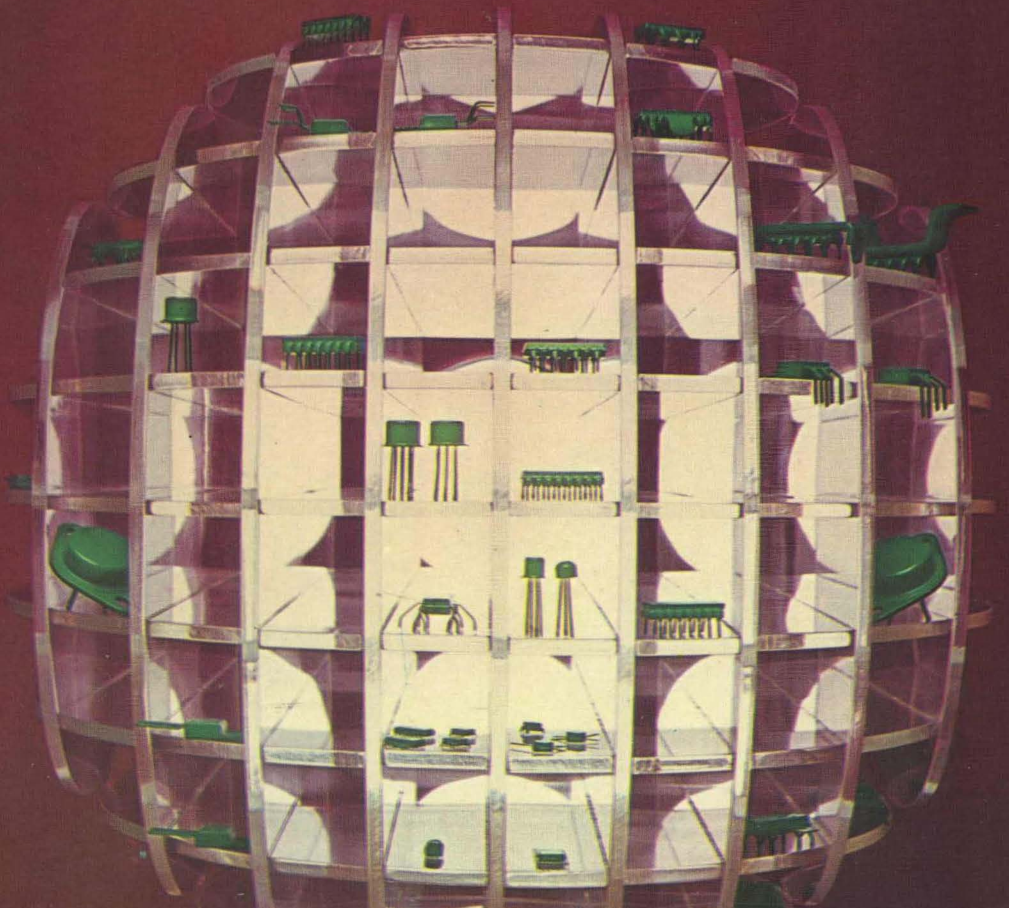
databook

SGS ATES

SMALL SIGNAL TRANSISTORS
3rd EDITION



SMALL SIGNAL TRANSISTORS

databook

SGS-ATES

SMALL SIGNAL TRANSISTORS
3rd EDITION
ISSUED DECEMBER 1978

INTRODUCTION

This databook contains data sheets on the SGS-ATES range of discrete devices for small signal consumer, industrial and professional applications, with the exclusion of the RF and hybrid devices which are contained in a separate databook.
A selection guide by characteristics and application is provided to enable fast identification of the most suitable device for your requirement.
The information on each product has been presented in order that the performance of the product can be readily evaluated within any required equipment design.

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SELECTION GUIDE BY CHARACTERISTICS AND APPLICATION

Silicon PNP transistors for low level, low noise applications

Type	Package	P_{tot} (mW)	V_{CEO} (V)	h_{FE} min/max	@ I_C (mA)	$V_{CE(sat)}$ @ (V) max	I_C/I_B (mA)	f_T (MHz) min	NF (dB)	Page
BC177	TO-18	300	45	125/500*	2	0.25	50/5	200 typ.	10	**20**
BC178	TO-18	300	25	125/500*	2	0.25	50/5	200 typ.	10	**20**
BC179	TO-18	300	20	125/500*	2	0.25	50/5	200 typ.	4	**20**
BC477	TO-18	360	80	110/450	2	0.25	50/5	150 typ.	10	**48**
BC478	TO-18	360	50	110/450	2	0.25	50/5	150 typ.	6	**48**
BC479	TO-18	360	40	220/450	2	0.25	50/5	150 typ.	4	**48**
BCY78	TO-18	390	32	120/630	2	0.8	100/2.5	180 typ.	6	**66**
BCY79	TO-18	390	45	120/460	2	0.8	100/2.5	180 typ.	6	**66**
BFX37	TO-18	360	80	70/230	0.01	0.4	50/5	40	3.5	**111**
2N3962	TO-18	360	60	100/300	0.01	0.25	10/0.5	40	3	**297**
2N3964	TO-18	360	45	250/500	0.01	0.25	10/0.5	50	2	**297**
2N3965	TO-18	360	60	250/500	0.01	0.25	10/0.5	50	2	**297**

* h_{fe} @ 1 kHz

Silicon NPN transistors for low level, low noise applications

Type	Package	P_{tot} (mW)	V_{CEO} (V)	h_{FE} min/max	@ I_C (mA)	$V_{CE(sat)}$ @ (V) max	I_C/I_B (mA)	f_T (MHz) min	NF (dB)	Page
BC107	TO-18	300	45	110/450*	2	0.6	100/5	100	10	**2**
BC108	TO-18	300	20	110/800*	2	0.6	100/5	100	10	**2**
BC109	TO-18	300	20	200/800*	2	0.6	100/5	100	4	**2**
BCY58	TO-18	360	32	120/630	2	0.7	100/2.5	100	6	**55**
BCY59	TO-18	360	45	120/630	2	0.7	100/2.5	100	6	**55**
BFR16	TO-18	360	60	150 typ.	0.01	0.35	1/0.1	70	4	**99**
BFR17	TO-18	360	60	130/–	0.01	0.35	1/0.1	70	3	**101**
2N930	TO-18	300	45	100/500	0.01	1	10/0.5	30	3	**236**
2N2483	TO-18	360	60	40/120	0.01	0.35	1/0.1	60	4	**257**
2N2484	TO-18	360	60	100/500	0.01	0.35	1/0.1	60	3	**257**

* h_{fe} @ 1 kHz

Silicon PNP transistors for fast and ultra fast switches

Type	Package	P_{tot} (mW)	V_{CEO} (V)	h_{FE} min/max	@ I_C (mA)	$V_{CE(sat)}$ (V) max	@ I_C/I_B (mA)	f_T (MHz) min	t_{off} (ns)	Page
BSX29	TO-18	360	12	30/120	30	0.2	30/3	400	90	**185**
2N2894	TO-18	360	12	40/120	30	0.2	100/10	400	90	**263**
2N3012	TO-18	360	12	30/120	30	0.5	100/10	400	75	**263**
2N3209	TO-18	360	20	30/120	30	0.2	30/3	400	90	**263**

Silicon NPN transistors for fast and ultra fast switches

Type	Package	P_{tot} (mW)	V_{CEO} (V)	h_{FE} min/max	@ I_C (mA)	$V_{CE(sat)}$ (V) max	@ I_C/I_B (mA)	f_T (MHz) min	t_s t_{off}* (ns)	Page
BSS26	TO-18	360	40	40	100	1.2	500/50	250	60*	**153**
BSV59	TO-18	360	30	30/140	150	0.4	150/15	250	40*	**161**
BSX19	TO-18	360	15	20/60	10	0.6	100/10	400	10	**169**
BSX20	TO-18	360	15	40/120	10	0.6	100/10	450	13	**169**
BSX26	TO-18	360	15	30/120	30	0.5	300/30	350	18	**173**
BSX27	TO-18	300	6	25/125	10	0.25	10/1	600	6	**177**
BSX28	TO-18	360	12	30/120	10	0.25	30/3	400	13	**181**
BSX32	TO-39	800	40	60/150	100	0.5	500/50	300	60*	**189**
BSX39	TO-18	360	20	40/120	30	0.28	100/10	350	18	**201**
BSX93	TO-18	360	15	40/120	10	0.2	10/1	400	13	**209**
2N709	TO-18	300	6	20/120	10	0.25	10/1	600	6	**225**
2N914	TO-18	360	15	30/120	10	0.7	200/20	300	20	**231**
2N2369	TO-18	360	15	40/120	10	0.25	10/1	500	13	**251**
2N2369A	TO-18	360	15	40/120	10	0.2	10/1	500	13	**253**
2N3009	TO-18	360	15	25	100	0.28	100/10	350	18	**272**
2N3010	TO-18	300	6	25/125	10	0.25	10/1	600	6	**225**
2N3013	TO-18	360	15	25	100	0.5	300/30	350	18	**272**
2N3014	TO-18	360	20	30/120	30	0.18	100/10	350	18	**272**
2N3725	TO-39	800	50	60/150	100	0.52	500/50	300	60*	**293**

Silicon PNP high voltage transistors

Type	Package	P_{tot} (mW)	V_{CEO} (V)	h_{FE} min/max	@ I_C (mA)	$V_{CE(sat)}$ (V) max	@ I_C/I_B (mA)	f_T (MHz) min	C_{CBO} (pF)	Page
BC393	TO-18	400	180	50/–	10	0.3	10/1	50	4	**38**
BFW43	TO-18	400	150	40/–	10	0.5	10/1	60	5	**108**
BFW44	TO-39	700	150	40/–	10	0.5	10/1	60	5	**108**
BFX90	TO-18	400	180	80/300	10	0.25	10/1	40	5	**129**
BFX91	TO-39	700	180	80/300	10	0.25	10/1	40	5	**129**
2N5415S	TO-39	1000	200	30/150	10	2.5	50/5	15	15	**314**

Silicon NPN high voltage transistors

Type	Package	P_{tot} (mW)	V_{CEO} (V)	h_{FE} min	@ I_C (mA)	$V_{CE(sat)}$ (V) max	@ I_C/I_B (mA)	f_T (MHz) min	C_{re}* C_{CBO} (pF)	Page
BC394	TO-18	400	180	30	10	0.3	10/1	50	5	**40**
BF257	TO-39	1000	160	25	30	1	30/6	90 typ.	3*	**80**
BF258	TO-39	1000	250	25	30	1	30/6	90 typ.	3*	**80**
BF259	TO-39	1000	300	25	30	1	30/6	90 typ.	3*	**80**
BF457	TO-126	1250	160	30	30	1	50/10	90 typ.	4*	**92**
BF458	TO-126	1250	250	30	30	1	50/10	90 typ.	4*	**92**
BF459	TO-126	1250	300	30	30	1	50/6	90 typ.	4*	**92**
BF657	TO-39	1000	160	25	30	1	30/6	50	3*	**95**
BF658	TO-39	1000	250	25	30	1	30/6	50	3*	**95**
BF659	TO-39	1000	300	25	30	1	30/6	50	3*	**95**
BFS89	TO-39	1000	300	90 typ.	50	1	30/6	50	3*	**106**
2N3440S	TO-39	1000	250	40	20	0.5	50/5	15	–	**286**

Silicon PNP general purpose transistors

Type	Package	P_{tot} (mW)	V_{CEO} (V)	h_{FE} min/max	@ I_C (mA)	$V_{CE(sat)}$ (V) max	@ I_C/I_B (mA)	f_T (MHz) min	t_s t_{off}* (ns)	Page
BC139	TO-39	700	40	40/–	100	0.8	300/30	200 typ.	–	**11**
BC160	TO-39	800	40	40/250	100	0.35 typ	500/50	50	650*	**17**
BC161	TO-39	800	60	40/250	100	0.36 typ	500/50	50	650*	**17**
BC297	TO-18	375	45	75/260	100	0.7	500/50	250	–	**25**
BC298	TO-18	375	25	75/260	100	0.7	500/50	250	–	**25**
BC303	TO-39	850	60	40/240	150	0.65	150/15	75	–	**32**
BC304	TO-39	850	45	40/240	150	0.65	150/15	75	–	**32**
BC460	TO-39	1000	40	40/250	500	1	1000/100	50	–	**45**
BC461	TO-39	1000	60	40/250	500	1	1000/100	50	–	**45**
BCY70	TO-18	350	40	50/–	10	0.5	50/5	250	350	**60**
BCY71	TO-18	350	45	100/600	10	0.5	50/5	200	–	**60**
BCY72	TO-18	350	25	50/–	10	0.5	50/5	200	350	**60**
BFX38	TO-39	800	55	85/–	100	0.5	500/50	100	350	**116**
BFX39	TO-39	800	55	40/–	100	0.5	500/50	100	350	**116**
BFX40	TO-39	800	75	85/–	100	0.5	500/50	100	350	**116**
BFX41	TO-39	800	75	40/–	100	0.5	500/50	100	350	**116**
BFX48	TO-18	360	30	90/–	10	0.3	50/5	400	160*	**120**
BSV15	TO-39	850	40	40/250	100	1	500/25	50	500	**157**
BSV16	TO-39	850	60	40/250	100	1	500/25	50	500	**157**
BSX36	TO-18	360	40	40/–	10	0.5	150/15	100	100*	**197**
2N2904	TO-39	600	40	40/120	150	0.4	150/15	200	80	**266**
2N2904A	TO-39	600	60	40/120	150	0.4	150/15	200	80	**269**
2N2905	TO-39	600	40	100/300	150	0.4	150/15	200	80	**266**
2N2905A	TO-39	600	60	100/300	150	0.4	150/15	200	80	**269**
2N2906	TO-18	400	40	40/120	150	0.4	150/15	200	80	**266**
2N2906A	TO-18	400	60	40/120	150	0.4	150/15	200	80	**269**
2N2907	TO-18	400	40	100/300	150	0.4	150/15	200	80	**266**
2N2907A	TO-18	400	60	100/300	150	0.4	150/15	200	80	**269**
2N3250	TO-18	360	40	50/150	10	0.5	50/5	250	175	**283**
2N3251	TO-18	360	40	100/300	10	0.5	50/5	300	200	**283**
2N4030	TO-39	800	60	40/120	100	0.5	500/50	100	350	**301**
2N4031	TO-39	800	80	40/120	100	0.5	500/50	100	350	**301**
2N4032	TO-39	800	60	100/300	100	0.5	500/50	150	350	**301**
2N4033	TO-39	800	80	100/300	100	0.5	500/50	150	350	**301**
2N4034	TO-18	360	40	70/200	10	0.3	50/5	400	150*	**304**
2N4035	TO-18	360	40	150/300	10	0.3	50/5	450	150*	**304**
2N4036	TO-39	1000	65	40/140	150	0.65	150/15	60	700*	**307**
2N5322/BSS17	TO-39	1000	75	30/130	500	0.7	500/50	50	1000*	**312**
2N5323/BSS18	TO-39	1000	50	40/250	500	1.2	500/50	50	1000*	**312**

Silicon NPN general purpose transistors

Type	Package	P_{tot} (mW)	V_{CEO} V_{CER}* (V)	h_{FE} min/max	@ I_C (mA)	$V_{CE(sat)}$ (V) max	@ I_C (mA)	f_T (MHz) min	t_s t_{off}* (ns)	Page
BC119	TO-39	800	30	40/120	150	0.35	150	40	–	9
BC140	TO-39	800	40	40/250	100	0.35 typ.	500	50	850*	14
BC141	TO-39	800	60	40/250	100	0.35 typ.	500	50	850*	14
BC300	TO-39	800	80	40/240	150	0.5	150	120 typ.	–	28
BC301	TO-39	800	60	40/240	150	0.5	150	120 typ.	–	28
BC302	TO-39	800	45	40/240	150	0.5	150	120 typ.	–	28
BC377	TO-18	375	25	75/260	100	0.7	500	300 typ.	–	35
BC378	TO-18	375	40	75/260	100	0.7	500	300 typ.	–	35
BC440	TO-39	1000	40	40/240	500	1	1000	50	–	42
BC441	TO-39	1000	60	40/240	500	1	1000	50	–	42
BFR18	TO-18	500	55	60/180	150	0.25	150	60	–	103
BFX69	TO-39	800	30	40/120	150	1.5	150	60	–	123
BFX69A	TO-39	800	40	40	150	0.8	150	60	–	123
BFY50	TO-39	800	35	30	150	0.2	150	60	140 typ.	135
BFY51	TO-39	800	30	40	150	0.35	150	50	160 typ.	135
BFY52	TO-39	800	20	60	150	0.35	150	50	220 typ.	135
BFY56	TO-39	800	45	30/150	150	0.3	150	40	800*	138
BFY56A	TO-39	800	55	40/120	150	0.25	150	60	800*	138
BSS15	TO-39	1000	75	30/130	500	0.5	500	50	800*	310
BSS16	TO-39	1000	50	40/250	500	0.8	500	50	800*	310
BSX33	TO-18	500	55	50	50	0.3	150	60	800*	193
BSX45	TO-39	1000	40	40/250	100	1	1000	50	850*	205
BSX46	TO-39	1000	60	40/250	100	1	1000	50	850*	205
BSY51	TO-39	800	25	40/120	150	0.8	150	100 typ.	–	213
BSY52	TO-39	800	25	100/300	150	0.8	150	100 typ.	–	213
BSY53	TO-39	800	25	40/120	150	0.6	150	100 typ.	–	217
BSY54	TO-39	800	30	100/300	150	0.6	150	100 typ.	–	217
BSY55	TO-39	800	80	40/120	150	0.6	150	100 typ.	–	221
BSY56	TO-39	800	80	100/300	150	0.6	150	100 typ.	–	221
2N718A	TO-18	500	50*	40/120	150	1.5	150	60	–	228
2N956	TO-18	500	50*	100/300	150	1.5	150	70	–	228
2N1613	TO-39	800	50*	40/120	150	1.5	150	60	–	238
2N1711	TO-39	800	50*	100/300	150	1.5	150	70	–	238
2N1893	TO-39	800	80	40/120	150	5	150	50	–	242
2N2218	TO-39	800	30	40/120	150	1.6	500	250	225	245
2N2218A	TO-39	800	40	40/120	150	1	500	250	225	247
2N2219	TO-39	800	30	100/300	150	1.6	500	250	225	245
2N2219A	TO-39	800	40	100/300	150	1	500	250	225	247
2N2221	TO-18	500	30	40/120	150	1.6	500	250	225	245

Silicon NPN general purpose transistors (continued)

Type	Package	P_{tot} (mW)	V_{CEO} V_{CER}* (V)	h_{FE} min/max	@ I_C (mA)	$V_{CE(sat)}$ (V) max	@ I_C (mA)	f_T (MHz) min	t_s t_{off}* (ns)	Page
2N2221A	TO-18	500	40	40/120	150	1	500	250	225	**247**
2N2222	TO-18	500	30	100/300	150	1.6	500	250	225	**245**
2N2222A	TO-18	500	40	100/300	150	1	500	250	225	**247**
2N3019	TO-39	800	80	100/300	150	0.5	500	100 typ	–	**275**
2N3020	TO-39	800	80	40/120	150	0.5	500	80 typ	–	**275**
2N3053	TO-39	800	40	50/250	150	1.4	150	100 typ	–	**278**
2N3107	TO-39	800	60	100/300	150	1.4	150	100 typ	–	**280**
2N3108	TO-39	800	60	40/120	150	1.4	150	100 typ	–	**280**
2N3109	TO-39	800	40	100/300	150	1.4	150	100 typ	–	**280**
2N3110	TO-39	800	40	40/120	150	1.4	150	100 typ	–	**280**
2N3700	TO-18	500	80	100/300	150	0.5	500	100	–	**290**
2N3701	TO-18	500	80	40/120	150	0.5	500	80	–	**290**
2N5320	TO-39	1000	75	30/130	500	0.5	500	50	800*	**310**
2N5321	TO-39	1000	50	40/250	500	0.8	500	50	800*	**310**

Silicon NPN transistors for high frequency applications

Type	Package	P_{tot} (mW)	V_{CEO} (V)	h_{FE} min	@ I_C (mA)	f_T (MHz) min	C_{re} (pF)	P_G (dB)	@ f (MHz)	Page
BF167	TO-72	150	30	30	4	600	0.15	24	36	**72**
BF173	TO-72	175	25	38	7	1000	0.23	26 typ	36	**76**
BF271	TO-72	250	25	30	10	900	0.22	24	36	**84**
BF287	TO-72	250	40	40	2	700	0.22	25	5.5	**86**
BF288	TO-72	250	40	65	1	500	0.24	18	10.7	**89**

CROSS REFERENCE

TYPE	SGS-ATES NEAREST	PAGE
BC100	BF259	80
BC107	BC107	2
BC108	BC108	2
BC109	BC109	2
BC110	BC394	40
BC113	BFR16	99
BC114	BFR17	101
BC115	BC140	14
BC116	BC160	17
BC117	BC394	40
BC118	BC107	2
BC119	BC119	9
BC120	BC119	9
BC125	BC377	35
BC126	BC298	25
BC129	BC107	2
BC130	BC108	2
BC131	BC108	2
BC132	BC109	2
BC134	BC107	2
BC135	BC107	2
BC136	BC140	14
BC137	BC139	11
BC138	BC140	14
BC139	BC139	11
BC140	BC140	14
BC141	BC141	14
BC142	BC301	28
BC143	BC303	32
BC144	BC140	14
BC145	BC394	40
BC147	BC107	2
BC148	BC108	2
BC149	BC109	2
BC150	BC108	2
BC151	BC108	2

TYPE	SGS-ATES NEAREST	PAGE
BC152	BC108	2
BC153	BC177	20
BC154	BC177	20
BC157	BC177	20
BC158	BC178	20
BC159	BC179	20
BC160	BC160	17
BC161	BC161	17
BC167	BC107	2
BC168	BC108	2
BC169	BC109	2
BC170	BC108	2
BC171	BC107	2
BC172	BC108	2
BC173	BC109	2
BC174	BFR16	99
BC177	BC177	20
BC181	BC177	20
BC182	BC107	2
BC183	BC107	2
BC184	BC107	2
BC185	BC301	28
BC186	BC177	20
BC187	BC178	20
BC190	BC107	2
BC192	BC298	25
BC200	BC179	20
BC204	BC177	20
BC205	BC178	20
BC206	BC179	20
BC207	BC107	2
BC208	BC108	2
BC209	BC109	2
BC210	BC377	35
BC211	BC141	14
BC212	BC177	20

TYPE	SGS-ATES NEAREST	PAGE
BC213	BC178	20
BC214	BC179	20
BC215	BC297	25
BC216	BC298	25
BC218	BC108	2
BC220	BC107	2
BC221	BC298	25
BC222	BC378	35
BC223	BC377	35
BC224	BC478	48
BC225	BC478	48
BC226	BC302	28
BC231	BC297	25
BC232	BC377	35
BC236	BC394	40
BC237	BC107	2
BC238	BC108	2
BC239	BC109	2
BC250	BC179	20
BC251	BC177	20
BC252	BC178	20
BC253	BC179	20
BC254	BC394	40
BC255	BC394	40
BC256	BC477	48
BC257	BC177	20
BC258	BC178	20
BC259	BC179	20
BC260	BC179	20
BC261	BC177	20
BC262	BC178	20
BC263	BC178	20
BC266	BC477	48
BC267	BC107	2
BC268	BC108	2
BC269	BC109	2

TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE
BC270	BC109	2	BC328	BC298	25.	BC383	BC108	2
BC271	BC378	35	BC329	BFY76	148	BC384	BC108	2
BC272	BC377	35	BC330	BC107	2	BC385	BC107	2
BC280	BFR16	99	BC331	BFY76	148	BC386	BC109	2
BC281	BC178	20	BC332	BC107	2	BC387	BC377	35
BC282	BC377	35	BC333	BC108	2	BC388	BC297	25
BC283	BC297	25	BC334	BC178	20	BC393	BC393	38
BC284	BC378	35	BC335	BC109	2	BC394	BC394	40
BC285	BC394	40	BC336	BC179	20	BC395	BC141	14
BC286	BC301	28	BC337	BC377	35	BC396	BC161	17
BC287	BC303	32	BC338	BC378	35	BC400	BC477	48
BC294	BC160	17	BC340	BC140	14	BC407	BC107	2
BC295	BC108	2	BC341	BC141	14	BC408	BC108	2
BC297	BC297	25	BC342	BC141	14	BC409	BC109	2
BC298	BC298	25	NC343	BC161	17	BC417	BC177	20
BC300	BC300	28	BC344	BC300	28	BC418	BC178	20
BC301	BC301	28	BC345	BC303	32	BC419	BC179	20
BC302	BC302	28	BC347	BC107	2	BC420	BC393	38
BC303	BC303	32	BC348	BC108	2	BC429	BC440	42
BC304	BC304	34	BC349	BC109	2	BC430	BC460	45
BC307	BC177	20	BC350	BC177	20	BC431	BC301	28
BC308	BC178	20	BC351	BC178	20	BC432	BC303	32
BC309	BC179	20	BC352	BC179	20	BC437	BC107	2
BC310	BC141	14	BC354	BC478	48	BC438	BC108	2
BC311	BC161	17	BC355	BC478	48	BC439	BC109	2
BC312	BF258	80	BC357	BC479	48	BC440	BC440	42
BC313	BC303	32	BC358	BC109	2	BC441	BC441	42
BC315	BC177	20	BC360	BC160	17	BC446	BC477	48
BC317	BC107	2	BC361	BC161	17	BC448	BC477	48
BC318	BC108	2	BC368	BC440	42	BC451	BC107	2
BC319	BC109	2	BC369	BC460	45	BC452	BC108	2
BC320	BC177	20	BC370	BC298	25	BC453	BC109	2
BC321	BC178	20	BC377	BC377	35	BC454	BC177	20
BC322	BC179	20	BC378	BC378	35	BC455	BC178	20
BC324	BC301	28	BC381	BC177	20	BC456	BC179	20
BC327	BC297	25	BC382	BC107	2	BC460	BC460	45

CROSS REFERENCE (continued)

TYPE	SGS-ATES NEAREST	PAGE
BC461	BC461	45
BC467	BC107	2
BC468	BC108	2
BC469	BC109	2
BC477	BC477	48
BC478	BC478	48
BC479	BC479	48
BC512	BC177	20
BC513	BC178	20
BC514	BC179	20
BC520	BFR16	99
BC521	BFR17	101
BC522	BFR17	101
BC523	BFR16	99
BC524	BC107	2
BC525	BC478	48
BC526	BC477	48
BC529	BC297	25
BC530	BC393	38
BC531	BC393	38
BC532	BC394	40
BC533	BC394	40
BC535	2N3700	290
BC546	BFY76	148
BC547	BC107	2
BC548	BC108	2
BC549	BC109	2
BC550	BC107	2
BC556	BC477	48
BC557	BC478	48
BC558	BC478	48
BC559	BC479	48
BC560	BC478	48
BC582	BC107	2
BC583	BC108	2
BC584	BC109	2
BC585	BFR16	99
BC586	BC177	20
BC635	BC377	35
BC636	BC297	25
BC714	BC177	20
BC727	BC297	25
BC728	BC298	25
BC737	BC377	35
BC738	BC378	35
BCW10	BCY58	55
BCW11	BCY78	66
BCW12	BCY59	55
BCW13	BCY79	66
BCW14	BCY59	55
BCW15	BCY79	66
BCW16	BCY59	55
BCW17	BCY79	66
BCW20	BCY58	55
BCW21	BCY78	66
BCW22	BCY59	55
BCW23	BCY79	66
BCW34	2N2222A	247
BCW35	2N2907A	269
BCW36	2N2222A	247
BCW37	2N2907A	269
BCW44	BFX69A	123
BCW45	BFX41	116
BCW50	BC394	40
BCW62	2N3962	297
BCW63	BCY79	66
BCW64	BCY79	66
BCW73	2N2221	245
BCW74	2N2221A	247
BCW75	2N2906	266
BCW76	2N2906A	269
BCW77	2N2219	245
BCW78	2N2219A	247
BCW79	2N2905	266
BCW80	2N2905A	269
BCW82	BFR16	99
BCW83	BCY59	55
BCW84	BCY59	55
BCW85	BFX37	111
BCW86	BC177	20
BCW87	BCY59	55
BCW88	BCY79	55
BCW90	BC377	35
BCW91	BSX33	193
BCW92	BC297	25
BCW93	2N2907A	269
BCW94	2N2222A	247
BCW95	BFR18	103
BCW96	2N2907	266
BCW97	2N2907A	269
BCW98	BCY59	55
BCW99	BCY79	66
BCX25	BCY59	55
BCX26	BCY79	66
BCX40	BC441	42
BCX45	2N2221A	247
BCX46	2N2906A	269
BCX47	2N2222A	247
BCX48	2N2907A	269
BCX49	2N3701	290
BCX58	BCY58	55
BCX59	BCY59	55
BCX60	BC461	45
BCX73	2N2222	245
BCX74	2N2222A	247
BCX75	2N2907	266
BCX76	2N2907A	269
BCX78	BCY78	66

TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE
BCX79	BCY79	66	BF241	BF173	76	BF338	BF259	80
BCY56	BCY59	55	BF248	2N2222	245	BF355	BF259	80
BCY58	BCY58	55	BF249	2N2907	266	BF367	BF167	72
BCY59	BCY59	55	BF250	2N2222	245	BF371	BF271	84
BCY66	BCY59	55	BF257	BF257	80	BF373	BF173	76
BCY67	BCY79	66	BF258	BF258	80	BF390	BF259	80
BCY69	BCY58	55	BF259	BF259	80	BF391	BC394	40
BCY70	BCY70	60	BF260	BF167	72	BF456	BF457	92
BCY71	BCY71	60	BF261	BF167	72	BF457	BF457	92
BCY72	BCY72	60	BF270	BF167	72	BF458	BF458	92
BCY78	BCY78	66	BF271	BF271	84	BF459	BF459	92
BCY79	BCY79	66	BF287	BF287	86	BF497	BF173	76
BF120	BC394	40	BF288	BF288	89	BF523	BF271	84
BF137	BF257	80	BF291	BC107	2	BF596	BF167	72
BF156	BF257	80	BF292	BF258	80	BF597	BF173	76
BF157	BF257	80	BF293	BC107	2	BFR10	2N2218	245
BF162	BF167	72	BF294	BF257	80	BFR11	2N2221	245
BF163	BF167	72	BF297	BF257	80	BFR12	BCY59	55
BF164	BF167	72	BF298	BF258	80	BFR16	BFR16	99
BF167	BF167	72	BF299	BF259	80	BFR17	BFR17	101
BF173	BF173	76	BF302	BF288	89	BFR18	BFR18	103
BF174	BF258	80	BF303	BF287	86	BFR19	BFX69	123
BF176	BF173	76	BF304	BF288	89	BFR20	2N3019	275
BF177	BF257	80	BF305	BF258	80	BFR21	2N1893	242
BF178	BF258	80	BF306	BF173	76	BFR22	2N1893	242
BF179	BF259	80	BF307	BF288	89	BFR23	2N4036	307
BF198	BF167	72	BF308	BF271	84	BFR24	2N4036	307
BF199	BF173	76	BF309	BF271	84	BFR39	BFR18	103
BF207	BF167	72	BF310	BF173	76	BFR40	2N3700	290
BF208	BF271	84	BF311	BF173	76	BFR56	BC440	42
BF214	BF288	89	BF321	BC108	2	BFR57	BF257	80
BF215	BF271	84	BF322	2N2218	245	BFR58	BF258	80
BF224	BF173	76	BF323	2N2904	266	BFR59	BF259	80
BF225	BF271	84	BF325	BF167	72	BFR77	2N1893	242
BF226	BF288	89	BF336	BF257	80	BFR78	2N3020	275
BF240	BF167	72	BF337	BF258	80	BFR86	BC394	40

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TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE
BFR87	BC394	40	BFV65	BSX26	173	BFX41	BFX41	116
BFS61	BSX33	193	BFV66	2N2221A	247	BFX43	2N2369	251
BFS62	BF173	76	BFV66A	2N2222A	247	BFX44	2N2369A	253
BFS69	BC178	20	BFV67	2N709	225	BFX48	BFX48	120
BFS89	BFS89	106	BFV68	2N2483	257	BFX50	2N2222A	247
BFS90	BFW44	108	BFV68A	2N2484	257	BFX51	2N2221A	247
BFS91	BFX91	129	BFV90A	2N2222	245	BFX68	2N1711	238
BFS92	BFX41	116	BFV90B	2N2221	245	BFX68A	2N1711	238
BFS93	BFX40	116	BFV99	2N2221A	247	BFX69	BFX69	123
BFS94	BFX39	116	BFW20	BC477	48	BFX69A	BFX69A	123
BFS95	BFX38	116	BFW21	BFX37	111	BFX74	2N2904	266
BFS99	BC394	40	BFW22	BC478	48	BFX74A	BFX39	116
BFT22	2N2906	266	BFW24	2N3108	280	BFX77	BFR16	99
BFT29	2N3701	290	BFW25	2N3110	280	BFX84	2N1893	242
BFT30	BSX33	193	BFW26	2N3109	280	BFX85	2N1893	242
BFT31	2N956	228	BFW29	2N2219	245	BFX86	2N1711	238
BFT39	BSS15	310	BFW31	2N2905	266	BFX87	2N2905A	269
BFT40	BSS16	310	BFW32	2N2219	245	BFX88	2N2905	266
BFT41	2N5321	310	BFW33	BSY56	221	BFX91	BFX91	129
BFT45	2N3440S	289	BFW36	BF257	80	BFX93	2N930	236
BFT57	BC394	40	BFW38	BF257	80	BFX94	2N2221	245
BFT60	2N4033	301	BFW43	BFW43	108	BFX94A	2N2221A	247
BFT61	2N4030	301	BFW44	BFW44	108	BFX95	2N2222	245
BFT62	2N4030	301	BFW45	BF257	80	BFX95A	2N2222A	247
BFT69	2N4031	301	BFW63	2N2222	245	BFX96	2N2218	245
BFT79	2N4031	301	BFW63A	2N2222A	247	BFX96A	2N2218A	247
BFT80	2N4033	301	BFX12	BFX48	120	BFX97	2N2219	245
BFT81	2N4032	301	BFX13	BFX48	120	BFX97A	2N2219A	247
BFV23	BSX23	185	BFX23	BSX32	189	BFX98	BF257	80
BFV56	BSS26	153	BFX29	2N2904A	269	BFY25	2N2219A	247
BFV56A	BSS26	153	BFX35	2N2907	266	BFY26	2N2222A	247
BFV57	BSV59	161	BFX36	2N2907A	269	BFY33	BFY56	138
BFV57A	BSS26	153	BFX37	BFX37	111	BFY34	2N1613	238
BFV64	2N2907	266	BFX38	BFX38	116	BFY40	2N1711	238
BFV64A	2N2907A	269	BFX39	BFX39	116	BFY41	BF257	80
BFV64B	2N2907	266	BFX40	BFX40	116	BFY43	BF257	80

TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE
BFY44	BFY56A	138	BSS68	BC393	38	BSW27	2N3725	293
BFY45	BF257	80	BSV15	BSV15	157	BSW28	BSX32	189
BFY46	2N1711	238	BSV16	BSV16	157	BSW29	BSX32	189
BFY50	BFY50	135	BSV17	BSV16	157	BSW37	2N2894	263
BFY51	BFY51	135	BSV21	2N2894	263	BSW38	BSX19	169
BFY52	BFY52	135	BSV23	BSX28	181	BSW41	2N2221A	247
BFY53	BFX69	123	BSV24	BSX28	181	BSW42	BCY58	55
BFY55	BFX69A	123	BSV25	BSX19	169	BSW42A	BCY59	55
BFY56	BFY56	138	BSV26	BSX19	169	BSW43A	BCY59	55
BFY56A	BFY56A	138	BSV27	BSX20	169	BSW44	BCY78	66
BFY57	BF257	80	BSV33	BSX29	185	BSW44A	BCY79	66
BFY64	2N2905	266	BSV59	BSV59	161	BSW45	BCY78	66
BFY65	BF257	80	BSV68	BFW43	108	BSW45A	BCY79	66
BFY67	BFX69	123	BSV69	BSX32	189	BSW49	BSX32	189
BFY68	2N1711	238	BSV77	2N3725	293	BSW51	2N2218	245
BFY70	2N2218A	247	BSV82	BSS17	312	BSW52	2N2219	245
BFY72	2N2218	245	BSV83	BSS18	312	BSW53	2N2218A	247
BFY76	BFY76	148	BSV84	BSS15	310	BSW54	2N2219A	247
BFY77	2N2484	257	BSV85	BSS16	310	BSW61	2N2221	245
BSS11	BSX20	169	BSV89	BSX19	169	BSW62	2N2222	245
BSS12	BSX28	181	BSV90	BSX20	169	BSW63	2N2221A	247
BSS15	BSS15	310	BSV91	BSX20	169	BSW64	2N2222A	247
BSS16	BSS16	310	BSV92	BSX26	173	BSW72	2N2906	266
BSS17	BSS17	312	BSV95	2N3725	293	BSW73	2N2907	266
BSS18	BSS18	312	BSW19	2N2906	266	BSW74	2N2906A	269
BSS23	BSS26	153	BSW19A	2N2907	266	BSW75	2N2907A	269
BSS26	BSS26	153	BSW20	2N2906	266	BSW82	2N2221	245
BSS27	2N3725	293	BSW20A	2N2907	266	BSW83	2N2222	245
BSS28	BSX32	189	BSW21	BCY78	66	BSW84	2N2221	245
BSS29	BSX32	189	BSW21A	BCY79	66	BSW85	2N2222A	247
BSS30	2N1893	242	BSW22	BCY78	66	BSX19	BSX19	169
BSS31	2N3019	275	BSW22A	BCY79	66	BSX20	BSX20	169
BSS40	BSS26	153	BSW23	2N2904	266	BSX21	BC394	40
BSS41	BSS26	153	BSW24	2N2904A	269	BSX22	2N5321	310
BSS48	2N3440S	286	BSW25	BSX29	185	BSX23	2N5320	310
BSS59	2N3700	290	BSW26	BSS26	173	BSX24	2N2221	245

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TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE
BSX25	2N2222	245	BSX95	2N1613	238	BSY82	BFY52	135
BSX26	BSX26	173	BSX96	2N1711	238	BSY83	BFY56A	138
BSX27	BSX27	177	BSX97	2N2221	245	BSY84	2N1711	238
BSX28	BSX28	181	BSY10	2N2218A	247	BSY85	BSX45	205
BSX29	BSX29	185	BSY11	2N2219	245	BSY86	BSX46	205
BSX30	BSX32	189	BSY17	BSX19	169	BSY87	BSY56	221
BSX33	BSX33	193	BSY18	BSX20	169	BSY88	2N3107	280
BSX36	BSX36	197	BSY19	BSX26	173	BSY89	BCY58	55
BSX38A	BCY58	55	BSY20	BSX20	169	BSY95	BSX19	169
BSX38B	BCY59	55	BSY21	BSX26	173	BSY95A	BSX20	169
BSX39	BSX39	201	BCY22	BCY59	55	2N656	BSX46	205
BSX44	2N709	225	BSY23	BSX19	169	2N657	BC300	28
BSX45	BSX45	205	BSY34	BSX32	189	2N696	BFX69	123
BSX46	BSX46	205	BSY38	BSX19	169	2N697	2N1613	238
BSX47	BFY56	138	BSY40	BSX29	185	2N698	2N1893	242
BSX48	BSS26	153	BSY41	BSX29	185	2N706	BSX26	173
BSX49	BSS26	153	BSY44	BFX69A	123	2N706A	BSX19	169
BSX51	BCY58	55	BSY45	2N1893	242	2N707	BSX39	201
BSX52	BCY59	55	BSY46	2N1613	238	2N708	BSX26	173
BSX53	BCY58	55	BSY51	BSY51	213	2N709	2N709	225
BSX54	BCY59	55	BSY52	BSY52	213	2N718A	2N718A	228
BSX59	BSX32	189	BSY53	BSY53	217	2N720A	BFR18	103
BSX60	2N3725	293	BSY54	BSY54	217	2N721	2N2906	266
BSX61	2N3725	293	BSY55	BSY55	221	2N722	2N2906A	269
BSX76	BSX20	169	BSY56	BSY56	221	2N735	2N2483	257
BSX77	2N2369A	253	BSY58	BSX32	189	2N736	BFR18	103
BSX78	BSX20	169	BSY62A	BSX19	169	2N743	BSX19	169
BSX87	BSX26	173	BSY62B	BSX20	169	2N744	BSX20	169
BSX87A	BSX26	173	BSY63	BSX93	209	2N753	2N2369A	253
BSX88	BSX39	201	BSY70	BSX39	201	2N754	2N1893	242
BSX88A	BSX39	201	BSY71	2N1711	238	2N760A	BFY76	148
BSX89	BSX19	169	BSY72	BCY58	55	2N780	2N930	236
BSX90	BSX20	169	BSY73	BCY58	55	2N834	BSX20	169
BSX91	2N2369A	253	BSY74	BCY59	55	2N869	BSX29	185
BSX92	2N2369	251	BSY78	2N2222	245	2N870	BSX33	193
BSX93	BSX93	209	BSY81	BFY51	135	2N871	BFR18	103

TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE	TYPE	SGS-ATES NEAREST	PAGE
2N910	BFR18	103	2N2221	2N2221	245	2N2927	2N2904A	269
2N911	BSX33	193	2N2221A	2N2221A	247	2N2959	2N2219A	247
2N912	BFR18	103	2N2222	2N2222	245	2N3009	2N3009	272
2N914	2N914	231	2N2222A	2N2222A	247	2N3010	2N3010	225
2N929	BFY76	148	2N2297	BFY56	138	2N3011	BSX28	181
2N930	2N930	236	2N2368	BSX19	169	2N3012	2N3012	263
2N956	2N956	228	2N2369	2N2369	251	2N3013	2N3013	272
2N978	2N2906	266	2N2369A	2N2369A	253	2N3014	2N3014	272
2N995	BSX29	185	2N2405	BC300	28	2N3015	BSX32	189
2N1132	2N2904	266	2N2410	BSX32	189	2N3019	2N3019	275
2N1420	2N2219	245	2N2412	BSX29	185	2N3020	2N3020	275
2N1507	2N2219	245	2N2475	2N709	225	2N3036	2N1893	242
2N1572	2N1893	242	2N2477	2N3725	293	2N3053	2N3053	278
2N1573	2N1893	242	2N2483	2N2483	257	2N3070	2N2905A	269
2N1574	2N3020	275	2N2484	2N2484	257	2N3073	2N2906A	269
2N1613	2N1613	238	2N2511	BFY76	148	2N3107	2N3107	280
2N1711	2N1711	238	2N2586	BFR17	101	2N3108	2N3108	280
2N1890	BSY55	221	2N2692	BCY59	55	2N3109	2N3109	280
2N1893	2N1893	242	2N2693	BCY59	55	2N3110	2N3110	280
2N1983	2N2219	245	2N2694	BCY59	55	2N3114	BF257	80
2N1984	2N2218	245	2N2711	BCY58	55	2N3117	BFR17	101
2N1985	2N1613	238	2N2712	BCY58	55	2N3121	2N2906A	269
2N1986	2N2218	245	2N2714	BCY59	55	2N3209	2N3209	263
2N1987	BFX69	123	2N2845	BSS26	153	2N3250	2N3250	283
2N1990	2N1893	242	2N2848	BSX32	189	2N3251	2N3251	283
2N1991	2N2904	266	2N2864	BFY50	135	2N3252	2N3725	293
2N2049	BFY52	135	2N2868	BFX69A	123	2N3253	BSX32	189
2N2102	2N3020	275	2N2894	2N2894	263	2N3261	BSX20	169
2N2193	BSX45	205	2N2904	2N2904	266	2N3299	2N2218	245
2N2194A	2N2218A	247	2N2904A	2N2904A	269	2N3300	2N2219	245
2N2195	2N2218	245	2N2905	2N2905	266	2N3301	2N2221	245
2N2217	2N2218	245	2N2905A	2N2905A	269	2N3302	2N2222	245
2N2218	2N2218	245	2N2906	2N2906	266	2N3309	2N2218	245
2N2218A	2N2218A	247	2N2906A	2N2906A	269	2N3440	2N3440S	286
2N2219	2N2219	245	2N2907	2N2907	266	2N3440S	2N3440S	286
2N2219A	2N2219A	247	2N2907A	2N2907A	269	2N3485	2N2906	266

CROSS REFERENCE (continued)

TYPE	SGS-ATES NEAREST	PAGE
2N3486	2N2907	266
2N3502	2N2905A	269
2N3503	2N2905	266
2N3504	2N2907A	269
2N3505	2N2907	266
2N3565	BFR16	99
2N3566	2N1711	238
2N3567	2N1613	238
2N3568	BFY56A	138
2N3569	BFY56	138
2N3638	2N2905	266
2N3641	2N2218	245
2N3642	2N2218A	247
2N3643	2N2219	245
2N3644	2N2905	266
2N3645	2N2905A	269
2N3646	BSX26	173
2N3700	2N3700	290
2N3701	2N3701	290
2N3712	BF257	80
2N3725	2N3725	293
2N3776	2N5321	310
2N3777	2N5322	312
2N3793	BC107	2
2N3794	BC108	2
2N3825	BC109	2
2N3828	BC107	2
2N3829	BSX36	197
2N3903	2N2222	245
2N3904	2N2221	245
2N3905	2N2906	266
2N3906	2N2907	266
2N3930	BFX90	129
2N3931	BFX91	129
2N3962	2N3962	297
2N3963	2N3965	297
2N3964	2N3964	297
2N3965	2N3965	297
2N4013	BSS26	153
2N4014	BSS26	153
2N4030	2N4030	301
2N4031	2N4031	301
2N4032	2N4032	301
2N4033	2N4033	301
2N4034	2N4034	304
2N4035	2N4035	304
2N4036	2N4036	307
2N4037	2N4036	307
2N4046	BSX32	189
2N4047	2N3725	293
2N4058	BC177	20
2N4059	BC178	20
2N4060	BC177	20
2N4061	BC177	20
2N4062	BC178	20
2N4121	BCY70	60
2N4248	BC177	20
2N4249	BC177	20
2N4250	BC178	20
2N4258	BC179	20
2N4264	BC108	2
2N4265	BC107	2
2N4286	BC107	2
2N4287	BC107	2
2N4288	BC178	20
2N4289	BC177	20
2N4290	BC179	20
2N4291	BC179	20
2N4292	BC109	2
2N4293	BC109	2
2N4358	2N5415S	314
2N4359	BFX37	111
2N4402	2N2906	266
2N4403	2N2907	266
2N4917	2N3251	283
2N4927	BF258	80
2N5086	BCY79	66
2N5087	BCY79	66
2N5088	BCY59	55
2N5089	BCY59	55
2N5128	2N2219	245
2N5132	BC109	2
2N5135	BCY58	55
2N5136	BC119	9
2N5138	BCY79	66
2N5172	BCY58	55
2N5209	BC107	2
2N5210	BC107	2
2N5219	BC108	2
2N5262	BSS15	310
2N5320	2N5320	310
2N5321	2N5321	310
2N5322	2N5322	312
2N5323	2N5323	312
2N5415S	2N5415S	314
2N5550	BC394	40
2N5551	BC394	40

ALPHABETICAL LIST OF SYMBOLS

B	Bandwidth
b_{fb}	Common-base, forward transfer susceptance (output short-circuited, y matrix)
b_{fe}	Common-emitter, forward transfer susceptance (output short-circuited, y matrix)
b_{ib}	Common-base, input susceptance (output short-circuited, y matrix)
b_{ie}	Common-emitter, input susceptance (output short-circuited, y matrix)
b_{ob}	Common-base, output susceptance (input short-circuited, y matrix)
b_{oe}	Common-emitter, output susceptance (input short-circuited, y matrix)
b_{rb}	Common-base, reverse transfer susceptance (input short-circuited, y matrix)
b_{re}	Common-emitter, reverse transfer susceptance (input short-circuited y matrix)
C_{CBO}	Collector-base capacitance (emitter open to a.c. and d.c.)
C_{EBO}	Emitter-base capacitance (collector open to a.c. and d.c.)
C_i	Input capacitance
C_{ib}	Common-base, input capacitance (output a.c. short-circuited, h and y matrix)
C_{ibo}	Common-base, input capacitance (output a.c. open-circuited)
C_{ie}	Common-emitter, input capacitance (output a.c. short-circuited, h and y matrix)
C_o	Output capacitance
C_{ob}	Common-base, output capacitance (input a.c. short-circuited, y matrix)
C_{obo}	Common-base, output capacitance (input a.c. open-circuited, h matrix)
C_{oe}	Common-emitter, output capacitance (input a.c. short-circuited, y matrix)
C_{oeo}	Common-emitter, output capacitance (input a.c. open-circuited, h matrix)
C_{rb}	Common-base, reverse capacitance (input a.c. short-circuited, y matrix)
C_{re}	Common-emitter, reverse capacitance (input a.c. short-circuited, y matrix)
f	Frequency
Δf	Frequency deviation
f_T	Transition frequency
g_{fb}	Common-base, forward transconductance (input short-circuited, y matrix)
g_{fe}	Common-emitter, forward transconductance (input short-circuited, y matrix)
g_{ib}	Common-base, input conductance (output short-circuited, y matrix)
g_{ie}	Common-emitter, input conductance (output short-circuited, y matrix)

ALPHABETICAL LIST OF SYMBOLS (continued)

g_{ob}	Common-base, output conductance (input short-circuited, y matrix)
g_{oe}	Common-emitter, output conductance (input short-circuited, y matrix)
G_p	Power gain
G_{pb}	Common-base, power gain
G_{pe}	Common-emitter, power gain
g_{rb}	Common-base, reverse transconductance (input short-circuited, y matrix)
g_{re}	Common-emitter, reverse transconductance (input short-circuited, y matrix)
G_{tr}	Transducer power gain
G_U	Unilateralized power gain
G_{UM}	Maximum unilateralized power gain
G_v	Voltage gain
h_{fb}	Common-base, small-signal value of the short-circuit forward current transfer ratio
h_{fe}	Common-emitter, small-signal value of the short-circuit forward current transfer ratio
h_{FE}	Common-emitter, static value of the forward current transfer ratio
h_{FE1}/h_{FE2}	Common-emitter, static value of the forward current transfer matched pair ratio
h_{ib}	Common-base, small-signal value of the short-circuit input impedance
h_{ie}	Common-emitter, small-signal value of the short-circuit input impedance
h_{ob}	Common-base, small-signal value of the open-circuit output admittance
h_{oe}	Common-emitter, small-signal value of the open-circuit output admittance
h_{rb}	Common-base, small-signal value of the open-circuit reverse voltage transfer ratio
h_{re}	Common-emitter, small-signal value of the open-circuit reverse voltage transfer ratio
I_B	Base current
I_{B1}	Turn-on current
I_{B2}	Turn-off current
I_{BM}	Base peak current
I_C	Collector current
I_{CBO}	Collector cutoff current with emitter open
I_{CEO}	Collector cutoff current with base open
I_{CER}	Collector cutoff current with specified resistance between emitter and base
I_{CES}	Collector cutoff current with emitter short-circuited to base
I_{CEV}	Collector cutoff current with specified reverse voltage between emitter and base
I_{CEX}	Collector cutoff current with specified circuit between emitter and base

I_{CM}	Collector peak current
I_E	Emitter current
I_{EBO}	Emitter cutoff current with collector open
I_s	Supply current
NF	Noise figure
P_o	Output power of a specified circuit
P_{tot}	Total power dissipation
$r_{bb'}$	Base spreading resistance
$r_{bb'}\ C_{b'c}$	Feedback time constant
R_{BE}	Resistance between base and emitter
R_{EE}	Emitter dropping resistance
R_g	Internal resistance of generator
R_i	Input resistance
R_L	Load resistance
R_o	Output resistance
R_{th}	Thermal resistance
$R_{th\ j\text{-}amb}\ (R_{th\ j\text{-}a})$	Thermal resistance junction-to-ambient
$R_{th\ j\text{-}case}\ (R_{th\ j\text{-}c})$	Thermal resistance junction-to-case
$\frac{S+N}{N}$	Signal and noise to noise ratio
SVR	Supply voltage rejection
t	Time
$T_{amb}\ (T_a)$	Ambient temperature
$T_{case}\ (T_c)$	Case temperature
t_d	Delay time
t_f	Fall time
T_j	Junction temperature
T_l	Lead temperature
t_{off}	Turn-off-time
t_{on}	Turn-on-time
T_{op}	Operating temperature
t_p	Pulse time
t_r	Rise time
t_s	Storage time
$T_{stg}\ (T_s)$	Storage temperature
V_{BE}	Base-emitter voltage
$V_{BE(sat)}$	Base-emitter saturation voltage
$V_{(BR)CBO}$	Collector-base breakdown voltage with emitter open
$V_{(BR)CEO}$	Collector-emitter breakdown voltage with base open
$V_{(BR)CER}$	Collector-emitter breakdown voltage with specified resistance
$V_{(BR)CES}$	Collector-emitter breakdown voltage with emitter short-circuited to base
$V_{(BR)CEV}$	Collector-emitter breakdown voltage with specified reverse voltage between emitter and base
$V_{(BR)EBO}$	Emitter-base breakdown voltage with collector open
V_{CB}	Collector-base voltage

ALPHABETICAL LIST OF SYMBOLS (continued)

V_{CBO}	Collector-base voltage with emitter open
V_{CE}	Collector-emitter voltage
V_{CEK}	Knee voltage at specified condition
V_{CEO}	Collector-emitter voltage with base open
$V_{CEO(sus)}$	Collector-emitter sustaining voltage with base open
V_{CER}	Collector-emitter voltage with specified resistance between emitter and base
$V_{CER(sus)}$	Collector-emitter sustaining voltage with specified resistance between emitter and base
$V_{CE(sat)}$	Collector-emitter saturation voltage
V_{CES}	Collector-emitter voltage with emitter short-circuited to base
V_{CEV}	Collector-emitter voltage with specified reverse voltage between emitter and base
$V_{CEV(sus)}$	Collector-emitter sustaining voltage with specified reverse voltage between emitter and base
V_{CEX}	Collector-emitter voltage with specified circuit between emitter and base
$V_{CEX(sus)}$	Collector-emitter sustaining voltage with specified circuit between emitter and base
V_{EB}	Emitter-base voltage
V_{EBO}	Emitter-base voltage with collector open
V_i	Input voltage of a specified circuit
V_{int}	Interfering voltage
V_o	Output voltage of a specified circuit
V_{pp}	Peak-to-peak voltage
V_s	Supply voltage
y_{fb}	Common-base, small-signal value of the short-circuit forward transfer admittance
y_{fe}	Common-emitter, small-signal value of the short-circuit forward transfer admittance
y_{ib}	Common-base, small-signal value of the short-circuit input admittance
y_{ie}	Common-emitter, small-signal value of the short-circuit input admittance
y_{ob}	Common-base, small-signal value of the short-circuit output admittance
y_{oe}	Common-emitter, small-signal value of the short-circuit output admittance
y_{rb}	Common-base, small-signal value of the short-circuit reverse transfer admittance
y_{re}	Ccmmon-emitter, small-signal value of the short-circuit reverse transfer admittance
Z_{BE}	Impedance between base and emitter
Z_i	Input impedance
Z_o	Output impedance
τ_s	Storage time constant

φ_{fb}	Common-base, phase angle of the forward transadmittance (output short-circuited, y matrix)
φ_{fe}	Common-emitter, phase angle of the forward transadmittance (output short-circuited, y matrix)
φ_{ib}	Common-base, phase angle of the input admittance (output short-circuited, y matrix)
φ_{ie}	Common-emitter, phase angle of the input admittance (output short-circuited, y matrix)
φ_{ob}	Common-base, phase angle of the output admittance (input short-circuited, y matrix)
φ_{oe}	Common-emitter, phase angle of the output admittance (input short-circuited, y matrix)
φ_{rb}	Common-base, phase angle of the reverse transadmittance (input short-circuited, y matrix)
φ_{re}	Common-emitter, phase angle of the reverse transadmittance (input short-circuited, y matrix)

DATA SHEETS

BC 107
BC 108
BC 109

SILICON PLANAR NPN

LOW NOISE GENERAL PURPOSE AUDIO AMPLIFIERS

The BC 107, BC 108 and BC 109 are silicon planar epitaxial NPN transistors in TO-18 metal case. They are suitable for use in driver stages, low noise input stages and signal processing circuits of television receivers.
The complementary PNP types are respectively the BC 177, BC 178 and BC 179.

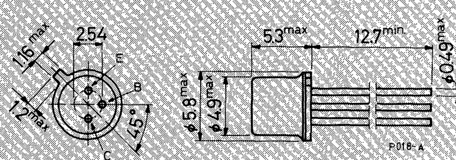
ABSOLUTE MAXIMUM RATINGS

		BC 107	BC 108	BC 109
V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V	30 V	30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	45 V	20 V	20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6 V	5 V	5 V
I_C	Collector current	100 mA		
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	0.3 W		
	at $T_{case} \leq 25$ °C	0.75 W		
T_{stg}	Storage temperature	-55 to 175 °C		
T_j	Junction temperature	175 °C		

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	for **BC 107**				
		V_{CB} = 40 V			15	nA
		V_{CB} = 40 V T_{amb} = 150 °C			15	μA
		for **BC 108 - BC 109**				
		V_{CB} = 20 V			15	nA
		V_{CB} = 20 V T_{amb} = 150 °C			15	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA				
		for **BC 107**	50			V
		for **BC 108**	30			V
		for **BC 109**	30			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA				
		for **BC 107**	45			V
		for **BC 108**	20			V
		for **BC 109**	20			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA				
		for **BC 107**	6			V
		for **BC 108**	5			V
		for **BC 109**	5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 10 mA I_B = 0.5 mA		70	250	mV
		I_C = 100 mA I_B = 5 mA		200	600	mV
V_{BE}*	Base-emitter voltage	I_C = 2 mA V_{CE} = 5 V	550	650	700	mV
		I_C = 10 mA V_{CE} = 5 V		700	770	mV
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 10 mA I_B = 0.5 mA		750		mV
		I_C = 100 mA I_B = 5 mA		900		mV

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C = 2 mA V_{CE} = 5 V				
		for **BC 107**	110	230	450	—
		for **BC 107** Gr. A	110	180	220	—
		for **BC 107** Gr. B	200	290	450	—
		for **BC 108**	110	350	800	—
		for **BC 108** Gr. A	110	180	220	—
		for **BC 108** Gr. B	200	290	450	—
		for **BC 108** Gr. C	420	520	800	—
		for **BC 109**	200	350	800	—
		for **BC 109** Gr. B	200	290	450	—
		for **BC 109** Gr. C	420	520	800	—
		I_C = 10 μA V_{CE} = 5 V				
		for **BC 107**		120		—
		for **BC 107** Gr. A		90		—
		for **BC 107** Gr. B	40	150		—
		for **BC 108**		120		—
		for **BC 108** Gr. A		90		—
		for **BC 108** Gr. B	40	150		—
		for **BC 108** Gr. C	100	270		—
		for **BC 109**	70	210		—
		for **BC 109** Gr. B	40	150		—
		for **BC 109** Gr. C	100	270		—
h_{fe}	Small signal current gain	I_C = 2 mA V_{CE} = 5 V f = 1 kHz				
		for **BC 107**		250		—
		for **BC 107** Gr. A		190		—
		for **BC 107** Gr. B		300		—
		for **BC 108**		370		—
		for **BC 108** Gr. A		190		—
		for **BC 108** Gr. B		300		—
		for **BC 108** Gr. C		500		—
		for **BC 109**		370		—
		for **BC 109** Gr. B		300		—
		for **BC 109** Gr. C		550		—
		I_C = 10 mA V_{CE} = 10 V f = 100 MHz		2		—
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10 V f = 1 MHz		4	6	pF

ELECTRICAL CHARACTERISTICS (continued)

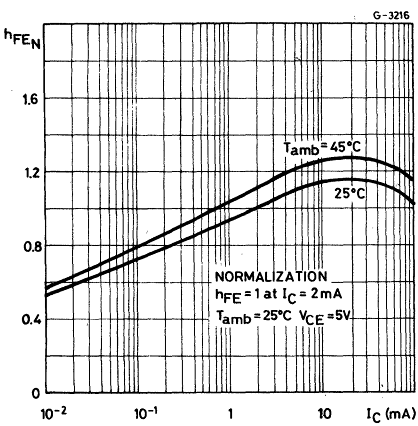
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5 V f = 1 MHz		11.5		pF
NF	Noise figure	I_C = 0.2 mA V_{CE} = 5 V R_g = 2 kΩ f = 1 kHz B = 200 Hz				
		for **BC 107**		2	10	dB
		for **BC 108**		2	10	dB
		for **BC 109**		1.5	4	dB
		I_C = 0.2 mA V_{CE} = 5 V R_g = 2 kΩ f = 10 Hz to 10 kHz B = 15.7 kHz				
		for **BC 109**		1.5	4	dB
h_{ie}	Input impedance	I_C = 2 mA V_{CE} = 5 V f = 1 kHz				
		for **BC 107**		4		kΩ
		for **BC 107** Gr. A		3		kΩ
		for **BC 107** Gr. B		4.8		kΩ
		for **BC 108**		5.5		kΩ
		for **BC 108** Gr. A		3		kΩ
		for **BC 108** Gr. B		4.8		kΩ
		for **BC 108** Gr. C		7		kΩ
		for **BC 109**		5.5		kΩ
		for **BC 109** Gr. B		4.8		kΩ
		for **BC 109** Gr. C		7		kΩ
h_{re}	Reverse voltage ratio	I_C = 2 mA V_{CE} = 5 V f = 1 kHz				
		for **BC 107**		2.2×10^{-4}		—
		for **BC 107** Gr. A		1.7×10^{-4}		—
		for **BC 107** Gr. B		2.7×10^{-4}		—
		for **BC 108**		3.1×10^{-4}		—
		for **BC 108** Gr. A		1.7×10^{-4}		—
		for **BC 108** Gr. B		2.7×10^{-4}		—
		for **BC 108** Gr. C		3.8×10^{-4}		—
		for **BC 109**		3.1×10^{-4}		—
		for **BC 109** Gr. B		2.7×10^{-4}		—
		for **BC 109** Gr. C		3.8×10^{-4}		—

ELECTRICAL CHARACTERISTICS (continued)

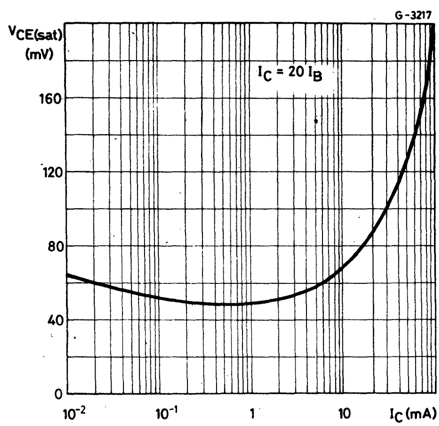
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{oe}	Output admittance	I_C = 2 mA V_{CE} = 5 V f = 1 kHz				
		for **BC 107**		20		µS
		for **BC 107** Gr. A		13		µS
		for **BC 107** Gr. B		26		µS
		for **BC 108**		30		µS
		for **BC 108** Gr. A		13		µS
		for **BC 108** Gr. B		26		µS
		for **BC 108** Gr. C		34		µS
		for **BC 109**		30		µS
		for **BC 109** Gr. B		26		µS
		for **BC 109** Gr. C		34		µS

* Pulsed: pulse duration = 300 µs, duty cycle = 1%

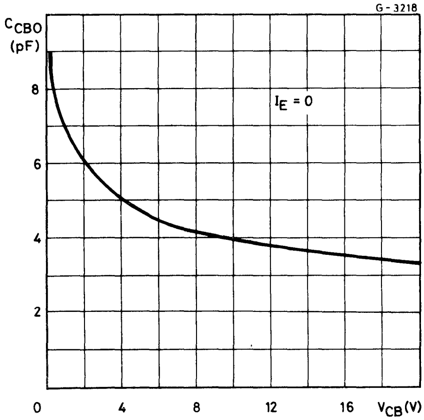
DC normalized current gain



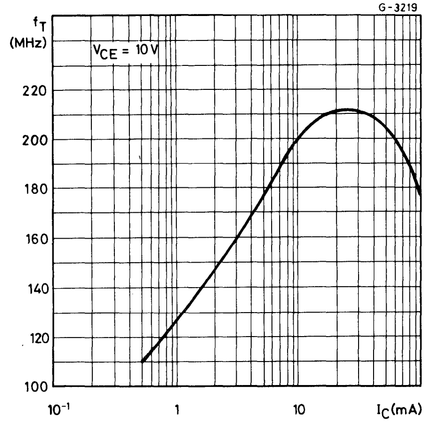
Collector-emitter saturation voltage



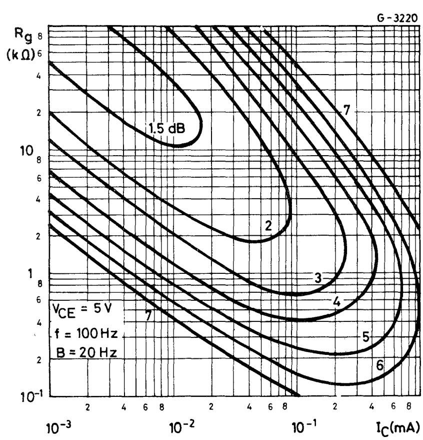
Collector-base capacitance



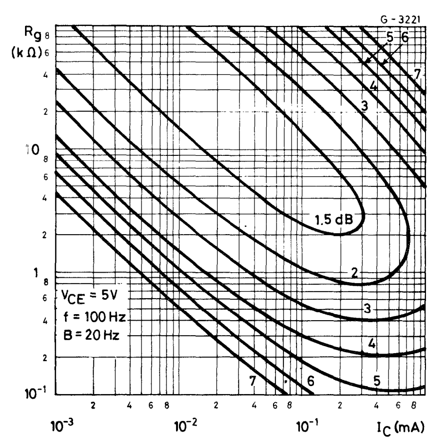
Transition frequency



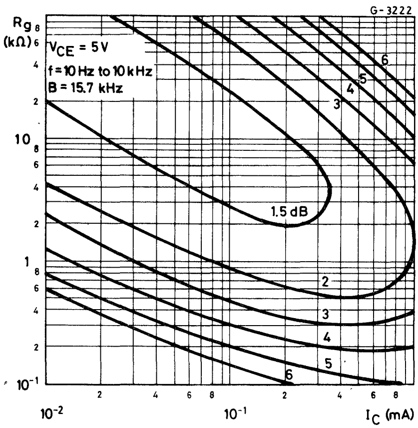
Noise figure (for **BC 109** only)



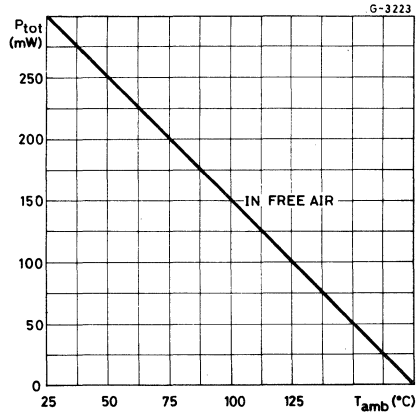
Noise figure (for **BC 109** only)



Noise figure (for **BC 109** only)



Power rating chart



BC 119

SILICON PLANAR NPN

AUDIO OUTPUT AMPLIFIER

The BC 119 is a silicon planar epitaxial NPN transistor in a TO-39 metal case. It is suitable for 1 W class "A" and up to 6 W class "B" audio output stages.

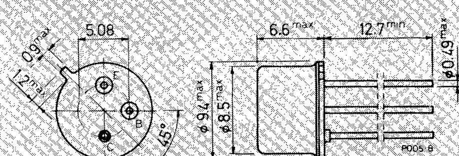
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	0.8	W
	at $T_{case} \leq 25\ °C$	5	W
	at $T_{case} \leq 100\ °C$	2.8	W
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

BC 119

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	35	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	220	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 40$ V $V_{CB} = 40$ V $T_{amb} = 150$ °C			100 20	nA µA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100$ µA	60			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 10$ mA	30			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100$ µA	5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	$I_C = 150$ mA $I_B = 15$ mA $I_C = 500$ mA $I_B = 50$ mA $I_C = 1$ A $I_B = 100$ mA		0.15 0.4 0.8	0.35 1.1 1.5	V V V
V_{BE}*	Base-emitter voltage	$I_C = 500$ mA $V_{CE} = 10$ V $I_C = 150$ mA $V_{CE} = 1$ V		1 0.85	1.8 1	V V
$V_{BE\ (sat)}$*	Base-emitter saturation voltage	$I_C = 150$ mA $I_B = 15$ mA $I_C = 1$ A $I_B = 0.1$ A		0.9 1.4	1.2 2	V V
h_{FE}*	DC current gain	$I_C = 50$ mA $V_{CE} = 1$ V $I_C = 150$ mA $V_{CE} = 1$ V $I_C = 500$ mA $V_{CE} = 10$ V	40 40 25	100 90 60	 120 	— — —
h_{FE_1}/h_{FE_2}	Matched pair	$I_C = 300$ mA $V_{CE} = 5$ V			1.4	—
f_T	Transition frequency	$I_C = 50$ mA $V_{CE} = 10$ V	40			MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10$ V		12	25	pF

* Pulsed: pulse duration = 300 µs, duty cycle = 1%

BC 139

SILICON PLANAR PNP

AUDIO OUTPUT AMPLIFIER

The BC 139 is a silicon planar epitaxial PNP transistor in a TO-39 metal case. It is particularly designed for use in audio output and driver stages. The complementary NPN type is the BC 119.

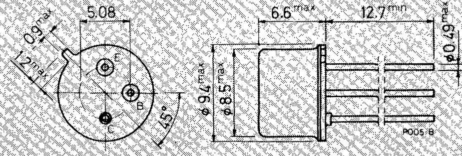
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.7	W
	at $T_{case} \leq 25°C$	3	W
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

THERMAL DATA

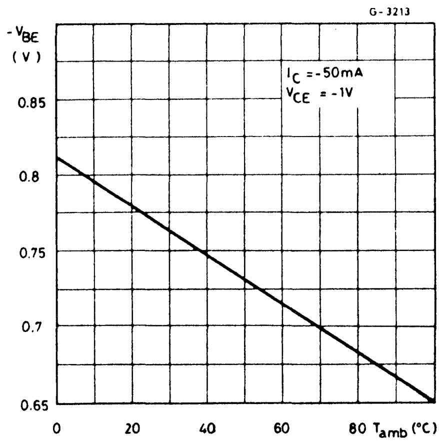
$R_{th\ j-case}$	Thermal resistance junction-case	max	58	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	250	°C/W

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

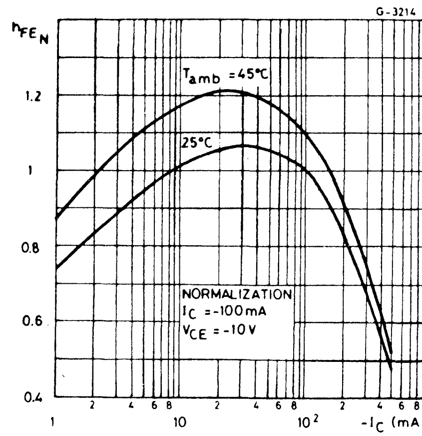
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E= 0)	V_{CB}= -30V V_{CB}= -30V T_{amb}= 75°C			-100 -50	nA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E= 0)	I_C = -10 μA	-40			V
$V_{(BR)CEO}$	*Collector-emitter breakdown voltage (I_B= 0)	I_C = -10 mA	-40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C= 0)	I_E = -10 μA	-5			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = -300 mA I_B = -30 mA		-0.45	-0.8	V
		I_C = -500 mA I_B = -50 mA		-1		V
V_{BE}	Base-emitter voltage	I_C = -10 mA V_{CE}= -10V		-0.7		V
		I_C = -100 mA V_{CE}= -10V		-0.77		V
		I_C = -300 mA V_{CE}= -1V		-0.97		V
h_{FE}*	DC current gain	I_C = -10 mA V_{CE}= -10V		90		–
		I_C = -100 mA V_{CE}= -10V	40	90		–
		I_C = -150 mA V_{CE}= -1V		45		–
		I_C = -300 mA V_{CE}= -1V	20	35		–
f_T	Transition frequency	I_C = -50 mA V_{CE}= -10V		200		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB}= -10V f = 1 MHz		6		pF

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

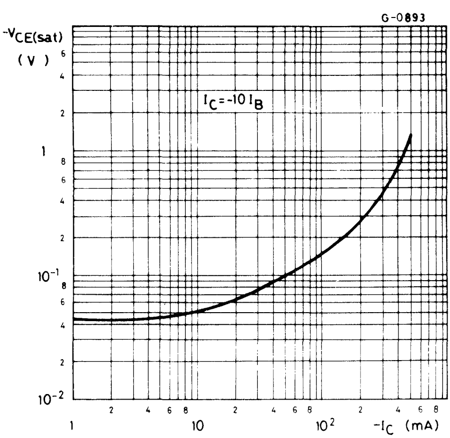
Base-emitter voltage



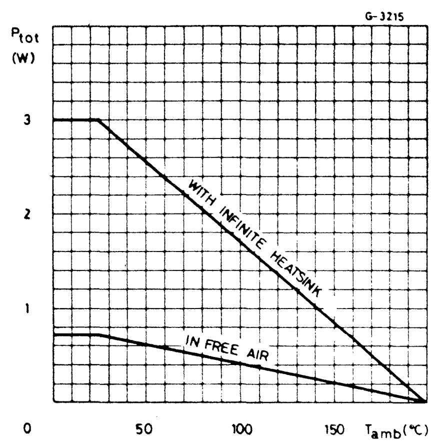
DC normalized current gain



Collector-emitter saturation voltage



Power rating chart



BC 140
BC 141

SILICON PLANAR NPN

GENERAL PURPOSE TRANSISTORS

The BC 140 and BC 141 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are particularly designed for audio amplifiers and switching applications up to 1 A.

The complementary PNP types are the BC 160 and BC 161.*

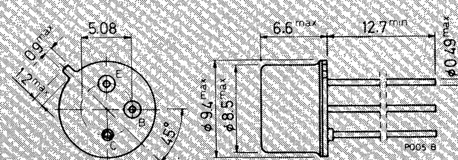
ABSOLUTE MAXIMUM RATINGS

		BC 140	BC 141
V_{CBO}	Collector-base voltage ($I_E = 0$)	60 V	80 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40 V	60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7 V	
I_C	Collector current	1 A	
I_B	Base current	0.1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	0.8 W	
	at $T_{case} \leq 25\ °C$	4 W	
T_{stg}	Storage temperature	-55 to 200 °C	
T_j	Junction temperature	200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

THERMAL DATA

$R_{th\ j-case}$	Thermal resistence junction-case	max	44	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	220	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 50 V			200	nA
		V_{CB} = 50 V T_{amb} = 150°C			200	μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA				
		for **BC 140**	60			V
		for **BC 141**	80			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = 10 mA				
		for **BC 140**	40			V
		for **BC 141**	60			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA	7			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 100 mA I_B = 10 mA		0.1		V
		I_C = 500 mA I_B = 50 mA		0.35		V
		I_C = 1 A I_B = 0.1 A		0.6	1	V
V_{BE}*	Base-emitter voltage	I_C = 1 A V_{CE} = 1 V		1.25	1.6	V

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C = 100 μA V_{CE} = 1 V				
		for **BC 140-141**		75		—
		for **BC 140-141** Gr. 6		28		—
		for **BC 140-141** Gr. 10		40		—
		I_C = 100 mA V_{CE} = 1 V				
		for **BC 140-141**	40	140	250	—
		for **BC 140-141** Gr. 6	40	63	100	—
		for **BC 140-141** Gr. 10	63	100	160	—
		I_C = 1 A V_{CE} = 1 V				
		for **BC 140-141**		26		—
		for **BC 140-141** Gr. 6		15		—
		for **BC 140-141** Gr. 10		20		—
h_{FE_1}/h_{FE_2}	Matched pair ratio	I_C = 100 mA V_{CE} = 1 V			1.25	—
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10 V	50			MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 20 V f = 1 MHz		12		pF
t_{on}	Turn-on time	I_C = 100 mA I_{B1} = 5 mA			250	ns
t_{off}	Turn-off time	I_C = 100 mA I_{B1} = I_{B2} = 5 mA			850	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

BC 160
BC 161

SILICON PLANAR NPN

GENERAL PURPOSE TRANSISTORS

The BC 160 and BC 161 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are particularly designed for audio amplifiers and switching applications up to 1 A.
The complementary NPN types are the BC 140 and BC 141.

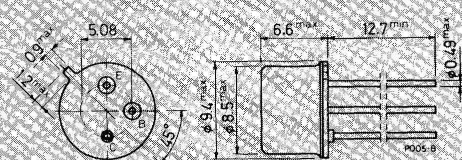
ABSOLUTE MAXIMUM RATINGS

		BC 160	BC 161
V_{CBO}	Collector-base voltage ($I_E = 0$)	-60 V	-80 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40 V	-60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_C	Collector current	-1 A	
I_B	Base current	-0.1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	0.8 W	
	at $T_{case} \leq 25\,°C$	4 W	
T_{stg}	Storage temperature	-55 to 200 °C	
T_j	Junction temperature	200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

BC 160
BC 161

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	44	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	220	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -50 V			-200	nA
		V_{CB} = -50 V T_{amb} = 150°C			-200	μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -100 μA				
		for **BC 160**	-60			V
		for **BC 161**	-80			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = -10 mA				
		for **BC 160**	-40			V
		for **BC 161**	-60			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -100 μA	-5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = -0.1 A I_B = -10 mA		-0.1		V
		I_C = -0.5 A I_B = -50 mA		-0.35		V
		I_C = -1 A I_B = -0.1 A		-0.6	-1	V
V_{BE}*	Base-emitter voltage	I_C = -1 A V_{CE} = -1 V		-1.1	-1.6	V
h_{FE}*	DC current gain	I_C = -100 μA V_{CE} = -1 V				
		for **BC 160-161**		110		—
		for **BC 160-161** Gr. 6		46		—
		for **BC 160-161** Gr. 10		80		—
		I_C = -100 mA V_{CE} = -1 V				
		for **BC 160-161**	40	140	250	—
		for **BC 160-161** Gr. 6	40	63	100	—
		for **BC 160-161** Gr. 10	63	100	160	—
		I_C = -1 A V_{CE} = -1 V				
		for **BC 160-161**		26		—
		for **BC 160-161** Gr. 6		15		—
		for **BC 160-161** Gr. 10		20		—

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE_1}/h_{FE_2}	Matched pair ratio	I_C = -100 mA V_{CE} = -1 V			1.25	—
f_T	Transition frequency	I_C = -50 mA V_{CE} = -10 V	50			MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -20 V f = 1 MHz		15		pF
t_{on}	Turn-on time	I_C = -100 mA I_{B1} = -5 mA			500	ns
t_{off}	Turn-off time	I_C = -100 mA I_{B1} = I_{B2} = -5 mA			650	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

BC 177
BC 178
BC 179

SILICON PLANAR PNP

LOW NOISE GENERAL PURPOSE AUDIO AMPLIFIERS

The BC 177, BC 178 and BC 179 are silicon planar epitaxial PNP transistors in TO-18 metal case. They are suitable for use in driver audio stages, low noise input audio stages and as low power, high gain general purpose transistors. The complementary NPN types are respectively the BC 107, BC 108 and BC 109.

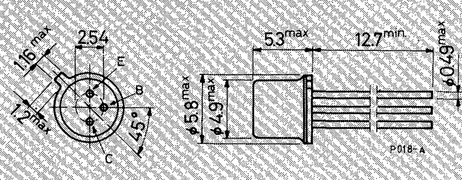
ABSOLUTE MAXIMUM RATINGS

		BC 177	BC 178	BC 179
V_{CBO}	Collector-base voltage ($I_E = 0$)	-50 V	-30 V	-25 V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-45 V	-25 V	-20 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-45 V	-25 V	-20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		-5 V	
I_{EM}	Emitter peak current		200 mA	
I_C	Collector current		-100 mA	
I_{CM}	Collector peak current		-200 mA	
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$		300 mW	
	at $T_{case} \leq 115°C$		300 mW	
T_{stg}	Storage temperature		-65 to 175 °C	
T_j	Junction temperature		175 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	500	°C/W

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

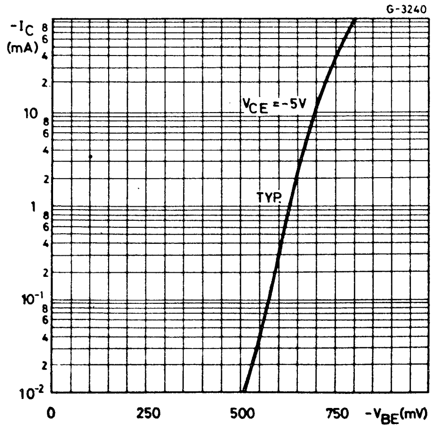
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -20V		-1	-100	nA
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -2 mA				
		for **BC 177**	-45			V
		for **BC 178**	-25			V
		for **BC 179**	-20			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10 µA				
		for **BC 177**	-50			V
		for **BC 178**	-30			V
		for **BC 179**	-25			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 µA	-5			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = -10 mA, I_B = -0.5 mA		-75	-250	mV
		I_C = -100 mA, I_B = -5 mA		-200		mV
V_{BE}	Base-emitter voltage	I_C = -2 mA V_{CE} = -5 V	-600	-640	-750	mV
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = -10 mA, I_B = -0.5 mA		-720		mV
		I_C = -100 mA, I_B = -5 mA		-860		mV
h_{FE}	DC current gain	I_C = -10 µA V_{CE} = -5V	30			–
h_{fe}	Small signal current gain	I_C = -2 mA V_{CE} = -5V, f = 1 kHz				
		for **BC 177** Gr. A	125		260	–
		for **BC 178** Gr. A	125		260	–
		for **BC 178** Gr. B	240		500	–
		for **BC 179** Gr. A	125		260	–
		for **BC 179** Gr. B	240		500	–

ELECTRICAL CHARACTERISTICS (continued)

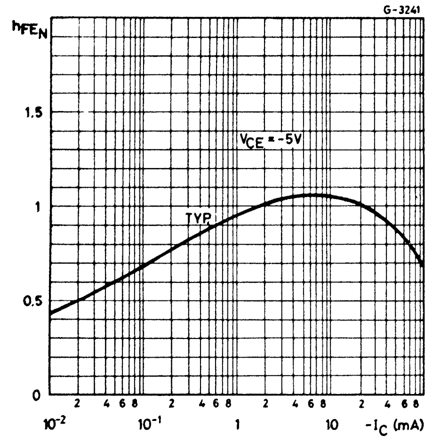
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	I_C = -10 mA V_{CE} = -5V		200		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10V		5.5		pF
NF	Noise figure	I_C = -0.2 mA V_{CE} = -5V R_g = 2 kΩ f = 1 kHz B = 200 Hz				
		for **BC 177**		2	10	dB
		for **BC 178**		2	10	dB
		for **BC 179**		1.2	4	dB
h_{ie}	Input impedance	I_C = -2 mA V_{CE} = -5V f = 1 kHz				
		for **BC 177** Gr. 6		1.5		kΩ
		for **BC 177** Gr. A		2.7		kΩ
		for **BC 178** Gr. 6		1.5		kΩ
		for **BC 178** Gr. A		2.7		kΩ
		for **BC 178** Gr. B		5.2		kΩ
		for **BC 179** Gr. A		2.7		kΩ
		for **BC 179** Gr. B		5.2		kΩ
h_{re}	Reverse voltage ratio	I_C = -2 mA V_{CE} = -5V f = 1 kHz				
		for **BC 177** Gr. 6		$1.8 \cdot 10^{-4}$		–
		for **BC 177** Gr. A		$2.7 \cdot 10^{-4}$		–
		for **BC 178** Gr. 6		$1.8 \cdot 10^{-4}$		–
		for **BC 178** Gr. A		$2.7 \cdot 10^{-4}$		–
		for **BC 178** Gr. B		$4.5 \cdot 10^{-4}$		–
		for **BC 179** Gr. A		$2.7 \cdot 10^{-4}$		–
		for **BC 179** Gr. B		$4.5 \cdot 10^{-4}$		–
h_{oe}	Output admittance	I_C = -2 mA V_{CE} = -5V f = 1 kHz				
		for **BC 177** Gr. 6		20		µS
		for **BC 177** Gr. A		25		µS
		for **BC 178** Gr. 6		20		µS
		for **BC 178** Gr. A		25		µS
		for **BC 178** Gr. B		35		µS
		for **BC 179** Gr. A		25		µS
		for **BC 179** Gr. B		35		µS

* Pulsed: pulse duration = 300 µs , duty cycle = 1%.

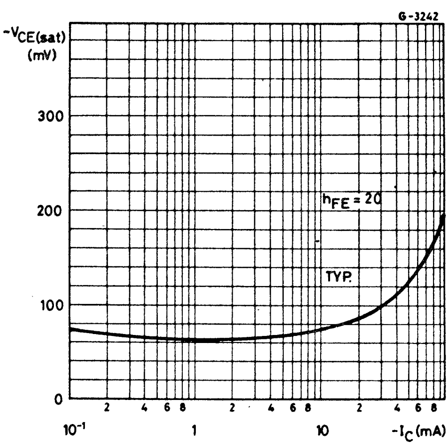
DC transconductance



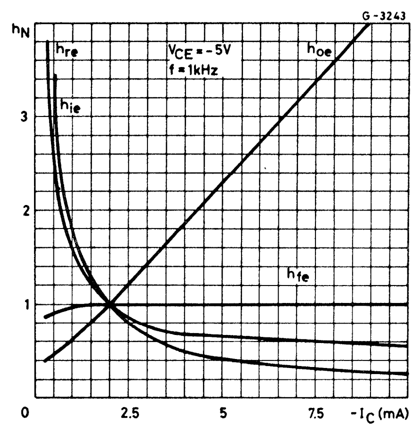
DC normalized current gain



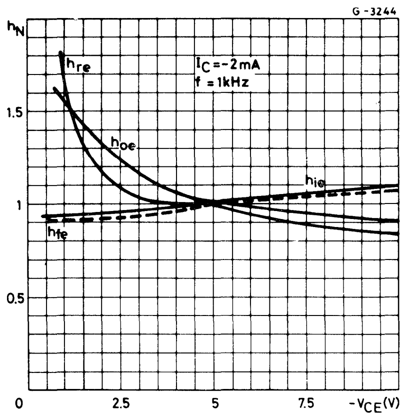
Collector-emitter saturation voltage



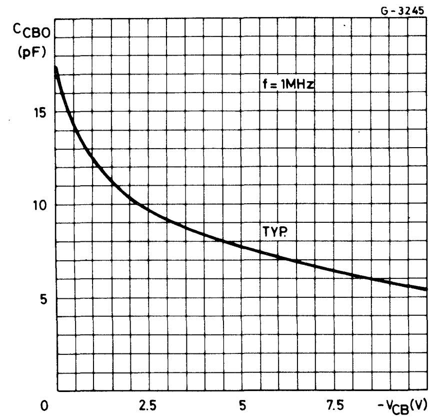
Typical normalized h parameters



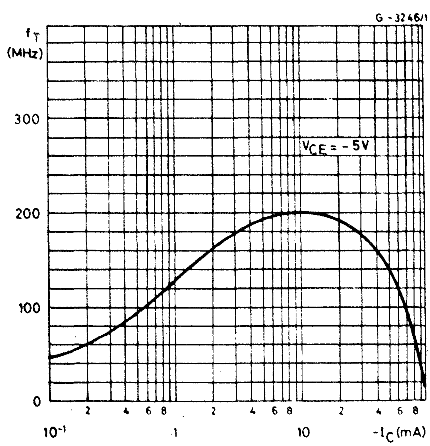
Typical normalized h parameters



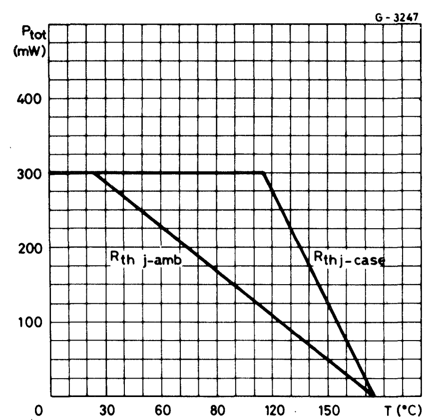
Collector-base capacitance



Transition frequency



Power rating chart



SILICON PLANAR PNP

BC 297
BC 298

AUDIO DRIVERS OR OUTPUT STAGES

The BC 297 and BC 298 are silicon planar epitaxial PNP transistors in TO-18 metal case. They are particularly intended for use in high current high gain applications, in driver stages of hi-fi equipments or in output stages of low power class B amplifiers.

The complementary NPN types are the BC 377 and BC 378, respectively.

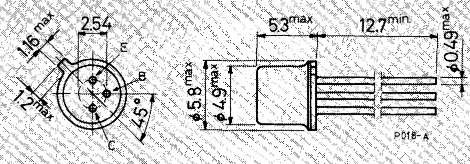
ABSOLUTE MAXIMUM RATINGS

		BC 297	BC 298
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-50 V	-30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-45 V	-25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_E	Emitter current	1.2 A	
I_C	Collector current	-1 A	
I_B	Base current	-0.2 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	375 mW	
	at $T_{case} \leq 75$ °C	1 W	
T_{stg}	Storage temperature	-65 to 175 °C	
T_j	Junction temperature	175 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

BC 297
BC 298

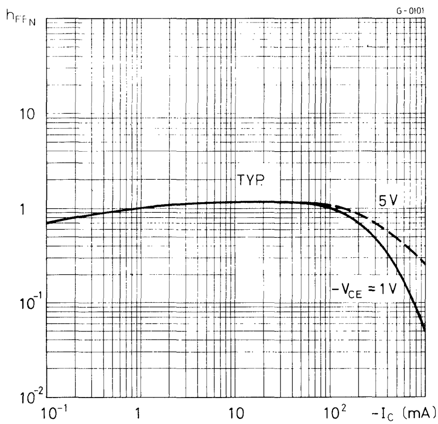
THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	100	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	400	°C/W

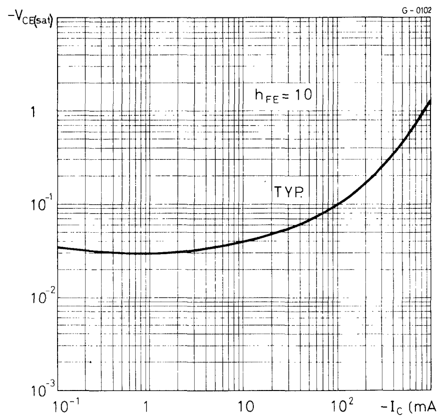
ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **BC 297** V_{CE} = -50 V			-100	nA
		for **BC 298** V_{CE} = -30 V			-100	nA
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = -10 mA for **BC 297**	-45			V
		for **BC 298**	-25			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA	-5			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	I_C = -500 mA I_B = -50 mA			-0.7	V
V_{BE}	Base-emitter voltage	I_C = -100 mA V_{CE} = -1 V		-770		mV
$V_{BE\ (sat)}$	Base-emitter saturation voltage	I_C = -500 mA I_B = -50 mA			-1.2	V
h_{FE}	DC current gain Gr. 6	I_C = -100 mA V_{CE} = -1 V	75		150	—
	Gr. 7	I_C = -100 mA V_{CE} = -1 V	125		260	—
		I_C = -300 mA V_{CE} = -1 V	30			—
h_{FE_1}/h_{FE_2}	Matched pair ratio	I_C = -100 mA V_{CE} = -1 V			1.41	—
f_T	Transition frequency	I_C = -50 mA V_{CE} = -10 V		250		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10 V		8		pF
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -0.5 V		30		pF

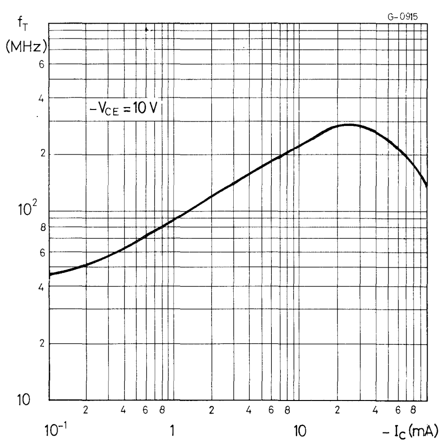
DC normalized current gain



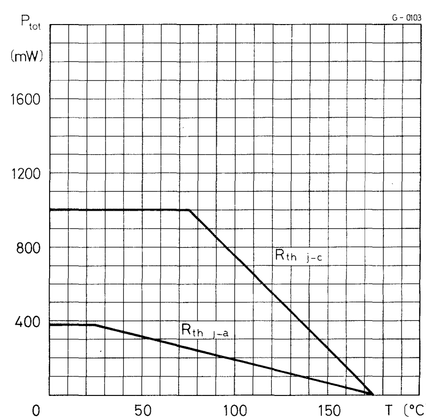
Collector-emitter saturation voltage



Typical transition frequency



Power rating chart



BC 300
BC 301
BC 302

SILICON PLANAR NPN

MEDIUM POWER AUDIO DRIVERS

The BC 300, BC 301 and BC 302 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are intended for audio driver stages in commercial and industrial equipments. In addition they are useful as high speed saturated switches and general purpose amplifiers. The PNP types complementary to BC 301 and BC 302 are respectively the BC 303 and BC 304.

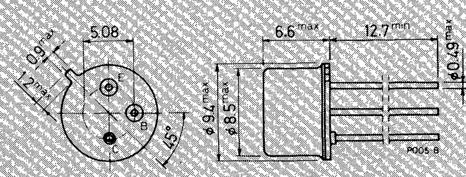
ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	BC 300	BC 301	BC 302
V_{CBO}	Collector-base voltage ($I_E = 0$)	120 V	90 V	60 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	80 V	60 V	45 V
V_{CEV}	Collector-emitter voltage ($V_{BE} = -1.5$ V)	120 V	90 V	—
V_{EBO}	Emitter-base voltage ($I_C = 0$)		7 V	
I_C	Collector current		0.5 A	
I_{CM}	Collector peak current		1 A	
I_{BM}	Base peak current		0.5 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C		0.85 W	
	at $T_{case} \leq 25$ °C		6 W	
T_{stg}	Storage temperature		-65 to 175 °C	
T_j	Junction temperature		175 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	25	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

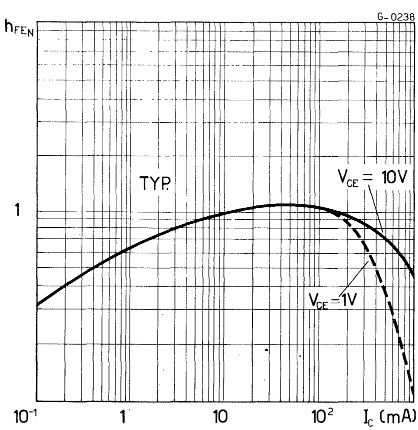
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 60$ V		5	20	nA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = 7$ V			20	nA
$V_{CEO(sus)}$*	Collector-emitter voltage ($I_B = 0$)	$I_C = 10$ mA				
		for **BC 300**	80			V
		for **BC 301**	60			V
		for **BC 302**	45			V
$V_{CEV(sus)}$*	Collector-emitter voltage	$I_C = 10$ mA $V_{BE} = -1.5$ V				
		for **BC 300**	120			V
		for **BC 301**	90			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$I_C = 150$ mA $I_B = 15$ mA		0.2	0.5	V
V_{BE}	Base-emitter voltage	$I_C = 150$ mA $V_{CE} = 10$ V		0.78		V
h_{FE}	DC current gain Gr. 4	$I_C = 150$ mA $V_{CE} = 10$ V	40		80	—
	Gr. 5	$I_C = 150$ mA $V_{CE} = 10$ V	70		140	—
	Gr. 6	$I_C = 150$ mA $V_{CE} = 10$ V	120		240	—
		$I_C = 0.1$ mA $V_{CE} = 10$ V	20			—
		$I_C = 500$ mA $V_{CE} = 10$ V	20			—
f_T	Transition frequency	$I_C = 10$ mA $V_{CE} = 10$ V		120		MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10$ V		10		pF
h_{ie}	Input impedance	$I_C = 5$ mA $V_{CE} = 10$ V, f = 1 kHz		1.1		kΩ

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

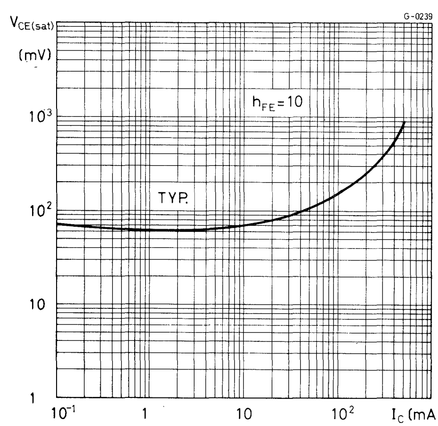
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
h_{re}	Reverse voltage ratio	I_C = 5 mA V_{CE} = 10 V f = 1 kHz	$1.7x10^{-4}$	—
h_{fe}	Small signal current gain	I_C = 5 mA V_{CE} = 10 V f = 1 kHz	140	—
h_{oe}	Output admittance	I_C = 5 mA V_{CE} = 10 V f = 1 kHz	14	μS

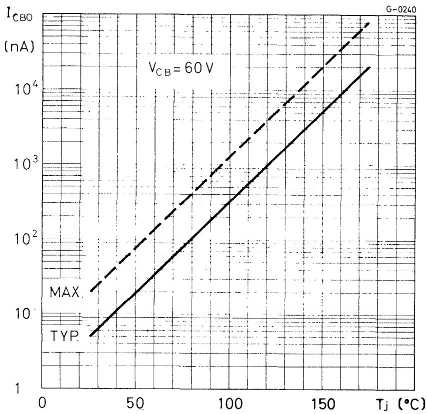
DC normalized current gain



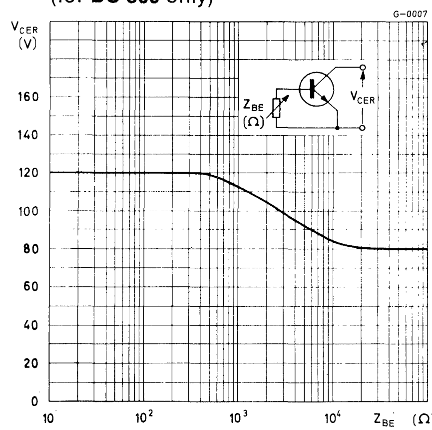
Collector-emitter saturation voltage



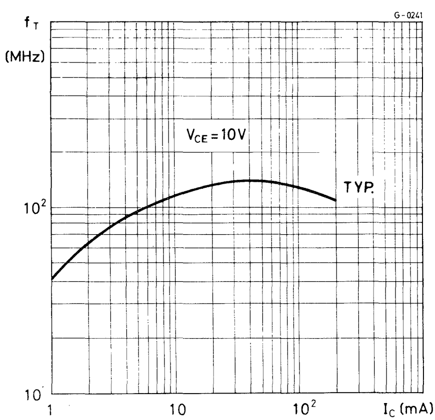
Collector cutoff current



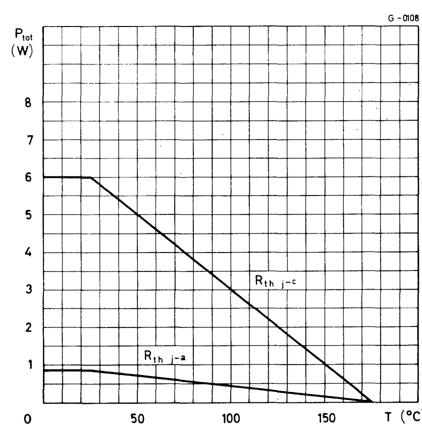
Collector-emitter breakdown voltage (for **BC 300** only)



Transition frequency



Power rating chart



BC 303
BC 304

SILICON PLANAR PNP

MEDIUM POWER AUDIO DRIVERS

The BC 303 and BC 304 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are intended particularly as audio driver stages in commercial and professional equipments. In addition they are useful as high speed saturated switches and general purpose amplifiers. The complementary NPN types are respectively the BC 301 and BC 302.

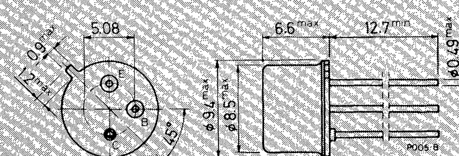
ABSOLUTE MAXIMUM RATINGS

		BC 303	BC 304
V_{CBO}	Collector-base voltage ($I_E = 0$)	-85 V	-60 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-60 V	-45 V
V_{CEV}	Collector-emitter voltage ($V_{BE} = 1.5V$)	-85 V	—
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-7 V	
I_C	Collector current	-0.5 A	
I_{CM}	Collector peak current	-1 A	
I_{BM}	Base peak current	-0.5 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.85 W	
	at $T_{case} \leq 25°C$	6 W	
T_{stg}	Storage temperature	-65 to 175 °C	
T_j	Junction temperature	175 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

BC 303
BC 304

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	25	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	175	°C/W

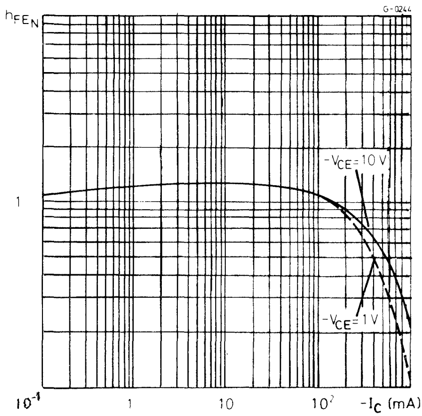
ELECTRICAL CHARACTERISTICS (T_{case} = 25°C unless otherwise specified)

Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -60V			-5	-20	nA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -5V				-20	nA
$V_{CEO\ (sus)}$*	Collector-emitter voltage (I_B = 0)	I_C = -10 mA	for **BC 303**	-60			V
			for **BC 304**	-45			V
$V_{CEV\ (sus)}$*	Collector-emitter voltage (for **BC 303** only)	I_C = -10 mA	V_{BE} = 1.5V	-85			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	I_C = -150 mA I_B = -15 mA			-0.25	-0.65	V
V_{BE}	Base-emitter voltage	I_C = -150 mA	V_{CE} = -10V		-0.78		V
h_{FE}	DC current gain Gr. 4	I_C = -150 mA	V_{CE} = -10V	40		80	–
	Gr. 5	I_C = -150 mA	V_{CE} = -10V	70		140	–
	Gr. 6	I_C = -150 mA	V_{CE} = -10V	120		240	–
		I_C = -0.1 mA	V_{CE} = -10V	20			–
		I_C = -500 mA	V_{CE} = -10V	20			–
f_T	Transition frequency	I_C = -10 mA	V_{CE} = -10V		75		MHz
C_{CBO}	Collector-base capacitance	I_E = 0	V_{CB} = -10V		15		pF
h_{ie}	Input impedance	I_C = -5 mA f = 1 kHz	V_{CE} = -10V		0.9		kΩ
h_{re}	Reverse voltage ratio	I_C = -5 mA f = 1 kHz	V_{CE} = -10V		$1.7 \cdot 10^{-4}$		–
h_{fe}	Small signal current gain	I_C = -5 mA f = 1 kHz	V_{CE} = -10V		140		–
h_{oe}	Output admittance	I_C = -5 mA f = 1 kHz	V_{CE} = -10V		45		μS

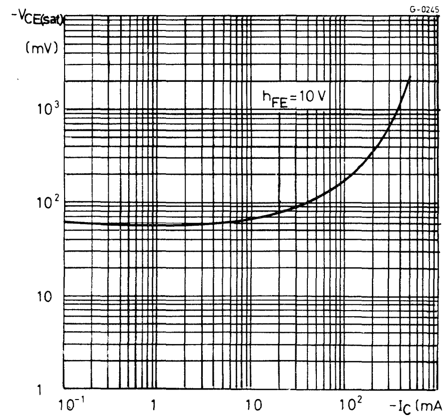
* Pulsed: pulse duration = 300 μs, duty cycle = 1%

BC 303
BC 304

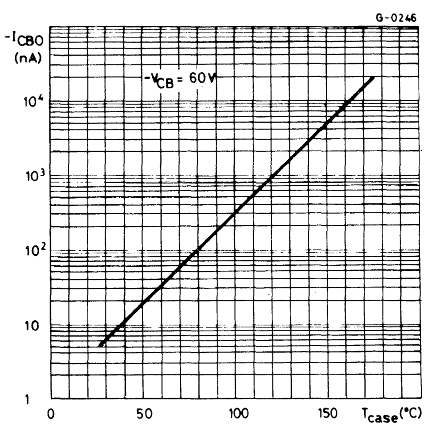
DC normalized current gain



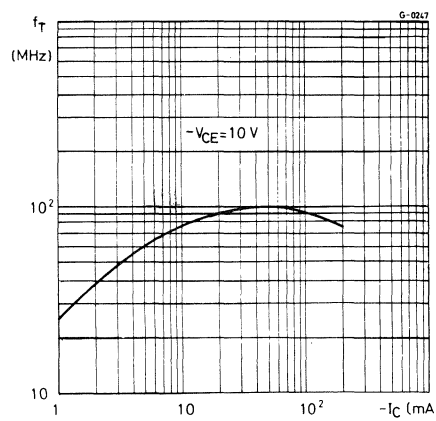
Collector-emitter saturation voltage



Collector cutoff current



Transition frequency



SILICON PLANAR NPN

BC 377
BC 378

AUDIO DRIVERS OR OUTPUT STAGES

The BC 377 and BC 378 are silicon planar epitaxial NPN transistors in TO-18 metal case. They are particularly intended for use in high current, high gain applications, in driver stages of hi-fi equipments or in output stages of low power class B amplifiers. The complementary PNP types are the BC 297 and BC 298, respectively.

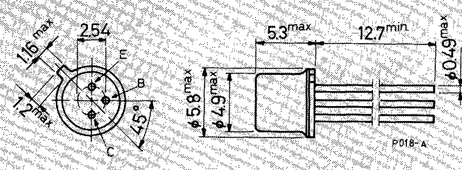
ABSOLUTE MAXIMUM RATINGS

		BC 377	BC 378
V_{CES}	Collector-emitter voltage ($V_{EB} = 0$)	50 V	30 V
→ V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40 V	25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6 V	
I_E	Emitter current	-1.2 A	
I_C	Collector current	1 A	
I_B	Base current	0.2 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\,°C$	375 mW	
	at $T_{case} \leq 75\,°C$	1 W	
T_{stg}	Storage temperature	-65 to 175 °C	
T_j	Junction temperature	175 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

BC 377
BC 378

THERMAL DATA

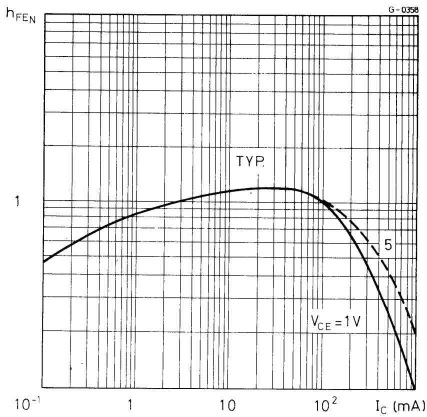
$R_{th\ j-case}$	Thermal resistance junction-case	max	100	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	400	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

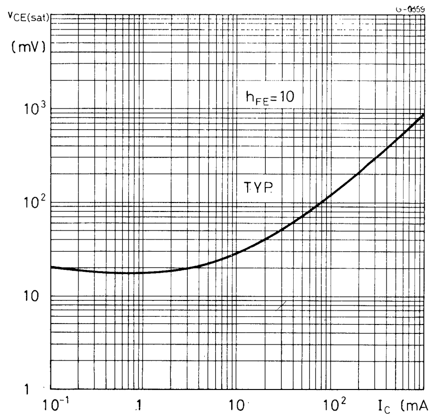
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **BC 377** V_{CE} = 50 V for **BC 378** V_{CE} = 30 V			15 15	nA nA
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA	6			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 2 mA for **BC 377** for **BC 378**	40 25			V V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	I_C = 500 mA I_B = 50 mA			0.7	V
V_{BE}	Base-emitter voltage	I_C = 100 mA V_{CE} = 1 V		740		mV
$V_{BE\ (sat)}$	Base-emitter saturation voltage	I_C = 500 mA I_B = 50 mA			1.2	V
h_{FE}	DC current gain Gr. 6 Gr. 7	I_C = 100 mA V_{CE} = 1 V I_C = 100 mA V_{CE} = 1 V I_C = 300 mA V_{CE} = 1 V	75 125		150 260	— — —
h_{FE_1}/h_{FE_2}	Matched pair ratio	I_C = 100 mA V_{CE} = 1 V			1.41	—
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10 V		300		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10 V		8		pF
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5 V		30		pF

BC 377
BC 378

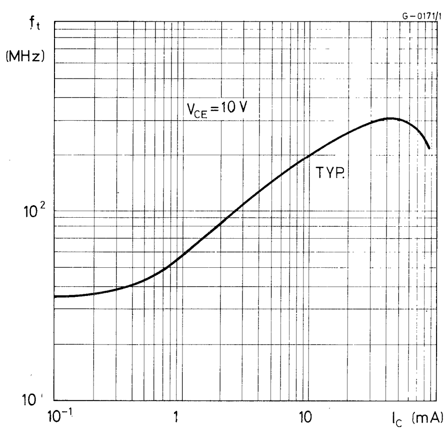
DC normalized current gain



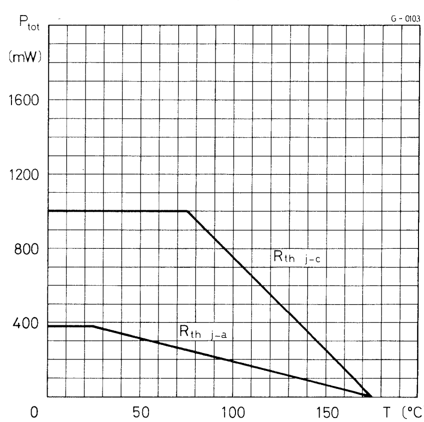
Collector-emitter saturation voltage



Transition frequency



Power rating chart



BC 393

SILICON PLANAR PNP

HIGH VOLTAGE AMPLIFIER

The BC 393 is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case, designed for general purpose high-voltage and video amplifier applications.
The complementary NPN type is the BC 394.

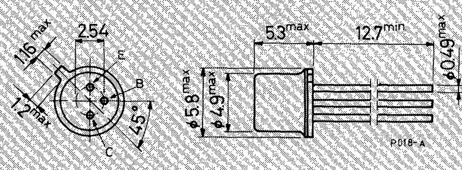
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-180	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-180	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-6	V
I_C	Collector current	-100	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25\ °C$	0.4	W
	at $T_{case} \leqslant 25\ °C$	1.4	W
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	440	°C/W

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

Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB}= -100V				50	nA
		V_{CB}= -100V	T_{amb}= 150 °C			50	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10 μA		-180			V
$V_{CEO\,(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = -2 mA		-180			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -10 μA		-6			V
$V_{CE\,(sat)}$	Collector-emitter saturation voltage	I_C = -10 mA	I_B = -1 mA		-100	-300	mV
		I_C = -50 mA	I_B = -5 mA		-230		mV
$V_{BE\,(sat)}$	Base-emitter saturation voltage	I_C = -10 mA	I_B = -1 mA		-750	-900	mV
		I_C = -50 mA	I_B = -5 mA		-850		mV
h_{FE}*	DC current gain	I_C = -1 mA	V_{CE}= -10V		140		–
		I_C = -10 mA	V_{CE}= -10V	50	150		–
f_T	Transition frequency	I_C = -10 mA	V_{CE}= -10V	50	120		MHz
C_{CBO}	Collector-base capacitance	I_E = 0	V_{CB}= -10V				
		f = 1 MHz			4	7	pF

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

BC 394

SILICON PLANAR NPN

HIGH VOLTAGE AMPLIFIER

The BC 394 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, designed for general purpose high-voltage and video amplifier applications.
The complementary PNP type is the BC 393.

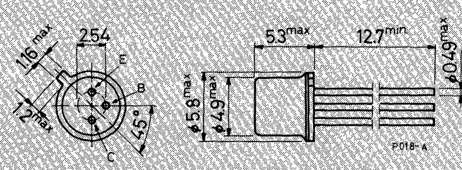
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	180	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	180	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6	V
I_C	Collector current	100	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25$ °C	0.4	W
	at $T_{case} \leqslant 25$ °C	1.4	W
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	440	°C/W

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

Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 100V				50	nA
		V_{CB} = 100V	T_{amb} = 150 °C			50	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA		180			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 10 mA		180			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA		6			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 10 mA	I_B = 1 mA		200	300	mV
		I_C = 50 mA	I_B = 5 mA		400		mV
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = 10 mA	I_B = 1 mA		750	900	mV
		I_C = 50 mA	I_B = 5 mA		850		mV
h_{FE}*	DC current gain	I_C = 1 mA	V_{CE} = 10V		80		–
		I_C = 10 mA	V_{CE} = 10V	30	90		–
f_T	Transition frequency	I_C = 10 mA	V_{CE} = 10V	50	90		MHz
C_{CBO}	Collector-base capacitance	I_E = 0, f = 1 MHz	V_{CB} = 10V		5		pF

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

BC 440
BC 441

SILICON PLANAR NPN

MEDIUM POWER AMPLIFIER

The BC 440 and BC 441 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are intended for general purpose applications, especially for driver stages.
The complementary PNP types are respectively the BC 460 and BC 461.

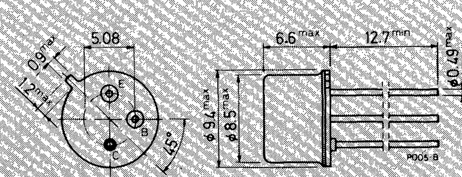
ABSOLUTE MAXIMUM RATINGS

		BC 440	BC 441
V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V	75 V
$V_{CEO\ (sus)}$	Collector-emitter voltage ($I_B = 0$)	40 V	60 V
V_{CER}	Collector-emitter voltage ($R_{BE} \leq 100\ \Omega$)	50 V	75 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V	
I_{CM}	Collector peak current	2 A	
I_{BM}	Base peak current	1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	1 W	
	at $T_{case} \leq 25\ °C$	10 W	
T_{stg}	Storage temperature	-65 to 200 °C	
T_j	Junction temperature	200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

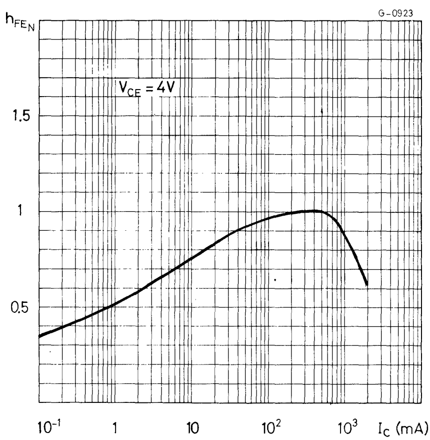
ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 40 V			100	nA
I_{CER}	Collector cutoff current (R_{BE} = 100 Ω)	for **BC 440** V_{CE} = 50 V for **BC 441** V_{CE} = 70 V			10 10	μA μA
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA	5			V
$V_{CEO(sus)}$*	Collector-emitter voltage ($I_B = 0$)	I_C = 10 mA for **BC 440** for **BC 441**	40 60			V V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 1 A I_B = 100 mA			1	V
$V_{BE\ (sat)}$*	Base-emitter saturation voltage	I_C = 1 A I_B = 100 mA			1.5	V
h_{FE}*	DC current gain Gr. 4	I_C = 500 mA V_{CE} = 4 V	40		70	—
	Gr. 5	I_C = 500 mA V_{CE} = 4 V	60		130	—
	Gr. 6	I_C = 500 mA V_{CE} = 4 V	115		250	—
		I_C = 1 A V_{CE} = 2 V (for **BC 440** only)	20			—
h_{FE_1}/h_{FE_2}	Matched pair ratio	I_C = 500 mA V_{CE} = 4 V			1.4	—
f_T	Transition frequency	I_C = 50 mA V_{CE} = 4 V	50			MHz

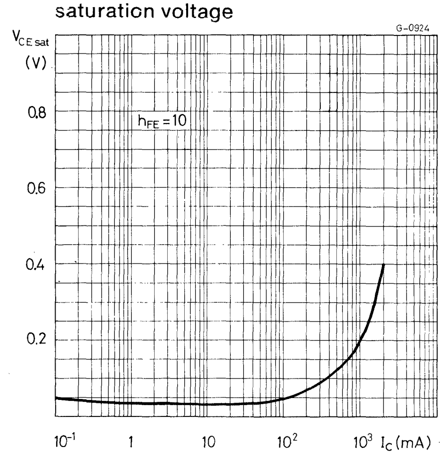
* Pulsed: pulse duration = 300 μs, duty cycle = 1%

BC 440
BC 441

Typical DC normalized current gain



Typical collector-emitter saturation voltage



SILICON PLANAR PNP

BC 460
BC 461

MEDIUM POWER AMPLIFIER

The BC 460 and BC 461 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are intended for general purpose applications, especially for driver stages.

The complementary NPN types are respectively the BC 440 and BC 441.

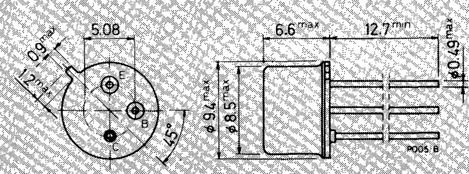
ABSOLUTE MAXIMUM RATINGS

		BC 460	BC 461
V_{CBO}	Collector-base voltage ($I_E = 0$)	-50 V	-75 V
$V_{CEO\,(sus)}$	Collector-emitter voltage ($I_B = 0$)	-40 V	-60 V
V_{CER}	Collector-emitter voltage ($R_{BE} \leq 100\ \Omega$)	-50 V	-75 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_{CM}	Collector peak current	-2 A	
I_{BM}	Base peak current	-1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	1 W	
	at $T_{case} \leq 25\ °C$	10 W	
T_{stg}	Storage temperature	-65 to 200 °C	
T_j	Junction temperature	200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

BC 460
BC 461

THERMAL DATA

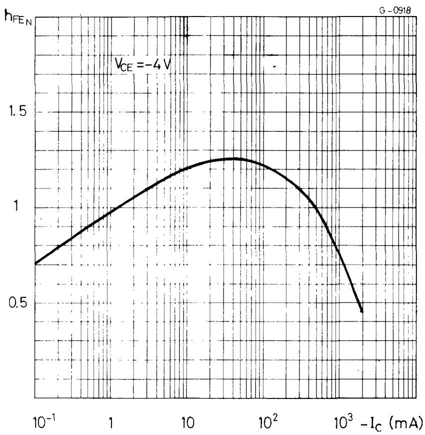
$R_{th\ j-case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

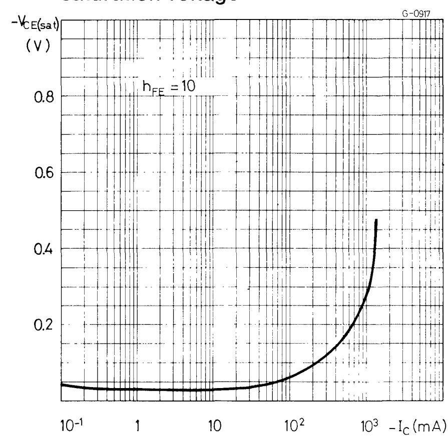
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -40 V			-100	nA
I_{CER}	Collector cutoff current (R_{BE} = 100 Ω)	for **BC 460** V_{CE} = -50 V for **BC 461** V_{CE} = -70 V			-10 -10	μA μA
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -100 μA	-5			V
$V_{CEO(sus)}^{*}$	Collector-emitter voltage ($I_B = 0$)	I_C = -10 mA for **BC 460** for **BC 461**	-40 -60			V V
$V_{CE\ (sat)}^{*}$	Collector-emitter saturation voltage	I_C = -1 A I_B = -100 mA			-1	V
$V_{BE\ (sat)}^{*}$	Base-emitter saturation voltage	I_C = -1 A I_B = -100 mA			-1.5	V
h_{FE}^{*}	DC current gain Gr. 4	I_C = -500 mA V_{CE} = -4 V	40		70	—
	Gr. 5	I_C = -500 mA V_{CE} = -4 V	60		130	—
	Gr. 6	I_C = -500 mA V_{CE} = -4 V	115		250	—
		I_C = -1 A V_{CE} = -2 V (for **BC 460** only)	20			—
h_{FE_1}/h_{FE_2}	Matched pair ratio	I_C = -500 mA V_{CE} = -4 V			1.4	—
f_T	Transition frequency	I_C = -50 mA V_{CE} = -4 V	50			MHz

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

Typical DC normalized current gain



Typical collector-emitter saturation voltage



BC 477
BC 478
BC 479

SILICON PLANAR PNP

LOW NOISE GENERAL PURPOSE AUDIO AMPLIFIERS

The BC 477, BC 478 and BC 479 are silicon planar epitaxial PNP transistors in TO-18 metal case.

The BC 477 is a high voltage type designed for use in audio amplifiers or driver stages, and in the signal processing circuits of TV sets. The BC 478 and BC 479 are respectively low noise and very low noise types, designed for general preamplifier or amplifier applications.

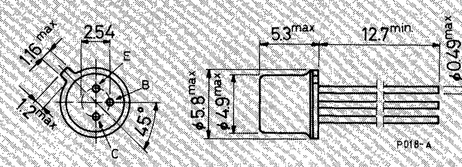
ABSOLUTE MAXIMUM RATINGS

		BC 477	BC 478	BC 479
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-90 V	-50 V	-40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-80 V	-50 V	-40 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		-6 V	
I_C	Collector current		-150 mA	
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C		0.36 W	
	at $T_{case} \leq 25$ °C		1.2 W	
T_{stg}	Storage temperature		-55 to 200 °C	
T_j	Junction temperature		200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	480	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **BC 477**				
		V_{CE} = -70 V			-10	nA
		V_{CE} = -70 V T_{amb} = 125°C			-10	μA
		for **BC 478**				
		V_{CE} = -40 V			-10	nA
		V_{CE} = -40 V T_{amb} = 125°C			-10	μA
		for **BC 479**				
		V_{CE} = -30 V			-10	nA
		V_{CE} = -30 V T_{amb} = 125°C			-10	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -4 V			-10	nA
$V_{(BR)\ CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10 μA				
		for **BC 477**	-90			V
		for **BC 478**	-50			V
		for **BC 479**	-40			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -5 mA				
		for **BC 477**	-80			V
		for **BC 478**	-50			V
		for **BC 479**	-40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA	-6			V

ELECTRICAL CHARACTERISTICS (continued)

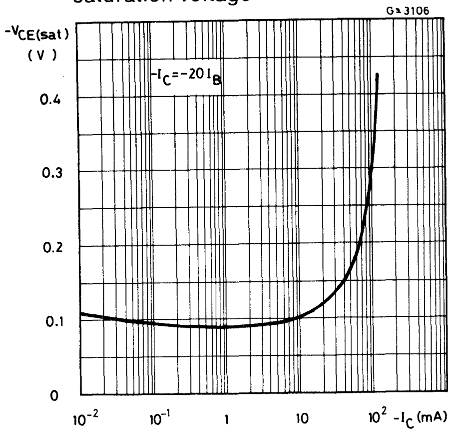
Parameter		Test conditions	Min.	Typ.	Max.	Unit
$V_{CE\,(sat)}$*	Collector-emitter saturation voltage	I_C = -10 mA, I_B = -0.5 mA		-0.1	-0.25	V
		I_C = -100 mA, I_B = -5 mA		-0.3		V
V_{BE}*	Base-emitter voltage	I_C = -2 mA V_{CE} = -5 V	-0.55	-0.65	-0.75	V
$V_{BE\,(sat)}$*	Base-emitter saturation voltage	I_C = -10 mA, I_B = -0.5 mA		-0.75	-0.9	V
		I_C = -100 mA, I_B = -5 mA		-0.9		V
h_{FE}*	DC current gain	I_C = -10 µA V_{CE} = -5 V				
		for **BC 477**	30	115		—
		for **BC 477** Gr. VI	30	70		—
		for **BC 477** Gr. A	50	130		—
		for **BC 478**	50	195		—
		for **BC 478** Gr. A	50	130		—
		for **BC 478** Gr. B	100	250		—
		for **BC 479**	100	290		—
		for **BC 479** Gr. B	100	250		—
		I_C = -2 mA V_{CE} = -5 V				
		for **BC 477**	70		250	—
		for **BC 477** Gr. VI	70		130	—
		for **BC 477** Gr. A	110		250	—
		for **BC 478**	110		450	—
		for **BC 478** Gr. A	110		250	—
		for **BC 478** Gr. B	220		450	—
		for **BC 479**	220			—
		for **BC 479** Gr. B	220		450	—
		I_C = -10 mA V_{CE} = -5 V				
		for **BC 477**		160		—
		for **BC 477** Gr. VI		100		—
		for **BC 477** Gr. A		180		—
		for **BC 478**		270		—
		for **BC 478** Gr. A		180		—
		for **BC 478** Gr. B		350		—
		for **BC 479**		400		—
		for **BC 479** Gr. B		350		—

* Pulsed: pulse duration = 300 µs, duty cycle = 1%

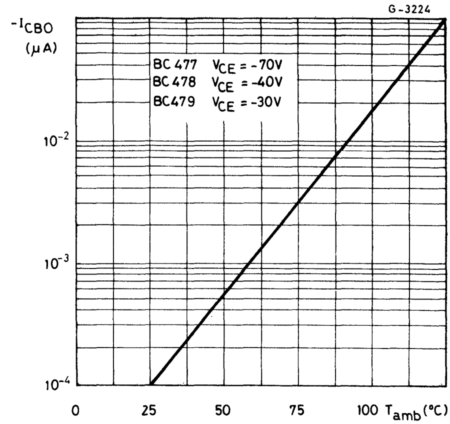
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	I_C = -2 mA V_{CE} = -5 V f = 1 kHz				
		for **BC 477**	75		260	—
		for **BC 477** Gr. VI	75		150	—
		for **BC 477** Gr. A	125		260	—
		for **BC 478**	125		500	—
		for **BC 478** Gr. A	125		260	—
		for **BC 478** Gr. B	240		500	—
		for **BC 479**	240			—
		for **BC 479** Gr. B	240		500	—
		I_C = -10 mA V_{CE} = -5 V f = 20 MHz		7.5		—
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -5 V		4	6	pF
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -0.5 V		11	15	pF
NF	Noise figure	I_C = -20 μA V_{CE} = -5 V R_g = 10 kΩ f = 10 Hz to 10 kHz B = 15.7 kHz				
		for **BC 479**		0.8	3.5	dB
		I_C = -200 μA V_{CE} = -5 V R_g = 2 kΩ f = 10 Hz to 10 kHz B = 15.7 kHz				
		for **BC 478**		1.5		dB
		for **BC 479**		1	4	dB
		I_C = -20 μA V_{CE} = -5 V R_g = 10 kΩ f = 1 kHz B = 200 Hz				
		for **BC 479**		0.5	2.5	dB
		I_C = -200 μA V_{CE} = -5 V R_g = 2 kΩ f = 1 kHz B = 200 Hz				
		for **BC 477**		2	10	dB
		for **BC 478**		1.2	6	dB
		for **BC 479**		0.8	4	dB

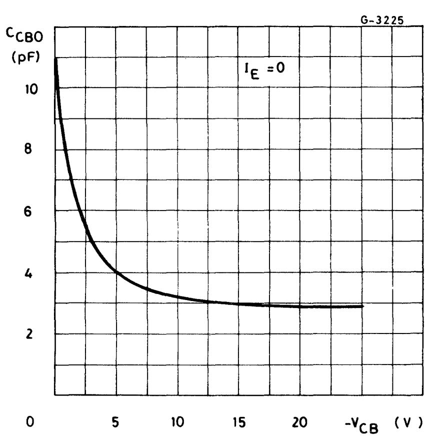
Typical collector-emitter saturation voltage



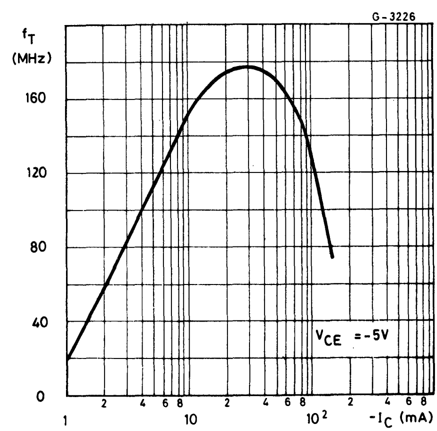
Typical collector cutoff current



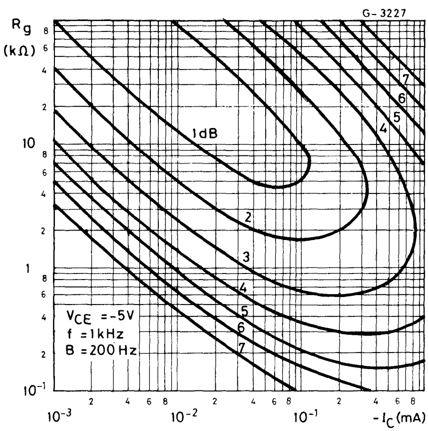
Typical collector-base capacitance



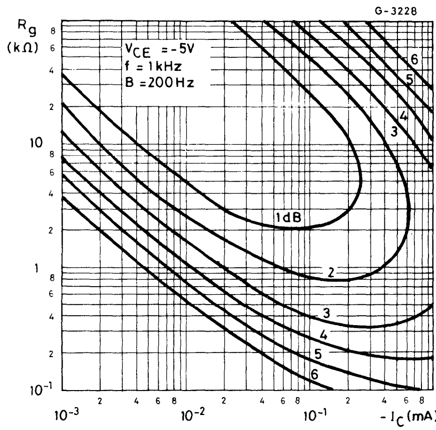
Transition frequency



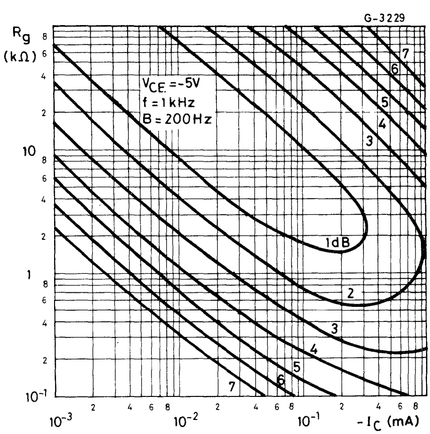
Noise figure (for **BC 477** only)



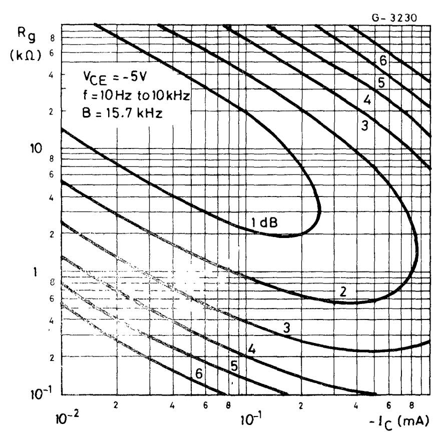
Noise figure (for **BC 478** only)



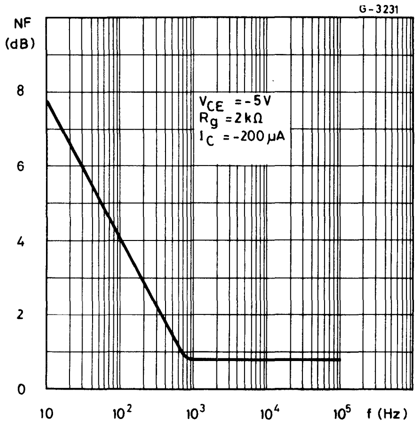
Noise figure (for **BC 479** only)



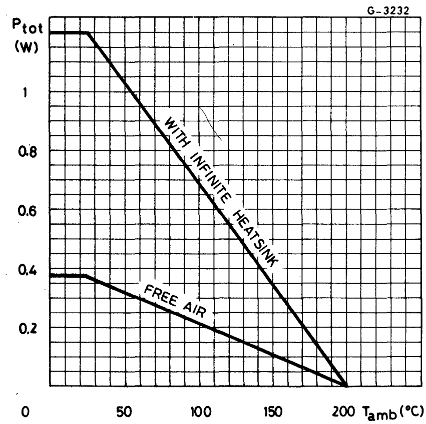
Noise figure (for **BC 479** only)



Noise figure vs. frequency (for **BC 479** only)



Power rating chart



SILICON PLANAR NPN

BCY 58
BCY 59

LOW-NOISE AUDIO AMPLIFIERS

The BCY58 and BCY59 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case.
They are intended for use in audio input stages, driver stages and low-noise input stages.
The complementary PNP types are respectively the BCY 78 and BCY 79.

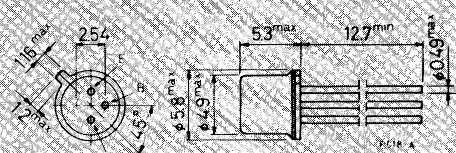
ABSOLUTE MAXIMUM RATINGS

		BCY 58	BCY 59
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	32 V	45 V
V_{CEO}	Collettor-emitter voltage ($I_B = 0$)	32 V	45 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7 V	
I_C	Collector current	200 mA	
I_B	Base current	50 mA	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36 W	
	at $T_{case} \leqslant 25°C$	1.2 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

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BCY 58
BCY 59

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

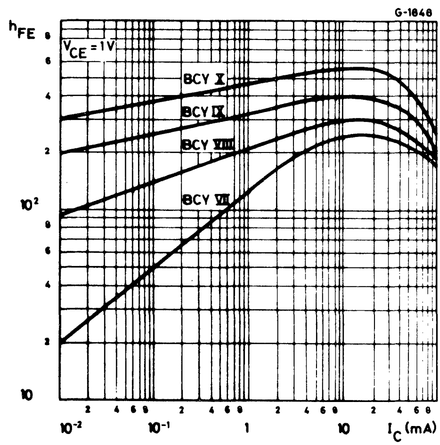
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **BCY58**				
		V_{CE} = 32V		0.1	10	nA
		V_{CE} = 32 V T_{amb} = 150°C		0.1	10	μA
		for **BCY59**				
		V_{CE} = 45V		0.1	10	nA
		V_{CE} = 45V T_{amb} = 150°C		0.1	10	μA
I_{CEX}	Collector cutoff current (V_{BE} = -0.2V)	for **BCY58**				
		V_{CE} = 32V T_{amb} = 100°C			20	μA
		for **BCY59**				
		V_{CE} = 45V T_{amb} = 100°C			20	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			10	nA
$V_{(BR)CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 2 mA for **BCY58**	32			V
		for **BCY59**	45			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 10 mA I_B = 0.25 mA		0.12	0.35	V
		I_C = 100 mA I_B = 2.5 mA		0.4	0.7	V
V_{BE}	Base-emitter voltage	I_C = 2 mA V_{CE} = 5V	0.55	0.65	0.7	V
		I_C = 100 mA V_{CE} = 1V		0.75		V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 10 mA I_B = 0.25 mA	0.6	0.7	0.85	V
		I_C = 100 mA I_B = 2.5 mA	0.75	0.9	1.2	V

ELECTRICAL CHARACTERISTICS (continued)

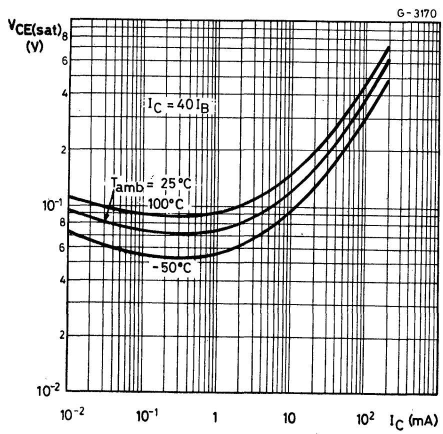
	Parameter		Test conditions		Min.	Typ.	Max.	Unit
h_{FE}	DC current gain		$I_C = 10\ \mu A$	$V_{CE} = 5V$		195		–
				Gr. VII		100		–
				Gr. VIII	20	140		–
				Gr. IX	40	195		–
				Gr. X	100	280		–
		*	$I_C = 2$ mA	$V_{CE} = 5V$	120	350	630	–
				Gr. VII	120	170	220	–
				Gr. VIII	180	250	310	–
				Gr. IX	250	350	460	–
				Gr. X	380	500	630	–
		*	$I_C = 10$ mA	$V_{CE} = 1V$	80	365		–
				Gr. VII	80	175		–
				Gr. VIII	120	260		–
				Gr. IX	160	365		–
				Gr. X	240	520		–
		*	$I_C = 100$ mA	$V_{CE} = 1V$	40			–
				Gr. VII	40			–
				Gr. VIII	45			–
				Gr. IX	60			–
				Gr. X	60			–
h_{fe}	Small signal current gain		$I_C = 2$ mA, f = 1 kHz	$V_{CE} = 5V$	125			–
				Gr. VII	125		250	–
				Gr. VIII	175		350	–
				Gr. IX	250		500	–
				Gr. X	350		700	–
f_T	Transition frequency		$I_C = 10$ mA, f = 100 MHz	$V_{CE} = 5V$		200		MHz
C_{EBO}	Emitter-base capacitance		$I_C = 0$, f = 1 MHz	$V_{EB} = 0.5V$		11	15	pF
C_{CBO}	Collector-base capacitance		$I_E = 0$, f = 1 MHz	$V_{CB} = 10V$		3.5	6	pF
NF	Noise figure		$I_C = 0.2$ mA, $R_g = 2\ k\Omega$	$V_{CE} = 5V$, f = 1 kHz		2	6	dB
t_{on}	Turn-on time		$I_C = 10$ mA, $I_{B1} = 1$ mA	$V_{CC} = 10V$		85	150	ns
			$I_C = 100$ mA, $I_{B1} = 10$ mA	$V_{CC} = 10V$		55	150	ns
t_{off}	Turn-off time		$I_C = 10$ mA, $I_{B1} = -I_{B2} = 1$ mA	$V_{CC} = 10V$		480	800	ns
			$I_C = 100$ mA, $I_{B1} = -I_{B2} = 10$ mA	$V_{CC} = 10V$		480	800	ns

* Pulsed: pulse duration = 300 μs; duty cycle = 1%

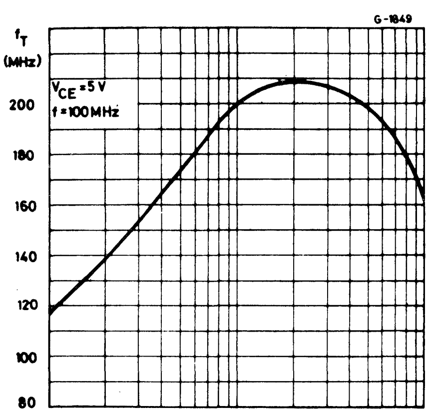
DC current gain



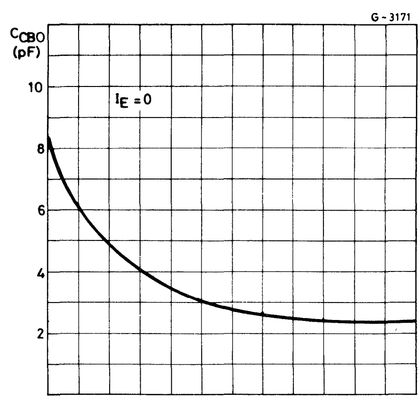
Collector-emitter saturation voltage



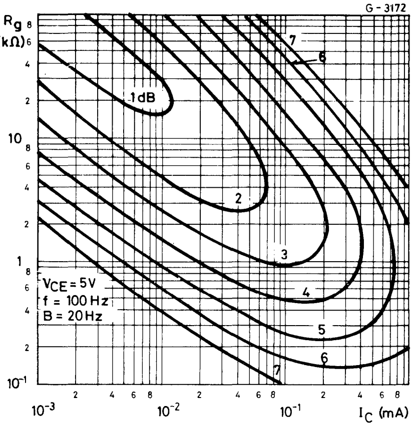
Transition frequency



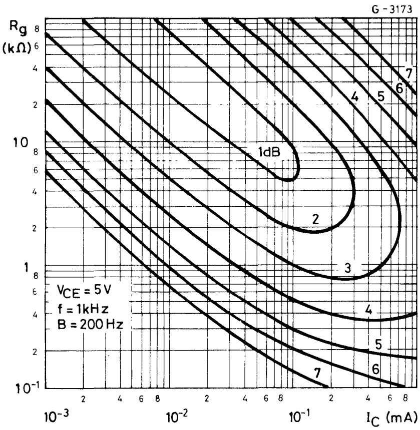
Collector-base capacitance



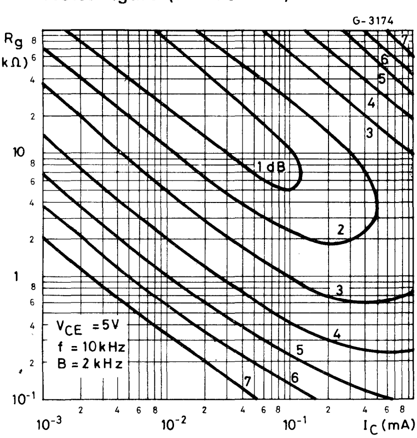
Noise figure (f= 100 Hz)



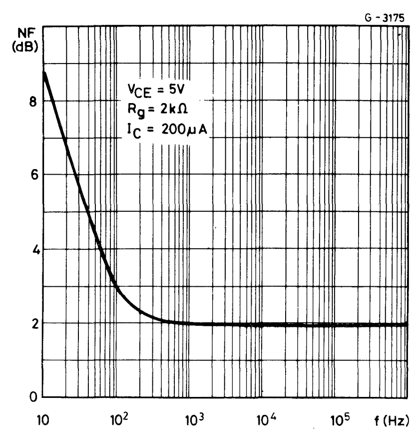
Noise figure (f = 1 kHz)



Noise figure (f = 10 kHz)



Noise figure vs. frequency



BCY 70
BCY 71
BCY 72

SILICON PLANAR PNP

GENERAL PURPOSE APPLICATIONS

The BCY 70, BCY 71 and BCY 72 are silicon planar epitaxial PNP transistors in Jedec TO-18 metal case. They are intended for general purpose amplifier and switching applications.

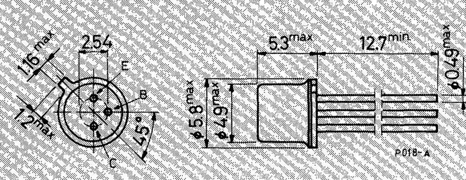
ABSOLUTE MAXIMUM RATINGS

		BCY 70	BCY 71	BCY 72
V_{CBO}	Collector-base voltage ($I_E = 0$)	-50 V	-45 V	-25 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40 V	-45 V	-25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V		
I_{CM}	Collector peak current	-200 mA		
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	350 mW		
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C		

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction–case	max	150	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction–ambient	max	500	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)					
		for **BCY 70**				
		$V_{CB} = -40V$			-10	nA
		$V_{CB} = -50V$			-500	nA
		$V_{CB} = -40V$ $T_{amb} = 100°C$			-500	nA
		for **BCY 71**				
		$V_{CB} = -40V$			-50	nA
		$V_{CB} = -45V$			-500	nA
		$V_{CB} = -40V$ $T_{amb} = 100°C$			-2	μA
		for **BCY 72**				A
		$V_{CB} = -20V$			-50	nA
		$V_{CB} = -25V$			-500	nA
		$V_{CB} = -20V$ $T_{amb} = 100°C$			-2	μA
I_{CEX}	Collector cutoff current ($V_{BE} = 3V$)	$V_{CE} = -50V$			-20	nA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = -5V$			-500	nA
$V_{CE\,(sat)}$	Collector-emitter saturation voltage	$I_C = -10$ mA $I_B = -1$ mA			-0.25	V
	*	$I_C = -50$ mA $I_B = -5$ mA			-0.5	V
$V_{BE\,(sat)}$	Base-emitter saturation voltage	$I_C = -10$ mA $I_B = -1$ mA				
		for **BCY 70** and **BCY 71** only	-0.6		-0.9	V
	*	$I_C = -50$ mA $I_B = -5$ mA			-1.2	V

ELECTRICAL CHARACTERISTICS (continued)

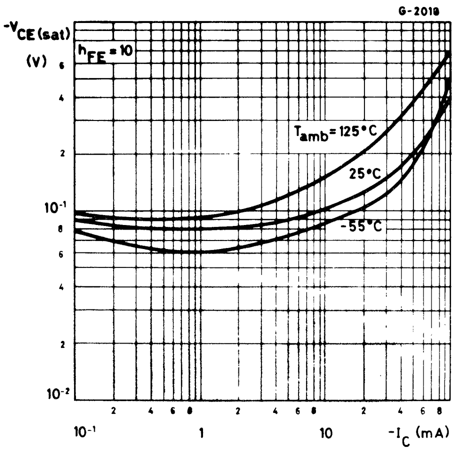
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	for **BCY 70**				
		I_C = -0.1 mA V_{CE} = -1V	40			–
		I_C = -1 mA V_{CE} = -1V	45			–
		I_C = -10 mA V_{CE} = -1V	50			–
	*	I_C = -50 mA V_{CE} = -1V	15			–
		for **BCY 71**				
		I_C = -0.01mA V_{CE} = -1V	40			–
		I_C = -0.1 mA V_{CE} = -1V	80			–
		I_C = -1 mA V_{CE} = -1V	90			–
		I_C = -10 mA V_{CE} = -1V	100		600	–
		for **BCY 72**				
		I_C = -1 mA V_{CE} = -1V	40			–
		I_C = -10 mA V_{CE} = -1V	50			–
h_{fe}	Small signal current gain (for **BCY 71** only)	I_C = -1 mA V_{CE} = -10V f = 1 kHz	100		400	–
f_T	Transition frequency	I_C = -0.1 mA V_{CE} = -20V f = 10.7 MHz				
		for **BCY 71**	15			MHz
		I_C = -10 mA V_{CE} = -20V f = 100 MHz				
		for **BCY 70**	250			MHz
		for **BCY 71** and **BCY 72**	200			MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -1V f = 1 MHz			8	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10V f = 1 MHz			6	pF
NF	Noise figure	I_C = -0.1 mA V_{CE} = -5V R_g = 2 kΩ f = 10 to 10 000 Hz				
		for **BCY 70** and **BCY 72**			6	dB
		for **BCY 71**			2	dB
h_{ie}	Input impedance (for **BCY 71** only)	I_C = -1 mA V_{CE} = -10V f = 1 kHz	2		12	kΩ
h_{re}	Reverse voltage ratio (for **BCY 71** only)	I_C = -1 mA V_{CE} = -10V f = 1 kHz			$20x10^{-4}$	–

ELECTRICAL CHARACTERISTICS (continued)

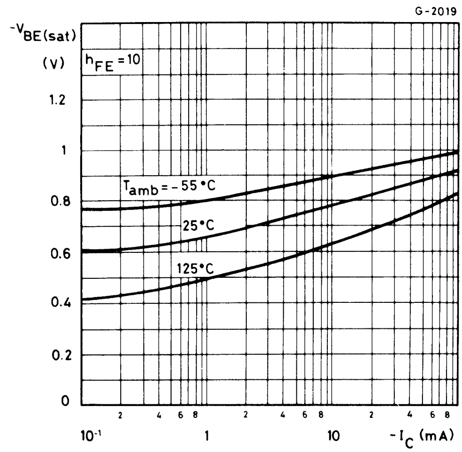
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{oe}	Output admittance (for **BCY 71** only)	I_C = -1 mA V_{CE} = -10V f = 1 kHz	10		60	μS
t_d	Delay time (for **BCY 70** and **BCY 72** only)	I_C = -10 mA V_{CC} = -3V I_{B1} = -1 mA		23	35	ns
t_r	Rise time (for **BCY 70** and **BCY 72** only)	I_C = -10 mA V_{CC} = -3V I_{B1} = -1 mA		25	35	ns
t_s	Storage time (for **BCY 70** and **BCY 72** only)	I_C = -10 mA V_{CC} = -3V I_{B1} = -I_{B2} = -1 mA		270	350	ns
t_f	Fall time (for **BCY 70** and **BCY 72** only)	I_C = -10 mA V_{CC} = -3V I_{B1} = -I_{B2} = -1 mA		50	80	ns
t_{on}	Turn-on time (for **BCY 70** and **BCY 72** only)	I_C = -10 mA V_{CC} = -3V I_{B1} = -1 mA		48	65	ns
t_{off}	Turn-off time (for **BCY 70** and **BCY 72** only)	I_C = -10 mA V_{CC} = -3V I_{B1} = -I_{B2} = -1 mA		320	420	ns

*Pulsed: pulse duration = 300 μs, duty cycle = 1%

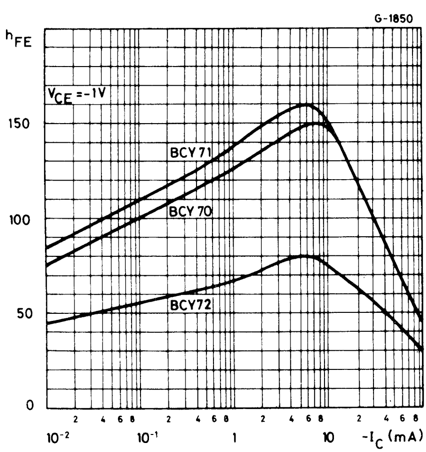
Collector-emitter saturation voltage



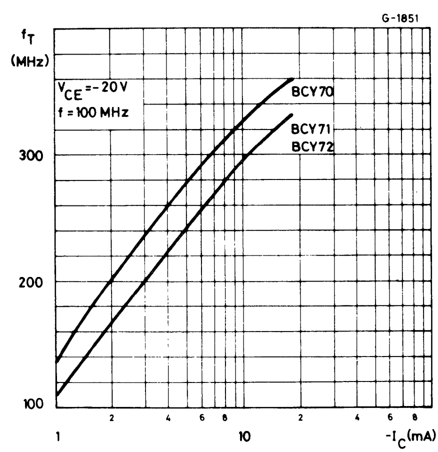
Base-emitter saturation voltage



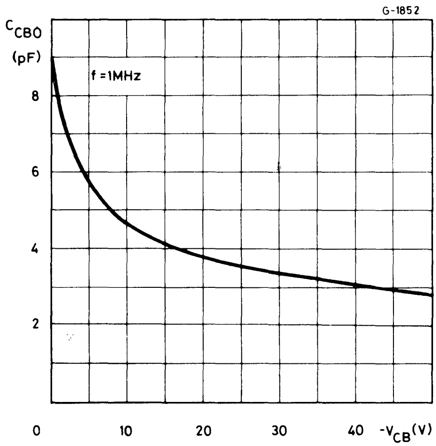
DC current gain



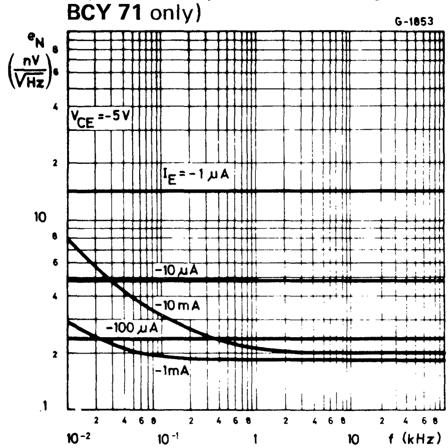
Transition frequency



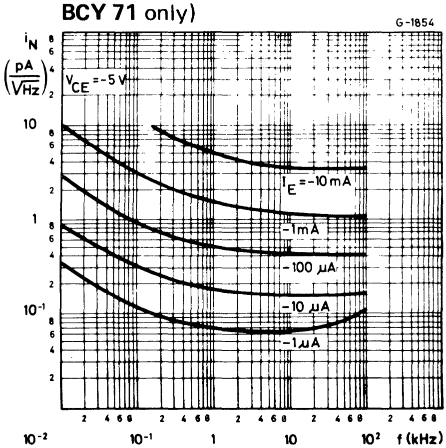
Collector-base capacitance



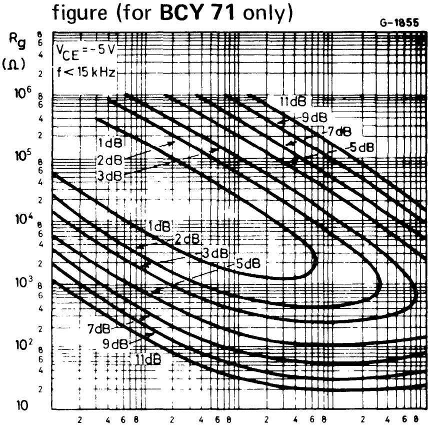
Equivalent input noise voltage (for **BCY 71** only)



Equivalent input noise current (for **BCY 71** only)



Countours of constant white noise figure (for **BCY 71** only)



BCY 78
BCY 79

SILICON PLANAR PNP

LOW-NOISE AUDIO AMPLIFIERS

The BCY 78 and BCY 79 are silicon planar epitaxial PNP transistors in Jedec TO-18 metal case. They are designed for use in audio driver and low-noise input stages.
The complementary NPN types are respectively the BCY 58 and BCY 59.

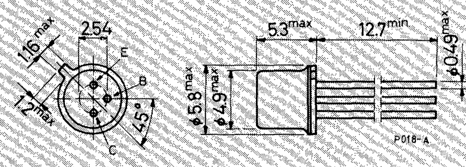
ABSOLUTE MAXIMUM RATINGS

		BCY 78	BCY 79
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-32 V	-45 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-32 V	-45 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_C	Collector current	-200 mA	
I_B	Base current	-20 mA	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	390 mW	
	at $T_{case} \leqslant 45°C$	1 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	150	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	450	°C/W

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

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **BCY 78**					
		V_{CE} = -25V			-2	-20	nA
		V_{CE} = -32V				-100	nA
		V_{CE} = -25V	T_{amb} = 150°C			-10	μA
		for **BCY 79**					
		V_{CE} = -35V			-2	-20	nA
		V_{CE} = -45V				-100	nA
		V_{CE} = -35V	T_{amb} = 150°C			-10	μA
I_{CEX}	Collector cutoff current (V_{BE} = 0.2V)	for **BCY 78**					
		V_{CE} = -32V	T_{amb} = 100°C			-20	μA
		for **BCY 79**					
		V_{CE} = -45V	T_{amb} = 100°C			-20	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -4V				-20	nA
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10 μA					
			for **BCY 78**	-32			V
			for **BCY 79**	-45			V
$V_{(BR)CEO}$	Collector-emitter breakdown voltage (I_B= 0)	I_C = -2 mA					
			for **BCY 78**	-32			V
			for **BCY 79**	-45			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -1 μA		-5			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C=-10mA	I_B = -0.25 mA		-0.12	-0.25	V
	*	I_C=-100mA	I_B = -2.5 mA		-0.4	-0.8	V

ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{BE}	Base-emitter voltage	I_C=-10 μA V_{CE} = -5V		-0.55		V
		I_C= -2 mA V_{CE} = -5V	-0.6	-0.65	-0.75	V
		I_C=-10 mA V_{CE} = -1V		-0.68		V
		* I_C=-100 mA V_{CE} = -1V		-0.75		V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C =-10 mA I_B = -0.25 mA	-0.6	-0.7	-0.85	V
		* I_C = -100 mA I_B = -2.5 mA	-0.7	-0.85	-1.2	V
h_{FE}	DC current gain	I_C = -10 μA V_{CE} = -5V				
		Gr. VII		140		–
		Gr. VIII	30	200		–
		Gr. IX	40	270		–
		I_C = -2 mA V_{CE} = -5V				
		Gr. VII	120	170	220	–
		Gr. VIII	180	250	310	–
		Gr. IX	250	350	460	–
		I_C = -10 mA V_{CE} = -1V				
		Gr. VII	80	180		–
		Gr. VIII	120	260	400	–
		Gr. IX	160	360	630	–
		* I_C = -100 mA V_{CE} = -1V				
		Gr. VII	40			–
		Gr. VIII	45			–
		Gr. IX	60			–
		for **BCY 78** only Gr. X				
		I_C=-0.01 mA V_{CE} = -5V	100	340		–
		I_C=-2 mA V_{CE} = -5V	380	500	630	–
		I_C=-10 mA V_{CE} = -1V	240	500	1000	–
		* I_C=-100 mA V_{CE} = -1V	60			–
h_{fe}	Small signal current gain	I_C = -2 mA V_{CE} = -5V f = 1 kHz				
		Gr. VII	125	200	250	–
		Gr. VIII	175	260	350	–
		Gr. IX	250	330	500	–
		for **BCY 78** only Gr. X	350	520	700	–
f_T	Transition frequency	I_C = -10 mA V_{CE} = -5V f = 100 MHz		180		MHz

ELECTRICAL CHARACTERISTICS (continued)

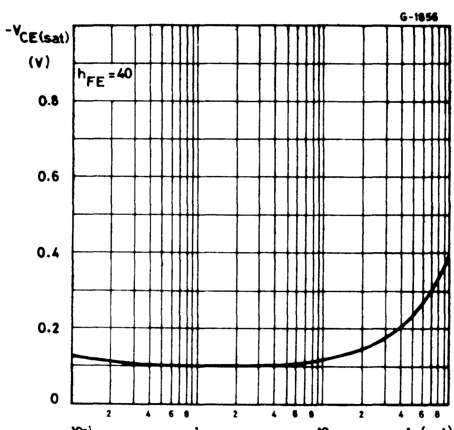
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = -0.5V$ $f = 1$ MHz		11	15	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -10V$ $f = 1$ MHz		4.5	7	pF
NF	Noise figure	$I_C = -0.2$ mA $V_{CE} = -5V$ $R_g = 2$ kΩ $f = 1$ kHz		2	6	dB
h_{ie}	Input impedance	$I_C = -2$ mA $V_{CE} = -5V$ $f = 1$ kHz				
		Gr. VII		2.7		kΩ
		Gr. VIII		3.6		kΩ
		Gr. IX		4.5		kΩ
		for **BCY 78** only Gr. X		7.5		kΩ
h_{re}	Reverse voltage ratio	$I_C = -2$ mA $V_{CE} = -5V$ $f = 1$ kHz				
		Gr. VII		1.5×10^{-4}		–
		Gr. VIII		2×10^{-4}		–
		Gr. IX		2×10^{-4}		–
		for **BCY 78** only Gr. X		3×10^{-4}		–
h_{oe}	Output admittance	$I_C = -2$ mA $V_{CE} = -5V$ $f = 1$ kHz				
		Gr. VII		18	30	μS
		Gr. VIII		24	50	μS
		Gr. IX		30	60	μS
		for **BCY 78** only Gr. X		50	100	μS
t_d	Delay time	$I_C = -10$ mA $V_{CC} = -10V$ $I_{B1} = -1$ mA		35		ns
		$I_C = -100$ mA $V_{CC} = -10V$ $I_{B1} = -10$ mA		5		ns
t_r	Rise time	$I_C = -10$ mA $V_{CC} = -10V$ $I_B = -1$ mA		50		ns
		$I_C = -100$ mA $V_{CC} = -10V$ $I_{B1} = -10$ mA		50		ns
t_s	Storage time	$I_C = -10$ mA $V_{CC} = -10V$ $I_{B1} = -I_{B2} = -1$ mA		400		ns
		$I_C = -100$ mA $V_{CC} = -10V$ $I_{B1} = -I_{B2} = -10$ mA		250		ns

ELECTRICAL CHARACTERISTICS (continued)

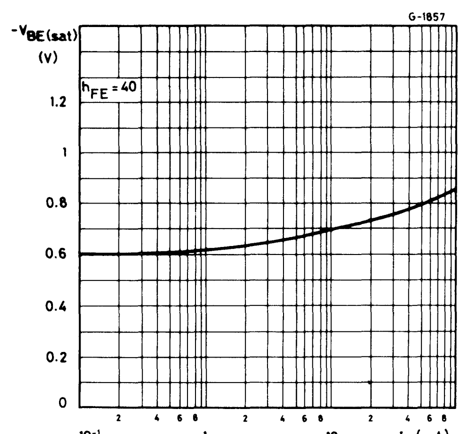
Parameter		Test conditions	Min.	Typ.	Max.	Unit
t_f	Fall time	$I_C = -10$ mA $V_{CC} = -10V$ $I_{B1} = -I_{B2} = -1$ mA		80		ns
		$I_C = -100$ mA $V_{CC} = -10V$ $I_{B1} = -I_{B2} = -10$ mA		200		ns
t_{on}	Turn-on time	$I_C = -10$ mA $V_{CC} = -10V$ $I_{B1} = -1$ mA		85	150	ns
		$I_C = -100$ mA $V_{CC} = -10$ V $I_{B1} = -10$ mA		55	150	ns
t_{off}	Turn-off time	$I_C = -10$ mA $V_{CC} = -10V$ $I_{B1} = -I_{B2} = -1$ mA		480	800	ns
		$I_C = -100$ mA $V_{CC} = -10V$ $I_{B1} = -I_{B2} = -10$ mA		450	800	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

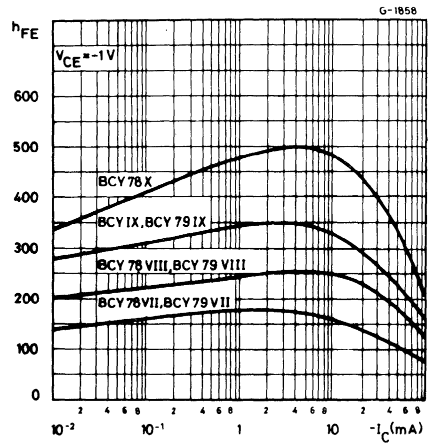
Collector-emitter saturation voltage



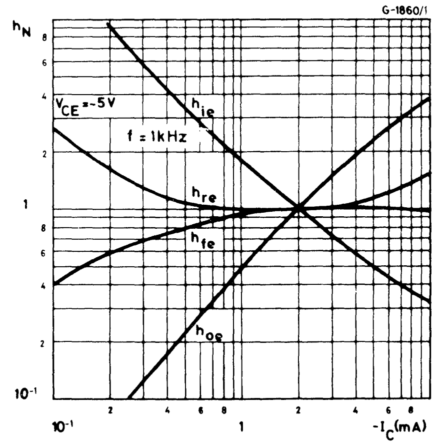
Base-emitter saturation voltage



DC current gain



Normalized h parameters



BF 167

SILICON PLANAR NPN

TV AGC IF AMPLIFIER

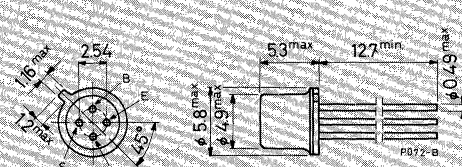
The BF 167 is a silicon planar NPN transistor in a TO-72 metal case. It is particularly designed for use in forward AGC IF amplifiers of TV receivers. It is characterized by very low feedback capacitance due to a screening diffusion under the base pad.

ABSOLUTE MAXIMUM RATINGS

V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	25	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	150	mW
T_{stg}	Storage temperature	-55 to 175	°C
T_j	Junction temperature	175	°C

MECHANICAL DATA

Dimensions in mm



(sim. to **TO-72**)

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	1000	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 10 V			50	nA
		V_{CE} = 10 V T_{amb} = 100°C			5	μA
$V_{(BR)\ CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10 μA	40			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 5 mA	30			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA	4			V
V_{BE}*	Base-emitter voltage	I_C = 4 mA V_{CE} = 10 V		0.74		V
h_{FE}*	DC current gain	I_C = 1 mA V_{CE} = 10 V		35		—
		I_C = 4 mA V_{CE} = 10 V	30	45		—
		I_C = 10 mA V_{CE} = 10 V		20		—
f_T	Transition frequency	I_C = 4 mA V_{CE} = 10 V		600		MHz
$-C_{re}$	Reverse capacitance	I_C = 0 V_{CE} = 10 V f = 1 MHz		0.15		pF
NF	Noise figure	I_C = 4 mA V_{CE} = 10 V R_g = 100 Ω f = 36 MHz		3		dB
G_{pe}**	Power gain	I_E = 4 mA V_{CE} = 10 V f = 36 MHz	24	28		dB

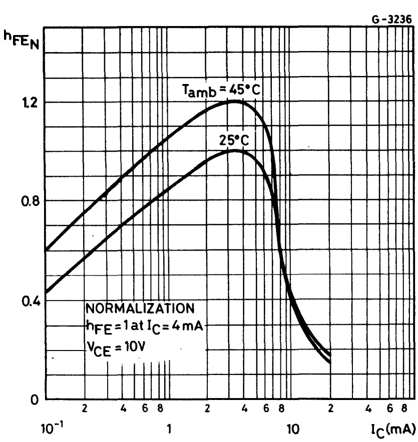
* Pulsed: pulse duration = 300 μs, duty cycle = 1%

** See test circuit

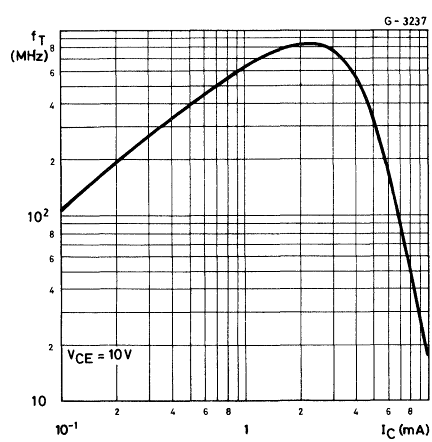
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
ΔG_{pe}	Power gain control	V_{EE} = -25 V R_{EE} = 3.9 kΩ f = 36 MHz		60		dB
g_{ie}	Input conductance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		3.8		mS
b_{ie}	Input susceptance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		5		mS
g_{fe}	Forward transconductance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		95		mS
b_{fe}	Forward transusceptance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		34		mS
g_{oe}	Output conductance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		62		μS
b_{oe}	Output susceptance	I_C = 4 mA V_{CE} = 10 V f = 36 MHz		270		μS

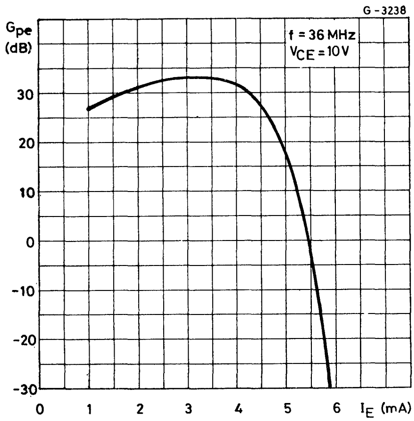
DC normalized current gain



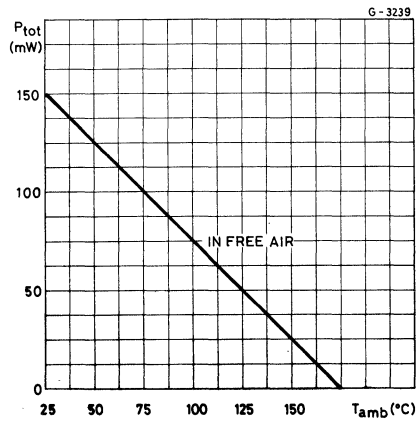
Transition frequency



Power gain

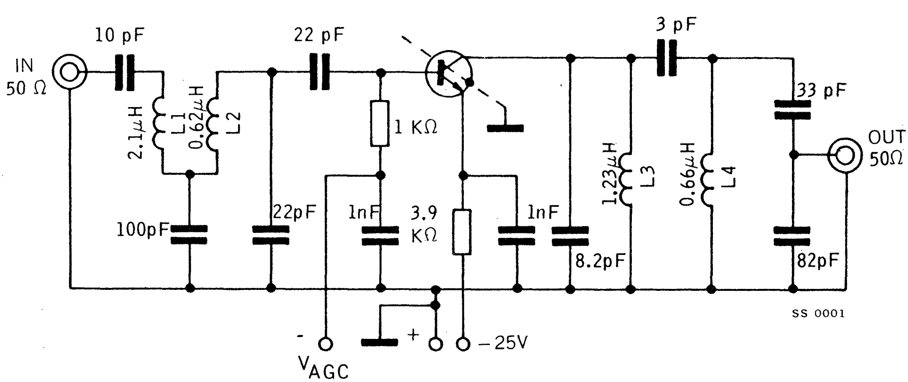


Power rating chart



TEST CIRCUIT

Power gain (f = 36 MHz)



BF 173

SILICON PLANAR NPN

VIDEO IF AMPLIFIER

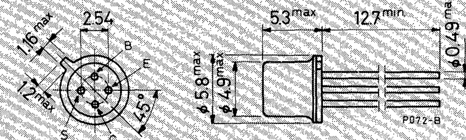
The BF 173 is a silicon planar epitaxial NPN transistor in a Jedec TO-72 metal case with a very low feedback capacitance. This transistor is intended for use in video IF amplifiers, particularly for the output stage.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	25	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	175	mW
	at $T_{case} \leq 25\ °C$	230	mW
T_{stg}	Storage temperature	-55 to 175	°C
T_j	Junction temperature	175	°C

MECHANICAL DATA

Dimensions in mm



(sim. to TO-72)

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	850	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 20 V			20	nA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 4 V			100	μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	40			V
$V_{(BR)\ CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 2 mA	25			V
V_{BE}	Base-emitter voltage	I_C = 7 mA V_{CE} = 10 V			0.9	V
f_T	Transition frequency	I_C = 5 mA V_{CE} = 10 V		1000		MHz
$-C_{re}$	Reverse capacitance	I_C = 5 mA V_{CE} = 10 V f = 0.5 MHz		0.23		pF
I_B	Base current	I_C = 7 mA V_{CE} = 10 V		61	185	μA
V_o*	Output voltage	I_C = 7.2 mA V_{CE} = 12 V f = 38.9 MHz	6	7.7		V
G_{tr}	Transducer power gain	I_C = 7.2 mA V_{CE} = 12 V f = 36.4 MHz		26		dB
g_{ie}	Input conductance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		3		mS
C_{ie}	Input capacitance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		22		pF

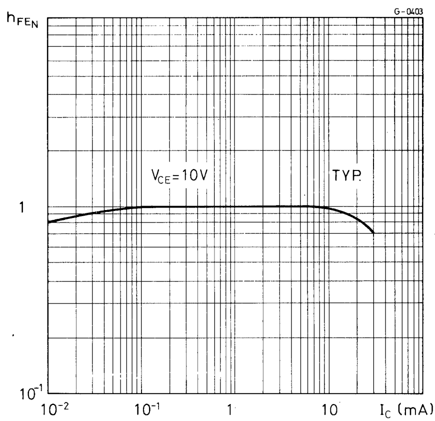
* Voltage across the detector load R_L = 2.7 kΩ for 30% syncronisation pulse compression

ELECTRICAL CHARACTERISTICS (continued)

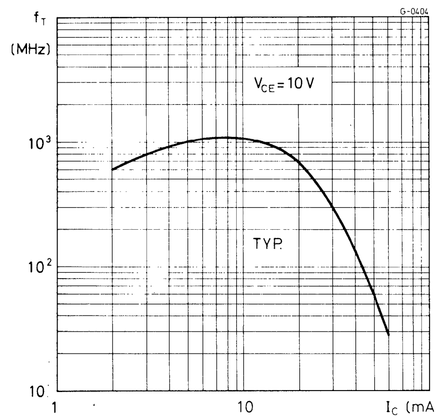
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$\|y_{re}\|$	Reverse transadmittance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		55		μS
φ_{re}	Phase angle of reverse transadmittance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		267°		—
$\|y_{fe}\|$	Forward transadmittance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		165		mS
φ_{fe}	Phase angle of forward transadmittance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		336°		—
g_{oe}	Output conductance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		65		μS
C_{oe}	Output capacitance	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		1.9		pF
G_{UM}*	Maximum unilateralized power gain	I_C = 7 mA V_{CE} = 10 V f = 35 MHz		44.5		dB

* $G_{UM} = 10 \log \dfrac{|y_{fe}|^2}{4\, g_{ie}\, g_{oe}}$

DC normalized current gain

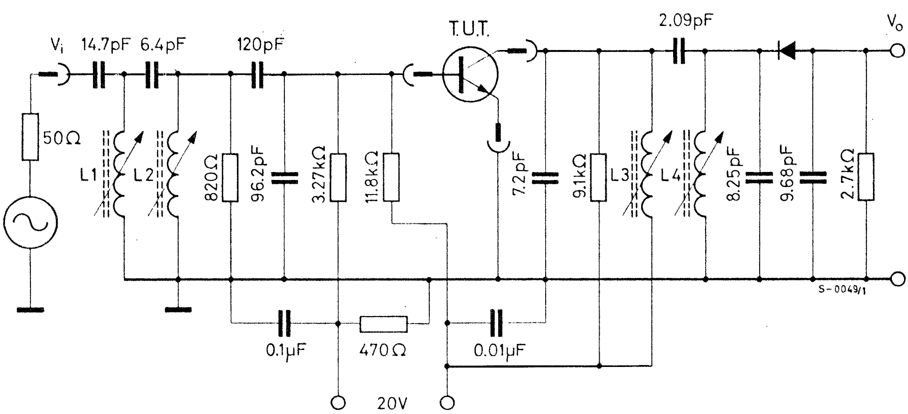


Transition frequency



TEST CIRCUIT

G_{tr} test circuit



L₁ = 0.8 μH, 9 turns ∅ 0.15 mm. enameled silk-covered copper wire. **L₂** = 0.25 μH, 4 turns ∅ 0.15 mm. enameled silk-covered copper wire. **L₃** = 1.7 μH, 12.5 turns ∅ 0.15 mm. enameled silk-covered copper wire **L₄** = 1.3 μH, 11 turns ∅ 0.15 mm. enameled silk-covered copper wire.

BF 257
BF 258
BF 259

SILICON PLANAR NPN

HIGH VOLTAGE VIDEO AMPLIFIERS

The BF 257, BF 258 and BF 259 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are particularly designed for video output stages in CTV and MTV sets, class A audio output stages and drivers for horizontal deflection circuits.

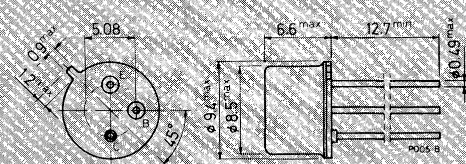
ABSOLUTE MAXIMUM RATINGS

		BF 257	BF 258	BF 259
V_{CBO}	Collector-base voltage ($I_E = 0$)	160 V	250 V	300 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	160 V	250 V	300 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V		
I_C	Collector current	100 mA		
I_{CM}	Collector peak current	200 mA		
P_{tot}	Total power dissipation at $T_{case} \leq 50$ °C	5 W		
T_{stg}	Storage temperature	-55 to 200 °C		
T_j	Junction temperature	200 °C		

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

THERMAL DATA

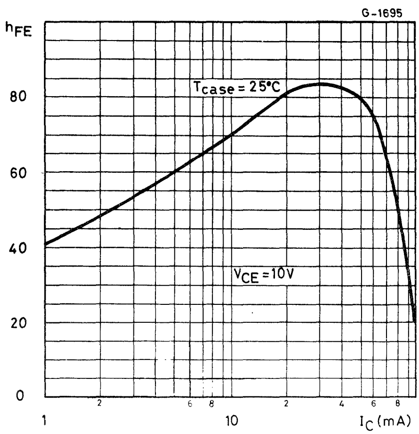
$R_{th\ j-case}$	Thermal resistance junction-case	max	30	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

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

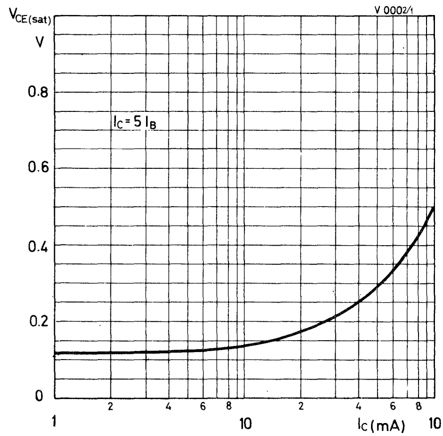
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	for **BF 257** V_{CB} = 100 V for **BF 258** V_{CB} = 200 V for **BF 259** V_{CB} = 250 V			50 50 50	nA nA nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA for **BF 257** for **BF 258** for **BF 259**	160 250 300			V V V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA for **BF 257** for **BF 258** for **BF 259**	160 250 300			V V V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA	5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 30 mA I_B = 6 mA			1	V
h_{FE}*	DC current gain	I_C = 30 mA V_{CE} = 10 V	25			—
f_T	Transition frequency	I_C = 15 mA V_{CE} = 10 V		90		MHz
$-C_{re}$	Reverse capacitance	I_C = 0 V_{CE} = 30 V f = 1 MHz		3		pF

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

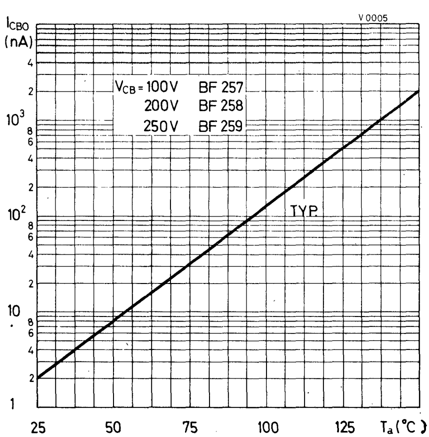
DC current gain



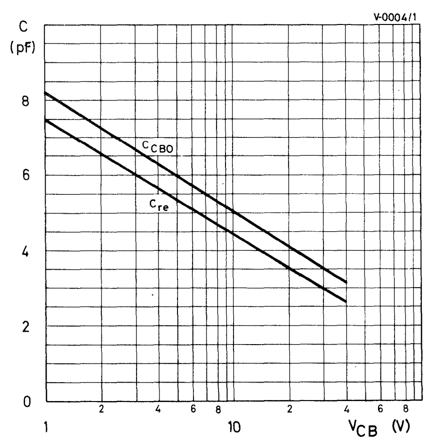
Collector-emitter saturation voltage



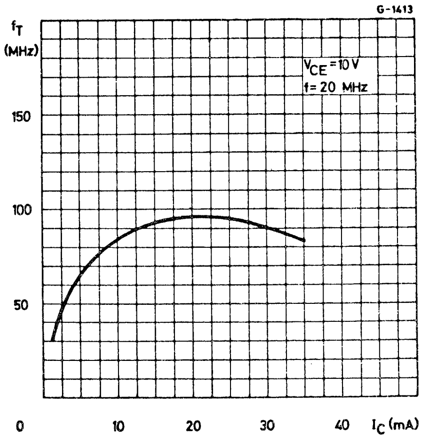
Collector cutoff current



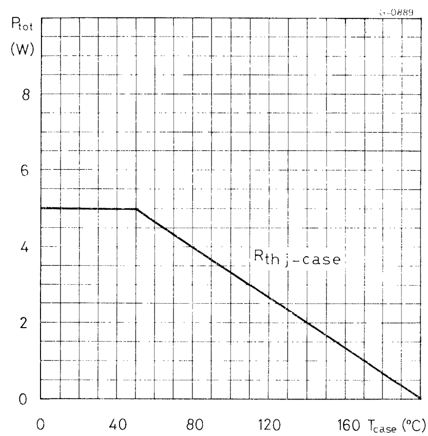
Collector-base capacitance



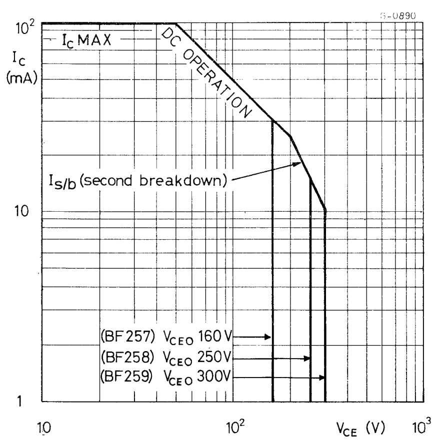
Transition frequency



Power rating chart



Safe operating area



BF 271

SILICON PLANAR NPN

VIDEO IF AMPLIFIER

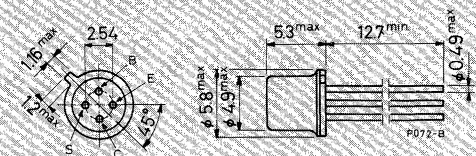
The BF 271 is a silicon planar NPN transistor in a TO-72 metal case. This device has been specifically designed for use in output stages of IF video amplifiers. It features high power gain, low feedback capacitance and excellent linearity.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	25	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	250	mW
	at $T_{case} \leq 25°C$	430	mW
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm



(sim. to TO-72)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	700	°C/W

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

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE}= 0)	V_{CE}= 10V				100	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E= 0)	I_C = 10 μA		30			V
$V_{(BR)CEO}$	Collector-emitter breakdown voltage (I_B= 0)	I_C = 1 mA		25			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C= 0)	I_E = 10 μA		4			V
V_{BE}	Base-emitter voltage	I_C = 10 mA	V_{CE}= 5V		780		mV
h_{FE}*	DC current gain	I_C = 1 mA I_C = 10 mA	V_{CE}= 10V V_{CE}= 10V	 30	55 75		– –
f_T	Transition frequency	I_C = 10 mA	V_{CE}= 10V		900		MHz
$-C_{re}$	Reverse capacitance	I_C = 0 f = 1 MHz	V_{CE}= 10V		0.22		pF
G_{pe}	Power gain	I_C = 10 mA f = 36 MHz	V_{CE}= 10V	24	27		dB
g_{ie}	Input conductance	I_C = 10 mA f = 36 MHz	V_{CE}= 10V		4.8		mS
b_{ie}	Input susceptance	I_C= 10 mA f = 36 MHz	V_{CE}= 10V		5.2		mS
g_{fe}	Forward transconductance	I_C = 10 mA f = 36 MHz	V_{CE}= 10V		200		mS
b_{fe}	Forward transusceptance	I_C = 10 mA f = 36 MHz	V_{CE}= 10V		80		mS
g_{oe}	Output conductance	I_C = 10 mA f = 36 MHz	V_{CE}= 10V		80		μS
b_{oe}	Output susceptance	I_C = 10 mA f = 36 MHz	V_{CE}= 10V		380		μS

* Pulsed: pulse duration = 300 μs; duty cycle = 1%.

BF 287

SILICON PLANAR NPN

AM MIXER-OSCILLATOR AND AM-FM AMPLIFIER

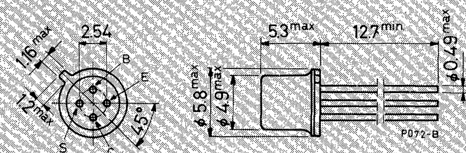
The BF 287 is a silicon planar NPN transistor in a TO-72 metal case. It is primarily intended for use in the AM mixer-oscillator stage and as IF amplifier of AM-FM radios.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	250	mW
	at $T_{case} \leq 45$ °C	220	mW
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm



(sim. to **TO-72**)

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	700	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 10 V			100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA	40			V
$V_{CEO\ (sus)}$	Collector-emitter sustaining voltage (I_B = 0)	I_C = 5 mA	40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA	4			V
V_{BE}	Base-emitter voltage	I_C = 1 mA V_{CE} = 7 V I_C = 2 mA V_{CE} = 10 V		710 740		mV mV
h_{FE}	DC current gain	I_C = 1 mA V_{CE} = 7 V I_C = 2 mA V_{CE} = 10 V	30 40	50 60		— —
f_T	Transition frequency	I_C = 1 mA V_{CE} = 7 V f = 100 MHz I_C = 2 mA V_{CE} = 10 V f = 100 MHz		600 700		MHz MHz
G_{pe}	Power gain	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz I_C = 2 mA V_{CE} = 10 V f = 5.5 MHz	42 18 25	45 22 29		dB dB dB
g_{ie}	Input conductance	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz		0.17 0.25		mS mS
b_{ie}	Input susceptance	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz		24 0.52		μS mS

BF 287

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
g_{fe}	Forward transconductance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		35		mS
		f = 10.7 MHz		35		mS
$-b_{fe}$	Forward transusceptance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		40		µS
		f = 10.7 MHz		0.96		mS
g_{oe}	Output conductance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		6		µS
		f = 10.7 MHz		11		µS
b_{oe}	Output susceptance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		4.5		µS
		f = 10.7 MHz		100		µS

BF 288

SILICON PLANAR NPN

GAIN CONTROLLED AM-FM IF AMPLIFIER

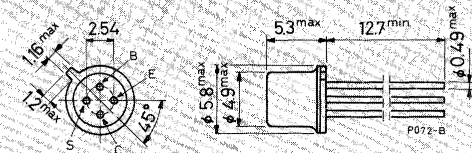
The BF 288 is a silicon planar NPN transistor in a TO-72 metal case. It is primarily intended for use in the gain controlled IF stages of AM and AM/FM radio receivers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	20	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	250	mW
	at $T_{amb} \leq 45$ °C	220	mW
T_{stg}	Storage temperature	-55 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm



(sim. to **TO-72**)

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BF 288

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	700	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 7 V			100	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA	40			V
$V_{CEO\ (sus)}$	Collector-emitter sustaining voltage (I_B = 0)	I_C = 5 mA	40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA	4			V
V_{BE}	Base-emitter voltage	I_C = 1 mA V_{CE} = 7 V		740		mV
h_{FE}	DC current gain	I_C = 1 mA V_{CE} = 7 V	65	90		—
f_T	Transition frequency	I_C = 1 mA V_{CE} = 7 V		500		MHz
$-C_{re}$	Reverse capacitance	V_{CE} = 7 V f = 1 MHz		0.24		pF
G_{pe}	Power gain	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz	 42 18	 45 22		 dB dB
g_{ie}	Input conductance	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz		 0.17 0.25		 mS mS
b_{ie}	Input susceptance	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz		 24 0.52		 μS mS
g_{fe}	Forward transconductance	I_C = 1 mA V_{CE} = 7 V f = 470 kHz f = 10.7 MHz		 35 35		 mS mS

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
$-b_{fe}$	Forward transusceptance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		40		μS
		f = 10.7 MHz		0.95		mS
g_{oe}	Output conductance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		6		μS
		f = 10.7 MHz		11		μS
b_{oe}	Output susceptance	I_C = 1 mA V_{CE} = 7 V				
		f = 470 kHz		4.5		μS
		f = 10.7 MHz		100		μS

BF 457
BF 458
BF 459

SILICON PLANAR NPN

HIGH VOLTAGE VIDEO AMPLIFIERS

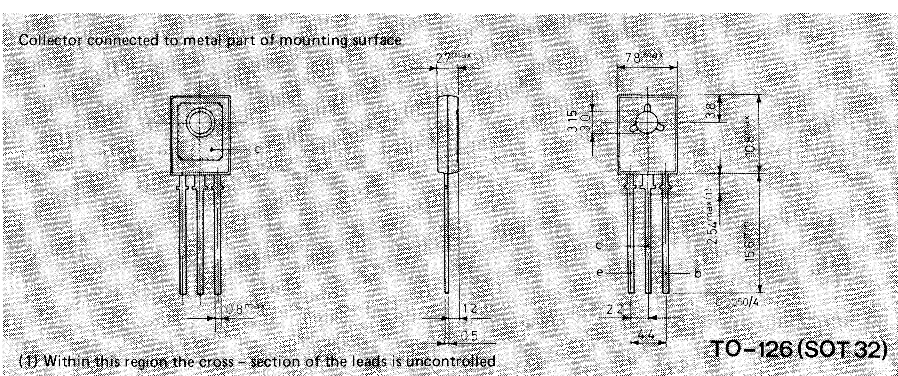
The BF 457, BF 458 and BF 459 are silicon planar epitaxial NPN transistors in Jedec TO-126 plastic package. They are particularly intended for use as video output stages in colour and black and white TV receivers, class A output stages and drivers for horizontal deflection circuits. These transistors have been studied in order to guarantee the maximum resistance against flash over.

ABSOLUTE MAXIMUM RATINGS

		BF 457	BF 458	BF 459
V_{CBO}	Collector-base voltage ($I_E = 0$)	160 V	250 V	300 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	160 V	250 V	300 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V		
I_{CM}	Collector peak current	300 mA		
I_{BM}	Base peak current	50 mA		
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	1.25 W		
	$T_{case} \leq 25$ °C	12.5 W		
T_{stg}	Storage temperature	-55 to 150 °C		
T_j	Junction temperature	150 °C		

MECHANICAL DATA

Dimensions in mm



THERMAL DATA

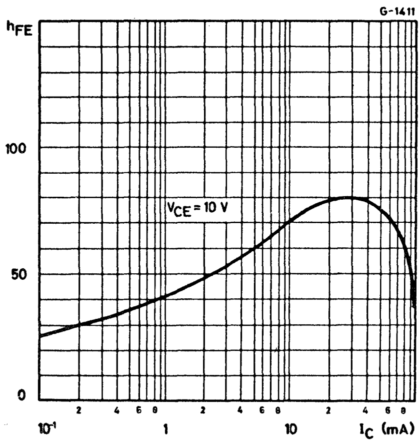
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	10	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	100	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

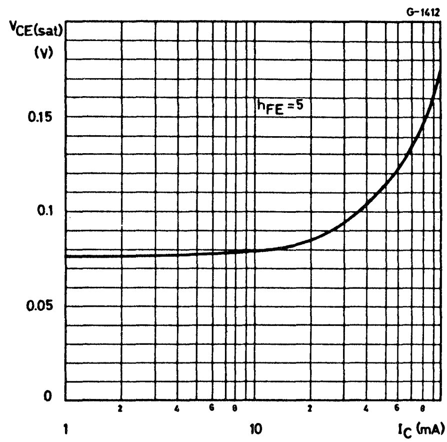
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **BF 457**	V_{CB} = 100V			50	nA
		for **BF 458**	V_{CB} = 200V			50	nA
		for **BF 459**	V_{CB} = 250V			50	nA
$V_{(BR)\,CEO}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 10 mA	for **BF 457**	160			V
			for **BF 458**	250			V
			for **BF 459**	300			V
$V_{(BR)\,EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA		5			V
$V_{CE\,(sat)}$*	Collector-emitter saturation voltage	I_C = 50 mA	I_B = 10 mA			1	V
h_{FE}*	DC current gain	I_C = 30 mA	V_{CE} = 10V	30	80		–
f_T	Transition frequency	I_C = 30 mA	V_{CE} = 10V		90		MHz
$-C_{re}$	Reverse capacitance	I_C = 0, f = 1 MHz	V_{CE} = 30V		4		pF
C_{oe}	Output capacitance	I_C ≡ 0, f = 1 MHz	V_{CE} = 30V		5		pF

* Pulsed: pulse duration = 300 μs, duty cycle 1%

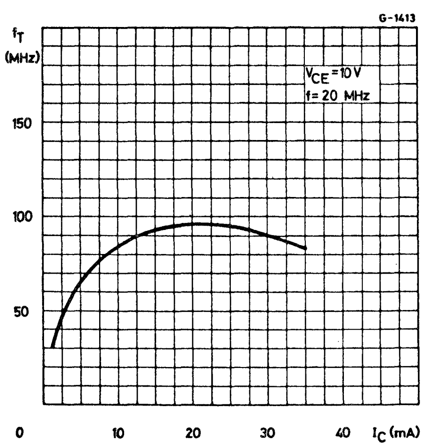
Typical DC current gain



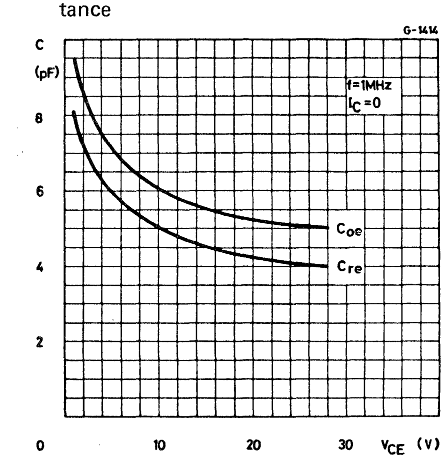
Typical collector-emitter saturation voltage



Typical transition frequency



Typical output and reverse capacitance



SILICON PLANAR NPN

BF 657
BF 658
BF 659

PRELIMINARY DATA

MEDIUM POWER VIDEO AMPLIFIERS

The BF 657, BF 658 and BF 659 are silicon planar epitaxial NPN transistors in TO-39 metal case. **They are particularly designed for application with precision "IN-LINE" large screen CRT (thermal resistance ⩽ 20°C/W).**

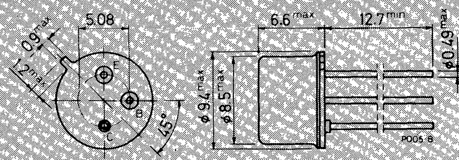
ABSOLUTE MAXIMUM RATINGS

		BF 657	BF 658	BF 659
V_{CBO}	Collector-base voltage ($I_E = 0$)	160 V	250 V	300 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	160 V	250 V	300 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		5 V	
I_C	Collector current		100 mA	
I_{CM}	Collector peak current		200 mA	
P_{tot}	Total power dissipation at $T_{case} \leqslant 60°C$		7 W	
	at $T_{case} \leqslant 140°C$		3 W	
T_{stg}	Storage temperature		-55 to 200 °C	
T_j	Junction temperature		200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

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THERMAL DATA

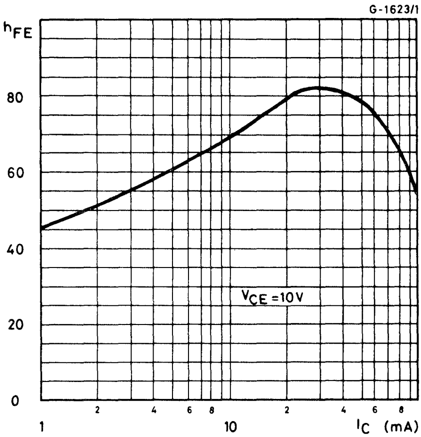
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	20	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	175	°C/W

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

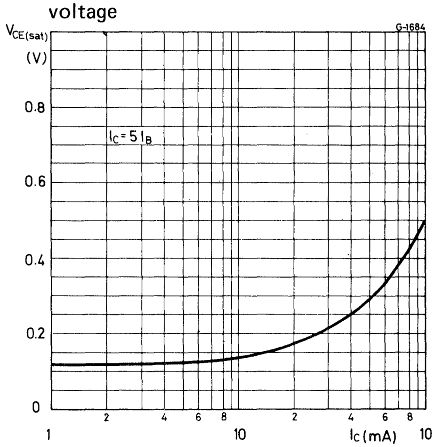
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **BF 657**	V_{CB} = 100V			50	nA
		for **BF 658**	V_{CB} = 200V			50	nA
		for **BF 659**	V_{CB} = 250V			50	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA	for **BF 657**	160			V
			for **BF 658**	250			V
			for **BF 659**	300			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = 10 mA	for **BF 657**	160			V
			for **BF 658**	250			V
			for **BF 659**	300			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA		5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 30 mA	I_B = 6 mA			1	V
h_{FE}*	DC current gain	I_C = 30 mA	V_{CE} = 10V	25			—
f_T	Transition frequency	I_C = 15 mA	V_{CE} = 10V		90		MHz
$-C_{re}$	Reverse capacitance	I_C = 0 f = 1 MHz	V_{CE} = 30V		3		pF

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

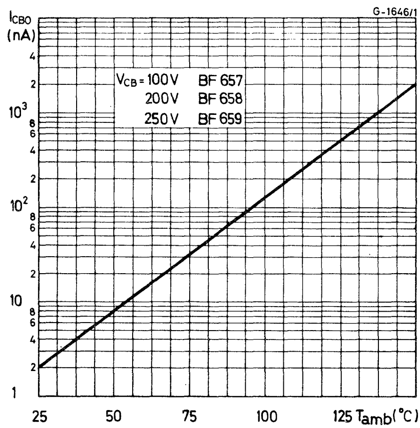
Typical DC current gain



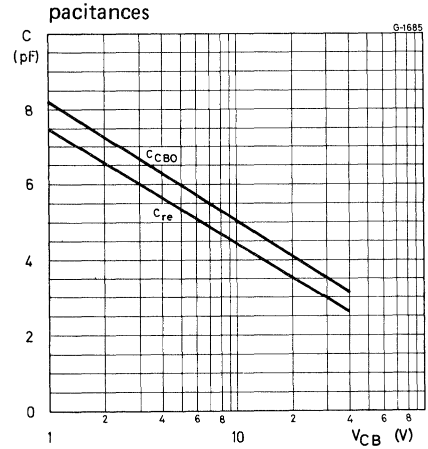
Typical collector-emitter saturation voltage



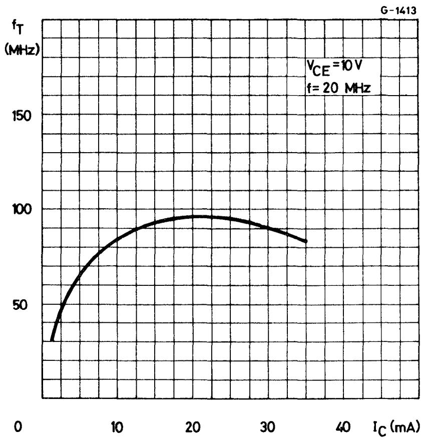
Typical collector cutoff current



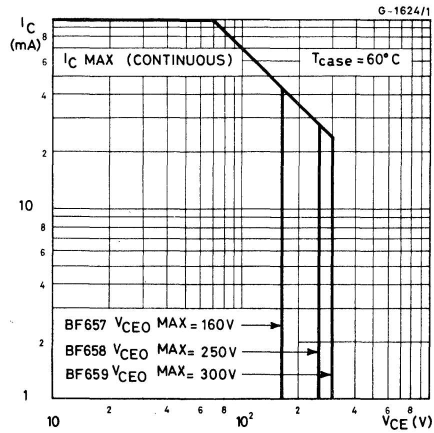
Typical collector-base and reverse capacitances



Typical transition frequency



Safe operating areas



BFR 16

SILICON PLANAR NPN

LOW-LEVEL, LOW-NOISE HIGH GAIN AMPLIFIER

The BFR 16 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal-case designed for use in high performance, low-level, low-noise amplifier applications.

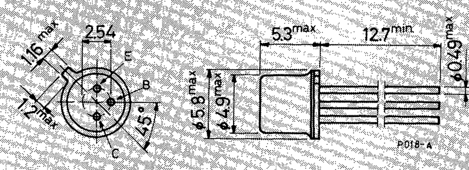
ABSOLUTE MAXIMUM RATINGS

V_{CEO}	Collector-emitter voltage ($I_B = 0$)	60	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	60	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	8	V
I_C	Collector current	50	mA
P_{tot}	Total power dissipation at $T_{amb} = 25°C$	0.36	W
	$T_{case} = 25°C$	1.2	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

BFR 16

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{EB} = 0)	V_{CE} = 50V V_{CE} = 50V	 T_{amb} = 150°C		0.1 0.1	10 10	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			0.1	10	nA
$V_{CEO(sus)}$ *	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10 mA		60			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{EB} = 0)	I_C = 10 μA		60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA		8			V
h_{FE} *	DC current gain	I_C = 10 μA I_C = 100 μA I_C = 1 mA I_C = 10 mA	V_{CE} = 5V V_{CE} = 5V V_{CE} = 5V V_{CE} = 5V	 80 150 150	150 220 350 370	 490 	– – – –
h_{fe}	Small signal current gain	I_C = 1 mA f = 1 kHz	V_{CE} = 5V		350		–
f_T	Transition frequency	I_C = 1 mA f = 20 MHz	V_{CE} = 5V	70	100		MHz
C_{CBO}	Collector-base capacitance	I_E = 0	V_{CB} = 5V		3.5	6	pF
C_{EBO}	Emitter-base capacitance	I_C = 0	V_{EB} = 0.5V		3.5	6	pF
NF	Noise figure	I_C = 10 μA R_g = 10 kΩ f = 10 Hz to 10 kHz f = 1 kHz	V_{CE} = 5V		 1.5 1	 4 4	 dB dB
h_{ie}	Input impedance	I_C = 1 mA f = 1 kHz	V_{CE} = 5V		10		kΩ
h_{oe}	Output admittance				17		μS
h_{re}	Reverse voltage ratio				$4.3 \cdot 10^{-4}$		–

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

SILICON PLANAR NPN

BFR 17

LOW-LEVEL, LOW-NOISE, VERY HIGH GAIN AMPLIFIER

The BFR 17 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, designed for use in high performance low level, low noise amplifier applications.

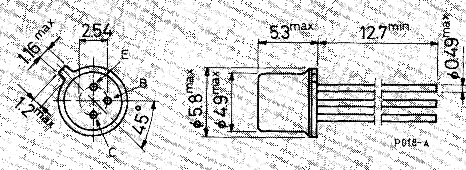
ABSOLUTE MAXIMUM RATINGS

V_{CES}	Collector-emitter voltage (V_{BE} = 0)	60	V
V_{CEO}	Collector-emitter voltage (I_B = 0)	60	V
V_{EBO}	Emitter-base voltage (I_C = 0)	8	V
I_C	Collector current	50	mA
P_{tot}	Total power dissipation at T_{amb} = 25°C	0.36	W
	T_{case} = 25°C	1.2	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

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BFR 17

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE}= 0)	V_{CE}= 50V V_{CE}= 50V	 T_{amb}=150°C		0.1 0.1	20 20	nA μA
I_{EBO}	Emitter cutoff current (I_C= 0)	V_{EB}= 5V			0.1	20	nA
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B=0)	I_C= 10 mA		60			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE}= 0)	I_C= 10 μA		60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C= 0)	I_E= 10 μA		8			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C= 1 mA	I_B= 0.1 mA		0.15	0.35	V
V_{BE}*	Base-emitter voltage	I_C= 1 mA I_C= 100 μA	V_{CE}= 5V V_{CE}= 5V		0.64 0.58	 0.70	V V
h_{FE}*	DC current gain	I_C= 10 μA I_C= 100 μA I_C= 1 mA I_C= 10 mA	V_{CE}= 5V V_{CE}= 5V V_{CE}= 5V V_{CE}= 5V	130 220 450	220 300 530 530		– – – –
h_{fe}	Small signal current gain	I_C= 1 mA f = 1 kHz	V_{CE}= 5V		530		–
f_T	Transition frequency	I_C= 1 mA f = 20 MHz	V_{CE}= 5V	70	100		MHz
C_{CBO}	Collector-base capacit.	I_E= 0	V_{CB}= 5V		3.5	6	pF
C_{EBO}	Emitter-base capacit.	I_C= 0	V_{EB}= 0.5V		3.5	6	pF
NF	Noise figure	I_C= 10 μA R_g= 10 kΩ f = 10 Hz to 10 kHz f = 1 kHz f = 10 kHz	V_{CE}= 5V		 1.5 1 1	 4 3 3	 dB dB dB
h_{ie}	Input impedance	I_C= 1 mA f = 1 kHz	V_{CE}= 5V		10		kΩ
h_{oe}	Output admittance				20		μS
h_{re}	Reverse voltage ratio				$4.5 \cdot 10^{-4}$		–

* Pulsed: pulse duration = 300 μs, duty cycle= 1%

SILICON PLANAR NPN

HIGH-VOLTAGE, HIGH-CURRENT AMPLIFIER

The BFR 18 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. This device is designed for amplifier applications over a wide range of voltage and current.

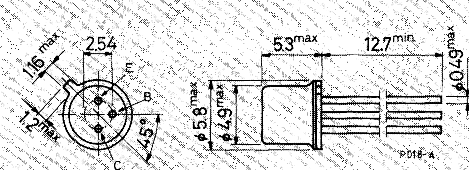
ABSOLUTE MAXIMUM RATINGS

V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	85	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	55	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.5	W
	at $T_{case} \leq 25°C$	1.8	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

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BFR 18

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	97	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	350	°C/W

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

Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 60V V_{CE} = 60V	 T_{amb} = 150°C		0.2 0.2	10 10	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			0.1		nA
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 100μA		85			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10mA		55			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100μA		7			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 150mA I_C = 500mA I_C = 1A	I_B = 15mA I_B = 50mA I_B = 0.1A		0.13 0.30 0.65	0.25 1	V V V
V_{BE}	Base-emitter voltage	I_C = 10mA	V_{CE} = 1V		0.66		V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 150mA I_C = 500mA I_C = 1A	I_B = 15mA I_B = 50mA I_B = 0.1A		0.85 1.1 1.35	1 1.6	V V V

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions		Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	$I_C = 100\mu A$	$V_{CE} = 1V$	30	75		–
		$I_C = 10mA$	$V_{CE} = 1V$	70	120	180	–
		$I_C = 150mA$	$V_{CE} = 1V$	60	90	180	–
		$I_C = 500mA$	$V_{CE} = 1V$	30	45		–
		$I_C = 150mA$ $T_{amb} = -55°C$	$V_{CE} = 1V$	15			–
h_{fe}	Small signal current gain	$I_C = 1mA$ f = 1 kHz	$V_{CE} = 5V$		120		–
f_T	Transition frequency	$I_C = 50mA$ f = 20MHz	$V_{CE} = 10V$	60	90		MHz
C_{EBO}	Emitter - base capacitance	$I_C = 0$ f = 1MHz	$V_{EB} = 0.5V$		50	80	pF
C_{CBO}	Collector - base capacitance	$I_E = 0$ f = 1MHz	$V_{CB} = 10V$		12	20	pF
NF	Noise figure	$I_C = 30\mu A$ $R_g = 1k\Omega$	$V_{CE} = 10V$ f = 1kHz		2	7	dB
h_{ie}	Input impedance	$I_C = 1mA$ f = 1kHz	$V_{CE} = 5V$		2.2		kΩ
h_{re}	Reverse voltage ratio	$I_C = 1mA$ f = 1 kHz	$V_{CE} = 5V$		2.4×10^{-4}		–
h_{oe}	Output admittance	$I_C = 1mA$ f = 1kHz	$V_{CE} = 5V$		8.5		μS

* Pulsed: pulse duration = 300μs, duty cycle = 1%

BFS 89

SILICON PLANAR NPN

NIXIE DRIVER

The BFS 89 is a silicon planar epitaxial NPN transistor in Jedec TO-39 metal case. It is intended particularly as nixie driver, amplifier and for switching applications.

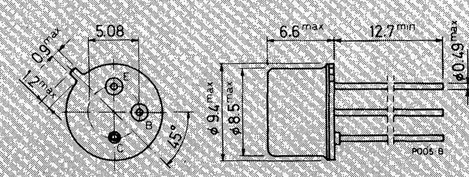
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	300	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	300	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	150	mA
I_{CM}	Collector peak current	500	mA
P_{tot}	Total power dissipation at $T_{case} \leq 25°C$	5	W
T_{stg}, T_j	Storage and junction temperature	-55 to 175	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

THERMAL DATA

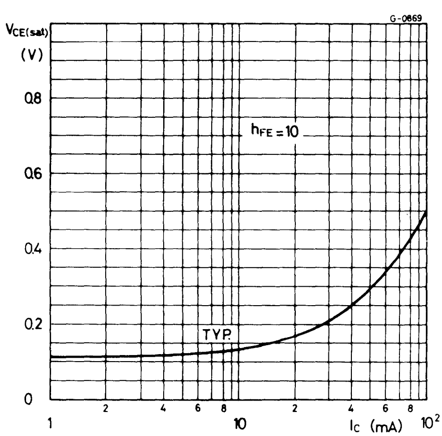
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max 30 °C/W

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

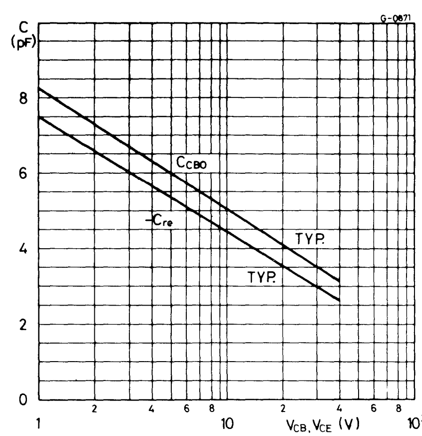
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 250V				50	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA		300			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10 mA		300			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 30 mA	I_B = 6 mA			1	V
h_{FE}	DC current gain	I_C = 50 mA	V_{CE} = 10V	25			–
f_T	Transition frequency	I_C = 30 mA	V_{CE} = 10V		90		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 f = 1 MHz	V_{CB} = 30V		3.5		pF
$-C_{re}$	Reverse capacitance	I_C = 1 mA f = 1 MHz	V_{CE} = 30V		3		pF

*Pulsed: pulse duration = 300 μs, duty cycle = 1%

Collector-emitter saturation voltage



Collector-base and reverse capacitances



BFW 43
BFW 44

SILICON PLANAR PNP

HIGH VOLTAGE AMPLIFIERS

The BFW 43 and BFW 44 are silicon planar epitaxial PNP transistors in Jedec TO-18 (BFW43) and Jedec TO-39 (BFW 44) metal cases.
Both devices are designed for use in amplifiers where high voltage and high gain are necessary. In particular, they feature a $V_{CEO(sus)}$ of 150V and are specified over a wide range of currents.

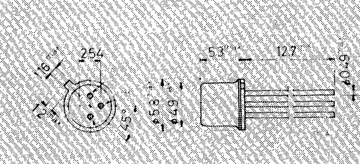
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-150	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-150	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-6	V
I_C	Collector current	-100	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$		
	for **BFW 43**	0.4	W
	for **BFW 44**	0.7	W
	at $T_{case} \leqslant 25°C$		
	for **BFW 43**	1.4	W
	for **BFW 44**	2.5	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

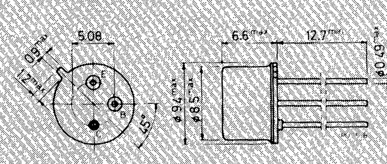
Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

Collector connected to case



(sim. to **TO-39**)

THERMAL DATA

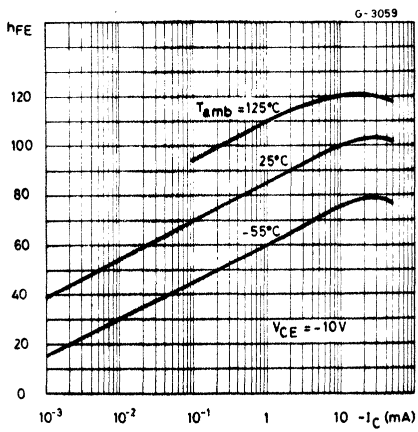
			BFW 43	BFW 44
$R_{th\ j-case}$	Thermal resistance junction-case	max	125 °C/W	70 °C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	438 °C/W	250 °C/W

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

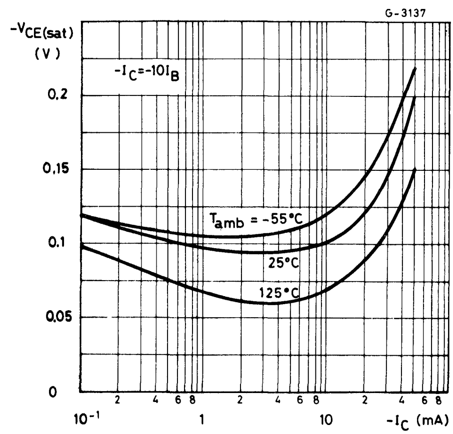
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -100V V_{CB} = -100V T_{amb}=125°C		-0.2 -0.03	-10 -10	nA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10μA	-150			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = -2mA	-150			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -10μA	-6			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = -10mA I_B = -1mA		-0.1	-0.5	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = -10mA I_B = -1mA		-0.74	-0.9	V
h_{FE}	DC current gain * *	I_C = -1mA V_{CE}=-10V I_C = -10mA V_{CE}=-10V I_C = -10μA V_{CE}=-10V T_{amb} = -55°C	40 40	85 100 30		– – –
f_T	Transition frequency	V_{CE} = -10V f = 20MHz I_C = -1mA I_C =-10mA	 60	 50		 MHz MHz
C_{EBO}	Emitter-base capacitance	$I_C = 0$ V_{EB}=-0.5V f = 1MHz		20	25	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ V_{CB} = -5V f = 1MHz		5	7	pF

*Pulsed: pulse duration = 300μs, duty cycle = 1%

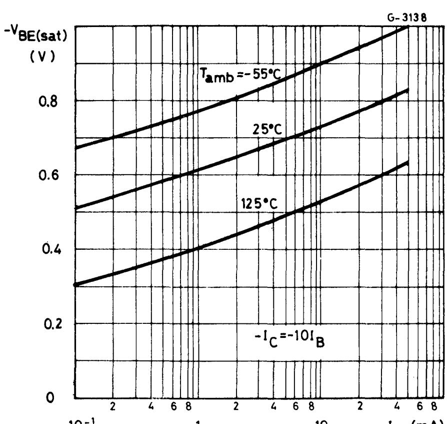
DC current gain



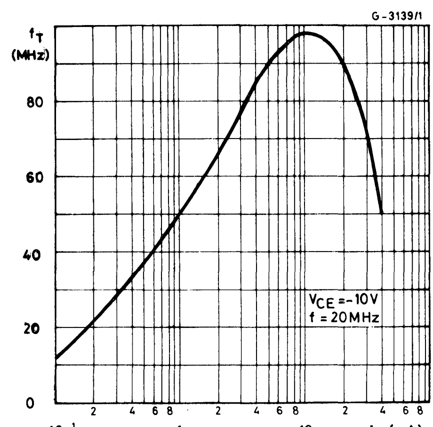
Collector-emitter saturation voltage



Base-emitter saturation voltage



Transition frequency



SILICON PLANAR PNP

BFX 37

LOW-LEVEL, LOW-NOISE AMPLIFIER

The BFX37 is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case, designed for use in high performance, low-level, low-noise amplifiers over a wide frequency range. It features high current gain over the range from 1μA to 100 mA and excellent NF at low frequency.

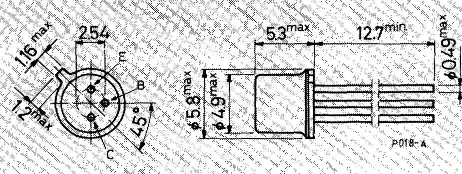
ABSOLUTE MAXIMUM RATINGS

V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-90	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-80	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-6	V
I_C	Collector current	-100	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36	W
	at $T_{case} \leqslant 25°C$	1.2	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

BFX 37

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

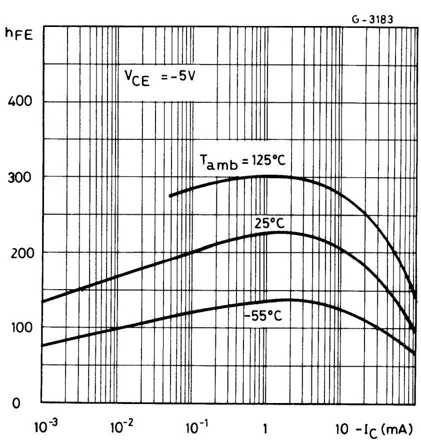
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -70 V			-0.1	-10	nA
		V_{CE} = -70V	T_{amb}=150 °C		-0.1	-10	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -4 V			-0.1	-10	nA
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10μA		-90			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = -5mA		-80			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10μA		-6			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = -10mA	I_B=-0.5mA		-0.1	-0.25	V
		I_C = -50mA	I_B= -5mA		-0.15	-0.4	V
V_{BE}	Base-emitter voltage	I_C = -1 mA	V_{CE} = -5V		-0.65		V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = -10mA	I_B=-0.5 mA		-0.73	-0.9	V
		I_C = -50mA	I_B= -5 mA		-0.82	-0.95	V
h_{FE}	DC current gain	I_C = - 1μA	V_{CE} = -5V		130		–
		I_C = -10μA	V_{CE} = -5V	70	170	230	–
		I_C = -100μA	V_{CE} = -5V	125	200		–
		I_C = -1 mA	V_{CE} = -5V	125	220	280	–
	*	I_C = -10 mA	V_{CE} = -5V	125	200		–
h_{fe}	Small signal current gain	I_C = -1 mA, f = 1 kHz	V_{CE} = -5V		250		–
f_T	Transition frequency	I_C = -0.5mA, f = 20 MHz	V_{CE} = -5V	40	70		MHz

ELECTRICAL CHARACTERISTICS (continued)

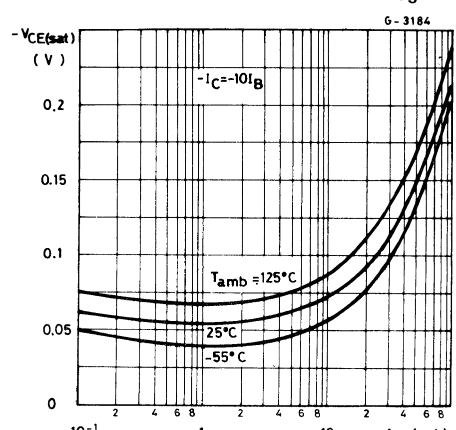
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = -0.5V$ f = 1 MHz		12	15	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -5V$ f = 1 MHz		4.5	6	pF
NF	Noise figure	$I_C = -20\mu A$ $V_{CE} = -5V$ $R_g = 10k\Omega$ f = 1 kHz		0.8	2.5	dB
		f = 10 to 10 000 Hz		1	3.5	dB
h_{ie}	Input impedance	$I_C = -1mA$ $V_{CE} = -5V$ f = 1 kHz		6.5		kΩ
h_{re}	Reverse voltage ratio	$I_C = -1$ mA $V_{CE} = -5V$ f = 1 kHz		2.5×10^{-4}		–
h_{oe}	Output admittance	$I_C = -1mA$ $V_{CE} = -5V$ f = 1 kHz		15		μS

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

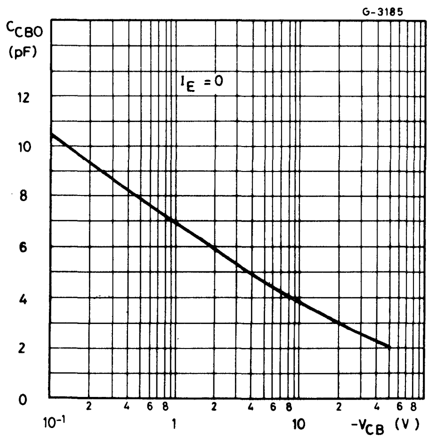
DC current gain



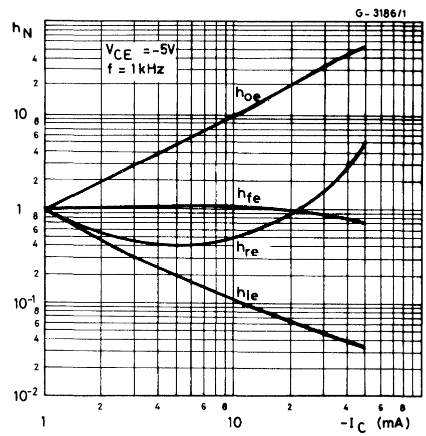
Collector-emitter saturation voltage



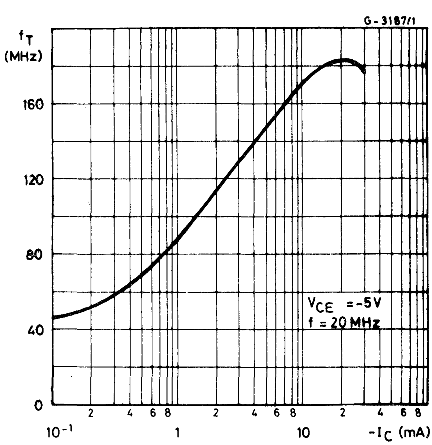
Collector-base capacitance



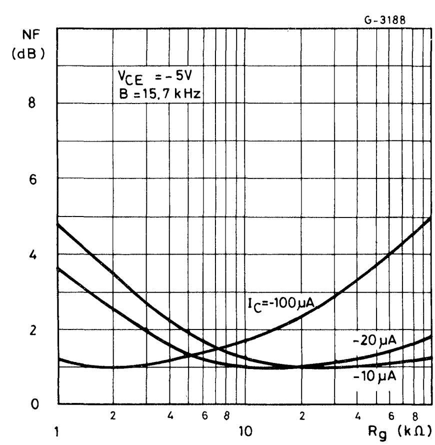
Normalized h parameters



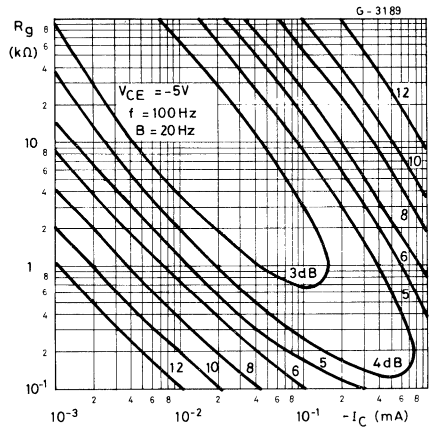
Transition frequency



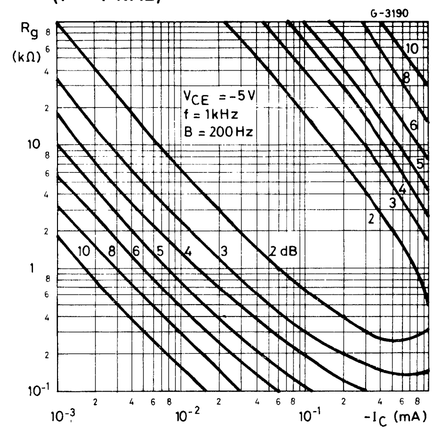
Noise figure vs. source resistance



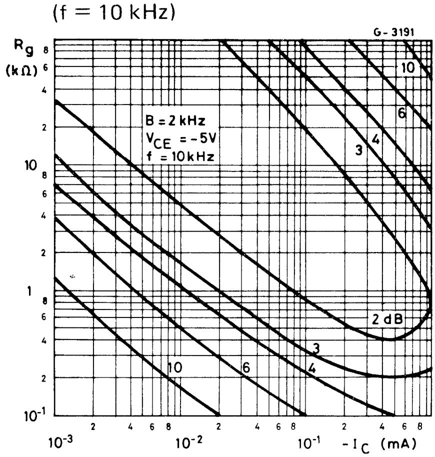
Contours of constant noise figure
(f = 100 Hz)



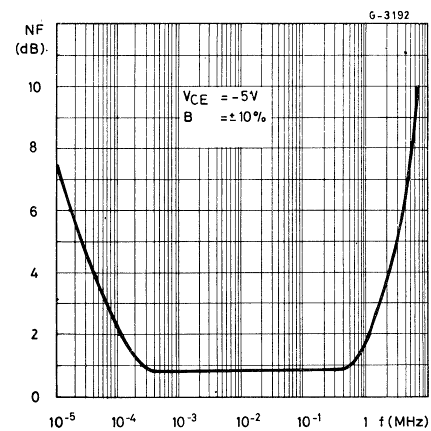
Contours of constant noise figure
(f = 1 kHz)



Contours of constant noise figure
(f = 10 kHz)



Noise figure vs. frequency



BFX 38
BFX 39
BFX 40
BFX 41

SILICON PLANAR PNP

HIGH-VOLTAGE, GENERAL PURPOSE TYPES

The BFX38, BFX39, BFX40 and BFX41 are silicon planar epitaxial PNP transistors in Jedec TO-39 metal case, designed for a wide variety of applications. They are particularly useful as complementary drivers (BFY56A is a good complement) in output and switching applications where high voltage and high current are required.

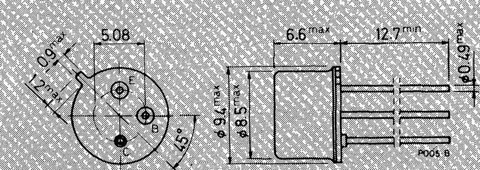
ABSOLUTE MAXIMUM RATINGS

		BFX38 BFX39	BFX40 BFX41
V_{CBO}	Collector-base voltage ($I_E = 0$)	-55 V	-75 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-55 V	-75 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_C	Collector current	-1 A	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.8 W	
	at $T_{case} \leqslant 25°C$	4 W	
T_{stg}, T_j	Storage and junction temperature	-55 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	44	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	219	°C/W

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

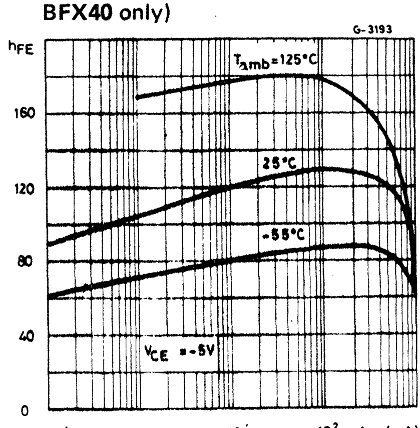
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **BFX38 - BFX39**				
		V_{CB} = -40V		-0.2	-50	nA
		V_{CB} = -40V T_{amb}=125°C		-0.25	-50	μA
		for **BFX40 - BFX41**				
		V_{CB} = -50V		-0.2	-50	nA
		V_{CB} = -50V T_{amb}=125°C		-0.25	-50	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10μA				
		for **BFX38 - BFX39**	-55			V
		for **BFX40 - BFX41**	-75			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = - 10mA				
		for **BFX38 - BFX39**	-55			V
		for **BFX40 - BFX41**	-75			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -10μA	-5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = -150mA I_B = -15mA		-0.12	-0.15	V
		I_C = -500mA I_B = -50mA		-0.3	-0.5	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = -150mA I_B = -15mA		-0.8	-0.9	V
		I_C = -500mA I_B = -50mA		-0.9	-1.1	V
h_{FE}	DC current gain	for **BFX 38 - BFX 40**				
		I_C = -100μA V_{CE} = -5V	60	90		—
	*	I_C = -100mA V_{CE} = -5V	85	130		—
	*	I_C = -500mA V_{CE} = -5V	60	120		—
		for **BFX39 - BFX41**				
		I_C = -100μA V_{CE} = -5V	30	45		—
	*	I_C = -100mA V_{CE} = -5V	40	70		—
	*	I_C = -500mA V_{CE} = -5V	25	65		—

ELECTRICAL CHARACTERISTICS (continued)

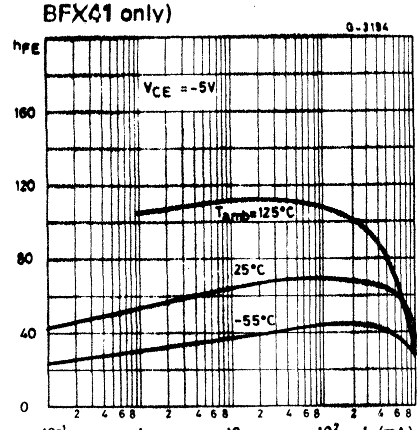
	Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	*	I_C = -1 A V_{CE} = -5V				
			for **BFX38**	30			–
			for **BFX39**	15			–
			for **BFX40**	25			–
			for **BFX41**	10			–
		*	I_C = -100 mA V_{CE} = -5V T_{amb} = -55°C				
			for **BFX38 - BFX40**	30			–
			for **BFX39 - BFX41**	15			–
f_T	Transition frequency		I_C = -50 mA V_{CE} = -10V f = 100 MHz	100	150		MHz
C_{EBO}	Emitter-base capacitance		I_C = 0 V_{EB} = -0.5V f = 1 MHz		75	120	pF
C_{CBO}	Collector-base capacitance		I_E = 0 V_{CB} = -10V f = 1 MHz		15	20	pF
t_{on}	Turn-on time		I_C = -500 mA V_{CC} = -30V I_{B1} = -50 mA		33	100	ns
t_s	Storage time		I_C = -500 mA V_{CC} = -30V I_{B1} = $-I_{B2}$ = -50 mA		160	350	ns
t_f	Fall time		I_C = -500 mA V_{CC} = -30V I_{B1} = $-I_{B2}$ = -50 mA		27	50	ns

*Pulsed: pulse duration = 300 μs, duty cycle = 1%

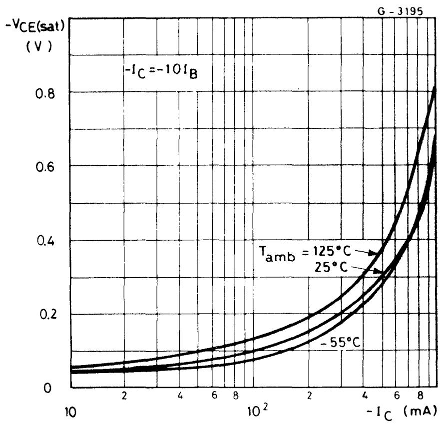
DC current gain (for **BFX38** and **BFX40** only)



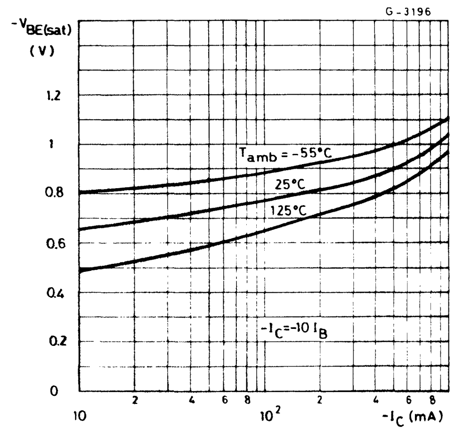
DC current gain (for **BFX39** and **BFX41** only)



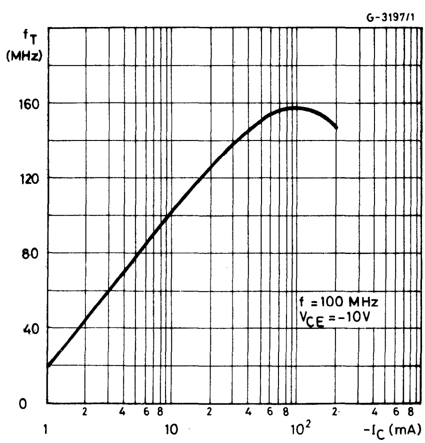
Collector-emitter saturation voltage



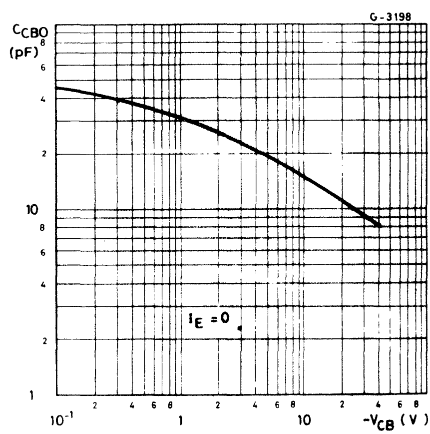
Base-emitter saturation voltage



Transition frequency



Collector-base capacitance



BFX 48

SILICON PLANAR PNP

HIGH-FREQUENCY AMPLIFIER

The BFX 48 is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case. It is suitable for a wide range of applications including low noise, low current high gain RF and wide band pulse amplifiers.

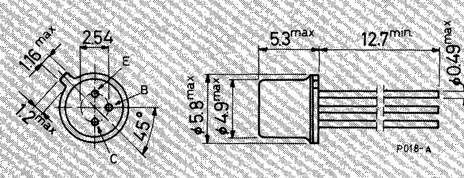
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-30	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-100	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36	W
	at $T_{case} \leqslant 25°C$	1	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	175	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

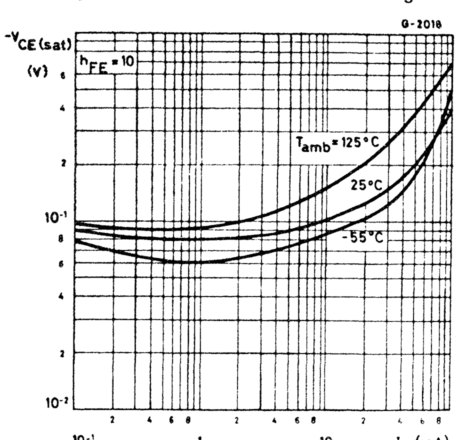
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -20V				-15	nA
		V_{CE} = -20V	T_{amb} = 125°C			-15	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA		-30			V
$V_{CEO\ (sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = -10 mA		-30			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA		-5			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	I_C = -1 mA	I_B = -0.1 mA			-0.13	V
		I_C = -10 mA	I_B = -1 mA		-0.1	-0.14	V
		I_C = -50 mA	I_B = -5 mA			-0.3	V
$V_{BE\ (sat)}$	Base-emitter saturation voltage	I_C = -1 mA	I_B = -0.1 mA			-0.75	V
		I_C = -10 mA	I_B = -1 mA		-0.77	-0.9	V
		I_C = -50 mA	I_B = -5 mA			-1.1	V
h_{FE}	DC current gain	I_C = -10 μA	V_{CE} = -1V	40	80		–
		I_C = -100 μA	V_{CE} = -1V	70	130		–
	*	I_C = -10 mA	V_{CE} = -1V	90	160		–
	*	I_C = -50 mA	V_{CE} = -1V	20	40		–
	*	I_C = -10 mA T_{amb} = -55°C	V_{CE} = -1V	30			–
f_T	Transition frequency	I_C = -10 mA f = 100 MHz	V_{CE} = -20V	400	550		MHz

ELECTRICAL CHARACTERISTICS (continued)

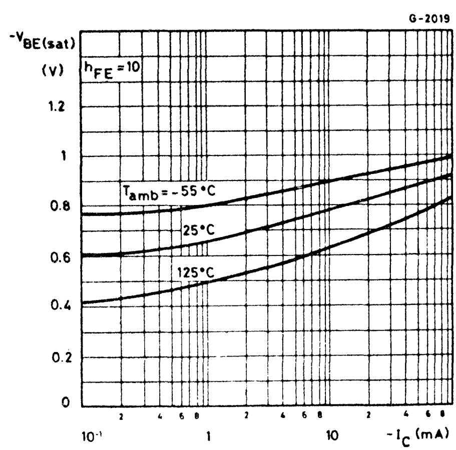
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = -0.5V$ $f = 1$ MHz		4	5.5	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -10V$ $f = 1$ MHz		2.2	3.5	pF
NF	Noise figure	$I_C = -1$ mA $V_{CE} = -5V$ $f = 100$ MHz $R_g = 100\ \Omega$		3.5	6	dB
t_{on}	Turn-on time	$I_C = -50$ mA $I_{B1} = -5$ mA		20	50	ns
t_{off}	Turn-off time	$I_C = -50$ mA $I_{B1} = -I_{B2} = -5$ mA		95	160	ns
$r_{bb'}C_{b'c}$	Feedback time constant	$I_C = -10$ mA $V_{CE} = -20V$ $f = 80$ MHz			40	ps

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

Collector-emitter saturation voltage



Base-emitter saturation voltage



SILICON PLANAR NPN

BFX 69
BFX 69A

GENERAL PURPOSE AMPLIFIERS

The BFX 69 and BFX 69A are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case. They are designed for amplifier applications over a wide range of voltage and current.

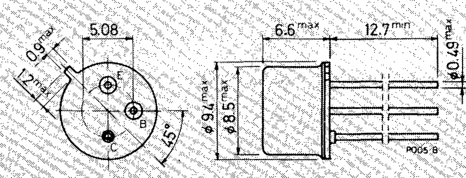
ABSOLUTE MAXIMUM RATINGS

		BFX 69	BFX 69A
V_{CBO}	Collector-base voltage ($I_E = 0$)	75 V	80 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30 V	40 V
V_{CER}	Collector-emitter voltage ($R_{Be} \leqslant 10\Omega$)	50 V	–
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7 V	
I_C	Collector current	1 A	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25$ °C	0.8 W	
	at $T_{case} \leqslant 25$ °C		
	for **BFX 69**	3 W	
	for **BFX 69A**	5 W	
	at $T_{case} \leqslant 100$ °C		
	for **BFX 69**	1.7 W	
	for **BFX 69A**	2.8 W	
T_{stg}, T_j	Storage and junction temperature	-55 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

BFX 69
BFX 69A

THERMAL DATA

			BFX 69	BFX 69 A
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	58.3 °C/W	35 °C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	219 °C/W	219 °C/W

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

Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 60 V	for **BFX 69**		0.3	10	nA
			for **BFX 69A**		0.4	10	nA
		V_{CB} = 60 V	T_{amb} = 125°C for **BFX 69**		0.4	10	μA
			for **BFX 69A**		0.5	10	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = 5V			0.05	10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 0.1 mA	for **BFX 69**	75			V
			for **BFX 69A**	80			V
$V_{CER(sus)}$*	Collector-emitter sustaining voltage ($R_{BE} \leq 10\Omega$)	I_C = 10 mA	for **BFX 69**	50			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 10 mA	for **BFX 69**	30			V
			for **BFX 69A**	40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 0.1 mA		7			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 150 mA	I_B = 15 mA for **BFX 69**		0.6	1.5	V
			for **BFX 69A**		0.4	0.8	V
		I_C = 500 mA	I_B = 50 mA for **BFX 69A**			1.2	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 150 mA	I_B = 15 mA for **BFX 69**		0.95	1.3	V
			for **BFX 69A**		0.86	1.1	V
		I_C = 500 mA	I_B = 50 mA for **BFX 69A**			1.8	V

ELECTRICAL CHARACTERISTICS (continued)

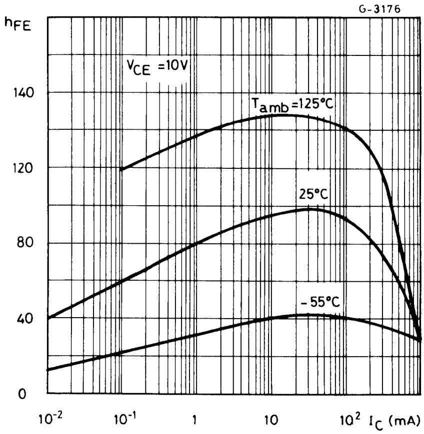
Parameter		Test conditions		Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	$I_C = 10\ \mu A$	$V_{CE} = 10V$				
			for **BFX 69**		35		–
			for **BFX 69A**		40		–
		$I_C = 0.1\ mA$	$V_{CE} = 10V$				
			for **BFX 69**	20	50		–
			for **BFX 69A**	30	60		–
	*	$I_C = 10\ mA$	$V_{CE} = 10V$				
			for **BFX 69**	35	80		–
			for **BFX 69A**	40	95		–
	*	$I_C = 150\ mA$	$V_{CE} = 10V$				
			for **BFX 69**	40	80	120	–
			for **BFX 69A**	40	90		–
	*	$I_C = 500\ mA$	$V_{CE} = 10V$				
			for **BFX 69**	20	55		–
			for **BFX 69A**	25	60		–
	*	$I_C = 10\ mA$, $T_{amb} = -55°C$	$V_{CE} = 10V$				
			for **BFX 69**	20	35		–
	*	$I_C = 150\ mA$, $T_{amb} = -55°C$	$V_{CE} = 10V$				
			for **BFX 69A**	20	40		–
h_{fe}	Small signal current gain	$I_C = 1\ mA$, $f = 1\ kHz$	$V_{CE} = 5V$				
			for **BFX 69**	30	55	100	–
			for **BFX 69A**		70		–
		$I_C = 5\ mA$, $f = 1\ kHz$	$V_{CE} = 10V$				
			for **BFX 69**	35	70	150	–
f_T	Transition frequency	$I_C = 50\ mA$, $f = 20\ MHz$	$V_{CE} = 10V$	60	80		MHz
C_{EBO}	Emitter-base capacitance	$I_C = 0$, $f = 1\ MHz$	$V_{EB} = 0.5V$		50	80	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$, $f = 1\ MHz$	$V_{CB} = 10V$				
			for **BFX 69**		18	25	pF
			for **BFX 69A**		13	20	pF

ELECTRICAL CHARACTERISTICS (continued)

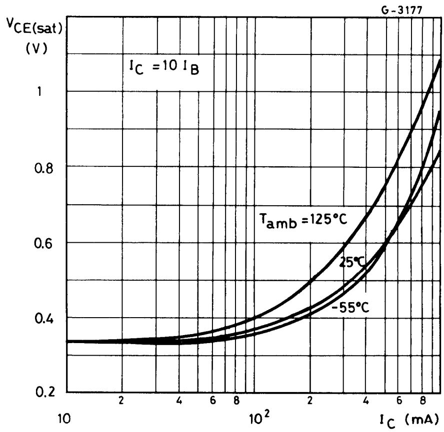
Parameter		Test conditions		Min.	Typ.	Max.	Unit
NF	Noise figure	I_C = 0.3 mA R_g = 510 Ω	V_{CE} = 10V f = 1 kHz for **BFX 69**		6	12	dB
		I_C = 30 μA R_g = 1 kΩ	V_{CE} = 10V f = 1 kHz for **BFX 69A**		3.5	7	dB
h_{ie}	Input impedance	I_C = 1 mA f = 1 kHz	V_{CE} = 5V for **BFX 69**		2.2		kΩ
			for **BFX 69A**		1.8		kΩ
h_{re}	Reverse voltage ratio	I_C = 1 mA f = 1 kHz	V_{CE} = 5V for **BFX 69**		3.6×10^{-4}		–
			for **BFX 69A**		2.1×10^{-4}		–
h_{oe}	Output admittance	I_C = 1 mA f = 1 kHz	V_{CE} = 5V for **BFX 69**		12.5		μS
			for **BFX 69A**		8		μS
h_{ib}	Input impedance	I_C = 1 mA f = 1 kHz	V_{CB} = 5V for **BFX 69**	24	27	34	Ω
			for **BFX 69A**		27		Ω
		I_C = 5 mA	V_{CB} = 10V for **BFX 69**	4	6.3	8	Ω
h_{rb}	Reverse voltage ratio	I_C = 1 mA f = 1 kHz	V_{CB} = 5V for **BFX 69**		0.7×10^{-4}	3×10^{-4}	–
			for **BFX 69A**		0.5×10^{-4}		–
		I_C = 5 mA f = 1 kHz	V_{CB} = 10V for **BFX 69**		0.8×10^{-4}	3×10^{-4}	–
h_{ob}	Output admittance	I_C = 1 mA f = 1 kHz	V_{CB} = 5V for **BFX 69**	0.1	0.16	0.5	μS
			for **BFX 69A**		0.12		μS
		I_C = 5 mA f = 1 kHz	V_{CB} = 10V for **BFX 69**	0.1	0.19	1	μS

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

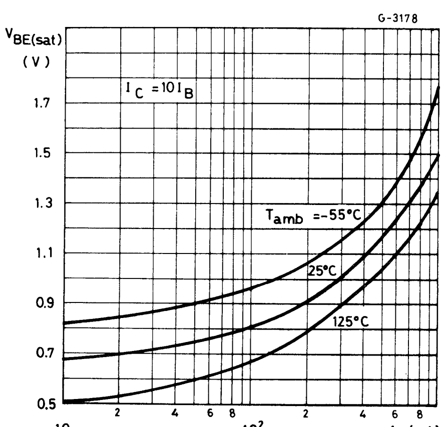
DC current gain



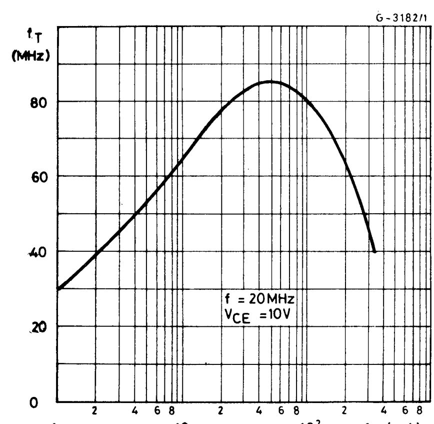
Collector-emitter saturation voltage



Base-emitter saturation voltage

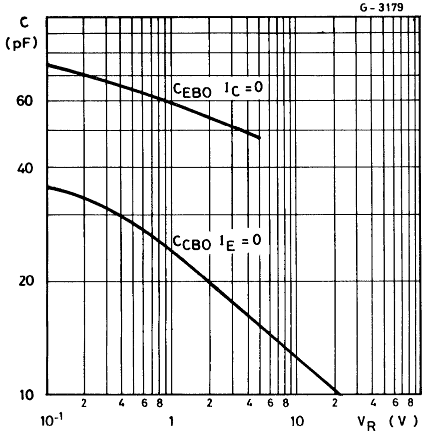


Transition frequency

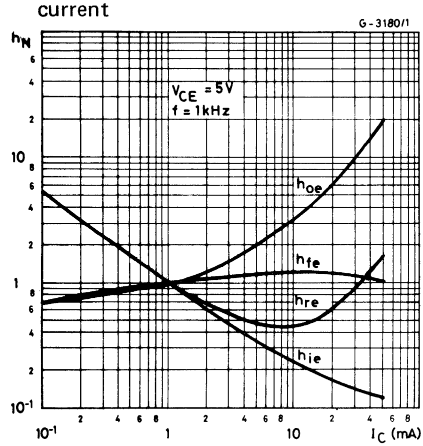


BFX 69
BFX 69A

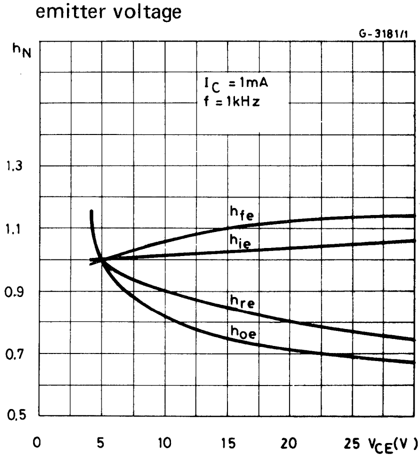
Emitter-base and collector-base capacitances



Normalized h parameters vs. collector current



Normalized h parameters vs. collector-emitter voltage



SILICON PLANAR PNP

BFX 90
BFX 91

HIGH-VOLTAGE AMPLIFIERS

The BFX 90 and BFX 91 are silicon planar epitaxial PNP transistors in Jedec TO-18 (BFX 90) and Jedec TO-39 (BFX 91) metal cases.
Both devices feature high voltage, high gain, low noise and excellent current gain linearity from 10 μA to 50 mA.

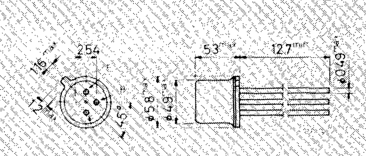
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-180	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-180	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-6	V
I_C	Collector current	-100	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25$ °C		
	for **BFX 90**	0.4	W
	for **BFX 91**	0.7	W
	at $T_{case} \leqslant 25$ °C		
	for **BFX 90**	1.4	W
	for **BFX 91**	2.5	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

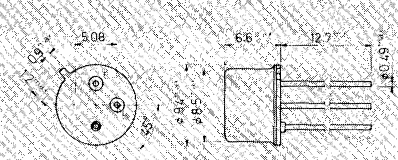
Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

Collector connected to case



(sim. to **TO-39**)

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BFX 90
BFX 91

THERMAL DATA

			BFX 90	BFX 91
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	125 °C/W	70 °C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	438 °C/W	250 °C/W

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

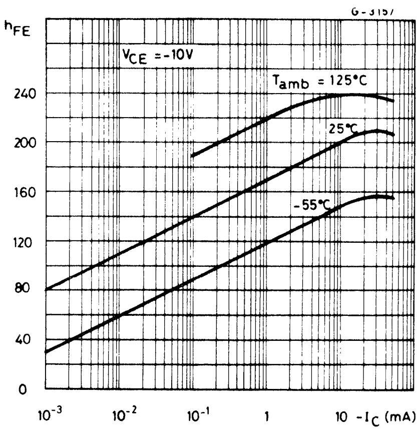
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB}= -100V		-0.2	-10	nA
		V_{CB}= -100V T_{amb}= 125°C		-0.03	-10	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB}= -4V		-0.2	-10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10 μA	-180			V
$V_{CEO\,(sus)}$	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = -2 mA	-180			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -10 μA	-6			V
$V_{CE\,(sat)}$*	Collector-emitter saturation voltage	I_C = -10 mA I_B = -1 mA		-0.1	-0.25	V
$V_{BE\,(sat)}$*	Base-emitter saturation voltage	I_C = -10 mA I_B = -1 mA		-0.74	-0.9	V
h_{FE}	DC current gain	I_C = -10 μA V_{CE}= -10V	60	110		–
	*	I_C = -1 mA V_{CE}= -10V	80	170		–
	*	I_C = -10 mA V_{CE}= -10V	80	200	300	–
		I_C = -10 μA V_{CE}= -10V T_{amb}= -55°C	15	60		–
		I_C = -100 μA V_{CE}= -10V T_{amb}= -55°C	30	90		–
h_{fe}	Small signal current gain	I_C = -1 mA V_{CE}= -10V f = 1 kHz	100		400	–
f_T	Transition frequency	I_C = -1 mA V_{CE}= -10V f = 20 MHz	40	60	160	MHz

ELECTRICAL CHARACTERISTICS (continued)

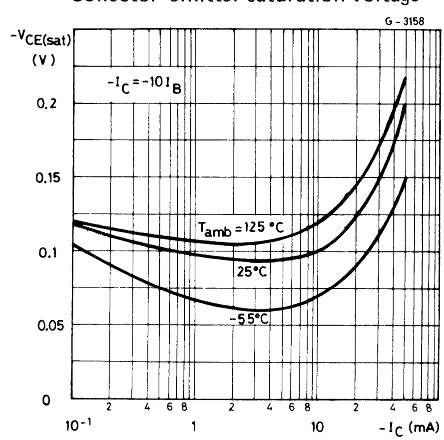
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = -0.5V$ $f = 1$ MHz		20	25	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -5V$ $f = 1$ MHz		5	7	pF
NF	Noise figure	$I_C = -10\ \mu A$ $V_{CE} = -5V$ $R_g \equiv 10\ k\Omega$ $f = 10$ kHz $B = 2$ kHz		1	3	dB
		$f = 1$ kHz $B = 200$ Hz		1	3	dB
		$f = 100$ Hz $B = 20$ Hz		2	10	dB
h_{ie}	Input impedance	$I_C = -1$ mA $V_{CE} = -10V$ $f = 1$ kHz	2.5		12	kΩ
h_{oe}	Output admittance	$I_C = -1$ mA $V_{CE} = -10V$ $f = 1$ kHz	5		25	μS

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

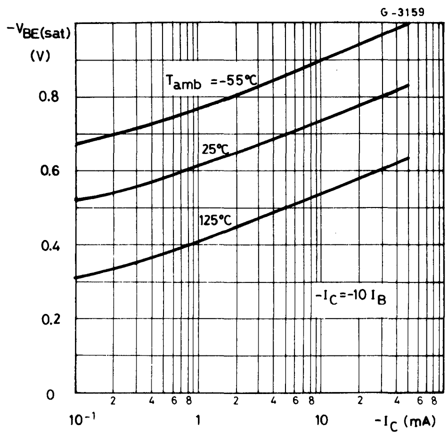
DC current gain



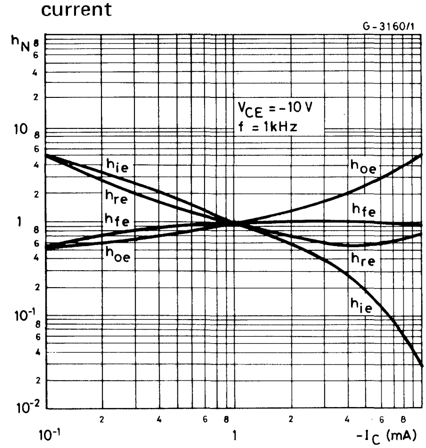
Collector-emitter saturation voltage



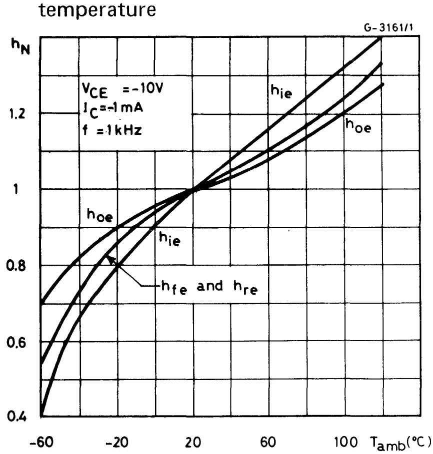
Base-emitter saturation voltage



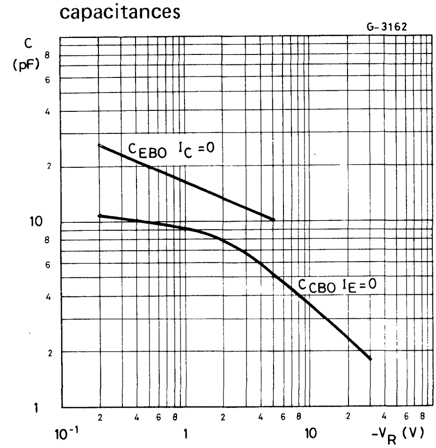
Normalized h parameters vs. collector current



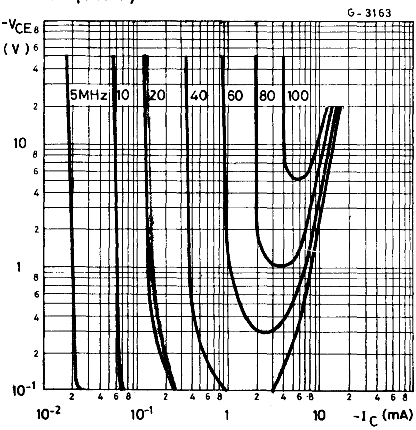
Normalized h parameters vs. ambient temperature



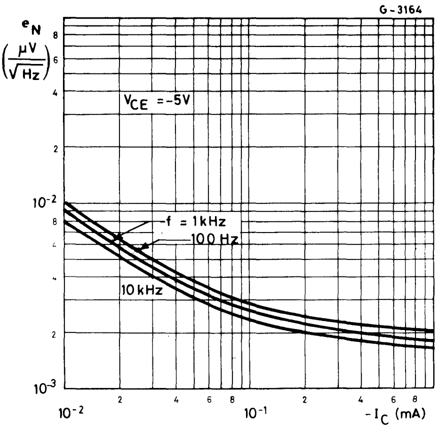
Emitter-base and collector-base capacitances



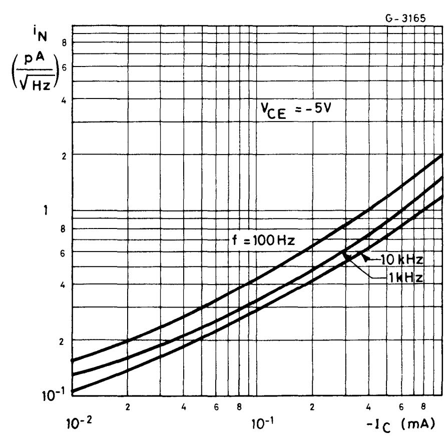
Contours of constant transition frequency



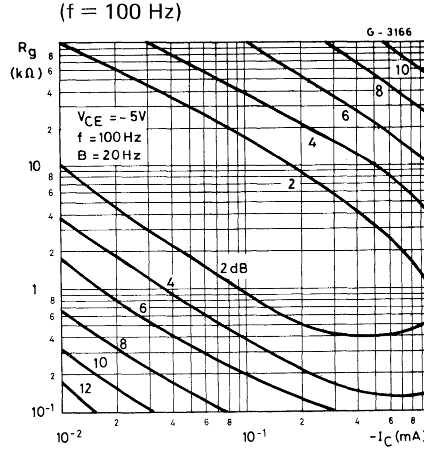
Equivalent input noise voltage



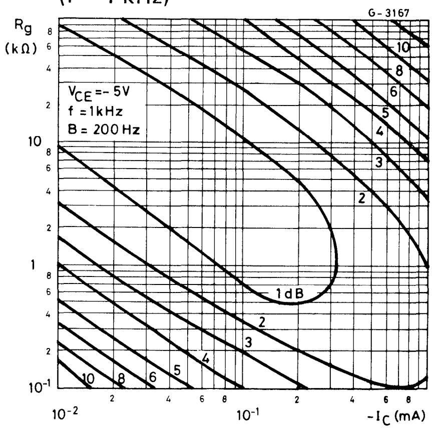
Equivalent input noise current



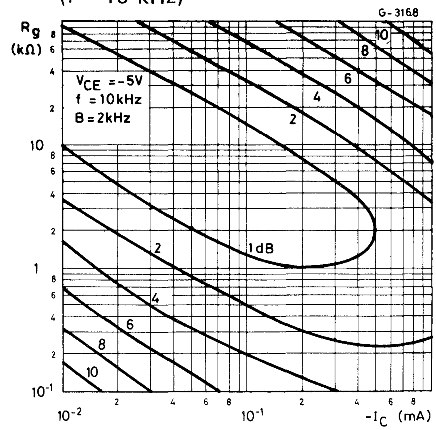
Contours of constant noise figure (f = 100 Hz)



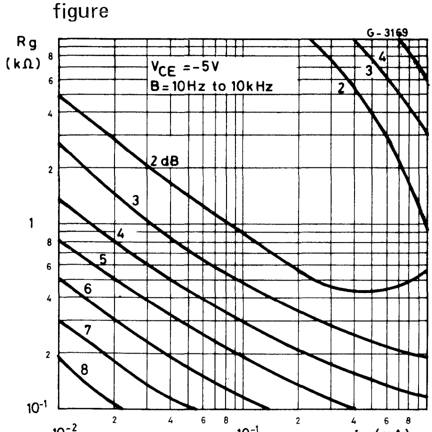
Contours of constant noise figure (f = 1 kHz)



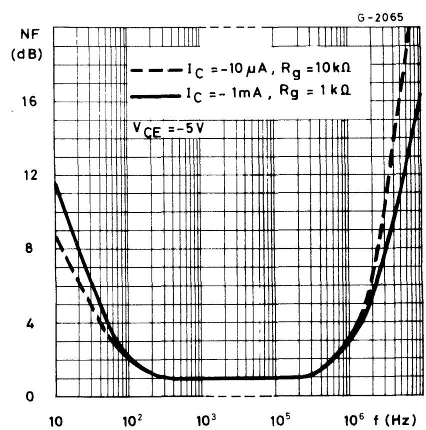
Contours of constant noise figure (f = 10 kHz)



Contours of constant wide band noise figure



Noise figure vs. frequency



SILICON PLANAR NPN

BFY 50
BFY 51
BFY 52

MEDIUM-POWER AMPLIFIERS

The BFY50, BFY51 and BFY52 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case. They are intended for general purpose linear and switching applications.

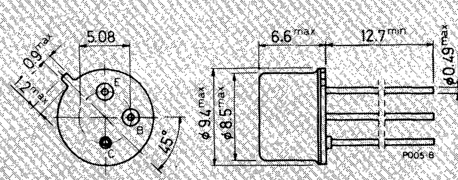
ABSOLUTE MAXIMUM RATINGS

		BFY 50	BFY 51	BFY 52
V_{CBO}	Collector-base voltage ($I_E = 0$)	80 V	60 V	40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	35 V	30 V	20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		6 V	
I_C	Collector current		1 A	
I_{CM}	Collector peak current		1.5 A	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$		0.8 W	
	at $T_{case} \leqslant 25°C$		5 W	
T_{stg}, T_j	Storage and junction temperature		-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	35	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	218	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25°C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	for **BFY 50**				
		V_{CB} = 60V		2	50	nA
		V_{CB} = 60V T_{case} = 100°C		0.055	2.5	μA
		for **BFY 51**				
		V_{CB} = 40V		2	50	nA
		V_{CB} = 40V T_{case} = 100°C		0.055	2.5	μA
		for **BFY 52**				
		V_{CB} = 30V		2	50	nA
		V_{CB} = 30V T_{case} = 100°C		0.055	2.5	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			50	nA
		V_{EB} = 5V T_{case} = 100°C			2.8	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA for **BFY 50**	80			V
		for **BFY 51**	60			V
		for **BFY 52**	40			V
$V_{CEO(sus)}$ *	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10 mA for **BFY 50**	35			V
		for **BFY 51**	30			V
		for **BFY 52**	20			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA	6			V
$V_{CE(sat)}$ *	Collector-emitter saturation voltage	I_C = 150 mA I_B = 15 mA				
		for **BFY 50**		0.14	0.2	V
		for **BFY 51** and **BFY 52**		0.14	0.35	V
		I_C = 1A I_B = 0.1 A				
		for **BFY 50**		0.7	1	V
		for **BFY 51** and **BFY 52**		0.7	1.6	V
$V_{BE(sat)}$ *	Base-emitter saturation voltage	I_C = 150 mA I_B = 15 mA		0.95		V
		I_C = 1A I_B = 0.1 A		1.5	2	V
h_{FE} *	DC current gain	for **BFY 50**				
		I_C = 10 mA V_{CE} = 6V	20	40		–
		I_C = 150 mA V_{CE} = 6V	30	55		–
		I_C = 1A V_{CE} = 6V	15	30		–
		for **BFY 51**				
		I_C = 10 mA V_{CE} = 6V	30	55		–
		I_C = 150 mA V_{CE} = 6V	40	70		–
		I_C = 1 A V_{CE} = 6V	15	40		–
		for **BFY 52**				
		I_C = 10 mA V_{CE} = 6V	30	80		–
		I_C = 150 mA V_{CE} = 6V	60	130		–
		I_C = 1 A V_{CE} = 6V	15	60		–

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	$V_{CE}=6V$ f = 1 kHz $I_C = 1$ mA				
		for **BFY 51**		30	42	–
		for **BFY 52**		30	84	–
		$I_C = 10$ mA				
		for **BFY 50**		45		–
		for **BFY 51**		60		–
		for **BFY 52**		120		–
f_T	Transition frequency	$I_C = 50$ mA $V_{CE}=6V$				
		for **BFY 50**	60	100		MHz
		for **BFY 51**	50	110		MHz
		for **BFY 52**	50	120		MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 12V$ f = 1 MHz		7	12	pF
h_{ie}	Input impedance	$I_C = 10$ mA $V_{CE} = 6V$ f = 1 kHz				
		for **BFY 50**		180		Ω
		for **BFY 51**		220		Ω
		for **BFY 52**		400		Ω
h_{re}	Reserve voltage ratio	$I_C = 10$ mA $V_{CE} = 6V$ f = 1 kHz				
		for **BFY 50**		55×10^{-6}		–
		for **BFY 51**		70×10^{-6}		–
		for **BFY 52**		130×10^{-6}		–
h_{oe}	Output admittance	$I_C = 10$ mA $V_{CE} = 6V$ f = 1 kHz				
		for **BFY 50**		30		μS
		for **BFY 51**		35		μS
		for **BFY 52**		70		μS
t_d	Delay time	$I_C = 150$ mA $V_{CC} = 10V$ $I_{B1} = 15$ mA $V_{BE} = -2V$		25		ns
t_r	Rise time	$I_C = 150$ mA $V_{CC} = 10V$ $I_{B1} = 15$ mA $V_{BE} = -2V$		30		ns
t_s	Storage time	$I_C = 150$ mA $V_{CC} = 10V$ $I_{B1} = -I_{B2} = 15$ mA				
		for **BFY 50**		140		ns
		for **BFY 51**		160		ns
		for **BFY 52**		220		ns
t_f	Fall time	$I_C = 150$ mA $V_{CC} = 10V$ $I_{B1} = -I_{B2} = 15$ mA				
		for **BFY 50** and **BFY 51**		35		ns
		for **BFY 52**		40		ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

BFY 56
BFY 56A

SILICON PLANAR NPN

AMPLIFIERS AND SWITCHES

The BFY 56 and BFY 56A are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case. They are designed for amplifier and switching applications over a wide range of voltage and current.

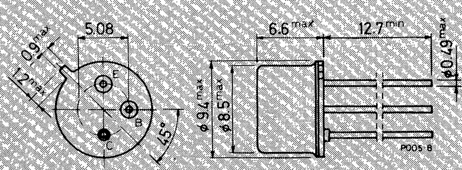
ABSOLUTE MAXIMUM RATINGS

		BFY 56	BFY 56A
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	85 V	85 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	45 V	55 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7 V	
I_C	Collector current	1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.8 W	
	at $T_{case} \leq 25°C$	5 W	
T_{stg}, T_j	Storage and junction temperature	-55 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	35	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	219	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 50V V_{CE} = 50V T_{amb} = 150°C		0.2 0.2	20 20	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V		0.1	20	nA
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 100 μA	85			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage	I_C = 10 mA for **BFY 56** for **BFY 56A**	 45 55			 V V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA	7			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	for **BFY 56** I_C = 150 mA I_B = 15 mA I_C = 1 A I_B = 0.1 A for **BFY 56A** I_C = 10 mA I_B = 1 mA I_C = 150 mA I_B = 15 mA I_C = 1 A I_B = 0.1 mA		 0.13 0.65 0.05 0.13 0.65	 0.3 1.2 0.25 1	 V V V V V

BFY 56
BFY 56A

ELECTRICAL CHARACTERISTICS (continued)

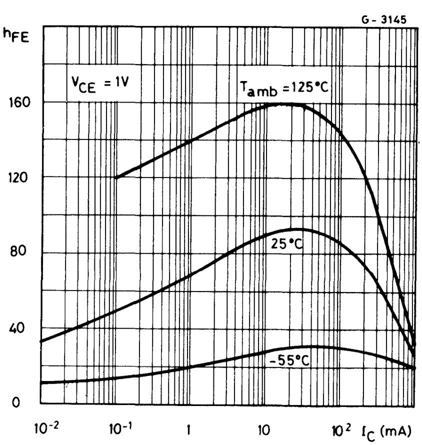
Parameter		Test conditions	Min.	Typ.	Max.	Unit
$V_{BE(sat)}$*	Base-emitter saturation voltage	for **BFY 56**				
		I_C = 150 mA I_B = 15 mA		0.85	1.5	V
		I_C = 1 A I_B = 0.1 A		1.5	2.3	V
		for **BFY 56A**				
		I_C = 10 mA I_B = 1 mA		0.68	0.8	V
		I_C = 150 mA I_B = 15 mA		0.85	1	V
		I_C = 1 A I_B = 0.1 A		1.3	1.6	V
h_{FE}	DC current gain	for **BFY 56**				
		I_C = 0.1 mA V_{CE} = 10V	15	50		–
	*	I_C = 500 mA V_{CE} = 10V	20	55		–
	*	I_C = 150 mA V_{CE} = 1V	30	70	150	–
		for **BFY 56A**				
		I_C = 0.1 mA V_{CE} = 1V	20	50		–
	*	I_C = 5 mA V_{CE} = 1V	50	85	120	–
	*	I_C = 150 mA V_{CE} = 1V	40	80	120	–
	*	I_C = 500 mA V_{CE} = 10V	25	55		–
h_{fe}	Small signal current gain	I_C = 1 mA V_{CE} = 5V				
		f = 1 kHz				
		for **BFY 56**		60		–
		for **BFY 56A**		80		–
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10V				
		f = 20 MHz				
		for **BFY 56**	40	90		MHz
		for **BFY 56A**	60	90		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V				
		f = 1 MHz		50	80	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V				
		f = 1 MHz		14	25	pF
h_{ie}	Input impedance	I_C = 1 mA V_{CE} = 5V				
		f = 1 kHz				
		for **BFY 56**		1.8		kΩ
		for **BFY 56A**		2		kΩ
h_{re}	Reverse voltage ratio	I_C = 1 mA V_{CE} = 5V				
		f = 1 kHz		2.1×10^{-4}		–

ELECTRICAL CHARACTERISTICS (continued)

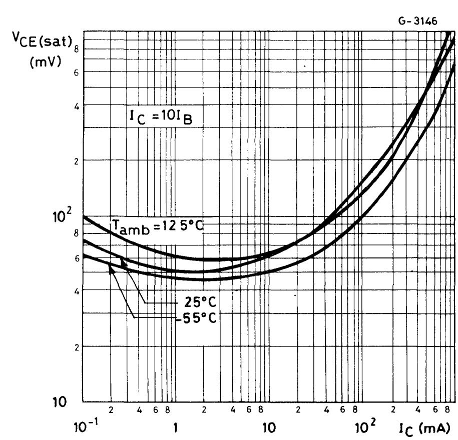
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{oe}	Output admittance	I_C = 1 mA V_{CE} = 5V f = 1 kHz		8		μS
h_{ib}	Input impedance	I_C = 1 mA V_{CB} = 5V f = 1 kHz		27		Ω
h_{rb}	Reverse voltage ratio	I_C = 1 mA V_{CB} = 5V f = 1 kHz		0.5×10^{-4}		–
h_{ob}	Output admittance	I_C = 1 mA V_{CB} = 5V f = 1 kHz		0.12		μS
t_{on}	Turn-on time	I_C = 150 mA V_{CC}= 20V I_{B1}= 7.5 mA		150	225	ns
t_{off}	Turn-off time	I_C = 150 mA V_{CC}= 20V I_{B1}= $-I_{B2}$ = 7.5 mA		350	800	ns

*Pulsed: pulse duration = 300 μs, duty cycle = 1%

DC current gain

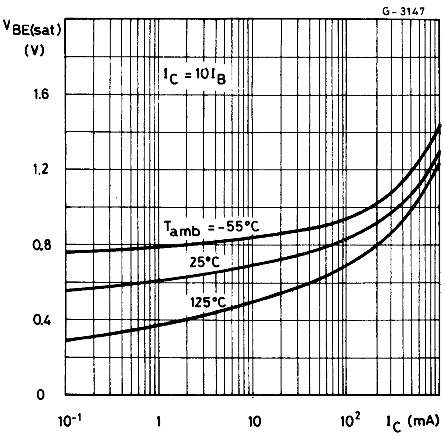


Collector-emitter saturation voltage

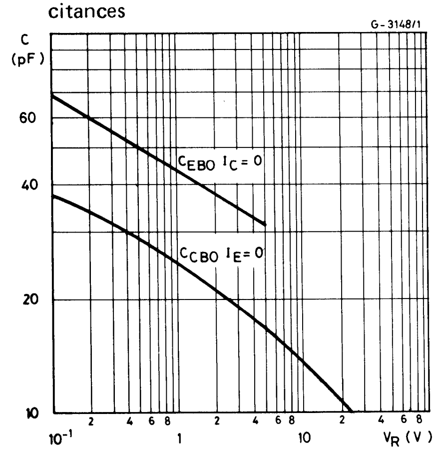


BFY 56
BFY 56A

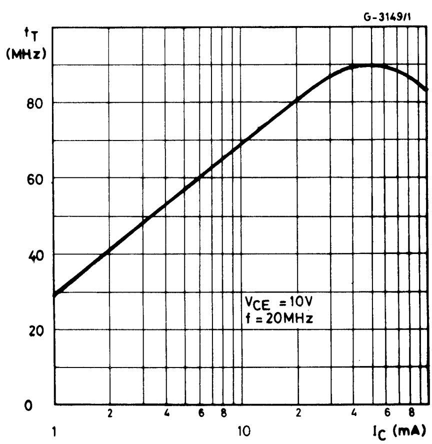
Base-emitter saturation voltage



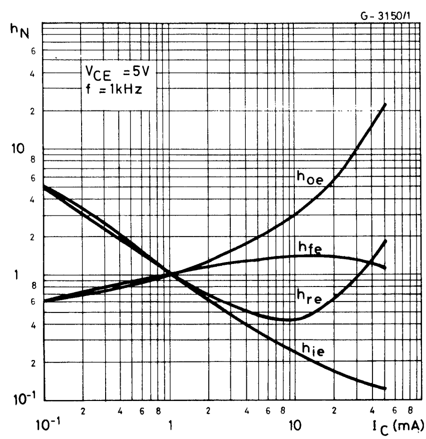
Emitter-base and collector-base capacitances



Transition frequency



Normalized h parameters



SILICON PLANAR PNP

BFY 64

HIGH-CURRENT GENERAL PURPOSE TRANSISTOR

The BFY 64 is a silicon planar epitaxial PNP transistor in Jedec TO-39 metal case. It is designed for digital and analog applications at current levels up to 500 mA, line driver, memory applications and in low-noise amplifiers.

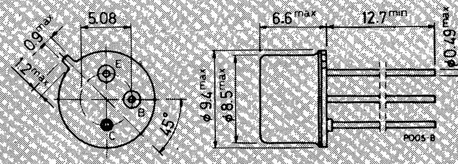
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	- 5	V
I_C	Collector current	-500	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.7	W
	at $T_{case} \leqslant 25°C$	3	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

BFY 64

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	58	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	250	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -25V		-0.2	-30	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA	-40			V
$V_{CEO\,(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = -10 mA	-40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA	-5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = - 50 mA I_B = -2.5 mA I_C = -150 mA I_B = -15 mA I_C = -500 mA I_B = -50 mA		-0.08 -0.18 -0.6	-0.3 -0.5 -1.8	V V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = - 50 mA I_B = -2.5 mA I_C = -150 mA I_B = -15 mA I_C = -500 mA I_B = -50 mA		-0.92 -1 	-1.1 -1.4 -2.2	V V V

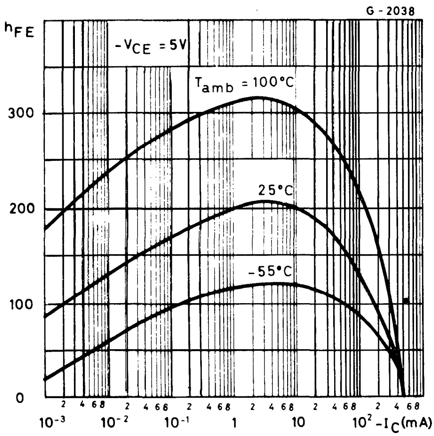
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	I_C = - 10 μA V_{CE} = -10V		130		–
		I_C = - 1 mA V_{CE} = -10V		200		–
	*	I_C = - 10 mA V_{CE} = -10V	80	200		–
	*	I_C = - 50 mA V_{CE} = - 1V		150		–
	*	I_C = -150 mA V_{CE} = -10V		130		–
h_{fe}	Small signal current gain	I_C = -10 mA V_{CE} = -10V f = 1 kHz		200		–
f_T	Transition frequency	I_C = -50 mA V_{CE} = -20V f = 100 MHz	200	250		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -0.5V f = 1 MHz		15	25	pF
C_{CBO}	Collector - base capacitance	I_E = 0 V_{CB} = -10V f = 1 MHz		6	10	pF
NF	Noise figure	I_C = -30 μA V_{CE} = -5V R_g = 10 kΩ f = 1 kHz		1		dB
h_{ie}	Input impedance	I_C = -10 mA V_{CE} = -10V f = 1 kHz		1		kΩ
h_{re}	Reverse voltage ratio	I_C = -10 mA V_{CE} = -10V f = 1 kHz		2.4×10^{-4}		–
h_{oe}	Output admittance	I_C = -10 mA V_{CE} = -10V f = 1 kHz		110		μS
t_{on}	Turn-on time	I_C = -300 mA V_{CC}= -30V I_{B1}= -30 mA		35	50	ns
t_{off}	Turn-off time	I_C = -300 mA V_{CC}= -30V I_{B1} = $-I_{B2}$ = -30 mA		70	120	ns

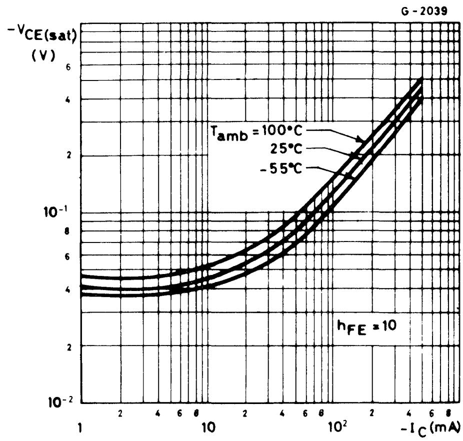
*Pulsed: pulse duration = 300 μs, duty cycle = 1%

BFY 64

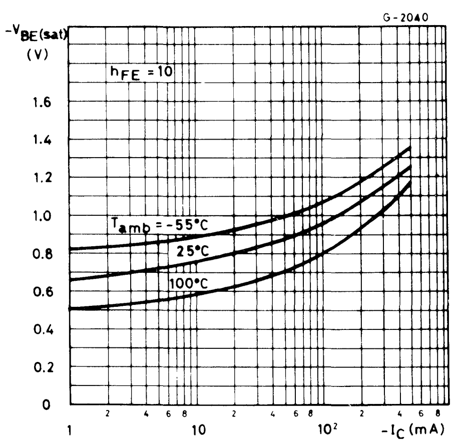
DC current gain



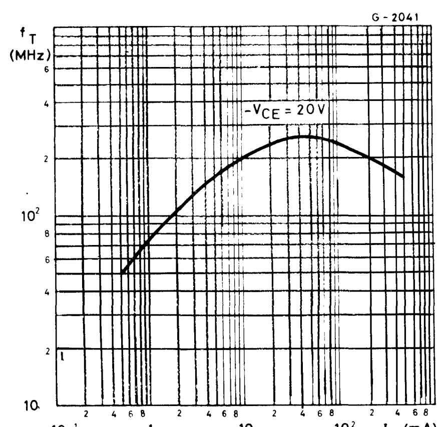
Collector-emitter saturation voltage



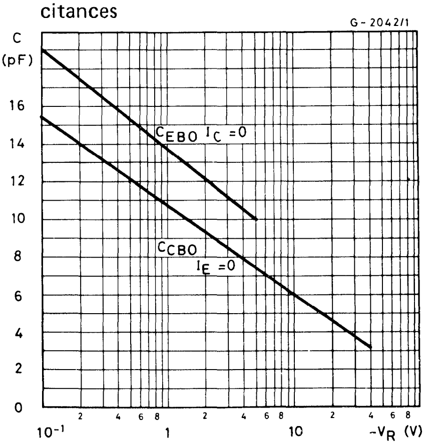
Base-emitter saturation voltage



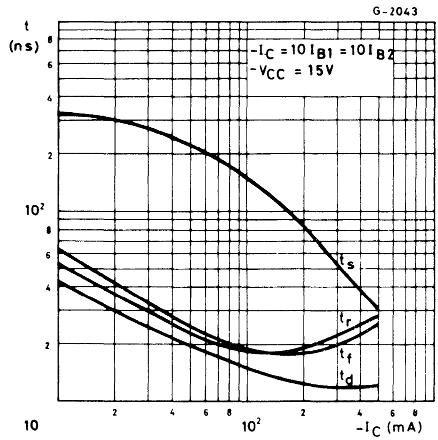
Transition frequency



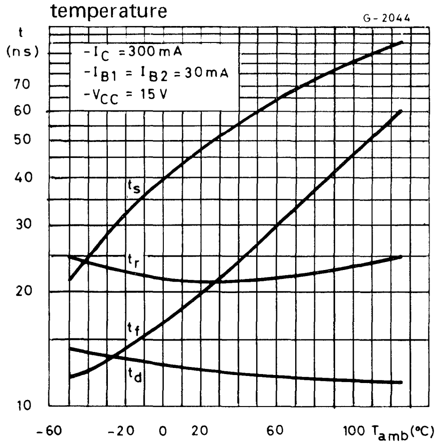
Emitter-base and collector-base capacitances



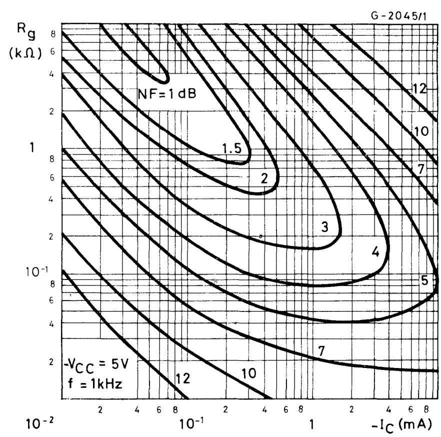
Switching characteristics



Switching characteristics vs. ambient temperature



Contours of constant noise figure



BFY 76

SILICON PLANAR NPN

LOW-LEVEL, LOW-NOISE AMPLIFIER

The BFY 76 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed for use in high-performance, low level, low noise amplifier circuits from audio to high frequencies.

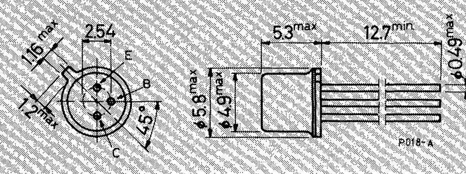
ABSOLUTE MAXIMUM RATINGS

V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	60	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	8	V
I_C	Collector current	50	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36	W
	$T_{case} \leqslant 25°C$	1.2	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 50V V_{CE} = 50V T_{amb} = 150°C		0.1 0.1	20 20	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V		0.1	20	nA
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10 μA	60			V
→ $V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10 mA	60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA	8			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 1 mA I_B = 0.1 mA		0.15	0.35	V
V_{BE}	Base-emitter voltage	I_C = 100 μA V_{CE} = 5V	0.5	0.58	0.7	V
→ h_{FE}*	DC current gain	I_C = 10 μA V_{CE} = 5V I_C = 100 μA V_{CE} = 5V I_C = 1 mA V_{CE} = 5V I_C = 5 mA V_{CE} = 5V	30 150 	70 120 190 220	 300 	– – – –
h_{fe}	Small signal current gain	I_C = 1 mA V_{CE} = 5V f = 1 kHz	80	220	300	–
f_T	Transition frequency	I_C = 1 mA V_{CE} = 5V f = 20 MHz	70	100		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz		3.5	6	pF

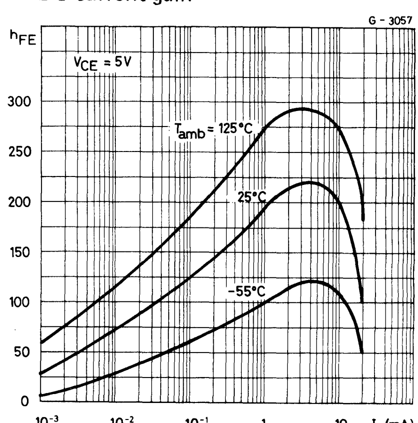
BFY 76

ELECTRICAL CHARACTERISTICS (continued)

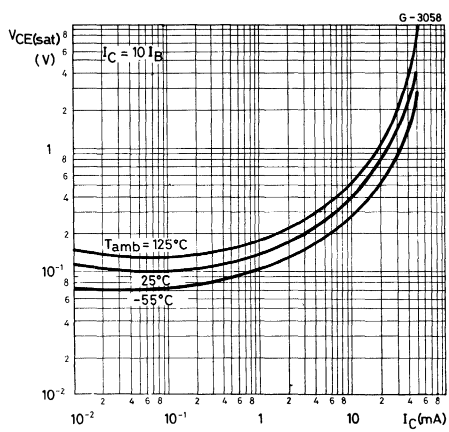
	Parameter	Test conditions		Min.	Typ.	Max.	Unit
C_{CBO}	Collector-base capacitance	$I_E = 0$ f = 1 MHz	$V_{CB} = 5V$		3.5	6	pF
NF	Noise figure	$I_C = 10\ \mu A$ $R_g = 10\ k\Omega$	$V_{CE} = 5V$ f = 100 Hz f = 1 kHz f = 10 to 10 000 Hz		4 1.5 1.9	15 4 4	dB dB dB
h_{ie}	Input impedance	$I_C = 1$ mA f = 1 kHz	$V_{CE} = 5V$	1.5	8	15	kΩ
h_{re}	Reverse voltage ratio	$I_C = 1$ mA f = 1 kHz	$V_{CE} = 5V$		3×10^{-4}	8×10^{-4}	–
h_{oe}	Output admittance	$I_C = 1$ mA f = 1 kHz	$V_{CE} = 5V$		11	35	μS
h_{ib}	Input impedance	$I_C = 1$ mA f = 1 kHz	$V_{CB} = 5V$	25	27	32	Ω

*Pulsed: pulse duration = 300 μs, duty cycle = 1%

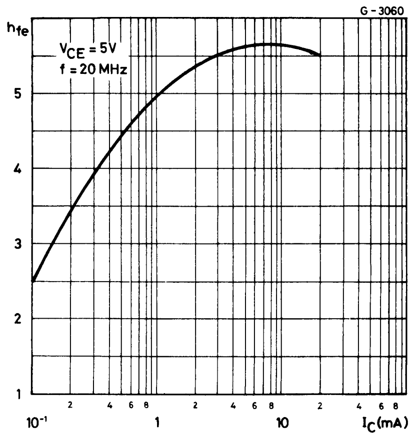
DC current gain



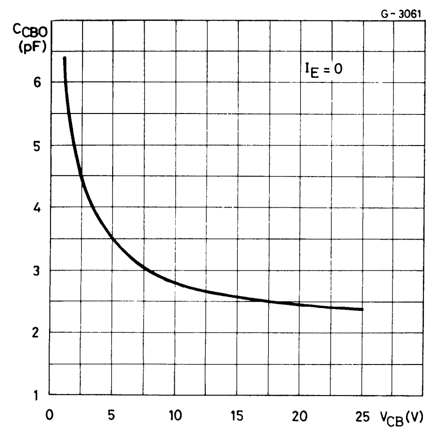
Collector-emitter saturation voltage



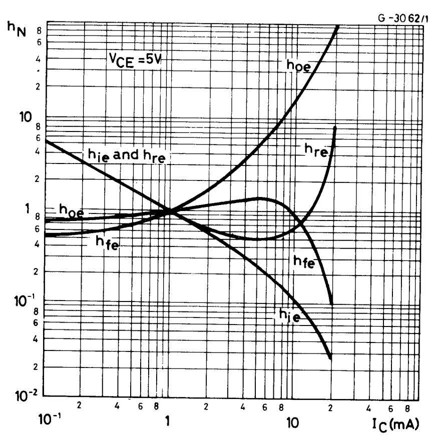
High frequency current gain



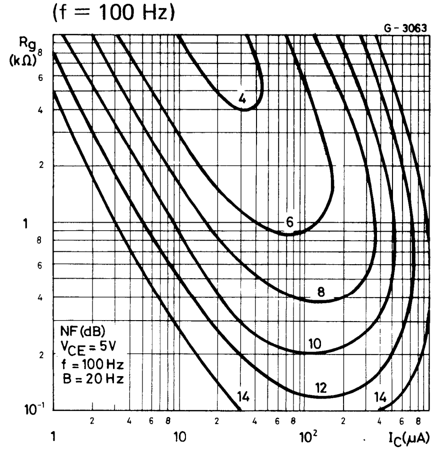
Collector-base capacitance



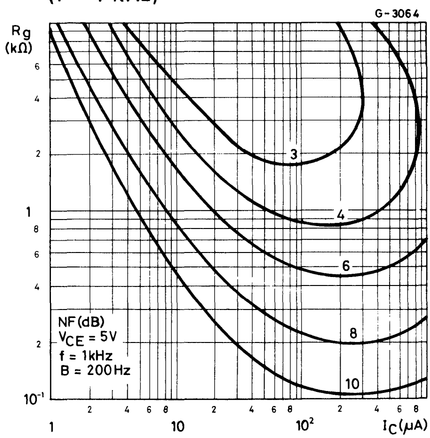
Normalized h parameters



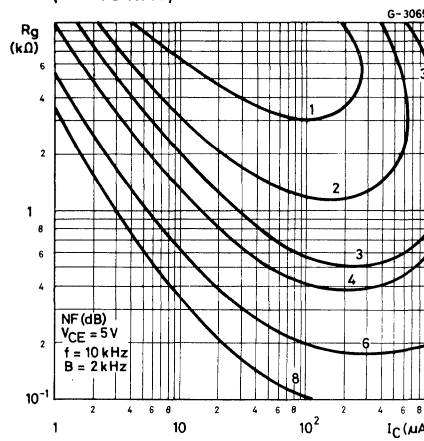
Contours of constant noise figure (f = 100 Hz)



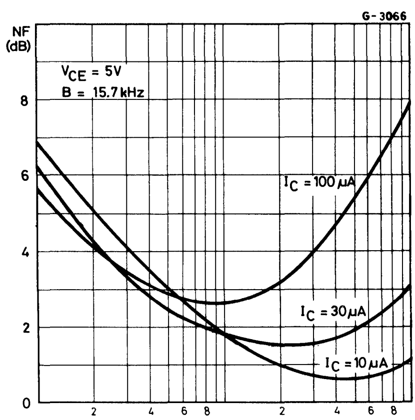
Contours of constant noise figure
(f = 1 kHz)



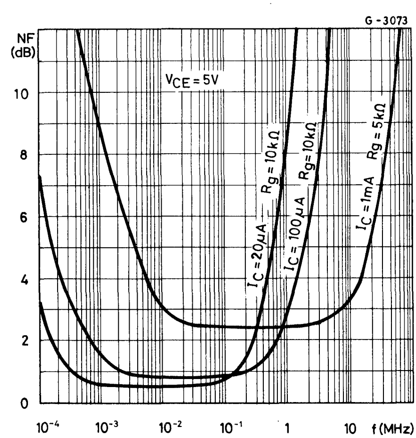
Contours of constant noise figure
(f = 10 kHz)



Noise figure vs. source resistance



Noise figure vs. frequency



SILICON PLANAR NPN

BSS 26

HIGH-VOLTAGE, HIGH-CURRENT SWITCH

The BSS 26 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is intended for high voltage, high current switching applications.

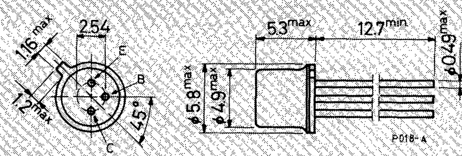
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	60	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36	W
	at $T_{case} \leqslant 25°C$	1.2	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

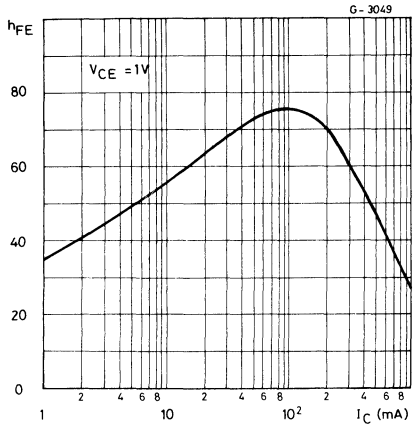
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

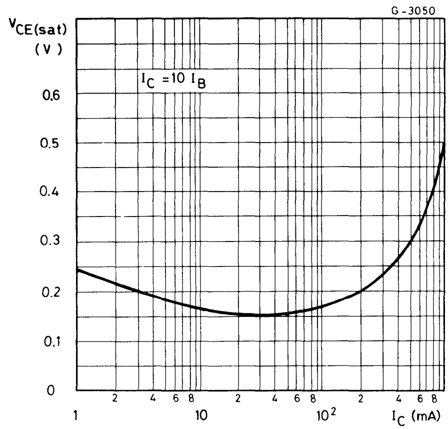
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 40V$ $V_{CB} = 40$ $T_{amb} = 100°C$		0.1 20	1.7 120	μA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu A$	60			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage ($V_{BE} = 0$)	$I_C = 10\ \mu A$	60			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 10$ mA	40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu A$	6			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 100 mA I_B = 10 mA I_C = 500 mA I_B = 50 mA I_C = 1 A I_B = 0.1 A		0.17 0.3 0.5	0.3 0.5 0.95	V V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 100 mA I_B = 10 mA I_C = 500 mA I_B = 50 mA I_C = 1 A I_B = 0.1 A	 0.8 	0.78 0.95 1.05	0.9 1.2 1.7	V V V
h_{FE}*	DC current gain	I_C = 10 mA V_{CE} = 1V I_C = 100 mA V_{CE} = 1V I_C = 500 mA V_{CE} = 1V I_C = 1 A V_{CE} = 5V	25 40 25 	55 75 45 45		– – – –
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10V f = 100 MHz	250	400		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz		40	55	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 1 MHz		4.8	12	pF
t_{on}	Turn-on time	I_C = 500 mA V_{CC}= 30V I_{B1}= 50 mA		15	35	ns
t_{off}	Turn-off time	I_C = 500 mA V_{CC}= 30V $I_{B1} = -I_{B2}$ = 50 mA		40	60	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

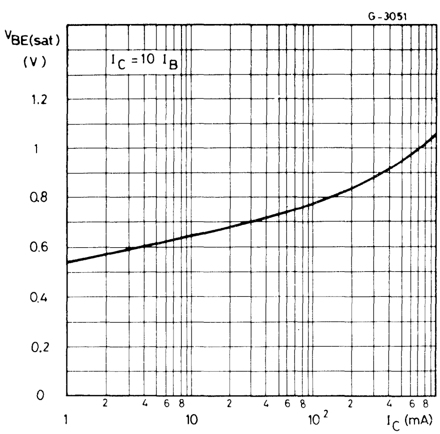
DC current gain



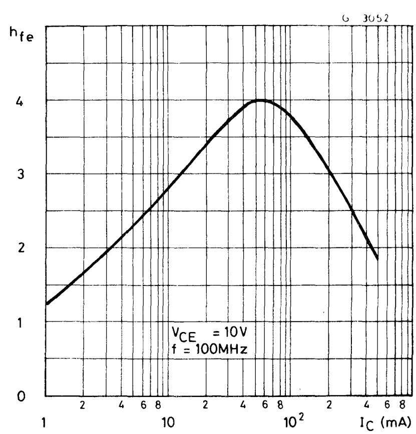
Collector-emitter saturation voltage



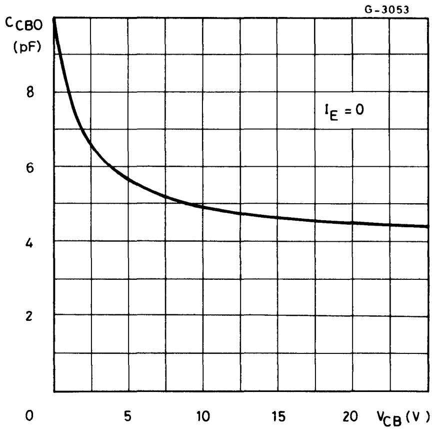
Base-emitter saturation voltage



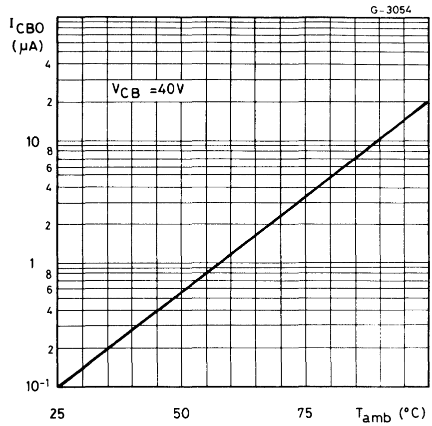
High frequency current gain



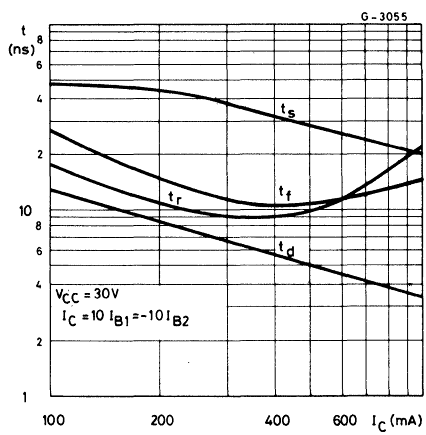
Collector-base capacitance



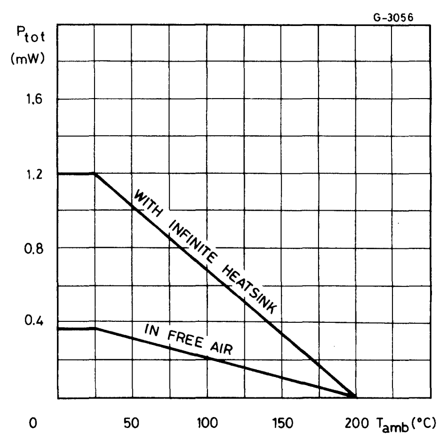
Collector cutoff current



Switching characteristics



Power rating chart



SILICON PLANAR PNP

BSV 15
BSV 16

MEDIUM POWER AMPLIFIERS

The BSV 15 and BSV 16 are silicon planar epitaxial PNP transistors in Jedec TO-39 metal case, intended for use in medium power general industrial applications.

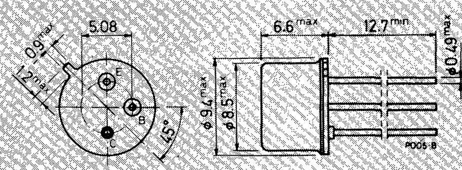
ABSOLUTE MAXIMUM RATINGS

		BSV15	BSV16
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-40 V	-60 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40 V	-60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_C	Collector current	- 1 A	
I_B	Base current	-0.2 A	
P_{tot}	Total power dissipation at $T_{case} \leq 25°C$	5 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

7/76

BSV 15
BSV 16

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	35	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	200	°C/W

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

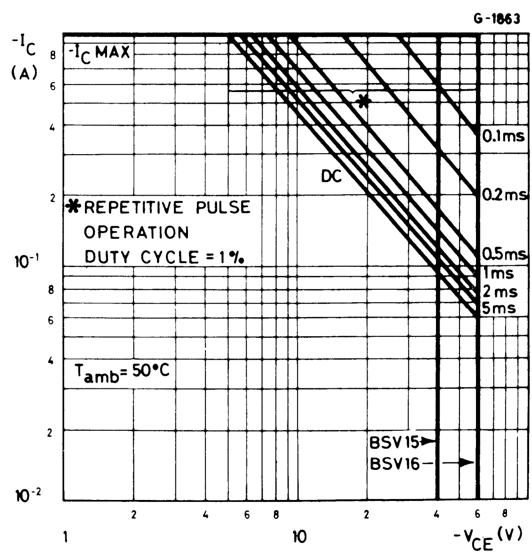
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **BSV 15**				
		V_{CE} = -40V			-0.1	μA
		V_{CE} = -40V T_{amb} = 150°C			-50	μA
		for **BSV 16**				
		V_{CE} = -60V			-0.1	μA
		V_{CE} = -60V T_{amb} = 150°C			-50	μA
I_{CEX}	Collector cutoff current (V_{BE} = 0.2 V)	for **BSV 15**				
		V_{CE} = -40V T_{amb} = 100°C			-50	μA
		for **BSV 16**				
		V_{CE} = -60V T_{amb} = 100°C			-50	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -4V			-50	nA
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10 μA				
		for **BSV 15**	-40			V
		for **BSV 16**	-60			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = - 10 mA				
		for **BSV 15**	-40			V
		for **BSV 16**	-60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA	-5			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = -500 mA I_B = -25 mA	-0.25		-1	V
V_{BE}	Base-emitter voltage	I_C = -100 mA V_{CE} = -1V			-1	V
		I_C = -500 mA V_{CE} = -1V	-0.7	-0.85	-1.4	V
h_{FE}	DC current gain	I_C = -0.1 mA V_{CE} = -1V				
		Gr. 6	15	44		–
		Gr. 10	20	75		–
		Gr. 16	30	120		–
		I_C = -100 mA V_{CE} = -1V				
		Gr. 6	40	63	100	–
		Gr. 10	63	100	160	–
		Gr. 16	100	160	250	–

ELECTRICAL CHARACTERISTICS (continued)

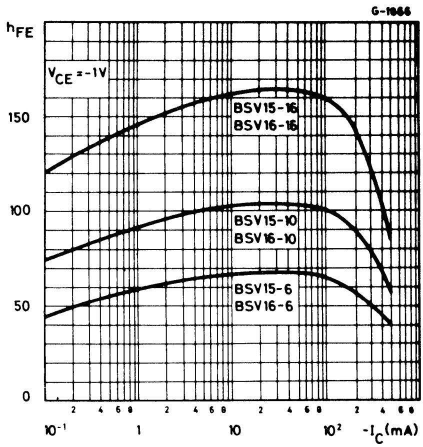
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	I_C = -500 mA V_{CE} = -1V Gr. 6	20	40		–
		Gr. 10	25	55		–
		Gr. 16	35	85		–
h_{fe}	Small signal current gain	I_C = -1 mA V_{CE} = -5V f = 1kHz	20			–
f_T	Transition frequency	I_C = -50 mA V_{CE} = -1V f = 20 MHz	50			MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -0.5V f = 1 MHz		180		pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10V f = 1 MHz		20	30	pF
t_s	Storage time	I_C = -100 mA V_{CC} = -20V I_{B1} = $-I_{B2}$ = -5mA			500	ns
t_f	Fall time	I_C = -100 mA V_{CC} = -20V I_{B1} = $-I_{B2}$ = -5 mA			150	ns
t_{on}	Turn-on time	I_C = -100 mA V_{CC} = -20V I_{B1} = -5 mA			500	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

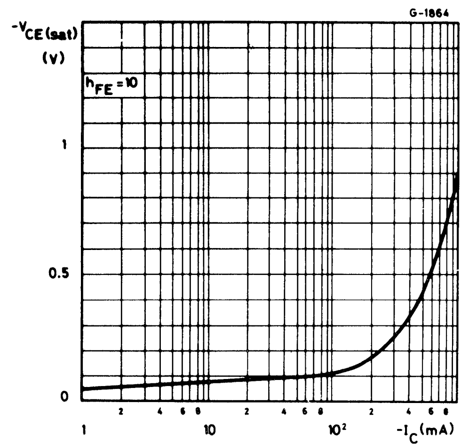
Safe operating areas



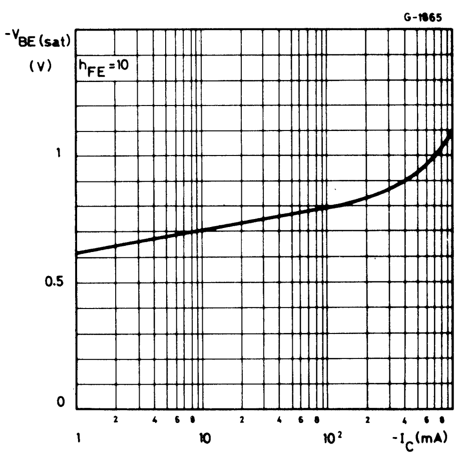
DC current gain



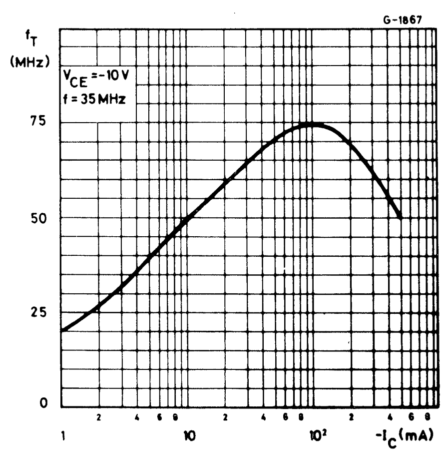
Collector-emitter saturation voltage



Base-emitter saturation voltage



Transition frequency



BSV 59

SILICON PLANAR NPN

HIGH-SPEED SATURATED SWITCH

The BSV 59 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is intended for high speed switching applications at collector currents up to 500 mA.

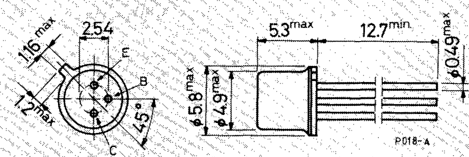
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	500	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36	W
	at $T_{case} \leqslant 25°C$	1.2	W
	at $T_{case} \leqslant 100°C$	0.68	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-18)

BSV 59

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

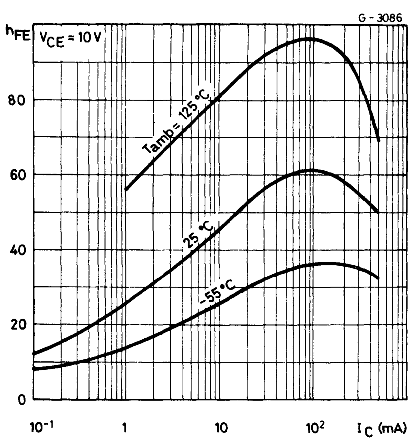
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 30V$		40	200	nA
		$V_{CB} = 30V$ $T_{amb} = 125°C$		20	200	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 0.1$ mA	60			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 10$ mA	30			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 0.1$ mA	5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	$I_C = 50$ mA $I_B = 5$ mA		0.16		V
		$I_C = 150$ mA $I_B = 15$ mA		0.22	0.4	V
		$I_C = 500$ mA $I_B = 50$ mA		0.48	1	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	$I_C = 50$ mA $I_B = 5$ mA		0.78		V
		$I_C = 150$ mA $I_B = 15$ mA		0.85	1.2	V
		$I_C = 500$ mA $I_B = 50$ mA		1.12	1.6	V
h_{FE}*	DC current gain	$I_C = 50$ mA $V_{CE} = 10V$		60		–
		$I_C = 150$ mA $V_{CE} = 10V$	30	60	140	–
		$I_C = 500$ mA $V_{CE} = 10V$	20	50		–
		$I_C = 150$ mA $V_{CE} = 1V$		50		–
		$I_C = 500$ mA $V_{CE} = 1V$	10	30		–

ELECTRICAL CHARACTERISTICS (continued)

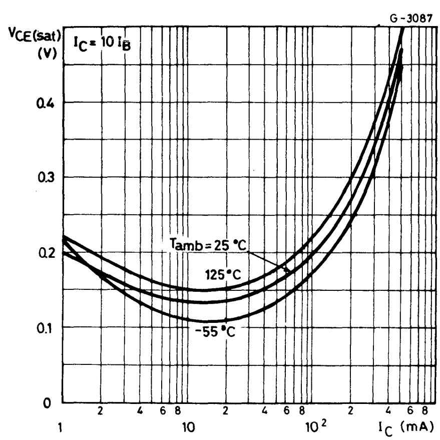
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10V f = 100 MHz	250	350		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz		38		pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 1 MHz		6	8	pF
t_{on}	Turn-on time	I_C = 150 mA V_{CC} = 10V I_{B1} = 15 mA		18	40	ns
t_{off}	Turn-off time	I_C = 150 mA V_{CC} = 10V I_{B1} = $-I_{B2}$ = 15 mA		25	40	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

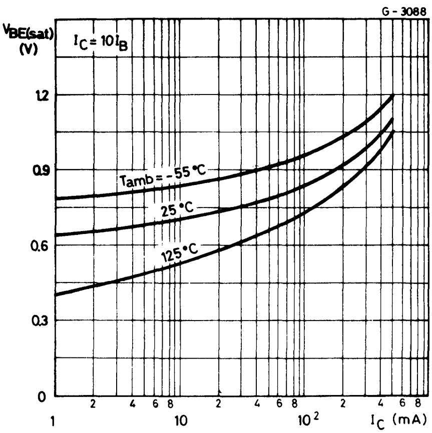
DC current gain



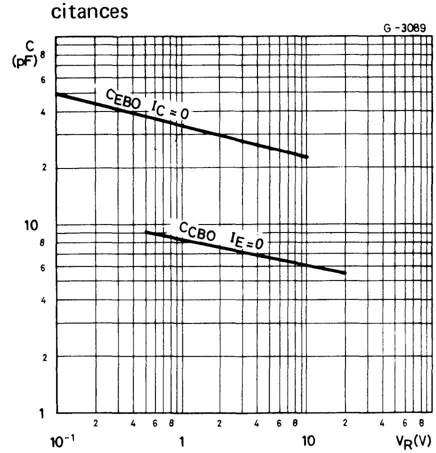
Collector-emitter saturation voltage



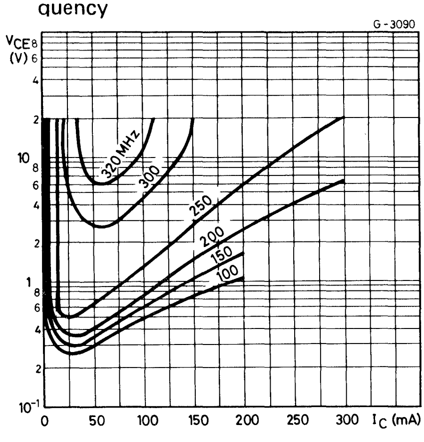
Base-emitter saturation voltage



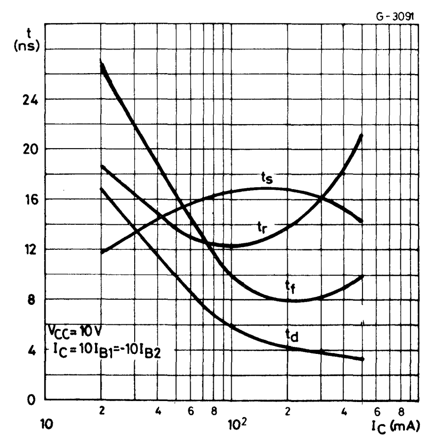
Emitter-base and collector-base capacitances



Contours of constant transition frequency



Switching characteristics



SILICON PLANAR NPN

BSX 12

HIGH-SPEED, HIGH-CURRENT SWITCH

The BSX12 is a silicon planar epitaxial NPN transistor in low profile TO-39 metal case, with very high speed switching capability at high currents.

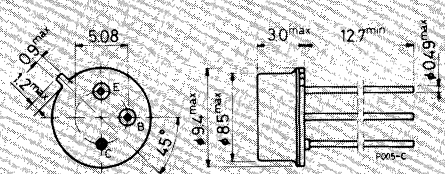
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	25	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	12	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.6	W
	at $T_{case} \leq 25°C$	3	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

BSX 12

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	58.3	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	292	°C/W

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

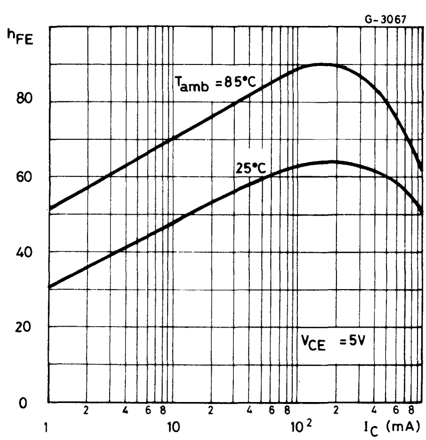
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 15V			1.5	100	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 500 μA		25			V
$V_{CEO(sus)}$ *	Collector-emitter sustaining voltage (I_B=0)	I_C = 10 mA		12			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C=0)	I_E = 100 μA		4			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 10mA	I_B = 1 mA		0.17	0.25	V
	*	I_C = 100mA	I_B = 10mA		0.18	0.23	V
	*	I_C = 300mA	I_B = 30mA		0.24	0.33	V
	*	I_C = 1A	I_B = 100mA		0.51	0.7	V
	*	I_C = 300mA T_{amb}=85°C	I_B = 30mA		0.25	0.5	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = 10mA	I_B = 1mA		0.68	0.78	V
	*	I_C = 100mA	I_B = 10mA		0.84	1.1	V
	*	I_C = 300mA	I_B = 30mA		1	1.3	V
	*	I_C = 1A	I_B = 100mA	0.9	1.36	2.1	V
h_{FE} *	DC current gain	I_C = 10 mA	V_{CE} = 0.5V	20	45		–
		I_C = 100mA	V_{CE} = 0.5V	30			–
		I_C = 300mA	V_{CE} = 0.5V	30	60	120	–
f_T	Transition frequency	I_C = 100mA	f = 100MHz				
			V_{CE} = 5V	450	650		MHz
			V_{CB} = 0	200			MHz

ELECTRICAL CHARACTERISTICS (continued)

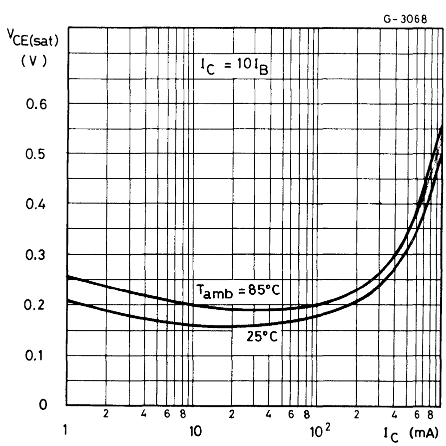
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5V$ $f = 1 MHz$		14.8	25	pF
C_{EBO}	Collector-base capacitance	$I_E = 0$ $f = 1 MHz$ $V_{CB} = 5V$ $V_{CB} = 0$		6.2	15 25	pF pF
t_s	Storage time	$I_C = 100mA$ $V_{CC} = 5V$ $I_{B1} = -I_{B2} = 100mA$		13	15	ns
t_{on}	Turn-on time	$I_C = 1A$ $V_{CC} = 12V$ $I_{B1} = 100mA$		10	15	ns
t_{off}	Turn-off time	$I_C = 1A$ $V_{CC} = 12V$ $I_{B1} = -I_{B2} = 100mA$		15	25	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

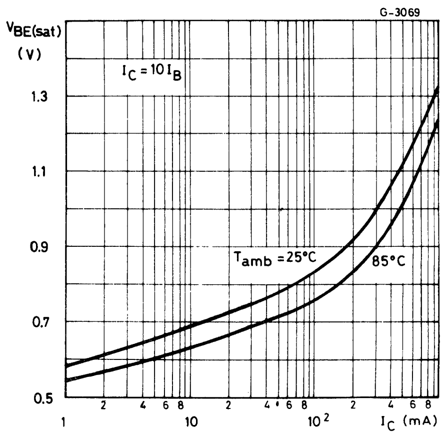
DC current gain



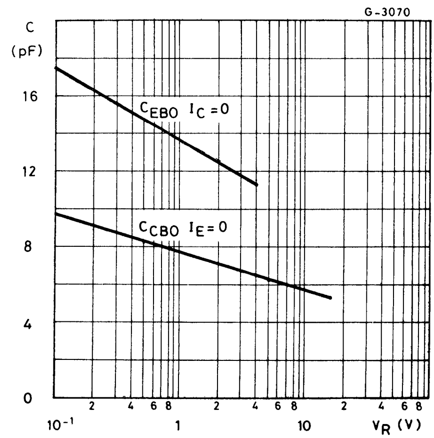
Collector-emitter saturation voltage



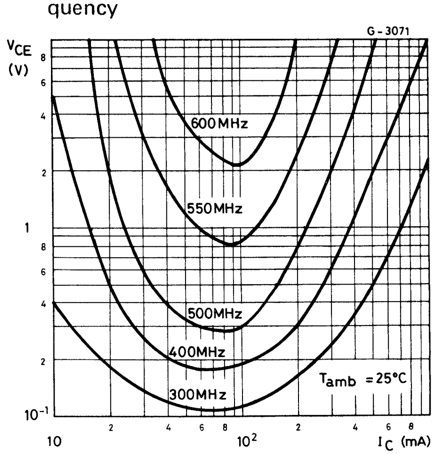
Base-emitter saturation voltage



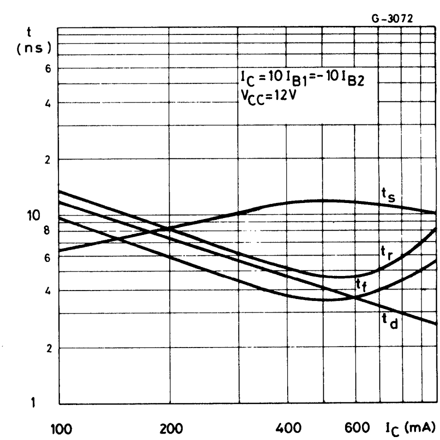
Emitter-base and collector-base capacitances



Contours of constant transistion frequency



Switching characteristics



SILICON PLANAR NPN

BSX 19
BSX 20

HIGH-SPEED SATURATED SWITCHES

The BSX 19 and BSX 20 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case. They are primarily intended for very high speed saturated switching applications.

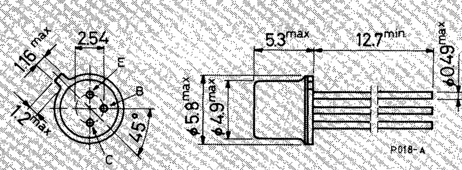
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	15	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4.5	V
I_{CM}	Collector peak current ($t = 10\ \mu s$)	0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.36	W
	at $T_{case} \leq 25°C$	1.2	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

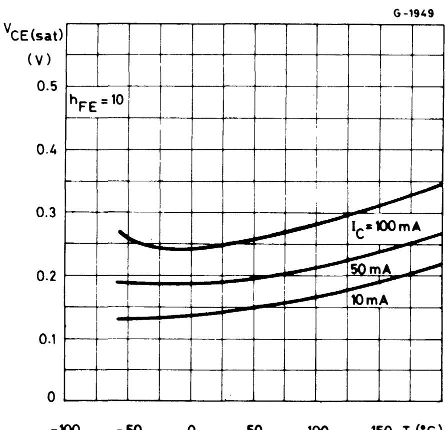
Parameter			Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)		V_{CB} = 20V V_{CB} = 20V T_{amb} = 150°C			0.4 30	μA μA
I_{CES}	Collector cutoff current (V_{BE} = 0)		V_{CE} = 15V T_{amb} = 55°C V_{CE} = 40V			0.4 1	μA μA
I_{CEX}	Collector cutoff current (V_{BE} = -3V)		V_{CE} = 15V T_{amb} = 55°C			0.6	μA
I_{EBO}	Emitter cutoff current (I_C = 0)		V_{EB} = 4.5V			10	μA
I_{BEX}	Base cutoff current (V_{BE} = -3V)		V_{CE} = 15V T_{amb} = 55°C			0.6	μA
$V_{CER\ (sus)}$	* Collector-emitter sustaining voltage (R_{BE} = 10Ω)		I_C = 10 mA	20			V
$V_{CEO\ (sus)}$	* Collector-emitter sustaining voltage (I_B = 0)		I_C = 10 mA	15			V
$V_{CE\ (sat)}$	Collector-emitter saturation voltage	* * 	I_C = 10 mA I_B = 1 mA I_C = 100 mA I_B = 10 mA for **BSX 19** I_C = 10 mA I_B = 0.6 mA for **BSX 20** I_C = 10 mA I_B = 0.3 mA			0.25 0.6 0.3 0.3	V V V V
V_{BE}	Base-emitter voltage		I_C = 30 μA V_{CE} = 20V T_{amb} = 100°C	0.35			V
$V_{BE\ (sat)}$	Base-emitter saturation voltage	*	I_C = 10 mA I_B = 1 mA I_C = 100 mA I_B = 10 mA	0.7		0.85 1.5	V V
h_{FE}	DC current gain	* *	for **BSX 19** I_C = 10 mA V_{CE} = 1V I_C = 100 mA V_{CE} = 2V I_C = 10 mA V_{CE} = 1V T_{amb} = -55°C for **BSX 20** I_C = 10 mA V_{CE} = 1V I_C = 100 mA V_{CE} = 2V I_C = 10 mA V_{CE} = 1V T_{amb} = -55°C	 20 10 10 40 20 20		 60 120	 – – – – – –

ELECTRICAL CHARACTERISTICS (continued)

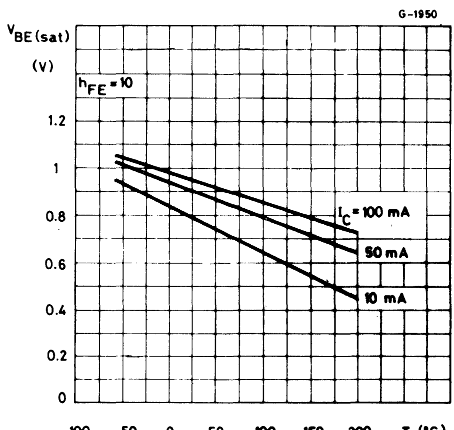
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	I_C = 10 mA V_{CE} = 10V for **BSX 19** for **BSX 20**	 400 500	 500 600		 MHz MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 1V			4.5	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 5V			4	pF
t_s	Storage time	I_C = 10 mA V_{CC} = 10V I_{B1} = $-I_{B2}$ = 10 mA for **BSX 19** for **BSX 20**		 5 6	 10 13	 ns ns
t_{on}	Turn-on time	I_C = 10 mA V_{CC} = 3V I_{B1} = 3 mA I_C = 100 mA V_{CC} = 6V I_{B1} = 40 mA			 12 7	 ns ns
t_{off}	Turn-off time	I_C = 10 mA V_{CC} = 3V I_{B1} = 3 mA I_{B2} = −1.5 mA for **BSX 19** for **BSX 20** I_C = 100 mA V_{CC} = 6V I_{B1} = 40 mA I_{B2} = −20 mA for **BSX 19** for **BSX 20**			 15 18 18 21	 ns ns ns ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

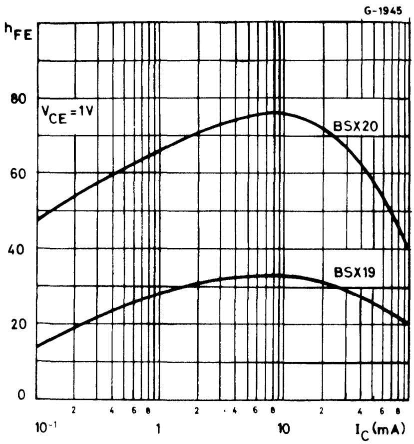
Collector-emitter saturation voltage



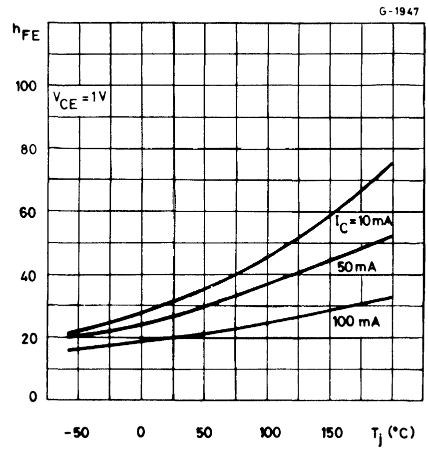
Base-emitter saturation voltage



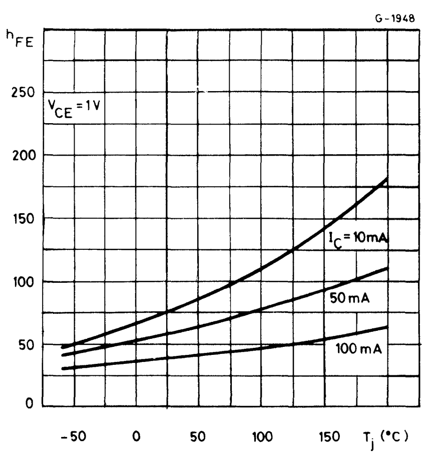
DC current gain



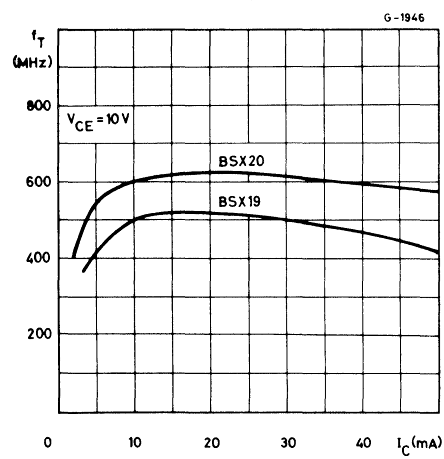
DC current gain (for **BSX 19** only)



DC current gain (for **BSX 20** only)



Transition frequency



SILICON PLANAR NPN

BSX 26

HIGH-SPEED SATURATED SWITCH

The BSX 26 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed for switching applications up to 500mA.

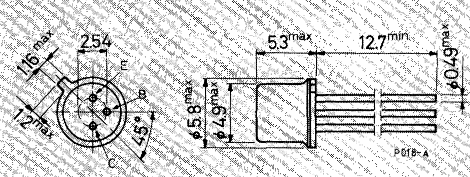
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	15	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	500	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.36	W
	at $T_{case} \leq 25°C$	1.2	W
	at $T_{case} \leq 100°$ C	0.68	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

BSX 26

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

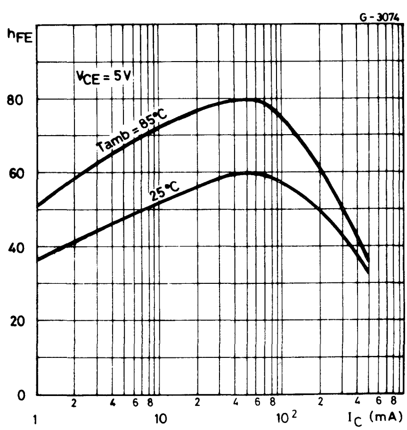
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 20V				0.5	μA
		V_{CE} = 20V	T_{amb}=85°C			15	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100μA		40			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 100μA		40			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10mA		15			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100μA		4			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 30 mA	I_B = 3mA		0.16	0.18	V
	*	I_C = 100mA	I_B = 10mA		0.18	0.28	V
	*	I_C = 300mA	I_B = 30mA		0.39	0.5	V
		I_C = 30mA T_{amb} = 85°C	I_B = 3mA		0.18	0.3	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = 30mA	I_B = 3mA	0.75	0.82	0.95	V
	*	I_C = 100mA	I_B = 10mA		0.97	1.2	V
	*	I_C = 300mA	I_B = 30mA		1.3	1.7	V
h_{FE}*	DC current gain	I_C = 30mA	V_{CE} = 0.4V	30	60	120	–
		I_C = 100mA	V_{CE} = 0.5V	25	55		–
		I_C = 300mA	V_{CE} = 1V	15			–

ELECTRICAL CHARACTERISTICS (continued)

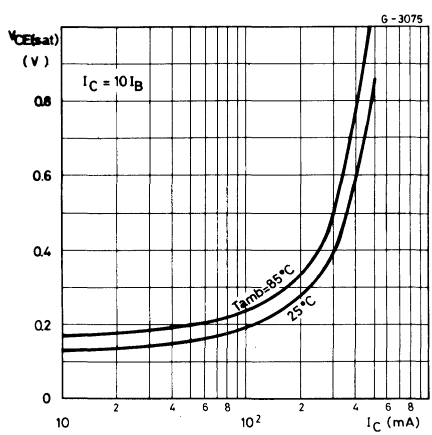
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	I_C = 30mA V_{CE} = 10V f = 100 MHz	350	550		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz		6.5	8	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 5V f = 1 MHz		3.3	5	pF
t_s	Storage time	I_C = 10mA V_{CC} = 10V I_{B1} = -I_{B2} = 10mA		8	18	ns
t_{on}	Turn-on time	I_C = 300mA V_{CC} = 15V I_{B1} = 30mA		9	15	ns
t_{off}	Turn-off time	I_C = 300mA V_{CC} = 15V I_{B1} = -I_{B2} = 30mA		15	25	ns

*Pulsed: pulse duration = 300μs, duty cycle = 1%

DC current gain

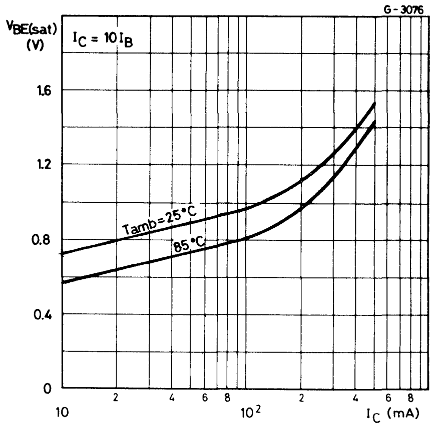


Collector - emitter saturation voltage

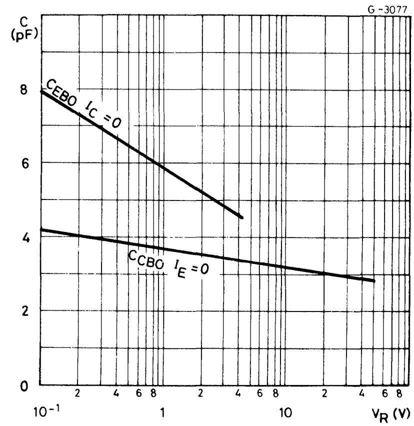


BSX 26

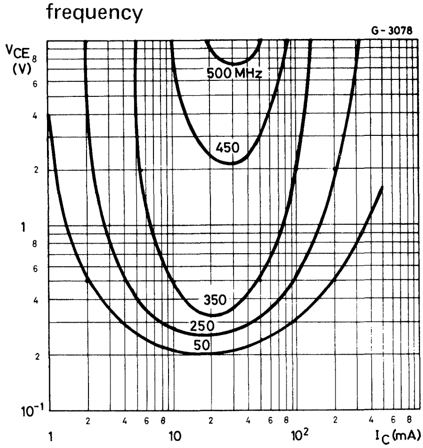
Base - emitter saturation voltage



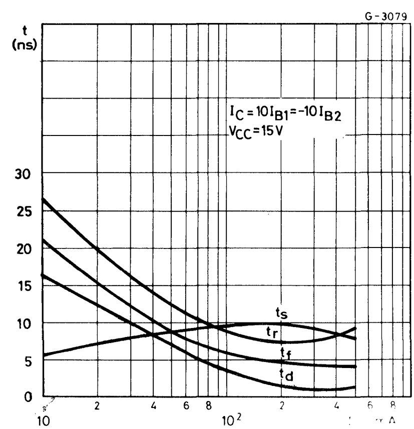
Emitter - base and collector - base capacitances



Contours of constant transition frequency



Switching characteristics



SILICON PLANAR NPN

BSX 27

HIGH-SPEED SATURATED SWITCH

The BSX 27 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed specifically for high speed saturated switching applications.

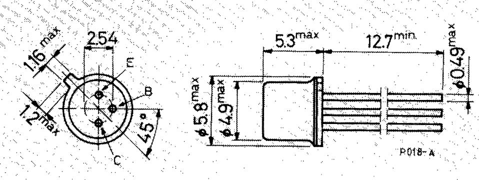
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	15	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	11	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	6	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	150	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.3	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	583	°C/W

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

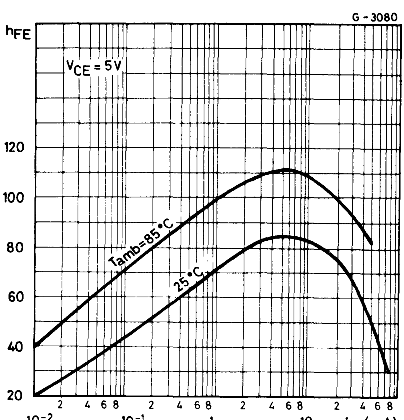
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 5V				100	nA
		V_{CE} = 11V				10	μA
		V_{CE} = 5V	T_{amb}=85°C			5	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10μA		15			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10μA		11			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10mA		6			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10μA		4			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 1mA	I_B = 0.1mA		0.18	0.25	V
		I_C = 10mA	I_B = 1mA		0.19	0.25	V
		I_C = 30mA	I_B = 3mA		0.23	0.38	V
		I_C = 10mA T_{amb} = 85°C	I_B = 1mA		0.2	0.4	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = 1mA	I_B = 0.1mA	0.68	0.74	0.85	V
		I_C = 10mA	I_B = 1mA	0.75	0.84	0.95	V
		I_C = 30mA	I_B = 3mA		0.93	1.3	V
h_{FE}	DC current gain	I_C = 1mA	V_{CE} = 0.4V	15			–
	*	I_C = 10mA	V_{CE} = 0.4V	25	80	125	–
	*	I_C = 30mA	V_{CE} = 0.4V	15	60		–
f_T	Transition frequency	I_C = 10mA f = 100MHz	V_{CE} = 4 V	600	800		MHz

ELECTRICAL CHARACTERISTICS (continued)

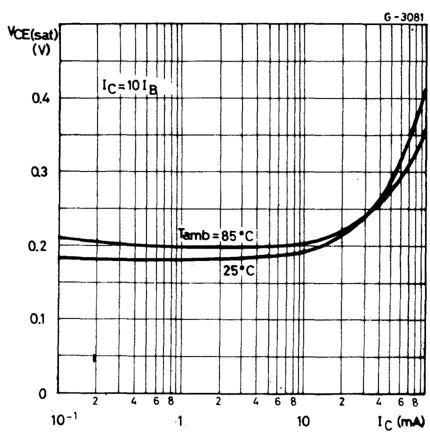
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5V$ f = 1 MHz		1.7	2	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 5 V$ f = 1 MHz		2.3	3	pF
t_s	Storage time	$I_C = 5 mA$ $V_{CC} = 3V$ $I_{B1} = -I_{B2} = 5 mA$		3	6	ns
t_{on}	Turn-on time	$I_C = 10 mA$ $V_{CC} = 1V$ $I_{B1} = 2 mA$			12	ns
t_{off}	Turn-off time	$I_C = 10mA$ $V_{CC} = 1V$ $I_{B1} = -I_{B2} = 1mA$			12	ns

* Pulsed: pulse duration = 300μs, duty cycle = 1%

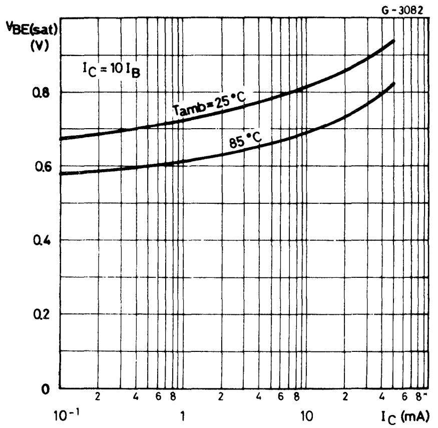
DC current gain



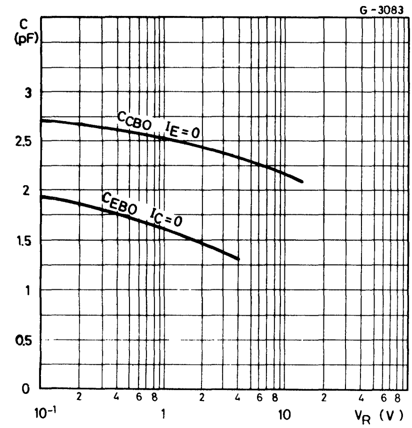
Collector-emitter saturation voltage



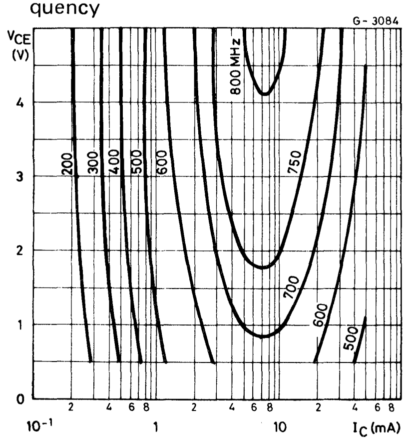
Base-emitter saturation voltage



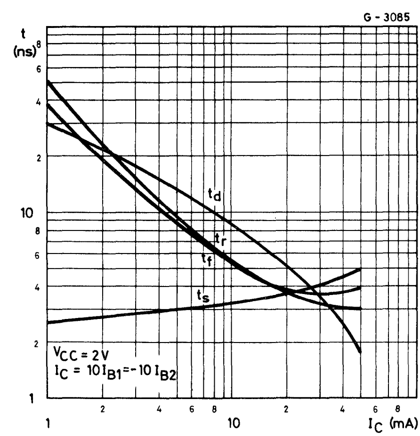
Emitter-base and collector-base capacitances



Contours of constant transition frequency



Switching characteristics



SILICON PLANAR NPN

BSX 28

HIGH-SPEED SATURATED SWITCH

The BSX 28 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal-case. It is designed specifically for high speed saturated switching applications.

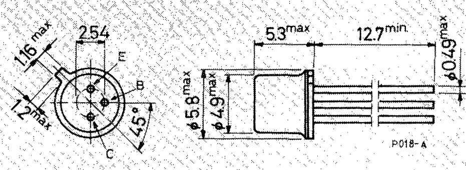
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	30	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	12	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4.5	V
I_C	Collector current	500	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.36	W
	at $T_{case} \leq 25°C$	1.2	W
	at $T_{case} \leq 100°C$	0.68	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

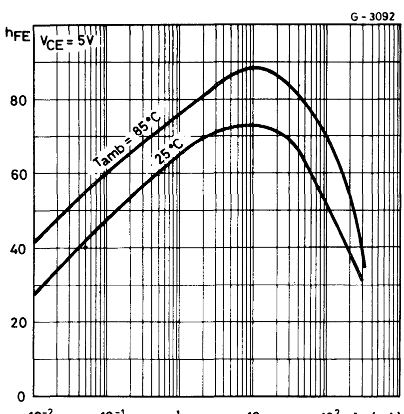
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 20V				0.4	μA
		V_{CE} = 20V	T_{amb} = 85°C			10	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10μA		30			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10μA		30			V
$V_{CEO(sus)}$ *	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10mA		12			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100μA		4.5			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 10mA	I_B = 1mA		0.15	0.2	V
		I_C = 30mA	I_B = 3mA		0.18	0.25	V
	*	I_C = 100mA	I_B = 10mA		0.3	0.5	V
		I_C = 10mA T_{amb} = 85°C	I_B = 1mA		0.17	0.3	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = 10mA	I_B = 1mA	0.72	0.8	0.87	V
		I_C = 30mA	I_B = 3mA		0.9	1.15	V
	*	I_C = 100mA	I_B = 10mA		1.1	1.6	V
h_{FE} *	DC current gain	I_C = 10mA	V_{CE}=0.35V	30	70	120	—
		I_C = 30mA	V_{CE}=0.4V	25	70		—
		I_C = 100mA	V_{CE}= 1V	12	50		—
f_T	Transition frequency	I_C = 20mA f = 100 MHz	V_{CE}= 10V	400	650		MHz

ELECTRICAL CHARACTERISTICS (continued)

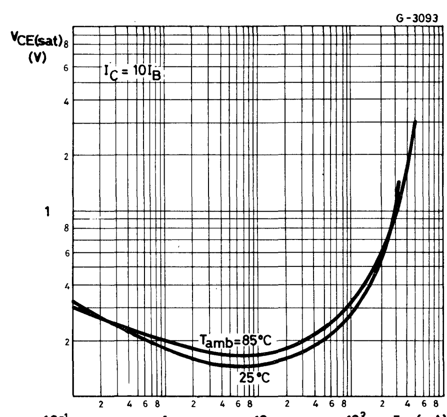
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 5V$ $f = 1 MHz$		2.3	4	pF
t_s	Storage time	$I_C = 10mA$ $V_{CC} = 10V$ $I_{B1} = -I_{B2} = 10 mA$		6.5	13	ns
t_{on}	Turn-on time	$I_C = 30mA$ $V_{CC} = 2V$ $I_{B1} = 3mA$		9	15	ns
t_{off}	Turn-off time	$I_C = 30mA$ $V_{CC} = 2V$ $I_{B1} = -I_{B2} = 3mA$		13	20	ns

*Pulsed: pulse duration = 300μs, duty cycle = 1%

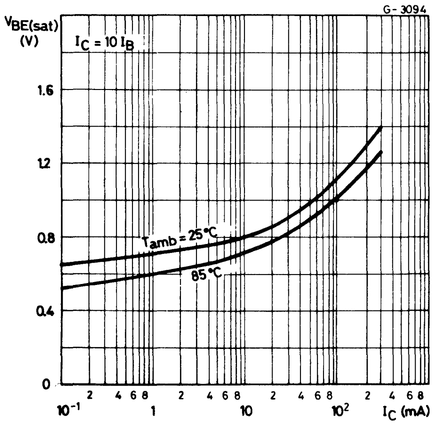
DC current gain



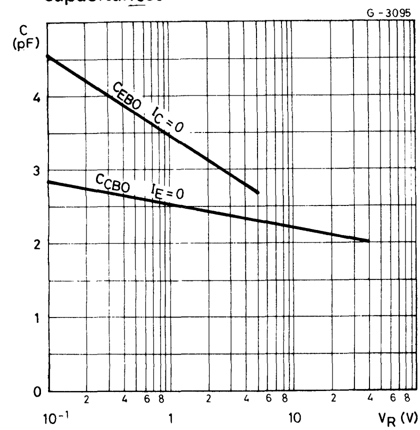
Collector - emitter saturation voltage



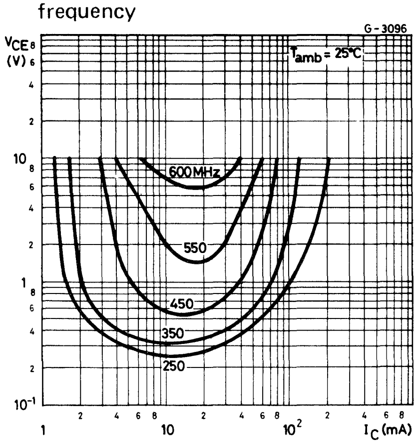
Base - emitter saturation voltage



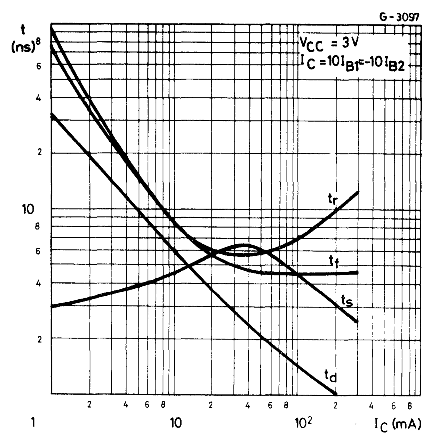
Emitter - base and collector - base capacitances



Contours of constant transition frequency



Switching characteristics



SILICON PLANAR PNP

BSX 29

SWITCH AND RF AMPLIFIER

The BSX 29 is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case. It is designed for saturated and nonsaturated switching circuits requiring up to 200 mA of collector current.

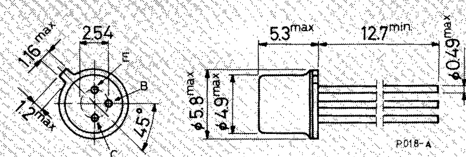
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-12	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-12	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-12	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-4	V
I_C	Collector current	-200	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.36	W
	at $T_{case} \leq 25°C$	1.2	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

BSX 29

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction - case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction - ambient	max	486	°C/W

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

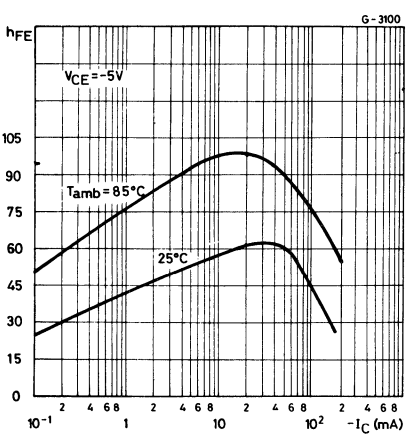
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -6V				-80	nA
		V_{CE} = -6V	T_{amb}=85°C			-5	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10μA		-12			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10μA		-12			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = -10mA		-12			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -100μA		-4			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = -10mA	I_B = -1mA		-0.07	-0.15	V
		I_C = -30mA	I_B = -3mA		-0.1	-0.2	V
		* I_C = -100mA	I_B = -10mA		-0.25	-0.5	V
		I_C = -30mA, T_{amb} = 85°C	I_B = -3mA		-0.15	-0.4	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = -10mA	I_B = -1mA	-0.78	-0.96	-0.98	V
		I_C = -30mA	I_B = -3mA	-0.85	-1.12	-1.2	V
		* I_C = -100mA	I_B = -10mA		-1.4	-1.7	V
h_{FE}*	DC current gain	I_C = -10mA	V_{CE}=-0.3V	25	50		–
		I_C = -30mA	V_{CE}=-0.5V	30	60	120	–
		I_C = -100mA	V_{CE}=-1V	20	40		–
f_T	Transition frequency	I_C = -30mA, f = 100MHz	V_{CE}=-10V	400	700		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0, f = 1MHz	V_{EB}= -0.5V		3.8	6	pF

ELECTRICAL CHARACTERISTICS (continued)

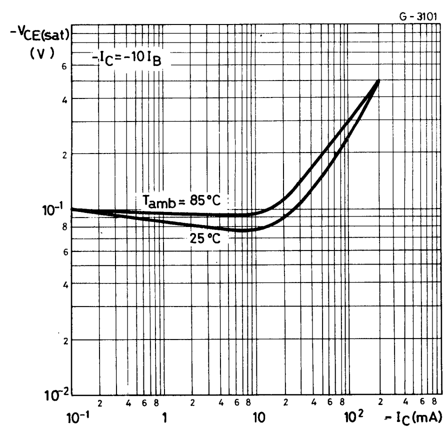
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{CBO}	Collector-base capacitance	$I_E = 0$ V_{CB}=-5V f = 1MHz		3.3	6	pF
t_{on}	Turn-on time	I_C = -30mA V_{CC} =-2V I_{B1}=-1.5mA		25	60	ns
t_{off}	Turn-off time	I_C = -30mA V_{CC}= -2V $I_{B1} = -I_{B2}$ = -1.5mA		35	90	ns

* Pulsed: pulse duration = 300μs, duty cycle = 1%

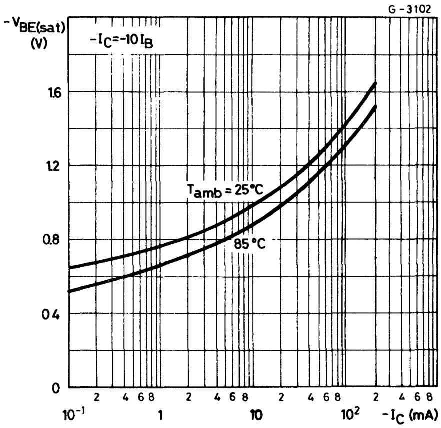
DC current gain



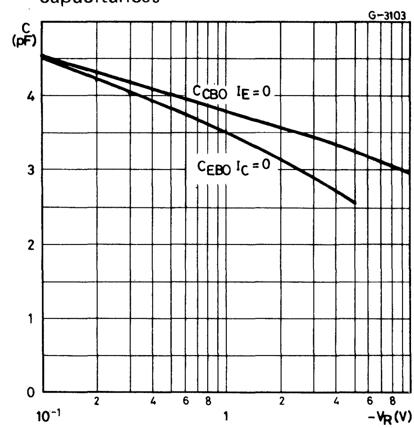
Collector - emitter saturation voltage



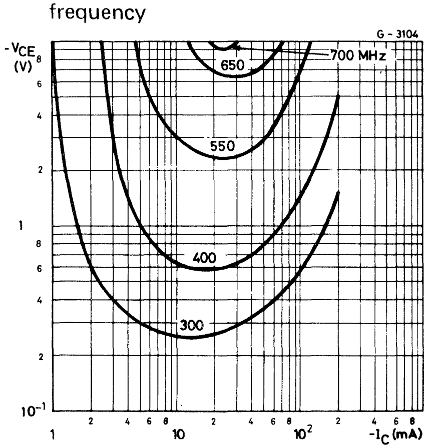
Base - emitter saturation voltage



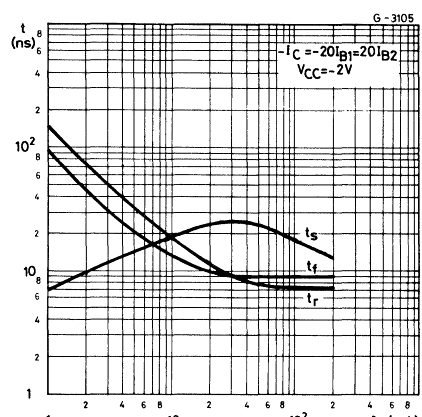
Emitter - base and collector - base capacitances



Contours of constant transition frequency



Switching characteristics



SILICON PLANAR NPN

BSX 32

HIGH-VOLTAGE, HIGH-CURRENT SWITCH

The BSX 32 is a silicon planar epitaxial NPN transistor in Jedec TO-39 metal case. It is designed for high voltage, high current switching applications.

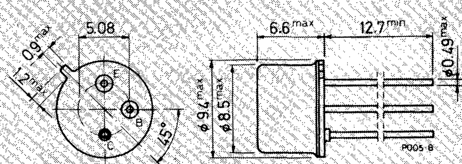
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	65	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.8	W
	at $T_{case} \leqslant 25°C$	3.5	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

BSX 32

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	50	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	219	°C/W

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

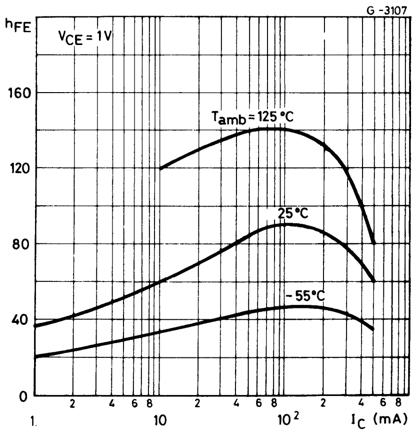
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 50V$				4	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\mu A$		65			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 10mA$		40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\mu A$		6			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	$I_C = 100mA$	$I_B = 10mA$		0.17	0.25	V
		$I_C = 500mA$	$I_B = 50mA$		0.36	0.5	V
		$I_C = 1A$	$I_B = 100mA$		0.6	0.85	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	$I_C = 100mA$	$I_B = 10mA$		0.8	0.9	V
		$I_C = 500mA$	$I_B = 50mA$			1.5	V
		$I_C = 1A$	$I_B = 100mA$			2	V
h_{FE}*	DC current gain	$I_C = 10mA$	$V_{CE} = 1V$	30	60		–
		$I_C = 100mA$	$V_{CE} = 1V$	60	90	150	–
		$I_C = 500mA$	$V_{CE} = 1V$	25	60		–
		$I_C = 1A$	$V_{CE} = 5V$	20	60		–
		$V_{CE} = 1V$	$T_{amb} = -55°C$				
			$I_C = 100mA$	30	45		–
			$I_C = 500mA$	15	35		–
f_T	Transition frequency	$I_C = 50mA$ f = 100MHz	$V_{CE} = 10V$	300			MHz

ELECTRICAL CHARACTERISTICS (continued)

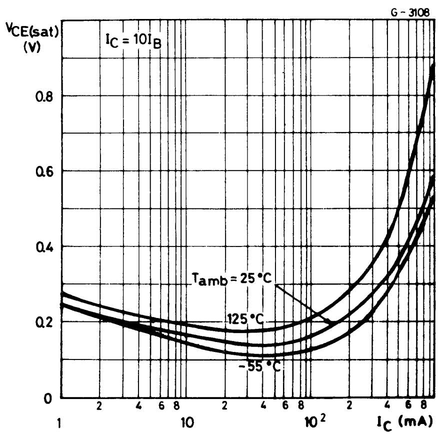
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5V$ $f = 1MHz$		40	55	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10V$ $f = 1MHz$		6	10	pF
t_{on}	Turn-on time	$I_C = 500mA$ $V_{CC} = 30V$ $I_{B1} = 50mA$		22	35	ns
t_{off}	Turn-off time	$I_C = 500mA$ $V_{CC} = 30V$ $I_{B1} = -I_{B2} = 50mA$		40	60	ns

* Pulsed: pulse duration = 300μs, duty cycle = 1%

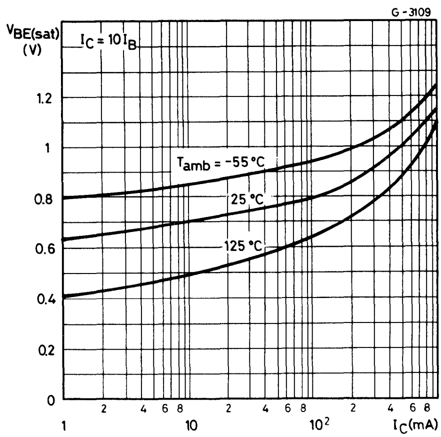
DC current gain



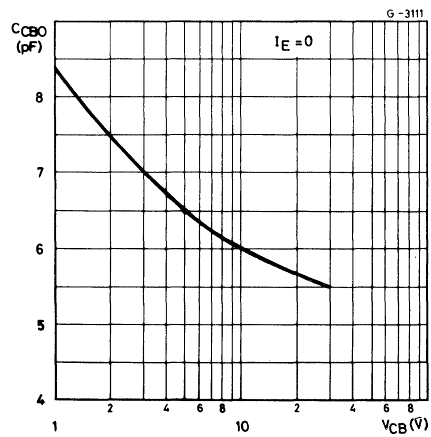
Collector - emitter saturation voltage



Base - emitter saturation voltage



Collector - base capacitance



BSX 33

SILICON PLANAR NPN

HIGH-VOLTAGE, HIGH-CURRENT SWITCH

The BSX 33 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, designed for high voltage and high current switching applications. It features useful current gain from 100μA to 500 mA and a low saturation voltage allowing switching operation at 1 A.

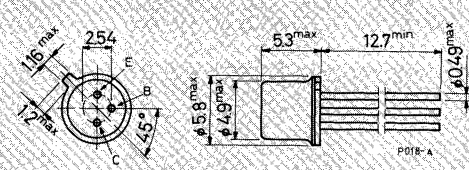
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	85	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	55	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.5	W
	at $T_{case} \leqslant 25°C$	1.8	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

BSX 33

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	97	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	350	°C/W

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

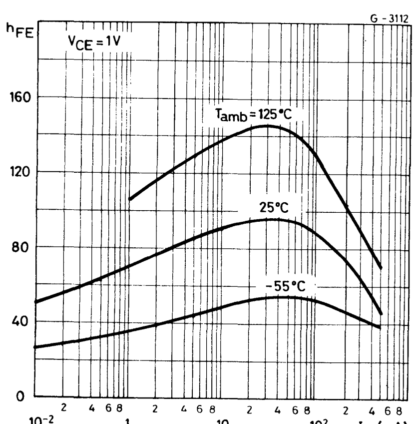
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 60V$				10	nA
		$V_{CB} = 60V$	T_{amb} =150°C			10	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = 5V$				10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\mu A$		85			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 10mA$		55			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\mu A$		7			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	$I_C = 50mA$	$I_B = 5mA$		0.08		V
		$I_C = 150mA$	$I_B = 15mA$		0.15	0.3	V
		$I_C = 1A$	$I_B = 0.1A$		0.6	1	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	$I_C = 50mA$	$I_B = 5mA$		0.76		V
		$I_C = 150mA$	$I_B = 15mA$		0.85	1.1	V
		$I_C = 1A$	$I_B = 0.1A$		1.2	1.6	V
h_{FE}*	DC current gain	$I_C = 100\mu A$	$V_{CE} = 1V$	20	50		–
		$I_C = 5mA$	$V_{CE} = 1V$	50	85		–
		$I_C = 50mA$	$V_{CE} = 1V$	50	95		–
		$I_C = 150mA$	$V_{CE} = 1V$	40	80		–
		$I_C = 500mA$	$V_{CE} = 1V$	20	45		–
h_{fe}	Small signal current gain	$I_C = 1\ mA$ f = 1kHz	$V_{CE} = 5V$		85		–
f_T	Transistion frequency	$I_C = 50mA$ f = 20MHz	$V_{CE} = 10V$	60	90		MHz

ELECTRICAL CHARACTERISTICS (continued)

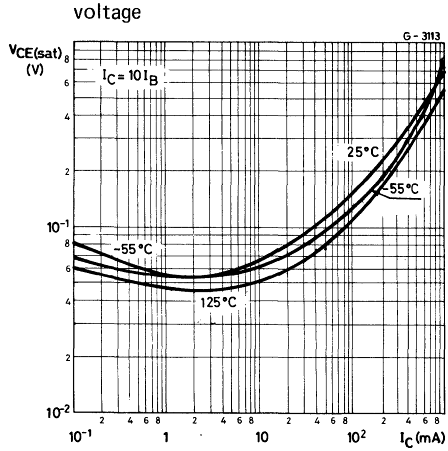
	Parameter	Test conditions	Min. Typ. Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5V$ $f = 1MHz$	50 80	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10V$ $f = 1MHz$	12 20	pF
h_{ie}	Input impedance	$I_C = 1mA$ $V_{CE} = 5V$ $f = 1 kHz$	2	kΩ
h_{re}	Reverse voltage transfer ratio	$I_C = 1mA$ $V_{CE} = 5V$ $f = 1kHz$	$2.2x10^{-4}$	–
h_{oe}	Output admittance	$I_C = 1mA$ $V_{CE} = 5V$ $f = 1kHz$	8	μS
t_{on}	Turn-on time	$I_C = 150mA$ $V_{CC} = 20V$ $I_{B1} = 7.5mA$	120 200	ns
t_{off}	Turn-off time	$I_C = 150mA$ $V_{CC} = 20V$ $I_{B1} = -I_{B2} = 7.5mA$	350 800	ns

*Pulsed: pulse duration = 300μs, duty cycle = 1%

DC current gain

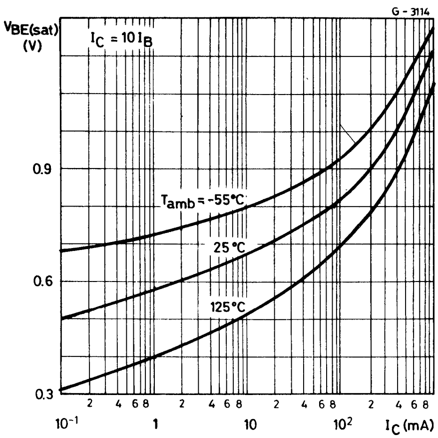


Collector-emitter saturation voltage voltage

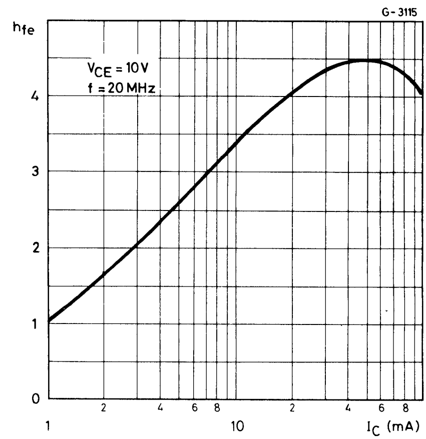


BSX 33

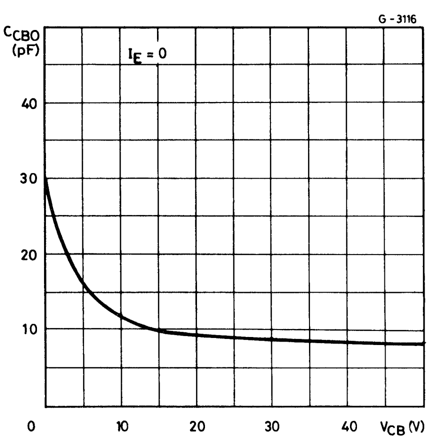
Base - emitter saturation voltage



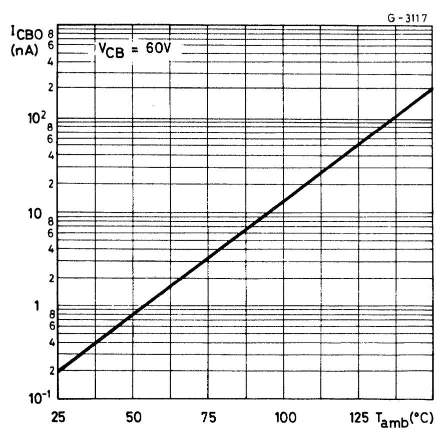
High frequency current gain



Collector - base capacitance



Collector cutoff current



BSX 36

SILICON PLANAR PNP

HIGH-CURRENT SWITCH

The BSX 36 is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case, specially suited for line and relay drivers, memory applications, and as low noise amplifiers.

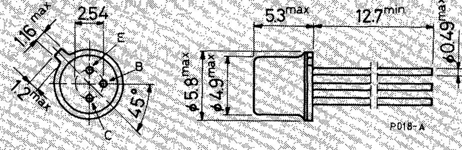
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36	W
	at $T_{case} \leqslant 25°C$	1.2	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

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BSX 36

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

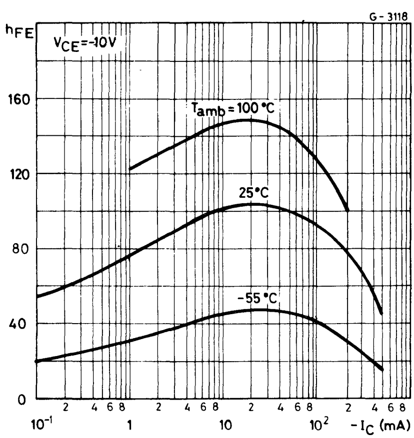
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -25V			-0.2	-15	nA
		V_{CB} = -25V	T_{amb}=125°C			-15	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10μA		-40			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = -10 mA		-40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -10μA		-5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = -50mA	I_B = -5mA		-0.08	-0.3	V
		I_C = -150mA	I_B = -15mA		-0.18	-0.5	V
		I_C = -500mA	I_B = -50mA		-0.6	-1.8	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = -50mA	I_B = -5mA		-0.92	-1.1	V
		I_C = -150mA	I_B = -15mA		-1	-1.4	V
		I_C = -500mA	I_B = -50mA			-2.2	V
h_{FE}	DC current gain	I_C = -10μA	V_{CE} = -10V		50		–
		I_C = -1mA	V_{CE} = -10V		75		–
	*	I_C = -10mA	V_{CE} = -10V	40	100		–
	*	I_C = -50mA	V_{CE} = -10V		100		–
	*	I_C = -150mA	V_{CE} = -10V		85		–
f_T	Transition frequency	I_C = - 50mA, f = 100 MHz	V_{CE} = -20V	100	200		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0, f = 1 MHz	V_{EB} = -0.5V			25	pF

ELECTRICAL CHARACTERISTICS (continued)

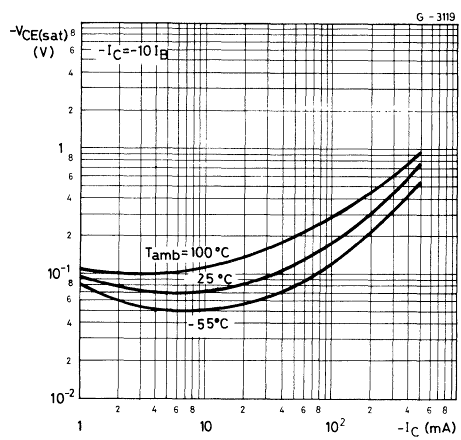
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{CBO}	Collector-base capacitance	$I_C = 0$ $V_{CB} = -10V$ $f = 1MHz$		6	8	pF
NF	Noise figure	$I_C = -30\mu A$ $V_{CE} = -5V$ $R_g = 10k\Omega$ $f = 1kHz$		1		dB
t_{on}	Turn-on time	$I_C = -300mA$ $V_{CC} = -30V$ $I_{B1} = -30mA$		17	40	ns
t_{off}	Turn-off time	$I_C = -300mA$ $V_{CC} = -30V$ $I_{B1} = -I_{B2} = -30mA$			100	ns

* Pulsed: pulse duration = 300μs, duty cycle = 1%

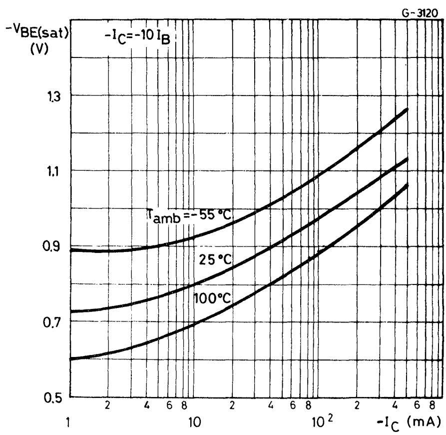
DC current gain



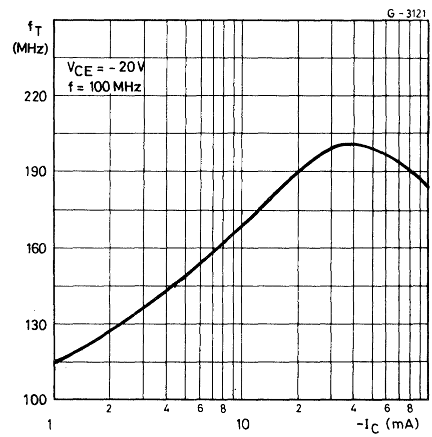
Collector - emitter saturation voltage



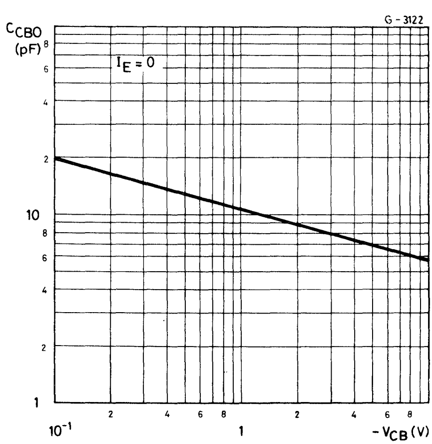
Base-emitter saturation voltage



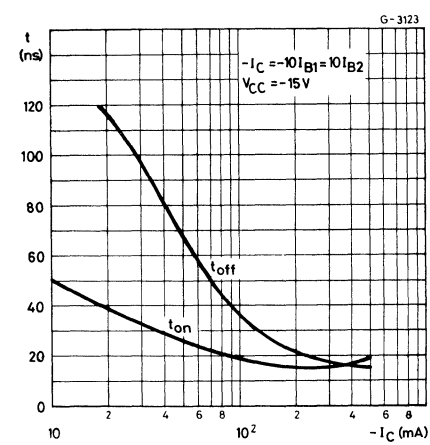
Transition frequency



Collector-base capitance



Swiching characteristics



SILICON PLANAR NPN

BSX 39

HIGH-SPEED SATURATED SWITCH

The BSX 39 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed for very fast switching applications up to 500 mA.

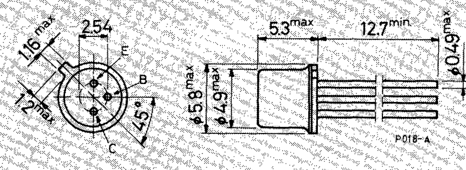
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	45	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	20	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	500	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36	W
	at $T_{case} \leqslant 25°C$	1.2	W
	at $T_{case} \leqslant 100°C$	0.68	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

BSX 39

THERMAL DATA

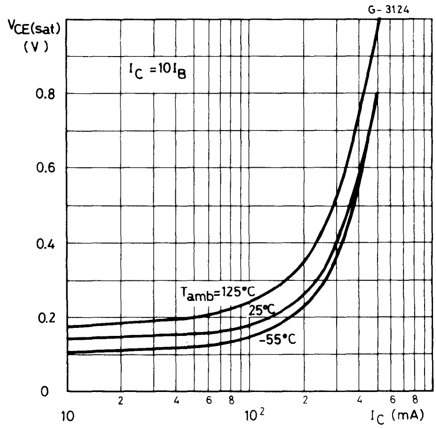
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

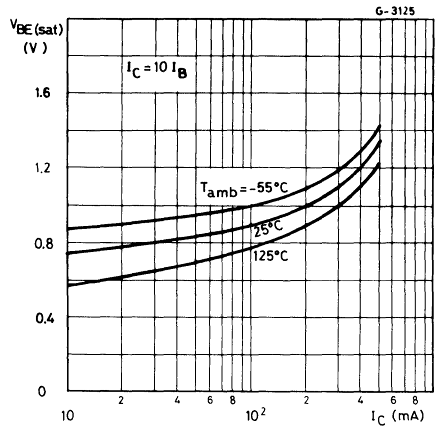
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 20V V_{CE} = 20V T_{amb} = 125°C		0.02	0.1 30	µA µA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 µA	45			V
$V_{CEO\ (sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10 mA	20			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 µA	5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 30mA I_B = 3mA I_C = 100mA I_B = 10mA I_C = 300mA I_B = 30mA I_C = 30mA I_B = 3mA T_{amb} = 85°C		0.15 0.18 0.39 0.17	0.18 0.28 0.5 0.3	V V V V
$V_{BE\ (sat)}$*	Base-emitter saturation voltage	I_C = 30mA I_B = 3mA I_C = 100mA I_B = 10mA I_C = 300mA I_B = 30mA	0.75	0.8 0.9 1.1	0.95 1.2 1.7	V V V
h_{FE}*	DC current gain	I_C = 30mA V_{CE} = 0.4V I_C = 100mA V_{CE} = 0.5V I_C = 300mA V_{CE} = 1V I_C = 30mA V_{CE} = 0.4V T_{amb} = -55°C	40 25 15 12	60 55 40	120	– – – –
f_T	Transition frequency	I_C = 30mA V_{CE} = 10V f = 100 MHz	350	600		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1MHz		7	8	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 5V f = 1MHz		4	5	pF
t_s	Storage time	I_C = 10mA V_{CC} = 10V I_{B1} = $-I_{B2}$ = 10mA		8	18	ns
t_{on}	Turn - on time	I_C = 300mA V_{CC} = 10V I_{B1} = 30mA		9	15	ns
t_{off}	Turn-off time	I_C = 300mA V_{CC} = 10V I_{B1} = $-I_{B2}$ = 30mA		15	25	ns

* Pulsed: pulse duration = 300µs, duty cycle = 1%

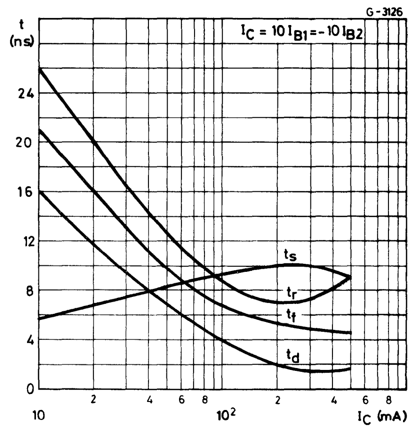
Collector - emitter saturation voltage



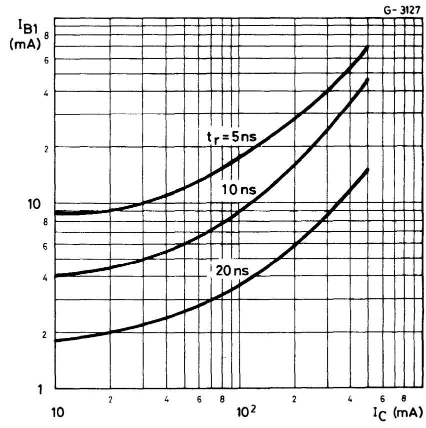
Base - emitter saturation voltage



Switching characteristics

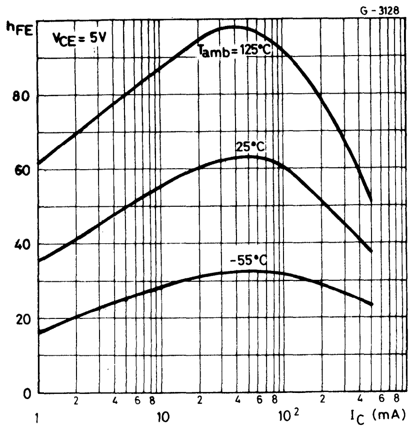


Switching characteristics

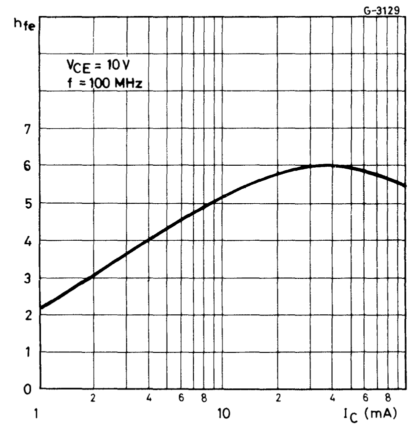


BSX 39

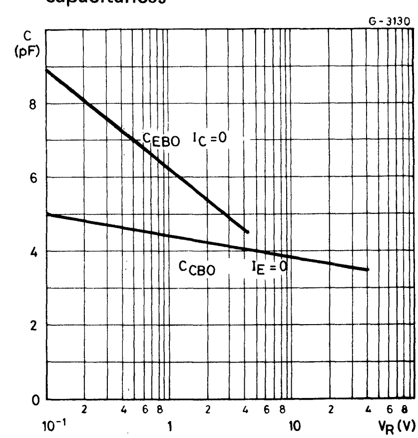
DC current gain



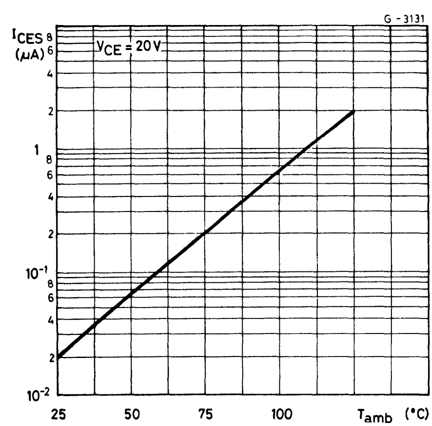
High frequency current gain



Emitter - base and collector - base capacitances



Collector cutoff current



SILICON PLANAR NPN

BSX 45
BSX 46

MEDIUM POWER AMPLIFIERS

The BSX 45 and BSX 46 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case, intended for use in medium power general industrial applications.

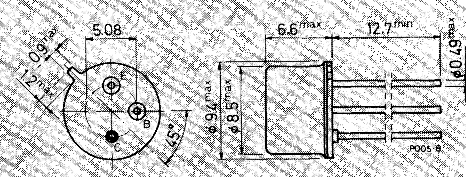
ABSOLUTE MAXIMUM RATINGS

		BSX 45	BSX 46
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	80 V	100 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40 V	60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7 V	
I_C	Collector current	1 A	
I_B	Base current	0.2 A	
P_{tot}	Total power dissipation at $T_{case} \leqslant 25°C$	5 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

BSX 45
BSX 46

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	35	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	200	°C/W

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

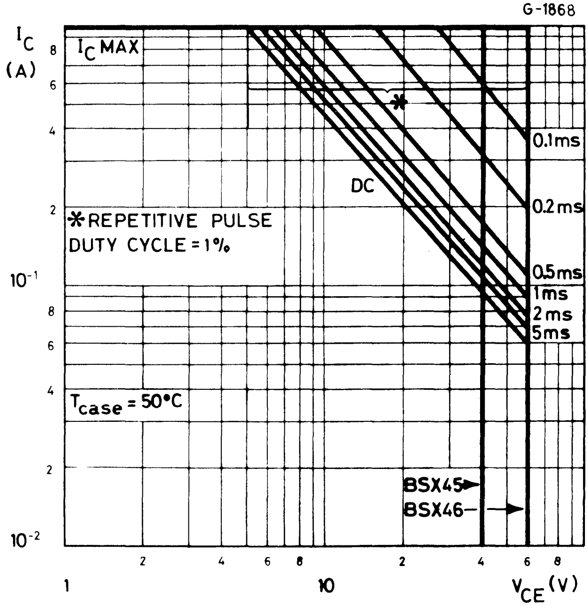
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 60V			1	30	nA
		V_{CE} = 60V	T_{amb} = 150°C		1	10	μA
I_{CEX}	Collector cutoff current (V_{BE} = -0.2V)	V_{CE} = 60V	T_{amb} = 100°C			50	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V				10	nA
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 100 μA	for **BSX 45**	80			V
			for **BSX 46**	100			V
$V_{CEO\ (sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10 mA	for **BSX 45**	40			V
			for **BSX 46**	60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA		7			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 1 A	I_B = 0.1 A		0.7	1	V
		I_C = 500 mA	I_B = 25 mA		0.5	0.9	V
V_{BE}	Base-emitter voltage	I_C = 0.1 A	V_{CE} = 1V			1	V
		I_C = 0.5A	V_{CE} = 1V	0.75		1.5	V
	*	I_C = 1A	V_{CE} = 1V		1.3	2	V
h_{FE}	DC current gain	I_C = 0.1 mA	V_{CE} = 1V				
			Gr. 6	10	28		–
			Gr. 10	15	40		–
			Gr. 16	25	90		–
	*	I_C = 100 mA	V_{CE} = 1V				
			Gr. 6	40	63	100	–
			Gr. 10	63	100	160	–
			Gr. 16	100	160	250	–
	*	I_C = 500 mA	V_{CE} = 1V				
			Gr. 6	15	25		–
			Gr. 10	25	40		–
			Gr. 16	35	60		–
	*	I_C = 1A	V_{CE} = 1V				
			Gr. 6		15		–
			Gr. 10		20		–
			Gr. 16		30		–

ELECTRICAL CHARACTERISTICS (continued)

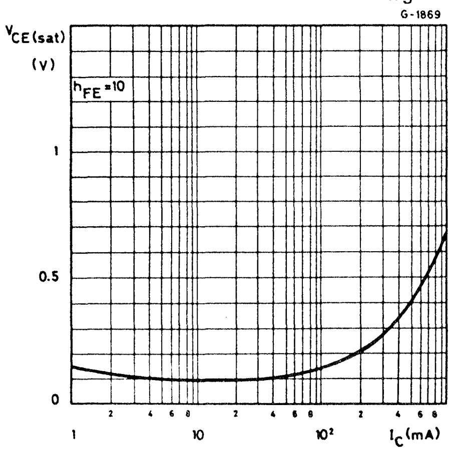
Parameter		Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10V f = 20 MHz	50			MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz			80	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 1 MHz for **BSX 45** for **BSX 46**			25 20	pF pF
NF	Noise figure	I_C = 100 μA V_{CE} = 10V R_g = 1 kΩ f = 1 kHz		3.5		dB
t_{on}	Turn-on time	I_C = 100 mA V_{CC} = 20V I_{B1} = 5 mA			200	ns
t_{off}	Turn-off time	I_C = 100 mA V_{CC} = 20V I_{B1} = $-I_{B2}$ = 5 mA			850	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

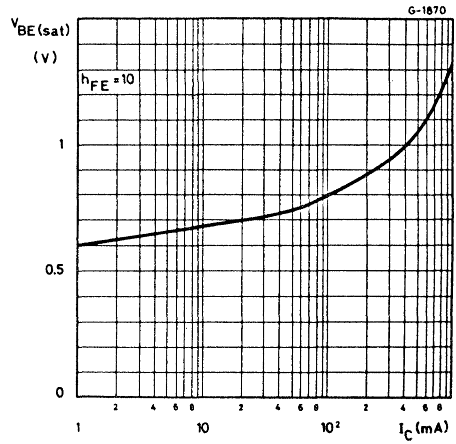
Safe operating areas



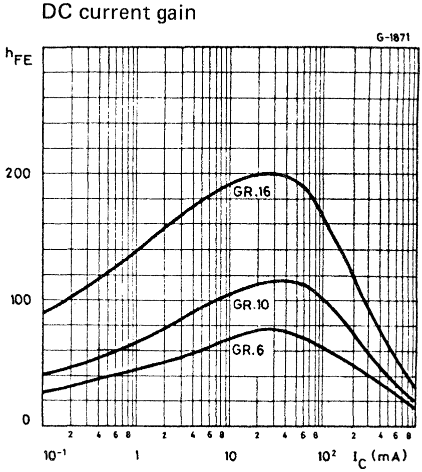
Collector-emitter saturation voltage



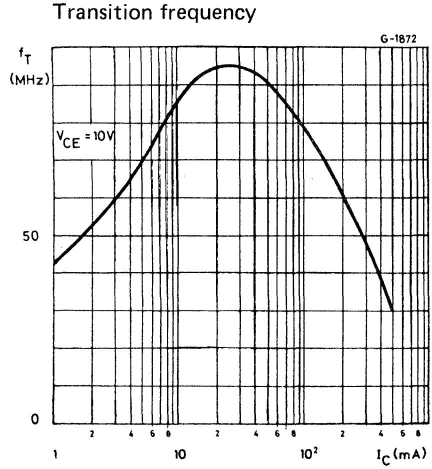
Base-emitter saturation voltage



DC current gain



Transition frequency



BSX 93

SILICON PLANAR NPN

HIGH-FREQUENCY SATURATED SWITCH

The BSX93 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed specifically for high-speed saturated switching applications.

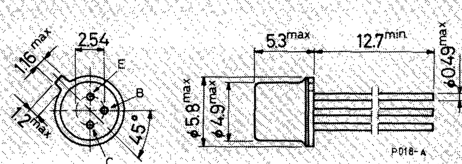
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	15	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	150	mA
I_{CM}	Collector peak current ($t = 10\ \mu s$)	500	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.36	W
	at $T_{case} \leq 25°C$	1	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

BSX 93

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	175	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

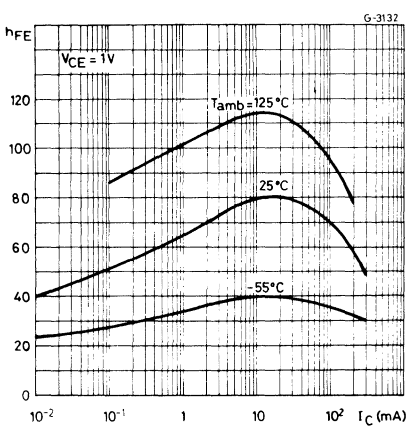
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 20V		0.1	0.2	μA
		V_{CB} = 20V T_{amb} = 150°C		10	70	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 10 μA	40			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10 μA	40			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 10 mA	15			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 10 μA	5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 10 mA I_B = 1 mA		0.15	0.2	V
V_{BE}	Base-emitter voltage	I_C = 10 mA V_{CE} = 1V		0.7		V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 10 mA I_B = 1 mA	0.72	0.75	0.85	V
h_{FE}*	DC current gain	I_C = 10 mA V_{CE} = 1V	40	80	120	–
		I_C = 100 mA V_{CE} = 1V	20	70		–
		I_C = 10 mA V_{CE} = 1V T_{amb} = -55°C	20	40		–
f_T	Transition frequency	I_C = 10 mA V_{CE} = 10V f = 100 MHz	400	650		MHz

ELECTRICAL CHARACTERISTICS (continued)

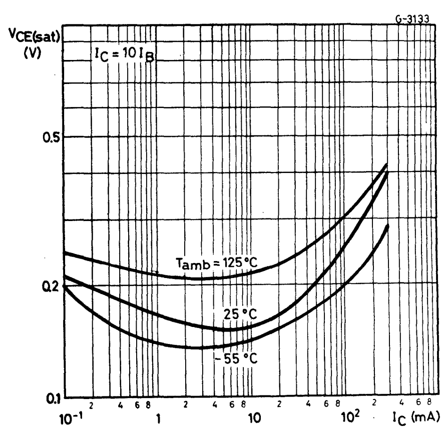
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5V$ $f = 1$ MHz		3.8	6	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 5V$ $f = 1$ MHz		2.5	4	pF
t_s	Storage time	$I_C = 10$ mA $V_{CC} = 10V$ $I_{B1} = -I_{B2} = 10$ mA		6	13	ns
t_{on}	Turn-on time	$I_C = 10$ mA $V_{CC} = 3V$ $I_{B1} = 3$ mA		9	12	ns
t_{off}	Turn-off time	$I_C = 10$ mA $V_{CC} = 3V$ $I_{B1} = 3$ mA $I_{B2} = -1.5$ mA		13	18	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

DC current gain

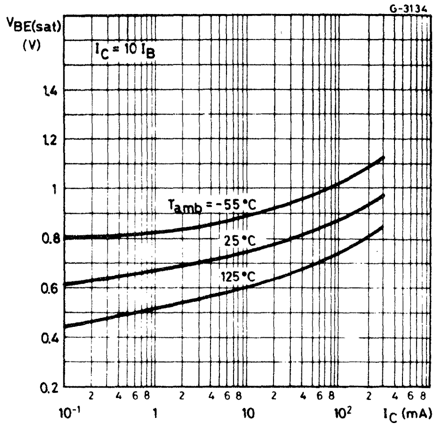


Collector-emitter saturation voltage

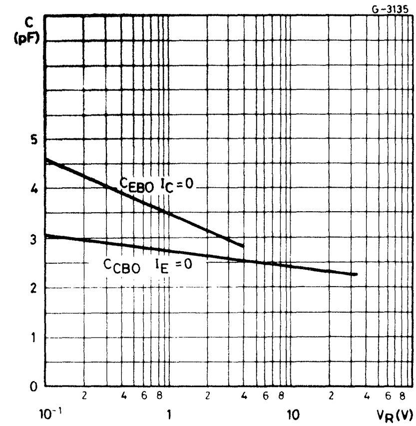


BSX 93

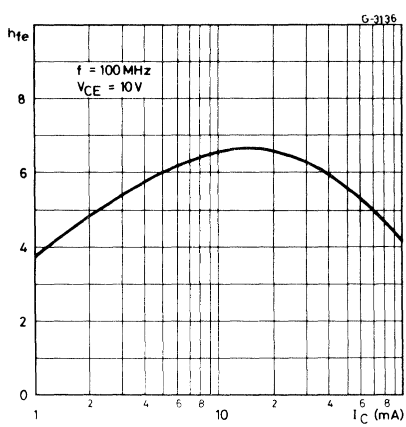
Base-emitter saturation voltage



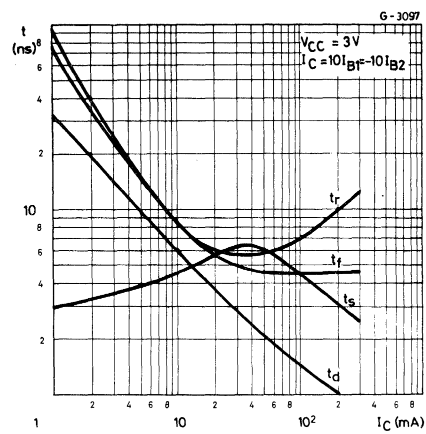
Emitter-base and collector-base capacitances



High frequency current gain



Switching characteristics



SILICON PLANAR NPN

BSY 51
BSY 52

PRELIMINARY DATA

GENERAL PURPOSE AMPLIFIERS

The BSY 51 and BSY 52 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case, intended for use in high performance amplifier, oscillator and switching circuits.

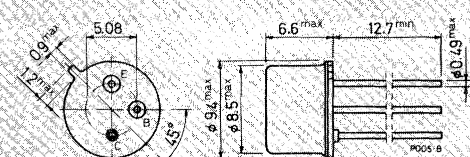
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	500	mA
P_{tot}	Total power dissipation at $T_{amb} = 25°C$	0.8	W
	$T_{case} = 25°C$	3	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

BSY 51
BSY 52

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	58	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	220	°C/W

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

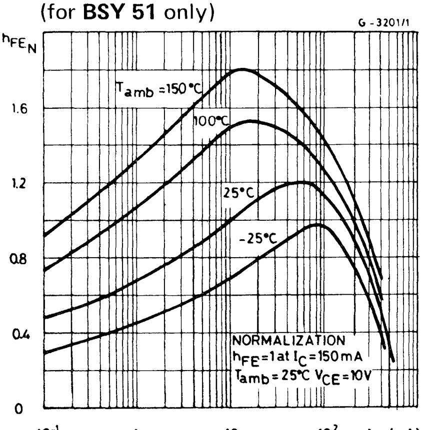
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E= 0)	V_{CB}= 30V				100	nA
		V_{CB}= 30V	T_{amb}=150°C			100	μA
I_{EBO}	Emitter cutoff current (I_C= 0)	V_{EB}= 3V				50	nA
$V_{CE(sat)}$*	Collector-emitter saturation-voltage	I_C= 150 mA	I_B= 15 mA		0.15	0.8	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C= 150 mA	I_B= 15 mA		0.95	1.2	V
h_{FE}*	DC current gain	for **BSY 51**					
		I_C= 1 mA	V_{CE}= 10V		50		–
		I_C= 10 mA	V_{CE}= 10V	30	75		–
		I_C= 150 mA	V_{CE}= 10V	40		120	–
		I_C= 500 mA	V_{CE}= 10V		15		–
		for **BSY 52**					
		I_C= 1 mA	V_{CE}= 10V		100		–
		I_C= 10 mA	V_{CE}= 10V	70	135		–
		I_C= 150 mA	V_{CE}= 10V	100		300	–
		I_C= 500 mA	V_{CE}= 10V		25		–
f_T	Transition frequency	I_C= 50 mA, f = 50 MHz	V_{CE}= 10V		100		MHz
C_{CBO}	Collector-base capacitance	I_E= 0, f = 1 MHz	V_{CB}= 10V		10		pF
C_{EBO}	Emitter-base capacitance	I_C= 0, f = 1 MHz	V_{EB}= 0.5V		23		pF
NF	Noise figure	I_C= 0.3 mA, R_g= 1.5 kΩ	V_{CE}= 10V, f=30Hz to 15kHz		6		dB

ELECTRICAL CHARACTERISTICS (continued)

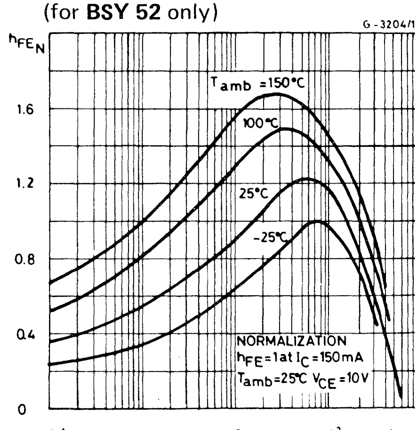
	Parameter	Test conditions		Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	I_C = 1 mA f = 1 kHz	V_{CE} = 10V				
			for **BSY 51**	30		100	–
			for **BSY 52**	50		200	–
h_{ie}	Input impedance	I_C = 1 mA f = 1 kHz	V_{CE} = 10V				
			for **BSY 51**	0.8		4.5	kΩ
			for **BSY 52**	1		8	kΩ
h_{re}	Reverse voltage ratio	I_C = 1 mA f = 1 kHz	V_{CE} = 10V			$3 \cdot 10^{-4}$	–
h_{oe}	Output admittance	I_C = 1 mA f = 1 kHz	V_{CE} = 10V				
			for **BSY 51**	3.5		13	μS
			for **BSY 52**	4.5		15	μS

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

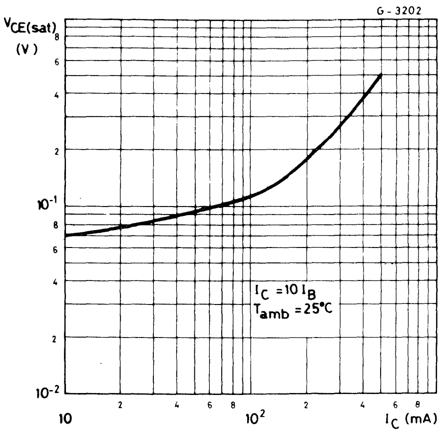
DC normalized current gain (for **BSY 51** only)



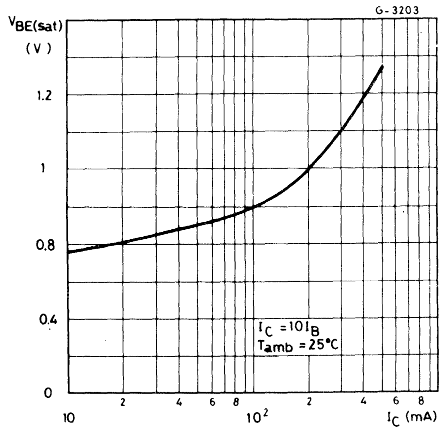
DC normalized current gain (for **BSY 52** only)



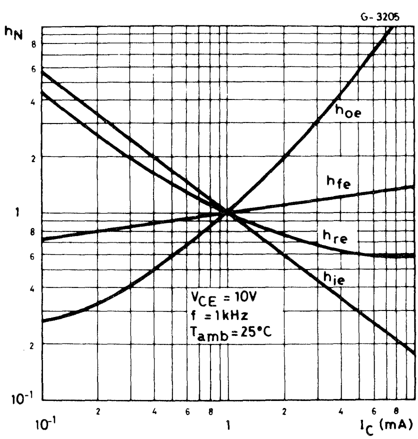
Collector-emitter saturation voltage



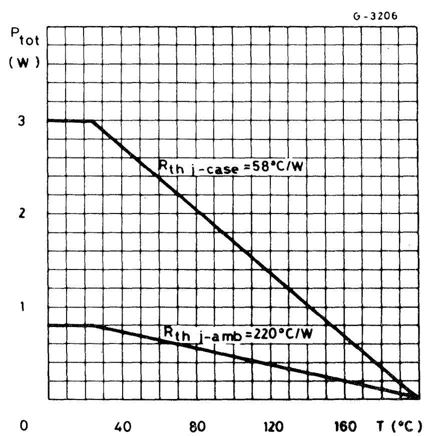
Base-emitter saturation voltage



Normalized h parameters



Power rating chart



SILICON PLANAR NPN

BSY 53
BSY 54

PRELIMINARY DATA

GENERAL PURPOSE AMPLIFIERS

The BSY 53 and BSY 54 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case, intended for use in general purpose amplifiers.

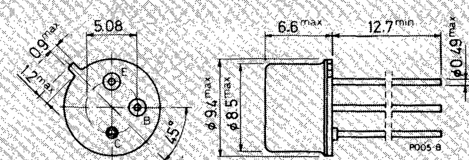
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	75	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_E = 0$)	7	V
I_C	Collector current	750	mA
P_{tot}	Total power dissipation at $T_{amb} = 25°C$	0.8	W
	at $T_{case} = 25°C$	3	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

BSY 53
BSY 54

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	58	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	220	°C/W

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

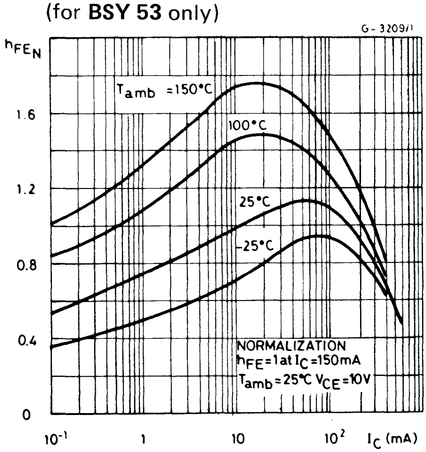
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 60V				10	nA
		V_{CB} = 60V	T_{amb} = 150°C			10	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V				10	nA
$V_{CE(sat)}$ *	Collector-emitter saturation-voltage	I_C = 150 mA	I_B = 15 mA		0.15	0.6	V
		I_C = 500 mA	I_B = 50 mA		0.5	1.2	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = 150 mA	I_B = 15 mA		0.95	1.2	V
h_{FE}	DC current gain	for **BSY 53**					
		I_C = 0.1 mA	V_{CE} = 10V	20	40		–
		I_C = 1 mA	V_{CE} = 10V		50		–
	*	I_C = 10 mA	V_{CE} = 10V	35	65		–
	*	I_C = 150 mA	V_{CE} = 10V	40		120	–
	*	I_C = 500 mA	V_{CE} = 10V	20	35		–
		for **BSY 54**					
		I_C = 0.01 mA	V_{CE} = 10V	20	55		–
		I_C = 0.1 mA	V_{CE} = 10V	35	80		–
		I_C = 1 mA	V_{CE} = 10V		100		–
	*	I_C = 10 mA	V_{CE} = 10V	80	135		–
	*	I_C = 150 mA	V_{CE} = 10V	100		300	–
	*	I_C = 500 mA	V_{CE} = 10V	40	60		–
f_T	Transition frequency	I_C = 50 mA, f = 50 MHz	V_{CE} = 10V		100		MHz
C_{CBO}	Collector-base capacitance	I_E = 0, f = 1 MHz	V_{CB} = 10V		10		pF
C_{EBO}	Emitter-base capacitance	I_C = 0, f = 1 MHz	V_{EB} = 0.5V		23		pF
NF	Noise figure	I_C = 0.3 mA, R_g = 1.5 kΩ	V_{CE} = 10V, f=30Hz to 15kHz		3	8	dB

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.

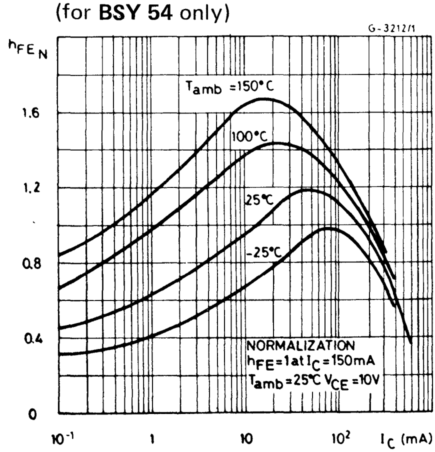
ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	$I_C = 1$ mA f = 1 kHz	$V_{CE} = 10V$				
			for **BSY 53**	30		100	–
			for **BSY 54**	50		250	–
h_{ie}	Input admittance	$I_C = 1$ mA f = 1 kHz	$V_{CE} = 10V$				
			for **BSY 53**	0.8		4.5	kΩ
			for **BSY 54**	1.6		9	kΩ
h_{re}	Reverse voltage ratio	$I_C = 1$ mA f = 1 kHz	$V_{CE} = 10V$		$3 \cdot 10^{-4}$		–
h_{oe}	Output admittance	$I_C = 1$ mA f = 1 kHz	$V_{CE} = 10V$				
			for **BSY 53**	3.5		10	μS
			for **BSY 54**	4.5		12.5	μS

DC normalized current gain
(for **BSY 53** only)

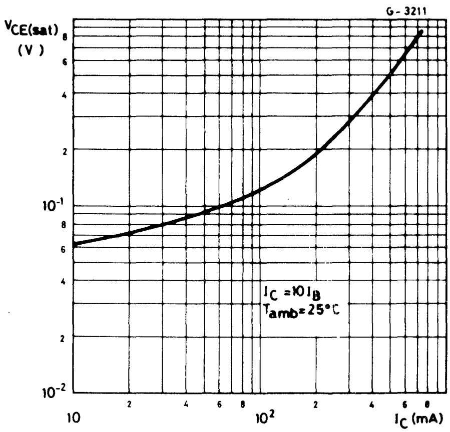


DC normalized current gain
(for **BSY 54** only)

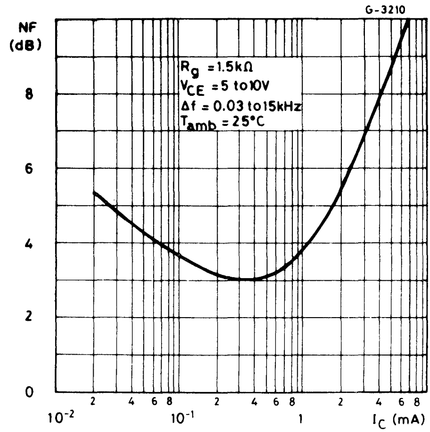


BSY 53
BSY 54

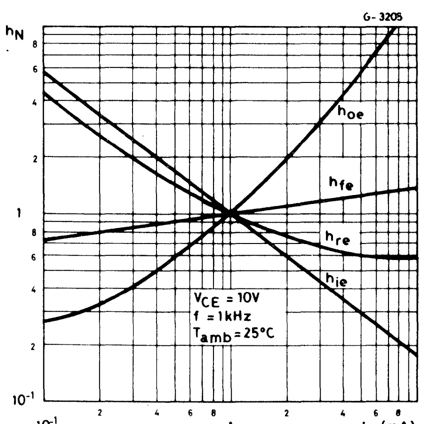
Collector-emitter saturation voltage



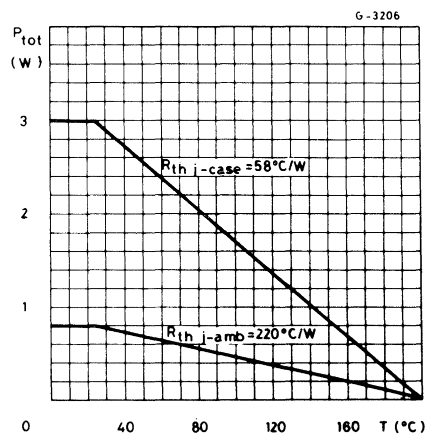
NF vs. collector current



Normalized h parameters



Power rating chart



SILICON PLANAR NPN

BSY 55
BSY 56

PRELIMINARY DATA

GENERAL PURPOSE AMPLIFIERS

The BSY 55 and BSY 56 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case, intended for use in high performance amplifier, oscillator and switching circuits.

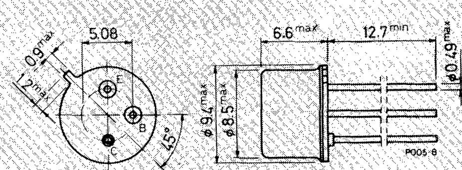
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	120	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	80	V
V_{EBO}	Emitter-base voltage ($I_E = 0$)	7	V
I_C	Collector-current	500	mA
P_{tot}	Total power dissipation at $T_{amb} = 25°C$	0.8	W
	at $T_{case} = 25°C$	3	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

BSY 55
BSY 56

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	58	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	220	°C/W

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

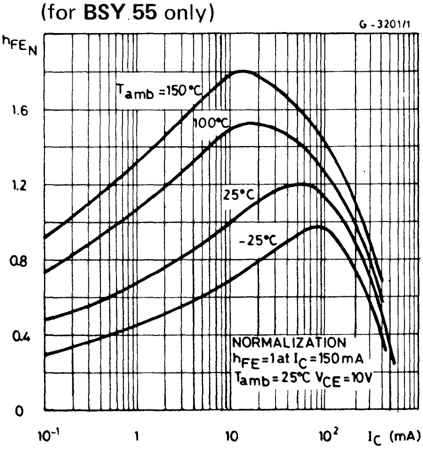
	Parameter	Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 90V				10	nA
		V_{CB} = 90V	T_{amb} = 150°C			10	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V				10	nA
$V_{CE(sat)}$ *	Collector-emitter saturation-voltage	I_C = 150 mA	I_B = 15 mA		0.2	0.6	V
$V_{BE(sat)}$ *	Base-emitter saturation voltage	I_C = 150 mA	I_B = 15 mA		1	1.3	V
h_{FE}	DC current gain	for **BSY 55**					
		I_C = 0.1 mA	V_{CE} = 10V	20	50		–
		I_C = 1 mA	V_{CE} = 10V		60		–
	*	I_C = 10 mA	V_{CE} = 10V	35	65		–
	*	I_C = 150 mA	V_{CE} = 10V	40		120	–
	*	I_C = 500 mA	V_{CE} = 10V		20		–
		for **BSY 56**					
		I_C = 0.1 mA	V_{CE} = 10V	35	100		–
		I_C = 1 mA	V_{CE} = 10V		125		–
	*	I_C = 10 mA	V_{CE} = 10V	75	180		–
	*	I_C = 150 mA	V_{CE} = 10V	100		300	–
	*	I_C = 500 mA	V_{CE} = 10V		35		–
f_T	Transition frequency	I_C = 50 mA, f = 50 MHz	V_{CE} = 10V		100		MHz
C_{CBO}	Collector-base capacitance	I_E = 0, f = 1 MHz	V_{CB} = 10V		10		pF
C_{EBO}	Emitter-base capacitance	I_C = 0, f = 1 MHz	V_{EB} = 0.5V		23		pF
NF	Noise figure	I_C = 0.3 mA, R_g = 1.5 kΩ	V_{CE} = 10V, f=30Hz to 15kHz		6		dB

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.

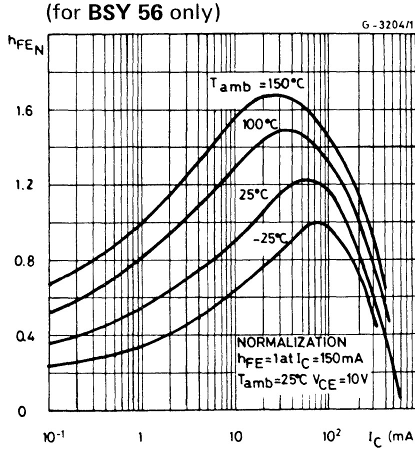
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions		Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	I_C = 1 mA f = 1 kHz	V_{CE} = 10V				
			for **BSY 55**	30		150	–
			for **BSY 56**	60		250	–
h_{ie}	Input impedance	I_C = 1 mA f = 1 kHz	V_{CE} = 10V				
			for **BSY 55**	0.8		5	kΩ
			for **BSY 56**	1.6		9	kΩ
h_{re}	Reverse voltage ratio	I_C = 1 mA f = 1 kHz	V_{CE} = 10V			$3 \cdot 10^{-4}$	–
h_{oe}	Output admittance	I_C = 1 mA f = 1 kHz	V_{CE} = 10V				
			for **BSY 55**	2		7	μS
			for **BSY 56**	3		10	μS

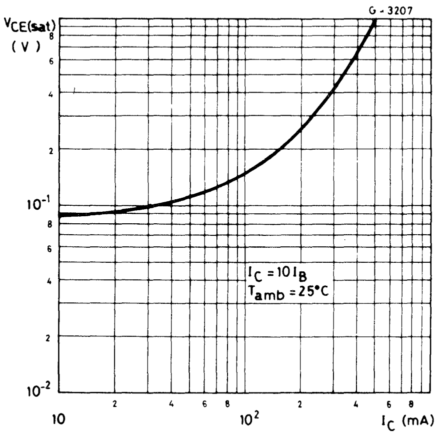
DC normalized current gain
(for **BSY 55** only)



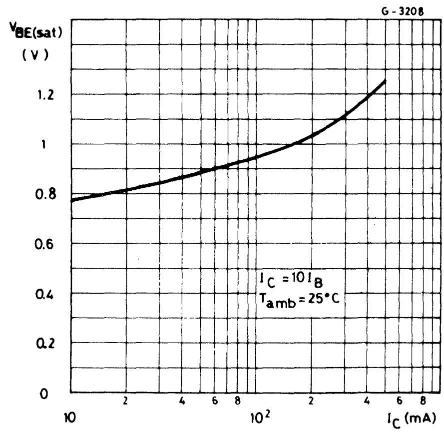
DC normalized current gain
(for **BSY 56** only)



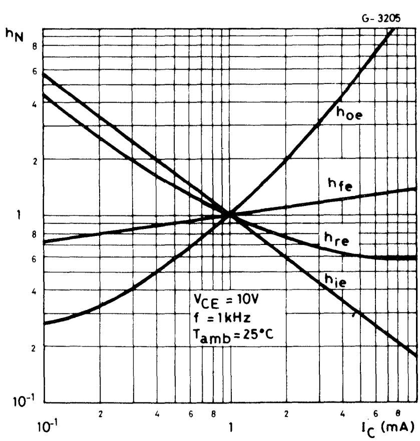
Collector-emitter saturation voltage



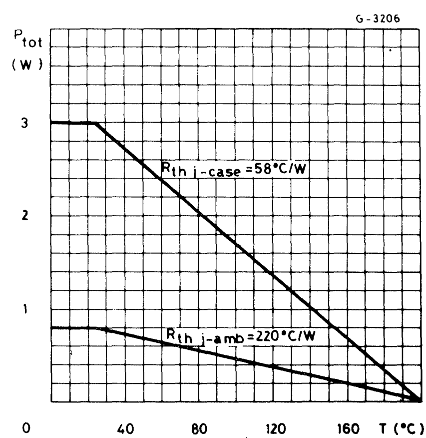
Base-emitter saturation voltage



Normalized h parameters



Power rating chart



2N 709
2N 3010

SILICON PLANAR NPN

ULTRA HIGH-SPEED SATURATED SWITCHES

The 2N 709 and 2N 3010 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case.
They are designed for switching applications up to 50 mA.

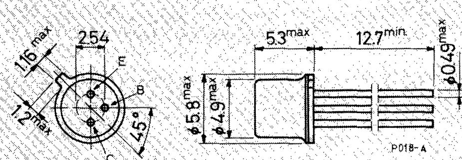
ABSOLUTE MAXIMUM RATINGS

		2N 709	2N 3010
V_{CBO}	Collector-base voltage ($I_E = 0$)	15 V	15 V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	–	11 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	6 V	6 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V	
I_C	Collector current	50 mA	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.3 W	
	at $T_{case} \leqslant 100°C$	0.5 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	583	°C/W

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

Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$) (for **2N 709** only)	$V_{CB} = 5V$ $V_{CB} = 5V$	 $T_{amb} = 125°C$			50 5	nA μA
I_{CES}	Collector cutoff current ($V_{BE} = 0$) (for **2N 3010** only)	$V_{CE} = 5V$ $V_{CE} = 5V$	 $T_{amb} = 85°C$			100 5	nA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu A$		15			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage ($V_{BE} = 0$) (for **2N 3010** only)	$I_C = 10\ \mu A$		11			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 10$ mA		6			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu A$		4			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	for **2N 709** $I_C = 3$ mA for **2N 3010** $I_C = 1$ mA $I_C = 10$ mA $I_C = 30$ mA	 $I_B = 0.15$ mA $I_B = 0.1$ mA $I_B = 1$ mA $I_B = 3$ mA			 0.3 0.25 0.25 0.38	 V V V V

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions		Min.	Typ.	Max.	Unit
$V_{BE\,(sat)}$*	Base-emitter saturation voltage	for **2N 709**					
		$I_C = 3$ mA	$I_B = 0.15$ mA	0.7		0.85	V
		for **2N 3010**					
		$I_C = 1$ mA	$I_B = 0.1$ mA	0.68		0.85	V
		$I_C = 10$ mA	$I_B = 1$ mA	0.75		0.95	V
		$I_C = 30$ mA	$I_B = 3$ mA			1.3	V
h_{FE}*	DC current gain	for **2N 709**					
		$I_C = 10$ mA	$V_{CE} = 0.5V$	20		120	–
		$I_C = 30$ mA	$V_{CE} = 1V$	15			–
		$I_C = 10$ mA, $T_{amb} = -55°C$	$V_{CE} = 0.5V$	10			–
		for **2N 3010**					
		$I_C = 1$ mA	$V_{CE} = 0.4V$	15			–
		$I_C = 10$ mA	$V_{CE} = 0.4V$	25		125	–
		$I_C = 30$ mA	$V_{CE} = 1V$	15			–
f_T	Transition frequency	$V_{CE} = 4V$	f = 100 MHz				
		$I_C = 5$ mA	for **2N 709**	600			MHz
		$I_C = 10$ mA	for **2N 3010**	600			MHz
C_{EBO}	Emitter-base capacitance	$I_C = 0$, f = 1 MHz	$V_{EB} = 0.5V$			2	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$, f = 1 MHz	$V_{CB} = 5V$			3	pF
t_s	Storage time	$I_C = 5$ mA, $I_{B1} = -I_{B2} = 5$ mA	$V_{CC} = 3V$			6	ns
t_{on}	Turn-on time	$I_C = 10$ mA, $I_{B1} = 2$ mA	$V_{CC} = 1V$				
			for **2N 709**			15	ns
			for **2N 3010**			12	ns
t_{off}	Turn-off time	$I_C = 10$ mA, $I_{B1} = -I_{B2} = 1$ mA	$V_{CC} = 1V$				
			for **2N 709**			15	ns
			for **2N 3010**			12	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 718A
2N 956

SILICON PLANAR NPN

AMPLIFIERS AND SWITCHES

The 2N 718A and 2N 956 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case, intended for high-speed switching and amplifier applications.

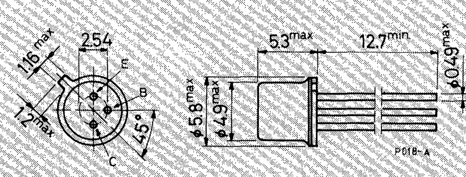
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	75	V
V_{CER}	Collector-emitter voltage ($R_{BE} \leqslant 10\Omega$)	50	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.5	W
	at $T_{case} \leqslant 25°C$	1.8	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

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THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	97	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	350	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 60V			10	nA
		V_{CB} = 60V T_{amb} = 150°C			10	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = 5V				
		for **2N 718A**			10	nA
		for **2N 956**			5	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA	75			V
$V_{CER(sus)}$*	Collector-emitter sustaining voltage ($R_{BE} \leq 10\Omega$)	I_C = 10 mA	50			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA	7			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 150 mA I_B = 15 mA		0.24	1.5	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 150 mA I_B = 15 mA		1	1.3	V
h_{FE}	DC current gain	for **2N 718A**				
		I_C = 0.1 mA V_{CE} = 10V	20			–
		I_C = 10 mA V_{CE} = 10V	35			–
	*	I_C = 150 mA V_{CE} = 10V	40		120	–
	*	I_C = 500 mA V_{CE} = 10V	20			–
		I_C = 10 mA V_{CE} = 10V T_{amb} = -55°C	20			–
		for **2N 956**				
		I_C = 0.01 mA V_{CE} = 10V	20			–
		I_C = 0.1 mA V_{CE} = 10V	35			–

ELECTRICAL CHARACTERISTICS (continued)

Parameter			Test conditions		Min.	Typ.	Max.	Unit
h_{FE}	DC current gain		for **2N 956**					
			I_C = 10 mA	V_{CE} = 10V	75			–
		*	I_C = 150 mA	V_{CE} = 10V	100		300	–
		*	I_C = 500 mA	V_{CE} = 10V	40			–
			I_C = 10 mA, T_{amb} = -55°C	V_{CE} = 10V	35			–
h_{fe}	Small signal current gain		for **2N 718A**					
			I_C = 1 mA	V_{CE} = 5V	30		100	–
			I_C = 5 mA	V_{CE} = 10V	35		150	–
			for **2N 956**					
			I_C = 1 mA	V_{CE} = 5V	50		200	–
			I_C = 5 mA	V_{CE} = 10V	70		300	–
f_T	Transition frequency		I_C = 50 mA, f = 20 MHz	V_{CE} = 10V				
				for **2N 718A**	60	300		MHz
				for **2N 956**	70	300		MHz
C_{EBO}	Emitter-base capacitance		I_C = 0, f = 1 MHz	V_{EB} = 0.5V		20	80	pF
C_{CBO}	Collector-base capacitance		I_E = 0, f = 1 MHz	V_{CB} = 10V		4	25	pF
NF	Noise figure		I_C = 300 μA, f = 1 kHz	V_{CE} = 10V				
				for **2N 718A**			12	dB
				for **2N 956**			8	dB
h_{ib}	Input impedance		f = 1 kHz					
			I_C = 1 mA	V_{CB} = 5V	24		34	Ω
			I_C = 5 mA	V_{CB} = 10V	4		8	Ω
h_{rb}	Reverse voltage ratio		f = 1 kHz					
			for **2N 718A**					
			I_C = 1 mA	V_{CB} = 5V			3×10^{-4}	–
			I_C = 5 mA	V_{CB} = 10V			3×10^{-4}	–
			for **2N 956**					
			I_C = 1 mA	V_{CB} = 5V			5×10^{-4}	–
			I_C = 5 mA	V_{CB} = 10V			5×10^{-4}	–
h_{ob}	Output admittance		f= 1 kHz					
			I_C = 1 mA	V_{CB} = 5V	0.1		0.5	μS
			I_C = 5 mA	V_{CB} = 10V	0.1		1	μS

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 914

SILICON PLANAR NPN

SATURATED LOGIC SWITCH AND VHF AMPLIFIER

The 2N 914 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is primarily a universal switch but it is also an excellent high speed, high gain logic and memory driver at collector currents up to 500 mA.

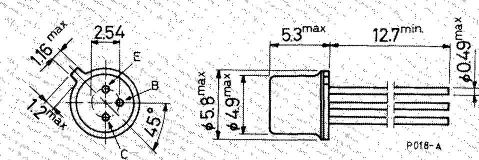
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CER}	Collector-emitter voltage ($R_{BE} \leqslant 10\ \Omega$)	20	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	15	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	500	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36	W
	at $T_{case} \leqslant 25°C$	1.2	W
	at $T_{case} \leqslant 100°C$	0.68	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

2N 914

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

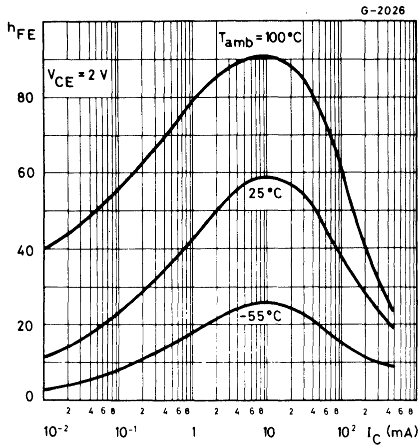
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 20V V_{CB} = 20V T_{amb} = 150°C			25 15	nA μA
I_{CEX}	Collector cutoff current (V_{BE} = -0.25V)	V_{CE} = 20V T_{amb} = 125°C			10	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = 4V			100	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 1 μA	40			V
$V_{CER\,(sus)}$*	Collector-emitter sustaining voltage ($R_{BE} \leqslant 10\Omega$)	I_C = 10 mA	20			V
$V_{CEO\,(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 10 mA	15			V

ELECTRICAL CHARACTERISTICS (continued)

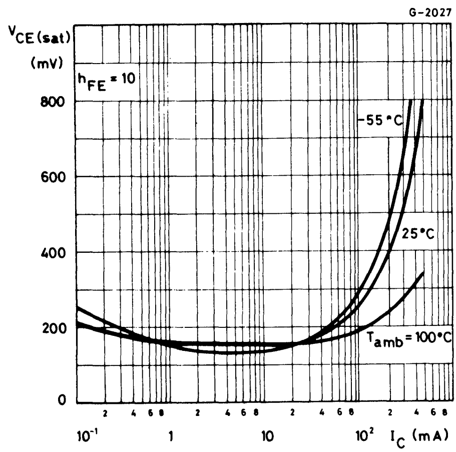
Parameter		Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu A$	5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	$I_C = 20$ mA $I_B = 2$ mA $I_C = 200$ mA $I_B = 20$ mA		0.2 0.4	0.25 0.7	V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	$I_C = 10$ mA $I_B = 1$ mA	0.7	0.74	0.8	V
h_{FE}*	DC current gain	$I_C = 10$ mA $V_{CE} = 1V$ $I_C = 500$ mA $V_{CE} = 5V$ $I_C = 10$ mA $V_{CE} = 1V$ $T_{amb} = -55°C$	30 10 12	55 17 28	120	– – –
f_T	Transition frequency	$I_C = 20$ mA $V_{CE} = 10V$ f = 100 MHz	300	370		MHz
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5V$ f = 1 MHz			9	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10V$ f = 1 MHz		4.5	6	pF
t_s	Storage time	$I_C = 20$ mA $V_{CC} = 5V$ $I_{B1} = -I_{B2} = 20$ mA		13	20	ns
t_{on}	Turn-on time	$I_C = 200$ mA $V_{CC} = 5V$ $I_{B1} = 40$ mA		25	40	ns
t_{off}	Turn-off time	$I_C = 200$ mA $V_{CC} = 5V$ $I_{B1} = 40$ mA $I_{B2} = -20$ mA		25	40	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

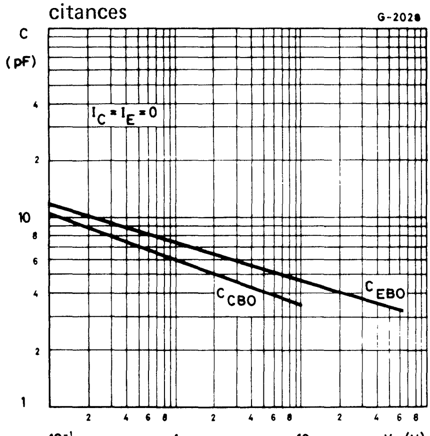
DC current gain



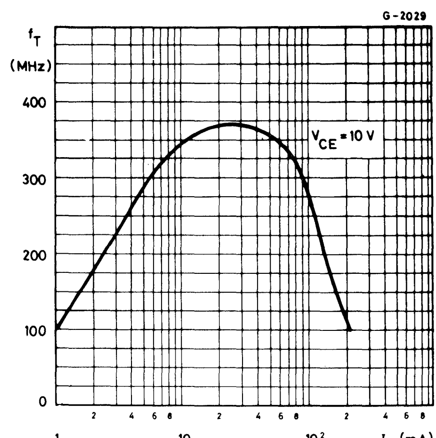
Collector-emitter saturation voltage



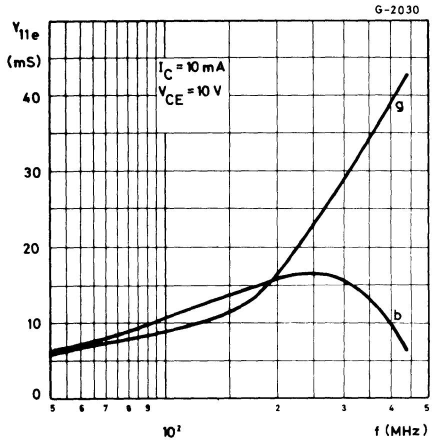
Collector-base and emitter-base capacitances



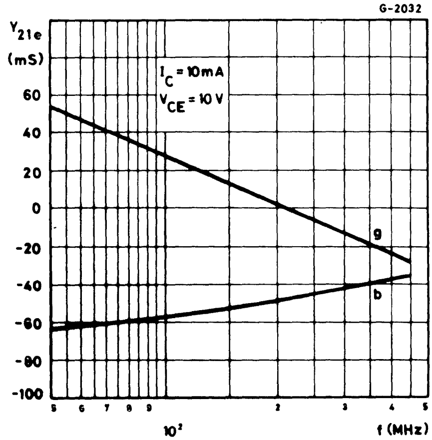
Transition frequency



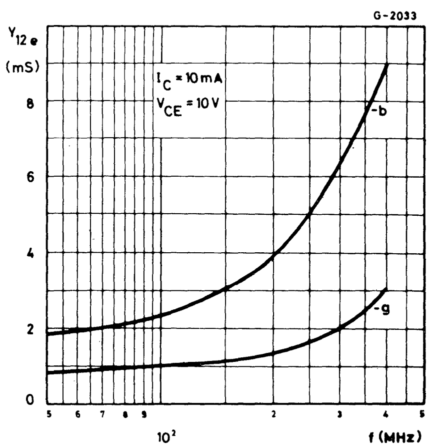
Input admittance



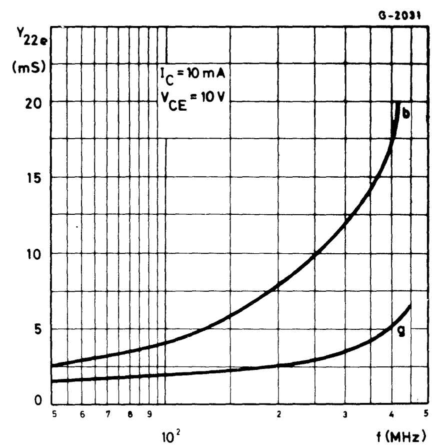
Forward transadmittance



Reverse transadmittance



Output admittance



2N 930

SILICON PLANAR NPN

LOW-LEVEL, LOW-NOISE AMPLIFIER

The 2N 930 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, designed for use in high performance, low-level, low-noise amplifier applications.

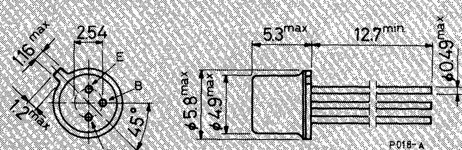
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	45	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	45	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	30	mA
P_{tot}	Total power dissipation at $T_{amb} = 25°C$	0.3	W
	$T_{case} = 25°C$	0.6	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	292	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	583	°C/W

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

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E= 0)	V_{CB}= 45V				10	nA
I_{CES}	Collector cutoff current (V_{BE}= 0)	V_{CE}= 45V V_{CE}= 45V	 T_{amb}=150°C			10 10	nA μA
I_{CEO}	Collector cutoff current (I_B= 0)	V_{CE}= 5V				2	nA
I_{EBO}	Emitter cutoff current (I_C= 0)	V_{EB}= 5V				10	nA
$V_{CEO(sus)}$ *	Collector-emitter sustaining voltage (I_B= 0)	I_C= 10 mA		45			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C= 0)	I_E= 10 nA		5			V
$V_{CE(sat)}$ *	Collector-emitter sustaining voltage	I_C= 10 mA	I_B= 0.5 mA			1	V
V_{BE} *	Base-emitter voltage	I_C= 10 mA	I_B= 0.5 mA	0.6		1	V
h_{FE} *	DC current gain	I_C= 10 μA I_C= 0.5 mA I_C= 10 mA I_C= 10 μA T_{amb}= -55°C	V_{CE}= 5V V_{CE}= 5V V_{CE}= 5V V_{CE}= 5V	100 150 20		300 600	– – – –
h_{fe}	Small signal current gain	I_C= 1 mA f= 1 kHz	V_{CE}= 5V	150		600	–
f_T	Transition frequency	I_C= 0.5 mA f = 30 MHz	V_{CE}= 5V	30			MHz
C_{CBO}	Collector-base capacitance	I_E= 0 f = 1 MHz	V_{CB}= 5V			8	pF
NF	Noise figure	I_C= 10 μA f = 1 kHz	V_{CE}= 5V R_g= 10 kΩ			3	dB
h_{ib}	Input impedance	I_C= 1 mA f = 1 kHz	V_{CB}= 5V	25		32	Ω
h_{ob}	Output admittance					1	μS
h_{rb}	Reverse voltage ratio					$6x10^{-4}$	–

* Pulsed: pulse duration = 300 μs, duty cycle = 1%.

2N 1613
2N 1711

SILICON PLANAR NPN

SWITCHES AND UNIVERSAL AMPLIFIERS

The 2N 1613 and 2N 1711 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case. They are designed for use in high performance amplifier, oscillator and switching circuits.
The 2N 1711 is also used to advantage in amplifiers where low noise is an important factor.

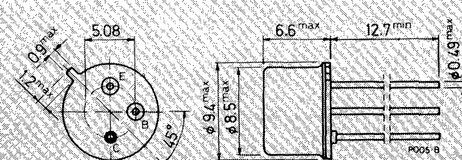
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	75	V
V_{CER}	Collector-emitter voltage ($R_{BE} \leqslant 10\ \Omega$)	50	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7	V
I_C	Collector current	500	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.8	W
	at $T_{case} \leqslant 25°C$	3	W
	at $T_{case} \leqslant 100°C$	1.7	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	58.3	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	219	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 60V$		0.3	10	nA
		$V_{CB} = 60V$ $T_{amb} = 150°C$		0.4	10	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = 5V$ for **2N 1613**		0.05	10	nA
		for **2N 1711**		0.05	5	nA
$V_{(BR)\,CBO}$	Collector-base breakdown voltage	$I_C = 0.1$ mA	75			V
$V_{CER\,(sus)}$*	Collector-emitter sustaining voltage ($R_{BE} \leqslant 10\Omega$)	$I_C = 10$ mA	50			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 0.1$ mA	7			V
$V_{CE\,(sat)}$*	Collector-emitter saturation voltage	$I_C = 150$ mA $I_B = 15$ mA for **2N 1613**		0.6	1.5	V
		for **2N 1711**		0.5	1.5	V
$V_{BE\,(sat)}$*	Base-emitter saturation voltage	$I_C = 150$ mA $I_B = 15$ mA		0.95	1.3	V
h_{FE}	DC current gain	for **2N 1613**				
		$I_C = 0.01$ mA $V_{CE} = 10V$		35		–
		$I_C = 0.1$ mA $V_{CE} = 10V$	20	50		–
	*	$I_C = 10$ mA $V_{CE} = 10V$	35	80		–
	*	$I_C = 150$ mA $V_{CE} = 10V$	40	80	120	–
	*	$I_C = 500$ mA $V_{CE} = 10V$	20	55		–
	*	$I_C = 10$ mA $V_{CE} = 10V$ $T_{amb} = 55°C$	20	35		–

2N 1613
2N 1711

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	for **2N 1711**				
		$I_C = 0.01$ mA $V_{CE} = 10V$	20	60		–
		$I_C = 0.1$ mA $V_{CE} = 10V$	35	80		–
	*	$I_C = 10$ mA $V_{CE} = 10V$	75	130		–
	*	$I_C = 150$ mA $V_{CE} = 10V$	100	130	300	–
	*	$I_C = 500$ mA $V_{CE} = 10V$	40	75		–
	*	$I_C = 10$ mA $V_{CE} = 10V$ $T_{amb} = -55°C$	35	65		–
h_{fe}	Small signal current gain	for **2N 1613**				
		$I_C = 1$ mA $V_{CE} = 5V$ f = 1 kHz	30	55	100	–
		$I_C = 5$ mA $V_{CE} = 10V$ f = 1 kHz	35	70	150	–
		for **2N 1711**				
		$I_C = 1$ mA $V_{CE} = 5V$ f = 1 kHz	50	115	200	–
		$I_C = 5$ mA $V_{CE} = 10V$ f = 1 kHz	70	135	300	–
f_T	Transition frequency	$I_C = 50$ mA $V_{CE} = 10V$ f = 20 MHz				
		for **2N 1613**	60	80		MHz
		for **2N 1711**	70	100		MHz
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5V$ f = 1 MHz		50	80	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10V$ f = 1 MHz		18	25	pF
NF	Noise figure	$I_C = 0.3$ mA $V_{CE} = 10V$ $R_g = 510\ \Omega$ f = 1 kHz				
		for **2N 1613**		6	12	dB
		for **2N 1711**		3.5	8	dB
h_{ib}	Input impedance	$I_C = 1$ mA $V_{CB} = 5V$ f = 1 kHz	24	27	34	Ω

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions		Min.	Typ.	Max.	Unit
h_{ib}	Input impedance	I_C = 5 mA f = 1 kHz	V_{CB} = 10V	4	6.3	8	Ω
h_{rb}	Reverse voltage ratio	I_C = 1 mA f = 1 kHz	V_{CB} = 5V				
			for **2N 1613**		$0.7x10^{-4}$	$3x10^{-4}$	–
			for **2N 1711**		$1.2x10^{-4}$	$5x10^{-4}$	–
		I_C = 5 mA f = 1 kHz	V_{CB} = 10V				
			for **2N 1613**		$0.8x10^{-4}$	$3x10^{-4}$	–
			for **2N 1711**		$1.2x10^{-4}$	$5x10^{-4}$	–
h_{ob}	Output admittance	I_C = 1 mA f = 1 kHz	V_{CB} = 5V	0.1	0.16	0.5	μS
		I_C = 5 mA f = 1 kHz	V_{CB} = 5V	0.1	0.19	1	μS
h_{ie}	Input impedance	I_C = 1 mA f = 1 kHz	V_{CE} = 5V				
			for **2N 1613**		2.2		kΩ
			for **2N 1711**		4.4		kΩ
h_{re}	Reverse voltage ratio	I_C = 1 mA f = 1 kHz	V_{CE} = 5V				
			for **2N 1613**		$3.6x10^{-4}$		–
			for **2N 1711**		$7.3x10^{-4}$		–
h_{oe}	Output admittance	I_C = 1 mA f = 1 kHz	V_{CE} = 5V				
			for **2N 1613**		12.5		μS
			for **2N 1711**		23.8		μS

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 1893

SILICON PLANAR NPN

GENERAL PURPOSE HIGH-VOLTAGE TYPE

The 2N 1893 is a silicon planar epitaxial NPN transistor in Jedec TO-39 metal case, designed for use in high-performance amplifier, oscillator and switching circuits.
It provides greater voltage swings in oscillator and amplifier circuits and more protection in inductive switching circuits due to its 120V collector-to-base voltage rating.

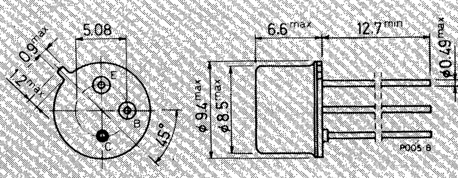
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	120	V
V_{CER}	Collector-emitter voltage ($R_{BE} \leqslant 10\ \Omega$)	100	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	80	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7	V
I_C	Collector current	0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.8	W
	at $T_{case} \leqslant 25°C$	3	W
	at $T_{case} \leqslant 100°C$	1.7	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	58	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	219	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB}= 90V		0.3	10	nA
		V_{CB}= 90V T_{amb}= 150°C		1.5	15	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB}= 5V			10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA	120			V
$V_{CER(sus)}$*	Collector-emitter sustaining voltage ($R_{BE} \leqslant 10\ \Omega$)	I_C = 10 mA	100			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 10 mA	80			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA	7			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 50 mA I_B= 5 mA			1.2	V
		I_C = 150 mA I_B= 15 mA			5	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 50 mA I_B= 5 mA		0.82	0.9	V
		I_C = 150 mA I_B= 15 mA		0.96	1.3	V
h_{FE}	DC current gain	I_C = 0.1 mA V_{CE}= 10V	20	50		–
	*	I_C = 10 mA V_{CE}= 10V	35	80		–
	*	I_C = 150 mA V_{CE}= 10V	40	80	120	–
	*	I_C = 10 mA V_{CE}= 10V T_{amb}= -55°C	20	40		–

2N 1893

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	I_C = 1 mA V_{CE} = 5V f = 1 kHz I_C = 5 mA V_{CE} = 10V f = 1 kHz	30 45	70 85	100	– –
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10V f = 20 MHz	50	70		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz		55	85	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 1 MHz		13	15	pF
h_{ib}	Input impedance	I_C = 1 mA V_{CB} = 5V f = 1 kHz I_C = 5 mA V_{CB} = 10V f = 1 kHz	20 4	27 6.4	30 8	Ω Ω
h_{rb}	Reverse voltage ratio	I_C = 1 mA V_{CB} = 5V f = 1 kHz I_C = 5 mA V_{CB} = 10V f = 1 kHz		0.5×10^{-4} 0.6×10^{-4}	1.25×10^{-4} 1.5×10^{-4}	– –
h_{ob}	Output admittance	I_C = 1 mA V_{CB} = 5V f = 1 kHz I_C = 5 mA V_{CB} = 10V f = 1 kHz		0.12 0.14	0.5 0.5	μS μS
h_{ie}	Input impedance	I_C = 1 mA V_{CE} = 5V f = 1 kHz		2.8		kΩ
h_{re}	Reverse voltage ratio	I_C = 1 mA V_{CE} = 5V f = 1 kHz		3.5×10^{-4}		–
h_{oe}	Output admittance	I_C = 1 mA V_{CE} = 5V f = 1 kHz		11		μS

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

SILICON PLANAR NPN

2N 2218
2N 2219
2N 2221
2N 2222

HIGH-SPEED SWITCHES

The 2N 2218, 2N 2219, 2N 2221 and 2N 2222 are silicon planar epitaxial NPN transistors in Jedec TO-39 (for 2N 2218 and 2N 2219) and in Jedec TO-18 (for 2N 2221 and 2N 2222) metal cases. They are designed for high-speed switching applications at collector currents up to 500 mA, and feature useful current gain over a wide range of collector current, low leakage currents and low saturation voltages.

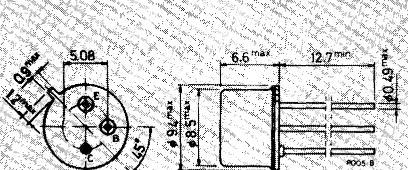
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	0.8	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$		
	for **2N 2218** and **2N 2219**	0.8	W
	for **2N 2221** and **2N 2222**	0.5	W
	at $T_{case} \leqslant 25°C$		
	for **2N 2218** and **2N 2219**	3	W
	for **2N 2221** and **2N 2222**	1.8	W
T_{stg}	Storage temperature	-65 to 200	°C
T_j	Junction temperature	175	°C

MECHANICAL DATA

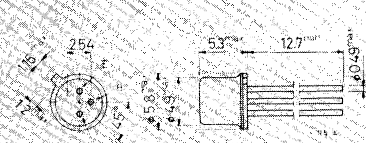
Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

Collector connected to case



(sim. to **TO-18**)

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THERMAL DATA

			2N 2218 2N 2219	2N 2221 2N 2222
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	50 °C/W	83.3 °C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	187.5 °C/W	300 °C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 50V V_{CB} = 50V T_{amb} = 150°C			10 10	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 3V			10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA	60			V
$V_{(BR)CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA	30			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA	5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 150 mA I_B = 15 mA I_C = 500 mA I_B = 50 mA			0.4 1.6	V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 150 mA I_B = 15 mA I_C = 500 mA I_B = 50 mA			1.3 2.6	V V
h_{FE}	DC current gain	for **2N 2218** and **2N 2221**				
		I_C = 0.1 mA V_{CE} = 10V	20			–
		I_C = 1 mA V_{CE} = 10V	25			–
		I_C = 10 mA V_{CE} = 10V	35			–
	*	I_C = 150 mA V_{CE} = 10V	40		120	–
	*	I_C = 500 mA V_{CE} = 10V	20			–
	*	I_C = 150 mA V_{CE} = 1V	20			–
		for **2N 2219** and **2N 2222**				
		I_C = 0.1 mA V_{CE} = 10V	35			–
		I_C = 1 mA V_{CE} = 10V	50			–
		I_C = 10 mA V_{CE} = 10V	75			–
	*	I_C = 150 mA V_{CE} = 10V	100		300	–
	*	I_C = 500 mA V_{CE} = 10V	30			–
	*	I_C = 150 mA V_{CE} = 1V	50			–
f_T	Transition frequency	I_C = 20 mA V_{CE} = 20V f = 100 MHz	250			MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 100 kHz			8	pF
$R_{e(hie)}$	Real part of input impedance	I_C = 20 mA V_{CE} = 20V f = 300 MHz			60	Ω

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

SILICON PLANAR NPN

2N 2218 A
2N 2219 A
2N 2221 A
2N 2222A

HIGH-SPEED SWITCHES

The 2N 2218A, 2N 2219A, 2N 2221A and 2N 2222A are silicon planar epitaxial NPN transistors in Jedec TO-39 (for 2N 2218A and 2N 2219A) and in Jedec TO-18 (for 2N 2221A and 2N 2222A) metal cases. They are designed for high-speed switching applications at collector currents up to 500 mA, and feature useful current gain over a wide range of collector current, low leakage currents and low saturation voltages.

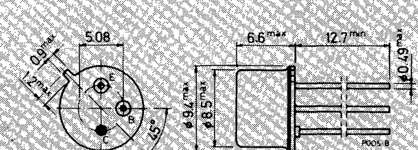
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	75	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6	V
I_C	Collector current	0.8	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$		
	for **2N 2218A** and **2N 2219A**	0.8	W
	for **2N 2221A** and **2N 2222A**	0.5	W
	at $T_{case} \leqslant 25°C$		
	for **2N 2218A** and **2N 2219A**	3	W
	for **2N 2221A** and **2N 2222A**	1.8	W
T_{stg}	Storage temperature	-65 to 200	°C
T_j	Junction temperature	175	°C

MECHANICAL DATA

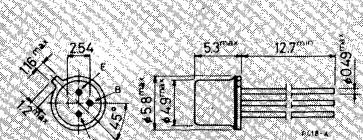
Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

			2N 2218A 2N 2219A	2N 2221A 2N 2222A
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	50 °C/W	83.3 °C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	187.5 °C/W	300 °C/W

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

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 60V$ $V_{CB} = 60V$ $T_{amb} = 150°C$			10 10	nA μA
I_{CEX}	Collector cutoff current ($V_{BE} = -3V$)	$V_{CE} = 60V$			10	nA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = 3V$			10	nA
I_{BEX}	Base cutoff current ($V_{BE} = -3V$)	$V_{CE} = 60V$			20	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu A$	75			V
$V_{(BR)CEO}$	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10\ mA$	40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu A$	6			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	$I_C = 150\ mA$ $I_B = 15\ mA$ $I_C = 500\ mA$ $I_B = 50\ mA$			0.3 1	V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	$I_C = 150\ mA$ $I_B = 15\ mA$ $I_C = 500\ mA$ $I_B = 50\ mA$	0.6		1.2 2	V V
h_{FE}	DC current gain	for **2N 2218A** and **2N 2221A** $I_C = 0.1\ mA$ $V_{CE} = 10V$ $I_C = 1\ mA$ $V_{CE} = 10V$ * $I_C = 10\ mA$ $V_{CE} = 10V$ * $I_C = 150\ mA$ $V_{CE} = 10V$ * $I_C = 500\ mA$ $V_{CE} = 10V$ * $I_C = 150\ mA$ $V_{CE} = 1V$ * $I_C = 10\ mA$ $V_{CE} = 10V$ $T_{amb} = -55°C$	 20 25 35 40 25 20 15		 120	 – – – – – – –

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	for **2N 2219A** and **2N 2222A**				
		I_C = 0.1 mA V_{CE} = 10V	35			–
		I_C = 1 mA V_{CE} = 10V	50			–
	*	I_C = 10 mA V_{CE} = 10V	75			–
	*	I_C = 150 mA V_{CE} = 10V	100		300	–
	*	I_C = 500 mA V_{CE} = 10V	40			–
	*	I_C = 150 mA V_{CE} = 1V	50			–
	*	I_C = 10 mA V_{CE} = 10V T_{amb} = -55°C	35			–
h_{fe}	Small signal current gain	I_C = 1 mA V_{CE} = 10V f = 1 kHz				
		for **2N 2218A** and **2N 2221A**	30		150	–
		for **2N 2219A** and **2N 2222A**	50		300	–
		I_C = 10 mA V_{CE} = 10V f = 1kHz				
		for **2N 2218A** and **2N 2221A**	50		300	–
		for **2N 2219A** and **2N 2222A**	75		375	–
f_T	Transition frequency	I_C = 20 mA V_{CE} = 20V f = 100 MHz				
		for **2N 2218A** and **2N 2221A**	250			MHz
		for **2N 2219A** and **2N 2222A**	300			MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 100 kHz			25	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 100 kHz			8	pF
$R_{e(h_{ie})}$	Real part of input impedance	I_C = 20 mA V_{CE} = 20V f = 300 MHz			60	Ω
NF	Noise figure	I_C = 100 μA V_{CE} = 0V R_g = 1 kΩ f = 1 kHz			4	dB
h_{ie}**	Input impedance	I_C = 1 mA V_{CE} = 10V				
		for **2N 2218A** and **2N 2221A**	1		3.5	Ω
		for **2N 2219A** and **2N 2222A**	2		8	Ω
		I_C = 10 mA V_{CE} = 10V				
		for **2N 2218A** and **2N 2221A**	0.2		1	Ω
		for **2N 2219A** and **2N 2222A**	0.25		1.25	Ω

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{re} **	Reverse voltage ratio	I_C = 1 mA V_{CE} = 10V				
		for **2N 2218A** and **2N 2221A**			$5x10^{-4}$	–
		for **2N 2219A** and **2N 2222A**			$8x10^{-4}$	–
		I_C = 10 mA V_{CE} = 10V				
		for **2N 2218A** and **2N 2221A**			$2.5x10^{-4}$	–
		for **2N 2219A** and **2N 2222A**			$4x10^{-4}$	–
h_{oe} **	Output admittance	I_C = 1 mA V_{CE} = 10V				
		for **2N 2218A** and **2N 2221A**	3		15	μS
		for **2N 2219A** and **2N 2222A**	5		35	μS
		I_C = 10 mA V_{CE} = 10V				
		for **2N 2218A** and **2N 2221A**	10		100	μS
		for **2N 2219A** and **2N 2222A**	25		200	μS
t_d	Delay time	I_C = 150 mA V_{CC} = 30V I_{B1} = 15 mA V_{BE} = -0.5V			10	ns
t_r	Rise time	I_C = 150 mA V_{CC} = 30V I_{B1} = 15 mA V_{BE} = -0.5V			25	ns
t_s	Storage time	I_C = 150 mA V_{CC} = 30V I_{B1} = $-I_{B2}$ = 15 mA			225	ns
t_f	Fall time	I_C = 150 mA V_{CC} = 30V I_{B1} = $-I_{B2}$ = 15 mA			60	ns
$r_{bb'}C_{b'c}$	Feedback time constant	I_C = 20 mA V_{CE} = 20V f = 31.8 MHz			150	ps

* Pulsed: pulse duration = 300 μs, duty cycle = 1%
** f = 1 kHz

SILICON PLANAR NPN

2N 2369

HIGH-FREQUENCY SATURATED SWITCH

The 2N 2369 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed specifically for high-speed saturated switching applications at current levels from 100 μA to 100 mA.

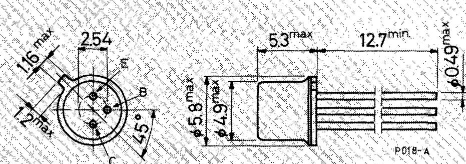
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	15	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4.5	V
I_{CM}	Collector peak current ($t = 10\ \mu s$)	0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.36	W
	at $T_{case} \leq 25°C$	1.2	W
	at $T_{case} \leq 100°C$	0.68	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

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2N 2369

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 20V$ $V_{CB} = 20V$ $T_{amb} = 150°C$			0.4 30	μA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu A$	40			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage ($V_{BE} = 0$)	$I_C = 10\ \mu A$	40			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 10$ mA	15			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu A$	4.5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	$I_C = 10$ mA $I_B = 1$ mA		0.2	0.25	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	$I_C = 10$ mA $I_B = 1$ mA	0.7	0.75	0.85	V
h_{FE}*	DC current gain	$I_C = 10$ mA $V_{CE} = 1V$ $I_C = 100$ mA $V_{CE} = 2V$ $I_C = 10$ mA $V_{CE} = 1V$ $T_{amb} = -55°C$	40 20 20		120	– – –
f_T	Transition frequency	$I_C = 10$ mA $V_{CE} = 10V$ f = 100 MHz	500	650		MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 5V$ f = 1 MHz		2.5	4	pF
t_s	Storage time	$I_C = 10$ mA $V_{CC} = 10V$ $I_{B1} = -I_{B2} = 10mA$		6	13	ns
t_{on}	Turn-on time	$I_C = 10$ mA $V_{CC} = 3V$ $I_{B1} = 3$ mA		9	12	ns
t_{off}	Turn-off time	$I_C = 10$ mA $V_{CC} = 3V$ $I_{B1} = 3$ mA $I_{B2} = -1.5mA$		13	18	ns

* Pulsed: pulse duration = 300μs, duty cycle = 1%

SILICON PLANAR NPN

2N 2369A

HIGH-SPEED SATURATED SWITCH

The 2N 2369A is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed specifically for high-speed saturated switching applications at current levels from 100 μA to 100 mA.

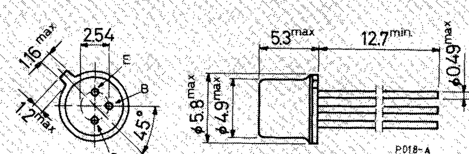
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	15	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4.5	V
I_C	Collector current	0.2	A
I_{CM}	Collector current (10 μs pulse)	0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.36	W
	at $T_{case} \leq 25°C$	1.2	W
	at $T_{case} \leq 100°C$	0.68	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

2N 2369A

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

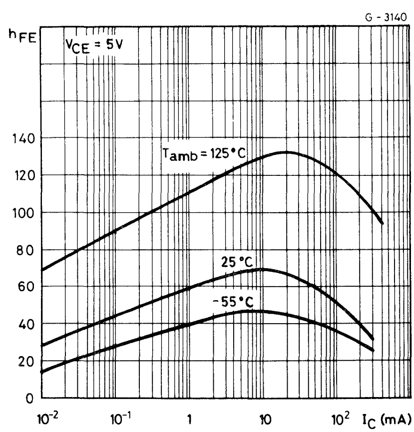
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 20V$ $T_{amb} = 150°C$			30	μA
I_{CES}	Collector cutoff current ($V_{BE} = 0$)	$V_{CE} = 20V$			0.4	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu A$	40			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage ($V_{BE} = 0$)	$I_C = 10\ \mu A$	40			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 10$ mA	15			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu A$	4.5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	$I_C = 10$ mA $I_B = 1$ mA		0.14	0.2	V
		$I_C = 30$ mA $I_B = 3$ mA		0.17	0.25	V
		$I_C = 100$ mA $I_B = 10$ mA		0.28	0.5	V
		$I_C = 10$ mA $I_B = 1$ mA $T_{amb} = 125°C$		0.19	0.3	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	$I_C = 10$ mA $I_B = 1$ mA	0.7	0.8	0.85	V
		$I_C = 30$ mA $I_B = 3$ mA		0.9	1.15	V
		$I_C = 100$ mA $I_B = 10$ mA		1.1	1.6	V
		$I_C = 10$ mA $I_B = 1$ mA $T_{amb} = -55$ to 125°C	0.59		1.02	V
h_{FE}*	DC current gain	$I_C = 10$ mA $V_{CE} = 0.35V$	40	63	120	–
		$I_C = 10$ mA $V_{CE} = 1V$	40	66	120	–
		$I_C = 30$ mA $V_{CE} = 0.4V$	30	71		–
		$I_C = 100$ mA $V_{CE} = 1V$	20			–

ELECTRICAL CHARACTERISTICS (continued)

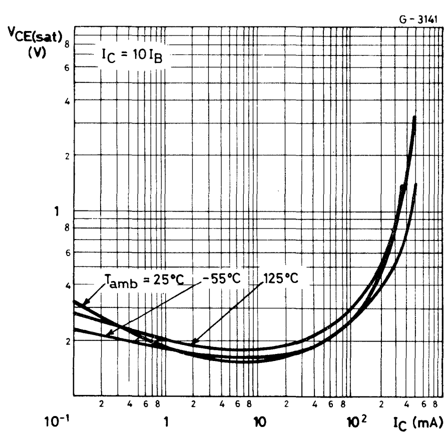
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C = 10 mA V_{CE} = 0.35V T_{amb} = -55°C	20	50		–
f_T	Transition frequency	I_C = 10 mA V_{CE} = 10V f = 100 MHz	500	675		MHz
C_{CBO}	Collector- base capacitance	I_E = 0 V_{CB} = 5V f = 1 MHz		2.3	4	pF
t_s	Storage time	I_C = 10 mA V_{CC} = 10V I_{B1} = -I_{B2} = 10 mA		6	13	ns
t_{on}	Turn-on time	I_C = 10 mA V_{CC} = 3V I_{B1} = 3 mA		9	12	ns
t_{off}	Turn-off time	I_C = 10 mA V_{CC} = 3V I_{B1} = 3 mA I_{B2} = -1.5 mA		13	18	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

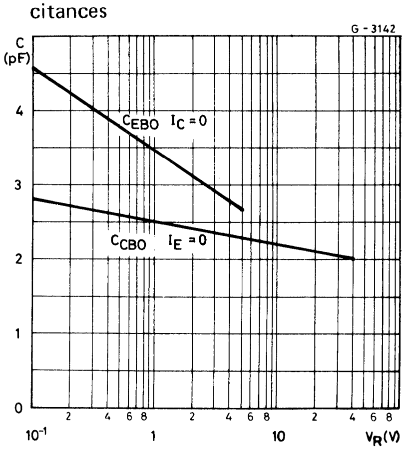
DC current gain



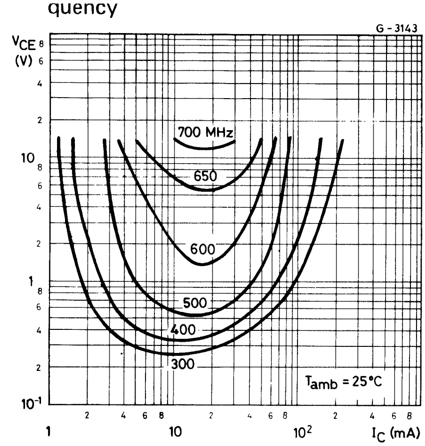
Collector-emitter saturation voltage



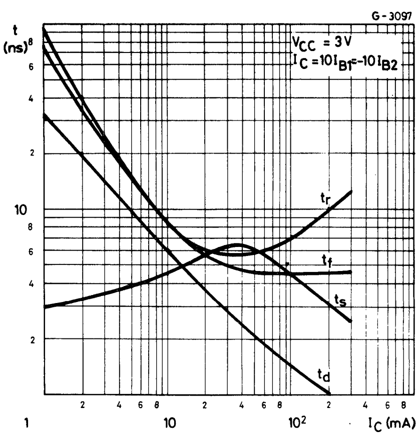
Collector-base and emitter-base capacitances



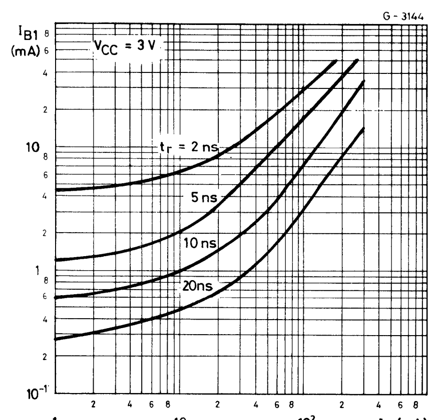
Contours of constant transition frequency



Switching characteristics



Switching characteristics



SILICON PLANAR NPN

2N 2483
2N 2484

LOW-LEVEL, LOW-NOISE AMPLIFIERS

The 2N 2483 and 2N 2484 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case. They are designed for use in high-performance, low-noise amplifier circuits from audio to high-frequency.

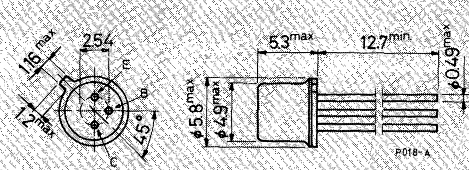
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	60	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6	V
I_C	Collector current	50	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant$ 25°C	0.36	W
	at $T_{case} \leqslant$ 25°C	1.2	W
	at $T_{case} \leqslant$ 100°C	0.68	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

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2N 2483
2N 2484

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 45V$ $V_{CB} = 45V$ $T_{amb} = 150°C$		0.1 0.2	10 10	nA μA
I_{CEO}	Collector cutoff current ($I_B = 0$)	$V_{CE} = 5V$		0.1		nA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = 5V$		0.1	10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu A$	60			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 10\ mA$	60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu A$	6			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$I_C = 1\ mA$ $I_B = 0.1\ mA$		0.2	0.35	V
V_{BE}	Base-emitter voltage	$I_C = 100\ \mu A$ $V_{CE} = 5V$	0.5	0.57	0.7	V
h_{FE}	DC current gain	for **2N 2483**				
		$I_C = 10\ \mu A$ $V_{CE} = 5V$	40	80	120	–
		$I_C = 100\ \mu A$ $V_{CE} = 5V$	75	140		–
		$I_C = 500\ \mu A$ $V_{CE} = 5V$	100	200		–
		$I_C = 1\ mA$ $V_{CE} = 5V$	175	230		–
	*	$I_C = 10\ mA$ $V_{CE} = 5V$		280	500	–
		$I_C = 10\ \mu A$ $V_{CE} = 5V$ $T_{amb} = -55°C$	10			–
		for **2N 2484**				
		$I_C = 1\ \mu A$ $V_{CE} = 5V$	30	200		–
		$I_C = 10\ \mu A$ $V_{CE} = 5V$	100	290	500	–
		$I_C = 100\ \mu A$ $V_{CE} = 5V$	175	375		–
		$I_C = 500\ \mu A$ $V_{CE} = 5V$	200	430		–
		$I_C = 1\ mA$ $V_{CE} = 5V$	250	450		–
	*	$I_C = 10\ mA$ $V_{CE} = 5V$		430	800	–
		$I_C = 10\ \mu A$ $V_{CE} = 5V$ $T_{amb} = -55°C$	20			–

ELECTRICAL CHARACTERISTICS (continued)

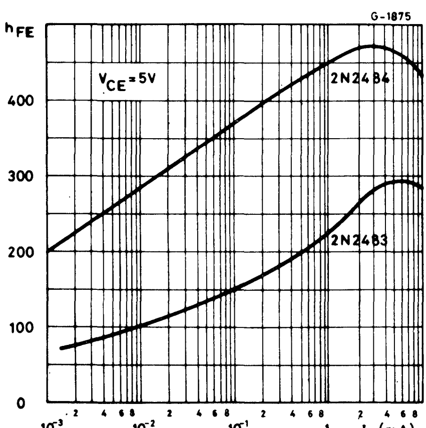
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	I_C = 1 mA V_{CE} = 5V f = 1 kHz				
		for **2N 2483**	80	280	450	–
		for **2N 2484**	150	400	900	–
f_T	Transition frequency	for **2N 2483**				
		I_C = 50 μA V_{CE} = 5V f = 5 MHz	12	20		MHz
		I_C = 500 μA V_{CE} = 5V f = 30 MHz	60	69		MHz
		for **2N 2484**				
		I_C = 50 μA V_{CE} = 5V f = 5 MHz	15	20		MHz
		I_C = 500 μA V_{CE} = 5V f = 30 MHz	60	78		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz		3.5	6	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 5V f = 1 MHz		3.5	6	pF
NF	Noise figure	I_C = 10 μA V_{CE} = 5V R_g = 10 kΩ f = 100 Hz				
		for **2N 2483**		4	15	dB
		for **2N 2484**		4	10	dB
		f = 1 kHz				
		for **2N 2483**		1.9	4	dB
		for **2N 2484**		1.8	3	dB
		f = 10 kHz				
		for **2N 2483**		0.7	3	dB
		for **2N 2484**		0.6	2	dB
		f = 10 to 10 000 Hz				
		for **2N 2483**		1.9	4	dB
		for **2N 2484**		1.8	3	dB
h_{ie}**	Input impedance	I_C = 1 mA V_{CE} = 5V				
		for **2N 2483**	1.5	7.5	13	kΩ
		for **2N 2484**	3.5	15	24	kΩ
h_{re}**	Reverse voltage ratio	I_C = 1 mA V_{CE} = 5V				
		for **2N 2483**		3×10^{-4}	8×10^{-4}	–
		for **2N 2484**		4.25×10^{-4}	8×10^{-4}	–

ELECTRICAL CHARACTERISTICS (continued)

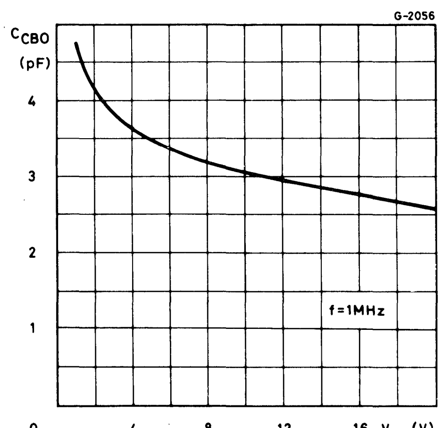
Parameter		Test conditions		Min.	Typ.	Max.	Unit
h_{oe}**	Output admittance	$I_C = 1$ mA	$V_{CE} = 5V$				
			for **2N 2483**		11	30	µS
			for **2N 2484**		15	40	µS
h_{ib}**	Input impedance	$I_C = 1$ mA	$V_{CB} = 5V$	25	27	32	Ω

* Pulsed: pulse duration = 300 µs, duty cycle = 1%
** f = 1 kHz

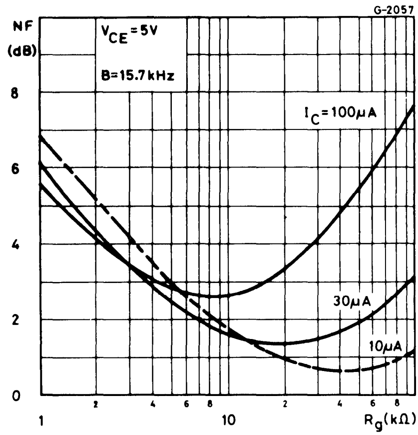
DC current gain



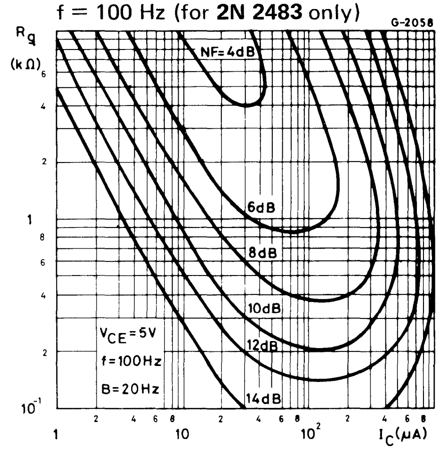
Collector-base capacitance



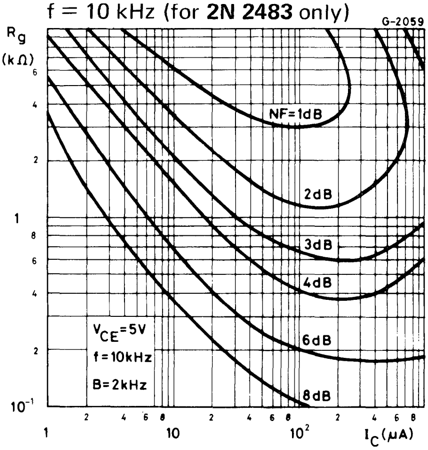
Noise figure vs. source resistance



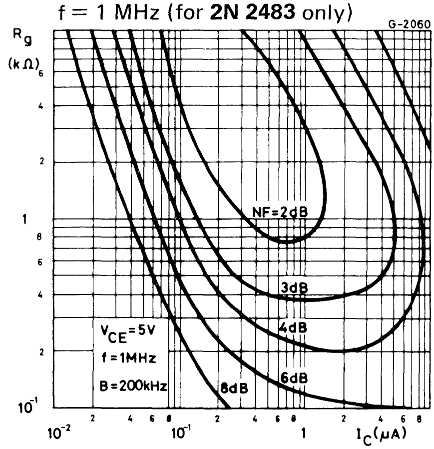
Contours of constant noise figure
f = 100 Hz (for **2N 2483** only)



Contours of constant noise figure
f = 10 kHz (for **2N 2483** only)

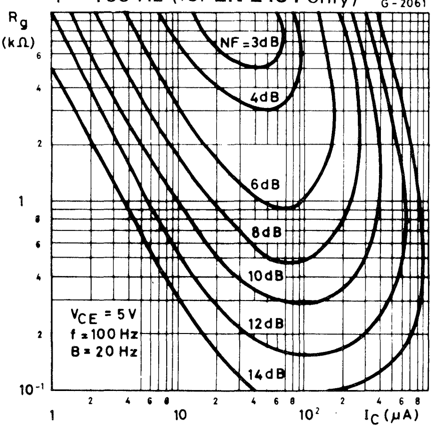


Contours of constant noise figure
f = 1 MHz (for **2N 2483** only)



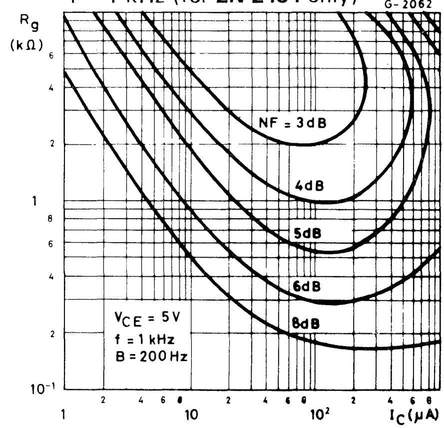
Contours of constant noise figure
f = 100 Hz (for **2N 2484** only)

G-2061



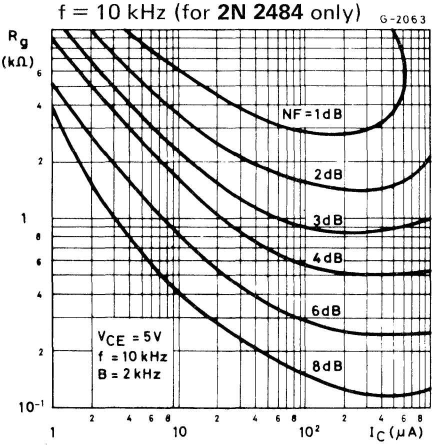
Contours of constant noise figure
f = 1 kHz (for **2N 2484** only)

G-2062



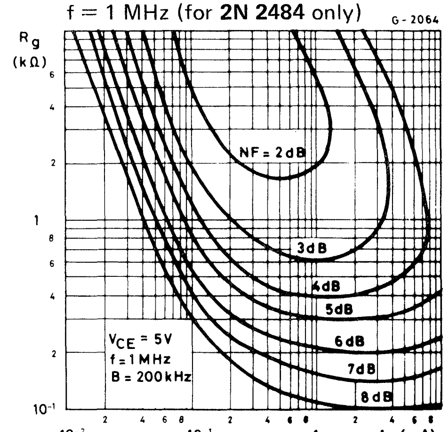
Contours of constant noise figure
f = 10 kHz (for **2N 2484** only)

G-2063



Contours of constant noise figure
f = 1 MHz (for **2N 2484** only)

G-2064



SILICON PLANAR PNP

2N 2894
2N 3012
2N 3209

HIGH-SPEED SATURATED SWITCHES

The 2N 2894, 2N 3012 and 2N 3209 are silicon planar epitaxial PNP transistors in Jedec TO-18 metal case, intended for high speed, low saturation switching applications up to 100 mA.

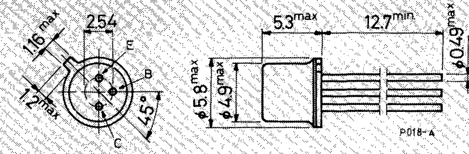
ABSOLUTE MAXIMUM RATINGS

		2N 2894 2N 3012	2N 3209
V_{CBO}	Collector-base voltage ($I_E = 0$)	-12 V	-20 V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-12 V	-20 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-12 V	-20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-4 V	
I_C	Collector current	-200 mA	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36 W	
	at $T_{case} \leqslant 25°C$	1.2 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0) (for **2N 2894** only)	V_{CB} = -6V T_{amb} = 125°C			-10	μA
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **2N 2894**				
		V_{CE} = -6V			-80	nA
		for **2N 3012**				
		V_{CE} = -6V			-80	nA
		V_{CE} = -6V T_{amb} = 85°C			-5	μA
		for **2N 3209**				
		V_{CE} = -10V			-80	nA
		V_{CE} = -10V T_{amb} = 125°C			-10	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA				
		for **2N 2894** and **2N 3012**	-12			V
		for **2N 3209**	-20			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10 μA				
		for **2N 2894** and **2N 3012**	-12			V
		for **2N 3209**	-20			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = -10 mA				
		for **2N 2894** and **2N 3012**	-12			V
		for **2N 3209**	-20			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -100 μA	-4			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	for **2N 2894** and **2N 3012**				
		I_C = -10 mA I_B = -1 mA			-0.15	V
		I_C = -30 mA I_B = -3 mA			-0.2	V
		I_C = -100 mA I_B = -10 mA			-0.5	V
		for **2N 3209**				
		I_C = -10 mA I_B = -1 mA			-0.15	V
		I_C = -30 mA I_B = -3 mA			-0.2	V
		I_C = -100 mA I_B = -10 mA			-0.6	V

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
$V_{CE(sat)}$*	Collector-emitter saturation voltage	for **2N 3012** only I_C = -30 mA I_B = -3 mA T_{amb} = 85°C			-0.4	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = -10 mA I_B = -1 mA	-0.78		-0.98	V
		I_C = -30 mA I_B = -3 mA	-0.85		-1.2	V
		I_C = -100 mA I_B = -10 mA			-1.7	V
h_{FE}*	DC current gain	I_C = -10 mA V_{CE} = -0.3V				
		for **2N 2894**	30			–
		for **2N 3012** and **2N 3209**	25			–
		I_C = -30 mA V_{CE} = -0.5V				
		for **2N 2894**	40		150	–
		for **2N 3012** and **2N 3209**	30		120	–
		I_C = -100 mA V_{CE} = -1 V				
		for **2N 2894**	25			–
		for **2N 3012**	20			–
		for **2N 3209**	15			–
		I_C = -30 mA V_{CE} = -0.5V T_{amb} = -55°C				
		for **2N 2894**	17			–
		for **2N 3209**	12			–
f_T	Transition frequency	I_C = -30 mA V_{CE} = -10V f = 100 MHz	400			MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -0.5V f = 1 MHz			6	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -5V f = 1 MHz				
		for **2N 2894** and **2N 3012**			6	pF
		for **2N 3209**			5	pF
t_{on}	Turn-on time	I_C = -30 mA V_{CC} = -2V I_{B1} = -1.5 mA			60	ns
t_{off}	Turn-off time	I_C = -30 mA V_{CC} = -2V I_{B1} = $-I_{B2}$ = -1.5 mA				
		for **2N 2894** and **2N 3209**			90	ns
		for **2N 3012**			75	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 2904
2N 2905
2N 2906
2N 2907

SILICON PLANAR PNP

GENERAL PURPOSE AMPLIFIERS AND SWITCHES

The 2N 2904, 2N 2905, 2N 2906 and 2N 2907 are silicon planar epitaxial PNP transistors in Jedec TO-39 (for 2N 2904 and 2N 2905) and in Jedec TO-18 (for 2N 2906 and 2N 2907) metal cases. They are designed for high-speed saturated switching and general purpose applications.

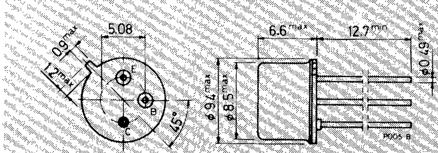
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-600	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$		
	for **2N 2904** and **2N 2905**	0.6	W
	for **2N 2906** and **2N 2907**	0.4	W
	at $T_{case} \leqslant 25°C$		
	for **2N 2904** and **2N 2905**	3	W
	for **2N 2906** and **2N 2907**	1.8	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

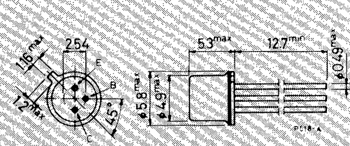
Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

			2N 2904 2N 2905	2N 2906 2N 2907
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	58.3 °C/W	97.3 °C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	292 °C/W	437.5 °C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -50V V_{CB} = -50V T_{amb} = 150°C			-20 -20	nA μA
I_{CEX}	Collector cutoff current (V_{BE} = 0.5V)	V_{CE} = -30V			-50	nA
I_{BEX}	Base cutoff current (V_{BE} = 0.5V)	V_{CE} = -30V			-50	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10 μA	-60			V
$V_{CEO(sus)}$ *	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = -10 mA	-40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -10 μA	-5			V
$V_{CE(sat)}$ *	Collector-emitter saturation voltage	I_C = -150 mA I_B = -15 mA I_C = -500 mA I_B = -50 mA			-0.4 -1.6	V V
$V_{BE(sat)}$ *	Base-emitter saturation voltage	I_C = -150 mA I_B = -16 mA I_C = -500 mA I_B = -50 mA			-1.3 -2.6	V V
h_{FE}	DC current gain	for **2N 2904** and **2N 2906** I_C = -0.1 mA V_{CE} = -10V I_C = -1 mA V_{CE} = -10V I_C = -10 mA V_{CE} = -10V * I_C = -150 mA V_{CE} = -10V * I_C = -500 mA V_{CE} = -10V	 20 25 35 40 20		 120 	 – – – – –

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	for **2N 2905** and **2N 2907**				
		I_C = -0.1 mA V_{CE}= -10V	35			–
		I_C = -1 mA V_{CE}= -10V	50			–
		I_C = -10 mA V_{CE}= -10V	75			–
	*	I_C = -150 mA V_{CE}= -10V	100		300	–
	*	I_C = -500 mA V_{CE}= -10V	30			–
f_T	Transition frequency	I_C = -50 mA V_{CE}= -20V f = 100 MHz	200			MHz
C_{EBO}	Emitter-base capacitance	I_C= 0 V_{EB}= -2V f = 100 kHz			30	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB}= -10V f = 100 kHz			8	pF
t_d	Delay time	I_C = -150 mA V_{CC}= -30V I_{B1} = -15 mA			10	ns
t_r	Rise time	I_C = -150 mA V_{CC}= -30V I_{B1} = -15 mA			40	ns
t_s	Storage time	I_C = -150 mA V_{CC}= -6V I_{B1} = -I_{B2} = -15 mA			80	ns
t_f	Fall time	I_C = -150 mA V_{CC}= -6V I_{B1} = -I_{B2} = -15 mA			30	ns

*Pulsed: pulse duration = 300 μs, duty cycle = 1%

SILICON PLANAR PNP

2N 2904A
2N 2905A
2N 2906A
2N 2907A

GENERAL PURPOSE AMPLIFIERS AND SWITCHES

The 2N 2904A, 2N 2905A, 2N 2906A and 2N 2907A are silicon planar epitaxial PNP transistors in Jedec TO-39 (for 2N 2904A and 2N 2905A) and in Jedec TO-18 (for 2N 2906A and 2N 2907A) metal cases. They are designed for high-speed saturated switching and general purpose applications.

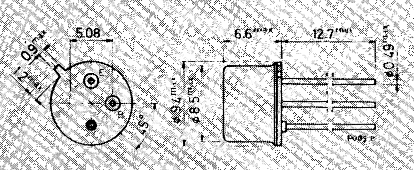
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-60	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	- 5	V
I_C	Collector current	-600	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$		
	for **2N 2904A** and **2N 2905A**	0.6	W
	for **2N 2906A** and **2N 2907A**	0.4	W
	at $T_{case} \leq 25°C$		
	for **2N 2904A** and **2N 2905A**	3	W
	for **2N 2906A** and **2N 2907A**	1.8	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

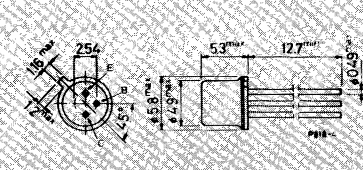
Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

			2N 2904A 2N 2905A	2N 2906A 2N 2907A
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	58.3 °C/W	97.3 °C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	292 °C/W	437.5 °C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -50V			-10	nA
		V_{CB} = -50V T_{amb} = 150°C			-10	μA
I_{CEX}	Collector cutoff current (V_{BE} = 0.5V)	V_{CE} = -30V			-50	nA
I_{BEX}	Base cutoff current (V_{BE} = 0.5V)	V_{CE} = -30V			-50	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10 μA	-60			V
$V_{CEO(sus)}$ *	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = -10 mA	-60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = -10 μA	-5			V
$V_{CE(sat)}$ *	Collector-emitter saturation voltage	I_C = -150 mA I_B = -15 mA			-0.4	V
		I_C = -500 mA I_B = -50 mA			-1.6	V
$V_{BE(sat)}$ *	Base-emitter saturation voltage	I_C = -150 mA I_B = -15 mA			-1.3	V
		I_C = -500 mA I_B = -50 mA			-2.6	V
h_{FE}	DC current gain	for **2N 2904A** and **2N 2906A**				
		I_C = -0.1 mA V_{CE} = -10V	40			—
		I_C = -1 mA V_{CE} = -10V	40			—
		I_C = -10 mA V_{CE} = -10V	40			—
		* I_C = -150 mA V_{CE} = -10V	40		120	—
		* I_C = -500 mA V_{CE} = -10V	40			—

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	for **2N 2905A** and **2N 2907A**				
		I_C= -0.1 mA V_{CE}= -10V	75			–
		I_C= -1 mA V_{CE}= -10V	100			–
		I_C= -10 mA V_{CE}= -10V	100			–
		* I_C= -150 mA V_{CE}= -10V	100		300	–
		* I_C= -500 mA V_{CE}= -10V	50			–
f_T	Transition frequency	I_C= -50 mA V_{CE}= -20V f = 100 MHz	200			MHz
C_{EBO}	Emitter-base capacitance	I_C= 0 V_{EB}= -2V f = 100 kHz			30	pF
C_{CBO}	Collector-base capacitance	I_E= 0 V_{CB}= -10V f = 100 kHz			8	pF
t_d	Delay time	I_C= -150 mA V_{CC}= -30V I_{B1}= -15 mA			10	ns
t_r	Rise time	I_C= -150 mA V_{CC}= -30V I_{B1}= -15 mA			40	ns
t_s	Storage time	I_C= -150 mA V_{CC}= -6V I_{B1}= $-I_{B2}$= -15 mA			80	ns
t_f	Fall time	I_C= -150 mA V_{CC}= -6V I_{B1}= $-I_{B2}$= -15 mA			30	ns
t_{on}	Turn-on time	I_C= -150 mA V_{CC}= -30V I_{B1}= -15 mA			45	ns
t_{off}	Turn-off time	I_C= -150 mA V_{CC}= -6V I_{B1}= $-I_{B2}$= -15 mA			100	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 3009
2N 3013
2N 3014

SILICON PLANAR NPN

HIGH-SPEED SATURATED SWITCHES

The 2N 3009, 2N 3013 and 2N 3014 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case, intended for high-speed, low-saturation switching application up to 300 mA.

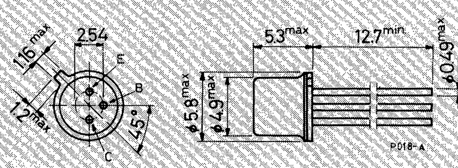
ABSOLUTE MAXIMUM RATINGS

		2N 3009	2N 3013	2N 3014
V_{CBO}	Collector-base voltage ($I_E = 0$)	40 V	40 V	40 V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	40 V	40 V	40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	15 V	15 V	20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V	5 V	5 V
I_C	Collector current		200 mA	
I_{CM}	Collector peak current ($t \leqslant 10\ \mu s$)		500 mA	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$		0.36 W	
	at $T_{case} \leqslant 25°C$		1.2 W	
	at $T_{case} \leqslant 100°C$		0.68 W	
T_{stg}, T_j	Storage and junction temperature		-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 20 V				
		for **2N 3009**			0.5	μA
		for **2N 3013** and **2N 3014**			0.3	μA
		V_{CE} = 20V T_{amb} = 85°C				
		for **2N 3009**			15	μA
		V_{CE} = 20V T_{amb} = 125°C				
		for **2N 3013** and **2N 3014**			40	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	40			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 100 μA	40			V
$V_{CEO\ (sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10 mA				
		for **2N 3009** and **2N 3013**	15			V
		for **2N 3014**	20			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA				
		for **2N 3009**	4			V
		for **2N 3013** and **2N 3014**	5			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 30 mA I_B = 3 mA			0.18	V
		I_C = 10 mA I_B = 1 mA				
		for **2N 3014**			0.18	V
		I_C = 100 mA I_B = 10 mA				
		for **2N 3009** and **2N 3013**			0.28	V
		for **2N 3014**			0.35	V
		I_C = 300 mA I_B = 30 mA				
		for **2N 3009** and **2N 3013**			0.5	V
		I_C = 30 mA I_B = 3 mA T_{amb} = 85°C				
		for **2N 3009**			0.3	V
		I_C = 30 mA I_B = 3 mA T_{amb} = 125°C				
		for **2N 3013** and **2N 3014**			0.25	V

ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{BE(sat)}$ *	Base-emitter saturation voltage	I_C = 10 mA I_B = 1 mA for **2N 3014**	0.7		0.8	V
		I_C = 30 mA I_B = 3 mA	0.75		0.95	V
		I_C = 100 mA I_B = 10 mA			1.2	V
		I_C = 300 mA I_B = 30 mA for **2N 3009** and **2N 3013**			1.7	V
h_{FE} *	DC current gain	I_C = 10 mA V_{CE} = 0.4V for **2N 3014**	25			–
		I_C = 30 mA V_{CE} = 0.4V	30		120	–
		I_C = 100 mA V_{CE} = 0.5V for **2N 3009** and **2N 3013**	25			–
		I_C = 100 mA V_{CE} = 1V for **2N 3014**	25			–
		I_C = 300 mA V_{CE} = 1V for **2N 3009** and **2N 3013**	15			–
		I_C = 30 mA V_{CE} = 0.4V T_{amb} = -55°C for **2N 3013** and **2N 3014**	12			–
f_T	Transition frequency	I_C = 30 mA V_{CE} = 10V f = 100 MHz	350			MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz			8	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 5V f = 1 MHz			5	pF
t_s	Storage time	I_C = 10 mA V_{CC} = 10V I_{B1} = $-I_{B2}$ = 10 mA			18	ns
t_{on}	Turn-on time	I_C = 30 mA V_{CC} = 2V I_{B1} = 3 mA for **2N 3014**			16	ns
		I_C = 300 mA V_{CC} = 15V I_{B1} = 30 mA for **2N 3009** and **2N 3013**			15	ns
t_{off}	Turn-off time	I_C = 30 mA V_{CC} = 2V I_{B1} = $-I_{B2}$ = 3 mA for **2N 3014**			25	ns
		I_C = 300 mA V_{CC} = 15V I_{B1} = $-I_{B2}$ = 30 mA for **2N 3009** and **2N 3013**			25	ns

* Pulsed: pulse duration = 300 μs, duty cycle= 1%

SILICON PLANAR NPN

2N 3019
2N 3020

HIGH-CURRENT, HIGH-FREQUENCY AMPLIFIERS

The 2N 3019 and 2N 3020 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case, designed for high-current, high-frequency amplifier applications. They feature high gain and low saturation voltages.

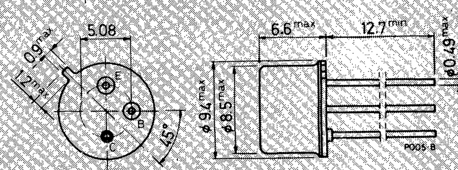
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	140	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	80	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.8	W
	at $T_{case} \leqslant 25°C$	5	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

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2N 3019
2N 3020

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	35	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	219	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 90V V_{CB} = 90V T_{amb} = 150°C			10 10	nA μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = 5V			10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA	140			V
$V_{CEO\,(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 10 mA	80			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA	7			V
$V_{CE\,(sat)}$*	Collector-emitter saturation voltage	I_C = 150 mA I_B = 15 mA I_C = 500 mA I_B = 50 mA			0.2 0.5	V V
$V_{BE\,(sat)}$*	Base-emitter saturation voltage	I_C = 150 mA I_B = 15 mA			1.1	V
h_{FE}*	DC current gain	I_C = 0.1 mA V_{CE} = 10V for **2N 3019** for **2N 3020** I_C = 10 mA V_{CE} = 10V for **2N 3019** for **2N 3020** I_C = 150 mA V_{CE} = 10V for **2N 3019** for **2N 3020** I_C = 500 mA V_{CE} = 10V for **2N 3019** for **2N 3020** I_C = 1A V_{CE} = 10V I_C = 150 mA V_{CE} = 10V T_{amb} = -55°C for **2N 3019**	 50 30 90 40 100 40 50 30 15 40		 100 120 300 120 100 	 – – – – – – – – – –

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	$I_C = 1$ mA f = 1 kHz	$V_{CE} = 5V$				
			for **2N 3019**	80		400	–
			for **2N 3020**	30		200	–
f_T	Transition frequency	$I_C = 50$ mA f = 20 MHz	$V_{CE} = 10V$				
			for **2N 3019**	100			MHz
			for **2N 3020**	80			MHz
C_{EBO}	Emitter-base capacitance	$I_C = 0$ f = 1MHz	$V_{EB} = 0.5V$			60	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ f = 1 MHz	$V_{CB} = 10V$			12	pF
NF	Noise figure (for **2N 3019** only)	$I_C = 100\,\mu A$ f = 1 kHz	$V_{CE} = 10V$ $R_g = 1\,k\Omega$			4	dB
$r_{bb'}C_{b'c}$	Feedback time constant	$I_C = 10$ mA f = 4 MHz	$V_{CE} = 10V$			400	ps

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 3053

SILICON PLANAR NPN

AMPLIFIER AND SWITCH

The 2N 3053 is a silicon planar epitaxial NPN transistor in Jedec TO-39 metal case, intended for medium-current switching and amplifier applications.

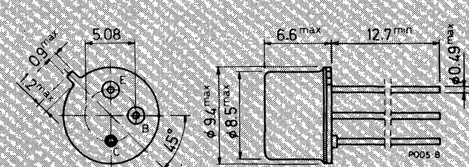
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	700	mA
P_{tot}	Total power dissipation at $T_{case} \leqslant 25°C$	5	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	35	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CEX}	Collector cutoff current (V_{BE} = -1.5V)	V_{CE} = 60V			250	nA
I_{BEX}	Base cutoff current (V_{BE} = -1.5V)	V_{CE} = 60V			250	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	60			V
$V_{(BR)CEO}$	Collector-emitter breakdown voltage (I_B = 0)	I_C = 100 μA	40			V
$V_{CER(sus)}$ *	Collector-emitter sustaining voltage ($R_{BE} \leqslant 10\Omega$)	I_C = 10 mA	50			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA	5			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 150 mA I_B = 15 mA			1.4	V
V_{BE}	Base-emitter voltage	I_C = 150 mA V_{CE} = 2.5V			1.7	V
$V_{BE(sat)}$	Base-emitter saturation voltage	I_C = 150 mA I_B = 15 mA			1.7	V
h_{FE} *	DC current gain	I_C = 150 mA V_{CE} = 2.5V I_C = 150 mA V_{CE} = 10V	25 50		 250	– –
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10V f = 20 MHz	100			MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz			80	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 1 MHz			15	pF

* Pulse: pulse duration = 300 μs, duty cycle = 1%

2N 3107
2N 3108
2N 3109
2N 3110

SILICON PLANAR NPN

GENERAL PURPOSE AMPLIFIERS AND SWITCHES

The 2N 3107, 2N 3108, 2N 3109 and 2N 3110 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case primarily intended for large signal, low noise industrial applications.

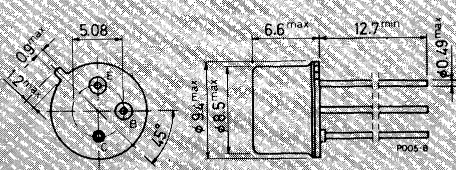
ABSOLUTE MAXIMUM RATINGS

		2N 3109 2N 3110	2N 3107 2N 3108
V_{CBO}	Collector-base voltage ($I_E = 0$)	80 V	100 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40 V	60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7 V	
I_C	Collector current	1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25\ °C$	0.8 W	
	at $T_{case} \leq 25\ °C$	5 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	35	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	219	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 60V T_{amb} = 150°C			10	μA
I_{CES}	Collector cutoff current ($V_{BE} = 0$)	V_{CE} = 60V			10	nA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = 5V			10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA for **2N 3109** and **2N 3110** for **2N 3107** and **2N 3108**	 80 100			 V V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 10 mA for **2N 3109** and **2N 3110** for **2N 3107** and **2N 3108**	 40 60			 V V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	I_E = 100 μA	7			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 150 mA I_B = 15 mA I_C = 1A I_B = 100 mA			0.25 1	V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 150 mA I_B = 15 mA I_C = 1A I_B = 100 mA			1.1 2	V V

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	for **2N 3107** and **2N 3109**				
		I_C = 150 mA V_{CE} = 1V	100		300	–
		I_C = 0.1 mA V_{CE} = 10V	35			–
		I_C = 500 mA V_{CE} = 10V	40			–
		I_C = 150 mA V_{CE} = 10V T_{amb} = -55°C	30			–
		for **2N 3108** and **2N 3110**				
		I_C = 150 mA V_{CE} = 1V	40		120	–
		I_C = 0.1 mA V_{CE} = 10V	20			–
		I_C = 500 mA V_{CE} = 10V	25			–
		I_C = 150 mA V_{CE} = 10V T_{amb} = -55°C	15			–
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10V f = 20 MHz				
		for **2N 3107** and **2N 3109**	70			MHz
		for **2N 3108** and **2N 3110**	60			MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz			80	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 1 MHz				
		for **2N 3107** and **2N 3108**			20	pF
		for **2N 3109** and **2N 3110**			25	pF
NF	Noise figure	I_C = 30 μA V_{CE} = 10V f = 1 kHz R_g = 1 kΩ			7	dB
t_{on}	Turn-on time	I_C = 150 mA V_{CC} = 20V I_{B1} = 7.5 mA			200	ns
t_{off}	Turn-off time	I_C = 150 mA V_{CC} = 20V I_{B1} = $-I_{B2}$ = 7.5 mA				
		for **2N 3107** and **2N 3109**			1000	ns
		for **2N 3108** and **2N 3110**			600	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

SILICON PLANAR PNP

2N 3250
2N 3251

AMPLIFIERS AND SWITCHES

The 2N 3250 and 2N 3251 are silicon planar epitaxial PNP transistors in Jedec TO-18 metal case. They are suited for switching and amplifier applications.

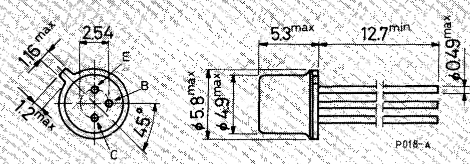
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-50	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-200	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36	W
	at $T_{case} \leqslant 25°C$	1.2	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

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2N 3250
2N 3251

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	487	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CEX}	Collector cutoff current (V_{BE}= 3V)	V_{CE}= -40V			-20	nA
I_{BEX}	Base cutoff current (V_{BE}= 3V)	V_{CE}= -40V			-50	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA	-50			V
$V_{CEO\,(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = -10 mA	-40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C= 0)	I_E = -10 μA	-5			V
$V_{CE\,(sat)}$*	Collector-emitter saturation voltage	I_C = -10 mA I_B = -1 mA I_C = -50 mA I_B = -5 mA			0.25 0.5	V V
$V_{BE\,(sat)}$*	Base-emitter saturation voltage	I_C = -10 mA I_B = -1 mA I_C = -50 mA I_B = -5 mA	0.6		0.9 1.2	V V
h_{FE}*	DC current gain	for **2N 3250** I_C = -0.1 mA V_{CE}= -1V I_C = -1 mA V_{CE}= -1V I_C = -10 mA V_{CE}= -1V I_C = -50 mA V_{CE}= -1V for **2N 3251** I_C = -0.1 mA V_{CE}= -1V I_C = -1 mA V_{CE}= -1V I_C = -10 mA V_{CE}= -1V I_C = -50 mA V_{CE}= -1V	 40 45 50 15 80 90 100 30		 150 300 	 – – – – – – – –
h_{fe}	Small signal current gain	I_C = -1 mA V_{CE}= -10V f = 1 kHz for **2N 3250** for **2N 3251**	 50 100		 200 400	 – –

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	I_C = -10 mA V_{CE} = -20V f = 100 MHz for **2N 3250** for **2N 3251**	 250 300			 MHz MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -1V f = 1 MHz			8	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10V f = 1 MHz			6	pF
NF	Noise figure	I_C = -100 μA V_{CE} = -5V f = 100 Hz R_g = 1 kΩ			6	dB
h_{ie}	Input impedance	I_C = -1 mA V_{CE} = -10V f = 1 kHz for **2N 3250** for **2N 3251**	 1 2		 6 12	 kΩ kΩ
h_{re}	Reverse voltage ratio	I_C = -1 mA V_{CE} = -10V f = 1 kHz for **2N 3250** for **2N 3251**			 10×10^{-4} 20×10^{-4}	 – –
h_{oe}	Output admittance	I_C = -1 mA V_{CE} = -10V f = 1 kHz for **2N 3250** for **2N 3251**	 4 10		 40 60	 μS μS
t_d	Delay time	I_C = 10 mA V_{CC} = 3V I_{B1} = 1 mA			35	ns
t_r	Rise time	I_C = 10 mA V_{CC} = 3V I_{B1} = 1 mA			35	ns
t_s	Storage time	I_C = 10 mA V_{CC} = 3V I_{B1} = $-I_{B2}$ = 1 mA for **2N 3250** for **2N 3252**			 175 200	 ns ns
t_f	Fall time	I_C = 10 mA V_{CC} = 3V I_{B1} = $-I_{B2}$ = 1 mA			50	ns
$r_{bb'}C_{b'c}$	Feedback time constant	I_C = -10 mA V_{CE} = -20V			250	ps

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 3440S

EPITAXIAL PLANAR NPN

HIGH VOLTAGE AMPLIFIER

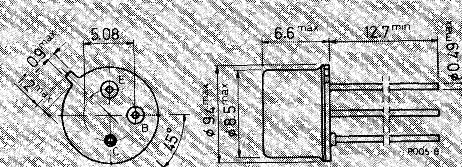
The 2N 3440S is a silicon planar epitaxial NPN transistor in Jedec TO-39 metal case, intended for high voltage switching and linear amplifier applications. The complementary PNP type is the 2N 5415S.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	300	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	250	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	1	W
	$T_{case} \leq 25°C$	10	W
T_{stg}	Storage temperature	-65 to 200	°C
T_j	Junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm



(sim. to TO-39)

THERMAL DATA

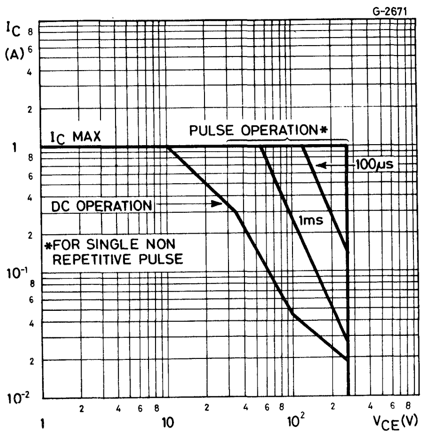
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	175	°C/W

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

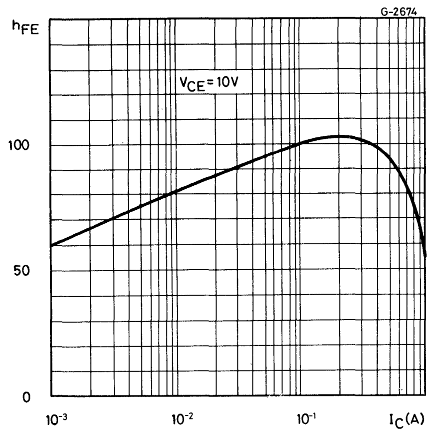
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 250 V			20	μA
I_{CEO}	Collector cutoff current ($I_B = 0$)	V_{CE} = 200 V			50	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = 6 V			20	μA
$V_{CEO\ (sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = 50 mA	250			V
$V_{CE\ (sat)}$*	Collector-emitter saturation voltage	I_C = 50mA I_B = 4 mA			0.5	V
$V_{BE\ (sat)}$*	Base-emitter saturation voltage	I_C = 50mA I_B = 4 mA			1.3	V
h_{FE}*	DC current gain	I_C = 20mA V_{CE} = 10V	40		160	—
f_T	Transition frequency	I_C = 10mA V_{CE} = 10V	15			MHz

* Pulsed: pulse duration = 300 μs, duty cycle = 1.5%

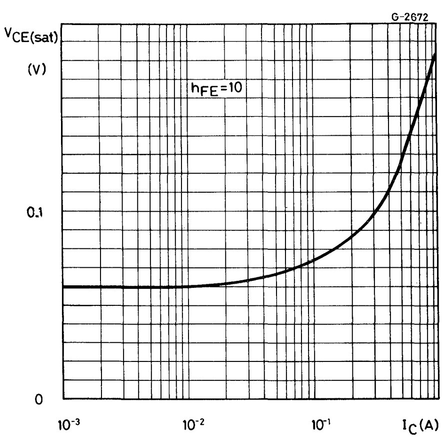
Safe operating areas



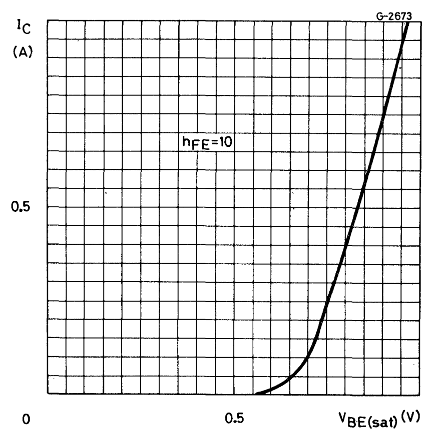
DC current gain



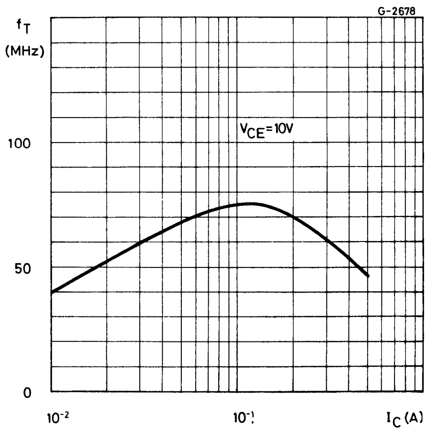
Collector-emitter saturation voltage



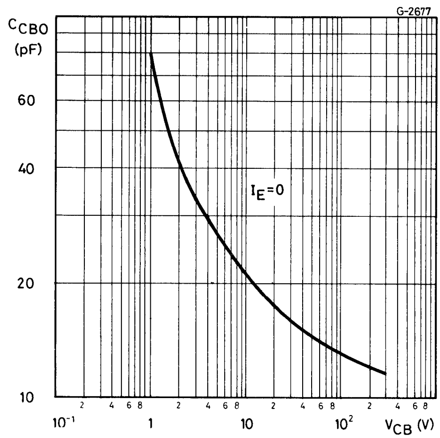
Base-emitter saturation voltage



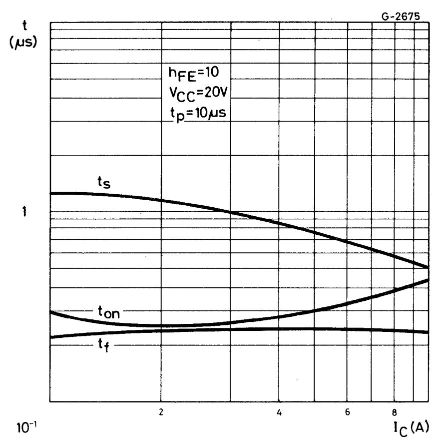
Transition frequency



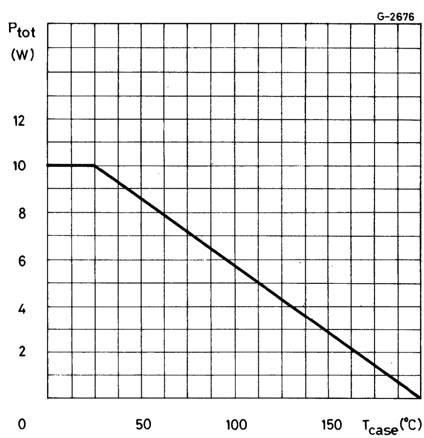
Collector-base capacitance



Saturated switching characteristics



Power rating chart



2N 3700
2N 3701

SILICON PLANAR NPN

GENERAL PURPOSE AMPLIFIERS

The 2N 3700 and 2N 3701 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case, intended for small signal, low noise industrial applications.

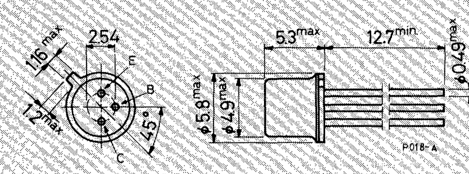
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	140	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	80	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25\ °C$	0.5	W
	at $T_{case} \leqslant 25\ °C$	1.8	W
	at $T_{case} \leqslant 100\ °C$	1	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	97	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	350	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 90V V_{CB} = 90V T_{amb} = 150°C			10 10	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	140			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10 mA	80			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA	7			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 150 mA I_B = 15 mA I_C = 500 mA I_B = 50 mA			0.2 0.5	V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 150 mA I_B = 15 mA			1.1	V

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions		Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	for **2N 3700**					
		I_C = 0.1 mA	V_{CE} = 10V	50			–
		I_C = 10 mA	V_{CE} = 10V	90			–
		I_C = 150 mA	V_{CE} = 10V	100		300	–
		I_C = 500 mA	V_{CE} = 10V	50			–
		I_C = 1A	V_{CE} = 10V	15			–
		I_C = 150 mA	V_{CE} = 10V				
		T_{amb} = -55°C		40			–
		for **2N 3701**					
		I_C = 0.1 mA	V_{CE} = 10V	30		100	–
		I_C = 10 mA	V_{CE} = 10V	40		120	–
		I_C = 150 mA	V_{CE} = 10V	40		120	–
		I_C = 500 mA	V_{CE} = 10V	30		100	–
		I_C = 1A	V_{CE} = 10V	15			–
h_{fe}	Small signal current gain	I_C = 1 mA f = 1 kHz	V_{CE} = 5V				
			for **2N 3700**	80		400	–
			for **2N 3701**	30		200	–
f_T	Transition frequency	I_C = 50 mA f = 20 MHz	V_{CE} = 10V				
			for **2N 3700**	100		200	MHz
			for **2N 3701**	80		200	MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 f = 1 MHz	V_{EB} = 0.5V			60	pF
C_{CBO}	Collector-base capacitance	I_E = 0 f = 1 MHz	V_{CB} = 10V			12	pF
$r_{bb'}C_{b'c}$	Feedback time constant	I_C = 10 mA f = 4 MHz	V_{CB} = 10V	25		400	ps

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

SILICON PLANAR NPN

2N 3725

HIGH-VOLTAGE, HIGH-CURRENT SWITCH

The 2N 3725 is a silicon planar epitaxial transistor in TO-39 metal case. It is a high-voltage, high-current switch used for memory applications requiring breakdown voltages up to 50V and operating currents to 1A. Fast switching times are assured because of the high minimum f_T (300 MHz) and tight control on storage time.

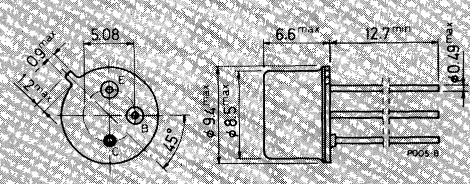
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	80	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	80	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	50	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25$ °C	0.8	W
	at $T_{case} \leqslant 25$ °C	3.5	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	50	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	220	°C/W

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

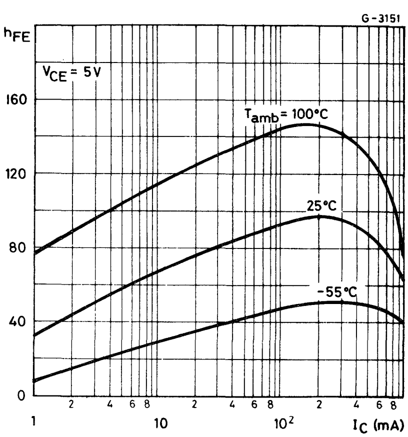
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 60V				1.7	μA
		V_{CB} = 60V	T_{amb} = 100°C			120	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA		80			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10 μA		80			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 10 mA		50			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA		6			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 10 mA	I_B = 1 mA		0.19	0.25	V
		I_C = 100 mA	I_B = 10 mA		0.21	0.26	V
		I_C = 300 mA	I_B = 30 mA		0.31	0.4	V
		I_C = 500 mA	I_B = 50 mA		0.4	0.52	V
		I_C = 800 mA	I_B = 80 mA		0.5	0.8	V
		I_C = 1000mA	I_B = 100 mA		0.6	0.95	V

ELECTRICAL CHARACTERISTICS (continued)

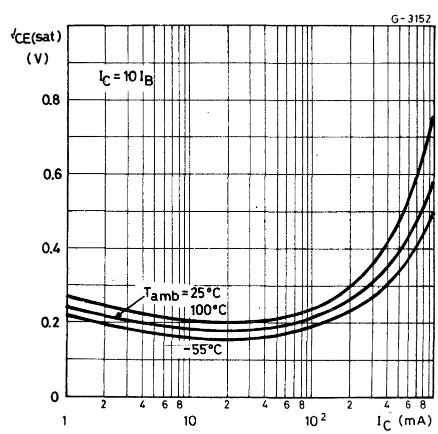
Parameter		Test conditions		Min.	Typ.	Max.	Unit
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 10 mA	I_B = 1 mA		0.64	0.76	V
		I_C = 100 mA	I_B = 10 mA		0.75	0.86	V
		I_C = 300 mA	I_B = 30 mA		0.89	1.1	V
		I_C = 500 mA	I_B = 50 mA	0.8		1.1	V
		I_C = 800 mA	I_B = 80 mA		1.0	1.5	V
		I_C = 1000mA	I_B = 100 mA		1.1	1.7	V
h_{FE}*	DC current gain	I_C = 10 mA	V_{CE} = 1 V	30	60		–
		I_C = 100 mA	V_{CE} = 1 V	60	90	150	–
		I_C = 300 mA	V_{CE} = 1 V	40	60		–
		I_C = 1000mA	V_{CE} = 5 V	25	65		–
		I_C = 800 mA	V_{CE} = 2 V	20	40		–

*Pulsed: pulse duration = 300 μs; duty cycle = 1%

DC current gain

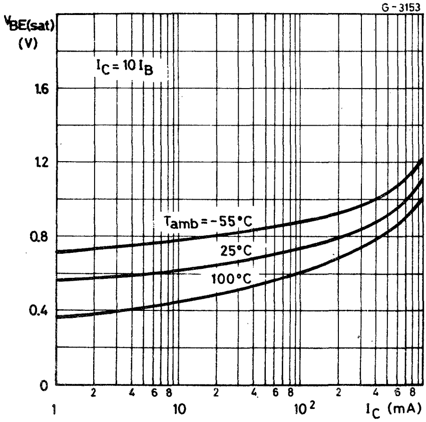


Collector-emitter saturation voltage

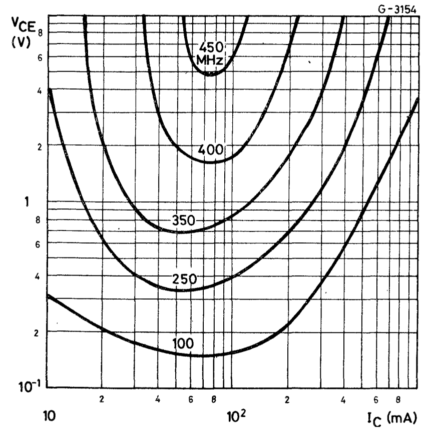


2N 3725

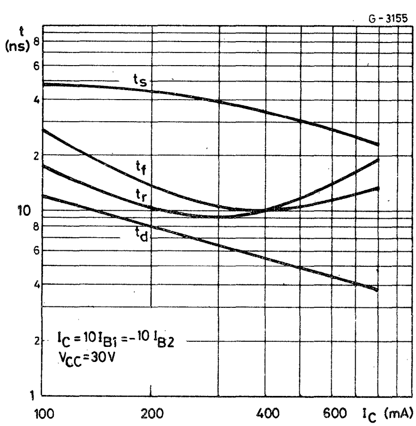
Base-emitter saturation voltage



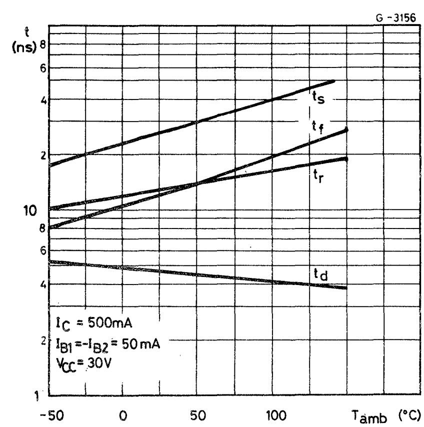
Contours of constant transition frequency



Switching characteristics



Switching characteristics



SILICON PLANAR PNP

2N 3962
2N 3964
2N 3965

LOW NOISE, LOW LEVEL AMPLIFIERS

The 2N 3962, 2N 3964 and 2N 3965 are silicon planar epitaxial PNP transistors in Jedec TO-18 metal case particularly intended for use in low noise applications. They features are excellent current gain linearity from 1 μA to 50 mA.

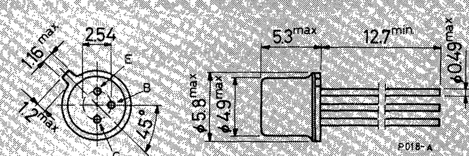
ABSOLUTE MAXIMUM RATINGS

		2N 3964	2N 3962 2N 3965
V_{CBO}	Collector-base voltage ($I_E = 0$)	-45 V	-60 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-45 V	-60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-6 V	
I_C	Collector current	-200 mA	
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.36 W	
	at $T_{case} \leq 25°C$	1.2 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	487	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **2N 3964**				
		V_{CE} = -40V			-10	nA
		V_{CE} = -40V T_{amb} = 150°C			-10	μA
		for **2N 3962** and **2N 3965**				
		V_{CE} = -50V			-10	nA
		V_{CE} = -50V T_{amb} = 150°C			-10	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -4V			-10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA				
		for **2N 3964**	-45			V
		for **2N 3962** and **2N 3965**	-60			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10 μA				
		for **2N 3964**	-45			V
		for **2N 3962** and **2N 3965**	-60			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = -5 mA				
		for **2N 3964**	-45			V
		for **2N 3962** and **2N 3965**	-60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -10 μA	-6			V
$V_{CE(sat)}$	Collector-emitter saturation voltage *	I_C = -10 mA I_B = -0.5 mA			-0.25	V
		I_C = -50 mA I_B = -5 mA			-0.4	V
$V_{BE(sat)}$	Base-emitter saturation voltage *	I_C = -10 mA I_B = -0.5 mA			-0.9	V
		I_C = -50 mA I_B = -5 mA			-0.95	V
h_{FE}	DC current gain	for **2N 3962**				
		I_C = -1 μA V_{CE} = -5V	60			–
		I_C = -10 μA V_{CE} = -5V	100		300	–
		I_C = -100 μA V_{CE} = -5V	100			–
		I_C = -1 mA V_{CE} = -5V	100		450	–
	*	I_C = -10 mA V_{CE} = -5V	100			–
	*	I_C = -50 mA V_{CE} = -5V	90			–
		I_C = -10 μA V_{CE} = -5V T_{amb} = -55°C	40			–

ELECTRICAL CHARACTERISTICS (continued)

Parameter			Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain		for **2N 3962**				
		*	I_C = -50 mA V_{CE} = -5V T_{amb} = -55°C	45			–
			I_C = -1 mA V_{CE} = -5V T_{amb} = 100°C			600	–
			for **2N 3964** and **2N 3965**				
			I_C = -1 μA V_{CE} = -5V	180			–
			I_C = -10 μA V_{CE} = -5V	250		500	–
			I_C = -100μA V_{CE} = -5V	250			–
			I_C = -1 mA V_{CE} = -5V	250		600	–
		*	I_C = -10 mA V_{CE} = -5V	200			–
		*	I_C = -50 mA V_{CE} = -5V	180			–
			I_C = -10 μA V_{CE} = -5V T_{amb} = -55°C	100			–
		*	I_C = -50 mA V_{CE} = -5V T_{amb} = -55°C	90			–
			I_C = -1 mA V_{CE} = -5V T_{amb} = 100°C			800	–
h_{fe}	Small signal current current gain		I_C = -1 mA V_{CE} = -5V f = 1 kHz				
			for **2N 3962**	100		550	–
			for **2N 3964** and **2N 3965**	250		700	–
f_T	Transition frequency		I_C = -0.5 mA V_{CE} = -5V f = 20 MHz				
			for **2N 3962**	40		160	MHz
			for **2N 3964** and **2N 3965**	50		160	MHz
C_{EBO}	Emitter-base capacitance		I_C = 0 V_{EB} = -0.5V f = 1 MHz			15	pF
C_{CBO}	Collector-base capacitance		I_E = 0 V_{CB} = -5V f = 1 MHz			6	pF
NF	Noise figure		I_C = -20 μA V_{CE} = -5V R_g = 10 kΩ				
			for **2N 3962**				
			f = 10 to 10 000 Hz			3	dB
			f = 100 Hz B = 15 Hz			10	dB
			f = 1 kHz B = 150 Hz			3	dB
			f = 10 kHz B = 1.5 kHz			3	dB
			for **2N 3964** and **2N 3965**				
			f = 10 to 10 000 Hz			2	dB
			f = 10 Hz B = 2 Hz			8	dB
			f = 100 Hz B = 15 Hz			4	dB
			f = 1 kHz B = 150 Hz			2	dB
			f = 10 kHz B = 1.5 kHz			2	dB

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{ie}	Input impedance	I_C= -1 mA V_{CE}= -5V f= 1 kHz for **2N 3962** for **2N 3964** and **2N 3965**	 2.5 6		 17 20	 kΩ kΩ
h_{re}	Reverse voltage ratio	I_C= -1 mA V_{CE}= -5V f= 1 kHz			$10x10^{-4}$	–
h_{oe}	Output admittance	I_C= -1 mA V_{CE}= -5V f= 1 kHz for **2N 3962** for **2N 3964** and **2N 3965**	 5 5		 40 50	 μS μS

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 4030
2N 4031
2N 4032
2N 4033

SILICON PLANAR PNP

GENERAL PURPOSE AMPLIFIERS AND SWITCHES

The 2N 4030, 2N 4031, 2N 4032 and 2N 4033 are silicon planar epitaxial PNP transistors in Jedec TO-39 metal case primarily intended for large signal, low noise industrial applications.

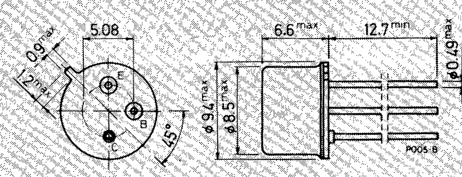
ABSOLUTE MAXIMUM RATINGS

		2N 4030 2N 4032	2N 4031 2N 4033
V_{CBO}	Collector-base voltage ($I_E = 0$)	-60 V	-80 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-60 V	-80 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_C	Collector current	-1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	0.8 W	
	at $T_{case} \leq 25°C$	4 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

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THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	44	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	218	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E= 0)	for **2N 4030** and **2N 4032**				
		V_{CB}= -50V			-50	nA
		V_{CB}= -50V T_{amb}= 150°C			-50	µA
		for **2N 4031** and **2N 4033**				
		V_{CB}= -60V			-50	nA
		V_{CB}= -60V T_{amb}= 150°C			-50	µA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E= 0)	I_C= -10 µA				
		for **2N 4030** and **2N 4032**	-60			V
		for **2N 4031** and **2N 4033**	-80			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B= 0)	I_C= -10 mA				
		for **2N 4030** and **2N 4032**	-60			V
		for **2N 4031** and **2N 4033**	-80			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C= 0)	I_E= -10 µA	-5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C= -150 mA I_B= -15 mA			-0.15	V
		I_C= -500 mA I_B= -50 mA			-0.5	V
		I_C= -1A I_B= -100 mA for **2N 4030** and **2N 4032**			-1	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C= -150 mA I_B= -15 mA			-0.9	V
		I_C= -500 mA I_B= -50 mA			-1.1	V
		I_C= -1A I_B= -100 mA for **2N 4030** and **2N 4032**			-1.2	V

ELECTRICAL CHARACTERISTICS (continued)

Parameter			Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain		$I_C = -100\ \mu A$ $V_{CE} = -5V$				
			for **2N 4030** and **2N 4031**	30			—
			for **2N 4032** and **2N 4033**	75			—
		*	$I_C = -100\ mA$ $V_{CE} = -5V$				
			for **2N 4030** and **2N 4031**	40		120	—
			for **2N 4032** and **2N 4033**	100		300	—
		*	$I_C = -500\ mA$ $V_{CE} = -5V$				
			for **2N 4030** and **2N 4031**	25			—
			for **2N 4032** and **2N 4033**	70			—
		*	$I_C = -1A$ $V_{CE} = -5V$				
			for **2N 4030**	15			—
			for **2N 4031**	10			—
			for **2N 4032**	40			—
			for **2N 4033**	25			—
		*	$I_C = -100\ mA$ $V_{CE} = -5V$ $T_{amb} = -55°C$				
			for **2N 4030** and **2N 4031**	15			—
			for **2N 4032** and **2N 4033**	40			—
f_T	Transition frequency		$I_C = -50\ mA$ $V_{CE} = -10V$ $f = 100\ MHz$				
			for **2N 4030** and **2N 4031**	100		400	MHz
			for **2N 4032** and **2N 4033**	150		500	MHz
C_{EBO}	Emitter-base capacitance		$I_C = 0$ $V_{EB} = -0.5V$ $f = 1\ MHz$			110	pF
C_{CBO}	Collector-base capacitance		$I_E = 0$ $V_{CB} = -10V$ $f = 1\ MHz$			20	pF
t_s	Storage time		$I_C = -500\ mA$ $V_{CC} = -30V$ $I_{B1} = -I_{B2} = -50\ mA$			350	ns
t_f	Fall time		$I_C = -500\ mA$ $V_{CC} = -30V$ $I_{B1} = -I_{B2} = -50\ mA$			50	ns
t_{on}	Turn-on time		$I_C = -500\ mA$ $V_{CC} = -30V$ $I_{B1} = -I_{B2} = -50\ mA$			100	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 4034
2N 4035

SILICON PLANAR PNP

GENERAL PURPOSE AMPLIFIERS AND SWITCHES

The 2N 4034 and 2N 4035 are silicon planar epitaxial PNP transistors in Jedec TO-18 metal case, primarily intended for small signal, low noise industrial applications.

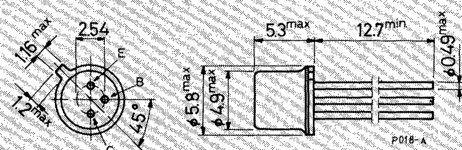
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-100	mA
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36	W
	at $T_{case} \leqslant 25°C$	1	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-18**)

2N 4034
2N 4035

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	175	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

Parameter			Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)		V_{CE} = -30V				-15	nA
			V_{CE} = -30V	T_{amb} = 125°C			-15	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)		I_C = -10 μA		-40			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)		I_C = -10 μA		-40			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)		I_C = -10 mA		-40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)		I_E = -10 μA		-5			V
$V_{CE(sat)}$	Collector-emitter saturation voltage		I_C = -1 mA	I_B = -0.1 mA			-0.13	V
		*	I_C = -10 mA	I_B = -1 mA			-0.14	V
		*	I_C = -50 mA	I_B = -5 mA			-0.3	V
$V_{BE(sat)}$	Base-emitter saturation voltage		I_C = -1 mA	I_B = -0.1 mA			-0.75	V
		*	I_C = -10 mA	I_B = -1 mA	-0.7		-0.9	V
		*	I_C = -50 mA	I_B = -5 mA			-1.1	V
h_{FE}	DC current gain		for **2N 4034**					
			I_C = -10 μA	V_{CE} = -1V	20			–
			I_C = -100 μA	V_{CE} = -1V	50			–
			I_C = -1 mA	V_{CE} = -1V	60			–
		*	I_C = -10 mA	V_{CE} = -1V	70		200	–
		*	I_C = -50 mA	V_{CE} = -1V	15			–
		*	I_C = -10 mA T_{amb} = -55°C	V_{CE} = -1V	30			–
			for **2N 4035**					
			I_C = -10 μA	V_{CE} = -1V	70			–
			I_C = -100 μA	V_{CE} = -1V	140			–
			I_C = -1 mA	V_{CE} = -1V	150			–
		*	I_C = -10 mA	V_{CE} = -1V	150		300	–
		*	I_C = -50 mA	V_{CE} = -1V	30			–
		*	I_C = -10 mA T_{amb} = -55°C	V_{CE} = -1V	70			–

2N 4034
2N 4035

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	$I_C = -1$ mA $V_{CE} = -10$V f = 1 kHz for **2N 4034** for **2N 4035**	 50 150		 300 450	 – –
f_T	Transition frequency	$I_C = -10$ mA $V_{CE} = -20$V f = 100 MHz for **2N 4034** for **2N 4035**	 400 450			 MHz MHz
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = -0.5$V f = 1 MHz			5.5	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -10$V f = 1 MHz			3.5	pF
NF	Noise figure	$I_C = -1$ mA $V_{CE} = -5$V f = 100 MHz $R_g = 100\Omega$			6	dB
t_{on}	Turn-on time	$I_C = -50$ mA $V_{CC} = -30$V $I_{B1} = -5$ mA			40	ns
t_{off}	Turn-off time	$I_C = -50$ mA $V_{CC} = -30$V $I_{B1} = -I_{B2} = -5$ mA			150	ns
h_{ie}	Input impedance	$I_C = -1$ mA $V_{CE} = -10$V f = 1 kHz for **2N 4034** for **2N 4035**	 1 4		 8 12	 kΩ kΩ
h_{re}	Reverse voltage ratio	$I_C = -1$ mA $V_{CE} = -10$V f = 1 kHz for **2N 4034** for **2N 4035**			 3×10^{-4} 4×10^{-4}	 – –
h_{oe}	Output admittance	$I_C = -1$ mA $V_{CE} = -10$V f = 1 kHz for **2N 4034** for **2N 4035**	 2 8		 24 40	 µS µS
$r_{bb'}C_{b'c}$	Feedback time constant	$I_C = -10$ mA $V_{CE} = -20$V f = 80 MHz			40	ps

* Pulsed: pulse duration = 300 µs, duty cycle= 1%

SILICON PLANAR PNP

2N 4036

MEDIUM-SPEED SWITCH

The 2N 4036 is a silicon planar epitaxial PNP transistor in Jedec TO-39 metal case. It is intended particularly as medium speed saturated switch and general purpose amplifier.

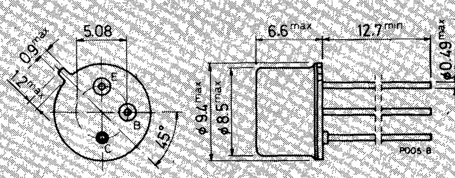
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-90	V
V_{CEX}	Collector-emitter voltage ($V_{BE} = 1.5V$)	-85	V
V_{CER}	Collector-emitter voltage ($R_{BE} \leqslant 200\Omega$)	-85	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-65	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-7	V
I_C	Collector current	-1	A
I_B	Base current	-0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	1	W
	at $T_{case} \leqslant 25°C$	7	W
T_{stg}, T_j	Storage and junction temperature	-65 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to **TO-39**)

2N 4036

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	25	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	175	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E= 0)	V_{CB}= -60V			-20	nA
I_{CEO}	Collector cutoff current (I_B= 0)	V_{CE}= -30V			-0.5	μA
I_{EBO}	Emitter cutoff current (I_C= 0)	V_{EB}= -5V			-20	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E= 0)	I_C= -100 μA	-90			V
$V_{CEX\,(sus)}$*	Collector-emitter sustaining voltage (V_{BE}= 1.5V)	I_C= -10 mA	-85			V
$V_{CER\,(sus)}$*	Collector-emitter sustaining voltage (R_{BE}= 200Ω)	I_C= -10 mA	-85			V
$V_{CEO\,(sus)}$*	Collector-emitter sustaining voltage (I_B= 0)	I_C= -10 mA	-65			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C= 0)	I_E= -100 μA	-7			V
$V_{CE\,(sat)}$	Collector-emitter saturation voltage	I_C= -150 mA I_B= -15 mA			-0.65	V
V_{BE}*	Base-emitter voltage	I_C= -150 mA V_{CE}= -10V			-1.1	V

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	I_C = -0.1 mA V_{CE} = -10V	20			–
	*	I_C = -150 mA V_{CE} = -10V	40		140	--
	*	I_C = -500 mA V_{CE} = -10V	20			–
f_T	Transition frequency	I_C = -50 mA V_{CE} = -10V f = 20 MHz	60			MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -0.5V f = 1 MHz			90	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10V f = 1 MHz			30	pF
t_{on}	Turn-on time	I_C = -150 mA V_{CC} = -30V I_{B1} = -15 mA			110	ns
t_{off}	Turn-off time	I_C = -150 mA V_{CC} = -30V I_{B1} = $-I_{B2}$ = -15 mA			700	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 5320/BSS15
2N 5321/BSS16

SILICON PLANAR NPN

MEDIUM-POWER AMPLIFIERS

The 2N 5320/BSS 15 and 2N 5321/BSS 16 are silicon planar epitaxial NPN transistors in Jedec TO-39 metal case. They are especially intended for high-voltage medium power applications in industrial and commercial equipments.
The complementary PNP types are respectively the 2N 5322 and 2N 5323.

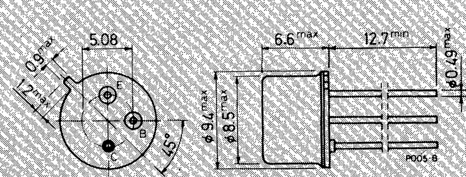
ABSOLUTE MAXIMUM RATINGS

		2N 5320	2N 5321
V_{CBO}	Collector-base voltage ($I_E = 0$)	100 V	75 V
V_{CEV}	Collector-emitter voltage ($V_{BE} = -1.5V$)	100 V	75 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	75 V	50 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6 V	5 V
I_C	Collector current	2 A	
I_B	Base current	1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	1 W	
	at $T_{case} \leq 25°C$	10 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25°C unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **2N 5320** $V_{CB} = 80V$			0.5	μA
		for **2N 5321** $V_{CB} = 60V$			5	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	for **2N 5320** $V_{EB} = 5V$			0.1	μA
		for **2N 5321** $V_{EB} = 4V$			0.5	μA
$V_{(BR)CEV}$	Collector-emitter breakdown voltage (V_{BE}= -1.5V)	$I_C = 0.1$ mA for **2N 5320**	100			V
		for **2N 5321**	75			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 10$ mA for **2N 5320**	75			V
		for **2N 5321**	50			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 0.1$ mA for **2N 5320**	6			V
		for **2N 5321**	5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	$I_C = 500$ mA $I_B = 50$ mA for **2N 5320**			0.5	V
		for **2N 5321**			0.8	V
V_{BE} *	Base-emitter voltage	$I_C = 500$ mA $V_{CE} = 4V$ for **2N 5320**			1.1	V
		for **2N 5321**			1.4	V
h_{FE}*	DC current gain	for **2N 5320** $I_C = 500$ mA $V_{CE} = 4V$	30		130	–
		$I_C = 1$ A $V_{CE} = 2V$	10			–
		for **2N 5321** $I_C = 500$ mA $V_{CE} = 4V$	40		250	–
f_T	Transition frequency	$I_C = 50$ mA $V_{CE} = 4V$	50			MHz
t_{on}	Turn-on time	$I_C = 500$ mA $V_{CC} = 30V$ $I_{B1} = 50$ mA			80	ns
t_{off}	Turn-off time	$I_C = 500$ mA $V_{CC} = 30V$ $I_{B1} = -I_{B2} = 50$ mA			800	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 5322/BSS17
2N 5323/BSS18

SILICON PLANAR PNP

MEDIUM-POWER AMPLIFIERS

The 2N 5322/BSS17 and 2N 5323/BSS18 are silicon planar epitaxial PNP transistors in Jedec TO-39 metal case. They are especially intended for high-voltage medium power applications in industrial and commercial equipments.
The complementary NPN types are respectively the 2N 5320 and 2N 5321.

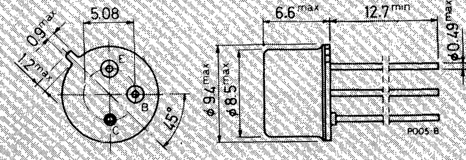
ABSOLUTE MAXIMUM RATINGS

		2N 5322	2N 5323
V_{CBO}	Collector-base voltage ($I_E = 0$)	-100 V	-75 V
V_{CEV}	Collector-emitter voltage ($V_{BE} = 1.5V$)	-100 V	-75 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-75 V	-50 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-6 V	-5 V
I_C	Collector current	-2 A	
I_B	Base current	-1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	1 W	
	at $T_{case} \leq 25°C$	10 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25°C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **2N 5322** V_{CB} = -80V			-0.5	μA
		for **2N 5323** V_{CB} = -60V			-5	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	for **2N 5322** V_{EB} = -5V			-0.1	μA
		for **2N 5323** V_{EB} = -4V			-0.5	μA
$V_{(BR)CEV}$	Collector-emitter breakdown voltage (V_{BE} = 1.5V)	I_C = -0.1 mA for **2N 5322**	-100			V
		for **2N 5323**	-75			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = -10 mA for **2N 5322**	-75			V
		for **2N 5323**	-50			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C= 0)	I_E = -0.1 mA for **2N 5322**	-6			V
		for **2N 5323**	-5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = -500 mA I_B = -50 mA for **2N 5322**			-0.7	V
		for **2N 5323**			-1.2	V
V_{BE}*	Base-emitter voltage	I_C = -500 mA V_{CE} = -4V for **2N 5322**			-1.1	V
		for **2N 5323**			-1.4	V
h_{FE}*	DC current gain	for **2N 5322** I_C = -500 mA V_{CE} = -4V	30		130	—
		I_C = -1A V_{CE} = -2V	10			—
		for **2N 5323** I_C = -500 mA V_{CE} = -4V	40		250	—
f_T	Transition frequency	I_C = -50 mA V_{CE} = -4V	50			MHz
t_{on}	Turn-on time	I_C = -500 mA V_{CC} = -30V I_{B1} = -50 mA			100	ns
t_{off}	Turn-off time	I_C = -500 mA V_{CC} = -30V $I_{B1} = -I_{B2}$ = -50 mA			1000	ns

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

2N 5415S

SILICON PLANAR PNP

HIGH-VOLTAGE AMPLIFIER

The 2N 5415S is a silicon planar epitaxial PNP transistor in Jedec TO-39 metal case, intended for high voltage switching and linear amplifier applications. The complementary NPN type is 2N 3440S.

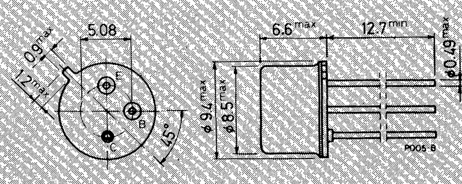
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-200	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-200	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-4	V
I_{CM}	Collector peak current	-1	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	1	W
	at $T_{case} \leq 25°C$	10	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



(sim. to TO-39)

2N 5415S

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	175	°C/W

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

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -175V			-50	μA
I_{CEO}	Collector cutoff current ($I_B = 0$)	V_{CE} = -150V			-50	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = -4V			-20	μA
$V_{CEO\,(sus)}$*	Collector-emitter sustaining voltage ($I_B = 0$)	I_C = -10 mA	-200			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = -50 mA I_B = -5 mA			-2.5	V
V_{BE}*	Base-emitter voltage	I_C = -50 mA V_{CE} = -10V			-1.5	V
h_{FE}*	DC current gain	I_C = -50 mA V_{CE} = -10V	30		150	–
f_T	Transition frequency	I_C = -10 mA V_{CE} = -10V f = 5 MHz	15			MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10V f = 1 MHz			15	pF

* Pulsed: pulse duration = 300 μs, duty cycle = 1%

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Centro Grafico S - Milano

Suggested price
U.S. $ 4
(including tax)