SMALL SIGNAL TRANSISTORS
5th EDITION
ISSUED APRIL 1982

INTRODUCTION

This databook contains data sheets on the SGS-ATES range of discrete devices for small signal consumer, industrial and professional applications, including RF devices.
A selection guide by characteristics and applications is provided to enable fast identification of the most suitable device for you 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 APPLICATIONS

NPN GENERAL PURPOSE TRANSISTORS – TO-18

V_{CEO} V_{CER}* (V)	h_{FE} min/max	@ I_C (mA)	Type	$V_{CE(sat)}$ (V) max	@ I_C (mA)	f_T (MHz) min	t_s t_{off}* (ns)	P_{tot} (mW)	ALSO AVAILABLE
55	50/–	50	**BSX33**	0.3	150	60	800*	500	
25	75/260	100	**BC377**	0.7	500	300 typ.	–	375	
40	75/260	100	**BC378**	0.7	500	300 typ.	–	375	
30	100/300	150	**2N2222**	1.6	500	250	225	500	2N2221
40	100/300	150	**2N2222A**	1	500	250	225	500	2N2221A
50*	100/300	150	**2N956**	1.5	150	70	–	500	2N718A
55	60/180	150	**BFR18**	0.25	150	60	–	500	
80	40/–	150	**2N720A**	5	150	50	–	500	
80	100/300	150	**2N3700**	0.5	500	100 typ.	–	500	2N3302

NPN GENERAL PURPOSE TRANSISTORS – TO-39

V_{CEO} V_{CER}* (V)	h_{FE} min/max	@ I_C (mA)	Type	$V_{CE(sat)}$ (V) max	@ I_C (mA)	f_T (MHz) min	t_s t_{off}* (ns)	P_{tot} (mW)	ALSO AVAILABLE
40	40/250	100	**BC140**	0.35 typ.	500	50	850*	800	
60	40/250	100	**BC141**	0.35 typ.	500	50	850*	800	
30	40/–	150	**BFY51**	0.35	150	50	160 typ.	800	BFY52
30	100/300	150	**2N2219**	1.6	500	250	225	800	2N2218
35	30/–	150	**BFY50**	0.2	150	60	140 typ.	800	
40	50/250	150	**2N3053**	1.4	150	100 typ.	–	800	
40	100/300	150	**2N2219A**	1	500	250	225	800	2N2218A
50*	40/120	150	**2N1613**	1.5	150	60	–	800	
50*	100/300	150	**2N1711**	1.5	150	70	–	800	
55	40/120	150	**BFY56A**	0.25	150	60	800*	800	BFY56
60	40/240	150	**BC301**	0.5	150	120 typ.	–	800	BC302
60	40/120	150	**2N3108**	1.4	150	100 typ.	–	800	2N3110
60	100/300	150	**2N3107**	1.4	150	100 typ.	–	800	2N3109
65	40/120	150	**2N2102**	0.5	150	60	30*	1000	

NPN GENERAL PURPOSE TRANSISTORS – TO-39 (continued)

V_{CEO} V_{CER}* (V)	h_{FE} min/max	@ I_C (mA)	Type	$V_{CE(sat)}$ (V) max	@ I_C (mA)	f_T (MHz) min	t_s t_{off}* (ns)	P_{tot} (mW)	ALSO AVAILABLE
80	40/240	150	**BC300**	0.5	150	120 typ.	–	800	
80	40/120	150	**BSY55**	0.6	150	100 typ.	–	800	BSY53
80	40/120	150	**2N1893**	5	150	50	–	800	
80	40/120	150	**2N3020**	0.5	500	80 typ.	–	800	
80	100/300	150	**BSY56**	0.6	150	100 typ.	–	800	BSY54
80	100/300	150	**2N3019**	0.5	500	100 typ.	–	800	
40	40/240	500	**BC440**	1	1000	50	–	1000	
50	40/250	500	**2N5321**	0.8	500	50	800*	1000	
60	40/240	500	**BC441**	1	1000	50	–	1000	
75	30/130	500	**2N5320**	0.5	500	50	800*	1000	

PNP GENERAL PURPOSE TRANSISTORS – TO-18

V_{CEO} (V)	h_{FE} min/max	@ I_C (mA)	Type	$V_{CE(sat)}$ (V) max	@ I_C/I_B (mA)	f_T (MHz) min	t_s t_{off}* (ns)	P_{tot} (mW)	ALSO AVAILABLE
30	90/–	10	**BFX48**	0.3	50/5	400	160*	360	
40	50/–	10	**BCY70**	0.5	50/5	250	350	350	
40	100/300	10	**2N3251**	0.5	50/5	300	200	360	2N3250
40	150/300	10	**2N4035**	0.3	50/5	450	150*	360	
45	100/600	10	**BCY71**	0.5	50/5	200	–	350	BCY72
40	100/300	150	**2N2907**	0.4	150/15	200	80	400	
45	100/300	150	**2N3504**	0.4	150/15	200	40	400	2N3505
60	40/120	150	**2N2906A**	0.4	150/15	200	80	400	2N2906
60	100/300	150	**2N2907A**	0.4	150/15	200	80	400	

SELECTION GUIDE BY CHARACTERISTICS AND APPLIC. (contd.)

PNP GENERAL PURPOSE TRANSISTORS – TO-39

V_{CEO} (V)	h_{FE} @ I_C min/max	(mA)	Type	$V_{CE(sat)}$ @ I_C/I_B (V) max	(mA)	f_T (MHz) min	t_s t_{off}* (ns)	P_{tot} (mW)	ALSO AVAILABLE
55	.85/–	100	**BFX38**	0.5	500/50	100	350	800	BFX39
75	40/–	100	**BFX41**	0.5	500/50	100	350	800	
75	85/–	100	**BFX40**	0.5	500/50	100	350	800	
80	100/300	100	**2N4033**	0.5	500/50	150	350	800	2N4031/2
40	50/250	150	**2N4037**	0.3	150/15	100	110	700	
40	100/230	150	**2N2905**	0.4	150/15	200	80	600	
60	40/240	150	**BC303**	0.65	150/15	75	–	850	BC304
60	40/120	150	**2N2904A**	0.4	150/15	200	80	600	2N2904
60	100/300	150	**2N2905A**	0.4	150/15	200	80	600	
65	40/140	150	**2N4036**	0.65	150/15	60	700*	1000	
40	40/250	500	**BC460**	1	1000/100	50	–	1000	
60	40/250	500	**BC461**	1	1000/100	50	–	1000	
75	30/130	500	**2N5322**	0.7	500/50	50	1000*	1000	2N5323

NPN TRANSISTORS FOR LOW LEVEL, LOW NOISE APPLICATIONS – TO-18

V_{CEO} (V)	h_{FE} @ I_C min/max	(mA)	Type	$V_{CE(sat)}$ @ I_C/I_B (V) max	(mA)	f_T (MHz) min	NF (dB)	P_{tot} (mW)	ALSO AVAILABLE
45	100/500	0.01	**2N930**	1	10/0.5	30	3	300	
60	100/500	0.01	**2N2484**	0.35	1/0.1	60	3	360	2N2483
60	130/–	0.01	**BFR17**	0.35	1/0.1	70	3	360	
60	150/300	1	**BFY76**	0.35	1/01	100	4	360	
20	110/800*	2	**BC108**	0.6	100/5	100	10	300	
20	200/800*	2	**BC109**	0.6	100/5	100	4	300	
45	110/450*	2	**BC107**	0.6	100/5	100	10	300	
45	120/630	2	**BCY59**	0.7	100/2.5	100	6	360	BCY58

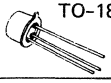
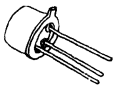
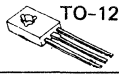
* h_{fe} @ 1 KHz.

PNP TRANSISTORS FOR LOW LEVEL, LOW NOISE APPLICATIONS – TO-18

V_{CEO} (V)	h_{FE} min/max	@ I_C (mA)	Type	$V_{CE(sat)}$ (V) max	@ I_C/I_B (mA)	f_T (MHz) min	NF (dB)	P_{tot} (mW)	ALSO AVAILABLE
45	250/500	0.01	**2N3964**	0.25	10/0.5	50	2	360	2N3965
80	70/230	0.01	**BFX37**	0.4	50/5	40	3.5	360	
80	100/300	0.01	**2N3963**	0.25	10/0.5	40	3	360	2N3962
25	125/500*	2	**BC178**	0.25	50/5	200 typ.	10	300	BC179
45	120/460	2	**BCY79**	0.8	100/2.5	180 typ.	6	390	BCY78
45	125/500*	2	**BC177**	0.25	50/5	200 typ.	10	300	
50	110/450	2	**BC478**	0.25	50/5	150 typ.	6	360	BC479
80	110/250	2	**BC477**	0.25	50/5	150 typ.	10	360	

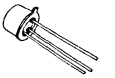
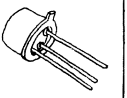
* h_{fe} @ 1 KHz.

HIGH VOLTAGE TRANSISTORS

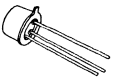
Polarity	V_{CEO} (V)	h_{FE} min/max	@ I_C (mA)	Type	$V_{CE(sat)}$ (V) max	@ I_C/I_B (mA)	f_T (MHz) min	P_{tot} (mW)	PACKAGE
PNP	150	40/–	10	**BFW43**	0.5	10/1	60	400	TO-18 
NPN	180	30/–	10	**BC394**	0.3	10/1	50	400	
PNP	180	50/–	10	**BC393**	0.3	10/1	50	400	
NPN	200	40/–	30	**BSS72S**	0.5	50/5	200	500	TO-39 
PNP	200	40/250	30	**BSS75S**	0.4	30/3	200	500	
PNP	150	40/–	10	**BFW44**	0.5	10/1	60	700	
PNP	180	80/300	10	**BFX91**	0.25	10/1	40	700	
PNP	180	80/300	10	**2N3931**	0.25	10/1	60	700	
PNP	200	30/150	10	**2N5415S**	2.5	50/5	15	1000	
NPN	250	25/–	30	**BF258**	1	30/6	90 typ.	1000	
NPN	150	30/–	30	**2N3114**	1	50/5	40	800	
NPN	250	30/–	30	**BF458**	1	50/10	90 typ.	1250	TO-126 
NPN	300	30/–	30	**BF459**	1	50/10	90 typ.	1250	

SELECTION GUIDE BY CHARACTERISTICS AND APPLIC. (contd.)

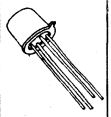
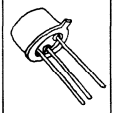
NPN TRANSISTORS FOR FAST AND ULTRA FAST SWITCHES

V_{CEO} (V)	h_{FE} min/max	@ I_C (mA)	Type	$V_{CE(sat)}$ (V) max	@ I_C/I_B (mA)	f_T (MHz) min	t_s t_{off}* (ns)	P_{tot} (mW)	PACKAGE
12	30/120	10	**BSX28**	0.25	30/3	400	13	360	TO-18
15	30/120	10	**2N708**	0.4	10/1	300	75*	360	
15	30/120	10	**2N914**	0.7	200/20	300	20	360	
15	40/120	10	**BSX20**	0.6	100/10	450	13	360	
15	40/120	10	**2N2369**	0.25	10/1	500	13	360	
15	40/120	10	**2N2369A**	0.2	10/1	500	13	360	
15	30/120	30	**BSX26**	0.5	300/30	350	18	360	
20	30/120	30	**2N3014**	0.18	100/10	350	18	360	
20	40/120	30	**BSX39**	0.28	100/10	350	18	360	
15	25/–	100	**2N3013**	0.5	300/30	350	18	360	
30	60/150	100	**2N4013**	0.20	100/10	300	60*	500	
30	30/120	150	**2N2845**	0.4	150/15	350	40*	360	
40	60/150	100	**BSX32**	0.5	500/50	300	60*	800	TO-39
50	60/150	100	**2N3725**	0.52	500/50	300	60*	800	

PNP TRANSISTORS FOR FAST AND ULTRA FAST SWITCHES

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

TRANSISTORS FOR RF APPLICATIONS (For current production or maintenance only)

Polar.	Max. ratings		Type	Main function	Trans. freq.		Noise figure			Gain		PACKAGE
	V_{CEO} (V)	I_C (mA)			f_T (MHz)	@ I_C (mA)	NF and I_C (dB)	(mA)	f (MHz)	P_G (dB)	f MHz)	
PNP	35	20	**BF272S**	VHF/UHF amp.	900	3	3	3	800	16	800	TO-72
PNP	35	20	**BF316A**	VHF/UHF osc.	600	3	5	3	800	12	800	
PNP	35	20	**BFR38**	VHF/UBF amp.	1000	3	3.5	3	800	14	800	
NPN	25	25	**BF271**	IF amplifier	900	10	–	–	–	24	36	
NPN	30	25	**BFY90**	Wide-band amp.	1400	25	5.5	2	800	8	800	
NPN	12	50	**2N5179**	VHF amplifier	1400	5	3	1.5	200	21	200	
NPN	15	50	**2N918**	UHF oscillator	900	4	5	1	60	21	200	
NPN	25	150	**BFW16A**	Wide-band amp.	1200	150	5	30	200	6.5	800	TO-39
NPN	30	200	**BFR36**	VHF/UHF amp.	1400	70	4.5	70	200	16	200	
NPN	20	400	**2N5109**	Wide-band amp.	1500	50	3	10	200	13	200	
NPN	20	500	**2N4427**	VHF/UHF amp.	800	50	–	–	–	–	–	
NPN	30	500	**2N3866**	VHF/UHF amp.	800	50	–	–	–	–	–	

CROSS REFERENCE

TYPE	SGS-ATES NEAREST	PAGE
BC100	BF259	106
BC107	BC107	24
BC108	BC108	24
BC109	BC109	24
BC110	BC394	74
BC113	BFY76	159
BC114	BFR17	117
BC115	BC140	36
BC116	BC160	46
BC117	BC394	74
BC118	BC107	24
BC119	BC119	31
BC120	BC119	31
BC125	BC377	68
BC126	BC298	59
BC129	BC107	24
BC130	BC108	24
BC131	BC108	24
BC132	BC109	24
BC134	BC107	24
BC135	BC107	24
BC136	BC140	36
BC137	BC139	33
BC138	BC140	36
BC139	BC139	33
BC140	BC140	36
BC141	BC141	36
BC142	BC142	40
BC143	BC143	43
BC144	BC140	36
BC145	BC394	74
BC147	BC107	24

TYPE	SGS-ATES NEAREST	PAGE
BC148	BC108	24
BC149	BC109	24
BC150	BC108	24
BC151	BC108	24
BC152	BC108	24
BC153	BC177	50
BC154	BC177	50
BC157	BC177	50
BC158	BC178	50
BC159	BC179	50
BC160	BC160	46
BC161	BC161	46
BC167	BC107	24
BC168	BC108	24
BC169	BC109	24
BC170	BC108	24
BC171	BC107	24
BC172	BC108	24
BC173	BC109	24
BC174	BFY76	159
BC177	BC177	50
BC181	BC177	50
BC182	BC107	24
BC183	BC107	24
BC184	BC107	24
BC185	BC301	62
BC186	BC177	50
BC187	BC178	50
BC190	BC107	24
BC192	BC298	59
BC200	BC179	50
BC204	BC177	50

TYPE	SGS-ATES NEAREST	PAGE
BC205	BC178	50
BC206	BC179	50
BC207	BC107	24
BC208	BC108	24
BC209	BC109	24
BC210	BC377	68
BC211	BC141	36
BC212	BC177	50
BC213	BC178	50
BC214	BC179	50
BC215	BC297	59
BC216	BC298	59
BC218	BC108	24
BC220	BC107	24
BC221	BC298	59
BC222	BC378	68
BC223	BC377	68
BC224	BC478	83
BC225	BC478	83
BC226	BC302	62
BC231	BC297	59
BC232	BC377	68
BC236	BC394	74
BC237	BC107	24
BC238	BC108	24
BC239	BC109	24
BC250	BC179	50
BC251	BC177	50
BC252	BC178	50
BC253	BC179	50
BC254	BC394	74
BC255	BC394	74

TYPE	SGS-ATES NEAREST	PAGE
BC256	BC477	83
BC257	BC177	83
BC258	BC178	50
BC259	BC179	50
BC260	BC179	50
BC261	BC177	50
BC262	BC178	50
BC263	BC178	50
BC266	BC477	83
BC267	BC107	24
BC268	BC108	24
BC269	BC109	24
BC270	BC109	24
BC271	BC378	68
BC272	BC377	68
BC280	BFY76	159
BC281	BC178	50
BC282	BC377	68
BC283	BC297	59
BC284	BC378	68
BC285	BC394	74
BC286	BC286	55
BC287	BC287	57
BC294	BC160	46
BC295	BC108	24
BC297	BC297	59
BC298	BC298	59
BC300	BC300	62
BC301	BC301	62
BC302	BC302	62
BC303	BC303	65
BC304	BC304	65

TYPE	SGS-ATES NEAREST	PAGE
BC307	BC177	50
BC308	BC178	50
BC309	BC179	50
BC310	BC141	36
BC312	BF258	106
BC313	BC303	65
BC315	BC177	50
BC317	BC107	24
BC318	BC108	24
BC319	BC109	24
BC320	BC177	50
BC321	BC178	50
BC322	BC179	50
BC324	BC301	62
BC327	BC297	59
BC328	BC298	59
BC329	BFY76	159
BC330	BC107	24
BC331	BFY76	159
BC332	BC107	24
BC333	BC108	24
BC334	BC178	50
BC335	BC109	24
BC336	BC178	50
BC337	BC377	68
BC338	BC378	68
BC340	BC140	36
BC341	BC141	36
BC342	BC141	36
BC343	BC161	46
BC344	BC300	62
BC345	BC303	65

TYPE	SGS-ATES NEAREST	PAGE
BC347	BC107	24
BC348	BC108	24
BC349	BC109	24
BC350	BC177	50
BC351	BC178	50
BC352	BC179	50
BC354	BC478	83
BC355	BC478	83
BC357	BC479	83
BC358	BC109	24
BC360	BC160	46
BC361	BC161	46
BC368	BC440	77
BC369	BC460	80
BC370	BC298	59
BC377	BC377	68
BC378	BC378	68
BC381	BC177	50
BC382	BC107	24
BC383	BC108	24
BC384	BC108	24
BC385	BC107	24
BC386	BC109	24
BC387	BC377	68
BC388	BC297	59
BC393	BC393	71
BC394	BC394	74
BC395	BC141	36
BC396	BC161	46
BC400	BC477	83
BC407	BC107	24
BC408	BC108	24

CROSS REFERENCE (continued)

TYPE	SGS-ATES NEAREST	PAGE
BC409	BC109	24
BC417	BC177	50
BC418	BC178	50
BC419	BC179	50
BC420	BC393	71
BC429	BC440	77
BC430	BC460	80
BC431	BC301	62
BC432	BC303	65
BC437	BC107	24
BC438	BC108	24
BC439	BC109	24
BC440	BC440	77
BC441	BC441	77
BC446	BC477	83
BC448	BC477	83
BC451	BC107	24
BC452	BC108	24
BC453	BC109	24
BC454	BC177	50
BC455	BC178	50
BC456	BC179	50
BC460	BC460	80
BC461	BC461	80
BC467	BC107	24
BC468	BC108	24
BC469	BC109	24
BC477	BC477	83
BC478	BC478	83
BC479	BC479	83
BC512	BC177	50
BC513	BC178	50

TYPE	SGS-ATES NEAREST	PAGE
BC514	BC179	50
BC520	BFY76	159
BC521	BFR17	117
BC522	BFR17	117
BC523	BFY76	159
BC524	BC107	24
BC525	BC478	83
BC526	BC477	83
BC529	BC297	59
BC530	BC393	71
BC531	BC393	71
BC532	BC394	74
BC533	BC394	74
BC535	2N3700	327
BC546	BFY76	159
BC547	BC107	24
BC548	BC108	24
BC549	BC109	24
BC550	BC107	24
BC556	BC477	83
BC557	BC478	83
BC558	BC478	83
BC559	BC479	83
BC560	BC478	83
BC582	BC107	24
BC583	BC108	24
BC584	BC109	24
BC585	BFY76	159
BC586	BC177	50
BC635	BC377	68
BC636	BC297	59
BC714	BC177	50

TYPE	SGS-ATES NEAREST	PAGE
BC727	BC297	59
BC728	BC298	59
BC737	BC377	68
BC738	BC378	68
BCW10	BCY58	89
BCW11	BCY78	100
BCW12	BCY59	89
BCW13	BCY79	100
BCW14	BCY59	89
BCW15	BCY79	100
BCW16	BCY59	89
BCW17	BCY79	100
BCW20	BCY58	89
BCW21	BCY78	100
BCW22	BCY59	89
BCW23	BCY79	100
BCW34	2B2222A	264
BCW35	2N2907A	297
BCW36	2N2222A	264
BCW37	2N2907A	297
BCW44	2N1613	254
BCW45	BFX41	132
BCW50	BC394	74
BCW62	2N3962	344
BCW63	BCY79	100
BCW64	BCY79	100
BCW73	2N2221	262
BCW74	2N2221A	264
BCW75	2N2906	294
BCW76	2N2906A	297
BCW77	2N2219	262
BCW78	2N2219A	264

TYPE	SGS-ATES NEAREST	PAGE
BCW79	2N2905	294
BCW80	2N2905A	297
BCW82	BFY76	159
BCW83	BCY59	89
BCW84	BCY59	89
BCW85	BFX37	127
BCW86	BC177	50
BCW87	BCY59	89
BCW88	BCY79	100
BCW90	BC377	68
BCW91	BSX33	209
BCW92	BC297	59
BCW93	2N2907A	297
BCW94	2N2222A	264
BCW95	BFR18	120
BCW96	2N2907	294
BCW97	2N2907A	297
BCW98	BCY59	89
BCW99	BCY79	100
BCX25	BCY59	89
BCX26	BCY79	100
BCX40	BC441	77
BCX45	2N2221A	264
BCX46	2N2906A	297
BCX47	2N2222A	264
BCX48	2N2907A	297
BCX58	BCY58	89
BCX59	BCY59	89
BCX60	BC461	80
BCX73	2N2222	262
BCX74	2N2222A	264
BCX75	2N2907	294

TYPE	SGS-ATES NEAREST	PAGE
BCX76	2N2907A	297
BCX78	BCY78	100
BCX79	BCY79	100
BCY56	BCY59	89
BCY58	BCY58	89
BCY59	BCY59	89
BCY66	BCY59	89
BCY67	BCY79	100
BCY69	BCY58	89
BCY70	BCY70	94
BCY71	BCY71	94
BCY72	BCY72	94
BCY78	BCY78	100
BCY79	BCY79	100
BF120	BC394	74
BF137	BF257	106
BF156	BF257	106
BF157	BF257	106
BF174	BF258	106
BF177	BF257	106
BF178	BF258	106
BF179	BF259	106
BF248	2N2222	262
BF249	2N2907	294
BF250	2N2222	262
BF257	BF257	106
BF258	BF258	106
BF259	BF259	106
BF291	BC107	24
BF292	BF258	106
BF293	BC107	24
BF294	BF257	106

TYPE	SGS-ATES NEAREST	PAGE
BF297	BF257	106
BF298	BF258	106
BF299	BF259	106
BF305	BF258	106
BF321	BC108	24
BF322	2N2218	262
BF323	2N2904	294
BF336	BF257	106
BF337	BF258	106
BF338	BF259	106
BF355	BF259	106
BF390	BF259	106
BF391	BC394	74
BF456	BF457	110
BF457	BF457	110
BF458	BF458	110
BF459	BF459	110
BFR10	2N2218	262
BFR11	2N2221	262
BFR12	BCY59	89
BFR16	BFY76	159
BFR17	BFR17	117
BFR18	BFR18	120
BFR20	2N3019	307
BFR21	2N1893	257
BFR22	2N1893	257
BFR23	2N4036	365
BFR24	2N4037	368
BFR39	BFR18	120
BFR40	2N3700	327
BFR56	BC440	77
BFR57	BF257	106

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TYPE	SGS-ATES NEAREST	PAGE
BFR58	BF258	106
BFR59	BF259	106
BFR77	2N1893	257
BFR78	2N3020	307
BFR86	BC394	74
BFS61	BSX33	209
BFS69	BC178	50
BFS90	BFW44	124
BFS91	BFX91	140
BFS92	BFX41	132
BFS93	BFX40	132
BFS94	BFX39	132
BFS95	BFX38	132
BFS99	BC394	74
BFT22	2N2906	294
BFT30	BSX33	209
BFT31	2N956	243
BFT41	2N5321	370
BFT57	BC394	74
BFT60	2N4033	357
BFT61	2N4030	357
BFT62	2N4030	357
BFT69	2N4031	357
BFT79	2N4031	357
BFT80	2N4033	257
BFT81	2N4032	357
BFV56	BSS26	164
BFV56A	BSS26	164
BFV57A	BSS26	164
BFV64	2N2907	294
BFV64A	2N2907A	297
BFV64B	2N2907	294

TYPE	SGS-ATES NEAREST	PAGE
BFV65	BSX26	191
BFV66	2N2221A	264
BFV66A	2N2222A	264
BFV68	2N2483	279
BFV68A	2N2484	279
BFV90A	2N2222	262
BFV90B	2N2221	262
BFV99	2N2221A	264
BFW20	BC477	83
BFW21	BFX37	127
BFW22	BC478	83
BFW24	2N3108	312
BFW25	2N3110	312
BFW26	2N3109	312
BFW29	2N2219	262
BFW31	2N2905	294
BFW32	2N2219	262
BFW33	BSY56	237
BFW36	BF257	106
BFW38	BF257	106
BFW43	BFW43	124
BFW44	BFW44	124
BFW45	BF257	106
BFW63	2N2222	262
BFW63A	2N2222A	264
BFX12	BFX48	137
BFX13	BFX48	137
BFX23	BSX32	205
BFX29	2N2904A	297
BFX35	2N2907	294
BFX36	2N2907A	297
BFX37	BFX37	127

TYPE	SGS-ATES NEAREST	PAGE
BFX38	BFX38	132
BFX39	BFX39	132
BFX40	BFX40	132
BFX41	BFX41	132
BFX43	2N2369	272
BFX44	2N2369A	274
BFX48	BFX48	137
BFX50	2N2222A	264
BFX51	2N2221A	264
BFX68	2N1711	254
BFX68A	2N1711	254
BFX69	2N1613	254
BFX69A	2N1613	254
BFX74	2N2904	294
BFX74A	BFX39	132
BFX84	2N1893	257
BFX85	2N1893	257
BFX86	2N1711	254
BFX87	2N2905A	297
BFX88	2N2905	294
BFX90	BFX90	140
BFX91	BFX91	140
BFX93	2N930	252
BFX94	2N2221	262
BFX94A	2N2221A	264
BFX95	2N2222	262
BFX95A	2N2222A	264
BFX96	2N2218	262
BFX96A	2N2218A	264
BFX97	2N2219	262
BFX97A	2N2219A	264
BFX98	BF257	106

TYPE	SGS-ATES NEAREST	PAGE
BFY25	2N2219A	264
BFY26	2N2222A	264
BFY33	BFY56	149
BFY34	2N1613	254
BFY40	2N1711	254
BFY41	BF257	106
BFY43	BF257	106
BFY44	BFY56A	149
BFY45	BF257	106
BFY46	2N1711	254
BFY50	BFY50	146
BFY51	BFY51	146
BFY52	BFY52	146
BFY53	2N1613	254
BFY55	2N1613	254
BFY56	BFY56	149
BFY56A	BFY56A	149
BFY56B	BFY56A	149
BFY57	BF257	106
BFY64	BFY64	154
BFY65	BF257	106
BFY67	2N1613	254
BFY68	2N1711	254
BFY70	2N2218A	264
BFY72	2N2218	262
BFY76	BFY76	159
BFY77	2N2484	279
BSS11	BSX20	186
BSS12	BSX28	196
BSS15	2N5320	370
BSS16	2N5321	370
BSS17	2N5322	372

TYPE	SGS-ATES NEAREST	PAGE
BSS18	2N5323	372
BSS23	BSS26	164
BSS26	BSS26	164
BSS27	2N3725	334
BSS28	BSX32	205
BSS29	BSX32	205
BSS30	2N1893	257
BSS31	2N3019	307
BSS40	BSS26	164
BSS41	BSS26	164
BSS59	2N3700	327
BSS68	BC393	71
BSS71S	BSS71S	169
BSS72S	BSS72S	172
BSS74S	BSS74S	175
BSS75S	BSS75S	178
BSV15	BSV15	181
BSV16	BSV16	181
BSV17	BSV16	181
BSV21	2N2894	289
BSV23	BSX28	196
BSV24	BSX28	196
BSV25	BSX19	186
BSV26	BSX19	186
BSV27	BSX20	186
BSV33	BSX29	200
BSV68	BFW43	124
BSV69	BSX32	205
BSV77	2N3725	334
BSV82	2N5322	372
BSV83	2N5323	372
BSV84	2N5320	370

TYPE	SGS-ATES NEAREST	PAGE
BSV85	2N5321	370
BSV89	BSX19	186
BSV90	BSX20	186
BSV91	2N2369	272
BSV92	BSX26	191
BSV95	2N3725	334
BSW19	2N2906	294
BSW19A	2N2907	294
BSW20	2N2906	294
BSW20A	2N2907	294
BSW21	BCY78	100
BSW21A	BCY79	100
BSW22	BCY78	100
BSW22A	BCY79	100
BSW23	2N2904	294
BSW24	2N2904A	297
BSW25	BSX29	200
BSW26	BSS26	164
BSW27	2N3725	334
BSW28	BSX32	205
BSW29	BSX32	205
BSW37	2N2894	289
BSW38	BSX19	186
BSW41	2N2221A	264
BSW42	BCY58	89
BSW42A	BCY59	89
BSW43A	BCY59	89
BSW44	BCY78	100
BSW44A	BCY79	100
BSW45	BCY78	100
BSW45A	BCY79	100
BSW49	BSX32	205

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TYPE	SGS-ATES NEAREST	PAGE
BSW51	2N2218	262
BSW52	2N2219	262
BSW53	2N2218A	264
BSW54	2N2219A	264
BSW61	2N2221	262
BSW62	2N2222	262
BSW63	2N2221A	264
BSW64	2N2222A	264
BSW72	2N2906	294
BSW73	2N2907	294
BSW74	2N2906A	297
BSW75	2N2907A	297
BSW82	2N2221	262
BSW83	2N2222	262
BSW84	2N2221	262
BSW85	2N2222A	264
BSX19	BSX19	186
BSX20	BSX20	186
BSX21	BC394	74
BSX22	2N5321	370
BSX23	2N5320	370
BSX24	2N2221	262
BSX25	2N2222	262
BSX26	BSX26	191
BSX28	BSX28	196
BSX29	BSX29	200
BSX30	BSX32	205
BSX33	BSX33	209
BSX38A	BCY58	89
BSX38B	BCY59	89
BSX39	BSX39	213
BSX45	BSX45	218

TYPE	SGS-ATES NEAREST	PAGE
BSX46	BSX46	218
BSX47	BFY56	149
BSX48	BSS26	164
BSX49	BSS26	164
BSX51	BCY58	89
BSX52	BCY59	89
BSX53	BCY58	89
BSX54	BCY59	89
BSX59	BSX32	205
BSX60	2N3725	334
BSX61	2N3725	334
BSX76	BSX20	186
BSX77	2N2369A	274
BSX78	BSX20	186
BSX87	BSX26	191
BSX87A	BSX26	191
BSX88	BSX39	213
BSX88A	BSX88A	223
BSX89	BSX19	186
BSX90	BSX20	186
BSX91	2N2369A	274
BSX92	2N2369	272
BSX93	BSX93	228
BSX95	2N1613	254
BSX96	2N1711	254
BSX97	2N2221	262
BSY10	2N2218A	264
BSY11	2N2219	262
BSY17	BSX19	186
BSY18	BSX20	186
BSY19	BSX26	191
BSY20	BSX20	186

TYPE	SGS-ATES NEAREST	PAGE
BSY21	BSX26	191
BSY22	BCY59	89
BSY23	BSX19	186
BSY34	BSX32	205
BSY38	BSX19	186
BSY40	BSX29	200
BSY41	BSX29	200
BSY44	2N1613	254
BSY45	2N1893	257
BSY46	2N1613	254
BSY53	BSY53	233
BSY54	BSY54	233
BSY55	BSY55	237
BSY56	BSY56	237
BSY58	BSX32	205
BSY62A	BSX19	186
BSY62B	BSX20	186
BSY63	BSX93	228
BSY70	BSX39	213
BSY71	2N1711	254
BSY72	BCY58	89
BSY73	BCY58	89
BSY74	BCY59	89
BSY78	2N2222	262
BSY83	BFY56A	149
BSY84	2N1711	254
BSY85	BSX45	218
BSY86	BSX46	218
BSY87	BSY56	237
BSY88	2N3107	312
BSY89	BCY58	89
BSY95	BSX19	186

TYPE	SGS-ATES NEAREST	PAGE
BSY95A	BSX20	186
2N656	BSX46	218
2N657	BC300	62
2N696	BSY53	233
2N697	2N1613	254
2N698	2N1893	257
2N706	BSX26	191
2N706A	BSX19	186
2N707	BSX39	213
2N708	2N708	241
2N718A	2N718A	243
2N720A	2N720A	246
2N721	2N2906	294
2N722	2N2906A	297
2N735	2N2483	279
2N736	BFR18	120
2N743	BSX19	186
2N744	BSX20	186
2N753	2N2369A	274
2N754	2N1893	257
2N760A	BFY76	159
2N780	2N930	252
2N834	BSX20	186
2N869	BSX29	200
2N870	BSX33	209
2N871	BFR18	120
2N910	BFR18	120
2N911	BSX33	209
2N912	BFR18	120
2N914	2N914	248
2N929	BFY76	159
2N930	2N930	252

TYPE	SGS-ATES NEAREST	PAGE
2N956	2N956	243
2N978	2N2906	294
2N995	BSX29	200
2N1132	2N2904	294
2N1420	2N2219	262
2N1507	2N2219	262
2N1572	2N1893	257
2N1573	2N1893	257
2N1574	2N3020	307
2N1613	2N1613	254
2N1711	2N1711	254
2N1890	BSY55	237
2N1893	2N1893	257
2N1983	2N2219	262
2N1984	2N2218	262
2N1985	2N1613	254
2N1986	2N2218	262
2N1987	2N1613	254
2N1990	2N1893	257
2N1991	2N2904	294
2N2049	BFY52	146
2N2102	2N2102	260
2N2193	BSX45	218
2N2194A	2N2218A	264
2N2195	2N2218	262
2N2217	2N2218	262
2N2218	2N2218	262
2N2218A	2N2218A	264
2N2219	2N2219	262
2N2219A	2N2219A	264
2N2221	2N2221	262
2N2221A	2N2221A	264

TYPE	SGS-ATES NEAREST	PAGE
2N2222	2N2222	262
2N2222A	2N2222A	264
2N2297	BFY56	237
2N2368	2N2368	270
2N2369	2N2369	272
2N2369A	2N2369A	274
2N2405	BC300	62
2N2410	BSX32	205
2N2412	BSX29	200
2N2477	2N3725	334
2N2483	2N2483	279
2N2484	2N2484	279
2N2511	BFY76	159
2N2586	BFR17	117
2N2692	BCY59	89
2N2693	BCY59	89
2N2694	BCY59	89
2N2711	BCY58	89
2N2712	BCY58	89
2N2714	BCY59	89
2N2845	2N2845	285
2N2848	BSX32	205
2N2864	BFY50	146
2N2868	BSY53	233
2N2894	2N2894	289
2N2904	2N2904	294
2N2904A	2N2904A	297
2N2905	2N2905	294
2N2905A	2N2905A	297
2N2906	2N2906	294
2N2906A	2N2906A	297
2N2907	2N2907	294

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TYPE	SGS-ATES NEAREST	PAGE
2N2907A	2N2907A	297
2N2927	2N2904A	297
2N2959	2N2219A	264
2N3009	2N3013	302
2N3011	BSX28	196
2N3012	2N2894	289
2N3013	2N3013	302
2N3014	2N3014	302
2N3015	BSX32	205
2N3019	2N3019	307
2N3020	2N3020	307
2N3036	2N1893	257
2N3053	2N3053	310
2N3070	2N2905A	297
2N3073	2N2906A	297
2N3107	2N3107	312
2N3108	2N3108	312
2N3109	2N3109	312
2N3110	2N3110	312
2N3114	2N3114	316
2N3117	BFR17	117
2N3121	2N2906A	297
2N3209	2N3209	289
2N3250	2N3250	318
2N3251	2N3251	318
2N3252	2N3725	334
2N3253	BSX32	205
2N3261	BSX20	186
2N3299	2N2218	262
2N3300	2N2219	262
2N3301	2N3301	321
2N3302	2N3302	321

TYPE	SGS-ATES NEAREST	PAGE
2N3309	2N2218	262
2N3485	2N2906	294
2N3486	2N2907	294
2N3502	2N3502	324
2N3503	2N3503	324
2N3504	2N3504	324
2N3505	2N3505	324
2N3565	BFY76	159
2N3566	2N1711	254
2N3567	2N1613	254
2N3568	BFY56A	149
2N3569	BFY56	149
2N3638	2N2905	294
2N3641	2N2218	262
2N3642	2N2218A	264
2N3643	2N2219	262
2N3644	2N2905	294
2N3645	2N2905A	297
2N3646	BSX26	191
2N3700	2N3700	327
2N3712	BF257	106
2N3725	2N3725	334
2N3776	2N5321	370
2N3777	2N5322	372
2N3793	BC107	24
2N3794	BC108	24
2N3825	BC109	24
2N3828	BC107	24
2N3903	2N2222	262
2N3904	2N2221	262
2N3905	2N2906	294
2N3906	2N2907	294

TYPE	SGS-ATES NEAREST	PAGE
2N3930	2N3930	339
2N3931	2N3931	339
2N3962	2N3962	344
2N3963	2N3963	344
2N3964	2N3964	344
2N3965	2N3965	344
2N4013	2N4013	348
2N4014	2N4014	352
2N4030	2N4030	357
2N4031	2N4031	357
2N4032	2N4032	357
2N4033	2N4033	357
2N4035	2N4035	362
2N4036	2N4036	365
2N4037	2N4037	368
2N4046	BSX32	205
2N4047	2N3725	334
2N4058	BC177	50
2N4059	BC178	50
2N4060	BC177	50
2N4061	BC177	50
2N4062	BC178	50
2N4121	BCY70	94
2N4248	BC177	50
2N4249	BC177	50
2N4250	BC178	50
2N4258	BC179	50
2N4264	BC108	24
2N4265	BC107	24
2N4286	BC107	24
2N4287	BC107	24
2N4288	BC178	50

TYPE	SGS-ATES NEAREST	PAGE
2N4289	BC177	50
2N4290	BC179	50
2N4291	BC179	50
2N4292	BC109	24
2N4293	BC109	24
2N4358	2N5415S	374
2N4359	BFX37	127
2N4402	2N2906	294
2N4403	2N2907	294
2N4917	2N3251	318
2N4927	BF258	106
2N5086	BCY79	100
2N5087	BCY79	100
2N5088	BCY59	89
2N5089	BCY59	89
2N5128	2N2219	262
2N5132	BC109	24
2N5135	BCY58	89
2N5136	BC119	31
2N5138	BCY79	100
2N5172	BCY58	89
2N5209	BC107	24
2N5210	BC107	24
2N5219	BC108	24
2N5320	2N5320	370
2N5321	2N5321	370
2N5322	2N5322	372
2N5323	2N5323	372
2N5415S	2N5415S	374
2N5550	BC394	74
2N5551	BC394	74
2SA561	BC297	59

TYPE	SGS-ATES NEAREST	PAGE
2SA565	BC297	59
2SA578	BC177	50
2SA673	BC297	59
2SA677	BC298	59
2SC80	BC108	24
2SC99	BC109	24
2SC100	2N1613	254
2SC108	2N1711	254
2SC120	2N1711	254
2SC122	2N2369	272
2SC150	BFY50	146
2SC155	BC108	24
2SC156	BC109	24
2SC172	BSX20	186
2SC188	2N2218	262
2SC189	2N2218A	264
2SC196	BSX20	186
2SC197	BFY51	146
2SC199	BSY54	233
2SC204	BSX19	186
2SC206	BC107	24
2SC228	BSY53	233
2SC233	BSY54	233
2SC237	2N2369	272
2SC266	BC108	24
2SC273	2N1711	254
2SC281	BC107	24
2SC282	BFY50	146
2SC283	2N1613	254
2SC284	2N1711	254
2SC320	BC107	24
2SC368	BC107	24

TYPE	SGS-ATES NEAREST	PAGE
2SC468	BSX19	186
2SC540	BC109	24
2SC588	2N3107	312
2SC605	2N3108	312
MM2193A	2N2218A	264
MM2483	2N2483	279
MM3019	2N3019	307
MM3020	2N3020	307
MM3053	2N3053	310
MM3905	2N3250	318
MM3906	2N3251	318

DATA SHEETS

BC 107
BC 108
BC 109

EPITAXIAL 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.

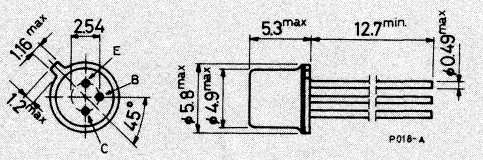
ABSOLUTE MAXIMUM RATINGS

		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**	40	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)

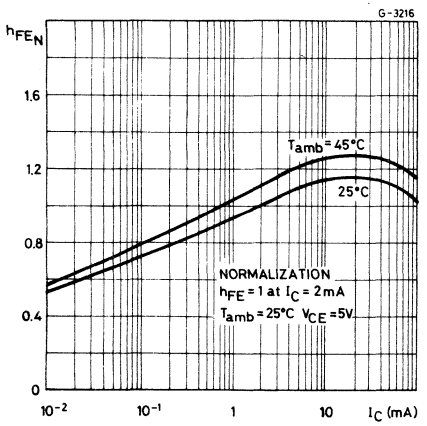
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5$ V f = 1 MHz		12		pF
NF	Noise figure	$I_C = 0.2$ mA $V_{CE} = 5$ V $R_g = 2$ kΩ f = 1 kHz B = 200 Hz				
		for **BC 107**		2	10	dB
		for **BC 108**		2	10	dB
		for **BC 109**		1.5	4	dB
		$I_C = 0.2$ 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)

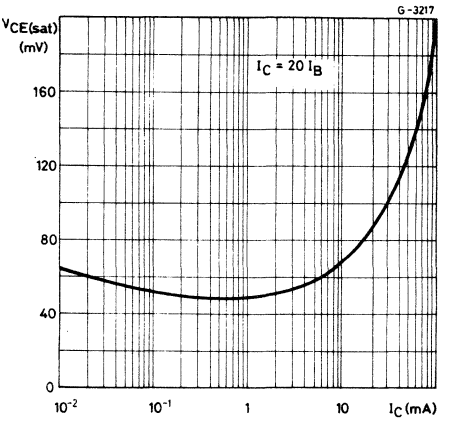
Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{oe} Output admittance	I_C = 2 mA V_{CE} = 5 V f = 1 kHz				
	for **BC 107**		20		µS
	for **BC 107** Gr. A		13		µS
	for **BC 107** Gr. B		26		µS
	for **BC 108**		30		µS
	for **BC 108** Gr. A		13		µS
	for **BC 108** Gr. B		26		µS
	for **BC 108** Gr. C		34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

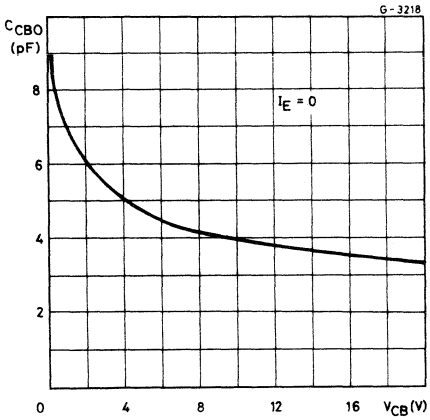
DC normalized current gain



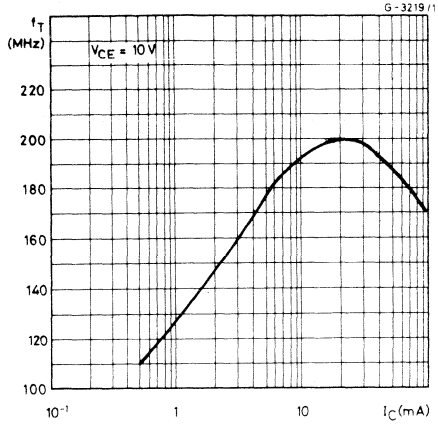
Collector-emitter saturation voltage



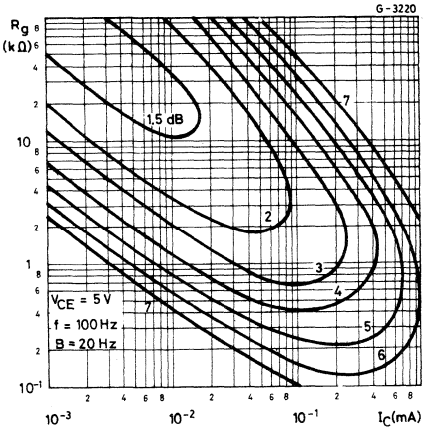
Collector-base capacitance



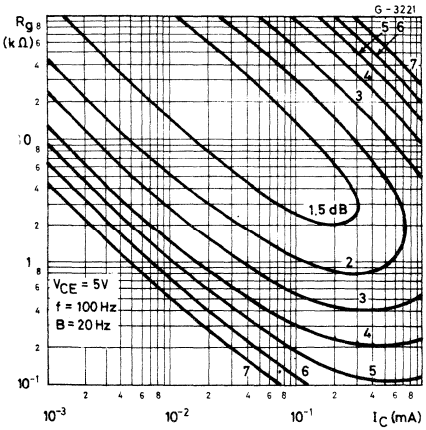
Transition frequency



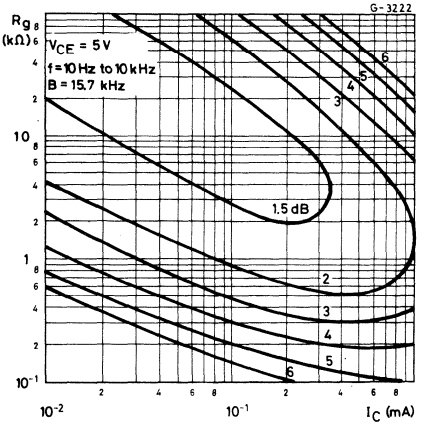
Noise figure (for **BC 109** only)



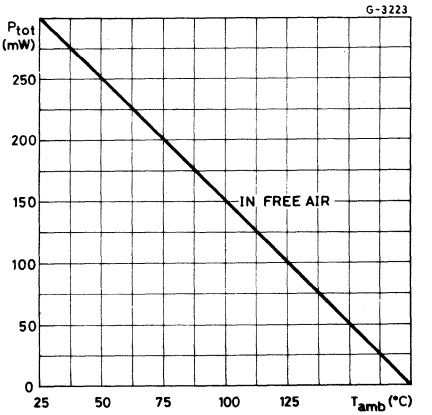
Noise figure (for **BC 109** only)



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



Power rating chart



EPITAXIAL PLANAR NPN

BC 119

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.

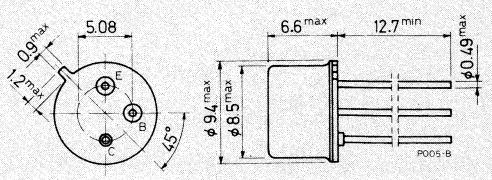
ABSOLUTE MAXIMUM RATINGS

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**)

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			100	nA
		V_{CB} = 40 V T_{amb} = 150 °C			20	μA
$V_{(BR)\ CBO}$	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 = 30mA	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		0.15	0.35	V
		I_C = 500 mA I_B = 50 mA		0.4	1.1	V
		I_C = 1 A I_B = 100 mA		0.8	1.5	V
V_{BE}*	Base-emitter voltage	I_C = 500 mA V_{CE} = 10 V		1	1.8	V
		I_C = 150 mA V_{CE} = 1 V		0.85	1	V
$V_{BE\ (sat)}$*	Base-emitter saturation voltage	I_C = 150 mA I_B = 15 mA		0.9	1.2	V
		I_C = 1 A I_B = 0.1 A		1.4	2	V
h_{FE}*	DC current gain	I_C = 50 mA V_{CE} = 1 V	40	100		—
		I_C = 150 mA V_{CE} = 1 V	40	90	120	—
		I_C = 500 mA V_{CE} = 10 V	25	60		—
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%

EPITAXIAL PLANAR PNP

BC 139

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.

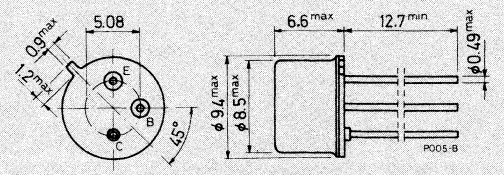
ABSOLUTE MAXIMUM RATINGS

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 $T_{amb} \leqslant 25°C$	0.7	W
	at $T_{case} \leqslant 25°C$	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

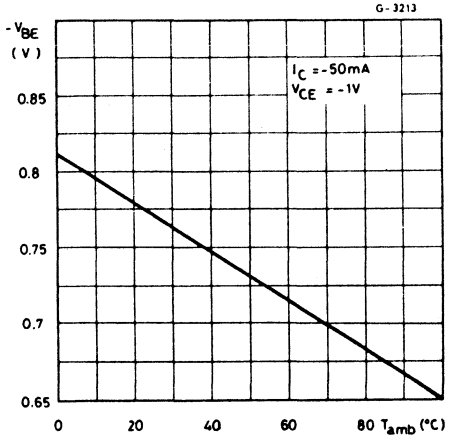
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	58	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	250	°C/W

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

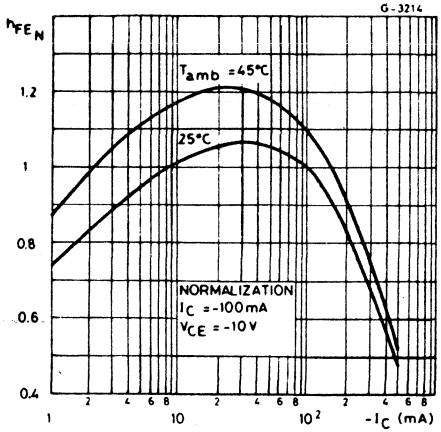
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -30V			-100	nA
		V_{CB} = -30V T_{amb} = 75°C			-50	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA	-40			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -10 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%

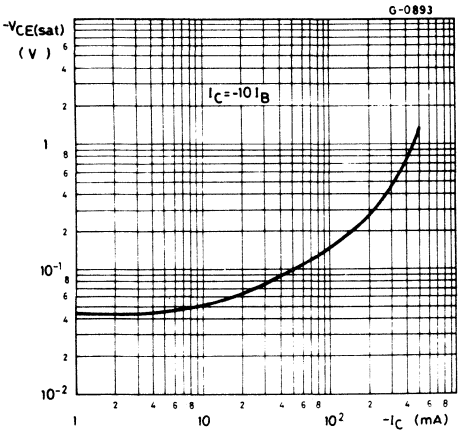
Base-emitter voltage



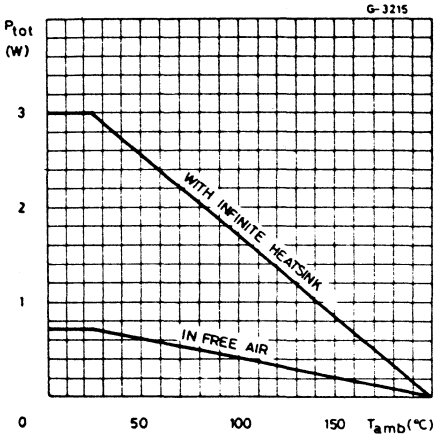
DC normalized current gain



Collector-emitter saturation voltage



Power rating chart



BC 140
BC 141

EPITAXIAL 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 1A. The complementary PNP types are the BC 160 and BC 161.

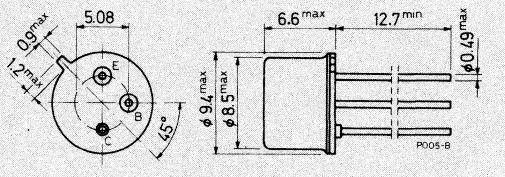
ABSOLUTE MAXIMUM RATINGS

		BC 140	BC 141
V_{CBO}	Collector-base voltage ($I_E = 0$)	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	0.1 A	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 45°C$	0.65 W	
	at $T_{case} \leqslant 45°C$	3.7 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-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	200	°C/W

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

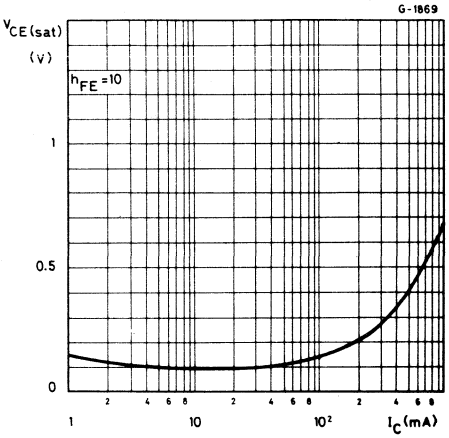
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (I_E = 0)	V_{CES} = 60V				100	nA
		V_{CES} = 60V	T_{amb} = 150°C			100	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	for **BC 140**	80			V
			for **BC 141**	100			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30 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 = 1A	I_B = 0.1A		0.6	1	V
V_{BE}*	Base-emitter voltage	I_C = 1A	V_{CE} = 1V		1.25	1.8	V

ELECTRICAL CHARACTERISTICS (continued)

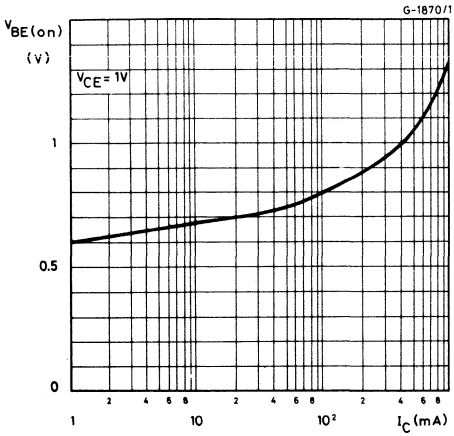
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C = 100 μA V_{CE}= 1V				
		for **BC 140-141**		75		–
		for **BC 140-141** Gr. 6		28		–
		for **BC 140-141** Gr. 10		40		–
		for **BC 140-141** Gr. 16		90		–
		I_C = 100 mA V_{CE}= 1V				
		for **BC 140-141**	40	140	250	–
		for **BC 140-141** Gr. 6	40	63	100	–
		for **BC 140-141** Gr. 10	63	100	160	–
		for **BC 140-141** Gr. 16	100	160	250	–
		I_C = 1A V_{CE}= 1V				
		for **BC 140-141**		26		–
		for **BC 140-141** Gr. 6		15		–
		for **BC 140-141** Gr. 10		20		–
		for **BC 140-141** Gr. 16		30		–
f_T	Transition frequency	I_C = 50 mA V_{CE}= 10V	50			MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB}= 10V f = 1 MHz		12	25	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%.

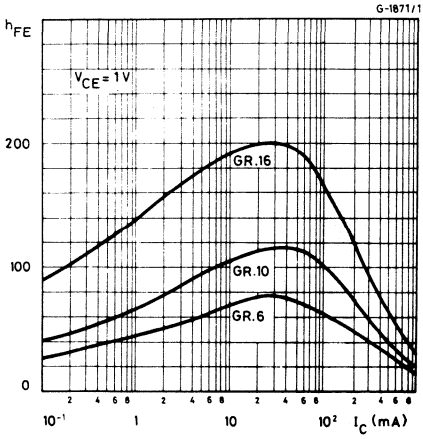
Collector-emitter saturation voltage



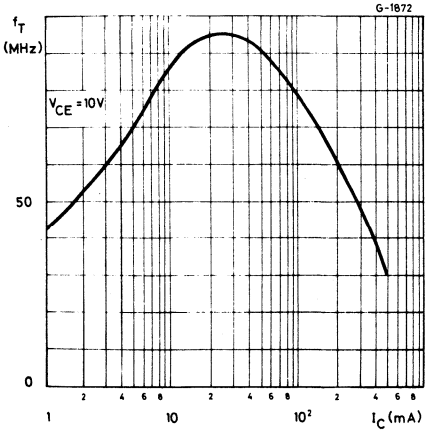
Base-emitter voltage



DC current gain



Transition frequency.



BC 142

EPITAXIAL PLANAR NPN

AUDIO AMPLIFIER

The BC 142 is a silicon planar epitaxial NPN transistor specially intended for use as driver in high power audio amplifier.

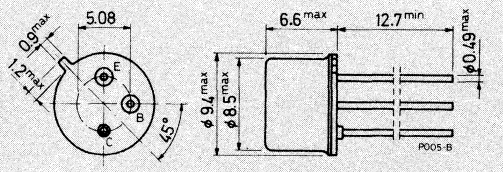
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	80	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	1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.75	W
	at $T_{case} \leqslant 25°C$	4	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

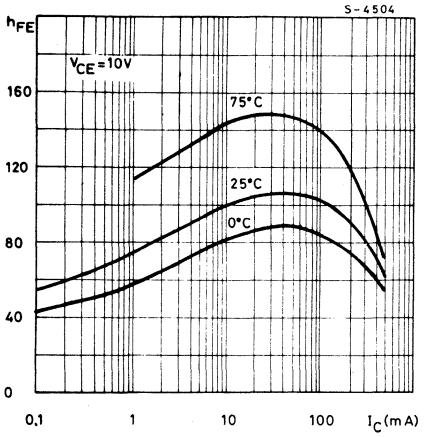
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	37	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	200	°C/W

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

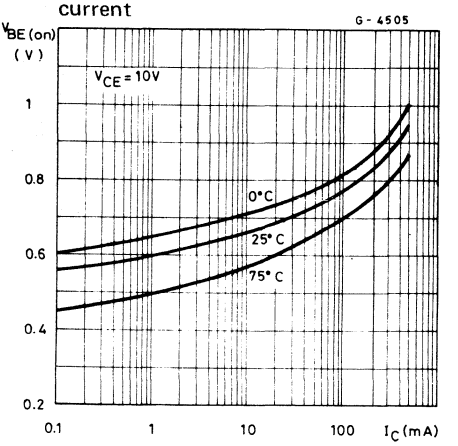
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 40V V_{CB} = 40V T_{amb} = 150°C			50 50	nA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	80			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30mA	60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA	5			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 200 mA I_B = 20 mA I_C = 500 mA I_B = 50 mA		0.15 0.3	0.4	V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 200 mA I_B = 20 mA			1.5	V
V_{BE}*	Base-emitter voltage	I_C = 200 mA V_{CE} = 2V		0.85		V
h_{FE}*	DC current gain	I_C = 10 mA V_{CE} = 10V I_C = 100 mA V_{CE} = 10V I_C = 200 mA V_{CE} = 2V I_C = 500 mA V_{CE} = 2V	 20 	100 100 60 30		– – – –
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10V f = 20 MHz		80		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V		12		pF

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

DC current gain vs. collector current



Base-emitter on voltage vs. collector current



EPITAXIAL PLANAR PNP

BC 143

AUDIO AMPLIFIER

The BC 143 is a silicon planar epitaxial PNP transistor specifically designed for use in the driver of high power audio amplifiers.

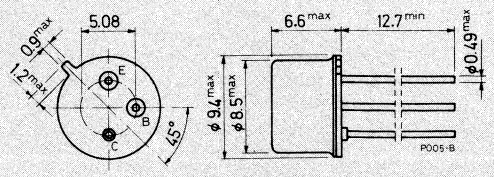
ABSOLUTE MAXIMUM RATINGS

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	-1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.75	W
	at $T_{case} \leqslant 25°C$	4	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

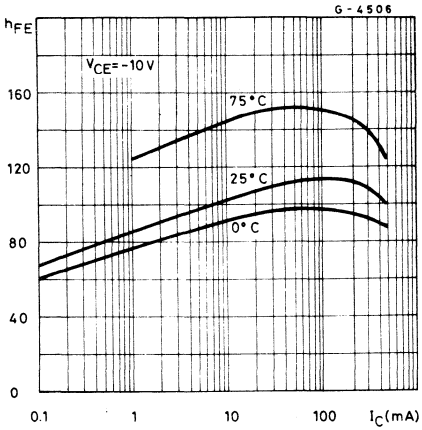
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	37	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	200	°C/W

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

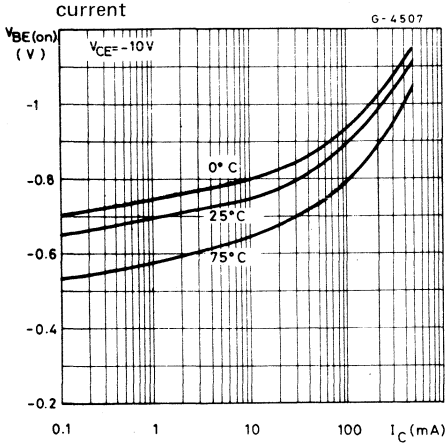
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -30V V_{CB} = - 30V (T_{amb} = 150°C)			-50 -50	nA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	-60			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 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 = 500 mA I_B = 50 mA I_C = 1A I_B = 100 mA		-0.25 -0.7	-0.5 -1	V V
V_{BE}*	Base-emitter voltage	I_C = -500 mA V_{CE} = -10V		-1.1		V
h_{FE}*	DC current gain	I_C = 10 mA V_{CE} = -10V I_C = 100 mA V_{CE} = -10V I_C = -300 mA V_{CE} = -1V I_C = 500 mA V_{CE} = -1V	 20 	100 110 40 25		– – – –
h_{fe}	High frequency current gain	I_C = 50 mA V_{CE} = -10V f = 100 MHz		1.5		–
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10V f = 1 MHz		13		pF

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

DC current gain vs. collector current



Base-emitter on voltage vs. collector current



BC 160
BC 161

EPITAXIAL 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 1A. The complementary NPN types are the BC 140 and BC 141.

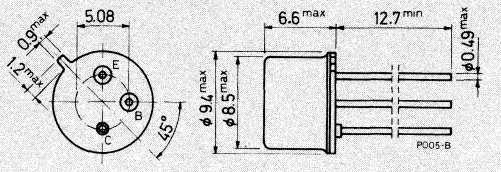
ABSOLUTE MAXIMUM RATINGS

		BC 160	BC 161
V_{CBO}	Collector-base voltage ($I_E = 0$)	-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	-0.1 A	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 45°C$	0.65 W	
	at $T_{case} \leqslant 45°C$	3.7 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-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	200	°C/W

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

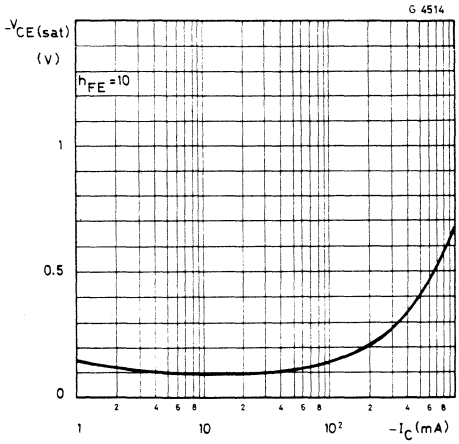
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (I_E = 0)	V_{CES} = 40V for **BC 160**			-100	nA
		V_{CES} = 60V for **BC 161**			-100	nA
		V_{CES} = 40V for **BC 160** T_{amb} = 150°C			-100	μA
		V_{CES} = 60V for **BC 161** T_{amb} = 150°C			-100	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -100 μA for **BC 160**	-40			V
		for **BC 161**	-60			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 = -1A I_B = -0.1A		-0.6	-1	V
V_{BE}*	Base-emitter voltage	I_C = -1 A V_{CE} = -1 V		-1	-1.7	V
h_{FE}*	DC current gain	I_C = -100 μA V_{CE} = -1V				
		for **BC 160-161**		110		–
		for **BC 160-161** Gr. 6		46		–
		for **BC 160-161** Gr. 10		80		–
		for **BC 160-161** Gr. 16		120		–
		I_C = -100 mA V_{CE} = -1V				
		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	–
		for **BC 160-161** Gr. 16	100	160	250	–

ELECTRICAL CHARACTERISTICS (continued)

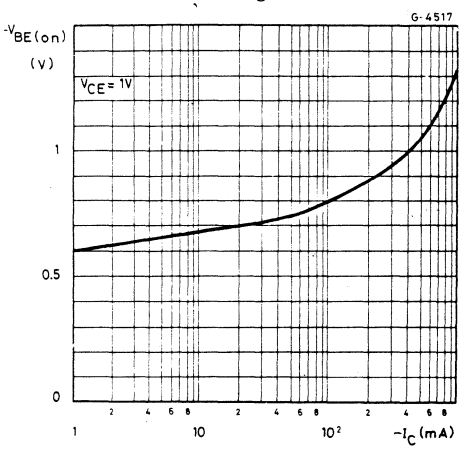
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C = -1A V_{CE} = -1V for **BC 160-161** for **BC 160-161** Gr. 6 for **BC 160-161** Gr. 10 for **BC 160-161** Gr. 16		 26 15 20 30		 – – – –
f_T	Transition frequency	I_C = -50 mA V_{CE} = -10V	50			MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -20V f = 1 MHz		15	30	pF
C_{EBO}	Emitter-base capacitance	V_{EB} = -0.5V f = 1 MHz			180	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%.

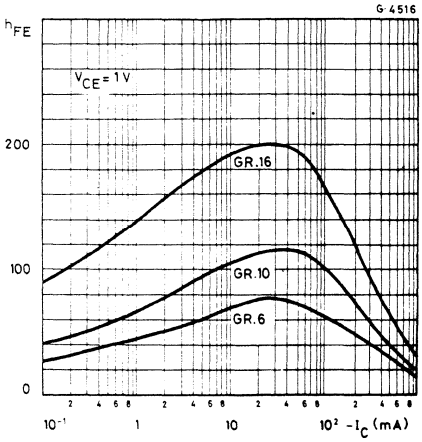
Collector-emitter saturation voltage



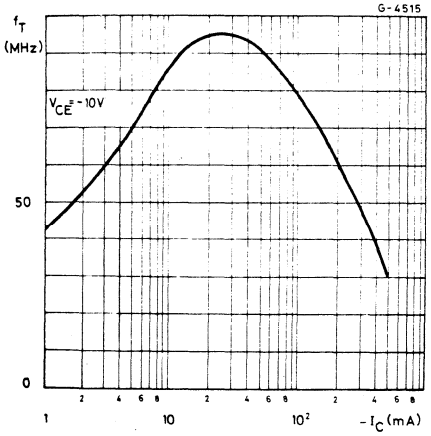
Base-emitter voltage



DC current gain



Transition frequency



BC 177
BC 178
BC 179

EPITAXIAL 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.

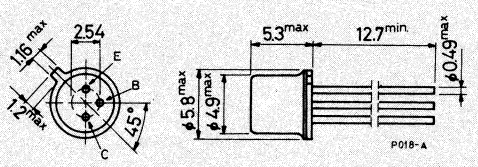
ABSOLUTE MAXIMUM RATINGS

		BC 177	BC 178	BC 179
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-50 V	-30 V	-25 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_C	Collector current		-100 mA	
I_{CM}	Collector peak current		-200 mA	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$		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)

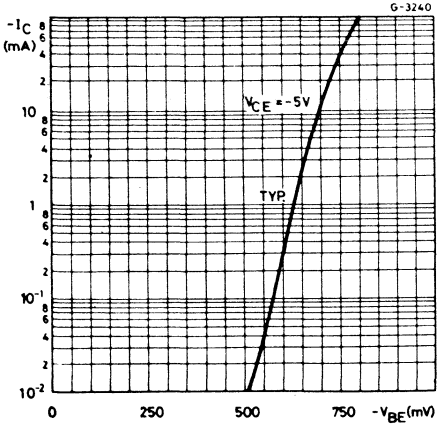
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -20V		-1	-100	nA
		V_{CE} = -20V T_{amb} = 150°C			-10	μA
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -2 mA for **BC 177**	-45			V
		for **BC 178**	-25			V
		for **BC 179**	-20			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	-550	-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}	Small signal current gain	I_C = -2 mA V_{CE} = -5V, f = 1 kHz				
		for **BC 177** Gr. A	125		260	–
		for **BC 177** Gr. B	240		500	–
		for **BC 178** Gr. A	125		260	–
		for **BC 178** Gr. B	240		500	–
		for **BC 179** Gr. B	240		500	–

ELECTRICAL CHARACTERISTICS (continued)

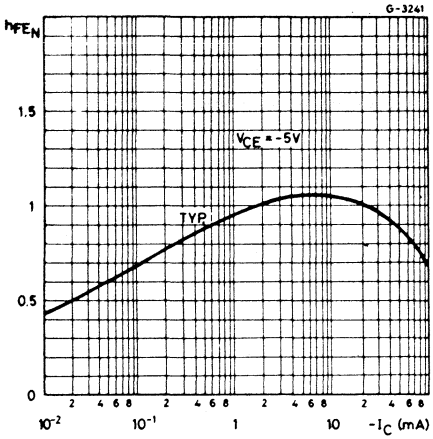
Parameter		Test conditions		Min.	Typ.	Max.	Unit
f_T	Transition frequency	I_C = -10 mA f = 100 MHz	V_{CE} = -5V		200		MHz
C_{CBO}	Collector-base capacitance	I_E = 0	V_{CB} = -10V		5.0		pF
NF	Noise figure	I_C = -0.2 mA R_g = 2 kΩ B = 200 Hz	V_{CE} = -5V f = 1 kHz				
			for **BC 177**		2	10	dB
			for **BC 178**		2	10	dB
			for **BC 179**		1.2	4	dB
h_{ie}	Input impedance	I_C = -2 mA f = 1 kHz	V_{CE} = -5V				
			for **BC 177** Gr. A		2.7		kΩ
			for **BC 177** Gr. B		5.2		kΩ
			for **BC 178** Gr. A		2.7		kΩ
			for **BC 178** Gr. B		5.2		kΩ
			for **BC 179** Gr. B		5.2		kΩ
h_{re}	Reverse voltage ratio	I_C = -2 mA f = 1 kHz	V_{CE} = -5V				
			for **BC 177** Gr. A		$2.7 \cdot 10^{-4}$		—
			for **BC 177** Gr. B		$4.5 \cdot 10^{-4}$		—
			for **BC 178** Gr. A		$2.7 \cdot 10^{-4}$		—
			for **BC 178** Gr. B		$4.5 \cdot 10^{-4}$		—
			for **BC 179** Gr. B		$4.5 \cdot 10^{-4}$		—
h_{oe}	Output admittance	I_C = -2 mA f = 1 kHz	V_{CE} = -5V				
			for **BC 177** Gr. A		25		μS
			for **BC 177** Gr. B		35		μS
			for **BC 178** Gr. A		25		μS
			for **BC 178** Gr. B		35		μS
			for **BC 179** Gr. B		35		μS

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

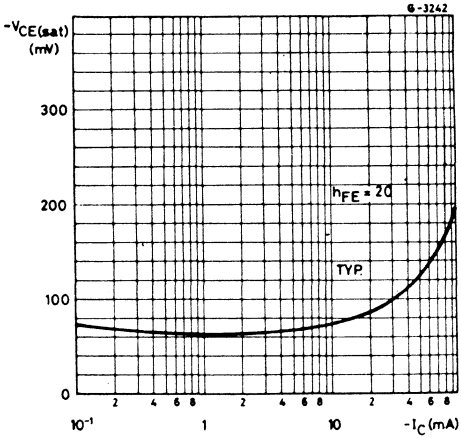
DC transconductance



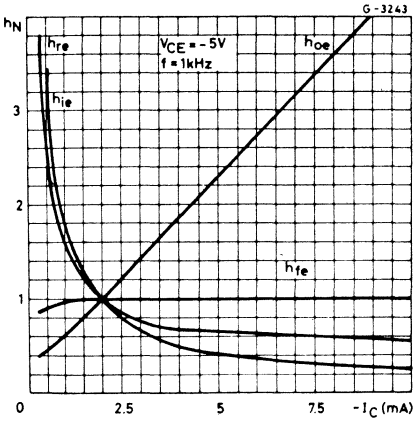
DC normalized current gain



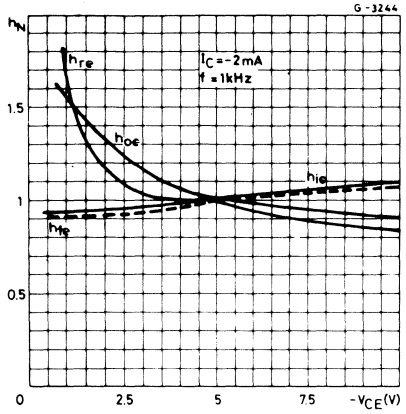
Collector-emitter saturation voltage



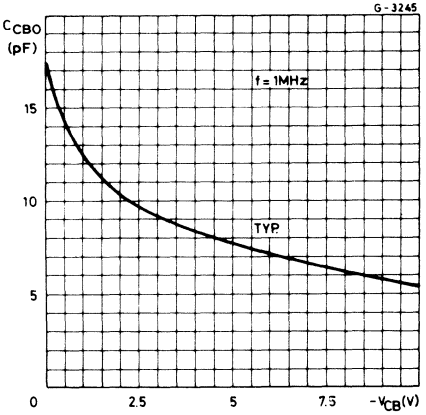
Normalized h parameters



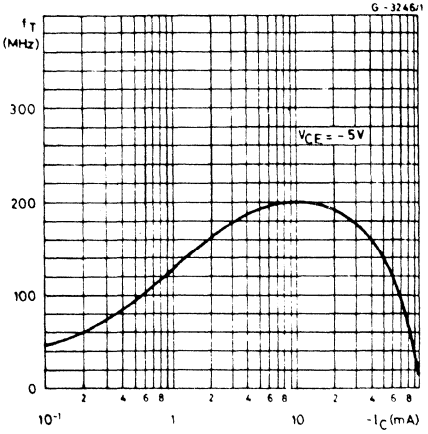
Normalized h parameters



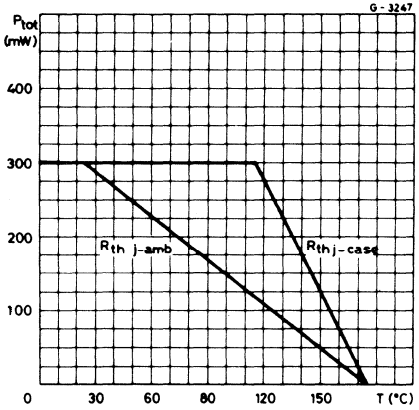
Collector-base capacitance



Transition frequency



Power rating chart



EPITAXIAL PLANAR NPN

BC 286

AUDIO AMPLIFIER

The BC286 is a silicon planar epitaxial NPN transistor in TO-39 metal case. It is mainly intended for use as audio amplifier.
The complementary PNP type is the BC287.

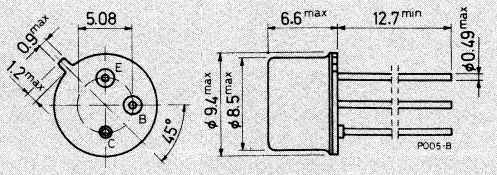
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	70	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	1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.75	W
	at $T_{case} \leqslant 25°C$	4	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	37	°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_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 30V				20	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA		70			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30 mA		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 = 500 mA I_C = 1A	I_B = 50 mA I_B = 0.1A		0.4 0.7	 1	V V
V_{BE} *	Base-emitter voltage	I_C = 500 mA	V_{CE} = 2V		1		V
h_{FE} *	DC current gain	I_C = 100 mA I_C = 500 mA	V_{CE} = 2V V_{CE} = 2V	 20	90 60		– –
f_T	Transition frequency	I_C = 50 mA f = 100 MHz	V_{CE} = 5V		 100		 MHz
C_{CBO}	Collector-base capacitance	I_E = 0 f = 1 MHz	V_{CB} = 10V		12		pF

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

EPITAXIAL PLANAR PNP

BC 287

AUDIO AMPLIFIER

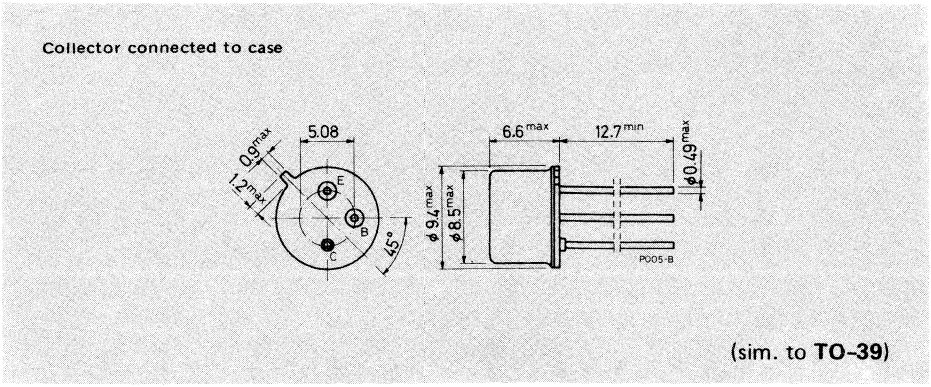
The BC287 is a silicon planar epitaxial PNP transistor in TO-39 metal case. It is particularly intended for use as audio amplifier.
The complementary NPN type is the BC286.

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	-1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.75	W
	at $T_{case} \leqslant 25°C$	4	W
T_{stg}, T_j	Storage and junction temperature	-55 to 175	°C

MECHANICAL DATA

Dimensions in mm



THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	37	°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_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -30V		0.1	50	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	-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 = -50 mA I_C = -1 A I_B = 0.1A		-0.25 -0.7	 -1	V V
V_{BE}*	Base-emitter voltage	I_C = -500 mA V_{CE} = -2V		-0.93		V
h_{FE}*	DC current gain	I_C = -100 mA V_{CE} = -2V I_C = -500 mA V_{CE} = -2V	 20	90 60		– –
f_T	Transition frequency	I_C = -50 mA V_{CE} = -5V f = 100 MHz		150		MHz
C_{CBO}	Collector-base capacitance (I_E = 0)	V_{CB} = -10V f = 1 MHz		13		pF

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

EPITAXIAL PLANAR PNP

BC 297
BC 298

AUDIO DRIVERS

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.

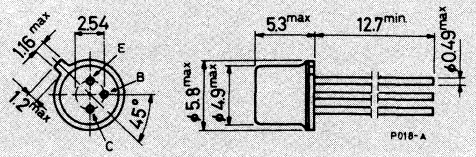
ABSOLUTE MAXIMUM RATINGS

		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_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**)

THERMAL DATA

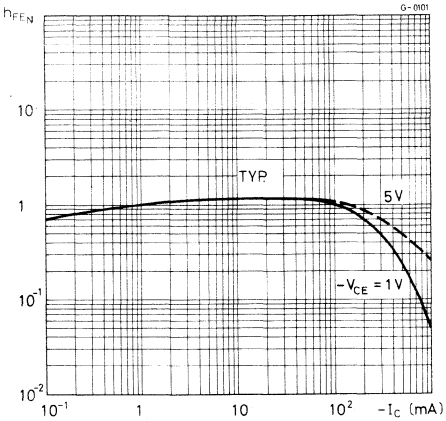
$R_{th\ j-case}$	Thermal resistance junction-case	max	100	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	400	°C/W

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

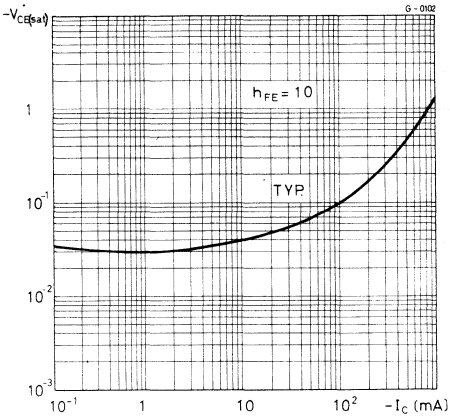
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **BC 297** V_{CE} = -50 V for **BC 298** V_{CE} = -30 V			-100 -100	nA nA
$V_{(BR)\ CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -10 mA for **BC 297** for **BC 298**	-45 -25			V V
$V_{(BR)\ EBO}$	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. 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	75 100 30		260 260	— — —
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

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

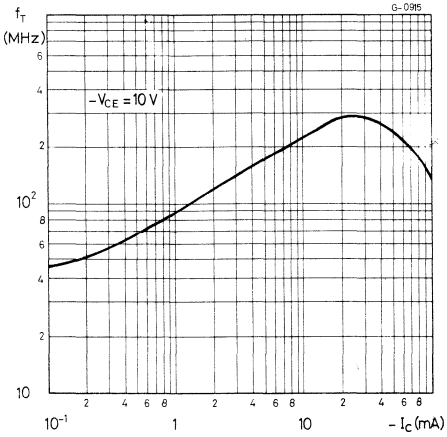
DC normalized current gain



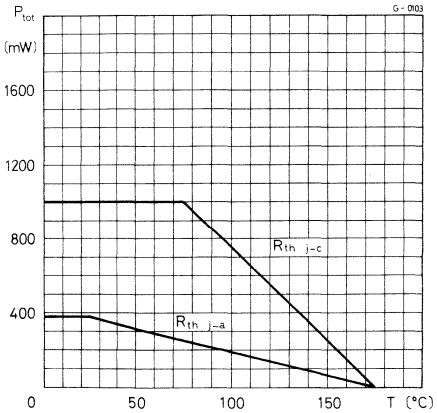
Collector-emitter saturation voltage



Transition frequency



Power rating chart



BC 300
BC 301
BC 302

EPITAXIAL 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.

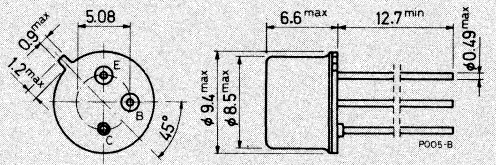
ABSOLUTE MAXIMUM RATINGS

		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_{EBO}	Emitter-base voltage ($I_C = 0$)	7 V		
I_C	Collector current	0.5 A		
I_{CM}	Collector peak current	1 A		
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.85 W		
	at $T_{case} \leqslant 25°C$	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

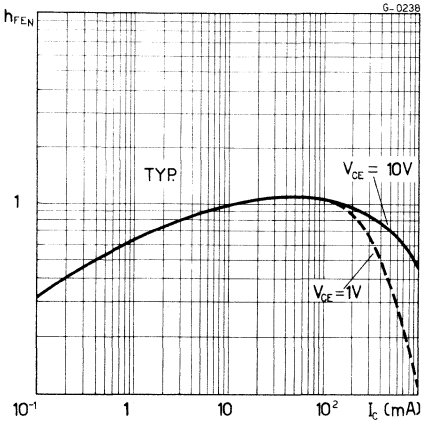
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	25	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	175	°C/W

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

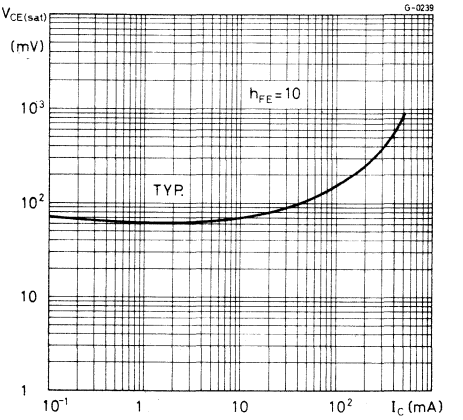
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 60V			5	20	nA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V				10	nA
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30 mA	for **BC 300**	80			V
			for **BC 301**	60			V
			for **BC 302**	45			V
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	for **BC 300**	120			V
			for **BC 301**	90			V
			for **BC 302**	60			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} = 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		100		MHz
C_{CBO}	Collector-base capacitance	I_E = 0	V_{CB} = 10V		12		pF
h_{ie}	Input impedance	I_C = 5 mA, f = 1 kHz	V_{CE} = 10V		1.1		kΩ
h_{re}	Reverse voltage ratio	I_C = 5 mA, f = 1 kHz	V_{CE} = 10V		1.7×10^{-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		14		μS

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

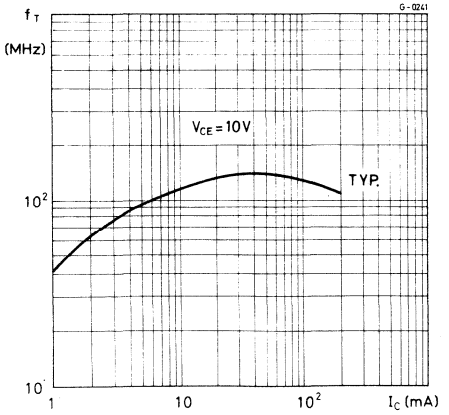
DC normalized current gain



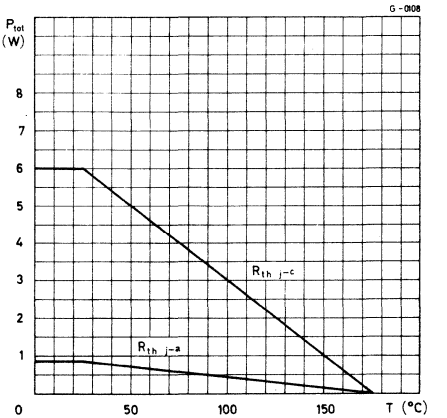
Collector-emitter saturation voltage



Transition frequency



Power rating chart



EPITAXIAL PLANAR PNP

BC 303
BC 304

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.

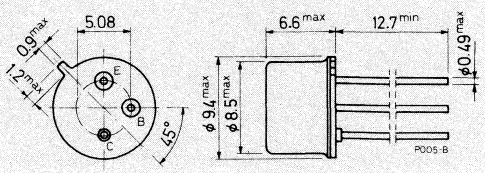
ABSOLUTE MAXIMUM RATINGS

		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_{EBO}	Emitter-base voltage ($I_C = 0$)	-6 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

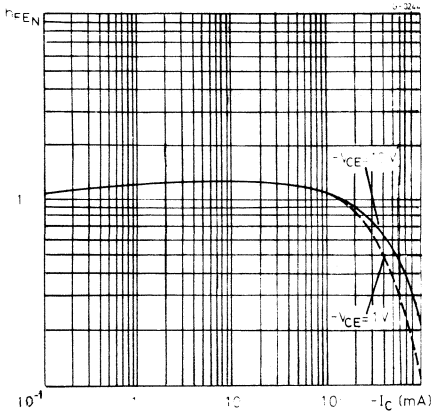
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	25	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	175	°C/W

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

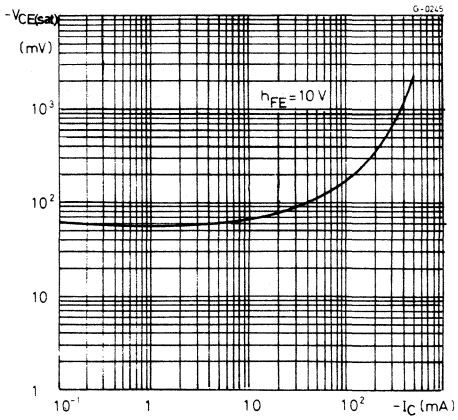
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -60V			-5	-20	nA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -5V				-20	nA
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = -10 mA	for **BC 303**	-60			V
			for **BC 304**	-45			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 = -50 mA, f = 100 MHz	V_{CE} = -10V		100		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%

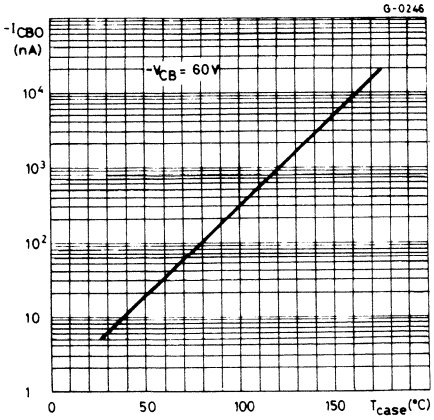
DC normalized current gain



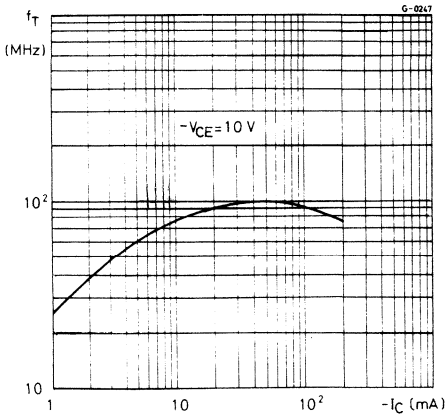
Collector-emitter saturation voltage



Collector cutoff current



Transition frequency



BC 377
BC 378

EPITAXIAL PLANAR NPN

AUDIO DRIVERS

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.

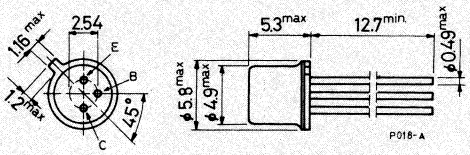
ABSOLUTE MAXIMUM RATINGS

		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_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**)

THERMAL DATA

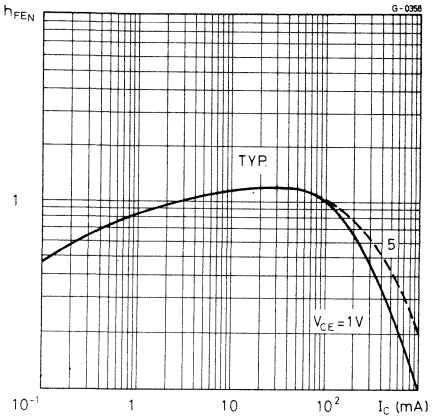
$R_{th\ j-case}$	Thermal resistance junction-case	max	100	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	400	°C/W

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

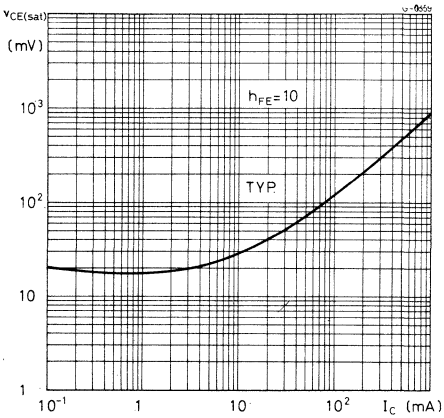
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **BC 377** V_{CE} = 50 V for **BC 378** V_{CE} = 30 V			15 15	nA nA
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA	6			V
$V_{(BR)\ CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	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	I_C = 100 mA V_{CE} = 1 V Gr. 7 I_C = 100 mA V_{CE} = 1 V I_C = 300 mA V_{CE} = 1 V	75 125 35		260 260 	— — —
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10 V		100		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10 V		10		pF
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5 V		30		pF

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

DC normalized current gain



Collector-emitter saturation voltage



EPITAXIAL PLANAR PNP

BC 393

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.

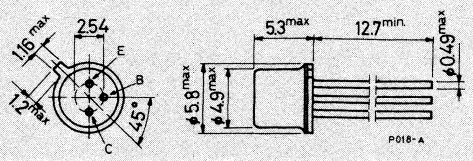
ABSOLUTE MAXIMUM RATINGS

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

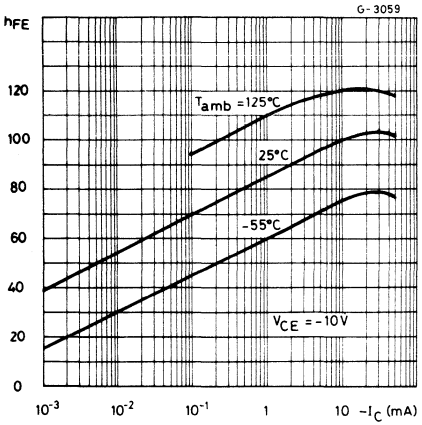
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	440	°C/W

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

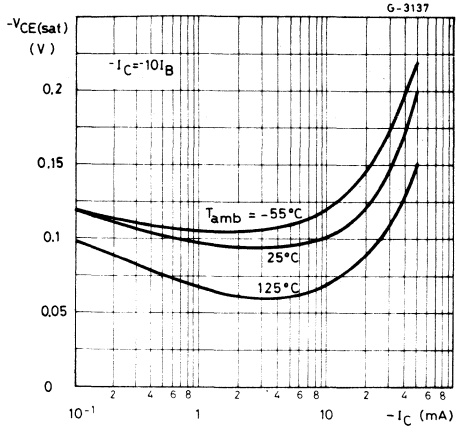
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -100V V_{CB} = -100V T_{amb} = 150 °C			50 50	nA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA	-180			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -2 mA	-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 I_C = -50 mA I_B = -5 mA		-100 -230	-300	mV mV
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = -10 mA I_B = -1 mA I_C = -50 mA I_B = -5 mA		-750 -850	-900	mV mV
h_{FE}*	DC current gain	I_C = -1 mA V_{CE} = -10V I_C = -10 mA V_{CE} = -10V	 50	85 100		– –
f_T	Transition frequency	I_C = -10 mA V_{CE} = -10V	50	95		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%

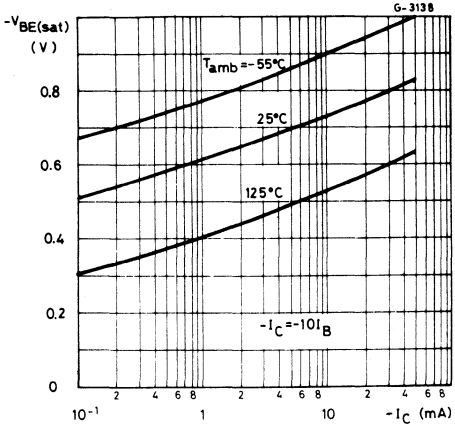
DC current gain



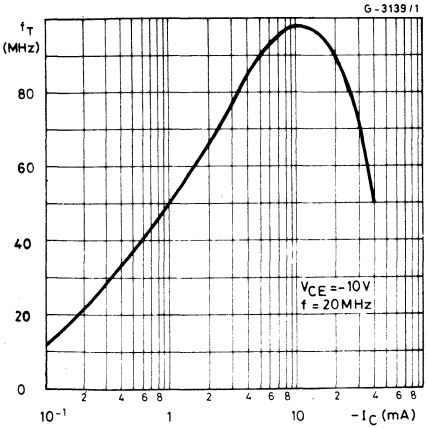
Collector-emitter saturation voltage



Base-emitter saturation voltage



Transition frequency



BC 394

EPITAXIAL 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.

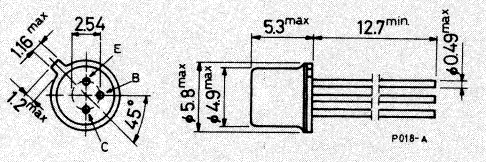
ABSOLUTE MAXIMUM RATINGS

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

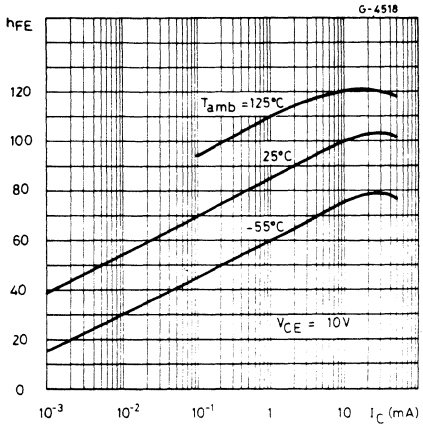
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	440	°C/W

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

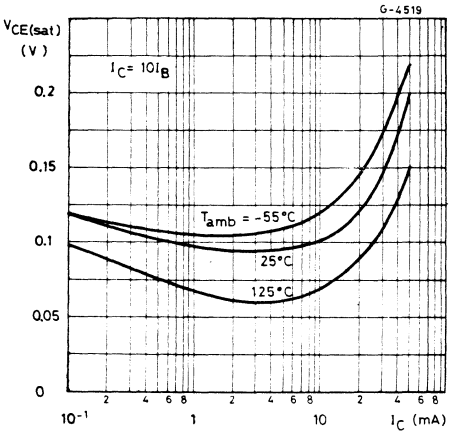
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 100V V_{CB} = 100V	 T_{amb} = 150 °C			50 50	nA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA		180			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA		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_C = 50 mA	I_B = 1 mA I_B = 5 mA		200 400	300	mV mV
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 10 mA I_C = 50 mA	I_B = 1 mA I_B = 5 mA		750 850	900	mV mV
h_{FE}*	DC current gain	I_C = 1 mA I_C = 10 mA	V_{CE} = 10V V_{CE} = 10V	 30	85 100		– –
f_T	Transition frequency	I_C = 10 mA	V_{CE} = 10V	50	95		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%

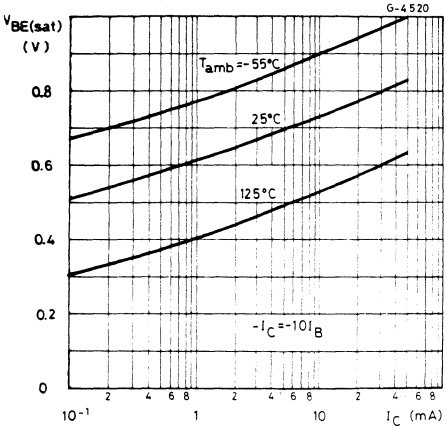
DC current gain



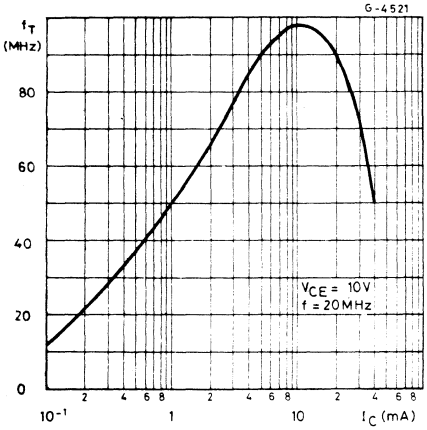
Collector-emitter saturation voltage



Base-emitter saturation voltage



Transition frequency



EPITAXIAL PLANAR NPN

BC 440
BC 441

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.

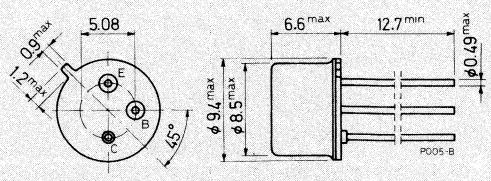
ABSOLUTE MAXIMUM RATINGS

		BC 440	BC 441
V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V	70 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	70 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V	
I_{CM}	Collector peak current	2 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

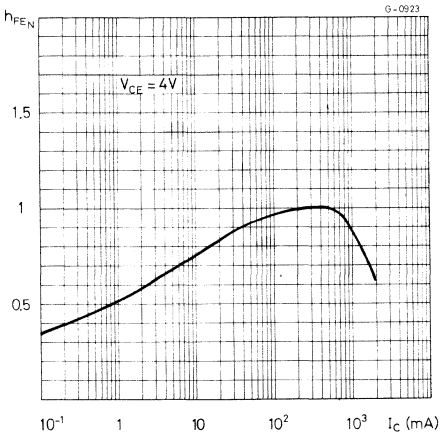
$R_{th\ j-case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

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

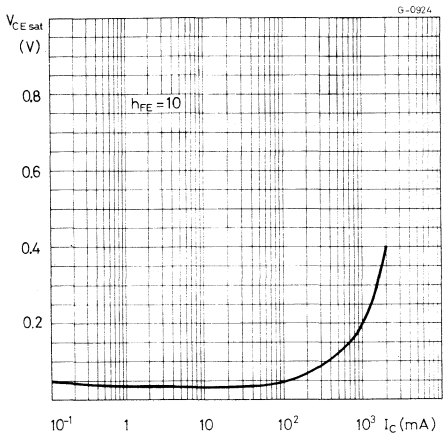
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 40 V			100	nA
I_{CER}	Collector cutoff current (R_{BE} = 100 Ω)	for **BC 440** V_{CE} = 50 V for **BC 441** V_{CE} = 70 V			10 10	μA μA
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA	5			V
$V_{(BR)\ CEO}$*	Collector-emitter breakdown 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			—
f_t	Transition frequency	I_C = 50 mA V_{CE} = 4 V	50			MHz

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

DC normalized current gain



Collector-emitter saturation voltage



BC 460
BC 461

EPITAXIAL PLANAR PNP

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.

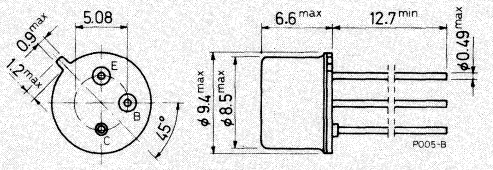
ABSOLUTE MAXIMUM RATINGS

		BC 460	BC 461
V_{CBO}	Collector-base voltage ($I_E = 0$)	-50 V	-70 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	-70 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V	
I_{CM}	Collector peak current	-2 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

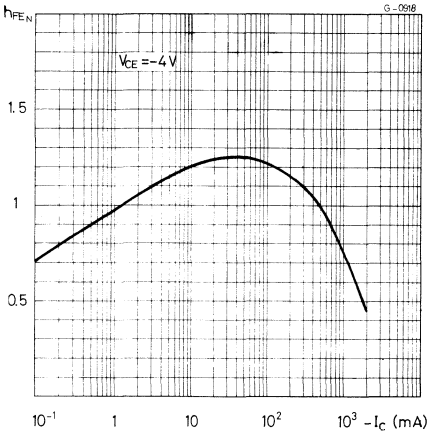
$R_{th\ j-case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

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

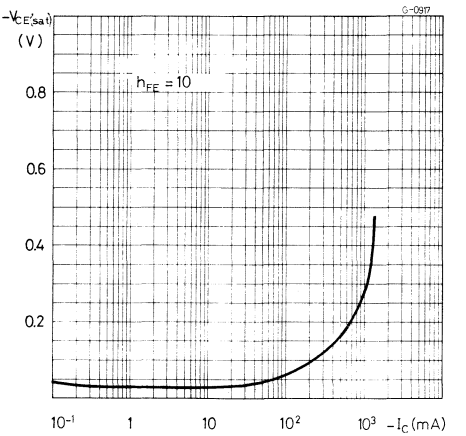
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -40 V			-100	nA
I_{CER}	Collector cutoff current (R_{BE} = 100 Ω)	for **BC 460** V_{CE} = -50 V for **BC 461** V_{CE} = -70 V			-10 -10	μA μA
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = -100 μA	-5			V
$V_{(BR)\ CEO}$*	Collector-emitter breakdown 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			—
f_T	Transition frequency	I_C = -50 mA V_{CE} = -4 V	50			MHz

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

DC normalized current gain



Collector-emitter saturation voltage



EPITAXIAL PLANAR PNP

BC 477
BC 478
BC 479

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.

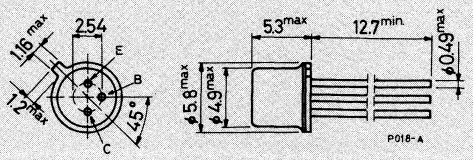
ABSOLUTE MAXIMUM RATINGS

		BC 477	BC 478	BC 479
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-90 V	-40 V	-40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-80 V	-40 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 $T_{amb} \leqslant 25°C$		0.36 W	
	at $T_{case} \leqslant 25°C$		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**)

6/81

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	485	°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} = -70V			-10	nA
		V_{CE} = -70V T_{amb} = 125°C			-10	μA
		for **BC 479, BC 478**				
		V_{CE} = -30V			-10	nA
		V_{CE} = -30V T_{amb} = 125°C			-10	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -4V			-10	nA
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10 μA				
		for **BC 477**	-90			V
		for **BC 478**	-40			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**	-40			V
		for **BC 479**	-40			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		-0.1	-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} = -5V	-0.55	-0.65	-0.75	V

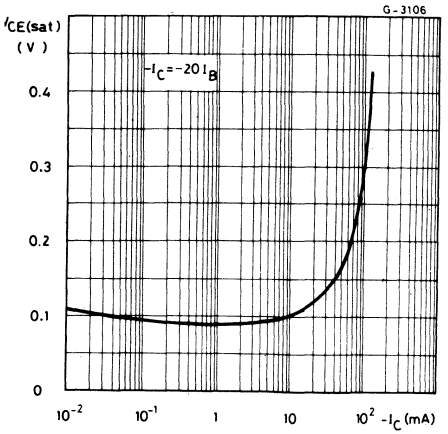
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
$V_{BE(sat)}$*	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} = -5V				
		for **BC 477**	30	115		–
		for **BC 478**	50	195		–
		for **BC 479**	100	290		–
		I_C = -2 mA V_{CE} = -5V				
		for **BC 477**	110		250	–
		for **BC 478**	110		450	–
		for **BC 479**	200			–
		I_C = -10 mA V_{CE} = -5V				
		for **BC 477**		160		–
		for **BC 478**		270		–
		for **BC 479**		350		–
h_{fe}	Small signal current gain	I_C = -2 mA V_{CE} = -5V f = 1 kHz				
		for **BC 477**	125		260	–
		for **BC 478**	125		500	–
		for **BC 479**	220			–
		I_C = -10 mA V_{CE} = -5V f = 20 MHz		7.5		–
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -5V		4	6	pF
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -0.5V		11	15	pF
NF	Noise figure	I_C = -20 μA V_{CE} = -5V R_g = 10 kΩ f = 10 Hz to 10 kHz B = 15.7 kHz for **BC 479**		0.8	3.5	dB

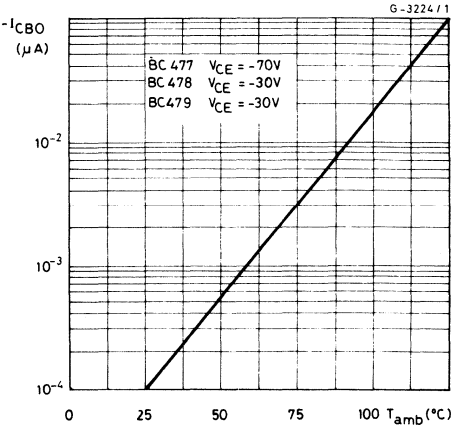
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
NF	Noise figure	I_C = -200 μA V_{CE} = -5V 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} = -5V R_g = 10 kΩ f = 1 kHz B = 200 Hz				
		for **BC 479**		0.5	2.5	dB
		I_C = -200μA V_{CE} = -5V 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

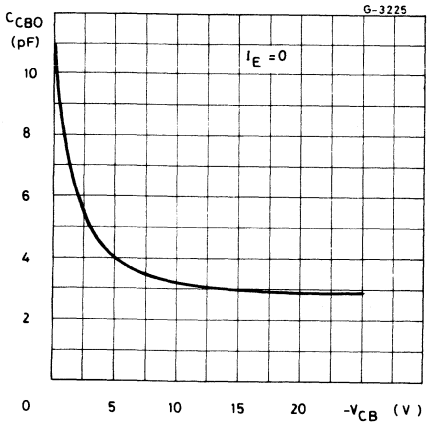
Collector-emitter saturation voltage



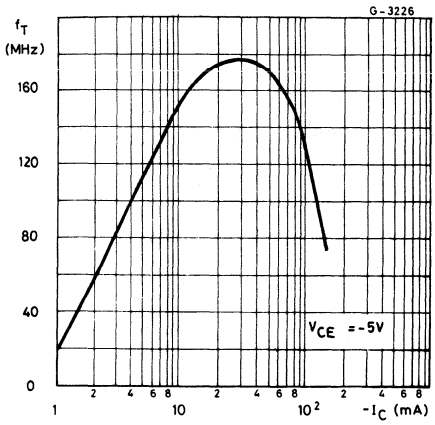
Collector cutoff current



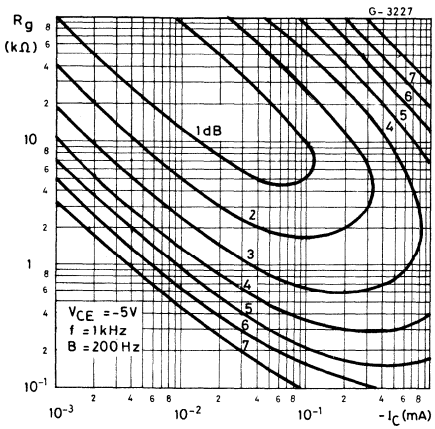
Collector-base capacitance



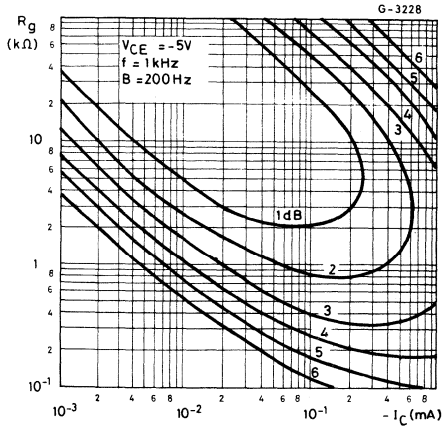
Transition frequency



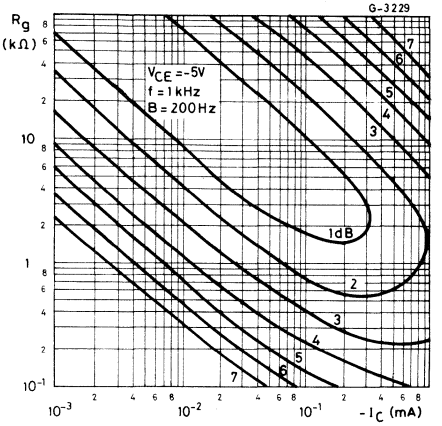
Noise figure (for **BC 477** only)



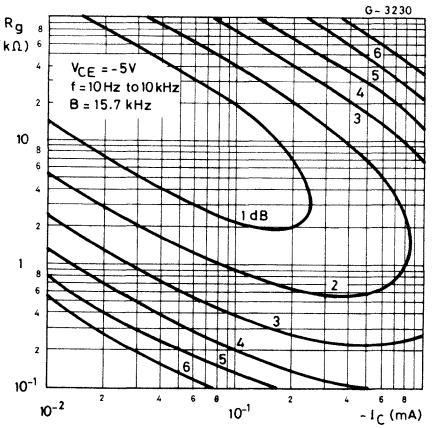
Noise figure (for **BC 478** only)



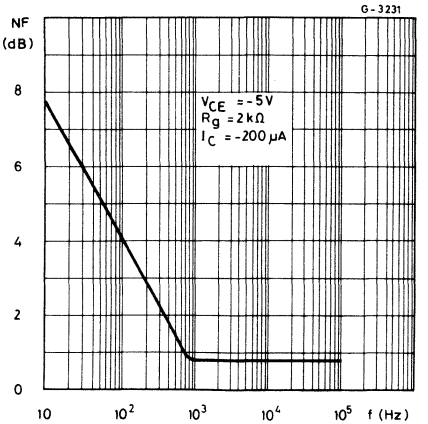
Noise figure (for **BC 479** only)



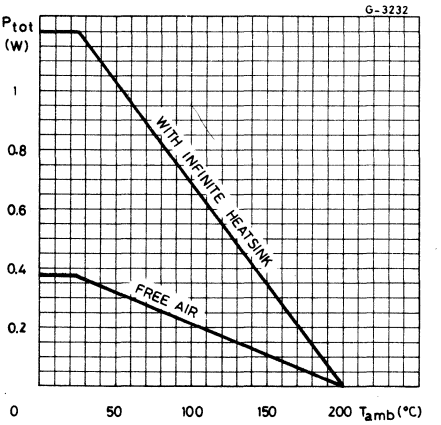
Noise figure (for **BC 479** only)



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



Power rating chart



EPITAXIAL 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.

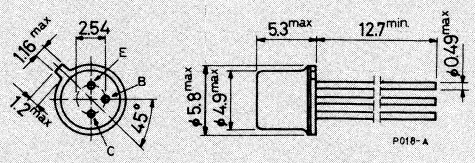
ABSOLUTE MAXIMUM RATINGS

		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 $T_{amb} \leqslant 25°C$	0.39 W	
	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**)

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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	450	°C/W

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

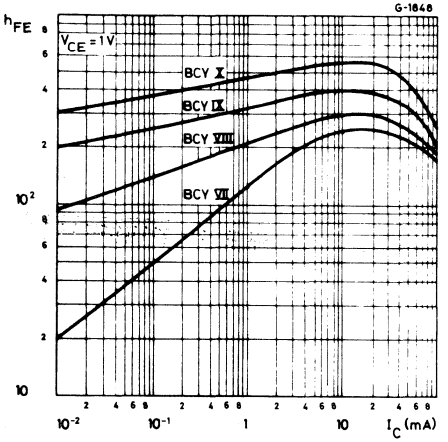
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **BCY58**				
		V_{CE} = 32V		0.1	10	nA
		V_{CE} = 32 V T_{amb} = 150°C		0.1	10	μA
		for **BCY59**				
		V_{CE} = 45V		0.1	10	nA
		V_{CE} = 45V T_{amb} = 150°C		0.1	10	μA
I_{CEX}	Collector cutoff current (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)

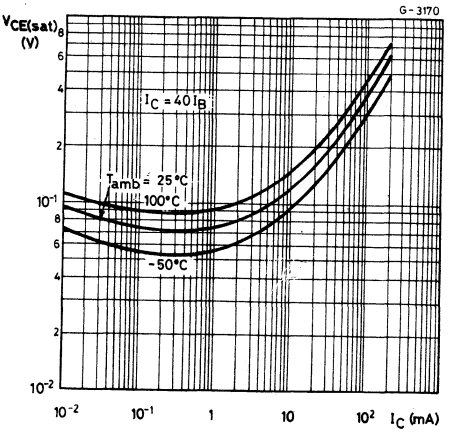
Parameter		Test conditions		Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C = 10 μA	V_{CE} = 5V		195		–
			Gr. VII		100		–
			Gr. VIII	20	140		–
			Gr. IX	40	195		–
			Gr. X	100	280		–
		I_C = 2 mA	V_{CE} = 5V	120	350	630	–
			Gr. VII	120	170	220	–
			Gr. VIII	180	250	310	–
			Gr. IX	250	350	460	–
			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 kΩ	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%

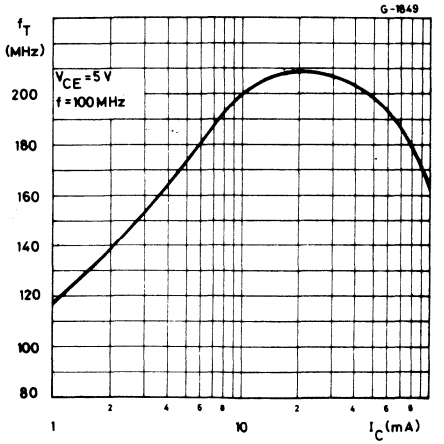
DC current gain



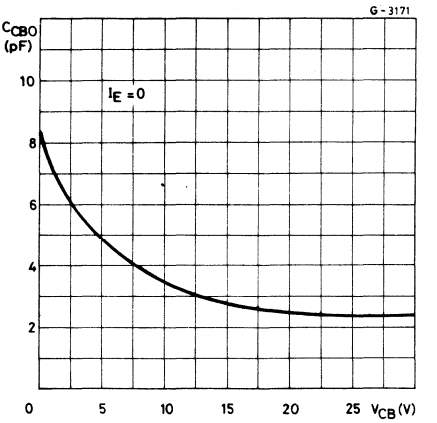
Collector-emitter saturation voltage



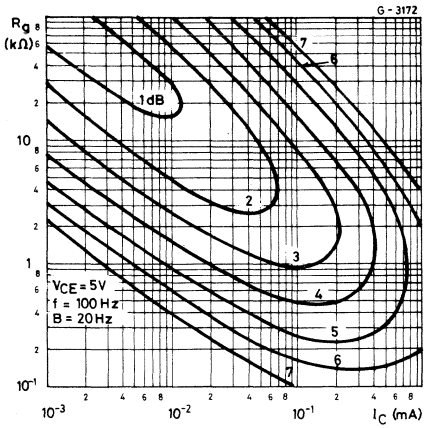
Transition frequency



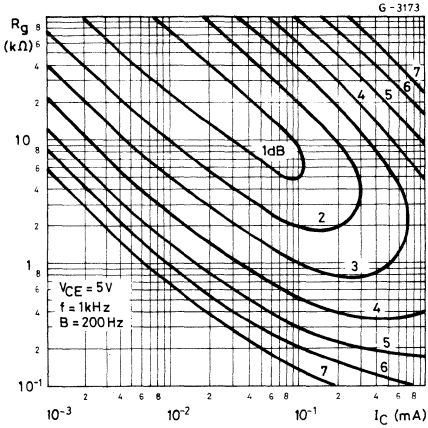
Collector-base capacitance



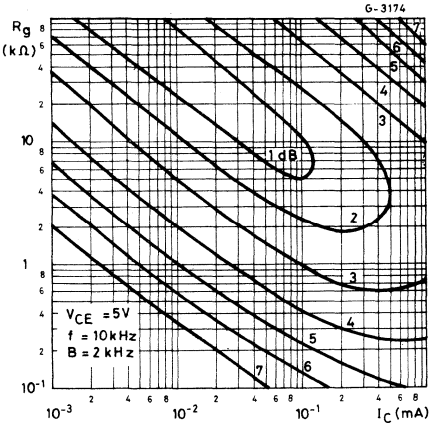
Noise figure (f= 100 Hz)



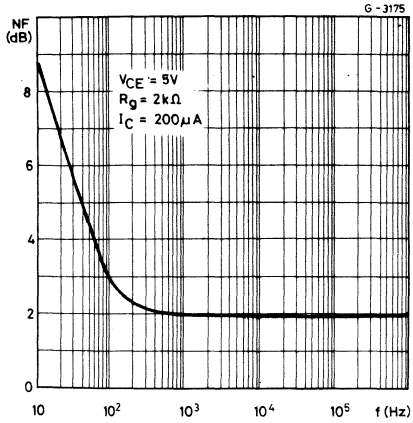
Noise figure (f = 1 kHz)



Noise figure (f = 10 kHz)



Noise figure vs. frequency



BCY 70
BCY 71
BCY 72

EPITAXIAL 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.

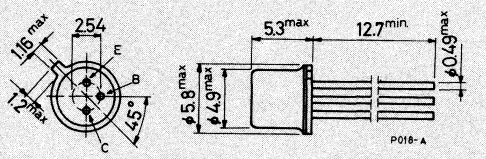
ABSOLUTE MAXIMUM RATINGS

		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_{CES}	Collector cutoff current (V_{BE} = 0)	for **BCY 70**				
		V_{CE} = -20V			-10	nA
		V_{CE} = -50V			-500	nA
		for **BCY 71**				
		V_{CB} = -20V			-100	nA
		V_{CB} = -45V			-10	μA
		for **BCY 72**				
		V_{CB} = -20V			-100	nA
		V_{CB} = -25V			-10	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -5V			-10	μA
$V_{CE(sat)}$*	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)

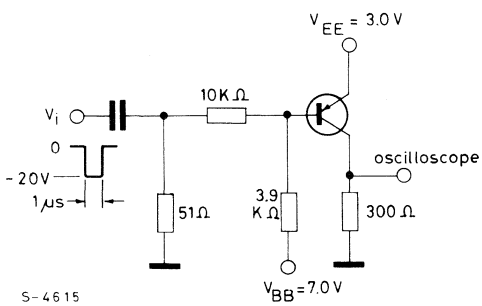
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	for **BCY 70**				
		I_C = -0.1 mA V_{CE} = -1V	40			–
		I_C = -1 mA V_{CE} = -1V	45			–
		I_C = -10 mA V_{CE} = -1V	50			–
		I_C = -50 mA V_{CE} = -1V	15			–
		for **BCY 71**				
		I_C = -0.01mA V_{CE} = -1V		60		–
		I_C = -0.1 mA V_{CE} = -1V	80			–
		I_C = -1 mA V_{CE} = -1V	90			–
		I_C = -10 mA V_{CE} = -1V	100		600	–
		I_C = -50 mA V_{CE} = -1V	15			
		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			20×10^{-4}	–

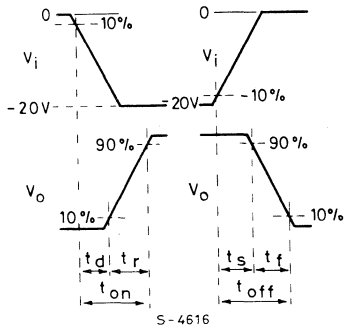
ELECTRICAL CHARACTERISTICS (continued)

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_{EE} = 3V I_{B1} = -1 mA		23	35	ns
t_r	Rise time (for **BCY 70** and **BCY 72** only)	I_C = -10 mA V_{EE} = 3V I_{B1} = -1 mA		25	35	ns
t_s	Storage time (for **BCY 70** and **BCY 72** only)	I_C = -10 mA V_{EE} = 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_{EE} = 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_{EE} = 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_{EE} = 3V I_{B1} = $-I_{B2}$ = -1 mA		320	420	ns

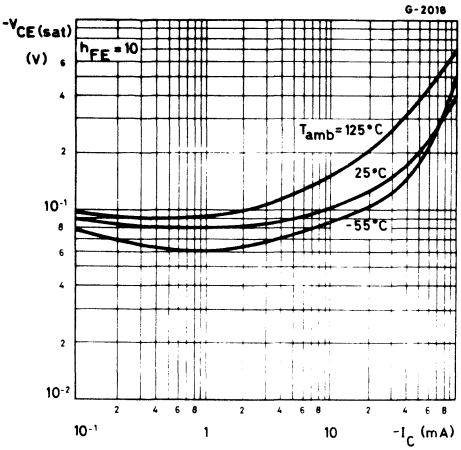
*Pulsed: pulse duration = 300 μs, duty cycle = 1%

Test circuit for switching times

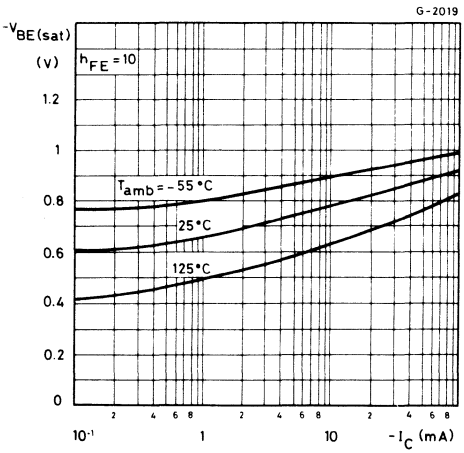




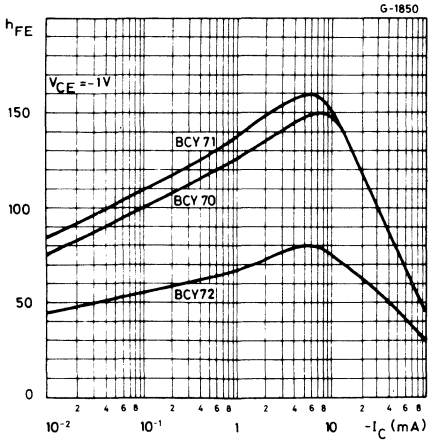
Collector-emitter saturation voltage



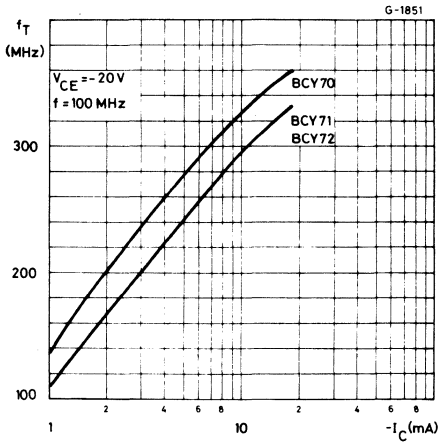
Base-emitter saturation voltage



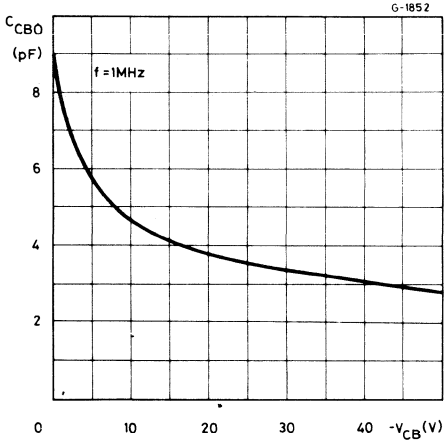
DC current gain



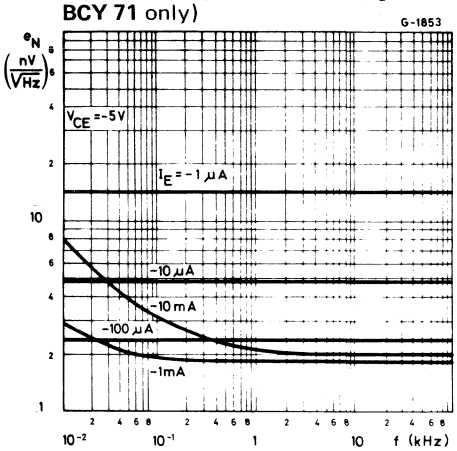
Transition frequency



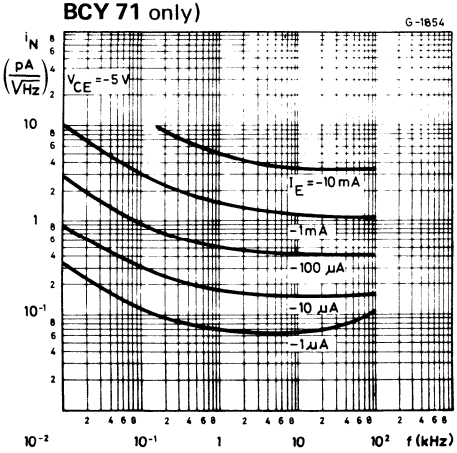
Collector-base capacitance



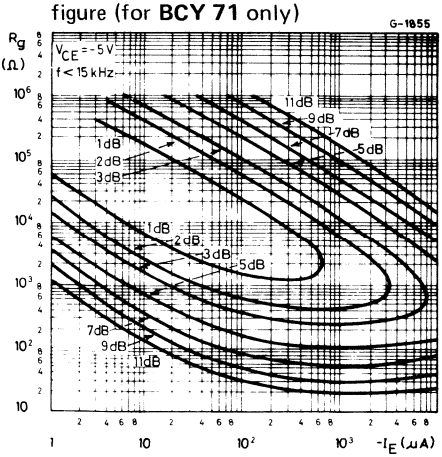
Equivalent input noise voltage (for **BCY 71** only)



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



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



BCY 78
BCY 79

EPITAXIAL 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.

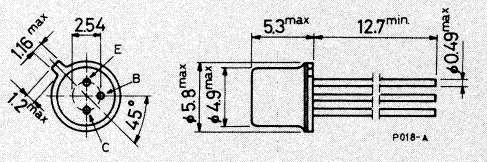
ABSOLUTE MAXIMUM RATINGS

		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

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

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)

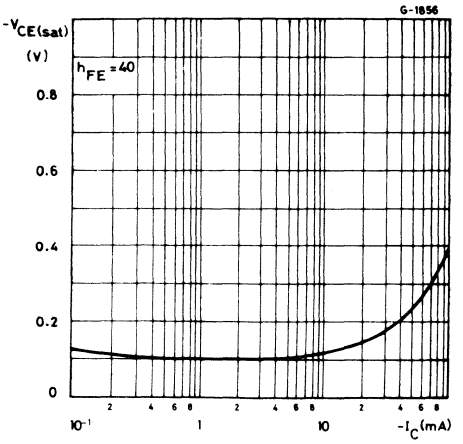
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = -0.5V$ f = 1 MHz		11	15	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -10V$ f = 1 MHz		4.5	7	pF
NF	Noise figure	$I_C = -0.2$ mA $V_{CE} = -5V$ $R_g = 2$ kΩ f = 1 kHz		2	6	dB
h_{ie}	Input impedance	$I_C = -2$ 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)

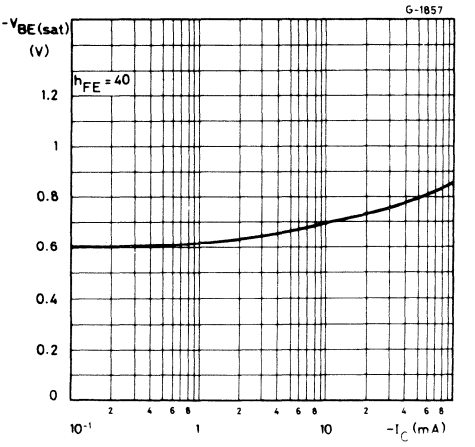
Parameter		Test conditions	Min.	Typ.	Max.	Unit
t_f	Fall time	$I_C = -10$ mA $V_{CC} = -10$V $I_{B1} = -I_{B2} = -1$ mA $I_C = -100$ mA $V_{CC} = -10$V $I_{B1} = -I_{B2} = -10$ mA		80 200		ns ns
t_{on}	Turn-on time	$I_C = -10$ mA $V_{CC} = -10$V $I_{B1} = -1$ mA $I_C = -100$ mA $V_{CC} = -10$ V $I_{B1}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

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

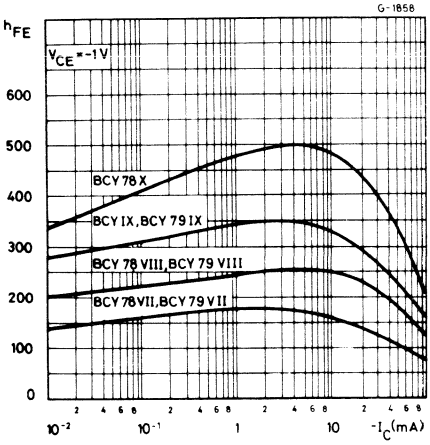
Collector-emitter saturation voltage



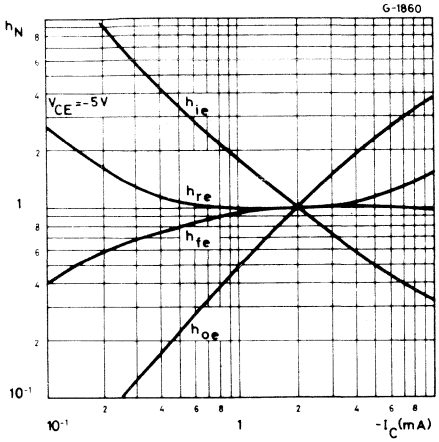
Base-emitter saturation voltage



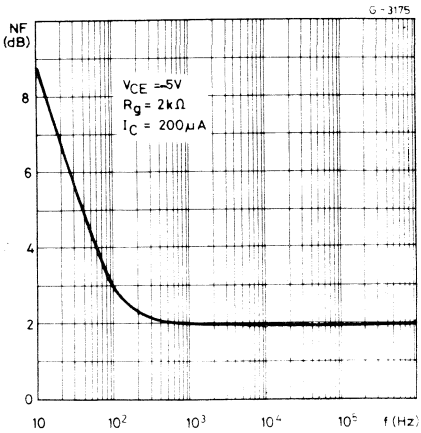
DC current gain



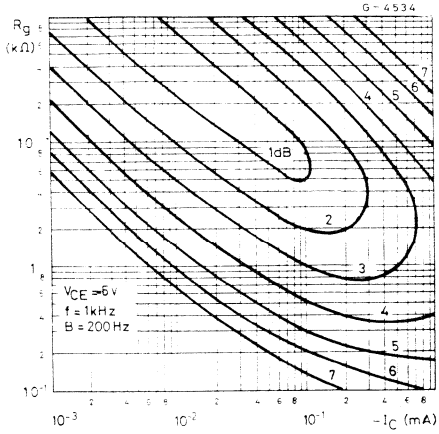
Normalized h parameters



Noise figure vs. frequency



Noise figure (f = 1 kHz)



BF 257
BF 258
BF 259

EPITAXIAL 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.

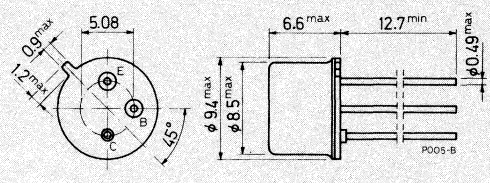
ABSOLUTE MAXIMUM RATINGS

		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

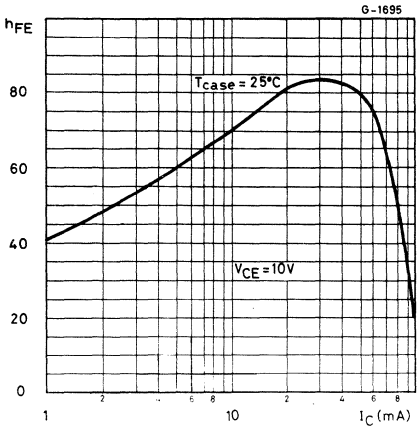
$R_{th\ j-case}$	Thermal resistance junction-case	max	30	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

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

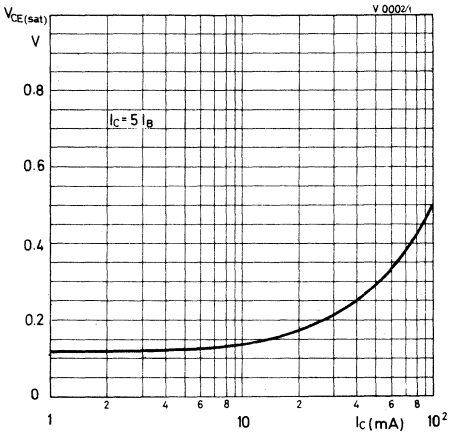
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **BF 257** $V_{CB} = 100$ V			50	nA
		for **BF 258** $V_{CB} = 200$ V			50	nA
		for **BF 259** $V_{CB} = 250$ V			50	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu A$ for **BF 257**	160			V
		for **BF 258**	250			V
		for **BF 259**	300			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10$ mA for **BF 257**	160			V
		for **BF 258**	250			V
		for **BF 259**	300			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu A$	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_{rb}	Reverse capacitance	$I_C = 0$ $V_{CE} = 30$ V, f = 1 MHz			3	pF

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

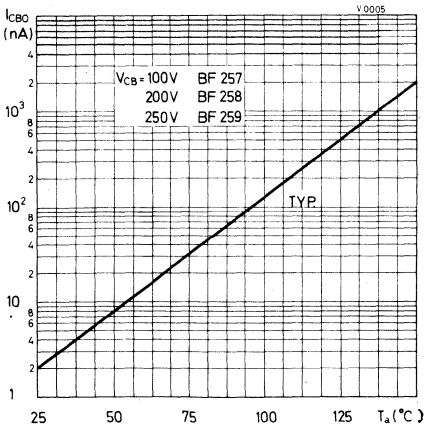
DC current gain



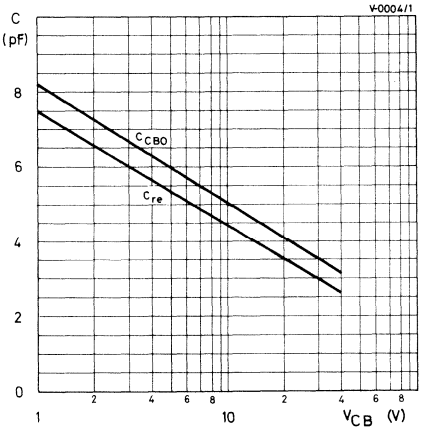
Collector-emitter saturation voltage



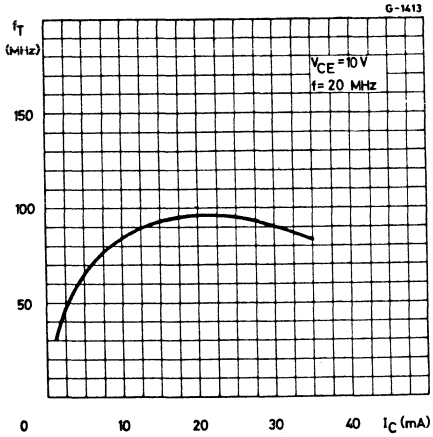
Collector cutoff current



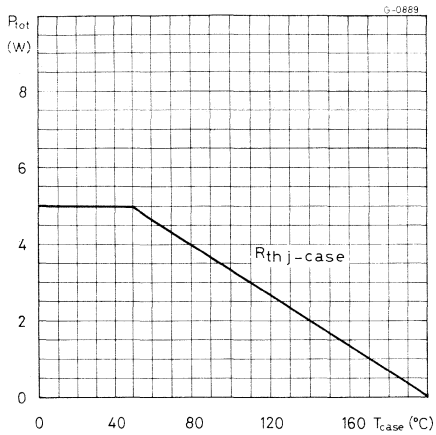
Collector-base capacitance



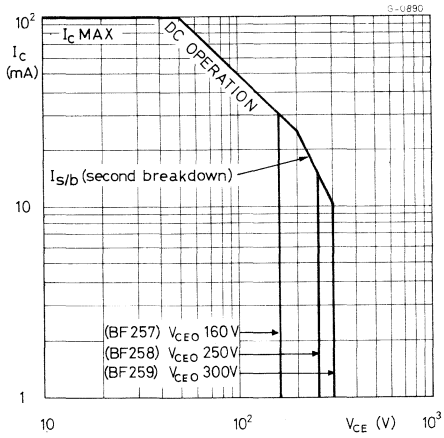
Transition frequency



Power rating chart



Safe operating area



BF 457
BF 458
BF 459

EPITAXIAL PLANAR NPN

HIGH VOLTAGE VIDEO AMPLIFIERS

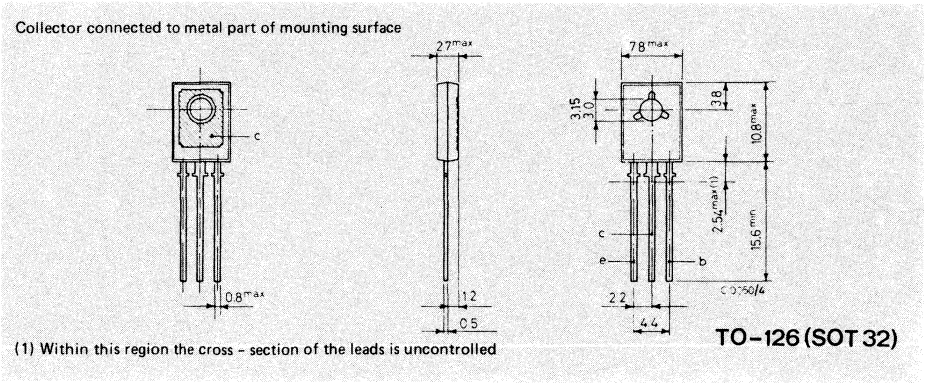
The BF 457, BF 458 and BF 459 are silicon planar epitaxial NPN transistors in Jedec TO-126 plastic package. They are particularly intended for use as video output stages in colour and black and white TV receivers, class A output stages and drivers for horizontal deflection circuits. These transistors 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 $T_{amb} \leqslant 25$ °C	1.25 W		
	$T_{case} \leqslant 25$ °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

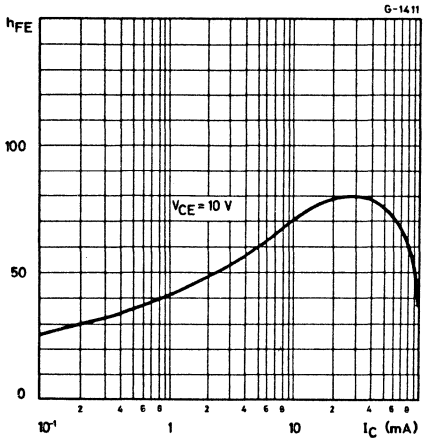
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	10	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	100	°C/W

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

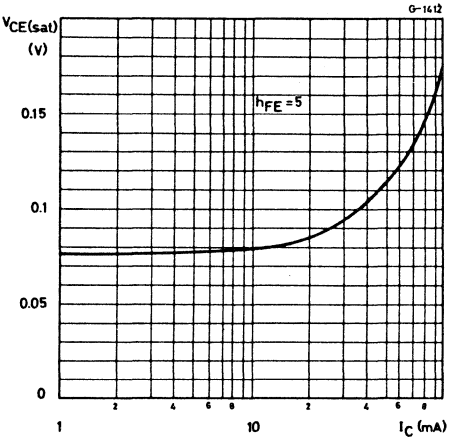
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **BF 457**	V_{CB} = 100V			50	nA
		for **BF 458**	V_{CB} = 200V			50	nA
		for **BF 459**	V_{CB} = 250V			50	nA
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = 10 mA					
			for **BF 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%

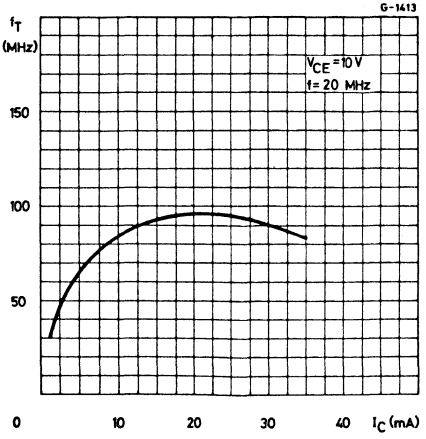
DC current gain



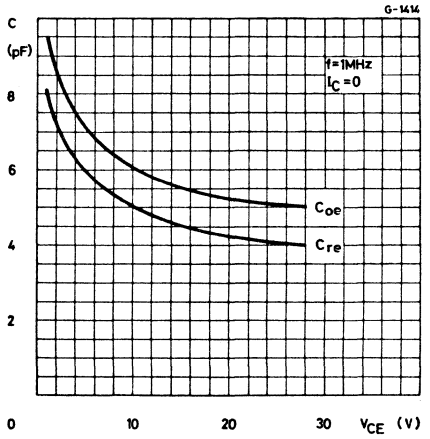
Collector-emitter saturation voltage



Transition frequency



Output and reverse capacitance



EPITAXIAL PLANAR NPN

BF 657
BF 658
BF 659

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).**

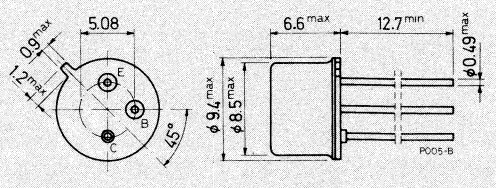
ABSOLUTE MAXIMUM RATINGS

		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**)

THERMAL DATA

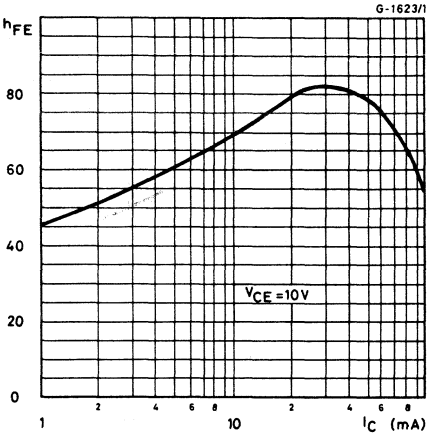
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	20	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	175	°C/W

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

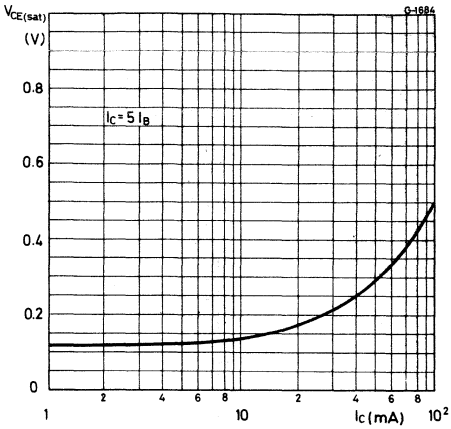
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	for **BF 657**	V_{CB} = 100V			50	nA
		for **BF 658**	V_{CB} = 200V			50	nA
		for **BF 659**	V_{CB} = 250V			50	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 100 μA					
			for **BF 657**	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%

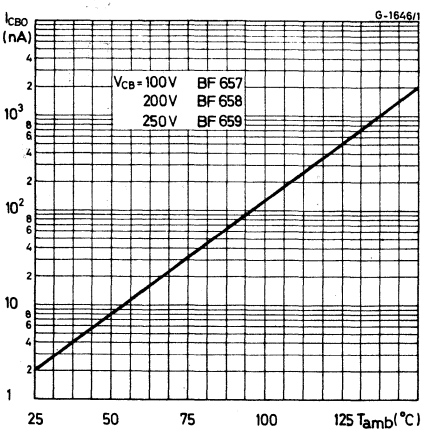
DC current gain



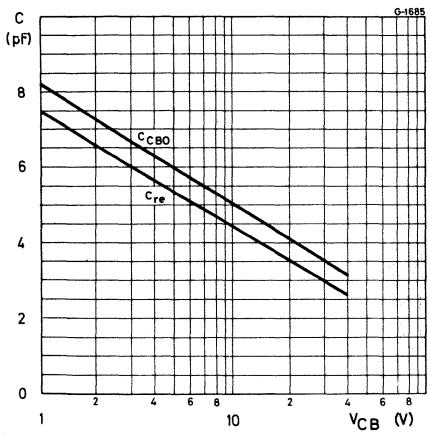
Collector-emitter saturation voltage



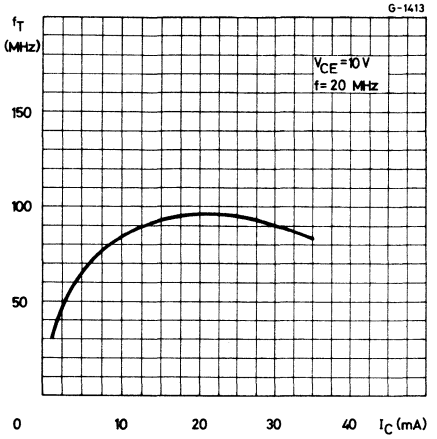
Collector cutoff current



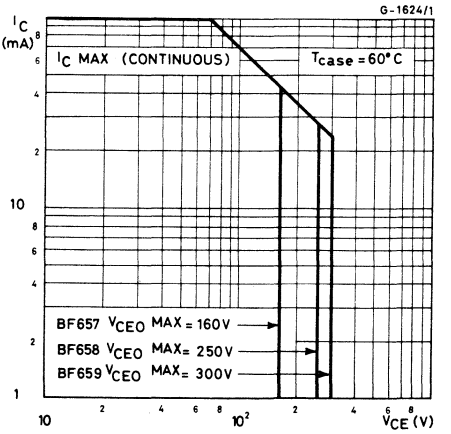
Collector-base and reverse capacitances



Transition frequency



Safe operating areas



EPITAXIAL 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.

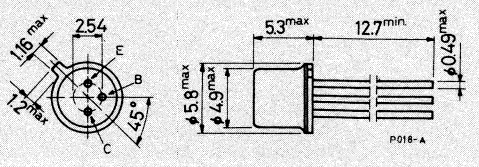
ABSOLUTE MAXIMUM RATINGS

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**)

THERMAL DATA

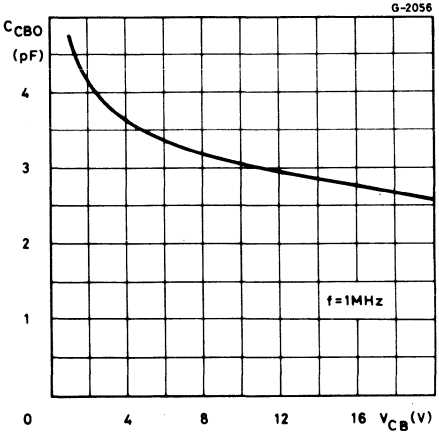
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

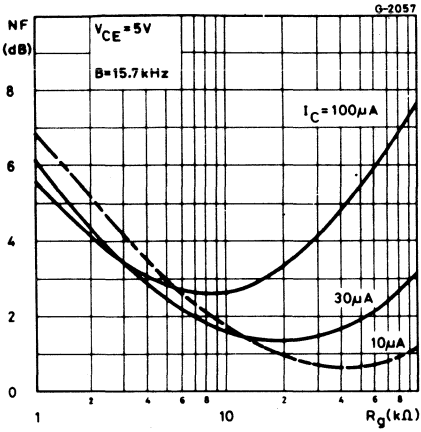
	Parameter	Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 50V V_{CE} = 50V	 T_{amb}=150°C		0.1 0.1	20 20	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			0.1	20	nA
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA		60			V
$V_{(BR)CES}$	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		 1.8 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%

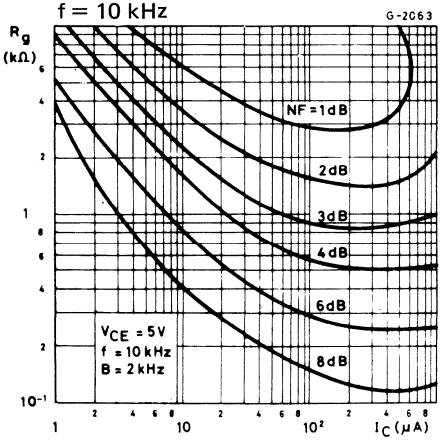
Collector-base capacitance



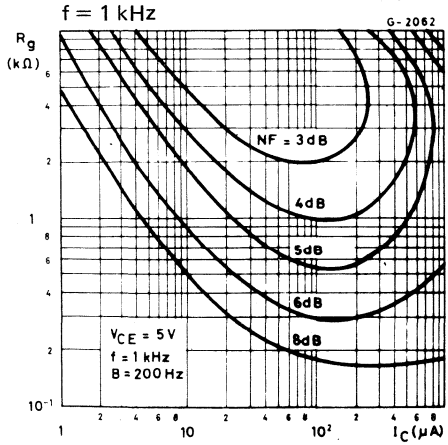
Noise figure vs. source resistance



Contours of constant noise figure
f = 10 kHz



Contours of constant noise figure
f = 1 kHz



BFR 18

EPITAXIAL 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.

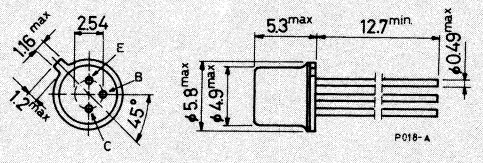
ABSOLUTE MAXIMUM RATINGS

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 $T_{amb} \leqslant 25°C$	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**)

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)

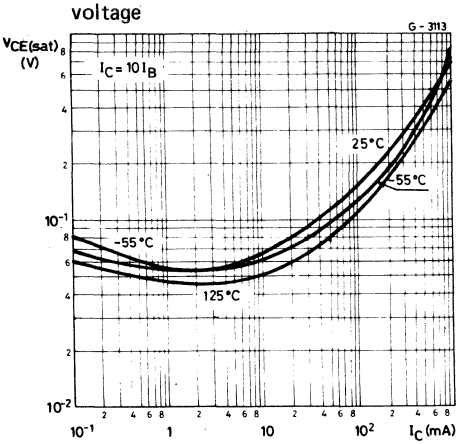
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 60V V_{CE} = 60V	 T_{amb} = 150°C		0.2 0.2	10 10	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			0.1	10	nA
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 100μA		85			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30 mA		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)

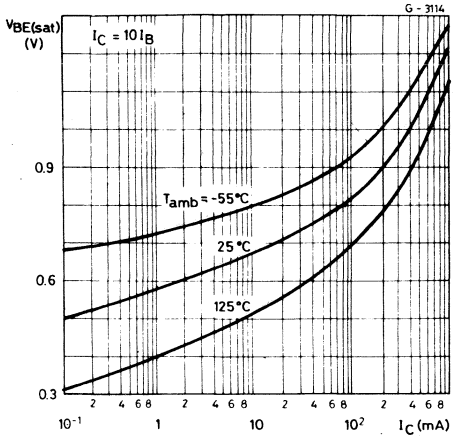
Parameter		Test conditions		Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	$I_C = 100\mu A$	$V_{CE} = 1V$	30	75		–
		$I_C = 10mA$	$V_{CE} = 1V$	70	120	180	–
		$I_C = 150mA$	$V_{CE} = 1V$	60	90	180	–
		$I_C = 500mA$	$V_{CE} = 1V$	30	45		–
		$I_C = 150mA$	$V_{CE} = 1V$				
		$T_{amb} = -55°C$		15			–
h_{fe}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

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

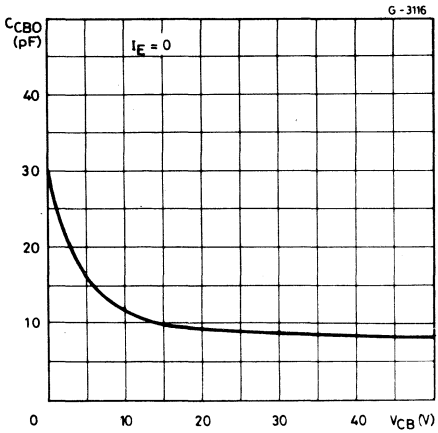
Collector-emitter saturation voltage voltage



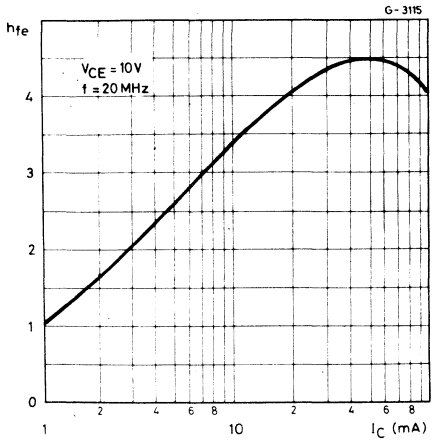
Base-emitter saturation voltage



Collector-base capacitance



High frequency current gain



BFW 43
BFW 44

EPITAXIAL 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} of 150V and are specified over a wide range of currents.

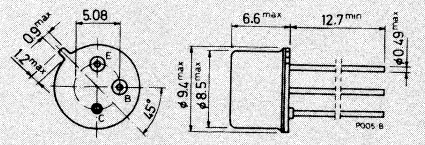
ABSOLUTE MAXIMUM RATINGS

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

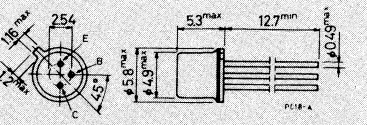
Dimensions in mm

Collector connected to case



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

Collector connected to case



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

THERMAL DATA

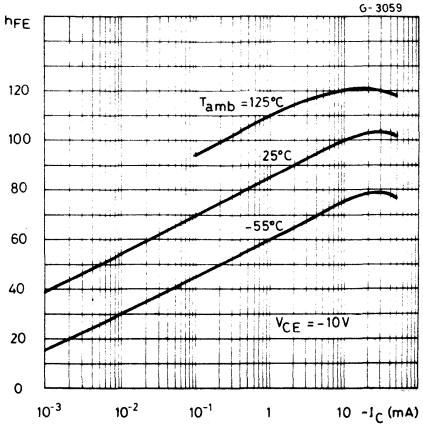
			BFW 43	BFW 44
$R_{th\ j-case}$	Thermal resistance junction-case	max	125 °C/W	70 °C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	438 °C/W	250 °C/W

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

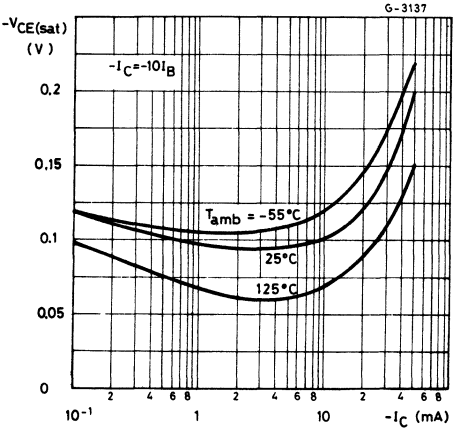
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -100V V_{CB} = -100V	 T_{amb}=125°C		-0.2 -0.03	-10 -10	nA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10μA		-150			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	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 I_C = -10mA I_C = -10μA T_{amb} = -55°C	V_{CE}=-10V V_{CE}=-10V V_{CE}=-10V	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 f = 1MHz	V_{EB}=-0.5V		20	25	pF
C_{CBO}	Collector-base capacitance	I_E = 0 f = 1MHz	V_{CB} = -5V		5	7	pF

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

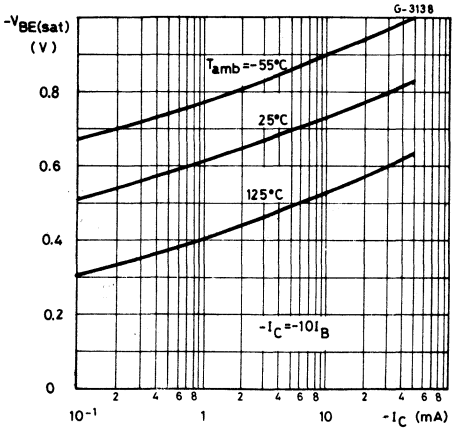
DC current gain



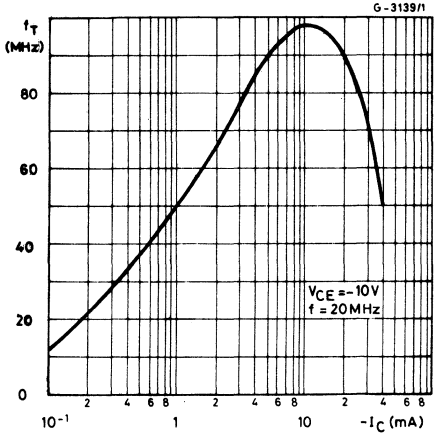
Collector-emitter saturation voltage



Base-emitter saturation voltage



Transition frequency



EPITAXIAL 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.

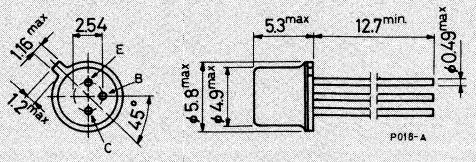
ABSOLUTE MAXIMUM RATINGS

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)

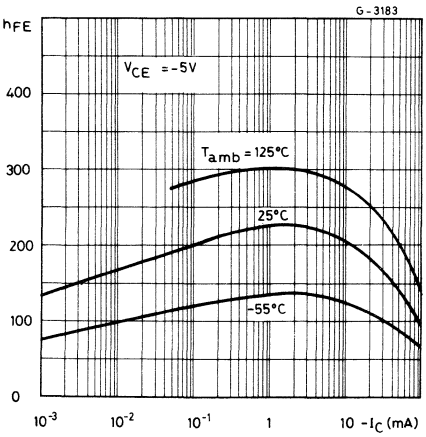
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -70 V			-0.1	-10	nA
		V_{CE} = -70V	T_{amb}=150 °C		-0.1	-10	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -4 V			-0.1	-10	nA
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10μA		-90			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown 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 = -1mA	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 = -1mA	V_{CE} = -5V	125	220	280	–
		I_C = -10mA	V_{CE} = -5V	125	200		–
h_{fe}	Small signal current gain	I_C = -1mA 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)

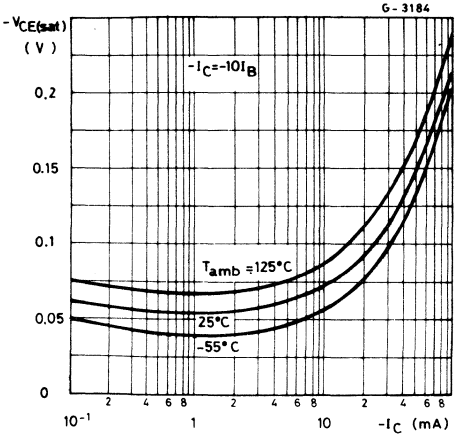
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ V_{EB}=-0.5V f = 1MHz		12	15	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ V_{CB} = -5V f = 1MHz		4.5	6	pF
NF	Noise figure	I_C = -20μA V_{CE} = -5V R_g = 10kΩ f = 1 kHz f = 10 to 10 000 Hz		0.8 1	2.5 3.5	dB dB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

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

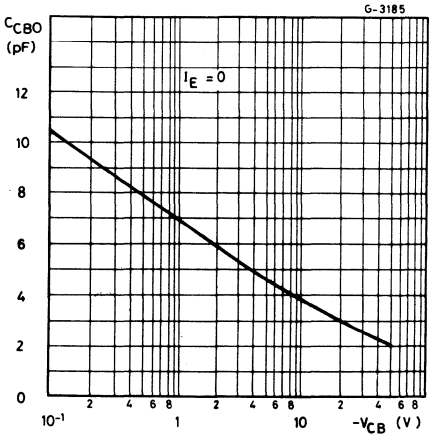
DC current gain



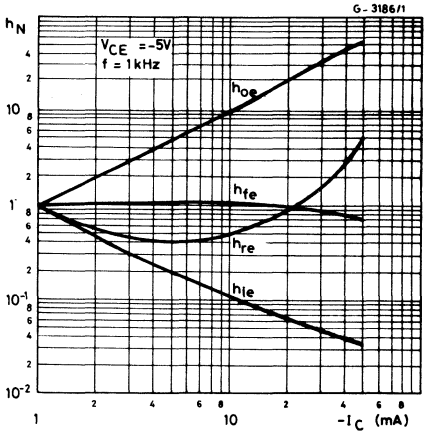
Collector-emitter saturation voltage



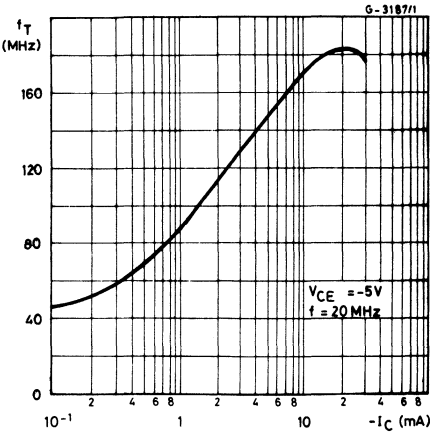
Collector-base capacitance



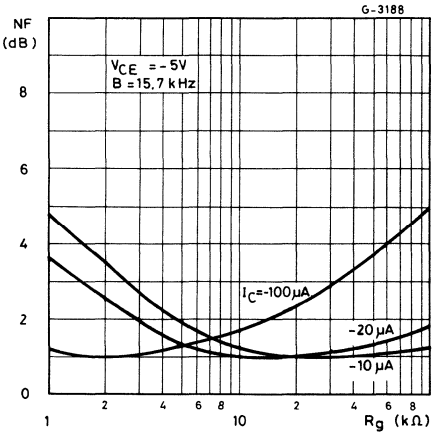
Normalized h parameters



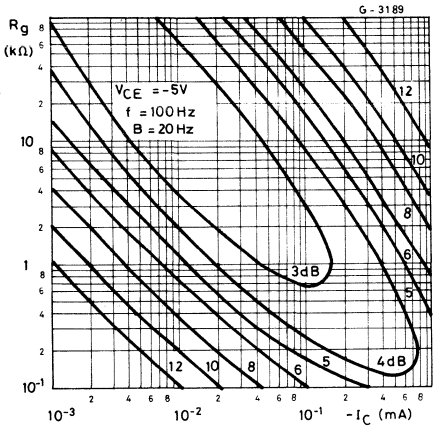
Transition frequency



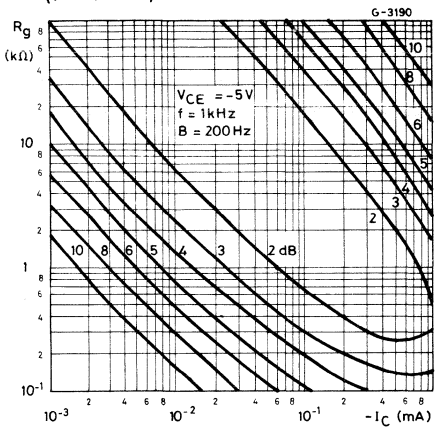
Noise figure vs. source resistance



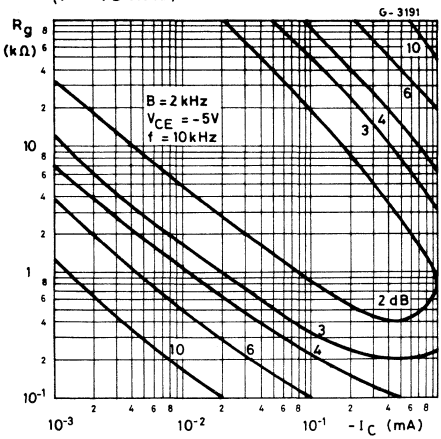
Contours of constant noise figure
(f = 100 Hz)



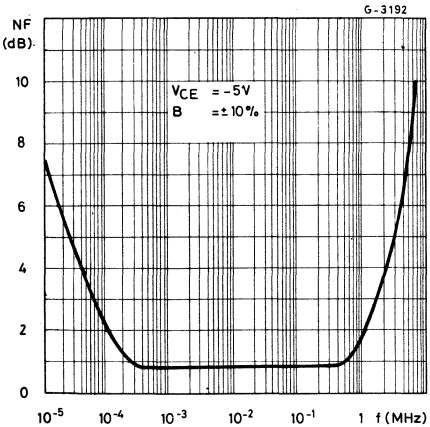
Contours of constant noise figure
(f = 1 kHz)



Contours of constant noise figure
(f = 10 kHz)



Noise figure vs. frequency



BFX 38
BFX 39
BFX 40
BFX 41

EPITAXIAL 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.

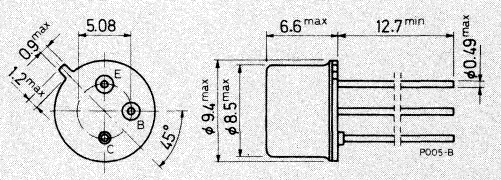
ABSOLUTE MAXIMUM RATINGS

		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 ($I_E = 0$)	$I_C = -10\mu A$				
		for **BFX38 - BFX39**	-55			V
		for **BFX40 - BFX41**	-75			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -10mA$				
		for **BFX38 - BFX39**	-55			V
		for **BFX40 - BFX41**	-75			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\mu A$	-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**				
		$I_C = -100\mu A$ $V_{CE} = -5V$	60	90		–
		$I_C = -100mA$ $V_{CE} = -5V$	85	130		–
		$I_C = -500mA$ $V_{CE} = -5V$	60	120		–
		for **BFX39 - BFX41**				
		$I_C = -100\mu A$ $V_{CE} = -5V$	30	45		–
		$I_C = -100mA$ $V_{CE} = -5V$	40	70		–
		$I_C = -500mA$ $V_{CE} = -5V$	25	65		–

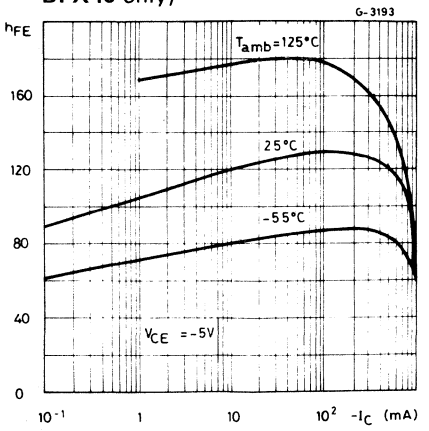
ELECTRICAL CHARACTERISTICS (continued)

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

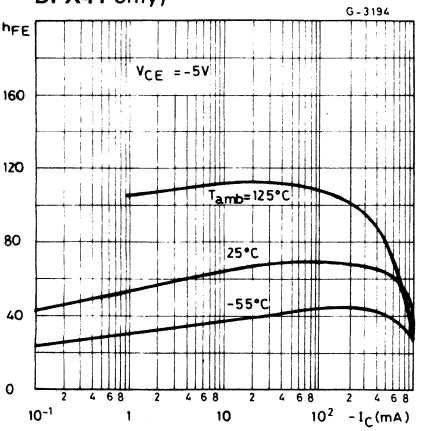
*Pulsed: pulse duration = 300 μs, duty cycle = 1%

** See test circuit

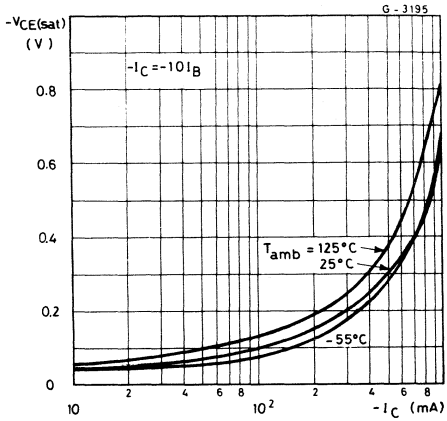
DC current gain (for **BFX38** and **BFX40** only)



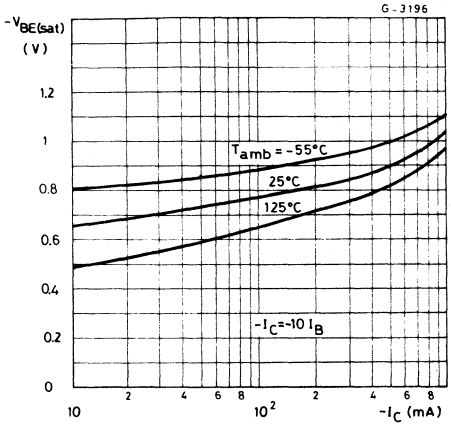
DC current gain (for **BFX39** and **BFX41** only)



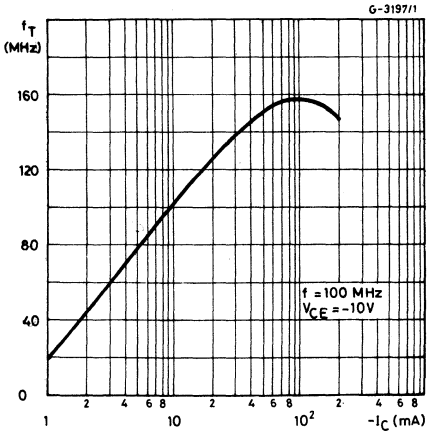
Collector-emitter saturation voltage



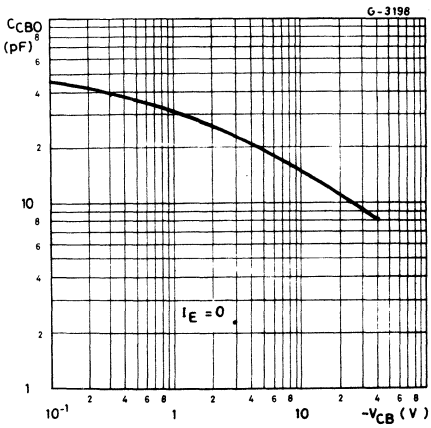
Base-emitter saturation voltage



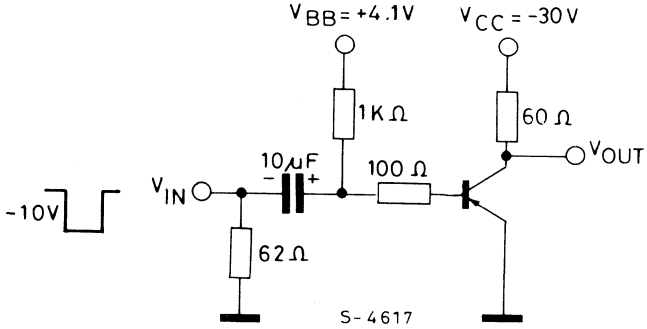
Transition frequency



Collector-base capacitance



Test circuit for t_{on}, t_s and t_f



PULSE GENERATOR:
t_r, t_f < 20 ns
PW = 10 μs
Z_{IN} = 50Ω
DC < 2%

TO OSCILLOSCOPE:
$t_r \approx$ 10 ns
Z_{IN} > 100 KΩ

EPITAXIAL PLANAR PNP

BFX 48

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.

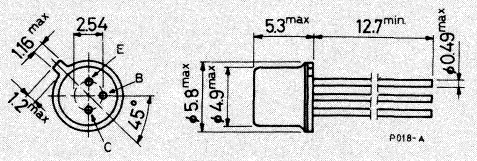
ABSOLUTE MAXIMUM RATINGS

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)

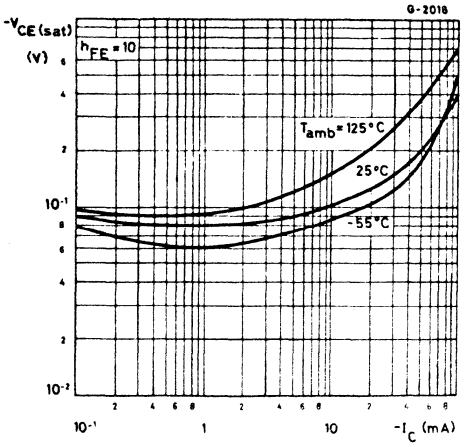
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -20V			-15	nA
		V_{CE} = -20V T_{amb} = 125°C			-15	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA	-30			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = -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 = -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 V_{CE} = -1V T_{amb} = -55°C	30			–
f_T	Transition frequency	I_C = -10 mA V_{CE} = -20V f = 100 MHz	400	550		MHz

ELECTRICAL CHARACTERISTICS (continued)

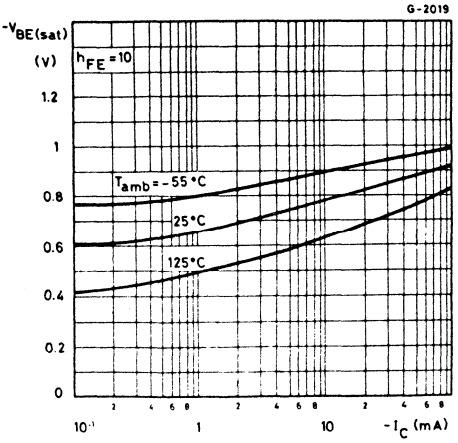
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = -0.5V$ $f = 1$ MHz		4	5.5	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -10V$ $f = 1$ MHz		2.2	3.5	pF
NF	Noise figure	$I_C = -1$ mA $V_{CE} = -5V$ $f = 100$ MHz $R_g = 100\ \Omega$		3.5	6	dB
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



BFX 90
BFX 91

EPITAXIAL PLANAR PNP

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.

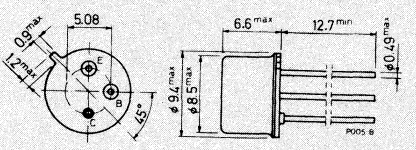
ABSOLUTE MAXIMUM RATINGS

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

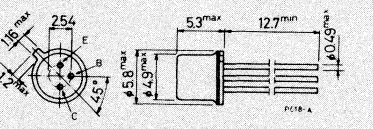
Dimensions in mm

Collector connected to case



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

Collector connected to case



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

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)

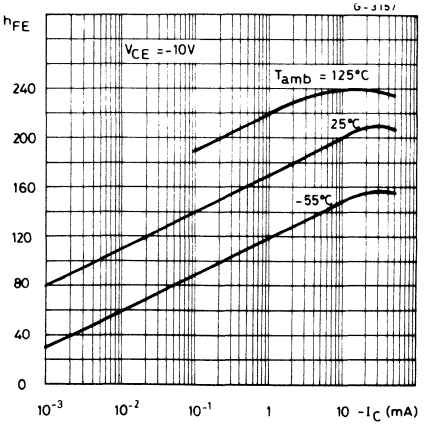
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = -100V V_{CB} = -100V T_{amb} = 125°C			-10 -10	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = -4V			-10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA	-180			V
$V_{(BR)CEO}$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

ELECTRICAL CHARACTERISTICS (continued)

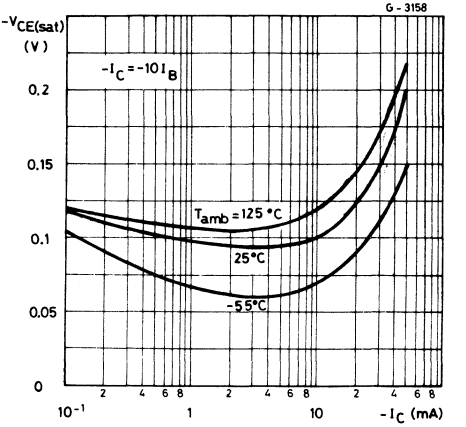
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = -0.5V$ $f = 1$ MHz		20	25	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -5V$ $f = 1$ MHz		5	7	pF
NF	Noise figure	$I_C = -10\ \mu A$ $V_{CE} = -5V$ $R_g \equiv 10\ k\Omega$ $f = 10$ kHz $B =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

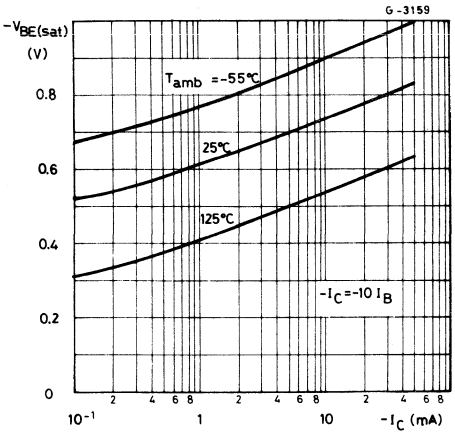
DC current gain



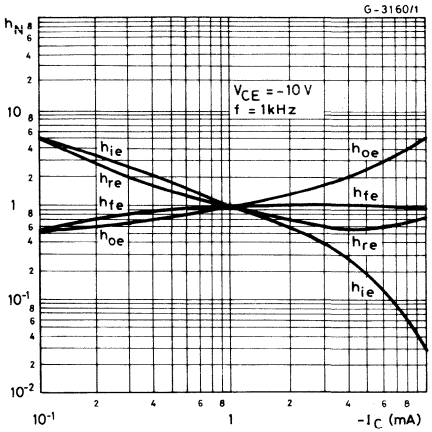
Collector-emitter saturation voltage



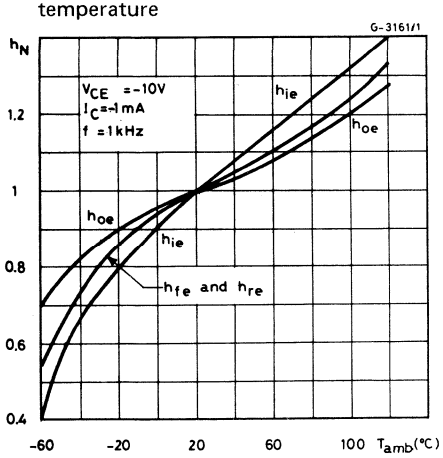
Base-emitter saturation voltage



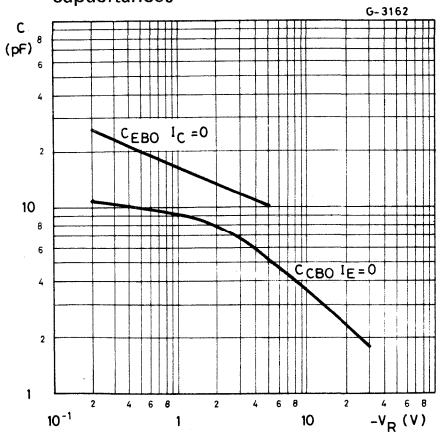
Normalized h parameters vs. collector current



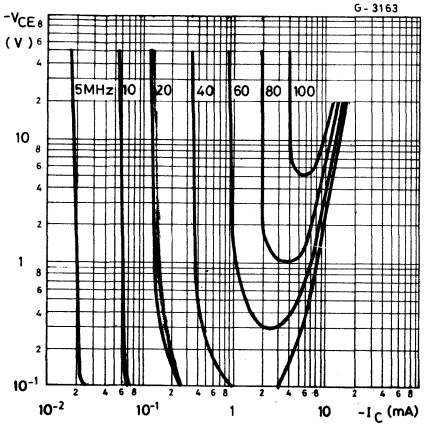
Normalized h parameters vs. ambient temperature



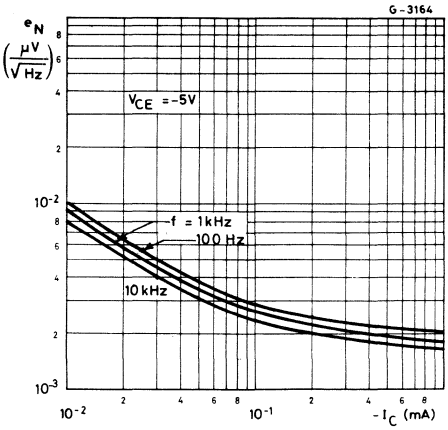
Emitter-base and collector-base capacitances



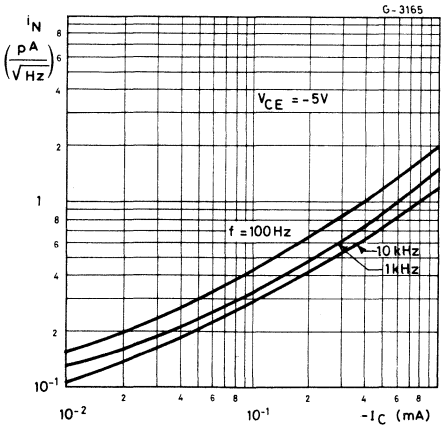
Contours of constant transition frequency



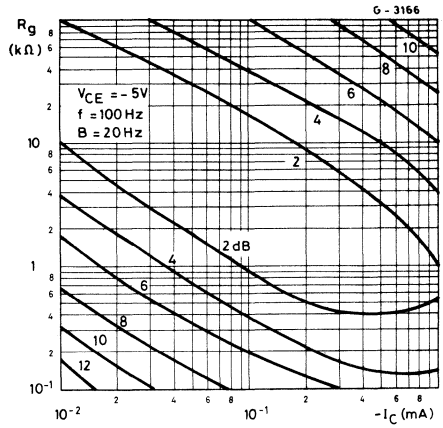
Equivalent input noise voltage



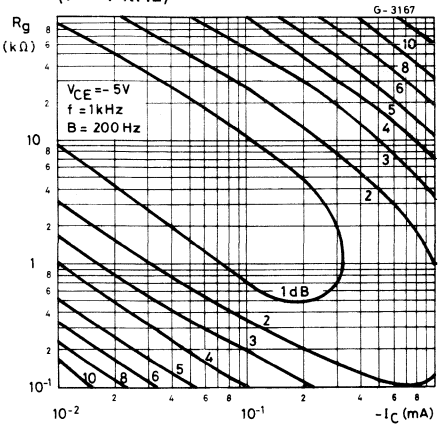
Equivalent input noise current



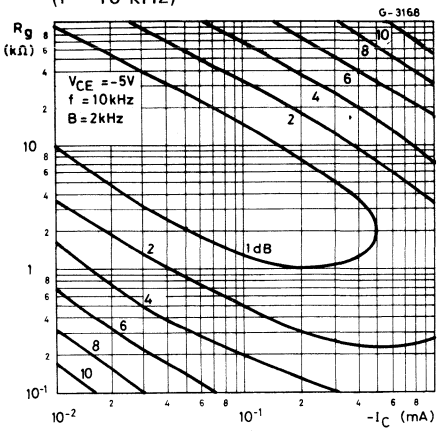
Contours of constant noise figure (f = 100 Hz)



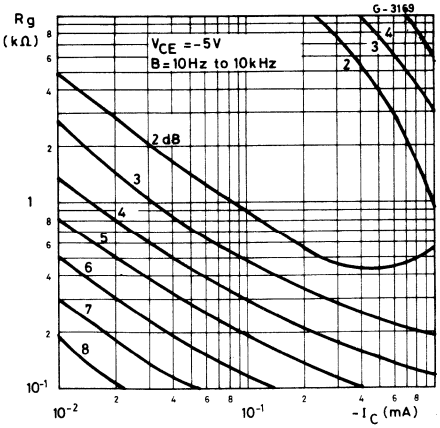
Contours of constant noise figure
(f = 1 kHz)



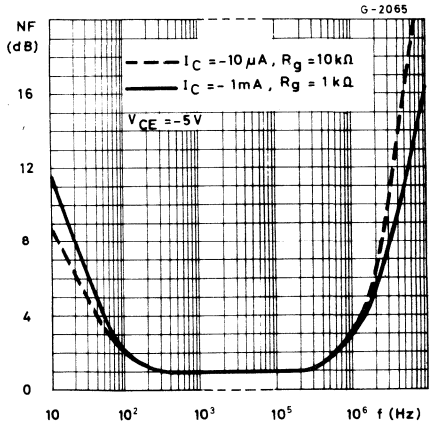
Contours of constant noise figure
(f = 10 kHz)



Contours of constant wide band noise figure



Noise figure vs. frequency



BFY 50
BFY 51
BFY 52

EPITAXIAL PLANAR NPN

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.

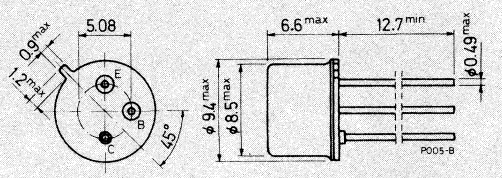
ABSOLUTE MAXIMUM RATINGS

		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			50	nA
		V_{CB} = 60V T_{case} = 100°C			2.5	μA
		for **BFY 51**				
		V_{CB} = 40V			50	nA
		V_{CB} = 40V T_{case} = 100°C			2.5	μA
		for **BFY 52**				
		V_{CB} = 30V			50	nA
		V_{CB} = 30V T_{case} = 100°C			2.5	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			50	nA
		V_{EB} = 5V T_{case} = 100°C			2.5	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
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30 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	1.3	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} = 10V	20	40		–
		I_C = 150 mA V_{CE} = 10V	30	55		–
		I_C = 1A V_{CE} = 10V	15	30		–
		for **BFY 51**				
		I_C = 10 mA V_{CE} = 10V	30	55		–
		I_C = 150 mA V_{CE} = 10V	40	70		–
		I_C = 1 A V_{CE} = 10V	15	40		–
		for **BFY 52**				
		I_C = 10 mA V_{CE} = 10V	30	80		–
		I_C = 150 mA V_{CE} = 10V	60	130		–
		I_C = 1 A V_{CE} = 10V	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 50**		25		–
		for **BFY 51**		30		–
		for **BFY 52**		40		–
		$I_C = 10$ mA				
		for **BFY 50**		45		–
		for **BFY 51**		60		–
		for **BFY 52**		120		–
f_T	Transition frequency	$I_C = 50$ mA $V_{CE}= 10V$				
		for **BFY 50**	60	100		MHz
		for **BFY 51**	50	110		MHz
		for **BFY 52**	50	120		MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10V$ f = 1 MHz		10		pF
h_{ie}	Input impedance	$I_C = 10$ mA $V_{CE} = 5V$ 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 $V_{CE} = 5V$ 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 $V_{CE} = 5$ V 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 $V_{BE} = -2V$		15		ns
t_r	Rise time	$I_C = 150$ mA $V_{CC} = 10V$ $I_{B1} = 15$ mA $V_{BE} = -2V$		40		ns
t_s	Storage time	$I_C = 150$ mA $V_{CC} = 10V$ $I_{B1} = -I_{B2} = 15$ mA		300		ns
t_f	Fall time	$I_C = 150$ mA $V_{CC} = 10V$ $I_{B1} = -I_{B2} = 15$ mA		60		ns

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

EPITAXIAL PLANAR NPN

BFY 56
BFY 56A

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.

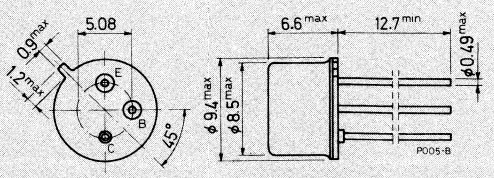
ABSOLUTE MAXIMUM RATINGS

		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 $T_{amb} \leqslant 25°C$	0.8 W	
	at $T_{case} \leqslant 25°C$	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		0.2	20	nA
		V_{CE} = 50V T_{amb} = 150°C		0.2	20	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
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30 mA				
		for **BFY 56**	45			V
		for **BFY 56A**	55			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		0.13	0.3	V
		I_C = 1 A I_B = 0.1 A		0.65	1.2	V
		for **BFY 56A**				
		I_C = 10 mA I_B = 1 mA		0.05		V
		I_C = 150 mA I_B = 15 mA		0.13	0.25	V
		I_C = 1 A I_B = 0.1 mA		0.65	1	V

ELECTRICAL CHARACTERISTICS (continued)

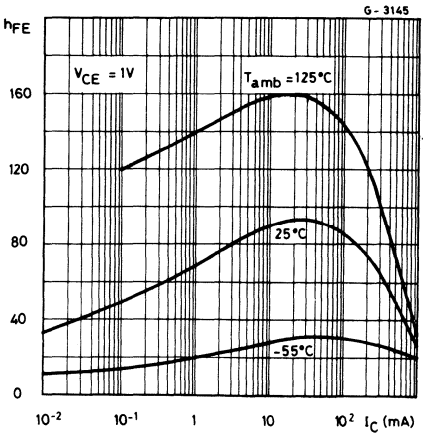
Parameter		Test conditions	Min.	Typ.	Max.	Unit
$V_{BE(sat)}$*	Base-emitter saturation voltage	for **BFY 56**				
		I_C = 150 mA I_B = 15 mA		0.85	1.5	V
		I_C = 1 A I_B = 0.1 A		1.5	2.3	V
		for **BFY 56A**				
		I_C = 10 mA I_B = 1 mA		0.68	0.8	V
		I_C = 150 mA I_B = 15 mA		0.85	1	V
		I_C = 1 A I_B = 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		–
		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)

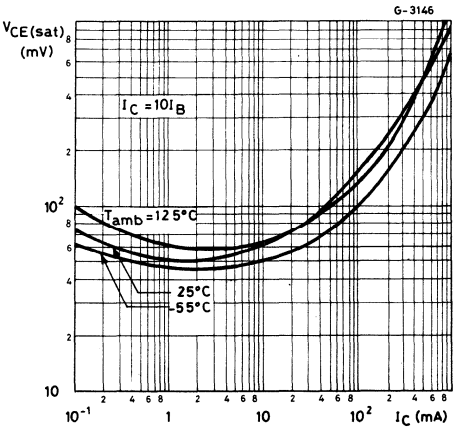
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{oe}	Output admittance	I_C = 1 mA V_{CE} = 5V f = 1 kHz		8		μS
t_{on}	Turn-on time	I_C = 150 mA V_{CC} = 20V I_{B1} = 7.5 mA		150	225	ns
t_{off}	Turn-off time	I_C = 150 mA V_{CC} = 20V I_{B1} = $-I_{B2}$ = 7.5 mA		350	800	ns

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

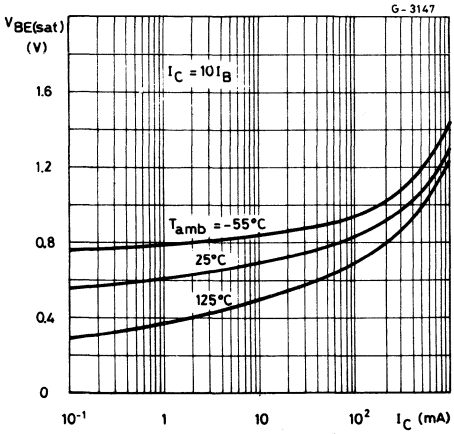
DC current gain



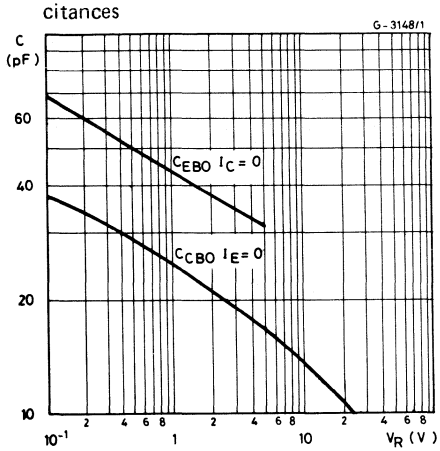
Collector-emitter saturation voltage



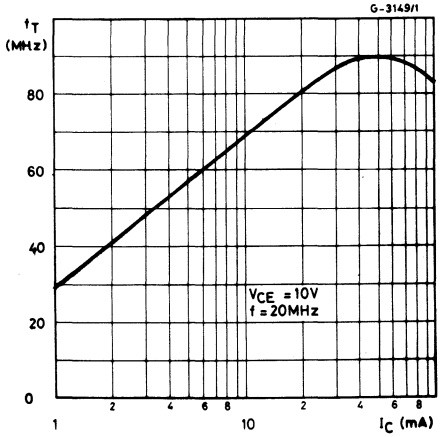
Base-emitter saturation voltage



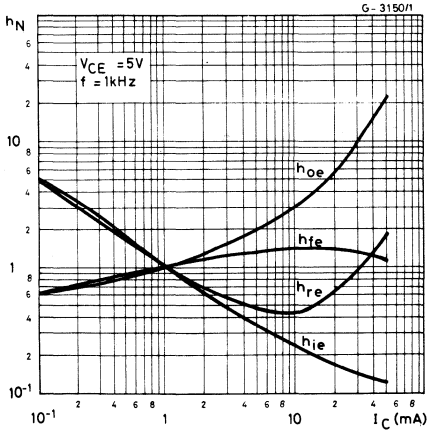
Emitter-base and collector-base capacitances



Transition frequency



Normalized h parameters



SGS BFY 64

EPITAXIAL PLANAR PNP

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.

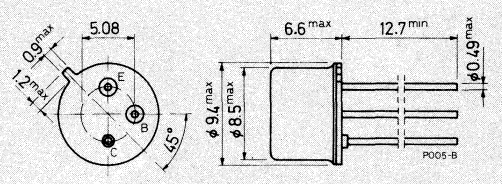
ABSOLUTE MAXIMUM RATINGS

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**)

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)

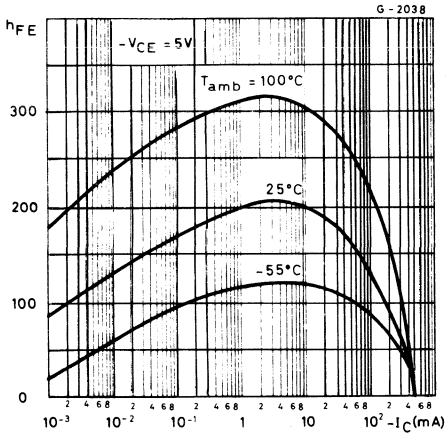
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -25V			-30	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA	-40			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -10 mA	-40			V
$V_{(BR)EBO}$	Emitter-base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

ELECTRICAL CHARACTERISTICS (continued)

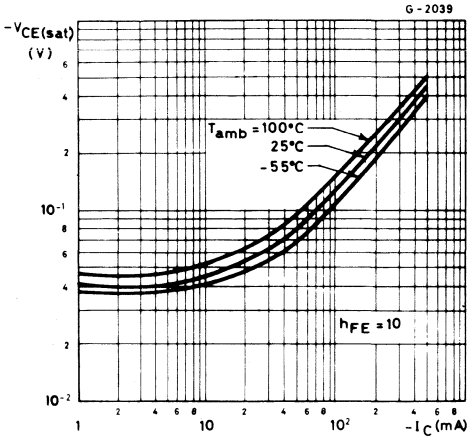
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	I_C = - 10 μA V_{CE} = -10V		130		–
		I_C = - 1 mA V_{CE} = -10V		200		–
	*	I_C = - 10 mA V_{CE} = -10V	80	200		–
	*	I_C = - 50 mA V_{CE} = - 1V		150		–
	*	I_C = -150 mA V_{CE} = -10V		130		–
h_{fe}	Small signal current gain	I_C = -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} = -2V f = 1 MHz		15	30	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%

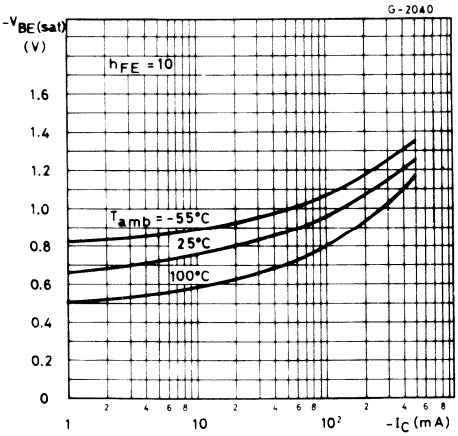
DC current gain



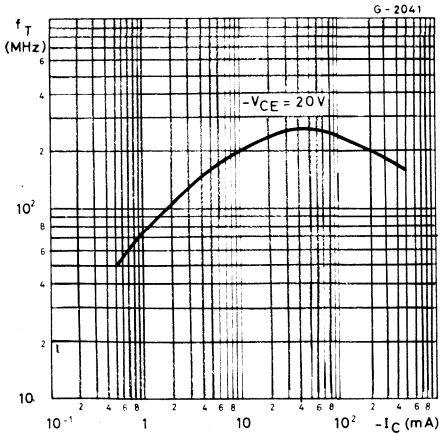
Collector-emitter saturation voltage



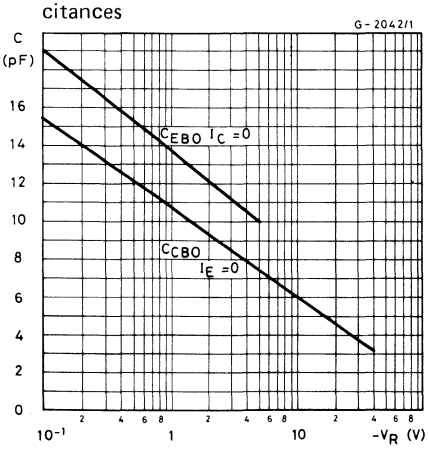
Base-emitter saturation voltage



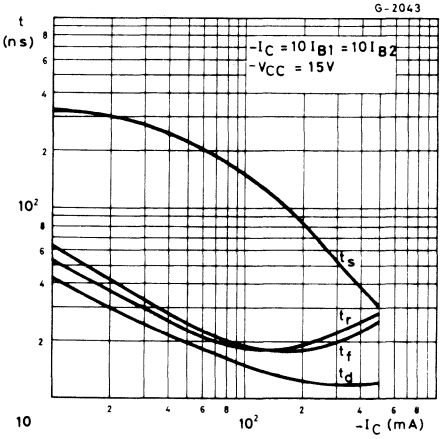
Transition frequency



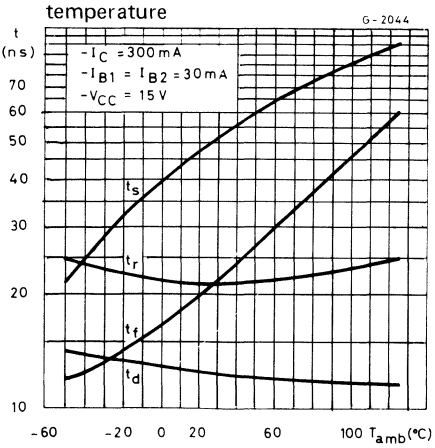
Emitter-base and collector-base capacitances



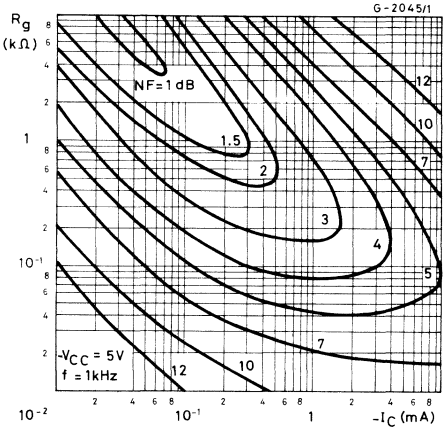
Switching characteristics



Switching characteristics vs. ambient temperature



Contours of constant noise figure



EPITAXIAL PLANAR NPN

BFY 76

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.

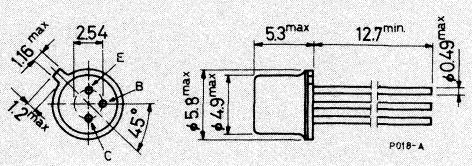
ABSOLUTE MAXIMUM RATINGS

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)

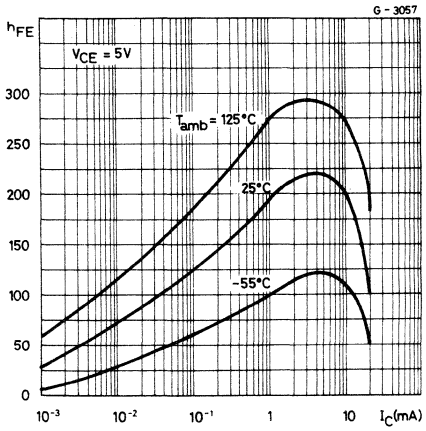
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 50V V_{CE} = 50V T_{amb} = 150°C			20 20	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			20	nA
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10 μA	60			V
$V_{(BR)CEO}$*	Collector-emitter breakdown 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	350	–
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

ELECTRICAL CHARACTERISTICS (continued)

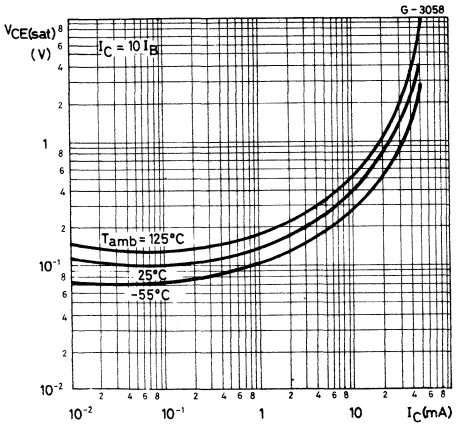
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 5V$ f = 1 MHz		3.5	6	pF
NF	Noise figure	$I_C = 10\ \mu A$ $V_{CE} = 5V$ $R_g = 10\ k\Omega$				
		f = 100 Hz		4	15	dB
		f = 1 kHz		1.5	4	dB
		f = 10 to 10 000 Hz		1.9	4	dB
h_{ie}	Input impedance	$I_C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

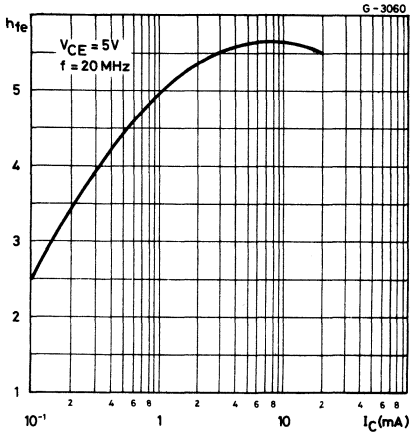
DC current gain



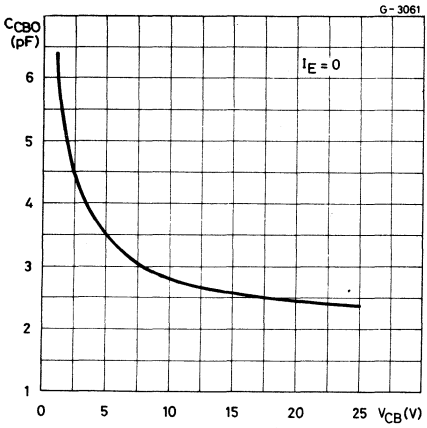
Collector-emitter saturation voltage



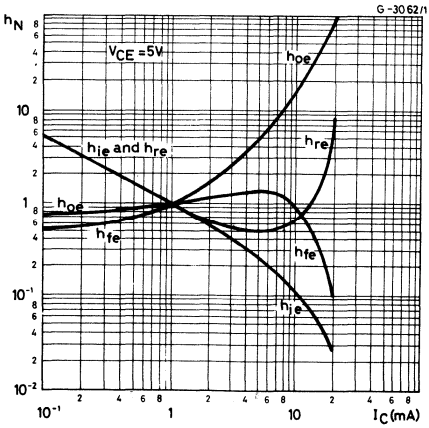
High frequency current gain



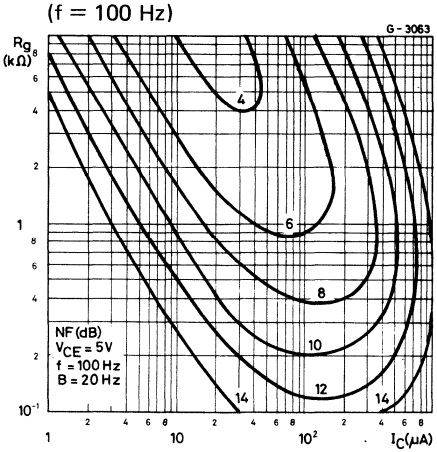
Collector-base capacitance



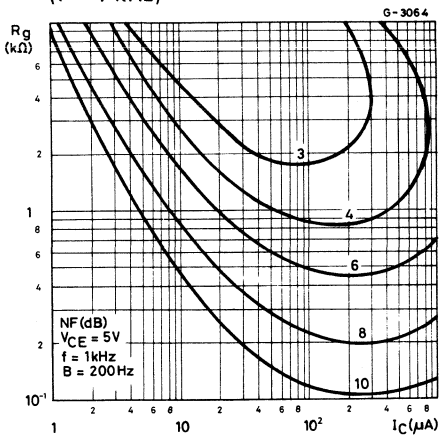
Normalized h parameters



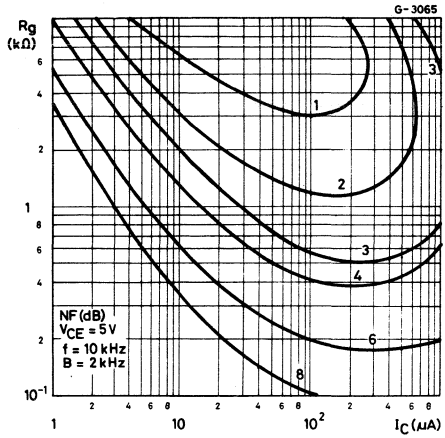
Contours of constant noise figure (f = 100 Hz)



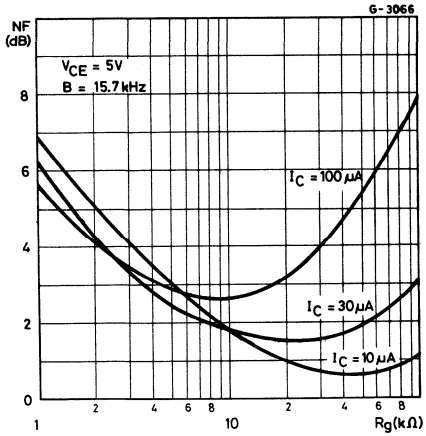
Contours of constant noise figure
(f = 1 kHz)



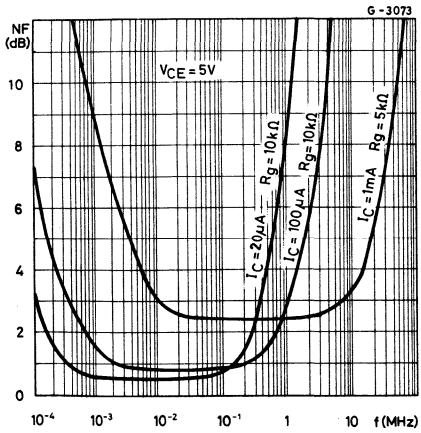
Contours of constant noise figure
(f = 10 kHz)



Noise figure vs. source resistance



Noise figure vs. frequency



BSS 26

EPITAXIAL PLANAR NPN

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.

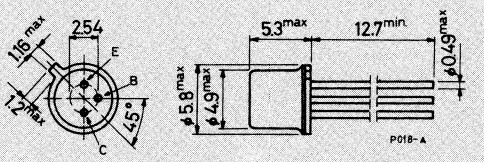
ABSOLUTE MAXIMUM RATINGS

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

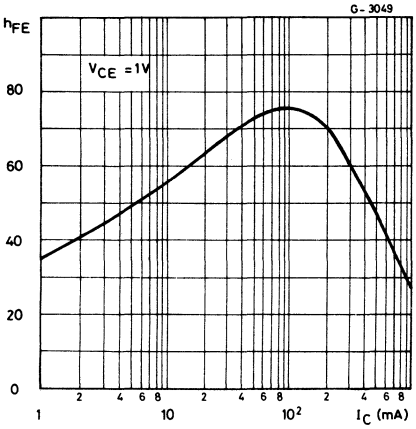
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

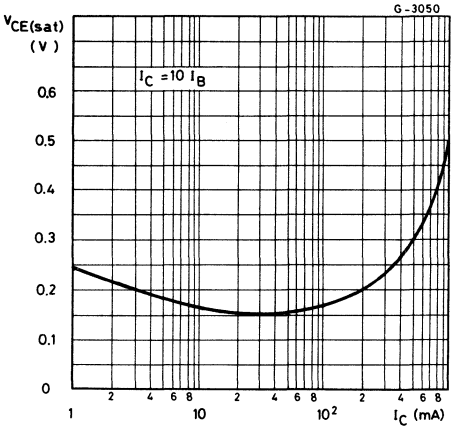
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 40V$ $V_{CB} = 40$ $T_{amb} = 100°C$			1.7 120	μA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu A$	60			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage ($V_{BE} = 0$)	$I_C = 10\ \mu A$	60			V
$V_{(BR)CEO}$*	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	$I_C = 100$ 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% ** See test circuit.

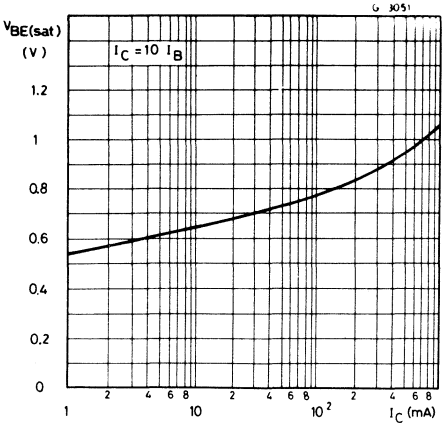
DC current gain



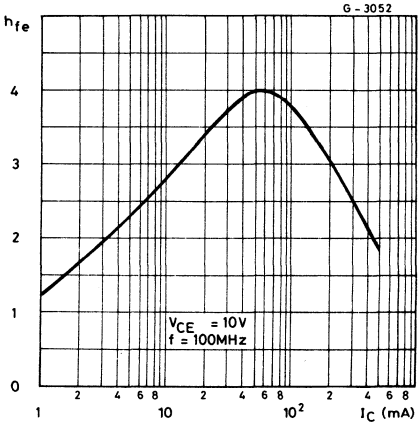
Collector-emitter saturation voltage



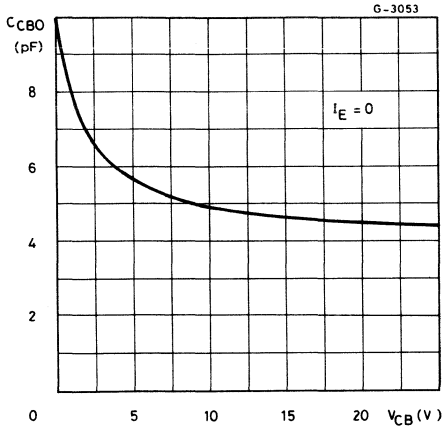
Base-emitter saturation voltage



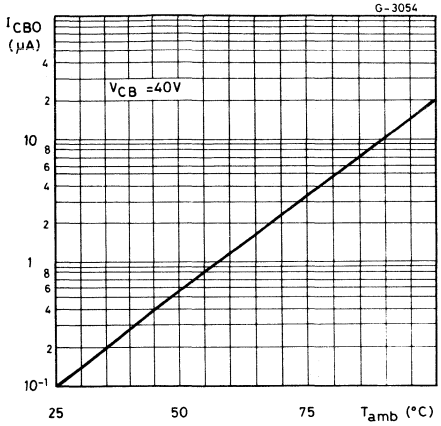
High frequency current gain



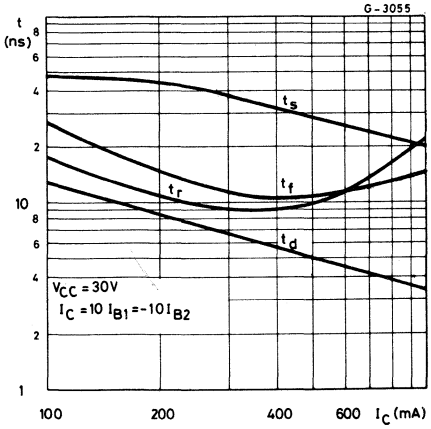
Collector-base capacitance



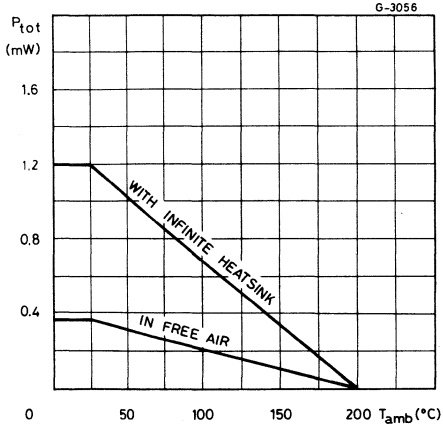
Collector cutoff current



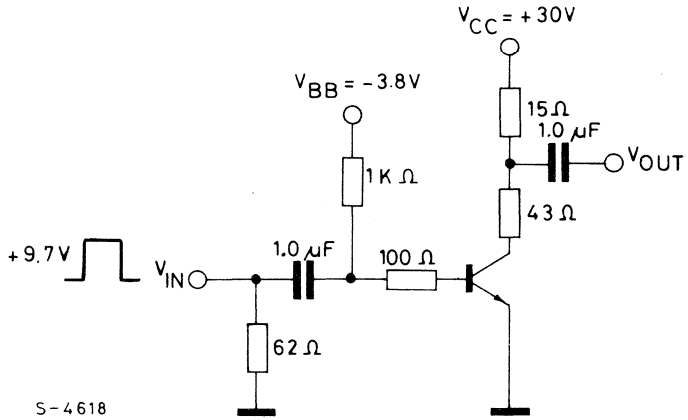
Switching characteristics



Power rating chart



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
t_r, $t_f \leqslant 1.0$ ns
PW ≈ 10 μs
Z_{IN} = 50Ω
DC < 2%

TO OSCILLOSCOPE:
t_r < 1.0 ns
$Z_{IN} \geqslant 100$ kΩ

EPITAXIAL PLANAR NPN

BSS 71S

PRELIMINARY DATA

HIGH VOLTAGE AMPLIFIER

The BSS 71S is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed for high voltage amplifier and switching applications at current levels from 100 μA to 100 mA. The complementary PNP type is the BSS 74S.

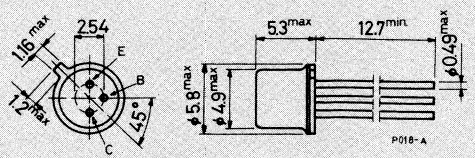
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage	200	V
V_{CEO}	Collector-emitter voltage	200	V
V_{EBO}	Emitter-base voltage	6	V
I_C	Collector current	200	mA
I_B	Base current	50	mA
P_{tot}	Total device dissipation at $T_{amb} \leqslant 25°C$	0.5	W
	at $T_{case} \leqslant 25°C$	2.5	W
T_{stg}, T_j	Storage and junction temperature	200	°C

MECHANICAL DATA

Dimensions in mm

Collector connected to case



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

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THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	70	°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} = 150V				50	nA
I_{CEO}	Collector cutoff current (I_B = 0)	V_{CE} = 150V				500	nA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{BE} = 5V				50	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA		200			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA		200			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			0.3	V
		I_C = 30 mA	I_B = 3 mA			0.4	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			0.8	V
		I_C = 30 mA	I_B = 3 mA			0.9	V
		I_C = 50 mA	I_B = 5 mA			1	V
h_{FE}*	DC current gain	I_C = 100 μA	V_{CE} = 1V	20			–
		I_C = 1 mA	V_{CE} = 10V	30			–
		I_C = 10 mA	V_{CE} = 10V	50			–
		I_C = 30 mA	V_{CE} = 10V	40		250	–

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	$I_C = 20$ mA $V_{CE} = 20$V f = 20 MHz	50		200	MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 20$V f = 1 MHz		3.5		pF
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5$V f = 1 MHz		45		pF
t_{on}	Turn-on time	$I_C = 50$ mA $I_{B1} = 10$ mA $V_{CC} = 100$V		100		ns
t_{off}	Turn-off time	$I_C = 50$mA $I_{B1} = -I_{B2} = -10$ mA $V_{CC} = 100$V		400		ns

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

BSS 72S

EPITAXIAL PLANAR NPN

PRELIMINARY DATA

HIGH VOLTAGE AMPLIFIER

The BSS 72S is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is designed for high voltage amplifier and switching applications at current levels from 100 μA to 100 mA. The complementary PNP type is the BSS 75S.

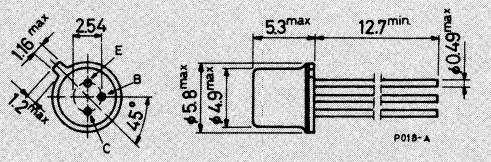
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage	200	V
V_{CEO}	Collector-emitter voltage	200	V
V_{EBO}	Emitter-base voltage	6	V
I_C	Collector current	200	mA
I_B	Base current	50	mA
P_{tot}	Total device dissipation at $T_{amb} \leqslant 25°C$	0.5	W
	at $T_{case} \leqslant 25°C$	2.5	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	70	°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} = 150V				50	nA
I_{CEO}	Collector cutoff current (I_B = 0)	V_{CE} = 150V				500	nA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{BE} = 5V				50	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA		200			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA		200			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			0.3	V
		I_C = 30 mA	I_B = 3 mA			0.4	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			0.8	V
		I_C = 30 mA	I_B = 3 mA			0.9	V
		I_C = 50 mA	I_B = 5 mA			1	V
h_{FE} *	DC current gain	I_C = 1 mA	V_{CE} = 10V	30			–
		I_C = 10 mA	V_{CE} = 10V	50			–
		I_C = 30 mA	V_{CE} = 10V	40		250	–

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	$I_C = 20$ mA $V_{CE} = 20$V f = 20 MHz	50		200	MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 20$V f = 1 MHz		3.5		pF
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5$V f = 1 MHz		45		pF
t_{on}	Turn-on time	$I_C = 50$ mA $I_{B1} = 10$ mA $V_{CC} = 100$V		100		ns
t_{off}	Turn-off time	$I_C = 50$mA $I_{B1} = -I_{B2} = -10$mA $V_{CC} = 100$V		400		ns

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

EPITAXIAL PLANAR PNP

BSS 74S

PRELIMINARY DATA

HIGH VOLTAGE AMPLIFIER

The BSS 74S is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case. It is designed for high voltage amplifier and switching applications at current levels from 100 μA to 100 mA. The complementary NPN type is the BSS 71S.

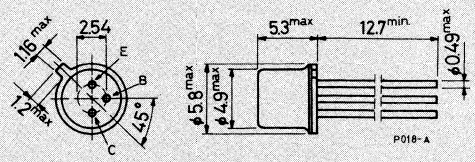
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage	-200	V
V_{CEO}	Collector-emitter voltage	-200	V
V_{EBO}	Emitter-base voltage	-6	V
I_C	Collector current	-100	mA
I_B	Base current	-50	mA
P_{tot}	Total device dissipation at $T_{amb} \leqslant 25°C$	0.5	W
	at $T_{case} \leqslant 25°C$	2.5	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	70	°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} = -150V			-50	nA
I_{CEO}	Collector cutoff current (I_B = 0)	V_{CE} = -150V			-500	nA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{BE} = 5V			-50	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = - 100 μA	-200			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = -2 mA	-200			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			-0.3	V
		I_C = -30 mA I_B = -3 mA			-0.4	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			-0.8	V
		I_C = -30 mA I_B = -3 mA			-0.9	V
		I_C = -50 mA I_B = -5 mA			-1	V
h_{FE} *	DC current gain	I_C = -100 μA V_{CE} = -1V	20			–
		I_C = -1 mA V_{CE} = -10V	30			–
		I_C = -10 mA V_{CE} = -10V	50			–
		I_C = -30 mA V_{CE} = -10V	35		150	–

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	I_C = -20 mA V_{CE} = -20V f = 20 MHz	50		200	MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -20V f = 1 MHz		3.5		pF
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -0.5V f = 1 MHz		45		pF
t_{on}	Turn-on time	I_C = -50 mA I_{B1} = -10 mA V_{CC} = -100V		100		ns
t_{off}	Turn-off time	I_C=-50mA I_{B1}=-I_{B2}=-10mA V_{CC} = -100V		400		ns

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

SGS BSS 75S

EPITAXIAL PLANAR PNP

PRELIMINARY DATA

HIGH VOLTAGE AMPLIFIER

The BSS 75S is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case. It is designed for high voltage amplifier and switching applications at current levels from 100 μA to 100 mA. The complementary NPN type is the BSS 72S.

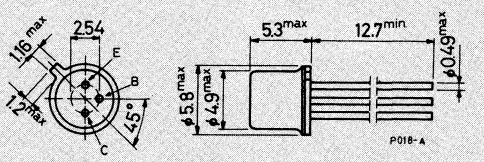
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage		-200	V
V_{CEO}	Collector-emitter voltage		-200	V
V_{EBO}	Emitter-base voltage		-6	V
I_C	Collector current		-100	mA
I_B	Base current		-50	mA
P_{tot}	Total device dissipation	at $T_{amb} \leqslant 25°C$	0.5	W
		at $T_{case} \leqslant 25°C$	2.5	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	70	°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} = -150V			-50	nA
I_{CEO}	Collector cutoff current (I_B = 0)	V_{CE} = -150V			-500	nA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{BE} = 5V			-50	nA
$V_{(BR)CBO}$	Collector-emitter saturation voltage (I_E = 0)	I_C = - 100 μA	-200			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = -2 mA	-200			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			-0.3	V
		I_C = -30 mA I_B = -3 mA			-0.4	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			-0.8	V
		I_C = -30 mA I_B = -3 mA			-0.9	V
		I_C = -50 mA I_B = -5 mA			-1	V
h_{FE}*	DC current gain	I_C = -1 mA V_{CE} = -10V	30			–
		I_C = -10 mA V_{CE} = -10V	50			–
		I_C = -30 mA V_{CE} = -10V	40		250	–

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	I_C = -20 mA V_{CE} = -20V f = 20 MHz	50		200	MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -20V f = 1 MHz		3.5		pF
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = -0.5V f = 1 MHz		45		pF
t_{on}	Turn-on time	I_C = -50 mA I_{B1} = -10 mA V_{CC} = -100V		100		ns
t_{off}	Turn-off time	I_C = -50mA I_{B1} = -I_{B2} = -10mA V_{CC} = -100V		400		ns

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

EPITAXIAL 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.

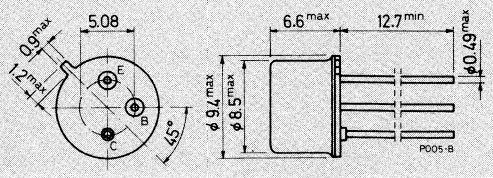
ABSOLUTE MAXIMUM RATINGS

		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 $T_{case} \leqslant 25°C$	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	200	°C/W

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

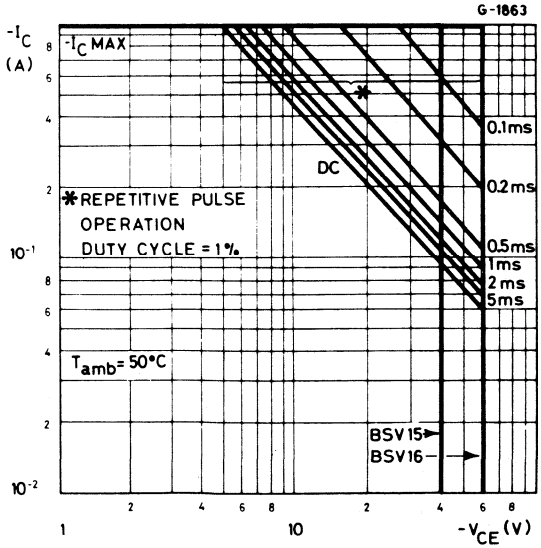
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **BSV 15**					
		V_{CE} = -40V				-0.1	μA
		V_{CE} = -40V	T_{amb} = 150°C			-50	μA
		for **BSV 16**					
		V_{CE} = -60V				-0.1	μA
		V_{CE} = -60V	T_{amb} = 150°C			-50	μA
I_{CEX}	Collector cutoff current (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)

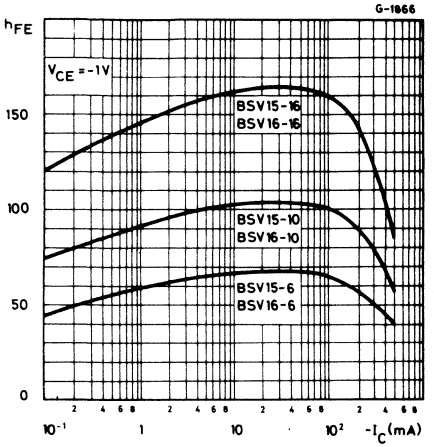
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	I_C = -500 mA V_{CE} = -1V Gr. 6 Gr. 10 Gr. 16	 20 25 35	 40 55 85		 – – –
h_{fe}	Small signal current gain	I_C = -1 mA V_{CE} = -5V f = 1kHz	20			–
f_T	Transition frequency	I_C = -50 mA V_{CE} = -1V f = 20 MHz	50			MHz
C_{EBO}	Emitter-base 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% ** See test circuit.

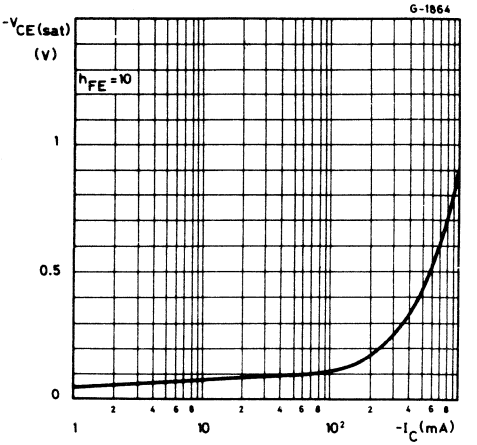
Safe operating areas



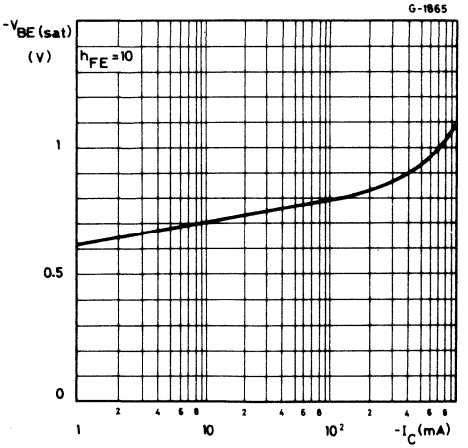
DC current gain



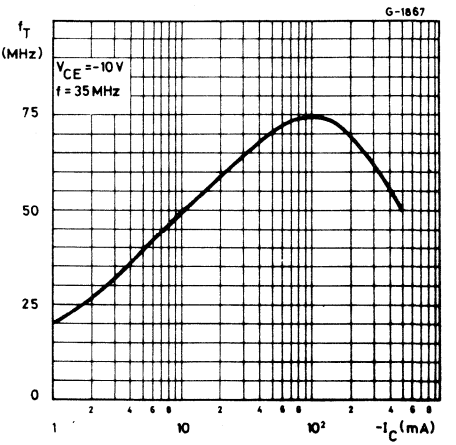
Collector-emitter saturation voltage



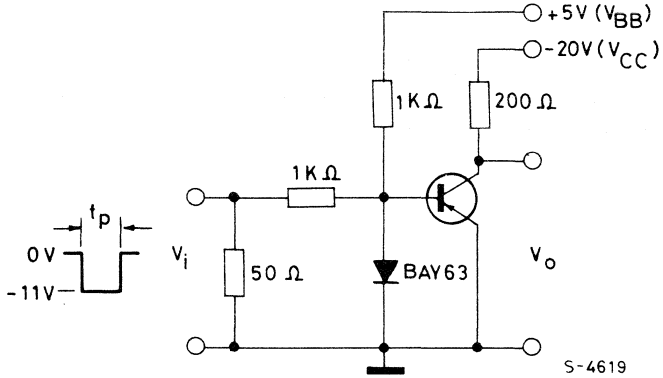
Base-emitter saturation voltage



Transition frequency



Test circuit for t_s, t_f and t_{on}



PULSE GENERATOR:
$t_p \geqslant 10\ \mu s$
$t_r \leqslant 15$ ns
$t_f \leqslant 15$ ns
$Z_s = 50\Omega$

TO OSCILLOSCOPE:
$t_r \leqslant 15$ ns
$Z_{IN} \geqslant 100\ K\Omega$

BSX 19
BSX 20

EPITAXIAL PLANAR NPN

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.

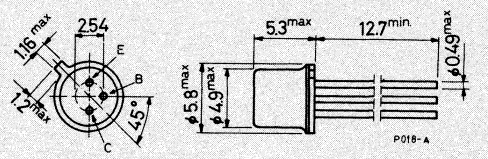
ABSOLUTE MAXIMUM RATINGS

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 $T_{amb} \leqslant 25°C$	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)

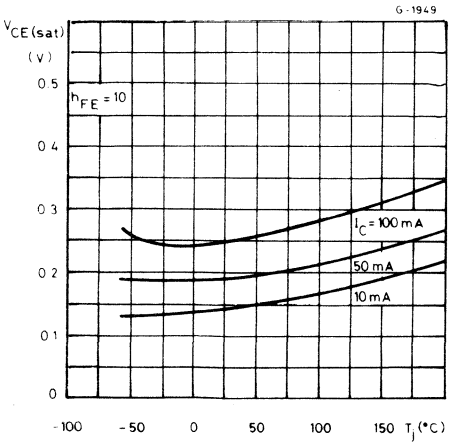
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 20V V_{CB} = 20V T_{amb} = 150°C			0.4 30	μA μA
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 15V T_{amb} = 55°C V_{CE} = 40V			0.4 1	μA μA
I_{CEX}	Collector cutoff current (V_{BE} = -3V)	V_{CE} = 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
$V_{(BR)CEO}$*	Collector-emitter breakdown 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)

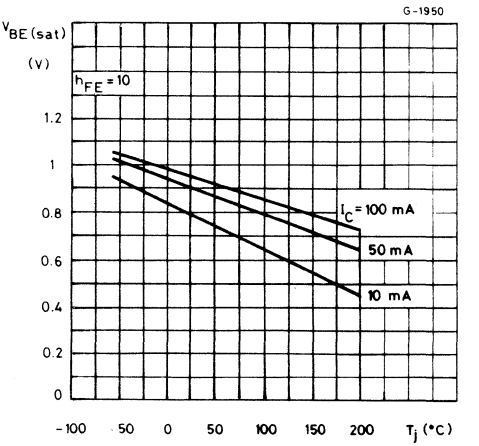
Parameter		Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	$I_C = 10$ mA $V_{CE} = 10$V for **BSX 19** for **BSX 20**	 400 500	 500 600		 MHz MHz
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 1$V			4.5	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 5$V			4	pF
t_s **	Storage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

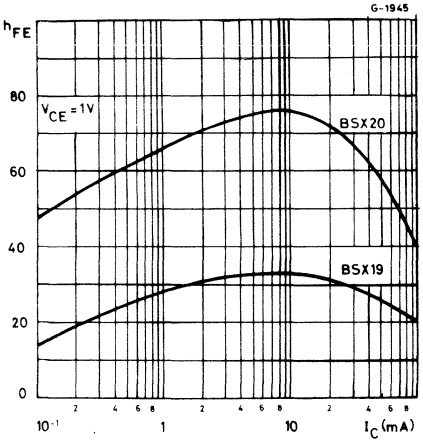
Collector-emitter saturation voltage



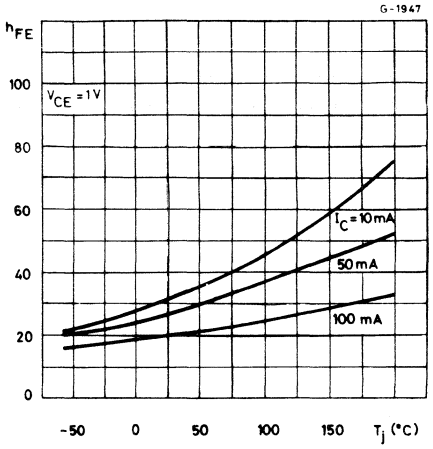
Base-emitter saturation voltage



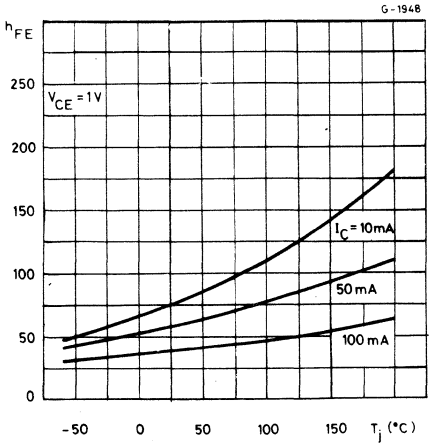
DC current gain



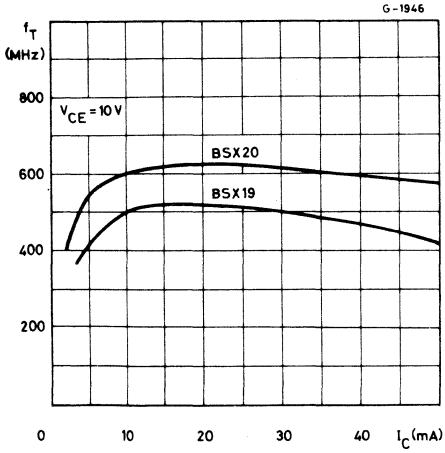
DC current gain (for **BSX 19** only)



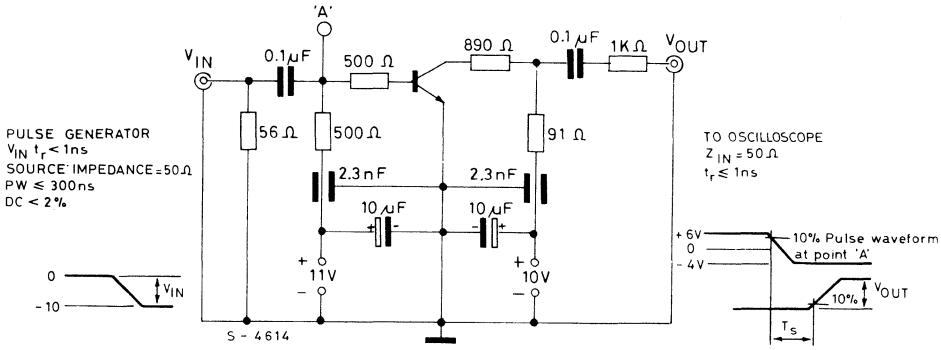
DC current gain (for **BSX 20** only)



Transition frequency



Test circuit for t_s



EPITAXIAL 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.

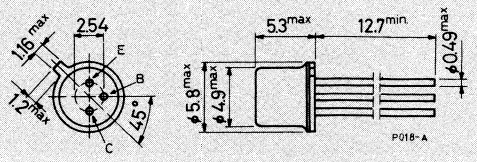
ABSOLUTE MAXIMUM RATINGS

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 $T_{amb} \leqslant 25°C$	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

$R_{th\ j-case}$	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_{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
$V_{(BR)CEO}$ *	Collector-emitter breakdown 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	I_B = 3mA				
		T_{amb} = 85°C			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			–

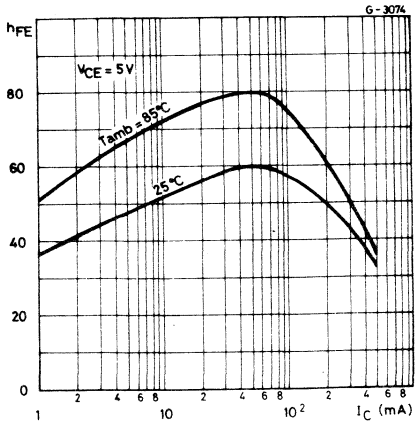
ELECTRICAL CHARACTERISTICS (continued)

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

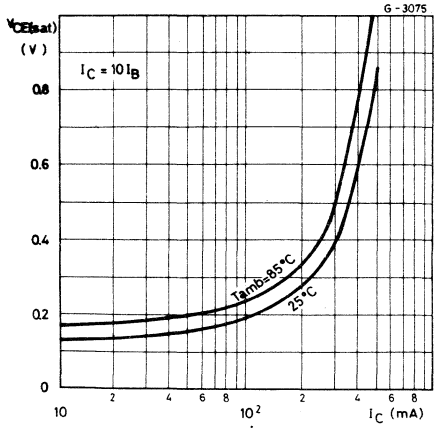
*Pulsed: pulse duration = 300 μs, duty cycle = 1%

** See test circuit.

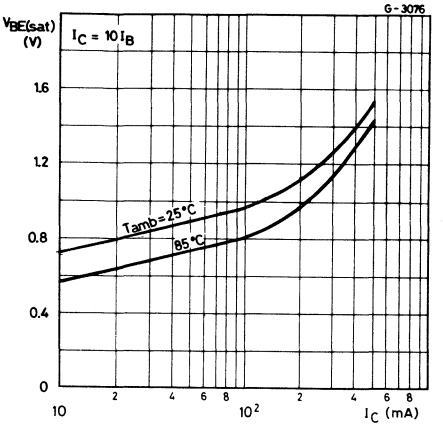
DC current gain



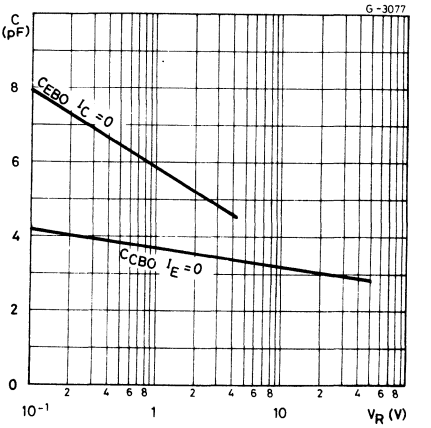
Collector - emitter saturation voltage



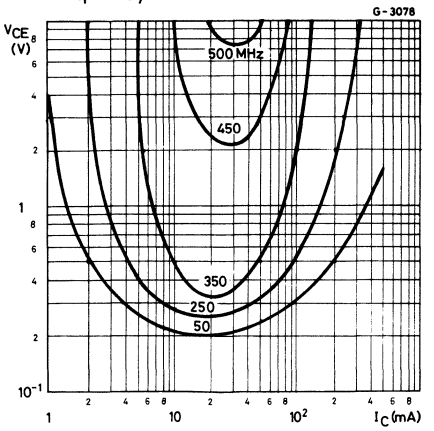
Base - emitter saturation voltage



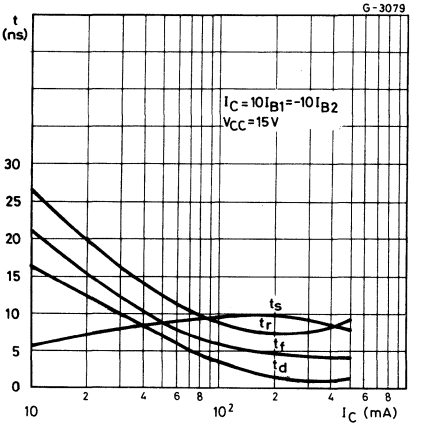
Emitter - base and collector - base capacitances



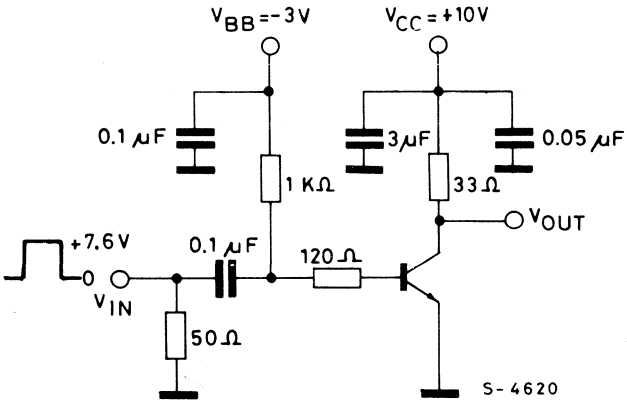
Contours of constant transition frequency



Switching characteristics



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
t_r, t_f < 1.0 ns
PW ≥ 240 ns
Z_{IN} = 50Ω

TO OSCILLOSCOPE:
t_r < 1.0 ns
Z_{IN} ≈ 100 kΩ

BSX 28

EPITAXIAL PLANAR NPN

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.

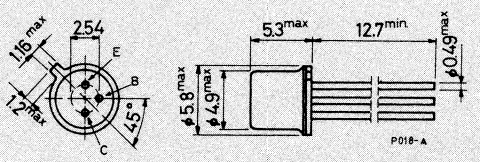
ABSOLUTE MAXIMUM RATINGS

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 $T_{amb} \leqslant 25°C$	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)

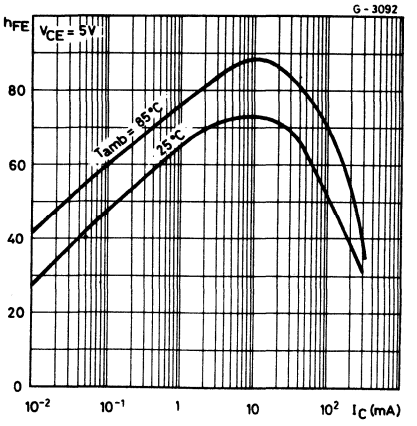
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 20V V_{CE} = 20V T_{amb} = 85°C			0.4 10	μA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10μA	30			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10μA	30	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

ELECTRICAL CHARACTERISTICS (continued)

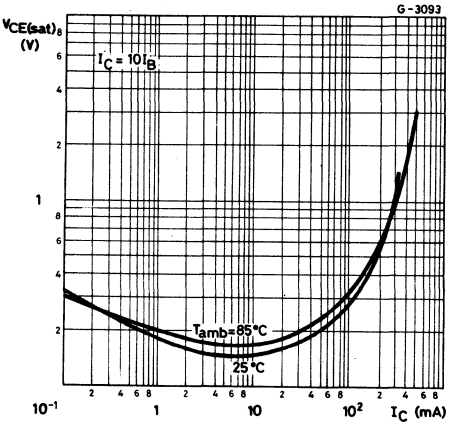
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 5V$ f = 1 MHz		2.3	4	pF
t_s	Storage time	$I_C = 10mA$ $V_{CC} = 10V$ $I_{B1} = -I_{B2} = 10$ mA		6.5	13	ns
t_{on}	Turn-on time	$I_C = 30mA$ $V_{CC} = 2V$ $I_{B1} = 3mA$		9	15	ns
t_{off}	Turn-off time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

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

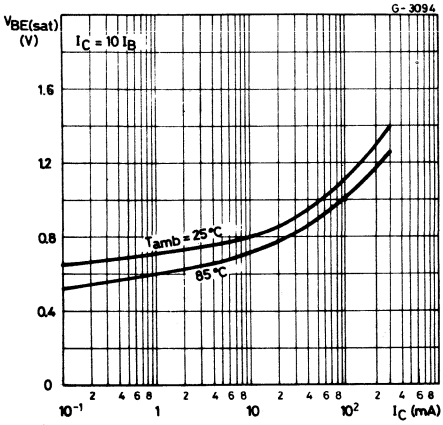
DC current gain



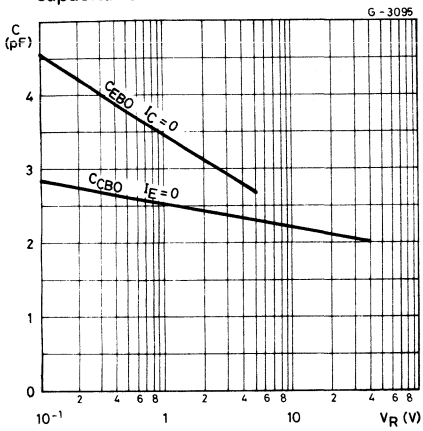
Collector - emitter saturation voltage



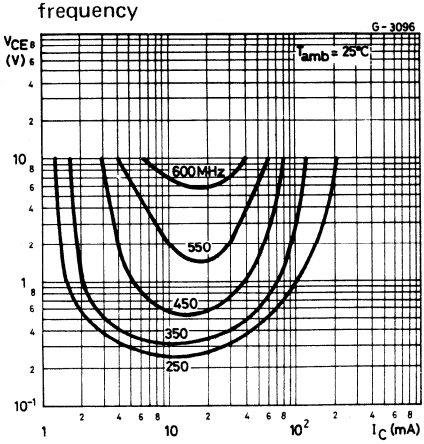
Base - emitter saturation voltage



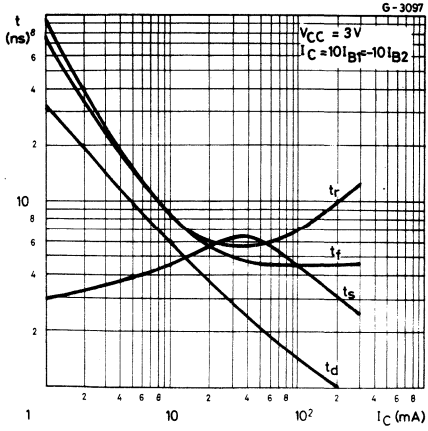
Emitter - base and collector - base capacitances



Contours of constant transition frequency



Switching characteristics



BSX 29

EPITAXIAL PLANAR PNP

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.

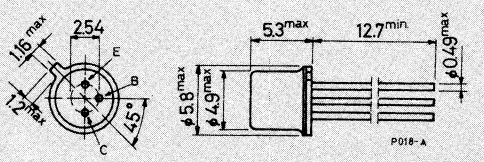
ABSOLUTE MAXIMUM RATINGS

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 $T_{amb} \leqslant 25°C$	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

$R_{th\ j-case}$	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_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = -6V V_{CE} = -6V T_{amb}=85°C			-80 -5	nA 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
$V_{(BR)CEO}$*	Collector-emitter breakdown 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 I_C = -30mA I_B = -3mA I_C = -100mA I_B = -10mA I_C = -30mA I_B = -3mA T_{amb} = 85°C		-0.07 -0.1 -0.25 -0.15	-0.15 -0.2 -0.5 -0.4	V V V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = -10mA I_B = -1mA I_C = -30mA I_B = -3mA I_C = -100mA I_B = -10mA	-0.75 -0.80 	 -1.4	-0.95 -1 -1.7	V V V
h_{FE}*	DC current gain	I_C = -10mA V_{CE}=-0.3V I_C = -30mA V_{CE}=-0.5V I_C = -100mA V_{CE}=-1V	25 30 20	50 60 40	 120 	– – –
f_T	Transition frequency	I_C = -30mA V_{CE}=-10V f = 100MHz	400	700		MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB}= -0.5V f = 1MHz		3.8	6	pF

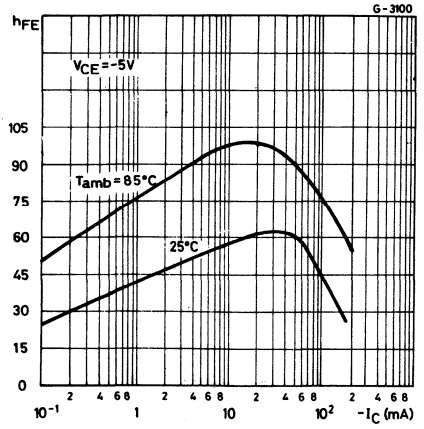
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB}=-5V$ f = 1 MHz		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

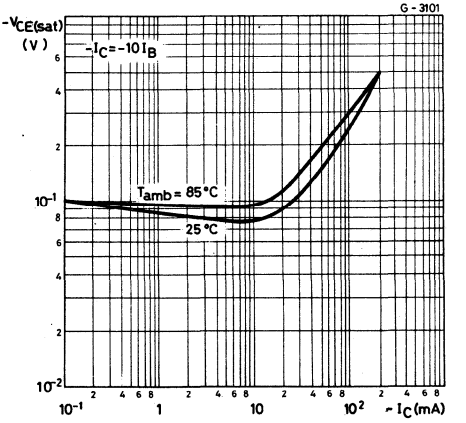
* Pulsed: pulse duration = 300μs, duty cycle = 1%

** See test circuit

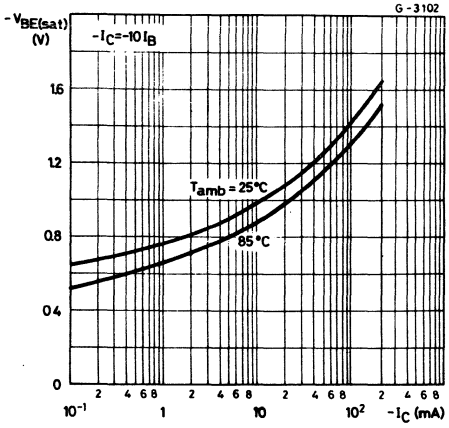
DC current gain



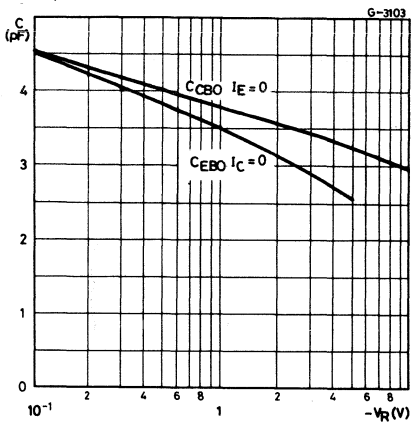
Collector - emitter saturation voltage



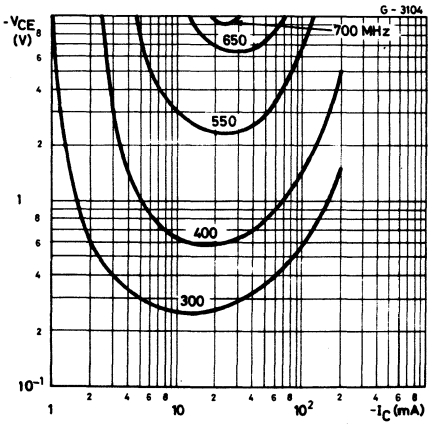
Base - emitter saturation voltage



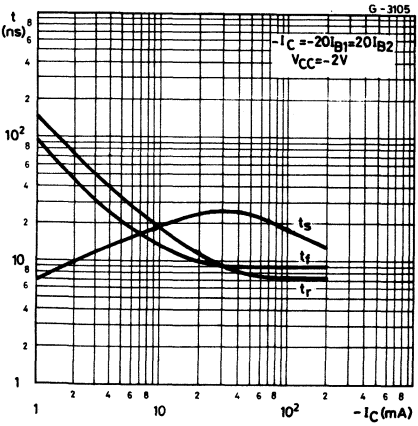
Emitter - base and collector - base capacitances



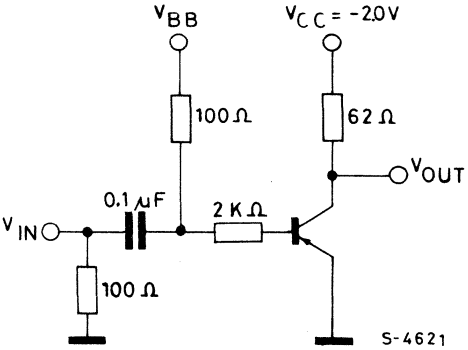
Contours of constant transition frequency



Switching characteristics



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
$t_r \leqslant 1.0$ ns
PW = 400 ns
$Z_{IN} = 50\Omega$

TO OSCILLOSCOPE:
$t_r \leqslant 1.0$ ns
$Z_{IN} \geqslant 100$ kΩ

t_{on} $V_{BB} = +3.0V$, $V_{IN} = -7.0V$
t_{off} $V_{BB} = -4.0V$, $V_{IN} = +6.0V$

EPITAXIAL 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.

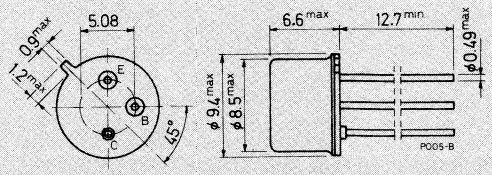
ABSOLUTE MAXIMUM RATINGS

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**)

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 ($I_E = 0$)	$V_{CB} = 50V$			0.25	4	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\mu A$		65			V
$V_{(BR)CEO}$*	Collector-emitter breakdown 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	$I_C = 50mA$	$V_{CE} = 10V$				
		$f = 100MHz$			400		MHz

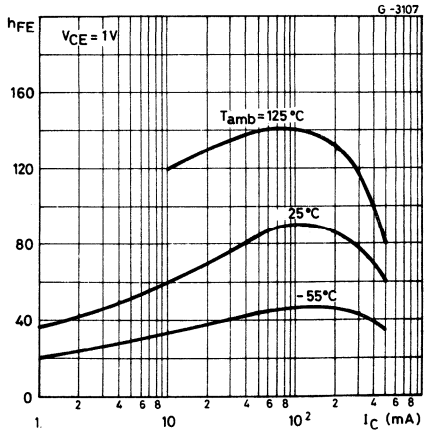
ELECTRICAL CHARACTERISTICS (continued)

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	$I_C = 500mA$ $V_{CC} \equiv 30V$ $I_{B1} = -I_{B2} = 50mA$		40	60	ns

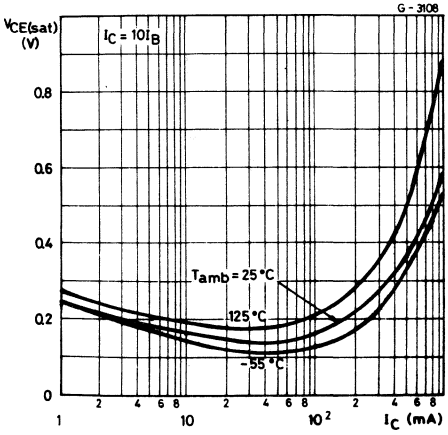
* Pulsed: pulse duration = 300μs, duty cycle = 1%

** See test circuit

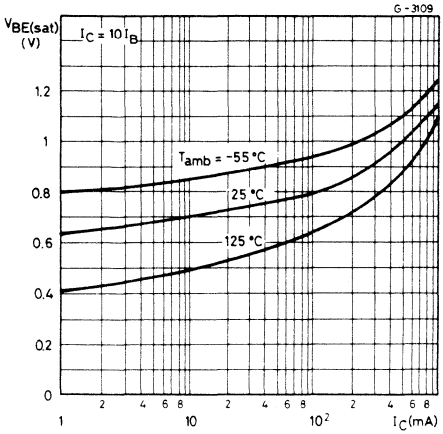
DC current gain



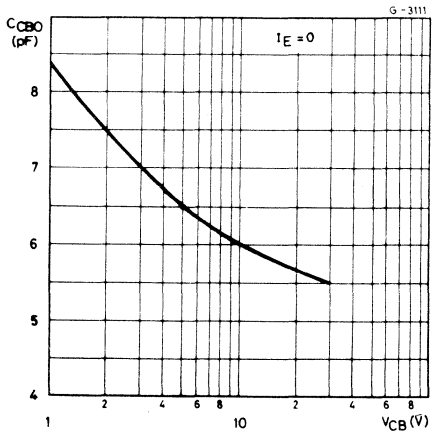
Collector - emitter saturation voltage



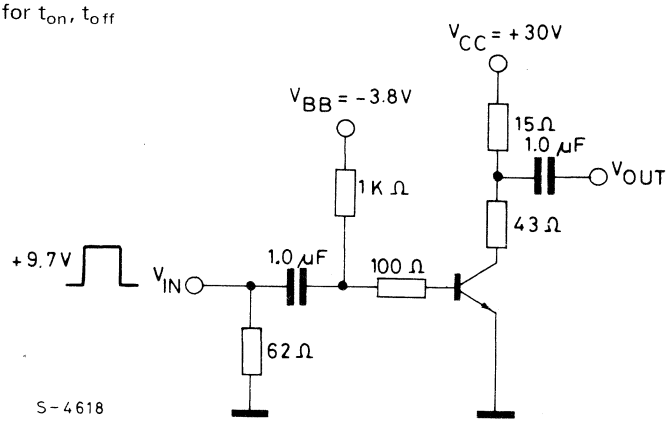
Base - emitter saturation voltage



Collector - base capacitance



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
$t_r, t_f \leqslant 1.0$ ns
PW ≈ 1.0 μs
$Z_{IN} = 50\Omega$
DC < 2%

TO OSCILLOSCOPE:
$t_r < 1.0$ ns
$Z_{IN} \geqslant 100$ kΩ

EPITAXIAL PLANAR NPN

BSX 33

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.

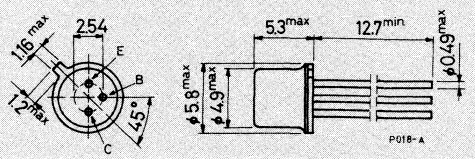
ABSOLUTE MAXIMUM RATINGS

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**)

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)

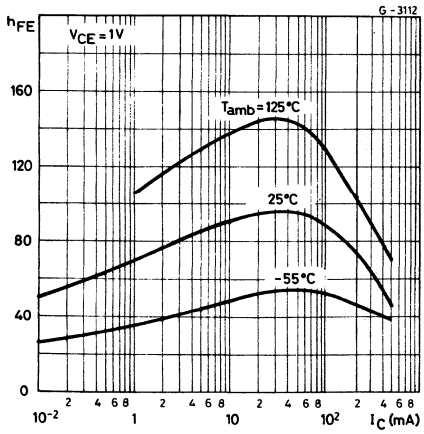
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 60V$				10	nA
		$V_{CB} = 60V$	$T_{amb} = 150°C$			10	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = 5V$				10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\mu A$		85			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 30$ mA		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		–
		$I_C = 10mA$	$V_{CE} = 1V$	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)

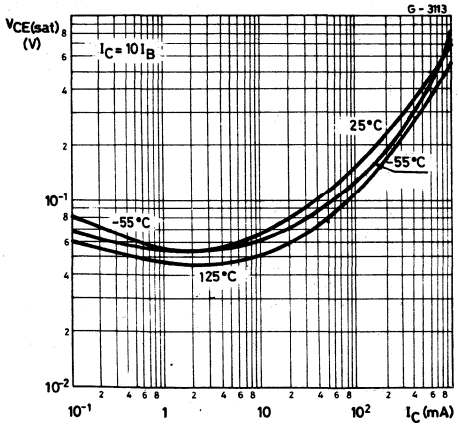
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5V$ f = 1MHz		50	80	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10V$ f = 1MHz		12	20	pF
h_{ie}	Input impedance	$I_C = 1mA$ $V_{CE} = 5V$ f = 1 kHz		2		kΩ
h_{re}	Reverse voltage transfer ratio	$I_C = 1mA$ $V_{CE} = 5V$ f = 1kHz		2.2×10^{-4}		–
h_{oe}	Output admittance	$I_C = 1mA$ $V_{CE} = 5V$ f = 1 kHz		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%

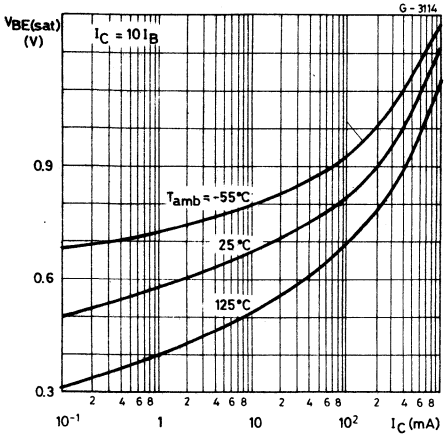
DC current gain



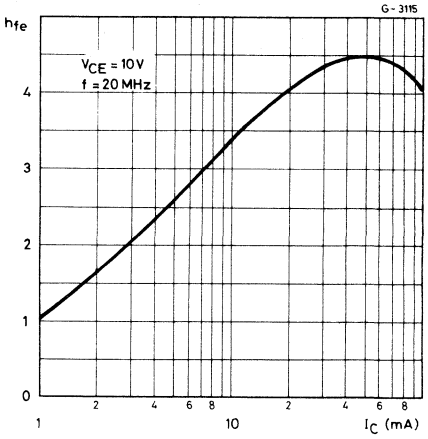
Collector-emitter saturation voltage voltage



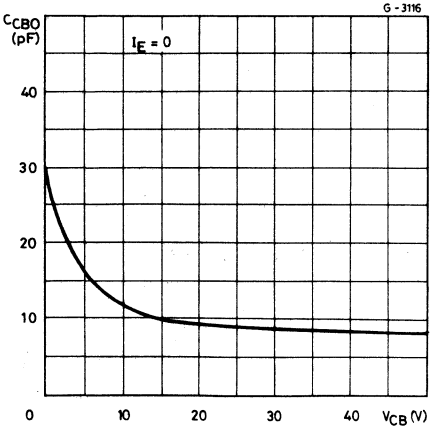
Base - emitter saturation voltage



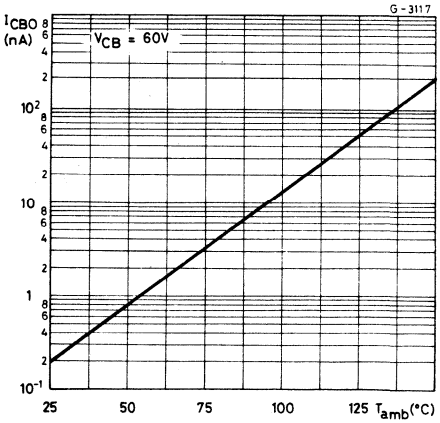
High frequency current gain



Collector - base capacitance



Collector cutoff current



EPITAXIAL 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.

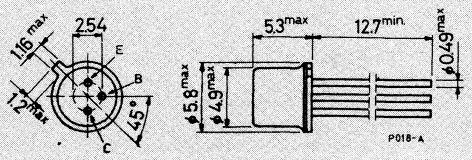
ABSOLUTE MAXIMUM RATINGS

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**)

THERMAL DATA

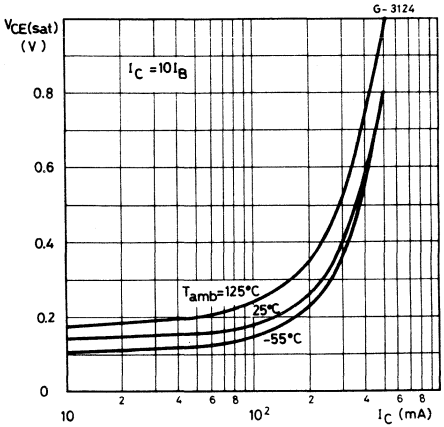
$R_{th\ j-case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

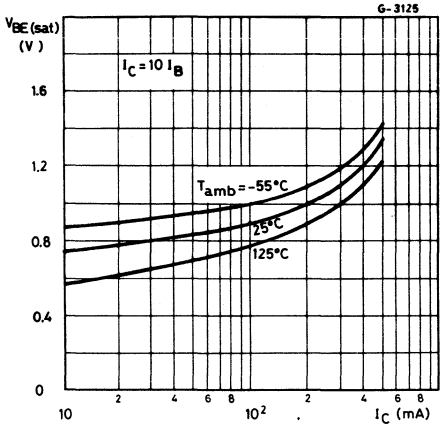
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 20V V_{CE} = 20V T_{amb} = 125°C			0.1 30	μA μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage(I_E = 0)	I_C = 100 μA	45			V
$V_{(BR)CEO}$*	Collec.-emitter breakdown voltage (I_B = 0)	I_C = 10 mA	20			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% ** See test circuit

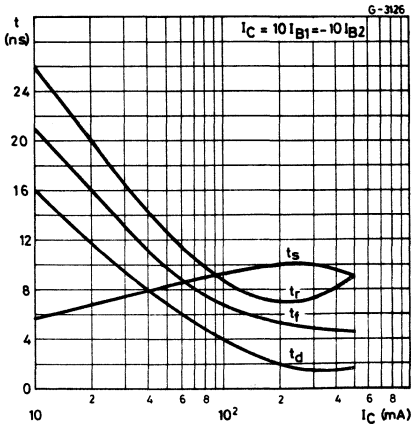
Collector - emitter saturation voltage



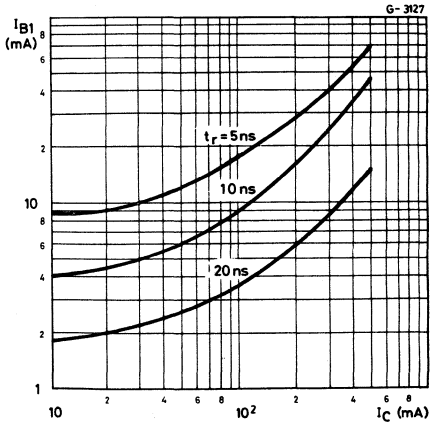
Base - emitter saturation voltage



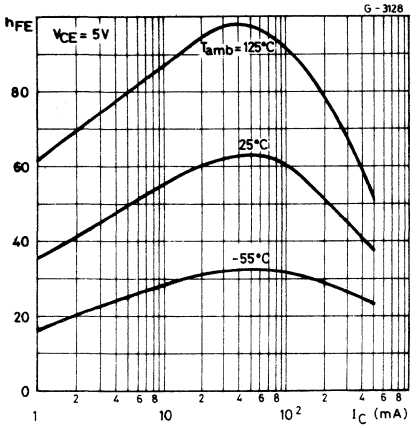
Switching characteristics



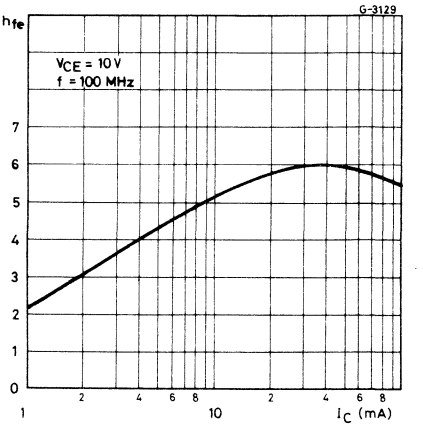
Switching characteristics



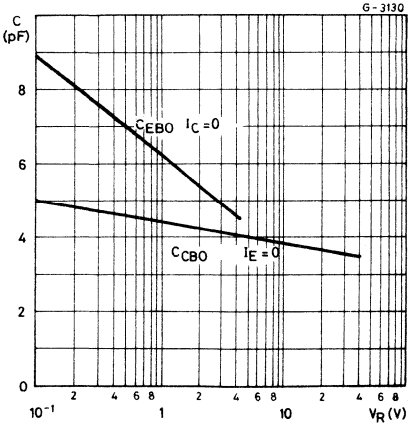
DC current gain



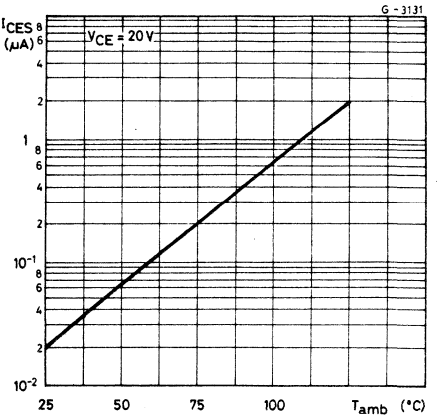
High frequency current gain



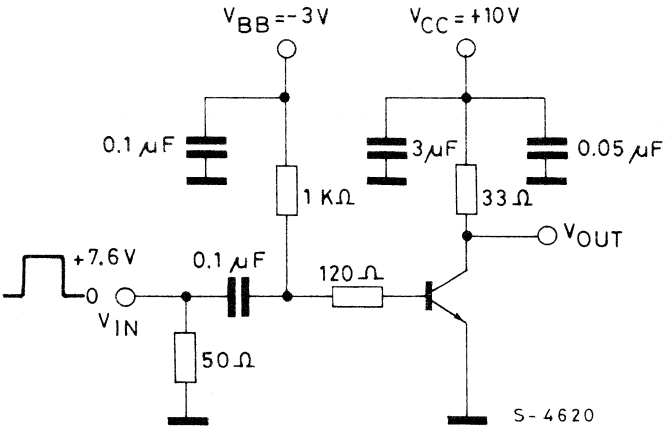
Emitter – base and collector – base capacitances



Collector cutoff current



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
t_r, t_f < 1.0 ns
PW ⩾ 240 ns
Z_{IN} = 50Ω

TO OSCILLOSCOPE:
t_r < 1.0 ns
Z_{IN} ≈ 100 KΩ

BSX 45
BSX 46

EPITAXIAL PLANAR NPN

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.

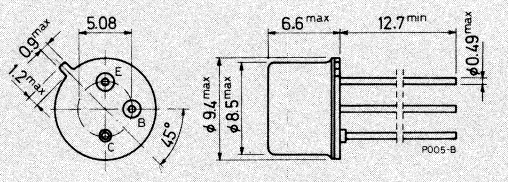
ABSOLUTE MAXIMUM RATINGS

		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**)

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)

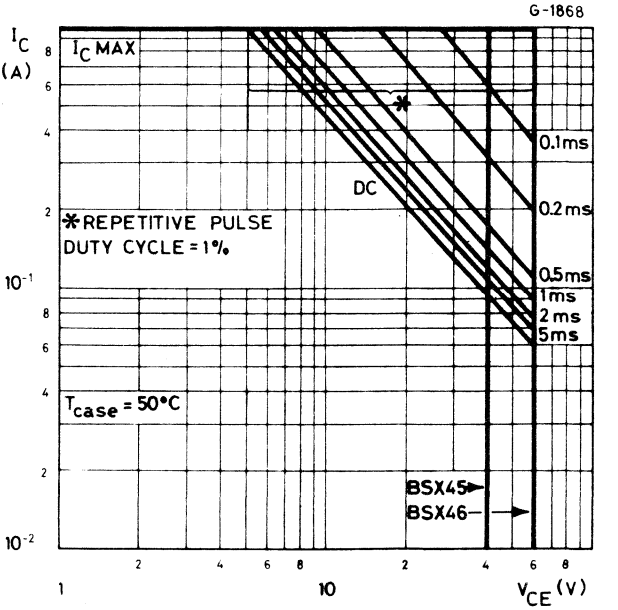
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 60V				30	nA
		V_{CE} = 60V	T_{amb} = 150°C			10	μA
I_{CEX}	Collector cutoff current (V_{BE} = -0.2V)	V_{CE} = 60V	T_{amb} = 100°C			50	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V				10	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
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30 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
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)

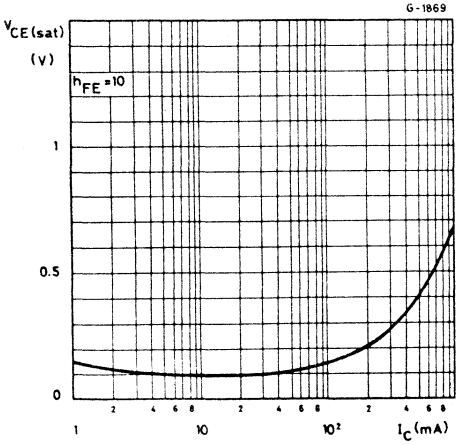
Parameter		Test conditions		Min.	Typ.	Max.	Unit
f_T	Transition frequency	I_C = 50 mA f = 20 MHz	V_{CE} = 10V	50			MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 f = 1 MHz	V_{EB} = 0.5V			80	pF
C_{CBO}	Collector-base capacitance	I_E = 0 f = 1 MHz	V_{CB} = 10V for **BSX 45** for **BSX 46**		 25 20		 pF pF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

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

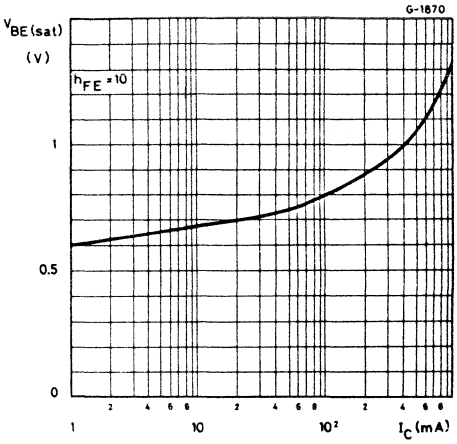
Safe operating areas



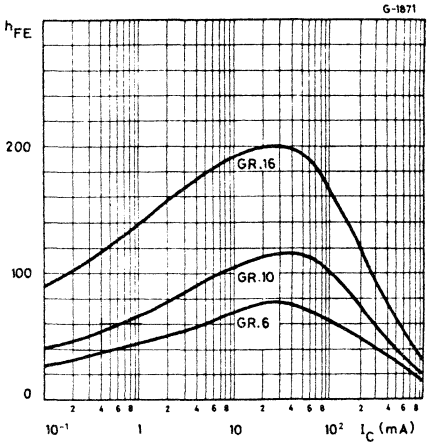
Collector-emitter saturation voltage



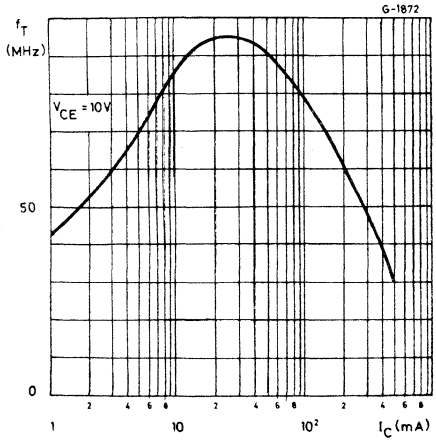
Base-emitter saturation voltage



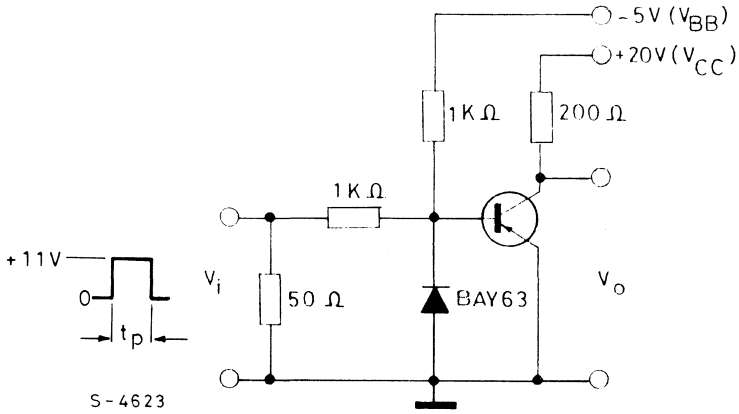
DC current gain



Transition frequency



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
$t_p \geqslant 10\ \mu s$
$t_r \leqslant 15$ ns
$t_f \leqslant 15$ ns
$Z_s = 50\Omega$

TO OSCILLOSCOPE:
$t_r \leqslant 15$ ns
$Z_{IN} \geqslant 100\ K\Omega$

EPITAXIAL PLANAR NPN

BSX 88A

HIGH FREQUENCY, HIGH SPEED

The BSX 88A is a silicon planar epitaxial NPN transistor specially designed as high speed saturated logic switch. It features 20 Volt. V_{CEO}, low saturation voltage and fast switching times from 10 to 300 mA.

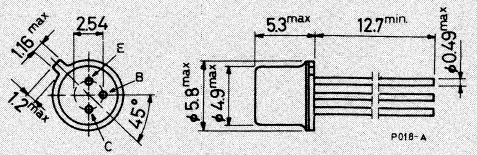
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	20	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5.5	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
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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THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	145	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	486	°C/W

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

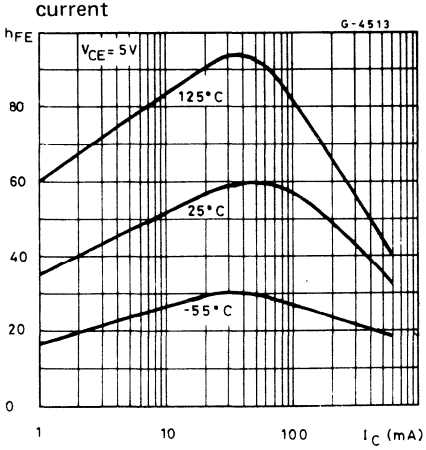
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{EB} = 0)	V_{CE} = 20V				0.3	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA		40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 100 μA		5.5			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA		20			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 10 mA I_C = 100 mA	I_B = 1 mA I_B = 10 mA			0.18 0.39	V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 10 mA I_C = 100 mA	I_B = 1 mA I_B = 10 mA	0.72	0.77	0.8 1.2	V V
h_{FE}*	DC current gain	I_C = 0.5 mA I_C = 10 mA I_C = 100 mA	V_{CE} = 1V V_{CE} = 1V V_{CE} = 1V	15 30 35	30 50 55		– – –
h_{fe}	High frequency current gain (f = 100 MHz)	I_C = 30 mA	V_{CE} = 10V	3.5	5.8		–
C_{CBO}	Collector-base capacitance	I_E = 0 f = 1 MHz	V_{CB} = 5V		3	5	pF
C_{EBO}	Emitter-base capacitance	I_C = 0 f = 1 MHz	V_{EB} = 0.5V		7	8	pF

ELECTRICAL CHARACTERISTICS (continued)

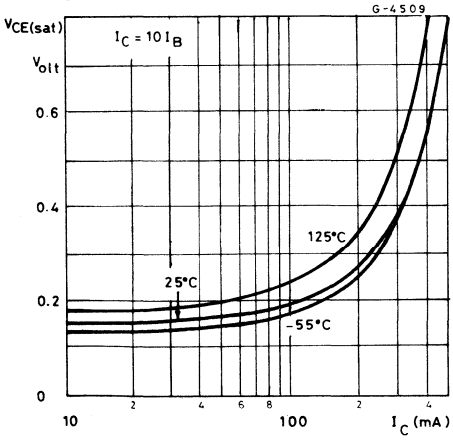
Parameter		Test conditions	Min.	Typ.	Max.	Unit
t_s**	Change storage time costant	$I_C = I_{B1} = I_{B2} = 10$ mA			20	ns
t_{on}**	Turn on time	$I_C = 10$ mA $I_{B1} = 3$ mA $V_{BE} = -2V$			30	ns
t_{off}**	Turn off time	$I_C = 10$ mA $I_{B1} = 3$ mA $V_{BE} = -2V$			70	ns

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

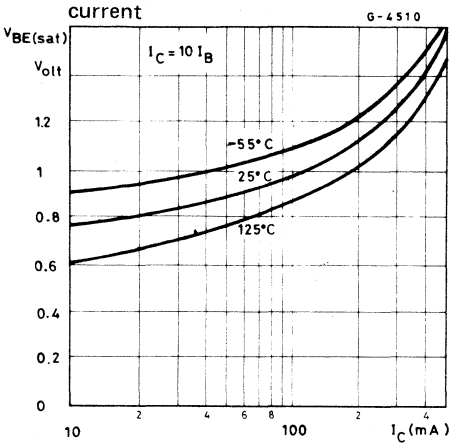
DC pulse current gain vs. collector current



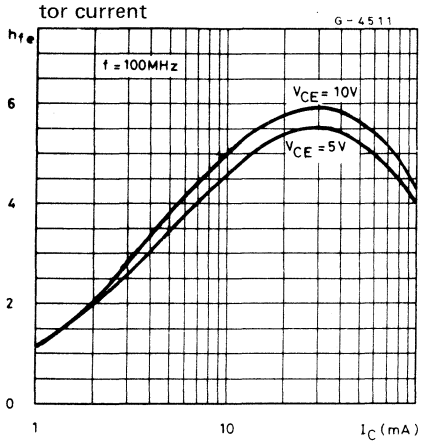
Collector saturation voltage vs. collector current



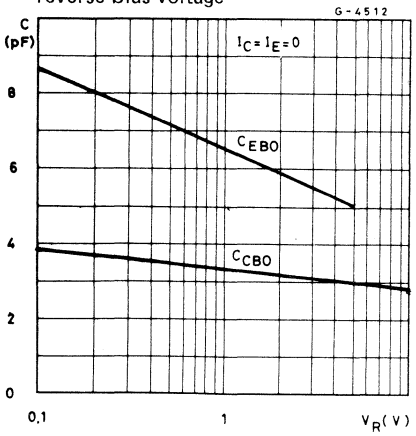
Base saturation voltage vs. collector current



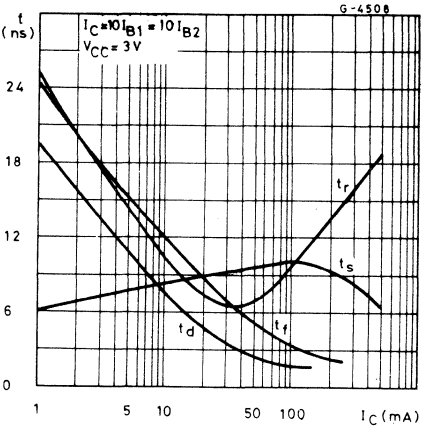
High frequency current gain vs. collector current



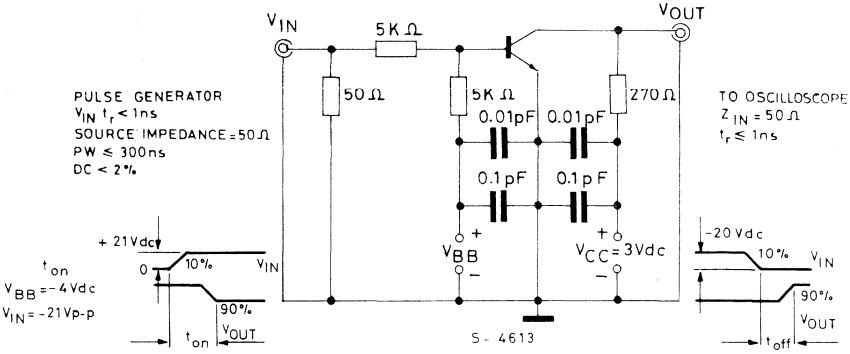
Input and output capacitance vs. reverse bias voltage



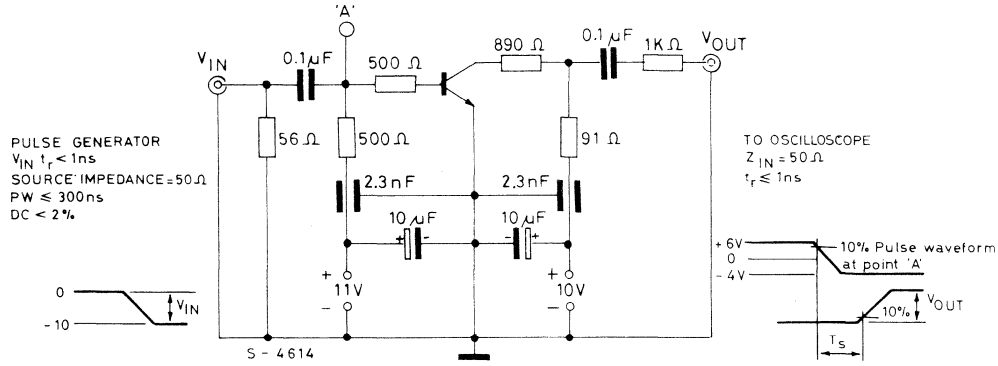
Switching times vs. collector current



Test circuit for t_{on}, t_{off}



Test circuit for t_s



BSX 93

EPITAXIAL 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.

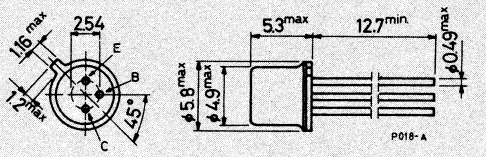
ABSOLUTE MAXIMUM RATINGS

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 μs)	500	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)

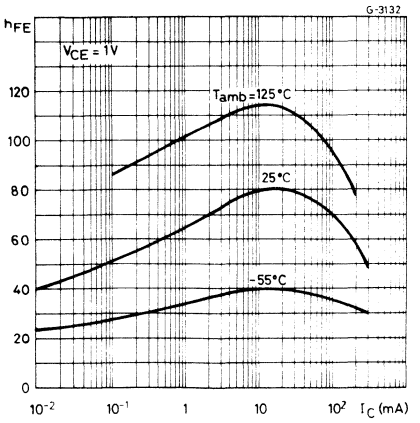
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 20V V_{CB} = 20V T_{amb} = 150°C			0.2 70	μA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA	40			V
$V_{(BR)CES}$ *	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10 μA	40			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown 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 I_C = 100 mA V_{CE} = 1V I_C = 10 mA V_{CE} = 1V T_{amb} = -55°C	40 20 20	80 70 40	120	– – –
f_T	Transition frequency	I_C = 10 mA V_{CE} = 10V f = 100 MHz	400	650		MHz

ELECTRICAL CHARACTERISTICS (continued)

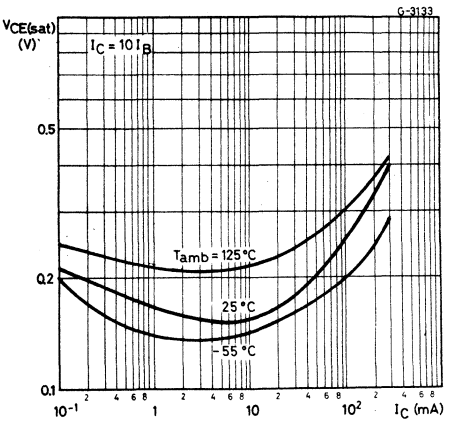
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5V$ f = 1 MHz		3.8	6	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 5V$ f = 1 MHz		2.5	4	pF
t_s	Storage time	$I_C = 10$ mA $V_{CC} = 10V$ $I_{B1} = -I_{B2} = 10$ mA		6	13	ns
t_{on} **	Turn-on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

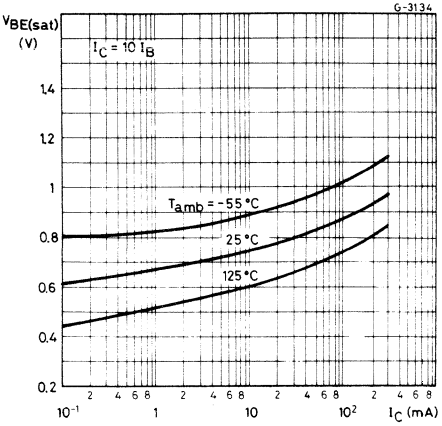
DC current gain



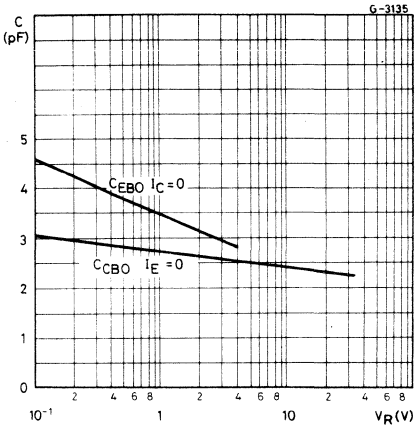
Collector-emitter saturation voltage



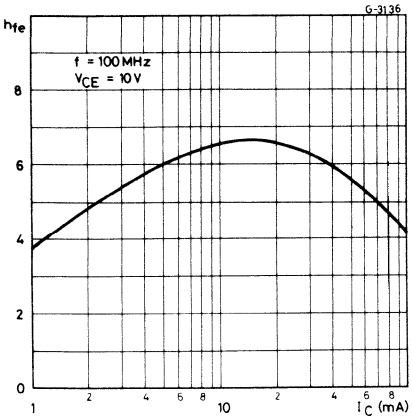
Base-emitter saturation voltage



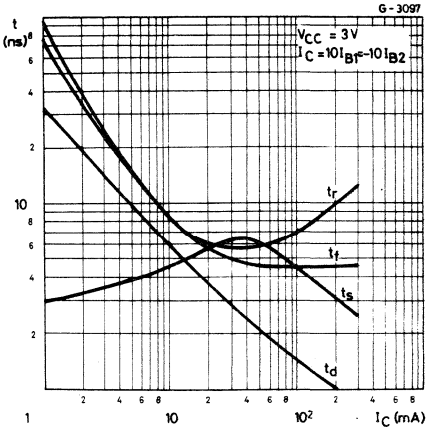
Emitter-base and collector-base capacitances



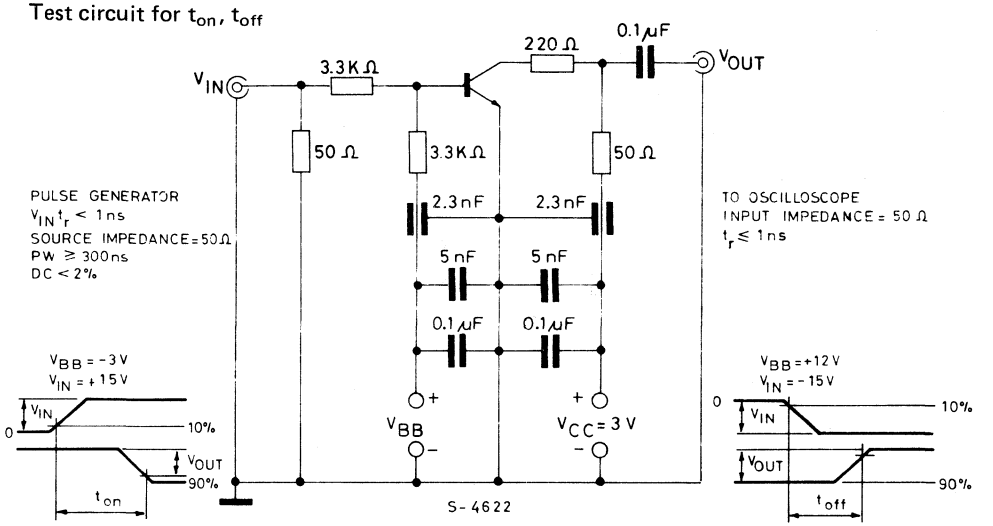
High frequency current gain



Switching characteristics



Test circuit for t_{on}, t_{off}



EPITAXIAL PLANAR NPN

BSY 53
BSY 54

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.

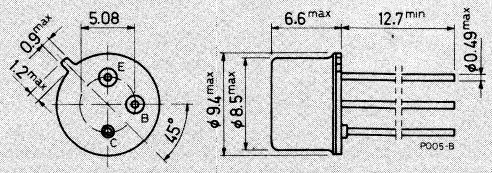
ABSOLUTE MAXIMUM RATINGS

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**)

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)

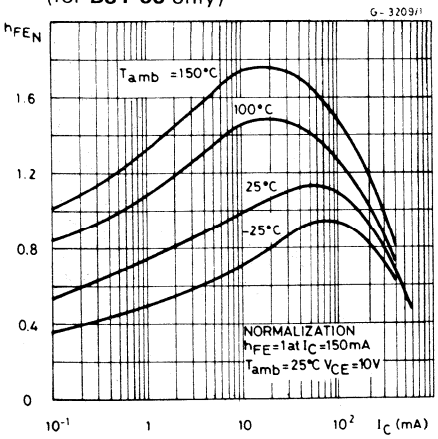
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 60V				10	nA
		V_{CB} = 60V	T_{amb} = 150°C			10	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V				10	nA
$V_{CE(sat)}$ *	Collector-emitter saturation-voltage	I_C = 150 mA	I_B = 15 mA		0.15	0.6	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	75	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	V_{CE} = 10V				
		f = 50 MHz			100		MHz
C_{CBO}	Collector-base capacitance	I_E = 0	V_{CB} = 10V				
		f = 1 MHz			10		pF
C_{EBO}	Emitter-base capacitance	I_C = 0	V_{EB} = 0.5V				
		f = 1 MHz			23		pF
NF	Noise figure	I_C = 0.3 mA	V_{CE} = 10V				
		R_g = 1.5 kΩ	f=30Hz to 15kHz		3	8	dB

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

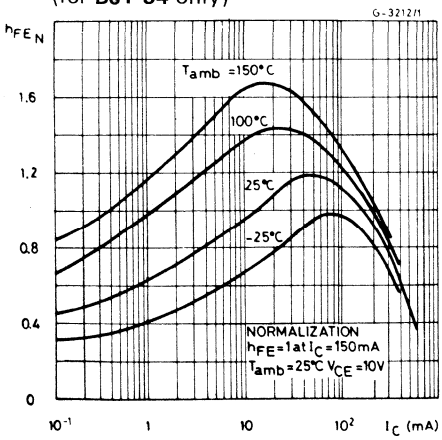
ELECTRICAL CHARACTERISTICS (continued)

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		150	–
			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

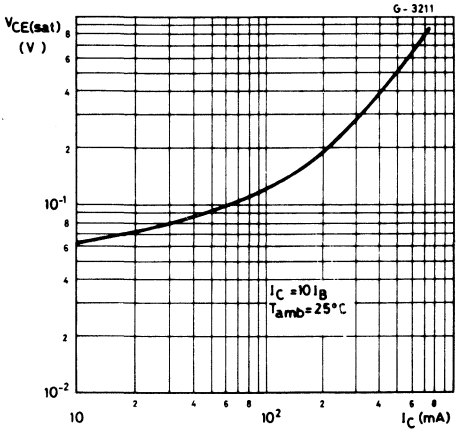
DC normalized current gain
(for **BSY 53** only)



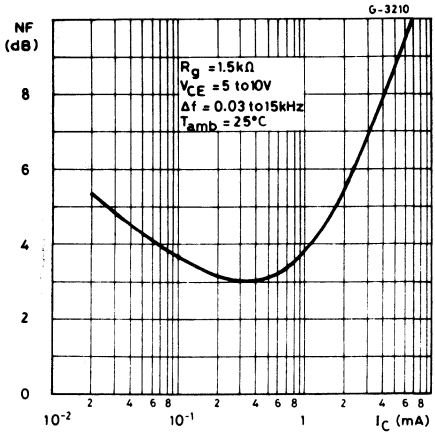
DC normalized current gain
(for **BSY 54** only)



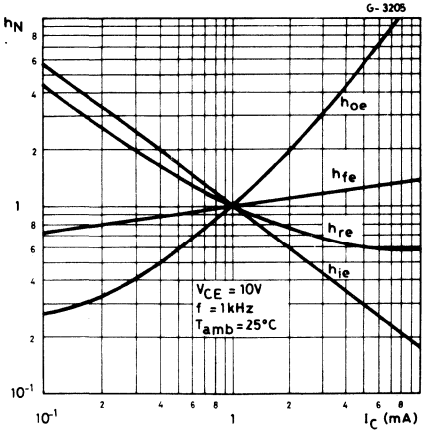
Collector-emitter saturation voltage



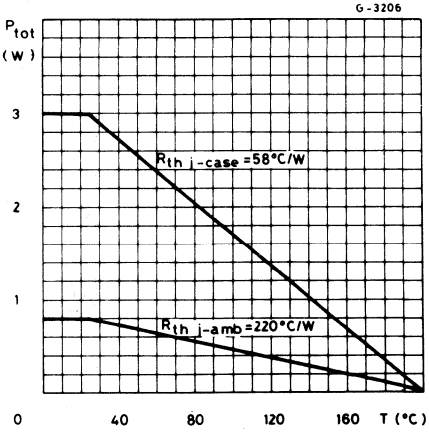
NF vs. collector current



Normalized h parameters



Power rating chart



EPITAXIAL PLANAR NPN

BSY 55
BSY 56

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.

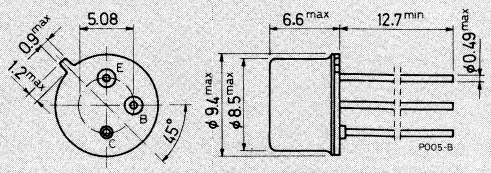
ABSOLUTE MAXIMUM RATINGS

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**)

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)

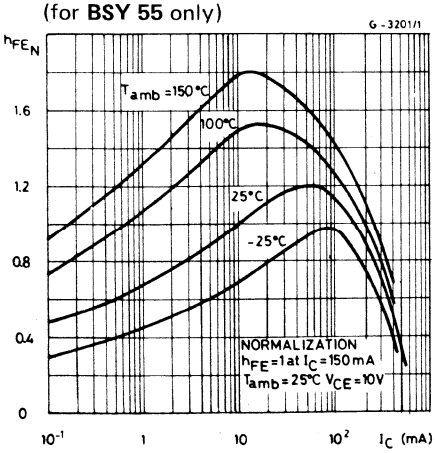
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 90V			10	nA
		V_{CB} = 90V T_{amb} = 150°C			10	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			10	nA
$V_{CE(sat)}$ *	Collector-emitter saturation-voltage	I_C = 150 mA I_B = 15 mA		0.2	0.6	V
$V_{BE(sat)}$ *	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 V_{CE} = 10V f = 50 MHz		100		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 1 MHz		10		pF
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz		23		pF
NF	Noise figure	I_C = 0.3 mA V_{CE} = 10V R_g = 1.5 kΩ f=30Hz to 15kHz		6		dB

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

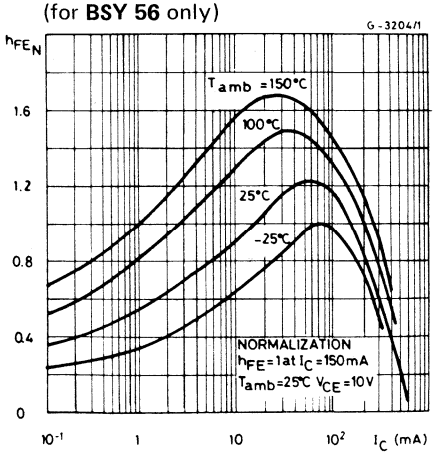
ELECTRICAL CHARACTERISTICS (continued)

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

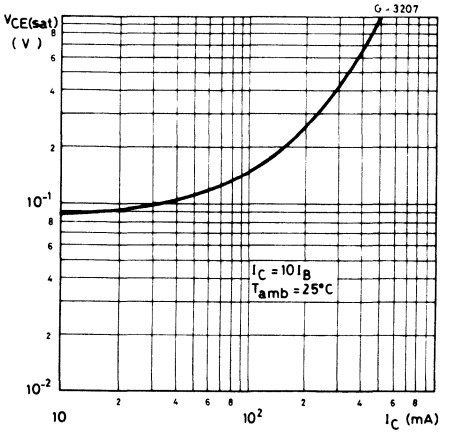
DC normalized current gain
(for **BSY 55** only)



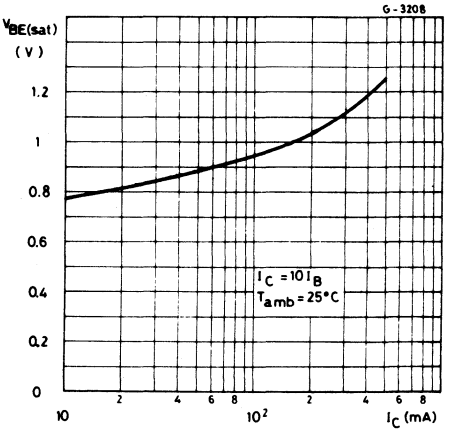
DC normalized current gain
(for **BSY 56** only)



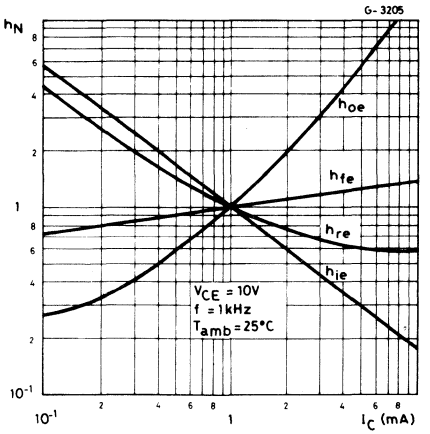
Collector-emitter saturation voltage



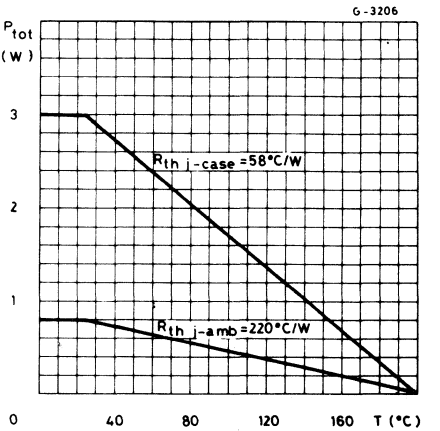
Base-emitter saturation voltage



Normalized h parameters



Power rating chart



EPITAXIAL PLANAR NPN

2N 708

HIGH SPEED SATURATED SWITCH

The 2N708 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, designed for very fast switching applications.

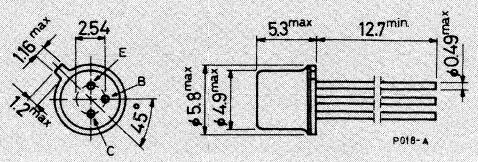
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	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	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_g	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			25 15	nA 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 = 10 mA	15			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_C = 0)	I_E = 10 μA	5			V
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 4V			100	nA
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 10 mA I_B = 1 mA			0.4	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 10 mA I_B = 1 mA			0.9	V
h_{FE}*	DC current gain	I_C = 0.5 mA V_{CE} = 1V I_C = 10 mA V_{CE} = 1V T_{amb} = -55°C I_C = 10 mA V_{CE} = 1V	15 30 15		 120 	– – –
h_{fe}	High frequency current gain	I_C = 10 mA V_{CE} = 10V f = 100 MHz	3			–
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 1 MHz			6	pF
t_s	Storage time	I_C = 10 mA V_{CC} = 10V I_{B1} = -I_{B2} = 10 mA			25	ns
t_{on}	Turn-on time	I_C = 10 mA V_{CC} = 10V I_{B1} = 3 mA			40	ns
t_{off}	Turn-off time	I_C = 10 mA V_{CC} = 10V I_{B1} = 3 mA I_{B2} = -1 mA			75	ns

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

EPITAXIAL PLANAR NPN

2N 718A
2N 956

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.

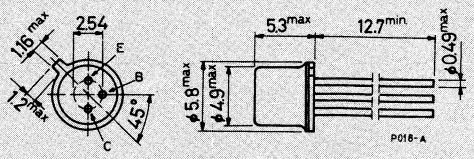
ABSOLUTE MAXIMUM RATINGS

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**)

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} = 60V V_{CB} = 60V T_{amb} = 150°C			10 10	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V for **2N 718A** for **2N 956**			10 5	nA nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	75			V
$V_{(BR)CER}$ *	Collector-emitter breakdown 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	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 I_C = 10 mA V_{CE} = 10V I_C = 150 mA V_{CE} = 10V I_C = 500 mA V_{CE} = 10V I_C = 10 mA V_{CE} = 10V T_{amb} = -55°C for **2N 956** I_C = 0.01 mA V_{CE} = 10V I_C = 0.1 mA V_{CE} = 10V	 20 35 40 20 20 20 35		 120 	 – – – – – – –

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	V_{CE} = 10V				
		T_{amb} = -55°C		35			–
h_{fe}	Small signal current gain	for **2N 718A**					
		I_C = 1 mA	V_{CE} = 5V	30		150	–
		I_C = 5 mA	V_{CE} = 10V	35		150	–
		for **2N 956**					
		I_C = 1 mA	V_{CE} = 5V	50		300	–
		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			MHz
			for **2N 956**	70			MHz
C_{EBO}	Emitter-base capacitance	I_C = 0 f = 1 MHz	V_{EB} = 0.5V			80	pF
C_{CBO}	Collector-base capacitance	I_E = 0 f = 1 MHz	V_{CB} = 10V			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

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

SGS 2N 720A

EPITAXIAL PLANAR NPN

HIGH VOLTAGE GENERAL PURPOSE

The 2N720A is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case. It is suitable for a wide variety of amplifier and switching applications.

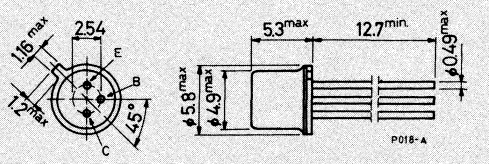
ABSOLUTE MAXIMUM RATINGS

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 ($I_C = 0$)	7	V
I_C	Collector current	500	mA
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**)

THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	97.2	°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				10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA		120			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30 mA		80			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage (I_E = 0)	I_E = 100 μA		7			V
I_{EBO}	Emitter cutoff current (I_E = 0)	V_{EB} = 5V				10	nA
$V_{CE(sat)}$ *	Collector-emitter saturation voltage	I_C = 50 mA I_C = 150 mA	I_B = 5 mA I_B = 15 mA			1.2 5	V V
$V_{BE(sat)}$ *	Base-emitter saturation voltage	I_C = 50 mA I_C = 150 mA	I_B = 5 mA I_B = 15 mA			0.9 1.3	V V
h_{FE} *	DC current gain	I_C = 100 μA I_C = 10 mA I_C = 150 mA	V_{CE} = 10V V_{CE} = 10V V_{CE} = 10V	20 35 40		 120	– – –
h_{fe}	High frequency current gain	I_C = 50 mA f = 20 MHz	V_{CE} = 10V	2.5			–
C_{CBO}	Collector-base capacitance	I_E = 0 f = 1 MHz	V_{CB} = 10V			15	pF
C_{EBO}	Emitter-base capacitance	I_C = 0 f = 1 MHz	V_{EB} = 0.5V			85	pF

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

SGS 2N 914

EPITAXIAL 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.

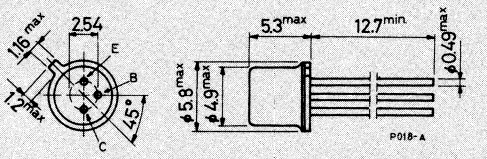
ABSOLUTE MAXIMUM RATINGS

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**)

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)

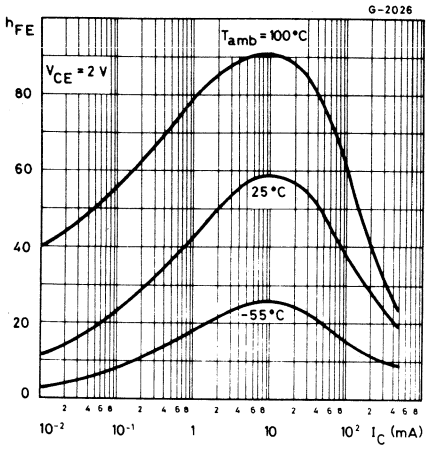
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = 20V			25	nA
		V_{CB} = 20V T_{amb} = 150°C			15	μA
I_{CEX}	Collector cutoff current (V_{BE} = -0.25V)	V_{CE} = 20V T_{amb} = 125°C			10	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = 4V			100	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = 1 μA	40			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage ($R_{BE} \leqslant 10\Omega$)	I_C = 10 mA	20			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = 30 mA	15			V

ELECTRICAL CHARACTERISTICS (continued)

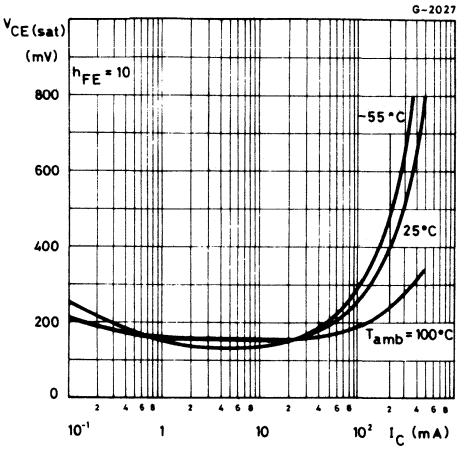
Parameter		Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu A$	5			V
$V_{CE(sat)}$ *	Collector-emitter saturation voltage	$I_C = 20$ mA $I_B = 2$ mA $I_C = 200$ mA $I_B = 20$ mA		0.2 0.4	0.25 0.7	V V
$V_{BE(sat)}$ *	Base-emitter saturation voltage	$I_C = 10$ 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%

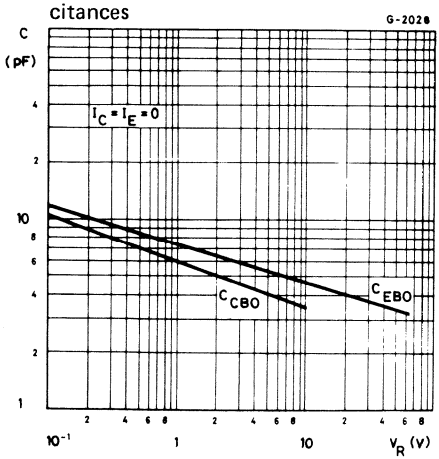
DC current gain



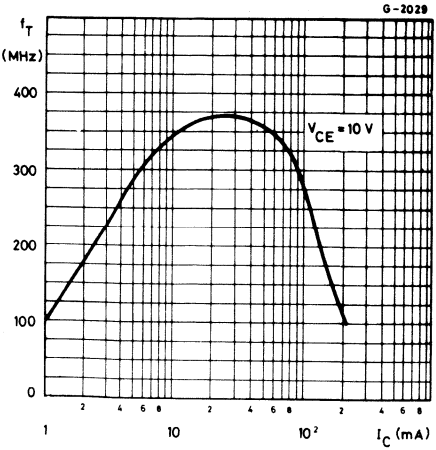
Collector-emitter saturation voltage



Collector-base and emitter-base capacitances



Transition frequency



SGS 2N 930

EPITAXIAL 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.

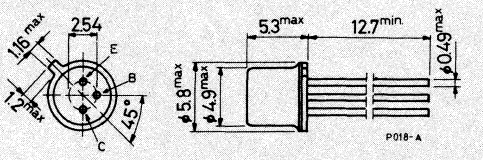
ABSOLUTE MAXIMUM RATINGS

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
$V_{(BR)CEO}$*	Collector-emitter breakdown 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

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

SGS

2N 1613
2N 1711

EPITAXIAL 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.

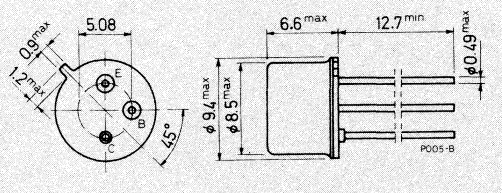
ABSOLUTE MAXIMUM RATINGS

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	°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 ($I_E = 0$)	$V_{CB} = 60V$			10	nA
		$V_{CB} = 60V$ $T_{amb} = 150°C$			10	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = 5V$ for **2N 1613**			10	nA
		for **2N 1711**			5	nA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage	$I_C = 0.1$ mA	75			V
$V_{(BR)CER}$ *	Collector-emitter breakdown 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		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		–

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 T_{amb} = -55°C	V_{CE} = 10V	35	65		–
h_{fe}	Small signal current gain	for **2N 1613**					
		I_C = 1 mA f = 1 kHz	V_{CE} = 10V	30	70	150	–
		for **2N 1711**					
		I_C = 1 mA f = 1 kHz	V_{CE} = 10V	70	135	300	–
f_T	Transition frequency	I_C = 50 mA f = 20 MHz	V_{CE} = 10V				
			for **2N 1613**	60	80		MHz
			for **2N 1711**	70	100		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		18	25	pF
NF	Noise figure	I_C = 0.3 mA R_g = 510Ω	V_{CE} = 10V f = 1 kHz				
			for **2N 1613**		6	12	dB
			for **2N 1711**		3.5	8	dB
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**		3.6×10^{-4}		–
			for **2N 1711**		7.3×10^{-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%.

EPITAXIAL PLANAR NPN

2N 1893

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.

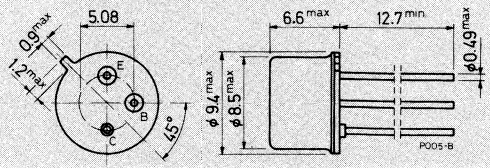
ABSOLUTE MAXIMUM RATINGS

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)

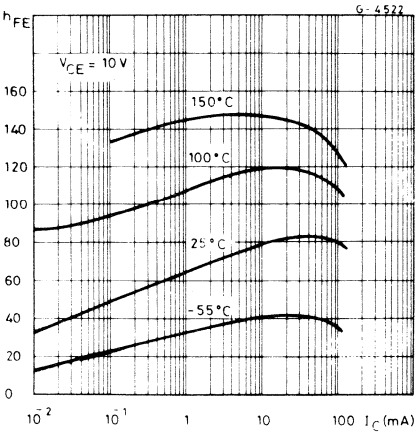
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 90V			10	nA
		V_{CB} = 90V T_{amb} = 150°C			15	μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	120			V
$V_{(BR)CER}$ *	Collector-emitter breakdown voltage ($R_{BE} \leqslant 10\ \Omega$)	I_C = 10 mA	100			V
$V_{(BR)CEO}$	Collector-emitter breakdown 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			0.5	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		–

ELECTRICAL CHARACTERISTICS (continued)

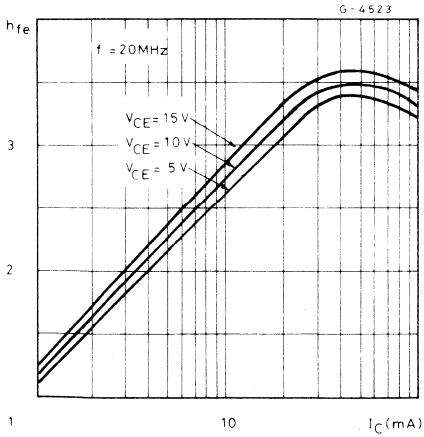
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	$I_C = 1$ mA $V_{CE} = 5$V f = 1 kHz	30	70	150	–
		$I_C = 5$ mA $V_{CE} = 10$V f = 1 kHz	45	85		–
f_T	Transition frequency	$I_C = 50$ mA $V_{CE} = 10$V f = 20 MHz	50	70		MHz
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5$V f = 1 MHz		55	85	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10$V f = 1 MHz		13	15	pF

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

DC current gain



High frequency current gain



SGS 2N 2102

EPITAXIAL PLANAR NPN

GENERAL PURPOSE AMPLIFIER AND SWITCH

The 2N2102 is a silicon planar epitaxial NPN transistor in Jedec TO-39 metal case. It is intended for a wide variety of small-signal and medium power applications in military and industrial equipments.

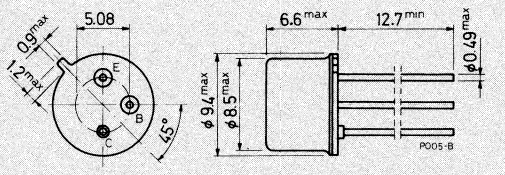
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	120	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	65	V
V_{CER}	Collector-emitter voltage ($R_{BE} \leqslant 10\Omega$)	80	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	1	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	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 V_{CB} = 60V T_{amb} = 150°C			2 2	nA μA
I_{EBO}	Emitter cutoff current (I_C = 0)	V_{EB} = 5V			5	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	120			V
$V_{CEO(sus)}$*	Collector-emitter sustaining voltage (I_B = 0)	I_C = 30 mA	65			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 150 mA I_B = 15 mA			0.5	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 = 10 μA V_{CE} = 10V I_C = 100 μA 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 = 1A V_{CE} = 10V	10 20 35 40 25 10		 120 	– – – – – –
h_{fe}	High frequency current gain	I_C = 50mA V_{CE} = 10V f = 20 MHz		6		–
NF	Noise figure	I_C=300μA V_{CE}=10V f=1KHz BW= 1 Hz R_G = 510Ω			8	dB
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 1 MHz			15	pF
C_{EBO}	Emitter-base capacitance	I_C = 0 V_{EB} = 0.5V f = 1 MHz			80	pF

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

SGS

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

EPITAXIAL PLANAR NPN

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.

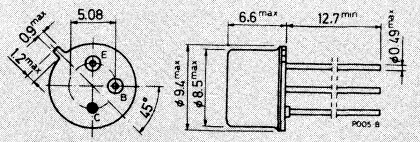
ABSOLUTE MAXIMUM RATINGS

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

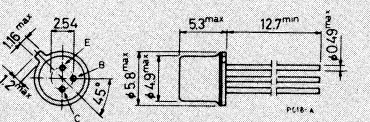
Dimensions in mm

Collector connected to case



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

Collector connected to case



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

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			10	nA
		V_{CB} = 50V T_{amb} = 150°C			10	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			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 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%

SGS

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

EPITAXIAL PLANAR NPN

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.

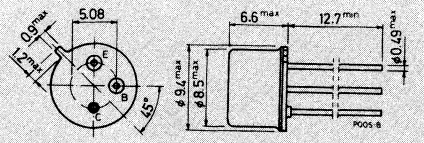
ABSOLUTE MAXIMUM RATINGS

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

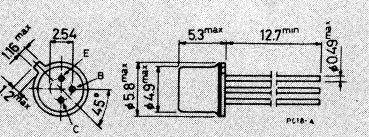
Dimensions in mm

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 ($I_E = 0$)	$V_{CB} = 60V$			10	nA
		$V_{CB} = 60V$ $T_{amb} = 150°C$			10	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	$I_C = 150\ mA$ $I_B = 15\ mA$			0.3	V
		$I_C = 500\ mA$ $I_B = 50\ mA$			1	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	$I_C = 150\ mA$ $I_B = 15\ mA$	0.6		1.2	V
		$I_C = 500\ mA$ $I_B = 50\ mA$			2	V
h_{FE}*	DC current gain	for **2N 2218A** and **2N 2221A**				
		$I_C = 0.1\ mA$ $V_{CE} = 10V$	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	–
		$I_C = 500\ mA$ $V_{CE} = 10V$	25			–
		$I_C = 150\ mA$ $V_{CE} = 1V$	20			–
		$I_C = 10\ mA$ $V_{CE} = 10V$ $T_{amb} = -55°C$	15			–

ELECTRICAL CHARACTERISTICS (continued)

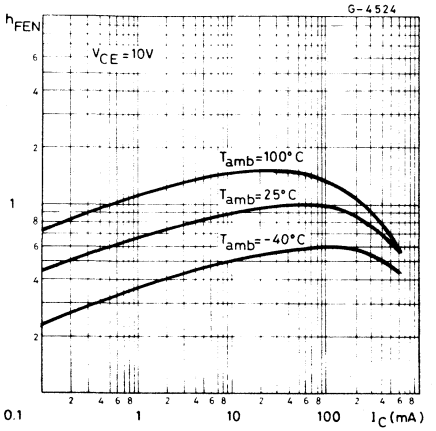
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE} *	DC current gain	for **2N 2219A** and **2N 2222A**				
		I_C = 0.1 mA V_{CE} = 10V	35			–
		I_C = 1 mA V_{CE} = 10V	50			–
		I_C = 10 mA V_{CE} = 10V	75			–
		I_C = 150 mA V_{CE} = 10V	100		300	–
		I_C = 500 mA V_{CE} = 10V	40			–
		I_C = 150 mA 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} = 10V 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)

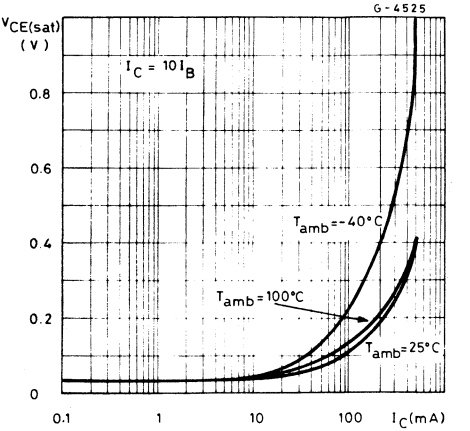
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{re} **	Reverse voltage ratio	I_C = 1 mA V_{CE} = 10V				
		for **2N 2218A** and **2N 2221A**			$5x10^{-4}$	–
		for **2N 2219A** and **2N 2222A**			$8x10^{-4}$	–
		I_C = 10 mA V_{CE} = 10V				
		for **2N 2218A** and **2N 2221A**			$2.5x10^{-4}$	–
		for **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_{BB} = -0.5V			10	ns
t_r ***	Rise time	I_C = 150 mA V_{CC} = 30V				
		I_{B1} = 15 mA V_{BB} = -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
*** See test circuit.

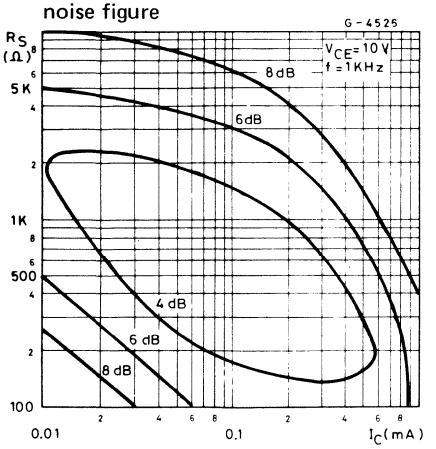
Normalized DC current gain



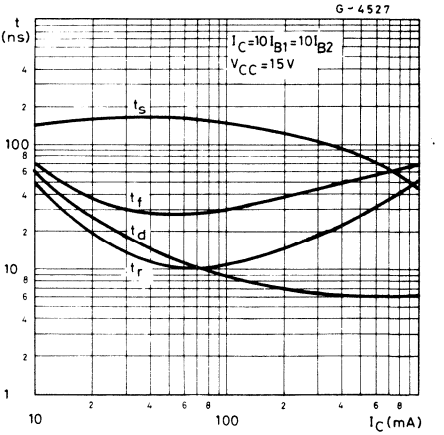
Collector-emitter saturation voltage



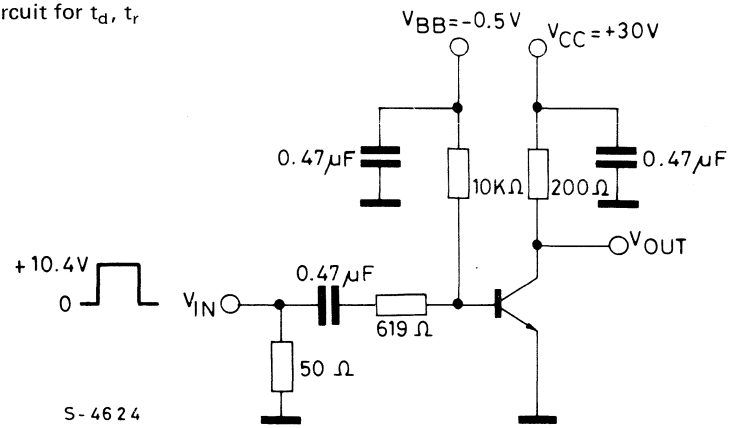
Contours of constant narrow band noise figure



Switching time vs. collector current



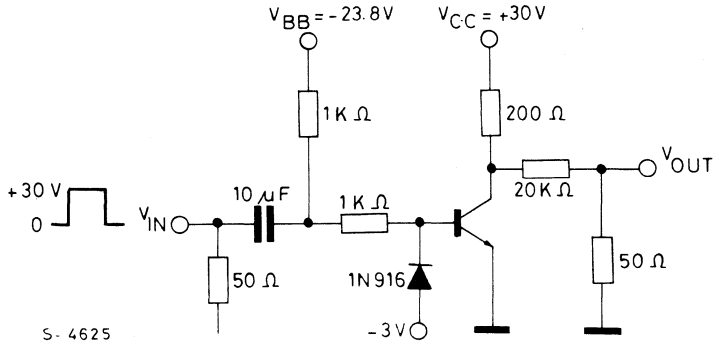
Test circuit for t_d, t_r



PULSE GENERATOR:
$t_r \leqslant 20$ ns
PW $\leqslant 200$ ns
$Z_{IN} = 50\Omega$

TO OSCILLOSCOPE:
$t_r \leqslant 5.0$ ns
$Z_{IN} < 100$ KΩ
$C_{IN} \leqslant 12$ pF

Test circuit for t_s, t_f



PULSE GENERATOR:
PW $\approx 10\ \mu s$
$Z_{IN} = 50\Omega$
$T_C \leqslant 5.0$ ns

TO OSCILLOSCOPE:
$t_r < 5.0$ ns
$Z_{IN} > 100$ KΩ
$C_{IN} \leqslant 12$ pF

SGS 2N 2368

EPITAXIAL PLANAR NPN

HIGH-FREQUENCY SATURATED SWITCH

The 2N 2368 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.

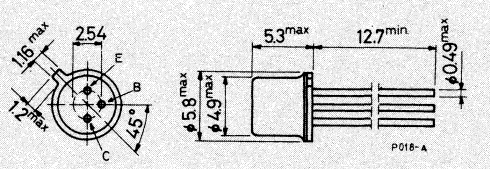
ABSOLUTE MAXIMUM RATINGS

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 μs)	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
	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_{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
$V_{(BR)CEO}$ *	Collector-emitter breakdown 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 $V_{CE} = 1V$ $T_{amb} = -55°C$	20 10 10		60	– – –
f_T	Transition frequency	$I_C = 10$ mA $V_{CE} = 10V$ f = 100 MHz	400	550		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 $V_{CC} = 10V$ $I_{B1} = -I_{B2} = 10$mA		5	10	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		10	15	ns

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

SGS **2N 2369**

EPITAXIAL PLANAR NPN

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.

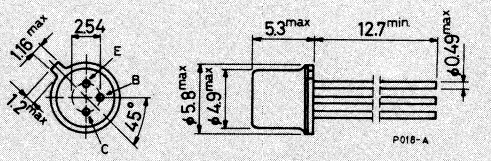
ABSOLUTE MAXIMUM RATINGS

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 μs)	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
	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_{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
$V_{(BR)CEO}$ *	Collector-emitter breakdown 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%

SGS **2N 2369A**

EPITAXIAL PLANAR NPN

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.

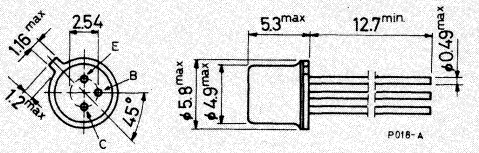
ABSOLUTE MAXIMUM RATINGS

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 $T_{amb} \leqslant 25°C$	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)

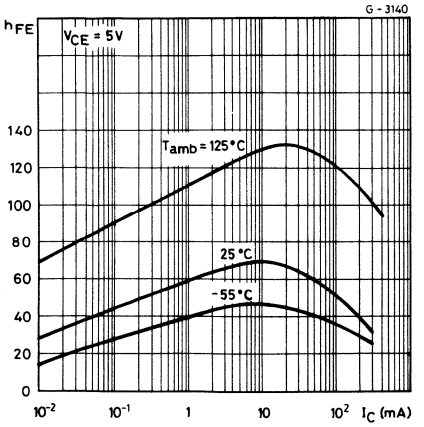
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 20V$ $T_{amb} = 150°C$			30	μA
I_{CES}	Collector cutoff current ($V_{BE} = 0$)	$V_{CE} = 20V$			0.4	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu A$	40			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage ($V_{BE} = 0$)	$I_C = 10\ \mu A$	40			V
$V_{(BR)CEO}$*	Collector-emitter breakdown 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)

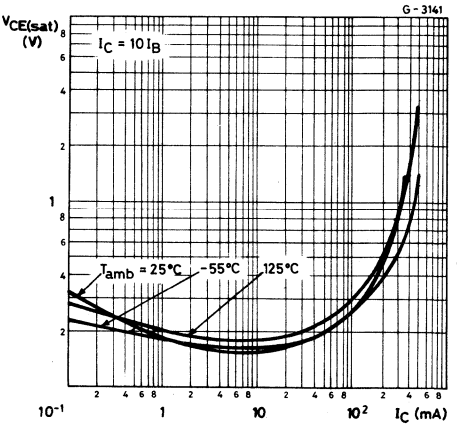
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE} *	DC current gain	I_C = 10 mA V_{CE} = 0.35V T_{amb} = -55°C	20	50		–
f_T	Transition frequency	I_C = 10 mA V_{CE} = 10V f = 100 MHz	500	675		MHz
C_{CBO}	Collector- base capacitance	I_E = 0 V_{CB} = 5V f = 1 MHz		2.3	4	pF
t_s **	Storage time	I_C = 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% ** See test circuit

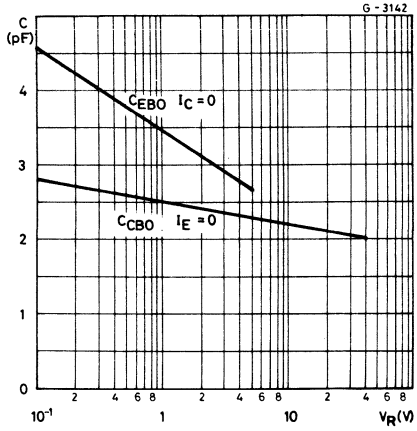
DC current gain



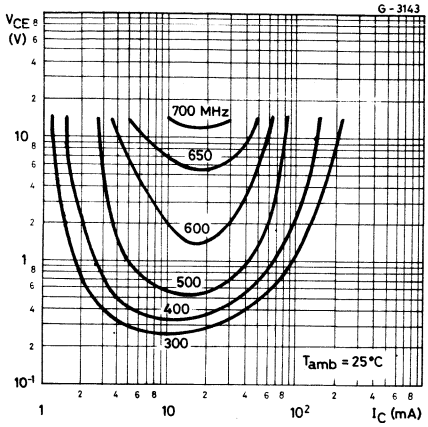
Collector-emitter saturation voltage



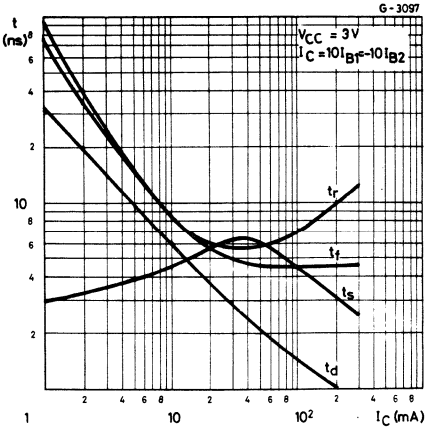
Collector-base and emitter-base capacitances



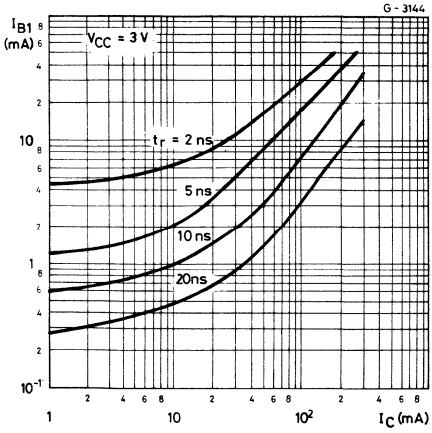
Contours of constant transition frequency



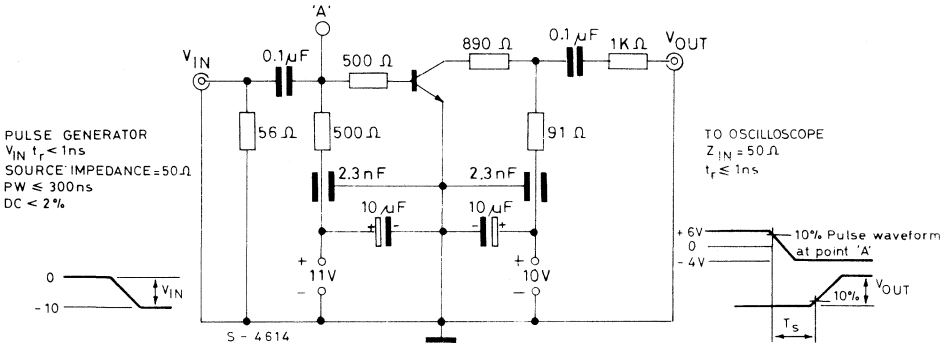
Switching characteristics



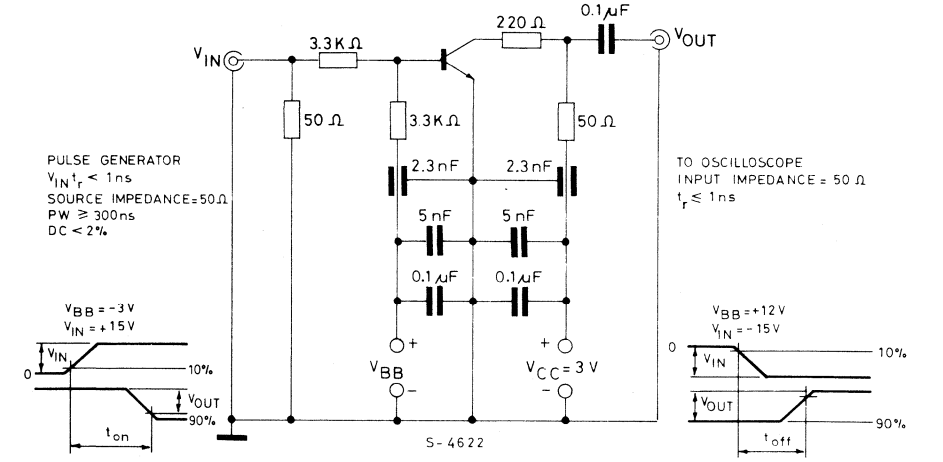
Switching characteristics



Test circuit for t_s



Test circuit for t_{on}, t_{off}



EPITAXIAL 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.

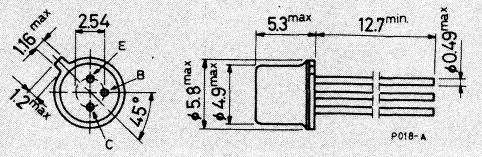
ABSOLUTE MAXIMUM RATINGS

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**)

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 ($I_E = 0$)	$V_{CB} = 45V$ $V_{CB} = 45V$ $T_{amb} = 150°C$			10 10	nA μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = 5V$			10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu A$	60			V
$V_{(BR)CEO}$*	Collector-emitter breakdown 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)

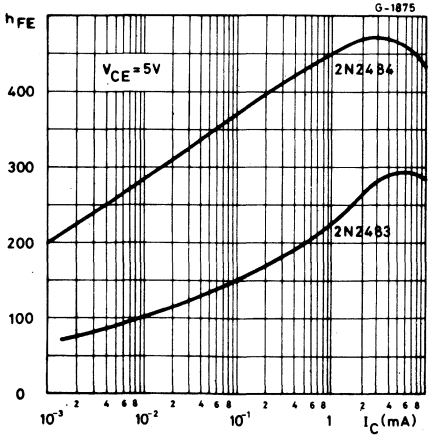
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	I_C = 1 mA V_{CE} = 5V f = 1 kHz				
		for **2N 2483**	80	280	450	–
		for **2N 2484**	150	400	900	–
f_T	Transition frequency	for **2N 2483**				
		I_C = 50 μA V_{CE} = 5V f = 5 MHz	12	20		MHz
		I_C = 500 μA V_{CE} = 5V f = 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)

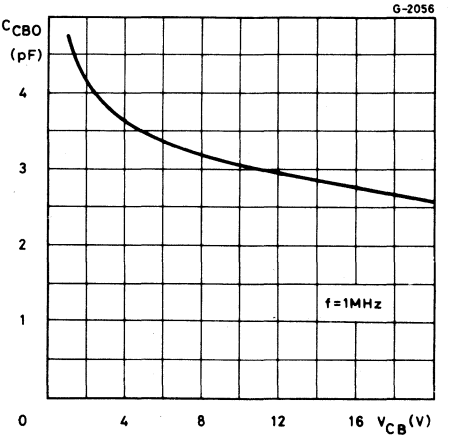
Parameter		Test conditions		Min.	Typ.	Max.	Unit
h_{oe}**	Output admittance	I_C = 1 mA	V_{CE} = 5V				
			for **2N 2483**		11	30	μS
			for **2N 2484**		15	40	μS

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

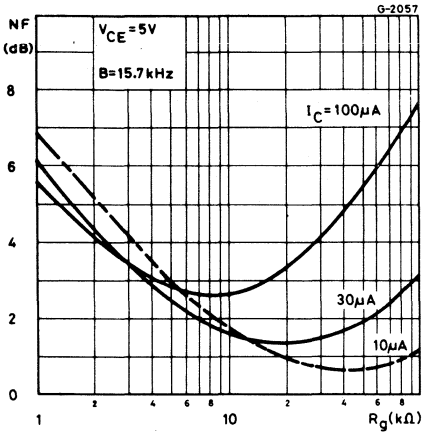
DC current gain



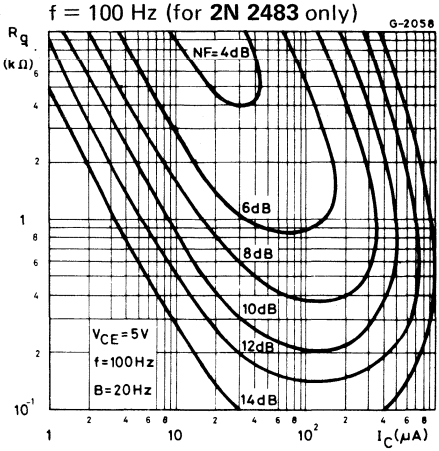
Collector-base capacitance



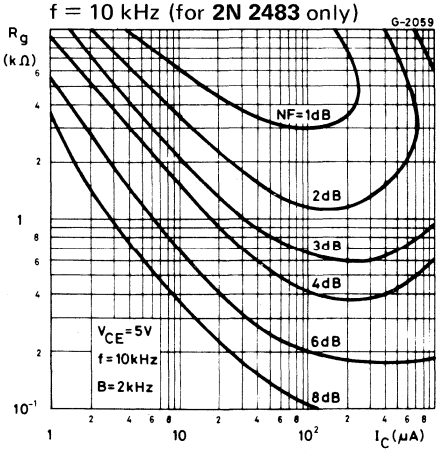
Noise figure vs. source resistance



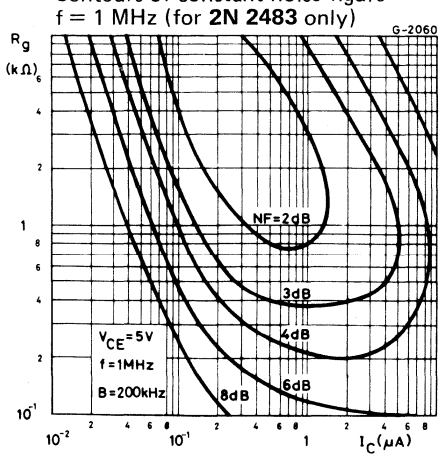
Contours of constant noise figure
f = 100 Hz (for **2N 2483** only)



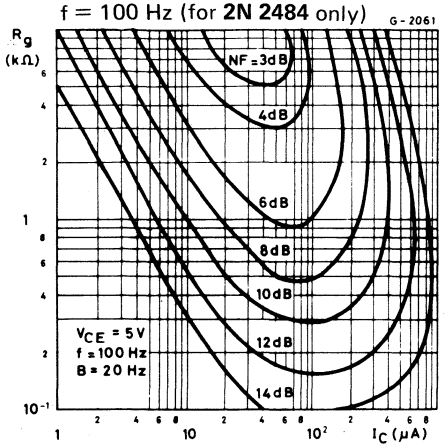
Contours of constant noise figure
f = 10 kHz (for **2N 2483** only)



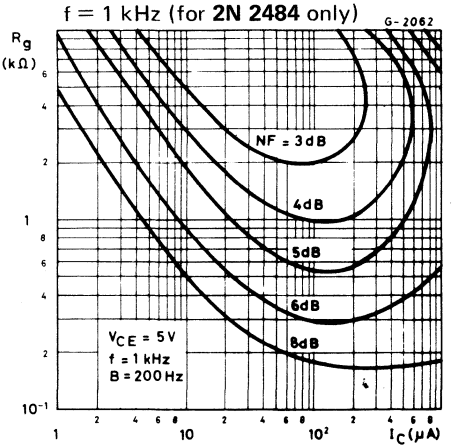
Contours of constant noise figure
f = 1 MHz (for **2N 2483** only)



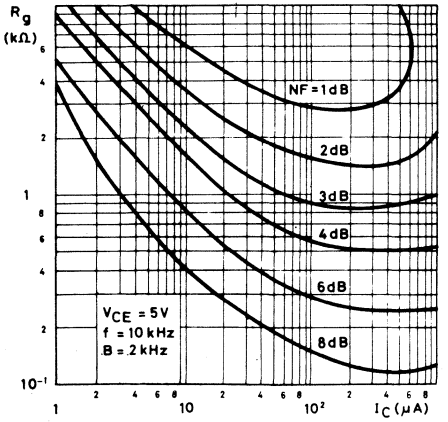
Contours of constant noise figure
f = 100 Hz (for **2N 2484** only)



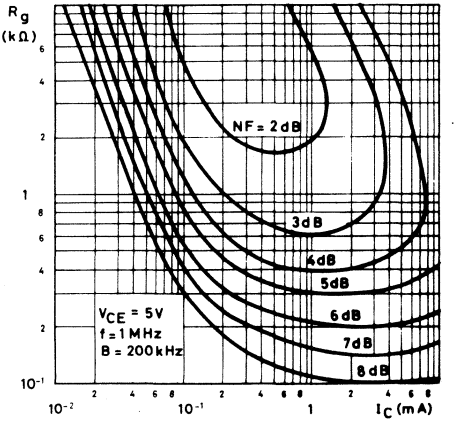
Contours of constant noise figure
f = 1 kHz (for **2N 2484** only)



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



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



EPITAXIAL PLANAR NPN

2N 2845

HIGH-SPEED SATURATED SWITCH

The 2N 2845 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.

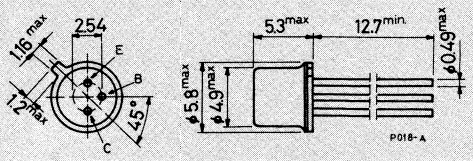
ABSOLUTE MAXIMUM RATINGS

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**)

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)

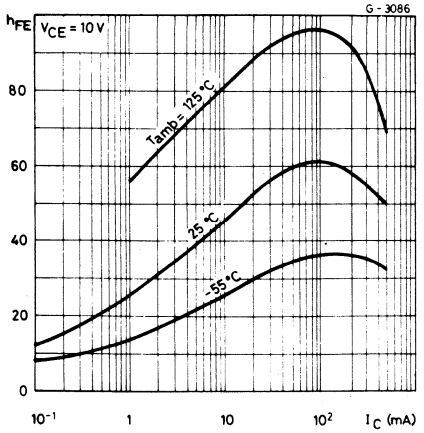
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 30V$			200	nA
		$V_{CB} = 30V$ $T_{amb} = 125°C$			200	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 0.1$ mA	60			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 30$ 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	120	–
		$I_C = 500$ mA $V_{CE} = 10V$	20	50		–
		$I_C = 500$ mA $V_{CE} = 1V$	10	30		–

ELECTRICAL CHARACTERISTICS (continued)

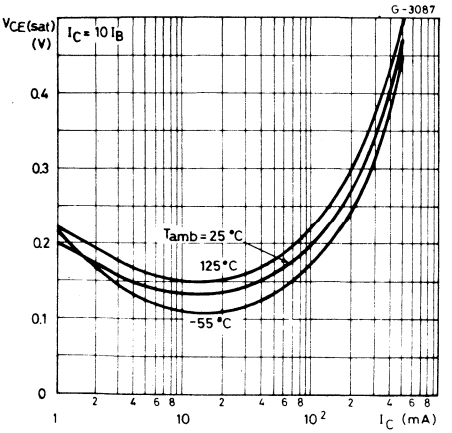
Parameter		Test conditions	Min.	Typ.	Max.	Unit
f_T	Transition frequency	I_C = 50 mA V_{CE} = 10V f = 100 MHz	250	350		MHz
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = 10V f = 1 MHz		6	8	pF
t_{on}	Turn-on time	I_C = 150 mA V_{CC} = 10V I_{B1} = 15 mA		18	40	ns
t_{off}	Turn-off time	I_C = 150 mA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

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

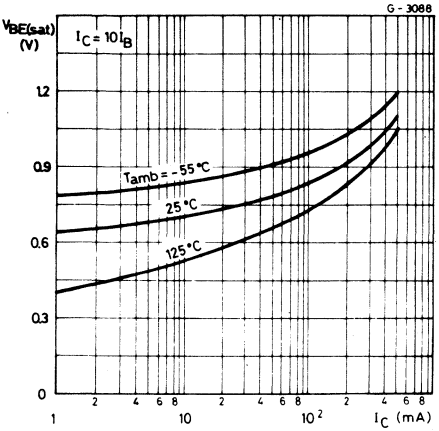
DC current gain



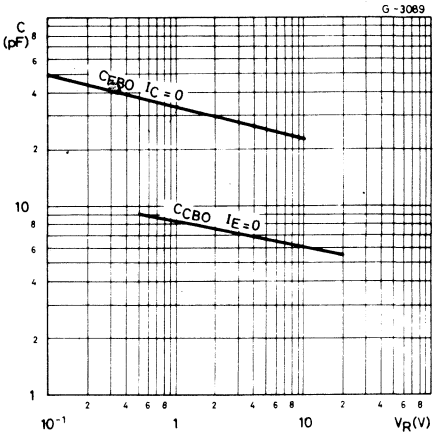
Collector-emitter saturation voltage



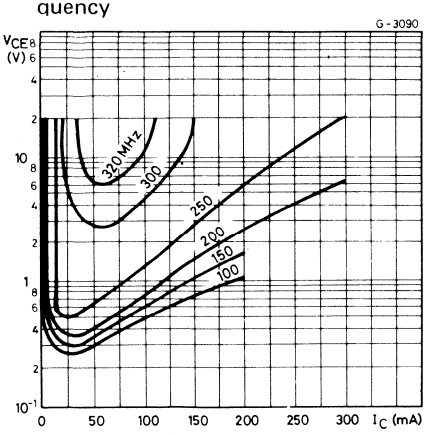
Base-emitter saturation voltage



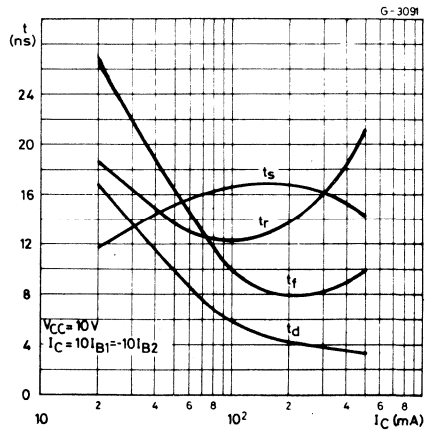
Emitter-base and collector-base capacitances



Contours of constant transition frequency



Switching characteristics



EPITAXIAL PLANAR PNP

2N 2894
2N 3209

HIGH-SPEED SATURATED SWITCHES

The 2N 2894, 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.

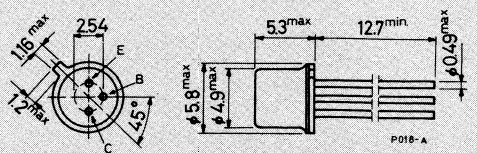
ABSOLUTE MAXIMUM RATINGS

		2N 2894	2N 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)

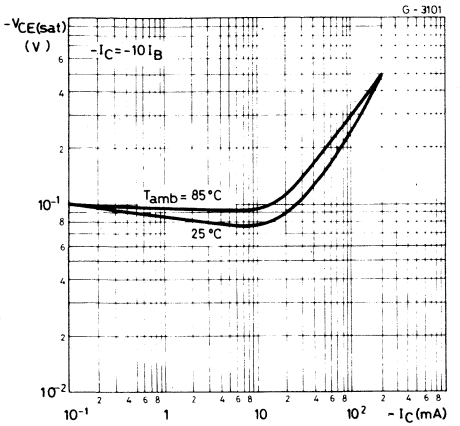
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0) (for **2N 2894** only)	V_{CB} = -6V T_{amb} = 125°C			-10	μA
I_{CES}	Collector cutoff current (V_{BE} = 0)	for **2N 2894**				
		V_{CE} = -6V			-80	nA
		for **2N 3209**				
		V_{CE} = -10V			-80	nA
		V_{CE} = -10V T_{amb} = 125°C			-10	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA				
		for **2N 2894**	-12			V
		for **2N 3209**	-20			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = -10 μA				
		for **2N 2894**	-12			V
		for **2N 3209**	-20			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = -10 mA				
		for **2N 2894**	-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**				
		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)

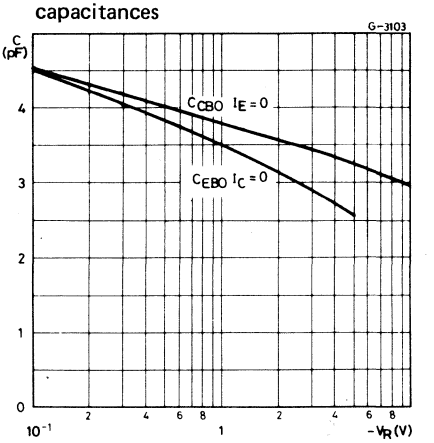
Parameter		Test conditions	Min.	Typ.	Max.	Unit
$V_{BE(sat)}$ *	Base-emitter saturation voltage	I_C = -10 mA I_B = -1 mA		-0.78	-0.98	V
		I_C = -30 mA I_B = -3 mA		-0.85	-1.2	V
		I_C = -100 mA I_B = -10 mA			-1.7	V
h_{FE} *	DC current gain	I_C = -10 mA V_{CE} = -0.3V				
		for **2N 2894**	30			–
		for **2N 3209**	25			–
		I_C = -30 mA V_{CE} = -0.5V				
		for **2N 2894**	40		150	–
		for **2N 3209**	30		120	–
		I_C = -100 mA V_{CE} = -1 V				
		for **2N 2894**	25			–
		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**			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

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

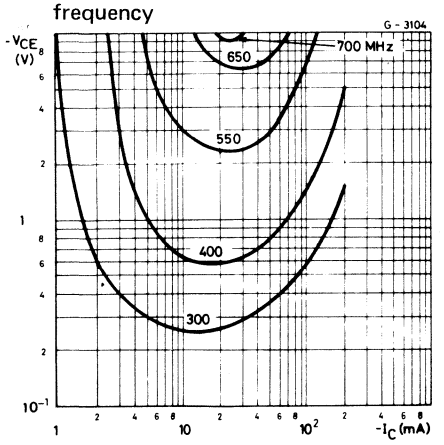
Collector-emitter saturation voltage



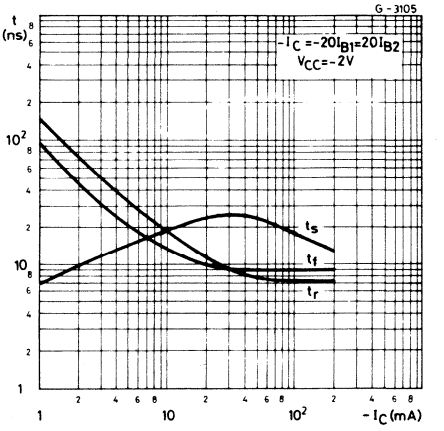
Emitter-base and collector-base capacitances



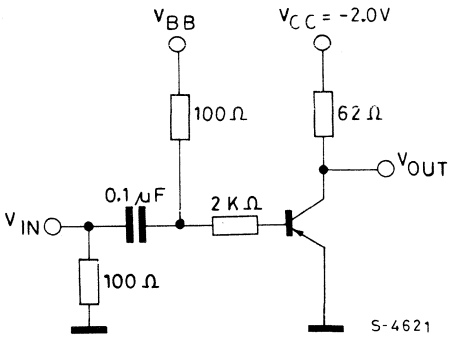
Contours of constant transition frequency



Switching characteristics



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
$t_r \leqslant 1.0$ ns
DC < 2
PW = 400 ns
$Z_{IN} = 50\Omega$

TO OSCILLOSCOPE:
$t_r \leqslant 1.0$ ns
$Z_{IN} \geqslant 100\ K\Omega$

t_{on} $V_{BB} = +3.0V$, $V_{IN} = -7.0V$
t_{off} $V_{BB} = -4.0V$, $V_{IN} = +6.0V$

SGS

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

EPITAXIAL 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.

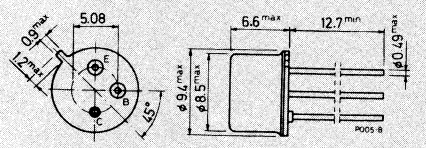
ABSOLUTE MAXIMUM RATINGS

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

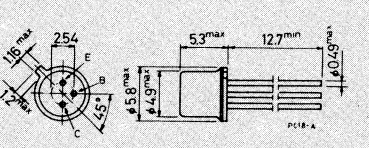
Dimensions in mm

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 ($I_E = 0$)	$V_{CB} = -50V$			-20	nA
		$V_{CB} = -50V$ $T_{amb} = 150°C$			-20	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 ($I_E = 0$)	$I_C = -10\ \mu A$	-60			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -10$ mA	-40			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu A$	-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 $I_B = -16$ mA			-1.3	V
		$I_C = -500$ mA $I_B = -50$ mA			-2.6	V
h_{FE} *	DC current gain	for **2N 2904** and **2N 2906**				
		$I_C = -0.1$ 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			–

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 = 1 MHz			30	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10V f = 1 MHz			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%

EPITAXIAL 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.

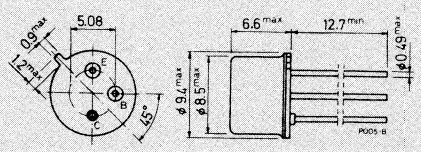
ABSOLUTE MAXIMUM RATINGS

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 $T_{amb} \leqslant 25°C$		
	for **2N 2904A** and **2N 2905A**	0.6	W
	for **2N 2906A** and **2N 2907A**	0.4	W
	at $T_{case} \leqslant 25°C$		
	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

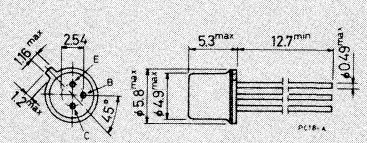
Dimensions in mm

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 ($I_E = 0$)	$I_C = -10\ \mu A$	-60			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -10$ mA	-60			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu A$	-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			–

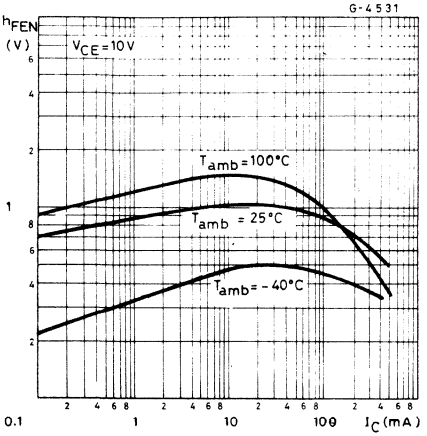
ELECTRICAL CHARACTERISTICS (continued)

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 = 1 MHz			30	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB} = -10V f = 1 MHz			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

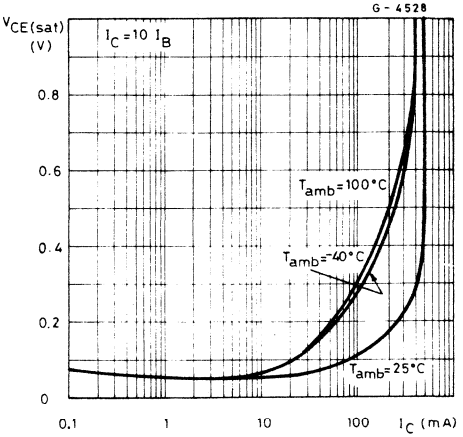
* Pulsed: pulse duration = 300 μs, duty cycle = 1%

** See test circuit.

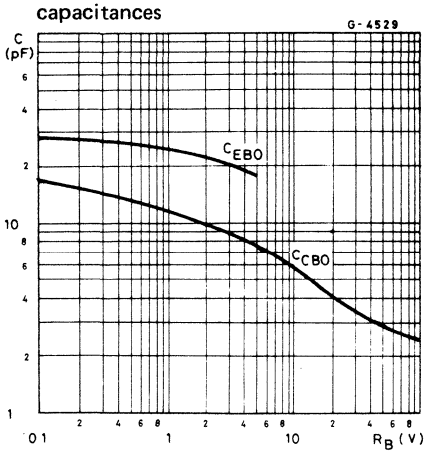
Normalized DC current gain



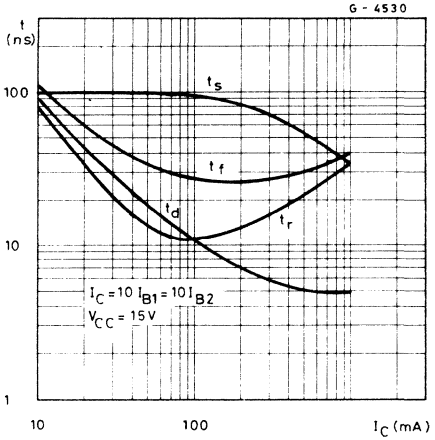
Collector-emitter saturation voltage



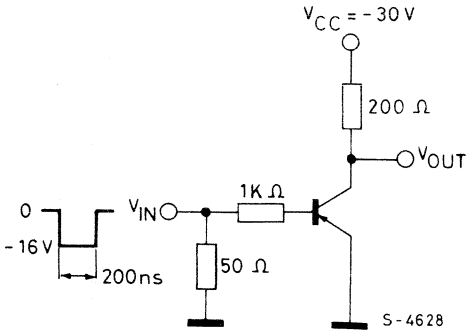
Collector-base and emitter-base capacitances



Switching characteristics



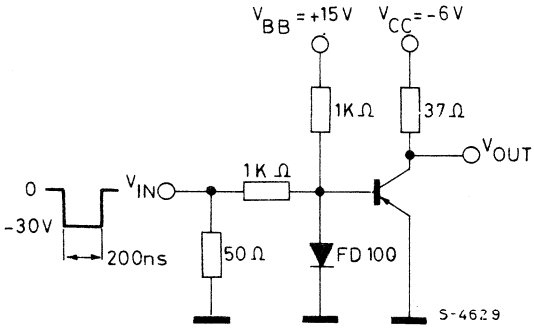
Test circuit for t_{on}, t_r, t_d



PULSE GENERATOR:
$t_r \leqslant 2.0$ ns
Frequency = 150 Hz
$Z_o = 50\Omega$

TO OSCILLOSCOPE:
$t_r \leqslant 5.0$ ns
$Z_{IN} = 10\ M\Omega$

Test circuit for t_{off}, t_s, t_f



PULSE GENERATOR:
$t_r \leqslant 2.0$ ns
Frequency = 150 Hz
$Z_o = 50\Omega$

TO OSCILLOSCOPE:
$t_r \leqslant 5.0$ ns
$Z_{IN} = 10\ M\Omega$

SGS

2N 3013
2N 3014

EPITAXIAL PLANAR NPN

HIGH-SPEED SATURATED SWITCHES

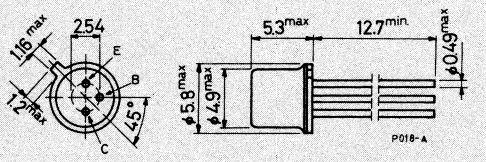
The 2N 3013 and 2N 3014 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case, intended for high-speed, low-saturation switching application up to 300 mA.

ABSOLUTE MAXIMUM RATINGS		2N 3013	2N 3014
V_{CBO}	Collector-base voltage ($I_E = 0$)	40 V	40 V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	40 V	40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	15 V	20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	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)

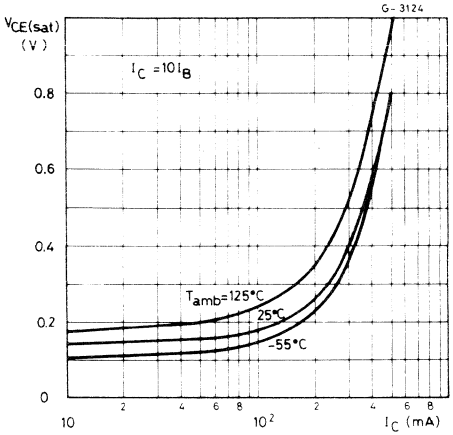
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current (V_{BE} = 0)	V_{CE} = 20V for **2N 3013** and **2N 3014**			0.3	μA
		V_{CE} = 20V T_{amb} = 125°C for **2N 3013** and **2N 3014**			40	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 100 μA	40			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 100 μA	40			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA for **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 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 3013**			0.28	V
		for **2N 3014**			0.35	V
		I_C = 300 mA I_B = 30 mA for **2N 3013**			0.5	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)

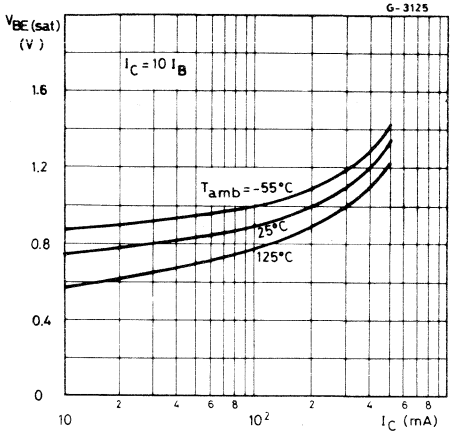
Parameter		Test conditions	Min.	Typ.	Max.	Unit
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 10 mA I_B = 1 mA for **2N 3014**	0.7		0.8	V
		I_C = 30 mA I_B = 3 mA	0.75		0.95	V
		I_C = 100 mA I_B = 10 mA			1.2	V
		I_C = 300 mA I_B = 30 mA for **2N 3013**			1.7	V
h_{FE}*	DC current gain	I_C = 10 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 3013**	25			–
		I_C = 100 mA V_{CE} = 1V for **2N 3014**	25			–
		I_C = 300 mA V_{CE} = 1V for **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 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 3013**			25	ns

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

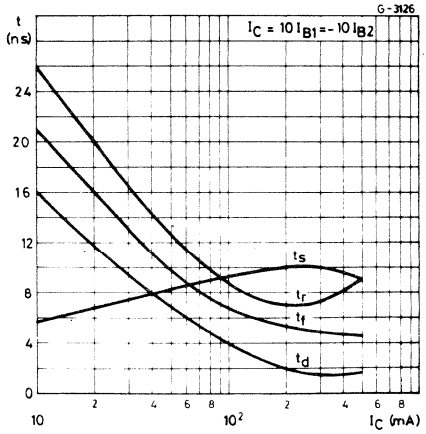
Collector-emitter saturation voltage



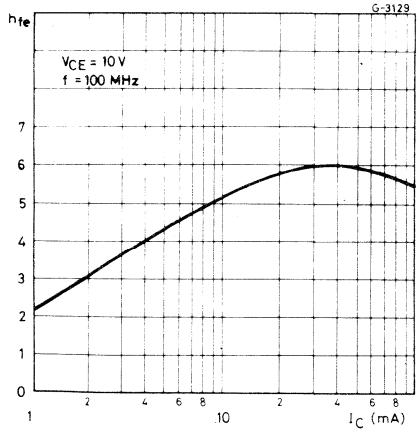
Base-emitter saturation voltage



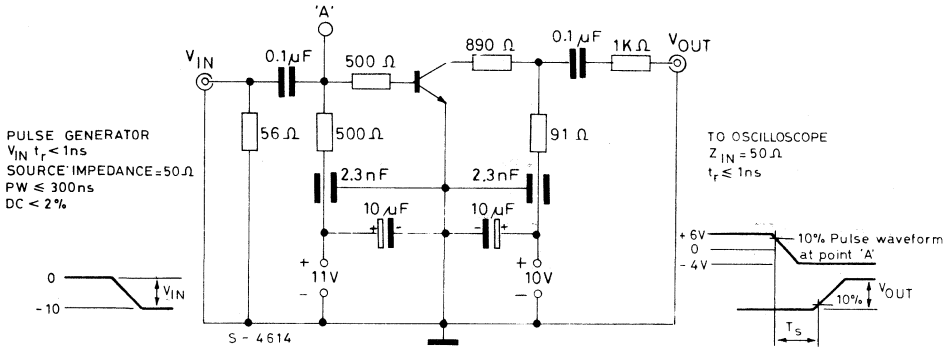
Switching characteristics



High frequency gain



Test circuit for t_s



EPITAXIAL 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.

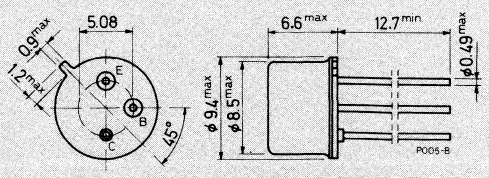
ABSOLUTE MAXIMUM RATINGS

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**)

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
$V_{(BR)CEO}$*	Collector-emitter breakdown 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_C = 500 mA	I_B = 15 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**	50			–
			for **2N 3020**	30		100	–
		I_C = 10 mA	V_{CE} = 10V				
			for **2N 3019**	90			–
			for **2N 3020**	40		120	–
		I_C = 150 mA	V_{CE} = 10V				
			for **2N 3019**	100		300	–
			for **2N 3020**	40		120	–
		I_C = 500 mA	V_{CE} = 10V				
			for **2N 3019**	50			–
			for **2N 3020**	30		100	–
		I_C = 1A	V_{CE} = 10V	15			–
		I_C = 150 mA T_{amb} = -55°C	V_{CE} = 10V				
			for **2N 3019**	40			–

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** for **2N 3020**	80 30		400 200	— —
f_T	Transition frequency	$I_C = 50$ mA f = 20 MHz	$V_{CE} = 10V$				
			for **2N 3019** for **2N 3020**	100 80			MHz 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%

SGS 2N 3053

EPITAXIAL 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.

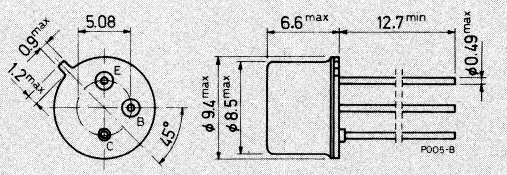
ABSOLUTE MAXIMUM RATINGS

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

$R_{th\ j\text{-}case}$	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
$V_{(BR)CBO}$	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
$V_{(BR)CER}$ *	Collector-emitter breakdown 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%

SGS

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

EPITAXIAL 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.

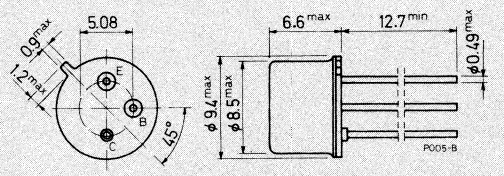
ABSOLUTE MAXIMUM RATINGS

		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 $T_{amb} \leqslant 25$ °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	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
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30mA 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

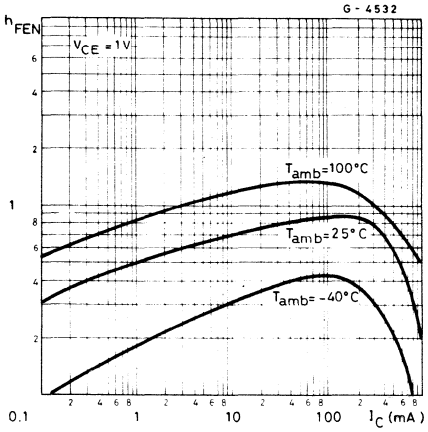
ELECTRICAL CHARACTERISTICS (continued)

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			8	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			1000	ns

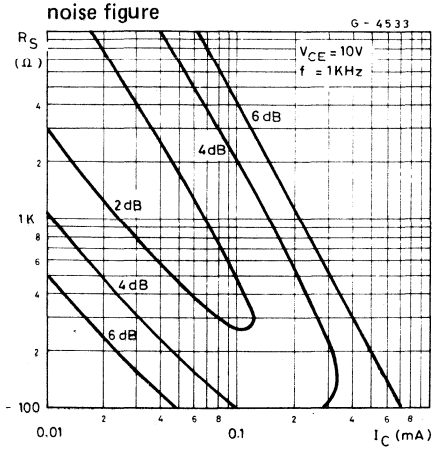
* Pulsed: pulse duration = 300 μs, duty cycle = 1%

** See test circuit.

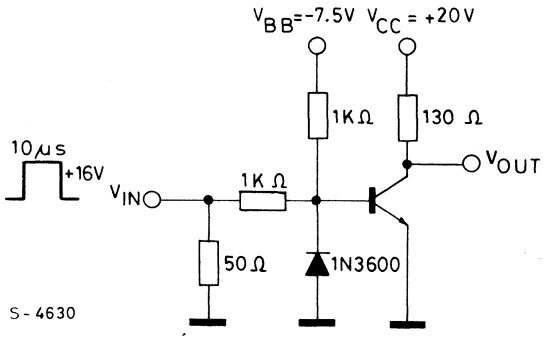
Normalized DC current gain



Countours of constant narrow band noise figure



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
t_r of input pulse < 15 ns
t_f of input pulse < 15 ns

TO OSCILLOSCOPE:
t_r > 15 ns
Z_{IN} ≈ 100 KΩ

SGS 2N 3114

EPITAXIAL PLANAR NPN

HIGH VOLTAGE AMPLIFIER

The 2N3114 is a silicon planar epitaxial NPN transistor in Jedec TO-39 metal case. It is primarily intended for high voltage, medium power applications.

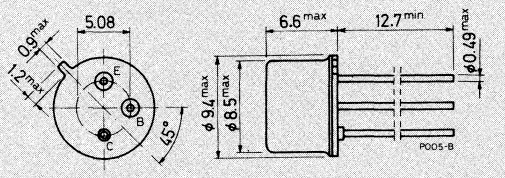
ABSOLUTE MAXIMUM RATINGS

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 ($I_C = 0$)	5	V
I_C	Collector circuit	150	mA
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	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} = 100V V_{CB} = 100V T_{amb} = 150°C			10 10	nA 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 = 100 μA	150			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = 10 mA	150			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 = 5 mA			1	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 50 mA I_B = 5 mA			0.9	V
h_{FE}*	DC current gain	I_C = 100 μA V_{CE} = 10V I_C = 30 mA V_{CE} = 10V T_{amb} = -55°C I_C = 30 mA V_{CE} = 10V	15 30 12	35 60 24	 120 	– – –
h_{fe}	High frequency current gain	I_C = 30 mA V_{CE} = 10V f = 20 MHz	2			–
C_{EBO}	Emitter-base capacitance	V_{EB} = 0.5V f = 1 MHz			80	pF
C_{CBO}	Collector-base capacitance	V_{CB} = 20V f = 1 MHz			9	pF

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

SGS 2N 3250 2N 3251

EPITAXIAL PLANAR PNP

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.

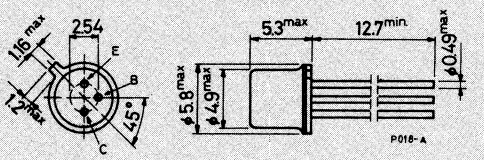
ABSOLUTE MAXIMUM RATINGS

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**)

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

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

EPITAXIAL PLANAR NPN

2N 3301
2N 3302

GENERAL PURPOSE AMPLIFIERS AND SWITCHES

The 2N3301 and 2N3302 are silicon planar epitaxial NPN transistors in Jedec TO-18 metal case. They are designed to cover a wide range of amplifier and switching applications.

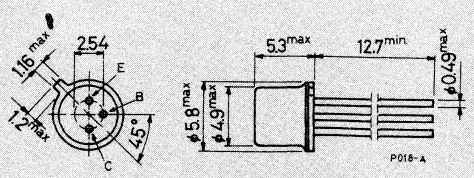
ABSOLUTE MAXIMUM RATINGS

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	0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$	0.36	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

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	97.2	°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			10	nA
		V_{CE} = 50V T_{amb} = 150°C			10	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			0.22	V
		I_C = 500 mA I_B = 50 mA			0.6	V
$V_{BE(sat)}$ *	Base-emitter saturation voltage	I_C = 150 mA I_B = 15 mA			1.1	V
		I_C = 500 mA I_B = 50 mA			1.5	V
h_{FE} *	DC current gain	for **2N3301**				
		I_C = 0.1 mA V_{CE} = 10V	20	40		–
		I_C = 1 mA V_{CE} = 10V	25	60		–
		I_C = 10 mA V_{CE} = 10V	35	70		–
		I_C = 150 mA V_{CE} = 10V	40		120	–
		I_C = 500 mA V_{CE} = 10V	20	60		–
		I_C = 150 mA V_{CE} = 1V	20	50		–
		for **2N3302**				
		I_C = 0.1 mA V_{CE} = 10V	35	80		–
		I_C = 1 mA V_{CE} = 10V	50	140		–
		I_C = 10 mA V_{CE} = 10V	75	200		–
		I_C = 150 mA V_{CE} = 10V	100		300	–
		I_C = 500 mA V_{CE} = 10V	50	125		–
		I_C = 150 mA V_{CE} = 1V	50	75		–

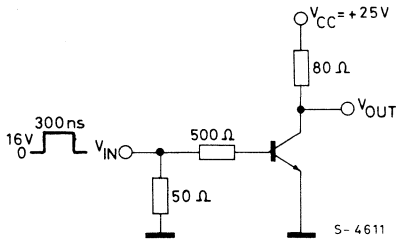
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	High frequency current gain	$I_C = 50$ mA $V_{CE} = 10$V f = 100 MHz	2.5			–
C_{EBO}	Emitter-base capacitance	$V_{EB} = 2$V f = 1 MHz			20	pF
C_{CBO}	Collector-base capacitance	$V_{CB} = 10$V f = 1 MHz			8	pF
t_{on}**	Turn-on time	$I_C = 300$ mA $V_{CC} = 25$V $I_{B1} = 30$ mA			60	ns
t_{off}**	Turn-off time	$I_C = 300$ mA $V_{CC} = 25$V $I_{B1} = -I_{B2} = 30$ mA			150	ns

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

Test circuit for t_{on}

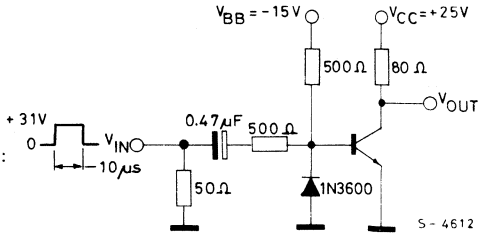
PULSE GENERATOR:
$t_r \leqslant 1.0$ ns
$Z_{IN} = 50\Omega$



TO OSCILLOSCOPE:
$t_r \leqslant 1.0$ ns
$Z_{IN} \approx 100$ kΩ

Test circuit for t_{off}

PULSE GENERATOR:
$t_r \leqslant 20$ ns
$Z_{IN} = 50\Omega$



TO OSCILLOSCOPE:
$t_r \leqslant 1.0$ ns
$Z_{IN} \approx 100$ kΩ

SGS

2N 3502
2N 3503
2N 3504
2N 3505

EPITAXIAL PLANAR PNP

GENERAL PURPOSE AMPLIFIERS AND SWITCHES

The 2N3502, 2N3503, 2N3504 and 2N3505 are silicon planar epitaxial PNP transistors in Jedec TO-39 (2N3502, 2N3503) and in Jedec TO-18 (2N3504, 2N3505) metal cases. They are designed for high-speed saturated switching and general purpose applications.

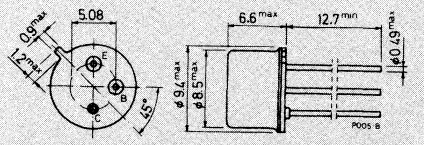
ABSOLUTE MAXIMUM RATINGS

		2N3502 2N3504	2N3503 2N3505
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 ($I_C = 0$)	5 V	
I_C	Collector current	600 mA	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$		
	for **2N 3504, 2N 3505**	0.4 W	
	for **2N 3502, 2N 3503**	0.7 W	
	at $T_{case} \leqslant 25°C$		
	for **2N 3504, 2N 3505**	1.3 W	
	for **2N 3502, 2N 3503**	3 W	
T_{stg}, T_j	Storage and junction temperature	-65 to 200 °C	

MECHANICAL DATA

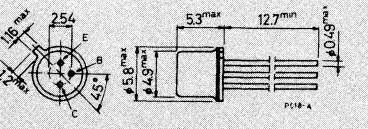
Dimensions in mm

Collector connected to case



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

Collector connected to case



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

THERMAL DATA

			2N3502 2N3503	2N3504 2N3505
$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	132 °C/W	58.3 °C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	437 °C/W	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)	for **2N 3503** and **2N 3505** V_{CE} = -50V			-10	nA
		for **2N 3502** and **2N 3504** V_{CE} = -30V			-10	μA
I_{CBO}	Collector cutoff current (I_E = 0)	for **2N 3503** and **2N 3505** V_{CE} = -50V T_{amb} = 150°C			-10	μA
		for **2N 3502** and **2N 3504** V_{CE} = -30V T_{amb} = 150°C			-10	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = -10 μA				
		for **2N 3503** and **2N 3505**	-60			V
		for **2N 3502** and **2N 3504**	-45			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -10 mA				
		for **2N 3503** and **2N 3505**	-60			V
		for **2N 3502** and **2N 3504**	-45			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			-0.25	V
		I_C = -150 mA I_B = -15 mA			-0.4	V
		I_C = -500mA I_B = -50 mA			-1.6	V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = -50 mA I_B = -2.5 mA			-1	V
		I_C = -150mA I_B = -15 mA			-1.3	V
		I_C = -500mA I_B = -50 mA			-2	V

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C = -0.01mA V_{CE}= -10V	80			–
		I_C = -0.1 mA V_{CE}= -10V	120			–
		I_C = -1 mA V_{CE}= -10V	135			–
		I_C = -10 mA V_{CE}= -10V	140			–
		I_C = -150 mA V_{CE}= -10V	100		300	–
		I_C = -500 mA V_{CE}= -10V	50			–
		T_{amb}= -55°C				
		I_C = 50 mA V_{CE}= 1V	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}= -0.5V f = 100 kHz			30	pF
C_{CBO}	Collector-base capacitance	I_E = 0 V_{CB}= -10V f = 1 MHz			8	pF
NF	Noise figure	I_C = -30 μA V_{CE}= -5V f = 1 kHz R_G= 10 KΩ			4	dB
t_{on}	Turn-on time	I_C = -300mA V_{CC}= -30V I_{B1}= -30 mA			40	ns
t_{off}	Turn-off time	I_C = -300 mA V_{CC}= -30V I_{B1}= -I_{B2}= -30 mA			100	ns

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

EPITAXIAL PLANAR NPN

2N 3700

GENERAL PURPOSE AMPLIFIERS

The 2N 3700 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, intended for small signal, low noise industrial applications.

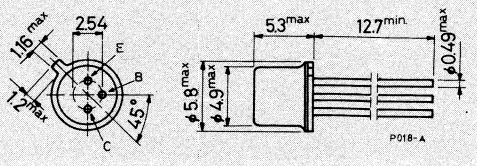
ABSOLUTE MAXIMUM RATINGS

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
$V_{(BR)CEO}$ *	Collector-emitter breakdown voltage (I_B = 0)	I_C = 30mA	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						
		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, T_{amb} = -55°C	V_{CE} = 10V	40			–
h_{fe}	Small signal current gain	I_C = 1 mA, f = 1 kHz	V_{CE} = 5V	80		400	–
f_T	Transition frequency	I_C = 50 mA, f = 20 MHz	V_{CE} = 10V		100		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%

SGS 2N 3724

EPITAXIAL PLANAR NPN

HIGH-CURRENT SWITCH

The 2N 3724 is a silicon planar epitaxial transistor in TO-39 metal case. It is a high-current switch used for memory applications requiring breakdown voltages up to 30V and operating currents to 1A.

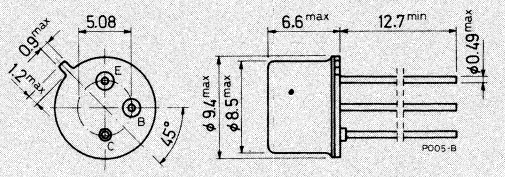
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	50	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	50	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	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)

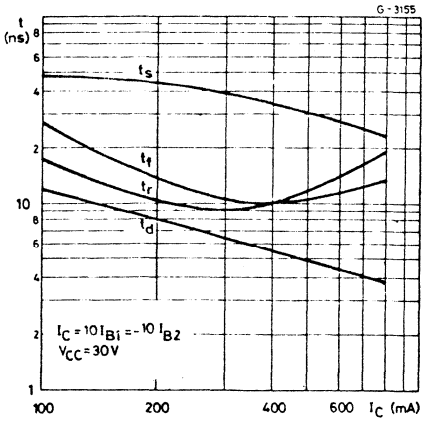
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 40V V_{CB} = 40V T_{amb} = 100°C			1.7 120	μA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA	50			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10 μA	50			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	6			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 10 mA I_B = 1 mA I_C = 100 mA I_B = 10 mA I_C = 300 mA I_B = 30 mA I_C = 500 mA I_B = 50 mA I_C = 800 mA I_B = 80 mA I_C = 1000mA I_B = 100 mA			0.25 0.20 0.32 0.42 0.65 0.75	V V V V V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 10 mA I_B = 1 mA I_C = 100 mA I_B = 10 mA I_C = 300 mA I_B = 30 mA I_C = 500 mA I_B = 50 mA I_C = 800 mA I_B = 80 mA I_C = 1000mA I_B = 100 mA	 0.9 	0.64 0.75 0.89 1.0 1.1	0.76 0.86 1.1 1.2 1.5 1.7	V V V V V V
h_{FE}*	DC current gain	I_C = 10 mA V_{CE} = 1V I_C = 100 mA V_{CE} = 1V I_C = 300 mA V_{CE} = 1V I_C = 1000mA V_{CE} = 5V I_C = 800 mA V_{CE} = 2V I_C = 500 mA V_{CE} = 1V	30 60 40 30 25 35	60 90 60	 150 	– – – – – –

ELECTRICAL CHARACTERISTICS (continued)

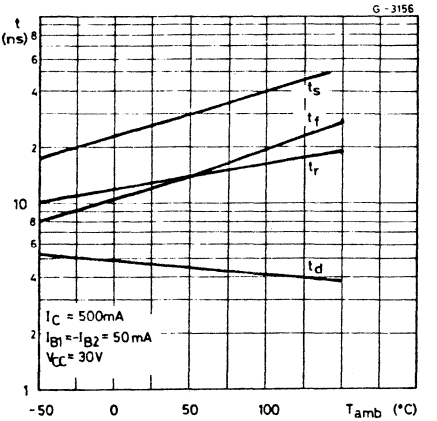
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	High frequency current gain	$I_C = 50$ mA $V_{CE} = 10$V f = 100 MHz	3			—
C_{CBO}	Collector-base capacitance	$I_C = 0$ $V_{CB} = 10$V f = 1 MHz			12	pF
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5$V f = 1 MHz			55	pF
t_{on} **	Turn-on time	$I_C = 500$ mA $V_{CC} = 30$V $I_B = 50$ mA			35	ns
t_{off} **	Turn off time	$I_C = 500$ mA $V_{CC} = 30$V $I_{B1} = -I_{B2} = 50$ mA			60	ns

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

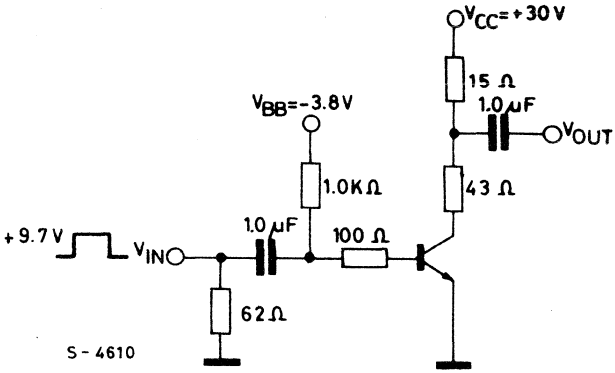
Switching characteristics



Switching characteristics



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
$t_r, t_f \leqslant 1.0$ ns
PW $\approx 1.0\ \mu s$
$Z_{IN} = 50\Omega$
DC < 2%

TO OSCILLOSCOPE:
$t_r < 1.0$ ns
$Z_{IN} \geqslant 100\ K\Omega$

SGS 2N 3725

EPITAXIAL PLANAR NPN

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.

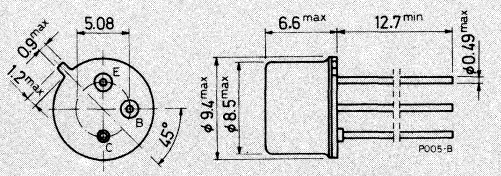
ABSOLUTE MAXIMUM RATINGS

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)

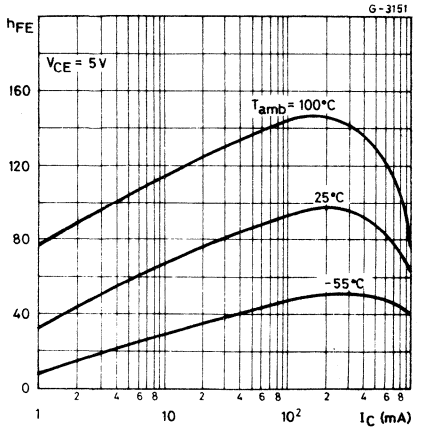
Parameter		Test conditions		Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 60V				1.7	μA
		V_{CB} = 60V	T_{amb} = 100°C			120	μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA		80			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10 μA		80			V
$V_{(BR)CEO}$*	Collector-emitter breakdown 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
$V_{BE(sat)}$*	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	0.9		1.2	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		–
		I_C = 500 mA	V_{CE} = 1V	35			–

ELECTRICAL CHARACTERISTICS (continued)

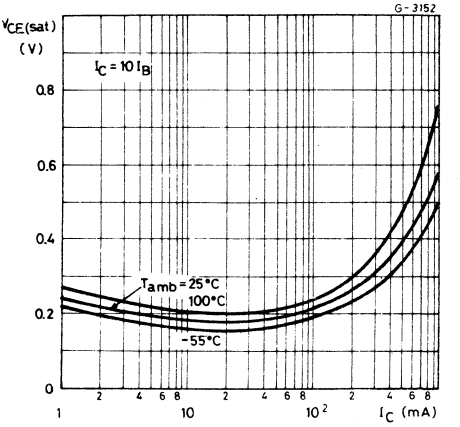
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	High frequency current gain	$I_C = 50$ mA $V_{CE} = 10$V f = 100 MHz	3			–
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10$V f = 1 MHz			10	pF
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{CB} = 0.5$V f = 1 MHz			55	pF
t_{on} **	Turn-on time	$I_C = 500$ mA $V_{CC} = 30$V $I_B = 50$ mA			35	ns
t_{off} **	Turn off time	$I_C = 500$ mA $V_{CC} = 30$V $I_{B1} = -I_{B2} = 50$ mA			60	ns

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

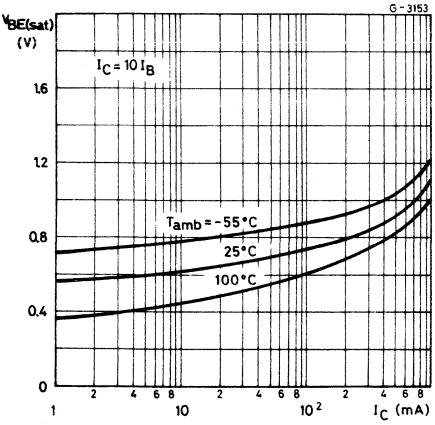
DC current gain



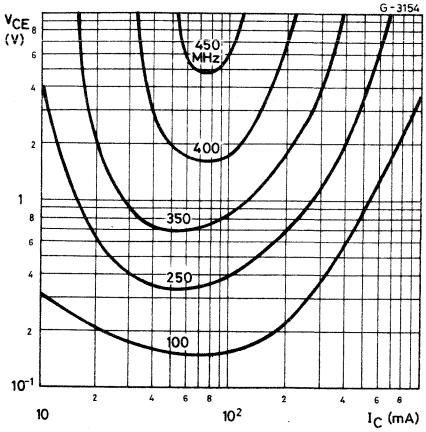
Collector-emitter saturation voltage



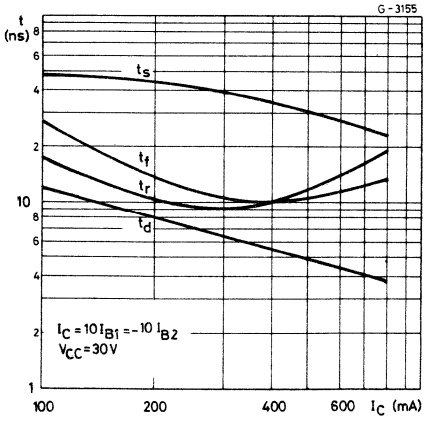
Base-emitter saturation voltage



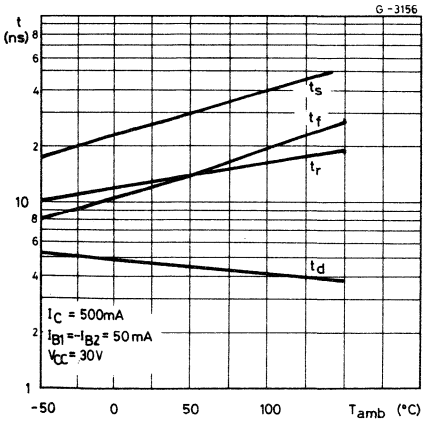
Contours of constant transition frequency



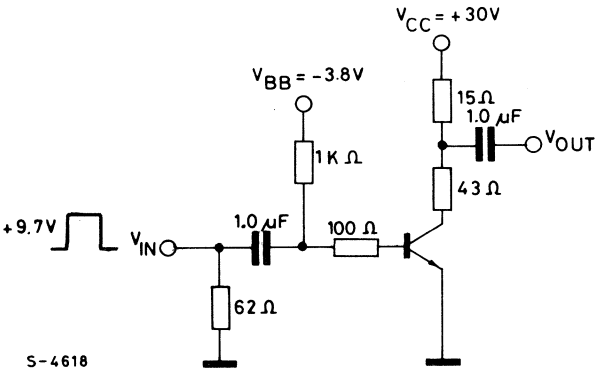
Switching characteristics



Switching characteristics



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
t_r, $t_f \leqslant 1.0$ ns
PW ≈ 1.0 μs
Z_{IN} = 50Ω
DC < 2%

TO OSCILLOSCOPE:
$t_r < 1.0$ ns
$Z_{IN} \geqslant 100$ KΩ

EPITAXIAL PLANAR PNP

2N 3930
2N 3931

HIGH-VOLTAGE AMPLIFIERS

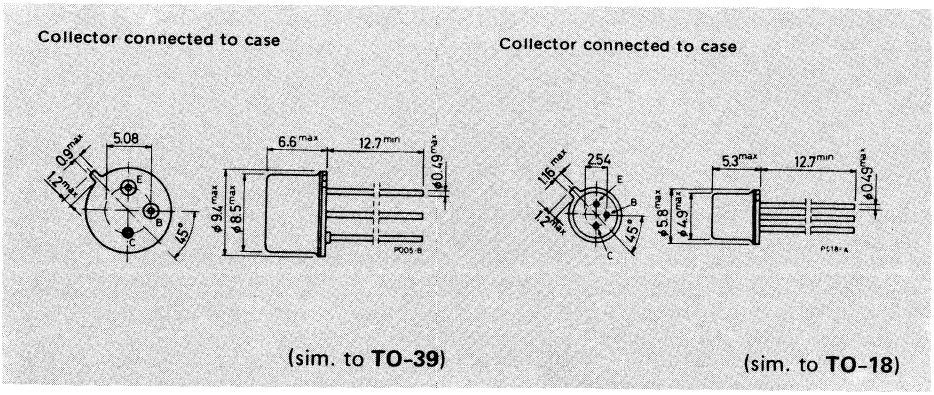
The 2N 3930 and 2N 3931 are silicon planar epitaxial PNP transistors in Jedec TO-18 (2N 3930) and Jedec TO-39 (2N 3931) metal cases.
Both devices feature high voltage, high gain, low noise and excellent current gain linearity from 10 μA to 50 mA.

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 **2N3930**	0.4	W
	for **2N3931**	0.7	W
	at $T_{case} \leqslant 25$ °C		
	for **2N3930**	1.4	W
	for **2N3931**	2.5	W
T_{stg}, T_j	Storage and junction temperature	-55 to 200	°C

MECHANICAL DATA

Dimensions in mm



THERMAL DATA

			2N 3930	2N 3931
$R_{th\ j\text{-}case}$	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)

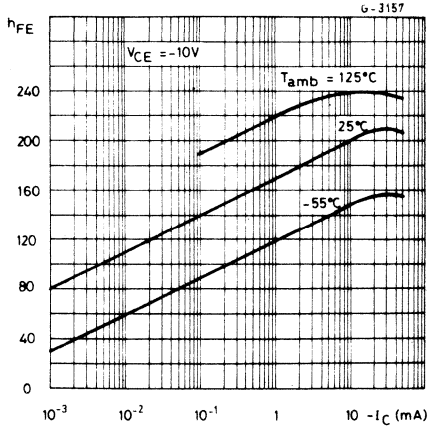
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	V_{CB} = -100V V_{CB} = -100V T_{amb} = 125°C			-10 -10	nA μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = -4V			-10	nA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	I_C = -10 μA	-180			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown 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 I_C = -1 mA V_{CE} = -10V I_C = -10 mA V_{CE} = -10V I_C = -10 μA V_{CE} = -10V T_{amb} = -55°C I_C = -100 μA V_{CE} = -10V T_{amb} = -55°C	60 80 80 15 30	110 170 200 60 90	 300 	– – – – –
f_T	Transition frequency	I_C = -1 mA V_{CE} = -10V f = 20 MHz	40	60	160	MHz

ELECTRICAL CHARACTERISTICS (continued)

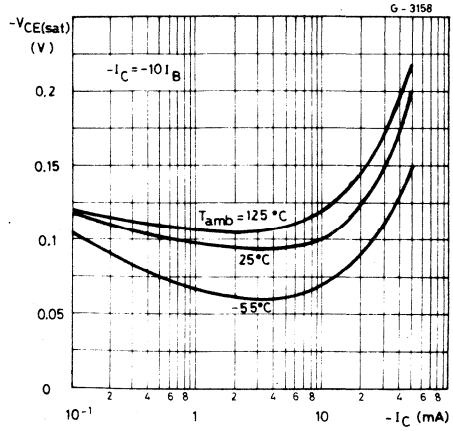
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = -0.5V$ $f = 1$ MHz		20	25	pF
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -5V$ $f = 1$ MHz		5	7	pF
NF	Noise figure	$I_C = -10\ \mu A$ $V_{CE} = -5V$ $R_g = 10\ k\Omega$ $f = 10$ kHz $B = 2$ kHz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

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

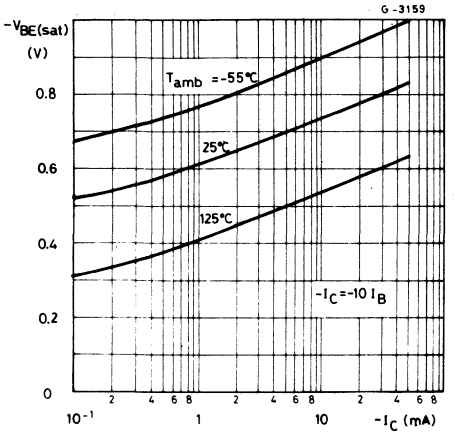
DC current gain



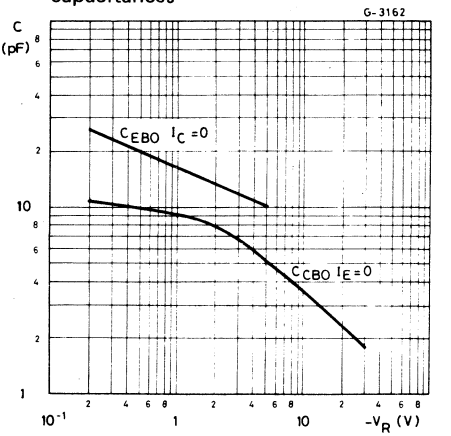
Collector-emitter saturation voltage



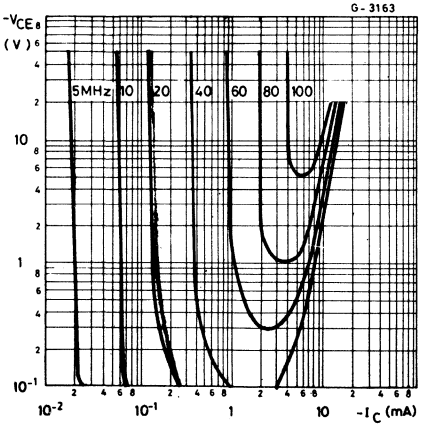
Base-emitter saturation voltage



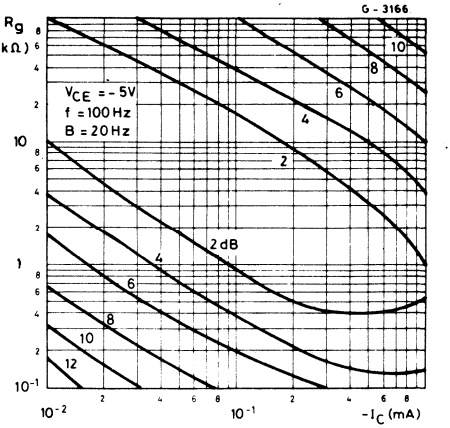
Emitter-base and collector-base capacitances



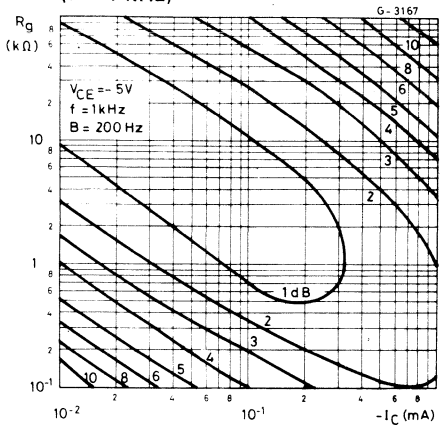
Contours of constant transition frequency



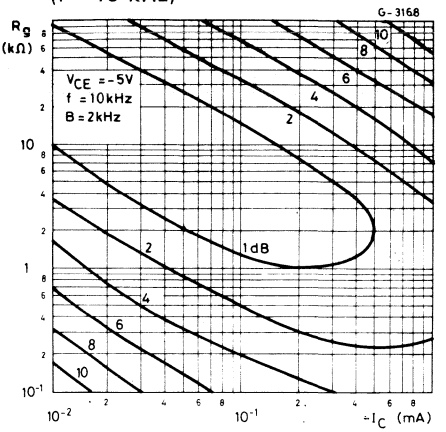
Contours of constant noise figure (f = 100 Hz)



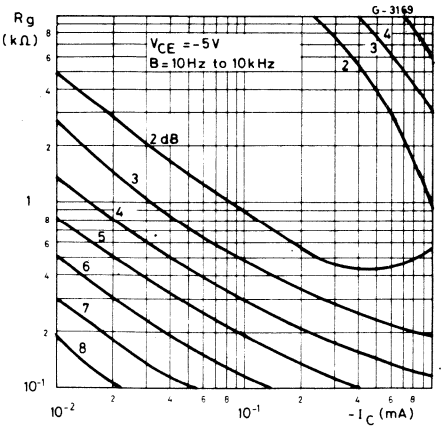
Contours of constant noise figure (f = 1 kHz)



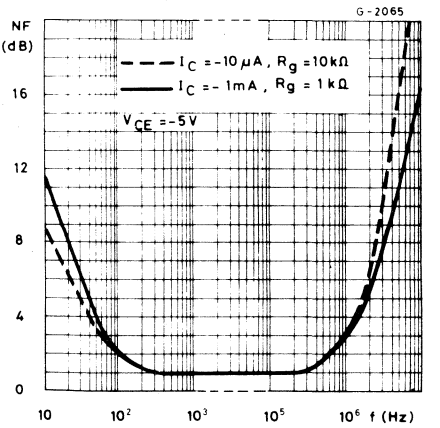
Contours of constant noise figure (f = 10 kHz)



Contours of constant wide band noise figure



Noise figure vs. frequency



SGS

2N 3962
2N 3963
2N 3964
2N 3965

EPITAXIAL PLANAR PNP

LOW NOISE, LOW LEVEL AMPLIFIERS

The 2N 3962, 2N 3963, 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.

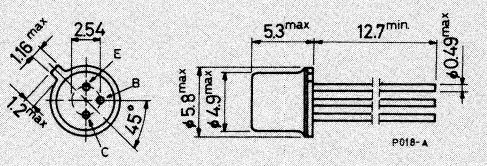
ABSOLUTE MAXIMUM RATINGS

		2N 3964	2N 3962 2N 3965	2N 3963
V_{CBO}	Collector-base voltage ($I_E = 0$)	-45 V	-60 V	-80 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-45 V	-60 V	-80 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		-6 V	
I_C	Collector current		-200 mA	
P_{tot}	Total power dissipation at $T_{amb} \leqslant 25°C$		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	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
		for **2N 3963**				
		V_{CE} = -70V			-10	nA
		V_{CE} = -70V T_{amb} = 150°C			-10	μA
I_{EBO}	Emitter cutoff current (I_C = o)	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
		for **2N 3963**	-80			V
$V_{(BR)CES}$	Collector-base breakdown voltage (V_{BE} = 0)	I_C = -10 μA				
		for **2N 3964**	-45			V
		for **2N 3962** and **2N 3965**	-60			V
		for **2N 3963**	-80			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -5 mA				
		for **2N 3964**	-45			V
		for **2N 3962** and **2N 3965**	-60			V
		for **2N 3963**	-80			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** and **2N 3963**				
		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** and **2N 3963**				
		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** and **2N 3963**	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** and **2N 3963**	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** and **2N 3963**				
		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** and **2N 3963**	2.5		17	kΩ
		for **2N 3964** and **2N 3965**	6		20	kΩ
h_{re}	Reverse voltage ratio	$I_C = -1$ mA $V_{CE} = -5V$ f= 1 kHz			10×10^{-4}	–
h_{oe}	Output admittance	$I_C = -1$ mA $V_{CE} = -5V$ f= 1 kHz				
		for **2N 3962** and **2N 3963**	5		40	μS
		for **2N 3964** and **2N 3965**	5		50	μS

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

SGS 2N 4013

EPITAXIAL PLANAR NPN

HIGH-CURRENT SWITCH

The 2N 4013 is a silicon planar epitaxial transistor in TO-18 metal case. It is a high-current switch used for memory applications requiring breakdown voltages up to 30V and operating currents to 1A.

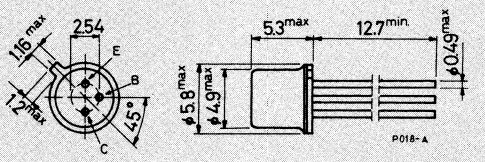
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	50	V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	50	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6	V
I_C	Collector current	1	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25°C$	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)

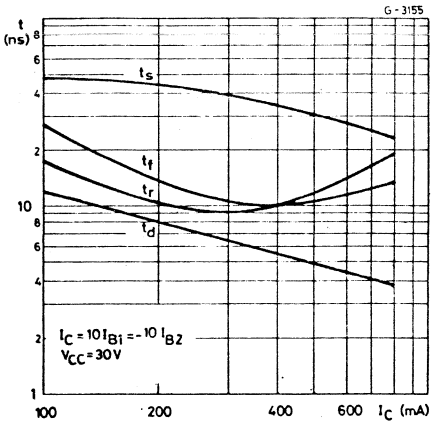
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 40V V_{CB} = 40V T_{amb} = 100°C			1.7 120	μA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA	50			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10 μA	50			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	6			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = 10 mA I_B = 1 mA I_C = 100 mA I_B = 10 mA I_C = 300 mA I_B = 30 mA I_C = 500 mA I_B = 50 mA I_C = 800 mA I_B = 80 mA I_C = 1000mA I_B = 100 mA			0.25 0.20 0.32 0.42 0.65 0.75	V V V V V V
$V_{BE(sat)}$*	Base-emitter saturation voltage	I_C = 10 mA I_B = 1 mA I_C = 100 mA I_B = 10 mA I_C = 300 mA I_B = 30 mA I_C = 500 mA I_B = 50 mA I_C = 800 mA I_B = 80 mA I_C = 1000mA I_B = 100 mA	 0.9 	0.64 0.75 0.89 1.0 1.1	0.76 0.86 1.1 1.2 1.5 1.7	V V V V V V
h_{FE}*	DC current gain	I_C = 10 mA V_{CE} = 1V I_C = 100 mA V_{CE} = 1V I_C = 300 mA V_{CE} = 1V I_C = 1000mA V_{CE} = 5V I_C = 800 mA V_{CE} = 2V I_C = 500 mA V_{CE} = 1V	30 60 40 30 25 35		 150	– – – – – –

ELECTRICAL CHARACTERISTICS (continued)

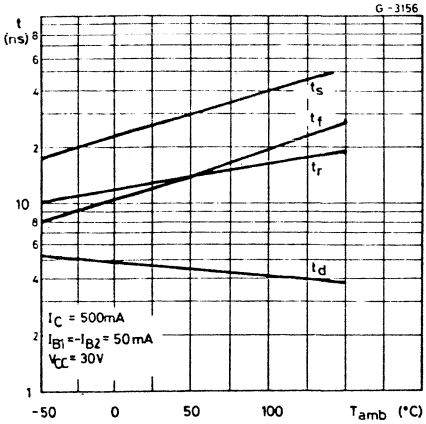
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	High frequency current gain	$I_C = 50$ mA $V_{CE} = 10$V f = 100 MHz	3			–
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10$V f = 1 MHz			12	pF
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5$V f = 1 MHz			55	pF
t_{on} **	Turn-on time	$I_C = 500$ mA $V_{CC} = 30$V $I_B = 50$ mA			35	ns
t_{off} **	Turn off time	$I_C = 500$ mA $V_{CC} = 30$V $I_{B1} = -I_{B2} = 50$ mA			60	ns

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

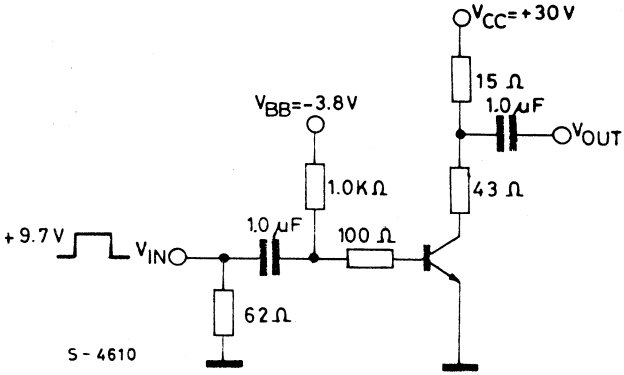
Switching characteristics



Switching characteristics



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
t_r, $t_f \leqslant 1.0$ ns
PW ≈ 1.0 μs
$Z_{IN} = 50\Omega$
DC < 2%

TO OSCILLOSCOPE:
$t_r < 1.0$ ns
$Z_{IN} \geqslant 100$ KΩ

SGS 2N 4014

EPITAXIAL PLANAR NPN

HIGH-VOLTAGE, HIGH-CURRENT SWITCH

The 2N 4014 is a silicon planar epitaxial transistor in TO-18 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.

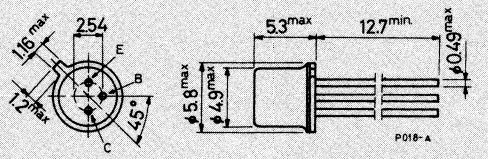
ABSOLUTE MAXIMUM RATINGS

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 $T_{amb} \leqslant 25°C$	0.36	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)

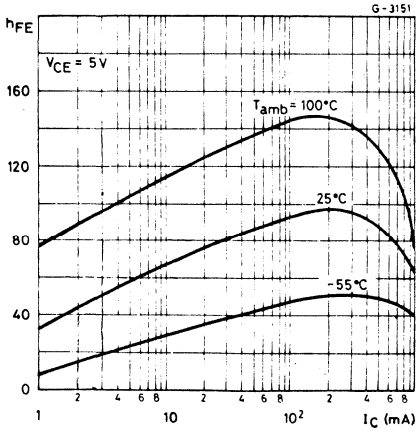
Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current (I_E = 0)	V_{CB} = 60V V_{CB} = 60V T_{amb} = 100°C			1.7 120	μA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage (I_E = 0)	I_C = 10 μA	80			V
$V_{(BR)CES}$	Collector-emitter breakdown voltage (V_{BE} = 0)	I_C = 10 μA	80			V
$V_{(BR)CEO}$ *	Collector-emitter breakdown 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 I_C = 100 mA I_B = 10 mA I_C = 300 mA I_B = 30 mA I_C = 500 mA I_B = 50 mA I_C = 800 mA I_B = 80 mA I_C = 1000mA I_B = 100 mA		0.19 0.21 0.31 0.4 0.5 0.6	0.25 0.26 0.4 0.52 0.8 0.95	V V V V V V
$V_{BE(sat)}$ *	Base-emitter saturation voltage	I_C = 10 mA I_B = 1 mA I_C = 100 mA I_B = 10 mA I_C = 300 mA I_B = 30 mA I_C = 500 mA I_B = 50 mA I_C = 800 mA I_B = 80 mA I_C = 1000mA I_B = 100 mA	 0.9 	0.64 0.75 0.89 1.0 1.1	0.76 0.86 1.1 1.2 1.5 1.7	V V V V V V
h_{FE} *	DC current gain	I_C = 10 mA V_{CE} = 1V I_C = 100 mA V_{CE} = 1V I_C = 300 mA V_{CE} = 1V I_C = 1000mA V_{CE} = 5V I_C = 800 mA V_{CE} = 2V I_C = 500 mA V_{CE} = 1V	30 60 40 25 20 35	60 90 60 65 40 	 150 	– – – – – –

ELECTRICAL CHARACTERISTICS (continued)

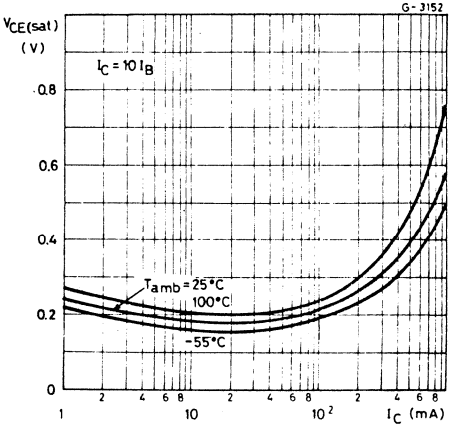
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	High frequency current gain	$I_C = 50$ mA $V_{CE} = 10$V f = 100 MHz	3			–
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10$V f = 1 MHz			10	pF
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5$V f = 1 MHz			55	pF
t_{on} **	Turn-on time	$I_C = 500$ mA $I_B = 50$ mA $V_{CC} = 30$V			35	ns
t_{off} **	Turn off time	$I_C = 500$ mA $V_{CC} = 30$V $I_{B1} = -I_{B2} = 50$ mA			60	ns

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

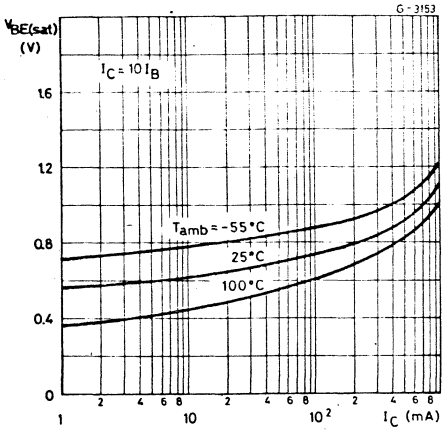
DC current gain



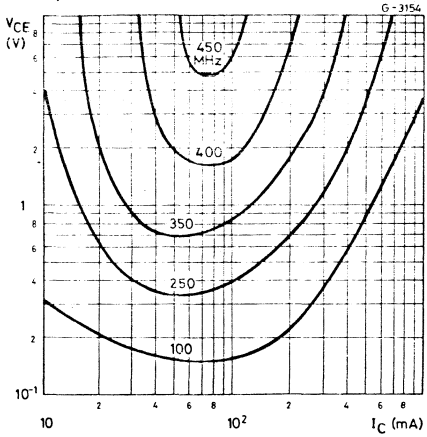
Collector-emitter saturation voltage



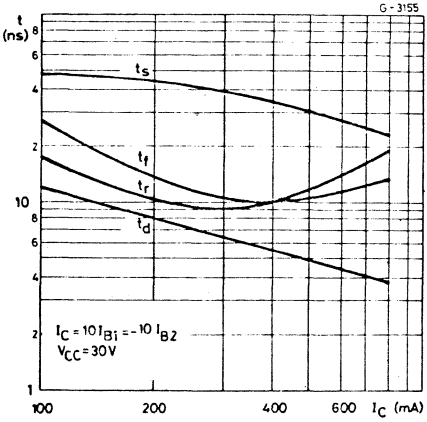
Base-emitter saturation voltage



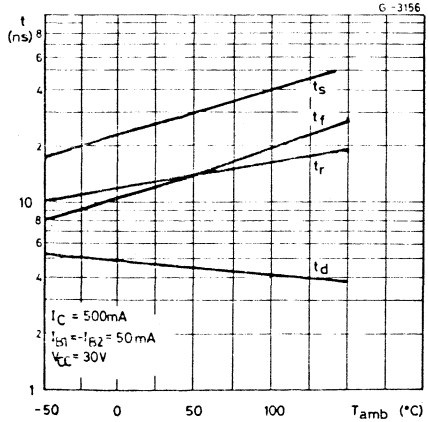
Contours of constant transition frequency



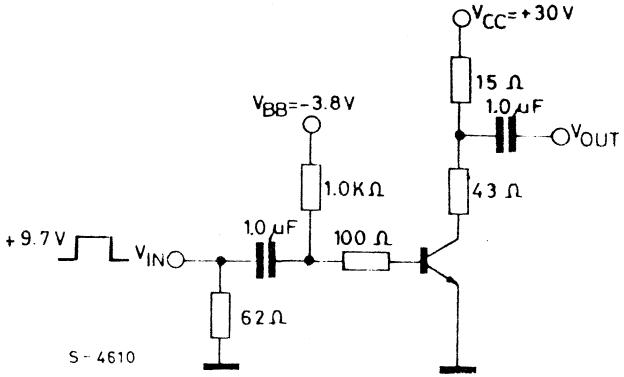
Switching characteristics



Switching characteristics



Test circuit for t_{on}, t_{off}



PULSE GENERATOR:
t_r, $t_f \leqslant 1.0$ ns
PW $\approx 1.0\ \mu s$
$Z_{IN} = 50\Omega$
DC < 2%

TO OSCILLOSCOPE:
$t_r < 1.0$ ns
$Z_{IN} \geqslant 100\ k\Omega$

EPITAXIAL PLANAR PNP

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

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.

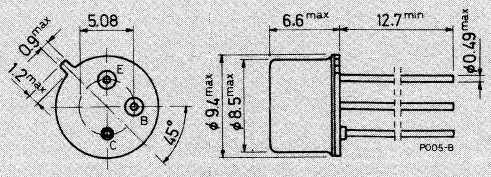
ABSOLUTE MAXIMUM RATINGS

		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 $T_{amb} \leqslant 25°C$	0.8 W	
	at $T_{case} \leqslant 25°C$	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
$V_{(BR)CEO}$*	Collector-emitter breakdown 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

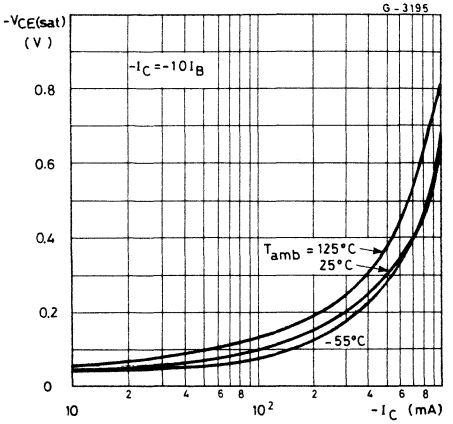
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C = -100 μA 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

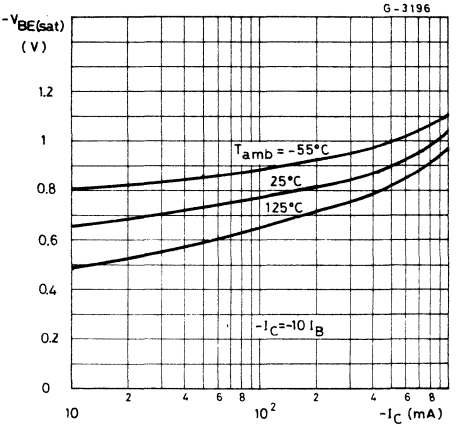
* Pulsed: pulse duration = 300 μs, duty cycle = 1%

** See test circuit

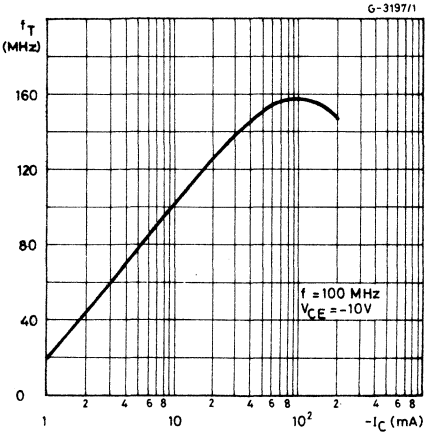
Collector-emitter saturation voltage



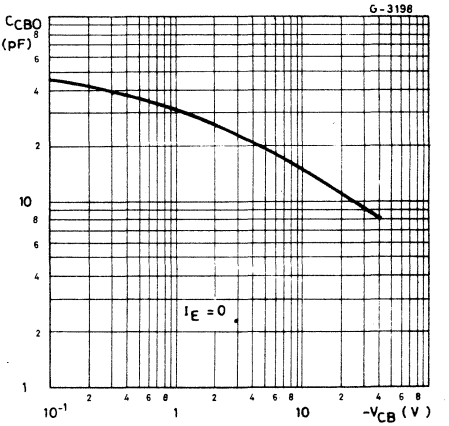
Base-emitter saturation voltage



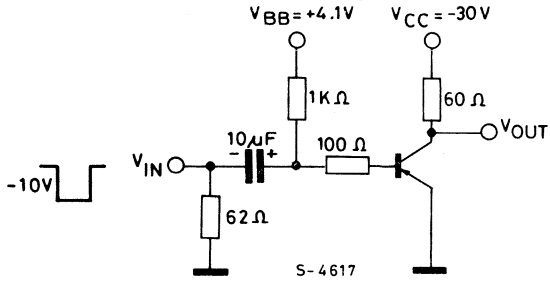
Transition frequency



Collector-base capacitance



Test circuit for t_{on}, t_s, t_f



PULSE GENERATOR:
t_r, t_f < 20 ns
PW = 1.0 μs
Z_{IN} = 50Ω
DC < 2%

TO OSCILLOSCOPE:
$t_r \approx$ 10 ns
Z_{IN} > 100 KΩ

SGS 2N 4035

EPITAXIAL PLANAR PNP

GENERAL PURPOSE AMPLIFIERS AND SWITCHES

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

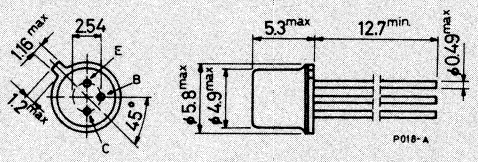
ABSOLUTE MAXIMUM RATINGS

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**)

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
$V_{(BR)CEO}$*	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 = -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	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	V_{CE} = -1V				
		T_{amb} = -55°C		70			–

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	150		450	–
f_T	Transition frequency	$I_C = -10$ mA $V_{CE} = -20$V f = 100 MHz	450			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	4		12	kΩ
h_{re}	Reverse voltage ratio	$I_C = -1$ mA $V_{CE} = -10$V f = 1 kHz			4×10^{-4}	–
h_{oe}	Output admittance	$I_C = -1$ mA $V_{CE} = -10$V f = 1 kHz	8		40	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%

EPITAXIAL 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.

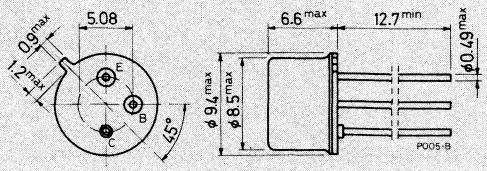
ABSOLUTE MAXIMUM RATINGS

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 ($I_C = 0$)	-6	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**)

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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
$V_{(BR)CEX}$*	Collector-emitter breakdown voltage (V_{BE} = 1.5V)	I_C = -10 mA	-85			V
$V_{(BR)CER}$*	Collector-emitter breakdown voltage (R_{BE} = 200Ω)	I_C = -10 mA	-85			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -10 mA	-65			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			-0.65	V
V_{BE}*	Base-emitter voltage	I_C = -150 mA V_{CE} = -10V			-1.1	V

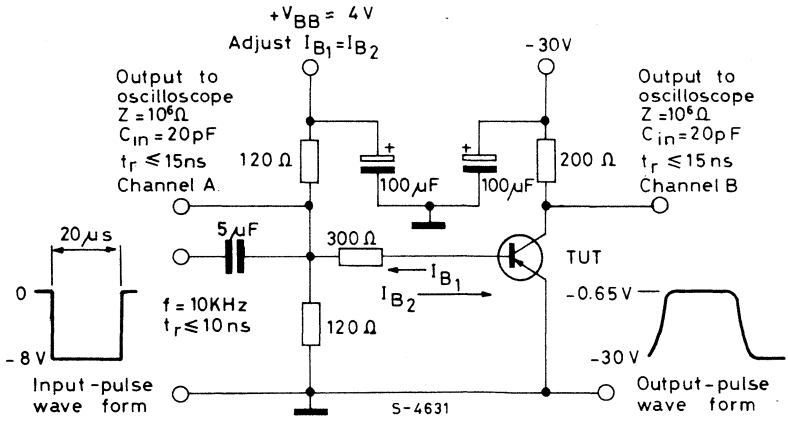
ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}*	DC current gain	I_C= -0.1 mA V_{CE}= -10V I_C= -150 mA V_{CE}= -10V I_C= -500 mA V_{CE}= -10V	20 40 20		 140 	– – –
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%

** See test circuit

Test circuit for t_{on}, t_{off}



SGS 2N 4037

EPITAXIAL PLANAR PNP

MEDIUM SPEED SWITCH

The 2N 4037 is a silicon planar epitaxial PNP transistor in a Jedec TO-39 metal case. It is intended particularly as medium speed saturated switch and general purpose amplifier.

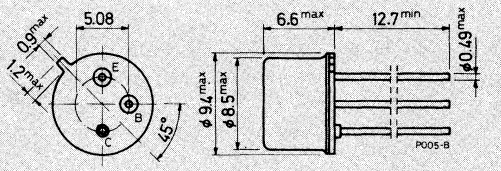
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{CER}	Collector-emitter voltage ($R_{BE} \leqslant 200\Omega$)	-60	V
V_{CEV}	Collector-emitter voltage ($V_{BE} = 1.5V$)	-60	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-6	V
I_C	Collector current	-1	A
I_B	Base current	-0.5	A
P_{tot}	Total power dissipation 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**)

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			-250	nA
I_{CEO}	Collector cutoff current ($I_B = 0$)	V_{CE} = -30V			-5	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	V_{EB} = -5V			-1	μA
V_{EBO}	Emitter-base voltage	I_E = -100 μA $I_C = 0$	-6			V
V_{CBO}	Collector-base voltage ($I_E = 0$)	I_C = -100 μA	-60			V
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage (I_B = 0)	I_C = -10 mA	-40			V
$V_{CE(sat)}$*	Collector-emitter saturation voltage	I_C = -150 mA I_B = -15 mA			-1.4	V
$V_{(BR)CEV}$*	Collector-emitter breakdown voltage	I_C = -10 mA V_{BE} = 1.5V	-60			V
$V_{(BR)CER}$*	Collector-emitter breakdown voltage	I_C = -10 mA R_{BE} = 200Ω	-60			V
V_{BE}*	Base-emitter voltage	I_C = -150 mA V_{CE} = -10V			-1.5	V
h_{FE}*	DC current gain	I_C = -1 mA V_{CE} = -10V I_C = -150 mA V_{CE} = -10V	15 50		 250	– –
h_{fe}	Small signal current gain	I_C = -50 mA V_{CE} = -10V f = 20 MHz	3			–
C_{CBO}	Collector-base capacitance ($I_E = 0$)	V_{CB} = -10V			30	pF
C_{EBO}	Emitter-base capacitance ($I_E = 0$)	V_{EB} = -0.5V			90	pF

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

SGS 2N 5320 2N 5321

EPITAXIAL PLANAR NPN

MEDIUM-POWER AMPLIFIERS

The 2N 5320 and 2N 5321 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.

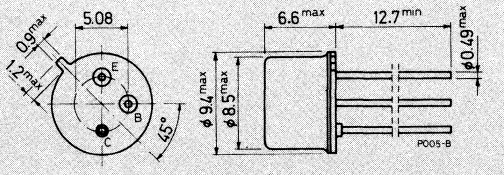
ABSOLUTE MAXIMUM RATINGS

		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 $T_{amb} \leqslant 25°C$	1 W	
	at $T_{case} \leqslant 25°C$	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
$V_{(BR)CEO}$ *	Collector-emitter breakdown 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 $V_{CE} = 4V$ f = 10 MHz	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%

SGS

2N 5322
2N 5323

EPITAXIAL PLANAR PNP

MEDIUM-POWER AMPLIFIERS

The 2N 5322 and 2N 5323 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.

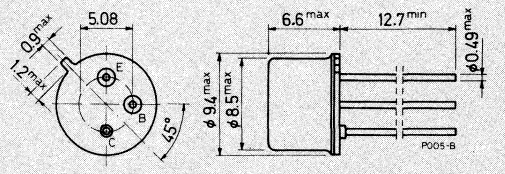
ABSOLUTE MAXIMUM RATINGS

		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 $T_{amb} \leqslant 25°C$	1 W	
	at $T_{case} \leqslant 25°C$	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
$V_{(BR)CEO}$*	Collector-emitter breakdown 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 f = 10 MHz	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%

SGS 2N 5415S

EPITAXIAL 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.

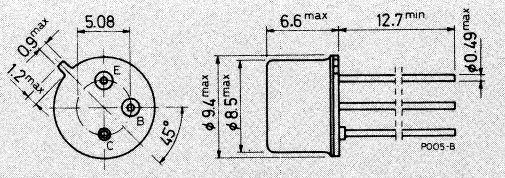
ABSOLUTE MAXIMUM RATINGS

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 $T_{amb} \leqslant 25°C$	1	W
	at $T_{case} \leqslant 25°C$	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**)

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
$V_{(BR)CEO}$*	Collector-emitter breakdown voltage ($I_B = 0$)	I_C = -2 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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