458	BST40
BF459	BST39
BF469	BF622
	BF722
BF470	BF623
	BF723
BF471	BF620
	BF720
BF472	BF621
	BF721
BF483	BF720
BF484	BF723
BF486	BF721
BF494	BFS19
BF494B	BFS19
BF495	BFS18
BF459C	BFS18
BF459D	BFS18
BF606A	BF660
BF819	BST40
	BSP20
BF857	BST40
	BSP20
BF858	BST40
	BSP20
BF859	BST39
BF869	BF622
	BF722
BF870	BF623
	BF723
BF871	BF620
	BF720
BF872	BF621
	BF721
BF926	BF660
BF960	BF989
BF964	BF994
	BF994S
BF966	BF996
	BF996S

conven.[1]	micro.[2]
BF970	BF569
BF970A	BF569
BF979	BF579
BF980	BF990
BF981	BF991
BF982	BF992
BFG65	BFG67
BFQ23	BFT93
BFQ24	BFT93
BFQ34	BFQ18A
	BF935
BFQ34T	BFQ18A
	BF935
BFQ51	BFT92
BFQ52	BFT92
BFQ65	BFQ67
BFR54	BSV52
BFR90	BFR92A
BFR91	BFR93A
BFR96	BFQ19
	BF927
BFR96S	BFQ19
	BF927
BFT24	BFT25
BFT44	BST16
	BSP16
BFT45	BST15/16
	BSP15/16
BFW11	BFR30
BFW12	BFR31
BFW13	BFT46
BFW16A	BFQ17
BFW30	BFR53
BFW92	BFS17
BFW93	BFR53
BFX29	BSR16
BFX30	BSR16
BFX84	BSR40
	BSP40
BFX85	BSR41
	BSP41
BFX86	BSR41
	BSP41
BFX87	BSR16
BFX88	BSR15
BFY50	BSR40
	BSP40
BFY51	BSR40
	BSP40
BFY52	BSR40
	BSP40

conven.[1]	micro.[2]
BFY55	BSR40
	BSP40
BFY90	BFS17
BR101	BRY62
BRY39	BRY62
BRY56	BRY61
BSR50	BST50
	BSP50
BSR51	BST51
	BSP51
BSR52	BST52
	BSP52
BSR60	BST60
	BSP60
BSR61	BST61
	BSP61
BSR62	BST62
	BSP62
BSS38	BSS64
BSS50	BST50
	BSP50
BSS51	BST51
	BSP51
BSS52	BST52
	BSP52
BSS60	BST60
	BSP60
BSS61	BST61
	BSP61
BSS62	BST62
	BSP62
BSS68	BSS63
BSV15	BSR30/31
	BSP30/31
BSV15-6	BSR30
	BSP30
BSV15-10	BSR30/31
	BSP30/31
BSV15-16	BSR31
	BSP31
BSV16	BSR30/31
	BSP30/31
BSV16-6	BSR30
	BSP30
BSV16-10	BSR30/31
	BSP30/31
BSV16-16	BSR31
	BSP31
BSV17	BSR32/33
	BSP32/33
BSV17-6	BSR32
	BSP32

[1] = *conventional type*
[2] = *microminiature type*

conven.[1]	micro.[2]	conven.[1]	micro.[2]	conven.[1]	micro.[2]
BC559B	BC859B	BCY57	BC849	BD136	BCX51
	BCF30		BCF32/33		BCP54
BC559C	BC859C	BCY58	BC849	BD136-10	BCX51-10
BC560	BC860		BCW60 fam.		BCP51-10
	BCF70	BCY58-VII	BCW60A	BD136-16	BCX51-16
BC560A	BC860A	BCY58-VIII	BC849B		BCP51-16
BC560B	BC860B		BCW60B	BD137	BCX55
	BCF70	BCY58-IX	BC849B		BCP55
BC560C	BC860C		BCW60C	BD137-10	BCX55-10
BC635	BCX54	BCY58-X	BC849C		BCP55-10
	BCP54		BCW60D	BD137-16	BCX55-16
BC635-10	BCX54-10	BCY59	BC850		BCP55-16
	BCP54-10		BCX70 fam.	BD138	BCX52
BC635-16	BCX54-16	BCY59-VII	BCX70G		BCP52
	BCP54-16	BCY59-VIII	BC850B	BD138-10	BCX52-10
BC636	BCX51		BCX70H		BCP52-10
	BCP51	BCY59-IX	BC850B	BD138-16	BCX52-16
BC636-10	BCX51-10		BCX70J		BCP52-16
	BCP51-10	BCY59-X	BC850C	BD139	BCX56
BC636-16	BCX51-16		BCX70K		BCP56
	BCP51-16	BCY65	BCV71	BD139-10	BCX56-10
BC637	BCX55		BCV72		BCP56-10
	BCP55	BCY70	BC860	BD139-16	BCX56-16
BC637-10	BCX55-10		BCF70		BCP56-16
	BCP55-10	BCY71	BC860	BD140	BCX53
BC637-16	BCX55-16		BCF70		BCP53
	BCP55-16	BCY72	BC859	BD140-10	BCX53-10
BC638	BCX52		BCF29/30		BCP53-10
	BCP52	BCY78	BC859	BD140-16	BCX53-16
BC638-10	BCX52-10		BCW61 fam.		BCP53-16
	BCP52-10	BCY78-VII	BC859A	BDX42	BST50
BC638-16	BCX52-16		BCW61A		BSP50
	BCP52-16	BCY78-VIII	BCY859A/B	BDX43	BST51
BC639	BCX56		BCW61B		BSP51
	BCP56	BCY78-IX	BC859B	BDX44	BST52
BC639-10	BCX56-10		BCW61C		BSP52
	BCP56-10	BCY78-X	BV859C	BDX45	BST60
BC639-16	BCX56-16		BCW61D		BSP60
	BCP56-16	BCY79	BC860	BDX46	BST61
BC640	BCX53		BCX71 fam.		BSP61
	BCP53	BCY79-VII	BC860A	BDX47	BST61
BC640-10	BCX53-10		BCX71G		BSP61
	BCP53-10	BCY79-VIII	BC860A/B	BF199	BFS20
BC640-16	BCX53-16		BCX71H	BF240	BF840
	BCP53-16	BCY79-IX	BC860B	BF241	BF841
BCX58	BCW60		BCX71J	BF324	BF824
BCX59	BCX70	BD135	BCX54	BF370	BSV52
BCX78	BCW61		BCP54		BF570
BCX79	BCX71	BD135-10	BCX54-10	BF410A	BF510
BCY56	BC850B		BCP54-10	BF410B	BF511
	BCF70	BD135-16	BCX54-16	BF410C	BF512
			BCP54-16	BF410D	BF513

[1] = *conventional type*
[2] = *microminiature type*

GENERAL

Type designation

Rating systems

Letter symbols

SOAR curves

Soldering recommendations
for SOT-37 and SOT-103 envelopes

s-parameters

TO-92
variant transistors on tape

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.

"Although not all type numbers accord with the Pro Electron system, the following explanation is given for the ones that do."

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

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)	Root-mean-square 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 DC values.

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

a) continuous (DC) 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 (DC) current flowing into the second base terminal

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

Subscripts for multiple devices

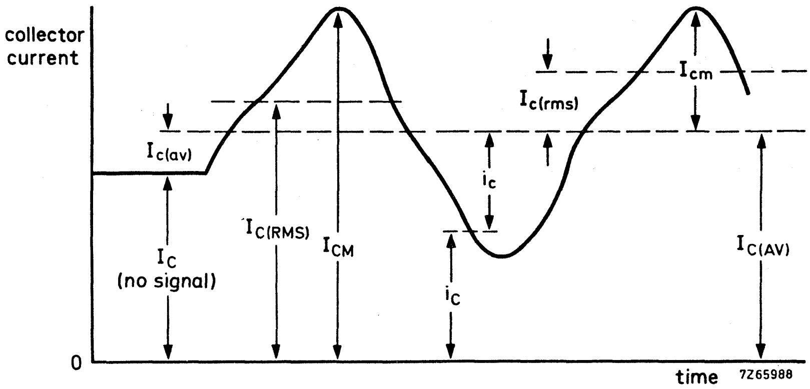
For multiple unit devices, the subscripts are modified by a number preceding the letter subscript; in the case of multiple subscripts, hyphens may be necessary to avoid misunderstanding.

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

V_{1C-2C} = continuous (DC) 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 (DC) current and a varying component.



LETTER SYMBOLS FOR ELECTRICAL PARAMETERS

Defenition

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 **(DC current gain)**

R_E = **DC value of the external emitter resistance**

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

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

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

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

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

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

Subscripts for four-pole matrix parameters

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

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

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

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

Distinction between real and imaginary parts

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

Examples: $Z_i = R_i + jX_i$

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

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

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

TRANSISTOR SAFE OPERATING AREA

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

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

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

Collector current

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

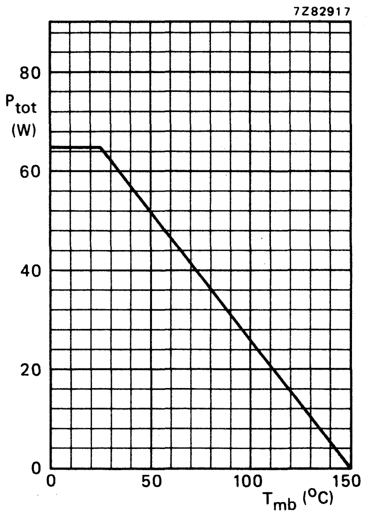
For power switching transistors I_{Csat} is given; this is the value at which switching times and saturation voltage is measured.

Collector-emitter voltage

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

Power dissipation

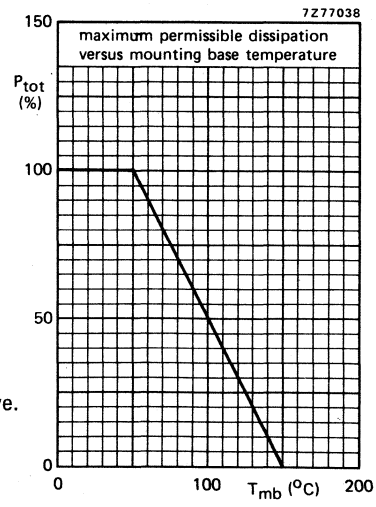
Maximum power dissipation $P_{tot\,max}$ is specified in the data sheets for a given mounting base temperature. This is usually 25 °C but may be any, much higher temperature. $P_{tot\,max}$ applies up to the stated temperature; above it derating must be applied. A power derating curve of the form shown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



(a)

Fig. 1 Power derating curve.

(b)



Total power dissipation is given by

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

The second term can usually be disregarded, so $P_{tot} \approx I_C V_{CE}$.
Heat dissipated in the collector-base junction flows through the thermal resistance between junction and mounting base, see Fig. 2.

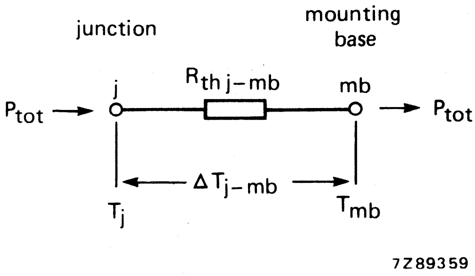


Fig. 2 Heat transport in a transistor with power dissipation constant with respect to time.

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

For pulsed operation a higher dissipation is permitted, because

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

Analogy with

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

yields

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

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

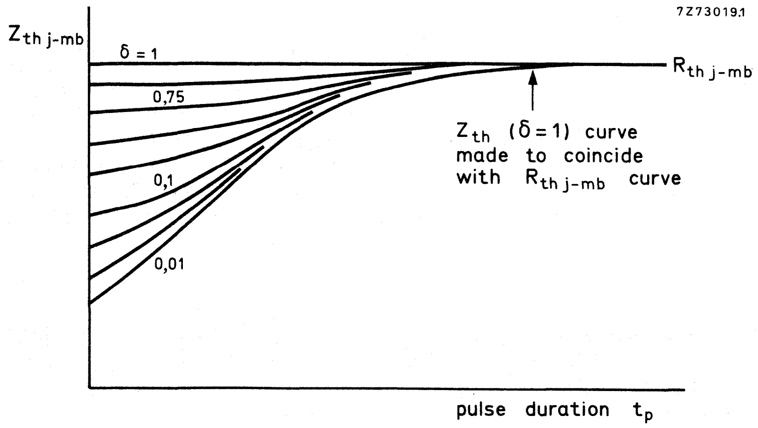


Fig. 3 A typical family of $Z_{th\ j\text{-}mb}$ curves for a power transistor.

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

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

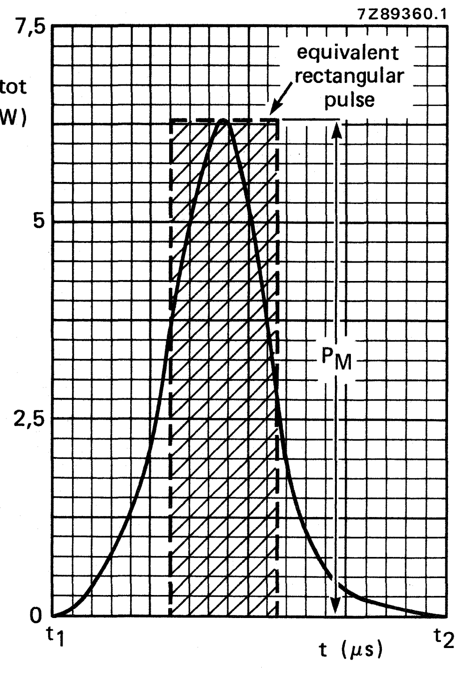


Fig. 4.

Second breakdown

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

THE SOAR BOUNDARIES

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

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

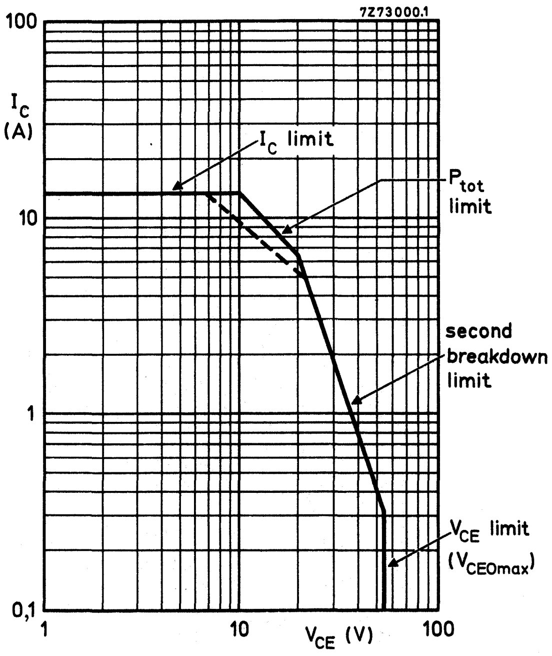


Fig. 5 A typical SOAR graph with boundaries named.

EXTENDING THE SOAR FOR SINGLE-SHOT AND REPETITIVE PULSED OPERATION

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

I_{CMmax}

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

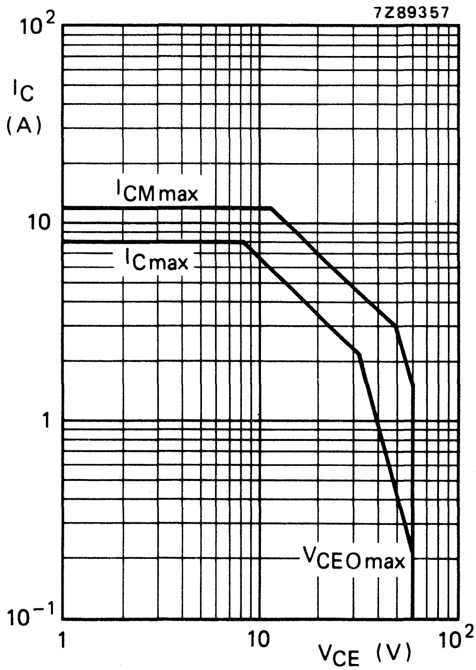


Fig. 6 Maximum collector current and collector-emitter voltage boundaries.

$P_{tot\ max}$

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

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

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

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

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

$T_{j\ max}$ = 150 °C; T_{mb} = 80 °C; t_p = 0,2 ms and δ = 0,1.

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

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

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

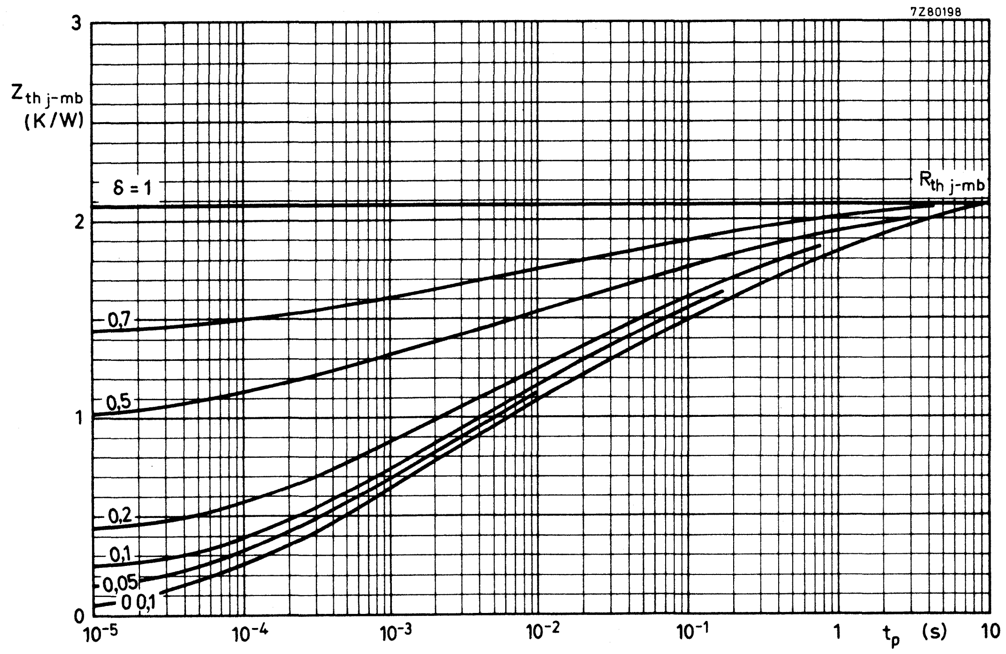


Fig. 7 Transient thermal impedance for example.

Second breakdown

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

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

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

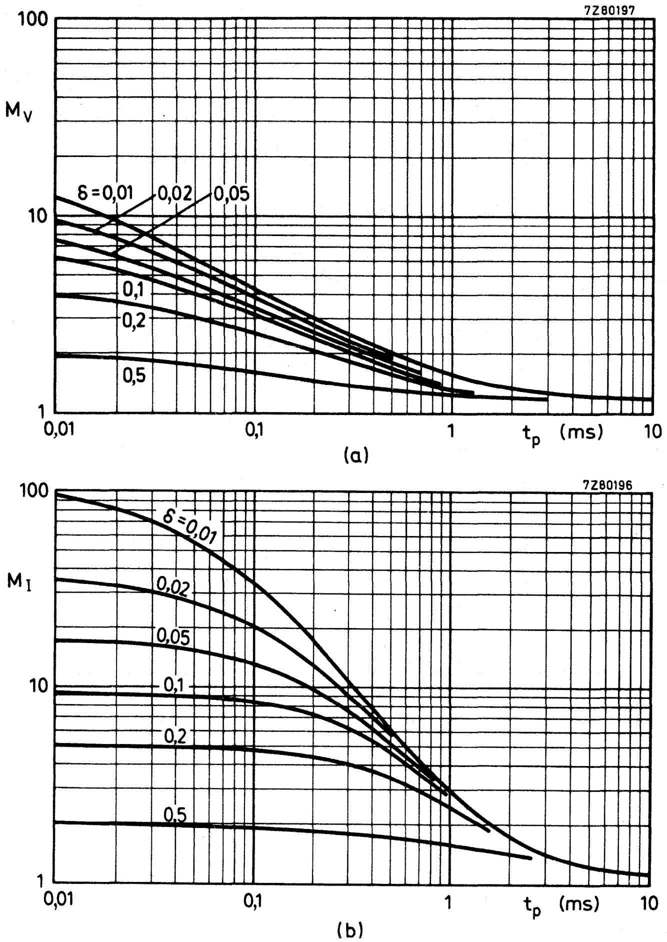


Fig. 8 Second breakdown multiplying factors as a function of pulse time, with duty factor as a parameter.

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

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

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

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

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

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

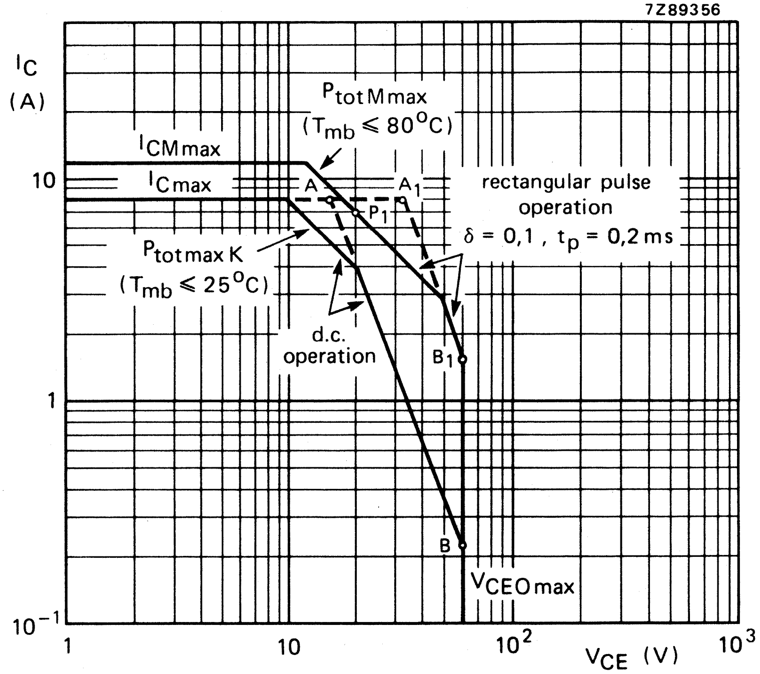


Fig. 9 Construction of the pulse operating area.

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

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

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

PULSE TRAINS AND COMPOSITE WAVEFORMS

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

Thermal considerations

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

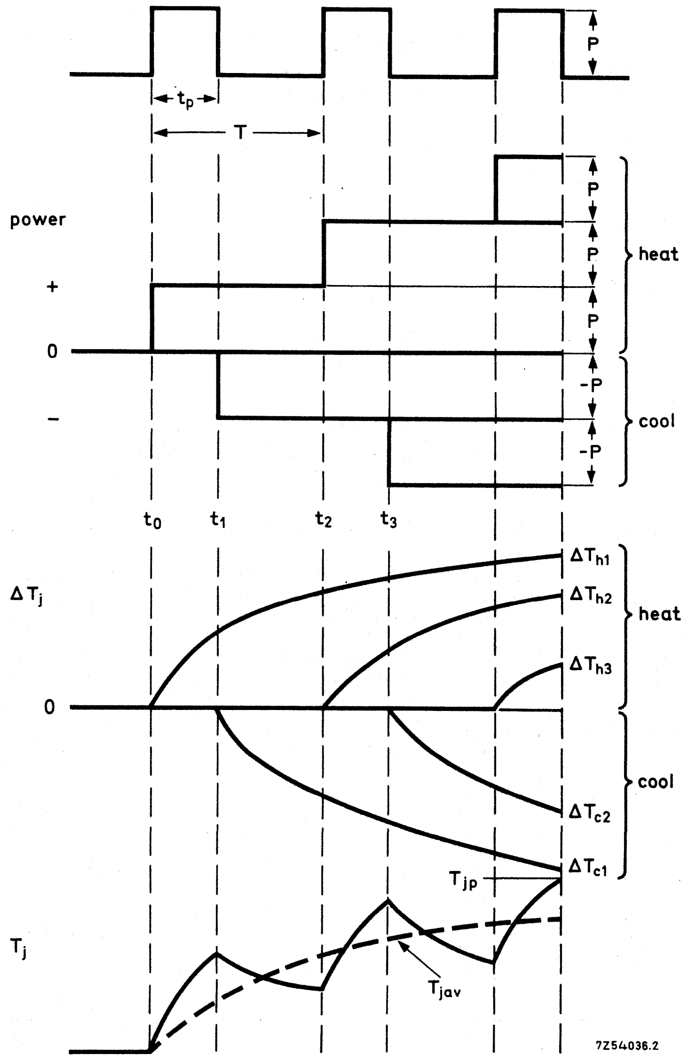


Fig. 10 The heating effect of three equidistant, equal-magnitude pulses. $T_{j\,av}$ is the average junction temperature. P = 100 W, t_p = 100 μs; T = 1 ms and δ = 0,1.

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

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

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

$T_{h1} = PZ_{th}(2{,}1\ \text{ms})$

$T_{h2} = PZ_{th}(1{,}1\ \text{ms})$

$T_{h3} = PZ_{th}(0{,}1\ \text{ms})$

and

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

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

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

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

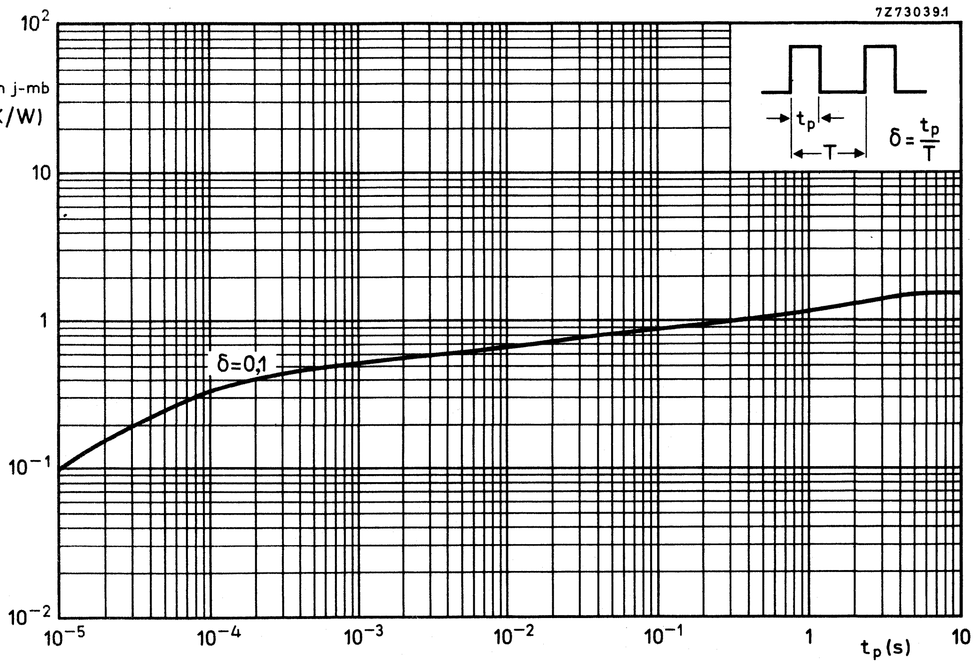


Fig. 11 Curve of $Z_{th\ j\text{-}mb} = f(t_p)$.

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

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

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

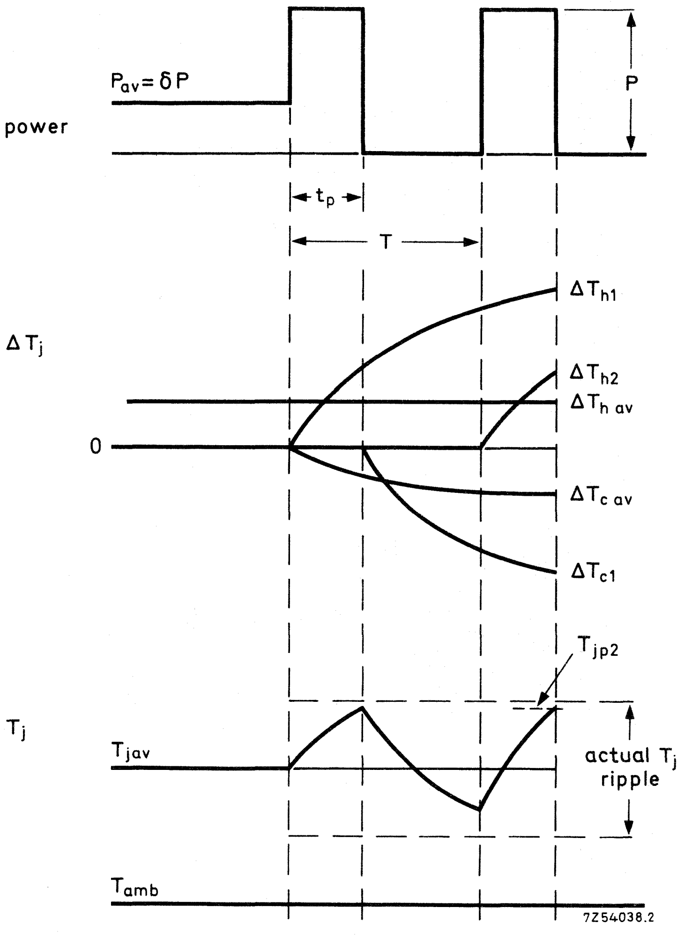


Fig. 12.

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

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

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

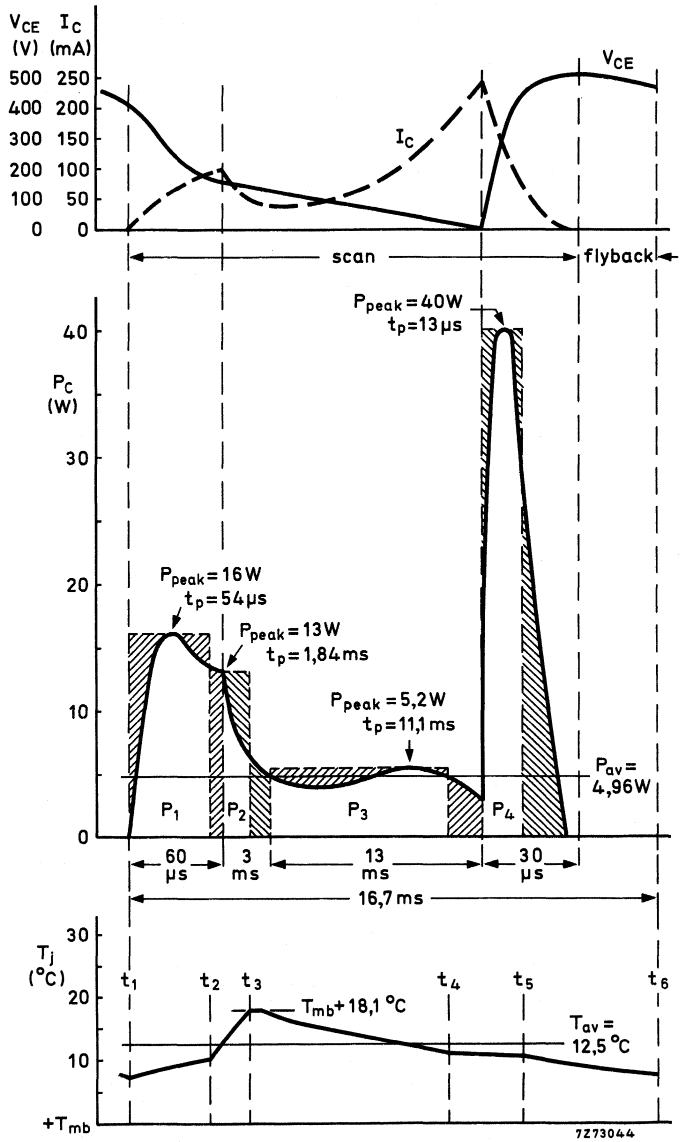


Fig. 13 Power waveforms showing their division into rectangular pulses and the junction temperature variations which they cause.

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

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

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

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

For t_3 yet another two terms:

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

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

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

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

EXAMPLE OF A SOAR CALCULATION

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

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

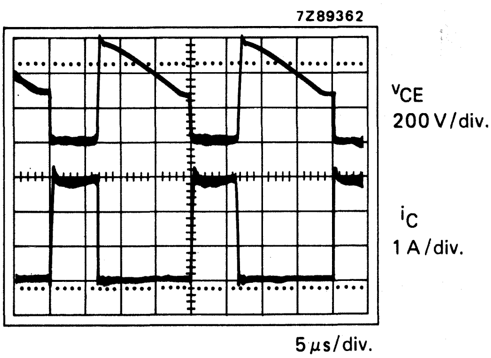


Fig. 14 Collector-current and collector-emitter voltage waveforms of a BU426A transistor in a 200 W SMPS.

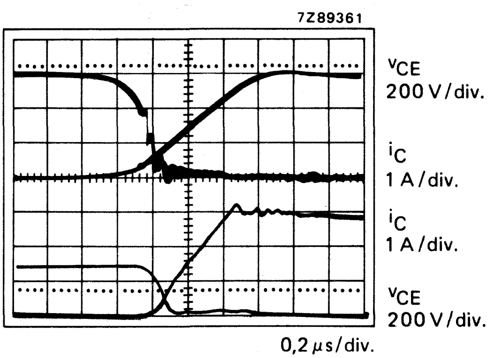


Fig. 15 Waveforms during turn-on and turn-off (lower part).

The duration of this equivalent pulse train is then given by

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

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

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

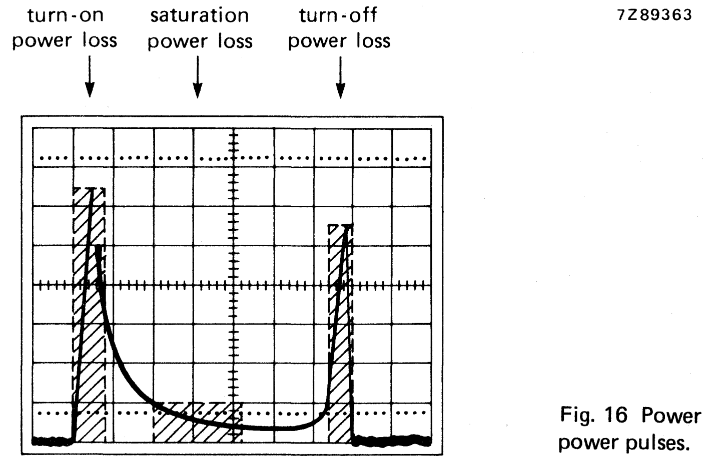


Fig. 16 Power loss and resultant rectangular power pulses.

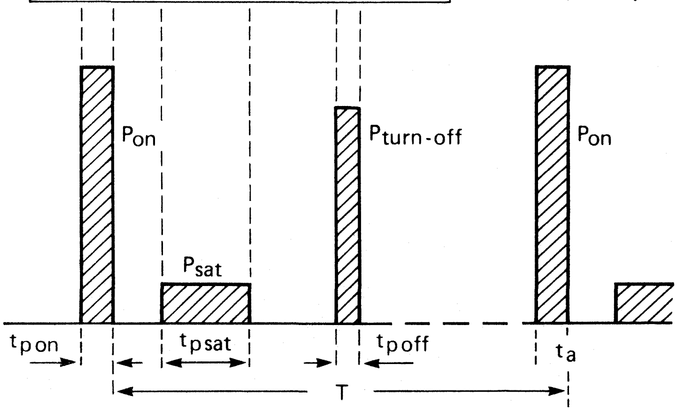


Fig. 17.

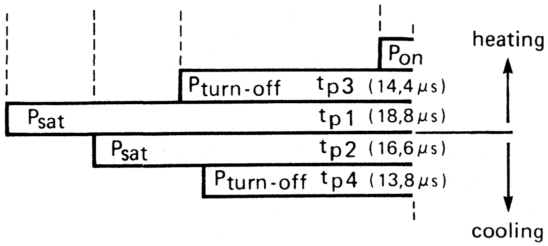


Fig. 18.

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

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

From

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

$$\Delta T_{j\text{-}mb(ta)} = (P_{sat} \times Z_{th(tp1)}) - (P_{sat} \times Z_{th(tp2)}) +$$

$$+ (P_{turn\text{-}off} \times Z_{th(tp3)}) - (P_{turn\text{-}off} \times Z_{th(tp4)}) + (P_{on} \times Z_{th(tp\,on)})$$

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

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

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

From

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

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

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

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

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

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

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

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

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

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

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

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

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

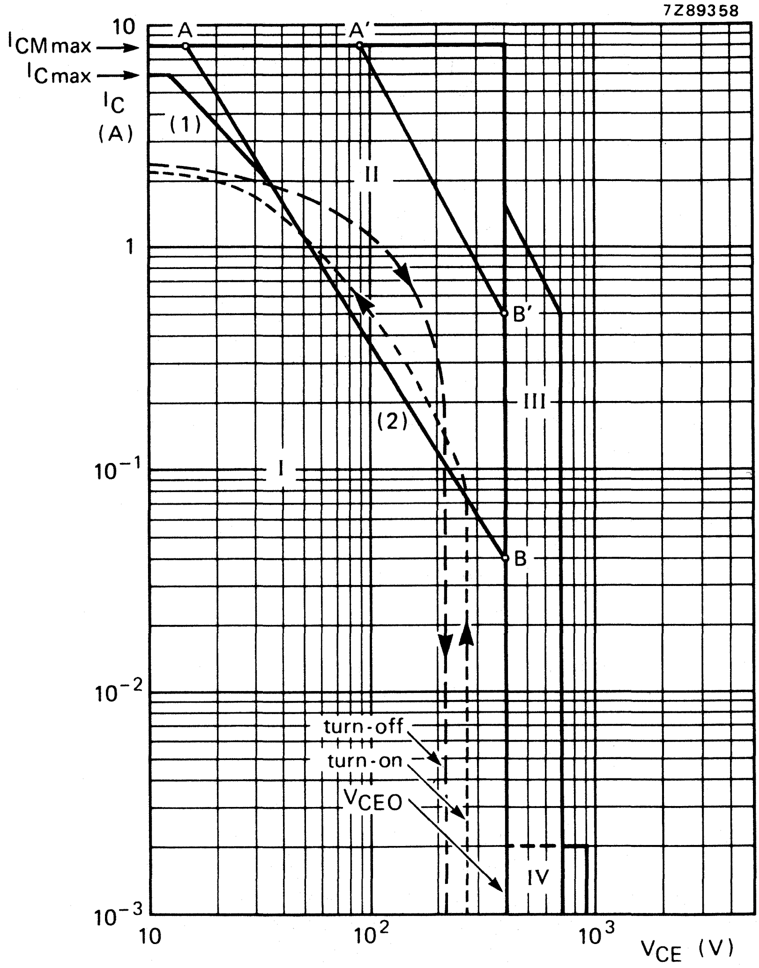


Fig. 19 Safe Operating ARea BU426A at $T_{mb} \leqslant 73\ ^{o}C$.

I Region of permissible d.c. operation.

II Permissible extension for repetitive pulse operation.

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

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

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

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

SOLDERING RECOMMENDATIONS SOT-37 AND SOT-103

Transistors in SOT-37 and SOT-103 envelopes may be mounted with leads flat (Fig. 1) or bent (Figs 2 and 3). Different soldering procedures apply for the different styles of mounting.

FLAT-LEAD MOUNTING

Soldering by hand

Avoid putting any force on the leads during or just after soldering.

Solder the three leads one at a time, *not* simultaneously.

Proceed from one lead to the adjacent lead, *not* to the opposite one.

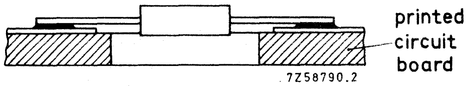


Fig. 1

Solder temperature	max.	300 °C
Soldering time	max.	5 s
Solder-to-case distance	min.	2 mm

BENT-LEAD MOUNTING

If leads are bent, all three may be soldered simultaneously if desired.

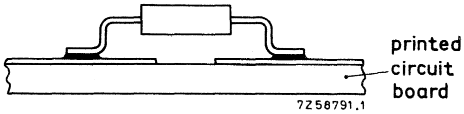


Fig. 2

Solder temperature	max.	300 °C
Soldering time	max.	10 s

DIP OR WAVE SOLDERING

When dip or wave soldering, the maximum allowable temperature of the solder is 260 °C. This temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds. The device may be mounted up to the lead projections, but the temperature of the body must not exceed the specified storage maximum.

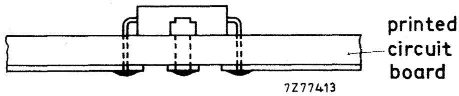
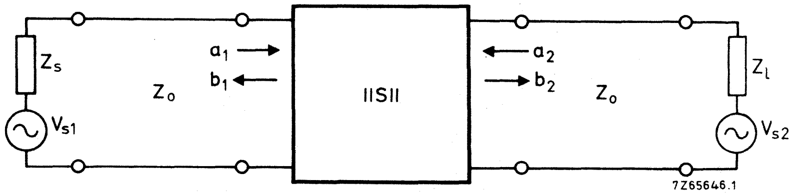


Fig. 3

Solder temperature	max.	260 °C
Soldering time	max.	5 s

SCATTERING PARAMETERS

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



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

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

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

V_i = incident voltage

V_r = reflected (generated) voltage

The four-pole equations for s-parameters are:

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

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

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

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

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

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

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

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

$s_i = s_{11}$ = Input reflection coefficient.
The complex ratio of the reflected wave and the incident wave at the input, under the conditions $Z_l = Z_o = 50\ \Omega$ 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 $Z_s = Z_o = 50\ \Omega$ 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 $Z_l = Z_o = 50\ \Omega$ 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 $Z_s = Z_o = 50\ \Omega$ and $V_{s1} = 0$.

TO-92 TRANSISTORS ON TAPE

Mechanical data

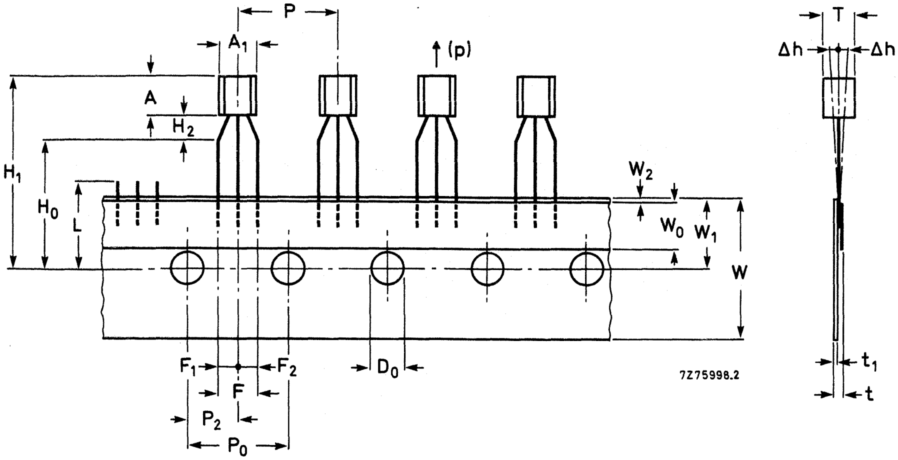


Fig.1 Tape specification.

TAPE SPECIFICATION

SYMBOL	DIMENSION	SPECIFICATIONS					REMARKS
		MIN.	NOM.	MAX.	TOL.	UNIT	
A_1	body width	4	–	4.8	–	mm	
A	body height	4.8	–	5.2	–	mm	
T	body thickness	3.5	–	3.9	–	mm	
P	pitch of component	–	12.7	–	±1	mm	
P_0	feed hole pitch	–	12.7	–	±0.3	mm	
	cumulative pitch error	–	–	–	±0.1	mm	note 1
P_2	feed hole centre to component centre	–	6.35	–	±0.4	mm	to be measured at bottom of clinch
F	distance between outer leads	–	5.08	–	+0.6/–0.2	mm	
Δh	component alignment	–	0	1	–	mm	at top of body
W	tape width	–	18	–	±0.5	mm	
W_0	hold-down tape width	–	6	–	±0.2	mm	
W_1	hole position	–	9	–	+0.7/–0.5	mm	
W_2	hold-down tape position	–	0.5	–	±0.2	mm	
H_0	lead wire clinch height	–	16.5	–	±0.5	mm	
H_1	component height	–	–	23.25	–	mm	
L	length of snipped leads	–	–	11	–	mm	
D_0	feed hole diameter	–	4	–	±0.2	mm	
t	total tape thickness	–	–	1.2	–	mm	t_1 0.3 to 0.6
F_1, F_2	lead-to-lead distance	–	2.54	–	+0.4/–0.2	mm	
H_2	clinch height	–	–	3	–	mm	
(p)	pull-out force	6	–	–	–	N	

Note

1. Measured over 20 devices.

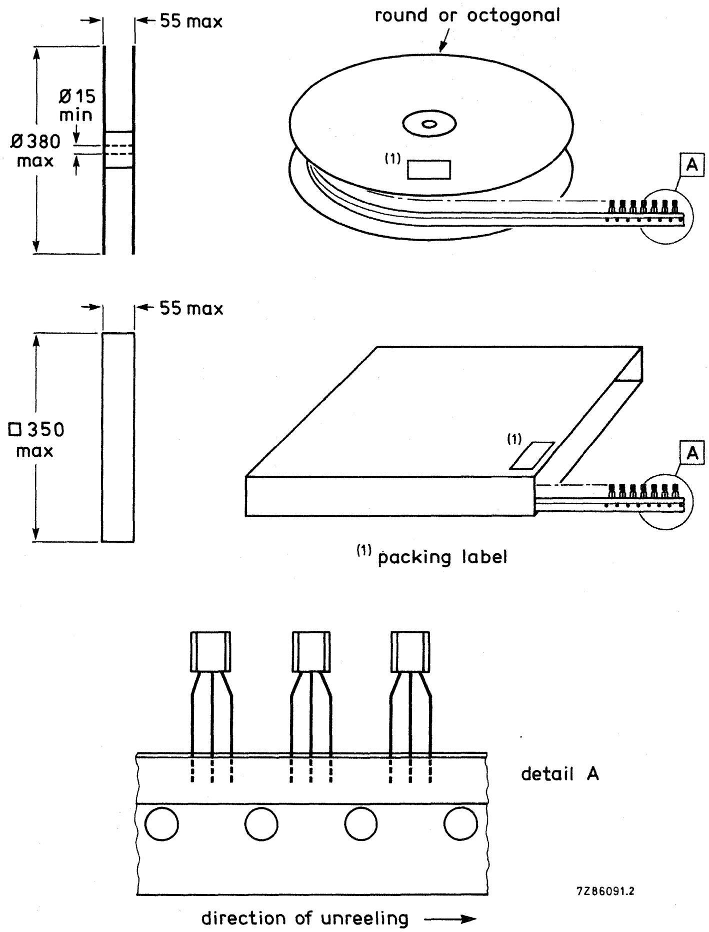
PACKING

The transistors are supplied on tape in boxes (ammopack) or on reels. The number per reel and per ammopack is 2000. The ammopack has 80 layers of 25 transistors each. Each layer contains 25 transistors, plus one empty position in order to fold the layer correctly. The ammopack is accessible from both sides, enabling the user to choose between "normal" (see Fig.2) and "reverse" tape.

"Normal" is indicated by a plus sign (+) on the ammopack and "reverse" by a minus sign (–). In the European version, the leading pin is the emitter.

DROPOUTS

A maximum of 0.5% of the specified number of transistors in each packing may be missing. Up to 3 consecutive components may be missing provided the gap is followed by 6 consecutive components.



Dimensions in mm.

Fig.2 Dimensions of reel and box.

TAPE SPLICING

Splice the carrier tape on the back and/or front so that the feed hole pitch (P_0) is maintained (see Fig.3).

BULK PACKING

In addition to TO-92 on tape, TO-92 can also be delivered in bulk. Products are packed in boxes in pink foil and plastic bags, 1000 pieces to a bag and 5 bags to a box. The standard bulk-packed TO-92 has straight leads (see Fig.4).

In addition to the standard TO-92 with straight leads, leads with delta pinning are available in bulk, on request (see Fig.5).

For all packing methods, products are in European pinning (CBE), US pinning (EBC) and Japanese pinning (ECB).

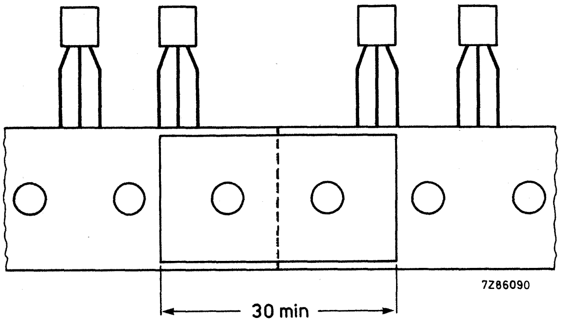


Fig.3 Jointing tape with splicing patch.

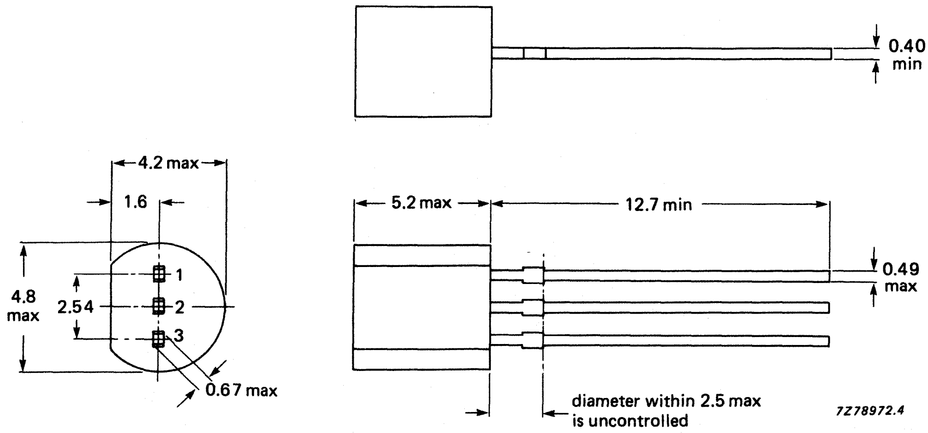


Fig.4 TO-92 with straight leads.

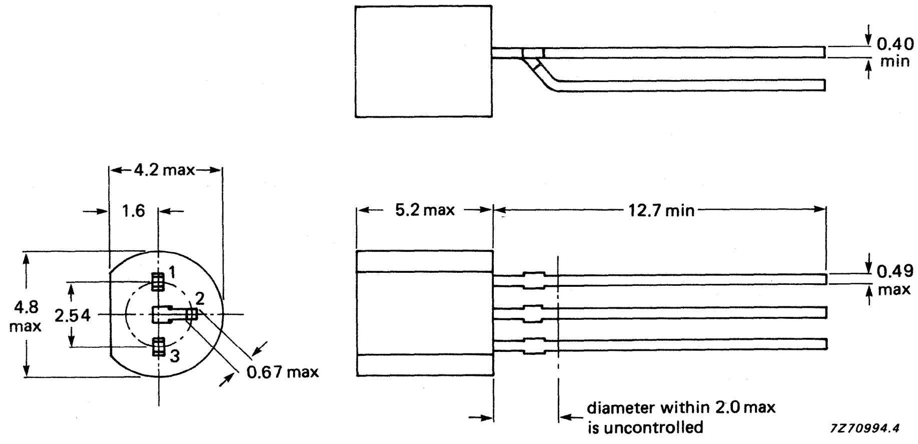


Fig.5 TO-92 with delta pinning.

DEVICE DATA

in alphanumerical sequence

A.F. SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in TO-18 metal envelopes with the collector connected to the case.

The **BC107** is primarily intended for use in driver stages of audio amplifiers and in signal processing circuits of television receivers.

The **BC108** is suitable for multitude of low-voltage applications e.g. driver stages or audio preamplifiers and in signal processing circuits of television receivers.

The **BC109** is primarily intended for low-noise input stages in tape recorders, hi-fi amplifiers and other audio-frequency equipment.

QUICK REFERENCE DATA

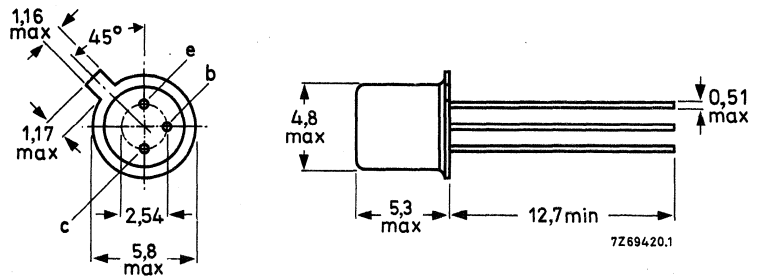
			BC107	BC108	BC109	
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	50	30	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	20	20	V
Collector current (peak value)	I_{CM}	max.	200	200	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	300	300	mW
Junction temperature	T_j	max.	175	175	175	°C
Small-signal current gain at T_j = 25 °C; I_C = 2 mA; V_{CE} = 5 V; f = 1 kHz	h_{fe}	>	125	125	240	
		<	500	900	900	
Transition frequency at f = 35 MHz; 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 = 30 Hz to 15 kHz	F	typ.	–	–	1,4	dB
		<	–	–	4,0	dB
f = 1 kHz; B = 200 Hz	F	typ.	2	2	1,2	dB

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case



Products approved to CECC 50 002-076/078.

RATINGS

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

			BC107	BC108	BC109	
Collector-base voltage (open emitter)	V_{CBO}	max.	50	30	30	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	50	30	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	20	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	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} = 25 °C	P_{tot}	max.		300		mW
Storage temperature range	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		175		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0,5	K/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0,2	K/mW

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}	<	15	μA
Base-emitter voltage*				
I_C = 2 mA; V_{CE} = 5 V	V_{BE}	typ.	620	mV
			550 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

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

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

Collector capacitance at f = 1 MHz $I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.		2,5	pF
Emitter capacitance at f = 1 MHz $I_C = I_c = 0$; $V_{EB} = 0,5$ V	C_e	typ.		9	pF
Transition frequency at f = 35 MHz $I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.		300	MHz

			BC107	BC108	BC109
Small signal current gain at f = 1 kHz $I_C = 2$ mA; $V_{CE} = 5$ V	h_{fe}	>	125	125	240
		<	500	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 dB
		<			4 dB
f = 1 kHz; B = 200 Hz	F	typ.	2	2	1,2 dB
		<	10	10	4 dB

			BC107A BC108A	BC107B BC108B BC109B	BC108C BC109C
D.C. current gain $I_C = 10$ μA; $V_{CE} = 5$ V	h_{FE}	>		40	100
		typ.	90	150	270
$I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	>	110	200	420
		typ.	180	290	520
		<	220	450	800
h parameters at f = 1 kHz (common emitter) $I_C = 2$ mA; $V_{CE} = 5$ V Input impedance	h_{ie}	>	1,6	3,2	6 kΩ
		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}
Small signal current gain	h_{fe}	>	125	240	450
		typ.	220	330	600
		<	260	500	900
Output admittance	h_{oe}	typ.	18	30	60 $\mu\Omega^{-1}$
		<	30	60	110 $\mu\Omega^{-1}$

Typical behaviour of collector current versus collector-emitter voltage

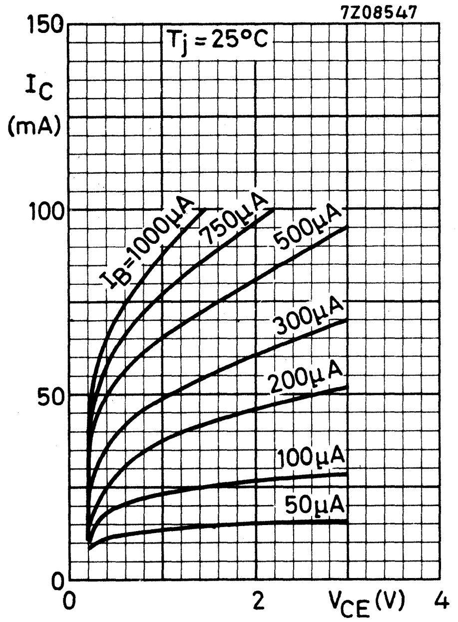


Fig. 2.

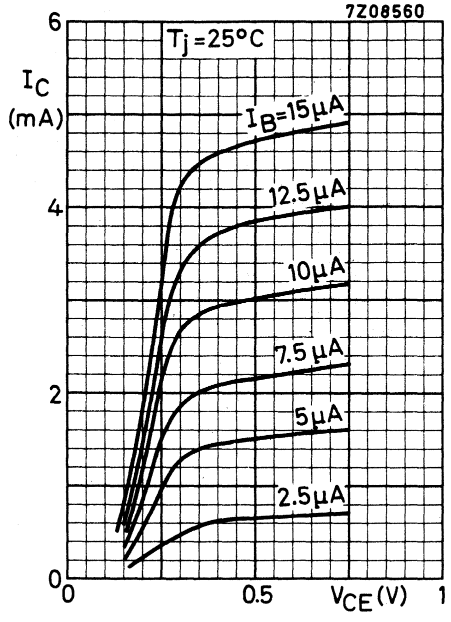


Fig. 3.

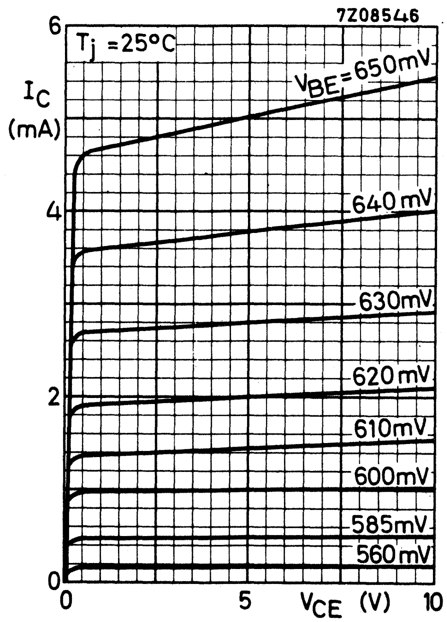


Fig. 4.

Typical behaviour of collector current versus collector-emitter voltage

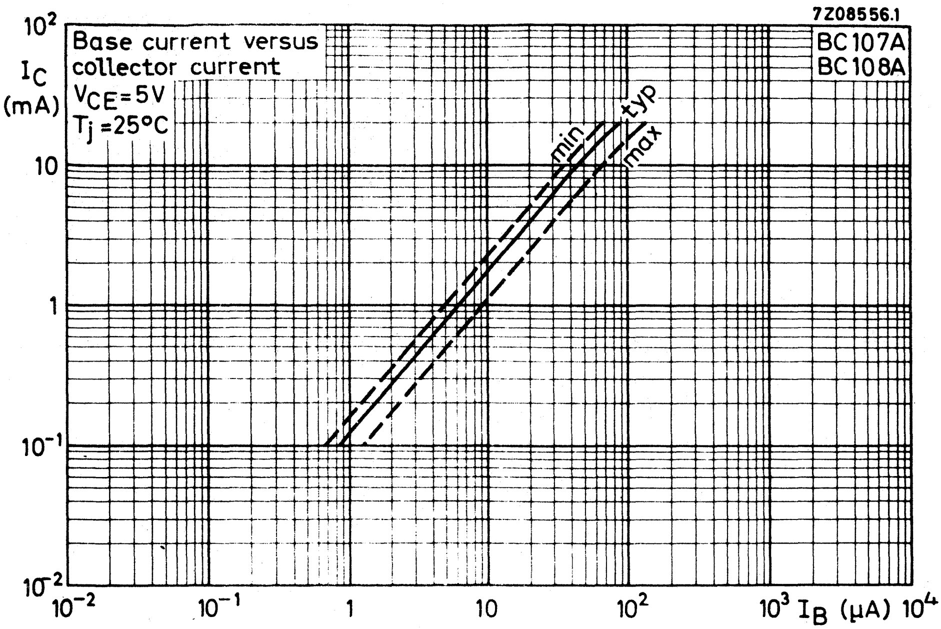

7Z08556.1
Base current versus
collector current
V_{CE}=5V
T_j=25°C
BC107A
BC108A
I_C
(mA)
10^2
10
1
10^{-1}
10^{-2}
10^{-2}
10^{-1}
1
10
10^2
10^3
I_B (μA)
10^4
min
typ
max

Fig. 5.

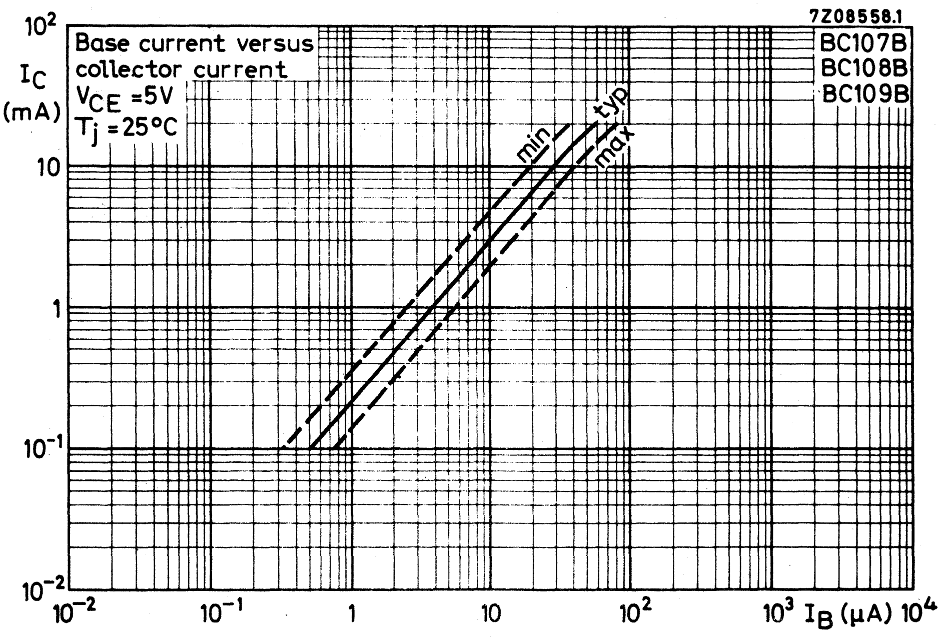

7Z08558.1
Base current versus
collector current
V_{CE}=5V
T_j=25°C
BC107B
BC108B
BC109B
I_C
(mA)
10^2
10
1
10^{-1}
10^{-2}
10^{-2}
10^{-1}
1
10
10^2
10^3
I_B (μA)
10^4
min
typ
max

Fig. 6.

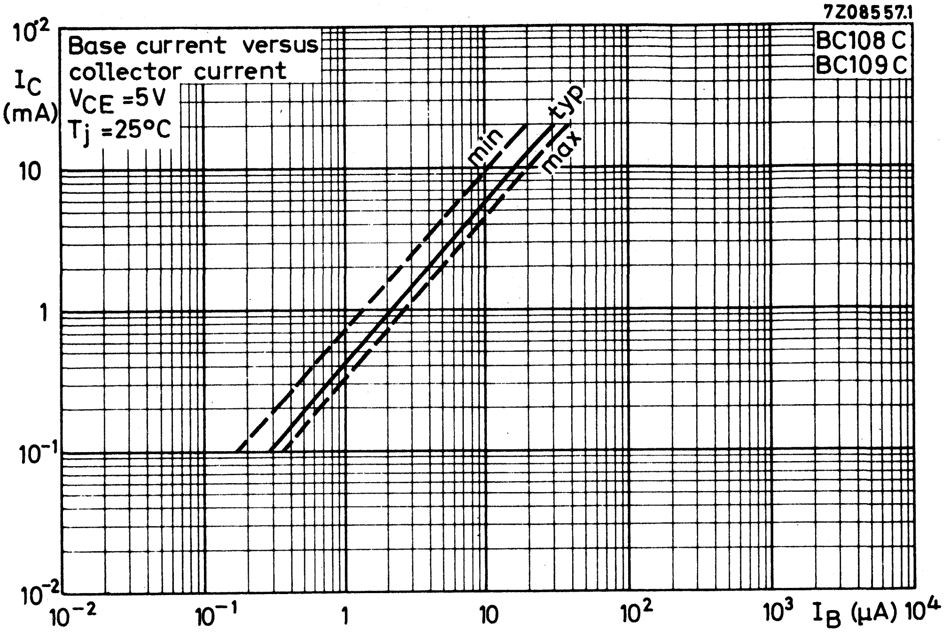


Fig. 7.

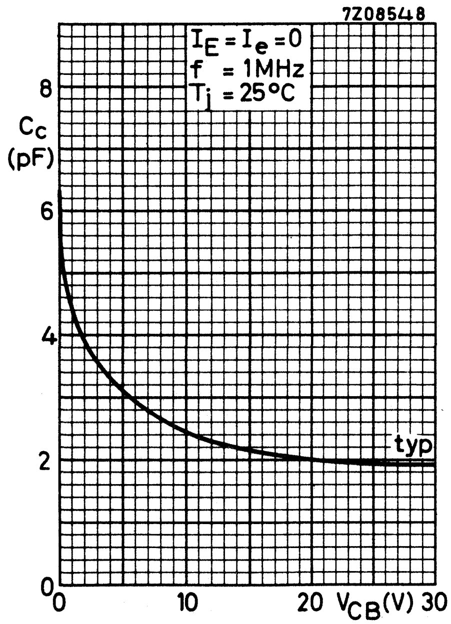


Fig. 8.

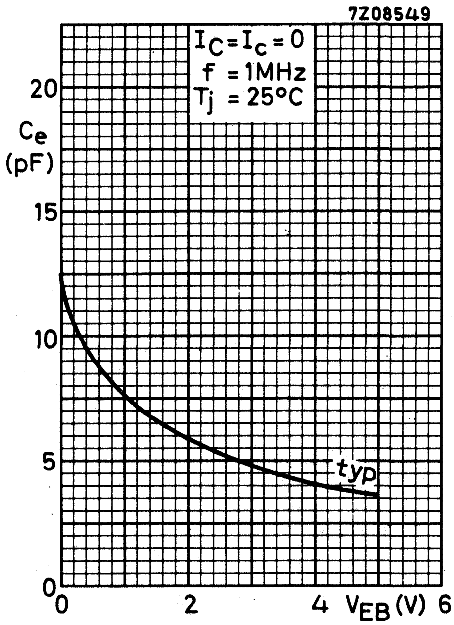


Fig. 9.

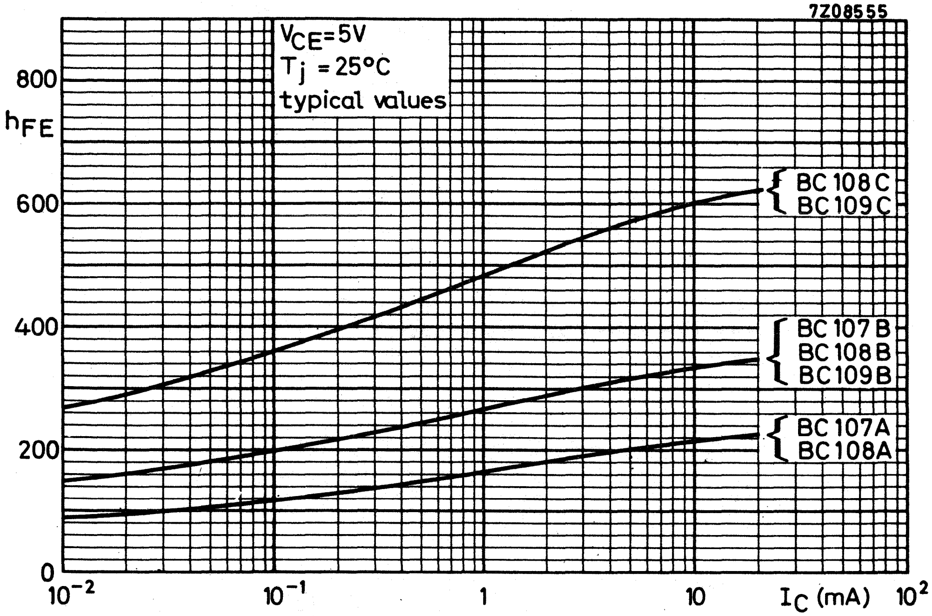

7Z08555
V_{CE}=5V
T_j = 25°C
typical values
800
h_{FE}
600
400
200
0
BC108C
BC109C
BC107B
BC108B
BC109B
BC107A
BC108A
10^{-2}
10^{-1}
1
10
I_C (mA)
10^2

Fig. 10.

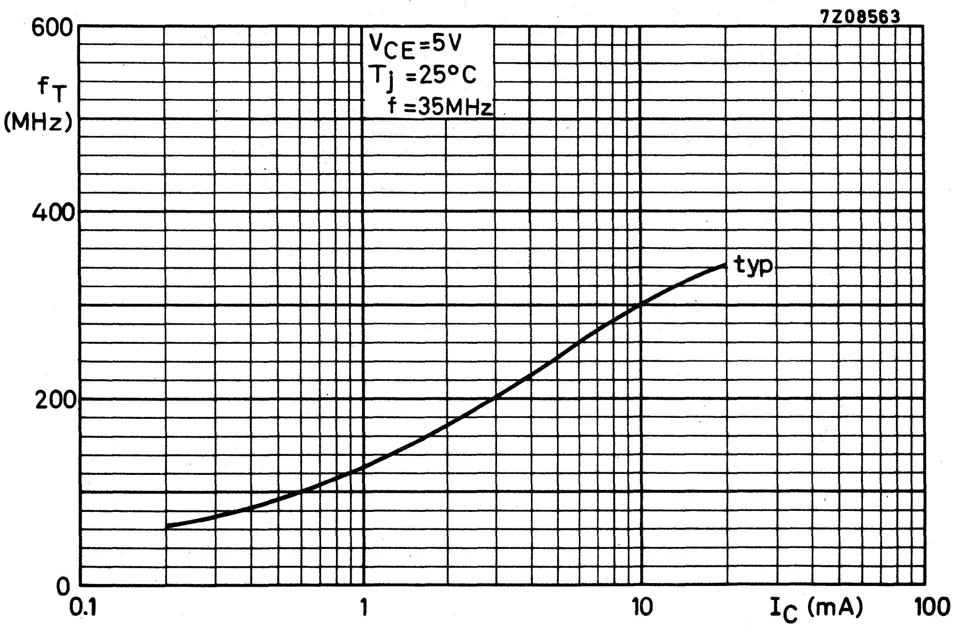

7Z08563
V_{CE}=5V
T_j =25°C
f =35MHz
600
f_T
(MHz)
400
200
0
typ
0.1
1
10
I_C (mA)
100

Fig. 11.

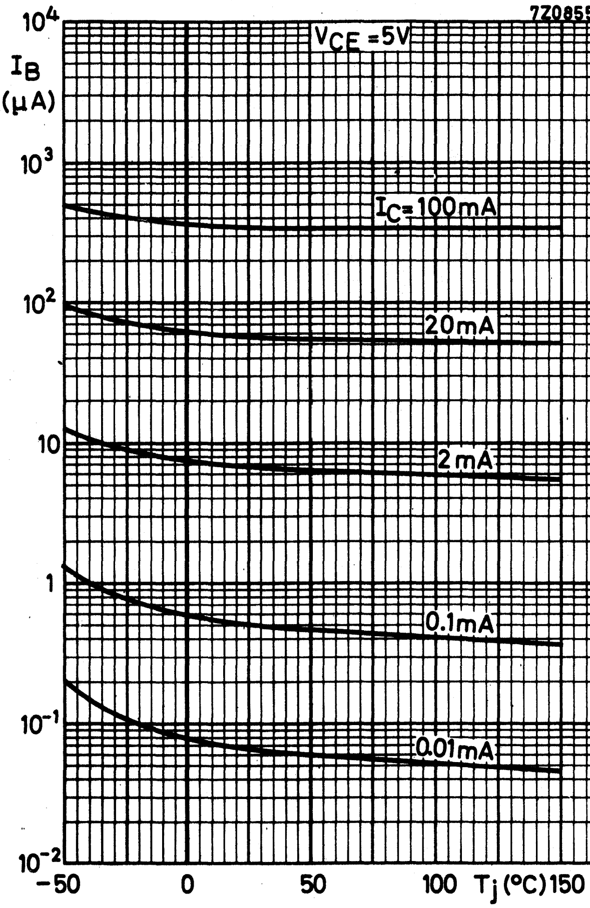


Fig. 12. Typical behaviour of base current versus junction temperature.

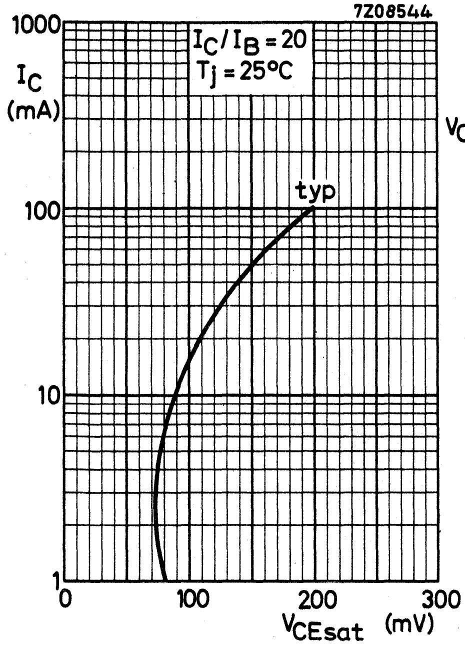


Fig. 13.

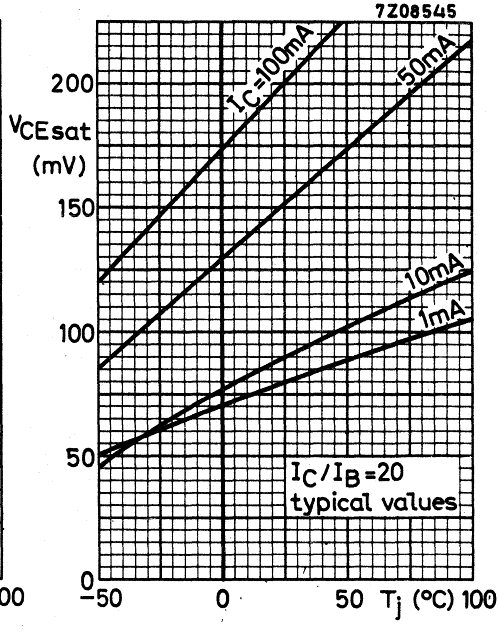


Fig. 14.

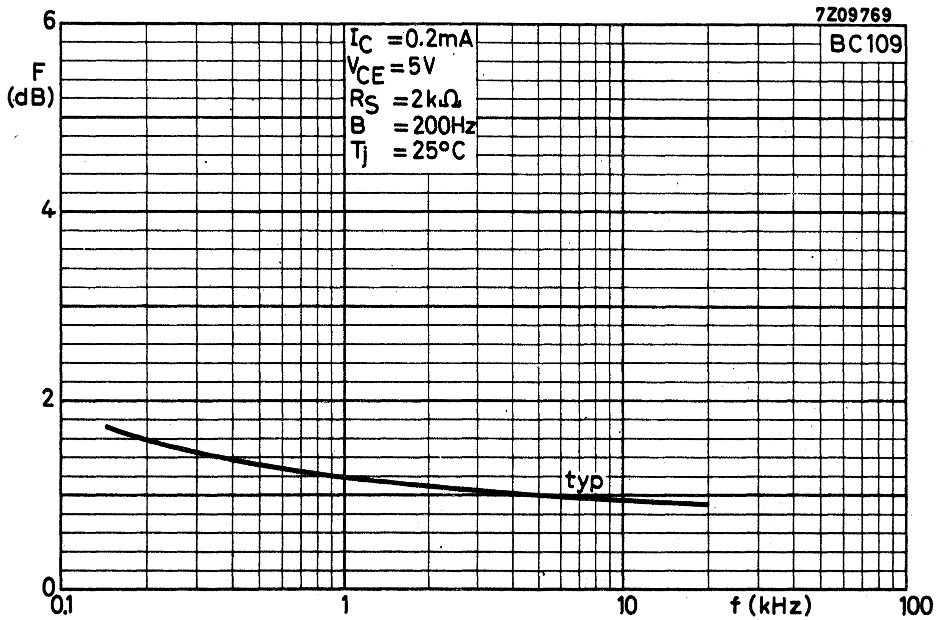


Fig. 15.

Curves of constant noise figure

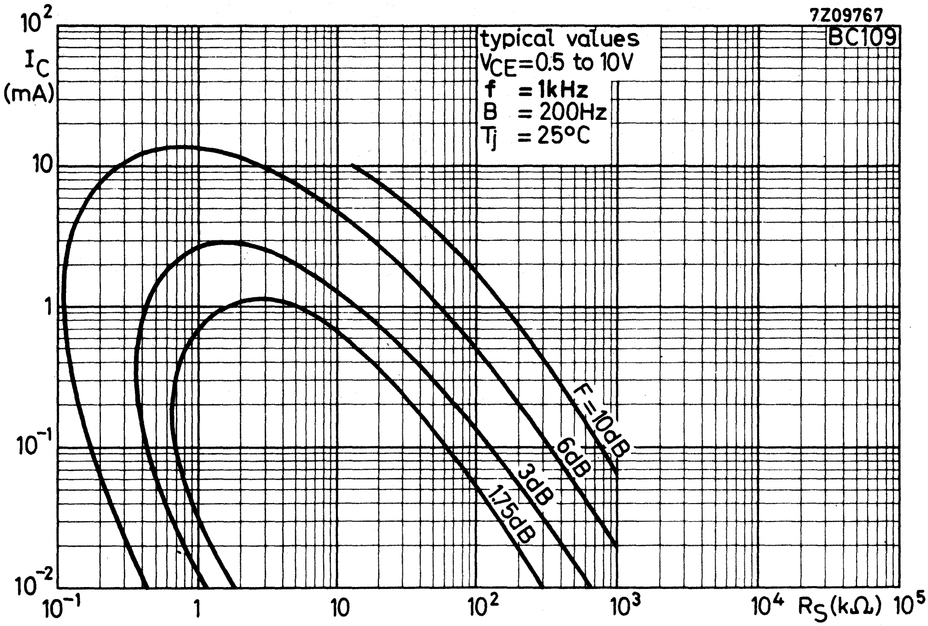


Fig. 16.

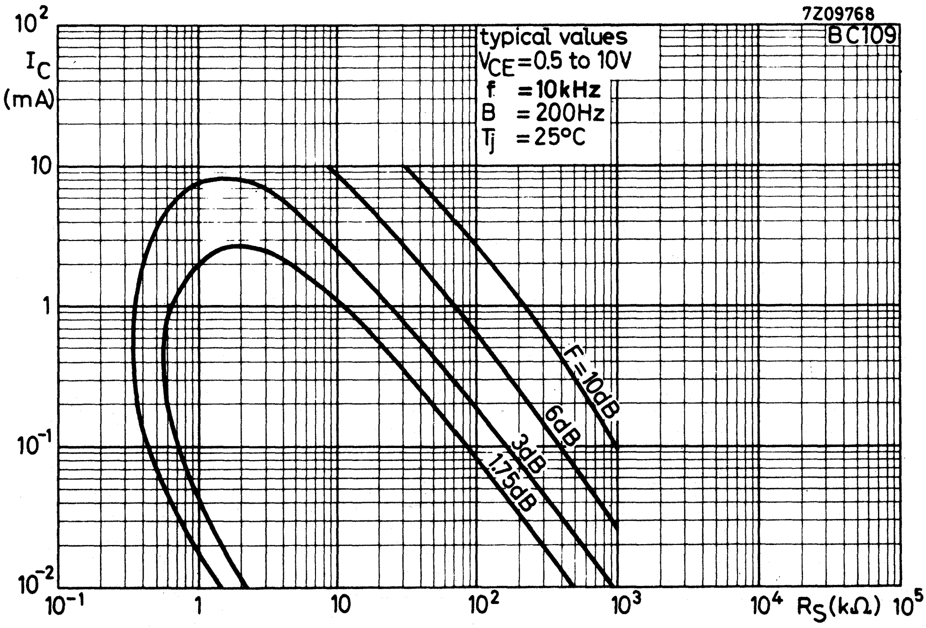


Fig. 17.

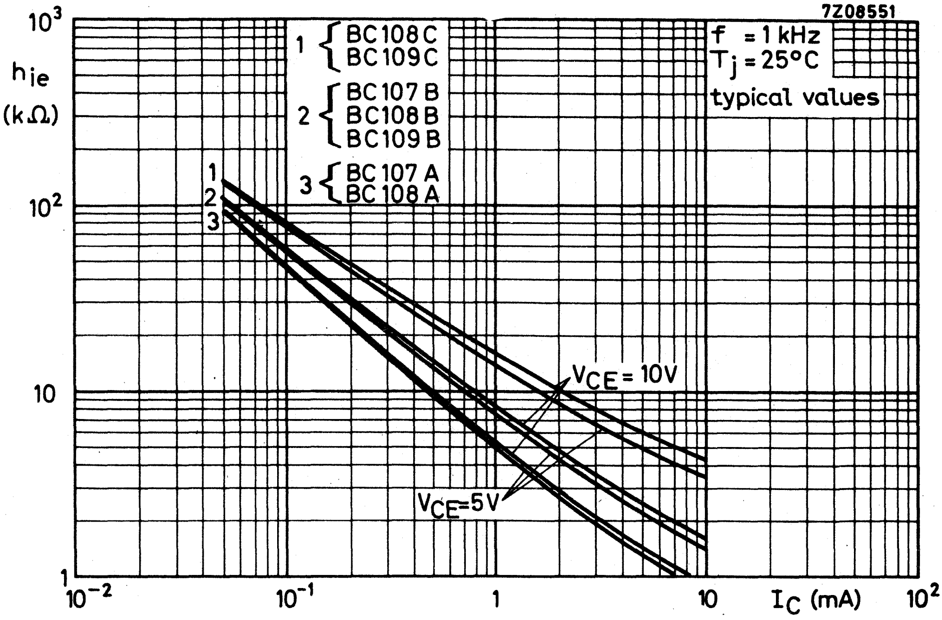

7Z08551
h_{ie}
(kΩ)
1 { BC108C BC109C
2 { BC107B BC108B BC109B
3 { BC107A BC108A
f = 1 kHz
T_j = 25°C
typical values
V_{CE} = 10V
V_{CE}=5V
I_C (mA)

Fig. 18.

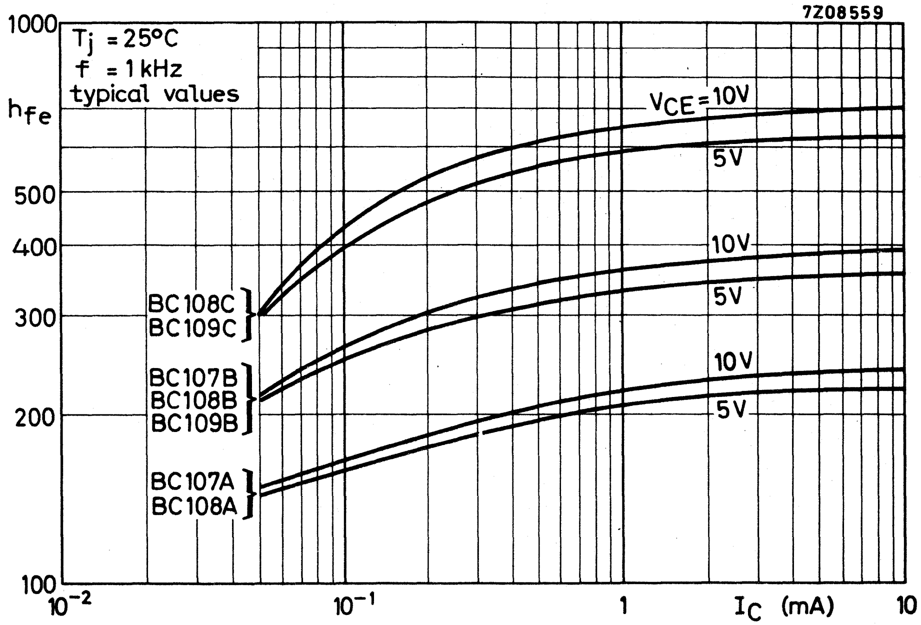

7Z08559
T_j = 25°C
f = 1 kHz
typical values
h_{fe}
V_{CE}=10V
5V
10V
5V
10V
5V
BC108C BC109C
BC107B BC108B BC109B
BC107A BC108A
I_C (mA)

Fig. 19.

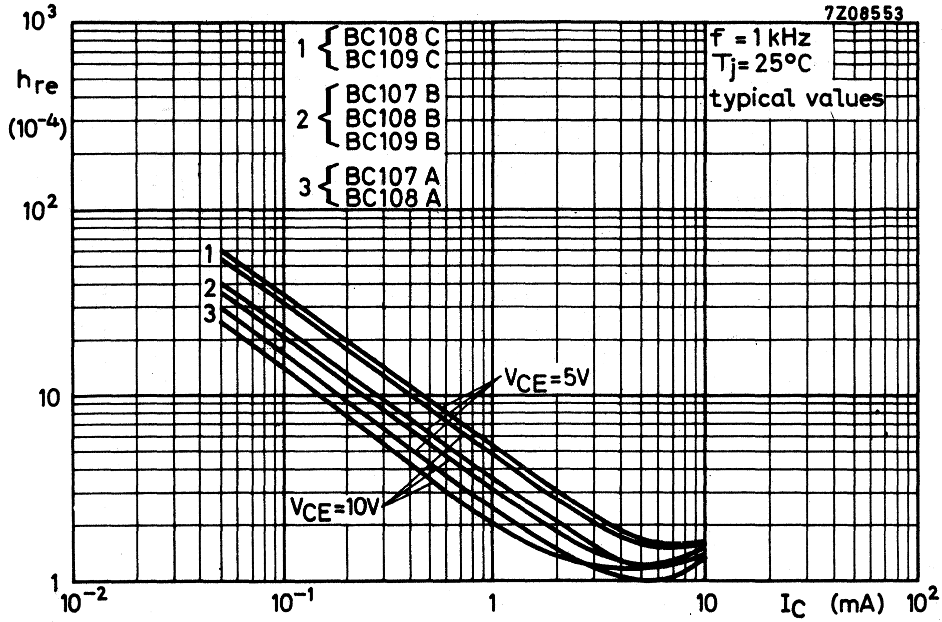

7Z08553
1 { BC108 C, BC109 C
2 { BC107 B, BC108 B, BC109 B
3 { BC107 A, BC108 A
f = 1 kHz
Tj = 25°C
typical values
hre
(10⁻⁴)
VCE = 5V
VCE = 10V
IC (mA)

Fig. 20.

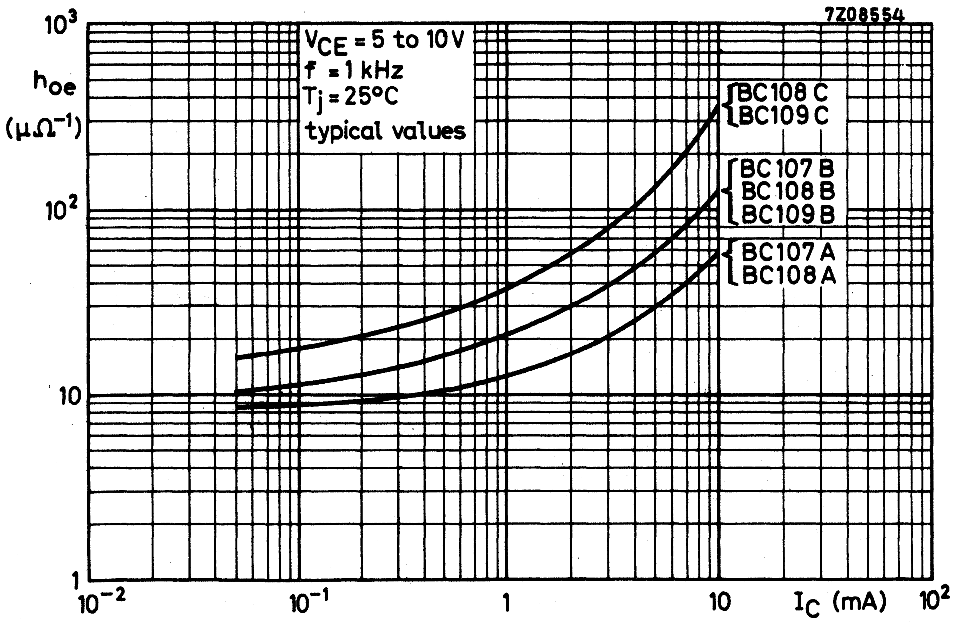

7Z08554
VCE = 5 to 10 V
f = 1 kHz
Tj = 25°C
typical values
hoe
(μΩ⁻¹)
BC108 C
BC109 C
BC107 B
BC108 B
BC109 B
BC107 A
BC108 A
IC (mA)

Fig. 21.

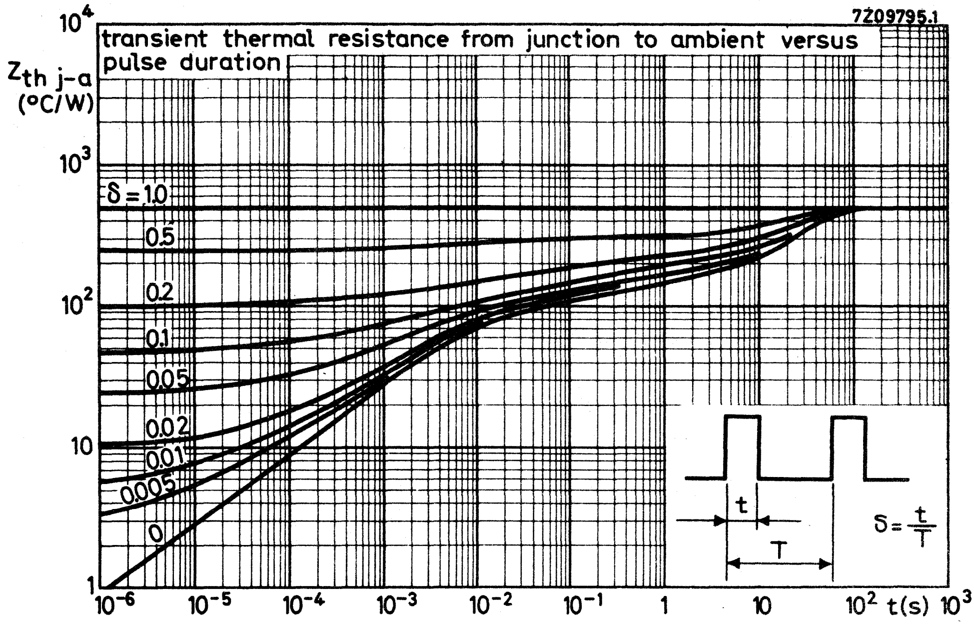

7Z09795.1
transient thermal resistance from junction to ambient versus pulse duration
Zth j-a (°C/W)
10^4
10^3
10^2
10
1
δ = 1.0
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0
t
T
δ = t/T
10^-6
10^-5
10^-4
10^-3
10^-2
10^-1
1
10
10^2
t(s)
10^3

Fig. 22.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in TO-39 metal envelopes for general purpose applications. P-N-P complements are BC160 and BC161.

QUICK REFERENCE DATA

			BC140	BC141	
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	V
Collector current (d.c.)	I_C	max.	1		A
Total power dissipation up to T_{case} = 45 °C	P_{tot}	max.	3,7		W
Junction temperature	T_j	max.	175		°C
Transition frequency at f = 20 MHz I_C = 50 mA; V_{CE} = 10 V	f_T	>	50		MHz

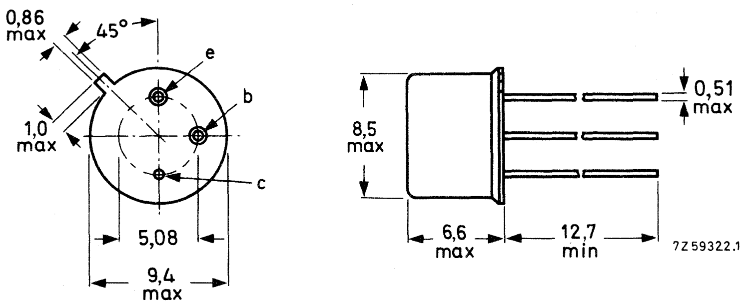
			BC140-10 BC141-10	BC140-16 BC141-16
D.C. current gain I_C = 100 mA; V_{CE} = 1 V	h_{FE}	>	63	100
		<	160	250

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case.



maximum lead diameter is guaranteed only for 12,7 mm.

RATINGS

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

			BC140	BC141	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	7	V
Collector current (d.c.)	I_C	max.	1		A
Base current (d.c.)	I_B	max.	100		mA
Total power dissipation up to T_{case} = 45 °C	P_{tot}	max.	3,7		W
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	175		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	35	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
V_{BE} = 0; V_{CE} = 60 V	I_{CES}	typ.	10	nA
		<	100	nA
V_{BE} = 0; V_{CE} = 60 V; T_{amb} = 150 °C	I_{CES}	typ.	10	μA
		<	100	μA
Base-emitter voltage				
I_C = 1 A; V_{CE} = 1 V	V_{BE}	typ.	1,2	V
		<	1,8	V
Saturation voltage				
I_C = 1 A; I_B = 100 mA	V_{CEsat}	typ.	0,6	V
		<	1,0	V
Transition frequency at f = 20 MHz				
I_C = 50 mA; V_{CE} = 10 V	f_T	>	50	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	<	25	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c$ = 0; V_{EB} = 0,5 V	C_e	<	80	pF

			BC140-10 BC141-10	BC140-16 BC141-16
D.C. current gain				
I_C = 100 μA; V_{CE} = 1 V	h_{FE}	typ.	40	90
		>	63	100
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	typ.	100	160
		<	160	250
I_C = 1 A; V_{CE} = 1 V	h_{FE}	typ.	20	30

CHARACTERISTICS (continued)

T_{amb} = 25 °C

Switching times

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

Turn-on time	t_{on}	<	250 ns
Turn-off time	t_{off}	<	850 ns

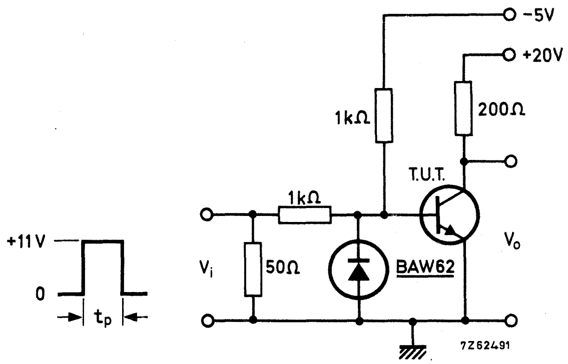


Fig. 2 Test circuit.

Pulse generator:

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

Oscilloscope:

Rise time	t_r	≤ 15 ns
Input impedance	Z_i	≥ 100 kΩ

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in TO-39 metal envelopes for general purpose applications. N-P-N complements are BC140 and BC141.

QUICK REFERENCE DATA

			BC160	BC161	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	V
Collector current (d.c.)	$-I_C$	max.	1		A
Total power dissipation up to T_{case} = 45 °C	P_{tot}	max.	3,7		W
Junction temperature	T_j	max.	175		°C
Transition frequency at f = 20 MHz $-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	>	50		MHz

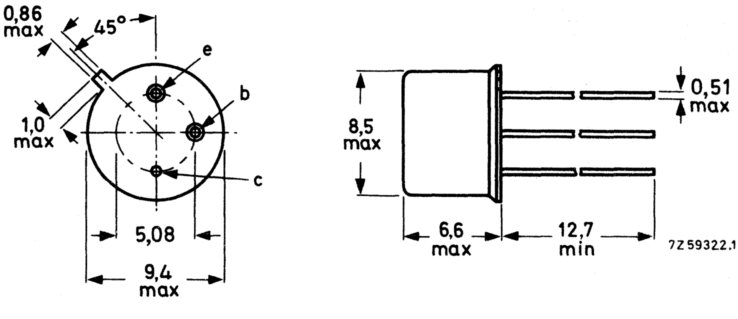
			BC160-10 BC161-10	BC160-16 BC161-16
D.C. current gain $-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}	>	63	100
		<	160	250

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case.



maximum lead diameter is guaranteed only for 12,7 mm.

RATINGS

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

			BC160	BC161	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	60	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	V
Collector current (d.c.)	$-I_C$	max.	1		A
Base current (d.c.)	$-I_B$	max.	100		mA
Total power dissipation up to T_{case} = 45 °C	P_{tot}	max.	3,7		W
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	175		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	35	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specfied

Collector cut-off current $V_{BE} = 0; -V_{CE} = -V_{CEOmax}$	$-I_{CES}$	typ. <	10 100	nA nA
$V_{BE} = 0; -V_{CE} = -V_{CEOmax}$; T_{amb} = 150 °C	$-I_{CES}$	typ. <	10 100	μA μA
Base-emitter voltage $-I_C$ = 1 A; $-V_{CE}$ = 1 V	$-V_{BE}$	typ. <	1,0 1,7	V V
Saturation voltage $-I_C$ = 1 A; $-I_B$ = 100 mA	$-V_{CEsat}$	typ. <	0,6 1,0	V V
Transition frequency at f = 20 MHz $-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	>	50	MHz
Collector capacitance at f = 1 MHz $I_E = I_e = 0; -V_{CB}$ = 10 V	C_c	<	30	pF
Emitter capacitance at f = 1 MHz $I_C = I_c = 0; -V_{EB}$ = 0,5 V	C_e	<	180	pF

			BC160-10 BC161-10	BC160-16 BC161-16
D.C. current gain $-I_C$ = 100 μA; $-V_{CE}$ = 1 V	h_{FE}	typ.	80	120
		>	63	100
$-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}	typ.	100	160
		<	160	250
$-I_C$ = 1 A; $-V_{CE}$ = 1 V	h_{FE}	typ.	20	30

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

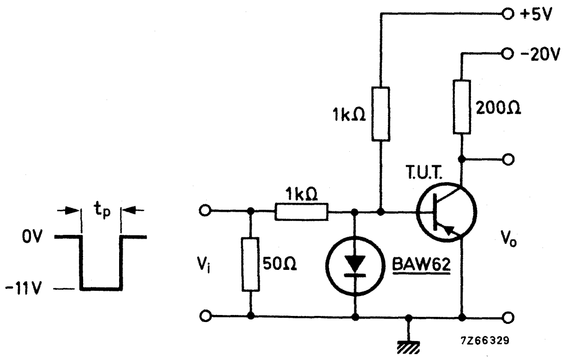


Fig. 2 Test circuit.

Pulse generator:

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

Oscilloscope:

Rise time	t_r	≤	15 ns
Input impedance	Z_i	≥	100 kΩ

A.F. SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in TO-18 metal envelopes with the collector connected to the case.

The **BC177** is a high-voltage type and primarily intended for use in driver stages of audio amplifiers and in signal processing circuits of television receivers.

The **BC178** is suitable for a multitude of low-voltage applications e.g. driver stages or audio preamplifiers and in signal processing circuits of television receivers.

The **BC179** is primarily intended for low-noise input stages in tape recorders, hi-fi amplifiers and other audio-frequency equipment.

Moreover, they are intended as complementary types for the BC107, BC108 and BC109.

QUICK REFERENCE DATA

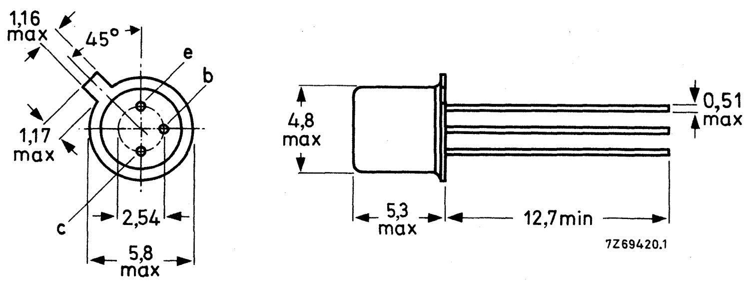
			BC177	BC178	BC179	
Collector-emitter voltage (+ V_{BE} = 1 V)	$-V_{CEX}$	max.	50	30	25	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	25	20	V
Collector current (peak value)	$-I_{CM}$	max.	200	200	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	300	300	mW
Junction temperature	T_j	max.	175	175	175	°C
Small-signal current gain at T_j = 25 °C; $-I_C$ = 2 mA; $-V_{CE}$ = 5 V; f = 1 kHz	h_{fe}	>	75	75	125	
		<	260	500	500	
Transition frequency at f = 35 MHz; $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	150	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	dB
		<	–	–	4,0	dB
f = 1 kHz; B = 200 Hz	F	<	10	10	4,0	dB

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case



Accessories: 56246 (distance disc).

RATINGS

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

			BC177	BC178	BC179	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	30	25	V
Collector-emitter voltage ($+ V_{BE}$ = 1 V)	$-V_{CEX}$	max.	50	30	25	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	25	20	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
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		300		mW
Storage temperature range	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		175		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0,5	K/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0,2	K/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0; -V_{CB} = 20$ V	$-I_{CBO}$	typ.	1	nA
		<	100	nA
T_j = 150 °C	$-I_{CBO}$	<	10	μA
Base-emitter voltage*				
$-I_C = 2$ mA; $-V_{CE} = 5$ V	$-V_{BE}$	typ.	650	mV
			600 to 750	mV
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
	$-V_{BEsat}$	typ.	850	mV
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0; -V_{CB} = 10$ V	C_c	typ.	4,0	pF
Transition frequency at f = 35 MHz				
$-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	150	MHz

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

			BC177	BC178	BC179
Noise figure at $R_S = 2\ k\Omega$					
$-I_C = 200\ \mu A$; $-V_{CE} = 5\ V$					
f = 30 Hz to 15 kHz	F	typ.			1,2 dB
		<			4 dB
f = 1 kHz; B = 200 Hz	F	typ.	2	2	1 dB
		<	10	10	4 dB

			BC177 BC178	BC177A BC178A BC179A	BC177B BC178B BC179B
D.C. current gain $-I_C = 2\ mA$; $-V_{CE} = 5\ V$	h_{FE}	typ.	140	180	290
Small signal current gain at f = 1 kHz $-I_C = 2\ mA$; $-V_{CE} = 5\ V$	h_{fe}	>	125	125	240
		<	500	260	500

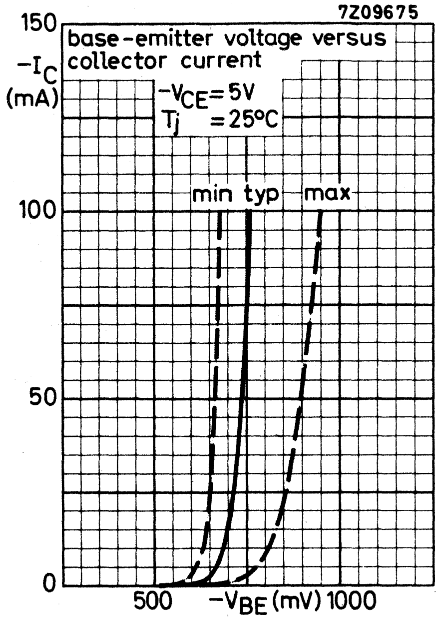


Fig. 2.

Typical behaviour of collector current versus collector-emitter voltage

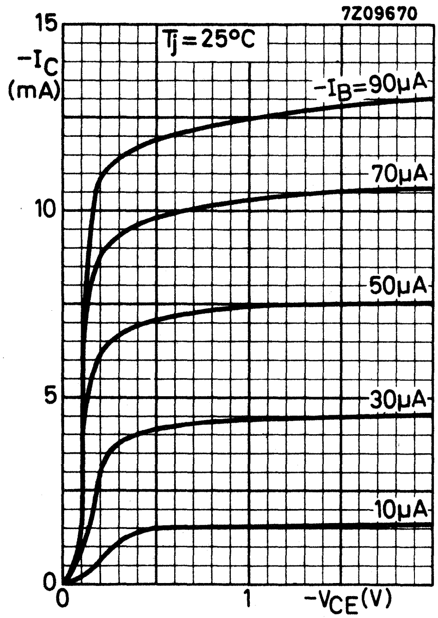


Fig. 3.

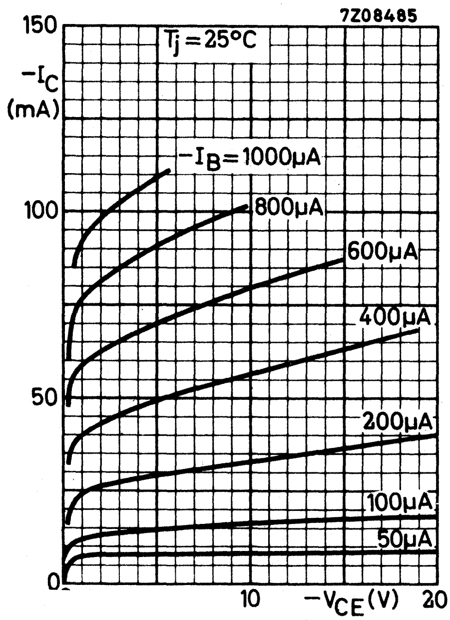


Fig. 4.

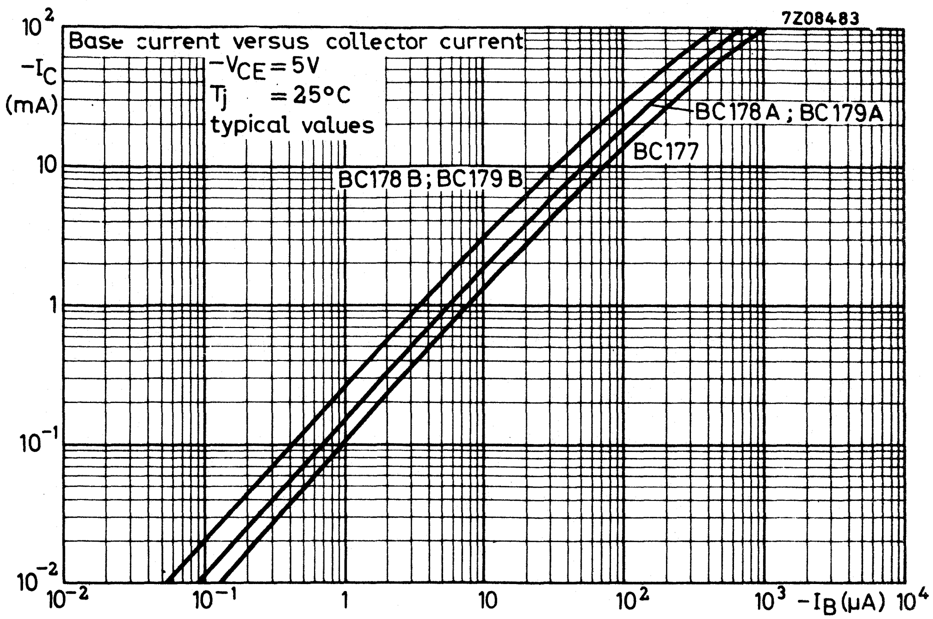

7Z08483
Base current versus collector current
$-V_{CE}$ = 5V
T_j = 25°C
typical values
$-I_C$ (mA)
BC178 A ; BC179A
BC177
BC178 B ; BC179 B
10^2
10
1
10^{-1}
10^{-2}
10^{-2}
10^{-1}
1
10
10^2
10^3
$-I_B$ (μA)
10^4

Fig. 5.

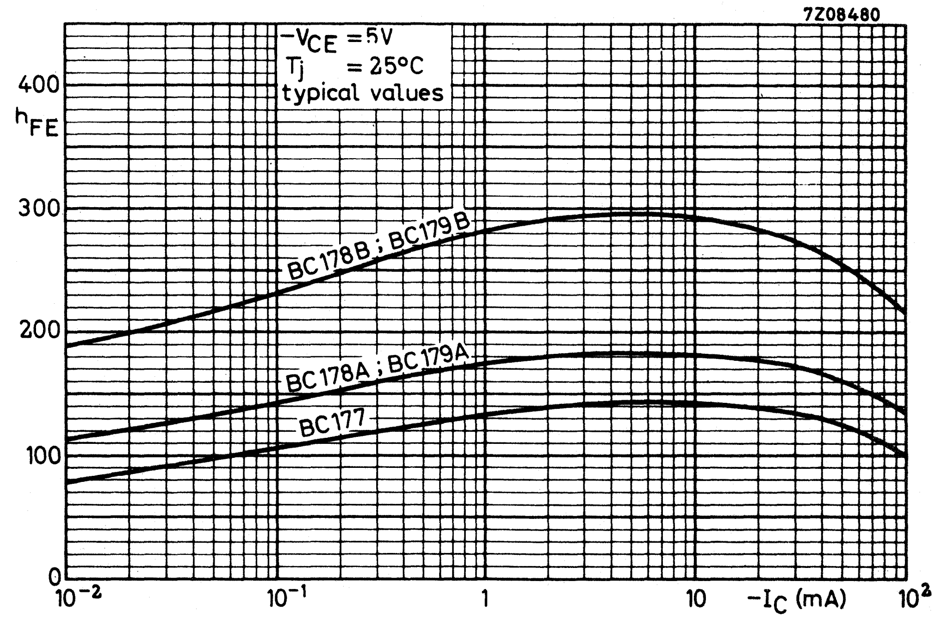

7Z08480
$-V_{CE}$ = 5V
T_j = 25°C
typical values
h_{FE}
400
300
200
100
0
BC178B ; BC179B
BC178A ; BC179A
BC177
10^{-2}
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 6.

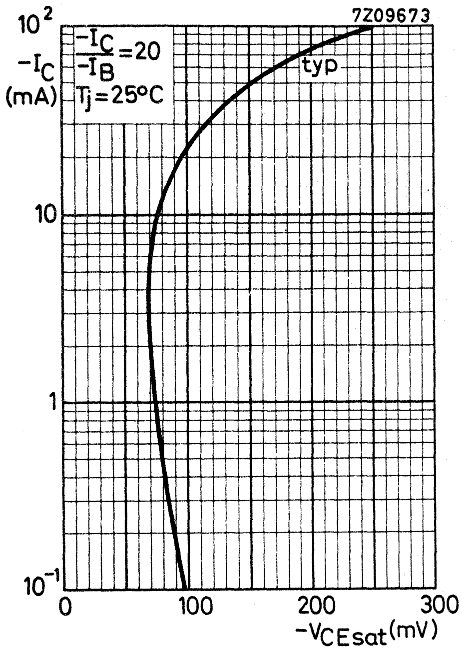


Fig. 7.

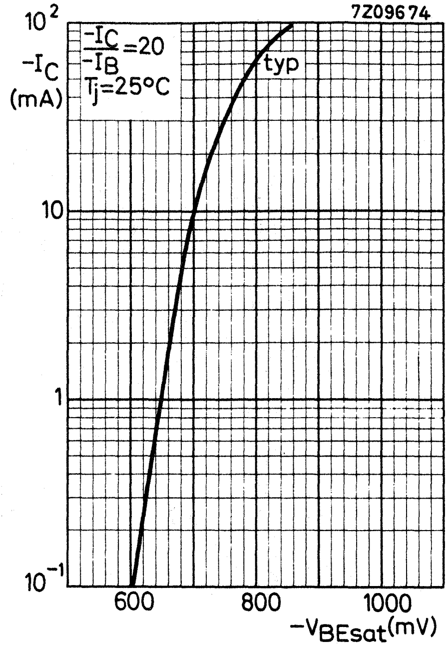


Fig. 8.

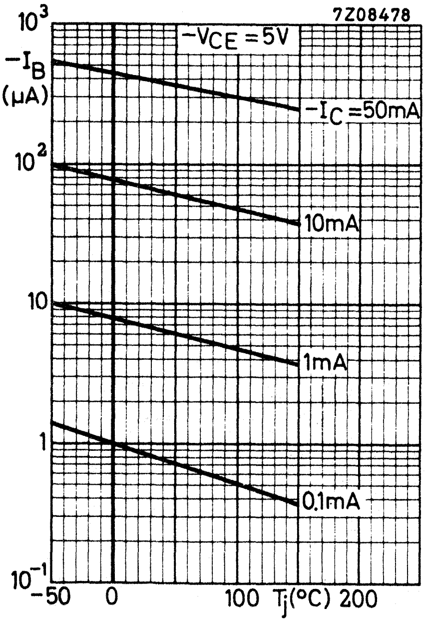


Fig. 9.

Typical behaviour of base current versus junction temperature.

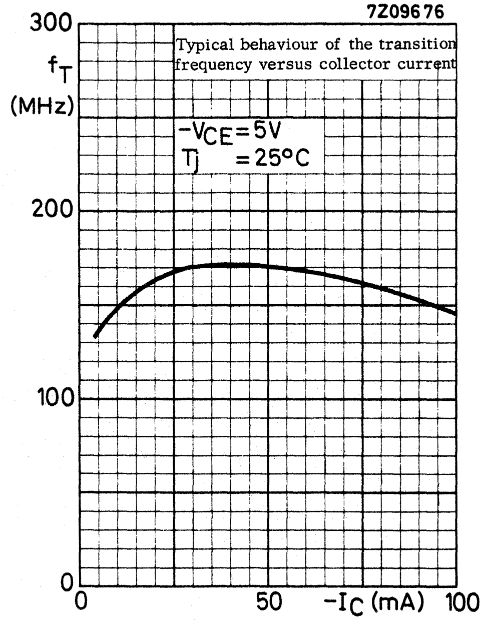


Fig. 10.

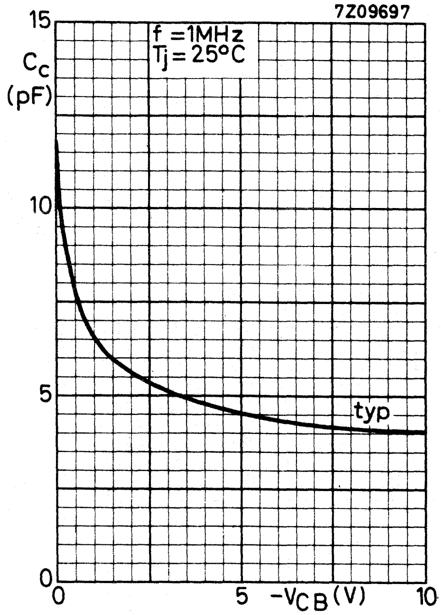

7Z09697
f = 1MHz
Tj = 25°C
Cc
(pF)
15
10
5
0
typ
0
5
-VCB (V)
10

Fig. 11.

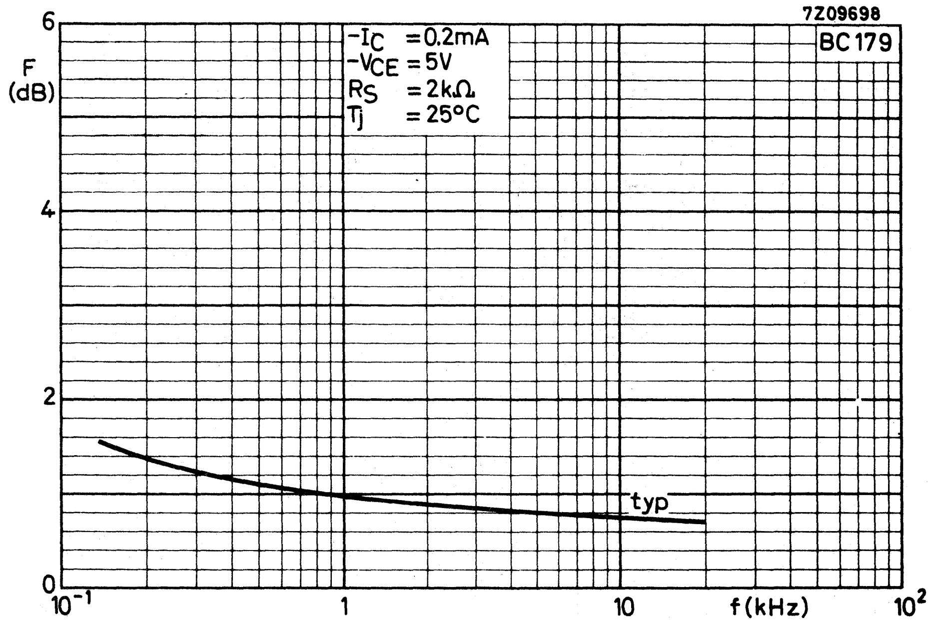

7Z09698
BC179
-IC = 0.2mA
-VCE = 5V
RS = 2kΩ
Tj = 25°C
F
(dB)
6
4
2
0
typ
10-1
1
10
f (kHz)
102

Fig. 12.

Curves of constant noise figure

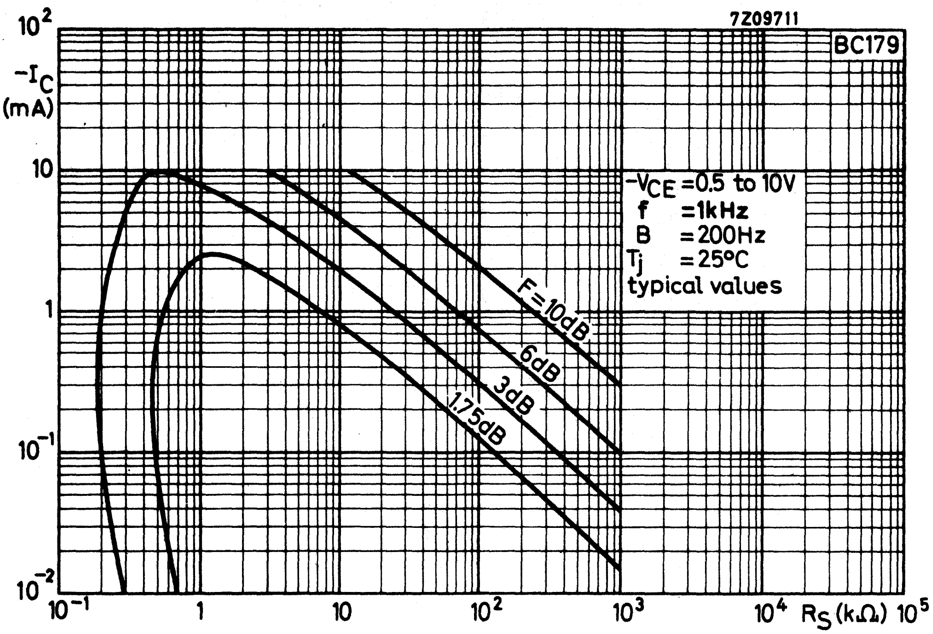


Fig. 13.

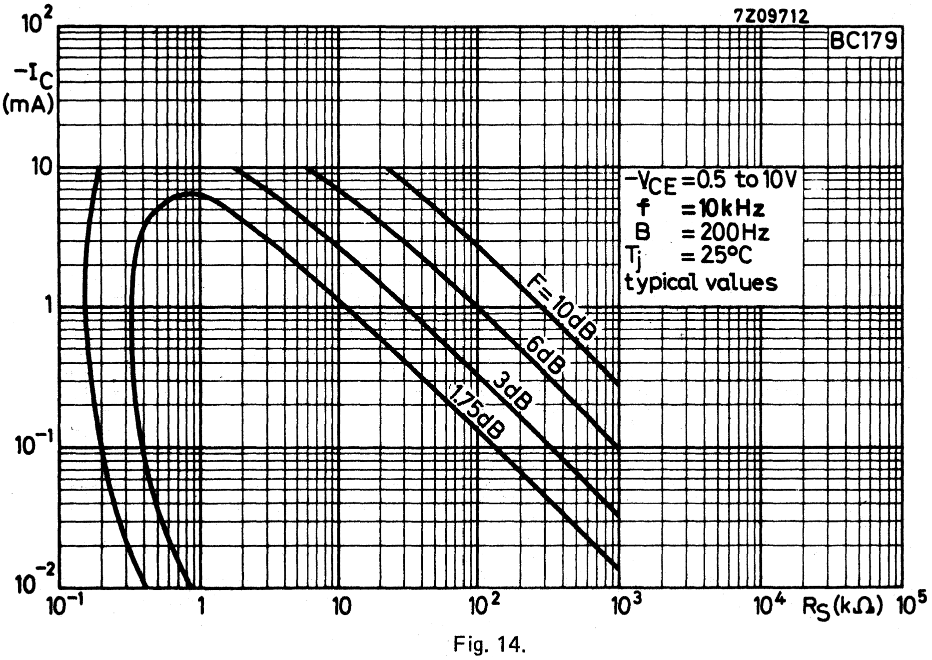


Fig. 14.

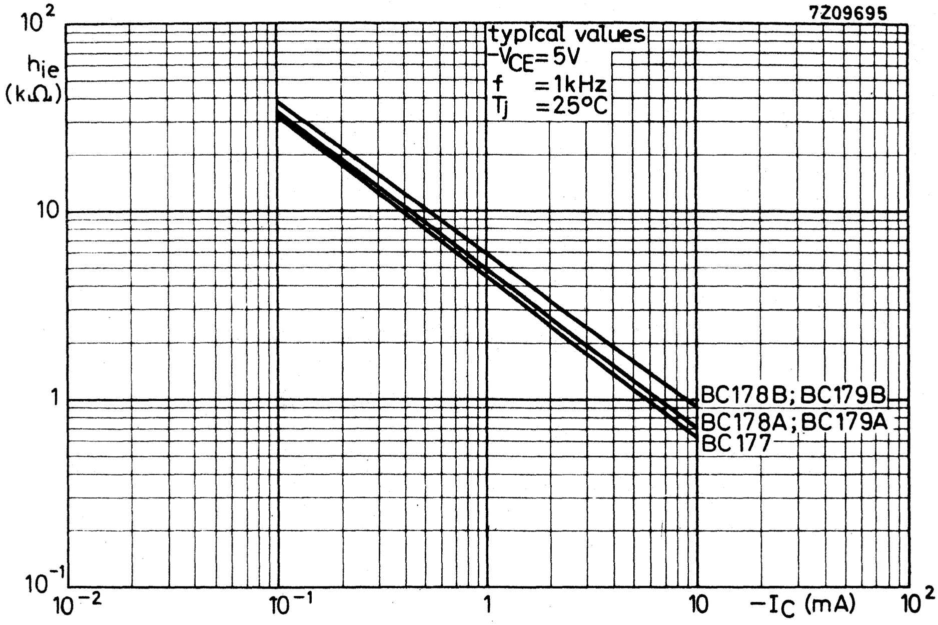

7Z09695
typical values
$-V_{CE}$ = 5V
f = 1kHz
T_j = 25°C
h_{ie} (kΩ)
10^2
10
1
10^{-1}
10^{-2}
10^{-1}
1
10
$-I_C$ (mA)
10^2
BC178B; BC179B
BC178A; BC179A
BC177

Fig. 15.

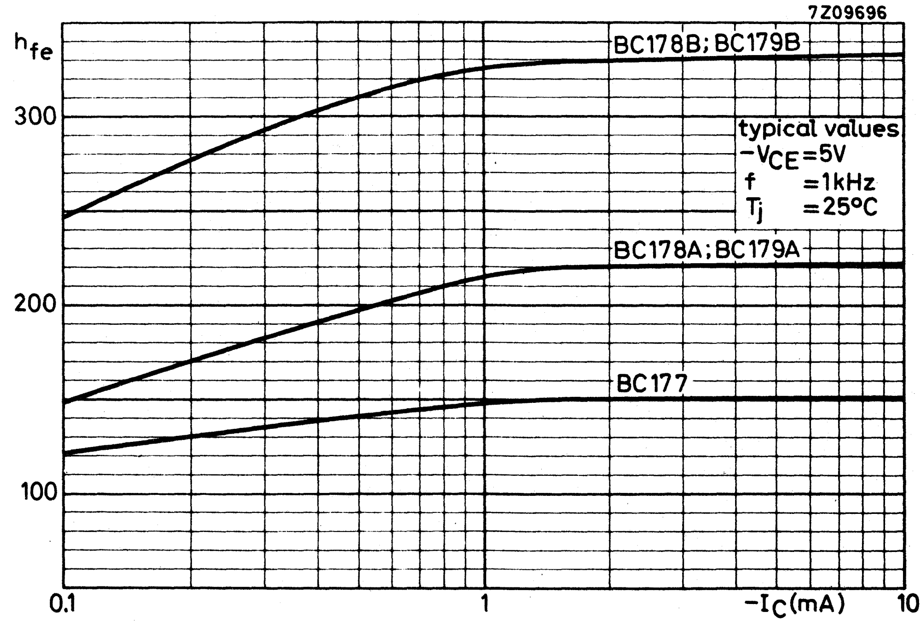

7Z09696
h_{fe}
300
200
100
0.1
1
$-I_C$(mA)
10
BC178B; BC179B
typical values
$-V_{CE}$ = 5V
f = 1kHz
T_j = 25°C
BC178A; BC179A
BC177

Fig. 16.

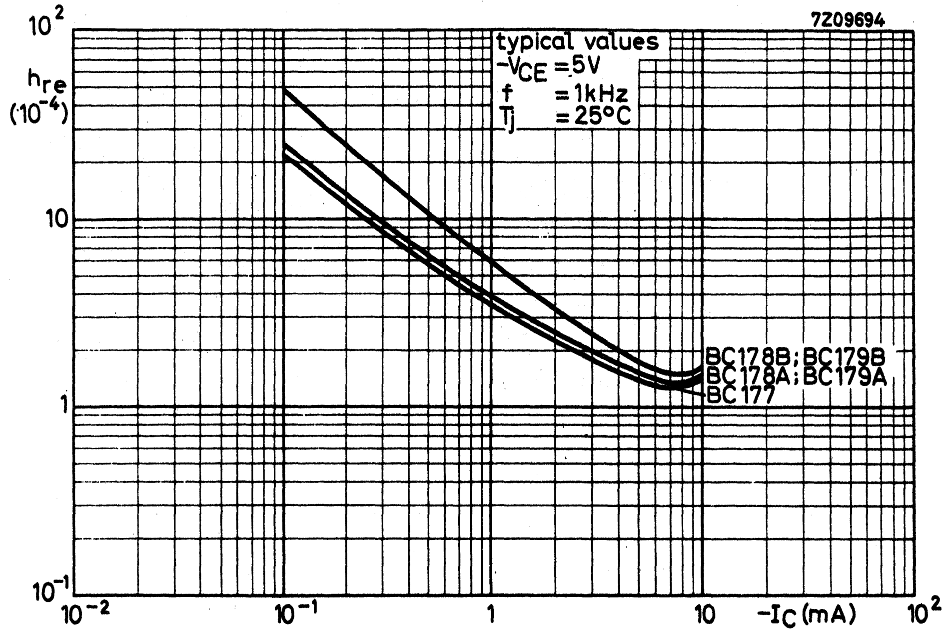

7Z09694
typical values
$-V_{CE}$ = 5V
f = 1kHz
T_j = 25°C
h_{re}
(10^{-4})
10^2
10
1
10^{-1}
10^{-2}
10^{-1}
1
10
$-I_C$ (mA)
10^2
BC178B; BC179B
BC178A; BC179A
BC177

Fig. 17.

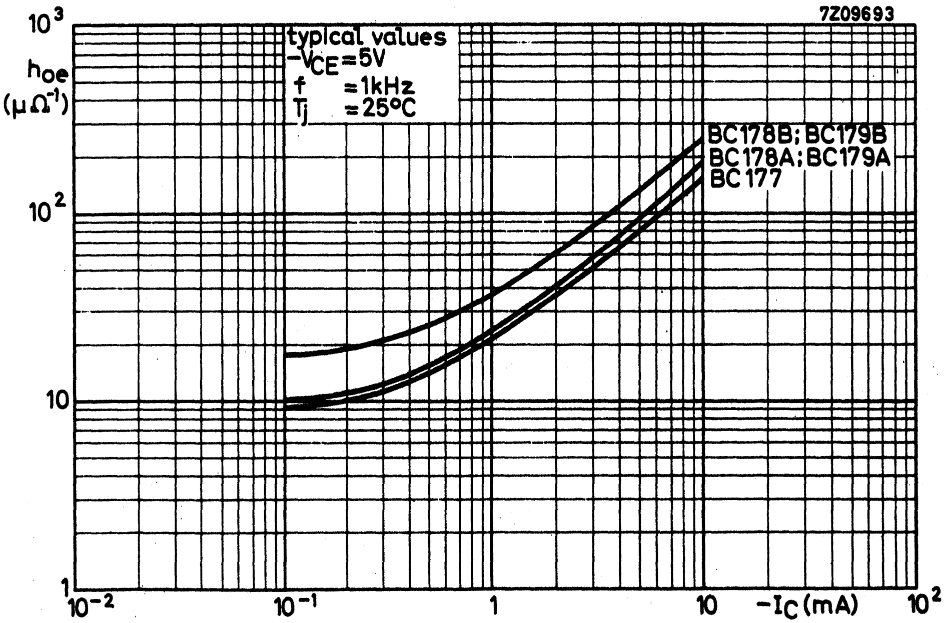

7Z09693
typical values
$-V_{CE}$ = 5V
f = 1kHz
T_j = 25°C
h_{oe}
($\mu\Omega^{-1}$)
10^3
10^2
10
1
10^{-2}
10^{-1}
1
10
$-I_C$ (mA)
10^2
BC178B; BC179B
BC178A; BC179A
BC177

Fig. 18.

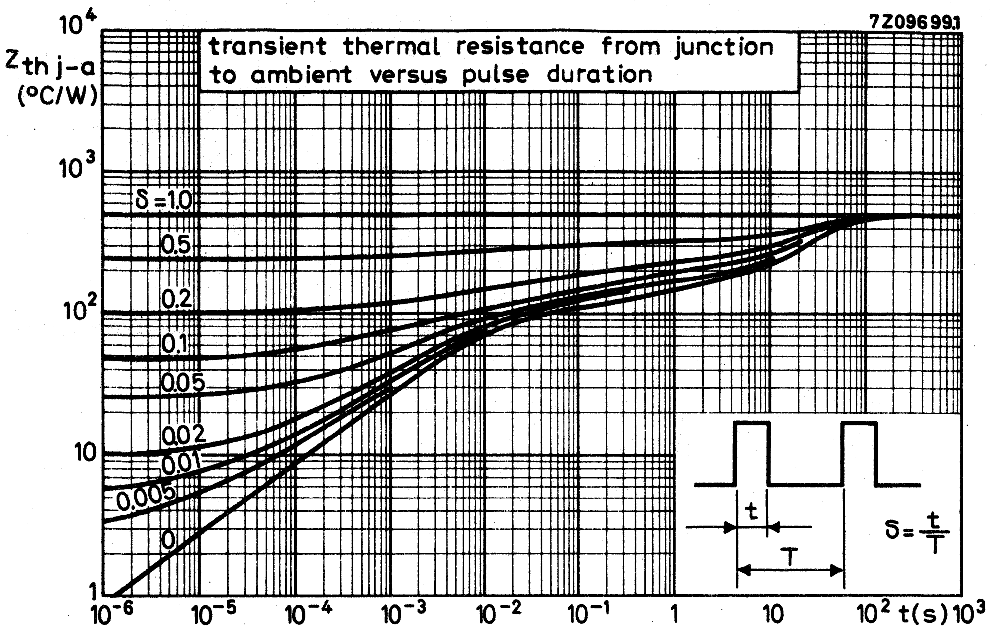

7Z09699.1
transient thermal resistance from junction to ambient versus pulse duration
$Z_{th\ j-a}$ (°C/W)
10^4
10^3
10^2
10
1
δ = 1.0
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t(s)
10^3
t
T
$\delta = \frac{t}{T}$

Fig. 19.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in plastic TO-92 envelopes, primarily intended for use in driver and output stages of audio amplifiers.

The BC327, BC327A, BC328 are complementary to the BC337, BC337A and BC338 respectively.

QUICK REFERENCE DATA

			BC327	BC327A	BC328	
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	50	60	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	25	V
Collector current (peak value)	$-I_{CM}$	max.		1000		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		800		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.		100		MHz
D.C. current gain $-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}			100 to 600		

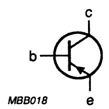
MECHANICAL DATA

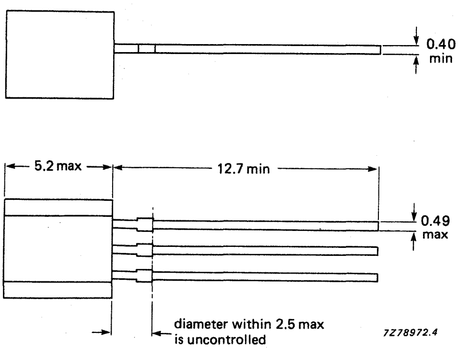
Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector





RATINGS

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

			BC327	BC327A	BC328	
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	50	60	30	V
Collector-emitter voltage (open base) $-I_C$ = 10 mA	$-V_{CEO}$	max.	45	60	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	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} = 25 °C	P_{tot}	max.		625		mW
up to T_{amb} = 25 °C	P_{tot}	max.		800		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	$R_{th\ j\text{-}a}$	=	0,2	K/mW
From junction to ambient	$R_{th\ j\text{-}a}$	=	0,156	K/mW*

* Transistor mounted on printed circuit board, max. lead length 4 mm, mounting pad for collector lead min. 10 mm x 10 mm.

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; BC327; BC328	h_{FE}	100 to 600		
BC327A	h_{FE}	100 to 400		
BC327-16, BC328-16	h_{FE}	100 to 250		
BC327-25, BC328-25	h_{FE}	160 to 400		
BC327-40, BC328-40	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

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

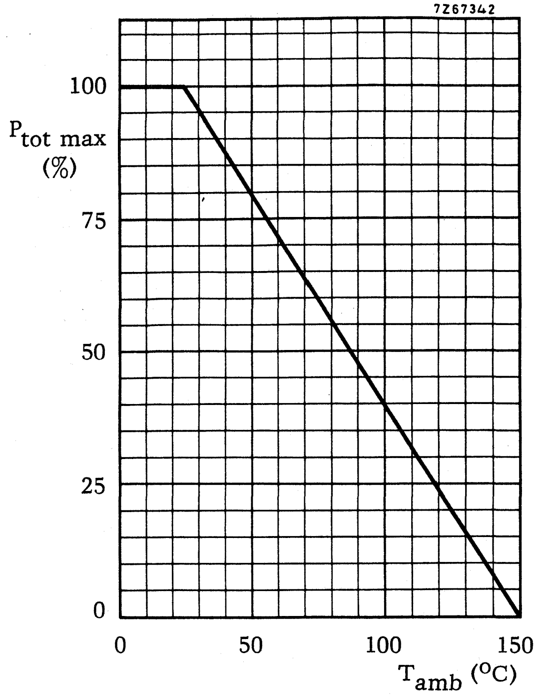

7Z67342
100
$P_{tot\ max}$ (%)
75
50
25
0
0
50
100
150
T_{amb} (°C)

Fig. 2.

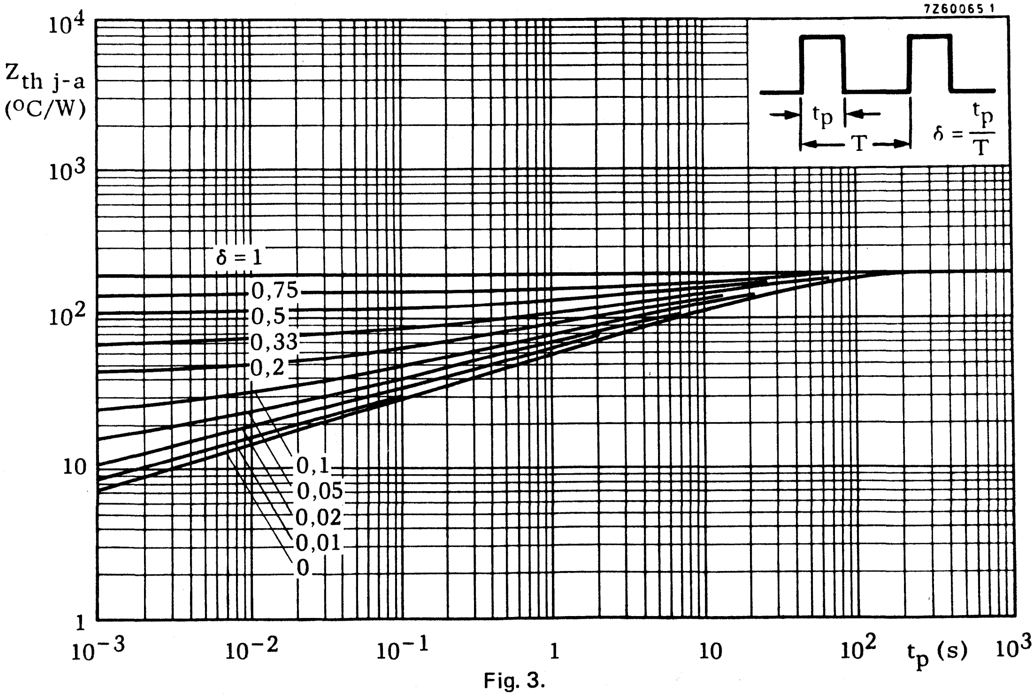

7Z60065 1
10^4
$Z_{th\ j\text{-}a}$ (°C/W)
10^3
10^2
10
1
t_p
T
$\delta = \frac{t_p}{T}$
δ = 1
0,75
0,5
0,33
0,2
0,1
0,05
0,02
0,01
0
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t_p (s)
10^3

Fig. 3.

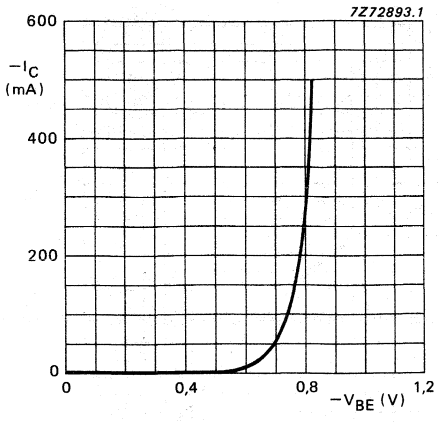


Fig. 4 $-V_{CE}$ = 1 V; T_j = 25 °C; typical values.

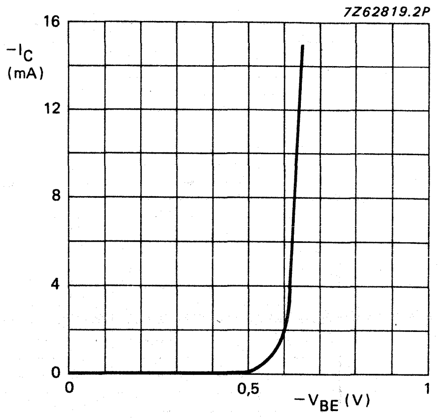


Fig. 5 $-V_{CE}$ = 5 V; T_j = 25 °C; typical values.

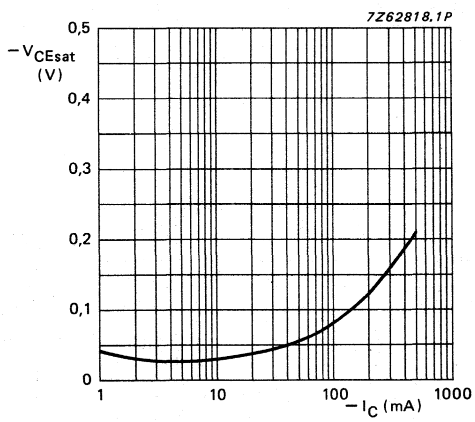


Fig. 6 I_C/I_B = 10; T_j = 25 °C; typical values.

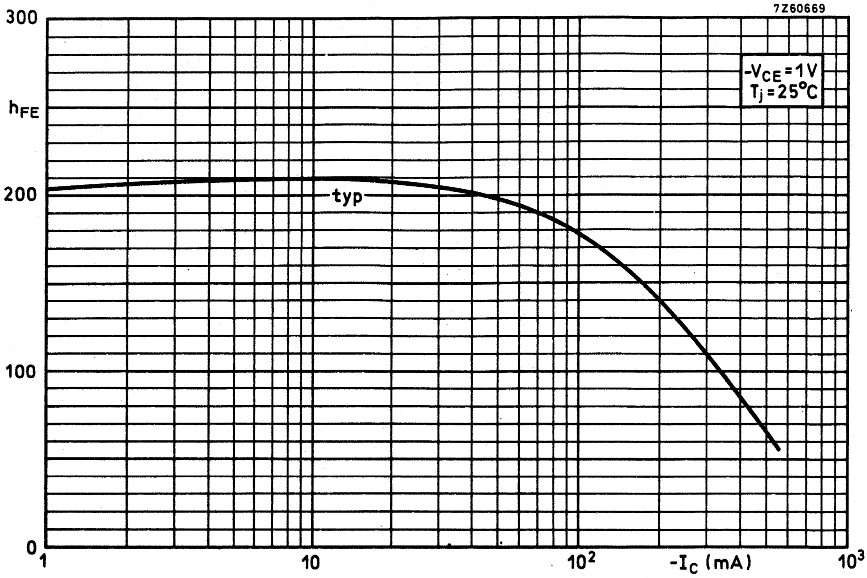

7Z60669
300
h_{FE}
200
100
0
1
10
10^2
$-I_C$ (mA)
10^3
$-V_{CE}$ = 1 V
T_j = 25 °C
typ

Fig. 7.

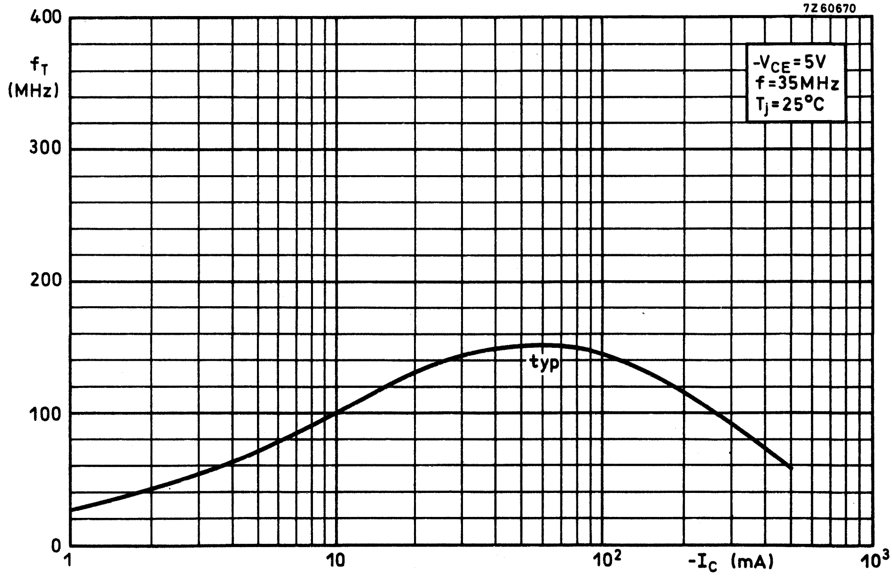

7Z60670
400
f_T
(MHz)
300
200
100
0
1
10
10^2
$-I_C$ (mA)
10^3
$-V_{CE}$ = 5 V
f = 35 MHz
T_j = 25 °C
typ

Fig. 8.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in piastic TO-92 envelopes, primarily intended for use in driver and output stages of audio amplifiers.

The BC337, BC337A, BC338 are complementary to the BC327, BC327A and BC328 respectively.

QUICK REFERENCE DATA

			BC337	BC337A	BC338	
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	50	60	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	25	V
Collector current (peak value)	I_{CM}	max.		1000		mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.		800		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
D.C. current gain $I_C = 100$ mA; $V_{CE} = 1$ V	h_{FE}			100 to 600		

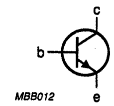
MECHANICAL DATA

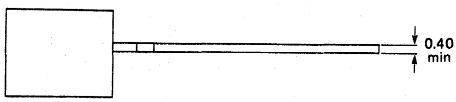
Dimensions in mm

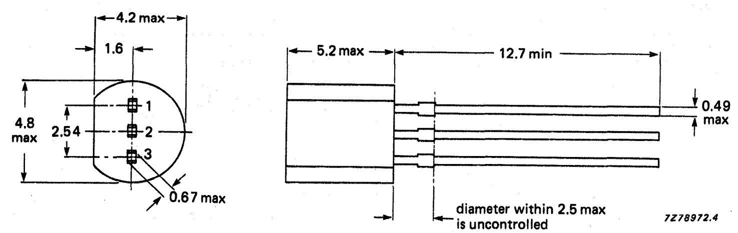
Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector







RATINGS

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

			BC337	BC337A	BC338	
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	50	60	30	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	45	60	25	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	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} = 25 °C	P_{tot}	max.		625		mW
up to T_{amb} = 25 °C	P_{tot}	max.		800		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	$R_{th\ j\text{-}a}$	=	0,2	K/mW
From junction to ambient	$R_{th\ j\text{-}a}$	=	0,156	K/mW*

* Transistor mounted on printed circuit board, max. lead length 4 mm, mounting pad for collector lead min. 10 mm x 10 mm.

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; BC337; BC338	h_{FE}		100 to 600
BC337A	h_{FE}		100 to 400
BC337-16, BC338-16	h_{FE}		100 to 250
BC337-25, BC338-25	h_{FE}		160 to 400
BC337-40, BC338-40	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.	5 pF

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

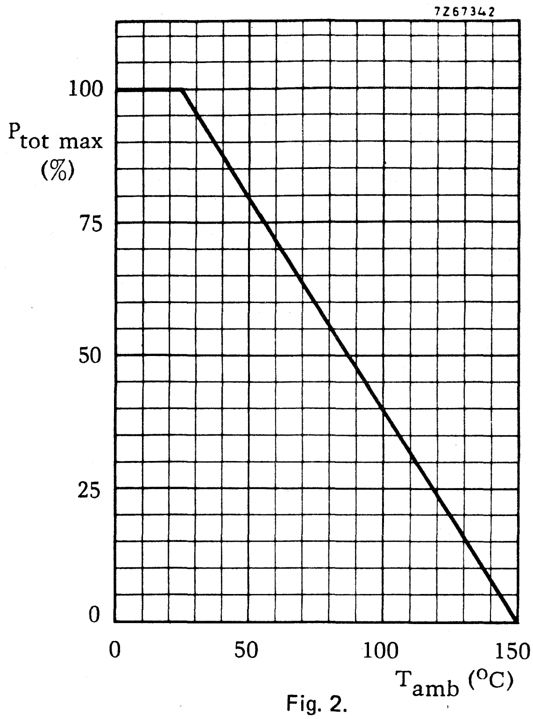

7Z67342
100
$P_{tot\ max}$ (%)
75
50
25
0
0
50
100
150
T_{amb} (°C)

Fig. 2.

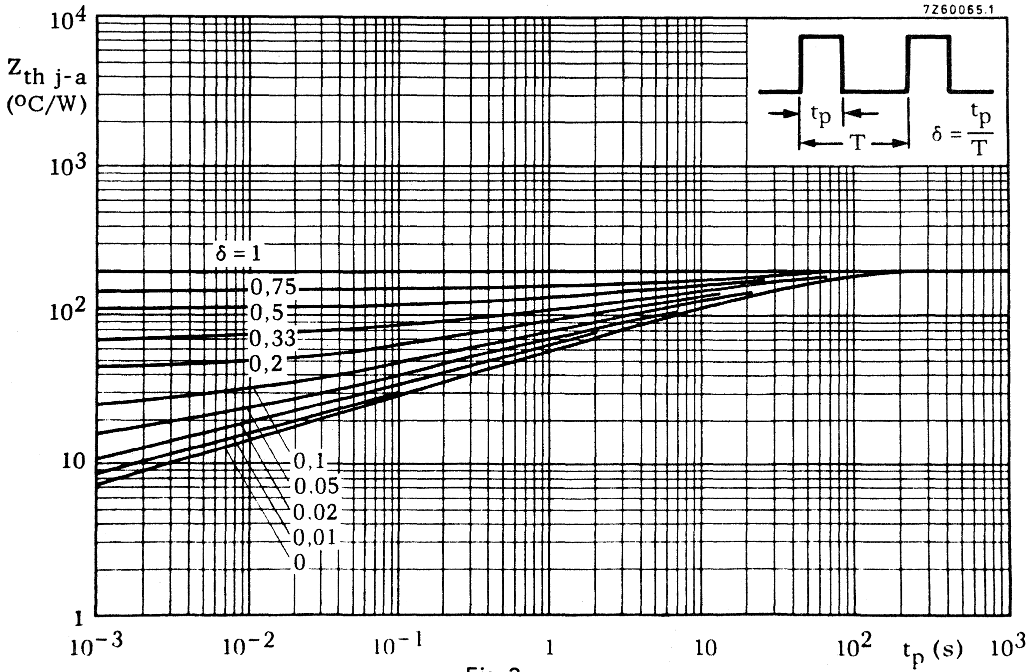

7Z60065.1
10^4
$Z_{th\ j-a}$ (°C/W)
10^3
10^2
10
1
δ = 1
0,75
0,5
0,33
0,2
0,1
0.05
0.02
0,01
0
t_p
T
$\delta = \frac{t_p}{T}$
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t_p (s)
10^3

Fig. 3.

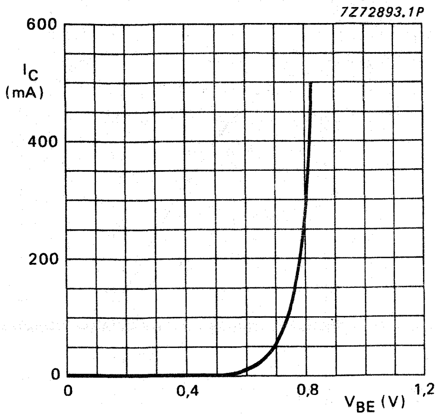


Fig. 4 V_{CE} = 1 V; T_j = 25 °C; typical values.

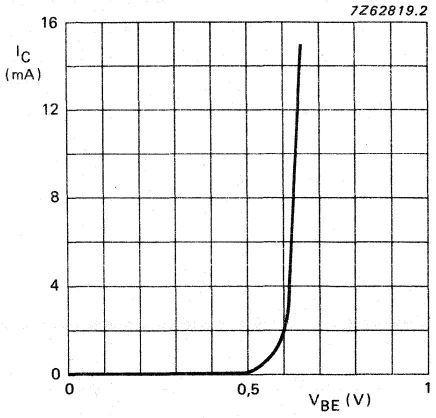


Fig. 5 V_{CE} = 5 V; T_j = 25 °C; typical values.

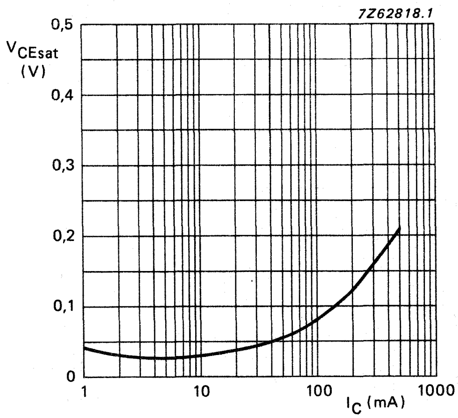


Fig. 6 I_C/I_B = 10; T_j = 25 °C; typical values.

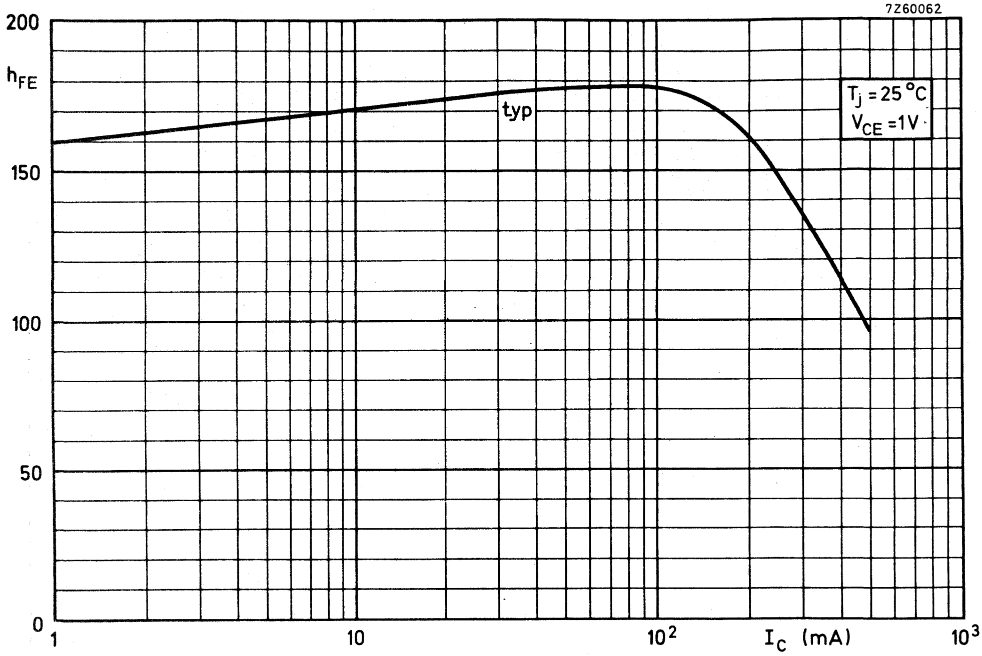


Fig. 7.

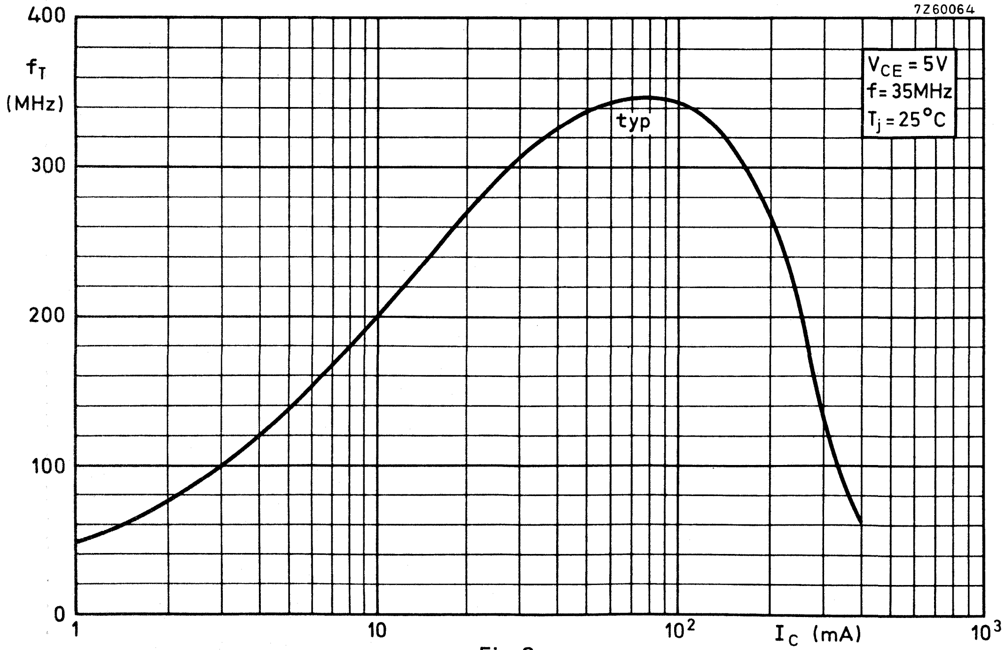


Fig. 8.

APPLICATION INFORMATION, see BC327; BC328.

SILICON PLANAR EPITAXIAL TRANSISTOR

NPN transistor in a plastic TO-92 envelope, intended for low-voltage, high current LF applications. BC368/BC369 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
DC 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	min.	40	MHz

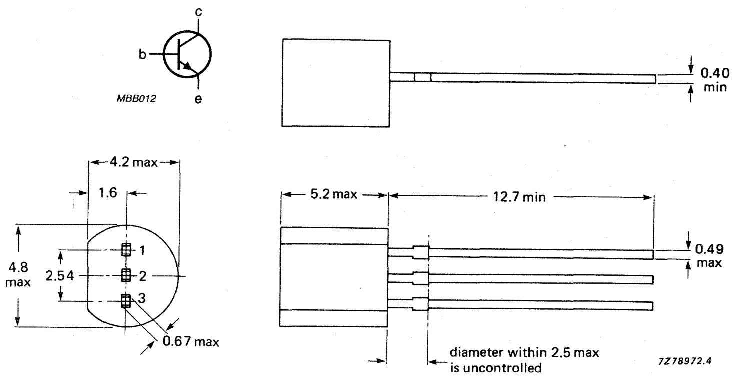
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



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 (DC)	I_C	max.	1	A
Collector current (peak value)	I_{CM}	max.	2	A
Base current (DC)	I_B	max.	100	mA
Base current (peak value)	I_{BM}	max.	200	mA
Total power dissipation				
at T_{amb} = 25 °C (in free air)	P_{tot}	max.	0,8	W
up to T_{amb} = 25 °C*	P_{tot}	max.	1	W
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	156	K/W
From junction to ambient*	$R_{th\ j\text{-}a}$	=	125	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	60	K/W

* Transistor mounted on printed-circuit board, maximum lead length 4 mm, mounting pad for collector lead min. 10 mm x 10 mm.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 25$ V	I_{CBO}	max.	10	μA
$I_E = 0$; $V_{CB} = 25$ V; $T_j = 150$ °C	I_{CBO}	max.	1	mA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	10	μA
Base-emitter voltage				
$I_C = 5$ mA; $V_{CE} = 10$ V	V_{BE}	max.	0.7	V
$I_C = 1$ A; $V_{CE} = 1$ V	V_{BE}	max.	1	V
Collector-emitter saturation voltage				
$I_C = 1$ A; $I_B = 100$ mA	V_{CEsat}	max.	0.5	V
DC current gain				
$I_C = 5$ mA; $V_{CE} = 10$ V	h_{FE}	min.	85 to 375	
$I_C = 500$ mA; $V_{CE} = 1$ V	h_{FE}		85 to 375	
$I_C = 1$ A; $V_{CE} = 1$ V	h_{FE}	min.	60	
Collector capacitance at f = 450 kHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	max.	40	pF
Transition frequency at f = 35 MHz				
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	min.	40	MHz

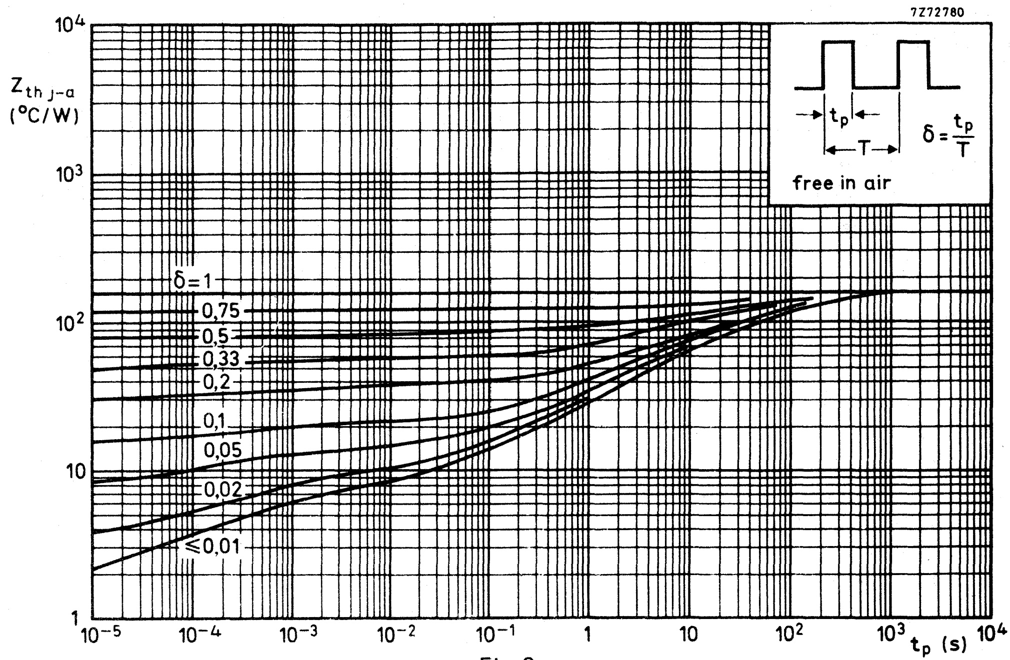

7Z72780
$Z_{th\ j-a}$ (°C/W)
10^4
10^3
10^2
10
1
$\delta = \frac{t_p}{T}$
t_p
T
free in air
δ = 1
0,75
0,5
0,33
0,2
0,1
0,05
0,02
≤0,01
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
10^4
t_p (s)

Fig. 2.

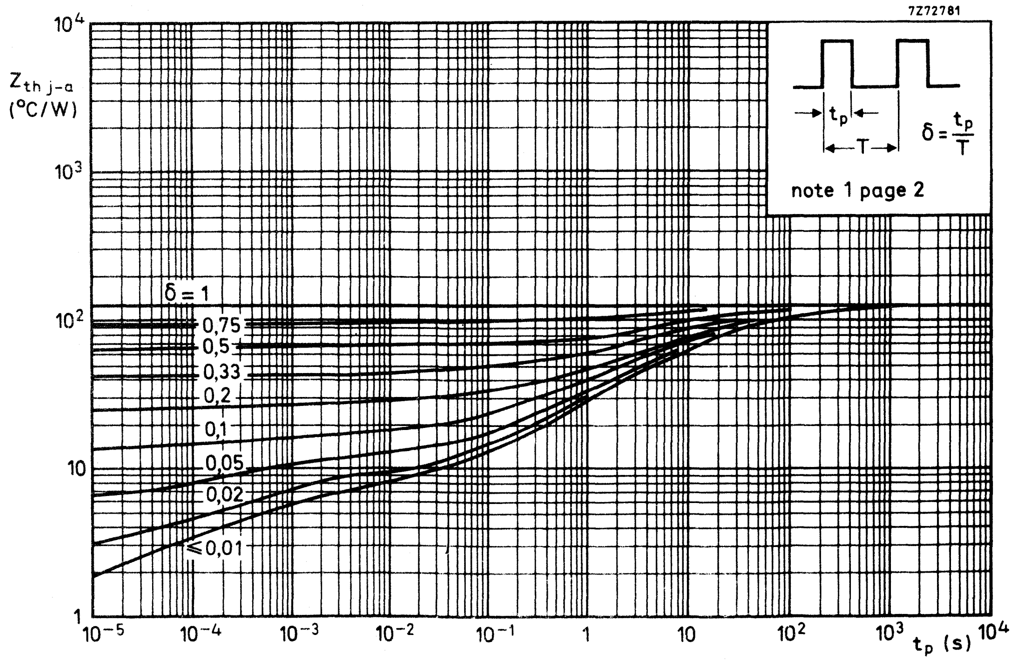

7Z72781
$Z_{th\ j-a}$ (°C/W)
10^4
10^3
10^2
10
1
$\delta = \frac{t_p}{T}$
t_p
T
note 1 page 2
δ = 1
0,75
0,5
0,33
0,2
0,1
0,05
0,02
≤0,01
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
10^4
t_p (s)

Fig. 3.

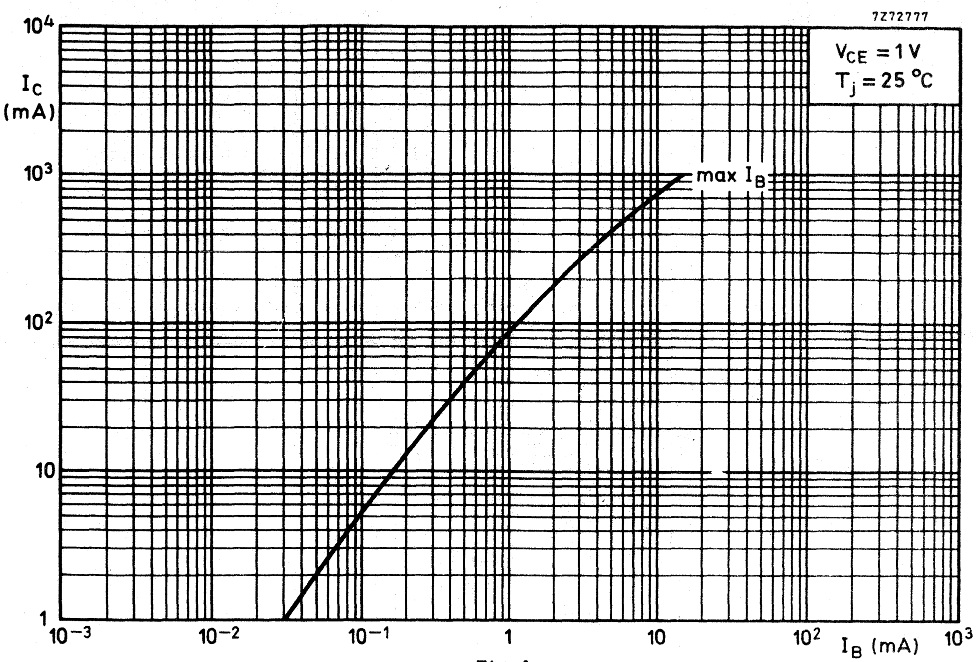

7Z72777
V_{CE} = 1 V
T_j = 25 °C
I_C (mA)
10^4
10^3
10^2
10
1
max I_B
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
I_B (mA)

Fig. 4.

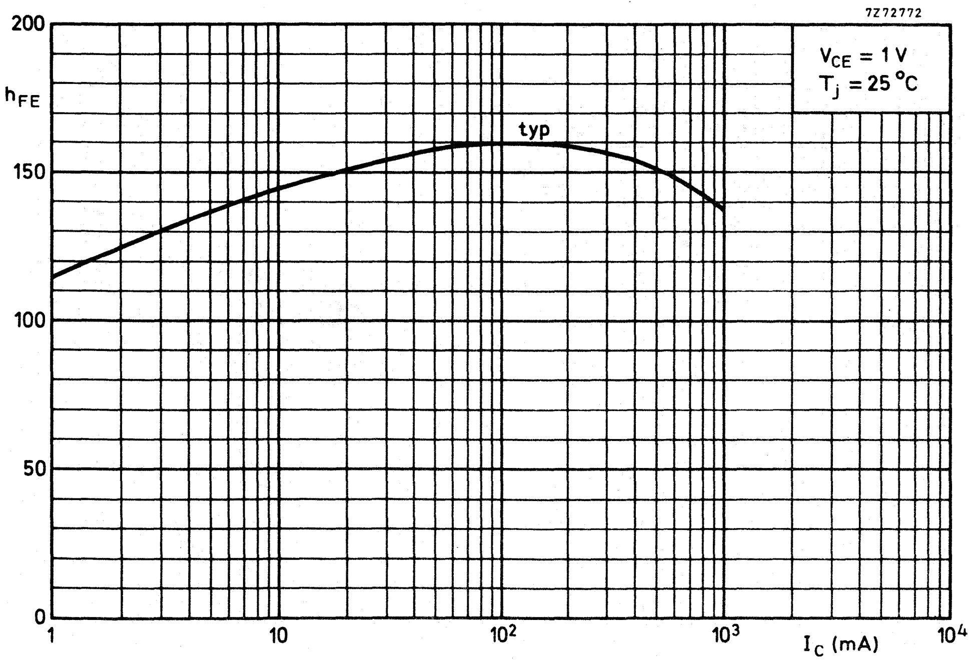

7Z72772
V_{CE} = 1 V
T_j = 25 °C
h_{FE}
200
150
100
50
0
typ
1
10
10^2
10^3
10^4
I_C (mA)

Fig. 5.

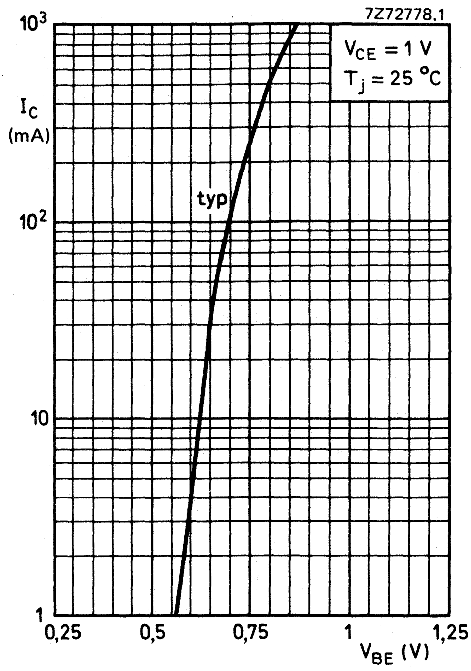


Fig. 6.

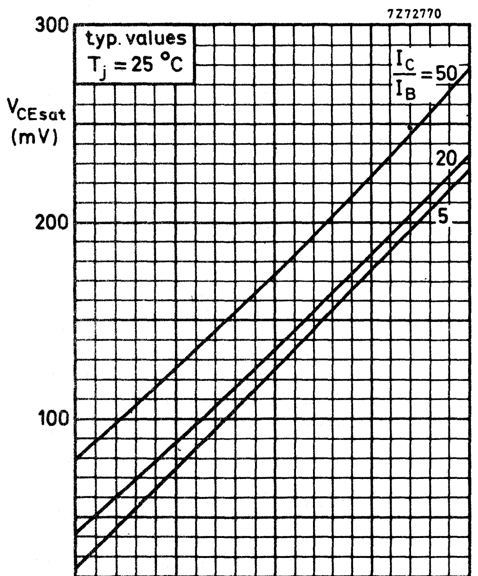


Fig. 7.

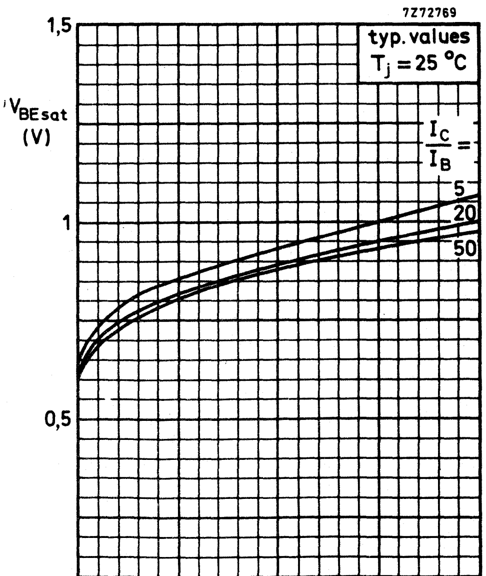


Fig. 8.

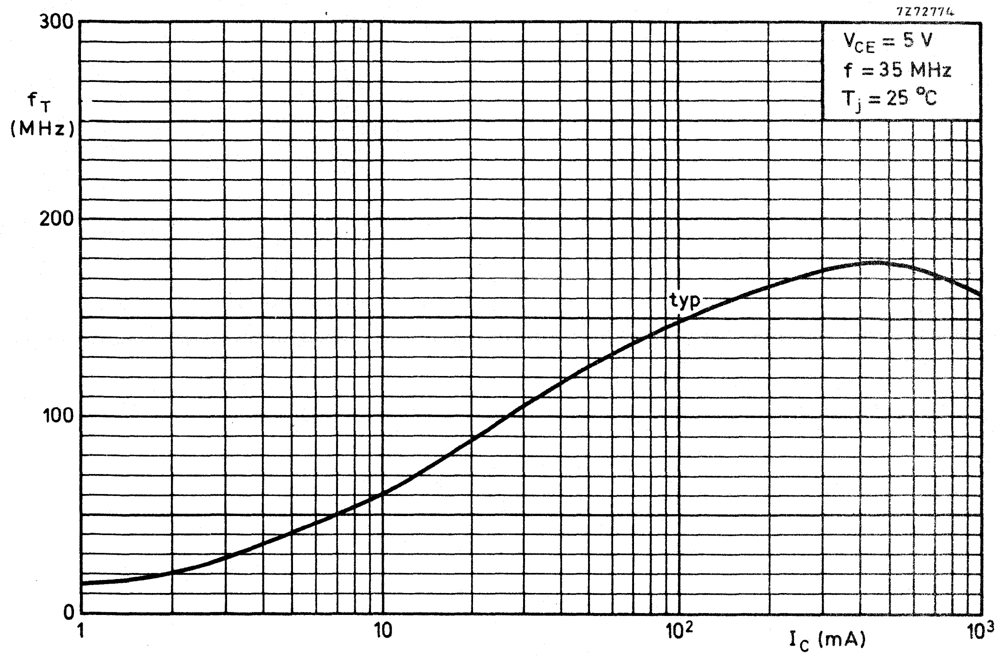

7Z72774
V_{CE} = 5 V
f = 35 MHz
T_j = 25 °C
f_T (MHz)
300
200
100
0
typ
1
10
10^2
10^3
I_C (mA)

Fig. 9.

SILICON PLANAR EPITAXIAL TRANSISTOR

PNP transistor in a plastic TO-92 envelope, intended for low-voltage, high-current LF applications. BC368/BC369 is the matched complementary pair suitable for class-B 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
DC 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	min.	40	MHz

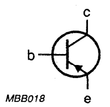
MECHANICAL DATA

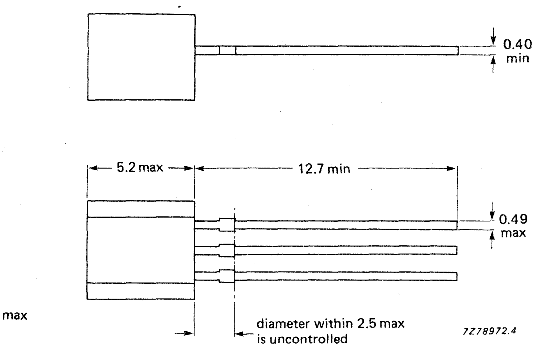
Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector





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 (DC)	$-I_C$	max.	1	A
Collector current (peak value)	$-I_{CM}$	max.	2	A
Base current (DC)	$-I_B$	max.	100	mA
Base current (peak value)	$-I_{BM}$	max.	200	mA
Total power dissipation				
at T_{amb} = 25 °C (in free air)	P_{tot}	max.	0,8	W
up to T_{amb} = 25 °C*	P_{tot}	max.	1	W
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	156	K/W
From junction to ambient*	$R_{th\ j\text{-}a}$	=	125	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	60	K/W

* Transistor mounted on printed-circuit board, maximum lead length 4 mm, mounting pad for collector lead min. 10 mm x 10 mm.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0; -V_{CB} = 25$ V	$-I_{CBO}$	max.	10	μA
$I_E = 0; -V_{CB} = 25$ V; $T_j = 150$ °C	$-I_{CBO}$	max.	1	mA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	max.	10	μA
Base-emitter voltage				
$-I_C = 5$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	max.	0.7	V
$-I_C = 1$ A; $-V_{CE} = 1$ V	$-V_{BE}$	max.	1	V
Collector-emitter saturation voltage				
$-I_C = 1$ A; $-I_B = 100$ mA	$-V_{CEsat}$	max.	0.5	V
DC current gain				
$-I_C = 5$ mA; $-V_{CE} = 10$ V	h_{FE}	min.	50	
$-I_C = 500$ mA; $-V_{CE} = 1$ V	h_{FE}		85 to 375	
$-I_C = 1$ A; $-V_{CE} = 1$ V	h_{FE}	min.	60	
Collector capacitance at f = 450 kHz				
$I_E = I_e = 0; -V_{CB} = 5$ V	C_c	max.	60	pF
Transition frequency at f = 35 MHz				
$-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	min.	40	MHz

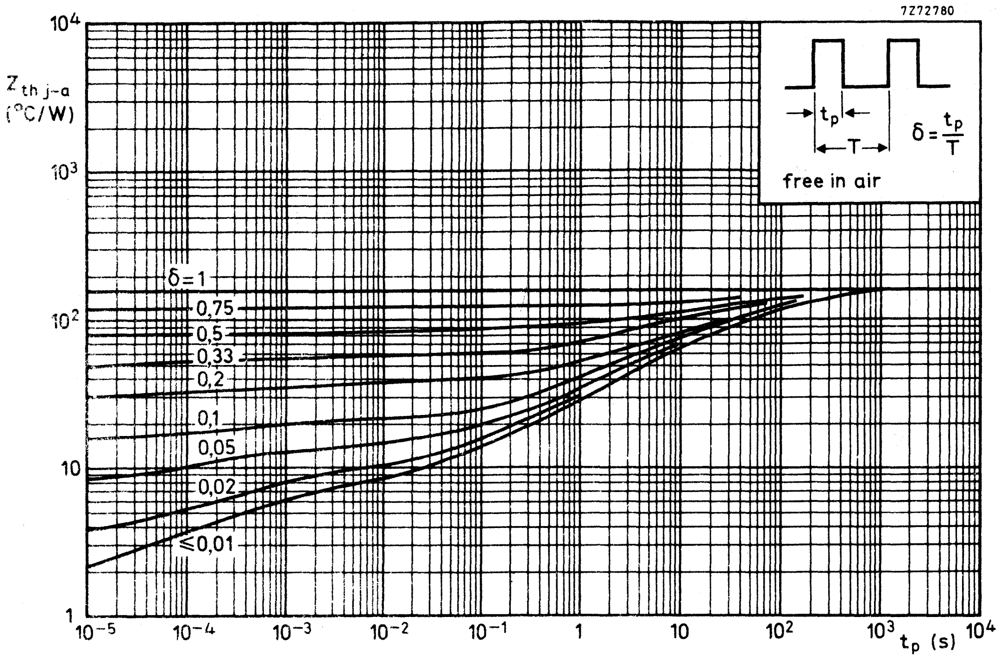

7Z72780
$Z_{th\ j-a}$
(°C/W)
10^4
10^3
10^2
10
1
$\delta = 1$
0,75
0,5
0,33
0,2
0,1
0,05
0,02
≤0,01
t_p
T
$\delta = \frac{t_p}{T}$
free in air
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
10^4
t_p (s)

Fig. 2.

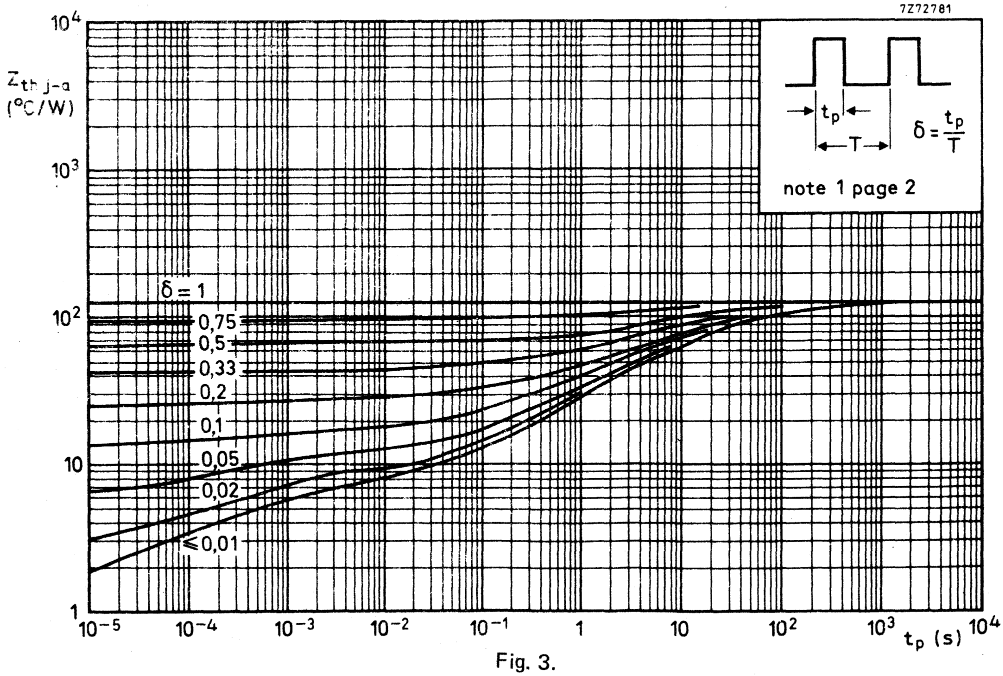

7Z72781
$Z_{th\ j-a}$
(°C/W)
10^4
10^3
10^2
10
1
$\delta = 1$
0,75
0,5
0,33
0,2
0,1
0,05
0,02
≤0,01
t_p
T
$\delta = \frac{t_p}{T}$
note 1 page 2
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
10^4
t_p (s)

Fig. 3.

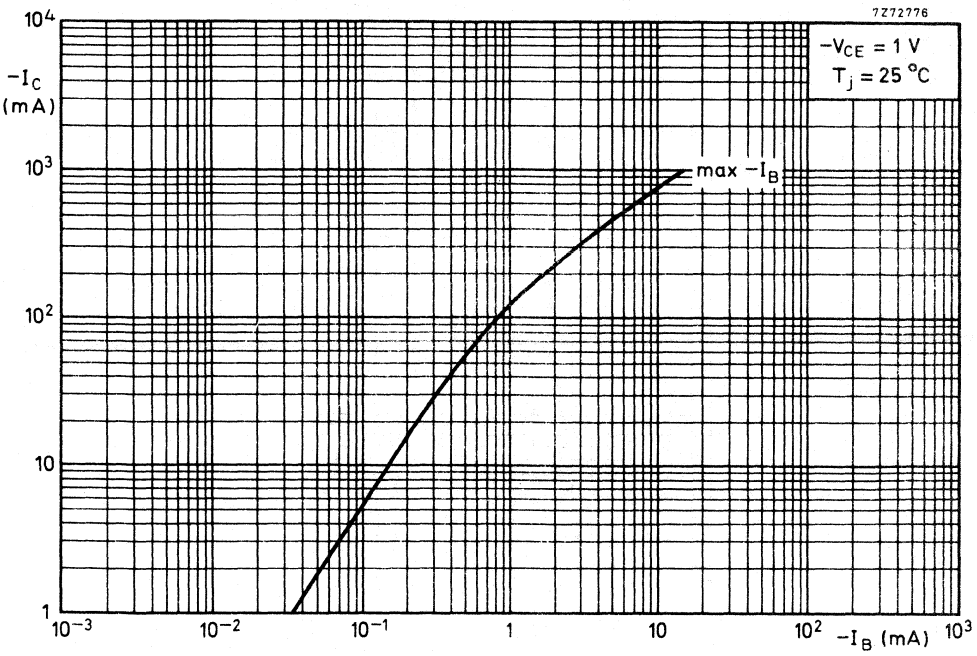

7Z72776
$-V_{CE}$ = 1 V
T_j = 25 °C
$-I_C$ (mA)
max $-I_B$
$-I_B$ (mA)
10^4
10^3
10^2
10
1
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3

Fig. 4.

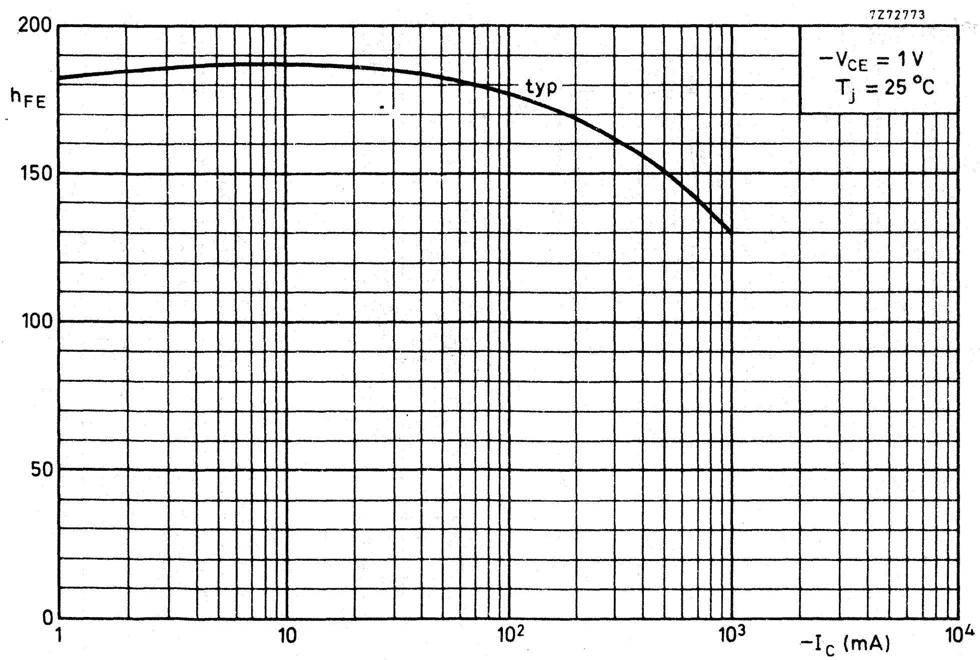

7Z72773
$-V_{CE}$ = 1 V
T_j = 25 °C
h_{FE}
typ
$-I_C$ (mA)
200
150
100
50
0
1
10
10^2
10^3
10^4

Fig. 5.

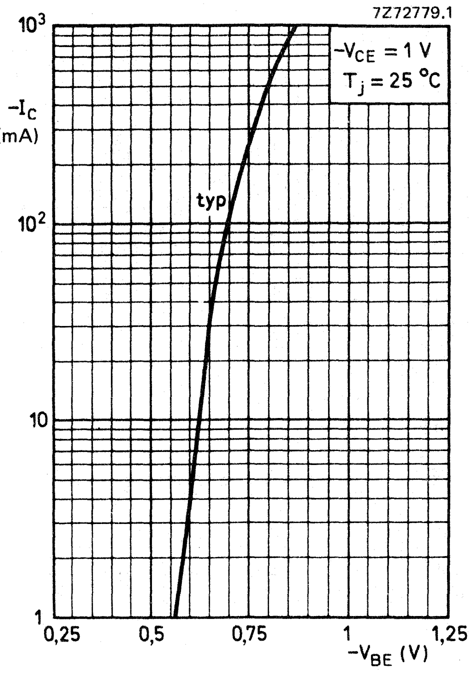


Fig. 6.

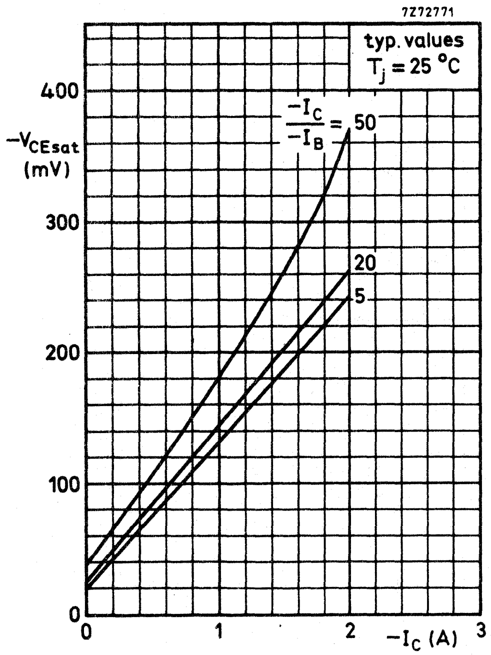


Fig. 7.

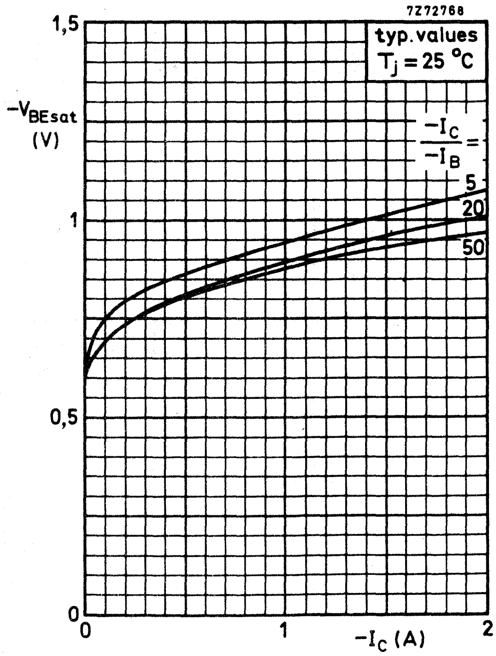


Fig. 8.

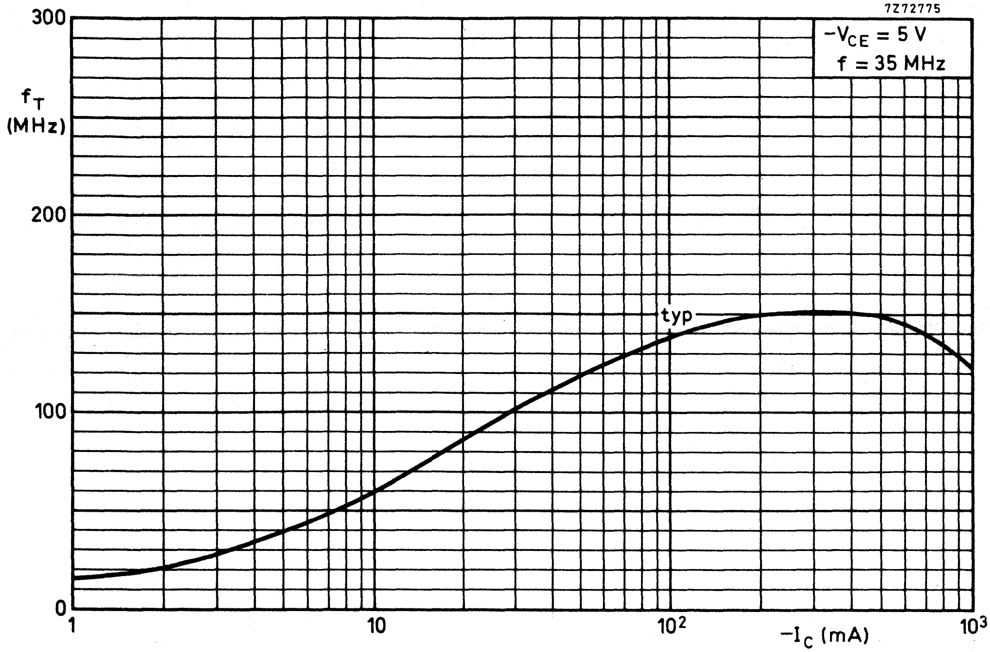


Fig. 9.

SILICON PLANAR EPITAXIAL TRANSISTOR

NPN transistor in a plastic TO-92 envelope, intended for low-voltage, high-current LF applications. BC375/BC376 is the matched complementary pair suitable for output stages up to 2 W.

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 (peak value)	I_{CM}	max.	1.5	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	800	mW
Junction temperature	T_j	max.	150	°C
DC current gain I_C = 150 mA; V_{CE} = 1 V	h_{FE}		100 to 400	
Transition frequency at f = 35 MHz I_C = 150 mA; V_{CE} = 1 V	f_T	typ.	150	MHz

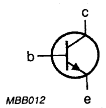
MECHANICAL DATA

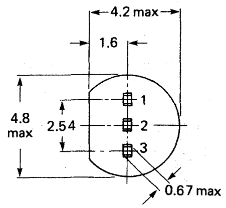
Dimensions in mm

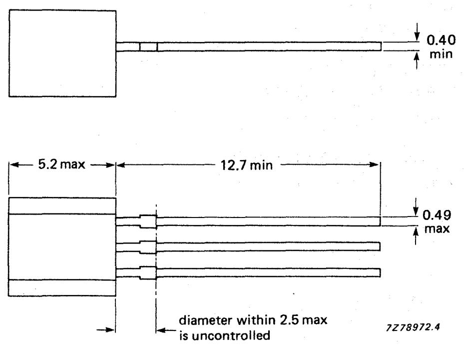
Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector







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.	6	V
Collector current (DC)	I_C	max.	1	A
Collector current (peak value)	I_{CM}	max.	1,5	A
Base current (DC)	I_B	max.	100	mA
Base current (peak value)	I_{BM}	max.	200	mA
Total power dissipation				
at T_{amb} = 25 °C (in free air)	P_{tot}	max.	625	mW
up to T_{amb} = 25 °C*	P_{tot}	max.	800	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	$R_{th\ j\text{-}a}$	=	200	K/W
From junction to ambient *	$R_{th\ j\text{-}a}$	=	156	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	95	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; V_{CB} = 25 V	I_{CBO}	max.	100	nA
$I_E = 0$; V_{CB} = 25 V; T_j = 150 °C	I_{CBO}	max.	5	μA
Emitter cut-off current				
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	max.	10	μA
Base-emitter voltage**				
I_C = 5 mA; V_{CE} = 10 V	V_{BE}	typ.	650	mV
I_C = 700 mA; V_{CE} = 1 V	V_{BE}	max.	1.1	V
Collector-emitter saturation voltage				
I_C = 700 mA; I_B = 70 mA	V_{CEsat}	typ.	250	mV
		max.	400	mV
D.C. current gain				
I_C = 5 mA; V_{CE} = 10 V	h_{FE}	min.	100	
I_C = 150 mA; V_{CE} = 1 V	h_{FE}		100 to 400	
I_C = 700 mA; V_{CE} = 1 V	h_{FE}	min.	50	
Transition frequency at f = 35 MHz				
I_C = 150 mA; V_{CE} = 1 V	f_T	typ.	150	MHz

* Transistor mounted on printed-circuit board, maximum lead length 4 mm, mounting pad for collector lead minimum 10 mm x 10 mm.

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

SILICON PLANAR EPITAXIAL TRANSISTOR

PNP transistor in a plastic TO-92, intended for low-voltage, high-current LF applications.
BC375/BC376 is the matched complementary pair suitable for output stages up to 2 W.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	V
Collector current (peak value)	$-I_{CM}$	max.	1.5	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	800	mW
Junction temperature	T_j	max.	150	°C
DC current gain $-I_C$ = 150 mA; $-V_{CE}$ = 1 V	h_{FE}		100 to 400	
Transition frequency at f = 35 MHz $-I_C$ = 150 mA; $-V_{CE}$ = 1 V	f_T	typ.	100	MHz

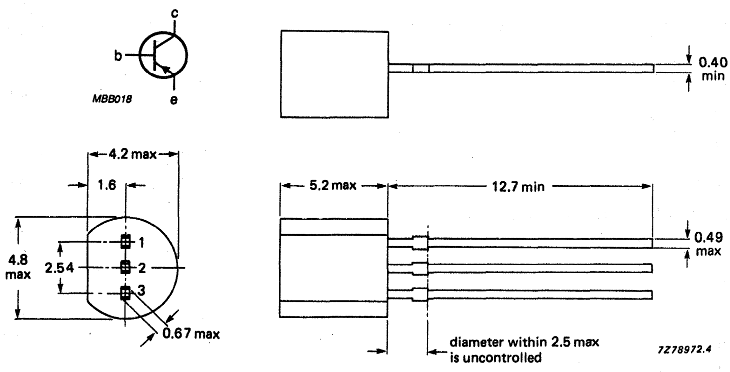
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



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.	30	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	6	V
Collector current (DC)	$-I_C$	max.	1	A
Collector current (peak value)	$-I_{CM}$	max.	1.5	A
Base current (DC)	$-I_B$	max.	100	mA
Base current (peak value)	$-I_{BM}$	max.	200	mA
Total power dissipation				
at T_{amb} = 25 °C (in free air)	P_{tot}	max.	625	mW
up to T_{amb} = 25 °C*	P_{tot}	max.	800	mW
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	200	K/W
From junction to ambient*	$R_{th\,j\text{-}a}$	=	156	K/W
From junction to case	$R_{th\,j\text{-}c}$	=	95	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 25$ V	$-I_{CBO}$	max.	100	nA
$I_E = 0$; $-V_{CB} = 25$ V; $T_j = 150$ °C	$-I_{CBO}$	max.	5	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	max.	10	μA
Base-emitter voltage**				
$-I_C = 5$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	650	mV
$-I_C = 700$ mA; $-V_{CE} = 1$ V	$-V_{BE}$	max.	1.1	V
Collector-emitter saturation voltage				
$-I_C = 700$ mA; $-I_B = 70$ mA	$-V_{CEsat}$	typ.	280	mV
		max.	400	mV
DC current gain				
$-I_C = 5$ mA; $-V_{CE} = 10$ V	h_{FE}	min.	100	
$-I_C = 150$ mA; $-V_{CE} = 1$ V	h_{FE}	100 to 400		
$-I_C = 700$ mA; $-V_{CE} = 1$ V	h_{FE}	min.	50	
Transition frequency at f = 35 MHz				
$-I_C = 150$ mA; $-V_{CE} = 1$ V	f_T	typ.	100	MHz

* Transistor mounted on printed-circuit board, maximum lead length 4 mm, mounting pad for collector lead minimum 10 mm x 10 mm.

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

SILICON PLANAR DARLINGTON TRANSISTOR

P-N-P silicon planar darlington transistor in a plastic TO-92 envelope.

N-P-N complement is BC517.

QUICK REFERENCE DATA

Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	V
Collector current	$-I_C$	max.	400	mA
Junction temperature	T_j	max.	150	°C
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	mW
D.C. current gain $-I_C$ = 20 mA; $-V_{CE}$ = 2 V	h_{FE}	>	30 000	
Collector-emitter saturation voltage $-I_C$ = 100 mA; $-I_B$ = 0,1 mA	$-V_{CEsat}$	max.	1	V
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	220	MHz

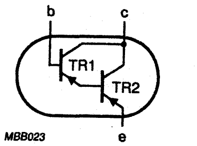
MECHANICAL DATA

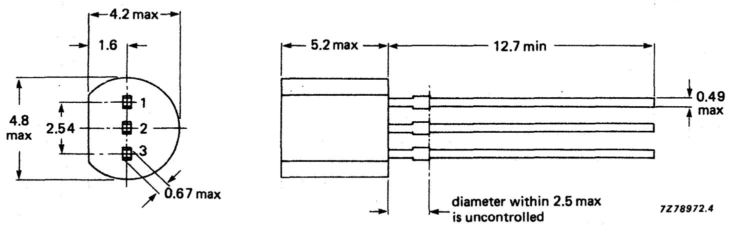
Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector





RATINGS

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

Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V
Collector current	$-I_C$	max.	400	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	mW
Junction temperature	T_j	max.	150	°C
Storage temperature	T_{stg}	−65 to + 150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	max.	200	K/W
From junction to case	$R_{th\ j\text{-}c}$	max.	90	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise stated

Collector cut-off current V_{CB} = 30 V	$-I_{CBO}$	max.	100	nA
Collector-emitter breakdown voltage $-I_C$ = 2 mA	$-V_{(BR)CEO}$	min.	30	V
Collector-base breakdown voltage	$-V_{(BR)CBO}$	min.	40	V
Emitter-base breakdown voltage	$-V_{(BR)EBO}$	min.	10	V
D.C. current gain $-I_C$ = 20 mA; $-V_{CE}$ = 2 V	h_{FE}	>	30 000	
Collector-emitter saturation voltage $-I_C$ = 100 mA; $-I_B$ = 0,1 mA	$-V_{CEsat}$	max.	1	V
Base-emitter voltage I_C = 10 mA; V_{CE} = 5 V	$-V_{BE}$	max.	1,4	V
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	220	MHz

SILICON PLANAR DARLINGTON TRANSISTOR

N-P-N silicon planar darlington transistor in a plastic TO-92 envelope.
P-N-P complement is BC516.

QUICK REFERENCE DATA

Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector current	I_C	max.	400	mA
Junction temperature	T_j	max.	150	°C
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	mW
D.C. current gain I_C = 20 mA; V_{CE} = 2 V	h_{FE}	>	30 000	
Collector-emitter saturation voltage I_C = 100 mA; I_B = 0,1 mA	V_{CEsat}	max.	1	V
Transition frequency at f = 100 MHz I_C = 30 mA; V_{CE} = 5 V	f_T	typ.	220	MHz

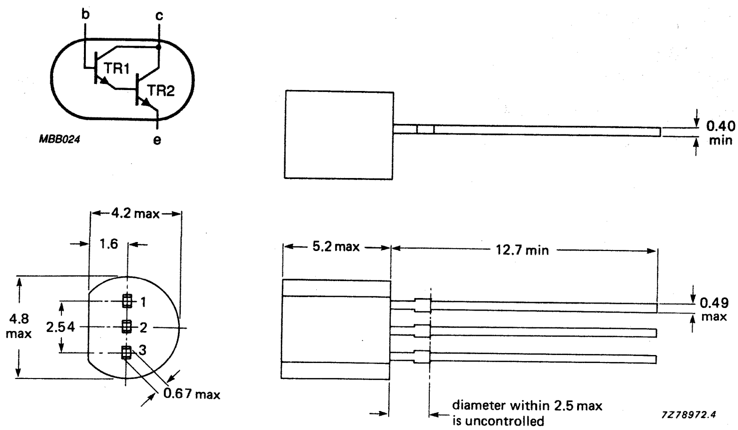
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

Collector-emitter voltage (open base)	V_{CEO}	max.	30 V
Collector-base voltage (open emitter)	V_{CBO}	max.	40 V
Emitter-base voltage (open collector)	V_{EBO}	max.	10 V
Collector current	I_C	max.	400 mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625 mW
Junction temperature	T_j	max.	150 °C
Storage temperature	T_{stg}		−65 to + 150 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	max.	200 K/W
From junction to case	$R_{th\ j\text{-}c}$	max.	90 K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise stated

Collector cut-off current V_{CB} = 30 V	I_{CBO}	max.	100 nA
Collector-emitter breakdown voltage I_C = 2 mA	$V_{(BR)CEO}$	min.	30 V
Collector-base breakdown voltage	$V_{(BR)CBO}$	min.	40 V
Emitter-base breakdown voltage	$V_{(BR)EBO}$	min.	10 V
D.C. current gain I_C = 20 mA; V_{CE} = 2 V	h_{FE}	>	30 000
Collector-emitter saturation voltage I_C = 100 mA; I_B = 0,1 mA	V_{CEsat}	max.	1 V
Base-emitter voltage I_C = 10 mA; V_{CE} = 5 V	V_{BE}	max.	1,4 V
Transition frequency at f = 100 MHz I_C = 30 mA; V_{CE} = 5 V	f_T	typ.	220 MHz

SILICON PLANAR EPITAXIAL TRANSISTORS

General purpose n-p-n transistors in a plastic TO-92 envelope, especially suitable for use in driver stages of audio amplifiers.

QUICK REFERENCE DATA

			BC546	BC547	BC548	
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} = 25 °C	P_{tot}	max.	500	500	500	mW
Junction temperature	T_j	max.	150	150	150	°C
D.C. current gain I_C = 2 mA; V_{CE} = 5 V	h_{FE}	>	110	110	110	
		<	450	800	800	
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

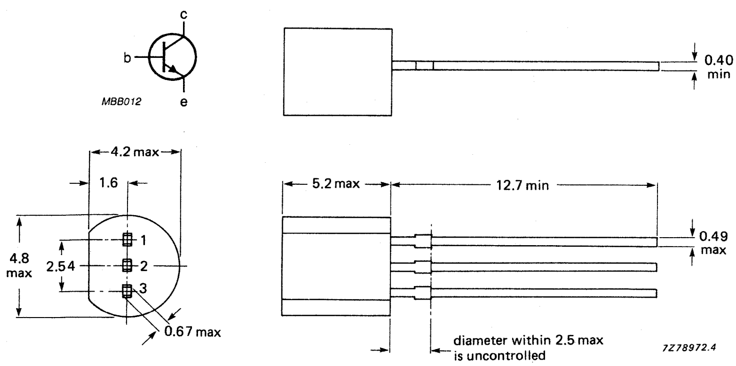
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BC546	BC547	BC548	
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} = 25 °C	P_{tot}	max.		500		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	$R_{th\,j\text{-}a}$	=	0,25	K/mW
From junction to case	$R_{th\,j\text{-}c}$	=	0,15	K/mW

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

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

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
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	2,5	pF
Emitter capacitance at f = 1 MHz $I_C = I_c = 0$; V_{EB} = 0,5 V	C_e	typ.	9	pF
Transition frequency at f = 35 MHz I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	MHz
Small signal current gain at f = 1 kHz I_C = 2 mA; V_{CE} = 5 V	h_{fe}		125 to 900	

			BC546	BC547	BC548	
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

			BC546A BC547A BC548A	BC546B BC547B BC548B	BC547C BC548C
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

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

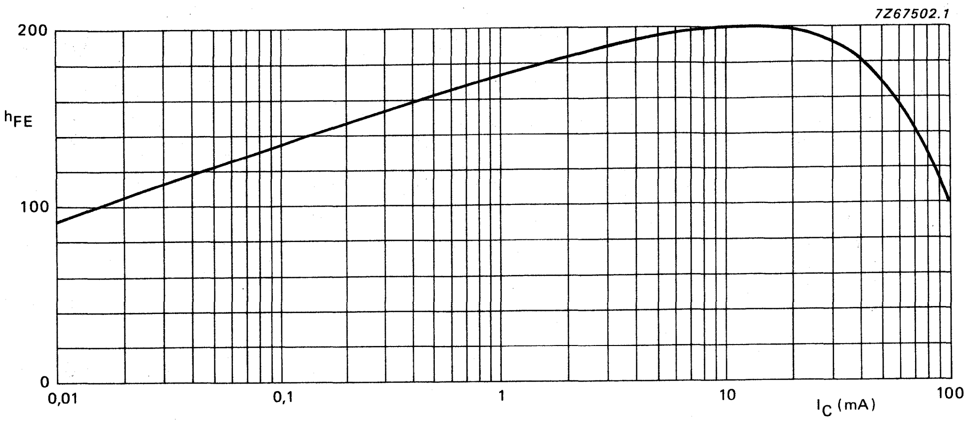


Fig. 2 BC546A, BC547A and BC548A
V_{CE} = 5 V; T_j = 25 °C; typical values.

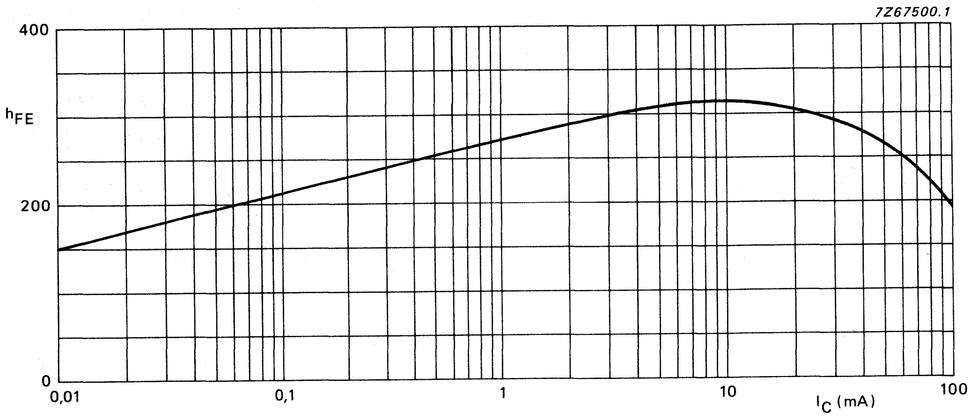


Fig. 3 BC546B, BC547B and BC548B
V_{CE} = 5 V; T_j = 25 °C; typical values.

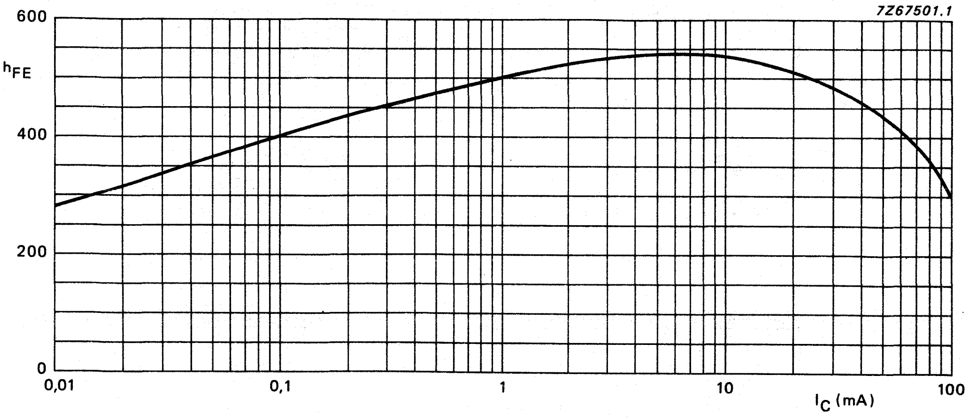


Fig. 4 BC547C and BC548C
V_{CE} = 5 V; T_j = 25 °C; typical values.

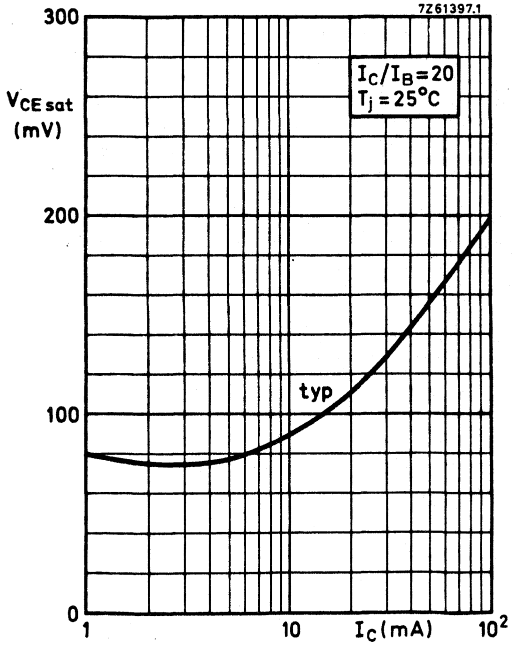


Fig. 5.

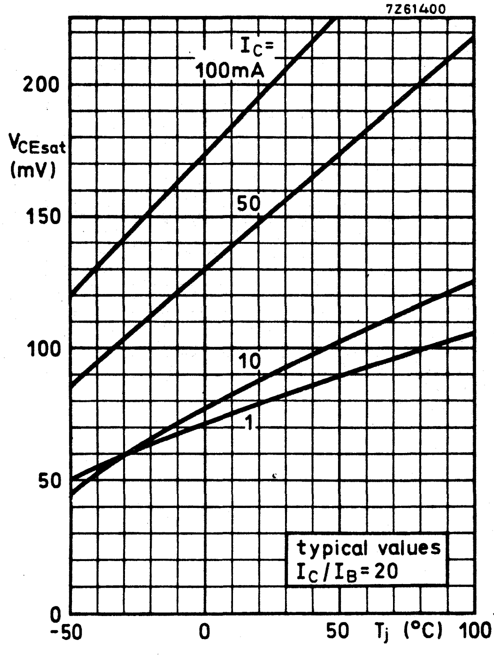


Fig. 6.

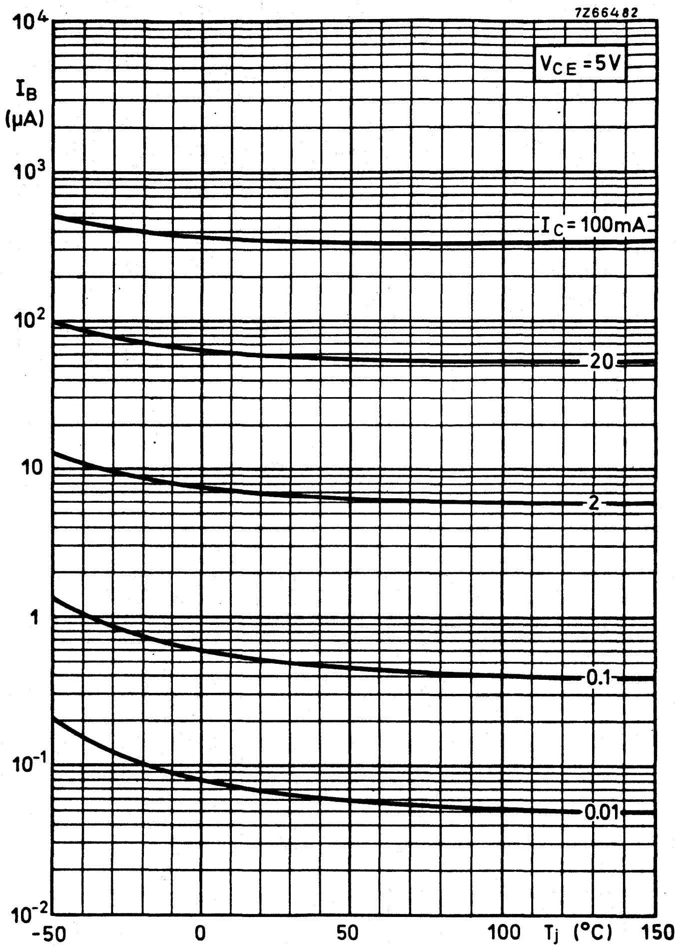

7Z66482
$V_{CE} = 5V$
I_B (μA)
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
$I_C = 100mA$
20
2
0.1
0.01
-50
0
50
100
T_j (°C)
150

Fig. 7.

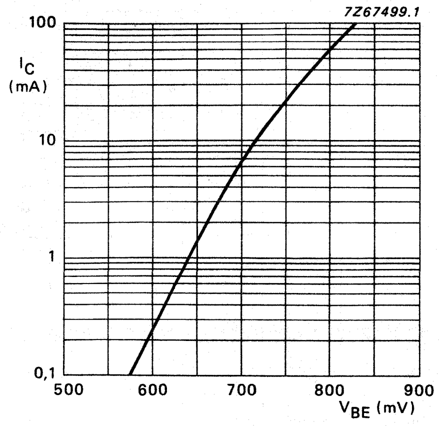


Fig. 8 V_{CE} = 5 V; T_j = 25 °C; typical values.

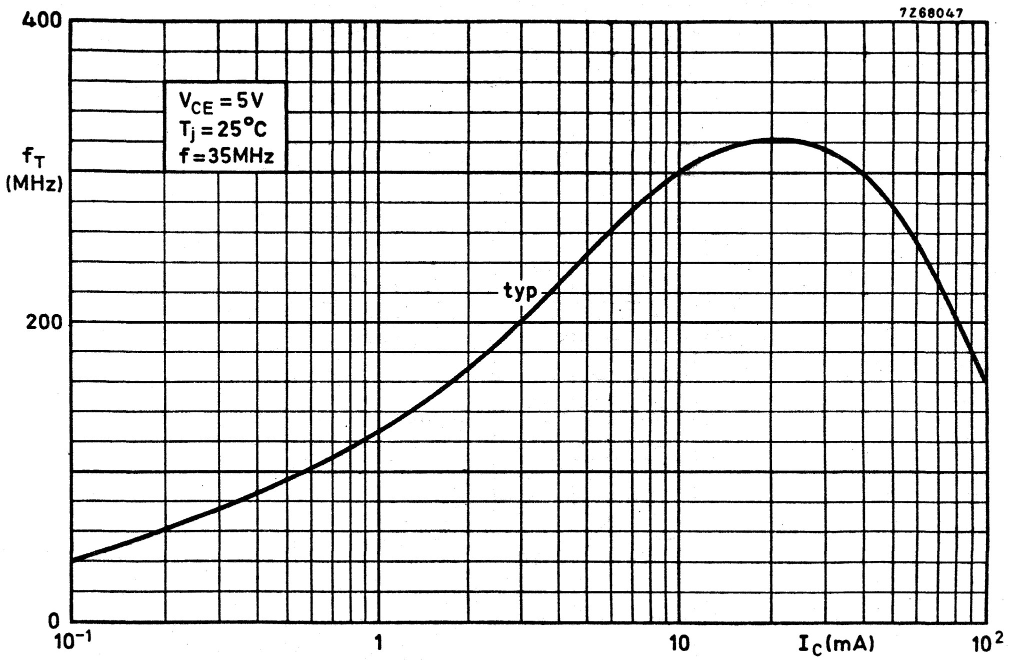


Fig. 9.

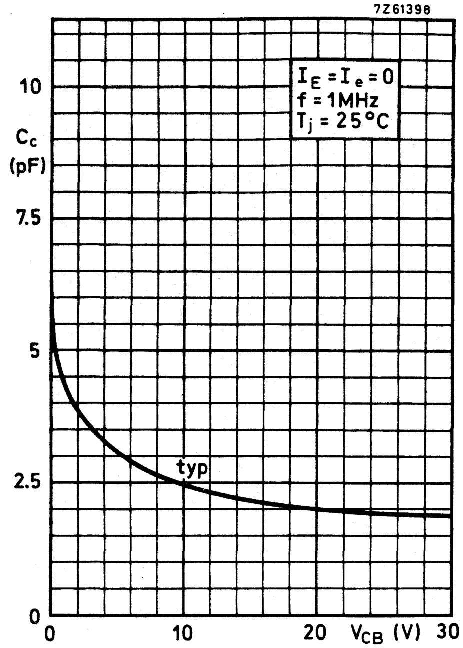

7Z61398
$I_E = I_e = 0$
f = 1MHz
$T_j = 25°C$
C_c (pF)
10
7.5
5
2.5
0
typ
0
10
20
V_{CB} (V)
30

Fig. 10.

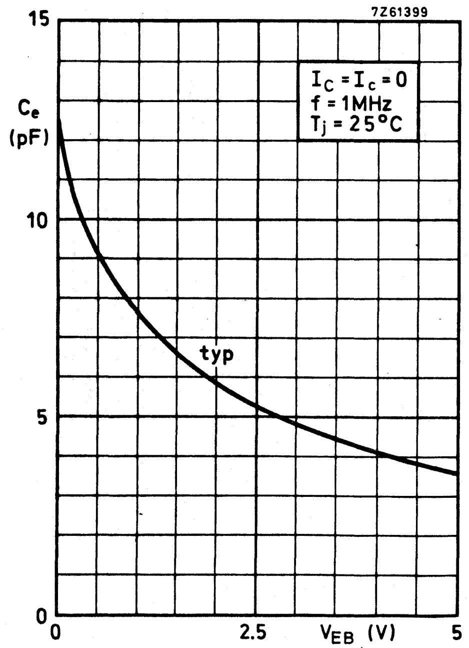

7Z61399
$I_C = I_c = 0$
f = 1MHz
$T_j = 25°C$
C_e (pF)
15
10
5
0
typ
0
2.5
V_{EB} (V)
5

Fig. 11.

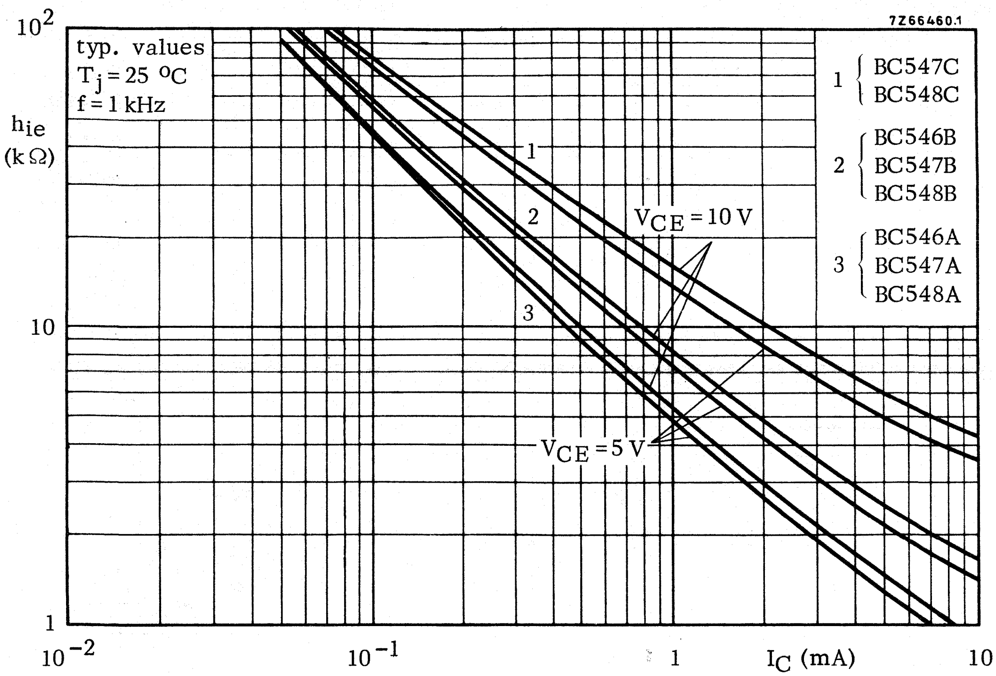

7Z66460.1
typ. values
$T_j = 25\ ^oC$
f = 1 kHz
h_{ie} (kΩ)
10^2
10
1
10^{-2}
10^{-1}
1
I_C (mA)
10
1 BC547C BC548C
2 BC546B BC547B BC548B
3 BC546A BC547A BC548A
1
2
3
$V_{CE} = 10\ V$
$V_{CE} = 5\ V$

Fig. 12.

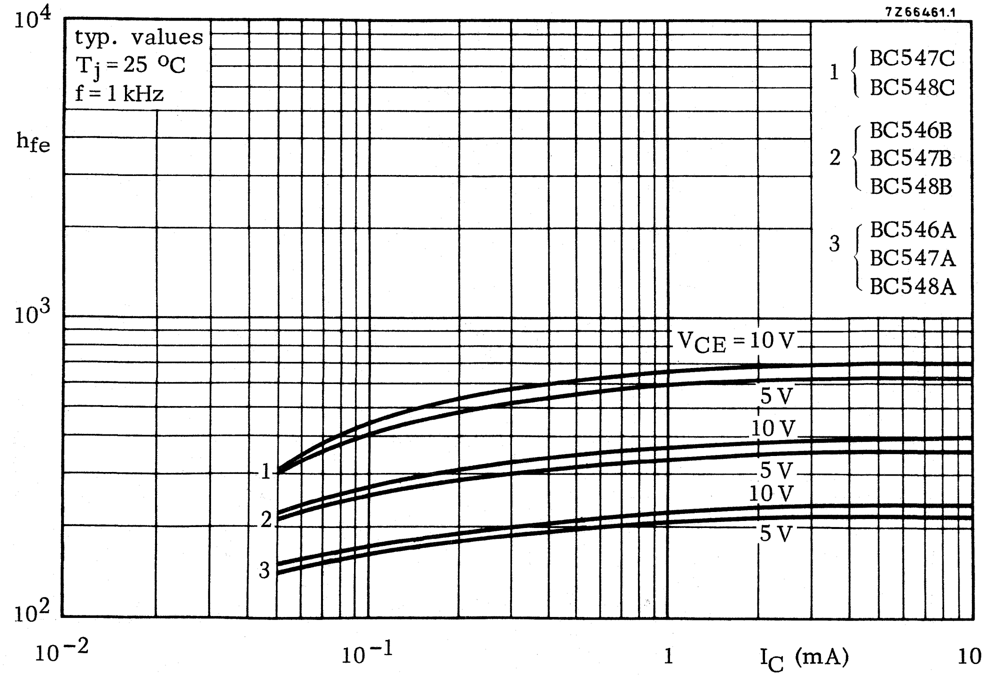

7Z66461.1
typ. values
$T_j = 25\ ^oC$
f = 1 kHz
h_{fe}
10^4
10^3
10^2
10^{-2}
10^{-1}
1
I_C (mA)
10
1 BC547C BC548C
2 BC546B BC547B BC548B
3 BC546A BC547A BC548A
$V_{CE} = 10\ V$
5 V
10 V
5 V
10 V
5 V
1
2
3

Fig. 13.

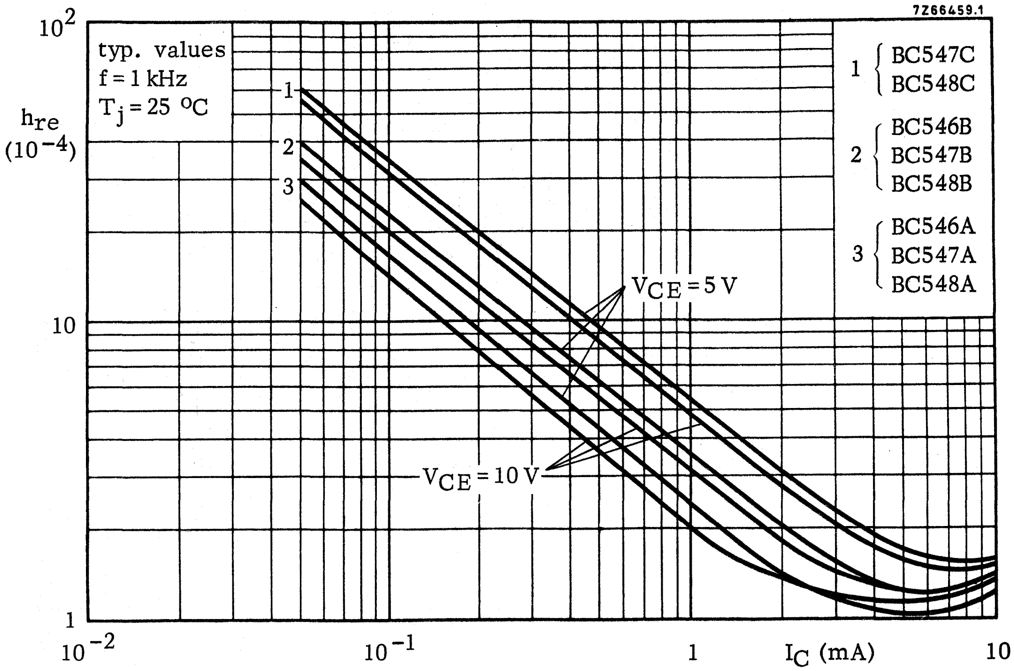

7Z66459.1
typ. values
f = 1 kHz
Tj = 25 °C
hre
(10−4)
1 { BC547C BC548C
2 { BC546B BC547B BC548B
3 { BC546A BC547A BC548A
VCE = 5 V
VCE = 10 V
IC (mA)

Fig. 14.

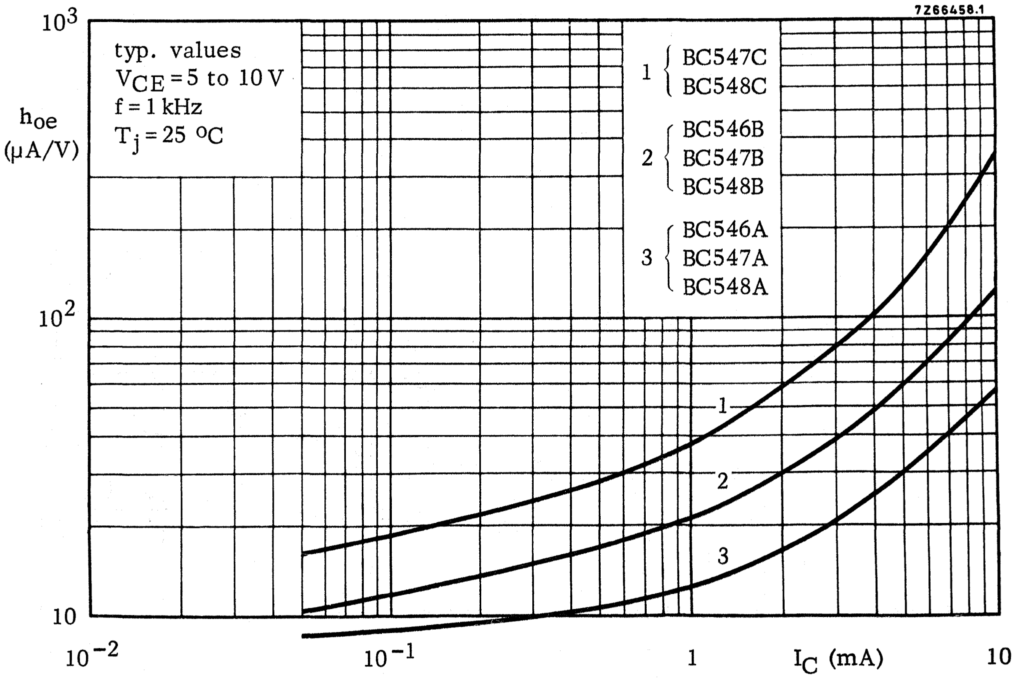

7Z66458.1
typ. values
VCE = 5 to 10 V
f = 1 kHz
Tj = 25 °C
hoe
(μA/V)
1 { BC547C BC548C
2 { BC546B BC547B BC548B
3 { BC546A BC547A BC548A
IC (mA)

Fig. 15.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in plastic TO-92 envelopes, primarily intended for low-noise input stages in tape recorders, hi-fi amplifiers and other audio-frequency equipment.

QUICK REFERENCE DATA

			BC549	BC550	
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} = 25 °C	P_{tot}	max	500	500	mW
Junction temperature	T_j	max	150	150	°C
D.C. current gain I_C = 2 mA; V_{CE} = 5 V	h_{FE}	> <	200 800	200 800	
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 4	1,4 3	dB 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

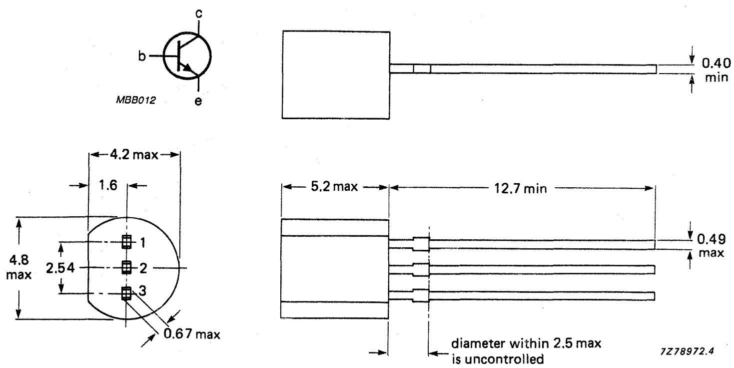
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BC549	BC550	
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} = 25 °C	P_{tot}	max.		500	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	$R_{th\ j\text{-}a}$	=	0,25	K/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0,15	K/mW

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

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

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

Collector capacitance at f = 1 MHz $I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.		2,5 pF
Emitter capacitance at f = 1 MHz $I_C = I_c = 0$; $V_{EB} = 0{,}5$ V	C_e	typ.		9 pF
Transition frequency at f = 35 MHz $I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.		300 MHz
Small signal current gain at f = 1 kHz $I_C = 2$ mA; $V_{CE} = 5$ V	h_{fe}		125 – 900	

			BC549	BC550
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

			BC549B BC550B	BC549C BC550C
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

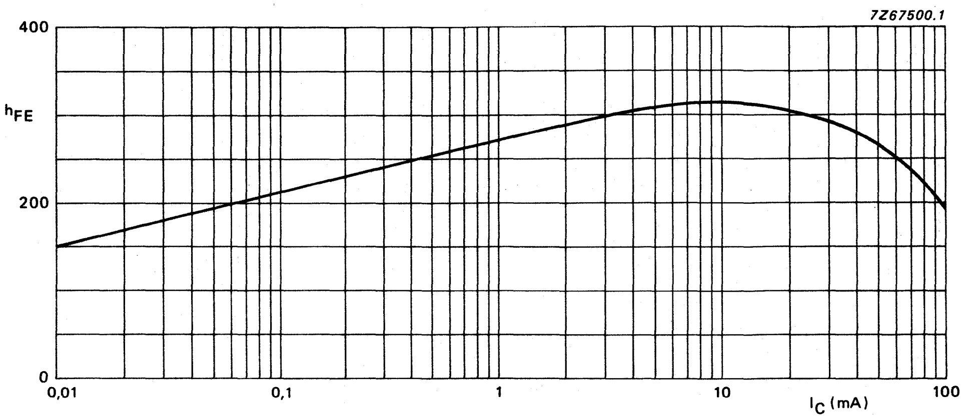


Fig. 2 BC549B and BC550B; V_{CE} = 5 V; T_j = 25 °C; typical values.

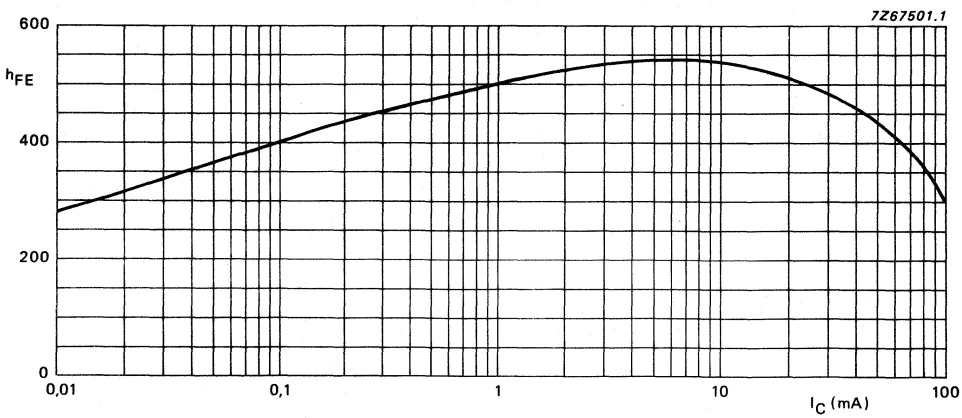


Fig. 3 BC549C and BC550C; V_{CE} = 5 V; T_j = 25 °C; typical values.

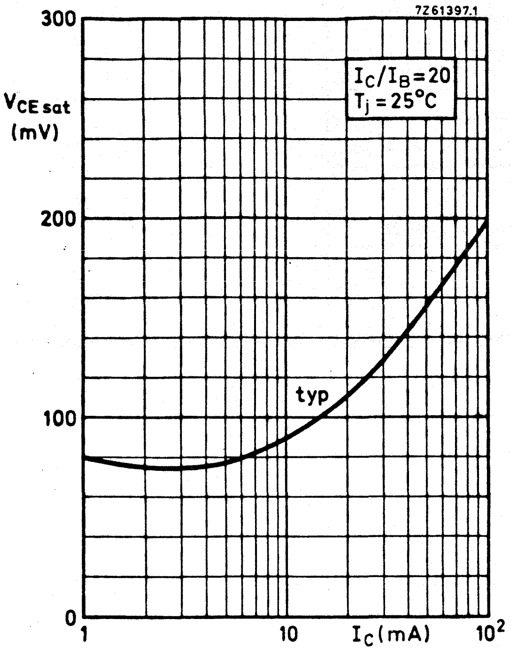


Fig. 4.

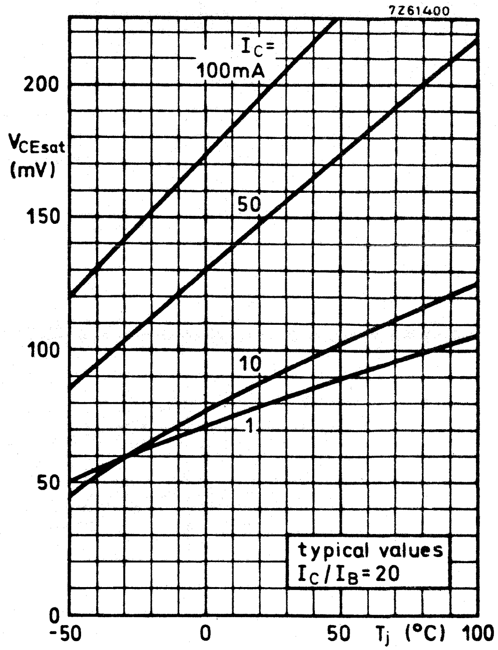


Fig. 5.

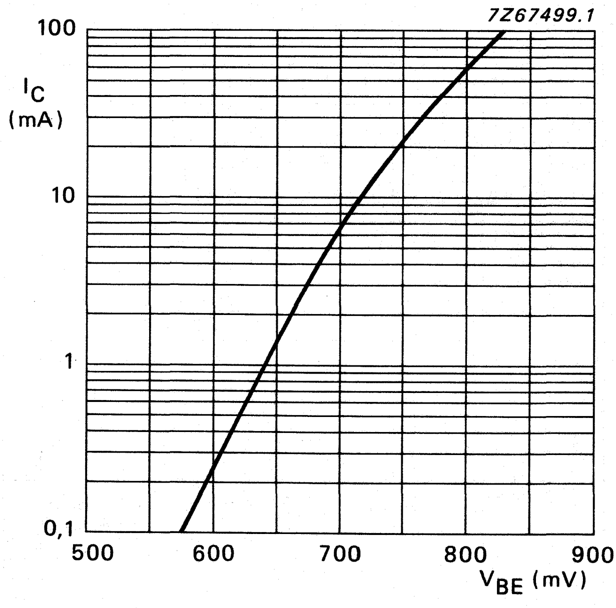


Fig. 6 $V_{CE} = 5$ V; $T_j = 25\ ^{o}C$; typical values.

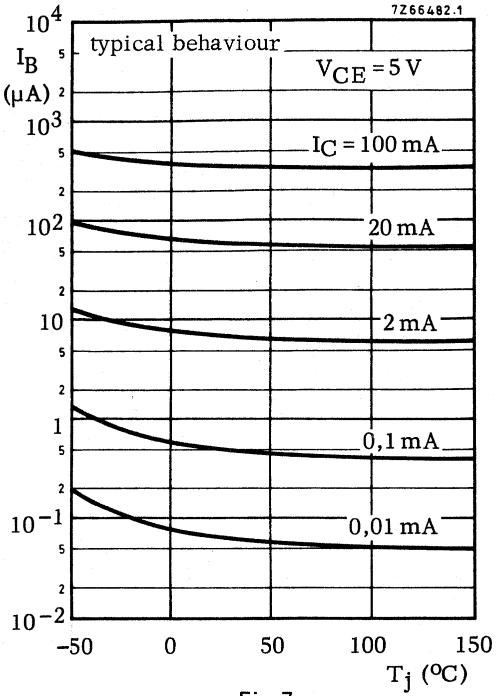

7Z66482.1
typical behaviour
I_B (μA)
V_{CE} = 5 V
I_C = 100 mA
20 mA
2 mA
0,1 mA
0,01 mA
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
−50
0
50
100
150
T_j (°C)

Fig. 7.

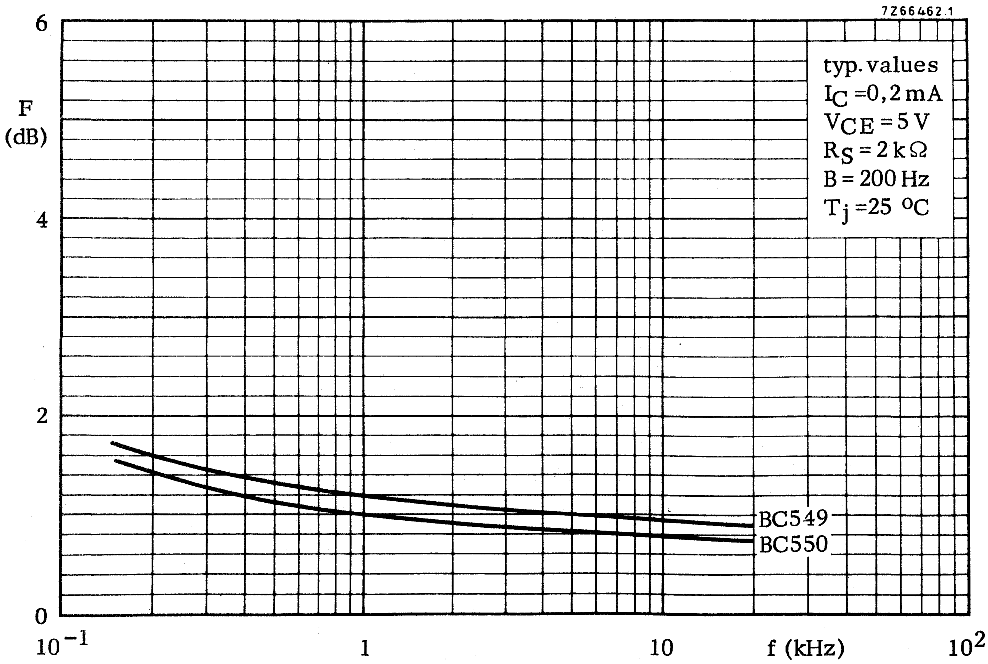

7Z66462.1
F (dB)
typ. values
I_C = 0,2 mA
V_{CE} = 5 V
R_S = 2 kΩ
B = 200 Hz
T_j = 25 °C
BC549
BC550
0
2
4
6
10^{-1}
1
10
f (kHz)
10^2

Fig. 8.

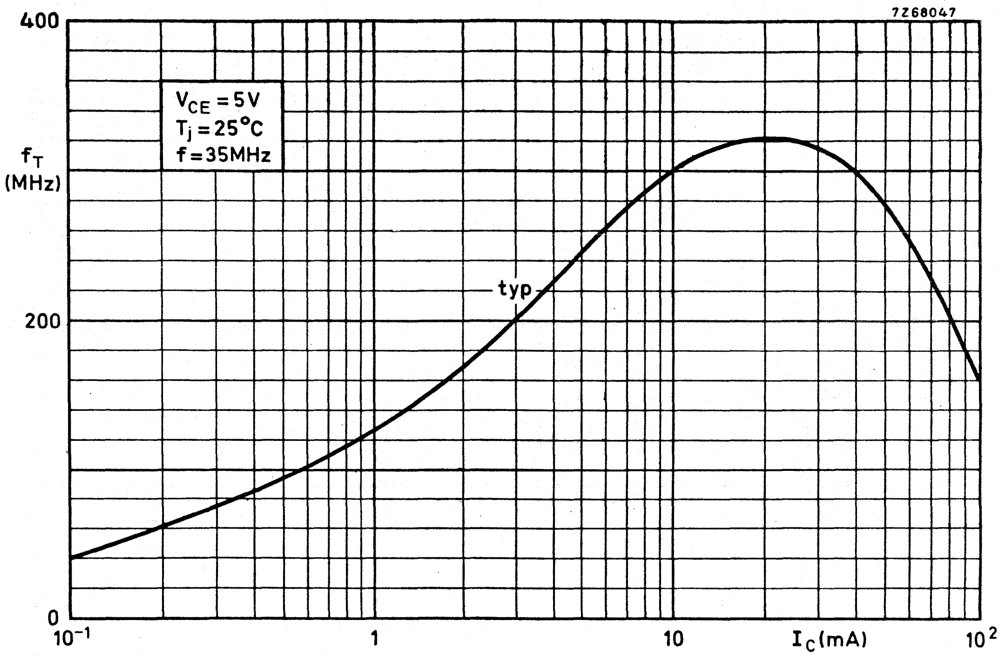


Fig. 9.

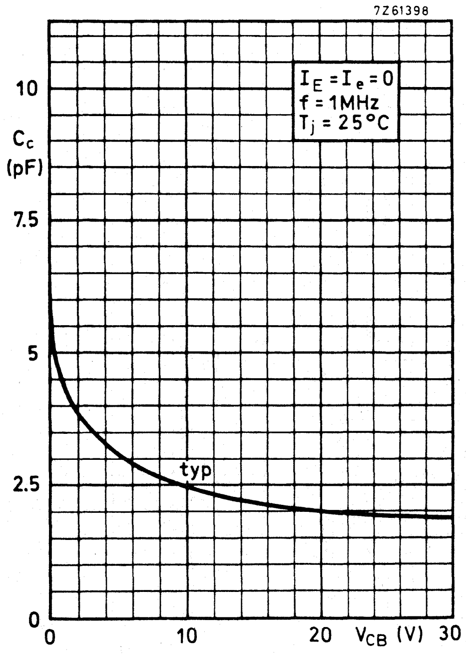


Fig. 10.

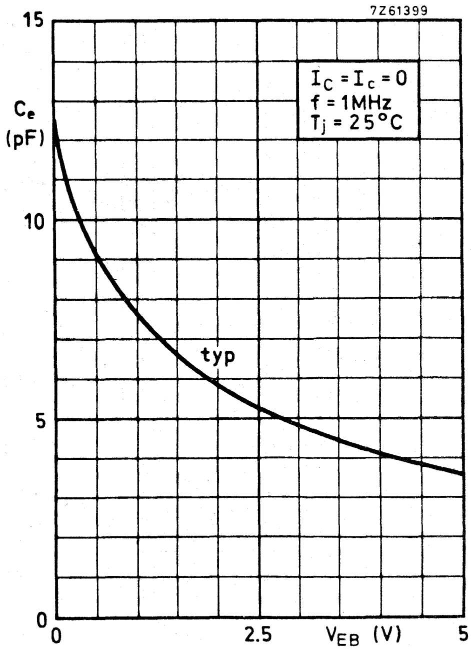


Fig. 11.

Curves of constant noise figure

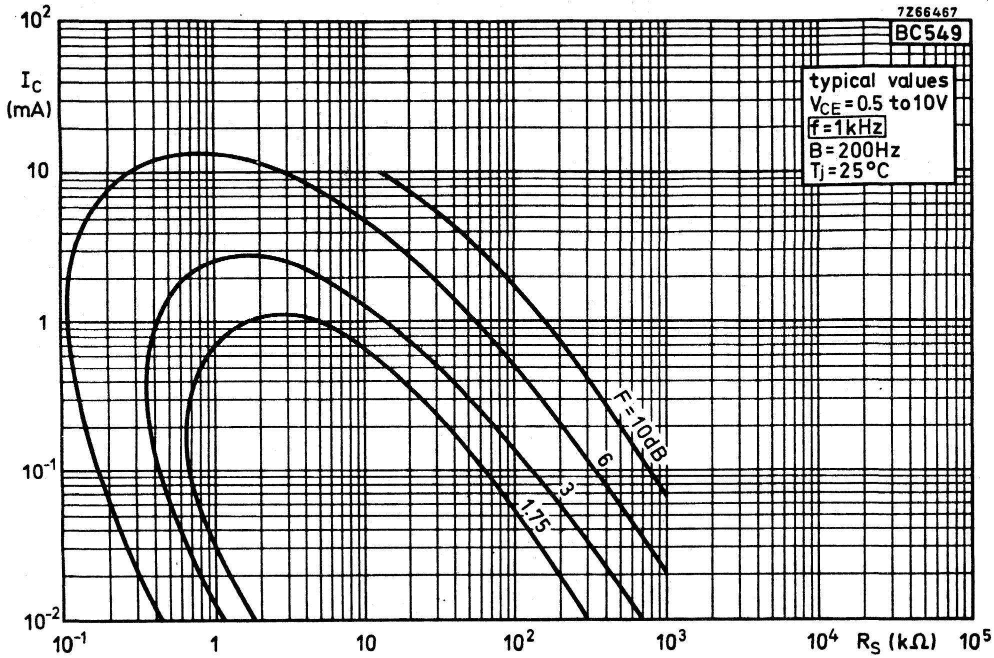


Fig. 12.

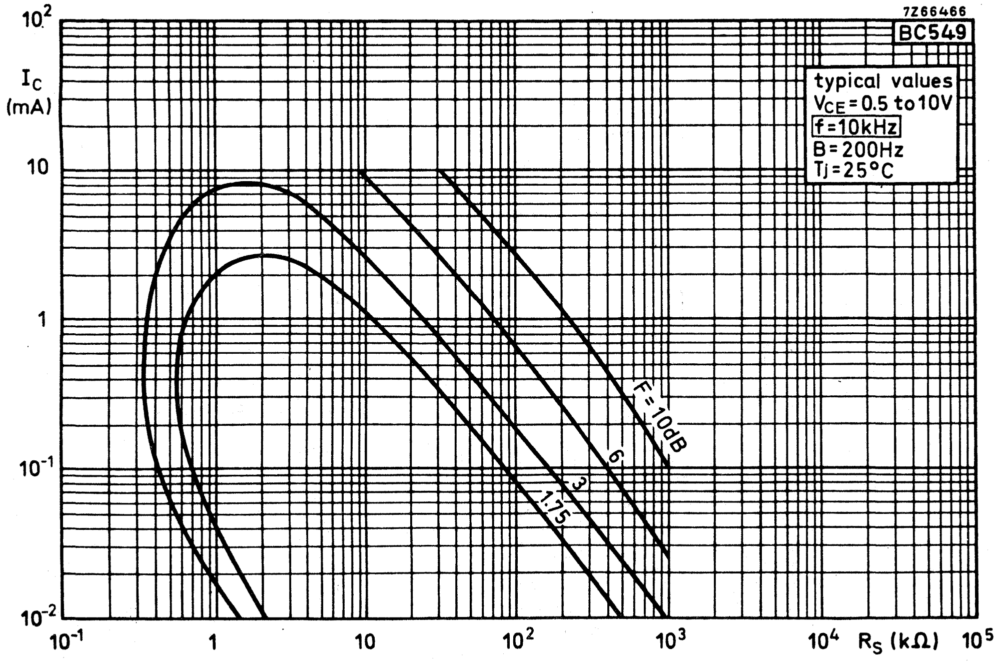


Fig. 13.

Curves of constant noise figure

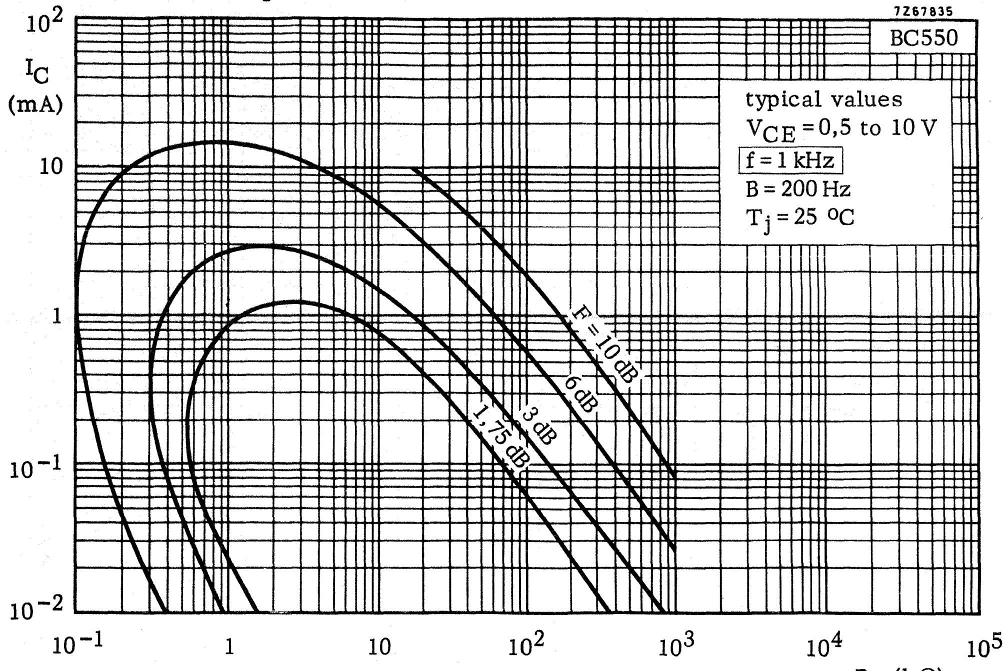


Fig. 14.

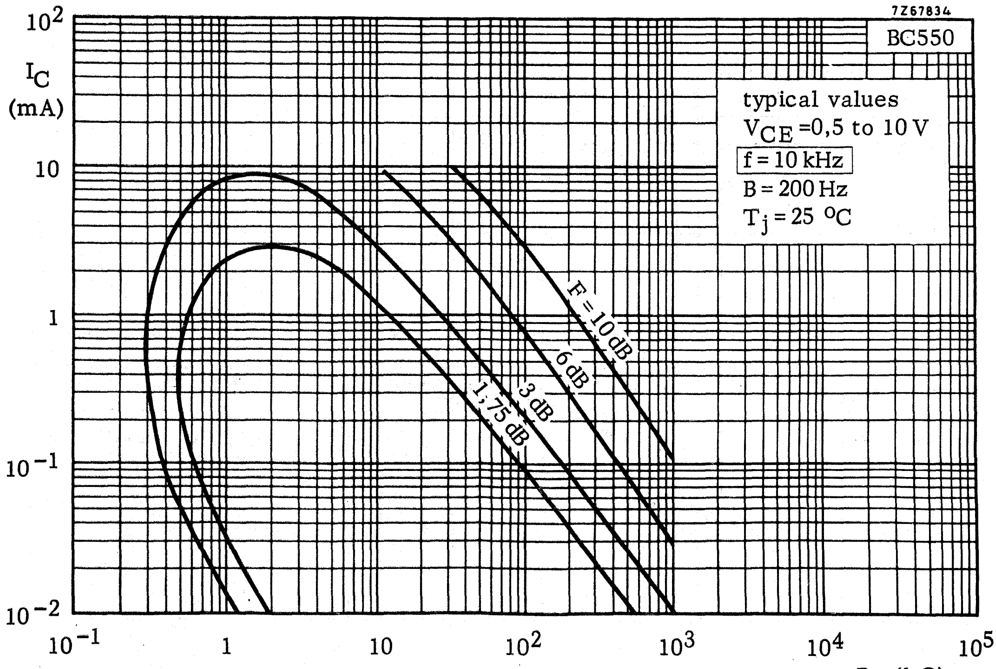


Fig. 15.

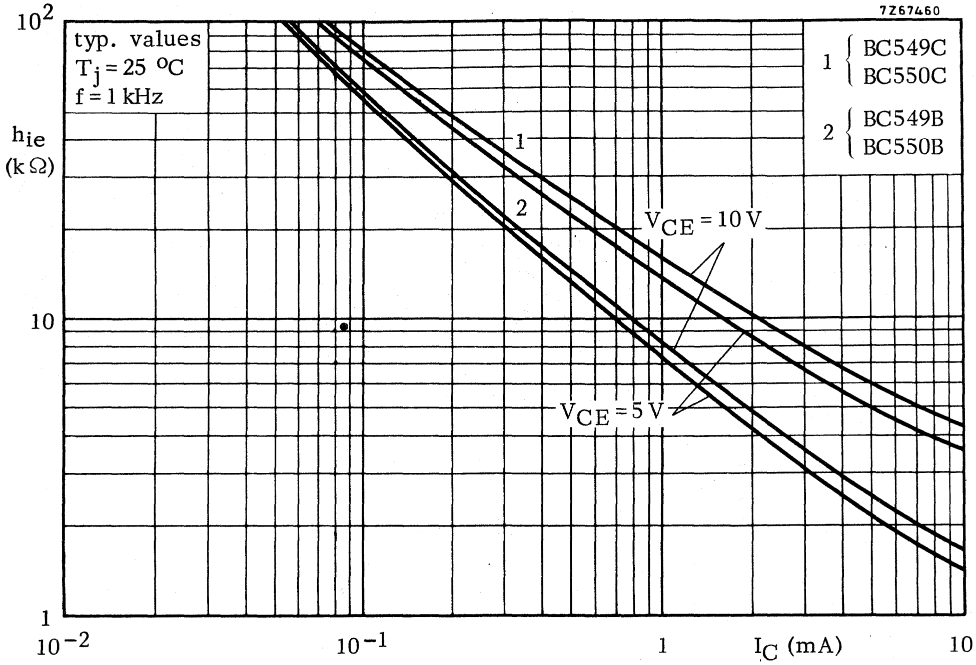

7Z67460
typ. values
T_j = 25 °C
f = 1 kHz
h_{ie}
(kΩ)
1 { BC549C BC550C
2 { BC549B BC550B
V_{CE} = 10 V
V_{CE} = 5 V
1
2
10^2
10
1
10^{-2}
10^{-1}
1
I_C (mA)
10

Fig. 16.

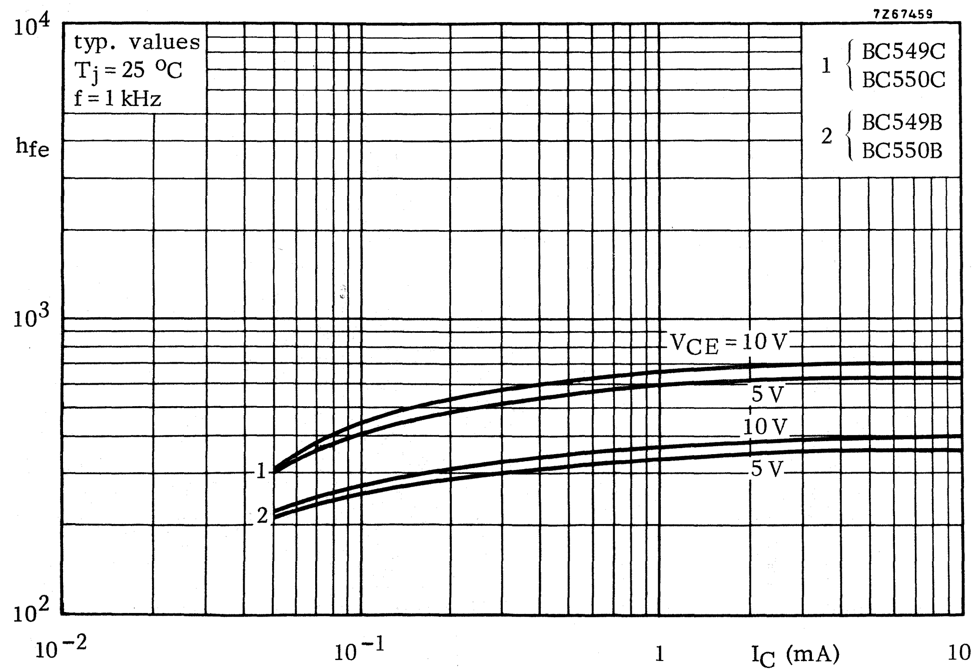

7Z67459
typ. values
T_j = 25 °C
f = 1 kHz
h_{fe}
1 { BC549C BC550C
2 { BC549B BC550B
V_{CE} = 10 V
5 V
10 V
5 V
1
2
10^4
10^3
10^2
10^{-2}
10^{-1}
1
I_C (mA)
10

Fig. 17.

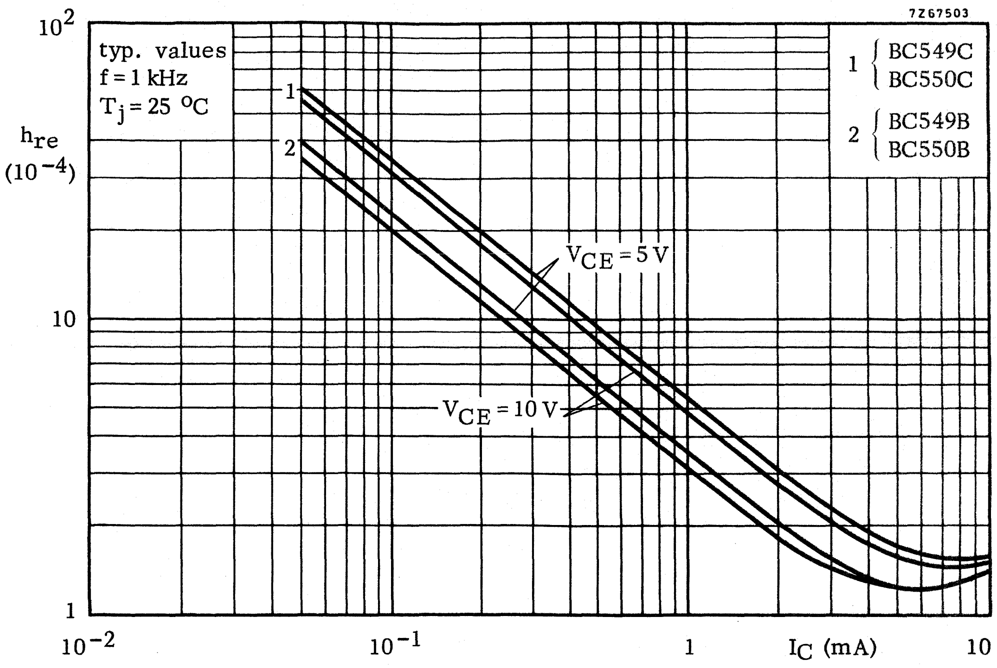

7Z67503
typ. values
f = 1 kHz
Tj = 25 °C
1 { BC549C BC550C
2 { BC549B BC550B
hre
(10^-4)
10^2
10
1
VCE = 5 V
VCE = 10 V
1
2
10^-2
10^-1
1
IC (mA)
10

Fig. 18.

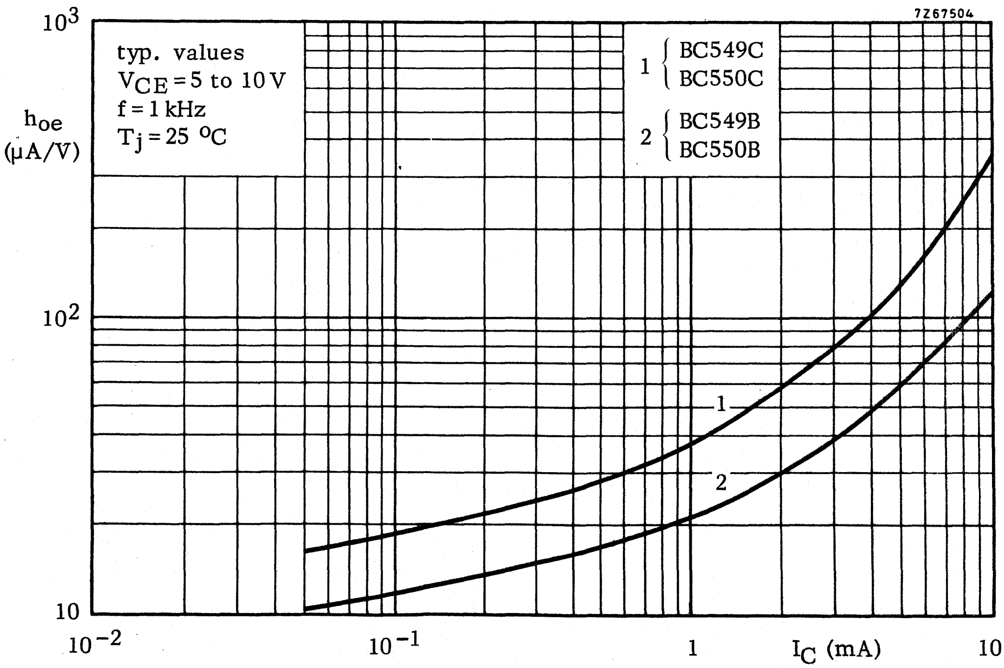

7Z67504
typ. values
VCE = 5 to 10 V
f = 1 kHz
Tj = 25 °C
1 { BC549C BC550C
2 { BC549B BC550B
hoe
(μA/V)
10^3
10^2
10
1
2
10^-2
10^-1
1
IC (mA)
10

Fig. 19.

SILICON PLANAR EPITAXIAL TRANSISTORS

General purpose p-n-p transistors in plastic TO-92 envelopes, especially suitable for use in driver stages of audio amplifiers.

QUICK REFERENCE DATA

			BC556	BC557	BC558	
Collector-emitter voltage (+ V_{BE} = 0 V)	$-V_{CES}$	max.	80	50	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	65	45	30	V
D.C. current gain $-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	> <	75 475	75 800	75 800	
Collector current (peak value)	$-I_{CM}$	max.		200		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		500		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
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

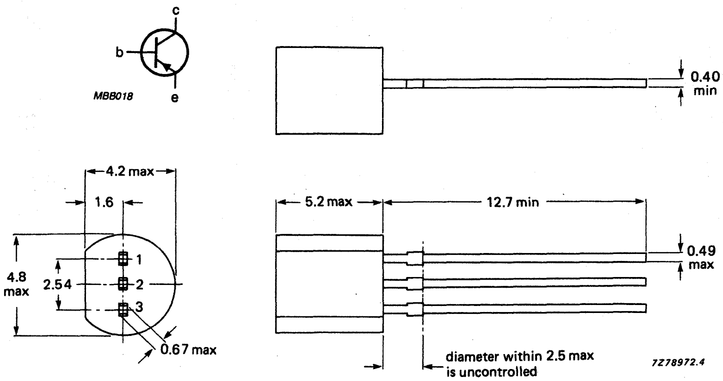
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92 variant.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BC556	BC557	BC558	
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.	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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	500	mW
Storage temperature	T_{stg}		−65 to + 150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	250	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	150	K/W

CHARACTERISTICS

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

Collector cut-off current				
$I_E = 0; -V_{CB} = 30$ V; $T_j = 25\ ^oC$	$-I_{CBO}$	typ.	1	nA
		<	15	nA
$T_j = 150\ ^oC$	$-I_{CBO}$	<	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
Saturation voltages**				
$-I_C = 10$ mA; $-I_B = 0{,}5$ mA	$-V_{CEsat}$	typ.	60	mV
		<	300	mV
	$-V_{BEsat}$	typ.	750	mV
$-I_C = 100$ mA; $-I_B = 5$ mA	$-V_{CEsat}$	typ.	180	mV
		<	650	mV
	$-V_{BEsat}$	typ.	930	mV

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

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

Collector capacitance at f = 1 MHz $I_E = I_e = 0$; $-V_{CE} = 10$ V	C_c	typ.	4	pF
Transition frequency at f = 35 MHz $-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	200	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

			BC556	BC557 BC558	BC556A BC557A BC558A	BC556B BC557B BC558B	BC557C BC558C
D.C. current gain $-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	>	75	75	125	220	420
		<	475	800	250	475	800

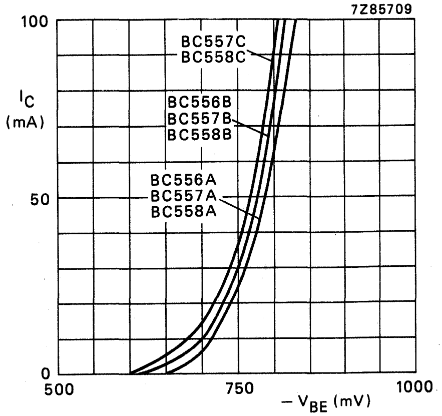


Fig. 2 $-V_{CE} = 5$ V; $T_j = 25$ °C.

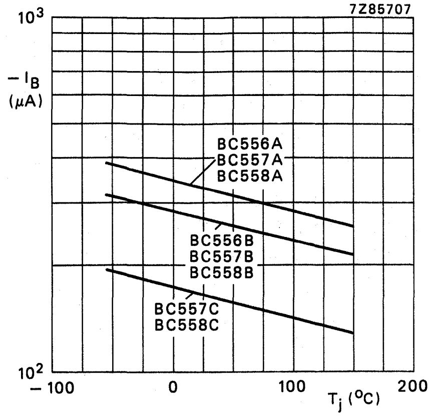


Fig. 3 $-V_{CE} = 5$ V; $I_C = 50$ mA.

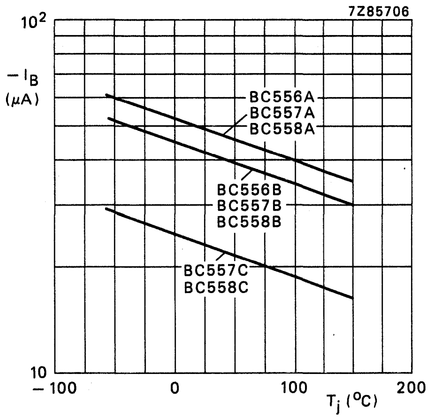


Fig. 4 $-V_{CE} = 5$ V; $I_C = 10$ mA.

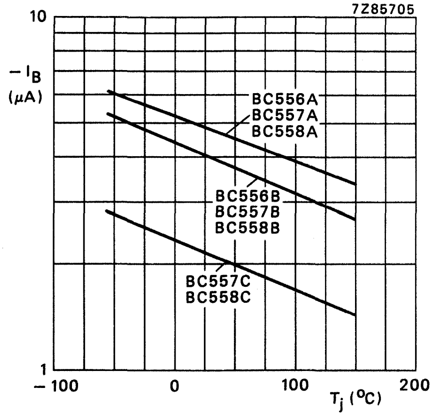


Fig. 5 $-V_{CE} = 5$ V; $I_C = 1$ mA.

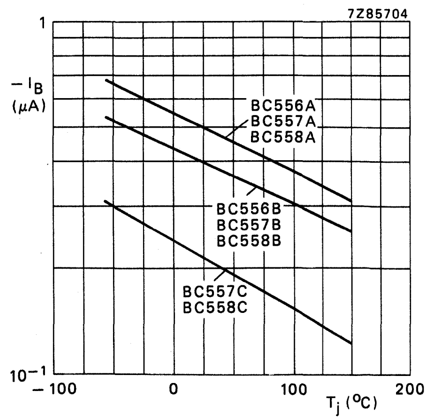


Fig. 6 $-V_{CE} = 5$ V; $I_C = 0{,}1$ mA.

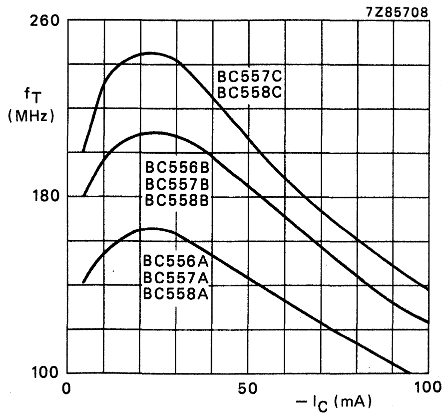


Fig. 7 $-V_{CE} = 5$ V; $T_j = 25$ °C; f = 35 MHz.

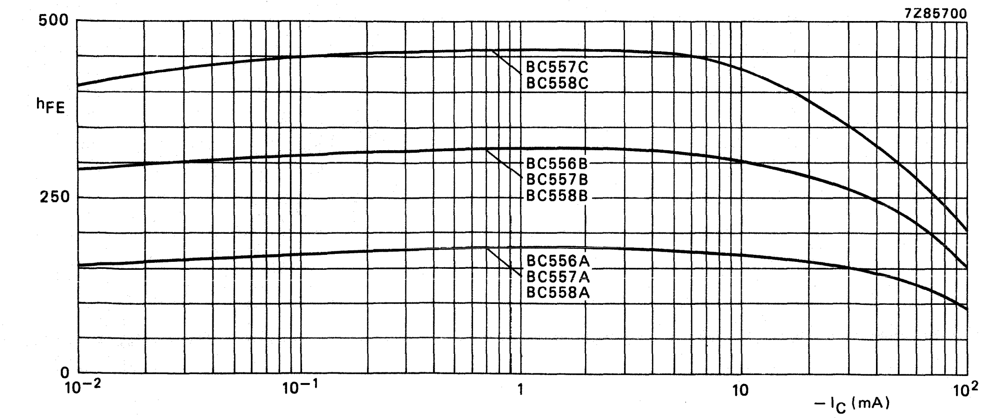


Fig. 8 $-V_{CE} = 5$ V; $T_j = 25$ °C.

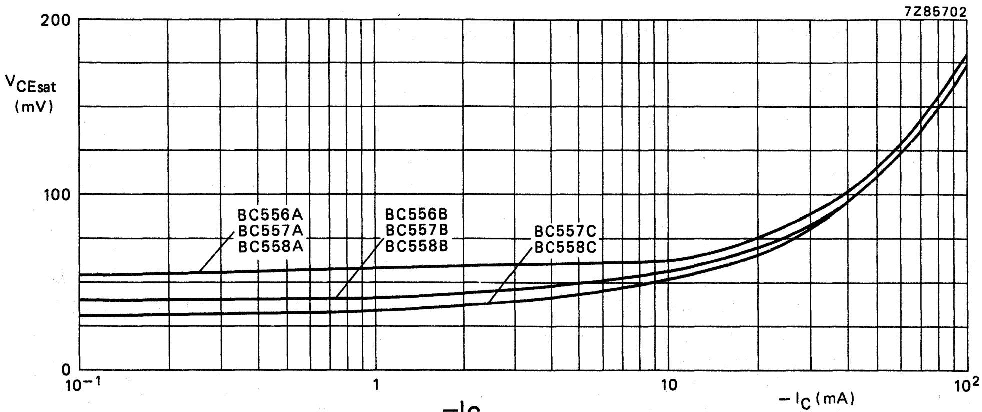


Fig. 9 $\frac{-I_C}{-I_B} = 20$; $T_j = 25$ °C.

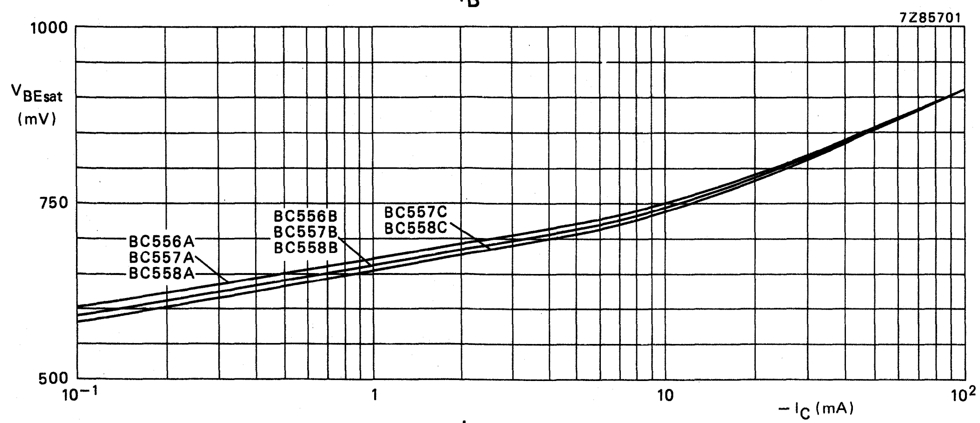


Fig. 10 $\frac{-I_C}{-I_B} = 20$; $T_j = 25$ °C.

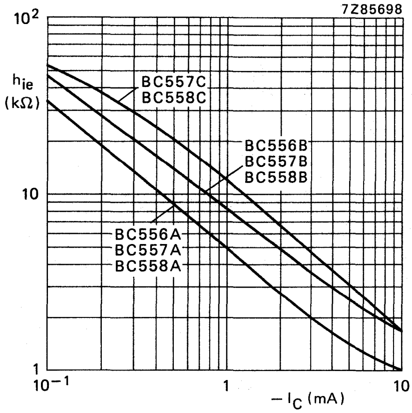


Fig. 11.

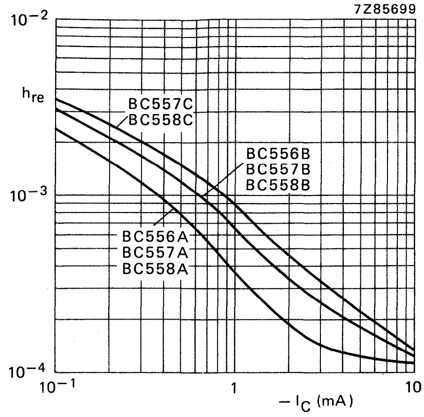


Fig. 12.

For Figs 11, 12, 13 and 14 the following conditions apply: $-V_{CE}$ = 5 V; f = 1 kHz; T_j = 25 °C.

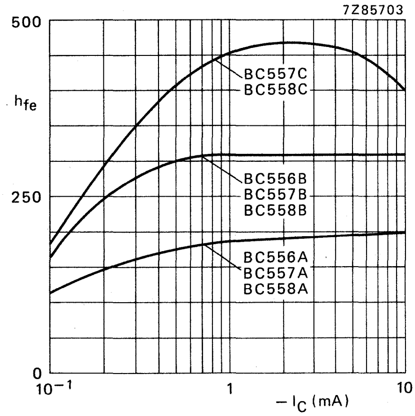


Fig. 13.

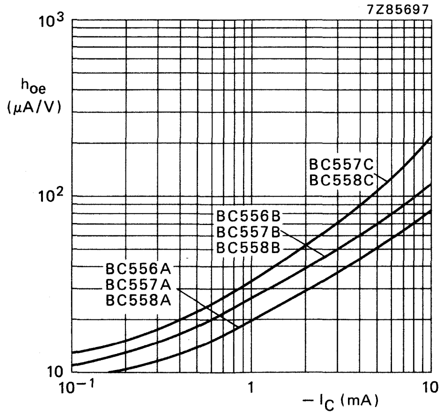


Fig. 14.

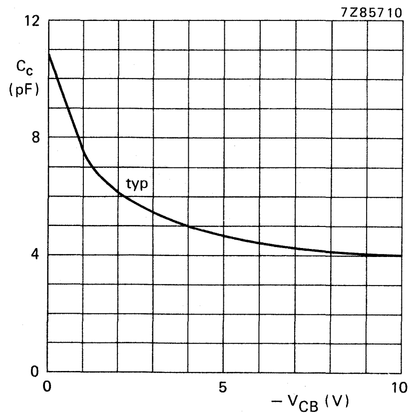


Fig. 15 f = 1 MHz; T_j = 25 °C.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in a plastic TO-92 envelope, primarily intended for low-noise input stages in tape recorders, hi-fi amplifiers and other audio-frequency equipment.

QUICK REFERENCE DATA

			BC559	BC560	
Collector-emitter voltage ($+V_{BE} = 0$ V)	$-V_{CES}$	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 $T_{amb} = 25$ °C	P_{tot}	max.	500	500	mW
Junction temperature	T_j	max.	150	150	°C
D.C. current gain $-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	>	125	125	
		<	800	800	
Transition frequency $-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	200	200	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	1	dB
		<	4	3	dB
f = 1 kHz; B = 200 Hz	F	<	4	4	dB
f = 10 kHz to 50 Hz (equivalent noise voltage)	V_N	<	–	0,11	μV

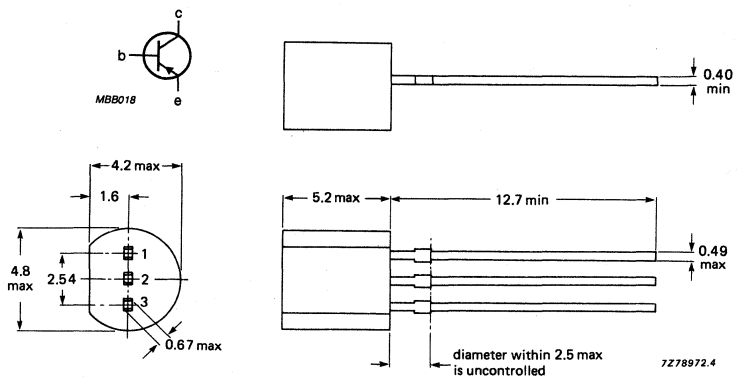
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BC559	BC560	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	50	V
Collector-emitter voltage ($+V_{BE}$ = 0 V)	$-V_{CES}$	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} = 25 °C	P_{tot}	max.	500	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	$R_{th\ j\text{-}a}$	=	250	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	150	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
Saturation voltages**				
$-I_C$ = 10 mA; $-I_B$ = 0,5 mA	$-V_{CEsat}$	typ.	60	mV
		<	300	mV
	$-V_{BEsat}$	typ.	750	mV
$-I_C$ = 100 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	typ.	180	mV
		<	650	mV
	$-V_{BEsat}$	typ.	930	mV

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

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

Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	typ.		4	pF
Transition frequency at f = 35 MHz					
$-I_C = 10$ mA; $-V_{CE} = 5$ B	f_T	typ.		200	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			BC559	BC560	
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; $-I_C = 200$ μA; $-V_{CE} = 5$ V; f = 10 Hz to 50 Hz; $T_{amb} = 25$ °C	V_n	<	–	0,11	μV

D.C. current gain			BC559 BC560	BC559A BC560A	BC559B BC560B	BC559C BC560C
$-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	>	125	125	220	420
		<	800	250	475	800

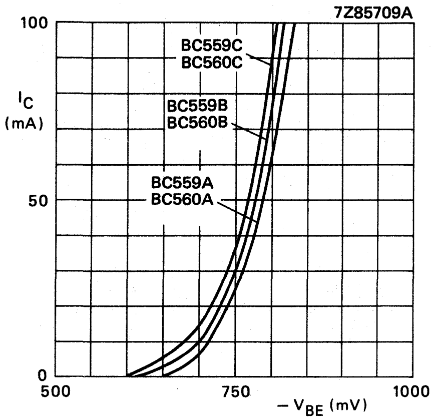


Fig. 2 $-V_{CE}$ = 5 V; T_j = 25 °C.

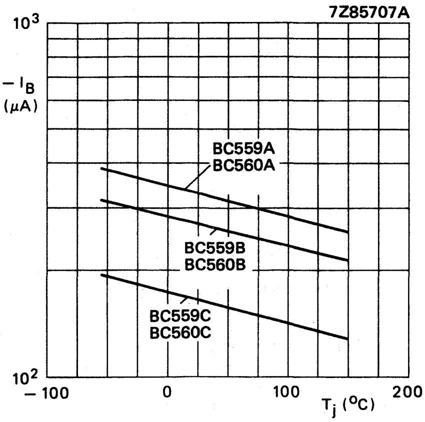


Fig. 3 $-V_{CE}$ = 5 V; I_C = 50 mA.

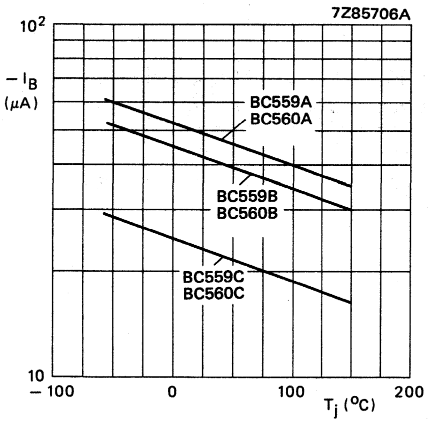


Fig. 4 $-V_{CE}$ = 5 V; I_C = 10 mA.

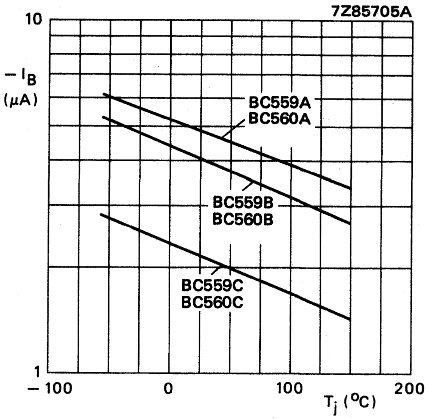


Fig. 5 $-V_{CE}$ = 5 V; I_C = 1 mA.

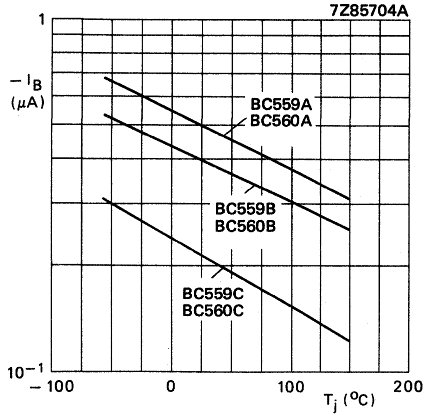


Fig. 6 $-V_{CE}$ = 5 V; I_C = 0,1 mA.

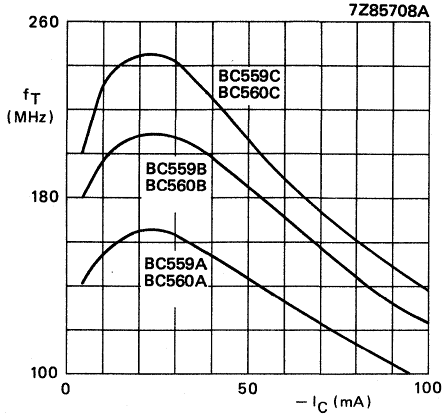


Fig. 7 $-V_{CE}$ = 5 V; T_j = 25 °C;
f = 35 MHz.

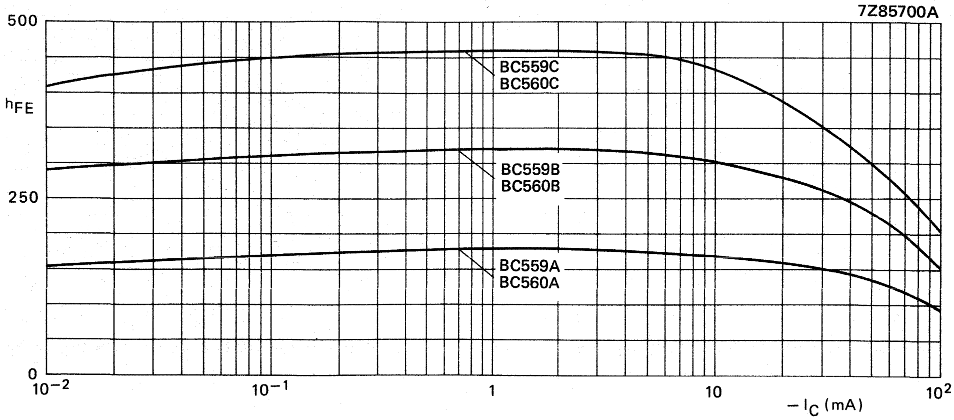


Fig. 8 $-V_{CE} = 5$ V; $T_j = 25$ °C.

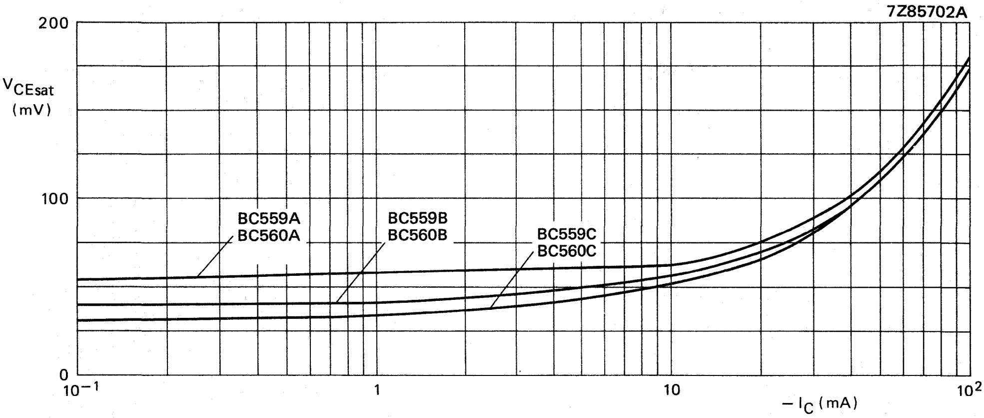


Fig. 9 $\frac{-I_C}{-I_B} = 20$; $T_j = 25$ °C.

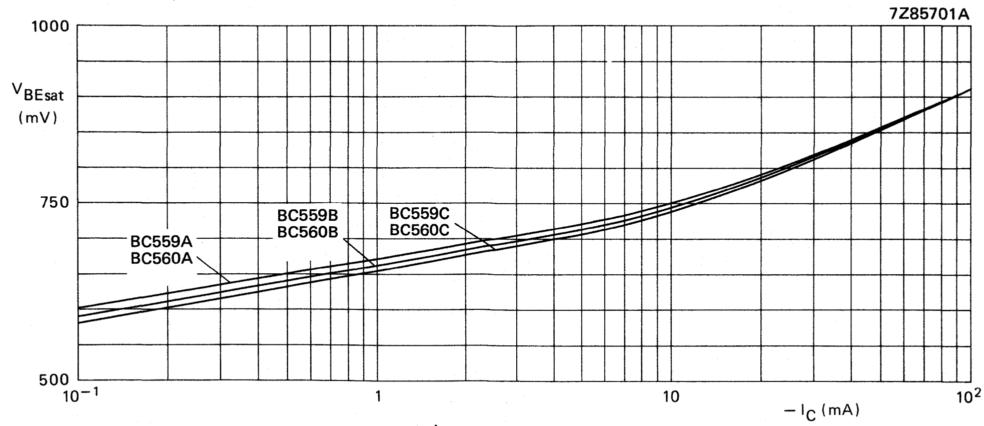


Fig. 10 $\frac{-I_C}{-I_B} = 20$; $T_j = 25$ °C.

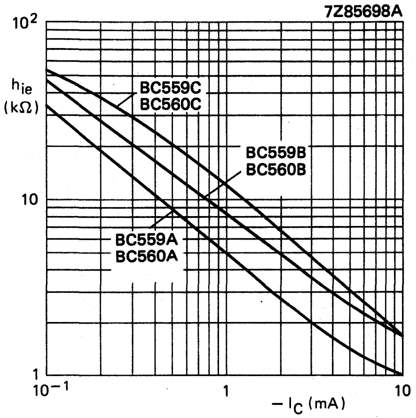


Fig. 11.

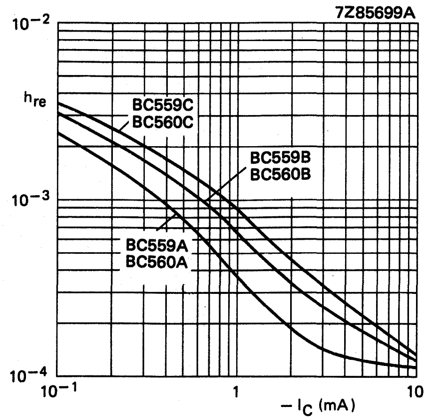


Fig. 12.

For Figs 11, 12, 13 and 14 the following conditions apply: $-V_{CE}$ = 5 V; f = 1 kHz; T_j = 25 °C.

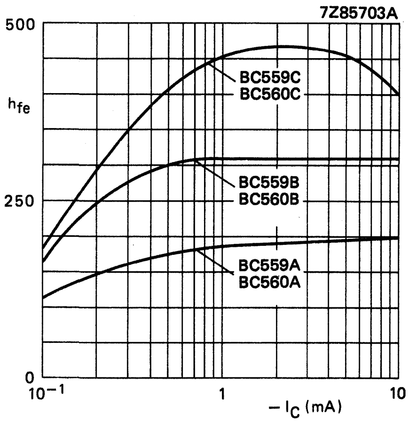


Fig. 13.

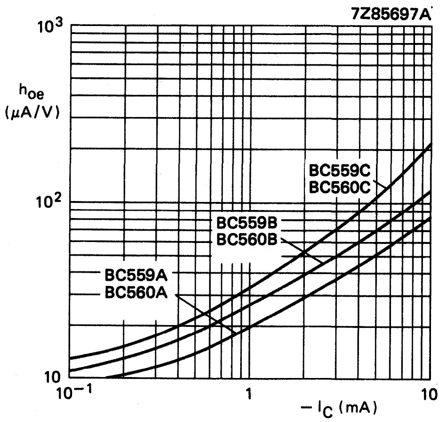


Fig. 14.

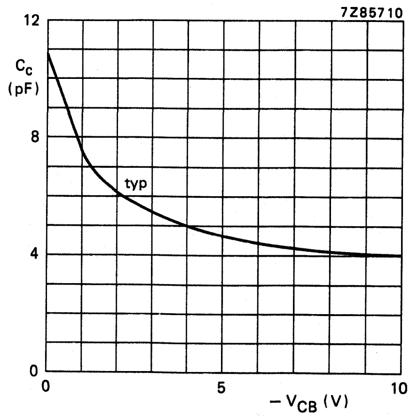


Fig. 15 f = 1 MHz; T_j = 25 °C.

curves of constant noise figure

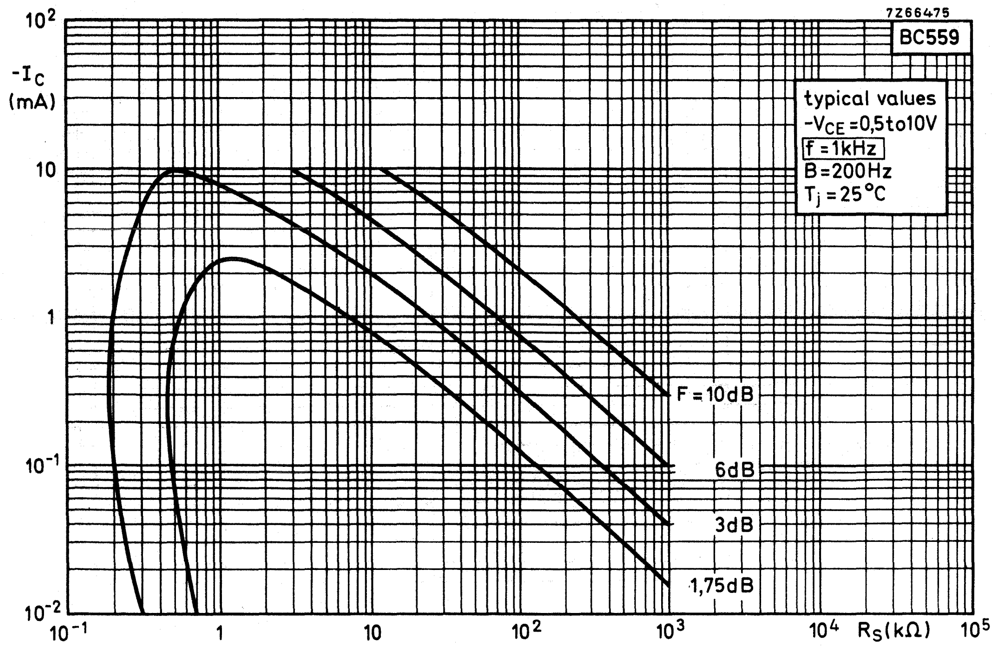


Fig. 16.

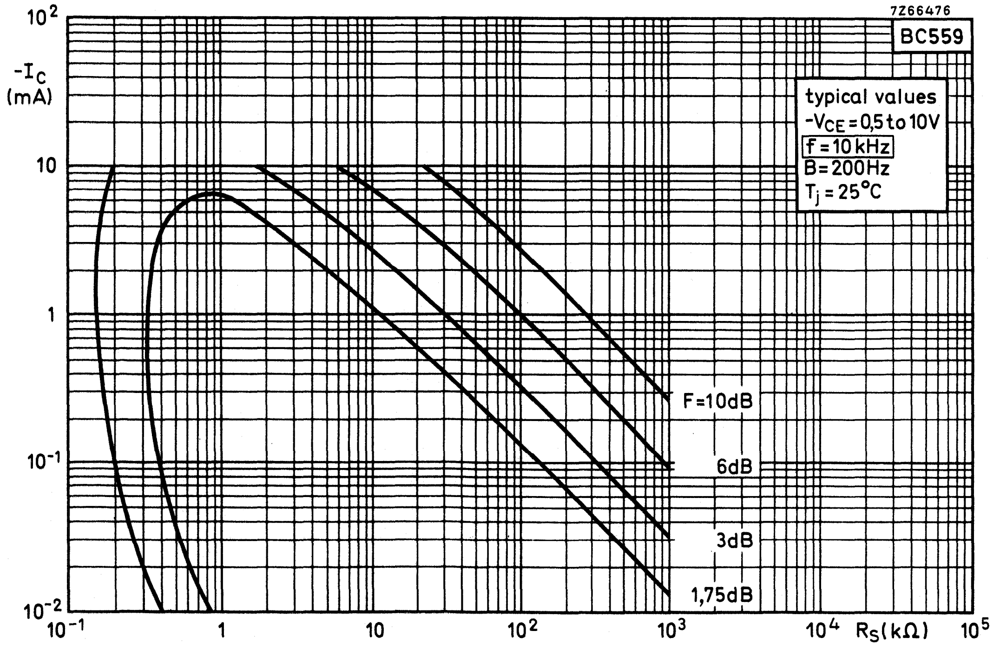


Fig. 17.

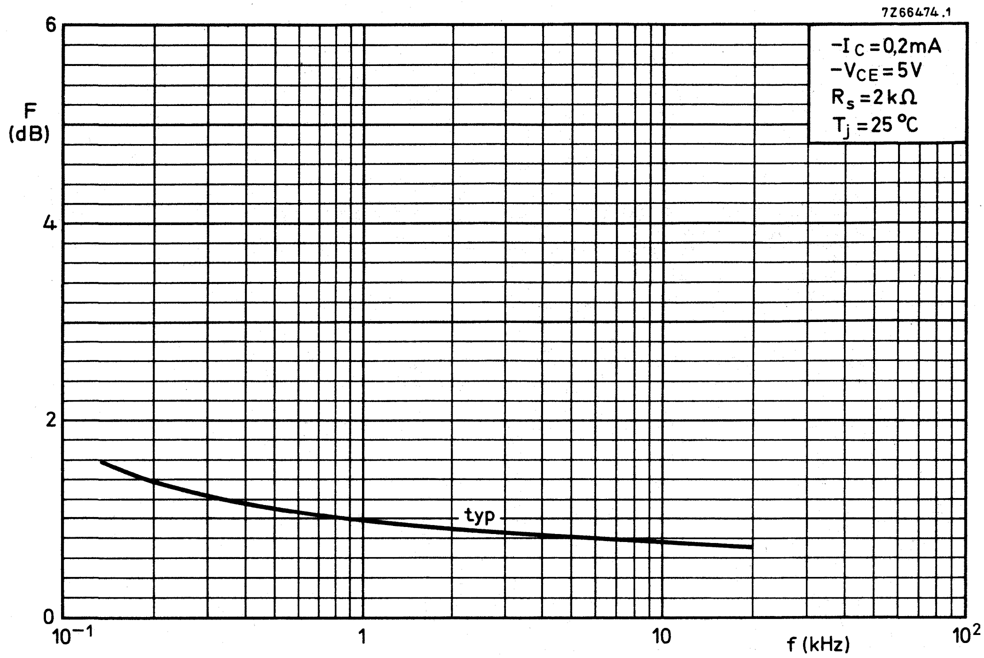

7Z66474.1
$-I_C = 0,2mA$
$-V_{CE} = 5V$
$R_s = 2 k\Omega$
$T_j = 25\ ^oC$
F (dB)
6
4
2
0
typ
10^{-1}
1
10
10^2
f (kHz)

Fig. 18.

NPN DARLINGTON TRANSISTOR

NPN small-signal Darlington transistors, each in a plastic TO-92 envelope.
They can be used for general purpose low frequency applications and as relay drivers etc.

QUICK REFERENCE DATA

			BC617	BC618	
Collector-base voltage	V_{CBO}	max.	50	80	V
Collector-emitter voltage	V_{CEO}	max.	40	55	V
DC collector current	I_C	max.	1		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
DC current gain I_C = 1 mA; V_{CE} = 5 V	h_{FE}	min.	4000	2000	

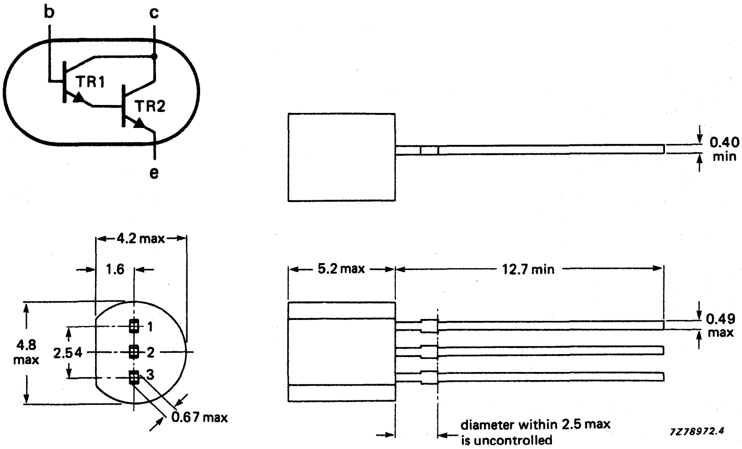
MECHANICAL DATA

Dimensions in mm

Fig.1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BC617	BC618	
Collector-base voltage	V_{CEO}	max.	50	80	V
Collector-emitter voltage	V_{CEO}	max.	40	55	V
Emitter-base voltage	V_{EBO}	max.	12		V
DC collector current	I_C	max.	1		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BC617	BC618	
Collector-emitter breakdown voltage I_C = 10 mA	$V_{(BR)CES}$	min.	40	55	V
Collector-base breakdown voltage I_C = 10 μA	$V_{(BR)CBO}$	min.	50	80	V
Emitter-base breakdown voltage I_E = 100 nA	$V_{(BR)EBO}$	min.	12	12	
Collector cut-off current V_{CB} = 40 V; I_E = 0	I_{CBO}	max.	50	–	nA
V_{CB} = 60 V; I_E = 0	I_{CBO}	max.	–	50	nA
Emitter cut-off current V_{EB} = 10 V; I_C = 0	I_{EBO}	max.	50	50	nA
DC current gain I_C = 1 mA; V_{CE} = 5 V	h_{FE}	min.	4000	2000	
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	min.	10000	4000	
I_C = 200 mA; V_{CE} = 5 V	h_{FE}	min.	10000	10000	
		max.	70000	70000	
Collector-emitter satuarion voltage I_C = 200 mA; I_B = 0.2 mA	V_{CEsat}	max.	1.1		V
Base-emitter saturation voltage I_C = 200 mA; I_B = 0.2 mA	V_{BEsat}	max.	1.6		V
Transition frequency at T_{amb} = 25 °C I_C = 500 mA; V_{CE} = 5 V; f = 100 MHz	f_T	min.	155		MHz
Output capacitance V_{CB} = 30 V; I_E = 0	C_{ob}	typ.	3.5		pF

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a plastic TO-92 envelope, primarily intended for use in driver stages of audio amplifiers. P-N-P complements are BC636, BC638 and BC640.

QUICK REFERENCE DATA

			BC635	BC637	BC639	
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	250	250	
Transition frequency I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	130	130	130	MHz

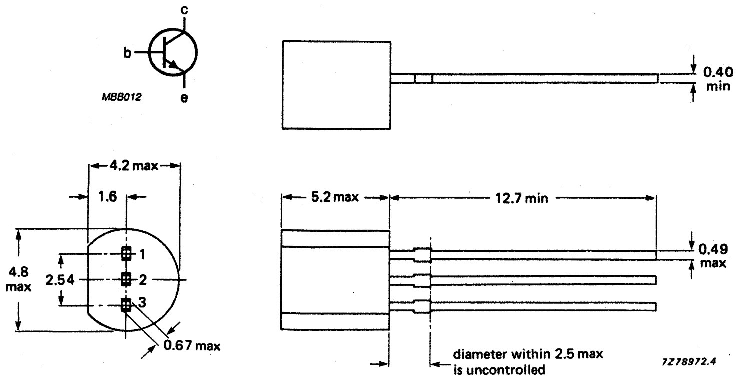
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BC635	BC637	BC639	
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-emitter voltage (R_{BE} = 0)	V_{CES}	max.	45	60	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V
Collector current (d.c.)	I_C	max.		1		A
Collector current (peak value)	I_{CM}	max.		1,5		A
Emitter current (peak value)	$-I_{EM}$	max.		1,5		A
Base current (d.c.)	I_B	max.		100		mA
Base current (peak value)	I_{BM}	max.		200		mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.		0,8		W
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	$R_{th\,j\text{-}a}$	=	156	K/W
From junction to ambient	$R_{th\,j\text{-}a}$	=	125	K/W*
From junction to case	$R_{th\,j\text{-}c}$	=	60	K/W

* Transistor mounted on printed circuit board, max. lead length 4 mm, mounting pad for collector lead min. 10 mm x 10 mm.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 30$ V	I_{CBO}	<	100	nA
$I_E = 0$; $V_{CB} = 30$ V; $T_j = 150$ °C	I_{CBO}	<	10	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	μA
Base-emitter voltage				
$I_C = 500$ mA; $V_{CE} = 2$ V	V_{BE}	<	1	V
Saturation voltage				
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	0,5	V
D.C. current gain				
$I_C = 5$ mA; $V_{CE} = 2$ V	h_{FE}	>	25	
$I_C = 150$ mA; $V_{CE} = 2$ V*	h_{FE}	> <	40 250	
$I_C = 500$ mA; $V_{CE} = 2$ V	h_{FE}	>	25	
Transition frequency at f = 35 MHz				
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	130	MHz

* BC635-10 BC637-10 BC639-10	h_{FE}	> <	63 160
BC635-16 BC637-16 BC639-16	h_{FE}	> <	100 250

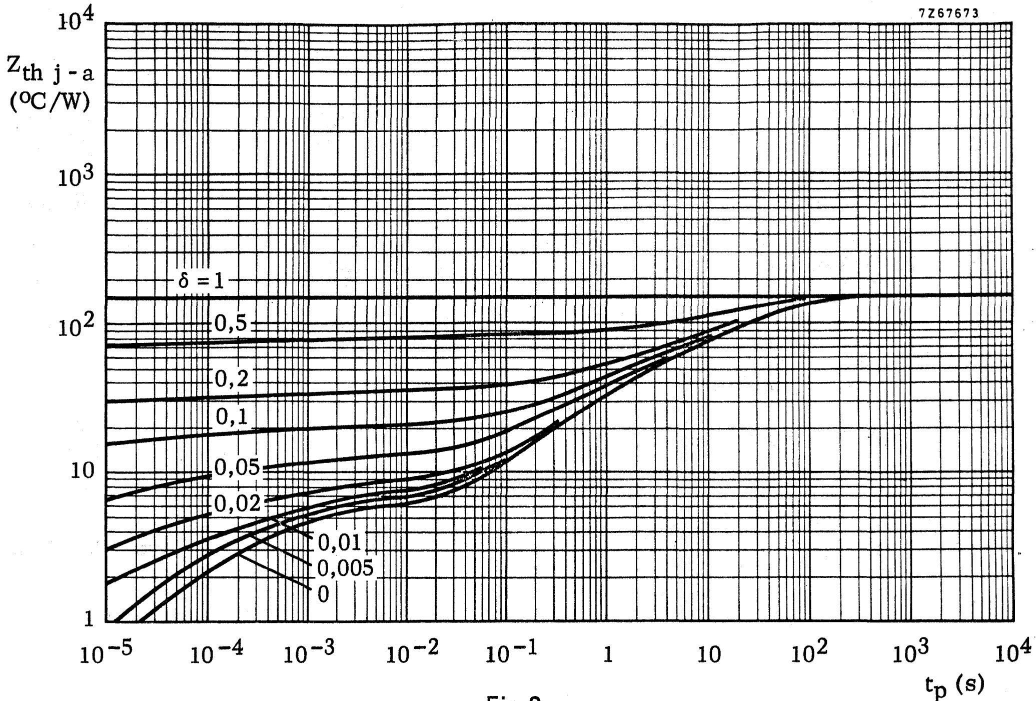

7Z67673
$Z_{th\ j-a}$ ($^oC/W$)
10^4
10^3
10^2
10
1
δ = 1
0,5
0,2
0,1
0,05
0,02
0,01
0,005
0
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
10^4
t_p (s)

Fig. 2.

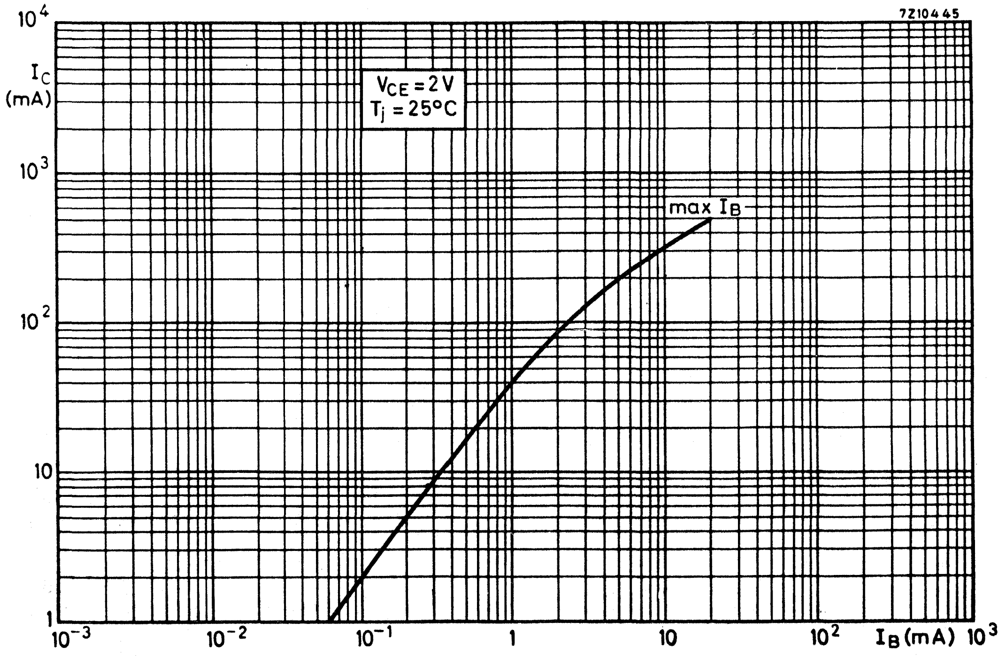

7Z10445
I_C (mA)
10^4
10^3
10^2
10
1
$V_{CE} = 2\,V$
$T_j = 25^oC$
max I_B
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
I_B (mA)
10^3

Fig. 3.

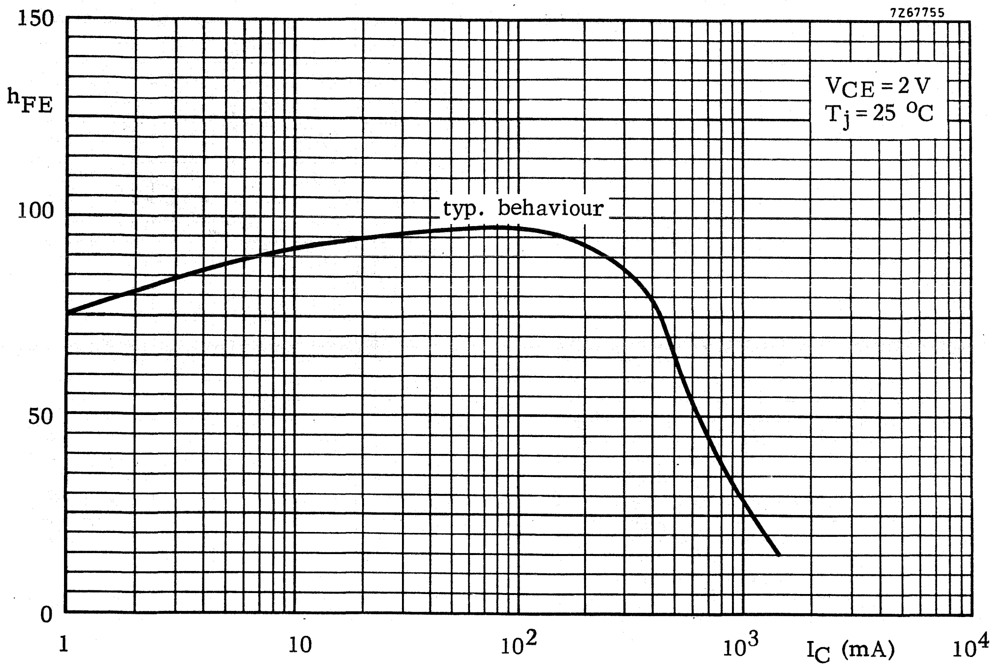


Fig. 4.

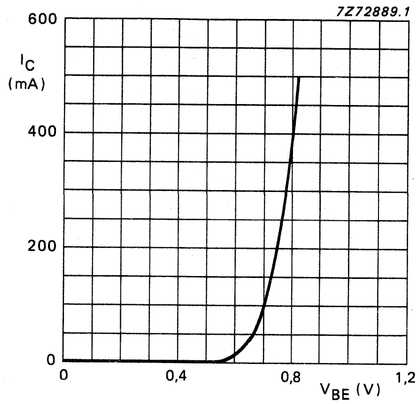


Fig. 5 V_{CE} = 2 V; T_j = 25 °C; typical values.

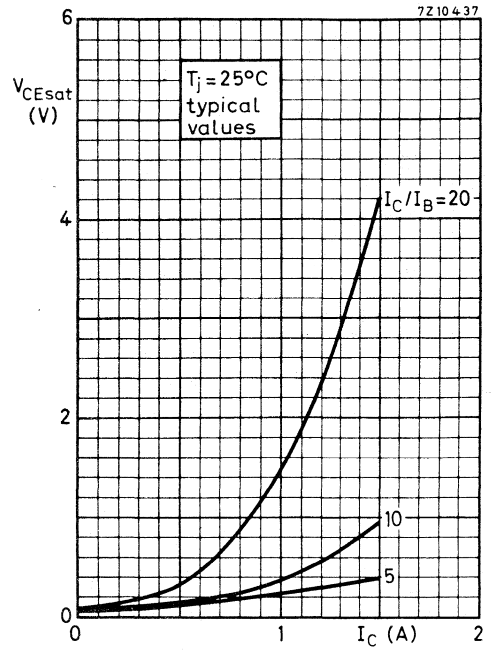


Fig. 6.

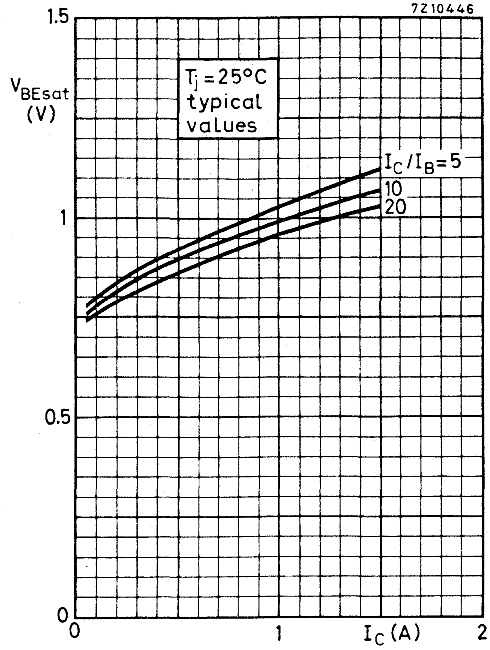


Fig. 7.

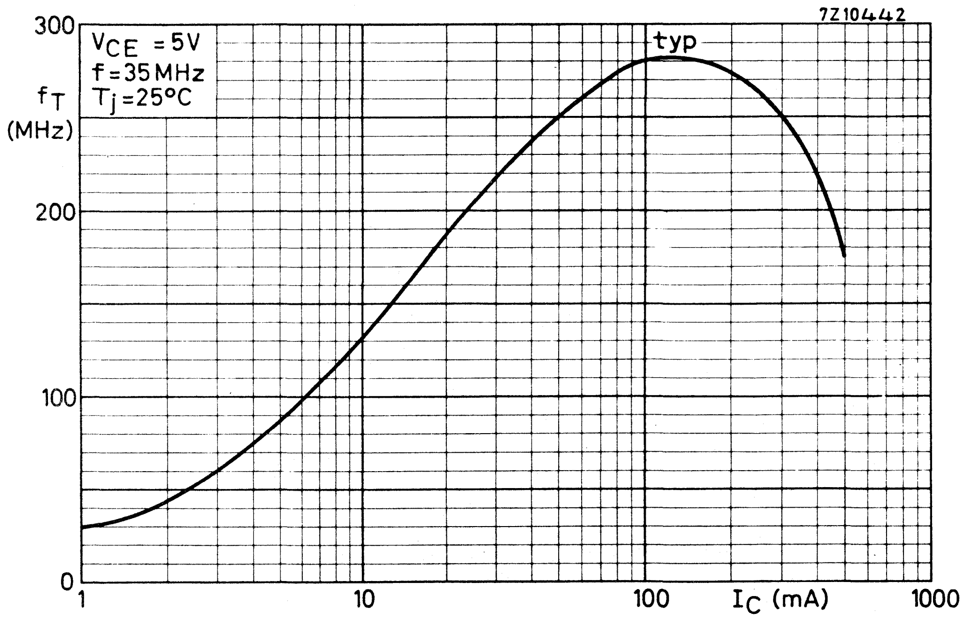


Fig. 8.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in a plastic TO-92 envelope, primarily intended for use in driver stages of audio amplifiers. N-P-N complements are BC635, BC637 and BC639.

QUICK REFERENCE DATA

			BC636	BC638	BC640	
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	250	250	
Transition frequency $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	50	50	50	MHz

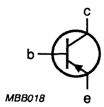
MECHANICAL DATA

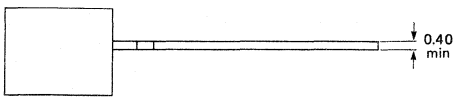
Dimensions in mm

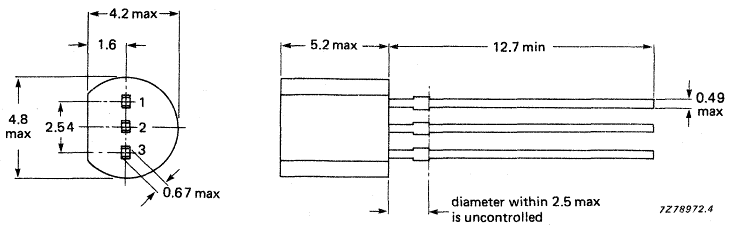
Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector







RATINGS

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

			BC636	BC638	BC640	
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-emitter voltage ($-V_{BE}$ = 0)	$-V_{CES}$	max.	45	60	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V
Collector current (d.c.)	$-I_C$	max.		1		A
Collector current (peak value)	$-I_{CM}$	max.		1,5		A
Emitter current (peak value)	I_{EM}	max.		1,5		A
Base current (d.c.)	$-I_B$	max.		100		mA
Base current (peak value)	$-I_{BM}$	max.		200		mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.		0,8		W
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	$R_{th\,j\text{-}a}$	=	156	K/W
From junction to ambient	$R_{th\,j\text{-}a}$	=	125	K/W*
From junction to case	$R_{th\,j\text{-}c}$	=	60	K/W

* Transistor mounted on printed circuit board, max. lead length 4 mm, mounting pad for collector lead min. 10 mm x 10 mm.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $-V_{CB} = 30$ V	$-I_{CBO}$	<	100 nA
$I_E = 0$; $-V_{CB} = 30$ V; $T_j = 150$ °C	$-I_{CBO}$	<	10 μA
Emitter cut-off current			
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	10 μA
Base-emitter voltage			
$-I_C = 500$ mA; $-V_{CE} = 2$ V	$-V_{BE}$	<	1 V
Saturation voltage			
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	0,5 V
D.C. current gain			
$-I_C = 5$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25
$-I_C = 150$ mA; $-V_{CE} = 2$ V*	h_{FE}	> <	40 250
$-I_C = 500$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25
Transition frequency at f = 35 MHz			
$-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	50 MHz

* BC636-10 BC638-10 BC640-10	h_{FE}	> <	63 160
BC636-16 BC638-16 BC640-16	h_{FE}	> <	100 250

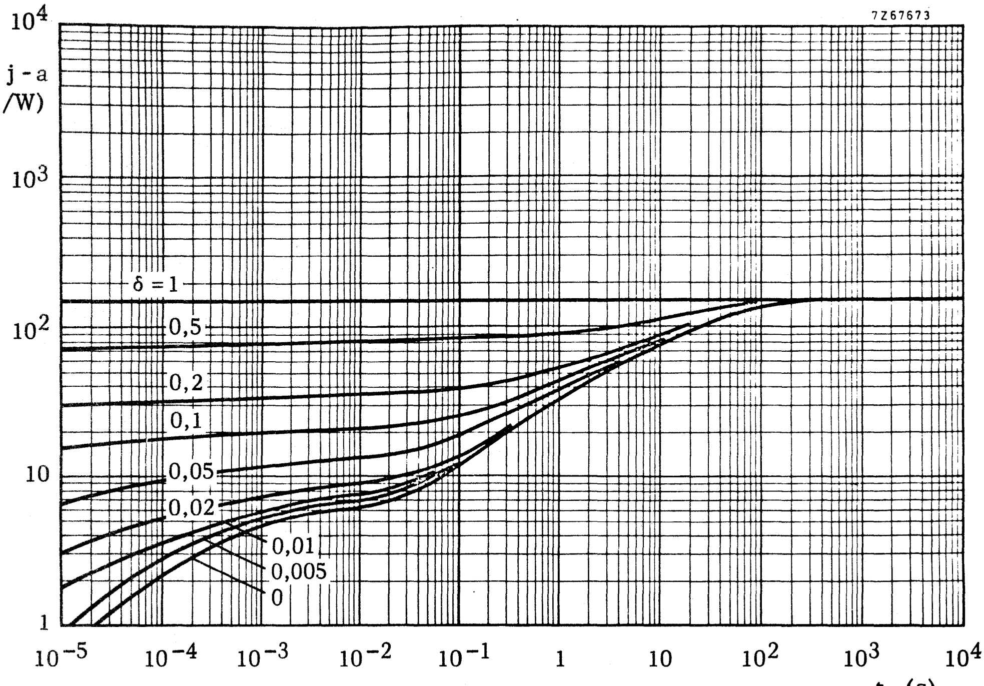

7Z67673
$Z_{th\ j-a}$ (°C/W)
δ = 1
0,5
0,2
0,1
0,05
0,02
0,01
0,005
0
10^4
10^3
10^2
10
1
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
10^4
t_p (s)

Fig. 2.

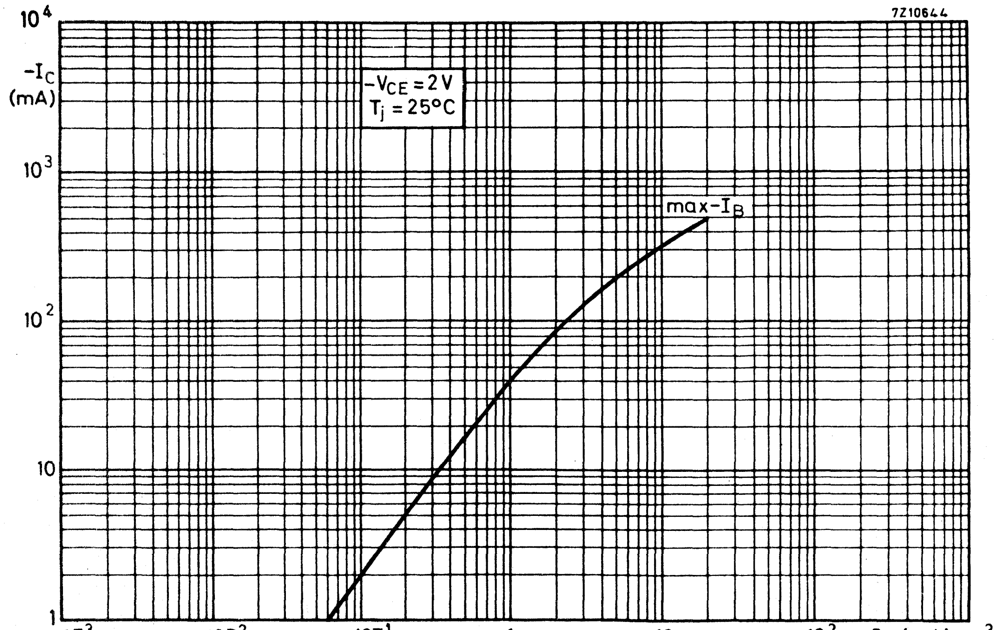

7Z10644
$-I_C$ (mA)
$-V_{CE} = 2$ V
$T_j = 25$ °C
max $-I_B$
10^4
10^3
10^2
10
1
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
$-I_B$ (mA)
10^3

Fig. 3.

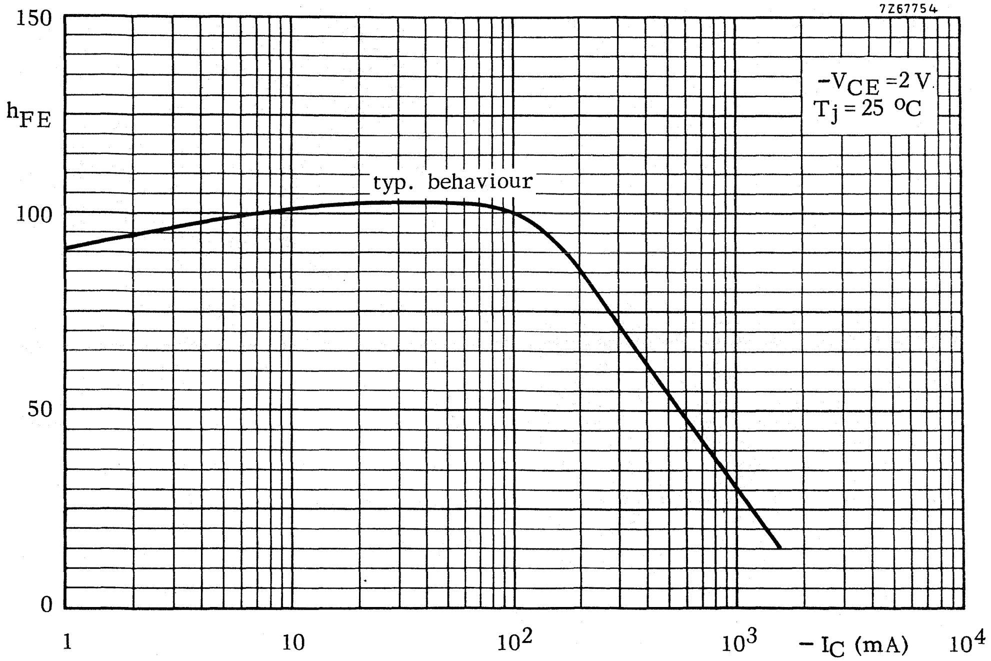


Fig. 4.

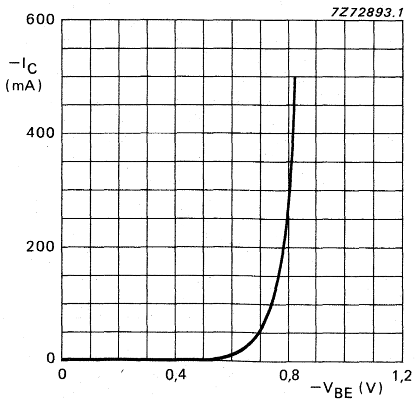


Fig. 5 $-V_{CE}$ = 2 V; T_j = 25 °C; typical values.

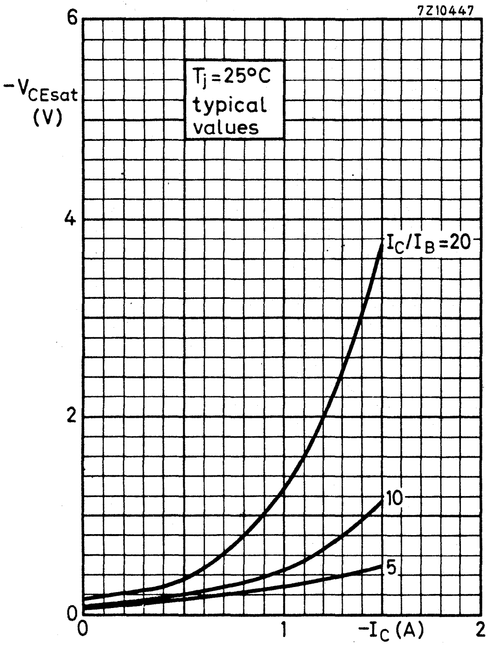


Fig. 6.

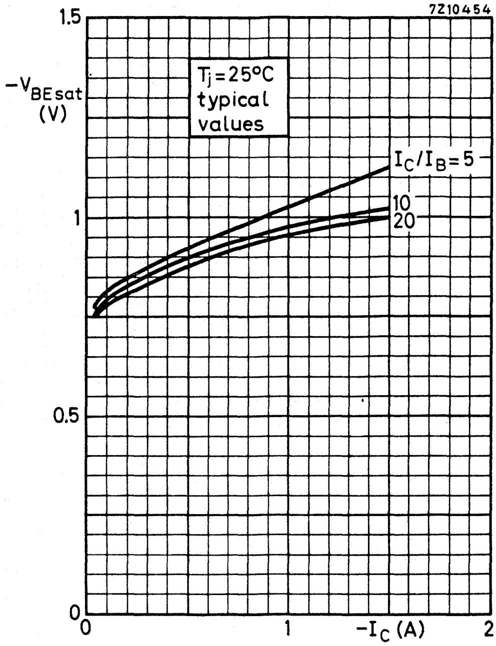


Fig. 7.

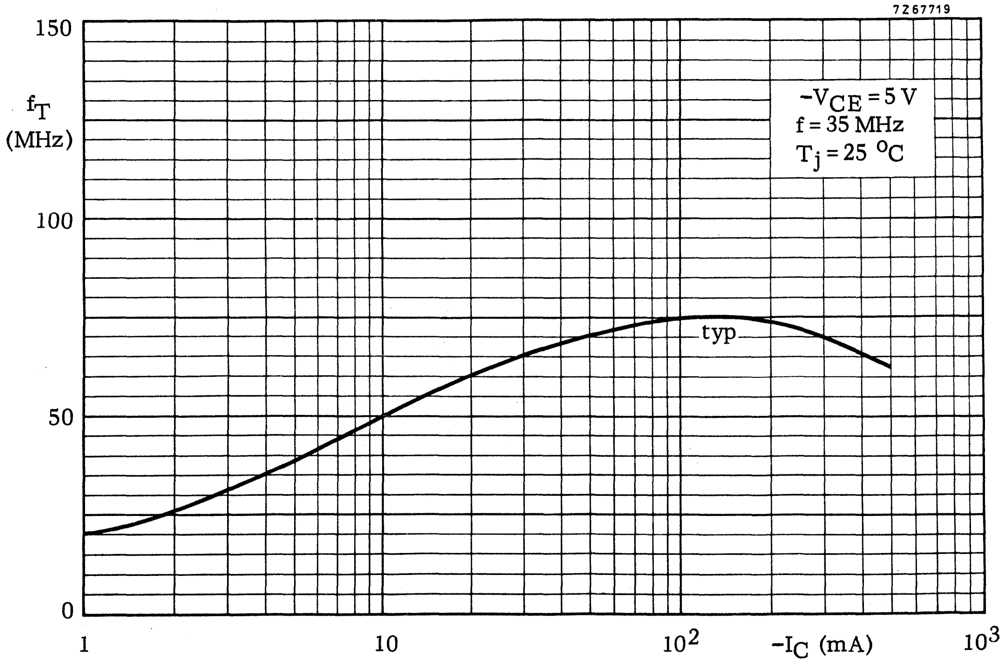


Fig. 8.

SMALL-SIGNAL DARLINGTON TRANSISTORS

NPN epitaxial small-signal Darlington transistors, each in a plastic TO-92 envelope with an integrated diode and resistor.

They can be used for general purpose low frequency applications and as relay drivers etc.

PNP complementary types are the BC876, BC878, and BC880.

QUICK REFERENCE DATA

			BC875	877	879	
Collector-base voltage	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	V
DC collector current	I_C	max.		1		A
Total power dissiaption up to T_{amb} = 25 °C	P_{tot}	max.		0.8		W
DC current gain I_C = 150 mA; V_{CE} = 10 V	h_{FE}	min.		1000		

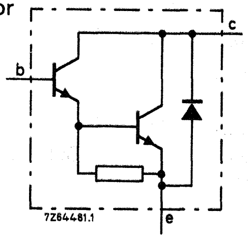
MECHANICAL DATA

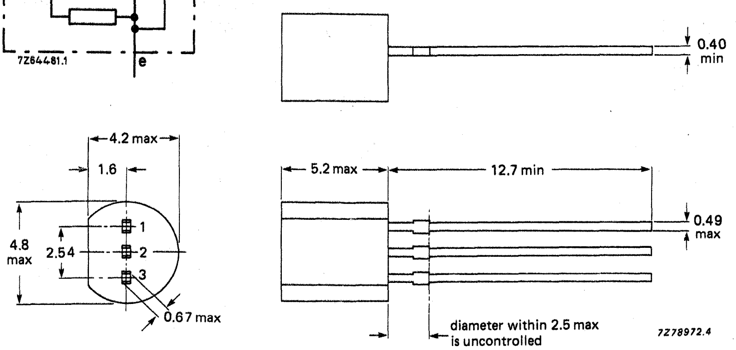
Dimensions in mm

Fig.1 TO-92.

Pinning

1 = base
2 = collector
3 = emitter





RATINGS

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

			BC875	877	879	
Collector-base voltage	V_{CBO}	max.	60	80	100	V
Collector-emitter voltage	V_{CEO}	max.	45	60	80	V
Emitter-base voltage	V_{EBO}	max.		5		V
DC collector current	I_C	max.		1		A
Total power dissipation up to						
T_{amb} = 25 °C	P_{tot}	max.		0.8		W
T_{amb} = 25 °C (note 1)	P_{tot}	max.		1		W
Storage temperature range	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	156	K/W
From junction to ambient (note 1)	$R_{th\ j\text{-}a}$	=	125	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BC875	877	879	
Collector-emitter breakdown voltage						
I_C = 50 mA; I_B = 0	$V_{(BR)CEO}$	min.	45	60	80	V
Collector-base breakdown voltage						
I_C = 100 μA; I_B = 0	$V_{(BR)CBO}$	min.	60	80	100	V
Emitter-base breakdown voltage						
I_E = 100 μA; I_C = 0	$V_{(BR)EBO}$	min.	5	5	5	V
Collector cut-off current						
V_{CB} = 60 V; I_E = 0	I_{CBO}	max.	100	—	—	nA
V_{CB} = 80 V; I_E = 0	I_{CBO}	max.	—	100	—	nA
V_{CB} = 100 V; I_E = 0	I_{CBO}	max.	—	—	100	nA
V_{CE} = 22.2 V; I_B = 0	I_{CEO}	max.	500	—	—	nA
V_{CE} = 30 V; I_B = 0	I_{CEO}	max.	—	500	—	nA
V_{CE} = 40 V; I_B = 0	I_{CEO}	max.	—	—	500	nA
Emitter cut-off current						
V_{EB} = 4 V; I_C = 0	I_{EBO}	max.		100		nA
DC current gain						
I_C = 150 mA; V_{CE} = 10 V	h_{FE}	min.		1000		
I_C = 0.5 A; V_{CE} = 10 V	h_{FE}	min.		2000		

Note

1. Mounted on a printed circuit board, max. lead length 4 mm, mounting pad for collector lead min. 10 mm x 10 mm.

			BC875	877	879	
Collector-emitter saturation voltage						
I_C = 0.5 A; I_B = 0.5 mA	V_{CEsat}	max.		1.3		V
I_C = 1.0 A; I_B = 1.0 mA	V_{CEsat}	max.		1.8		V
Base-emitter saturation voltage						
I_C = 1.0 A; I_B = 1.0 mA	V_{BEsat}	max.		2.2		V
Transition frequency at T_{amb} = 25 °C						
I_C = 0.5 A; V_{CE} = 5 V; f = 35 MHz	f_T	typ.		200		MHz

SMALL-SIGNAL DARLINGTON TRANSISTORS

PNP epitaxial small-signal Darlington transistors, each in a plastic TO-92 envelope with an integrated diode and resistor.

They can be used for general purpose low frequency applications and as relay drivers etc.

NPN complementary types are the BC875, BC877, and BC879.

QUICK REFERENCE DATA

			BC876	878	880	
Collector-base voltage	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	V
DC collector current	$-I_C$	max.		1		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		0.8		W
DC current gain $-I_C$ = 150 mA; $-V_{CE}$ = 10 V	h_{FE}	min.		1000		

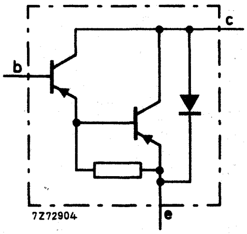
MECHANICAL DATA

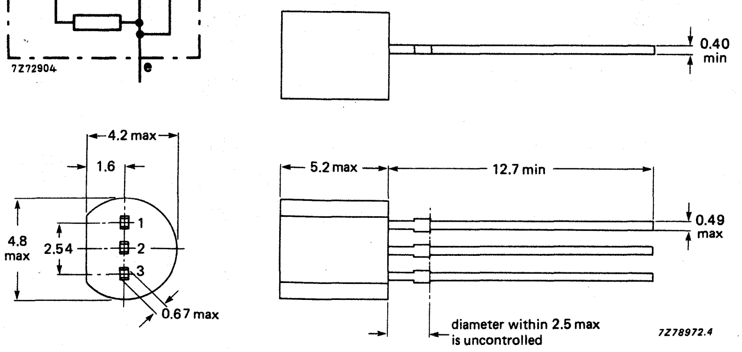
Dimensions in mm

Fig.1 TO-92.

Pinning

1 = base
2 = collector
3 = emitter





RATINGS

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

			BC876	878	880	
Collector-base voltage	$-V_{CBO}$	max.	60	80	100	V
Collector-emitter voltage	$-V_{CEO}$	max.	45	60	80	V
Emitter-base voltage	$-V_{EBO}$	max.		5		V
DC collector current	$-I_C$	max.		1		A
Total power dissipation up to						
T_{amb} = 25 °C	P_{tot}	max.		0.8		W
T_{amb} = 25 °C (note 1)	P_{tot}	max.		1		W
Storage temperature range	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	156	K/W
From junction to ambient (note 1)	$R_{th\ j\text{-}a}$	=	125	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BC876	878	880	
Collector-emitter breakdown voltage						
$-I_C$ = 50 mA; $-I_B$ = 0	$-V_{(BR)CEO}$	min.	45	60	80	V
Collector-base breakdown voltage						
$-I_C$ = 100 μA; $-I_B$ = 0	$-V_{(BR)CBO}$	min.	60	80	100	V
Emitter-base breakdown voltage						
$-I_E$ = 100 μA; $-I_C$ = 0	$-V_{(BR)EBO}$	min.	5	5	5	V
Collector cut-off current						
$-V_{CB}$ = 60 V; $-I_E$ = 0	$-I_{CBO}$	max.	100	—	—	nA
$-V_{CB}$ = 80 V; $-I_E$ = 0	$-I_{CBO}$	max.	—	100	—	nA
$-V_{CB}$ = 100 V; $-I_E$ = 0	$-I_{CBO}$	max.	—	—	100	nA
$-V_{CE}$ = 22.2 V; $-I_B$ = 0	$-I_{CEO}$	max.	500	—	—	nA
$-V_{CE}$ = 30 V; $-I_B$ = 0	$-I_{CEO}$	max.	—	500	—	nA
$-V_{CE}$ = 40 V; $-I_B$ = 0	$-I_{CEO}$	max.	—	—	500	nA
Emitter cut-off current						
$-V_{EB}$ = 4 V; $-I_C$ = 0	$-I_{EBO}$	max.		100		nA
DC current gain						
$-I_C$ = 150 mA; $-V_{CE}$ = 10 V	h_{FE}	min.		1000		
$-I_C$ = 0.5 A; $-V_{CE}$ = 10 V	h_{FE}	min.		2000		

Note

1. Mounted on a printed circuit board, max. lead length 4 mm, mounting pad for collector lead min. 10 mm x 10 mm.

			BC876	878	880	
Collector-emitter saturation voltage						
$-I_C$ = 0.5 A; $-I_B$ = 0.5 mA	$-V_{CEsat}$	max.		1.3		V
$-I_C$ = 1.0 A; $-I_B$ = 1.0 mA	$-V_{CEsat}$	max.		1.8		V
Base-emitter saturation voltage						
$-I_C$ = 1.0 A; $-I_B$ = 1.0 mA	$-V_{BEsat}$	max.		2.2		V
Transition frequency at T_{amb} = 25 °C						
$-I_C$ = 0.5 A; $-V_{CE}$ = 5 V; f = 35 MHz	f_T	typ.		200		MHz

Philips Components

Data sheet	
status	Preliminary specification
date of issue	June 1990

BCX22

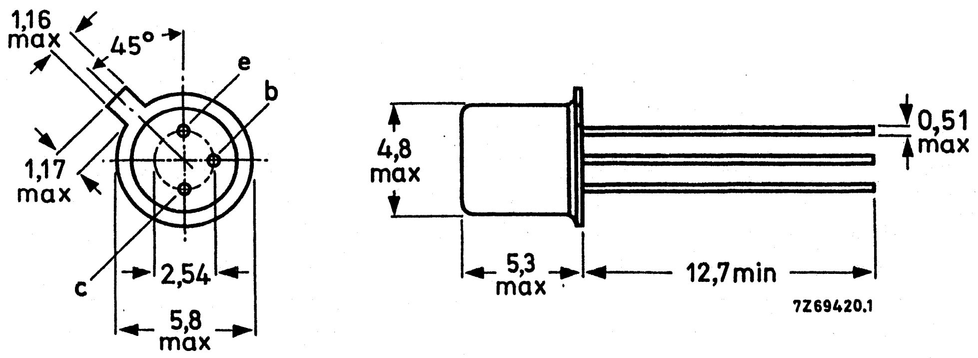
Silicon planar epitaxial transistor

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{CEO}	collector-emitter voltage		-	-	125	V
I_C	collector current	average value	-	-	800	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	-	-	450	mW
P_{tot}	total power dissipation	$T_{case} \leq 45$ °C	-	-	1.55	W
T_j	junction temperature		-	-	200	°C
h_{FE}	DC current gain	$V_{CE} = 1$ V $I_C = 100$ mA	63			
V_{CEsat}	collector-emitter saturation voltage	$I_B = 30$ mA $I_C = 300$ mA	-	-	0.9	V
f_T	transition frequency	$V_{CE} = 5$ V $I_C = 10$ mA	-	100	-	MHz

MECHANICAL DATA

Dimensions in mm



Collector connected to case.

Fig.1 TO-18.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CES}	collector-emitter voltage	$V_{BE} = 0$	-	125	V
V_{CEO}	collector-emitter voltage	$I_B = 0$	-	125	V
V_{EBO}	emitter-base voltage	$I_C = 0$	-	5	V
I_C	collector current		-	800	mA
I_{CM}	collector current	peak value	-	1	A
I_B	base current		-	100	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	-	450	mW
P_{tot}	total power dissipation	$T_{case} \leq 45$ °C	-	1.55	W
T_{stg}	storage temperature range		−65	150	°C
T_j	junction temperature		-	200	°C

THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient	500	K/W
$R_{th\ j\text{-}c}$	from junction to case	200	K/W

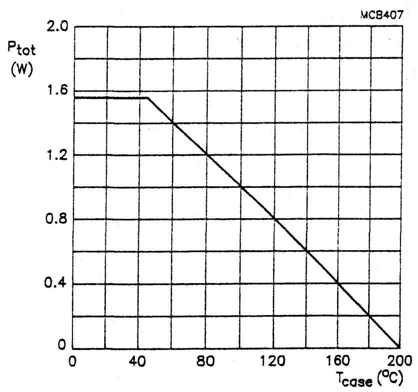


Fig.2 Total power dissipation as a function of case temperature.

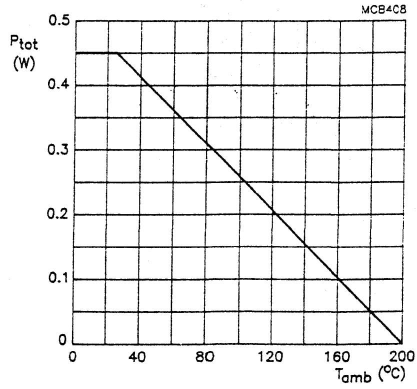


Fig.3 Total power dissipation as a function of ambient temperature.

Silicon planar epitaxial transistor BCX22

CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{(BR)CES}$	collector-emitter breakdown voltage	V_{BE} = 0 I_C = 100 μA	125	-	-	V
$V_{(BR)CEO}$	collector-emitter breakdown voltage	I_B = 0 I_C = 10 mA	125	-	-	V
$V_{(BR)EBO}$	emitter-base breakdown voltage	I_E = 100 μA I_C = 0	5	-	-	V
I_{CES}	collector cut-off current	V_{BE} = 0 V_{CE} = 100 V	-	-	100	nA
I_{CES}	collector cut-off current	V_{BE} = 0 V_{CE} = 100 V T_{amb} = 150 °C	-	-	10	μA
V_{CEsat}	collector-emitter saturation voltage	I_B = 30 mA I_C = 300 mA	-	-	0.9	V
V_{BEsat}	base-emitter saturation voltage	I_B = 30 mA I_C = 300 mA	-	-	1.4	V
h_{FE}	DC current gain	V_{CE} = 1 V I_C = 100 mA	63	-	-	
h_{FE}	DC current gain	V_{CE} = 1 V I_C = 200 mA	40	-	-	
f_T	transition frequency	V_{CE} = 5 V I_C = 10 mA f = 20 MHz	-	100	-	MHz
C_c	collector capacitance	V_{CB} = 10 V I_E = 0 f = 1 MHz	-	12	-	pF

Philips Components

Data sheet	
status	Preliminary specification
date of issue	June 1990

BCX23

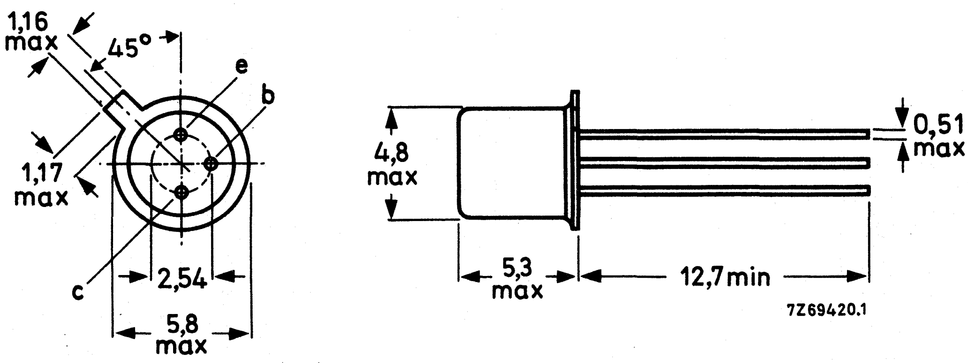
Silicon planar epitaxial transistor

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$-V_{CEO}$	collector-emitter voltage		-	-	125	V
$-I_C$	collector current		-	-	800	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	-	-	450	mW
P_{tot}	total power dissipation	$T_{case} \leq 45$ °C	-	-	1.55	W
T_j	junction temperature		-	-	200	°C
h_{FE}	DC current gain	$-V_{CE} = 1$ V $-I_C = 100$ mA	63	-	-	
$-V_{CEsat}$	collector-emitter saturation voltage	$-I_B = 30$ mA $-I_C = 300$ mA	-	-	0.9	V
f_T	transition frequency	$-V_{CE} = 5$ V $-I_C = 10$ mA	-	100	-	MHz

MECHANICAL DATA

Dimensions in mm



Collector connected to case.

Fig.1 TO-18.

Silicon planar epitaxial transistor BCX23

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$-V_{CES}$	collector-emitter voltage	$V_{BE} = 0$	-	125	V
$-V_{CEO}$	collector-emitter voltage	$I_B = 0$	-	125	V
$-V_{EBO}$	emitter-base voltage	$I_C = 0$	-	5	V
$-I_C$	collector current	average value	-	800	mA
$-I_{CM}$	collector current	peak value	-	1	A
$-I_B$	base current		-	100	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	-	450	mW
P_{tot}	total power dissipation	$T_{case} \leq 45$ °C	-	1.55	W
T_{stg}	storage temperature range		−65	150	°C
T_j	junction temperature		-	175	°C

THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient	500	K/W
$R_{th\ j\text{-}c}$	from junction to case	200	K/W

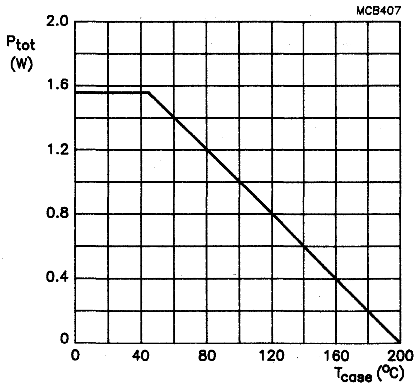


Fig.2 Total power dissipation as a function of case temperature.

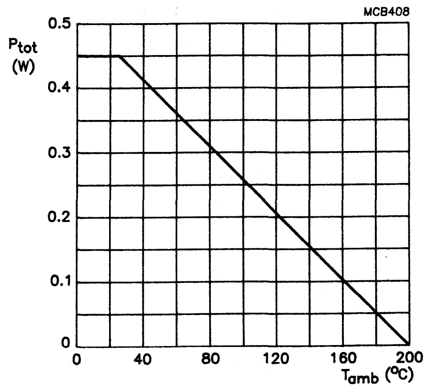


Fig.3 Total power dissipation as a function of ambient temperature.

Silicon planar epitaxial transistor BCX23

CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$-V_{(BR)CES}$	collector-emitter breakdown voltage	V_{BE} = 0 $-I_C$ = 100 μA	125	-	-	V
$-V_{(BR)CEO}$	collector-emitter breakdown voltage	I_B = 0 $-I_C$ = 10 mA	125	-	-	V
$-V_{(BR)EBO}$	emitter-base breakdown voltage	$-I_E$ = 100 μA I_C = 0	5	-	-	V
$-I_{CES}$	collector cut-off current	V_{BE} = 0 $-V_{CE}$ = 100 V	-	-	100	nA
$-I_{CES}$	collector cut-off current	V_{BE} = 0 $-V_{CE}$ = 100 V T_{amb} = 150 °C	-	-	10	μA
$-V_{CEsat}$	collector-emitter saturation voltage	$-I_B$ = 30 mA $-I_C$ = 300 mA	-	-	0.9	V
$-V_{BEsat}$	base-emitter saturation voltage	$-I_B$ = 30 mA $-I_C$ = 300 mA	-	-	1.4	V
h_{FE}	DC current gain	$-V_{CE}$ = 1 V $-I_C$ = 100 mA	63	-	-	
h_{FE}	DC current gain	$-V_{CE}$ = 1 V $-I_C$ = 200 mA	40	-	-	
f_T	transition frequency	$-V_{CE}$ = 5 V $-I_C$ = 10 mA f = 20 MHz	-	100	-	MHz
C_c	collector capacitance	$-V_{CB}$ = 10 V I_E = 0 f = 1 MHz	-	12	-	pF

N-P-N SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon planar epitaxial transistors in a plastic TO-92 envelope.
P-N-P complementary types are BCX78 and BCX79.

QUICK REFERENCE DATA

			BCX58	BCX59	
Collector-emitter voltage (open base)	V_{CEO}	max.	32	45	V
Collector-emitter voltage (emitter to base)	V_{CES}	max.	32	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7		V
Collector current (peak)	I_{CM}	max.	200		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	450		mW
Junction temperature	T_j	max.	150		°C
Transition frequency	f_T	>	125		MHz

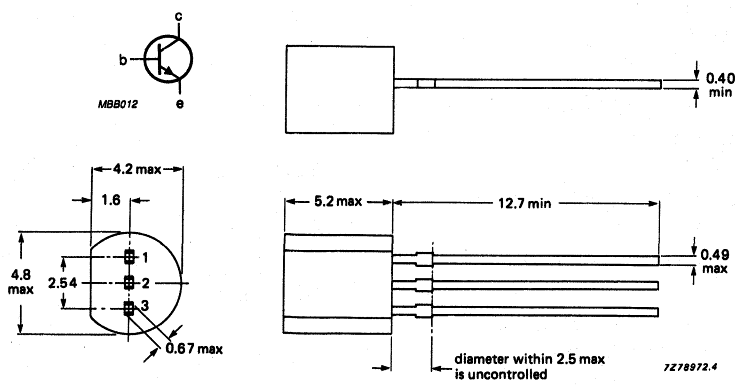
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BCX58	BCX59	
Collector-emitter voltage (open base)	V_{CEO}	max.	32	45	V
Collector-emitter voltage (emitter to base)	V_{CES}	max.	32	45	V
Emitter-base voltage	V_{EBO}	max.	7		V
Collector current (d.c.)	I_C	max.	100		mA
Collector current (peak value)	I_{CM}	max.	200		mA
Base current (d.c.)	I_B	max.	50		mA
Total power dissipation up to T_{amb} = 25 ^oC	P_{tot}	max.	450		mW
Junction temperature	T_j	max.	150		^oC
Storage temperature	T_{stg}		−55 to +150		^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	280	K/W

CHARACTERISTICS

T_j = 25 ^oC unless otherwise specified

			BCX58	BCX59	
Collector-emitter current					
V_{CE} = 32 V	I_{CES}	<	10		nA
V_{CE} = 32 V; T_j = 125 ^oC	I_{CES}	<	2,5		μA
V_{CE} = 32 V; V_{BE} = 0,2 V; T_j = 100 ^oC	I_{CEX}	<	20		μA
Collector-emitter current					
V_{CE} = 45 V	I_{CES}	<		10	nA
V_{CE} = T_j = 125 ^oC	I_{CES}	<		2,5	μA
V_{CE} = 45 ^oC; V_{BE} = 0,2 V; T_j = 100 ^oC	I_{CEX}	<		20	μA
Emitter-base current					
V_{EBO} = 5 V	I_{EBO}	<	20	20	nA
Collector-emitter breakdown voltage					
I_C = 10 mA	$V_{(BR)CEO}$	>	32	45	V
Emitter-base breakdown voltage					
I_{EBO} = 1 μA	$V_{(BR)EBO}$	>	7		V
Collector-emitter saturation voltage					
I_C = 100 mA; I_B = 2,5 mA	V_{CEsat}	<	0,5		V
I_C = 100 mA; I_B = 2,5 mA	V_{BEsat}	<	1,0		V
Collector-base capacitance at 1 MHz					
V_{CBO} = 10 V	C_{cb}	<	4,5		pF

			BCX58	BCX59	
Emitter-base capacitance at 1 MHz					
$V_{EBO} = 0,5$ V	C_{eb}	>		15	pF
Transition frequency at f = 100 MHz					
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	<		125	MHz
Noise figure at f = 1 kHz					
$I_C = 0,2$ mA; $V_{CE} = 5$ V; $R_S = 2$ kΩ	F	<		6	dB
		typ.		2	dB

type		BCX58, BCX59				BCX58
h_{FE} group		7	8	9	10	BCX59
V_{CE} (V)	I_C (mA)	h_{FE}	h_{FE}	h_{FE}	h_{FE}	V_{BE} (V)
5	0,01	78	145 (>20)	220 (>40)	300 (>100)	0,5
5	2	170	250	350	500	0,62
		(120 – 220)	(180 – 310)	(250 – 460)	(380 – 630)	(0,55 – 0,7)
1	10	190	260	380	550	0,7
		(>80)	(120 – 400)	(160 – 630)	(240 – 1000)	
1	100	>40	>45	>60	>60	0,83

P-N-P SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P silicon planar epitaxial transistors in a plastic TO-92 envelope.
N-P-N complementary types are BCX58 and BCX59.

QUICK REFERENCE DATA

			BCX78	BCX79	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	32	45	V
Collector-emitter voltage (emitter to base)	$-V_{CES}$	max.	32	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current (peak)	$-I_{CM}$	max.	200		mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	450		mW
Junction temperature	T_j	max.	150		^{o}C
Transition frequency	f_T	>	200		MHz

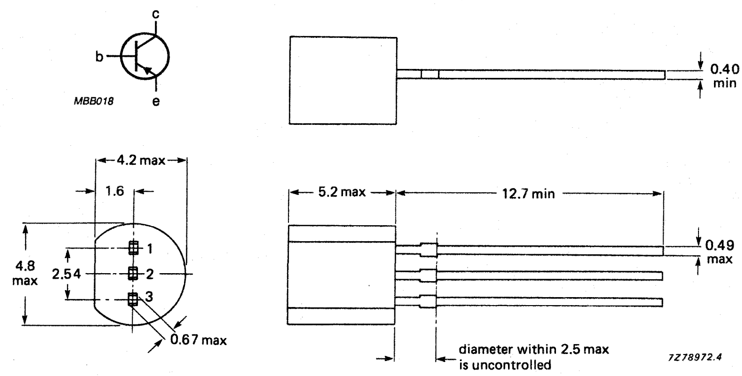
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BCX78	BCX79	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	32	45	V
Collector-emitter voltage (emitter to base)	$-V_{CES}$	max.	32	45	V
Emitter-base voltage	$-V_{EBO}$	max.	5		V
Collector current (d.c.)	$-I_C$	max.	100		mA
Collector current (peak value)	$-I_{CM}$	max.	200		mA
Base current (d.c.)	$-I_B$	max.	50		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	450		mW
Junction temperature	T_j	max.	150		°C
Storage temperature	T_{stg}		−55 to +150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	max.	280	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BCX78	BCX79	
Collector-emitter current					
$-V_{CE}$ = 32 V	$-I_{CES}$	<	10		nA
$-V_{CE}$ = 32 V; T_j = 125 °C	$-I_{CES}$	<	2,5		μA
$-V_{CE}$ = 32 V; $-V_{BE}$ = 0,2 V; T_j = 100 °C	$-I_{CEX}$	<	20		μA
Collector-emitter current					
$-V_{CE}$ = 45 V	$-I_{CES}$	<		10	nA
$-V_{CE}$ = T_j = 125 °C	$-I_{CES}$	<		2,5	μA
$-V_{CE}$ = 45 °C; $-V_{BE}$ = 0,2 V; T_j = 100 °C	$-I_{CEX}$	<		20	μA
Emitter-base current					
$-V_{EBO}$ = 4 V	$-I_{EBO}$	<	20	20	nA
Collector-emitter breakdown voltage					
$-I_C$ = 10 mA	$-V_{(BR)CEO}$	>	32	45	V
Emitter-base breakdown voltage					
$-I_{EBO}$ = 1 μA	$-V_{(BR)EBO}$	>	5		V
Collector-emitter saturation voltage					
$-I_C$ = 100 mA; $-I_B$ = 2,5 mA	$-V_{CEsat}$	<	0,6		V
$-I_C$ = 100 mA; $-I_B$ = 2,5 mA	$-V_{BEsat}$	<	1,0		V
Collector-base capacitance at 1 MHz					
$-V_{CBO}$ = 10 V	C_{cb}	<	4,5		pF
Emitter-base capacitance at 1 MHz					
$-V_{EBO}$ = 0,5 V	C_{eb}	<	15		pF

Values shown once in the BCX78 column without a BCX79 entry where the ruled divider ends are printed centred and apply to both types.

			BCX78	BCX79	
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	>	200		MHz
Noise figure at f = 1 kHz $-I_C$ = 0,2 mA; $-V_{CE}$ = 5 V; R_S = 2 kΩ	F	<	6		dB
		typ.	2		dB

type		BCX78, BCX79				BCX78
h_{FE} group		7	8	9	10	BCX79
$-V_{CE}$ (V)	$-I_C$ (mA)	h_{FE}	h_{FE}	h_{FE}	h_{FE}	$-V_{BE}$ (V)
5	0,01	140	200 (>30)	270 (>40)	340 (>100)	0,55
5	2	170 (120 – 220)	250 (180 – 310)	350 (250 – 460)	500 (380 – 630)	0,65 (0,6 – 0,7)
1	10	180 (>80)	260 (120 – 400)	360 (160 – 630)	500 (240 – 1000)	0,68
1	100	>40	>45	>60	>60	0,76 (<0,9)

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in TO-18 metal envelopes with the collector connected to the case.

They are intended for general purpose very high-gain low level and low-noise applications. Moreover, they are also suitable for low-speed switching applications.

QUICK REFERENCE DATA

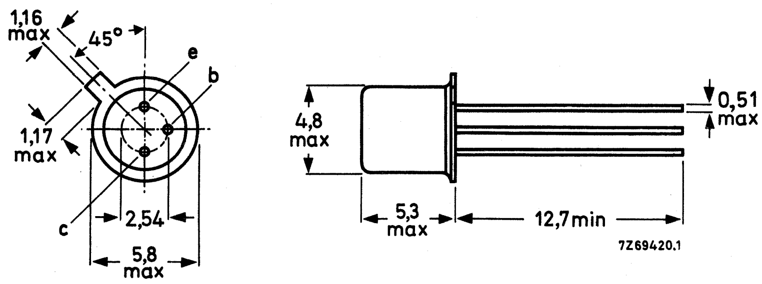
			BCY56	BCY57	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	20	V
Collector current (d.c.)	I_C	max.	100	100	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	300	mW
Junction temperature	T_j	max.	175	175	°C
D.C. current gain at T_j = 25 °C					
I_C = 10 μA; V_{CE} = 5 V	h_{FE}	>	40	100	
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	>	100	200	
		<	450	800	
Transition frequency					
I_C = 0,5 mA; V_{CE} = 5 V	f_T	typ.	85	100	MHz
Noise figure at R_S = 2 kΩ					
I_C = 200 μA; V_{CE} = 5 V		typ.	1,5	1,5	dB
f = 30 Hz to 15,7 kHz	F	<	5,0	5,0	dB

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case



Accessories 56246 (distance disc).

Products approved to CECC 50 002-164.

RATINGS (Limiting values)*

			BCY56	BCY57	
Collector-base voltage (open emitter)	V_{CBO}	max.	45	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	20	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.	100	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0,5	K/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0,2	K/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current $I_E = 0$; V_{CB} = 20 V	I_{CBO}	<	100	nA
Emitter cut-off current $I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	100	nA
Base-emitter voltage** I_C = 2 mA; V_{CE} = 5 V	V_{BE}	typ.	650 600 to 700	mV mV
Collector-emitter saturation voltage I_C = 10 mA; I_B = 1 mA	V_{CEsat}	typ.	80	mV
I_C = 100 mA; I_B = 10 mA	V_{CEsat}	typ.	200	mV

* Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

		BCY56	BCY57	
D.C. current gain				
I_C = 10 μA; V_{CE} = 5 V	h_{FE}	> 40	100	
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	typ. 200 100 to 450	400 200 to 800	
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	> 100	200	
Transition frequency				
I_C = 0,5 mA; V_{CE} = 5 V	f_T	typ. 85	100	MHz
I_C = 10 mA; V_{CE} = 5 V	f_T	typ. 250	350	MHz
h parameters at f = 1 kHz				
I_C = 2 mA; V_{CE} = 5 V				
Input impedance	h_{ie}	typ. 3,5	7,5	kΩ
Reverse voltage transfer	h_{re}	typ. 1,75	3,5	10^{-4}
Small signal current gain	h_{fe}	typ. 250 125 to 500	500 240 to 900	
Output admittance	h_{oe}	typ. 17,5	35	μS
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 5 V	C_c	typ. 4,5	4,5	pF
Noise figure				
I_C = 200 μA; V_{CE} = 5 V; R_S = 2 kΩ				
f = 30 Hz to 15,7 kHz	F	typ. 1,5 < 5	1,5 5	dB dB

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in TO-18 metal envelopes with the collector connected to the case, for use in amplifier and switching applications.

QUICK REFERENCE DATA

			BCY58	BCY59	
Collector-emitter voltage (open base)	V_{CEO}	max.	32	45	V
Collector current (d.c.)	I_C	max.	200	200	mA
Total power dissipation					
up to T_{amb} = 45 °C	P_{tot}	max.	330	330	mW
up to T_{case} = 45 °C	P_{tot}	max.	1000	1000	mW
Junction temperature	T_j	max.	200	200	°C

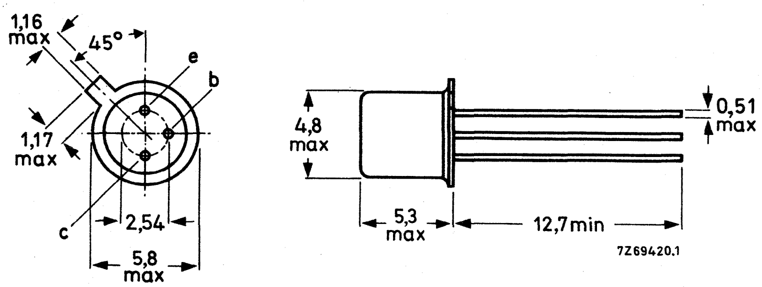
			BCY58–VII / BCY59–VII	VIII / VIII	IX / IX	X / X	
Small-signal current gain at T_j = 25 °C; I_C = 2 mA; V_{CE} = 5 V; f = 1 kHz	h_{fe}	>	125	175	250	350	
		<	250	350	500	700	
Transition frequency at f = 100 MHz; I_C = 10 mA; V_{CE} = 5 V	f_T	>	150				MHz
Noise figure at R_S = 2 kΩ; I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	typ.	2				dB

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case



Accessories 56246 (distance disc).

Products approved to CECC 50 002-030/031.

RATINGS

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

			BCY58	BCY59	
Collector emitter voltage (V_{BE} = 0)	V_{CES}	max.	32	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	32	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	7	V

Collector current	I_C	max.	200	mA
Base current	I_B	max.	50	mA
Total power dissipation up to T_{case} = 45 °C	P_{tot}	max.	1000	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0,45	K/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0,15	K/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BCY58	BCY59	
Collector cut-off currents					
V_{CE} = 32 V; V_{BE} = 0	I_{CES}	<	10		nA
V_{CE} = 45 V; V_{BE} = 0	I_{CES}	<		10	nA
V_{CE} = 32 V; V_{BE} = 0; T_j = 150 °C	I_{CES}	<	10		μA
V_{CE} = 45 V; V_{BE} = 0; T_j = 150 °C	I_{CES}	<		10	μA
Emitter cut-off current					
I_C = 0; V_{EB} = 5 V	I_{EBO}	<	10	10	nA
Collector-emitter breakdown voltage					
I_B = 0; I_C = 2 mA	$V_{(BR)CEO}$	>	32	45	V
Emitter-base breakdown voltage					
I_C = 0; I_E = 1 μA	$V_{(BR)EBO}$	>	7	7	V

Base emitter voltage				
I_C = 10 μA; V_{CE} = 5 V	V_{BE}	typ.	0,5	V
I_C = 20 μA; V_{CE} = $V_{CEO\,max}$; T_j = 100 °C	V_{BE}	>	0,2	V
I_C = 2 mA; V_{CE} = 5 V	V_{BE}	typ.	0,62	V
			0,55 to 0,70	V
I_C = 10 mA; V_{CE} = 1 V	V_{BE}	typ.	0,70	V
I_C = 100 mA; V_{CE} = 1 V	V_{BE}	typ.	0,76	V
Saturation voltages				
I_C = 10 mA; I_B = 0,25 mA	V_{CEsat}	typ.	100	mV
			50 to 350	mV
	V_{BEsat}	typ.	700	mV
			600 to 850	mV
I_C = 100 mA; I_B = 2,5 mA	V_{CEsat}	typ.	250	mV
			150 to 700	mV
		typ.	875	mV
			750 to 1200	mV
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 10 V	C_c	<	5,0	pF
Emitter capacitance at f = 1 MHz				
I_C = I_c = 0; V_{EB} = 0,5 V	C_e	<	15	pF
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 5 V	f_T	>	150	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	dB
		<	6	dB

CHARACTERISTICS (continued)

			BCY58VII BCY59VII	BCY58VIII BCY59VIII	BCY58IX BCY59IX	BCY58X BCY59X	
D.C. current gain							
I_C = 10 μA; V_{CE} = 5 V	h_{FE}	>	–	20	40	100	
		typ.	20	95	190	300	
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	>	120	180	250	380	
		typ.	170	250	350	500	
		<	220	310	460	630	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	>	80	120	160	240	
		typ.	250	300	390	550	
		<	–	400	630	1000	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	>	40	45	60	60	
h parameters at f = 1 kHz							
I_C = 2 mA; V_{CE} = 5 V							
Input impedance	h_{ie}	typ.	2,7	3,6	4,5	7,5	kΩ
Reverse voltage transfer ratio	h_{re}	typ.	1,5	2	3	3	10^{-4}
Small signal current gain	h_{fe}	typ.	200	260	330	520	
Output admittance	h_{oe}	typ.	18	24	30	50	μS

Switching times

I_C = 10 mA; I_B = 1 mA; $-I_{BM}$ = 1 mA
R1 = 5 kΩ; R_L = 990 Ω
V_{BB} = 3,6 V

delay time	t_d	typ.	35	ns
rise time	t_r	typ.	50	ns
turn on time	t_{on}	typ.	85	ns
		<	150	ns
storage time	t_s	typ.	400	ns
fall time	t_f	typ.	80	ns
turn off time	t_{off}	typ.	480	ns
		<	800	ns

I_C = 100 mA; I_B = 10 mA; $-I_{BM}$ = 10 mA
R1 = 500 Ω; R2 = 700 Ω; R_L = 98 Ω
V_{BB} = 5 V

delay time	t_d	typ.	5	ns
rise time	t_r	typ.	50	ns
turn on time	t_{on}	typ.	55	ns
		<	150	ns
storage time	t_s	typ.	250	ns
fall time	t_f	typ.	200	ns
turn off time	t_{off}	typ.	450	ns
		<	800	ns

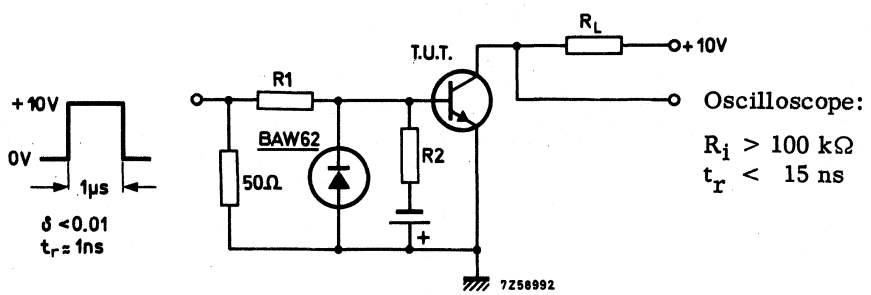


Fig. 2 Test circuit for switching times.

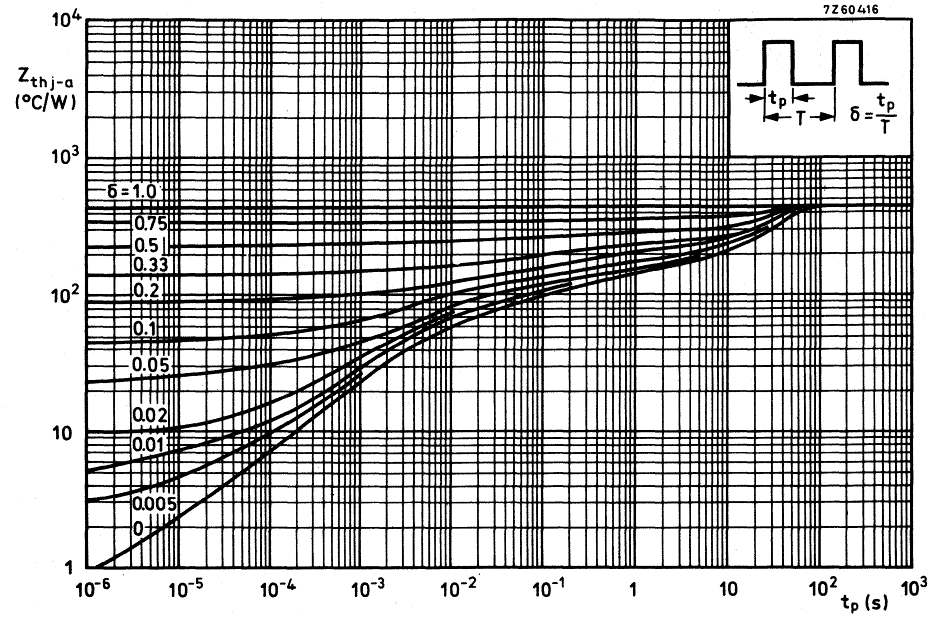


Fig. 3.

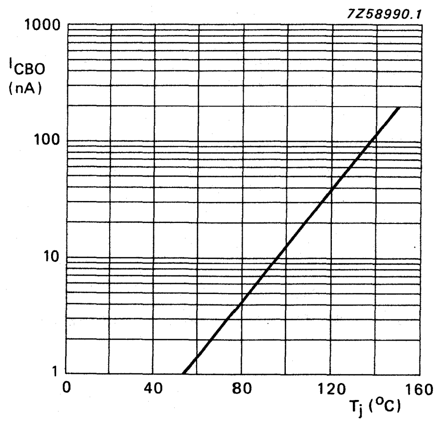


Fig. 4 V_{CB} = 32 V (BCY58); 45 V (BCY59); typical values.

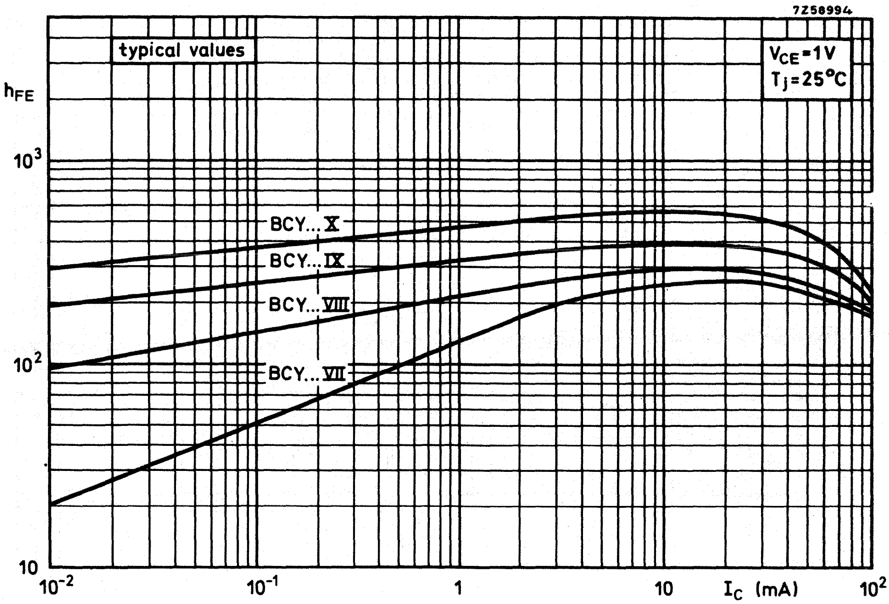


Fig. 5.

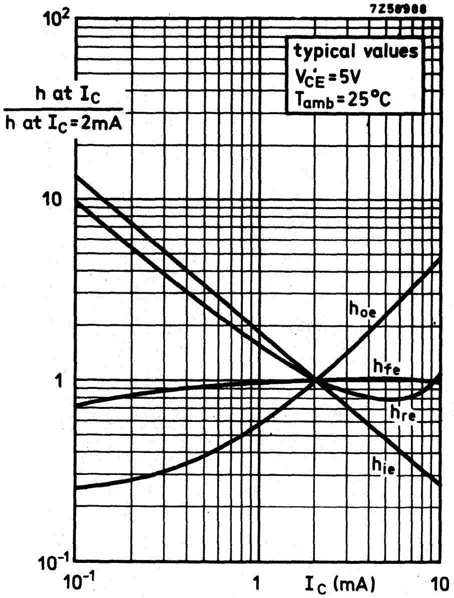


Fig. 6.

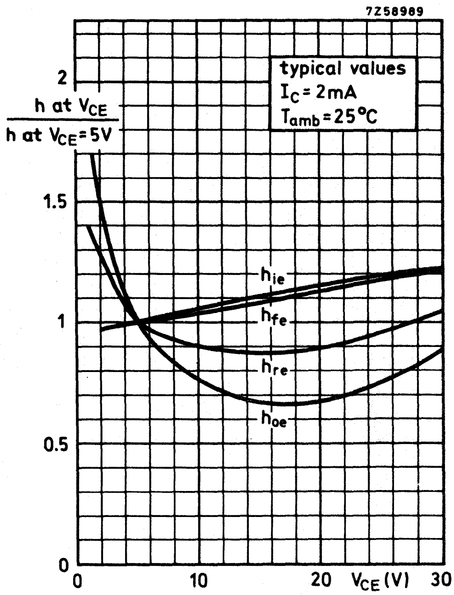


Fig. 7.

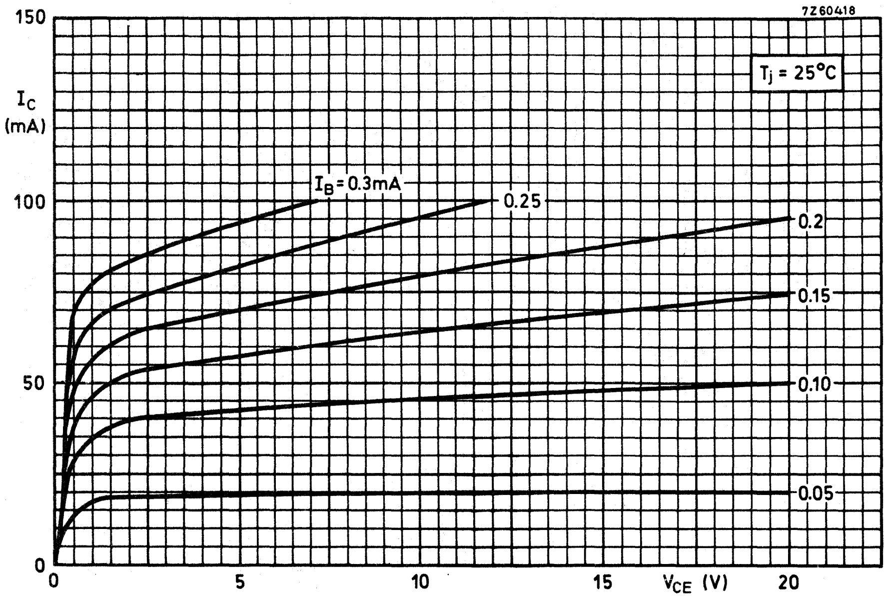


Fig. 8.

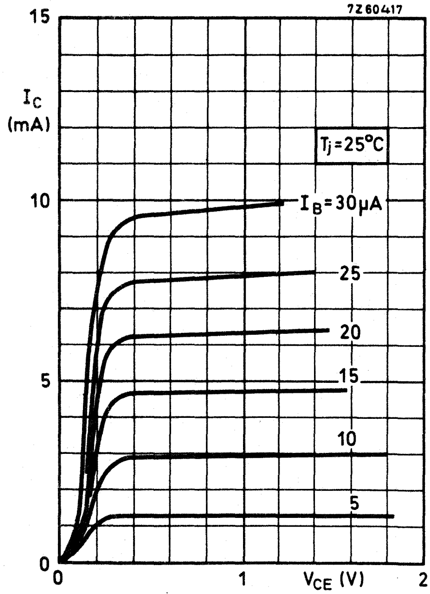


Fig. 9.

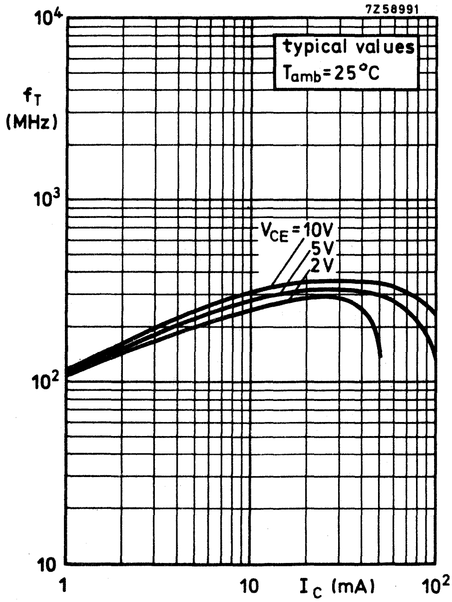


Fig. 10.

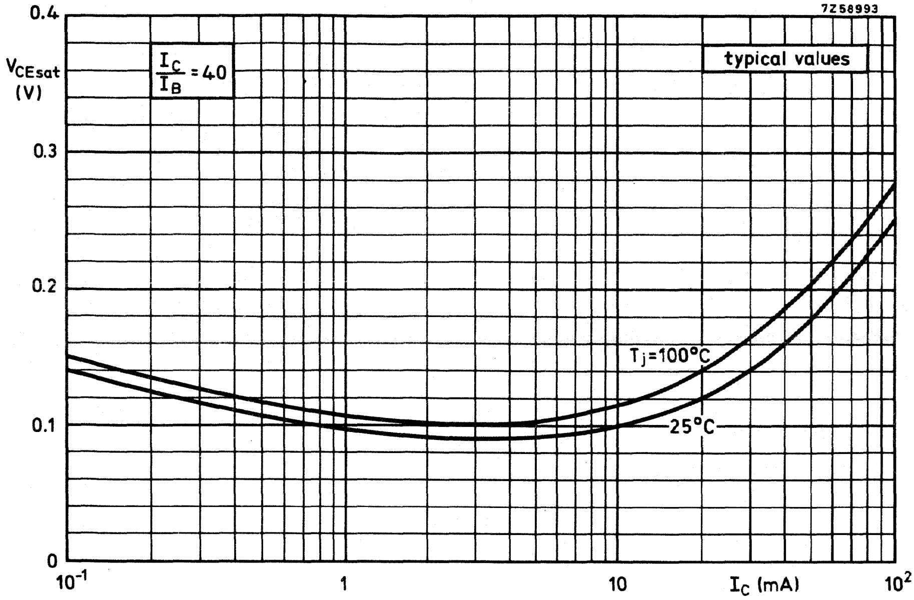

7Z58993
0.4
0.3
0.2
0.1
0
V_{CEsat} (V)
$\frac{I_C}{I_B} = 40$
typical values
T_j=100°C
25°C
10^{-1}
1
10
I_C (mA)
10^2

Fig. 11.

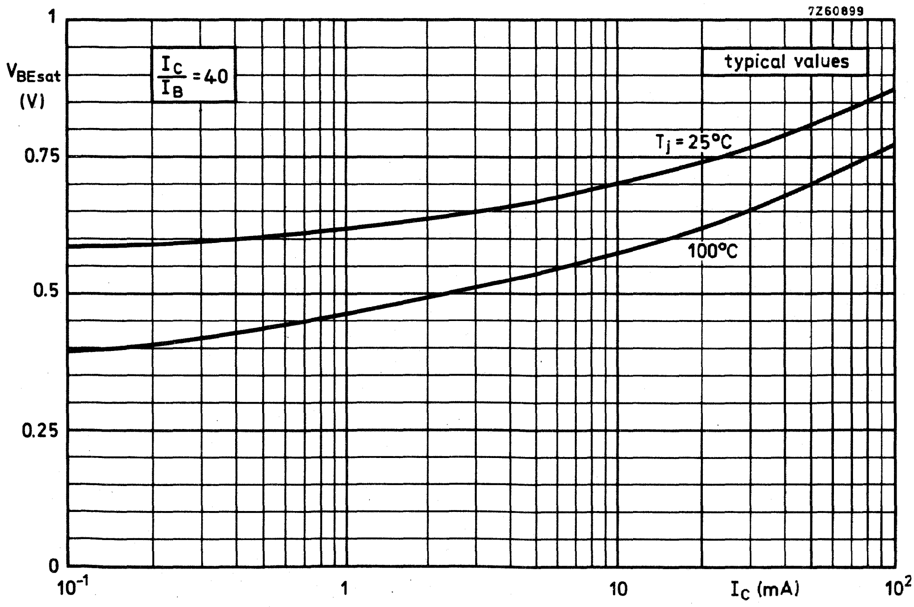

7Z60899
1
0.75
0.5
0.25
0
V_{BEsat} (V)
$\frac{I_C}{I_B} = 40$
typical values
T_j = 25°C
100°C
10^{-1}
1
10
I_C (mA)
10^2

Fig. 12.

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in TO-18 metal envelope with the collector connected to the case and designed for use in amplifier and switching applications.

QUICK REFERENCE DATA

Collector-emitter voltage (open base)	V_{CEO}	max.	60	V
Collector current (d.c.)	I_C	max.	200	mA
Total power dissipation				
up to T_{case} = 45 °C	P_{tot}	max.	1000	mW
up to T_{amb} = 45 °C	P_{tot}	max.	330	mW
Junction temperature	T_j	max.	200	°C

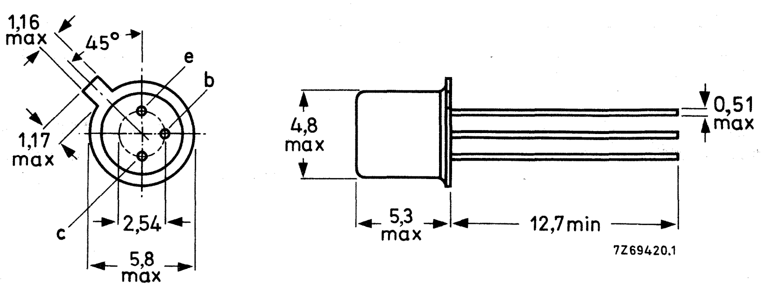
			BCY65-VII	VIII	IX
Small-signal current gain at f = 1 kHz		⩾	125	175	250
I_C = 2 mA; V_{CE} = 5 V	h_{fe}	typ.	200	260	330
		⩽	250	350	500

Transition frequency at f = 100 MHz I_C = 10 mA; V_{CE} = 5 V	f_T	⩾	125	MHz
Noise figure at R_S = 2 kΩ I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	⩽	6	dB

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.



Collector connected to case.

RATINGS (up to $T_{j\,max}$)

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

Collector-emitter voltage				
$V_{BE} = 0$	V_{CES}	max.	60	V
open base	V_{CEO}	max.	60	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V
Collector current (d.c.)	I_C	max.	200	mA
Base current (d.c.)	I_B	max.	50	mA
Total power dissipation				
up to $T_{case} = 45\ ^{o}C$	P_{tot}	max.	1000	mW
up to $T_{amb} = 45\ ^{o}C$	P_{tot}	max.	330	mW
Junction temperature	T_j	max.	200	^{o}C
Storage temperature range	T_{stg}		−65 to + 150	^{o}C

THERMAL RESISTANCE

From junction to ambient	$R_{th\,j\text{-}a}$	max.	0,45	K/W
From junction to case	$R_{th\,j\text{-}c}$	max.	0,15	K/W

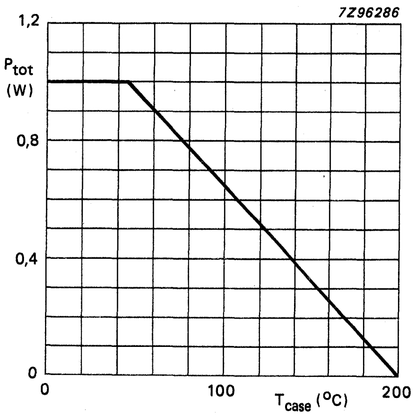


Fig. 2 Total power dissipation versus case temperature.

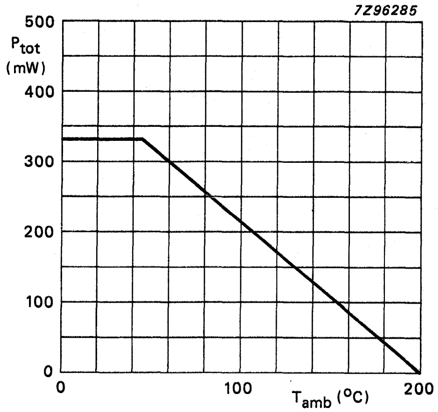


Fig. 3 Total power dissipation versus ambient temperature.

CHARACTERISTICS

T_{amb} = 25 °C unless indicated otherwise

Collector cut-off currents			
V_{CE} = 60 V; V_{BE} = 0	I_{CES}	⩽	10 nA
V_{CE} = 60 V; V_{BE} = 0; T_{amb} = 150 °C	I_{CES}	⩽	10 μA
V_{CE} = 60 V; V_{BE} = 0,2 V; T_{amb} = 100 °C	I_{CEX}	⩽	20 μA
Emitter cut-off current			
V_{EB} = 5 V; I_C = 0	I_{BEO}	⩽	10 nA
Collector-emitter breakdown voltage			
I_B = 0; I_C = 2 mA	$V_{(BR)CEO}$	⩾	60 V
Emitter-base breakdown voltage			
I_C = 0; I_E = 1 μA	$V_{(BR)EBO}$	⩾	7 V
Base-emitter voltage			
V_{CE} = 5 V; I_C = 10 μA	V_{BE}	typ.	500 mV
V_{CE} = 5 V; I_C = 2 mA	V_{BE}		550 to 700 mV
V_{CE} = 1 V; I_C = 10 mA	V_{BE}	typ.	700 mV
V_{CE} = 1 V; I_C = 50 mA	V_{BE}	typ.	760 mV
Saturation voltages			
I_C = 10 mA; I_B = 0,25 mA	V_{CEsat}	⩽	350 mV
	V_{BEsat}		600 to 850 mV
I_C = 50 mA; I_B = 1,25 mA	V_{CEsat}	⩽	700 mV
	V_{BEsat}	⩽	1200 mV
Transition frequency at f = 100 MHz			
I_C = 10 mA; V_{CE} = 5 V	f_T	⩾	125 MHz
Noise figure at R_S = 2 kΩ			
I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	⩽	6 dB
Collector capacitance at f = 1 MHz			
V_{CB} = 10 V; I_E = 0	C_c	⩽	6 pF
Emitter capacitance at f = 1 MHz			
V_{EB} = 0,5 V; I_C = 0	C_e	⩽	15 pF

D.C. current gain

			BCY65-VII	BCY65-VIII	BCY65-IX
V_{CE} = 5 V; I_C = 10 μA	h_{FE}	⩾	–	20	40
		typ.	20	95	190
V_{CE} = 5 V; I_C = 2 mA	h_{FE}	⩾	120	180	250
		typ.	170	250	350
		⩽	220	310	460
V_{CE} = 1 V; I_C = 10 mA	h_{FE}	⩾	80	120	160
		typ.	250	300	390
		⩽	–	400	630
V_{CE} = 1 V; I_C = 50 mA	h_{FE}	⩾	40	45	60

			BCY65-VII	BCY65-VIII	BCY65-IX	
h-parameters f = 1 kHz; T_{amb} = 25 °C; V_{CE} = 5 V; I_C = 2 mA						
input impedance	h_{ie}	⩾	1,6	2,5	3,2	kΩ
		typ.	2,7	3,6	4,5	kΩ
		⩽	4,5	6,0	8,5	kΩ
reverse voltage transfer ratio	h_{re}	typ.	$1,5 \cdot 10^{-4}$	$2 \cdot 10^{-4}$	$3 \cdot 10^{-4}$	
small-signal current gain	h_{fe}	⩾	125	175	250	
		typ.	200	260	330	
		⩽	250	350	500	
output admittance	h_{oe}	typ.	18	24	30	µs
		⩽	30	50	60	µs

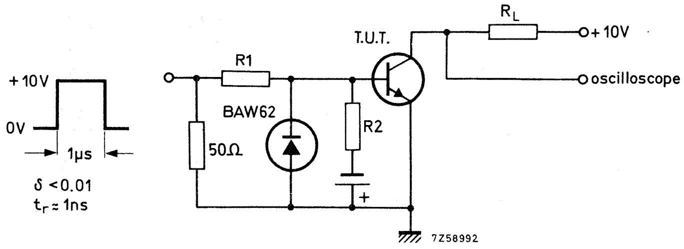
Switching times (see Fig. 4)

I_C = 10 mA; I_B = $-I_{BM}$ = 1 mA
R_1 = R_2 = 5 kΩ; R_L = 990 Ω; V_{BB} = 5 V

delay time	t_d	typ.	35	ns
rise time	t_r	typ.	50	ns
turn-on time	t_{on}	typ.	85	ns
		⩽	150	ns
storage time	t_s	typ.	400	ns
fall time	t_f	typ.	80	ns
turn-off time	t_{off}	typ.	480	ns
		⩽	800	ns

I_C = 50 mA; I_B = $-I_{BM}$ = 5 mA
R_1 = 1 kΩ; R_2 = 1,3 kΩ; R_L = 195 Ω; V_{BB} = 4,7 V

delay time	t_d	typ.	15	ns
rise time	t_r	typ.	50	ns
turn-on time	t_{on}	typ.	65	ns
		⩽	150	ns
storage time	t_s	typ.	300	ns
fall time	t_f	typ.	150	ns
turn-off time	t_{off}	typ.	450	ns
		⩽	800	ns



Oscilloscope:
R_i > 100 kΩ
t_r < 15 ns

Fig. 4 Test circuit.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in TO-18 metal envelopes intended for general purpose industrial applications. The BCY71 is a low noise version.

QUICK REFERENCE DATA

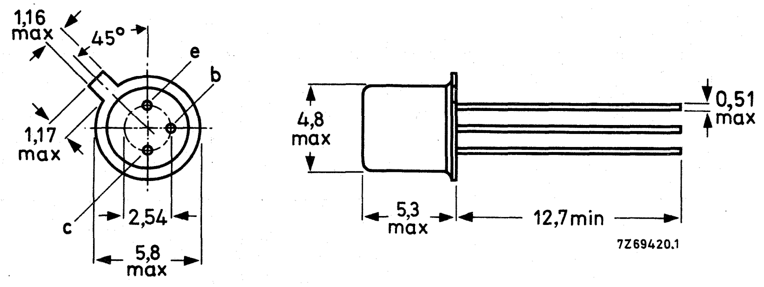
			BCY70	BCY71	BCY72	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	45	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	45	25	V
Collector current (peak value)	$-I_{CM}$	max.		200		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		350		mW
Junction temperature	T_j	max.		200		°C
D.C. current gain $-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	>		100		
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 20 V	f_T	>		250		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case.



Accessories: 56246 (distance disc).

Products approved to CECC 50 002-079/081.

RATINGS

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

			BCY70	BCY71	BCY72	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	45	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	45	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5,0	5,0	5,0	V
Collector current (d.c.)	$-I_C$	max.		200		mA
Collector current (peak value)	$-I_{CM}$	max.		200		mA
Emitter current (peak value)	I_{EM}	max.		200		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		350		mW
Storage temperature range	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		200		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	500	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	150	K/W

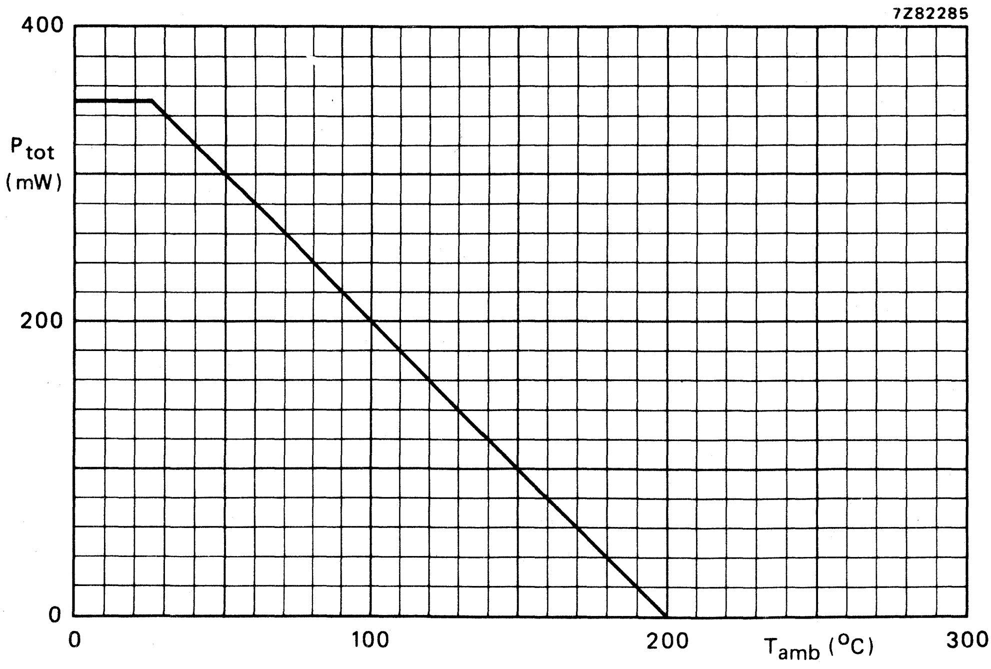


Fig. 2 Maximum permissible power dissipation as a function of ambient temperature.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

				BCY70	BCY71	BCY72	
Collector cut-off current							
$I_E = 0; -V_{CB} = -V_{CBOmax}$		$-I_{CBO}$	<	500	500	500	nA
$I_E = 0; -V_{CB} = 40$ V		$-I_{CBO}$	<	10	50	–	nA
$I_E = 0; -V_{CB} = 40$ V; $T_j = 100$ °C		$-I_{CBO}$	<	0,5	2,0	–	μA
$I_E = 0; -V_{CB} = 25$ V		$-I_{CBO}$	<	–	–	50	nA
$I_E = 0; -V_{CB} = 25$ V; $T_j = 100$ °C		$-I_{CBO}$	<	–	–	2,0	μA
$-V_{CE} = 50$ V; $-V_{EB} = 3{,}0$ V		$-I_{CEX}$	<	20	–	–	nA
Emitter cut-off current							
$I_C = 0; -V_{EB} = 4{,}0$ V		$-I_{EBO}$	<		10		nA
$I_C = 0; -V_{EB} = 4{,}0$ V; $T_j = 100$ °C		$-I_{EBO}$	<		2,0		μA
$I_C = 0; -V_{EB} = 5{,}0$ V		$-I_{EBO}$	<		500		nA
Saturation voltages							
$-I_C = 10$ mA; $-I_B = 10$ mA		$-V_{CEsat}$	<		250		mV
		$-V_{BEsat}$	<		600 to 900		mV
$-I_C = 50$ mA; $-I_B = 5{,}0$ mA		$-V_{CEsat}$	<		500		mV
		$-V_{BEsat}$	<		1200		mV
D.C. current gain							
$-I_C = 10$ μA; $-V_{CE} = 1{,}0$ V		h_{FE}	>		60		
$-I_C = 0{,}1$ mA; $-V_{CE} = 1{,}0$ V		h_{FE}	>		80		
$-I_C = 1{,}0$ mA; $-V_{CE} = 1{,}0$ V		h_{FE}	>		100		
$-I_C = 10$ mA; $-V_{CE} = 1{,}0$ V		h_{FE}	>		100		
$-I_C = 10$ mA; $-V_{CE} = 1{,}0$ V	**BCY71**	h_{FE}	<		500		
$-I_C = 50$ mA; $-V_{CE} = 1{,}0$ V		h_{FE}	>		45		
Collector capacitance at f = 1 MHz							
$I_E = I_e = 0; -V_{CB} = 10$ V		C_c	<		6,0		pF
Emitter capacitance at f = 1 MHz							
$I_C = I_c = 0; -V_{EB} = 1{,}0$ V		C_e	<		8,0		pF
Transition frequency at T_{amb} = 25 °C							
$-I_C = 10$ mA; $-V_{CE} = 20$ V; f = 100 MHz		f_T	>	250	250	250	MHz
$-I_C = 100$ μA; $-V_{CE} = 20$ V; f = 10,7 MHz		f_T	>	–	15	–	MHz
Noise figure							
$-I_C = 100$ μA; $-V_{CE} = 5{,}0$ V f = 10 Hz to 10 kHz; $R_S = 2{,}0$ kΩ		F	<	6,0	2,0	6,0	dB
h-parameters (common emitter)							
$-I_C = 10$ mA; $-V_{CE} = 10$ V; f = 1 kHz; T_{amb} = 25 °C							
Input impedance		h_{ie}	typ.	–	4,0	–	kΩ
Reverse voltage transfer ratio		h_{re}	typ.	–	2,1	–	10^{-4}
Small-signal current gain		h_{fe}	typ.	–	325	–	
Output admittance		h_{oe}	typ.	–	20	–	μS

Switching times of the **BCY70** and **BCY72**

$-I_C$ = 10 mA; $-I_{Bon}$ = + I_{Boff} = 1 mA

delay time	t_d	<	35 ns
rise time	t_r	<	35 ns
turn-on time	t_{on}	<	65 ns
storage time	t_s	<	420 ns
fall time	t_f	<	80 ns
turn-off time	t_{off}	<	500 ns

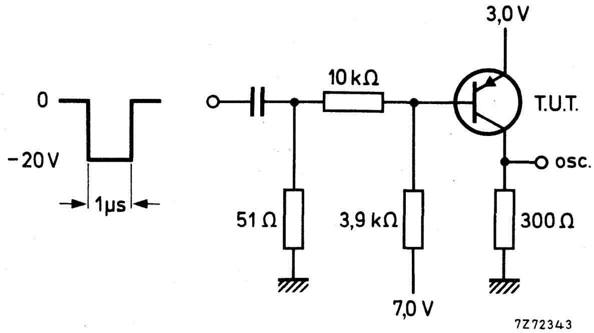


Fig. 3 Test circuit.

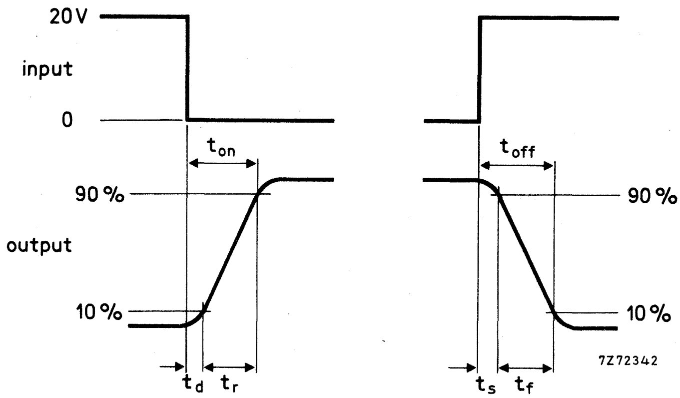


Fig. 4 Switching waveforms.

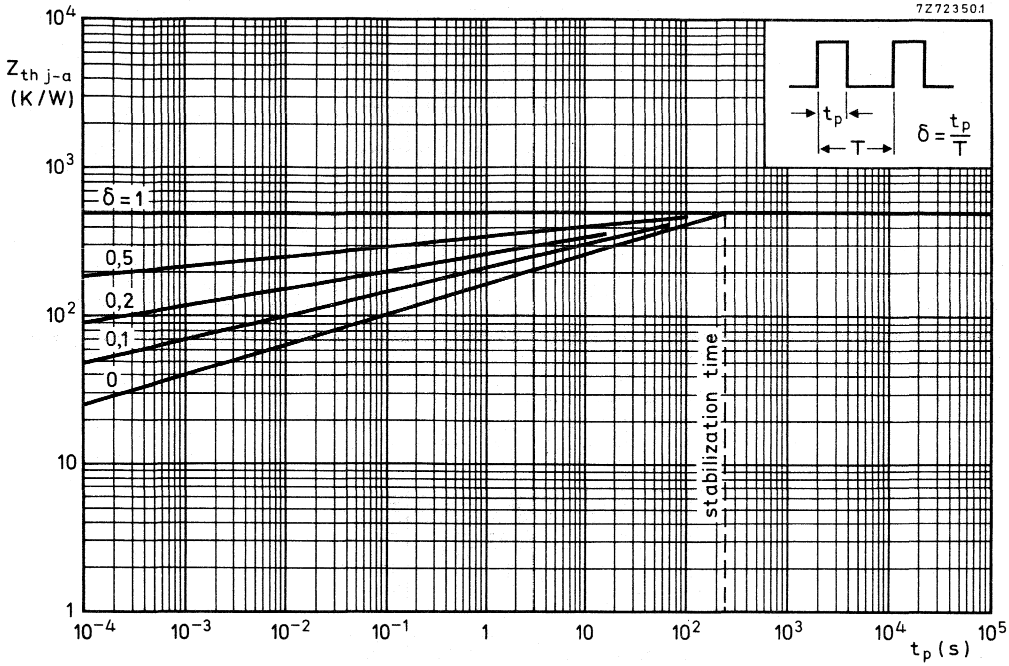

7Z72350.1
$Z_{th\ j-a}$ (K/W)
10^4
10^3
10^2
10
1
δ = 1
0,5
0,2
0,1
0
stabilization time
t_p
T
$\delta = \frac{t_p}{T}$
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
10^4
10^5
t_p (s)

Fig. 5.

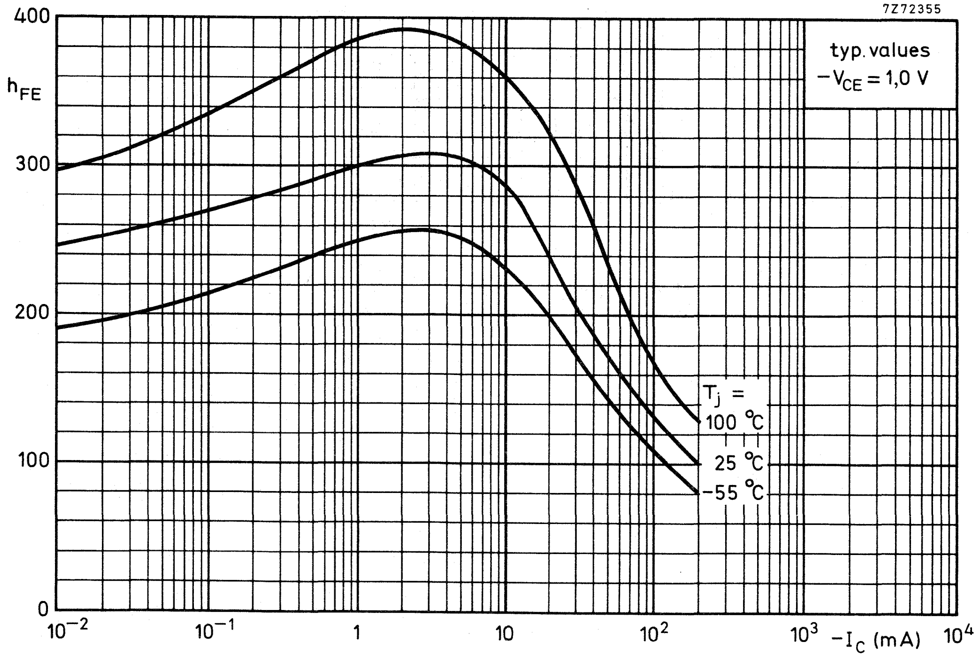

7Z72355
typ. values
$-V_{CE} = 1{,}0$ V
h_{FE}
400
300
200
100
0
T_j =
100 °C
25 °C
-55 °C
10^{-2}
10^{-1}
1
10
10^2
10^3
$-I_C$ (mA)
10^4

Fig. 6.

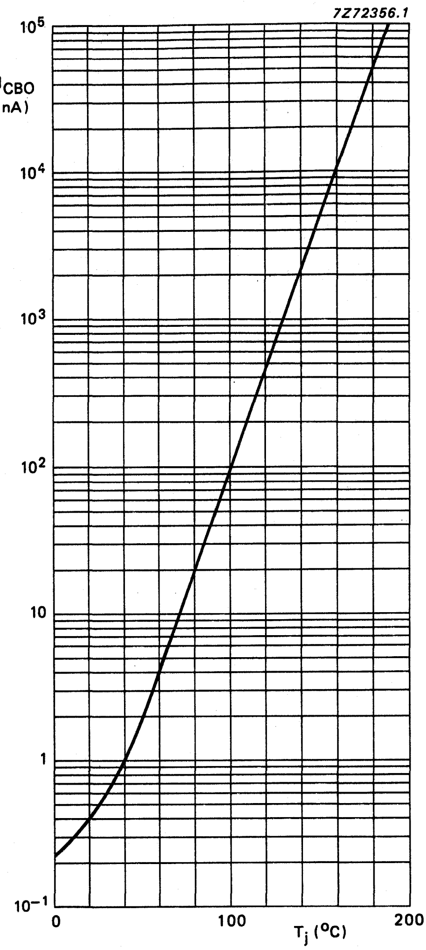


Fig. 7 $-V_{CB}$ = 40 V for BCY70 and BCY71; $-V_{CB}$ = 25 V for BCY72; typical values.

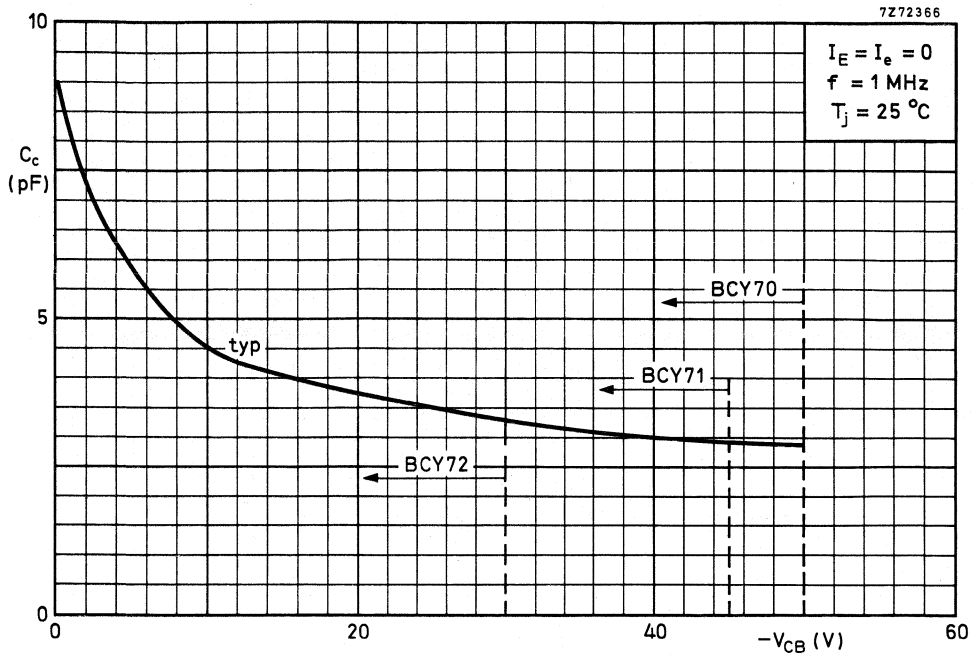

7Z72366
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
C_c (pF)
10
5
0
typ
BCY70
BCY71
BCY72
0
20
40
$-V_{CB}$ (V)
60

Fig. 8.


7Z72365
$I_C = I_c = 0$
f = 1 MHz
T_j = 25 °C
C_e (pF)
10
5
0
typ
0
2
4
$-V_{EB}$ (V)
6

Fig. 9.

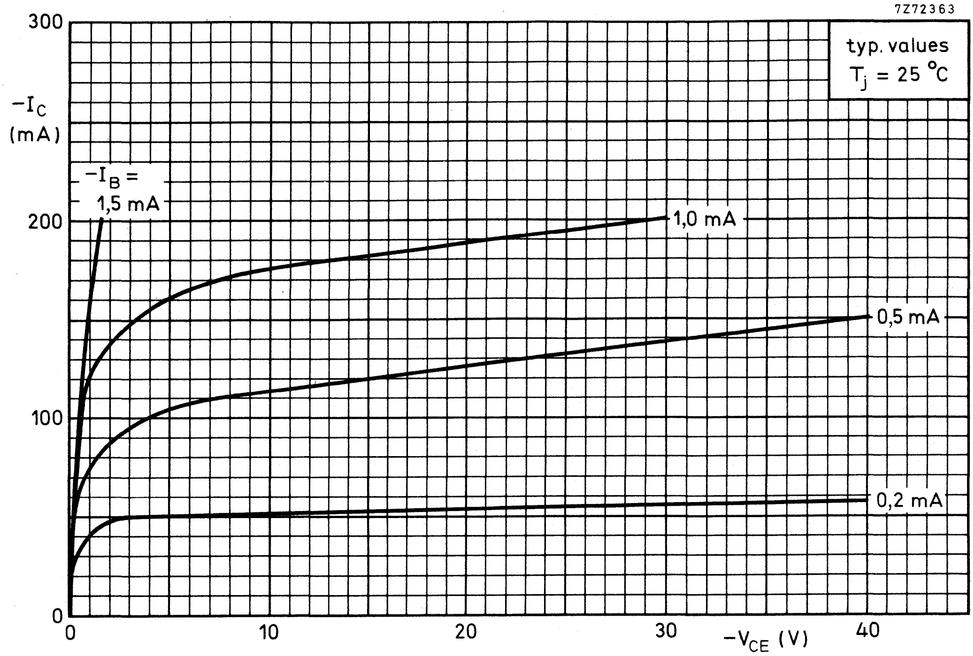

7Z72363
typ. values
T_j = 25 °C
$-I_C$
(mA)
300
200
100
0
$-I_B$ =
1,5 mA
1,0 mA
0,5 mA
0,2 mA
0
10
20
30
40
$-V_{CE}$ (V)

Fig. 10.

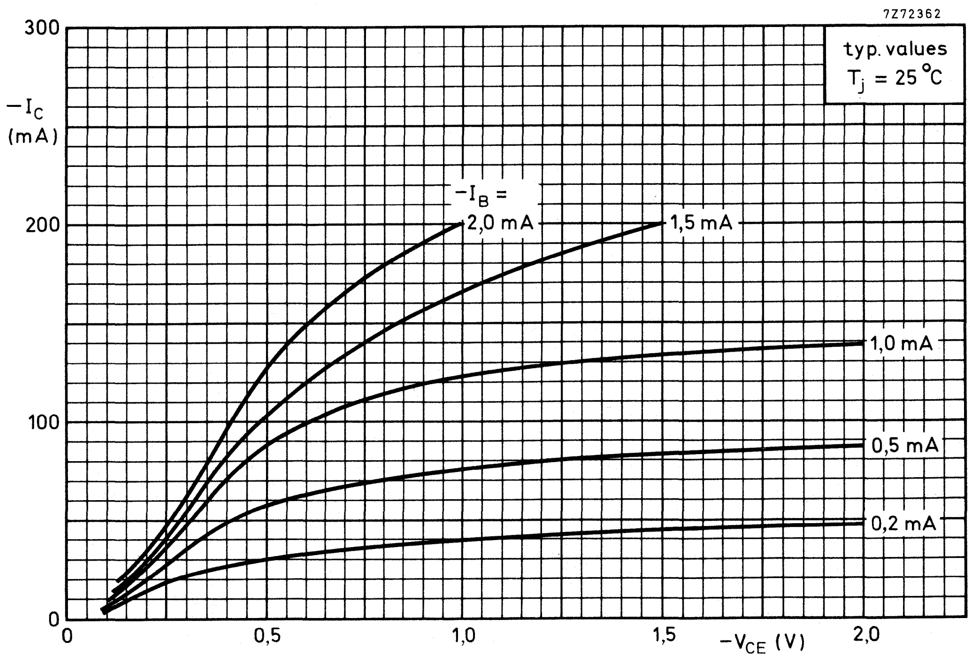

7Z72362
typ. values
T_j = 25 °C
$-I_C$
(mA)
300
200
100
0
$-I_B$ =
2,0 mA
1,5 mA
1,0 mA
0,5 mA
0,2 mA
0
0,5
1,0
1,5
2,0
$-V_{CE}$ (V)

Fig. 11.

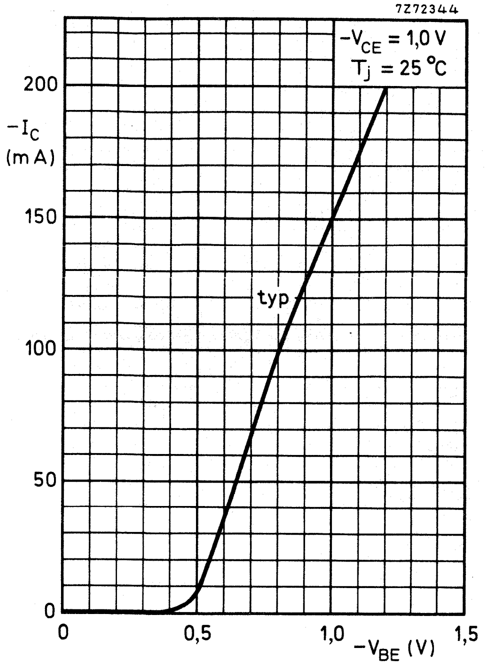


Fig. 12.

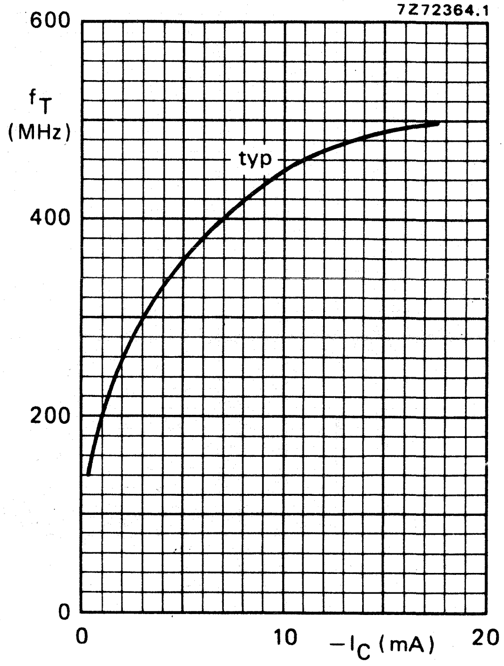


Fig. 13 $-V_{CE}$ = 20 V; f = 100 MHz; T_{amb} = 25 °C.

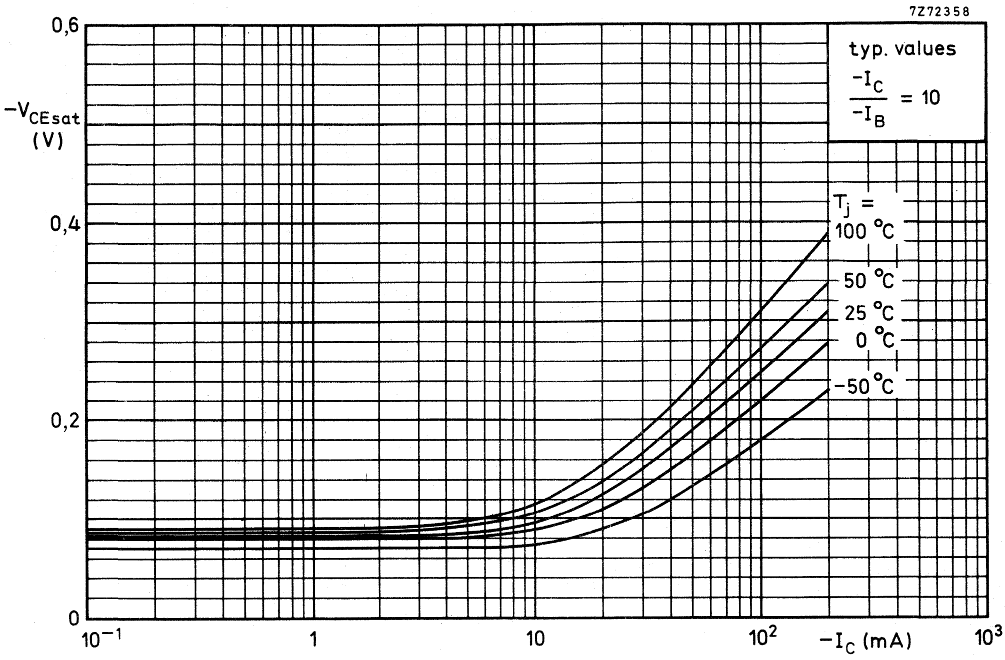

7Z72358
typ. values
$\frac{-I_C}{-I_B} = 10$
$-V_{CEsat}$ (V)
0,6
0,4
0,2
0
T_j =
100 °C
50 °C
25 °C
0 °C
-50 °C
10^{-1}
1
10
10^2
$-I_C$ (mA)
10^3

Fig. 14.

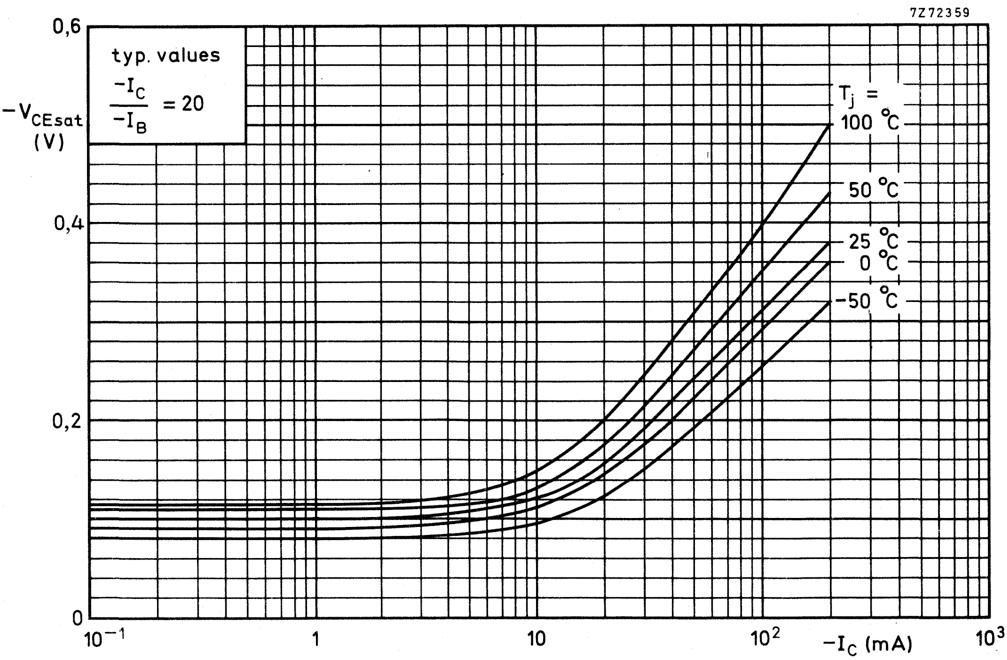

7Z72359
typ. values
$\frac{-I_C}{-I_B} = 20$
$-V_{CEsat}$ (V)
0,6
0,4
0,2
0
T_j =
100 °C
50 °C
25 °C
0 °C
-50 °C
10^{-1}
1
10
10^2
$-I_C$ (mA)
10^3

Fig. 15.

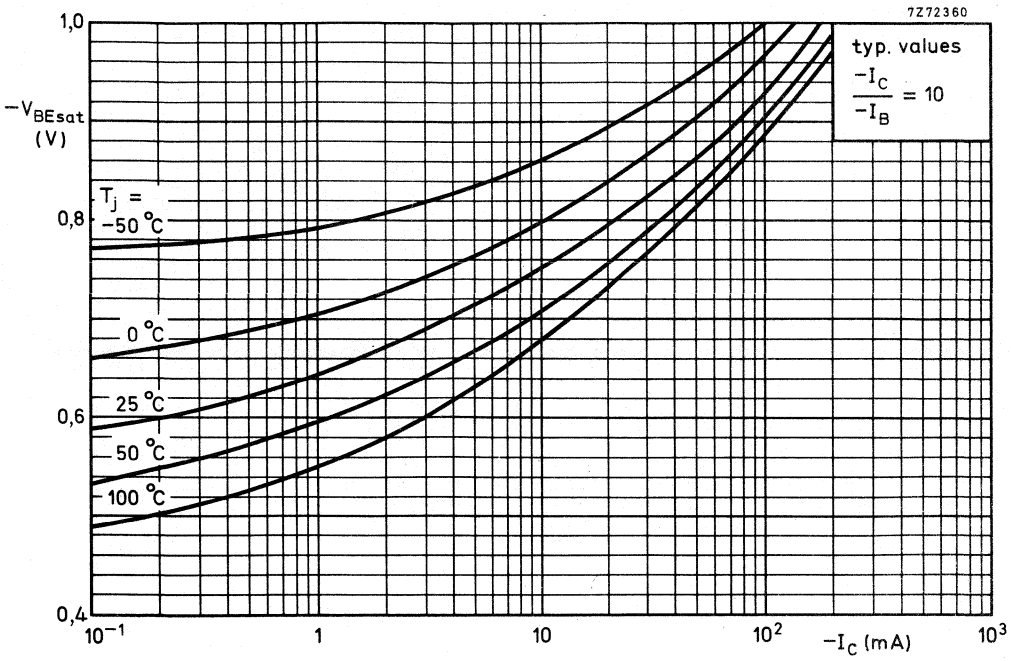

7Z72360
typ. values
$\frac{-I_C}{-I_B} = 10$
$-V_{BEsat}$ (V)
1,0
0,8
0,6
0,4
$T_j =$ −50 °C
0 °C
25 °C
50 °C
100 °C
10^{-1}
1
10
10^2
$-I_C$ (mA)
10^3

Fig. 16.

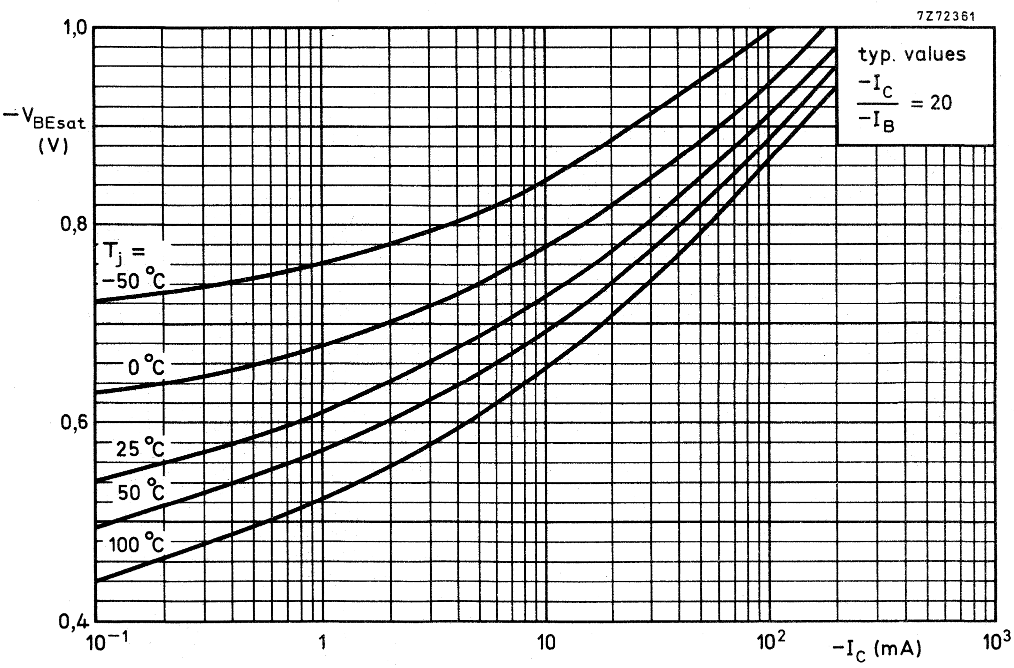

7Z72361
typ. values
$\frac{-I_C}{-I_B} = 20$
$-V_{BEsat}$ (V)
1,0
0,8
0,6
0,4
$T_j =$ −50 °C
0 °C
25 °C
50 °C
100 °C
10^{-1}
1
10
10^2
$-I_C$ (mA)
10^3

Fig. 17.

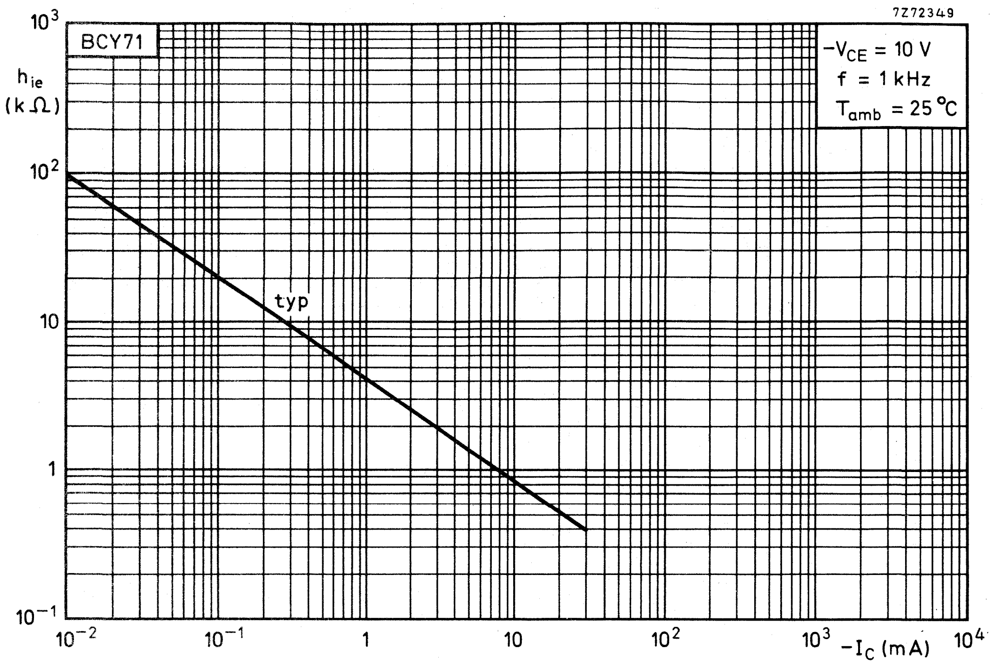

7Z72349
BCY71
h_{ie} (kΩ)
$-V_{CE}$ = 10 V
f = 1 kHz
T_{amb} = 25 °C
typ
$-I_C$ (mA)

Fig. 18.

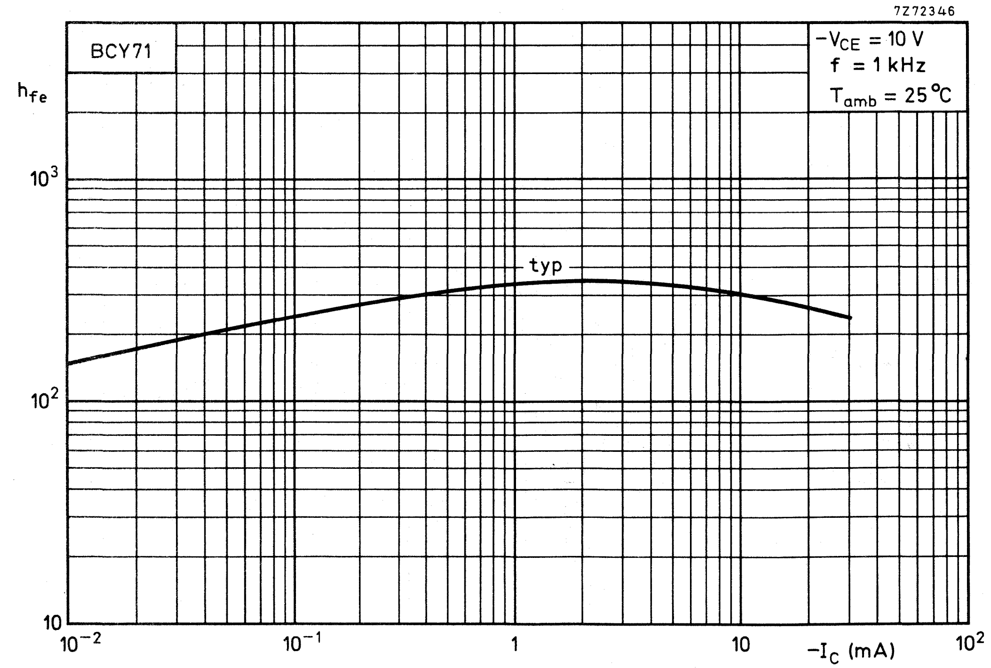

7Z72346
BCY71
h_{fe}
$-V_{CE}$ = 10 V
f = 1 kHz
T_{amb} = 25 °C
typ
$-I_C$ (mA)

Fig. 19.

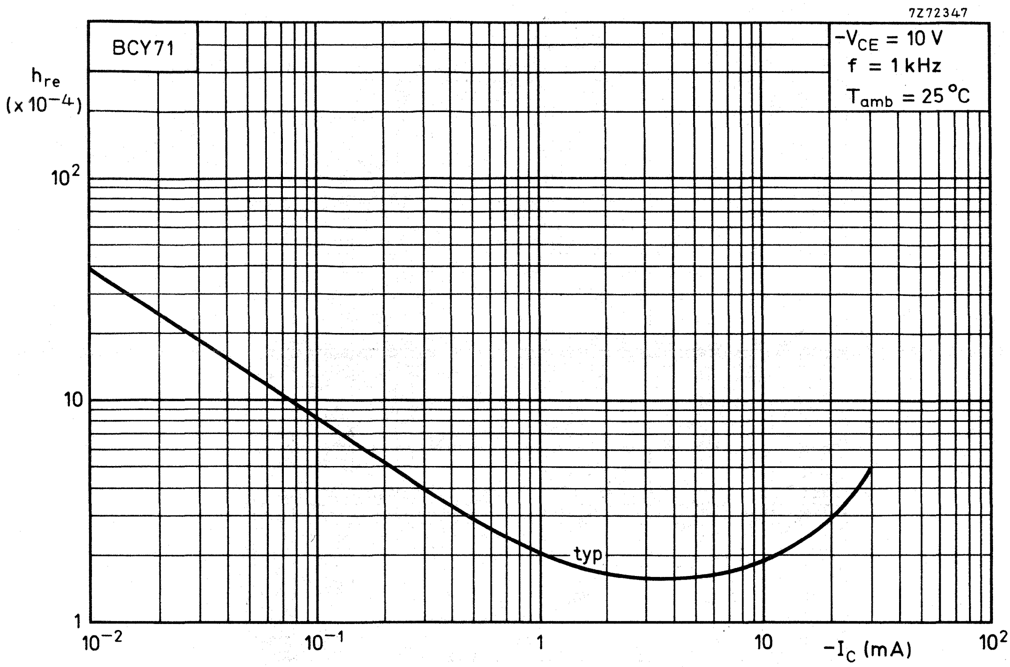

7Z72347
BCY71
h_{re}
($\times 10^{-4}$)
$-V_{CE}$ = 10 V
f = 1 kHz
T_{amb} = 25 °C
typ
10^2
10
1
10^{-2}
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 20.

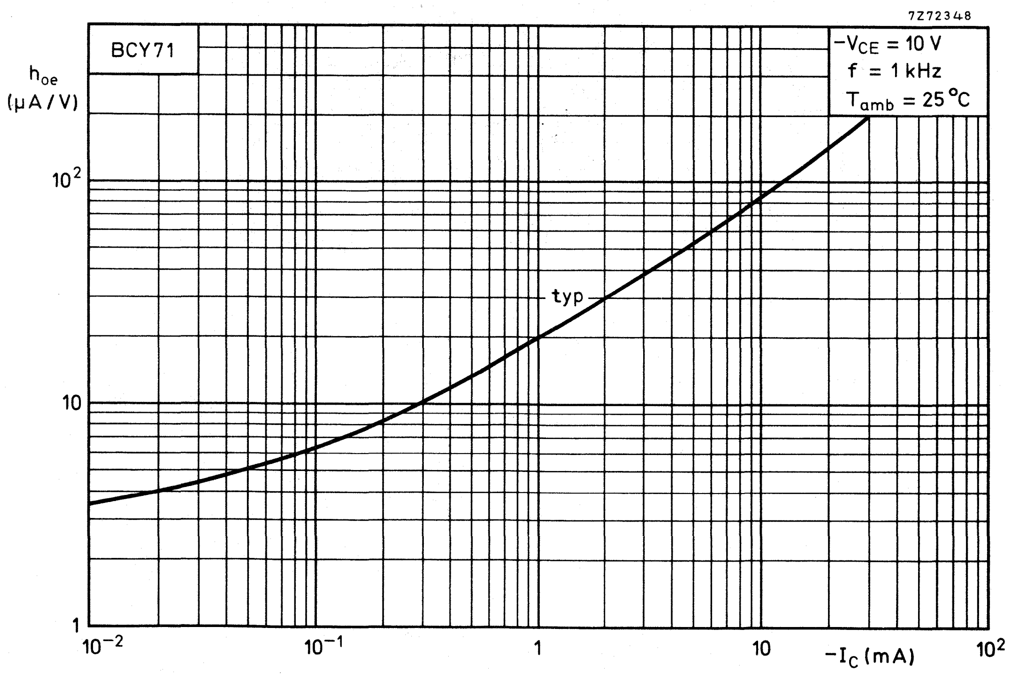

7Z72348
BCY71
h_{oe}
(µA/V)
$-V_{CE}$ = 10 V
f = 1 kHz
T_{amb} = 25 °C
typ
10^2
10
1
10^{-2}
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 21.

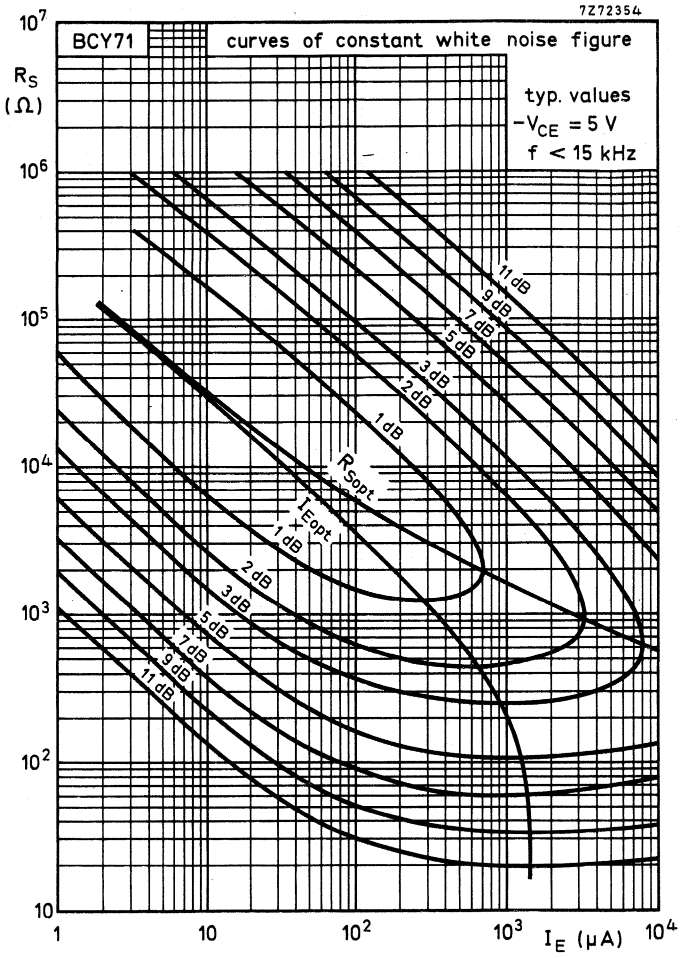


Fig. 22.

See also the graph and text on next page.

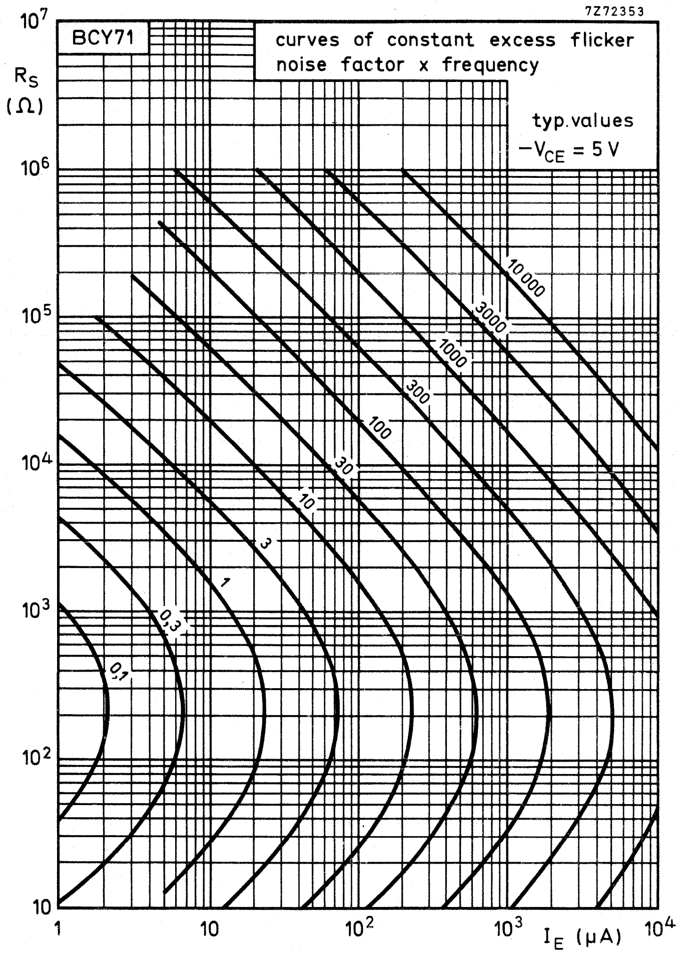


Fig. 23.

Determination of total noise figure

Total noise at f < 15 kHz includes flicker noise and white noise.

The relationship is as follows: noise factor = 1 + flicker noise factor + white noise factor.

The flicker noise factor can be derived from the curves of the graph above, the white noise factor from the curves of the graph on preceding page.

Example:

Assume a BCY71 operating at f = 200 Hz; I_E = 200 μA with a source resistance R_S = 10 kΩ. From the graph on this page it follows that at I_E = 200 μA with R_S = 10 kΩ the product of frequency and flicker noise factor is 110. Since the frequency is 200 Hz, the flicker noise factor is 110/200 = 0,55. It follows that at I_E = 200 μA with R_S = 10 kΩ the white noise figure is 0,9 dB, representing a factor of 1,23. Thus the total noise factor = 0,55 + 1,23 = 1,78 or 2,5 dB.

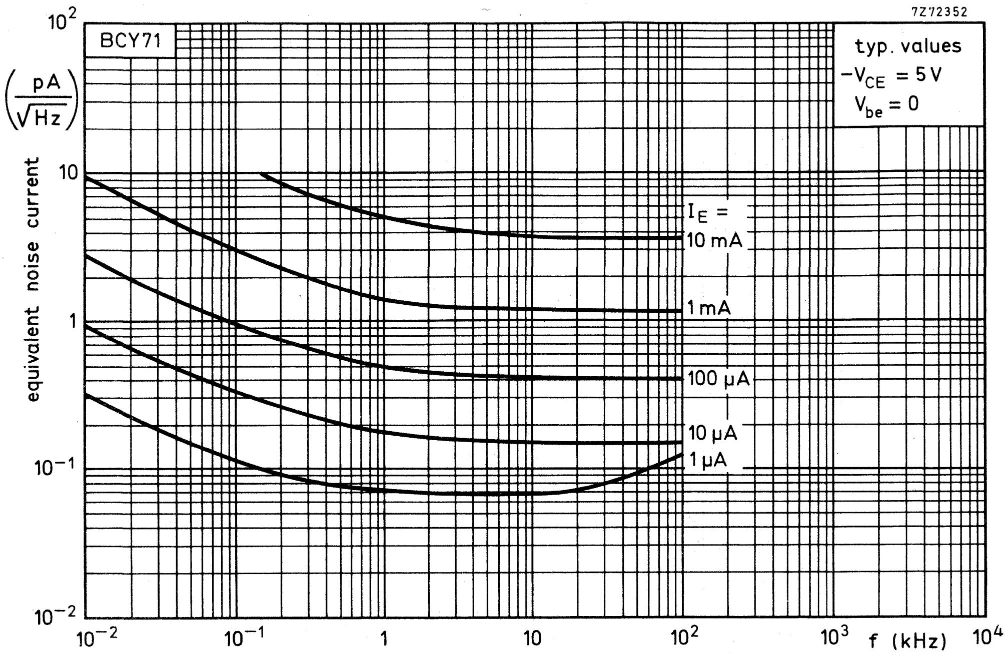

7Z72352
BCY71
typ. values
$-V_{CE}$ = 5 V
V_{be} = 0
equivalent noise current
(pA/√Hz)
10^2
10
1
10^{-1}
10^{-2}
I_E =
10 mA
1 mA
100 μA
10 μA
1 μA
10^{-2}
10^{-1}
1
10
10^2
10^3
f (kHz)
10^4

Fig. 24.

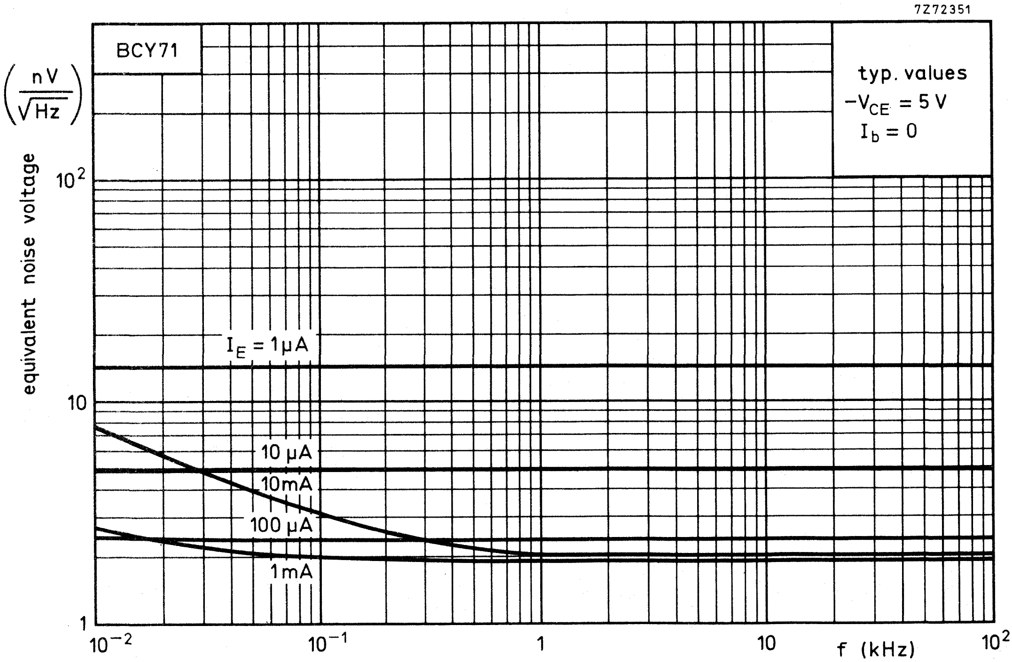

7Z72351
BCY71
typ. values
$-V_{CE}$ = 5 V
I_b = 0
equivalent noise voltage
(nV/√Hz)
10^2
10
1
I_E = 1 μA
10 μA
10mA
100 μA
1mA
10^{-2}
10^{-1}
1
10
f (kHz)
10^2

Fig. 25.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in TO-18 metal envelopes, intended for use in amplifier and switching applications.

QUICK REFERENCE DATA

			BCY78	BCY79	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	32	45	V
Collector current (d.c.)	$-I_C$	max.	200		mA
Total power dissipation					
up to T_{amb} = 45 °C	P_{tot}	max.	345		mW
up to T_{case} = 45 °C	P_{tot}	max.	1000		mW
Junction temperature	T_j	max.	200		°C

			BCY78–VII / BCY79–VII	VIII / VIII	IX / IX	X
Small-signal current gain $-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{fe}	>	125	175	250	350
		<	250	350	500	700

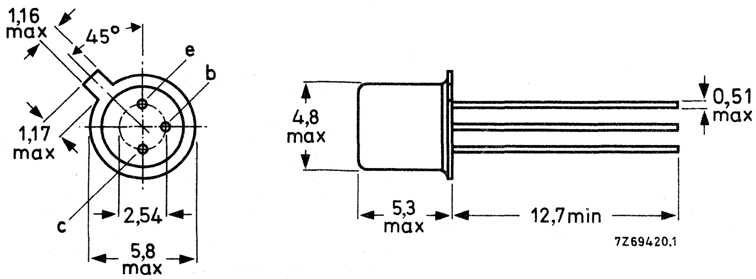
Transition frequency at f = 35 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	180	MHz
Noise figure at R_S = 2 kΩ $-I_C$ = 200 µA; $-V_{CE}$ = 5 V f = 1 kHz; B = 200 Hz	F	typ.	2	dB

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case



Accessories: 56246 (distance disc).

Products approved to CECC 50 002-079/081.

RATINGS

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

			BCY78	BCY79	
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	45	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	32	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	V
Collector current (d.c.)	$-I_C$	max.	200		mA
Base current (d.c.)	$-I_B$	max.	20		mA
Total power dissipation					
up to T_{amb} = 45 °C	P_{tot}	max.	345		mW
up to T_{case} = 45 °C	P_{tot}	max.	1000		mW
Storage temperature range	T_{stg}		−65 to 150		°C
Junction temperature	T_j	max.	200		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0,45	K/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0,15	K/mW

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			BCY78	BCY79	
Collector cut-off currents					
V_{BE} = 0; $-V_{CE}$ = 25 V	$-I_{CES}$	typ.	2	–	nA
		<	20	–	nA
V_{BE} = 0; $-V_{CE}$ = 35 V	$-I_{CES}$	typ.	–	2	nA
		<	–	20	nA
V_{BE} = 0; $-V_{CE}$ = 25 V; T_{amb} = 150 °C	$-I_{CES}$	<	10	–	µA
V_{BE} = 0; $-V_{CE}$ = 35 V; T_{amb} = 150 °C	$-I_{CES}$	<	–	10	µA
V_{BE} = 0; $-V_{CE}$ = $-V_{CEO\,max}$	$-I_{CES}$	<	100	100	nA
$-V_{EB}$ = 0,2 V; $-V_{CE}$ = $-V_{CEO\,max}$; T_{amb} = 100 °C	$-I_{CEX}$	<	20	20	µA
Emitter cut-off current					
I_C = 0; $-V_{EB}$ = 4 V	$-I_{EBO}$	<	20	20	nA
Collector-emitter breakdown voltage					
V_{BE} = 0; $-I_C$ = 10 µA	$-V_{(BR)CES}$	>	32	45	V
I_B = 0; $-I_C$ = 2 mA	$-V_{(BR)CEO}$	>	32	45	V
Emitter-base breakdown voltage					
I_C = 0; $-I_E$ = 1 µA	$-V_{(BR)EBO}$	>	5		V
Base-emitter voltage					
$-I_C$ = 10 µA; $-V_{CE}$ = 5 V	$-V_{BE}$	typ.	550		mV
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	$-V_{BE}$	typ.	650		mV
			600 to 750		mV
$-I_C$ = 10 mA; $-V_{CE}$ = 1 V	$-V_{BE}$	typ.	680		mV
$-I_C$ = 100 mA; $-V_{CE}$ = 1 V	$-V_{BE}$	typ.	750		mV
Saturation voltages					
$-I_C$ = 10 mA; $-I_B$ = 250 µA	$-V_{CEsat}$	typ.	120		mV
		<	250		mV
	$-V_{BEsat}$	typ.	700		mV
			600 to 850		mV
$-I_C$ = 100 mA; $-I_B$ = 2,5 mA	$-V_{CEsat}$	typ.	400		mV
		<	800		mV
	$-V_{BEsat}$	typ.	850		mV
			700 to 1200		mV
Transition frequency at f = 35 MHz					
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	180		MHz

Collector capacitance at f = 1 MHz							
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	<			7,0		pF
Emitter capacitance at f = 1 MHz							
$I_C = I_c = 0$; $-V_{EB} = 0{,}5$ V	C_e	<			15		pF
Noise figure at $R_S = 2$ kΩ							
$-I_C = 200$ μA; $-V_{CE} = 5$ V		typ.			2		dB
f = 1 kHz; B = 200 Hz	F	<			6		dB

			BCY78-VII	VIII	IX	X	
			BCY79-VII	VIII	IX		
D.C. current gain							
$-I_C = 10$ μA; $-V_{CE} = 5$ V	h_{FE}	>	–	30	40	100	
		typ.	140	200	270	340	
$-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	>	120	180	250	380	
		typ.	170	250	350	500	
		<	220	310	460	630	
$-I_C = 10$ mA; $-V_{CE} = 1$ V	h_{FE}	>	80	120	160	240	
		typ.	180	260	360	500	
		<	–	400	630	1000	
$-I_C = 100$ mA; $-V_{CE} = 1$ V	h_{FE}	>	40	45	60	60	
h-parameters at f = 1 kHz							
$-I_C = 2$ mA; $-V_{CE} = 5$ V							
Input impedance	h_{ie}	typ.	2,7	3,6	4,5	7,5	kΩ
Reverse voltage transfer ratio	h_{re}	typ.	1,5	2	2	3	10^{-4}
Small-signal current gain	h_{fe}	typ.	200	260	330	520	
Output admittance	h_{oe}	typ.	18	24	30	50	μS

Switching times

$-I_{C\,on} = 10$ mA; $-I_{B\,on} = I_{B\,off} = 1$ mA
$R1 = R2 = 5$ kΩ; $R_L = 990$ Ω
$V_B = 3{,}6$ V

delay time	t_d	typ.	35 ns
rise time	t_r	typ.	50 ns
turn-on time ($t_d + t_r$)	t_{on}	typ.	85 ns
		<	150 ns
storage time	t_s	typ.	400 ns
fall time	t_f	typ.	80 ns
turn-off time ($t_s + t_f$)	t_{off}	typ.	480 ns
		<	800 ns

$-I_{C\,on} = 100$ mA; $-I_{B\,on} = I_{B\,off} = 10$ mA
$R1 = 500$ Ω; $R2 = 700$ Ω; $R_L = 98$ Ω
$V_B = 5$ V

delay time	t_d	typ.	5 ns
rise time	t_r	typ.	50 ns
turn-on time ($t_d + t_r$)	t_{on}	typ.	55 ns
		<	150 ns
storage time	t_s	typ.	250 ns
fall time	t_f	typ.	200 ns
turn-off time ($t_s + t_f$)	t_{off}	typ.	450 ns
		<	800 ns

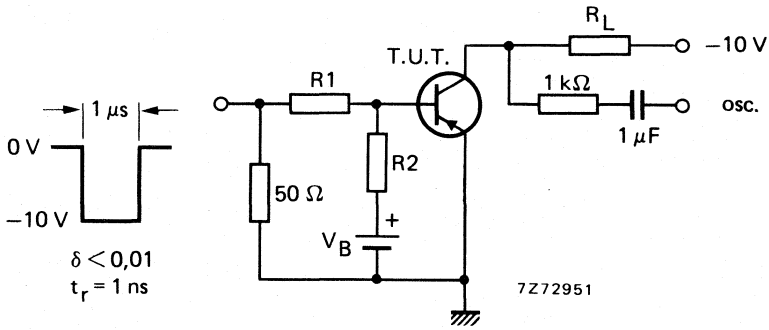


Fig. 2 Test circuit.

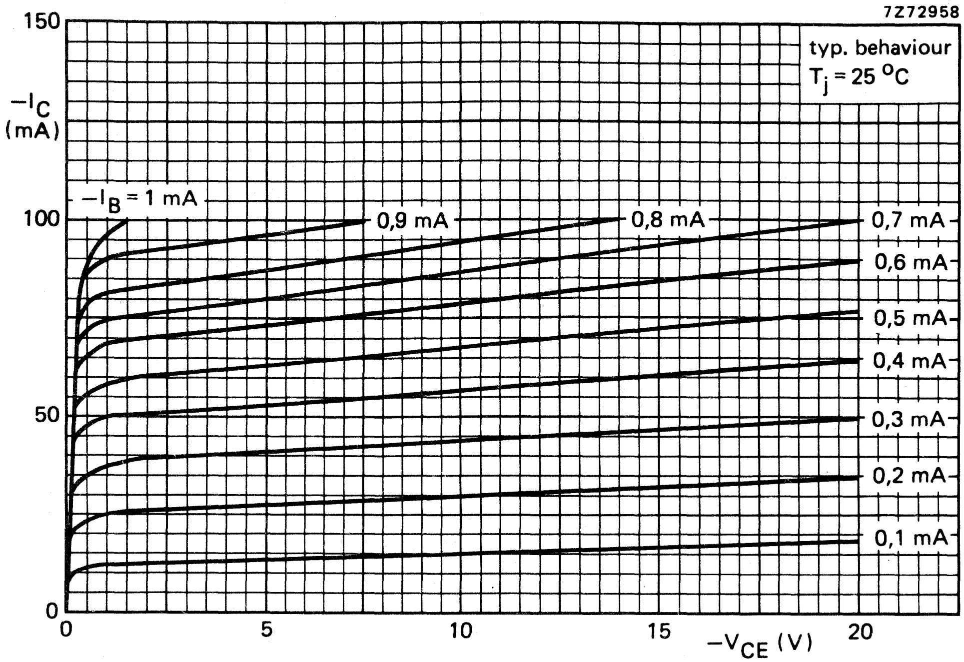


Fig. 3.

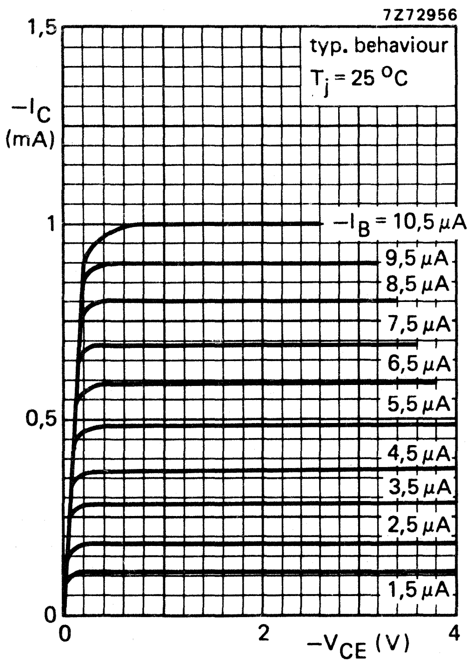


Fig. 4.

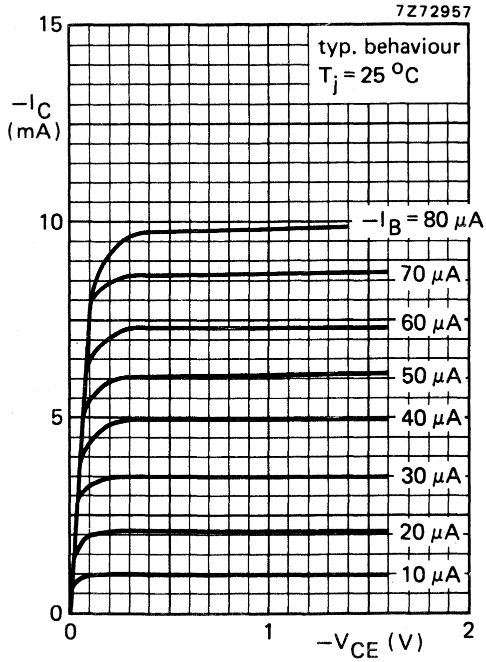


Fig. 5.

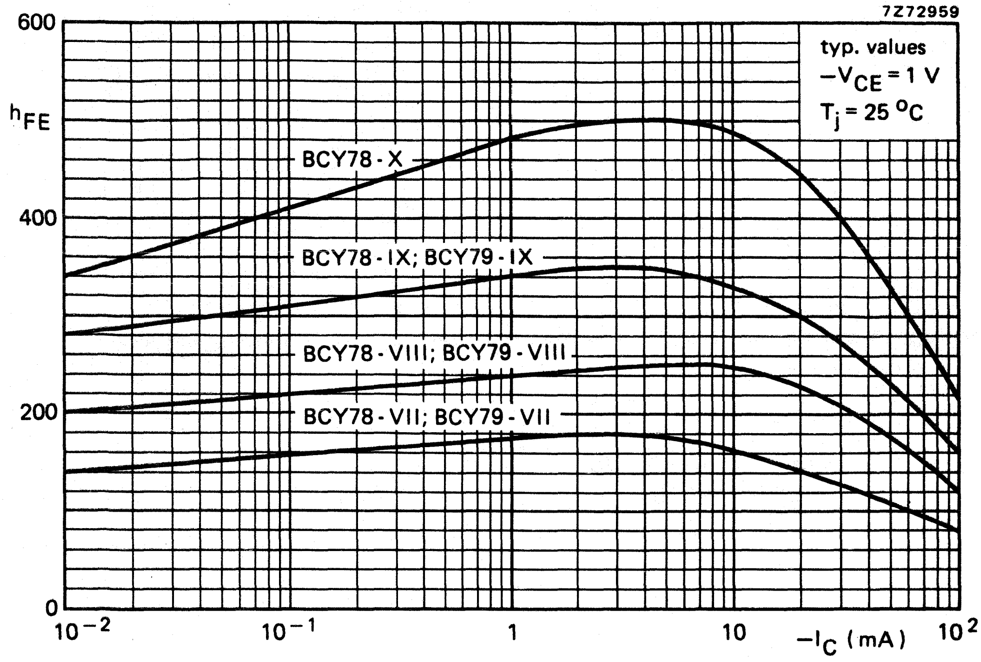

7Z72959
600
400
200
0
h_{FE}
typ. values
$-V_{CE} = 1$ V
$T_j = 25$ °C
BCY78 - X
BCY78 - IX; BCY79 - IX
BCY78 - VIII; BCY79 - VIII
BCY78 - VII; BCY79 - VII
10^{-2}
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 6.

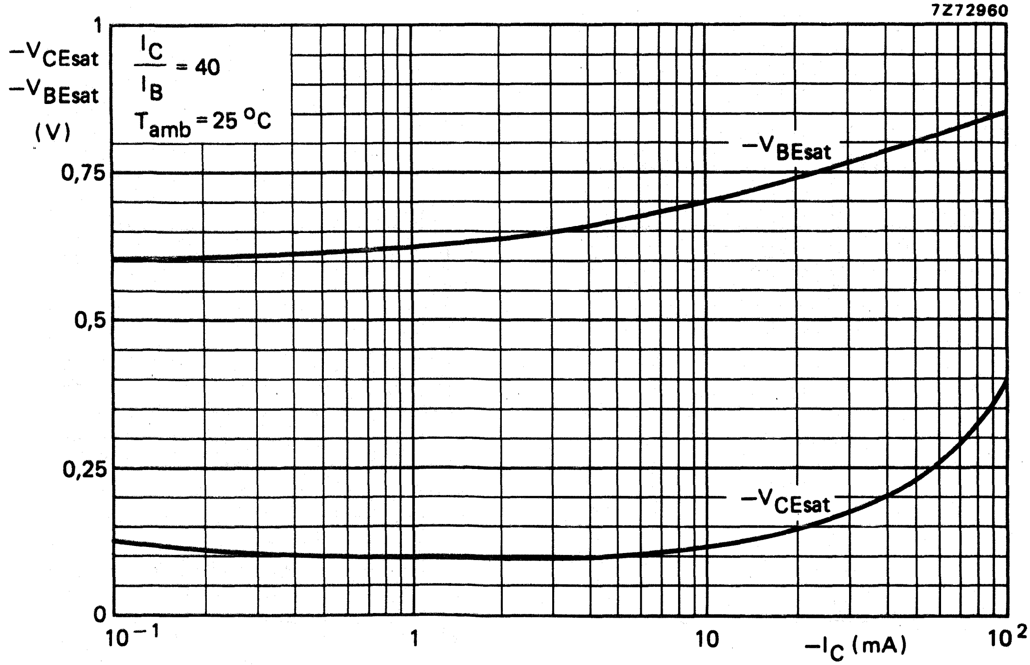

7Z72960
1
0,75
0,5
0,25
0
$-V_{CEsat}$
$-V_{BEsat}$
(V)
$\frac{I_C}{I_B} = 40$
$T_{amb} = 25$ °C
$-V_{BEsat}$
$-V_{CEsat}$
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 7.

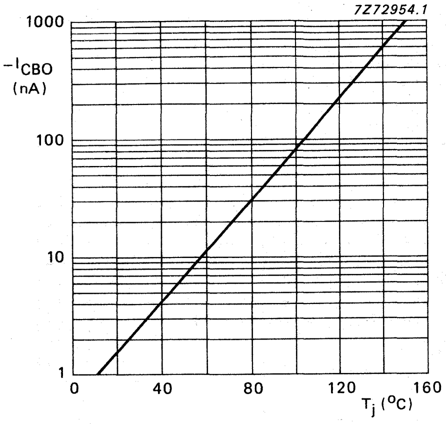


Fig. 8 $-V_{CB}$ = 25 V for BCY78;
$-V_{CB}$ = 35 V for BCY79;
typical values.

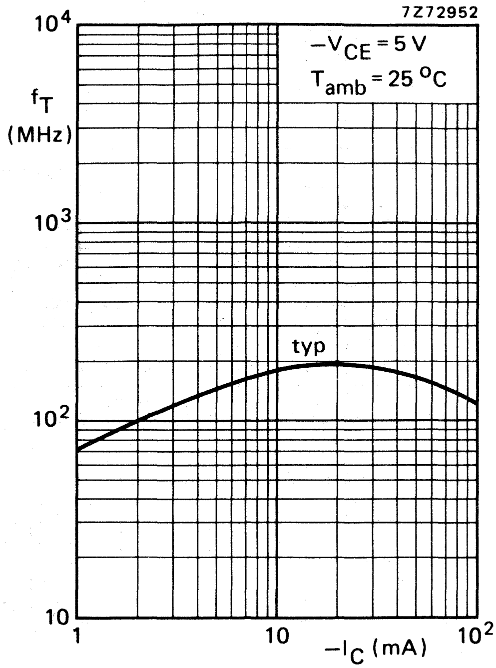


Fig. 9.

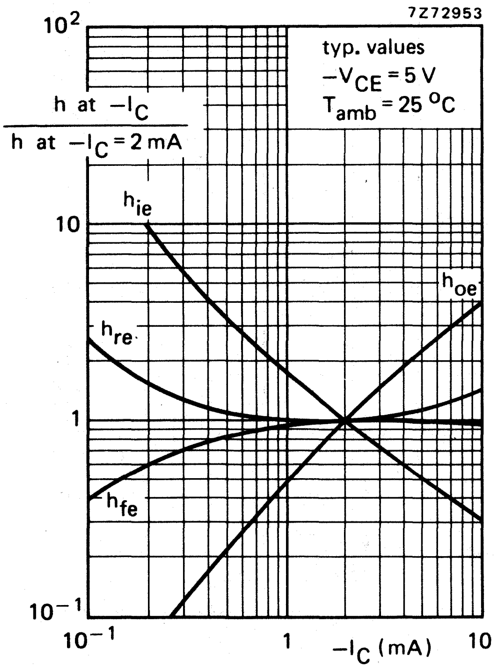


Fig. 10.

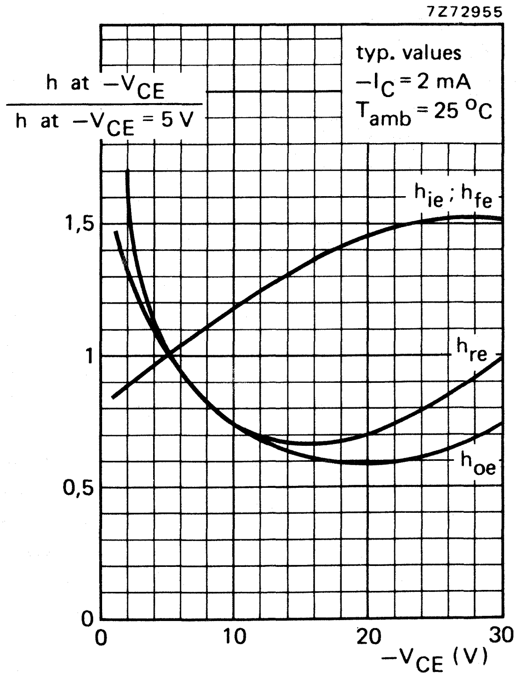


Fig. 11.

N-P-N SILICON PLANAR DUAL TRANSISTORS FOR DIFFERENTIAL AMPLIFIERS

Matched dual n-p-n transistors in a TO-71 metal envelope with all leads insulated from the case. They are primarily intended for differential amplifier applications in general industrial service; e.g. instrumentation and control.

Products are divided into three types according to their matching accuracy.
The BCY87 and BCY88 are intended for applications in pre-stages of differential amplifiers where low offset, drift and noise are of prime importance. The BCY89 is for second stages, long-tailed pairs and more general purposes.

QUICK REFERENCE DATA

Ratings

Collector-base voltage (open emitter)	V_{CBO}	max	45	V
Collector-emitter voltage (open base)	V_{CEO}	max	40	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max	150	mW
Junction temperature	T_j	max	175	°C

Characteristics of the complete device with collector-base voltage of 10 V and sum of emitter currents from 10 to 100 μA.

			BCY87	BCY88	BCY89	
Ratio of collector currents at $V_{1B-1E} = V_{2B-2E}$	I_{1C}/I_{2C}		0,9–1,11	0,8–1,25	0,67–1,5	
Base current difference at $V_{1B-1E} = V_{2B-2E}$	$\lvert I_{1B}-I_{2B} \rvert$	<	25	80	300	nA
Equivalent differential voltage change with temperature *	$\left\lvert \frac{\Delta V}{\Delta T} \right\rvert$	<	3	6	10	μV/K
Equivalent differential current change with temperature *	$\left\lvert \frac{\Delta I}{\Delta T} \right\rvert$	<	0,5	2	10	nA/K

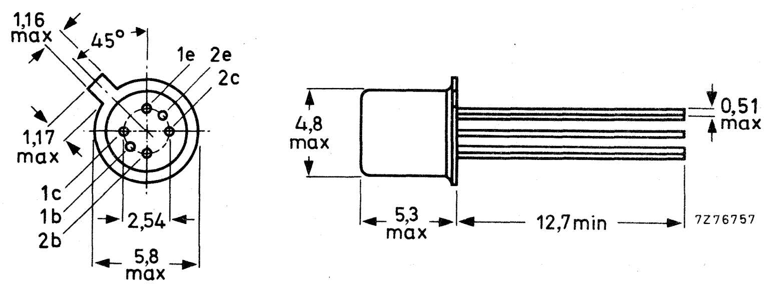
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-71.

All leads insulated from the case

Accessories: 56263 (cooling fin).



* T_{amb} = −20 °C to +90 °C.

RATINGS (see after Fig. 9)

CHARACTERISTICS of the individual transistors

T_{amb} = 25 °C unless otherwise specified

			BCY87	BCY88	BCY89	
Collector cut-off currents						
$I_E = 0$; $V_{CB} = 20$ V; $T_{amb} = 90$ °C	I_{CBO}	<	5	20	–	nA
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	–	–	10	nA
D.C. current gain						
$I_C = 5$ μA; $V_{CB} = 10$ V	h_{FE}	>	80	–	–	
$I_C = 50$ μA; $V_{CB} = 10$ V	h_{FE}	>	100	100	100	
		<	450	450	450	
$I_C = 500$ μA; $V_{CB} = 10$ V	h_{FE}	>	–	120	–	
		<	–	600	–	
$I_C = 10$ mA; $V_{CB} = 10$ V	h_{FE}	>	–	–	100	
		<	–	–	600	
Transition frequency						
$-I_E = 50$ μA; $V_{CB} = 10$ V	f_T	>	10	10	10	MHz
$-I_E = 500$ μA; $V_{CB} = 10$ V	f_T	>	50	50	50	MHz
Collector capacitance at f = 1 MHz						
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	3,5	3,5	3,5	pF
Noise figures						
$I_C = 50$ μA; $V_{CE} = 5$ V; $R_S = 10$ kΩ Bandwidth 10 Hz to 15 kHz	F	<	3	4	4	dB
1 kHz spot noise figure $I_C = 50$ μA; $V_{CE} = 5$ V; R_S = opt. Bandwidth = 200 Hz	F	<	4	5	5	dB

CHARACTERISTICS of the complete device

These characteristics are valid under the following conditions:

a. Collector-base voltage of both transistors not exceeding 10 V ($V_{1C-1B} = V_{2C-2B} \leq 10$ V)

b. Sum of the emitter currents from 10 to 100 μA
$-(I_{1E} + I_{2E}) = 10$ to 100 μA

MATCHING CHARACTERISTICS

		BCY87	BCY88	BCY89	
Ratio of collector currents $V_{1B-1E} = V_{2B-2E}$	I_{1C}/I_{2C}	0,9-1,11	0,8-1,25	0,67-1,5	
Difference between base-emitter voltages $I_{1C} = I_{2C}$	$\lvert V_{1B-1E} - V_{2B-2E}\rvert$	< 3	6	10	mV
Difference between base currents $V_{1B-1E} = V_{2B-2E}$	$\lvert I_{1B}-I_{2B}\rvert$	< 25	80	300	nA
D.C. current gain ratio $I_{1C} = I_{2C}$	h_{1FE}/h_{2FE}	0,9-1,11	0,8-1,25	–	

Illustration of matching characteristics

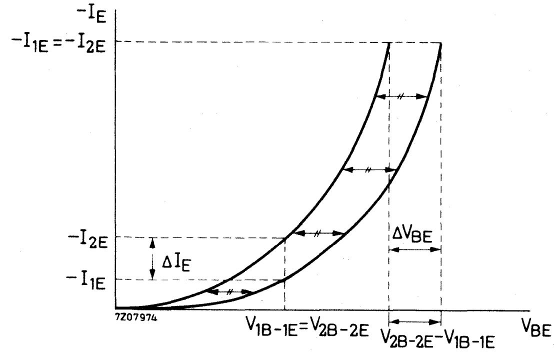


Fig. 2.

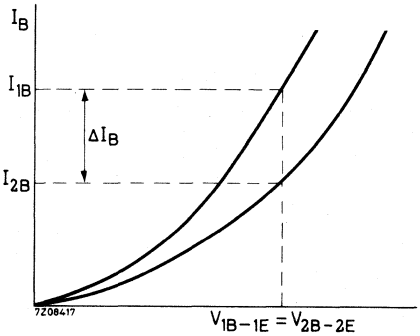


Fig. 3.

$$\frac{I_{2E}}{I_{1E}} = \exp. \frac{q}{KT} \cdot \Delta V_{BE}$$

$\frac{I_{2E}}{I_{1E}}$ measured at $\Delta V_{BE} = 0$

ΔV_{BE} measured at $\frac{I_{2E}}{I_{1E}} = 1$

CHARACTERISTICS of the complete device (continued)

Equivalent circuit for drift

In the equivalent circuit the transistors are considered to be drift free.

All temperature coefficients are concentrated in the voltage source $\frac{\Delta V}{\Delta T}$ and in the current source $\frac{\Delta I}{\Delta T}$.

It should be noted that the differential current change given is only valid when the source resistances are almost equal; the differential voltage change only when the base-emitter voltages are almost equal.

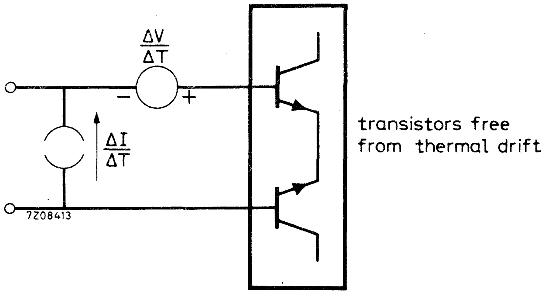


Fig. 4.

Block symbol of test amplifier

The test amplifier, used in the tests on page 5, is described on pages 6 and 7. It is represented by the following amplifier symbol:

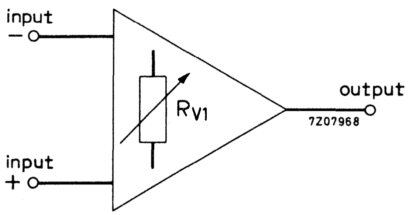


Fig. 5.

Equivalent differential voltage change with temperature

			BCY87	BCY88	BCY89	
T_{amb} = −20 to + 90 °C	$\left\lvert\frac{\Delta V}{\Delta T}\right\rvert$	typ.	1	2	4	μV/K
		<	3	6	10	μV/K

Equivalent differential current change with temperature

			BCY87	BCY88	BCY89	
T_{amb} = −20 to + 90 °C	$\left\lvert\frac{\Delta I}{\Delta T}\right\rvert$	<	0,5	2	10	nA/K

Test methods

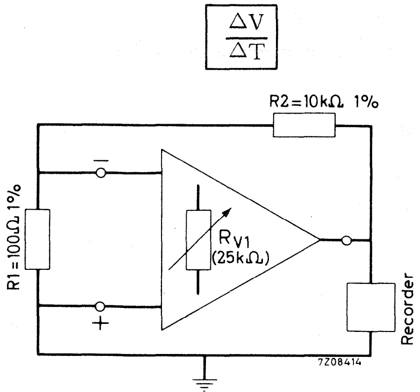


Fig. 6.

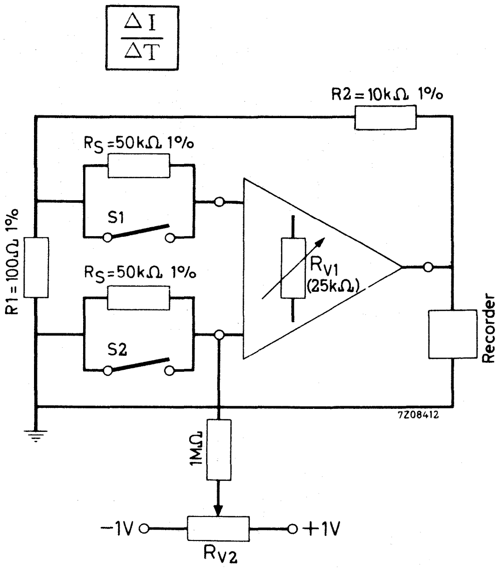


Fig. 7.

Note

To prevent contact potentials, connections should be soldered.

Amplification factor determined by feedback circuit: $\frac{R2}{R1} = 100$

Output voltage against time is recorded.

The temperature of the amplifier is adjusted to T_1 between −20 and + 90 °C. When it has stabilized, the output voltage is brought to zero ($|V_{T1}| < 1$ mV)*. The amplifier temperature is then adjusted to T_2 between −20 to + 90 °C. When it has stabilized the output voltage can be read off.

Then: $\frac{\Delta V}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2}$ or $\frac{\Delta I}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \cdot \frac{1}{2R_S}$

* For $\frac{\Delta V}{\Delta T}$: adjusted by R_{V1}

For $\frac{\Delta I}{\Delta T}$: first by R_{V1} with S1 and S2 closed, then by R_{V2} with the switches open.

Differential test-amplifier

The test amplifier (including feedback resistors, source-resistors and biasing-resistors) should be mounted in a small box to ensure a uniform temperature throughout.

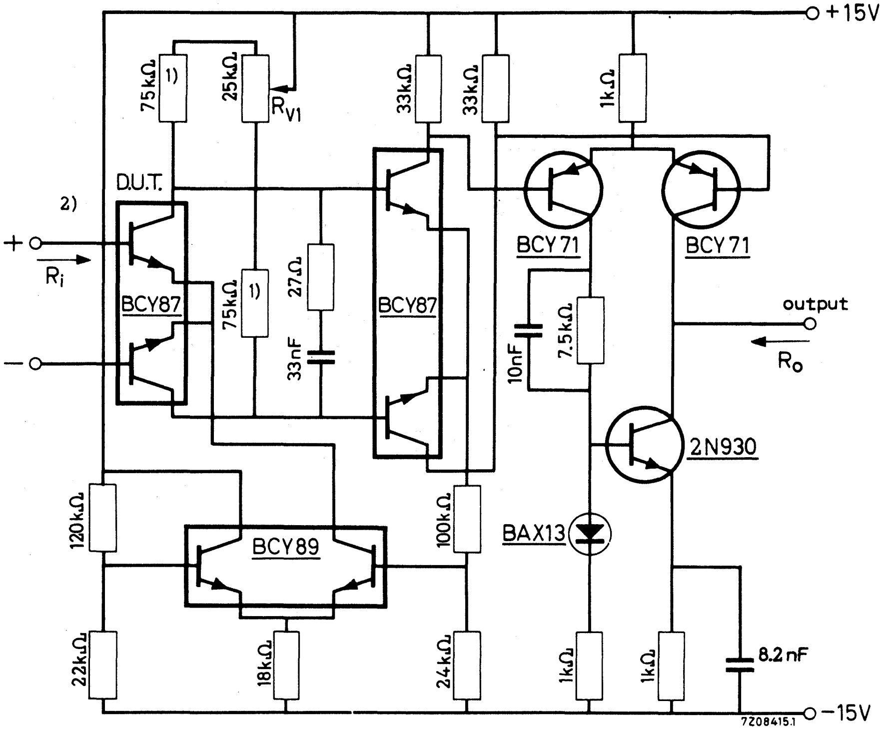


Fig. 8.

1) Relative temperature coefficient $< 10^{-5}/^{\circ}C$.

2) The device at the input is the device under test.

Performance of the test amplifier

Open loop voltage gain (Z_L = 10 kΩ)	G_v	typ.	10^5	
Frequency at which G_v = 1	f_1	typ.	10	MHz
Maximum common mode input voltage range			± 10	V
Maximum output current			± 2,5	mA
Maximum output voltage			± 10	V
Input resistance	R_i		100	kΩ
Output resistance	R_o	typ.	20	kΩ
Common mode rejection ratio			10^5	

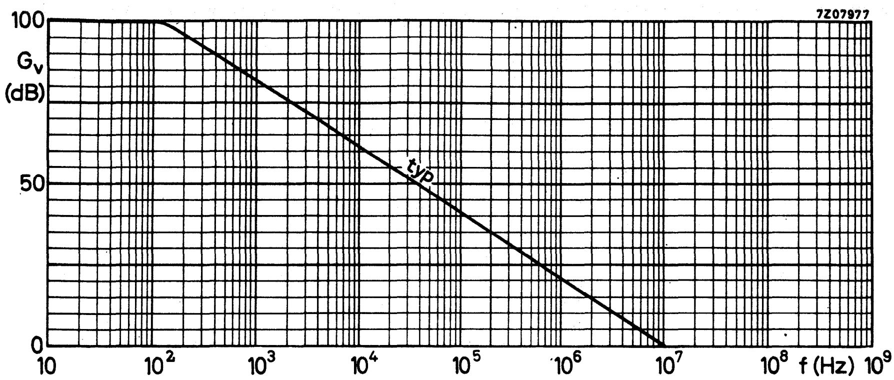


Fig. 9.

RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c.)	I_C	max.	30	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	1	K/mW

SILICON PLANAR TRANSISTOR

N-P-N transistor in a plastic TO-92 envelope. The BF198 has a very low feedback capacitance and is intended for use in the forward gain control stage of the television i.f. amplifier.

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 (d.c.)	I_C	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 100 MHz I_C = 4 mA; V_{CE} = 10 V	f_T	typ.	400	MHz
Feedback capacitance at f = 10,7 MHz I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	200	fF
Max. unilateralized power gain I_C = 4 mA; V_{CE} = 10 V; f = 35 MHz	G_{UM}	typ.	42	dB
f = 45 MHz	G_{UM}	typ.	39	dB
Gain control range	ΔG_{tr}	typ.	60	dB

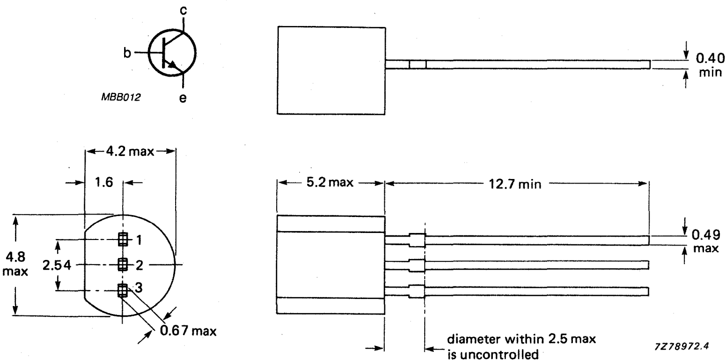
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



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 (d. c.)	I_C	max.	25	mA
Collector current (peak value)	I_{CM}	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	mW
Storage temperature range	T_{stg}	−65 to +150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0,25	K/mW

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Base current at about 50 dB gain control				
I_C = 6 mA; V_{CE} = 2 V	I_B	<	270	μA
I_C = 15 mA; V_{CE} = 5 V	I_B	<	1,5	mA
Base current				
I_C = 4 mA; V_{CE} = 10 V	I_B	typ.	60	μA
		<	150	μA
Base-emitter voltage [1]				
I_C = 4 mA; V_{CE} = 10 V	V_{BE}	typ.	760	mV
		<	850	mV
Feedback capacitance at f = 10.7 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	200	fF
Transition frequency at f = 100 MHz				
I_C = 4 mA; V_{CE} = 10 V	f_T	typ.	400	MHz
Noise figure				
I_C = 4 mA; V_{CE} = 10 V G_S = 10 mA/V; f = 35 MHz; B_S = 0	F	typ.	3	dB

y parameters (common emitter)

I_C = 4 mA; V_{CE} = 10 V

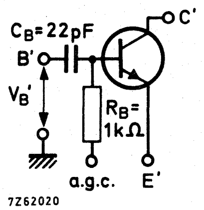
			f = 35	45	MHz
Input conductance	g_{ie}	typ.	3,2	4,8	mS
Input capacitance	C_{ie}	typ.	37	35	pF
Feedback admittance	$\|y_{re}\|$	typ.	47	60	μS
Phase angle of feedback admittance	φ_{re}	typ.	268°	268°	
Transfer admittance	$\|y_{fe}\|$	typ.	105	100	mS
Phase angle of transfer admittance	φ_{fe}	typ.	340°	340°	
Output conductance	g_{oe}	typ.	50	60	μS
Output capacitance	C_{oe}	typ.	1,3	1,3	pF
Maximum unilateralized power gain $G_{UM} = 10 \log \frac{\|y_{fe}\|^2}{4 g_{ie} g_{oe}}$ I_C = 4 mA; V_{CE} = 10 V	G_{UM}	typ.	42	39	dB

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

Equivalent gain control transistor

To ensure an almost constant input admittance and an output conductance that varies little with gain control, we recommend that where a BF198 is used in a gain controlled i.f. stage, a series base capacitor of 22 pF and a bias resistor of 1 kΩ be used.

Fig. 2



The transistor with these additional components is effectively an "equivalent transistor" for gain control purposes, the signal handling capability of which may be expressed in terms of voltage. (Without these components the varying input admittance means that the signal handling capability can only be expressed in terms of power).

The signal handling capability of the equivalent transistor as a function of ΔG_{tr} (the reduction in transducer gain with gain control) will be found on Figs. 3 to 6.

a. Voltage versus ΔG_{tr} curves for a γ distortion of 5% are below.

b. Voltage versus ΔG_{tr} curves for an in-band cross modulation factor of 1% are on Figs. 5 and 6.

Graphs of the y-parameters are on Figs. 13 to 28.

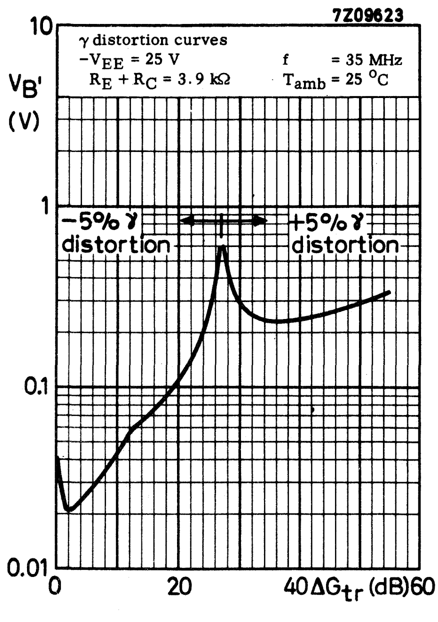


Fig. 3

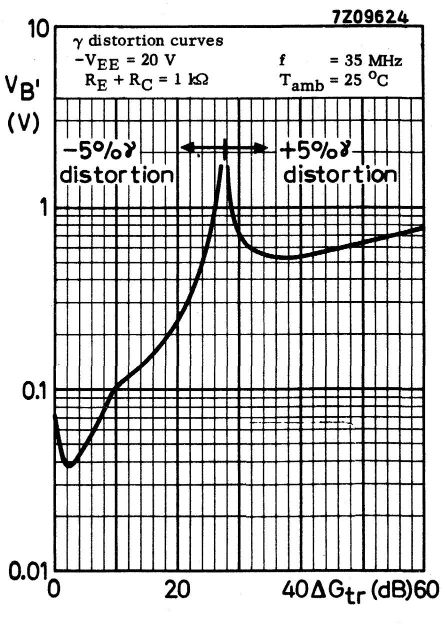


Fig. 4

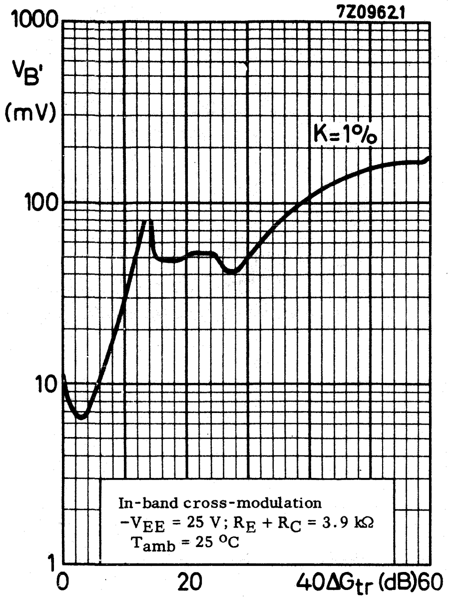

7Z09621
1000
$V_{B'}$
(mV)
K=1%
100
10
1
0
20
40 ΔG_{tr} (dB) 60
In-band cross-modulation
$-V_{EE}$ = 25 V; $R_E + R_C$ = 3.9 kΩ
T_{amb} = 25 °C

Fig. 5

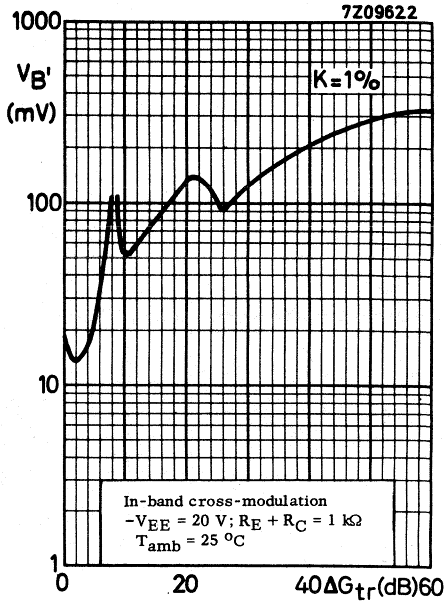

7Z09622
1000
$V_{B'}$
(mV)
K=1%
100
10
1
0
20
40 ΔG_{tr} (dB) 60
In-band cross-modulation
$-V_{EE}$ = 20 V; $R_E + R_C$ = 1 kΩ
T_{amb} = 25 °C

Fig. 6

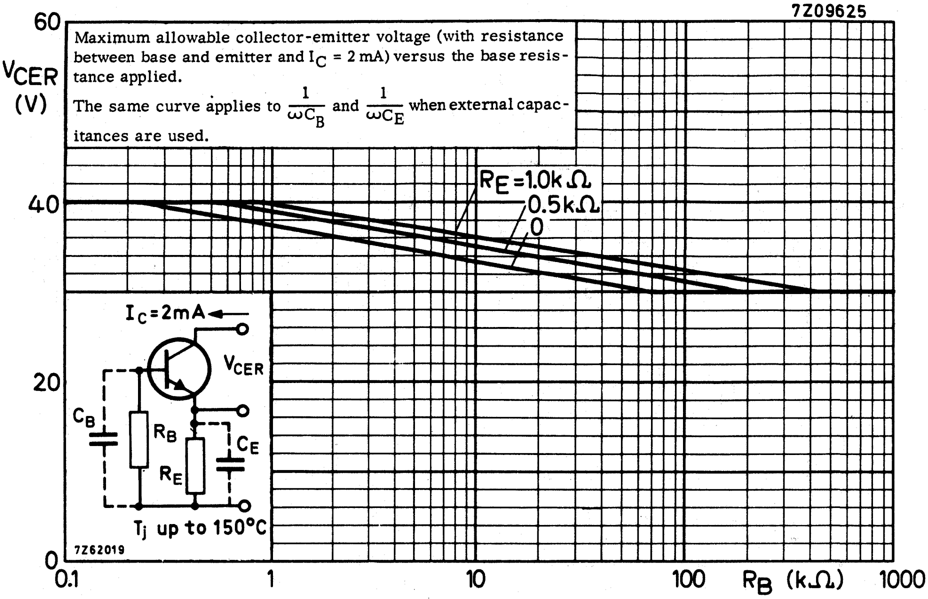


Fig. 7

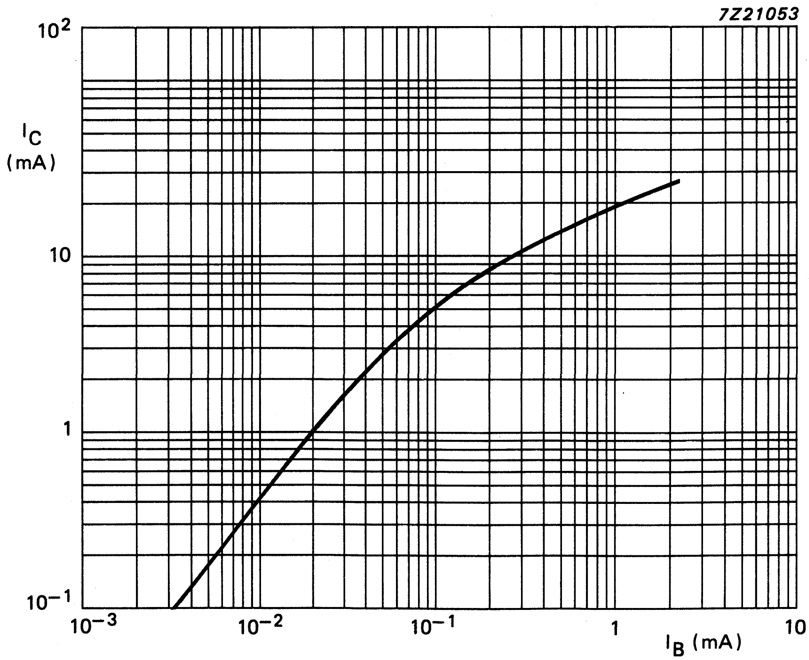


Fig. 8 Base current as a function of collector current; V_{CE} = 10 V; T_j = 25 °C; typical values.

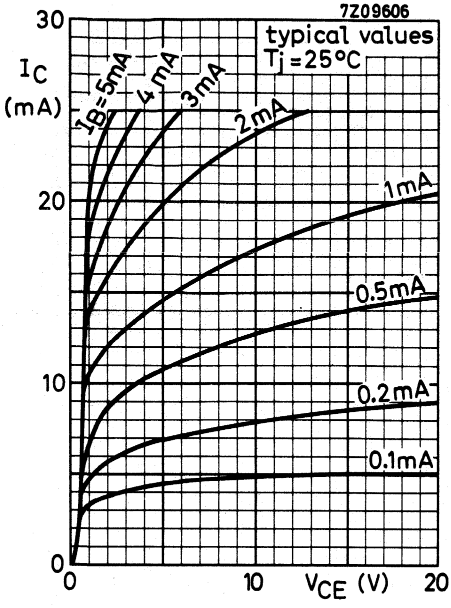


Fig. 9

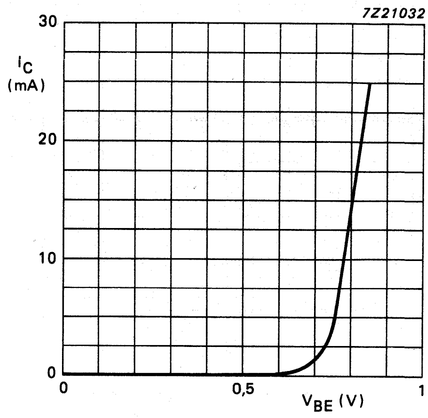


Fig. 10 V_{CE} = 10 V; T_j = 25 °C; typical values.

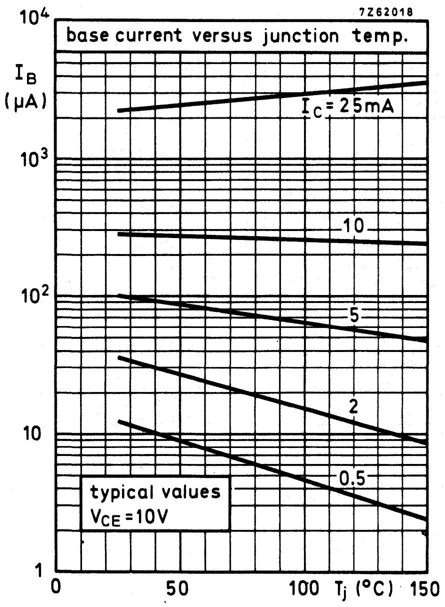


Fig. 11

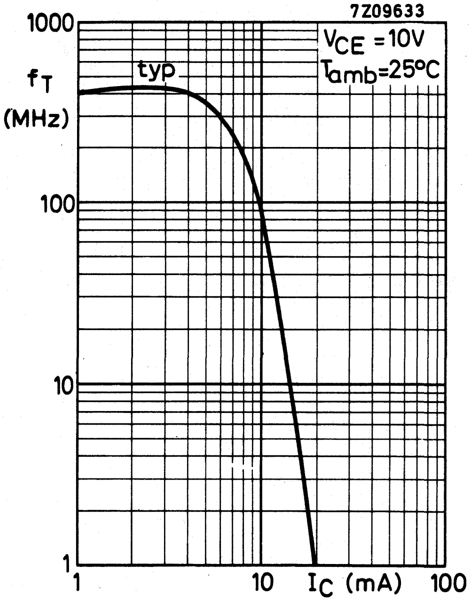


Fig. 12

Voltage control; $-V_{EE}$ = 25 V; $R_E + R_C$ = 3.9 kΩ; f = 35 MHz

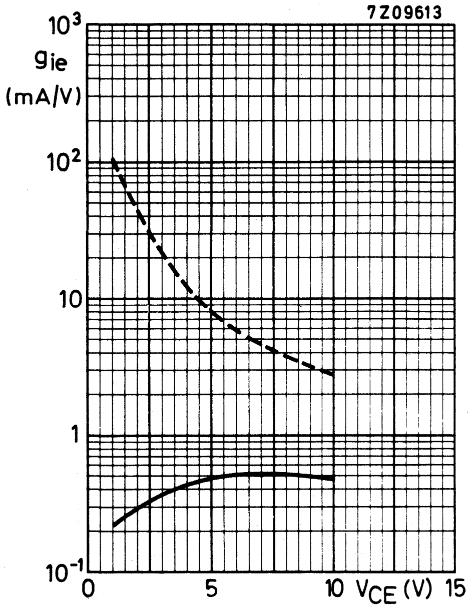


Fig. 13

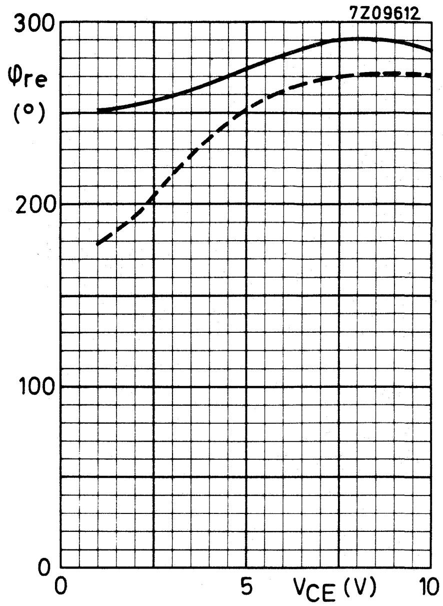


Fig. 14

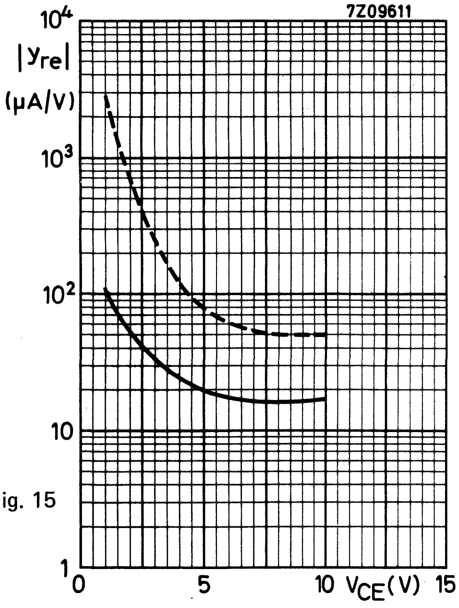


Fig. 15

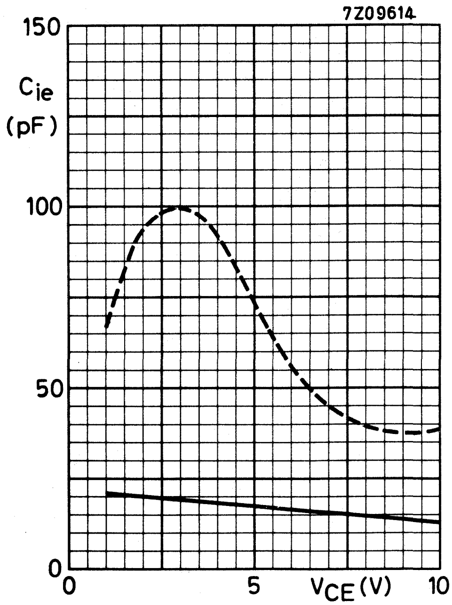


Fig. 16

y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on Fig. 2 (dashed curves apply to the transistor only).

Voltage control; $-V_{EE}$ = 25 V; $R_E + R_C$ = 3.9 kΩ; f = 35 MHz

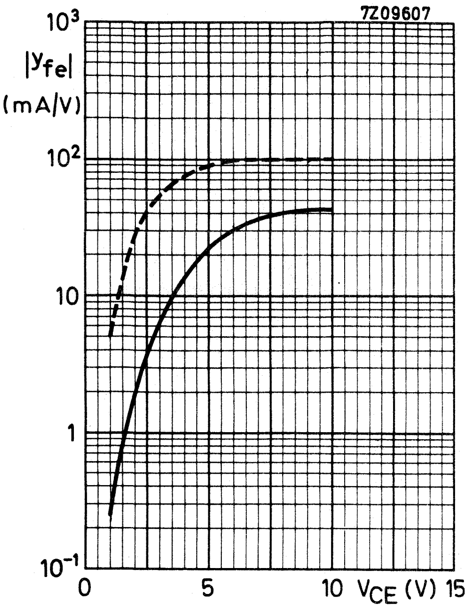


Fig. 17

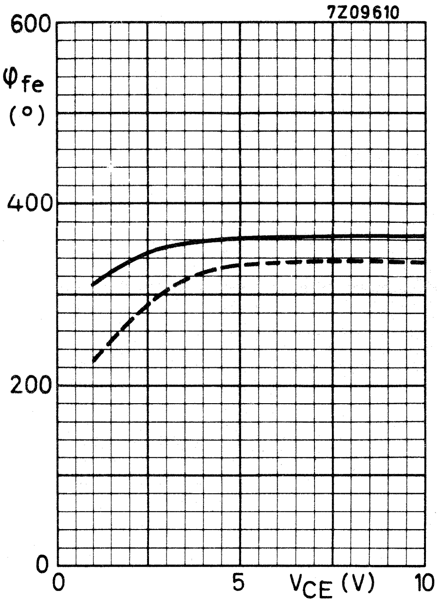


Fig. 18

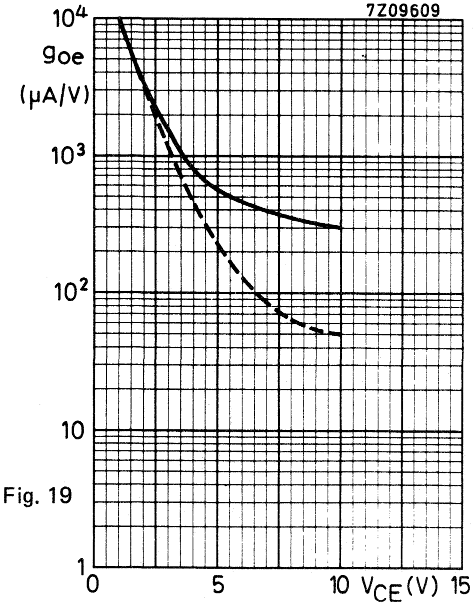


Fig. 19

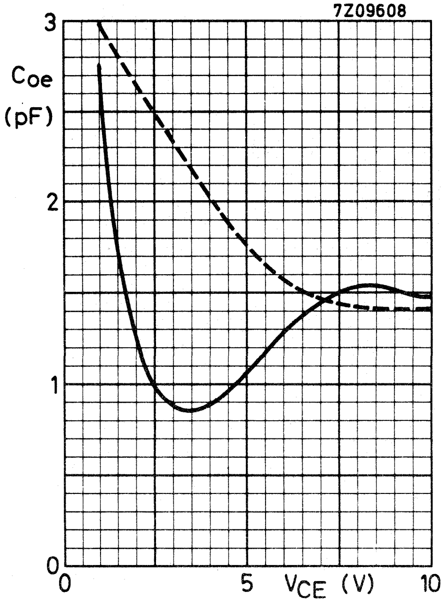


Fig. 20

y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on Fig. 2 (dashed curves apply to the transistor only).

Current control; $-V_{EE}$ = 20 V; $R_E + R_C$ = 1 kΩ; f = 35 MHz

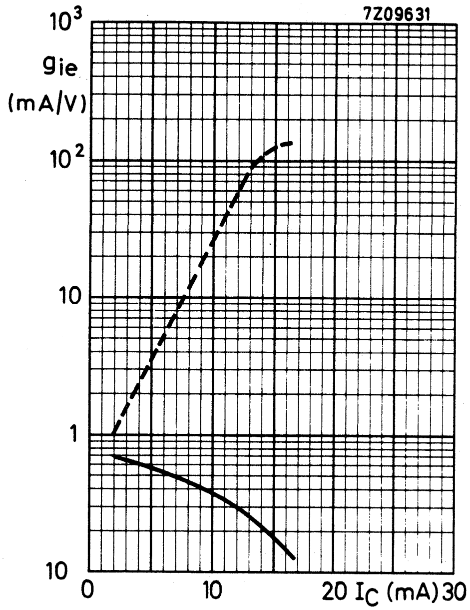


Fig. 21

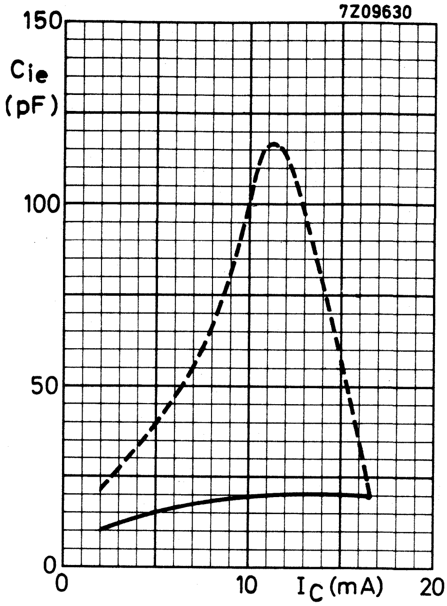


Fig. 22

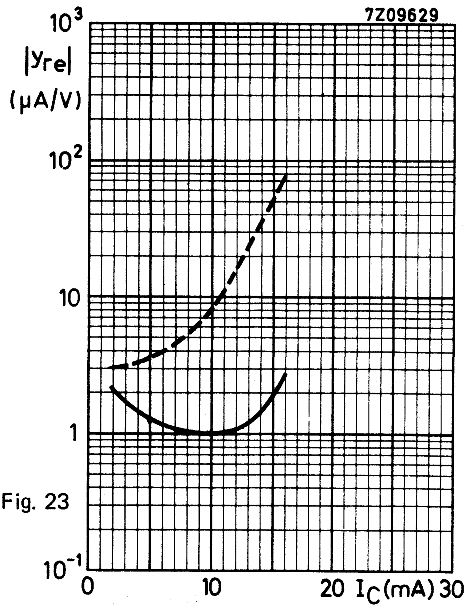


Fig. 23

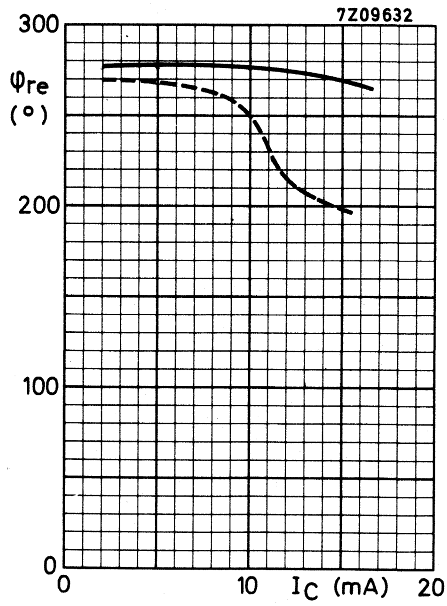


Fig. 24

y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on Fig. 2 (dashed curves apply to the transistor only).

Current control; $-V_{EE} = 20$ V; $R_E + R_C = 1$ kΩ; f = 35 MHz

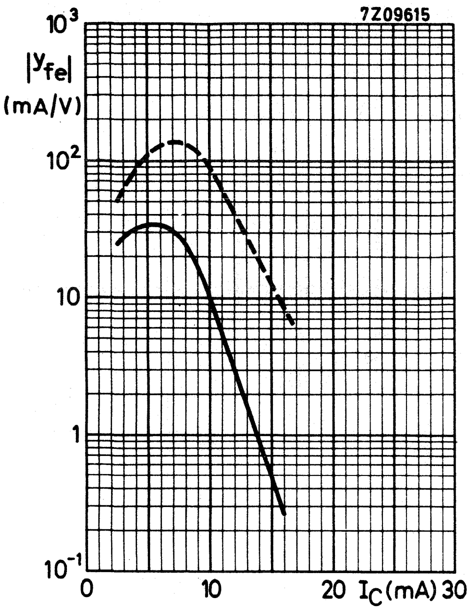


Fig. 25

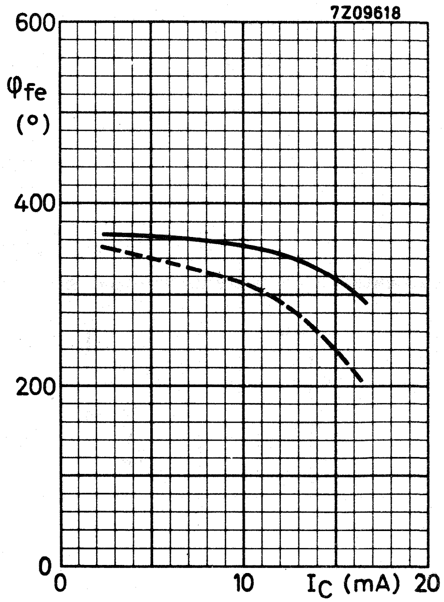


Fig. 26

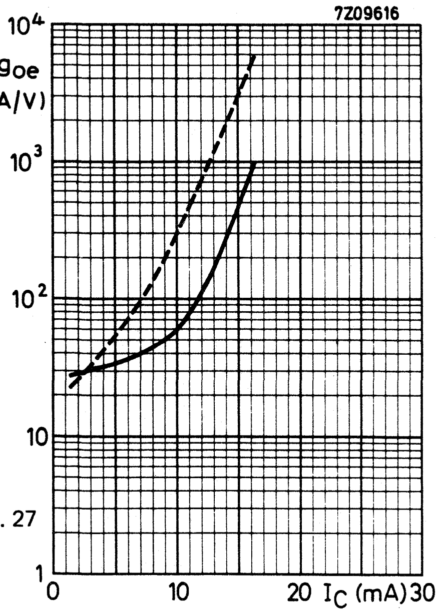


Fig. 27

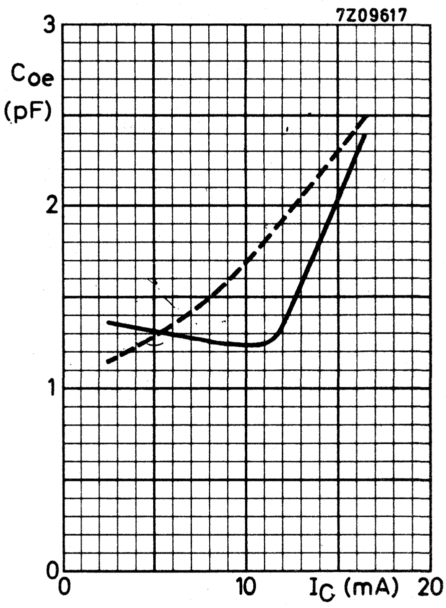


Fig. 28

y-parameters of the equivalent gain control transistor, including base capacitor and base resistor as shown on Fig. 2 (dashed curves apply to the transistor only).

APPLICATION INFORMATION

First stage of an i.f. amplifier

Basic circuit with voltage gain control: $R_E + R_C$ = 3.9 kΩ; $-V_{EE}$ = 25 V

current gain control: $R_E + R_C$ = 1 kΩ; $-V_{EE}$ = 20 V

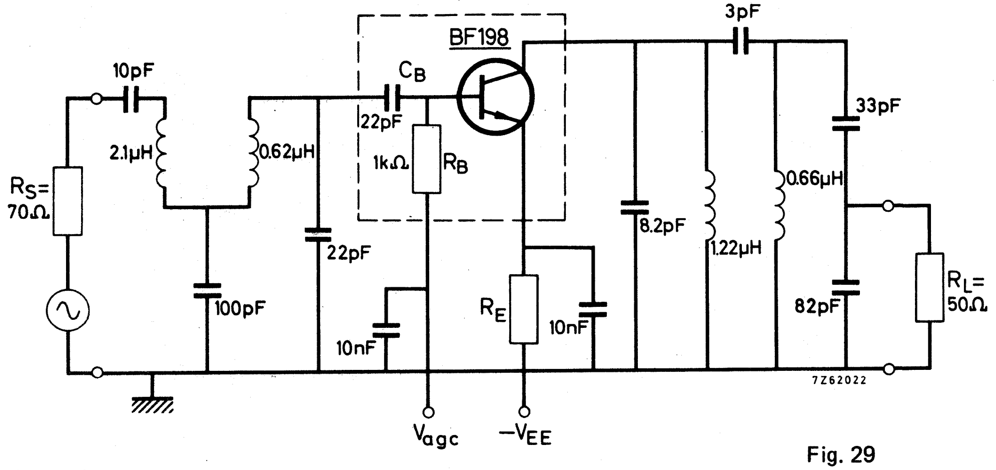


Fig. 29

Transducer gain

$$G_{tr} \text{ (in dB)} = 10 \log \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

f = 36.4 MHz; I_C = 4 mA; $R_E + R_C$ = 3.9 kΩ; $-V_{EE}$ = 25 V $\quad G_{tr}$ typ. 25.5 dB

Gain control range (see also upper graphs next page) $\quad \Delta G_{tr}$ typ. 60 dB

Voltage gain control

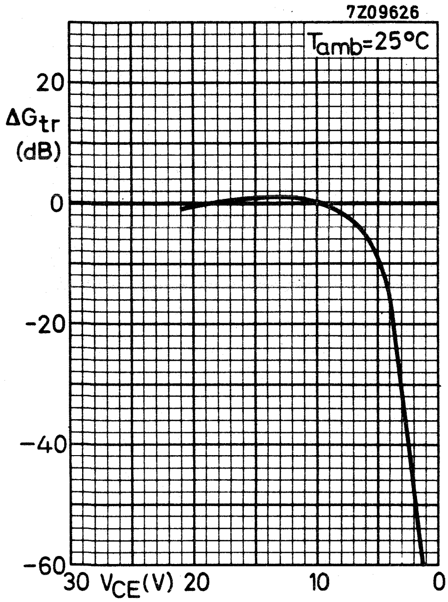


Fig. 30

Current gain control

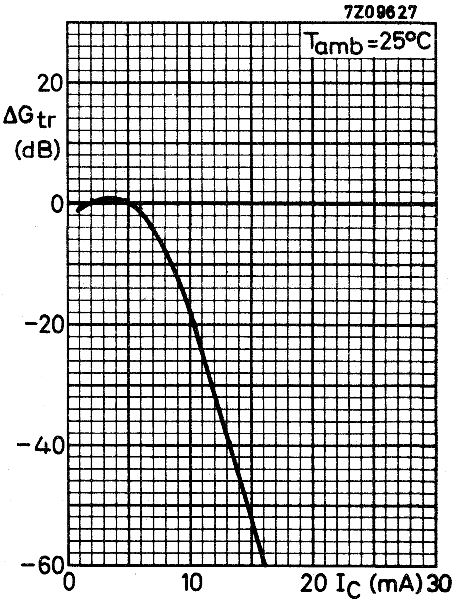


Fig. 31

Curves of constant gain reduction

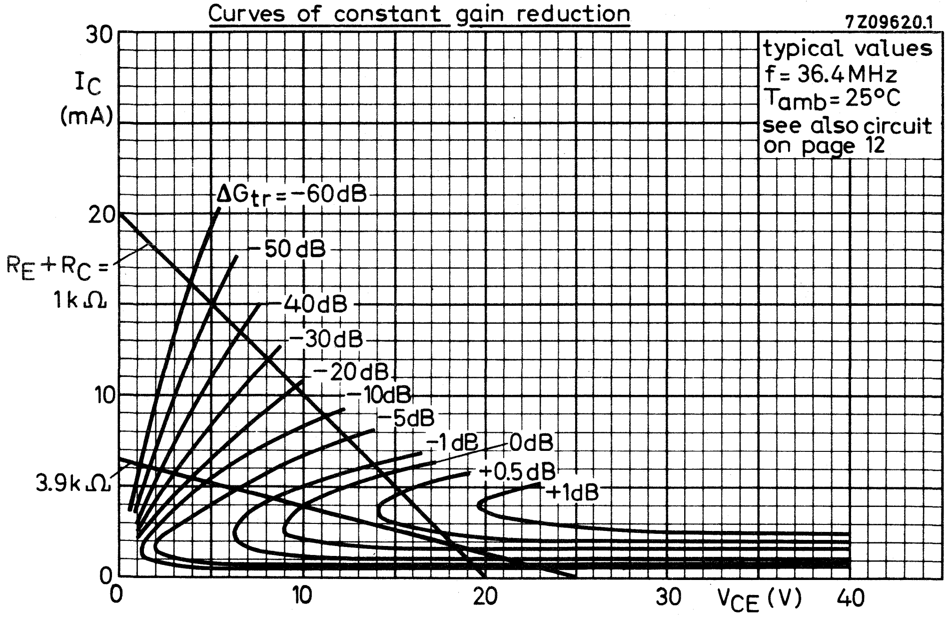


Fig. 32

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a plastic TO-92 envelope.

The BF199 has a very low feedback capacitance and is intended for use in the output stage of a vision i.f. amplifier.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	25	V
Collector current (d.c.)	I_C	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	150	°C
Transition frequency at f = 100 MHz I_C = 5 mA; V_{CE} = 10 V	f_T	typ.	550	MHz
Feedback capacitance at f = 10,7 MHz I_C = 1 mA; V_{CE} = 10 V	C_{re}	typ.	340	fF
Maximum unilateral power gain I_C = 7 mA; V_{CE} = 10 V; f = 35 MHz	G_{UM}	typ.	44,4	dB
Video detector output voltage	V_O	typ.	7,7	V

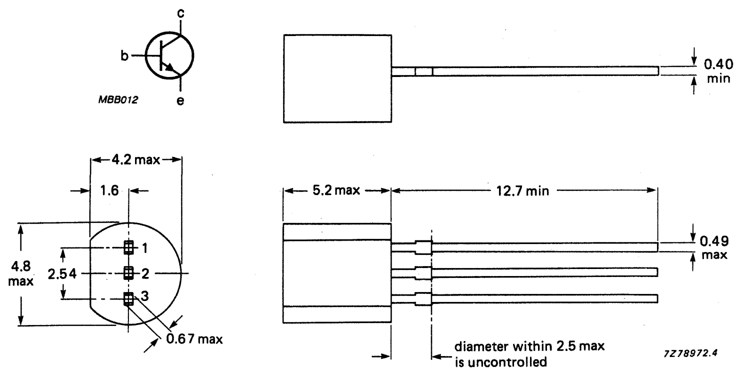
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



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.	25	V
Emitter-base voltage (open collector)	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} = 25 °C	P_{tot}	max.	500	mW
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	0,25	K/mW

CHARACTERISTICS

T_{amb} = 25 °C

Base current			
I_C = 7 mA; V_{CE} = 10 V	I_B	typ.	60 μA
		<	185 μA
Base-emitter voltage *			
I_C = 7 mA; V_{CE} = 10 V	V_{BE}	typ.	775 mV
		<	925 mV
Transition frequency at f = 100 MHz			
I_C = 5 mA; V_{CE} = 10 V	f_T	typ.	550 MHz
Feedback capacitance at f = 10,7 MHz			
I_C = 1 mA; V_{CE} = 10 V	C_{re}	typ.	340 fF
y-parameters (common emitter)			
I_C = 7 mA; V_{CE} = 10 V; f = 35 MHz			
input conductance	g_{ie}	typ.	5,5 mS
input capacitance	C_{ie}	typ.	55 pF
feedback admittance	$\|y_{re}\|$	typ.	75 μS
phase angle of feedback admittance	φ_{re}	typ.	268°
transfer admittance	$\|y_{fe}\|$	typ.	220 mS
phase angle of transfer admittance	φ_{fe}	typ.	338°
output conductance	g_{oe}	typ.	80 μS
output capacitance	C_{oe}	typ.	2,0 pF
Maximum unilateral power gain			
$G_{UM} = 10 \log \frac{\|y_{fe}\|^2}{4 g_{ie} g_{oe}}$			
I_C = 7 mA; V_{CE} = 10 V	G_{UM}	typ.	44,4 dB

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

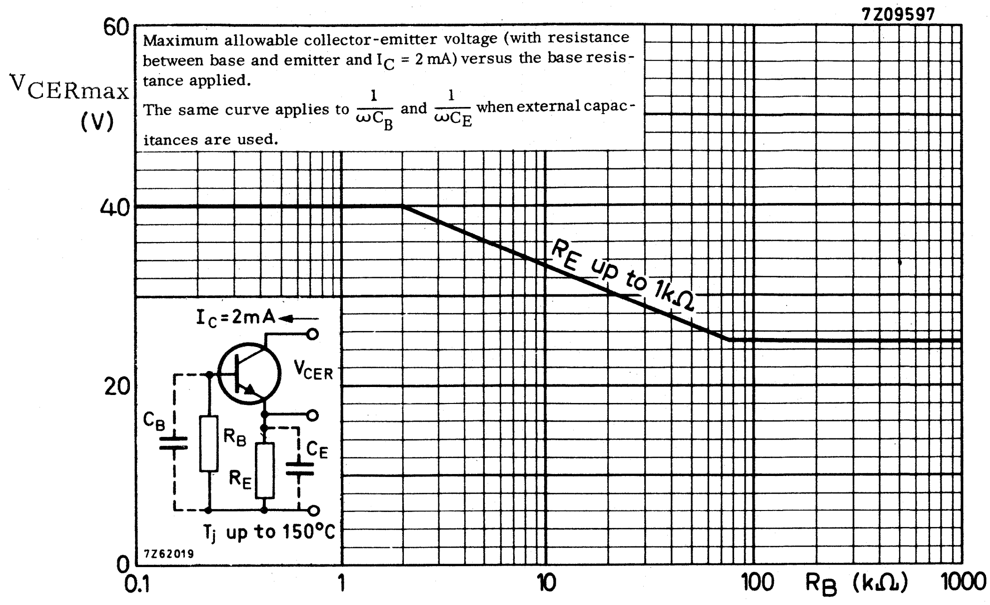

7Z09597
Maximum allowable collector-emitter voltage (with resistance between base and emitter and I_C = 2 mA) versus the base resistance applied.
The same curve applies to 1/ωC_B and 1/ωC_E when external capacitances are used.
V_CERmax (V)
60
40
20
0
0.1
1
10
100
R_B (kΩ)
1000
R_E up to 1kΩ
I_C = 2mA
V_CER
C_B
R_B
R_E
C_E
T_j up to 150°C
7Z62019

Fig. 2.

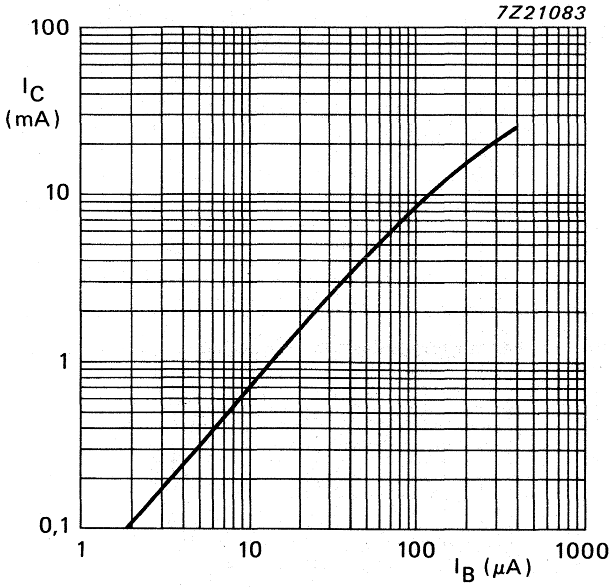


Fig. 3 V_{CE} = 10 V; T_j = 25 °C; typical values.

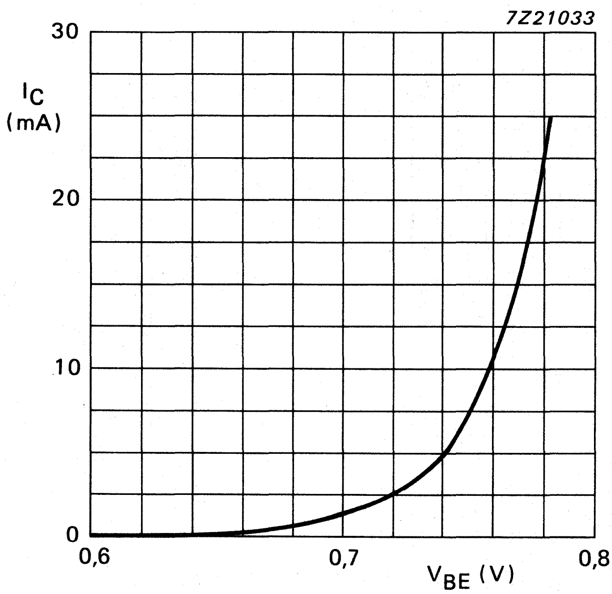


Fig. 4 V_{CE} = 10 V; T_j = 25 °C; typical values.

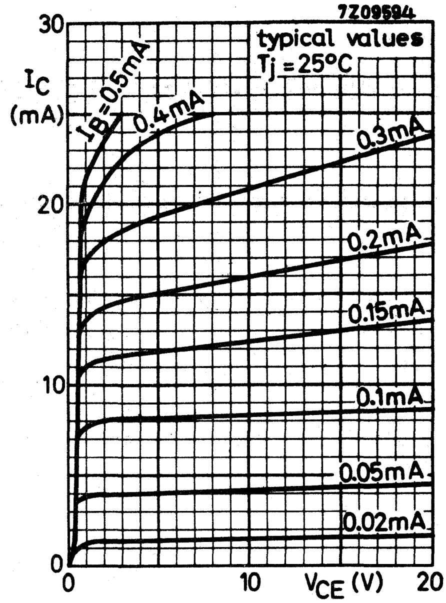


Fig. 5.

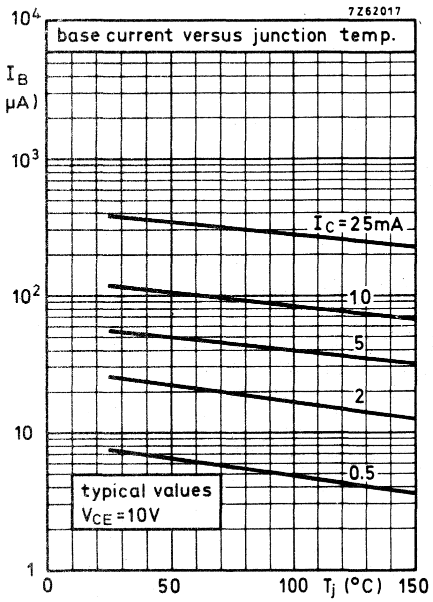


Fig. 6.

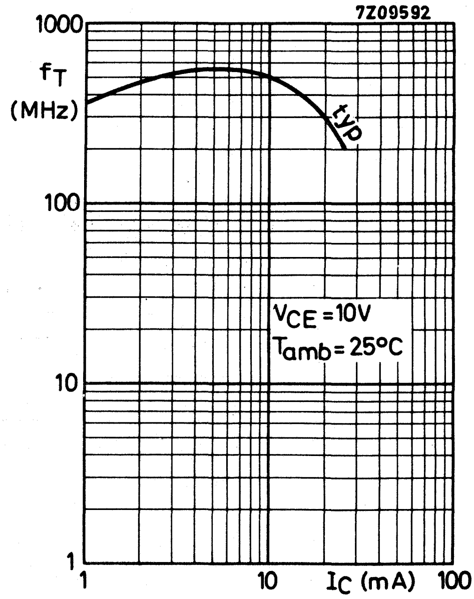


Fig. 7.

HF SILICON PLANAR EPITAXIAL TRANSISTORS

NPN transistors in a plastic envelope, recommended for AM mixers and IF amplifiers in AM/FM receivers.

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 (DC)	I_C	max.		25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		300	mW
Junction temperature	T_j	max.		150	°C
			BF240	BF241	
DC current gain I_C = 1 mA; V_{CE} = 10 V	h_{FE}		67 to 220	35 to 125	μA
Transition frequency I_C = 1 mA; V_{CE} = 10 V	f_T	min.	150		MHz
Feedback capacitance at f = 1 MHz I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	max.		0.34	pF

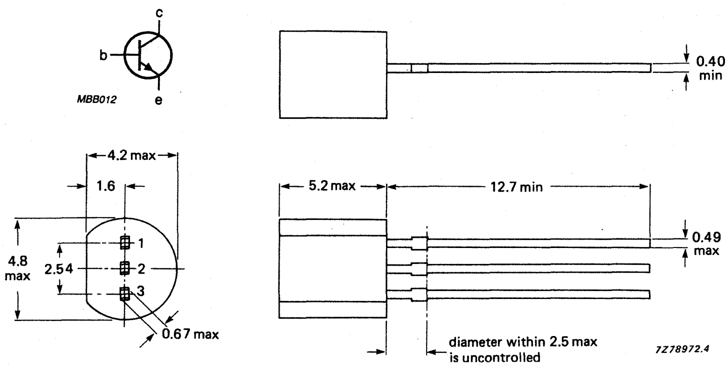
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



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 (DC)	I_C	max.	25 mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300 mW
Storage temperature range	T_{stg}		−65 to +150 °C
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	420 K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current					
$I_E = 0$; V_{CB} = 20 V	I_{CBO}	max.	100		nA
$I_E = 0$; V_{CB} = 20 V; T_{amb} = 150 °C	I_{CBO}	max.	4		μA
Base-emitter voltage					
I_C = 1 mA; V_{CE} = 10 V	V_{BE}	typ.	700		mV
			650 to 740		mV
			BF240	BF241	
DC current gain					
I_C = 1 mA; V_{CE} = 10 V	h_{FE}		67 to 220	35 to 125	μA
Transition frequency at f = 100 MHz					
I_C = 1 mA; V_{CE} = 10 V	f_T	min.	150		MHz
Feedback capacitance at f = 1 MHz					
I_C = 1 mA; V_{CE} = 10 V	C_{re}	max.	0.34		pF
Emitter-base cut-off current					
$I_C = 0$; V_{EB} = 3 V	I_{EBO}	max.	100		nA

y parameters (common emitter) Lead length = 3 mm

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

			BF240		BF241		
	f	=	0.45	10.7	0.45	10.7	MHz
Input conductance	g_{ie}	typ.	0.2	0.3	0.4	0.5	mA
Input capacitance	C_{ie}	typ.	17	14	23	19	pF
Transfer admittance	$\|y_{fe}\|$	typ.	37	37	37	37	mS
Phase angle of transfer admittance	φ_{fe}	typ.	0^o	0^o	0^o	0^o	
Output conductance	g_{oe}	max.	8.3	10.5	8.3	10.5	μS
Output capacitance	C_{oe}	typ.	1	1	1	1	pF
Feedback admittance	$\|y_{re}\|$	typ.	0.75	18	0.75	18	μS
Phase angle of feedback admittance	φ_{re}	typ.	270^o	270^o	270^o	270^o	

I_C = 4 mA; V_{CE} = 10 V; f = 35 MHz (BF240, BF241)

Input conductance	g_{ie}	typ.	4	mS
Input capacitance	C_{ie}	typ.	25	pF
Transfer admittance	$\|y_{fe}\|$	typ.	125	mS
Output conductance	g_{oe}	typ.	62	μS
Output capacitance	C_{oe}	typ.	1	pF

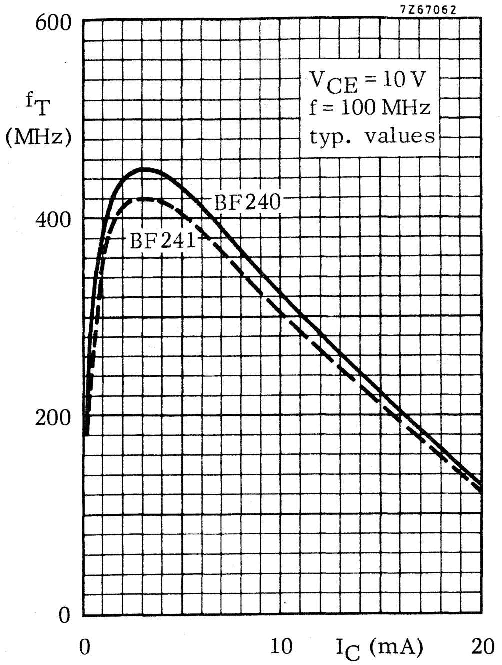

7Z67062
600
400
200
0
f_T
(MHz)
V_{CE} = 10 V
f = 100 MHz
typ. values
BF240
BF241
0
10
I_C (mA)
20

Fig. 2.

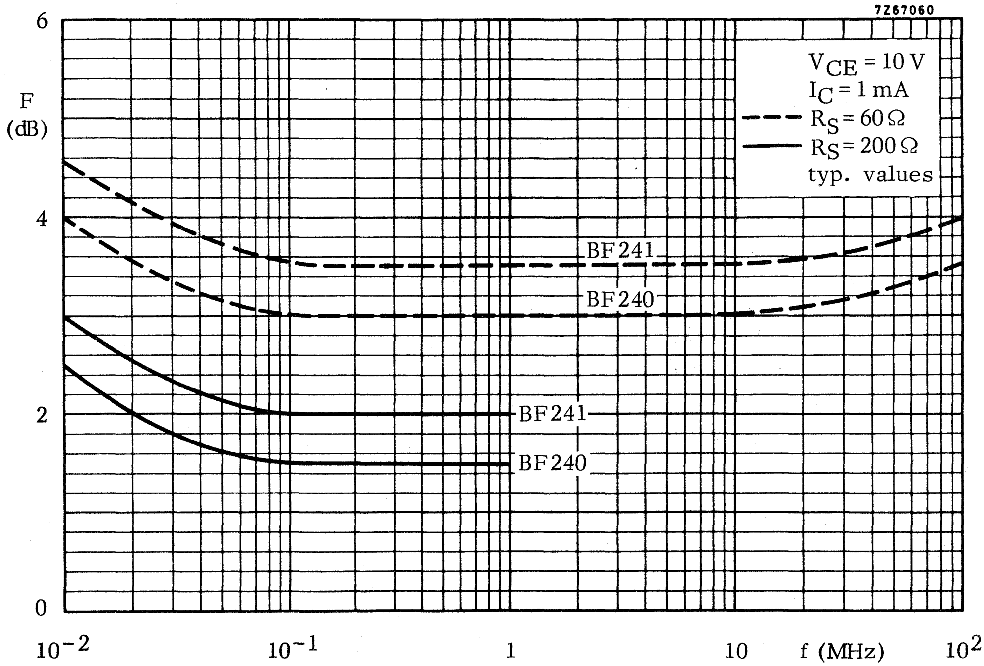

7Z67060
6
4
2
0
F
(dB)
V_{CE} = 10 V
I_C = 1 mA
R_S = 60 Ω
R_S = 200 Ω
typ. values
BF241
BF240
BF241
BF240
10^{-2}
10^{-1}
1
10
f (MHz)
10^2

Fig. 3.

H.F. SILICON PLANAR EPITAXIAL TRANSISTOR

P-N-P transistor in a plastic envelope especially intended for r.f. stages in f.m. front-ends in common base configuration.

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} = 45 °C	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	150	°C
Base current $-I_C$ = 4 mA; $-V_{CE}$ = 10 V	$-I_B$	typ. >	80 160	μA μA
Transition frequency $-I_C$ = 4 mA; $-V_{CE}$ = 10 V	f_T	typ.	450	MHz
Noise figure at f = 100 MHz $-I_C$ = 2 mA; $-V_{CE}$ = 10 V; G_s = 16,7 mA/V	F	typ.	3	dB
Feedback capacitance at f = 1 MHz V_{EB} = 0; $-V_{CB}$ = 10 V	C_{rb}	typ.	0,1	pF

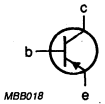
MECHANICAL DATA

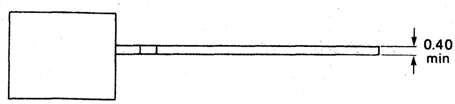
Dimensions in mm

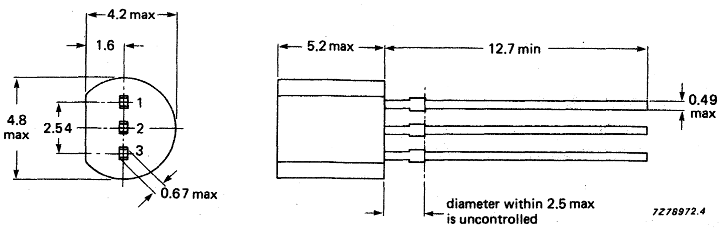
Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector







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} = 45 °C	P_{tot}	max.	250	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	$R_{th\ j\text{-}a}$	=	420	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0; -V_{CB} = 30$ V	$-I_{CBO}$	<	50	nA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 4$ V	$-I_{EBO}$	<	10	µA
Base current				
$-I_C = 4$ mA; $-V_{CE} = 10$ V	$-I_B$	typ. <	80 160	µA µA
$-I_C = 1$ mA; $-V_{CE} = 10$ V	$-I_B$	typ.	22	µA
Base-emitter voltage				
$-I_C = 4$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	0,76	V
Transition frequency at f = 100 MHz				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	f_T	typ.	350	MHz
$-I_C = 4$ mA; $-V_{CE} = 10$ V	f_T	typ.	450	MHz
$-I_C = 8$ mA; $-V_{CE} = 10$ V	f_T	typ.	440	MHz
Feedback capacitance at f = 1 MHz				
$V_{EB} = 0; -V_{CB} = 10$ V	C_{rb}	typ.	0,1	pF
Noise factor at f = 100 MHz				
$-I_C = 2$ mA; $-V_{CE} = 10$ V;				
G_s = 16,7 mS	F	typ.	3	dB
$-I_C = 5$ mA; $-V_{CE} = 10$ V;				
G_s = 6,7 mA/V; $-jB_s$ = 5 mS	F	typ.	3,5	dB
y-parameters (common base) at f = 100 MHz				
$-I_C = 4$ mA; $-V_{CB} = 10$ V				
Input conductance	g_{ib}	typ.	125	mS
Input capacitance	$-C_{ib}$	typ.	64	pF
Transfer admittance	$\|y_{fb}\|$	typ.	100	mS
Phase angle of transfer admittance	φ_{fb}	typ.	147°	
Output conductance	g_{ob}	typ.	40	µS
Output capacitance	C_{ob}	typ.	1,25	pF
Feedback admittance	$\|y_{rb}\|$	typ.	220	µS
Phase angle of feedback admittance	$-\varphi_{rb}$	typ.	85°	

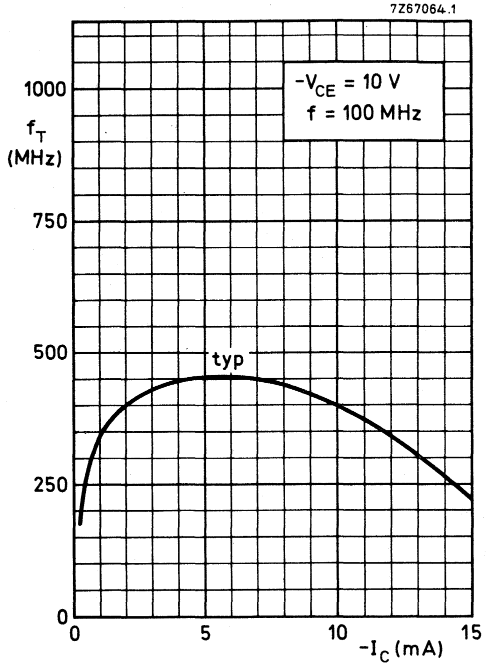

7Z67064.1
$-V_{CE}$ = 10 V
f = 100 MHz
f_T
(MHz)
1000
750
500
250
0
typ
0
5
10
15
$-I_C$ (mA)

Fig. 2

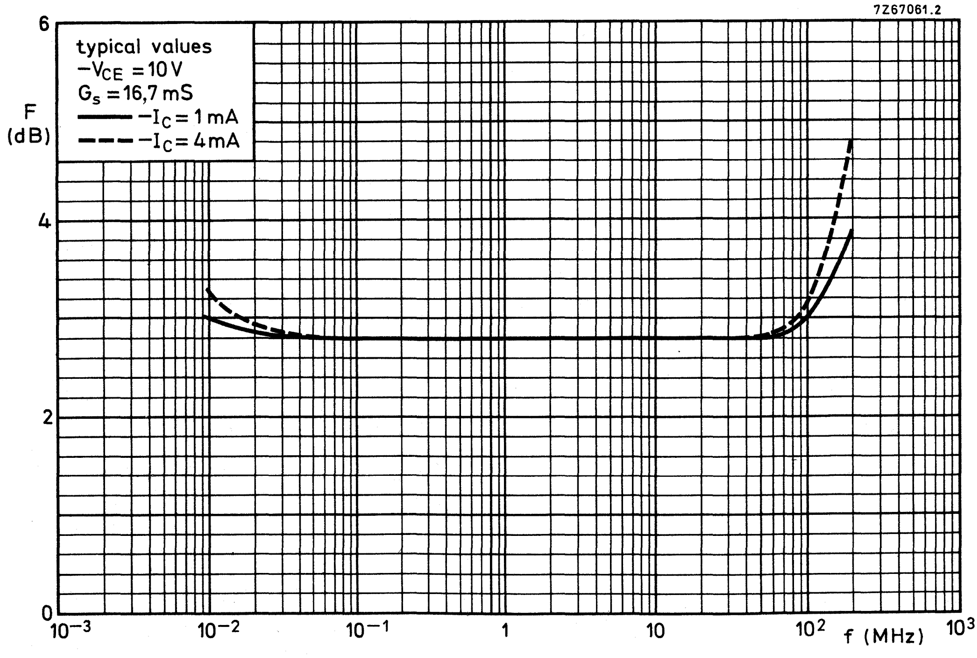

7Z67061.2
typical values
$-V_{CE}$ = 10 V
G_s = 16,7 mS
$-I_C$ = 1 mA
$-I_C$ = 4 mA
F
(dB)
6
4
2
0
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
f (MHz)
10^3

Fig. 3

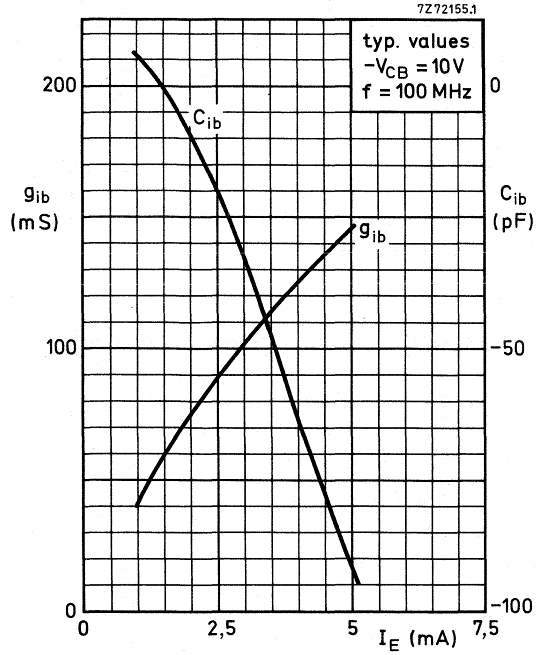


Fig. 4

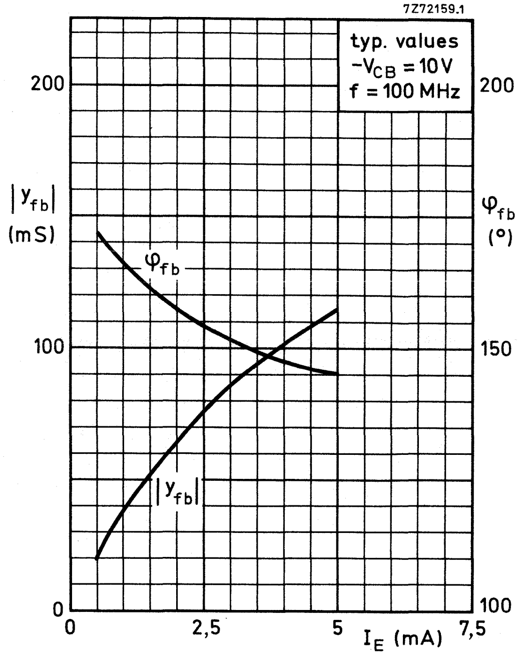


Fig. 5

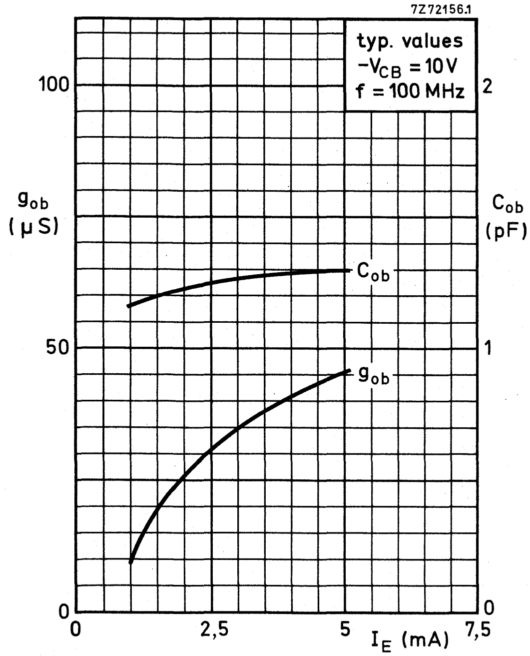


Fig. 6

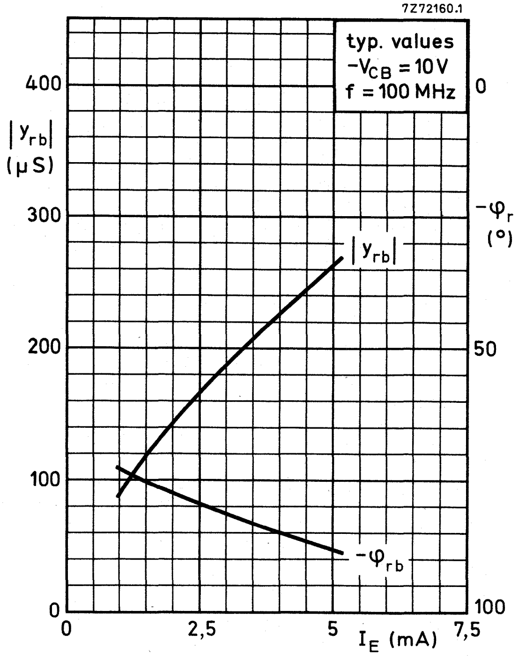


Fig. 7

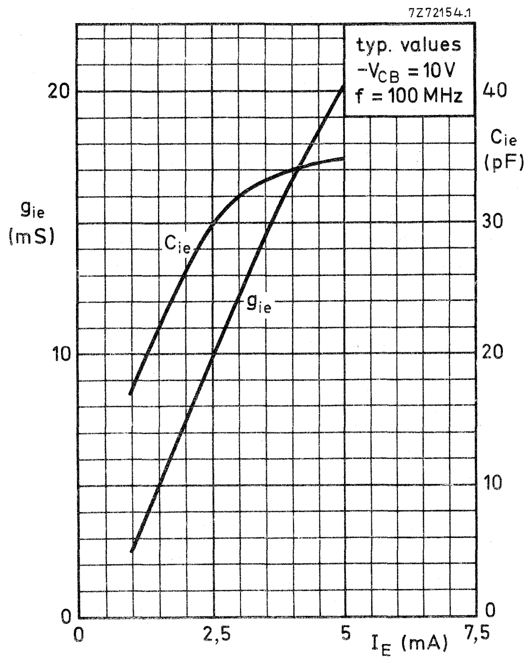


Fig. 8

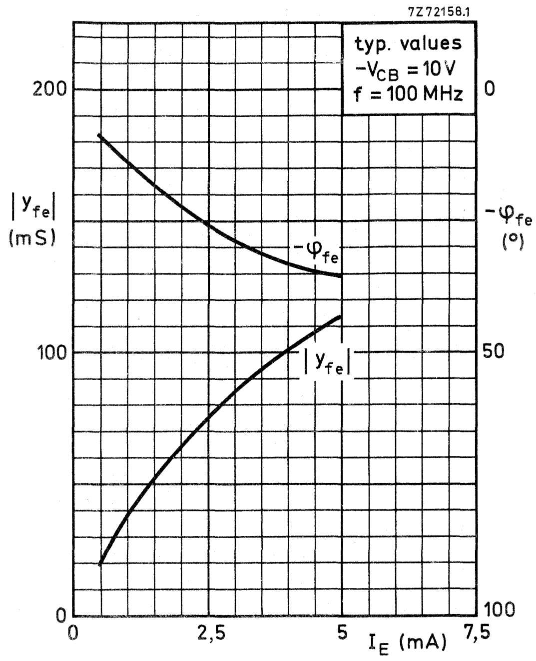


Fig. 9

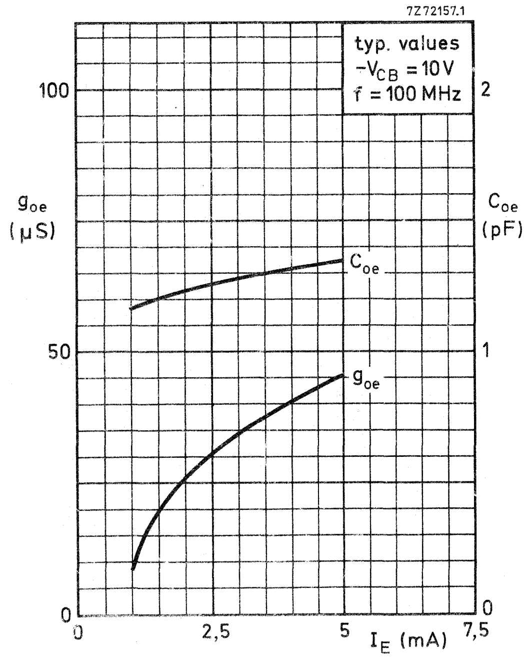


Fig. 10

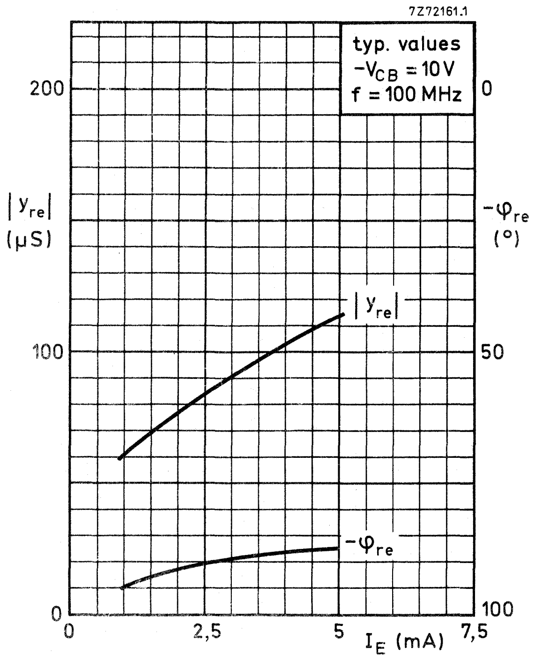


Fig. 11

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a plastic TO-92 envelope, intended for use in large-signal handling i.f. pre-amplifiers of TV receivers in combination with surface acoustic wave filters.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (d.c.)	I_C	max.	100	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	150	°C
D.C. current gain I_C = 10 mA; V_{CE} = 1 V	h_{FE}	>	40	
Transition frequency at f = 100 MHz I_C = 40 mA; V_{CE} = 10 V	f_T	>	490	MHz
Voltage gain at f = 36 MHz (see Fig. 4) I_C = 20 mA; V_{CE} ≈ 10,4 V	G_v	typ.	24	dB
Interference voltage for K = 1% (see Fig. 4)	$V_{(int)rms}$	typ.	120	mV

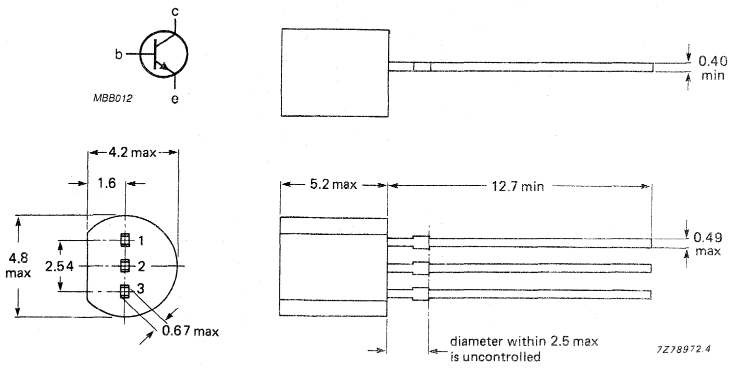
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



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.	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4,5	V
Collector current (d.c.)	I_C	max.	100	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	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	$R_{th\ j\text{-}a}$	=	250	K/W

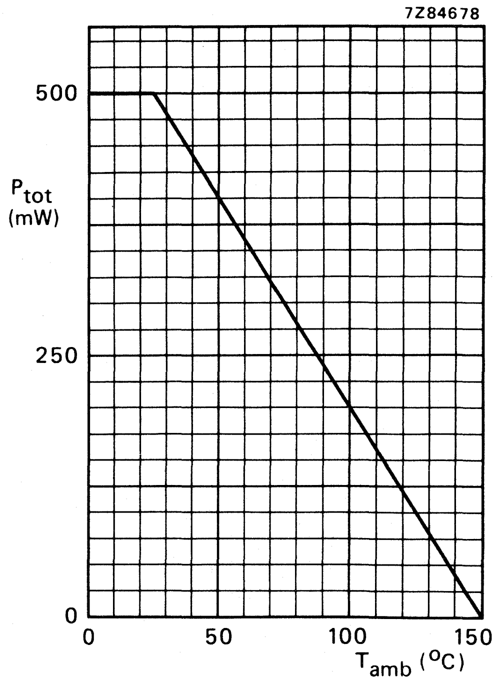


Fig. 2 Power dissipation derating curve as a function of ambient temperature.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	400 nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 125$ °C	I_{CBO}	<	30 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 2$ V	I_{EBO}	<	100 nA
D.C. current gain			
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	>	40
Transition frequency at f = 100 MHz			
$I_C = 10$ mA; $V_{CE} = 10$ V	f_T	>	500 MHz
$I_C = 40$ mA; $V_{CE} = 10$ V	f_T	>	490 MHz
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	2,2 pF
Emitter capacitance at f = 1 MHz			
$I_C = I_c = 0$; $V_{EB} = 1$ V	C_e	<	4,5 pF
Feedback capacitance at f = 1 MHz			
$I_C = 0$; $V_{CE} = 10$ V	C_{re}	typ.	1,6 pF

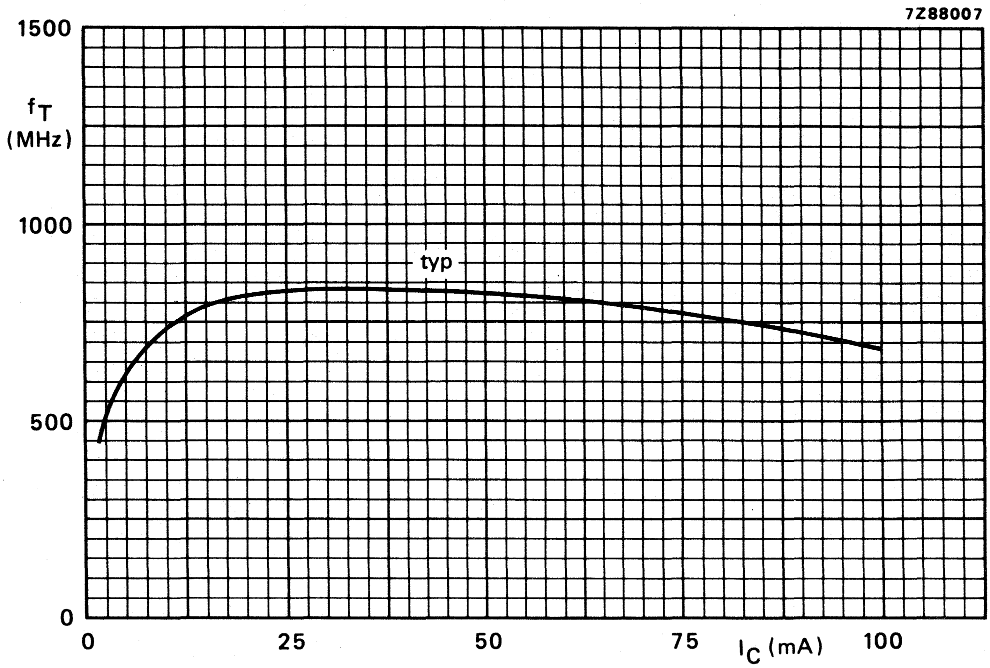
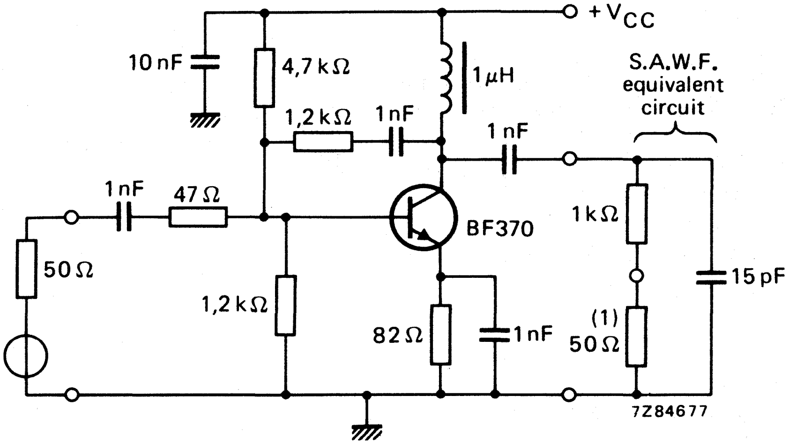


Fig. 3 $V_{CE} = 10$ V; $T_j = 25$ °C.

APPLICATION INFORMATION



(1) Test instrument load.

Fig. 4 Large-signal handling i.f. preamplifier for surface acoustic wave filter.

Performance

Supply voltage	V_{CC}	=	12 V
Collector current	I_C	=	20 mA
Measuring frequency	f_i	=	36 MHz
Input impedance	Z_i	typ.	50 Ω//1 pF
Output impedance	Z_o	$<$	100 Ω
Voltage gain $G_v \text{ (in dB)} = 20 \log \frac{V_o}{V_i}$	G_v	typ.	24 dB
Interference voltage for K = 1%*	$V_{(int)rms}$	typ.	120 mV

* Input terminal voltage at 50 Ω internal resistance of signal generator, interference frequency 40 MHz, 80% modulated with 1 kHz.

SILICON EPITAXIAL TRANSISTORS

N-P-N transistors in plastic TO-92 envelope primarily intended for class-B video output stages in colour television and professional monitor equipment. P-N-P complements are BF421 and BF423.

QUICK REFERENCE DATA

			BF420	BF422	
Collector-base voltage (open emitter)	V_{CBO}	max.	300	250	V
Collector-emitter voltage	V_{CER}	max.	300		V
	V_{CEO}	max.		250	V
Collector current (peak value)	I_{CM}	max.	100		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	830		mW
Junction temperature	T_j	max.	150		°C
D.C. current gain at T_j = 25 °C; I_C = 25 mA; V_{CE} = 20 V	h_{FE}	>	50		
Transition frequency; 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

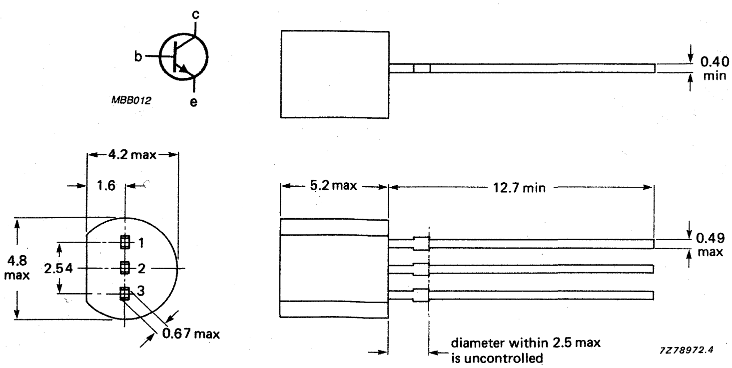
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BF420	BF422	
Collector-base voltage (open emitter)	V_{CBO}	max.	300	250	V
Collector-emitter voltage					
R_{BE} = 2,7 kΩ	V_{CER}	max.	300		V
$I_B = 0$	V_{CEO}	max.		250	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*	P_{tot}	max.	830		mW
Storage temperature	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient*	$R_{th\ j\text{-}a}$	=	150	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

			BF420	BF422	
Collector cut-off currents					
$I_E = 0$; V_{CB} = 200 V	I_{CBO}	<	10	10	nA
R_{BE} = 2,7 kΩ; V_{CE} = 200 V; T_j = 150 °C	I_{CER}	<	10	10	μA
Emitter cut-off current					
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	10		μA
D.C. current gain					
I_C = 25 mA; V_{CE} = 20 V	h_{FE}	>	50		
High-frequency knee voltage**					
I_C = 25 mA; T_j = 150 °C	V_{CEK}	typ.	20		V
Saturation voltage					
I_C = 30 mA; I_B = 5 mA	V_{CEsat}	<	0,6		V
Transition frequency					
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

* Transistor mounted on a printed-circuit board, mounting pad for collector lead minimum 10 mm x 10 mm; maximum length 4 mm.

** The high-frequency knee voltage of a transistor is that value of the collector-emitter voltage at which the small-signal gain, measured in a practical circuit, has dropped to 80% of the gain at V_{CE} = 50 V. A further reduction of the collector-emitter voltage results in a rapid increase of the distortion of the signal.

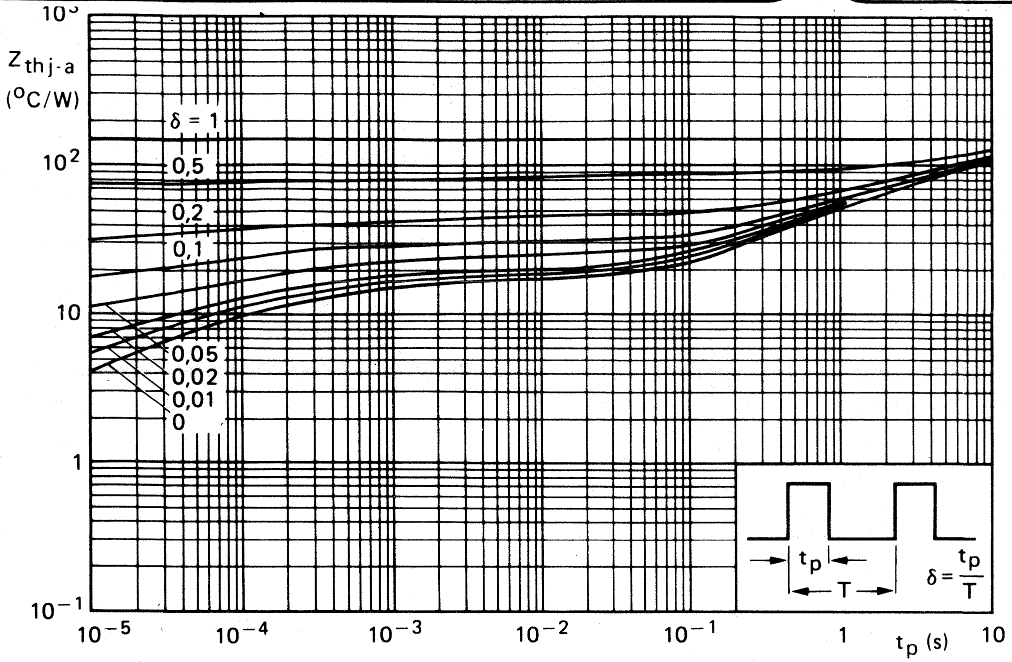


Fig. 2 Thermal impedance from junction to ambient versus pulse duration. Maximum lead length 3 mm; mounting pad for collector lead minimum 10 mm x 10 mm.

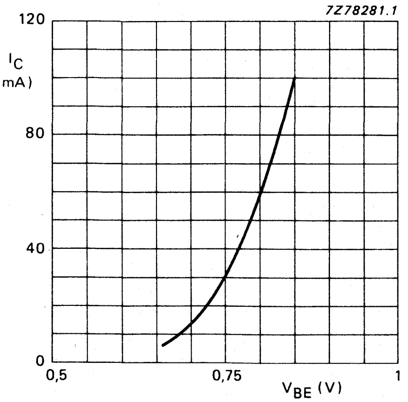


Fig. 3. V_{CE} = 20 V; T_j = 25 °C.

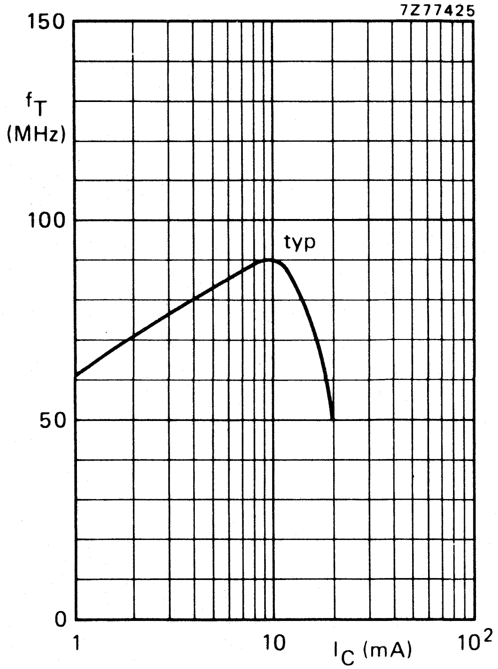


Fig. 4 V_{CE} = 10 V; T_j = 25 °C; f = 35 MHz.

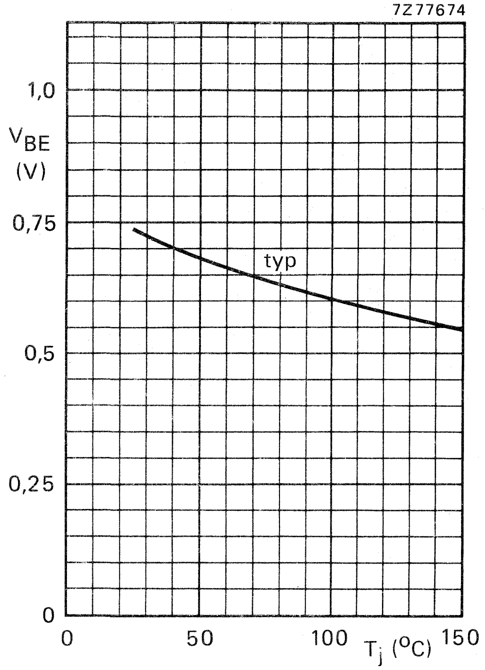


Fig. 5 I_C = 25 mA; V_{CE} = 20 V.

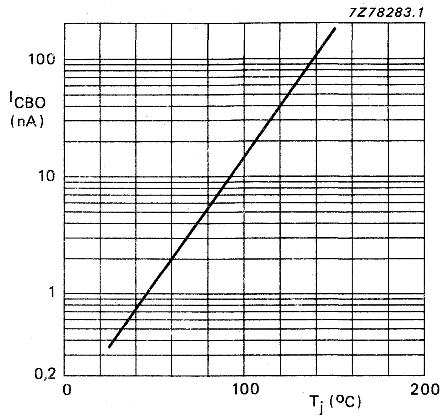


Fig. 6 V_{CB} = 200 V; typical values.

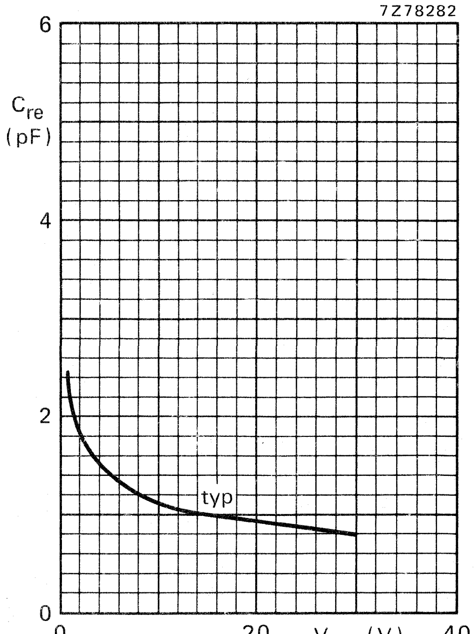


Fig. 7 I_C = 0; f = 1 MHz; T_j = 25 °C.

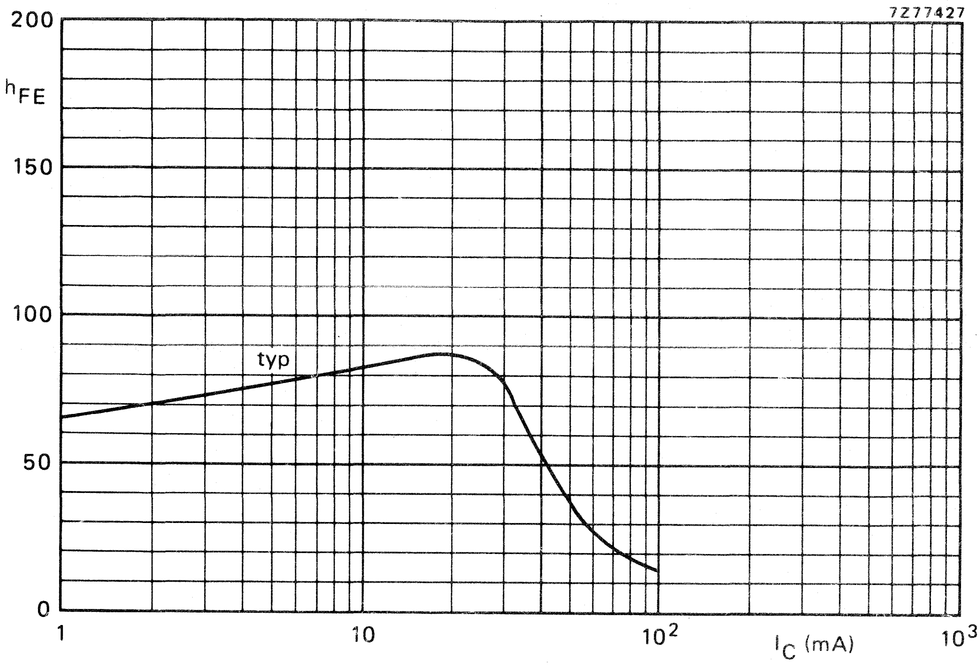


Fig. 8 V_{CE} = 20 V; T_j = 25 °C.

SILICON EPITAXIAL TRANSISTORS

P-N-P transistors in plastic TO-92 envelope primarily intended for class-B video output stages in colour television and professional monitor equipment. N-P-N complements are BF420 and BF422.

QUICK REFERENCE DATA

			BF421	BF423	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	300	250	V
Collector-emitter voltage	$-V_{CER}$	max.	300		V
	$-V_{CEO}$	max.		250	V
Collector current (peak value)	$-I_{CM}$	max.	100		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	830		mW
Junction temperature	T_j	max.	150		°C
D.C. current gain at T_j = 25 °C $-I_C$ = 25 mA; $-V_{CE}$ = 20 V	h_{FE}	>	50		
Transition frequency $-I_C$ = 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

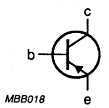
MECHANICAL DATA

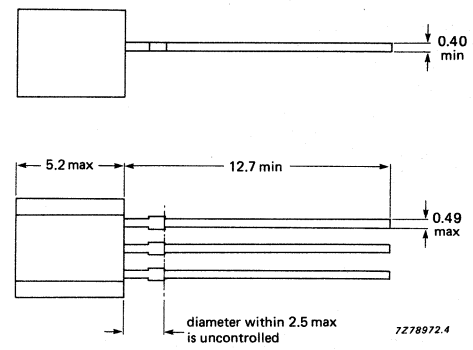
Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector





RATINGS

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

			BF421	BF423	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	300	250	V
Collector-emitter voltage					
R_{BE} = 2,7 kΩ	$-V_{CER}$	max.	300		V
I_B = 0	$-V_{CEO}$	max.		250	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*	P_{tot}	max.	830		mW
Storage temperature	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient*	$R_{th\ j\text{-}a}$	=	150	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

			BF421	BF423	
Collector cut-off currents					
$I_E = 0$; $-V_{CB}$ = 200 V	$-I_{CBO}$	<	10	10	nA
R_{BE} = 2,7 kΩ; $-V_{CE}$ = 200 V; T_j = 150 °C	$-I_{CER}$	<	10	10	μA
Emitter cut-off current					
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	10		μA
D.C. current gain					
$-I_C$ = 25 mA; $-V_{CE}$ = 20 V	h_{FE}	>	50		
High-frequency knee voltage**					
$-I_C$ = 25 mA; T_j = 150 °C	$-V_{CEK}$	typ.	20		V
Saturation voltage					
$-I_C$ = 30 mA; $-I_B$ = 5 mA	$-V_{CE\ sat}$	<	0,6		V
Transition frequency					
$-I_C$ = 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

* Transistor mounted on a printed-circuit board, mounting pad for collector lead minimum 10 mm x 10 mm; maximum length 4 mm.

** The high-frequency knee voltage of a transistor is that value of the collector-emitter voltage at which the small-signal gain, measured in a practical circuit, has dropped to 80% of the gain at V_{CE} = 50 V. A further reduction of the collector-emitter voltage results in a rapid increase of the distortion of the signal.

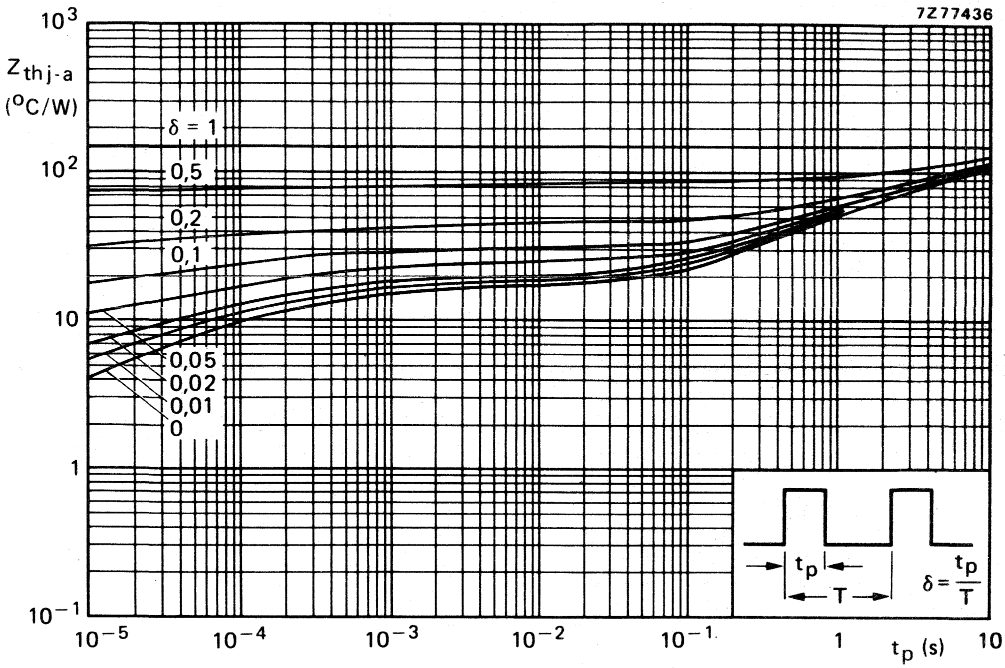


Fig. 2 Thermal impedance from junction to ambient versus pulse duration. Maximum lead length 3 mm; mounting pad for collector lead minimum 10 mm x 10 mm.

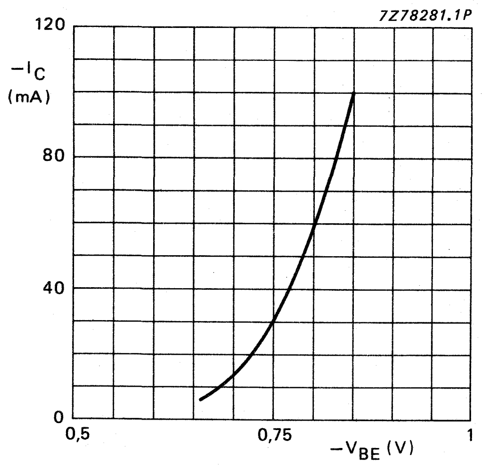


Fig. 3 $-V_{CE}$ = 20 V; T_j = 25 °C.

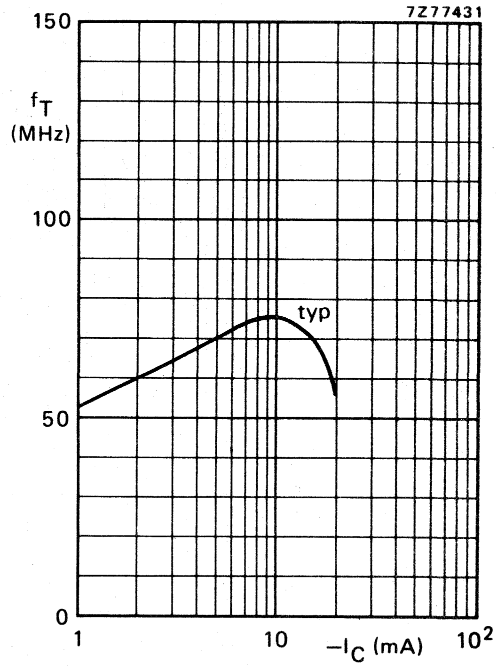


Fig. 4 $-V_{CE}$ = 10 V; T_j = 25 °C; f = 35 MHz.

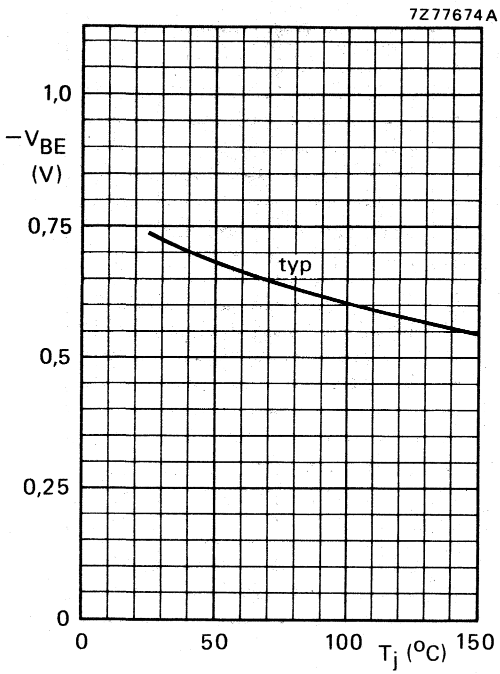


Fig. 5 $-I_C$ = 25 mA; $-V_{CE}$ = 20 V.

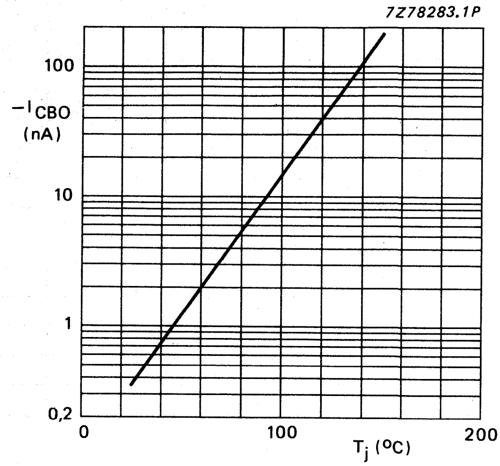


Fig. 6 $-V_{CB}$ = 200 V; typical values.

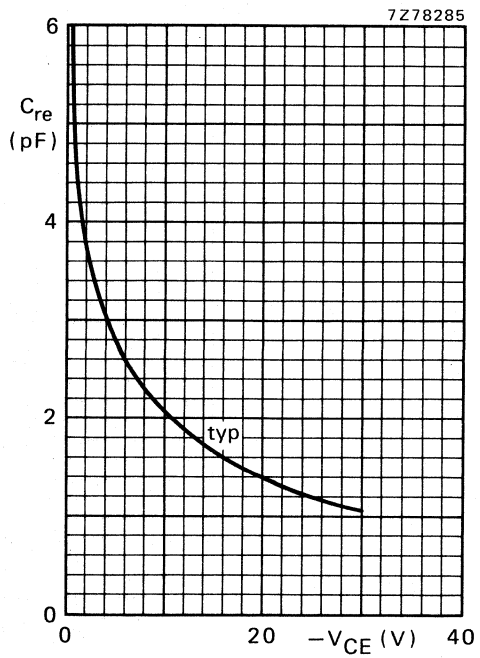


Fig. 7 I_C = 0; f = 1 MHz; T_j = 25 °C.

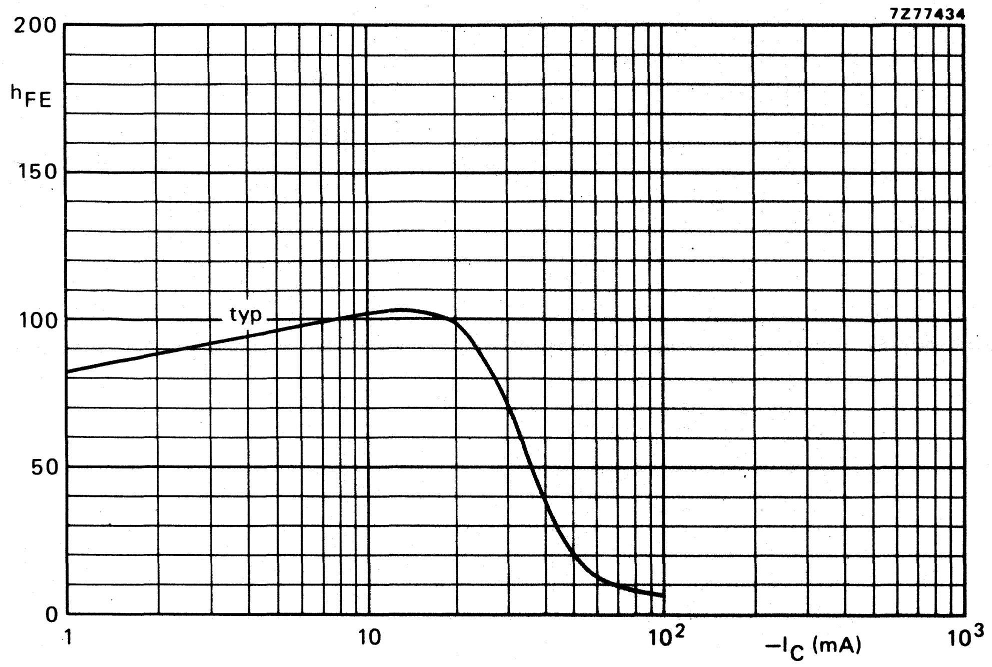


Fig. 8 Typical values at $-V_{CE}$ = 20 V; T_j = 25 °C.

HF SILICON PLANAR EPITAXIAL TRANSISTORS

PNP transistors in a plastic envelope intended for HF and IF applications in radio receivers, especially for mixer stages in AM receivers and IF stages in AM/FM receivers with negative earth.

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 (DC)		$-I_C$	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C		P_{tot}	max.	300	mW
Junction temperature		T_j	max.	150	°C
DC current gain $-I_C$ = 1 mA; $-V_{CE}$ = 10 V	BF450:	h_{FE}		62 to 200	µA
	BF451:	h_{FE}		30 to 90	µA
Transition frequency $-I_C$ = 1 mA; $-V_{CE}$ = 10 V		f_T	min.	350	MHz

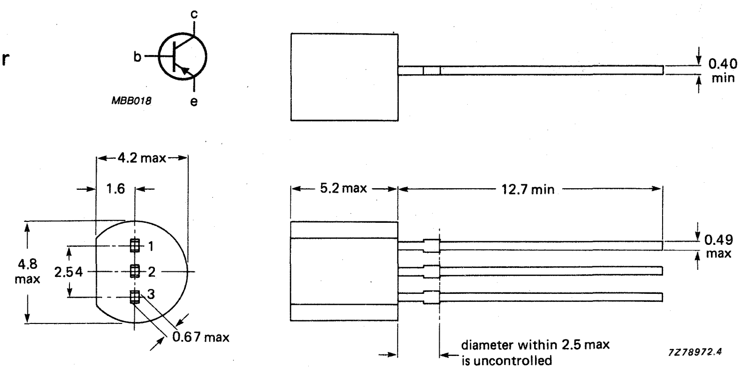
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



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 (DC)	$-I_C$	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	420	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise stated

Collector cut-off current					
$I_E = 0$; $-V_{CB} = 30$ V		$-I_{CBO}$	max.	50	nA
$I_E = 0$; $-V_{CB} = 30$ V; $T_{amb} = 150$ °C		$-I_{CBO}$	max.	4	μA
Emitter-cut-off current					
$I_C = 0$; $-V_{EB} = 3$ V		$-I_{EBO}$	max.	100	μA
DC current gain	BF450	h_{FE}		62 to 200	μA
$-I_C = 1$ mA; $-V_{CE} = 10$ V	BF451	h_{FE}		30 to 90	μA
Base-emitter voltage					
$-I_C = 1$ mA; $-V_{CE} = 10$ V		$-V_{BE}$		680 to 780	mV
Transition frequency at f = 100 MHz					
$-I_C = 1$ mA; $-V_{CE} = 10$ V		f_T	typ.	350	MHz
Feedback capacitance at f = 1 MHz					
$-I_C = 1$ mA; $-V_{CE} = 10$ V		C_{re}	typ.	0.43	pF

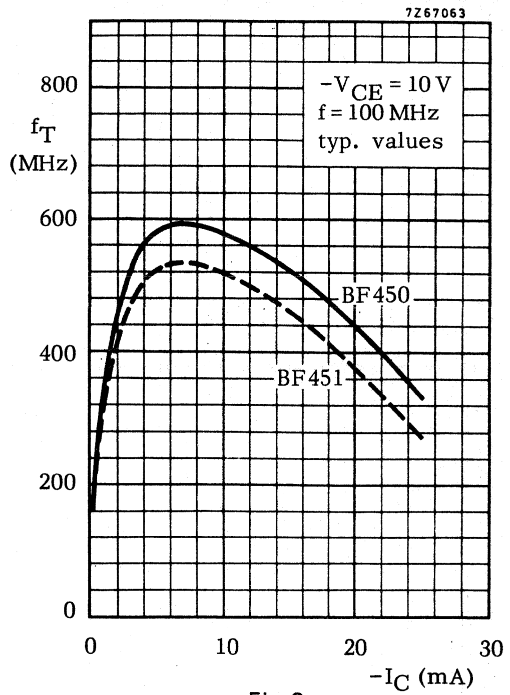

7Z67063
800
600
400
200
0
f_T
(MHz)
$-V_{CE}$ = 10 V
f = 100 MHz
typ. values
BF450
BF451
0
10
20
30
$-I_C$ (mA)

Fig. 2.

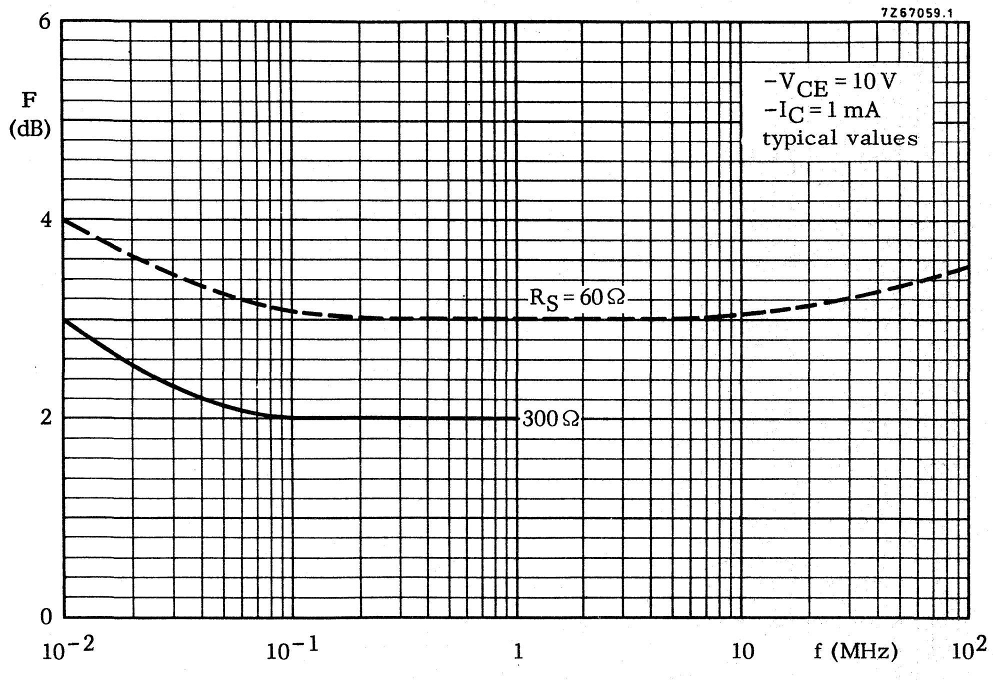

7Z67059.1
6
4
2
0
F
(dB)
$-V_{CE}$ = 10 V
$-I_C$ = 1 mA
typical values
R_S = 60 Ω
300 Ω
10^{-2}
10^{-1}
1
10
f (MHz)
10^2

Fig. 3.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in TO-92 envelope and intended for use in video output stages in black-and-white and in colour television receivers.

QUICK REFERENCE DATA

			BF483	BF485	BF487	
Collector-base voltage (open emitter)	V_{CBO}	max.	300	350	400	V
Collector-emitter voltage (open base)	V_{CEO}	max.	250	300	350	V
Collector current (peak value)	I_{CM}	max.		100		mA
Total power dissipation (free air)	P_{tot}	max.		830		mW
D.C. current gain $I_C = 25$ mA; $V_{CE} = 20$ V	h_{FE}	$\geq$		50		
Transition frequency $-I_E = 10$ mA; $V_{CB} = 10$ V	f_T			70 to 110		MHz
Junction temperature	T_j	max.		150		^oC

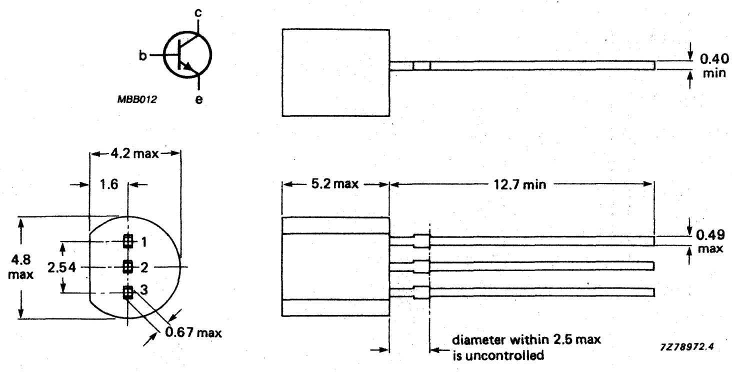
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BF483	BF485	BF487	
Collector-base voltage (open emitter)	V_{CBO}	max.	300	350	400	V
Collector-emitter voltage (open base)	V_{CEO}	max.	250	300	350	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5		V
Collector current						
d.c.	I_C	max.		50		mA
peak value	I_{CM}	max.		100		mA
Total power dissipation in free air up to T_{amb} = 25 °C	P_{tot}	max.		830		mW
Storage temperature	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient when mounted on a p.c. board and mounting pad for collector lead minimum 10 mm x 10 mm and maximum lead length 4 mm	$R_{th\ j\text{-}a}$	max.	150	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current $I_E = 0$; V_{CB} = 300 V	I_{CBO}	⩽	20	nA
Collector-emitter cut-off current V_{CE} = 250 V; R_{BE} = 2,7 kΩ; T_j = 150 °C	I_{CER}	⩽	20	μA
Emitter cut-off current $I_C = 0$; V_{EB} = 5 V	I_{EBO}	⩽	10	μA
High-frequency knee voltage I_C = 25 mA; T_j = 150 °C	V_{CEK}	⩽	20	V
D.C. current gain I_C = 25 mA; V_{CE} = 20 V	h_{FE}	⩾	50	
I_C = 40 mA; V_{CE} = 20 V	h_{FE}	⩾	20	
Transition frequency $-I_E$ = 10 mA; V_{CB} = 10 V	f_T		70 to 110	MHz
Feedback capacitance at f = 1 MHz $I_E = 0$; V_{CB} = 30 V	C_{re}	⩽	1,4	pF

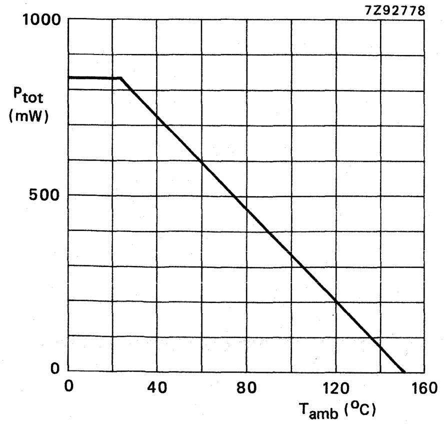


Fig. 2 Maximum permissible power dissipation.

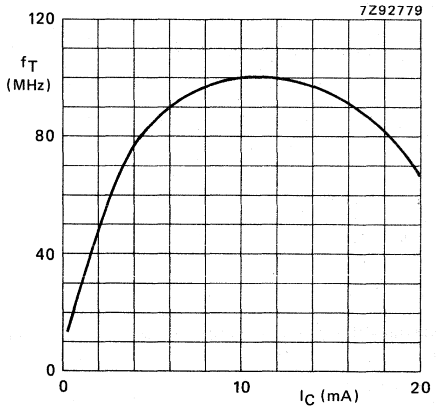


Fig. 3 V_{CE} = 10 V; f = 100 MHz; typical values.

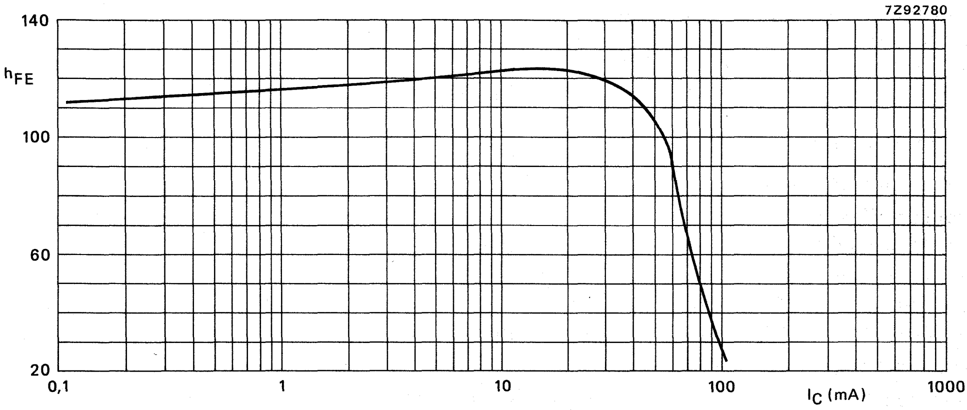


Fig. 4 T_j = 25 °C; V_{CE} = 20 V; typical values.

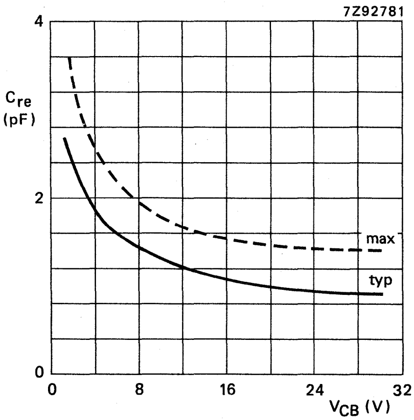


Fig. 5 I_E = 0; f = 1 MHz.

SILICON PLANAR EPITAXIAL TRANSISTORS

PNP transistors in a TO-92 envelope and intended for use in video output stages of black and white and colour television receivers.

QUICK REFERENCE DATA

			BF484	BF486	BF488	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	250	300	350	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	250	300	350	V
Collector current (peak value)	$-I_{CM}$	max.		100		mA
Total power dissipation (free air)	P_{tot}	max.		830		mW
DC current gain $-I_C = 25$ mA; $-V_{CE} = 20$ V	h_{FE}	min.		50		
Transition frequency $-I_C = 10$ mA; $-V_{CE} = 10$ V	f_T			70 to 110		MHz
Junction temperature	T_j	max.		150		°C

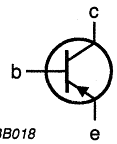
MECHANICAL DATA

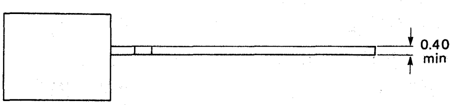
Dimensions in mm

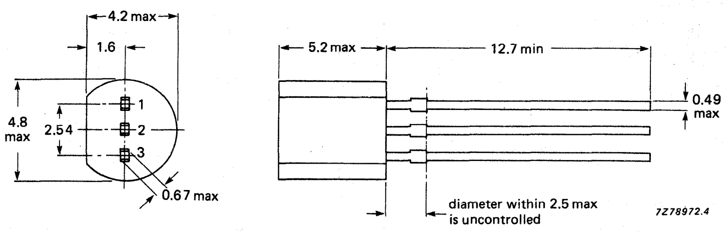
Fig.1 TO-92.

Pinning:

1. Base
2. Collector
3. Emitter







RATINGS

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

			BF484	BF486	BF488	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	250	300	350	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	250	300	350	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5		V
Collector current						
DC	$-I_C$	max.		100		mA
peak value	$-I_{CM}$	max.		100		mA
Total power dissipation in free air up to T_{amb} = 25 °C	P_{tot}	max.		830		mW
Storage temperature range	T_{stg}			−65 to 150		°C
Junction temperature	T_j			150		°C

THERMAL RESISTANCE

From junction to ambient when mounted on a printed-circuit board and mounting pad for collector lead minimum 10 mm x 10 mm and maximum lead length 4 mm	$R_{th\ j\text{-}a}$	max.	150	°C

CHARACTERISTICS

T_j = 25 °C unless otherwise stated

			BF484	BF486	BF488	
Collector-emitter breakdown voltage $-I_C$ = 2.5 mA; I_B = 0	$-V_{(BR)CEO}$	max.	250	300	350	V
Collector-base breakdown voltage $-I_C$ = 10 μA; I_E = 0	$-V_{(BR)CBO}$	max.	250	300	350	V
Emitter-base breakdown voltage $-I_E$ = 100 μA; I_C = 0	$-V_{(BR)EBO}$	max.	5	5	5	V
Collector cut-off current						
I_E = 0; $-V_{CB}$ = 200 V	$-I_{CBO}$	max.	20			nA
I_E = 0; $-V_{CB}$ = 250 V	$-I_{CBO}$	max.		20		nA
I_E = 0; $-V_{CB}$ = 300 V	$-I_{CBO}$	max.			20	nA
Collector-emitter cut-off current $-V_{CE}$ = 200 V; R_{BE} = 2.7 kΩ; T_j = 150 °C	$-I_{CER}$	max.		20		μA
High frequency knee voltage $-I_C$ = 25 mA; T_j = 150 °C	$-V_{CEK}$	max.		15		V
DC current gain						
$-I_C$ = 25 mA; $-V_{CE}$ = 20 V	h_{FE}	min.		50		
$-I_C$ = 40 mA; $-V_{CE}$ = 20 V	h_{FE}	min.		20		

Saturation voltages				
$-I_C = 20$ mA; $-I_B = 2$ mA	$-V_{CEsat}$	max.	0.5	V
	$-V_{BEsat}$	max.	0.9	V
Transition frequency at f = 100 MHz				
$-I_C = 10$ mA; $-V_{CE} = 10$ V	f_T		70 to 110	MHz
Feedback capacitance at f = 1 MHz				
$I_E = 0$; $-V_{CB} = 30$ V	C_{re}	max.	1.6	pF
Output capacitance at f = 1 MHz				
$I_E = 0$; $-V_{CB} = 20$ V	C_{ob}	max.	2.5	pF

SILICON PLANAR EPITAXIAL TRANSISTOR

NPN transistor in a plastic TO-92 envelope intended for HF applications in radio and television receivers; it is especially recommended for FM tuners, low noise AM mixer-oscillators with high source impedance and IF amplifiers in AM/FM receivers where a high current gain is of importance.

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 (DC)	I_C	max.	30	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	150	°C
DC current gain at T_j = 25 °C; I_C = 1 mA; V_{CE} = 10 V	h_{FE}		67 to 220	
Transition frequency; I_C = 1 mA; V_{CE} = 10 V	f_T	min.	120	MHz
		typ.	260	MHz

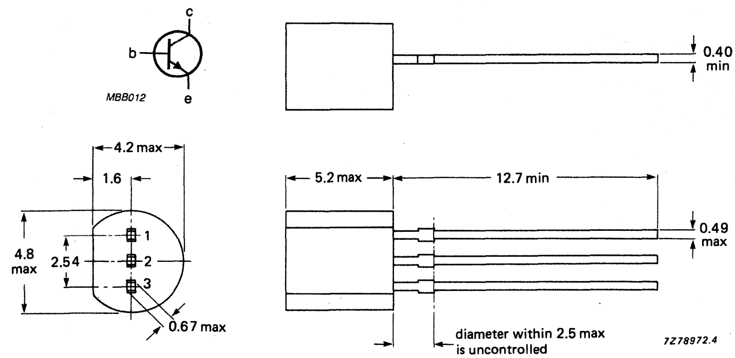
MECHANICAL DATA

Dimensions in mm

Fig.1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



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.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (DC)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	30	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	420	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Base-emitter voltage I_C = 1 mA; V_{CE} = 10 V		V_{BE}	0.65 to 0.74		V
DC current gain (see note 1) I_C = 1 mA; V_{CE} = 10 V	BF494	h_{FE}	67 to 220		
	BF494B	h_{FE}	100 to 220		
Feedback capacitance at f = 0.45 MHz I_C = 1 mA; V_{CE} = 10 V		C_{re}	max.	1	pF
Transition frequency I_C = 1 mA; V_{CE} = 10 V		f_T	min.	120	MHz
			typ.	260	MHz
Collector cut-off current I_E = 0; V_{CB} = 20 V		I_{CBO}	max.	100	nA
I_E = 0; V_{CB} = 20 V; T_{amb} = 150 °C		I_{CBO}	max.	4	μA
Emitter-base cut-off current I_C = 0; V_{EB} = 4 V		I_{EBO}	max.	100	nA

Note

1. V_{BE} decreases by about 1.7 mV/K with increasing temperature.

y parameters at f = 100 MHz (common base)
I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)

Input conductance	g_{ib}	typ.	32 mS
Input susceptance	$-b_{ib}$	typ.	3 mS
Feedback admittance	$\|y_{rb}\|$	typ.	500 μS
Phase angle of feedback admittance	φ_{rb}	typ.	272°
Transfer admittance	$\|y_{fb}\|$	typ.	33 mS
Phase angle of transfer admittance	φ_{fb}	typ.	150°
Output conductance	g_{ob}	typ.	22 μS
Output susceptance	b_{ob}	typ.	1.1 mS

y-parameters (common emitter)
I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)

		f = 10.7 MHz	f = 0.45 MHz
Input conductance	g_{ie}	< 0.64	0.54 mS
Output conductance	g_{oe}	< 13.5	11.5 μS

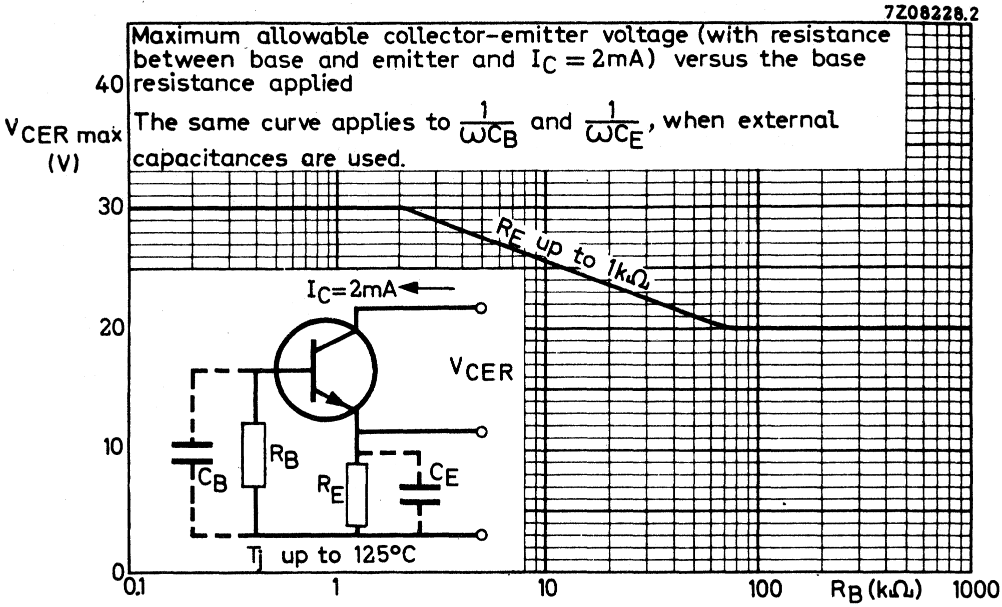

7Z08228.2
Maximum allowable collector-emitter voltage (with resistance between base and emitter and $I_C = 2mA$) versus the base resistance applied
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$, when external capacitances are used.
$V_{CER\,max}$ (V)
R_E up to 1kΩ
$I_C = 2mA$
V_{CER}
C_B
R_B
R_E
C_E
T_j up to 125°C
R_B (kΩ)
0
10
20
30
40
0.1
1
10
100
1000

Fig. 2.

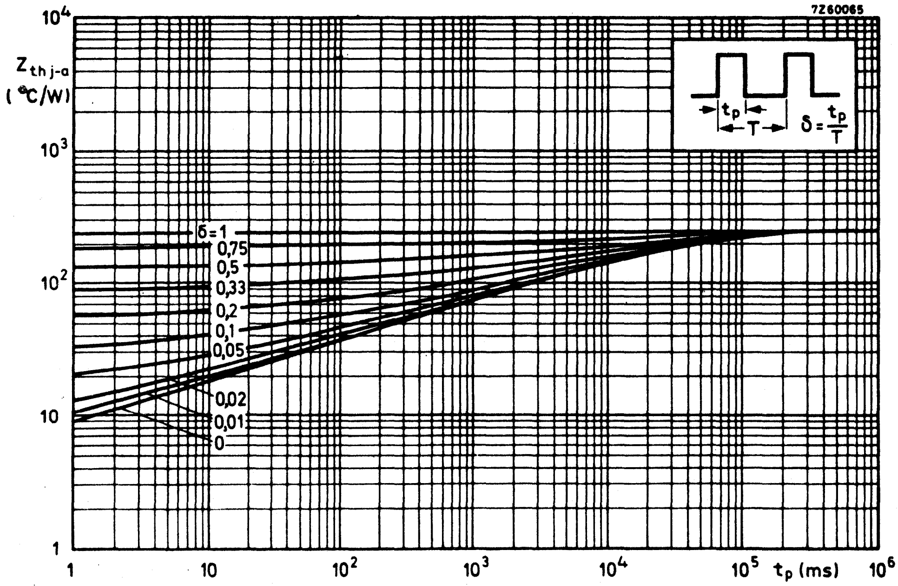

7Z60065
$Z_{th\,j\text{-}a}$ (°C/W)
$\delta = 1$
0,75
0,5
0,33
0,2
0,1
0,05
0,02
0,01
0
t_p
T
$\delta = \frac{t_p}{T}$
t_p (ms)
1
10
10^2
10^3
10^4
10^5
10^6

Fig. 3.

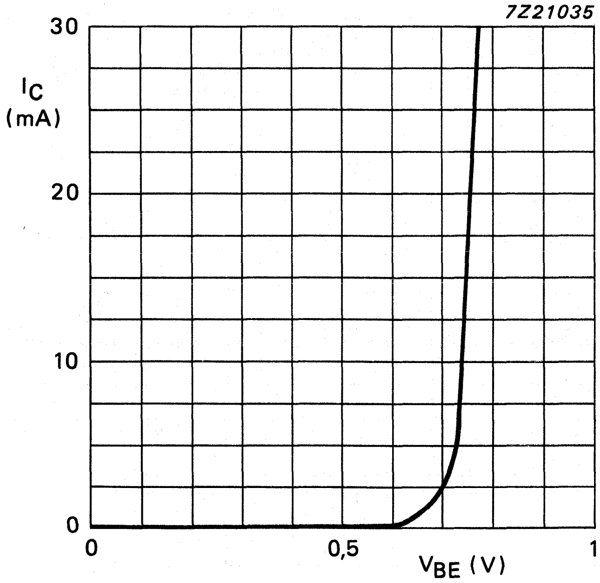


Fig. 4 V_{CE} = 2 V; T_j = 25 °C; typical values.

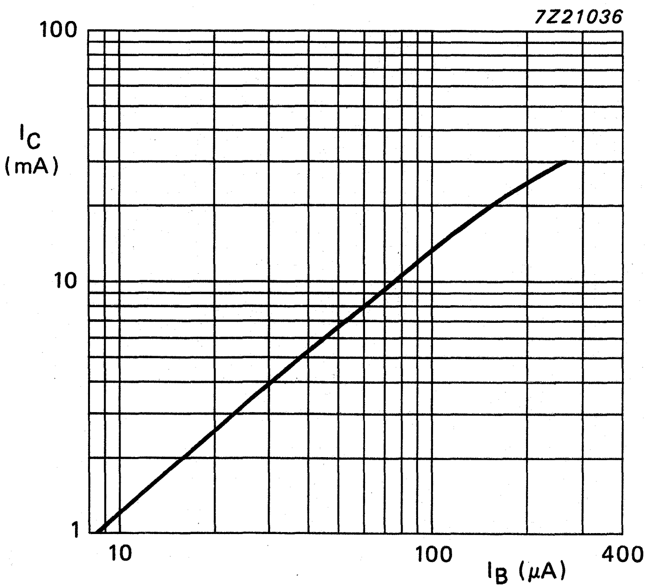


Fig. 5 V_{CE} = 2 V; T_j = 25 °C; typical values.

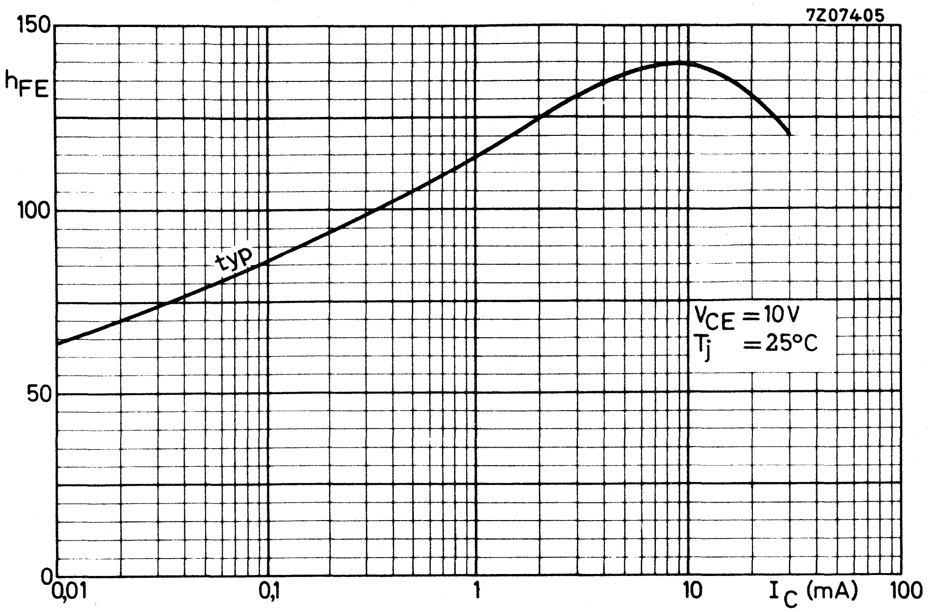

7Z07405
150
h_{FE}
100
50
0
0,01
0,1
1
10
I_C (mA)
100
typ
V_{CE} = 10 V
T_j = 25 °C

Fig. 6.

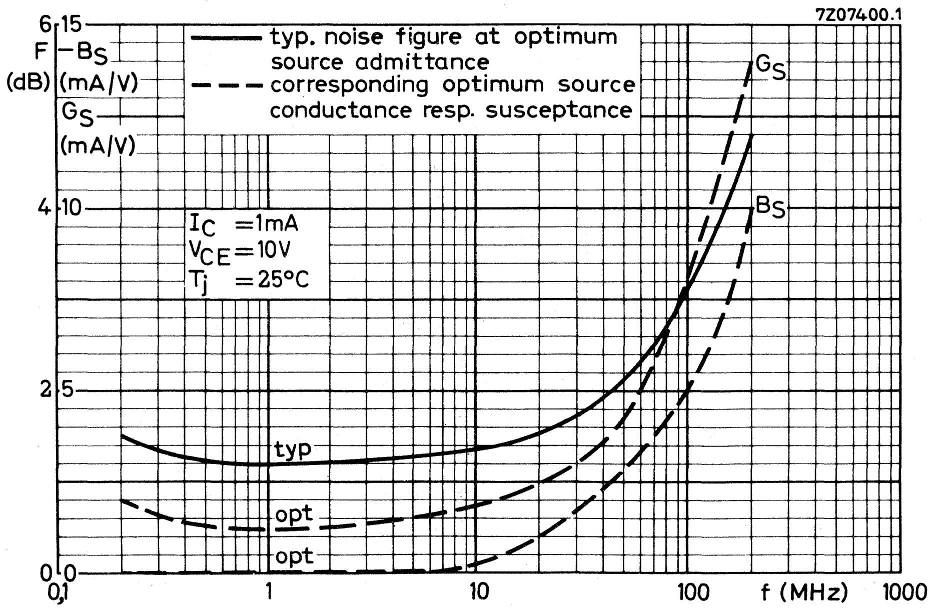

7Z07400.1
6
15
F
(dB)
$-B_S$
(mA/V)
G_S
(mA/V)
4
10
2
5
0
0
typ. noise figure at optimum source admittance
corresponding optimum source conductance resp. susceptance
I_C = 1 mA
V_{CE} = 10 V
T_j = 25 °C
G_S
B_S
typ
opt
opt
0,1
1
10
100
f (MHz)
1000

Fig. 7.

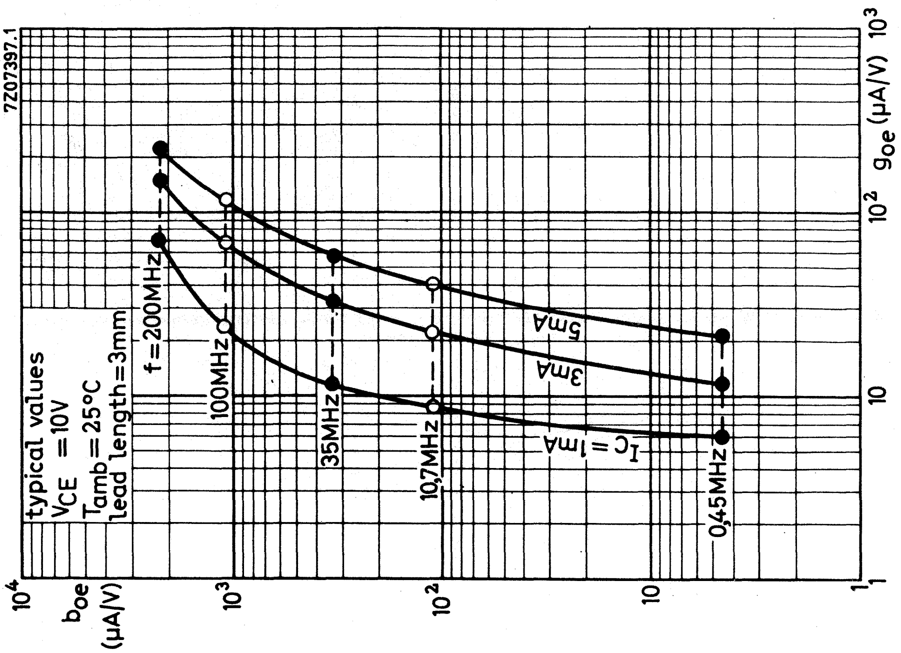

7Z07397.1
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 200MHz
100MHz
35MHz
10,7MHz
0,45MHz
I_C = 1mA
3mA
5mA
b_{oe} (μA/V)
g_{oe} (μA/V)
10^4
10^3
10^2
10
1
10^3

Fig. 8.

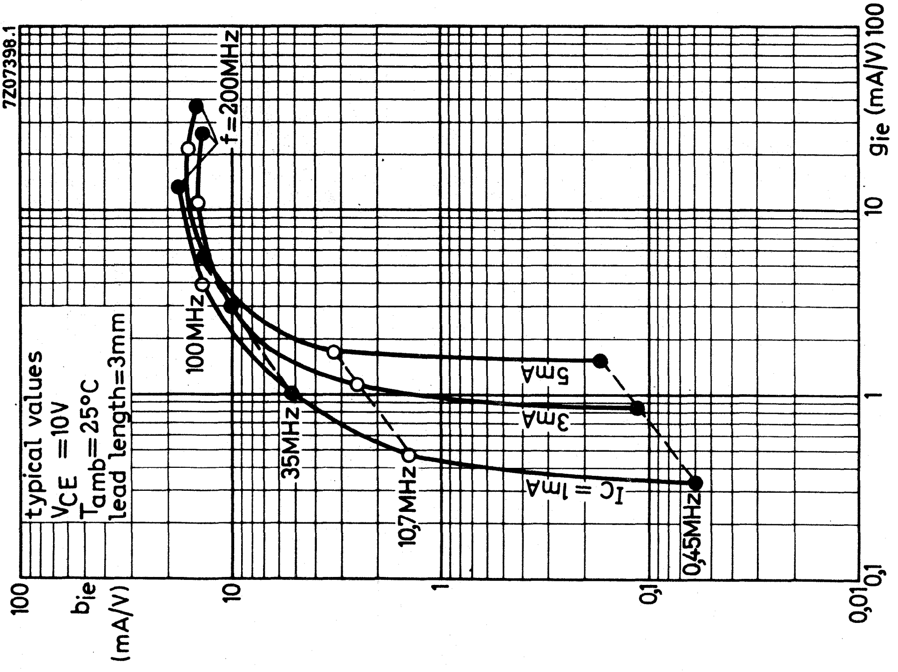
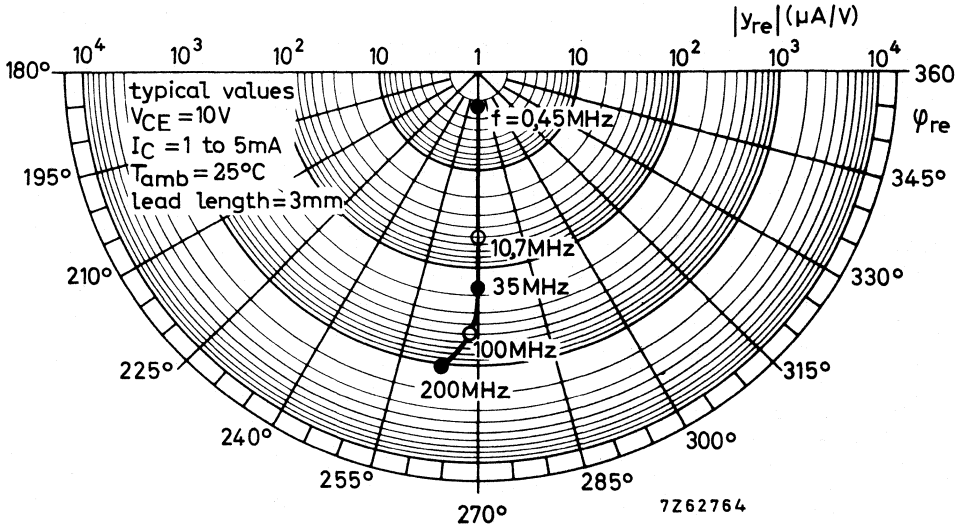
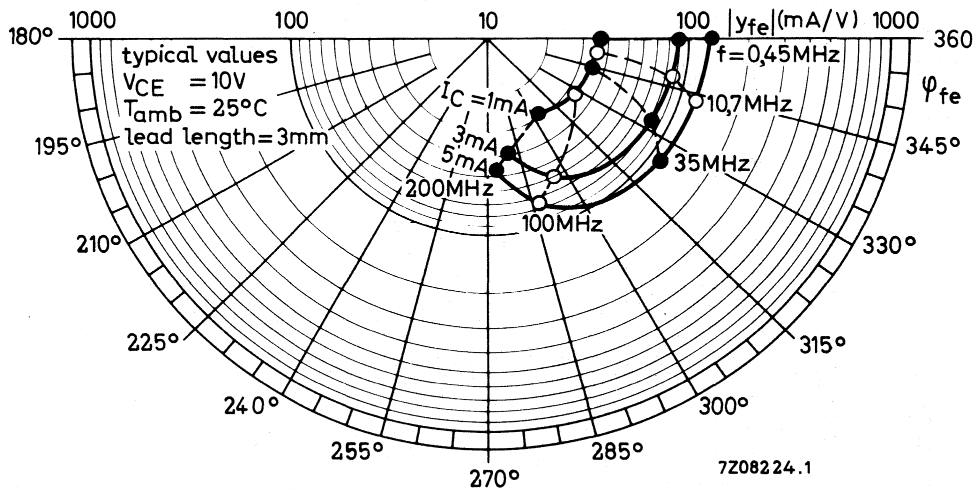

7Z07398.1
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 200MHz
100MHz
35MHz
10,7MHz
0,45MHz
I_C = 1mA
3mA
5mA
b_{ie} (mA/V)
g_{ie} (mA/V)
100
10
1
0,1
0,01
0,1

Fig. 9.



|yre| (μA/V)
10^4 10^3 10^2 10 1 10 10^2 10^3 10^4
180° 195° 210° 225° 240° 255° 270° 285° 300° 315° 330° 345° 360°
φre
typical values
VCE = 10V
IC = 1 to 5mA
Tamb = 25°C
lead length = 3mm
f = 0,45MHz
10,7MHz
35MHz
100MHz
200MHz
7Z62764

Fig. 10.



1000 100 10 100 |yfe| (mA/V) 1000
180° 195° 210° 225° 240° 255° 270° 285° 300° 315° 330° 345° 360°
φfe
typical values
VCE = 10V
Tamb = 25°C
lead length = 3mm
IC = 1mA
3mA
5mA
f = 0,45MHz
10,7MHz
35MHz
100MHz
200MHz
7Z08224.1

Fig. 11.

SILICON PLANAR EPITAXIAL TRANSISTOR

NPN transistor in a plastic TO-92 envelope intended for HF applications in radio and television receivers; it is especially recommended for FM tuners, IF amplifiers in AM/FM receivers where a low transistor output conductance is of importance, AM input stages of car radios where a low noise figure at low source impedance is required.

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 (DC)	I_C	max.	30	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	150	°C
DC current gain at T_j = 25 °C I_C = 1 mA; V_{CE} = 10 V	h_{FE}		35 to 125	
Transition frequency I_C = 1 mA; V_{CE} = 10 V	f_T	min.	120	MHz

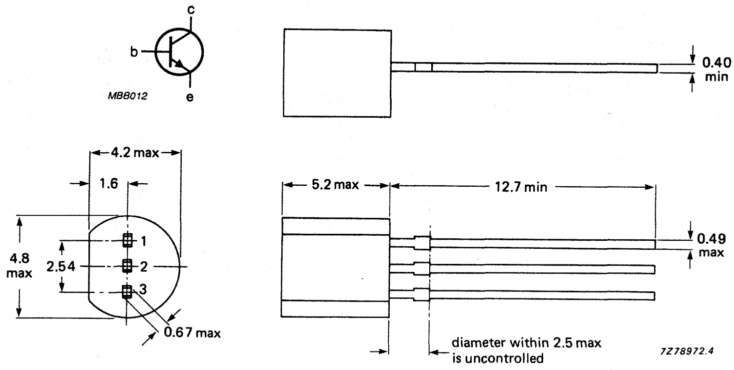
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (DC)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	30	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	420	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Base-emitter voltage					
I_C = 1 mA; V_{CE} = 10 V		V_{BE}		0.65 to 0.74	V
DC current gain					
I_C = 1 mA; V_{CE} = 10 V	BF495	h_{FE}		35 to 125	
	BF495C	h_{FE}		67 to 125	
Feedback capacitance at f = 0.45 MHz					
I_C = 1 mA; V_{CE} = 10 V		C_{re}	max.	1	pF
Transition frequency					
I_C = 1 mA; V_{CE} = 10 V		f_T	min.	120	MHz
Collector cut-off current					
I_E = 0; V_{CB} = 20 V		I_{CBO}	max.	100	nA
I_E = 0; V_{CB} = 20 V; T_{amb} = 150 °C		I_{CBO}	max.	4	μA
Emitter-base cut-off current					
I_C = 0; V_{EB} = 4 V		I_{EBO}	max.	100	nA

y parameters at f = 100 MHz (common base)

I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)

Input conductance	g_{ib}	typ.	34	mS
Input susceptance	$-b_{ib}$	typ.	1	mS
Feedback admittance	$\|y_{rb}\|$	typ.	490	μS
Phase angle of feedback admittance	φ_{rb}	typ.	272	°
Transfer admittance	$\|y_{fb}\|$	typ.	34	mS
Phase angle of transfer admittance	φ_{fb}	typ.	144	°
Output conductance	g_{ob}	typ.	12	μS
Output susceptance	b_{ob}	typ.	1,1	mS

y parameters (common emitter)

I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)

		f = 10,7 MHz	f = 0,45 MHz	
Input conductance	g_{ie}	< 0,96	0,86	mS
Output conductance	g_{oe}	< 9,5	7,0	μS

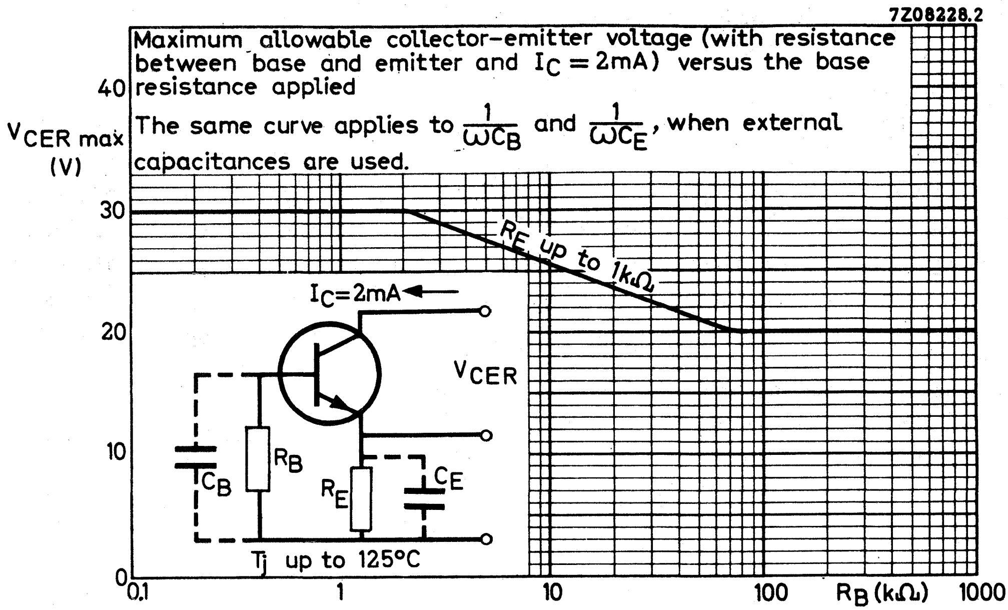

7Z08228.2
Maximum allowable collector-emitter voltage (with resistance between base and emitter and $I_C = 2mA$) versus the base resistance applied
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$, when external capacitances are used.
$V_{CER\,max}$ (V)
40
30
20
10
0
R_E up to 1kΩ
I_C=2mA
V_{CER}
C_B
R_B
R_E
C_E
T_j up to 125°C
0.1
1
10
100
R_B (kΩ)
1000

Fig. 2.

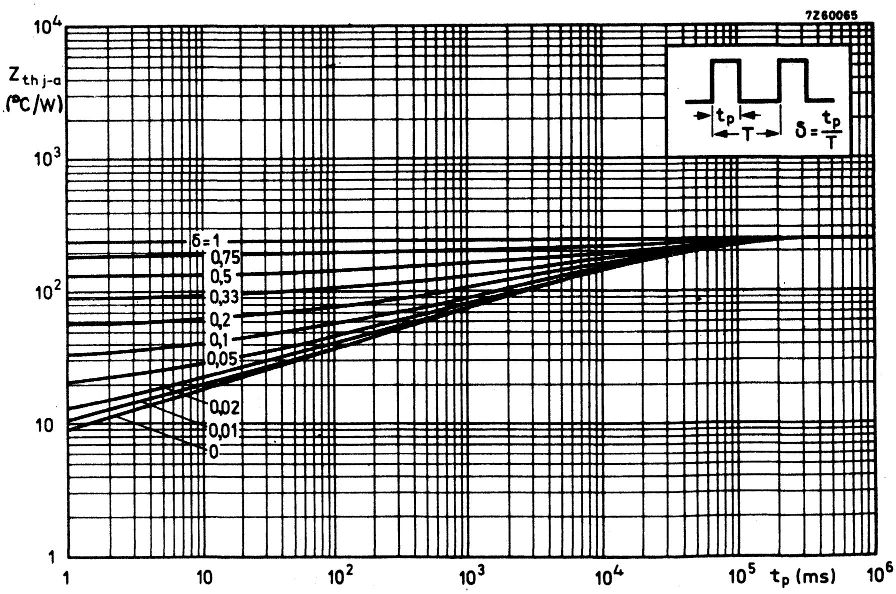

7Z60065
$Z_{th\,j\text{-}a}$ (°C/W)
10^4
10^3
10^2
10
1
δ=1
0,75
0,5
0,33
0,2
0,1
0,05
0,02
0,01
0
t_p
T
$\delta = \frac{t_p}{T}$
1
10
10^2
10^3
10^4
10^5
t_p (ms)
10^6

Fig. 3.

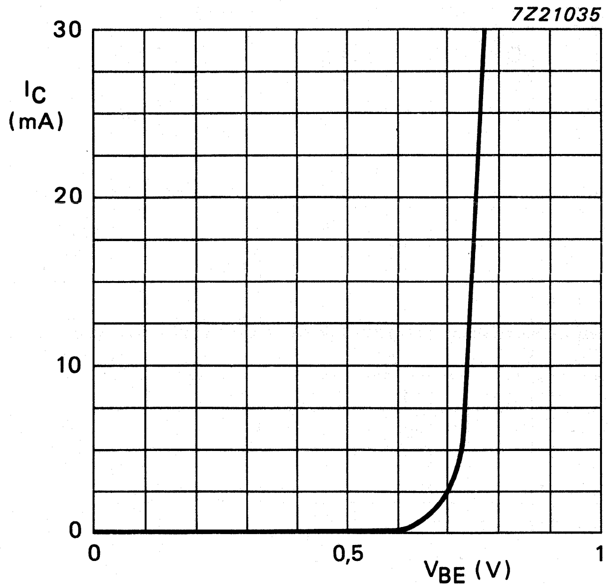


Fig. 4 V_{CE} = 2 V; T_j = 25 °C; typical values.

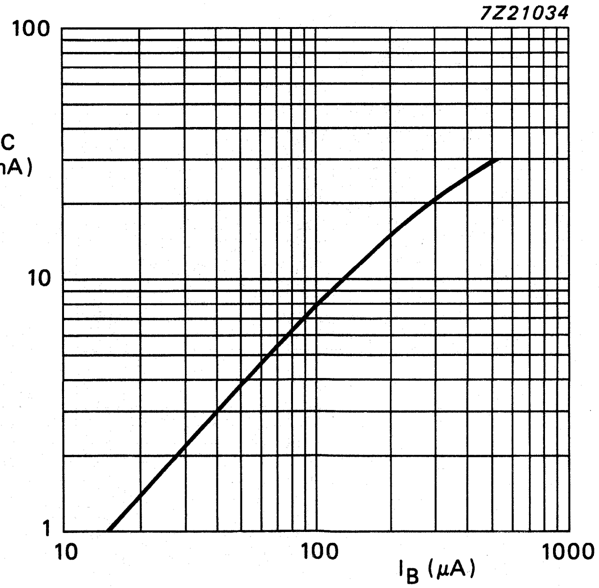


Fig. 5 V_{CE} = 2 V; T_j = 25 °C; typical values.

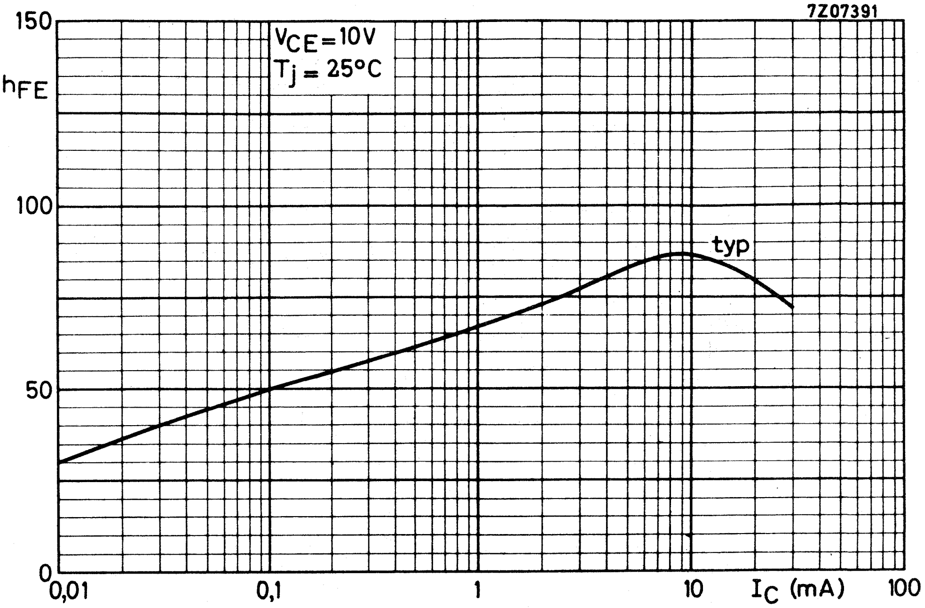

7Z07391
150
h_{FE}
100
50
0
$V_{CE} = 10 V$
$T_j = 25 °C$
typ
0,01
0,1
1
10
100
I_C (mA)

Fig. 6.

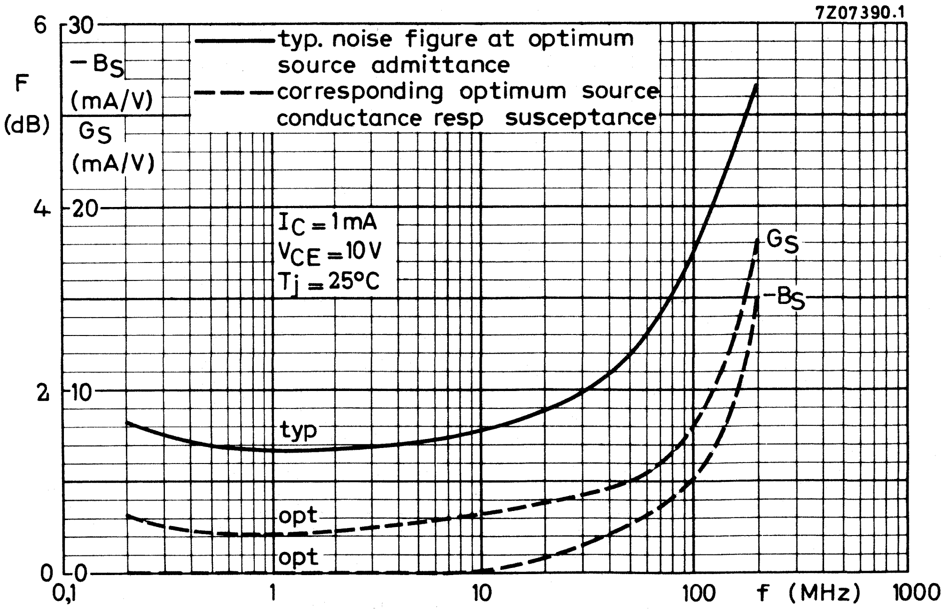

7Z07390.1
F
(dB)
$-B_S$
(mA/V)
G_S
(mA/V)
6
4
2
0
30
20
10
0
typ. noise figure at optimum source admittance
corresponding optimum source conductance resp susceptance
$I_C = 1 mA$
$V_{CE} = 10 V$
$T_j = 25 °C$
typ
opt
opt
G_S
$-B_S$
0,1
1
10
100
1000
f (MHz)

Fig. 7.

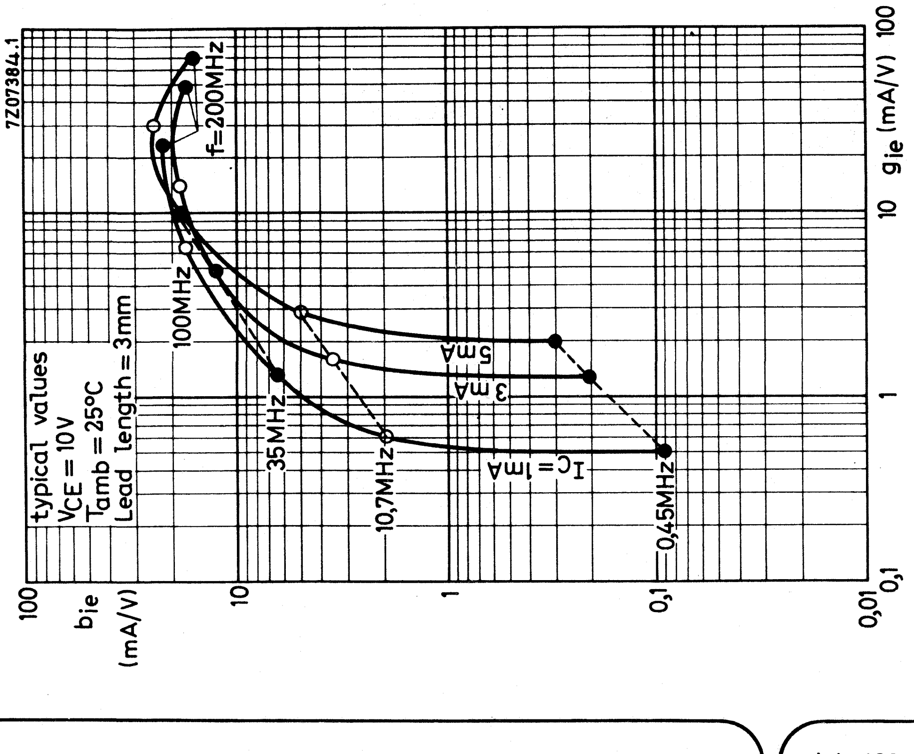

7Z07384.1
typical values
V_{CE} = 10V
T_{amb} = 25°C
Lead length = 3mm
f=200MHz
100MHz
35MHz
10,7MHz
0,45MHz
I_C = 1mA
3 mA
5 mA
b_{ie} (mA/V)
100
10
1
0,1
0,01
g_{ie} (mA/V)
0,1
1
10
100

Fig. 8.

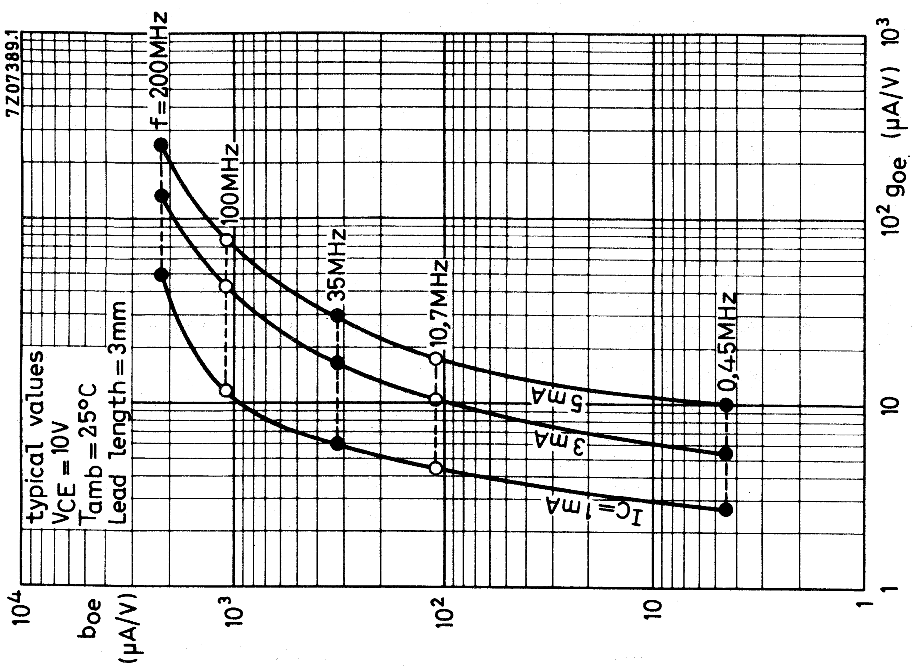

7Z07389.1
typical values
V_{CE} = 10V
T_{amb} = 25°C
Lead length = 3mm
f = 200MHz
100MHz
35MHz
10,7MHz
0,45MHz
I_C = 1mA
3 mA
5 mA
b_{oe} (µA/V)
10^4
10^3
10^2
10
1
g_{oe} (µA/V)
1
10
10^2
10^3

Fig. 9.

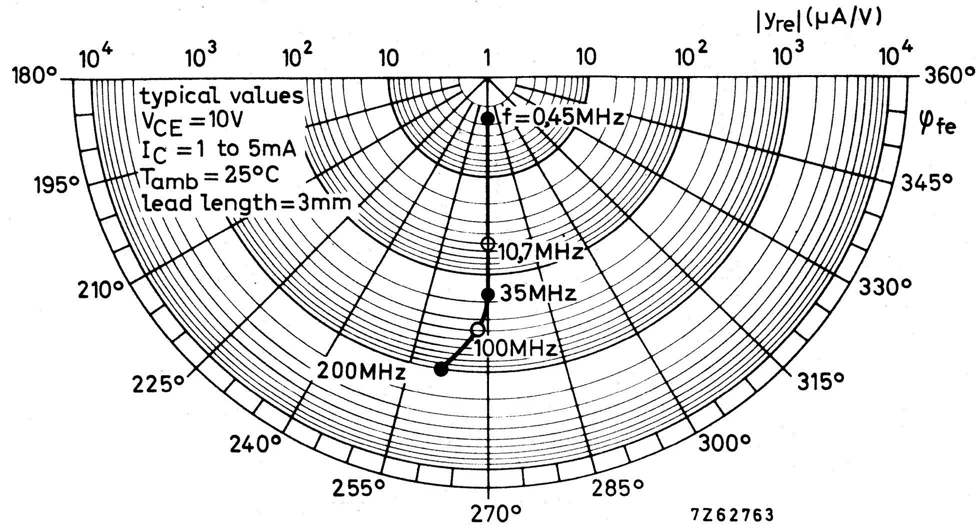

|yre| (µA/V)
10^4
10^3
10^2
10
1
10
10^2
10^3
10^4
180°
360°
φfe
195°
345°
210°
330°
225°
315°
240°
300°
255°
285°
270°
typical values
VCE = 10V
IC = 1 to 5mA
Tamb = 25°C
lead length = 3mm
f = 0,45MHz
10,7MHz
35MHz
100MHz
200MHz
7Z62763

Fig. 10.

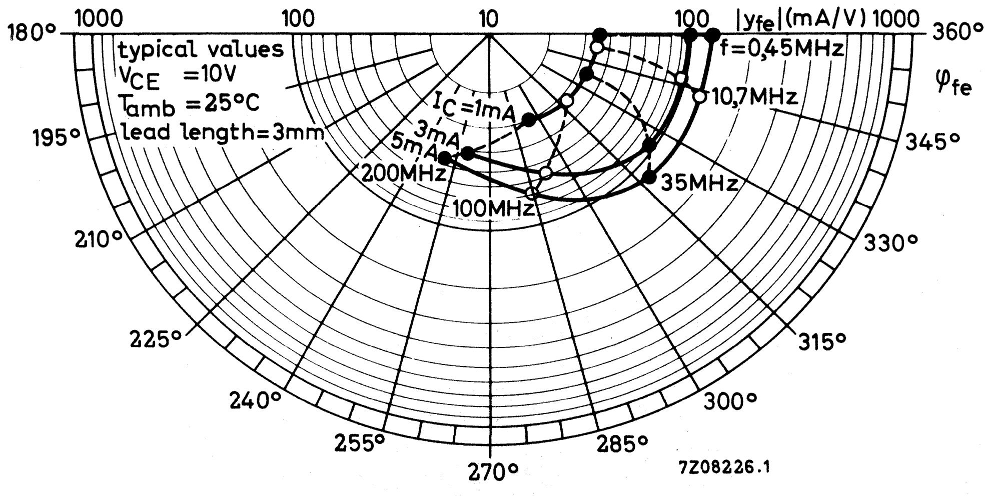

1000
100
10
100
|yfe| (mA/V)
1000
180°
360°
φfe
195°
345°
210°
330°
225°
315°
240°
300°
255°
285°
270°
typical values
VCE = 10V
Tamb = 25°C
lead length = 3mm
IC = 1mA
3mA
5mA
f = 0,45MHz
10,7MHz
35MHz
100MHz
200MHz
7Z08226.1

Fig. 11.

SUPERSEDES DATA OF JULY 1987

SILICON PLANAR TRANSISTOR

NPN transistor in a plastic TO-92 envelope intended for VHF applications, e.g. as gain controlled pre-amplifier in VHF television and FM tuners.

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 (DC)	I_C	max.	20	mA
Total power dissipation up to T_{amb} = 75 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	150	°C
Transition frequency $-I_E$ = 2 mA; V_{CB} = 10 V	f_T	min.	300	MHz

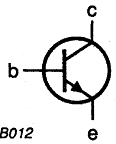
MECHANICAL DATA

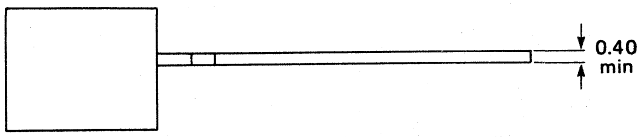
Dimensions in mm

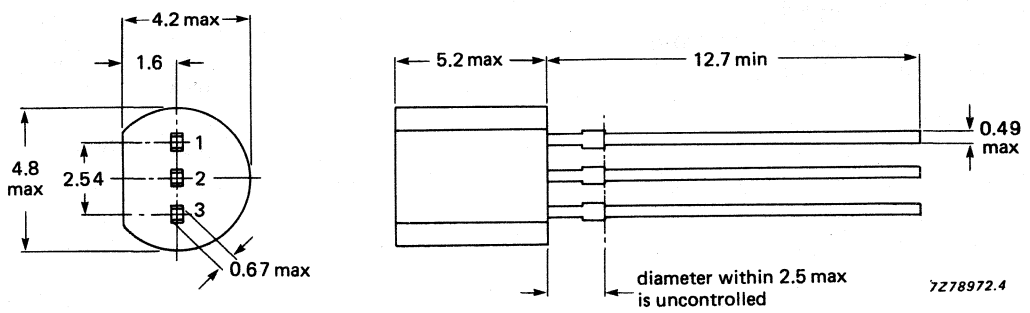
Fig.1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector







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.	20 V
Collector-emitter voltage ($R_{BE} \leqslant 1$ kΩ)	V_{CER}	max.	30 V
Emitter-base voltage (open collector)	V_{EBO}	max.	3 V
Collector current (DC)	I_C	max.	20 mA
Collector current (peak value)	I_{CM}	max.	20 mA
Total power dissipation up to T_{amb} = 75 °C	P_{tot}	max.	300 mW
Storage temperature range	T_{stg}		−65 to + 150 °C
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	420 K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

DC current gain			
$-I_E$ = 2 mA; V_{CB} = 10 V	h_{FE}	min.	13
$-I_E$ = 12 mA; V_{CB} = 7 V*	h_{FE}	min.	5
Emitter-base voltage			
$-I_E$ = 2 mA; V_{CB} = 10 V	$-V_{EB}$	max.	0.9 V
$-I_E$ = 12 mA; V_{CB} = 7 V*	$-V_{EB}$	max.	1.0 V
Transition frequency			
$-I_E$ = 2 mA; V_{CB} = 10 V	f_T		300 to 800 MHz
$-I_E$ = 4 mA; V_{CB} = 5 V	f_T	max.	530 MHz
Feedback capacitance at f = 10.7 MHz			
I_C = 1 mA; V_{CE} = 10 V	C_{re}	typ.	0.8 pF
		max.	1.0 pF
Collector cut-off current			
I_E = 0; V_{CB} = 20 V	I_{CBO}	max.	500 nA
I_E = 0; V_{CB} = 20 V; T_{amb} = 150 °C	I_{CBO}	max.	10 μA
Emitter-base cut-off current			
I_C = 0; V_{EB} = 2 V	I_{EBO}	max.	500 nA

* Measured under pulsed conditions; t_p = 300 μs; $\delta \leqslant 0.02$.

y-parameters at f = 100 MHz (common base)
I_C = 2 mA; V_{CE} = 10 V

Input conductance	g_{ib}	typ.	66 mS
Input susceptance	$-b_{ib}$	typ.	15 mS
Feedback admittance	$\|y_{rb}\|$	typ.	190 mS
Phase angle of feedback admittance	φ_{rb}	typ.	280°
Transfer admittance	$\|y_{fb}\|$	typ.	66 mS
Phase angle of transfer admittance	φ_{fb}	typ.	155°
Output conductance	g_{ob}	typ.	15 µS
Output susceptance	b_{ob}	typ.	660 µS

y-parameters at f = 50 MHz (common base)
$-I_E$ = 3 mA; V_{CB} = 10 V

Input conductance	g_{ib}	typ.	9.5 mS
Input susceptance	$-b_{ib}$	typ.	12 mS
Feedback admittance	$\|y_{rb}\|$	typ.	100 µS
Phase angle of feedback admittance	φ_{rb}	typ.	270°
Transfer admittance	$\|y_{fb}\|$	typ.	95 mS
Phase angle of transfer admittance	φ_{fb}	typ.	160°
Output conductance	g_{ob}	typ.	10 µS
Output susceptance	b_{ob}	typ.	350 µS

y-parameters at f = 200 MHz (common base)
$-I_E$ = 3 mA; V_{CB} = 10 V

Input conductance	g_{ib}	typ.	70 mS
Input susceptance	$-b_{ib}$	typ.	46 mS
Feedback admittance	$\|y_{rb}\|$	typ.	340 µS
Phase angle of feedback admittance	φ_{rb}	typ.	275°
Transfer admittance	$\|y_{fb}\|$	typ.	85 mS
Phase angle of transfer admittance	φ_{fb}	typ.	130°
Output conductance	g_{ob}	typ.	75 µS
Output susceptance	b_{ob}	typ.	1.3 mS

SILICON PLANAR EPITAXIAL TRANSISTOR

P-N-P transistor in a TO-92 envelope intended for use as preamplifier, mixer and oscillator in v.h.f. and u.h.f. tuners.

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} = 45 °C	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	150	°C
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	<	6	dB
Transducer gain (common base) I_E = 3 mA; $-V_{CB}$ = 10 V	G_{tr}	>	14	dB

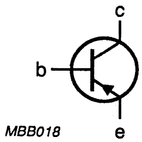
MECHANICAL DATA

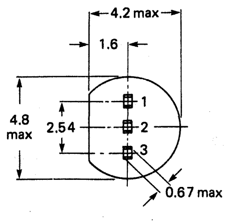
Dimensions in mm

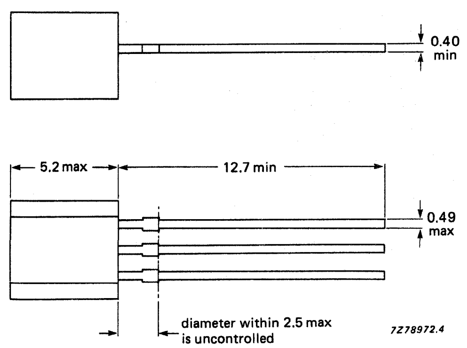
Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector







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.	20	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} = 45 °C	P_{tot}	max.	250	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	$R_{th\ j\text{-}a}$	=	420	K/W

CHARACTERISTICS

T_{amb} = 25 °C

Collector cut-off current $I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	<	50	nA
Base current $I_E = 1$ mA; $-V_{CB} = 10$ V	$-I_B$	<	33	μA
Collector-base breakdown voltage open emitter; $-I_C = 10$ μA	$-V_{(BR)CBO}$	>	30	V
Collector-emitter breakdown voltage open base; $-I_C = 2$ mA	$-V_{(BR)CEO}$	>	20	V
Emitter-base breakdown voltage open collector; $-I_E = 10$ μA	$-V_{(BR)EBO}$	>	4	V
Transition frequency at f = 100 MHz $I_E = 1$ mA; $-V_{CB} = 10$ V	f_T	typ.	350	MHz
$I_E = 5$ mA; $-V_{CB} = 10$ V	f_T	typ.	500	MHz
			400 to 700	MHz
Feedback capacitance at f = 1 MHz $I_E = 1$ mA; $-V_{CB} = 10$ V	C_{re}	typ.	0,5	pF
Noise figure at f = 200 MHz $I_E = 1$ mA; $-V_{CB} = 10$ V	F	typ.	5	dB
		<	6	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}	>	14	dB
		typ.	17,5	dB

SILICON PLANAR EPITAXIAL TRANSISTOR

P-N-P transistor in a plastic T-package intended for application as self-oscillating mixer stage in u.h.f. tuners.

QUICK REFERENCE DATA

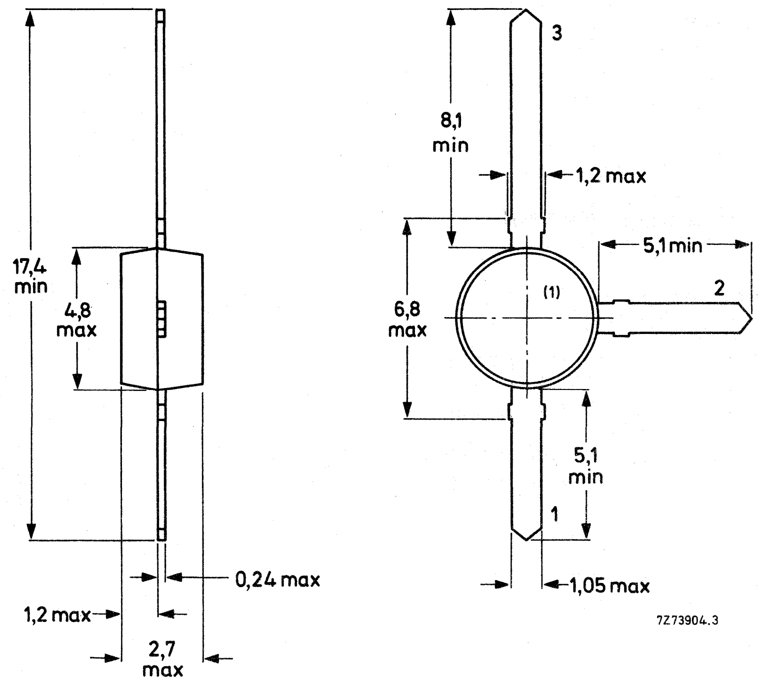
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	35 V
Collector current (d.c.)	$-I_C$	max.	30 mA
Total power dissipation up to T_{amb} = 55 °C	P_{tot}	max.	160 mW
Junction temperature	T_j	max.	150 °C
Transition frequency at f = 100 MHz I_E = 3 mA; $-V_{CB}$ = 10 V	f_T	typ.	900 MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-37.

Connections
1. Emitter
2. Base
3. Collector



(1) = type number marking.

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
Emitter current (d.c.)	I_E	max.	35	mA
Total power dissipation up to T_{amb} = 55 °C	P_{tot}	max.	160	mW
Storage temperature	T_{stg}	−55 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	600	K/W

CHARACTERISTICS

T_{amb} = 25 °C

Collector cut-off current				
$I_E = 0; -V_{CB} = 20$ V	$-I_{CBO}$	<	100	nA
Emitter cut-off current				
$I_C = 0; -V_{EB} = 1$ V	$-I_{EBO}$	<	100	nA
D.C. current gain				
$-I_C = 3$ mA; $-V_{CB} = 10$ V	h_{FE}	>	25	
		typ.	50	
Transition frequency at f = 100 MHz				
$I_E = 3$ mA; $-V_{CB} = 10$ V	f_T	typ.	900	MHz
		750 to 1060		MHz
$I_E = 7$ mA; $-V_{CB} = 5$ V	f_T	>	400	MHz
		typ.	700	MHz
Feedback capacitance at f = 1 MHz				
$I_E = 0; -V_{CB} = 10$ V	C_{rb}	typ.	110	fF
		<	140	fF
$I_E = 1$ mA; $-V_{CB} = 10$ V	C_{re}	typ.	475	fF
Noise figure at $R_S = 60\ \Omega$				
$I_E = 3$ mA; $-V_{CB} = 10$ V; f = 200 MHz	F	typ.	2,6	dB
$I_E = 3$ mA; $-V_{CB} = 10$ V; f = 800 MHz	F	typ.	4,7	dB
		<	6,0	dB
Transducer gain (common base) at f = 800 MHz				
$I_E = 3$ mA; $-V_{CB} = 10$ V; $R_S = 60\ \Omega$; $R_L = 500\ \Omega$	G_{tr}	>	13,0	dB
		typ.	14,5	dB

SILICON PLANAR EPITAXIAL TRANSISTOR

P-N-P transistor in a plastic T-package intended for application as self-oscillating mixer stage in u.h.f. tuners.

QUICK REFERENCE DATA

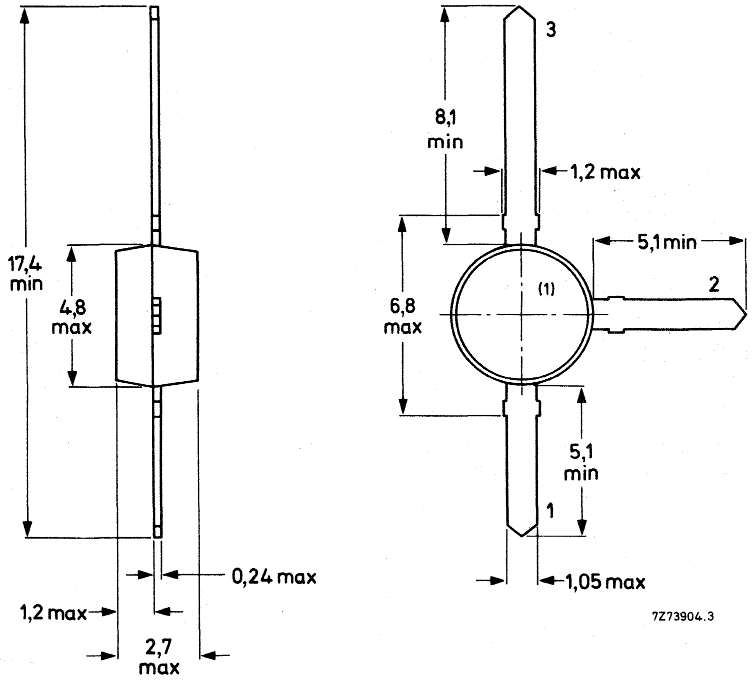
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	35	V
Collector current (d.c.)	$-I_C$	max.	30	mA
Total power dissipation up to T_{amb} = 55 °C	P_{tot}	max.	160	mW
Junction temperature	T_j	max.	150	°C
Transition frequency I_E = 3 mA; $-V_{CB}$ = 10 V	f_T	typ.	900	MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-37.

Connections
1. Emitter
2. Base
3. Collector



(1) = type number marking.

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
Emitter current (d.c.)	I_E	max.	35 mA
Total power dissipation up to T_{amb} = 55 °C	P_{tot}	max.	160 mW
Storage temperature	T_{stg}	−55 to + 150 °C	
Junction temperature	T_j	max.	150 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	600 K/W

CHARACTERISTICS

T_{amb} = 25 °C

Collector cut-off current $I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	≤	100 nA
Emitter cut-off current $I_C = 0$; $-V_{EB} = 1$ V	$-I_{EBO}$	≤	100 nA
D.C. current gain $-I_C = 3$ mA; $-V_{CB} = 10$ V	h_{FE}	≥ typ.	25 50
Transition frequency $I_E = 3$ mA; $-V_{CB} = 10$ V	f_T	typ. 750 to	900 MHz 1060 MHz
$I_E = 7$ mA; $-V_{CB} = 5$ V	f_T	≥ typ.	400 MHz 700 MHz
Feedback capacitance at f = 1 MHz $I_E = 0$; $-V_{CB} = 10$ V	C_{rb}	typ.	170 fF
$I_E = 1$ mA; $-V_{CB} = 10$ V	C_{re}	typ.	450 fF
Noise figure at $R_S = 60\ \Omega$ $I_E = 3$ mA; $-V_{CB} = 10$ V; f = 200 MHz	F	typ.	2,6 dB
$I_E = 3$ mA; $-V_{CB} = 10$ V; f = 800 MHz	F	typ. ≤	4,7 dB 6,0 dB
Transducer gain (common base) at f = 800 MHz $I_E = 3$ mA; $-V_{CB} = 10$ V; $R_S = 60\ \Omega$; $R_L = 500\ \Omega$	G_{tr}	≥ typ.	13,0 dB 15,0 dB

SILICON PLANAR TRANSISTOR

P-N-P transistor in a subminiature plastic T-package, primarily intended for application in r.f. stages in u.h.f. tuners using p-i-n diode attenuators.

QUICK REFERENCE DATA

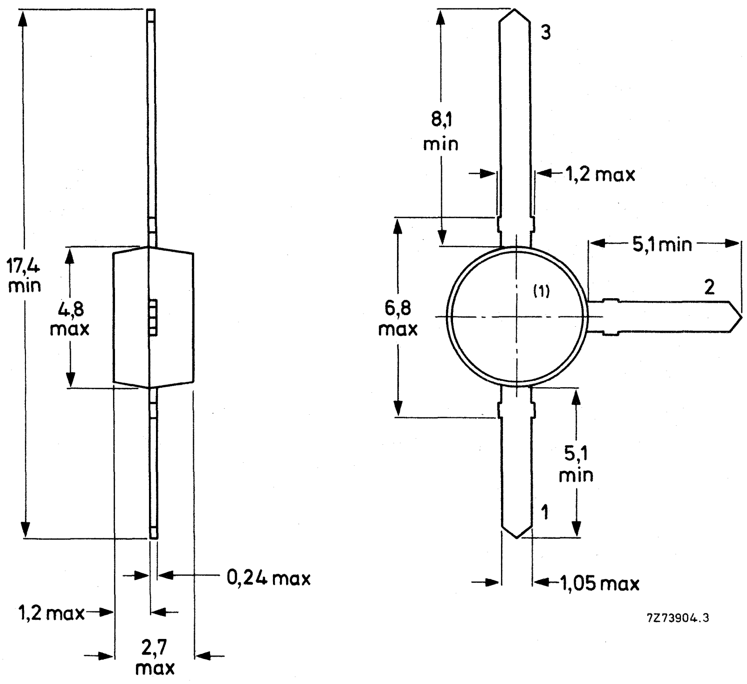
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20 V
Collector current (peak value)	$-I_{CM}$	max.	30 mA
Total power dissipation up to T_{amb} = 55 °C	P_{tot}	max.	140 mW
Junction temperature	T_j	max.	125 °C
Transition frequency at f = 100 MHz I_E = 10 mA; $-V_{CB}$ = 10 V	f_T	typ.	1350 MHz
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
Transducer gain (common base) I_E = 10 mA; $-V_{CB}$ = 10 V; f = 800 MHz R_S = 60 Ω; R_L = 500 Ω	G_{tr}	typ.	16 dB

MECHANICAL DATA

Fig. 1 SOT-37.

Connections

1. Emitter
2. Base
3. Collector



(1) = type number marking.

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.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	3	V
Collector current (peak value)	$-I_{CM}$	max.	30	mA
Base current (d.c.)	$-I_B$	max.	10	mA
Total power dissipation up to T_{amb} = 55 °C	P_{tot}	max.	140	mW
Storage temperature	T_{stg}		−55 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	500	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
Collector-base breakdown voltage open emitter; $-I_C = 10$ μA	$-V_{(BR)CBO}$	>	20	V
Collector-emitter breakdown voltage open base; $-I_C = 1$ mA	$-V_{(BR)CEO}$	>	20	V
Emitter-base breakdown voltage open collector; $-I_E = 10$ μA	$-V_{(BR)EBO}$	>	3	V
D.C. current gain $I_E = 2$ mA; $-V_{CB} = 10$ V	h_{FE}	>	15	
$I_E = 10$ mA; $-V_{CB} = 10$ V	h_{FE}	>	20	
Transition frequency at f = 100 MHz $I_E = 10$ mA; $-V_{CB} = 10$ V	f_T	typ.	1350	MHz
$I_E = 15$ mA; $-V_{CB} = 5$ V	f_T	typ.	1000	MHz
Feedback capacitance at f = 500 kHz $I_E = 0$; $-V_{CB} = 10$ V	C_{re}	typ.	0,65	pF
$I_E = 0$; $-V_{CB} = 10$ V	C_{rb}	typ.	120	fF
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 6,0	dB dB
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

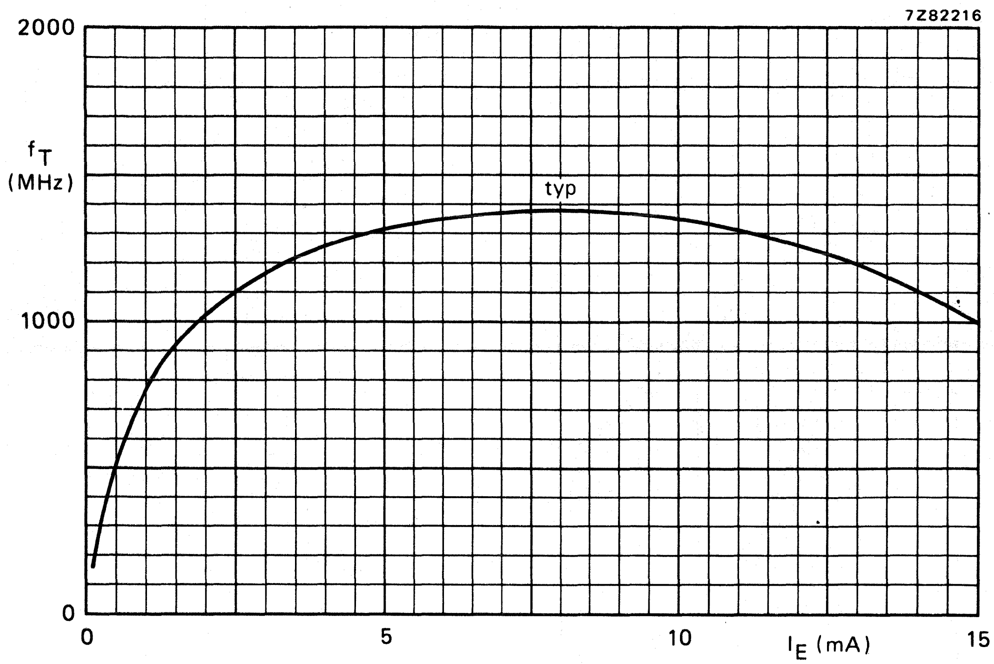


Fig. 2 $-V_{CB}$ = 10 V; T_j = 25 °C.

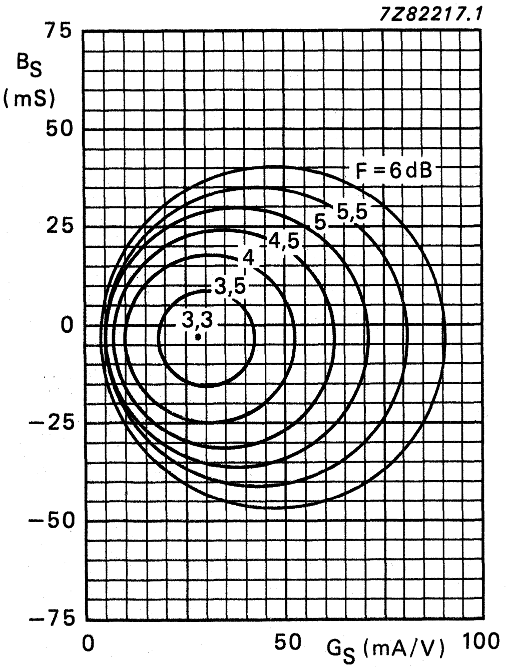


Fig. 3 I_E = 10 mA; $-V_{CB}$ = 10 V; f = 200 MHz; T_{amb} = 25 °C; typical values.

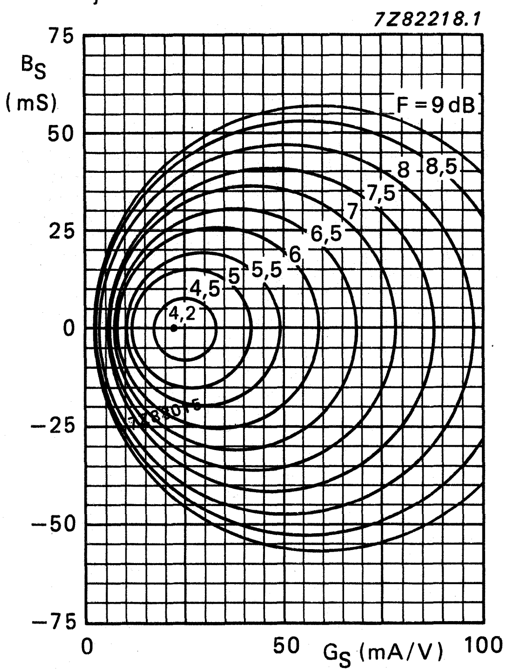


Fig. 4 I_E = 10 mA; $-V_{CB}$ = 10 V; f = 800 MHz; T_{amb} = 25 °C; typical values.

Conditions for Figs 5 to 8: I_E = 10 mA; ——— $-V_{CB}$ = 10 V; – – – – $-V_{CB}$ = 5 V; T_{amb} = 25 °C; typical values.

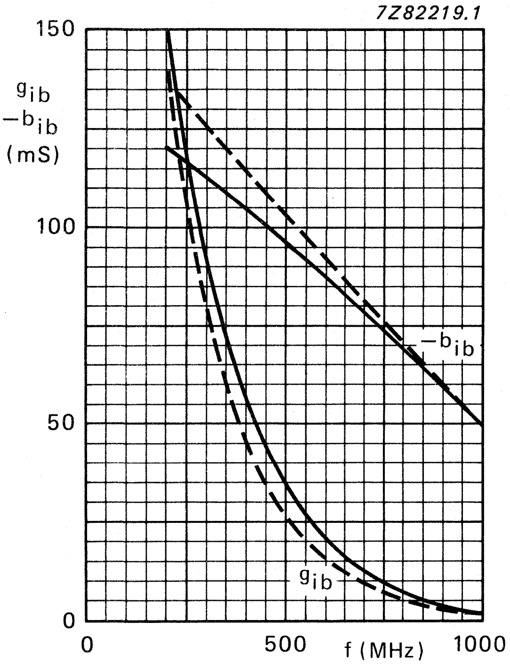


Fig. 5.

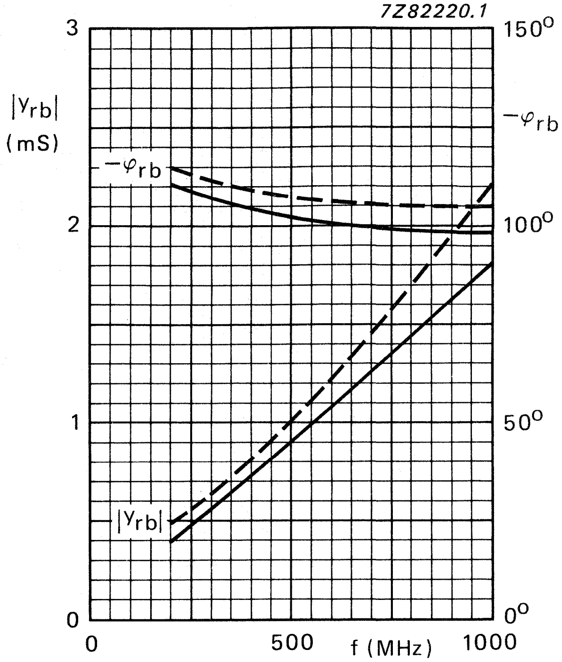


Fig. 6.

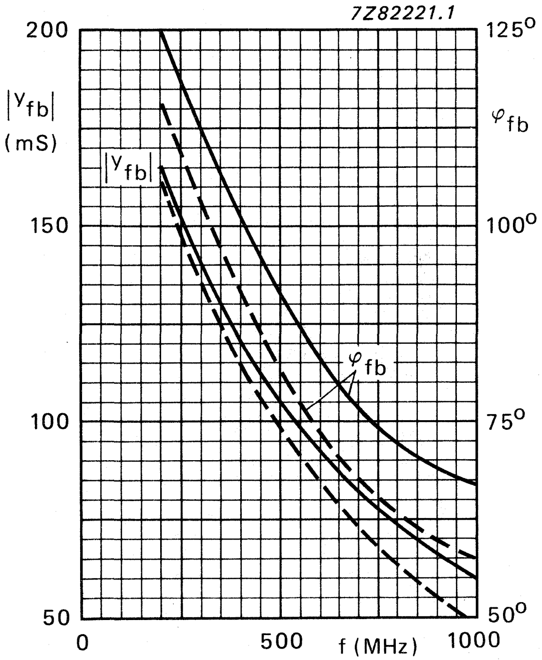


Fig. 7.

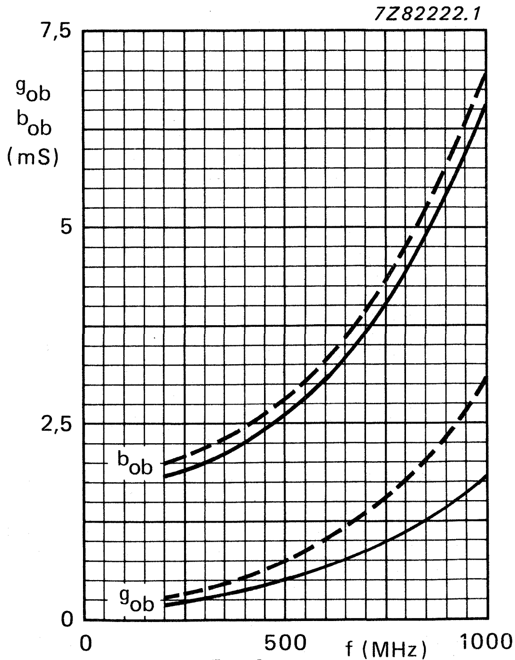


Fig. 8.

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a plastic TO-92 envelope primarily intended for use in active probes, frequency multipliers and linear amplifiers.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	mW
D.C. current I_C = 10 mA; V_{CE} = 1 V	h_{FE}	>	40	
Transition frequency at f = 100 MHz I_C = 10 mA; V_{CE} = 10 V	f_T	>	500	MHz

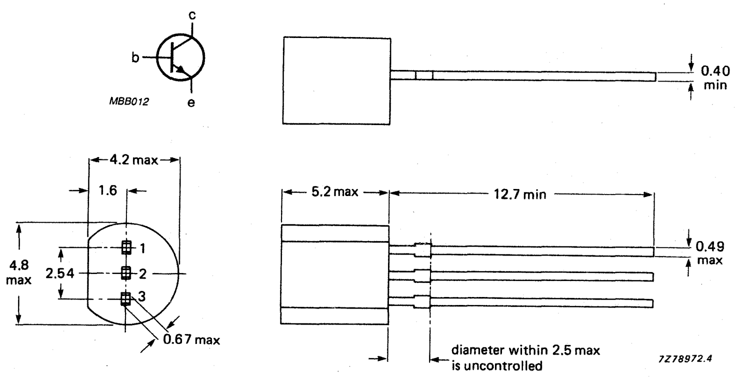
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



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 (V_{BE} = 0)	V_{CES}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4,5	V
Collector current (peak value; t_p = 10 μs)	I_{CM}	max.	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	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	$R_{th\ j\text{-}a}$	=	250	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 20 V	I_{CBO}	<	400	nA
I_E = 0; V_{CB} = 20 V; T_j = 125 °C	I_{CBO}	<	30	μA
Emitter cut-off current				
I_C = 0; V_{EB} = 2 V	I_{EBO}	<	100	nA
Saturation voltage				
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	<	0,25	V
	V_{BEsat}		0,70 to 0,85	V
Knee voltage				
I_C = 45 mA; I_B = value for which I_C = 50 mA at V_{CE} = 2 V	V_{CEK}	<	0,8	V
D.C. current gain				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	>	40	
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	500	MHz
I_C = 40 mA; V_{CE} = 10 V	f_T	>	490	MHz
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

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

$$G_{UM} = 10 \log \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$$

I_C = 10 mA; V_{CE} = 10 V; f = 200 MHz	G_{UM}	typ.	19	dB

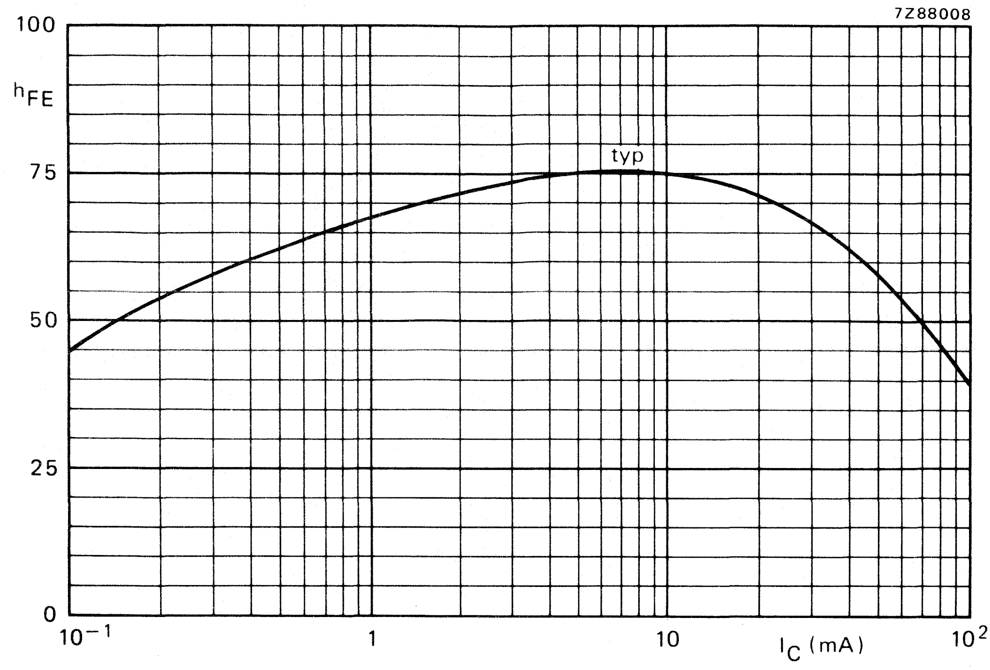


Fig. 2 V_{CE} = 1 V; T_j = 25 °C.

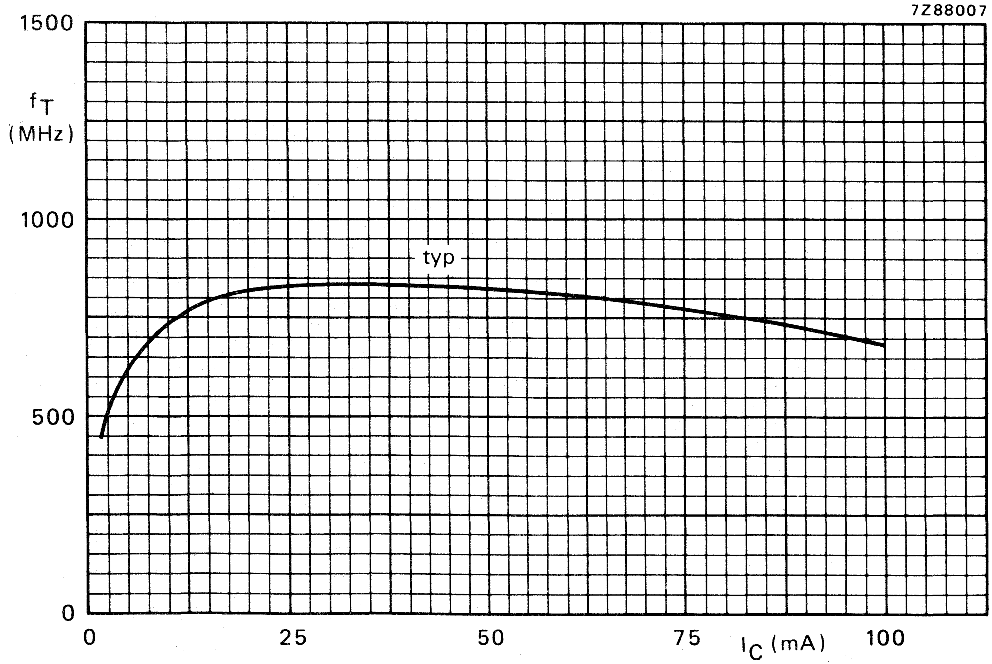


Fig. 3 V_{CE} = 10 V; T_j = 25 °C.

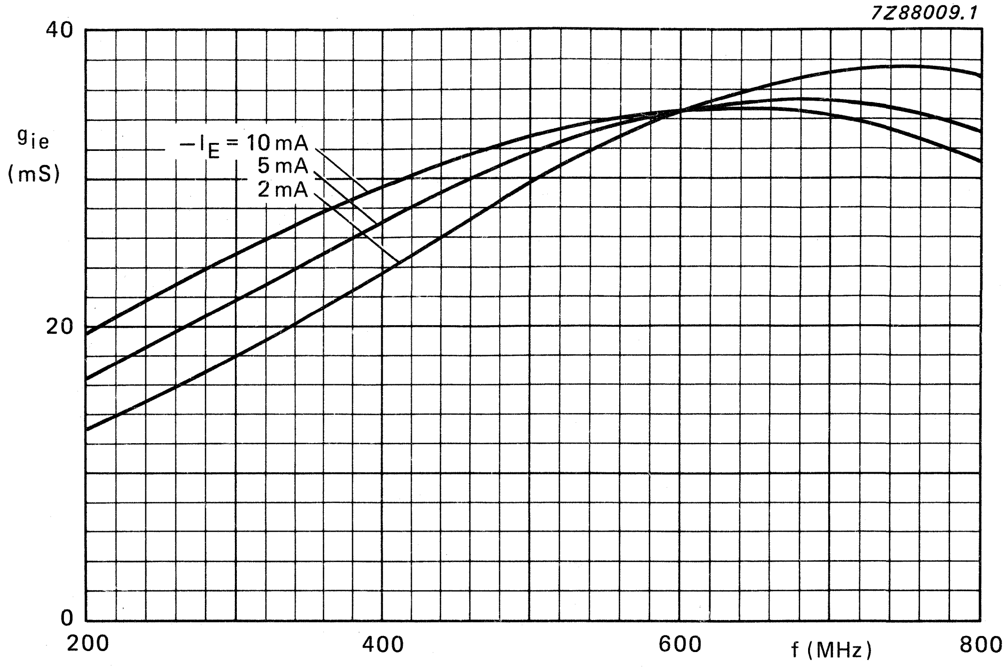


Fig. 4 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

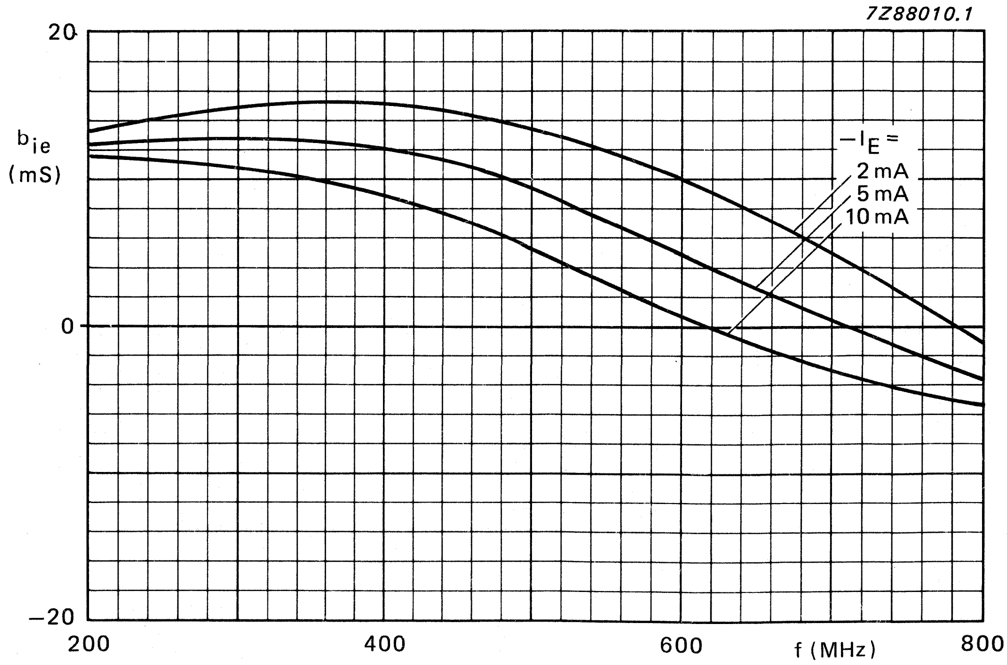


Fig. 5 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

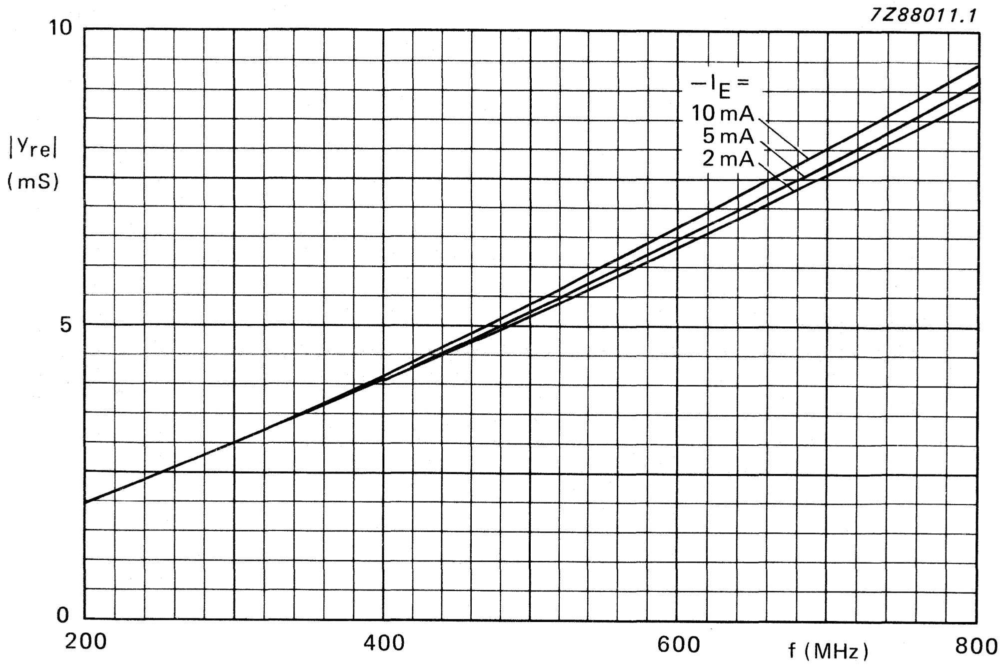


Fig. 6 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

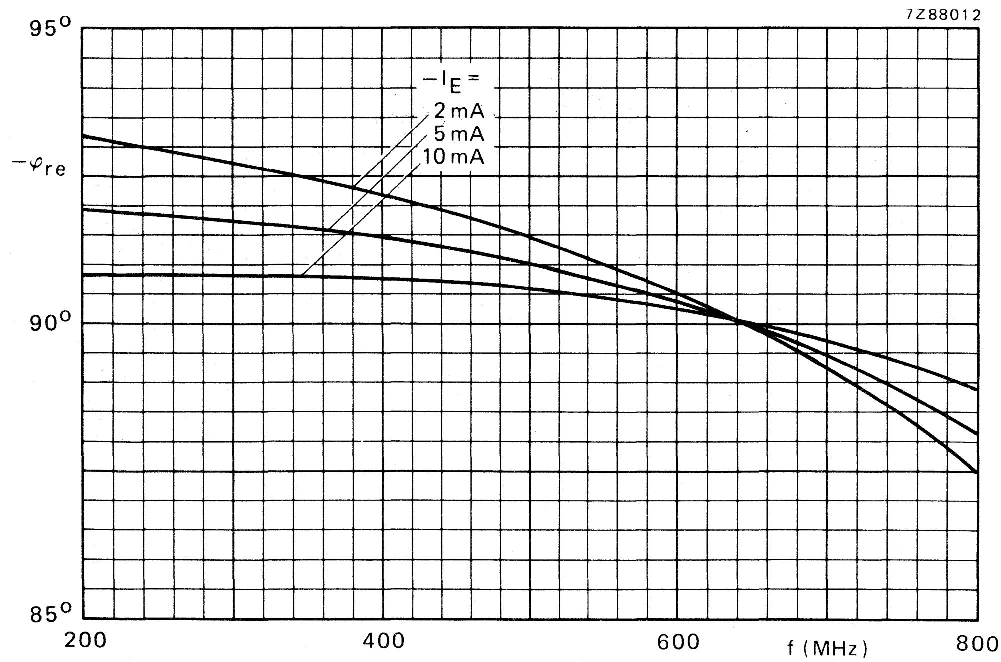


Fig. 7 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

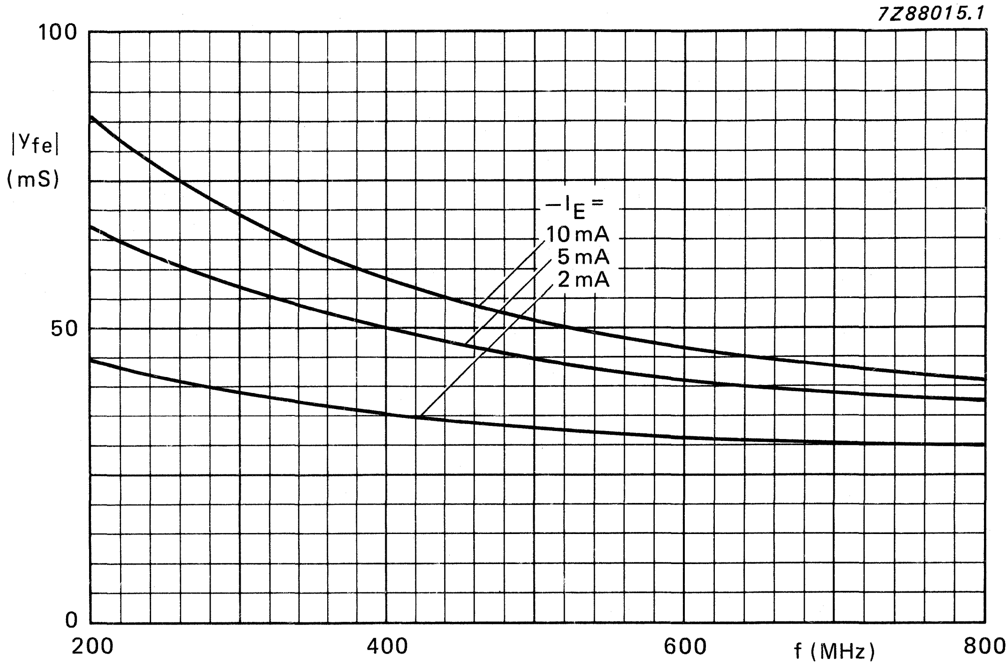


Fig. 8 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

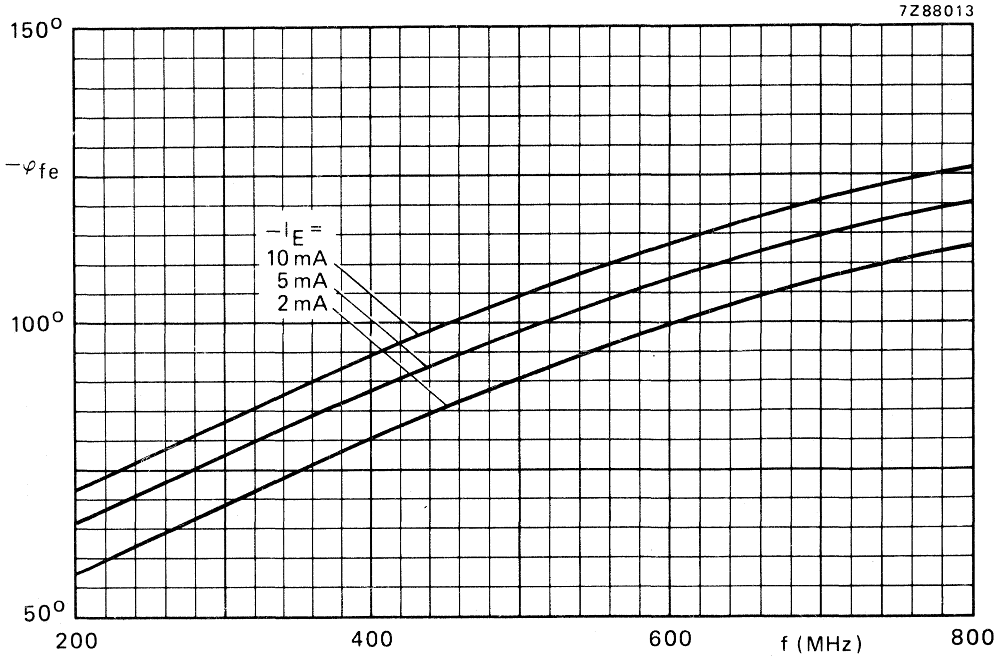


Fig. 9 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

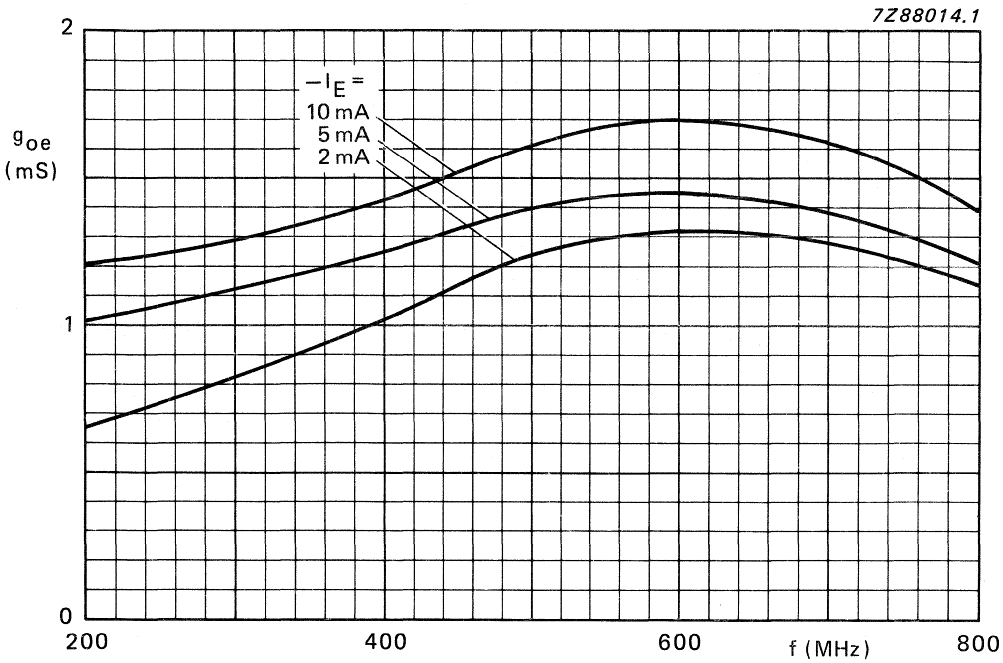


Fig. 10 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

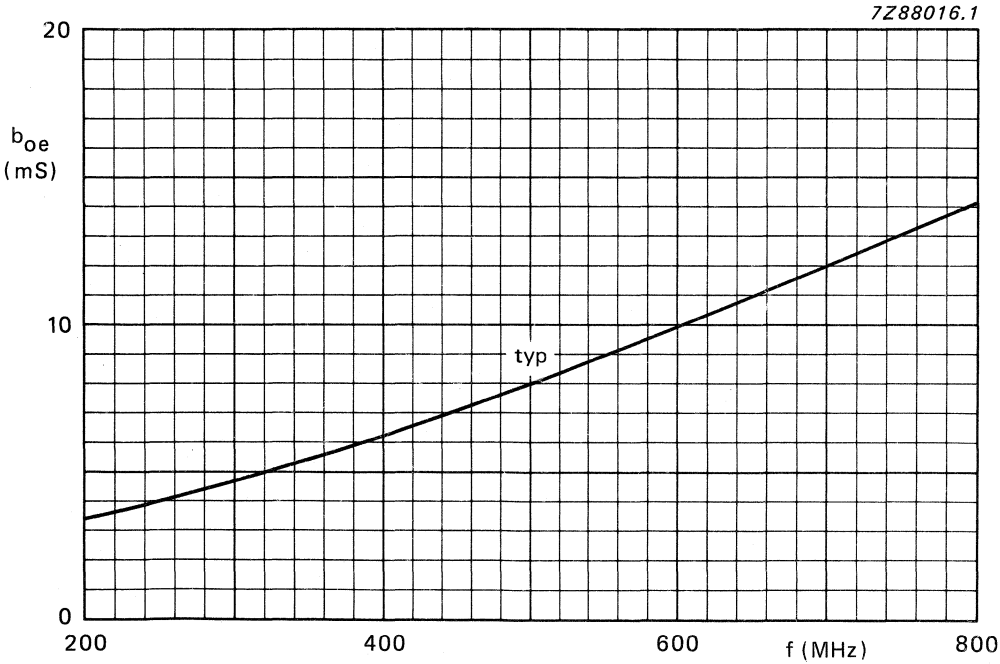


Fig. 11 V_{CB} = 10 V; $-I_E$ = 2 to 10 mA; T_{amb} = 25 °C

SILICON P-N-P HIGH-VOLTAGE TRANSISTORS

Planar epitaxial transistors in TO-39 metal envelopes, intended as general purpose amplifiers and switching devices in industrial and telephone applications.

QUICK REFERENCE DATA

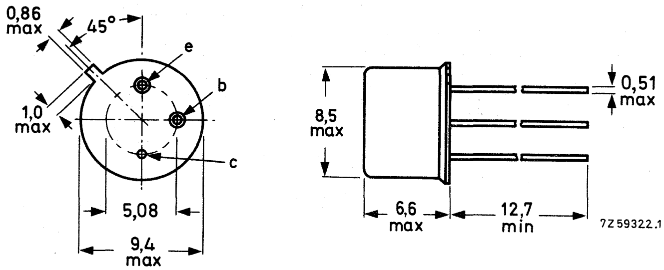
			BFT44	BFT45	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	300	250	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	300	250	V
Collector current (d.c.)	$-I_C$	max.	0,5		A
Total power dissipation up to T_{case} = 50 °C	P_{tot}	max.	5,0		W
Junction temperature	T_j	max.	200		°C
D.C. current gain $-I_C$ = 10 mA; $-V_{CE}$ = 10 V	h_{FE}		50 to 150		
Transition frequency at f = 35 MHz $-I_C$ = 15 mA; $-V_{CE}$ = 10 V	f_T	typ.	70		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case.



Maximum lead diameter is guaranteed only for 12,7 mm.

RATINGS

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

			BFT44	BFT45	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	300	250	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	300	250	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	V
Collector current (d.c.)	$-I_C$	max.	0,5		A
Total power dissipation up to T_{case} = 50 °C	P_{tot}	max.	5,0		W

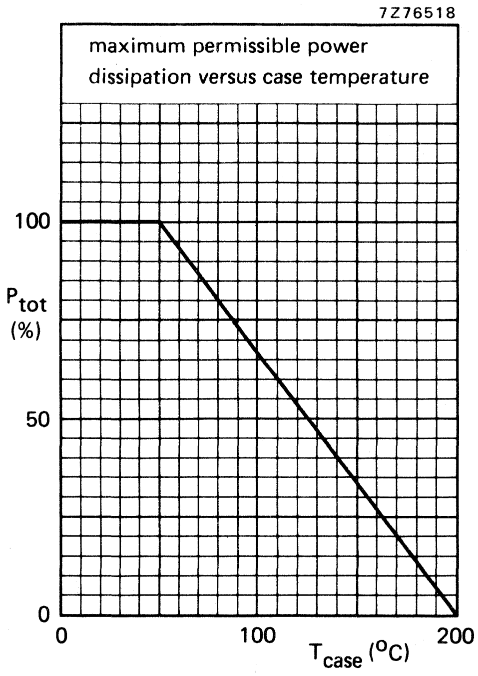


Fig. 2.

Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	200	K/W
From junction to case	$R_{th\,j\text{-}c}$	=	30	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 200$ V	$-I_{CBO}$	<	5	μA
$I_B = 0$; $-V_{CE} = 200$ V; $T_j = 125$ °C	$-I_{CEO}$	<	300	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 3$ V	$-I_{EBO}$	<	5	μA

			BFT44	BFT45	
Collector-emitter sustaining voltage					
$-I_C = 10$ mA; $I_B = 0$; $L = 25$ mH	$-V_{CEOsust}$	>	300	250	V*

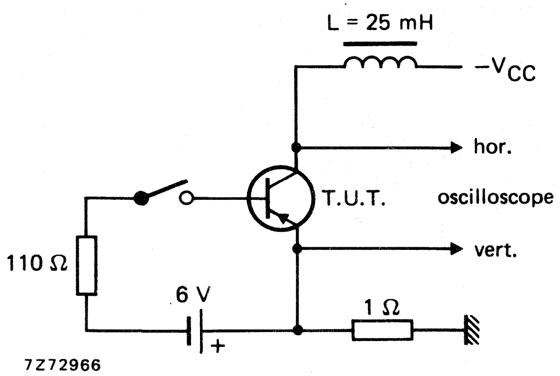


Fig. 3 Test circuit for $V_{CEOsust}$.

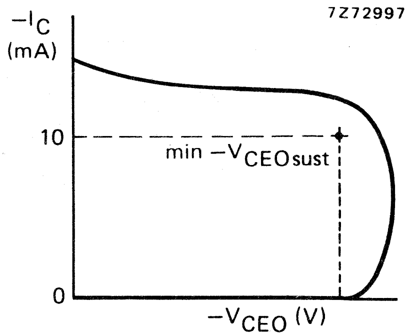


Fig. 4 Oscilloscope display for $V_{CEOsust}$.

Saturation voltages					
$-I_C = 10$ mA; $-I_B = 1$ mA		$-V_{CEsat}$	<	0,5	V
		$-V_{BEsat}$	<	0,8	V
$-I_C = 100$ mA; $-I_B = 10$ mA		$-V_{CEsat}$	<	1,4	V
		$-V_{BEsat}$	<	0,9	V
$-I_C = 500$ mA; $-I_B = 100$ mA	**BFT44**	$-V_{CEsat}$	<	5,0	V**
	BFT45	$-V_{CEsat}$	<	3,0	V**
		$-V_{BEsat}$	<	1,2	V**
D.C. current gain					
$-I_C = 1$ mA; $-V_{CE} = 10$ V		h_{FE}	>	30	
$-I_C = 10$ mA; $-V_{CE} = 10$ V		h_{FE}		50 to 150	
$-I_C = 100$ mA; $-V_{CE} = 10$ V		h_{FE}	>	50	**
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $-V_{CB} = 20$ V		C_c	<	15	pF

* $-V_{CC}$ = 0 to 50 V; f = 400 Hz; δ = 0,5 (see also test circuit).
** Measured under pulse conditions: t_p = 300 μs; $\delta \leqslant 0{,}02$.

CHARACTERISTICS (continued)

T_j = 25 °C

Transition frequency at f = 35 MHz				
$-I_C$ = 15 mA; $-V_{CE}$ = 10 V	f_T	typ.	70	MHz
Switching times				
$-I_{Con}$ = 50 mA; $-I_{Bon}$ = I_{Boff} = 5 mA (test circuit 1)	t_{on}	typ.	125	ns
	t_{off}	typ.	850	ns
$-I_{Con}$ = 500 mA; $-I_{Bon}$ = I_{Boff} = 100 mA (test circuit 2)	t_{on}	typ.	125	ns
	t_{off}	typ.	125	ns

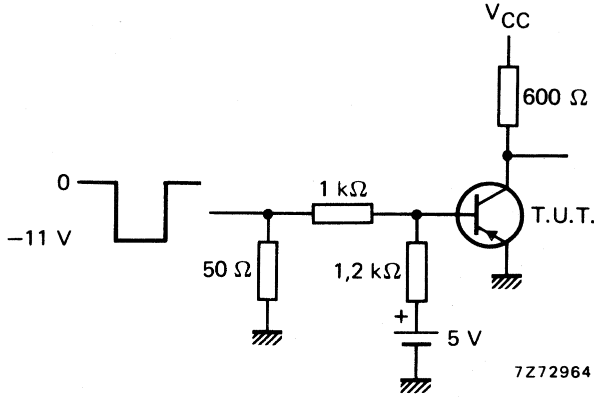


Fig. 5 Test circuit 1.

V_{CC} = −31 V
t_p = 10 μs

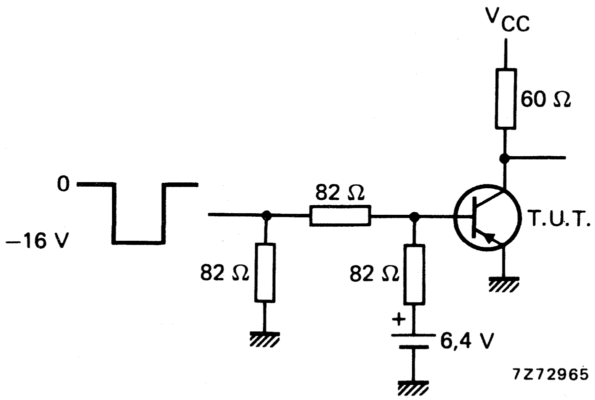


Fig. 6 Test circuit 2.

V_{CC} = −31 V
t_p = 10 μs

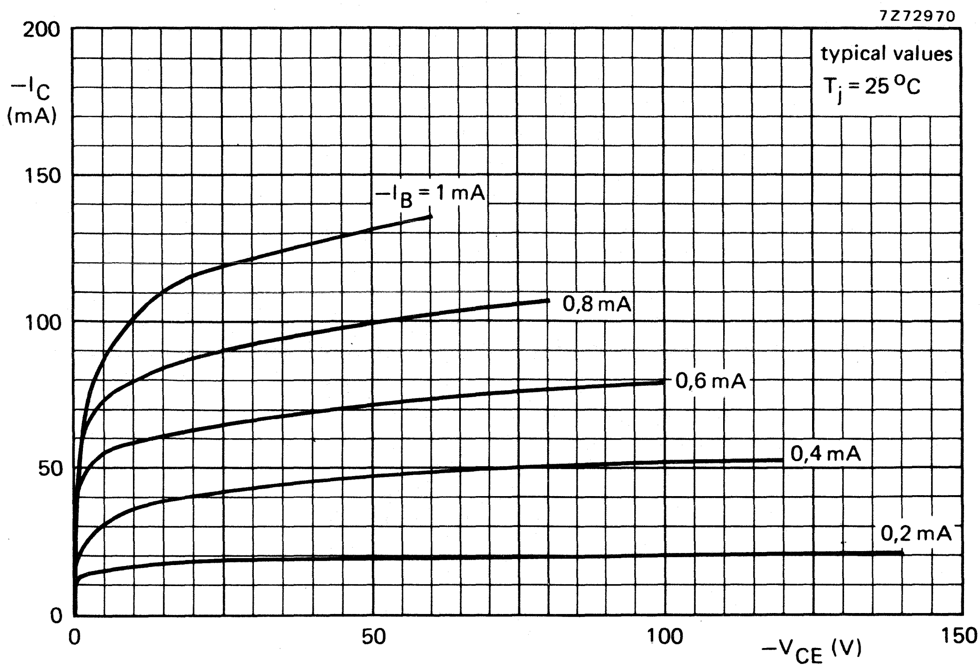

7Z72970
typical values
$T_j = 25\ ^oC$
$-I_C$ (mA)
200
150
100
50
0
$-I_B = 1\ mA$
0,8 mA
0,6 mA
0,4 mA
0,2 mA
0
50
100
150
$-V_{CE}$ (V)

Fig. 7.

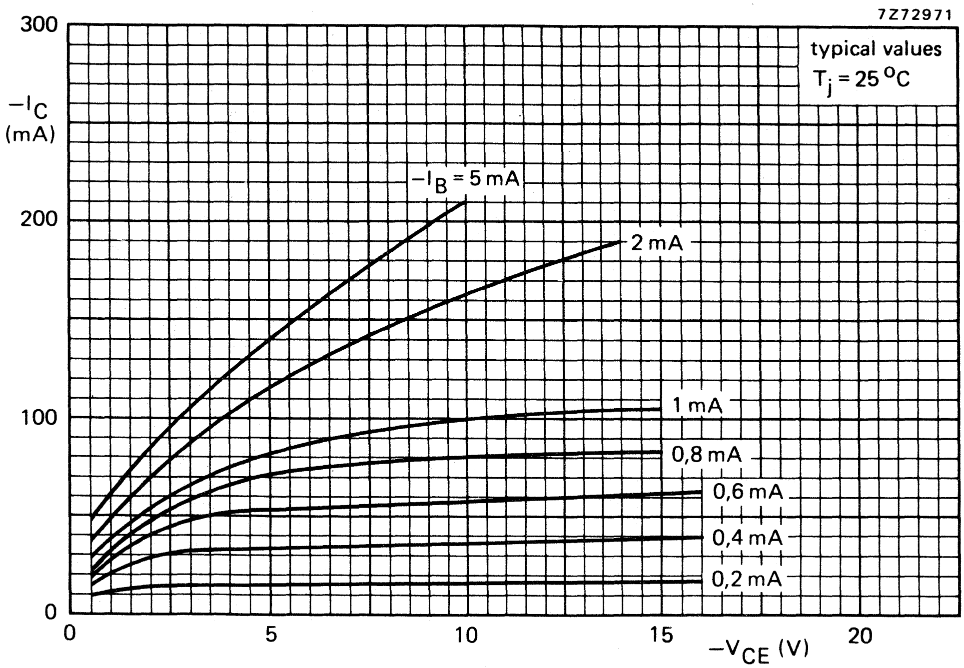

7Z72971
typical values
$T_j = 25\ ^oC$
$-I_C$ (mA)
300
200
100
0
$-I_B = 5\ mA$
2 mA
1 mA
0,8 mA
0,6 mA
0,4 mA
0,2 mA
0
5
10
15
20
$-V_{CE}$ (V)

Fig. 8.

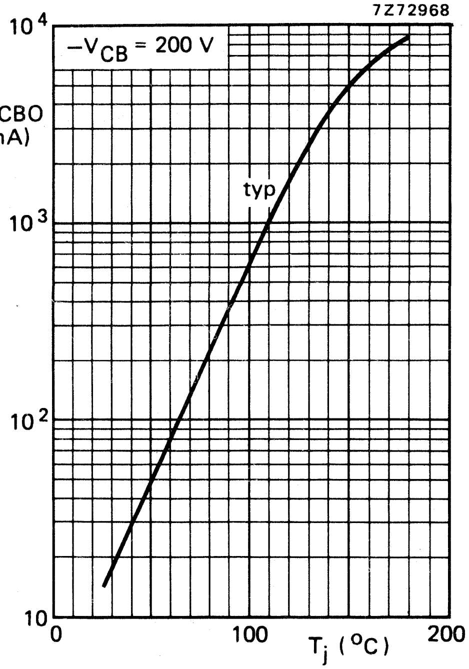


Fig. 9.

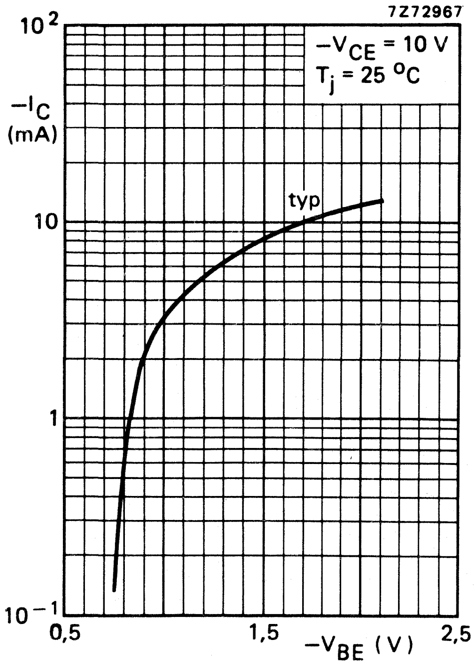


Fig. 10.

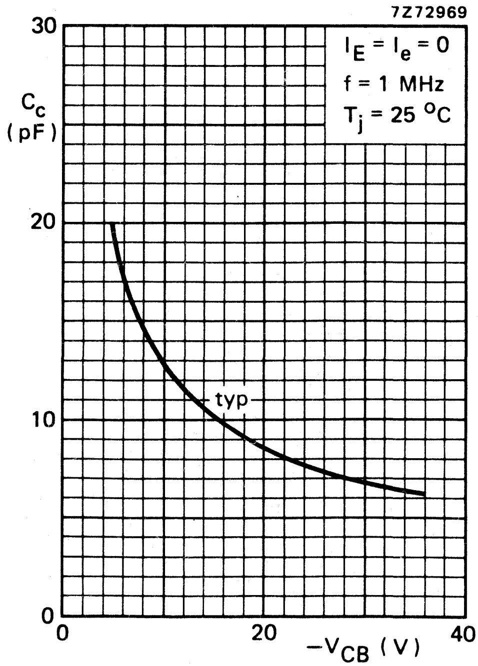


Fig. 11.

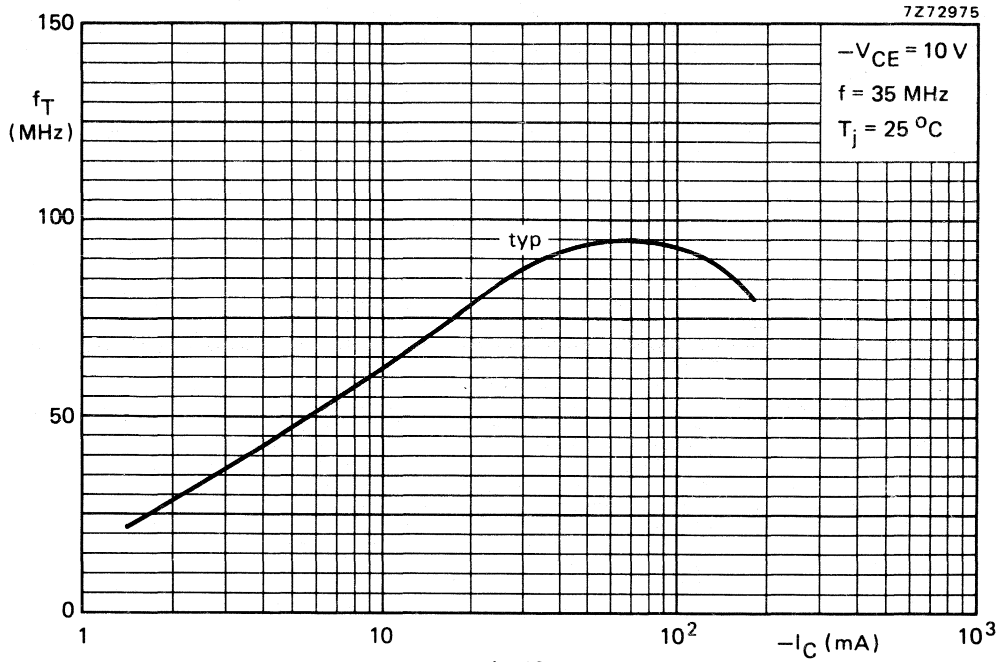

7Z72975
150
100
50
0
f_T
(MHz)
$-V_{CE}$ = 10 V
f = 35 MHz
T_j = 25 °C
typ
1
10
10^2
$-I_C$ (mA)
10^3

Fig. 12.

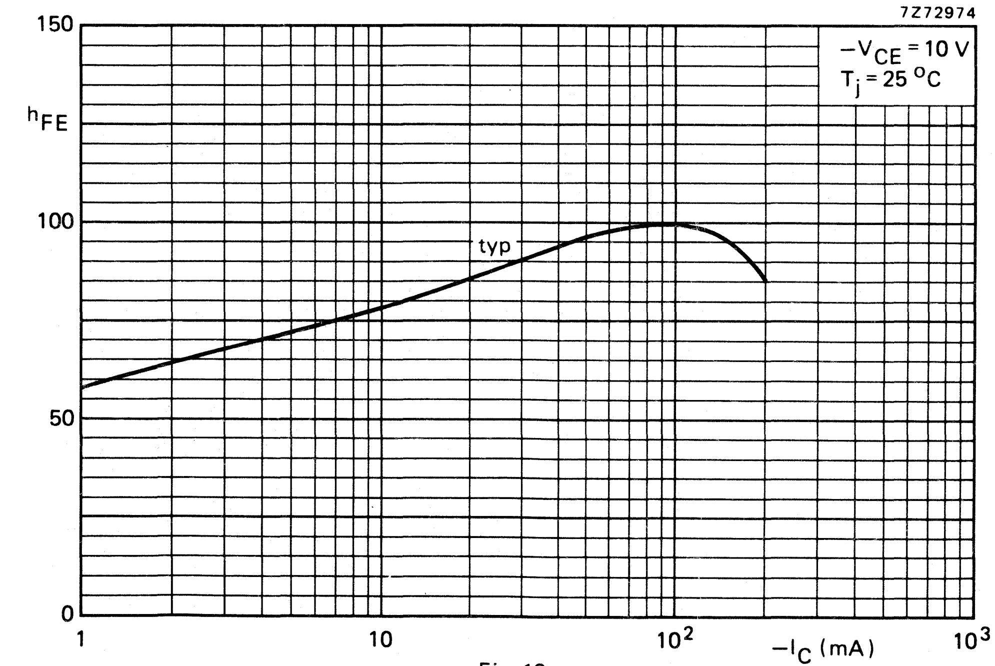

7Z72974
150
100
50
0
h_{FE}
$-V_{CE}$ = 10 V
T_j = 25 °C
typ
1
10
10^2
$-I_C$ (mA)
10^3

Fig. 13.

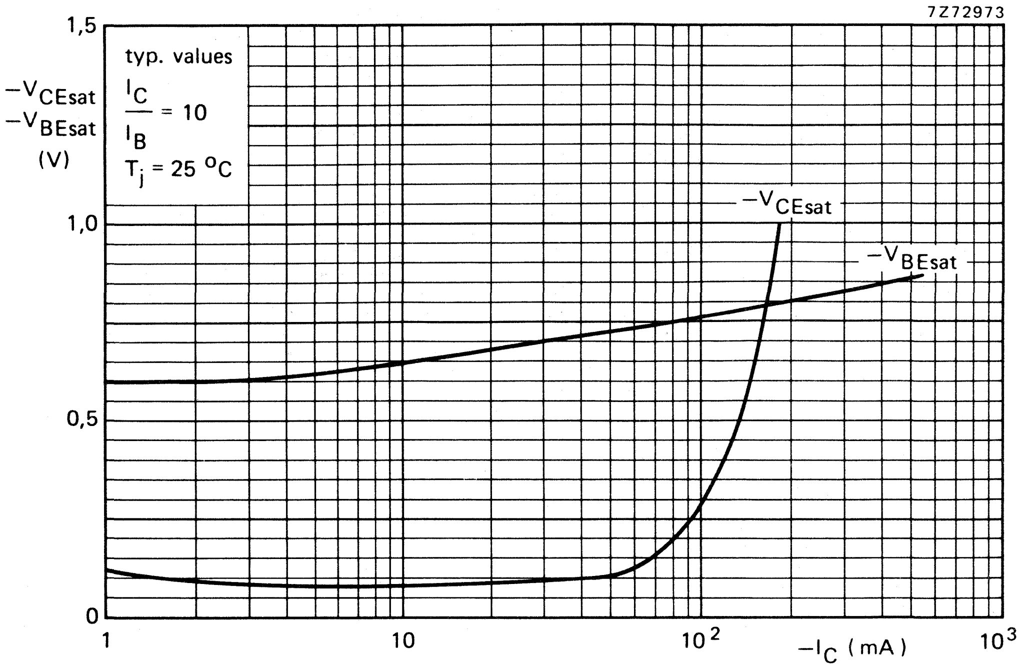

7Z72973
typ. values
$\frac{I_C}{I_B} = 10$
$T_j = 25\ ^oC$
$-V_{CEsat}$
$-V_{BEsat}$
(V)
1,5
1,0
0,5
0
1
10
10^2
10^3
$-I_C$ (mA)
$-V_{CEsat}$
$-V_{BEsat}$

Fig. 14.

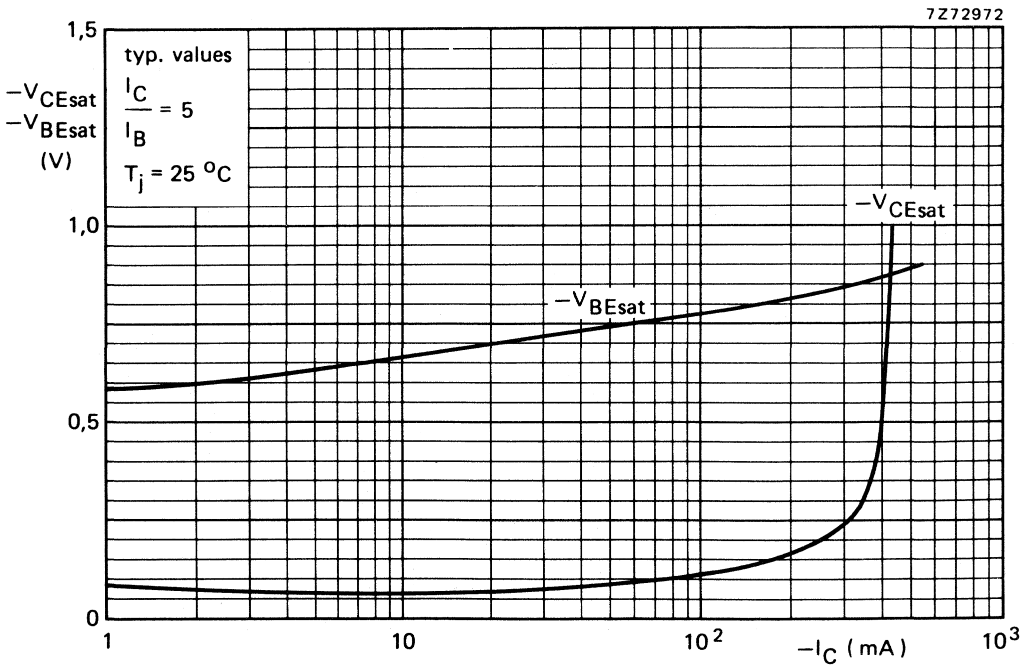

7Z72972
typ. values
$\frac{I_C}{I_B} = 5$
$T_j = 25\ ^oC$
$-V_{CEsat}$
$-V_{BEsat}$
(V)
1,5
1,0
0,5
0
1
10
10^2
10^3
$-I_C$ (mA)
$-V_{CEsat}$
$-V_{BEsat}$

Fig. 15.

SILICON PLANAR EPITAXIAL TRANSISTOR

PNP transistor in a TO-39 metal envelope for generai industrial applications.

QUICK REFERENCE DATA

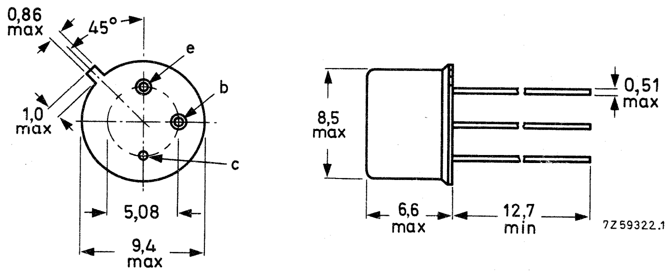
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60 V
Collector current (peak value)	$-I_{CM}$	max.	600 mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	600 mW
DC current gain $-I_C$ = 10 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	50
Transition frequency at f = 100 MHz $-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	min.	100 MHz

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12.7 mm.

Products approved to CECC 50 002-071, available on request.

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.	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5.0	V
Collector current (DC)	$-I_C$	max.	600	mA
peak value	$-I_{CM}$	max.	600	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	600	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	300	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

DC current gain				
$-I_C$ = 0.1 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	20	
$-I_C$ = 1.0 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	40	
$-I_C$ = 10 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	50	
$-I_C$ = 50 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	50	
$-I_C$ = 150 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	40	
Transition frequency at f = 100 MHz				
$-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	min.	100	MHz
Collector-emitter saturation voltage				
$-I_C$ = 150 mA; $-I_B$ = 15 mA	$-V_{CE(sat)}$	typ.	0.15	V
		max.	0.40	V
Base-emitter saturation voltage				
$-I_C$ = 30 mA; $-I_B$ = 1.0 mA	$-V_{BE(sat)}$	typ.	0.77	V
		max.	0.90	V
$-I_C$ = 30 mA; $-I_B$ = 1.0 mA	$-V_{BE(sat)}$	typ.	1.05	V
		max.	1.30	V
Collector capacitance				
$-V_{CB}$ = 10 V; I_E = I_e = 0; f = 1.0 MHz	C_c	typ.	6.0	pF
		max.	12	pF
Emitter capacitance				
$-V_{EB}$ = 2.0 V; I_C = I_c = 0; f = 1.0 MHz	C_e	typ.	18	pF
		max.	30	pF

Saturated switching times (see Figs 2 and 3)

Turn-on time	t_{on}	typ.	25	ns
		max.	60	ns
Turn-off time	t_{off}	typ.	55	ns
		max.	150	ns

h-parameters

Measured at $-I_C$ = 10 mA; $-V_{CE}$ = 10 V; f = 1.0 kHz; T_{amb} = 25 °C

Input impedance	h_{ie}	typ.	600	Ω
Voltage feedback ratio	h_{re}	typ.	1.5×10^{-4}	
Forward current transfer ratio	h_{fe}	typ.	155	
Output admittance	h_{oe}	typ.	104	μmho

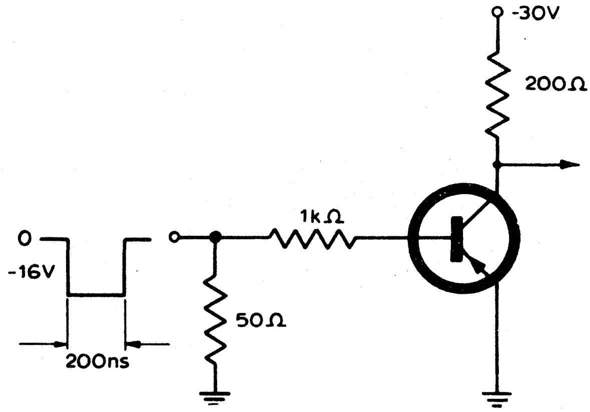


Fig.2 Saturated turn-on switching time.

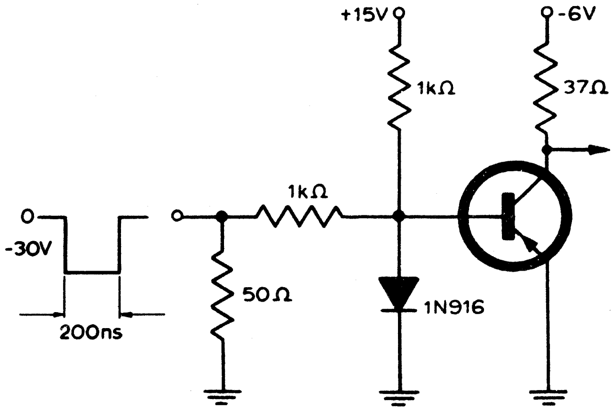


Fig.3 Saturated turn-off switching time.

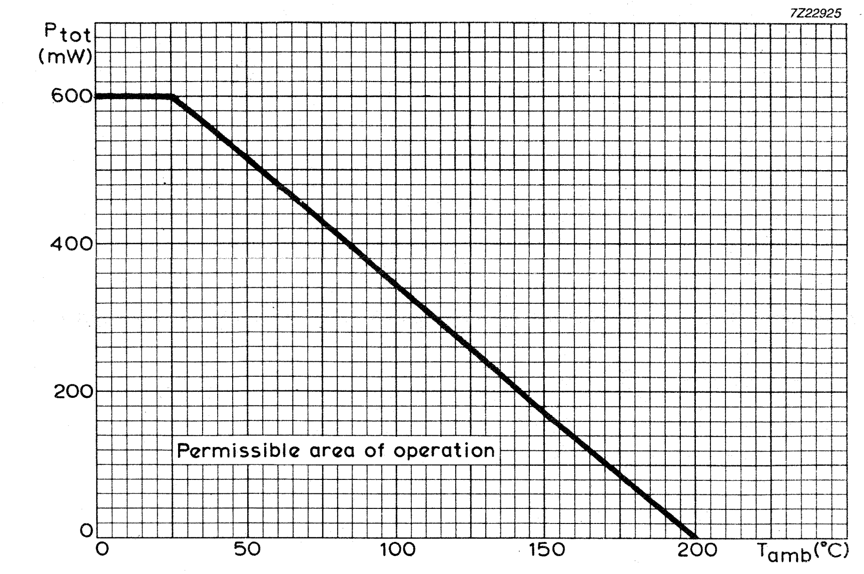


Fig.4 Maximum total dissipation plotted against ambient temperature.

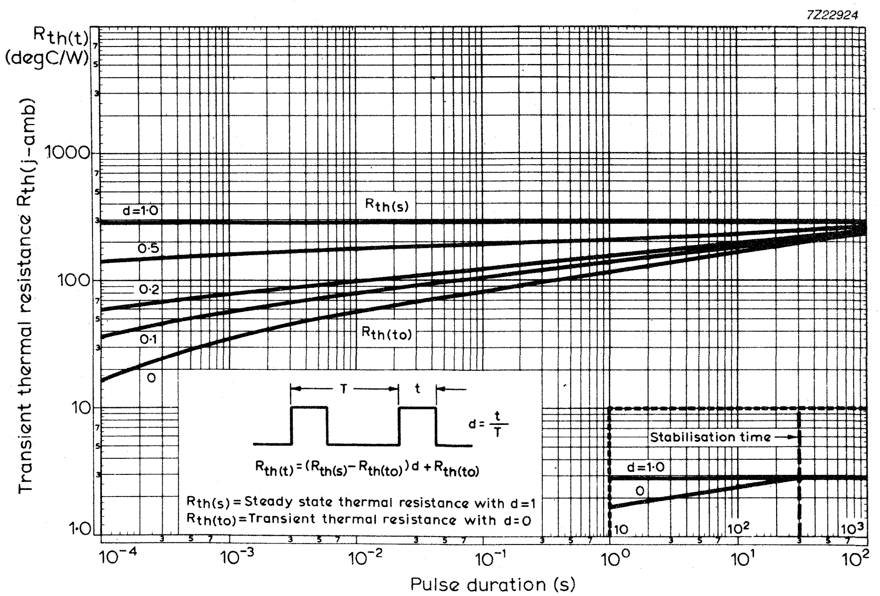


Fig.5 Transient thermal resistance for various duty factors plotted against pulse duration.

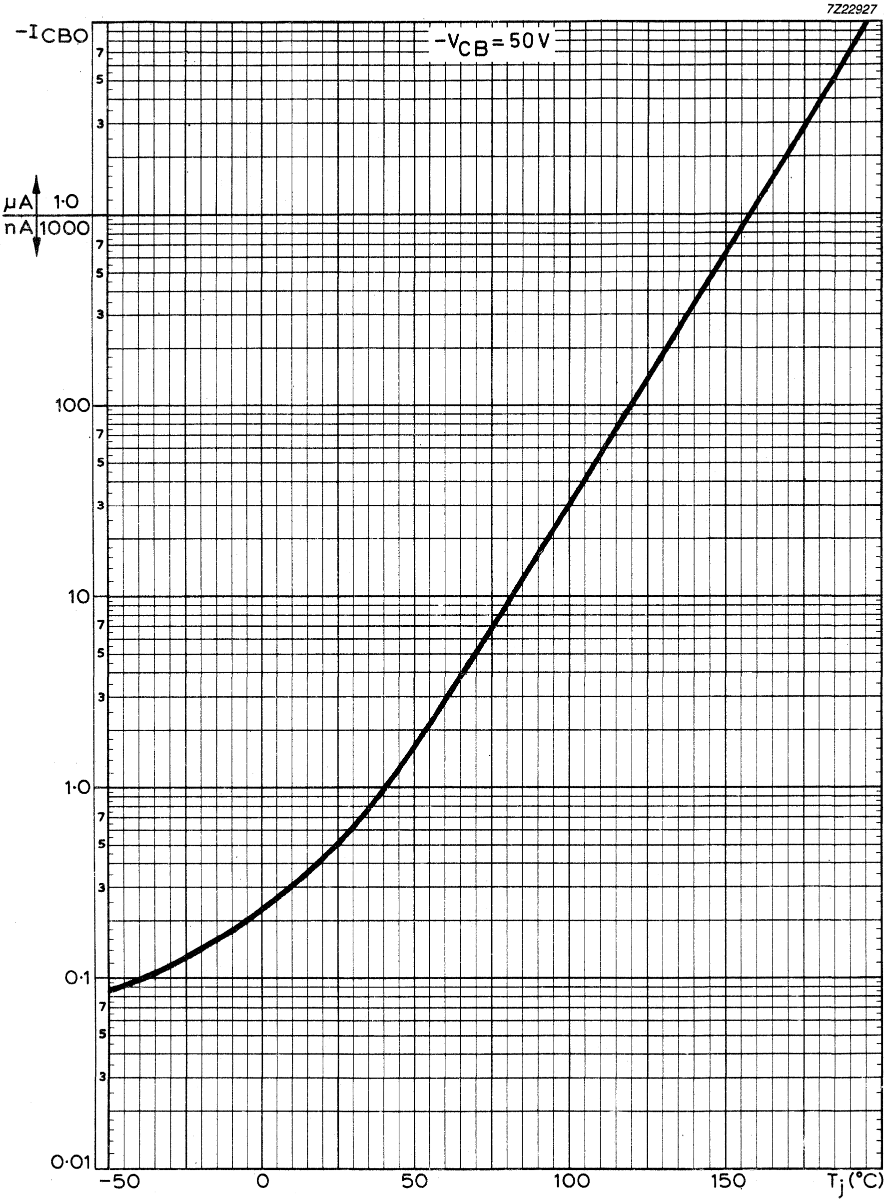


Fig.6 Typical variation of collector cut-off current with junction temperature.

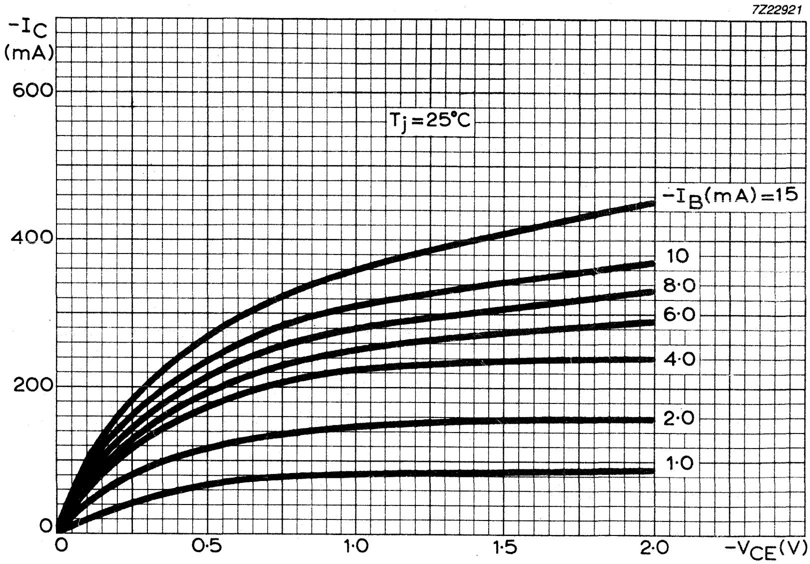


Fig.7 Typical output characteristics at low collector-emitter voltages.

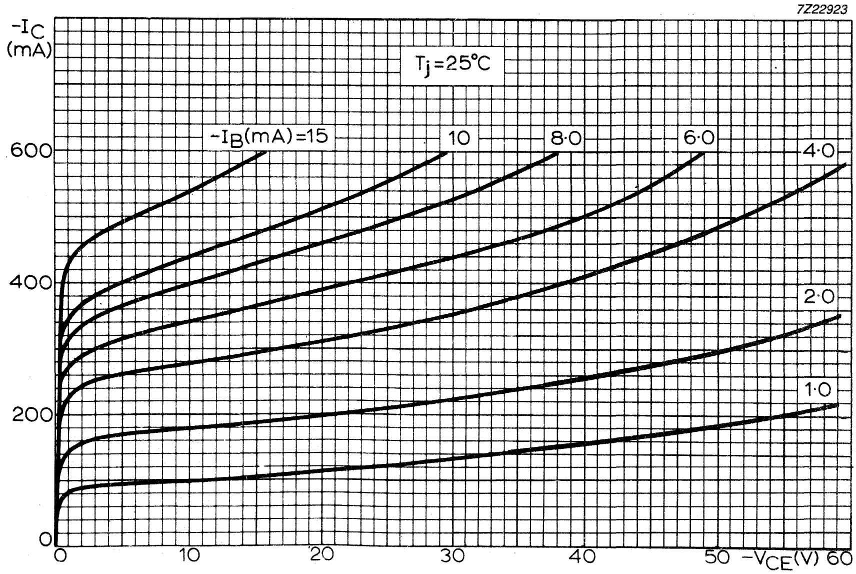


Fig.8 Typical output characteristics at high collector-emitter voltages.

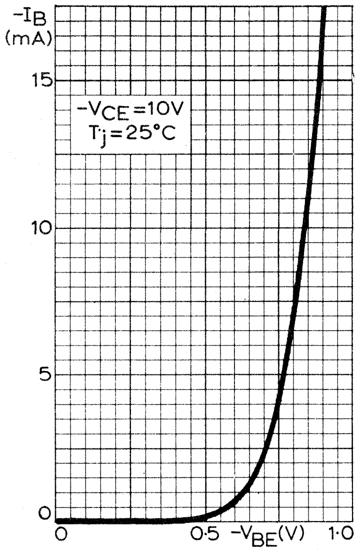


Fig.9 Typical transfer characteristic.

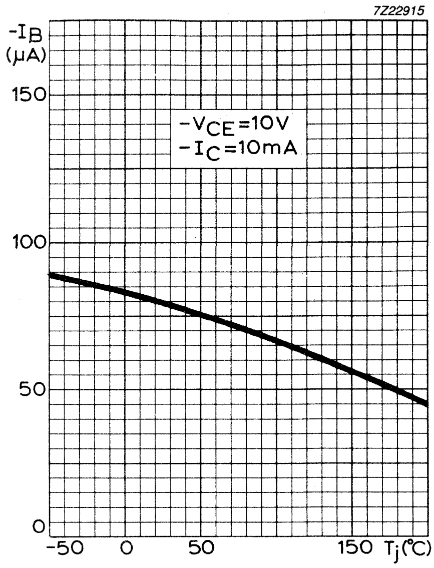


Fig.10 Typical mutual characteristic.

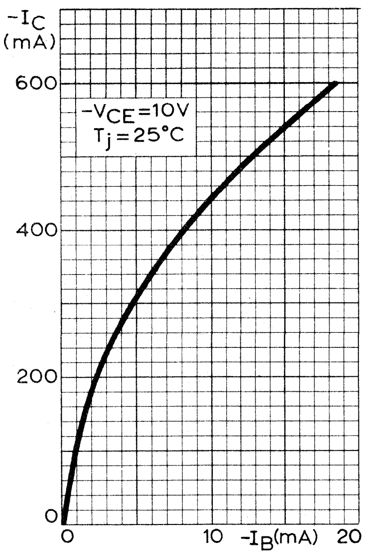


Fig.11 Typical input characteristic.

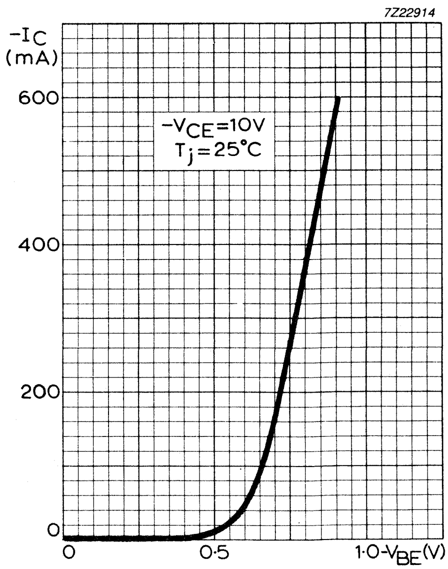


Fig.12 Typical base current as a function of junction temperature.

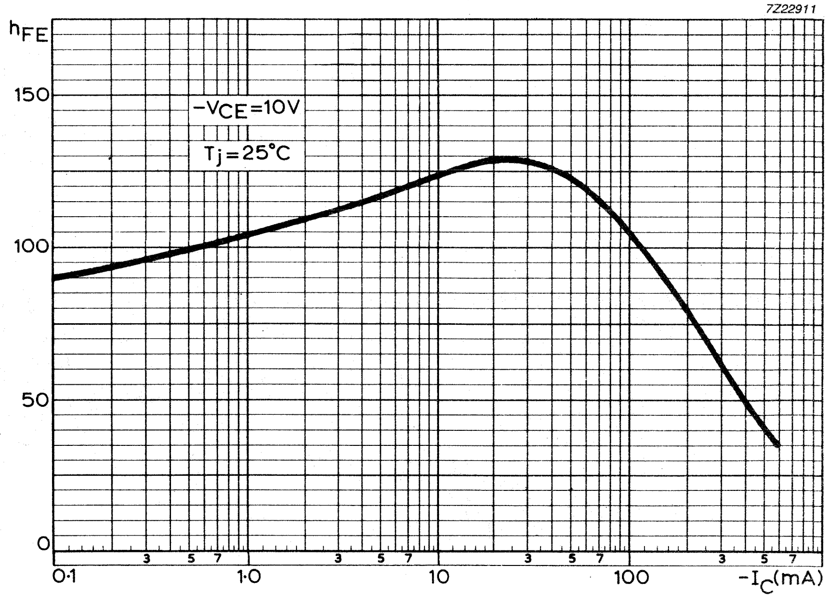


Fig.13 Typical variation of DC current gain with collector current.

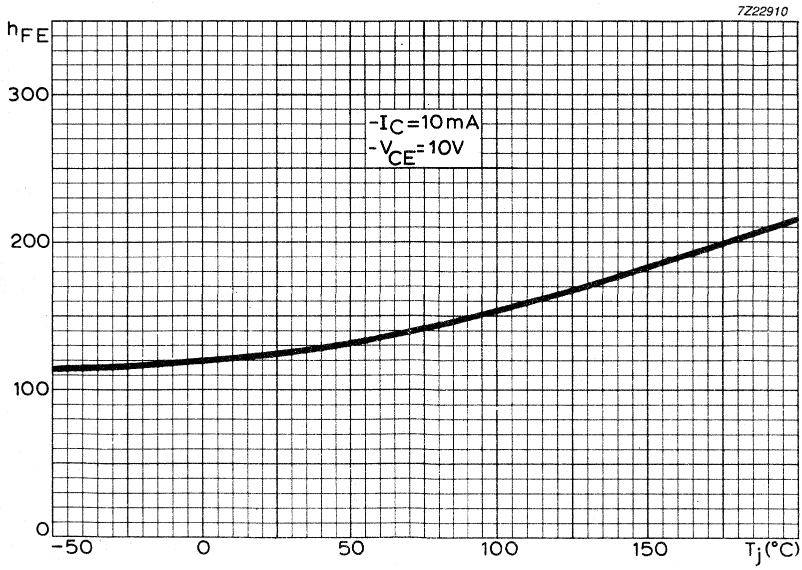


Fig.14 Typical variation of DC current gain with junction temperature.

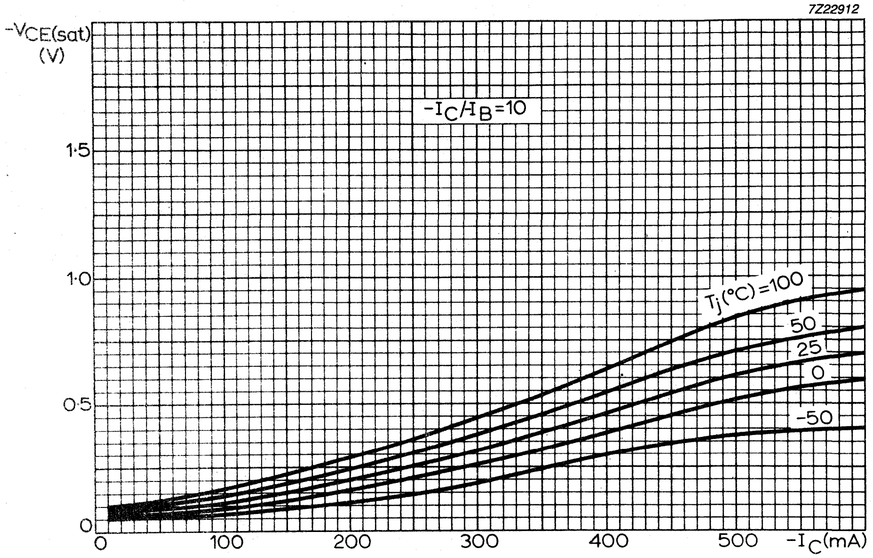


Fig.15 Typical variation of collector-emitter saturation voltage with collector current.

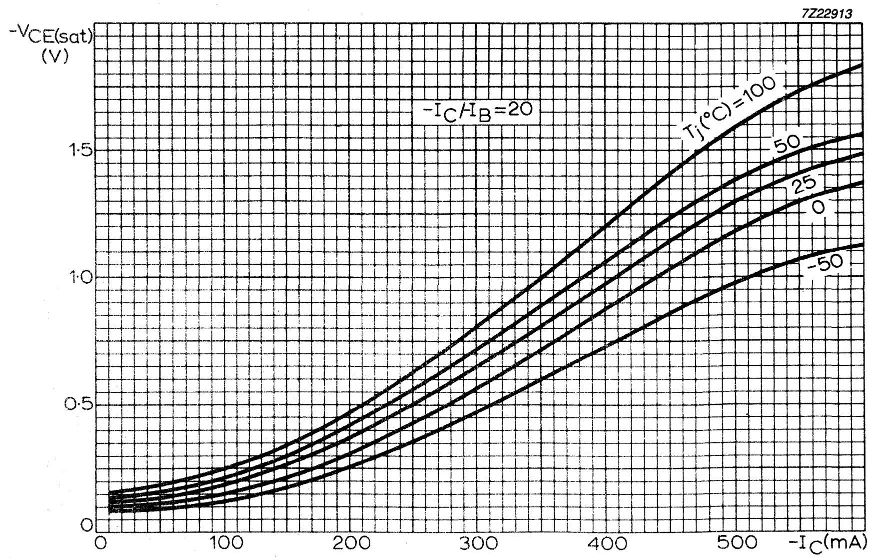


Fig.16 Typical variation of collector-emitter saturation voltage with collector current.

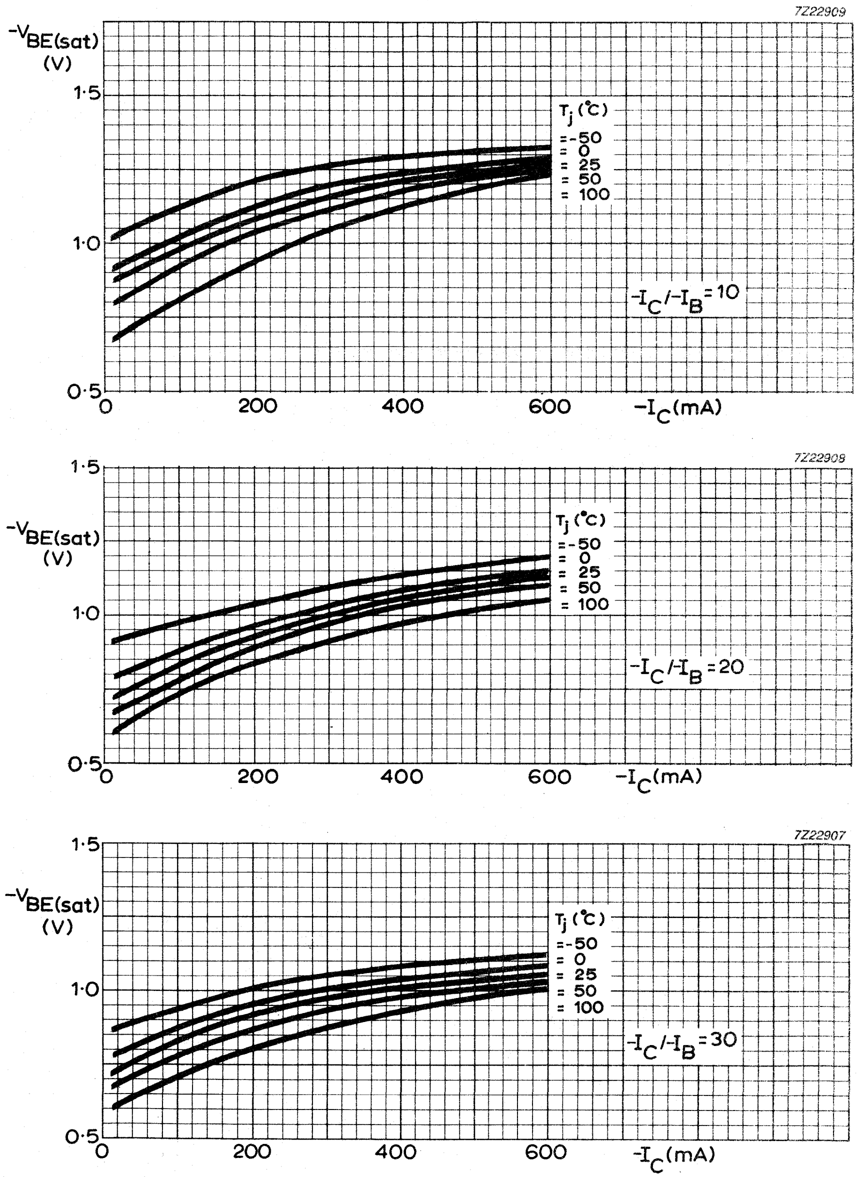


Fig.17 Typical variation of base-emitter saturation voltage with collector current.

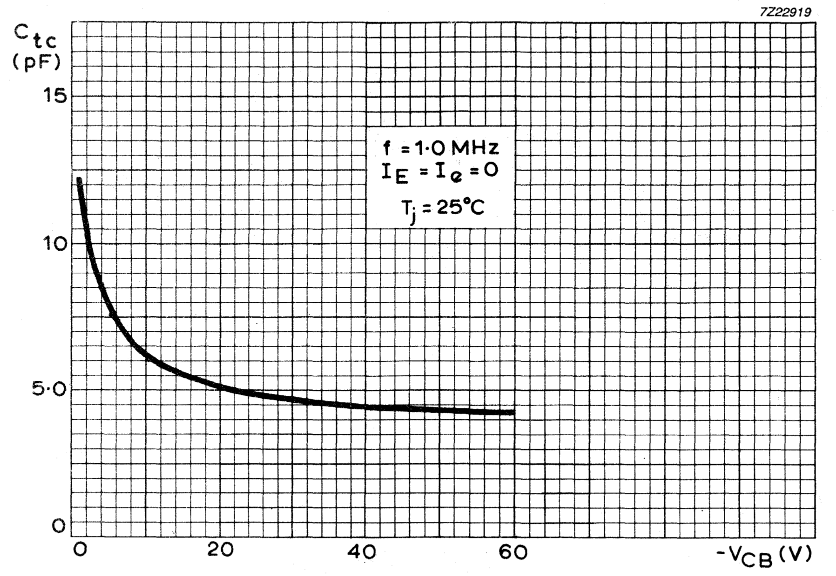


Fig.18 Typical variation of collector capacitance with collector-base voltage.

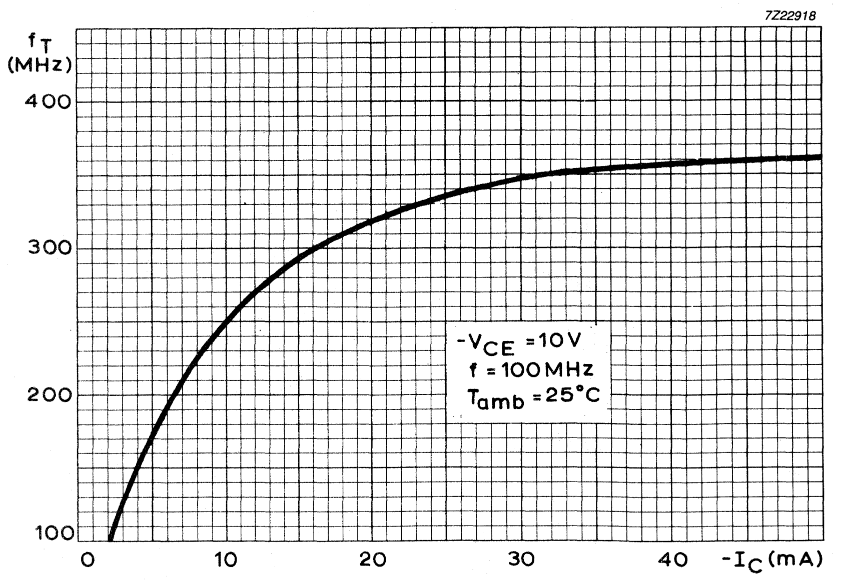


Fig.19 Typical variation of transition frequency with collector current.

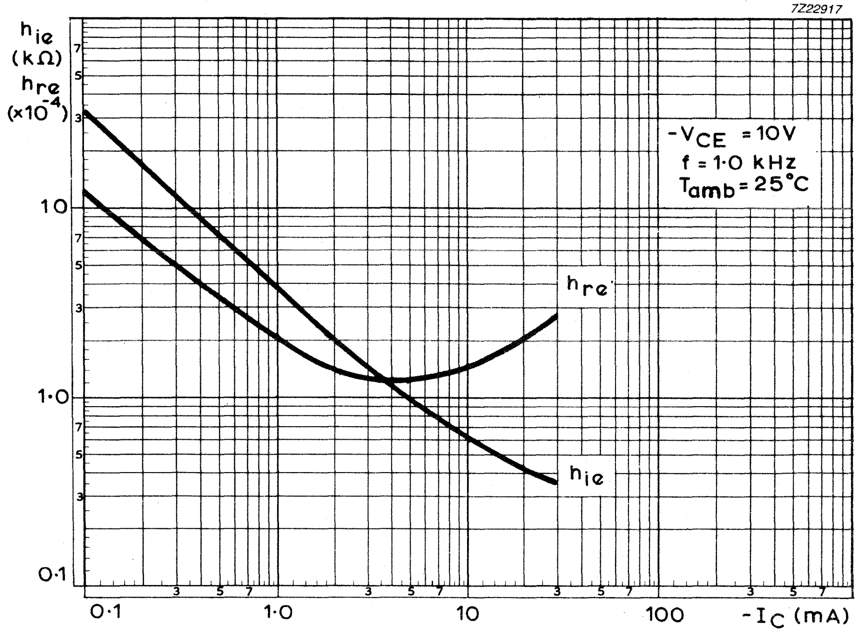


Fig.20 Typical input impedance and typical voltage feedback ratio plotted against collector current.

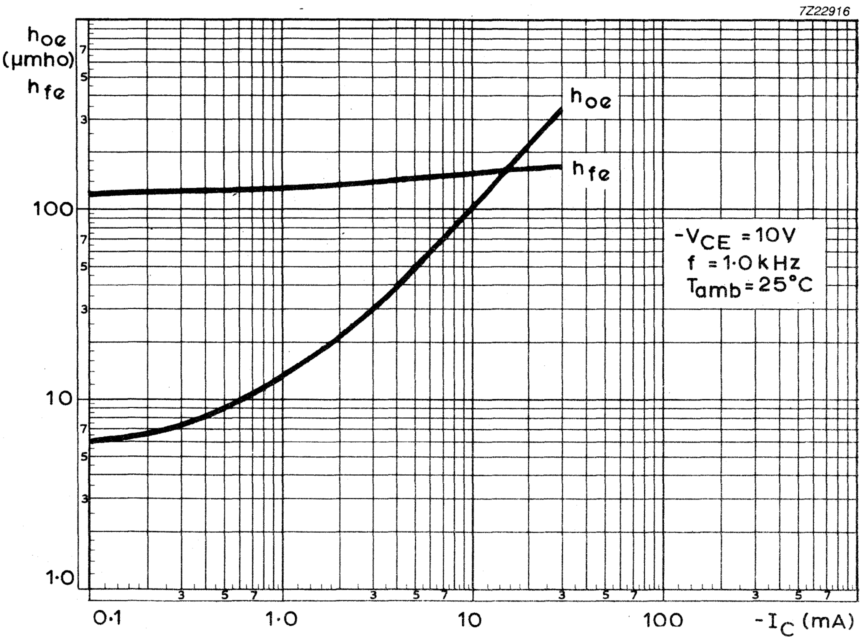


Fig.21 Typical forward current transfer ratio and typical output admittance plotted against collector current.

SILICON PLANAR EPITAXIAL TRANSISTOR

PNP transistor in a TO-39 metal envelope intended for switching applications.

QUICK REFERENCE DATA

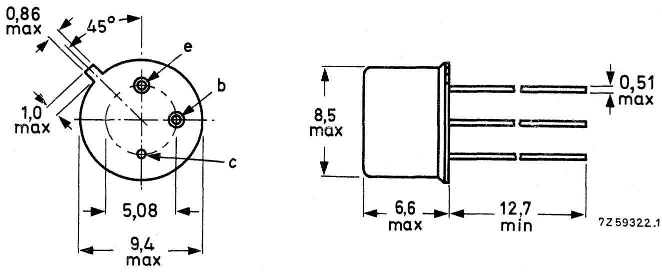
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	65	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	65	V
Collector current (peak value)	$-I_{CM}$	max.	600	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	600	mW
DC current gain $-I_C$ = 10 mA; $-V_{CE}$ = 0.4 V	h_{FE}	typ.	90 50 to 200	
Storage time $-I_{Con}$ = 100 mA; $-I_{Bon}$ = I_{Boff} = 10 mA	t_s	max.	250	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12.7 mm.

Products approved to CECC 50 004-083, available on request.

RATINGS

Limiting values of operation according to the Absolute Maximum System.

Electrical

$-V_{CBO}$	max.	65	V
$-V_{CEO}$	max.	65	V
$-V_{EBO}$	max.	5.0	V
$-I_C$	max.	600	mA
$-I_{CM}$	max.	600	mA
$-I_{EM}$	max.	600	mA
P_{tot} max. ($T_{amb} \leqslant 25$ °C	max.	600	mW

Temperature

T_{stg}	min.	−65	°C
T_{stg}	max.	150	°C
T_j	max.	200	°C

THERMAL CHARACTERISTIC

$R_{th(j\text{-}amb)}$	300	K/W

CHARACTERISTICS (T_j = 25 °C unless otherwise stated)

$-I_{CBO}$	Collector cut-off current			
	$-V_{CB}$ = 65 V; I_E = 0	max.	500	nA
	$-V_{CB}$ = 50 V; I_E = 0	max.	50	nA
	$-V_{CB}$ = 50 V; I_E = 0, T_j = 100 °C	max.	2.0	μA
$-I_{EBO}$	Emitter cut-off current			
	$-V_{EB}$ = 5.0 V; I_C = 0	max.	500	nA
	$-V_{EB}$ = 3.0 V; I_C = 0	max.	100	nA
$-V_{BE(sat)}$	Base-emitter saturation voltage			
	$-I_C$ = 30 mA; $-I_B$ = 1.0 mA	max.	0.90	V
	$-I_C$ = 150 mA; $-I_B$ = 15 mA	max.	1.30	V
h_{FE}	DC current gain			
	$-I_C$ = 1.0 mA; $-V_{CE}$ = 0.4 V	min.	40	
	$-I_C$ = 10 mA; $-V_{CE}$ = 0.4 V	min.	50	
		max.	200	
	$-I_C$ = 50 mA; $-V_{CE}$ = 0.4 V	min.	20	
	$-I_C$ = 150 mA; $-V_{CE}$ = 0.4 V	min.	10	

C_{tc}	Collector capacitance $-V_{CB} = 10$ V; $I_E = I_e = 0$; f = 1.0 MHz	typ.	6.0	pF
C_{te}	Emitter capacitance $-V_{EB} = 2.0$ V; $I_C = I_c = 0$; f = 1.0 MHz	typ.	18	pF

Saturated switching times

$-I_C = 100$ mA; $-I_{Bon} = I_{Boff} = 10$ mA; $V_{EE} = 10$ V; $V_{BEoff} = 2.0$ V

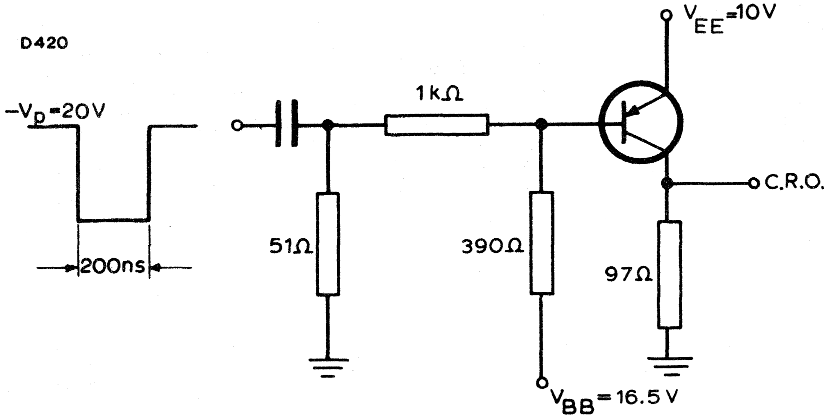
t_d	Delay time	typ. max.	9 15	ns ns
t_r	Rise time	typ. max.	18 40	ns ns
t_{on}	Turn-on time ($t_d + t_r$)	typ. max.	27 50	ns ns
t_s	Storage time	typ. max.	95 250	ns ns
t_f	Fail time	typ. max.	30 50	ns ns
t_{off}	Turn-off time ($t_s + t_f$)	typ. max.	125 290	ns ns

CHARACTERISTICS (cont'd)

Saturated switching times

Test circuit

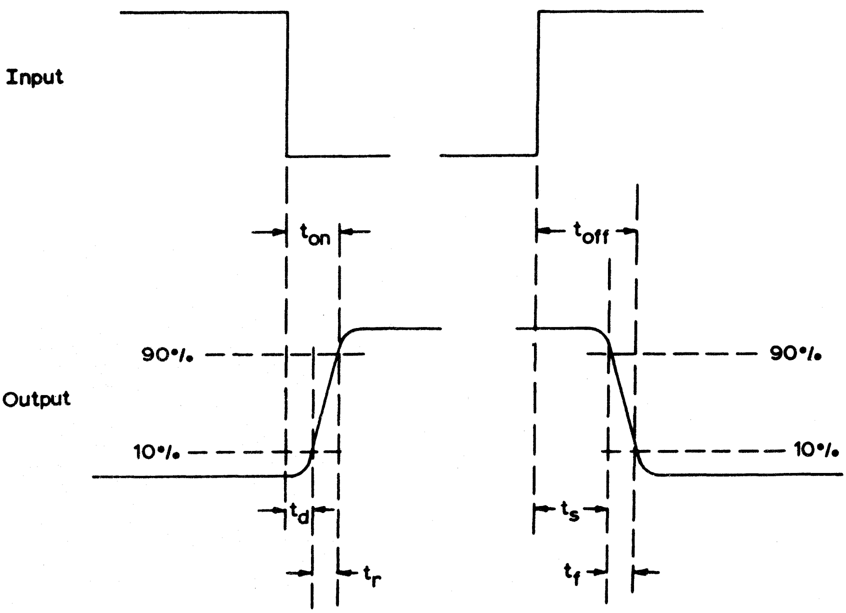
D420

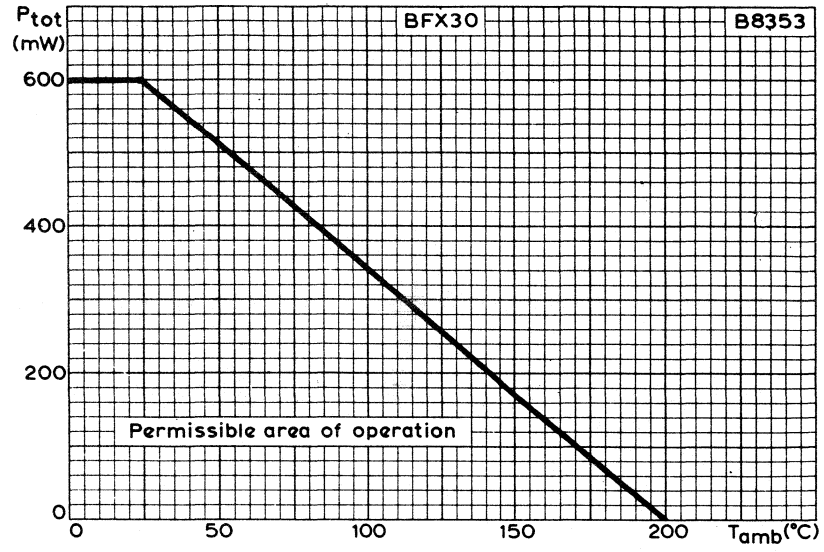


$-I_C = 100mA, -I_{B(on)} = I_{B(off)} = 10mA$

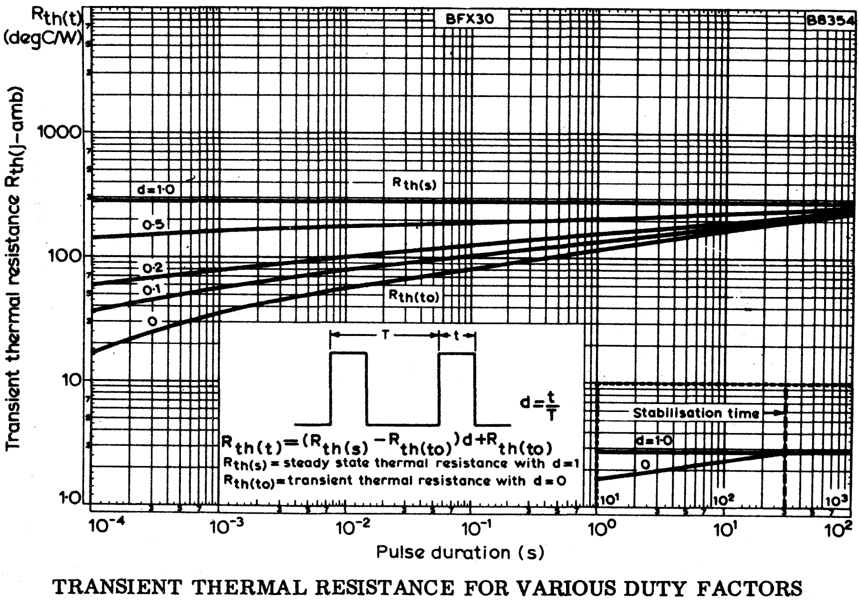
$V_{BE(off)} = 2 \cdot 0V$

Waveforms

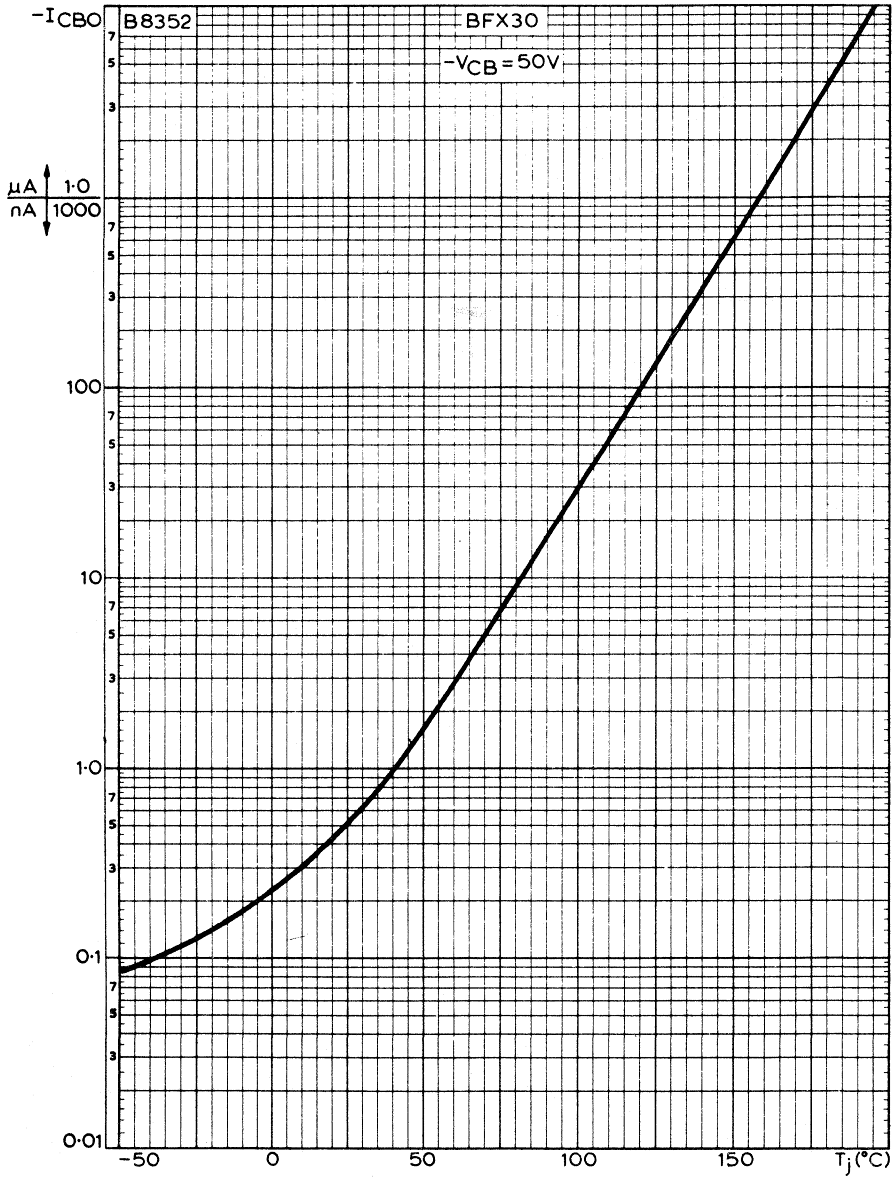




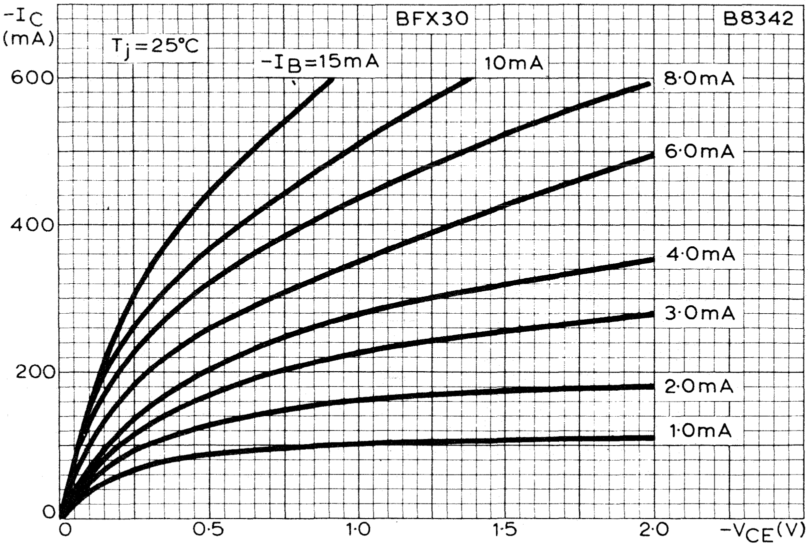
TOTAL DISSIPATION PLOTTED AGAINST AMBIENT TEMPERATURE

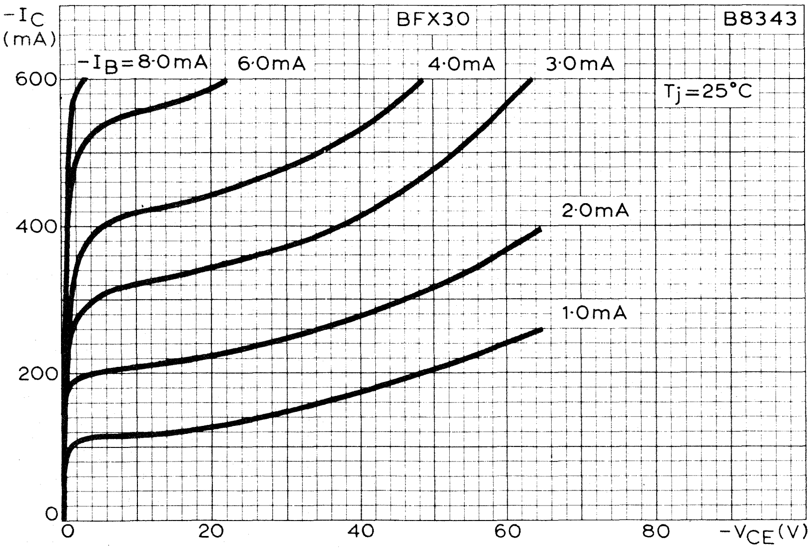


TRANSIENT THERMAL RESISTANCE FOR VARIOUS DUTY FACTORS PLOTTED AGAINST PULSE DURATION

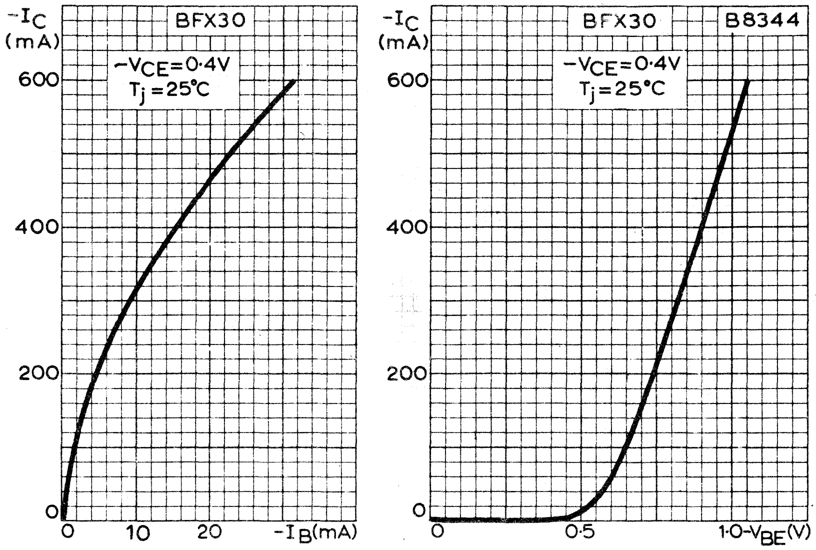


TYPICAL VARIATION OF COLLECTOR CUT-OFF CURRENT WITH JUNCTION TEMPERATURE

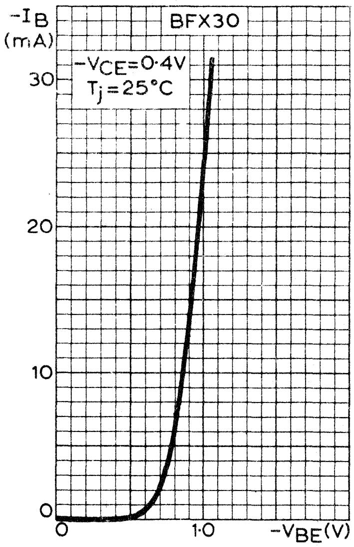




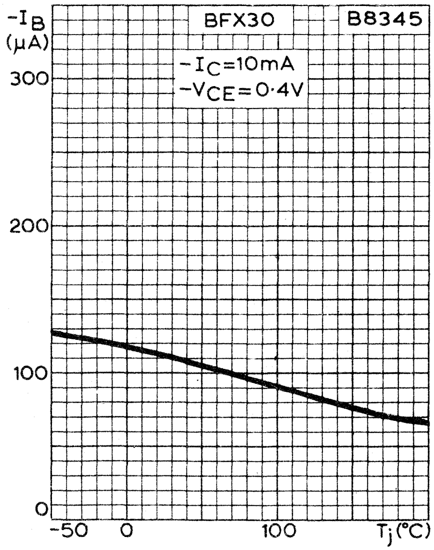
TYPICAL OUTPUT CHARACTERISTICS AT LOW AND HIGH COLLECTOR-EMITTER VOLTAGES



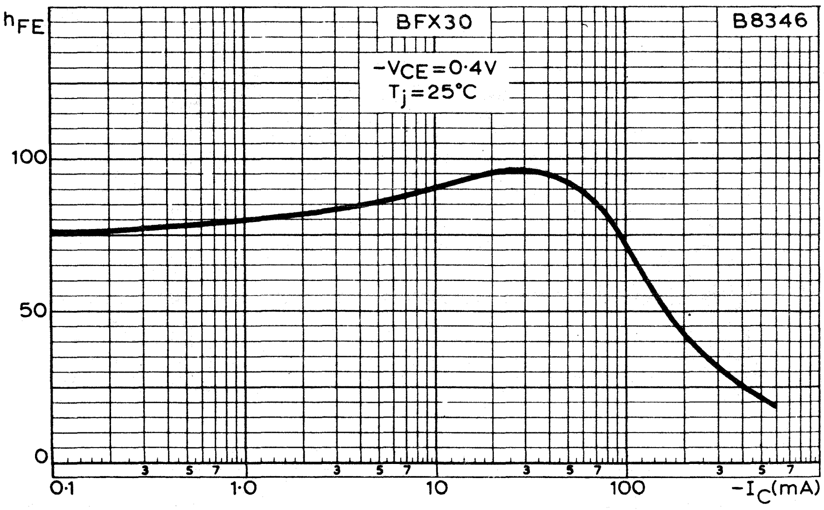
TYPICAL TRANSFER AND MUTUAL CHARACTERISTICS

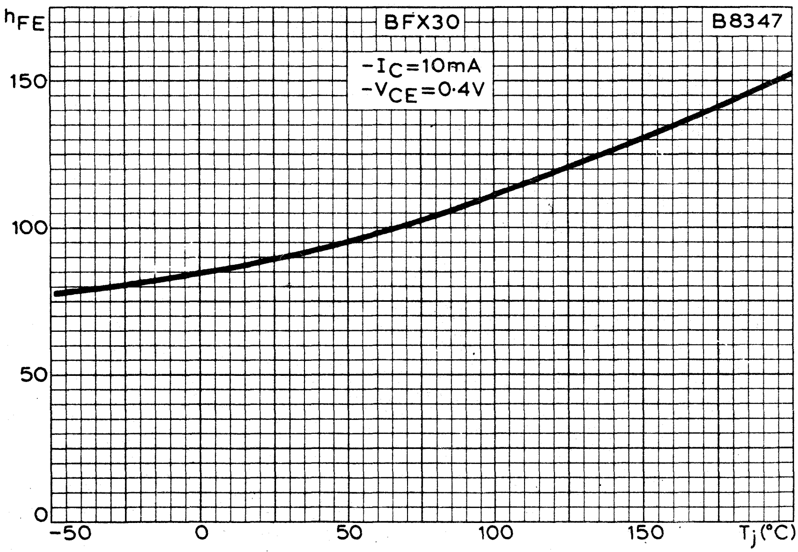


Typical input characteristics

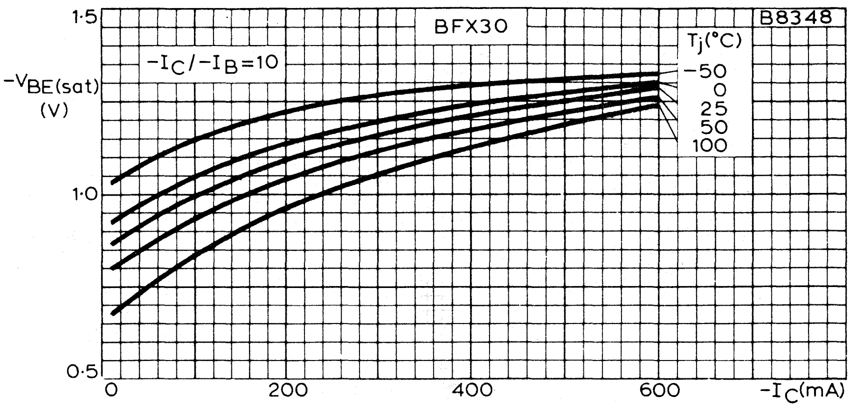


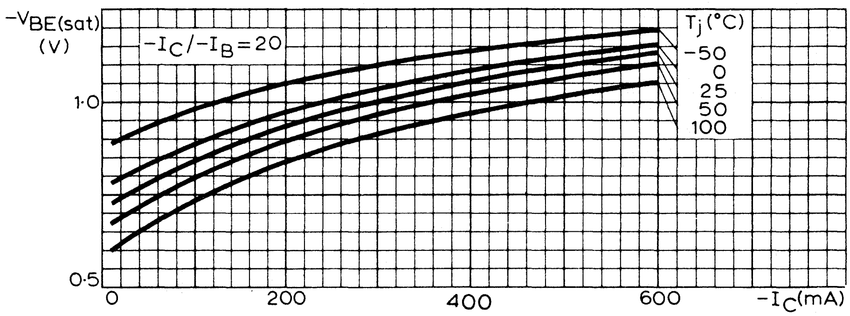
Typical base current versus junction temperature

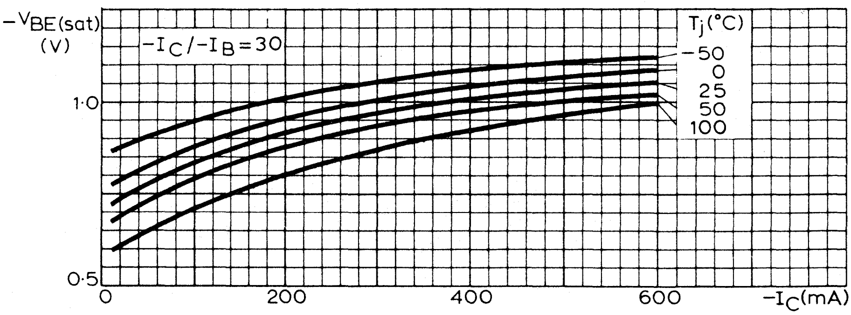




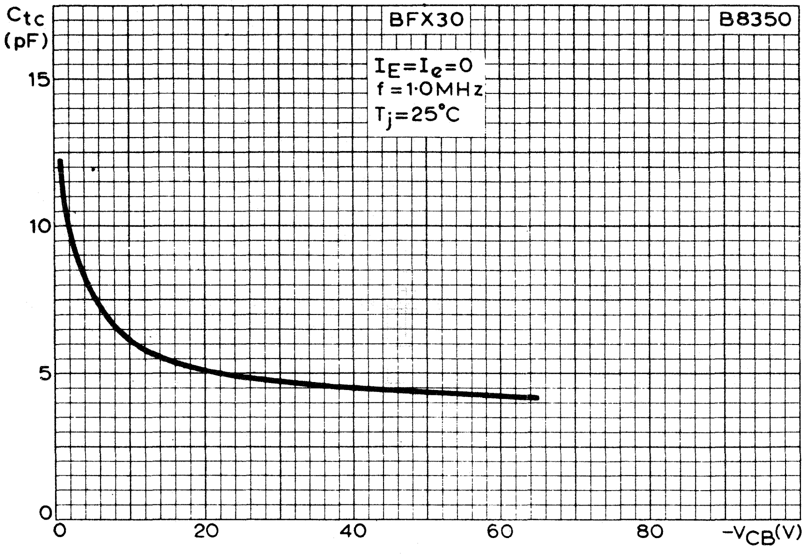
TYPICAL VARIATION OF STATIC FORWARD CURRENT TRANSFER RATIO WITH COLLECTOR CURRENT AND JUNCTION TEMPERATURE



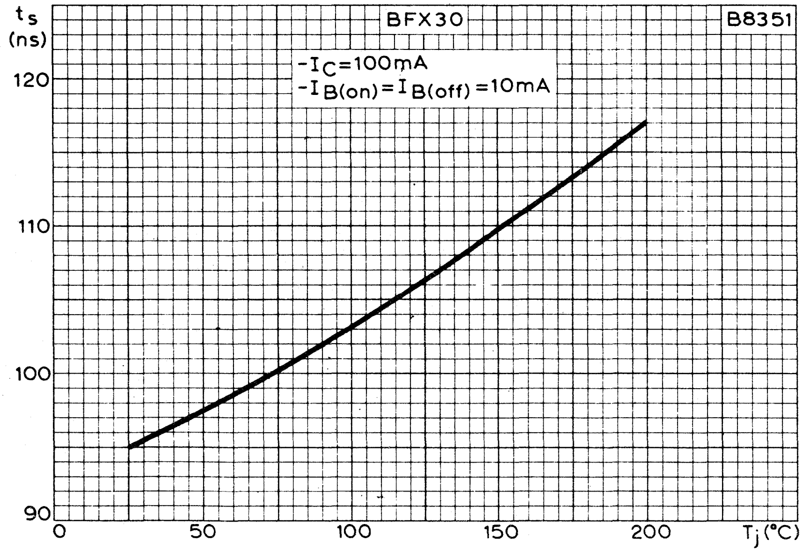




TYPICAL VARIATION OF BASE-EMITTER SATURATION VOLTAGE WITH COLLECTOR CURRENT AND I_C/I_B RATIO



TYPICAL VARIATION OF COLLECTOR CAPACITANCE WITH COLLECTOR-BASE VOLTAGE



TYPICAL VARIATION OF STORAGE TIME WITH JUNCTION TEMPERATURE

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-39 metal envelope primarily intended for use as high-current switching device, e.g. inverters and switching regulators.

QUICK REFERENCE DATA

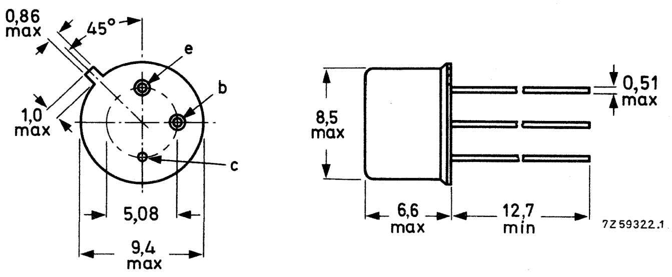
Collector-base voltage (open emitter)	V_{CBO}	max.	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	V
Collector current (peak value)	I_{CM}	max.	5,0	A
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	5,0	W
Junction temperature	T_j	max.	200	°C
D.C. current gain I_C = 2 A; V_{CE} = 2 V	h_{FE}	40 to	150	
Transition frequency at f = 35 MHz I_C = 0,5 A; V_{CE} = 5 V	f_T	>	70	MHz
Turn-off time when switched from I_C = 5 A; I_B = 0,5 A to cut-off with $-I_{BM}$ = 0,5 A	t_{off}	<	1,2	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 004-025.

RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	V
Collector current (d.c.)	I_C	max.	2,0	A
Collector current (peak value)	I_{CM}	max.	5,0	A
Base current (d.c.)	I_B	max.	1,0	A
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	5,0	W
up to T_{amb} = 25 °C	P_{tot}	max.	0,87	W
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	35	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current $V_{EB} = 0$; $V_{CE} = 60$ V	I_{CES}	<	10	µA
Emitter cut-off current $I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	<	10	µA
Saturation voltage $I_C = 5$ A; $I_B = 0,5$ A	V_{CEsat}	typ. <	0,77 1,0	V V
	V_{BEsat}	typ. <	1,43 1,8	V V
D.C. current gain $I_C = 1,0$ A; $V_{CE} = 2,0$ V	h_{FE}	typ.	130	
$I_C = 1,5$ A; $V_{CE} = 0,6$ V	h_{FE}	typ.	60	
$I_C = 2,0$ A; $V_{CE} = 2,0$ V	h_{FE}	typ.	110 40 to 150	
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	36	pF
Emitter-capacitance at f = 1 MHz $I_C = I_c = 0$; $V_{EB} = 0,5$ V	C_e	typ.	440	pF
Transition frequency at f = 35 MHz $I_C = 0,5$ A; $V_{CE} = 5$ V	f_T	> typ.	70 100	MHz MHz
Turn on time when switched from $-V_{BE} = 2,0$ V to $I_C = 5$ V; $I_B = 0,5$ A with $I_{BM} = 0,5$ A	t_{on}	typ. <	0,2 0,6	µs µs
Turn off time when switched from $I_C = 5$ A; $I_B = 0,5$ A to $-V_{BE} = 2,0$ V with $-I_{BM} = 0,5$ A	t_{off}	typ. <	0,34 1,2	µs µs

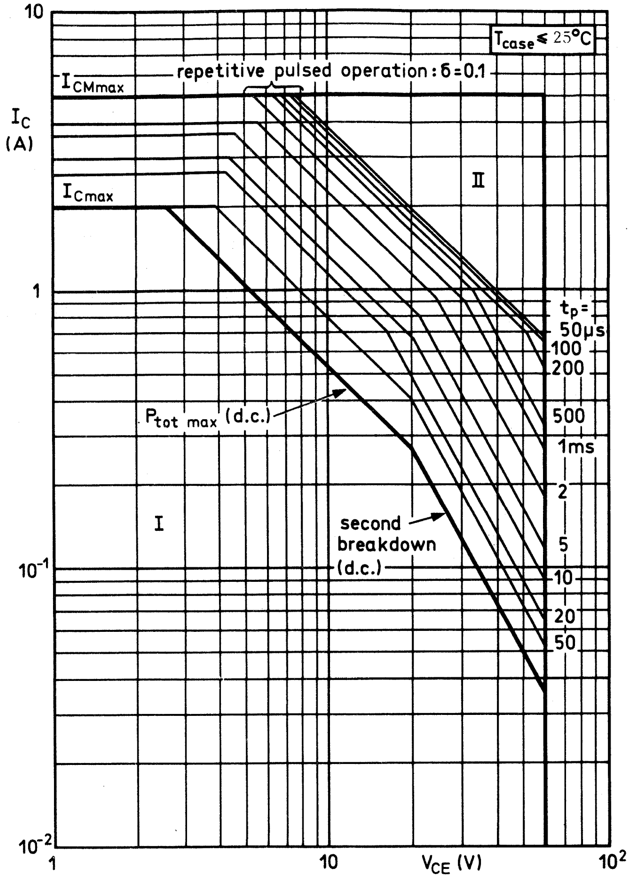


Fig. 2.

Safe Operation Area with the transistor forward biased

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

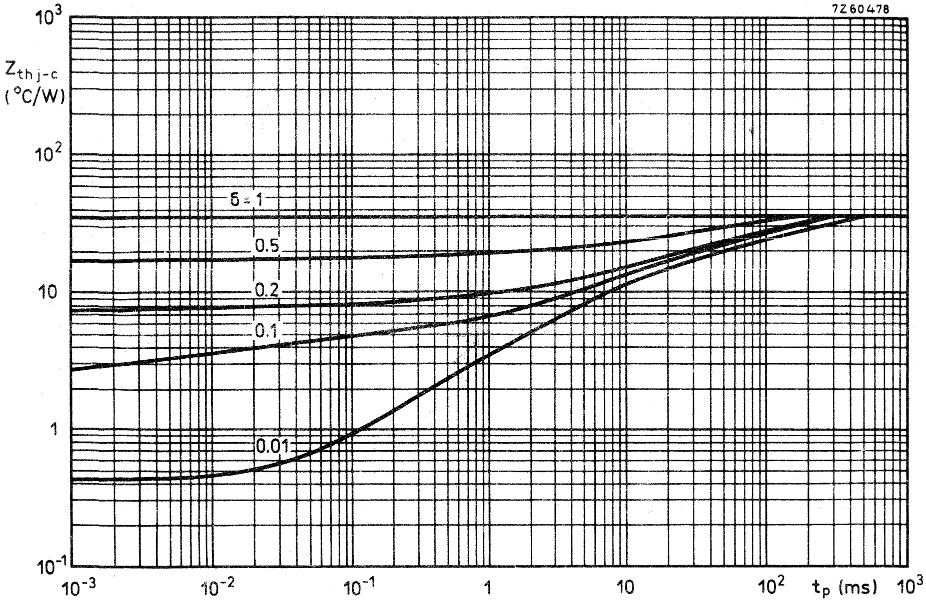

7Z60478
$Z_{th\ j-c}$ (°C/W)
10^3
10^2
10
1
10^{-1}
δ = 1
0.5
0.2
0.1
0.01
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t_p (ms)
10^3

Fig. 3.

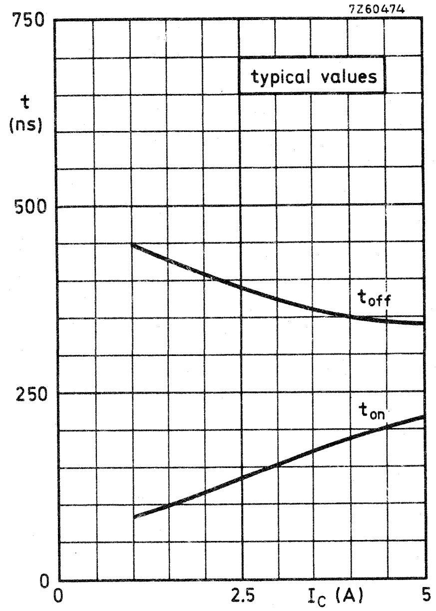

7Z60474
750
500
250
0
t (ns)
typical values
t_{off}
t_{on}
0
2.5
I_C (A)
5

Fig. 4.

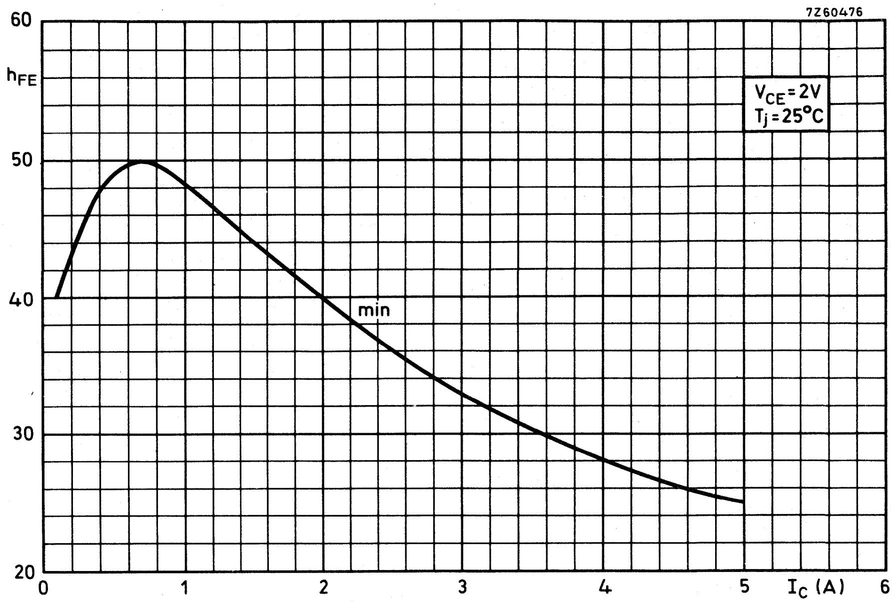


Fig. 5.

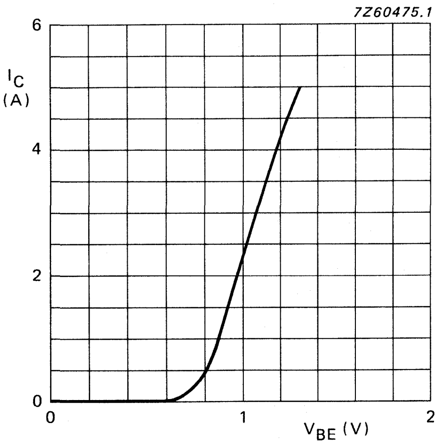


Fig. 6 V_{CE} = 2 V; T_j = 25 °C; typical values.

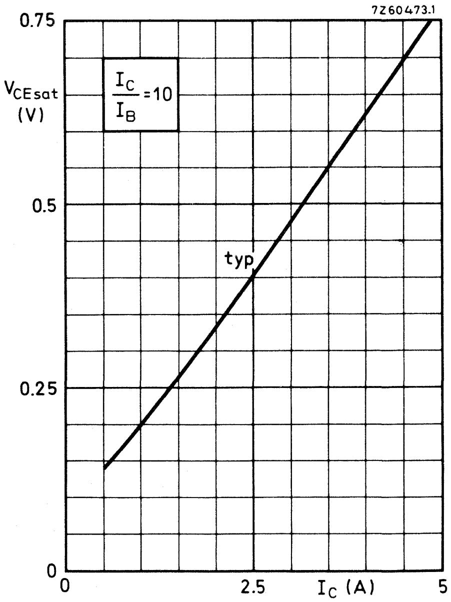


Fig. 7.

SILICON PLANAR EPITAXIAL TRANSISTORS

NPN transistors in TO-39 metal envelopes for general purpose industrial applications.

QUICK REFERENCE DATA

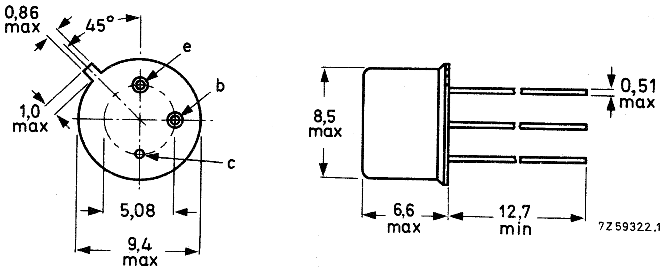
			BFX84	BFX85	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	60	V
Collector current (peak value)	I_{CM}	max.	1.0	1.0	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	800	800	mW
Total power dissipation up to T_{case} = 100 °C	P_{tot}	max.	2.86	2.86	W
DC current gain I_C = 150 mA; V_{CE} = 10 V	h_{FE}	min.	30	70	
		typ.	112	142	
Transition frequency at f = 35 MHz I_C = 50 mA; V_{CE} = 10 V; T_{amb} = 25 °C	f_T	min.	50	50	MHz

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-39.

Collector connected to case.



Maximum lead diameter is guaranteed only for 12.7 mm.

Products approved to CECC 50 004-100, available on request.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

	BFX84	BFX85	
V_{CBO} max.	100	100	V
V_{CE} max. (cut-off, $I_C \leq 1mA$)	100	100	V
V_{CEO} max.	60	60	V
V_{EBO} max.	6.0		V
I_C max.	1.0		A
I_{CM} max.	1.0		A
$-I_E$ max.	1.0		A
$-I_{EM}$ max.	1.0		A
I_B max.	100		mA
$\pm I_{BM}$ max.	100		mA
P_{tot} max. $T_{amb} \leq 25^{o}C$	800		mW
$T_{case} \leq 25^{o}C$	5.0		W
$T_{case} > 25, < 100^{o}C$	2.86		W

Temperature

T_{stg}	-65 to +150	^{o}C
T_j max.	175	^{o}C

THERMAL CHARACTERISTICS

$R_{th(j-amb)}$ in free air	200	K/W
$R_{th(j-case)}$	35	K/W

BFX84

ELECTRICAL CHARACTERISTICS ($T_j = 25^oC$ unless otherwise stated)

		Min.	Typ.	Max.	
I_{CBO}	Collector cut-off current				
	$V_{CB} = 100V$, $I_E = 0$	-	10	500	nA
	$V_{CB} = 100V$, $I_E = 0$, $T_j = 100^oC$	-	0.5	30	μA
	$V_{CB} = 80V$, $I_E = 0$	-	2.0	50	nA
	$V_{CB} = 80V$, $I_E = 0$, $T_j = 100^oC$	-	0.1	2.5	μA
I_{EBO}	Emitter cut-off current				
	$V_{EB} = 6.0V$, $I_C = 0$	-	10	500	nA
	$V_{EB} = 5.0V$, $I_C = 0$	-	2.0	50	nA
	$V_{EB} = 5.0V$, $I_C = 0$, $T_j = 100^oC$	-	0.1	2.5	μA
h_{FE}	Static forward current transfer ratio				
	$I_C = 10mA$, $V_{CE} = 10V$	20	80	-	
	$I_C = 150mA$, $V_{CE} = 10V$	30	112	-	
	$I_C = 500mA$, $V_{CE} = 10V$	20	70	-	
	$I_C = 1.0A$, $V_{CE} = 10V$	15	35	-	
$V_{CE(sat)}$	Collector-emitter saturation voltage				
	$I_C = 10mA$, $I_B = 1.0mA$	-	0.15	0.20	V
	$I_C = 150mA$, $I_B = 15mA$	-	0.15	0.35	V
	$I_C = 500mA$, $I_B = 50mA$	-	0.35	1.00	V
	$I_C = 1.0A$, $I_B = 100mA$	-	0.66	1.60	V
$V_{BE(sat)}$	Base-emitter saturation voltage				
	$I_C = 10mA$, $I_B = 1.0mA$	-	0.69	1.2	V
	$I_C = 150mA$, $I_B = 15mA$	-	0.92	1.3	V
	$I_C = 500mA$, $I_B = 50mA$	-	1.15	1.5	V
	$I_C = 1.0A$, $I_B = 100mA$	-	1.40	2.0	V
C_{Tc}	Collector capacitance				
	$V_{CB} = 10V$, $I_E = I_e = 0$, f = 1.0MHz	-	7.0	12	pF

BFX84

ELECTRICAL CHARACTERISTICS (contd.)

		Min.	Typ.	Max.	
f_T	Transition frequency $I_C = 50mA$, $V_{CE} = 10V$, $f = 35MHz$, $T_{amb} = 25^oC$	50	140	-	MHz

Saturated switching times

$I_C = 150mA$, $I_{B(on)} = -I_{B(off)} = 15mA$,
$-V_{EE} = 10V$, $-V_{BE(off)} = 2.0V$

		Min.	Typ.	Max.	
t_d	Delay time	-	15	-	ns
t_r	Rise time	-	40	-	ns
t_{on}	Turn-on time	-	55	-	ns
t_s	Storage time	-	300	-	ns
t_f	Fall time	-	60	-	ns
t_{off}	Turn-off time	-	360	-	ns

h-parameters

		Min.	Typ.	Max.	
h_{fe}	$I_C = 1.0mA$, $V_{CE} = 5.0V$, $f = 1.0kHz$, $T_{amb} = 25^oC$	10	65	-	
h_{ie}	$I_C = 10mA$, $V_{CE} = 5.0V$, $f = 1.0kHz$, $T_{amb} = 25^oC$	-	750	-	Ω
h_{re}		-	0.85	5.0	$\times 10^{-4}$
h_{fe}		15	80	-	
h_{oe}		-	35	80	µmho

BFX85

ELECTRICAL CHARACTERISTICS ($T_j = 25^oC$ unless otherwise stated)

		Min.	Typ.	Max.	
I_{CBO}	Collector cut-off current				
	$V_{CB} = 100V,\ I_E = 0$	-	10	500	nA
	$V_{CB} = 100V,\ I_E = 0,\ T_j = 100^oC$	-	0.5	30	μA
	$V_{CB} = 80V,\ I_E = 0$	-	2.0	50	nA
	$V_{CB} = 80V,\ I_E = 0,\ T_j = 100^oC$	-	0.1	2.5	μA
I_{EBO}	Emitter cut-off current				
	$V_{EB} = 6.0V,\ I_C = 0$	-	10	500	nA
	$V_{EB} = 5.0V,\ I_C = 0$	-	2.0	50	nA
	$V_{EB} = 5.0V,\ I_C = 0,\ T_j = 100^oC$	-	0.1	2.5	μA
h_{FE}	Static forward current transfer ratio				
	$I_C = 10mA,\ V_{CE} = 10V$	50	90	-	
	$I_C = 150mA,\ V_{CE} = 10V$	70	142	-	
	$I_C = 500mA,\ V_{CE} = 10V$	30	90	-	
	$I_C = 1.0A,\ V_{CE} = 10V$	15	50	-	
$V_{CE(sat)}$	Collector-emitter saturation voltage				
	$I_C = 10mA,\ I_B = 1.0mA$	-	0.15	0.20	V
	$I_C = 150mA,\ I_B = 15mA$	-	0.15	0.35	V
	$I_C = 500mA,\ I_B = 50mA$	-	0.35	1.00	V
	$I_C = 1.0A,\ I_B = 100mA$	-	0.66	1.60	V
$V_{BE(sat)}$	Base-emitter saturation voltage				
	$I_C = 10mA,\ I_B = 1.0mA$	-	0.69	1.2	V
	$I_C = 150mA,\ I_B = 15mA$	-	0.92	1.3	V
	$I_C = 500mA,\ I_B = 50mA$	-	1.15	1.5	V
	$I_C = 1.0A,\ I_B = 100mA$	-	1.40	2.0	V
C_{Tc}	Collector capacitance				
	$V_{CB} = 10V,\ I_E = I_e = 0,$ $f = 1.0MHz$	-	7.0	12	pF

BFX85

ELECTRICAL CHARACTERISTICS (contd.)

		Min.	Typ.	Max.	
f_T	Transition frequency $I_C = 50mA$, $V_{CE} = 10V$, $f = 35MHz$, $T_{amb} = 25^oC$	50	185	-	MHz
Saturated switching times					
	$I_C = 150mA$, $I_{B(on)} = -I_{B(off)} = 15mA$, $-V_{EE} = 10V$, $-V_{BE(off)} = 2.0V$				
t_d	Delay time	-	15	-	ns
t_r	Rise time	-	40	-	ns
t_{on}	Turn-on time	-	55	-	ns
t_s	Storage time	-	300	-	ns
t_f	Fall time	-	60	-	ns
t_{off}	Turn-off time	-	360	-	ns
h-parameters					
h_{fe}	$I_C = 1.0mA$, $V_{CE} = 5.0V$, $f = 1.0kHz$, $T_{amb} = 25^oC$	20	65	-	
h_{ie}	$I_C = 10mA$, $V_{CE} = 5.0V$, $f = 1.0kHz$, $T_{amb} = 25^oC$	-	750	-	Ω
h_{re}		-	0.85	5.0×10^{-4}	
h_{fe}		25	80	-	
h_{oe}		-	35	80	μmho

MEASUREMENT OF SATURATED SWITCHING TIMES

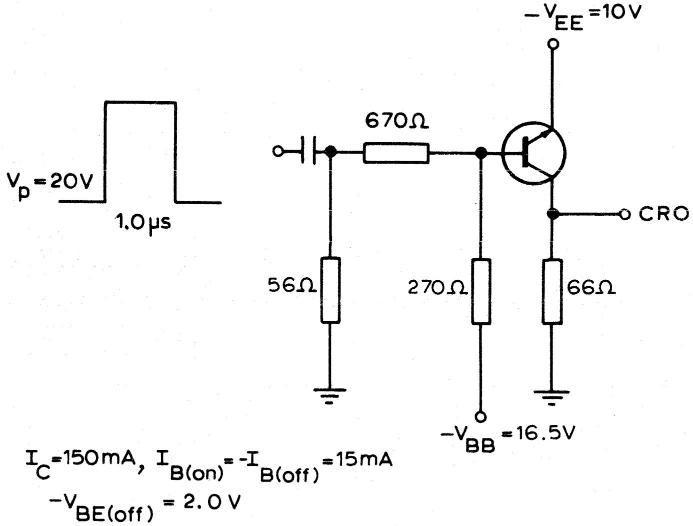


Fig.2 Test circuit.

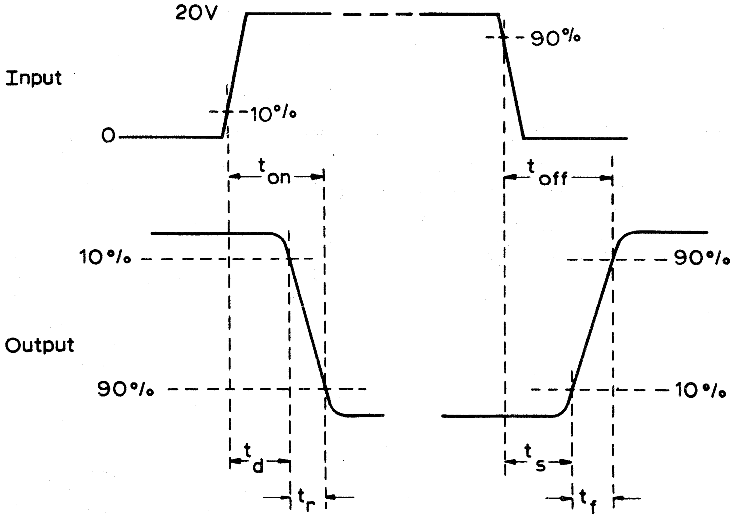


Fig.3 Switching waveforms.

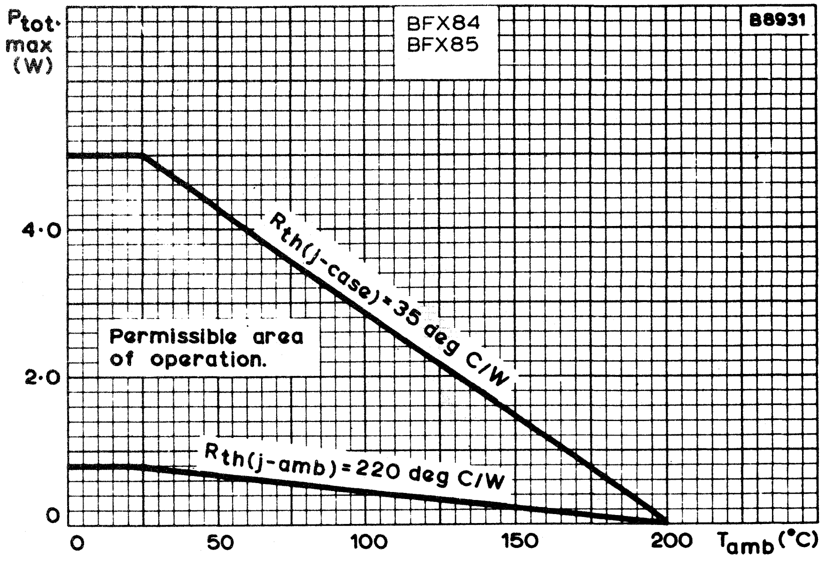


Fig.4 Maximum total dissipation plotted against ambient temperature.

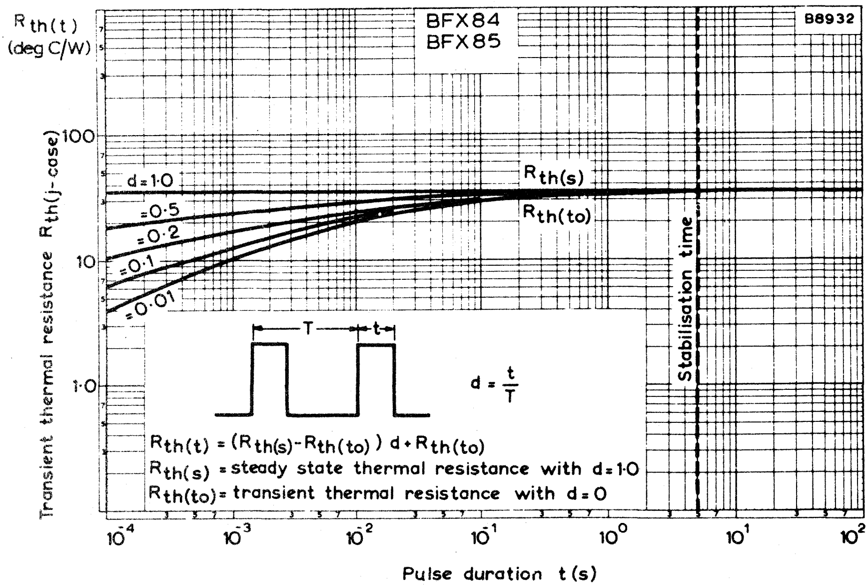


Fig.5 Transient thermal resistance for various duty factors plotted against pulse duration.

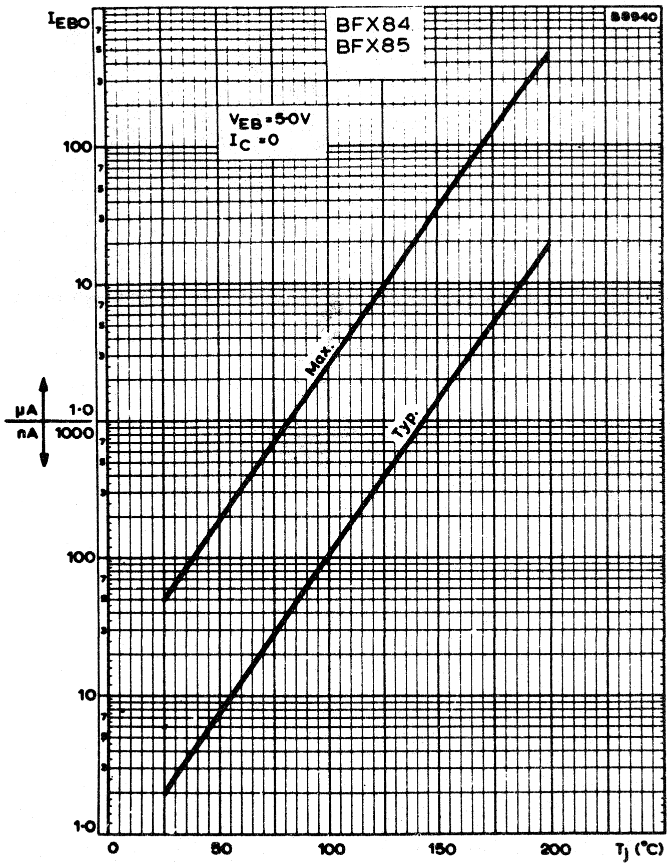


Fig.6 Collector and emitter cut-off currents plotted against junction temperature.

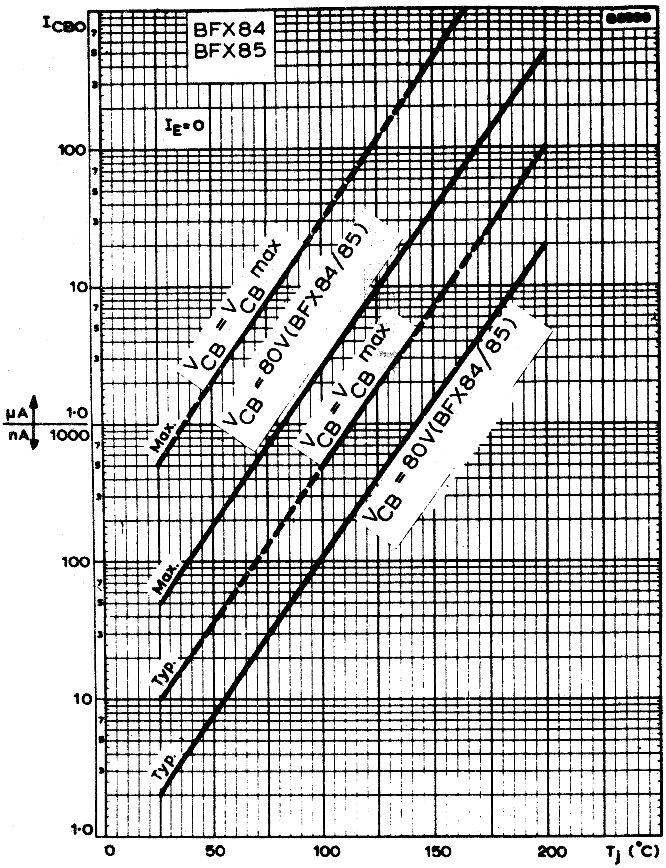


Fig.7 Collector and emitter cut-off currents plotted against junction temperature.

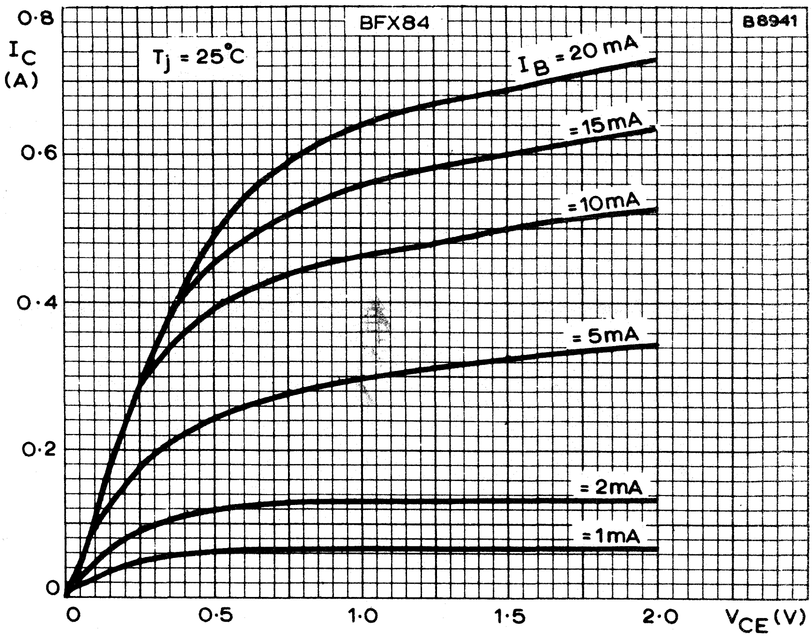


Fig.8 Typical output characteristics.

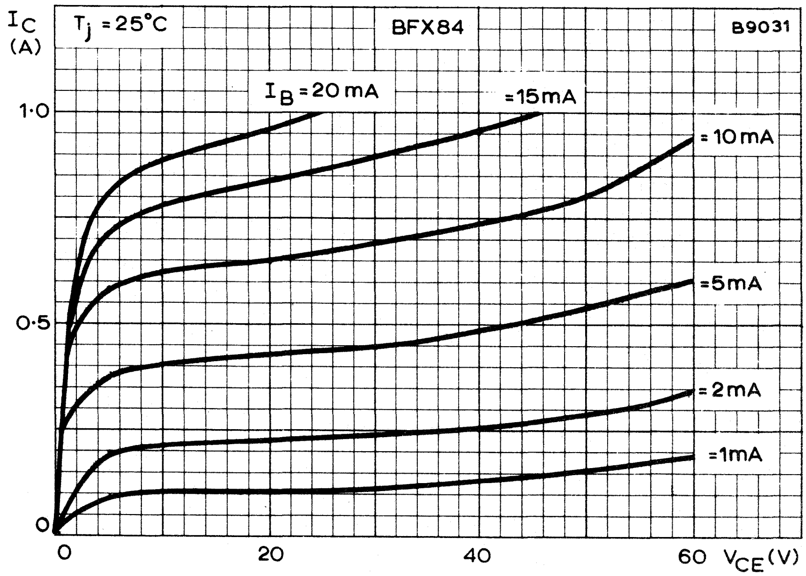


Fig.9 Typical output characteristics.

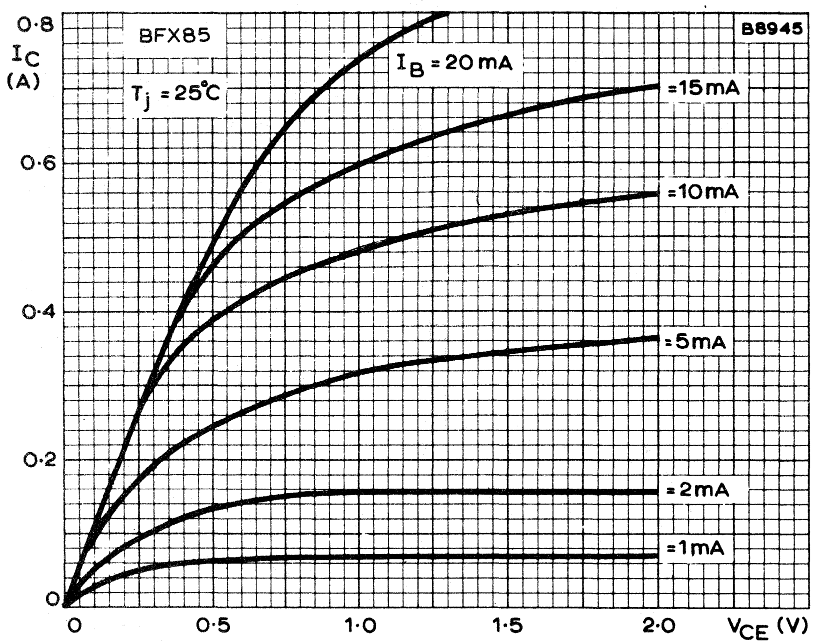


Fig.10 Typical output characteristics.

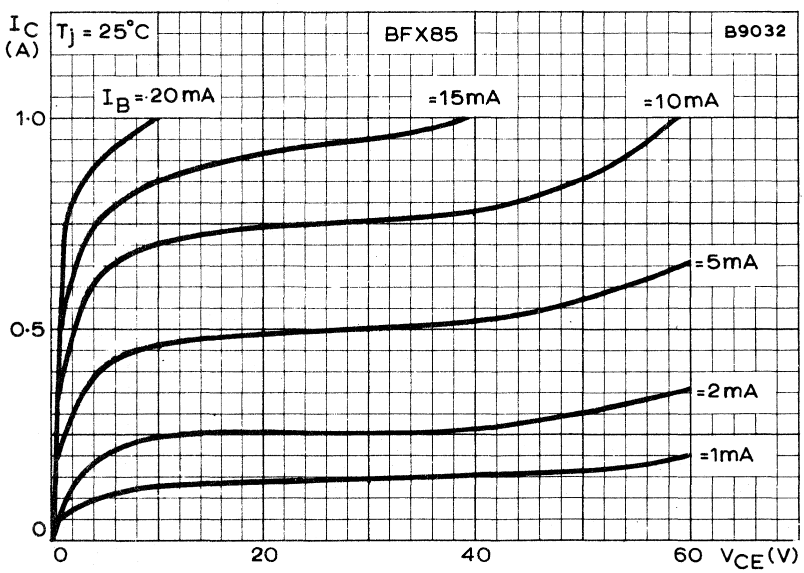


Fig.11 Typical output characteristics.

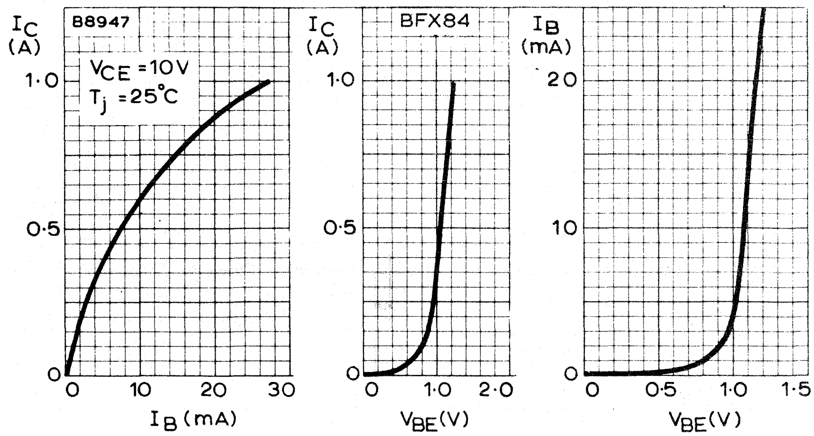


Fig.12 Typical transfer, mutual and input characteristics.

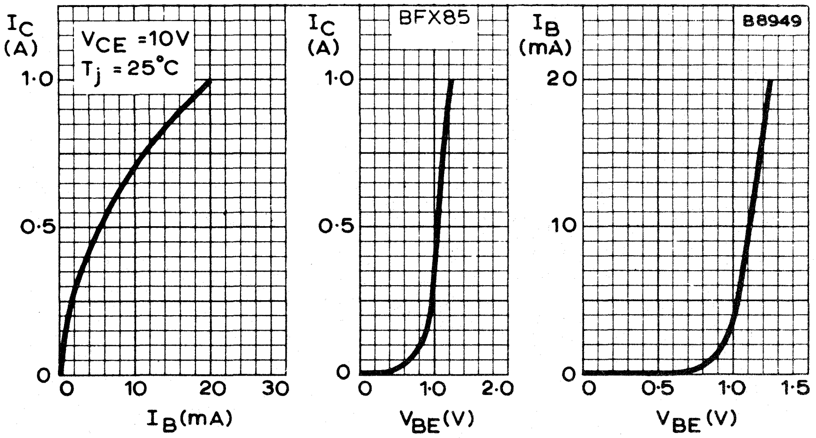


Fig.13 Typical transfer, mutual and input characteristics.

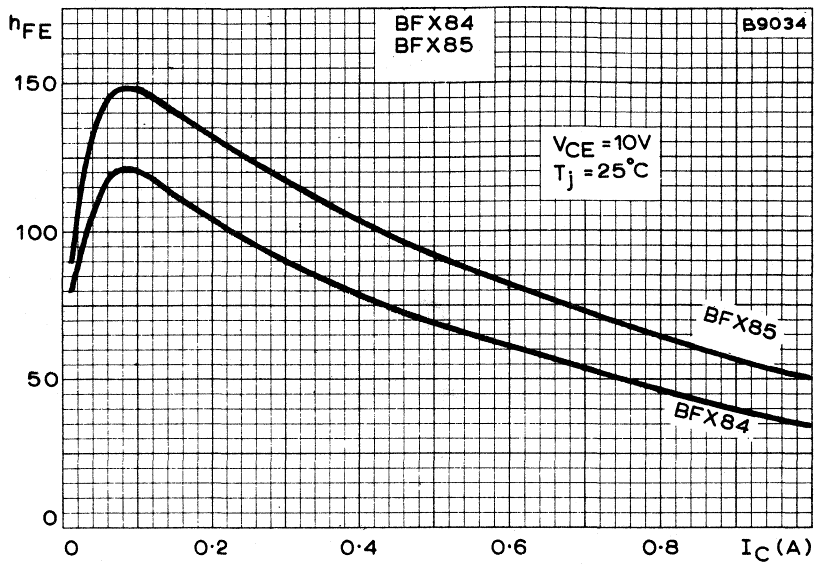


Fig.14 Typical static forward current transfer ratio plotted against collector current and junction temperature.

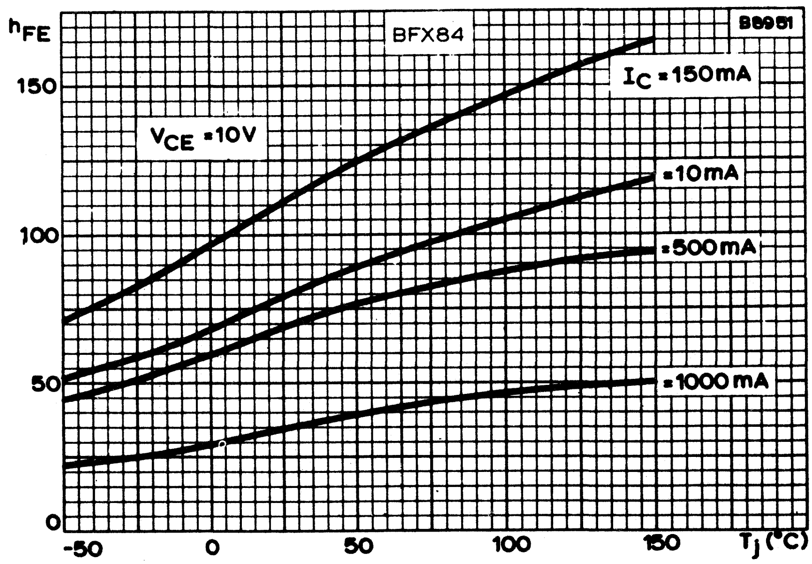


Fig.15 Typical static forward current transfer ratio plotted against collector current and junction temperature.

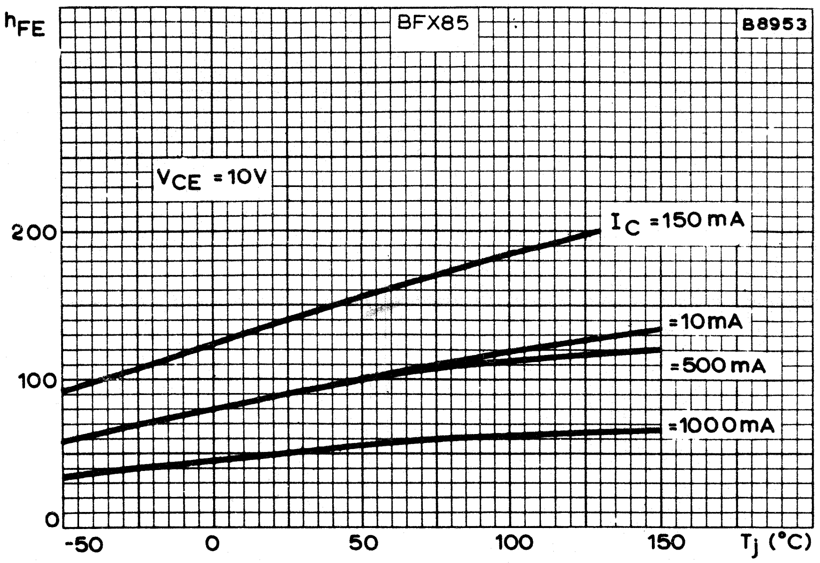


Fig.16 Typical static forward current transfer ratio plotted against junction temperature.

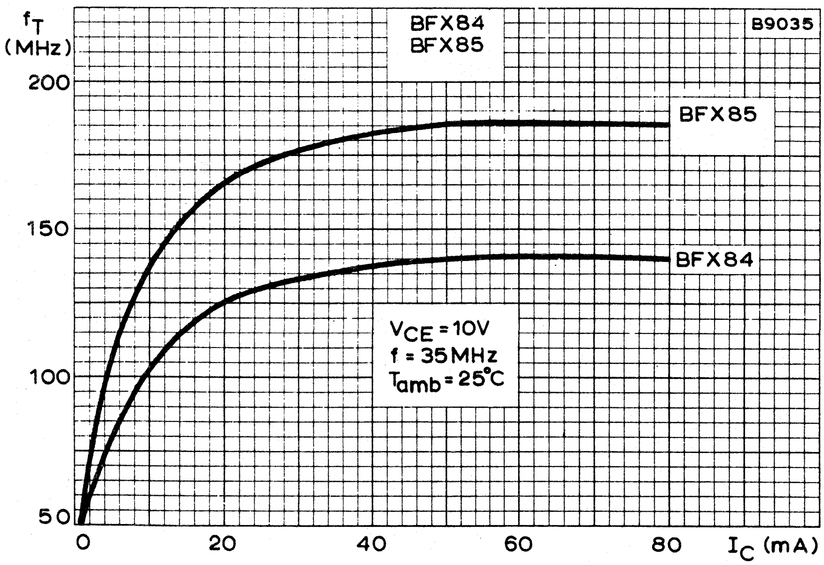


Fig.17 Typical transition frequency plotted against collector current.

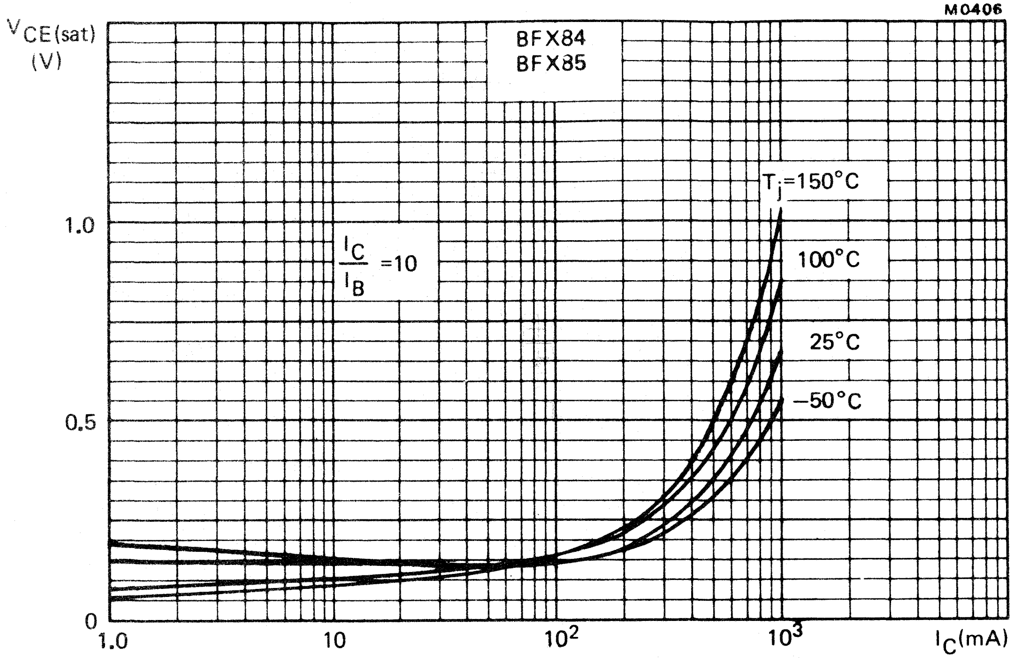


Fig.18 Typical collector-emitter saturation voltage plotted against collector current.

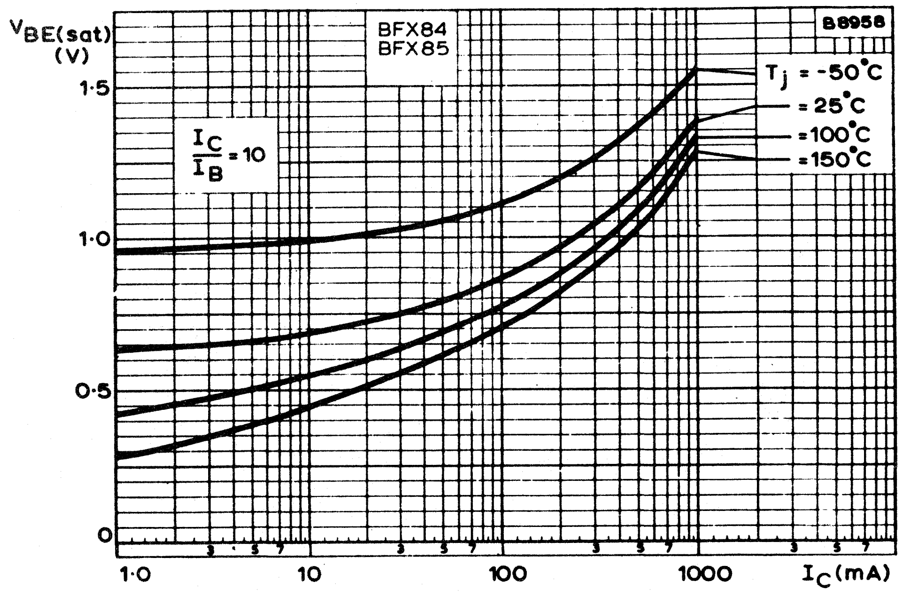


Fig.19 Typical base-emitter saturation voltage plotted against collector current.

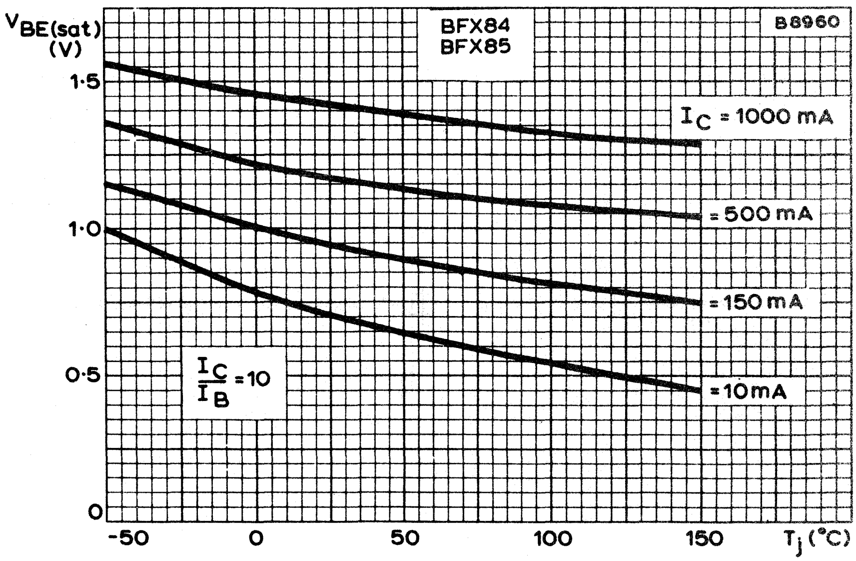


Fig.20 Typical base-emitter saturation voltage plotted against junction temperature.

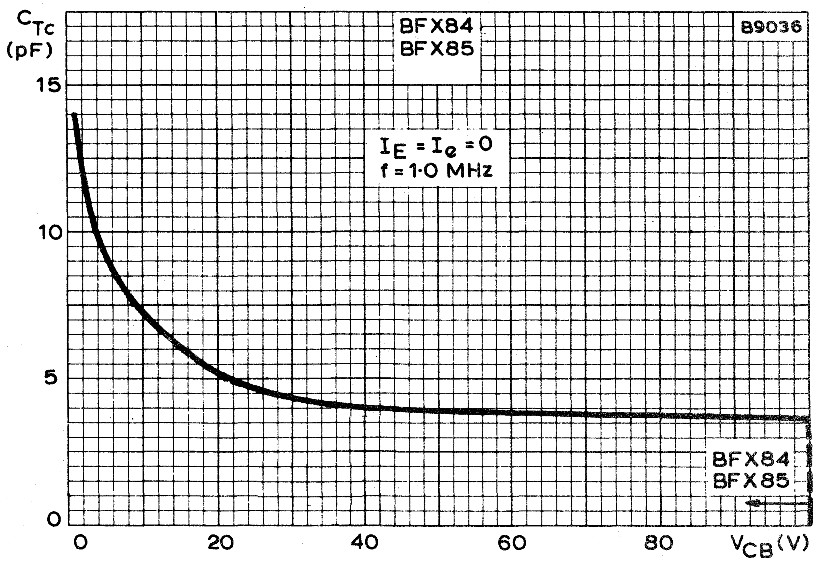


Fig.21 Typical collector capacitance plotted against collector-base voltage.

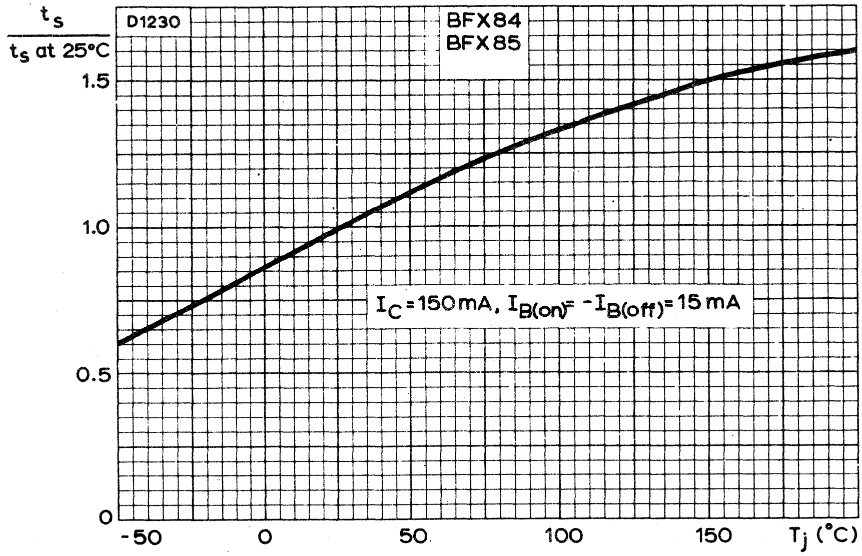


Fig.22 Typical storage time normalised at 25 °C.

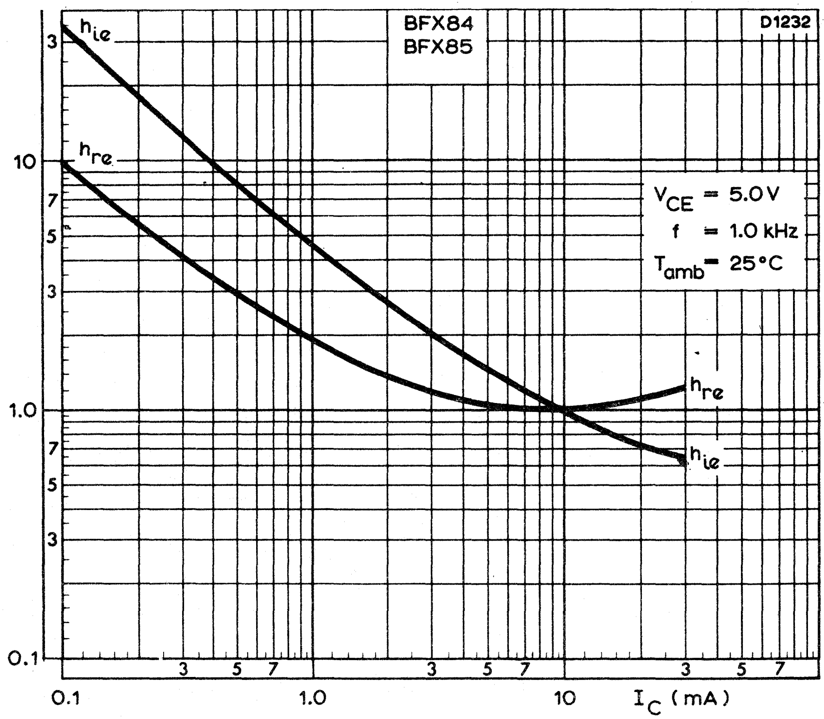


Fig.23.

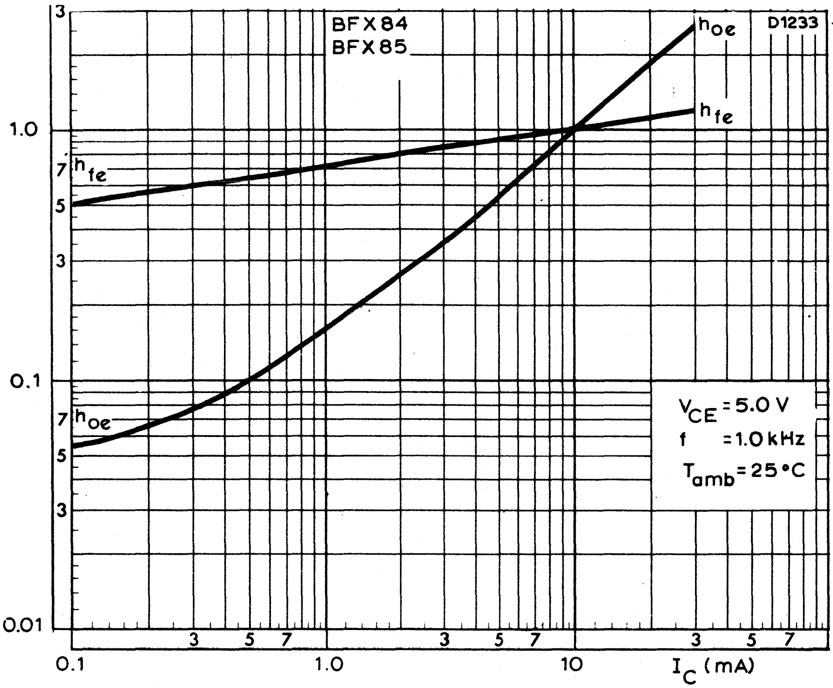


Fig.24 Typical h-parameters normalised at I_C = 10 mA.

SILICON PLANAR EPITAXIAL TRANSISTORS

PNP transistors in TO-39 metal envelopes for general industrial applications.

QUICK REFERENCE DATA

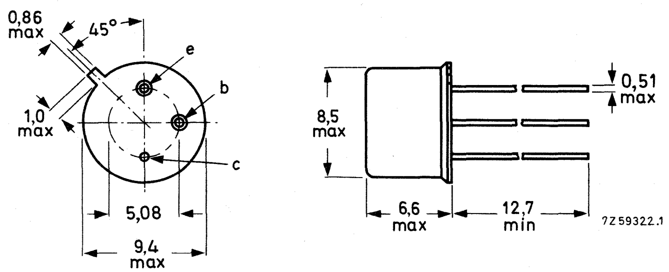
			BFX87	BFX88	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	40	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	50	40	V
Collector current (peak value)	$-I_{CM}$	max.	600	600	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	600	600	mW
DC current gain $-I_C$ = 10 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	40	40	
		typ.	125	125	
Transition frequency at f = 100 MHz $-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	min.	100	100	MHz

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12.7 mm.

Products approved to CECC 50 002-71.

RATINGS

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

			BFX87	BFX88	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	40	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	50	40	V
Collector current (DC)	$-I_C$	max.	600		mA
Collector current (peak value)	$-I_{CM}$	max.	600		mA
Emitter current	I_{EM}	max.	600		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	600		mW
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	+ 200		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	300	K/W

CHARACTERISTICS

			BFX87	BFX88	
Collector cut-off current					
$-V_{CB}$ = 50 V; I_E = 0	$-I_{CBO}$	typ.	1.0	–	nA
		max.	500	–	nA
$-V_{CB}$ = 40 V; I_E = 0	$-I_{CBO}$	typ.	0.5	1.0	nA
		max.	50	500	nA
$-V_{CB}$ = 30 V; I_E = 0	$-I_{CBO}$	typ.	–	0.5	nA
		max.	–	50	nA
$-V_{CB}$ = 40 V; I_E = 0; T_j = 100 °C	$-I_{CBO}$	typ.	0.03	–	μA
		max.	2.0	–	μA
$-V_{CB}$ = 30 V; I_E = 0; T_j = 100 °C	$-I_{CBO}$	typ.	–	0.03	μA
		max.	–	2.0	μA
Emitter cut-off current					
$-V_{EB}$ = 4.0 V; I_C = 0	$-I_{EBO}$	typ.	2.0		nA
		max.	500		nA
$-V_{EB}$ = 3.0 V; I_C = 0	$-I_{EBO}$	typ.	1.0		nA
		max.	100		nA

DC current gain				
$-I_C$ = 1.0 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	40	
		typ.	105	
$-I_C$ = 10 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	40	
		typ.	125	
$-I_C$ = 150 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	40	
		typ.	90	
$-I_C$ = 500 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	25	
		typ.	40	
Collector-emitter saturation voltage				
$-I_C$ = 150 mA; $-I_B$ = 15 mA	$-V_{CE(sat)}$	typ.	0.15	V
		max.	0.40	V
Base-emitter saturation voltage				
$-I_C$ = 30 mA; $-I_B$ = 1.0 mA	$-V_{BE(sat)}$	typ.	0.77	V
		max.	0.90	V
$-I_C$ = 150 mA; $-I_B$ = 15 mA	$-V_{BE(sat)}$	typ.	1.05	V
		max.	1.30	V
Collector capacitance				
$-V_{CB}$ = 10 V; $I_E = I_e$ = 0; f = 1.0 MHz	C_c	typ.	6.0	pF
		max.	12	pF
Emitter capacitance				
$-V_{EB}$ = 2.0 V; $I_C = I_c$ = 0; f = 1.0 MHz	C_e	typ.	18	pF
		max.	30	pF
Transition frequency				
$-I_C$ = 50 mA; $-V_{CE}$ = 10 V; f = 100 MHz; T_{amb} = 25 °C	f_T	min.	100	MHz
		typ.	360	MHz
Saturated switching times				
Turn-on time	t_{on}	typ.	25	ns
		max.	60	ns
Turn-off time	t_{off}	typ.	55	ns
		max.	150	ns

h-parameters

Measured at $-I_C$ = 10 mA; $-V_{CE}$ = 10 V; f = 1.0 kHz; T_{amb} = 25 °C

Input impedance	h_{ie}	typ.	600	Ω
Voltage feedback ratio	h_{re}	typ.	1.50×10^{-4}	
Forward current transfer ratio	h_{fe}	typ.	155	
Output admittance	h_{oe}	typ.	104	μmho

TEST CIRCUITS

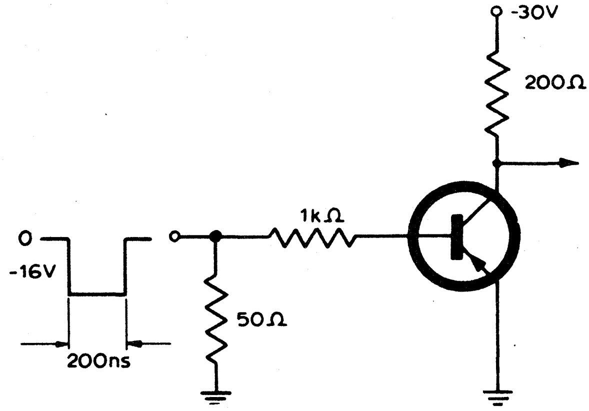


Fig.2 Saturated turn-on switching time.

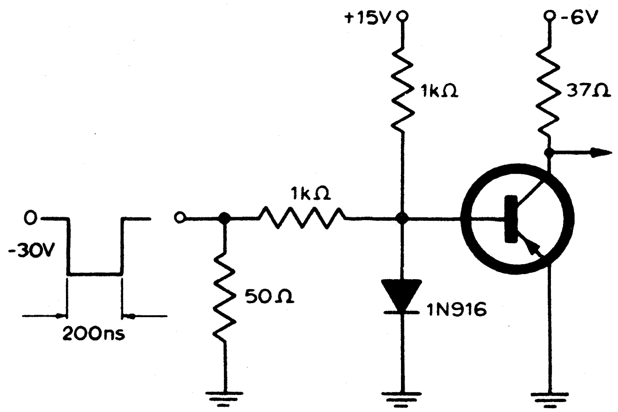


Fig.3 Saturated turn-off switching time.

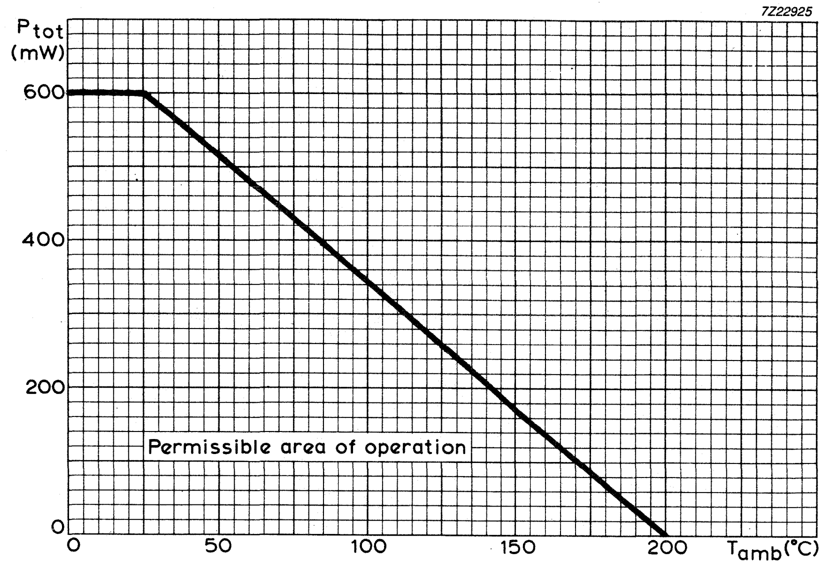


Fig.4 Maximum total dissipation plotted against ambient temperature.

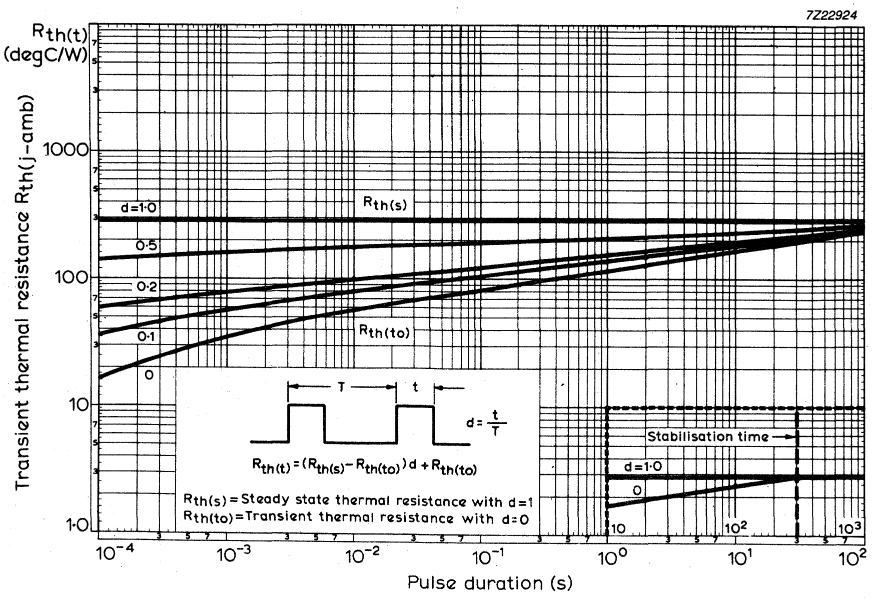


Fig.5 Transient thermal resistance for various duty factors plotted against pulse duration.

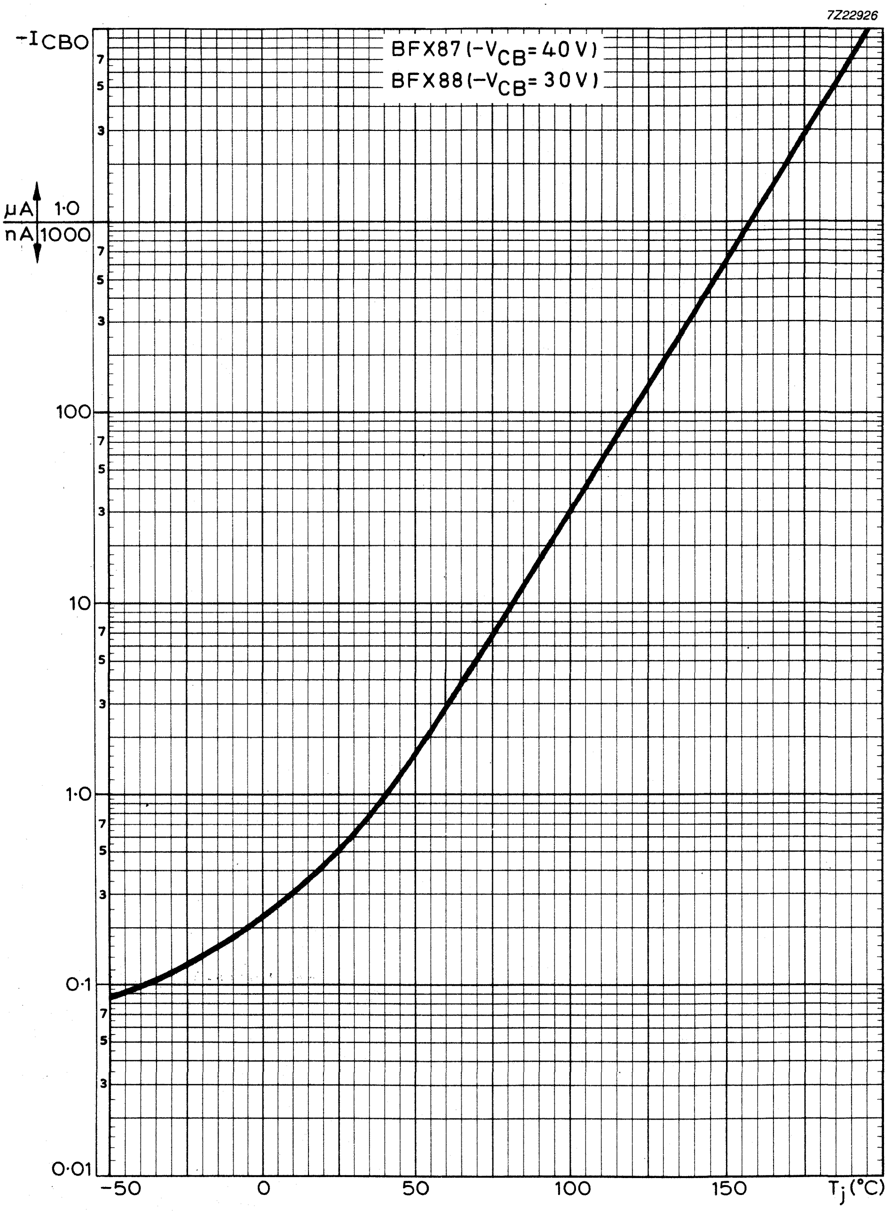


Fig.6 Typical variation of collector cut-off current with junction temperature.

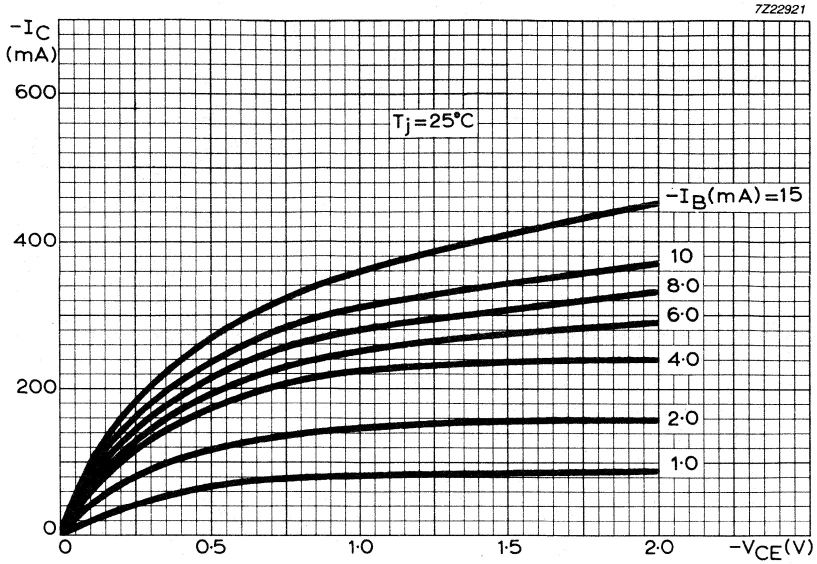


Fig.7 Typical output characteristics at low collector-emitter voltages.

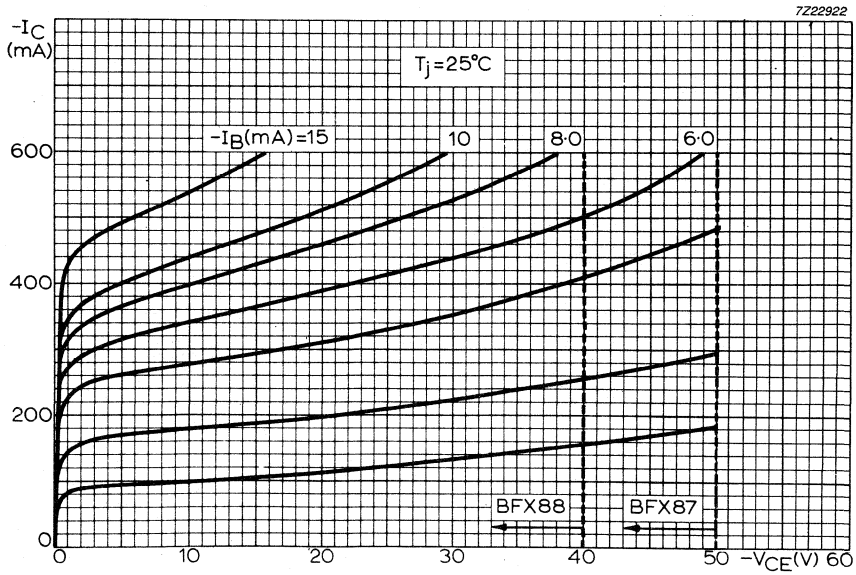


Fig.8 Typical output characteristics at high collector-emitter voltages.

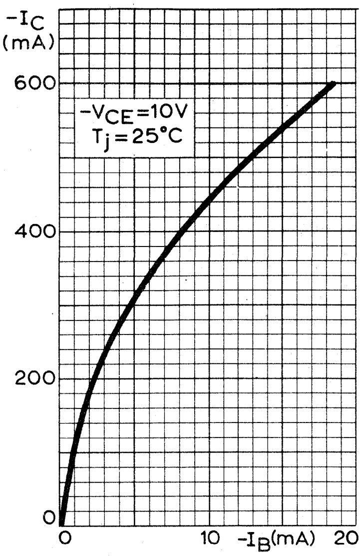


Fig.9 Typical transfer characteristic.

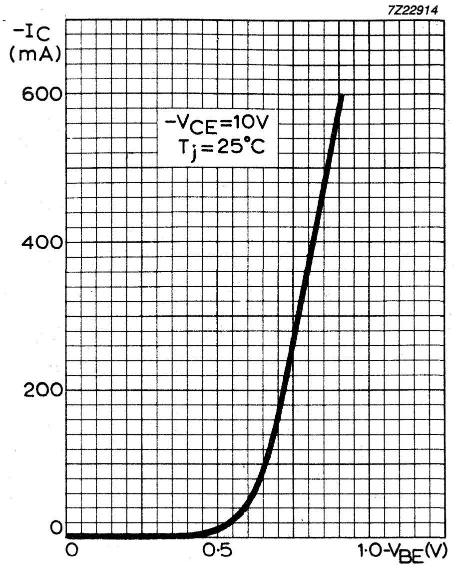


Fig.10 Typical mutual characteristic.

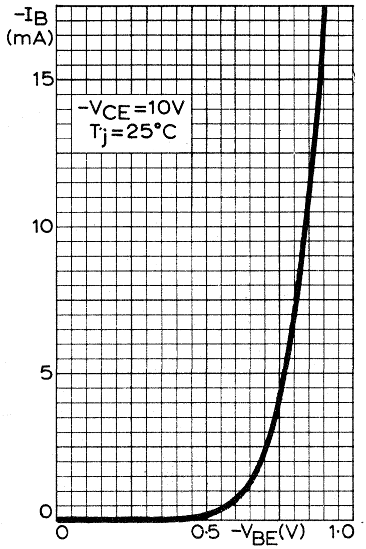


Fig.11 Typical input characteristic.

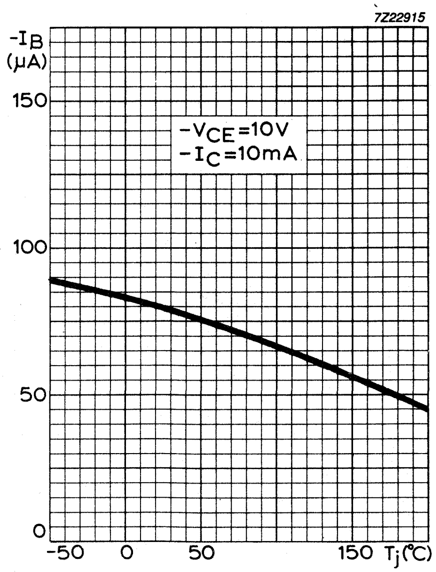


Fig.12 Typical base current as a function of junction temperature.

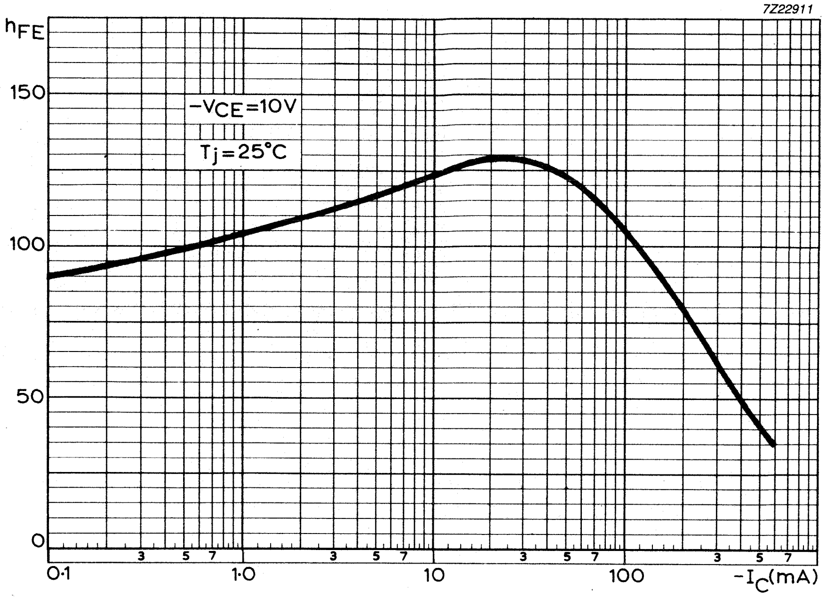


Fig.13 Typical variation of DC current gain with collector current.

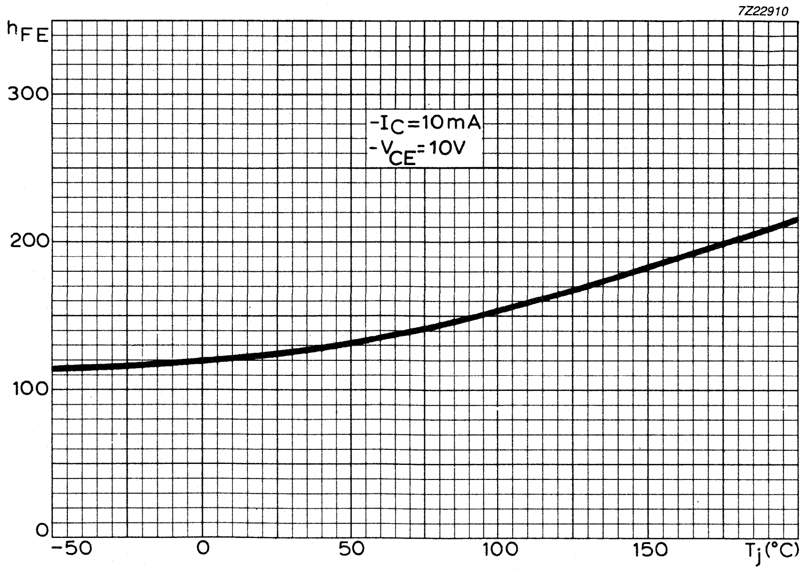


Fig.14 Typical variation of DC current gain with junction temperature.

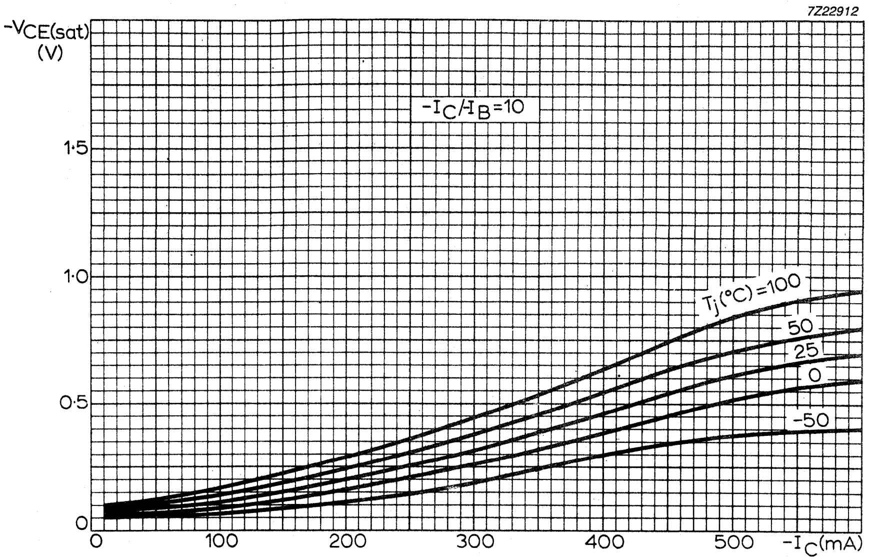


Fig.15 Typical variation of collector-emitter saturation voltage with collector current.

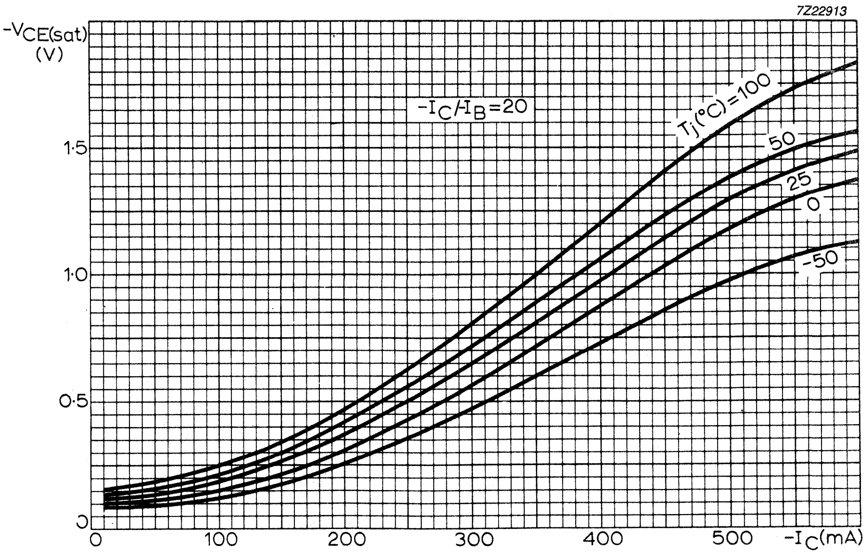


Fig.16 Typical variation of collector-emitter saturation voltage with collector current.

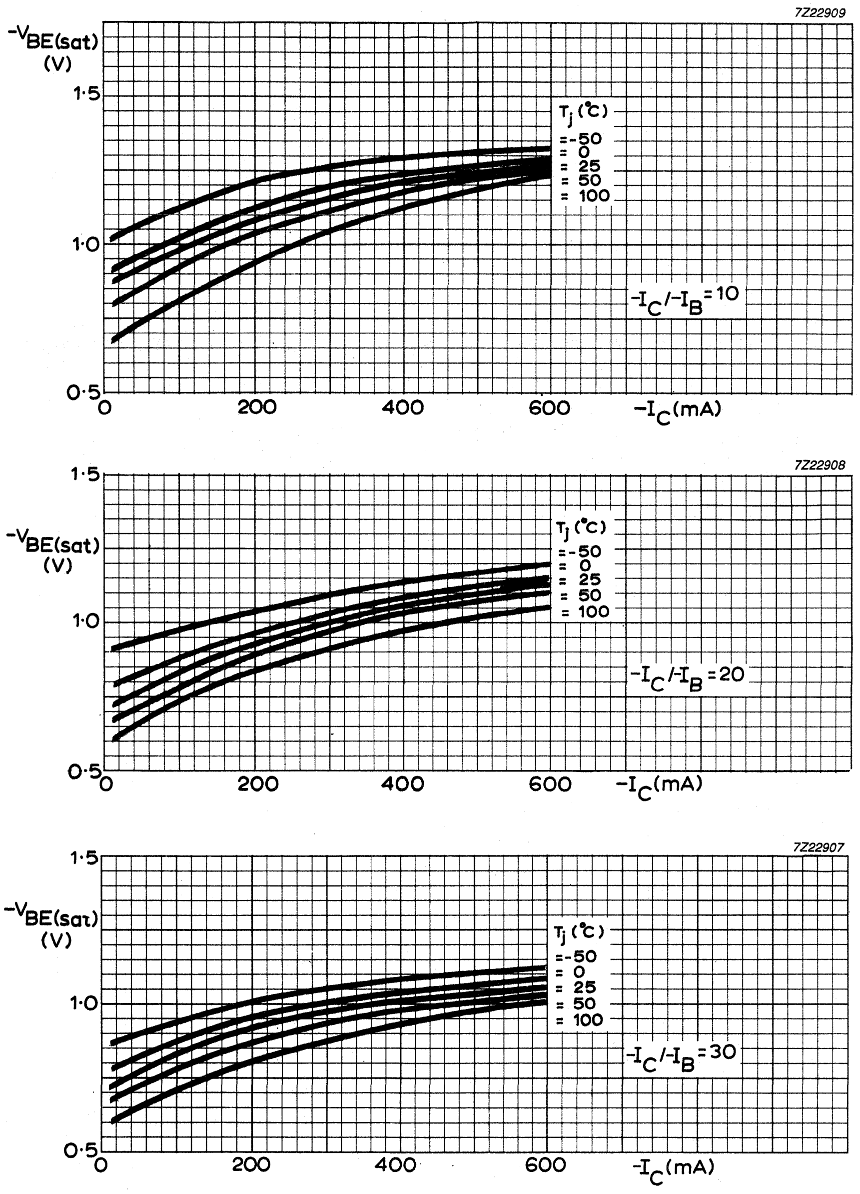


Fig.17 Typical variation of base-emitter saturation voltage with collector current.

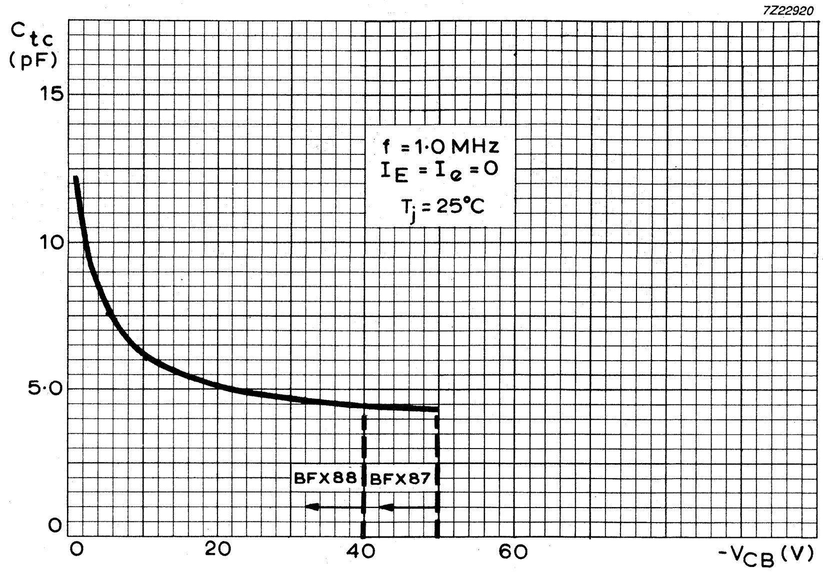


Fig.18 Typical variation of collector capacitance with collector-base voltage.

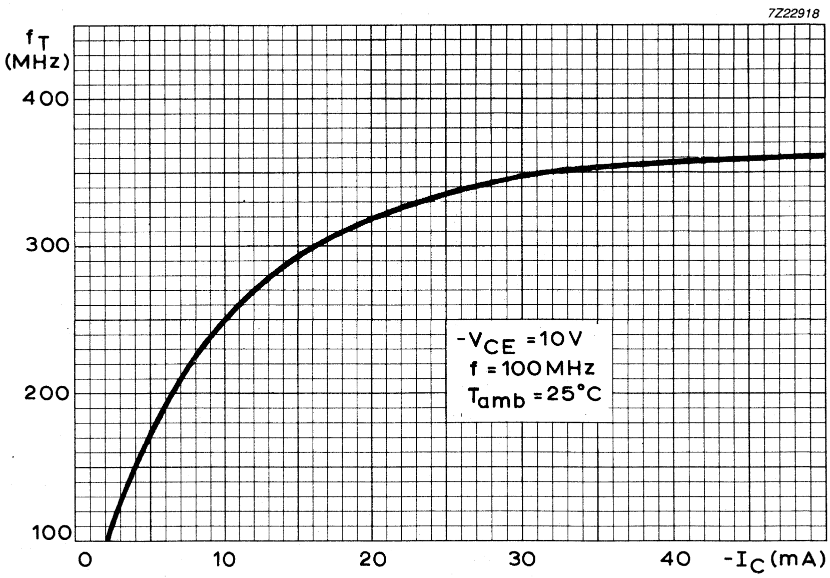


Fig.19 Typical variation of transition frequency with collector current.

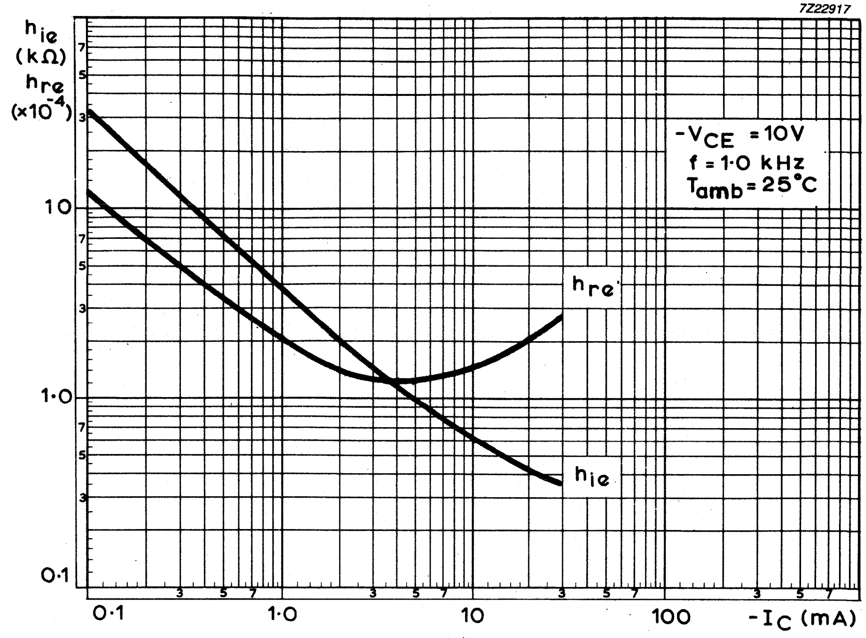


Fig.20 Typical input impedance and typical voltage feedback ratio plotted against collector current.

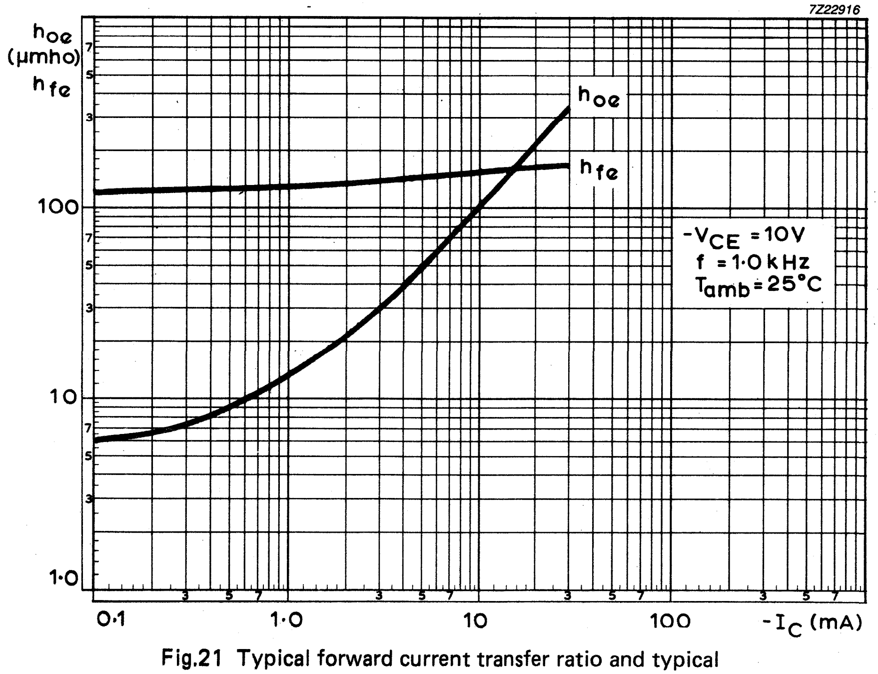


Fig.21 Typical forward current transfer ratio and typical output admittance plotted against collector current.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in TO-39 metal envelopes intended for general purpose industrial applications.

QUICK REFERENCE DATA

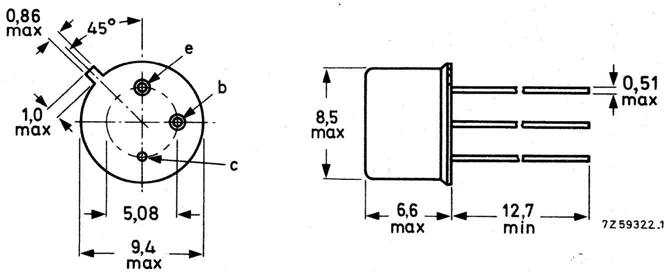
			BFY50	BFY51	BFY52	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	60	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	30	20	V
Collector current (peak value)	I_{CM}	max.	1,0	1,0	1,0	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	800	800	800	mW
Total power dissipation up to T_{case} = 100 °C	P_{tot}	max.	2,86	2,86	2,86	W
D.C. current gain I_C = 150 mA; V_{CE} = 10 V	h_{FE}	>	30	40	60	
		typ.	112	123	142	
Transition frequency at f = 35 MHz I_C = 50 mA; V_{CE} = 10 V; T_{amb} = 25 °C	f_T	>	60	50	50	MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 002-089.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

	BFY50	BFY51	BFY52	
V_{CBO} max.	80	60	40	V
V_{CE} max. (cut-off, $I_C \leq 1mA$)	80	60	40	V
V_{CEO} max.	35	30	20	V
V_{EBO} max.		6.0		V
I_C max.		1.0		A
I_{CM} max.		1.0		A
$-I_E$ max.		1.0		A
$-I_{EM}$ max.		1.0		A
I_B max.		100		mA
$\pm I_{BM}$ max.		100		mA
P_{tot} max. $T_{amb} \leq 25^oC$		800		mW
$T_{case} \leq 25^oC$		5.0		W
$T_{case} > 25, < 100^oC$		2.86		W

Temperature

T_{stg}	-65 to +150	^oC
T_j max.	200	^oC

THERMAL CHARACTERISTICS

$R_{th(j-amb)}$ in free air	220	K/W
$R_{th(j-case)}$	35	K/W

BFY50

ELECTRICAL CHARACTERISTICS ($T_j = 25^oC$ unless otherwise stated)

		Min.	Typ.	Max.	
I_{CBO}	Collector cut-off current				
	$V_{CB} = 80V$, $I_E = 0$	-	–	500	nA
	$V_{CB} = 80V$, $I_E = 0$, $T_j = 100^oC$	-	–	30	μA
	$V_{CB} = 60V$, $I_E = 0$	-	–	50	nA
	$V_{CB} = 60V$, $I_E = 0$, $T_j = 100^oC$	-	–	2.5	μA
I_{EBO}	Emitter cut-off current				
	$V_{EB} = 6.0V$, $I_C = 0$	-	–	500	nA
	$V_{EB} = 5.0V$, $I_C = 0$	-	–	50	nA
	$V_{EB} = 5.0V$, $I_C = 0$, $T_j = 100^oC$	-	–	2.5	μA
h_{FE}	Static forward current transfer ratio				
	$I_C = 10mA$, $V_{CE} = 10V$	20	–	-	
	$I_C = 150mA$, $V_{CE} = 10V$	30	–	-	
	$I_C = 500mA$, $V_{CE} = 10V$	20	–	-	
	$I_C = 1.0A$, $V_{CE} = 10V$	15	–	-	
$V_{CE(sat)}$	Collector-emitter saturation voltage				
	$I_C = 10mA$, $I_B = 1.0mA$	-	–	0.20	V
	$I_C = 150mA$, $I_B = 15mA$	-	–	0.20	V
	$I_C = 500mA$, $I_B = 50mA$	-	–	0.70	V
	$I_C = 1.0A$, $I_B = 100mA$	-	–	1.00	V
$V_{BE(sat)}$	Base-emitter saturation voltage				
	$I_C = 10mA$, $I_B = 1.0mA$	-	–	1.2	V
	$I_C = 150mA$, $I_B = 15mA$	-	–	1.3	V
	$I_C = 500mA$, $I_B = 50mA$	-	–	1.5	V
	$I_C = 1.0A$, $I_B = 100mA$	-	–	2.0	V
C_{Tc}	Collector capacitance				
	$V_{CB} = 10V$, $I_E = I_e = 0$, f = 1.0MHz	-	7.0	12	pF

BFY50

ELECTRICAL CHARACTERISTICS (contd.)

		Min.	Typ.	Max.	
f_T	Transition frequency $I_C = 50mA$, $V_{CE} = 10V$, $f = 35MHz$, $T_{amb} = 25^oC$	60	140	-	MHz

Saturated switching times

$I_C = 150mA$, $I_{B(on)} = -I_{B(off)} = 15mA$,
$-V_{EE} = 10V$, $-V_{BE(off)} = 2.0V$

		Min.	Typ.	Max.	
t_d	Delay time	-	15	-	ns
t_r	Rise time	-	40	-	ns
t_{on}	Turn-on time	-	55	-	ns
t_s	Storage time	-	300	-	ns
t_f	Fall time	-	60	-	ns
t_{off}	Turn-off time	-	360	-	ns

h-parameters

		Min.	Typ.	Max.	
h_{fe}	$I_C = 1.0mA$, $V_{CE} = 5.0V$, $f = 1.0kHz$, $T_{amb} = 25^oC$	–	65	-	
h_{ie}	$I_C = 10mA$, $V_{CE} = 5.0V$, $f = 1.0kHz$, $T_{amb} = 25^oC$	-	750	-	Ω
h_{re}		-	0.85	–	$\times 10^{-4}$
h_{fe}		–	80	-	
h_{oe}		-	35	–	μS

BFY51

ELECTRICAL CHARACTERISTICS ($T_j = 25^oC$ unless otherwise stated)

		Min.	Typ.	Max.	
I_{CBO}	Collector cut-off current				
	$V_{CB} = 60V,\ I_E = 0$	-	—	500	nA
	$V_{CB} = 60V,\ I_E = 0,\ T_j = 100^oC$	-	—	30	μA
	$V_{CB} = 40V,\ I_E = 0$	-	—	50	nA
	$V_{CB} = 40V,\ I_E = 0,\ T_j = 100^oC$	-	—	2.5	μA
I_{EBO}	Emitter cut-off current				
	$V_{EB} = 6.0V,\ I_C = 0$	-	—	500	nA
	$V_{EB} = 5.0V,\ I_C = 0$	-	—	50	nA
	$V_{EB} = 5.0V,\ I_C = 0,\ T_j = 100^oC$	-	—	2.5	μA
h_{FE}	Static forward current transfer ratio				
	$I_C = 10mA,\ V_{CE} = 10V$	30	—	-	
	$I_C = 150mA,\ V_{CE} = 10V$	40	—	-	
	$I_C = 500mA,\ V_{CE} = 10V$	25	—	-	
	$I_C = 1.0A,\ V_{CE} = 10V$	15	—	-	
$V_{CE(sat)}$	Collector-emitter saturation voltage				
	$I_C = 10mA,\ I_B = 1.0mA$	-	—	0.20	V
	$I_C = 150mA,\ I_B = 15mA$	-	—	0.35	V
	$I_C = 500mA,\ I_B = 50mA$	-	—	1.00	V
	$I_C = 1.0A,\ I_B = 100mA$	-	—	1.60	V
$V_{BE(sat)}$	Base-emitter saturation voltage				
	$I_C = 10mA,\ I_B = 1.0mA$	-	—	1.2	V
	$I_C = 150mA,\ I_B = 15mA$	-	—	1.3	V
	$I_C = 500mA,\ I_B = 50mA$	-	—	1.5	V
	$I_C = 1.0A,\ I_B = 100mA$	-	—	2.0	V
C_{Tc}	Collector capacitance				
	$V_{CB} = 10V,\ I_E = I_e = 0,$ $f = 1.0MHz$	-	7.0	12	pF

BFY51/BFY52

ELECTRICAL CHARACTERISTICS (contd.)

		Min.	Typ.	Max.	
f_T	Transition frequency $I_C = 50mA$, $V_{CE} = 10V$, $f = 35MHz$, $T_{amb} = 25^oC$	50	-	-	MHz
Saturated switching times	$I_C = 150mA$, $I_{B(on)} = -I_{B(off)} = 15mA$, $-V_{EE} = 10V$, $-V_{BE(off)} = 2.0V$				
t_d	Delay time	-	15	-	ns
t_r	Rise time	-	40	-	ns
t_{on}	Turn-on time	-	55	-	ns
t_s	Storage time	-	300	-	ns
t_f	Fall time	-	60	-	ns
t_{off}	Turn-off time	-	360	-	ns
h-parameters					
h_{fe}	$I_C = 1.0mA$, $V_{CE} = 5.0V$, $f = 1.0kHz$, $T_{amb} = 25^oC$	–	65	-	
h_{ie}	$I_C = 10mA$, $V_{CE} = 5.0V$, $f = 1.0kHz$, $T_{amb} = 25^oC$	–	750	–	Ω
h_{re}		–	0.85	–	$\times 10^{-4}$
h_{fe}		–	80	–	
h_{oe}		–	35	–	μS

BFY52

ELECTRICAL CHARACTERISTICS ($T_j = 25^oC$ unless otherwise stated)

		Min.	Typ.	Max.	
I_{CBO}	Collector cut-off current				
	$V_{CB} = 40V$, $I_E = 0$	-	–	500	nA
	$V_{CB} = 40V$, $I_E = 0$, $T_j = 100^oC$	-	–	30	μA
	$V_{CB} = 30V$, $I_E = 0$	-	–	50	nA
	$V_{CB} = 30V$, $I_E = 0$, $T_j = 100^oC$	-	–	2.5	μA
I_{EBO}	Emitter cut-off current				
	$V_{EB} = 6.0V$, $I_C = 0$	-	–	500	nA
	$V_{EB} = 5.0V$, $I_C = 0$	-	–	50	nA
	$V_{EB} = 5.0V$, $I_C = 0$, $T_j = 100^oC$	-	–	2.5	μA
h_{FE}	Static forward current transfer ratio				
	$I_C = 10mA$, $V_{CE} = 10V$	30	–	-	
	$I_C = 150mA$, $V_{CE} = 10V$	60	–	-	
	$I_C = 500mA$, $V_{CE} = 10V$	30	–	-	
	$I_C = 1.0A$, $V_{CE} = 10V$	15	–	-	
$V_{CE(sat)}$	Collector-emitter saturation voltage				
	$I_C = 10mA$, $I_B = 1.0mA$	-	–	0.20	V
	$I_C = 150mA$, $I_B = 15mA$	-	–	0.35	V
	$I_C = 500mA$, $I_B = 50mA$	-	–	1.00	V
	$I_C = 1.0A$, $I_B = 100mA$	-	–	1.60	V
$V_{BE(sat)}$	Base-emitter saturation voltage				
	$I_C = 10mA$, $I_B = 1.0mA$	-	–	1.2	V
	$I_C = 150mA$, $I_B = 15mA$	-	–	1.3	V
	$I_C = 500mA$, $I_B = 50mA$	-	–	1.5	V
	$I_C = 1.0A$, $I_B = 100mA$	-	–	2.0	V
C_{Tc}	Collector capacitance				
	$V_{CB} = 10V$, $I_E = I_e = 0$, $f = 1.0MHz$	-	7.0	12	pF

MEASUREMENT OF SATURATED SWITCHING TIMES

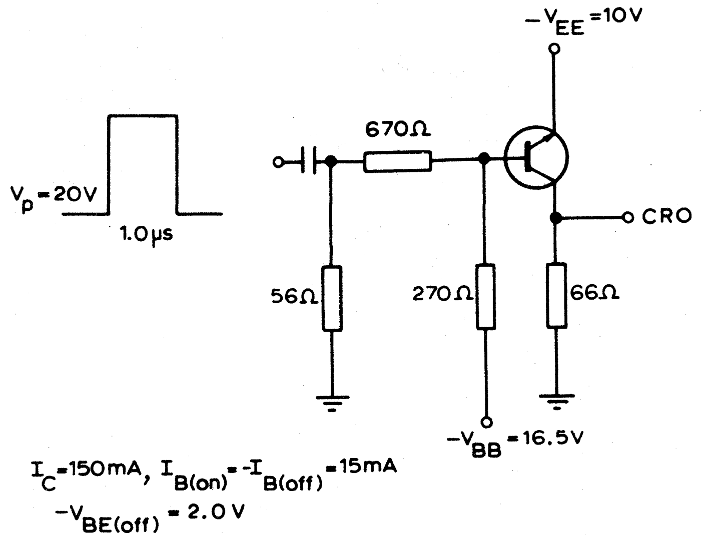


Fig. 2 Test circuit.

Switching waveforms

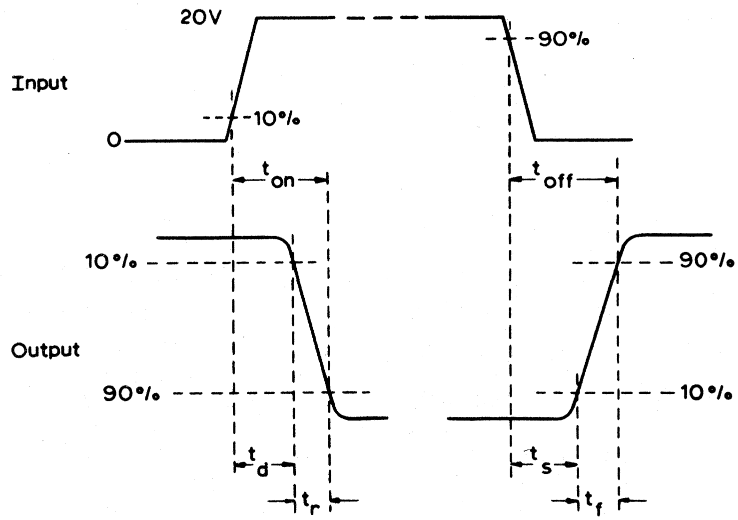


Fig. 3 Waveforms.

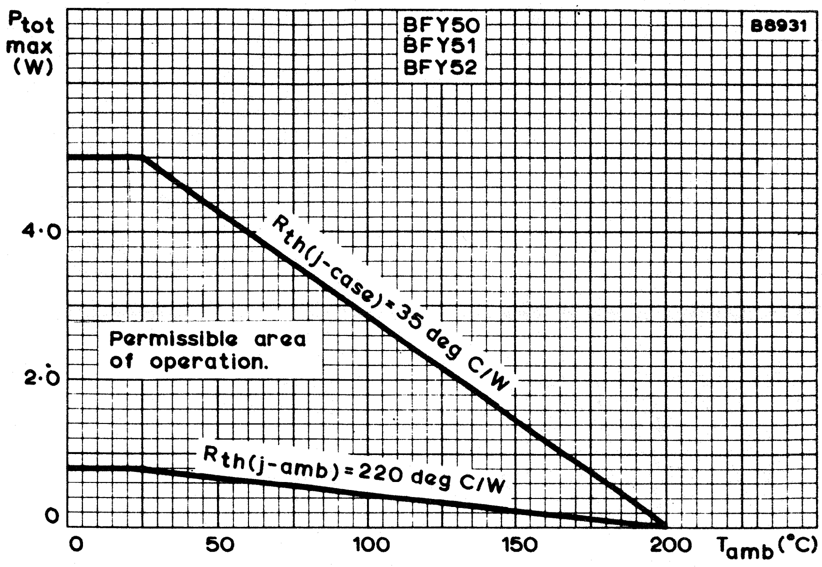

Ptot max (W)
BFY50
BFY51
BFY52
B8931
4·0
2·0
0
Rth(j-case) = 35 deg C/W
Permissible area of operation.
Rth(j-amb) = 220 deg C/W
0
50
100
150
200
Tamb (°C)

Fig. 4.

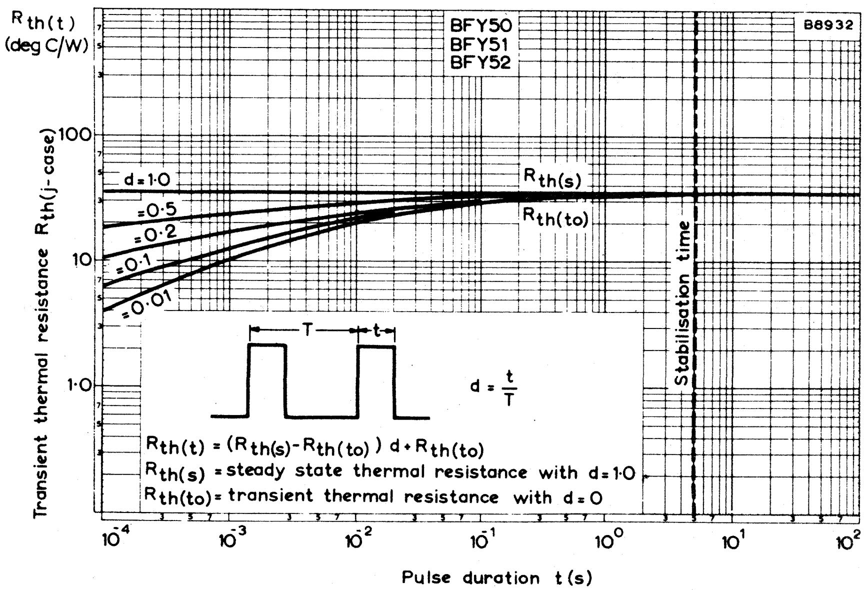

Rth(t) (deg C/W)
BFY50
BFY51
BFY52
B8932
100
10
1·0
Transient thermal resistance Rth(j-case)
d = 1·0
= 0·5
= 0·2
= 0·1
= 0·01
Rth(s)
Rth(to)
T
t
d = t/T
Rth(t) = (Rth(s) - Rth(to)) d + Rth(to)
Rth(s) = steady state thermal resistance with d = 1·0
Rth(to) = transient thermal resistance with d = 0
Stabilisation time
10^-4
10^-3
10^-2
10^-1
10^0
10^1
10^2
Pulse duration t (s)

Fig. 5.

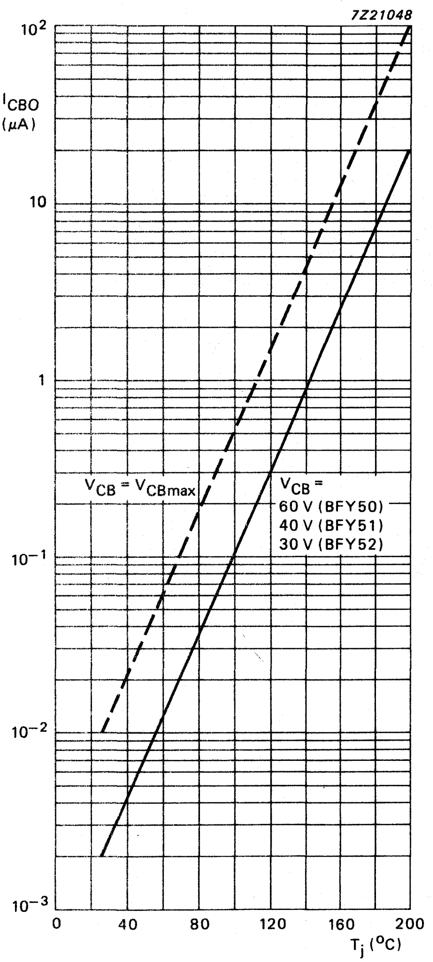


Fig. 6 $I_E = 0$.

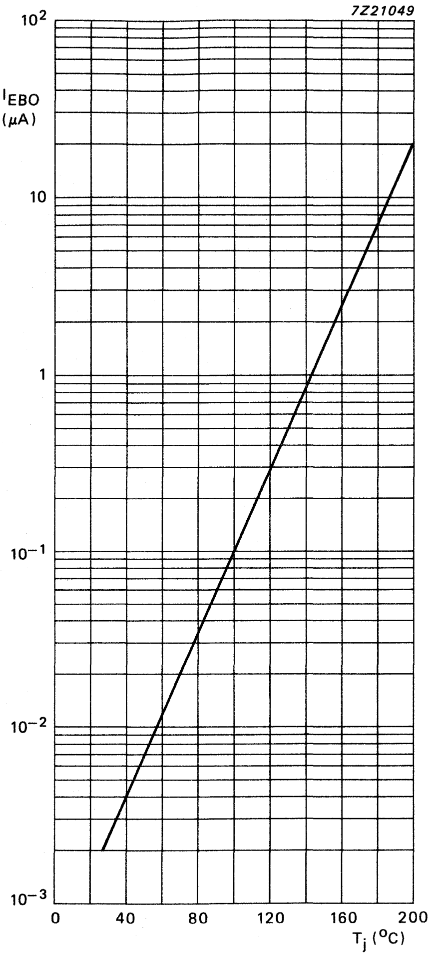


Fig. 7 V_{EB} = 5,0 V; I_C = 0; typical values.

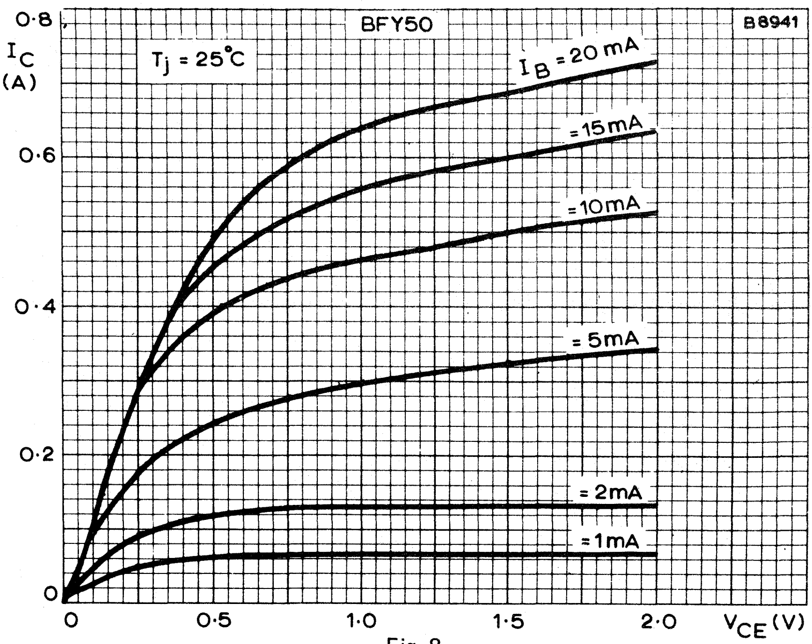

BFY50
B8941
I_C (A)
$T_j = 25°C$
$I_B = 20$ mA
= 15 mA
= 10 mA
= 5 mA
= 2 mA
= 1 mA
0
0·2
0·4
0·6
0·8
0
0·5
1·0
1·5
2·0
V_{CE} (V)

Fig. 8.

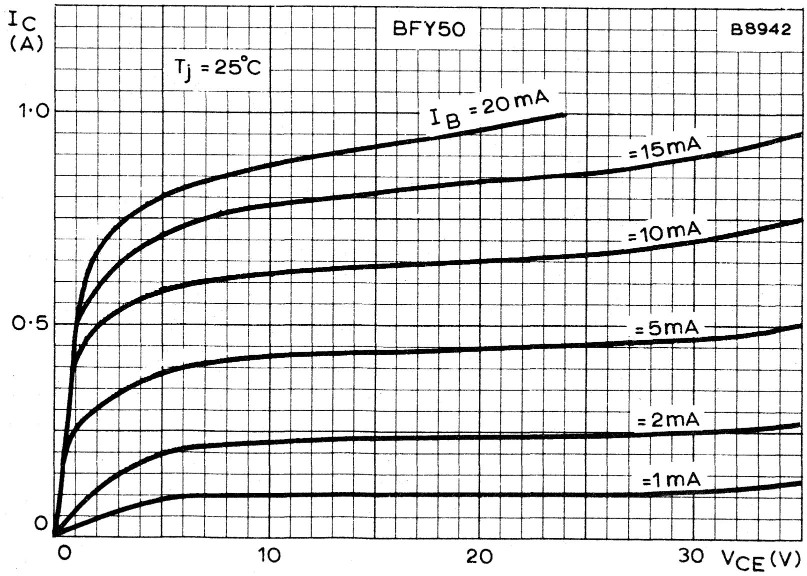

BFY50
B8942
I_C (A)
$T_j = 25°C$
$I_B = 20$ mA
= 15 mA
= 10 mA
= 5 mA
= 2 mA
= 1 mA
0
0·5
1·0
0
10
20
30
V_{CE} (V)

Fig. 9.

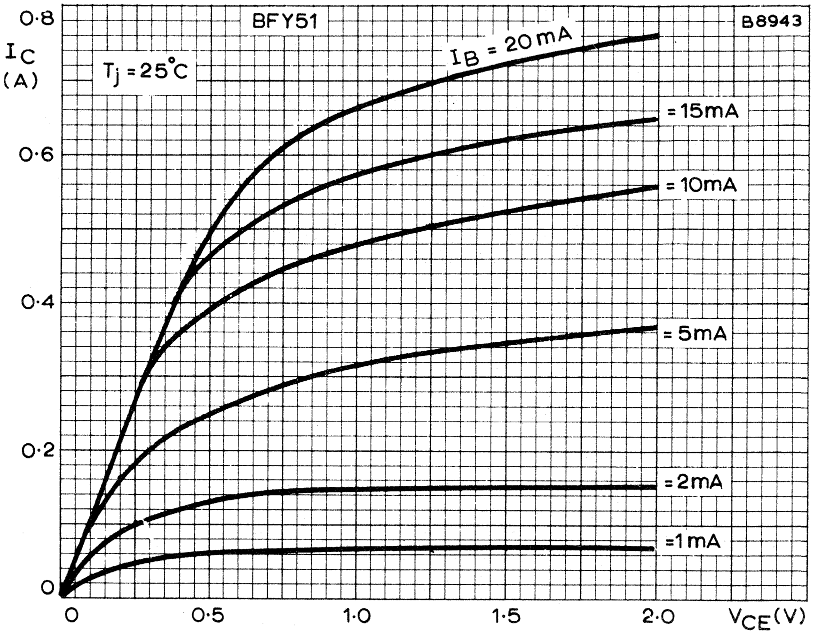

BFY51
B8943
I_C (A)
$T_j = 25°C$
I_B = 20 mA
= 15mA
= 10mA
= 5mA
= 2mA
= 1mA
0·8
0·6
0·4
0·2
0
0
0·5
1·0
1·5
2·0
V_{CE} (V)

Fig. 10.

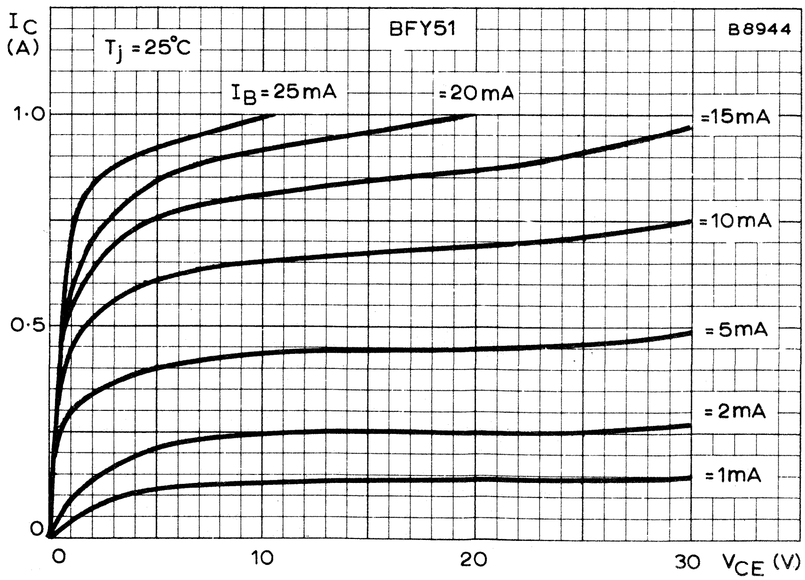

BFY51
B8944
I_C (A)
$T_j = 25°C$
I_B = 25mA
= 20mA
= 15mA
= 10mA
= 5mA
= 2mA
= 1mA
1·0
0·5
0
0
10
20
30
V_{CE} (V)

Fig. 11.

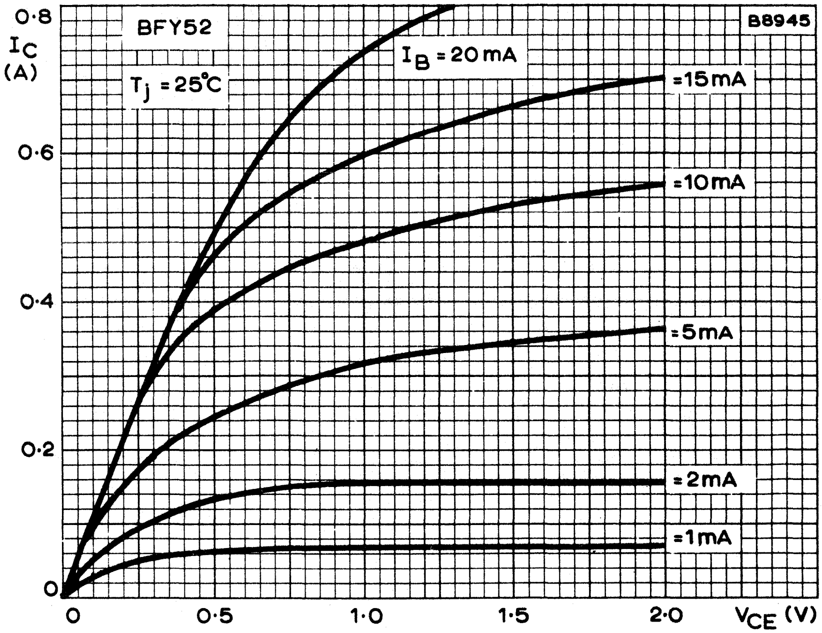

BFY52
B8945
I_C (A)
T_j = 25°C
I_B = 20 mA
= 15 mA
= 10 mA
= 5 mA
= 2 mA
= 1 mA
0·8
0·6
0·4
0·2
0
0
0·5
1·0
1·5
2·0
V_{CE} (V)

Fig. 12.

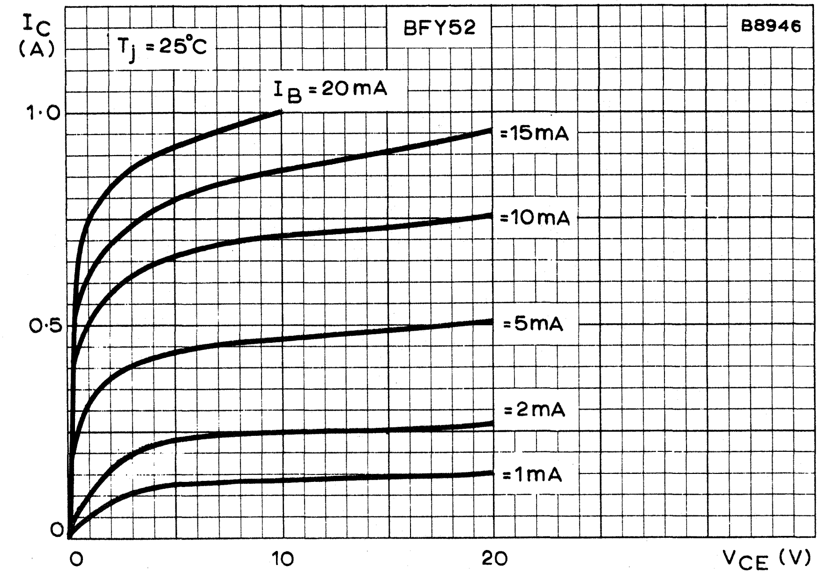

I_C (A)
T_j = 25°C
BFY52
B8946
I_B = 20 mA
= 15 mA
= 10 mA
= 5 mA
= 2 mA
= 1 mA
1·0
0·5
0
0
10
20
V_{CE} (V)

Fig. 13.

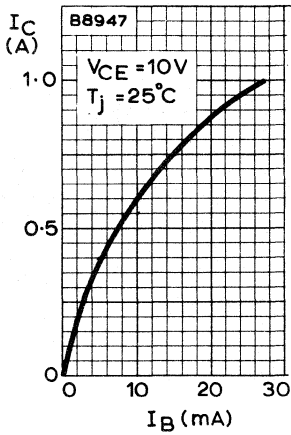


Fig. 14.

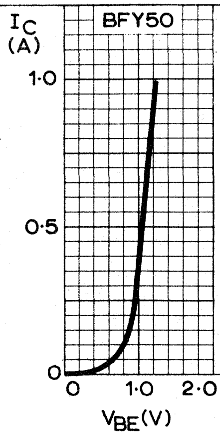


Fig. 15.

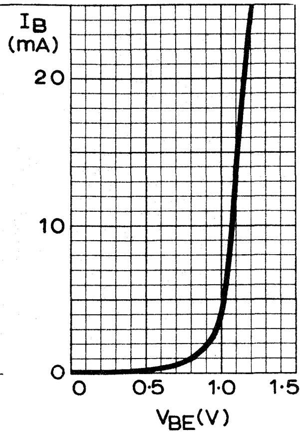


Fig. 16.

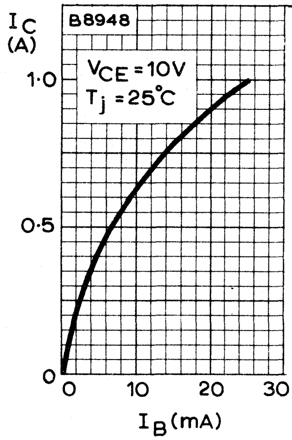


Fig. 17.

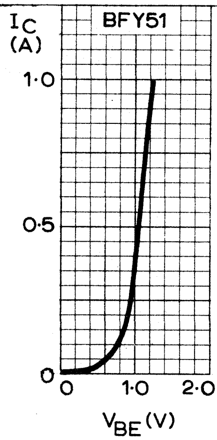


Fig. 18.

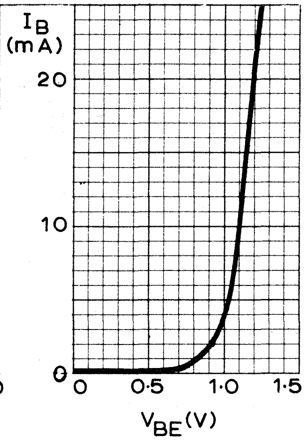


Fig. 19.

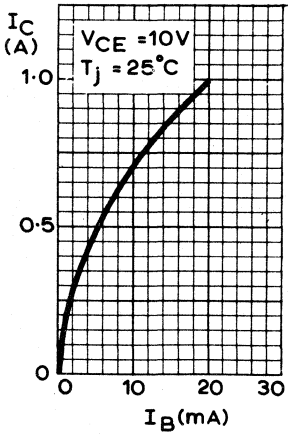


Fig. 20.

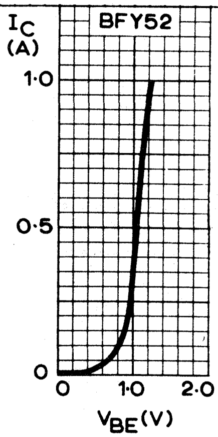


Fig. 21.

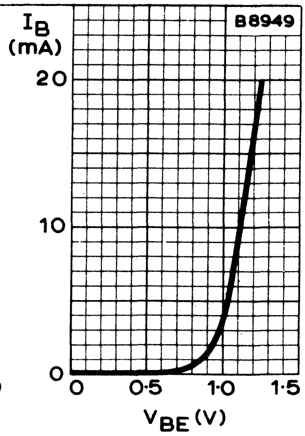


Fig. 22.

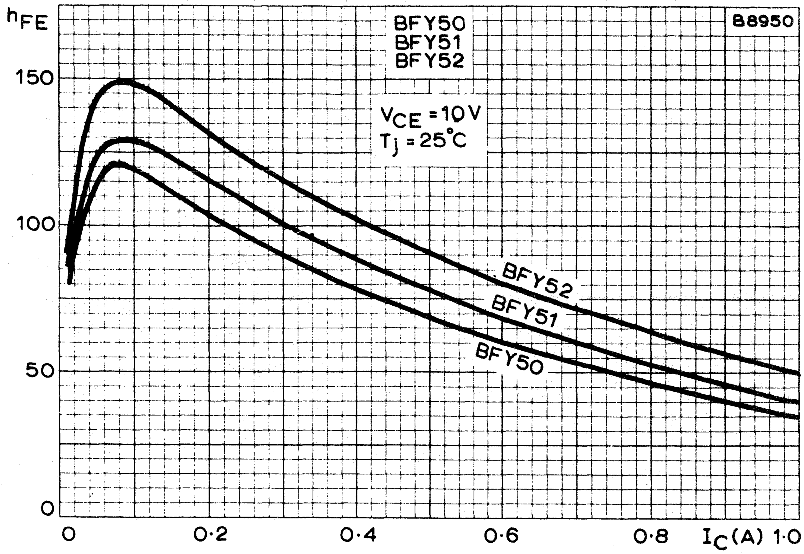

hFE
BFY50
BFY51
BFY52
B8950
VCE = 10 V
Tj = 25 °C
150
100
50
0
BFY52
BFY51
BFY50
0
0·2
0·4
0·6
0·8
IC (A) 1·0

Fig. 23.

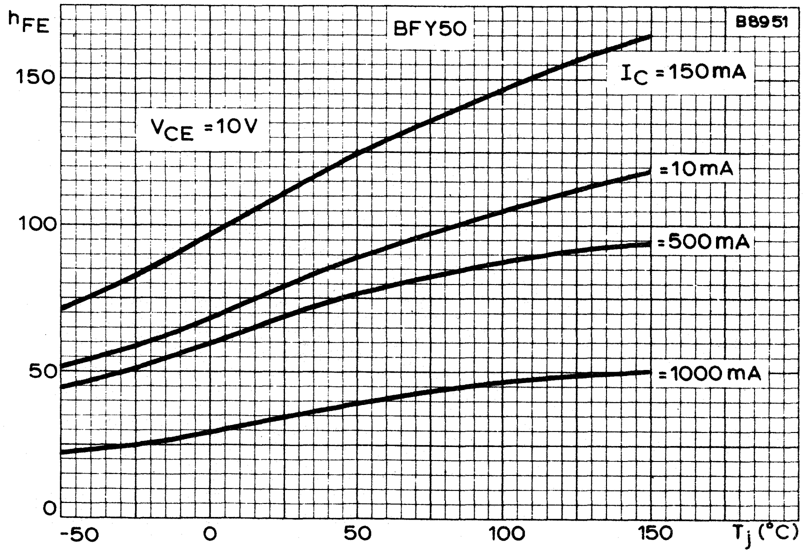

hFE
BFY50
B8951
IC = 150 mA
VCE = 10 V
= 10 mA
= 500 mA
= 1000 mA
150
100
50
0
-50
0
50
100
150
Tj (°C)

Fig. 24.

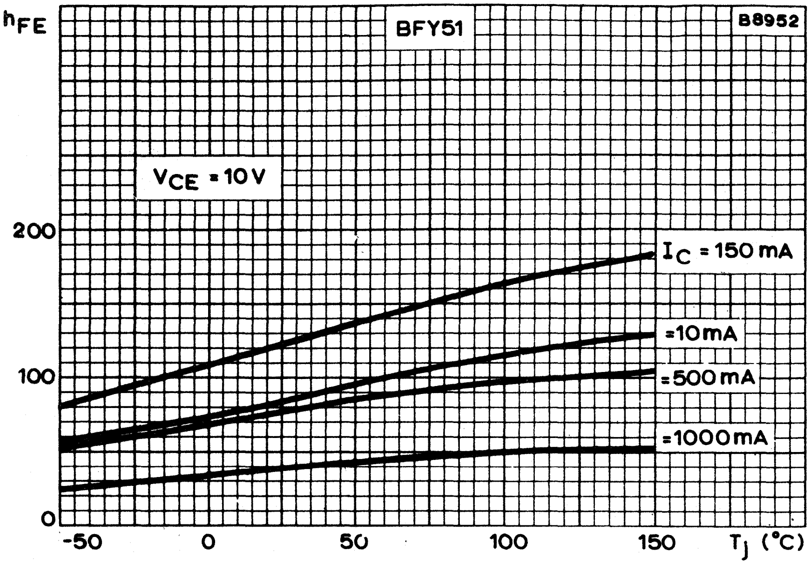

hFE
BFY51
B8952
VCE = 10 V
IC = 150 mA
= 10 mA
= 500 mA
= 1000 mA
200
100
0
-50
0
50
100
150
Tj (°C)

Fig. 25.

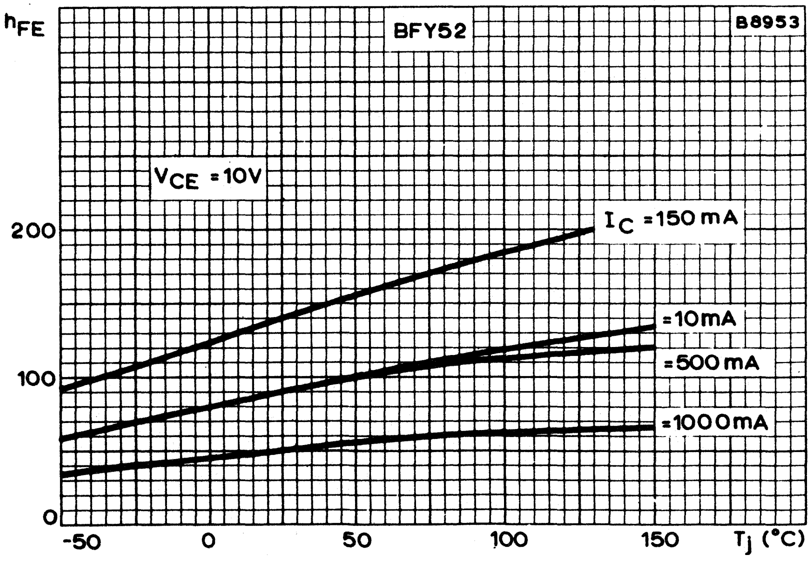

hFE
BFY52
B8953
VCE = 10V
IC = 150 mA
= 10 mA
= 500 mA
= 1000 mA
200
100
0
-50
0
50
100
150
Tj (°C)

Fig. 26.

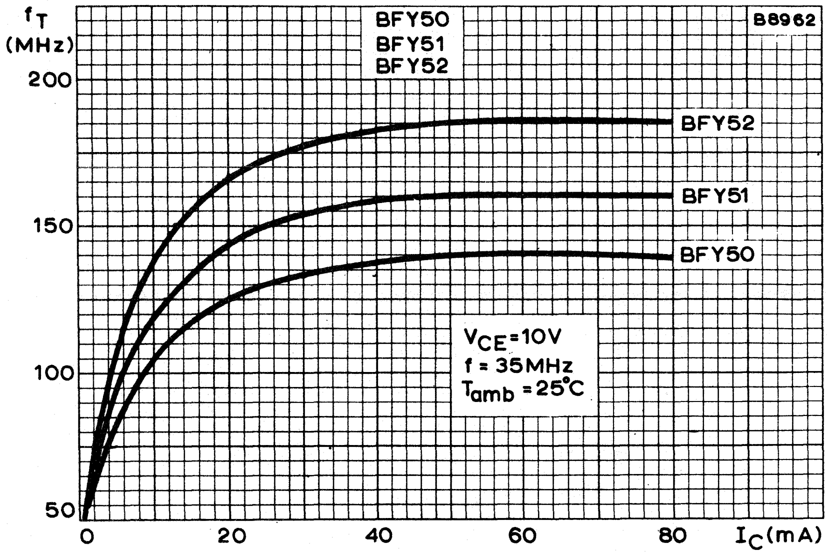


Fig. 27.

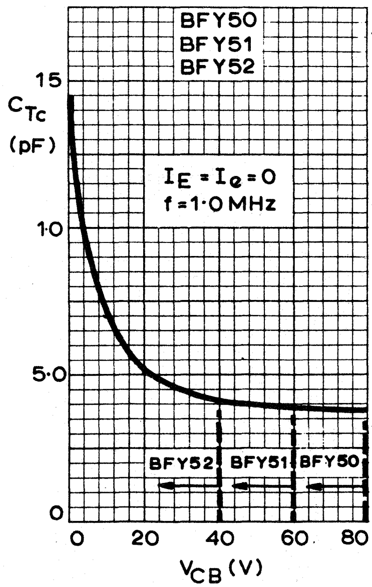


Fig. 28.

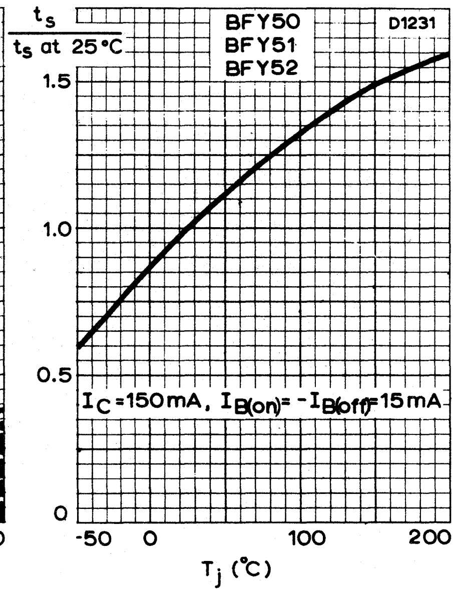


Fig. 29.

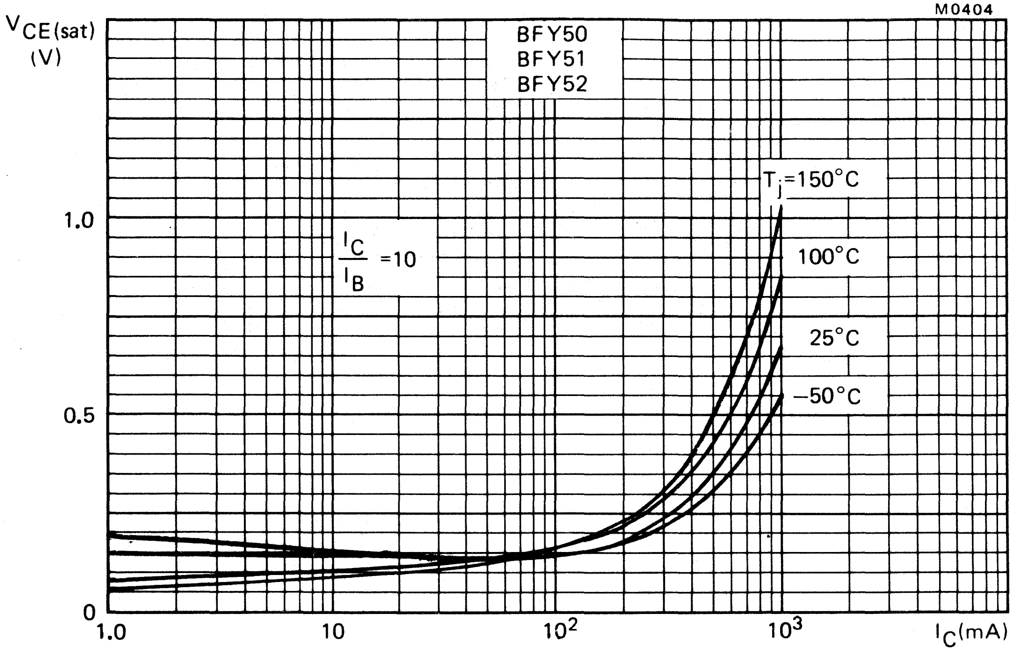

M0404
VCE(sat) (V)
BFY50
BFY51
BFY52
IC/IB =10
Tj=150°C
100°C
25°C
−50°C
1.0
0.5
0
1.0
10
10²
10³
IC(mA)

Fig. 30.

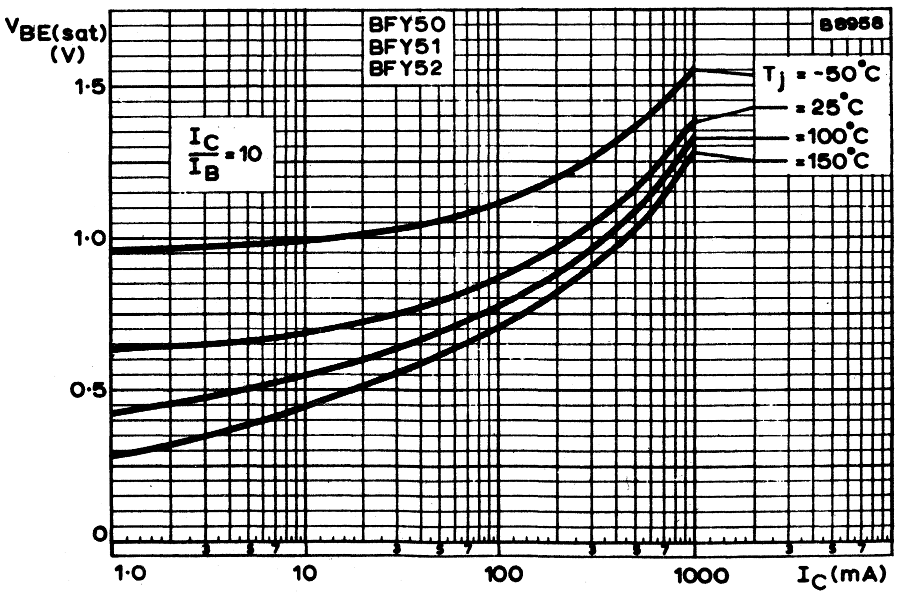

VBE(sat) (V)
BFY50
BFY51
BFY52
B8958
IC/IB = 10
Tj = -50°C
= 25°C
= 100°C
= 150°C
1·5
1·0
0·5
0
1·0
10
100
1000
IC (mA)

Fig. 31.

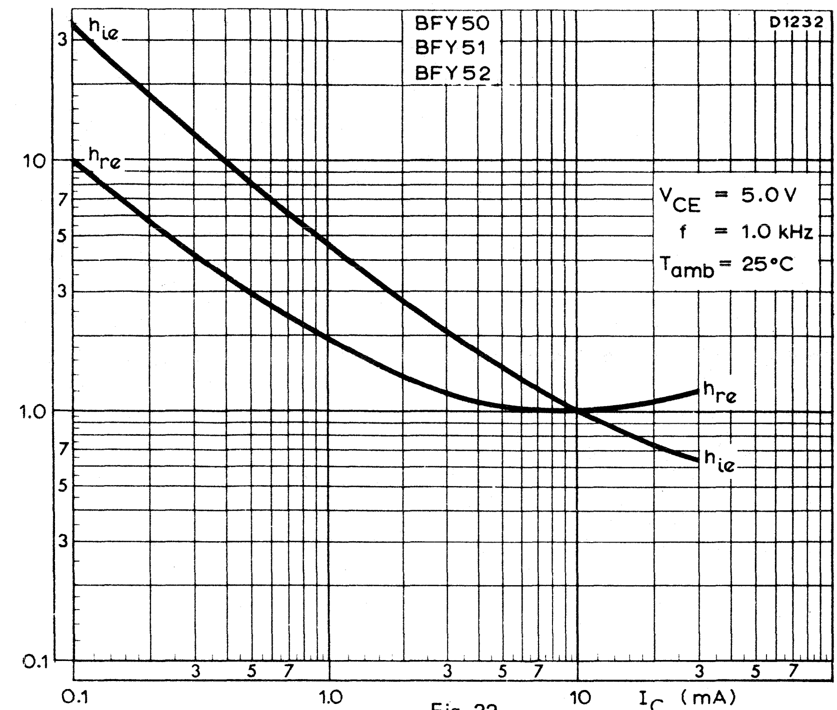

h_ie
h_re
BFY50
BFY51
BFY52
D1232
V_CE = 5.0 V
f = 1.0 kHz
T_amb = 25 °C
0.1
1.0
10
I_C (mA)

Fig. 32.

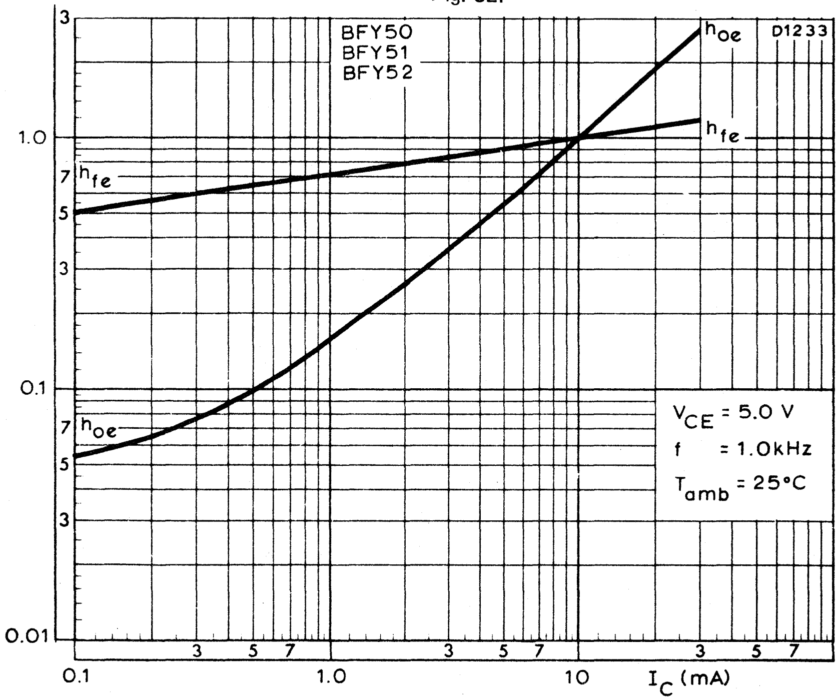

h_oe
h_fe
BFY50
BFY51
BFY52
D1233
V_CE = 5.0 V
f = 1.0 kHz
T_amb = 25 °C
0.01
0.1
1.0
10
I_C (mA)

Fig. 33.

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in TO-39 metal case with the collector connected to the case. It is primarily intended for use in high frequency and very high frequency oscillators and amplifiers as well as for output stages of servo amplifiers.

QUICK REFERENCE DATA

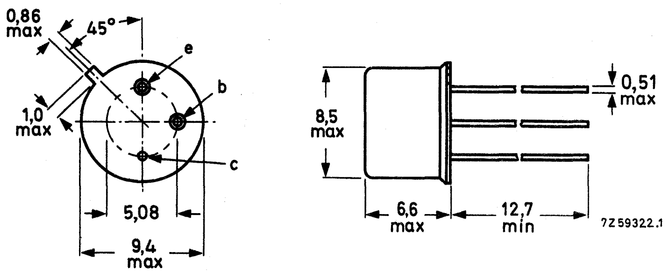
Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	V
Collector current (d.c.)	I_C	max.	1	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	800	mW
Junction temperature	T_j	max.	200	°C
D.C. current gain at T_j = 25 °C I_C = 150 mA; V_{CE} = 10 V	h_{FE}		40 to 120	
Transition frequency I_C = 50 mA; V_{CE} = 10 V	f_T	>	60	MHz
Collector-emitter saturation voltage I_C = 1 A; I_B = 100 mA	V_{CEsat}	<	1	V

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V
Collector current (d.c.)	I_C	max.	1	A
Collector current (peak value)	I_{CM}	max.	1	A
Emitter current (d.c.)	$-I_E$	max.	1	A
Emitter current (peak value)	$-I_{EM}$	max.	1	A
Total power dissipation up to T_{amb} = 40 ^{o}C	P_{tot}	max.	4	W
Total power dissipation without cooling fin up to T_{amb} = 25 ^{o}C	P_{tot}	max.	0,8	W
Storage temperature range	T_{stg}		–65 to +150	^{o}C
Junction temperature	T_j	max.	200	^{o}C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0,22	K/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0,035	K/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	10 nA
$I_E = 0$; $V_{CB} = 60$ V; $T_j = 150$ °C	I_{CBO}	<	10 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10 nA
Saturation voltages			
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0,2 V
$I_C = 1$ A; $I_B = 100$ mA *) **)	V_{CEsat}	<	1,0 V
	V_{BEsat}	<	1,6 V
Sustaining voltage			
$I_C = 30$ mA; $I_B = 0$ **	$V_{CEOsust}$	>	35 V
D.C. current gain **			
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	30
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}		40 to 120
$I_C = 1$ A; $V_{CE} = 10$ V	h_{FE}	>	15
Feedback time constant			
$I_C = 10$ mA; $V_{CB} = 10$ V; f = 4 MHz	r_b, C_c	<	800 ps
Collector capacitance at f = 500 kHz			
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	12 pF
Emitter capacitance at f = 500 kHz			
$I_C = I_c = 0$; $V_{EB} = 0,5$ V	C_e	<	80 pF
Transition frequency			
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	60 MHz

* Measured with a lead length of 1 cm.

** Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration = 300 μs; duty cycle $\delta < 0,01$.

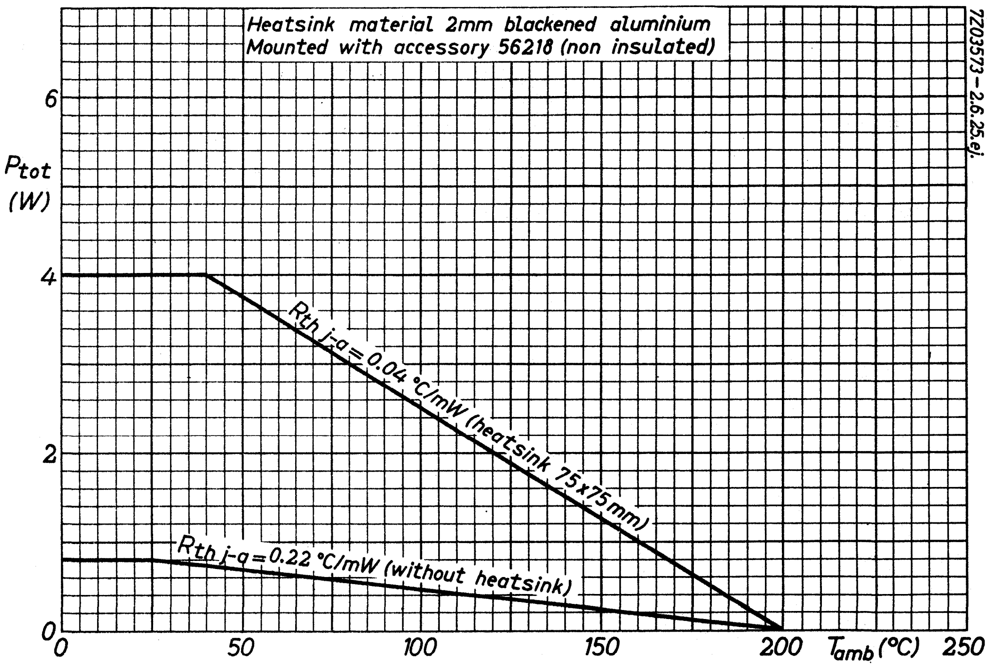

Heatsink material 2mm blackened aluminium
Mounted with accessory 56218 (non insulated)
7Z03573-2.6.25.ej.
P_{tot} (W)
6
4
2
0
$R_{th\ j-a}$ = 0.04 °C/mW (heatsink 75 x 75 mm)
$R_{th\ j-a}$ = 0.22 °C/mW (without heatsink)
0
50
100
150
200
T_{amb} (°C)
250

Fig. 2.

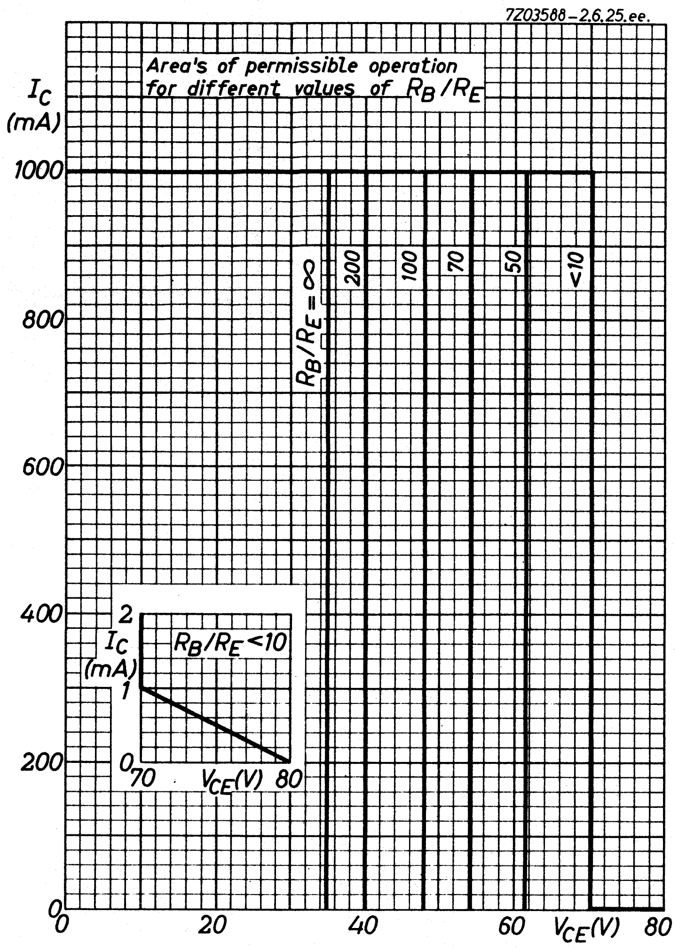

7Z03588-2.6.25.ee.
Area's of permissible operation for different values of R_B/R_E
I_C (mA)
1000
800
600
400
200
0
$R_B/R_E = \infty$
200
100
70
50
<10
0
20
40
60
V_{CE}(V)
80
2
I_C (mA)
1
0
R_B/R_E<10
70
V_{CE}(V)
80

Fig. 3.

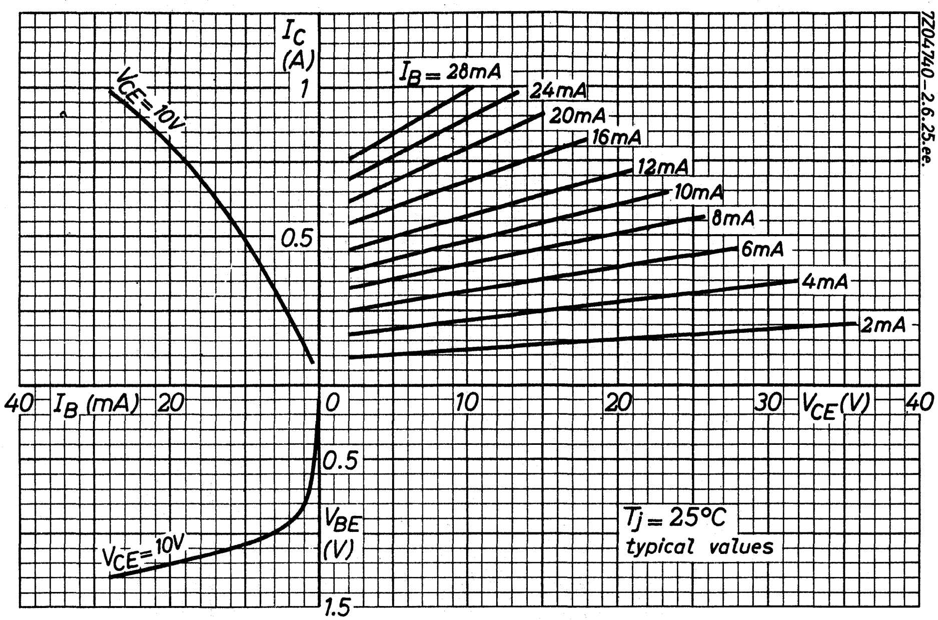

I_C (A)
1
0.5
I_B = 28mA
24mA
20mA
16mA
12mA
10mA
8mA
6mA
4mA
2mA
V_{CE} = 10V
40 I_B (mA) 20
0 10 20 30 V_{CE}(V) 40
0.5
V_{BE} (V)
1.5
V_{CE} = 10V
T_j = 25°C
typical values
7Z04140 – 2.6.25.ee.

Fig. 4.

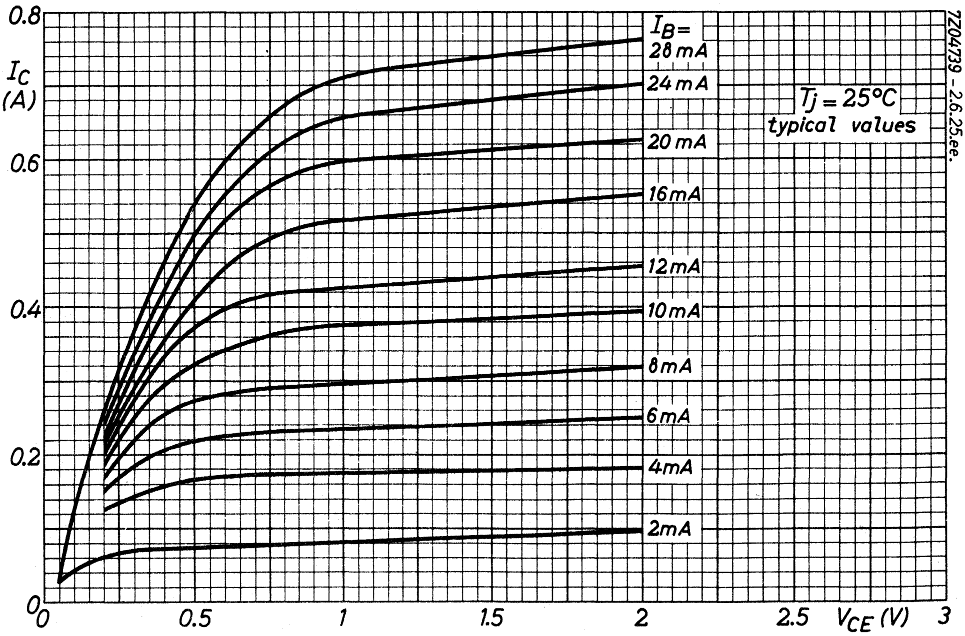

0.8
I_C (A)
0.6
0.4
0.2
0
0 0.5 1 1.5 2 2.5 V_{CE} (V) 3
I_B = 28 mA
24 mA
20 mA
16mA
12mA
10mA
8mA
6mA
4mA
2mA
T_j = 25°C
typical values
7Z04139 – 2.6.25.ee.

Fig. 5.

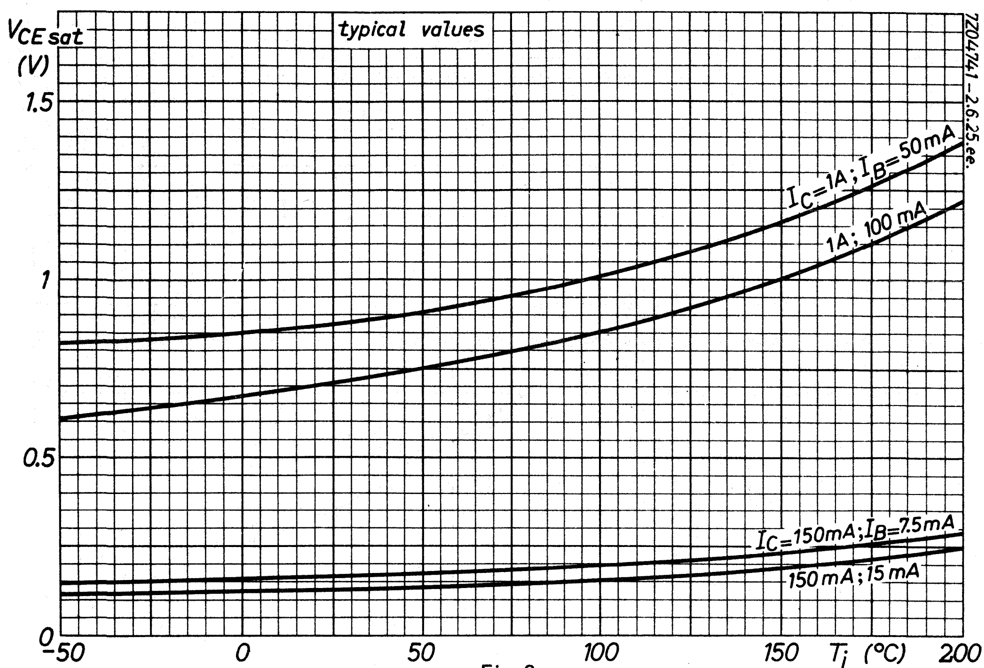

$V_{CE\,sat}$ (V)
typical values
7Z04741-2.6.25.ee.
I_C=1A; I_B=50mA
1A; 100 mA
I_C=150mA; I_B=7.5mA
150 mA; 15 mA
1.5
1
0.5
0
−50
0
50
100
150
200
T_j (°C)

Fig. 6.

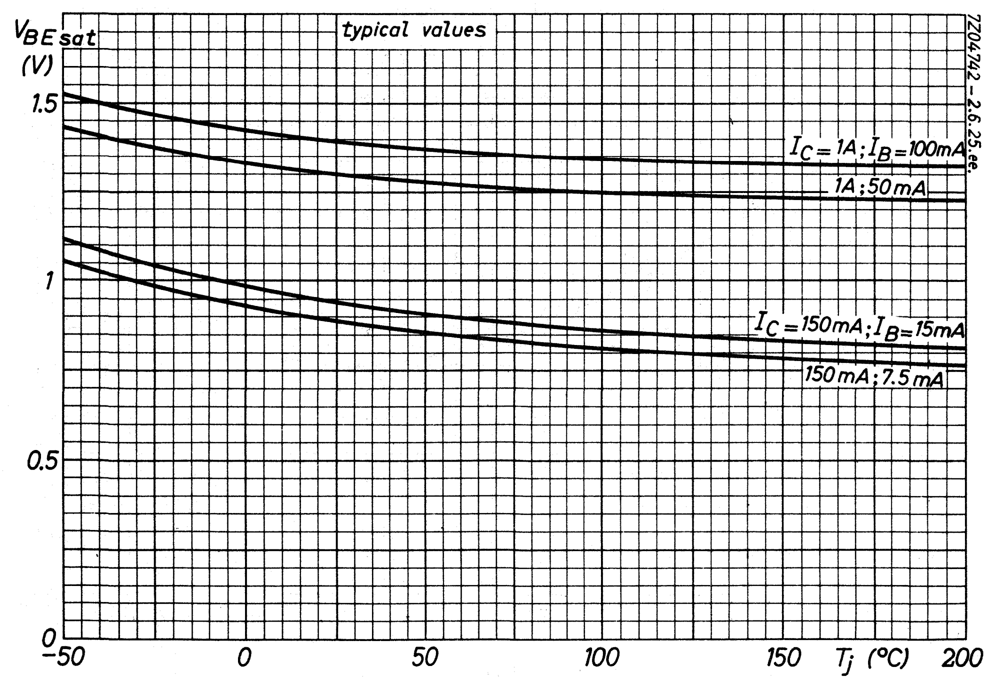

$V_{BE\,sat}$ (V)
typical values
7Z04742-2.6.25.ee.
I_C=1A; I_B=100mA
1A; 50mA
I_C=150mA; I_B=15mA
150mA; 7.5mA
1.5
1
0.5
0
−50
0
50
100
150
200
T_j (°C)

Fig. 7.

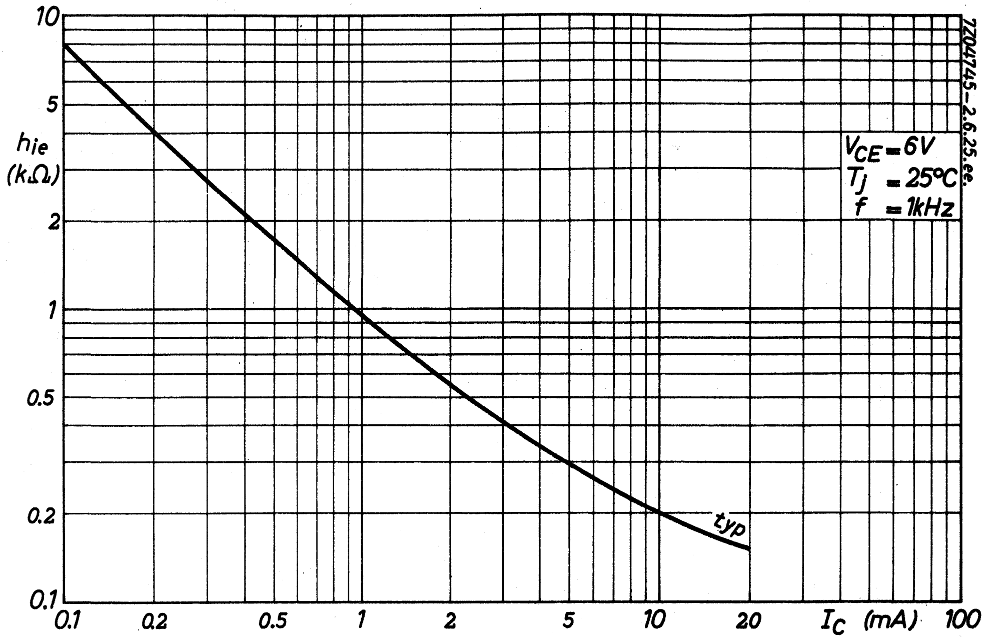

7Z04745-2.6.25.ee.
V_{CE} = 6V
T_j = 25°C
f = 1kHz
h_{ie} (kΩ)
typ
I_C (mA)
10
5
2
1
0.5
0.2
0.1
0.1
0.2
0.5
1
2
5
10
20
100

Fig. 8.

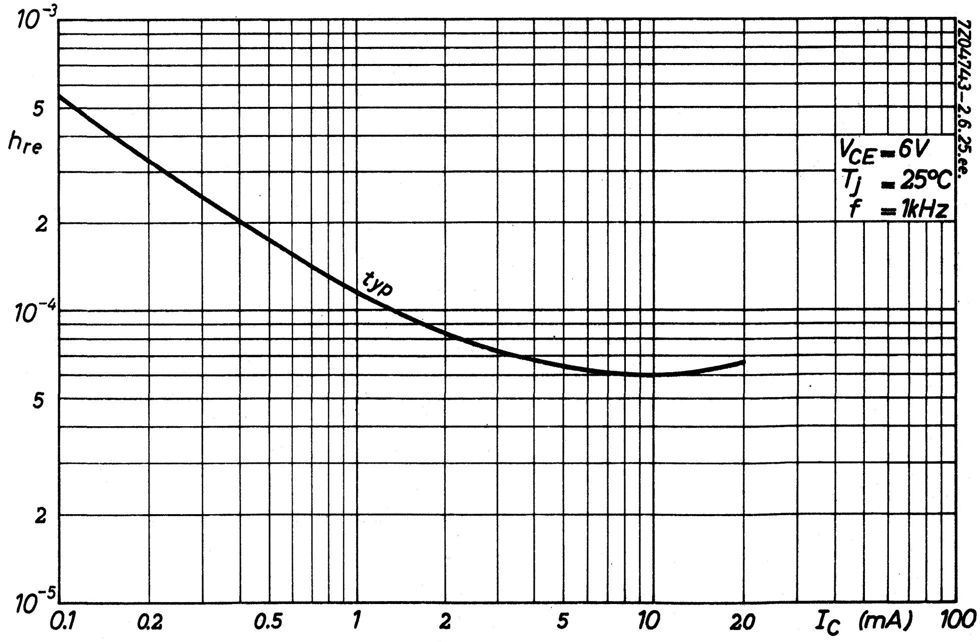

7Z04743-2.6.25.ee.
V_{CE} = 6V
T_j = 25°C
f = 1kHz
h_{re}
typ
I_C (mA)
10^{-3}
5
2
10^{-4}
5
2
10^{-5}
0.1
0.2
0.5
1
2
5
10
20
100

Fig. 9.

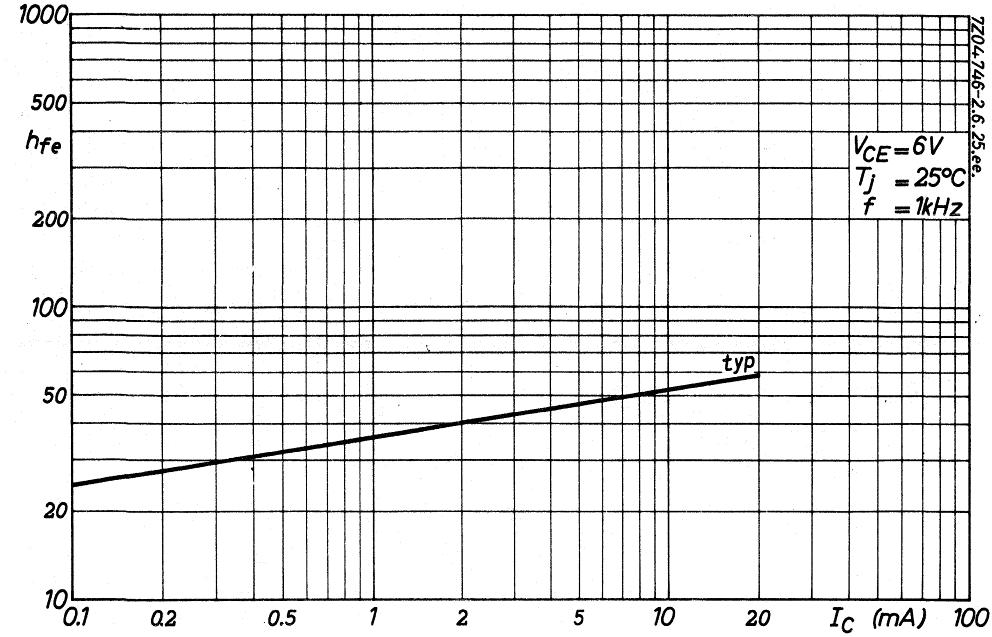

1000
500
h_{fe}
200
100
50
20
10
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100
typ
$V_{CE} = 6V$
$T_j = 25°C$
$f = 1kHz$
7Z04746-2.6.25.ee.

Fig. 10.

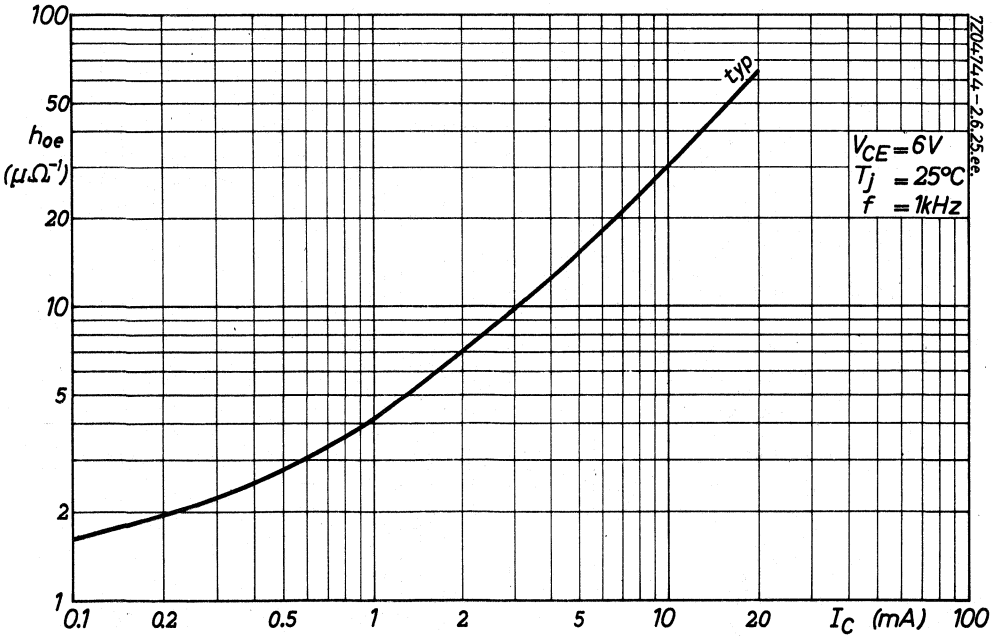

100
50
h_{oe}
($\mu\Omega^{-1}$)
20
10
5
2
1
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100
typ
$V_{CE} = 6V$
$T_j = 25°C$
$f = 1kHz$
7Z04744-2.6.25.ee.

Fig. 11.

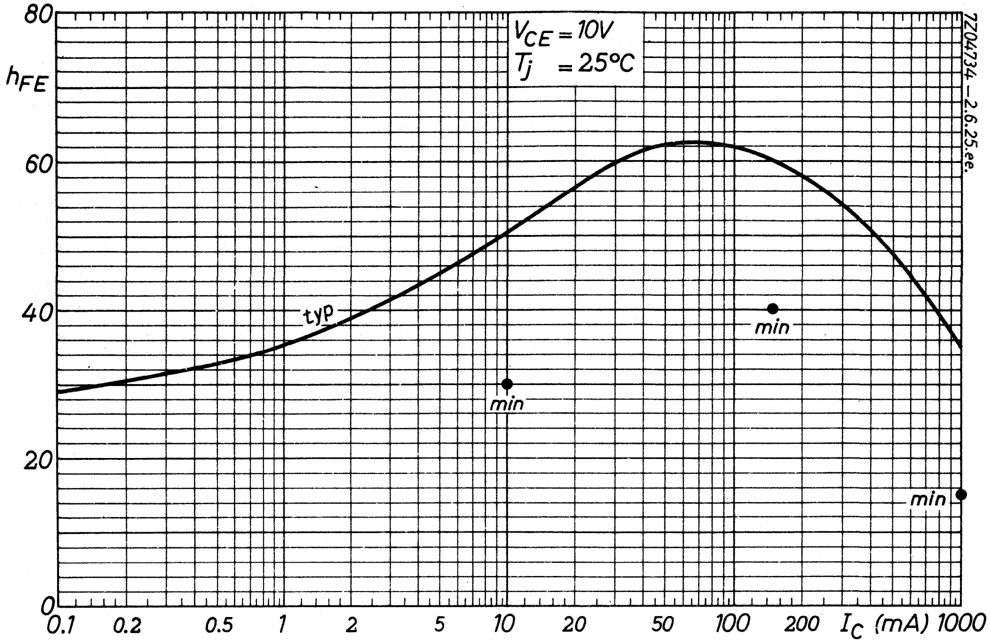

80
60
40
20
0
hFE
VCE = 10V
Tj = 25°C
typ
min
min
min
0.1
0.2
0.5
1
2
5
10
20
50
100
200
IC (mA) 1000
7Z04734–2.6.25.ee.

Fig. 12.

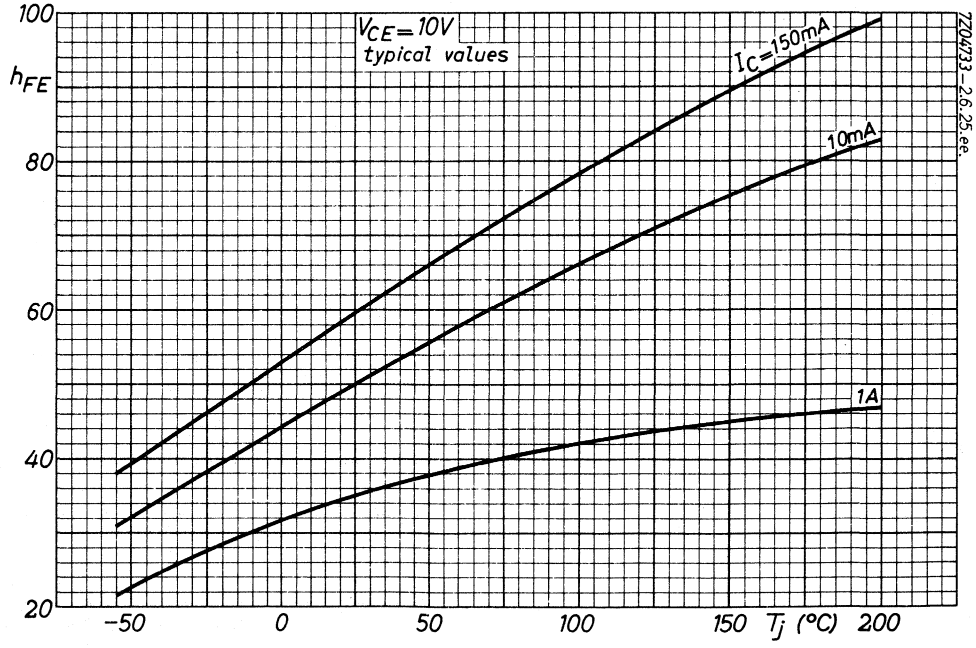
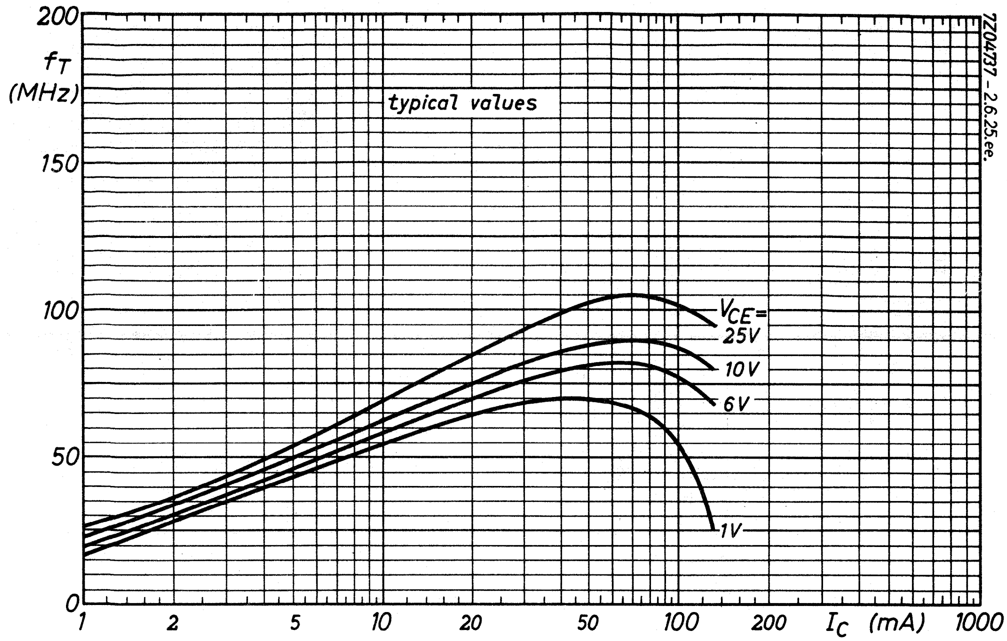
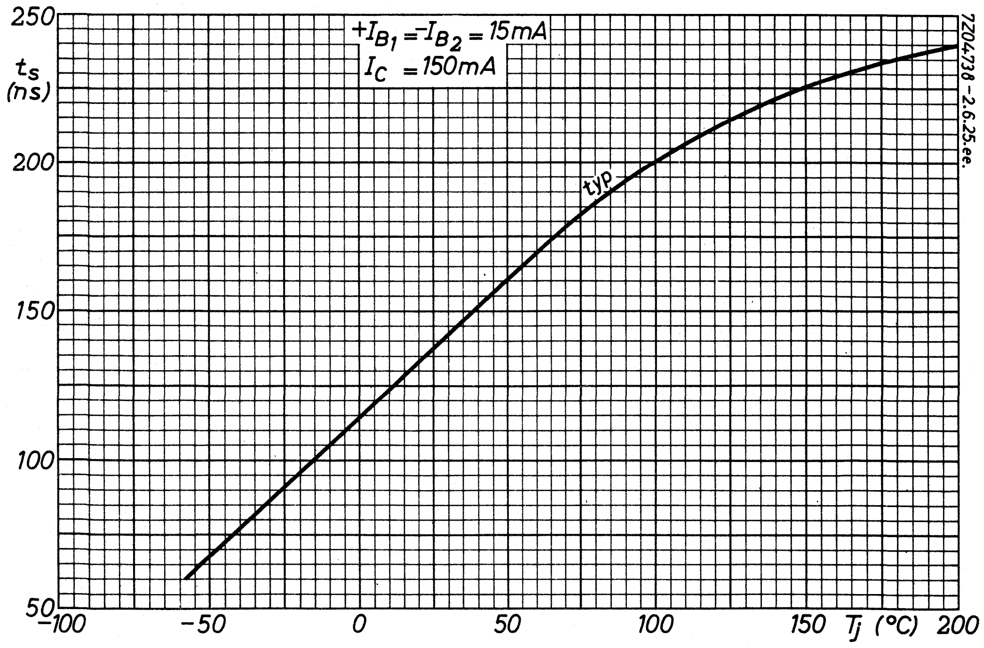

100
80
60
40
20
hFE
VCE = 10V
typical values
IC = 150mA
10mA
1A
−50
0
50
100
150
Tj (°C)
200
7Z04733–2.6.25.ee.

Fig. 13.



200
f_T
(MHz)
typical values
150
100
50
0
V_{CE}=
25V
10V
6V
1V
1
2
5
10
20
50
100
200
I_C (mA)
1000
7Z04737 - 2.6.25.ee.

Fig. 14.



250
t_s
(ns)
$+I_{B1} = -I_{B2} = 15mA$
$I_C = 150mA$
typ
200
150
100
50
−100
−50
0
50
100
150
T_j (°C)
200
7Z04738 - 2.6.25.ee.

Fig. 15.

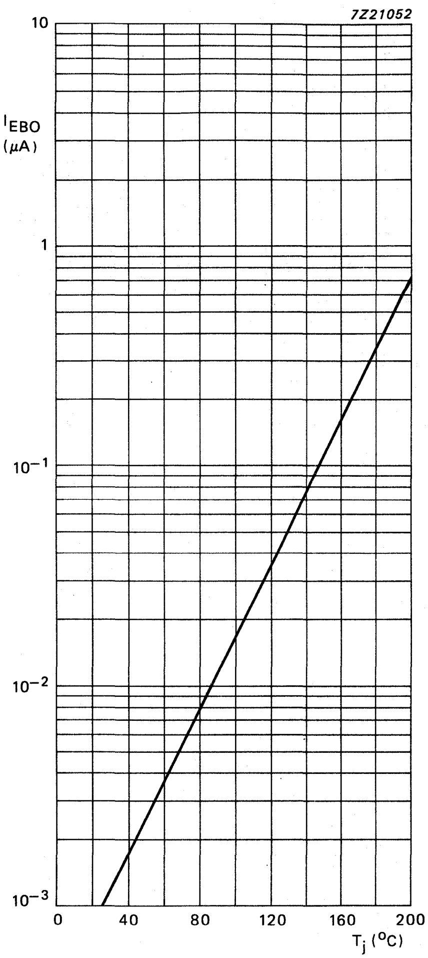


Fig. 16 V_{EB} = 5 V; typical values.

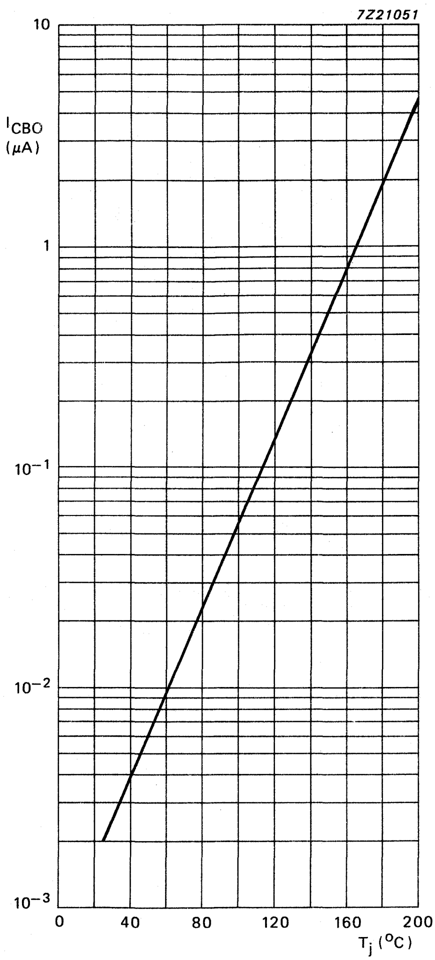


Fig. 17 V_{CB} = 60 V; typical values.

SILICON CONTROLLED SWITCH

The BR101 is a planar p-n-p-n switch in a TO-72 metal envelope, intended for time base circuits and other television applications. It is also suitable as trigger device for thyristors. It is an integrated p-n-p/n-p-n transistor pair of which all electrodes are accessible. The collector of the n-p-n transistor is connected to the case.

QUICK REFERENCE DATA

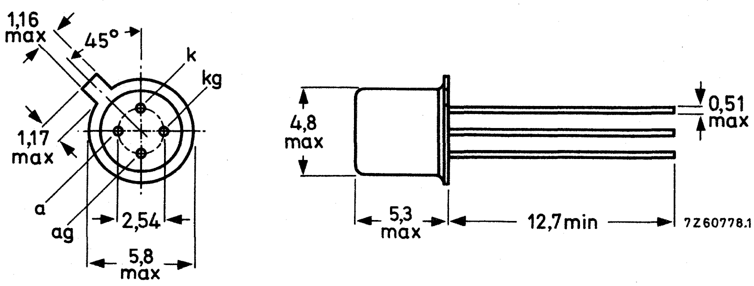
p-n-p transistor				
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	50	V
n-p-n transistor				
Collector-base voltage (open emitter)	V_{CBO}	max.	50	V
Repetitive peak emitter current (peak value)	$-I_{ERM}$	max.	2,5	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	275	mW
Junction temperature	T_j	max.	150	°C
Forward on-state voltage I_A = 50 mA; I_{AG} = 0; $R_{KG\text{-}K}$ = 10 kΩ	V_{AK}	$<$	1,4	V
Holding current I_{AG} = 10 mA; $-V_{BB}$ = 2 V; $R_{KG\text{-}K}$ = 10 kΩ	I_H	$<$	1,0	mA

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-72.

Collector of the n-p-n transistor (ag = anode gate) connected to the case



RATINGS

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

			p-n-p	n-p-n	
Collector-base voltage (open emitter)	V_{CBO}	max.	−50	50	V
Collector-emitter voltage (R_{BE} = 10 kΩ)	V_{CER}	max.	−	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	−50	−	V
Emitter-base voltage (open collector)	V_{EBO}	max.	−50	5	V *
Emitter current (d.c.)	I_E	max.	175	−175	mA
Repetitive peak emitter current (peak value) t_p = 10 μs; δ = 0,01	I_{ERM}	max.	2,5	−2,5	A
Collector current (d.c.)	I_C	max.	−	175	mA **
Collector current (peak value)	I_{CM}	max.	−	175	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	275		mW
Storage temperature range	T_{stg}		−65 to +150		°C
Operating junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0,45	K/mW

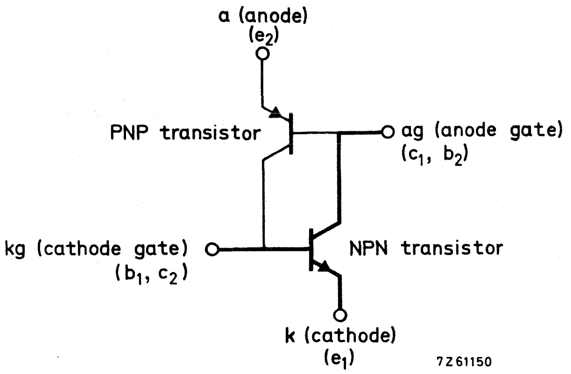
* Exceeding of this voltage is allowed during the discharge of a capacitor of max. 390 pF, provided the charge does not exceed 50 nC.

** Provided the I_E rating will not be exceeded.

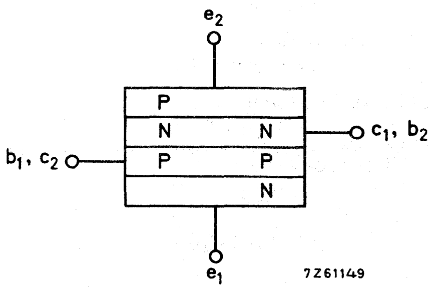
MEANING OF SYMBOLS, used in the schematic presentation of the S.C.S.

2 transistors equivalent circuit

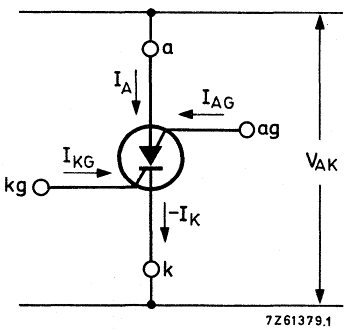
n-p-n transistor + p-n-p transistor



p-n-p-n S.C.S. equivalent circuit



S.C.S. symbol



CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Individual N-P-N transistor

Collector cut-off current			
V_{CE} = 50 V; R_{BE} = 10 kΩ	I_{CER}	<	0,5 μA
V_{CE} = 50 V; R_{BE} = 10 kΩ; T_j = 150 °C	I_{CER}	<	50 μA
Emitter cut-off current			
I_C = 0; V_{EB} = 5 V; T_j = 150 °C	I_{EBO}	<	50 μA

CHARACTERISTICS (continued)

Individual N-P-N transistor

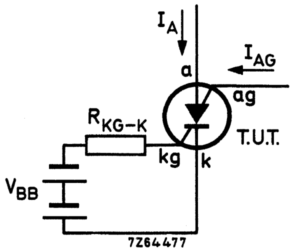
Saturation voltages I_C = 10 mA; I_B = 1 mA	V_{CEsat} V_{BEsat}	< <	500 mV 900 mV
D.C. current gain I_C = 10 mA; V_{CE} = 2 V	h_{FE}	>	50
Transition frequency I_C = 10 mA; V_{CE} = 2 V	f_T	typ.	300 MHz
Collector capacitance $I_E = I_e = 0$; V_{CB} = 20 V	C_c	<	5 pF
Emitter capacitance $I_C = I_c = 0$; V_{EB} = 1 V	C_e	<	25 pF

Individual P-N-P transistor

Collector cut-off current $I_B = 0$; $-V_{CE}$ = 50 V; T_j = 150 °C	$-I_{CEO}$	<	50 µA
Emitter cut-off current $I_C = 0$; $-V_{EB}$ = 50 V; T_j = 150 °C	$-I_{EBO}$	<	50 µA
D.C. current gain I_E = 1 mA; V_{CB} = 0	h_{FE}		0,25 to 2,5

Combined device

Forward on-state voltage at $R_{KG\text{-}K}$ = 10 kΩ I_A = 50 mA; I_{AG} = 0	V_{AK}	<	1,4 V
I_A = 1 mA; I_{AG} = 10 mA	V_{AK}	<	1,2 V
Holding current at $R_{KG\text{-}K}$ = 10 kΩ I_{AG} = 10 mA; $-V_{BB}$ = 2 V	I_H	<	1,0 mA



Philips Components

Data sheet	
status	Preliminary specification
date of issue	December 1990

BRY39
Programmable unijunction transistor

DESCRIPTION

A planar pnpn trigger device in a TO-72 metal envelope, intended for use in switching applications such as motor control, oscillators, relay replacement, timers, pulse shapers, etc.

PINNING

Anode gate (ag) connected to case.

PIN	DESCRIPTION
1	cathode
2	cathode gate
3	anode gate
4	anode

ACCESSORIES

56246 (distance disc).

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{GA}	gate-anode voltage		–	70	V
I_A	anode current	DC value up to T_{amb} = 25 °C	–	175	mA
T_j	operating junction temperature		–	150	°C
$I_{(P)}$	peak point current	V_S = 10 V R_G = 10 kΩ	–	0.2	µA

PIN CONFIGURATION

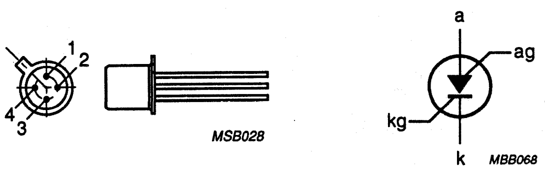


Fig.1 Simplified outline and symbol.

Programmable unijunction transistor

BRY39

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{GA}	gate-anode voltage		–	70	V
I_A	anode current	average value up to T_{amb} = 25 °C	–	175	mA
I_{ARM}	repetitive peak anode current	t_p = 10 µs δ = 0.01	–	2.5	A
I_{ASM}	non-repetitive peak anode current	t_p = 10 µs T_j = 150 °C	–	3	A
dI_A/dt	rate of rise of anode current	up to I_A = 2.5 A	–	20	A/µs
P_{tot}	total power dissipation	up to T_{amb} = 25 °C	–	275	mW
T_{stg}	storage temperature range		–65	200	°C
T_j	junction temperature		–	150	°C
T_{amb}	ambient operating temperature range		–65	150	°C

THERMAL RESISTANCE

SYMBOL	PARAMETER	MAX.	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient in free air	450	K/W

EXPLANATION OF SYMBOLS

For application of the BRY39 as a programmable unijunction transistor, only the anode gate is used. To simplify the symbols, the term gate, instead of anode gate, will be used (see Fig.2).

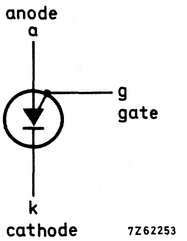


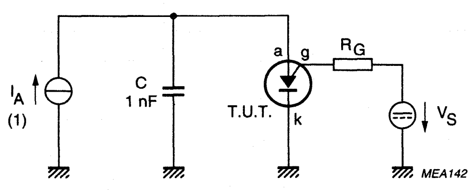
Fig.2 Explanation of symbols.

Programmable unijunction transistor BRY39

CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{(P)}$	peak point current (see Figs 3 and 8)	V_S = 10 V R_G = 10 kΩ	–	–	0.2	µA
		V_S = 10 V R_G = 100 kΩ	–	–	0.06	µA
$I_{(V)}$	valley point current (see Figs 3 and 8)	V_S = 10 V R_G = 10 kΩ	–	–	2	µA
		V_S = 10 V R_G = 100 kΩ	–	–	1	µA
V_{offset}	offset voltage (for V_P and V_S, see Fig.8)	typical curve I_A = 0	–	V_P–V_S	–	V
I_{GAO}	gate-anode leakage current	I_K = 0 V_{GA} = 70 V	–	–	10	nA
I_{GKS}	gate-cathode leakage current	V_{AK} = 0 V_{KG} = 70 V	–	–	100	nA
V_{AK}	anode-cathode voltage	I_A = 100 mA	–	–	1.4	V
V_{OM}	peak output voltage (see Figs 9 and 10)	V_{AA} = 20 V C = 10 nF	6	–	–	V
t_r	rise time (see Fig.10)	V_{AA} = 20 V C = 10 nF	–	–	80	ns



(1) Controllable current source.

Fig.3 Test circuit for peak and valley point currents.

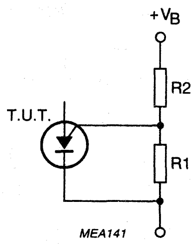


Fig.4 BRY39 with 'program' resistors R1 and R2.

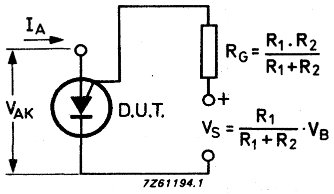


Fig.5 Equivalent test circuit for characteristics testing.

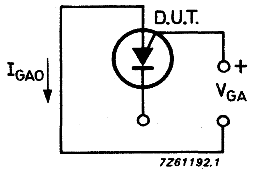


Fig.6 Equivalent test circuit for gate-anode leakage current.

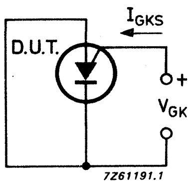


Fig.7 Equivalent test circuit for gate-cathode leakage current.

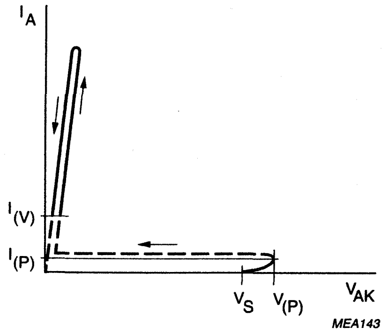


Fig.8 Offset voltage.

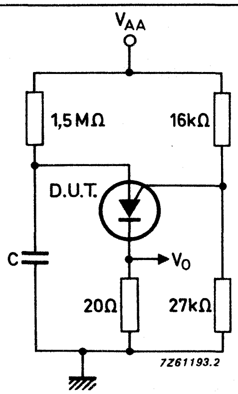


Fig.9 Test circuit for peak output voltage.

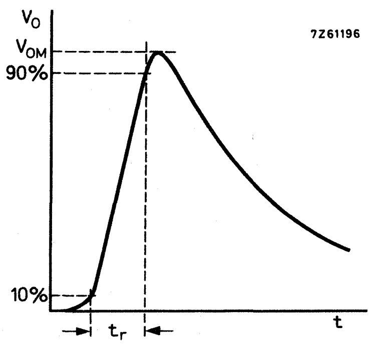
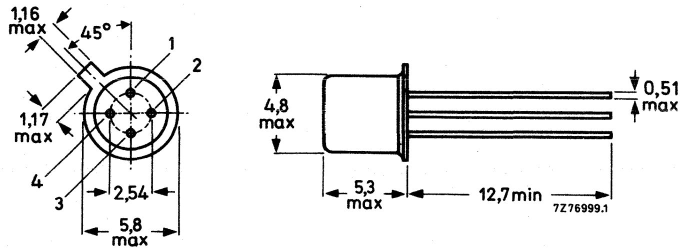


Fig.10 Peak output voltage.

Programmable unijunction transistor

BRY39

PACKAGE OUTLINE



Dimensions in mm.

Fig.11 TO-72.

Philips Components

Data sheet	
status	Preliminary specification
date of issue	December 1990

BRY39
Silicon controlled switch

DESCRIPTION

A silicon planar pnpn switch in a TO-72 metal envelope, intended for use in switching applications. It is an integrated pnp/npn transistor pair, with all electrodes accessible.

PINNING - TO-72

Collector of the npn transistor (ag, anode gate) connected to case.

PIN	DESCRIPTION
1	cathode
2	cathode gate
3	anode gate
4	anode

ACCESSORIES

56246 (distance disc).

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
PNP transistor					
$-V_{EBO}$	emitter-base voltage		–	70	V
NPN transistor					
V_{CBO}	collector-base voltage		–	70	V
$-I_{ERM}$	repetitive peak emitter current		–	2.5	A
P_{tot}	total power dissipation	up to T_{amb} = 25 °C	–	275	mW
T_j	operating junction temperature		–	150	°C
V_{AK}	forward on-state voltage	I_A = 50 mA I_{AG} = 0 R_{KG-K} = 10 kΩ	–	1.4	V
I_H	holding current	I_{AG} = 10 mA $-V_{BB}$ = 2 V R_{KG-K} = 10 kΩ	–	1	mA
t_{on}	turn-on time		–	0.25	µs
t_{off}	turn-off time		15	–	µs

PIN CONFIGURATION

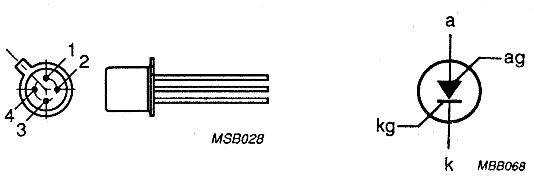


Fig.1 Simplified outline and symbol.

TEST CIRCUITS

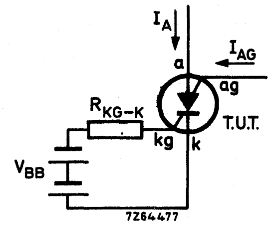


Fig.2 Equivalent test circuit for holding current.

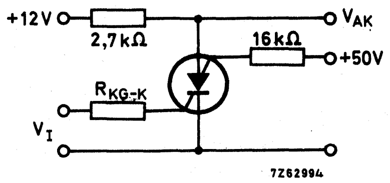


Fig.3 Test circuit for turn-on time.

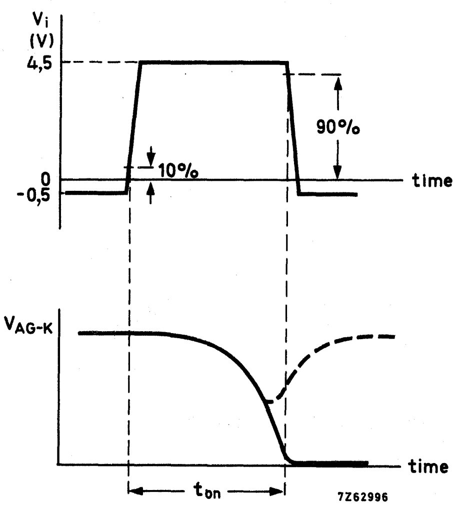


Fig.4 Pulse duration increased until dashed curve disappears.

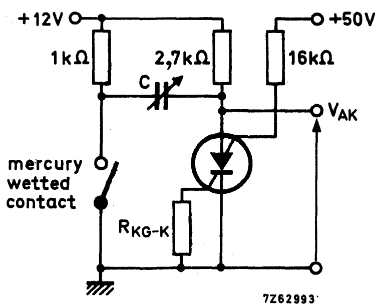


Fig.5 Test circuit for turn-off time.

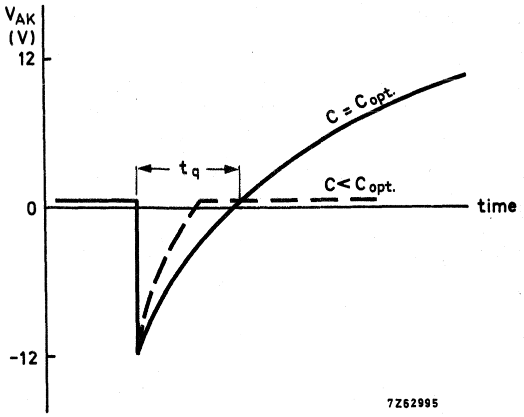


Fig.6 Capacitance increased until C = C_{opt} dashed curve disappears.

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter			
	pnp		–	–70	V
	npn		–	70	V
V_{CER}	collector-emitter voltage	R_{BE} = 10 kΩ			
	pnp		–	–	
	npn		–	70	V
V_{CEO}	collector-emitter voltage	open base			
	pnp		–	–70	V
	npn		–	–	
V_{EBO}	emitter-base voltage	open collector			
	pnp		–	–70	V
	npn		–	5	V
I_C	collector current (note 1)	DC value			
	pnp		–	–	
	npn		–	175	mA
I_{CM}	collector current (note 2)	peak value			
	pnp		–	–	
	npn		–	175	mA
I_E	emitter current	DC value			
	pnp		–	175	mA
	npn		–	–175	mA
I_{ERM}	repetitive peak emitter current	t_p = 10 μs δ = 0.01			
	pnp		–	2.5	A
	npn		–	–2.5	A
P_{tot}	total power dissipation	up to T_{amb} = 25 °C	–	275	mW
T_{stg}	storage temperature range		–65	200	°C
T_j	junction temperature		–	150	°C
T_{amb}	ambient operating temperature range		–65	150	°C

Notes

1. Provided the I_E rating is not exceeded.
2. During switch-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.

THERMAL RESISTANCE

SYMBOL	PARAMETER	MAX.	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient in free air	450	K/W

Silicon controlled switch BRY39

CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Individual npn transistor						
I_{CER}	collector cut-off current	V_{CE} = 70 V R_{BE} = 10 kΩ	–	–	100	nA
		V_{CE} = 70 V R_{BE} = 10 kΩ T_j = 150 °C	–	–	10	μA
I_{EBO}	emitter cut-off current	V_{EB} = 5 V I_C = 0 T_j = 150 °C	–	–	10	μA
V_{CEsat}	collector-emitter saturation voltage	I_C = 10 mA I_B = 1 mA	–	–	500	mV
V_{BEsat}	base-emitter saturation voltage	I_C = 10 mA I_B = 1 mA	–	–	900	mV
h_{FE}	DC current gain	I_C = 10 mA V_{CE} = 2 V	50	–	–	
f_T	transition frequency	I_C = 10 mA V_{CE} = 2 V f = 100 MHz	–	170	–	MHz
C_c	collector capacitance	$I_E = I_e$ = 0 V_{CB} = 20 V	–	–	5	pF
C_e	emitter capacitance	$I_E = I_e$ = 0 V_{EB} = 1 V	–	–	25	pF
Individual pnp transistor						
$-I_{CEO}$	collector cut-off current	$-V_{CE}$ = 70 V I_B = 0 T_j = 150 °C	–	–	10	μA
$-I_{EBO}$	emitter cut-off current	$-V_{EB}$ = 70 V I_C = 0 T_j = 150 °C	–	–	10	μA
h_{FE}	DC current gain	I_E = 1 mA V_{CB} = 0	–	5	–	
Combined device						
V_{AK}	forward on-state voltage	R_{KG-K} = 10 kΩ I_A = 50 mA I_{AG} = 0	–	–	1.4	V
		R_{KG-K} = 10 kΩ I_A = 50 mA I_{AG} = 0 T_j = –55 °C	–	–	1.9	V
		R_{KG-K} = 10 kΩ I_A = 1 mA I_{AG} = 10 mA	–	–	1.2	V

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_H	holding current (see Fig.2)	R_{KG-K} = 10 kΩ I_{AG} = 10 mA $-V_{BB}$ = 2 V	–	–	1	mA
Switching times						
t_{on}	turn-on time	V_{KG-K} = −0.5 to 4.5 V R_{KG-K} = 1 kΩ	–	–	0.25	µs
		V_{KG-K} = −0.5 to 4.5 V R_{KG-K} = 10 kΩ	–	–	1.5	µs
t_{off}	turn-off time	R_{KG-K} = 10 kΩ	–	15	–	µs

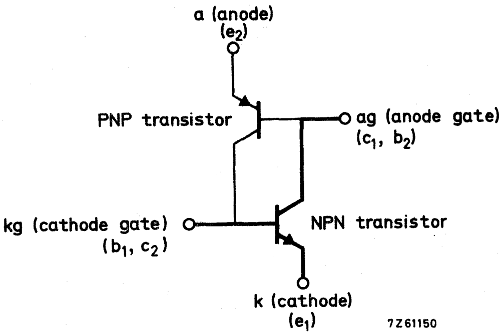


Fig.7 Two transistor equivalent circuit.

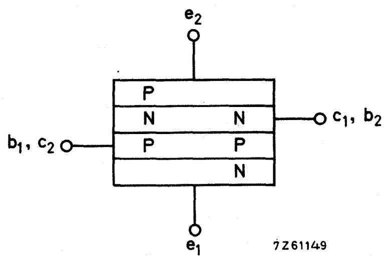


Fig.8 PNPN silicon controlled switch structure.

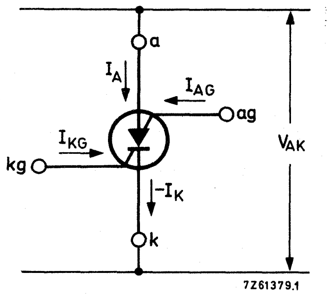
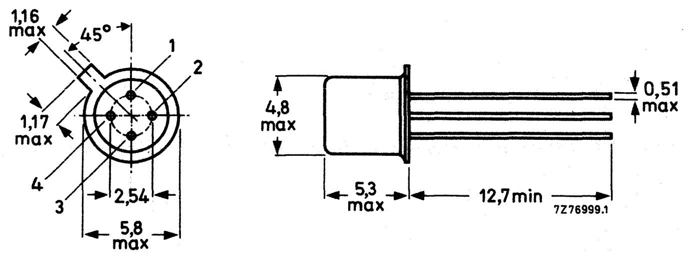


Fig.9 ·con controlled switch symbol.

PACKAGE OUTLINE



Dimensions in mm.

Fig.10 TO-72.

PROGRAMMABLE UNIJUNCTION TRANSISTOR

Silicon planar PNPN trigger device in a plastic TO-92 envelope, intended for use in switching applications such as motor control, oscillators, relay replacement, timers, pulse shaper etc.

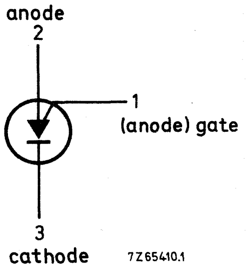
QUICK REFERENCE DATA

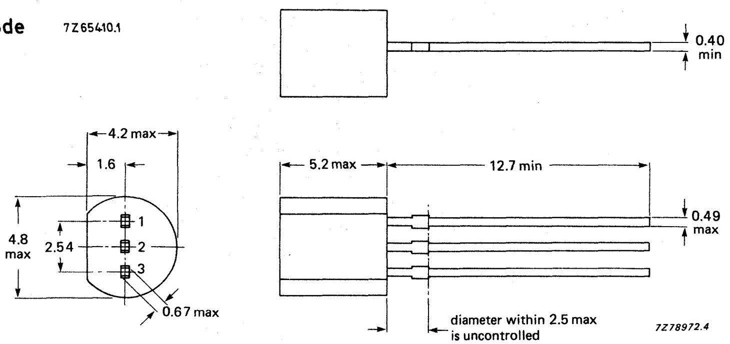
Gate-anode voltage	V_{GA}	max.	70	V
Anode current (average)	$I_{A(AV)}$	max.	175	mA
Total power dissipation up to T_{amb} = 75 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	150	°C
Peak point current V_S = 10 V; R_G = 10 kΩ	I_P	max.	0.2	μA
Valley point current V_S = 10 V; R_G = 10 kΩ	I_V	min.	2	μA

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.





A and B selections are available on request.

RATINGS

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

Gate-anode voltage	V_{GA}	max.	70	V
Anode current (average)	$I_{A(AV)}$	max.	175	mA
Repetitive peak anode current t_p = 10 μs; δ = 0,01	I_{ARM}	max.	2,5	A
Non-repetitive peak anode current t_p = 10 μs	I_{ASM}	max.	3,0	A
Rate of rise of anode current up to I_A = 2,5 A	$\frac{dI_A}{dt}$	max.	20	A/μs
Total power dissipation up to T_{amb} = 75 °C	P_{tot}	max.	300	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	$R_{th\ j\text{-}a}$	=	250	K/W

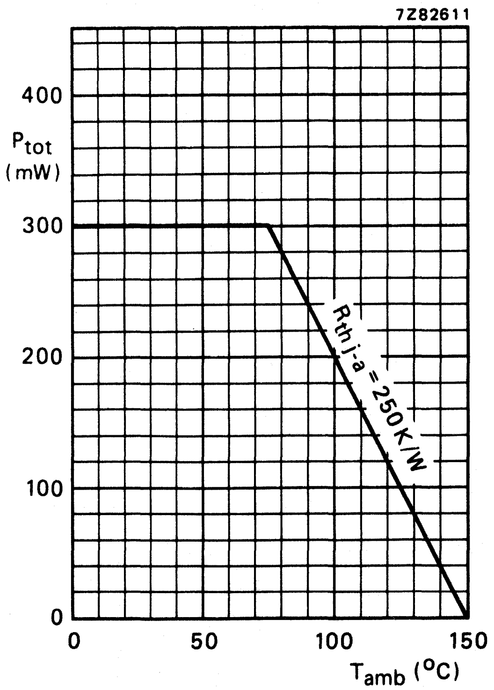


Fig. 2 Maximum permissible power dissipation as a function of ambient temperature.

CHARACTERISTICS

$T_{amb} = 25\ ^{o}C$

Peak point current (see Fig. 10)			
$V_S = 10$ V; $R_G = 10$ kΩ	I_P	max.	0.2 μA
$V_S = 10$ V; $R_G = 100$ kΩ	I_P	max.	0.06 μA
Valley point current (see Fig. 10)			
$V_S = 10$ V; $R_G = 10$ kΩ	I_V	min.	2 μA
$V_S = 10$ V; $R_G = 100$ kΩ	I_V	min.	1 μA

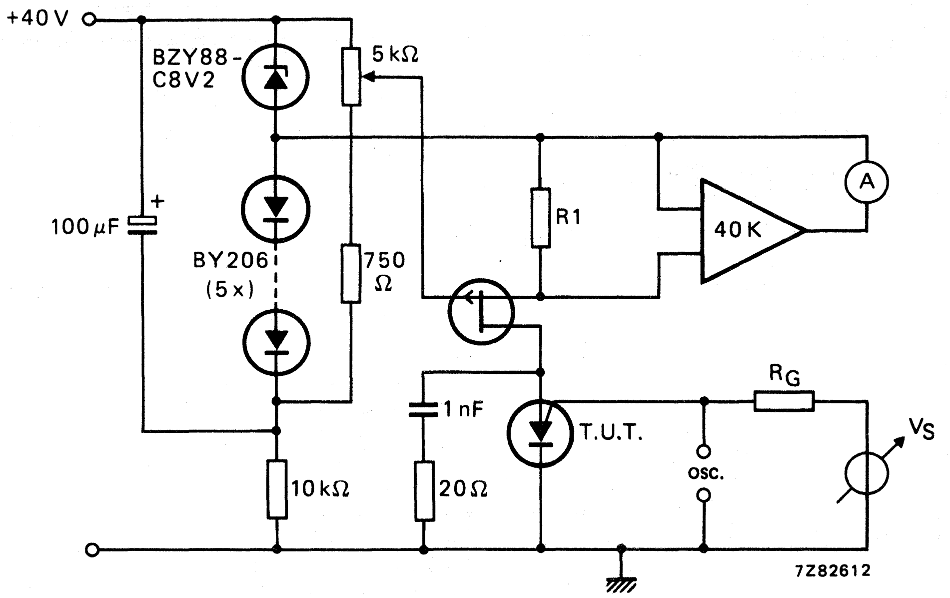


Fig. 3 Measuring circuit for I_P and I_V by means of value of R1. $R1 = \frac{1}{I_A}$ (that is maximum voltage drop over R1 is 1 V). Internal resistance of oscilloscope is 10 MΩ.

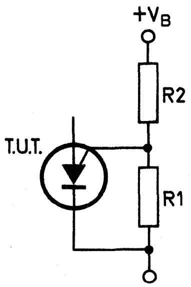


Fig. 4 **BRY56** with "program" resistors R1 and R2.

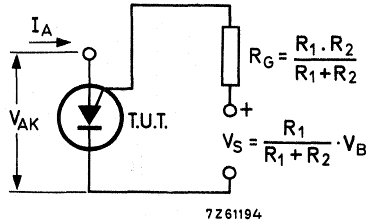


Fig. 5 Equivalent test circuit for characteristics testing.

Gate-anode leakage current (see Fig. 6)
$I_K = 0$; $V_{GA} = 70$ V — I_{GAO} max. 10 nA

Gate-cathode leakage current (see Fig. 7)
$V_{AK} = 0$; $V_{GK} = 70$ V — I_{GKS} max. 100 nA

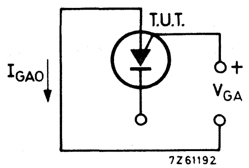


Fig. 6.

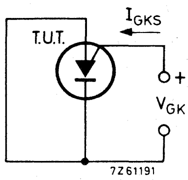


Fig. 7.

Anode-cathode voltage
$I_A = 100$ mA — V_{AK} max. 1,4 V

Peak output voltage (see Figs 8 and 9)
$V_{AA} = 20$ V; C = 10 nF — V_{OM} min. 6 V

Offset voltage (see Fig. 10) $V_{offset} = V_P - V_S$ ($I_A = 0$)

Rise time (see Fig. 9)
$V_{AA} = 20$ V; C = 10 nF — t_r max. 80 ns

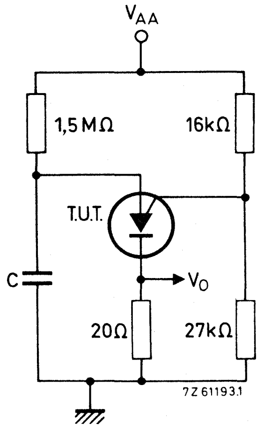


Fig. 8.

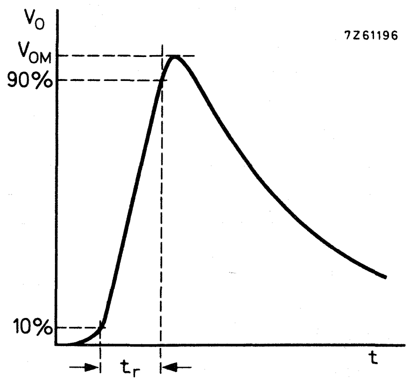


Fig. 9.

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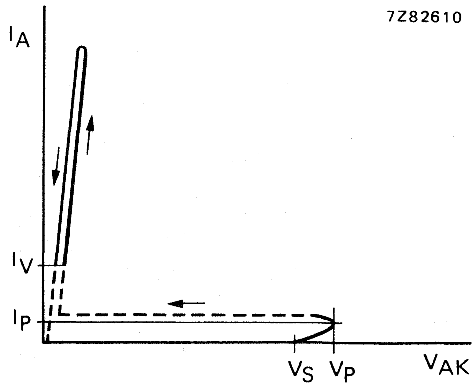


Fig. 10.

N-P-N DARLINGTON TRANSISTORS

Silicon planar transistors in plastic TO-92 envelopes, intended for industrial switching applications e.g. print hammer, solenoid, relay and lamp driving.

P-N-P complements are the BSR60, BSR61 and BSR62.

QUICK REFERENCE DATA

			BSR50	BSR51	BSR52	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	90	V
Collector-emitter voltage (see Fig. 5)	V_{CER}	max.	45	60	80	V
Collector current (average)	$I_{C(AV)}$	max.		1,0		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		0,8		W
Junction temperature	T_j	max.		150		°C
Collector-emitter saturation voltage I_C = 0,5 A; I_B = 0,5 mA	V_{CEsat}	<		1,3		V
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		
Turn-off time when switched from I_{Con} = 500 mA; I_{Bon} = 0,5 mA to cut-off with $-I_{Boff}$ = 0,5 mA	t_{off}	<		1,5		μs

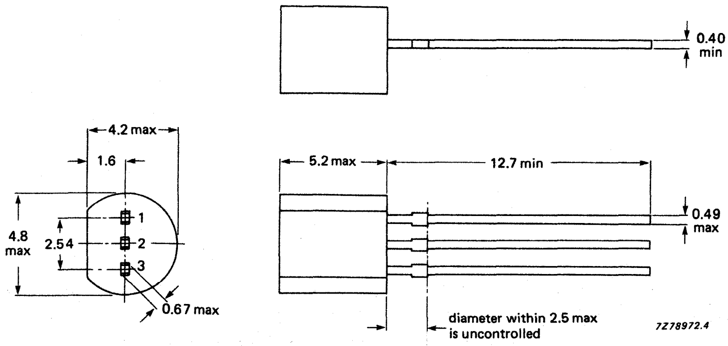
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92. For circuit diagram, see Fig. 2.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BSR50	BSR51	BSR52	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	90	V
Collector-emitter voltage (see Fig. 5)	V_{CER}	max.	45	60	80	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V
Collector current (average)	$I_{C(AV)}$	max.		1,0		A
Collector current (peak value)	I_{CM}	max.		2,0		A
Base current (d.c.)	I_B	max.		0,1		A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.		0,8		W
up to T_{amb} = 25 °C *	P_{tot}	max.		1,0		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 $R_{th\ j\text{-}a}$ = 156 K/W

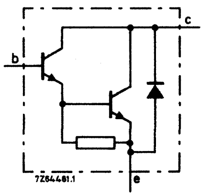


Fig. 2 Circuit diagram.

* Transistor mounted on printed-circuit board, maximum lead length 3 mm, mounting pad for collector lead minimum 10 mm x 10 mm.

** Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

$T_j = 25\ ^oC$

Collector cut-off voltage				
$I_E = 0$; $V_{CB} = 45$ V	**BSR50**	I_{CBO}	<	50 nA
$I_E = 0$; $V_{CB} = 60$ V	**BSR51**	I_{CBO}	<	50 nA
$I_E = 0$; $V_{CB} = 80$ V	**BSR52**	I_{CBO}	<	50 nA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 4$ V		I_{EBO}	<	50 nA
Saturation voltages				
$I_C = 0{,}5$ A; $I_B = 0{,}5$ mA		V_{CEsat}	<	1,3 V
		V_{BEsat}	<	1,9 V
$I_C = 1{,}0$ A; $I_B = 1{,}0$ mA	**BSR51**	V_{CEsat}	<	1,6 V
		V_{BEsat}	<	2,2 V
$I_C = 1{,}0$ A; $I_B = 4{,}0$ mA	**BSR50; BSR52**	V_{CEsat}	<	1,6 V
		V_{BEsat}	<	2,2 V
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
Small-signal current gain at f = 35 MHz				
$I_C = 500$ mA; $V_{CE} = 5$ V		h_{fe}	typ.	10

Switching times see page 4.

Switching times (see Figs 3 and 4)

I_{Con} = 500 mA; I_{Bon} = $-I_{Boff}$ = 0,5 mA

Turn-on time	t_{on}	typ.	0,4 μs
Turn-off time	t_{off}	<	1,5 μs

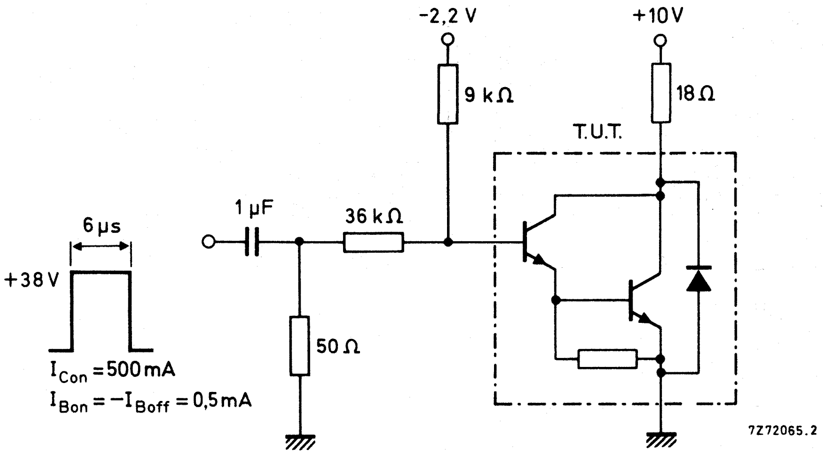


Fig. 3 Test circuit for 500 mA switching.

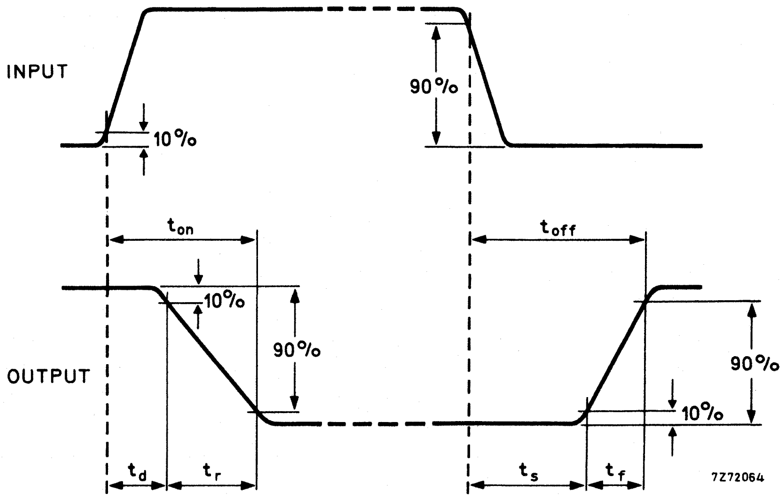


Fig. 4 Switching waveforms.

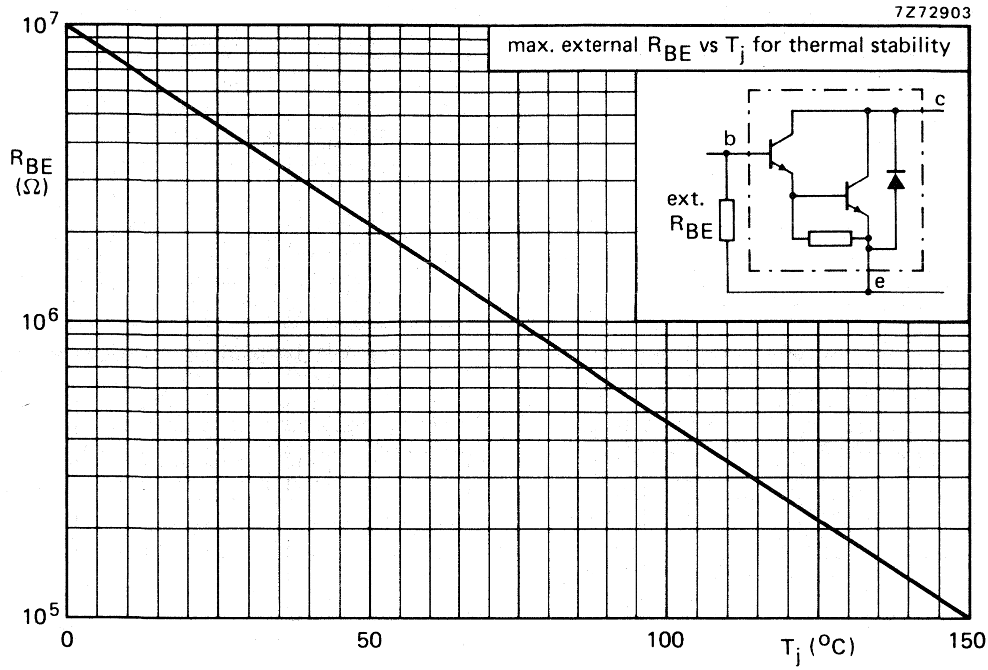


Fig. 5.

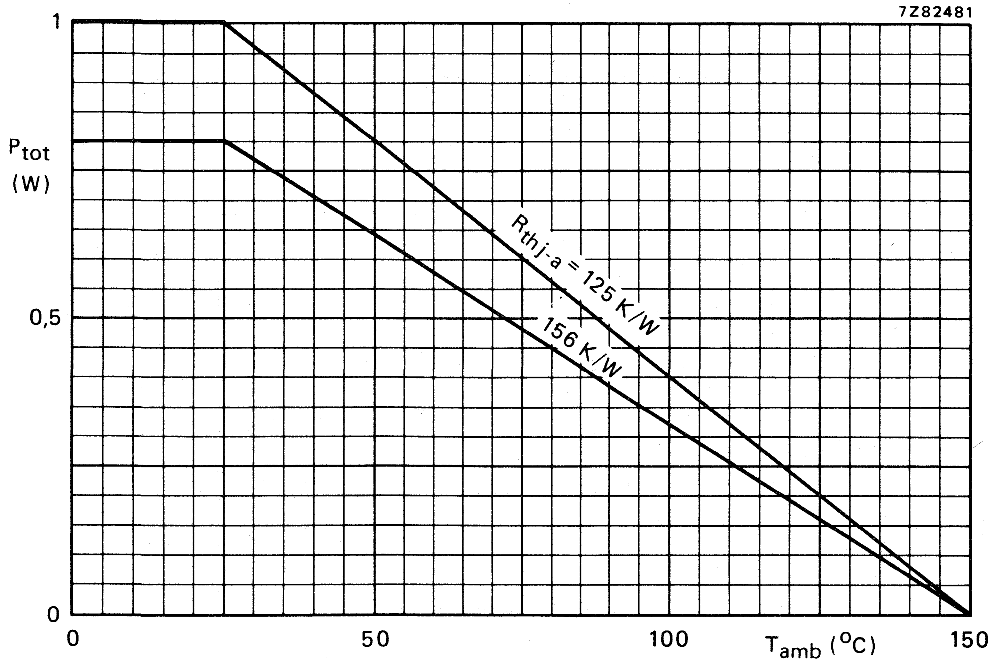


Fig. 6 Maximum permissible power dissipation as a function of ambient temperature.

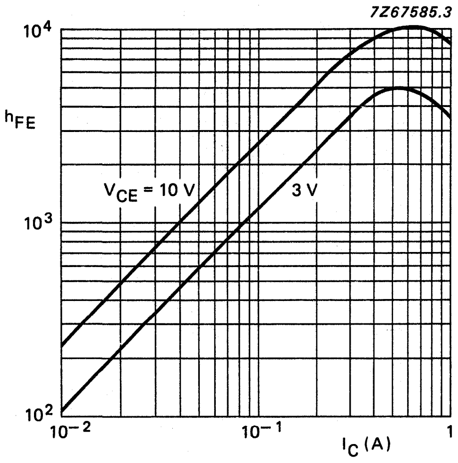


Fig. 7 T_j = 25 °C; typical values.

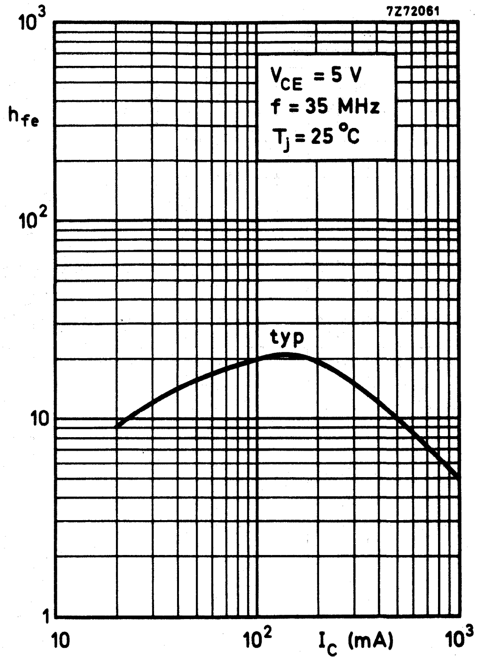


Fig. 8.

P-N-P DARLINGTON TRANSISTORS

Silicon planar transistors in plastic TO-92 envelopes, intended for industrial applications e.g. print hammer, solenoid, relay and lamp driving.

N-P-N complements are the BSR50, BSR51 and BSR52.

QUICK REFERENCE DATA

			BSR60	BSR61	BSR62	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	90	V
Collector-emitter voltage (see Fig. 6)	$-V_{CER}$	max.	45	60	80	V
Collector current (average)	$-I_{C(AV)}$	max.	1,0	1,0	1,0	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0,8	0,8	0,8	W
Junction temperature	T_j	max.	150	150	150	°C
Collector-emitter saturation voltage $-I_C$ = 0,5 A; $-I_B$ = 0,5 mA	$-V_{CEsat}$	<	1,3	1,3	1,4	V
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		
Turn-off time when switched from $-I_{Con}$ = 500 mA; $-I_{Bon}$ = 0,5 mA to cut-off with + I_{Boff} = 0,5 mA	t_{off}	<		1,5		μs

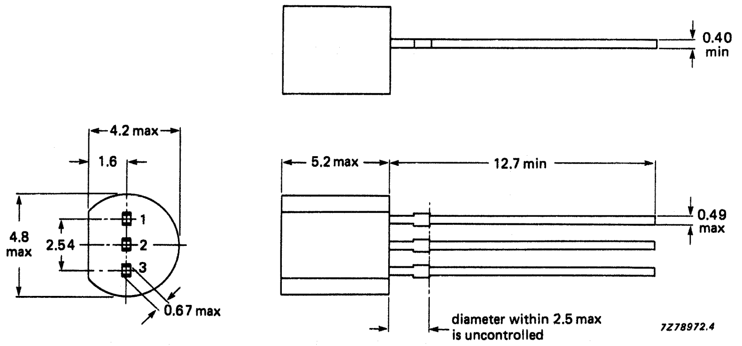
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92. For circuit diagram, see Fig. 2.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			BSR60	BSR61	BSR62	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	90	V
Collector-emitter voltage (see Fig. 6)	$-V_{CER}$	max.	45	60	80	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V
Collector current (average)	$-I_{C(AV)}$	max.		1,0		A
Collector current (peak value)	$-I_{CM}$	max.		2,0		A
Base current (d.c.)	$-I_B$	max.		0,1		A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.		0,8		W
up to T_{amb} = 25 °C *	P_{tot}	max.		1,0		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	$R_{th\ j\text{-}a}$	=	156	K/W

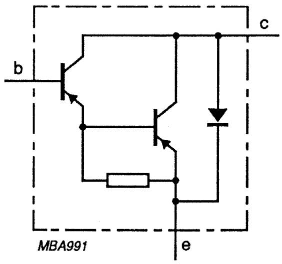


Fig. 2 Circuit diagram.

* Transistor mounted on printed-circuit board, maximum lead length 3 mm, mounting pad for collector lead minimum 10 mm x 10 mm.

** Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

$T_j = 25\ ^oC$

Collector cut-off current					
$I_E = 0; -V_{CB} = 45$ V	**BSR60**	$-I_{CBO}$	<	50	nA
$I_E = 0; -V_{CB} = 60$ V	**BSR61**	$-I_{CBO}$	<	50	nA
$I_E = 0; -V_{CB} = 80$ V	**BSR62**	$-I_{CBO}$	<	50	nA
Emitter cut-off current					
$I_C = 0; -V_{EB} = 4$ V		$-I_{EBO}$	<	50	nA
Saturation voltages					
$-I_C = 0{,}5$ A; $-I_B = 0{,}5$ mA	**BSR60; BSR61**	$-V_{CEsat}$	<	1,3	V
		$-V_{BEsat}$	<	1,9	V
$-I_C = 0{,}5$ A; $-I_B = 0{,}5$ mA	**BSR62**	$-V_{CEsat}$	<	1,4	V
		$-V_{BEsat}$	<	2,0	V
$-I_C = 1{,}0$ A; $-I_B = 1{,}0$ mA	**BSR61**	$-V_{CEsat}$	<	1,6	V
		$-V_{BEsat}$	<	2,2	V
$-I_C = 1{,}0$ A; $-I_B = 4{,}0$ mA	**BSR60**	$-V_{CEsat}$	<	1,6	V
		$-V_{BEsat}$	<	2,2	V
$-I_C = 1{,}0$ A; $-I_B = 4{,}0$ mA	**BSR62**	$-V_{CEsat}$	<	1,8	V
		$-V_{BEsat}$	<	2,4	V
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	
Small-signal current gain at f = 35 MHz					
$-I_C = 500$ mA; $-V_{CE} = 5$ V		h_{fe}	typ.	10	

Switching times see page 4.

Switching times (see Figs 3 and 4)

$-I_{Con} = 500$ mA; $-I_{Bon} = +I_{Boff} = 0{,}5$ mA

Turn-on time	t_{on}	<	1,0 μs
Turn-off time	t_{off}	<	1,5 μs

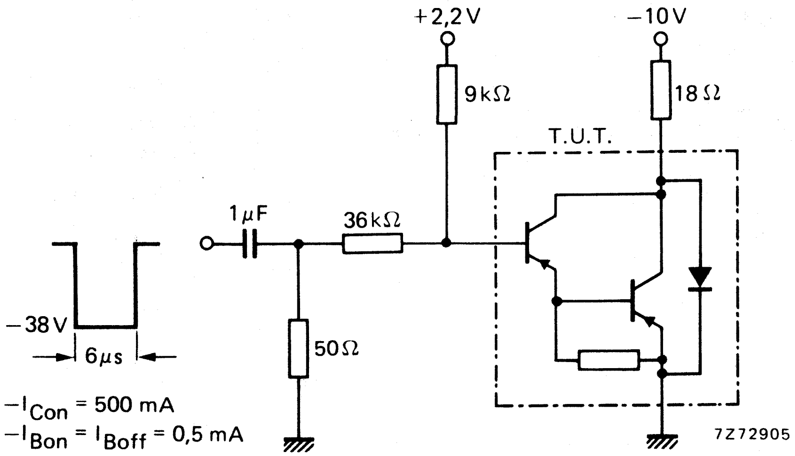


Fig. 3 Test circuit for 500 mA switching.

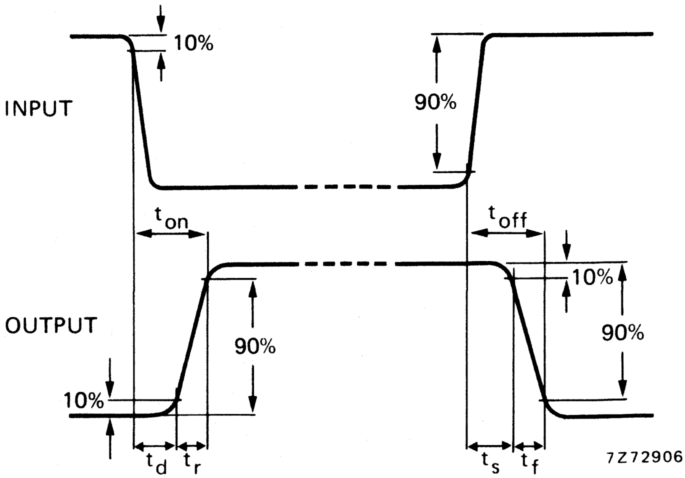


Fig. 4 Switching waveforms.

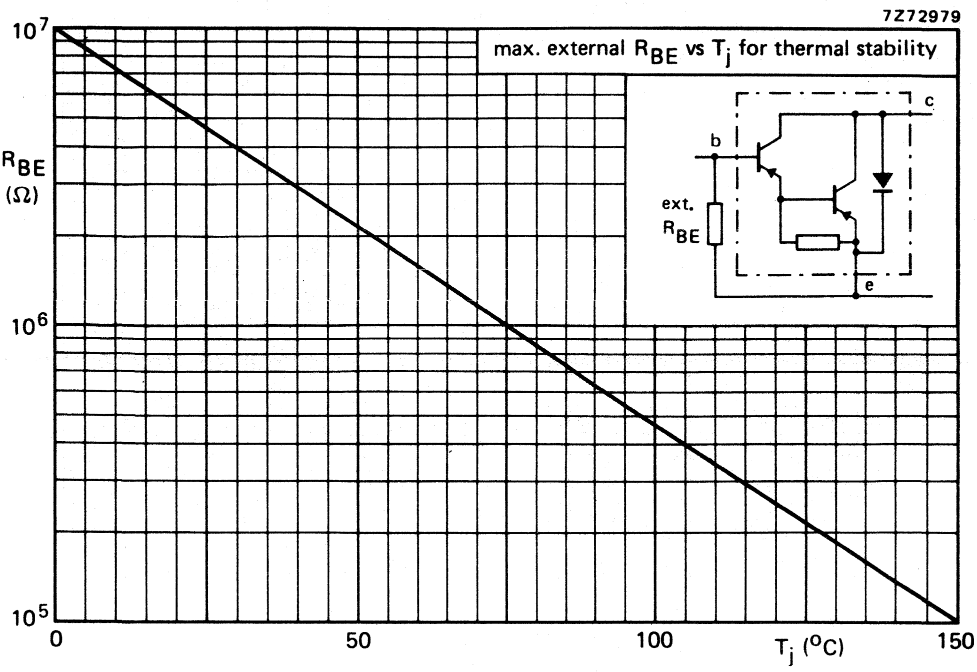


Fig. 5.

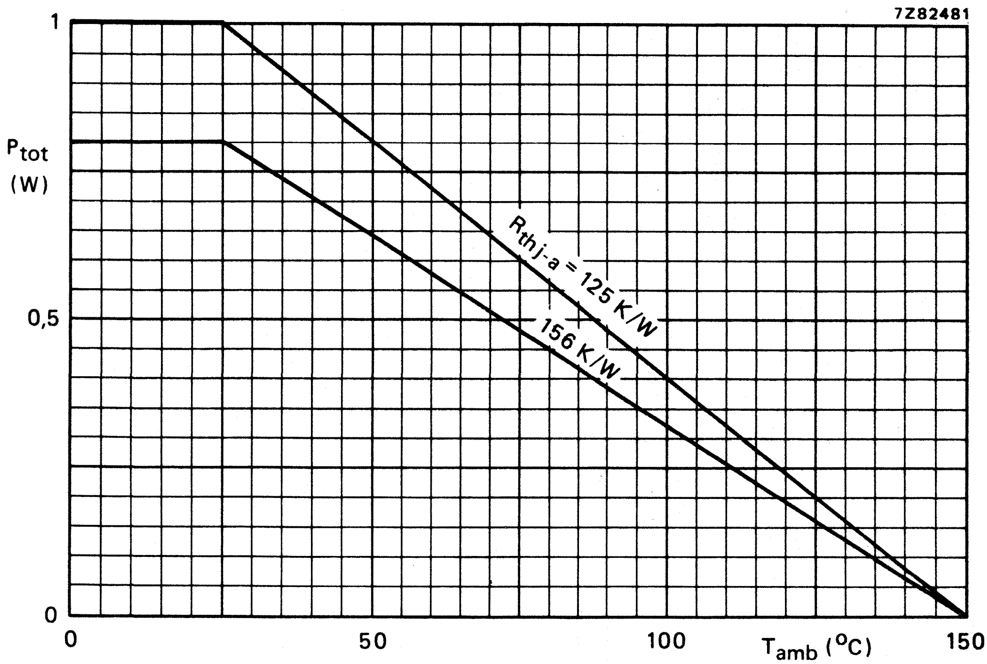


Fig. 6 Maximum permissible power dissipation as a function of ambient temperature.

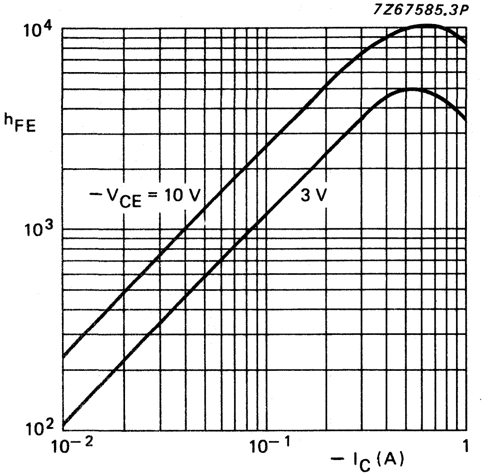


Fig. 7 T_j = 25 °C.

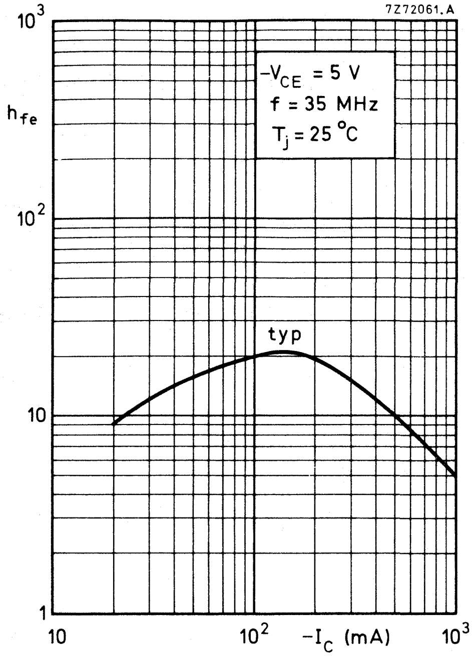


Fig. 8.

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a plastic TO-92 envelope. It is primarily intended for general purpose switching and as driver for numerical indicator tubes.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	100	V
Collector current (peak value)	I_{CM}	max.	250	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	150	°C
D.C. current gain I_C = 4 mA; V_{CE} = 1 V	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_{Con} = 15 mA; I_{Bon} = 1 mA; $-I_{Boff}$ = 1 mA	t_{off}	$<$	1	µs

Note
The BSS38 may be operated in the breakdown region up to V_{CE} = 160 V, provided P_{tot} at T_{amb} = 85 °C does not exceed 100 mW.

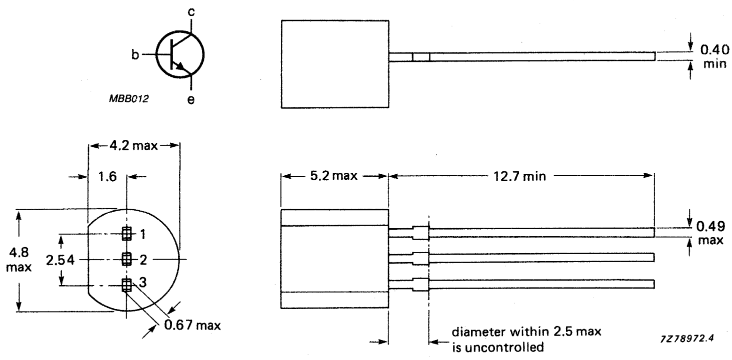
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	120	V*
Collector-emitter voltage (open base)	V_{CEO}	max.	100	V*
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c. or averaged over any 20 ms period)	$I_{C(AV)}$	max.	100	mA
Collector current (peak value)	I_{CM}	max.	250	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	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	$R_{th\ j\text{-}a}$	=	0,25	°C/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

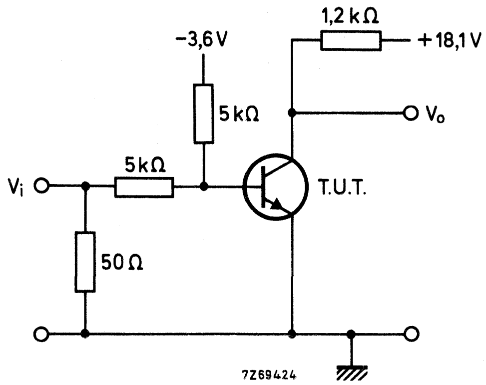
Collector cut-off current				
$I_E = 0$; $V_{CB} = 90$ V	I_{CBO}	<	200	nA
$I_E = 0$; $V_{CB} = 90$ V; $T_j = 150$ °C	I_{CBO}	<	50	μA
$V_{BE} = 0$; $V_{CE} = 80$ V; $T_j = 85$ °C	I_{CES}	<	20	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	<	200	nA
$I_C = 0$; $V_{EB} = 4$ V; $T_j = 150$ °C	I_{EBO}	<	50	μA
Saturation voltages				
I_C = 4 mA; I_B = 0,4 mA	V_{CEsat}	<	0,7	V
	V_{BEsat}	<	1,2	V
I_C = 50 mA; I_B = 15 mA	V_{CEsat}	<	3,0	V
D.C. current gain				
I_C = 4 mA; V_{CE} = 1 V	h_{FE}	>	20	
		typ.	80	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	typ.	80	

* The BSS38 may be operated in the breakdown region up to V_{CE} = 160 V, provided P_{tot} at T_{amb} = 85 °C does not exceed 100 mW.

CHARACTERISTICS (continued)

Transition frequency at f = 35 MHz I_C = 4 mA; V_{CE} = 10 V	f_T	>	60 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	<	17 pF
Switching time Turn-off time when switched from I_{Con} = 15 mA; I_{Bon} = 1 mA to cut-off with $-I_{Boff}$ = 1 mA	t_{off}	<	1 μs

Test circuit for measuring turn-off time:



Pulse generator:

Input voltage	V_i	= + 10 V
Pulse duration	t_p	= 1 μs
Duty factor	δ	= 0,01
Source impedance	Z_S	= 50 Ω

N-P-N DARLINGTON TRANSISTORS

Silicon planar transistors in TO-39 metal envelopes, intended for industrial switching applications e.g. print hammer, solenoid, relay and lamp driving.

P-N-P complements are the BSS60, BSS61 and BSS62.

QUICK REFERENCE DATA

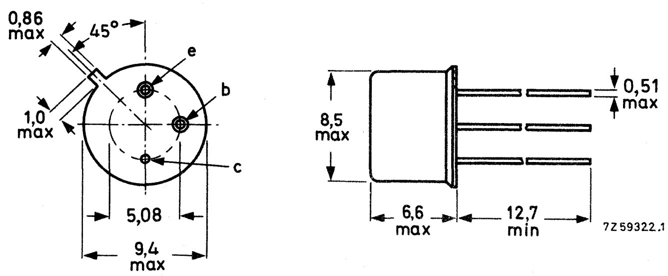
				BSS50	BSS51	BSS52	
Collector-base voltage (open emitter)		V_{CBO}	max.	60	80	90	V
Collector-emitter voltage (see Fig. 4)		V_{CER}	max.	45	60	80	V
Collector current (d.c.)		I_C	max.		1,0		A
Total power dissipation							
up to T_{amb} = 25 °C		P_{tot}	max.		0,8		W
up to T_{case} = 25 °C		P_{tot}	max.		5,0		W
Collector-emitter saturation voltage							
I_C = 1,0 A; I_B = 1,0 mA	BSS51	V_{CEsat}	<		1,6		V
I_C = 1,0 A; I_B = 4,0 mA	BSS50; BSS52	V_{CEsat}	<		1,6		V
D.C. current gain							
I_C = 500 mA; V_{CE} = 10 V		h_{FE}	>		2000		
Turn-off time when switched from I_{Con} = 500 mA; I_{Bon} = 0,5 mA to cut-off with $-I_{Boff}$ = 0,5 mA		t_{off}	typ.		1,5		μs

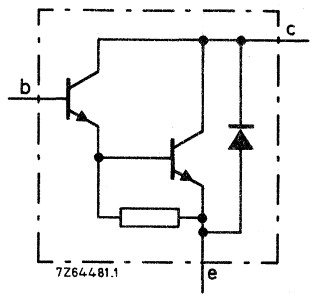
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case





Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 004-073, available on request.

RATINGS

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

			BSS50	BSS51	BSS52	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	90	V
Collector-emitter voltage (see Fig. 4)	V_{CER}	max.	45	60	80	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5,0	5,0	5,0	V
Collector current (d.c.)	I_C	max.		1,0		A
Collector current (peak value)	I_{CM}	max.		2,0		A
Base current (d.c.)	I_B	max.		0,1		A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.		0,8		W
up to T_{case} = 25 °C	P_{tot}	max.		5,0		W
Storage temperature range	T_{stg}			−65 to + 150		°C
Junction temperature *	T_j	max.		200		°C

THERMAL RESISTANCE *

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	220	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	35	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 45 V	BSS50	I_{CBO}	<	50 nA
I_E = 0; V_{CB} = 60 V	BSS51	I_{CBO}	<	50 nA
I_E = 0; V_{CB} = 80 V	BSS52	I_{CBO}	<	50 nA
Emitter cut-off current				
I_C = 0; V_{EB} = 4,0 V		I_{EBO}	<	50 nA
Base-emitter voltage				
I_C = 150 mA; V_{CE} = 10 V		V_{BE}		1,3 to 1,65 V
I_C = 500 mA; V_{CE} = 10 V		V_{BE}		1,4 to 1,75 V
Saturation voltages				
I_C = 500 mA; I_B = 0,5 mA		V_{CEsat}	<	1,3 V
		V_{BEsat}	<	1,9 V
I_C = 500 mA; I_B = 0,5 mA; T_j = 200 °C		V_{CEsat}	<	1,3 V
I_C = 1,0 A; I_B = 1,0 mA	BSS51	V_{CEsat}	<	1,6 V
		V_{BEsat}	<	2,2 V
I_C = 1,0 A; I_B = 1,0 mA; T_j = 200 °C	BSS51	V_{CEsat}	<	2,3 V
I_C = 1,0 A; I_B = 4,0 mA	BSS50; BSS52	V_{CEsat}	<	1,6 V
		V_{BEsat}	<	2,2 V
I_C = 1,0 A; I_B = 4,0 mA; T_j = 200 °C	BSS50; BSS52	V_{CEsat}	<	1,6 V
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
Small-signal current gain at f = 35 MHz				
I_C = 500 mA; V_{CE} = 5 V		h_{fe}	typ.	10

Switching times (see Figs 2 and 3)

I_{Con} = 500 mA; I_{Bon} = $-I_{Boff}$ = 0,5 mA

Turn-on time	t_{on}	typ.	0,4 μs
Turn-off time	t_{off}	typ.	1,5 μs

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

Turn-on time	t_{on}	typ.	0,4 μs
Turn-off time	t_{off}	typ.	1,5 μs

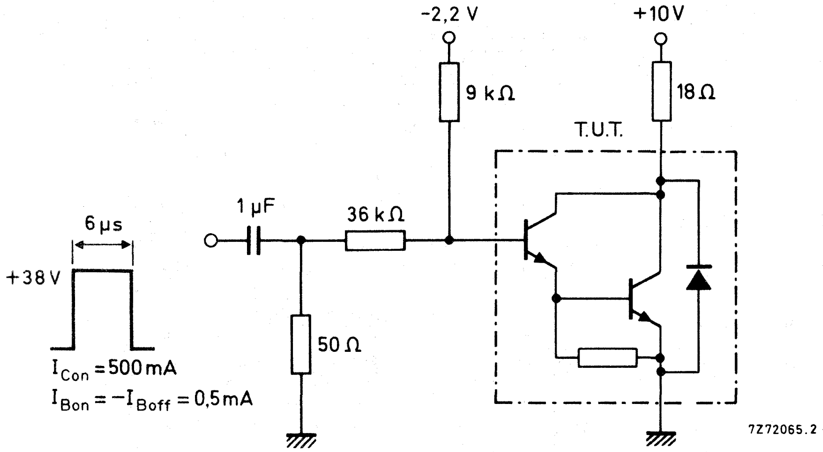


Fig. 2 Test circuit for 500 mA switching.

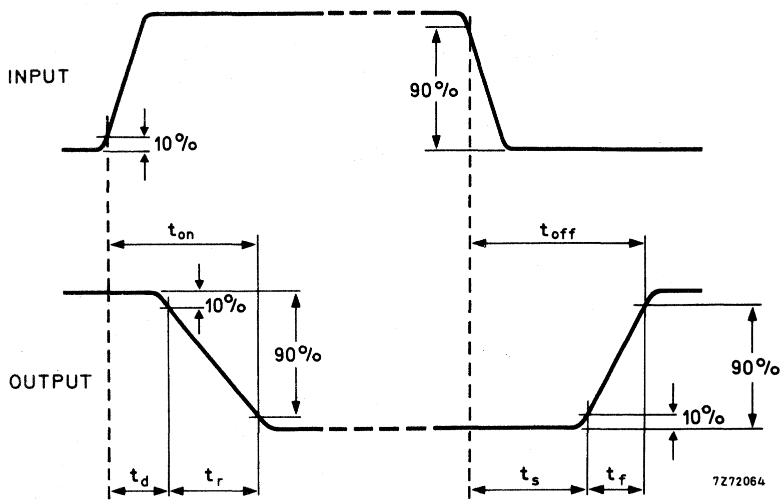


Fig. 3 Switching waveforms.

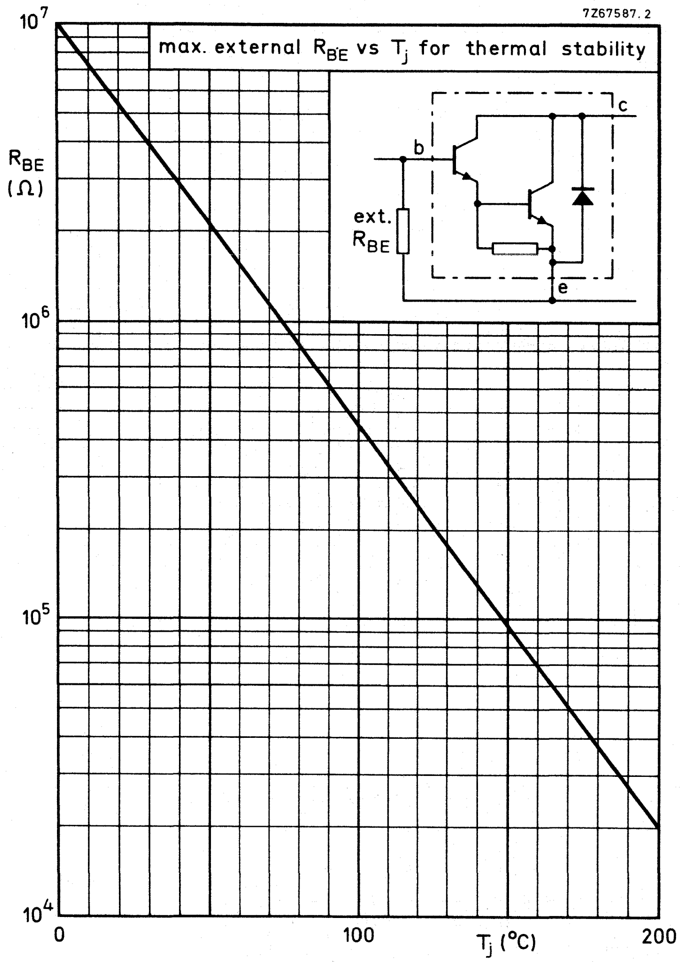

7Z67587.2
max. external R_BE vs T_j for thermal stability
10^7
10^6
10^5
10^4
R_BE (Ω)
ext. R_BE
b
c
e
0
100
T_j (°C)
200

Fig. 4.

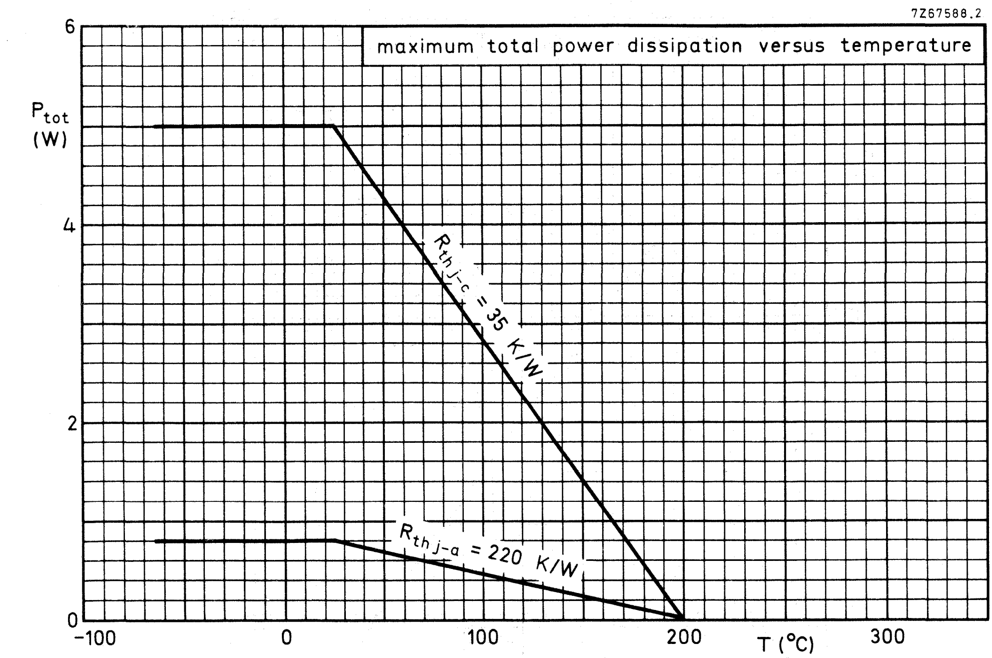

7Z67588.2
maximum total power dissipation versus temperature
Ptot (W)
6
4
2
0
−100
0
100
200
300
T (°C)
Rth j-c = 35 K/W
Rth j-a = 220 K/W

Fig. 5.

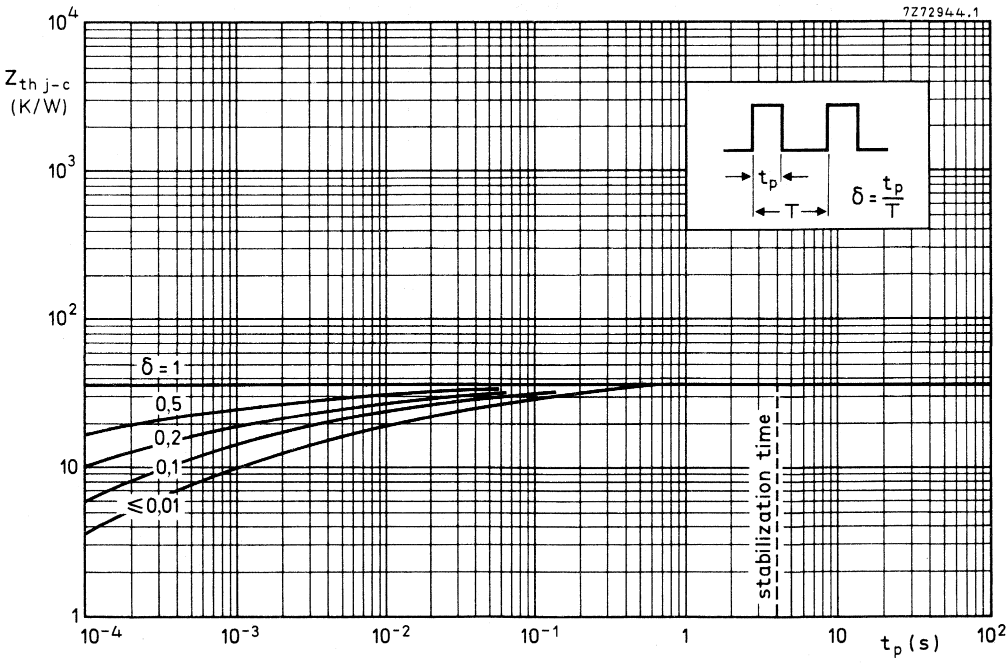

7Z72944.1
Zth j-c (K/W)
10^4
10^3
10^2
10
1
δ = 1
0,5
0,2
0,1
≤ 0,01
tp
T
δ = tp/T
stabilization time
10^-4
10^-3
10^-2
10^-1
1
10
10^2
tp (s)

Fig. 6.

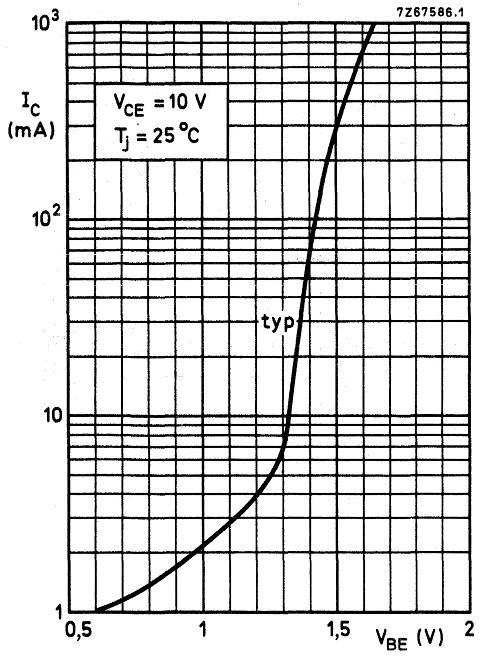


Fig. 7.

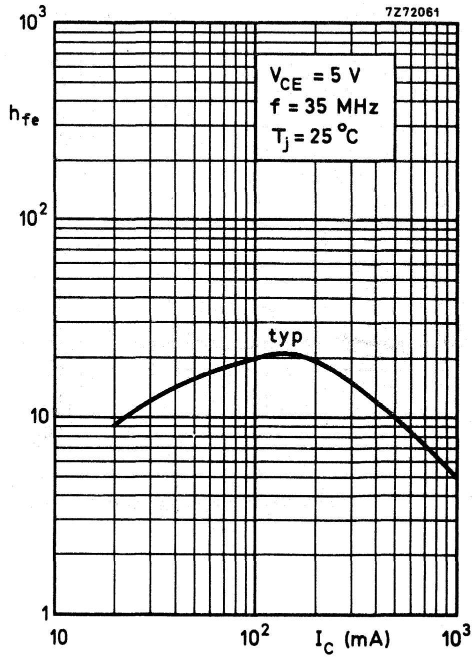


Fig. 8.

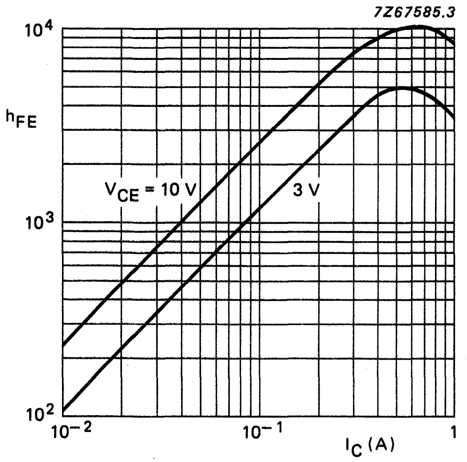


Fig. 9 T_j = 25 °C; typical values.

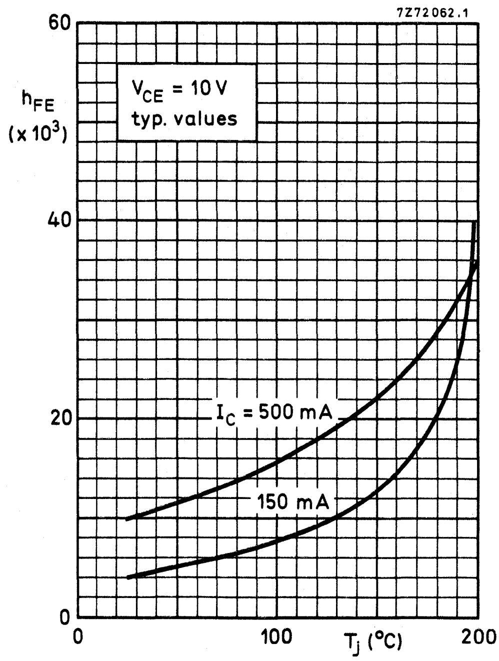


Fig. 10.

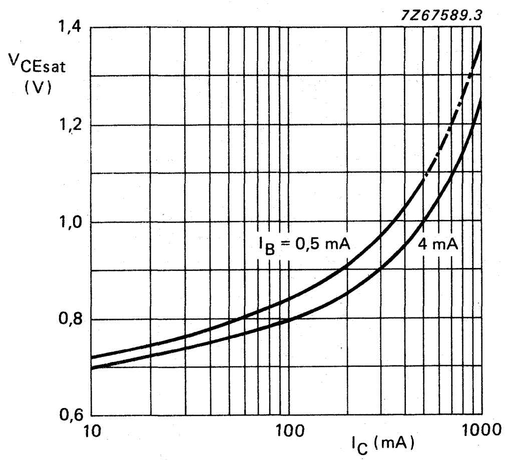


Fig. 11 T_j = 25 °C; typical values.

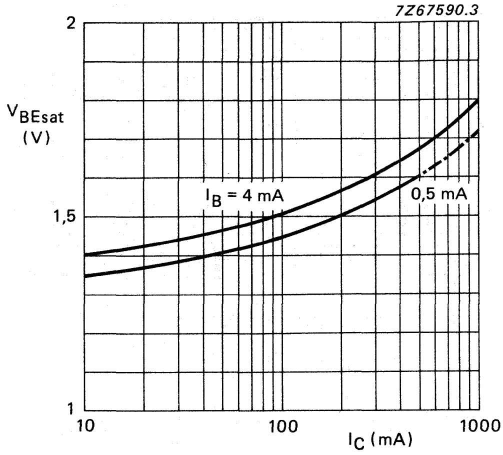


Fig. 12 T_j = 25 °C; typical values.

P-N-P DARLINGTON TRANSISTORS

Silicon planar transistors in TO-39 metal envelopes, intended for industrial switching applications e.g. print hammer, solenoid, relay and lamp driving.

N-P-N complements are the BSS50, BSS51 and BSS52.

QUICK REFERENCE DATA

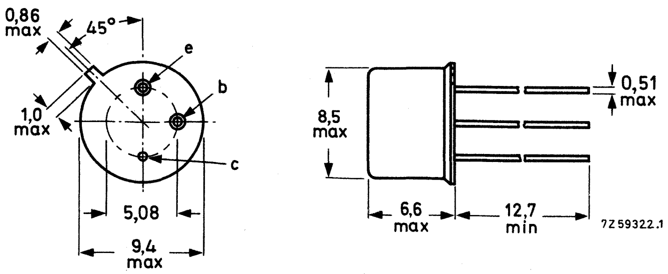
			BSS60	BSS61	BSS62	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	90	V
Collector-emitter voltage (see Fig. 4)	$-V_{CER}$	max.	45	60	80	V
Collector current (d.c.)	$-I_C$	max.		1,0		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		0,8		W
up to T_{case} = 25 °C	P_{tot}	max.		5,0		W
Collector-emitter saturation voltage $-I_C$ = 1,0 A; $-I_B$ = 1,0 mA **BSS61**	$-V_{CEsat}$	<		1,6		V
$-I_C$ = 1,0 A; $-I_B$ = 4,0 mA **BSS60; BSS62**	$-V_{CEsat}$	<		1,6		V
D.C. current gain $-I_C$ = 500 mA; $-V_{CE}$ = 10 V	h_{FE}	>		2000		
Turn-off time when switched from $-I_{Con}$ = 500 mA; $-I_{Bon}$ = 0,5 mA to cut-off with $-I_{Boff}$ = 0,5 mA	t_{off}	typ.		1,5		µs

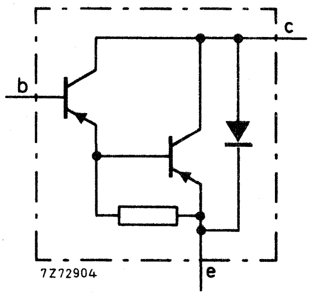
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case





Maximum lead diameter is guaranteed only for 12,7 mm

Products approved to CECC 50 004-074.

RATINGS

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

			BSS60	BSS61	BSS62	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	90	V
Collector-emitter voltage (see Fig. 4)	$-V_{CER}$	max.	45	60	80	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5,0	5,0	5,0	V
Collector current (d.c.)	$-I_C$	max.		1,0		A
Collector current (peak value)	$-I_{CM}$	max.		2,0		A
Base current (d.c.)	$-I_B$	max.		0,1		A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.		0,8		W
up to T_{case} = 25 °C	P_{tot}	max.		5,0		W
Storage temperature range	T_{stg}			−65 to + 150		°C
Junction temperature *	T_j	max.		200		°C

THERMAL RESISTANCE *

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	220	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	35	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current					
$I_E = 0; -V_{CB} = 45$ V	BSS60	$-I_{CBO}$	<	50	nA
$I_E = 0; -V_{CB} = 60$ V	BSS61	$-I_{CBO}$	<	50	nA
$I_E = 0; -V_{CB} = 80$ V	BSS62	$-I_{CBO}$	<	50	nA
Emitter cut-off current					
$I_C = 0; -V_{EB} = 4,0$ V		$-I_{EBO}$	<	100	nA
Saturation voltages					
$-I_C = 500$ mA; $-I_B = 0,5$ mA		$-V_{CEsat}$	<	1,3	V
		$-V_{BEsat}$	<	1,9	V
$-I_C = 500$ mA; $-I_B = 0,5$ mA; $T_j = 200$ °C		$-V_{CEsat}$	<	1,3	V
$-I_C = 1,0$ A; $-I_B = 1,0$ mA	BSS61	$-V_{CEsat}$	<	1,6	V
		$-V_{BEsat}$	<	2,2	V
$-I_C = 1,0$ A; $-I_B = 1,0$ mA; $T_j = 200$ °C	BSS61	$-V_{CEsat}$	<	1,6	V
$-I_C = 1,0$ A; $-I_B = 4,0$ mA	BSS60; BSS62	$-V_{CEsat}$	<	1,6	V
		$-V_{BEsat}$	<	2,2	V
$-I_C = 1,0$ A; $-I_B = 4,0$ mA; $T_j = 200$ °C	BSS60; BSS62	$-V_{CEsat}$	<	1,6	V
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	
Small-signal current gain at f = 35 MHz					
$-I_C = 500$ mA; $-V_{CE} = 5$ V		h_{fe}	typ.	10	

Switching times (see Figs 2 and 3)

$-I_{Con}$ = 500 mA; $-I_{Bon}$ = I_{Boff} = 0,5 mA

Turn-on time	t_{on}	typ.	0,4 μs
Turn-off time	t_{off}	typ.	1,5 μs

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

Turn-on time	t_{on}	typ.	0,4 μs
Turn-off time	t_{off}	typ.	1,5 μs

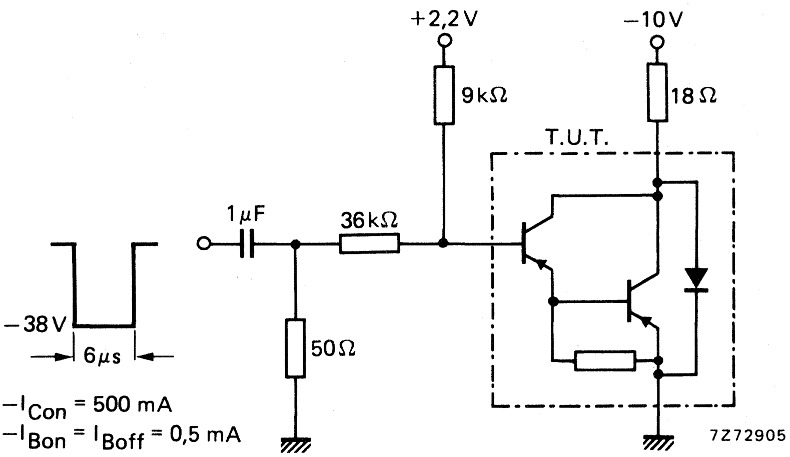


Fig. 2 Test circuit for 500 mA switching.

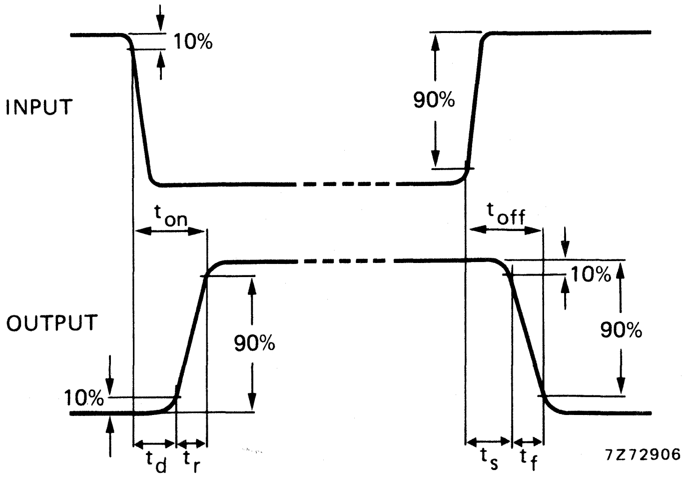


Fig. 3 Switching waveforms.

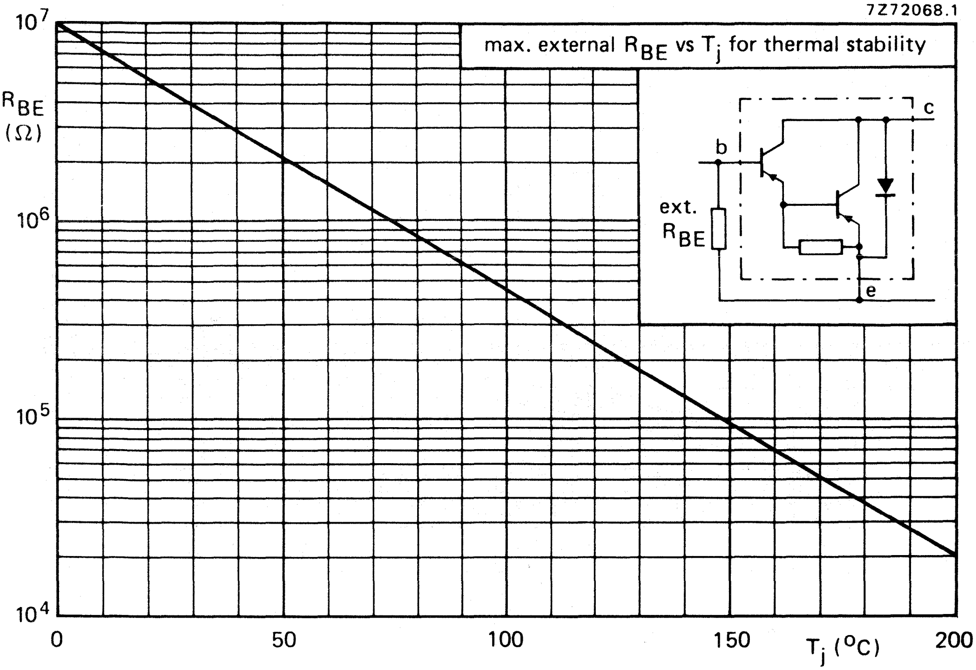

7Z72068.1
max. external R_{BE} vs T_j for thermal stability
10^7
R_{BE}
(Ω)
10^6
10^5
10^4
0
50
100
150
200
T_j (°C)
c
b
ext.
R_{BE}
e

Fig. 4.

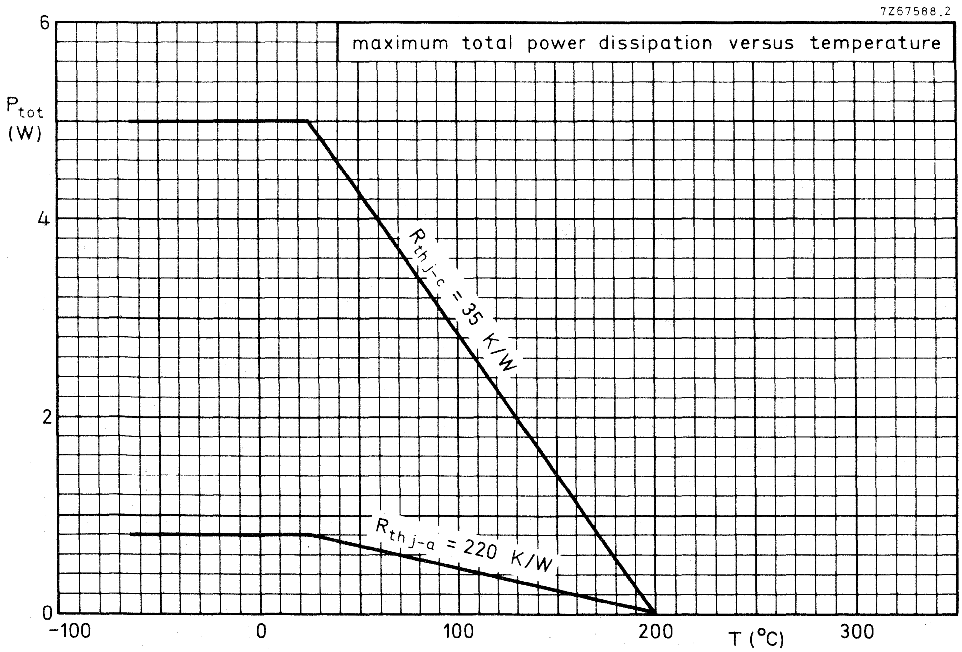

7Z67588.2
maximum total power dissipation versus temperature
6
P_{tot}
(W)
4
2
0
−100
0
100
200
300
T (°C)
$R_{th\ j\text{-}c}$ = 35 K/W
$R_{th\ j\text{-}a}$ = 220 K/W

Fig. 5.

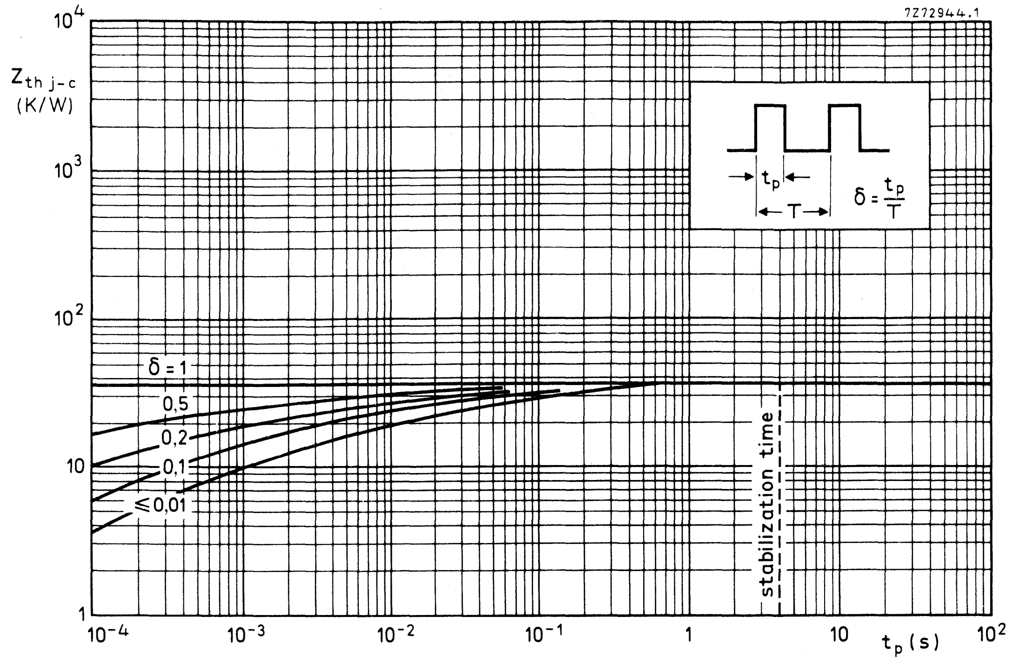


Fig. 6 Thermal impedance as a function of pulse duration.

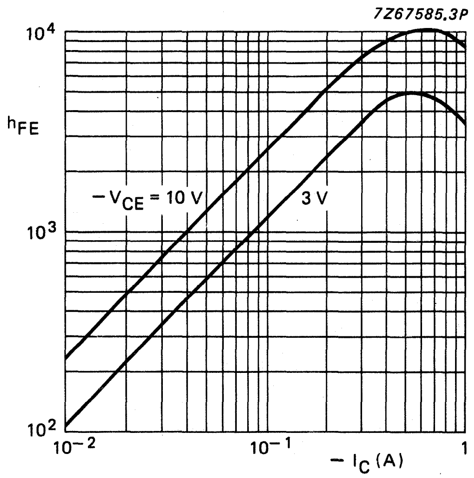


Fig. 7 T_j = 25 °C; typical values

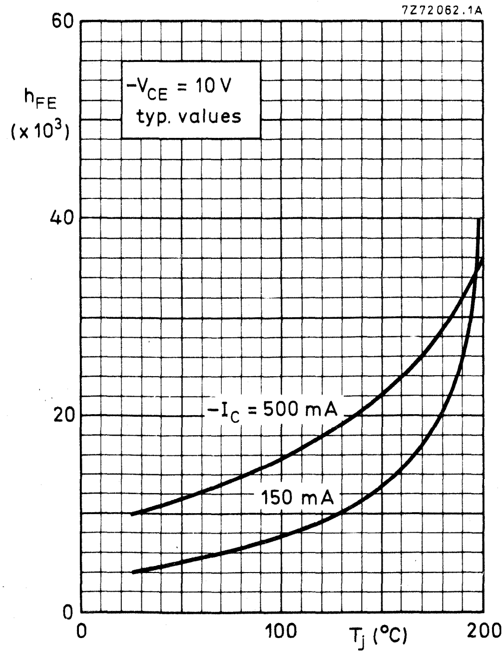


Fig. 8.

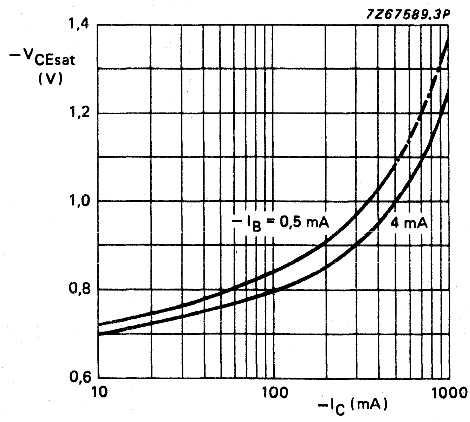

7Z67589.3P
$-V_{CEsat}$
(V)
1,4
1,2
1,0
0,8
0,6
10
100
1000
$-I_C$ (mA)
$-I_B$ = 0,5 mA
4 mA

Fig. 9.

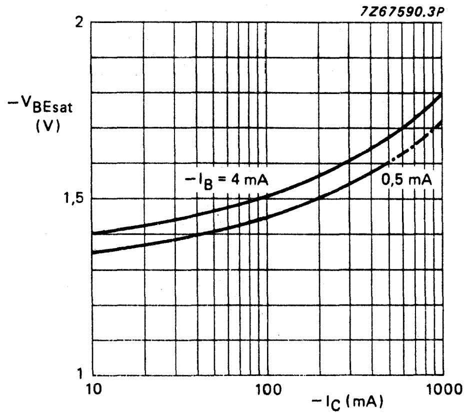

7Z67590.3P
$-V_{BEsat}$
(V)
2
1,5
1
10
100
1000
$-I_C$ (mA)
$-I_B$ = 4 mA
0,5 mA

Fig. 10.

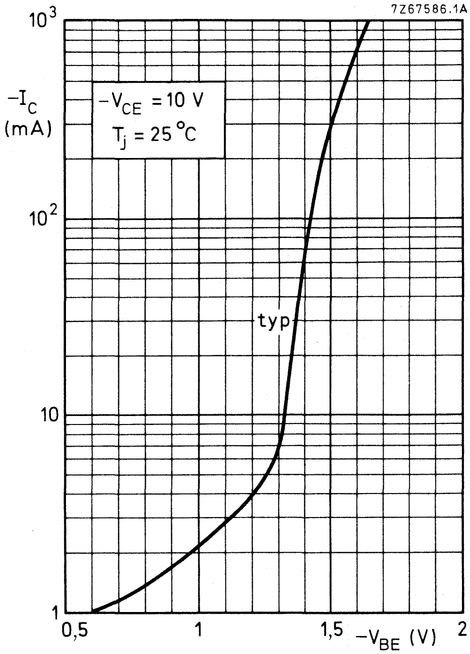

7Z67586.1A
$-I_C$ (mA)
$-V_{CE}$ = 10 V
T_j = 25 °C
typ
10^3
10^2
10
1
0,5
1
1,5
2
$-V_{BE}$ (V)

Fig. 11.

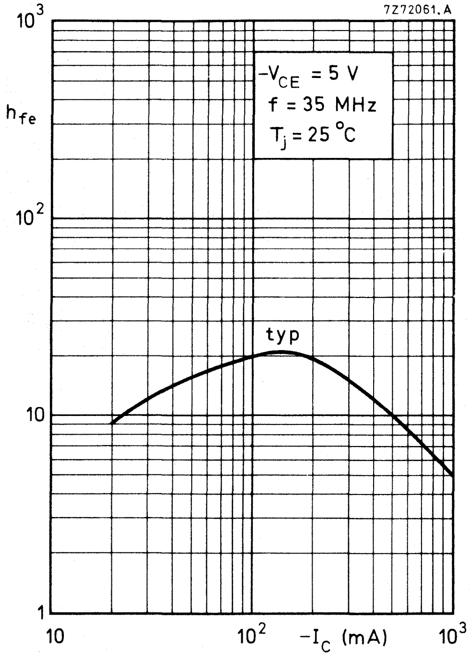

7Z72061.A
h_{fe}
$-V_{CE}$ = 5 V
f = 35 MHz
T_j = 25 °C
typ
10^3
10^2
10
1
10
10^2
$-I_C$ (mA)
10^3

Fig. 12.

HIGH-VOLTAGE P-N-P TRANSISTOR

Silicon planar epitaxial transistor in a plastic TO-92 envelope. It is intended for anode switching in dynamically driven numerical indicator tubes and as general purpose switching device.

QUICK REFERENCE DATA

Collector-emitter voltage (R_{BE} = 10 kΩ)	$-V_{CER}$	max.	110	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	100	V
Collector current (d.c.)	$-I_C$	max.	100	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	150	°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

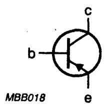
MECHANICAL DATA

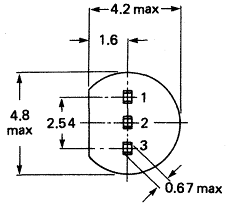
Dimensions in mm

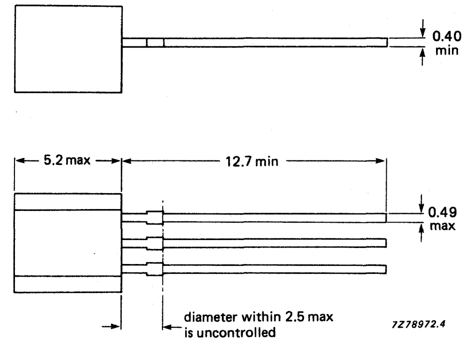
Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector







RATINGS

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	110	V
Collector-emitter voltage (R_{BE} = 10 kΩ)	$-V_{CER}$	max.	110	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	6	V
Collector current (d.c.)	$-I_C$	max.	100	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	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	$R_{th\ j\text{-}a}$	=	0,25	K/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current $I_E = 0$; $-V_{CB}$ = 100 V; T_j = 70 °C	$-I_{CBO}$	<	10	μA
Saturation voltages $-I_C$ = 25 mA; $-I_B$ = 2,5 mA	$-V_{CEsat}$	<	250	mV
	$-V_{BEsat}$	<	900	mV
D.C. current gain $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	h_{FE}	>	30	
$-I_C$ = 25 mA; $-V_{CE}$ = 5 V	h_{FE}	>	30	
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; $-V_{CB}$ = 10 V	C_c	<	5	pF
Transition frequency at f = 35 MHz $-I_C$ = 25 mA; $-V_{CE}$ = 5 V	f_T	>	50	MHz

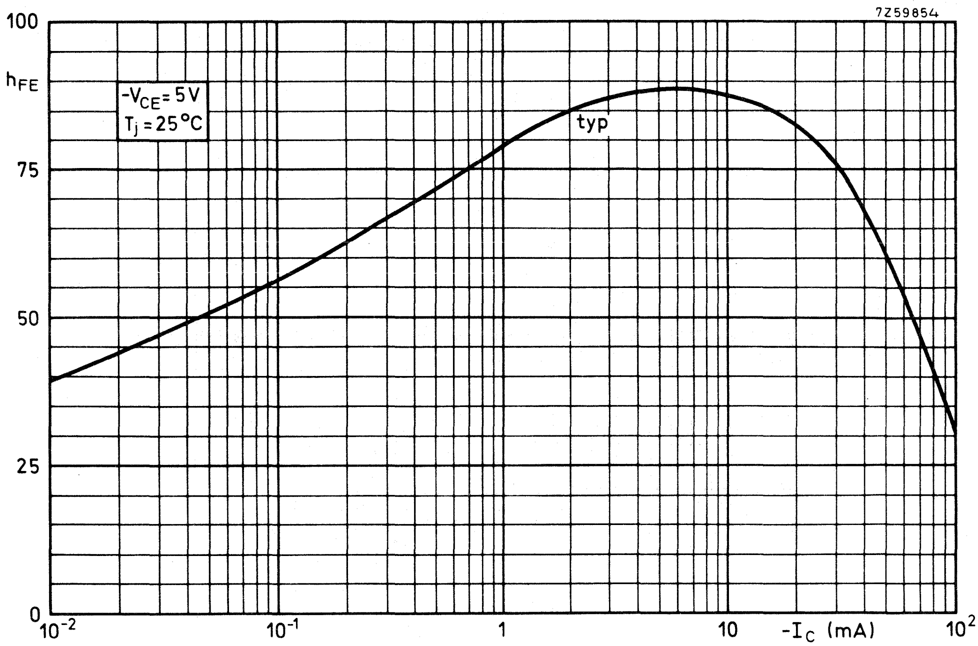

7Z59854
100
h_{FE}
75
50
25
0
$-V_{CE} = 5 V$
$T_j = 25 °C$
typ
10^{-2}
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 2.

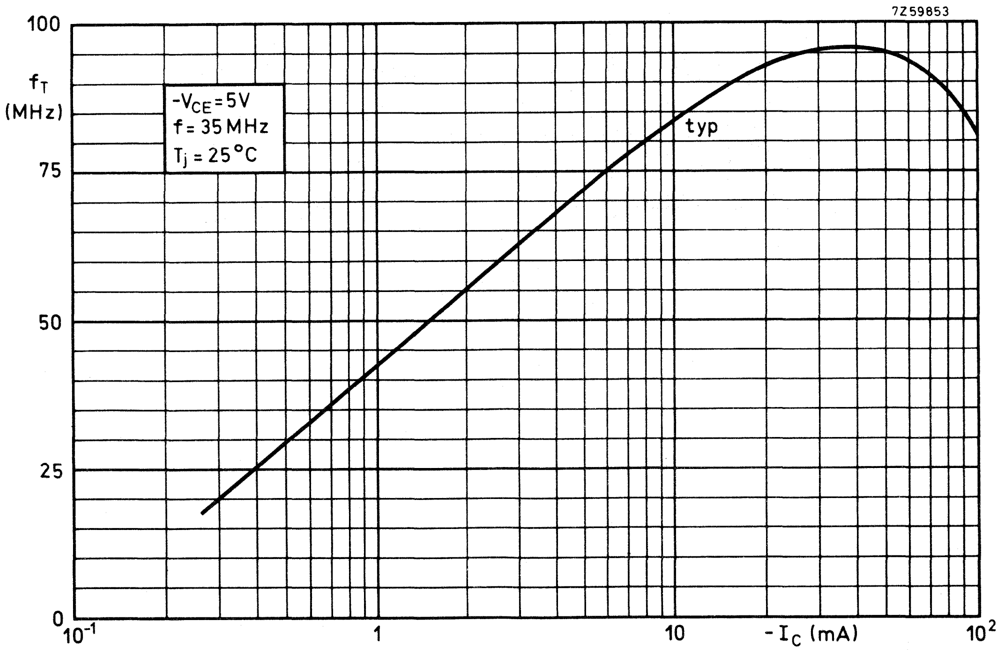

7Z59853
100
f_T
(MHz)
75
50
25
0
$-V_{CE} = 5 V$
f = 35 MHz
$T_j = 25 °C$
typ
10^{-1}
1
10
$-I_C$ (mA)
10^2

Fig. 3.

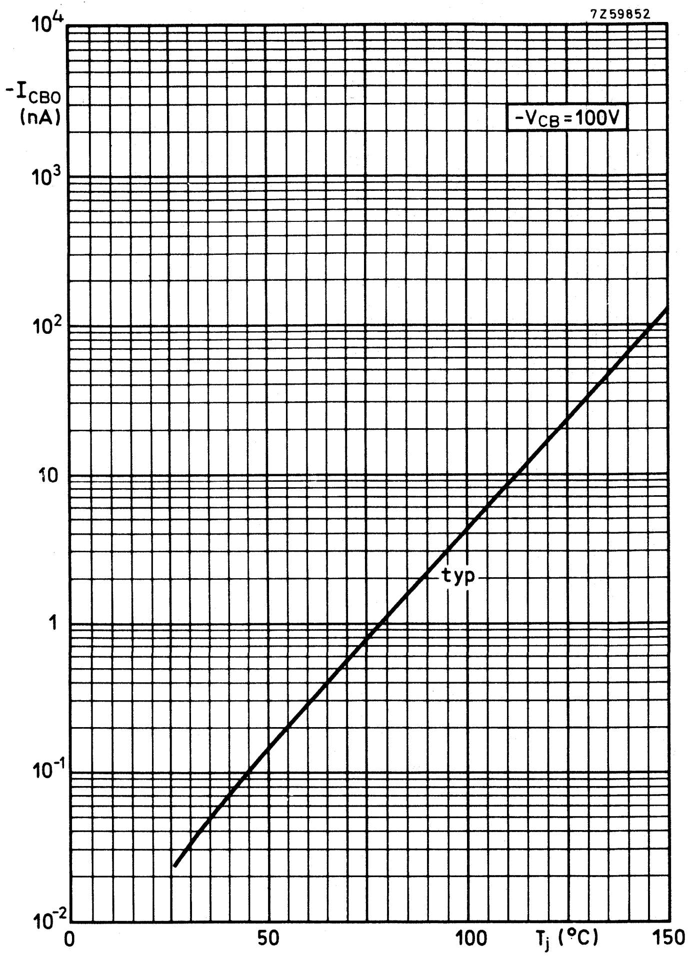

7Z59852
$-I_{CBO}$ (nA)
$-V_{CB} = 100V$
typ
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
0
50
100
T_j (°C)
150

Fig. 4.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in TO-39 metal envelopes with the collector connected to the case. These transistors are intended for general industrial applications.

QUICK REFERENCE DATA

			BSV15	BSV16	BSV17	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	V
Collector current (d.c.)	$-I_C$	max.		1,0		A
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.		0,8		W
up to T_{case} = 25 °C	P_{tot}	max.		5,0		W
Junction temperature	T_j	max.		200		°C
Transition frequency at f = 20 MHz						
$-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	>		50		MHz

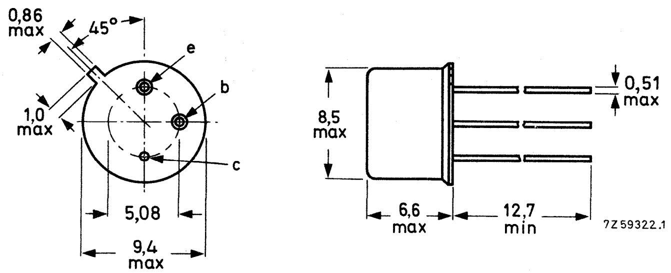
		BSV15–10 BSV16–10 BSV17–10	BSV15–16 BSV16–16
D.C. current gain $-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}	63–160	100–250

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 002-131.

RATINGS

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

			BSV15	BSV16	BSV17	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	80	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	40	60	90	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	5	V
Collector current (d.c.)	$-I_C$	max.		1,0		A
Base current (d.c.)	$-I_B$	max.		200		mA
Total power dissipation						
up to T_{amb} = 25 °C	P_{tot}	max.		0,8		W
up to T_{case} = 25 °C	P_{tot}	max.		5,0		W
up to T_{mb} = 50 °C	P_{tot}	max.		5,0		W
Storage temperature range	T_{stg}			--65 to +150		°C
Junction temperature	T_j	max.		200		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	220	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	35	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	30	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			BSV15	BSV16	BSV17	
Collector cut-off currents						
V_{BE} = 0; $-V_{CE}$ = 40 V	$-I_{CES}$	<	100	–	–	nA
V_{BE} = 0; $-V_{CE}$ = 40 V; T_{amb} = 150 °C	$-I_{CES}$	<	50	–	–	μA
V_{BE} = 0; $-V_{CE}$ = 60 V	$-I_{CES}$	<	–	100	–	nA
V_{BE} = 0; $-V_{CE}$ = 60 V; T_{amb} = 150 °C	$-I_{CES}$	<	–	50	–	μA
V_{BE} = 0; $-V_{CE}$ = 80 V	$-I_{CES}$	<	–	–	100	nA
V_{BE} = 0; $-V_{CE}$ = 80 V; T_{amb} = 150 °C	$-I_{CES}$	<	–	–	50	μA
$-V_{BE}$ = 0,2 V; $-V_{CE}$ = 40 V; T_{amb} = 100 °C	$-I_{CEX}$	<	50	–	–	μA
$-V_{BE}$ = 0,2 V; $-V_{CE}$ = 60 V; T_{amb} = 100 °C	$-I_{CEX}$	<	–	50	–	μA
$-V_{BE}$ = 0,2 V; $-V_{CE}$ = 80 V; T_{amb} = 100 °C	$-I_{CEX}$	<	–	–	50	μA
Emitter cut-off current						
I_C = 0; $-V_{EB}$ = 4 V	$-I_{EBO}$	<	50	50	50	nA
Breakdown voltages						
I_B = 0; $-I_C$ = 50 mA; t_p = 200 μs; δ = 0,01	$-V_{(BR)CEO}$	>	40	60	80	V
V_{BE} = 0; $-I_C$ = 10 μA	$-V_{(BR)CES}$	>	40	60	90	V
I_C = 0; $-I_E$ = 10 μA	$-V_{(BR)EBO}$	>	5	5	5	V

Base-emitter voltage				
$-I_C$ = 100 mA; $-V_{CE}$ = 1 V	$-V_{BE}$	<	1,0	V
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	$-V_{BE}$	typ.	0,85	V
			0,7 to 1,4	V
Saturation voltage				
$-I_C$ = 500 mA; $-I_B$ = 25 mA	$-V_{CEsat}$	<	1,0	V
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; $-V_{CB}$ = 10 V **BSV15; BSV16**	C_c	typ.	20	pF
		<	30	pF
$I_E = I_e$ = 0; $-V_{CB}$ = 10 V **BSV17**	C_c	typ.	15	pF
		<	25	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c$ = 0; $-V_{EB}$ = 0,5 V	C_e	typ.	180	pF
Transition frequency at f = 20 MHz				
$-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	>	50	MHz

CHARACTERISTICS (continued)

			BSV15–10 BSV16–10 BSV17–10	BSV15–16 BSV16–16	
D.C. current gain					
$-I_C$ = 0,1 mA; $-V_{CE}$ = 1 V	h_{FE}	>	20	30	
		typ.	75	120	
$-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}	typ.	100	160	
			63 to 160	100 to 250	
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}	>	25	35	
		typ.	55	85	
h-parameter at f = 1 kHz					
$-I_C$ = 1 mA; $-V_{CE}$ = 5 V					
Small signal current gain	h_{fe}	>	20		
Switching times					
Turn-on time					
$-I_C$ = 100 mA; $-I_B$ = $+I_{BM}$ = 5 mA	t_{on}	<	500		ns
Turn-off time					
$-I_C$ = 100 mA; $-I_B$ = $+I_{BM}$ = 5 mA					
Storage time	t_s	<	500		ns
Fall time	t_f	<	150		ns

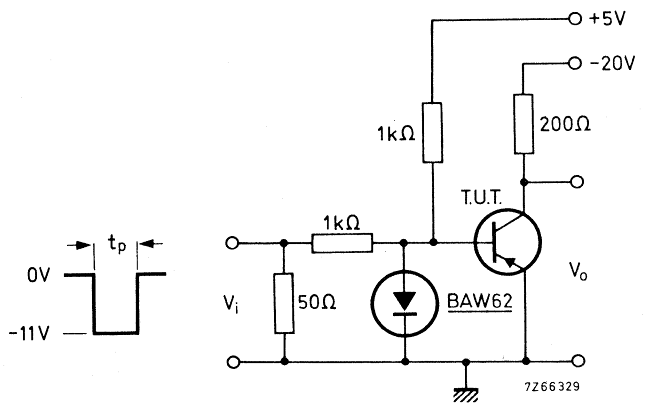


Fig. 2 Test circuit.

Pulse generator:

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

Oscilloscope:

Rise time	⩽ 15 ns
Input impedance	⩾ 100 kΩ

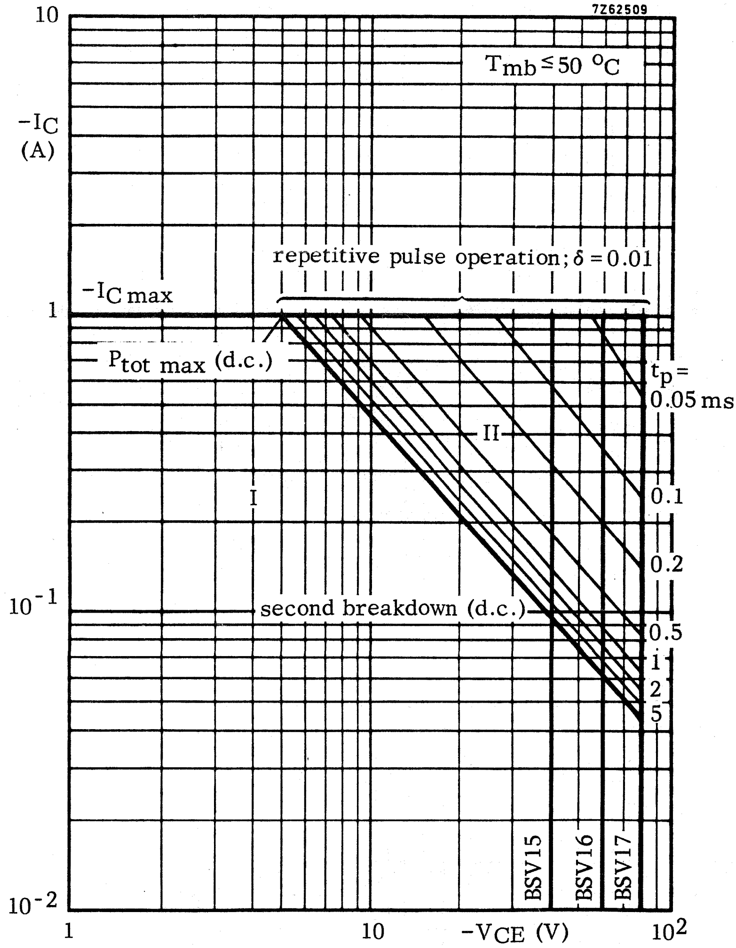


Fig. 3.

Safe Operating Area with the transistor forward biased

I Region of permissible d.c. operation

II Permissible extension for repetitive pulse operation.

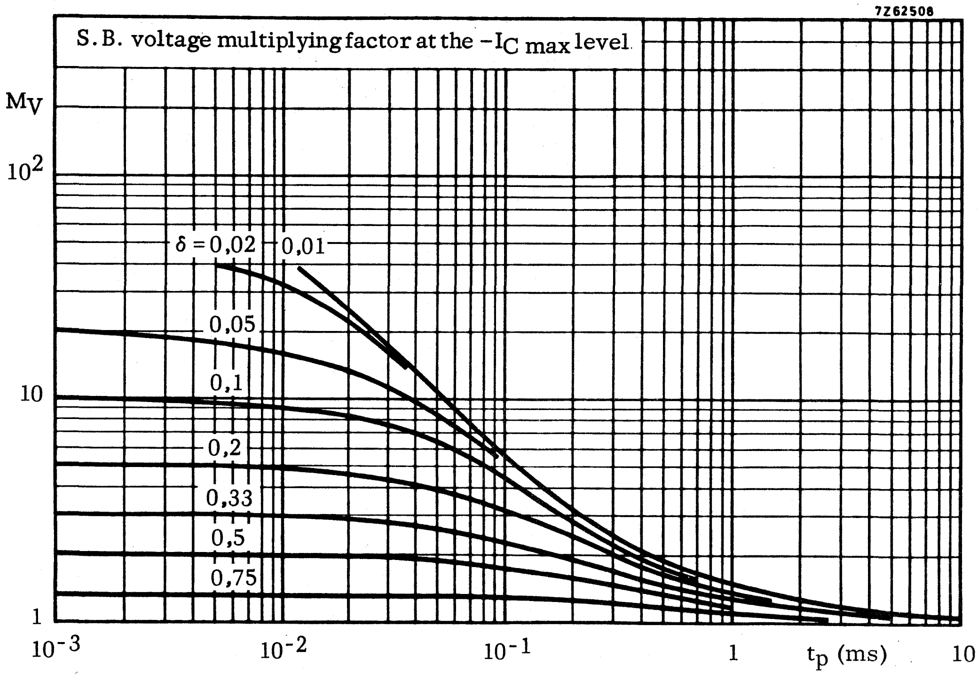

7Z62508
S.B. voltage multiplying factor at the $-I_{C\,max}$ level
M_V
10^2
10
1
δ = 0,02
0,01
0,05
0,1
0,2
0,33
0,5
0,75
10^{-3}
10^{-2}
10^{-1}
1
t_p (ms)
10

Fig. 4.

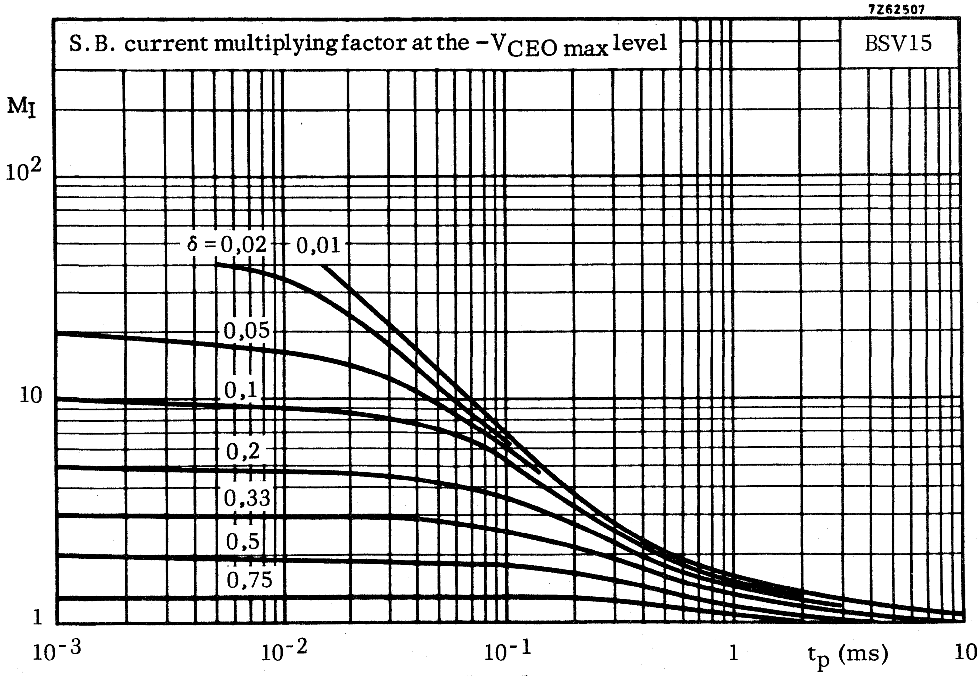

7Z62507
S.B. current multiplying factor at the $-V_{CEO\,max}$ level
BSV15
M_I
10^2
10
1
δ = 0,02
0,01
0,05
0,1
0,2
0,33
0,5
0,75
10^{-3}
10^{-2}
10^{-1}
1
t_p (ms)
10

Fig. 5.

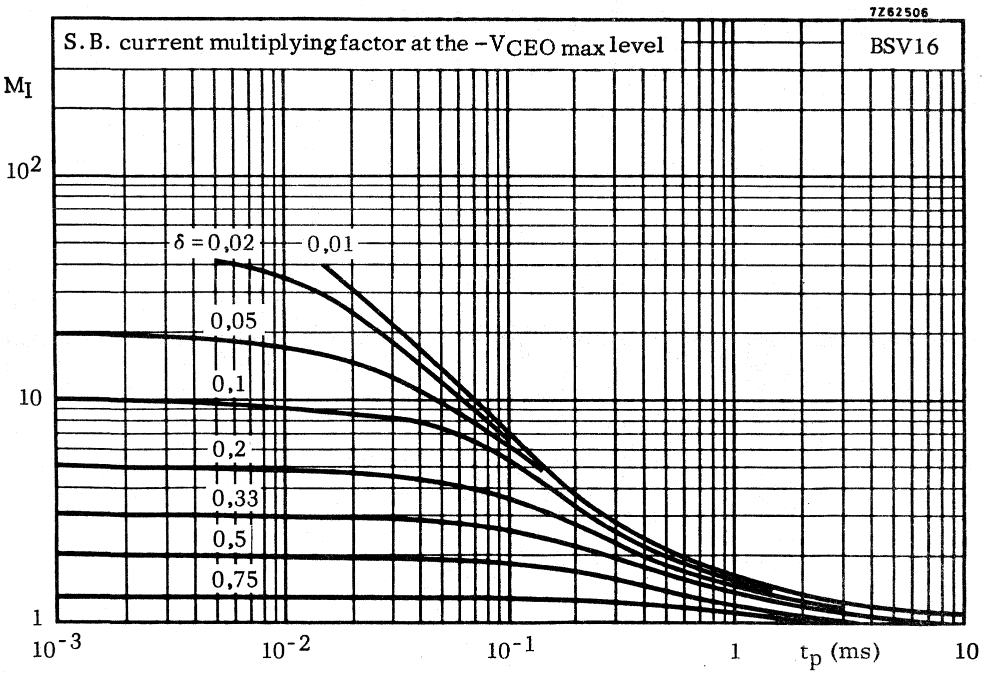

7Z62506
S.B. current multiplying factor at the $-V_{CEO\,max}$ level
BSV16
M_I
10^2
10
1
δ = 0,02
0,01
0,05
0,1
0,2
0,33
0,5
0,75
10^{-3}
10^{-2}
10^{-1}
1
t_p (ms)
10

Fig. 6.

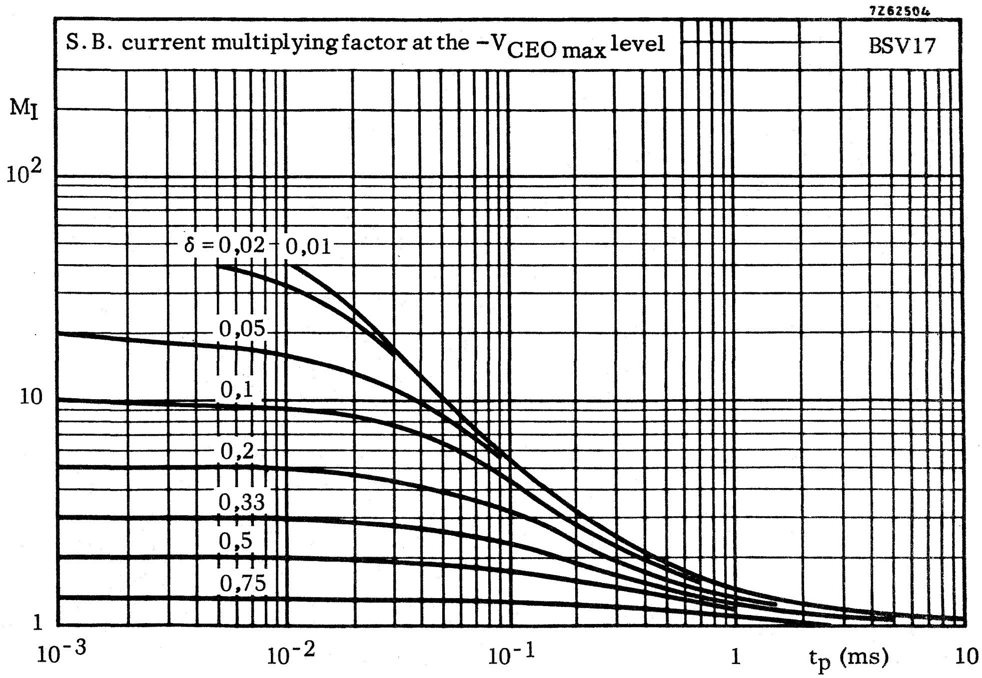

7Z62504
S.B. current multiplying factor at the $-V_{CEO\,max}$ level
BSV17
M_I
10^2
10
1
δ = 0,02
0,01
0,05
0,1
0,2
0,33
0,5
0,75
10^{-3}
10^{-2}
10^{-1}
1
t_p (ms)
10

Fig. 7.

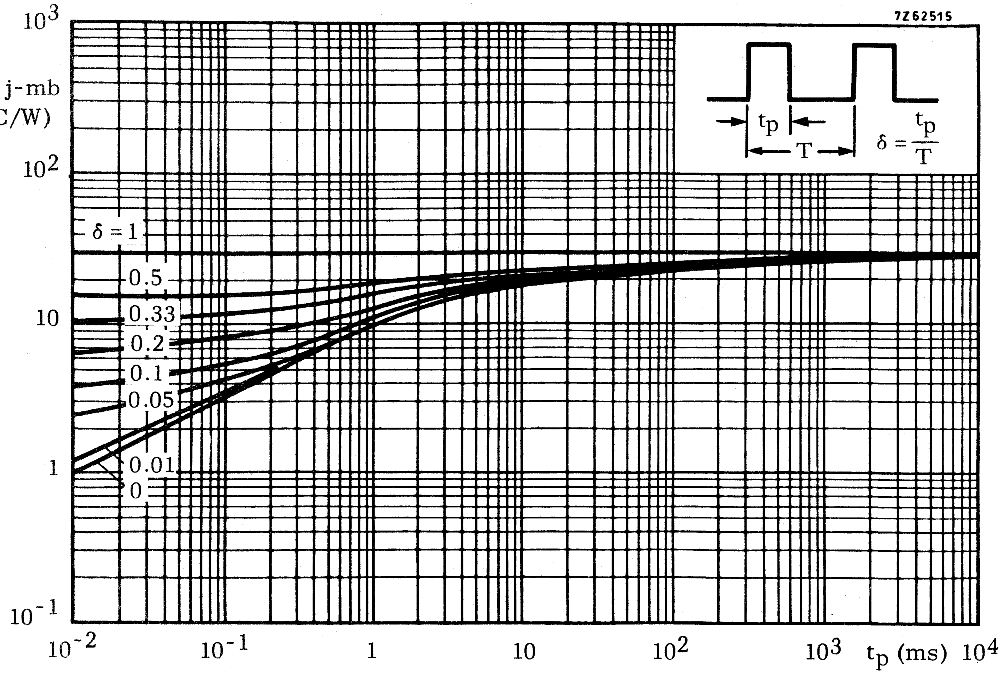

7Z62515
10^3
Z_th j-mb
(°C/W)
10^2
δ = 1
0.5
0.33
0.2
0.1
0.05
0.01
0
10
1
10^-1
10^-2
10^-1
1
10
10^2
10^3
t_p (ms)
10^4
t_p
T
δ = t_p/T

Fig. 8.

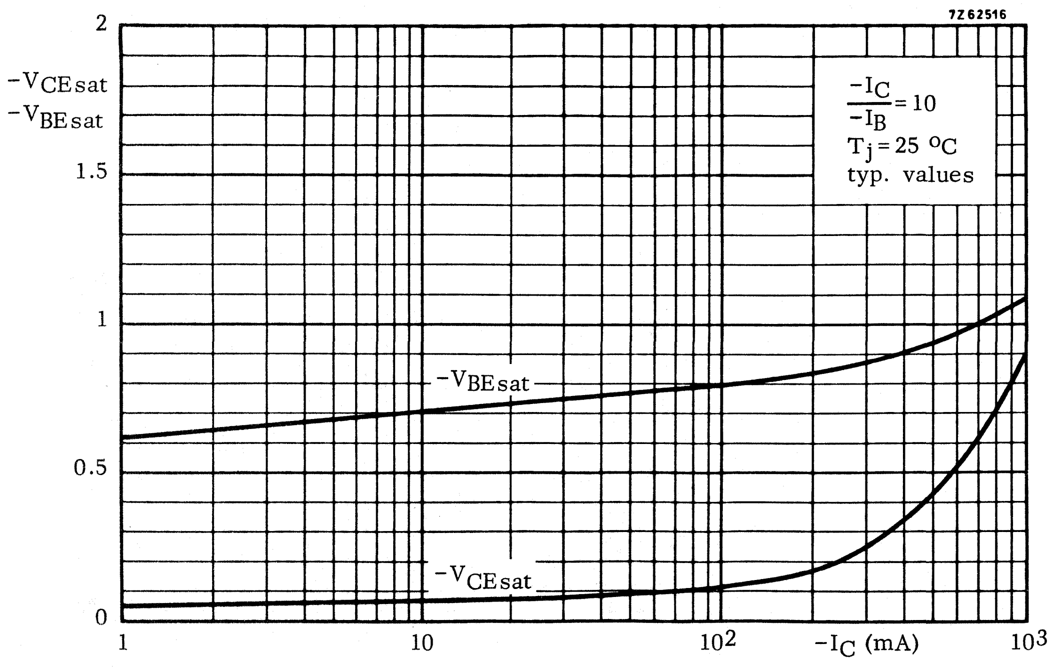

7Z62516
2
−V_CEsat
−V_BEsat
1.5
1
0.5
0
−I_C/−I_B = 10
T_j = 25 °C
typ. values
−V_BEsat
−V_CEsat
1
10
10^2
−I_C (mA)
10^3

Fig. 9.

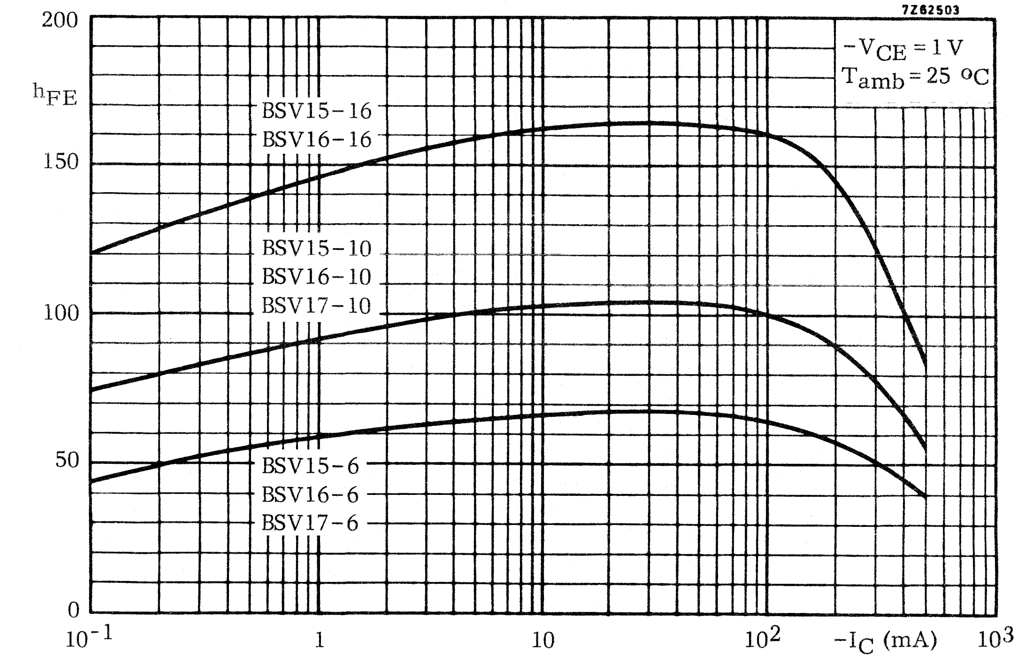

7Z62503
200
h_{FE}
150
100
50
0
BSV15−16
BSV16−16
BSV15−10
BSV16−10
BSV17−10
BSV15−6
BSV16−6
BSV17−6
$-V_{CE}$ = 1 V
T_{amb} = 25 °C
10^{-1}
1
10
10^2
$-I_C$ (mA)
10^3

Fig. 10.

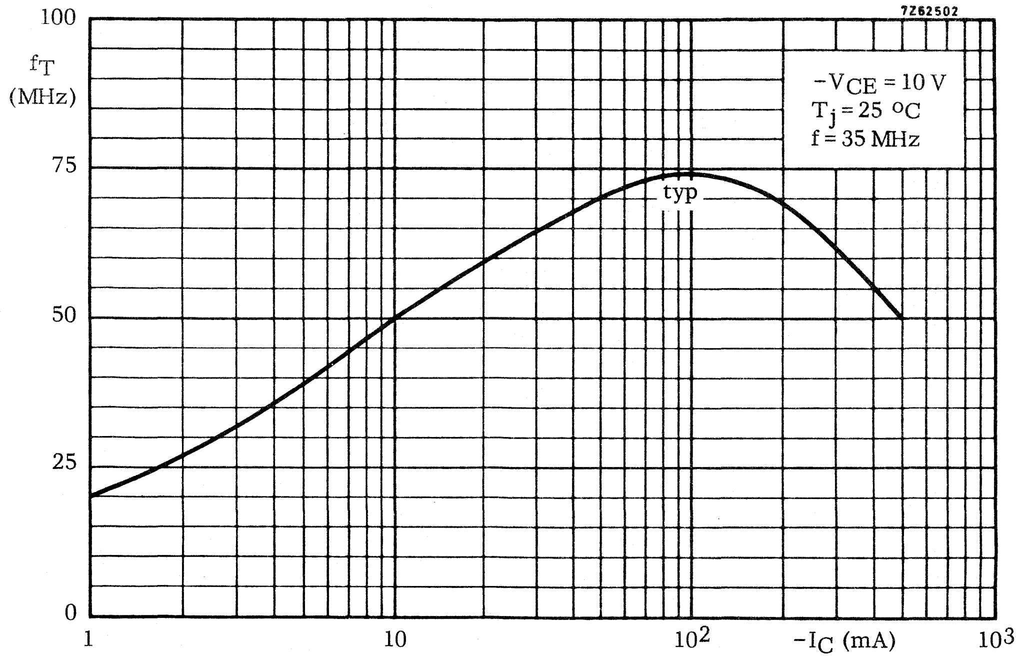

7Z62502
100
f_T (MHz)
75
50
25
0
typ
$-V_{CE}$ = 10 V
T_j = 25 °C
f = 35 MHz
1
10
10^2
$-I_C$ (mA)
10^3

Fig. 11.

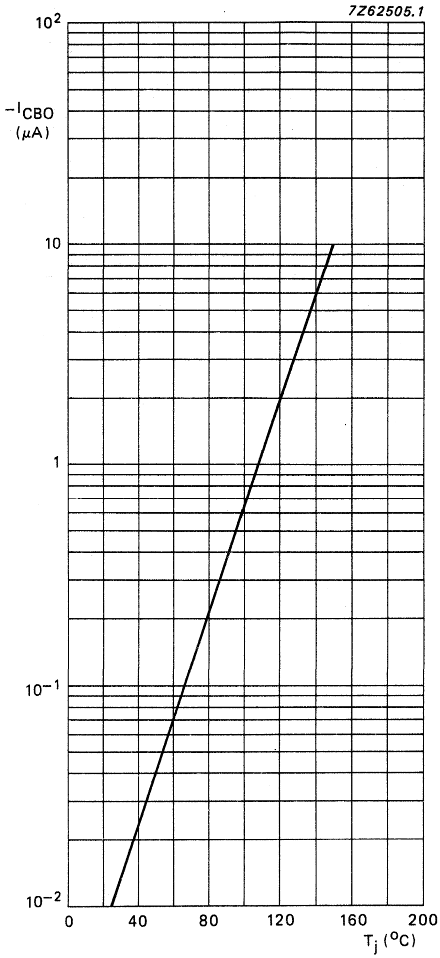


Fig. 12.

$-V_{CBO}$ = 40 V; BSV15;
$-V_{CBO}$ = 60 V; BSV16;
$-V_{CBO}$ = 80 V; BSV17;
typical values.

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-39 metal envelope primarily intended for use as a print hammer drive. It has good high current saturation characteristics.

QUICK REFERENCE DATA

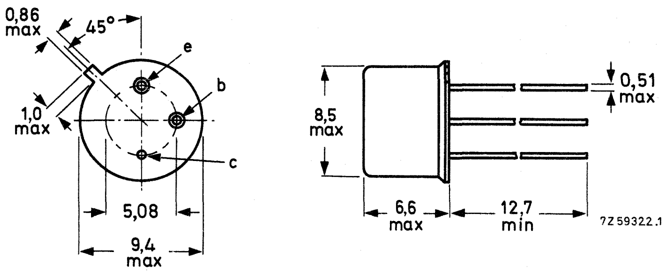
Collector-base voltage (open emitter)	V_{CBO}	max.	100	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	V
Collector current (peak value)	I_{CM}	max.	5,0	A
Total power dissipation up to T_{case} = 50 °C	P_{tot}	max.	5,0	W
Junction temperature	T_j	max.	175	°C
D.C. current gain I_C = 2 A; V_{CE} = 2 V	h_{FE}	>	40	
Transition frequency at f = 35 MHz I_C = 0,5 A; V_{CE} = 5 V	f_T	typ.	100	MHz
Turn-off time when switched from I_{Con} = 5 A; I_{Bon} = 0,5 A to cut-off with $-I_{Boff}$ = 0,5 A	t_{off}	<	1,2	μs

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 004-025.

RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	100	V
Collector-emitter voltage ($R_{BE} \leqslant 50\ \Omega$)	V_{CER}	max.	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c.)	I_C	max.	2,0	A
Collector current (peak value)	I_{CM}	max.	5,0	A
Base current (d.c.)	I_B	max.	1,0	A
Total power dissipation up to T_{case} = 50 °C	P_{tot}	max.	5,0	W
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}c}$	=	25	K/W

CHARACTERISTICS

T_j = 25 °C

Collector cut-off current $I_E = 0$; V_{CB} = 60 V	I_{CBO}	<	10	μA
Emitter cut-off current $I_C = 0$; V_{EB} = 4 V	I_{EBO}	<	10	μA
Saturation voltages I_C = 5 A; I_B = 0,5 A	V_{CEsat} V_{BEsat}	< <	1,0 1,8	V V
D.C. current gain I_C = 2 A; V_{CE} = 2 V	h_{FE}	>	40	
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	80	pF
Transition frequency at f = 35 MHz I_C = 0,5 A; V_{CE} = 5 V	f_T	typ.	100	MHz
Switching times I_{Con} = 5 A; $I_{Bon} = -I_{Boff}$ = 0,5 A $-V_{BEoff}$ = 2 V turn-on time	t_{on}	<	0,6	μs
turn-off time	t_{off}	<	1,2	μs

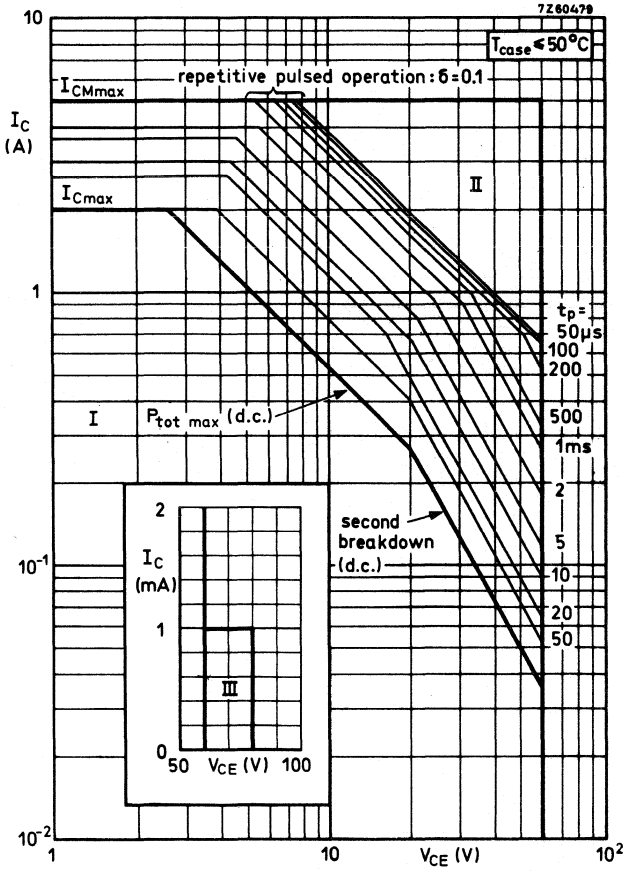


Fig. 2.

Safe Operating Area

I Region of permissible d.c. operation
II Permissible extension for repetitive pulsed operation
III D.C. operation in this region is allowable, provided $R_{BE} \leq 50\ \Omega$.

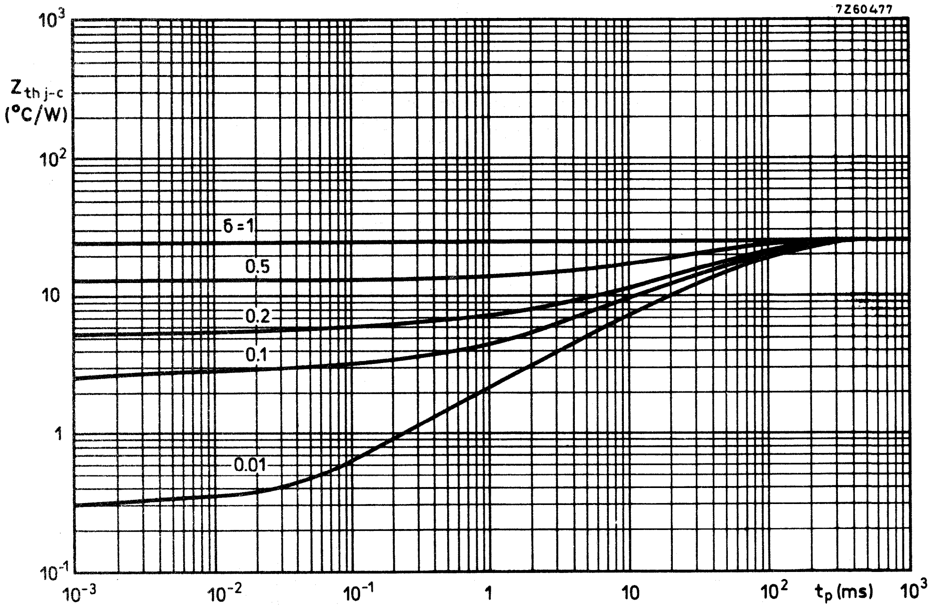

7Z60477
$Z_{th\,j-c}$
(°C/W)
10^3
10^2
10
1
10^{-1}
δ = 1
0.5
0.2
0.1
0.01
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
t_p (ms)
10^3

Fig. 3.

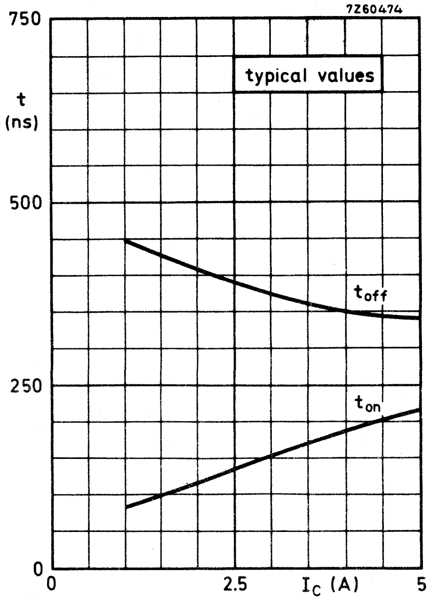

7Z60474
750
t
(ns)
500
250
0
typical values
t_{off}
t_{on}
0
2.5
I_C (A)
5

Fig. 4.

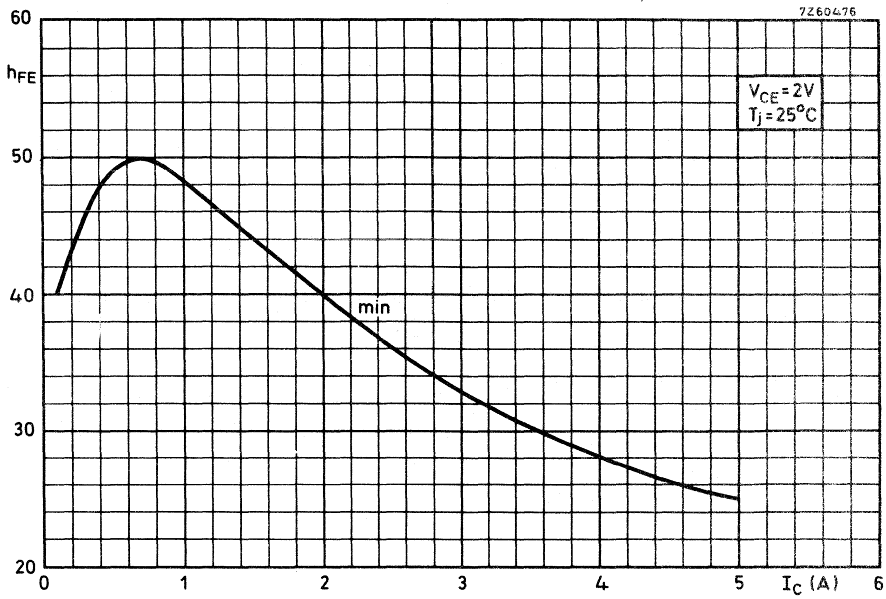


Fig. 5.

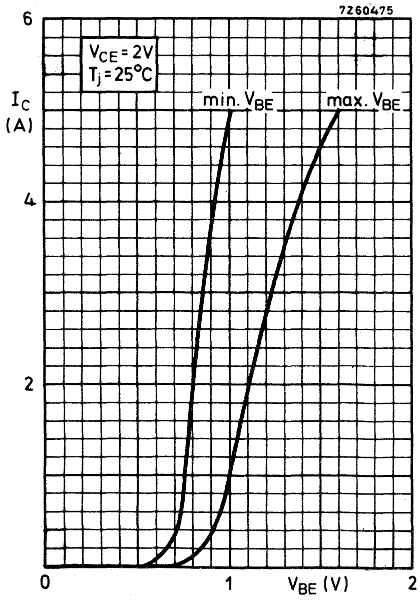


Fig. 6.

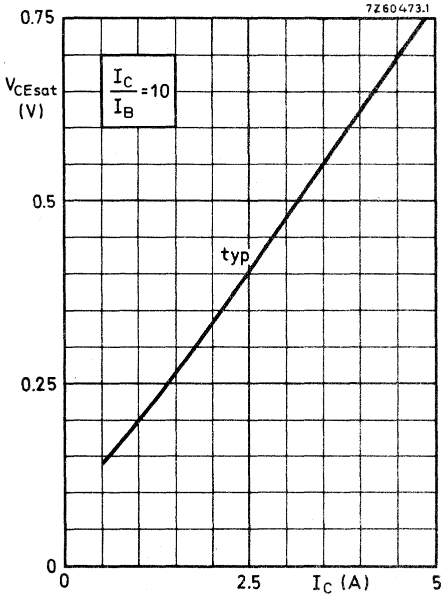


Fig. 7.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors primarily intended for general purpose industrial and switching applications.

QUICK REFERENCE DATA

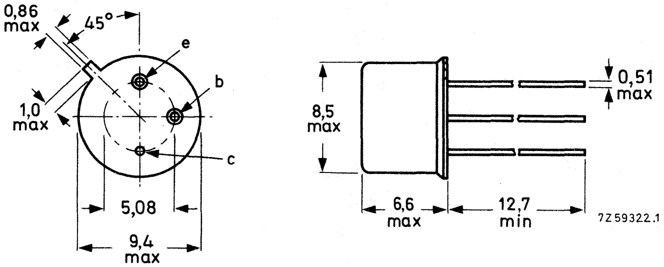
			BSW66A	BSW67A	BSW68A	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	120	150	V
Collector-emitter voltage (open base)	V_{CEO}	max.	100	120	150	V
Collector current (peak value)	I_{CM}	max.		2		A
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.		5,0		W
Collector-emitter saturation voltage I_C = 500 mA; I_B = 50 mA	V_{CEsat}	<		400		mV
D.C. current gain I_C = 10 mA; V_{CE} = 5 V	h_{FE}	>		30		
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	>		30		
Transition frequency at f = 35 MHz I_C = 100 mA; V_{CE} = 20 V	f_T	typ.		130		MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case.



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 004-040.

RATINGS

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

			BSW66A	BSW67A	BSW68A	
Collector-base voltage (open emitter)	V_{CBO}	max.	100	120	150	V
Collector-emitter voltage (open base) *	V_{CEO}	max.	100	120	150	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	6	6	V
Collector current (d.c. or average)	I_C	max.		1		A
Collector current (peak value; $t_p \leqslant 20$ ms)	I_{CM}	max.		2		A
Total power dissipation up to						
$T_{amb} = 25$ °C	P_{tot}	max.		0,8		W
$T_{case} = 25$ °C	P_{tot}	max.		5,0		W
Storage temperature range	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		200		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	220	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	35	K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

			BSW66A	BSW67A	BSW68A	
Collector cut-off current						
$I_E = 0$; $V_{CB} = V_{CBOmax}$	I_{CBO}	<		100		μA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$	I_{CBO}	<		100		nA
$I_E = 0$; $V_{CB} = ½V_{CBOmax}$; $T_j = 150$ °C	I_{CBO}	<		50		μA
Emitter cut-off current						
$I_C = 0$; $V_{EB} = 6$ V	I_{EBO}	<		100		μA
$I_C = 0$; $V_{EB} = 3$ V	I_{EBO}	<		100		nA
Collector-emitter breakdown voltage						
$I_B = 0$; $I_C = 10$ mA	$V_{(BR)CEO}$	>	100	120	150	V
Saturation voltages						
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	<		150		mV
	V_{BEsat}	<		900		mV
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<		400		mV
	V_{BEsat}	<		1,1		V
$I_C = 1,0$ A; $I_B = 150$ mA	V_{CEsat}	<		1,0		V
	V_{BEsat}	<		1,4		V

* See Application Information

D.C. current gain				
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	>	30	
I_C = 100 mA; V_{CE} = 5 V	h_{FE}	>	40	
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	>	30	
I_C = 1,0 A; V_{CE} = 5 V	h_{FE}	>	10	
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				
$I_C = I_c = 0$; $V_{EB} = 0$	C_e	<	300	pF
Transition frequency at f = 35 MHz				
I_C = 100 mA; V_{CE} = 20 V	f_T	typ.	130	MHz
Turn-on time (see Fig. 2)				
I_{Con} = 500 mA; I_{Bon} = 50 mA; $-V_{BEoff}$ = 4 V	t_{on}	typ.	0,5	μs
Turn-off time (see Fig. 2)				
I_{Con} = 500 mA; $I_{Bon} = -I_{Boff}$ = 50 mA	t_{off}	typ.	0,9	μs

Pulse generator:
$t_p \geq 5\ \mu s$
$t_r \leq 10$ ns
$t_f \leq 10$ ns

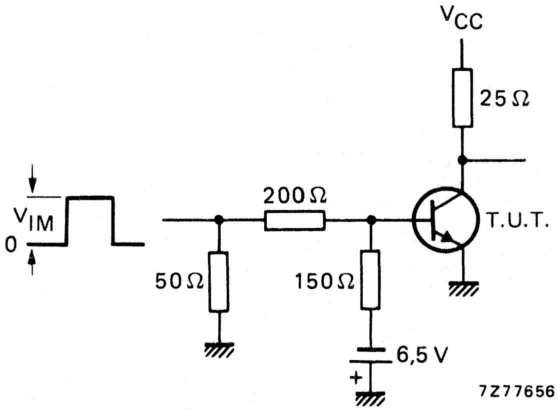


Fig. 2 Test circuit for saturated switching characteristics.
V_{CC} = 13 V; V_{IM} = 21 V.

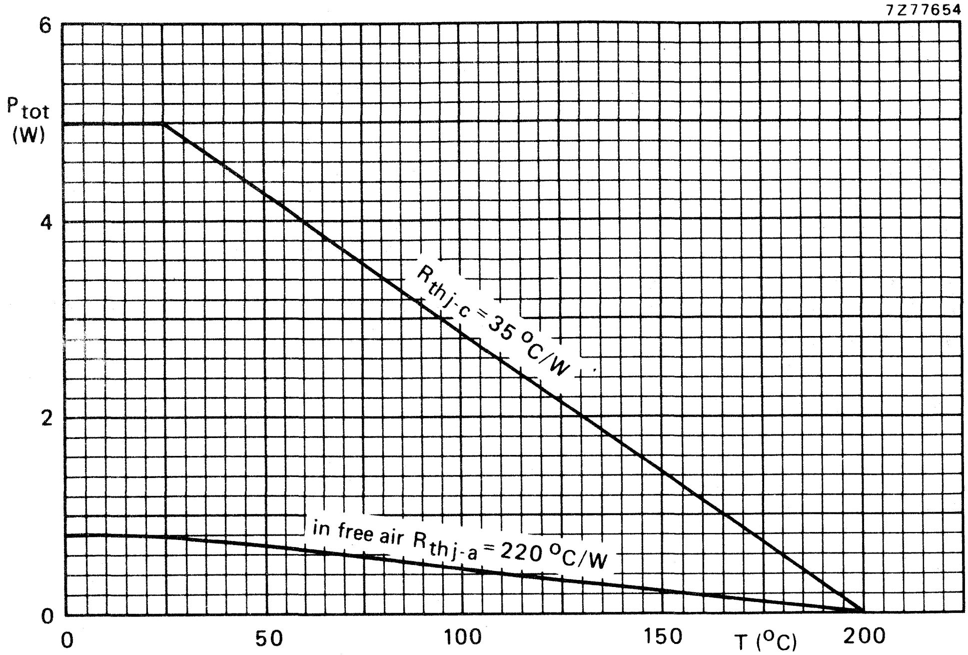


Fig. 3 Maximum permissible power dissipation versus temperature.

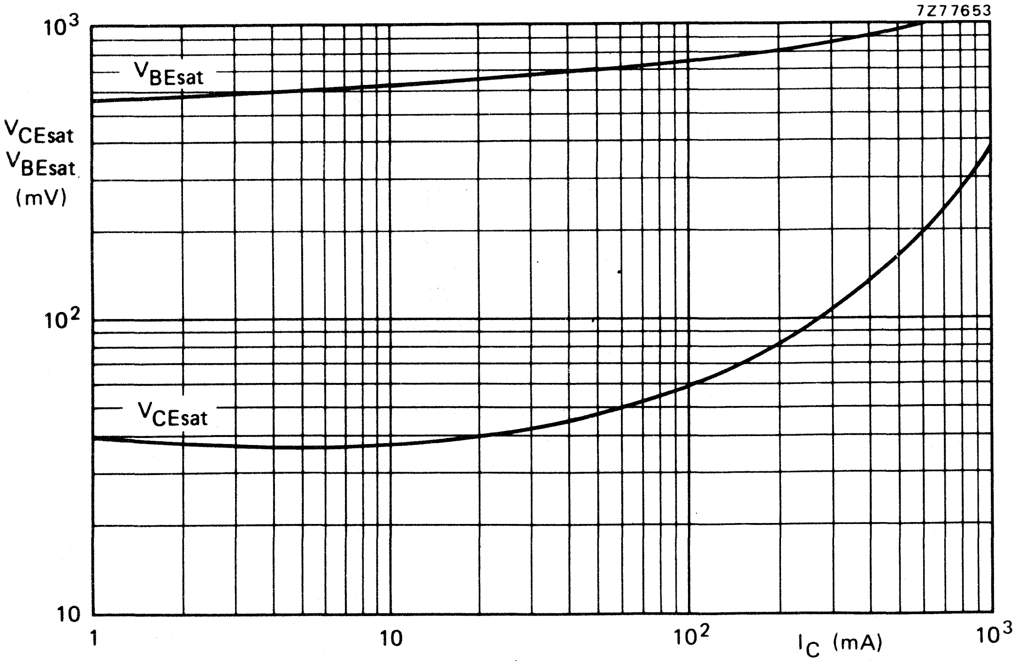


Fig. 4 I_C/I_B = 10; T_j = 25 °C; typical values.

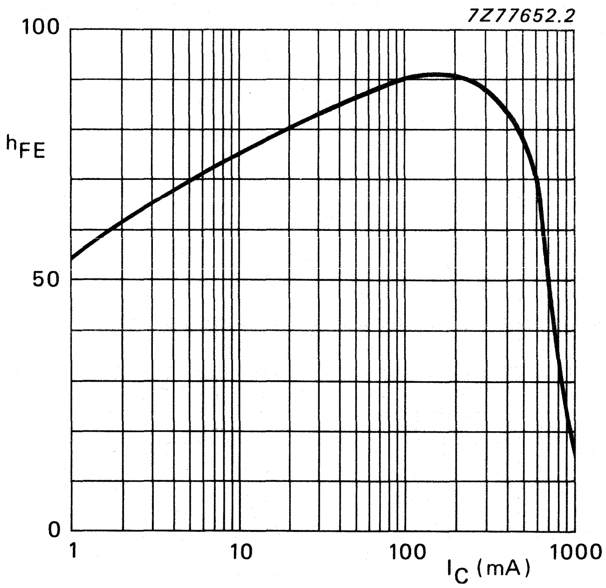


Fig. 5 V_{CE} 5 V; T_j = 25 °C; typical values.

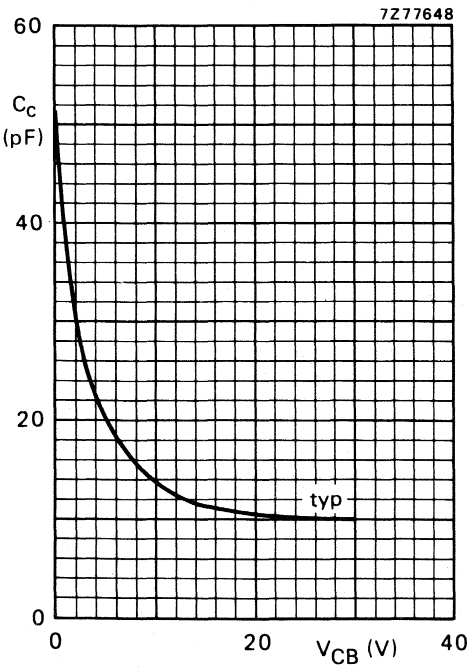


Fig. 6 $I_E = I_e = 0$; T_j = 25 °C.

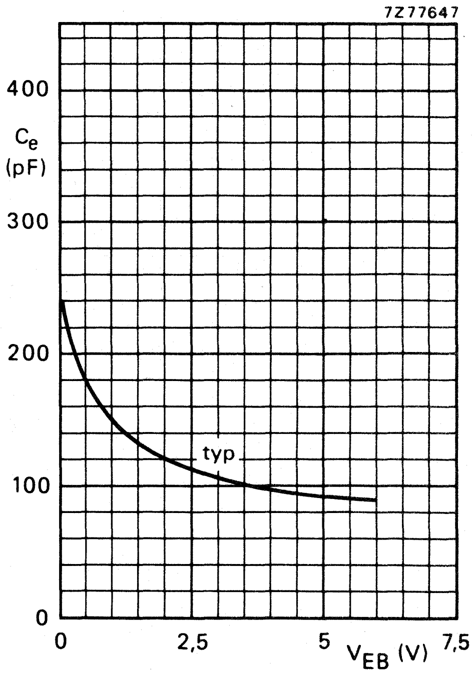


Fig. 7 $I_C = I_c = 0$; T_j = 25 °C.

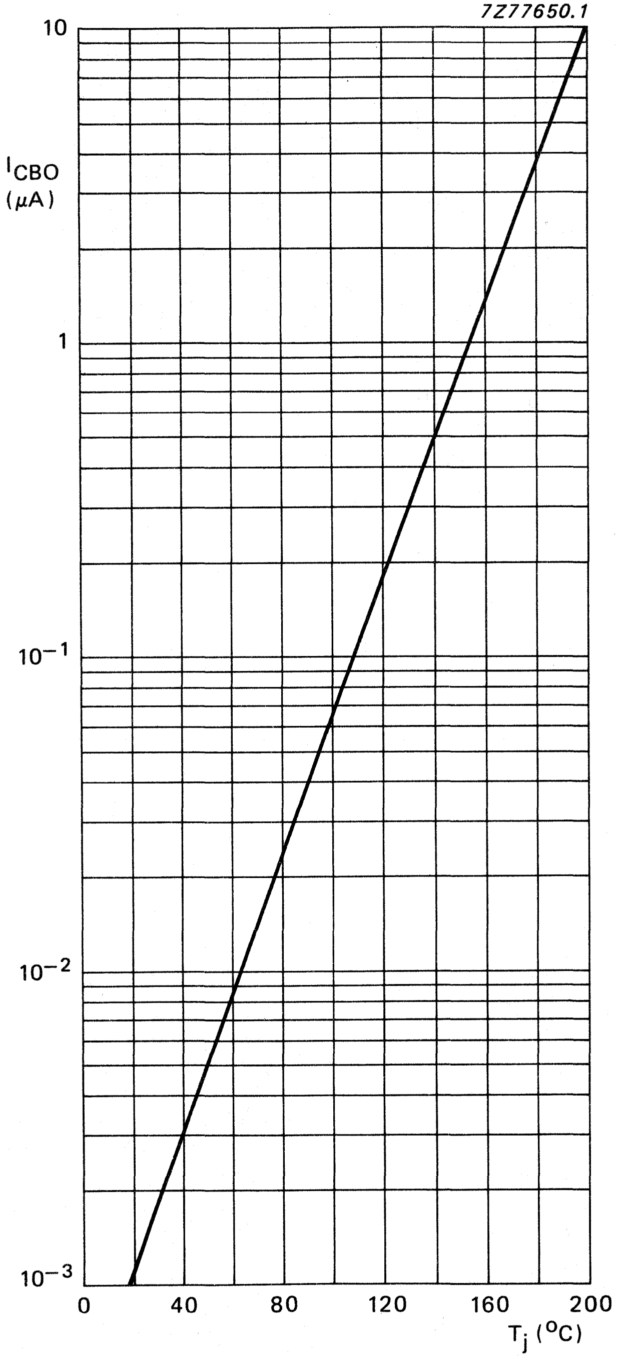


Fig. 8 $V_{CB} = V_{CBOmax}$; typical values.

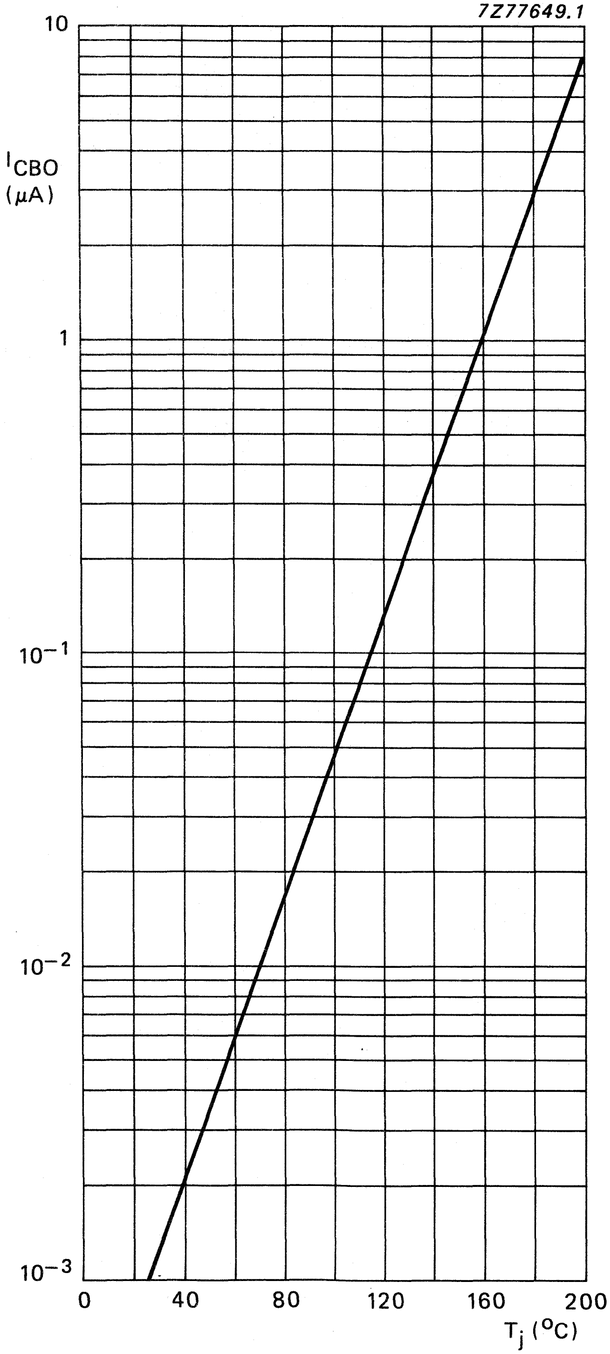


Fig. 9 $V_{CB} = ½V_{CBOmax}$; typical values.

APPLICATION INFORMATION

Clamped inductive load turn-off capability

With a base-emitter resistance of ⩾ 330 Ω, i.e. an available reverse base current of ⩽ 2 mA, and the maximum permitted clamping voltage i.e. the rated V_{CEOmax}, the transistor will be free from second-breakdown effects when turning off from collector current values up to the rated I_{CMmax} of 2 A. See Figs 10 and 11.

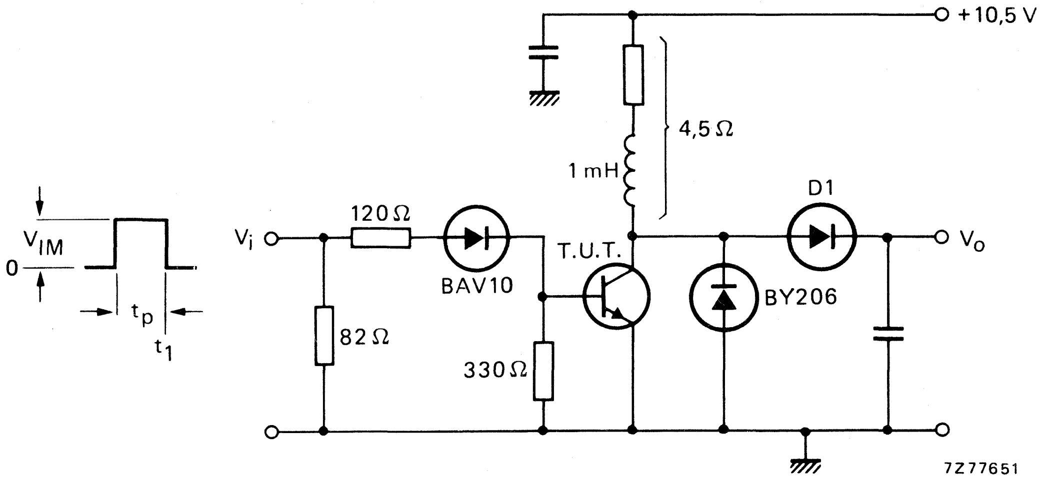


Fig. 10 Test circuit: V_{IM} = 50 V; t_p = 3 ms; $\delta \leqslant 0{,}03$.
D1 = BY206 or combinations of suitable faster diodes.
V_o Adjusted to make $V_{(CL)}$ equal to rated V_{CEOmax} (see Fig. 11).

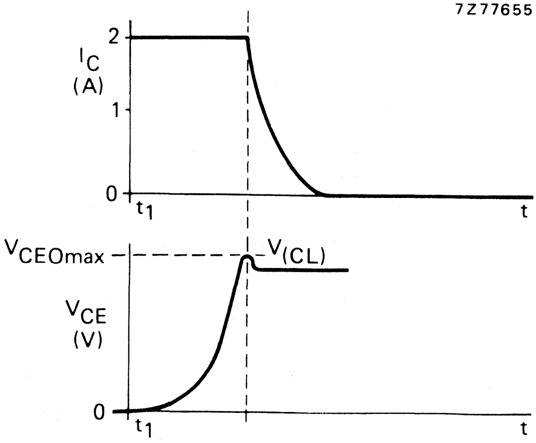


Fig. 11 Waveforms.

SILICON PLANAR EPITAXIAL TRANSISTORS

NPN transistors in TO-18 metal envelopes, primarily intended for high-speed saturated switching and HF amplifier applications.

QUICK REFERENCE DATA

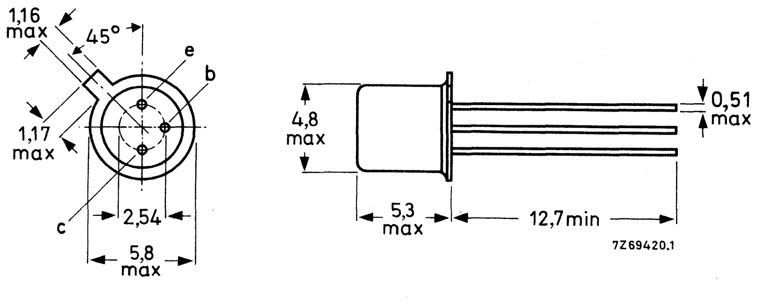
Collector-base voltage (open emitter)	V_{CBO}	max.	40 V
Collector-emitter voltage (open base)	V_{CEO}	max.	15 V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	40 V
Collector current (peak value)	I_{CM}	max.	500 mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360 mW
DC current gain at T_j = 25 °C			
I_C = 10 mA; V_{CE} = 1 V	h_{FE}		40 to 120
I_C = 100 mA; V_{CE} = 2 V	h_{FE}	min.	20
Transition frequency			
I_C = 10 mA; V_{CE} = 10 V	f_T	min.	500 MHz
Storage time			
$I_C = I_B = -I_{BM}$ = 10 mA	t_s	max.	13 ns

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-18.

Collector connected to case



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.	15	V
Collector-emitter voltage with V_{BE} = 0	V_{CES}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.5	V
Collector current (peak value; t = 10 μs)	I_{CM}	max.	500	mA
Total power dissipation up to T_{amb} = 25 ^{o}C	P_{tot}	max.	360	mW
Storage temperature range	T_{stg}		−65 to +150	^{o}C
Junction temperature	T_j	max.	200	^{o}C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	480	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	150	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	max.	400	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	max.	30	μA
$V_{BE} = 0$; $V_{CE} = 15$ V; $T_j = 55$ °C	I_{CES}	max.	0.40	μA
$V_{BE} = 0$; $V_{CE} = 40$ V	I_{CES}	max.	1.0	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 4.5$ V	I_{EBO}	max.	10	μA
Currents at reverse biased emitter junction				
$V_{CE} = 15$ V; $-V_{BE} = 3$ V; $T_j = 55$ °C	I_{CEX}	max.	0.60	μA
	$-I_{BEX}$	max.	0.60	μA
Sustaining voltages				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	min.	15	V
$I_C = 10$ mA; $R_{BE} = 10\ \Omega$	$V_{CERsust}$	min.	20	V
Base-emitter voltage (see also Fig.6)				
$I_C = 30$ μA; $V_{CE} = 20$ V; $T_j = 100$ °C	V_{BE}	min.	0.35	V
Saturation voltages				
$I_C = 10$ mA; $I_B = 0.3$ mA	V_{CEsat}	max.	0.3	V
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	max.	0.25	V
	V_{BEsat}		0.70 to 0.85	V
$I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	max.	0.60	V
	V_{BEsat}	max.	1.50	V
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	max.	4	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 1$ V	C_e	max.	4.5	pF

CHARACTERISTICS (continued)

DC current gain

I_C = 10 mA; V_{CE} = 1 V	h_{FE}		40 to 120	
I_C = 10 mA; V_{CE} = 1 V; T_j = −55 °C	h_{FE}	min.	20	
I_C = 100 mA; V_{CE} = 2 V	h_{FE}	min.	20	

Transition frequency

I_C = 10 mA; V_{CE} = 10 V	f_T	min.	500	MHz
		typ.	600	MHz

Switching times

Storage time (see also relevant Figs.)

$I_C = I_B = -I_{BM}$ = 10 mA	t_s	typ.	6	ns
		max.	13	ns

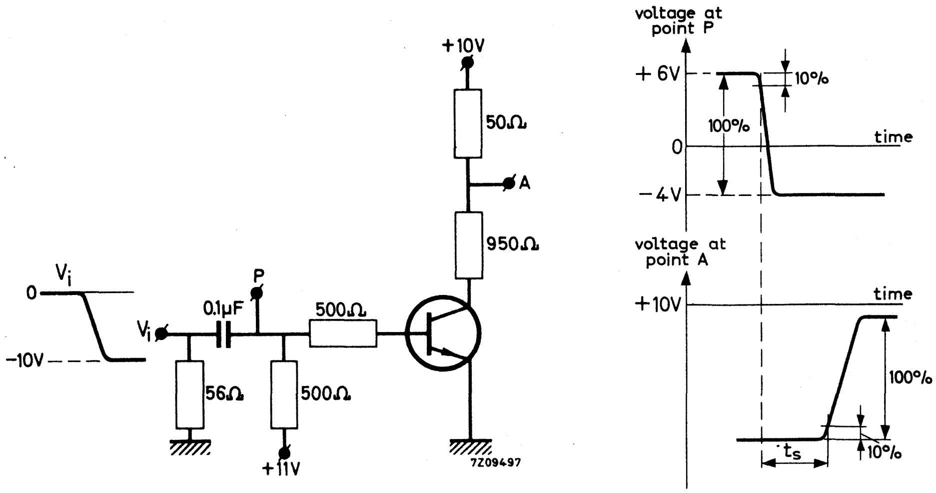


Fig. 2 Test circuit and timing waveforms.

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

Switching times

Turn on time (see also relevant Figs.)

from $-V_{BE}$ = 1.5 V to I_C = 10 mA; I_B = 3 mA	t_{on}	max.	12	ns
from $-V_{BE}$ = 2.25 V to I_C = 100 mA; I_B = 40 mA	t_{on}	max.	7	ns

Turn off time (see also relevant Figs.)

from I_C = 10 mA; I_B = 3 mA to cut-off with $-I_{BM}$ = 1.5 mA	t_{off}	max.	18	ns
from I_C = 100 mA; I_B = 40 mA to cut-off with $-I_{BM}$ = 20 mA	t_{off}	max.	21	ns

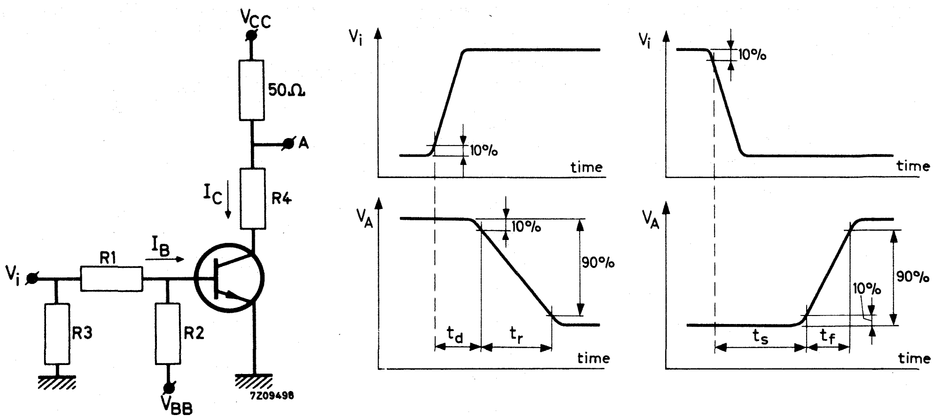


Fig. 3 Test circuit and timing waveforms.

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)	R1;R2 (kΩ)	R3 (Ω)	R4 (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
100	40	20	6	0.33	56	0	4.5	2.25	20	15.3	20

Note

$-I_{BM}$ 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.

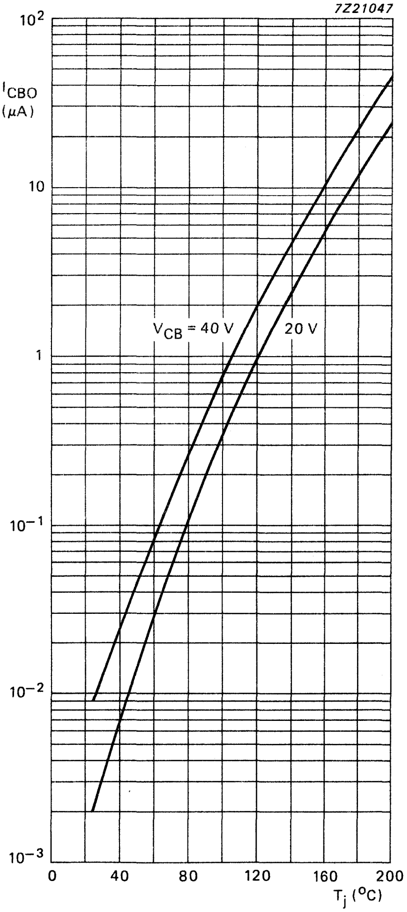

7Z21047
10^2
I_{CBO} (μA)
10
1
10^{-1}
10^{-2}
10^{-3}
V_{CB} = 40 V
20 V
0
40
80
120
160
200
T_j (°C)

Fig.4.

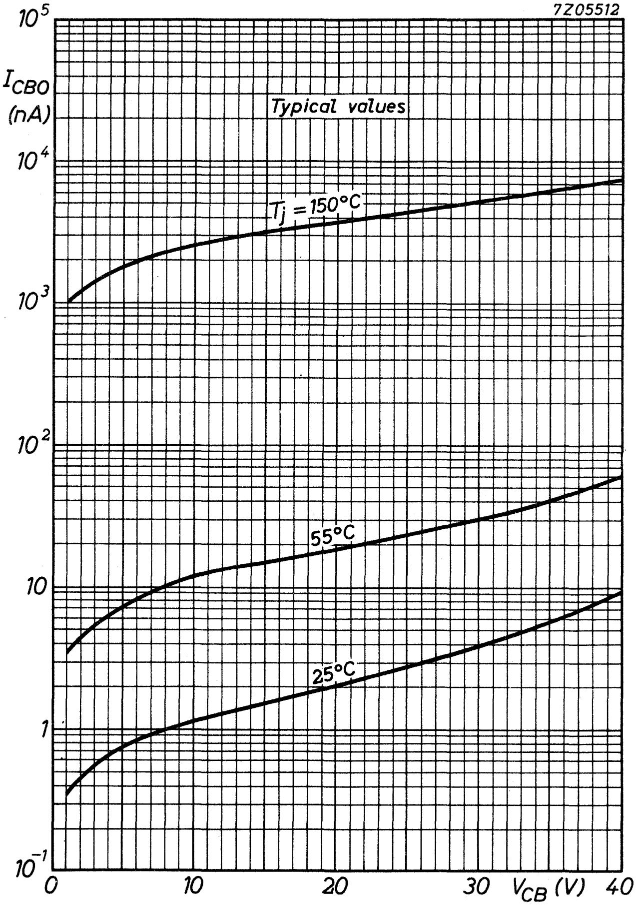

7Z05512
10^5
I_{CBO} (nA)
Typical values
10^4
T_j = 150°C
10^3
10^2
55°C
10
25°C
1
10^{-1}
0
10
20
30
V_{CB} (V)
40

Fig.5.

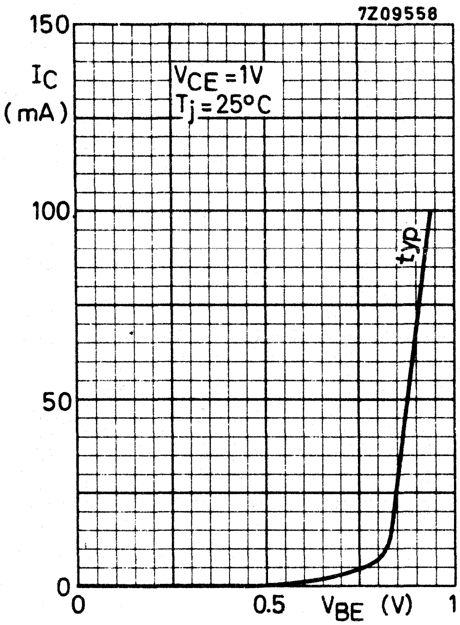

7Z09558
150
I_C
(mA)
V_{CE} = 1V
T_j = 25°C
100
typ
50
0
0
0.5
V_{BE} (V)
1

Fig.6.

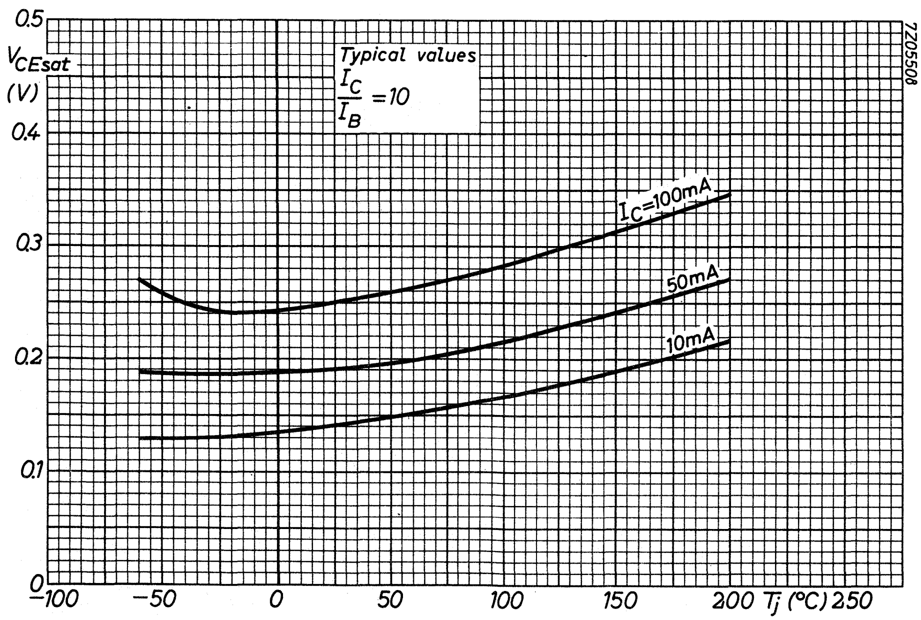
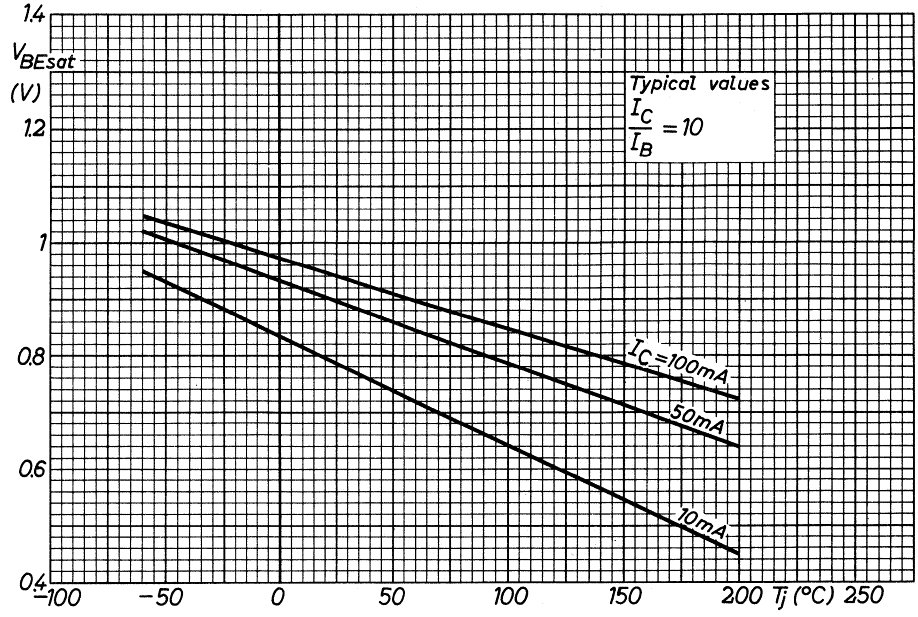
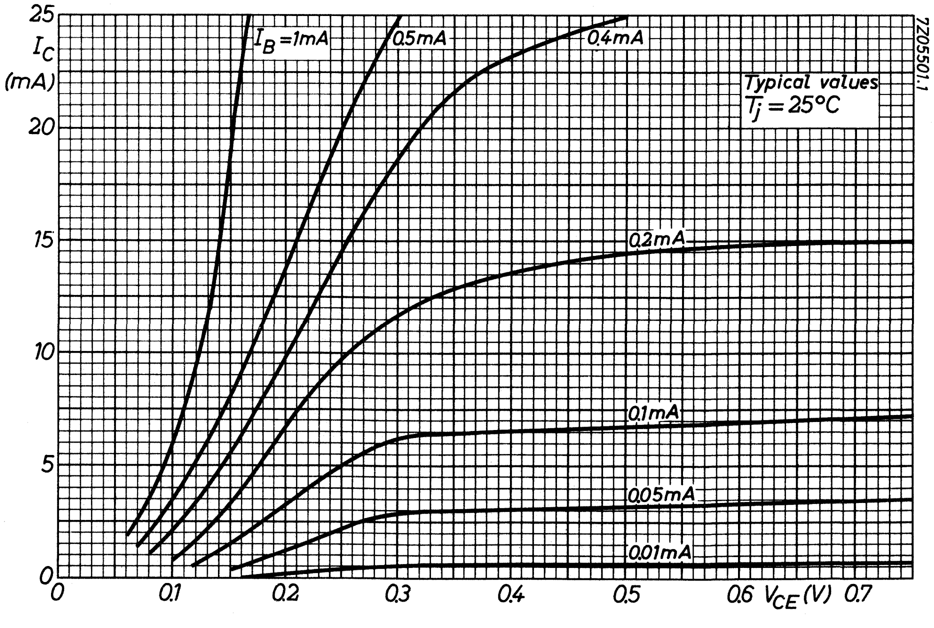

0.5
V_{CEsat}
(V)
0.4
0.3
0.2
0.1
0
Typical values
$\frac{I_C}{I_B}$ = 10
I_C=100mA
50mA
10mA
7Z05508
−100
−50
0
50
100
150
200
T_j (°C)
250

Fig.7.



1.4
V_{BEsat}
(V)
1.2
1
0.8
0.6
0.4
Typical values
$\frac{I_C}{I_B} = 10$
$I_C = 100mA$
50mA
10mA
−100
−50
0
50
100
150
200
T_j (°C)
250

Fig.8.



25
I_C
(mA)
20
15
10
5
0
$I_B = 1mA$
0.5mA
0.4mA
0.2mA
0.1mA
0.05mA
0.01mA
Typical values
$T_j = 25°C$
7Z05501.1
0
0.1
0.2
0.3
0.4
0.5
0.6
V_{CE} (V)
0.7

Fig.9.

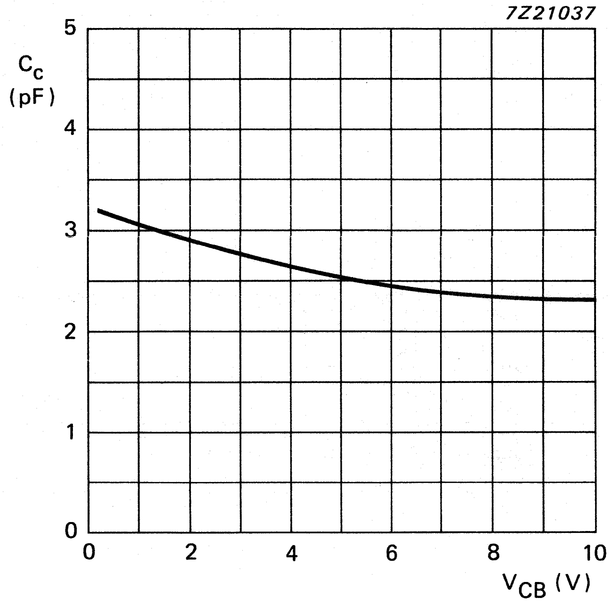


Fig.10 T_j = 25 °C; f = 1 MHz; $I_E = I_e = 0$.

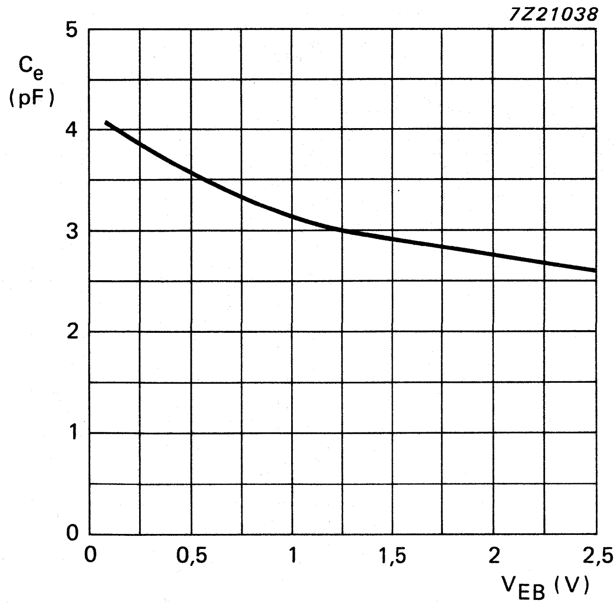


Fig.11 T_j = 25 °C; f = 1 MHz; $I_C = I_c = 0$.

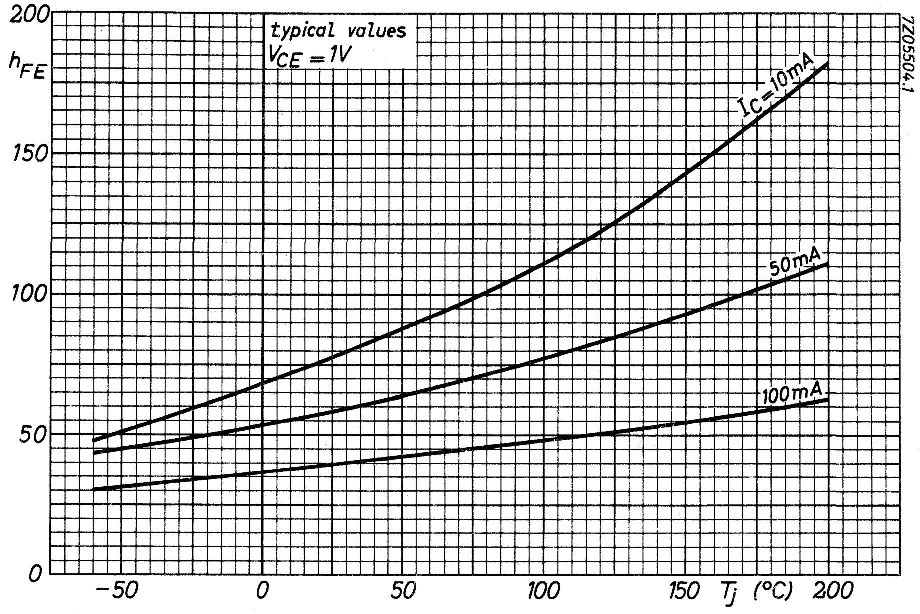

typical values
$V_{CE} = 1V$
7Z05504.1
h_{FE}
200
150
100
50
0
$I_C = 10mA$
50mA
100mA
−50
0
50
100
150
T_j (°C)
200

Fig. 12.

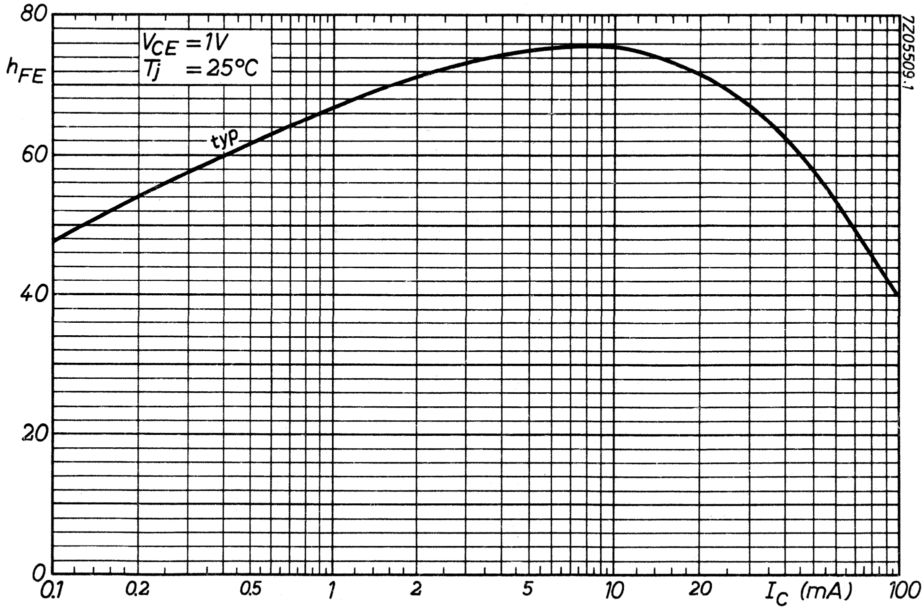

$V_{CE} = 1V$
$T_j = 25°C$
7Z05509.1
h_{FE}
80
60
40
20
0
typ
0.1
0.2
0.5
1
2
5
10
20
I_C (mA)
100

Fig. 13.

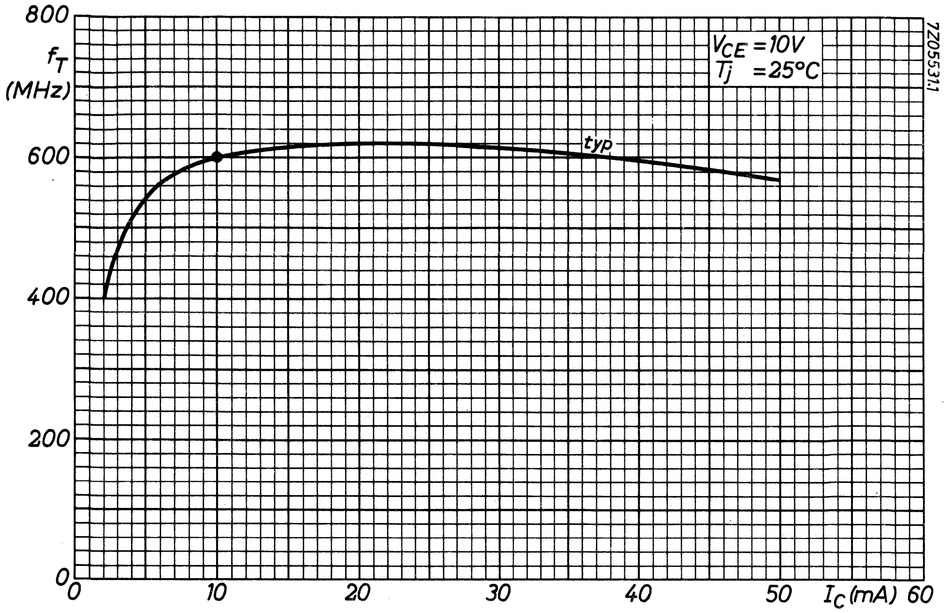

800
f_T
(MHz)
600
400
200
0
V_{CE} = 10V
T_j = 25°C
7Z05531.1
typ
0
10
20
30
40
50
I_C (mA) 60

Fig.14.

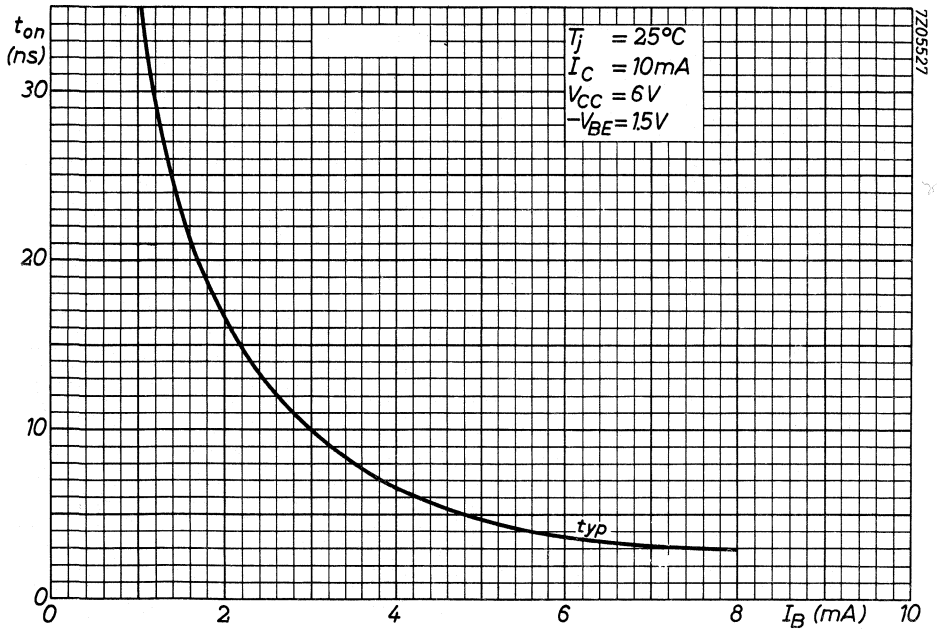
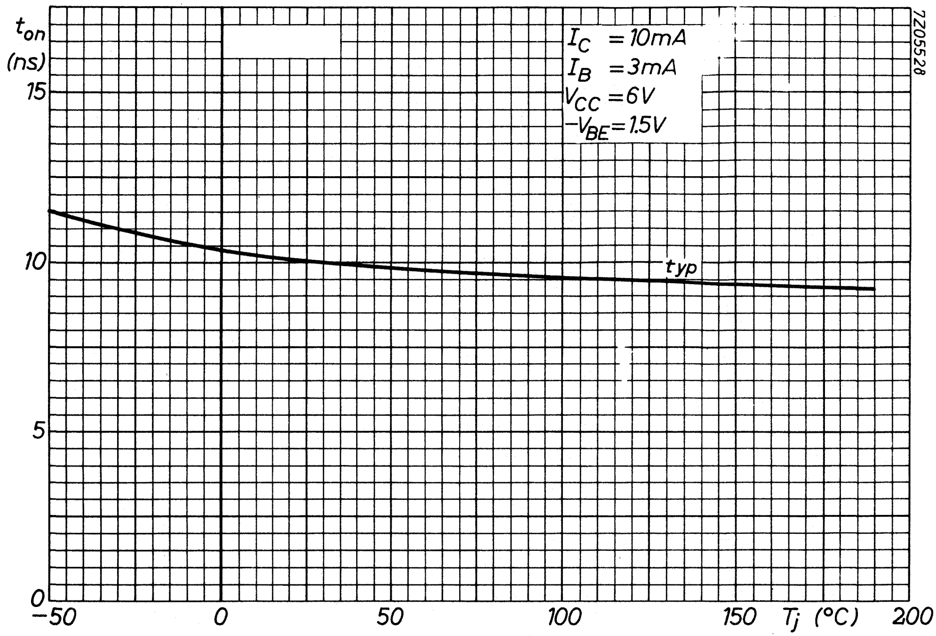
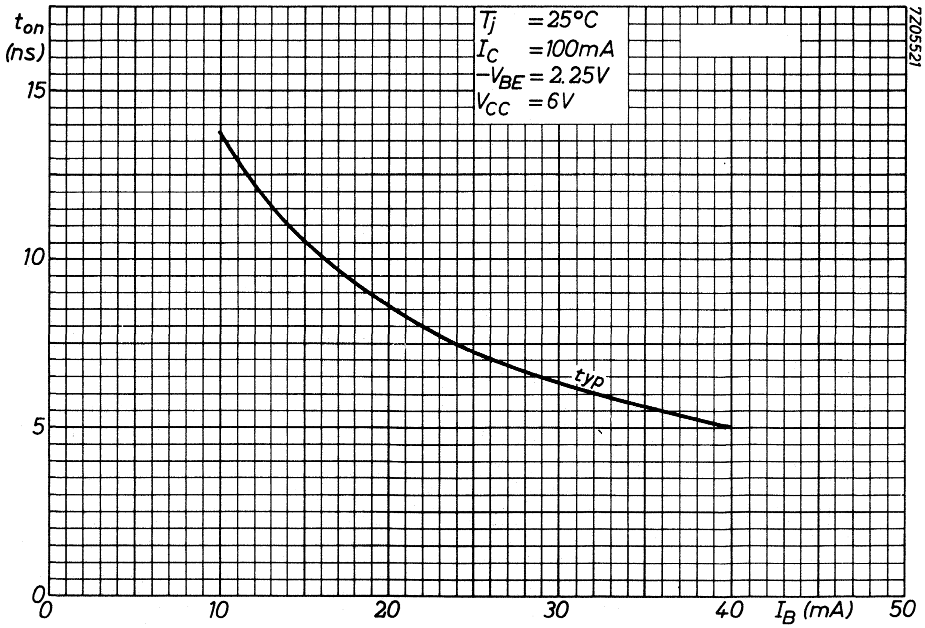

t_{on}
(ns)
30
20
10
0
T_j = 25°C
I_C = 10mA
V_{CC} = 6 V
$-V_{BE}$ = 1.5V
7Z05527
typ
0
2
4
6
8
I_B (mA)
10

Fig.15.



t_{on} (ns)
15
10
5
0
−50
0
50
100
150
T_j (°C)
200
I_C = 10mA
I_B = 3mA
V_{CC} = 6V
$-V_{BE}$ = 1.5V
typ
7Z05528

Fig.16.



t_{on} (ns)
15
10
5
0
0
10
20
30
40
I_B (mA)
50
T_j = 25°C
I_C = 100mA
$-V_{BE}$ = 2.25V
V_{CC} = 6V
typ
7Z05521

Fig.17.

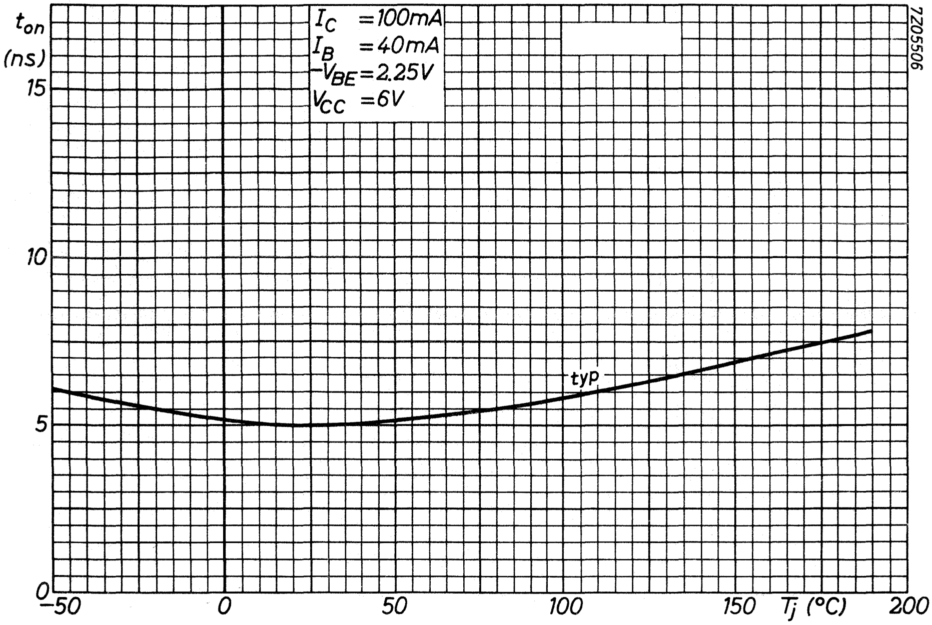

t_{on}
(ns)
15
10
5
0
−50
0
50
100
150
T_j (°C)
200
I_C = 100mA
I_B = 40mA
$-V_{BE}$ = 2.25V
V_{CC} = 6V
typ
7Z05506

Fig.18.

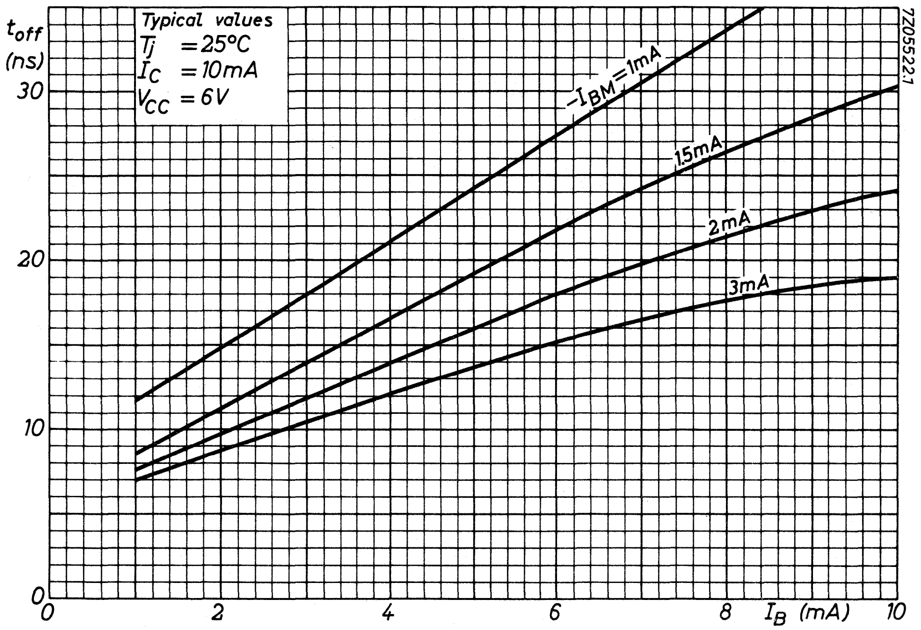

t_{off}
(ns)
30
20
10
0
0
2
4
6
8
I_B (mA)
10
Typical values
T_j = 25°C
I_C = 10mA
V_{CC} = 6V
$-I_{BM}$ = 1mA
1.5mA
2mA
3mA
7Z05522.1

Fig.19.

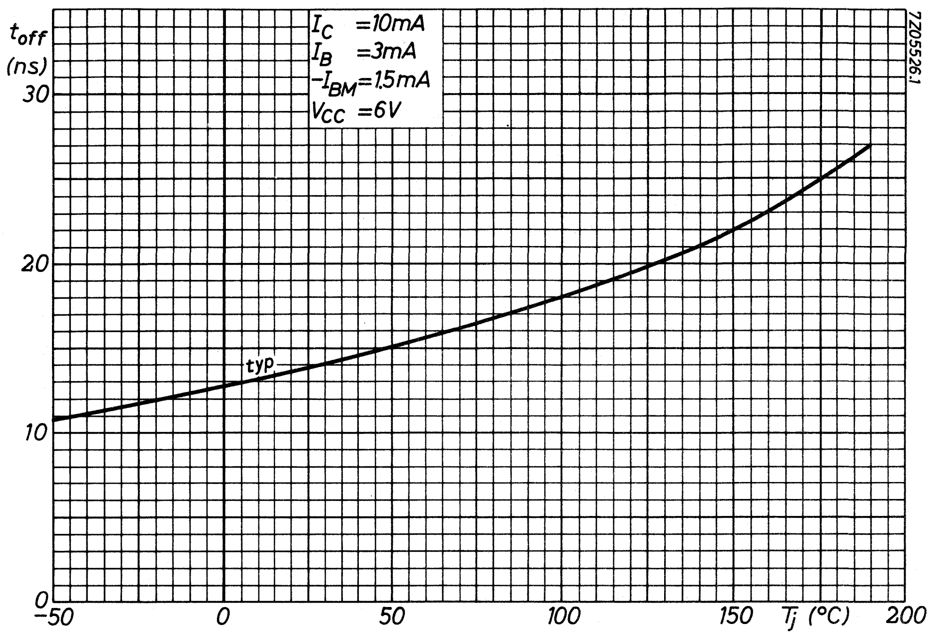

t_{off} (ns)
I_C = 10mA
I_B = 3mA
$-I_{BM}$ = 1.5mA
V_{CC} = 6V
typ
7Z05526.1
30
20
10
0
−50
0
50
100
150
T_j (°C)
200

Fig.20.

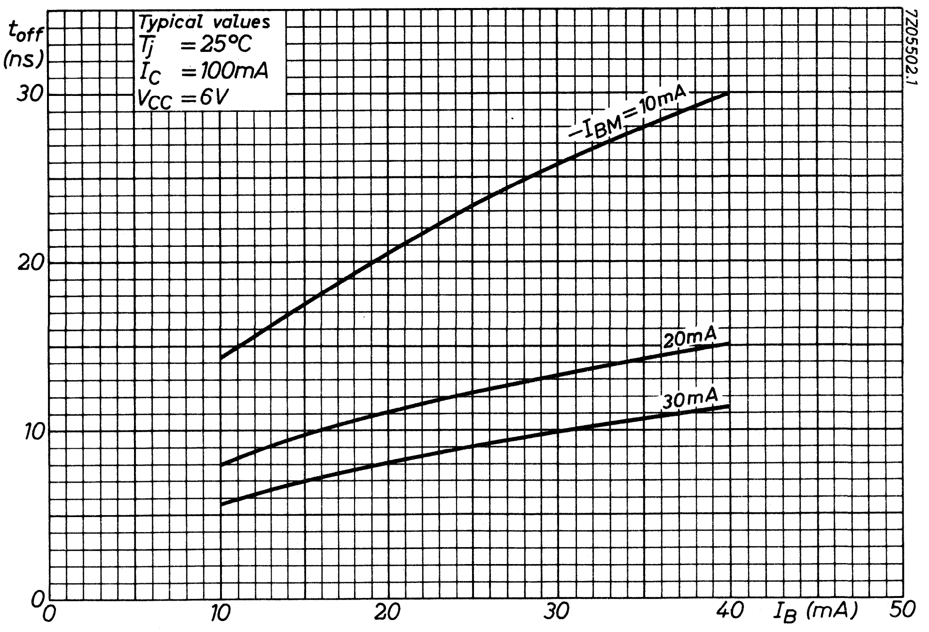

t_{off} (ns)
Typical values
T_j = 25°C
I_C = 100mA
V_{CC} = 6V
$-I_{BM}$ = 10mA
20mA
30mA
7Z05502.1
30
20
10
0
0
10
20
30
40
I_B (mA)
50

Fig.21.

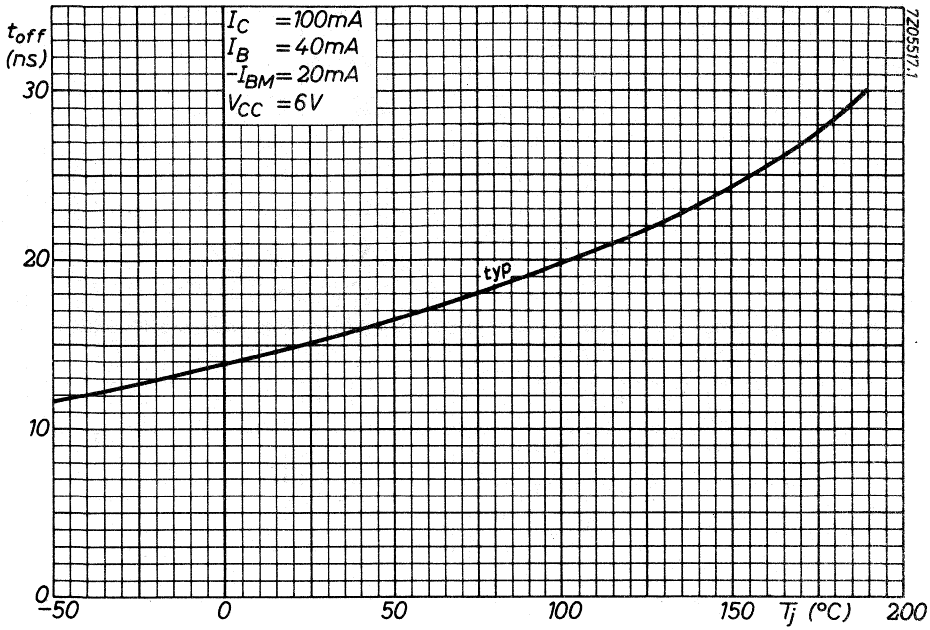

t_{off} (ns)
30
20
10
0
I_C = 100mA
I_B = 40mA
$-I_{BM}$ = 20mA
V_{CC} = 6V
typ
−50
0
50
100
150
T_j (°C)
200
7Z05517.1

Fig.22.

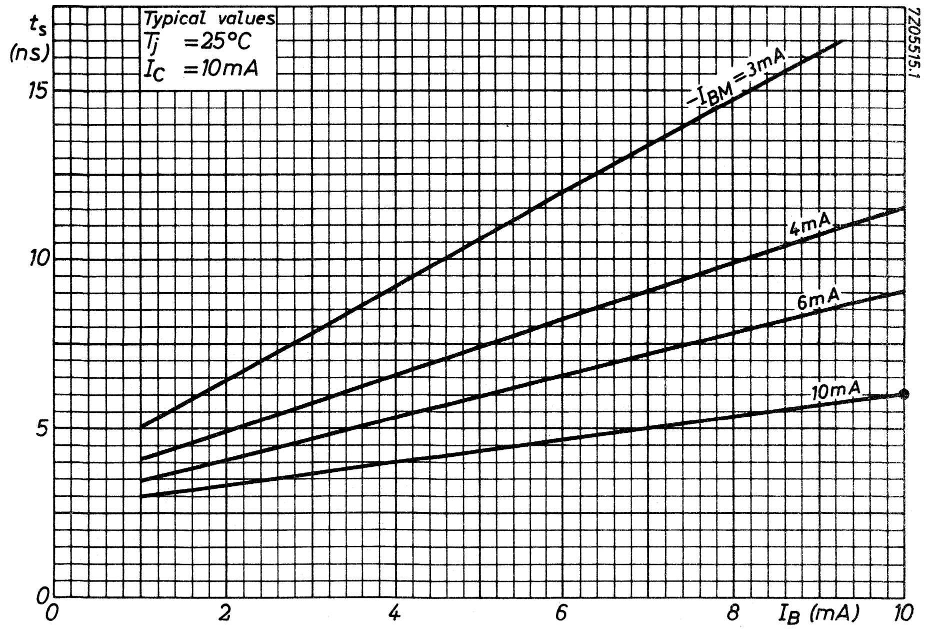
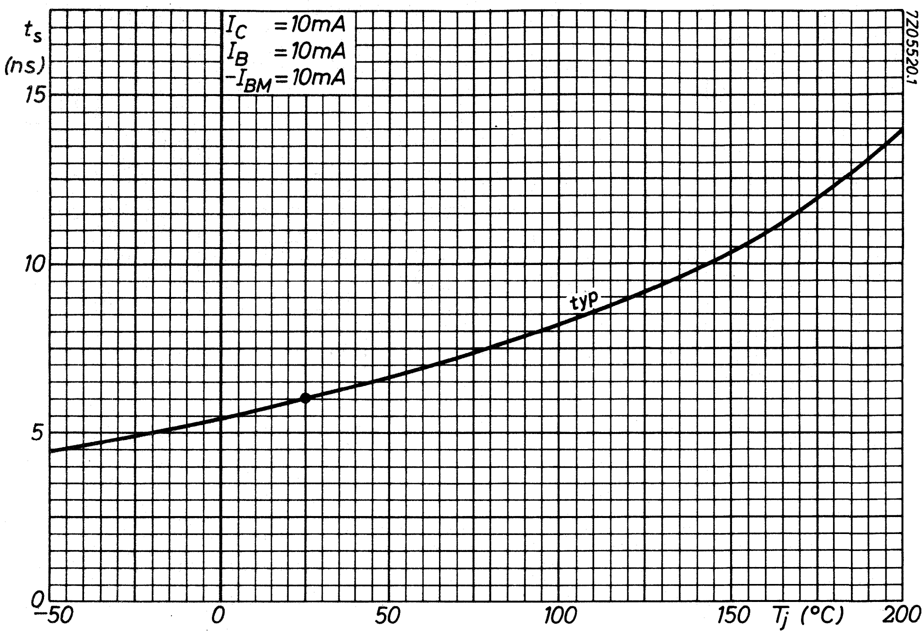

t_s (ns)
15
10
5
0
Typical values
T_j = 25°C
I_C = 10mA
$-I_{BM}$ = 3mA
4mA
6mA
10mA
0
2
4
6
8
I_B (mA)
10
7Z05515.1

Fig.23.



t_s
(ns)
15
10
5
0
I_C = 10mA
I_B = 10mA
$-I_{BM}$ = 10mA
typ
−50
0
50
100
150
T_j (°C)
200
7Z05520.1

Fig.24.

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N silicon planar epitaxial transistor in a TO-39 encapsulation.

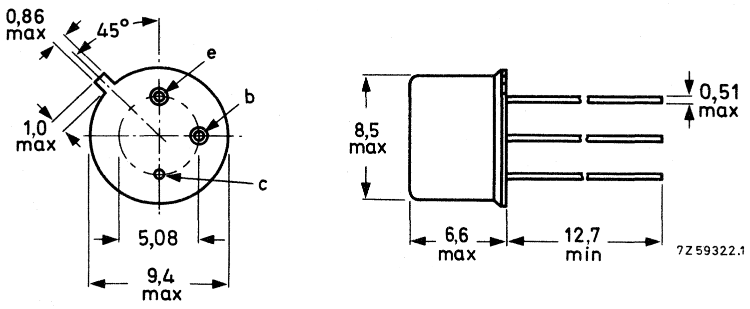
The BSX32 is designed for use in high current switching applications.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	V
Collector current	I_C	max.	1	A
D.C. current gain I_C = 1 A; V_{CE} = 5 V	h_{FE}	min.	20	
		typ.	60	
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	800	mW
Junction temperature	T_j	max.	200	°C
Transition frequency at f = 100 MHz I_C = 50 mA; V_{CE} = 10 V	f_T	min.	300	MHz

Fig. 1 TO-39.

Dimensions in mm



RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	V
Collector current	I_C	max.	1	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	800	mW
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	3,5	W
Storage temperature range	T_{stg}		−65 to 150	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}case}$	max.	50	K/W
From junction to ambient	$R_{th\ j\text{-}amb}$	max.	219	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current $I_E = 0$; $V_{CB} = 50$ V	I_{CBO}	max.	4	μA
Collector-base breakdown voltage $I_E = 0$; $I_C = 100$ μA	$V_{(BR)CBO}$	min.	65	V
Emitter-base breakdown voltage $I_C = 0$; $I_E = 100$ μA	$V_{(BR)EBO}$	min.	6	V
Collector-emitter sustaining voltage $I_B = 0$; $I_C = 10$ mA	$V_{CEOsust}$	min.	40	V
Saturation voltages* $I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	typ. max.	0,17 0,25	V V
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	typ. max.	0,36 0,5	V V
$I_C = 1$ A; $I_B = 100$ mA	V_{CEsat}	typ. max.	0,6 0,85	V V
$I_C = 100$ mA; $I_B = 10$ mA	V_{BEsat}	typ. max.	0,8 0,9	V V
$I_C = 500$ mA; $I_B = 50$ mA	V_{BEsat}	max.	1,5	V
$I_C = 1$ A; $I_B = 100$ mA	V_{BEsat}	max.	2	V

* Pulsed: pulse duration = 300 μs; duty cycle = 1%.

CHARACTERISTICS (continued)

D.C. current gain*				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	min.	30	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	min. max.	60 150	
I_C = 500 mA; V_{CE} = 1 V	h_{FE}	min. typ.	25 60	
I_C = 1 A; V_{CE} = 5 V	h_{FE}	min. typ.	20 60	
I_C = 100 mA; V_{CE} = 1 V; T_{amb} = −55 °C	h_{FE}	min.	30	
I_C = 500 mA; V_{CE} = 1 V; T_{amb} = −55 °C	h_{FE}	min.	15	
Transition frequency at f = 100 MHz				
I_C = 50 mA; V_{CE} = 10 V	f_T	min.	300	MHz
Emitter-base capacitance at f = 1 MHz				
I_C = 0; V_{EB} = 0,5 V	C_{eb}	max.	55	pF
Collector-base capacitance at f = 1 MHz				
I_E = 0; V_{CB} = 10 V	C_{cb}	max.	10	pF
Turn-off time				
I_C = 500 mA; V_{CC} = 30 V I_{B1} = 50 mA	t_{on}	max.	35	ns
Turn-off time				
I_C = 500 mA; V_{CC} = 30 V $I_B = -I_{B2}$ = 50 mA	t_{off}	max.	60	ns

* Pulsed: pulse duration = 300 μs; duty cycle = 1%.

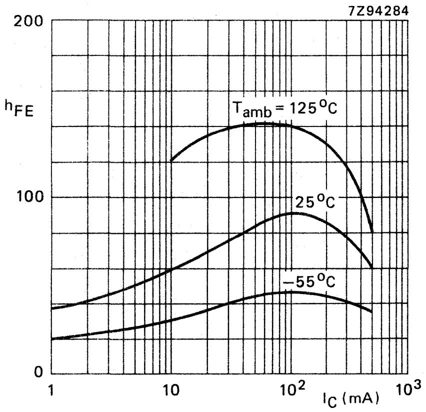


Fig. 2 D.C. current gain; V_{CE} = 1 V.

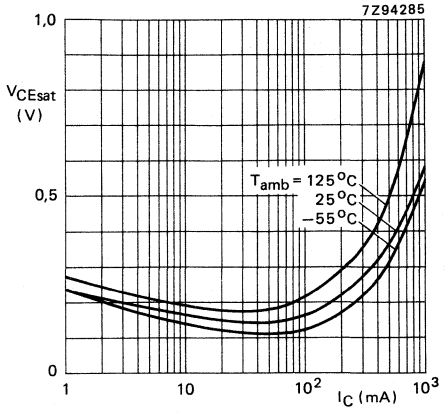


Fig. 3 Collector-emitter saturation voltage; I_C = 10 x I_B.

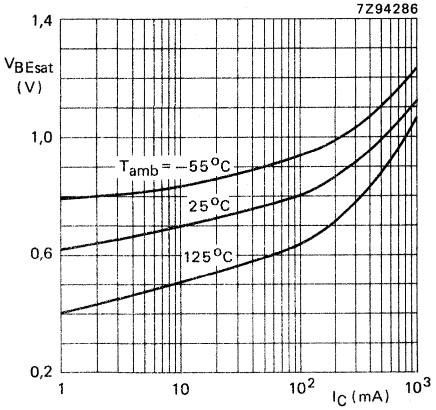


Fig. 4 Base-emitter saturation voltage; I_C = 10 x I_B.

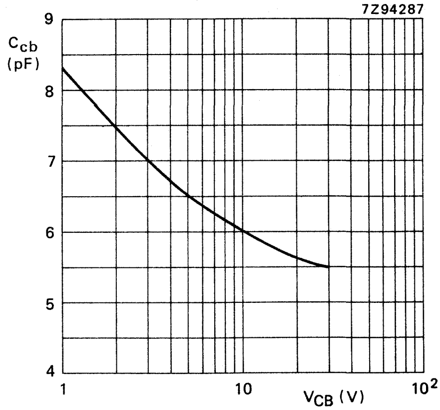


Fig. 5 Collector-base capacitance; I_E = 0.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in TO-39 metal envelopes with the collector connected to the case. These transistors are intended for general industrial applications.

QUICK REFERENCE DATA

			BSX45	BSX46	BSX47	
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	V
Collector current (d.c.)	I_C	max.		1		A
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.		6,25		W
Junction temperature	T_j	max.		200		°C
Transition frequency at f = 20 MHz; I_C = 50 mA; V_{CE} = 10 V	f_T	>		50		MHz

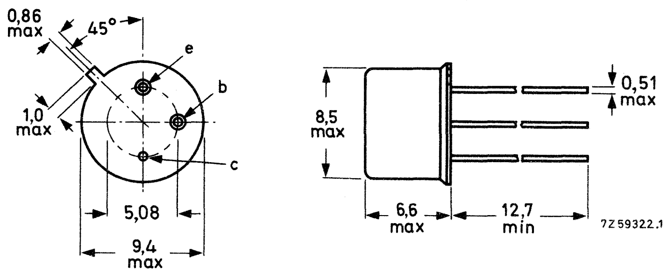
			BSX45–10 BSX46–10 BSX47–10	BSX45–16 BSX46–16
D.C. current gain; I_C = 100 mA; V_{CE} = 1 V	h_{FE}	>	63	100
		<	160	250

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case.



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 002-174.

RATINGS

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

			BSX45	BSX46	BSX47	
Collector-emitter voltage (open base)	V_{CEO}	max.	40	60	80	V
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	80	100	120	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	7	7	V
Collector current (d.c.)	I_C	max.		1		A
Base current (d.c.)	I_B	max.		200		mA
Total power dissipation up to $T_{case} = 25\ ^oC$	P_{tot}	max.		6,25		W
Storage temperature range	T_{stg}			−65 to + 150		^oC
Junction temperature	T_j	max.		200		^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	28	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			BSX45	BSX46	BSX47	
Collector cut-off currents						
V_{BE} = 0; V_{CE} = 60 V	I_{CES}	<	30	30	–	nA
V_{BE} = 0; V_{CE} = 60 V; T_{amb} = 150 °C	I_{CES}	<	10	10	–	μA
V_{BE} = 0; V_{CE} = 80 V	I_{CES}	<	–	–	30	nA
V_{BE} = 0; V_{CE} = 80 V; T_{amb} = 150 °C	I_{CES}	<	–	–	10	μA
V_{BE} = 0,2 V; V_{CE} = 60 V; T_{amb} = 100 °C	I_{CEX}	<	50	50	–	μA
V_{BE} = 0,2 V; V_{CE} = 80 V; T_{amb} = 100 °C	I_{CEX}	<	–	–	50	μA
Emitter cut-off current						
I_C = 0; V_{EB} = 5 V	I_{EBO}	<	10	10	10	nA
Collector-emitter breakdown voltage						
open base; I_C = 50 mA	$V_{(BR)CEO}$	>	40	60	80	V
V_{BE} = 0; I_C = 100 μA	$V_{(BR)CES}$	>	80	100	120	V
Emitter-base breakdown voltage						
open collector; I_E = 100 μA	$V_{(BR)EBO}$	>	7	7	7	V
Base-emitter voltage						
I_C = 100 mA; V_{CE} = 1 V	V_{BE}	<	1	1	1	V
I_C = 500 mA; V_{CE} = 1 V	V_{BE}	>	0,75	0,75	0,75	V
		<	1,50	1,50	1,50	V
I_C = 1 A; V_{CE} = 1 V	V_{BE}	<	2,00	2,00	2,00	V
Saturation voltage						
I_C = 1000 mA; I_B = 100 mA	V_{CEsat}	<	1,0	1,0	–	V
I_C = 500 mA; I_B = 25 mA	V_{CEsat}	<	–	–	0,9	V
Transition frequency at f = 20 MHz						
I_C = 50 mA; V_{CE} = 10 V	f_T	>	50	50	50	MHz
Collector capacitance at f = 1 MHz						
I_E = I_e = 0; V_{CB} = 10 V	C_c	<	25	20	15	pF
Emitter capacitance at f = 1 MHz						
I_C = I_c = 0; V_{EB} = 0,5 V	C_e	<	80	80	80	pF
Noise figure at f = 1 kHz						
I_C = 100 μA; V_{CE} = 10 V; R_S = 1 kΩ; B = 200 Hz	F	typ.	3,5	3,5	3,5	dB

			BSX45–10 BSX46–10 BSX47–10	BSX45–16 BSX46–16	
D.C. current gain					
$I_C = 100\ \mu A$; $V_{CE} = 1\ V$	h_{FE}	>	15	25	
		typ.	40	90	
$I_C = 100\ mA$; $V_{CE} = 1\ V$	h_{FE}	>	63	100	
		typ.	100	160	
		<	160	250	
$I_C = 500\ mA$; $V_{CE} = 1\ V$	h_{FE}	>	25	35	
		typ.	40	60	
$I_C = 1\ A$; $V_{CE} = 1\ V$	h_{FE}	typ.	20	30	
Switching times (see Fig. 2)					
$I_{Con} = 100\ mA$; $I_{Bon} = -I_{Boff} = 5\ mA$					
Turn-on time	t_{on}	<	200		ns
Turn-off time	t_{off}	<	850		ns

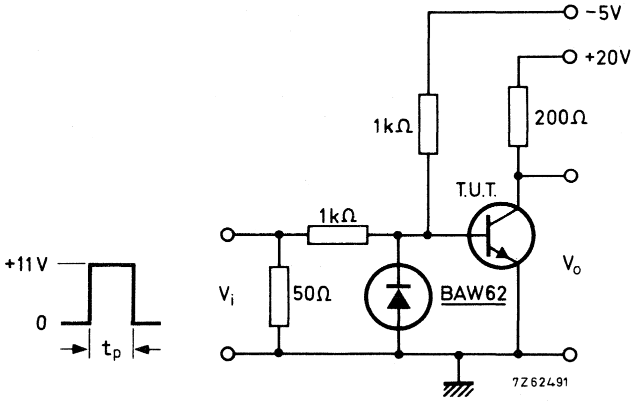


Fig. 2 Switching times test circuit.

Pulse generator:

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

Oscilloscope:

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

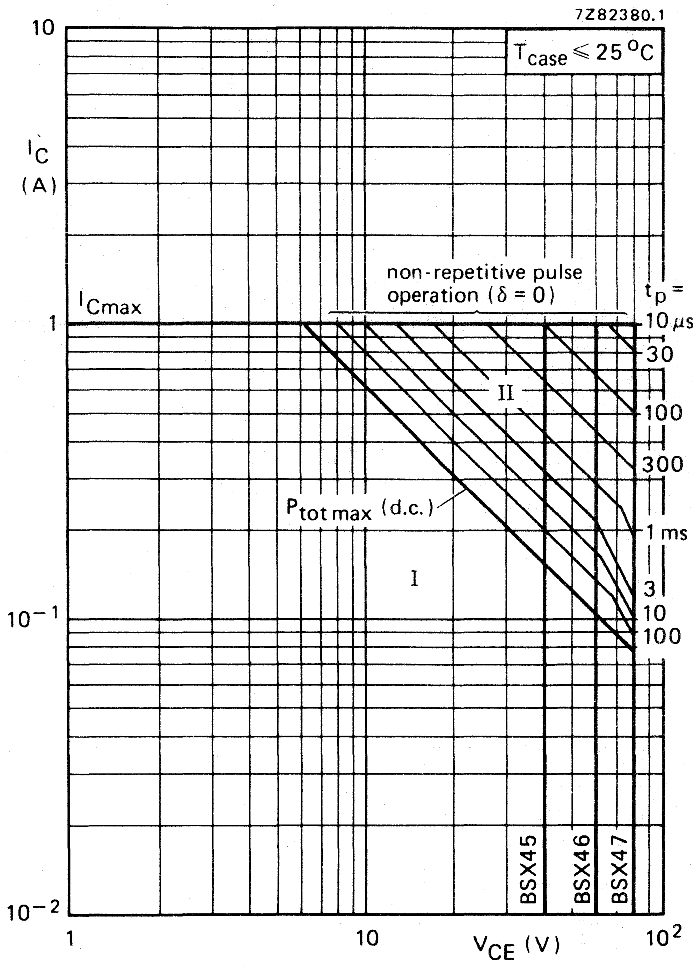


Fig. 3 Safe Operating ARea; $T_{case} \leq 25\ ^oC$*.

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

* At case temperatures > 25 °C derate constant power portion of boundaries such that:

$P_{(t_p,\,o)} = \dfrac{200 - T_{case}}{Z_{th\,(t_p,\,o)}}$. (For very short forward mode pulse durations, i.e. $t_p < 3\ \mu s$, assume 3 μs values for Z_{th}.)

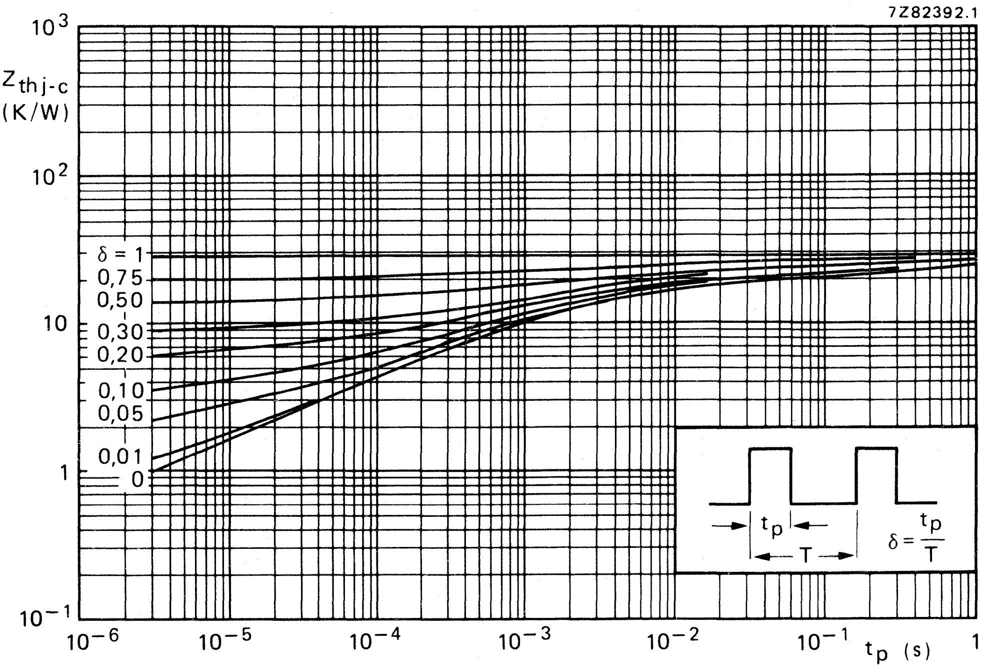


Fig. 4 Thermal impedance versus pulse duration. Stabilization time is 10 s.

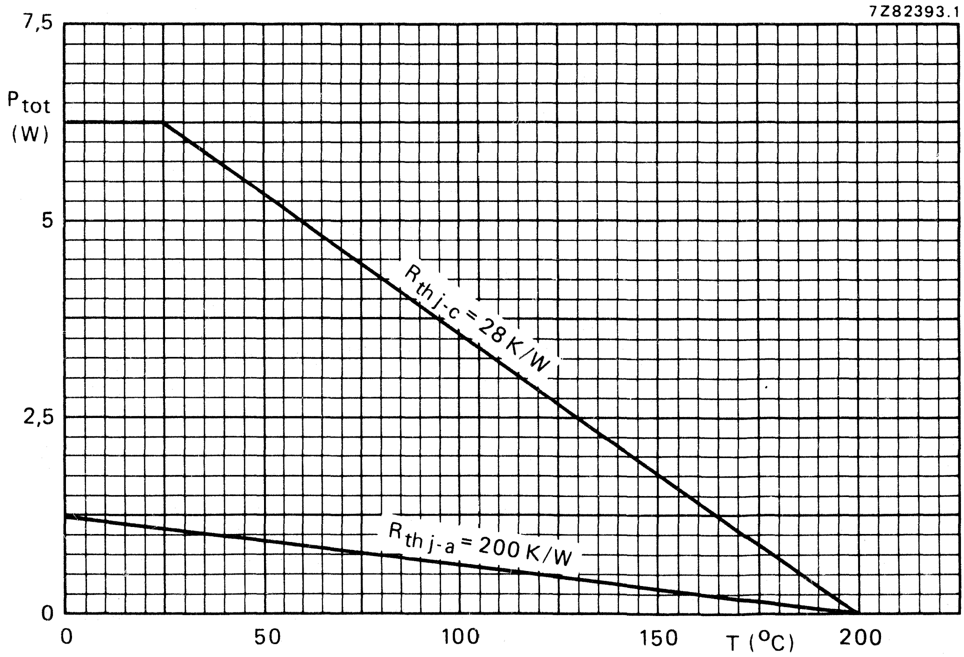


Fig. 5 Maximum permissible power dissipation as a function of temperature.

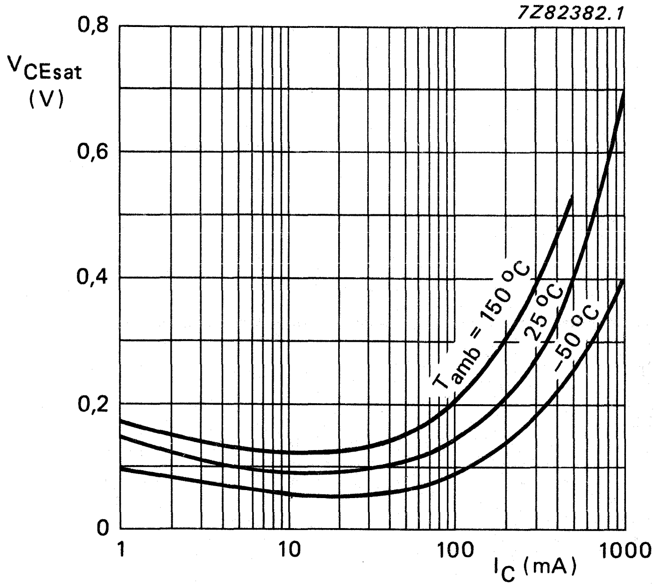


Fig. 6 $I_C/I_B = 10$; —— typical values; at $T_{amb} = 25$ °C.

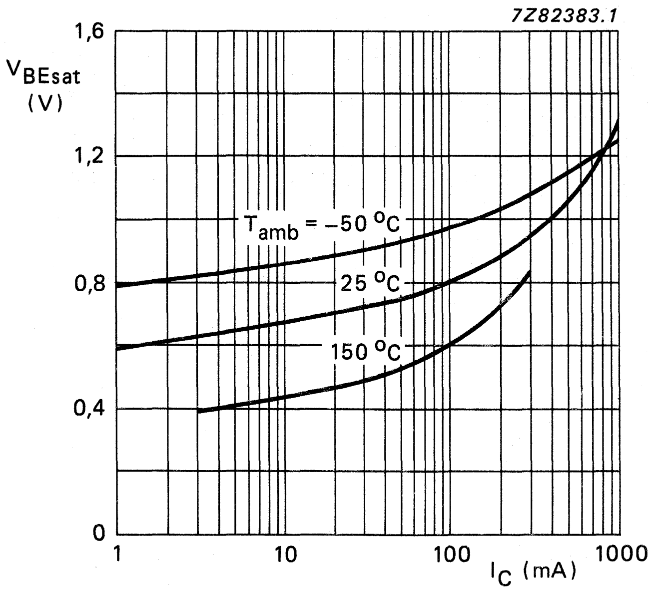


Fig. 7 $I_C/I_B = 10$; —— typical values; at $T_{amb} = 25$ °C.

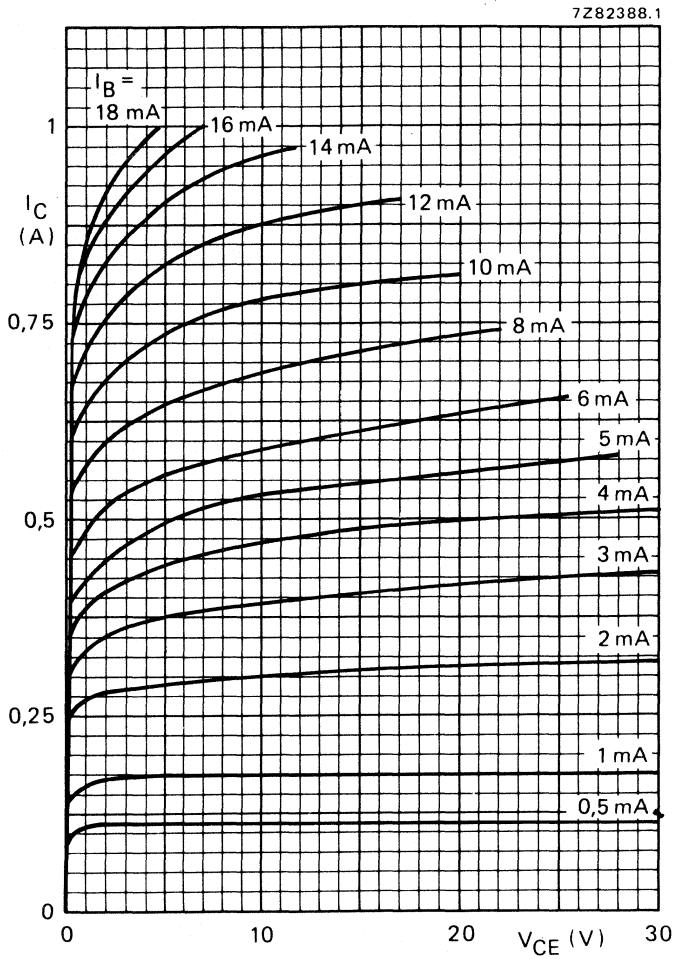


Fig. 8 Typical values; T_j = 25 °C.

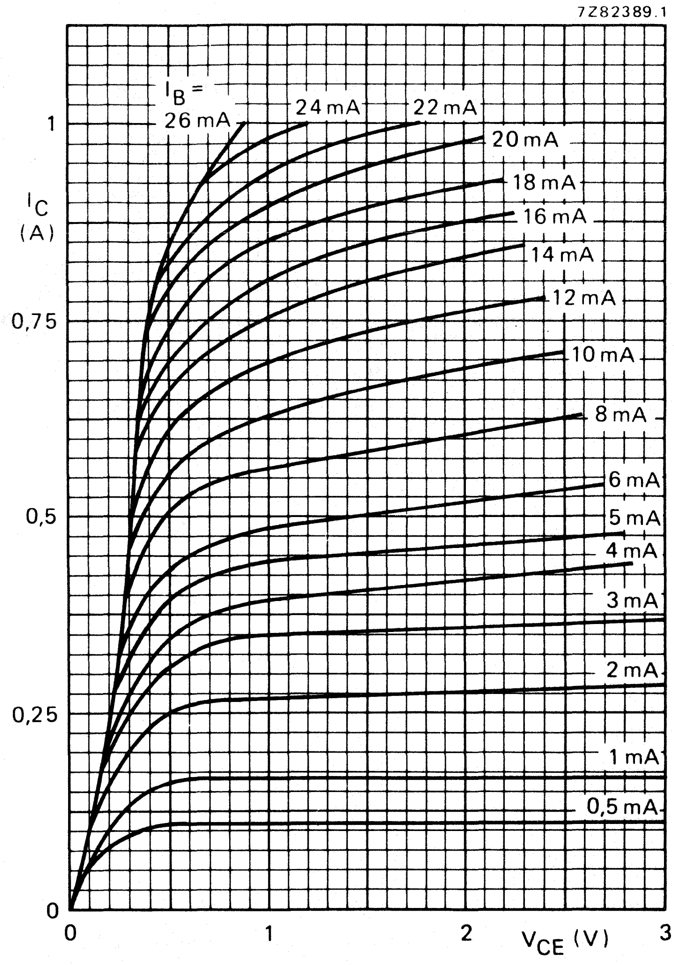


Fig. 9 Typical values; T_j = 25 °C.

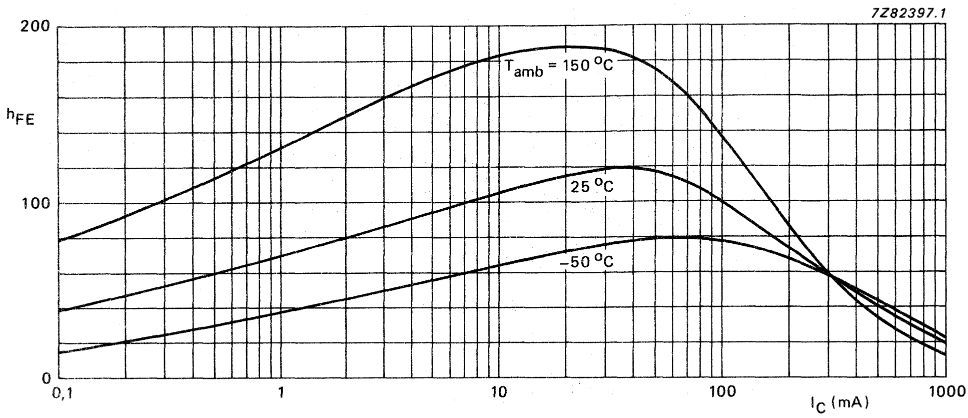


Fig. 10 V_{CE} = 1 V; ——typical values; T_{amb} = 25 °C; Group—10.

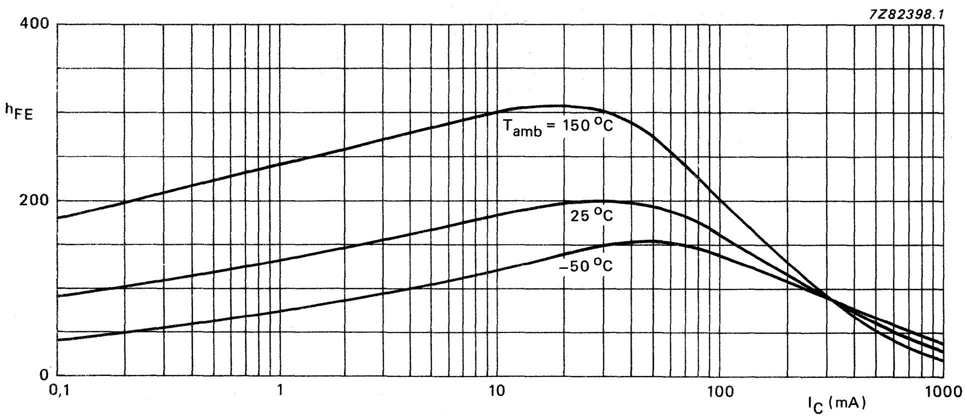


Fig. 11 V_{CE} = 1 V; ——typical values; T_{amb} = 25 °C; Group—16.

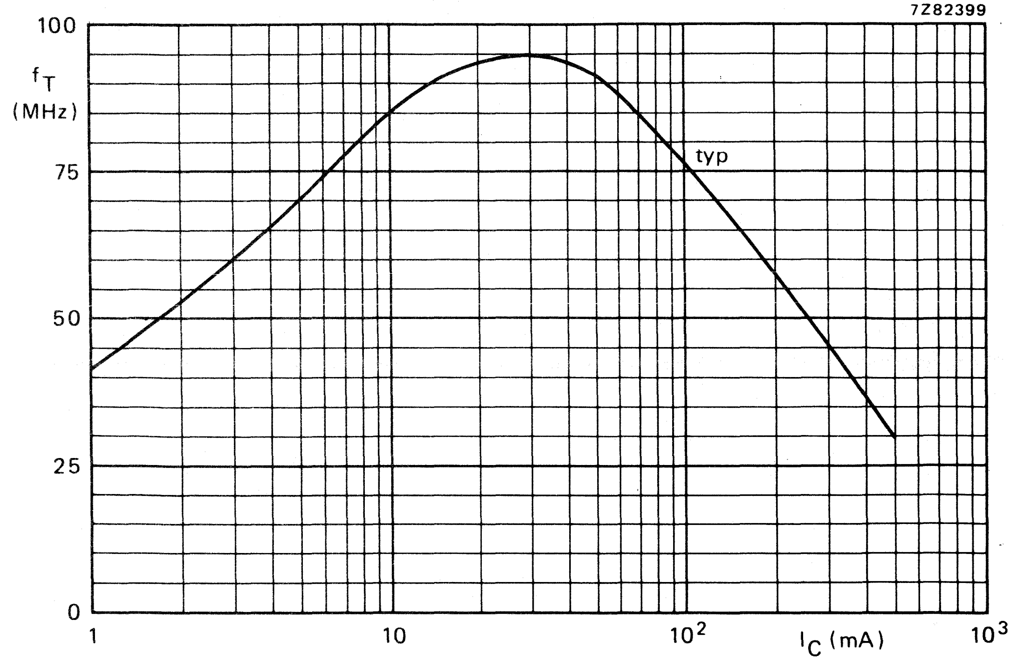


Fig. 12 V_{CE} = 10 V; f = 20 MHz; T_j = 25 °C.

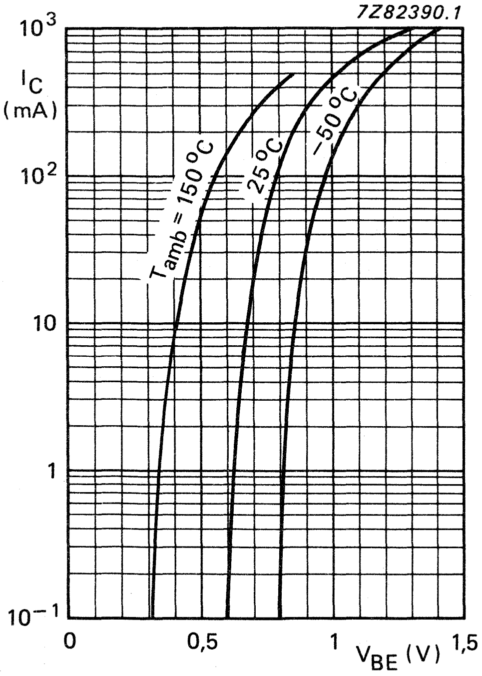


Fig. 13 V_{CE} = 1 V; —— typical values; T_{amb} = 25 °C.

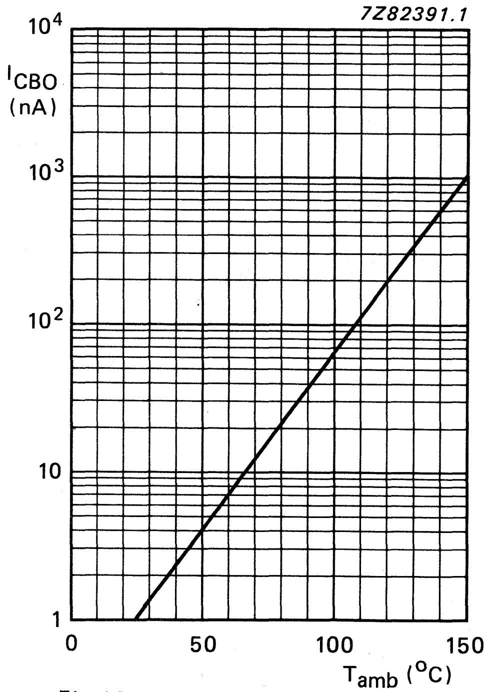


Fig. 14 V_{CBO} = 60 V for **BSX45** and **BSX46**; V_{CBO} = 80 V for **BSX47**; typical values.

Philips Components

Data sheet	
status	Preliminary specification
date of issue	August 1990

BSX49

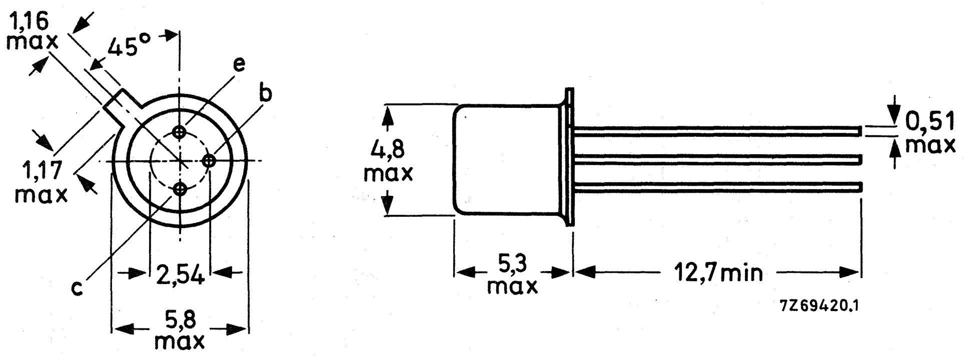
Silicon planar epitaxial transistor

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage		-	60	V
V_{CEO}	collector-emitter voltage		-	40	V
I_C	collector current		-	600	mA
P_{tot}	total power dissipation	$T_{case} \leq 45°C$	-	1	W
T_j	junction temperature		-	200	°C
h_{FE}	DC current gain	$V_{CE} = 1$ V $I_C = 100$ mA	25		
f_T	transition frequency	$V_{CE} = 10$ V $I_C = 30$ mA	250	-	MHz

MECHANICAL DATA

Dimensions in mm



Collector connected to case.

Fig.1 TO-18.

Silicon planar epitaxial transistor — BSX49

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	$I_E = 0$	-	60	V
V_{CES}	collector-emitter voltage	$V_{BE} = 0$	-	60	V
V_{CES}	collector-emitter voltage	$I_B = 0$	-	40	V
V_{EBO}	emitter-base voltage	$I_C = 0$	-	5	V
I_C	collector current		-	600	mA
I_B	base current		-	200	mA
P_{tot}	total power dissipation	$T_{case} \leq 45$ °C	-	1	W
T_{stg}	storage temperature range		−65	150	°C
T_j	junction temperature		-	200	°C

THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient	500	K/W
$R_{th\ j\text{-}c}$	from junction to case	200	K/W

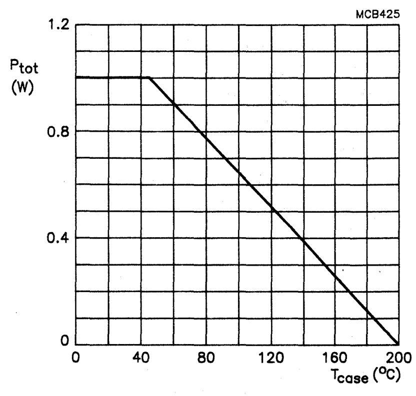


Fig.2 Total power dissipation as a function of case temperature.

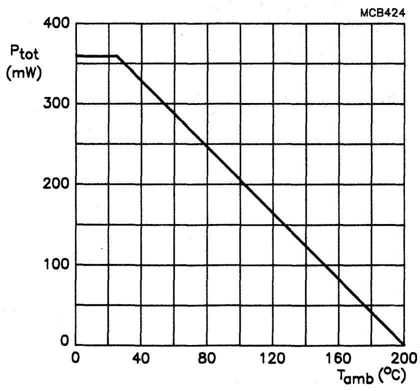


Fig.3 Total power dissipation as a function of ambient temperature.

Silicon planar epitaxial transistor BSX49

CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CBO}	collector cut-off current	$I_E = 0$ $V_{CB} = 50$ V	-	-	70	nA
V_{CEsat}	collector-emitter saturation voltage	$I_B = 10$ mA $I_C = 100$ mA	-	170	-	mV
V_{CEsat}	collector-emitter saturation voltage	$I_B = 50$ mA $I_C = 500$ mA	-	-	1	V
V_{BEsat}	base-emitter saturation voltage	$I_B = 10$ mA $I_C = 100$ mA	-	0.85	-	V
V_{BEsat}	base-emitter saturation voltage	$I_B = 50$ mA $I_C = 500$ mA	-	-	1.5	V
h_{FE}	current gain	$V_{CE} = 1$ V $I_C = 10$ mA	-	37	-	
h_{FE}	current gain	$V_{CE} = 1$ V $I_C = 100$ mA	25	-	-	
h_{FE}	current gain	$V_{CE} = 1$ V $I_C = 500$ mA	10	-	-	
f_T	transition frequency	$V_{CE} = 10$ V $I_C = 30$ mA f = 100 MHz	250	-	-	MHz
C_c	collector capacitance	$V_{CB} = 10$ V $I_E = 0$	-	-	6	pF
C_e	emitter capacitance	$V_{EB} = 1$ V $I_C = 0$	-	22	-	pF
Switching times						
t_{on}	turn-on time	$I_{CX} = 150$ mA $I_{BX} = -I_{BY} = 15$ mA	-	30	-	ns
t_{off}	turn-off time	$I_{CX} = 150$ mA $I_{BX} = -I_{BY} = 15$ mA	-	50	-	ns
t_{on}	turn-on time	$I_{CX} = 500$ mA $I_{BX} = 50$ mA $-I_{BY} = 25$ mA	-	30	-	ns
t_{off}	turn-off time	$I_{CX} = 500$ mA $I_{BX} = 50$ mA $-I_{BY} = 25$ mA	-	65	-	ns

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a TO-39 metal envelope with the collector connected to the case. The BSX59, BSX60 and BSX61 are primarily intended for very high speed core-driving purposes.

QUICK REFERENCE DATA

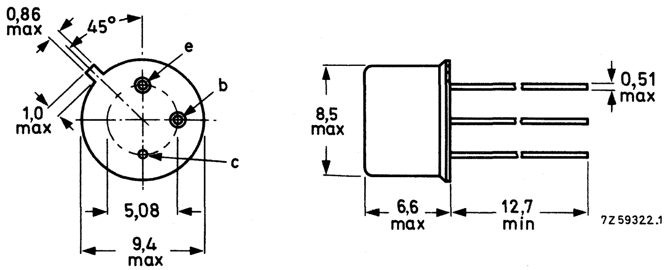
			BSX59	BSX60	BSX61	
Collector-base voltage (open emitter)	V_{CBO}	max.	70	70	70	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	30	45	V
Collector current (peak value)	I_{CM}	max.	1	1	1	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0,8	0,8	0,8	W
Junction temperature	T_j	max.	200	200	200	°C
D.C. current gain I_C = 500 mA; V_{CE} = 1 V	h_{FE}	>	30	30	30	
Saturation voltage I_C = 500 mA; I_B = 50 mA	V_{CEsat}	<	0,5	0,5	0,7	V
Transition frequency I_C = 50 mA; V_{CE} = 10 V	f_T	>	250	250	250	MHz
Turn-off time I_{Con} = 500 mA; I_{Bon} = $-I_{Boff}$ = 50 mA	t_{off}	<	60	70	100	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case.



Maximum lead diameter is guaranteed only for 12,7 mm.

RATINGS

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

			BSX59	BSX60	BSX61	
Collector-base voltage (open emitter)	V_{CBO}	max.	70	70	70	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	45	30	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	5	5	V

Collector current (d.c.)	I_C	max.	1	A
Collector current (peak value)	I_{CM}	max.	1	A
Emitter current (peak value)	$-I_{EM}$	max.	1	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0,8	W
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	220	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	43	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	35	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BSX59	BSX60	BSX61	
Collector cut-off current						
$I_E = 0$; $V_{CB} = 40$ V	I_{CBO}	<	500	500	500	nA
$I_E = 0$; $V_{CB} = 40$ V; $T_j = 150$ °C	I_{CBO}	<	300	300	300	μA
Emitter cut-off current						
$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	<	300	300	500	nA
$I_C = 0$; $V_{EB} = 4$ V; $T_j = 150$ °C	I_{EBO}	<	50	50	50	μA
Currents at reverse biased emitter junction						
$-V_{BE} = 4$ V; $V_{CE} = 40$ V	$+I_{CEX}$	<	500	500	1000	nA
	$-I_{BEX}$	<	500	500	1000	nA
$-V_{BE} = 4$ V; $V_{CE} = 40$ V; $T_j = 150$ °C	$+I_{CEX}$	<	300	300	500	μA
	$-I_{BEX}$	<	300	300	500	μA
Saturation voltages						
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0,3	0,3	0,5	V
	V_{BEsat}	<	1,0	1,0	1,0	V
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	0,5	0,5	0,7	V
	V_{BEsat}	>	0,85	0,7	0,7	V
		<	1,2	1,3	1,3	V
$I_C = 1$ A; $I_B = 100$ mA	V_{CEsat}	<	1,0	1,0	1,3	V
	V_{BEsat}	<	1,8	1,8	1,8	V
D.C. current gain						
$I_C = 150$ mA; $V_{CE} = 1$ V	h_{FE}	>	30	30	30	
$I_C = 500$ mA; $V_{CE} = 1$ V	h_{FE}	>	30	30	30	
		<	90	90	90	
$I_C = 1$ A; $V_{CE} = 5$ V	h_{FE}	>	20	25	20	
Transition frequency						
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	250	250	250	MHz
Collector capacitance at f = 1 MHz						
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	6	6	6	pF
		<	10	10	10	pF
Emitter capacitance at f = 1 MHz						
$I_C = I_c = 0$; $V_{EB} = 0,5$ V	C_e	typ.	36	36	36	pF
		<	50	50	50	pF

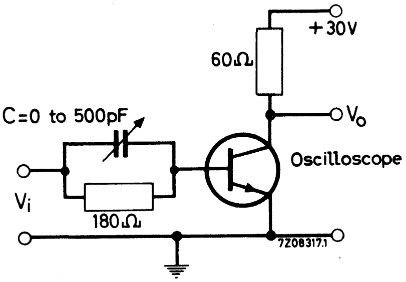
CHARACTERISTICS

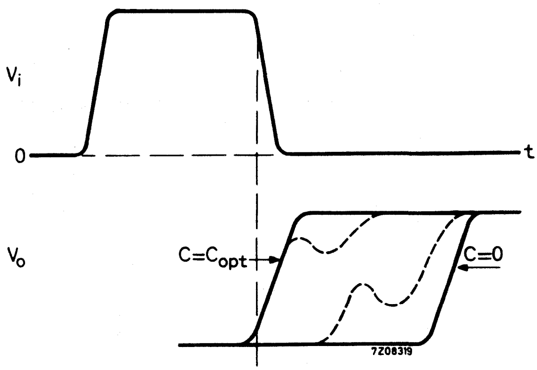
T_j = 25 °C unless otherwise specified

Recovered charge

I_C = 500 mA; I_B = 50 mA — BSX60 — Q_s < 5 nC

Test circuit:





Adjust C from zero to C_{opt}

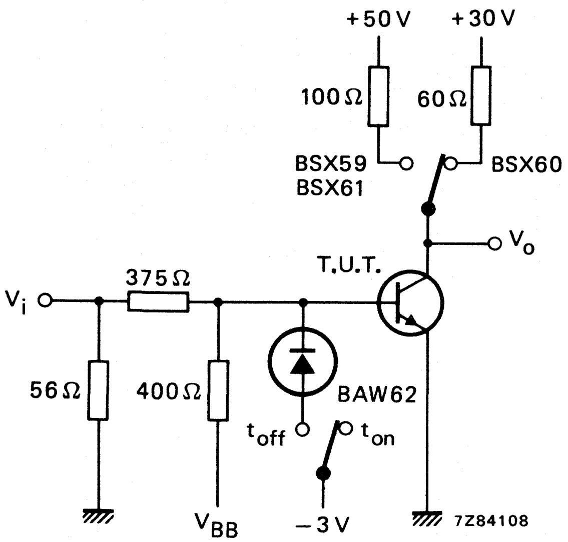
$Q_s = C_{opt} \cdot V_i$

Pulse generator:

Pulse duration	t_p = 10 μs
Duty cycle	δ = 0,02

Switching times (see also Figs 4, 11 and 12)

			BSX59	BSX60	BSX61	
Turn-on time when switched from $-V_{BE}$ = 2 V to I_{Con} = 500 mA; I_{Bon} = 50 mA	t_{on}	typ.	17	17	18	ns
		<	35	40	50	ns
Turn-off time when switched from I_{Con} = 500 mA; I_{Bon} = 50 mA to cut-off with $-I_{Boff}$ = 50 mA*	t_{off}	typ.	45	58	70	ns
		<	60	70	100	ns



	t_{on}	t_{off}	
$-V_{BB}$	4	16,7	V
V_i	24,75	37,5	V

Fig. 4 Switching circuit.

Pulse generator:

Pulse duration	t_p	⩾	500 ns
Rise time	t_r	⩽	5 ns
Fall time	t_f	⩽	5 ns
Output resistance	R_o	=	50 Ω (during pulse, otherwise infinite)

* $-I_{Boff}$ is the reverse current that can flow during switching off. The indicated $-I_{Boff}$ is determined and limited by the applied cut-off voltage and the series resistance.

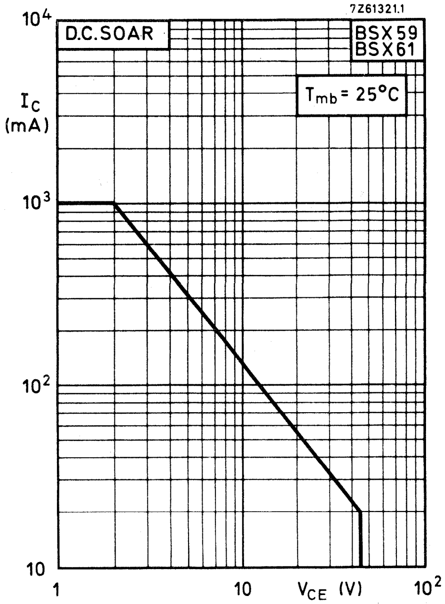


Fig. 5.

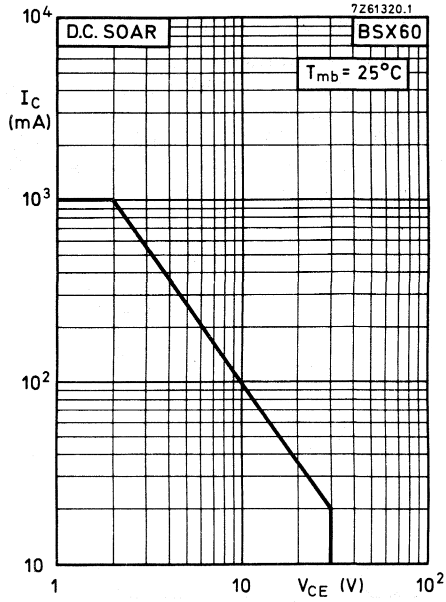


Fig. 6.

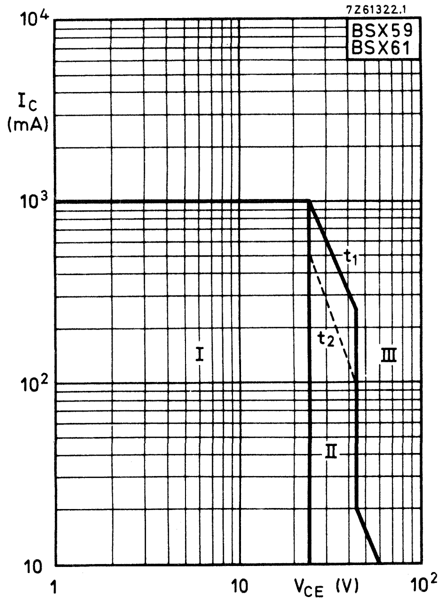


Fig. 7.

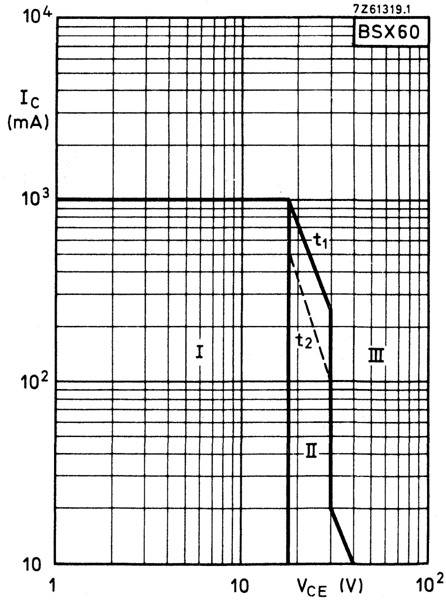


Fig. 8.

I Region of permissible operation during switching off with $-V_{BB}$ = 4 V; R_{BE} = 39 Ω.

II Permissible extension for repetitive pulsed operation.
t_1 limits operations with $t_p \leqslant 0,1$ μs; δ = 0,25
t_2 limits operations with $t_p \leqslant$ 1 μs; δ = 0,25

III Operation in this area is not allowed.

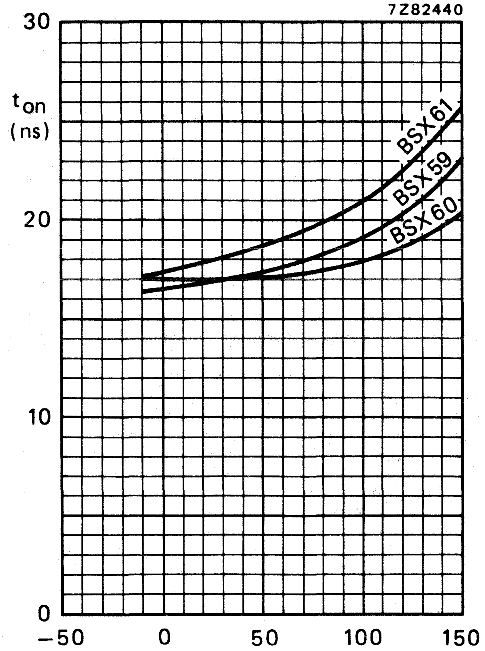


Fig. 9 $-V_{BEoff} = 2$ V; $I_{Con} = 500$ mA; $I_{Bon} = 50$ mA; typ. values. (See also Fig. 4).

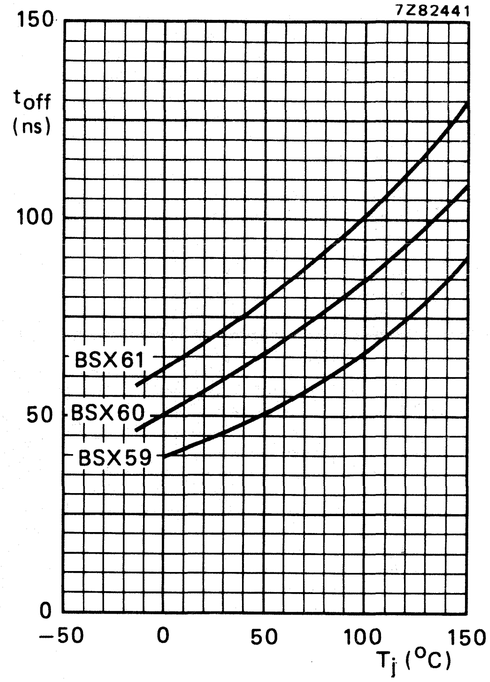


Fig. 10 $I_{Con} = 500$ mA; $I_{Bon} = -I_{Boff} = 50$ mA; typical values. (See also Fig. 4).

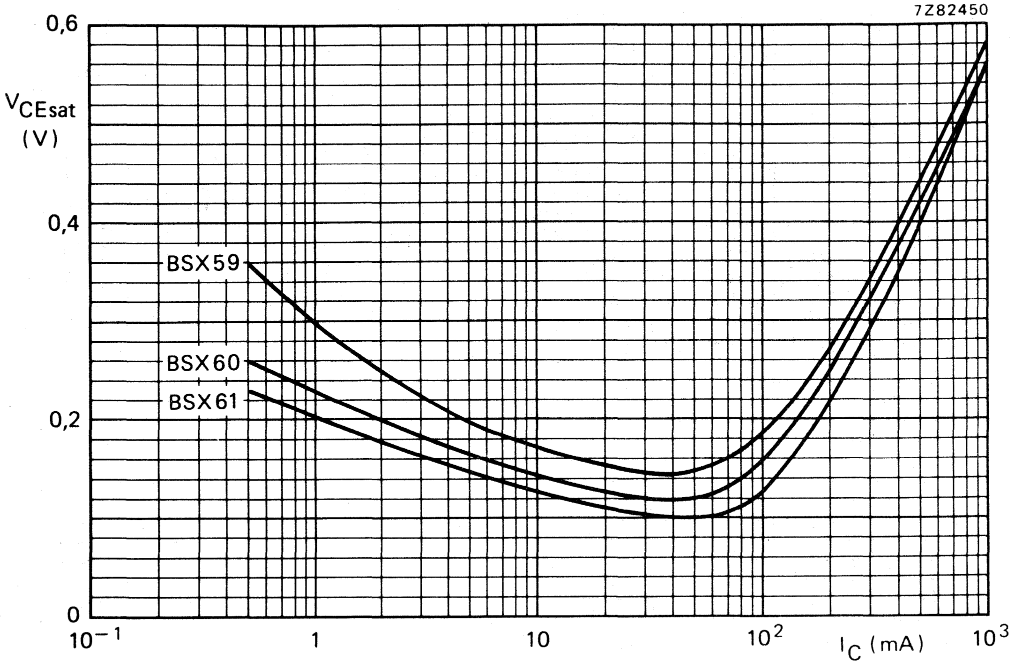


Fig. 11 $I_C/I_B = 10$; $T_j = 25\ ^oC$; typical values.

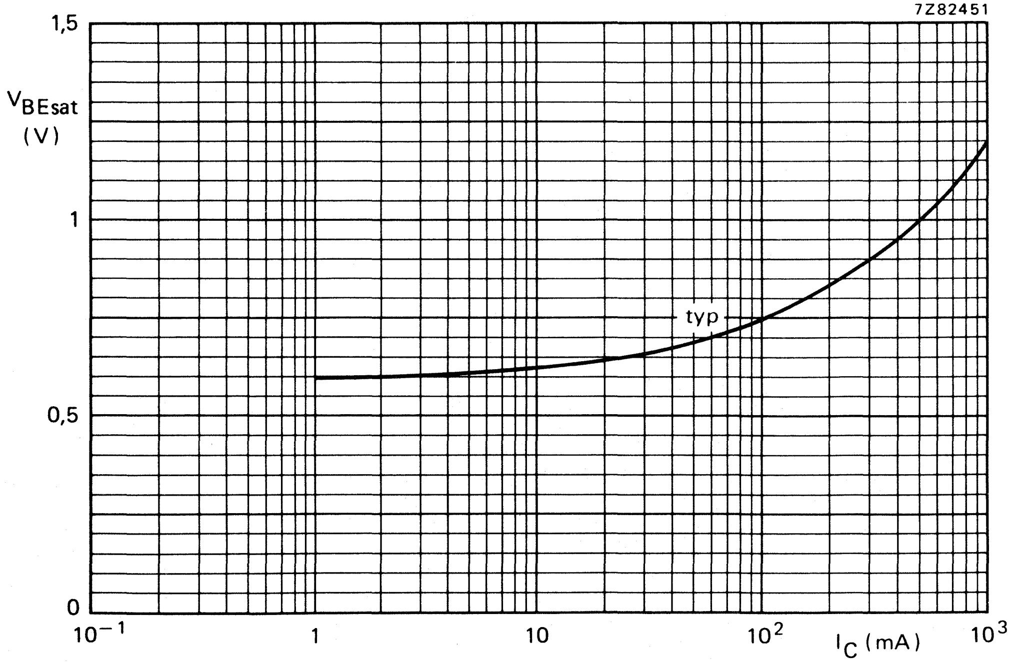


Fig. 12 $I_C/I_B = 10$; $T_j = 25\ ^oC$.

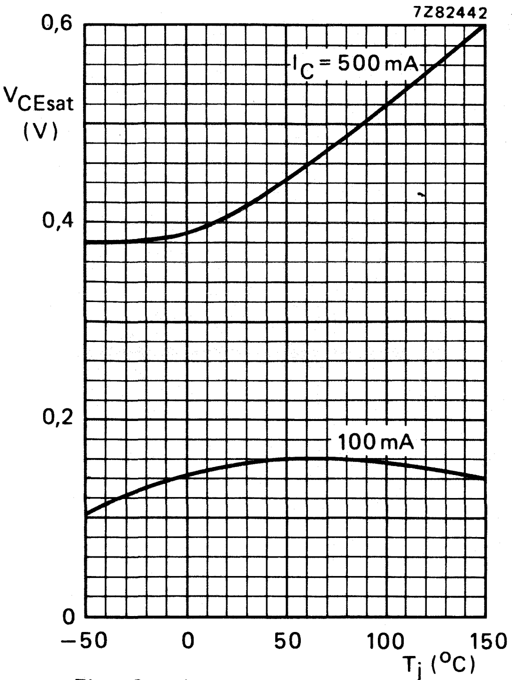


Fig. 13 I_C/I_B = 10; typical values.

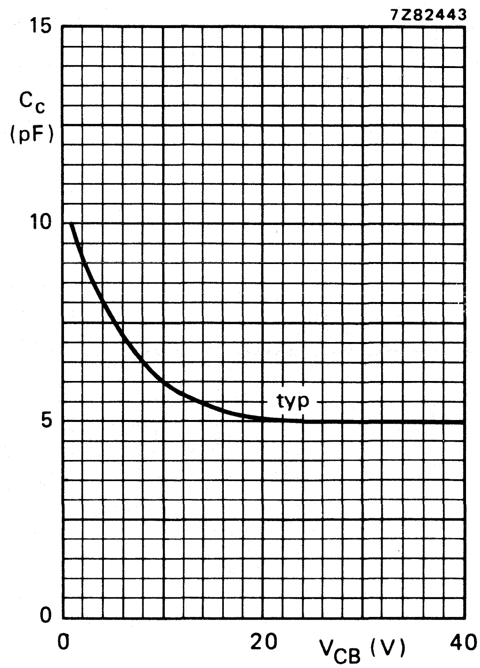


Fig. 14 $I_E = I_e = 0$; f = 1 MHz; T_j = 25 °C.

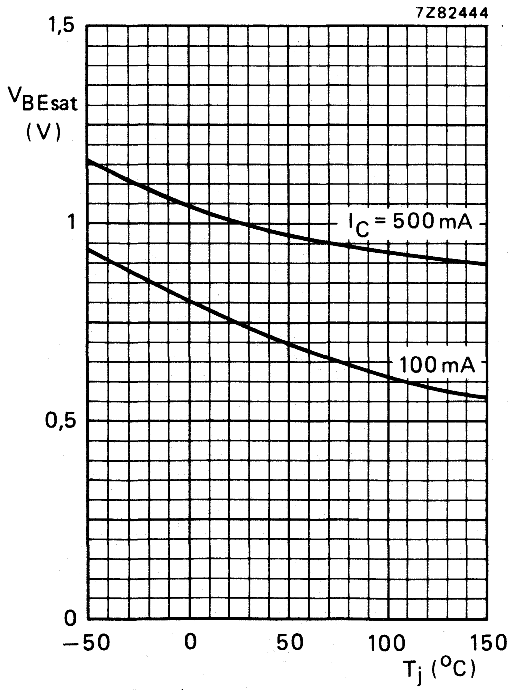


Fig. 15 I_C/I_B = 10; typical values.

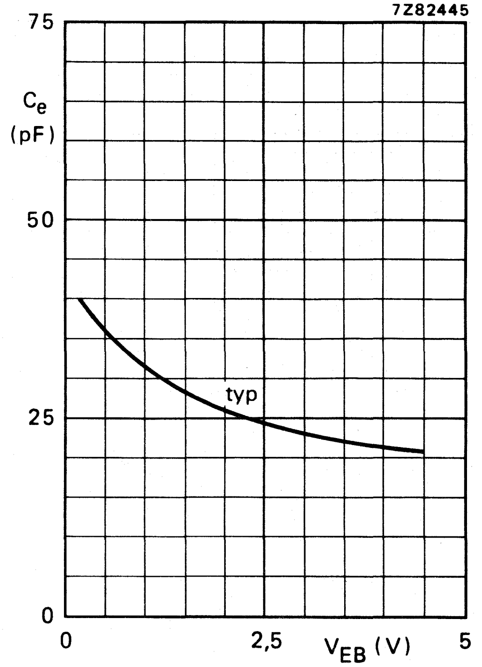


Fig. 16 $I_C = I_c = 0$; f = 1 MHz; T_j = 25 °C.

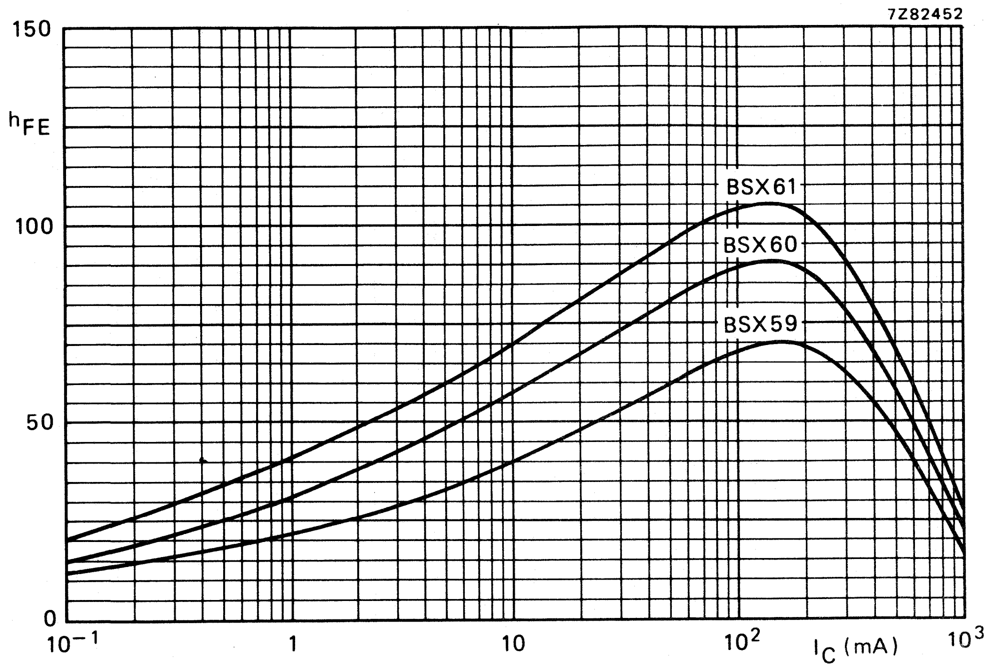


Fig. 17 V_{CE} = 1 V; T_j = 25 °C; typical values.

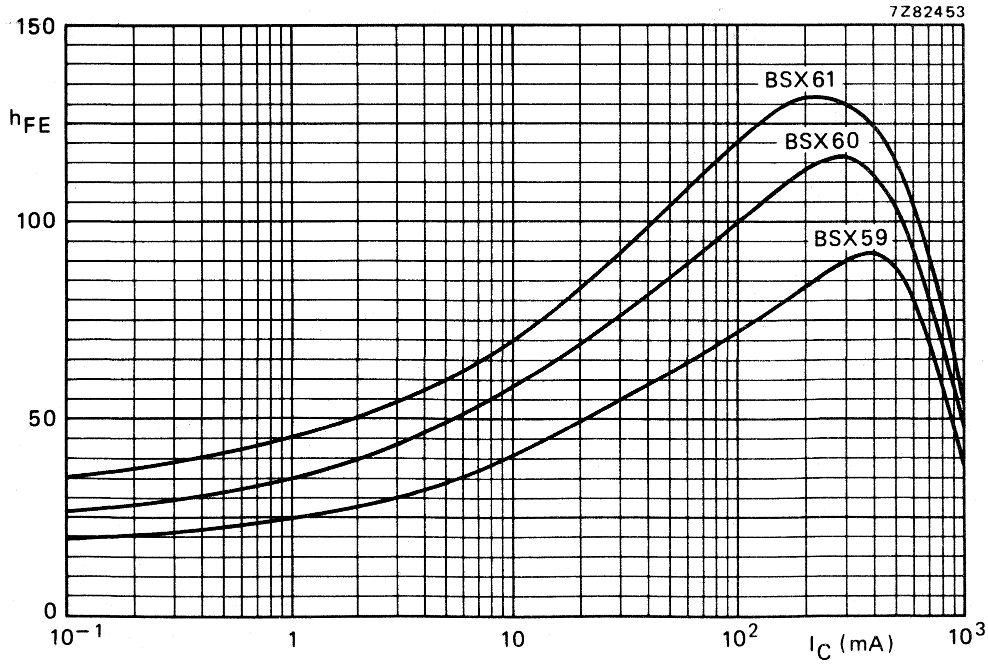


Fig. 18 V_{CE} = 5 V; T_j = 25 °C; typical values.

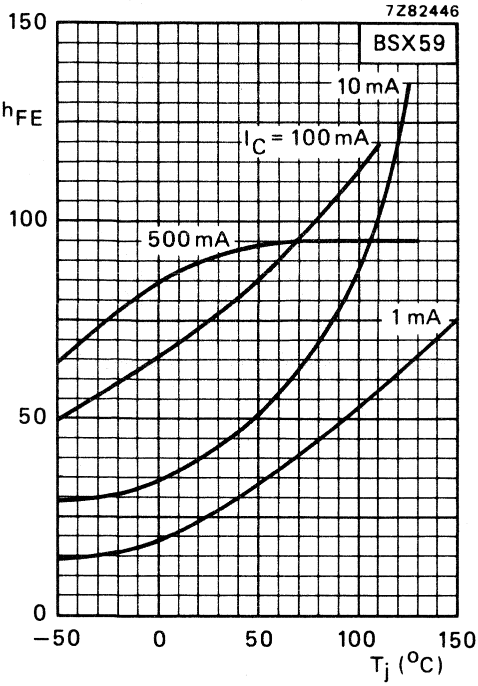


Fig. 19 V_{CE} = 5 V; typical values.

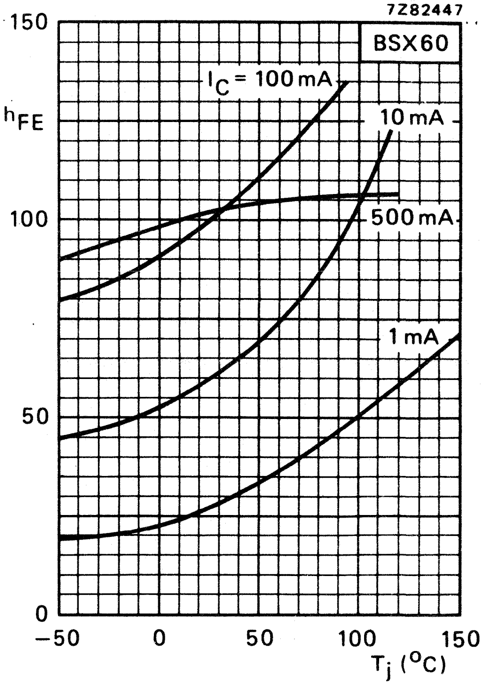


Fig. 20 V_{CE} = 5 V; typical values.

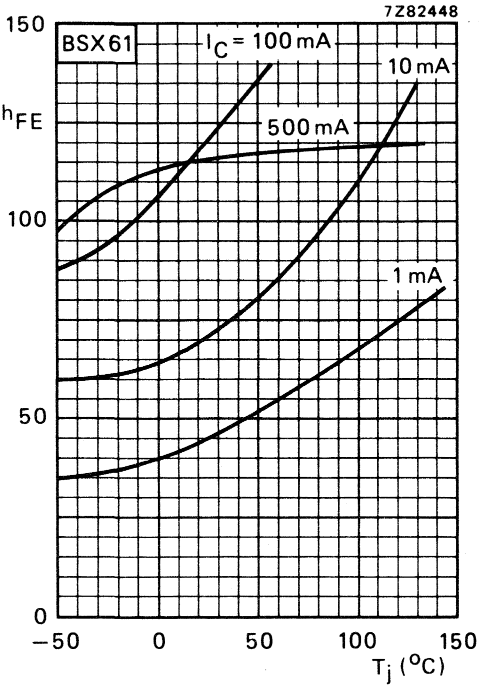


Fig. 21 V_{CE} = 5 V; typical values.

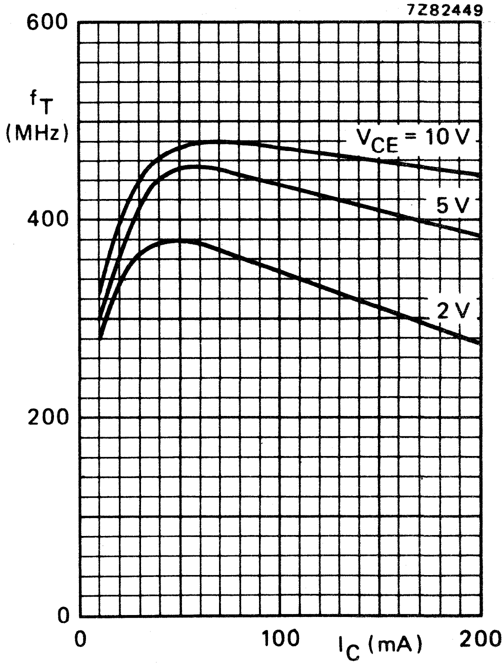


Fig. 22 f = 100 MHz; T_j = 25 °C; typ. values.

Philips Components

Data sheet	
status	Preliminary specification
date of issue	June 1990

BSX62-10, -16/BSX63-10, -16

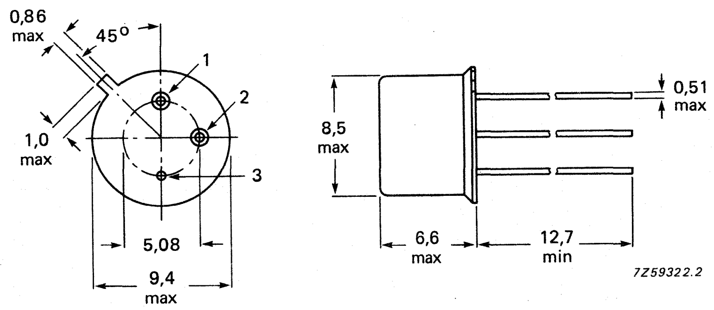
Silicon planar epitaxial transistors

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNIT
V_{CEO}	collector-emitter voltage		BSX62	-	-	40	V
			BSX63	-	-	60	V
I_C	collector current			-	-	3	A
P_{tot}	total power dissipation	T_{amb} = 25 °C		-	-	875	mW
P_{tot}	total power dissipation	T_{case} = 25 °C		-	-	5	W
T_j	junction temperature			-	-	200	°C
h_{FE}	DC current gain	V_{CE} = 1 V I_C = 1 A	BSX62-10 BSX63-10	63	-	160	
			BSX62-16 BSX63-16	100	-	250	
f_T	transition frequency	V_{CE} = 10 V I_C = 200 mA		-	70	-	MHz

MECHANICAL DATA

Dimensions in mm



Collector connected to case.

Fig.1 TO-39.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS		MIN.	MAX.	UNIT
V_{CES}	collector-emitter voltage	$V_{BE} = 0$	BSX62 BSX63	- -	60 80	V V
V_{CEO}	collector-emitter voltage	$I_B = 0$	BSX62 BSX63	- -	40 60	V V
V_{EBO}	emitter-base voltage	$I_C = 0$		-	5	V
I_C	collector current			-	3	A
I_B	base current			-	500	mA
P_{tot}	total power dissipation	$T_{case} \leq 25$ °C		-	5	A
T_j	junction temperature			-	200	°C
T_{stg}	storage temperature range			–65	150	°C

THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient	200	K/W
$R_{th\ j\text{-}c}$	from junction to case	28	K/W

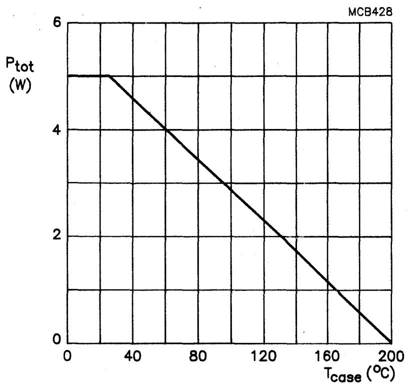


Fig.2 Total power dissipation as a function of case temperature.

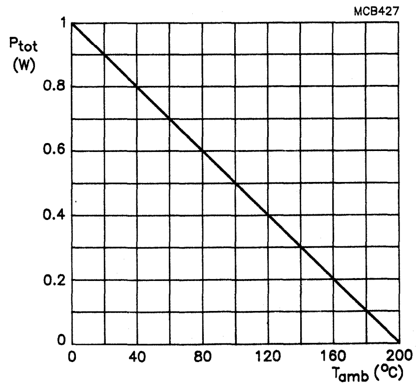


Fig.3 Total power dissipation as a function of ambient temperature.

CHARACTERISTICS

T_{case} = 25 °C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNIT
I_{CES}	collector-emitter cut-off current	V_{BE} = 0 V_{CE} = 40 V	BSX62	-	-	100	nA
I_{CES}	collector-emitter cut-off current	V_{BE} = 0 V_{CE} = 40 V T_{case} = 150 °C	BSX62	-	-	100	µA
I_{CES}	collector-emitter cut-off current	V_{BE} = 0 V_{CE} = 60 V	BSX63	-	-	100	nA
I_{CES}	collector-emitter cut-off current	V_{BE} = 0 V_{CE} = 60 V T_{case} = 150 °C	BSX63	-	-	100	µA
$V_{(BR)CBO}$	collector-base breakdown voltage	I_E = 0 I_C = 100 µA	BSX62 BSX63	60 80	- -	- -	V V
$V_{(BR)CEO}$	collector-emitter breakdown voltage	I_B = 0 I_C = 100 mA	BSX62 BSX63	40 60	- -	- -	V V
$V_{(BR)EBO}$	emitter-base breakdown voltage	I_E = 10 µA I_C = 0		5	-	-	V
V_{CEsat}	collector-emitter saturation voltage	I_B = 100 mA I_C = 1 A		-	-	0.7	V
V_{CEsat}	collector-emitter saturation voltage	I_B = 200 mA I_C = 2 A		-	-	0.8	V
V_{BEsat}	base-emitter saturation voltage	I_B = 100 mA I_C = 1 A		-	-	1.2	V
V_{BEsat}	base-emitter saturation voltage	I_B = 200 mA I_C = 2 A		-	-	1.3	V
V_{BE}	base-emitter voltage	V_{CE} = 1 V I_C = 100 mA		-	-	1	V
V_{BE}	base-emitter voltage	V_{CE} = 1 V I_C = 1 A		-	-	1.2	V
V_{BE}	base-emitter voltage	V_{CE} = 5 V I_C = 2 A		-	-	1.3	V
f_T	transition frequency	V_{CE} = 10 V I_C = 200 mA		30	-	-	MHz
C_c	collector capacitance	V_{CB} = 10 V I_E = 0		-	-	70	pF

SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNIT
Switching times							
t_{on}	turn-on time	$I_{CX} \approx 1$ A $I_{BX} = -I_{BY} \approx 50$ mA		-	-	0.3	μs
t_{off}	turn-off time	$I_{CX} \approx 1$ A $I_{BX} = -I_{BY} \approx 50$ mA		-	-	1.5	μs
h_{FE}	DC current gain	$V_{CE} = 1$ V $I_C = 100$ mA	BSX62-10 BSX63-10	-	110	-	
			BSX62-16 BSX63-16	-	180	-	
h_{FE}	DC current gain	$V_{CE} = 1$ V $I_C = 1$ A	BSX62-10 BSX63-10	63	100	160	
			BSX62-16 BSX63-16	100	160	250	
h_{FE}	DC current gain	$V_{CE} = 5$ V $I_C = 2$ A	BSX62-10 BSX63-10	-	70	-	
			BSX62-16 BSX63-16	-	120	-	

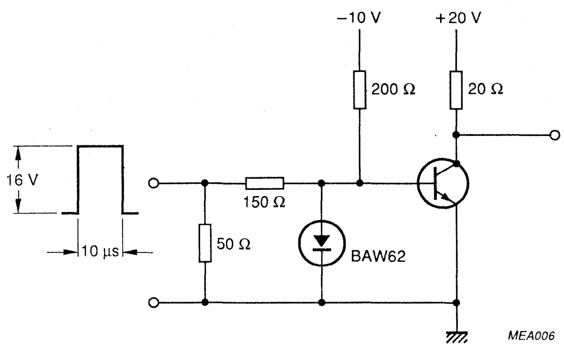


Fig.4 Switching times test circuit.

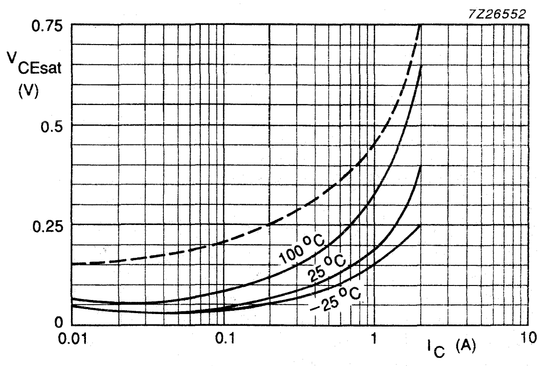


Fig.5 Collector-emitter saturation voltage as a function of collector current; I_C:I_B = 10; – typical values at T_{amb}; --- maximum values at T_{case} = 25 °C.

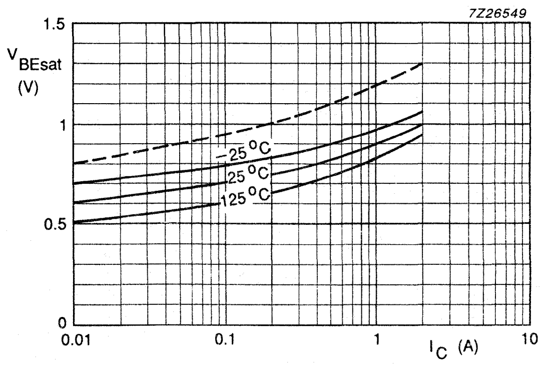


Fig.6 Base-emitter saturation voltage as a function of collector current; I_C:I_B = 10; – typical values at T_{amb}; --- maximum values at T_{case} = 25 °C.

Silicon planar epitaxial transistors BSX62-10, -16/BSX63-10, -16

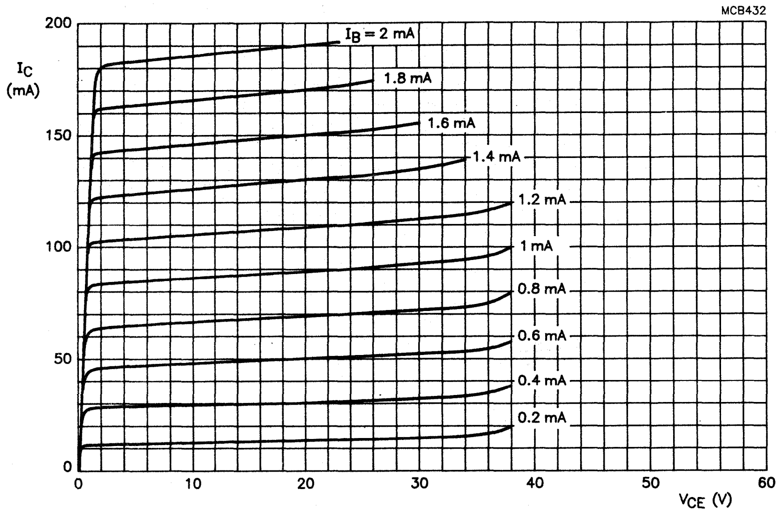


Fig.7 Collector current as a function of collector-emitter voltage; BSX62.

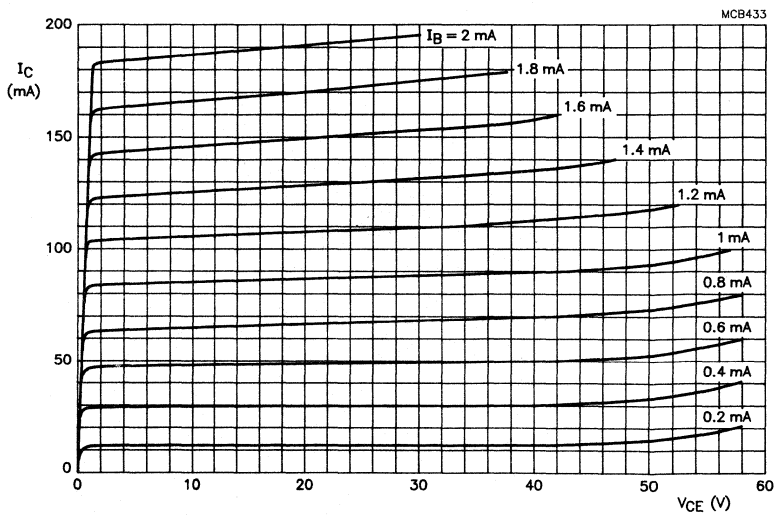


Fig.8 Collector current as a function of collector-emitter voltage; BSX63.

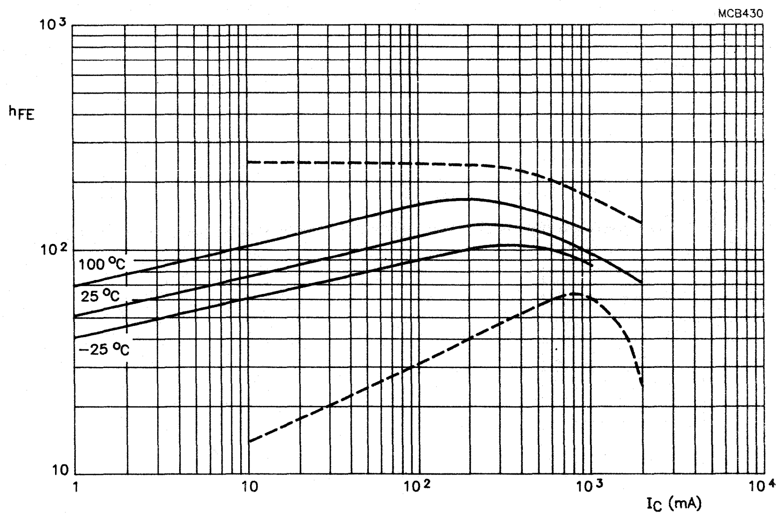


Fig.9 Current gain as a function of collector current; BSX62-10 and BSX63-10; V_{CE} = 1 V; – typical values at T_{amb}; --- minimum values at T_{case} = 25 °C.

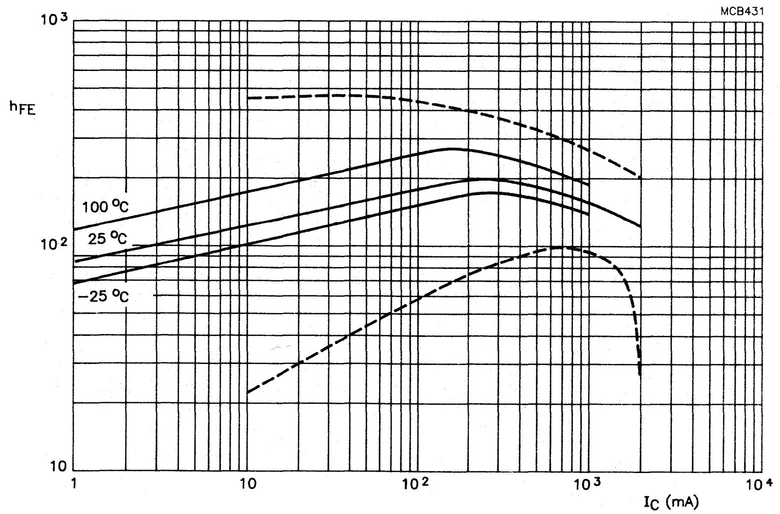


Fig.10 Current gain as a function of collector current; BSX62-16 and BSX63-16; V_{CE} = 1 V; – typical values at T_{amb}; --- minimum values at T_{case} = 25 °C.

Silicon planar epitaxial transistors BSX62-10, -16/BSX63-10, -16

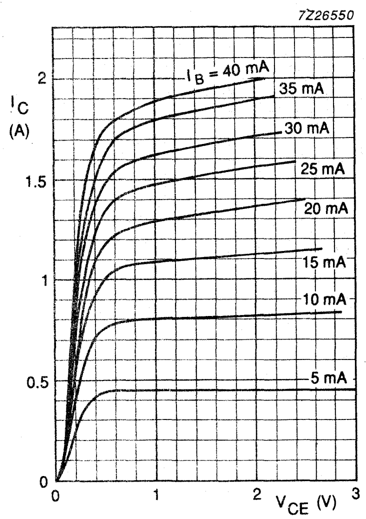


Fig.11 Collector current as a function of collector-emitter voltage.

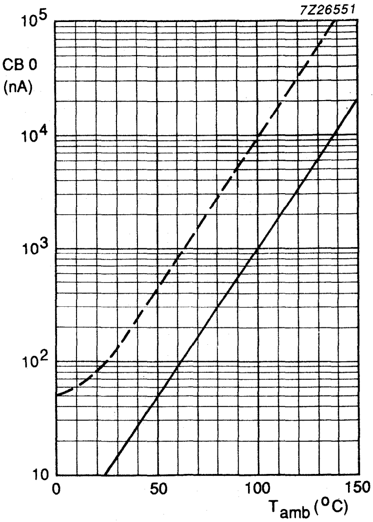


Fig.12 Collector cut-off current as a function of ambient temperature; V_{CB} = 40 V (BSX62) and 60 V (BSX63); --- maximum values; – typical values.

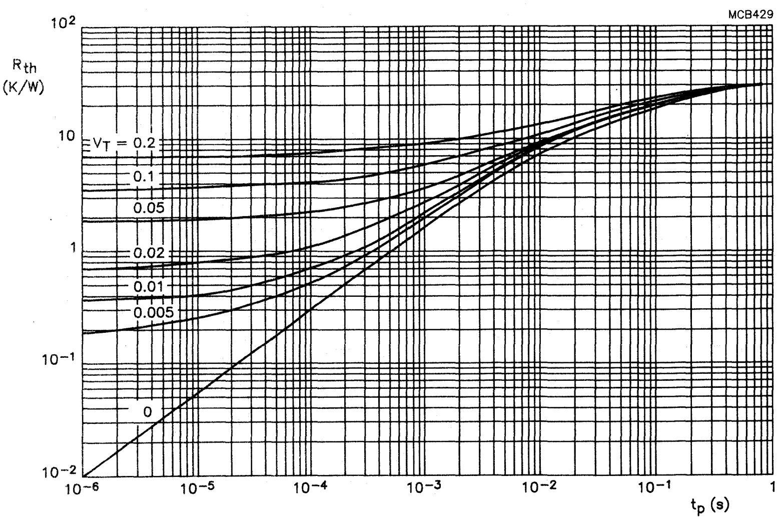


Fig.13 Thermal resistance as a function of pulse time.

SILICON PLANAR EPITAXIAL TRANSISTOR

NPN transistors in a TO-18 metal envelope intended for general purpose low level switching applications.

QUICK REFERENCE DATA

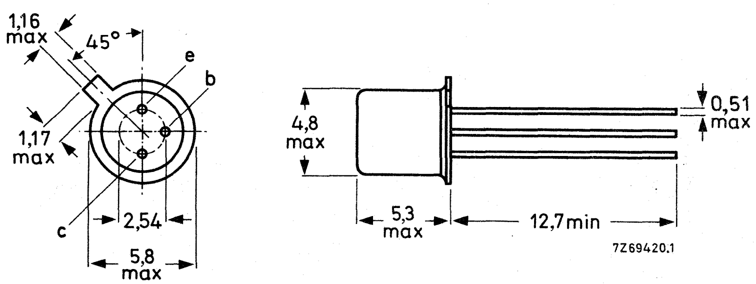
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
DC current gain I_C = 10 mA; V_{CE} = 0.35 V	h_{FE}		50 to 200	
Transition frequency at f = 100 MHz I_C = 10 mA; V_{CE} = 9.0 V	f_T	min.	200	MHz
Storage time	t_s	max.	50	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case



RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

V_{CBO} max.	20	V
V_{CEO} max.	15	V
V_{EBO} max.	5.0	V
$I_{C(AV)}$ max. (see note 1)	100	mA
I_{CM} max.	200	mA
P_{tot} max. ($T_{amb} \leq 25^{o}C$)	300	mW

Temperature

T_{stg} min.	-65	^{o}C
T_{stg} max.	150	^{o}C
T_j max. (operating)	175	^{o}C

THERMAL CHARACTERISTIC

$R_{th(j\text{-}a)}$	500	K/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{o}C$ unless otherwise stated)

		Min.	Max.	
I_{CBO}	Collector cut-off current $V_{CB} = 16V$, $I_E = 0$	-	50	nA
$V_{BR(CBO)}$	Collector-base breakdown voltage $I_C = 1.0\mu A$	20	-	V
I_{EBO}	Emitter cut-off current $V_{EB} = 1.5V$, $I_C = 0$	-	25	nA
$V_{(BR)EBO}$	Emitter-base breakdown voltage $I_E = 10\mu A$	5.0	-	V
I_{CEO}	Collector-emitter cut-off current $V_{CE} = 12V$, $I_B = 0$	-	250	nA
$V_{(BR)CEO}$	Collector-emitter breakdown voltage $I_C = 10mA$ (see note 2)	15	-	V
f_T	Transition frequency $I_C = 10mA$, $V_{CE} = 9.0V$, $f = 100MHz$	200	-	MHz

Notes

1. Averaged over any 20 ms period.
2. Pulsed: Pulse width = 300 μs, duty cycle $< 2\%$.

		Min.	Max.	
h_{FE}	DC current gain			
	$I_C=1.0mA$, $V_{CE}=0.35V$	30	-	
	$I_C=10mA$, $V_{CE}=0.35V$	50	200	
$V_{CE(sat)}$	Collector-emitter saturation voltage			
	$I_C=10mA$, $I_B=0.2mA$	-	0.35	V
$V_{BE(sat)}$	Base-emitter saturation voltage			
	$I_C=10mA$, $I_B=0.2mA$	0.67	0.87	V
C_{ob}	Collector-base capacitance			
	$V_{CB}=9.0V$, $I_E=0$			
	f=1.0MHz	-	6.0	pF
t_s	Storage time			
	$I_C=10mA$	-	50	ns
	See test circuit on next page			

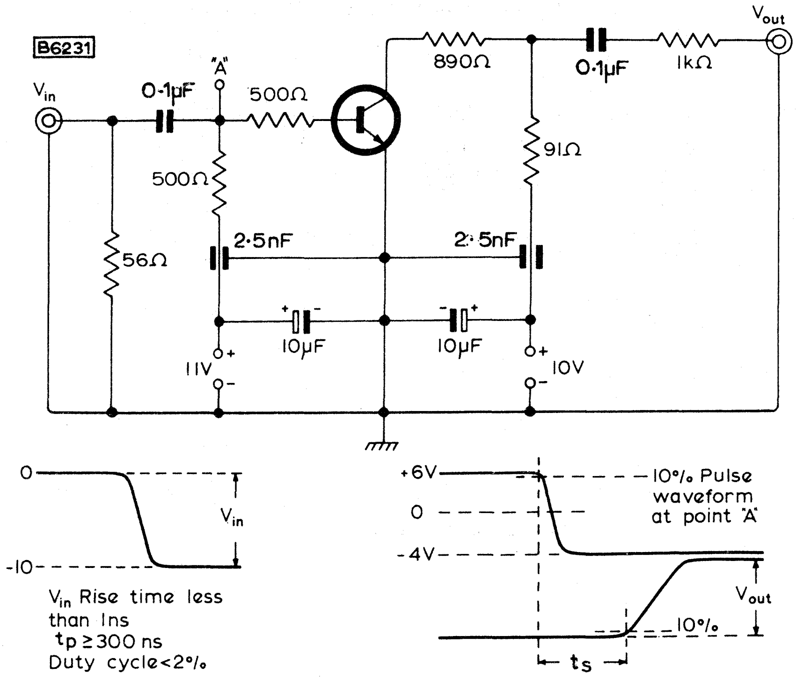


Fig.2 Test circuit and waveforms.

PNP SMALL-SIGNAL TRANSISTORS

PNP small-signal transistors in TO-92 envelopes, recommended for general purpose amplifier applications.

The complementary types are the JC500 and JC501 respectively.

QUICK REFERENCE DATA

			JA100	JA101	
Collector-base voltage	$-V_{CBS}$	max.	30	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	45	V
Collector current (DC)	$-I_C$	max.	100		mA
DC current gain $-I_C = 1$ mA; $-V_{CE} = 5$ V	h_{FE}		90 to 600		
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	500		mW

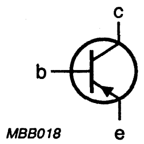
MECHANICAL DATA

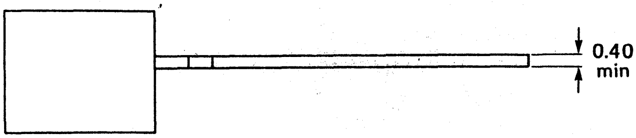
Dimensions in mm

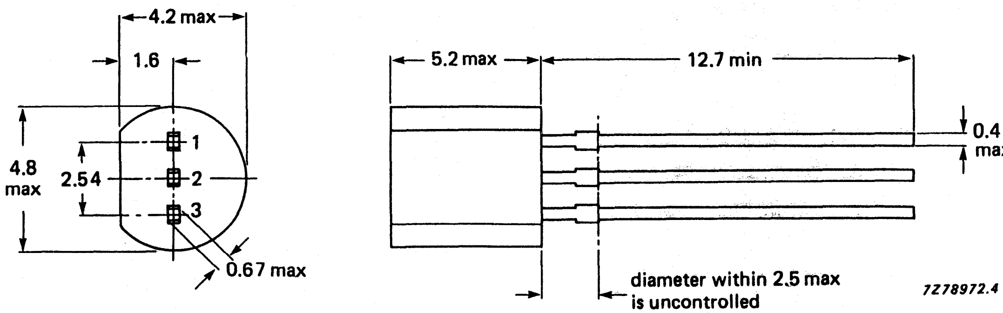
Fig.1 TO-92.

Pinning:

1 = base
2 = collector
3 = emitter







RATINGS

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

			JA100	JA101	
Collector-base voltage	$-V_{CBS}$	max.	30	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	45	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5.0		V
Collector current (DC)	$-I_C$	max.	100		mA
Collector current (peak)	$-I_{CM}$	max.	200		mA
Base current (DC)	$-I_B$	max.	50		mA
Base current (peak)	$-I_{BM}$	max.	100		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500		mW
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	250	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			JA100	JA101	
Collector-emitter breakdown voltage					
$-I_{CES}$ = 10 μA	$-V_{(BR)CES}$	>	30	50	V
$-I_{CEO}$ = 2 mA	$-V_{(BR)CEO}$	>	25	45	V
Emitter-base breakdown voltage					
$-I_{EBO}$ = 10 μA	$-V_{(BR)EBO}$	>	5.0	5.0	V
Collector cut-off current					
$-V_{CE}$ = 25 V	$-I_{CES}$	<	15	–	nA
$-V_{CE}$ = 45 V	$-I_{CES}$	<	–	15	nA
$-V_{CE}$ = 25 V; T_j = 125 °C	$-I_{CES}$	<	4.0	–	μA
$-V_{CE}$ = 45 V; T_j = 125 °C	$-I_{CES}$	<	–	4.0	μA
DC current gain*					
$-I_C$ = 1 mA; $-V_{CE}$ = 5 V	h_{FE}		90 to 600		
Collector-emitter saturation voltage					
$-I_C$ = 10 mA; $-I_B$ = 0.5 mA	$-V_{CE\ sat}$	<	0.3		V
$-I_C$ = 100 mA; $-I_B$ = 5 mA	$-V_{CE\ sat}$	typ.	0.5		V
Base-emitter saturation voltage					
$-I_C$ = 10 mA; $-I_B$ = 0.5 mA	$-V_{BE\ sat}$	typ.	0.7		V
$-I_C$ = 100 mA; $-I_B$ = 5 mA	$-V_{BE\ sat}$	typ.	0.85		V
Base-emitter voltage					
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	$-V_{BE\ on}$		0.55 to 0.7		V

* Group	O	P	Q	R
Range	90 - 180	135 - 270	200 - 400	300 - 600

Transition frequency at f = 50 MHz; $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	130	MHz
Collector-base capacitance $-V_{CBO}$ = 10 V; f = 1 MHz	C_{cb}	<	6.0	pF
Emitter-base capacitance $-V_{EBO}$ = 0.5 V; f = 1 MHz	C_{eb}	typ.	12	pF
Noise figure at R_S = 2 kΩ; f = 1 kHz; $-I_C$ = 200 μA; $-V_{CE}$ = 5 V	NF	<	10	dB

SILICON PLANAR EPITAXIAL TRANSISTORS

PNP transistors in plastic TO-92 variant envelopes, primarily intended for use in driver and output stages of audio amplifiers.

The JC327, JC327A, JC328 are complementary to the JC337, JC337A and JC338 respectively.

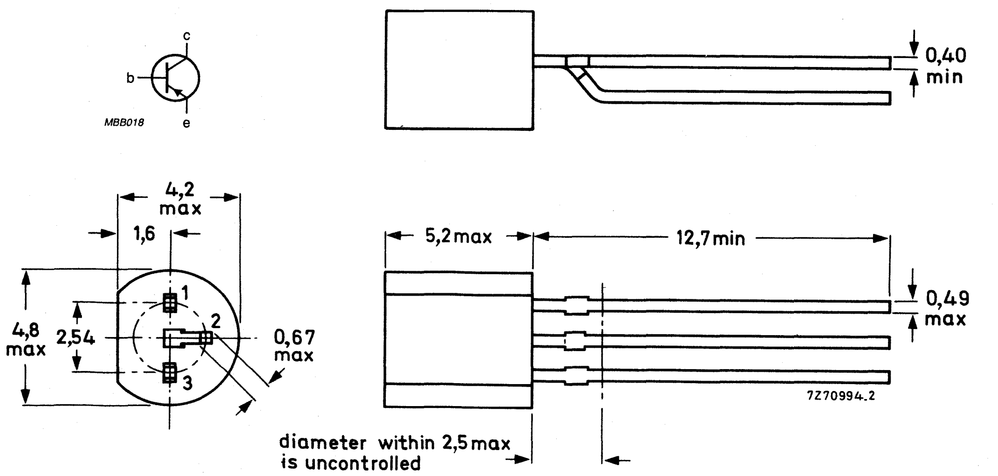
QUICK REFERENCE DATA

			JC327	JC327A	JC328	
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	50	60	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	25	V
Collector current (peak value)	$-I_{CM}$	max.		1000		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		800		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.		100		MHz
DC current gain; $-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}			100 to 600		

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92 variant.



RATINGS

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

			JC327	JC327A	JC328	
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	50	60	30	V
Collector-emitter voltage (open base) $-I_C$ = 10 mA	$-V_{CEO}$	max.	45	60	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.		5		V
Collector current (DC)	$-I_C$	max.		500		mA
Collector current (peak value)	$-I_{CM}$	max.		1000		mA
Emitter current (peak value)	I_{EM}	max.		1000		mA
Base current (DC)	$-I_B$	max.		100		mA
Base current (peak value)	$-I_{BM}$	max.		200		mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.		625		mW
up to T_{amb} = 25 °C	P_{tot}	max.		800		mW*
Storage temperature range	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.2	K/mW
From junction to ambient	$R_{th\ j\text{-}a}$	=	0.156	K/mW*

* Transistor mounted on printed-circuit board, max. lead length 4 mm, mounting pad for collector lead min. 10 mm x 10 mm.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; $-V_{CB}$ = 20 V; T_j = 25 °C	$-I_{CBO}$	max.	100	nA
I_E = 0; $-V_{CB}$ = 20 V; T_j = 150 °C	$-I_{CBO}$	max.	5	μA
Emitter cut-off current				
I_C = 0; $-V_{EB}$ = 5 V	$-I_{EBO}$	max.	10	μA
Base emitter voltage*				
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	$-V_{BE}$	max.	1.2	V
Saturation voltage				
$-I_C$ = 500 mA; $-I_B$ = 50 mA	$-V_{CEsat}$	max.	700	mV
DC current gain				
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}	min.	40	
$-I_C$ = 100 mA; $-V_{CE}$ = 1 V; JC327; JC328	h_{FE}		100 to 600	
JC327A	h_{FE}		100 to 400	
JC327-16, JC328-16	h_{FE}		100 to 250	
JC327-25, JC328-25	h_{FE}		160 to 400	
JC327-40, JC328-40	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

Note

For characteristics graphs, see BC327/327A/328, Figs 2 to 8.

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

SILICON PLANAR EPITAXIAL TRANSISTORS

NPN transistors in plastic TO-92 variant envelopes, primarily intended for use in driver and output stages of audio amplifiers.

The JC337, JC337A, JC338 are complementary to the JC327, JC327A and JC328 respectively.

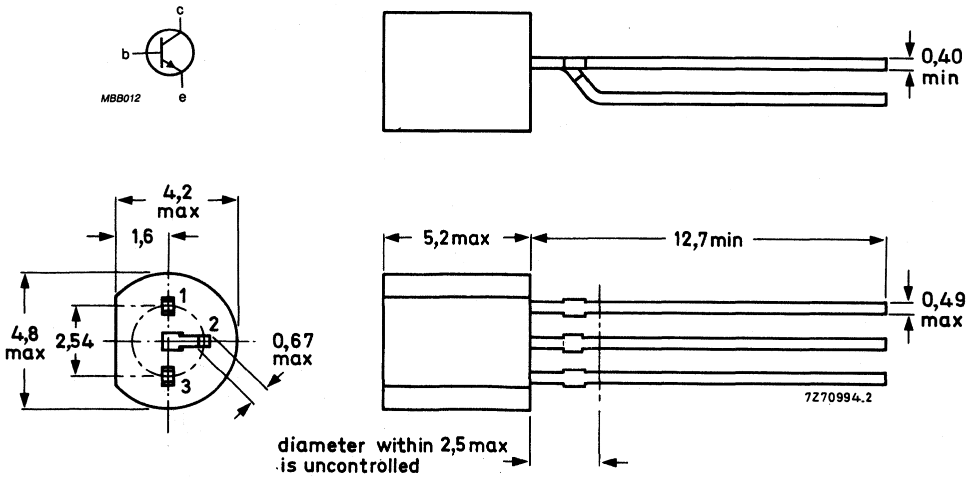
QUICK REFERENCE DATA

			JC337	JC337A	JC338	
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	50	60	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	60	25	V
Collector current (peak value)	I_{CM}	max.		1000		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		800		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.		100		MHz
DC current gain I_C = 100 mA; V_{CE} = 1 V	h_{FE}			100 to 600		

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92 variant.



RATINGS

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

			JC337	JC337A	JC338	
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	50	60	30	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	45	60	25	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5		V
Collector current (DC)	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 (DC)	I_B	max.		100		mA
Base current (peak value)	I_{BM}	max.		200		mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.		625		mW
up to T_{amb} = 25 °C	P_{tot}	max.		800		mW*
Storage temperature range	T_{stg}			–65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.2	K/mW
From junction to ambient	$R_{th\ j\text{-}a}$	=	0.156	K/mW*

* Transistor mounted on printed circuit board, max. lead length 4 mm, mounting pad for collector lead min. 10 mm x 10 mm.

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}	max.	100 nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	I_{CBO}	max.	5 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	10 μA
Base emitter voltage*			
$I_C = 500$ mA; $V_{CE} = 1$ V	V_{BE}	max.	1.2 V
Saturation voltage			
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	max.	700 mV
DC current gain			
$I_C = 500$ mA; $V_{CE} = 1$ V	h_{FE}	min.	40
$I_C = 100$ mA; $V_{CE} = 1$ V; JC337; JC338	h_{FE}		100 to 600
JC337A	h_{FE}		100 to 400
JC337-16, JC338-16	h_{FE}		100 to 250
JC337-25, JC338-25	h_{FE}		160 to 400
JC337-40, JC338-40	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

Note

For characteristics drawings, see BC337/337A/338, Figs 2 to 8.

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

NPN SMALL-SIGNAL TRANSISTORS

NPN small-signal transistors, in TO-92 envelopes. They are recommended for general purpose amplifier applications.

The complementary types are the JA100 and the JA101 respectively.

QUICK REFERENCE DATA

			JC500	JC501	
Collector-emitter voltage	V_{CES}	max.	30	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	25	45	V
Collector current (DC)	I_C	max.	100		mA
DC current gain $I_C = 1$ mA; $V_{CE} = 5$ V	h_{FE}		90 to 600		
Total power dissiaption up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	500		mW

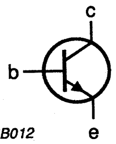
MECHANICAL DATA

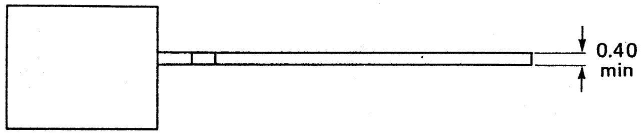
Dimensions in mm

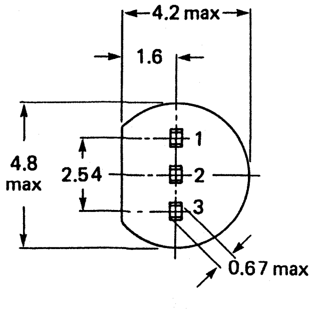
Fig.1 TO-92.

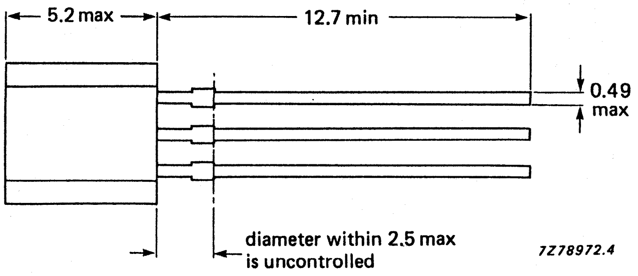
Pinning.

1 = base
2 = collector
3 = emitter









RATINGS

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

			JC500	JC501	
Collector-emitter voltage	V_{CES}	max.	30	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	25	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6.0		V
Collector current (DC)	I_C	max.	100		mA
Collector current (peak)	I_{CM}	max.	200		mA
Base current (DC)	I_B	max.	50		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500		mW
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	250	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			JC500	JC501	
Collector-emitter breakdown voltage I_{CEO} = 2 mA	$V_{(BR)CEO}$	>	25	45	V
Emitter-base breakdown voltage I_{EBO} = 1 μA	$V_{(BR)EBO}$	>	6.0	6.0	V
Collector cut-off current					
V_{CE} = 25 V	I_{CES}	<	15	–	nA
V_{CE} = 45 V	I_{CES}	<	–	15	nA
V_{CE} = 25 V; T_j = 125 °C	I_{CES}	<	4.0	–	μA
V_{CE} = 45 V; T_j = 125 °C	I_{CES}	<	–	4.0	μA
Emitter-base cut-off current V_{EB} = 6 V	I_{EBO}	<	1.0		μA
DC current gain * I_C = 1 mA; V_{CE} = 5 V	h_{FE}		90 to 600		
Collector-emitter saturation voltage					
I_C = 10 mA; I_B = 0.5 mA	$V_{CE\,sat}$	<	0.2		V
I_C = 100 mA; I_B = 5 mA	$V_{CE\,sat}$	<	0.6		V
Base-emitter saturation voltage					
I_C = 10 mA; I_B = 0.5 mA	$V_{BE\,sat}$	<	0.83		V
I_C = 100 mA; I_B = 5 mA	$V_{BE\,sat}$	<	1.06		V
Base-emitter voltage I_C = 2 mA; V_{CE} = 5 V	V_{BE}		0.55 to 0.7		V

*Group	O	P	Q	R
Range	90 - 180	135 - 270	200 - 400	300 - 600

Transition frequency at f = 100 MHz; I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	130	MHz
Collector-base capacitance V_{CBO} = 10 V; f = 1 MHz	C_{cb}	$<$	6.0	pF
Emitter-base capacitance V_{EBO} = 0.5 V; f = 1 MHz	C_{eb}	typ.	8.0	pF
Noise figure at R_S = 2 kΩ; f = 1 kHz; I_C = 200 μA; $-V_{CE}$ = 5 V	F	$<$	10	dB

SILICON PLANAR EPITAXIAL TRANSISTORS

General purpose NPN transistors in a plastic TO-92, especially suitable for use in driver stages of audio amplifiers.

QUICK REFERENCE DATA

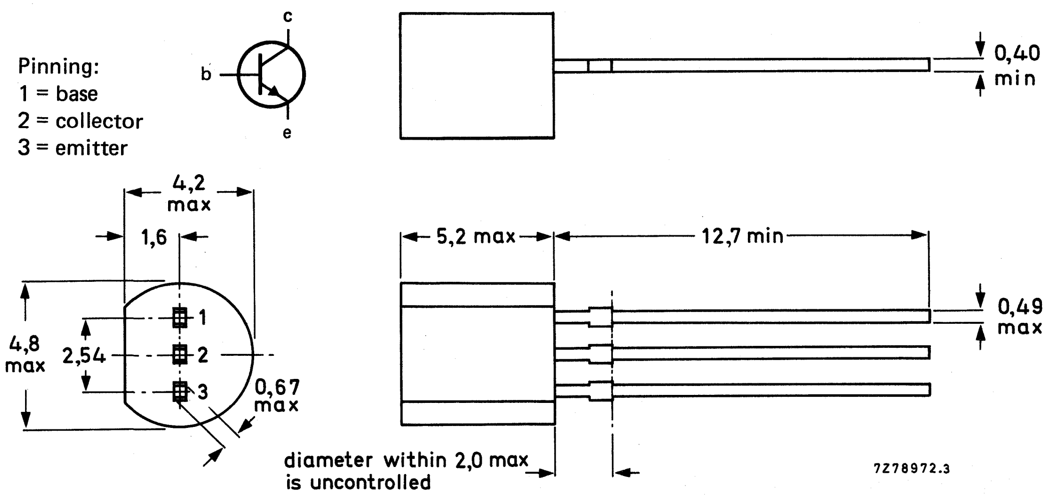
			JC546	JC547	JC548	
Collector-emitter voltage ($V_{BE} = 0$)	V_{CES}	max.	80	50	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	65	45	30	V
Collector current (peak value)	I_{CM}	max.	200	200	200	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	500	500	500	mW
Junction temperature	T_j	max.	150	150	150	^oC
DC current gain $I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	>	110	110	110	
		<	450	800	800	
Transition frequency $I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	300	300	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	typ.	2	2	2	dB

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning:
1 = base
2 = collector
3 = emitter



RATINGS

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

			JC546	JC547	JC548	
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 (DC)	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} = 25 °C	P_{tot}	max.	500	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0,25	K/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0,15	K/mW

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

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

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
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	2,5	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; V_{EB} = 0,5 V	C_e	typ.	9	pF
Transition frequency at f = 35 MHz				
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	MHz
Small signal current gain at f = 1 kHz				
I_C = 2 mA; V_{CE} = 5 V	h_{fe}		125 to 900	

			JC546	JC547	JC548	
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

			JC546A JC547A JC548A	JC546B JC547B JC548B	JC547C JC548C
DC 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

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

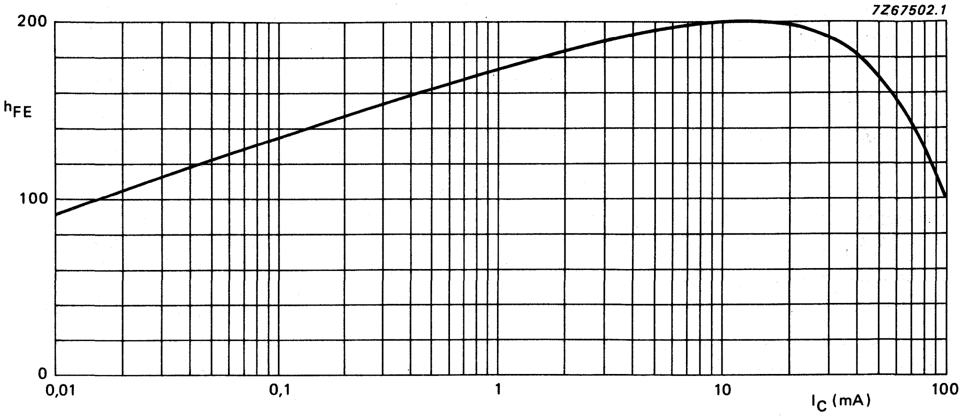


Fig. 2 JC546A; JC547A and JC548A
V_{CE} = 5 V; T_j = 25 °C; typical values.

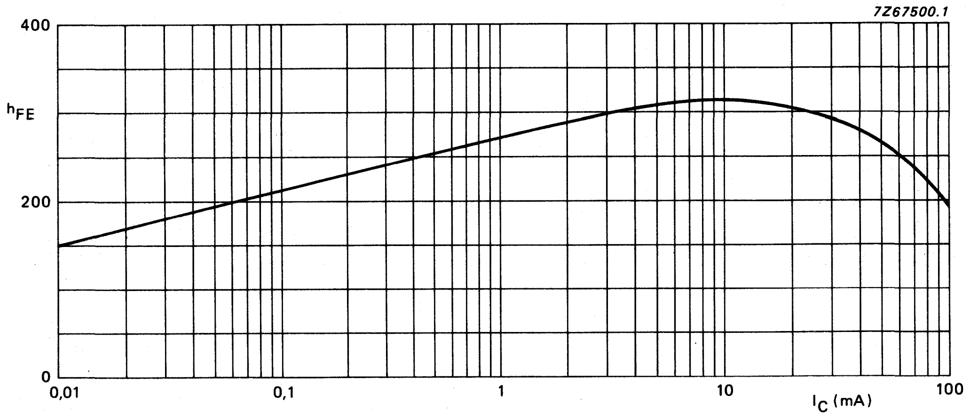


Fig. 3 JC546B; JC547B and JC548B
V_{CE} = 5 V; T_j = 25 °C; typical values.

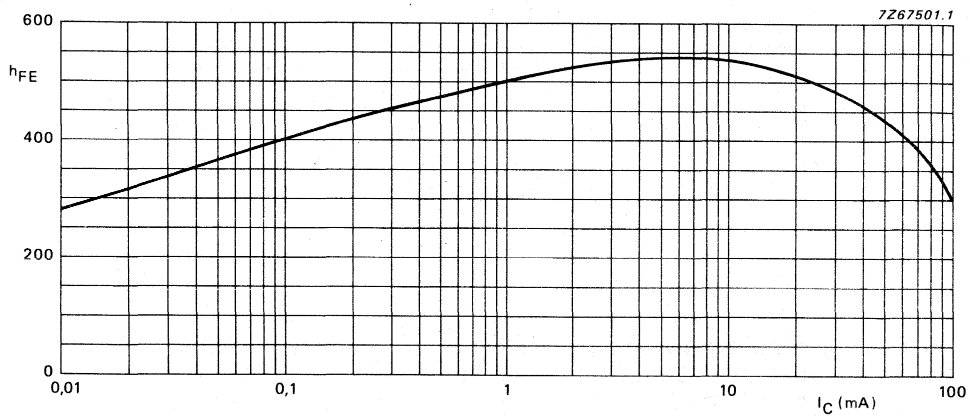


Fig. 4 JC547C and JC548C
V_{CE} = 5 V; T_j = 25 °C; typical values.

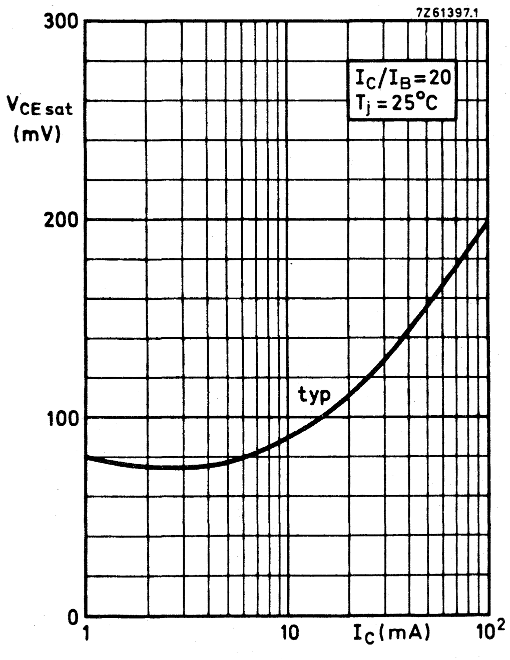


Fig. 5.

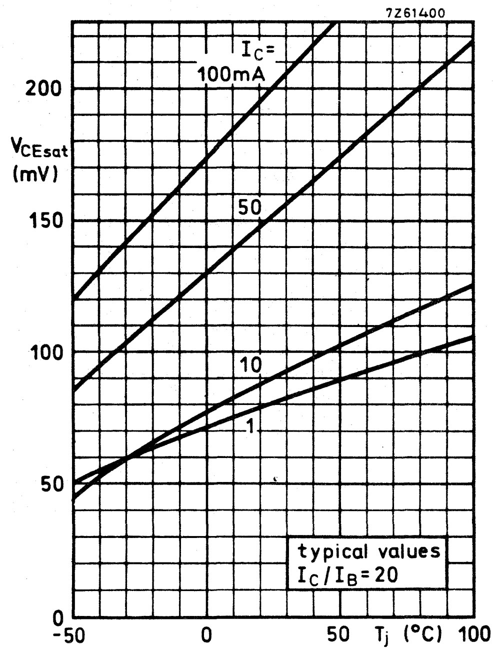
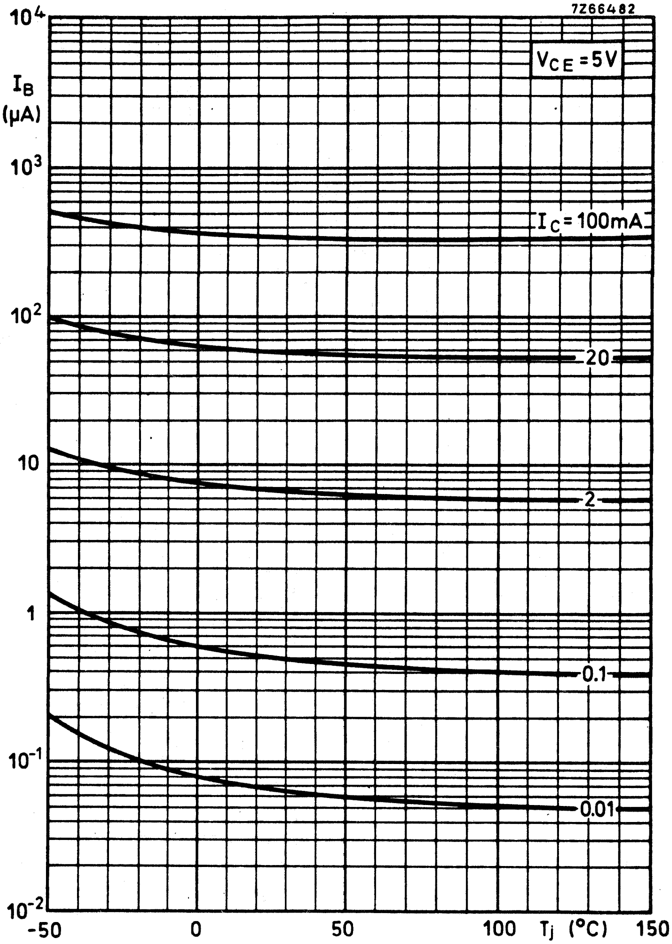


Fig. 6.



7Z66482
V_{CE} = 5V
I_B (μA)
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
I_C = 100mA
20
2
0.1
0.01
-50
0
50
100
T_j (°C)
150

Fig. 7.

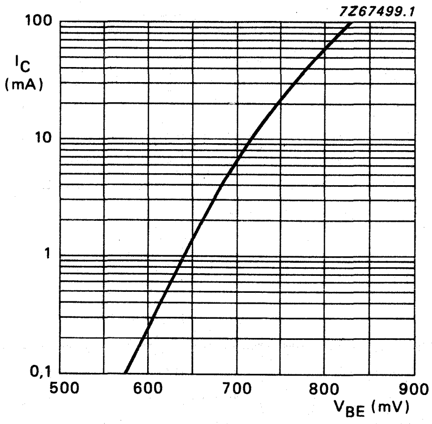


Fig. 8 V_{CE} = 5 V; T_j = 25 °C; typical values.

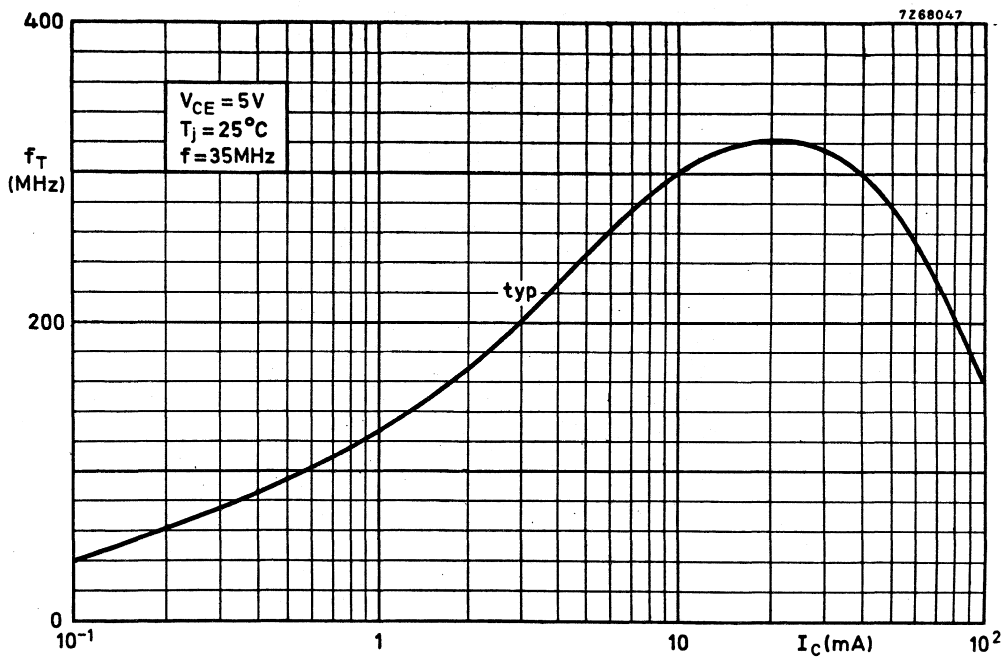


Fig. 9.

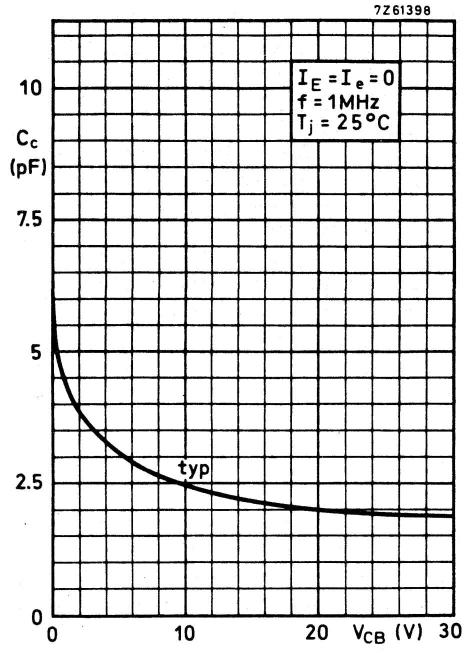

7Z61398
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c
(pF)
10
7.5
5
2.5
0
typ
0
10
20
V_{CB} (V)
30

Fig. 10.

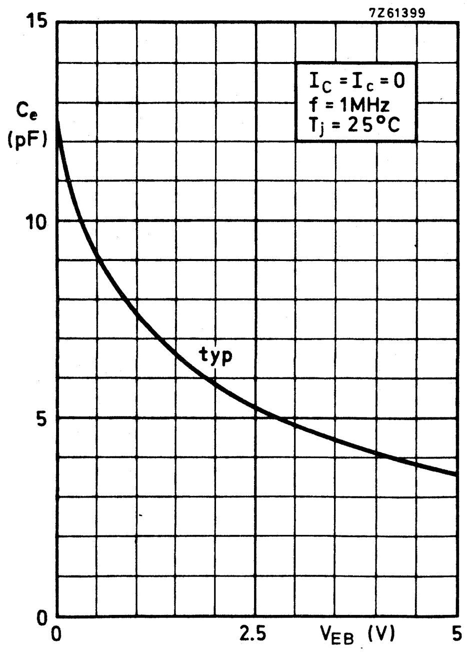

7Z61399
$I_C = I_c = 0$
f = 1MHz
T_j = 25°C
C_e
(pF)
15
10
5
0
typ
0
2.5
V_{EB} (V)
5

Fig. 11.

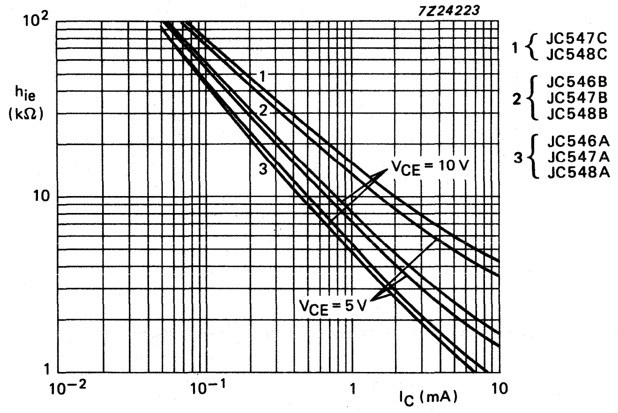

7Z24223
10^2
h_{ie}
(kΩ)
10
1
10^{-2}
10^{-1}
1
10
I_C (mA)
1
2
3
V_{CE} = 10 V
V_{CE} = 5 V
1 { JC547C JC548C
2 { JC546B JC547B JC548B
3 { JC546A JC547A JC548A

Fig. 12.

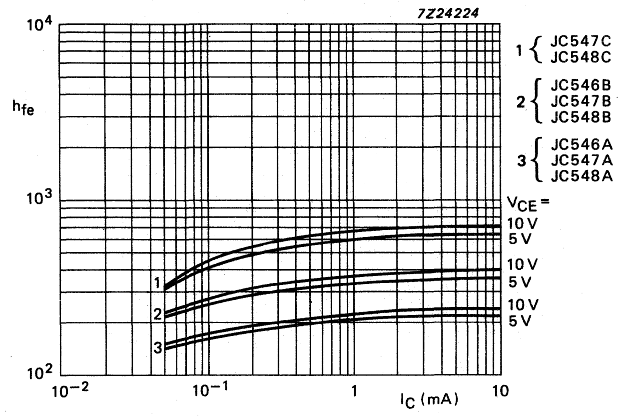

7Z24224
10^4
h_{fe}
10^3
10^2
10^{-2}
10^{-1}
1
10
I_C (mA)
1
2
3
V_{CE} =
10 V
5 V
10 V
5 V
10 V
5 V
1 { JC547C JC548C
2 { JC546B JC547B JC548B
3 { JC546A JC547A JC548A

Fig. 13.

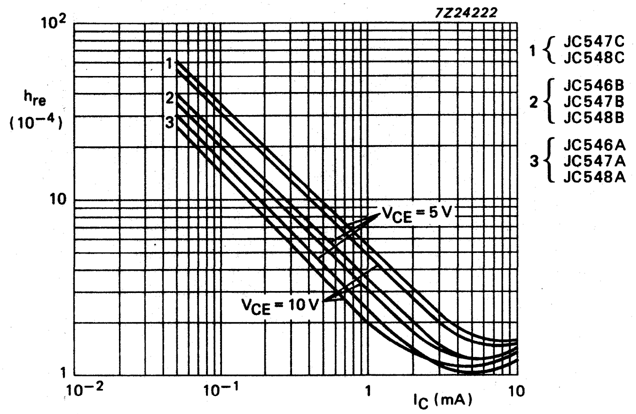

7Z24222
10^2
h_{re}
(10^{-4})
10
1
10^{-2}
10^{-1}
1
10
I_C (mA)
V_{CE} = 5 V
V_{CE} = 10 V
1
2
3
1 { JC547C JC548C
2 { JC546B JC547B JC548B
3 { JC546A JC547A JC548A

Fig. 14.

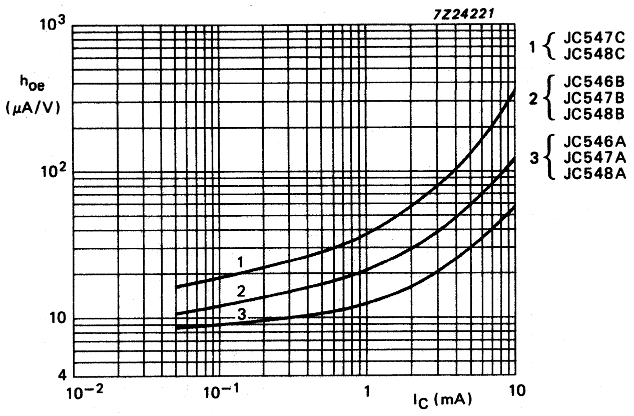

7Z24221
10^3
h_{oe}
(μA/V)
10^2
10
4
10^{-2}
10^{-1}
1
10
I_C (mA)
1
2
3
1 { JC547C JC548C
2 { JC546B JC547B JC548B
3 { JC546A JC547A JC548A

Fig. 15.

SILICON PLANAR EPITAXIAL TRANSISTORS

NPN transistors in plastic TO-92 variants, primarily intended for low-noise input stages in tape recorders, hi-fi amplifiers and other audio-frequency equipment.

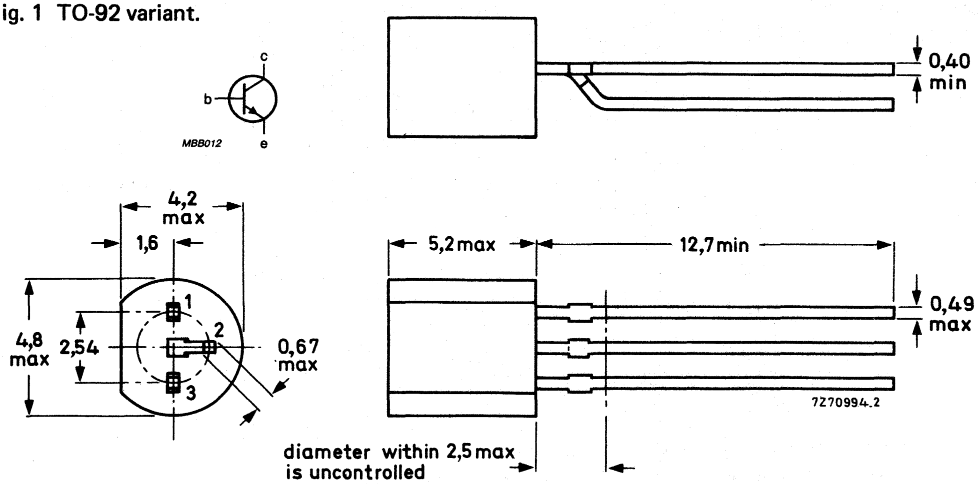
QUICK REFERENCE DATA

			JC549	JC550	
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} = 25 °C	P_{tot}	max.	500	500	mW
Junction temperature	T_j	max.	150	150	°C
DC current gain I_C = 2 mA; V_{CE} = 5 V	h_{FE}	min. max.	200 800	200 800	
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. max.	1.4 4	1.4 3	dB dB
f = 1 kHz; B = 200 Hz	F	typ.	1.2	1	dB
f = 10 Hz to 50 Hz (equivalent noise voltage)	V_n	min.	–	0.135	μV

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92 variant.



RATINGS

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

			JC549	JC550	
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 (DC)	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} = 25 °C	P_{tot}	max.	500	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.25	K/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.15	K/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; V_{CB} = 30 V	I_{CBO}	max.	15	nA
$I_E = 0$; V_{CB} = 30 V; T_j = 150 °C	I_{CBO}	max.	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}	max.	770	mV
Saturation voltages **				
I_C = 10 mA; I_B = 0,5 mA	V_{CEsat}	typ.	90	mV
		max.	250	mV
	V_{BEsat}	typ.	700	mV
I_C = 100 mA; I_B = 5 mA	V_{CEsat}	typ.	200	mV
		max.	600	mV
	V_{BEsat}	typ.	900	mV

* V_{BE} decreases by about 2 mV/K with increasing temperature.
** V_{BEsat} decreases by about 1.7 mV/K with increasing temperature.

Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	2.5 pF	
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0{,}5$ V	C_e	typ.	9 pF	
Transition frequency at f = 35 MHz				
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	300 MHz	
Small signal current gain at f = 1 kHz				
$I_C = 2$ mA; $V_{CE} = 5$ V	h_{fe}		125 – 900	

			JC549	JC550
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
		max.	4	3 dB
f = 1 kHz; B = 200 Hz	F	typ.	1.2	1 dB
		max.	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

			JC549B JC550B	JC549C JC550C
DC current gain				
$I_C = 10$ μA; $V_{CE} = 5$ V	h_{FE}	typ.	150	270
$I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	min.	200	420
		typ.	290	520
		max.	450	800

Note

For characteristics graphs, see BC549/550, Figs 2 to 19.

SILICON PLANAR EPITAXIAL TRANSISTORS

General purpose pnp transistors in plastic TO-92 envelopes, especially suitable for use in driver stages of audio amplifiers.

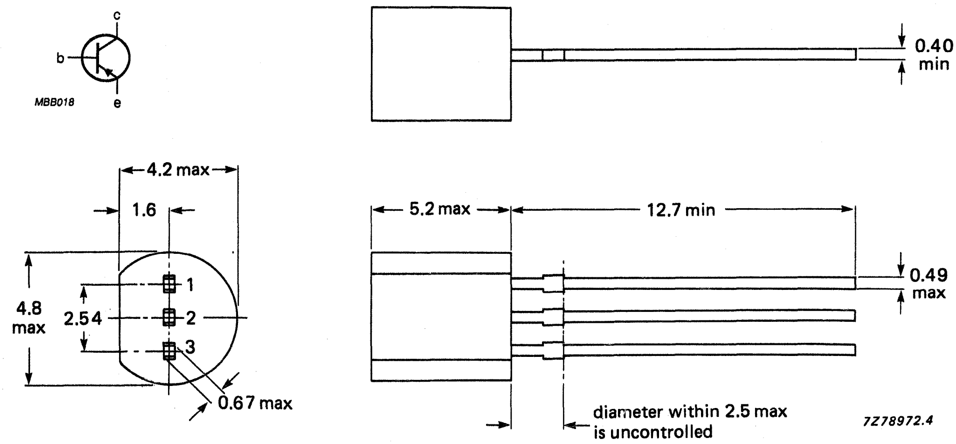
QUICK REFERENCE DATA

			JC556	JC557	JC558	
Collector-emitter voltage (+ V_{BE} = 0 V)	$-V_{CES}$	max.	80	50	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	65	45	30	V
DC current gain $-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	min. max.	75 475	75 800	75 800	
Collector current (peak value)	$-I_{CM}$	max.		200		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		500		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
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

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92



RATINGS

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

			JC556	JC557	JC558	
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.	5	5	5	V

Collector current (DC)	$-I_C$	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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	500	mW
Storage temperature range	T_{stg}		−65 to + 150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	250	K/W
From junction to case	$R_{th\ j-c}$	=	150	K/W

CHARACTERISTICS

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

Collector cut-off current				
$I_E = 0; -V_{CB} = 30\ V; T_j = 25\ ^oC$	$-I_{CBO}$	typ.	1	nA
		max.	15	nA
$T_j = 150\ ^oC$	$-I_{CBO}$	max.	4	μA
Base-emitter voltage (see note 1)				
$-I_C = 2\ mA; -V_{CE} = 5\ V$	$-V_{BE}$	typ.	650	mV
			600 to 750	mV
$-I_C = 10\ mA; -V_{CE} = 5\ V$	$-V_{BE}$	max.	820	mV
Saturation voltages (see note 2)				
$-I_C = 10\ mA; -I_B = 0.5\ mA$	$-V_{CEsat}$	typ.	60	mV
		max.	300	mV
	$-V_{BEsat}$	typ.	750	mV
$-I_C = 100\ mA; -I_B = 5\ mA$	$-V_{CEsat}$	typ.	180	mV
		max.	650	mV
	$-V_{BEsat}$	typ.	930	mV

Notes

1. $-V_{BE}$ decreases by about 2 mV/K with increasing temperature.
2. $-V_{BEsat}$ decreases by about 1.7 mV/K with increasing temperature.

Collector capacitance at f = 1 MHz $I_E = I_e = 0; -V_{CE} = 10$ V	C_c	typ.	4	pF
Transition frequency at f = 35 MHz $-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	200	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. max.	2 10	dB dB

			JC556	JC557 JC558	JC556A JC557A JC558A	JC556B JC557B JC558B	JC557C JC558C
DC current gain $-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	min.	75	75	125	220	420
		max.	475	800	250	475	800

Note

For characteristics graphs, see BC556 to 558, Figs 2 to 15.

SILICON PLANAR EPITAXIAL TRANSISTORS

PNP transistors in a plastic TO-92 variant, primarily intended for low-noise input stages in tape recorders, hi-fi amplifiers and other audio-frequency equipment.

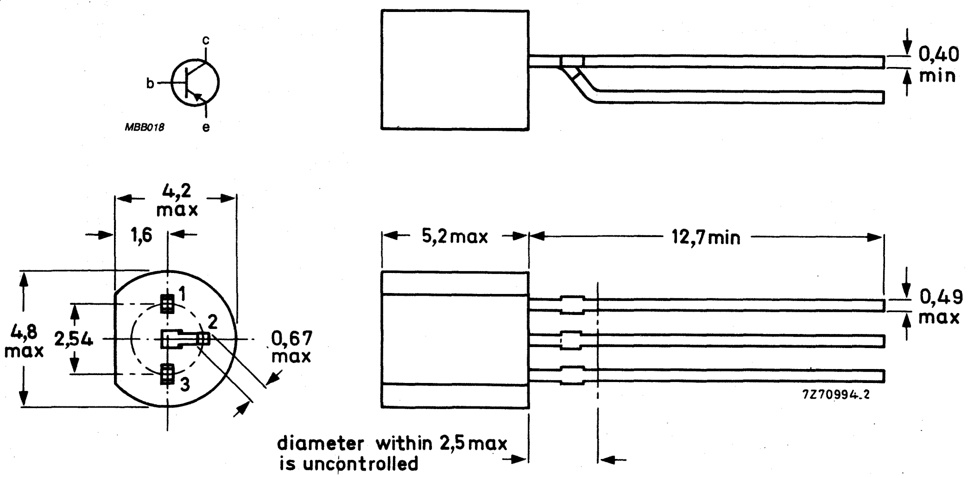
QUICK REFERENCE DATA

			JC559	JC560	
Collector-emitter voltage ($+V_{BE} = 0$ V)	$-V_{CES}$	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 $T_{amb} = 25$ °C	P_{tot}	max.	500	500	mW
Junction temperature	T_j	max.	150	150	°C
DC current gain $-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	min.	125	125	
		max.	800	800	
Transition frequency $-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	200	200	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	1	dB
		max.	4	3	dB
f = 1 kHz; B = 200 Hz	F	max.	4	4	dB
f = 10 kHz to 50 Hz (equivalent noise voltage)	V_N	max.	–	0.11	μV

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92 variant.



RATINGS

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

			JC559	JC560	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	50	V
Collector-emitter voltage ($+V_{BE} = 0$ V)	$-V_{CES}$	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 (DC)	$-I_C$	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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	500		mW
Storage temperature range	T_{stg}		−65 to +150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	250	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	150	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 30$ V; $T_j = 25\ ^oC$	$-I_{CBO}$	typ.	1	nA
		max.	15	nA
$T_j = 150\ ^oC$	$-I_{CBO}$	max.	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	$-V_{BE}$	max.	820	mV
Saturation voltages**				
$-I_C = 10$ mA; $-I_B = 0{,}5$ mA	$-V_{CEsat}$	typ.	60	mV
		max.	300	mV
	$-V_{BEsat}$	typ.	750	mV
$-I_C = 100$ mA; $-I_B = 5$ mA	$-V_{CEsat}$	typ.	180	mV
		max.	650	mV
	$-V_{BEsat}$	typ.	930	mV

* $-V_{BE}$ decreases by about 2 mV/K with increasing temperature.
** $-V_{BEsat}$ decreases by about 1.7 mV/K with increasing temperature.

Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	typ.		4	pF
Transition frequency at f = 35 MHz					
$-I_C = 10$ mA; $-V_{CE} = 5$ B	f_T	typ.		200	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			JC559	JC560	
f = 30 Hz to 15 kHz	F	typ.	1.2	1	dB
		max.	4	3	dB
f = 1 kHz; B = 200 Hz	F	typ.	1	1	dB
		max.	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.	–	0.11	μV

DC current gain			JC559 JC560	JC559A JC560A	JC559B JC560B	JC559C JC560C
$-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	min.	125	125	220	420
		max.	800	250	475	800

Note

For characteristics drawings, see BC559/560, Figs 2 to 18.

SILICON PLANAR EPITAXIAL TRANSISTOR

NPN transistor in a plastic TO-92 variant intended for HF applications in radio and television receivers; it is especially recommended for FM tuners, low noise AM mixer-oscillators with high source impedance and IF amplifiers in AM/FM receivers where a high current gain is of importance.

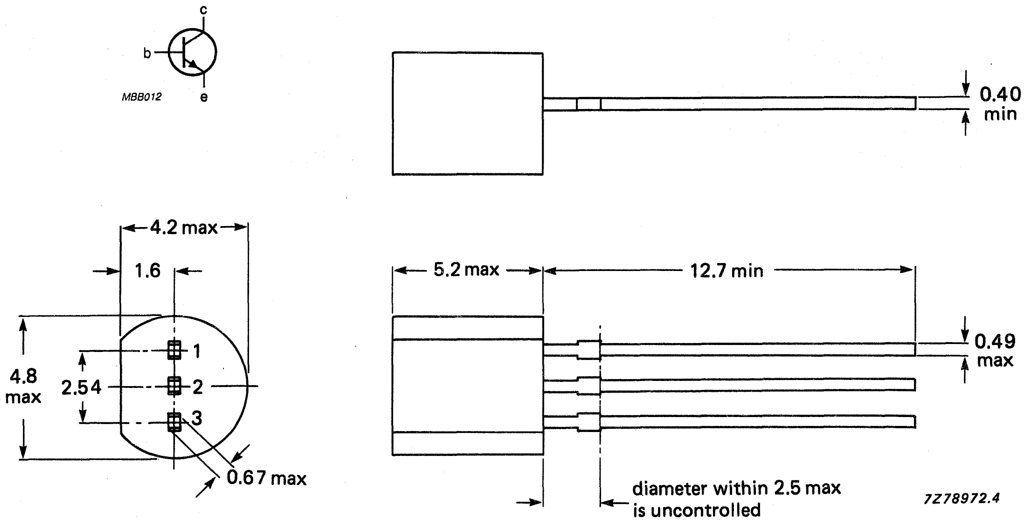
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	30 V
Collector-emitter voltage (open base)	V_{CEO}	max.	20 V
Collector current (DC)	I_C	max.	30 mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300 mW
Junction temperature	T_j	max.	150 °C
DC current gain at T_j = 25 °C I_C = 1 mA; V_{CE} = 10 V	h_{FE}		67 to 220
Transition frequency I_C = 1 mA; V_{CE} = 10 V	f_T	min. typ.	120 MHz 260 MHz

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-92.



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.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (DC)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	30	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Storage temperature range	T_{stg}		–65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	420	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Base-emitter voltage I_C = 1 mA; V_{CE} = 10 V		V_{BE}		0.65 to 0.74	V
DC current gain (see note 1) I_C = 1 mA; V_{CE} = 10 V	JF494	h_{FE}		67 to 220	
Feedback capacitance at f = 0.45 MHz I_C = 1 mA; V_{CE} = 10 V		C_{re}	max.	1	pF
Transition frequency I_C = 1 mA; V_{CE} = 10 V		f_T	min. typ.	120 260	MHz MHz
Collector cut-off current I_E = 0; V_{CB} = 20 V		I_{CBO}	max.	100	nA
I_E = 0; V_{CB} = 20 V; T_{amb} = 150 °C		I_{CBO}	max.	4	μA
Emitter-base cut-off current I_C = 0; V_{EB} = 4 V		I_{EBO}	max.	100	nA

Note

1. V_{BE} decreases by approximately 1.7 mV/K with increasing temperature.

y parameters at f = 100 MHz (common base)
I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)

Input conductance	g_{ib}	typ.	32 mS
Input susceptance	$-b_{ib}$	typ.	3 mS
Feedback admittance	$\|y_{rb}\|$	typ.	500 μS
Phase angle of feedback admittance	φ_{rb}	typ.	272°
Transfer admittance	$\|y_{fb}\|$	typ.	33 mS
Phase angle of transfer admittance	φ_{fb}	typ.	150°
Output conductance	g_{ob}	typ.	22 μS
Output susceptance	b_{ob}	typ.	1.1 mS

y-parameters (common emitter)
I_C = 1 mA; V_{CE} = 10 V (lead length = 3 mm)

		f = 10.7 MHz	f = 0.45 MHz
Input conductance	g_{ie}	< 0.64	0.54 mS
Output conductance	g_{oe}	< 13.5	11.5 μS

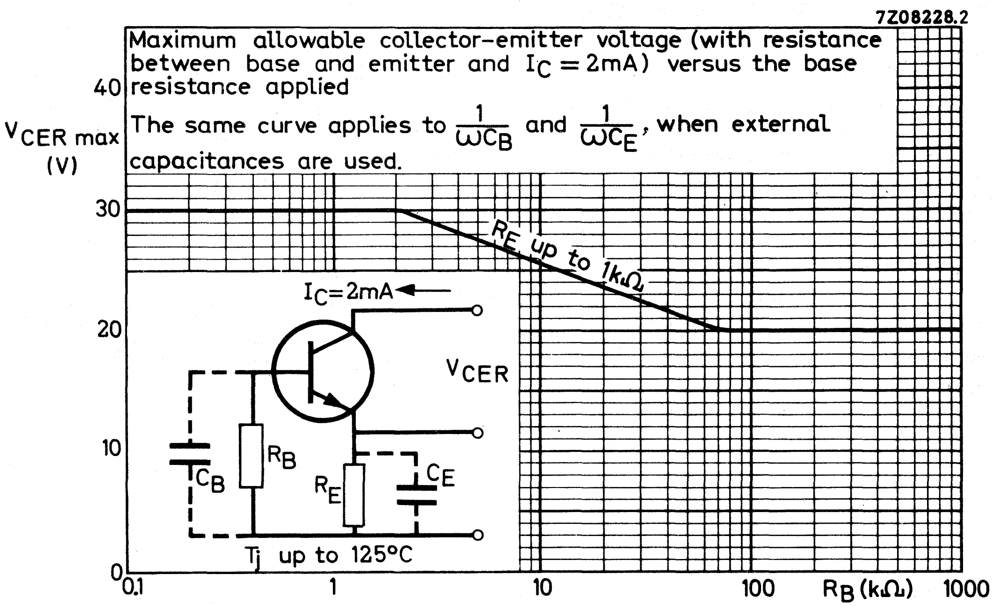

7Z08228.2
Maximum allowable collector-emitter voltage (with resistance between base and emitter and $I_C = 2mA$) versus the base resistance applied
The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$, when external capacitances are used.
$V_{CER\,max}$ (V)
40
30
20
10
0
0.1
1
10
100
1000
R_B (kΩ)
R_E up to 1kΩ
I_C=2mA
V_{CER}
C_B
R_B
R_E
C_E
T_j up to 125°C

Fig.2.

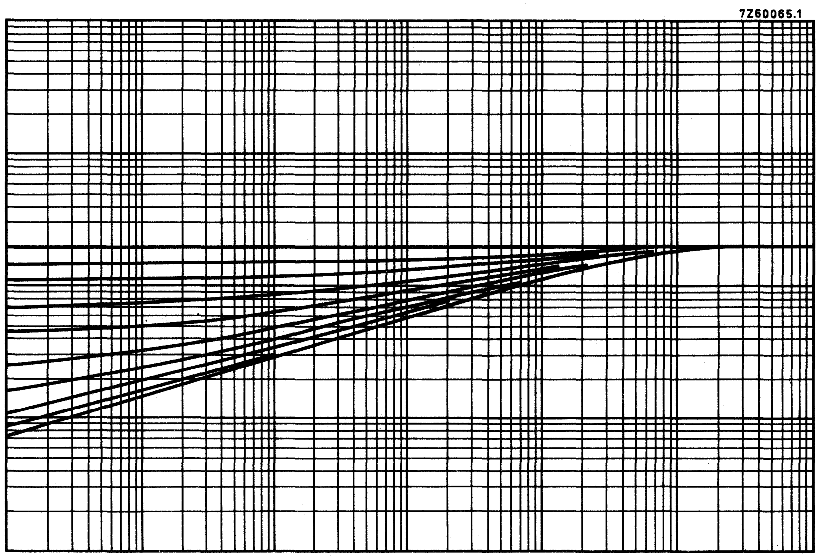

7Z60065.1

Fig.3.

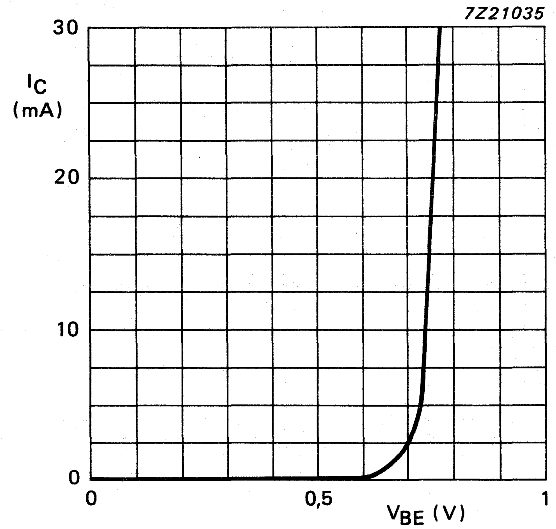


Fig.4 V_{CE} = 2 V; T_j = 25 °C; typical values.

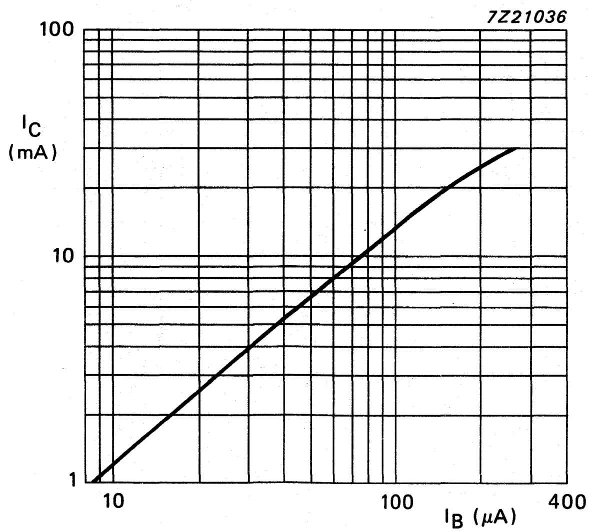


Fig.5 V_{CE} = 2 V; T_j = 25 °C; typical values.

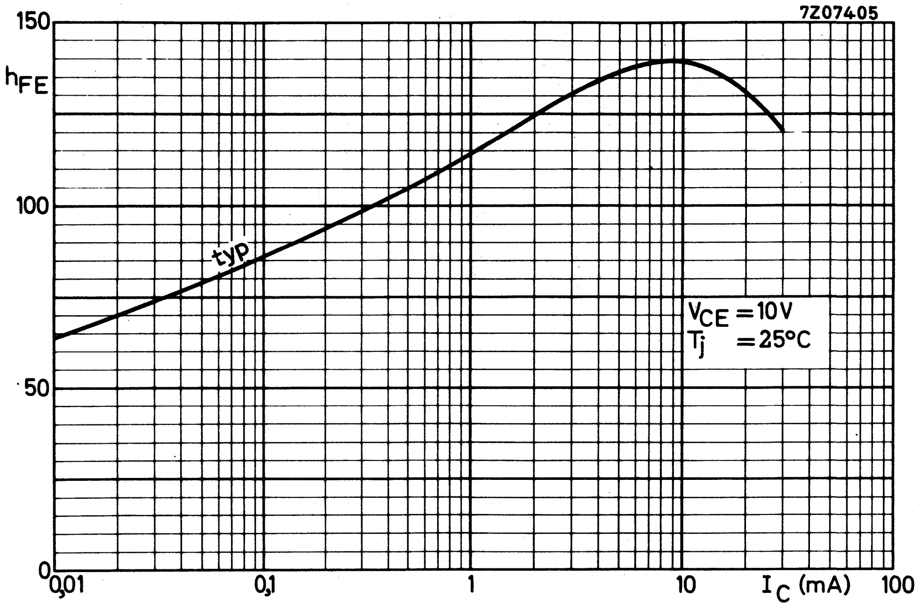

7Z07405
150
h_{FE}
100
typ
50
0
0,01
0,1
1
10
I_C (mA)
100
V_{CE} = 10V
T_j = 25°C

Fig.6.

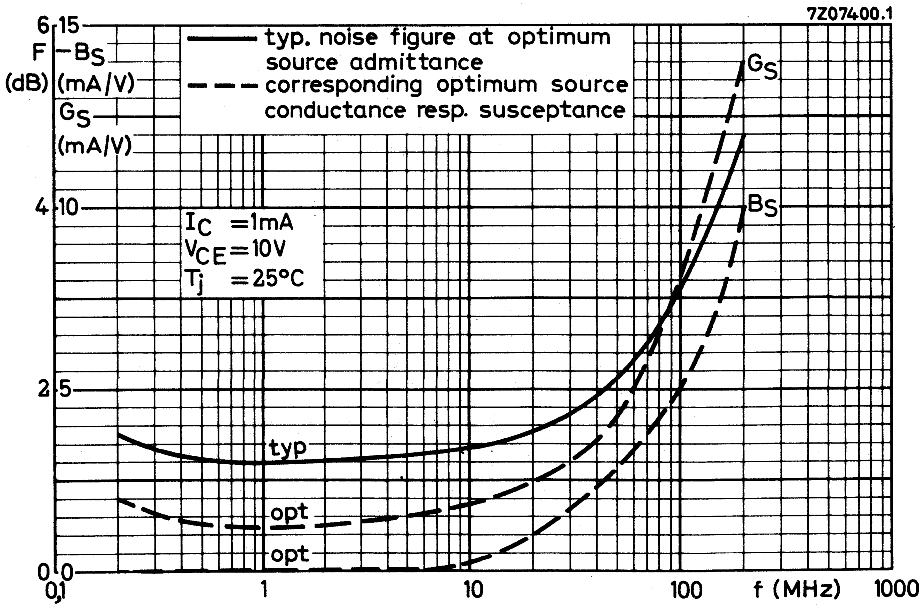

7Z07400.1
F
(dB)
$-B_S$
(mA/V)
G_S
(mA/V)
typ. noise figure at optimum source admittance
corresponding optimum source conductance resp. susceptance
I_C = 1mA
V_{CE} = 10V
T_j = 25°C
6
15
4
10
2
5
0
0
typ
opt
opt
G_S
B_S
0,1
1
10
100
f (MHz)
1000

Fig.7.

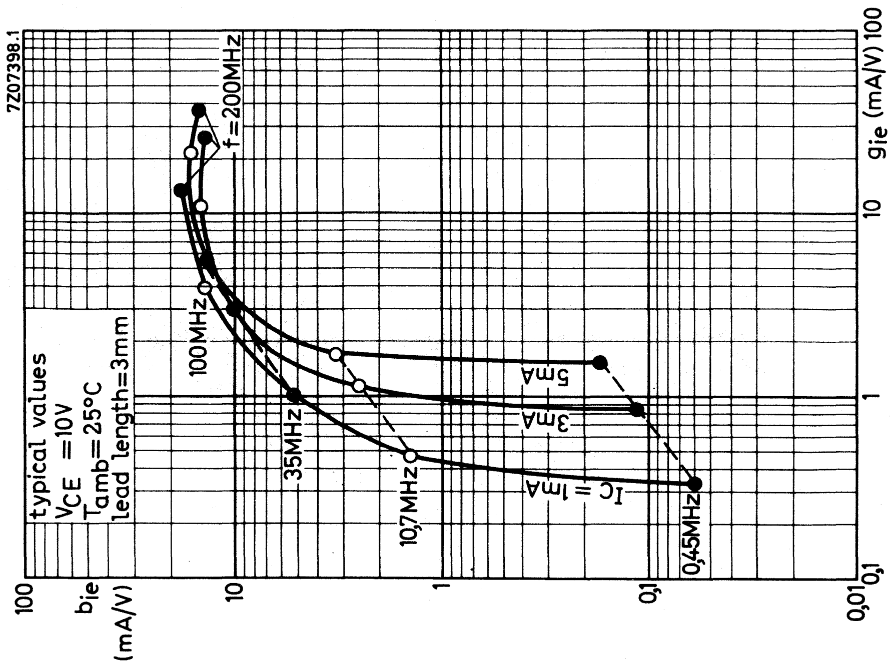

7Z07398.1
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 200MHz
100MHz
35MHz
10,7MHz
0,45MHz
I_C = 1mA
3mA
5mA
b_{ie} (mA/V)
g_{ie} (mA/V)
100
10
1
0,1
0,01
0,1
1
10
100

Fig.9.

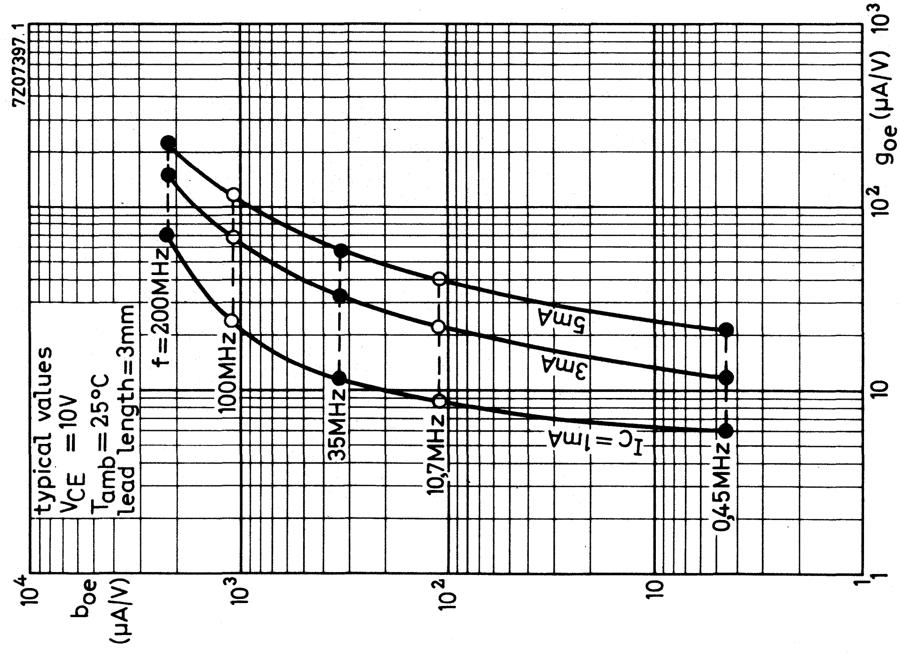
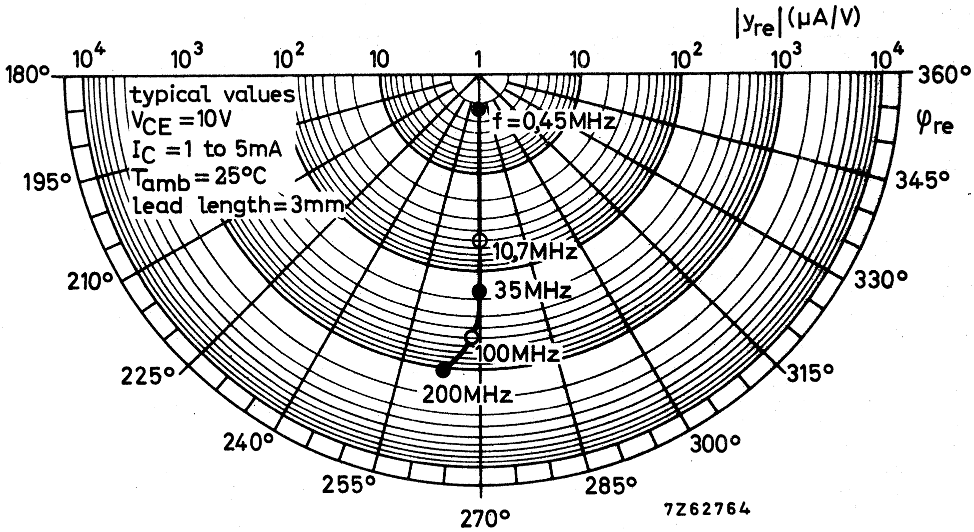
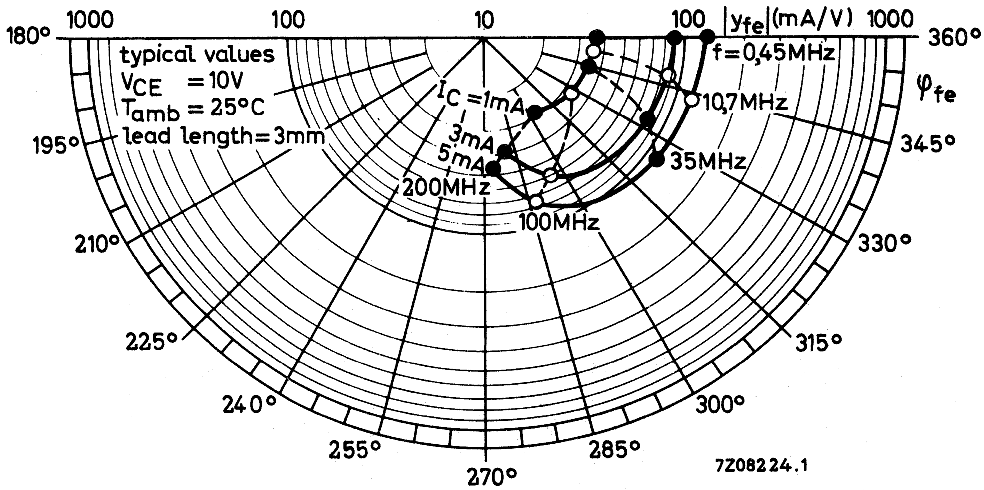

7Z07397.1
typical values
V_{CE} = 10V
T_{amb} = 25°C
lead length = 3mm
f = 200MHz
100MHz
35MHz
10,7MHz
0,45MHz
I_C = 1mA
3mA
5mA
b_{oe} (μA/V)
g_{oe} (μA/V)
10^4
10^3
10^2
10
1
1
10
10^2
10^3

Fig.8.



|y_re| (μA/V)
10^4 10^3 10^2 10 1 10 10^2 10^3 10^4
180° 195° 210° 225° 240° 255° 270° 285° 300° 315° 330° 345° 360°
φ_re
typical values
V_CE = 10V
I_C = 1 to 5mA
T_amb = 25°C
lead length = 3mm
f = 0,45MHz
10,7MHz
35MHz
100MHz
200MHz
7Z62764

Fig.10.



1000 100 10 100 |y_fe| (mA/V) 1000
180° 195° 210° 225° 240° 255° 270° 285° 300° 315° 330° 345° 360°
φ_fe
typical values
V_CE = 10V
T_amb = 25°C
lead length = 3mm
I_C = 1mA
3mA
5mA
f = 0,45MHz
10,7MHz
35MHz
100MHz
200MHz
7Z08224.1

Fig.11.

SILICON PLANAR EPITAXIAL TRANSISTORS

PNP silicon planar epitaxial transistors, each in a plastic TO-92 envelope.
They are intended for use in amplifier applications.

QUICK REFERENCE DATA

			MPS3702	MPS3703	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	30	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	50	V
Collector current (DC)	$-I_C$	max.	600		mA
Total power dissipation at $T_{amb} \leq 25\ ^oC$	P_{tot}	max.	625		mW
Collector-emitter saturation voltage $-I_C = 50$ mA; $-I_B = 5$ mA	$-V_{CEsat}$	max.	0.25		V
DC current gain $-I_C = 50$ mA; $-V_{CE} = 5$ V	h_{FE}	min.	60	30	
		max.	300	150	

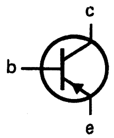
MECHANICAL DATA

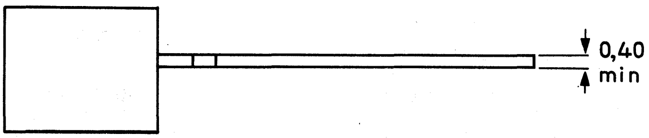
Dimensions in mm

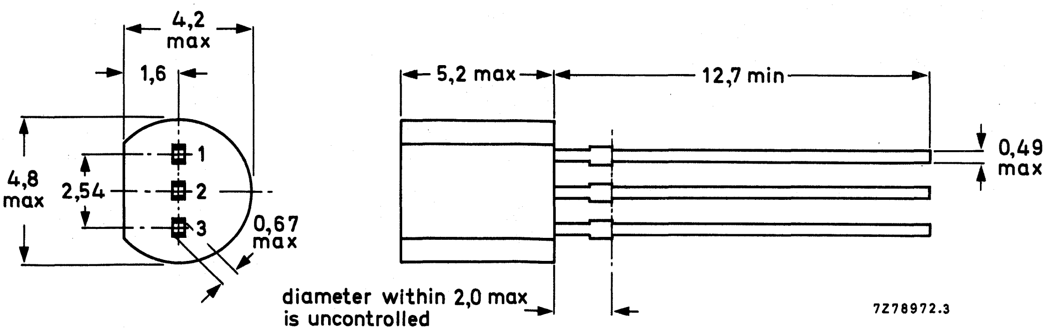
Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter







RATINGS

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

			MPS3702	MPS3703	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	30	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	50	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current (DC)	$-I_C$	max.	600		mA
Total power dissipation at $T_{amb} \leqslant 25\ ^oC$	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		–65 to + 150		^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

			MPS3702	MPS3703	
Collector-emitter breakdown voltage $I_B = 0; -I_C = 10$ mA	$-V_{(BR)CEO}$	min.	25	30	V
Collector-base breakdown voltage $-I_C = 100\ \mu A; I_E = 0$	$-V_{(BR)CBO}$	min.	40	50	V
Emitter-base breakdown voltage $-I_E = 100\ \mu A; I_C = 0$	$-V_{(BR)EBO}$	min.	5		V
Collector cut-off current $I_E = 0; -V_{CB} = 20$ V	$-I_{CBO}$	max.	100		nA
Emitter cut-off current $I_C = 0; -V_{EB} = 3$ V	$-I_{EBO}$	max.	100		nA
DC current gain $-I_C = 50$ mA; $-V_{CE} = 5$ V	h_{FE}	min.	60	30	
		max.	300	150	
Base-emitter on-state voltage $-I_C = 50$ mA; $-V_{CE} = 5$ V	$-V_{BE(on)}$	min.	0.6	–	V
		max.	–	0.1	V
Collector-emitter saturation voltage $-I_C = 50$ mA; $-I_B = 5$ mA	$-V_{CEsat}$	min.	0.25		V
Transition frequency at f = 100 MHz $-I_C = 50$ mA; $-V_{CE} = 5$ V	f_T	min.	100		MHz
Collector-base capacitance at f = 1 MHz $I_E = 0; -V_{CB} = 10$ V	C_{ob}	max.	12		pF

SILICON PLANAR EPITAXIAL TRANSISTORS

NPN silicon planar epitaxial transistors, each in a plastic TO-92 envelope.
They are intended for use in amplifier applications.

QUICK REFERENCE DATA

			MPS3704	05	06	
Collector-emitter voltage (open base)	V_{CEO}	max.	30	30	20	V
Collector-base voltage (open emitter)	V_{CBO}	max.	50	50	40	V
Collector current (DC)	I_C	max.		600		mA
Total power dissipation at $T_{amb} \leq 25\ ^oC$	P_{tot}	max.		625		mW
Collector-emitter saturation voltage $I_C = 100$ mA; $I_B = 5$ mA	V_{CEsat}	min.	0.6	0.8	1.0	V
DC current gain $I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	min.	100	50	30	
		max.	300	150	600	

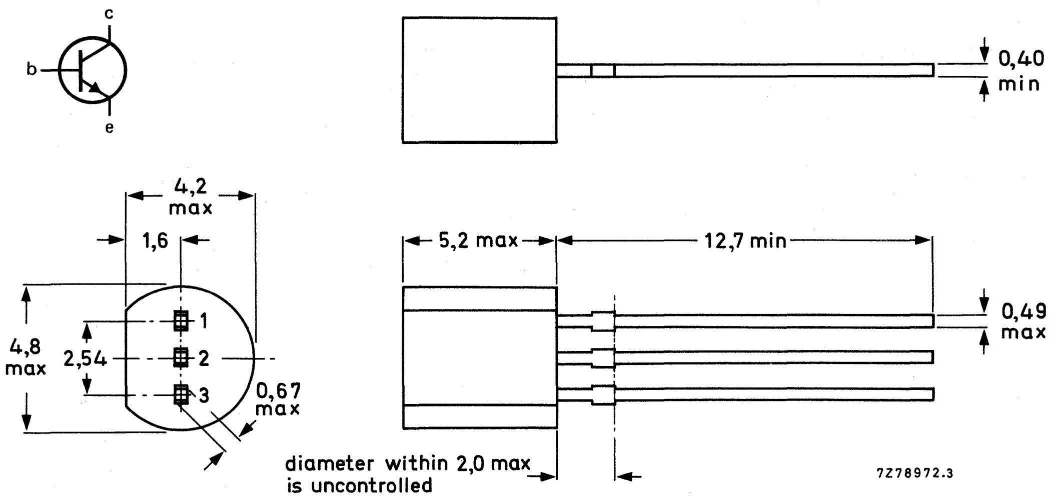
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



RATINGS

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

			MPS3704	05	06	
Collector-emitter voltage (open base)	V_{CEO}	max.	30	30	20	V
Collector-base voltage (open emitter)	V_{CBO}	max.	50	50	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.		5		V
Collector current (DC)	I_C	max.		600		mA
Total power dissipation at $T_{amb} \leq 25\ ^oC$	P_{tot}	max.		625		mW
Storage temperature range	T_{stg}			−65 to + 150		^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

			MPS3704	05	06	
Collector-emitter breakdown voltage $I_B = 0$; $I_C = 10$ mA	$V_{(BR)CEO}$	min.	30	30	20	V
Collector-base breakdown voltage $I_C = 100\ \mu A$; $I_E = 0$	$V_{(BR)CBO}$	min.	50	50	40	V
Emitter-base breakdown voltage $I_C = 0$; $I_E = 100\ \mu A$	$V_{(BR)EBO}$	min.		5		V
Collector cut-off current $I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	max.		100		nA
Emitter cut-off current $I_C = 0$; $V_{EB} = 3$ V	I_{EBO}	max.		100		nA
DC current gain $I_C = 50$ mA; $V_{CE} = 5$ V	h_{FE}	min. max.	100 300	50 150	30 600	
Collector-emitter saturation voltage $I_C = 100$ mA; $I_B = 5$ mA	V_{CEsat}	max.	0.6	0.8	1.0	V
Base-emitter on-state voltage $I_C = 100$ mA; $V_{CE} = 5$ V	$V_{BE(on)}$	min. max.		0.5 1.0		V V
Transition frequency at f = 100 MHz $I_C = 50$ mA; $V_{CE} = 5$ V	f_T	min.		100		MHz
Collector-base capacitance at f = 1 MHz $I_E = 0$; $V_{CB} = 10$ V	C_{ob}	max.		12		pF

SILICON PLANAR EPITAXIAL TRANSISTOR

NPN transistors in plastic TO-92 envelopes, primarily intended for general switching applications for industrial service.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	V
Collector current (DC)	I_C	max.	200	mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	625	mW
Junction temperature	T_j	max.	150	°C
DC current gain I_C = 10 mA; V_{CE} = 1 V	h_{FE}	min. max.	100 300	
Transition frequency at f = 100 MHz I_C = 10 mA; V_{CE} = 20 V	f_T	min.	180	MHz

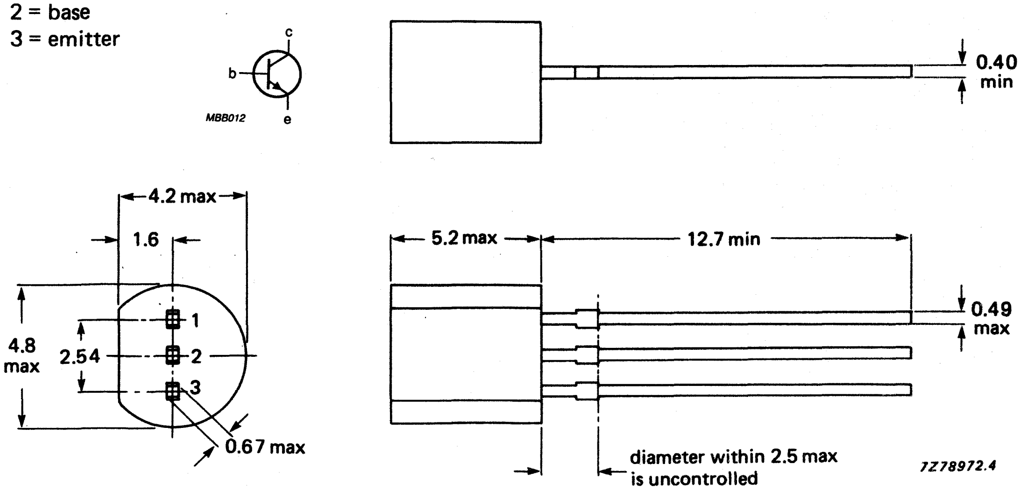
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



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 (DC)	I_C	max.	200	mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	625	mW
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_{amb} = 25 °C

Currents at reverse biased emitter junction				
V_{CE} = 30 V; $-V_{BE}$ = 3 V	I_{CEX}	max.	50	nA
	$-I_{BEX}$	max.	50	nA
Saturation voltages (see note 1)				
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	max.	200	mV
	V_{BEsat}		650 to 850	mV
I_C = 50 mA; I_B = 5 mA	V_{CEsat}	max.	300	mV
	V_{BEsat}	max.	950	mV
DC current gain (see note 1)				
I_C = 0.1 mA; V_{CE} = 1 V	h_{FE}	min.	40	
I_C = 1 mA; V_{CE} = 1 V	h_{FE}	min.	70	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	min.	100	
		max.	300	
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	min.	60	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	min.	30	
Collector capacitance at 100 kHz $\leqslant f \leqslant$ 1 MHz				
$I_E = I_e = 0$; V_{CB} = 5 V	C_c	max.	5	pF
Emitter capacitance at 100 kHz $\leqslant f \leqslant$ 1 MHz				
$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	max.	15	pF
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 20 V	f_T	min.	180	MHz
Noise figure at R_S = 1 kΩ				
I_C = 100 μA; V_{CE} = 5 V				
f = 10 Hz to 15.7 kHz	F	max.	5	dB

Note

1. Measured under pulse conditions: t_p = 300 μs; δ = 0.02.

SWITCHING CHARACTERISTICS

Delay time V_{CC} = 3.0 V DC, $V_{BE(off)}$ = 0.5 V DC I_C = 10 mA DC, I_{B1} = 1 mA DC	t_d	max.	45	ns
Rise time V_{CC} = 3.0 V DC, $V_{BE(off)}$ = 0.5 V DC I_C = 10 mA DC, I_{B1} = 1 mA DC	t_r	max.	55	ns
Storage time V_{CC} = 3.0 V DC, I_C = 10 mA DC I_{B1} = I_{B2} = 1 mA DC	t_{stg}	max.	900	ns
Fall time V_{CC} = 3.0 V DC, I_C = 10 mA DC I_{B1} = I_{B2} = 1 mA DC	t_f	max.	90	ns

SILICON PLANAR EPITAXIAL TRANSISTOR

PNP transistors in plastic TO-92 envelopes, primarily intended for general switching applications for industrial service.

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 (DC)	$-I_C$	max.	200	mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	625	mW
Junction temperature	T_j	max.	150	°C
DC current gain $-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	min. max.	100 300	
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 20 V	f_T	min.	150	MHz

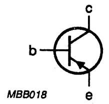
MECHANICAL DATA

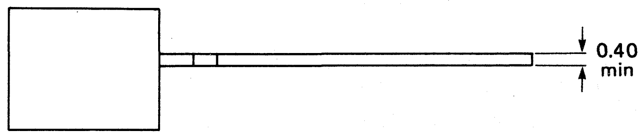
Dimensions in mm

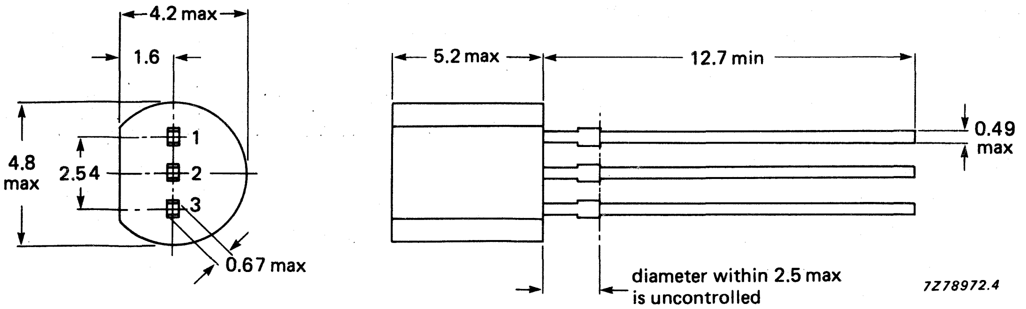
Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter







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 (DC)	$-I_C$	max.	200	mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	625	mW
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_{amb} = 25 °C

Currents at reverse biased emitter junction				
$-V_{CE}$ = 30 V; $+V_{BE}$ = 3 V	$-I_{CEX}$	max.	50	nA
	$+I_{BEX}$	max.	50	nA
Saturation voltages (see note 1)				
$-I_C$ = 10 mA; $-I_B$ = 1 mA	$-V_{CEsat}$	max.	250	mV
	$-V_{BEsat}$		650 to 850	mV
$-I_C$ = 50 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	max.	400	mV
	$-V_{BEsat}$	max.	950	mV
DC current gain (see note 1)				
$-I_C$ = 0.1 mA; V_{CE} = 1 V	h_{FE}	min.	60	
$-I_C$ = 1 mA; V_{CE} = 1 V	h_{FE}	min.	80	
$-I_C$ = 10 mA; V_{CE} = 1 V	h_{FE}	min.	100	
		max.	300	
$-I_C$ = 50 mA; V_{CE} = 1 V	h_{FE}	min.	60	
$-I_C$ = 100 mA; V_{CE} = 1 V	h_{FE}	min.	30	
Collector capacitance at 100 kHz ⩽ f ⩽ 1 MHz				
$I_E = I_e = 0$; $-V_{CB}$ = 5 V	C_c	max.	5	pF
Emitter capacitance at 100 kHz ⩽ f ⩽ 1 MHz				
$I_C = I_c = 0$; $-V_{EB}$ = 0.5 V	C_e	max.	15	pF
Transition frequency at f = 100 MHz				
$-I_C$ = 10 mA; $-V_{CE}$ = 20 V	f_T	min.	150	MHz
Noise figure at R_S = 1 kΩ				
$-I_C$ = 100 μA; $-V_{CE}$ = 5 V				
f = 10 Hz to 15.7 kHz	F	max.	4	dB

Note

1. Measured under pulse conditions: t_p = 300 μs; δ = 0.02.

SWITCHING CHARACTERISTICS

Delay time				
V_{CC} = 3.0 V DC, V_{BE}(off) = 0.5 V DC				
I_C = 10 mA DC, I_{B1} = 1 mA DC	t_d	max.	45	ns
Rise time				
V_{CC} = 3.0 V DC, V_{BE}(off) = 0.5 V DC				
I_C = 10 mA DC, I_{B1} = 1 mA DC	t_r	max.	55	ns
Storage time				
V_{CC} = 3.0 V DC, I_C = 10 mA DC				
I_{B1} = I_{B2} = 1 mA DC	t_{stg}	max.	600	ns
Fall time				
V_{CC} = 3.0 V DC, I_C = 10 mA DC				
I_{B1} = I_{B2} = 1 mA DC	t_f	max.	90	ns

AMPLIFIER TRANSISTOR

General purpose n-p-n transistors in TO-92 envelopes. The complementary types are MPS6517 to MPS6519.

QUICK REFERENCE DATA

			MPS6513	6514	6515	
Collector-emitter voltage	V_{CEO}	max.	30	25	25	V
Collector current (d.c.)	I_C	max.	100	100	100	mA
D.C. current gain I_C = 100 mA; V_{CE} = 10 V	h_{FE}	>	60	90	150	
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		625		mW

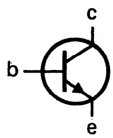
MECHANICAL DATA

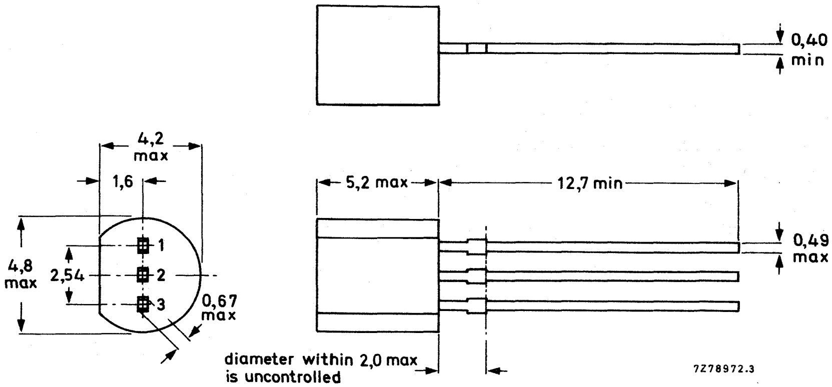
Dimensions in mm

Fig. 1 TO-92.

Pinning;

1 = collector
2 = base
3 = emitter





RATINGS

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

			MPS6513	6514	6515	
Collector-emitter voltage	V_{CEO}	max.	30	25	25	V
Collector-base voltage	V_{CBO}	max.		40		V
Emitter-base voltage	V_{EBO}	max.		4,0		V
Collector current (d.c.)	I_C	max.		100		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		625		mW
Storage temperature range	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MPS6513	6514	6515	
Collector-emitter breakdown voltage I_C = 0,5 mA; I_B = 0	$V_{(BR)CEO}$	>	30	25	25	V
Emitter-base breakdown voltage I_E = 10 μA; I_C = 0	$V_{(BR)EBO}$	>	4,0	4,0	4,0	V
Collector cut-off current V_{CB} = 30 V; I_E = 0	I_{CBO}	<	50	50	50	nA
D.C. current gain I_C = 2 mA; V_{CE} = 10 V	h_{FE}	=	90 to 180	150 to 300	250 to 500	
I_C = 100 mA; V_{CE} = 10 V	h_{FE}	>	60	90	150	
Collector-emitter saturation voltage I_C = 50 mA; I_B = 5 mA	V_{CEsat}	<		0,5		V
Output capacitance V_{CB} = 10 V; I_E = 0; f = 100 kHz	C_{obo}	<		3,5		pF

AMPLIFIER TRANSISTOR

General purpose p-n-p transistors in TO-92 envelopes. The complementary types are MPS6513 to MPS6515.

QUICK REFERENCE DATA

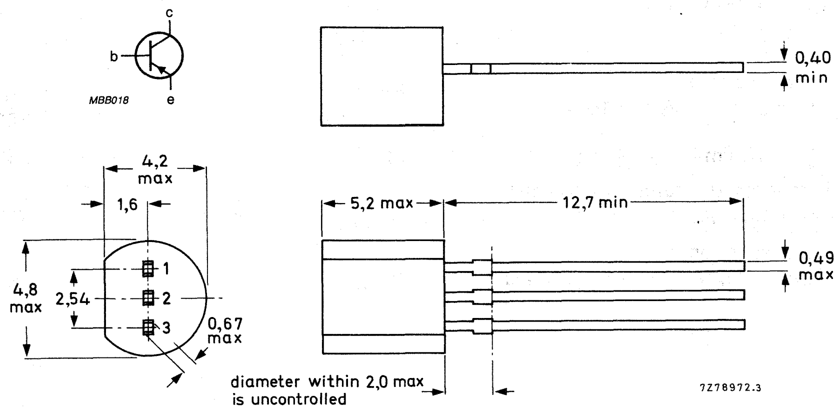
			MPS6517	6518	6519	
Collector-emitter voltage	$-V_{CEO}$	max.	40	40	25	V
Collector current (d.c.)	$-I_C$	max.	100	100	100	mA
D.C. current gain $-I_C$ = 100 mA; $-V_{CE}$ = 10 V	h_{FE}	>	60	90	150	
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		625		mW

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning;
1 = collector
2 = base
3 = emitter



RATINGS

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

			MPS6517	6518	6519	
Collector-emitter voltage	$-V_{CEO}$	max.	40	40	25	V
Collector-base voltage	$-V_{CBO}$	max.	40	40	25	V
Emitter-base voltage	$-V_{EBO}$	max.		4,0		V
Collector current (d.c.)	$-I_C$	max.		100		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		625		mW
Storage temperature range	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MPS6517	6518	6519	
Collector-emitter breakdown voltage $-I_C$ = 0,5 mA; I_B = 0	$-V_{(BR)CEO}$	>	40	40	25	V
Emitter-base breakdown voltage $-I_E$ = 10 μA; I_C = 0	$-V_{(BR)EBO}$	>	4,0	4,0	4,0	V
Collector cut-off current $-V_{CB}$ = 30 V; I_E = 0	$-I_{CBO}$	<	50	50	–	nA
$-V_{CB}$ = 20 V; I_E = 0	$-I_{CBO}$	<	–	–	50	nA
D.C. current gain $-I_C$ = 2 mA; $-V_{CE}$ = 10 V	h_{FE}	=	90 to 180	150 to 300	250 to 500	
$-I_C$ = 100 mA; $-V_{CE}$ = 10 V	h_{FE}	>	60	90	150	
Collector-emitter saturation voltage $-I_C$ = 50 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	<		0,5		V
Output capacitance $-V_{CB}$ = 10 V; I_E = 0; f = 100 kHz	C_{obo}	<		3,5		pF

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N small-signal transistors in plastic TO-92 envelope intended for low-noise applications in audio equipment.

Complementary types are MPS6522 and MPS6523.

QUICK REFERENCE DATA

Collector-emitter voltage (open base)	V_{CEO}	max.	25		V
Collector-base voltage (open emitter)	V_{CBO}	max.	40		V
Collector current (d.c.)	I_C	max.	100		mA
Total device dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Collector-emitter saturation voltage I_C = 50 mA; I_B = 5 mA	V_{CEsat}	max.	0,5		V
			MPS6520	MPS6521	
D.C. current gain I_C = 100 μA; V_{CE} = 10 V	h_{FE}	min.	100	150	
I_C = 2 mA; V_{CE} = 10 V	h_{FE}	min.	200	300	
		max.	400	600	

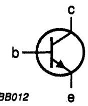
MECHANICAL DATA

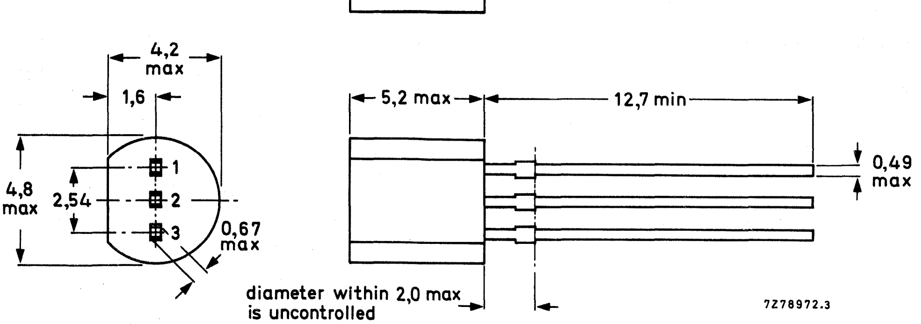
Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter





RATINGS

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

Collector-emitter voltage (open base)	V_{CEO}	max.	25	V
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4,0	V
Collector current (d.c.)	I_C	max.	100	mA
Total device dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	mW
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector-emitter breakdown voltage $I_B = 0$; I_C = 0,5 mA	$V_{(BR)CEO}$	min.	25	V
Emitter-base breakdown voltage I_E = 10 μA; $I_C = 0$	$V_{(BR)EBO}$	min.	4,0	V
Collector cut-off current V_{CB} = 30 V; $I_E = 0$	I_{CBO}	max.	50	nA
Collector-emitter saturation voltage I_C = 50 mA; I_B = 5 mA	V_{CEsat}	max.	0,5	V
Output capacitance at f = 100 kHz V_{CB} = 10 V; $I_E = 0$	C_o	max.	3,5	pF
Noise figure at T_{amb} = 25 °C I_C = 10 μA; V_{CE} = 5 V; R_S = 10 kΩ; f = 10 Hz to 10 kHz	F	max.	3,0	dB

			MPS6520	MPS6521
D.C. current gain I_C = 100 μA; V_{CE} = 10 V	h_{FE}	min.	100	150
I_C = 2 mA; V_{CE} = 10 V	h_{FE}	min.	200	300
		max.	400	600

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P small-signal transistors in plastic TO-92 envelope intended for low-noise applications in audio equipment.

Complementary types are MPS6520 and MPS6521.

QUICK REFERENCE DATA

Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25		V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25		V
Collector current (d.c.)	$-I_C$	max.	100		mA
Total device dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Collector-emitter saturation voltage $-I_C$ = 50 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	max.	0,5		V
			MPS6522	MPS6523	
D.C. current gain $-I_C$ = 100 μA; $-V_{CE}$ = 10 V	h_{FE}	min.	100	150	
$-I_C$ = 2 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	200	300	
		max.	400	600	

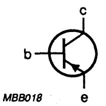
MECHANICAL DATA

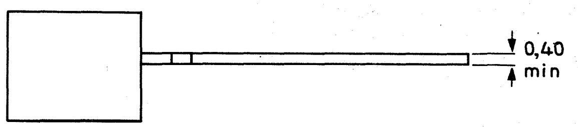
Dimensions in mm

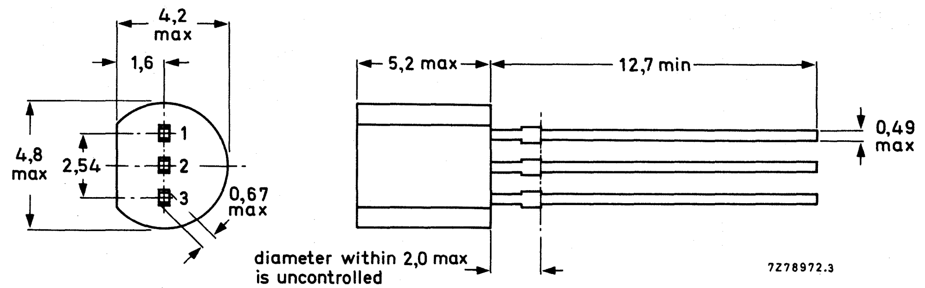
Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter







RATINGS

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

Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	4,0	V
Collector current (d.c.)	$-I_C$	max.	100	mA
Total device dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	mW
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector-emitter breakdown voltage $I_B = 0$; $-I_C = 0{,}5$ mA	$-V_{(BR)CEO}$	min.	25	V
Emitter-base breakdown voltage $-I_E = 10\ \mu A$; $I_C = 0$	$-V_{(BR)EBO}$	min.	4,0	V
Collector cut-off current $-V_{CB} = 30$ V; $I_E = 0$	$-I_{CBO}$	max.	50	nA
Collector-emitter saturation voltage $-I_C = 50$ mA; $-I_B = 5$ mA	$-V_{CEsat}$	max.	0,5	V
Output capacitance at f = 100 kHz $-V_{CB} = 10$ V; $I_E = 0$	C_o	max.	3,5	pF
Noise figure at T_{amb} = 25 °C $-I_C = 10\ \mu A$; $-V_{CE} = 5$ V; $R_S = 10\ k\Omega$; f = 10 Hz to 10 kHz	F	max.	3,0	dB

			MPS6522	MPS6523
D.C. current gain $-I_C = 100\ \mu A$; $-V_{CE} = 10$ V	h_{FE}	min.	100	150
$-I_C = 2$ mA; $-V_{CE} = 10$ V	h_{FE}	min.	200	300
		max.	400	600

SILICON PLANAR EPITAXIAL TRANSISTORS

NPN silicon planar epitaxial small-signal transistors, each in a plastic TO-92 envelope.

They are intended for amplifier applications.

PNP complementary types are MPS6534 and MPS6535.

QUICK REFERENCE DATA

			MPS6531	MPS6532	
Collector-emitter voltage (open base)	V_{CEO}	max.	40	30	V
Collector-base voltage (open emitter)	V_{CBO}	max.	60	50	V
DC collector current	I_C	max.	600		mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Collector-emitter saturation voltage I_C = 100 mA; I_B = 10 mA	V_{CEsat}	max.	0.3	0.5	V
DC current gain I_C = 100 mA; V_{CE} = 1 V	h_{FE}	min.	90	30	
		max.	270	—	

MECHANICAL DATA

Dimensions in mm

Pinning

1 = collector
2 = base
3 = emitter

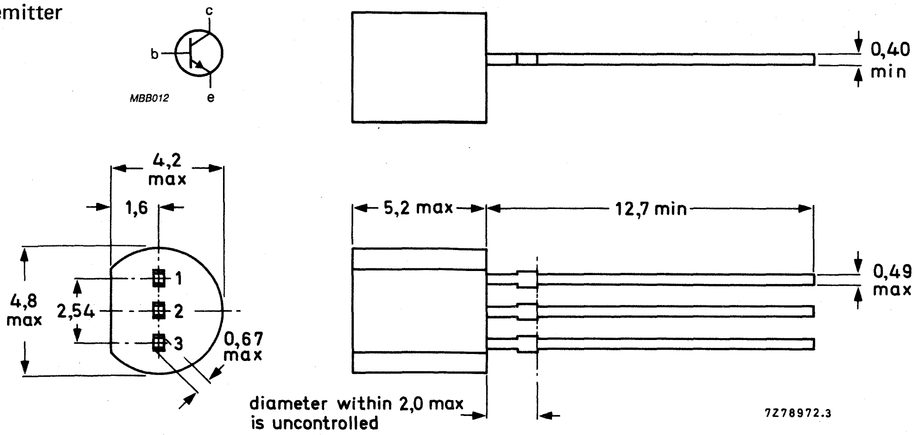


Fig. 1 TO-92.

RATINGS

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

			MPS6531	MPS6532	
Collector-emitter voltage (open base)	V_{CEO}	max.	40	30	V
Collector-base voltage (open emitter)	V_{CBO}	max.	60	50	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5.0		V
DC collector current	I_C	max.	600		mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	=	200		K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MPS6531	MPS6532	
Collector-emitter breakdown voltage					
$I_B = 0$; I_C = 10 mA	$V_{(BR)CEO}$	min.	40	30	V
Collector-base breakdown voltage					
$I_E = 0$; I_C = 10 μA	$V_{(BR)CBO}$	min.	60	50	V
Collector cut-off currents					
$I_E = 0$; V_{CB} = 40 V	I_{CBO}	max.	50	–	nA
$I_E = 0$; V_{CB} = 30 V	I_{CBO}	max.	–	100	nA
$I_E = 0$; V_{CB} = 40 V; T_{amb} = 60 °C	I_{CBO}	max.	2	–	μA
$I_E = 0$; V_{CB} = 30 V; T_{amb} = 60 °C	I_{CBO}	max.	–	5	μA
DC current gain					
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	min.	60	–	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	min.	90	30	
		max.	270	–	
I_C = 500 mA; V_{CE} = 10 V	h_{FE}	min.	50	–	
Collector-emitter saturation voltage					
I_C = 100 mA; I_B = 10 mA	V_{CEsat}	max.	0.3	0.5	V
Base-emitter saturation voltage					
I_C = 100 mA; I_B = 10 mA	V_{BEsat}	max.	1.0	1.2	V
Collector-base capacitance					
$I_E = 0$; V_{CB} = 10 V; f = 1 MHz	C_{ob}	max.	5	5	pF

SILICON PLANAR EPITAXIAL TRANSISTORS

PNP silicon planar epitaxial small-signal transistors, each in a plastic TO-92 envelope.
They are intended for amplifier applications.
NPN complementary types are MPS6531 and MPS6532.

QUICK REFERENCE DATA

			MPS6534	MPS6535	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	30	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	30	V
DC collector current	$-I_C$	max.	600		mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Collector-emitter saturation voltage $-I_C$ = 100 mA; $-I_B$ = 10 mA	$-V_{CEsat}$	max.	0.3	0.5	V
DC current gain $-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}	min.	90	30	
		max.	270	—	

MECHANICAL DATA

Dimensions in mm

Pinning

1 = collector
2 = base
3 = emitter

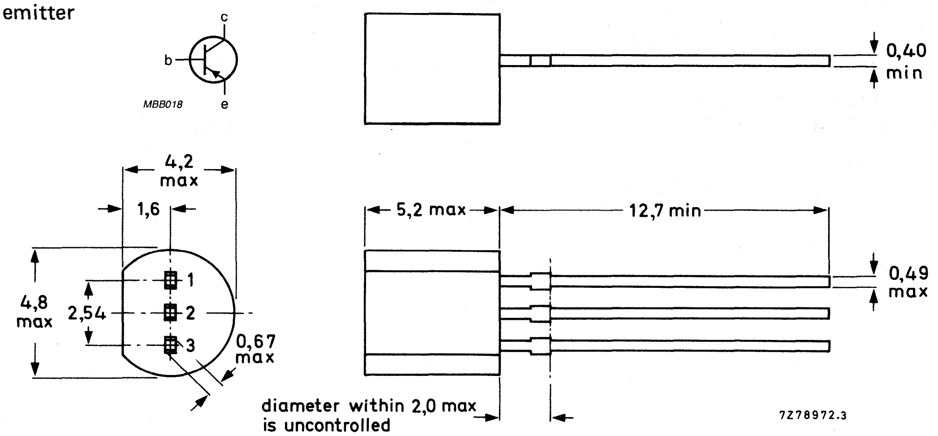


Fig. 1 TO-92.

RATINGS

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

			MPS6534	MPS6535	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	30	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	30	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5.0		V
DC collector current	$-I_C$	max.	600		mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	=	200		K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MPS6534	MPS6535	
Collector-emitter breakdown voltage $-I_B = 0$; $-I_C$ = 10 mA	$-V_{(BR)CEO}$	min.	40	30	V
Collector-base breakdown voltage $-I_E = 0$; $-I_C$ = 10 μA	$-V_{(BR)CBO}$	min.	40	30	V
Collector cut-off currents $-I_E = 0$; $-V_{CB}$ = 30 V	$-I_{CBO}$	max.	50	50	nA
$-I_E = 0$; $-V_{CB}$ = 30 V; T_{amb} = 60 °C	$-I_{CBO}$	max.	2	—	μA
$-I_E = 0$; $-V_{CB}$ = 20 V; T_{amb} = 60 °C	$-I_{CBO}$	max.	—	5	μA
DC current gain $-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	min.	60	—	
$-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}	min.	90	30	
		max.	270	—	
$-I_C$ = 500 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	50	—	
Collector-emitter saturation voltage $-I_C$ = 100 mA; $-I_B$ = 10 mA	$-V_{CEsat}$	max.	0.3	0.5	V
Base-emitter saturation voltage $-I_C$ = 100 mA; $-I_B$ = 10 mA	$-V_{BEsat}$	max.	1.0	1.2	V
Collector-base capacitance $-I_E = 0$; $-V_{CB}$ = 10 V; f = 1 MHz	C_{ob}	max.	5	5	pF

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon planar epitaxial transistors in plastic TO-92 envelope for general purpose applications.

QUICK REFERENCE DATA

			MPSA05	MPSA06	
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	V
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	V
Collector current (d.c.)	I_C	max.	500		mA
Total device dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Collector-emitter saturation voltage I_C = 100 mA; I_B = 10 mA	V_{CEsat}	max.	0,25		V
D.C. current gain I_C = 10 mA; V_{CE} = 1,0 V	h_{FE}	min.	50		

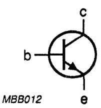
MECHANICAL DATA

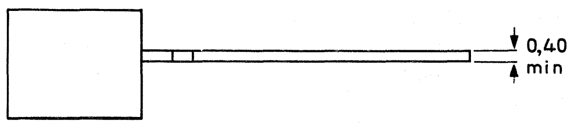
Dimensions in mm

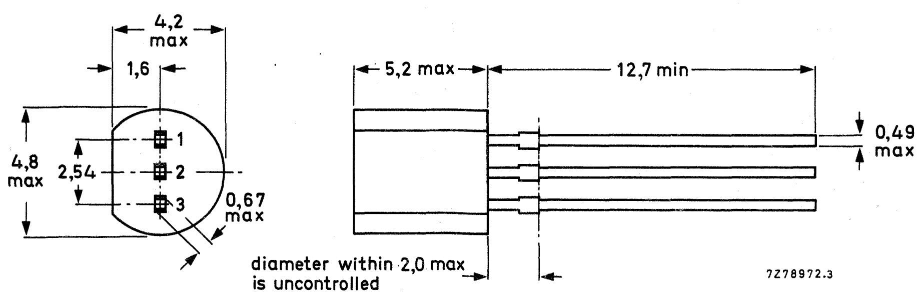
Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter







RATINGS

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

			MPSA05	MPSA06	
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	V
Collector-base voltage (open emitter)	V_{CBO}	max.	60	80	V
Emitter-base voltage (open collector)	V_{EBO}		4,0		V
Collector current (d.c.)	I_C	max.	500		mA
Total device dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MPSA05	MPSA06	
Collector-emitter breakdown voltage I_B = 0; I_C = 1,0 mA	$V_{(BR)CEO}$		60	80	V
Emitter-base breakdown voltage I_E = 100 μA; I_C = 0	$V_{(BR)EBO}$		4,0		V
Collector-emitter cut-off current I_B = 0; V_{CE} = 60 V	I_{CEO}	max.	0,1		μA
Collector cut-off current I_E = 0; V_{CB} = 60 V	I_{CBO}	max.	0,1		μA
I_E = 0; V_{CB} = 80 V	I_{CBO}	max.		0,1	μA
D.C. current gain I_C = 10 mA; V_{CE} = 1,0 V	h_{FE}	min.	50		
I_C = 100 mA; V_{CE} = 1,0 V	h_{FE}	min.	50		
Saturation voltage I_C = 100 mA; I_B = 10 mA	V_{CEsat}	max.	0,25		V
Base-emitter ON-voltage I_C = 100 mA; V_{CE} = 1,0 V	$V_{BE(on)}$	max.	1,2		V
Transition frequency at f = 100 MHz* I_C = 10 mA; V_{CE} = 2,0 V	f_T	min.	100		MHz

* f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

SILICON PLANAR EPITAXIAL DARLINGTON TRANSISTORS

N-P-N silicon planar epitaxial darlington transistors in plastic TO-92 envelope for general purpose applications.

QUICK REFERENCE DATA

			MPSA13	MPSA14	
Collector-emitter voltage					
$V_{BE} = 0$	V_{CES}	max.	30		V
Collector-base voltage					
(open emitter)	V_{CBO}	max.	30		V
Collector current (d.c.)	I_C	max.	500		mA
Total device dissipation					
at $T_{amb} = 25\ ^oC$	P_{tot}	max.	625		mW
Collector-emitter saturation voltage					
$I_C = 100$ mA; $I_B = 0,1$ mA	V_{CEsat}	max.	1,5		V
D.C. current gain					
$I_C = 10$ mA; $V_{CE} = 5,0$ V	h_{FE}	min.	5000	10 000	

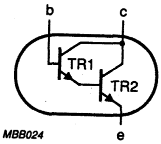
MECHANICAL DATA

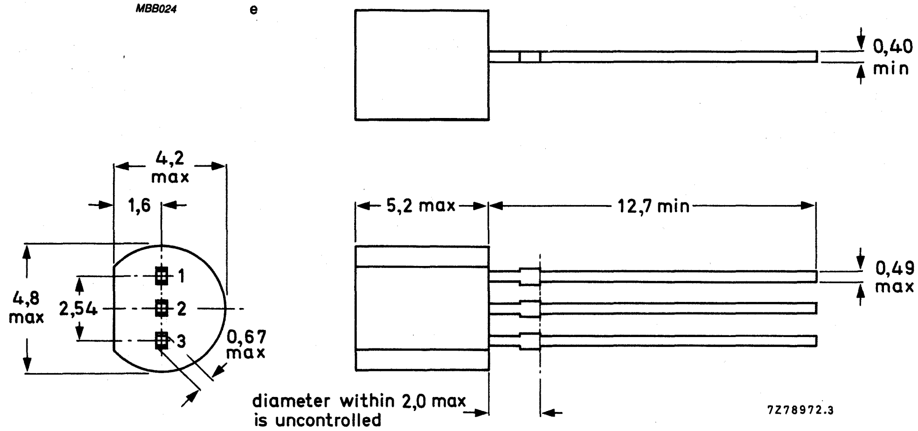
Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter





RATINGS

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

			MPSA13	MPSA14	
Collector-emitter voltage $V_{BE} = 0$	V_{CES}	max.	30		V
Collector-base voltage (open emitter)	V_{CBO}	max.	30		V
Emitter-base voltage (open collector)	V_{EBO}	max.	10		V
Collector current (d.c.)	I_C	max.	500		mA
Total device dissipation at $T_{amb} = 25\ ^oC$	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		−65 to +150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

			MPSA13	MPSA14	
Collector-emitter breakdown voltage $I_B = 0$; $I_C = 100\ \mu A$	$V_{(BR)CES}$	min.	30		V
Collector cut-off current $I_E = 0$; $V_{CB} = 30$ V	I_{CBO}	max.	0,1		μA
Emitter cut-off current $I_C = 0$; $V_{BE} = 10$ V	I_{EBO}	max.	0,1		μA
D.C current gain $I_C = 10$ mA; $V_{CE} = 5{,}0$ V	h_{FE}	min.	5000	10 000	
$I_C = 100$ mA; $V_{CE} = 5{,}0$ V	h_{FE}	min.	10 000	20 000	
Saturation voltage $I_C = 100$ mA; $I_B = 0{,}1$ mA	V_{CEsat}	max.	1,5		V
Base-emitter ON-voltage $I_C = 100$ mA; $V_{CE} = 5{,}0$ V	$V_{BE(on)}$	max.	2,0		V
Transition frequency at f = 100 MHz* $I_C = 10$ mA; $V_{CE} = 5{,}0$ V; $T_{amb} = 25\ ^oC$	f_T	min.	125		MHz

* f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

NPN DARLINGTON TRANSISTOR

NPN small-signal Darlington transistors, each in a plastic TO-92 envelope.
PNP complementary types are MPSA75, MPSA76, and MPSA77.

QUICK REFERENCE DATA

			MPSA25	26	27	
Collector-emitter voltage	V_{CEO}	max.	40	50	60	V
Emitter-base voltage	V_{EBO}	max.		10		V
DC collector current	I_C	max.		500		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		500		mW
DC current gain I_C = 10 mA, V_{CE} = 5 V	h_{FE}	min.		10000		

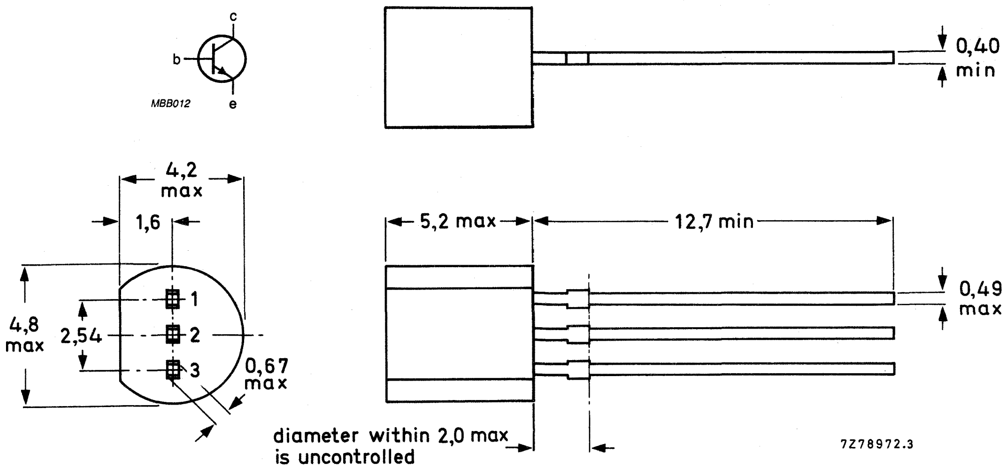
MECHANICAL DATA

Dimensions in mm

Fig.1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



RATINGS

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

			MPSA25	26	27	
Collector-emitter voltage	V_{CEO}	max	40	50	60	V
Emitter-base voltage	V_{EBO}	max.		10		V
DC collector current	I_C	max.		500		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		500		mW
Storage temperature range	T_{stg}			−65 to +150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	250	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MPSA25	26	27	
Collector-emitter breakdown voltage I_C = 100 μA; V_{BE} = 0	$V_{(BR)CES}$	min.	50	50	60	V
Collector-base breakdown voltage I_C = 100 μA; I_E = 0	$V_{(BR)CBO}$	min.	40	50	60	V
Collector cut-off current V_{CB} = 40 V; I_E = 0	I_{CBO}	max.	100	100	−	nA
V_{CB} = 50 V; I_E = 0	I_{CBO}	max.	−	−	100	nA
Emitter cut-off current V_{EB} = 10 V; I_C = 0	I_{EBO}	max.		100		nA
DC current gain I_C = 10 mA; V_{CE} = 5 V	h_{FE}	min.		10000		
I_C = 100 mA; V_{CE} = 5 V	h_{FE}	min.		10000		
Collector-emitter saturation voltage I_C = 100 mA; I_B = 0.1 mA	V_{CEsat}	max.		1.5		V
Base-emitter on-voltage I_C = 100 mA; V_{CE} = 5 V	V_{Beon}	max.		2.0		V
Transition frequency at T_{amb} = 25 °C I_C = 30 mA; V_{CE} = 5 V; f = 100 MHz	f_T	min.		125		MHz
		typ.		220		MHz

HIGH VOLTAGE SILICON PLANAR TRANSISTORS

N-P-N high voltage silicon planar transistors in plastic TO-92 envelope for use in general purpose applications.

QUICK REFERENCE DATA

			MPSA42	MPSA43	
Collector-emitter voltage (open base)	V_{CEO}	max.	300	200	V
Collector-base voltage (open emitter)	V_{CBO}	max.	300	200	V
Collector current (d.c.)	I_C	max.	500		mA
Total device dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Collector-emitter saturation voltage I_C = 20 mA; I_B = 2,0 mA	V_{CEsat}	max.	0,5		V
D.C. current gain I_C = 30 mA; V_{CE} = 10 V	h_{FE}	min.	40		

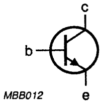
MECHANICAL DATA

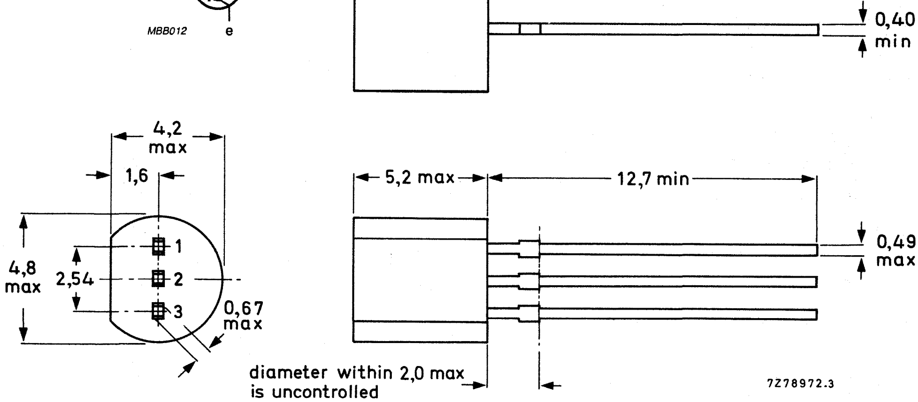
Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter





RATINGS

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

			MPSA42	MPSA43	
Collector-emitter voltage (open base)	V_{CEO}	max.	300	200	V
Collector-base voltage (open emitter)	V_{CBO}	max.	300	200	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6,0		V
Collector current (d.c.)	I_C	max.	500		mA
Total device dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MPSA42	MPSA43	
Collector-emitter breakdown voltage* $I_B = 0$; I_C = 1,0 mA	$V_{(BR)CES}$		300	200	V
Collector-base breakdown voltage $I_E = 0$; I_C = 100 μA	$V_{(BR)CBO}$		300	200	V
Emitter-base breakdown voltage $I_C = 0$; I_E = 100 μA	$V_{(BR)EBO}$		6,0		V
Collector cut-off current $I_E = 0$; V_{CB} = 200 V	I_{CBO}	max.	0,1		μA
$I_E = 0$; V_{CB} = 160 V	I_{CBO}	max.		0,1	μA
Emitter cut-off current $I_C = 0$; V_{BE} = 6,0 V	I_{EBO}	max.	0,1		μA
$I_C = 0$; V_{BE} = 4,0 V	I_{EBO}	max.		0,1	μA
D.C. current gain* I_C = 1 mA; V_{CE} = 10 V	h_{FE}	min.	25		
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	min.	40		
I_C = 30 mA; V_{CE} = 10 V	h_{FE}	min.	40		
Saturation voltages* I_C = 20 mA; I_B = 2,0 mA	V_{CEsat}	max.	0,5		V
I_C = 20 mA; I_B = 2,0 mA	V_{BEsat}	max.	0,9		V
Transition frequency at f = 100 MHz I_C = 10 mA; V_{CE} = 20 V	f_T	min.	50		MHz
Collector-base capacitance at f = 1 kHz V_{CB} = 20 V; $I_E = 0$	C_{cb}	max.	3,0	4,0	pF

* Pulse test: pulse width ⩽ 300 μs, duty cycle ⩽ 2%.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P silicon planar epitaxial transistors in plastic TO-92 envelope for general purpose applications.

QUICK REFERENCE DATA

			MPSA55	MPSA56	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	V
Collector current (d.c.)	$-I_C$	max.	500		mA
Total device dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Collector-emitter saturation voltage $-I_C$ = 100 mA; $-I_B$ = 10 mA	$-V_{CEsat}$	max.	0,25		V
D.C. current gain $-I_C$ = 100 mA; $-V_{CE}$ = 1,0 V	h_{FE}	min.	50		

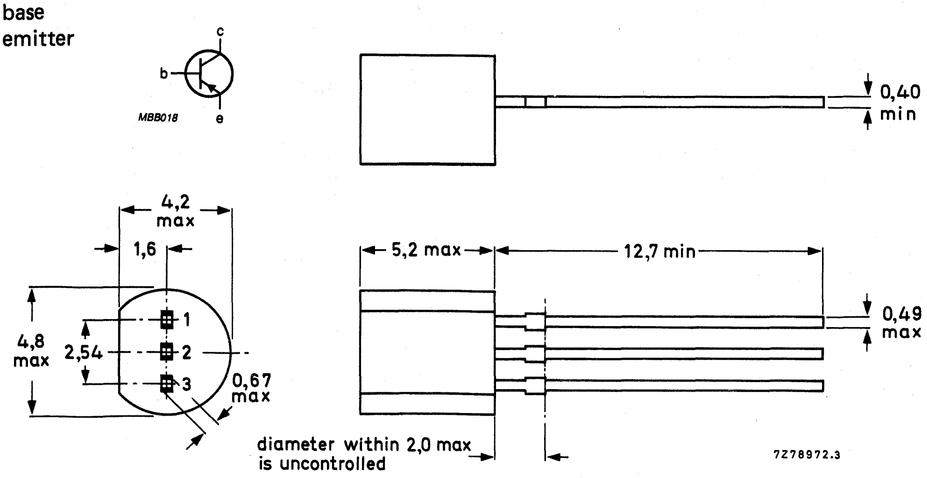
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



RATINGS

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

			MPSA55	MPSA56	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	4,0		V
Collector current (d.c.)	$-I_C$	max.	500		mA
Total device dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MPSA55	MPSA56	
Collector-emitter breakdown voltage $I_B = 0$; I_C = 1,0 mA	$-V_{(BR)CEO}$	min.	60	80	V
Emitter-base breakdown voltage $-I_E$ = 100 μA; $-I_C = 0$	$-V_{(BR)EBO}$	min.	4,0		V
Collector cut-off current $I_E = 0$; $-V_{CB}$ = 60 V	$-I_{CBO}$	max.	0,1		μA
$I_E = 0$; $-V_{CB}$ = 80 V	$-I_{CBO}$	max.		0,1	μA
Collector-emitter cut-off current $I_B = 0$; $-V_{CE}$ = 60 V	$-I_{CEO}$	max.	0,1		μA
D.C. current gain $-I_C$ = 10 mA; $-V_{CE}$ = 1,0 V	h_{FE}	min.	50		
$-I_C$ = 100 mA; $-V_{CE}$ = 1,0 V	h_{FE}	min.	50		
Saturation voltage $-I_C$ = 100 mA; $-I_B$ = 10 mA	$-V_{CEsat}$	max.	0,25		V
Base-emitter on-voltage $-I_C$ = 100 mA; $-V_{CE}$ = 1,0 V	$-V_{BE(on)}$	max.	1,2		V
Transition frequency at f = 100 MHz* $-I_C$ = 100 mA; $-V_{CE}$ = 1,0 V	f_T	min.	50		MHz

* f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

P-N-P DARLINGTON TRANSISTORS

P-N-P darlington transistors in a plastic TO-92 envelope for general purpose applications.

QUICK REFERENCE DATA

			MPSA63	MPSA64	
Collector-emitter voltage $V_{BE} = 0$	$-V_{CES}$	max.	30	30	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	30	V
Collector current (d.c.)	$-I_C$	max.	500	500	mA
Total device dissipation at $T_{amb} = 25\ ^oC$	P_{tot}	max.	625	625	mW
Collector-emitter saturation voltage $-I_C = 100$ mA; $-I_B = 0,1$ mA	$-V_{CEsat}$	max.	1,5	1,5	V
D.C. current gain $-I_C = 10$ mA; $-V_{CE} = 5,0$ V	h_{FE}	min.	5000	10 000	

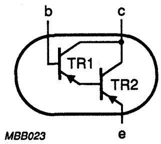
MECHANICAL DATA

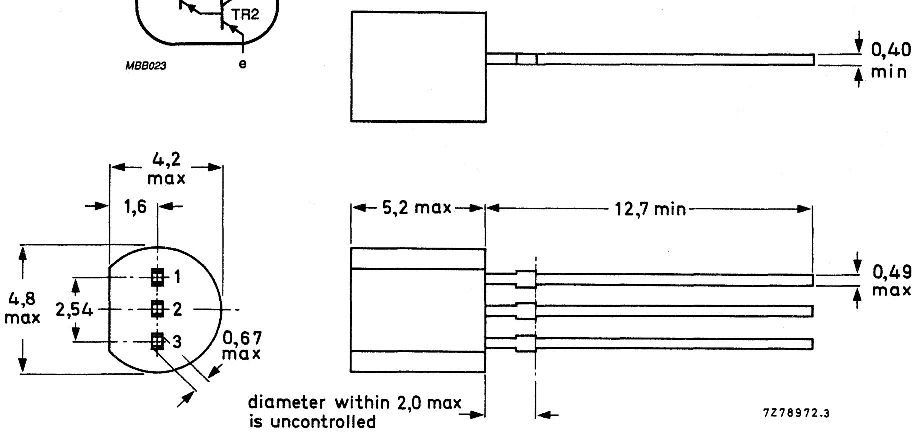
Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter





RATINGS

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

			MPSA63	MPSA64	
Collector-emitter voltage $V_{BE} = 0$	$-V_{CES}$	max.	30		V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30		V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10		V
Collector current (d.c.)	$-I_C$	max.	500		mA
Total device dissipation at $T_{amb} = 25\ ^oC$	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		−65 to +150		^oC
Junction temperature	T_j	max.	150		^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

			MPSA63	MPSA64	
Collector-emitter breakdown voltage $-I_C = 100\ \mu A$; $-V_{BE} = 0$	$-V_{(BR)CES}$	min.	30		V
Collector cut-off current $I_E = 0$; $-V_{CB} = 30\ V$	$-I_{CBO}$	max.	100		nA
Emitter cut-off current $I_C = 0$; $-V_{BE} = 10\ V$	$-I_{EBO}$	max.	100		nA
D.C. current gain $-I_C = 10\ mA$; $-V_{CE} = 5{,}0\ V$	h_{FE}	min.	5000	10 000	
$-I_C = 100\ mA$; $-V_{CE} = 5{,}0\ V$	h_{FE}	min.	10 000	20 000	
Saturation voltage $-I_C = 100\ mA$; $-I_B = 0{,}1\ mA$	$-V_{CEsat}$	max.	1,5		V
Base-emitter ON-voltage* $-I_C = 100\ mA$; $-V_{CE} = 5{,}0\ V$	$-V_{BE(on)}$		2,0		V
Transition frequency at f = 100 MHz* $-I_C = 100\ mA$; $-V_{CE} = 5{,}0\ V$	f_T	min.	125		MHz

* f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

PNP DARLINGTON TRANSISTOR

PNP small-signal Darlington transistors, each in a plastic TO-92 envelope.
NPN complementary types are MPSA25, 26, and 27.

QUICK REFERENCE DATA

			MPSA75	76	77	
Collector-emitter voltage	$-V_{CEO}$	max.	40	50	60	V
Emitter-base voltage	$-V_{EBO}$	max.		10		V
Collector current (DC)	$-I_C$	max.		500		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		500		mW
DC current gain $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	h_{FE}	min.		10 000		

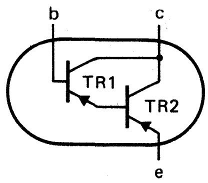
MECHANICAL DATA

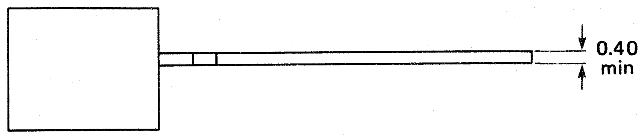
Dimensions in mm

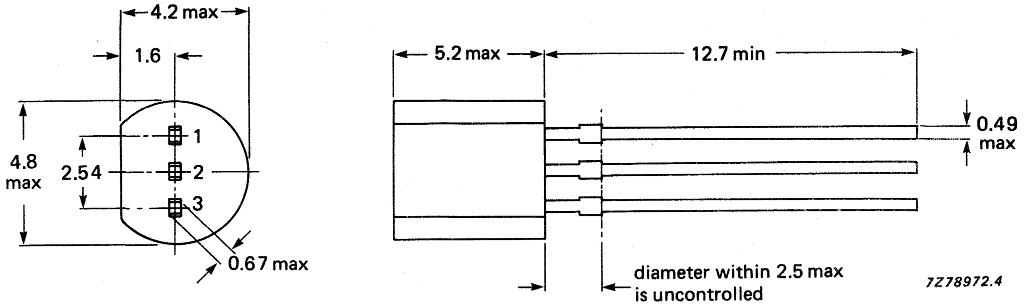
Fig.1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter







RATINGS

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

			MPSA75	76	77	
Collector-emitter voltage	$-V_{CEO}$	max.	40	50	60	V
Emitter-base voltage	$-V_{EBO}$	max.		10		V
Collector current (DC)	$-I_C$	max.		500		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.		500		mW
Storage temperature range	T_{stg}			−65 to + 150		°C
Junction temperature	T_j	max.		150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	250	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MPSA75	76	77	
Collector-emitter breakdown voltage $-I_C$ = 100 μA; $-V_{BE}$ = 0	$-V_{(BR)CES}$	min.	40	50	60	V
Collector-base breakdown voltage $-I_C$ = 100 μA; $-I_E$ = 0	$-V_{(BR)CBO}$	min.	40	50	60	V
Collector cut-off current $-V_{CB}$ = 40 V; $-I_E$ = 0	$-I_{CBO}$	max.	100	100	−	nA
$-V_{CB}$ = 50 V; $-I_E$ = 0	$-I_{CBO}$	max.	−	−	100	nA
Emitter cut-off current $-V_{EB}$ = 40 V; $-I_C$ = 0	$-I_{EBO}$	max.		100		nA
DC current gain $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	h_{FE}	min.		10 000		
$-I_C$ = 100 mA; $-V_{CE}$ = 5 V	h_{FE}	min.		10 000		
Collector-emitter saturation voltage $-I_C$ = 100 mA; $-I_B$ = 0.1 mA	$-V_{CEsat}$	max.		1.5		V
Base-emitter on-voltage $-I_C$ = 10 mA; $-V_{CE}$ = 5 V	$-V_{BEon}$	max.		2.0		V
Transition frequency at T_{amb} = 25 °C $-V_C$ = 30 mA; $-V_{CE}$ = 5 V; f = 100 MHz	f_T	min.		125		MHz
		typ.		220		MHz

HIGH VOLTAGE SILICON PLANAR TRANSISTORS

P-N-P high voltage silicon planar transistors in plastic TO-92 envelope for general purpose applications.

QUICK REFERENCE DATA

			MPSA92	MPSA93	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	300	200	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	300	200	V
Collector current (d.c.)	$-I_C$	max.	500		mA
Total device dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Collector-emitter saturation voltage $-I_C$ = 20 mA; $-I_B$ = 2,0 mA	$-V_{CEsat}$	max.	0,5		V
D.C. current gain $-I_C$ = 30 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	25		

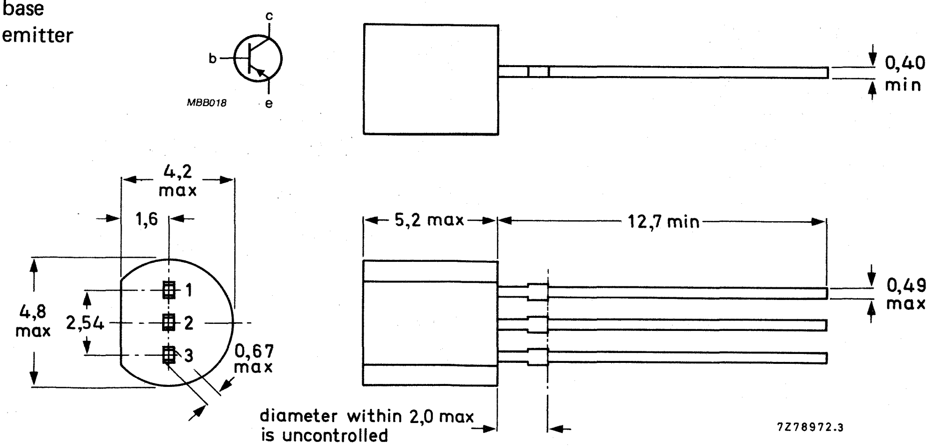
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



RATINGS

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

			MPSA92	MPSA93	
Collector-emitter voltage (open base)	V_{CEO}	max.	300	200	V
Collector-base voltage (open emitter)	V_{CBO}	max.	300	200	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5,0		V
Collector current (d.c.)	I_C	max.	500		mA
Total device dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			MPSA92	MPSA93	
Collector-emitter breakdown voltage $I_B = 0$; $-I_C$ = 1,0 mA	$-V_{(BR)CEO}$	min.	300	200	V
Collector-base breakdown voltage $I_E = 0$; $-I_C$ = 100 μA	$-V_{(BR)CBO}$	min.	300	200	V
Emitter-base breakdown voltage $I_C = 0$; $-I_E$ = 100 μA	$-V_{(BR)EBO}$	min.	5,0		V
Collector cut-off current $I_E = 0$; $-V_{CB}$ = 200 V	$-I_{CBO}$	max.	0,25		μA
$I_E = 0$; $-V_{CB}$ = 160 V	$-I_{CBO}$	max.		0,25	μA
Emitter cut-off current $I_C = 0$; $-V_{BE}$ = 3,0 V	$-I_{EBO}$	max.	0,1		μA
D.C. current gain* $-I_C$ = 1,0 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	25		
$-I_C$ = 10 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	40		
$-I_C$ = 30 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	25		
Saturation voltages* $-I_C$ = 20 mA; $-I_B$ = 2,0 mA	$-V_{CEsat}$	max.	0,5		V
$-I_C$ = 20 mA; $-I_B$ = 2,0 mA	$-V_{BEsat}$	max.	0,9		V
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 20 V	f_T	min.	50		MHz
Collector-base capacitance at f = 1 MHz $-V_{CB}$ = 20 V; $I_E = 0$	C_{cb}	max.	6,0	8,0	pF

* Pulse test: pulse width ≤ 300 μs, duty cycle ≤ 2%.

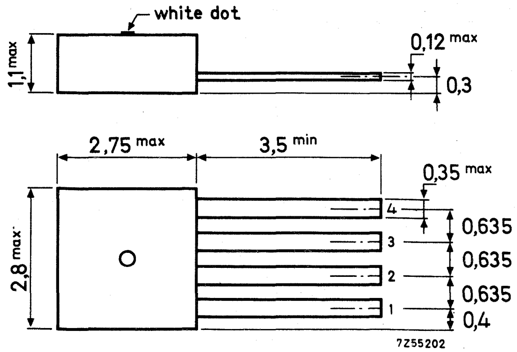
INTEGRATED AMPLIFIER
for use in ear hearing aids

Monolithic integrated circuit amplifier in a plastic envelope, primarily intended for use in ear hearing aids.

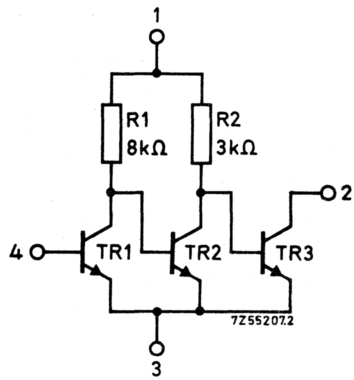
QUICK REFERENCE DATA				
For meaning of symbols see test circuit				
Supply voltage	V_{1-3}	max.	5	V
Supply current	I_2	max.	5	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	25	mW
The following data are measured in test circuit				
Total supply current	I_{tot}	typ.	1	mA
Transducer gain	G_{tr}	>	77	dB
		typ.	85	dB
Output power at d_{tot} = 10%	P_o	>	0,2	mW
Cut-off frequency (−3 dB)	f_c	>	20	kHz

PACKAGE OUTLINE (Dimensions in mm)

SOT-20



CIRCUIT DIAGRAM



The sealing of the plastic envelope withstands the accelerated damp heat test of IEC recommendation 68-2 (test D, severity IV, 6 cycles).

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

Voltages

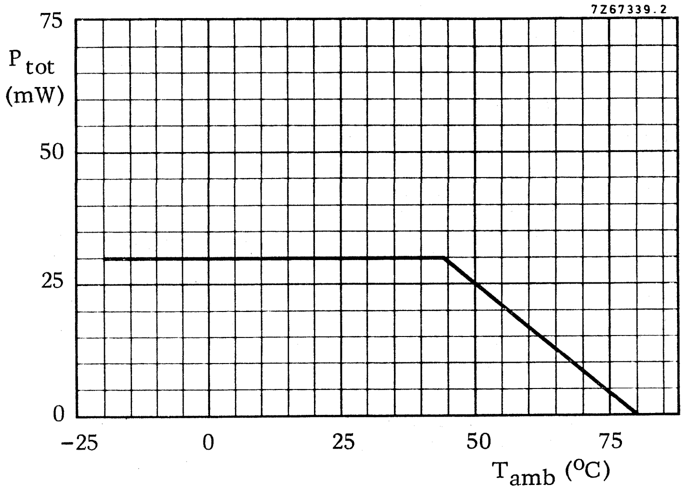
Supply voltage	V_{1-3}	max.	5	V
Output voltage	V_{2-3}	max.	5	V [1]
Input voltage	$-V_{4-3}$	max.	5	V

Currents

Output current	I_2	max.	5	mA
Input current	I_4	max.	5	mA

Power dissipation

Power derating curve



Temperatures

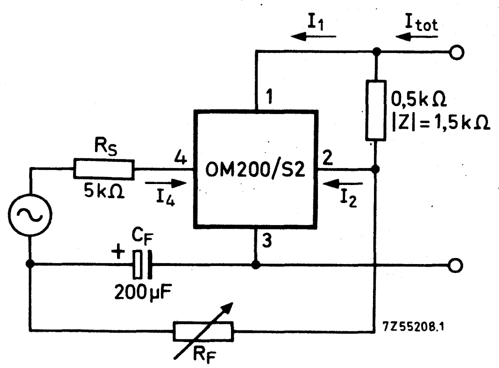
Storage temperature	T_{stg}	−20 to +80	°C
Ambient temperature (see derating curve above)	T_{amb}	−20 to +80	°C

1) This value may be exceeded during inductive switch-off for transient energies < 10 μWs.

CHARACTERISTICS at $V_{1-3} = 1,3$ V; $I_2 = 0,7$ mA and $T_{amb} = 25$ °C unless otherwise specified

Supply currents (no signal)	I_{tot}	<	1,1	mA	
	I_1	typ.	0,30	mA	
Transducer gain at f = 1 kHz	G_{tr}	>	77	dB	1)
		typ.	85	dB	
Total distortion at f = 1 kHz					
P_o = 100 µW	d_{tot}	typ.	4	%	
		<	6	%	
P_o = 200 µW	d_{tot}	<	10	%	
Noise figure at R_S = 5 kΩ					
B = 400 to 3200 Hz	F	typ.	2,5	dB	
		<	6	dB	2)
Cut-off frequency (−3 dB)	f_c	>	20	kHz	
Value of R_F to adjust I_2 at 0,7 mA	R_F		170 to 1000	kΩ	
		typ.	400	kΩ	

Test circuit



Note

I_2 = 0,7 mA; adjusted by means of R_F
V_{1-3} = 1,3 V; T_{amb} = 25 °C

1) The transducer gain is defined as the ratio of the output power in the load |Z| = 1,5 kΩ and the available input power of the source with R_S = 5 kΩ.

$$G_{tr} = \frac{P_o}{V_i^2/4\,R_S}$$

2) Due to special processing and pre-measuring, the flutter-noise level is extremely low.

SOLDERING RECOMMENDATIONS

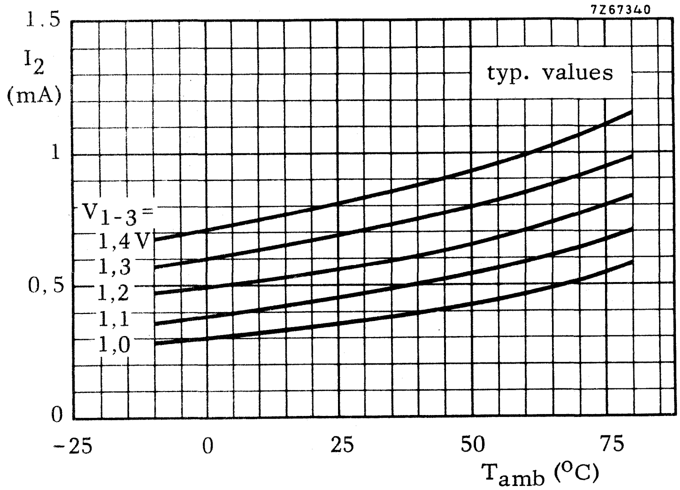
1. Iron soldering

   At a maximum iron temperature of 300 °C the maximum permissible soldering time is 3 seconds, provided the solder spot is at least 0, 5 mm from the seal and the leads are not soldered at the same time. Soldering in immediate subsequence is allowed.

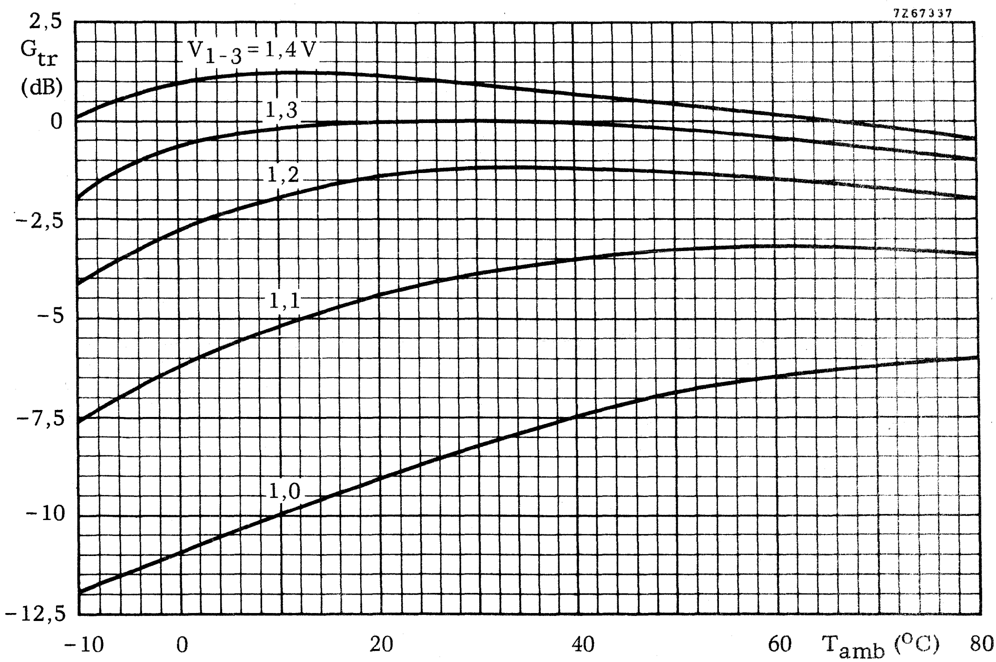
2. Dipsoldering

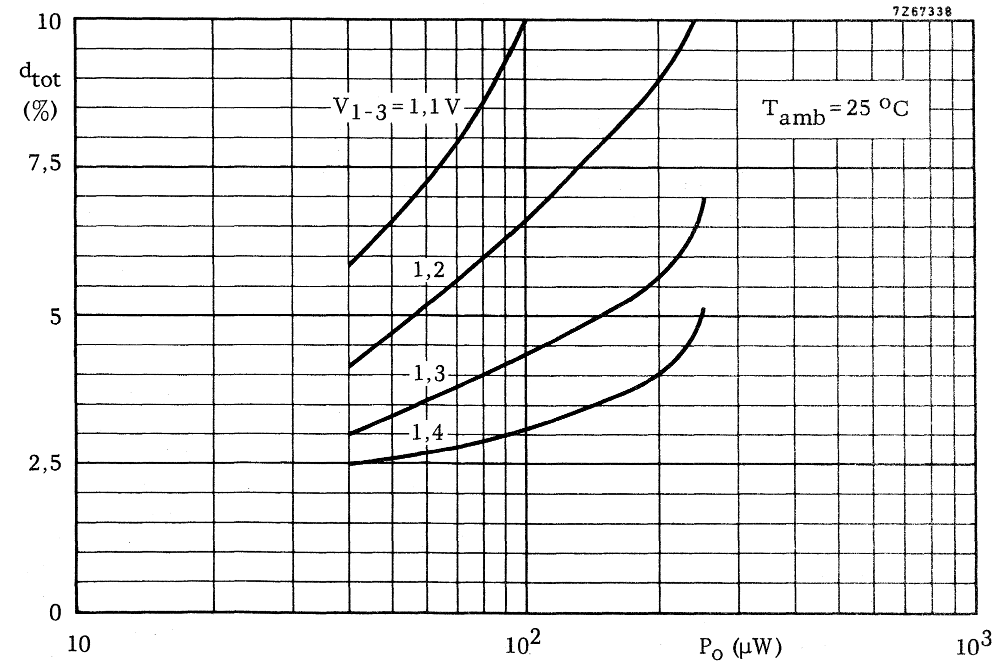
   At a maximum solder temperature of 250 °C the maximum permissible soldering time is 3 seconds, provided the soldered spot is at least 0, 5 mm from the seal.

CHARACTERISTICS



The graph applies to test circuit on previous page.


7Z67337
2,5
G_{tr}
(dB)
0
−2,5
−5
−7,5
−10
−12,5
V_{1-3} = 1,4 V
1,3
1,2
1,1
1,0
−10
0
20
40
60
T_{amb} (°C)
80


7Z67338
10
d_{tot}
(%)
7,5
5
2,5
0
V_{1-3} = 1,1 V
1,2
1,3
1,4
T_{amb} = 25 °C
10
10^2
P_o (μW)
10^3

SILICON PLANAR EPITAXIAL TRANSISTORS

NPN transistors in plastic TO-92 envelopes, primarily intended for switching and linear applications.

QUICK REFERENCE DATA

			PH2222	PH2222A	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	75	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	40	V
Collector current (DC)	I_C	max.	800	800	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	625	mW
Junction temperature	T_j	max.	150	150	°C
DC current gain at T_j = 25 °C I_C = 10 mA; V_{CE} = 10 V	h_{FE}	min.	75	75	
Transition frequency at f = 100 MHz I_C = 20 mA; V_{CE} = 20 V	f_T	min.	250	300	MHz
Storage time I_{Con} = 150 mA; I_{Bon} = $-I_{Boff}$ = 15 mA	t_s	max.	–	225	ns

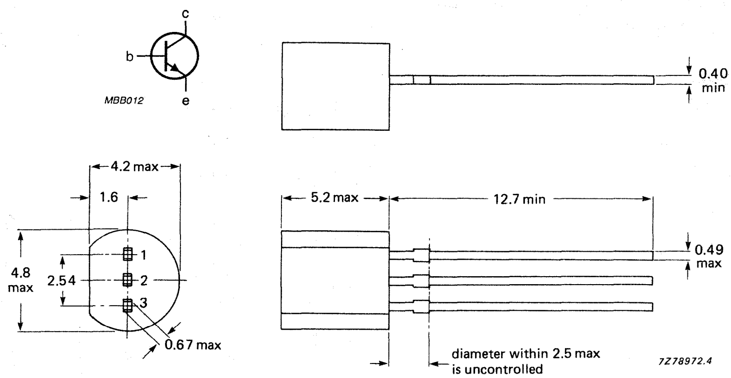
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



RATINGS

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

			PH2222	PH2222A	
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 (DC)	I_C	max.	800		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}	max.	−65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			PH2222	PH2222A	
Collector cut-off current					
$I_E = 0$; V_{CB} = 50 V	I_{CBO}	max.	10	–	nA
$I_E = 0$; V_{CB} = 50 V; T_{amb} = 150 °C	I_{CBO}	max.	10	–	μA
$I_E = 0$; V_{CB} = 60 V	I_{CBO}	max.	–	10	nA
$I_E = 0$; V_{CB} = 60 V; T_{amb} = 150 °C	I_{CBO}	max.	–	10	μA
Emitter cut-off current $I_C = 0$; V_{EB} = 3 V	I_{EBO}	max.	10	10	nA
Currents are reverse biased emitter junction V_{CE} = 60 V; $-V_{BE}$ = 3 V	I_{CEX}	max.	–	10	nA
	$-I_{BEX}$	max.	–	20	nA
Breakdown voltages					
$I_E = 0$; I_C = 10 μA	$V_{(BR)CBO}$	min.	60	75	V
$I_B = 0$; I_C = 10 mA	$V_{(BR)CEO}$	min.	30	40	V
$I_C = 0$; I_E = 10 μA	$V_{(BR)EBO}$	min.	5	6	V
Saturation voltages (see Note 1) I_C = 150 mA; I_B = 15 mA	V_{CEsat}	max.	0.4	0.3	V
	V_{BEsat}	min.	–	0.6	V
		max.	1.3	1.2	V
I_C = 500 mA; I_B = 50 mA	V_{CEsat}	max.	1.6	1.0	V
	V_{BEsat}	max.	2.6	2.0	V

Note

1. Measured under pulse conditions: $t_p \leqslant 300\ \mu s$, $\delta \leqslant 0.02$.

			PH2222	PH2222A	
DC current gain					
I_C = 0.1 mA; V_{CE} = 10 V	h_{FE}	min.	35	35	
I_C = 1 mA; V_{CE} = 10 V	h_{FE}	min.	50	50	
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	min.	75	75	
I_C = 10 mA; V_{CE} = 10 V; T_{amb} = −55 °C	h_{FE}	min.	–	35	
I_C = 150 mA; V_{CE} = 1 V (see note 1)	h_{FE}	min.	50	50	
I_C = 150 mA; V_{CE} = 10 V (see note 1)	h_{FE}	min.	100	100	
		max.	300	300	
I_C = 500 mA; V_{CE} = 10 V (see note 1)	h_{FE}	min.	30	40	
Transition frequency at f = 100 MHz					
I_C = 20 mA; V_{CE} = 20 V	f_T	min.	250	300	MHz
Collector capacitance at f = 100 kHz					
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	max.	8	8	pF
Emitter capacitance at f = 100 kHz					
$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	max.	–	25	pF
h-parameters (common emiiter)					
I_C = 1 mA; V_{CE} = 10V; f = 1 kHz					
Input impedance	h_{ie}	min.	–	2	kΩ
		max.	–	8	kΩ
Reverse voltage transfer ratio	h_{re}	max.	–	8	10^{-4}
Small-signal current gain	h_{fe}	min.	–	50	
		max.	–	300	
Output admittance	h_{oe}	min.	–	5	μS
		max.	–	35	μS
I_C = 10 mA; V_{CE} = 10 V; f = 1 kHz					
Input impedance	h_{ie}	min.	–	0.25	kΩ
		max.	–	1.25	kΩ
Reverse voltage transfer ratio	h_{re}	max.	–	4	10^{-4}
Small-signal current gain	h_{fe}	min.	–	75	
		max.	–	375	
Output admittance	h_{oe}	min.	–	25	μS
		max.	–	200	μS
I_C = 20 mA; V_{CE} = 20 V; f = 100 MHz					
Small-signal current gain	h_{fe}	min.	2.5	3.0	
Noise figure at f = 1 kHz					
I_C = 0.1 mA; V_{CE} = 10 V					
R_G = 1 kΩ; B = 1 Hz	F	max.	–	4	dB

Note

1. Measured under pulse conditions: $t_p \leqslant 300\ \mu s$; $\delta \leqslant 0.02$.

Switching times (between 10% and 90% levels) for **PH2222A**

Turn-on time when switched to I_{Con} = 150 mA (see Fig. 2)				
delay time	t_d	max.	10	ns
rise time	t_r	max.	25	ns
Turn-off time when switched from I_{Con} = 150 mA (see Fig. 3)				
storage time	t_s	max.	225	ns
fall time	t_f	max.	60	ns

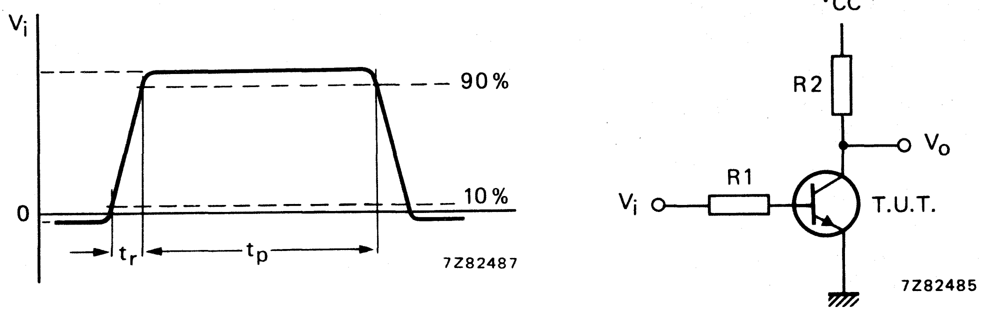


Fig. 2 Input waveform and test circuit for determining delay time and rise time.

V_i = –0,5 V 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	min.	100	kΩ
rise time	t_r	⩽	2	ns	input capacitance	C_i	max.	12	pF
duty factor	δ	=	0,02		rise time	t_r	max.	5	ns

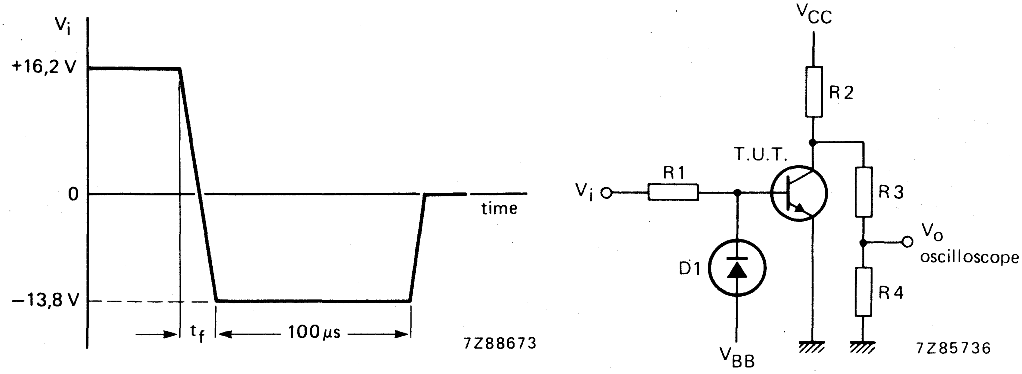


Fig. 3 Input waveform and test circuit for determining storage time and fall time.

V_{CC} = + 30 V; V_{BB} = –3 V; R1 = 1 kΩ; R2 = 200 Ω; R3 = 20 kΩ; R4 = 50 Ω; D1 = 1N916.

Pulse generator:					Oscilloscope:				
fall time	t_f	max.	5	ns	input impedance	Z_i	min.	100	kΩ
					input capacitance	C_i	max.	12	pF
					rise time	t_r	max.	5	ns

SILICON PLANAR EPITAXIAL SWITCHING TRANSISTOR

N-P-N transistor in a plastic TO-92 envelope intended for high-speed switching applications.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	mW
D.C. current gain				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}		40 to 120	
I_C = 100 mA; V_{CE} = 2 V	h_{FE}	>	20	
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	500	MHz
Storage time				
$I_{Con} = I_{Bon} = -I_{Boff}$ = 10 mA	t_s	<	13	ns

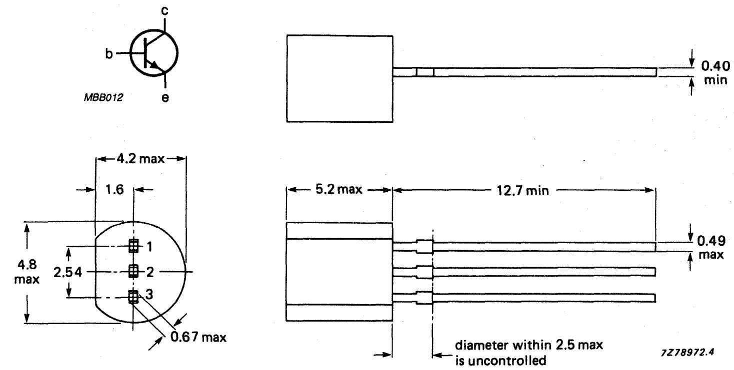
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



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 (V_{BE} = 0)	V_{CES}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4,5	V
Collector current (peak value; t_p = 10 μs)	I_{CM}	max.	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	mW
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	250	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 20 V	I_{CBO}	<	400	nA
I_E = 0; V_{CB} = 20 V; T_j = 125 °C	I_{CBO}	<	30	μA
Emitter cut-off current				
I_C = 0; V_{EB} = 2 V	I_{EBO}	<	100	nA
Saturation voltages				
I_C = 10 mA; I_B = 0,3 mA	V_{CEsat}	<	0,30	V
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	<	0,25	V
	V_{BEsat}	0,70 to 0,85		V
I_C = 100 mA; I_B = 10 mA	V_{CEsat}	<	0,60	V
	V_{BEsat}	<	1,50	V
D.C. current gain				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	40 to 120		
I_C = 10 mA; V_{CE} = 1 V; T_{amb} = −55 °C	h_{FE}	>	20	
I_C = 100 mA; V_{CE} = 2 V	h_{FE}	>	20	
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	500	MHz
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 (see Fig. 2)				
I_{Con} = I_{Bon} = $-I_{Boff}$ = 10 mA	t_s	typ.	6	ns
		<	13	ns

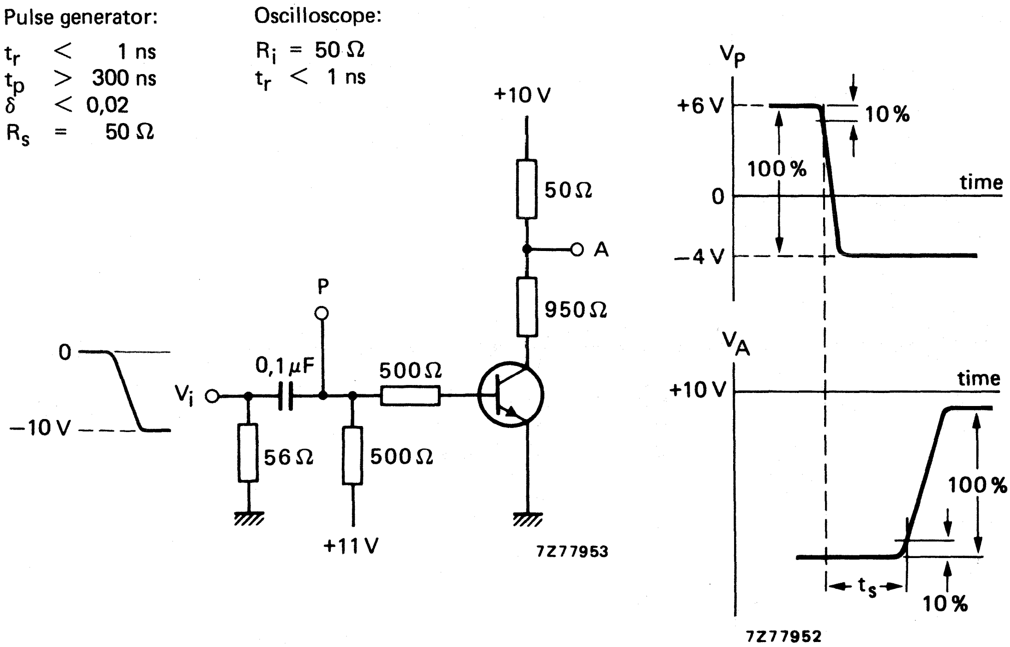


Fig. 2 Test circuit and waveforms.

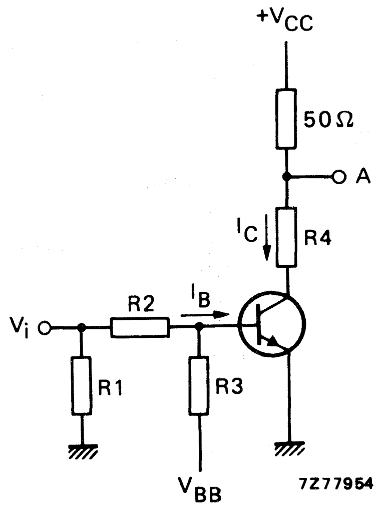
Turn-on time (see Fig. 3)			
from $-V_{BEoff}$ = 1,5 V to I_{Con} = 10 mA; I_{Bon} = 3 mA	t_{on}	< 12	ns
from $-V_{BEoff}$ = 2,25 V to I_{Con} = 100 mA; I_{Bon} = 40 mA	t_{on}	< 7	ns
Turn-off time (see Fig. 3)			
I_{Con} = 10 mA; I_{Bon} = 3 mA; $-I_{Boff}$ = 1,5 mA	t_{off}	< 18	ns
I_{Con} = 100 mA; I_{Bon} = 40 mA; $-I_{Boff}$ = 20 mA	t_{off}	< 21	ns

Pulse generator:

t_r < 1 ns
t_p > 300 ns
δ < 0,02
R_s = 50 Ω

Oscilloscope:

R_i = 50 Ω
t_r < 1 ns



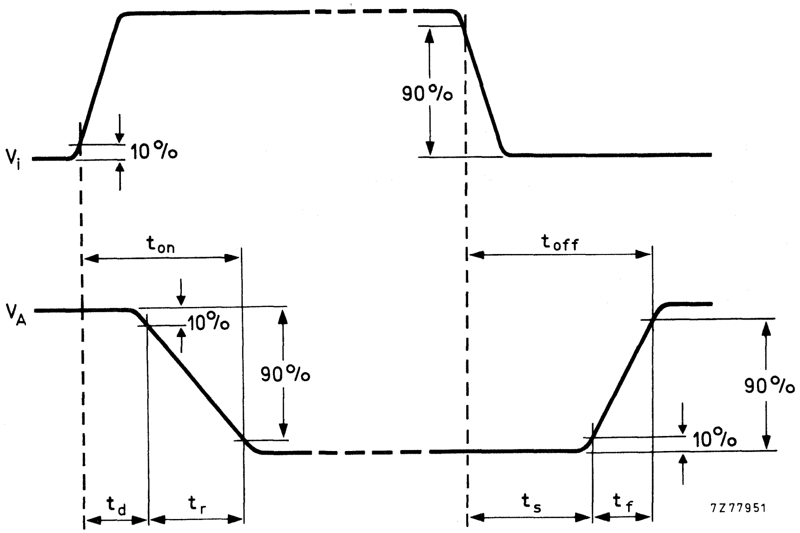


Fig. 3 Test circuit and waveforms.

I_{Con} mA	I_{Bon} mA	I_{Boff} mA	V_{CC} V	R1 Ω	R2; R3 kΩ	R4 Ω	turn-on time V_{BB} V	turn-on time V_{BE} V	turn-on time V_i V	turn-off time V_{BB} V	turn-off time V_i V
10	3	−1,5	3	50	3,30	220	−3,0	−1,50	15	12,0	−15
100	40	−20	6	56	0,33	0	−4,5	−2,25	20	15,3	−20

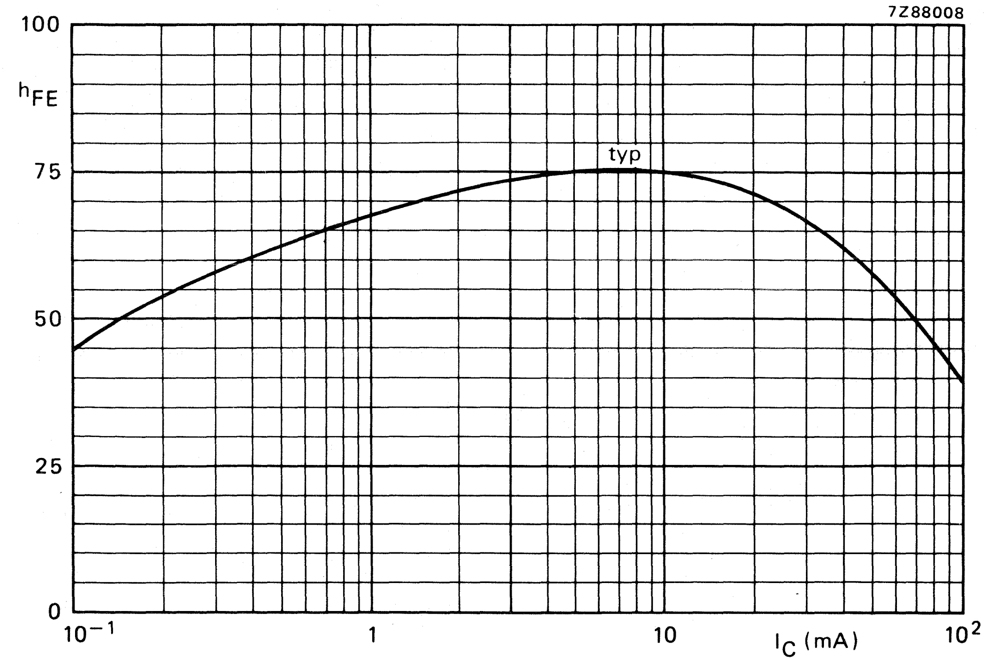


Fig. 4 V_{CE} = 1 V; T_j = 25 °C.

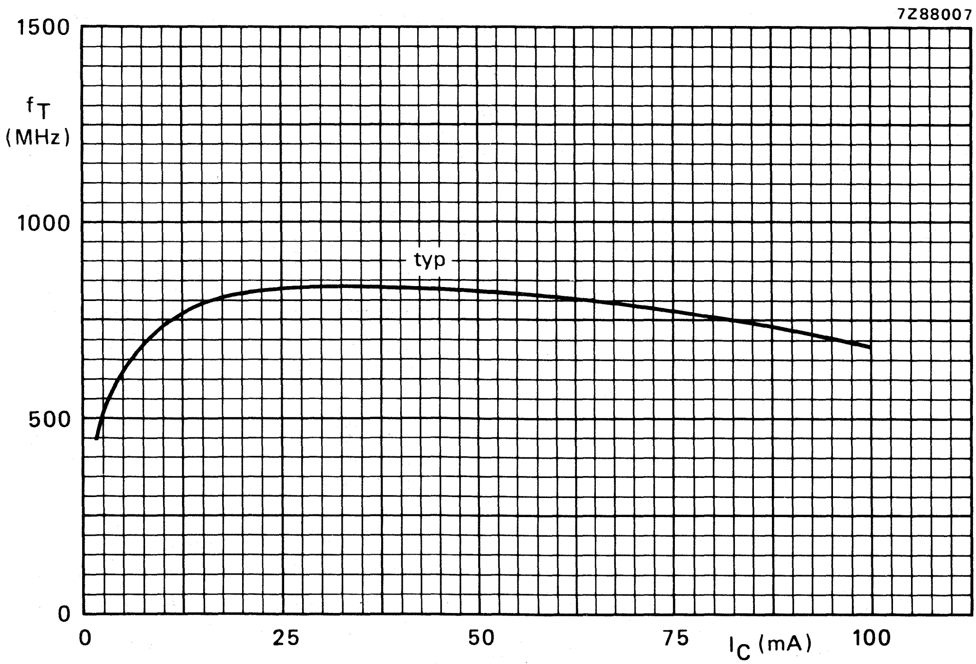


Fig. 5 V_{CE} = 10 V; T_j = 25 °C.

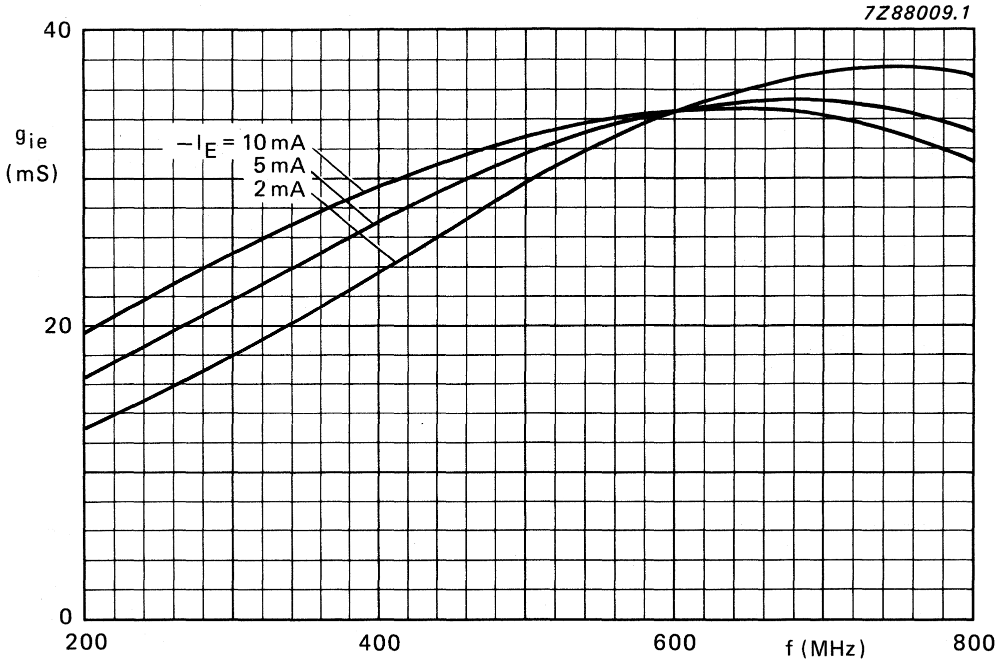


Fig. 6 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

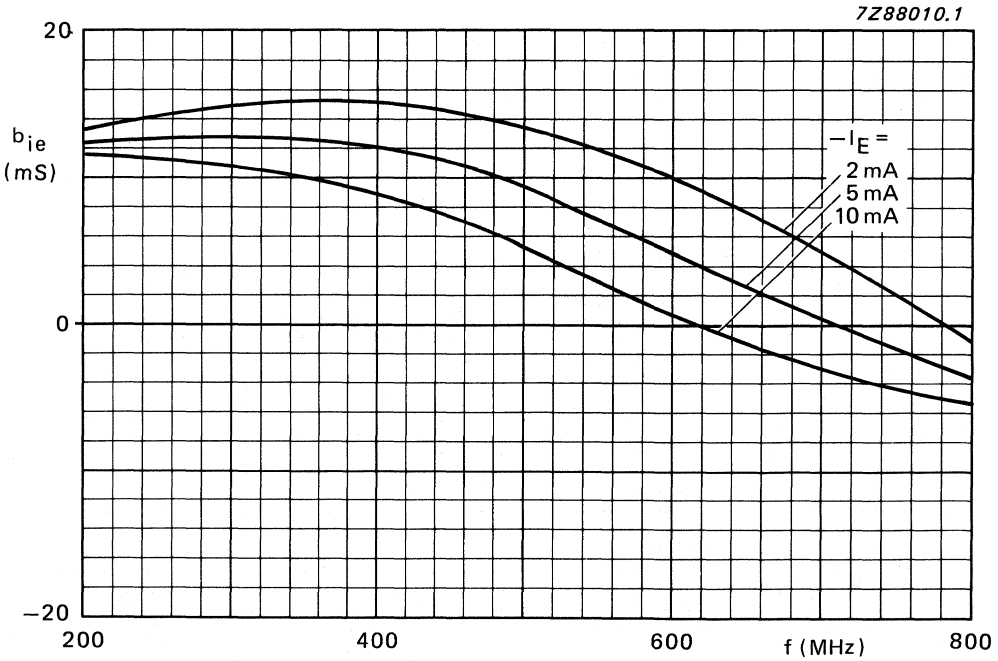


Fig. 7 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

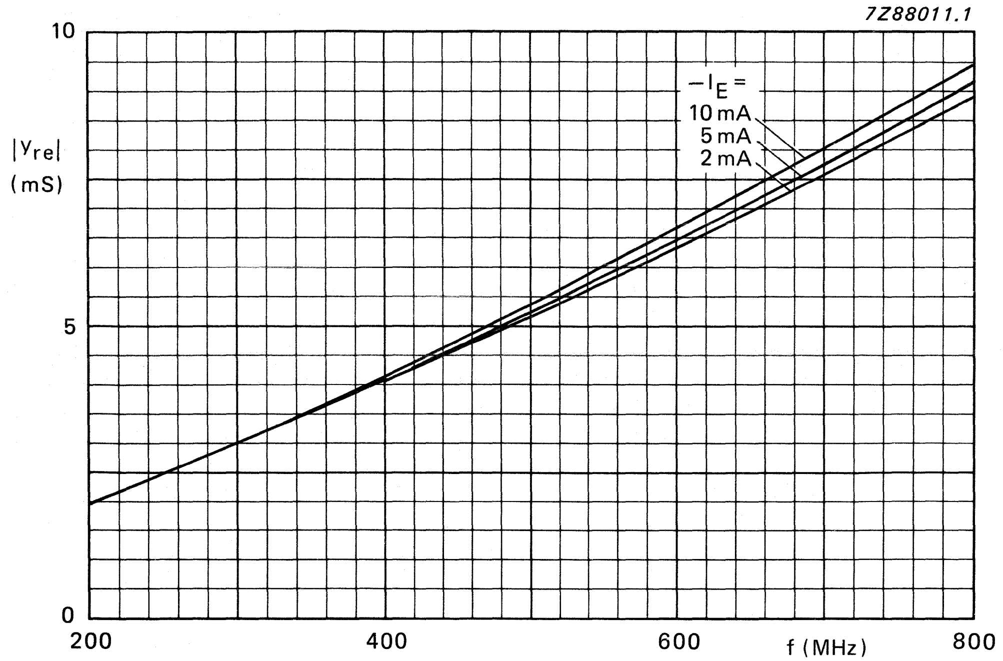


Fig. 8 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

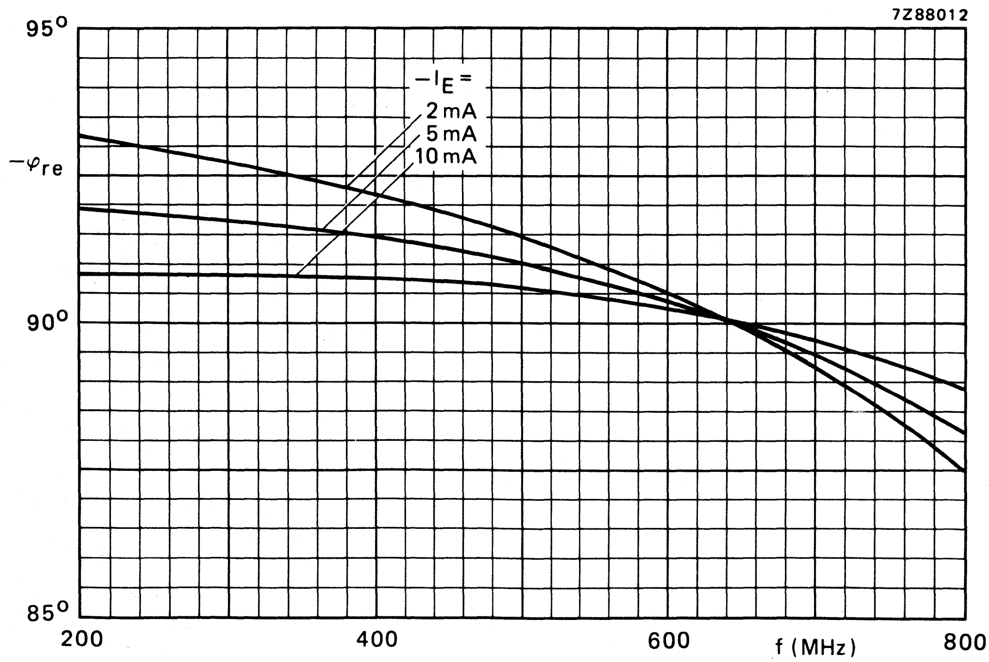


Fig. 9 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

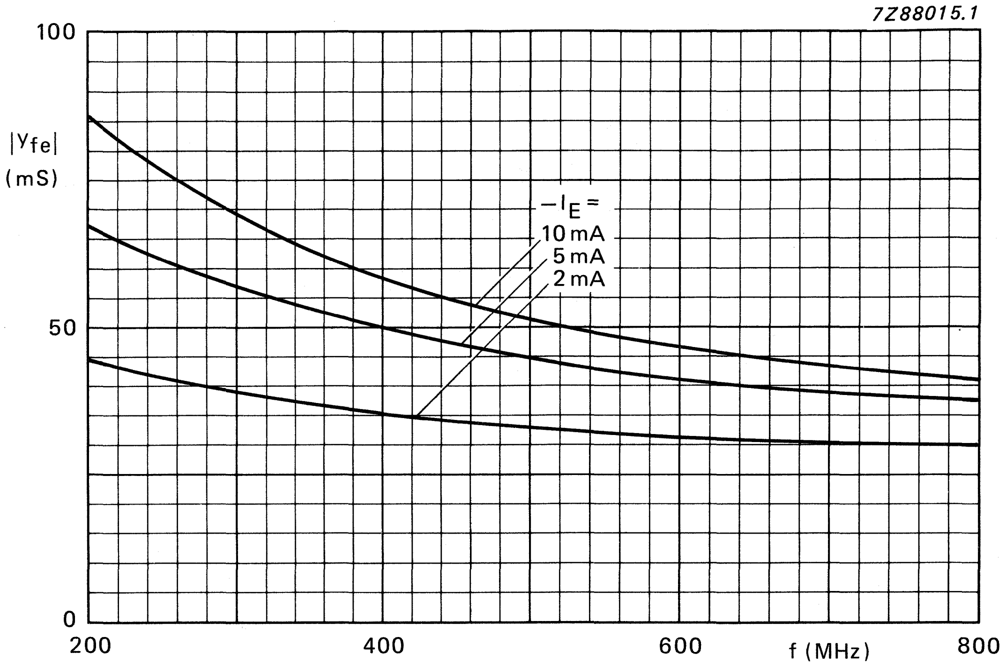


Fig. 10 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

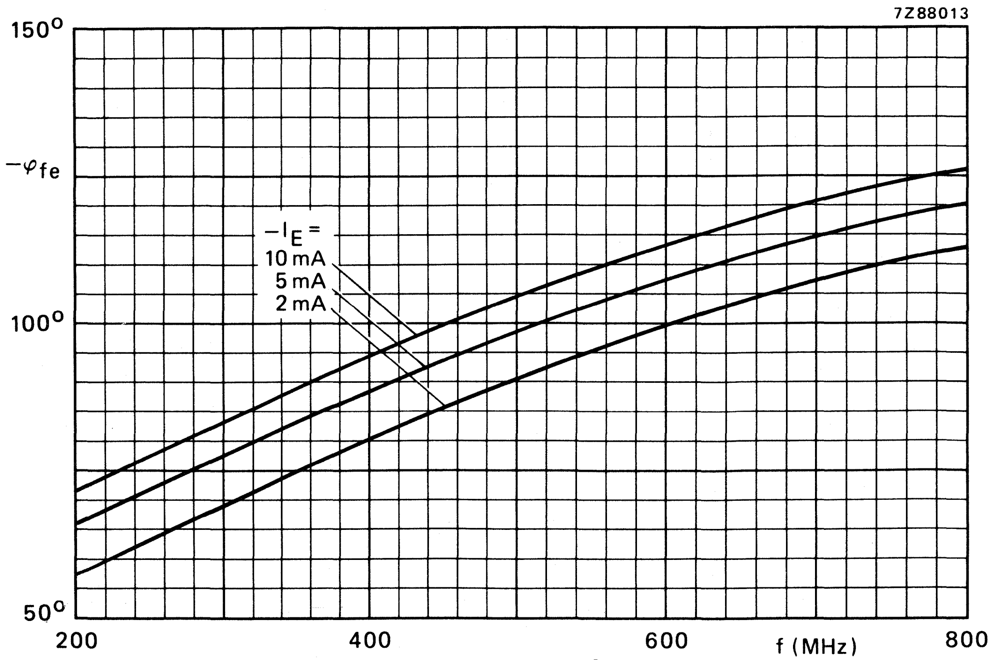


Fig. 11 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

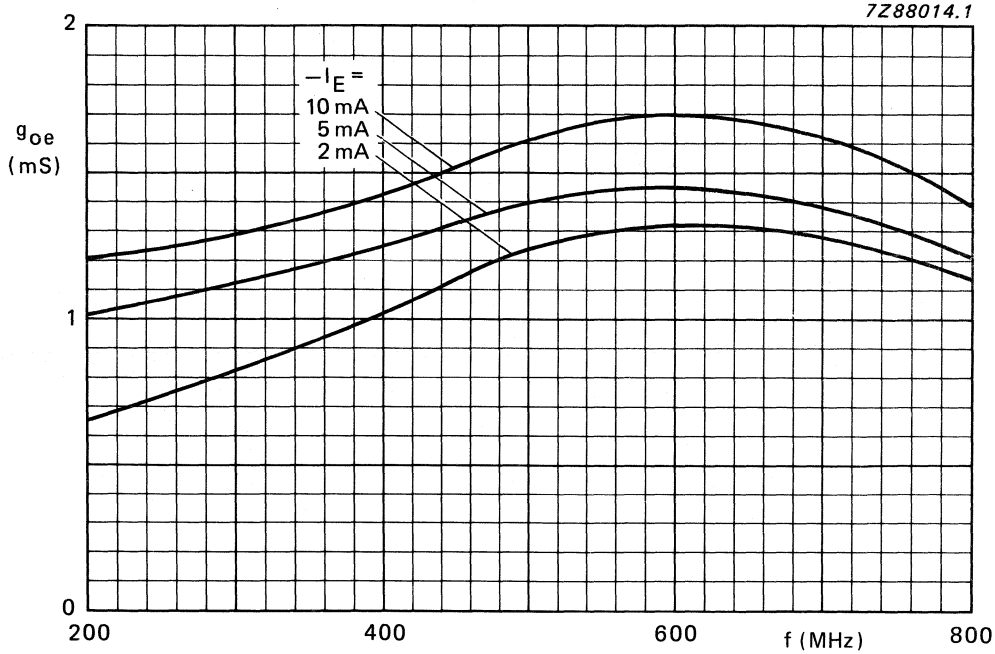


Fig. 12 V_{CB} = 10 V; T_{amb} = 25 °C; typical values.

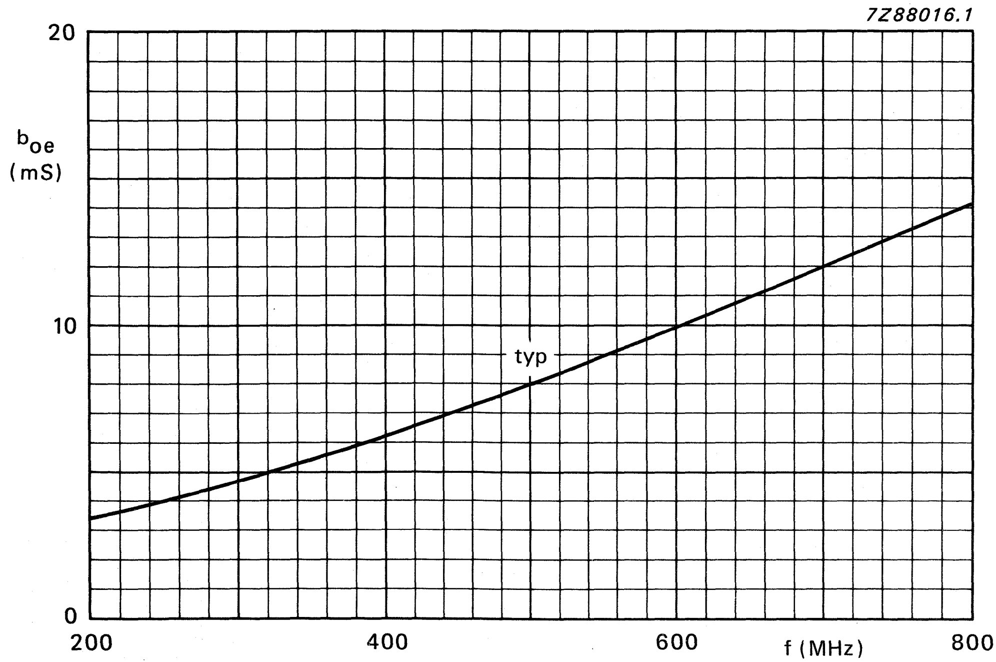


Fig. 13 V_{CB} = 10 V; $-I_E$ = 2 to 10 mA; T_{amb} = 25 °C.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P medium power transistors in plastic TO-92 envelopes, primarily designed for high-speed switching and driver applications for industrial service.

QUICK REFERENCE DATA

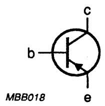
Collector-base voltage (open emitter)		$-V_{CBO}$	max.	60	V
Collector-emitter voltage (open base)	PH2907	$-V_{CEO}$	max.	40	V
	PH2907A	$-V_{CEO}$	max.	60	V
Collector current (d.c.)		$-I_C$	max.	600	mA
Total power dissipation up to T_{amb} = 25 °C		P_{tot}	max.	625	mW
Junction temperature		T_j	max.	150	°C
D.C. current gain at T_j = 25 °C $-I_C$ = 150 mA; $-V_{CE}$ = 10 V		h_{FE}	100 to 300		
Transition frequency at f = 100 MHz $-I_C$ = 50 mA; $-V_{CE}$ = 20 V; T_j = 25 °C		f_T	>	200	MHz
Storage time $-I_{Con}$ = 150 mA; $-I_{Bon}$ = I_{Boff} = 15 mA		t_s	<	80	ns

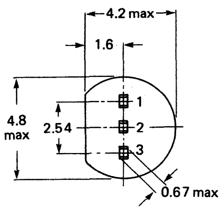
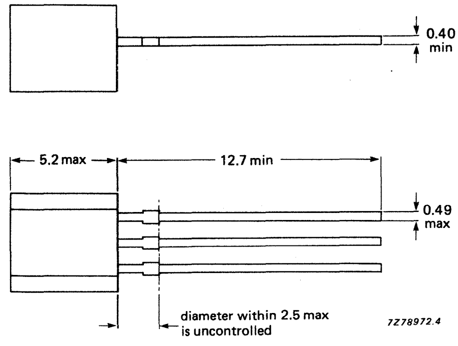
MECHANICAL DATA of **PH2907** and **PH2907A** — Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector



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)	**PH2907**	$-V_{CEO}$	max.	40	V
	PH2907A	$-V_{CEO}$	max.	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.	625	mW
Storage temperature range		T_{stg}	−65 to + 150		°C
Junction temperature		T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			2N2907	2N2907A	
Collector cut-off current					
$I_E = 0; -V_{CB} = 50$ V	$-I_{CBO}$	<	20	10	nA
$I_E = 0; -V_{CB} = 50$ V; $T_{amb} = 150$ °C	$-I_{CBO}$	<	20	10	μA
$+V_{BE} = 0,5$ V; $-V_{CE} = 30$ V	$-I_{CEX}$	<	50	50	nA
Base current					
$+V_{BE} = 0,5$ V; $-V_{CE} = 30$ V	I_{BEX}	<	50	50	nA
Collector-base breakdown voltage					
open emitter; $-I_C = 10$ μA	$-V_{(BR)CBO}$	>	60	60	V
Collector-emitter breakdown voltage*					
open base; $-I_C = 10$ mA	$-V_{(BR)CEO}$	>	40	60	V
Emitter-base breakdown voltage					
open collector; $-I_E = 10$ μA	$-V_{(BR)EBO}$	>	5	5	V
Saturation voltages*					
$-I_C = 150$ mA; $-I_B = 15$ mA	$-V_{CEsat}$	<	0,4	0,4	V
	$-V_{BEsat}$	<	1,3	1,3	V
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	1,6	1,6	V
	$-V_{BEsat}$	<	2,6	2,6	V
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	100	
		<	300	300	
$-I_C = 500$ mA; $-V_{CE} = 10$ V*	h_{FE}	>	30	50	
Collector capacitance at f = 100 kHz					
$I_E = I_e = 0; -V_{CB} = 10$ V	C_c	<	8		pF
Emitter capacitance at f = 100 kHz					
$I_C = I_c = 0; -V_{EB} = 2$ V	C_e	<	30		pF
Transition frequency at f = 100 MHz					
$-I_C = 50$ mA; $-V_{CE} = 20$ V*	f_T	>	200		MHz

* Measured under pulse conditions to avoid excessive dissipation: $t_p \leqslant 300$ μs; $\delta \leqslant 0,02$.

Turn-on time (see Fig. 2)
when switched to $-I_{Con}$ = 150 mA; $-I_{Bon}$ = 15 mA

delay time	t_d	<	10 ns
rise time	t_r	<	40 ns
turn-on time	t_{on}	<	45 ns

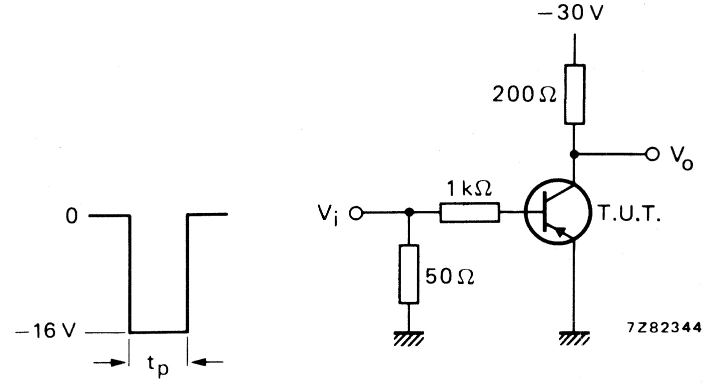


Fig. 2 Input waveform and test circuit for determining delay, rise and turn-on time.

Turn-off time (see Fig. 3)
when switched from $-I_{Con}$ = 150 mA; $-I_{Bon}$ = 15 mA
to cut-off with + I_{Boff} = 15 mA

storage time	t_s	<	80 ns
fall time	t_f	<	30 ns
turn-off time	t_{off}	<	100 ns

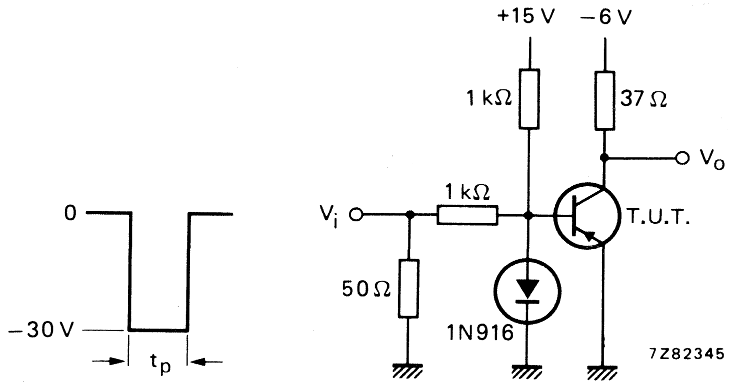


Fig. 3 Input waveform and test circuit for determining storage, fall and turn-off time.

Pulse generator (see Figs 2 and 3)

frequency	f	=	150 Hz
pulse duration	t_p	=	200 ns
rise time	t_r	⩽	2 ns
output impedance	Z_o	=	50 Ω

Oscilloscope (see Figs 2 and 3)

rise time	t_r	⩽	5 ns
input impedance	Z_i	⩽	10 MΩ

SILICON P-N-P HIGH-VOLTAGE TRANSISTORS

P-N-P high-voltage small-signal transistors, primarily intended for use in telephony applications and encapsulated in a TO-92 enveloppe.

QUICK REFERENCE DATA

			PH5415	PH5416	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	200	350	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	200	300	V
Collector current	$-I_C$	max.	1,0	1,0	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	625	mW
Junction temperature	T_j	max.	150	150	°C
Collector-emitter saturation voltage $-I_C$ = 50 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	<	0,8	0,8	V
D.C. current gain $-I_C$ = 50 mA; $-V_{CE}$ = 10 V	h_{FE}	>	30	30	
		<	150	120	

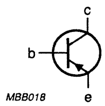
MECHANICAL DATA

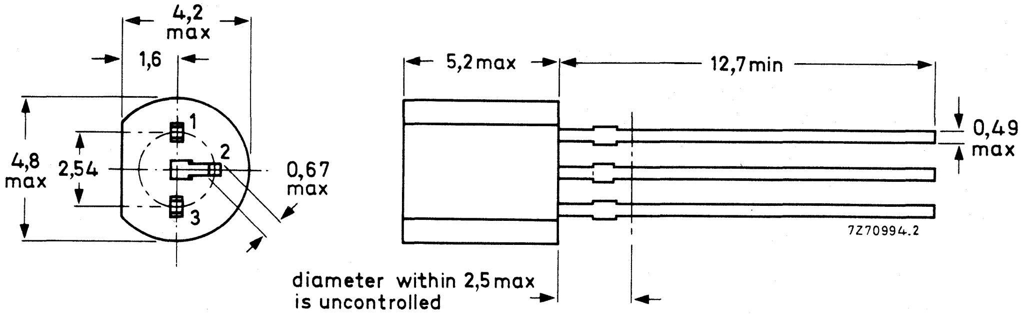
Dimension in mm

Fig. 1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector





RATINGS

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

			PH5415	PH5416	
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.	4,0	6,0	V
Collector current (d.c.)	$-I_C$	max.	1,0		A
Base current	$-I_B$	max.	0,5		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Junction temperature	T_j	max.	150		°C
Storage temperature range	T_{stg}		–65 to 150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			PH5415	PH5416	
Collector cut-off currents					
$I_E = 0; -V_{CB}$ = 175 V	$-I_{CBO}$	<	0,1		μA
$I_E = 0; -V_{CB}$ = 280 V	$-I_{CBO}$	<		0,1	μA
$I_B = 0; -V_{CE}$ = 150 V	$-I_{CEO}$	<	1,0		μA
$I_B = 0; -V_{CE}$ = 250 V	$-I_{CEO}$	<		1,0	μA
Emitter cut-off current					
$I_C = 0; -V_{EB}$ = 4 V	$-I_{EBO}$	<	1,0		μA
$I_C = 0; -V_{EB}$ = 6 V	$-I_{EBO}$	<		1,0	μA
Collector-emitter sustaining voltage $I_B = 0; -I_C$ = 50 mA	$-V_{CEOsust}$	>	200	300	V
Saturation voltages $-I_C$ = 50 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	<	0,8	0,8	V
	$-V_{BEsat}$	<	1,0	1,0	V
D.C. current gain $-I_C$ = 50 mA; $-V_{CE}$ = 10 V	h_{FE}	>	30	30	
		<	150	120	
Transition frequency at f = 5 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 10 V; T_{amb} = 25 °C	f_T	>	15		MHz
Small-signal current gain at f = 5 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 10 V; T_{amb} = 25 °C	h_{fe}	>	25		
Real part (Re) of input impedance (h_{ie}) $-V_{CE}$ = 10 V; $-I_C$ = 5 mA; f = 1 MHz; T_{amb} = 25 °C	$Re(h_{ie})$	<	300		Ω
Input capacitance at f = 1 MHz $I_C = 0; -V_{EB}$ = 5 V; T_{amb} = 25 °C	C_e	<	75		pF
Output capacitance at f = 1 MHz $I_E = 0; -V_{CB}$ = 10 V; T_{amb} = 25 °C	C_c	<	15		pF

SILICON EPITAXIAL TRANSISTORS

NPN transistors in a microminiature (SMD) plastic envelope intended for surface mounted applications. They are primarily intended for use in telephony and professional communication equipment.

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 (DC)	I_C	max.	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
DC current gain I_C = 10 mA; V_{CE} = 1 V	h_{FE}		100 to 300	
Transition frequency at f = 35 MHz I_C = 10 mA; V_{CE} = 20 V	f_T	min.	300	MHz

MECHANICAL DATA

Dimensions in mm

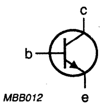
Fig.1 SOT23.

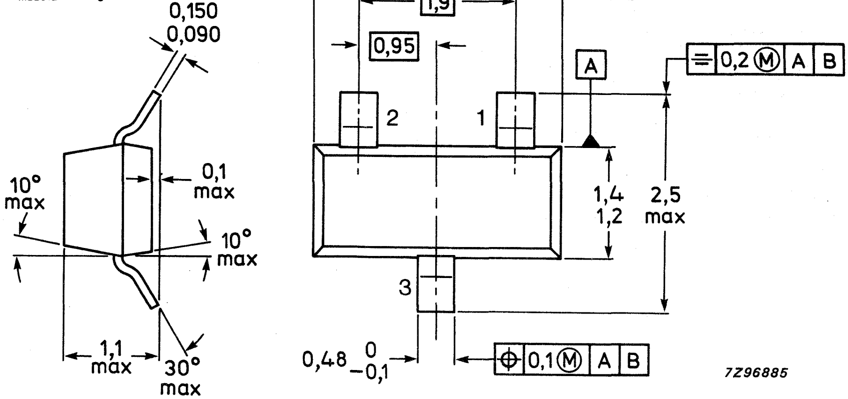
Marking code

PMBS3904: P9A

Pinning

1 = base
2 = emitter
3 = collector





TOP VIEW

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 (DC)	I_C	max.	200	mA
Total power dissipation* up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

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

Thermal resistance from junction to ambient*	$R_{th\,j\text{-}a}$	=	430	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector-emitter breakdown voltage** I_C = 1 mA; I_B = 0	$V_{(BR)CEO}$	min.	40	V
Collector-base breakdown voltage I_C = 10 μA; I_E = 0	$V_{(BR)CBO}$	min.	60	V
Emitter-base breakdown voltage I_E = 10 μA; I_C = 0	$V_{(BR)EBO}$	min.	6	V
Collector cut-off current V_{CE} = 30 V; V_{EB} = 3 V	I_{CEX}	max.	50	nA
Output capacitance at f = 1 MHz I_E = 0; V_{CB} = 5 V	C_c	max.	4	pF
Input capacitance at f = 1 MHz I_C = 0; V_{BE} = 0,5 V	C_e	max.	8	pF
Base current with reverse biased emitter junction V_{EB} = 3 V; V_{CE} = 30 V	I_{BEX}	max.	50	nA

* Mounted on a ceramic substrate: area = 10 x 8 mm^2; thickness = 0.7 mm.

** Pulse test conditions: t_p = 300 μs; duty factor ≤ 2%.

Saturation voltages				
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	max.	0.2	V
I_C = 50 mA; I_B = 5 mA		max.	0.3	V
I_C = 10 mA; I_B = 1 mA	V_{BEsat}	min.	0.65	V
		max.	0.85	V
I_C = 50 mA; I_B = 5 mA	V_{BEsat}	max.	0.95	V
DC current gain*				
I_C = 0.1 mA; V_{CE} = 1 V	h_{FE}	min.	40	
I_C = 1 mA; V_{CE} = 1 V	h_{FE}	min.	70	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	min.	100	
		max.	300	
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	min.	60	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	min.	30	
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 20 V	f_T	min.	300	MHz
Noise figure at R_S = 1 kΩ				
I_C = 100 μA; V_{CE} = 5 V				
f = 10 Hz to 15.7 kHz	F	max.	5	dB
h-parameters (common emitter)				
I_C = 1 mA; V_{CE} = 10 V; f = 1 kHz				
Input impedance	h_{ie}		1 to 10	kΩ
Reverse voltage transfer ratio	h_{re}		0.5 to 8	10^{-4}
Small-signal current gain	h_{fe}		100 to 400	
Output admittance	h_{oe}		1 to 40	μs

* Pulse test condition: t_p = 300 μs; duty factor ≤ 2%.

SILICON EPITAXIAL TRANSISTOR

PNP transistor in a microminiature (SMD) plastic envelope intended for surface mounted applications. The PMBT3906 is primarily intended for use in telephony and professional communication equipment.

QUICK REFERENCE DATA

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 (DC)	$-I_C$	max.	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
DC current gain $-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}		100 to 300	
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 20 V	f_T	min.	250	MHz

MECHANICAL DATA

Dimensions in mm

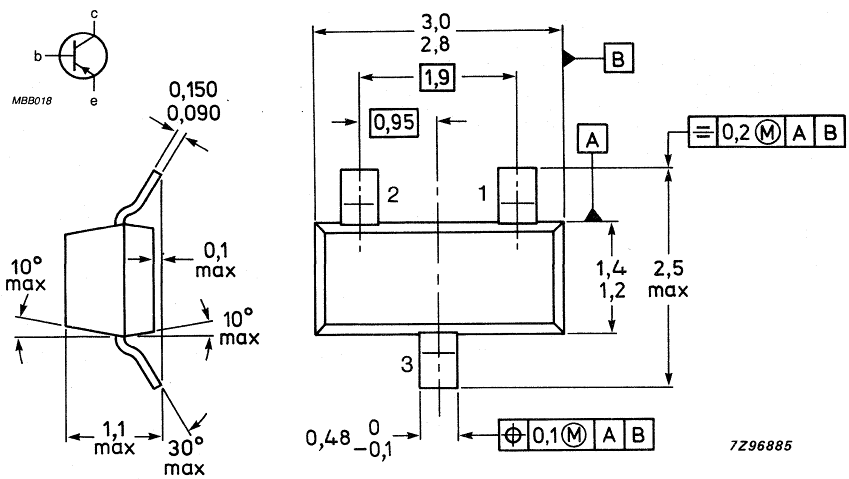
Fig. 1 SOT-23.

Marking code

PMBS3906 : PO6

Pinning

1 = base
2 = emitter
3 = collector



TOP VIEW

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 (DC)	$-I_C$	max.	200	mA
Total power dissipation* up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Storage temperature range	T_{stg}		−65 to +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 ambient	$R_{th\ j\text{-}a}$	=	430	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector-emitter breakdown voltage▲ $-I_C$ = 1 mA; I_B = 0	$-V_{(BR)CEO}$	min.	40	V
Collector-base breakdown voltage $-I_C$ = 10 μA; I_E = 0	$-V_{(BR)CBO}$	min.	40	V
Emitter-base breakdown voltage $-I_E$ = 10 μA; I_C = 0	$-V_{(BR)EBO}$	min.	5	V
Collector cut-off current $-V_{CE}$ = 30 V; $-V_{EB}$ = 3 V	$-I_{CE}$	max.	50	nA
Base current with reverse biased emitter junction	$-I_{BEX}$	max.	50	nA
Output capacitance at f = 100 kHz I_E = 0; $-V_{CB}$ = 5 V	C_c	max.	4.5	pF
Input capacitance at f = 100 kHz I_C = 0; $-V_{BE}$ = 0.5 V	C_e	max.	10	pF

* Mounted on a ceramic substrate: area = 10 x 8 mm; thickness = 0.7 mm.

** See Thermal characteristics.

▲ Pulse test conditions: t_p = 300 μs; duty factor ≤ 2%.

Saturation voltages			
$-I_C$ = 10 mA; $-I_B$ = 1 mA	$-V_{CEsat}$	max.	0.25 V
$-I_C$ = 50 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	max. min.	0.4 V 0.65 V
$-I_C$ = 10 mA; $-I_B$ = 1 mA	$-V_{BEsat}$	max.	0.85 V
$-I_C$ = 50 mA; $-I_B$ = 5 mA	$-V_{BBsat}$	max.	0.95 V
D.C. current gain			
$-I_C$ = 0.1 mA; $-V_{CE}$ = 1 V	h_{FE}	min.	60
$-I_C$ = 1 mA; $-V_{CE}$ = 1 V	h_{FE}	min.	80
$-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	min. max.	100 300
$-I_C$ = 50 mA; $-V_{CE}$ = 1 V	h_{FE}	min.	60
$-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}	min.	30
Transition frequency at f = 100 MHz			
$-I_C$ = 10 mA; $-V_{CE}$ = 20 V	f_T	min.	250 MHz
Noise figure at R_S = 1 kΩ			
$-I_C$ = 100 μA; $-V_{CE}$ = 5 V f = 10 Hz to 15,7 kHz	F	max.	4 dB
h-parameters (common emitter)			
$-I_C$ = 1 mA; $-V_{CE}$ = 10 V; f = 1 kHz			
Input impedance	h_{ie}	min. max.	2.0 kΩ 12 kΩ
Reverse voltage transfer ratio	h_{re}	min. max.	1.0 10^{-4} 10 10^{-4}
Small signal current gain	h_{fe}	min. max.	100 400
Output admittance	h_{oe}	min. max.	30 μS 60 μS

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon planar epitaxial transistors in a plastic TO-92 envelope primarily intended for linear and switching applications.

P-N-P complement is PN2907/2907A.

QUICK REFERENCE DATA

			PN2222	PN2222A	
Collector-emitter voltage (open base)	V_{CEO}	max.	30	40	V
Collector-base voltage (open emitter)	V_{CBO}	max.	60	75	V
Collector current (d.c.)	I_C	max.	600	600	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	625	mW
Collector-emitter saturation voltage I_C = 150 mA; I_B = 15 mA	V_{CEsat}	max.	0,4	0,3	V
D.C. current gain I_C = 150 mA; V_{CE} = 10 V	h_{FE}	min.	100	100	
		max.	300	300	

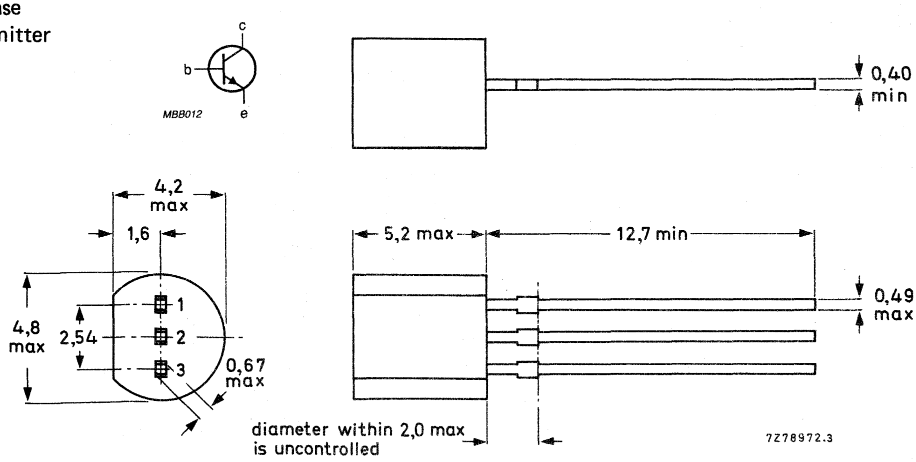
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



RATINGS

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

			PN2222	PN2222A	
Collector-emitter voltage (open base)	V_{CEO}	max.	30	40	V
Collector-base voltage (open emitter)	V_{CBO}	max.	60	75	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5,0	6,0	V
Collector current (d.c.)	I_C	max.	600		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		–65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

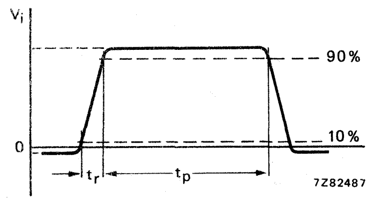
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			PN2222	PN2222A	
Collector-emitter breakdown voltage $I_B = 0$; I_C = 10 mA	$V_{(BR)CEO}$	min.	30	40	V
Collector-base breakdown voltage $I_E = 0$; I_C = 10 μA	$V_{(BR)CBO}$	min.	60	75	V
Emitter-base breakdown voltage I_E = 10 μA; $I_C = 0$	$V_{(BR)EBO}$	min.	5,0	6,0	V
Base cut-off current V_{CE} = 60 V; $-V_{BE}$ = 3 V	I_{BEX}	max.	–	20	nA
Collector cut-off current V_{CE} = 60 V; $-V_{BE}$ = 3 V	I_{CEX}	max.	–	10	nA
Emitter cut-off current $I_C = 0$; V_{EB} = 3 V	I_{EBO}	max.	–	10	nA
Collector cut-off current $I_E = 0$; V_{CB} = 50 V	I_{CBO}	max.	10	–	nA
$I_E = 0$; V_{CB} = 60 V	I_{CBO}	max.	–	10	nA
$I_E = 0$; V_{CB} = 50 V; T_{amb} = 125 °C	I_{CBO}	max.	10	–	μA
$I_E = 0$; V_{CB} = 60 V; T_{amb} = 125 °C	I_{CBO}	max.	–	10	μA

			PN2222	PN2222 / PN2222A	PN2222A	
D.C. current gain						
I_C = 0,1 mA; V_{CE} = 10 V	h_{FE}	min.		35		
I_C = 1 mA; V_{CE} = 10 V	h_{FE}	min.		50		
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	min.		75		
I_C = 10 mA; V_{CE} = 10 V; T_{amb} = −55 °C	h_{FE}	min.	–		35	
I_C = 150 mA; V_{CE} = 10 V	h_{FE}	min. max.		100 300		
I_C = 150 mA; V_{CE} = 1 V	h_{FE}	min.	30	50	–	
I_C = 500 mA; V_{CE} = 10 V	h_{FE}	min.	30		40	
Saturation voltages						
I_C = 150 mA; I_B = 15 mA	V_{CEsat}	max.	0,4		0,3	V
I_C = 500 mA; I_B = 50 mA	V_{CEsat}	min.	1,6		1,0	V
I_C = 150 mA; I_B = 15 mA	V_{BEsat}	max.	1,3		–	V
I_C = 150 mA; I_B = 15 mA	V_{BEsat}	min. max.			0,6 1,2	V V
I_C = 500 mA; I_B = 50 mA	V_{BEsat}	max.	2,6		2,0	V
Transition frequency at f = 100 MHz						
I_C = 20 mA; V_{CE} = 20 V; T_{amb} = 25 °C	f_T	min.	250		300	MHz
Output capacitance at f = 1 MHz						
I_E = 0; V_{CB} = 10 V	C_c	max.		8,0		pF
Input capacitance at f = 1 MHz						
I_C = 0; V_{EB} = 0,5 V	C_e	max.	30		25	pF
Input impedance at f = 1 kHz						
I_C = 1 mA; V_{CE} = 10 V; T_{amb} = 25 °C	h_{ie}	min. max.	– –		2,0 8,0	kΩ kΩ
I_C = 10 mA; V_{CE} = 10 V; T_{amb} = 25 °C	h_{ie}	min. max.	– –		0,25 1,25	kΩ kΩ
Voltage feedback ratio at f = 1 kHz						
I_C = 1 mA; V_{CE} = 10 V; T_{amb} = 25 °C	h_{re}	max.	–		$8,0 \times 10^{-4}$	
I_C = 10 mA; V_{CE} = 10 V; T_{amb} = 25 °C	h_{re}	max.	–		$4,0 \times 10^{-4}$	
Small-signal current gain at f = 1 kHz						
I_C = 1 mA; V_{CE} = 10 V; T_{amb} = 25 °C	h_{fe}	min. max.	– –		50 300	
I_C = 10 mA; V_{CE} = 10 V; T_{amb} = 25 °C	h_{fe}	min. max.	– –		75 375	
Output admittance at f = 1 kHz						
I_C = 1 mA; V_{CE} = 10 V; T_{amb} = 25 °C	h_{oe}	min. max.	– –		5,0 35	µmhos µmhos
I_C = 10 mA; V_{CE} = 10 V; T_{amb} = 25 °C	h_{oe}	min. max.	– –		25 200	µmhos µmhos

			PN2222	PN2222A
Noise figure at R_S = 1 kΩ I_C = 100 μA; V_{CE} = 10 V; f = 1 kHz; T_{amb} = 25 °C	F	max.	–	4,0 dB
Switching times at T_{amb} = 25 °C				
Turn-on time (see Fig. 2) I_C = 150 mA; I_{Bon} = 15 mA V_{CC} = 30 V; $V_{EB(off)}$ = 0,5 V				
delay time	t_d	max.	–	10 ns
rise time	t_r	max.	–	25 ns
Turn-off time (see Fig. 3) I_C = 150 mA; I_{Bon} = I_{Boff} = 15 mA V_{CC} = 30 V				
storage time	t_s	max.	–	225 ns
fall time	t_f	max.	–	60 ns



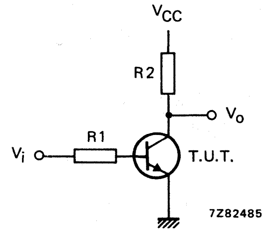
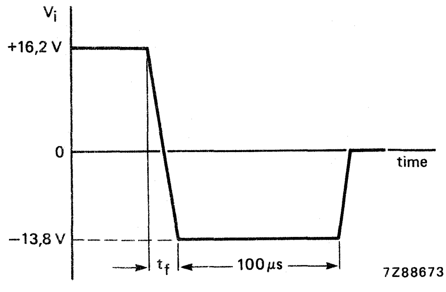


Fig. 2 Input waveform and test circuit for determining delay time and rise time.

V_i = –0,5 V 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	=	0,02	rise time	t_r	<	5 ns



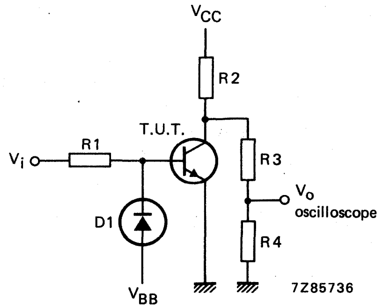


Fig. 3 Input waveform and test circuit for determining storage time and fall time.

SILICON PLANAR EPITAXIAL TRANSISTOR

NPN silicon planar epitaxial transistor in plastic TO-92 envelope intended for switching applications.

QUICK REFERENCE DATA

Collector-emitter voltage (open base)		V_{CEO}	max.	15	V
Collector-base voltage (open emitter)		V_{CBO}	max.	40	V
Collector current (DC)		I_C	max.	600	mA
Total device dissipation up to T_{amb} = 25 °C		P_{tot}	max.	625	mW
Collector-emitter saturation voltage					
I_C = 10 mA; I_B = 1 mA	PN2369	V_{CEsat}	max.	0.25	V
I_C = 10 mA; I_B = 1 mA	PN2369A	V_{CEsat}	max.	0.20	V
DC current gain					
I_C = 10 mA; V_{CE} = 1 V	PN2369	h_{FE}	min.	40	
			max.	120	
I_C = 10 mA; V_{CE} = 0.35 V	PN2369A	h_{FE}	min.	40	
			max.	120	
Transition frequency at f = 100 MHz I_C = 10 mA; V_{CE} = 10 V		f_T	min.	500	MHz

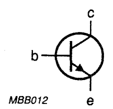
MECHANICAL DATA

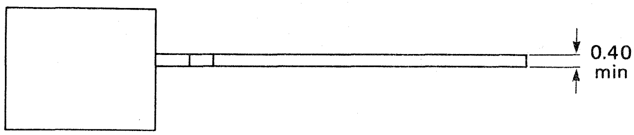
Dimensions in mm

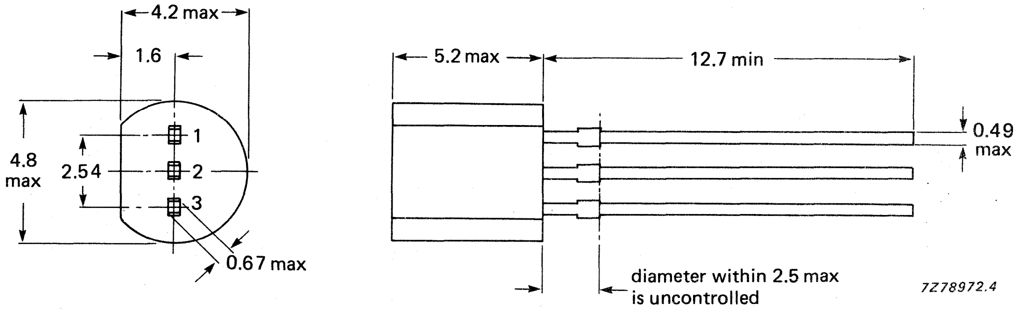
Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter







RATINGS

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

Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.5	V
Collector current (DC)	I_C	max.	500	mA
Total device dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	mW
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector-emitter breakdown voltage I_B = 0; I_C = 10 mA		$V_{(BR)CEO}$	min.	15	V
Collector-emitter breakdown voltage I_B = 10 μA; V_{BE} = 0		$V_{(BR)CES}$	min.	40	V
Collector-base breakdown voltage I_E = 0; I_C = 10 μA		$V_{(BR)CBO}$	min.	40	V
Emitter-base breakdown voltage I_E = 10 μA; I_C = 0		$V_{(BR)EBO}$	min.	4.5	V
Collector cut-off current V_{CB} = 20 V; I_E = 0		I_{CBO}	max.	0.4	μA
V_{CB} = 20 V; I_E = 0; T_A = 125 °C		I_{CBO}	max.	30	μA
DC current gain I_C = 10 mA; V_{CE} = 1 V	PN2369	h_{FE}	min. max.	40 120	
I_C = 10 mA; V_{CE} = 1 V; T_{amb} = 125 °C		h_{FE}	min.	20	
I_C = 100 mA; V_{CE} = 2 V		h_{FE}	min.	20	
I_C = 10 mA; V_{CE} = 0.35 V	PN2369A	h_{FE}	min. max.	40 120	
I_C = 30 mA; V_{CE} = 0.40 V		h_{FE}	>	30	
I_C = 100 mA; V_{CE} = 1.0 V		h_{FE}	>	20	
I_C = 10 mA; V_{CE} = 0.35 V; T_{amb} = −55 °C		h_{FE}	>	20	
Transition frequency at f = 100 MHz I_C = 10 mA; V_{CE} = 10 V		f_T	min.	500	MHz

Saturation voltages				
I_C = 10 mA; I_B = 1 mA	PN2369	V_{Cesat}	max.	0.25 V
I_C = 10 mA; I_B = 1 mA		V_{BEsat}	min. max.	0.70 V 0.85 V
I_C = 10 mA; I_B = 1 mA	PN2369A	V_{CEsat}	$<$	0.20 V
I_C = 30 mA; I_B = 3 mA		V_{CEsat}	$<$	0.25 V
I_C = 100 mA; I_B = 10 mA		V_{CEsat}	$<$	0.50 V
I_C = 10 mA, I_B = 10 mA		V_{CEsat}	$<$	0.30 V
I_C = 10 mA, I_B = 1 mA		V_{CEsat}	min. max.	0.70 V 0.85 V
Output capacitance at f = 1 MHz I_E = 0; V_{CB} = 5 V		C_c	max.	4 pF
Small-signal current gain at f = 100 MHz I_C = 10 mA; V_{CE} = 10 V; T_{amb} = 25 °C		h_{fe}	min.	5

Switching times

Storage time (see Fig.2) $I_{B\,on}$ = $I_{B\,off}$ = I_C = 10 mA; T_{amb} = 25 °C	t_s	typ. max.	5 ns 13 ns
Turn-on time (see Fig.3) I_C = 10 mA; V_{CC} = 3 V; $I_{B\,on}$ = 3 mA; T_{amb} = 25 °C	t_{on}	typ. max.	8 ns 12 ns
Turn-off time (see Fig.3) I_C = 10 mA; V_{CC} = 3 V; $I_{B\,on}$ = 3 mA; $I_{B\,off}$ = 1.5 mA; T_{amb} = 25 °C	t_{off}	typ. max.	10 ns 18 ns

Pulse generator:

t_r < 1 ns
t_p > 300 ns
δ < 0.02
R_s = 50 Ω

Oscilloscope:

R_i = 50 Ω
t_r < 1 ns

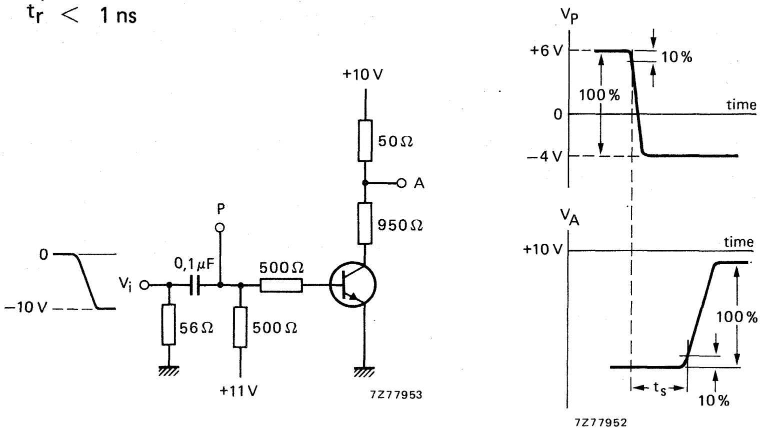


Fig.2 Test circuit and waveforms.

Pulse generator:

t_r < 1 ns
t_p > 300 ns
δ < 0.02
R_s = 50 Ω

Oscilloscope:

R_i = 50 Ω
t_r < 1 ns

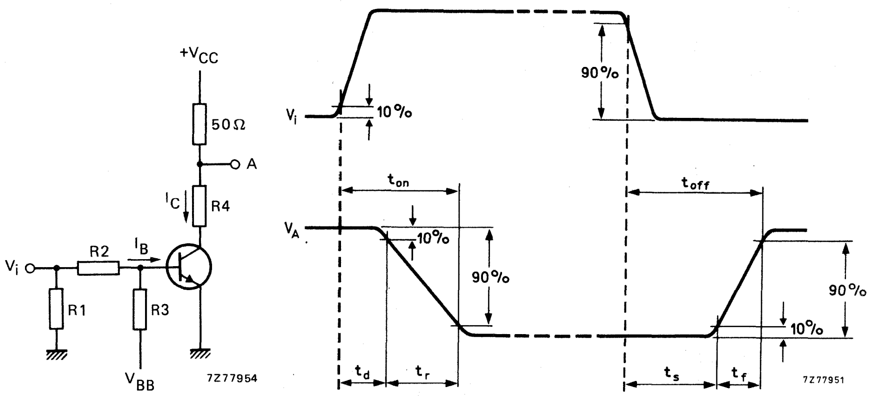


Fig.3 Test circuit and waveforms.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P silicon planar epitaxial transistors in plastic TO-92 envelope for general purpose applications.
N-P-N complement is PN2222/A.

QUICK REFERENCE DATA

			PN2907	PN2907A	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60		V
Collector current (d.c.)	$-I_C$	max.	600		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Collector-emitter saturation voltage $-I_C$ = 150 mA; $-I_B$ = 15 mA	$-V_{CEsat}$	max.	0,4		V
D.C. current gain $-I_C$ = 150 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	100		
		max.	300		

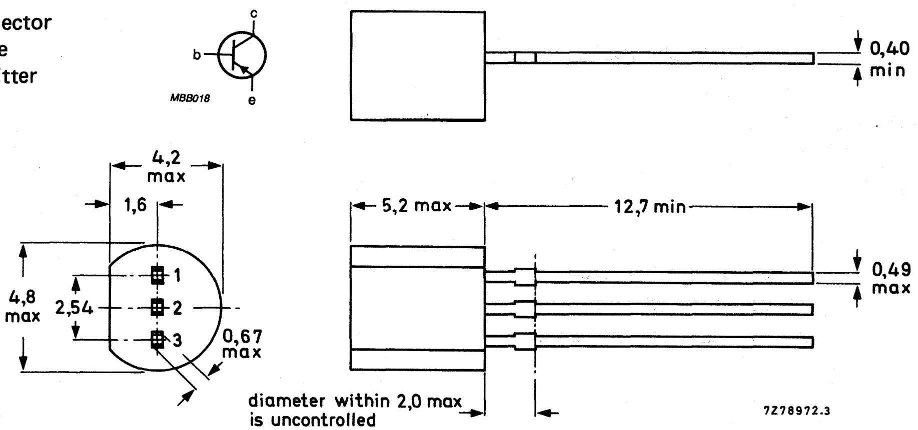
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



RATINGS

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

			PN2907	PN2907A	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60		V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5,0		V
Collector current (d.c.)	$-I_C$	max.	600		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			PN2907	PN2907A	
Collector-emitter breakdown voltage $I_B = 0$; $-I_C$ = 10 mA	$-V_{(BR)CEO}$	min.	40	60	V
Collector-base breakdown voltage $I_E = 0$; $-I_C$ = 10 µA	$-V_{(BR)CBO}$	min.	60		V
Emitter-base breakdown voltage $-I_E$ = 10 µA; $I_C = 0$	$-V_{(BR)EBO}$	min.	5,0		V
Base cut-off current $-V_{CE}$ = 30 V; $-V_{BE}$ = 0,5 V	$-I_{BEX}$	max.	50		nA
Collector cut-off current $-V_{CE}$ = 30 V; $-V_{BE}$ = 0,5 V	$-I_{CEX}$	max.	50		nA
Collector cut-off current $I_E = 0$; V_{CB} = 50 V	$-I_{CBO}$	max.	20	10	nA
$I_E = 0$; V_{CB} = 50 V; T_{amb} = 125 °C	$-I_{CBO}$	max.	20	10	µA
D.C. current gain $-I_C$ = 0,1 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	35	75	
$-I_C$ = 1,0 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	50	100	
$-I_C$ = 10 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	75	100	
$-I_C$ = 150 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	100	100	
		max.	300	300	
$-I_C$ = 500 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	30	50	

			PN2907 / PN2907A	
Saturation voltages				
$-I_C$ = 150 mA; $-I_B$ = 15 mA	$-V_{CEsat}$	max.	0,4	V
$-I_C$ = 500 mA; $-I_B$ = 50 mA	$-V_{CEsat}$	max.	1,6	V
$-I_C$ = 150 mA; $-I_B$ = 15 mA	$-V_{BEsat}$	max.	1,3	V
$-I_C$ = 150 mA; $-I_B$ = 50 mA	$-V_{BEsat}$	max.	2,6	V
Transition frequency at f = 100 MHz				
$-I_C$ = 50 mA; $-V_{CE}$ = 20 V; T_{amb} = 25 °C	f_T	min.	200	MHz
Output capacitance at f = 1 MHz				
I_E = 0; $-V_{CB}$ = 10 V; T_{amb} = 25 °C	C_c	max.	8,0	pF
Input capacitance at f = 1 MHz				
I_C = 0; $-V_{EB}$ = 2,0 V; T_{amb} = 25 °C	C_e	max.	30	pF

Switching times

Turn-on time (see Fig. 2)				
$-I_C$ = 150 mA; $-I_{Bon}$ = 15 mA; $-V_{CC}$ = 30 V	t_{on}	max.	45	ns
delay time	t_d	max.	10	ns
rise time	t_r	max.	40	ns
Turn-off time (see Fig. 3)				
$-I_C$ = 150 mA; $-I_{Bon}$ = I_{Boff} = 15 mA; $-V_{CC}$ = 6,0 V	t_{off}	max.	100	ns
storage time	t_s	max.	80	ns
fall time	t_f	max.	30	ns

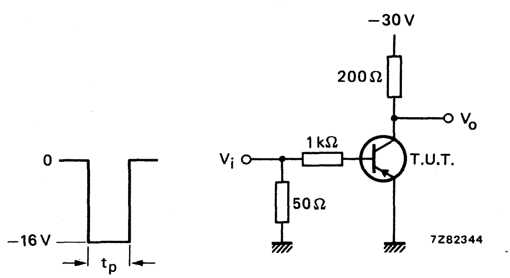


Fig. 2 Input waveform and test circuit for determining delay, rise and turn-on time.

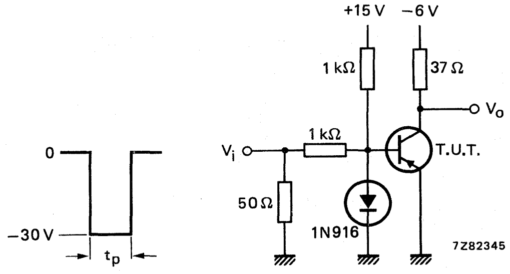


Fig. 3 Input waveform and test circuit for determining storage, fall and turn-off time.

Pulse generator (see Figs 2 and 3)

frequency	f	=	150 Hz
pulse duration	t_p	=	200 ns
rise time	t_r	⩽	2 ns
output impedance	Z_o	=	50 Ω

Oscilloscope (see Figs 2 and 3)

rise time	t_r	⩽	5 ns
input impedance	Z_i	⩽	10 MΩ

SILICON N-P-N HIGH-VOLTAGE TRANSISTORS

N-P-N high-voltage small-signal transistors in a TO-92 envelope and intended for use in telephony and professional communication equipment.

Complementary type is PN5415/5416.

QUICK REFERENCE DATA

			PN3439	PN3440	
Collector-base voltage (open emitter)	V_{CBO}	max.	400	300	V
Collector-emitter voltage (open base)	V_{CEO}	max.	350	250	V
Collector current (d.c.)	I_C	max.	1,0	1,0	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	625	mW
Junction temperature	T_j	max.	150	150	°C
Collector-emitter saturation voltage I_C = 50 mA; I_B = 4 mA	V_{CEsat}	<	0,5	0,5	V
D.C. current gain I_C = 2 mA; V_{CE} = 10 V	h_{FE}	>	30		
I_C = 20 mA; V_{CE} = 10 V	h_{FE}	>		40	

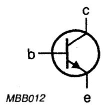
MECHANICAL DATA

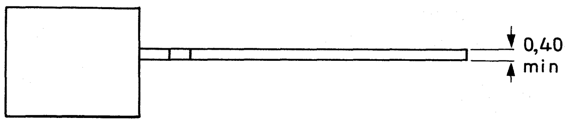
Dimensions in mm

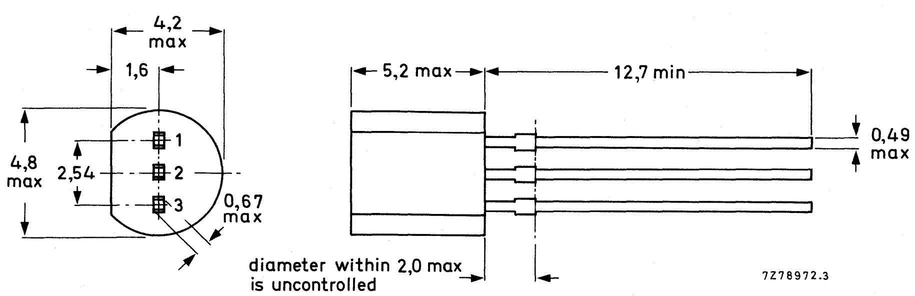
Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter







RATINGS

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

			PN3439	PN3440	
Collector-base voltage (open emitter)	V_{CBO}	max.	400	300	V
Collector-emitter voltage (open base)	V_{CEO}	max.	350	250	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5,0		V
Collector current (d.c.)	I_C	max.	1,0		A
Base current	I_B	max.	0,5		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Junction temperature	T_j	max.	150		°C
Storage temperature range	T_j		−65 to 150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			PN3439	PN3440	
Collector cut-off currents					
$I_E = 0$; V_{CB} = 360 V	I_{CBO}	<	0,1		μA
$I_E = 0$; V_{CB} = 250 V	I_{CBO}	<		0,1	μA
$I_B = 0$; V_{CE} = 300 V	I_{CEO}	<	1,0		μA
$I_B = 0$; V_{CE} = 200 V	I_{CEO}	<		1,0	μA
Emitter cut-off current $I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	10	10	μA
Collector-emitter sustaining voltage $I_B = 0$; I_C = 50 mA	V_{CEOsus}	>	350	250	V
Saturation voltages I_C = 50 mA; I_B = 4 mA	V_{CEsat}	<	0,5	0,5	V
	V_{BEsat}	<	1,3	1,3	V
D.C. current gain					
I_C = 2 mA; V_{CE} = 10 V	h_{FE}	>	30		
I_C = 20 mA; V_{CE} = 10 V	h_{FE}	>		40	
Transition frequency at f = 5 MHz I_C = 10 mA; V_{CE} = 10 V; T_{amb} = 25 °C	f_T	>	70		MHz
Small-signal current gain at f = 1 kHz I_C = 5 mA; V_{CE} = 10 V; T_{amb} = 25 °C	h_{fe}	>	25		
Real part (Re) of input impedance (h_{ie}) V_{CE} = 10 V; I_C = 5 mA; f = 1 MHz; T_{amb} = 25 °C	$Re(h_{ie})$	<	300		Ω
Input capacitance at f = 1 MHz $I_C = 0$; V_{EB} = 5 V; T_{amb} = 25 °C	C_e	<	20		pF
Output capacitance at f = 1 MHz $I_E = 0$; V_{CB} = 10 V; T_{amb} = 25 °C	C_c	<	2,0		pF

SILICON P-N-P HIGH-VOLTAGE TRANSISTORS

P-N-P high-voltage small-signal transistors in a TO-92 envelope and intended for use in telephony and professional communication equipment.

Complementary type is PN3439/3440.

QUICK REFERENCE DATA

			PN5415	PN5416	
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.	1,0	1,0	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	625	mW
Junction temperature	T_j	max.	150	150	°C
Collector-emitter saturation voltage $-I_C$ = 50 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	<	0,8	0,8	V
D.C. current gain $-I_C$ = 50 mA; $-V_{CE}$ = 10 V	h_{FE}	>	30	30	
		<	150	120	

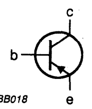
MECHANICAL DATA

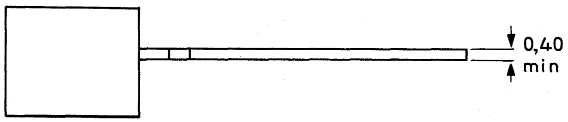
Dimensions in mm

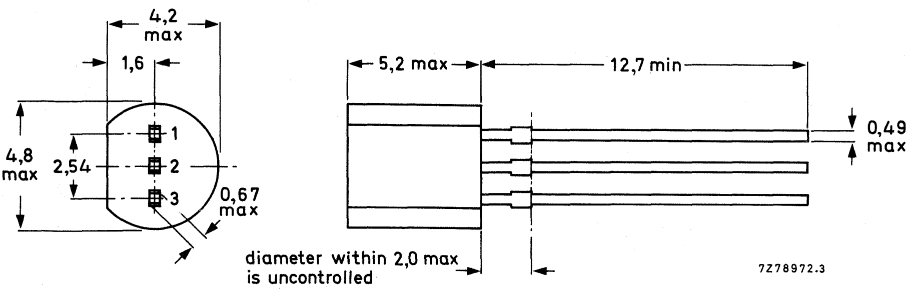
Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter







RATINGS

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

			PN5415	PN5416	
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.	4,0	6,0	V
Collector current (d.c.)	$-I_C$	max.	1,0		A
Base current	$-I_B$	max.	0,5		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Junction temperature	T_j	max.	150		°C
Storage temperature range	T_{stg}		−65 to 150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			PN5415	PN5416	
Collector cut-off currents					
$I_E = 0$; $-V_{CB}$ = 175 V	$-I_{CBO}$	<	0,1		μA
$I_E = 0$; $-V_{CB}$ = 280 V	$-I_{CBO}$	<		0,1	μA
$I_B = 0$; $-V_{CE}$ = 150 V	$-I_{CEO}$	<	1,0		μA
$I_B = 0$; $-V_{CE}$ = 250 V	$-I_{CEO}$	<		1,0	μA
Emitter cut-off current					
$I_C = 0$; $-V_{EB}$ = 4 V	$-I_{EBO}$	<	1,0		μA
$I_C = 0$; $-V_{EB}$ = 6 V	$-I_{EBO}$	<		1,0	μA
Collector-emitter sustaining voltage $I_B = 0$; $-I_C$ = 50 mA	$-V_{CEOsus}$	>	200	300	V
Saturation voltages $-I_C$ = 50 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	<	0,8	0,8	V
	$-V_{BEsat}$	<	1,0	1,0	V
D.C. current gain $-I_C$ = 50 mA; $-V_{CE}$ = 10 V	h_{FE}	>	30	30	
	h_{FE}	<	150	120	
Transition frequency at f = 5 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 10 V; T_{amb} = 25 °C	f_T	>	15		MHz
Small-signal current gain at f = 5 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 10 V; T_{amb} = 25 °C	h_{fe}	>	25		
Real part (Re) of input impedance (h_{ie}) $-V_{CE}$ = 10 V; $-I_C$ = 5 mA; f = 1 MHz; T_{amb} = 25 °C	$Re(h_{ie})$	<	300		Ω
Input capacitance at f = 1 MHz $I_C = 0$; $-V_{EB}$ = 5 V; T_{amb} = 25 °C	C_e	<	75		pF
Output capacitance at f = 1 MHz $I_E = 0$; $-V_{CB}$ = 10 V; T_{amb} = 25 °C	C_c	<	15		pF

SILICON EPITAXIAL TRANSISTORS

NPN high voltage transistors in a SOT89 envelope, intended for surface-mounted applications. They are primarily intended for use in telephony and professional communications equipment.

QUICK REFERENCE DATA

			PXTA42	PXTA43	
Collector-base voltage (open emitter)	V_{CBO}	max.	300	200	V
Collector-emitter voltage (open base)	V_{CEO}	max.	300	200	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6		V
Collector current (DC)	I_C	max.	500		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	1.0		W
Junction temperature	T_j	max.	150		°C
DC current gain I_C = 10 mA; V_{CE} = 10 V	h_{FE}	min.	40		
Transition frequency at f = 35 MHz I_C = 10 mA; V_{CE} = 20 V	f_T	min.	50		MHz
Feedback capacitance at f = 1 MHz I_C = 0; V_{CE} = 20 V	C_{re}	max.	3	4	pF

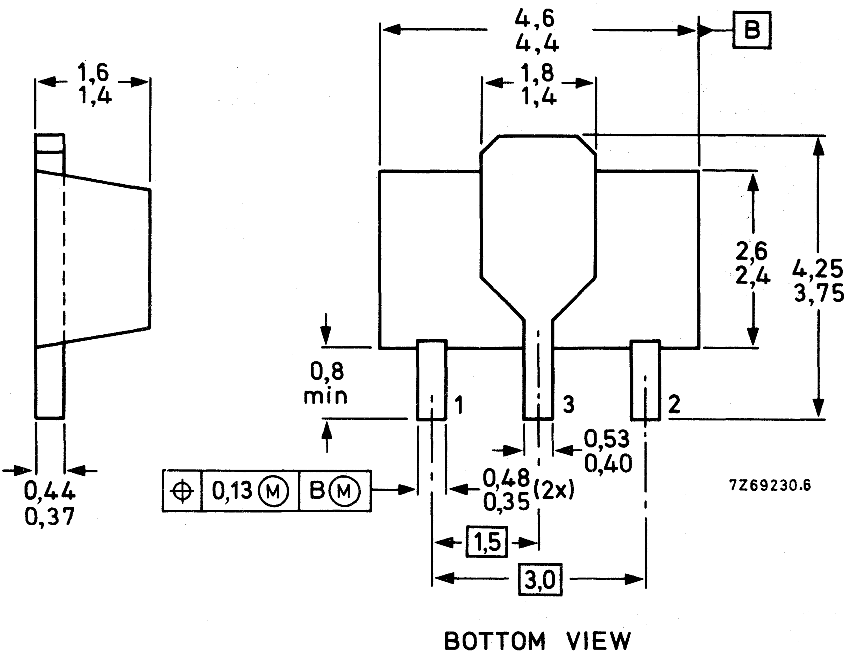
MECHANICAL DATA

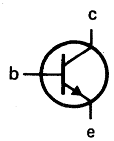
Dimensions in mm

Fig.1 SOT89.

Marking code

PXTA42 = p1D
PXTA43 = p1E





RATINGS

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

			PXTA42	PXTA43	
Collector-base voltage (open emitter)	V_{CBO}	max.	300	200	V
Collector-emitter voltage (open base)	V_{CEO}	max.	300	200	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6		V
Collector current (DC)	I_C	max.	500		mA
Total power dissipation* up to T_{amb} = 25 °C	P_{tot}	max.	1.0		W
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL CHARACTERISTICS

Thermal resistance from junction to ambient*	$R_{th\ j\text{-}a}$	=	125	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			PXTA42	PXTA43	
Collector-emitter breakdown voltage** I_C = 1 mA; I_B = 0	$V_{(BR)CEO}$	min.	300	200	V
Collector-base breakdown voltage I_C = 100 μA; I_E = 0	$V_{(BR)CBO}$	min.	300	200	V
Emitter-base breakdown voltage I_E = 100 μA; I_C = 0	$V_{(BR)EBO}$	min.	6	6	V
Collector cut-off current I_E = 0; V_{CB} = 200 V	I_{CBO}	max.	0.1	—	μA
I_E = 0; V_{CB} = 160 V	I_{CBO}	max.	—	0.1	μA
Emitter cut-off current I_C = 0; V_{BE} = 6 V	I_{EBO}	max.	0.1	—	μA
I_C = 0; V_{BE} = 4 V	I_{EBO}	max.	—	0.1	μA
Feedback capacitance at f = 1 MHz I_E = 0; V_{CB} = 20 V	C_{re}	max.	3	4	pF

* Mounted on a ceramic substrate; area = 2.5 cm^2; thickness = 0.7 mm.
** Pulse test conditions t_p = 300 μs; δ = 0.02.

Saturation voltages				
I_C = 20 mA; I_B = 2 mA	V_{CEsat}	max.	0.5	V
	V_{BEsat}	max.	0.9	V
DC current gain				
I_C = 1 mA; V_{CE} = 10 V		min.	25	
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	min.	40	
I_C = 30 mA; V_{CE} = 10 V		min.	40	
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 20 V	f_T	min.	50	MHz

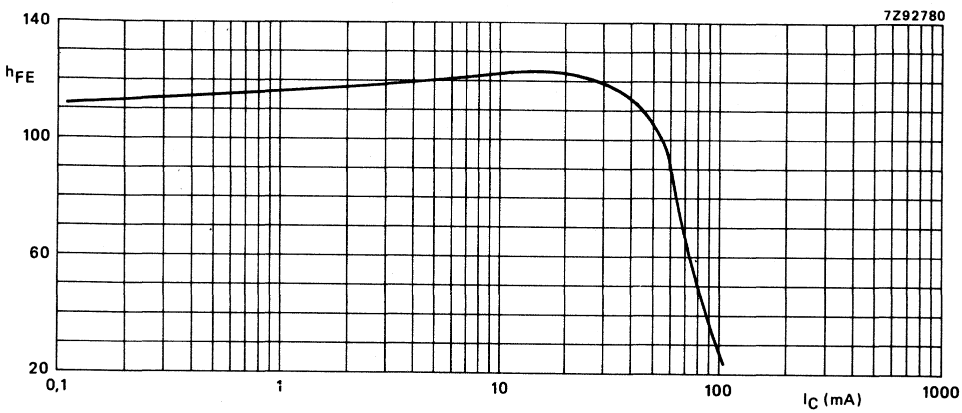


Fig. 2 T_j = 25 °C; V_{CE} = 20 V; typical values.

SILICON EPITAXIAL TRANSISTORS

PNP high voltage transistors in a SOT89 envelope, intended for surface-mounted applications. They are primarily intended for use in telephony and professional communications equipment.

QUICK REFERENCE DATA

			PXTA92	PXTA93	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	300	200	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	300	200	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current (DC)	$-I_C$	max.	500		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	1.0		W
DC current gain $-I_C$ = 10 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	40		
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 20 V	f_T	min.	50		MHz
Collector-base capacitance at f = 1 MHz I_E = 0; $-V_{CB}$ = 20 V	C_{cb}	max.	6	8	pF

MECHANICAL DATA

Dimensions in mm

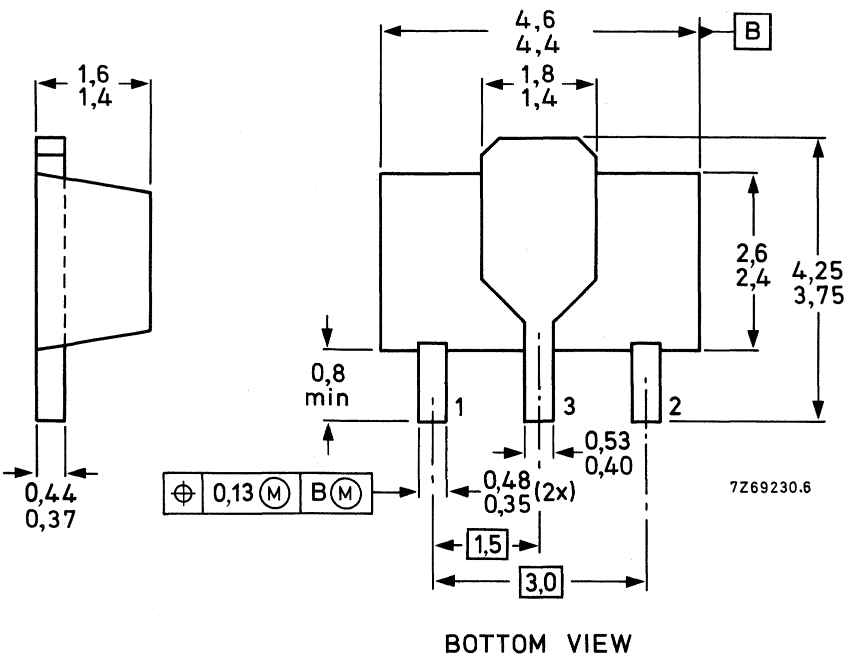
Fig.1 SOT89.

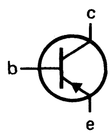
Marking code

PXTA92: p2D
PXTA93: p2E

Pinning:

1 = emitter
2 = base
3 = collector





RATINGS

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

			PXTA92	PXTA93	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	300	200	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	300	200	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current (DC)	$-I_C$	max.	500		mA
Total power dissipation * up to T_{amb} = 25 °C	P_{tot}	max.	1.0		W
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL CHARACTERISTICS

Thermal resistance from junction to ambient*	$R_{th\ j\text{-}a}$	=	125	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			PXTA92	PXTA93	
Collector-emitter breakdown voltage $-I_C$ = 1 mA; I_B = 0	$-V_{(BR)CEO}$	min.	300	200	V
Collector-base breakdown voltage $-I_C$ = 100 μA; I_E = 0	$-V_{(BR)CBO}$	min.	300	200	V
Collector cut-off current $-V_{CB}$ = 200 V; I_E = 0	$-I_{CBO}$	max.	0.25	–	μA
$-V_{CB}$ = 160 V; I_E = 0	$-I_{CBO}$	max.	–	0.25	μA
Emitter-base breakdown voltage $-I_E$ = 100 μA; I_C = 0	$-V_{(BR)EBO}$	min.	5		V
Emitter cut-off current I_C = 0; $-V_{BE}$ = 3 V	$-I_{EBO}$	max.	0.1		μA
Collector-base capacitance at f = 1 MHz; I_E = 0; $-V_{CB}$ = 20 V	C_{cb}	max.	6	8	pF
Saturation voltages $-I_C$ = 20 mA; $-I_B$ = 2 mA	$-V_{CEsat}$	max.	0.5		V
$-I_C$ = 20 mA; $-I_B$ = 2 mA	$-V_{BEsat}$	max.	0.9		V
DC current gain** $-I_C$ = 1 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	25		
$-I_C$ = 10 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	40		
$-I_C$ = 30 mA; $-V_{CE}$ = 10 V	h_{FE}	min.	25		
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 20 V	f_T	min.	50		MHz

* Device mounted on a ceramic substrate; area 2.5 cm^2; thickness 0.7 mm.
** Pulse test conditions: t_p = 300 μs; duty factor ≤ 2%.

N-P-N SILICON PLANAR TRANSISTOR

N-P-N transistors in TO-18 metal envelopes with the collector connected to the case.

These devices are primarily intended for use in high performance, low-level, low-noise amplifier applications both for direct current and for frequencies of up to 100 MHz.

QUICK REFERENCE DATA

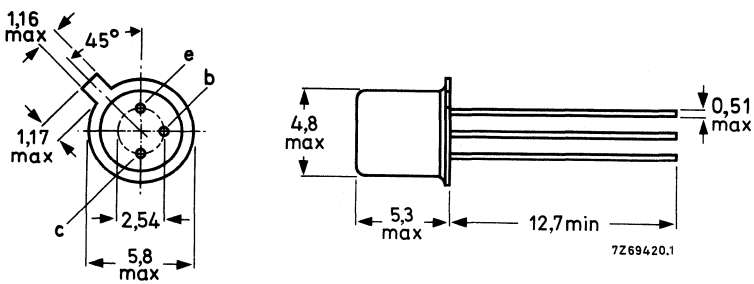
Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	V
Collector current (peak value)	I_{CM}	max.	60	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C				
I_C = 10 μA; V_{CE} = 5 V	h_{FE}	>	100	
		<	300	
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	>	150	
		<	600	
Transition frequency				
I_C = 0,5 mA; V_{CE} = 5 V	f_T	typ.	80	MHz
Noise figure at R_S = 10 kΩ				
I_C = 10 μA; V_{CE} = 5 V				
f = 10 Hz to 15 kHz	F	typ.	2	dB
		<	3	dB

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case.



RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	V
Collector-emitter voltage at V_{EB} = 0	V_{CES}	max.	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Collector current (d.c. or average over any 50 ms period)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	60	mA
Emitter current (d.c. or average over any 50 ms period)	$-I_E$	max.	35	mA
Emitter current (peak value)	$-I_{EM}$	max.	70	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0,5	K/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0,25	K/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 45$ V	I_{CBO}	<	10	nA
$I_B = 0$; $V_{CE} = 5$ V	I_{CEO}	<	2	nA
$V_{EB} = 0$; $V_{CB} = 45$ V	I_{CES}	<	10	nA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA
Emitter-base voltage				
$-I_E = 0{,}5$ mA; $V_{CB} = 5$ V	$-V_{EB}$		0,6 to 0,8	V
Saturation voltages				
$I_C = 10$ mA; $I_B = 0{,}5$ mA	V_{CEsat}	<	1	V
	V_{BEsat}		0,6 to 1	V
D.C. current gain				
$I_C = 10\ \mu$A; $V_{CE} = 5$ V	h_{FE}		100 to 300	
$I_C = 10\ \mu$A; $V_{CE} = 5$ V; $T_j = -55$ °C	h_{FE}	>	20	
$I_C = 500\ \mu$A; $V_{CE} = 5$ V	h_{FE}	>	150	
$I_C = 10$ mA; $V_{CE} = 5$ V	h_{FE}		150 to 600	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	8	pF
Transition frequency				
$I_C = 0{,}5$ mA; $V_{CE} = 5$ V	f_T	>	50	MHz
Cut-off frequency				
$I_C = 0{,}5$ mA; $V_{CE} = 5$ V	f_{hfe}	>	100	kHz
Noise figure (f = 10 Hz to 15 kHz)				
$I_C = 10\ \mu$A; $V_{CE} = 5$ V; $R_S = 10$ kΩ	F	typ.	2	dB
		<	3	dB
h parameters at f = 1 kHz				
$I_C = 1$ mA; $V_{CE} = 5$ V				
Input impedance	h_{ie}	typ.	10,0	kΩ
Reverse voltage transfer	h_{re}	typ.	5,5	10^{-4}
Small signal current gain	h_{fe}	typ.	350	
			150 to 600	
Output admittance	h_{oe}	typ.	25	μS

SILICON PLANAR TRANSISTOR

N-P-N double diffused transistor in a TO-39 metal envelope designed for a wide variety of applications including d.c. amplifiers, high-speed switching and high-speed amplifiers.

QUICK REFERENCE DATA

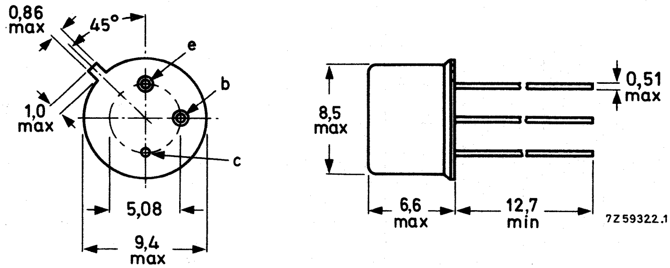
Collector-base voltage (open emitter)	V_{CBO}	max.	75	V
Collector-emitter voltage ($R_{BE} \leqslant 10\ \Omega$)	V_{CER}	max.	50	V
Collector current (peak value)	I_{CM}	max.	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0,8	W
D.C. current gain at T_j = 25 °C I_C = 150 mA; V_{CE} = 10 V	h_{FE}		40 to 120	
Transition frequency at f = 20 MHz I_C = 50 mA; V_{CE} = 10 V	f_T	>	60	MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 002-104.

RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	75	V
Collector-emitter voltage ($R_{BE} \leqslant 10\ \Omega$)	V_{CER}	max.	50	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V
Collector current (peak value)*	I_{CM}	max.	500	mA
Total power dissipation				
up to T_{amb} = 25 °C	P_{tot}	max.	0,8	W
at T_{case} = 100 °C	P_{tot}	max.	1,7	W
up to T_{case} = 25 °C	P_{tot}	max.	3,0	W
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	200	°C
Lead soldering temperature $>$ 1,5 mm from the seating plane; $t_{sld} < 10$ s.	T_{sld}	max.	300	°C

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}c}$	=	58,3	K/W

* With the exception of the collector current all other data are Jedec registered.

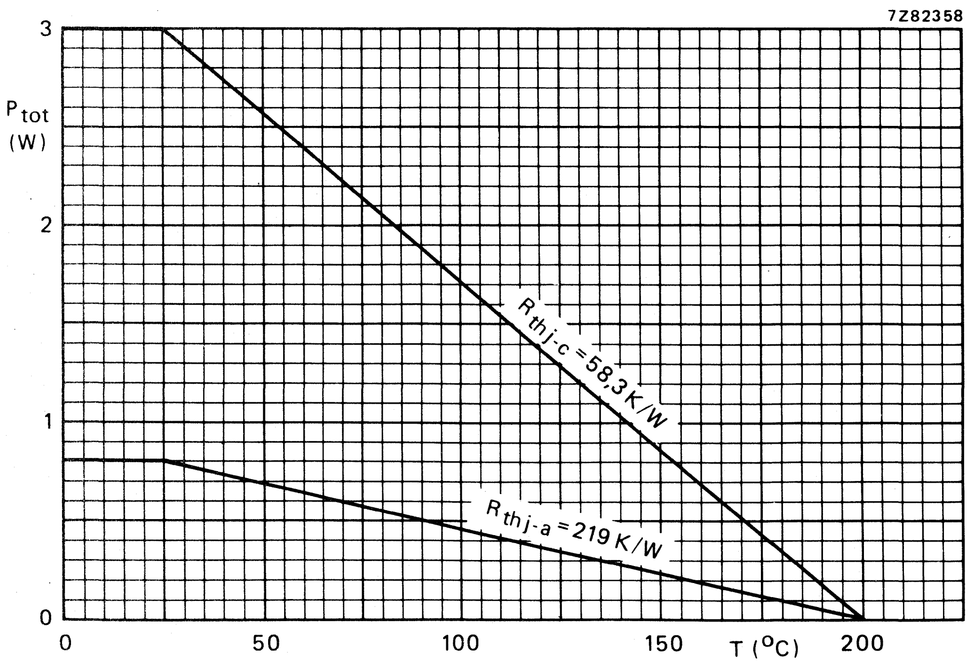


Fig. 2 Maximum permissible total power dissipation as a function of temperature.

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	10 nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	<	10 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10 nA
Collector-base breakdown voltage			
open emitter; $I_C = 100$ μA	$V_{(BR)CBO}$	>	75 V
Collector-emitter breakdown voltage*			
$I_C = 100$ mA; $R_{BE} \leqslant 10\ \Omega$	$V_{(BR)CER}$	>	50 V
Emitter-base breakdown voltage			
open collector; $I_E = 100$ μA	$V_{(BR)EBO}$	>	7 V
Saturation voltages*			
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	1,5 V
	V_{BEsat}	<	1,3 V
D.C. current gain			
$I_C =$ 0,1 mA; $V_{CE} = 10$ V	h_{FE}	>	20
$I_C =$ 10 mA; $V_{CE} = 10$ V*	h_{FE}	>	35
$I_C =$ 10 mA; $V_{CE} = 10$ V; $T_{amb} = -55$ °C	h_{FE}	>	20
$I_C = 150$ mA; $V_{CE} = 10$ V*	h_{FE}		40 to 120
$I_C = 500$ mA; $V_{CE} = 10$ V*	h_{FE}	>	20
Transition frequency at f = 20 MHz			
$I_C =$ 50 mA; $V_{CE} = 10$ V	f_T	>	60 MHz
Collector capacitance			
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	25 pF
Emitter capacitance			
$I_C = I_c = 0$; $V_{EB} = 0,5$ V	C_e	<	80 pF
Noise figure at f = 1 kHz			
$I_C = 0,3$ mA; $V_{CE} = 10$ V; $R_S = 510\ \Omega$; B = 1 Hz	F	<	12 dB

h-parameters at f = 1 kHz

Input impedance			
$I_C = 1$ mA; $V_{CB} =$ 5 V	h_{ib}		24 to 34 Ω
$I_C = 5$ mA; $V_{CB} = 10$ V	h_{ib}		4 to 8 Ω
Reverse voltage transfer ratio			
$I_C = 1$ mA; $V_{CE} =$ 5 V	h_{rb}	<	3 10^{-4}
$I_C = 5$ mA; $V_{CE} = 10$ V	h_{rb}	<	3 10^{-4}
Small-signal current gain			
$I_C = 1$ mA; $V_{CE} =$ 5 V	h_{fe}		30 to 100
$I_C = 5$ mA; $V_{CE} = 10$ V	h_{fe}		35 to 150

* Measured under pulse conditions to avoid excessive dissipation: $t_p = 300$ μs; $\delta \leqslant 0,02$.

Output admittance			
$I_C = 1$ mA; $V_{CE} = 5$ V	h_{ob}		0,05 to 0,5 μS
$I_C = 5$ mA; $V_{CE} = 10$ V	h_{ob}		0,05 to 0,5 μS
Total switching time (see Figs 3 to 6)			
$I_{Con} = 50$ mA; $V_{BEon} = -V_{BEoff} = 1$ V	$t_{on} + t_{off}$	<	30 ns

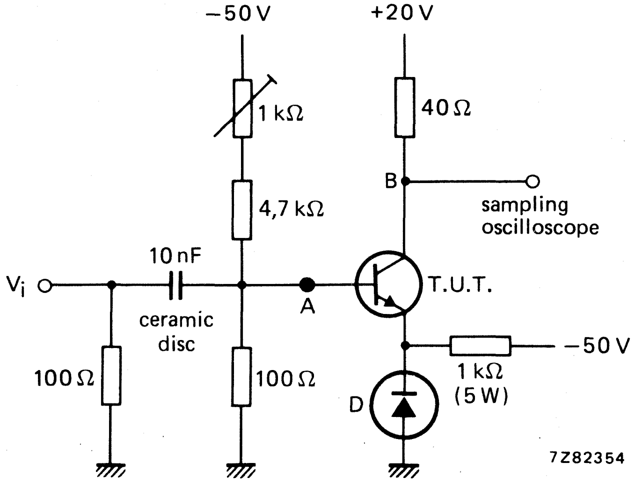


Fig. 3 Turn-on plus turn-off measuring circuit. D = BAW62.

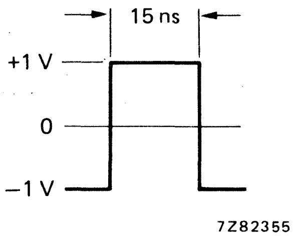


Fig. 4 Waveform at "A".
Pulse generator: t_r; t_f < 1 ns.

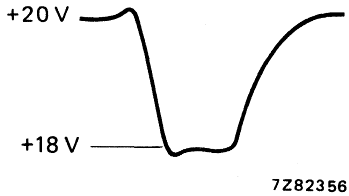


Fig. 5 Waveform at "B".

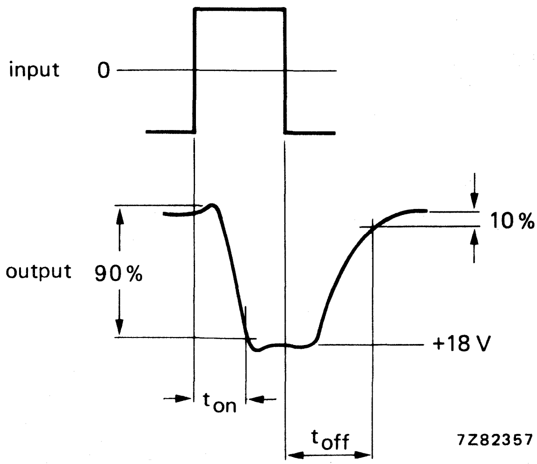


Fig. 6 Turn-on and turn-off time.

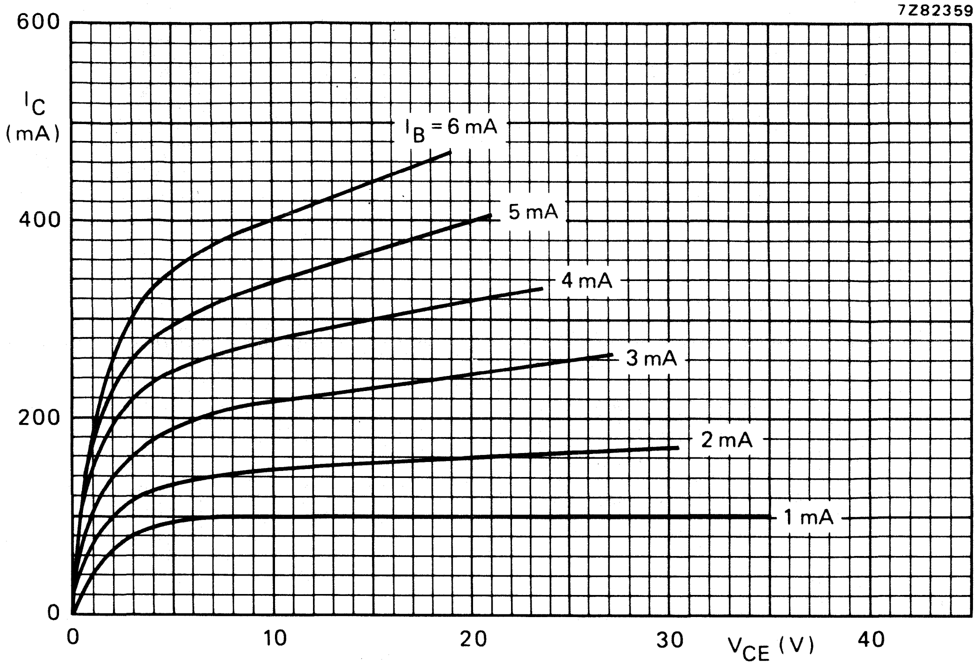


Fig. 7 T_j = 25 °C; typical values.

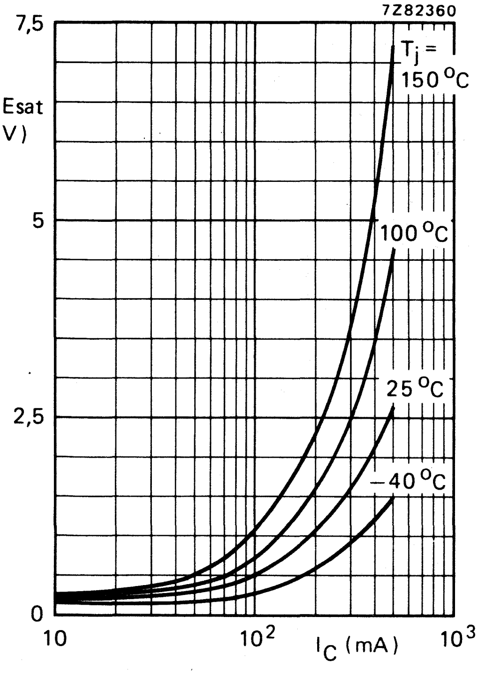


Fig. 8 I_C/I_B = 10; typical values.

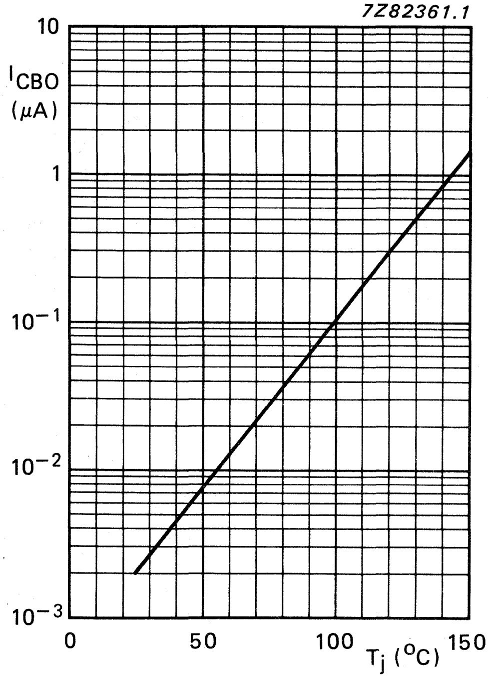


Fig. 9 V_{CB} = 60 V; typical values.

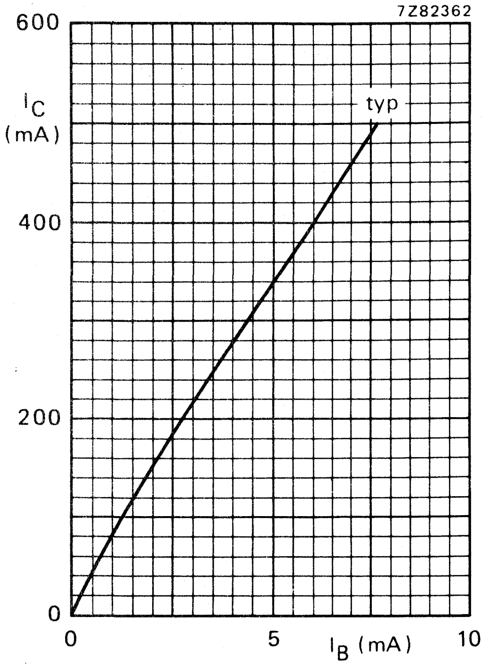


Fig. 10 $V_{CE} = 10$ V; $T_j = 25$ °C.

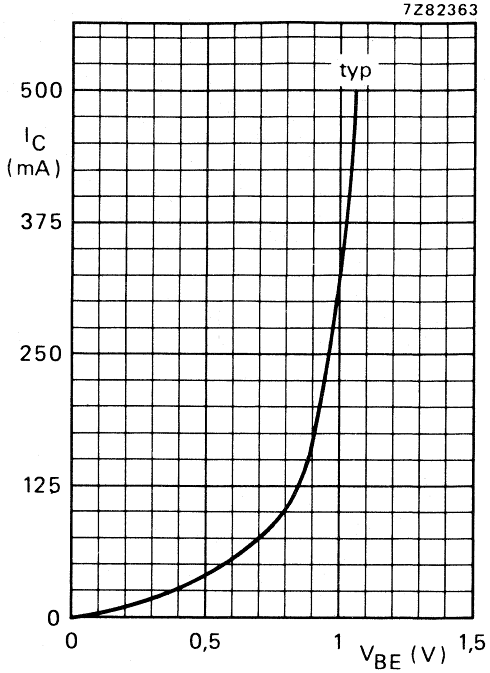


Fig. 11 $V_{CE} = 10$ V; $T_j = 25$ °C.

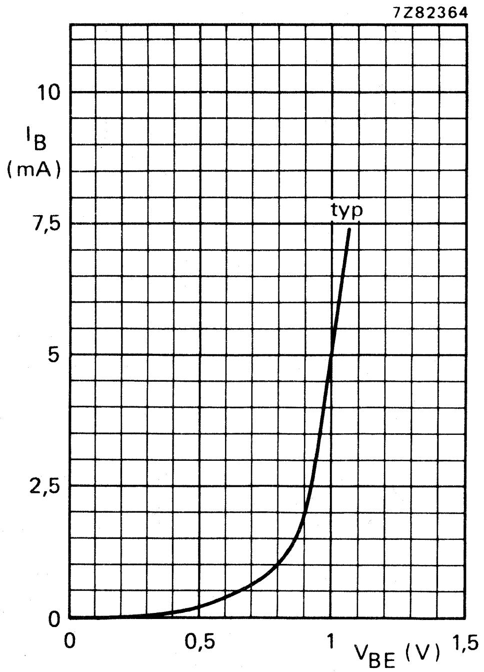


Fig. 12 $V_{CE} = 10$ V; $T_j = 25$ °C.

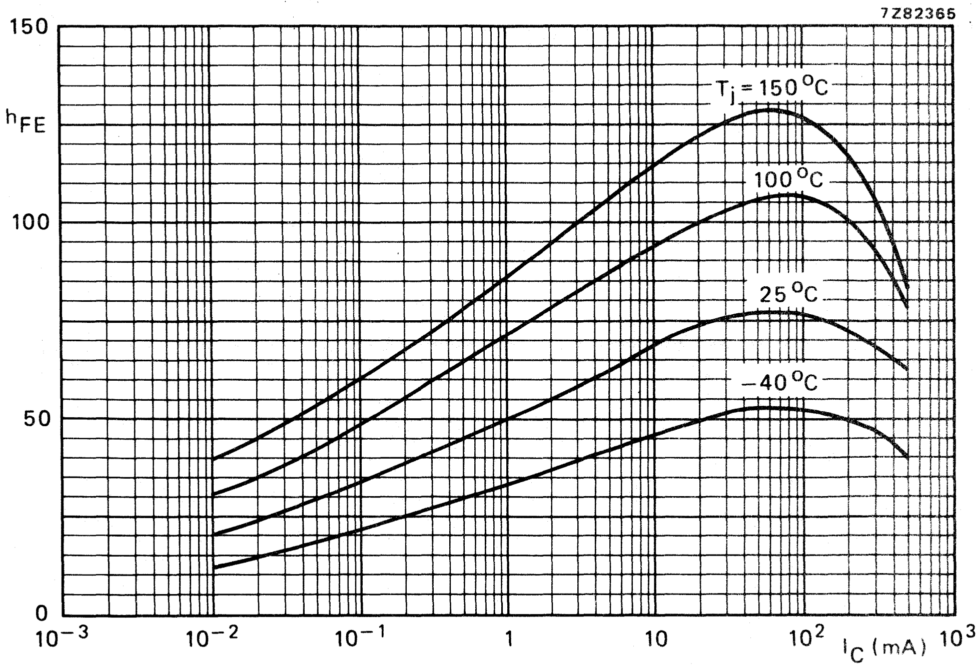


Fig. 13 $V_{CE} = 10$ V; typical values.

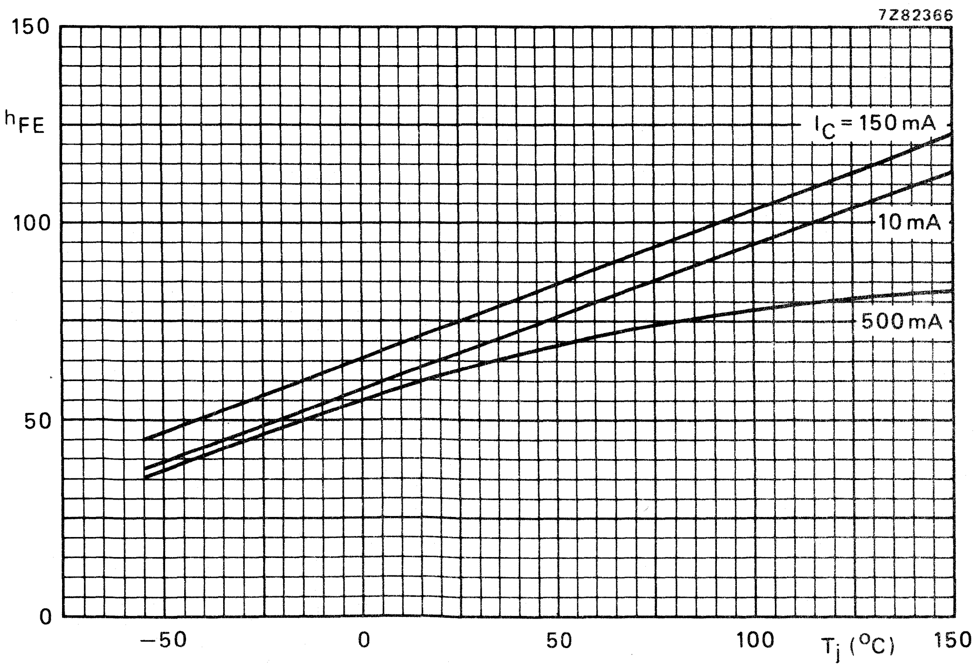


Fig. 14 $V_{CE} = 10$ V; typical values.

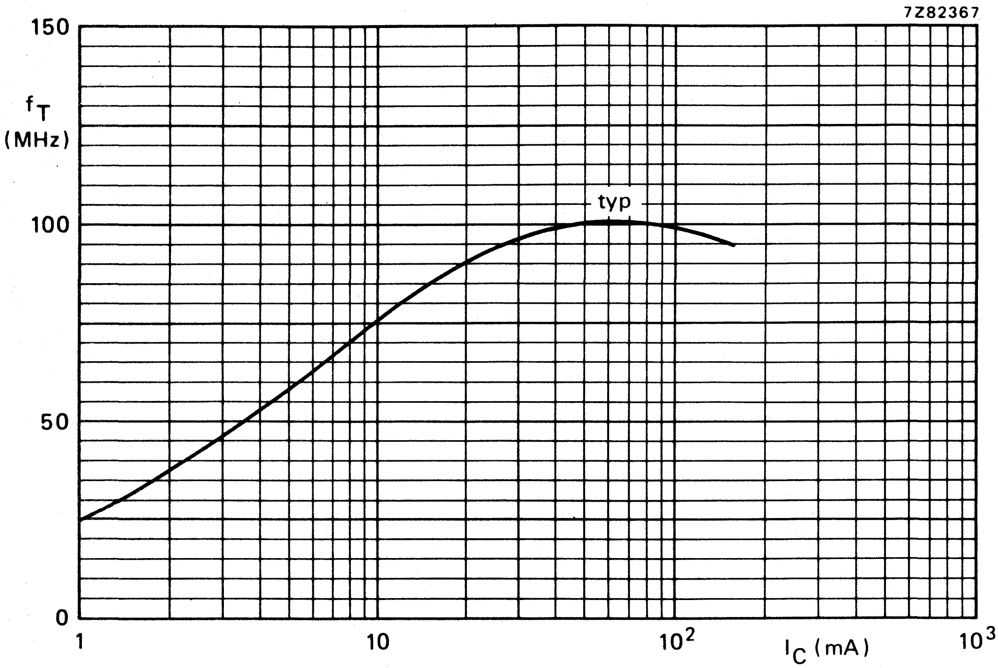


Fig. 15 V_{CE} = 10 V; f = 20 MHz; T_j = 25 °C.

SILICON PLANAR TRANSISTOR

N-P-N double diffused transistor in a TO-39 metal envelope designed for a wide variety of applications such as d.c. and wideband amplifiers.

QUICK REFERENCE DATA

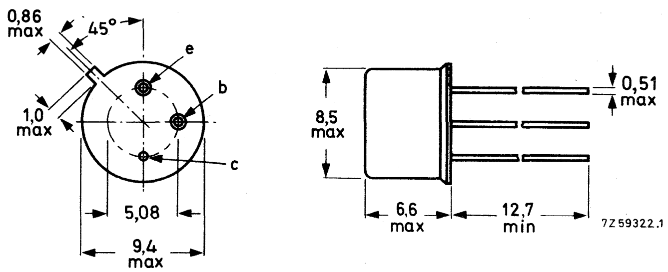
Collector-base voltage (open emitter)	V_{CBO}	max.	75	V
Collector-emitter voltage ($R_{BE} \leqslant 10\ \Omega$)	V_{CER}	max.	50	V
Collector current (peak value)	I_{CM}	max.	1,0	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0,8	W
D.C. current gain I_C = 150 mA; V_{CE} = 10 V	h_{FE}		100 to 300	
Transition frequency at f = 20 MHz I_C = 50 mA; V_{CE} = 10 V	f_T	>	70	MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 002-104.

RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	75	V
Collector-emitter voltage ($R_{BE} \leqslant 10\ \Omega$)	V_{CER}	max.	50	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7,0	V
Collector current (peak value)	I_{CM}	max.	1,0	A
Total power dissipation				
up to T_{amb} = 25 °C	P_{tot}	max.	0,8	W
up to T_{case} = 100 °C	P_{tot}	max.	1,7	W
up to T_{case} = 25 °C	P_{tot}	max.	3,0	W
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	200	°C
Lead soldering temperature				
> 1,5 mm from the seating plane; t_{sld} < 10 s	T_{sld}	max.	300	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	219	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	58,3	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	10 nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	<	10 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5{,}0$ V	I_{EBO}	<	5 nA
Collector-base breakdown voltage			
open emitter; $I_C = 100$ μA	$V_{(BR)CBO}$	>	75 V
Emitter-base breakdown voltage			
open collector; $I_E = 100$ μA	$V_{(BR)EBO}$	>	7,0 V
Collector-emitter sustaining voltage *			
$I_C = 100$ mA; $R_{BE} \leqslant 10\ \Omega$	$V_{CERsust}$	>	50 V
Saturation voltages *			
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0.5 V
	V_{BEsat}	<	1.3 V
D.C. current gain			
$I_C = 10$ μA ; $V_{CE} = 10$ V	h_{FE}	>	20
$I_C = 0{,}1$ mA; $V_{CE} = 10$ V	h_{FE}	>	35
$I_C = 10$ mA; $V_{CE} = 10$ V *	h_{FE}	>	75
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = -55$ °C	h_{FE}	>	35
$I_C = 150$ mA; $V_{CE} = 10$ V *	h_{FE}		100 to 300
$I_C = 500$ mA; $V_{CE} = 10$ V *	h_{FE}	>	40
Transition frequency at f = 20 MHz			
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	70 MHz
Collector capacitance			
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	25 pF
Emitter capacitance			
$I_C = I_c = 0$; $V_{EB} = 0{,}5$ V	C_e	<	80 pF
Noise figure at f = 1 kHz			
$I_C = 300$ μA; $V_{CE} = 10$ V; $R_S = 510\ \Omega$; B = 1 Hz	F	<	8,0 dB

h-parameters at f = 1 kHz

Input impedance			
$I_C = 1{,}0$ mA; $V_{CB} = 5{,}0$ V	h_{ib}		24 to 34 Ω
$I_C = 5{,}0$ mA; $V_{CB} = 10$ V	h_{ib}		4,0 to 8,0 Ω
Reverse voltage transfer ratio			
$I_C = 1{,}0$ mA; $V_{CB} = 5{,}0$ V	h_{rb}	<	5,0 10^{-4}
$I_C = 5{,}0$ mA; $V_{CB} = 10$ V	h_{rb}	<	5,0 10^{-4}
Small-signal current gain			
$I_C = 1{,}0$ mA; $V_{CE} = 5{,}0$ V	h_{fe}		50 to 200
$I_C = 5{,}0$ mA; $V_{CE} = 10$ V	h_{fe}		70 to 300

* Measured under pulse conditions to avoid excessive dissipation: $t_p \leqslant 300$ μs; $\delta \leqslant 0{,}02$.

Output admittance

I_C = 1,0 mA; V_{CE} = 5,0 V	h_{ob}	0,05 to 0,5 μS
I_C = 5,0 mA; V_{CE} = 10 V	h_{ob}	0,05 to 0,5 μS

SILICON TRANSISTOR

High voltage n-p-n transistor in a TO-39 metal envelope with the collector connected to the case. It is intended for use in high performance amplifier, oscillator and switching applications.

QUICK REFERENCE DATA

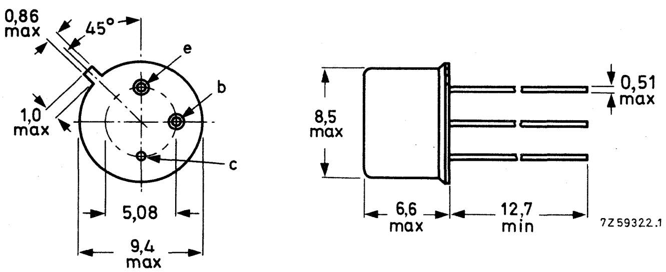
Collector-base voltage (open emitter)	V_{CBO}	max.	120	V
Collector-emitter voltage ($R_{BE} \leqslant 10\ \Omega$)	V_{CER}	max.	100	V
Collector current (d.c.)	I_C	max.	500	mA
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	3,0	W
Junction temperature	T_j	max.	200	°C
D.C. current gain				
I_C = 0,1 mA; V_{CE} = 10 V	h_{FE}	>	20	
I_C = 10 mA; V_{CE} = 10 V; T = −55 °C	h_{FE}	>	20	
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	>	35	
I_C = 150 mA; V_{CE} = 10 V	h_{FE}	40 to	120	

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 002-104.

RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	120	V
Collector-emitter voltage (open base)	V_{CEO}	max.	80	V
Collector-emitter voltage ($R_{BE} \leqslant 10\ \Omega$)	V_{CER}	max.	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7	V
Collector current (d.c.)	I_C	max.	500	mA
Total power dissipation				
up to T_{amb} = 25 °C	P_{tot}	max.	0,8	W
up to T_{case} = 100 °C	P_{tot}	max.	1,7	W
up to T_{case} = 25 °C	P_{tot}	max.	3,0	W
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	219	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	58,3	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = 90$ V	I_{CBO}	<	10 nA
$I_E = 0$; $V_{CB} = 90$ V; $T_{amb} = 150$ °C	I_{CBO}	<	15 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10 nA
Collector-emitter sustaining voltage *			
$I_C = 100$ mA; $R_{BE} \geqslant 10\ \Omega$	$V_{CERsust}$	>	100 V
$I_C = 30$ mA; $I_B = 0$	$V_{CEOsust}$	>	80 V
Saturation voltages *			
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0.5 V
	V_{BEsat}	<	1.3 V
$I_C = 50$ mA; $I_B = 5$ mA	V_{CEsat}	<	0.9 V
	V_{BEsat}	<	1.2 V
Breakdown voltages			
$I_E = 0$; $I_C = 100$ μA	$V_{(BR)CBO}$	>	120 V
$I_C = 0$; $I_E = 100$ μA	$V_{(BR)EBO}$	>	7,0 V
D.C. current gain			
$I_C = 0{,}1$ mA; $V_{CE} = 10$ V	h_{FE}	>	20
$I_C = 10$ mA; $V_{CE} = 10$ V; $T = -55$ °C	h_{FE}	>	20
$I_C = 10$ mA; $V_{CE} = 10$ V *	h_{FE}	>	35
$I_C = 150$ mA; $V_{CE} = 10$ V *	h_{FE}		40 to 120

* Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration $t \leqslant 300$ μs, duty cycle $\delta < 0{,}02$.

CHARACTERISTICS (continued)

h parameters at f = 1 kHz (common base)

I_C = 1 mA; V_{CE} = 5 V			
Input impedance	h_{ib}		20 to 30 Ω
Reverse voltage transfer ratio	h_{rb}		1,25 10^{-4}
Output conductance	h_{ob}		0,5 μS
I_C = 5 mA; V_{CE} = 10 V			
Input impedance	h_{ib}		4 to 8 Ω
Reverse voltage transfer ratio	h_{rb}		1,50 10^{-4}
Output conductance	h_{ob}		0,5 μS
Small signal current gain (common emitter)			
I_C = 1 mA; V_{CE} = 5 V; f = 1 kHz	h_{fe}		30 to 100
I_C = 5 mA; V_{CE} = 10 V; f = 1 kHz	h_{fe}	>	45
I_C = 50 mA; V_{CE} = 10 V; f = 20 MHz	h_{fe}	>	2,5
Collector capacitance			
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	15 pF
Emitter capacitance			
$I_C = I_c = 0$; V_{EB} = 0,5 V	C_e	<	85 pF

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a TO-39 metal envelope with the collector connected to the case. They are primarily intended for high speed switching. The 2N2219 is also suitable for d.c. and v.h.f./u.h.f. amplifiers.

QUICK REFERENCE DATA

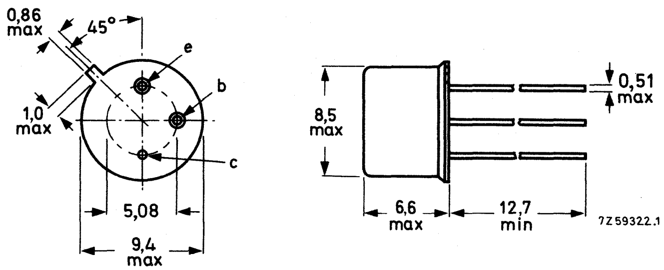
			2N2219	2N2219A	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	75	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	40	V
Collector current (d.c.)	I_C	max.	800	800	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0,8	0,8	W
Junction temperature	T_j	max.	200	200	°C
D.C. current gain at T_j = 25 °C I_C = 10 mA; V_{CE} = 10 V	h_{FE}	>	75	75	
Transition frequency at f = 100 MHz I_C = 20 mA; V_{CE} = 20 V	f_T	>	250	300	MHz
Storage time I_C = 150 mA; $I_B = -I_{BM}$ = 15 mA	t_s	<	–	225	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 004-029.

RATINGS

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

			2N2219	2N2219A	
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.	0,8		W
up to T_{case} = 25 °C	P_{tot}	max.	3		W
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	200		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	190	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	50	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N2219	2N2219A	
Collector cut-off current					
$I_E = 0$; V_{CB} = 50 V	I_{CBO}	<	10	–	nA
$I_E = 0$; V_{CB} = 50 V; T_{amb} = 150 °C	I_{CBO}	<	10	–	μA
$I_E = 0$; V_{CB} = 60 V	I_{CBO}	<	–	10	nA
$I_E = 0$; V_{CB} = 60 V; T_{amb} = 150 °C	I_{CBO}	<	–	10	μA
Emitter cut-off current					
$I_C = 0$; V_{EB} = 3 V	I_{EBO}	<	10	10	nA
Currents at reverse biased emitter junction					
V_{CE} = 60 V; $-V_{BE}$ = 3 V	I_{CEX}	<	–	10	nA
	$-I_{BEX}$	<	–	20	nA

* Applicable up to I_C = 500 mA

			2N2219	2N2219A
Breakdown voltages				
$I_E = 0$; $I_C = 10\ \mu A$	$V_{(BR)CBO}$	>	60	75 V
$I_B = 0$; $I_C = 10$ mA	$V_{(BR)CEO}$	>	30	40 V
$I_C = 0$; $I_E = 10\ \mu A$	$V_{(BR)EBO}$	>	5	6 V
Saturation voltages *				
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0,4	0,3 V
	V_{BEsat}	>	–	0,6 V
		<	1,3	1,2 V
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	1,6	1,0 V
	V_{BEsat}	<	2,6	2,0 V
D.C. current gain				
$I_C = 0,1$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	35
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	>	50	50
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	75	75
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = -55\ ^oC$	h_{FE}	>	–	35
$I_C = 150$ mA; $V_{CE} = 1$ V *	h_{FE}	>	50	50
$I_C = 150$ mA; $V_{CE} = 10$ V *	h_{FE}		100 to 300	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
Collector capacitance at f = 100 kHz				
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	8	8 pF
Emitter capacitance at f = 100 kHz				
$I_C = I_c = 0$; $V_{EB} = 0,5$ V	C_e	<	–	25 pF
Feedback time constant at f = 31,8 MHz				
$I_C = 20$ mA; $V_{CE} = 20$ V	r_b, C_c	<	–	150 ps

* Pulse duration ⩽ 300 μs; duty cycle ⩽ 2%.

h-parameters (common emitter)

			2N2219	2N2219A
I_C = 1 mA; V_{CE} = 10 V; f = 1 kHz				
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 μS
I_C = 10 mA; V_{CE} = 10 V; f = 1 kHz				
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 μS
I_C = 20 mA; V_{CE} = 20 V; f = 100 MHz			**2N2219**	**2N2219A**
Small signal current gain	h_{fe}	>	2,5	3,0
I_C = 20 mA; V_{CE} = 20 V; f = 300 MHz Real part of input impedance	Re(h_{ie})	<	60	60 Ω
Noise figure at f = 1 kHz I_C = 0,1 mA; V_{CE} = 10 V R_G = 1 kΩ; B = 1 Hz	F	<	–	4 dB
Switching times for 2N2219A Turn on time when wsitched from $-V_{BE}$ = 0,5 V to I_C = 150 mA; I_B = 15 mA				
Delay time	t_d	<		10 ns
Rise time	t_r	<		25 ns

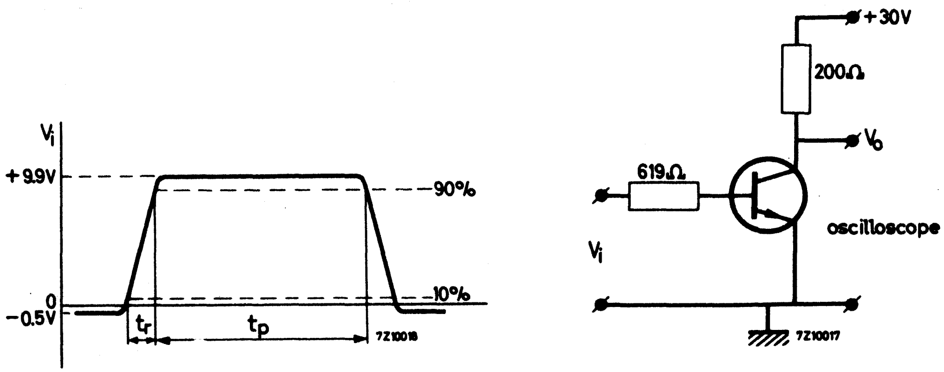


Fig. 2 Test circuit and waveforms.

Pulse generator:

pulse duration	$t_p \leqslant 200$ ns
rise time	$t_r \leqslant$ 2 ns

Oscilloscope:

input resistance	$R_i > 100$ kΩ
input capacitance	$C_i <$ 12 pF
rise time	$t_r <$ 5 ns

Switching times for 2N2219A

Turn off time
I_C = 150 mA; I_B = $-I_{BM}$ = 15 mA

Storage time	t_s	<	225	ns
Fall time	t_f	<	60	ns

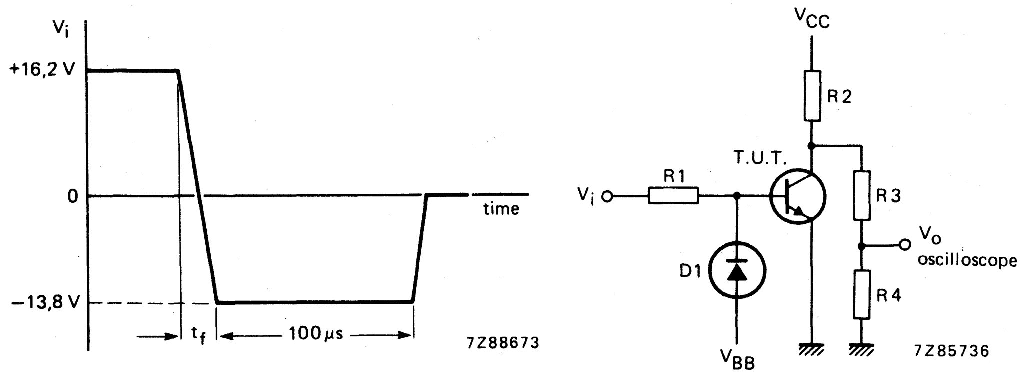


Fig. 3 Test circuit and waveform.
V_{CC} = + 30 V; V_{BB} = −3 V; R1 = 1 kΩ; R2 = 200 Ω; R3 = 20 kΩ; R4 = 50 Ω; D1 = 1N916.

Pulse generator:

fall time	t_f	<	5	ns

Oscilloscope:

input impedance	R_i	>	100	kΩ
input capacitance	C_i	<	12	pF
rise time	t_r	<	5	ns

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a TO-18 metal envelope with the collector connected to the case. They are primarily intended for high speed switching. The 2N2222 is also suitable for d.c. and v.h.f./u.h.f. amplifiers.

QUICK REFERENCE DATA

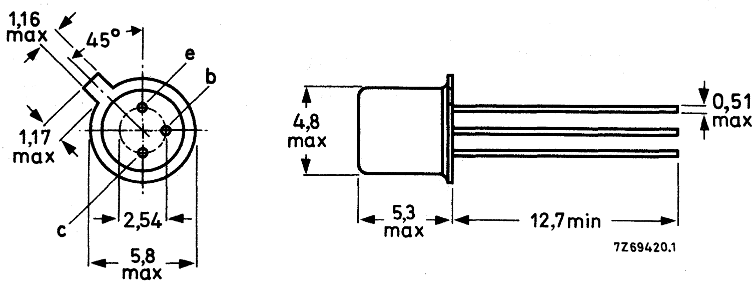
			2N2222	2N2222A	
Collector-base voltage (open emitter)	V_{CBO}	max.	60	75	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	40	V
Collector current (d.c.)	I_C	max.	800	800	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0,5	0,5	W
Junction temperature	T_j	max.	200	200	°C
D.C. current gain at T_j = 25 °C I_C = 10 mA; V_{CE} = 10 V	h_{FE}	>	75	75	
Transition frequency at f = 100 MHz I_C = 20 mA; V_{CE} = 20 V	f_T	>	250	300	MHz
Storage time I_C = 150 mA; I_B = $-I_{BM}$ = 15 mA	t_s	<	–	225	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case



Products approved to CECC 50 004-030, available on request.

RATINGS

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

			2N2222	2N2222A	
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.	0,5		W
up to T_{case} = 25 °C	P_{tot}	max.	1,2		W
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	200		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	350	K/W
From junction to case	$R_{th\ j-c}$	=	146	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N2222	2N2222A	
Collector cut-off current					
I_E = 0; V_{CB} = 50 V	I_{CBO}	<	10	–	nA
I_E = 0; V_{CB} = 50 V; T_{amb} = 150 °C	I_{CBO}	<	10	–	μA
I_E = 0; V_{CB} = 60 V	I_{CBO}	<	–	10	nA
I_E = 0; V_{CB} = 60 V; T_{amb} = 150 °C	I_{CBO}	<	–	10	μA
Emitter cut-off current					
I_C = 0; V_{EB} = 3 V	I_{EBO}	<	10	10	nA
Currents at reverse biased emitter junction					
V_{CE} = 60 V; $-V_{BE}$ = 3 V	I_{CEX}	<	–	10	nA
	$-I_{BEX}$	<	–	20	nA

* Applicable up to I_C = 500 mA.

			2N2222	2N2222A	
Breakdown voltages					
$I_E = 0$; $I_C = 10\ \mu A$	$V_{(BR)CBO}$	>	60	75	V
$I_B = 0$; $I_C = 10$ mA	$V_{(BR)CEO}$	>	30	40	V
$I_C = 0$; $I_E = 10\ \mu A$	$V_{(BR)EBO}$	>	5	6	V
Saturation voltages *					
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0,4	0,3	V
	V_{BEsat}	>	–	0,6	V
		<	1,3	1,2	V
$I_C = 500$ mA; $I_B = 50$ mA	V_{CEsat}	<	1,6	1,0	V
	V_{BEsat}	<	2,6	2,0	V
D.C. current gain					
$I_C = 0,1$ mA; $V_{CE} = 10$ V	h_{FE}	>	35	35	
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}	>	50	50	
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	75	75	
$I_C = 10$ mA; $V_{CE} = 10$ V; $T_{amb} = -55\ ^oC$	h_{FE}	>	–	35	
$I_C = 150$ mA; $V_{CE} = 1$ V *	h_{FE}	>	50	50	
$I_C = 150$ mA; $V_{CE} = 10$ V *	h_{FE}		100 to 300	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
Collector capacitance at f = 100 kHz					
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	8	8	pF
Emitter capacitance at f = 100 kHz					
$I_C = I_c = 0$; $V_{EB} = 0,5$ V	C_e	<	–	25	pF
Feedback time constant at f = 31,8 MHz					
$I_C = 20$ mA; $V_{CE} = 20$ V	r_b, C_c	<	–	150	ps

* Pulse duration ⩽ 300 μs; duty cycle ⩽ 2%.

h-parameters (common emitter)

			2N2222	2N2222A	
I_C = 1 mA; V_{CE} = 10 V; f = 1 kHz				2N2222A	
Input impedance	h_{ie}			2 to 8	kΩ
Reverse voltage transfer ratio	h_{re}	<		8	10^{-4}
Small signal current	h_{fe}			50 to 300	
Output admittance	h_{oe}			5 to 35	µS
I_C = 10 mA; V_{CE} = 10 V; f = 1 kHz					
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	µS
I_C = 20 mA; V_{CE} = 20 V; f = 100 MHz			2N2222	2N2222A	
Small signal current gain	h_{fe}	>	2,5	3,0	
I_C = 20 mA; V_{CE} = 20 V; f = 300 MHz					
Real part of input impedance	$Re(h_{ie})$	<	60	60	Ω
Noise figure at f = 1 kHz I_C = 0,1 mA; V_{CE} = 10 V R_G = 1 kΩ; B = 1 Hz	F	<	–	4	dB

Switching times for 2N2222A
Turn on time when switched from
$-V_{BE}$ = 0,5 V to I_C = 150 mA; I_B = 15 mA

Delay time	t_d	<	10	ns
Rise time	t_r	<	25	ns

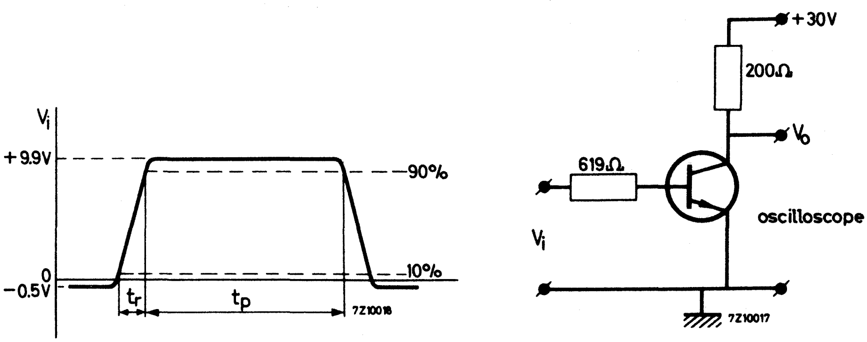


Fig. 2 Test circuit and waveform.

Pulse generator:

pulse duration	$t_p \leq 200$ ns
rise time	$t_r \leq$ 2 ns

Oscilloscope:

input resistance	R_i > 100 kΩ
input capacitance	C_i < 12 pF
rise time	t_r < 5 ns

Switching times for 2N2222A

Turn off time
$I_C = 150$ mA; $I_B = -I_{BM} = 15$ mA

Storage time	t_s	<	225 ns
Fall time	t_f	<	60 ns

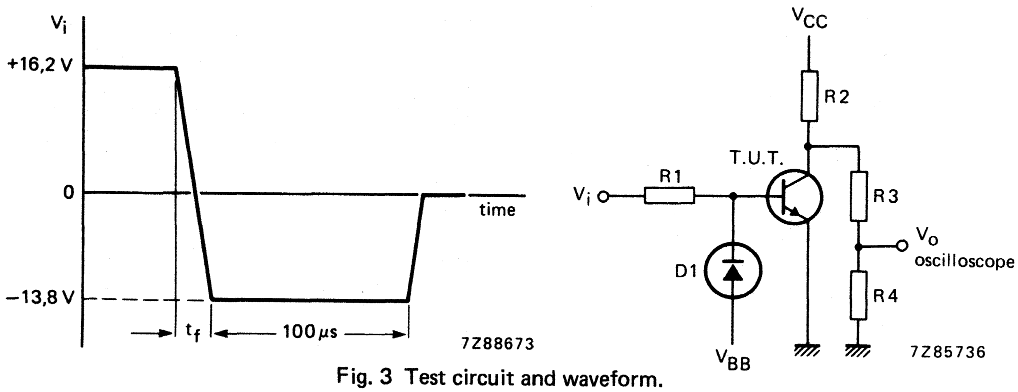


Fig. 3 Test circuit and waveform.

$V_{CC} = +30$ V; $V_{BB} = -3$ V; R1 = 1 kΩ; R2 = 200 Ω; R3 = 20 kΩ; R4 = 50 Ω; D1 = 1N916.

Pulse generator:

fall time	t_f	<	5 ns

Oscilloscope:

input impedance	R_i	>	100 kΩ
input capacitance	C_i	<	12 pF
rise time	t_r	<	5 ns

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor intended for large signal h.f. and v.h.f. amplifier applications.

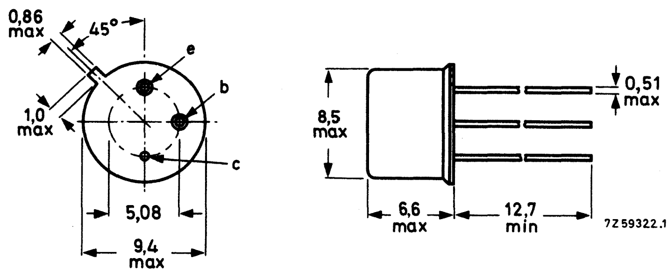
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	V
Collector current (d.c.)	I_C	max.	1,0	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0,8	W
Junction temperature	T_j	max.	200	°C
D.C. current gain I_C = 150 mA; V_{CE} = 10 V	h_{FE}		40 to 120	
Transition frequency at f = 20 MHz I_C = 50 mA; V_{CE} = 10 V	f_T	>	60	MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39; collector connected to case.



Maximum lead diameter is guaranteed only for 12,7 mm.

RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	V
Emitter-base voltage (open collector)	V_{EBO}	max.	7,0	V
Collector current (d.c.)	I_C	max.	1,0	A
Total power dissipation				
up to T_{case} = 25 °C	P_{tot}	max.	5,0	W
up to T_{case} = 100 °C	P_{tot}	max.	2,8	W
up to T_{amb} = 25 °C	P_{tot}	max.	0,8	W
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}c}$	=	35	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	219	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	<	10 nA
$I_E = 0$; $V_{CB} = 60$ V; $T_{amb} = 150$ °C	I_{CBO}	<	10 μA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5{,}0$ V	I_{EBO}	<	10 nA
Collector-emitter sustaining voltage*			
$I_C = 30$ mA; $I_B = 0$	$V_{CEOsust}$	>	35 V
Saturation voltages*			
$I_C = 150$ mA; $I_B = 15$ mA	V_{CEsat}	<	0,2 V
$I_C = 1$ A; $I_B = 100$ mA**	V_{CEsat}	<	1,0 V
	V_{BEsat}	<	1,6 V
D.C. current gain*			
$I_C = 10$ mA; $V_{CE} = 10$ V	h_{FE}	>	30
$I_C = 150$ mA; $V_{CE} = 10$ V	h_{FE}		40 to 120
$I_C = 1{,}0$ A; $V_{CE} = 10$ V	h_{FE}	>	15
Feedback time constant			
$I_C = 10$ mA; $V_{CB} = 10$ V; f = 4,0 MHz	$r_{bb'} C_{b'c}$	<	800 ps
Collector capacitance at f = 500 kHz			
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	<	12 pF
Emitter capacitance at f = 500 kHz			
$I_C = I_c = 0$; $V_{EB} = 0{,}5$ V	C_e	<	80 pF
Transition frequency at f = 20 MHz			
$I_C = 50$ mA; $V_{CE} = 10$ V	f_T	>	60 MHz

* Measured under pulse conditions to avoid excessive dissipation: $t_p = 300$ μs; $\delta \leqslant 0{,}01$.
** Measured with a lead length of 1 cm.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistor in a TO-18 metal envelope with the collector connected to the case. The 2N2369 is primarily intended for use in very high-speed saturated switching and v.h.f. amplification.

QUICK REFERENCE DATA

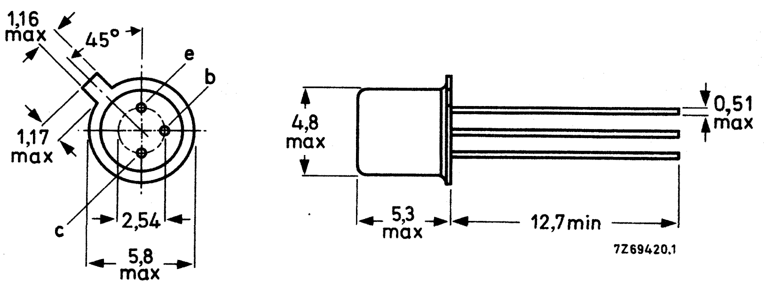
Collector-base voltage (open emitter)	V_{CBO}	max.	40 V
Collector-emitter voltage (open base)	V_{CEO}	max.	15 V
Collector current (peak value)	I_{CM}	max.	500 mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360 mW
Junction temperature	T_j	max.	200 °C
D.C. current gain at T_j = 25 °C I_C = 10 mA; V_{CE} = 1 V	h_{FE}		40 to 120
Transition frequency I_C = 10 mA; V_{CE} = 10 V	f_T	>	500 MHz
Storage time $I_C = I_B = -I_{BM}$ = 10 mA	t_s	<	13 ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case



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.	15	V
Collector-emitter voltage with $V_{BE} = 0$	V_{CES}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4,5	V
Collector current (peak value; t = 10 μs)	I_{CM}	max.	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW
Storage temperature range	T_{stg}		–65 to +150	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	480	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	145	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

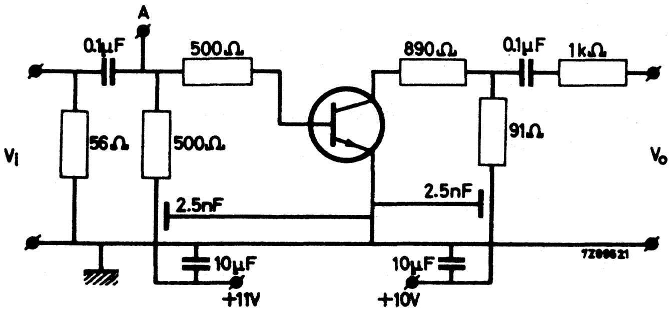
Collector cut-off current				
$I_E = 0$; V_{CB} = 20 V	I_{CBO}	<	0,4	μA
$I_E = 0$; V_{CB} = 20 V; T_j = 150 °C	I_{CBO}	<	30	μA
Sustaining voltage *				
I_C = 10 mA; I_B = 0	$V_{CEOsust}$	>	15	V*
Saturation voltages				
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	<	0,25	V
	V_{BEsat}		0,7 to 0,85	V
Collector capacitance at f = 140 kHz				
$I_E = I_e = 0$; V_{CB} = 5 V	C_c	<	4	pF
D.C. current gain*				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}		40 to 120	
I_C = 10 mA; V_{CE} = 1 V; T_j = –55 °C	h_{FE}	>	20	
I_C = 100 mA; V_{CE} = 2 V	h_{FE}	>	20	
Transition frequency				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	500	MHz

* Measured under pulsed conditions to avoid excessive dissipation.
Pulse duration t = 300 μs; duty cycle δ = 0,01.

CHARACTERISTICS (continued)

$T_j = 25\ ^{o}C$

Storage time			
$I_C = I_B = -I_{BM} = 10$ mA	t_s	<	13 ns



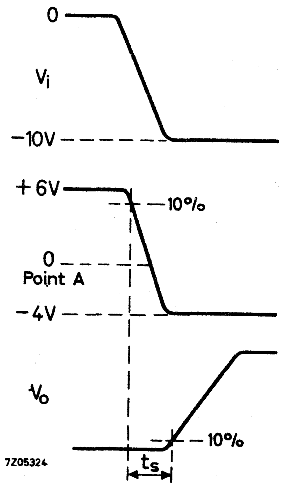


Fig. 2 Test circuit* and waveform.

Turn on time			
$I_C = 10$ mA; $I_B = 3$ mA; $-V_{BE} = 1{,}5$ V	t_{on}	<	12 ns
Turn off time			
$I_C = 10$ mA; $I_B = 3$ mA; $-I_{BM} = 1{,}5$ mA	t_{off}	<	18 ns

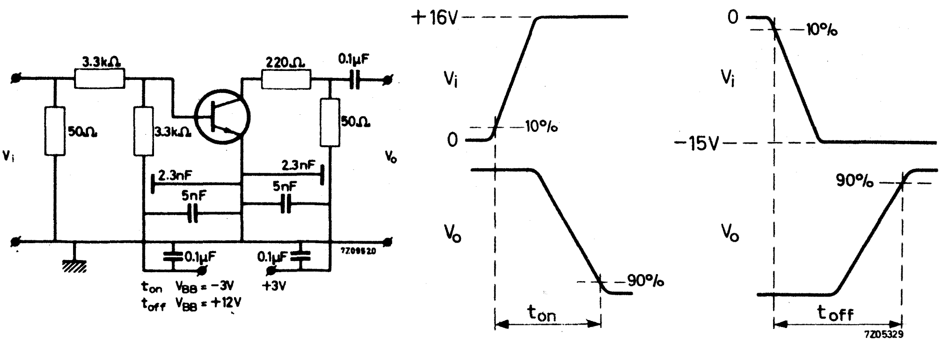


Fig. 3 Test circuit* and waveform.

* Pulse generator

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

Oscilloscope

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

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a TO-18 metal envelope primarily intended for high-speed saturated switching and high frequency amplifier applications.

QUICK REFERENCE DATA

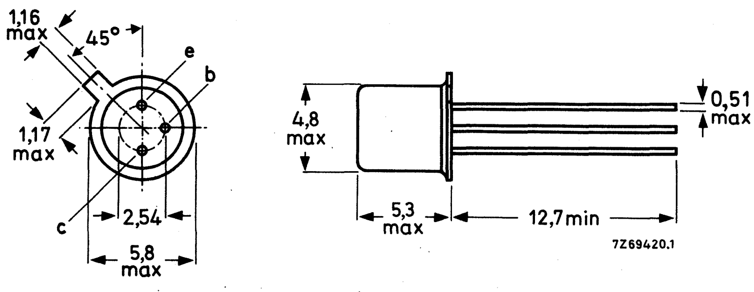
Collector-base voltage (open emitter)	V_{CBO}	max.	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value; t_p = 10 μs)	I_{CM}	max.	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW
Junction temperature	T_j	max.	200	°C
D.C. current gain at T_j = 25 °C				
I_C = 10 mA; V_{CE} = 0,35 V	h_{FE}	>	40	
I_C = 10 mA; V_{CE} = 1,0 V	h_{FE}	<	120	
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	500	MHz
Storage time				
I_{Con} = I_{Bon} = $-I_{Boff}$ = 10 mA	t_s	<	13	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case.



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) I_C = 0,01 mA to 10 mA	V_{CEO}	max.	15	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4,5	V
Collector current (d.c.)	I_C	max.	200	mA
Collector current (peak value; t_p = 10 μs)	I_{CM}	max.	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW
up to T_{case} = 25 °C	P_{tot}	max.	1200	mW
up to T_{case} = 100 °C	P_{tot}	max.	680	mW
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	486	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	146	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current			
V_{BE} = 0; V_{CE} = 20 V	I_{CES}	<	0,4 μA
I_E = 0; V_{CB} = 20 V; T_{amb} = 150 °C	I_{CBO}	<	30 μA
Base current			
V_{BE} = 0; V_{CE} = 20 V	$-I_{BEX}$	<	0,4 μA
Collector-base breakdown voltage			
open emitter; I_C = 10 μA	$V_{(BR)CBO}$	>	40 V
Collector-emitter breakdown voltage			
V_{BE} = 0; I_C = 10 μA	$V_{(BR)CES}$	>	40 V
Emitter-base breakdown voltage			
open collector; I_E = 10 μA	$V_{(BR)EBO}$	>	4,5 V
Collector-emitter sustaining voltage*			
open base; I_C = 10 mA	$V_{CEOsust}$	>	15 V
Saturation voltages			
I_C = 10 mA; I_B = 1,0 mA	V_{CEsat}	<	0,20 V
	V_{BEsat}		0,70 to 0,85 V
I_C = 10 mA; I_B = 1,0 mA; T_{amb} = 125 °C	V_{CEsat}	<	0,30 V
	V_{BEsat}	>	0,59 V
I_C = 10 mA; I_B = 1,0 mA; T_{amb} = −55 °C	V_{BEsat}	<	1,02 V
I_C = 30 mA; I_B = 3,0 mA	V_{CEsat}	<	0,25 V
	V_{BEsat}	<	1,15 V
I_C = 100 mA; I_B = 10 mA	V_{CEsat}	<	0,50 V
	V_{BEsat}	<	1,60 V
D.C. current gain*			
I_C = 10 mA; V_{CE} = 0,35 V	h_{FE}	>	40
I_C = 10 mA; V_{CE} = 0,35 V; T_{amb} = −55 °C	h_{FE}	>	20
I_C = 10 mA; V_{CE} = 1,0 V	h_{FE}	<	120
I_C = 30 mA; V_{CE} = 0,4 V	h_{FE}	>	30
I_C = 100 mA; V_{CE} = 1,0 V	h_{FE}	>	20
Collector capacitance at f = 140 kHz			
I_E = I_e = 0; V_{CB} = 5,0 V	C_c	<	4,0 pF
Transition frequency at f = 100 MHz			
I_C = 10 mA; V_{CE} = 10 V	f_T	>	500 MHz

* Measured under pulse conditions to avoid excessive dissipation: t_p = 300 μs; $\delta \leqslant 0{,}02$.

Storage time (see Figs 2 and 3)
$I_{Con} = I_{Bon} = -I_{Boff} = 10$ mA | t_s < 13 ns

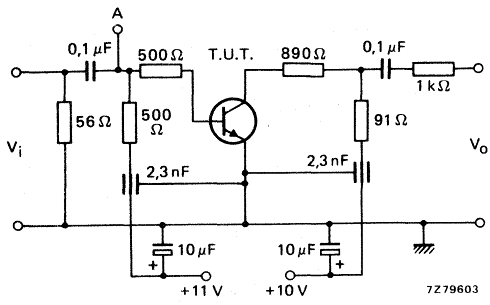


Fig. 2 Storage time test circuit.

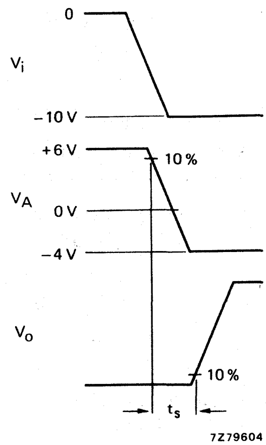


Fig. 3 Waveforms at input, point A and output.

Turn-on time (see Figs 4 and 5)
$I_{Con} = 10$ mA; $I_{Bon} = 3$ mA; $-V_{BEoff} = 1,5$ V | t_{on} < 12 ns

Turn-off time (see Figs 4 and 5)
$I_{Con} = 10$ mA; $I_{Bon} = 3$ mA; $-I_{Boff} = 1,5$ mA | t_{off} < 18 ns

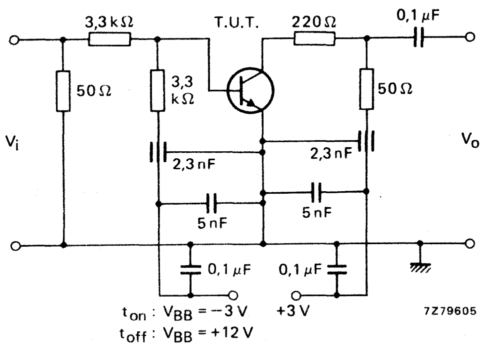


Fig. 4 Turn-on and turn-off test circuit.

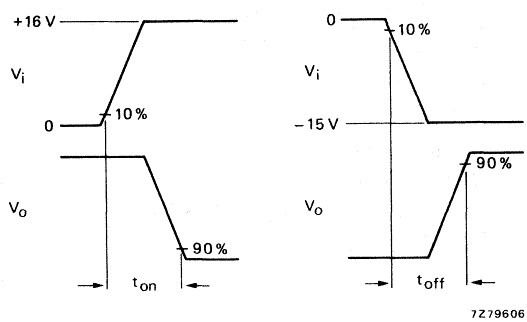


Fig. 5 Input and output waveforms.

Pulse generator:

Rise time	t_r	⩽	1 ns
Pulse duration	t_p	⩾	300 ns
Duty factor	δ	⩽	0,02
Source impedance	R_S	=	50 Ω

Oscilloscope:

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

SILICON PLANAR TRANSISTORS

N-P-N transistors in TO-18 metal envelopes with the collector connected to the case.

These transistors are primarily intended for use in high performance, low-level, low-noise amplifier applications both for direct current and frequencies of up to 100 MHz.

QUICK REFERENCE DATA

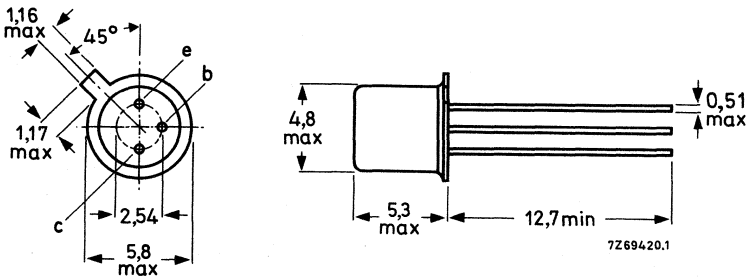
			2N2483	2N2484	
Collector-base voltage (open emitter)	V_{CBO}	max	60	60	V
Collector-emitter voltage (open base)	V_{CEO}	max	60	60	V
Collector current (peak value)	I_{CM}	max	50	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max	360	360	mW
Junction temperature	T_j	max	200	200	°C
D.C. current gain at T_j = 25 °C					
I_C = 10 μA; V_{CE} = 5 V	h_{FE}	>	40	100	
		<	120	500	
I_C = 1 mA; V_{CE} = 5 V	h_{FE}	>	175	250	
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	<	500	800	
Transition frequency					
I_C = 0,5 mA; V_{CE} = 5 V	f_T	typ	80	80	MHz
Noise figure at R_S = 10 kΩ					
I_C = 10 μA; V_{CE} = 5 V; B = 15,7 kHz	F	<	4	3	dB

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case



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.	60	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	V
Collector current (peak value)	I_{CM}	max.	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	360	mW
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	480	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	150	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N2483	2N2484	
Collector cut-off current					
$I_E = 0$; $V_{CB} = 45$ V	I_{CBO}	<		10	nA
$I_E = 0$; $V_{CB} = 45$ V; $T_j = 150$ °C	I_{CBO}	<		10	μA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<		10	nA
Base-emitter voltage					
$I_C = 0{,}1$ mA; $V_{CE} = 5$ V	V_{BE}			0,5 to 0,7	V
Collector-emitter saturation voltage					
$I_C = 1$ mA; $I_B = 0{,}1$ mA	V_{CEsat}	<		350	mV
D.C. current gain					
$I_C = 1$ μA; $V_{CE} = 5$ V	h_{FE}	>		30	
$I_C = 10$ μA; $V_{CE} = 5$ V	h_{FE}		40 to 120	100 to 500	
$I_C = 10$ μA; $V_{CE} = 5$ V; $T_j = 55$ °C	h_{FE}	>	10	20	
$I_C = 100$ μA; $V_{CE} = 5$ V	h_{FE}	>	75	175	
$I_C = 500$ μA; $V_{CE} = 5$ V	h_{FE}	>	100	200	
$I_C = 1$ mA; $V_{CE} = 5$ V	h_{FE}	>	175	250	
$I_C = 10$ mA; $V_{CE} = 5$ V*	h_{FE}	<	500	800	
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	6	6	pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c = 0$; $V_{EB} = 0{,}5$ V	C_e	<	6	6	pF
Transition frequency					
$I_C = 50$ μA; $V_{CE} = 5$ V	f_T	>	12	15	MHz
$I_C = 500$ μA; $V_{CE} = 5$ V	f_T	>	60	60	MHz
		typ.	80	80	MHz
Noise figure					
$I_C = 10$ μA; $V_{CE} = 5$ V; $R_S = 10$ kΩ					
f = 100 Hz; bandwidth 20 Hz	F	<	15	10	dB
f = 1 kHz; bandwidth 200 Hz	F	<	4	3	dB
f = 10 kHz; bandwidth 2 kHz	F	<	3	2	dB
Wide band: bandwidth 15,7 kHz	F	<	4	3	dB
h parameters at f = 1 kHz					
$I_C = 1$ mA; $V_{CE} = 5$ V					
Input impedance	h_{ie}		1,5 to 13	3,5 to 24	kΩ
Reverse voltage transferq	h_{re}	<	8	8	10^{-4}
Small signal current gain	h_{fe}		80 to 450	150 to 900	
Output admittance	h_{oe}	<	30	40	μS

* Measured under pulsed conditions to prevent excessive dissipation. Pulse duration t < 300 μs; duty cycle δ < 0,01.

Philips Components

Data sheet	
status	Preliminary specification
date of issue	December 1990

2N2646
Silicon unijunction transistor

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$-V_{EB2}$	emitter-base 2 voltage		–	–	30	V
I_{EM}	emitter current	peak value	–	–	2	A
P_{tot}	total power dissipation		–	–	300	mW
T_j	junction temperature		–	–	125	°C
R_{BB}	static inter-base resistance	V_{B2B1} = 3 V I_E = 0	–	7	–	kΩ
V_{EB1sat}	emitter-base 1 saturation voltage	V_{B2B1} = 10 V I_E = 50 mA	–	3.5	–	V
$I_{E(V)}$	emitter valley point current		4	6	–	mA
$I_{E(P)}$	emitter peak point current		–	1	5	µA

PINNING - TO-18

Base 2 connected to case.

PIN	DESCRIPTION
1	emitter
2	base 1
3	base 2

PIN CONFIGURATION

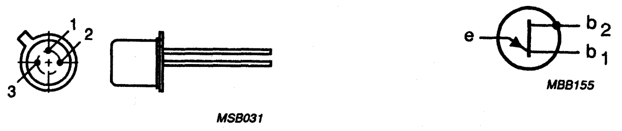


Fig.1 Simplified outline and symbol.

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$-V_{EB2}$	emitter-base 2 voltage		–	30	V
V_{B2B1}	inter-base voltage		–	35	V
I_E	emitter current	average value	–	50	mA
I_{EM}	emitter current (note 1)	peak value	–	2	A
P_{tot}	total power dissipation (note 2)	$T_{amb} \leq 25$ °C	–	300	mW
T_{stg}	storage temperature range		–65	150	°C
T_j	junction temperature		–	125	°C

Notes

1. Capacitor discharge ≤ 10 µF at ≤ 30 V.
2. Must be limited by external circuit.

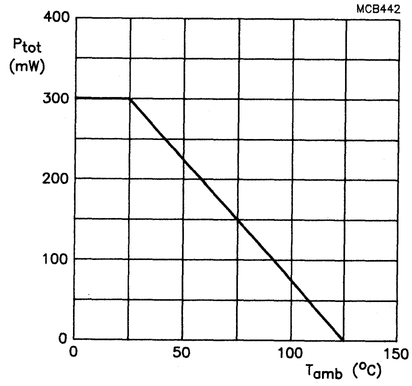


Fig.2 Power derating curve.

THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient	300	K/W

CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
R_{BB}	static inter-base resistance	V_{B2B1} = 3 V I_E = 0	4.7	7	9.1	kΩ
TC_{RBB}	inter-base resistance temperature coefficient	V_{B2B1} = 3 V I_E = 0 T_{amb} = −55 to 125 °C	0.1	–	0.9	%/K
$-I_{EB2O}$	emitter cut-off current	$-V_{EB2}$ = 30 V I_{B1} = 0	–	–	12	V
V_{EB1sat}	emitter-base 1 saturation voltage	V_{B2B1} = 10 V I_E = 50 mA	–	3.5	–	V
I_{B2mod}	inter-base current modulation	V_{B2B1} = 10 V I_E = 50 mA	–	15	–	mA
η	input/output ratio (note 1)	V_{B2B1} = 10 V	0.56	–	0.75	
$I_{E(V)}$	emitter valley point current	V_{B2B1} = 20 V R_{B2} = 100 Ω	4	6	–	mA
$I_{E(P)}$	emitter peak point current	V_{B2B1} = 25 V	–	1	5	µA
V_{OB1M}	base 1 impulse/output voltage		3	5	–	V

Note

1. $\eta = \frac{(V_{E(P)} - V_{EB1})}{V_{B2B1}}$, when $V_{E(P)}$ = emitter peak point voltage, V_{EB1} = emitter-base 1 breakdown voltage, (approximately 0.5 V at 10 µA), and V_{B2B1} = inter-base voltage.

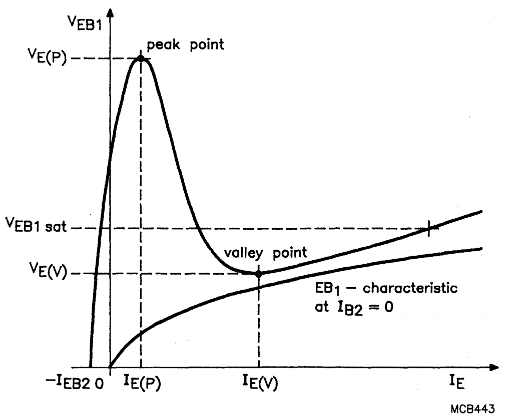


Fig.3 Impulse as a function of output voltage.

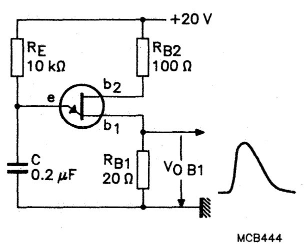
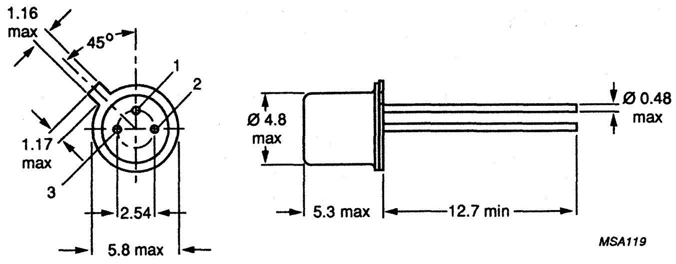


Fig.4 Impulse output circuit.

PACKAGE OUTLINE



Dimensions in mm.

Fig.5 TO-18.

Philips Components

Data sheet	
status	Preliminary specification
date of issue	December 1990

2N2894A
Silicon switching transistor

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$-V_{CBO}$	collector-base voltage		–	12	V
$-V_{CEO}$	collector-emitter voltage		–	12	V
$-I_C$	collector current		–	200	mA
P_{tot}	total power dissipation	$T_{case} \le 25$ °C	–	1.2	W
		$T_{amb} \le 25$ °C	–	360	mW
T_j	junction temperature		–	200	°C
h_{FE}	current gain	$-V_{CE} = 0.5$ V $-I_C = 30$ mA	40	150	
f_T	transition frequency	$-V_{CE} = 10$ V $-I_C = 30$ mA	800	–	MHz
t_{off}	turn-off time	$-I_{C\ on} = 30$ mA $-I_{B\ on} = I_{B\ off} = 1.5$ mA	–	35	ns

PINNING - TO-18

Collector connected to case.

PIN	DESCRIPTION
1	emitter
2	base
3	collector

PIN CONFIGURATION

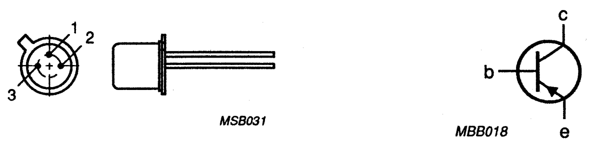


Fig.1 Simplified outline and symbol.

Silicon switching transistor 2N2894A

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$-V_{CBO}$	collector-base voltage	$I_E = 0$	–	12	V
$-V_{CEO}$	collector-emitter voltage	$I_B = 0$ $-I_C \leq 10$ mA	–	12	V
$-V_{EBO}$	emitter-base voltage	$I_C = 0$	–	4.5	V
$-I_C$	collector current		–	200	mA
P_{tot}	total power dissipation	$T_{case} \leq 25$ °C	–	1.2	W
		$T_{amb} \leq 25$°C	–	360	mW
T_{stg}	storage temperature range		–65	150	°C
T_j	junction temperature		–	200	°C

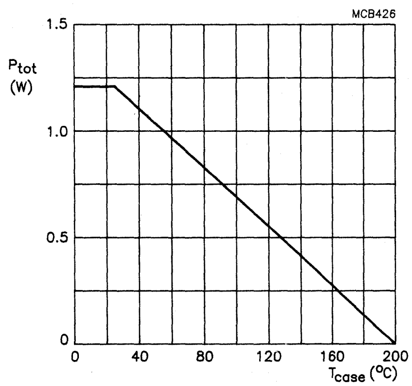


Fig.2 Total power dissipation as a function of case temperature.

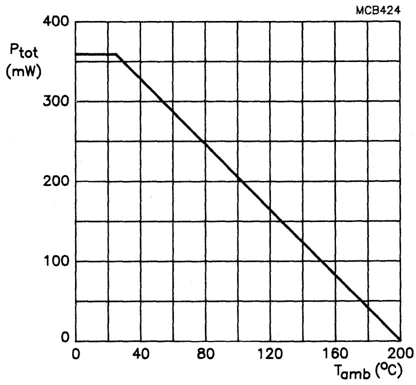


Fig.3 Total power dissipation as a function of ambient temperature.

THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient	486	K/W
$R_{th\ j\text{-}c}$	from junction to case	146	K/W

CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$-I_{CBO}$	collector cut-off current	$I_E = 0$ $-V_{CB} = 10$ V $T_{amb} = 125$ °C	–	10	μA
$-I_{CES}$	collector-emitter cut-off current	$V_{BE} = 0$ $-V_{CE} = 10$ V	–	50	nA
$-V_{(BR)CBO}$	collector-base breakdown voltage	$I_E = 0$ $-I_C = 10$ μA	12	–	V
$-V_{(BR)CES}$	collector-emitter breakdown voltage	$I_E = 0$ $-I_C = 10$ μA	12	–	V
$-V_{(BR)CEO}$	collector-emitter breakdown voltage	$I_B = 0$ $-I_C = 10$ mA	12	–	V
$-V_{(BR)EBO}$	emitter-base breakdown voltage	$I_C = 0$ $-I_E = 100$ μA	4.5	–	V
$-V_{CEsat}$	collector-emitter saturation voltage	$-I_B = 1$ mA $-I_C = 10$ mA	–	130	mV
		$-I_B = 3$ mA $-I_C = 30$ mA	–	190	mV
		$-I_B = 10$ mA $-I_C = 100$ mA	–	450	mV
$-V_{BEsat}$	base-emitter saturation voltage	$-I_B = 1$ mA $-I_C = 10$ mA	780	920	mV
		$-I_B = 3$ mA $-I_C = 30$ mA	0.85	1.15	V
		$-I_B = 10$ mA $-I_C = 100$ mA	–	1.5	V
h_{FE}	current gain	$-V_{CE} = 0.5$ V $-I_C = 1$ mA	20	–	
		$-V_{CE} = 0.3$ V $-I_C = 10$ mA	30	–	
		$-V_{CE} = 0.5$ V $-I_C = 30$ mA	40	150	
		$-V_{CE} = 0.5$ V $-I_C = 30$ mA $T_{amb} = -55$ °C	20	–	
		$-V_{CE} = 1$ V $-I_C = 100$ mA	30	–	
f_T	transition frequency	$-V_{CE} = 10$ V $-I_C = 30$ mA f = 100 MHz	800	–	MHz
C_c	collector capacitance	$-V_{CB} = 5$ V $I_E = 0$ f = 140 kHz	–	4.5	pF

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
C_e	emitter capacitance	$-V_{EB} = 0.5$ V $I_C = 0$ f = 140 kHz	–	6	pF
Switching times					
t_{on}	turn-on time (Fig.4)	$-I_{C\ on} = 30$ mA $-I_{B\ on} = I_{B\ off} = 1.5$ mA	–	60	ns
t_{off}	turn-off time (Fig.4)	$-I_{C\ on} = 30$ mA $-I_{B\ on} = I_{B\ off} = 1.5$ mA	–	35	ns
t_{on}	turn-on time (Fig.5)	$-I_{C\ on} = 30$ mA $-I_{B\ on} = I_{B\ off} = 3$ mA $-I_{C\ on} = -I_{B\ on} = I_{B\ off} = 10$ mA	–	20	ns
t_{off}	turn-off time (Fig.5)	$-I_{C\ on} = 30$ mA $-I_{B\ on} = I_{B\ off} = 3$ mA $-I_{C\ on} = -I_{B\ on} = I_{B\ off} = 10$ mA	–	25	ns
t_s	storage time factor	$-I_{C\ on} = 30$ mA $-I_{B\ on} = I_{B\ off} = 3$ mA $-I_{C\ on} = -I_{B\ on} = I_{B\ off} = 10$ mA	–	20	ns

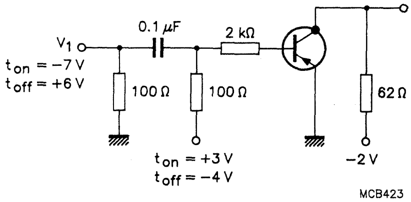


Fig.4 Switching times test circuit.

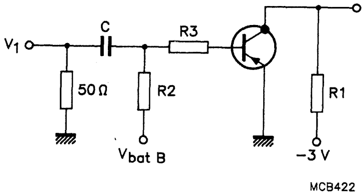


Fig.5 Switching times test circuit.

Silicon switching transistor 2N2894A

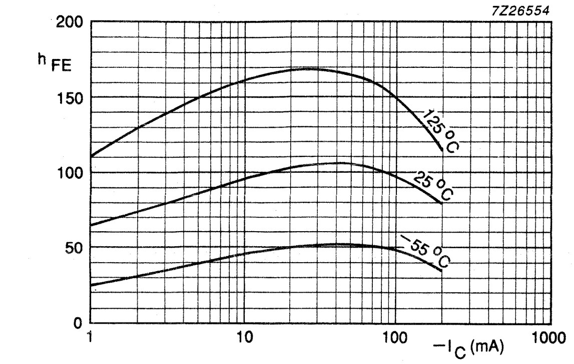


Fig.6 Current gain as a function of collector current; $-V_{CE}$ = 5 V.

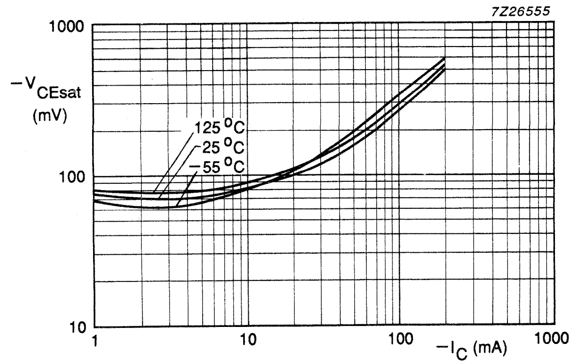


Fig.7 Collector-emitter saturation voltage as a function of collector current; I_C:I_B = 10.

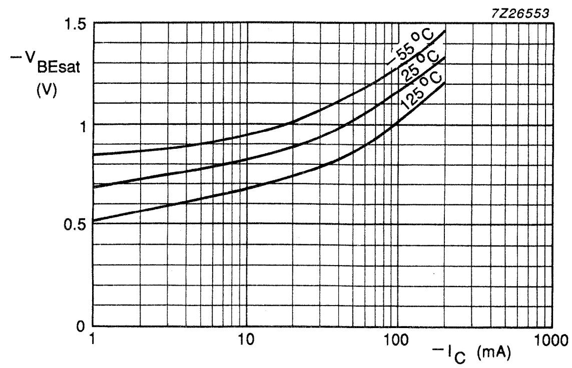
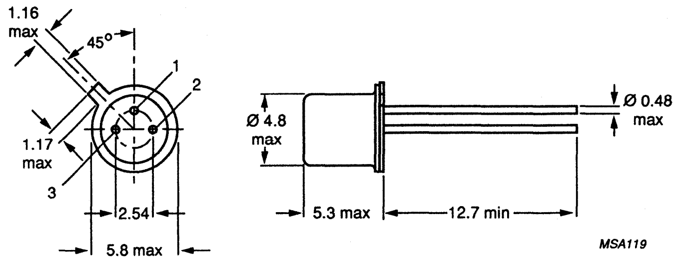


Fig.8 Base-emitter saturation voltage as a function of collector current; I_C:I_B = 10.

Silicon switching transistor 2N2894A

PACKAGE OUTLINE



Dimensions in mm.

Fig.9 TO-18.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in TO-39 metal envelopes designed primarily for high-speed switching and driver applications for industrial service.

QUICK REFERENCE DATA

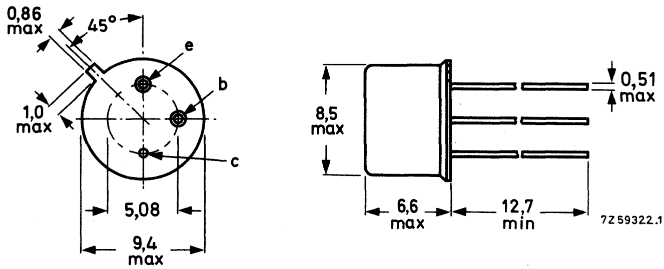
Collector-base voltage (open emitter)		$-V_{CBO}$	max.	60	V
Collector-emitter voltage (open base)	**2N2904**	$-V_{CEO}$	max.	40	V
	2N2904A	$-V_{CEO}$	max.	60	V
Collector current (d.c.)		$-I_C$	max.	600	mA
Total power dissipation up to T_{amb} = 25 °C		P_{tot}	max.	0,6	W
Junction temperature		T_j	max.	200	°C
D.C. current gain at T_j = 25 °C; $-I_C$ = 150 mA; $-V_{CE}$ = 10 V		h_{FE}		40 to 120	
Transition frequency at f = 100 MHz; $-I_C$ = 50 mA; $-V_{CE}$ = 20 V; T_j = 25 °C		f_T	>	200	MHz
Storage time; $-I_{Con}$ = 150 mA; $-I_{Bon}$ = I_{Boff} = 15 mA		t_s	<	80	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case.



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 002-102.

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) $-I_C < 100$ mA	2N2904	$-V_{CEO}$	max.	40	V
	2N2904A	$-V_{CEO}$	max.	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.	0,6	W
up to $T_{case} = 25$ °C		P_{tot}	max.	3,0	W
Storage temperature range		T_{stg}		−65 to +150	°C
Junction temperature		T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	292	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	58	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			2N2904	2N2904A	
Collector cut-off current					
$I_E = 0$; $-V_{CB} = 50$ V	$-I_{CBO}$	<	20	10	nA
$I_E = 0$; $-V_{CB} = 50$ V; $T_{amb} = 150$ °C	$-I_{CBO}$	<	20	10	μA
$+V_{BE} = 0{,}5$ V; $-V_{CE} = 30$ V	$-I_{CEX}$	<	50	50	nA
Base current					
$+V_{BE} = 0{,}5$ V; $-V_{CE} = 30$ V	I_{BEX}	<	50	50	nA
Collector-base breakdown voltage					
open emitter; $-I_C = 10$ μA	$-V_{(BR)CBO}$	>	60	60	V
Collector-emitter breakdown voltage *					
open base; $-I_C = 10$ mA	$-V_{(BR)CEO}$	>	40	60	V
Emitter-base breakdown voltage					
open collector; $-I_E = 10$ μA	$-V_{(BR)EBO}$	>	5	5	V
Saturation voltages *					
$-I_C = 150$ mA; $-I_B = 15$ mA	$-V_{CEsat}$	<	0,4	0,4	V
	$-V_{BEsat}$	<	1,3	1,3	V
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	1,6	1,6	V
	$-V_{BEsat}$	<	2,6	2,6	V
D.C. current gain					
$-I_C = 0{,}1$ mA; $-V_{CE} = 10$ V	h_{FE}	>	20	40	
$-I_C = 1$ mA; $-V_{CE} = 10$ V	h_{FE}	>	25	40	
$-I_C = 10$ mA; $-V_{CE} = 10$ V	h_{FE}	>	35	40	
$-I_C = 150$ mA; $-V_{CE} = 10$ V *	h_{FE}	>	40	40	
		<	120	120	
$-I_C = 500$ mA; $-V_{CE} = 10$ V *	h_{FE}	>	20	40	
Collector capacitance at f = 100 kHz					
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	<	8		pF
Emitter capacitance at f = 100 kHz					
$I_C = I_c = 0$; $-V_{EB} = 2$ V	C_e	<	30		pF
Transition frequency at f = 100 MHz					
$-I_C = 50$ mA; $-V_{CE} = 20$ V *	f_T	>	200		MHz

* Measured under pulse conditions to avoid excessive dissipation: $t_p \leq 300$ μs; $\delta \leq 0{,}02$.

Turn-on time (see Fig. 2)
when switched to $-I_{Con}$ = 150 mA; $-I_{Bon}$ = 15 mA

delay time	t_d	<	10 ns
rise time	t_r	<	40 ns
turn-on time	t_{on}	<	45 ns

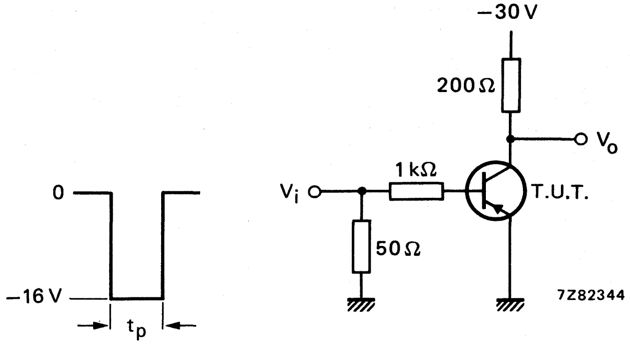


Fig. 2 Input waveform and test circuit for determining delay, rise and turn-on time.

Turn-off time (see Fig. 3)
when switched from $-I_{Con}$ = 150 mA; $-I_{Bon}$ = 15 mA
to cut-off with $+I_{Boff}$ = 15 mA

storage time	t_s	<	80 ns
turn-off time	t_{off}	<	100 ns

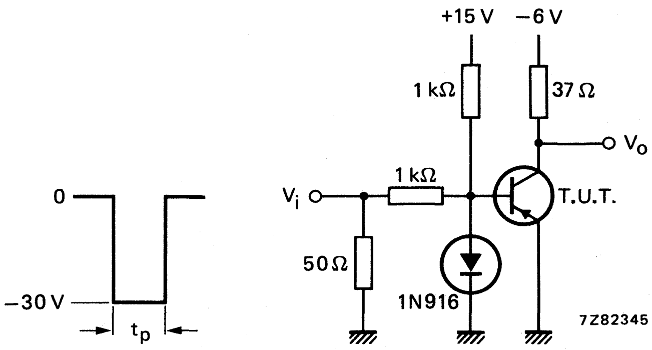


Fig. 3 Input waveform and test circuit for determining storage, fall and turn-off time.

Pulse generator (see Figs 2 and 3)

frequency	f	=	150 Hz
pulse duration	t_p	=	200 ns
rise time	t_r	⩽	2 ns
output impedance	Z_o	=	50 Ω

Oscilloscope (see Figs 2 and 3)

rise time	t_r	⩽	5 ns
input impedance	Z_i	=	10 MΩ

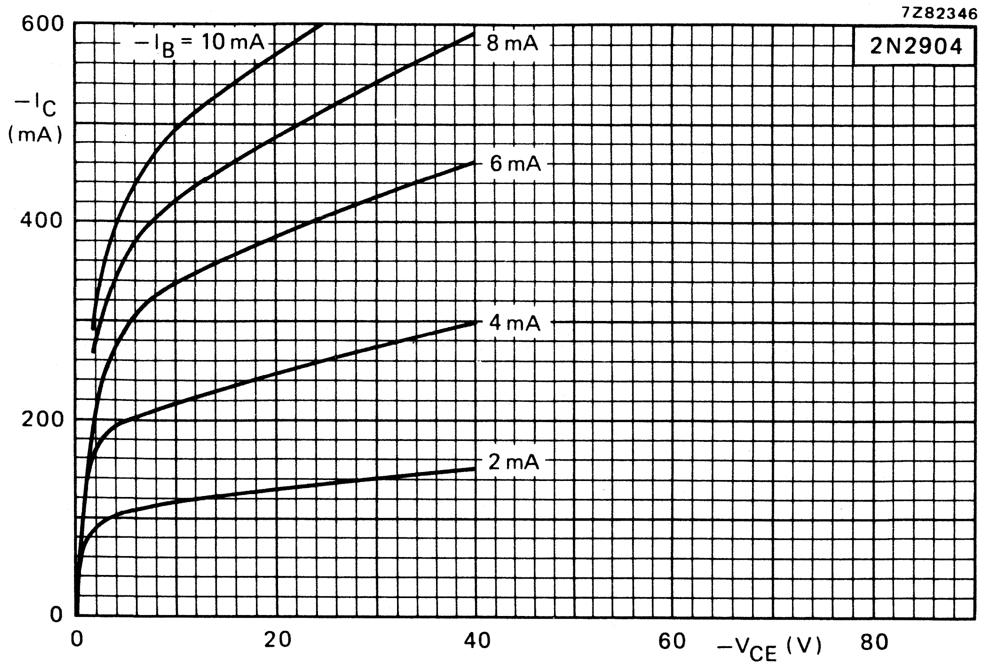


Fig. 4 Typical values; T_j = 25 °C.

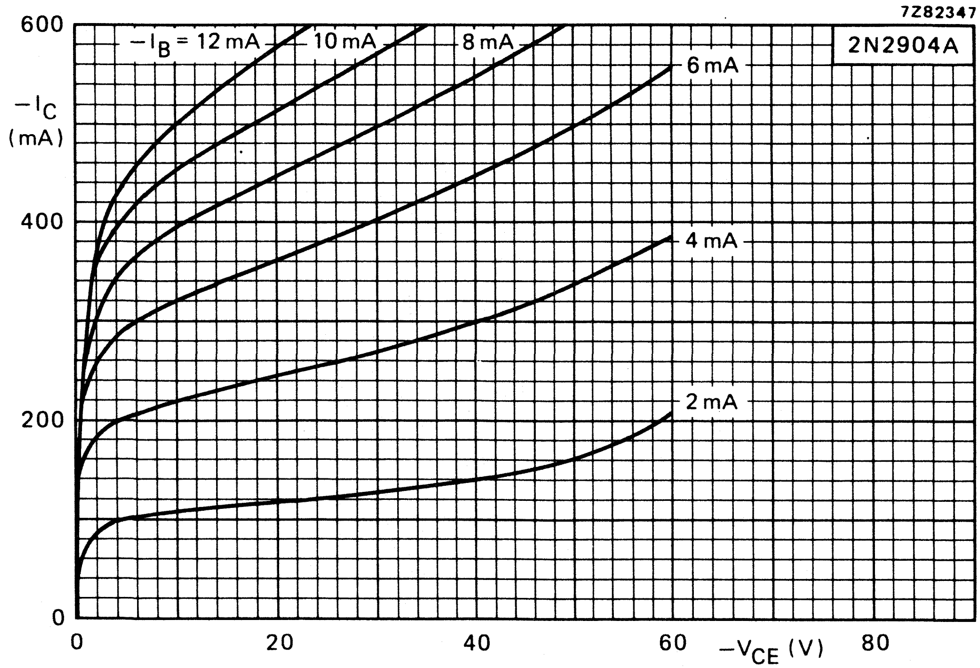


Fig. 5 Typical values; T_j = 25 °C.

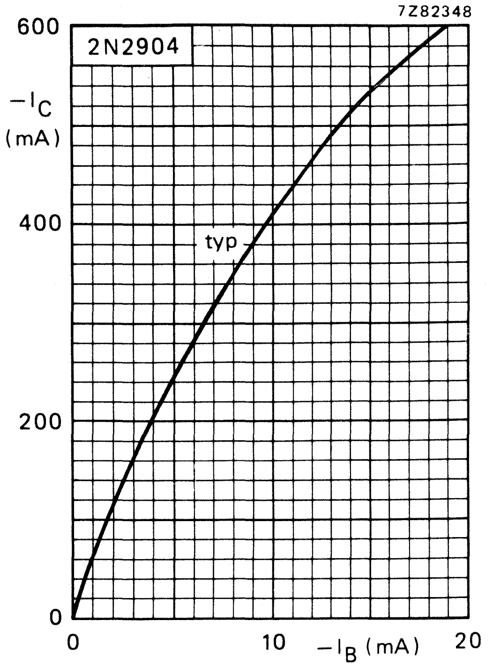


Fig. 6 $-V_{CE} = 5,0$ V; $T_J = 25$ °C.

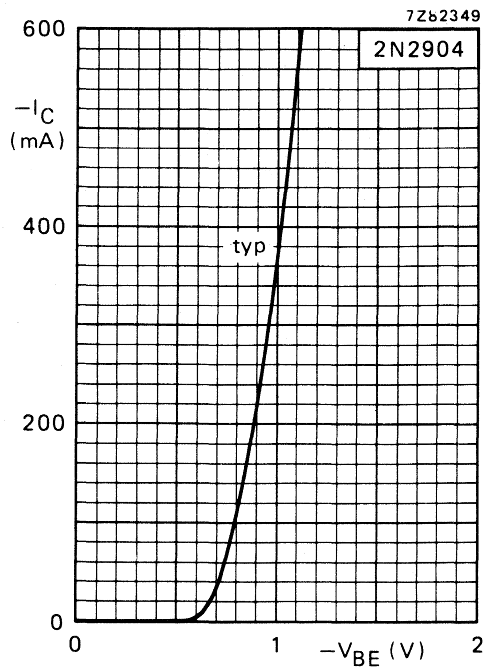


Fig. 7 $-V_{CE} = 5,0$ V; $T_j = 25$ °C.

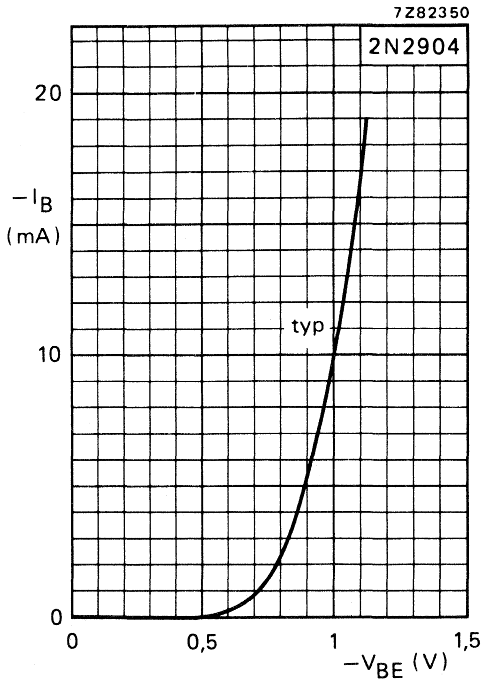


Fig. 8 $-V_{CE} = 5,0$ V; $T_j = 25$ °C.

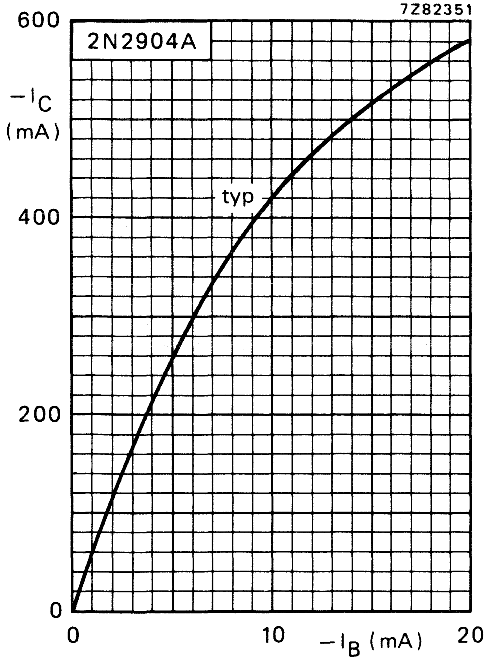


Fig. 9 $-V_{CE}$ = 5,0 V; T_j = 25 °C.

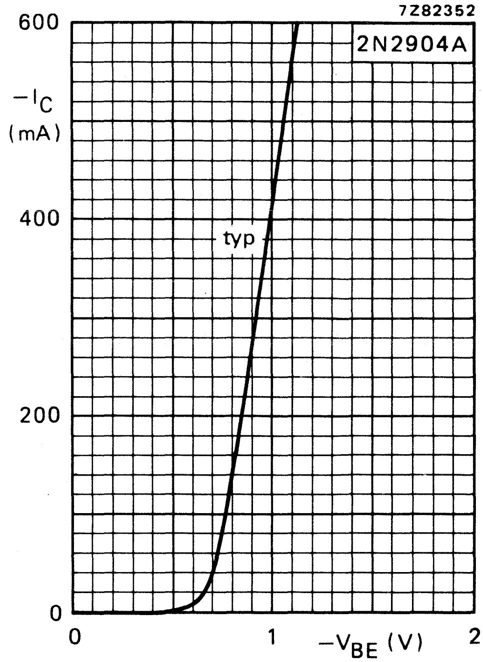


Fig. 10 $-V_{CE}$ = 5,0 V; T_j = 25 °C.

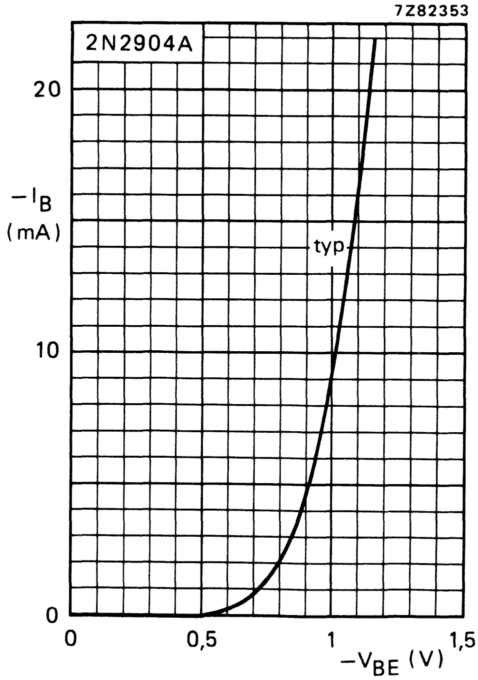


Fig. 11 $-V_{CE}$ = 5,0 V; T_j = 25 °C.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in TO-39 metal envelopes designed primarily for high-speed switching and driver applications for industrial service.

QUICK REFERENCE DATA

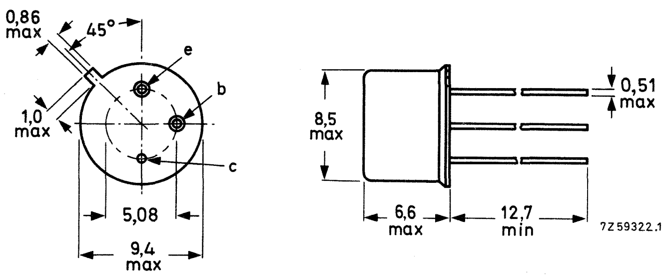
Collector-base voltage (open emitter)		$-V_{CBO}$	max.	60	V
Collector-emitter voltage (open base)	**2N2905**	$-V_{CEO}$	max.	40	V
	2N2905A	$-V_{CEO}$	max.	60	V
Collector current (d.c.)		$-I_C$	max.	600	mA
Total power dissipation up to T_{amb} = 25 °C		P_{tot}	max.	0,6	W
Junction temperature		T_j	max.	200	°C
D.C. current gain at T_j = 25 °C $-I_C$ = 150 mA; $-V_{CE}$ = 10 V		h_{FE}	100 to 300		
Transition frequency at f = 100 MHz $-I_C$ = 50 mA; $-V_{CE}$ = 20 V; T_j = 25 °C		f_T	>	200	MHz
Storage time $-I_{Con}$ = 150 mA; $-I_{Bon}$ = I_{Boff} = 15 mA		t_s	<	80	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case.



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 002-102.

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) $-I_C < 100$ mA	**2N2905**	$-V_{CEO}$	max.	40	V
	2N2905A	$-V_{CEO}$	max.	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.	0,6	W
up to T_{case} = 25 °C		P_{tot}	max.	3,0	W
Storage temperature range		T_{stg}	−65 to + 150		°C
Junction temperature		T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	292	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	58	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			2N2905	2N2905A	
Collector cut-off current					
$I_E = 0$; $-V_{CB} = 50$ V	$-I_{CBO}$	<	20	10	nA
$I_E = 0$; $-V_{CB} = 50$ V; $T_{amb} = 150$ °C	$-I_{CBO}$	<	20	10	μA
$+V_{BE} = 0{,}5$ V; $-V_{CE} = 30$ V	$-I_{CEX}$	<	50	50	nA
Base current					
$+V_{BE} = 0{,}5$ V; $-V_{CE} = 30$ V	I_{BEX}	<	50	50	nA
Collector-base breakdown voltage					
open emitter; $-I_C = 10$ μA	$-V_{(BR)CBO}$	>	60	60	V
Collector-emitter breakdown voltage*					
open base; $-I_C = 10$ mA	$-V_{(BR)CEO}$	>	40	60	V
Emitter-base breakdown voltage					
open collector; $-I_E = 10$ μA	$-V_{(BR)EBO}$	>	5	5	V
Saturation voltages*					
$-I_C = 150$ mA; $-I_B = 15$ mA	$-V_{CEsat}$	<	0,4	0,4	V
	$-V_{BEsat}$	<	1,3	1,3	V
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	1,6	1,6	V
	$-V_{BEsat}$	<	2,6	2,6	V
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	100	
		<	300	300	
$-I_C = 500$ mA; $-V_{CE} = 10$ V*	h_{FE}	>	30	50	
Collector capacitance at f = 100 kHz					
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	<	8		pF
Emitter capacitance at f = 100 kHz					
$I_C = I_c = 0$; $-V_{EB} = 2$ V	C_e	<	30		pF
Transition frequency at f = 100 MHz					
$-I_C = 50$ mA; $-V_{CE} = 20$ V*	f_T	>	200		MHz

* Measured under pulse conditions to avoid excessive dissipation; $t_p \leqslant 300$ μs; $\delta \leqslant 0{,}02$.

Turn-on time (see Fig. 2)
when switched to $-I_{Con}$ = 150 mA; $-I_{Bon}$ = 15 mA

delay time	t_d	<	10 ns
rise time	t_r	<	40 ns
turn-on time	t_{on}	<	45 ns

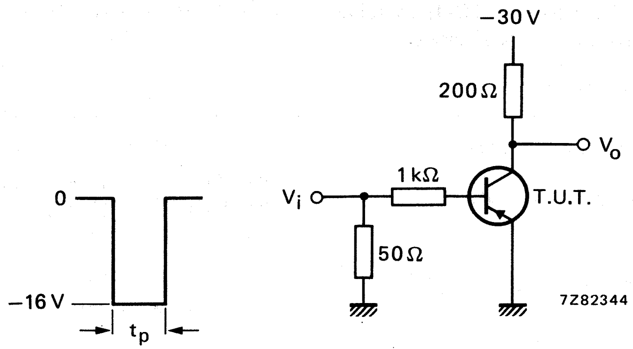


Fig. 2 Input waveform and test circuit for determining delay, rise and turn-on time.

Turn-off time (see Fig. 3)
when switched from $-I_{Con}$ = 150 mA; $-I_{Bon}$ = 15 mA
to cut-off with $+I_{Boff}$ = 15 mA

storage time	t_s	<	80 ns
turn-off time	t_{off}	<	100 ns

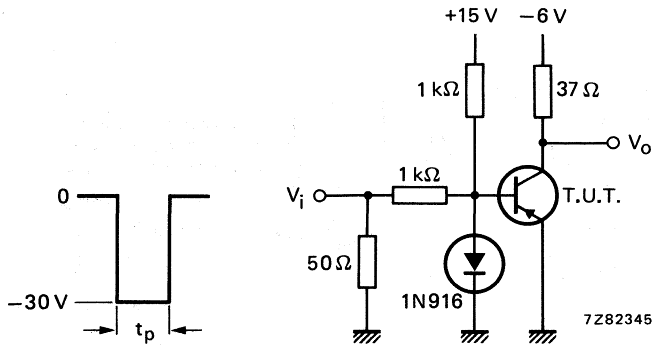


Fig. 3 Input waveform and test circuit for determining storage, fall and turn-off time.

Pulse generator (see Figs 2 and 3)

frequency	f	=	150 Hz
pulse duration	t_p	=	200 ns
rise time	t_r	≤	2 ns
output impedance	Z_o	=	50 Ω

Oscilloscope (see Figs 2 and 3)

rise time	t_r	≤	5 ns
input impedance	Z_i	=	10 MΩ

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P medium power transistors in TO-18 metal envelopes designed primarily for high-speed switching and driver applications for industrial service.

QUICK REFERENCE DATA

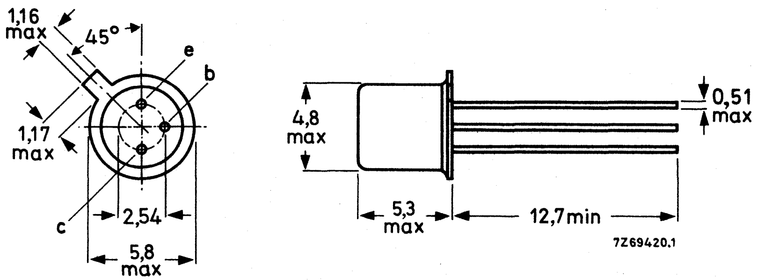
Collector-base voltage (open emitter)		$-V_{CBO}$	max.	60	V
Collector-emitter voltage (open base)	2N2906	$-V_{CEO}$	max.	40	V
	2N2906A	$-V_{CEO}$	max.	60	V
Collector current (d.c.)		$-I_C$	max.	600	mA
Total power dissipation up to T_{amb} = 25 °C		P_{tot}	max.	0,4	W
Junction temperature		T_j	max.	200	°C
D.C. current gain at T_j = 25 °C $-I_C$ = 150 mA; $-V_{CE}$ = 10 V		h_{FE}		40 to 120	
Transition frequency at f = 100 MHz $-I_C$ = 50 mA; $-V_{CE}$ = 20 V; T_j = 25 °C		f_T	>	200	MHz
Storage time $-I_{Con}$ = 150 mA; $-I_{Bon}$ = I_{Boff} = 15 mA		t_s	<	80	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case.



Products approved to CECC 50 002-103.

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) $-I_C < 100$ mA	**2N2906**	$-V_{CEO}$	max.	40	V
	2N2906A	$-V_{CEO}$	max.	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 $T_{amb} = 25\ ^oC$		P_{tot}	max.	0,4	W
up to $T_{case} = 25\ ^oC$		P_{tot}	max.	1,2	W
Storage temperature range		T_{stg}	−65 to + 150		^oC
Junction temperature		T_j	max.	200	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	438	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	146	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			2N2906	2N2906A	
Collector cut-off current					
$I_E = 0; -V_{CB} = 50$ V	$-I_{CBO}$	<	20	10	nA
$I_E = 0; -V_{CB} = 50$ V; $T_{amb} = 150$ °C	$-I_{CBO}$	<	20	10	µA
$+V_{BE} = 0{,}5$ V; $-V_{CE} = 30$ V	$-I_{CEX}$	<	50	50	nA
Base current					
$+V_{BE} = 0{,}5$ V; $-V_{CE} = 30$ V	I_{BEX}	<	50	50	nA
Collector-base breakdown voltage					
open emitter; $-I_C = 10$ µA	$-V_{(BR)CBO}$	>	60	60	V
Collector-emitter breakdown voltage*					
open base; $-I_C = 10$ mA	$-V_{(BR)CEO}$	>	40	60	V
Emitter-base breakdown voltage					
open collector; $-I_E = 10$ µA	$-V_{(BR)EBO}$	>	5	5	V
Saturation voltages*					
$-I_C = 150$ mA; $-I_B = 15$ mA	$-V_{CEsat}$	<	0,4	0,4	V
	$-V_{BEsat}$	<	1,3	1,3	V
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	1,6	1,6	V
	$-V_{BEsat}$	<	2,6	2,6	V
D.C. current gain					
$-I_C = 0{,}1$ mA; $-V_{CE} = 10$ V	h_{FE}	>	20	40	
$-I_C = 1$ mA; $-V_{CE} = 10$ V	h_{FE}	>	25	40	
$-I_C = 10$ mA; $-V_{CE} = 10$ V	h_{FE}	>	35	40	
$-I_C = 150$ mA; $-V_{CE} = 10$ V*	h_{FE}	>	40	40	
		<	120	120	
$-I_C = 500$ mA; $-V_{CE} = 10$ V*	h_{FE}	>	20	40	
Collector capacitance at f = 100 kHz					
$I_E = I_e = 0; -V_{CB} = 10$ V	C_c	<	8		pF
Emitter capacitance at f = 100 kHz					
$I_C = I_c = 0; -V_{EB} = 2$ V	C_e	<	30		pF
Transition frequency at f = 100 MHz					
$-I_C = 50$ mA; $-V_{CE} = 20$ V*	f_T	>	200		MHz

* Measured under pulse conditions to avoid excessive dissipation: $t_p \leqslant 300$ µs; $\delta \leqslant 0{,}02$.

Turn-on time (see Fig. 2)
when switched to $-I_{Con}$ = 150 mA; $-I_{Bon}$ = 15 mA

delay time	t_d	<	10	ns
rise time	t_r	<	40	ns
turn-on time	t_{on}	<	45	ns

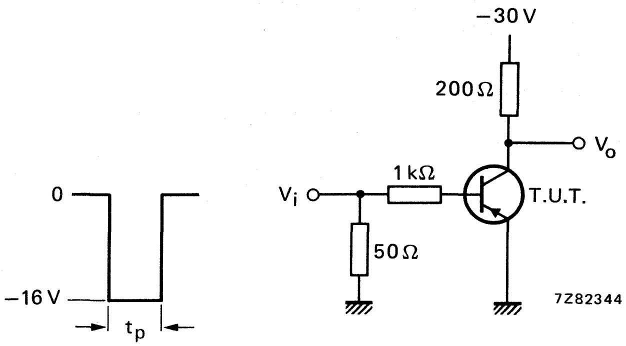


Fig. 2 Input waveform and test circuit for determining delay, rise and turn-on time.

Turn-off time (see Fig. 3)
when switched from $-I_{Con}$ = 150 mA; $-I_{Bon}$ = 15 mA
to cut-off with + I_{Boff} = 15 mA

storage time	t_s	<	80	ns
turn-off time	t_{off}	<	100	ns

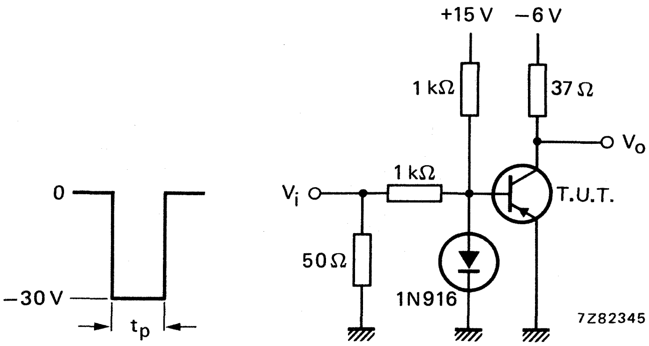


Fig. 3 Input waveform and test circuit for determining storage, fall and turn-off time.

Pulse generator (see Figs 2 and 3)

frequency	f	=	150	Hz
pulse duration	t_p	=	200	ns
rise time	t_r	⩽	2	ns
output impedance	Z_o	=	50	Ω

Oscilloscope (see Figs 2 and 3)

rise time	t_r	⩽	5	ns
input impedance	Z_i	⩽	10	MΩ

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P medium power transistors in TO-18 metal envelopes designed primarily for high-speed switching and driver applications for industrial service.

QUICK REFERENCE DATA

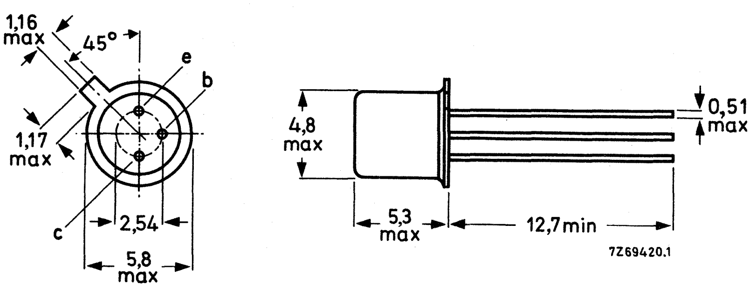
Collector-base voltage (open emitter)		$-V_{CBO}$	max.	60	V
Collector-emitter voltage (open base)	**2N2907**	$-V_{CEO}$	max.	40	V
	2N2907A	$-V_{CEO}$	max.	60	V
Collector current (d.c.)		$-I_C$	max.	600	mA
Total power dissipation up to T_{amb} = 25 °C		P_{tot}	max.	0,4	W
Junction temperature		T_j	max.	200	°C
D.C. current gain at T_j = 25 °C; $-I_C$ = 150 mA; $-V_{CE}$ = 10 V		h_{FE}		100 to 300	
Transition frequency at f = 100 MHz; $-I_C$ = 50 mA; $-V_{CE}$ = 20 V; T_j = 25 °C		f_T	>	200	MHz
Storage time; $-I_{Con}$ = 150 mA; $-I_{Bon}$ = I_{Boff} = 15 mA		t_s	<	80	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-18.

Collector connected to case.



Products approved to CECC 50 002-103.

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)					
$-I_C < 100$ mA	**2N2907**	$-V_{CEO}$	max.	40	V
	2N2907A	$-V_{CEO}$	max.	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.	0,4	W
up to $T_{case} = 25$ °C		P_{tot}	max.	1,2	W
Storage temperature range		T_{stg}	−65 to	+150	°C
Junction temperature		T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	438	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	146	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			2N2907	2N2907A	
Collector cut-off current					
$I_E = 0$; $-V_{CB} = 50$ V	$-I_{CBO}$	<	20	10	nA
$I_E = 0$; $-V_{CB} = 50$ V; $T_{amb} = 150$ °C	$-I_{CBO}$	<	20	10	μA
$+V_{BE} = 0,5$ V; $-V_{CE} = 30$ V	$-I_{CEX}$	<	50	50	nA
Base current					
$+V_{BE} = 0,5$ V; $-V_{CE} = 30$ V	I_{BEX}	<	50	50	nA
Collector-base breakdown voltage					
open emitter; $-I_C = 10$ μA	$-V_{(BR)CBO}$	>	60	60	V
Collector-emitter breakdown voltage *					
open base; $-I_C = 10$ mA	$-V_{(BR)CEO}$	>	40	60	V
Emitter-base breakdown voltage					
open collector; $-I_E = 10$ μA	$-V_{(BR)EBO}$	>	5	5	V
Saturation voltages *					
$-I_C = 150$ mA; $-I_B = 15$ mA	$-V_{CEsat}$	<	0,4	0,4	V
	$-V_{BEsat}$	<	1,3	1,3	V
$-I_C = 500$ mA; $-I_B = 50$ mA	$-V_{CEsat}$	<	1,6	1,6	V
	$-V_{BEsat}$	<	2,6	2,6	V
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	100	
		<	300	300	
$-I_C = 500$ mA; $-V_{CE} = 10$ V *	h_{FE}	>	30	50	
Collector capacitance at f = 100 kHz					
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	<	8		pF
Emitter capacitance at f = 100 kHz					
$I_C = I_c = 0$; $-V_{EB} = 2$ V	C_e	<	30		pF
Transition frequency at f = 100 MHz					
$-I_C = 50$ mA; $-V_{CE} = 20$ V *	f_T	>	200		MHz

* Measured under pulse conditions to avoid excessive dissipation: $t_p \leqslant 300$ μs; $\delta \leqslant 0,02$.

Turn-on time (see Fig. 2)
when switched to $-I_{Con}$ = 150 mA; $-I_{Bon}$ = 15 mA

delay time	t_d	<	10 ns
rise time	t_r	<	40 ns
turn-on time	t_{on}	<	45 ns

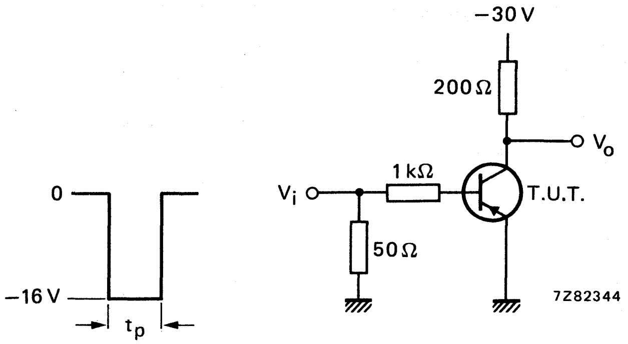


Fig. 2 Input waveform and test circuit for determining delay, rise and turn-on time.

Turn-off time (see Fig. 3)
when switched from $-I_{Con}$ = 150 mA; $-I_{Bon}$ = 15 mA
to cut-off with $+I_{Boff}$ = 15 mA

storage time	t_s	<	80 ns
turn-off time	t_{off}	<	100 ns

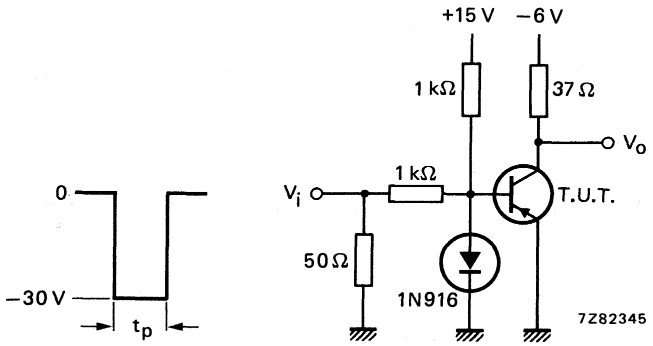


Fig. 3 Input waveform and test circuit for determining storage, fall and turn-off time.

Pulse generator (see Figs 2 and 3)

frequency	f	=	150 Hz
pulse duration	t_p	=	200 ns
rise time	t_r	⩽	2 ns
output impedance	Z_o	=	50 Ω

Oscilloscope (see Figs 2 and 3)

rise time	t_r	⩽	5 ns
input impedance	Z_i	⩽	10 MΩ

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in TO-39 metal envelopes intended for use as amplifiers and in switching circuits.

QUICK REFERENCE DATA

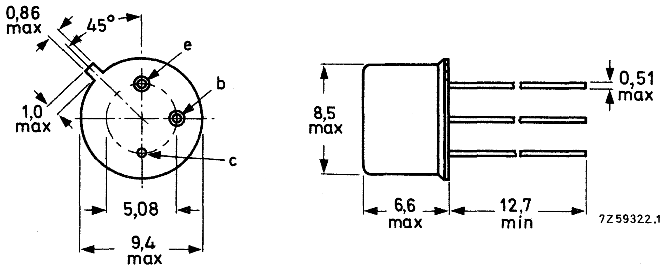
Collector-base voltage (open emitter)	V_{CBO}	max.	140		V
Collector-emitter voltage (open base)	V_{CEO}	max.	80		V
Collector current (d.c.)	I_C	max.	1		A
Total power dissipation					
up to T_{amb} = 25 °C	P_{tot}	max.	0,8		W
up to T_{case} = 25 °C	P_{tot}	max.	5,0		W
Junction temperature	T_j	max.	200		°C
			2N3019	**2N3020**	
D.C. current gain I_C = 150 mA; V_{CE} = 10 V	h_{FE}	>	100	40	
		<	300	120	
Transition frequency at f = 20 MHz I_C = 50 mA; V_{CE} = 10 V	f_T	>	100	80	MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

Products approved to CECC 50 002-175.

RATINGS

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

Collector-base voltage (open emitter)	V_{CBO}	max.	140 V
Collector-emitter voltage (open base)	V_{CEO}	max.	80 V
Emitter-base voltage (open collector)	V_{EBO}	max.	7 V
Collector current (d.c.)	I_C	max.	1 A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0,8 W
up to T_{case} = 25 °C	P_{tot}	max.	5,0 W
Storage temperature range	T_{stg}		–65 to +150 °C
Junction temperature	T_j	max.	200 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	218 K/W
From junction to case	$R_{th\ j\text{-}c}$	=	35 K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; V_{CB} = 90 V	I_{CBO}	<	10 nA
$I_E = 0$; V_{CB} = 90 V; T_{amb} = 150 °C	I_{CBO}	<	10 µA
Emitter cut-off current			
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	<	10 nA
Breakdown voltages			
$I_E = 0$; I_C = 100 µA	$V_{(BR)CBO}$	>	140 V
$I_B = 0$; I_C = 30 mA	$V_{(BR)CEO}$	>	80 V *
$I_C = 0$; I_E = 100 µA	$V_{(BR)EBO}$	>	7 V
Saturation voltages			
I_C = 150 mA; I_B = 15 mA	V_{CEsat}	<	0,2 V
	V_{BEsat}	<	1,1 V *
I_C = 500 mA; I_B = 50 mA	V_{CEsat}	<	0,5 V *

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

			2N3019	2N3020	
D.C. current gain *					
I_C = 0,1 mA; V_{CE} = 10 V	h_{FE}	>	50	30	
		<	–	100	
I_C = 10 mA; V_{CE} = 10 V	h_{FE}	>	90	40	
		<	–	120	
I_C = 150 mA; V_{CE} = 10 V	h_{FE}	>	100	40	
		<	300	120	
I_C = 150 mA; V_{CE} = 10 V; T_{case} = –55 °C	h_{FE}	>	40	–	
I_C = 500 mA; V_{CE} = 10 V	h_{FE}	>	50	30	
		<	–	100	
I_C = 1000 mA; V_{CE} = 10 V	h_{FE}	>	15	15	
Transition frequency at f = 20 MHz					
I_C = 50 mA; V_{CE} = 10 V	f_T	>	100	80	MHz
Collector capacitance at f = 1 MHz					
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	<	12	12	pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c$ = 0; V_{EB} = 0,5 V	C_e	<	60	60	pF
Feedback time constant at f = 4 MHz					
I_C = 10 mA; V_{CB} = 10 V	$r_{bb'}C_{b'c}$	<	400	400	ps
Small-signal current gain at f = 1 kHz					
I_C = 1,0 mA; V_{CE} = 5 V	h_{fe}	>	80	30	
		<	400	200	
Noise figure at f = 1 kHz					
I_C = 0,1 mA; V_{CE} = 10 V; R_S = 1 kΩ	F	<	4	–	dB

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

SILICON PLANAR TRANSISTOR

N-P-N transistor in a TO-39 metal envelope designed for medium speed, saturated and non-saturated switching applications for industrial service.

QUICK REFERENCE DATA

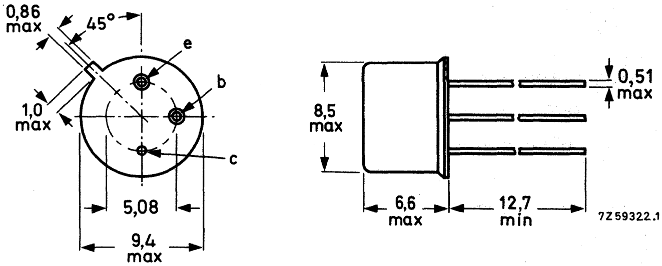
Collector-base voltage (open emitter)	V_{CBO}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	V
Collector current (d.c.)	I_C	max.	700	mA
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	5,0	W
Junction temperature	T_j	max.	200	°C
D.C. current gain I_C = 150 mA; V_{CE} = 10 V	h_{FE}		50 to 250	
Transition frequency at f = 20 MHz I_C = 50 mA; V_{CE} = 10 V	f_T	>	100	MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

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.	5	V
Collector current (d.c.)	I_C	max.	700	mA
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	5,0	W
Storage temperature range	T_{stg}	−65 to + 150		°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}c}$	=	35	K/W

CHARACTERISTICS

T_{amb} = 25 °C

Collector cut-off current				
V_{CE} = 30 V; $-V_{BE}$ = 1,5 V	I_{CEX}	<	0,25	μA
Emitter cut-off current				
I_C = 0; V_{EB} = 4 V	I_{EBO}	<	0,25	μA
Collector-base breakdown voltage				
open emitter; I_C = 100 μA	$V_{(BR)CBO}$	>	60	V
Collector-emitter breakdown voltage**				
open emitter; I_C = 100 μA	$V_{(BR)CEO}$	>	40	V
I_C = 100 mA; R_{BE} = 10 Ω	$V_{(BR)CER}$	>	50	V
Emitter-base breakdown voltage				
open collector; I_E = 100 μA	$V_{(BR)EBO}$	>	5	V
Base-emitter voltage				
I_C = 150 mA; V_{CE} = 2,5 V	V_{BE}	<	1,7	V
Saturation voltages				
I_C = 150 mA; I_B = 15 mA	V_{CEsat}	<	1,4	V
	V_{BEsat}	<	1,7	V
D.C. current gain				
I_C = 150 mA; V_{CE} = 2,5 V	h_{FE}	>	25	
I_C = 150 mA; V_{CE} = 10 V**	h_{FE}		50 to 250	
Collector capacitance at f = 140 kHz				
I_E = I_e = 0; V_{CB} = 10 V	C_c	<	15	pF
Emitter capacitance at f = 140 kHz				
I_C = I_c = 0; V_{EB} = 0,5 V	C_e	<	80	pF
Transition frequency at f = 20 MHz				
I_C = 50 mA; V_{CE} = 10 V	f_T	>	100	MHz

* For I_C = 0 to 100 mA (pulse conditions): t_p = 300 μs; δ = 0,018, 0 to 700 mA for shorter pulses.
** Measured under pulse conditions to avoid excessive dissipation: t_p = 300 μs; δ = 0,018.

SILICON NPN HIGH-VOLTAGE TRANSISTORS

NPN high-voltage small-signal transistors in a TO-39 envelope and intended for use in telephony and professional communication equipment.

Complementary type is 2N5415/5416.

QUICK REFERENCE DATA

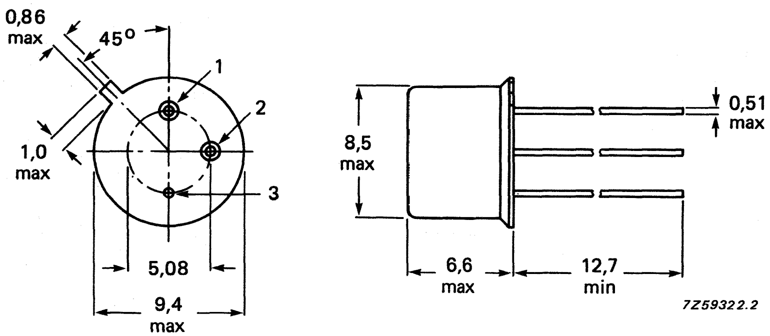
			2N3439	2N3440	
Collector-base voltage (open emitter)	V_{CBO}	max.	400	300	V
Collector-emitter voltage (open base)	V_{CEO}	max.	350	250	V
Collector current (DC)	I_C	max.	1.0	1.0	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	1	1	W
Junction temperature	T_j	max.	200	200	°C
Collector-emitter saturation voltage I_C = 50 mA; I_B = 4 mA	V_{CEsat}	max.	0.5	0.5	V
DC current gain I_C = 2 mA; V_{CE} = 10 V	h_{FE}	min.	30		
I_C = 20 mA; V_{CE} = 10 V	h_{FE}	min.		40	

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12.7 mm.

RATINGS

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

			2N3439	2N3440	
Collector-base voltage (open emitter)	V_{CBO}	max.	400	300	V
Collector-emitter voltage (open base)	V_{CEO}	max.	350	250	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5.0		V
Collector current (DC)	I_C	max.	1.0		A
Base current	I_B	max.	0.5		A
Total power dissipation					
up to T_{amb} = 25 °C	P_{tot}	max.	1		W
T_{case} = 25 °C	P_{tot}	max.	10		W
Junction temperature	T_j	max.	200		°C
Storage temperature range	T_j		–65 to 150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	219	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	58.3	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N3439	2N3440	
Collector cut-off currents					
$I_E = 0$; V_{CB} = 360 V	I_{CBO}	max.	0.1		μA
$I_E = 0$; V_{CB} = 250 V	I_{CBO}	max.		0.1	μA
$I_B = 0$; V_{CE} = 300 V	I_{CEO}	max.	1.0		μA
$I_B = 0$; V_{CE} = 200 V	I_{CEO}	max.		1.0	μA
Emitter cut-off current					
$I_C = 0$; V_{EB} = 5 V	I_{EBO}	max.	10	10	μA
Collector-emitter sustaining voltage					
$I_B = 0$; I_C = 50 mA	V_{CEOsus}	min.	350	250	V
Saturation voltages					
I_C = 50 mA; I_B = 4 mA	V_{CEsat}	max.	0.5	0.5	V
	V_{BEsat}	max.	1.3	1.3	V
DC current gain					
I_C = 2 mA; V_{CE} = 10 V	h_{FE}	min.	30		
I_C = 20 mA; V_{CE} = 10 V	h_{FE}	min.		40	
Transition frequency at f = 5 MHz					
I_C = 10 mA; V_{CE} = 10 V; T_{amb} = 25 °C	f_T	min.	70		MHz
Small-signal current gain at f = 1 kHz					
I_C = 5 mA; V_{CE} = 10 V; T_{amb} = 25 °C	h_{fe}	min.	25		
Real part (Re) of input impedance (h_{ie})					
V_{CE} = 10 V; I_C = 5 mA; f = 1 MHz; T_{amb} = 25 °C	$Re(h_{ie})$	max.	300		Ω
Input capacitance at f = 1 MHz					
$I_C = 0$; V_{EB} = 5 V; T_{amb} = 25 °C	C_e	max.	20		pF
Output capacitance at f = 1 MHz					
$I_E = 0$; V_{CB} = 10 V; T_{amb} = 25 °C	C_c	max.	2.0		pF

SUPERSEDES DATA OF OCTOBER 1981

SILICON PLANAR EPITAXIAL TRANSISTOR

NPN transistor in a plastic TO-92 envelope, primarily intended for high-speed, saturated switching applications for industrial service.

PNP complement is 2N3906.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	V
Collector current (DC)	I_C	max.	200	mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	350	mW
Junction temperature	T_j	max.	150	°C
DC current gain I_C = 10 mA; V_{CE} = 1 V	h_{FE}	min. max.	100 300	
Transition frequency at f = 100 MHz I_C = 10 mA; V_{CE} = 20 V	f_T	min.	300	MHz
Storage time I_{Con} = 10 mA; I_{Bon} = $-I_{Boff}$ = 1 mA	t_s	max.	200	ns

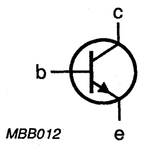
MECHANICAL DATA

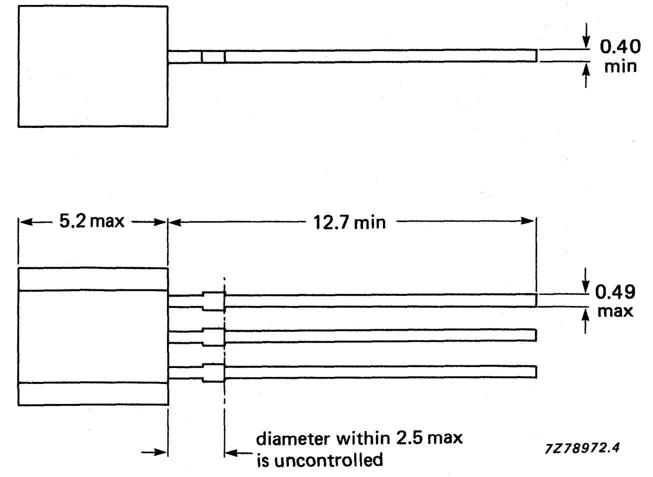
Dimensions in mm

Fig.1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector





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 (DC)	I_C	max.	200	mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	350	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	357	K/W

CHARACTERISTICS

T_{amb} = 25 °C

Currents at reverse biased emitter junction				
V_{CE} = 30 V; $-V_{BE}$ = 3 V	I_{CEX}	max.	50	nA
	$-I_{BEX}$	max.	50	nA
Saturation voltages *				
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	max.	200	mV
	V_{BEsat}		650 to 850	mV
I_C = 50 mA; I_B = 5 mA	V_{CEsat}	max.	300	mV
	V_{BEsat}	max.	950	mV
DC current gain*				
I_C = 0.1 mA; V_{CE} = 1 V	h_{FE}	min.	40	
I_C = 1 mA; V_{CE} = 1 V	h_{FE}	min.	70	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	min.	100	
		max.	300	
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	min.	60	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	min.	30	
Collector capacitance at 100 kHz ⩽ f ⩽ 1 MHz				
$I_E = I_e = 0$; V_{CB} = 5 V	C_c	max.	4	pF
Emitter capacitance at 100 kHz ⩽ f ⩽ 1 MHz				
$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	max.	8	pF
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 20 V	f_T	min.	300	MHz
Noise figure at R_S = 1 kΩ				
I_C = 100 μA; V_{CE} = 5 V				
f = 10 Hz to 15.7 kHz	F	max.	5	dB

* Measured under pulse conditions: t_p = 300 μs; δ = 0.02.

h-parameters (common emitter)
I_C = 1 mA; V_{CE} = 10 V; f = 1 kHz

Input impedance	h_{ie}	1 to 10 kΩ
Reverse voltage transfer ratio	h_{re}	0.5 to 8 10^{-4}
Small-signal current gain	h_{fe}	100 to 400
Output admittance	h_{oe}	1 to 40 μS

Switching times

Turn-on time (see Figs 2 and 3) when switched from
$-V_{BEoff}$ = 0.5 V to I_{Con} = 10 mA; I_{Bon} = 1 mA

Delay time	t_d	max. 35 ns
Rise time	t_r	max. 35 ns

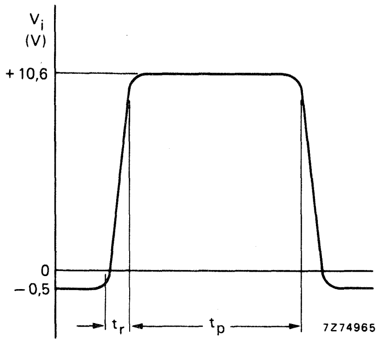


Fig. 2 Input waveform; $t_r < 1$ ns; t_p = 300 ns; δ = 0.02.

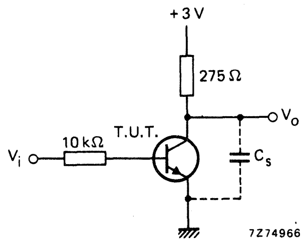


Fig. 3 Delay and rise time test circuit; total shunt capacitance of test jig and connectors $C_s < 4$ pF; scope impedance = 10 MΩ.

Turn-off time (see Figs 4 and 5)
I_{Con} = 10 mA; $I_{Bon} = -I_{Boff}$ = 1 mA

Storage time	t_s	max. 200 ns
Fall time	t_f	max. 50 ns

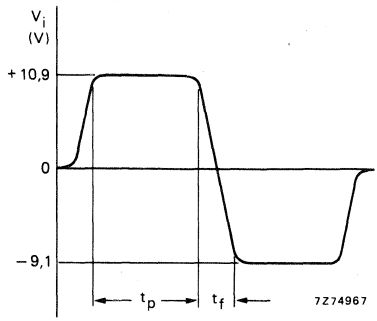


Fig. 4 Input waveform; $t_f < 1$ ns; 10 μs < t_p < 500 μs; δ = 0.02.

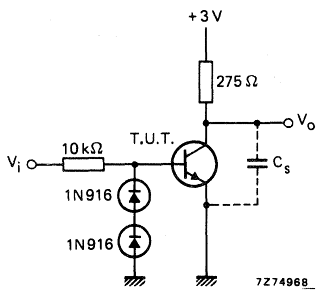


Fig. 5 Storage and fall time test circuit; total shunt capacitance of test jig and connectors $C_s < 4$ pF; scope impedance = 10 MΩ.

SUPERSEDES DATA OF OCTOBER 1984

SILICON PLANAR EPITAXIAL TRANSISTOR

PNP transistor in a plastic TO-92 envelope, primarily intended for high-speed, saturated switching applications for industrial service.

NPN complement is 2N3904.

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 (DC)	$-I_C$	max.	200	mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	350	mW
Junction temperature	T_j	max.	150	°C
DC current gain $-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	min. max.	100 300	
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 20 V	f_T	min.	250	MHz
Storage time $-I_{Con}$ = 10 mA; $-I_{Bon}$ = I_{Boff} = 1 mA	t_s	max.	225	ns

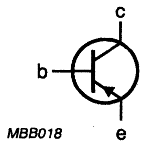
MECHANICAL DATA

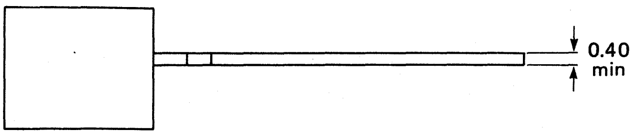
Dimensions in mm

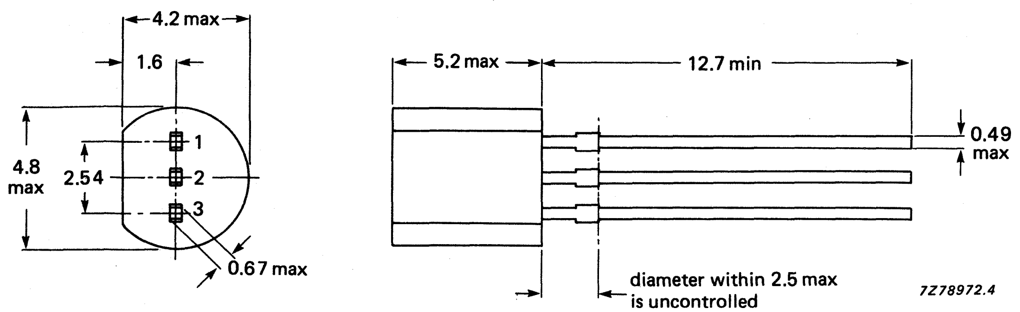
Fig.1 TO-92.

Pinning

1 = emitter
2 = base
3 = collector







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 (DC)	$-I_C$	max.	200	mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	350	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	357	K/W

CHARACTERISTICS

T_{amb} = 25 °C

Currents at reverse biased emitter junction $-V_{CE}$ = 30 V; + V_{BE} = 3 V	$-I_{CEX}$	max.	50	nA
	$+I_{BEX}$	max.	50	nA
Saturation voltages * $-I_C$ = 10 mA; $-I_B$ = 1 mA	$-V_{CEsat}$	max.	250	mV
	$-V_{BEsat}$		650 to 850	mV
$-I_C$ = 50 mA; $-I_B$ = 5 mA	$-V_{CEsat}$	max.	400	mV
	$-V_{BEsat}$	max.	950	mV
DC current gain* $-I_C$ = 0.1 mA; V_{CE} = 1 V	h_{FE}	min.	60	
$-I_C$ = 1 mA; V_{CE} = 1 V	h_{FE}	min.	80	
$-I_C$ = 10 mA; V_{CE} = 1 V	h_{FE}	min.	100	
		max.	300	
$-I_C$ = 50 mA; V_{CE} = 1 V	h_{FE}	min.	60	
$-I_C$ = 100 mA; V_{CE} = 1 V	h_{FE}	min.	30	
Collector capacitance at 100 kHz ⩽ f ⩽ 1 MHz $I_E = I_e = 0$; $-V_{CB}$ = 5 V	C_c	max.	4.5	pF
Emitter capacitance at 100 kHz ⩽ f ⩽ 1 MHz $I_C = I_c = 0$; $-V_{EB}$ = 0.5 V	C_e	max.	10	pF
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 20 V	f_T	min.	250	MHz
Noise figure at R_S = 1 kΩ $-I_C$ = 100 μA; $-V_{CE}$ = 5 V f = 10 Hz to 15.7 kHz	F	max.	4	dB

* Measured under pulse conditions: t_p = 300 μs; δ = 0.02.

h-parameters (common emitter)

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

Input impedance	h_{ie}	2 to 12 kΩ
Reverse voltage transfer ratio	h_{re}	0.1 to 10 10^{-4}
Small-signal current gain	h_{fe}	100 to 400
Output admittance	h_{oe}	3 to 60 μS

Switching times

Turn-on time (see Figs 2 and 3) when switched from

$+V_{BEoff} = 0.5$ V to $-I_{Con} = 10$ mA; $-I_{Bon} = 1$ mA

Delay time	t_d	max.	35 ns
Rise time	t_r	max.	35 ns

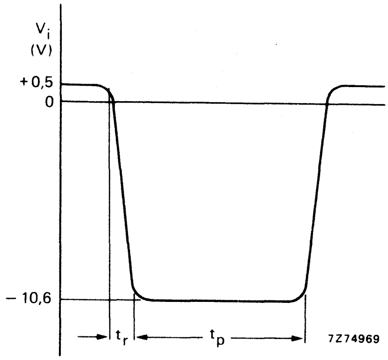


Fig. 2 Input waveform; $t_r < 1$ ns; $t_p = 300$ ns; δ = 0.02.

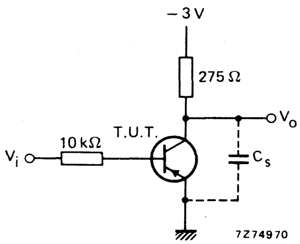


Fig. 3 Delay and rise time test circuit; total shunt capacitance of test jig and connectors $C_s < 4$ pF; scope impedance = 10 MΩ.

Turn-off time (see Figs 4 and 5)

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

Storage time	t_s	max.	225 ns
Fall time	t_f	max.	75 ns

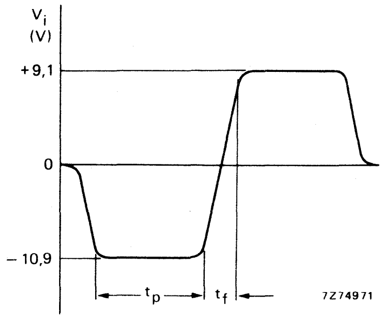


Fig. 4 Input waveform; $t_f < 1$ ns; 10 μs $< t_p <$ 500 μs; δ = 0.02.

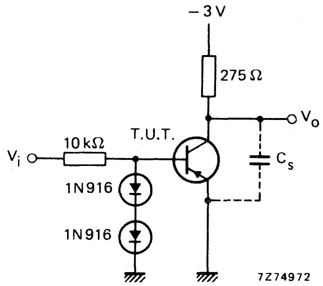


Fig. 5 Storage and fall time test circuit; total shunt capacitance of test jig and connectors $C_s < 4$ pF; scope impedance = 10 MΩ.

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in TO-39 metal envelopes primarily intended for large signal, low-noise, low-power audio frequency applications for industrial service.

QUICK REFERENCE DATA

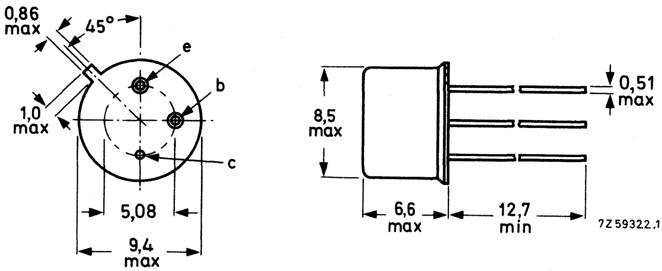
			2N4030 2N4032	2N4031 2N4033	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	V
Collector current (d.c.)	$-I_C$	max.	1		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0,8		W
Junction temperature	T_j	max.	200		°C
			2N4030 2N4031	2N4032 2N4033	
D.C. current gain $-I_C$ = 500 mA; $-V_{CE}$ = 5 V	h_{FE}	>	25	70	
Transition frequency at f = 100 MHz $-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	>	100	150	MHz

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

RATINGS

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

			2N4030 2N4032	2N4031 2N4033	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	5	V
Collector current (d.c.)	$-I_C$	max.	1		A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	0,8		W
up to T_{case} = 25 °C	P_{tot}	max.	4,0		W
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	200		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	218	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	44	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			2N4030 2N4032	2N4031 2N4033	
Collector cut-off current					
$I_E = 0$; $-V_{CB}$ = 50 V	$-I_{CBO}$	<	50	–	nA
$I_E = 0$; $-V_{CB}$ = 60 V	$-I_{CBO}$	<	–	50	nA
$I_E = 0$; $-V_{CB}$ = 50 V; T_{amb} = 150 °C	$-I_{CBO}$	<	50	–	μA
$I_E = 0$; $-V_{CB}$ = 60 V; T_{amb} = 150 °C	$-I_{CBO}$	<	–	50	μA
Emitter cut-off current					
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	10	10	μA
Breakdown voltages					
$I_E = 0$; $-I_C$ = 10 μA	$-V_{(BR)CBO}$	>	60	80	V
$I_B = 0$; $-I_C$ = 10 mA	$-V_{(BR)CEO}$	>	60	80	V *
$I_C = 0$; $-I_E$ = 10 μA	$-V_{(BR)EBO}$	>	5	5	V

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

			2N4030 2N4032	2N4031 2N4033	
Base-emitter voltage					
$-I_C$ = 500 mA; $-V_{CE}$ = 0,5 V	$-V_{BE}$	<	1,1	1,1	V *
$-I_C$ = 1000 mA; $-V_{CE}$ = 1,0 V	$-V_{BE}$	<	1,2	–	V *
Saturation voltages					
$-I_C$ = 150 mA; $-I_B$ = 15 mA	$-V_{CEsat}$	<	0,15	0,15	V
	$-V_{BEsat}$	<	0,90	0,90	V *
$-I_C$ = 500 mA; $-I_B$ = 50 mA	$-V_{CEsat}$	<	0,50	0,50	V
$-I_C$ = 1000 mA; $-I_B$ = 100 mA	$-V_{CEsat}$	<	1,00	–	V

				2N4030 2N4031	2N4032 2N4033	
D.C. current gain *						
$-I_C$ = 100 μA; $-V_{CE}$ = 5 V		h_{FE}	>	30	75	
$-I_C$ = 100 mA; $-V_{CE}$ = 5 V		h_{FE}	>	40	100	
			<	120	300	
$-I_C$ = 100 mA; $-V_{CE}$ = 5 V; T_{amb} = –55 °C		h_{FE}	>	15	40	
$-I_C$ = 500 mA; $-V_{CE}$ = 5 V		h_{FE}	>	25	70	
$-I_C$ = 1000 mA; $-V_{CE}$ = 5 V	**2N4030**	h_{FE}	>	15		
	2N4031	h_{FE}	>	10		
	2N4032	h_{FE}	>	40		
	2N4033	h_{FE}	>	25		
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	<	110		pF

			2N4030 2N4031	2N4032 2N4033	
Transition frequency at f = 100 MHz					
$-I_C$ = 50 mA; $-V_{CE}$ = 10 V	f_T	>	100	150	MHz
		<	400	500	MHz

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

Switching times

$-I_{Con}$ = 500 mA; $-I_{Bon}$ = 50 mA			
Turn-on time	t_{on}	<	100 ns
$-I_{Con}$ = 500 mA; $-I_{Bon}$ = $+I_{Boff}$ = 50 mA			
Storage time	t_s	<	350 ns
Fall time	t_f	<	50 ns

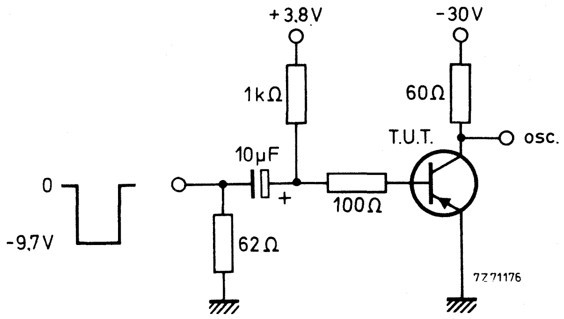


Fig. 2 Switching circuit.

Pulse generator:

Rise time	t_r	<	20 ns
Fall time	t_f	<	20 ns
Pulse duration	t_p	=	10 µs
Duty factor	δ	<	0,02
Source impedance	Z_S	=	50 Ω

Oscilloscope:

Rise time	t_r	=	10 ns
Input impedance	Z_I	>	100 kΩ

PNP POWER TRANSISTOR

PNP power transistor, housed in a TO-39 metal envelope. It is intended for use in amplifier and switching applications.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	90 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	65 V
Collector current (DC)	$-I_C$	max.	1.0 A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	7.0 W
DC current gain $-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}		20 to 200

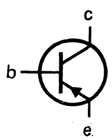
MECHANICAL DATA

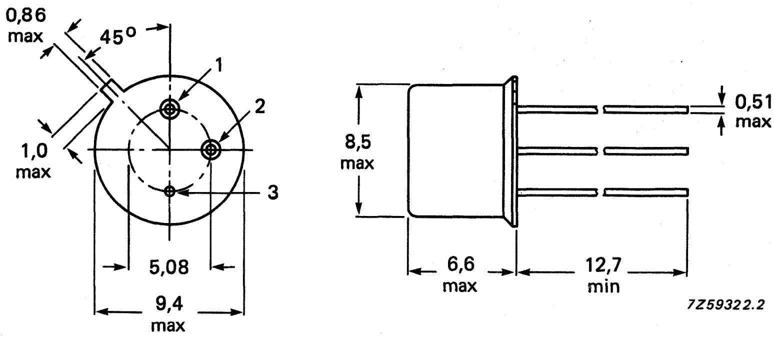
Dimensions in mm

Fig. 1 TO-39.

Pinning:

1 = emitter
2 = base
3 = collector





RATINGS

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	90	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	65	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	7.0	V
Collector current (DC)	$-I_C$	max.	1.0	A
Base current	$-I_B$	max.	0.5	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	7.0	W
Storage temperature range	T_{stg}		−55 to + 200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}c}$	25	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless stated otherwise

Collector-emitter sustaining voltage				
$-I_C$ = 100 mA; I_B = 0	$-V_{CEOsus}$	>	65	V
Collector cut-off current				
$-V_{CE}$ = 85 V; $-V_{EB}$ = 1.5 V	$-I_{CEX}$	<	100	mA
$-V_{CE}$ = 30 V; $-V_{EB}$ = 1.5 V; T_c = 150 °C	$-I_{CEX}$	<	0.1	mA
Collector cut-off current				
$-V_{CB}$ = 90 V; I_E = 0	$-I_{CEO}$	<	100	μA
Emitter cut-off current				
$-V_{EB}$ = 7 V; I_C = 0	$-I_{EBO}$	<	10	μA
DC current gain				
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}		20 to 200	
$-I_C$ = 0.1 mA; $-V_{CE}$ = 10 V	h_{FE}	>	20	
$-I_C$ = 150 mA; $-V_{CE}$ = 10 V	h_{FE}		40 to 140	
$-I_C$ = 150 mA; $-V_{CE}$ = 10 V	h_{FE}	>	20	
Saturation voltages				
$-I_C$ = 150 mA; $-I_B$ = 15 mA	$-V_{CEsat}$	<	0.65	V
	$-V_{BEsat}$	<	1.4	V
Base-emitter on-state voltage				
$-I_C$ = 150 mA; $-V_{CE}$ = 10 V	$-V_{BE\ on}$	<	1.5	V
Collector-base capacitance				
$-V_{CB}$ = 10 V; f = 1 MHz	C_{cb}	<	30	pF
High-frequency current gain				
$-I_C$ = 50 mA; $-V_{CE}$ = 10 V; f = 20 MHz	h_{FE}	>	3.0	
Switching characteristics				
rise time; I_{B1} = 15 mA	t_r	<	70	ns
storage time; I_{B2} = 15 mA	t_s	<	600	ns
fall time; I_{B2} = 15 mA	t_f	<	100	ns
turn-on time; I_{B1} = I_{B2}	t_{on}	<	110	ns
turn-off time; I_{B1} = I_{B2}	t_{off}	<	700	ns

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in plastic TO-92 envelopes, primarily intended for low-power, small-signal audio-frequency applications for consumer service.

P-N-P complements are 2N4125 and 2N4126.

QUICK REFERENCE DATA

			2N4123	2N4124	
Collector-base voltage (open emitter)	V_{CBO}	max.	40	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	25	V
Collector current (d.c.)	I_C	max.	200	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	350	350	mW
Junction temperature	T_j	max.	150	150	°C
Small-signal current gain I_C = 2 mA; V_{CE} = 10 V; f = 1 kHz	h_{fe}	> <	50 200	120 480	
Transition frequency at f = 100 MHz I_C = 10 mA; V_{CE} = 20 V	f_T	>	250	300	MHz
Noise figure at R_S = 1 kΩ I_C = 100 μA; V_{CE} = 5 V f = 10 Hz to 15,7 kHz	F	<	6	5	dB

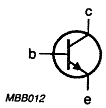
MECHANICAL DATA

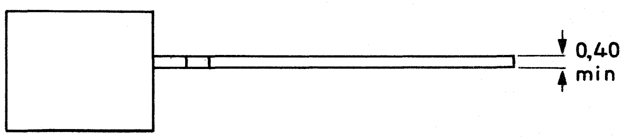
Dimensions in mm

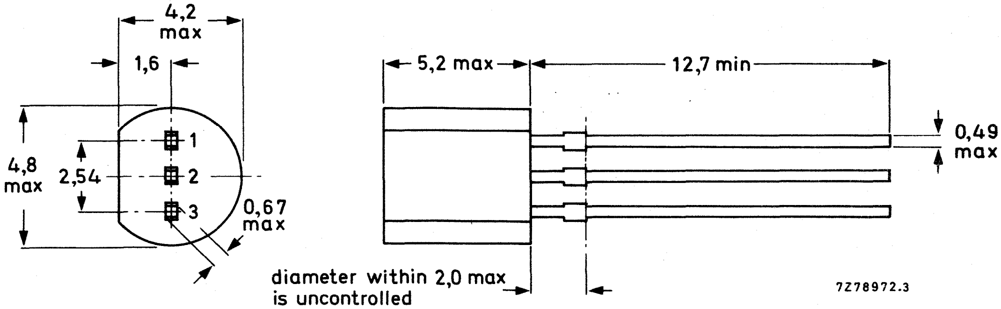
Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter







RATINGS

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

			2N4123	2N4124	
Collector-base voltage (open emitter)	V_{CBO}	max.	40	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	25	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} = 25 °C	P_{tot}	max.	350		mW
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	1000		mW
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	357	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	125	K/W

CHARACTERISTICS

T_{amb} = 25 °C

Collector cut-off current $I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	50	nA
Emitter cut-off current $I_C = 0$; $V_{EB} = 3$ V	I_{EBO}	<	50	nA
Saturation voltages * $I_C = 50$ mA; $I_B = 5$ mA	V_{CEsat}	<	300	mV
	V_{BEsat}	<	950	mV

			2N4123	2N4124	
D.C. current gain * I_C = 2 mA; V_{CE} = 1 V	h_{FE}	>	50	120	
		<	150	360	
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	>	25	60	
Collector capacitance at f = 100 kHz $I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	4	4	pF
Emitter capacitance at f = 100 kHz $I_C = I_c = 0$; $V_{EB} = 0{,}5$ V	C_e	<	8	8	pF
Transition frequency at f = 100 MHz $I_C = 10$ mA; $V_{CE} = 20$ V	f_T	>	250	300	MHz
Noise figure at $R_S = 1$ kΩ $I_C = 100\ \mu$A; $V_{CE} = 5$ V f = 10 Hz to 15,7 kHz	F	<	6	5	dB
Small-signal current gain $I_C = 2$ mA; $V_{CE} = 10$ V; f = 1 kHz	h_{fe}	>	50	120	
		<	200	480	

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

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in plastic TO-92 envelopes, primarily intended for low-power, small-signal audio-frequency applications for consumer service.

N-P-N complements are 2N4123 and 2N4124.

QUICK REFERENCE DATA

			2N4125	2N4126	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	25	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30	25	V
Collector current (d.c.)	$-I_C$	max.	200	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	350	350	mW
Junction temperature	T_j	max.	150	150	°C
Small-signal current gain $-I_C$ = 2 mA; $-V_{CE}$ = 10 V; f = 1 kHz	h_{fe}	>	50	120	
		<	200	480	
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 Hz to 15,7 kHz	F	<	5	4	dB

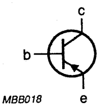
MECHANICAL DATA

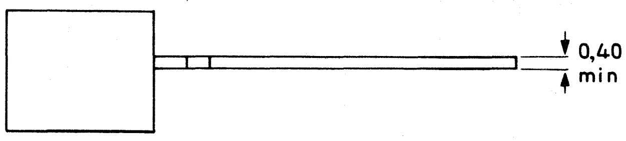
Dimensions in mm

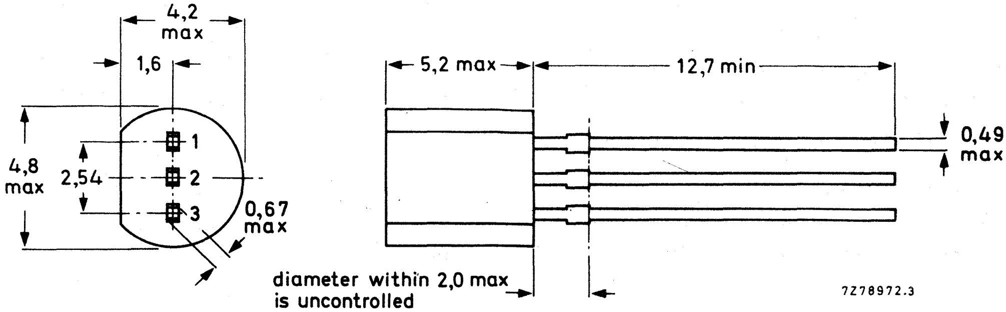
Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter







RATINGS

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

			2N4125	2N4126	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	25	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	4		V
Collector current (d.c.)	$-I_C$	max.	200		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	350		mW
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	1000		mW
Storage temperature range	T_{stg}		−65 to + 150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	357	K/W
From junction to case	$R_{th\ j-c}$	=	125	K/W

CHARACTERISTICS

T_{amb} = 25 °C

Collector cut-off current $I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	<	50	nA
Emitter cut-off current $I_C = 0$; $-V_{EB} = 3$ V	$-I_{EBO}$	<	50	nA
Saturation voltages * $-I_C = 50$ mA; $-I_B = 5$ mA	$-V_{CEsat}$	<	400	mV
	$-V_{BEsat}$	<	950	mV

			2N4125	2N4126	
D.C. current gain * $-I_C = 2$ mA; $-V_{CE} = 1$ V	h_{FE}	>	50	120	
		<	150	360	
$-I_C = 50$ mA; $-V_{CE} = 1$ V	h_{FE}	>	25	60	
Collector capacitance at f = 100 kHz $I_E = I_e = 0$; $-V_{CB} = 5$ V	C_c	<	4,5	4,5	pF
Emitter capacitance at f = 100 kHz $I_C = I_c = 0$; $-V_{EB} = 0,5$ V	C_e	<	10	10	pF
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 Hz to 15,7 kHz	F	<	5	4	dB
Small-signal current gain $-I_C = 2$ mA; $-V_{CE} = 10$ V; f = 1 kHz	h_{fe}	>	50	120	
		<	200	480	

* Measured under pulse conditions: $t_p = 300$ µs; $\delta = 0,02$.

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon planar epitaxial transistors in plastic TO-92 envelope for use in general purpose applications.

QUICK REFERENCE DATA

			2N4400	2N4401	
Collector-emitter voltage (open base)	V_{CEO}	max.	40	40	V
Collector-base voltage (open emitter)	V_{CBO}	max.	60	60	V
Collector current (d.c.)	I_C	max.	600	600	mA
Total device dissipation at T_{amb} = 25 °C	P_{tot}	max.	625	625	mW
Collector-emitter saturation voltage I_C = 500 mA; I_B = 50 mA	V_{CEsat}	max.	0,75	0,75	V
D.C. current gain I_C = 100 mA; V_{CE} = 2 V	h_{FE}	min.	50	150	
		max.	100	300	

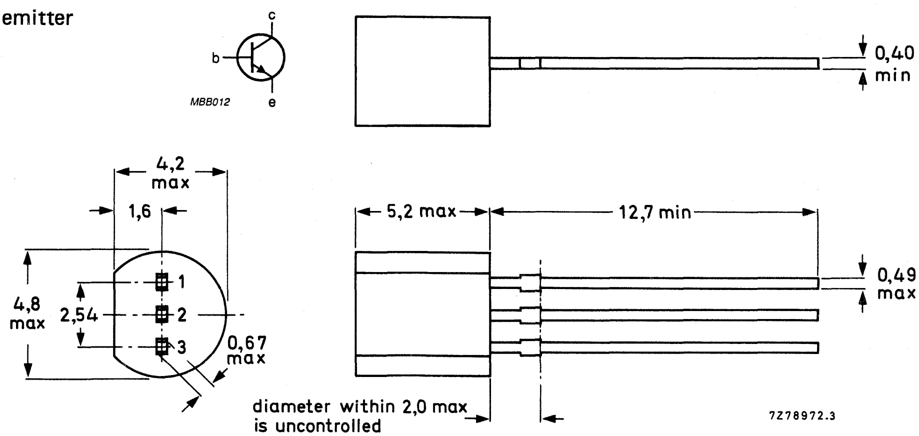
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



RATINGS

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

			2N4400	2N4401	
Collector-emitter voltage (open base)	V_{CEO}	max.	40		V
Collector-base voltage (open emitter)	V_{CBO}	max.	60		V
Emitter-base voltage (open collector)	V_{EBO}	max.	6		V
Collector current (d.c.)	I_C	max.	600		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N4400	2N4401	
Collector-emitter breakdown voltage I_B = 0; I_C = 1 mA	$V_{(BR)CEO}$	min.	40		V
Collector-base breakdown voltage I_E = 0; I_C = 0,1 mA	$V_{(BR)CBO}$	min.	60		V
Emitter-base breakdown voltage I_E = 0,1 mA; I_C = 0	$V_{(BR)EBO}$	min.	6		V
Base cut-off current V_{CE} = 35 V; $-V_{BE}$ = 0,4 V	I_{BEX}	max.	0,1		μA
Collector cut-off current V_{CE} = 35 V; $-V_{BE}$ = 0,4 V	I_{CEX}	max.	0,1		μA
D.C. current gain					
I_C = 0,1 mA; V_{CE} = 1 V	h_{FE}	min.	20		
I_C = 1 mA; V_{CE} = 1 V	h_{FE}	min.	20	40	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	min.	40	80	
I_C = 150 mA; V_{CE} = 1 V	h_{FE}	min.	50	100	
		max.	150	300	
I_C = 500 mA; V_{CE} = 2 V	h_{FE}	min.	20	40	
Saturation voltages					
I_C = 150 mA; I_B = 15 mA	V_{CEsat}	max.	0,4		V
	V_{BEsat}	min.	0,75		V
		max.	0,95		V
I_C = 500 mA; I_B = 50 mA	V_{CEsat}	max.	0,75		V
	V_{BEsat}	max.	1,2		V

			2N4400	2N4401	
Transition frequency at f = 100 MHz I_C = 20 mA; V_{CE} = 10 V	f_T	min.	200	250	MHz
Collector-base capacitance I_E = 0; V_{CB} = 5 V; f = 100 kHz	C_c	max.	6,5		pF
Emitter-base capacitance I_C = 0; V_{BE} = 0,5 V; f = 100 kHz	C_e	max.	30		pF
Input impedance at f = 1 kHz I_C = 1 mA; V_{CE} = 10 V	h_{ie}	min. max.	0,5 7,5	1,0 15	kΩ kΩ
Voltage feedback ratio at f = 1 kHz I_C = 1 mA; V_{CE} = 10 V	h_{re}	min. max.	0,1 8,0		$\times 10^{-4}$ $\times 10^{-4}$
Small-signal current gain I_C = 1 mA; V_{CE} = 10 V; f = 1 kHz	h_{fe}	min. max.	20 250	40 500	
Output admittance at f = 1 kHz I_C = 1 mA; V_{CE} = 10 V	h_{oe}	min. max.	1,0 30		μS μS

Switching times (resistive load)

Turn-on time I_C = 150 mA; I_{B1} = 15 mA; V_{CC} = 30 V; V_{EB} = 2 V				
delay time	t_d	max.	15	ns
rise time	t_r	max.	20	ns
Turn-off time I_C = 150 mA; I_{B1} = I_{B2} = 15 mA; V_{CC} = 30 V				
storage time	t_s	max.	225	ns
fall time	t_f	max.	30	ns

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P silicon planar epitaxial transistors in plastic TO-92 envelope for use in general purpose applications.

QUICK REFERENCE DATA

			2N4402	2N4403	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	40	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	40	V
Collector current (d.c.)	$-I_C$	max.	600	600	mA
Total device dissipation at T_{amb} = 25 °C	P_{tot}	max.	625	625	mW
Collector-emitter saturation voltage $-I_C$ = 500 mA; $-I_B$ = 50 mA	$-V_{CEsat}$	max.	0,75	0,75	V
D.C. current gain $-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}	min.	50	150	
		max.	100	300	

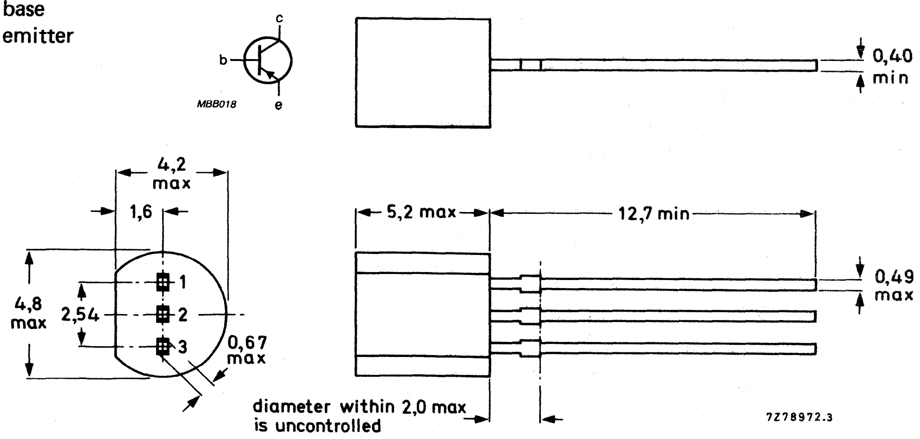
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



RATINGS

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

			2N4402	2N4403	
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40		V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40		V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current (d.c.)	$-I_C$	max.	600		mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	625		mW
Storage temperature range	T_{stg}		−65 to +150		°C
Junction temperature	T_j	max.	150		°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N4402	2N4403	
Collector-emitter breakdown voltage $I_B = 0$; $-I_C$ = 1 mA	$-V_{(BR)CEO}$	min.	40		V
Collector-base breakdown voltage $I_E = 0$; $-I_C$ = 0,1 mA	$-V_{(BR)CBO}$	min.	40		V
Emitter-base breakdown voltage $-I_E$ = 0,1 mA; $I_C = 0$	$-V_{(BR)EBO}$	min.	5		V
Base cut-off current $-V_{CE}$ = 35 V; V_{BE} = 0,4 V	$-I_{BEX}$	max.	0,1		μA
Collector cut-off current $-V_{CE}$ = 35 V; V_{BE} = 0,4 V	$-I_{CEX}$	max.	0,1		μA
D.C. current gain					
$-I_C$ = 0,1 mA; $-V_{CE}$ = 1 V	h_{FE}	min.		30	
$-I_C$ = 1 mA; $-V_{CE}$ = 1 V	h_{FE}	min.	30	60	
$-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	min.	50	100	
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}	min.	50	150	
		max.	150	300	
$-I_C$ = 500 mA; $-V_{CE}$ = 2 V	h_{FE}	min.	20		
Saturation voltages					
$-I_C$ = 150 mA; $-I_B$ = 15 mA	$-V_{CEsat}$	max.	0,4		V
	$-V_{BEsat}$	min.	0,75		V
		max.	0,95		V
$-I_C$ = 500 mA; $-I_B$ = 50 mA	$-V_{CEsat}$	max.	0,75		V
	$-V_{BEsat}$	max.	1,3		V

			2N4402		2N4403	
Transition frequency at f = 100 MHz						
$-I_C$ = 20 mA; $-V_{CE}$ = 10 V	f_T	min.	150		200	MHz
Collector-base capacitance						
I_E = 0; $-V_{CB}$ = 10 V; f = 140 kHz	C_{cb}	max.		8,5		pF
Emitter-base capacitance						
I_C = 0; $-V_{BE}$ = 0,5 V; f = 140 kHz	C_{eb}	max.		30		pF
Input impedance at f = 1 kHz						
$-I_C$ = 1 mA; $-V_{CE}$ = 10 V	h_{ie}	min.	0,75		1,5	kΩ
		max.	7,5		15	kΩ
Voltage feedback ratio at f = 1 kHz						
$-I_C$ = 1 mA; $-V_{CE}$ = 10 V	h_{re}	min.		0,1		$\times 10^{-4}$
		max.		8,0		$\times 10^{-4}$
Small-signal current gain						
$-I_C$ = 1 mA; $-V_{CE}$ = 10 V; f = 1 kHz	h_{fe}	min.	30		60	
		max.	250		500	
Output admittance at f = 1 kHz						
$-I_C$ = 1 mA; $-V_{CE}$ = 10 V	h_{oe}	min.		1,0		μS
		max.		100		μS

Switching times (resistive load)

Turn-on time				
$-I_C$ = 150 mA; $-I_{B1}$ = 15 mA;				
$-V_{CC}$ = 30 V; $-V_{EB}$ = 2 V				
delay time	t_d	max.	15	ns
rise time	t_r	max.	20	ns
Turn-off time				
$-I_C$ = 150 mA; $-I_{B1}$ = I_{B2} = 15 mA;				
$-V_{CC}$ = 30 V				
storage time	t_s	max.	225	ns
fall time	t_f	max.	30	ns

SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P small-signal transistors in plastic TO-92 envelope intended for low-noise stages in audio equipment. Complementary types are 2N5088/2N5089.

QUICK REFERENCE DATA

Collector-emitter voltage (open base)	$-V_{CEO}$	max.	50		V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50		V
Collector current (d.c.)	$-I_C$	max.	50		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625		mW
Collector-emitter saturation voltage $-I_C$ = 10 mA; $-I_B$ = 1 mA	$-V_{CEsat}$	max.	0,3		V
			2N5086	2N5087	
D.C. current gain $-I_C$ = 1 mA; $-V_{CE}$ = 5 V	h_{FE}	min.	150	250	

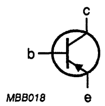
MECHANICAL DATA

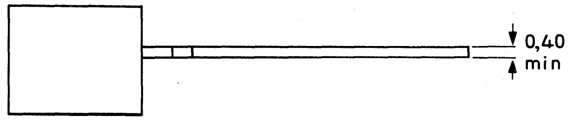
Dimensions in mm

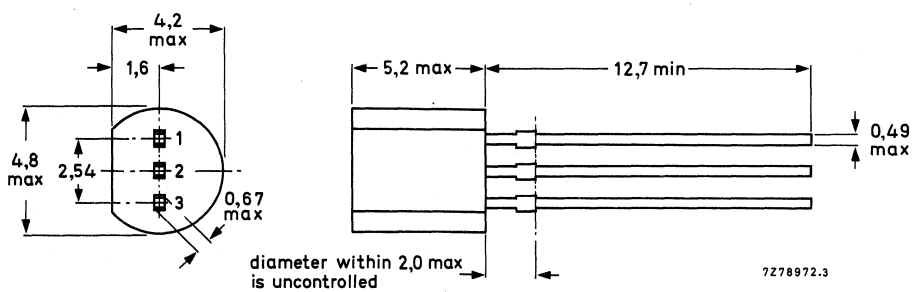
Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter







RATINGS

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

Collector-emitter voltage (open base)	$-V_{CEO}$	max.	50	V
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	3,0	V
Collector current (d.c.)	$-I_C$	max.	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	mW
Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector-emitter breakdown voltage $I_B = 0$; $-I_C$ = 1 mA	$-V_{(BR)CEO}$	min.	50	V
Collector-base breakdown voltage $I_E = 0$; $-I_C$ = 100 μA	$-V_{(BR)CBO}$	min.	50	V
Collector cut-off current $-V_{CB}$ = 10 V; $I_E = 0$	$-I_{CBO}$	max.	10	nA
$-V_{CB}$ = 35 V; $I_E = 0$	$-I_{CBO}$	max.	50	nA
Emitter cut-off current $-V_{EB}$ = 3 V; $I_C = 0$	$-I_{EBO}$	max.	50	nA
Collector-emitter saturation voltage $-I_C$ = 10 mA; $-I_B$ = 1 mA	$-V_{CEsat}$	max.	0,3	V
Base-emitter ON-voltage $-I_C$ = 1 mA; $-V_{CE}$ = 5 V	$-V_{BEon}$	max.	0,85	V
Transition frequency at f = 20 MHz $-I_C$ = 500 μA; $-V_{CE}$ = 5 V	f_T	min.	40	MHz
Collector capacitance at f = 100 kHz $-V_{CB}$ = 5 V; $I_E = 0$	C_c	max.	4,0	pF

			2N5086	2N5087
D.C. current gain $-I_C$ = 100 μA; $-V_{CE}$ = 5 V	h_{FE}	min.	150	250
		max.	500	800
$-I_C$ = 1 mA; $-V_{CE}$ = 5 V	h_{FE}	min.	150	250
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	h_{FE}	min.	150	250
Small-signal current gain at f = 1 kHz $-I_C$ = 1 mA; $-V_{CE}$ = 5 V	h_{fe}	min.	150	250
		max.	600	900

			2N5086	2N5087	
Noise figure at $-V_{CE}$ = 5 V; T_{amb} = 25 °C					
$-I_C$ = 20 μA; R_S = 10 kΩ; f = 10 Hz to 15,7 kHz	F	max.	3,0	2,0	dB
$-I_C$ = 100 μA; R_S = 3 kΩ; f = 1 kHz	F	max.	3,0	2,0	dB

SILICON PLANAR EPITAXIAL TRANSISTOR

NPN small-signal transistor in plastic TO-92 envelope intended for low-noise stages in audio equipment.
Complementary type is 2N5086.

QUICK REFERENCE DATA

Collector-emitter voltage (open base)	V_{CEO}	max.	30 V
Collector-base voltage (open emitter)	V_{CBO}	max.	35 V
Collector current (DC)	I_C	max.	50 mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625 mW
Collector-emitter saturation voltage I_C = 10 mA; I_B = 1 mA	V_{CEsat}	max.	0.5 V
DC current gain I_C = 1 mA; V_{CE} = 5 V	h_{FE}	min.	350

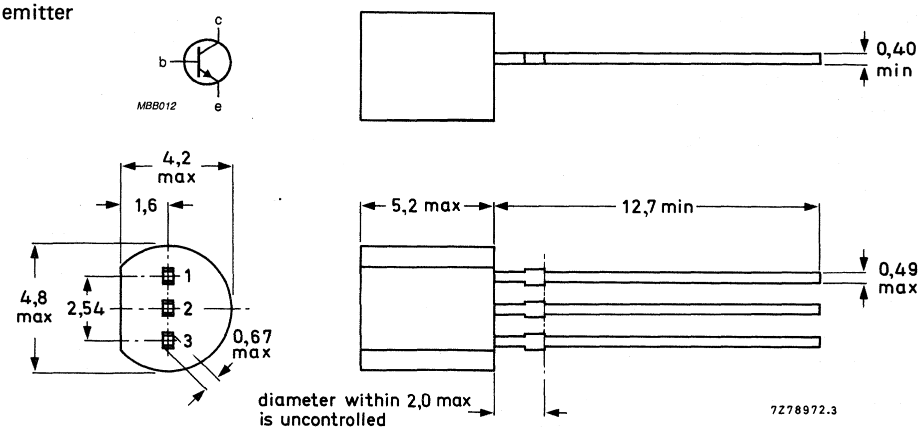
MECHANICAL DATA

Dimensions in mm

Fig.1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



RATINGS

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

Collector-emitter voltage (open base)	V_{CEO}	max.	30	V
Collector-base voltage (open emitter)	V_{CBO}	max.	35	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4.5	V
Collector current (DC)	I_C	max.	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	625	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector-emitter breakdown voltage I_B = 0; I_C = 1 mA	$V_{(BR)CEO}$	min.	30	V
Collector-base breakdown voltage I_E = 0; I_C = 100 μA	$V_{(BR)CBO}$	min.	35	V
Collector cut-off current V_{CB} = 20 V; I_E = 0	I_{CBO}	max.	50	nA
Emitter cut-off current V_{EBoff} = 3 V; I_C = 0 V_{EBoff} = 4.5 V; I_C = 0	I_{EBO}	max. max.	50 100	nA nA
Collector-emitter saturation voltage I_C = 10 mA; I_B = 1 mA	V_{CEsat}	max.	0.5	V
Base-emitter ON-voltage I_C = 10 mA; V_{CE} = 5 V	V_{BEon}	max.	0.8	V
Transition frequency at f = 20 MHz I_C = 500 μA; V_{CE} = 5 V	f_T	min.	50	MHz
DC current gain I_C = 100 μA; V_{CE} = 5 V	h_{FE}	min. max.	300 900	
I_C = 1 mA; V_{CE} = 5 V I_C = 10 mA; V_{CE} = 5 V	h_{FE}	min. min.	350 300	
Small-signal current gain at f = 1 kHz I_C = 1 mA; V_{CE} = 5 V	h_{fe}	min. max.	350 1400	
Noise figure at R_S = 10 kΩ; T_{amb} = 25 °C I_C = 100 μA; V_{CE} = 5 V; f = 10 Hz to 15.7 kHz	F	max.	3.0	dB
Collector capacitance at f = 100 kHz V_{CB} = 5 V; I_E = 0	C_c	max.	4.0	pF
Emitter capacitance at f = 100 kHz V_{BE} = 0.5 V; I_C = 0	C_e	max.	10	pF

SILICON P-N-P HIGH-VOLTAGE TRANSISTORS

P-N-P high-voltage small-signal transistors for general purposes and especially in telephony applications and encapsulated in a TO-92 envelope.

N-P-N complements are 2N5550 and 2N5551.

QUICK REFERENCE DATA

			2N5400	2N5401	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	130	160	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	120	150	V
Collector current	$-I_C$	max.	600	600	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	500	mW
Junction temperature	T_j	max.	150	150	°C
Collector-emitter saturation voltage I_C = 50 mA; I_B = 5 mA	V_{CEsat}	max.	0,5	0,5	V
D.C. current gain I_C = 10 mA; V_{CE} = −5 V	h_{FE}	min.	40	60	

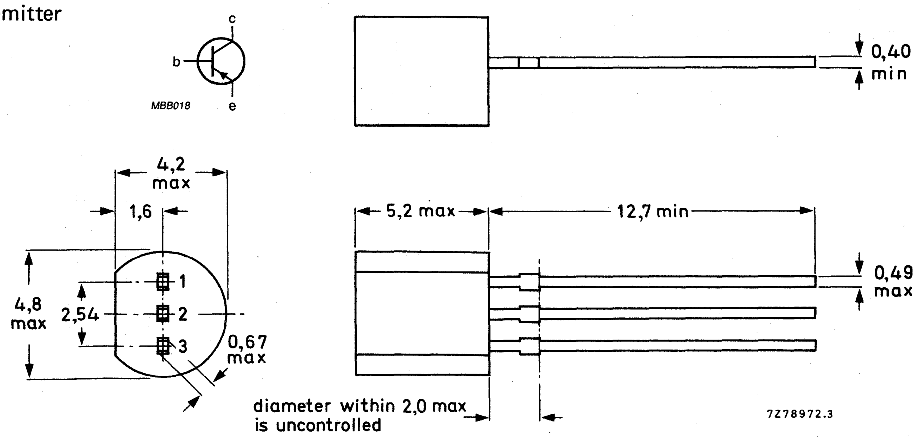
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



RATINGS

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

			2N5400	2N5401	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	130	160	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	120	150	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5		V
Collector current	$-I_C$	max.	600		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500		mW
Junction temperature	T_j	max.	150		°C
Storage temperature range	T_{stg}		−65 to + 150		°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	max.	250	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			2N5400	2N5401	
Collector cut-off current					
$I_E = 0$; $-V_{CB} = 100$ V	$-I_{CBO}$	max.	100		nA
$I_E = 0$; $-V_{CB} = 120$ V	$-I_{CBO}$	max.		50	nA
$I_E = 0$; $-V_{CB} = 100$ V; $T_{amb} = 100$ °C	$-I_{CBO}$	max.	100		µA
$I_E = 0$; $-V_{CB} = 120$ V; $T_{amb} = 100$ °C	$-I_{CBO}$	max.		50	µA
Emitter cut-off current					
$I_C = 0$; $-V_{EB} = 4{,}0$ V	$-I_{EBO}$	max.	50	50	nA
Breakdown voltages					
$I_C = 1{,}0$ mA; $I_B = 0$	$-V_{(BR)CEO}$	min.	120	150	V
$I_C = 100$ µA; $I_E = 0$	$-V_{(BR)CBO}$	min.	130	160	V
$I_C = 0$; $I_E = 10$ µA	$-V_{(BR)EBO}$	min.	5,0	5,0	V
Saturation voltages					
$-I_C = 10$ mA; $-I_B = 1{,}0$ mA	$-V_{CEsat}$	max.	0,2	0,2	V
	$-V_{BEsat}$	max.	1,0	1,0	V
$-I_C = 50$ mA; $-I_B = 5{,}0$ mA	$-V_{CEsat}$	max.	0,5	0,5	V
	$-V_{BEsat}$	max.	1,0	1,0	V
D.C. current gain					
$I_C = 1{,}0$ mA; $-V_{CE} = 5$ V	h_{FE}	min.	30	50	
$I_C = 10$ mA; $-V_{CE} = 5$ V	h_{FE}	min.	40	60	
		max.	180	240	
$I_C = 50$ mA; $-V_{CE} = 5$ V	h_{FE}	min.	40	50	
Small-signal current gain					
$I_C = 1{,}0$ mA; $-V_{CE} = 10$ V; f = 1 kHz	h_{fe}	min.	30	40	
		max.	200	200	
Output capacitance at f = 1 MHz					
$I_E = 0$; $-V_{CB} = 10$ V	C_o	max.	6	6	pF

			2N5400	2N5401	
Transition frequency at f = 100 MHz $-I_C$ = 10 mA; $-V_{CE}$ = 10 V	f_T	min.	100	100	MHz
		max.	400	300	MHz
Noise figure at R_S = 1 kΩ I_C = 250 μA; $-V_{CE}$ = 5 V; f = 10 Hz to 15,7 kHz	F	max.	8	8	dB

SILICON P-N-P HIGH-VOLTAGE TRANSISTORS

Transistors in TO-39 metal envelopes with the collector connected to the case. They are intended for high-speed switching and linear amplifier applications in military, industrial and commercial equipment.

QUICK REFERENCE DATA

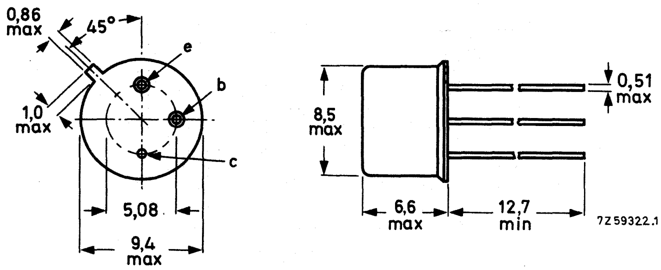
			2N5415	2N5416	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	200	350	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	200	300	V
Collector current (d.c.)	$-I_C$	max.	1	1	A
Total power dissipation up to T_{amb} = 50 °C	P_{tot}	max.	1	1	W
Junction temperature	T_j	max.	200	200	°C
D.C. current gain $-I_C$ = 50 mA; $-V_{CE}$ = 10 V	h_{FE}	>	30	30	
		<	150	120	

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-39.

Collector connected to case



Maximum lead diameter is guaranteed only for 12,7 mm.

RATINGS

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

			2N5415	2N5416	
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 (d.c.)	$-I_B$	max.	0,5		A
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	10		W
Total power dissipation up to T_{amb} = 50 °C	P_{tot}	max.	1		W

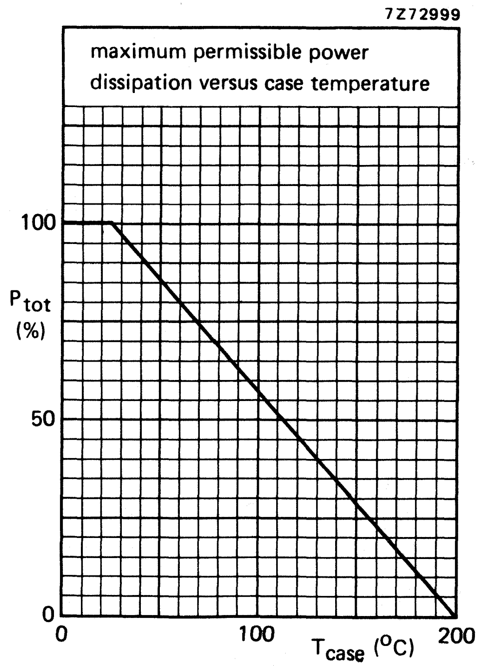


Fig. 2.

Storage temperature range	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}c}$	=	17,5	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	150	K/W

CHARACTERISTICS

T_{case} = 25 °C unless otherwise specified

			2N5415	2N5416	
Collector cut-off currents					
$I_E = 0; -V_{CB} = 175$ V	$-I_{CBO}$	<	50	–	μA
$I_E = 0; -V_{CB} = 280$ V	$-I_{CBO}$	<	–	50	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
Sustaining voltage					
$I_B = 0; -I_C = 0$ to 50 mA	$-V_{CEOsust}$	>	200	300	V*

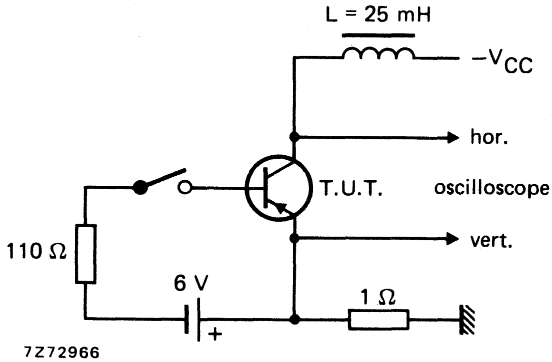


Fig. 3 Test circuit for $V_{CEOsust}$.

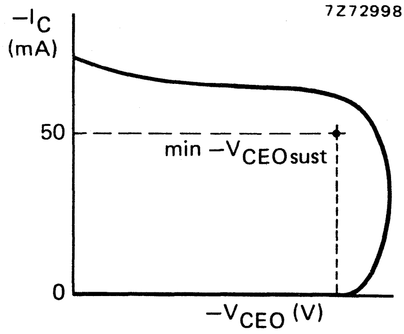


Fig. 4 Oscilloscope display for $V_{CEOsust}$.

			2N5415	2N5416	
Saturation voltages					
$-I_C = 50$ mA; $-I_B = 5$ mA	$-V_{CEsat}$	<	2,5	2,0	V
	$-V_{BEsat}$	<	1,5	1,5	V
D.C. current gain					
$-I_C = 50$ mA; $-V_{CE} = 10$ V	h_{FE}	>	30	30	
		<	150	120	
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0; -V_{CB} = 10$ V	C_c	<	15		pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c = 0; -V_{EB} = -V_{EBOmax}$	C_e	<	75		pF

* Measured under pulse conditions to avoid excessive dissipation.

Transition frequency at f = 5 MHz			
$-I_C$ = 10 mA; $-V_{CE}$ = 10 V	f_T	>	15 MHz
h-parameters (common emitter)			
$-I_C$ = 5 mA; $-V_{CE}$ = 10 V			
real part of input impedance at f = 1 MHz	$R_e(h_{ie})$	<	300 Ω
small-signal current gain at f = 1 kHz	h_{fe}	>	25

SILICON N-P-N HIGH-VOLTAGE TRANSISTORS

N-P-N high-voltage small-signal transistors for general purposes and especially telephony applications and encapsulated in a TO-92 envelope.

P-N-P complements are 2N5400 and 2N5401.

QUICK REFERENCE DATA

			2N5550	2N5551	
Collector-base voltage (open emitter)	V_{CBO}	max.	160	180	V
Collector-emitter voltage (open base)	V_{CEO}	max.	140	160	V
Collector current	I_C	max.	600	600	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500	500	mW
Junction temperature	T_j	max.	150	150	°C
Collector-emitter saturation voltage I_C = 50 mA; I_B = 5 mA	V_{CEsat}	max.	0,25	0,20	V
D.C. current gain I_C = 10 mA; V_{CE} = 5 V	h_{FE}	min.	60	80	

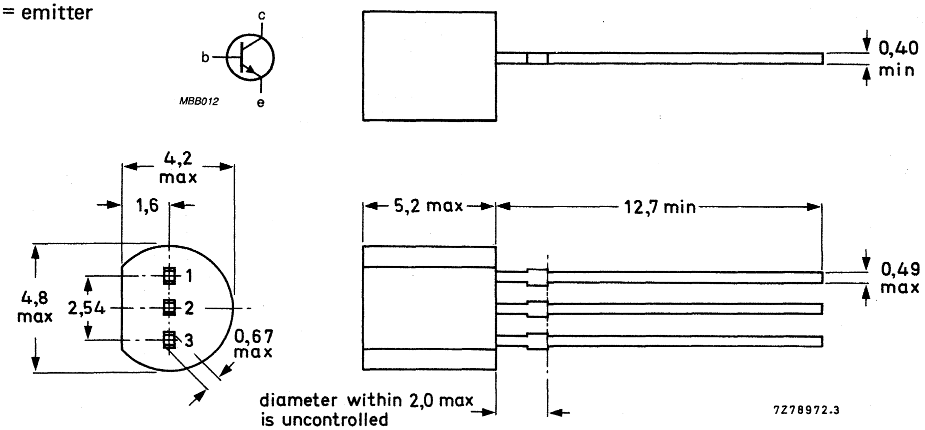
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-92.

Pinning

1 = collector
2 = base
3 = emitter



RATINGS

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

			2N5550	2N5551	
Collector-base voltage (open emitter)	V_{CBO}	max.	160	180	V
Collector-emitter voltage (open base)	V_{CEO}	max.	140	160	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6		V
Collector current	I_C	max.	600		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	500		mW
Junction temperature	T_j	max.	150		°C
Storage temperature range	T_{stg}		−65 to + 150		°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	max.	250	K/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

			2N5550	2N5551	
Collector cut-off current					
I_E = 0; V_{CB} = 100 V	I_{CBO}	max.	100		nA
I_E = 0; V_{CB} = 120 V	I_{CBO}	max.		50	nA
I_E = 0; V_{CB} = 100 V; T_{amb} = 100 °C	I_{CBO}	max.	100		μA
I_E = 0; V_{CB} = 120 V; T_{amb} = 100 °C	I_{CBO}	max.		50	μA
Emitter cut-off current					
I_C = 0; V_{EB} = 4,0 V	I_{EBO}	max.	50	50	nA
Breakdown voltages					
I_C = 1,0 mA; I_B = 0	$V_{(BR)CEO}$	min.	140	160	V
I_C = 100 μA; I_E = 0	$V_{(BR)CBO}$	min.	160	180	V
I_C = 0; I_E = 10 μA	$V_{(BR)EBO}$	min.	6,0	6,0	V
Saturation voltages					
I_C = 10 mA; I_B = 1,0 mA	V_{CEsat}	max.	0,15	0,15	V
	V_{BEsat}	max.	1,0	1,0	V
I_C = 50 mA; I_B = 5,0 mA	V_{CEsat}	max.	0,25	0,20	V
	V_{BEsat}	max.	1,2	1,0	V
D.C. current gain					
I_C = 1,0 mA; V_{CE} = 5 V	h_{FE}	min.	60	80	
I_C = 10 mA; V_{CE} = 5 V	h_{FE}	min.	60	80	
		max.	250	250	
I_C = 50 mA; V_{CE} = 5 V	h_{FE}	min.	20	30	
Small-signal current gain					
I_C = 1,0 mA; V_{CE} = 10 V; f = 1 kHz	h_{fe}	min.	50	50	
		max.	200	200	
Output capacitance at f = 1 MHz					
I_E = 0; V_{CB} = 10 V	C_o	max.	6	6	pF
Input capacitance at f = 1 MHz					
I_C = 0; V_{EB} = 0,5 V	C_i	max.	30	30	pF

			2N5550	2N5551	
Transition frequency at f = 100 MHz					
I_C = 10 mA; V_{CE} = 10 V	f_T	min.	100	100	MHz
		max.	300	300	MHz
Noise figure at R_S = 1 kΩ					
I_C = 250 μA; V_{CE} = 5 V; f = 10 Hz to 15,7 kHz	F	max.	10	8	dB

Silicon planar epitaxial transistor 2N5680

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$-V_{CBO}$	collector-base voltage		–	120	V
$-V_{CEO}$	collector-emitter voltage		–	120	V
$-I_C$	collector current		–	1	A
P_{tot}	total power dissipation	$T_{case} \leq 25$ °C	–	10	W
		$T_{amb} \leq 25$ °C	–	1	W
T_j	junction temperature		–	200	°C
h_{FE}	current gain	$-V_{CE} = 2$ V $-I_C = 250$ mA	40	150	
f_T	transition frequency	$-V_{CE} = 10$ V $-I_C = 100$ mA	30	–	MHz
$-V_{CEsat}$	collector-emitter saturation voltage	$-I_B = 25$ mA $-I_C = 250$ mA	–	0.6	V

PINNING - TO-39

Collector connected to case.

PIN	DESCRIPTION
1	emitter
2	base
3	collector

PIN CONFIGURATION

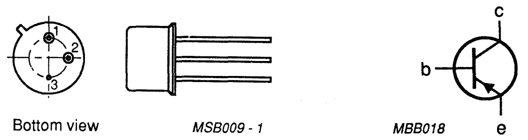


Fig.1 Simplified outline and symbol.

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$-V_{CBO}$	collector-base voltage	$I_E = 0$	–	120	V
$-V_{CEO}$	collector-emitter voltage	$I_B = 0$	–	120	V
$-V_{EBO}$	emitter-base voltage	$I_C = 0$	–	4	V
$-I_C$	collector current		–	1	A
$-I_B$	base current		–	0.5	A
P_{tot}	total power dissipation	$T_{case} \leq 25$ °C	–	10	W
		$T_{amb} \leq 25$°C	–	1	W
T_{stg}	storage temperature range		–65	200	°C
T_j	junction temperature		–	200	°C

Silicon planar epitaxial transistor 2N5680

THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient	175	K/W
$R_{th\ j\text{-}c}$	from junction to case	17.5	K/W

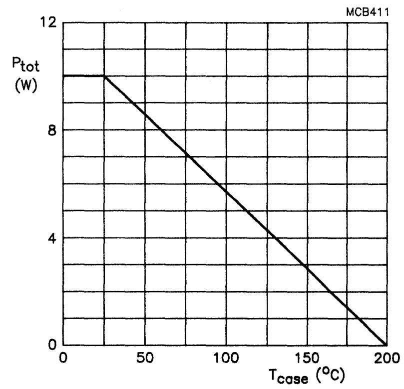


Fig.2 Total power dissipation as a function of case temperature.

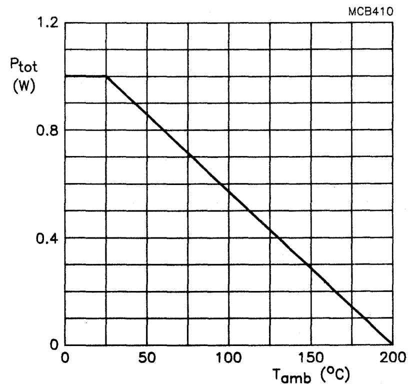


Fig.3 Total power dissipation as a function of ambient temperature.

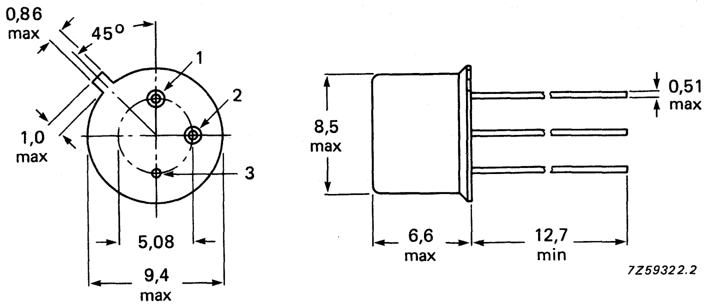
CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$-V_{(BR)CEO}$	collector-emitter breakdown voltage	$I_B = 0$ $-I_C = 10$ mA	120	–	V
$-I_{CBO}$	collector-base cut-off current	$I_E = 0$ $-V_{CB} = 120$ V	–	1	μA
$-I_{CEO}$	collector-emitter cut-off current	$I_B = 0$ $-V_{CE} = 80$ V	–	10	μA
$-I_{CEX}$	collector-emitter cut-off current	$V_{EB} = 1.5$ V $-V_{CE} = 120$ V	–	1	μA
		$V_{EB} = 1.5$ V $-V_{CE} = 120$ V $T_{case} = 150$ °C	–	1	mA
$-I_{EBO}$	emitter-base cut-off current	$I_C = 0$ $-V_{EB} = 4$ V	–	1	μA
$-V_{CEsat}$	collector-emitter saturation voltage	$-I_B = 25$ mA $-I_C = 250$ mA	–	0.6	V
		$-I_B = 50$ mA $-I_C = 500$ mA	–	1	V
		$-I_B = 200$ mA $-I_C = 1$ A	–	2	V
$-V_{BEsat}$	base-emitter saturation voltage	$-I_B = 25$ mA $-I_C = 250$ mA	–	1	V
h_{FE}	current gain	$-V_{CE} = 2$ V $-I_C = 250$ mA	40	150	
		$-V_{CE} = 2$ V $-I_C = 1$ A	5	–	
h_{fe}	small signal current gain	$-V_{CE} = 1.5$ V $-I_C = 200$ mA f = 1 kHz	40	–	
f_T	transition frequency	$-V_{CE} = 10$ V $-I_C = 100$ mA f = 10 MHz	30	–	MHz
C_c	collector capacitance	$-V_{CB} = 20$ V $I_E = 0$ f = 1 MHz	–	50	pF

Silicon planar epitaxial transistor 2N5680

PACKAGE OUTLINE



Dimensions in mm.

Fig.4 TO-39.

Philips Components

Data sheet	
status	Preliminary specification
date of issue	February 1991

2N6027/2N6028
Programmable unijunction transistors

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$\pm V_{AK}$	anode-cathode voltage		–	40	V
V_{GK}	gate-cathode voltage		–	40	V
$-V_{GK}$	gate-cathode voltage		–	5	V
I_{AM}	anode current	peak value $t_p = 20\ \mu s$	–	2	A
P_{tot}	total power dissipation	$T_{amb} \leq 25\ °C$	–	375	mW
$I_{(P)}$	peak point current	$R_{case} = 10\ k\Omega$			
	2N6027		–	5	μA
	2N6028		–	1	μA
$I_{(V)}$	valley point current	$R_{case} = 10\ k\Omega$			
	2N6027		70	–	μA
	2N6028		25	–	μA
		$R_{case} = 200\ \Omega$			
	2N6027		1.5	–	μA
	2N6028		1	–	μA

PINNING - TO-92

PIN	DESCRIPTION
1	cathode
2	gate
3	anode

PIN CONFIGURATION

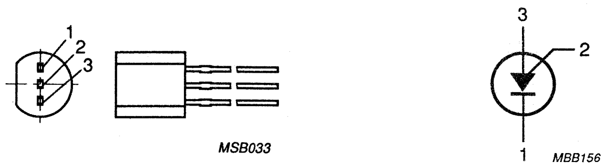


Fig.1 Simplified outline and symbol.

Programmable unijunction transistors

2N6027/2N6028

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$\pm V_{AK}$	anode-cathode voltage		–	40	V
$+V_{GK}$	gate-cathode voltage		–	40	V
$-V_{GK}$	gate-cathode voltage		–	5	V
$-V_{GA}$	gate-anode voltage		–	40	V
$\pm I_G$	gate current		–	50	mA
I_A	anode current (note 1)	average value $T_{amb} \leq 25$ °C	–	200	mA
I_{AM}	anode current	peak value $t_p/t = 0.01$ $t_p = 100$ µs	–	1	A
		peak value $t_p/t = 0.01$ $t_p = 20$ µs	–	2	A
I_{ASM}	non-repetitive peak anode current	$t = 10$ µs	–	5	A
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	–	375	mW
T_{stg}	storage temperature range		–55	150	°C
T_j	junction temperature		–	100	°C

Note

1. Derating 2.67 mA/K at $T_{amb} > 25$ °C.

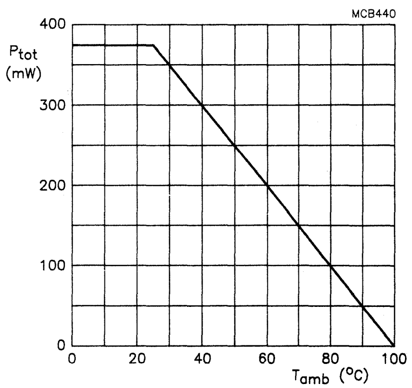


Fig.2 Power derating curve.

THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient	200	K/W

CHARACTERISTICS

T_{amb} = 25 °C.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$I_{(P)}$	peak point current	V_S = 10 V R_{case} = 10 kΩ			
	2N6027		–	5	μA
	2N6028		–	1	μA
		V_S = 10 V R_{case} = 1 MΩ			
	2N6027		–	2	μA
	2N6028		–	0.15	μA
$I_{(V)}$	valley point current	V_S = 10 V R_{case} = 200 MΩ			
	2N6027		1.5	–	mA
	2N6028		1	–	mA
		V_S = 10 V R_{case} = 10 kΩ			
	2N6027		70	–	μA
	2N6028		25	–	μA
		V_S = 10 V R_{case} = 1 MΩ			
	2N6027		–	50	μA
	2N6028		–	25	μA
V_T	on-state voltage	V_S = 10 V R_{case} = 10 kΩ	0.2	0.6	V
		V_S = 10 V R_{case} = 1 MΩ			
	2N6027		0.2	1.6	V
	2N6028		0.2	0.6	V
V_{AK}	anode-cathode voltage	I_A = 50 mA	–	1.5	V
I_{GAO}	gate-anode leakage current	V_S = 40 V I_K = 0	–	10	nA
I_{GKS}	gate-cathode leakage current	V_S = 40 V V_{AK} = 0	–	50	nA
V_{OM}	peak output voltage (see Fig.5)	V = 20 V C = 0.2 μF	6	–	V
t_r	rise time (see Fig.6)	V = 20 V C = 0.2 μF	–	80	ns

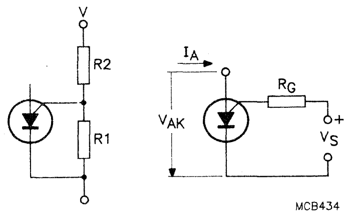


Fig.3 Equivalent test circuit for characterstics testing; $R_G = \frac{R_1 \times R_2}{R_1 + R_2}$; $V_S = \frac{R_1}{R_1 + R_2} \times V_B$.

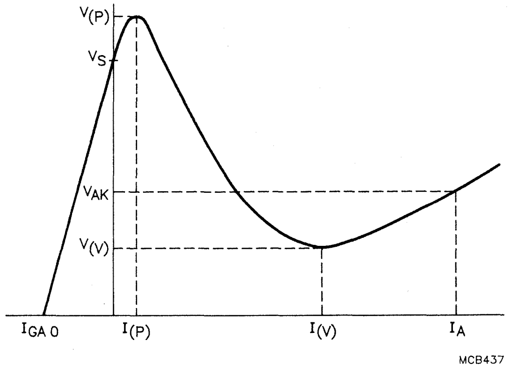


Fig.4 Offset voltage.

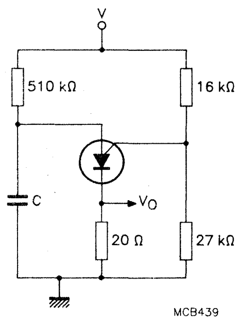


Fig.5 Test circuit for peak output voltage.

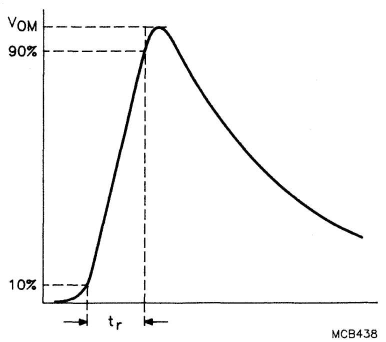


Fig.6 Peak output voltage.

Programmable unijunction transistors

2N6027/2N6028

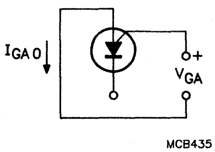


Fig.7 Gate-anode leakage current.

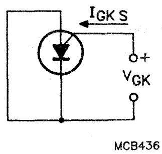
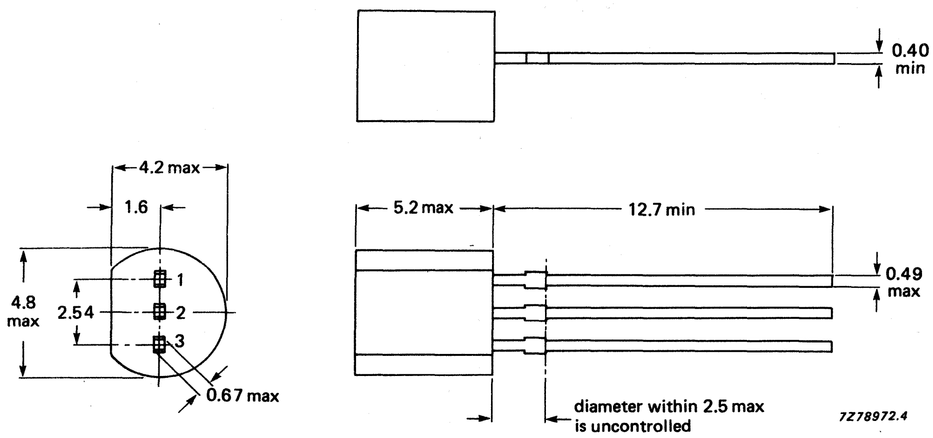


Fig.8 Gate-cathode leakage current.

PACKAGE OUTLINE



Dimensions in mm.

Fig.9 TO-92.

SILICON SMALL-SIGNAL TRANSISTOR

PNP small-signal transistor, in a plastic TO-92 envelope.

It is intended for use in audio amplifier driver stages and low speed switching applications etc.

NPN complementary type is the 2PC945.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	50	V
Collector current (DC)	$-I_C$	max.	100	mA
Total power dissipation at $T_{amb} \leq 25\ ^oC$	P_{tot}	max.	500	mW
Collector-emitter saturation voltage $-I_C = 100$ mA; $-I_B = 10$ mA	$-V_{CEsat}$	max.	0.3	V
DC current gain $-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{FE}	min.	90	
		max.	600	

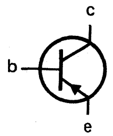
MECHANICAL DATA

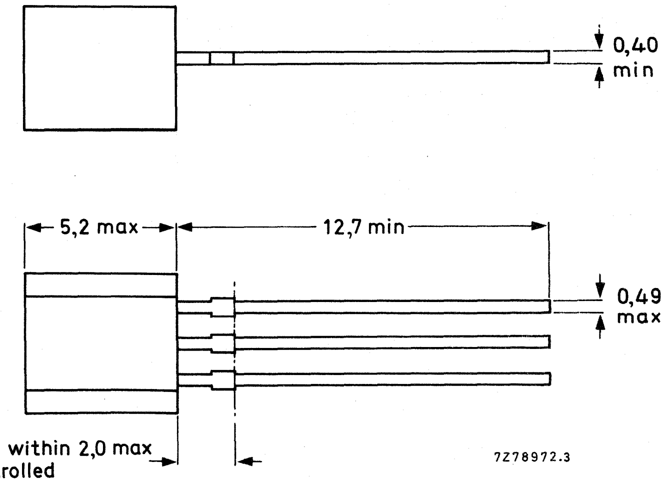
Dimensions in mm

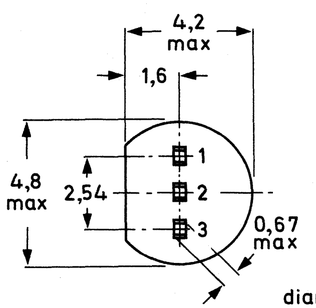
Fig.1 TO-92

Pinning

1 = base
2 = collector
3 = emitter







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.	50 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5.0 V
Collector current (DC)	$-I_C$	max.	100 mA
Base current (DC)	$-I_B$	max.	20 mA
Total power dissipation at $T_{amb} \leq 25\ ^oC$	P_{tot}	max.	500 mW
Junction temperature	T_j	max.	150 ^oC
Storage temperature range	T_{stg}	−65 to + 150 ^oC	

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	250 K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current $-I_E = 0; -V_{CB} = 60$ V	$-I_{CBO}$	max.	100 nA
Emitter cut-off current $-I_C = 0; -V_{EB} = 5$ V	$-I_{EBO}$	max.	100 nA
DC current gain $-I_C = 1$ mA; $-V_{CE} = 6$ V*	h_{FE}	min. max.	90 600
Collector-emitter saturation voltage $-I_C = 100$ mA; $-I_B = 10$ mA	$-V_{CEsat}$	max.	0.3 V
Base-emitter on-state voltage $-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BEon}$	min. max.	0.6 V 0.7 V
Transition frequency $-I_C = 10$ mA; $-V_{CE} = 6$ V	f_T	min. typ.	100 MHz 180 MHz
Collector-base capacitance $-I_E = 0; -V_{CB} = 10$ V; f = 1 MHz	C_{ob}	max. typ.	6.0 pF 4.5 pF
Noise figure $-I_C = 300\ \mu$A; $-V_{CE} = 6$ V; $R_s = 2$ kΩ; f = 100 Hz	F	max. typ.	20 dB 6.0 dB

* Classification of h_{FE}

Group	R	Q	P	K
Range	90 - 180	135 - 270	200 - 400	300 - 600

SILICON SMALL-SIGNAL TRANSISTORS

PNP small-signal transistors, each in a plastic TO-92 envelope.

They are intended for use in audio amplifier driver stages and other general purpose applications.

NPN complementary types are 2PC1815 and 2PC1815L.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	50	V
Collector current (DC)	$-I_C$	max.	150	mA
Total power dissipation at $T_{amb} \leq 25\ ^oC$	P_{tot}	max.	500	mW
Collector-emitter saturation voltage $-I_C = 100$ mA; $-I_B = 10$ mA	$-V_{CEsat}$	max.	0.3	V
DC current gain $-I_C = 2$ mA; $-V_{CE} = 6$ V	h_{FE}	min. max.	120 700	

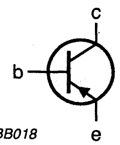
MECHANICAL DATA

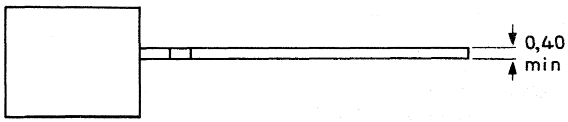
Dimensions in mm

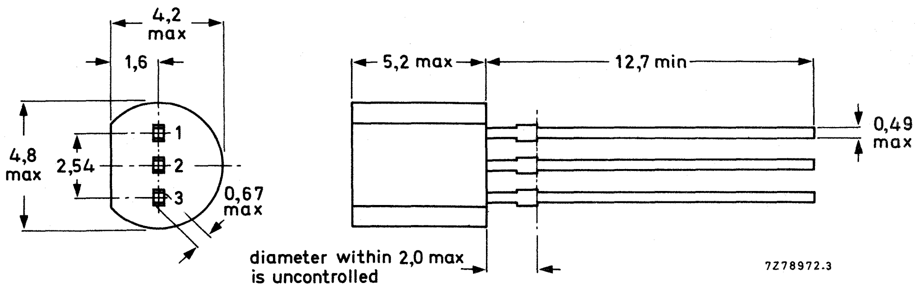
Fig.1 TO-92

Pinning

1 = base
2 = collector
3 = emitter







RATINGS

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

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	50 V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5.0 V
Collector current (DC)	$-I_C$	max.	150 mA
Base current (DC)	$-I_B$	max.	50 mA
Total power dissipation at $T_{amb} \leq 25$ °C	P_{tot}	max.	500 mW
Junction temperature	T_j	max.	150 °C
Storage temperature range	T_{stg}		−65 to + 150 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	250 K/W

CHARACTERISTICS

$T_j = 25$ °C unless otherwise specified

Collector cut-off current $-I_E = 0$; $-V_{CB} = 50$ V		$-I_{CBO}$	max.	100 nA
Emitter cut-off current $-I_C = 0$; $-V_{EB} = 5$ V		$-I_{EBO}$	max.	100 nA
DC current gain $-I_C = 150$ mA; $-V_{CE} = 6$ V		h_{FE}	min.	25
$-I_C = 2$ mA; $-V_{CE} = 6$ V *		h_{FE}	min. max.	120 700
Collector-emitter saturation voltage $-I_C = 100$ mA; $-I_B = 10$ mA		$-V_{CEsat}$	max.	0.3 V
Base-emitter saturation voltage $-I_C = 100$ mA; $-I_B = 10$ mA		$-V_{BEsat}$	max.	1.1 V
Transition frequency $-I_C = 1$ mA; $-V_{CE} = 10$ V		f_T	min.	80 MHz
Collector-output capacitance $-I_E = 0$; $-V_{CB} = 10$ V; f = 1 MHz		C_{ob}	typ. max.	4 pF 7 pF
Noise figure $-I_C = 100$ μA; $-V_{CE} = 6$ V; $R_s = 10$ kΩ; f = 1 kHz	2PA1015	F	max.	10 dB
	2PA1015L	F	max.	6 dB

* Classification of h_{FE}

Group	Y	GR	BL
Range	120 – 240	200 – 400	350 – 700

SILICON SMALL-SIGNAL TRANSISTOR

NPN small-signal transistor, in a plastic TO-92 envelope.

It is intended for use in audio amplifier driver stages and low speed switching applications etc.

PNP complementary type is the 2PA733.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	50	V
Collector current (DC)	I_C	max.	100	mA
Total power dissipation at $T_{amb} \leq 25\ ^oC$	P_{tot}	max.	500	mW
Collector-emitter saturation voltage $I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	max.	0.3	V
DC current gain $I_C = 1$ mA; $V_{CE} = 6$ V	h_{FE}	min.	90	
		max.	600	

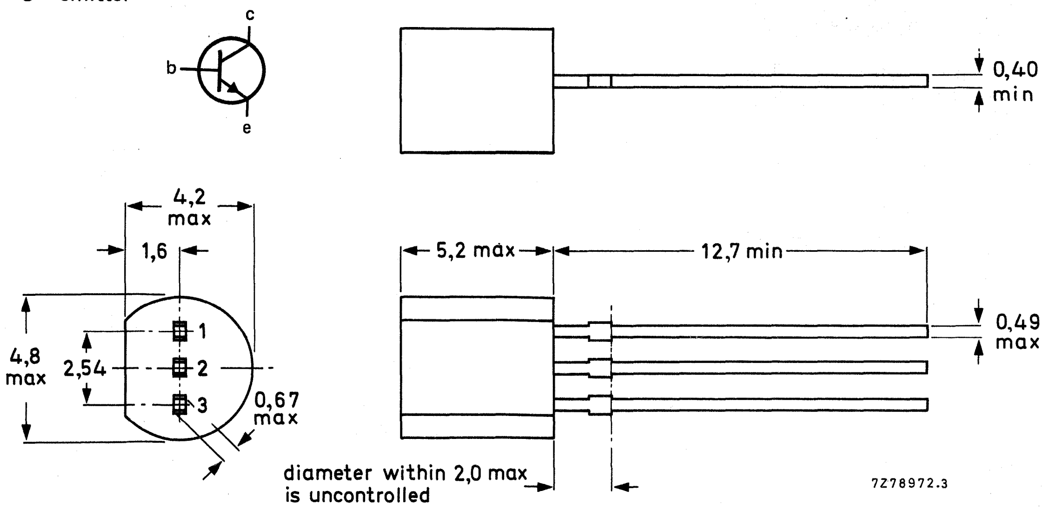
MECHANICAL DATA

Dimensions in mm

Fig.1 TO-92.

Pinning

1 = base
2 = collector
3 = emitter



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.	50	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5.0	V
Collector current (DC)	I_C	max.	100	mA
Base current (DC)	I_B	max.	20	mA
Total power dissipation at $T_{amb} \leq 25\ ^oC$	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	150	^oC
Storage temperature range	T_{stg}		−65 to + 150	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	250	K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current $I_E = 0$; $V_{CB} = 60$ V	I_{CBO}	max.	100	nA
Emitter cut-off current $I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	max.	100	nA
DC current gain $I_C = 0.1$ mA; $V_{CE} = 6$ V	h_{FE}	min.	50	
$I_C = 1$ mA; $V_{CE} = 6$ V*	h_{FE}	min. max.	90 600	
Collector-emitter saturation voltage $I_C = 100$ mA; $I_B = 10$ mA	V_{CEsat}	max.	0.3	V
Base-emitter on-state voltage $I_C = 1$ mA; $V_{CE} = 6$ V	V_{BEon}	min. max.	0.6 0.7	V V
Base-emitter saturation voltage $I_C = 100$ mA; $I_B = 10$ mA	V_{BEsat}	max.	1.1	V
Transition frequency $I_C = 10$ mA; $V_{CE} = 6$ V	f_T	min. max.	150 450	MHz MHz
Collector-base capacitance $I_E = 0$; $V_{CB} = 6$ V; f = 1 MHz	C_{ob}	max.	4.0	pF
Noise figure $I_C = 100\ \mu A$; $V_{CE} = 6$ V; $R_s = 2\ k\Omega$; f = 1 kHz	F	max.	15	dB

* Classification of h_{FE}

Group	R	Q	P	K
Range	90 - 180	135 - 270	200 - 400	300 - 600

SILICON SMALL-SIGNAL TRANSISTORS

NPN small-signal transistors, each in a TO-92 envelope.

They are intended for use in audio amplifier driver stages and other general purpose applications.

PNP complementary types are 2PA1015 and 2PA1015L.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	50	V
Collector current (DC)	I_C	max.	150	mA
Total power dissipation at $T_{amb} \leq 25\ ^oC$	P_{tot}	max.	500	mW
Collector-emitter saturation voltage I_C = 100 mA; I_B = 10 mA	V_{CEsat}	max.	0.3	V
DC current gain I_C = 2 mA; V_{CE} = 6 V	h_{FE}	min.	120	
		max.	700	

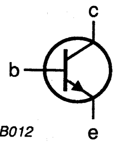
MECHANICAL DATA

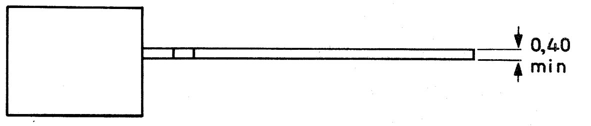
Dimensions in mm

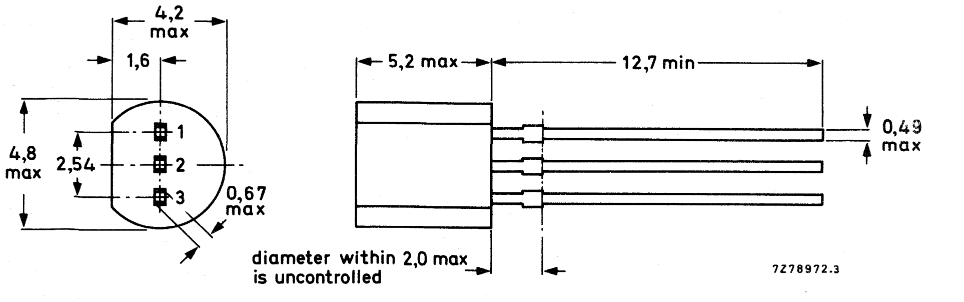
Fig.1 TO-92

Pinning

1 = base
2 = collector
3 = emitter







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.	50 V
Emitter-base voltage (open collector)	V_{EBO}	max.	5.0 V
Collector current (DC)	I_C	max.	150 mA
Base current (DC)	I_B	max.	50 mA
Total power dissipation at $T_{amb} \leqslant 25\ ^oC$	P_{tot}	max.	500 mW
Junction temperature	T_j	max.	150 ^oC
Storage temperature range	T_{stg}		−65 to + 150 ^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	250 K/W

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current $I_E = 0$; $V_{CB} = 60$ V		I_{CBO}	max.	100 nA
Emitter cut-off current $I_C = 0$; $V_{EB} = 5$ V		I_{EBO}	max.	100 nA
DC current gain $I_C = 150$ mA; $V_{CE} = 6$ V		h_{FE}	min.	25
$I_C = 2$ mA; $V_{CE} = 6$ V *		h_{FE}	min. max.	120 700
Collector-emitter saturation voltage $I_C = 100$ mA; $I_B = 10$ mA		V_{CEsat}	max.	0.3 V
Base-emitter saturation voltage $I_C = 100$ mA; $I_B = 10$ mA		V_{BEsat}	max.	1.1 V
Transition frequency $I_C = 1$ mA; $V_{CE} = 6$ V		f_T	min.	80 MHz
Collector-output capacitance $I_E = 0$; $V_{CB} = 10$ V; f = 1 MHz		C_{ob}	max. typ.	3.5 pF 2.5 pF
Noise figure $I_C = 100\ \mu A$; $V_{CE} = 6$ V; $R_s = 10\ k\Omega$; f = 1 kHz	2PC1815	F	max. typ.	10 dB 1 dB
	2PC1815L	F	max. typ.	3 dB 0.2 dB

* Classification of h_{FE}

Group	Y	GR	BL
Range	120 – 240	200 – 400	350 – 700

DATA HANDBOOK SYSTEM

Data handbook system

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Our data handbook system comprises more than 65 books with subjects including electronic components, subassemblies and magnetic products. The handbooks are classified into seven series:

INTEGRATED CIRCUITS;
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