DL126/D
Rev. 7, Nov-2001

Small-Signal Device Data

Bipolar Transistors, JFETs and Diodes

ON Semiconductor™

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CHAPTER 1
Selector Guide

Small–Signal

Bipolar Transistors, JFETs, and Diodes

In Brief . . .

This section highlights semiconductors that are the most popular and have a history of high usage for most applications.

It covers a wide range of Small–Signal semi–conductors. A large selection of bipolar transistors, JFETs and diodes are available for surface mount and insertion assembly technology.

Small–Signal Package Cross–Reference Table

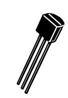
EIAJ	IEC	JEDEC	Other
	SOT–23		SST3
SC–59	SOT–346		SMT3. MPAK
SC–70	SOT–323		UMT3, CMPAK
SC–75, SC–90	SOT–416		EMT3, SMPAK
SC–89	SOT–490		EMT3
SC–74	SOT–457	**TSOP6**	SMT6, SC–59–6
SC–74A		**TSOP5**	SMT5, SC–59–5
SC–88	SOT–363		UMT6, SC–70–6
SC–88A	SOT–353		UMT5, SC–70–5
SC–77	**SOD–123**		SMD2
SC–76	**SOD–323**		UMD2, URP
SC–79	**SOD–523**		EMD2, UFP
SC–62	**SOT–89**		MPT3, UPAK
SC–73	**SOT–223**		
SC–43	SOT–54	**TO–92**	SPT
	SOT–666		EMT6
	SOT–665		EMT5
SO–16			

BOLD denotes an ON Semiconductor package name.

Page

Bipolar Transistors

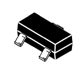
General–Purpose Transistors

NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE}		f_T MHz Min	NF dB Max	Package	Page
				Min	Max				
–	MPSL51	100	600	40	250	60	–		896
BC449	–	100	300	50	460	100	–		213
BC449A	–	100	300	120	220	100	–		213
BC447	–	80	500	50	460	100	–		213
MPS8099	***MPS8599***	80	500	100	300	150	–		847
MPSA06	***MPSA56***	80	500	100	–	100	–		855
2N4410	–	80	250	60	400	60	–		50
–	MPS6729	80	500	50	250	–	–		843
BC546	–	65	100	120	450	150	10		242
BC546B	BC556B	65	100	180	450	150	10		242, 249
BC487	–	60	500	60	400	–	–		217
BC487B	BC488B	60	500	160	400	–	–		217
MPSA05	MPSA55	60	500	100	–	100	–		855
–	***MPS2907A***	60	600	100	300	200	–		796
–	***2N5087***	50	50	250	800	40	2.0		55
BC182	BC212	50	100	120	500	200 (Typ)	10		190, 193
BC182A	–	50	100	120	260	200	10		190
BC182B	BC212B	50	100	200	500	200	10		190, 193
BC237	–	45	100	120	800	150	10		196
BC237A	–	45	100	120	220	150	10		196
BC237B	BC307B	45	100	200	460	150	10		196, 199
BC237C	BC307C	45	100	380	800	150	10		196, 199
BC337	BC327	45	800	100	630	210 (Typ)	–		205, 202
BC337–16	BC327–16	45	800	100	250	260 (Typ)	–	**TO–226AA, TO–92 Case 29–11 Page 1100**	205, 202
BC337–25	BC327–25	45	800	160	400	260 (Typ)	–		205, 202
BC337–40	BC327–40	45	800	250	630	260 (Typ)	–		205, 202
BC550C	BC560C	45	100	380	800	250 (Typ)	2.5		246, 255
–	BC557	45	100	120	800	150	10		249
BC547A	BC557A	45	100	120	220	150	10		242, 249
BC547B	BC557B	45	100	180	450	150	10		242, 249
BC547C	BC557C	45	100	380	800	150	10		242, 249
MPSA18	–	45	200	500	–	100	1.5		865
MPSA20	–	40	100	40	400	125	–		869
MPS2222A	–	40	600	100	300	300	–		787
2N4401	***2N4403***	40	600	100	300	200	–		40, 45
MPS6602	***MPS6652***	40	1000	50	–	100	–		837
2N3904	***2N3906***	40	200	100	300	250	5.0		29, 35
BC548B	BC558B	30	100	200	450	300 (Typ)	10		242, 249
BC548C	BC558C	30	100	420	800	300	10		242, 249
–	BC213	30	100	80	–	200	10		193
MPS2222	–	30	600	100	300	250	–		787
2N5088	–	30	50	350	–	50	3.0		61
2N5089	–	25	50	450	–	50	2.0		61
BC238B	–	25	100	200	460	150	10		196
BC238C	–	25	100	380	800	150	10		196
BC239C	–	25	100	380	800	150	4.0		196
BC338–25	–	25	800	160	400	150	–		205
MPS4124	–	25	200	120	360	170	5.0		811
–	MPS4126	25	200	120	360	170	4.0		813
MPS5172	–	25	100	100	500	–	–		815
MPS6521	MPS6523	25	100	300	600	–	3.0		826

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

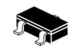
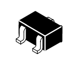
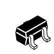
General–Purpose Transistors

NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE} Min	h_{FE} Max	f_T MHz Min	NF dB Max	Package	Page
MPSW05	MPSW55	60	500	60	–	50	250		903, 920
–	MPS6729	80	500	50	250	–	–	**TO–226AE** (1–WATT) **TO–92** **Case 29–10** **Page 1100**	843
MPSW06	***MPSW56***	80	500	80	–	50	–		903, 920
–	BSS63LT1	100	100	30	–	50	–0.25		370
BSS64LT1	–	80	100	20	–	60	0.15		372
BC846ALT1	–	65	100	110	220	100	10		275
BC846BLT1	–	65	100	200	450	100	10		275
–	***BC856ALT1***	65	100	125	250	100	10		300
–	***BC856BLT1***	65	100	220	475	100	10		300
–	***MMBT2907ALT1***	60	600	100	300	200	–		563
MMBT2484LT1	–	60	50	250	–	–	3.0		559
MMBT6428LT1	–	50	200	250	–	100	3.0 (Typ)		643
–	***MMBT5087LT1***	50	50	250	–	40	2.0		621
MMBT6429LT1	–	45	200	500	–	100	3.0 (Typ)		643
BC817–16LT1	–	45	500	100	250	100	–		272
BC817–25LT1	–	45	500	160	400	100	–		272
BC817–40LT1	–	45	500	250	600	100	–		272
–	BC807–16LT1	45	500	100	250	100	–		269
–	***BC807–25LT1***	45	500	160	400	100	–		269
–	***BC807–40LT1***	45	500	250	600	100	–		269
BC847ALT1	–	45	100	110	220	100	10		275
BC847BLT1	–	45	100	200	450	100	10		275
BC847CLT1	–	45	100	420	800	100	10		275
BC850BLT1	–	45	100	200	450	100	4.0		275
BC850CLT1	–	45	100	420	800	100	4.0	**TO–236AB, SOT–23** **Case 318–08** **Page 1101**	275
–	***BC857ALT1***	45	100	125	250	100	10		300
–	***BC857BLT1***	45	100	220	475	100	10		300
MMBT2222ALT1	–	40	600	100	300	300	4.0		553
MMBT3904LT1	–	40	200	100	300	200	5.0		572
–	***MMBT3906LT1***	40	200	100	300	250	4.0		593
MMBT4401LT1	–	40	600	100	300	250	–		608
–	***MMBT4403LT1***	40	600	100	300	200	–		613
BC848ALT1	–	30	100	110	220	100	10		275
BC848BLT1	–	30	100	200	450	100	10		275
BC848CLT1	–	30	100	420	800	100	10		275
BC849BLT1	–	30	100	200	450	100	4.0		275
BC849CLT1	–	30	100	420	800	100	4.0		275
–	***BC858ALT1***	30	100	125	250	100	10		300
–	***BC858BLT1***	30	100	220	475	100	10		300
–	***BC858CLT1***	30	100	420	800	100	10		300
–	***BC859BLT1***	30	100	220	475	100	4.0		300
–	***BC859CLT1***	30	100	420	800	100	4.0		300
MMBT5088LT1	–	30	50	300	900	5	3.0		627
MMBT5089LT1	–	25	50	400	1200	50	2.0		627
MMBT4124LT1	–	25	200	120	360	300	5.0		604

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

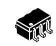
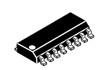
General–Purpose Transistors

NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE} Min	h_{FE} Max	f_T MHz Min	NF dB Max	Package	Page
MSD601–RT1	–	50	100	210	340	–	–		950
MSD601–ST1	–	50	100	290	460	–	–		950
MSD602–RT1	–	50	500	120	240	–	–		951
MSC2712GT1	–	50	100	200	400	–	–		938
–	***MSA1162GT1***	50	100	200	400	–	–	**SC–59**	929
–	***MSA1162YT1***	50	100	120	240	–	–	**Case 318D–04**	929
–	***MSB710–RT1***	50	500	120	240	–	–	**Page 1102**	934
–	***MSB709–RT1***	45	100	210	340	–	–		933
MSD1328–RT1	–	20	500	200	350	–	–		941
MSD1328–ST1	–	20	500	300	500	–	–		941
BC846AWT1	–	65	100	110	220	100	10		279
BC846BWT1	–	65	100	200	450	100	10		279
–	***BC856AWT1***	65	100	125	250	100	10		305
–	***BC856BWT1***	65	100	220	475	100	10		305
–	***MMBT2907AWT1***	60	600	100	–	200	–		567
MSD1819A–RT1	–	50	100	210	340	–	–		942
BC847AWT1	–	45	100	110	220	100	10		279
BC847BWT1	–	45	100	200	450	100	10		279
BC847CWT1	–	45	100	420	800	100	4.0		279
–	***BC857BWT1***	45	100	220	475	100	10		305
–	***BC857CWT1***	45	100	420	800	100	10		305
–	***MSB1218A–RT1***	45	100	210	340	–	–	**SC–70, SOT–323**	930
MMBT2222AWT1	–	40	600	100	300	300	4.0	**Case 419–04** **Page 1104**	548
MMBT3904WT1	–	40	200	100	300	300	5.0		584
–	***MMBT3906WT1***	40	200	100	300	250	4.0		584
BC848AWT1	–	30	100	110	220	100	10		279
BC848BWT1	–	30	100	200	450	100	10		279
BC848CWT1	–	30	100	420	800	100	4.0		279
–	***BC858AWT1***	30	100	110	220	100	10		305
–	***BC858BWT1***	30	100	200	450	100	10		305
MSC3930–BT1	–	20	30	70	140	150	–		940
2SC4617	–	50	100	120	560	180 (Typ)	–		105
–	***2SA1774***	50	100	120	560	140 (Typ)	–		103
BC847BTT1	–	45	100	200	450	100	10		296
BC847CTT1	–	45	100	420	800	100	4.0		296
–	***BC857BTT1***	45	100	220	475	100	10	**SOT–416, SC–75,** **SC–90**	315
–	***BC857CTT1***	45	100	420	800	100	10	**Case 463–01**	315
MMBT3904TT1	–	40	200	100	300	300	5.0	**Page 1106**	578
–	***MMBT3906TT1***	40	200	100	300	250	4.0		598
MMBT2222ATT1	–	40	600	100	300	300	4.0		543

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

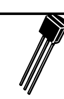
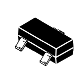
General–Purpose Multiple Transistors

Device	Type	$V_{(BR)CEO}$	I_C mA Max	h_{FE}		f_T MHz Min	NF dB Max	Package	Page
				Min	Max				
BC846BDW1T1	Dual NPN	65	100	200	450	100	10		283
BC856BDW1T1	Dual PNP	65	100	220	475	100	10		310
BC846BPDW1T1	Dual Complimentary	65	100	200	475	100	10		288
BC847BDW1T1	Dual NPN	45	100	200	290	100	10		283
BC847CDW1T1	Dual NPN	45	100	420	520	100	4.0		283
BC857BDW1T1	Dual PNP	45	100	220	290	100	10		310
BC857CDW1T1	Dual PNP	45	100	420	520	100	10		310
BC847BPDW1T1	Dual Complimentary	45	100	200	290	100	10		288
BC847CPDW1T1	Dual Complimentary	45	100	420	520	100	4.0/10		288
MBT3904DW1T1	Dual NPN	40	200	100	300	300	5.0	**SC–88, SOT–363**	464
MBT3906DW1T1	Dual PNP	40	200	100	300	250	4.0	**Case 419B–02**	470
MBT3946DW1T1	Dual Complimentary	40	200	100	300	250	5.0/4.0	**Page 1105**	475
BC848BDW1T1	Dual NPN	30	100	200	290	100	10		283
BC848CDW1T1	Dual NPN	30	100	420	250	100	4.0		283
BC858BDW1T1	Dual PNP	30	100	220	290	100	10		310
BC858CDW1T1	Dual PNP	30	100	420	520	100	10		310
BC848BPDW1T1	Dual Complimentary	30	100	200	290	100	10		288
BC848CPDW1T1	Dual Complimentary	30	100	420	520	100	4.0/10		288
MMPQ2222A	Quad NPN	40	500	100	300	200	–		712
MMPQ2369	Quad NPN	15	500	40	–	450	–		714
MMPQ3467	Quad PNP	40	1000	20	–	190 (Typ)	–		716
MMPQ3904	Quad NPN	40	200	75	–	250	–	**SO–16**	718
MMPQ3906	Quad PNP	40	200	75	–	200	–	**Case 751B–05**	720
MMPQ6700	Quad Complimentary	40	200	70	–	200	–	**Page 1107**	722

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

Low Noise and Good h_{FE} Linearity

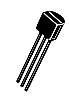
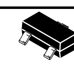
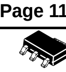
NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE}		f_T MHz Min	NF dB Max	Package	Page
				Min	Max				
–	***2N5087***	50	50	250	800	40	2.0		55
BC550C	BC560C	45	100	380	800	250 (Typ)	2.5		246, 255
MPSA18	–	45	200	500	–	100	1.5		865
2N5088	–	30	50	350	–	50	3.0	**TO–226AA, TO–92**	61
2N5089	–	25	50	450	–	50	2.0	**Case 29–11**	61
MPS6521	MPS6523	25	100	300	600	–	3.0	**Page 1100** (Note 1.)	826
MMBT5089LT1	–	25	50	400	–	50	2.0		627
MMBT5088LT1	–	30	50	300	900	5	3.0		627
MMBT2484LT1	–	60	50	250	–	–	3.0		559
MMBT6428LT1	–	50	200	250	–	100	3.0 (Typ)	**TO–236AB, SOT–23**	643
MMBT6429LT1	–	45	200	500	–	100	3.0 (Typ)	**Case 318–08**	643
–	***MMBT5087LT1***	50	50	250	–	40	2.0	**Page 1101**	621

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

1. N_F: Noise Figure at R_S = 2.0 kΩ, I_C = 200 μA, V_{CE} = 5.0 Volts. f = 30 Hz to 15 kHz.

Bipolar Transistors

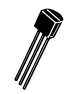
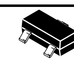
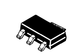
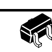
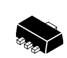
Darlington Transistors

NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE}		f_T MHz Min	NF dB Max	Package	Page
				Min	Max				
MPSW45A	–	50	1000	25K	150K	100	1.5	 **TO–226AE** (1–WATT) **TO–92** **Case 29–10** **Page 1100**	912
MPSW45	–	40	1000	25K	150K	100	1.5		912
–	MPSW63	30	500	10K	–	125	1.5		923
–	***MPSW64***	30	1000	20K	–	125	1.5		923
MPSW13	–	30	1000	10K	–	125	1.5		906
MPSW14	–	30	1000	20K	–	125	1.5		906
MPSA29	–	100	500	10K	–	125	1.5	 **TO–226AA, TO–92** **Case 29–11** **Page 1100**	878
BC372	–	100	1000	10K	160K	100	1.1		211
BC373	–	80	1000	10K	160K	100	1.1		211
MPSA27	MPSA77	60	500	10K	–	–	1.5		875, 887
BC618	–	55	1000	10K	50K	150	1.1		258
–	MPSA75	40	500	10K	–	–	1.5		887
2N6427	–	40	500	20K	200K	–	1.5		92
2N6426	–	40	500	30K	300K	125	1.5		92
MPSA14	***MPSA64***	30	500	20K	–	125	1.5		860, 884
MPSA13	MPSA63	30	500	10K	–	125	1.5		860, 884
BC517	–	30	1000	30K	–	200 (Typ)	1.0		237
MMBTA14LT1	***MMBTA64LT1***	30	300	20K	–	125	–	 **TO–236AB, SOT–23** **Case 318–08** **Page 1101**	663, 672
BSP52T1	–	80	1000	2000	–	–	–	 **SOT–223** **Case 318E–04** **Page 1103**	368

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

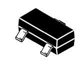
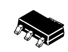
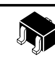
High Current Transistors (> 500 mA)

NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE} Min	h_{FE} Max	f_T MHz Min	NF dB Max	Package	Page
BC489	BC490	80	1000	60	400	200/150 (Typ)	0.3/0.5	 **TO–226AA, TO–92 Case 29–11 Page 1100**	227, 232
BC639	BC640	80	500	40	160	60	0.5		263, 266
BC489A	BC490A	80	1000	100	250	100	0.5		227, 232
BC489B	BC490B	80	1000	160	400	100	0.5		227, 232
BC639–16	BC640–16	80	1000	100	250	60	0.5		263, 266
MPS651	***MPS751***	60	2000	75	–	75	0.5		822
BC637	BC638	60	500	40	160	–	0.5		263, 266
BC635	BC636	45	500	40	250	200/150 (Typ)	–		263, 266
BC368	BC369	20	1000	60	–	65	0.5		208
MPSW01A	***MPSW51A***	40	1000	50	–	50	–	 **TO–226AE** (1–WATT) **TO–92 Case 29–10 Page 1100**	900, 917
MPSW01	MPSW51	30	1000	50	–	50	–		900, 917
MMBTA06LT1	***MMBTA56LT1***	80	500	100	–	100	–	 **TO–236AB, SOT–23 Case 318–08 Page 1101**	661, 671
BCP56T1	***BCP53T1***	80	1000	40	250	50 (Typ)	–	 **SOT–223 Case 318E–04 Page 1103**	321, 319
BCP56–10T1	***BCP53–10T1***	80	1000	63	160	50 (Typ)	–		321, 319
BCP56–16T1	***BCP53–16T1***	80	1000	100	250	50 (Typ)	–		321, 319
PZT2222AT1	–	40	600	100	300	300	–		1058
–	***PZT2907AT1***	60	600	100	300	200	–		1061
PZT651T1	***PZT751T1***	60	2000	75	–	75	–		1064, 1066
BCP68T1	***BCP69T1***	25	1000	85	375	60 (Typ)	–		324, 327
–	***NSL35TT1***	35	1000	100	–	–	–	 **SOT–416, SC–75, SC–90 Case 463–01 Page 1106**	1043
–	***NSL12TT1***	12	1000	100	–	–	–		1039
–	***NSL5TT1***	5.0	1000	100	–	–	–		1047
BCX56–10R1	–	80	1000	63	160	130 (Typ)	–	 **SOT–89 Case 1213–02 Page 1108**	329

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

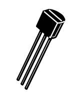
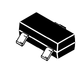
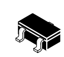
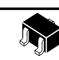
High Voltage Transistors (> 100 V)

NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE}		f_T MHz Min	NF dB Max	Package	Page
				Min	Max				
–	BF493S	350	500	40	–	50	20	 **TO–226AE** (1–WATT) **TO–92** **Case 29–10** **Page 1100**	349
MPSW42	–	300	500	40	–	50	0.5		909
–	***MPSW92***	300	500	25	–	50	0.5		926
BF393	–	300	500	40	–	50	–		340
2N5551	–	160	600	80	250	100	8.0		81
–	***2N5401***	150	600	60	240	100	8.0		65
2N6517	***2N6520***	350	500	30	200	40	–	 **TO–226AA, TO–92** **Case 29–11** **Page 1100**	97
MPSA42	–	300	500	40	–	50	0.5		881
–	***MPSA92***	300	500	40	–	50	0.5		889
BF422	BF423	250	500	50	–	60	–		343, 346
2N5550	–	160	600	80	–	100	0.15		81
2N6515	–	250	500	50	300	40	0.3		97
MMBT6517LT1	–	350	500	15	–	40	–	 **TO–236AB, SOT–23** **Case 318–08** **Page 1101**	647
–	***MMBT6520LT1***	350	500	15	–	40	–		651
MMBTA42LT1	–	300	500	40	–	50	–		668
–	***MMBTA92LT1***	300	500	25	–	50	–		674
MMBT5551LT1	–	160	600	80	250	–	–		635
–	***MMBT5401LT1***	150	500	50	–	100	8.0		631
PZTA96ST1	–	450	500	50	150	–	–	 **SOT–223** **Case 318E–04** **Page 1103**	1073
BSP19AT1	–	350	1000	40	–	70	–		366
PZTA42T1	***PZTA92T1***	300	500	40	–	50	–		1068, 1071
–	***BSP16T1***	300	1000	30	150	15	–		364
BF720T1	***BF721T1***	250	100	50	–	60	–		352, 355
MSD42WT1	–	300	150	40	–	–	–	 **SC–70, SOT–323** **Case 419–04** **Page 1104**	949
–	***MSB92WT1***	300	500	25	–	50	–		935
–	***MSB92AWT1***	300	500	120	200	50	–		935

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

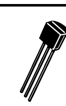
RF Transistors

NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE}		f_T MHz Min	Cap pF Max	Package	Page
				Min	Max				
MPSH10	–	25	–	60	–	650	C_{RB} = 0.65		892
BF959	–	20	100	40	–	600	C_{RE} = 0.65 (Typ)		358
MPSH17	–	15	–	25	250	800	C_{CB} = 0.9		894
MPS918	–	15	50	20	–	600	C_{OBO} = 1.7	**TO–226AA, TO–92 Case 29–11 Page 1100**	853
MPS5179	–	12	50	25	250	900	C_{CB} = 1.0		820
MPS3563	–	12	50	20	200	600	C_{OBO} = 1.7		853
MMBTH10LT1	–	25	–	60	–	650	C_{CB} = 0.7		677
MMBTH10–4LT1	–	25	–	120	240	800	C_{CB} = 0.7	**TO–236AB, SOT–23 Case 318–08 Page 1101**	677
MMBT918LT1	–	15	50	20	–	600	C_{OBO} = 1.7		659
MSD2714AT1	–	25	–	90	180	650	C_{CB} = 0.7		945
MSC2295–BT1	–	20	30	70	140	150	C_{RE} = 1.5		937
MSC2295–CT1	–	20	30	110	220	150	C_{RE} = 1.5	**SC–59 Case 318D–04 Page 1102**	937
MSC3130T1	–	10	50	75	400	1400	–		939
NSF2250WT1	–	15	50	120	250	2000	C_{OBO} = 1.2	 **SC–70, SOT–323 Case 419–04 Page 1104**	1030

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

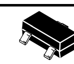
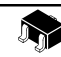
Switching Transistors

NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE}		f_T MHz Min	T_{off} ns Max	Package	Page
				Min	Max				
MPS3646	–	15	300	30	120	350	28		801
MPS2369	–	15	200	40	120	–	18		793
MPS2369A	–	15	200	40	120	–	18		793
2N4401	***2N4403***	40	600	100	300	200	–		40, 45
2N3904	***2N3906***	40	200	100	300	250	5.0	**TO–226AA, TO–92 Case 29–11 Page 1100**	29, 35
P2N2222A	–	40	600	100	300	300	285		1049
–	P2N2907A	60	600	100	300	200	110		1054

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

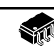
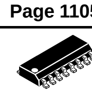
Switching Transistors

NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE}		f_T MHz Min	T_{off} ns Max	Package	Page
				Min	Max				
MMBT3904LT1	–	40	200	100	300	200	5.0		572
–	***MMBT3906LT1***	40	200	100	300	250	4.0		593
MMBT4401LT1	–	40	600	100	300	250	–	**TO–236AB, SOT–23**	608
–	***MMBT4403LT1***	40	600	100	300	200	–	**Case 318–08**	613
–	***MMBT3640LT1***	12	80	30	120	500	35	**Page 1101**	569
MMBT3904WT1	–	40	200	100	300	300	5.0		584
–	***MMBT3906WT1***	40	200	100	300	250	4.0	**SC–70, SOT–323 Case 419–04 Page 1104**	584
MMBT3904TT1	–	40	200	100	300	300	5.0	 **SOT–416, SC–75, SC–90**	578
–	***MMBT3906TT1***	40	200	100	300	250	4.0	**Case 463–01 Page 1106**	578

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

Multiple Switching Transistors

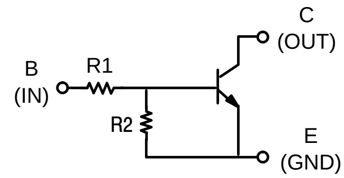
Device	Type	$V_{(BR)CEO}$	I_C mA Max	h_{FE}		f_T MHz Min	T_{off} ns Max	Package	Page
				Min	Max				
MBT3904DW1T1	Dual NPN	40	200	100	300	300	5.0		464
MBT3906DW1T1	Dual PNP	40	200	100	300	250	4.0	**SC–88, SOT–363**	464
MBT3946DW1T1	Dual Complimentary	40	200	100	300	250	5.0/4.0	**Case 419B–02 Page 1105**	464
MMPQ2369	Quad NPN	15	500	40	–	450	15 (Typ)		714
MMPQ3904	Quad NPN	40	200	75	–	250	136 (Typ)		718
MMPQ3906	Quad PNP	40	200	75	–	200	155 (Typ)	**SO–16**	720
MMPQ6700	Quad Complimentary	40	200	70	–	200	155 (Typ)	**Case 751B–05 Page 1107**	722

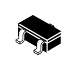
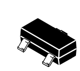
Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

Digital Transistors (Bias Resistor Transistors)

These devices include bias resistors on the semiconductor chip with the transistor. See the BRT diagram for orientation of resistors.



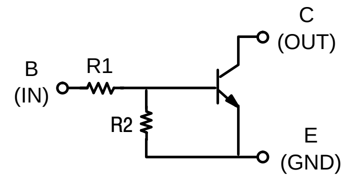
NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE} Min	R1 Ω	R2 Ω	Package	Page
DTC114E	DTA114E	50	100	35	10K	10K	 **TO–226AA, TO–92 Case 29–11 Page 1100**	402, 383
DTC124E	DTA124E	50	100	60	22K	22K		
DTC144E	DTA144E	50	100	80	47K	47K		
DTC143T	DTA143T	50	100	160	4.7K	∞		
DTC123E	DTA123E	50	100	8	2.2K	2.2K		
DTC143Z	DTA143Z	50	100	80	4.7K	47K		
DTC114Y	DTA114Y	50	100	80	10K	47K		
DTD113E	DTB113E	50	100	3	1K	1K		
DTC143E	DTA143E	50	100	15	4.7K	4.7K		
DTC114T	DTA114T	50	100	160	10K	∞		
MUN2211T1	***MUN2111T1***	50	100	35	10K	10K	 **SC–59 Case 318D–04 Page 1102**	967, 956
MUN2212T1	***MUN2112T1***	50	100	60	22K	22K		
MUN2213T1	***MUN2113T1***	50	100	80	47K	47K		
MUN2214T1	***MUN2114T1***	50	100	80	10K	47K		
MUN2215T1	***MUN2115T1***	50	100	160	10K	∞		
MUN2216T1	***MUN2116T1***	50	100	160	4.7K	∞		
MUN2230T1	***MUN2130T1***	50	100	3.0	1.0K	1.0K		
MUN2231T1	***MUN2131T1***	50	100	8.0	2.2K	2.2K		
MUN2232T1	***MUN2132T1***	50	100	15	4.7K	4.7K		
MUN2233T1	***MUN2133T1***	50	100	80	4.7K	47K		
MUN2234T1	***MUN2134T1***	50	100	80	22K	47K		
MUN2236T1	***MUN2136T1***	50	100	80	100K	100K		
MUN2237T1	***MUN2137T1***	50	100	80	47K	22K		
MUN2240T1	***MUN2140T1***	50	100	160	47K	∞		
MUN2241T1	–	50	100	160	100K	∞		
DTC144TT1	***DTA144TT1***	50	100	160	47K	∞		419, 400
MMUN2211LT1	***MMUN2111LT1***	50	100	35	10K	10K	 **TO–236AB, SOT–23 Case 318–08 Page 1101**	741, 734
MMUN2212LT1	***MMUN2112LT1***	50	100	60	22K	22K		
MMUN2213LT1	***MMUN2113LT1***	50	100	80	47K	47K		
MMUN2214LT1	***MMUN2114LT1***	50	100	80	10K	47K		
MMUN2215LT1	***MMUN2115LT1***	50	100	160	10K	∞		
MMUN2216LT1	***MMUN2116LT1***	50	100	160	4.7K	∞		
MMUN2230LT1	***MMUN2130LT1***	50	100	3.0	1.0K	1.0K		
MMUN2231LT1	***MMUN2131LT1***	50	100	8.0	2.2K	2.2K		
MMUN2232LT1	***MMUN2132LT1***	50	100	15	4.7K	4.7K		
MMUN2233LT1	***MMUN2133LT1***	50	100	80	4.7K	47K		
MMUN2234LT1	***MMUN2134LT1***	50	100	80	22K	47K		
MMUN2235LT1	–	50	100	80	2.2K	47K		
MMUN2238LT1	–	50	100	160	2.2K	∞		
MMUN2241LT1	–	50	100	160	100K	∞		

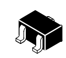
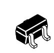
Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

Digital Transistors (Bias Resistor Transistors)

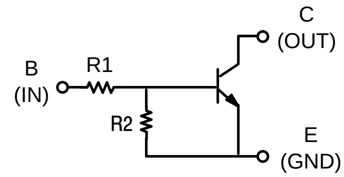
These devices include bias resistors on the semiconductor chip with the transistor. See the BRT diagram for orientation of resistors.



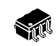
NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE} Min	R1 Ω	R2 Ω	Package	Page
MUN5211T1	***MUN5111T1***	50	100	35	10K	10K		
MUN5212T1	***MUN5112T1***	50	100	60	22K	22K		
MUN5213T1	***MUN5113T1***	50	100	80	47K	47K		
MUN5214T1	***MUN5114T1***	50	100	80	10K	47K		
MUN5215T1	***MUN5115T1***	50	100	160	10K	∞		
MUN5216T1	***MUN5116T1***	50	100	160	4.7K	∞		
MUN5230T1	***MUN5130T1***	50	100	3.0	1.0K	1.0K		1006, 988
MUN5231T1	***MUN5131T1***	50	100	8.0	2.2K	2.2K	**SC–70, SOT–323 Case 419–04 Page 1104**	
MUN5232T1	***MUN5132T1***	50	100	15	4.7K	4.7K		
MUN5233T1	***MUN5133T1***	50	100	80	4.7K	47K		
MUN5234T1	***MUN5134T1***	50	100	80	22K	47K		
MUN5235T1	***MUN5135T1***	50	100	80	2.2K	47K		
MUN5236T1	***MUN5136T1***	50	100	80	100K	100K		
MUN5237T1	***MUN5137T1***	50	100	80	47K	22K		
DTC114EET1	***DTA114EET1***	50	100	35	10K	10K		
DTC124EET1	***DTA124EET1***	50	100	60	22K	22K		
DTC144EET1	***DTA144EET1***	50	100	80	47K	47K		
DTC114YET1	***DTA114YET1***	50	100	80	10K	47K		
DTC114TET1	***DTA114TET1***	50	100	160	10K	∞		
DTC143TET1	***DTA143TET1***	50	100	160	4.7K	∞		
DTC123EET1	***DTA123EET1***	50	100	8.0	2.2K	2.2K	**SOT–416, SC–75, SC–90 Case 463–01 Page 1106**	410, 390
DTC143EET1	***DTA143EET1***	50	100	15	4.7K	4.7K		
DTC143ZET1	***DTA143ZET1***	50	100	80	4.7K	4.7K		
DTC124XET1	***DTA124XET1***	50	100	80	22K	47K		
DTC123JET1	***DTA123JET1***	50	100	80	2.2K	47K		
DTC115EET1	***DTA115EET1***	50	100	80	100K	100K		
DTC144WET1	***DTA144WET1***	50	100	80	47K	22K		

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Dual Digital Transistors (Bias Resistor Transistors)

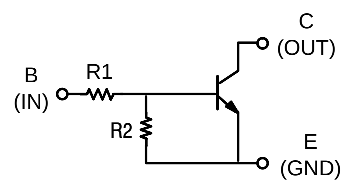


These devices include bias resistors on the semiconductor chip with the transistor. See the BRT diagram for orientation of resistors.

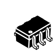
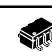
NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE} Min	R1 Ω	R2 Ω	Package	Page
MUN5211DW1T1	***MUN5111DW1T1***	50	100	35	10K	10K		
MUN5212DW1T1	***MUN5112DW1T1***	50	100	60	22K	22K		
MUN5213DW1T1	***MUN5113DW1T1***	50	100	80	47K	47K		
MUN5214DW1T1	***MUN5114DW1T1***	50	100	80	10K	47K		
MUN5215DW1T1	***MUN5115DW1T1***	50	100	160	10K	∞		
MUN5216DW1T1	***MUN5116DW1T1***	50	100	160	4.7K	∞		
MUN5230DW1T1	***MUN5130DW1T1***	50	100	3.0	1.0K	1.0K	**SC–88, SOT–363** **Duals** **Case 419B–02** **Page 1105**	998, 978
MUN5231DW1T1	***MUN5131DW1T1***	50	100	8.0	2.2K	2.2K		
MUN5232DW1T1	***MUN5132DW1T1***	50	100	15	4.7K	4.7K		
MUN5233DW1T1	***MUN5133DW1T1***	50	100	80	4.7K	47K		
MUN5234DW1T1	***MUN5134DW1T1***	50	100	80	22K	47K		
MUN5235DW1T1	***MUN5135DW1T1***	50	100	80	2.2K	47K		
MUN5236DW1T1	***MUN5136DW1T1***	50	100	80	100K	100K		
MUN5237DW1T1	***MUN5137DW1T1***	50	100	80	47K	22K		

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Combinational Digital Transistors (Bias Resistor Transistors)



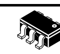
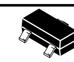
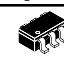
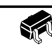
These devices include bias resistors on the semiconductor chip with the transistor. See the BRT diagram for orientation of resistors.

Device	Type	$V_{(BR)CEO}$	I_C mA Max	h_{FE} Min	Q1	Q2	Package	Page
MUN5311DW1T1		50	100	35	MUN5211	MUN5111		
MUN5312DW1T1		50	100	60	MUN5212	MUN5112		
MUN5313DW1T1		50	100	80	MUN5213	MUN5113		
MUN5314DW1T1		50	100	80	MUN5214	MUN5114		
MUN5315DW1T1		50	100	160	MUN5215	MUN5115		
MUN5316DW1T1		50	100	160	MUN5216	MUN5116		
MUN5330DW1T1	Dual Complimentary	50	100	3.0	MUN5230	MUN5130	**SC–88, SOT–363** **Case 419B–02** **Page 1105**	1015
MUN5331DW1T1		50	100	8.0	MUN5231	MUN5131		
MUN5332DW1T1		50	100	15	MUN5232	MUN5132		
MUN5333DW1T1		50	100	80	MUN5233	MUN5133		
MUN5334DW1T1		50	100	80	MUN5234	MUN5134		
MUN5335DW1T1		50	100	80	MUN5235	MUN5135		
UMA4NT1	Dual Common Emitter	50	100	160	MUN5211	MUN5211		1077
UMA6NT1	Dual Common Emitter	50	100	160	MUN5212	MUN5212		1077
UMC2NT1	Dual Common Base Collector	50	100	60	MUN5211	MUN5211	**SC–88A, SOT–353** **SC70–5** **Case 419A–02** **Page 1107**	1081
UMC3NT1	Dual Common Base Collector	50	100	35	4.7K/10K	MUN5213		1081
UMC5NT1	Dual Common Base Collector	50	100	20	MUN2240	MUN2240		1081

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Bipolar Transistors

Low Saturation Voltage Transistors

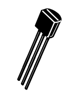
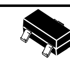
NPN	PNP	$V_{(BR)CEO}$	I_C mA Max	h_{FE} Min	h_{FE} Max	f_T MHz Min	$V_{CE(sat)}$ Max	Package	Page
MMBT2132T1	***MMBT2131T1***	30	700	150	–	–	0.25	 **SC–74, SC–59 Single Case 318F–02 Page 1103**	540, 537
MMBT489LT1	–	30	1000	300	900	100	0.20	 **TO–236AB, SOT–23 Case 318–08 Page 1101**	618
–	***MMBT589LT1***	30	1000	100	300	100	0.25		639
–	***MBT35200MT1***	35	2000	100	400	100	0.15	 **TSOP–6 Single Case 318G–02 Page 1104**	460
–	***MMBT6589T1***	30	1000	100	300	100	0.25		655
–	***NSL35TT1***	35	1000	100	–	–	0.37	 **SOT–416, SC–75, SC–90 Case 463–01 Page 1106**	1043
–	***NSL12TT1***	12	1000	100	–	–	0.35		1039

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Junctional Field–Effect Transistors

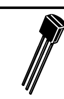
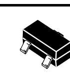
JFETs

Low–Frequency/Low–Noise

NPN	PNP	$R_e \lvert Y_{fs} \rvert$ @ 1 kHz mmho Min	$R_e \lvert Y_{os} \rvert$ @ 1 kHz μmho Max	C_{iss} pF Max	C_{rss} pF Max	V_{GSS} V_{GDO} Volts Min	$V_{GS(off)}$ Volts Min	Max	I_{DSS} mA Min	Max	Package	Page
2N5457	–	1.0	50	7.0	3.0	25	0.5	6.0	1.0	5.0		69
2N5458	–	1.5	50	7.0	3.0	25	1.0	7.0	2.0	9.0		69
–	***2N5460***	1.0	75	7.0	2.0	40	0.75	6.0	1.0	5.0		72
–	***2N5461***	1.5	75	7.0	2.0	40	1.0	7.5	2.0	9.0		72
–	***2N5462***	2.0	75	7.0	2.0	40	1.8	9.0	4.0	16		72
BF245A	–	3.0	–	–	–	30	0.5	8.0	2.0	6.5	**TO–226AA, TO–92 Case 29–11 Page 1100**	332
BF245B	–	3.0	–	–	–	30	0.5	8.0	6.0	15		332
BF256A	–	4.5	–	–	–	30	0.5	7.5	3.0	7.0		337
–	***MMBF5460LT1***	1.0	75	7.0	2.0	40	0.8	6.0	1.0	5.0		521
BFR30LT1	–	1.0	40	5.0	1.5	25	–	5.0	4.0	10	**TO–236AB, SOT–23 Case 318–08 Page 1101**	361
BFR31LT1	–	1.5	20	5.0	1.5	25	–	2.5	1.0	5.0		361

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

High–Frequency Amplifiers

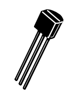
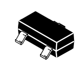
NPN Device	$R_e \lvert Y_{fs} \rvert$ mmho Min	$R_e \lvert Y_{os} \rvert$ μmho Max	C_{iss} pF Max	C_{rss} pF Max	NF dB Max	V_{GSS} V_{GDO} Volts Min	$V_{GS(off)}$ Volts Min	Max	I_{DSS} mA Min	Max	Package	Page
MPF102	1.6	200	7.0	3.0	–	25	–	8.0	2.0	20		771
2N5486	3.5	100	5.0	1.0	4.0	25	2.0	6.0	8.0	20		76
J309	12 (Typ)	250 (Typ)	7.5	2.5	1.5 (Typ)	25	1.0	4.0	12	30	**TO–226AA, TO–92 Case 29–11 Page 1100**	428
J310	12 (Typ)	250 (Typ)	7.5	2.5	1.5 (Typ)	25	2.0	6.5	24	60		428
MMBF5457LT1	1.0	50	7.0	3.0	4.0	25	0.5	6.0	1.0	5.0		518
MMBF5484LT1	3.0	50	5.0	1.0	3.0	25	0.3	3.0	1.0	5.0		524
MMBFJ309LT1	10	250	5.0	2.5	4.0	25	1.0	4.0	12	30	**TO–236AB, SOT–23 Case 318–08 Page 1101**	531
MMBFJ310LT1	8.0	250	5.0	2.5	4.0	25	2.0	6.5	24	60		531
MMBFU310LT1	10	250	5.0	2.5	4.0	25	2.5	6.0	24	60		534
MMBF4416LT1	4.5	50	4.0	0.8	2.0	30	–	6.0	5.0	15		513

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Junctional Field–Effect Transistors (continued)

JFETs (continued)

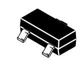
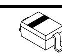
Switches and Choppers

NPN	PNP	$R_{DS(on)}$ Ω Max	C_{iss} pF Max	C_{rss} pF Max	V_{GSS} V_{GDO} Volts Min	$V_{GS(off)}$ Volts		I_{DSS} mA		t_{on} ns Max	t_{off} ns Max	Package	Page
						Min	Max	Min	Max				
J112	–	50	28	5.0	35	1.0	5.0	5.0	–	–	–		425
MPF4392	–	60	10	3.5	30	–	–	25	75	15	35		776
2N5639	–	60	10	4.0	30	–	8.0 (Typ)	25	–	–	–		90
MPF4393	–	100	10	3.5	30	–	12 (Typ)	5.0	30	15	55		776
J110	–	18	–	–	25	0.5	4.0	10	–	–	–		422
2N5555	–	150	5.0	1.2	25	–	–	15	–	5.0	15	**TO–226AA, TO–92 Case 29–11 Page 1100**	85
2N5638	–	30	10	4.0	30	–	–	50	–	4.0	5.0		90
J111	–	30	28	5.0	35	3.0	10	20	–	–	–		425
J113	–	100	28	5.0	35	0.5	3.0	2.0	–	–	–		425
MPF4856	–	25	18	8.0	40	4.0	10	50	–	6.0	25		781
MMBF4391LT1	–	30	10	3.5	30	4.0	10	50	150	–	–		509
MMBF4392LT1	–	60	10	3.5	30	2.0	5.0	25	75	–	–		509
MMBF4393LT1	–	100	10	3.5	30	0.5	3.0	5.0	30	–	–	**TO–236AB, SOT–23 Case 318–08 Page 1101**	509
–	***MMBFJ175LT1***	125	11	5.5	30	3.0	6.0	7.0	60	–	–		529
–	***MMBFJ177LT1***	300	–	–	30	0.8	2.5	1.5	20	–	–		530

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

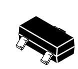
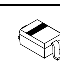
Tuning and Switching Diodes

Tuning Diodes – Abrupt Junction

Device	V_R Volts	C_T @ V_R = 4.0 V, 1.0 MHz			Cap Ratio Min	Q @ 4.0 V 50 MHz Typ	Package	Page
		pF Min	pF Nominal	pF Max				
MV2101	30	6.1	6.8	7.5	2.5	450	 TO–226AC, TO–92 2–Lead Case 182–06 Page 1101	685
MV2105	30	13.5	15	16.5	2.5	400		685
MV2109	30	29.7	33	36.3	2.5	200		685
LV2205	25	13	–	17	2.0	200		685
LV2209	25	26.4	–	39.6	2.5	150		685
MMBV2105LT1	30	13.5	15	16.5	2.5	400	 TO–236AB, SOT–23 Case 318–08 Page 1101	685
MMBV2107LT1	30	19.8	22	24.2	2.5	350		685
MMBV2109LT1	30	29.7	33	36.3	2.5	200		685
MMBV2101LT1	30	6.1	6.8	7.5	2.5	450		685
MMBV2103LT1	30	9.0	10	11	2.5	400		685
MMBV2108LT1	30	24.3	–	29.7	2.5	200		685
MMBV3102LT1	30	20	–	25	4.5	200		688
MMVL2101T1	30	6.1	6.8	7.5	2.5	400 (Min)	 SOD–323 Case 477–02 Page 1106	755
MMVL2105T1	30	13.5	15	16.5	2.5	350 (Min)		758

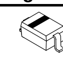
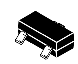
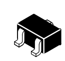
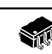
Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

Tuning Diodes – Hyper–Abrupt Junction

Device	V_R Volts	C_T (f = 1.0 MHz)			Cap Ratio			Q 3.0 V Min	Type	Package	Page
		pF Min	pF Max	Volts	Min	Max	Volts				
MV209	30	26	32	3.0	5.0	6.5	3.0/25	200	Single	 TO–226AC, TO–92 2–Lead Case 182–06 Page 1101	683
MV104	32	37	42	3.0	2.5	2.8	–	100	Single		1028
MMBV105GLT1	30	1.5	2.8	25	4.0	6.5	3.0/25	200	Single	 TO–236AB, SOT–23 Case 318–08 Page 1101	681
MMBV109LT1	30	26	32	3.0	5.0	6.5	3.0/25	200	Single		683
MMBV409LT1	20	26	32	3.0	1.5	1.9	3.0/8.0	200	Single		694
MMBV809LT1	20	4.5	6.1	2.0	1.8	2.6	2.0/8.0	300	Single		700
MMBV432LT1	14	43	48	2.0	1.5	2.0	–	100@ 2.0V	Single		696
MMBV609LT1	20	26	32	3.0	1.8	2.4	3/8	250	Dual Common Cathode		698
MMVL105GT1	30	1.5	2.8	25	4.0	6.5	3.0/25	200	Single	 SOD–323 Case 477–02 Page 1106	751
MMVL809T1	20	4.5	6.1	2	1.8	2.6	2.0/8.0	300	Single		769
MMVL3102T1	30	20	25	3	4.5	–	3.0/25	200	Single		761
MMVL109T1	30	26	32	3	5.0	6.5	3.0/25	200	Single		753
MMVL409T1	20	26	32	3	1.5	1.9	3.0/8.0	200	Single		767

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

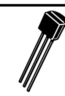
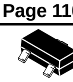
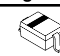
Schottky Diodes

Device	V_R Volts	C_T @ V		V_F Volts Max	I_R @ V		Type	Package	Page
		pF Max	Volts		nA Max	Volts			
MBD701	70	1.0	20	1.0	200	35	Single		458
MBD301	30	1.5	15	0.6	200	25	Single	**TO–226AC, TO–92 2–Lead**	454
MBD101	7.0	1.0	0	0.6	250	3.0	Single	**Case 182–06 Page 1101**	447
BAT54T1	30	10	1.0	0.4	2000	25	Single		159
MMSD301T1	30	1.5	15	0.6	200	25	Single	**SOD–123**	725
MMSD701T1	70	1.0	20	1.0	200	35	Single	**Case 425–04 Page 1105**	725
BAT54HT1	30	10	1.0	0.4	2000	25	Single		144
MMDL101T1	7	1.0	0	0.6	250	3.0	Single		702
MMDL301T1	30	1.5	15	0.6	200	25	Single	**SOD–323**	704
MMDL770T1	70	1.0	20	1.0	200	35	Single	**Case 477–02 Page 1106**	708
RB751V40T1	30	2.5	1.0	0.37	500	30	Single		1074
BAS40LT1	40	5.0	1.0	0.5	1000	25	Single		135
BAS40–04LT1	40	5.0	1.0	0.5	1000	25	Dual Series		131
BAS40–06LT1	40	5.0	1.0	0.5	1000	25	Dual Common Anode		133
BAS70LT1	70	2.0	0	0.75	100	50	Single		139
BAS70–04LT1	70	2.0	0	0.75	100	50	Dual Series		137
BAT54LT1	30	10	1.0	0.4	2000	25	Single		150
BAT54ALT1	30	10	1.0	0.4	2000	25	Dual Common Anode		141
BAT54SLT1	30	10	1.0	0.4	2000	25	Dual Series		153
MMBD701LT1	70	1.0	20	1.0	200	35	Single	**TO–236AB, SOT–23**	458
MMBD301LT1	30	1.5	15	0.6	200	25	Single	**Case 318–08**	454
MMBD101LT1	7.0	1.0	0	0.6	250	3.0	Single	**Page 1101**	447
MMBD452LT1	30	1.5	15	0.6	200	25	Dual Series		496
MMBD352LT1	7.0	1.0	0	0.6	250	3.0	Dual Series		492
MMBD353LT1	7.0	1.0	0	0.6	250	3.0	Dual Series		492
MMBD354LT1	7.0	1.0	0	0.6	250	3.0	Dual Common Cathode		492
MMBD355LT1	7.0	1.0	0	0.6	250	3.0	Dual Common Anode		492
BAT54WT1	30	10	1.0	0.4	2000	25	Single		162
BAT54SWT1	30	10	1.0	0.4	2000	25	Dual Series		156
MMBD330T1	30	1.5	15	0.6	200	25	Single		489
MMBD770T1	70	1.0	20	1.0	200	35	Single	**SC–70, SOT–323**	489
MMBD717LT1	20	2.5	1.0	0.37	1000	10	Dual Common Anode	**Case 419–04**	505
MMBD352WT1	7.0	1.0	0	0.6	250	3.0	Dual Series	**Page 1104**	494
MBD54DWT1	30	1.0	0	0.32	2000	25	Dual Series		456
MBD330DWT1	30	1.5	0	0.4	200	25	Dual Series		449
MBD770DWT1	70	1.0	0	0.5	200	35	Dual Series	**SC–88, SOT–363**	449
MBD110DWT1	7.0	1.0	0	0.6	250	3.0	Dual Series	**Case 419B–02 Page 1105**	449

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

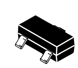
Switching Diodes

PIN Switching Diodes

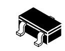
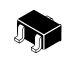
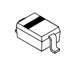
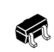
Device	V_R Volts Min	C_T @ V pF Max	C_T @ V Volts	Resistance Ω Max	I_R µA Max	Type	Package	Page
MPN3700	200	1.0	20	1.0	0.1	Single		692
MPN3404	20	2.0	15	0.85	0.1	Single	**TO–226AC, TO–92 2–Lead Case 182–06 Page 1101**	785
MSD6100	100	1.5	0.0	–	0.1	Dual Common Cathode		952
MSD6150	70	8.0	0.0	–	0.1	Dual Common Anode	**TO–226AA, TO–92 Case 29–11 Page 1100**	954
MMBV3700LT1	200	1.0	20	1.0	0.1	Single		692
MMBV3401LT1	35	1.0	20	0.7	0.1	Single	**TO–236AB, SOT–23 Case 318–08 Page 1101**	690
MMVL3700T1	200	1.0	20	1.0	0.1	Single		765
MMVL3401T1	35	1.0	20	0.7	0.1	Single	**SOD–323 Case 477–02 Page 1106**	763

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

General–Purpose Signal and Switching Diodes

Device	V_R Min Volts	I_R Max µA	V_F Min Volts	V_F Max Volts	C_T Max pF	t_{rr} Max ns	Type	Package	Page
BAS21LT1	250	0.1	–	1.0	5.0	50	Single		127
BAS21SLT1	250	1.0	–	1.0	5.0	50	Dual Series		129
MMBD914LT1	100	5.0	–	1.0	4.0	4.0	Single		507
BAS16LT1	75	1.0	–	1.0	2.0	6.0	Single		113
MMBD6050LT1	70	0.1	0.85	1.1	2.5	4.0	Single		498
BAL99LT1	70	2.5	–	1.0	1.5	6.0	Single		107
BAS116LT1	75	0.0	–	0.9	2.0	3000	Single		109
MMBD7000LT1	100	1.0	0.75	1.1	1.5	4.0	Dual Series		503
MMBD2836LT1	75	0.1	–	1.0	4.0	4.0	Dual Common Anode	**TO–236AB, SOT–23 Case 318–08 Page 1101**	485
MMBD2838LT1	75	0.1	–	1.0	4.0	4.0	Dual Common Cathode		487
BAV70LT1	70	5.0	–	1.0	1.5	6.0	Dual Common Cathode		167
BAV99LT1	70	2.5	–	1.0	1.5	4.0	Dual Series		178
BAW56LT1	70	2.5	–	1.0	2.0	6.0	Dual Common Anode		183
MMBD6100LT1	70	0.1	0.85	1.1	2.5	4.0	Dual Common Cathode		500
BAV74LT1	50	0.1	–	1.0	2.0	4.0	Dual Common Cathode		176
MMBD2835LT1	35	0.1	–	1.0	4.0	4.0	Dual Common Anode		485
MMBD2837LT1	35	0.1	–	1.0	4.0	4.0	Dual Common Cathode		487
BAV199LT1	70	0.005	–	0.9	2.0	3000	Dual Series		165

General–Purpose Signal and Switching Diodes

Device	V_R Min Volts	I_R Max µA	V_F Min Volts	V_F Max Volts	C_T Max pF	t_{rr} Max ns	Type	Package	Page
M1MA151AT1	40	0.1	–	1.2	2.0	3.0	Single	 **SC–59 Case 318D–04 Page 1102**	437
M1MA151KT1	40	0.1	–	1.2	2.0	3.0	Single		439
M1MA152AT1	80	0.1	–	1.2	2.0	3.0	Single		437
M1MA152KT1	80	0.1	–	1.2	2.0	3.0	Single		439
M1MA151WAT1	40	0.1	–	1.2	15	10	Dual Common Anode		441
M1MA151WKT1	40	0.1	–	1.2	2.0	3.0	Dual Common Cathode		443
M1MA152WAT1	80	0.1	–	1.2	15	10	Dual Common Anode		441
M1MA152WKT1	80	0.1	–	1.2	2.0	3.0	Dual Common Cathode		443
BAS16WT1	75	0.02		1.25	2.0	6.0	Single	 **SC–70, SOT–323 Case 419–04 Page 1104**	119
M1MA141KT1	40	0.1		1.2	2.0	3.0	Single		431
M1MA142KT1	80	0.1		1.2	2.0	3.0	Single		431
M1MA174T1	100	5.0		1.0	4.0	4.0	Single		445
M1MA142WKT1	80	0.1	–	1.2	2.0	3.0	Dual Common Cathode		435
M1MA142WAT1	80	0.1	–	1.2	15	10	Dual Common Anode		433
BAW56WT1	70	2.5	–	1.0	2.0	6.0	Dual Common Anode		188
BAV70WT1	70	5.0	–	1.0	1.5	6.0	Dual Common Cathode		173
BAV99WT1	70	2.5	–	1.0	1.5	6.0	Dual Series		180
BAV99RWT1	70	2.5	–	1.0	1.5	6.0	Dual Series		180
M1MA141WKT1	40	0.1	–	1.2	2.0	3.0	Dual Common Cathode		435
M1MA141WAT1	40	0.1	–	1.2	15	10	Dual Common Anode		433
DAP202U	–	0.1	–	1.2	3.5	10	Dual Common Anode		380
MMSD914T1	100	5.0	10	1.0	4.0	4.0	Single	 **SOD–123 Case 425–04 Page 1105**	732
MMSD71RKT1	80	0.5	100	1.2	2.0	4.0	Single		730
MMSD103T1	250	100	100	1.0	5.0	50	Single		723
MMSD4148T1	100	5.0	10	1.0	4.0	4.0	Single		728
BAS16HT1	75	1.0	–	1.0	2.0	6.0	Single	 **SOD–323 Case 477–02 Page 1106**	111
BAS20HT1	200	0.1			5.0	50	Single		122
BAS21HT1	250	0.1	–	1.0	5.0	50	Single		125
MMDL914T1	100	5.0	–	1.0	4.0	4.0	Single		710
MMDL6050T1	70	0.1	0.85	1.1	2.5	4.0	Single		706
BAS16TT1	75	1.0	–	1.0	2.0	6.0	Single	 **SOT–416, SC–75, SC–90 Case 463–01 Page 1106**	115
DA121TT1	80	1.0			2.0	6.0	Single		374
DAP222	80	0.1	–	1.2	3.5	4.0	Dual Common Anode		380
BAW56TT1	70	2.5	–	1.0	2.0	6.0	Dual Common Anode		185
DAN222	80	0.1	–	1.2	3.5	4.0	Dual Common Cathode		378
BAV70TT1	70	5.0	–	1.0	1.5	6.0	Dual Common Cathode		169

Devices listed in ***bold italic*** are ON Semiconductor preferred devices.

CHAPTER 2
Data Sheets

2N3903, 2N3904

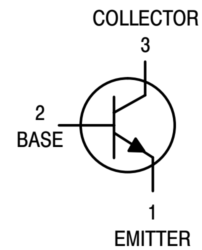
2N3903 is a Preferred Device

General Purpose Transistors

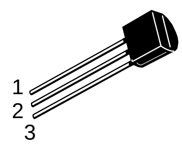
NPN Silicon

ON Semiconductor™

http://onsemi.com

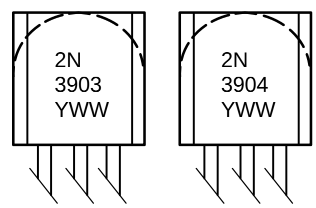


STYLE 1



TO–92
CASE 29
STYLE 1

MARKING DIAGRAMS



Y = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping
2N3903	TO–92	5000 Units/Box
2N3903RLRM	TO–92	2000/Ammo Pack
2N3904	TO–92	5000 Units/Box
2N3904RLRA	TO–92	2000/Tape & Reel
2N3904RLRE	TO–92	2000/Tape & Reel
2N3904RLRM	TO–92	2000/Ammo Pack
2N3904RLRP	TO–92	2000/Ammo Pack
2N3904RL1	TO–92	2000/Tape & Reel
2N3904ZL1	TO–92	2000/Ammo Pack

Preferred devices are recommended choices for future use and best overall value.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	60	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current – Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS (Note 1.)

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

1. Indicates Data in addition to JEDEC Requirements.

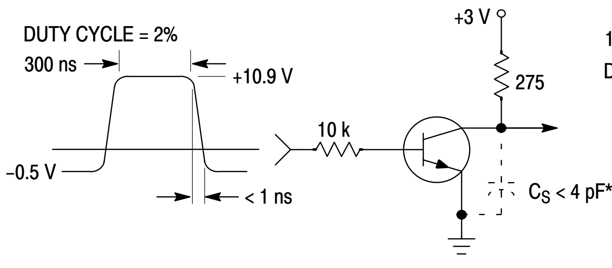
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

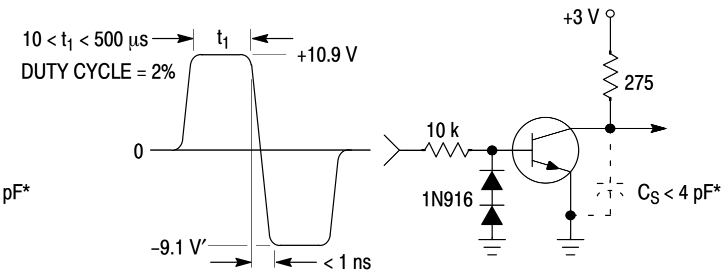
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (Note 2.) (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	–	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	–	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)		I_{BL}	–	50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)		I_{CEX}	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (Note 2.)		h_{FE}			–
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	2N3903		20	–	
	2N3904		40	–	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	2N3903		35	–	
	2N3904		70	–	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	2N3903		50	150	
	2N3904		100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)	2N3903		30	–	
	2N3904		60	–	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	2N3903		15	–	
	2N3904		30	–	
Collector–Emitter Saturation Voltage (Note 2.)		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			–	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc			–	0.3	
Base–Emitter Saturation Voltage (Note 2.)		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	0.95	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product		f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	2N3903		250	–	
	2N3904		300	–	
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	–	4.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	–	8.0	pF
Input Impedance		h_{ie}			k Ω
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3903		1.0	8.0	
	2N3904		1.0	10	
Voltage Feedback Ratio		h_{re}			X 10^{-4}
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3903		0.1	5.0	
	2N3904		0.5	8.0	
Small–Signal Current Gain		h_{fe}			–
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3903		50	200	
	2N3904		100	400	
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	1.0	40	μmhos
Noise Figure		NF			dB
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k Ω, f = 1.0 kHz)	2N3903		–	6.0	
	2N3904		–	5.0	

SWITCHING CHARACTERISTICS

Characteristic	Conditions		Symbol	Min	Max	Unit
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		t_d	–	35	ns
Rise Time			t_r	–	35	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	2N3903	t_s	–	175	ns
		2N3904		–	200	
Fall Time			t_f	–	50	ns

2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2%.





* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit

Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

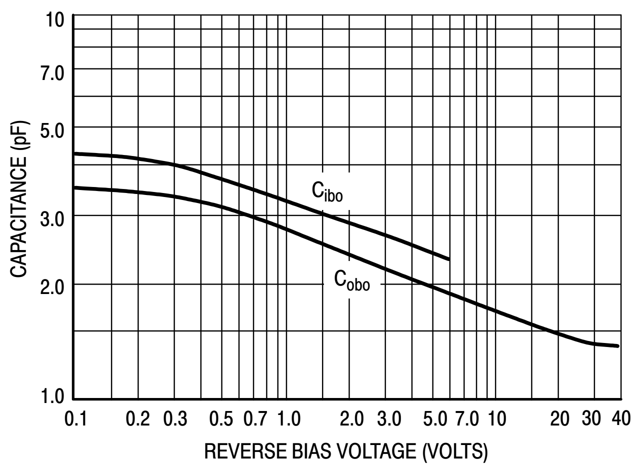


Figure 3. Capacitance

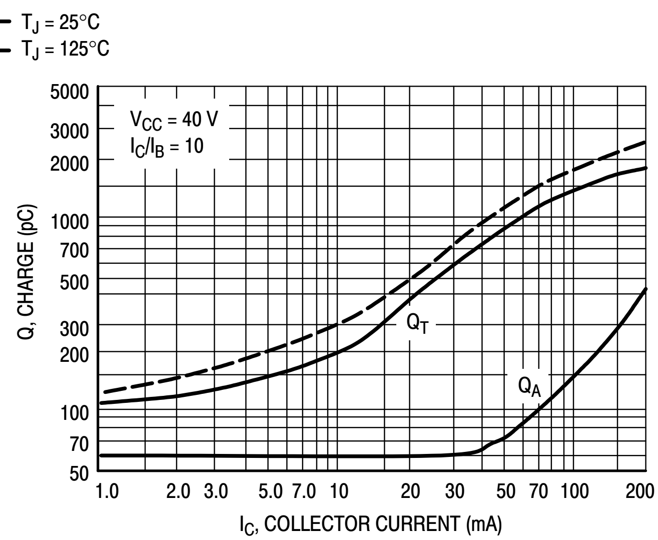


Figure 4. Charge Data

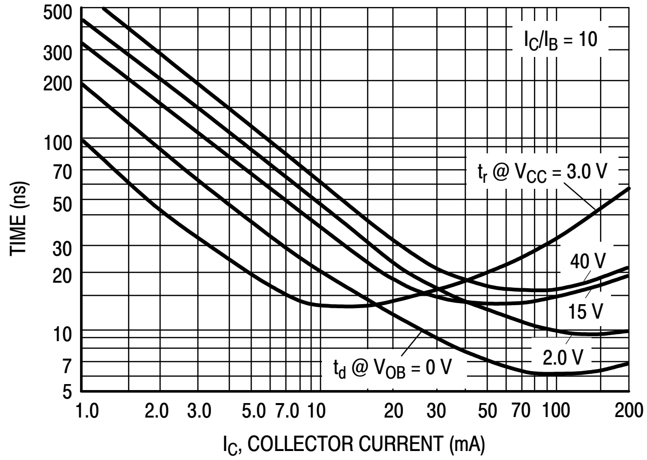


Figure 5. Turn−On Time

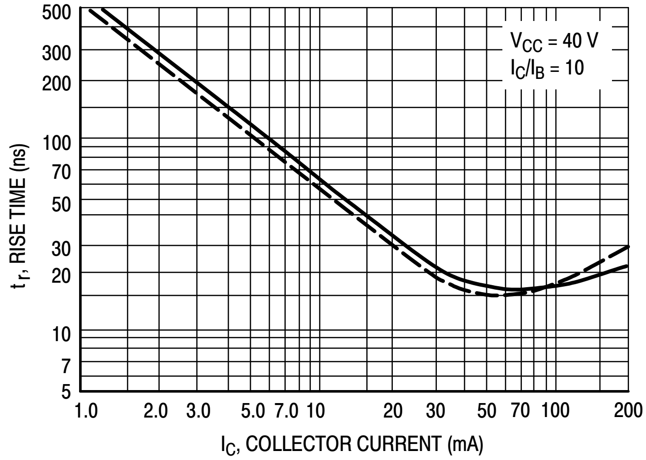


Figure 6. Rise Time

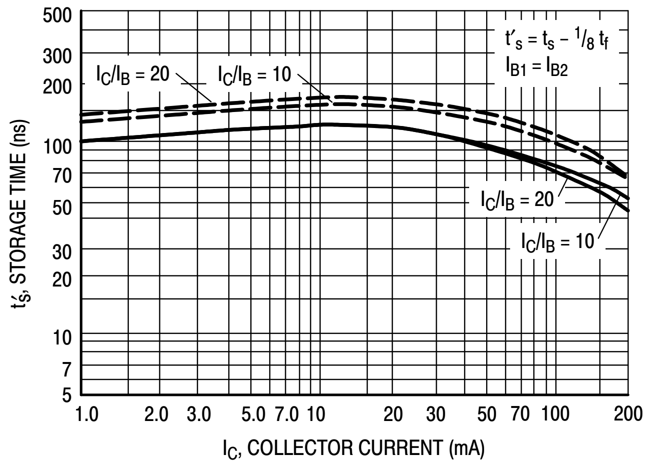


Figure 7. Storage Time

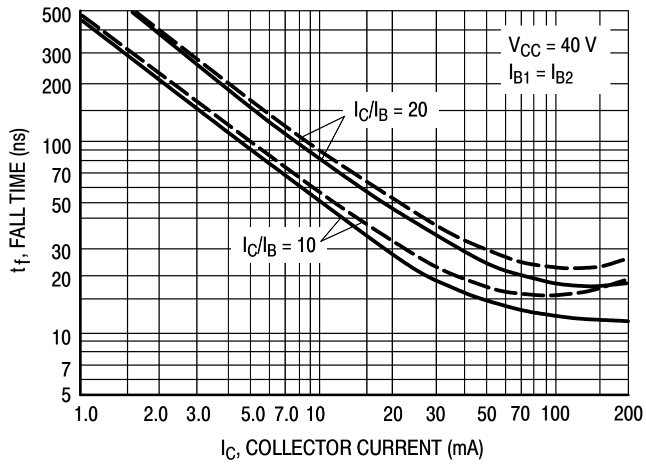


Figure 8. Fall Time

TYPICAL AUDIO SMALL−SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = 5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

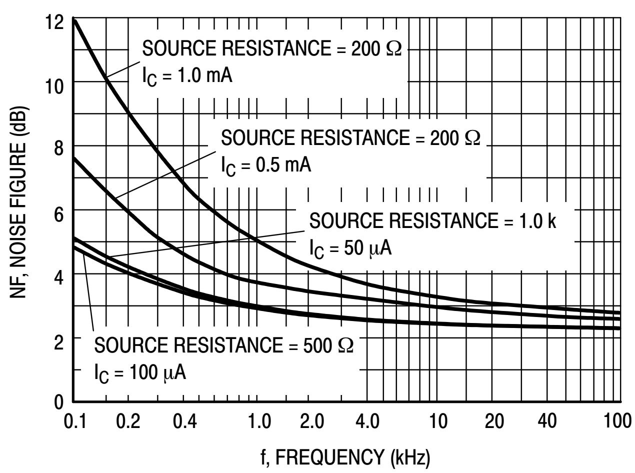


Figure 9.

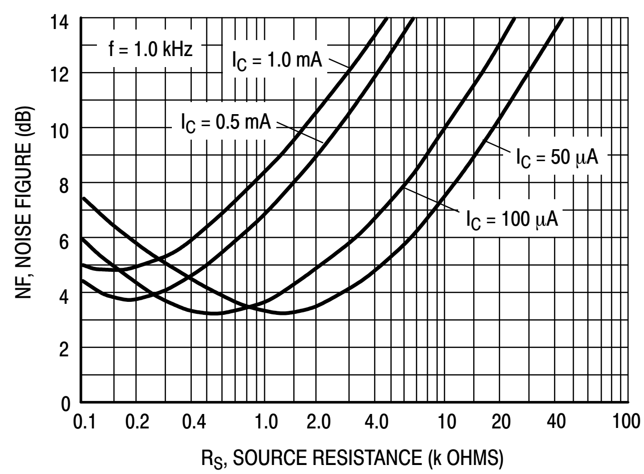


Figure 10.

h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

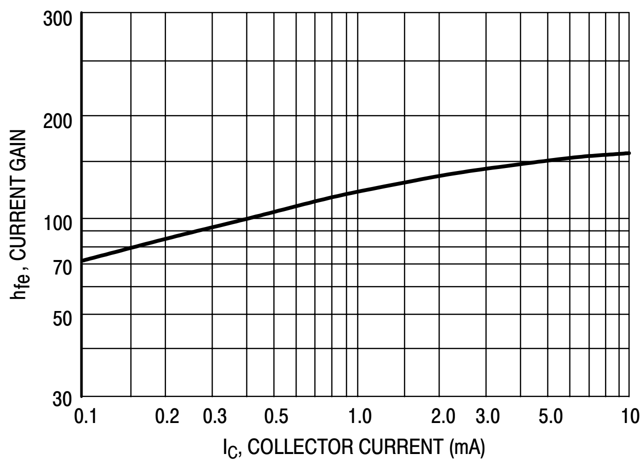


Figure 11. Current Gain

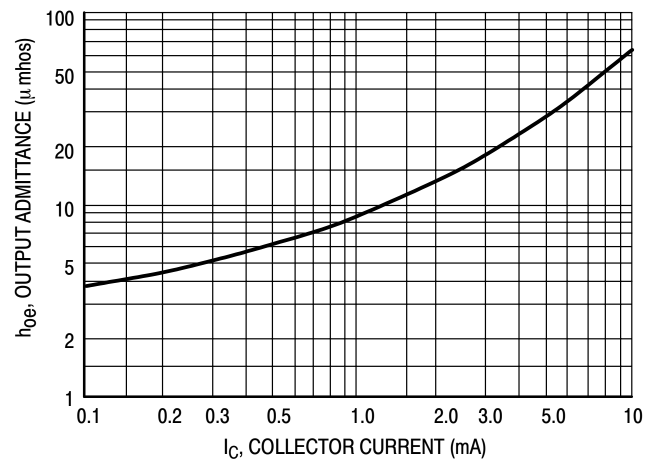


Figure 12. Output Admittance

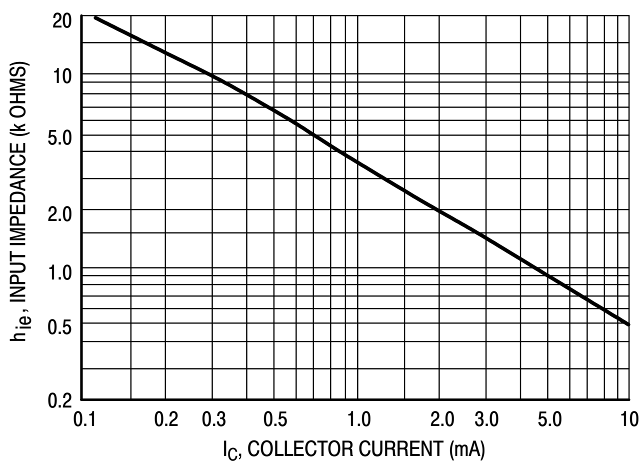


Figure 13. Input Impedance

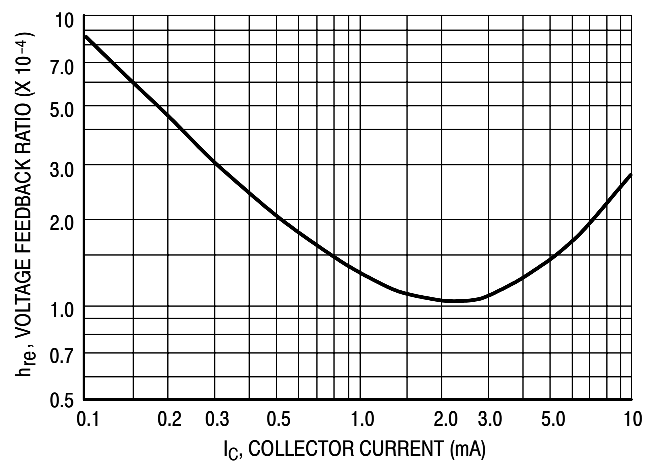


Figure 14. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

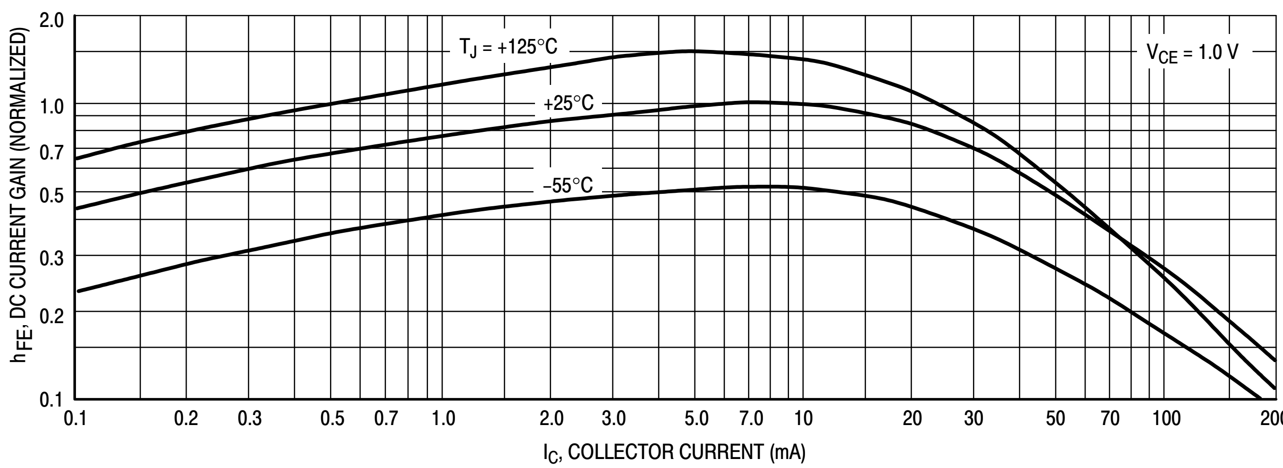


Figure 15. DC Current Gain

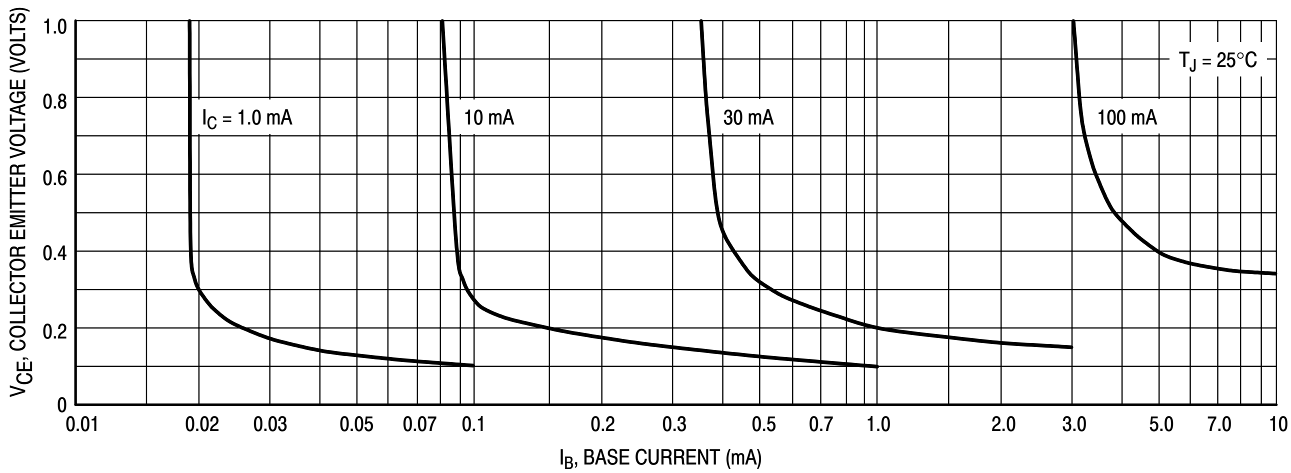


Figure 16. Collector Saturation Region

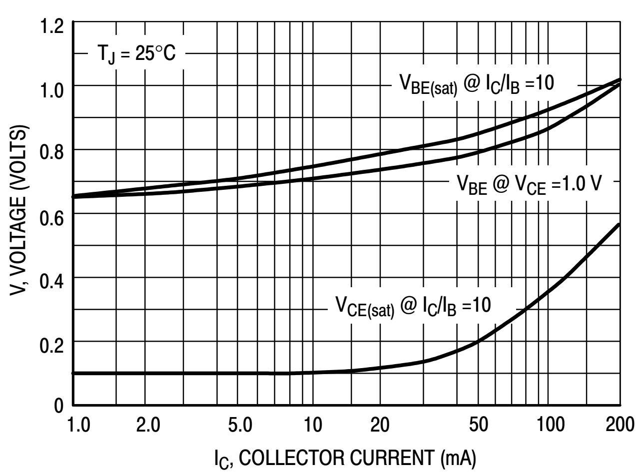


Figure 17. “ON” Voltages

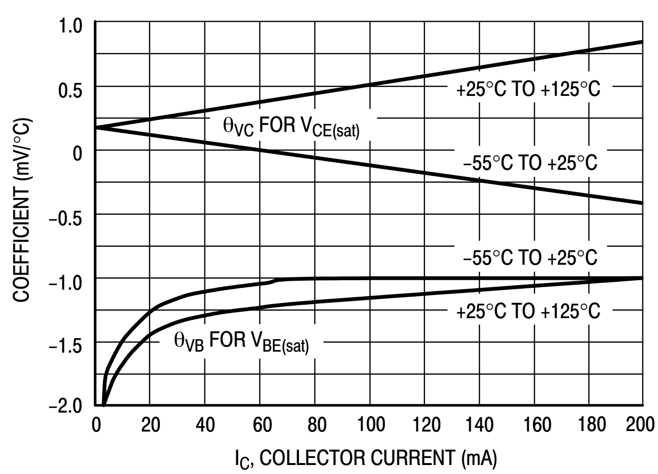


Figure 18. Temperature Coefficients

2N3906

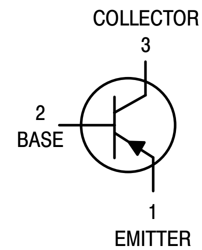
Preferred Device

General Purpose Transistors

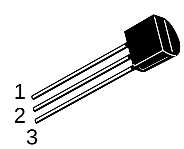
PNP Silicon

ON Semiconductor™

http://onsemi.com

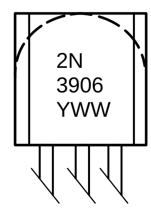


STYLE 1



TO–92
CASE 29
STYLE 1

MARKING DIAGRAMS



Y = Year
WW = Work Week

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	40	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current – Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 625 5.0	 mW mW/°C
Total Power Dissipation @ T_A = 60°C	P_D	250	mW
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.5 12	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS (Note 1.)

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

1. Indicates Data in addition to JEDEC Requirements.

ORDERING INFORMATION

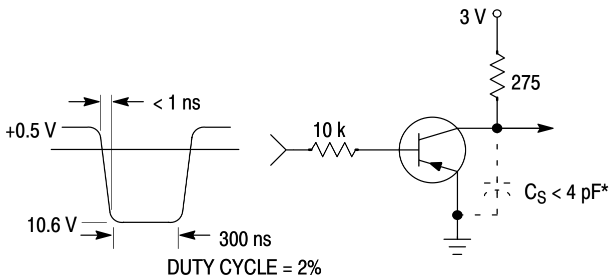
Device	Package	Shipping
2N3906	TO–92	5000 Units/Box
2N3906RLRA	TO–92	2000/Tape & Reel
2N3906RLRE	TO–92	2000/Tape & Reel
2N3906RLRM	TO–92	2000/Ammo Pack
2N3906RLRP	TO–92	2000/Ammo Pack
2N3906RL1	TO–92	2000/Tape & Reel
2N3906ZL1	TO–92	2000/Ammo Pack

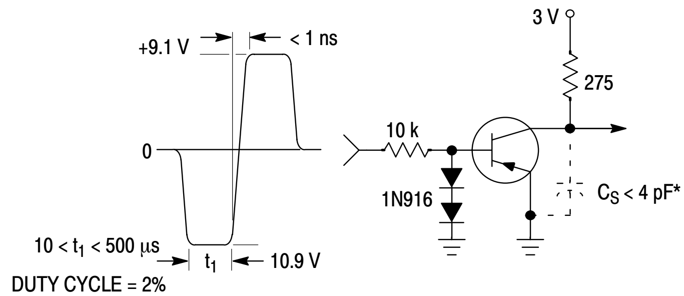
Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (Note 2.) (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	–	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	40	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	–	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)		I_{BL}	–	50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)		I_{CEX}	–	50	nAdc
ON CHARACTERISTICS (Note 2.)					
DC Current Gain		h_{FE}			–
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)			80	–	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)			30	–	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			–	0.25	
(I_C = 50 mAdc, I_B = 5.0 mAdc			–	0.4	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	0.95	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	250	–	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	–	4.5	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	–	10	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{ie}	2.0	12	kΩ
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{re}	0.1	10	X 10^{-4}
Small–Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{fe}	100	400	–
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	3.0	60	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)		NF	–	4.0	dB
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_d	–	35	ns
Rise Time		t_r	–	35	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_s	–	225	ns
Fall Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_f	–	75	ns

2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2%.



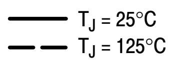


* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit

Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS



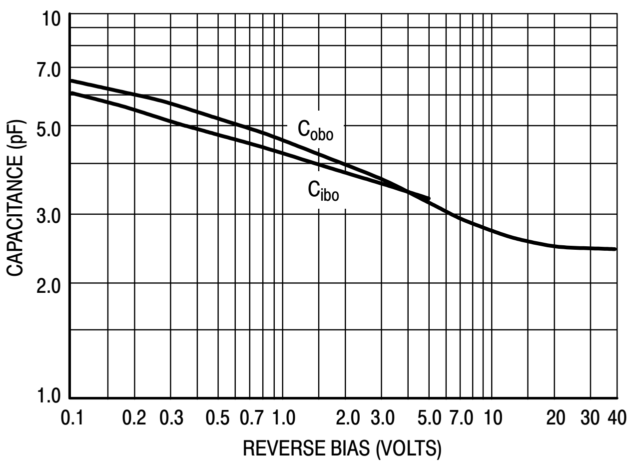


Figure 3. Capacitance

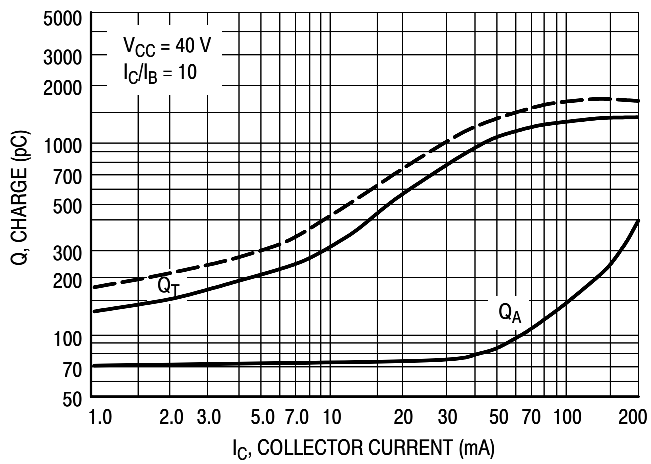


Figure 4. Charge Data

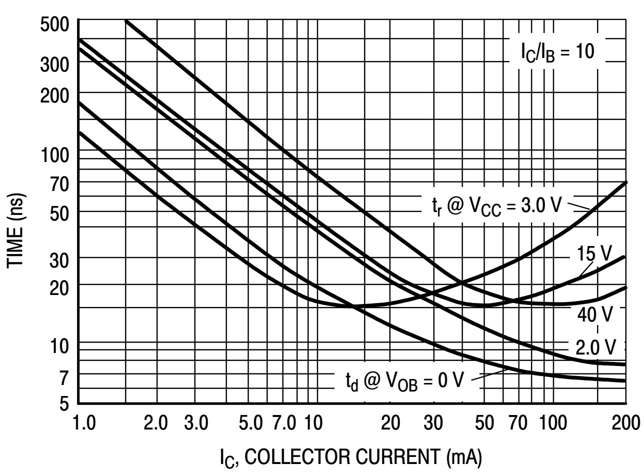


Figure 5. Turn−On Time

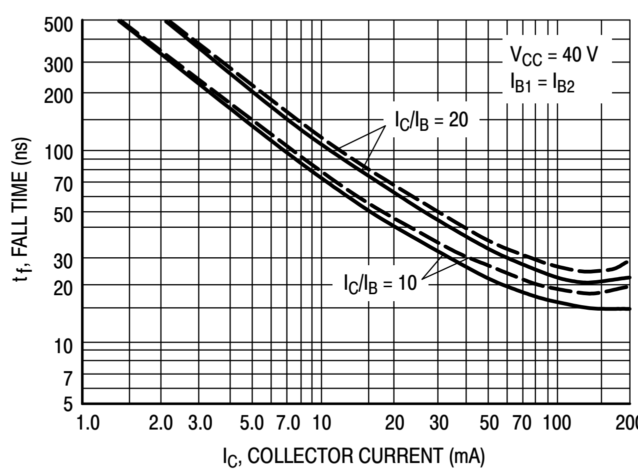


Figure 6. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = –5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

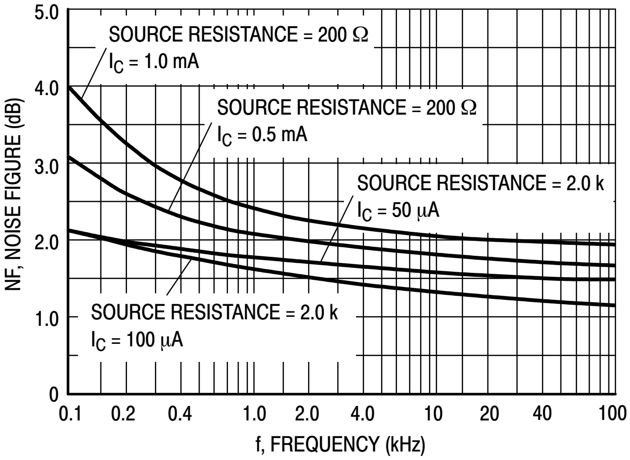


Figure 7.

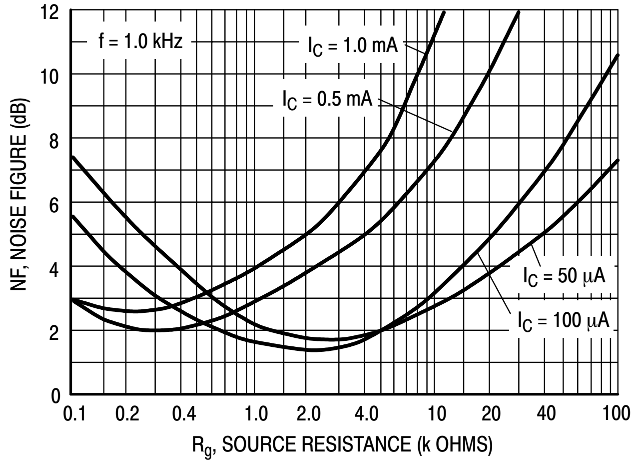


Figure 8.

h PARAMETERS

(V_{CE} = –10 Vdc, f = 1.0 kHz, T_A = 25°C)

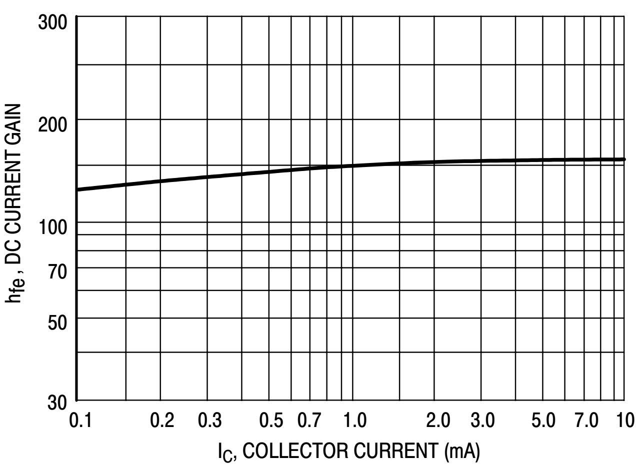


Figure 9. Current Gain

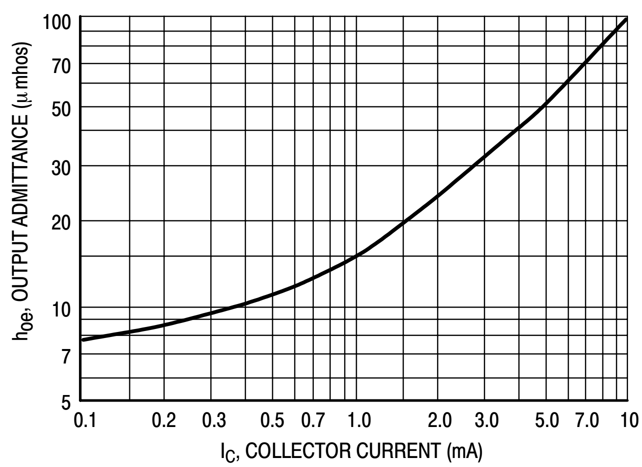


Figure 10. Output Admittance

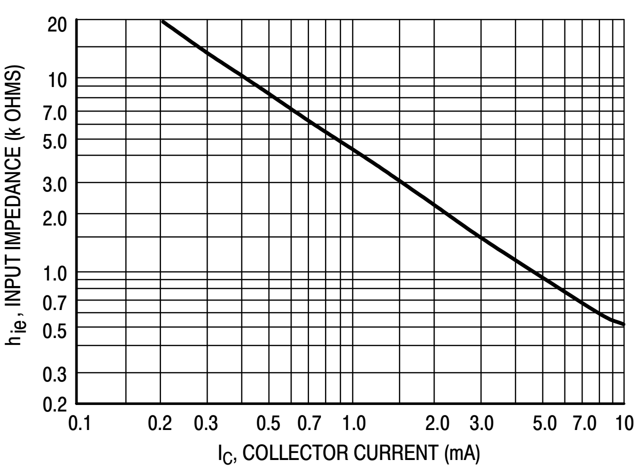


Figure 11. Input Impedance

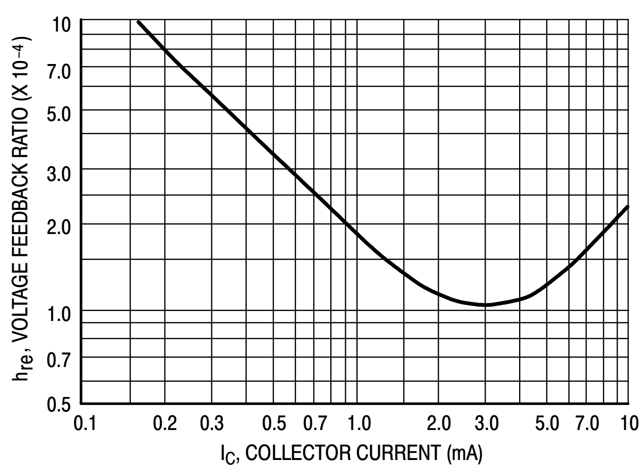


Figure 12. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

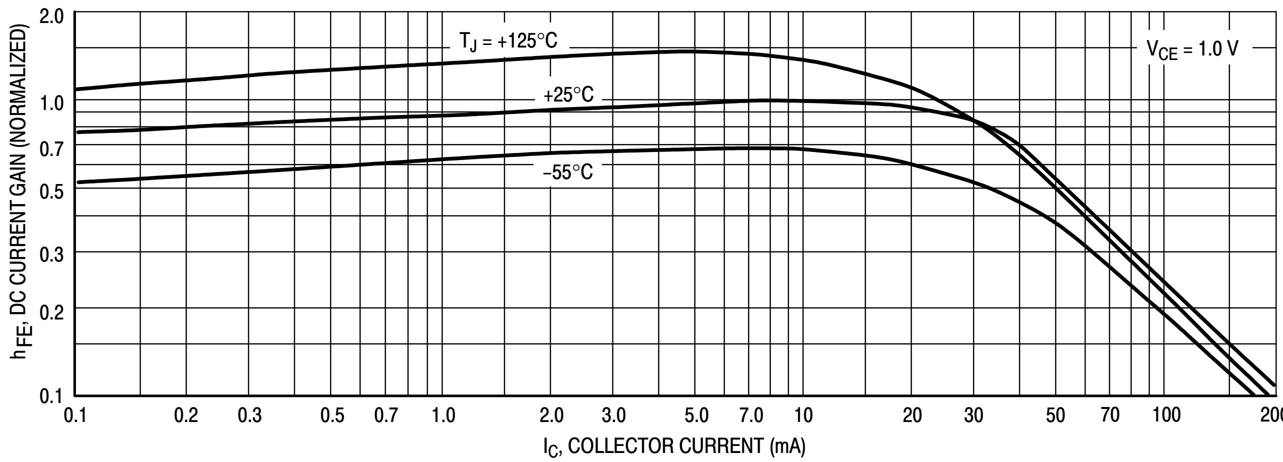


Figure 13. DC Current Gain

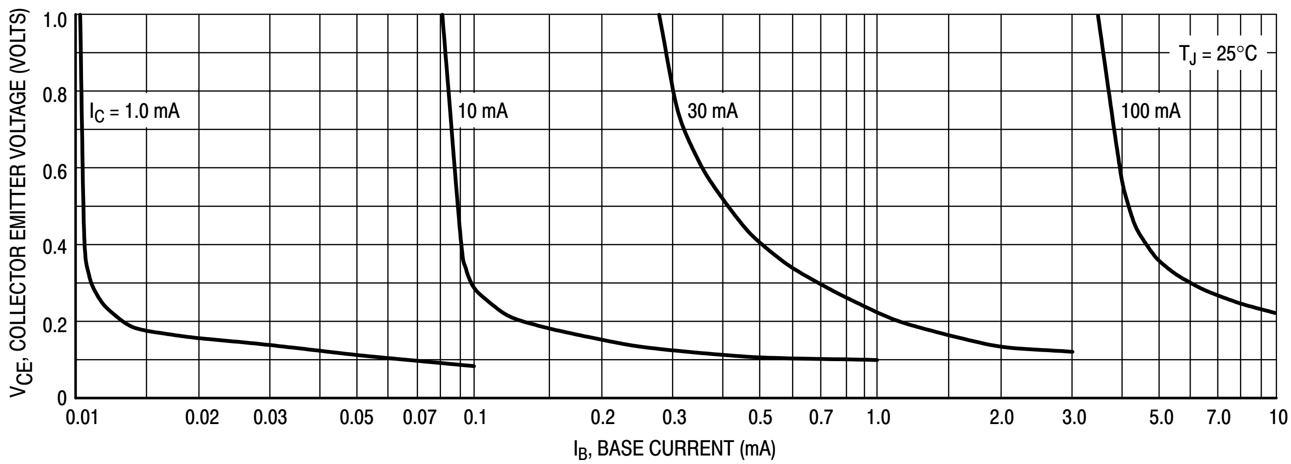


Figure 14. Collector Saturation Region

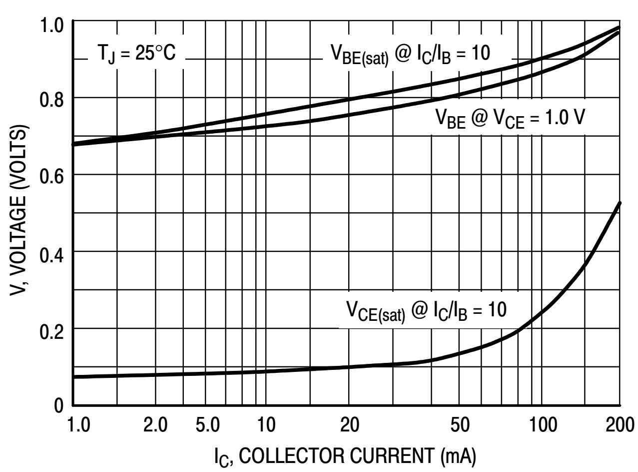


Figure 15. "ON" Voltages

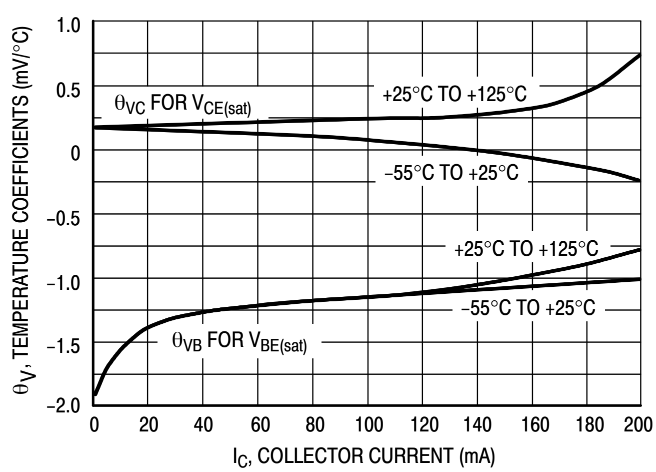
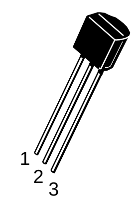


Figure 16. Temperature Coefficients

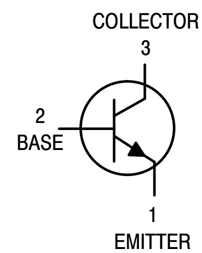
General Purpose Transistors
NPN Silicon

2N4401

ON Semiconductor Preferred Device



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	60	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector–Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current (V_{CE} = 35 Vdc, V_{EB} = 0.4 Vdc)	I_{BEV}	—	0.1	μAdc
Collector Cutoff Current (V_{CE} = 35 Vdc, V_{EB} = 0.4 Vdc)	I_{CEX}	—	0.1	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

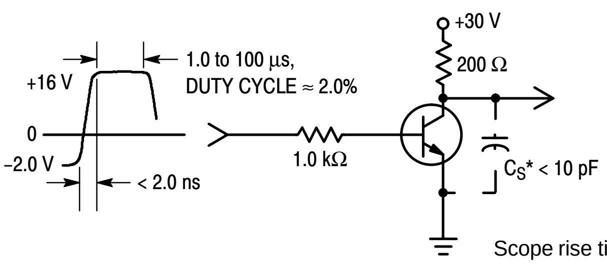
Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

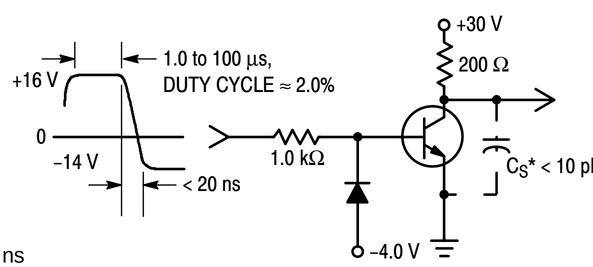
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]				
DC Current Gain	h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)		20	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)		40	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		80	—	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)		100	300	
(I_C = 500 mAdc, V_{CE} = 2.0 Vdc)		40	—	
Collector–Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		—	0.75	
Base–Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{BE(sat)}$	0.75	0.95	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		—	1.2	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	250	—	MHz
Collector–Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	6.5	pF
Emitter–Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{eb}	—	30	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{ie}	1.0	15	k ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{re}	0.1	8.0	X 10^{-4}
Small–Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	40	500	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{oe}	1.0	30	μmhos
SWITCHING CHARACTERISTICS				
Delay Time (V_{CC} = 30 Vdc, V_{BE} = 2.0 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	—	15	ns
Rise Time (V_{CC} = 30 Vdc, V_{BE} = 2.0 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_r	—	20	ns
Storage Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	—	225	ns
Fall Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_f	—	30	ns

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS





Scope rise time < 4.0 ns
*Total shunt capacitance of test jig connectors, and oscilloscope

Figure 1. Turn–On Time **Figure 2. Turn–Off Time**

TRANSIENT CHARACTERISTICS

25°C 100°C

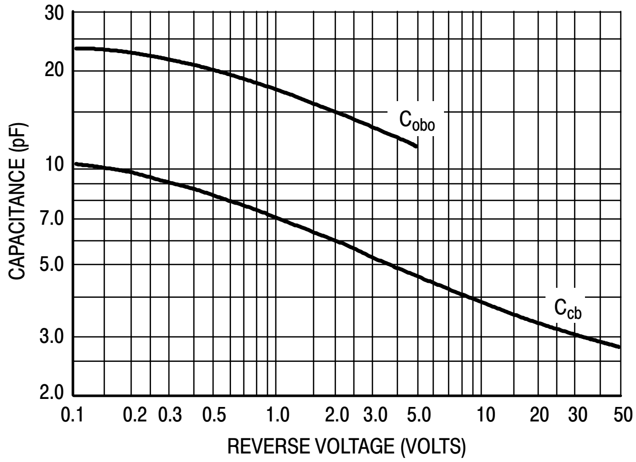


Figure 3. Capacitances

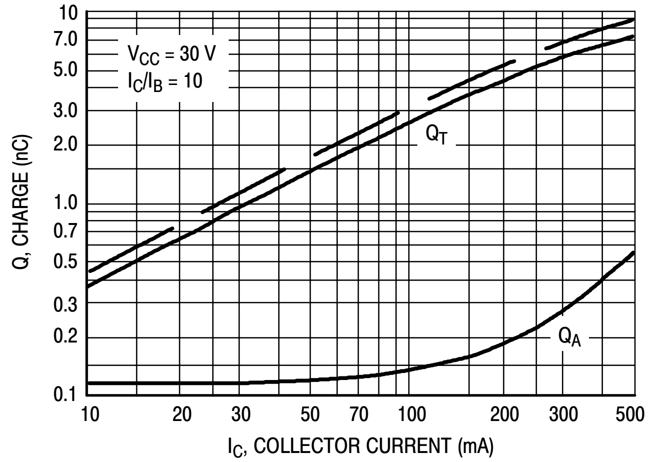


Figure 4. Charge Data

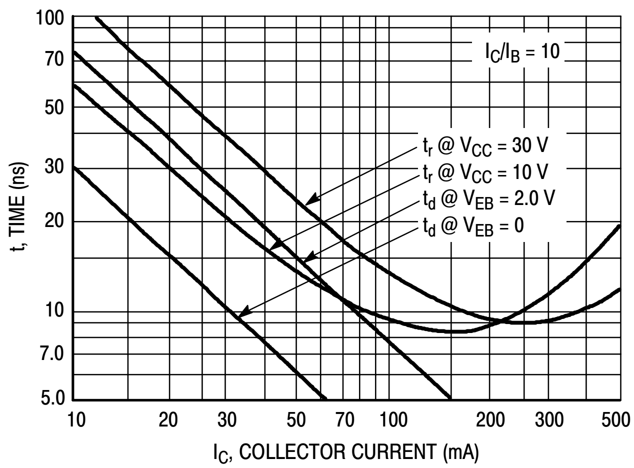


Figure 5. Turn–On Time

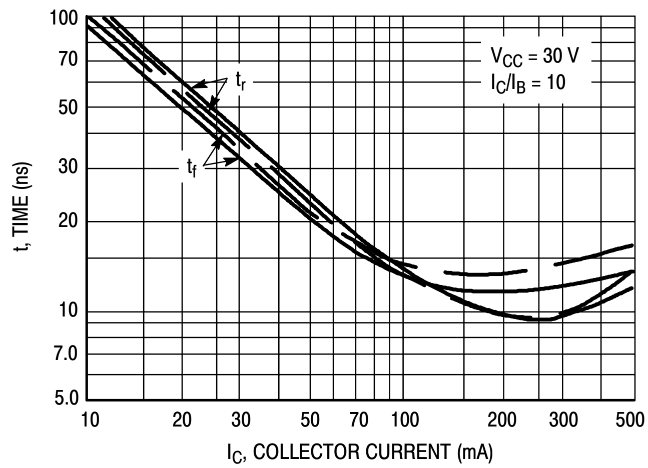


Figure 6. Rise and Fall Times

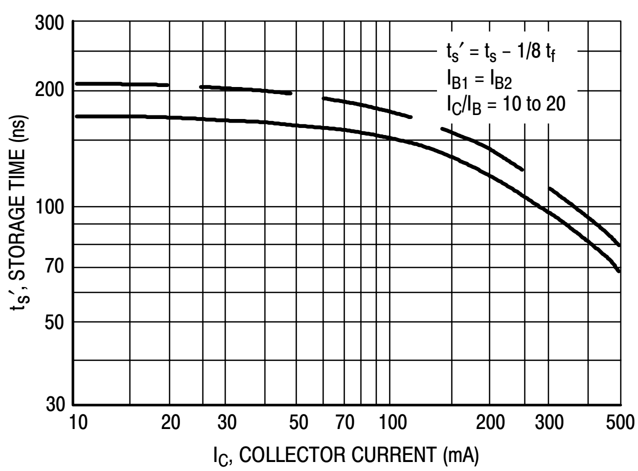


Figure 7. Storage Time

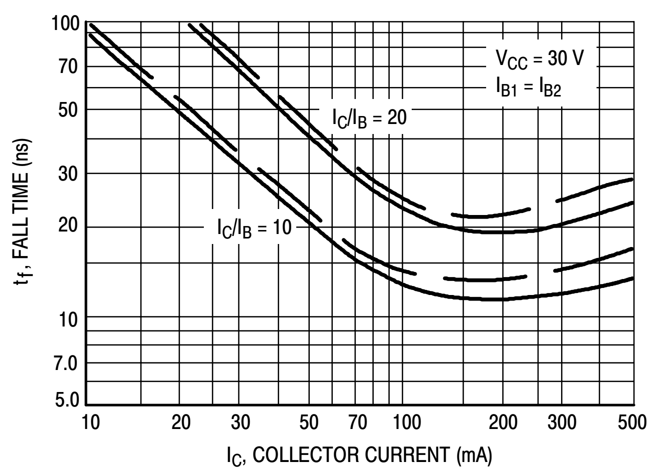


Figure 8. Fall Time

SMALL–SIGNAL CHARACTERISTICS

NOISE FIGURE

V_{CE} = 10 Vdc, T_A = 25°C; Bandwidth = 1.0 Hz

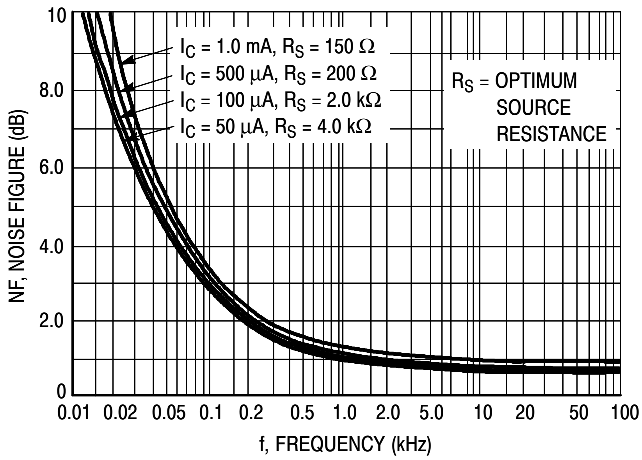


Figure 9. Frequency Effects

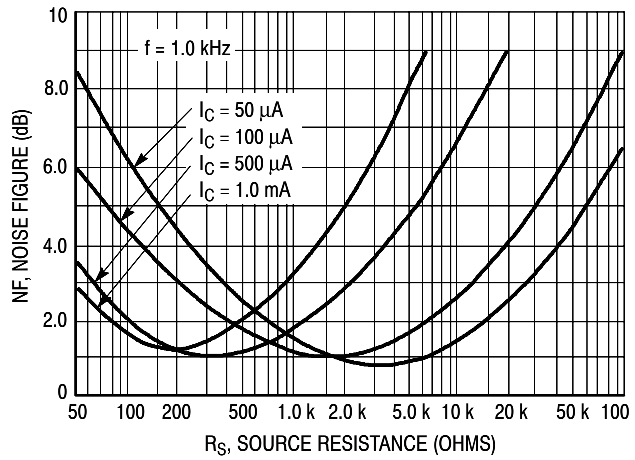


Figure 10. Source Resistance Effects

h PARAMETERS

V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C

This group of graphs illustrates the relationship between h_{fe} and other "h" parameters for this series of transistors. To obtain these curves, a high–gain and a low–gain unit were selected from the 2N4401 lines, and the same units were used to develop the correspondingly numbered curves on each graph.

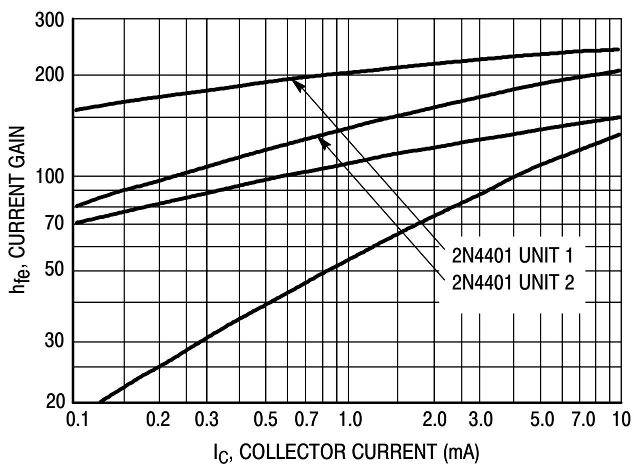


Figure 11. Current Gain

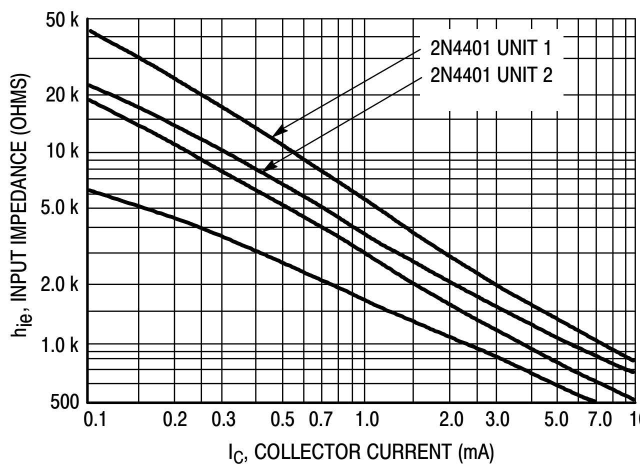


Figure 12. Input Impedance

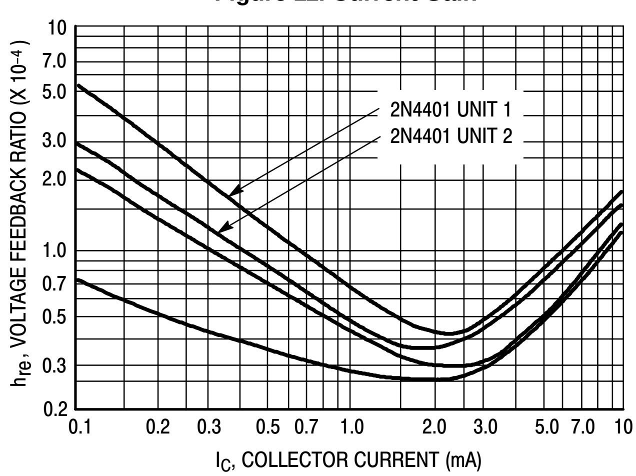


Figure 13. Voltage Feedback Ratio

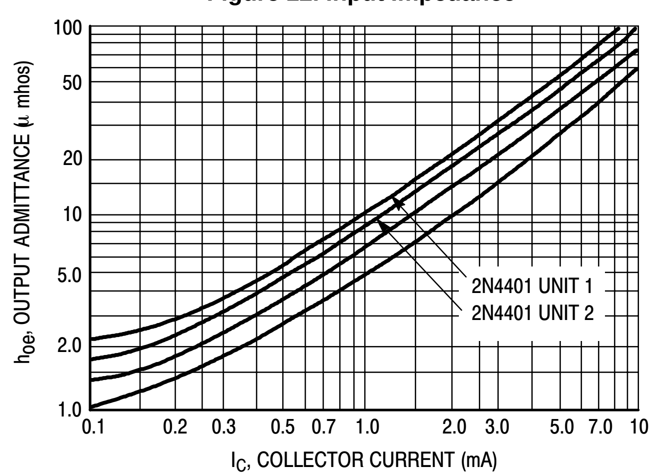


Figure 14. Output Admittance

STATIC CHARACTERISTICS

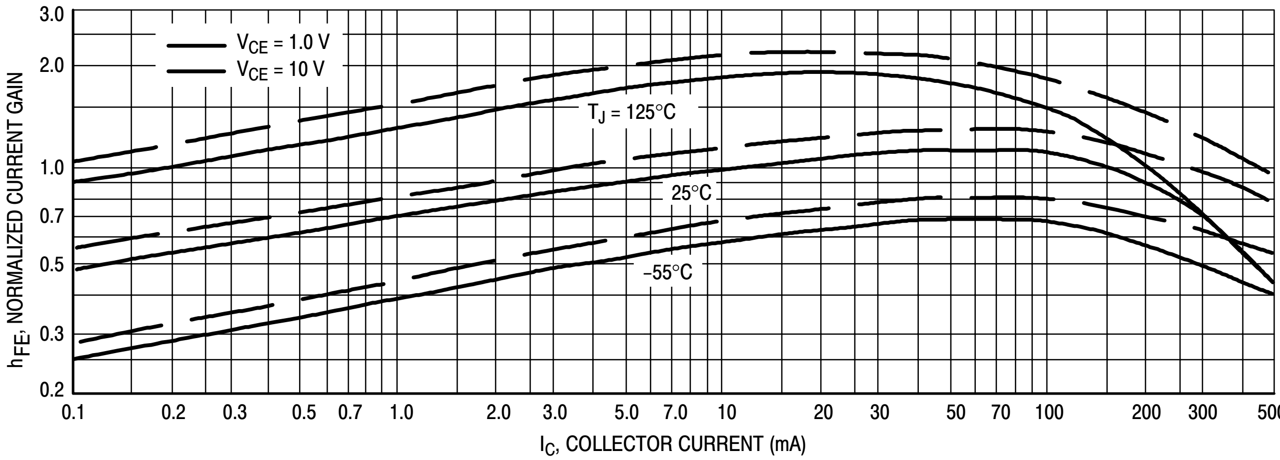


Figure 15. DC Current Gain

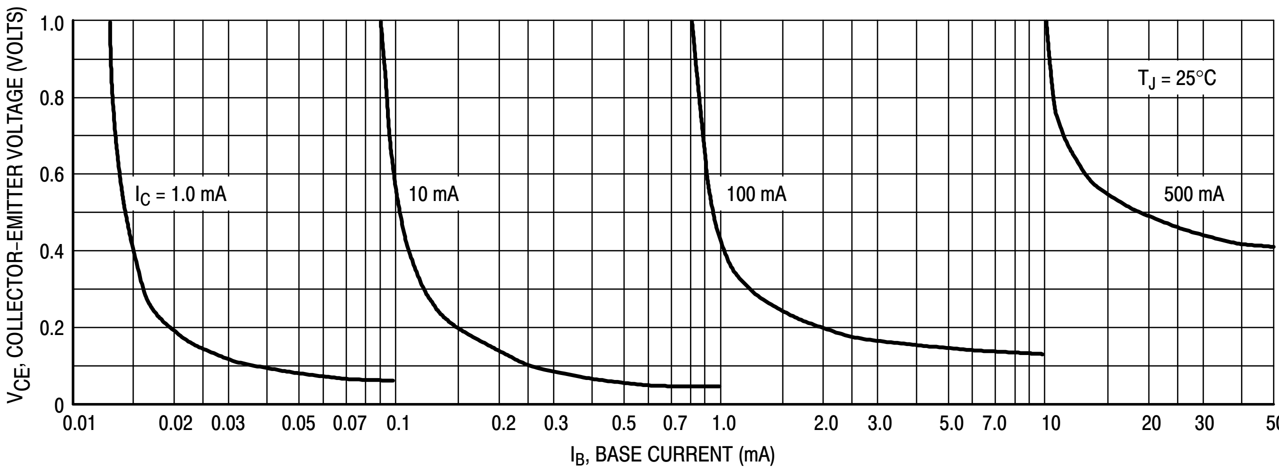


Figure 16. Collector Saturation Region

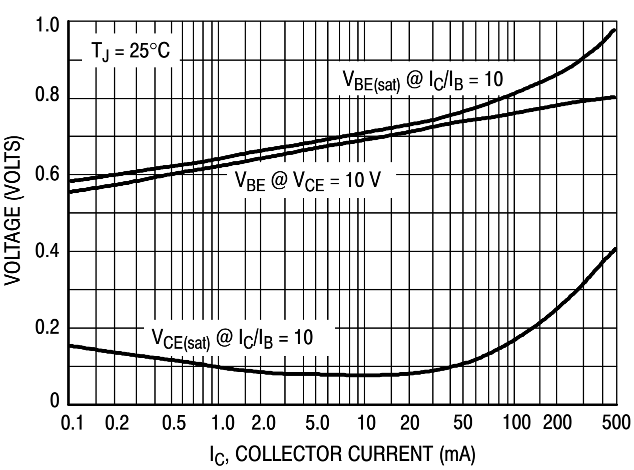


Figure 17. "On" Voltages

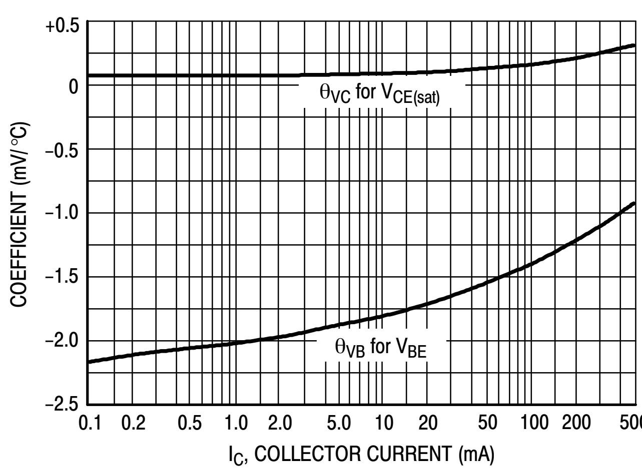
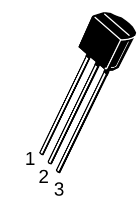


Figure 18. Temperature Coefficients

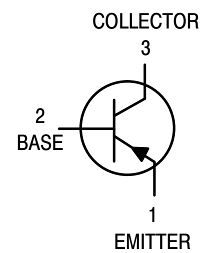
General Purpose Transistors
PNP Silicon

2N4403

ON Semiconductor Preferred Device



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	40	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector–Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Base Cutoff Current (V_{CE} = 35 Vdc, V_{EB} = 0.4 Vdc)	I_{BEV}	—	0.1	µAdc
Collector Cutoff Current (V_{CE} = 35 Vdc, V_{EB} = 0.4 Vdc)	I_{CEX}	—	0.1	µAdc

1. Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

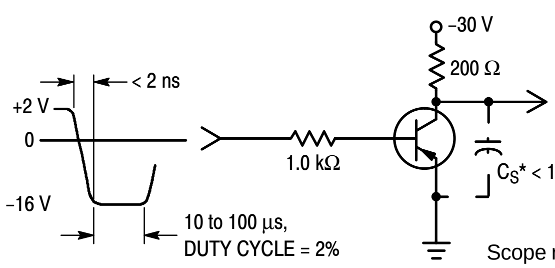
Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

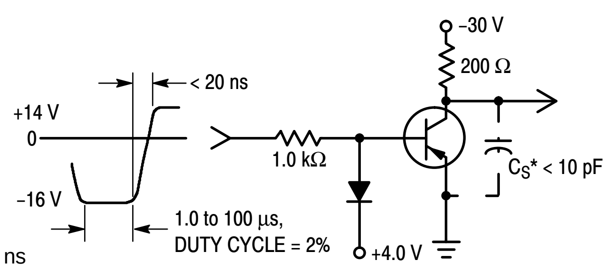
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)			30	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)			60	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			100	—	
(I_C = 150 mAdc, V_{CE} = 2.0 Vdc)(1)			100	300	
(I_C = 500 mAdc, V_{CE} = 2.0 Vdc)(1)			20	—	
Collector–Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	0.4	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	0.75	
Base–Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			0.75	0.95	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	1.3	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	200	—	MHz
Collector–Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	8.5	pF
Emitter–Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{eb}	—	30	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{ie}	1.5 k	15 k	ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{re}	0.1	8.0	X 10^{-4}
Small–Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{fe}	60	500	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	1.0	100	μmhos
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 30 Vdc, V_{BE} = +2.0 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	—	15	ns
Rise Time		t_r	—	20	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = 15 mA, I_{B2} = 15 mA)	t_s	—	225	ns
Fall Time		t_f	—	30	ns

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUIT





Scope rise time < 4.0 ns
*Total shunt capacitance of test jig connectors, and oscilloscope

Figure 1. Turn–On Time **Figure 2. Turn–Off Time**

TRANSIENT CHARACTERISTICS

—— 25°C —— 100°C

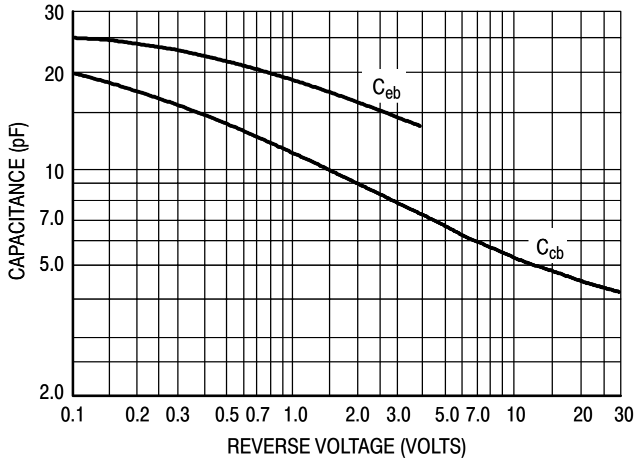


Figure 3. Capacitances

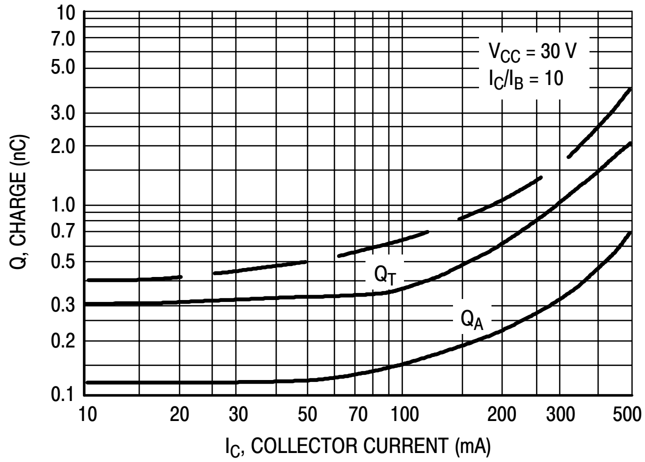


Figure 4. Charge Data

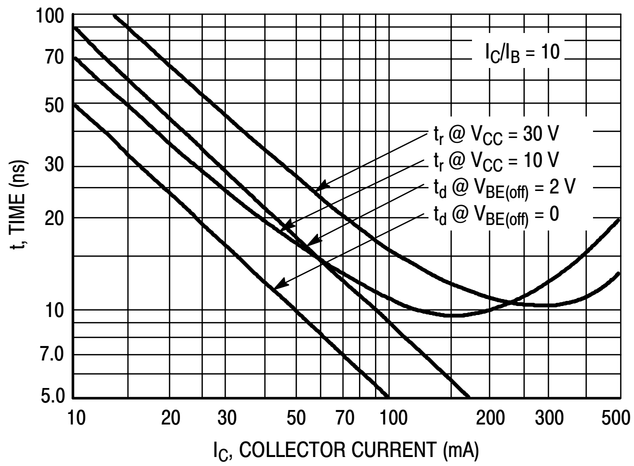


Figure 5. Turn–On Time

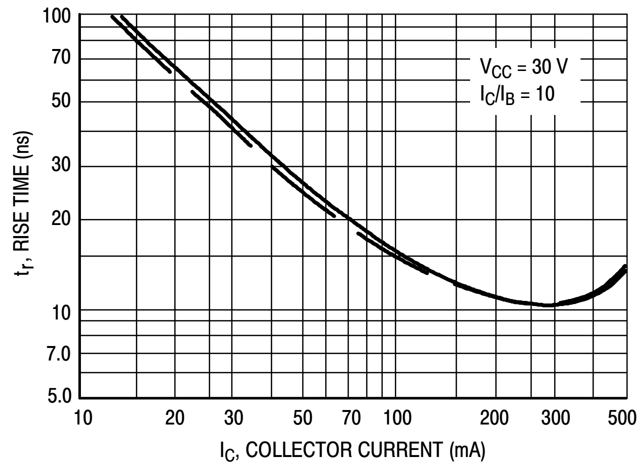


Figure 6. Rise Time

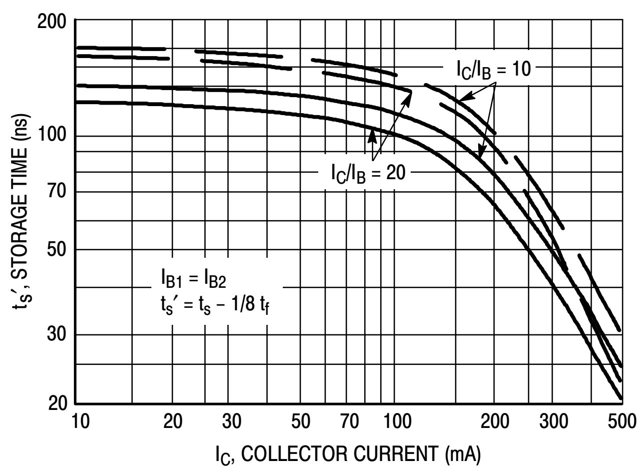


Figure 7. Storage Time

SMALL–SIGNAL CHARACTERISTICS

NOISE FIGURE

V_{CE} = –10 Vdc, T_A = 25°C; Bandwidth = 1.0 Hz

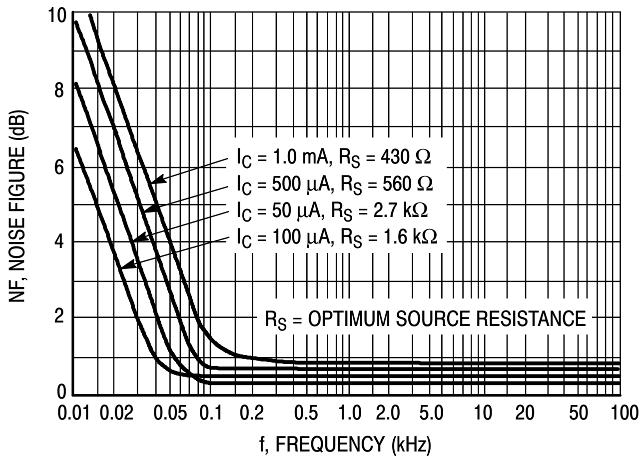


Figure 8. Frequency Effects

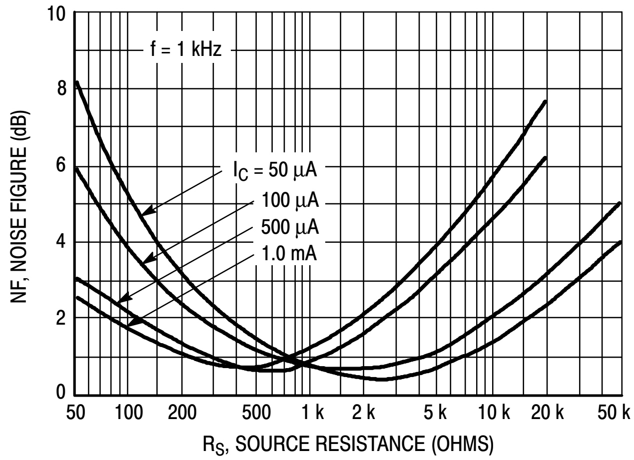


Figure 9. Source Resistance Effects

h PARAMETERS

V_{CE} = –10 Vdc, f = 1.0 kHz, T_A = 25°C

This group of graphs illustrates the relationship between h_{fe} and other "h" parameters for this series of transistors. To obtain these curves, a high–gain and a low–gain unit were selected from the 2N4403 lines, and the same units were used to develop the correspondingly–numbered curves on each graph.

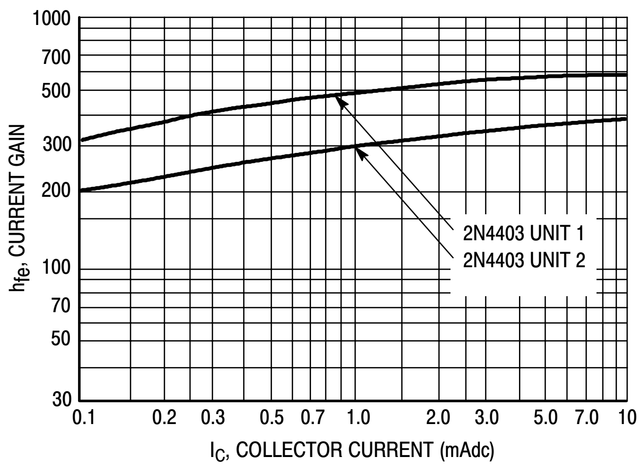


Figure 10. Current Gain

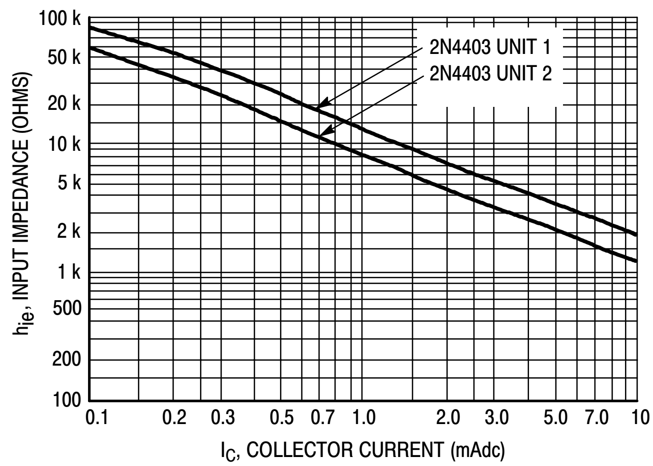


Figure 11. Input Impedance

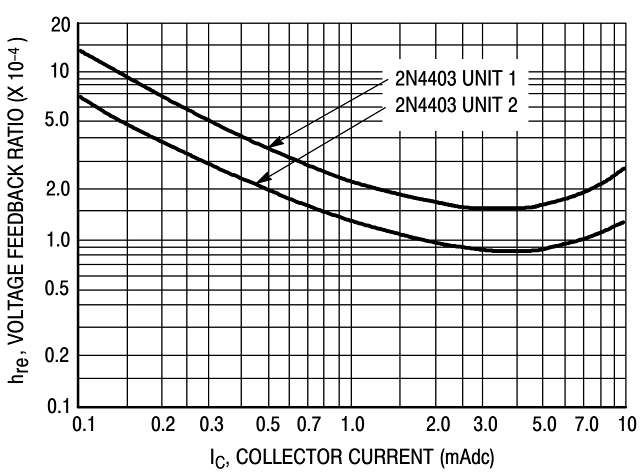


Figure 12. Voltage Feedback Ratio

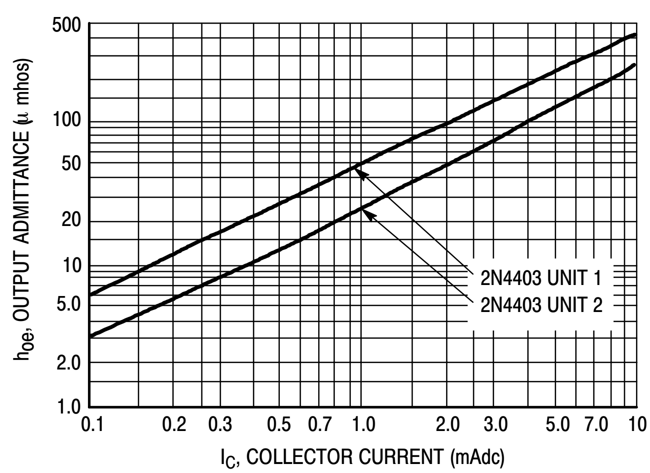


Figure 13. Output Admittance

STATIC CHARACTERISTICS

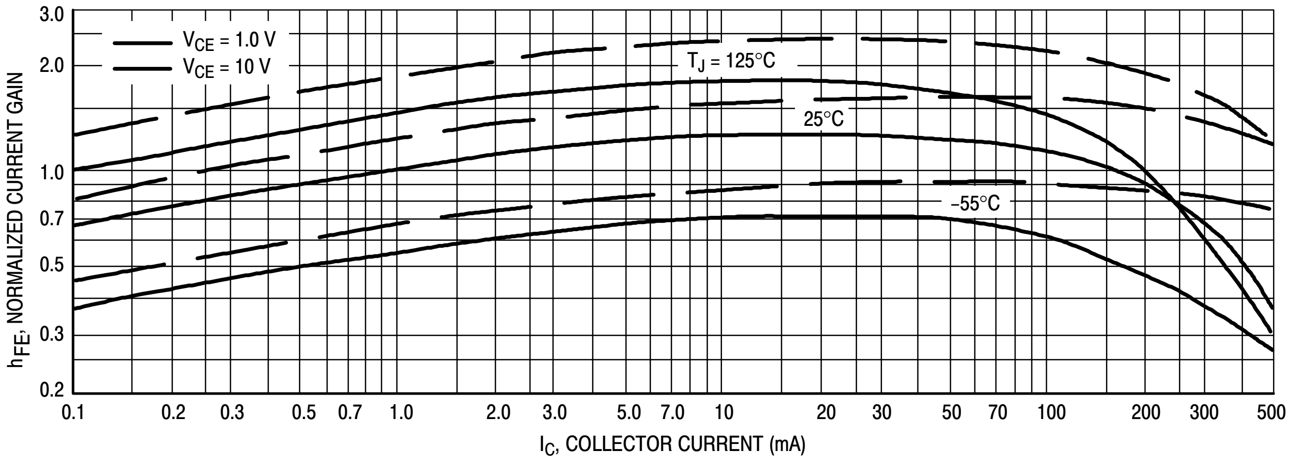


Figure 14. DC Current Gain

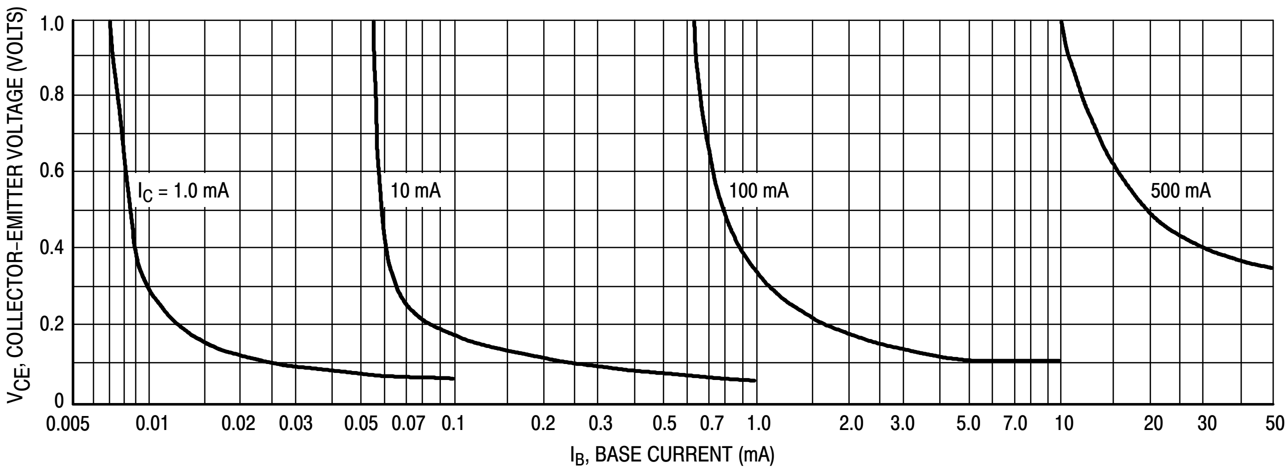


Figure 15. Collector Saturation Region

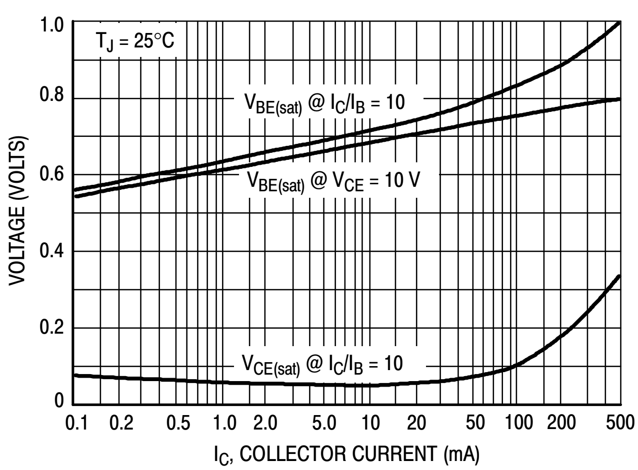


Figure 16. “On” Voltages

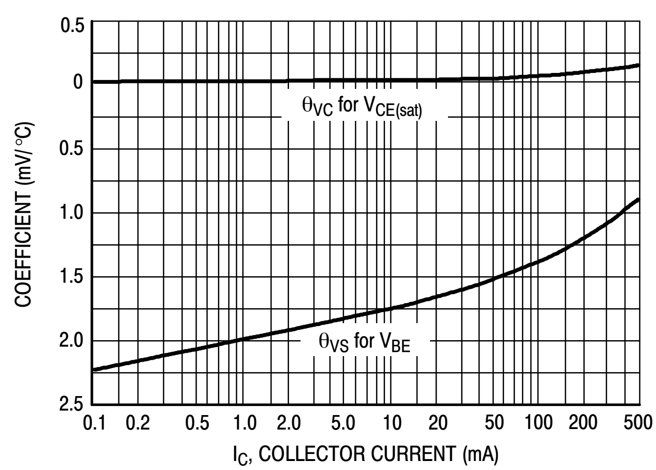


Figure 17. Temperature Coefficients

Amplifier Transistor
NPN Silicon

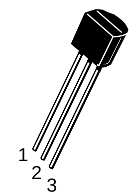
2N4410

MAXIMUM RATINGS

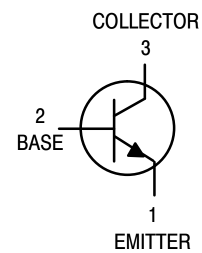
Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	80	Vdc
Collector–Base Voltage	V_{CBO}	120	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	250	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	80	—	Vdc
Collector–Emitter Breakdown Voltage (I_C = 500 µAdc, V_{BE} = 5.0 Vdc, R_{BE} = 8.2 k ohms)	$V_{(BR)CEX}$	120	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0)	$V_{(BR)CBO}$	120	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 100 Vdc, I_E = 0) (V_{CB} = 100 Vdc, I_E = 0, T_A = 100°C)	I_{CBO}	 — —	 0.01 1.0	µAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	µAdc

1. Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	 60 60	 — 400	—
Collector–Emitter Saturation Voltage (I_C = 1.0 mAdc, I_B = 0.1 mAdc)	$V_{CE(sat)}$	—	0.2	Vdc
Base–Emitter Saturation Voltage (I_C = 1.0 mAdc, I_B = 0.1 mAdc)	$V_{BE(sat)}$	—	0.8	Vdc
Base–Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	0.8	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product(2) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	f_T	60	300	MHz
Collector–Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz, emitter guarded)	C_{cb}	—	12	pF
Emitter–Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz, collector guarded)	C_{eb}	—	50	pF

2. $f_T = |h_{fe}| \bullet f_{test}$.

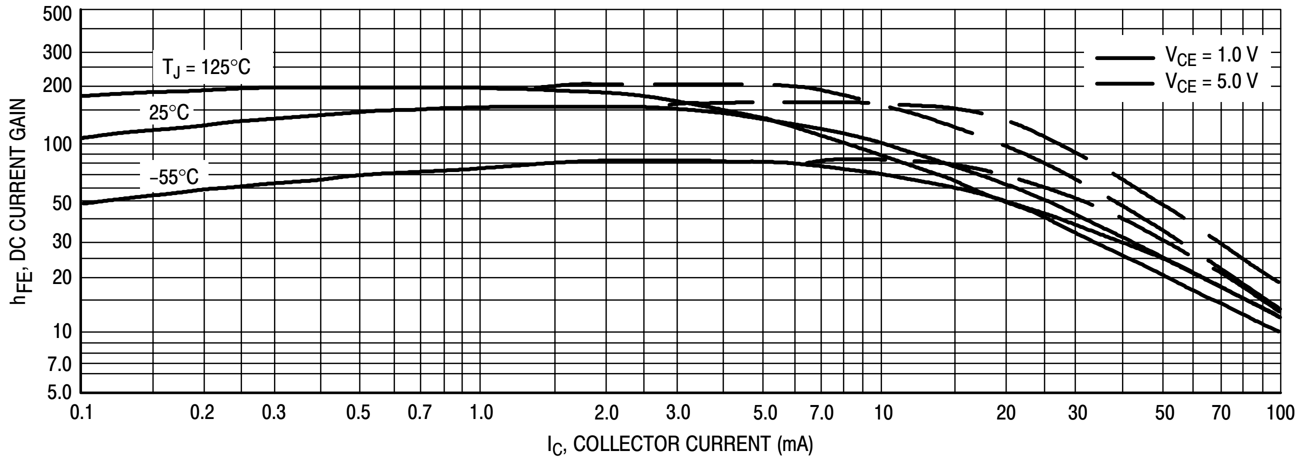


Figure 1. DC Current Gain

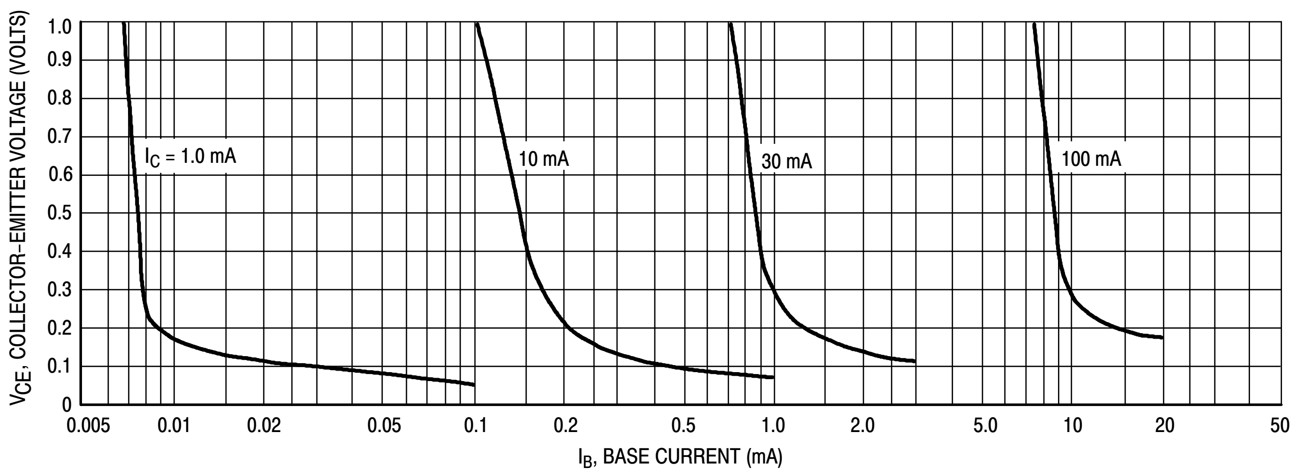


Figure 2. Collector Saturation Region

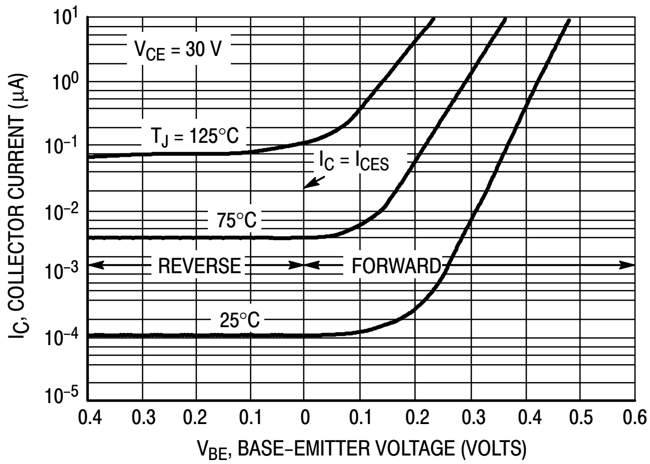


Figure 3. Collector Cut−Off Region

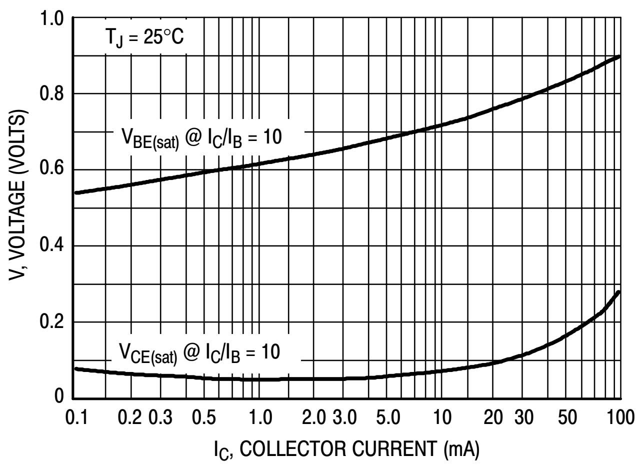


Figure 4. “On” Voltages

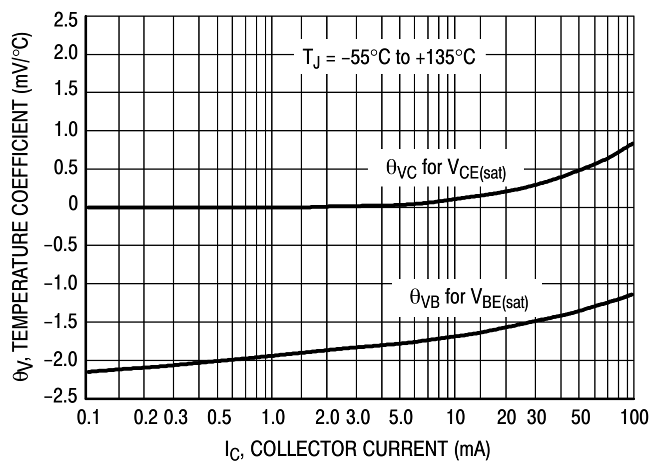
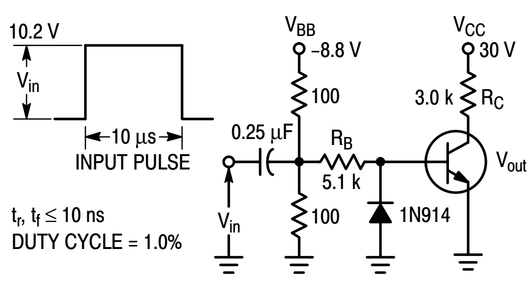


Figure 5. Temperature Coefficients



Values Shown are for I_C @ 10 mA

Figure 6. Switching Time Test Circuit

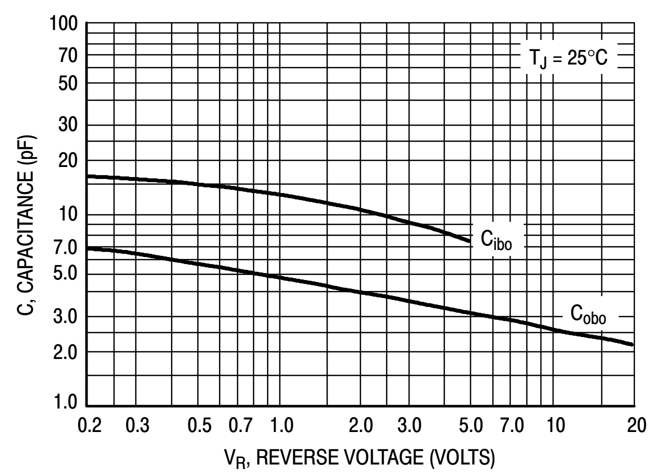


Figure 7. Capacitances

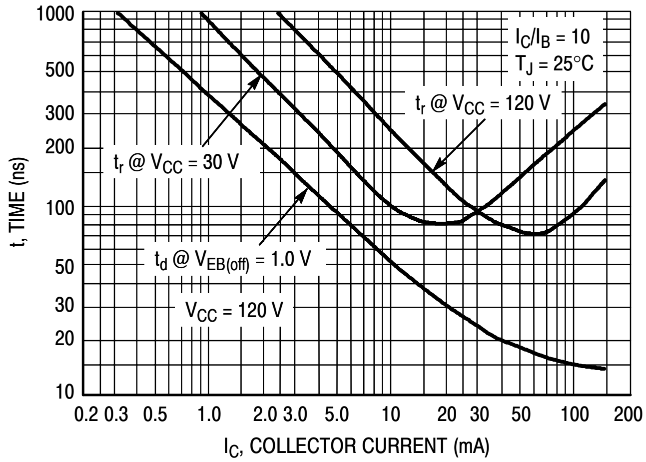


Figure 8. Turn–On Time

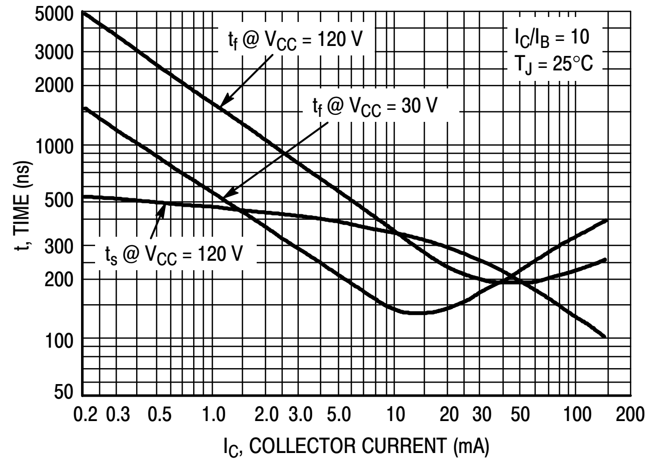
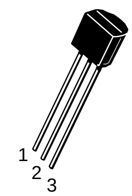


Figure 9. Turn–Off Time

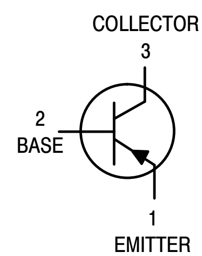
Amplifier Transistor
PNP Silicon

2N5087

ON Semiconductor Preferred Device



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	50	Vdc
Collector–Base Voltage	V_{CBO}	50	Vdc
Emitter–Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	Vdc
Collector Cutoff Current (V_{CB} = 35 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	50	nAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

June, 2001 – Rev. 1

Publication Order Number:
2N5087/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)		250	800	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)		250	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)(1)		250	—	
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.3	Vdc
Base–Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	0.85	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)	f_T	40	—	MHz
Collector–Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	4.0	pF
Small–Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{fe}	250	900	—
Noise Figure	NF			dB
(I_C = 20 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)		—	2.0	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 3.0 kΩ, f = 1.0 kHz)		—	2.0	

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

TYPICAL NOISE CHARACTERISTICS

(V_{CE} = –5.0 Vdc, T_A = 25°C)

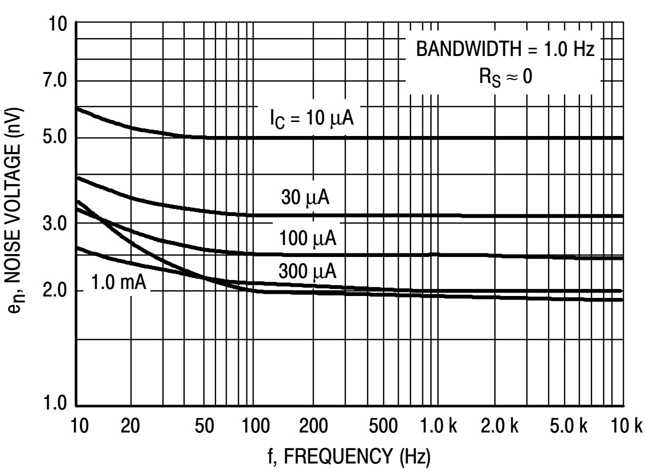


Figure 1. Noise Voltage

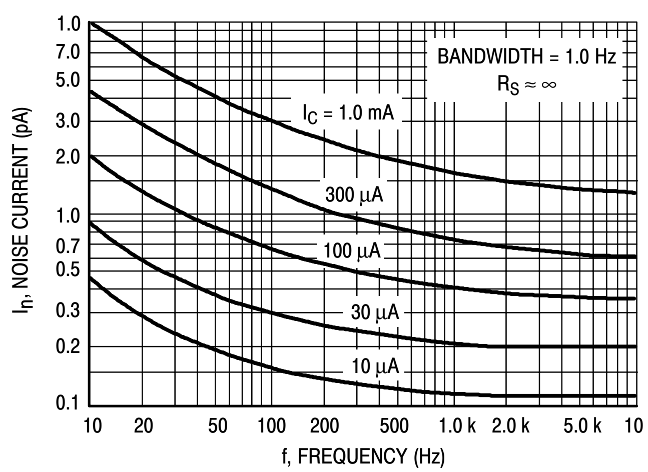


Figure 2. Noise Current

NOISE FIGURE CONTOURS

(V_{CE} = –5.0 Vdc, T_A = 25°C)

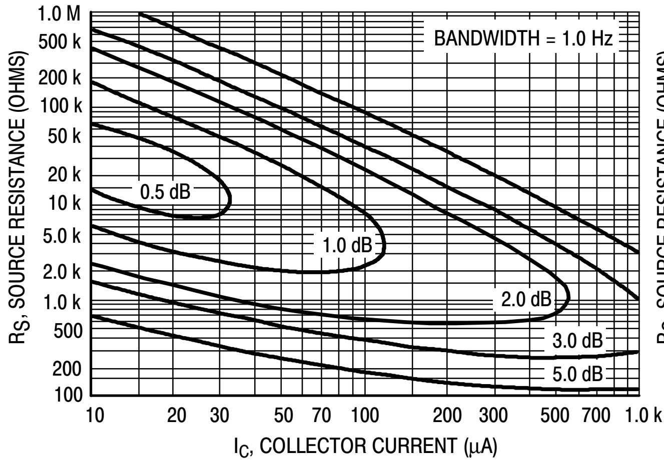


Figure 3. Narrow Band, 100 Hz

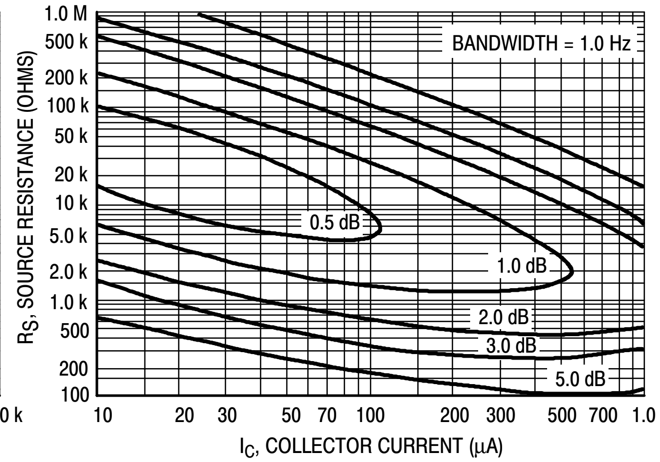


Figure 4. Narrow Band, 1.0 kHz

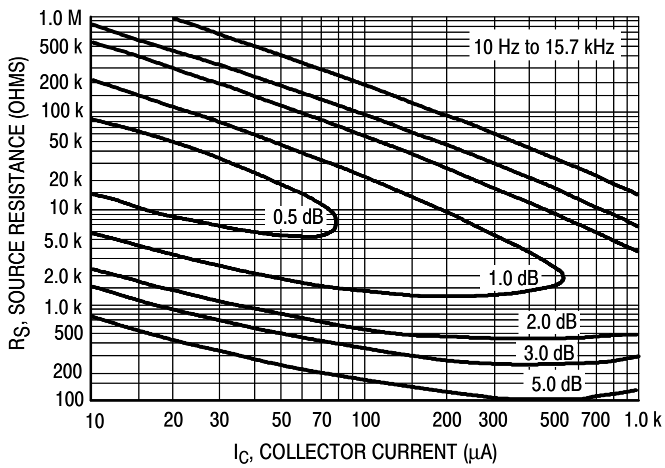


Figure 5. Wideband

Noise Figure is Defined as:

$$NF = 20 \log_{10}\left[\frac{e_n^2 + 4KTR_S + I_n{}^2 R_S{}^2}{4KTR_S}\right]^{1/2}$$

e_n = Noise Voltage of the Transistor referred to the input. (Figure 3)
I_n = Noise Current of the Transistor referred to the input. (Figure 4)
K = Boltzman's Constant (1.38 x 10^{-23} j/°K)
T = Temperature of the Source Resistance (°K)
R_S = Source Resistance (Ohms)

TYPICAL STATIC CHARACTERISTICS

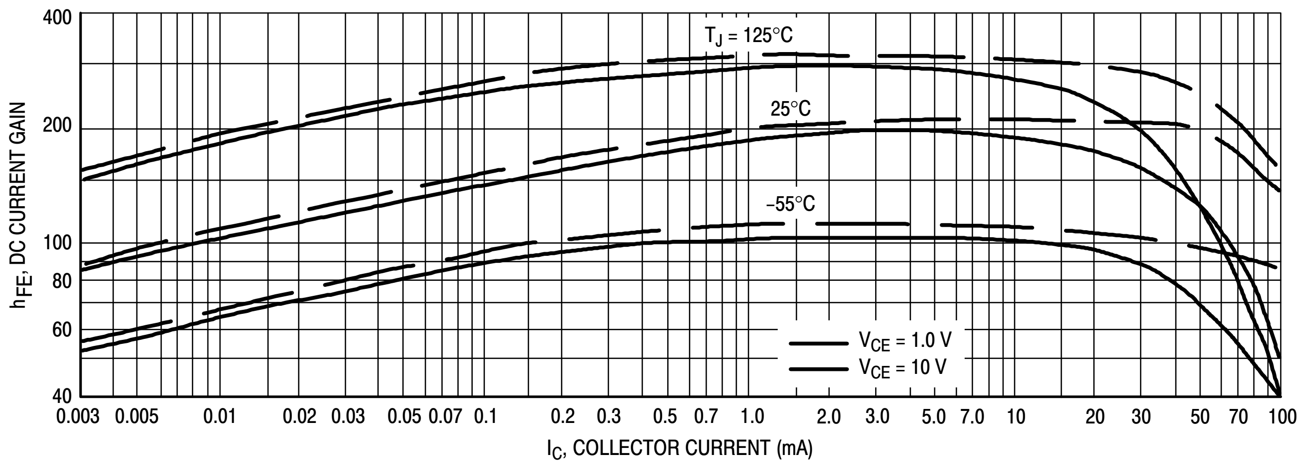


Figure 6. DC Current Gain

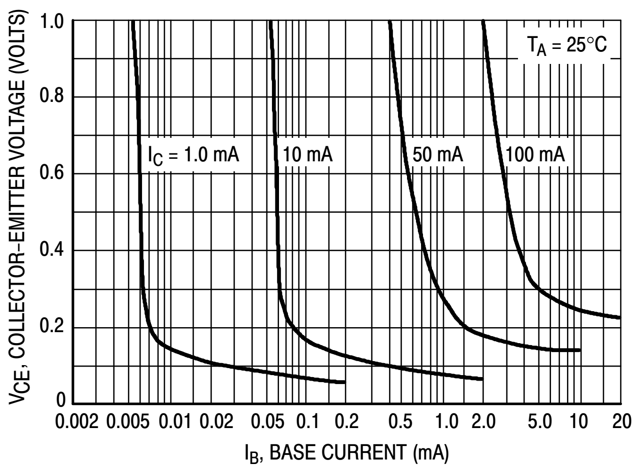


Figure 7. Collector Saturation Region

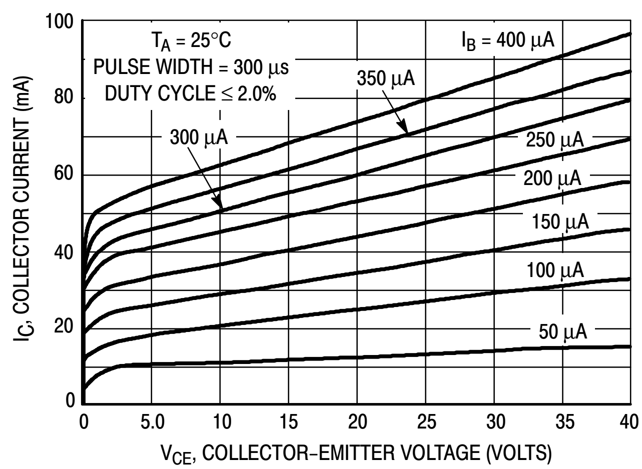


Figure 8. Collector Characteristics

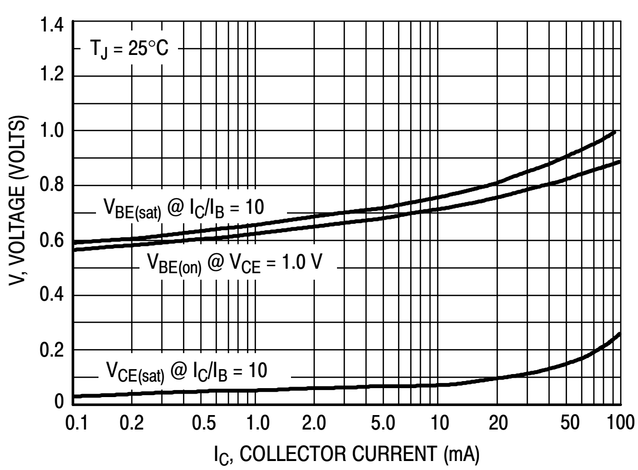


Figure 9. “On” Voltages

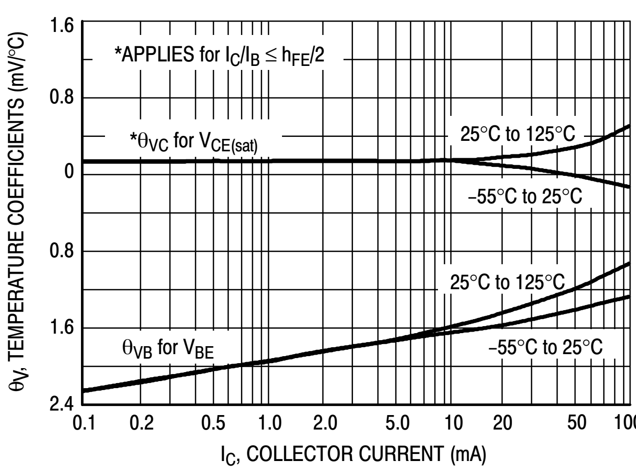


Figure 10. Temperature Coefficients

TYPICAL DYNAMIC CHARACTERISTICS

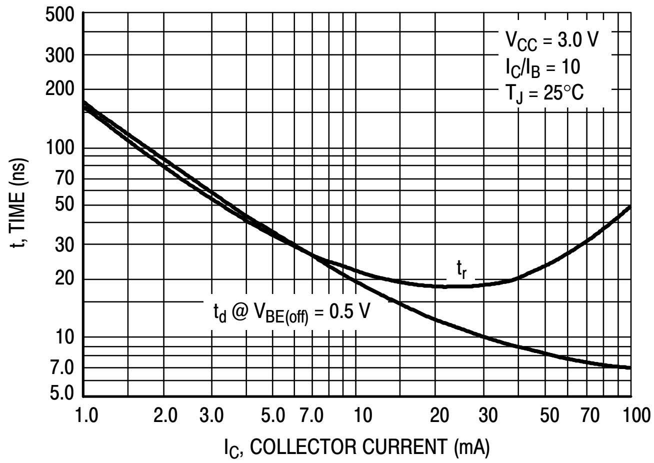


Figure 11. Turn–On Time

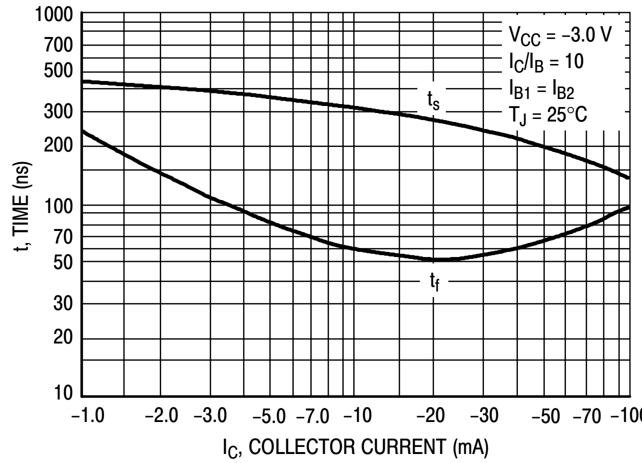


Figure 12. Turn–Off Time

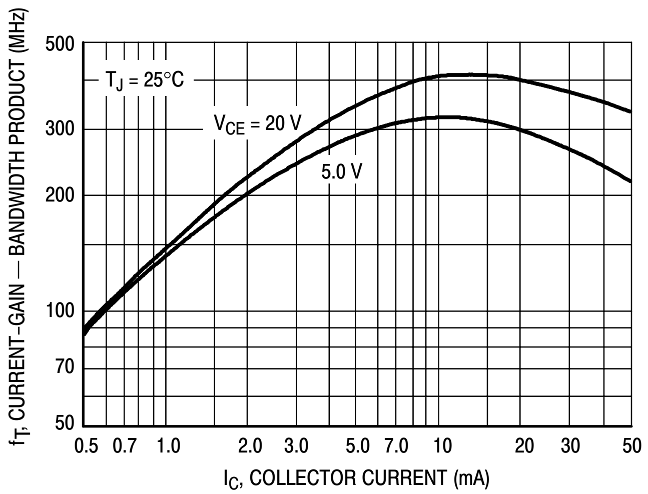


Figure 13. Current–Gain — Bandwidth Product

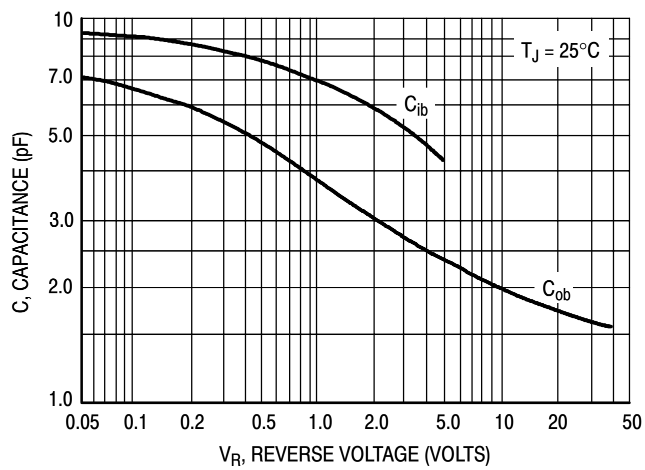


Figure 14. Capacitance

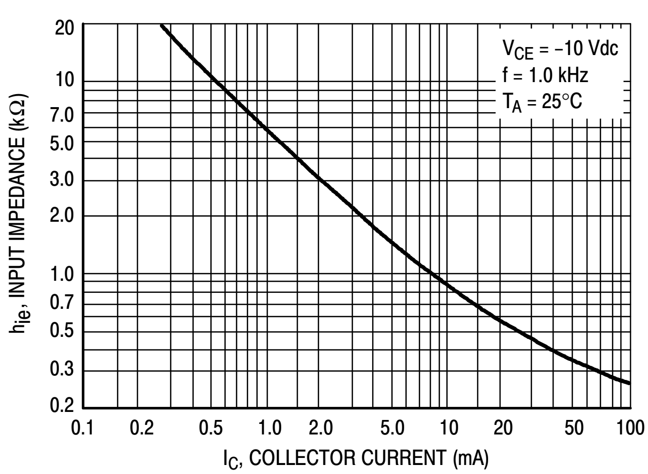


Figure 15. Input Impedance

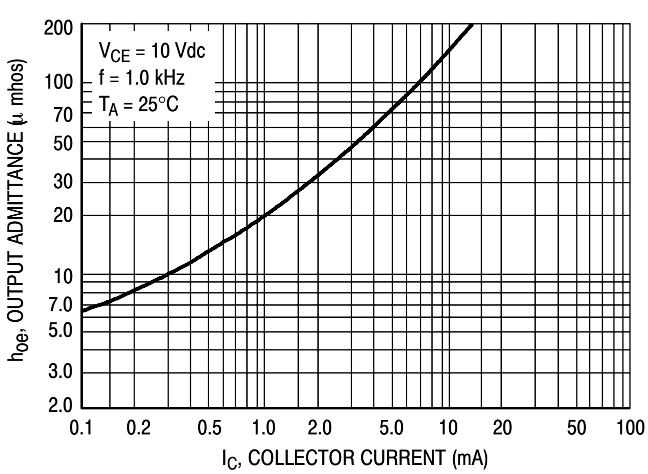


Figure 16. Output Admittance

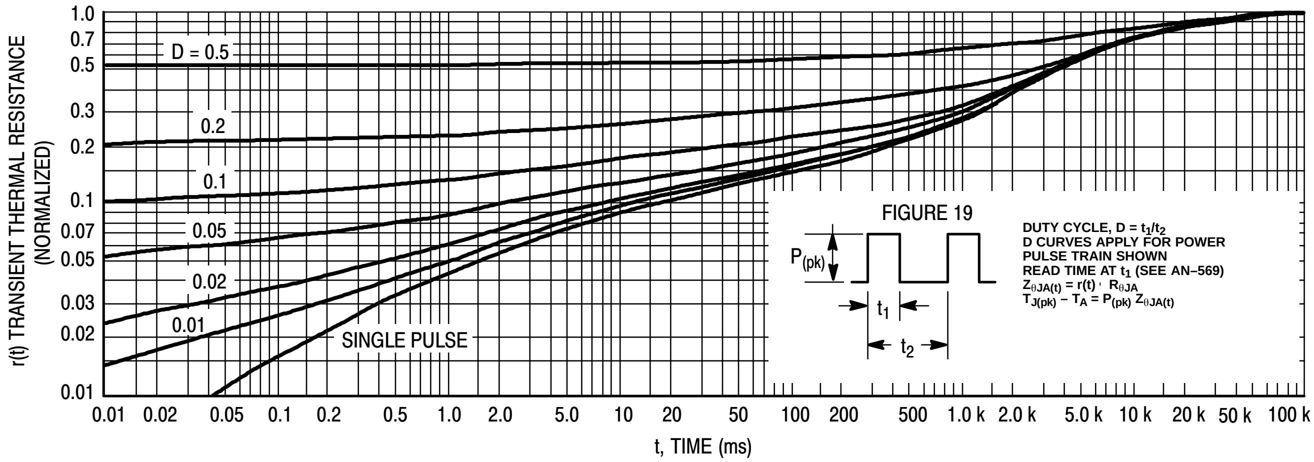


Figure 17. Thermal Response

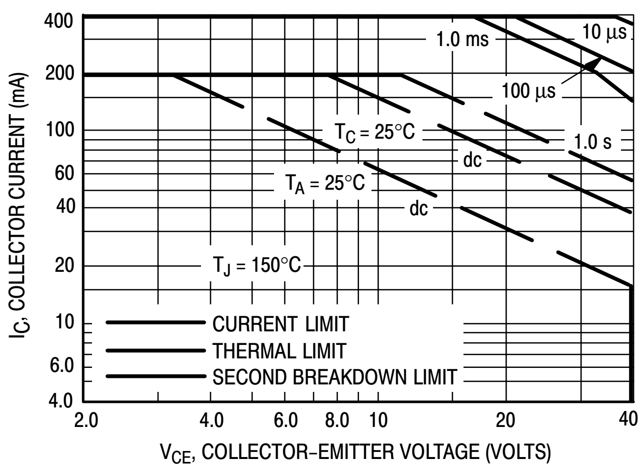


Figure 18. Active−Region Safe Operating Area

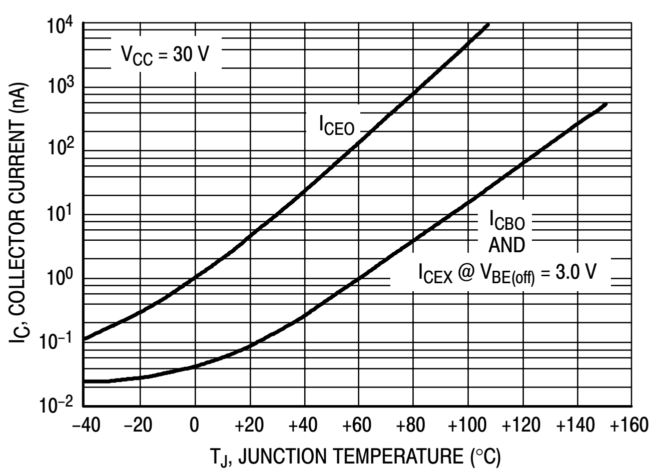


Figure 19. Typical Collector Leakage Current

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 18 is based upon $T_{J(pk)} = 150°C$; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \le 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 17. At high case or ambient temperatures, thermal limitations will reduce the power than can be handled to values less than the limitations imposed by second breakdown.

DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 19. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 17 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 17 by the steady state value $R_{\theta JA}$.

Example:

The 2N5087 is dissipating 2.0 watts peak under the following conditions:

$$t_1 = 1.0 \text{ ms}, t_2 = 5.0 \text{ ms } (D = 0.2)$$

Using Figure 17 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

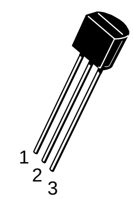
The peak rise in junction temperature is therefore

$$\Delta T = r(t) \times P_{(pk)} \times R_{\theta JA} = 0.22 \times 2.0 \times 200 = 88°C.$$

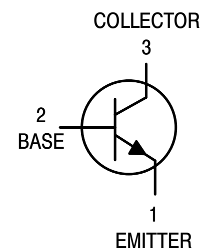
For more information, see ON Semiconductor Application Note AN569/D, available from the Literature Distribution Center or on our website at **www.onsemi.com**.

Amplifier Transistors
NPN Silicon

2N5088
2N5089



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	2N5088	2N5089	Unit
Collector–Emitter Voltage	V_{CEO}	30	25	Vdc
Collector–Base Voltage	V_{CBO}	35	30	Vdc
Emitter–Base Voltage	V_{EBO}	3.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(2) (I_C = 1.0 mAdc, I_B = 0)	 2N5088 2N5089	$V_{(BR)CEO}$	 30 25	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 2N5088 2N5089	$V_{(BR)CBO}$	 35 30	 — —	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) (V_{CB} = 15 Vdc, I_E = 0)	 2N5088 2N5089	I_{CBO}	 — —	 50 50	nAdc
Emitter Cutoff Current ($V_{EB(off)}$ = 3.0 Vdc, I_C = 0) ($V_{EB(off)}$ = 4.5 Vdc, I_C = 0)		I_{EBO}	 — —	 50 100	nAdc

1. $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N5088		300	900	
	2N5089		400	1200	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N5088		350	—	
	2N5089		450	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)(2)	2N5088		300	—	
	2N5089		400	—	
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base–Emitter On Voltage (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)(2)		$V_{BE(on)}$	—	0.8	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	50	—	MHz
Collector–Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	4.0	pF
Emitter–Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{eb}	—	10	pF
Small–Signal Current Gain		h_{fe}			—
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N5088		350	1400	
	2N5089		450	1800	
Noise Figure		NF			dB
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ,	2N5088		—	3.0	
f = 1.0 kHz)	2N5089		—	2.0	

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

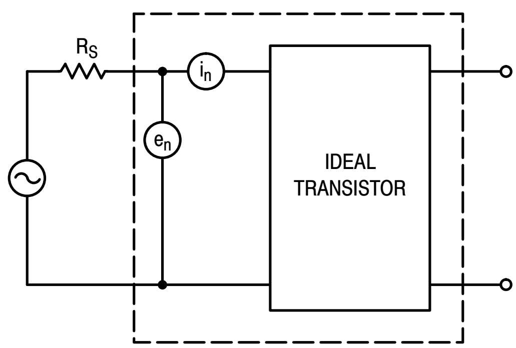


Figure 1. Transistor Noise Model

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

NOISE VOLTAGE

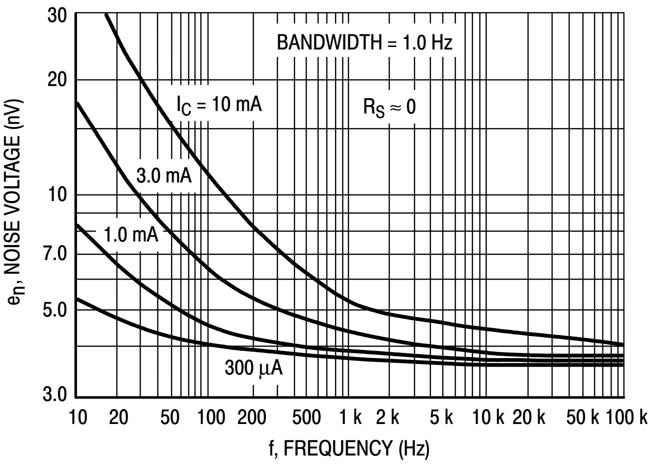


Figure 2. Effects of Frequency

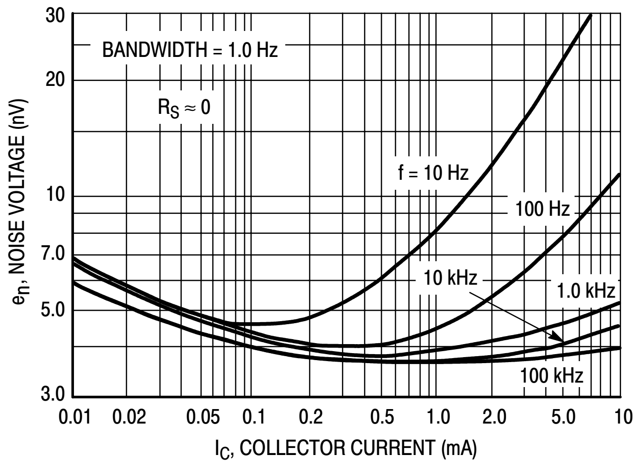


Figure 3. Effects of Collector Current

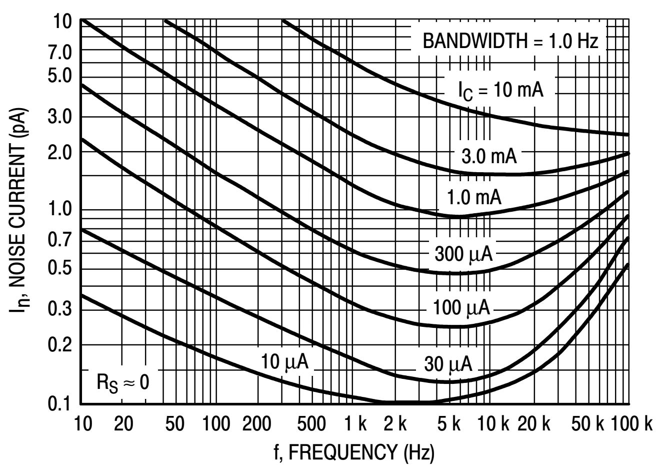


Figure 4. Noise Current

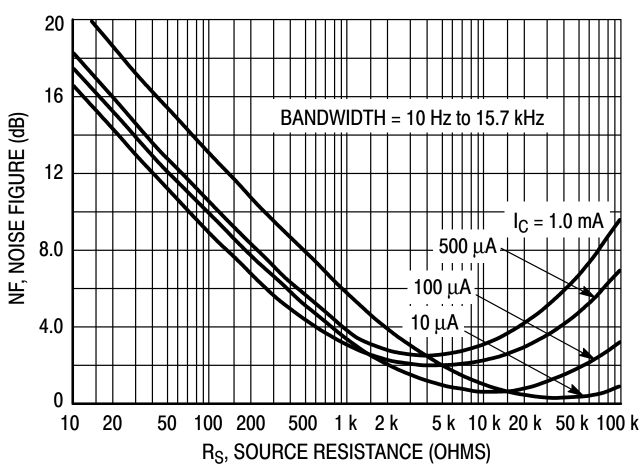


Figure 5. Wideband Noise Figure

100 Hz NOISE DATA

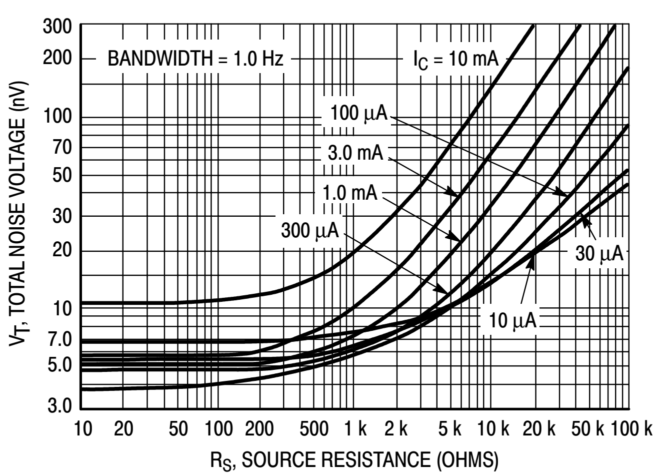


Figure 6. Total Noise Voltage

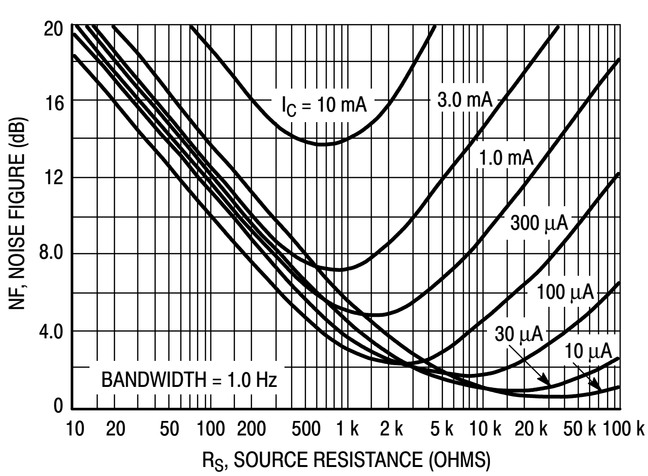


Figure 7. Noise Figure

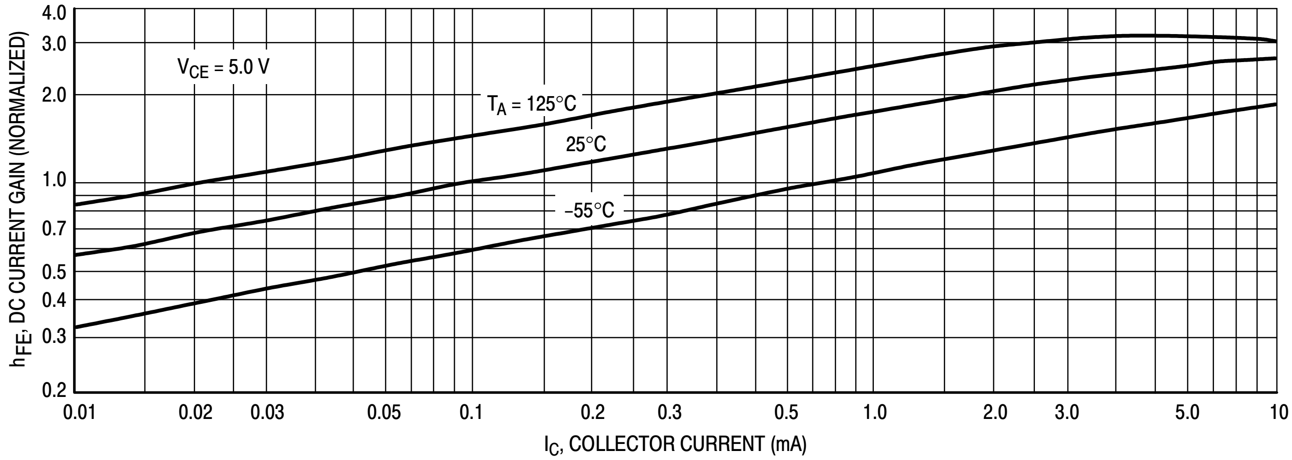


Figure 8. DC Current Gain

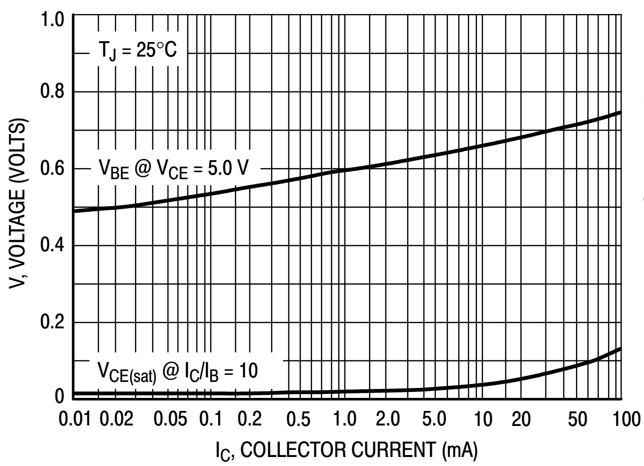


Figure 9. "On" Voltages

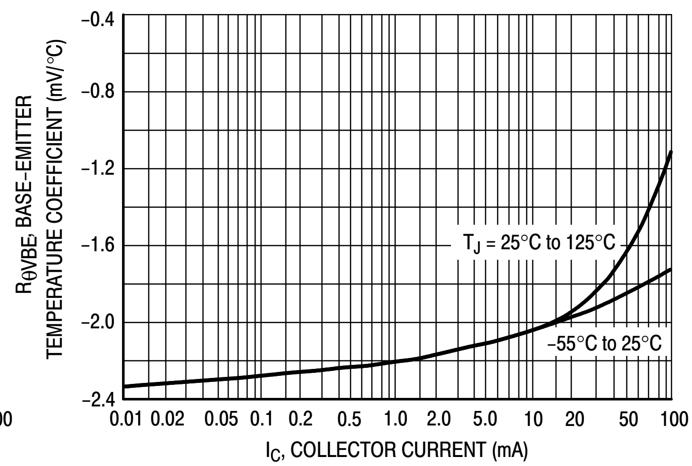


Figure 10. Temperature Coefficients

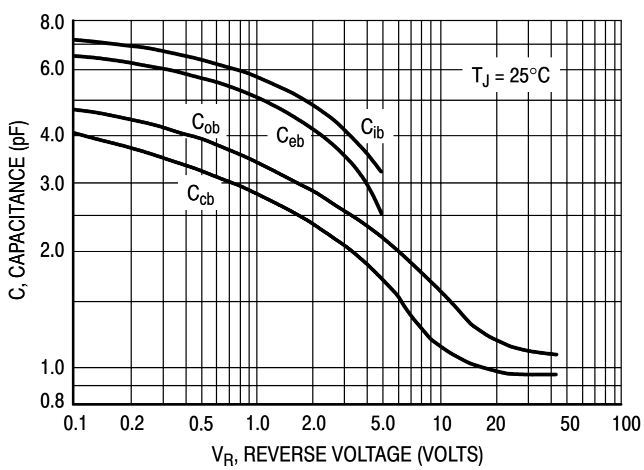


Figure 11. Capacitance

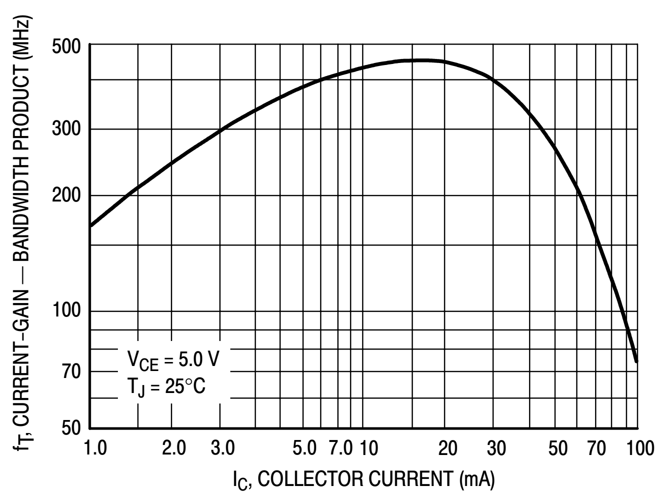
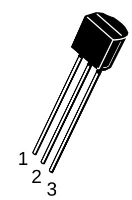


Figure 12. Current−Gain — Bandwidth Product

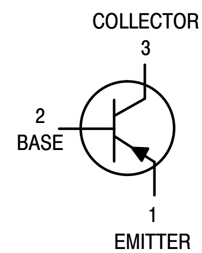
Amplifier Transistors
PNP Silicon

2N5401*

*ON Semiconductor Preferred Device



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	2N5400	2N5401	Unit
Collector–Emitter Voltage	V_{CEO}	120	150	Vdc
Collector–Base Voltage	V_{CBO}	130	160	Vdc
Emitter–Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	 2N5400 2N5401	$V_{(BR)CEO}$	 150	 —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 2N5400 2N5401	$V_{(BR)CBO}$	 160	 —	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 120 Vdc, I_E = 0) (V_{CB} = 120 Vdc, I_E = 0, T_A = 100°C)	 2N5401 2N5401	I_{CBO}	 — —	 50 50	
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	50	nAdc

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

June, 2001 – Rev. 0

Publication Order Number:
2N5401/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]				
DC Current Gain	h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)		50	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)		60	240	
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)		50	—	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	0.5	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	1.0	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	1.0	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	100	300	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Small–Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	40	200	—
Noise Figure (I_C = 250 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)	NF	—	8.0	dB

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

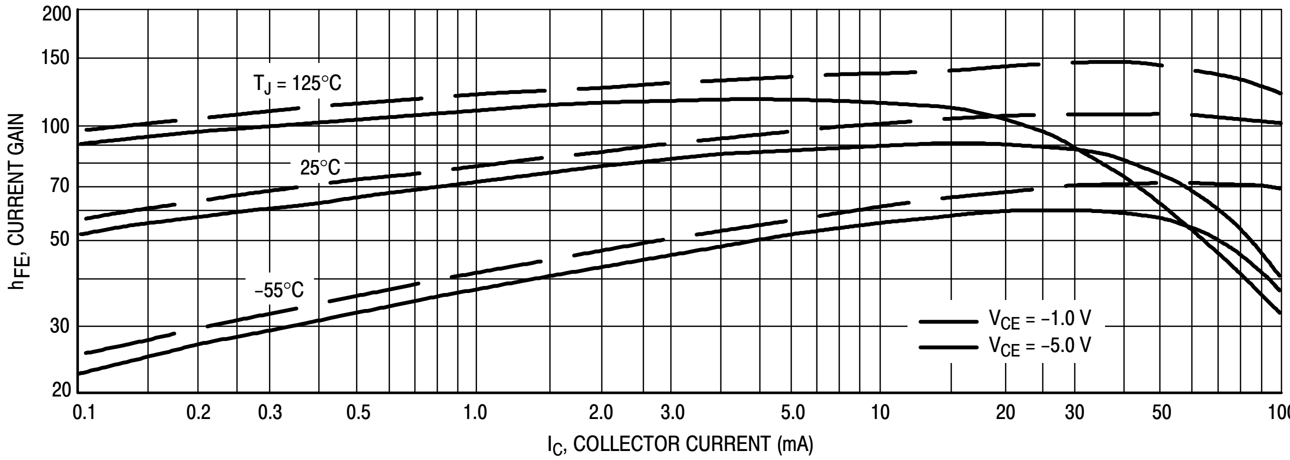


Figure 1. DC Current Gain

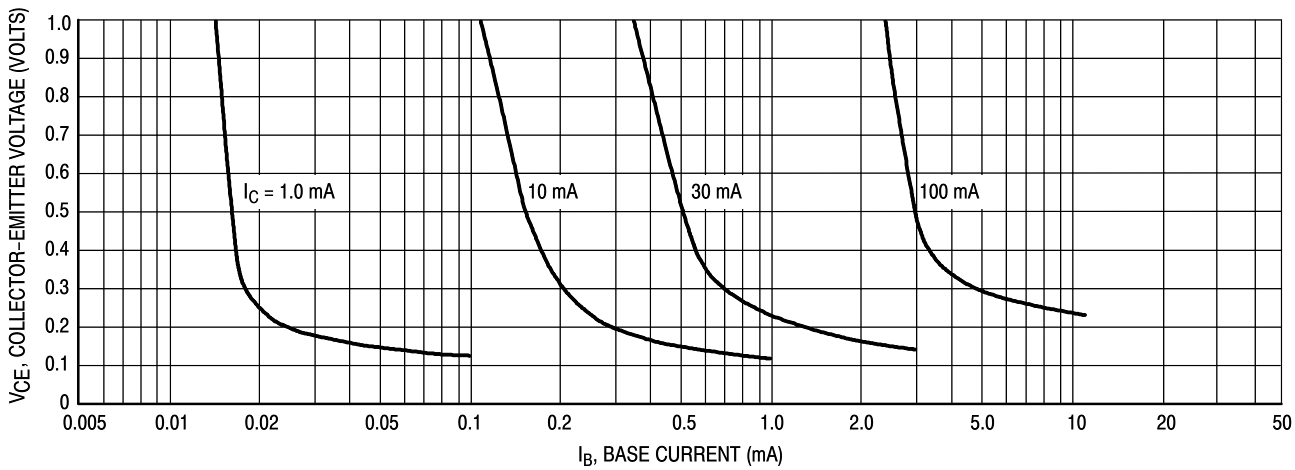


Figure 2. Collector Saturation Region

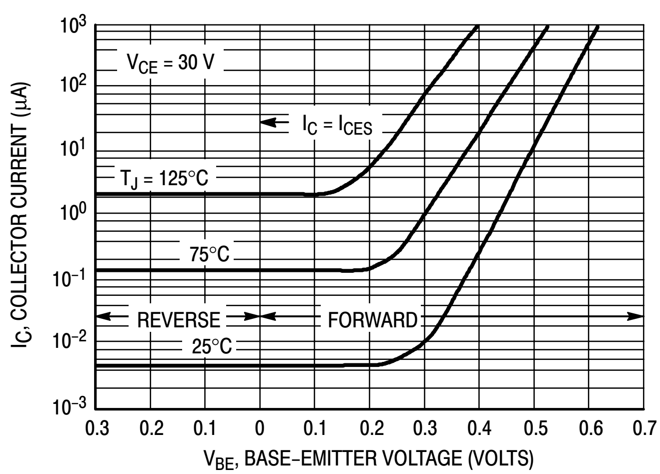


Figure 3. Collector Cut−Off Region

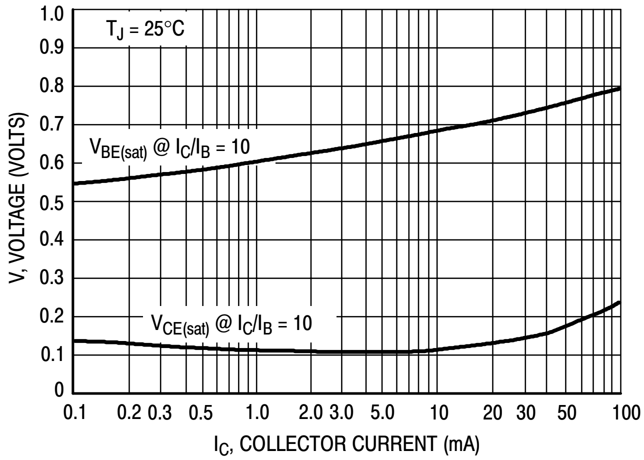


Figure 4. “On” Voltages

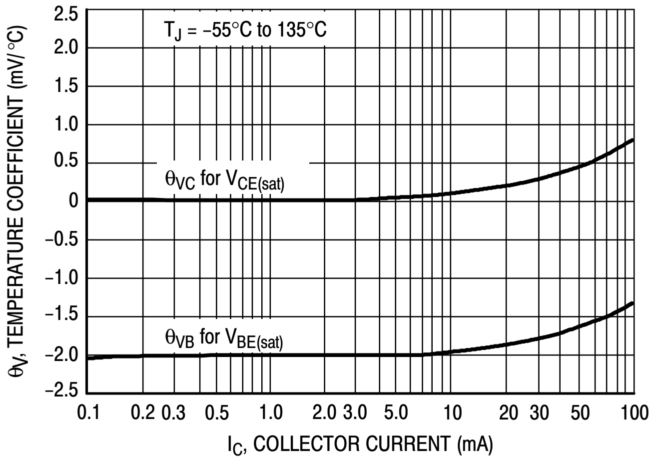
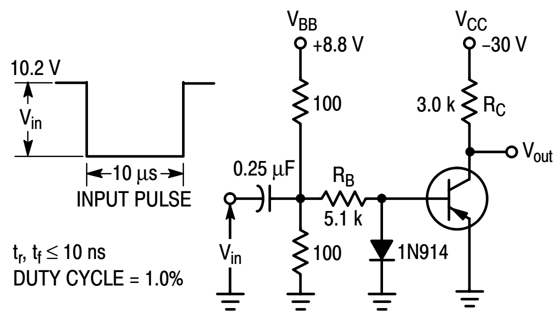


Figure 5. Temperature Coefficients



Values Shown are for I_C @ 10 mA

Figure 6. Switching Time Test Circuit

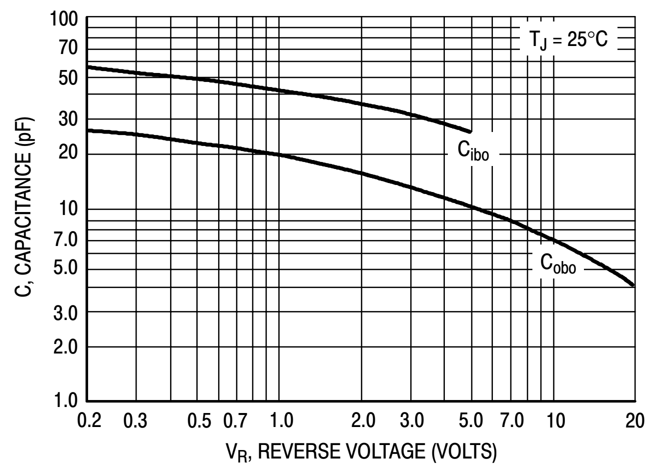


Figure 7. Capacitances

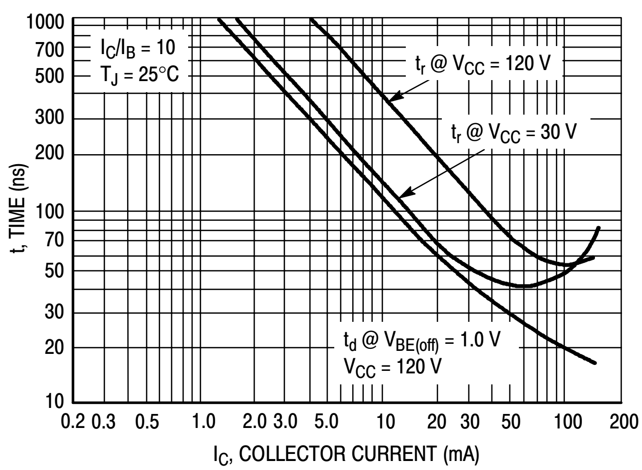


Figure 8. Turn–On Time

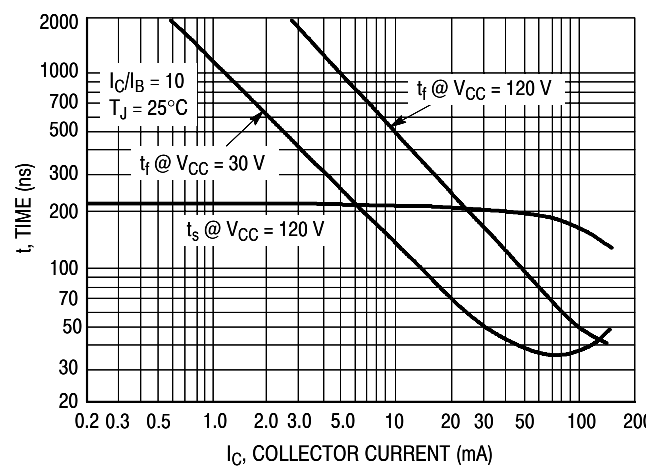


Figure 9. Turn–Off Time

2N5457, 2N5458

2N5457 and 2N5458 are Preferred Devices

JFETs - General Purpose

N–Channel – Depletion

N–Channel Junction Field Effect Transistors, depletion mode (Type A) designed for audio and switching applications.

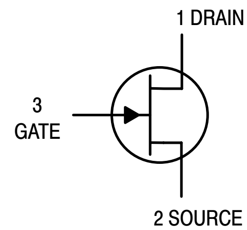
- N–Channel for Higher Gain
- Drain and Source Interchangeable
- High AC Input Impedance
- High DC Input Resistance
- Low Transfer and Input Capacitance
- Low Cross–Modulation and Intermodulation Distortion
- Unibloc Plastic Encapsulated Package

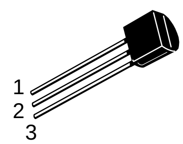
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	25	Vdc
Drain–Gate Voltage	V_{DG}	25	Vdc
Reverse Gate–Source Voltage	V_{GSR}	–25	Vdc
Gate Current	I_G	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 310 2.82	 mW mW/°C
Operating Junction Temperature	T_J	135	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

ON Semiconductor™

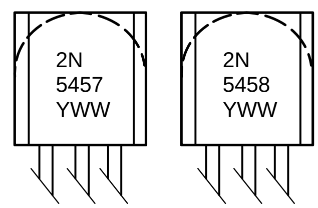
http://onsemi.com





TO–92
CASE 29
STYLE 5

MARKING DIAGRAMS



Y = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping
2N5457	TO–92	5000 Units/Box
2N5458	TO–92	5000 Units/Box

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Min	Max	Unit
OFF CHARACTERISTICS					
Gate–Source Breakdown Voltage (I_G = –10 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	–25	–25	–	Vdc
Gate Reverse Current (V_{GS} = –15 Vdc, V_{DS} = 0) (V_{GS} = –15 Vdc, V_{DS} = 0, T_A = 100°C)	I_{GSS}	– –	– –	1.0 –200	nAdc
Gate–Source Cutoff Voltage 2N5457 (V_{DS} = 15 Vdc, i_D = 1 nAdc) 2N5458	$V_{GS(off)}$	–1.0 –2.0	– –	–6.0 –7.0	Vdc
Gate–Source Voltage (V_{DS} = 15 Vdc, i_D = 100 μAdc) 2N5457 (V_{DS} = 15 Vdc, i_D = 200 μAdc) 2N5458	V_{GS}	– –	–2.5 –3.5	–6.0 –7.0	Vdc
ON CHARACTERISTICS					
Zero–Gate–Voltage Drain Current (Note 1.) 2N5638 (V_{DS} = 20 Vdc, V_{GS} = 0) 2N5639	I_{DSS}	1.0 2.0	3.0 6.0	5.0 9.0	mAdc
DYNAMIC CHARACTERISTICS					
Forward Transfer Admittance (Note 1.) 2N5638 (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 kHz) 2N5639	$\lvert Y_{fs} \rvert$	1000 1500	3000 4000	5000 5500	μmhos
Forward Transfer Admittance (Note 1.) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 kHz)	$\lvert Y_{os} \rvert$	–	10	50	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 kHz)	C_{iss}	–	4.5	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 kHz)	C_{rss}	–	1.5	3.0	pF

1. Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

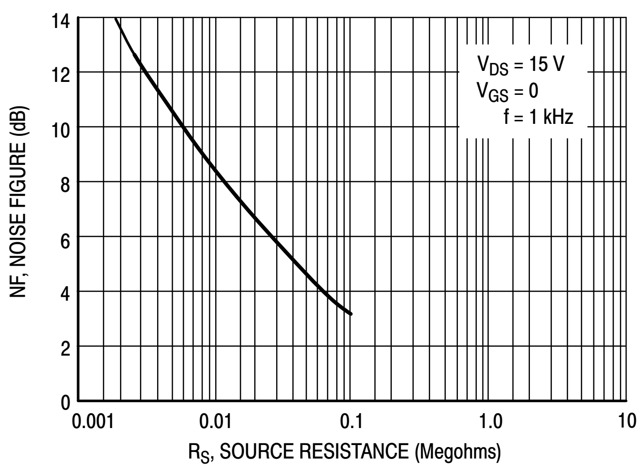


Figure 1. Noise Figure versus Source Resistance

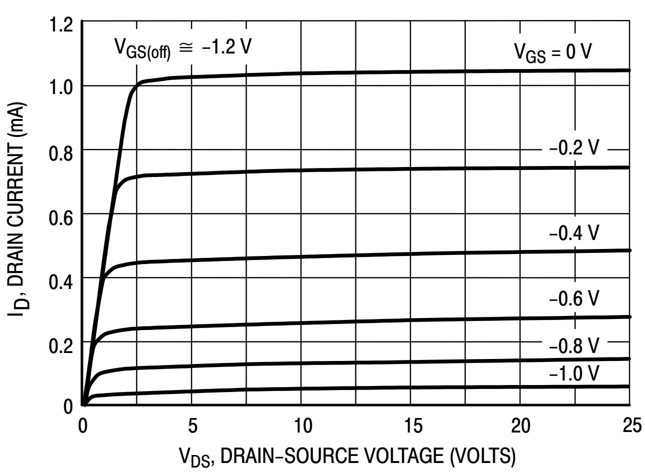


Figure 2. Typical Drain Characteristics

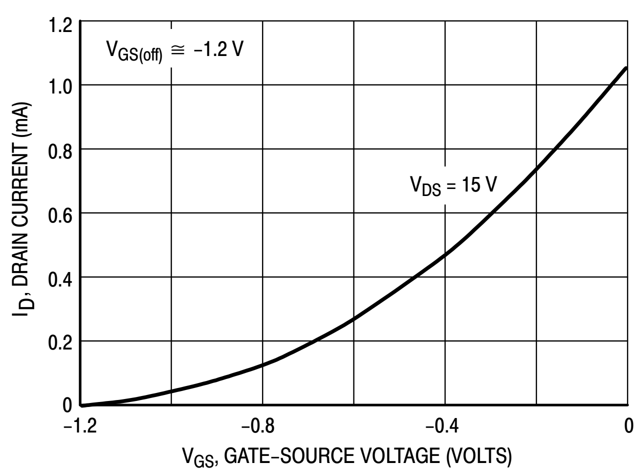


Figure 3. Common Source Transfer Characteristics

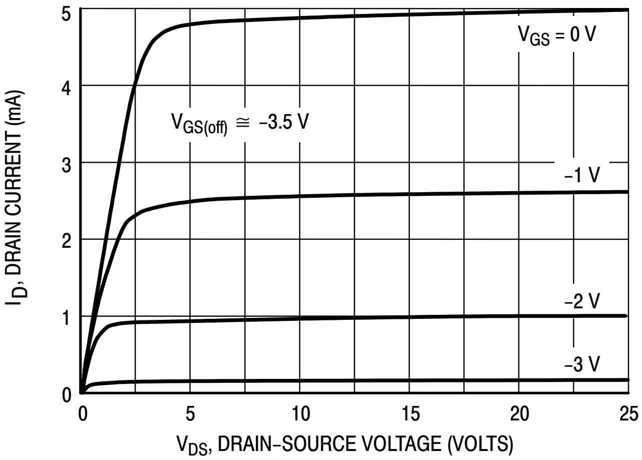


Figure 4. Typical Drain Characteristics

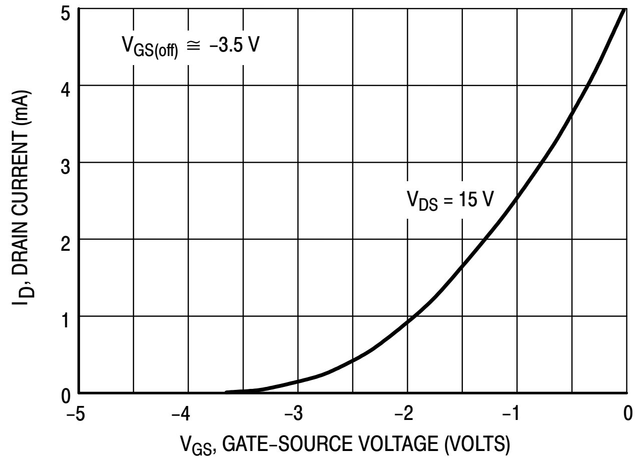


Figure 5. Common Source Transfer Characteristics

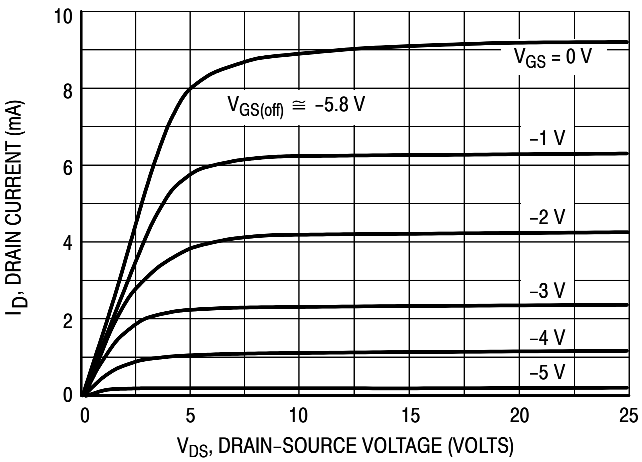


Figure 6. Typical Drain Characteristics

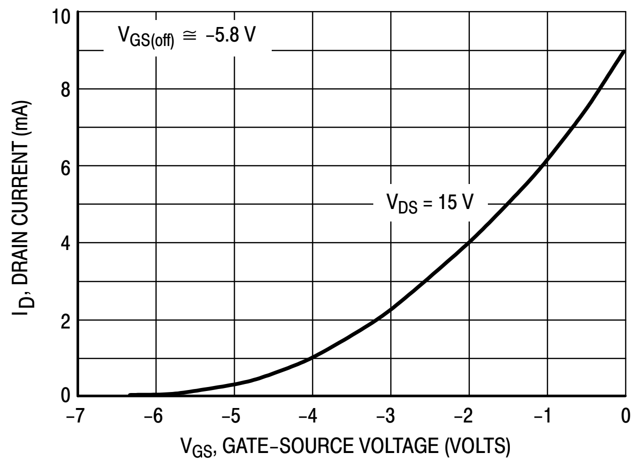
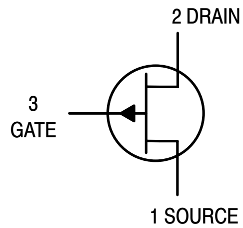


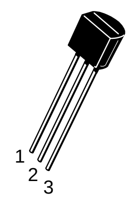
Figure 7. Common Source Transfer Characteristics

NOTE: Note: Graphical data is presented for dc conditions. Tabular data is given for pulsed conditions (Pulse Width = 630 ms, Duty Cycle = 10%). Under dc conditions, self heating in higher I_{DSS} units reduces I_{DSS}.

JFET Amplifiers
P–Channel — Depletion



2N5460
2N5461
2N5462



CASE 29–11, STYLE 7
TO–92 (TO–226AA)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Gate Voltage	V_{DG}	40	Vdc
Reverse Gate–Source Voltage	V_{GSR}	40	Vdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Junction Temperature Range	T_J	–65 to +135	°C
Storage Channel Temperature Range	T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate–Source Breakdown Voltage (I_G = 10 µAdc, V_{DS} = 0)	 2N5460, 2N5461, 2N5462	$V_{(BR)GSS}$	40	—	—	Vdc
Gate Reverse Current (V_{GS} = 20 Vdc, V_{DS} = 0) (V_{GS} = 30 Vdc, V_{DS} = 0) (V_{GS} = 20 Vdc, V_{DS} = 0, T_A = 100°C) (V_{GS} = 30 Vdc, V_{DS} = 0, T_A = 100°C)	 2N5460, 2N5461, 2N5462 2N5460, 2N5461, 2N5462	I_{GSS}	 — —	 — —	 5.0 1.0	 nAdc µAdc
Gate–Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 1.0 µAdc)	2N5460 2N5461 2N5462	$V_{GS(off)}$	0.75 1.0 1.8	— — —	6.0 7.5 9.0	Vdc
Gate–Source Voltage (V_{DS} = 15 Vdc, I_D = 0.1 mAdc) (V_{DS} = 15 Vdc, I_D = 0.2 mAdc) (V_{DS} = 15 Vdc, I_D = 0.4 mAdc)	 2N5460 2N5461 2N5462	V_{GS}	 0.5 0.8 1.5	 — — —	 4.0 4.5 6.0	Vdc

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
Zero–Gate–Voltage Drain Current (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	2N5460 2N5461 2N5462	I_{DSS}	–1.0 –2.0 –4.0	— — —	–5.0 –9.0 –16	mAdc
SMALL–SIGNAL CHARACTERISTICS						
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	2N5460 2N5461 2N5462	$\lvert y_{fs} \rvert$	1000 1500 2000	— — —	4000 5000 6000	μmhos
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)		$\lvert y_{os} \rvert$	—	—	75	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	—	5.0	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{rss}	—	1.0	2.0	pF
FUNCTIONAL CHARACTERISTICS						
Equivalent Short–Circuit Input Noise Voltage (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 Hz, BW = 1.0 Hz)		e_n	—	60	115	$nV/\sqrt{Hz}$

DRAIN CURRENT versus GATE SOURCE VOLTAGE

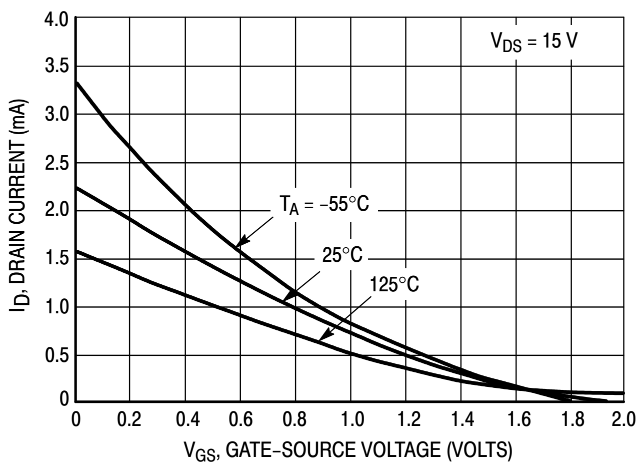


Figure 1. $V_{GS(off)}$ = 2.0 Volts

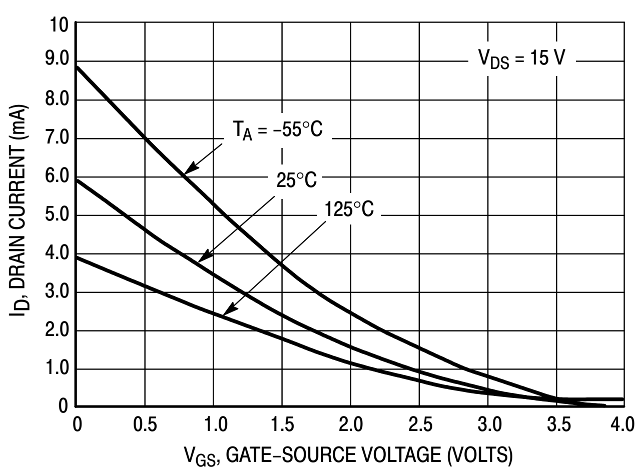


Figure 2. $V_{GS(off)}$ = 4.0 Volts

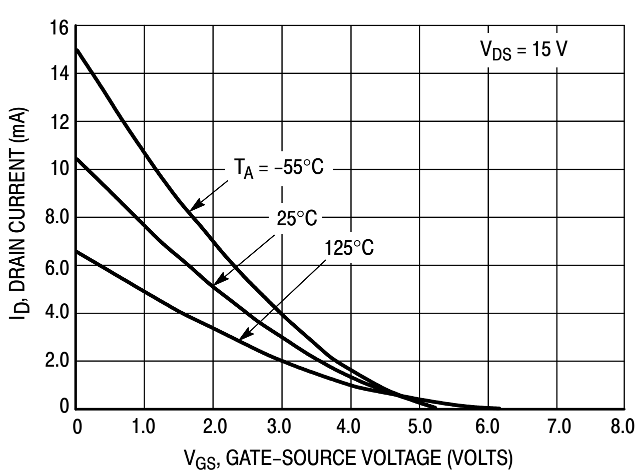


Figure 3. $V_{GS(off)}$ = 5.0 Volts

FORWARD TRANSFER ADMITTANCE versus DRAIN CURRENT

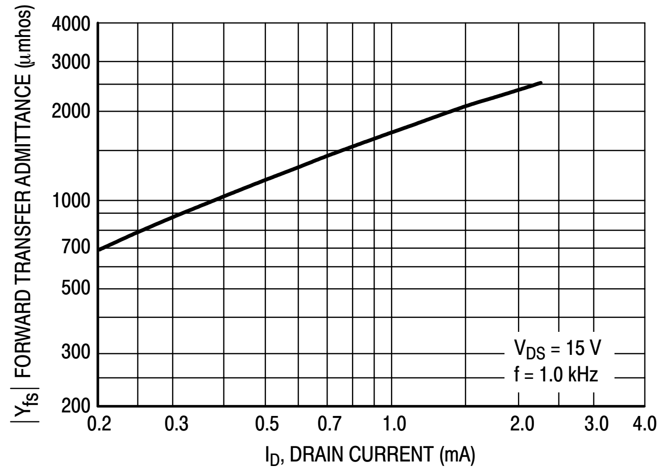


Figure 4. $V_{GS(off)}$ = 2.0 Volts

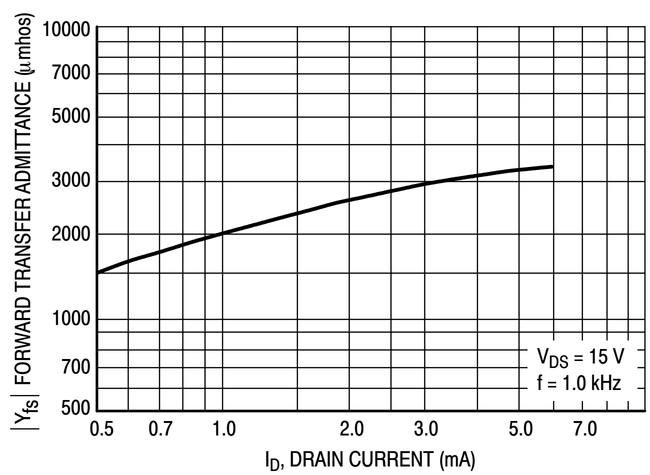


Figure 5. $V_{GS(off)}$ = 4.0 Volts

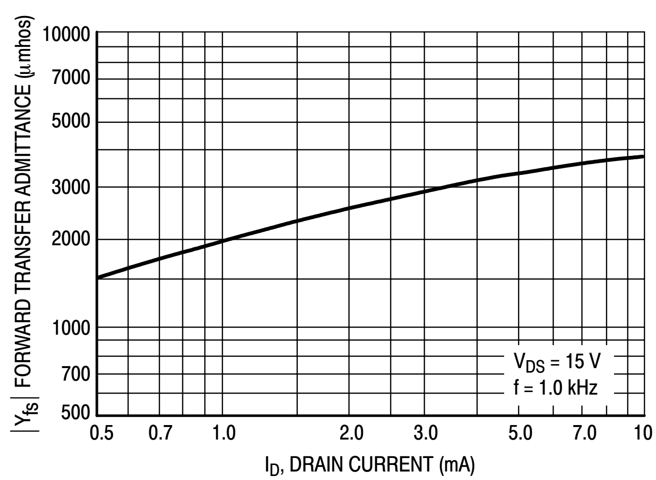


Figure 6. $V_{GS(off)}$ = 5.0 Volts

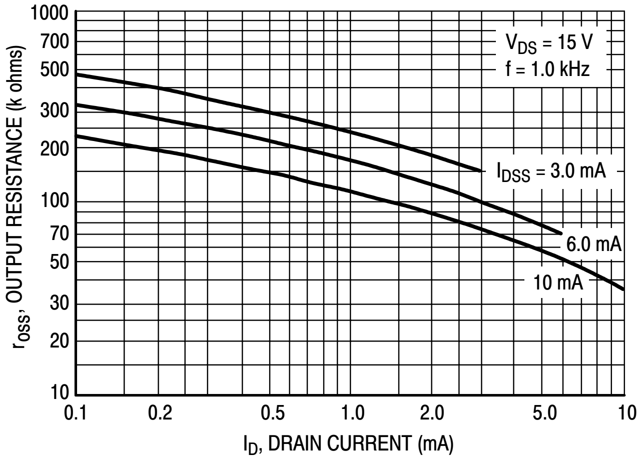


Figure 7. Output Resistance versus Drain Current

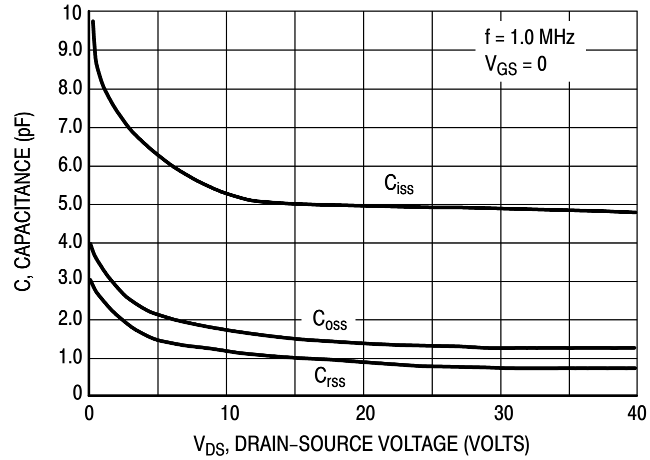


Figure 8. Capacitance versus Drain–Source Voltage

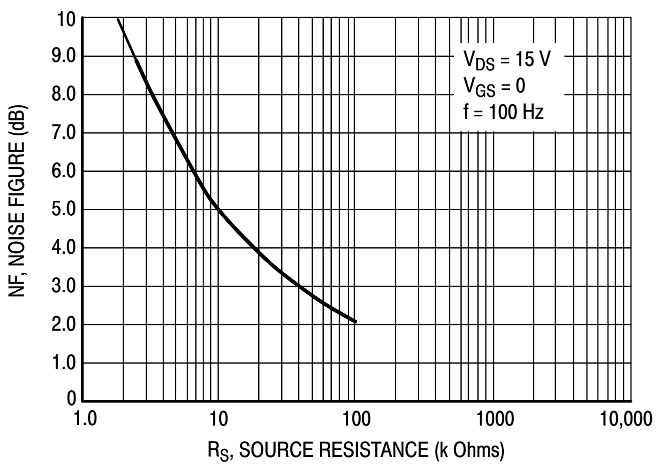
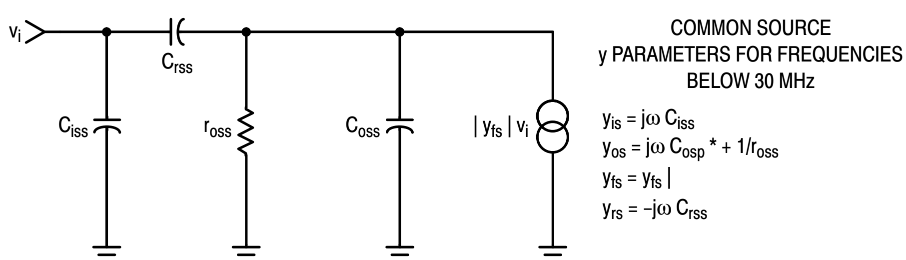


Figure 9. Noise Figure versus Source Resistance



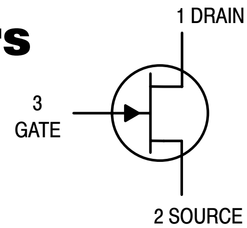
*C_{osp} is C_{oss} in parallel with Series Combination of C_{iss} and C_{rss}.

NOTE:

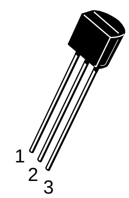
1. Graphical data is presented for dc conditions. Tabular data is given for pulsed conditions (Pulse Width = 630 ms, Duty Cycle = 10%).

Figure 10. Equivalent Low Frequency Circuit

JFET VHF/UHF Amplifiers
N–Channel — Depletion



2N5486



CASE 29–11, STYLE 5
TO–92 (TO–226AA)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Gate Voltage	V_{DG}	25	Vdc
Reverse Gate–Source Voltage	V_{GSR}	25	Vdc
Drain Current	I_D	30	mAdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Gate–Source Breakdown Voltage (I_G = –1.0 µAdc, V_{DS} = 0)	$V_{(BR)GSS}$	–25	—	—	Vdc
Gate Reverse Current (V_{GS} = –20 Vdc, V_{DS} = 0) (V_{GS} = –20 Vdc, V_{DS} = 0, T_A = 100°C)	I_{GSS}	— —	— —	–1.0 –0.2	nAdc µAdc
Gate Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 10 nAdc)	$V_{GS(off)}$	–2.0	—	–6.0	Vdc
ON CHARACTERISTICS					
Zero–Gate–Voltage Drain Current (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	8.0	—	20	mAdc
SMALL–SIGNAL CHARACTERISTICS					
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|y_{fs}\|$	4000	—	8000	µmhos
Input Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 400 MHz)	$Re(y_{is})$	—	—	1000	µmhos
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|y_{os}\|$	—	—	75	µmhos
Output Conductance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 400 MHz)	$Re(y_{os})$	—	—	100	µmhos
Forward Transconductance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 400 MHz)	$Re(y_{fs})$	3500	—	—	µmhos

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
SMALL–SIGNAL CHARACTERISTICS (continued)					
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	—	5.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	—	1.0	pF
Output Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	—	2.0	pF

COMMON SOURCE CHARACTERISTICS
ADMITTANCE PARAMETERS
(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C)

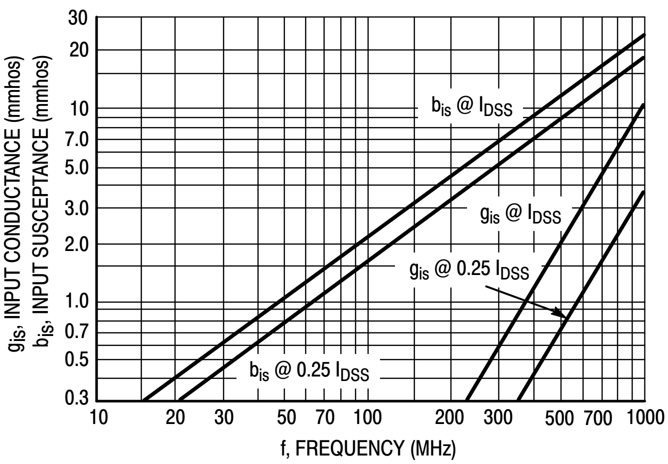


Figure 1. Input Admittance (y_{is})

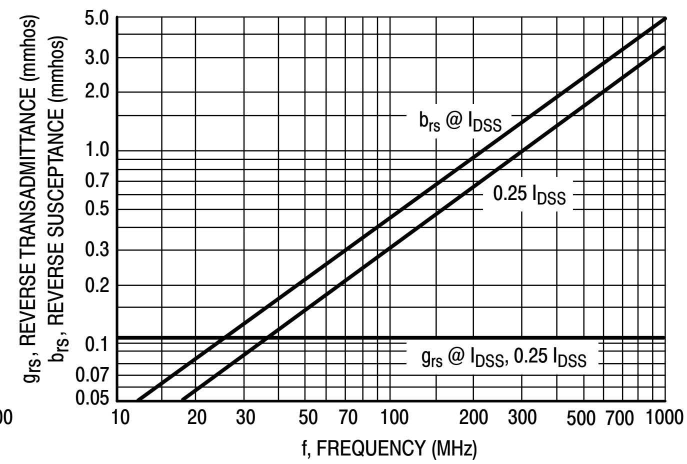


Figure 2. Reverse Transfer Admittance (y_{rs})

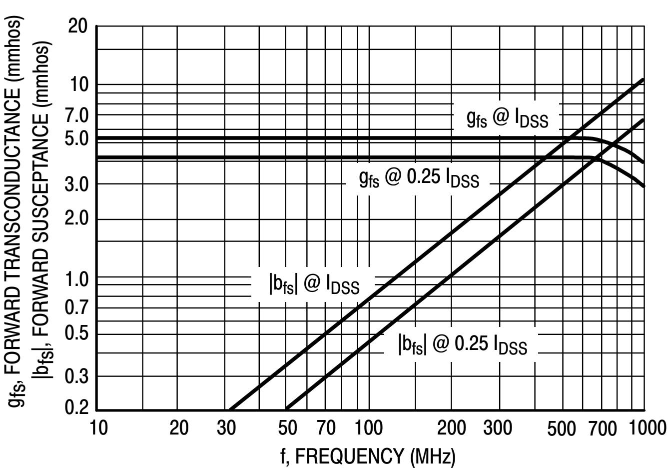


Figure 3. Forward Transadmittance (y_{fs})

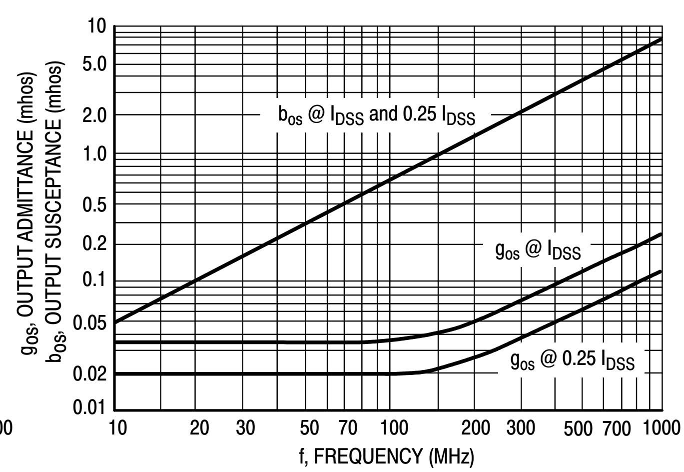


Figure 4. Output Admittance (y_{os})

COMMON SOURCE CHARACTERISTICS

S–PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

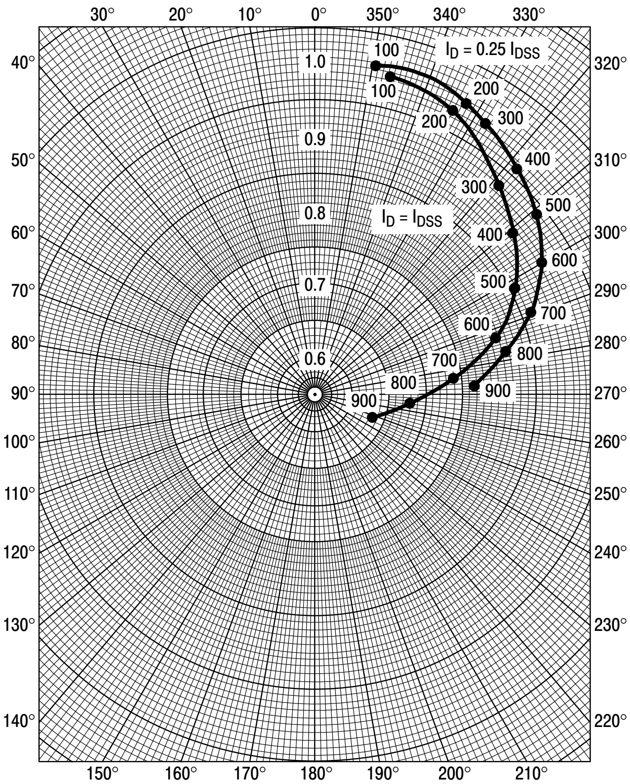


Figure 5. S_{11s}

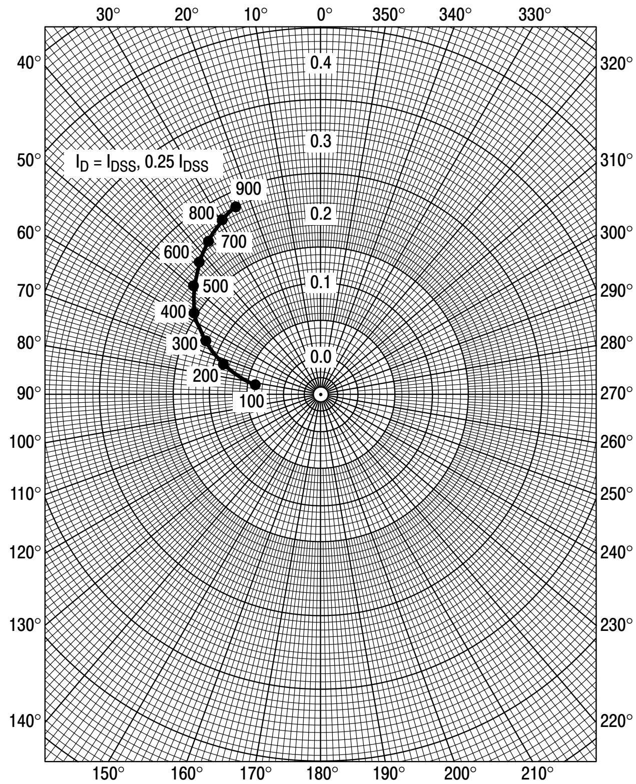


Figure 6. S_{12s}

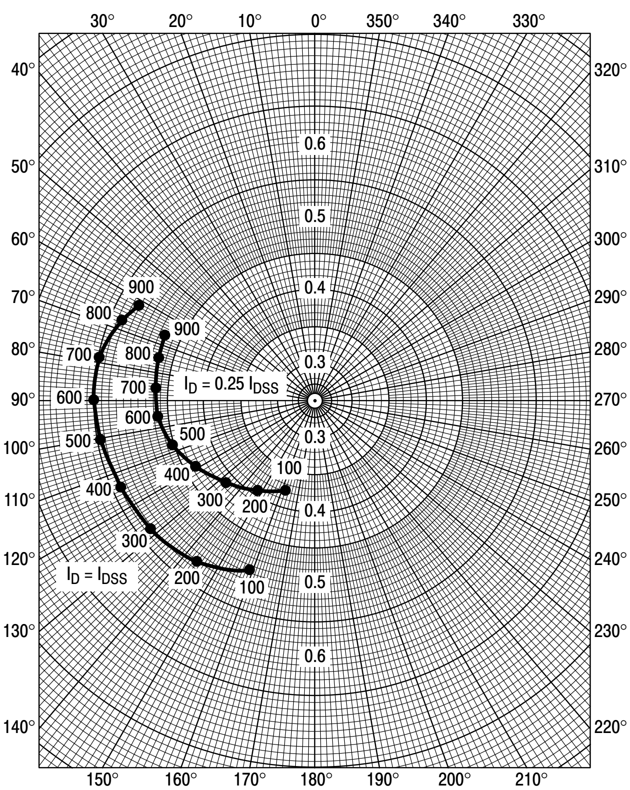


Figure 7. S_{21s}

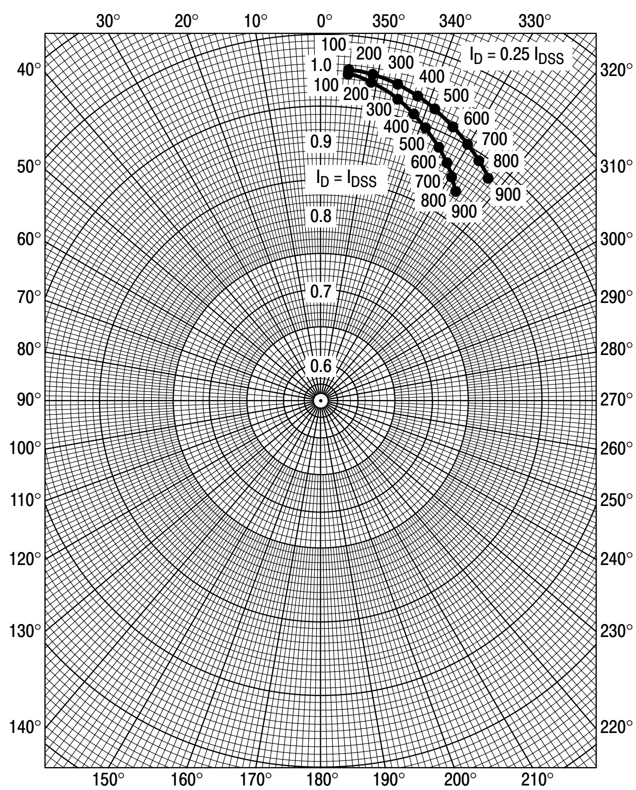


Figure 8. S_{22s}

COMMON GATE CHARACTERISTICS

ADMITTANCE PARAMETERS

(V_{DG} = 15 Vdc, $T_{channel}$ = 25°C)

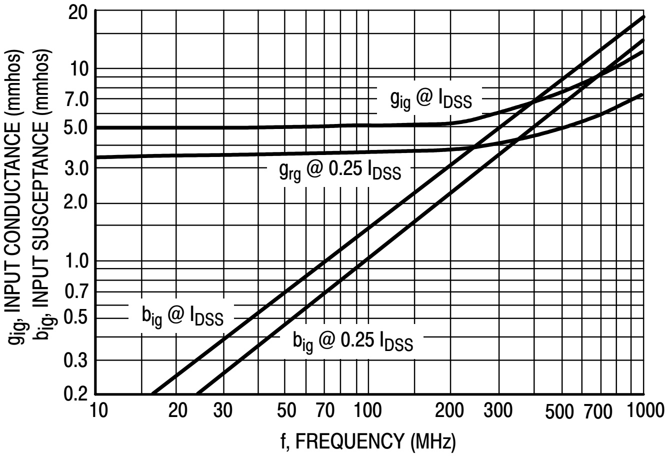


Figure 9. Input Admittance (y_{ig})

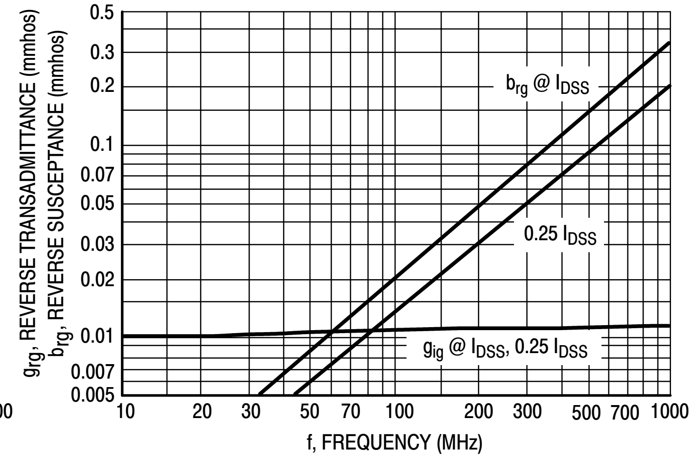


Figure 10. Reverse Transfer Admittance (y_{rg})

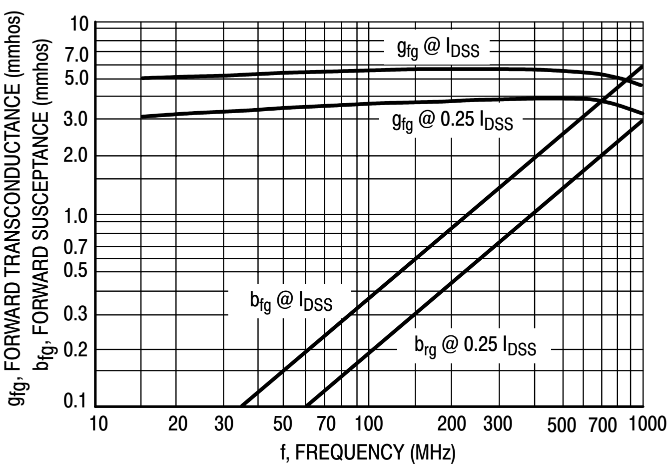


Figure 11. Forward Transfer Admittance (y_{fg})

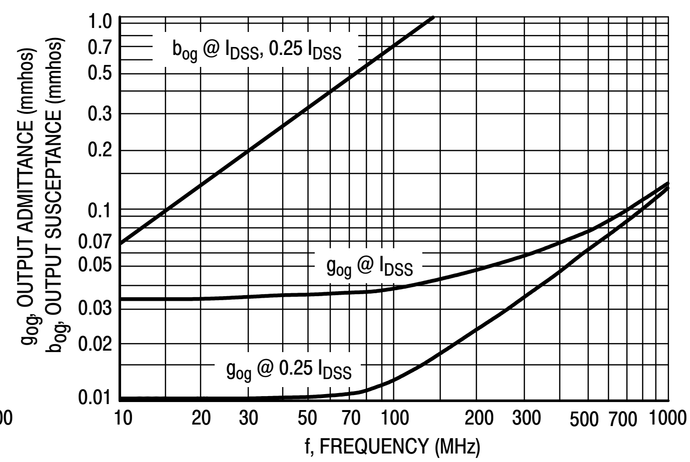


Figure 12. Output Admittance (y_{og})

COMMON GATE CHARACTERISTICS

S–PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

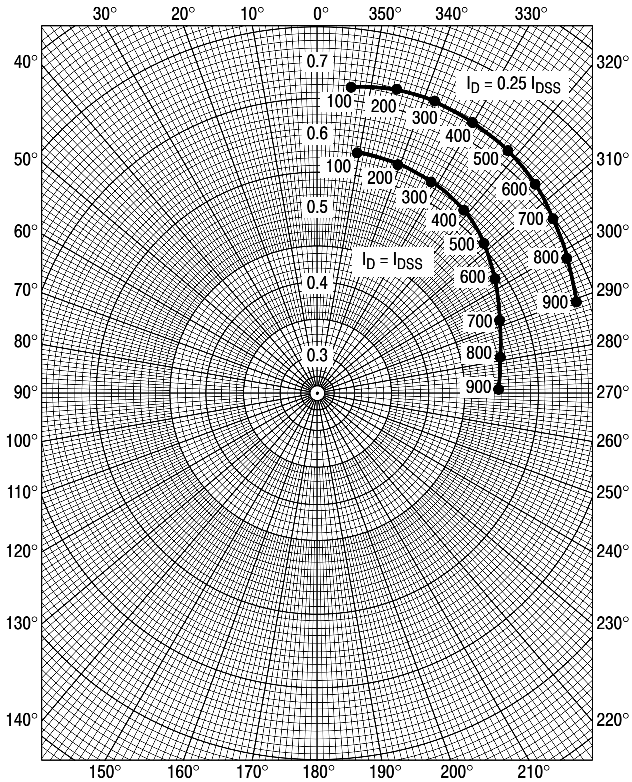


Figure 13. S_{11g}

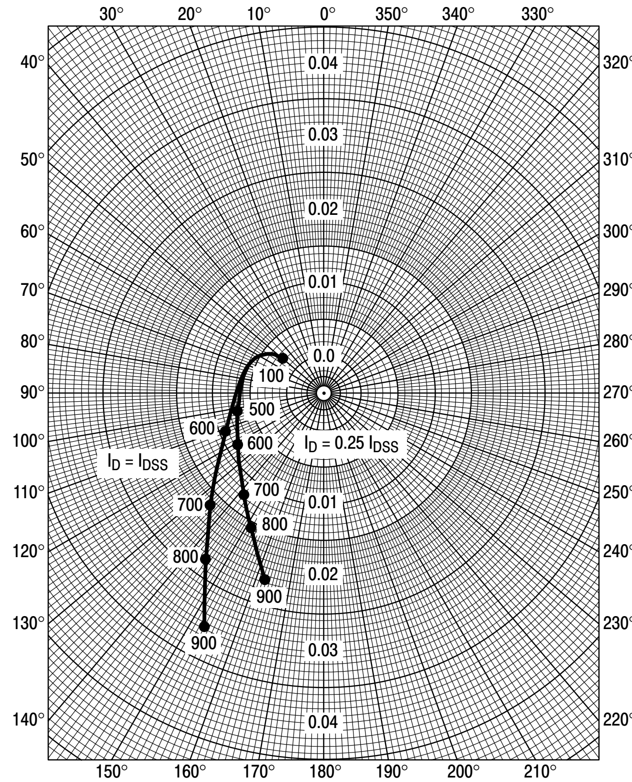


Figure 14. S_{12g}

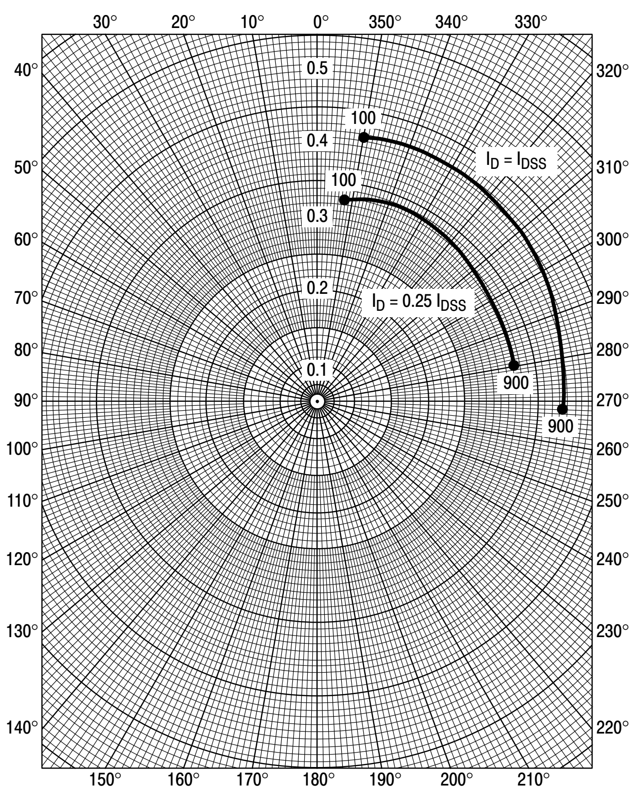


Figure 15. S_{21g}

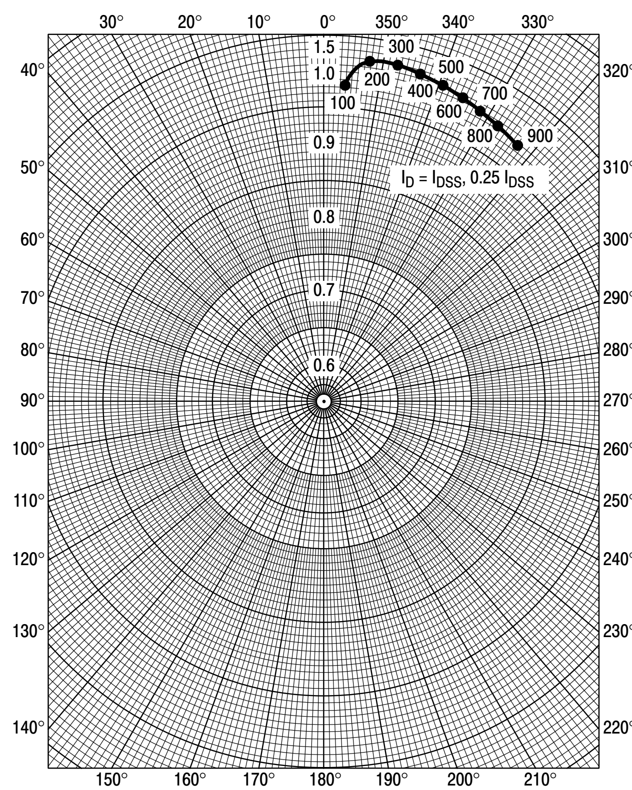
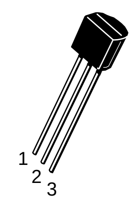


Figure 16. S_{22g}

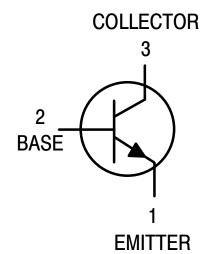
Amplifier Transistors
NPN Silicon

2N5550
2N5551*

***ON Semiconductor Preferred Device**



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	2N5550	2N5551	Unit
Collector–Emitter Voltage	V_{CEO}	140	160	Vdc
Collector–Base Voltage	V_{CBO}	160	180	Vdc
Emitter–Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage[(1)] (I_C = 1.0 mAdc, I_B = 0)	 2N5550 2N5551	$V_{(BR)CEO}$	 140 160	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 µAdc, I_E = 0)	 2N5550 2N5551	$V_{(BR)CBO}$	 160 180	 — —	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CB} = 100 Vdc, I_E = 0) (V_{CB} = 120 Vdc, I_E = 0) (V_{CB} = 100 Vdc, I_E = 0, T_A = 100°C) (V_{CB} = 120 Vdc, I_E = 0, T_A = 100°C)	 2N5550 2N5551 2N5550 2N5551	I_{CBO}	 — — — —	 100 50 100 50	 nAdc µAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	50	nAdc

1. Pulse Test: Pulse Width = 300 µs, Duty Cycle = 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain		h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N5550		60	—	
	2N5551		80	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N5550		60	250	
	2N5551		80	250	
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	2N5550		20	—	
	2N5551		30	—	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	Both Types		—	0.15	
(I_C = 50 mAdc, I_B = 5.0 mAdc)	2N5550		—	0.25	
	2N5551		—	0.20	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	Both Types		—	1.0	
(I_C = 50 mAdc, I_B = 5.0 mAdc)	2N5550		—	1.2	
	2N5551		—	1.0	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	100	300	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	6.0	pF
Input Capacitance		C_{ibo}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	2N5550		—	30	
	2N5551		—	20	
Small–Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{fe}	50	200	—
Noise Figure		NF			dB
(I_C = 250 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ,	2N5550		—	10	
f = 1.0 kHz)	2N5551		—	8.0	

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

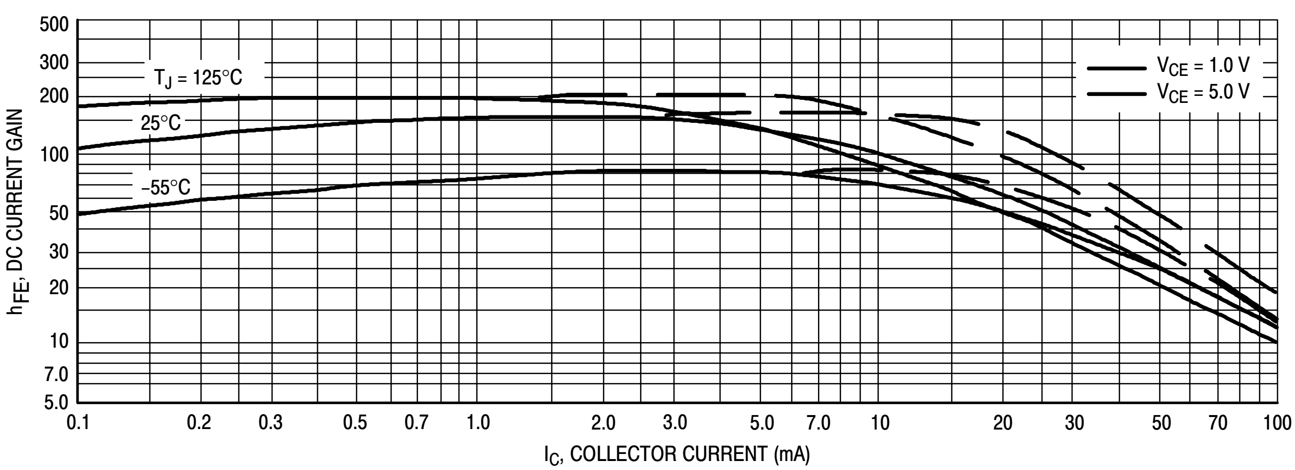


Figure 1. DC Current Gain

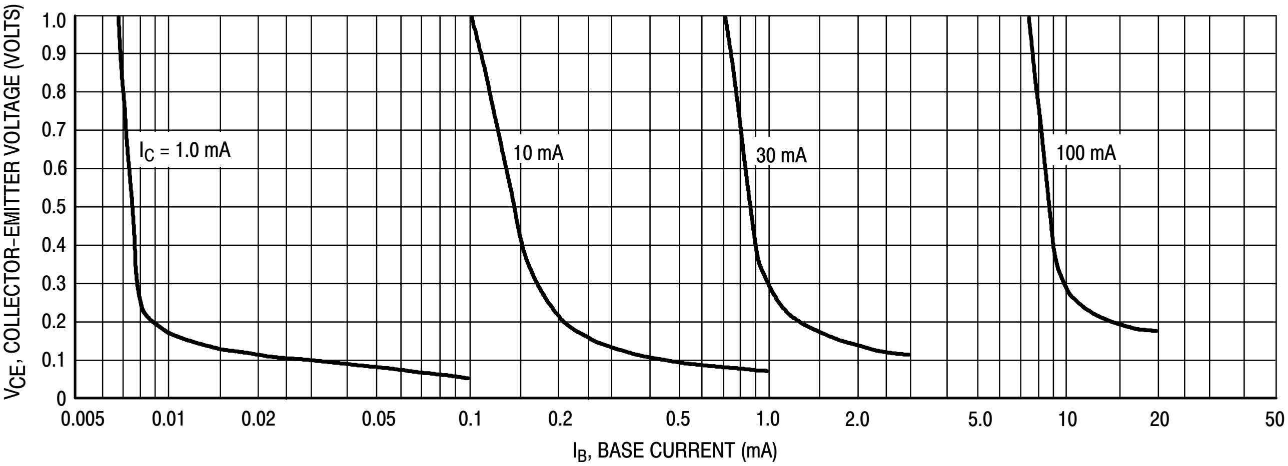


Figure 2. Collector Saturation Region

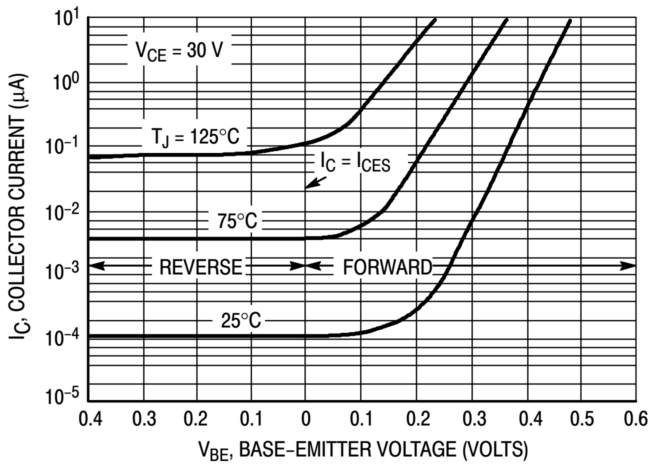


Figure 3. Collector Cut–Off Region

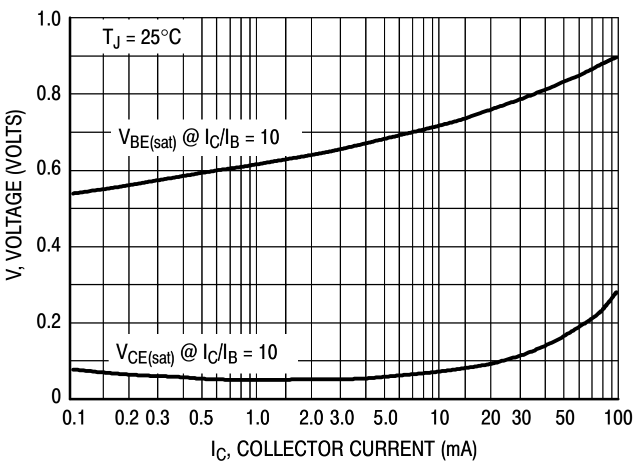


Figure 4. "On" Voltages

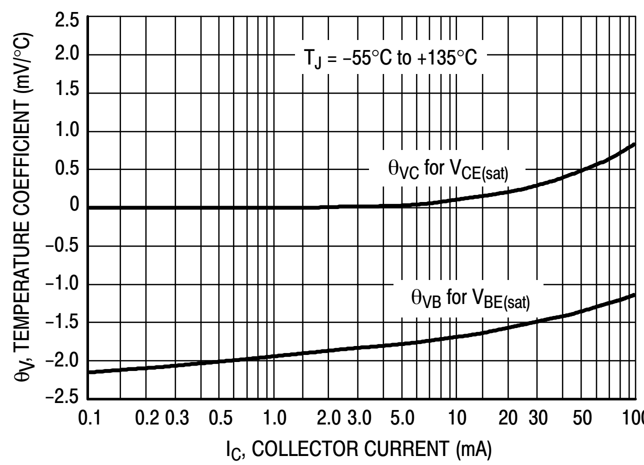
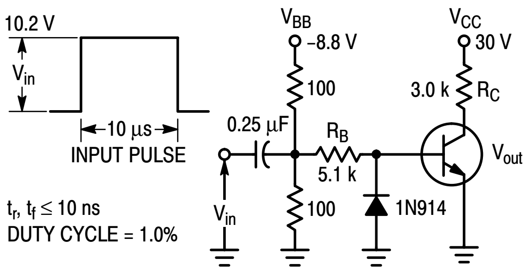


Figure 5. Temperature Coefficients



Values Shown are for I_C @ 10 mA

Figure 6. Switching Time Test Circuit

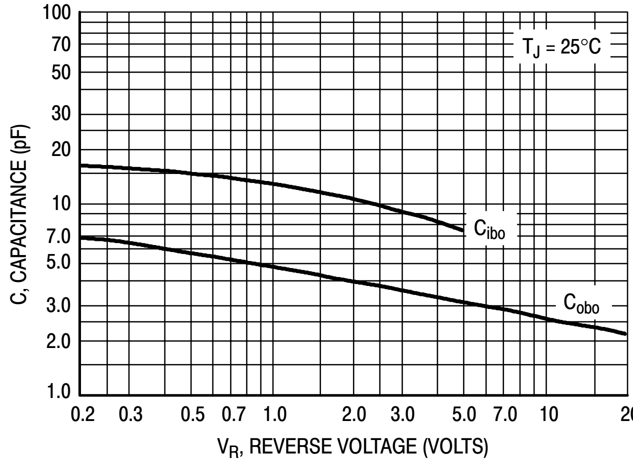


Figure 7. Capacitances

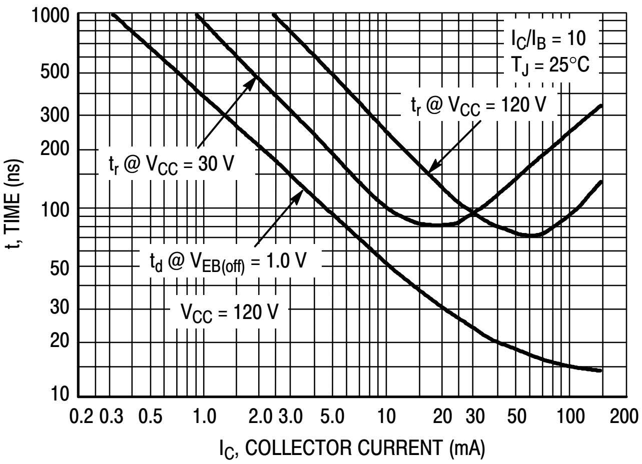


Figure 8. Turn–On Time

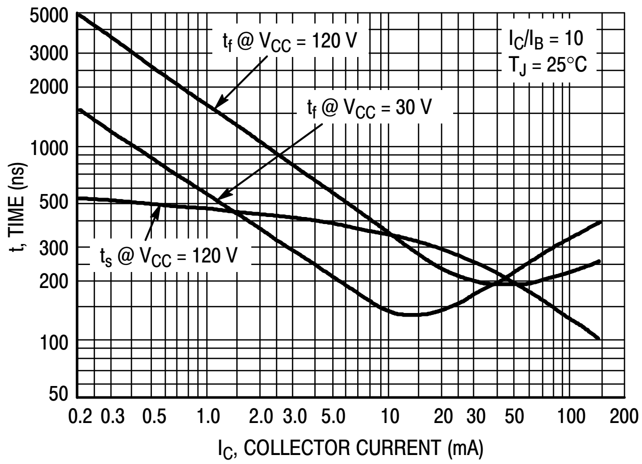
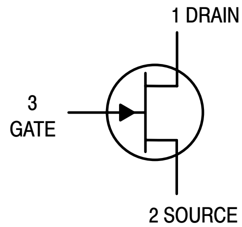
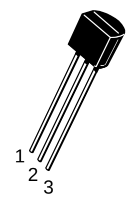


Figure 9. Turn–Off Time

JFET Switching
N–Channel — Depletion



2N5555



CASE 29–11, STYLE 5
TO–92 (TO–226AA)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	25	Vdc
Drain–Gate Voltage	V_{DG}	25	Vdc
Gate–Source Voltage	V_{GS}	25	Vdc
Forward Gate Current	I_{GF}	10	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Junction Temperature Range	T_J	–65 to +150	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate–Source Breakdown Voltage (I_G = 10 µAdc, V_{DS} = 0)	$V_{(BR)GSS}$	25	—	Vdc
Gate Reverse Current (V_{GS} = 15 Vdc, V_{DS} = 0)	I_{GSS}	—	1.0	nAdc
Drain Cutoff Current (V_{DS} = 12 Vdc, V_{GS} = –10 V) (V_{DS} = 12 Vdc, V_{GS} = –10 V, T_A = 100°C)	$I_{D(off)}$	— —	10 2.0	nAdc µAdc
ON CHARACTERISTICS				
Zero–Gate–Voltage Drain Current(1) (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	15	—	mAdc
Gate–Source Forward Voltage ($I_{G(f)}$ = 1.0 mAdc, V_{DS} = 0)	$V_{GS(f)}$	—	1.0	Vdc
Drain–Source On–Voltage (I_D = 7.0 mAdc, V_{GS} = 0)	$V_{DS(on)}$	—	1.5	Vdc
Static Drain–Source On Resistance (I_D = 0.1 mAdc, V_{GS} = 0)	$r_{DS(on)}$	—	150	Ohms

1. Pulse Test: Pulse Width < 300 µs, Duty Cycle < 3.0%.

SMALL–SIGNAL CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Small–Signal Drain–Source “ON” Resistance (V_{GS} = 0, I_D = 0, f = 1.0 kHz)	$r_{ds(on)}$	—	150	Ohms
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	5.0	pF
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = 10 Vdc, f = 1.0 MHz)	C_{rss}	—	1.2	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Turn–On Delay Time	(V_{DD} = 10 Vdc, $I_{D(on)}$ = 7.0 mAdc, $V_{GS(on)}$ = 0, $V_{GS(off)}$ = –10 Vdc) (See Figure 1)	$t_{d(on)}$	—	5.0	ns
Rise Time		t_r	—	5.0	ns
Turn–Off Delay Time	(V_{DD} = 10 Vdc, $I_{D(on)}$ = 7.0 mAdc, $V_{GS(on)}$ = 0, $V_{GS(off)}$ = –10 Vdc) (See Figure 1)	$t_{d(off)}$	—	15	ns
Fall Time		t_f	—	10	ns

May, 2001 – Rev. 2
Publication Order Number:
2N5555/D

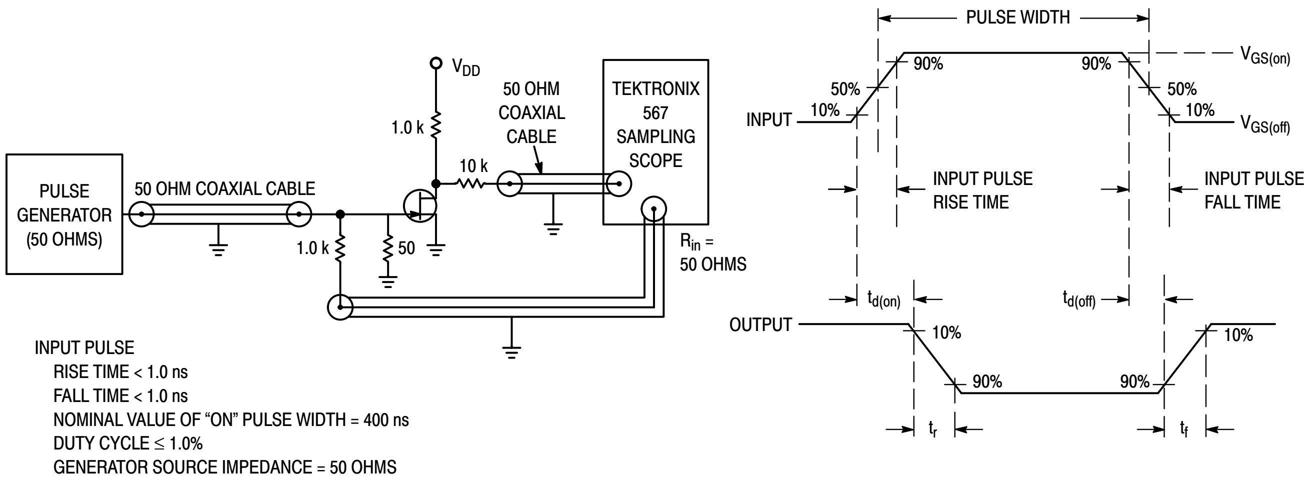


Figure 1. Switching Times Test Circuit

COMMON SOURCE CHARACTERISTICS

ADMITTANCE PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C)

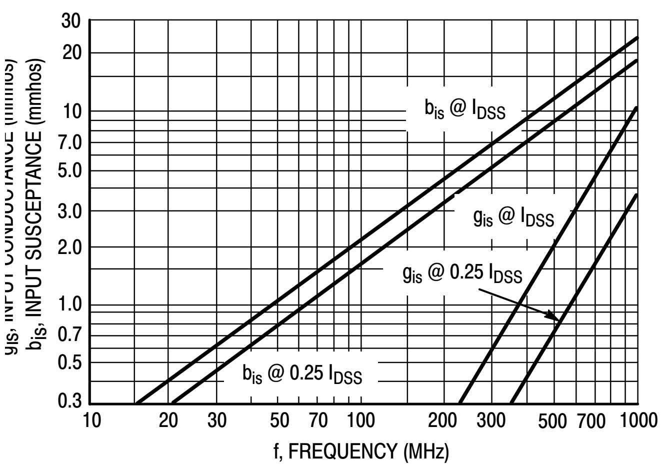


Figure 2. Input Admittance (y_{is})

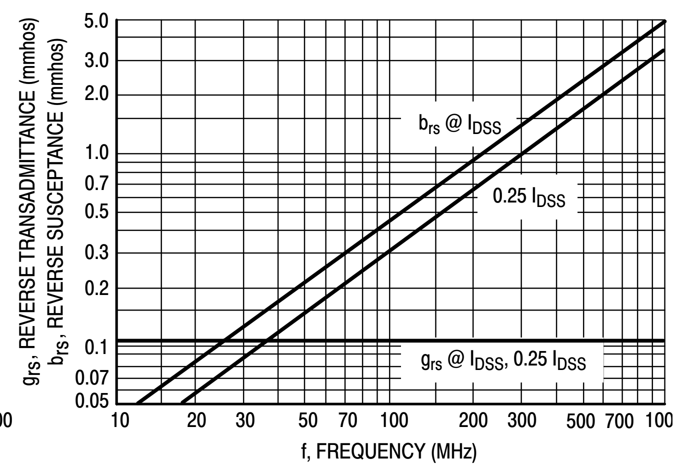


Figure 3. Reverse Transfer Admittance (y_{rs})

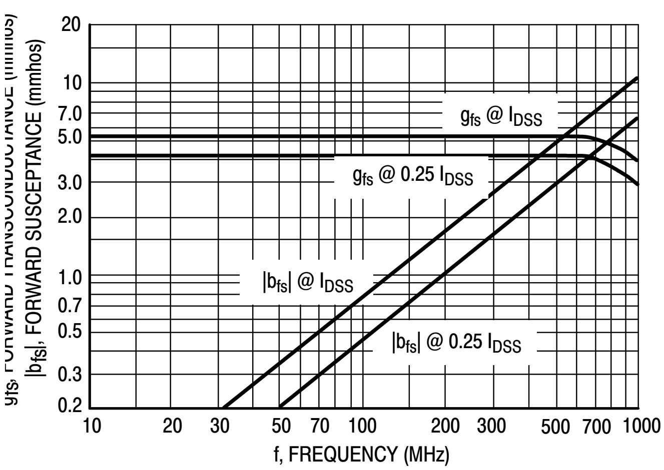


Figure 4. Forward Transadmittance (y_{fs})

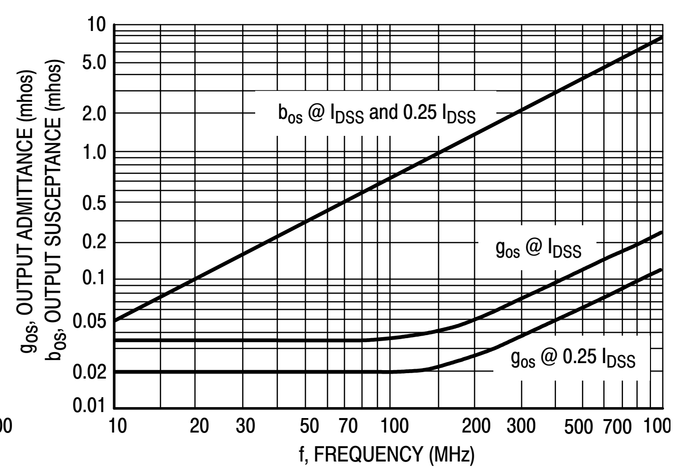


Figure 5. Output Admittance (y_{os})

COMMON SOURCE CHARACTERISTICS

S–PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

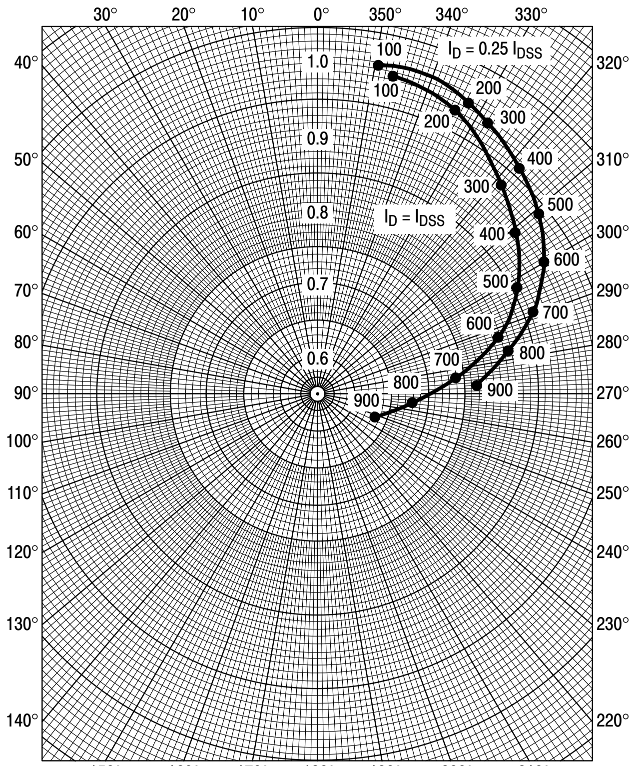


Figure 6. S_{11s}

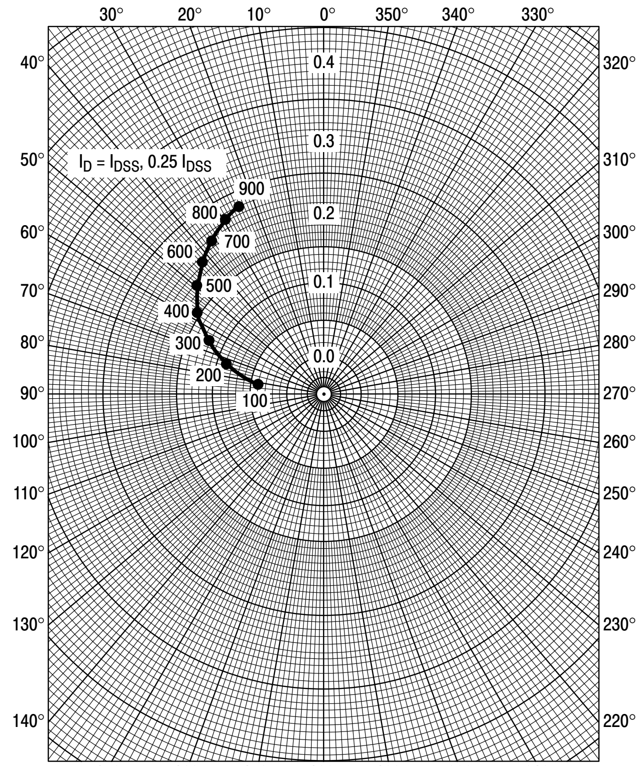


Figure 7. S_{12s}

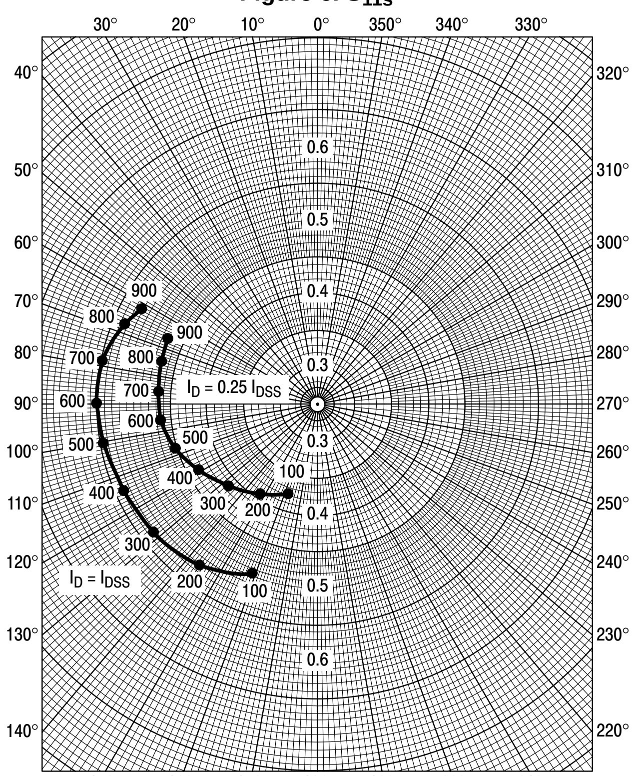


Figure 8. S_{21s}

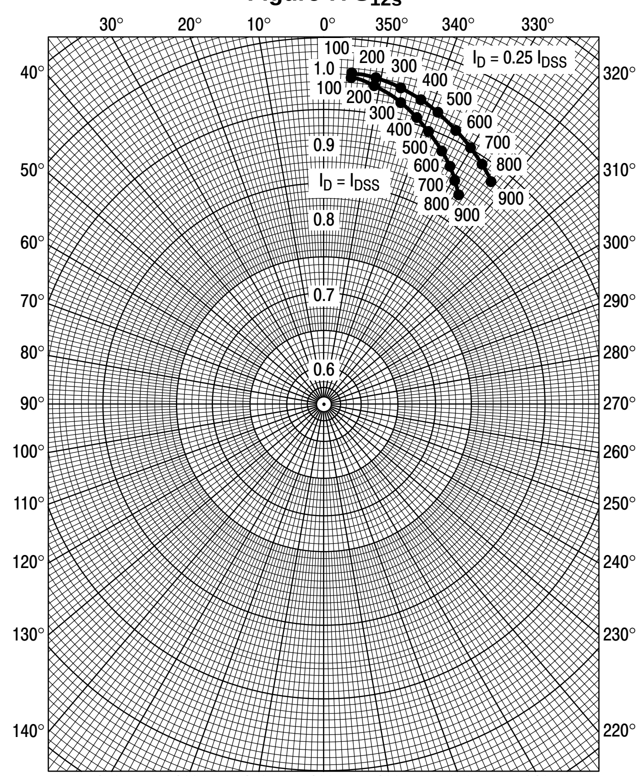


Figure 9. S_{22s}

COMMON GATE CHARACTERISTICS
ADMITTANCE PARAMETERS

(V_{DG} = 15 Vdc, $T_{channel}$ = 25°C)

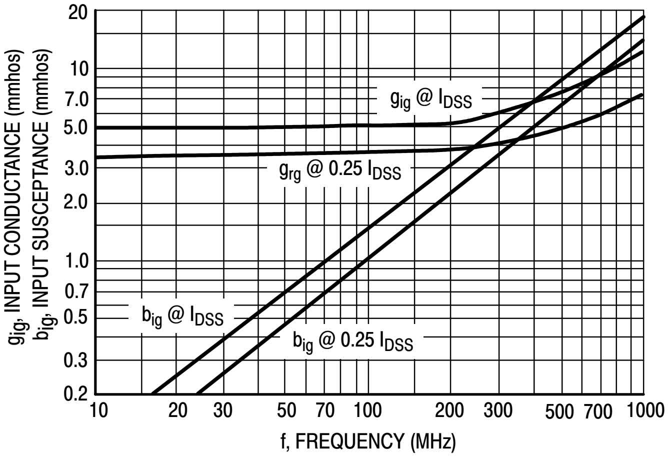


Figure 10. Input Admittance (y_{ig})

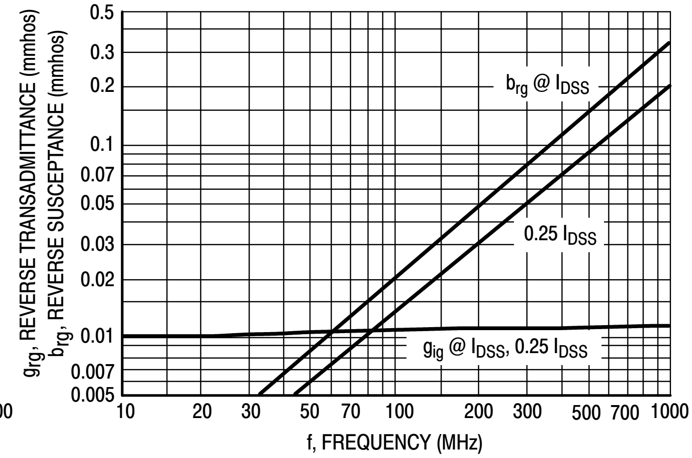


Figure 11. Reverse Transfer Admittance (y_{rg})

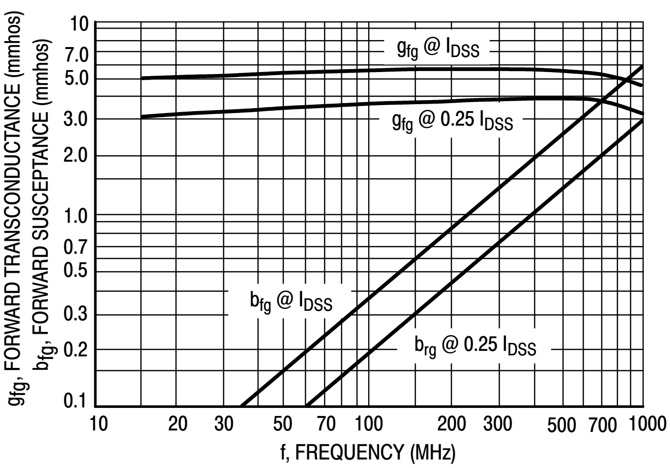


Figure 12. Forward Transfer Admittance (y_{fg})

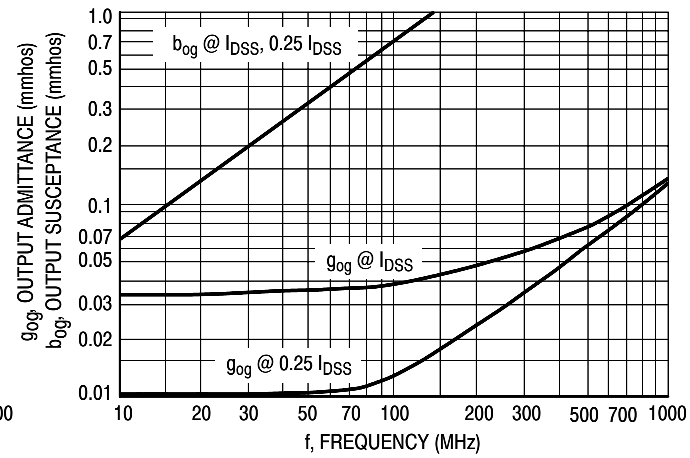


Figure 13. Output Admittance (y_{og})

COMMON GATE CHARACTERISTICS

S–PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

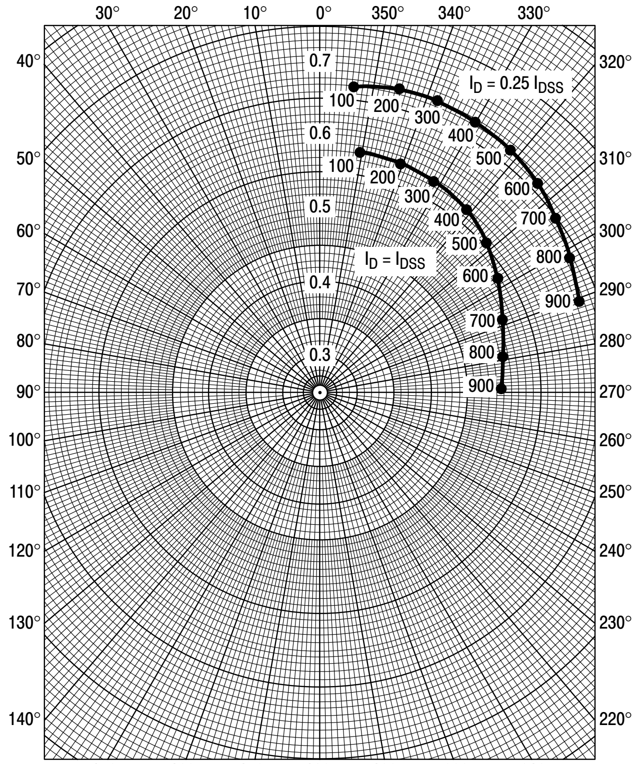


Figure 14. S_{11g}

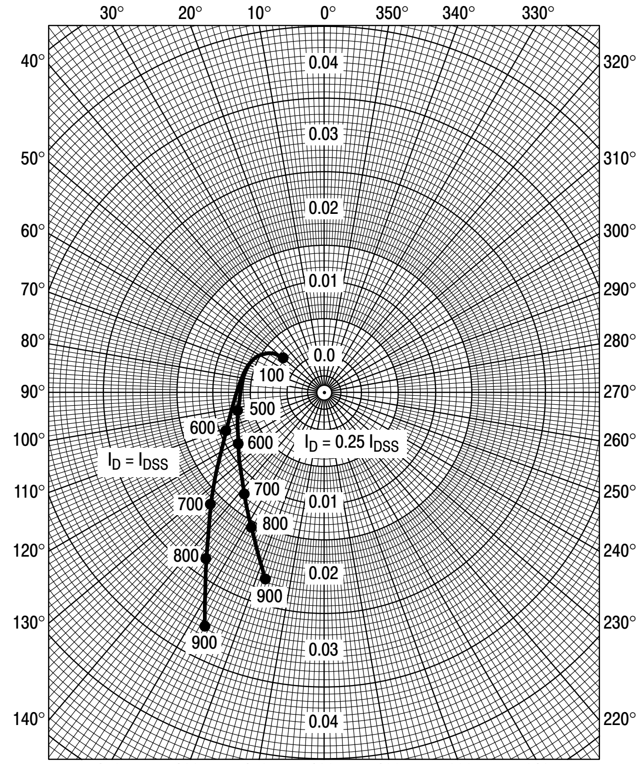


Figure 15. S_{12g}

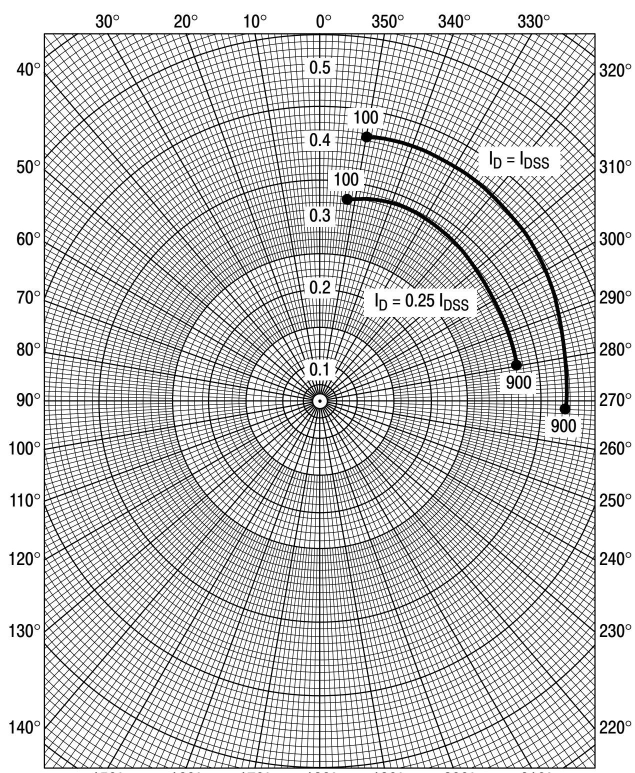


Figure 16. S_{21g}

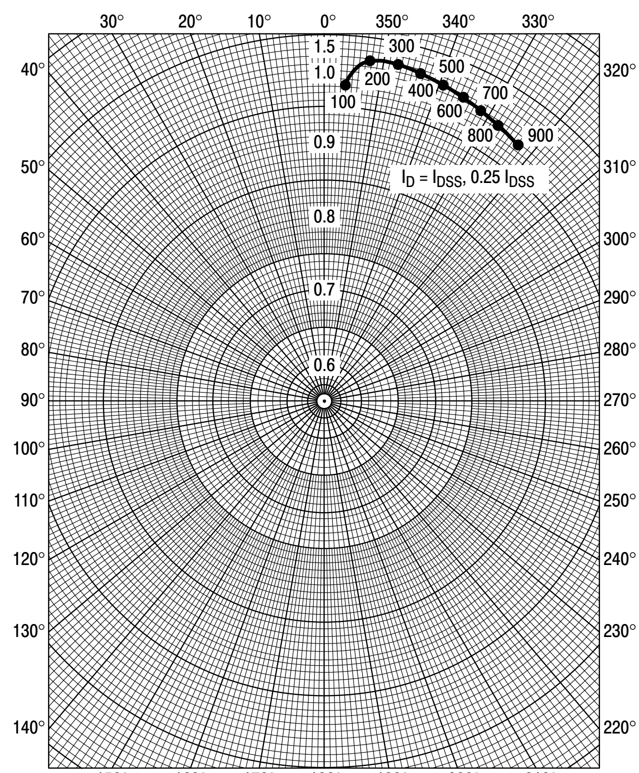


Figure 17. S_{22g}

2N5638, 2N5639

2N5638 is a Preferred Device

JFET Chopper Transistors

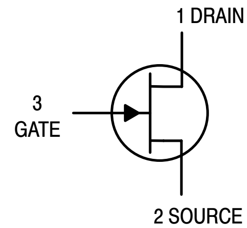
N–Channel – Depletion

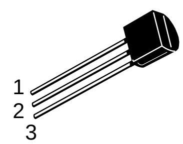
N–Channel Junction Field Effect Transistors, depletion mode (Type A) designed for chopper and high–speed switching applications.

- Low Drain–Source "ON" Resistance:
  RDS(on) = 30Ω for 2N5638
  RDS(on) = 60Ω for 2N5639
- Low Reverse Transfer Capacitance
  C_{rss} = 4.0 pF (Max) @ f = 1.0 MHz
- Fast Switching Characteristics
  t_r = 5.0 ns (Max) (2N5638)

ON Semiconductor™

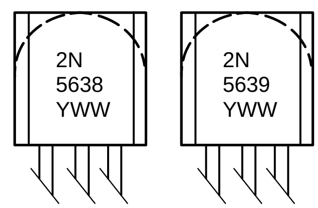
http://onsemi.com





TO–92
CASE 29
STYLE 5

MARKING DIAGRAMS



Y = Year
WW = Work Week

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	30	Vdc
Drain–Gate Voltage	V_{DG}	30	Vdc
Reverse Gate–Source Voltage	V_{GSR}	30	Vdc
Forward Gate Current	I_{GF}	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 310 2.82	 mW mW/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Operating Junction Temp Range	T_J	–65 to +135	°C

ORDERING INFORMATION

Device	Package	Shipping
2N5638RLRA	TO–92	2000/Tape & Reel
2N5639	TO–92	5000/Box
2N5369RLRA	TO–92	2000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

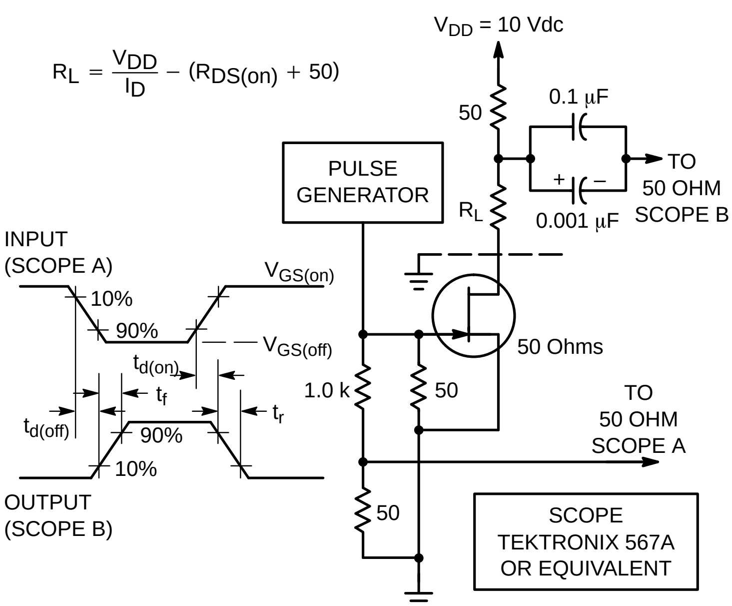


Figure 1. Switching Times Test Circuit

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate–Source Breakdown Voltage	(I_G = –1.0 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	35	–	Vdc
Gate Reverse Current	(V_{GS} = –15 Vdc, V_{DS} = 0) (V_{GS} = –15 Vdc, V_{DS} = 0, T_A = 100°C)	I_{GSS}	–	1.0 1.0	nAdc μAdc
Drain–Cutoff Current (V_{DS} = 15 Vdc, V_{GS} = –12 Vdc) (V_{DS} = 15 Vdc, V_{GS} = –12 Vdc, T_A = 100°C) (V_{DS} = 15 Vdc, V_{GS} = –8.0 Vdc) (V_{DS} = 15 Vdc, V_{GS} = –8.0 Vdc, T_A = 100°C)	 2N5638 2N5638 2N5639 2N5639	$I_{D(off)}$	–	 1.0 1.0 1.0 1.0	μAdc
ON CHARACTERISTICS					
Zero–Gate–Voltage Drain Current (Note 1.) (V_{DS} = 20 Vdc, V_{GS} = 0)	2N5638 2N5639	I_{DSS}	50 25	– –	mAdc
Drain–Source “ON” Voltage (I_D = 12 mAdc, V_{GS} = 0) (I_D = 6.0 mAdc, V_{GS} = 0)	 2N5638 2N5639	$V_{DS(on)}$	 – –	 0.5 0.5	Vdc
Static Drain–Source “ON” Resistance (I_D = 1.0 mAdc, V_{GS} = 0)	 2N5638 2N5639	$R_{DS(on)}$	 – –	 30 60	Ω
SMALL–SIGNAL CHARACTERISTICS					
Static Drain–Source “ON” Resistance (V_{GS} = 0, I_D = 0, f = 1.0 kHz)	 2N5638 2N5639	$R_{DS(on)}$	 – –	 30 60	Ω
Input Capacitance	(V_{DS} = 0, V_{GS} = –12 Vdc, f = 1.0 MHz)	C_{iss}	–	10	pF
Reverse Transfer Capacitance	(V_{DS} = 0, V_{GS} = –12 Vdc, f = 1.0 MHz)	C_{rss}	–	4.0	pF
SWITCHING CHARACTERISTICS (V_{DD} = 10 Vdc, $V_{GS(on)}$ = 0, $V_{GS(off)}$ = –10 Vdc, $R_{G'}$ = 50 Ω. See Figure 1 on page 90)					
Turn–On Delay Time	$I_{D(on)}$ = 12 mAdc, 2N5638 $I_{D(on)}$ = 6.0 mAdc, 2N5639	$t_{d(on)}$	– –	4.0 6.0	ns
Rise Time	$I_{D(on)}$ = 12 mAdc, 2N5638 $I_{D(on)}$ = 6.0 mAdc, 2N5639	t_r	– –	5.0 8.0	ns
Turn–Off Delay Time	$I_{D(on)}$ = 12 mAdc, 2N5638 $I_{D(on)}$ = 6.0 mAdc, 2N5639	$t_{d(off)}$	– –	5.0 10	ns
Fall Time	$I_{D(on)}$ = 12 mAdc, 2N5638 $I_{D(on)}$ = 6.0 mAdc, 2N5639	t_f	– –	10 20	ns

1. Pulse Width ≤ 300 μs, Duty Cycle ≤ 3.0%.

Darlington Transistors

NPN Silicon

2N6426*
2N6427

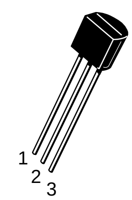
***ON Semiconductor Preferred Device**

MAXIMUM RATINGS

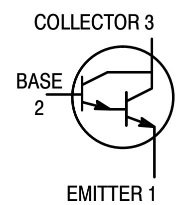
Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	40	Vdc
Emitter–Base Voltage	V_{EBO}	12	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



CASE 29–04, STYLE 1
TO–92 (TO–226AA)



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (1) (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	12	—	—	Vdc
Collector Cutoff Current (V_{CE} = 25 Vdc, I_B = 0)	I_{CES}	—	—	1.0	μAdc
Collector Cutoff Current (V_{CB}= 30 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current (V_{EB}= 10 Vdc, I_C = 0)	I_{EBO}	—	—	50	nAdc

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain(1)		h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N6426		20,000	—	200,000	
	2N6427		10,000	—	100,000	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	2N6426		30,000	—	300,000	
	2N6427		20,000	—	200,000	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	2N6426		20,000	—	200,000	
	2N6427		14,000	—	140,000	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 50 mAdc, I_B = 0.5 mAdc)			—	0.71	1.2	
(I_C = 500 mAdc, I_B = 0.5 mAdc			—	0.9	1.5	
Base–Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 0.5 mAdc)		$V_{BE(sat)}$	—	1.52	2.0	Vdc
Base–Emitter On Voltage (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	—	1.24	1.75	Vdc
SMALL–SIGNAL CHARACTERISTICS						
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	5.4	7.0	pF
Input Capacitance (V_{EB} = 1.0 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	10	15	pF
Input Impedance		h_{ie}				kΩ
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N6426		100	—	2000	
	2N6427		50	—	1000	
Small–Signal Current Gain		h_{fe}				—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N6426		20,000	—	—	
	2N6427		10,000	—	—	
Current–Gain — High Frequency		$\|h_{fe}\|$				—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	2N6426		1.5	2.4	—	
	2N6427		1.3	2.4	—	
Output Admittance (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		h_{oe}	—	—	1000	μmhos
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_S = 100 kΩ, f = 1.0 kHz)		NF	—	3.0	10	dB

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

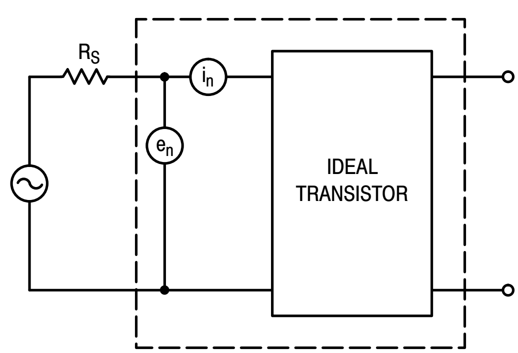


Figure 1. Transistor Noise Model

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

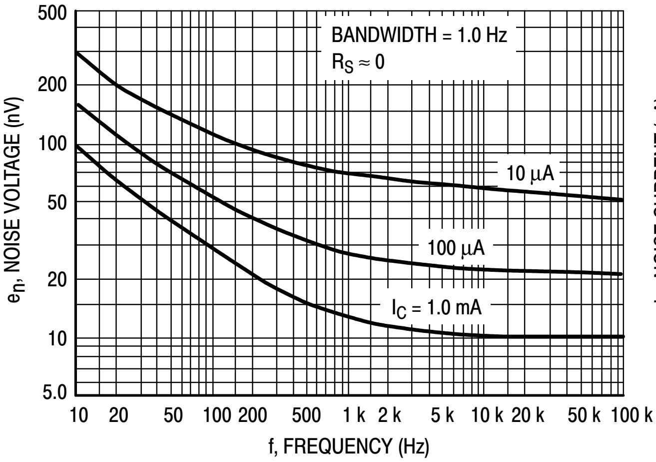


Figure 2. Noise Voltage

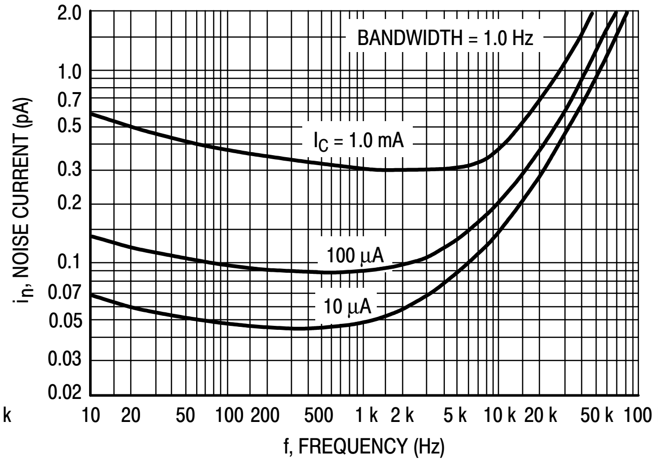


Figure 3. Noise Current

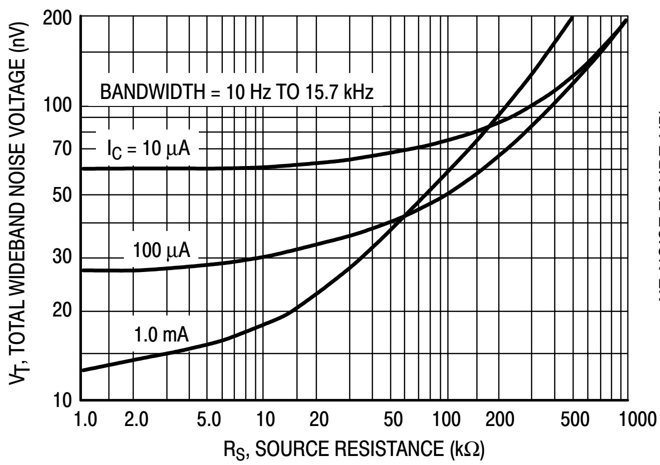


Figure 4. Total Wideband Noise Voltage

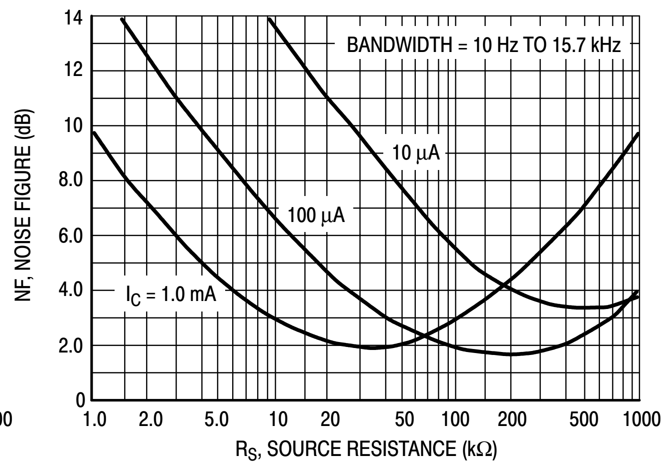


Figure 5. Wideband Noise Figure

SMALL–SIGNALCHARACTERISTICS

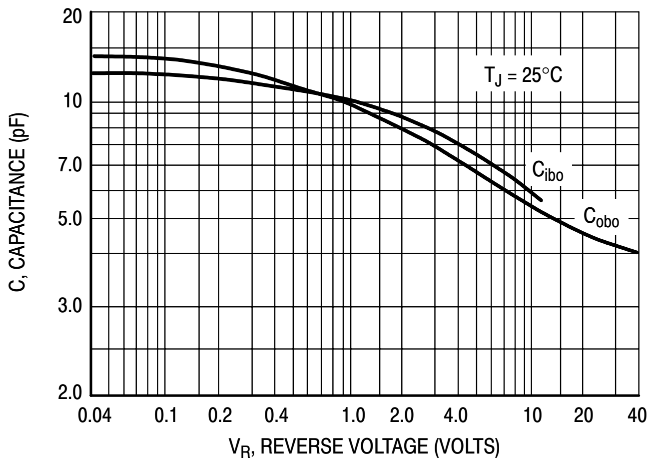


Figure 6. Capacitance

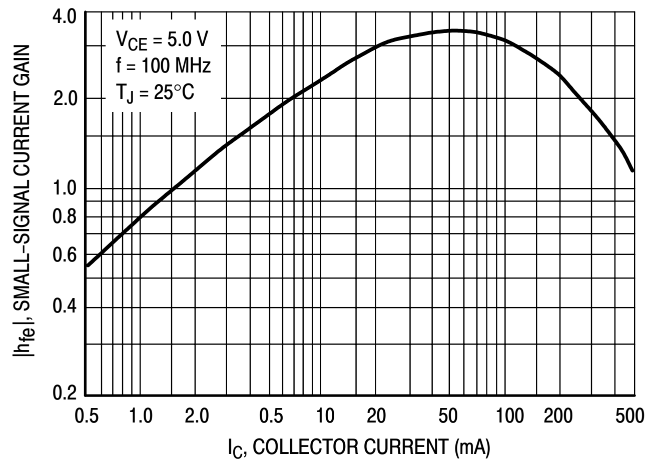


Figure 7. High Frequency Current Gain

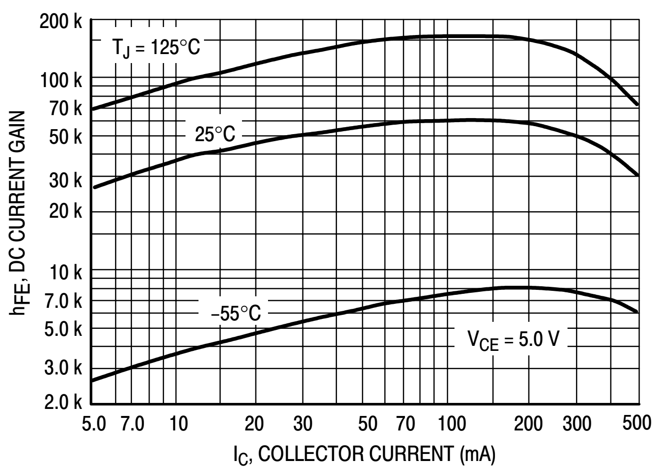


Figure 8. DC Current Gain

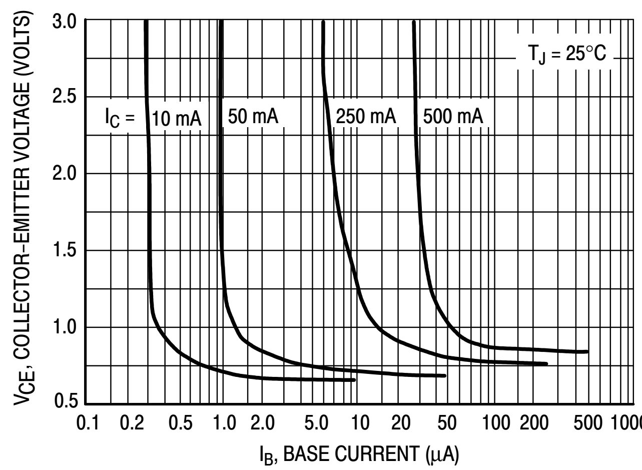


Figure 9. Collector Saturation Region

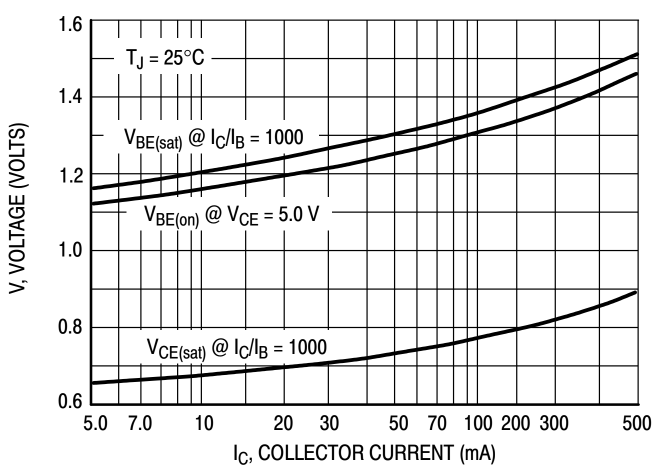


Figure 10. “On” Voltages

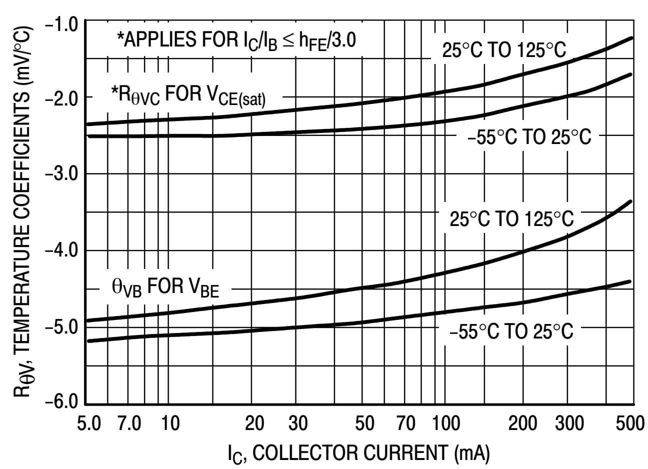


Figure 11. Temperature Coefficients

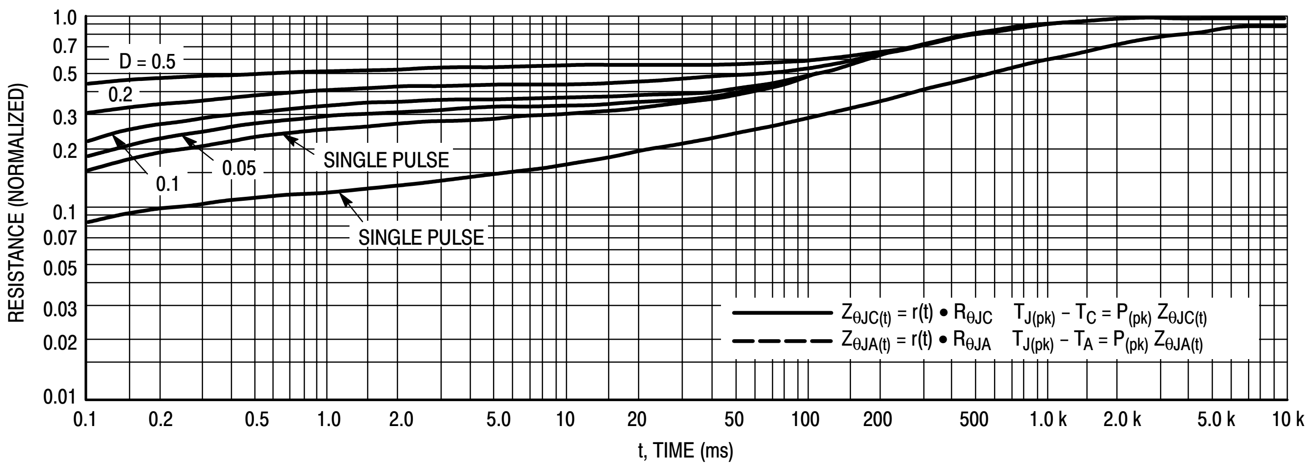


Figure 12. Thermal Response

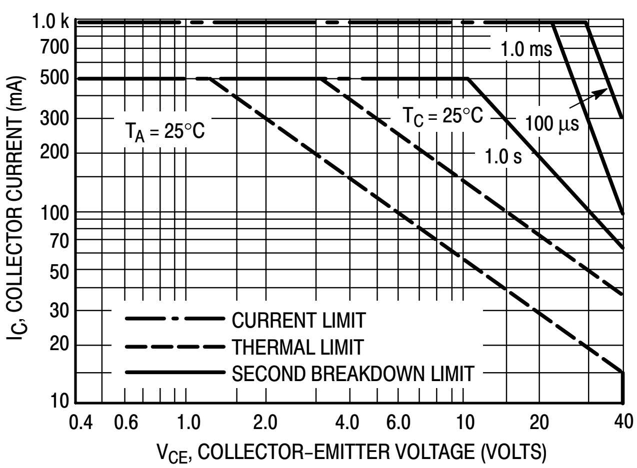
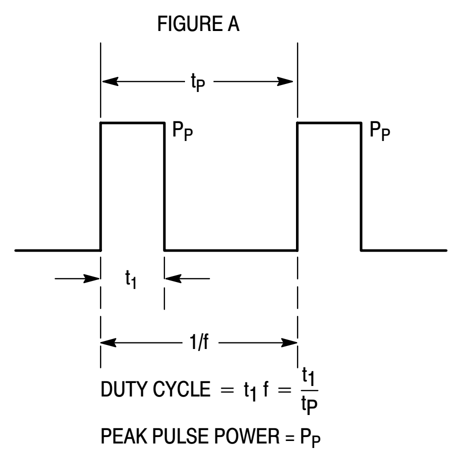


Figure 13. Active Region Safe Operating Area

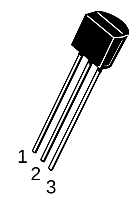


Design Note: Use of Transient Thermal Resistance Data

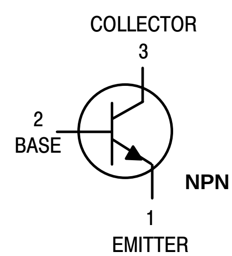
High Voltage Transistors

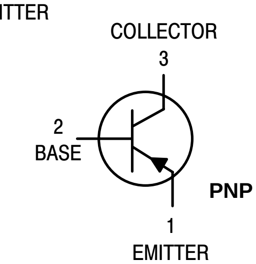
NPN
2N6515
2N6517
PNP
2N6520

Voltage and current are negative for PNP transistors



CASE 29–04, STYLE 1
TO–92 (TO–226AA)





MAXIMUM RATINGS

Rating	Symbol	2N6515	2N6517 2N6520	Unit
Collector–Emitter Voltage	V_{CEO}	250	350	Vdc
Collector–Base Voltage	V_{CBO}	250	350	Vdc
Emitter–Base Voltage 2N6515, 2N6516, 2N6517 2N6519, 2N6520	V_{EBO}	 6.0 5.0		Vdc
Base Current	I_B	250		mAdc
Collector Current – Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	2N6515 2N6517, 2N6520	$V_{(BR)CEO}$	250 350	– –	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	2N6515 2N6517, 2N6520	$V_{(BR)CBO}$	250 350	– –	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	2N6515, 2N6517 2N6520	$V_{(BR)EBO}$	6.0 5.0	– –	Vdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

October, 2001 – Rev. 3
Publication Order Number:
2N6515/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS (Continued)					
Collector Cutoff Current		I_{CBO}			nAdc
(V_{CB} = 150 Vdc, I_E = 0)	2N6515		–	50	
(V_{CB} = 250 Vdc, I_E = 0)	2N6517, 2N6520		–	50	
Emitter Cutoff Current		I_{EBO}			nAdc
(V_{EB} = 5.0 Vdc, I_C = 0)	2N6515, 2N6517		–	50	
(V_{EB} = 4.0 Vdc, I_C = 0)	2N6520		–	50	
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			–
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	2N6515		35	–	
	2N6517, 2N6520		20	–	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	2N6515		50	–	
	2N6517, 2N6520		30	–	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)	2N6515		50	300	
	2N6517, 2N6520		30	200	
(I_C = 50 mAdc, V_{CE} = 10 Vdc)	2N6515		45	220	
	2N6517, 2N6520		20	200	
(I_C = 100 mAdc, V_{CE} = 10 Vdc)	2N6515		25	–	
	2N6517, 2N6520		15	–	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			–	0.30	
(I_C = 20 mAdc, I_B = 2.0 mAdc)			–	0.35	
(I_C = 30 mAdc, I_B = 3.0 mAdc)			–	0.50	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	1.0	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			–	0.75	
(I_C = 20 mAdc, I_B = 2.0 mAdc)			–	0.85	
(I_C = 30 mAdc, I_B = 3.0 mAdc)			–	0.90	
Base–Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 10 Vdc)		$V_{BE(on)}$	–	2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product(1) (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)		f_T	40	200	MHz
Collector–Base Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	–	6.0	pF
Emitter–Base Capacitance		C_{eb}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	2N6515, 2N6517		–	80	
	2N6520		–	100	
SWITCHING CHARACTERISTICS					
Turn–On Time (V_{CC} = 100 Vdc, $V_{BE(off)}$ = 2.0 Vdc, I_C = 50 mAdc, I_{B1} = 10 mAdc)		t_{on}	–	200	μs
Turn–Off Time (V_{CC} = 100 Vdc, I_C = 50 mAdc, I_{B1} = I_{B2} = 10 mAdc)		t_{off}	–	3.5	μs

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

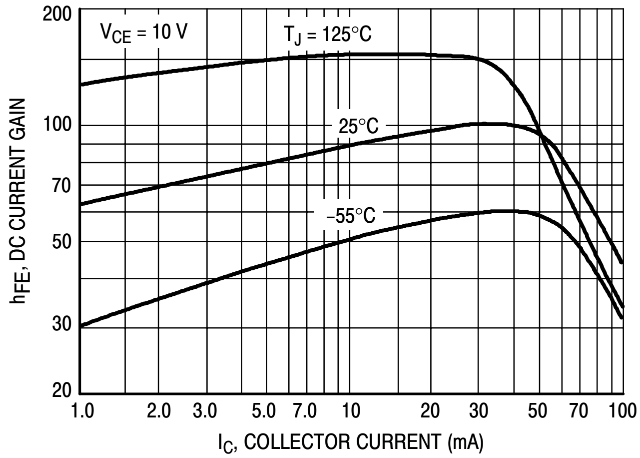


Figure 1. DC Current Gain – NPN 2N6515

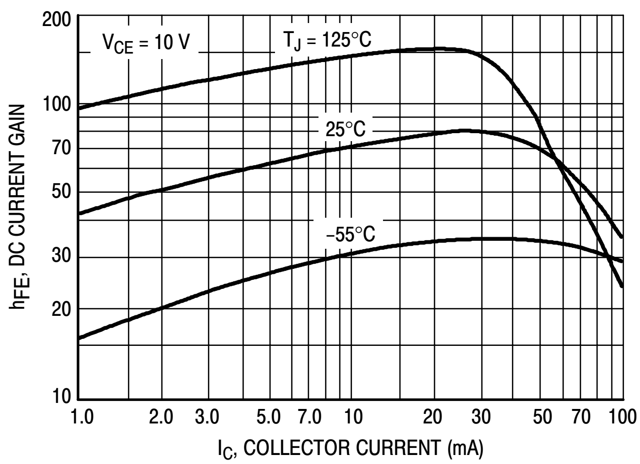


Figure 2. DC Current Gain – NPN 2N6517

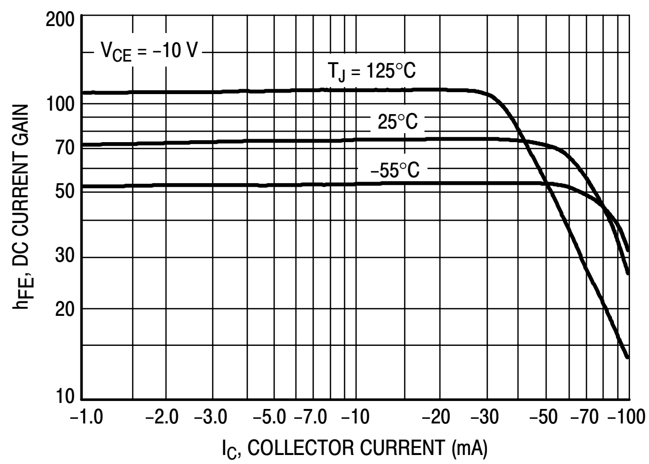


Figure 3. DC Current Gain – PNP 2N6520

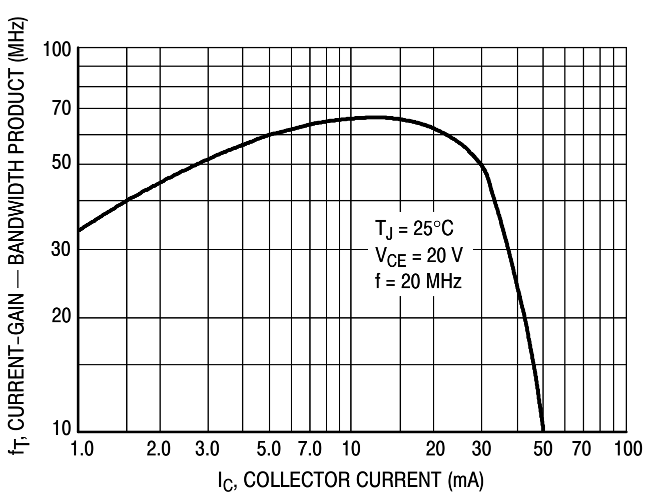


Figure 4. Current–Gain – Bandwidth Product – NPN 2N6515, 2N6517

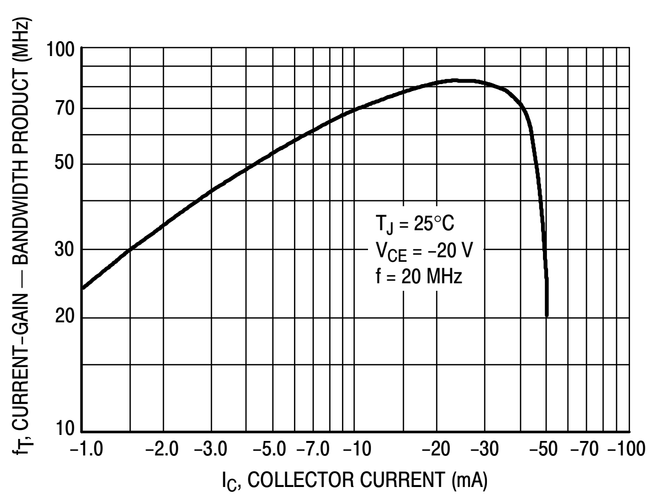


Figure 5. Current–Gain – Bandwidth Product – PNP 2N6520

NPN

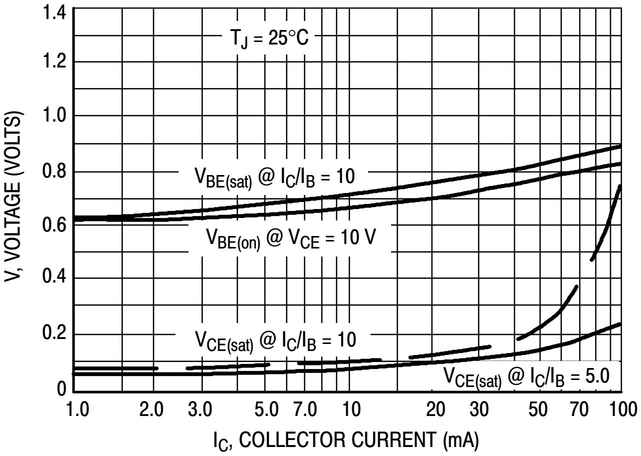


Figure 6. “On” Voltages – NPN 2N6515, 2N6517

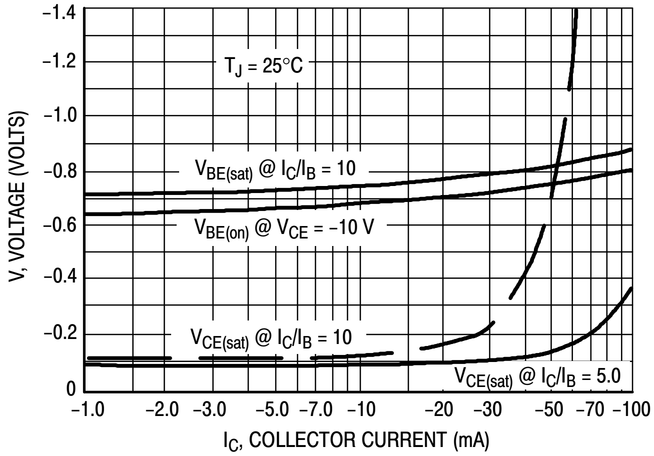


Figure 7. “On” Voltages – PNP 2N6520

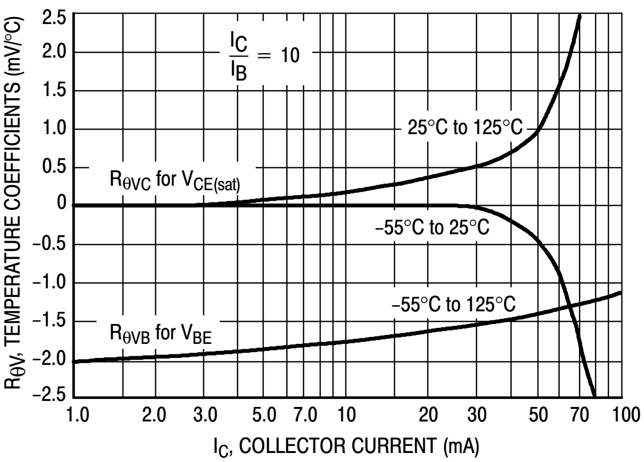


Figure 8. Temperature Coefficients – NPN 2N6515, 2N6517

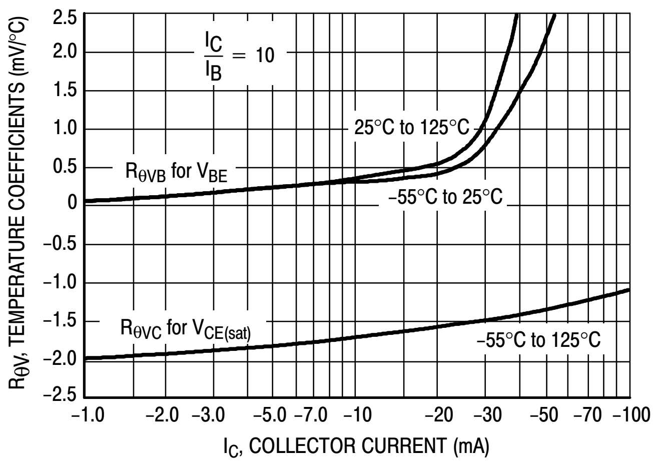


Figure 9. Temperature Coefficients – PNP 2N6520

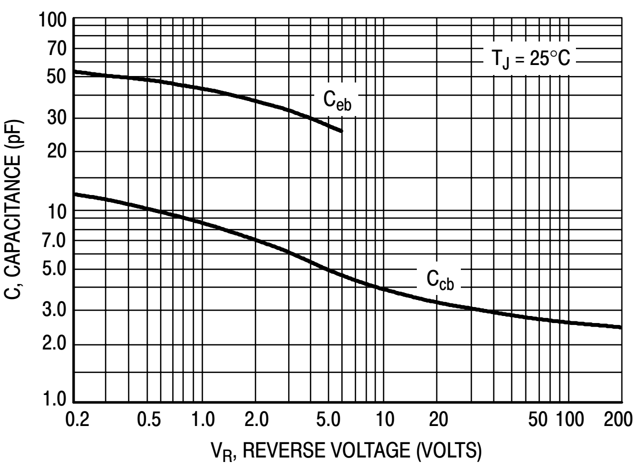


Figure 10. Capacitance – NPN 2N6515, 2N6517

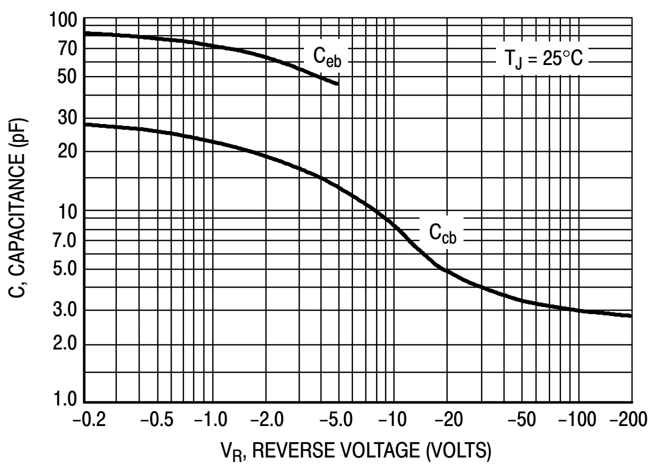


Figure 11. Capacitance – PNP 2N6520

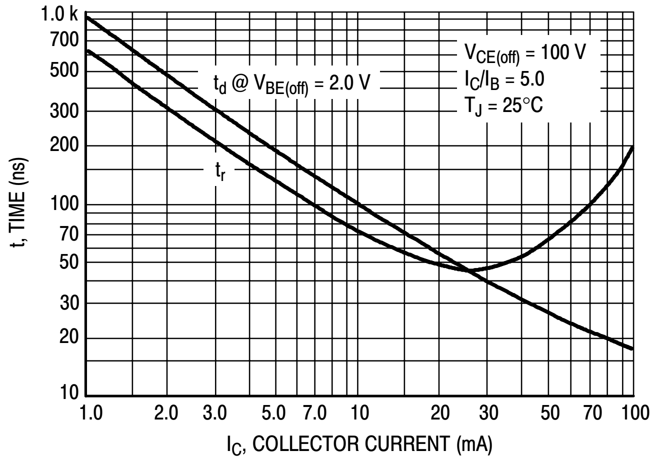


Figure 12. Turn–On Time – NPN 2N6515, 2N6517

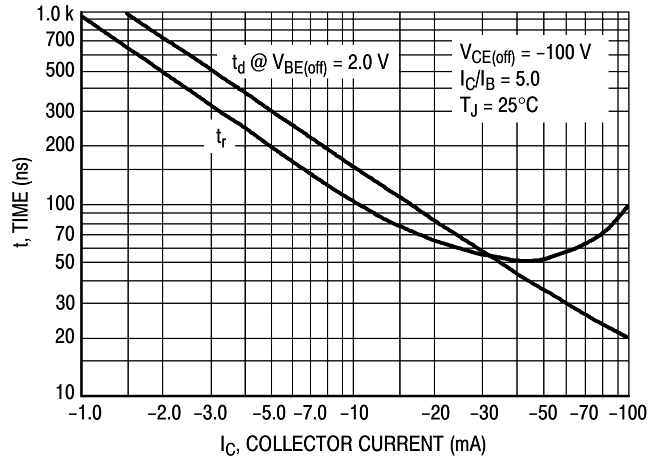


Figure 13. Turn–On Time – PNP 2N6520

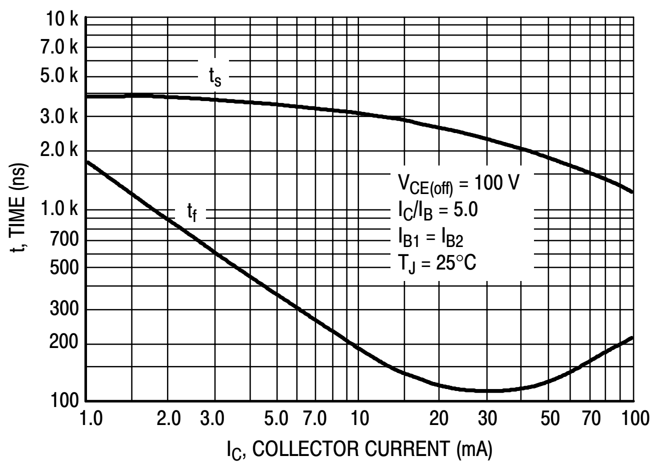


Figure 14. Turn–Off Time – NPN 2N6515, 2N6517

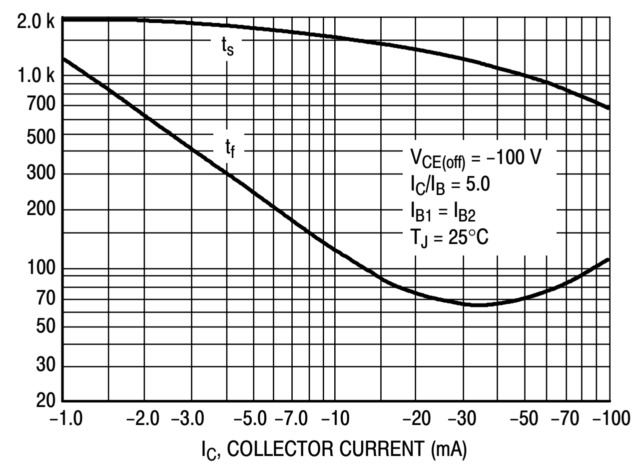


Figure 15. Turn–Off Time – PNP 2N6520

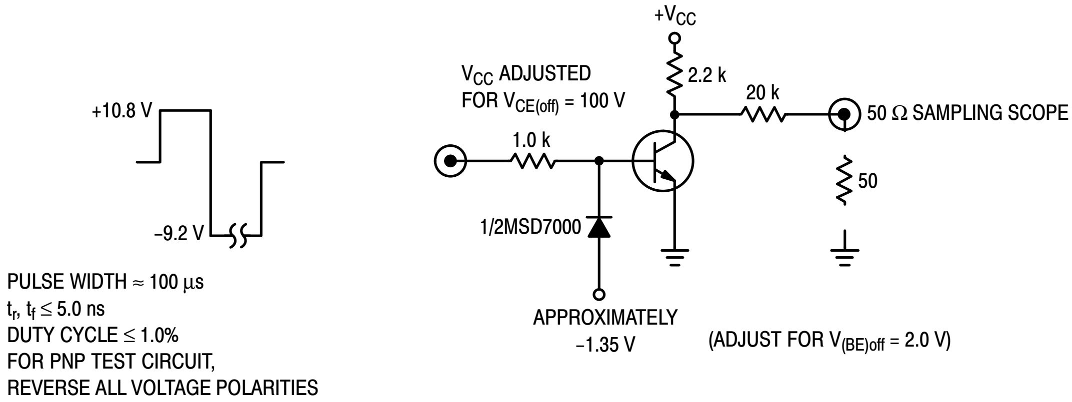


Figure 16. Switching Time Test Circuit

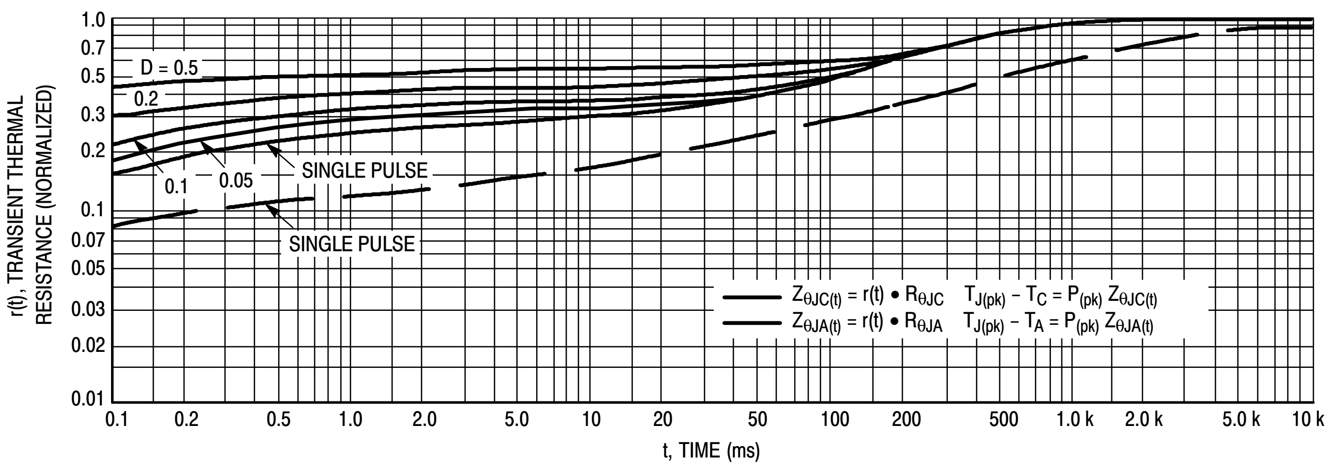


Figure 17. Thermal Response

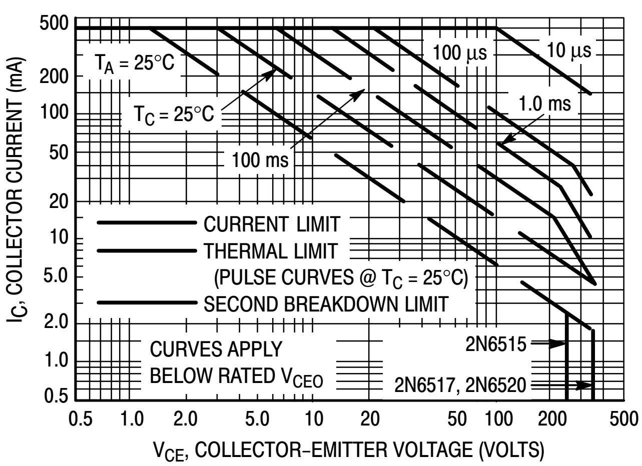
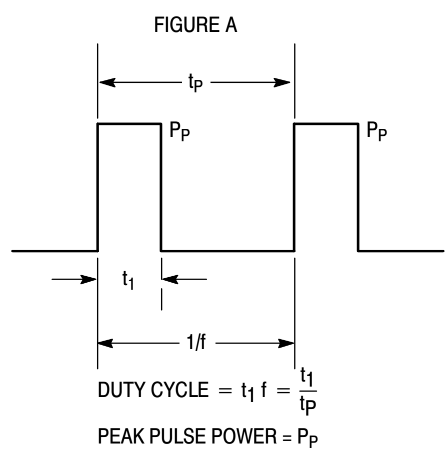


Figure 18. Active Region Safe Operating Area



Design Note: Use of Transient Thermal Resistance Data

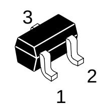
PNP Silicon General Purpose Amplifier Transistor

2SA1774

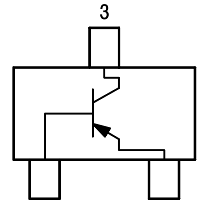
PNP GENERAL PURPOSE AMPLIFIER TRANSISTORS SURFACE MOUNT

This PNP transistor is designed for general purpose amplifier applications. This device is housed in the SOT–416/SC–90 package which is designed for low power surface mount applications, where board space is at a premium.

- Reduces Board Space
- High h_{FE}, 210–460 (typical)
- Low $V_{CE(sat)}$, < 0.5 V
- Available in 8 mm, 7–inch/3000 Unit Tape and Reel



CASE 463–01, STYLE 1
SOT–416/SC–90



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	$V_{(BR)CBO}$	–60	Vdc
Collector–Emitter Voltage	$V_{(BR)CEO}$	–50	Vdc
Emitter–Base Voltage	$V_{(BR)EBO}$	–6.0	Vdc
Collector Current — Continuous	I_C	–100	mAdc

DEVICE MARKING

2SA1774 = F9

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation(1)	P_D	150	mW
Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	–55 ~ +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
Collector–Base Breakdown Voltage (I_C = –50 µAdc, I_E = 0)	$V_{(BR)CBO}$	–60	—	—	Vdc
Collector–Emitter Breakdown Voltage (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–50	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –50 µAdc, I_E = 0)	$V_{(BR)EBO}$	–6.0	—	—	Vdc
Collector–Base Cutoff Current (V_{CB} = –30 Vdc, I_E = 0)	I_{CBO}	—	—	–0.5	nA
Emitter–Base Cutoff Current (V_{EB} = –5.0 Vdc, I_B = 0)	I_{EBO}	—	—	–0.5	µA
Collector–Emitter Saturation Voltage(2) (I_C = –50 mAdc, I_B = –5.0 mAdc)	$V_{CE(sat)}$	—	—	–0.5	Vdc
DC Current Gain(2) (V_{CE} = –6.0 Vdc, I_C = –1.0 mAdc)	h_{FE}	120	—	560	—
Transition Frequency (V_{CE} = –12 Vdc, I_C = –2.0 mAdc, f = 30 MHz)	f_T	—	140	—	MHz
Output Capacitance (V_{CB} = –12 Vdc, I_E = 0 Adc, f = 1 MHz)	C_{OB}	—	3.5	—	pF

1. Device mounted on a FR–4 glass epoxy printed circuit board using the minimum recommended footprint.
2. Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

TYPICAL ELECTRICAL CHARACTERISTICS

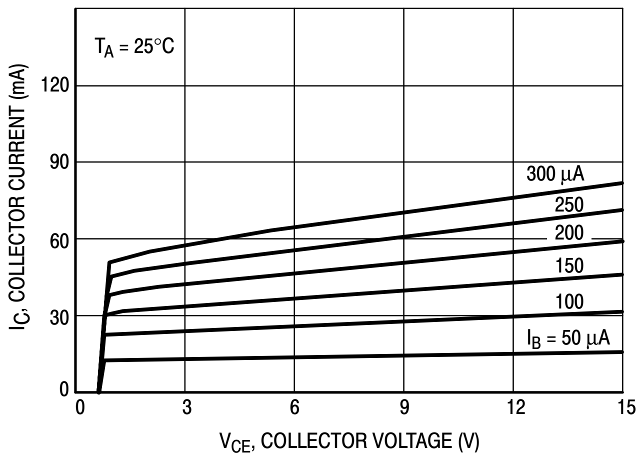


Figure 1. I_C – V_{CE}

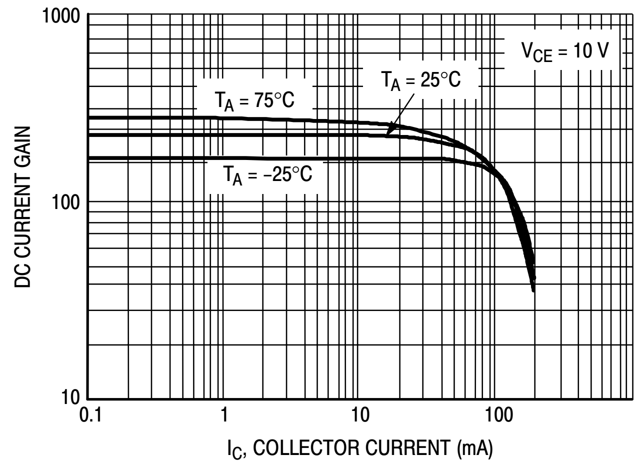


Figure 2. DC Current Gain

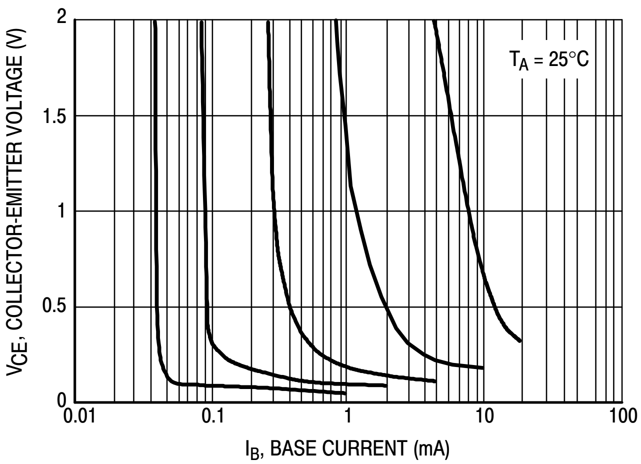


Figure 3. Collector Saturation Region

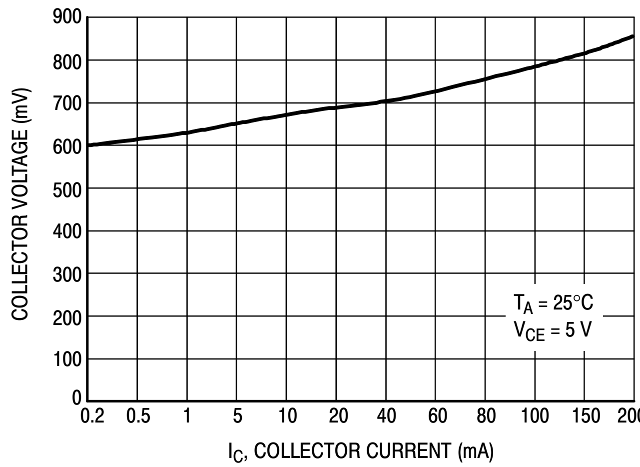


Figure 4. On Voltage

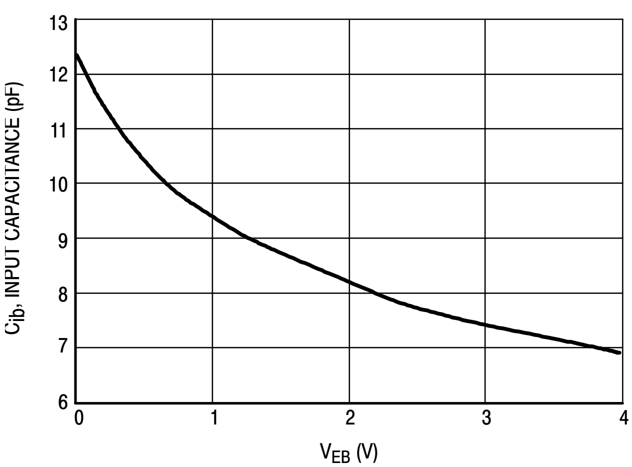


Figure 5. Capacitance

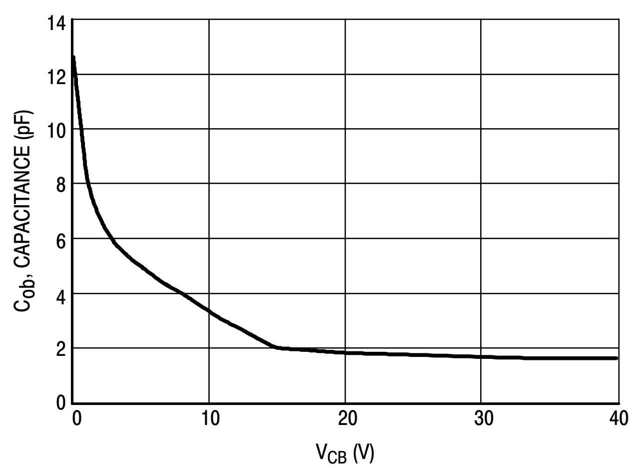


Figure 6. Capacitance

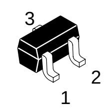
NPN Silicon General Purpose Amplifier Transistor

2SC4617

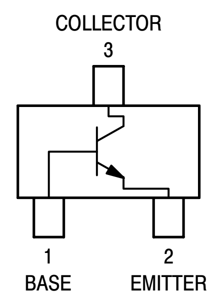
This NPN transistor is designed for general purpose amplifier applications. This device is housed in the SOT-416/SC–90 package which is designed for low power surface mount applications, where board space is at a premium.

- Reduces Board Space
- High h_{FE}, 210–460 (typical)
- Low $V_{CE(sat)}$, < 0.5 V
- Available in 8 mm, 7-inch/3000 Unit Tape and Reel

NPN GENERAL PURPOSE AMPLIFIER TRANSISTORS SURFACE MOUNT



CASE 463–01, STYLE 1
SOT–416/SC–90



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector-Base Voltage	$V_{(BR)CBO}$	50	Vdc
Collector-Emitter Voltage	$V_{(BR)CEO}$	50	Vdc
Emitter-Base Voltage	$V_{(BR)EBO}$	5.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

DEVICE MARKING

2SC4617 = B9

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation(1)	P_D	125	mW
Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	–55 ~ +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
Collector-Base Breakdown Voltage (I_C = 50 µAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 50 µAdc, I_E = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector-Base Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	0.5	µA
Emitter-Base Cutoff Current (V_{EB} = 4.0 Vdc, I_B = 0)	I_{EBO}	—	—	0.5	µA
Collector-Emitter Saturation Voltage(2) (I_C = 60 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	—	—	0.4	Vdc
DC Current Gain(2) (V_{CE} = 6.0 Vdc, I_C = 1.0 mAdc)	h_{FE}	120	—	560	—
Transition Frequency (V_{CE} = 12 Vdc, I_C = 2.0 mAdc, f = 30 MHz)	f_T	—	180	—	MHz
Output Capacitance (V_{CB} = 12 Vdc, I_C = 0 Adc, f = 1 MHz)	C_{OB}	—	2.0	—	pF

1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.
2. Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

TYPICAL ELECTRICAL CHARACTERISTICS

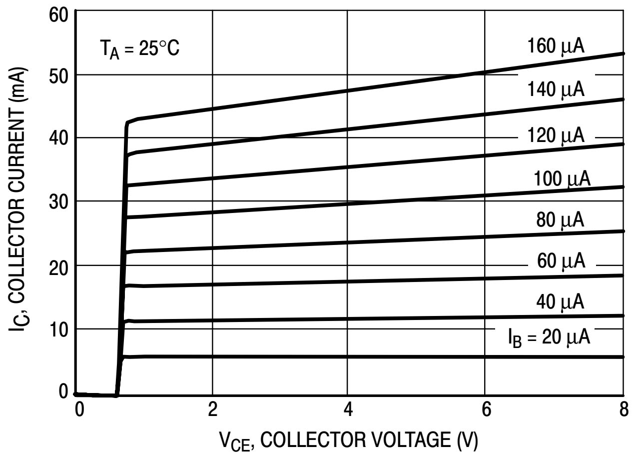


Figure 1. I_C – V_{CE}

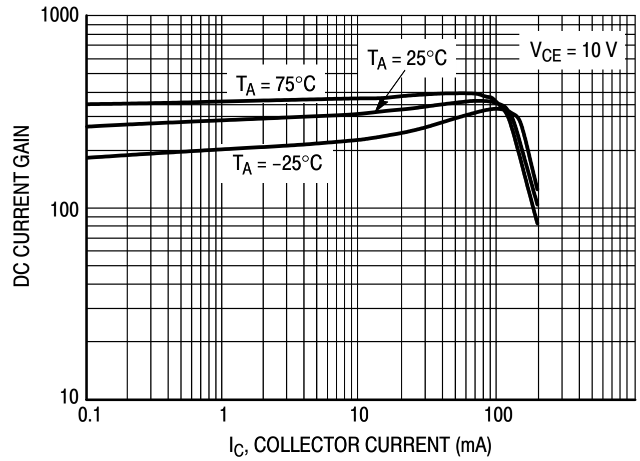


Figure 2. DC Current Gain

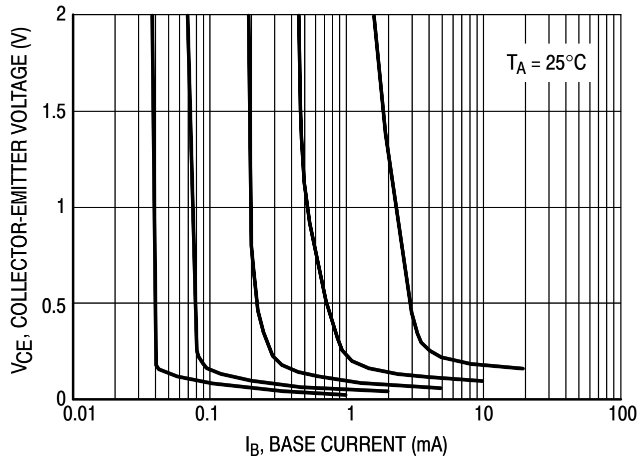


Figure 3. Collector Saturation Region

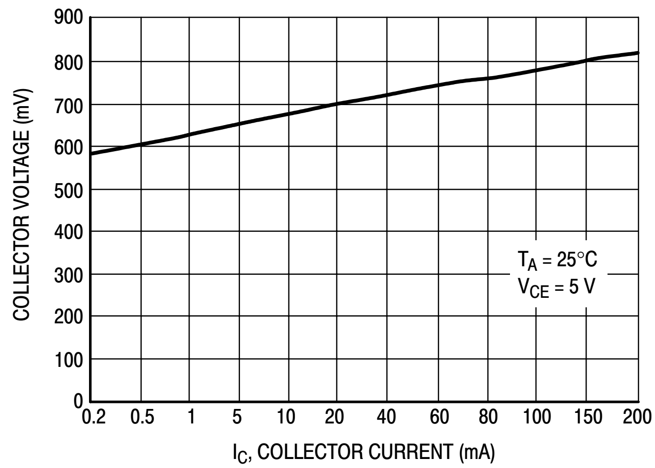


Figure 4. On Voltage

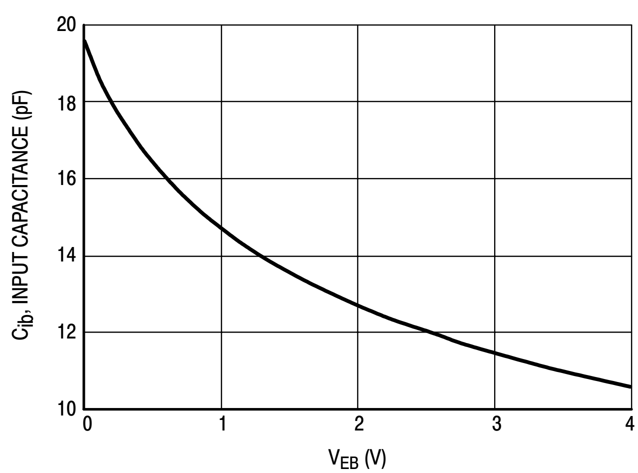


Figure 5. Capacitance

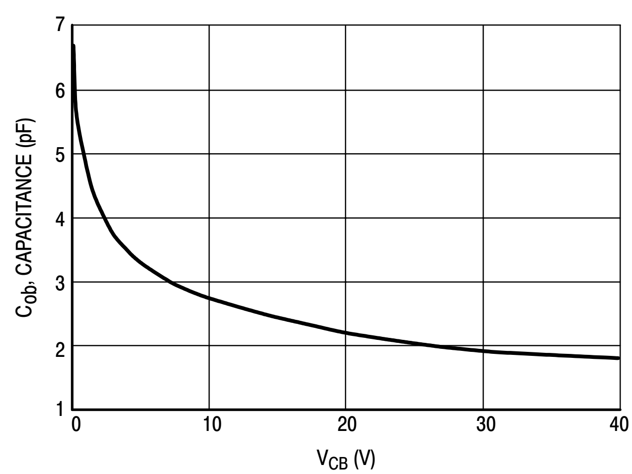


Figure 6. Capacitance

Switching Diode

BAL99LT1

MAXIMUM RATINGS

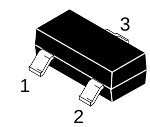
Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	70	Vdc
Peak Forward Current	I_F	100	mAdc

THERMAL CHARACTERISTICS

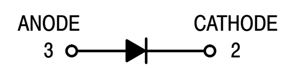
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BAL99LT1 = JF



CASE 318–08, STYLE 18
SOT–23 (TO–236AB)



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Voltage Leakage Current (V_R = 70 Vdc) (V_R = 25 Vdc, T_J = 150°C) (V_R = 70 Vdc, T_J = 150°C)	I_R	 — — —	 2.5 30 50	µAdc
Reverse Breakdown Voltage (I_R = 100 µAdc)	$V_{(BR)}$	70	—	Vdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 150 mAdc)	V_F	 — — — —	 715 855 1000 1250	mV
Recovery Current (I_F = 10 mAdc, V_R = 5.0 Vdc, R_L = 500 Ω)	Q_S	—	45	pC
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	1.5	pF
Reverse Recovery Time (I_F = I_R = 10 mAdc, R_L = 100 Ω, measured at I_R = 1.0 mAdc)	t_{rr}	—	6.0	ns
Forward Recovery Voltage (I_F = 10 mAdc, t_r = 20 ns)	V_{FR}	—	1.75	Vdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

March, 2001 – Rev. 1

Publication Order Number:
BAL99LT1/D

TYPICAL CHARACTERISTICS

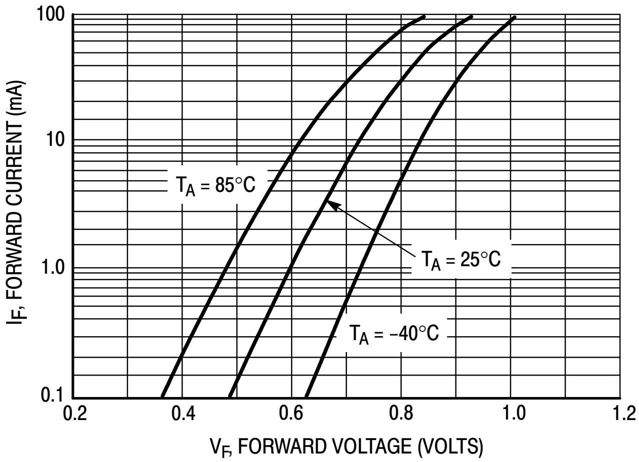


Figure 1. Forward Voltage

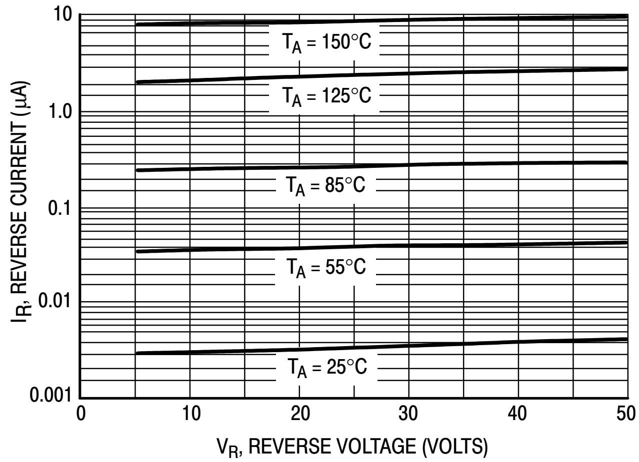


Figure 2. Leakage Current

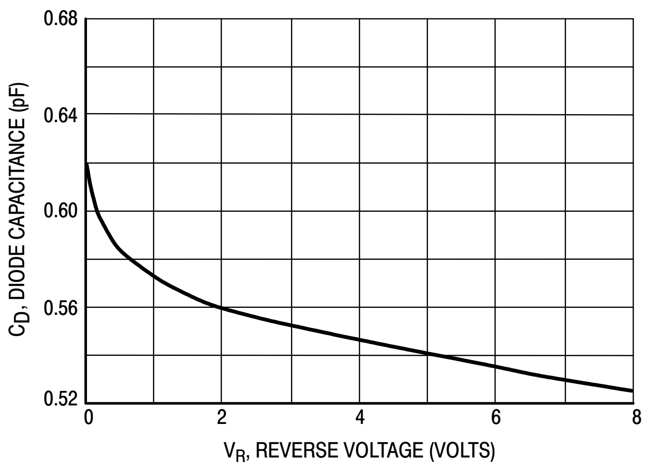


Figure 3. Capacitance

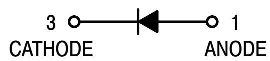
Switching Diode

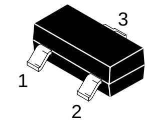
BAS116LT1

ON Semiconductor Preferred Device

This switching diode has the following features:

- Low Leakage Current Applications
- Medium Speed Switching Times
- Available in 8 mm Tape and Reel
  Use BAS116LT1 to order the 7 inch/3,000 unit reel
  Use BAS116LT3 to order the 13 inch/10,000 unit reel





CASE 318–08, STYLE 8
SOT–23 (TO–236AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	75	Vdc
Peak Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

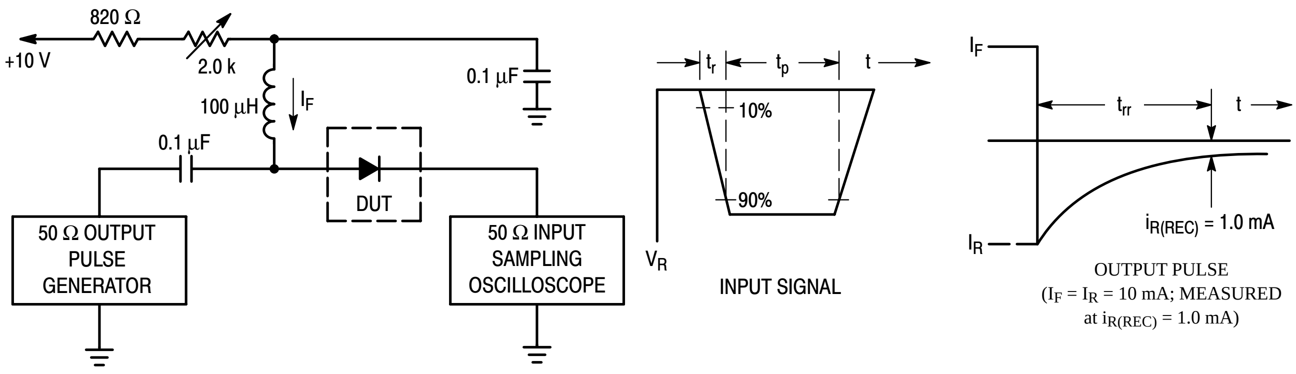
BAS116LT1 = JV

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage (I_{BR} = 100 μAdc)	$V_{(BR)}$	75	—	Vdc
Reverse Voltage Leakage Current (V_R = 75 Vdc) (V_R = 75 Vdc, T_J = 150°C)	I_R	— —	5.0 80	nAdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 150 mAdc)	V_F	— — — —	900 1000 1100 1250	mV
Diode Capacitance (V_R = 0 V, f = 1.0 MHz)	C_D	—	2.0	pF
Reverse Recovery Time (I_F = I_R = 10 mAdc) (Figure 1)	t_{rr}	—	3.0	μs

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.



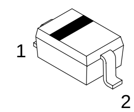
Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

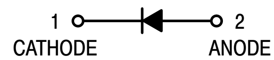
Switching Diode

BAS16HT1

ON Semiconductor Preferred Device



CASE 477–02, STYLE 1
SOD323



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	75	Vdc
Peak Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	200 1.57	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	635	°C/W
Junction and Storage Temperature	T_J, T_{stg}	150	°C

*FR-4 Minimum Pad

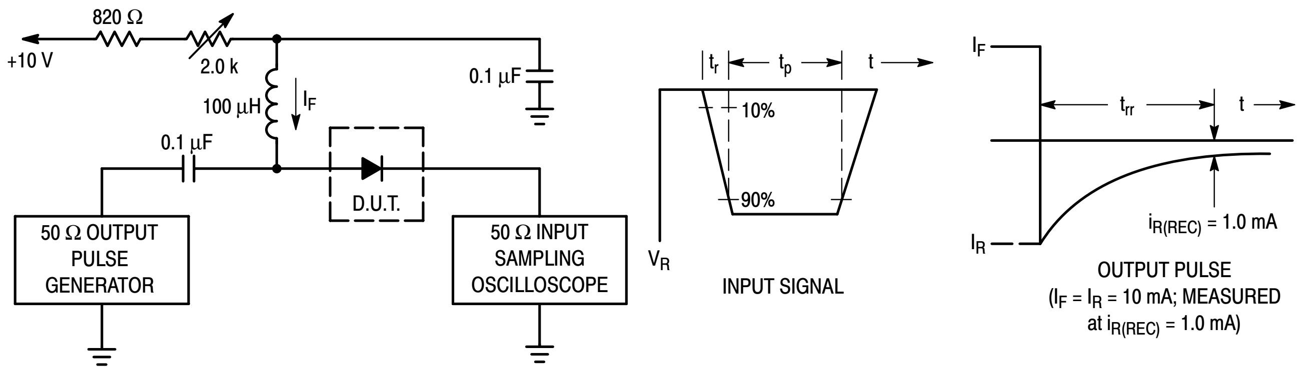
DEVICE MARKING

BAS16HT1 = A6

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Voltage Leakage Current (V_R = 75 Vdc) (V_R = 75 Vdc, T_J = 150°C) (V_R = 25 Vdc, T_J = 150°C)	I_R	 — — —	 1.0 50 30	µAdc
Reverse Breakdown Voltage (I_{BR} = 100 µAdc)	$V_{(BR)}$	75	—	Vdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 150 mAdc)	V_F	 — — — —	 715 855 1000 1250	mV
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.0	pF
Forward Recovery Voltage (I_F = 10 mAdc, t_r = 20 ns)	V_{FR}	—	1.75	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, R_L = 50 Ω)	t_{rr}	—	6.0	ns
Stored Charge (I_F = 10 mAdc to V_R = 5.0 Vdc, R_L = 500 Ω)	Q_S	—	45	pC

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

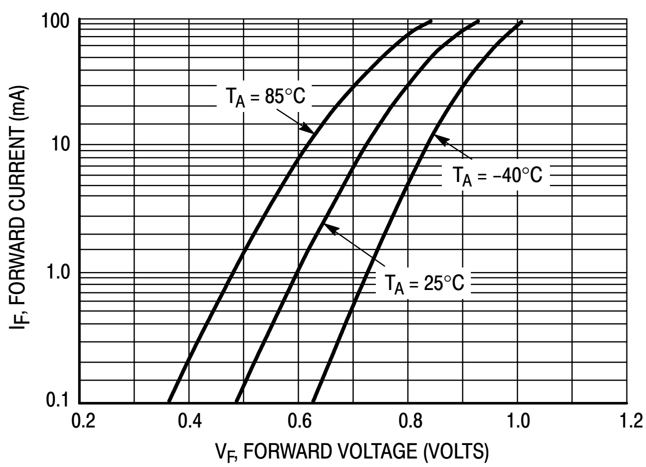


Figure 2. Forward Voltage

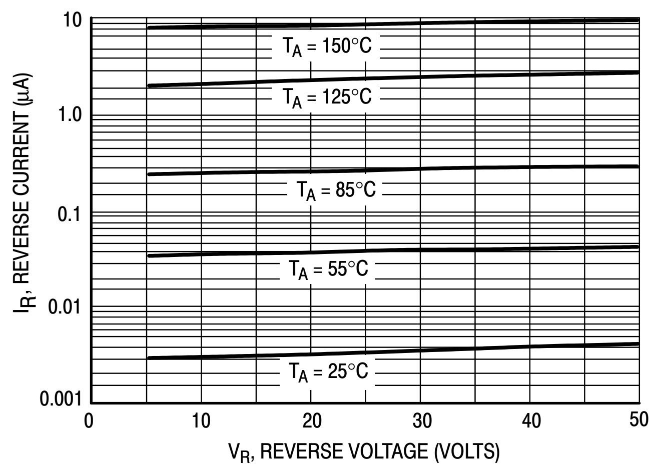


Figure 3. Leakage Current

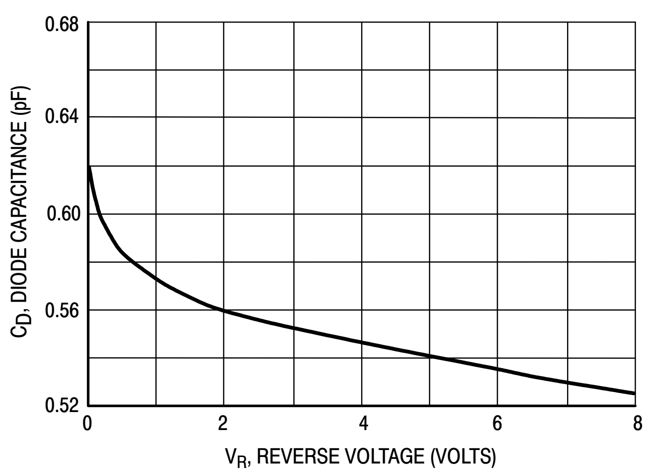
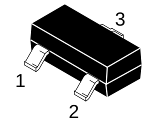


Figure 4. Capacitance

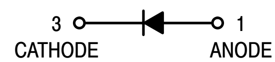
Switching Diode

BAS16LT1

ON Semiconductor Preferred Device



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	75	Vdc
Peak Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

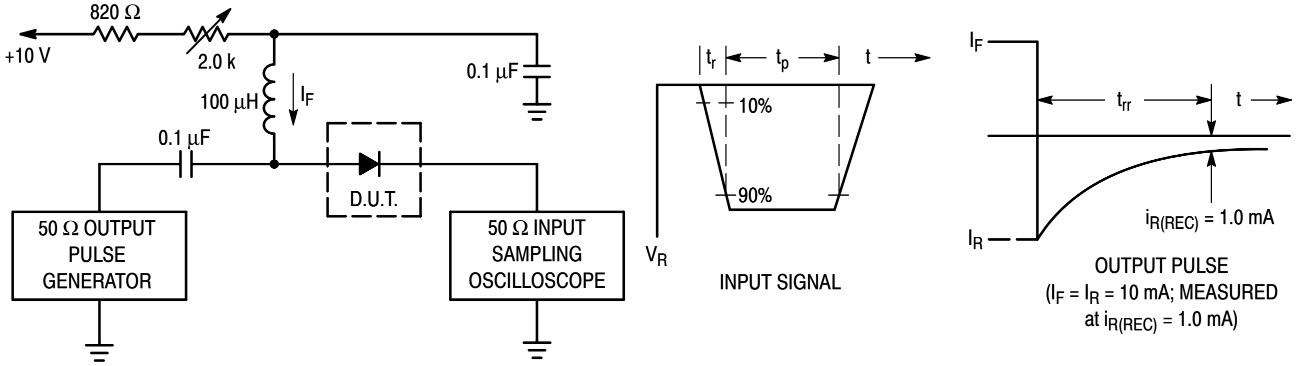
BAS16LT1 = A6

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Voltage Leakage Current (V_R = 75 Vdc) (V_R = 75 Vdc, T_J = 150°C) (V_R = 25 Vdc, T_J = 150°C)	I_R	 — — —	 1.0 50 30	µAdc
Reverse Breakdown Voltage (I_{BR} = 100 µAdc)	$V_{(BR)}$	75	—	Vdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 150 mAdc)	V_F	 — — — —	 715 855 1000 1250	mV
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.0	pF
Forward Recovery Voltage (I_F = 10 mAdc, t_r = 20 ns)	V_{FR}	—	1.75	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, R_L = 50 Ω)	t_{rr}	—	6.0	ns
Stored Charge (I_F = 10 mAdc to V_R = 5.0 Vdc, R_L = 500 Ω)	Q_S	—	45	pC

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p » t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

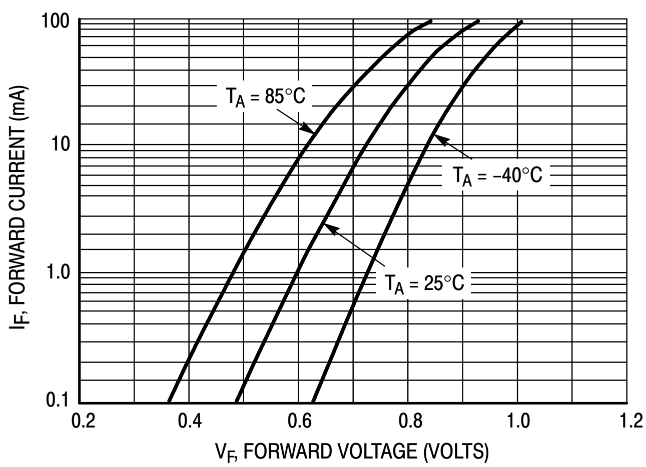


Figure 2. Forward Voltage

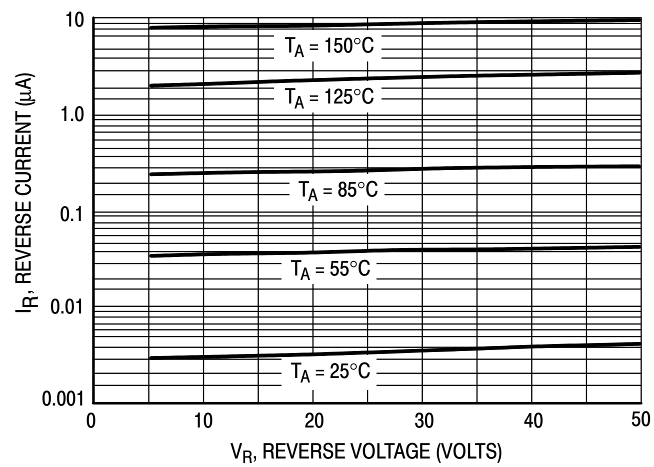


Figure 3. Leakage Current

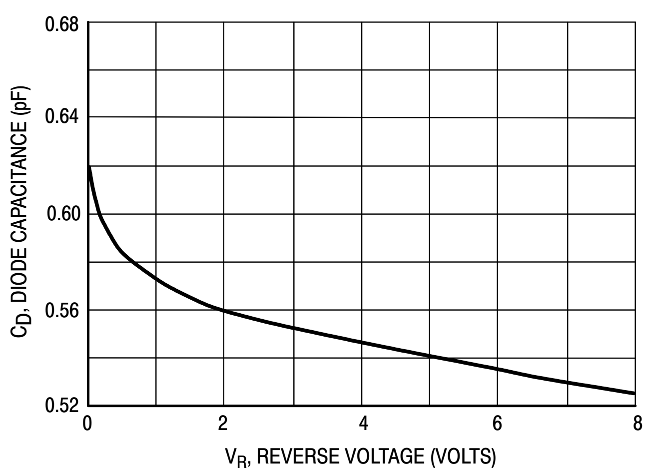


Figure 4. Capacitance

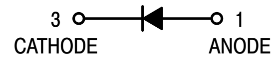
BAS16TT1

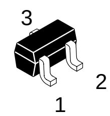
Preferred Device

Silicon Switching Diode

ON Semiconductor™

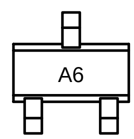
http://onsemi.com





CASE 463
SOT–416/SC–75
STYLE 2

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
BAS16TT1	SOT–416	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Continuous Reverse Voltage	V_R	75	V
Recurrent Peak Forward Current	I_F	200	mA
Peak Forward Surge Current Pulse Width = 10 μs	$I_{FM(surge)}$	500	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, FR–4 Board (1) T_A = 25°C Derated above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient (1)	$R_{\theta JA}$	555	°C/W
Total Device Dissipation, FR–4 Board (2) T_A = 25°C Derated above 25°C	P_D	360 2.9	mW mW/°C
Thermal Resistance, Junction to Ambient (2)	$R_{\theta JA}$	345	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) FR–4 @ Minimum Pad
(2) FR–4 @ 1.0 × 1.0 Inch Pad

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Forward Voltage	V_F			mV
(I_F = 1.0 mA)		—	715	
(I_F = 10 mA)		—	866	
(I_F = 50 mA)		—	1000	
(I_F = 150 mA)		—	1250	
Reverse Current	I_R			μA
(V_R = 75 V)		—	1.0	
(V_R = 75 V, T_J = 150°C)		—	50	
(V_R = 25 V, T_J = 150°C)		—	30	
Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.0	pF
Reverse Recovery Time (I_F = I_R = 10 mA, R_L = 50 Ω) (Figure 1)	t_{rr}	—	6.0	ns
Stored Charge (I_F = 10 mA to V_R = 6.0 V, R_L = 500 Ω) (Figure 2)	QS	—	45	PC
Forward Recovery Voltage (I_F = 10 mA, t_r = 20 ns) (Figure 3)	V_{FR}	—	1.75	V

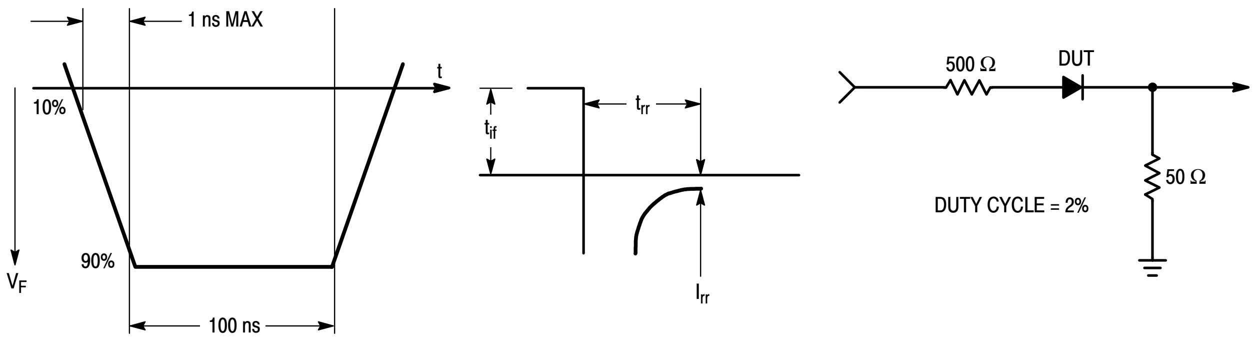


Figure 1. Reverse Recovery Time Equivalent Test Circuit

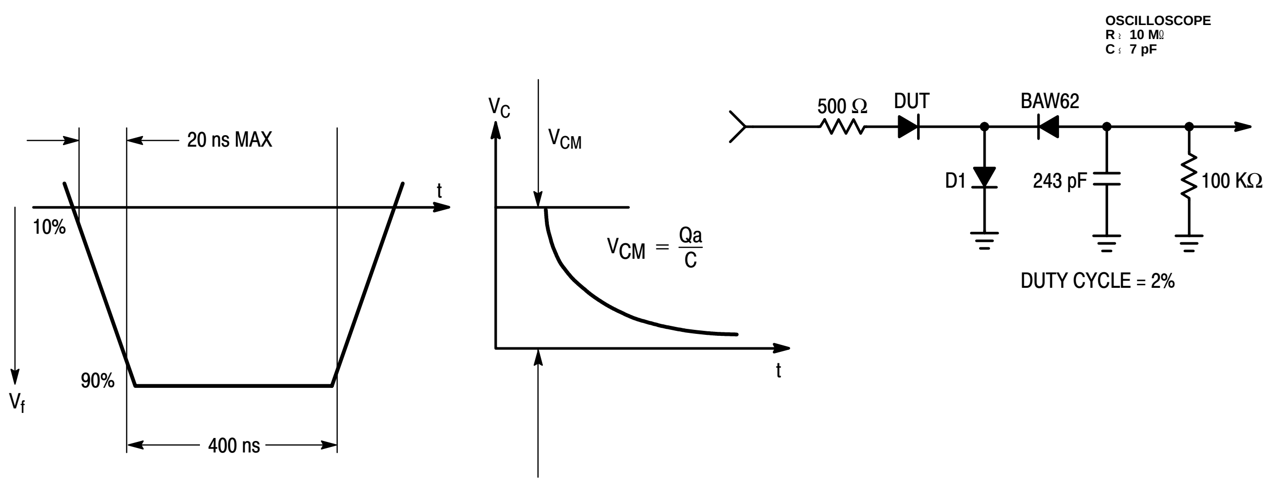


Figure 2. Stored Charge Equivalent Test Circuit

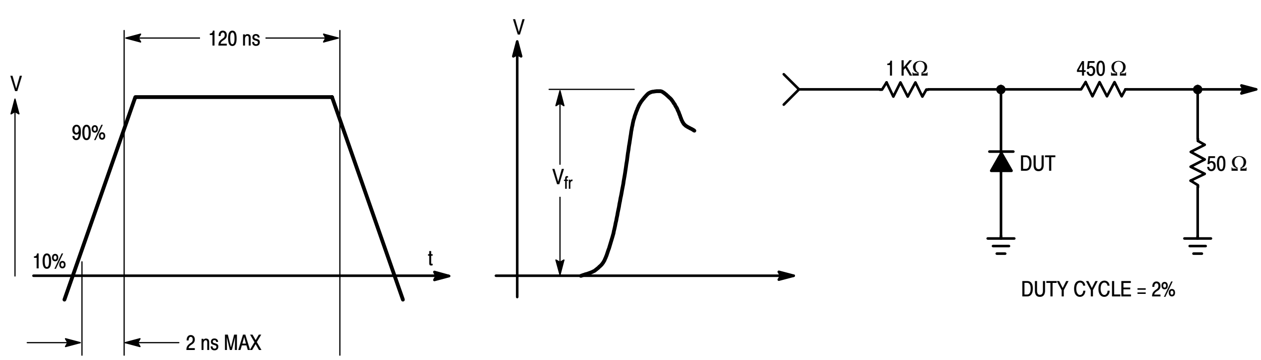


Figure 3. Forward Recovery Voltage Equivalent Test Circuit

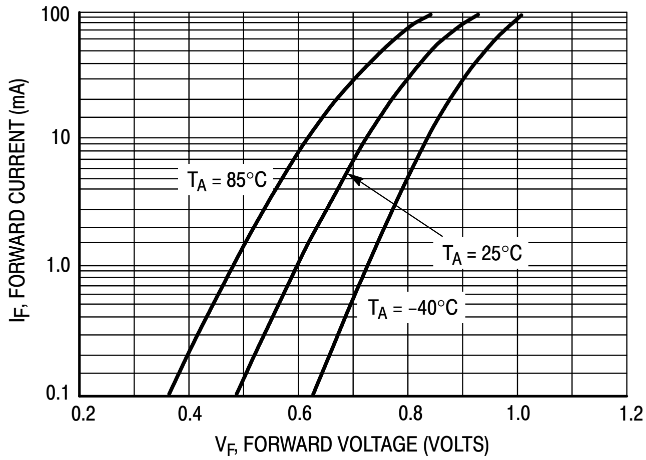


Figure 4. Forward Voltage

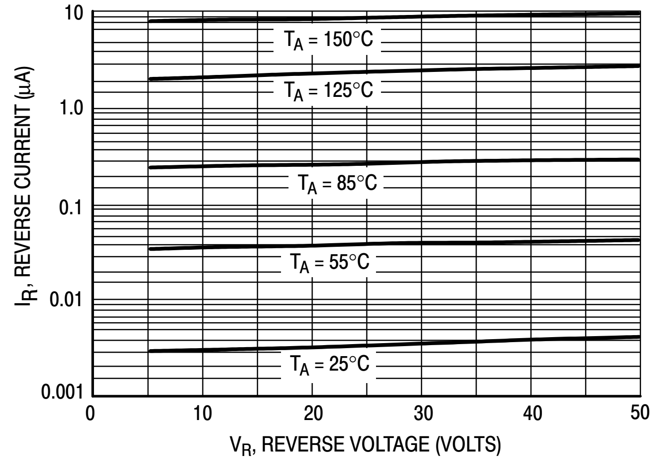


Figure 5. Leakage Current

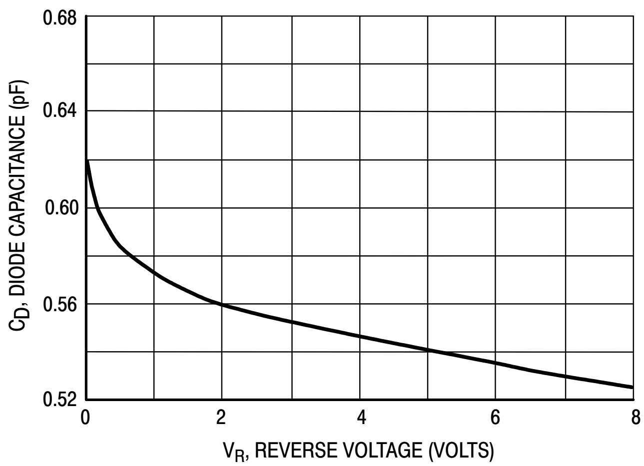


Figure 6. Capacitance

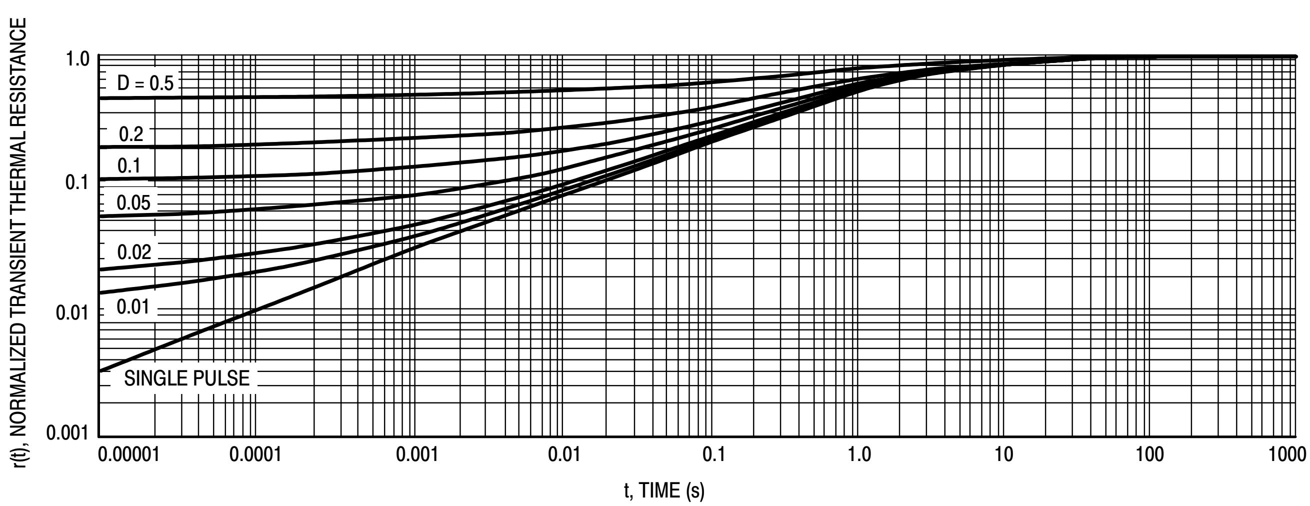
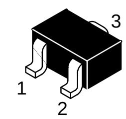


Figure 7. Normalized Thermal Response

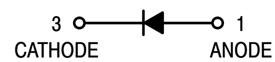
Silicon Switching Diode

BAS16WT1

ON Semiconductor Preferred Device



CASE 419–04, STYLE 2
SC–70/SOT–323



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Continuous Reverse Voltage	V_R	75	V
Recurrent Peak Forward Current	I_R	200	mA
Peak Forward Surge Current Pulse Width = 10 µs	$I_{FM(surge)}$	500	mA
Total Power Dissipation, One Diode Loaded T_A = 25°C Derate above 25°C Mounted on a Ceramic Substrate (10 x 8 x 0.6 mm)	P_D	200 1.6	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient One Diode Loaded Mounted on a Ceramic Substrate (10 x 8 x 0.6 mm)	$R_{\theta JA}$	0.625	°C/mW

DEVICE MARKING

BAS16WT1 = A6

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Forward Voltage (I_F = 1.0 mA) (I_F = 10 mA) (I_F = 50 mA) (I_F = 150 mA)	V_F	 — — — —	 715 866 1000 1250	mV
Reverse Current (V_R = 75 V) (V_R = 75 V, T_J = 150°C) (V_R = 25 V, T_J = 150°C)	I_R	 — — —	 1.0 50 30	µA
Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.0	pF
Reverse Recovery Time (I_F = I_R = 10 mA, R_L = 50 Ω) (Figure 1)	t_{rr}	—	6.0	ns
Stored Charge (I_F = 10 mA to V_R = 6.0 V, R_L = 500 Ω) (Figure 2)	QS	—	45	PC
Forward Recovery Voltage (I_F = 10 mA, t_r = 20 ns) (Figure 3)	V_{FR}	—	1.75	V

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

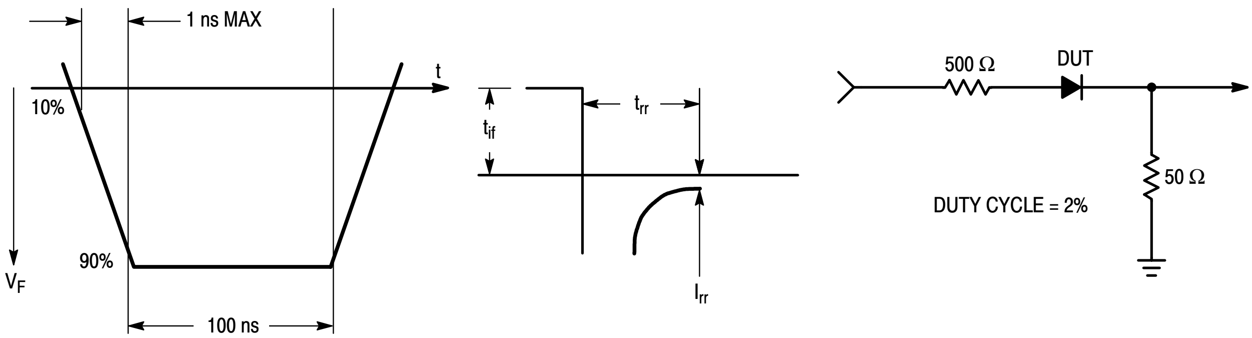


Figure 1. Reverse Recovery Time Equivalent Test Circuit

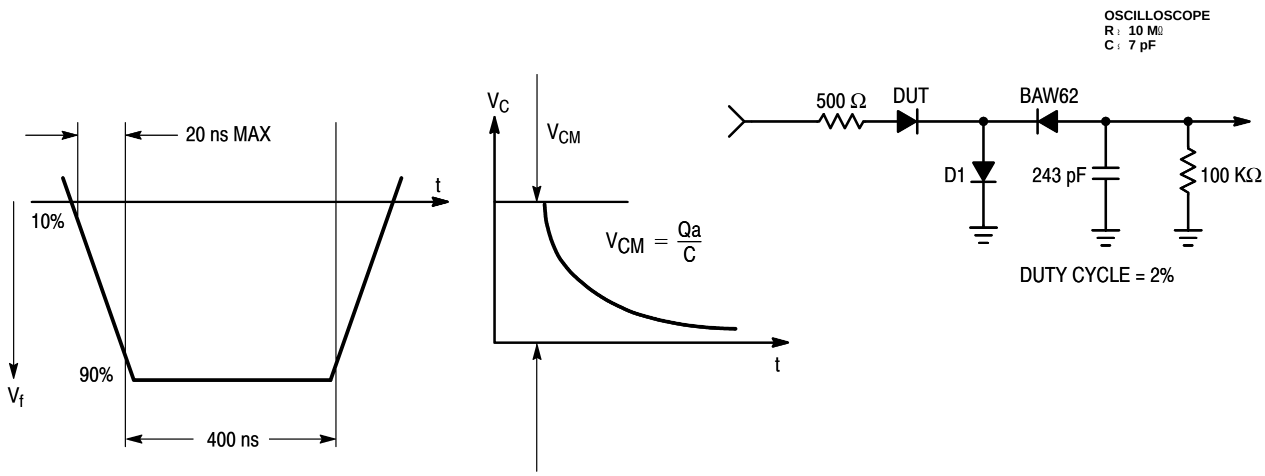


Figure 2. Stored Charge Equivalent Test Circuit

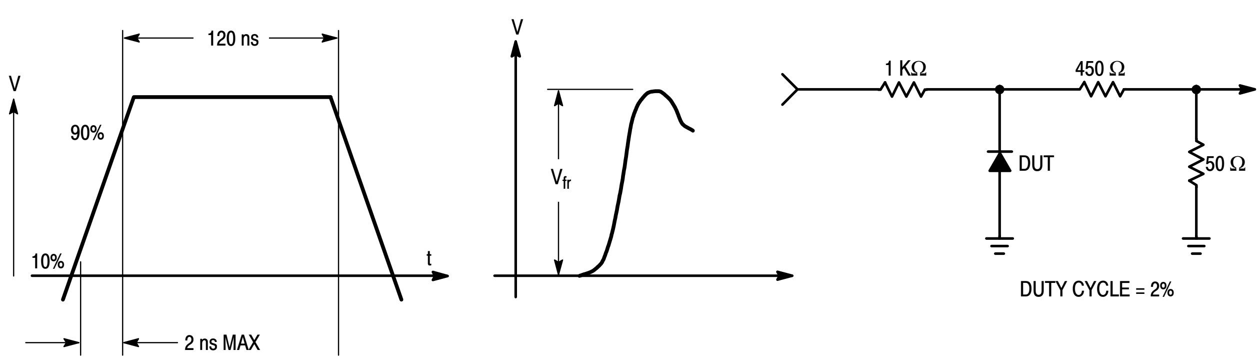


Figure 3. Forward Recovery Voltage Equivalent Test Circuit

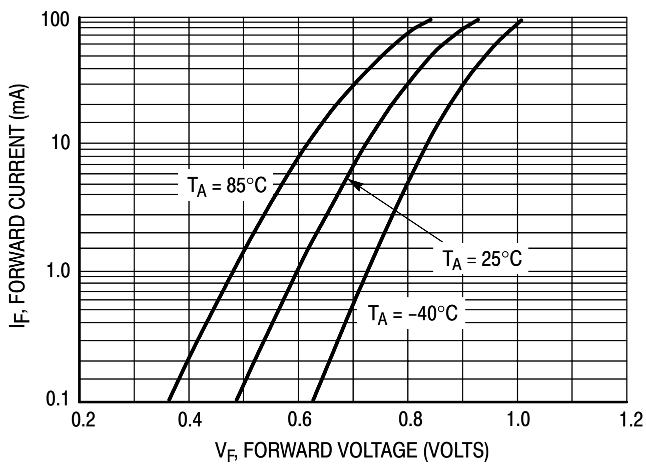


Figure 4. Forward Voltage

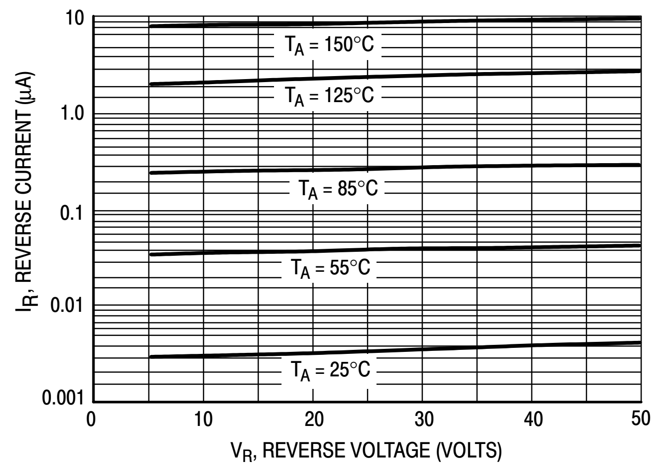


Figure 5. Leakage Current

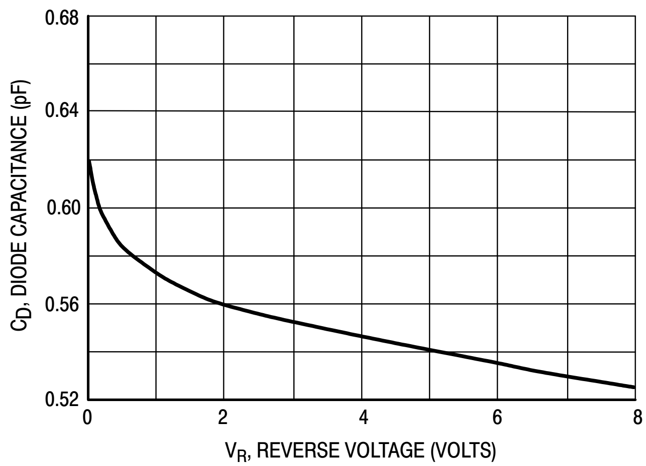


Figure 6. Capacitance

BAS20HT1

Preferred Device

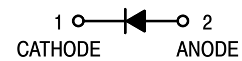
High Voltage Switching Diode

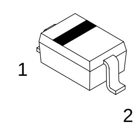
- Device Marking: JS

ON Semiconductor™

http://onsemi.com

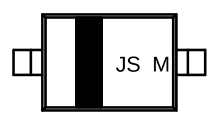
HIGH VOLTAGE SWITCHING DIODE





SOD–323
CASE 477
STYLE 1

MARKING DIAGRAM



JS = Specific Device Code
M = Date Code

MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Continuous Reverse Voltage	250	Vdc
I_F	Peak Forward Current	200	mAdc
$I_{FM(surge)}$	Peak Forward Surge Current	625	mAdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C Derate above 25°C	200 1.57	mW mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature Range	–55 to +150	°C

*FR–5 Minimum Pad

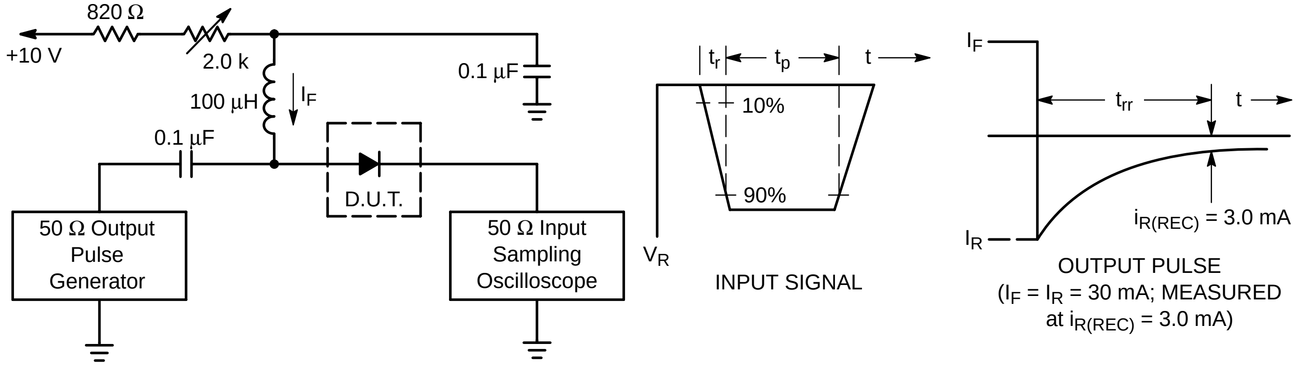
ORDERING INFORMATION

Device	Package	Shipping
BAS20HT1	SOD–323	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Voltage Leakage Current (V_R = 200 Vdc) (V_R = 200 Vdc, T_J = 150°C)	I_R	 – –	 1.0 100	µAdc
Reverse Breakdown Voltage (I_{BR} = 100 µAdc)	$V_{(BR)}$	250	–	Vdc
Forward Voltage (I_F = 100 mAdc) (I_F = 200 mAdc)	V_F	 – –	 1000 1250	mV
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	–	5.0	pF
Reverse Recovery Time (I_F = I_R = 30 mAdc, R_L = 100 Ω)	t_{rr}	–	50	ns



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 30 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 30 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

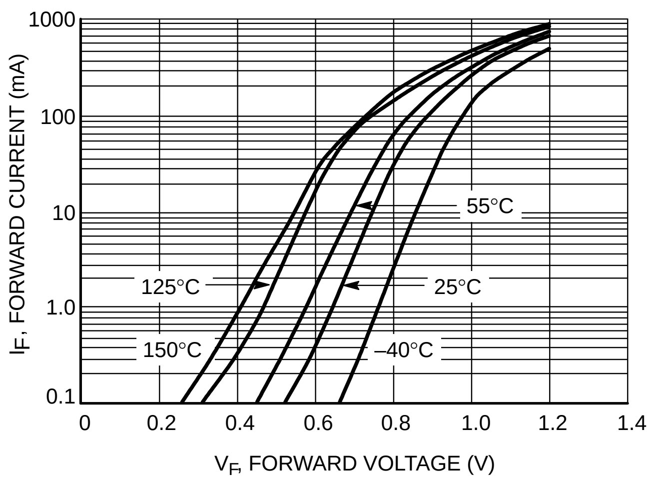


Figure 2. Forward Current

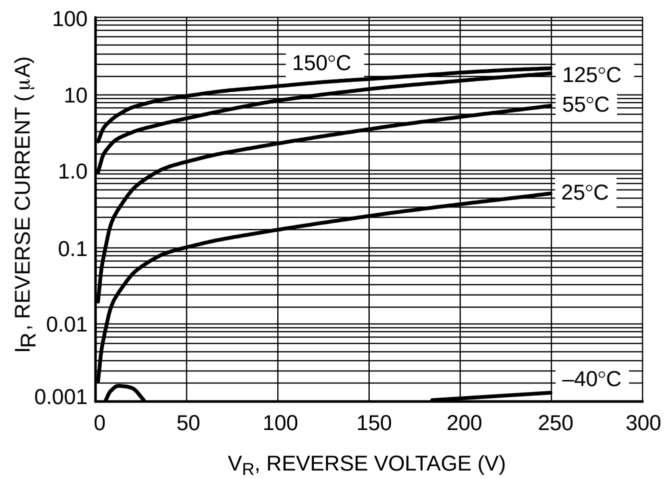


Figure 3. Leakage Current

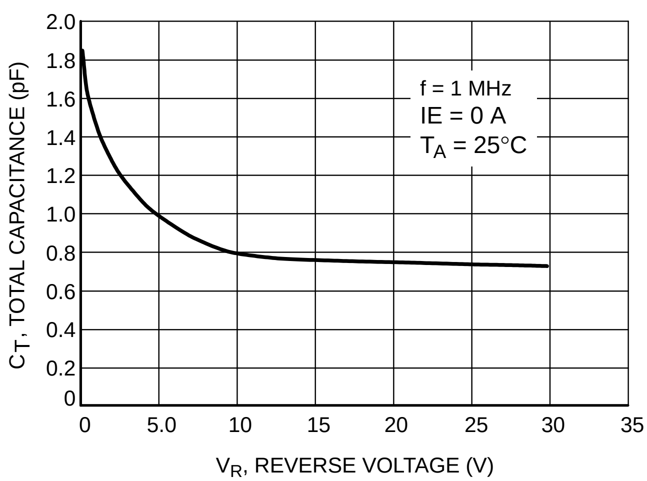


Figure 4. Total Capacitance

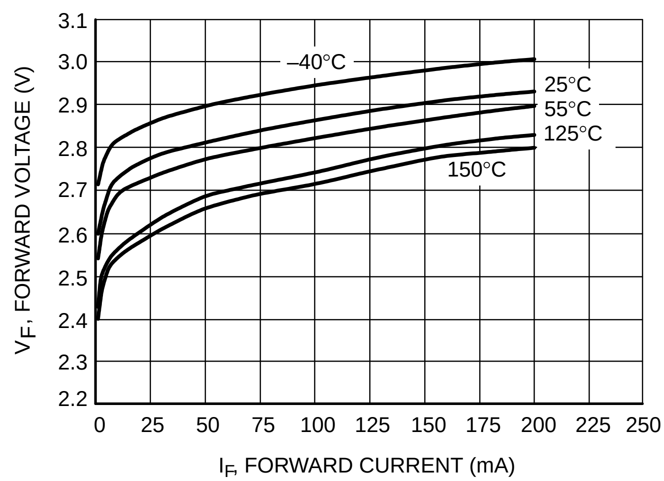


Figure 5. Forward Voltage

BAS21HT1

Preferred Device

High Voltage Switching Diode

- Device Marking: JS

ON Semiconductor™

http://onsemi.com

HIGH VOLTAGE SWITCHING DIODE

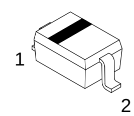
MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Continuous Reverse Voltage	250	Vdc
I_F	Peak Forward Current	200	mAdc
$I_{FM(surge)}$	Peak Forward Surge Current	625	mAdc

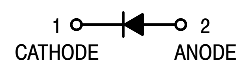
THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C Derate above 25°C	200 1.57	mW mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature Range	–55 to +150	°C

*FR–5 Minimum Pad



PLASTIC
SOD–323
CASE 477



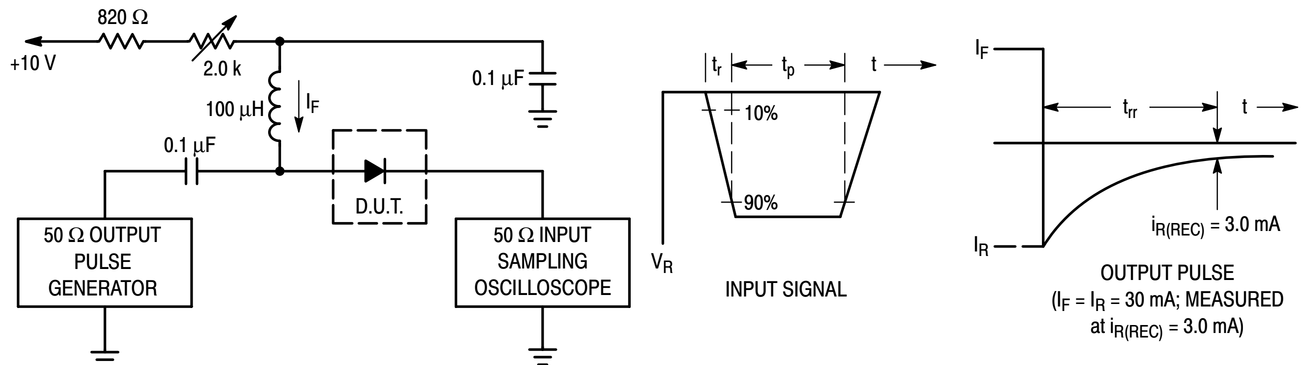
ORDERING INFORMATION

Device	Package	Shipping
BAS21HT1	SOD–323	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Voltage Leakage Current (V_R = 200 Vdc) (V_R = 200 Vdc, T_J = 150°C)	I_R	 — —	 1.0 100	μAdc
Reverse Breakdown Voltage (I_{BR} = 100 μAdc)	$V_{(BR)}$	250	—	Vdc
Forward Voltage (I_F = 100 mAdc) (I_F = 200 mAdc)	V_F	 — —	 1000 1250	mV
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	5.0	pF
Reverse Recovery Time (I_F = I_R = 30 mAdc, R_L = 100 Ω)	t_{rr}	—	50	ns



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 30 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 30 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

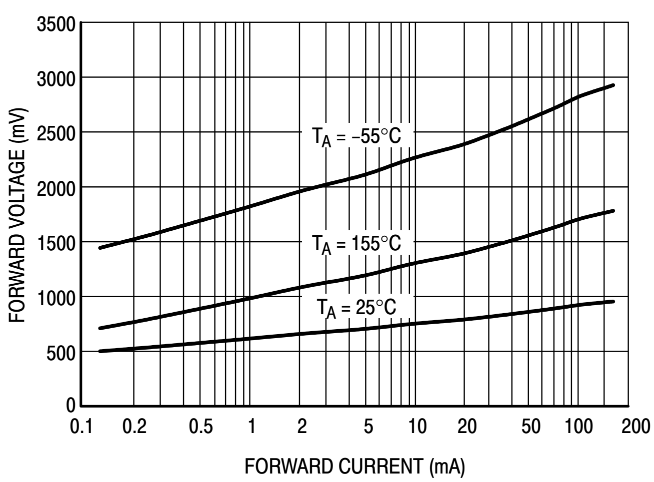


Figure 2. Forward Voltage

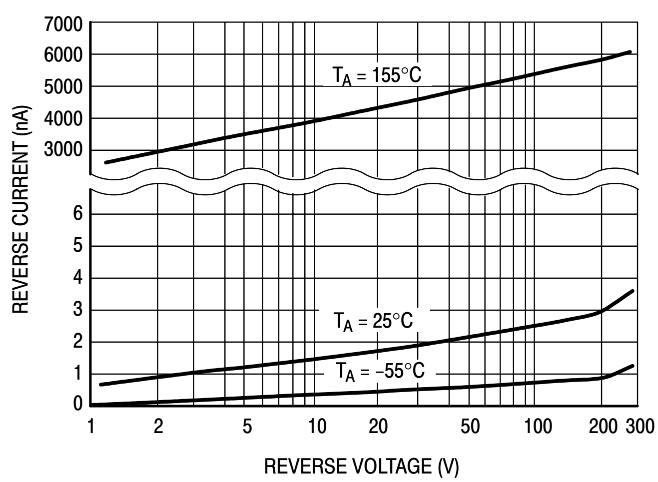
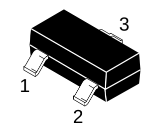


Figure 3. Reverse Leakage

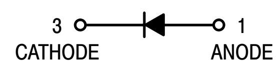
High Voltage Switching Diode

BAS21LT1

ON Semiconductor Preferred Device



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	250	Vdc
Peak Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	625	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BAS21LT1 = JS

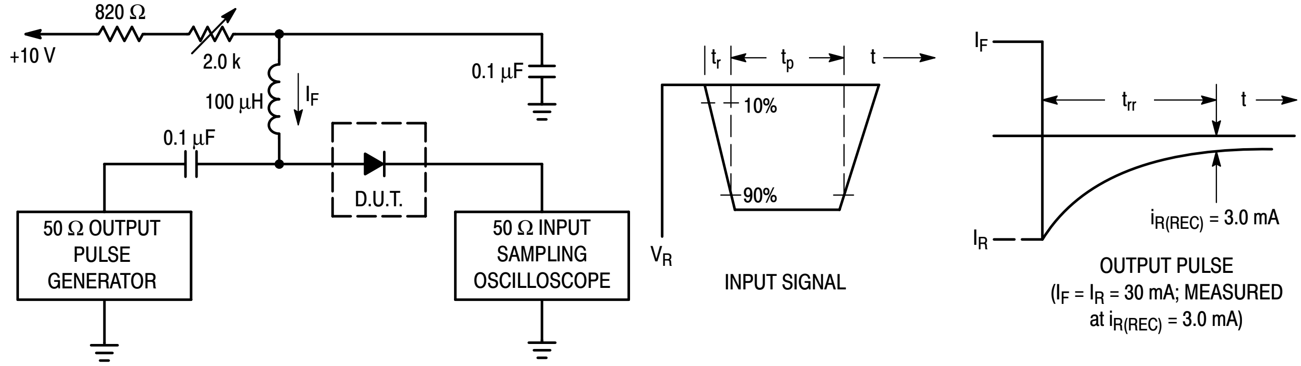
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Voltage Leakage Current (V_R = 200 Vdc) (V_R = 200 Vdc, T_J = 150°C)	I_R	 — —	 1.0 100	µAdc
Reverse Breakdown Voltage (I_{BR} = 100 µAdc)	$V_{(BR)}$	250	—	Vdc
Forward Voltage (I_F = 100 mAdc) (I_F = 200 mAdc)	V_F	 — —	 1000 1250	mV
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	5.0	pF
Reverse Recovery Time (I_F = I_R = 30 mAdc, R_L = 100 Ω)	t_{rr}	—	50	ns

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

Thermal Clad is a trademark of the Bergquist Company



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 30 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 30 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

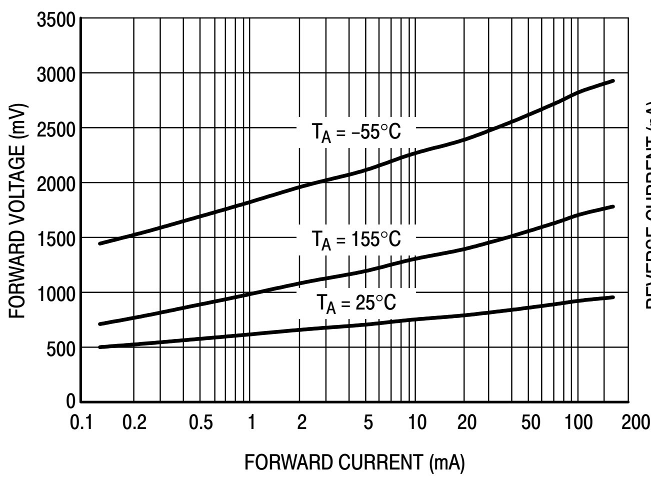


Figure 2. Forward Voltage

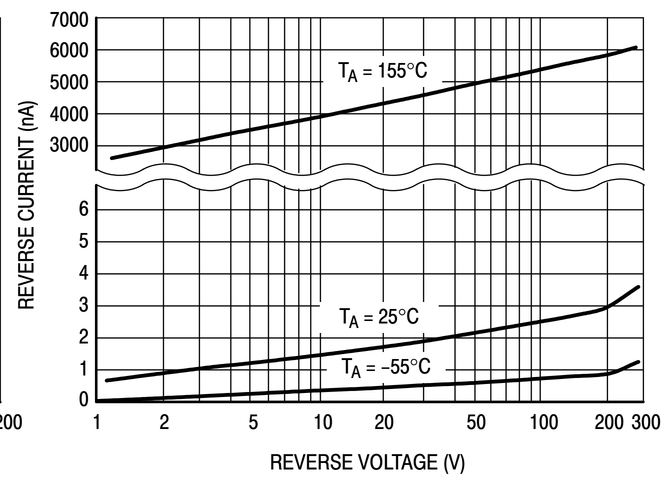


Figure 3. Reverse Leakage

BAS21SLT1

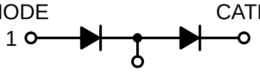
Preferred Device

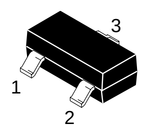
Dual Series High Voltage Switching Diode

- Moisture Sensitivity Level: 1
- ESD Rating – Human Body Model: Class 1
  – Machine Model: Class B

ON Semiconductor™

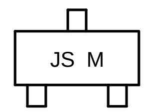
http://onsemi.com





SOT–23
CASE 318
STYLE 11

MARKING DIAGRAM



JS = Device Code
M = Date Code

ORDERING INFORMATION

Device	Package	Shipping
BAS21SLT1	SOT–23	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	250	Vdc
Peak Forward Current	I_F	225	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	625	mAdc

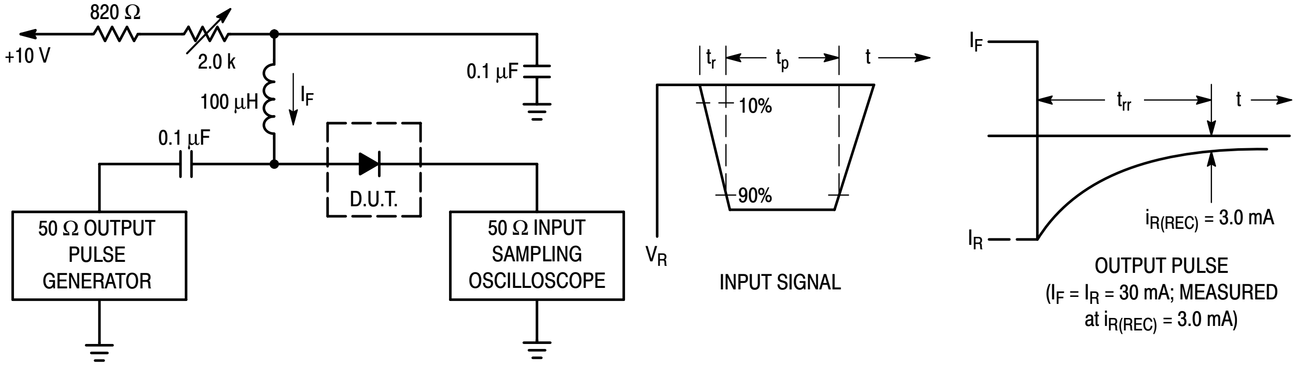
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board (Note 1.) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate, (Note 2.) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Voltage Leakage Current (V_R = 200 Vdc) (V_R = 200 Vdc, T_J = 150°C)	I_R	– –	1.0 100	μAdc
Reverse Breakdown Voltage (I_{BR} = 100 μAdc)	$V_{(BR)}$	250	–	Vdc
Forward Voltage (I_F = 100 mAdc) (I_F = 200 mAdc)	V_F	– –	1000 1250	mV
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	–	5.0	pF
Reverse Recovery Time (I_F = I_R = 30 mAdc, R_L = 100 Ω)	t_{rr}	–	50	ns

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 30 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 30 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

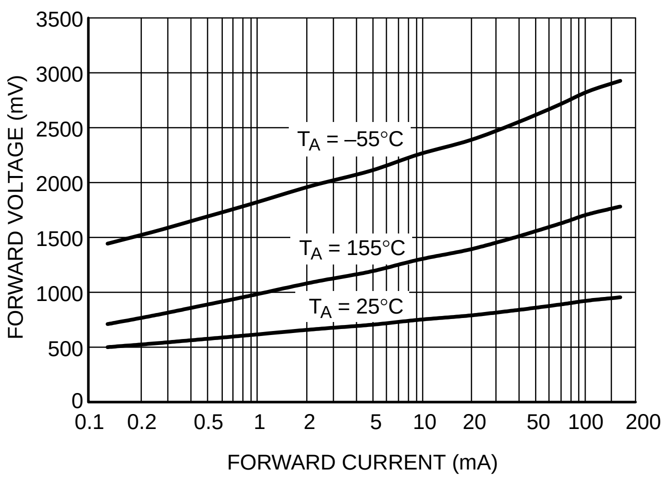


Figure 2. Forward Voltage

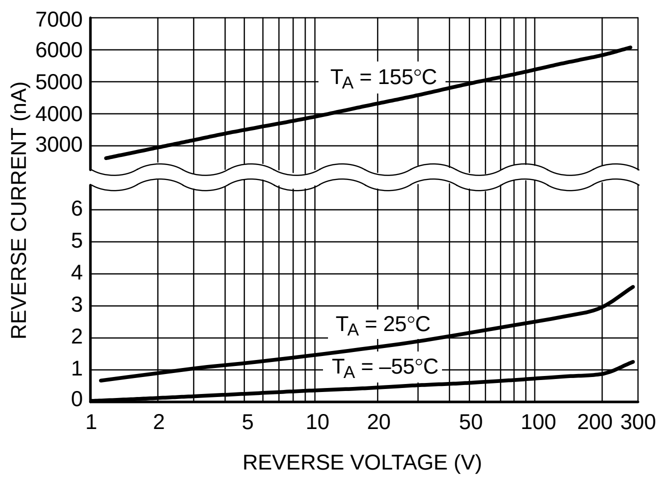


Figure 3. Reverse Leakage

BAS40-04LT1

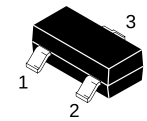
ON Semiconductor Preferred Device

Dual Series Schottky Barrier Diode

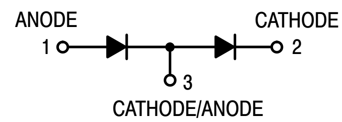
These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Low Forward Voltage

40 VOLTS
SCHOTTKY BARRIER DIODES



CASE 318–08, STYLE 11
SOT–23 (TO–236AB)



MAXIMUM RATINGS (T_J = 150°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	40	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 225 1.8	 mW mW/°C
Operating Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage (I_R = 10 µA)	$V_{(BR)R}$	40	—	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	—	5.0	pF
Reverse Leakage (V_R = 25 V)	I_R	—	1.0	µAdc
Forward Voltage (I_F = 0.1 mAdc)	V_F	—	380	mVdc
Forward Voltage (I_F = 30 mAdc)	V_F	—	500	mVdc
Forward Voltage (I_F = 100 mAdc)	V_F	—	1.0	Vdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

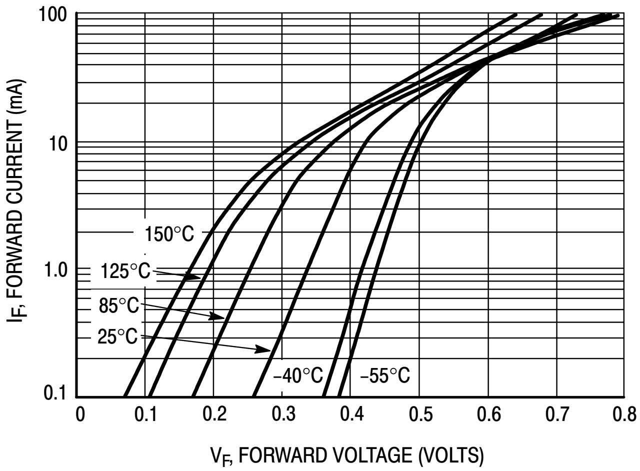


Figure 1. Typical Forward Voltage

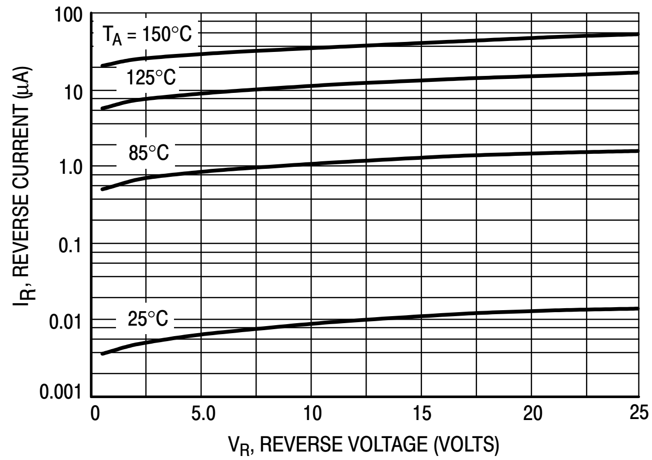


Figure 2. Reverse Current versus Reverse Voltage

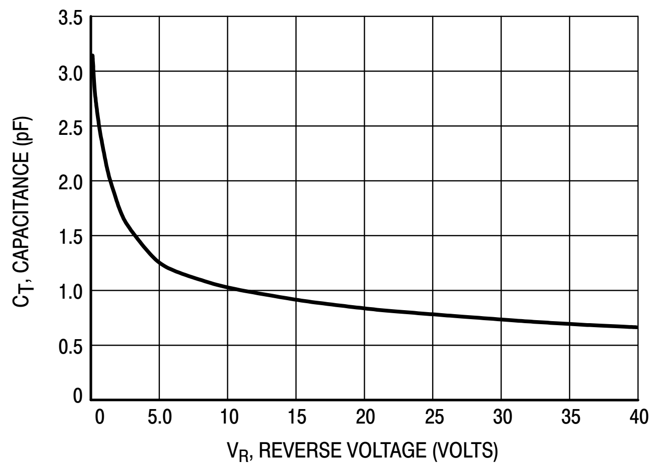


Figure 3. Typical Capacitance

BAS40-06LT1

Preferred Device

Common Anode Schottky Barrier Diodes

These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Low Forward Voltage
- Device Marking: L2

ON Semiconductor

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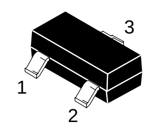
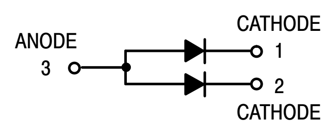
40 VOLTS
SCHOTTKY BARRIER DIODE



PLASTIC
SOT–23 (TO–236AB)
CASE 318



MAXIMUM RATINGS (T_J = 150°C unless otherwise noted)

Symbol	Rating	Value	Unit
V_R	Reverse Voltage	40	Volts

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_F	Forward Power Dissipation @ T_A = 25°C Derate above 25°C	 225 1.8	 mW mW/°C
T_J, T_{stg}	Operating Junction and Storage Temperature Range	–55 to +150	°C

ORDERING INFORMATION

Device	Package	Shipping
BAS40–06LT1	SOT–23	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	40	—	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	—	5.0	pF
Reverse Leakage (V_R = 25 V)	I_R	—	1.0	μAdc
Forward Voltage (I_F = 0.1 mAdc)	V_F	—	380	mVdc
Forward Voltage (I_F = 30 mAdc)	V_F	—	500	mVdc
Forward Voltage (I_F = 100 mAdc)	V_F	—	1.0	Vdc

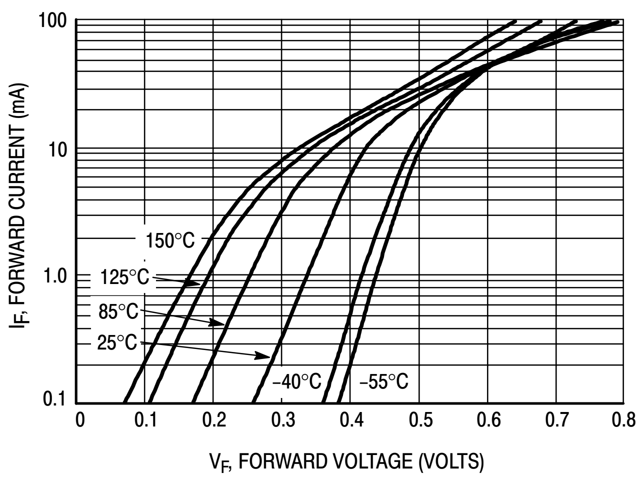


Figure 1. Typical Forward Voltage

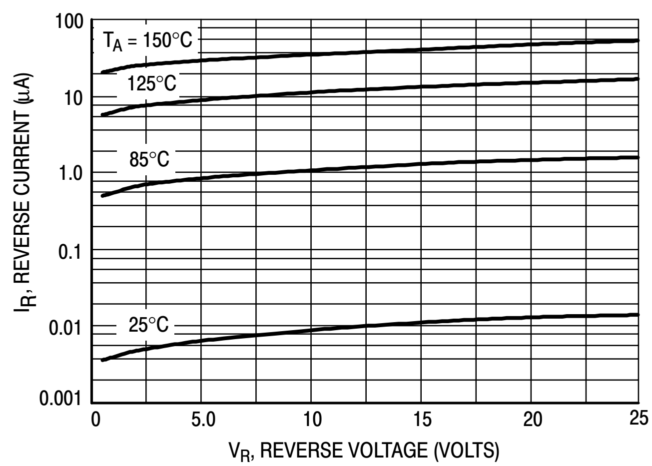


Figure 2. Reverse Current versus Reverse Voltage

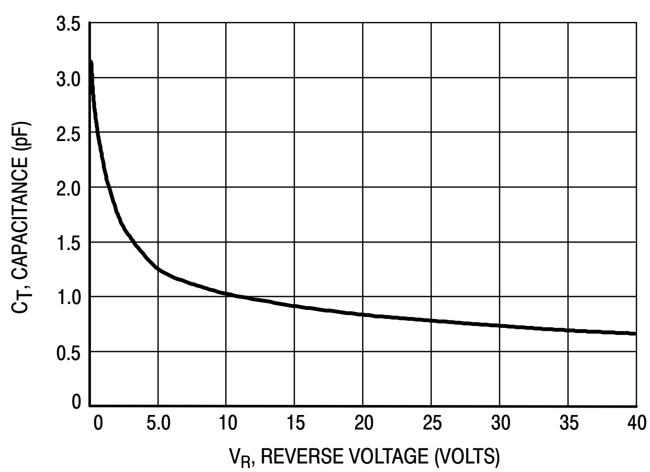


Figure 3. Typical Capacitance

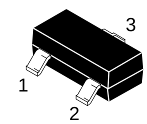
Schottky Barrier Diodes

These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

BAS40LT1

ON Semiconductor Preferred Device

40 VOLTS
SCHOTTKY BARRIER DIODES



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)

MAXIMUM RATINGS (T_J = 150°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	40	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 225 1.8	 mW mW/°C
Operating Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BAS40LT1 = B1

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	40	—	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	—	5.0	pF
Reverse Leakage (V_R = 25 V)	I_R	—	1.0	μAdc
Forward Voltage (I_F = 0.1 mAdc)	V_F	—	380	mVdc
Forward Voltage (I_F = 30 mAdc)	V_F	—	500	mVdc
Forward Voltage (I_F = 100 mAdc)	V_F	—	1.0	Vdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

Thermal Clad is a registered trademark of the Bergquist Company.

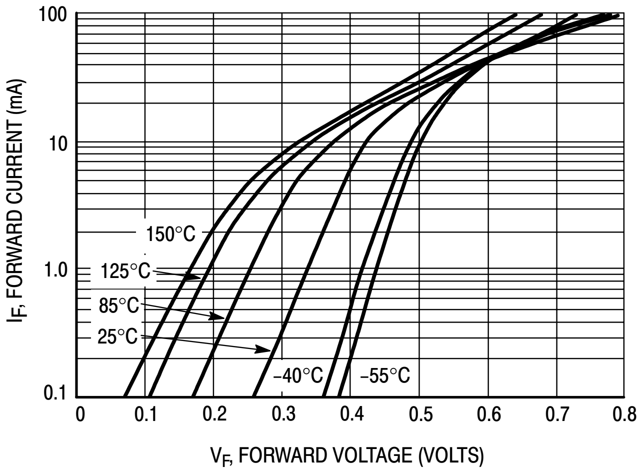


Figure 1. Typical Forward Voltage

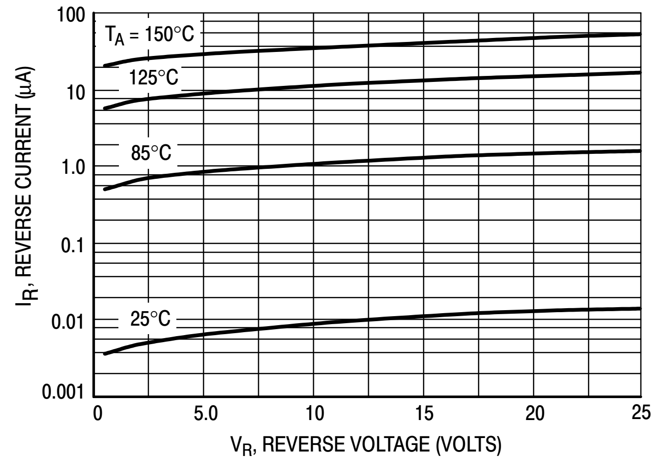


Figure 2. Reverse Current versus Reverse Voltage

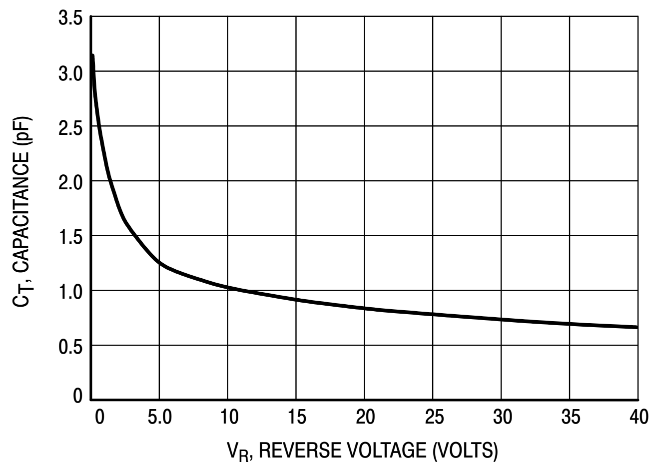


Figure 3. Typical Capacitance

BAS70-04LT1

Preferred Device

Dual Series Schottky Barrier Diode

These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Low Forward Voltage
- Device Marking: CG

MAXIMUM RATINGS (T_J = 150°C unless otherwise noted)

Symbol	Rating	Value	Unit
V_R	Reverse Voltage	70	Volts

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_F	Forward Power Dissipation @ T_A = 25°C Derate above 25°C	 225 1.8	 mW mW/°C
T_J, T_{stg}	Operating Junction and Storage Temperature Range	–55 to +150	°C

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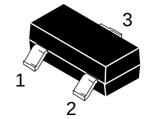
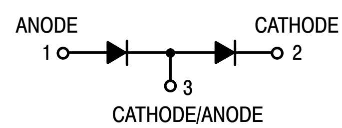
70 VOLTS
SCHOTTKY BARRIER DIODE



PLASTIC
SOT–23 (TO–236AB)
CASE 318



ORDERING INFORMATION

Device	Package	Shipping
BAS70–04LT1	SOT–23	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	70	—	Volts
Total Capacitance (V_R = 0 V, f = 1.0 MHz)	C_T	—	2.0	pF
Reverse Leakage (V_R = 50 V) (V_R = 70 V)	I_R	— —	0.1 10	μAdc
Forward Voltage (I_F = 1.0 mAdc)	V_F	—	410	mVdc
Forward Voltage (I_F = 10 mAdc)	V_F	—	750	mVdc
Forward Voltage (I_F = 15 mAdc)	V_F	—	1.0	Vdc

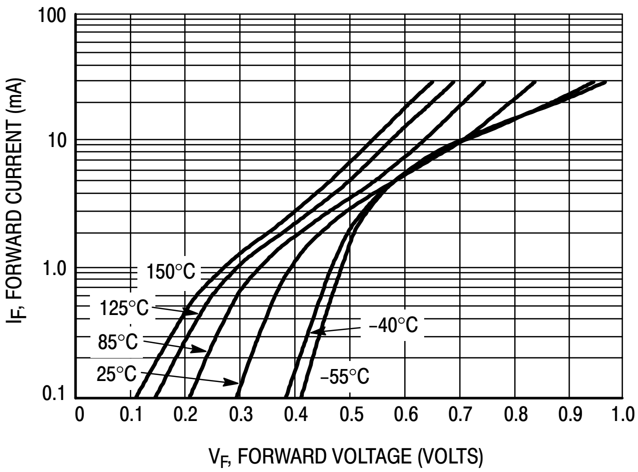


Figure 1. Typical Forward Voltage

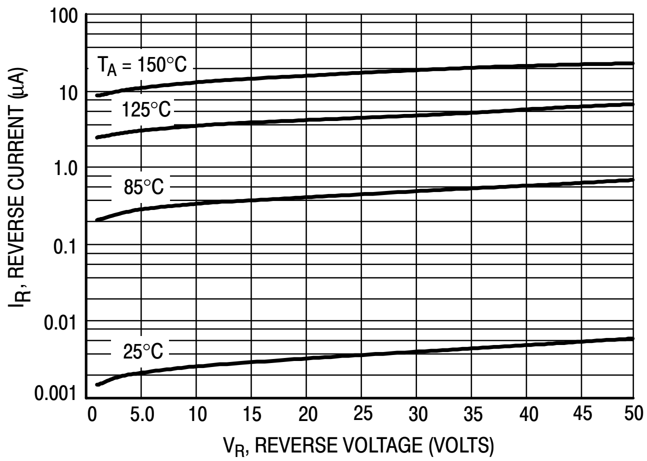


Figure 2. Reverse Current versus Reverse Voltage

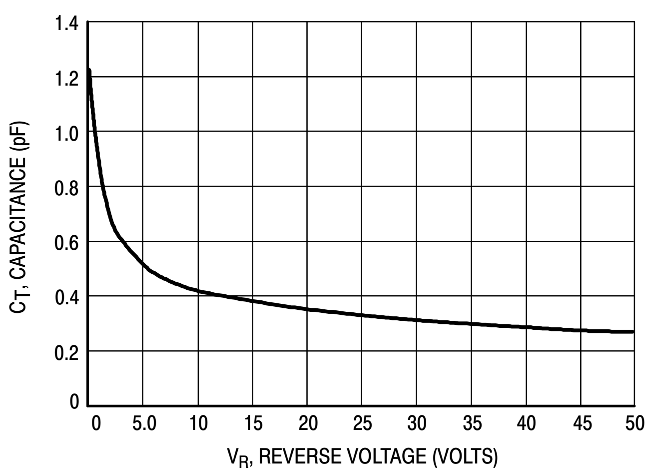


Figure 3. Typical Capacitance

Schottky Barrier Diodes

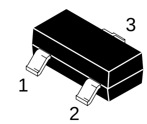
These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Low Forward Voltage

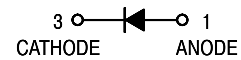
BAS70LT1

ON Semiconductor Preferred Device

70 VOLTS
SCHOTTKY BARRIER DIODES



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



MAXIMUM RATINGS (T_J = 150°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 225 1.8	 mW mW/°C
Operating Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BAS70LT1 = BE

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	70	—	Volts
Total Capacitance (V_R = 0 V, f = 1.0 MHz)	C_T	—	2.0	pF
Reverse Leakage (V_R = 50 V) (V_R = 70 V)	I_R	— —	0.1 10	μAdc
Forward Voltage (I_F = 1.0 mAdc)	V_F	—	410	mVdc
Forward Voltage (I_F = 10 mAdc)	V_F	—	750	mVdc
Forward Voltage (I_F = 15 mAdc)	V_F	—	1.0	Vdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

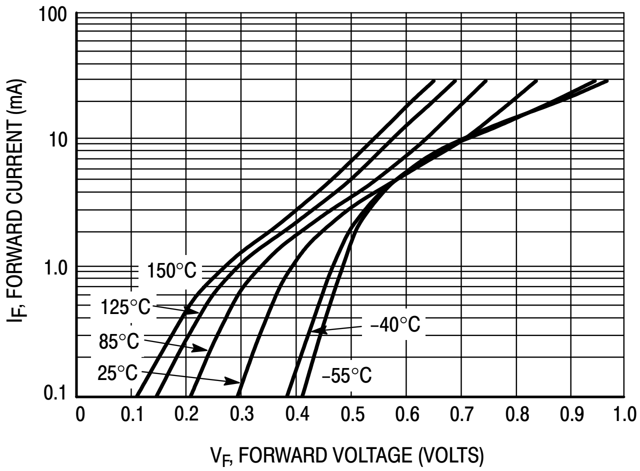


Figure 1. Typical Forward Voltage

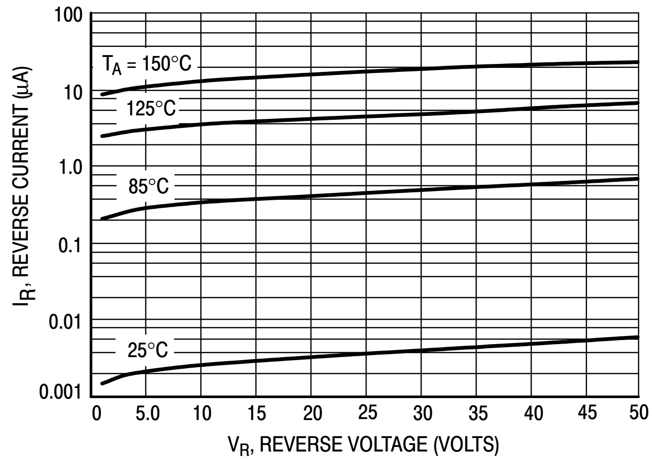


Figure 2. Reverse Current versus Reverse Voltage

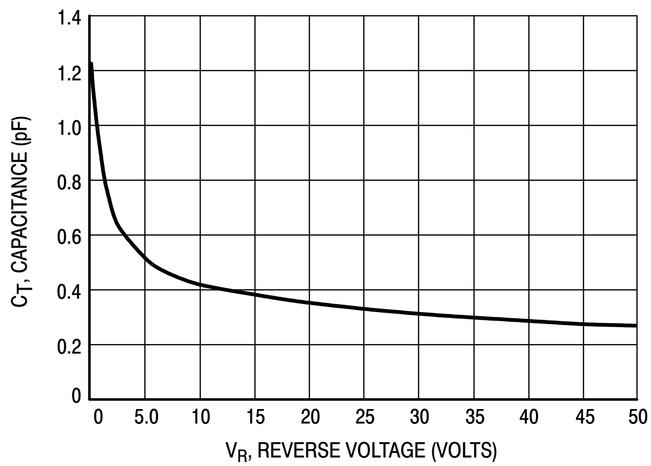


Figure 3. Typical Capacitance

BAT54ALT1

Preferred Device

Schottky Barrier Diodes

These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Low Forward Voltage – 0.35 Volts (Typ) @ I_F = 10 mAdc

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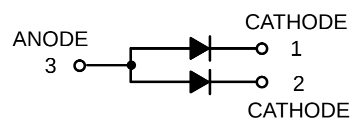
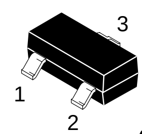
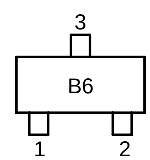
30 VOLTS SCHOTTKY BARRIER DETECTOR AND SWITCHING DIODES



MARKING DIAGRAM





(TO–236AB)
SOT–23
CASE 318
STYLE 12

MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 225 1.8	 mW mW/°C
Forward Current (DC)	I_F	200 Max	mA
Junction Temperature	T_J	125 Max	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

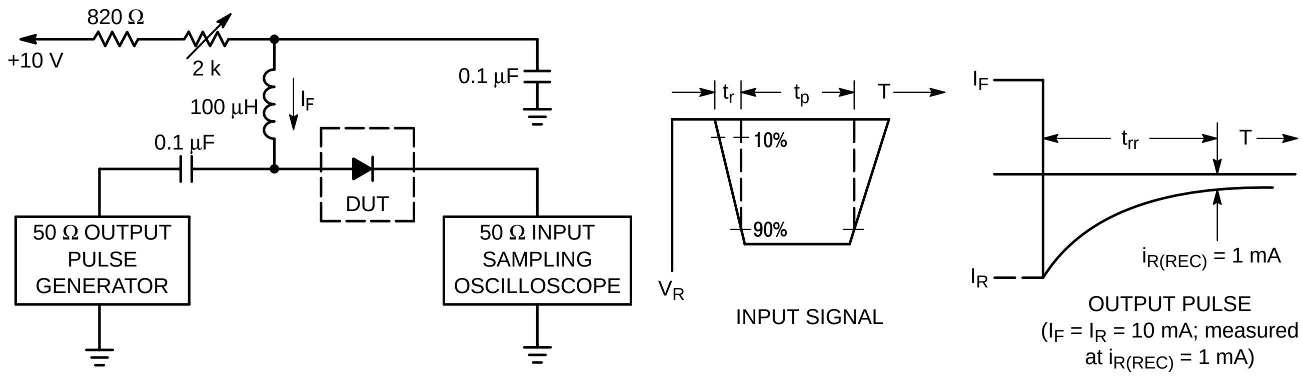
ORDERING INFORMATION

Device	Package	Shipping
BAT54ALT1	SOT–23	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (EACH DIODE)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	30	–	–	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	–	7.6	10	pF
Reverse Leakage (V_R = 25 V)	I_R	–	0.5	2.0	μAdc
Forward Voltage (I_F = 0.1 mAdc)	V_F	–	0.22	0.24	Vdc
Forward Voltage (I_F = 30 mAdc)	V_F	–	0.41	0.5	Vdc
Forward Voltage (I_F = 100 mAdc)	V_F	–	0.52	0.8	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc, Figure 1)	t_{rr}	–	–	5.0	ns
Forward Voltage (I_F = 1.0 mAdc)	V_F	–	0.29	0.32	Vdc
Forward Voltage (I_F = 10 mAdc)	V_F	–	0.35	0.40	Vdc
Forward Current (DC)	I_F	–	–	200	mAdc
Repetitive Peak Forward Current	I_{FRM}	–	–	300	mAdc
Non–Repetitive Peak Forward Current (t < 1.0 s)	I_{FSM}	–	–	600	mAdc



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

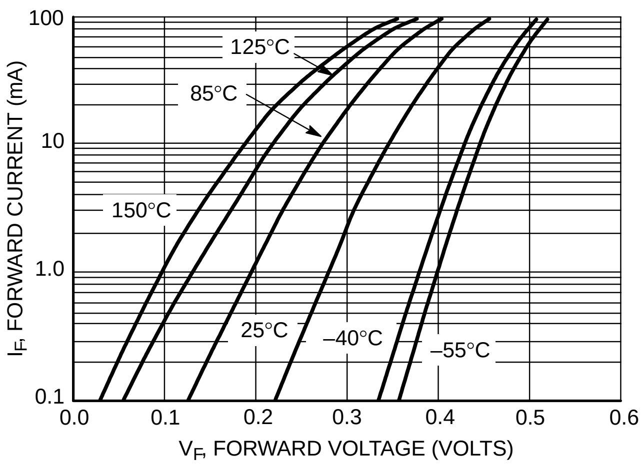


Figure 2. Forward Voltage

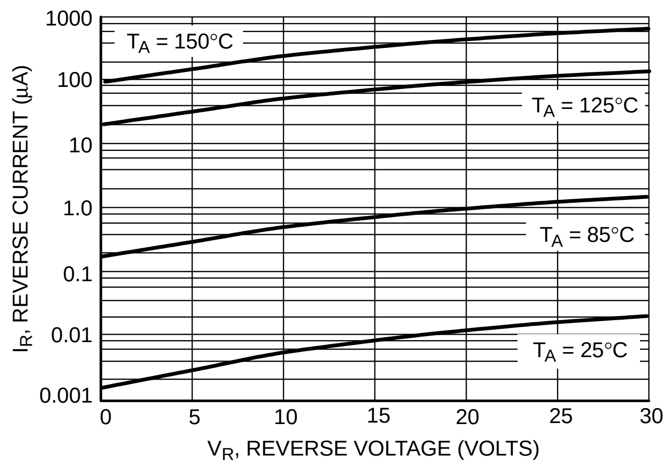


Figure 3. Leakage Current

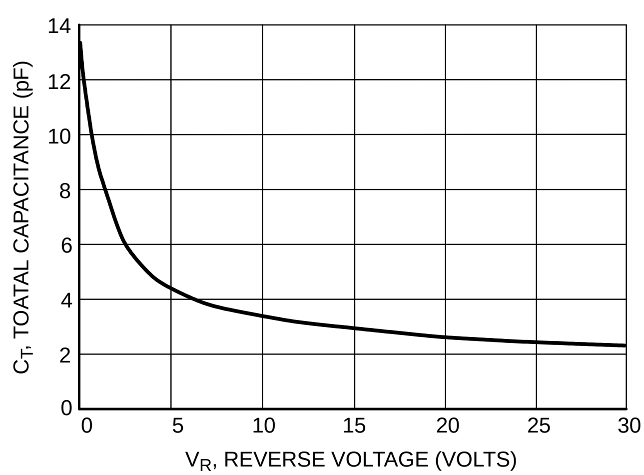


Figure 4. Total Capacitance

BAT54HT1

Preferred Device

Schottky Barrier Diodes

These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Low Forward Voltage — 0.35 Volts (Typ) @ I_F = 10 mAdc
- Device Marking: JV

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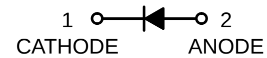
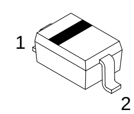
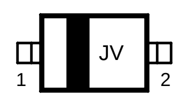
30 VOLT SILICON HOT–CARRIER DETECTOR AND SWITCHING DIODES



MARKING DIAGRAM





PLASTIC SOD–323 CASE 477

MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	V

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board, (Note 1.) T_A = 25°C Derate above 25°C	P_D	200 1.57	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	635	°C/W
Junction and Storage Temperature	T_J, T_{stg}	150	°C

1. FR–4 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
BAT54HT1	SOD–323	3000/Tape & Reel

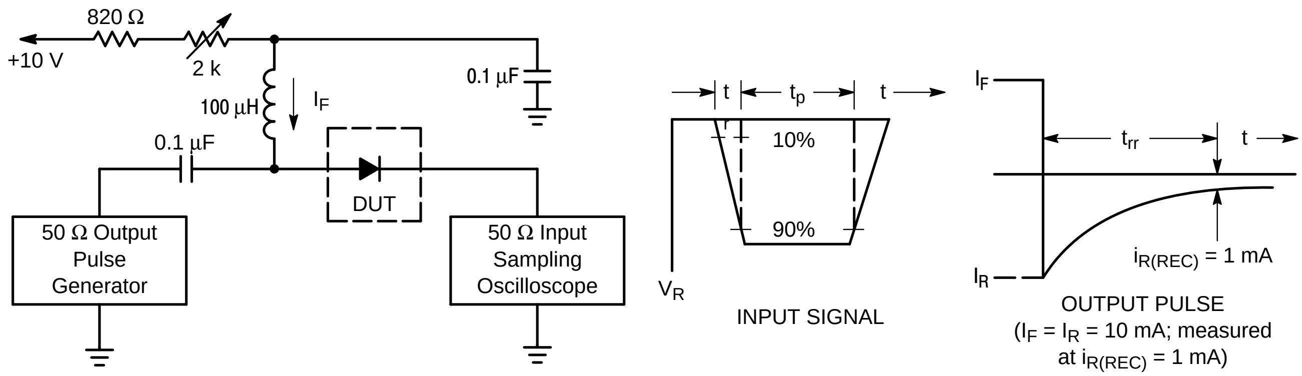
Preferred devices are recommended choices for future use and best overall value.

November, 2000 – Rev. 1

Publication Order Number:
BAT54HT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 µA)	$V_{(BR)R}$	30	—	—	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	—	7.6	10	pF
Reverse Leakage (V_R = 25 V)	I_R	—	0.5	2.0	µAdc
Forward Voltage (I_F = 0.1 mAdc)	V_F	—	0.22	0.24	Vdc
Forward Voltage (I_F = 30 mAdc)	V_F	—	0.41	0.5	Vdc
Forward Voltage (I_F = 100 mAdc)	V_F	—	0.52	0.8	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc) Figure 1	t_{rr}	—	—	5.0	ns
Forward Voltage (I_F = 1.0 mAdc)	V_F	—	0.29	0.32	Vdc
Forward Voltage (I_F = 10 mAdc)	V_F	—	0.35	0.40	Vdc
Forward Current (DC)	I_F	—	—	200	mAdc
Repetitive Peak Forward Current	I_{FRM}	—	—	300	mAdc
Non–Repetitive Peak Forward Current (t < 1.0 s)	I_{FSM}	—	—	600	mAdc



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

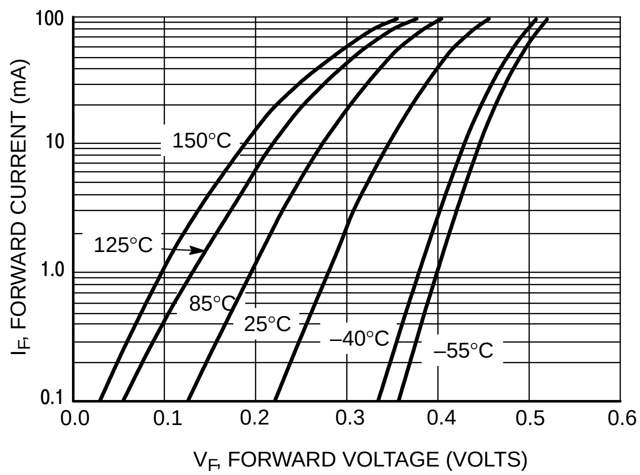


Figure 2. Forward Voltage

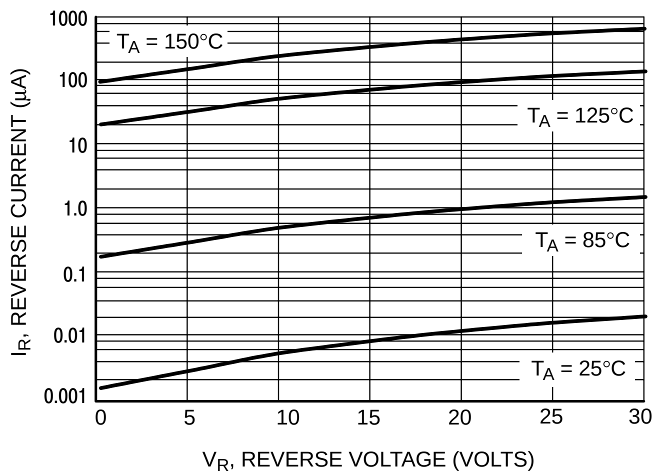


Figure 3. Leakage Current

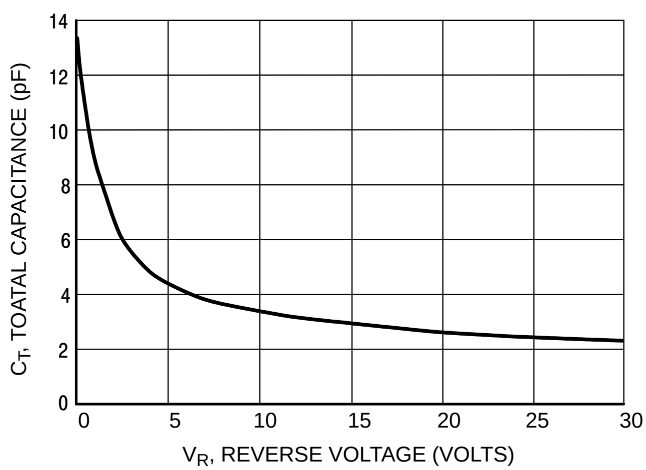


Figure 4. Total Capacitance

BAT54HT1

Preferred Device

Schottky Barrier Diodes

These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Low Forward Voltage — 0.35 Volts (Typ) @ I_F = 10 mAdc
- Device Marking: JV

MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	V

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board, (Note 1.) T_A = 25°C Derate above 25°C	P_D	200 1.57	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	635	°C/W
Junction and Storage Temperature	T_J, T_{stg}	150	°C

1. FR–4 Minimum Pad

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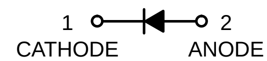
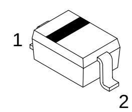
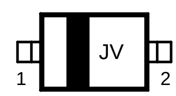
http://onsemi.com

30 VOLT SILICON HOT–CARRIER DETECTOR AND SWITCHING DIODES



MARKING DIAGRAM





PLASTIC SOD–323 CASE 477

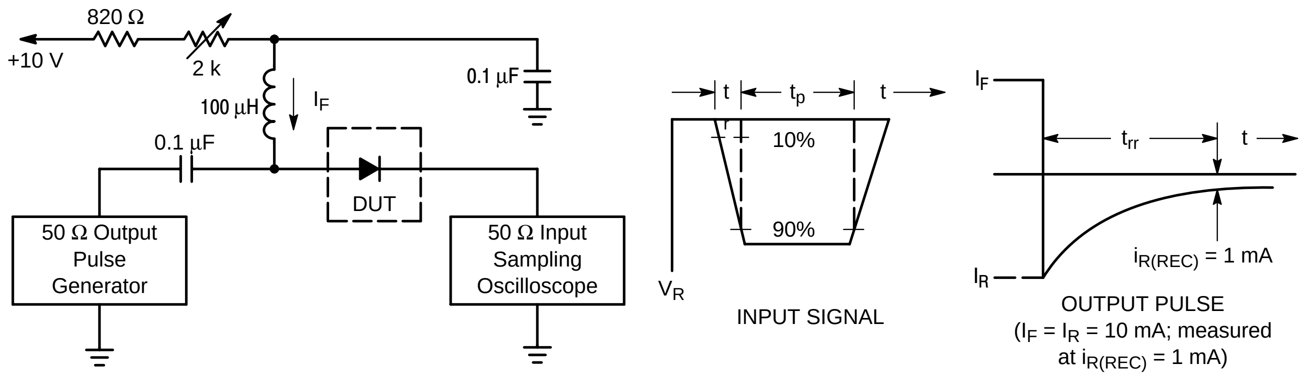
ORDERING INFORMATION

Device	Package	Shipping
BAT54HT1	SOD–323	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 µA)	$V_{(BR)R}$	30	—	—	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	—	7.6	10	pF
Reverse Leakage (V_R = 25 V)	I_R	—	0.5	2.0	µAdc
Forward Voltage (I_F = 0.1 mAdc)	V_F	—	0.22	0.24	Vdc
Forward Voltage (I_F = 30 mAdc)	V_F	—	0.41	0.5	Vdc
Forward Voltage (I_F = 100 mAdc)	V_F	—	0.52	0.8	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc) Figure 1	t_{rr}	—	—	5.0	ns
Forward Voltage (I_F = 1.0 mAdc)	V_F	—	0.29	0.32	Vdc
Forward Voltage (I_F = 10 mAdc)	V_F	—	0.35	0.40	Vdc
Forward Current (DC)	I_F	—	—	200	mAdc
Repetitive Peak Forward Current	I_{FRM}	—	—	300	mAdc
Non–Repetitive Peak Forward Current (t < 1.0 s)	I_{FSM}	—	—	600	mAdc



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p » t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

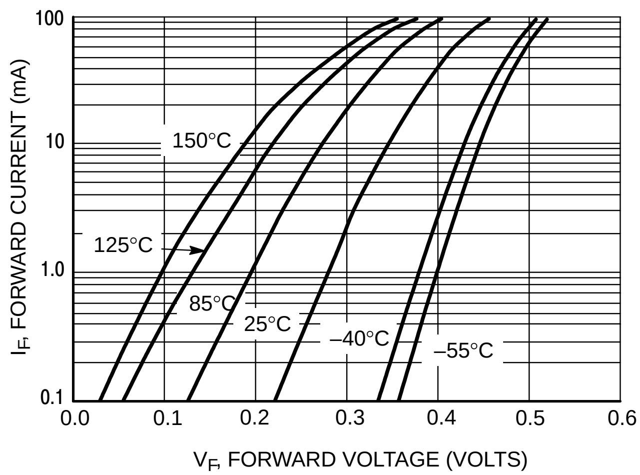


Figure 2. Forward Voltage

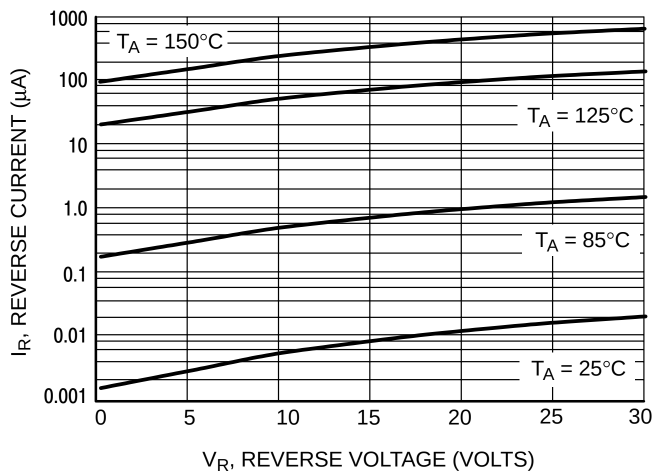


Figure 3. Leakage Current

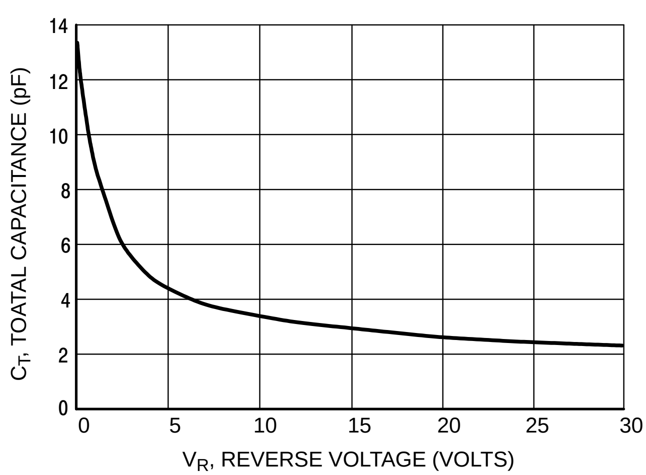


Figure 4. Total Capacitance

BAT54LT1

Preferred Device

Schottky Barrier Diodes

These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Low Forward Voltage – 0.35 Volts (Typ) @ I_F = 10 mAdc

MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 200 2.0	 mW mW/°C
Forward Current (DC)	I_F	200 Max	mA
Junction Temperature	T_J	125 Max	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

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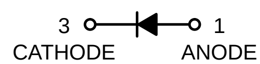
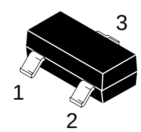
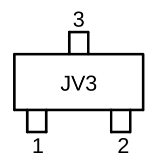
30 VOLTS
SILICON HOT–CARRIER DETECTOR AND SWITCHING DIODES



MARKING DIAGRAM



(TO–236AB)
SOT–23
CASE 318
STYLE 8



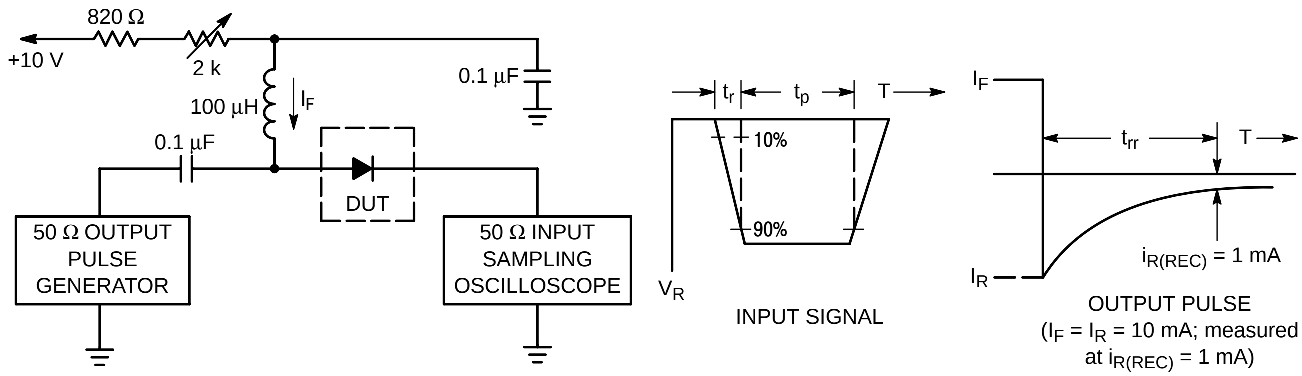
ORDERING INFORMATION

Device	Package	Shipping
BAT54LT1	SOT–23	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	30	–	–	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	–	7.6	10	pF
Reverse Leakage (V_R = 25 V)	I_R	–	0.5	2.0	μAdc
Forward Voltage (I_F = 0.1 mAdc)	V_F	–	0.22	0.24	Vdc
Forward Voltage (I_F = 30 mAdc)	V_F	–	0.41	0.5	Vdc
Forward Voltage (I_F = 100 mAdc)	V_F	–	0.52	0.8	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc, Figure 1)	t_{rr}	–	–	5.0	ns
Forward Voltage (I_F = 1.0 mAdc)	V_F	–	0.29	0.32	Vdc
Forward Voltage (I_F = 10 mAdc)	V_F	–	0.35	0.40	Vdc
Forward Current (DC)	I_F	–	–	200	mAdc
Repetitive Peak Forward Current	I_{FRM}	–	–	300	mAdc
Non–Repetitive Peak Forward Current (t < 1.0 s)	I_{FSM}	–	–	600	mAdc



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

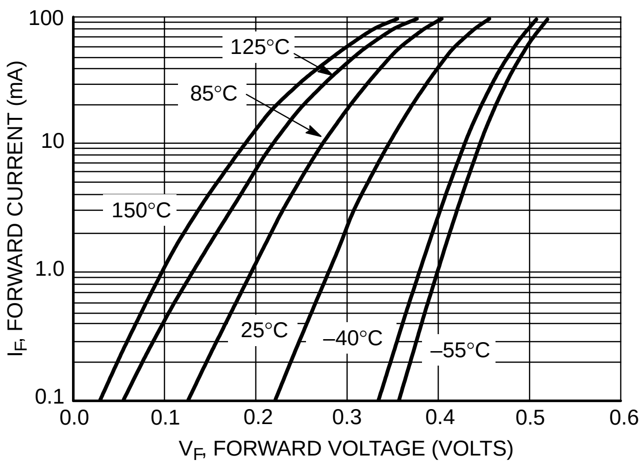


Figure 2. Forward Voltage

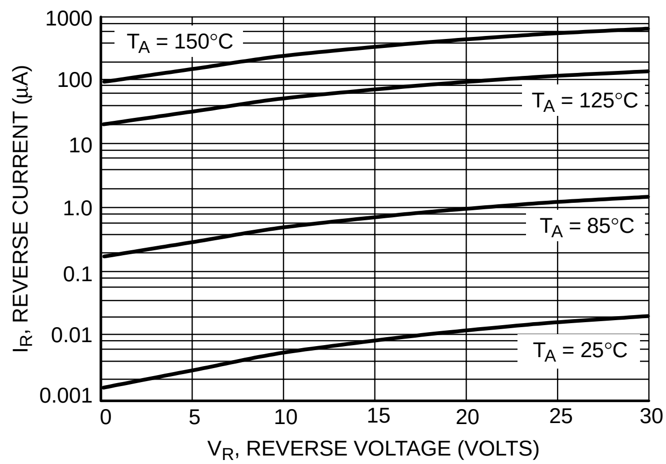


Figure 3. Leakage Current

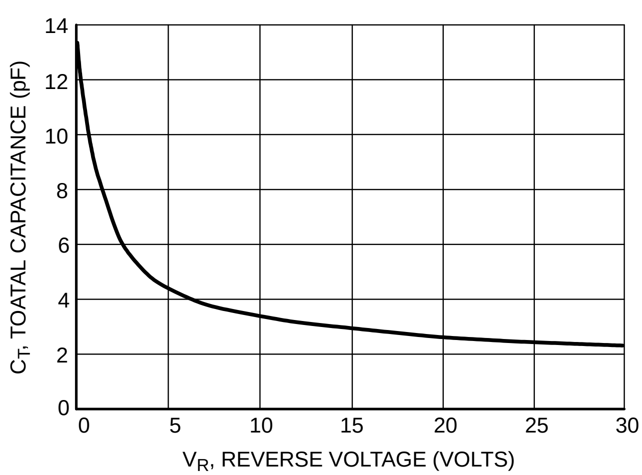


Figure 4. Total Capacitance

BAT54SLT1

Preferred Device

Dual Series Schottky Barrier Diodes

These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Low Forward Voltage – 0.35 Volts (Typ) @ I_F = 10 mAdc

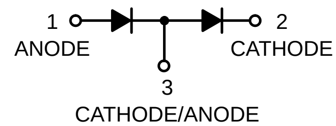
MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

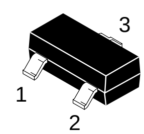
Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 225 1.8	 mW mW/°C
Forward Current (DC)	I_F	200 Max	mA
Junction Temperature	T_J	125 Max	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

ON Semiconductor™

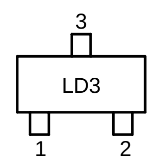
http://onsemi.com

30 VOLT DUAL HOT–CARRIER DETECTOR AND SWITCHING DIODES





MARKING DIAGRAM



(TO–236AB)
SOT–23
CASE 318
STYLE 11

ORDERING INFORMATION

Device	Package	Shipping
BAT54SLT1	SOT–23	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

November, 2000 – Rev. 6

Publication Order Number:
BAT54SLT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (EACH DIODE)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	30	–	–	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	–	7.6	10	pF
Reverse Leakage (V_R = 25 V)	I_R	–	0.5	2.0	μAdc
Forward Voltage (I_F = 0.1 mAdc)	V_F	–	0.22	0.24	Vdc
Forward Voltage (I_F = 30 mAdc)	V_F	–	0.41	0.5	Vdc
Forward Voltage (I_F = 100 mAdc)	V_F	–	0.52	0.8	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc, Figure 1)	t_{rr}	–	–	5.0	ns
Forward Voltage (I_F = 1.0 mAdc)	V_F	–	0.29	0.32	Vdc
Forward Voltage (I_F = 10 mAdc)	V_F	–	0.35	0.40	Vdc
Forward Current (DC)	I_F	–	–	200	mAdc
Repetitive Peak Forward Current	I_{FRM}	–	–	300	mAdc
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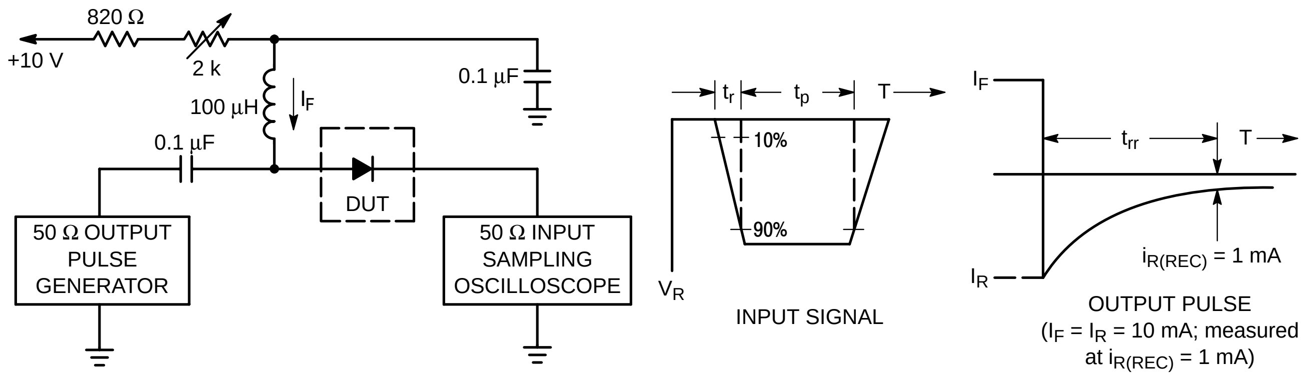

Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

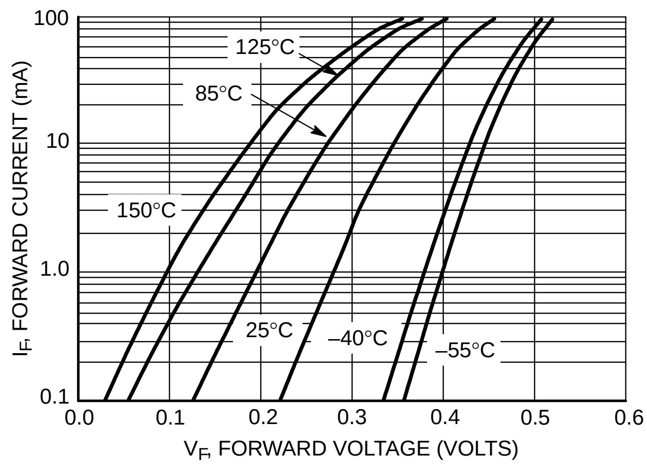

Figure 2. Forward Voltage

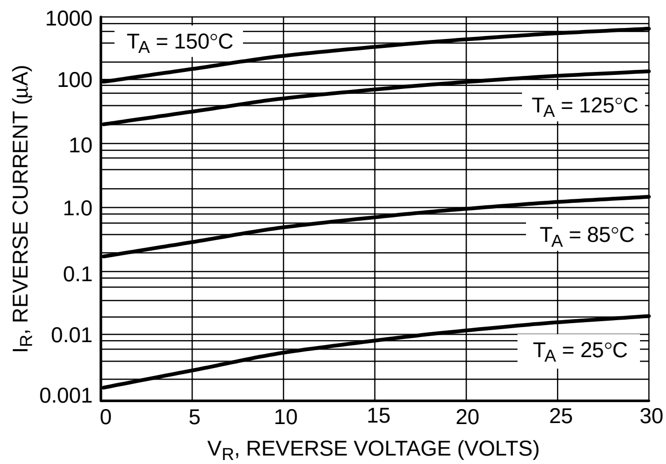

Figure 3. Leakage Current

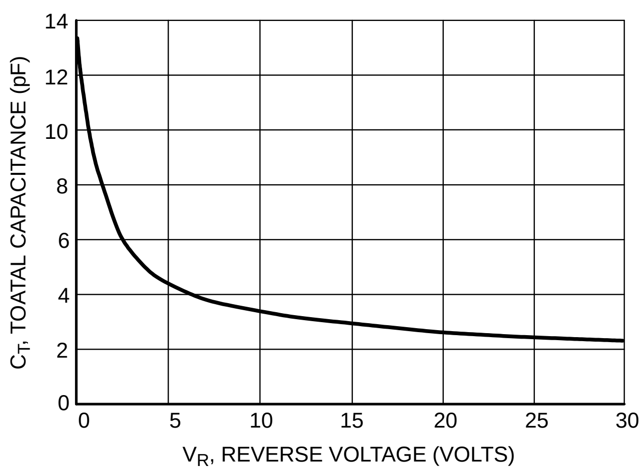

Figure 4. Total Capacitance

BAT54SWT1

Preferred Device

Dual Series Schottky Barrier Diodes

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- Extremely Fast Switching Speed
- Low Forward Voltage – 0.35 Volts (Typ) @ I_F = 10 mAdc

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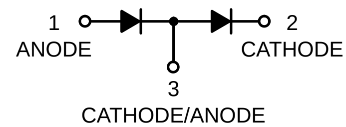
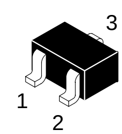
30 VOLT DUAL SERIES SCHOTTKY BARRIER DIODES



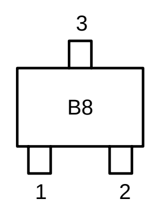
MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 200 1.6	 mW mW/°C
Forward Current (DC)	I_F	200 Max	mA
Junction Temperature	T_J	125 Max	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

MARKING DIAGRAM



(SC–70)
SOT–323
CASE 419
STYLE 9



ORDERING INFORMATION

Device	Package	Shipping
BAT54SWT1	SOT–323	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (EACH DIODE)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	30	–	–	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	–	7.6	10	pF
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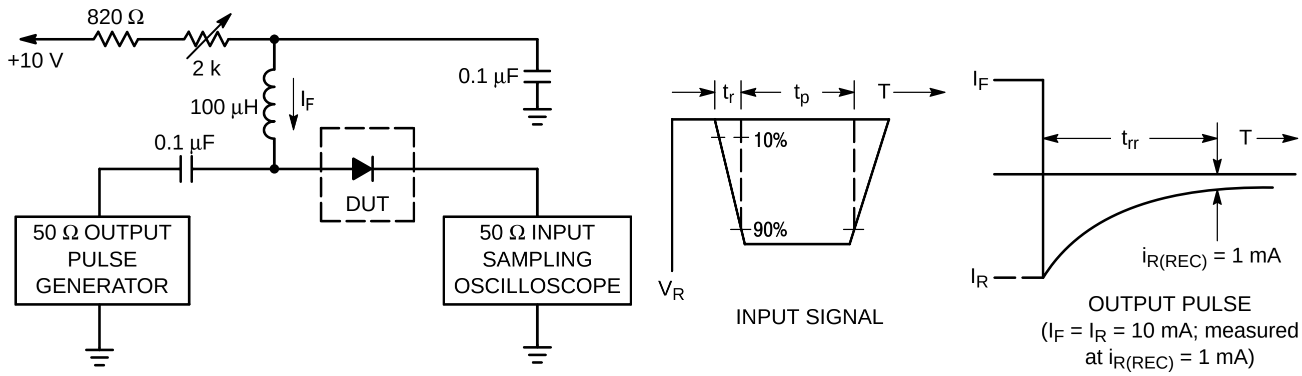
Forward Voltage (I_F = 30 mAdc)	V_F	–	0.41	0.5	Vdc
Forward Voltage (I_F = 100 mAdc)	V_F	–	0.52	0.8	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc, Figure 1)	t_{rr}	–	–	5.0	ns
Forward Voltage (I_F = 1.0 mAdc)	V_F	–	0.29	0.32	Vdc
Forward Voltage (I_F = 10 mAdc)	V_F	–	0.35	0.40	Vdc
Forward Current (DC)	I_F	–	–	200	mAdc
Repetitive Peak Forward Current	I_{FRM}	–	–	300	mAdc
Non–Repetitive Peak Forward Current (t < 1.0 s)	I_{FSM}	–	–	600	mAdc



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

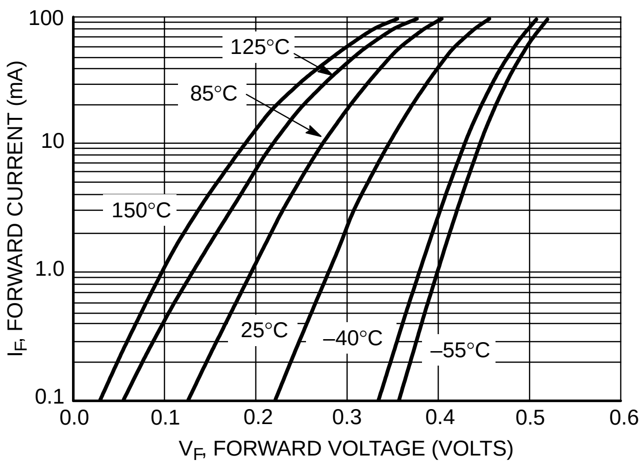


Figure 2. Forward Voltage

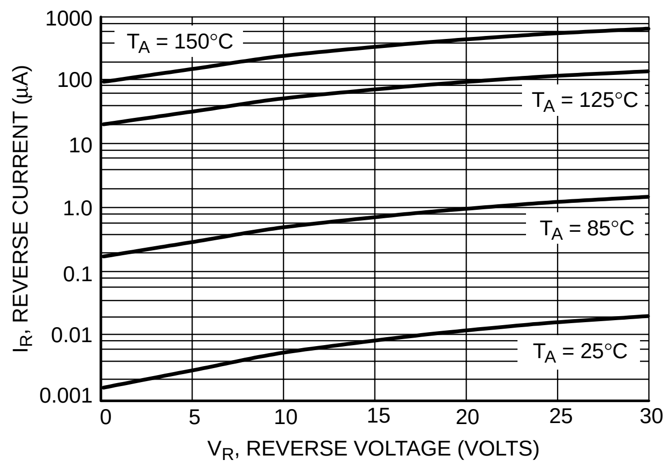


Figure 3. Leakage Current

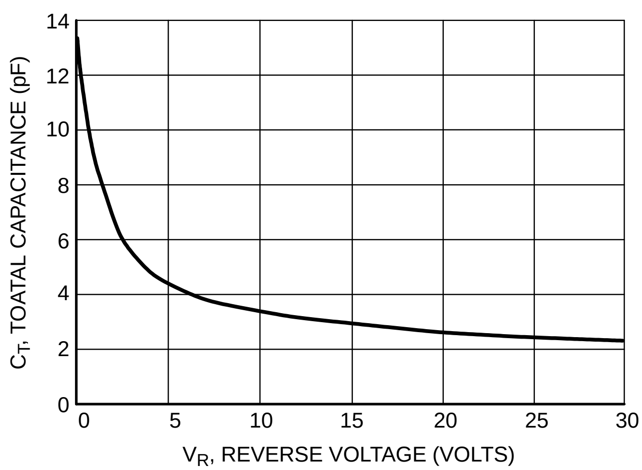


Figure 4. Total Capacitance

BAT54T1

Preferred Device

Schottky Barrier Diodes

These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Low Forward Voltage – 0.35 Volts (Typ) @ I_F = 10 mAdc

MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

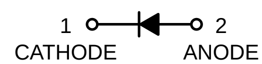
Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Volts
Forward Power Dissipation, FR–5 Board (Note 1.) @ T_A = 25°C Derate above 25°C	P_F	 400 3.2	 mW mW/°C
Thermal Resistance, Junction to Case	$R_{\theta JL}$	174	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	492	°C/W
Forward Current (DC)	I_F	200 Max	mA
Non–Repetitive Peak Forward Current t_p < 10 msec	I_{FSM}	600	mA
Repetitive Peak Forward Current Pulse Wave = 1 sec, Duty Cycle = 66%	I_{FRM}	300	mA
Junction Temperature	T_J	125 Max	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

1. FR-5 = 1.0 x 0.75 x 0.062 in.

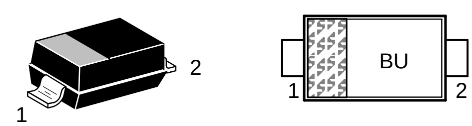
ON Semiconductor™

http://onsemi.com

30 VOLT SCHOTTKY BARRIER DETECTOR AND SWITCHING DIODES



MARKING DIAGRAM



SOD–123
CASE 425
STYLE 1

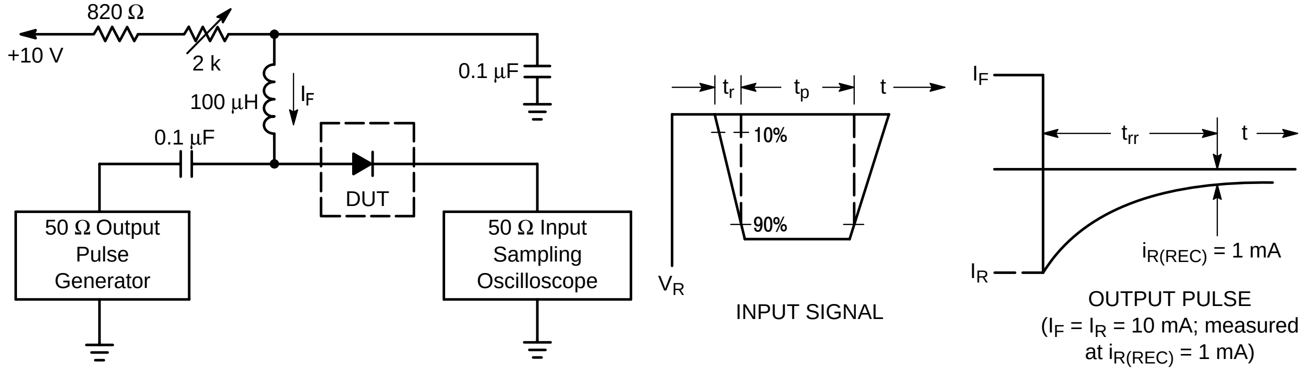
ORDERING INFORMATION

Device	Package	Shipping
BAT54T1	SOD–123	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	30	–	–	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	–	7.6	10	pF
Reverse Leakage (V_R = 25 V)	I_R	–	0.5	2.0	μAdc
Forward Voltage (I_F = 0.1 mAdc)	V_F	–	0.22	0.24	Vdc
Forward Voltage (I_F = 30 mAdc)	V_F	–	0.41	0.5	Vdc
Forward Voltage (I_F = 100 mAdc)	V_F	–	0.52	0.8	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc, Figure 1)	t_{rr}	–	–	5.0	ns
Forward Voltage (I_F = 1.0 mAdc)	V_F	–	0.29	0.32	Vdc
Forward Voltage (I_F = 10 mAdc)	V_F	–	0.35	0.40	Vdc
Forward Current (DC)	I_F	–	–	200	mAdc
Repetitive Peak Forward Current	I_{FRM}	–	–	300	mAdc
Non–Repetitive Peak Forward Current (t < 1.0 s)	I_{FSM}	–	–	600	mAdc



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p » t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

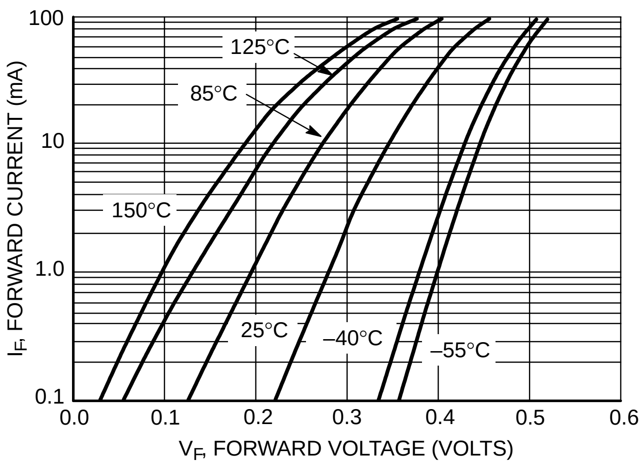


Figure 2. Forward Voltage

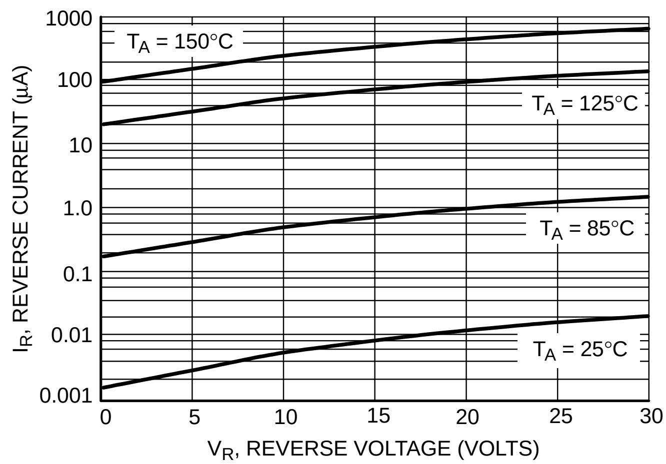


Figure 3. Leakage Current

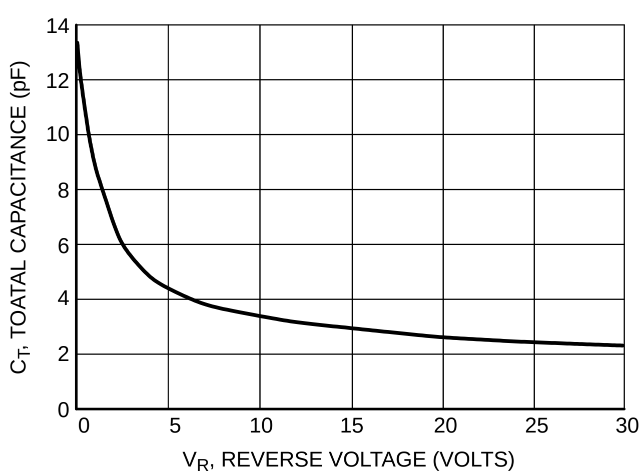


Figure 4. Total Capacitance

BAT54WT1

Preferred Device

Schottky Barrier Diode

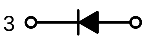
These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Extremely Low Forward Voltage – 0.35 Volts (Typ) @ I_F = 10 mAdc

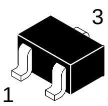
ON Semiconductor™

http://onsemi.com

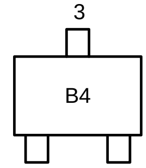
30 VOLT SCHOTTKY BARRIER DETECTOR AND SWITCHING DIODE



MARKING DIAGRAM



(SC–70)
SOT–323
CASE 419
STYLE 2



MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 200 1.6	 mW mW/°C
Forward Current (DC)	I_F	200 Max	mA
Junction Temperature	T_J	125 Max	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

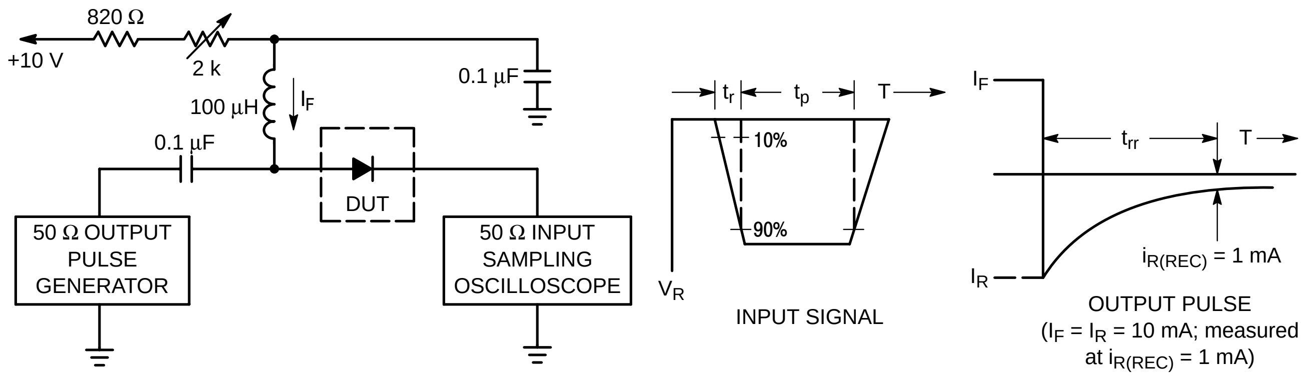
ORDERING INFORMATION

Device	Package	Shipping
BAT54WT1	SOT–323	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	30	–	–	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	–	7.6	10	pF
Reverse Leakage (V_R = 25 V)	I_R	–	0.5	2.0	μAdc
Forward Voltage (I_F = 0.1 mAdc)	V_F	–	0.22	0.24	Vdc
Forward Voltage (I_F = 30 mAdc)	V_F	–	0.41	0.5	Vdc
Forward Voltage (I_F = 100 mAdc)	V_F	–	0.52	0.8	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc, Figure 1)	t_{rr}	–	–	5.0	ns
Forward Voltage (I_F = 1.0 mAdc)	V_F	–	0.29	0.32	Vdc
Forward Voltage (I_F = 10 mAdc)	V_F	–	0.35	0.40	Vdc
Forward Current (DC)	I_F	–	–	200	mAdc
Repetitive Peak Forward Current	I_{FRM}	–	–	300	mAdc
Non–Repetitive Peak Forward Current (t < 1.0 s)	I_{FSM}	–	–	600	mAdc



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

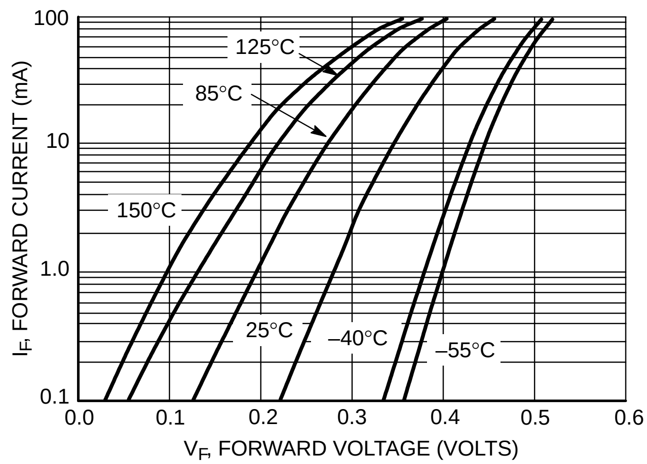


Figure 2. Forward Voltage

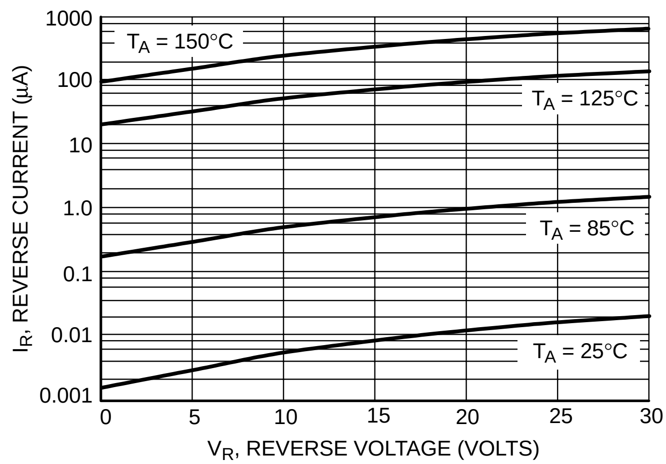


Figure 3. Leakage Current

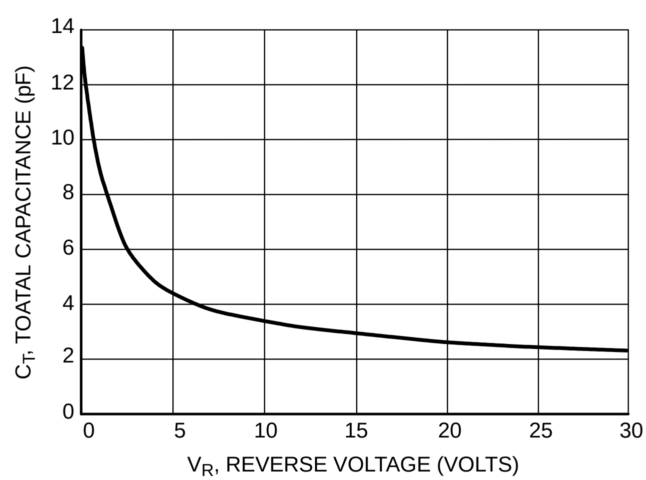


Figure 4. Total Capacitance

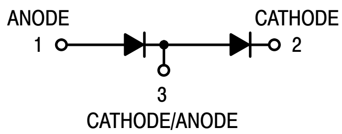
Dual Series Switching Diode

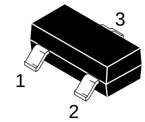
BAV199LT1

ON Semiconductor Preferred Device

This switching diode has the following features:

- Low Leakage Current Applications
- Medium Speed Switching Times
- Available in 8 mm Tape and Reel
  Use BAV199LT1 to order the 7 inch/3,000 unit reel
  Use BAV199LT3 to order the 13 inch/10,000 unit reel





CASE 318–08, STYLE 11
SOT–23 (TO–236AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	215	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc
Repetitive Peak Reverse Voltage	V_{RRM}	70	Vdc
Average Rectified Forward Current(1) (averaged over any 20 ms period)	$I_{F(AV)}$	715	mAdc
Repetitive Peak Forward Current	I_{FRM}	450	mAdc
Non–Repetitive Peak Forward Current t = 1.0 μs t = 1.0 ms t = 1.0 A	I_{FSM}	2.0 1.0 0.5	Adc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–65 to +150	°C

DEVICE MARKING

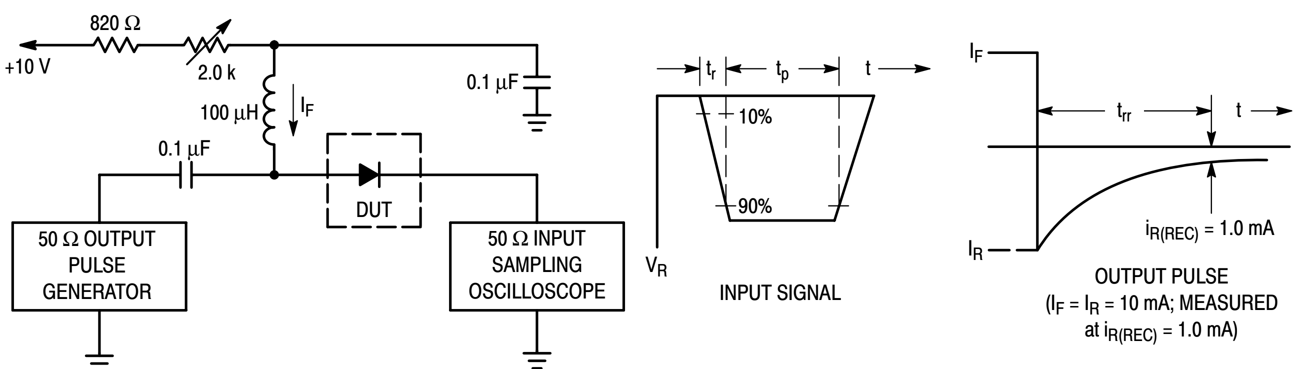
BAV199LT1 = JY

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) **(EACH DIODE)**

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (V_R = 70 Vdc)	I_R	—	5.0	nAdc
(V_R = 70 Vdc, T_J = 150°C)		—	80	
Diode Capacitance (V_R = 0 V, f = 1.0 MHz)	C_D	—	2.0	pF
Forward Voltage (I_F = 1.0 mAdc)	V_F	—	900	mVdc
(I_F = 10 mAdc)		—	1000	
(I_F = 50 mAdc)		—	1100	
(I_F = 150 mAdc)		—	1250	
Reverse Recovery Time (I_F = I_R = 10 mAdc) (Figure 1)	t_{rr}	—	3.0	μs

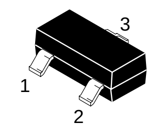


Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

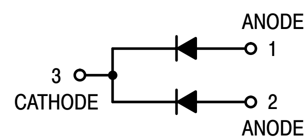
Figure 1. Recovery Time Equivalent Test Circuit

Monolithic Dual Switching Diode Common Cathode

BAV70LT1



CASE 318–08, STYLE 9
SOT–23 (TO–236AB)



MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

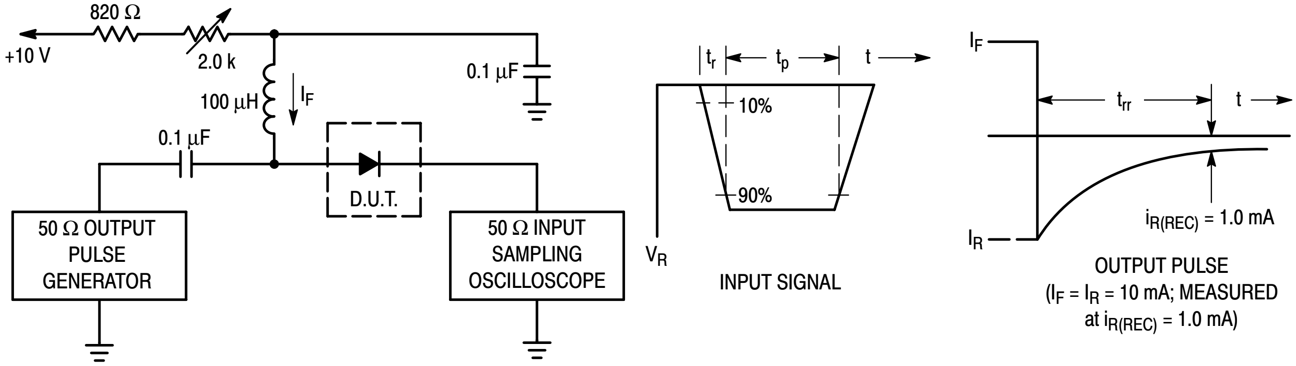
BAV70LT1 = A4

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) **(EACH DIODE)**

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 µAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (Note 3) (V_R = 25 Vdc, T_J = 150°C) (V_R = 70 Vdc) (V_R = 70 Vdc, T_J = 150°C)	I_R	 — — —	 60 2.5 100	µAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	1.5	pF
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 150 mAdc)	V_F	 — — — —	 715 855 1000 1250	mVdc
Reverse Recovery Time R_L = 100 Ω (I_F = I_R = 10 mAdc, V_R = 5.0 Vdc, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	6.0	ns

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. For each individual diode while second diode is unbiased.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

Curves Applicable to Each Anode

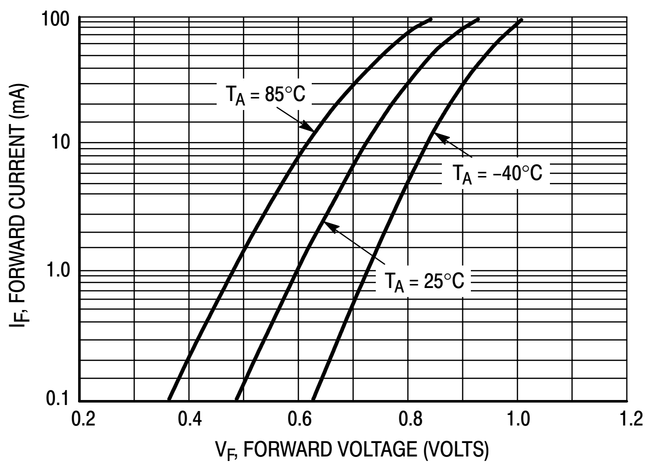


Figure 2. Forward Voltage

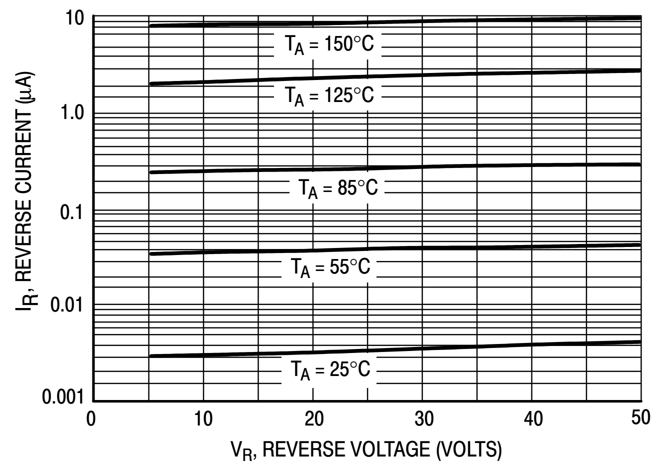


Figure 3. Leakage Current

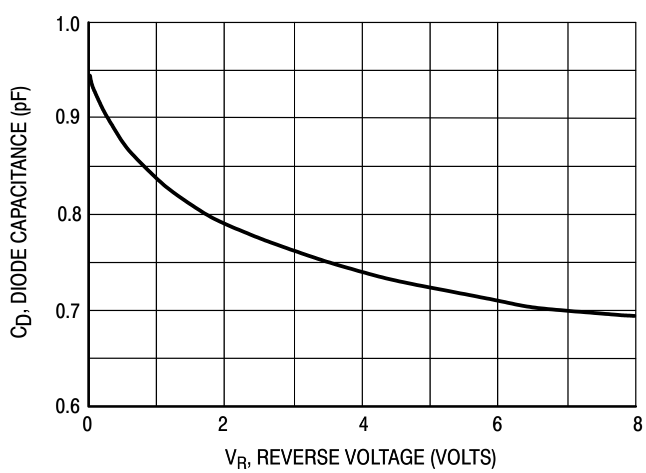


Figure 4. Capacitance

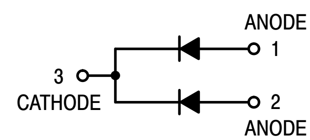
BAV70TT1

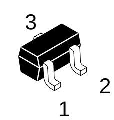
Preferred Device

Dual Switching Diode

ON Semiconductor

http://onsemi.com





CASE 463
SOT–416/SC–75
STYLE 3

MAXIMUM RATINGS (T_A = 25°C)

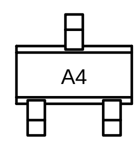
Rating	Symbol	Max	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, FR–4 Board (1) T_A = 25°C Derated above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient (1)	$R_{\theta JA}$	555	°C/W
Total Device Dissipation, FR–4 Board (2) T_A = 25°C Derated above 25°C	P_D	360 2.9	mW mW/°C
Thermal Resistance, Junction to Ambient (2)	$R_{\theta JA}$	345	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) FR–4 @ Minimum Pad
(2) FR–4 @ 1.0 × 1.0 Inch Pad

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
BAV70TT1	SOT–416	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (Note 3) (V_R = 70 Vdc) (V_R = 50 Vdc)	 I_R I_R	 — —	 5.0 100	 μAdc nAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	1.5	pF
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 150 mAdc)	V_F	 — — — —	 715 855 1000 1250	mVdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, R_L = 100 Ω, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	6.0	ns
Forward Recovery Voltage (I_F = 10 mAdc, t_r = 20 ns) (Figure 2)	V_{RF}	—	1.75	V

(3) For each individual diode while the second diode is unbiased.

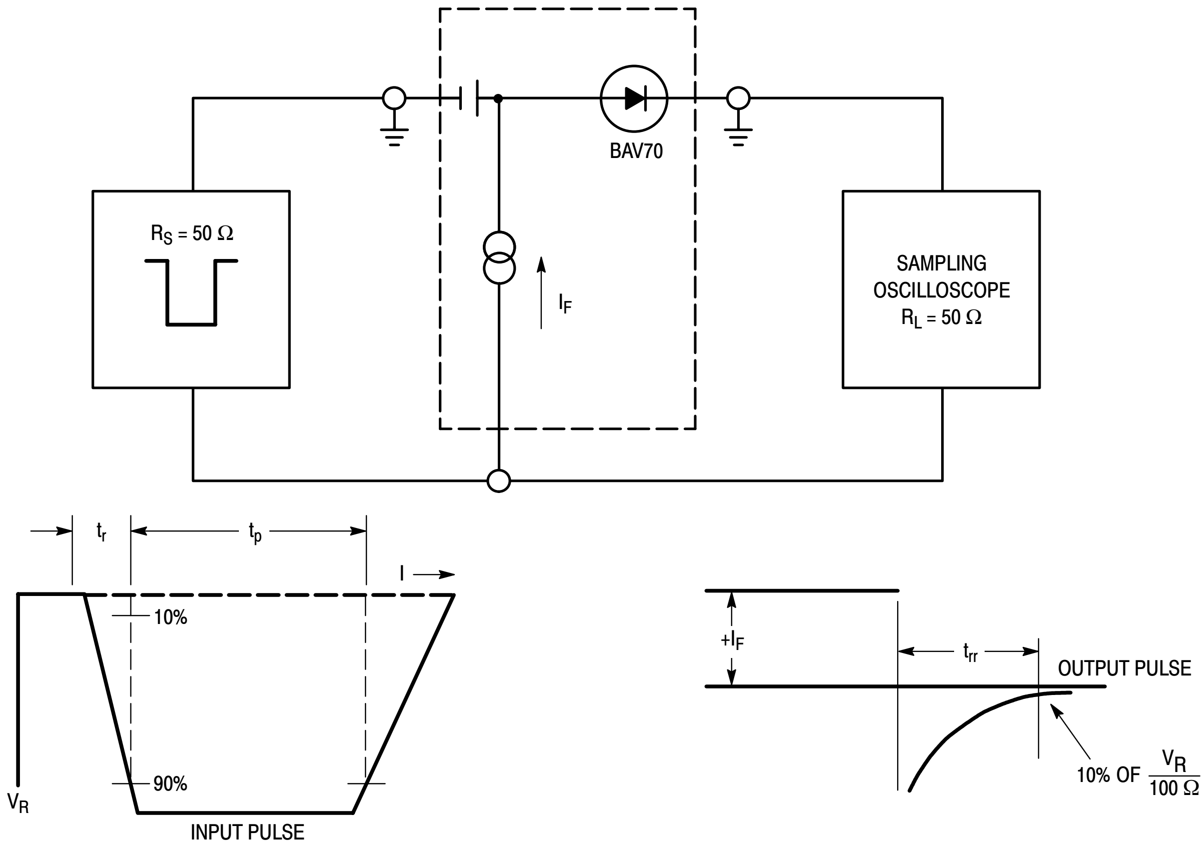


Figure 1. Recovery Time Equivalent Test Circuit

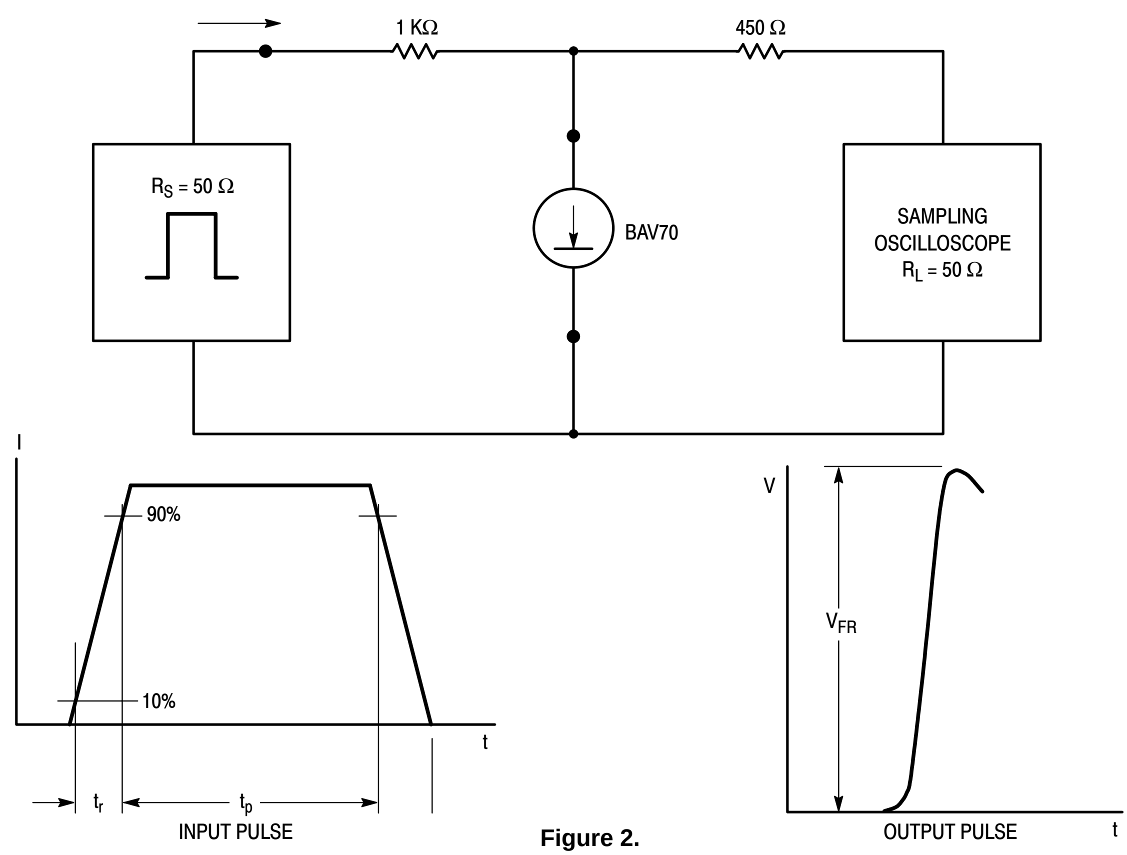


Figure 2.

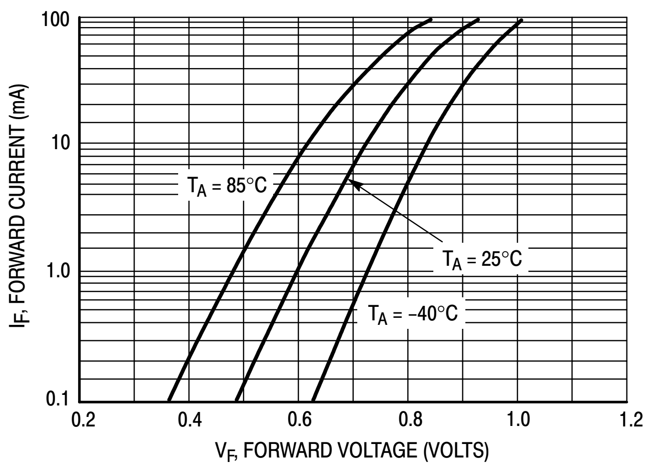


Figure 3. Forward Voltage

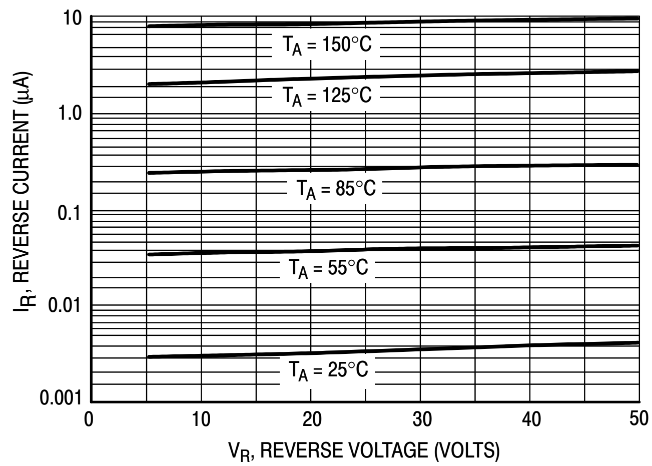


Figure 4. Leakage Current

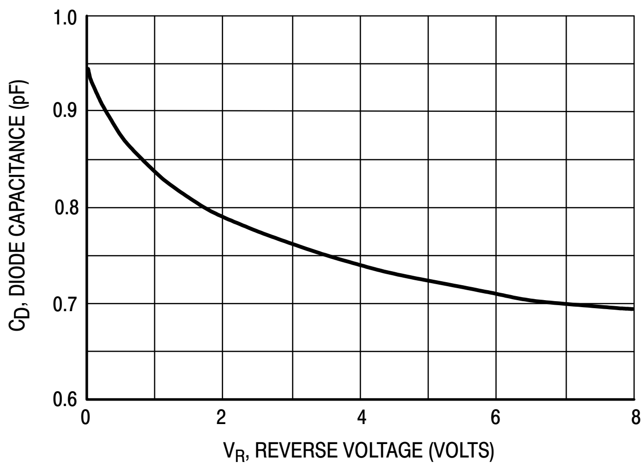


Figure 5. Capacitance

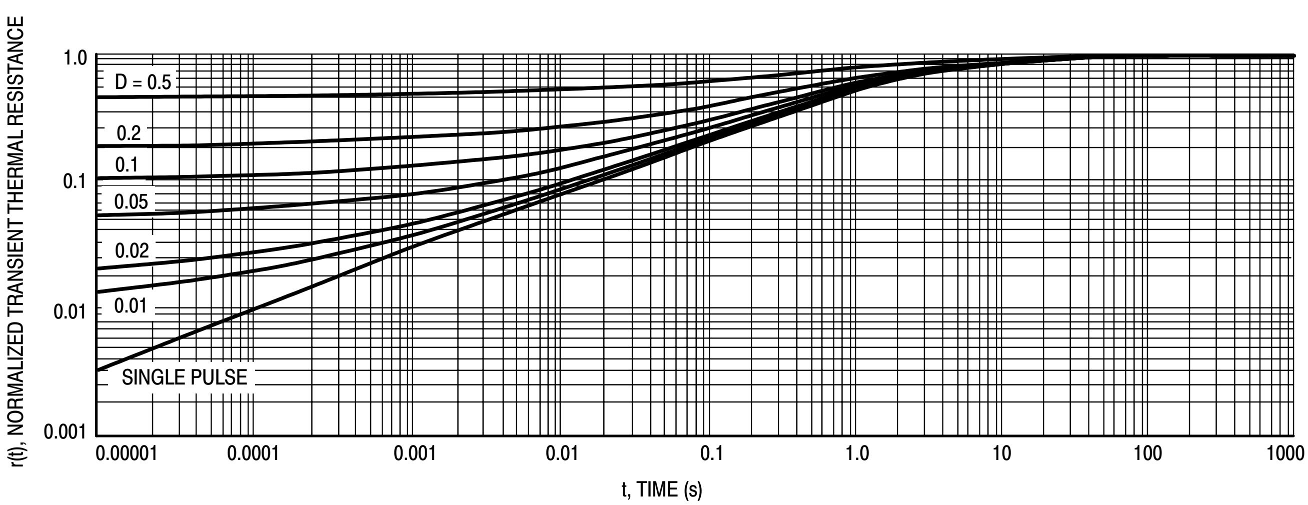
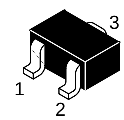


Figure 6. Normalized Thermal Response

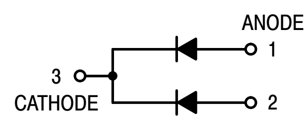
Dual Switching Diode

BAV70WT1

ON Semiconductor Preferred Device



CASE 419–04, STYLE 5
SC–70/SOT–323



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	200 1.6	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.625	°C/W
Total Device Dissipation Alumina Substrate(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BAV70WT1 = A4

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (Note 3) (V_R = 70 Vdc) (V_R = 50 Vdc)	 I_R I_R	 — —	 5.0 100	 μAdc nAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	1.5	pF
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 150 mAdc)	V_F	 — — — —	 715 855 1000 1250	mVdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, R_L = 100 Ω, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	6.0	ns
Forward Recovery Voltage (I_F = 10 mAdc, t_r = 20 ns) (Figure 2)	V_{RF}	—	1.75	V

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. For each individual diode while the second diode is unbiased.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1

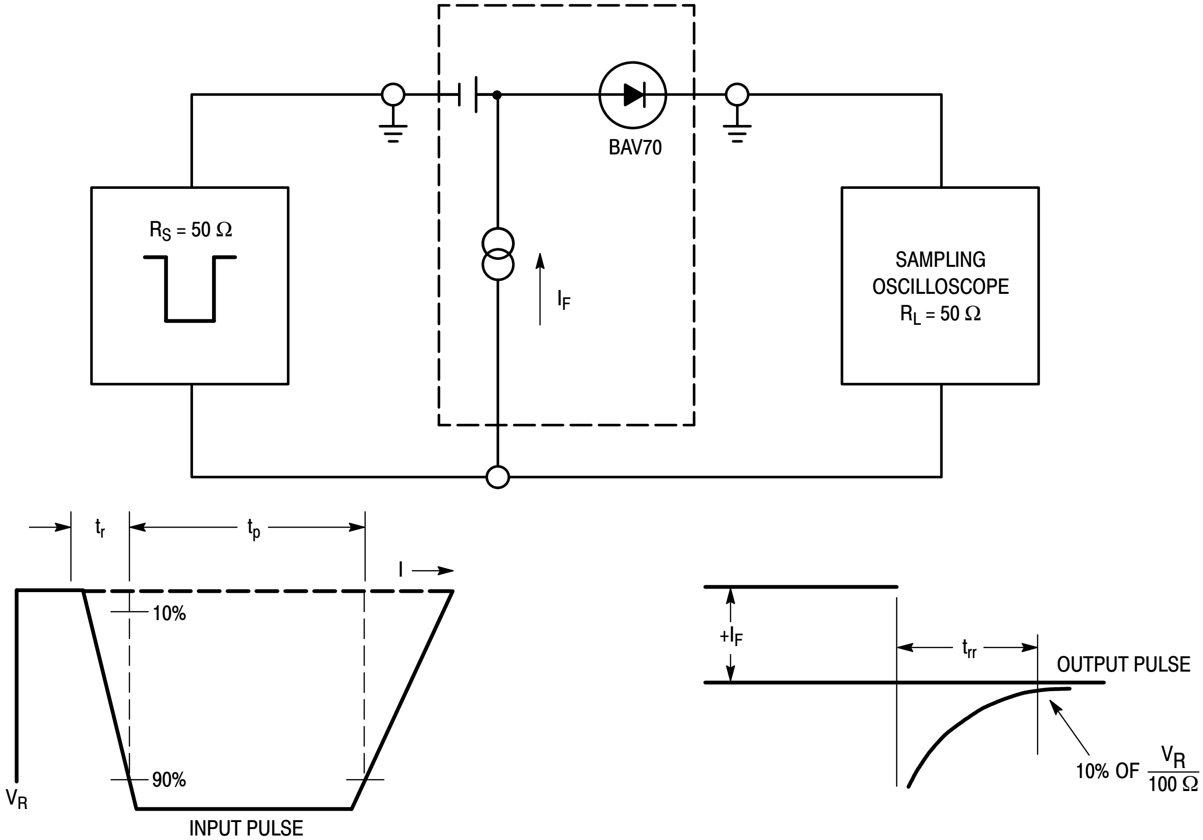


Figure 1. Recovery Time Equivalent Test Circuit

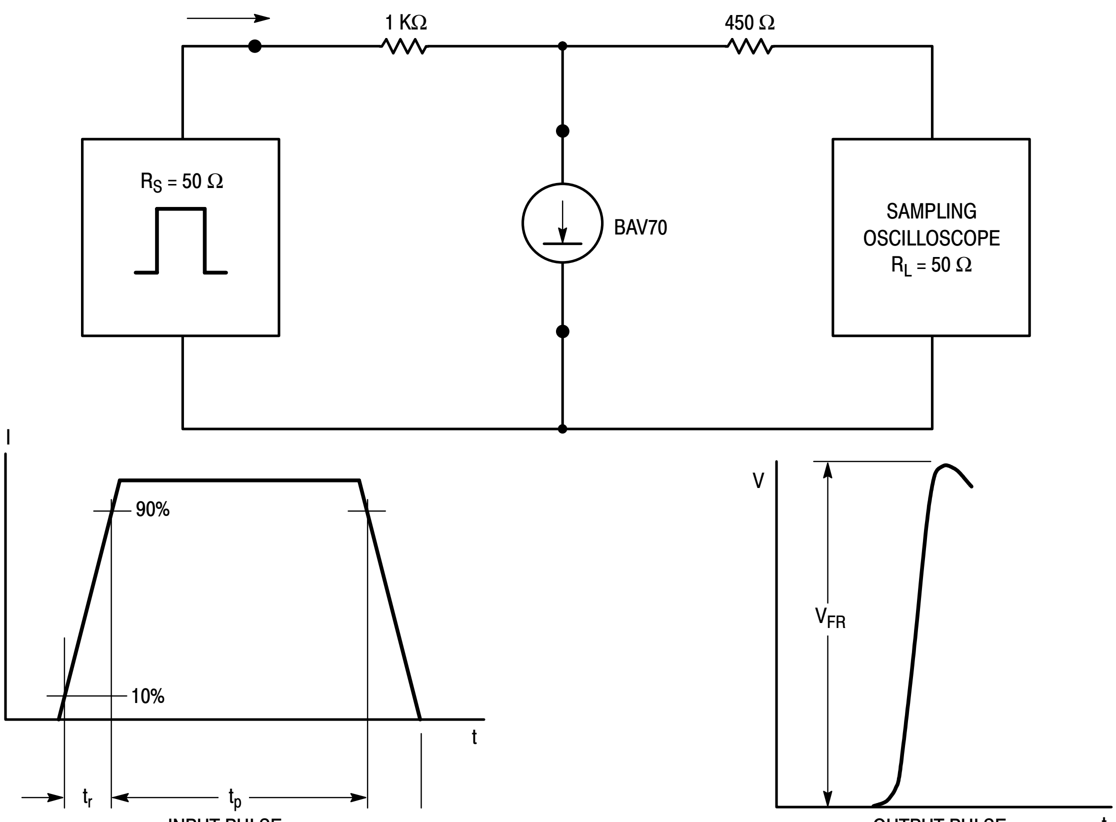


Figure 2.

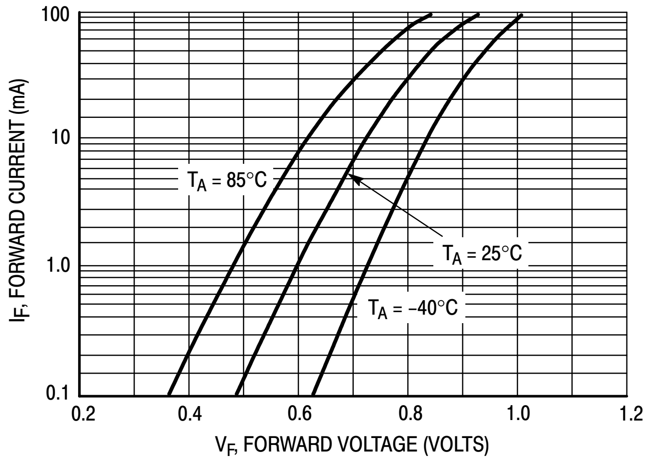


Figure 3. Forward Voltage

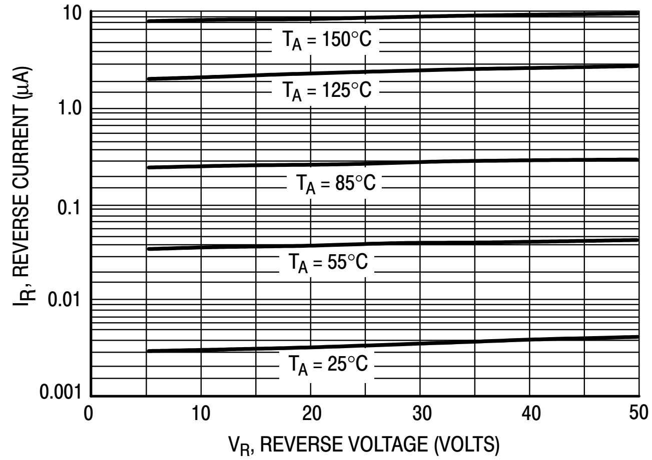


Figure 4. Leakage Current

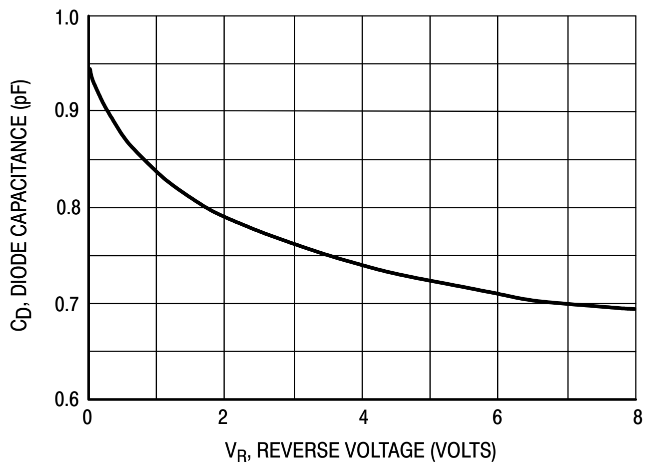
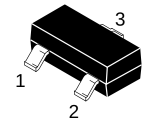


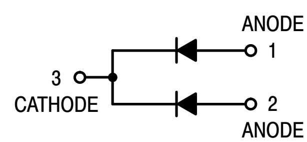
Figure 5. Capacitance

Monolithic Dual Switching Diode

BAV74LT1



CASE 318–08, STYLE 9
SOT–23 (TO–236AB)



MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	50	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BAV74LT1 = JA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (EACH DIODE)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 5.0 μAdc)	$V_{(BR)}$	50	—	Vdc
Reverse Voltage Leakage Current (Note 3.) (V_R = 50 Vdc, T_J = 125°C) (V_R = 50 Vdc)	I_R	 — —	 100 0.1	μAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.0	pF
Forward Voltage (I_F = 100 mAdc)	V_F	—	1.0	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc, measured at I_R = 1.0 mA, R_L = 100 Ω)	t_{rr}	—	4.0	ns

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. For each individual diode while the second diode is unbiased.

March, 2001 – Rev. 1

Publication Order Number:
BAV74LT1/D

Curves Applicable to Each Anode

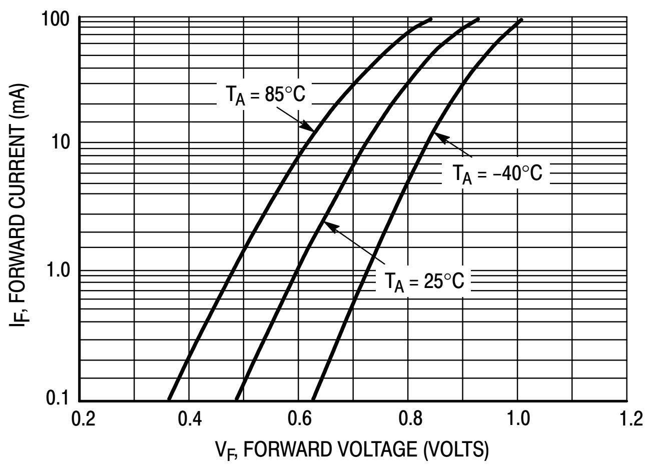


Figure 1. Forward Voltage

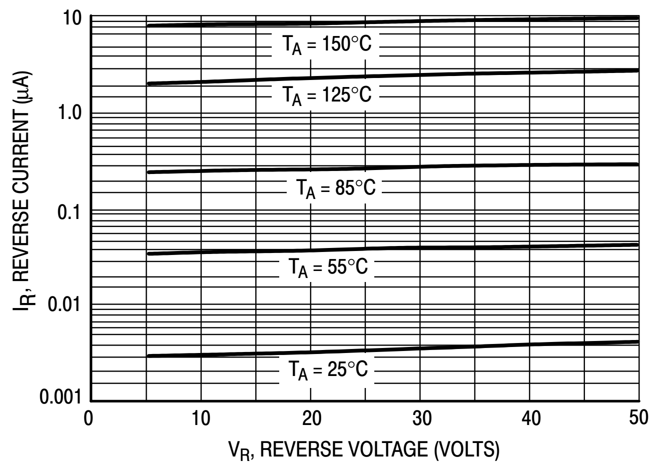


Figure 2. Leakage Current

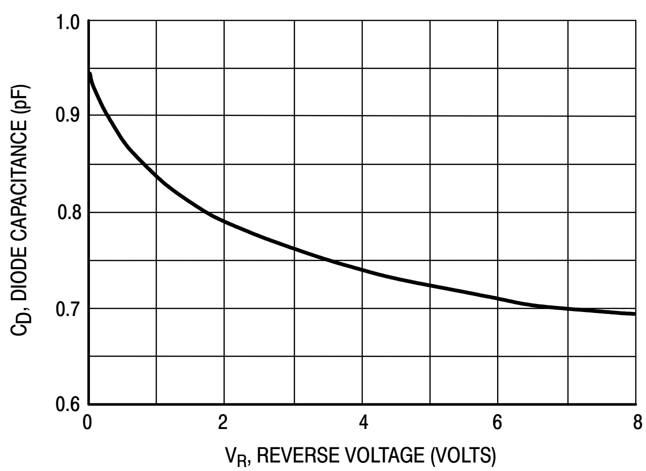


Figure 3. Capacitance

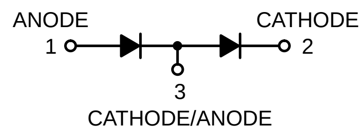
BAV99LT1

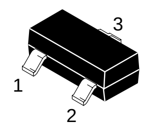
Preferred Device

Dual Series Switching Diode

ON Semiconductor

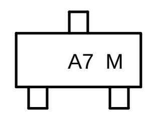
http://onsemi.com





CASE 318
SOT–23
STYLE 11

MARKING DIAGRAM



A7 = Device Code
M = Date Code

MAXIMUM RATINGS (Each Diode)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	215	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc
Repetitive Peak Reverse Voltage	V_{RRM}	70	V
Average Rectified Forward Current (Note 1.) (averaged over any 20 ms period)	$I_{F(AV)}$	715	mA
Repetitive Peak Forward Current	I_{FRM}	450	mA
Non–Repetitive Peak Forward Current t = 1.0 μs t = 1.0 ms t = 1.0 S	I_{FSM}	 2.0 1.0 0.5	A

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board (Note 1.) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate (Note 2.) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–65 to +150	°C

ORDERING INFORMATION

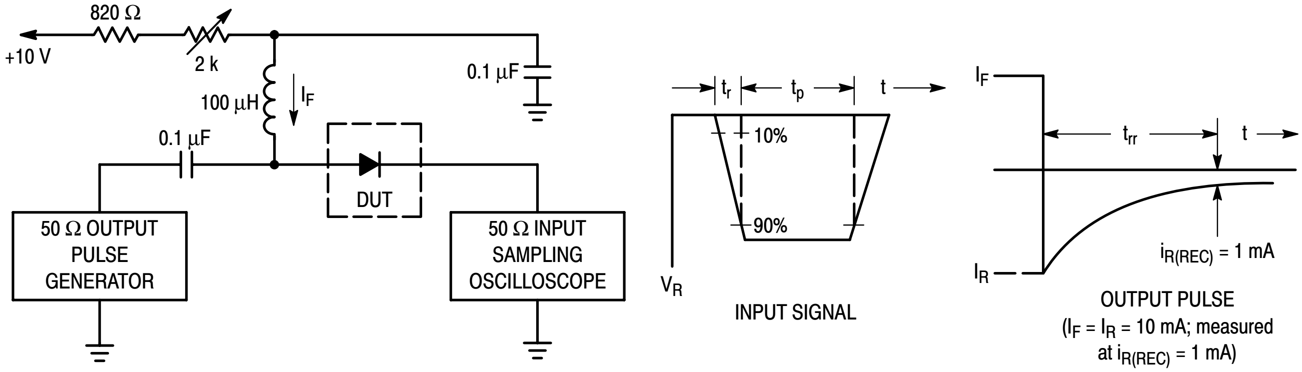
Device	Package	Shipping
BAV99LT1	SOT–23	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

OFF CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Each Diode)

Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μA)	$V_{(BR)}$	70	–	Vdc
Reverse Voltage Leakage Current (V_R = 70 Vdc) (V_R = 25 Vdc, T_J = 150°C) (V_R = 70 Vdc, T_J = 150°C)	I_R	– – –	2.5 30 50	μAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	–	1.5	pF
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 150 mAdc)	V_F	– – – –	715 855 1000 1250	mVdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $i_{R(REC)}$ = 1.0 mAdc) (Figure 1) R_L = 100 Ω	t_{rr}	–	6.0	ns
Forward Recovery Voltage (I_F = 10 mA, t_r = 20 ns)	V_{FR}	–	1.75	V

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

CURVES APPLICABLE TO EACH DIODE

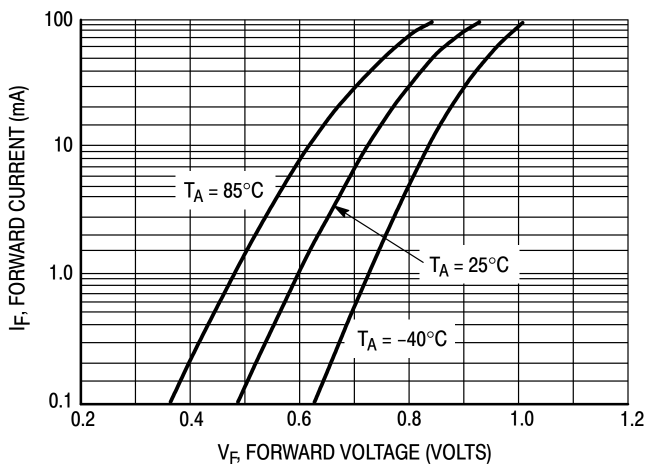


Figure 2. Forward Voltage

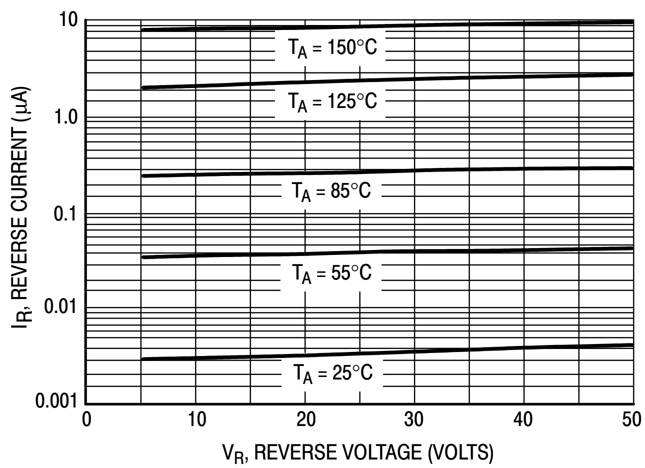


Figure 3. Leakage Current

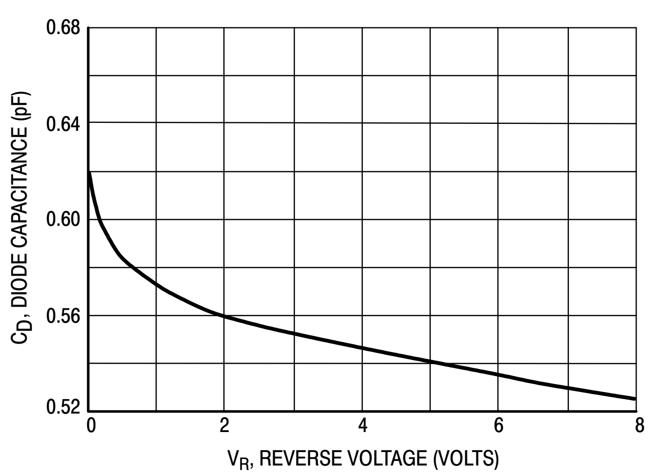


Figure 4. Capacitance

BAV99WT1, BAV99RWT1

Preferred Devices

Dual Series Switching Diodes

The BAV99WT1 is a smaller package, equivalent to the BAV99LT1.

Suggested Applications

- ESD Protection
- Polarity Reversal Protection
- Data Line Protection
- Inductive Load Protection
- Steering Logic

MAXIMUM RATINGS (Each Diode)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	215	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc
Repetitive Peak Reverse Voltage	V_{RRM}	70	V
Average Rectified Forward Current (Note 1.) (averaged over any 20 ms period)	$I_{F(AV)}$	715	mA
Repetitive Peak Forward Current	I_{FRM}	450	mA
Non–Repetitive Peak Forward Current t = 1.0 μs t = 1.0 ms t = 1.0 S	I_{FSM}	 2.0 1.0 0.5	A

1. FR–5 = 1.0 × 0.75 × 0.062 in.

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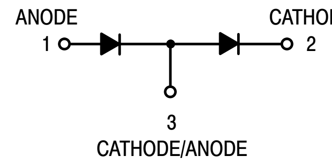
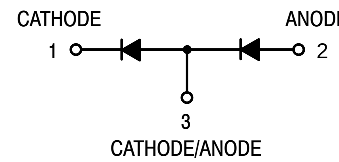
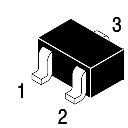


BAV99WT1
CASE 419–02, STYLE 9
SC–70/SOT–323

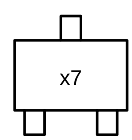


BAV99RWT1
CASE 419–02, STYLE 10
SC–70/SOT–323



SC–70
CASE 419

MARKING DIAGRAM



A7 = BAV99WT1
F7 = BAV99RWT1

ORDERING INFORMATION

Device	Package	Shipping
BAV99WT1	SC–70	3000/Tape & Reel
BAV99RWT1	SC–70	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

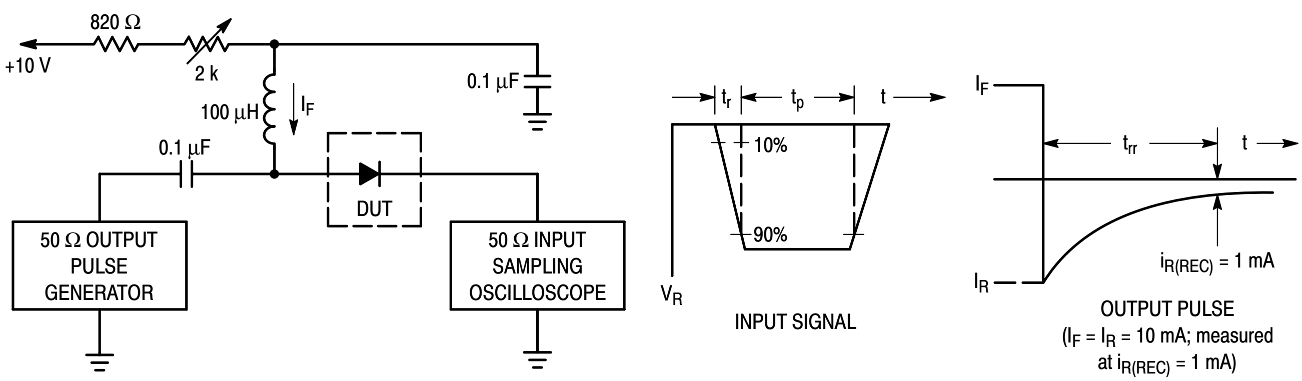
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board, (Note 1.) T_A = 25°C Derate above 25°C	P_D	200 1.6	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	625	°C/W
Total Device Dissipation Alumina Substrate, (Note 2.) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Each Diode)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μA)	$V_{(BR)}$	70	–	Vdc
Reverse Voltage Leakage Current (V_R = 70 Vdc) (V_R = 25 Vdc, T_J = 150°C) (V_R = 70 Vdc, T_J = 150°C)	I_R	– – –	2.5 30 50	μAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	–	1.5	pF
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 150 mAdc)	V_F	– – – –	715 855 1000 1250	mVdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $i_{R(REC)}$ = 1.0 mAdc) (Figure 1) R_L = 100 Ω	t_{rr}	–	6.0	ns
Forward Recovery Voltage (I_F = 10 mA, t_r = 20 ns)	V_{FR}	–	1.75	V

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.



Notes: (a) A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
(b) Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
(c) t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

CURVES APPLICABLE TO EACH DIODE

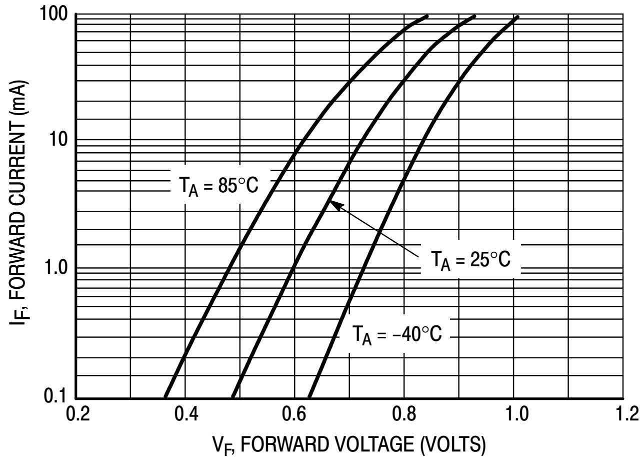


Figure 2. Forward Voltage

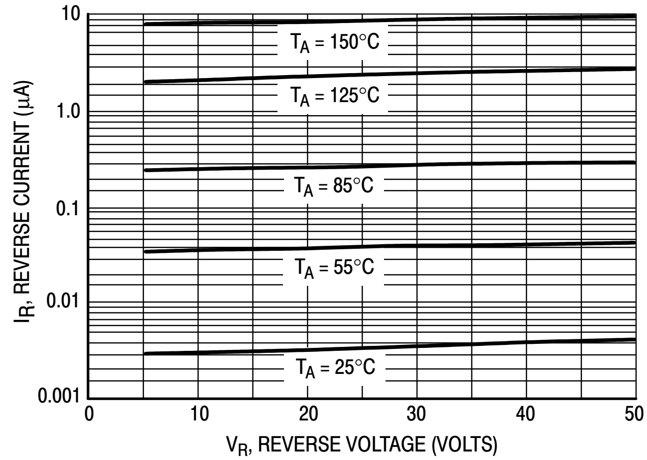


Figure 3. Leakage Current

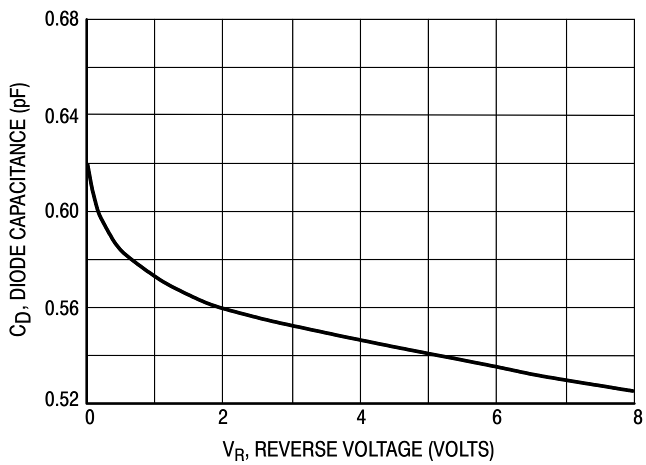
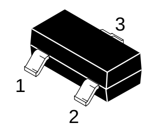


Figure 4. Capacitance

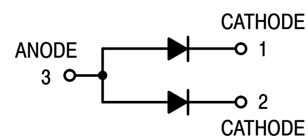
Monolithic Dual Switching Diode Common Anode

BAW56LT1

ON Semiconductor Preferred Device



CASE 318–08, STYLE 12
SOT–23 (TO–236AB)



MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

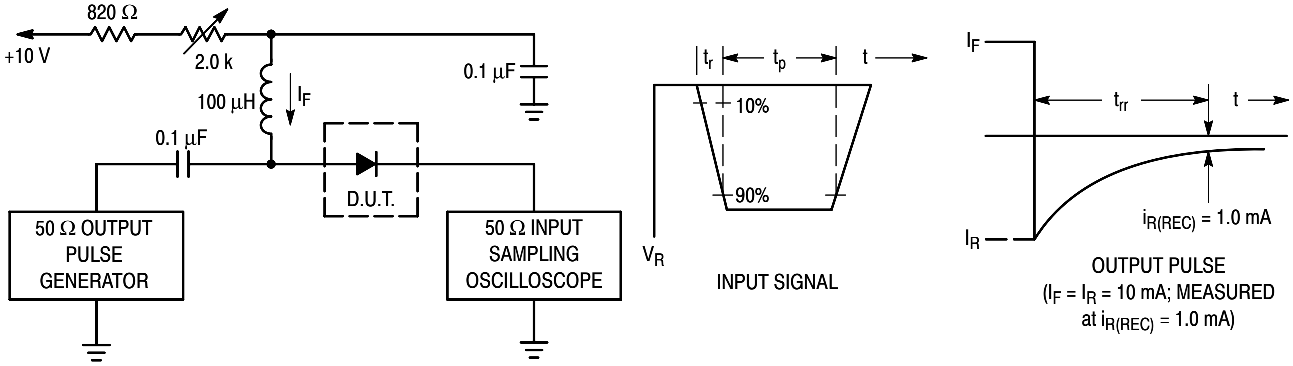
BAW56LT1 = A1

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (EACH DIODE)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 µAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_J = 150°C) (V_R = 70 Vdc) (V_R = 70 Vdc, T_J = 150°C)	I_R	 — — —	 30 2.5 50	µAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.0	pF
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 150 mAdc)	V_F	 — — — —	 715 855 1000 1250	mVdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1) R_L = 100 Ω	t_{rr}	—	6.0	ns

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

Curves Applicable to Each Cathode

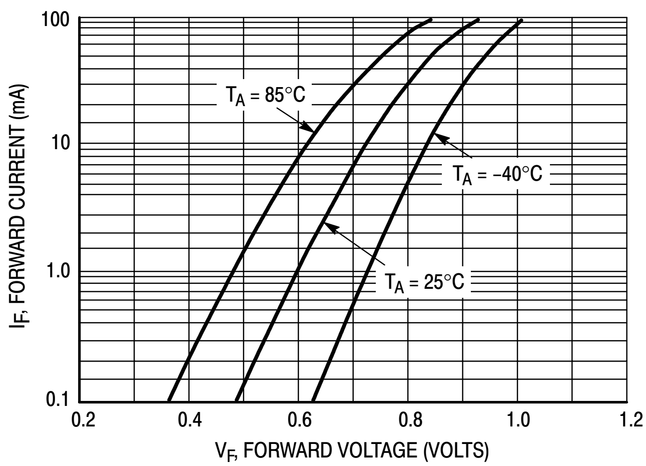


Figure 2. Forward Voltage

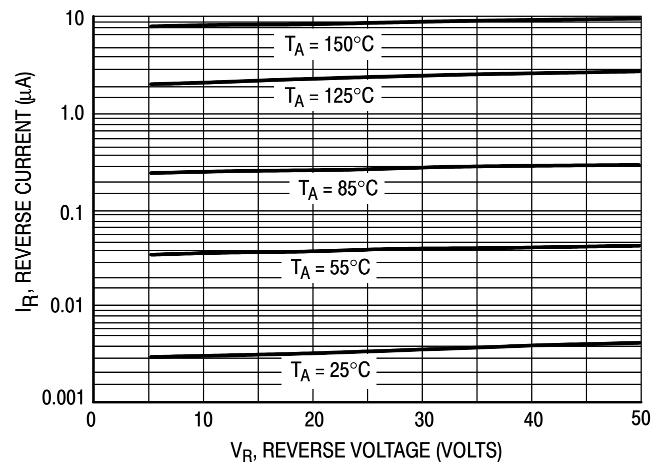


Figure 3. Leakage Current

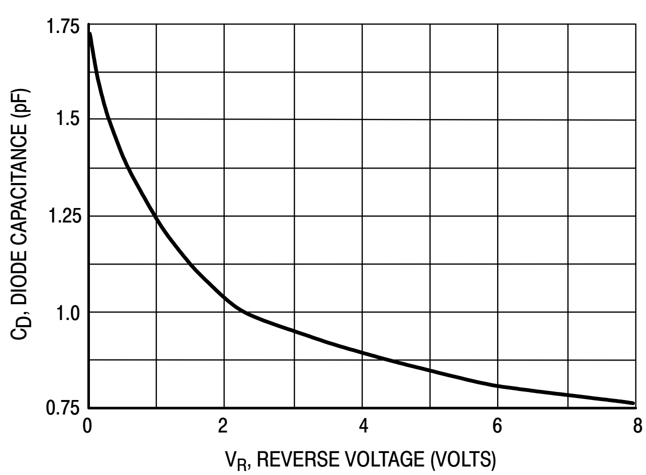


Figure 4. Capacitance

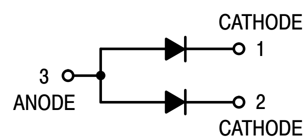
BAW56TT1

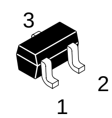
Preferred Device

Dual Switching Diode

ON Semiconductor

http://onsemi.com





CASE 463
SOT–416/SC–75
STYLE 4

MAXIMUM RATINGS (T_A = 25°C)

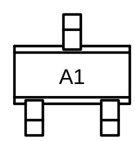
Rating	Symbol	Max	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, FR–4 Board (1) T_A = 25°C Derated above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient (1)	$R_{\theta JA}$	555	°C/W
Total Device Dissipation, FR–4 Board (2) T_A = 25°C Derated above 25°C	P_D	360 2.9	mW mW/°C
Thermal Resistance, Junction to Ambient (2)	$R_{\theta JA}$	345	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) FR–4 @ Minimum Pad
(2) FR–4 @ 1.0 × 1.0 Inch Pad

DEVICE MARKING



ORDERING INFORMATION

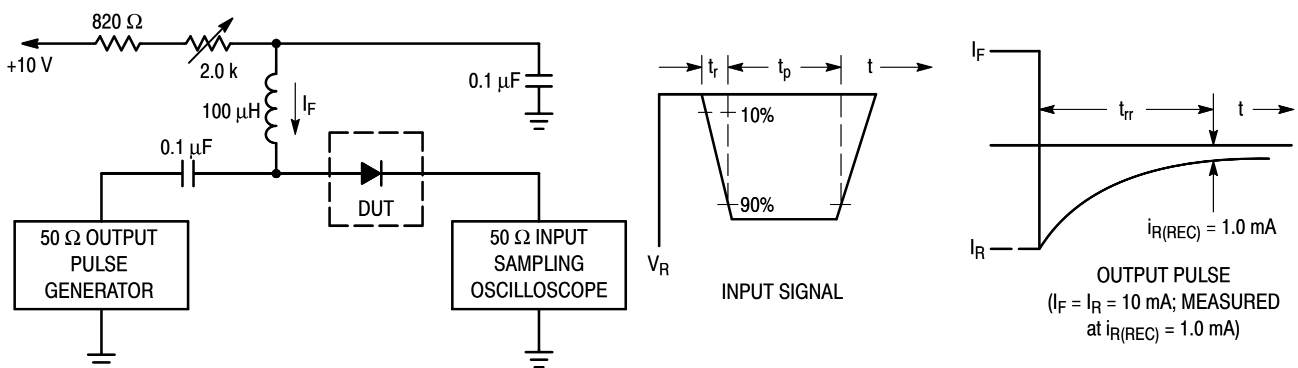
Device	Package	Shipping
BAW56TT1	SOT–416	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

May, 2000 – Rev. 1
Publication Order Number:
BAW56TT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_J = 150°C) (V_R = 70 Vdc) (V_R = 70 Vdc, T_J = 150°C)	I_R	 — — —	 30 2.5 50	μAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.0	pF
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 60 mAdc) (I_F = 150 mAdc)	V_F	 — — — —	 715 855 1000 1250	mVdc
Reverse Recovery Time ($I_F = I_R$ = 10 mAdc, R_L = 100 Ω, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	6.0	ns



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

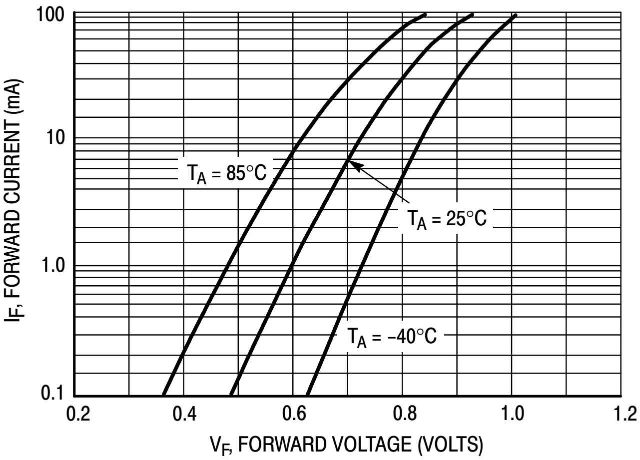


Figure 2. Forward Voltage

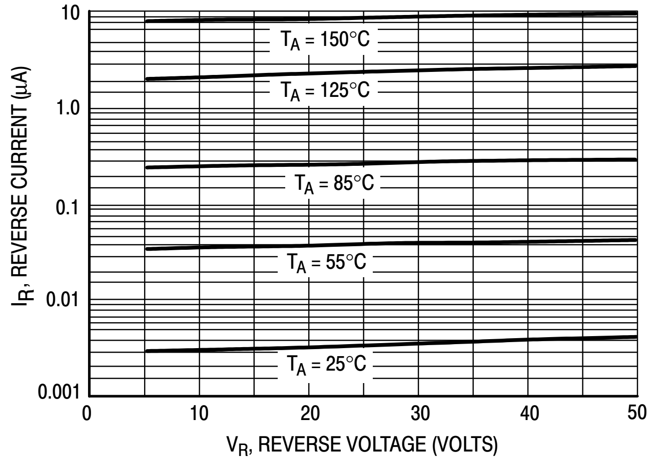


Figure 3. Leakage Current

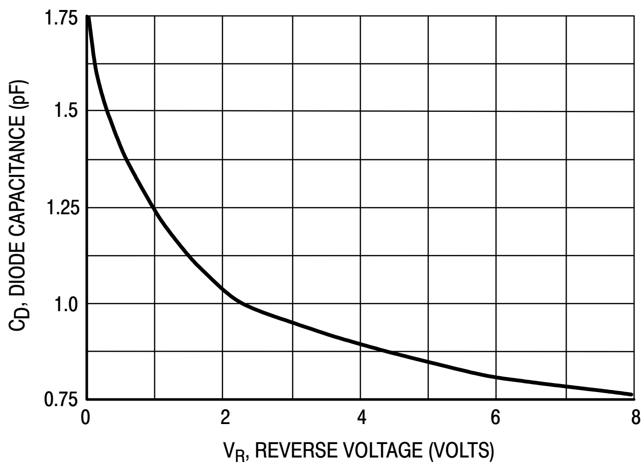


Figure 4. Capacitance

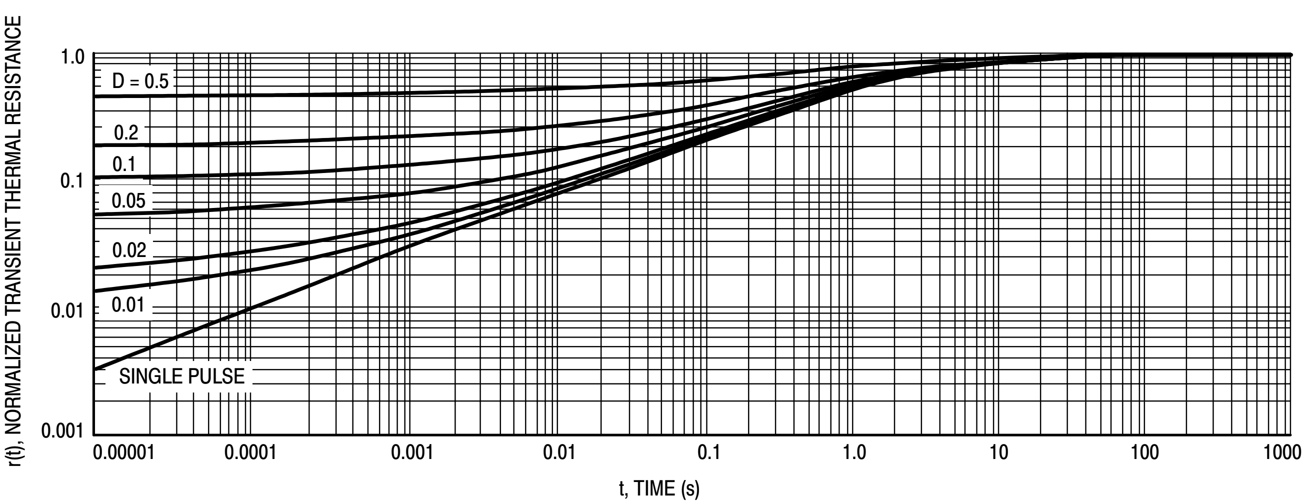
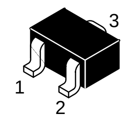


Figure 5. Normalized Thermal Response

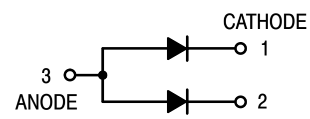
Dual Switching Diode

BAW56WT1

ON Semiconductor Preferred Device



CASE 419–04, STYLE 4
SC–70/SOT–323



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	200 1.6	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.625	°C/W
Total Device Dissipation Alumina Substrate(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BAW56WT1 = A1

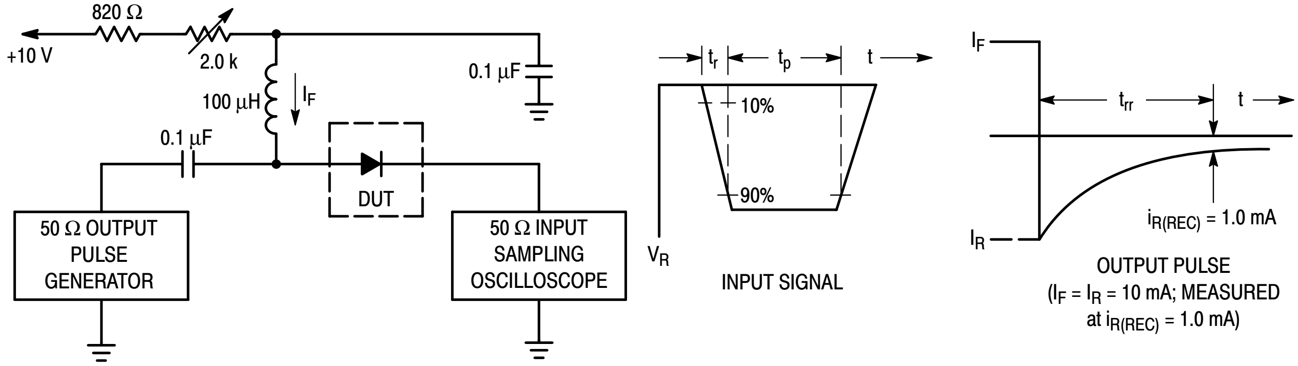
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 µAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_J = 150°C) (V_R = 70 Vdc) (V_R = 70 Vdc, T_J = 150°C)	I_R	 — — —	 30 2.5 50	µAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.0	pF
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 60 mAdc) (I_F = 150 mAdc)	V_F	 — — — —	 715 855 1000 1250	mVdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, R_L = 100 Ω, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	6.0	ns

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

Publication Order Number:
BAW56WT1/D
March, 2001 – Rev. 1



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

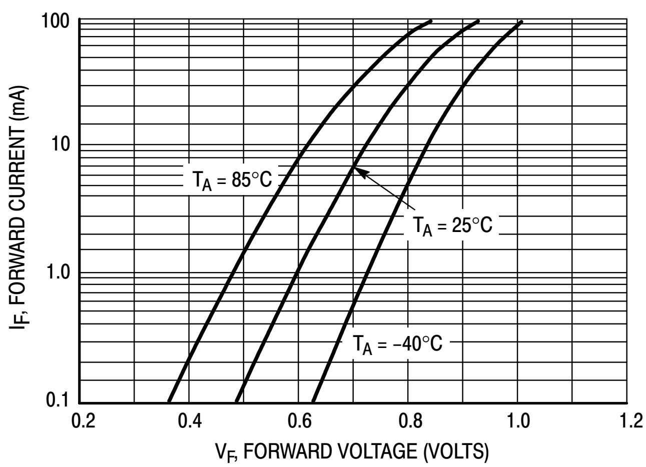


Figure 2. Forward Voltage

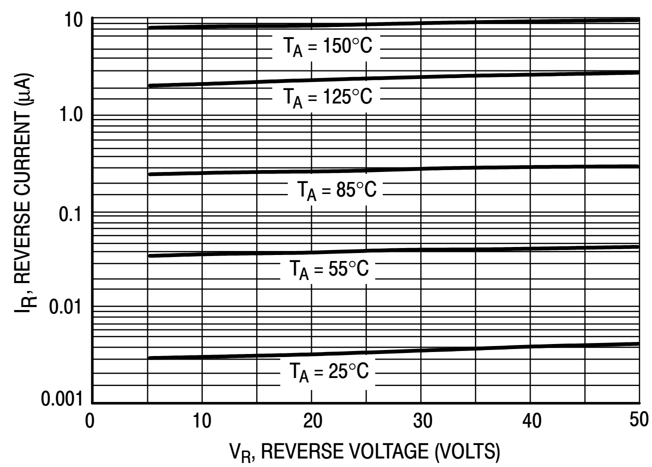


Figure 3. Leakage Current

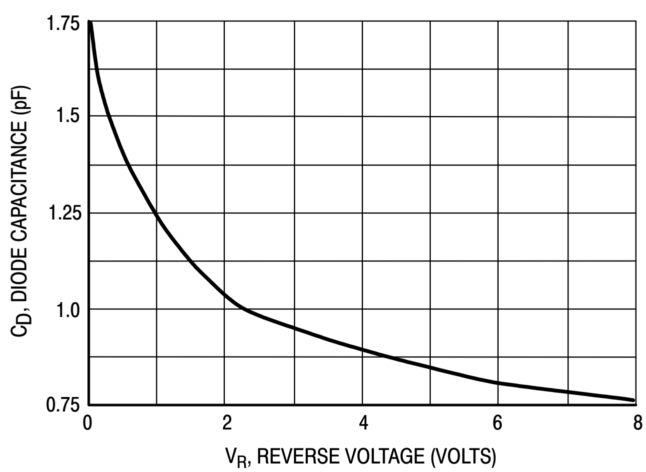
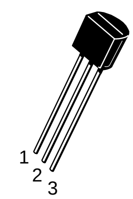


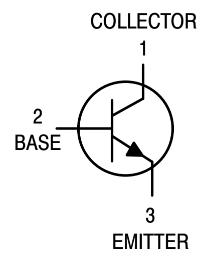
Figure 4. Capacitance

Amplifier Transistors
NPN Silicon

BC182
BC182A
BC182B



CASE 29–11, STYLE 17
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	BC182	Unit
Collector–Emitter Voltage	V_{CEO}	50	Vdc
Collector–Base Voltage	V_{CBO}	60	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 2.0 mA, I_B = 0)	$V_{(BR)CEO}$	50	—	—	V
Collector–Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	$V_{(BR)CBO}$	60	—	—	V
Emitter–Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	$V_{(BR)EBO}$	6.0	—	—	V
Collector Cutoff Current (V_{CB} = 50 V, V_{BE} = 0)	I_{CBO}	—	0.2	15	nA
Emitter–Base Leakage Current (V_{EB} = 4.0 V, I_C = 0)	I_{EBO}	—	—	15	nA

May, 2001 – Rev. 2

Publication Order Number:
BC182/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 μA, V_{CE} = 5.0 V)	BC182		40	—	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC182		120	—	500	
	BC182A		120		220	
	BC182B		180	—	500	
(I_C = 100 mA, V_{CE} = 5.0 V)	BC182		80		—	
Collector–Emitter On Voltage		$V_{CE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)			—	0.07	0.25	
(I_C = 100 mA, I_B = 5.0 mA)(1)			—	0.2	0.6	
Base–Emitter Saturation Voltage (I_C = 100 mA, I_B = 5.0 mA)(1)		$V_{BE(sat)}$	—	—	1.2	V
Base–Emitter On Voltage		$V_{BE(on)}$				V
(I_C = 100 μA, V_{CE} = 5.0 V)			—	0.5	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)			0.55	0.62	0.7	
(I_C = 100 mA, V_{CE} = 5.0 V)(1)			—	0.83	—	
DYNAMIC CHARACTERISTICS						
Current–Gain — Bandwidth Product		f_T				MHz
(I_C = 0.5 mA, V_{CE} = 3.0 V, f = 100 MHz)			—	100	—	
(I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)			150	200	—	
Common Base Output Capacitance (V_{CB} = 10 V, I_C = 0, f = 1.0 MHz)		C_{ob}	—	—	5.0	pF
Common Base Input Capacitance (V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz)		C_{ib}	—	8.0	—	pF
Small–Signal Current Gain		h_{fe}				—
(I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	BC182		125	—	500	
	BC182A		125	—	260	
	BC182B		240	—	500	
Noise Figure		NF				dB
(I_C = 0.2 mA, V_{CE} = 5.0 V, R_S = 2.0 kΩ, f = 1.0 kHz)			—	2.0	10	

1. Pulse Test: Tp 300 s, Duty Cycle 2.0%.

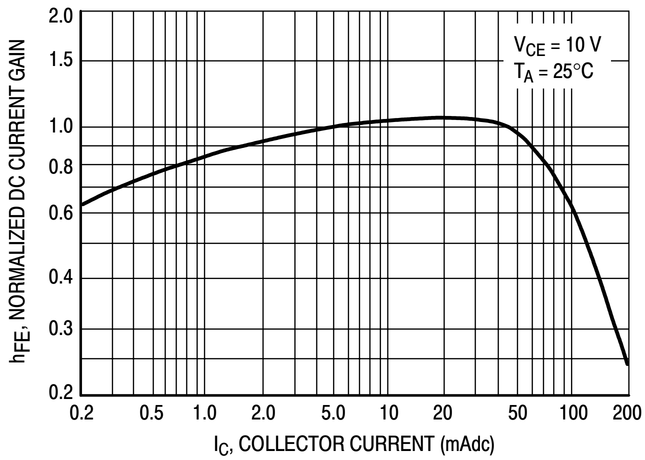


Figure 1. Normalized DC Current Gain

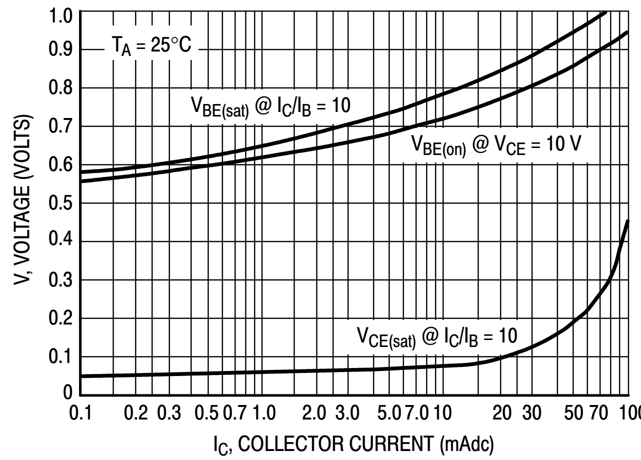


Figure 5. “Saturation” and “On” Voltages

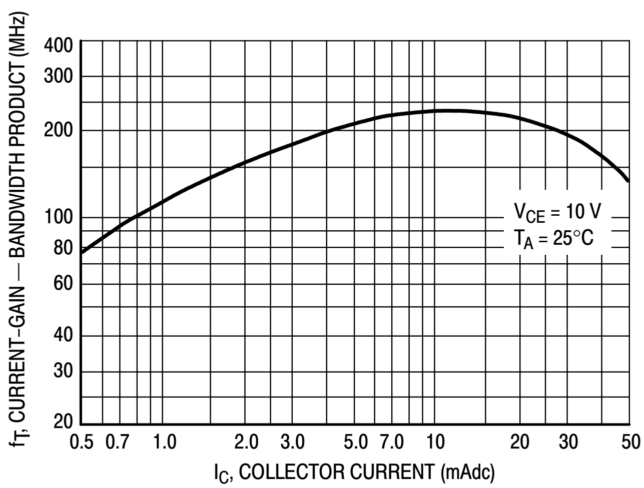


Figure 6. Current–Gain — Bandwidth Product

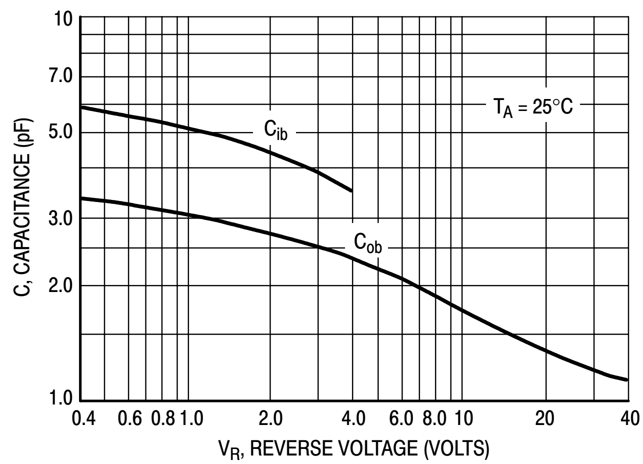


Figure 7. Capacitances

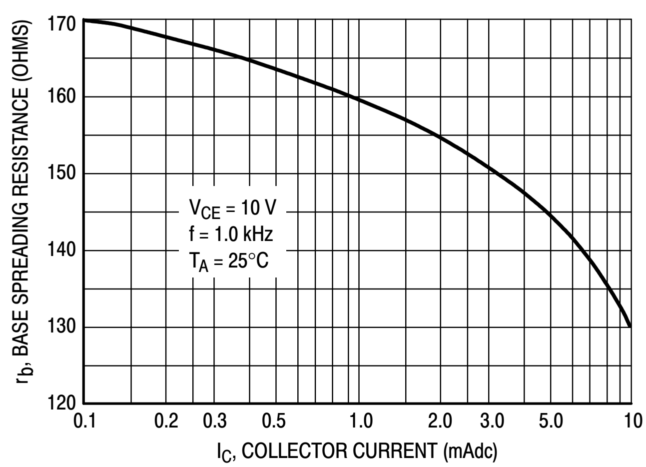


Figure 8. Base Spreading Resistance

BC212, BC212B, BC213

Amplifier Transistors

PNP Silicon

ON Semiconductor™

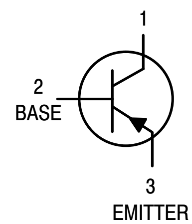
http://onsemi.com

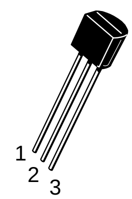
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage BC212 BC213	V_{CEO}	 –50 –30	Vdc
Collector-Base Voltage BC212 BC213	V_{CBO}	 –60 –45	Vdc
Emitter-Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Continuous	I_C	–100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 350 2.8	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.0 8.0	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

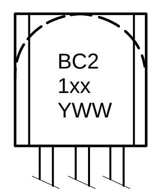
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W





TO–92
CASE 29
STYLE 17

MARKING DIAGRAMS



BC21xx	=	Specific Device Code
xx	=	2, 2B, or 3
Y	=	Year
WW	=	Work Week

ORDERING INFORMATION

Device	Package	Shipping
BC212	TO–92	5000 Units/Box
BC212B	TO–92	5000 Units/Box
BC212BRL1	TO–92	2000/Tape & Reel
BC212BZL1	TO–92	2000/Ammo Pack
BC213	TO–92	5000 Units/Box

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Collector–Emitter Breakdown Voltage (I_C = –2.0 mAdc, I_B = 0)	BC212 BC213	$V_{(BR)CEO}$	–50 –30	– –	– –	Vdc
Collector–Base Breakdown Voltage (I_C = –10 μA, I_E = 0)	BC212 BC213	$V_{(BR)CBO}$	–60 –45	– –	– –	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	BC212 BC213	$V_{(BR)EBO}$	–5 –5	– –	– –	Vdc
Collector–Emitter Leakage Current (V_{CB} = –30 V)	BC212 BC213	I_{CBO}	– –	– –	–15 –15	nAdc
Emitter–Base Leakage Current (V_{EB} = –4.0 V, I_C = 0)	BC212 BC213	I_{EBO}	– –	– –	–15 –15	nAdc

ON CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
DC Current Gain		h_{FE}				–
(I_C = –10 μAdc, V_{CE} = –5.0 Vdc)	BC212 BC213		40 40	– –	– –	
(I_C = –2.0 mAdc, V_{CE} = –5.0 Vdc)	BC212 BC213		60 80	– –	– –	
(I_C = –100 mAdc, V_{CE} = –5.0 Vdc) (Note 1.)	BC212 BC213		– –	120 140	– –	
Collector–Emitter Saturation Voltage (I_C = –10 mAdc, I_B = –0.5 mAdc) (I_C = –100 mAdc, I_B = –5.0 mAdc) (Note 1.)		$V_{CE(sat)}$	– –	–0.10 –0.25	– –0.6	Vdc
Base–Emitter Saturation Voltage (I_C = –100 mAdc, I_B = –5.0 mAdc)		$V_{BE(sat)}$	–	–1.0	–1.4	Vdc
Base–Emitter On Voltage (I_C = –2.0 mAdc, V_{CE} = –5.0 Vdc)		$V_{BE(on)}$	–0.6	–0.62	–0.72	Vdc

DYNAMIC CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
Current–Gain – Bandwidth Product (I_C = –10 mAdc, V_{CE} = –5.0 Vdc, f = 100 MHz)	BC212 BC213	f_T	– –	280 360	– –	MHz
Common–Base Output Capacitance (V_{CB} = –10 Vdc, I_C = 0, f = 1.0 MHz)		C_{ob}	–	–	6.0	pF
Noise Figure (I_C = –0.2 mAdc, V_{CE} = –5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, f = 200 Hz)	BC212, BC213	NF	–	–	10	dB
Small–Signal Current Gain (I_C = –2.0 mAdc, V_{CE} = –5.0 Vdc, f = 1.0 kHz)	BC212 BC213 BC212B	h_{fe}	60 80 200	– – –	– – 400	–

1. Pulse Test: Tp 300 s, Duty Cycle 2.0%.

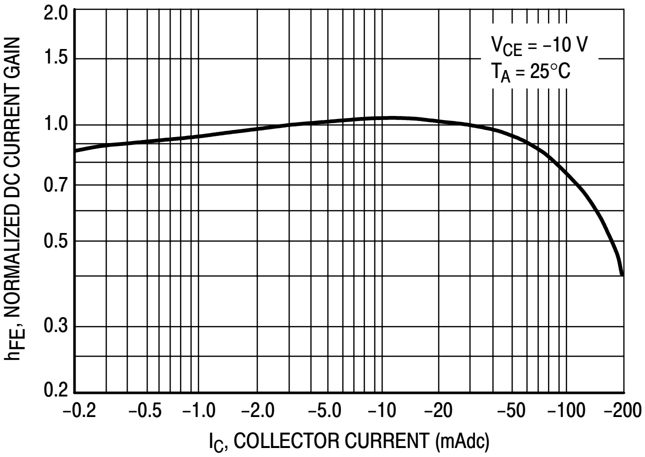


Figure 1. Normalized DC Current Gain

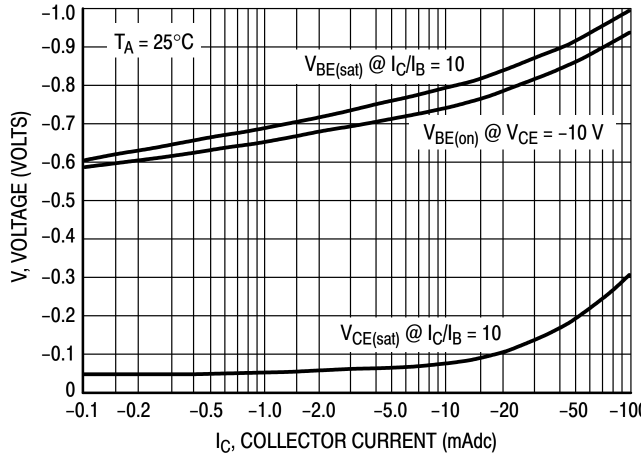


Figure 2. “Saturation” and “On” Voltages

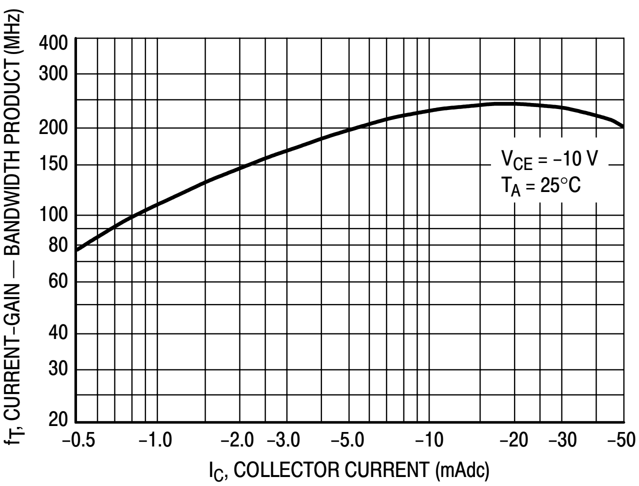


Figure 3. Current–Gain – Bandwidth Product

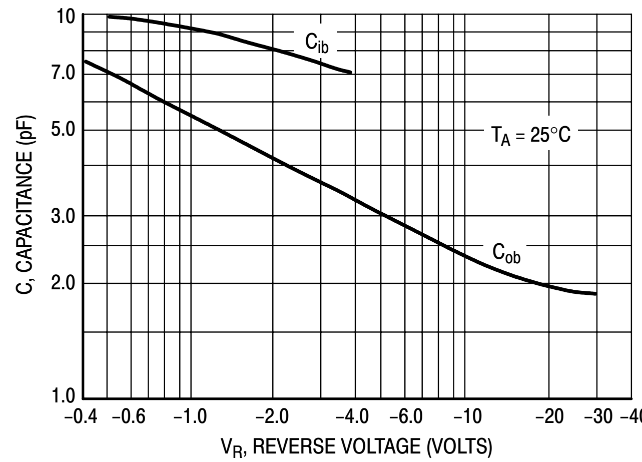


Figure 4. Capacitances

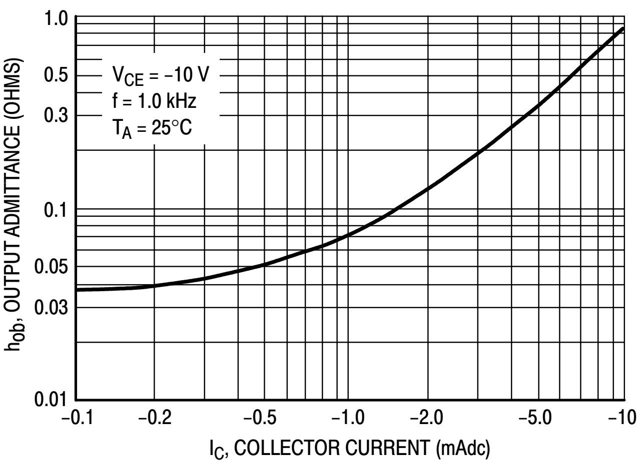


Figure 5. Output Admittance

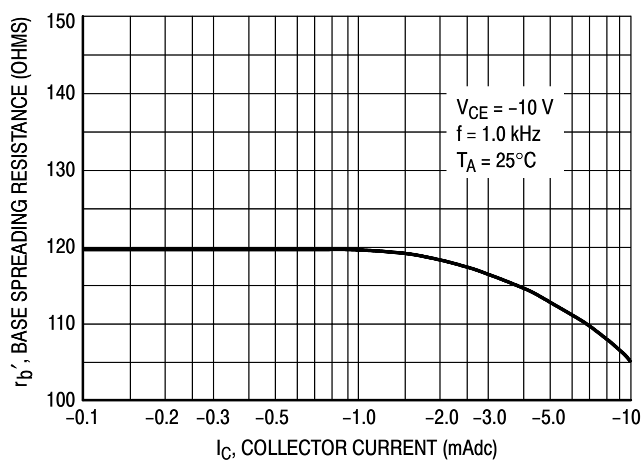
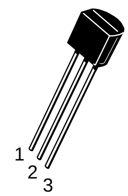


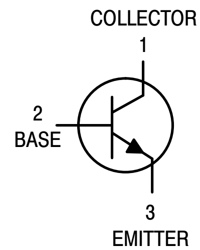
Figure 6. Base Spreading Resistance

BC237,A,B,C
BC238B,C
BC239C

Amplifier Transistors
NPN Silicon



CASE 29–11, STYLE 17
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	BC237	BC238	BC239	Unit
Collector–Emitter Voltage	V_{CEO}	45	25	25	Vdc
Collector–Emitter Voltage	V_{CES}	50	30	30	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	5.0	5.0	Vdc
Collector Current — Continuous	I_C	100			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0			Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = 2.0 mA, I_B = 0)	BC237 BC238 BC239	$V_{(BR)CEO}$	45 25 25	— — —	— — —	V
Emitter–Base Breakdown Voltage (I_E = 100 µA, I_C = 0)	BC237 BC238 BC239	$V_{(BR)EBO}$	6.0 5.0 5.0	— — —	— — —	V
Collector Cutoff Current		I_{CES}				
(V_{CE} = 30 V, V_{BE} = 0)	BC238 BC239		— —	0.2 0.2	15 15	nA
(V_{CE} = 50 V, V_{BE} = 0)	BC237		—	0.2	15	
(V_{CE} = 30 V, V_{BE} = 0) T_A = 125°C	BC238 BC239		— —	0.2 0.2	4.0 4.0	µA
(V_{CE} = 50 V, V_{BE} = 0) T_A = 125°C	BC237		—	0.2	4.0	

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Publication Order Number:
BC237/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 µA, V_{CE} = 5.0 V)	BC237A		—	90	—	
	BC237B/238B		—	150	—	
	BC237C/238C/239C		—	270	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC237		120	—	800	
	BC237A		120	170	220	
	BC237B/238B		200	290	460	
	BC237C/238C/239C		380	500	800	
(I_C = 100 mA, V_{CE} = 5.0 V)	BC237A		—	120	—	
	BC237B/238B		—	180	—	
	BC237C/238C/239C		—	300	—	
Collector–Emitter On Voltage		$V_{CE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)	BC237/BC238/BC239		—	0.07	0.2	
(I_C = 100 mA, I_B = 5.0 mA)	BC237/BC239		—	0.2	0.6	
	BC238				0.8	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)			—	0.6	0.83	
(I_C = 100 mA, I_B = 5.0 mA)			—	—	1.05	
Base–Emitter On Voltage		$V_{BE(on)}$				V
(I_C = 100 µA, V_{CE} = 5.0 V)			—	0.5	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)			0.55	0.62	0.7	
(I_C = 100 mA, V_{CE} = 5.0 V)			—	0.83	—	
DYNAMIC CHARACTERISTICS						
Current–Gain — Bandwidth Product		f_T				MHz
(I_C = 0.5 mA, V_{CE} = 3.0 V, f = 100 MHz)	BC237		—	100	—	
	BC238		—	120	—	
	BC239		—	140	—	
(I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)	BC237		150	200	—	
	BC238		150	240	—	
	BC239		150	280	—	
Collector–Base Capacitance (V_{CB} = 10 V, I_C = 0, f = 1.0 MHz)		C_{obo}	—	—	4.5	pF
Emitter–Base Capacitance (V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	8.0	—	pF
Noise Figure		NF				dB
(I_C = 0.2 mA, V_{CE} = 5.0 V, R_S = 2.0 kΩ, f = 1.0 kHz)	BC239		—	2.0	4.0	
(I_C = 0.2 mA, V_{CE} = 5.0 V, R_S = 2.0 kΩ, f = 1.0 kHz, Δf = 200 Hz)	BC237		—	2.0	10	
	BC238		—	2.0	10	
	BC239		—	2.0	4.0	

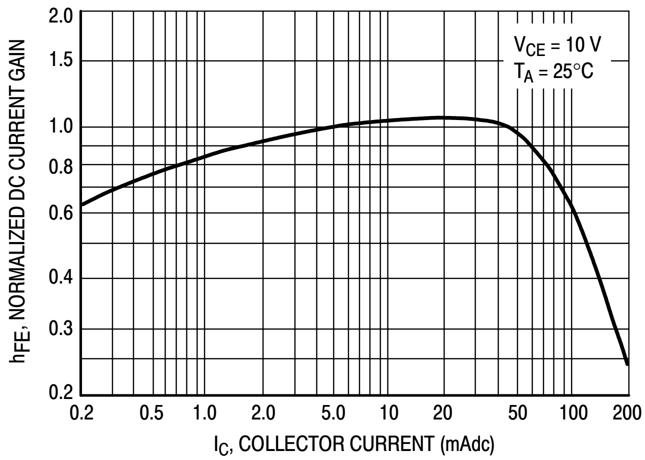


Figure 1. Normalized DC Current Gain

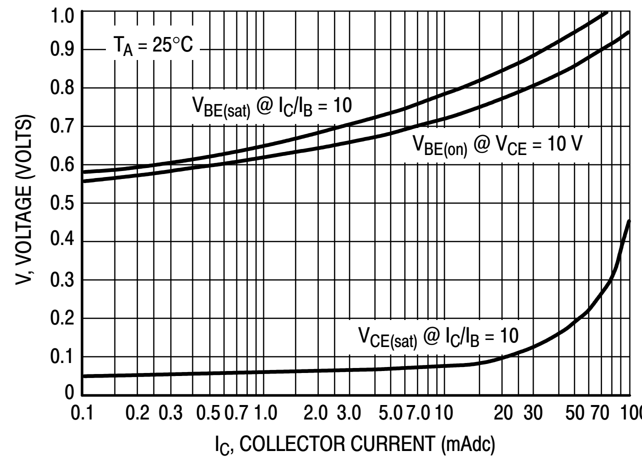


Figure 2. “Saturation” and “On” Voltages

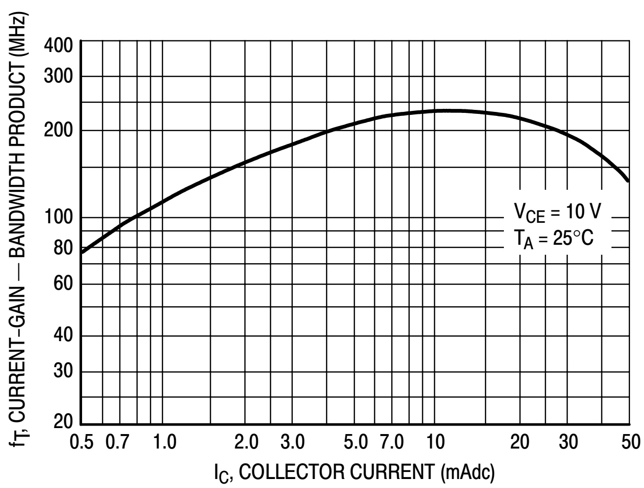


Figure 3. Current–Gain — Bandwidth Product

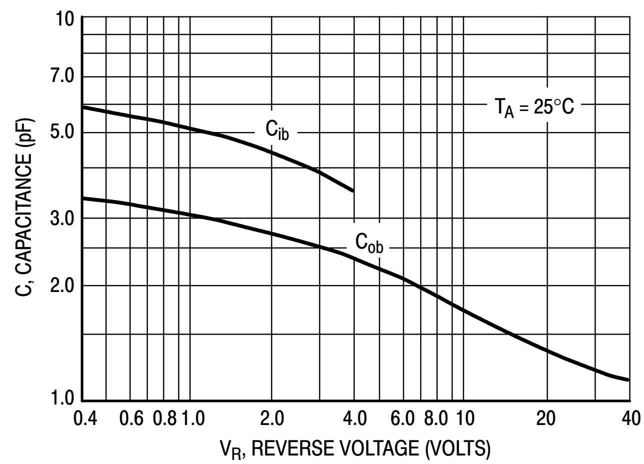


Figure 4. Capacitances

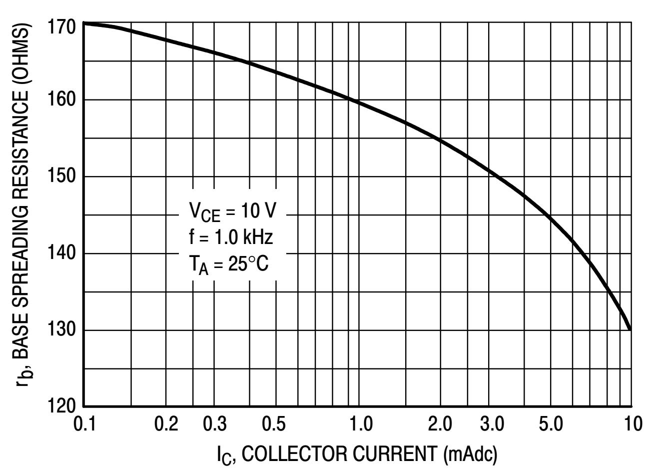


Figure 5. Base Spreading Resistance

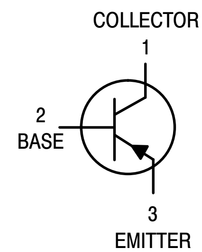
BC307B, BC307C

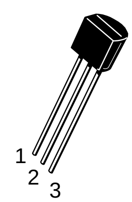
Amplifier Transistors

PNP Silicon

ON Semiconductor

http://onsemi.com





CASE 29
TO–92
STYLE 17

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	–45	Vdc
Collector-Base Voltage	V_{CBO}	–50	Vdc
Emitter-Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current — Continuous	I_C	–100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

ORDERING INFORMATION

Device	Package	Shipping
BC307B	TO–92	5000 Units/Box
BC307BRL1	TO–92	2000/Tape & Reel
BC307BZL1	TO–92	2000/Ammo Pack
BC307C	TO–92	5000 Units/Box

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = –2.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	–45	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –100 μAdc, I_C = 0)		$V_{(BR)EBO}$	–5.0	—	—	Vdc
Collector–Emitter Leakage Current		I_{CES}				
(V_{CES} = –50 V, V_{BE} = 0)			—	–0.2	–15	nAdc
(V_{CES} = –50 V, V_{BE} = 0) T_A = 125°C			—	–0.2	–4.0	μA
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = –10 μAdc, V_{CE} = –5.0 Vdc)	BC307B		—	150	—	
	BC307C		—	270	—	
(I_C = –2.0 mAdc, V_{CE} = –5.0 Vdc)	BC307		120	—	800	
	BC307B		200	290	460	
	BC307C		420	500	800	
(I_C = –100 mAdc, V_{CE} = –5.0 Vdc)	BC307B		—	180	—	
	BC307C		—	300	—	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = –10 mAdc, I_B = –0.5 mAdc)			—	–0.10	–0.3	
(I_C = –10 mAdc, I_B = see Note 1)			—	–0.30	–0.6	
(I_C = –100 mAdc, I_B = –5.0 mAdc)			—	–0.25	—	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = –10 mAdc, I_B = –0.5 mAdc)			—	–0.7	—	
(I_C = –100 mAdc, I_B = –5.0 mAdc)			—	–1.0	—	
Base–Emitter On Voltage (I_C = –2.0 mAdc, V_{CE} = –5.0 Vdc)		$V_{BE(on)}$	–0.55	–0.62	–0.7	Vdc
DYNAMIC CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –5.0 Vdc, f = 100 MHz)		f_T	—	280	—	MHz
Common Base Capacitance (V_{CB} = –10 Vdc, I_C = 0, f = 1.0 MHz)		C_{cbo}	—	—	6.0	pF
Noise Figure (I_C = –0.2 mAdc, V_{CE} = –5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz)		NF	—	2.0	10	dB

1. I_C = –10 mAdc on the constant base current characteristic, which yields the point I_C = –11 mAdc, V_{CE} = –1.0 V.

TYPICAL CHARACTERISTICS

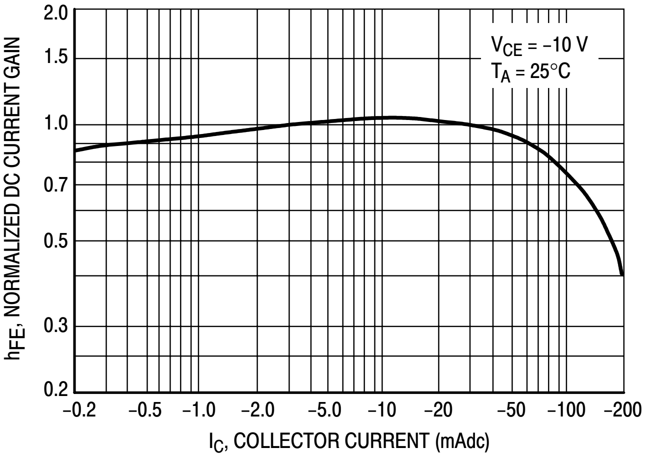


Figure 1. Normalized DC Current Gain

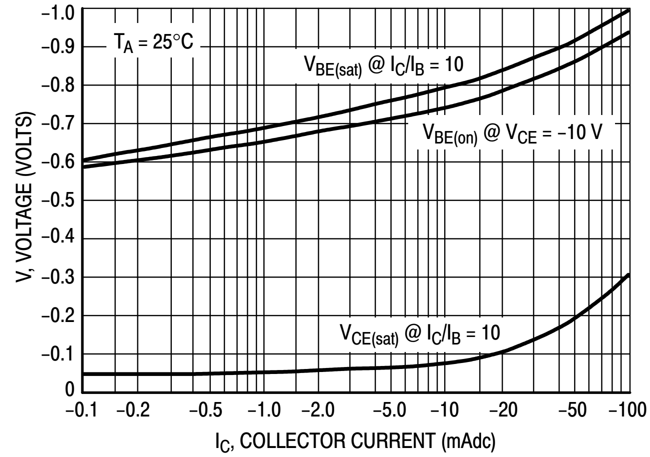


Figure 2. “Saturation” and “On” Voltages

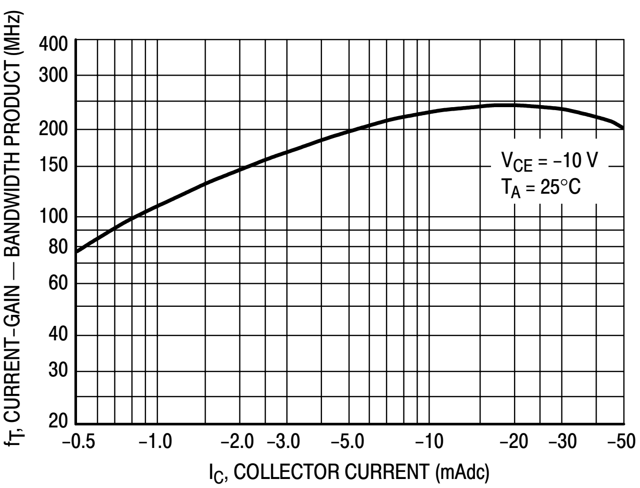


Figure 3. Current−Gain — Bandwidth Product

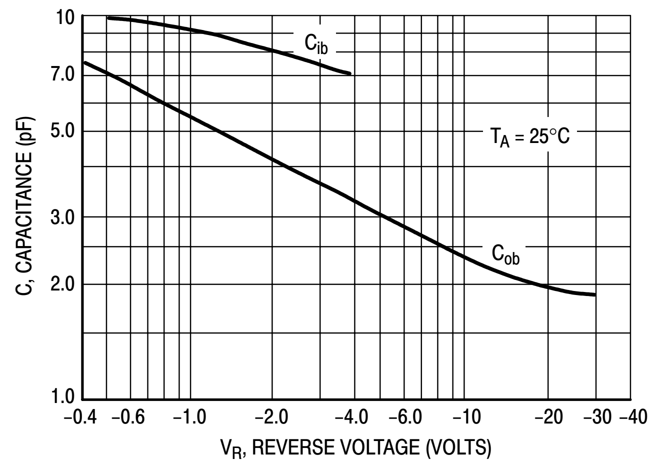


Figure 4. Capacitances

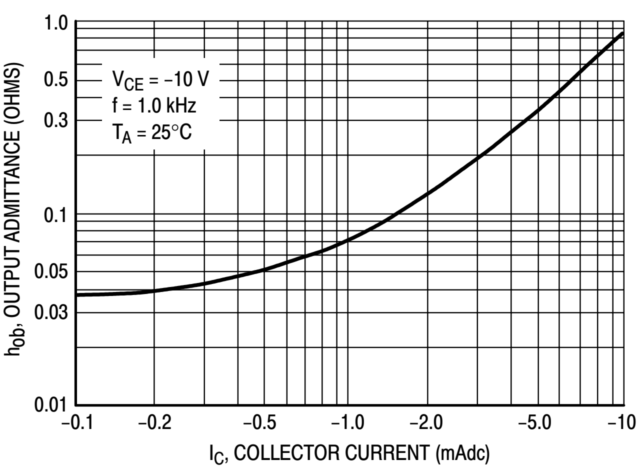


Figure 5. Output Admittance

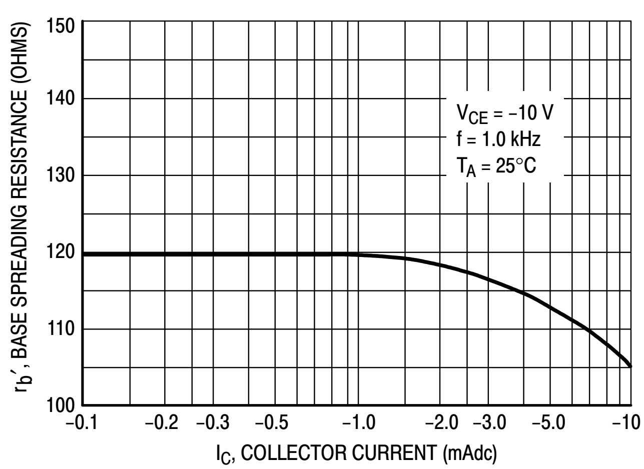
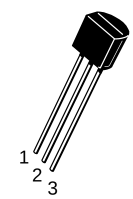


Figure 6. Base Spreading Resistance

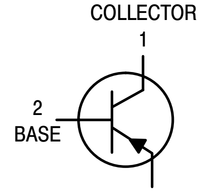
BC327, BC327-16, BC327-25, BC327-40

Amplifier Transistors

PNP Silicon



CASE 29–11, STYLE 17
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	BC327	Unit
Collector–Emitter Voltage	V_{CEO}	–45	Vdc
Collector–Base Voltage	V_{CBO}	–50	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Continuous	I_C	–800	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = –10 mA, I_B = 0)	$V_{(BR)CEO}$	–45	–	–	Vdc
Collector–Emitter Breakdown Voltage (I_C = –100 μA, I_E = 0)	$V_{(BR)CES}$	–50	–	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μA, I_C = 0)	$V_{(BR)EBO}$	–5.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = –30 V, I_E = 0)	I_{CBO}	–	–	–100	nAdc
Collector Cutoff Current (V_{CE} = –45 V, V_{BE} = 0)	I_{CES}	–	–	–100	nAdc
Emitter Cutoff Current (V_{EB} = –4.0 V, I_C = 0)	I_{EBO}	–	–	–100	nAdc

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ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = –100 mA, V_{CE} = –1.0 V)	BC327		100	–	630	
	BC327–16		100	–	250	
	BC327–25		160	–	400	
	BC327–40		250	–	630	
(I_C = –300 mA, V_{CE} = –1.0 V)			40	–	–	
Base–Emitter On Voltage (I_C = –300 mA, V_{CE} = –1.0 V)		$V_{BE(on)}$	–	–	–1.2	Vdc
Collector–Emitter Saturation Voltage (I_C = –500 mA, I_B = –50 mA)		$V_{CE(sat)}$	–	–	–0.7	Vdc
SMALL–SIGNAL CHARACTERISTICS						
Output Capacitance (V_{CB} = –10 V, I_E = 0, f = 1.0 MHz)		C_{ob}	–	11	–	pF
Current–Gain – Bandwidth Product (I_C = –10 mA, V_{CE} = –5.0 V, f = 100 MHz)		f_T	–	260	–	MHz

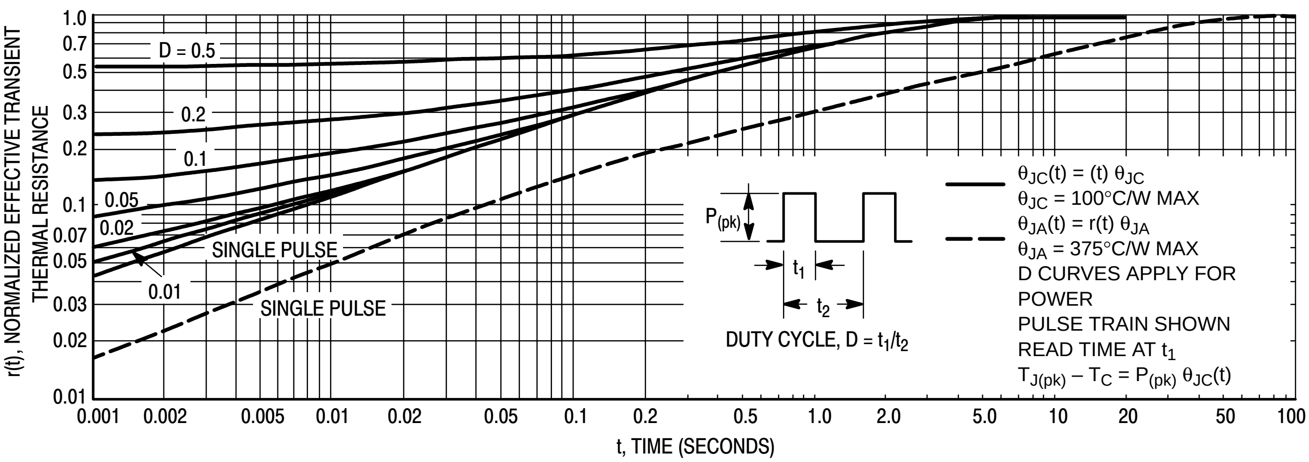


Figure 1. Thermal Response

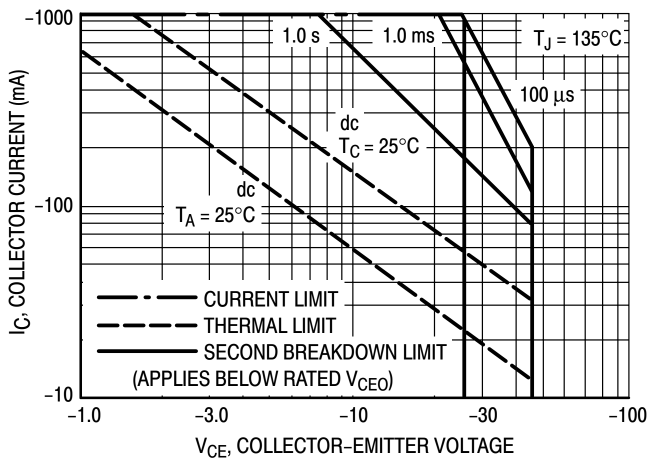


Figure 2. Active Region – Safe Operating Area

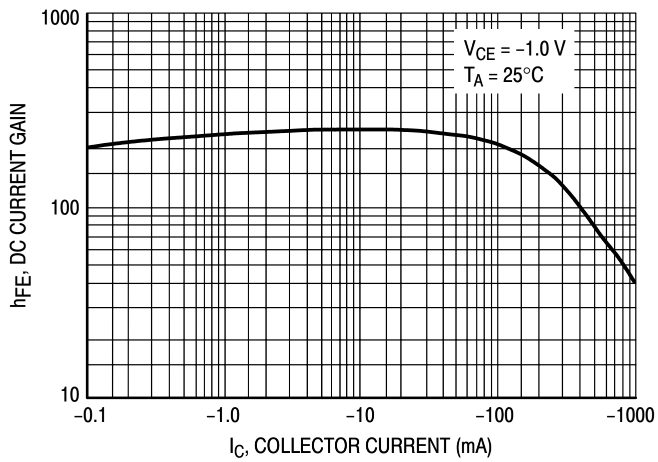


Figure 3. DC Current Gain

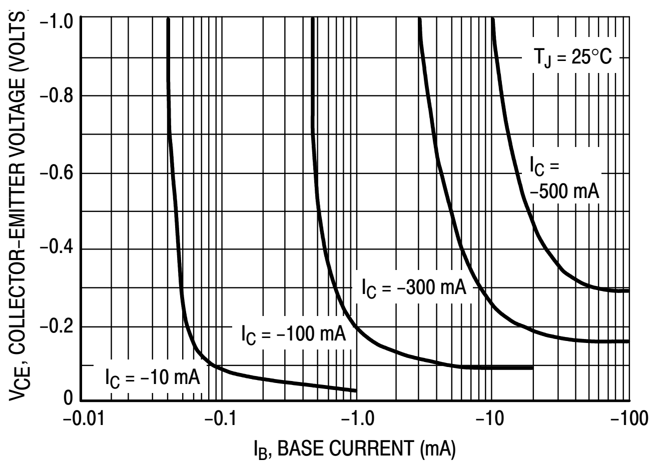


Figure 4. Saturation Region

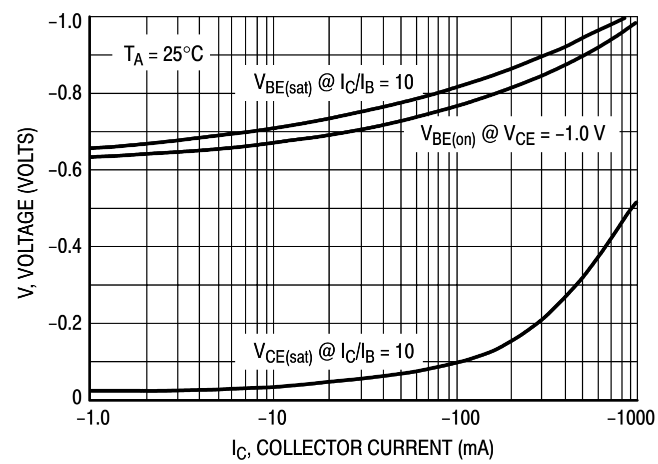


Figure 5. “On” Voltages

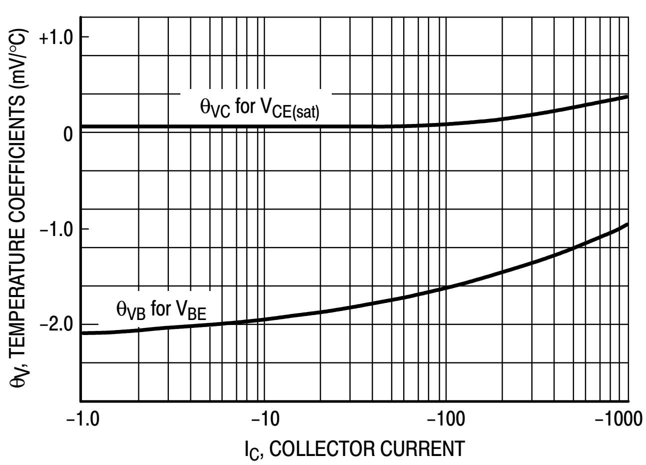


Figure 6. Temperature Coefficients

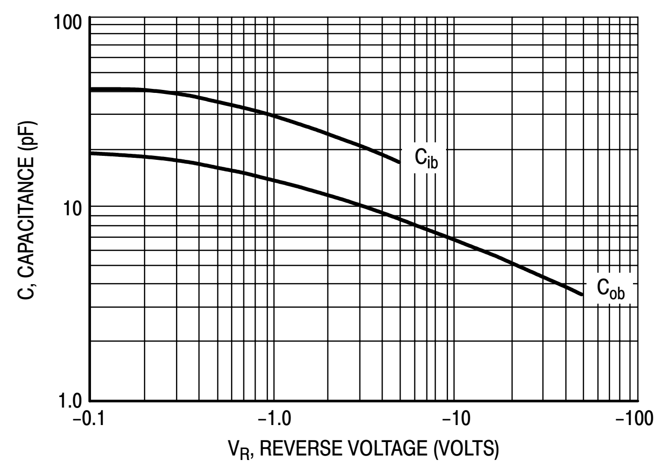
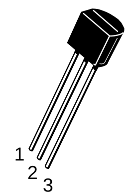


Figure 7. Capacitances

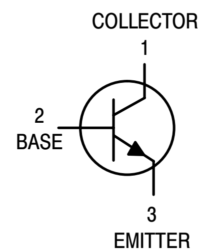
BC337, BC337-16, BC337-25, BC337-40, BC338-25

Amplifier Transistors

NPN Silicon



CASE 29–04, STYLE 17
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	BC337	BC338	Unit
Collector–Emitter Voltage	V_{CEO}	45	25	Vdc
Collector–Base Voltage	V_{CBO}	50	30	Vdc
Emitter–Base Voltage	V_{EBO}	5.0		Vdc
Collector Current – Continuous	I_C	800		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	 BC337 BC338	$V_{(BR)CEO}$	 45 25	 – –	 – –	Vdc
Collector–Emitter Breakdown Voltage (I_C = 100 µA, I_E = 0)	 BC337 BC338	$V_{(BR)CES}$	 50 30	 – –	 – –	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 µA, I_C = 0)		$V_{(BR)EBO}$	5.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0) (V_{CB} = 20 V, I_E = 0)	 BC337 BC338	I_{CBO}	 – –	 – –	 100 100	nAdc
Collector Cutoff Current (V_{CE} = 45 V, V_{BE} = 0) (V_{CE} = 25 V, V_{BE} = 0)	 BC337 BC338	I_{CES}	 – –	 – –	 100 100	nAdc
Emitter Cutoff Current (V_{EB} = 4.0 V, I_C = 0)		I_{EBO}	–	–	100	nAdc

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ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = 100 mA, V_{CE} = 1.0 V)	BC337		100	–	630	
	BC337–16		100	–	250	
	BC337–25/BC338–25		160	–	400	
	BC337–40		250	–	630	
(I_C = 300 mA, V_{CE} = 1.0 V)			60	–	–	
Base–Emitter On Voltage (I_C = 300 mA, V_{CE} = 1.0 V)		$V_{BE(on)}$	–	–	1.2	Vdc
Collector–Emitter Saturation Voltage (I_C = 500 mA, I_B = 50 mA)		$V_{CE(sat)}$	–	–	0.7	Vdc
SMALL–SIGNAL CHARACTERISTICS						
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)		C_{ob}	–	15	–	pF
Current–Gain – Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)		f_T	–	210	–	MHz

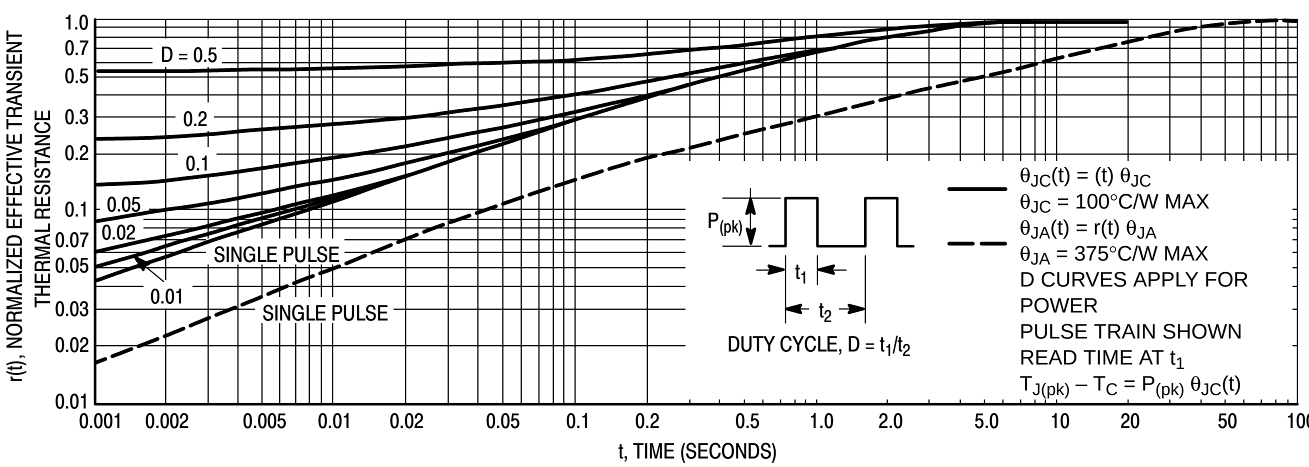


Figure 1. Thermal Response

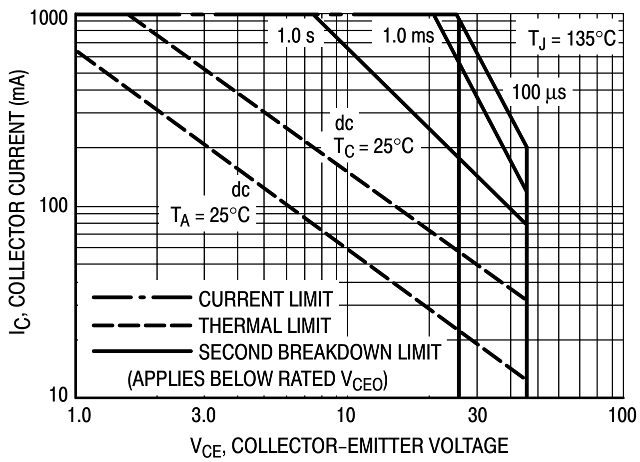


Figure 2. Active Region – Safe Operating Area

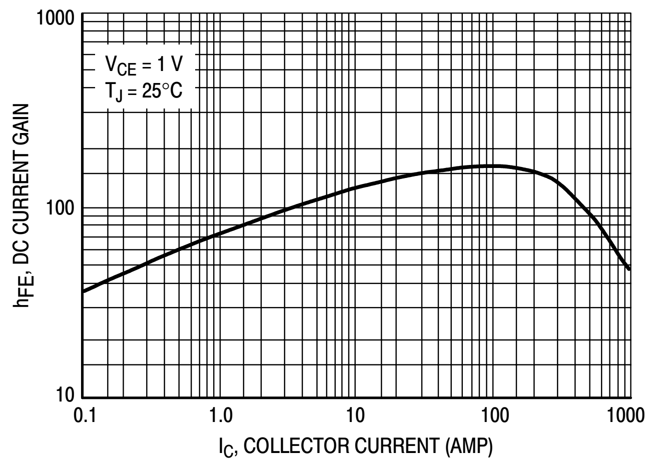


Figure 3. DC Current Gain

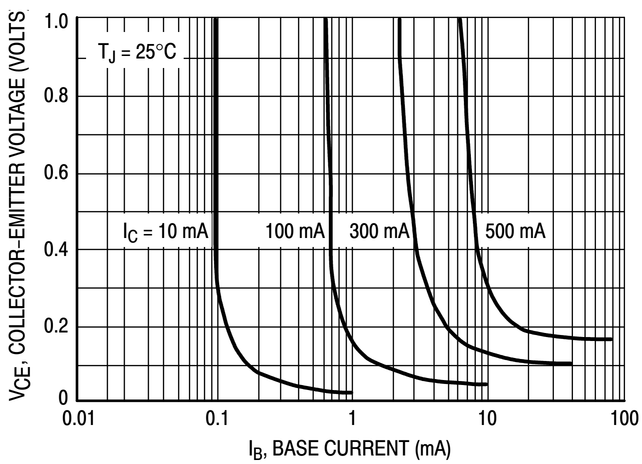


Figure 4. Saturation Region

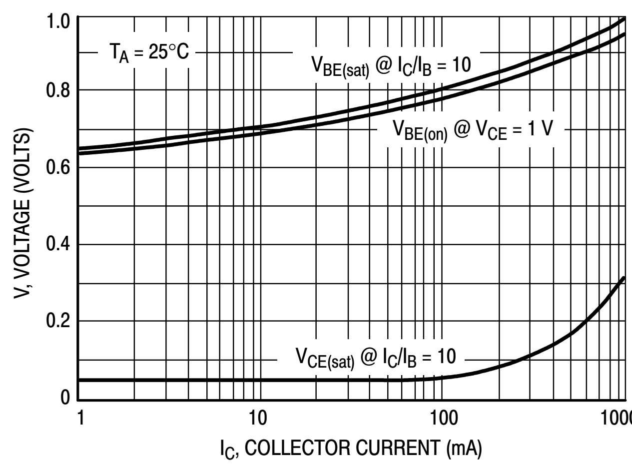


Figure 5. “On” Voltages

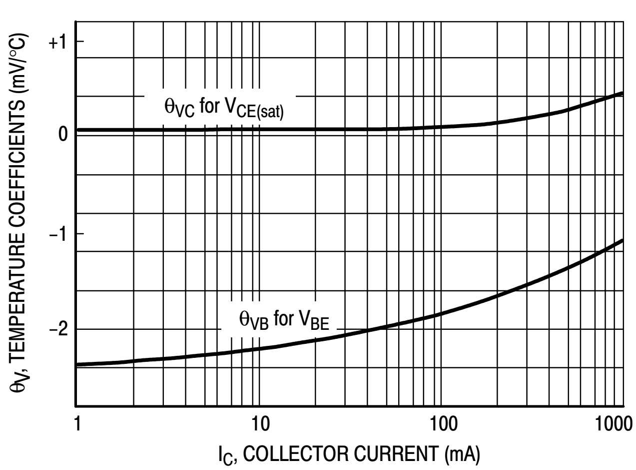


Figure 6. Temperature Coefficients

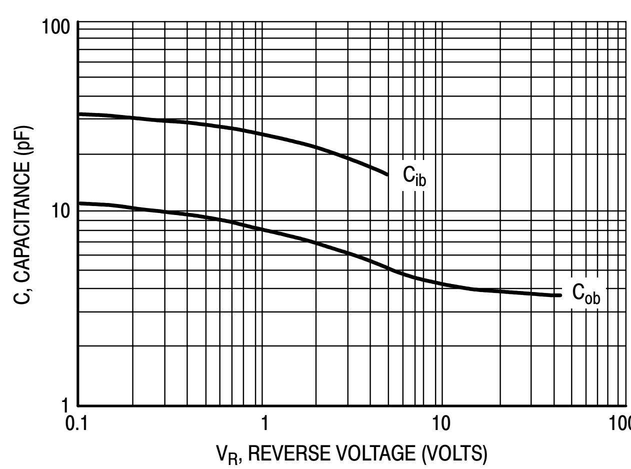
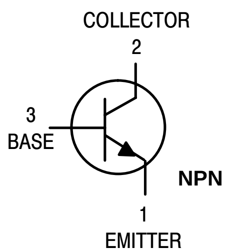
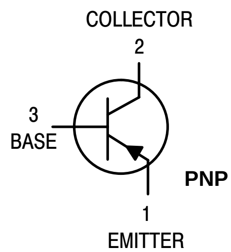


Figure 7. Capacitances

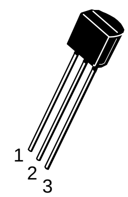
Amplifier Transistors





BC368 NPN, BC369 PNP

Voltage and current are negative for PNP transistors



CASE 29–04, STYLE 14
TO–92 (TO–226AA)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	20	Vdc
Collector–Emitter Voltage	V_{CES}	25	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 µA, I_E = 0)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 µA, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current	I_{CBO}				
(V_{CB} = 25 V, I_E = 0)		—	—	10	µAdc
(V_{CB} = 25 V, I_E = 0, T_J = 150°C)		—	—	1.0	mAdc
Emitter Cutoff Current (V_{EB} = 5.0 V, I_C = 0)	I_{EBO}	—	—	10	µAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				—
(V_{CE} = 10 V, I_C = 5.0 mA)		50	—	—	
(V_{CE} = 1.0 V, I_C = 0.5 A) BC368, 369		85	—	375	
BC368–25		170	—	375	
(V_{CE} = 1.0 V, I_C = 1.0 A)		60	—	—	
Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 V, f = 20 MHz)	f_T	65	—	—	MHz
Collector–Emitter Saturation Voltage (I_C = 1.0 A, I_B = 100 mA)	$V_{CE(sat)}$	—	—	0.5	V
Base–Emitter On Voltage (I_C = 1.0 A, V_{CE} = 1.0 V)	$V_{BE(on)}$	—	—	1.0	V

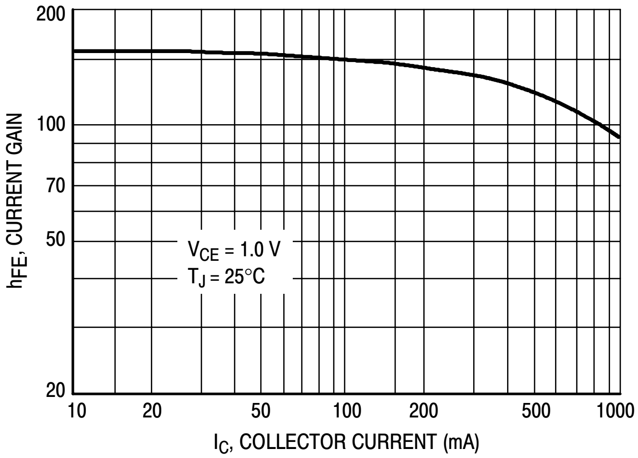


Figure 1. DC Current Gain

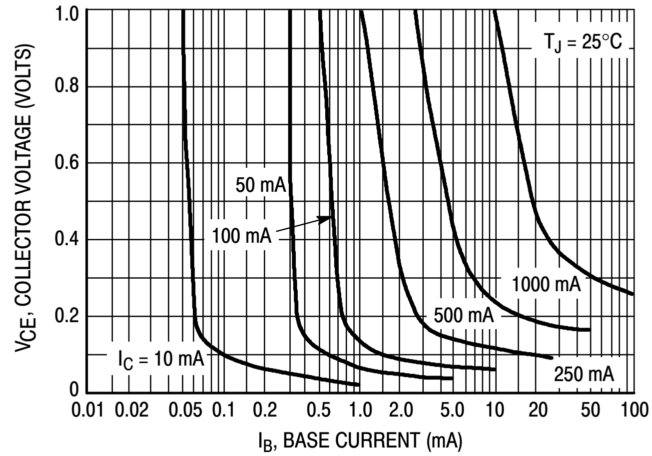


Figure 2. Collector Saturation Region

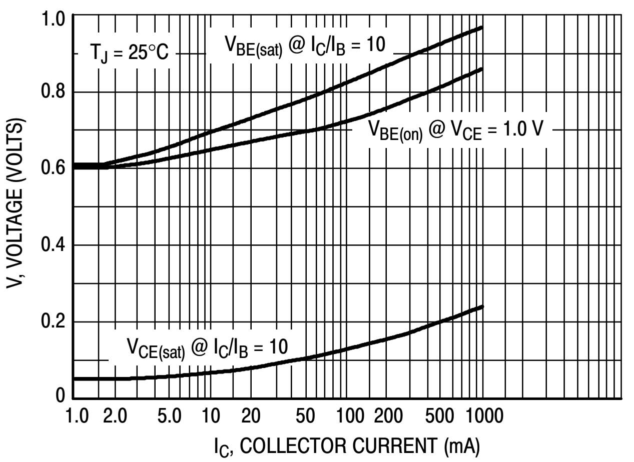


Figure 3. “On” Voltages

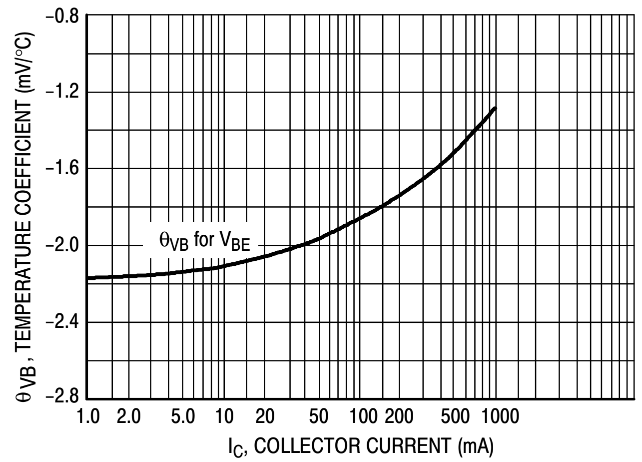


Figure 4. Temperature Coefficient

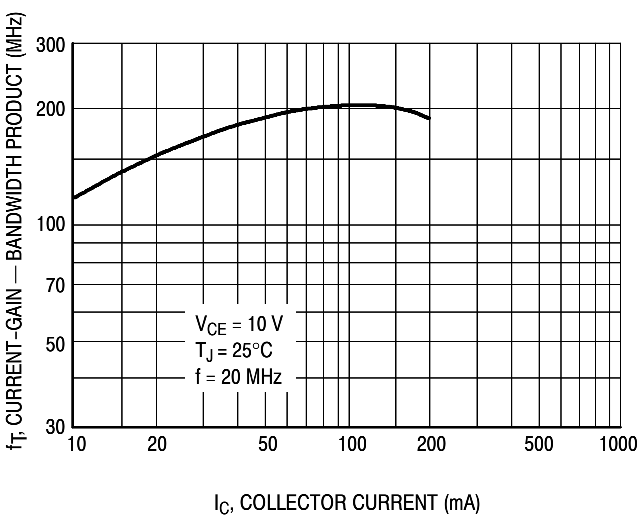


Figure 5. Current–Gain — Bandwidth Product

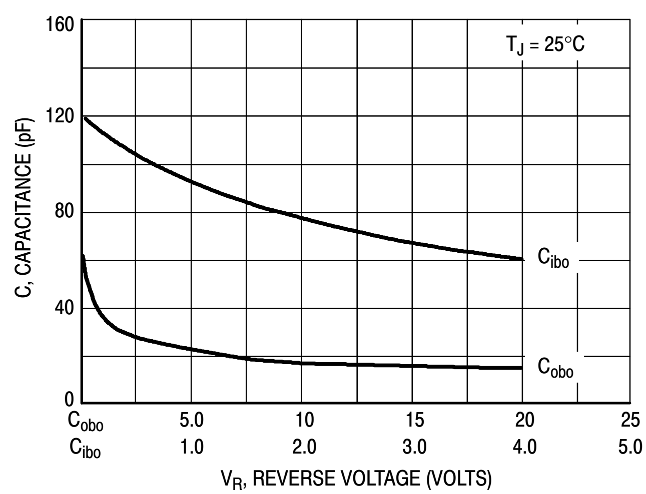
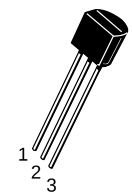


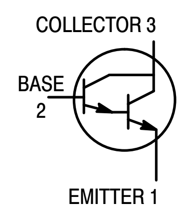
Figure 6. Capacitance

BC372
BC373

High Voltage Darlington Transistors
NPN Silicon



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	BC372	BC373	Unit
Collector–Emitter Voltage	V_{CES}	100	80	Vdc
Collector–Base Voltage	V_{CBO}	100	80	Vdc
Emitter–Base Voltage	V_{EBO}	12		Vdc
Collector Current — Continuous	I_C	1.0		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage(1) (I_C = 100 μAdc, I_B = 0)	 BC372 BC373	$V_{(BR)CES}$	 100 80	 — —	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 BC372 BC373	$V_{(BR)CBO}$	 100 80	 — —	 — —	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	12	—	—	Vdc
Collector Cutoff Current (V_{CB} = 80 Vdc, I_E = 0) (V_{CB} = 60 Vdc, I_E = 0)	 BC372 BC373	I_{CBO}	 — —	 — —	 100 100	nAdc
Emitter Cutoff Current (V_{EB} = 10 V, I_C = 0)		I_{EBO}	—	—	100	nAdc

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle 2.0%.

May, 2001 – Rev. 2
Publication Order Number:
BC272/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc) (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	8.0 10	— —	— 160	K
Collector–Emitter Saturation Voltage (I_C = 250 mAdc, I_B = 0.25 mAdc)	$V_{CE(sat)}$	—	1.0	1.1	Vdc
Base–Emitter Saturation Voltage (I_C = 250 mAdc, I_B = 0.25 mAdc)	$V_{BE(sat)}$	—	1.4	2.0	Vdc
DYNAMIC CHARACTERISTICS					
Current–Gain Bandwidth Product (I_C = 100 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	100	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	10	25	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_g = 100 k ohm, f = 1.0 kHz)	NF	—	2.0	—	dB

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle 2.0%.

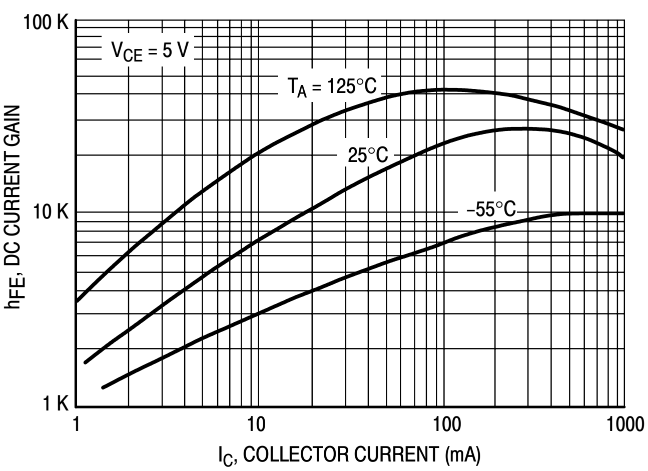


Figure 1. DC Current Gain

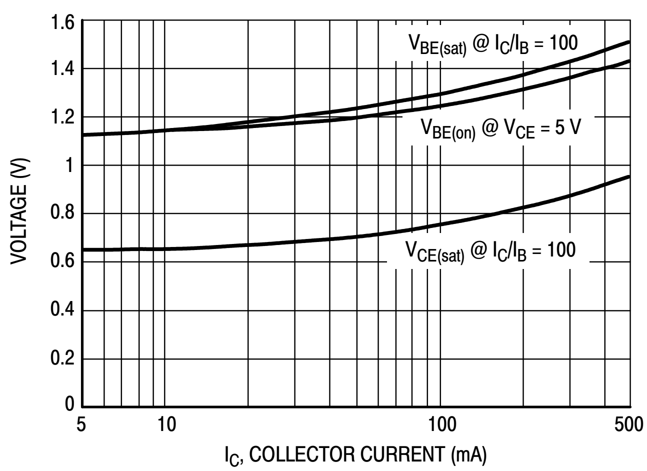


Figure 2. "Saturation" and "On" Voltages

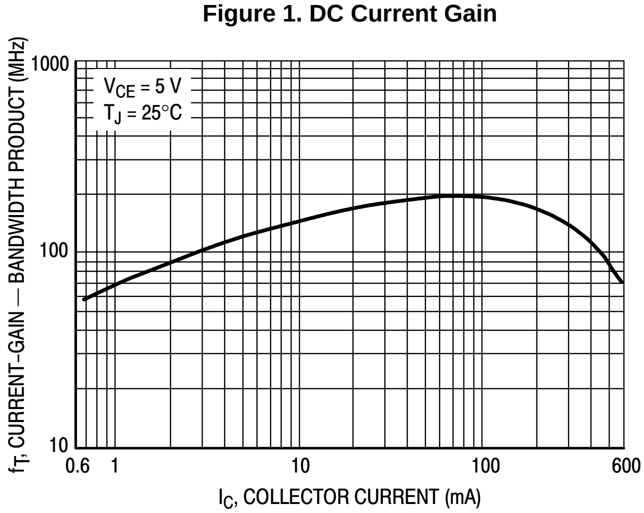


Figure 3. Current–Gain — Bandwidth Product

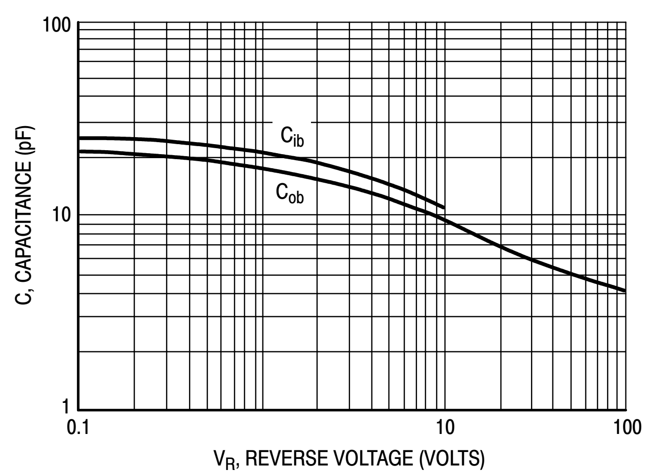


Figure 4. Capacitances

BC447, BC449, BC449A

High Voltage Transistors

PNP Silicon

ON Semiconductor™

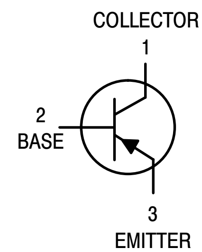
http://onsemi.com

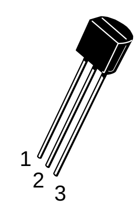
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage BC447 BC449, BC449A	V_{CEO}	 80 100	Vdc
Collector-Base Voltage BC447 BC449, BC449A	V_{CBO}	 80 100	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current – Continuous	I_C	300	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 625 5.0	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.5 12	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C
Moisture Sensitivity Level (MSL) Electrostatic Discharge (ESD)	MSL: 1 NA		

THERMAL CHARACTERISTICS

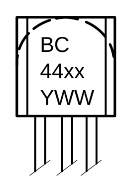
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W





CASE 29
TO–92
STYLE 17

MARKING DIAGRAM



BC44xx = Specific Device Code
xx = 7, 9 or 9A
Y = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping
BC447	TO–92	5000 Units/Box
BC449	TO–92	5000 Units/Box
BC449A	TO–92	5000 Units/Box

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (Note 1.)		$V_{(BR)CEO}$				Vdc
(I_C = 1.0 mAdc, I_B = 0)	BC447		80	–	–	
	BC449, BC449A		100	–	–	
Collector–Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0)	BC447		80	–	–	
	BC449, BC449A		100	–	–	
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	–	–	Vdc
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 60 Vdc, I_E = 0)	BC447		–	–	100	
(V_{CB} = 80 Vdc, I_E = 0)	BC449, BC449A		–	–	100	
ON CHARACTERISTICS (Note 1.)						
DC Current Gain		h_{FE}				–
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	BC447, BC449		50	–	460	
	BC449A		120	–	220	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	BC447, BC449		50	–	–	
	BC449A		100	–	–	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	BC447, BC449		50	–	–	
	BC449A		60	–	–	
Collector–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	–	0.125	0.25	Vdc
Base–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{BE(sat)}$	–	0.85	–	Vdc
Base–Emitter On Voltage		$V_{BE(on)}$				Vdc
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)			0.55	–	0.7	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc) (Note 1.)			–	0.76	1.2	
DYNAMIC CHARACTERISTICS						
Current–Gain – Bandwidth Product (I_C = 50 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	200	–	MHz

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle 2%

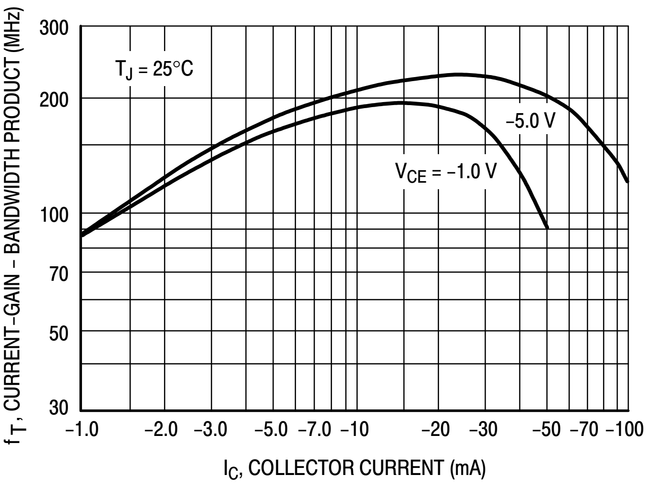


Figure 1. Current–Gain — Bandwidth Product

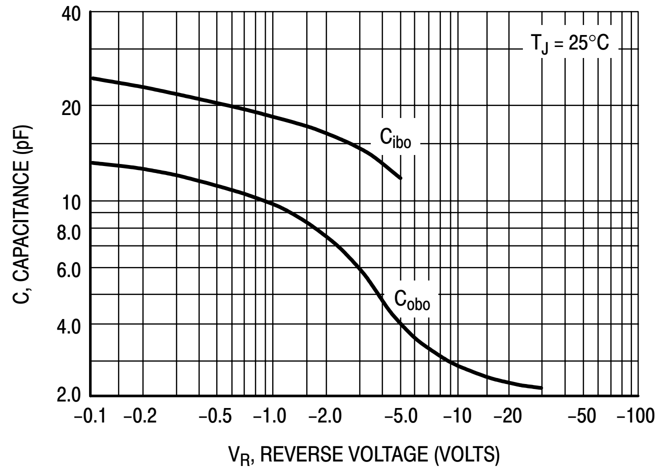


Figure 2. Capacitance

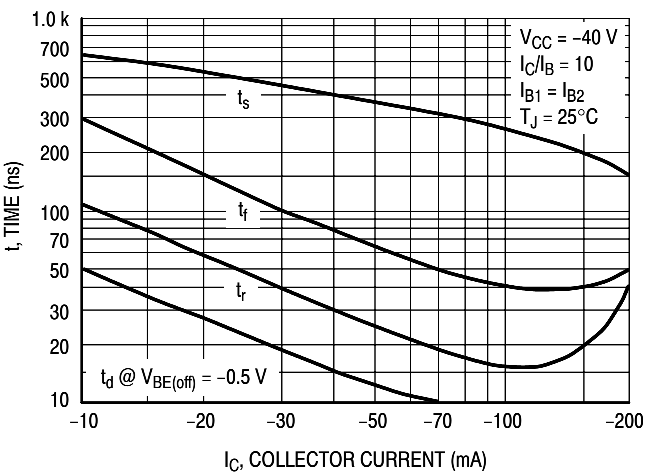


Figure 3. Switching Times

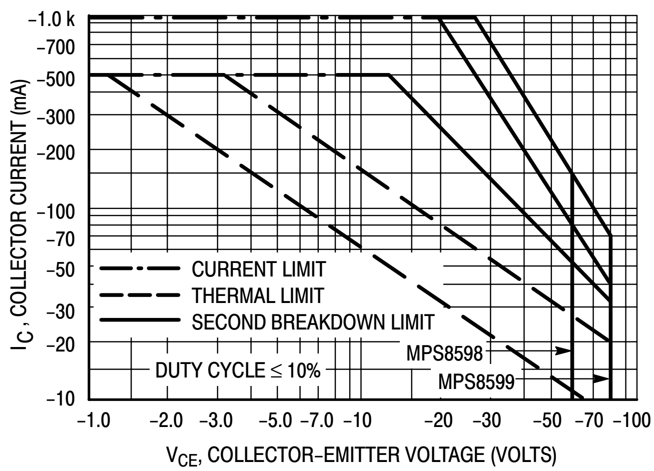


Figure 4. Active–Region Safe Operating Area

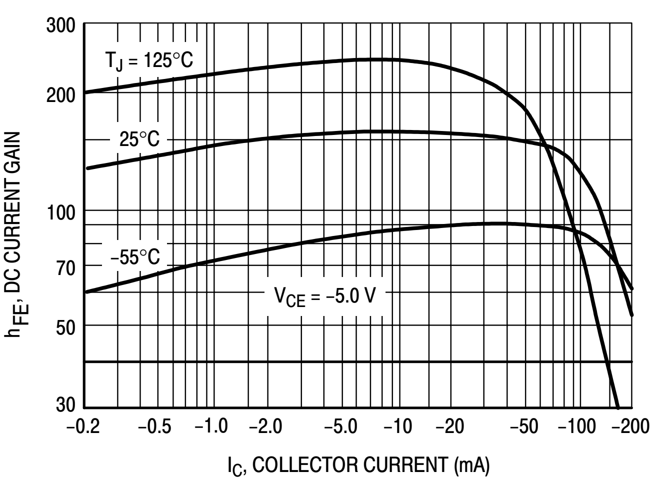


Figure 5. DC Current Gain

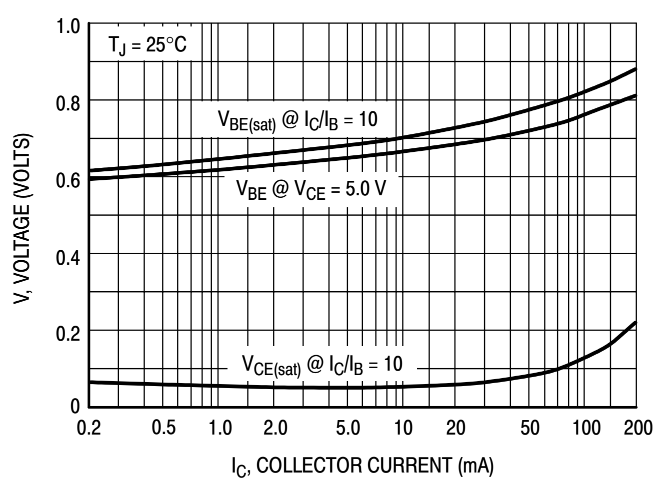


Figure 6. "ON" Voltages

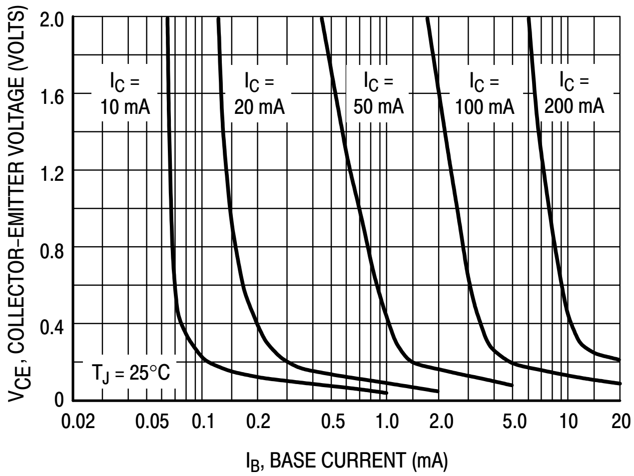


Figure 7. Collector Saturation Region

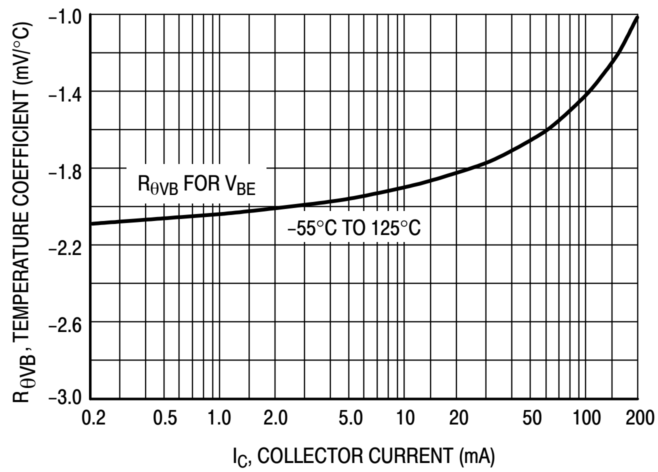


Figure 8. Base–Emitter Temperature Coefficient

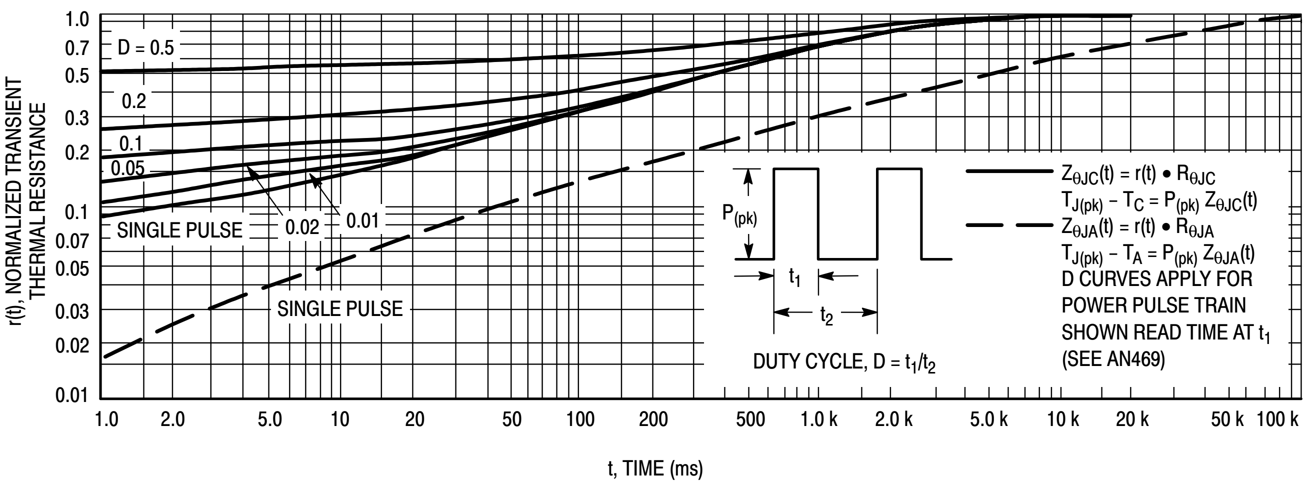


Figure 9. Thermal Response

BC487, BC487B

High Current Transistors

NPN Silicon

ON Semiconductor™

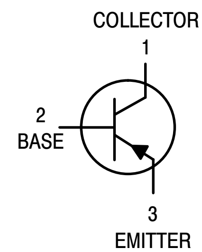
http://onsemi.com

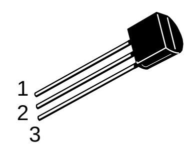
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	60	Vdc
Collector–Base Voltage	V_{CBO}	60	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current – Continuous	I_C	0.5	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

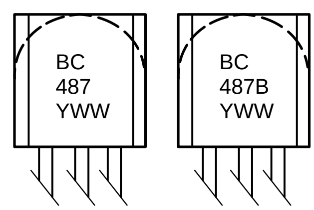
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W





TO–92
CASE 29
STYLE 17

MARKING DIAGRAMS



Y = Year
WW = Work Week

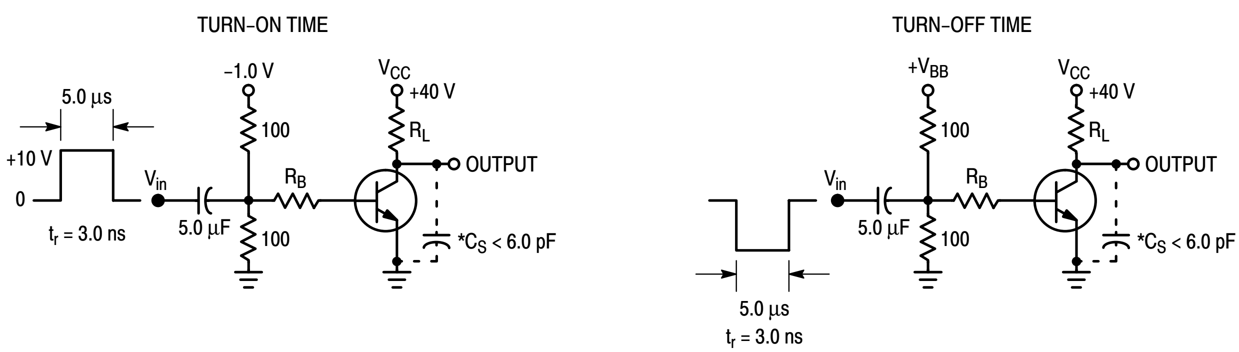
ORDERING INFORMATION

Device	Package	Shipping
BC487	TO–92	1000 Units/Box
BC487B	TO–92	1000 Units/Box
BC487BRL1	TO–92	2000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (Note 1.) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	60	–	–	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)	I_{CBO}	–	–	100	nAdc
ON CHARACTERISTICS*					
DC Current Gain	h_{FE}				–
(I_C = 10 mAdc, V_{CE} = 2.0 Vdc)		40	–	–	
(I_C = 100 mAdc, V_{CE} = 2.0 Vdc) BC487		60	–	400	
BC487B		160	260	400	
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)*		15	–	–	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		–	0.2	0.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)		–	0.3	–	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		–	0.85	1.2	
(I_C = 1.0 Adc, I_B = 100 mAdc)(1)		–	0.9	–	
DYNAMIC CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = 50 mAdc, V_{CE} = 2.0 Vdc, f = 100 MHz)	f_T	–	200	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	7.0	–	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	–	50	–	pF

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle 2.0%.



*Total Shunt Capacitance of Test Jig and Connectors
For PNP Test Circuits, Reverse All Voltage Polarities

Figure 1. Switching Time Test Circuits

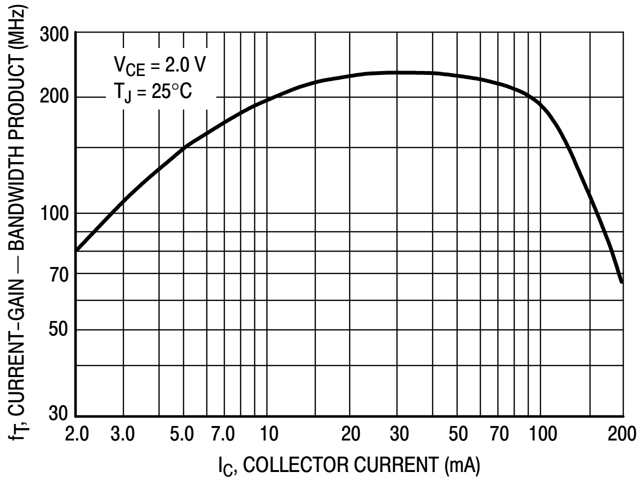


Figure 2. Current–Gain – Bandwidth Product

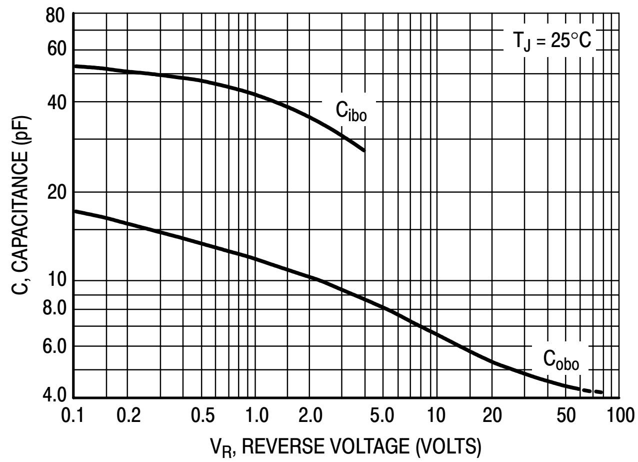


Figure 3. Capacitance

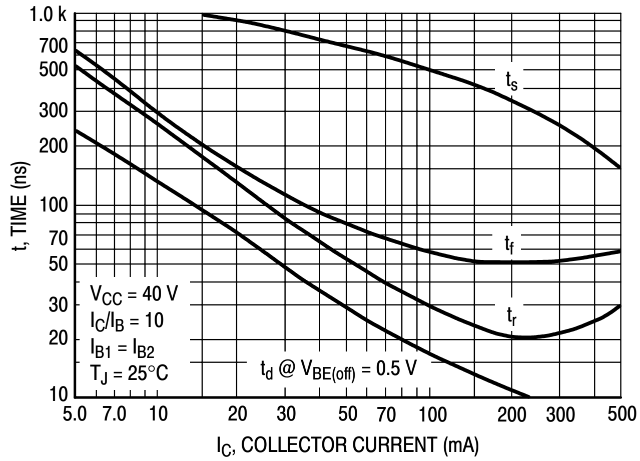


Figure 4. Switching Time

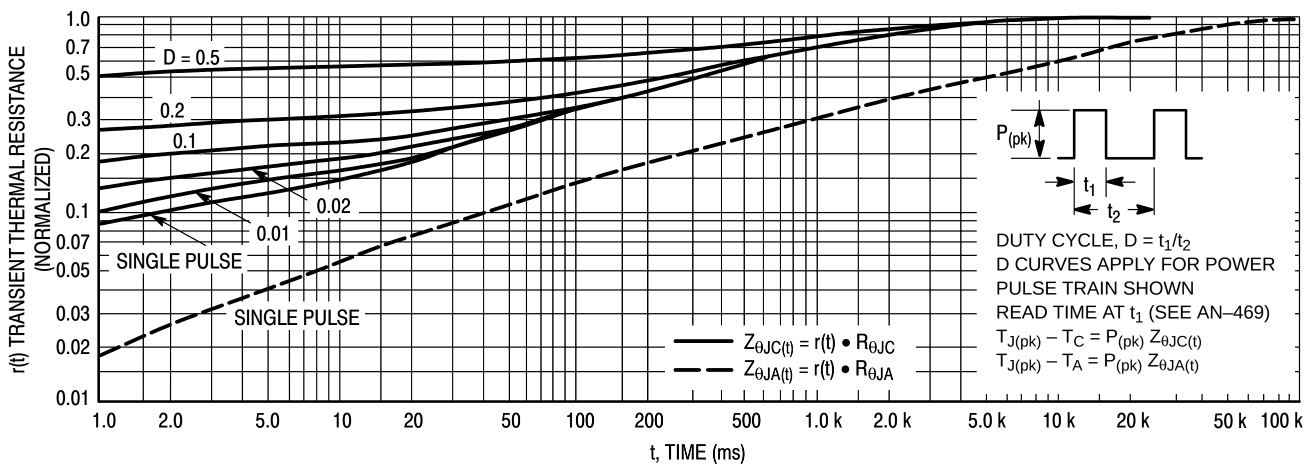


Figure 5. Thermal Response

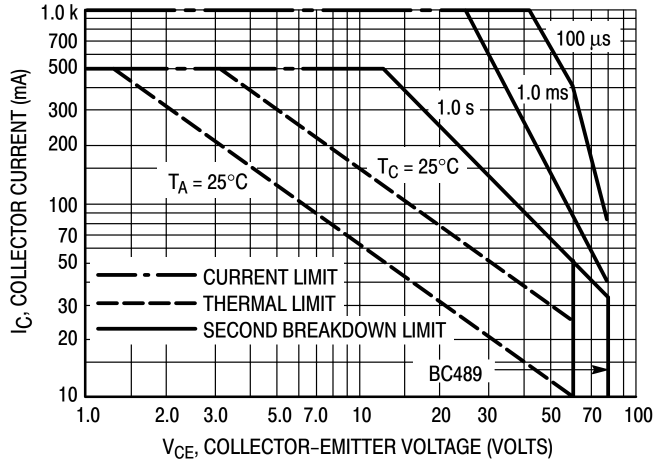


Figure 6. Active Region – Safe Operating Area

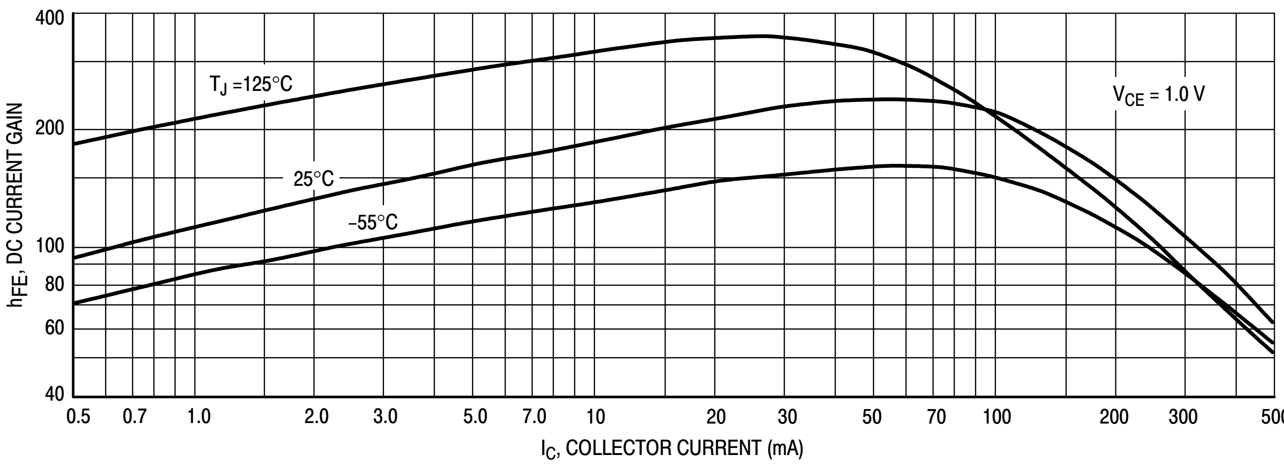


Figure 7. DC Current Gain

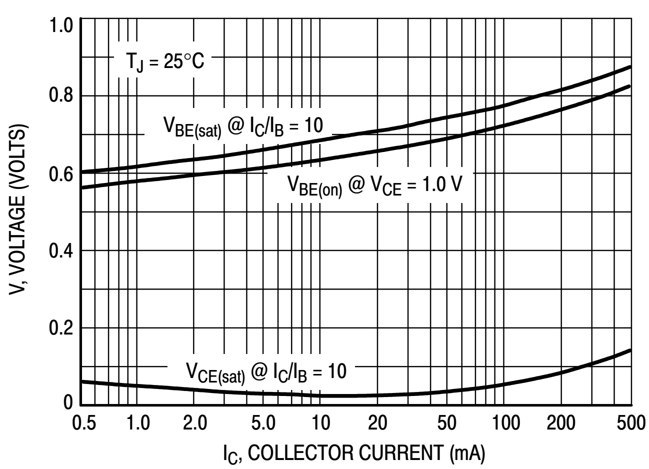


Figure 8. “On” Voltages

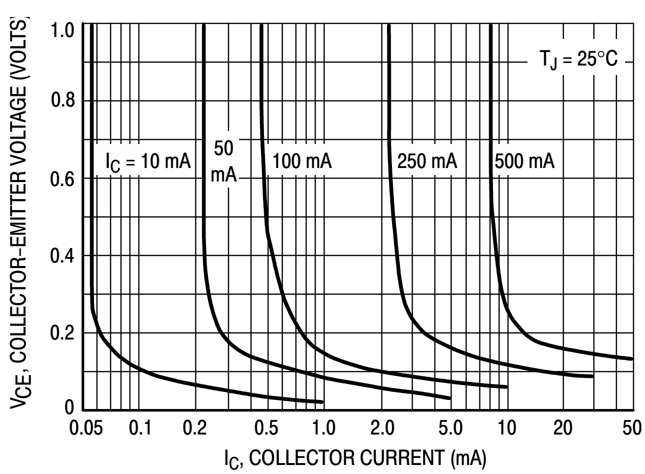


Figure 9. Collector Saturation Region

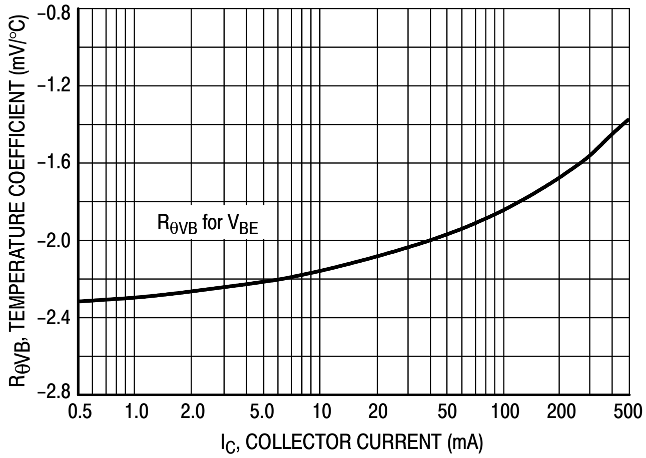


Figure 10. Base–Emitter Temperature Coefficient

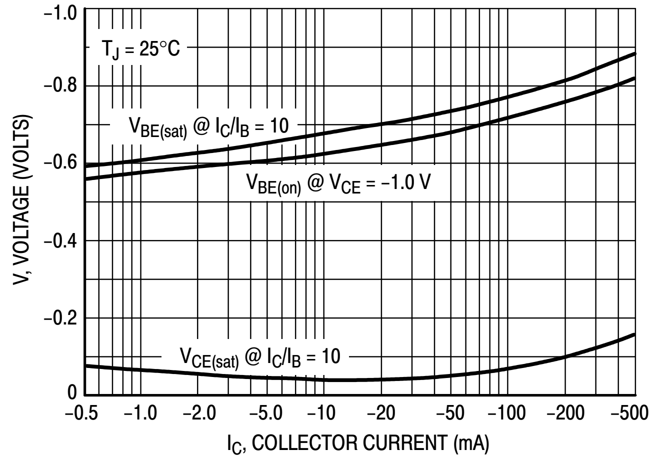


Figure 11. “On” Voltages

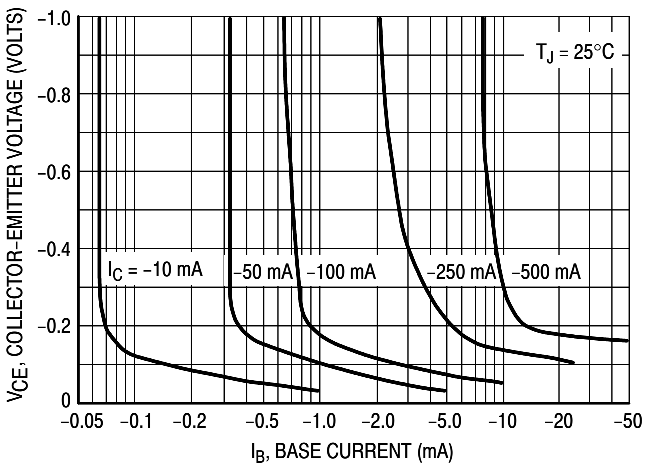


Figure 12. Collector Saturation Region

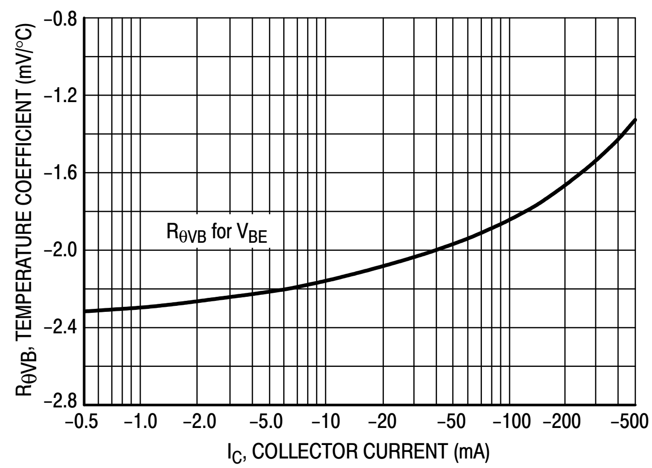


Figure 13. Base–Emitter Temperature Coefficient

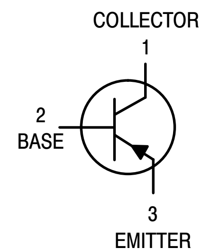
BC488B

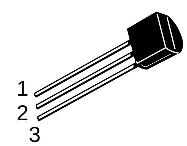
High Current Transistors

PNP Silicon

ON Semiconductor™

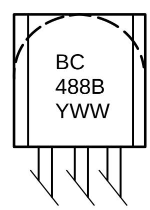
http://onsemi.com





TO–92
CASE 29
STYLE 17

MARKING DIAGRAMS



Y = Year
WW = Work Week

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	–60	Vdc
Collector-Base Voltage	V_{CBO}	–60	Vdc
Emitter-Base Voltage	V_{EBO}	–4.0	Vdc
Collector Current – Continuous	I_C	–1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

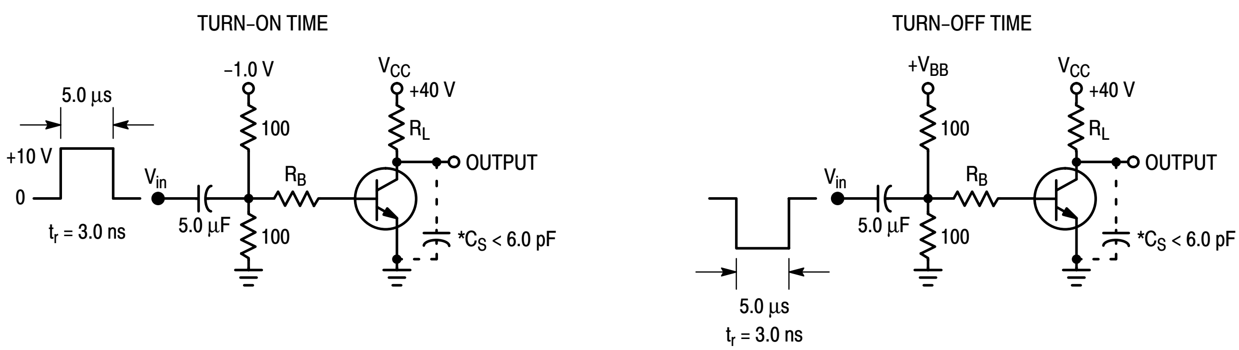
ORDERING INFORMATION

Device	Package	Shipping
BC488BRL1	TO–92	2000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(1) (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–60	–	–	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–60	–	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = –40 Vdc, I_E = 0)	I_{CBO}	–	–	–100	nAdc
ON CHARACTERISTICS*					
DC Current Gain	h_{FE}				–
(I_C = –10 mAdc, V_{CE} = –2.0 Vdc)		40	–	–	
(I_C = –100 mAdc, V_{CE} = –2.0 Vdc)		160	260	400	
(I_C = –1.0 Adc, V_{CE} = –5.0 Vdc)		15	–	–	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = –500 mAdc, I_B = –50 mAdc)		–	–0.25	–0.5	
(I_C = –1.0 Adc, I_B = –100 mAdc)		–	–0.5	–	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = –500 mAdc, I_B = –50 mAdc)		–	–0.9	–1.2	
(I_C = –1.0 Adc, I_B = –100 mAdc)		–	–1.0	–	
DYNAMIC CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = –50 mAdc, V_{CE} = –2.0 Vdc, f = 100 MHz)	f_T	–	150	–	MHz
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	9.0	–	pF
Input Capacitance (V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	–	110	–	pF

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle 2%.



*Total Shunt Capacitance of Test Jig and Connectors
For PNP Test Circuits, Reverse All Voltage Polarities

Figure 1. Switching Time Test Circuits

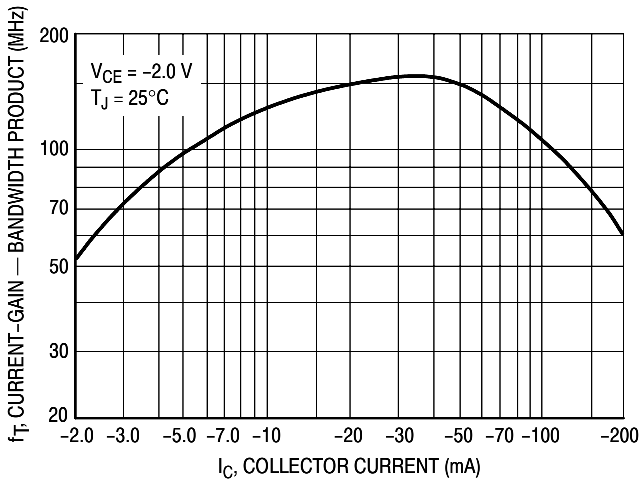


Figure 2. Current−Gain − Bandwidth Product

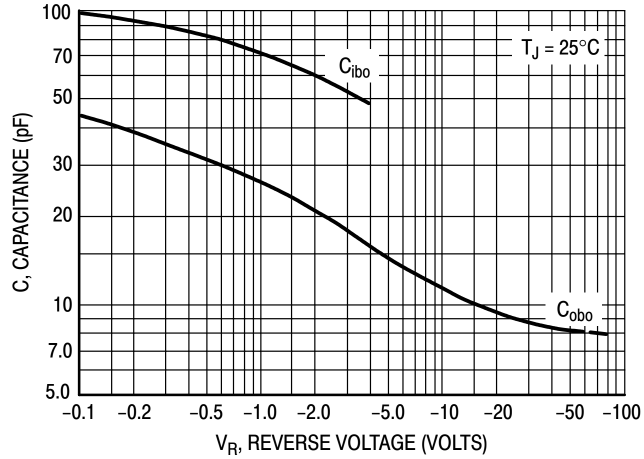


Figure 3. Capacitance

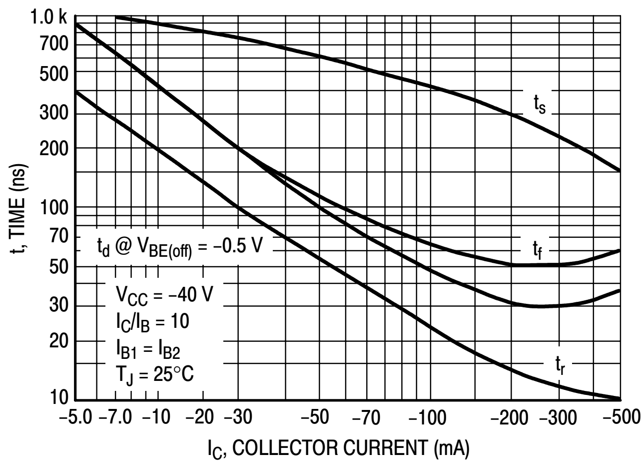


Figure 4. Switching Time

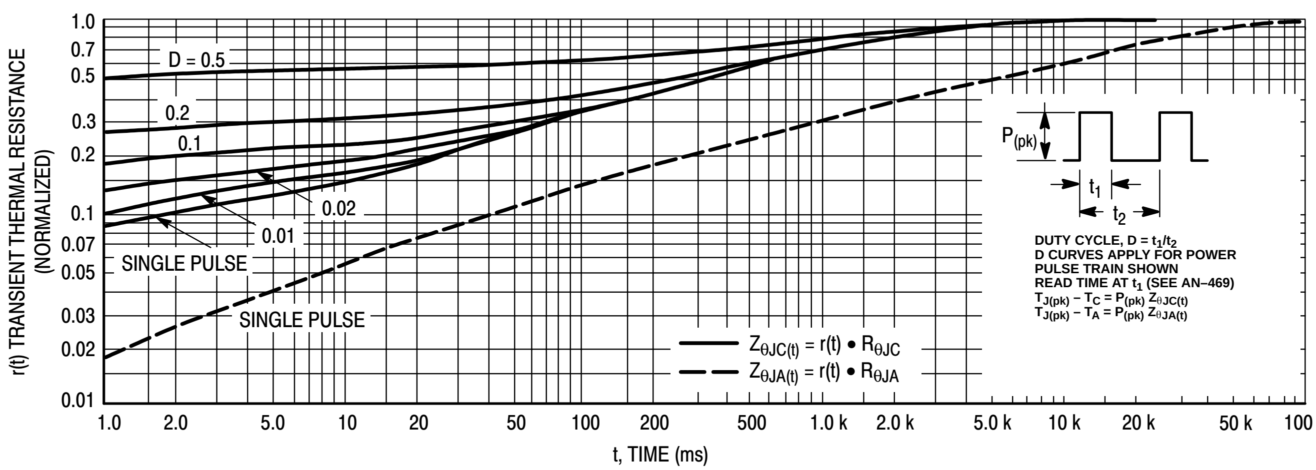


Figure 5. Thermal Response

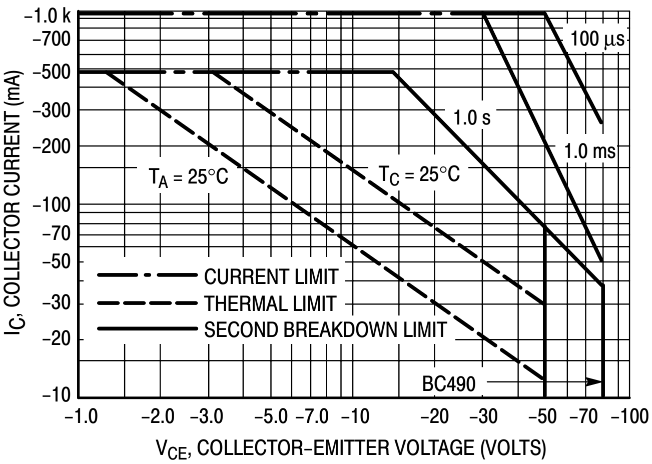


Figure 6. Active Region, Safe Operating Area

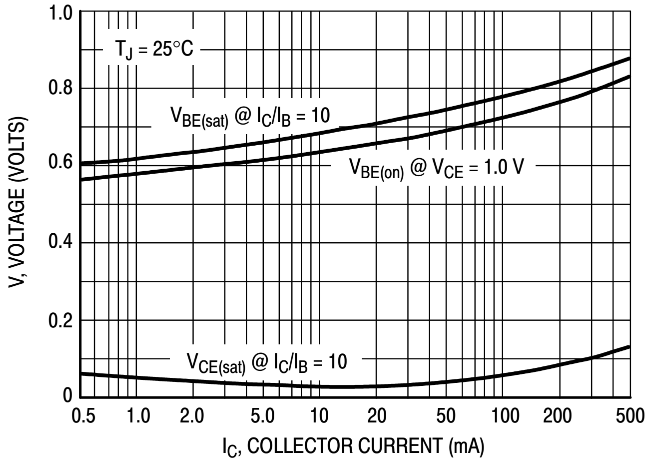


Figure 7. “On” Voltages

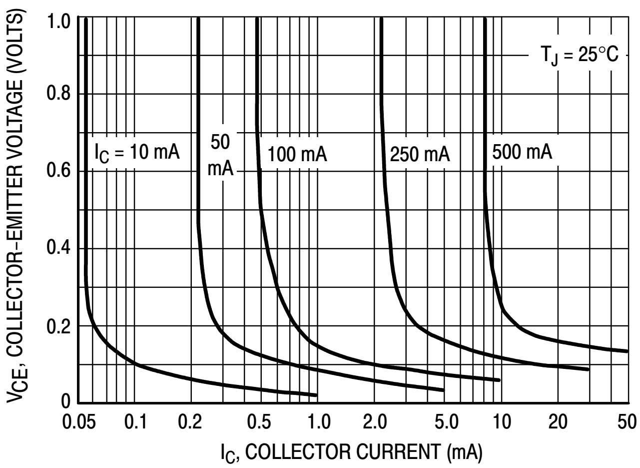


Figure 8. Collector Saturation Region

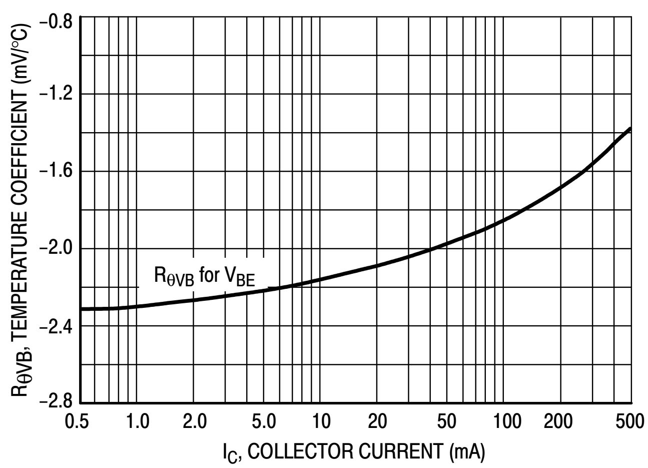


Figure 9. Base−Emitter Temperature Coefficient

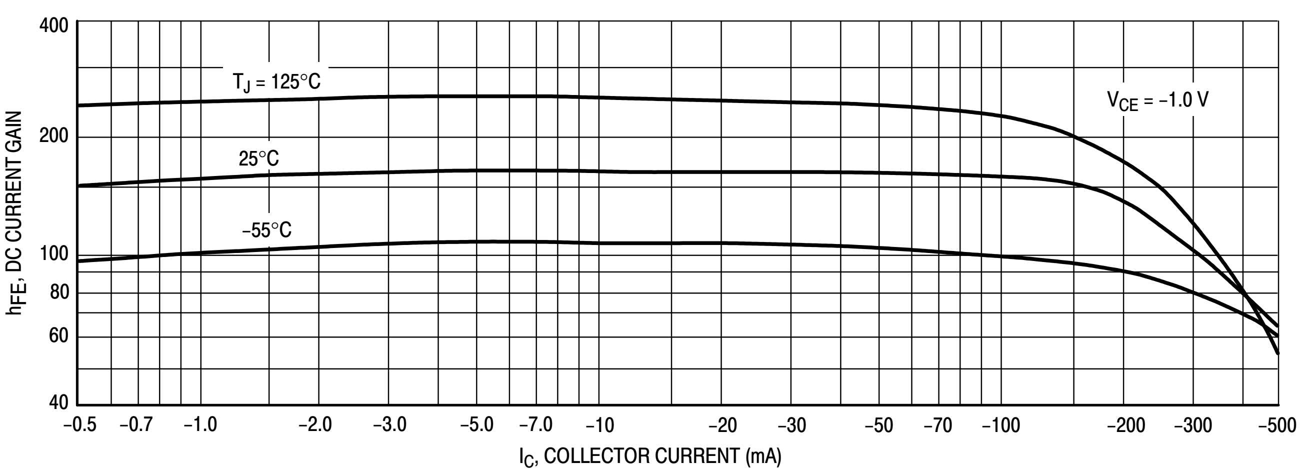


Figure 10. DC Current Gain

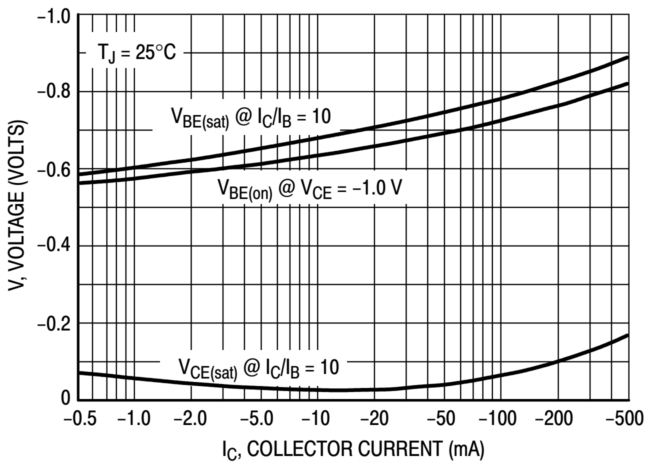


Figure 11. “On” Voltages

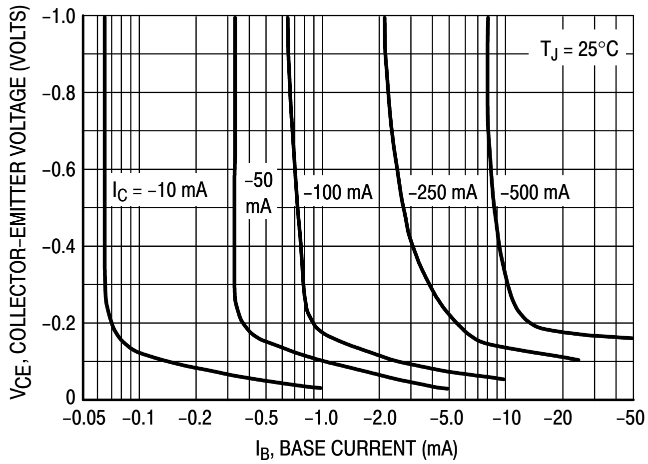


Figure 12. Collector Saturation Region

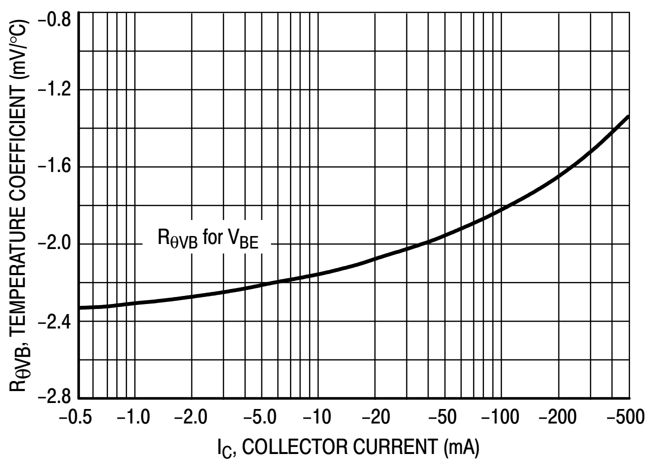


Figure 13. Base−Emitter Temperature Coefficient

High Current Transistors
NPN Silicon

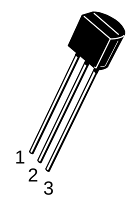
BC489, A, B

MAXIMUM RATINGS

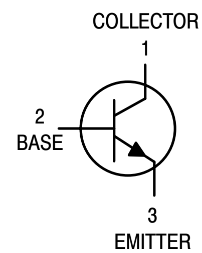
Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	80	Vdc
Collector–Base Voltage	V_{CBO}	80	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



CASE 29–04, STYLE 17
TO–92 (TO–226AA)



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	80	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)		$V_{(BR)CBO}$	80	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0)		I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS*						
DC Current Gain		h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 2.0 Vdc)			40	—	—	
(I_C = 100 mAdc, V_{CE} = 2.0 Vdc)	BC489		60	—	400	
	BC489A		100	160	250	
	BC489B		160	260	400	
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)*			15	—	—	

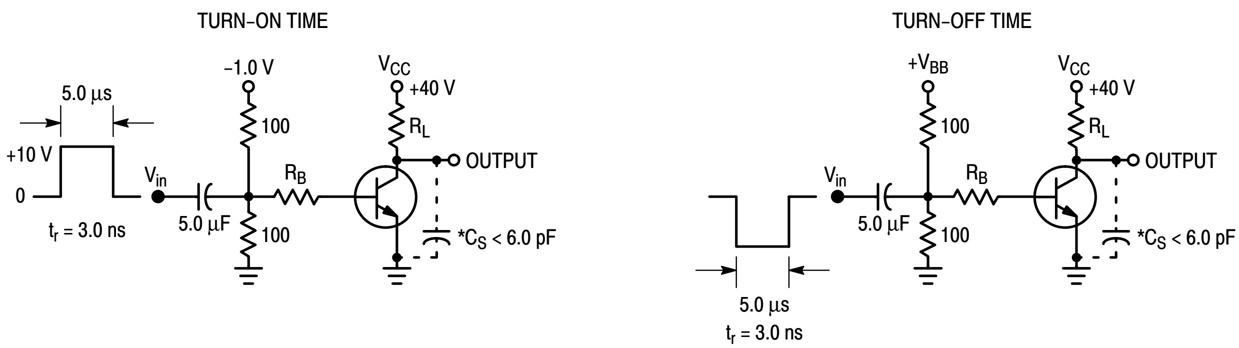
1. Pulse Test: Pulse Width = 300 μs, Duty Cycle 2%.

March, 2001 – Rev. 1
Publication Order Number:
BC489/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS* (Continued)					
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		—	0.2	0.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)		—	0.3	—	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		—	0.85	1.2	
(I_C = 1.0 Adc, I_B = 100 mAdc)(1)		—	0.9	—	
DYNAMIC CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 2.0 Vdc, f = 100 MHz)	f_T	—	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	7.0	—	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	—	50	—	pF

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle 2.0%.



*Total Shunt Capacitance of Test Jig and Connectors
For PNP Test Circuits, Reverse All Voltage Polarities

Figure 1. Switching Time Test Circuits

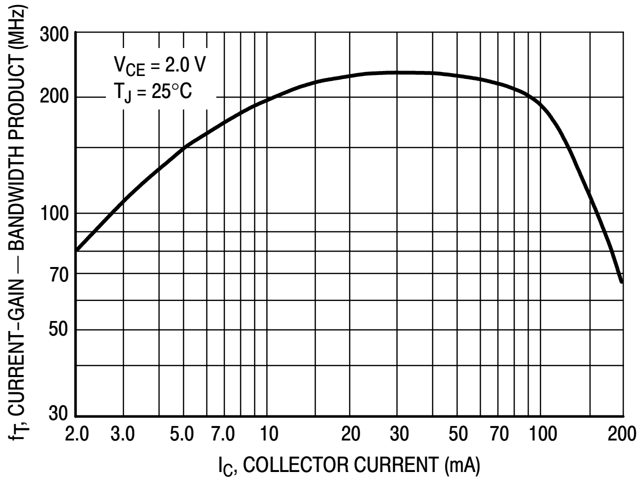


Figure 2. Current–Gain — Bandwidth Product

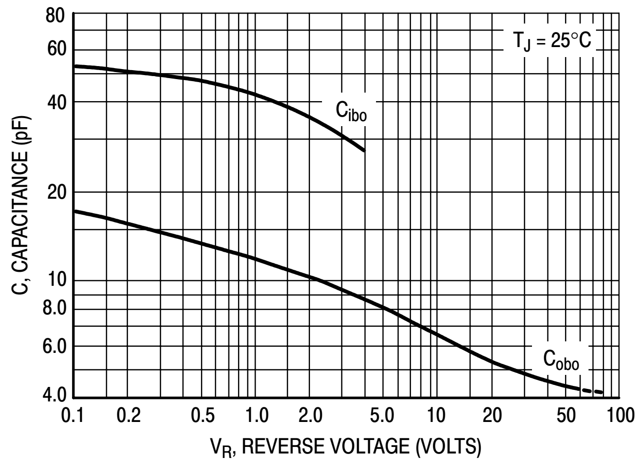


Figure 3. Capacitance

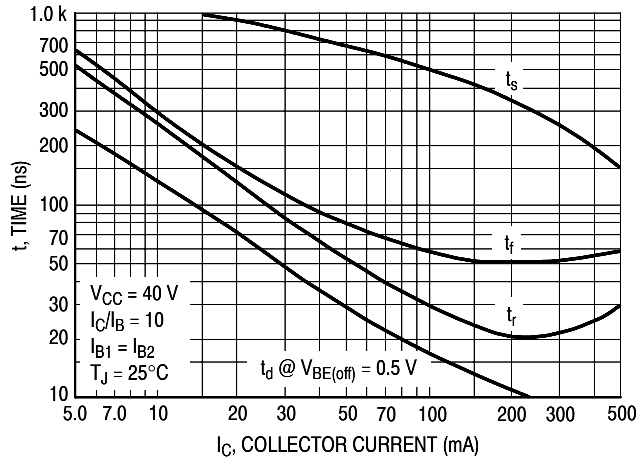


Figure 4. Switching Time

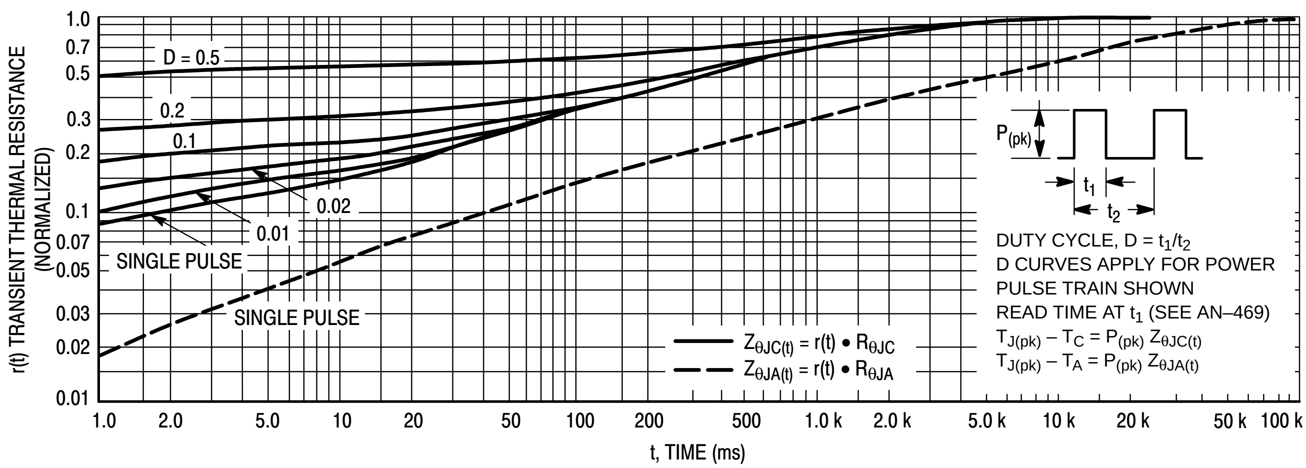


Figure 5. Thermal Response

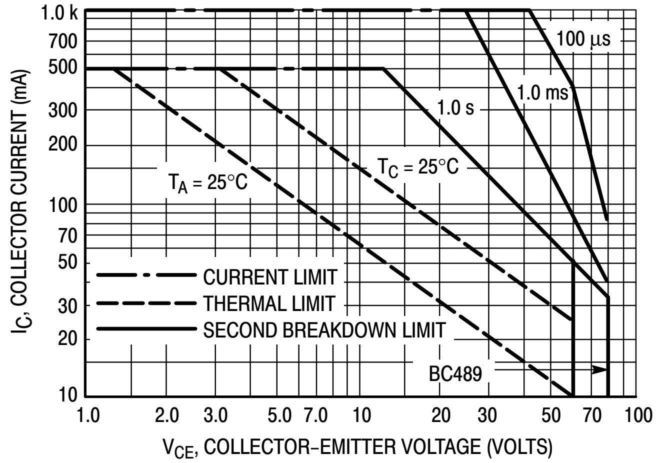


Figure 6. Active Region — Safe Operating Area

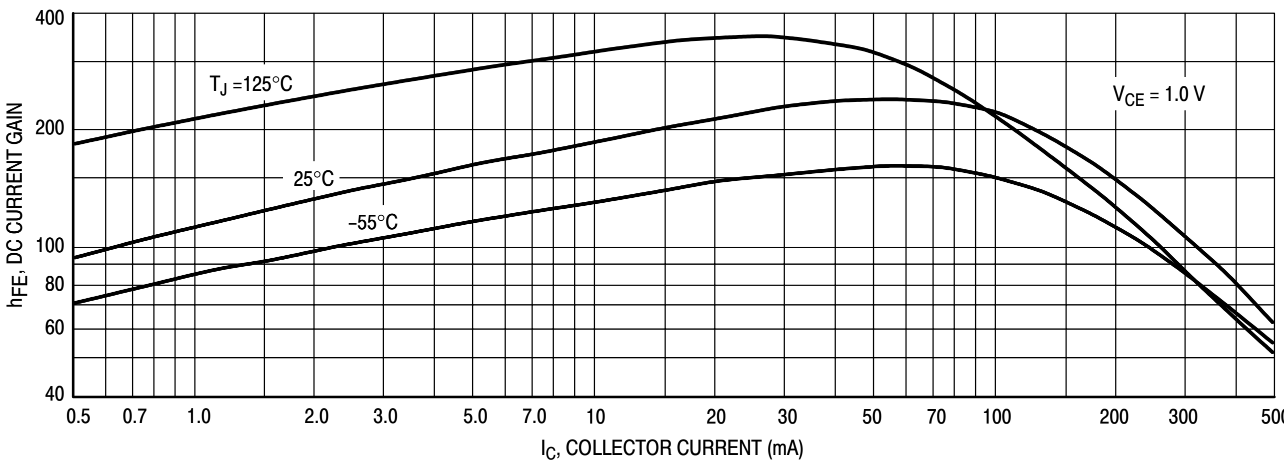


Figure 7. DC Current Gain

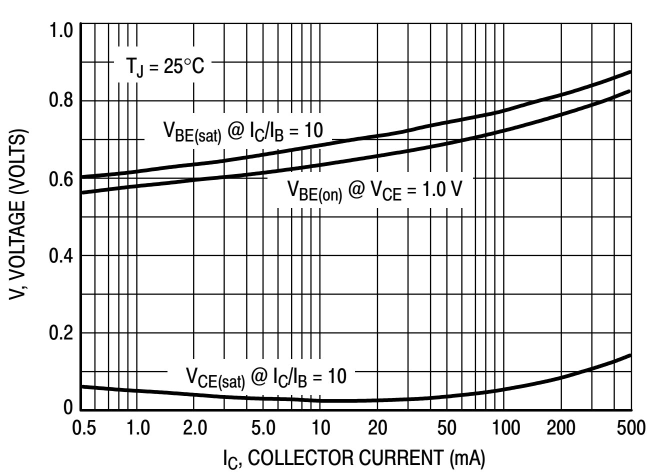


Figure 8. “On” Voltages

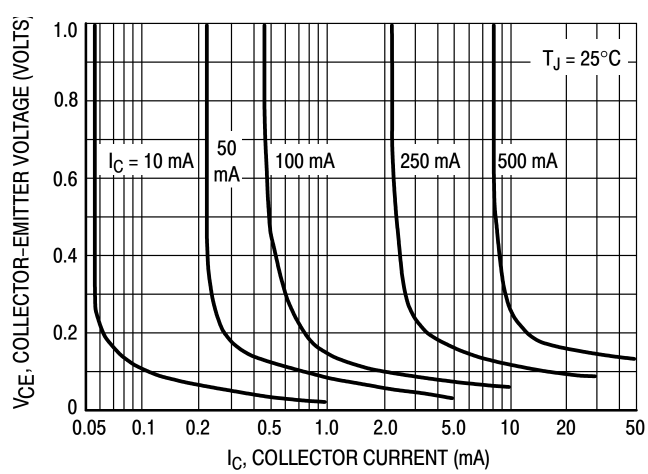


Figure 9. Collector Saturation Region

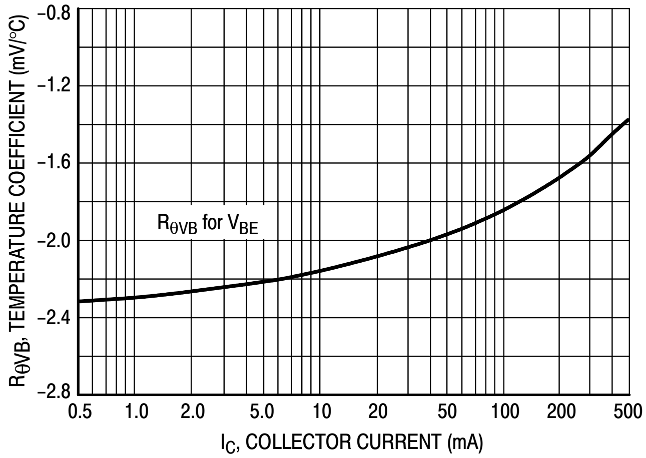


Figure 10. Base–Emitter Temperature Coefficient

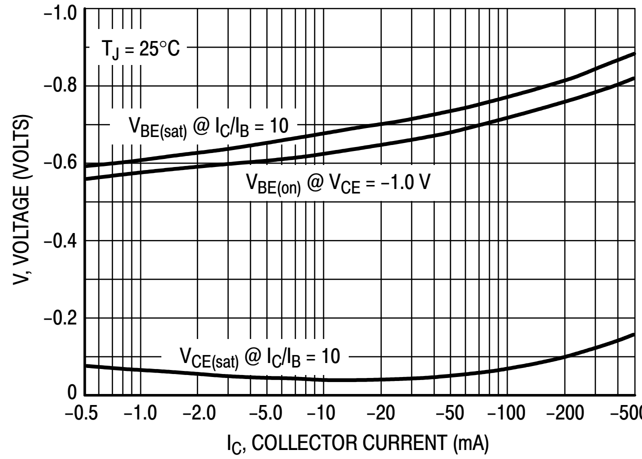


Figure 11. “On” Voltages

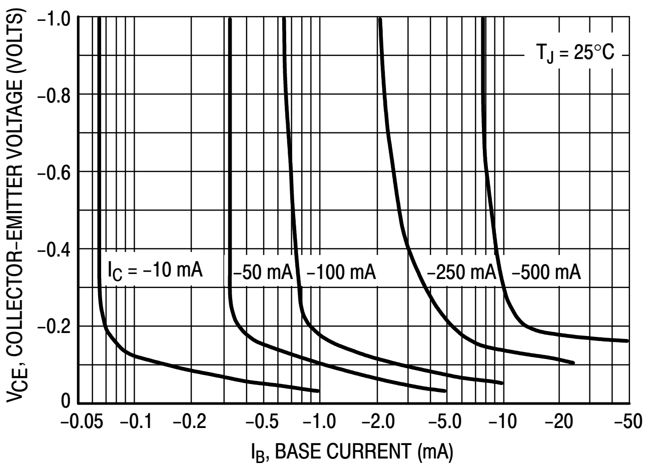


Figure 12. Collector Saturation Region

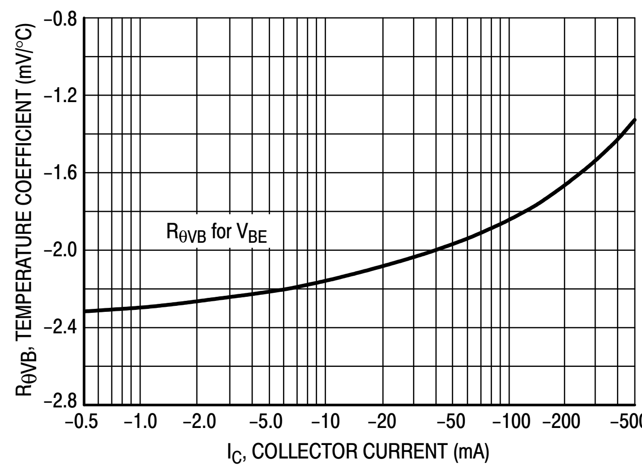


Figure 13. Base–Emitter Temperature Coefficient

BC490, BC490A, BC490B

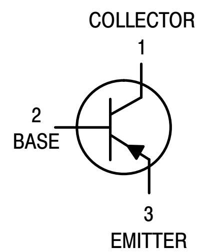
High Current Transistors

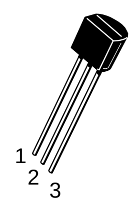
PNP Silicon

- Device Marking: 490
  490A
  490B

ON Semiconductor™

http://onsemi.com





CASE 29
TO–92
STYLE 17

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	–80	Vdc
Collector-Base Voltage	V_{CBO}	–80	Vdc
Emitter-Base Voltage	V_{EBO}	–4.0	Vdc
Collector Current — Continuous	I_C	–1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ORDERING INFORMATION

Device	Package	Shipping
BC490	TO–92	5000 Units/Box
BC490A	TO–92	5000 Units/Box
BC490AZL1	TO–92	2000/Ammo Pack
BC490BZL1	TO–92	2000/Ammo Pack

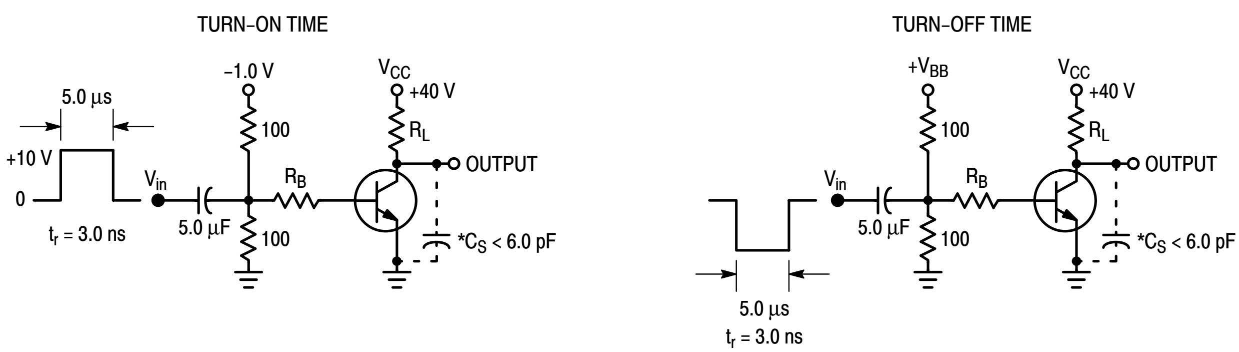
June, 2000 – Rev. 1

Publication Order Number:
BC490/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage[1] (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–80	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–80	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = –60 Vdc, I_E = 0)	I_{CBO}	—	—	–100	nAdc
ON CHARACTERISTICS*					
DC Current Gain	h_{FE}				—
(I_C = –10 mAdc, V_{CE} = –2.0 Vdc)		40	—	—	
(I_C = –100 mAdc, V_{CE} = –2.0 Vdc) BC490		60	—	400	
BC490A		100	140	250	
BC490B		160	—	400	
(I_C = –1.0 Adc, V_{CE} = –5.0 Vdc)		15	—	—	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = –500 mAdc, I_B = –50 mAdc)		—	–0.25	–0.5	
(I_C = –1.0 Adc, I_B = –100 mAdc)		—	–0.5	—	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = –500 mAdc, I_B = –50 mAdc)		—	–0.9	–1.2	
(I_C = –1.0 Adc, I_B = –100 mAdc)		—	–1.0	—	
DYNAMIC CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = –50 mAdc, V_{CE} = –2.0 Vdc, f = 100 MHz)	f_T	—	150	—	MHz
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	9.0	—	pF
Input Capacitance (V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	—	110	—	pF

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle 2%.



*Total Shunt Capacitance of Test Jig and Connectors
For PNP Test Circuits, Reverse All Voltage Polarities

Figure 1. Switching Time Test Circuits

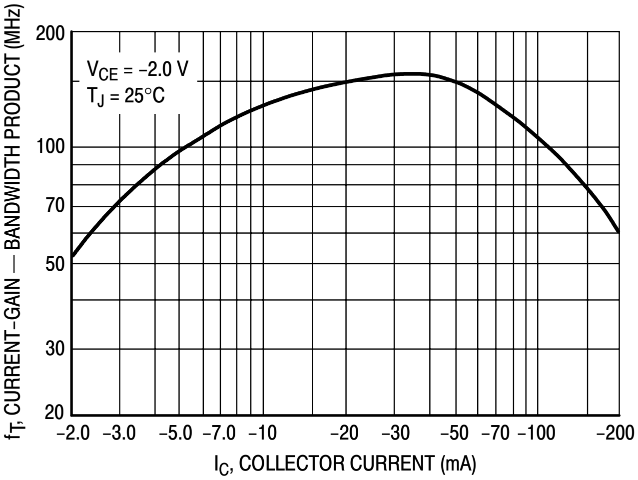


Figure 2. Current–Gain — Bandwidth Product

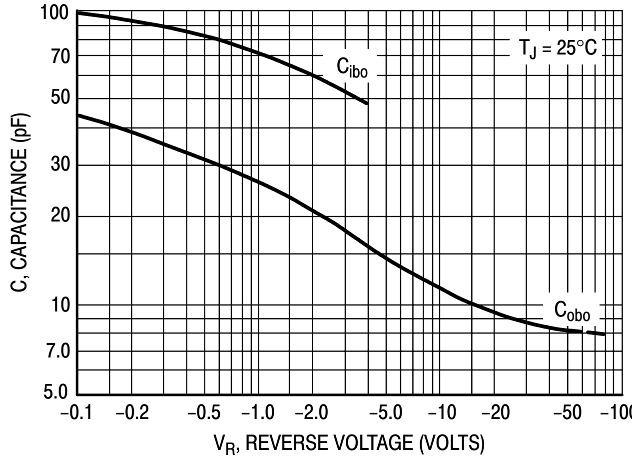


Figure 3. Capacitance

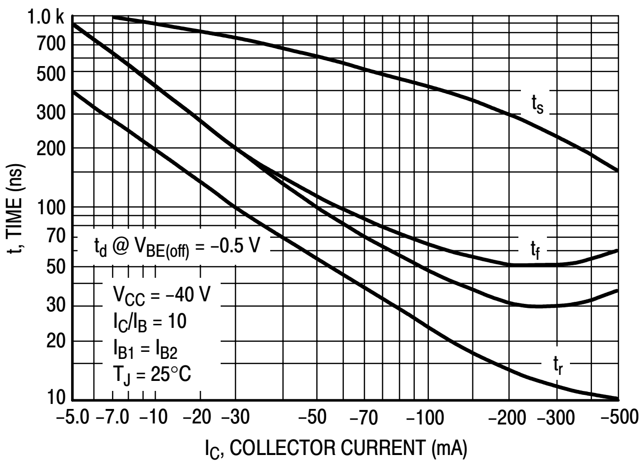


Figure 4. Switching Time

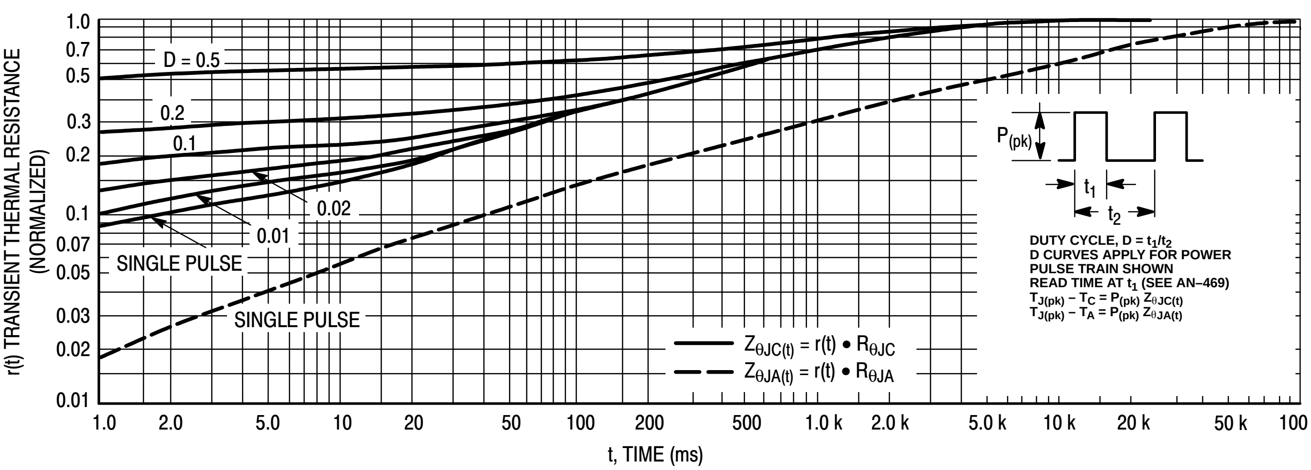


Figure 5. Thermal Response

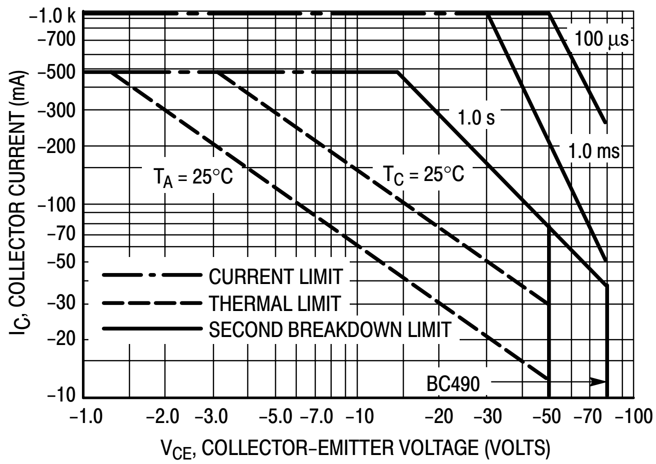


Figure 6. Active Region, Safe Operating Area

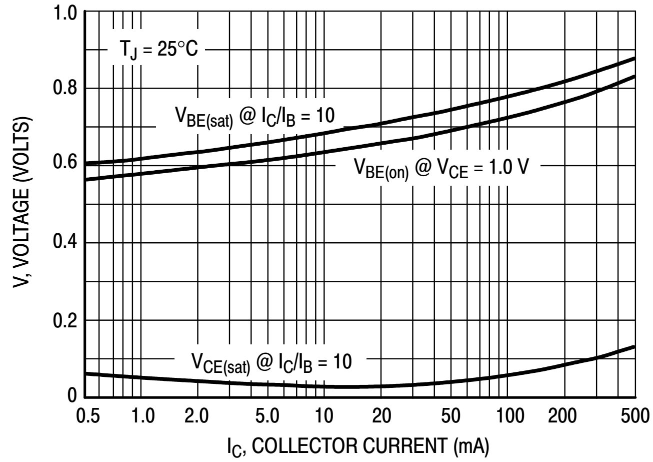


Figure 7. "On" Voltages

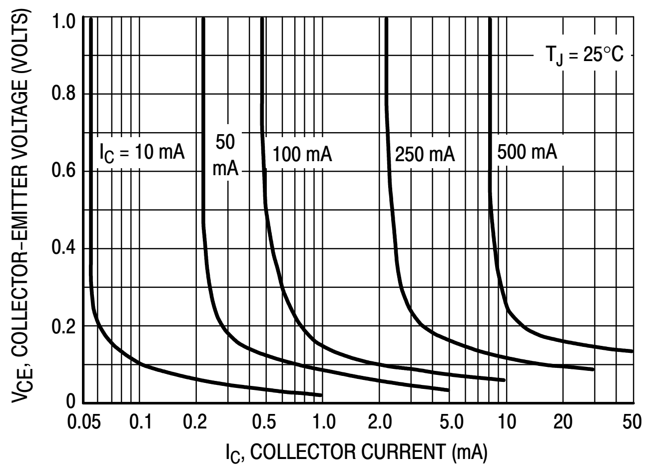


Figure 8. Collector Saturation Region

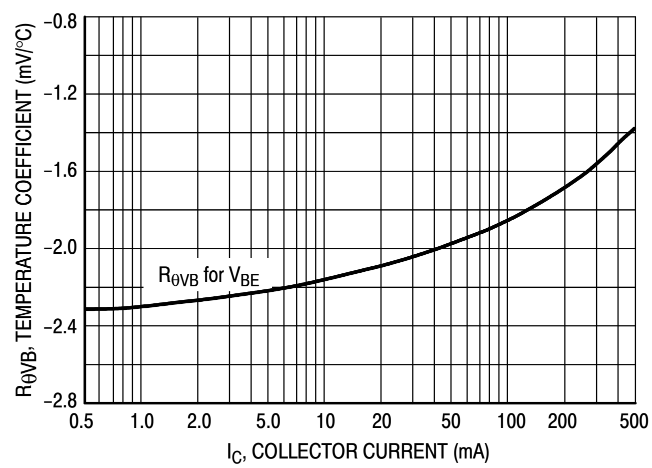


Figure 9. Base−Emitter Temperature Coefficient

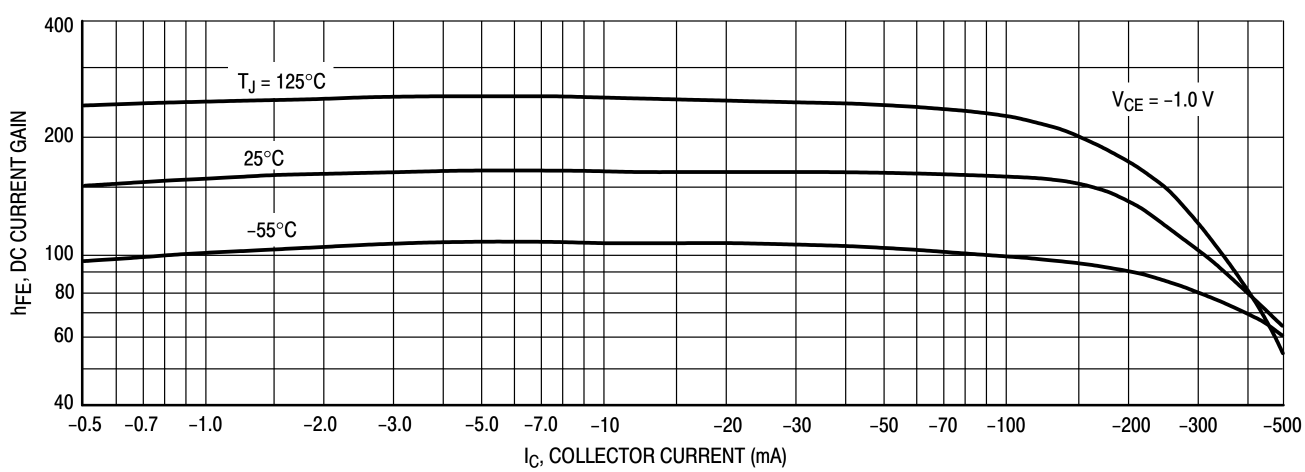


Figure 10. DC Current Gain

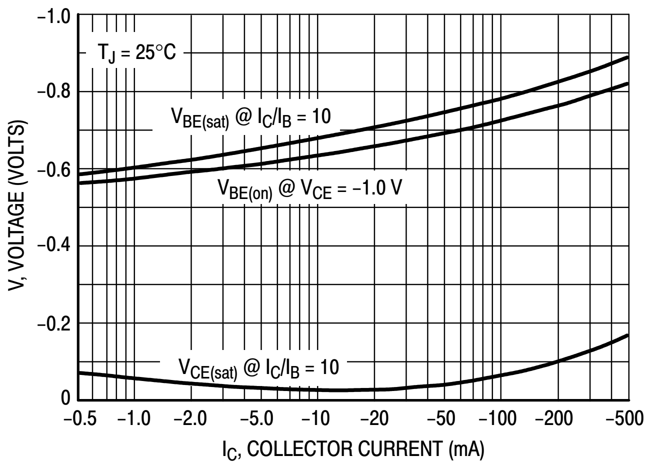


Figure 11. “On” Voltages

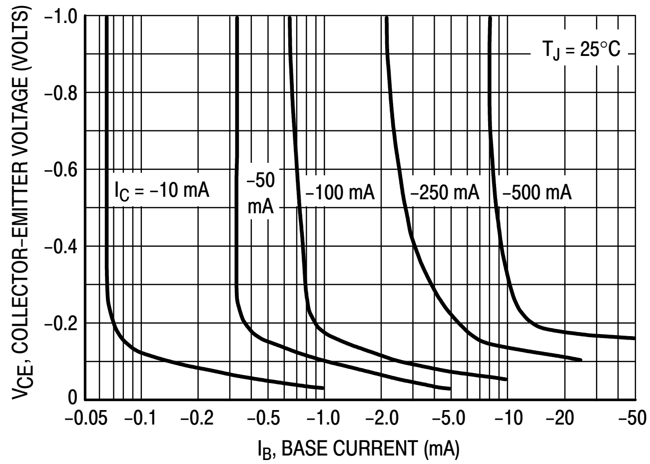


Figure 12. Collector Saturation Region

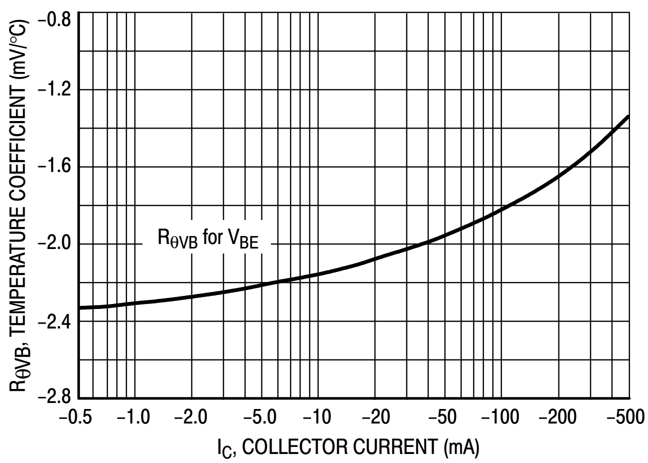
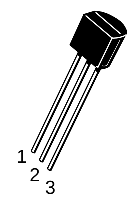


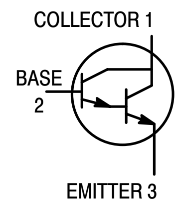
Figure 13. Base–Emitter Temperature Coefficient

Darlington Transistors
NPN Silicon

BC517



CASE 29–11, STYLE 17
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CES}	30	Vdc
Collector–Base Voltage	V_{CB}	40	Vdc
Emitter–Base Voltage	V_{EB}	10	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 12	mW mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 2.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	30	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 nAdc, I_C = 0)	$V_{(BR)EBO}$	10	—	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc)	I_{CES}	—	—	500	nAdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
Emitter Cutoff Current (V_{EB} = 10 Vdc, I_C = 0)	I_{EBO}	—	—	100	nAdc

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ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain (I_C = 20 mAdc, V_{CE} = 2.0 Vdc)	h_{FE}	30,000	—	—	—
Collector–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 0.1 mAdc)	$V_{CE(sat)}$	—	—	1.0	Vdc
Base–Emitter On Voltage (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	—	1.4	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product[2] (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	—	200	—	MHz

1. Pulse Test: Pulse Width ≤ 2.0%.
2. $f_T = |h_{fe}| \bullet f_{test}$

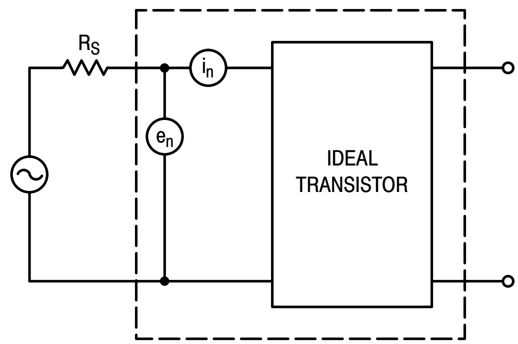


Figure 1. Transistor Noise Model

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

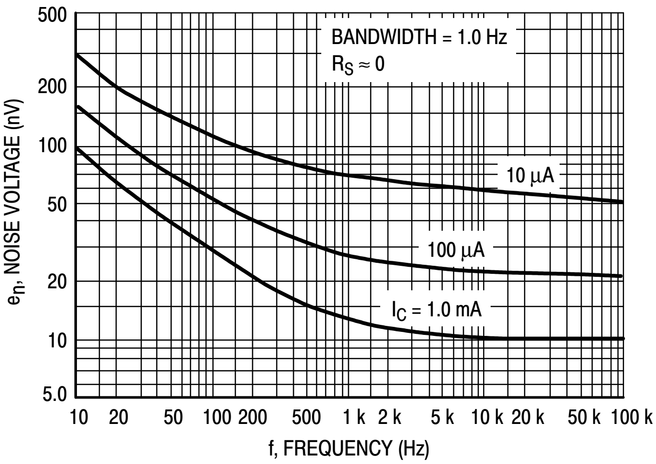


Figure 2. Noise Voltage

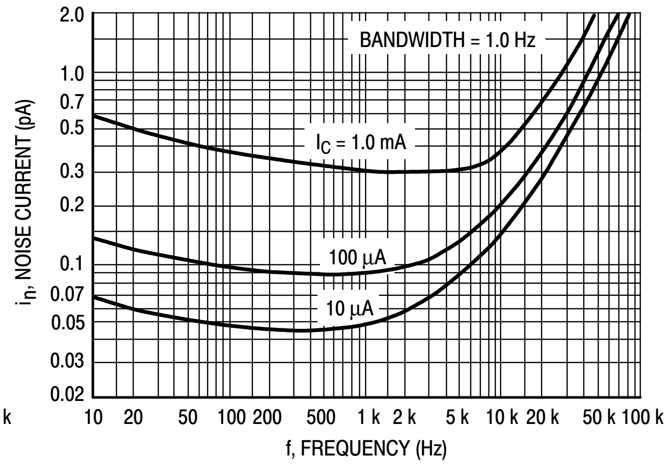


Figure 3. Noise Current

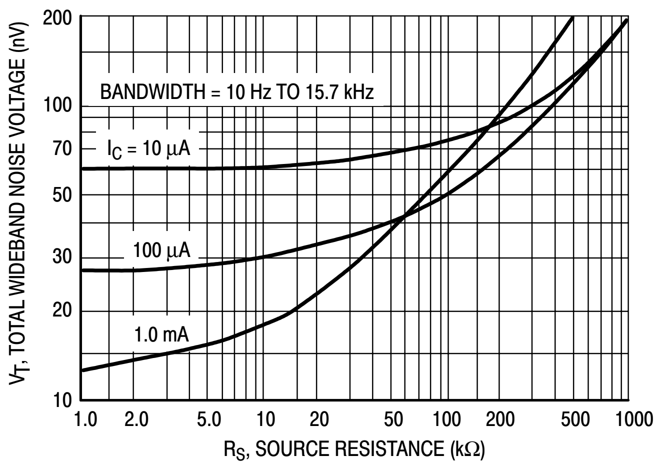


Figure 4. Total Wideband Noise Voltage

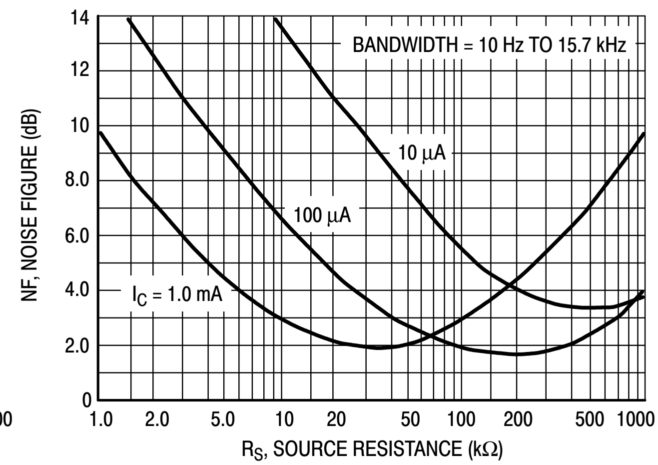


Figure 5. Wideband Noise Figure

SMALL–SIGNAL CHARACTERISTICS

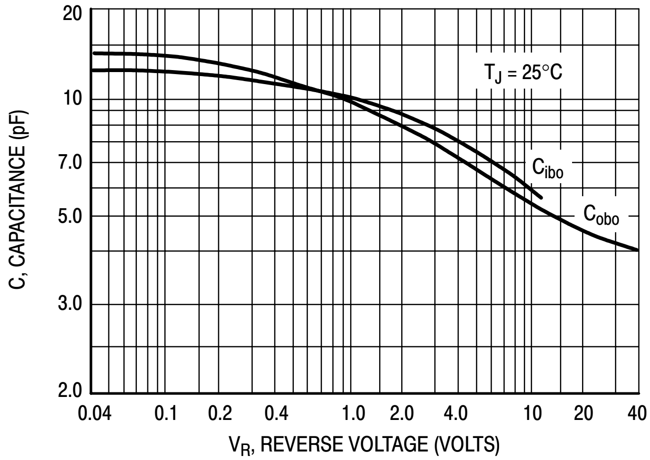


Figure 6. Capacitance

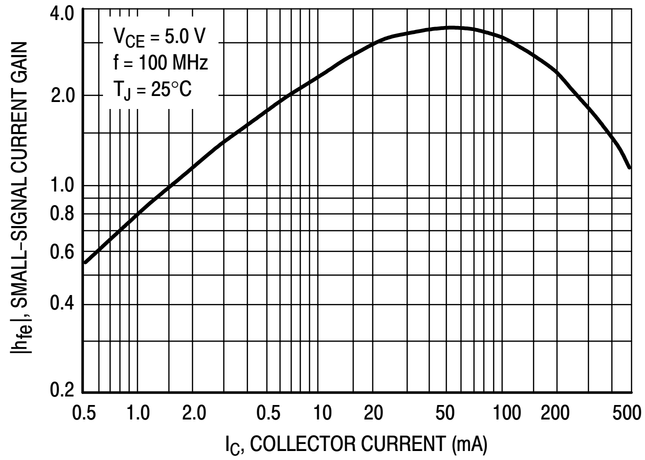


Figure 7. High Frequency Current Gain

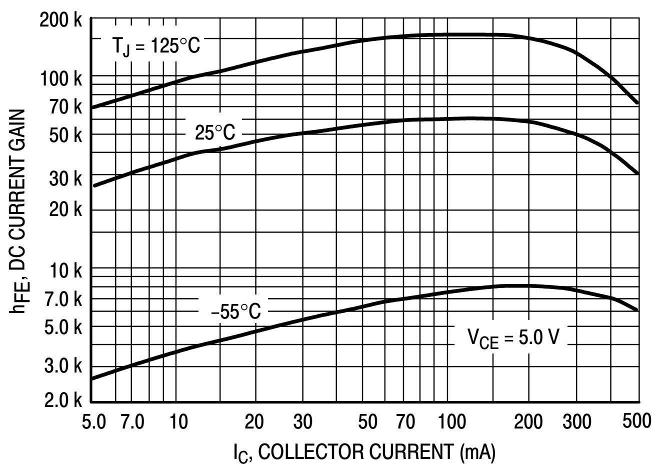


Figure 8. DC Current Gain

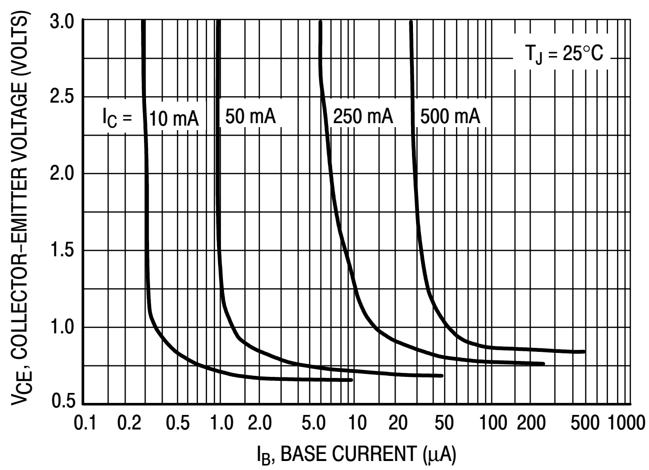


Figure 9. Collector Saturation Region

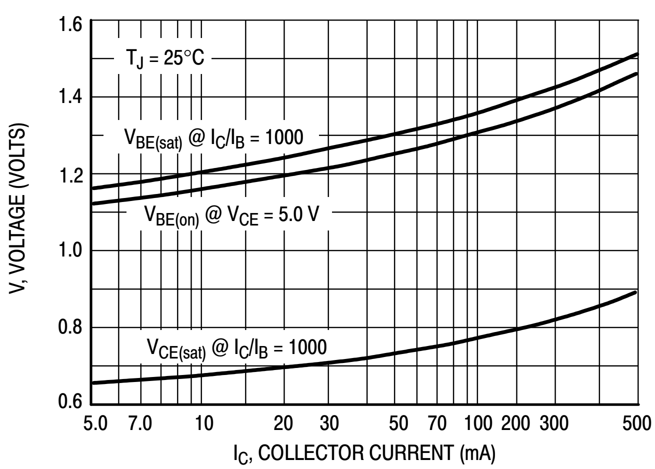


Figure 10. “On” Voltages

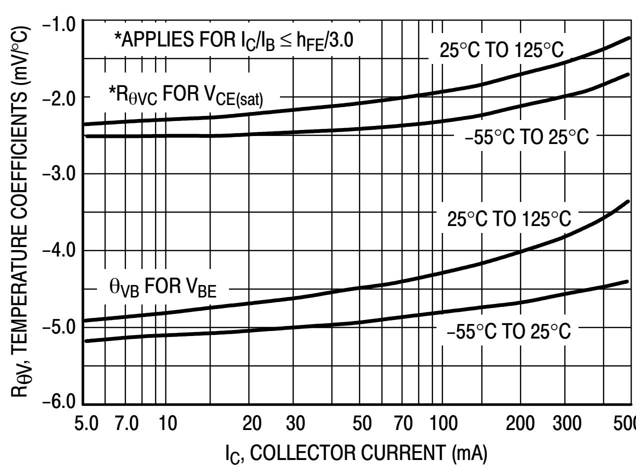


Figure 11. Temperature Coefficients

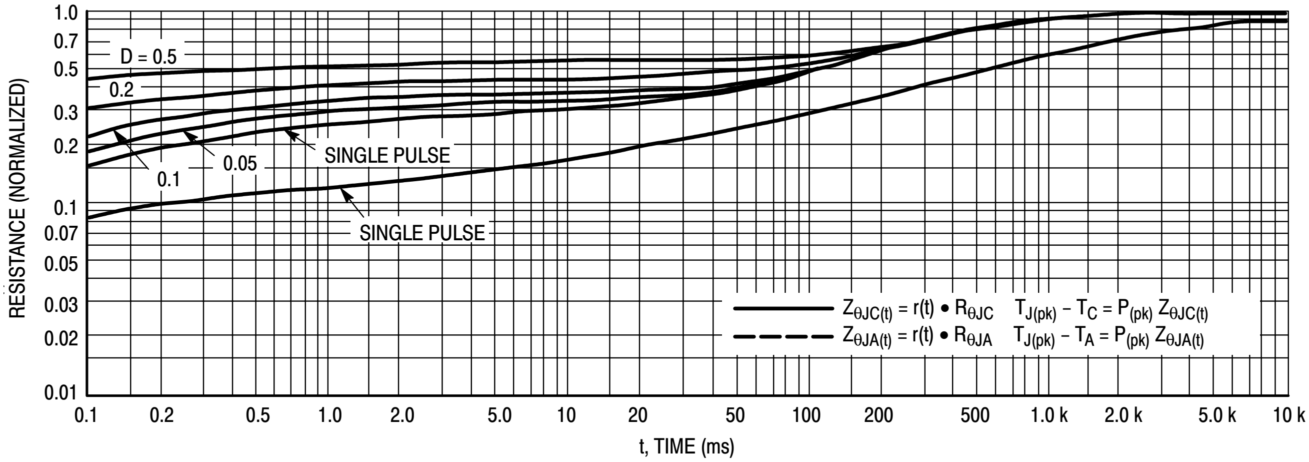


Figure 12. Thermal Response

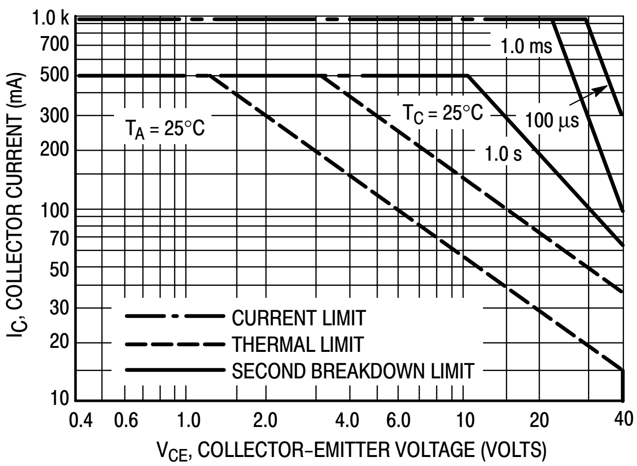
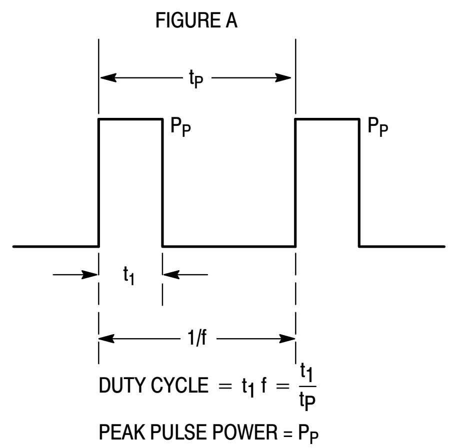


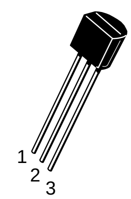
Figure 13. Active Region Safe Operating Area



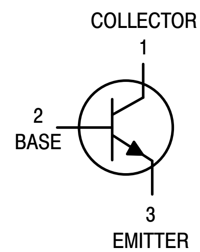
Design Note: Use of Transient Thermal Resistance Data

BC546
BC546B
BC547A
BC547B
BC547C
BC548B
BC548C

Amplifier Transistors
NPN Silicon



CASE 29–04, STYLE 17
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	BC546	BC547	BC548	Unit
Collector–Emitter Voltage	V_{CEO}	65	45	30	Vdc
Collector–Base Voltage	V_{CBO}	80	50	30	Vdc
Emitter–Base Voltage	V_{EBO}	6.0			Vdc
Collector Current — Continuous	I_C	100			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)	BC546 BC547 BC548	$V_{(BR)CEO}$	65 45 30	— — —	— — —	V
Collector–Base Breakdown Voltage (I_C = 100 μAdc)	BC546 BC547 BC548	$V_{(BR)CBO}$	80 50 30	— — —	— — —	V
Emitter–Base Breakdown Voltage (I_E = 10 μA, I_C = 0)	BC546 BC547 BC548	$V_{(BR)EBO}$	6.0 6.0 6.0	— — —	— — —	V
Collector Cutoff Current (V_{CE} = 70 V, V_{BE} = 0) (V_{CE} = 50 V, V_{BE} = 0) (V_{CE} = 35 V, V_{BE} = 0) (V_{CE} = 30 V, T_A = 125°C)	 BC546 BC547 BC548 BC546/547/548	I_{CES}	 — — — —	 0.2 0.2 0.2 —	 15 15 15 4.0	 nA μA

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ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 μA, V_{CE} = 5.0 V)	BC547A		—	90	—	
	BC546B/547B/548B		—	150	—	
	BC548C		—	270	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC546		110	—	450	
	BC547		110	—	800	
	BC548		110	—	800	
	BC547A		110	180	220	
	BC546B/547B/548B		200	290	450	
	BC547C/BC548C		420	520	800	
(I_C = 100 mA, V_{CE} = 5.0 V)	BC547A/548A		—	120	—	
	BC546B/547B/548B		—	180	—	
	BC548C		—	300	—	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)			—	0.09	0.25	
(I_C = 100 mA, I_B = 5.0 mA)			—	0.2	0.6	
(I_C = 10 mA, I_B = See Note 1)			—	0.3	0.6	
Base–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{BE(sat)}$	—	0.7	—	V
Base–Emitter On Voltage		$V_{BE(on)}$				V
(I_C = 2.0 mA, V_{CE} = 5.0 V)			0.55	—	0.7	
(I_C = 10 mA, V_{CE} = 5.0 V)			—	—	0.77	
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — Bandwidth Product		f_T				MHz
(I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)	BC546		150	300	—	
	BC547		150	300	—	
	BC548		150	300	—	
Output Capacitance (V_{CB} = 10 V, I_C = 0, f = 1.0 MHz)		C_{obo}	—	1.7	4.5	pF
Input Capacitance (V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	10	—	pF
Small–Signal Current Gain		h_{fe}				—
(I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	BC546		125	—	500	
	BC547/548		125	—	900	
	BC547A		125	220	260	
	BC546B/547B/548B		240	330	500	
	BC547C/548C		450	600	900	
Noise Figure		NF				dB
(I_C = 0.2 mA, V_{CE} = 5.0 V, R_S = 2 kΩ,	BC546		—	2.0	10	
f = 1.0 kHz, Δf = 200 Hz)	BC547		—	2.0	10	
	BC548		—	2.0	10	

Note 1: I_B is value for which I_C = 11 mA at V_{CE} = 1.0 V.

BC547/BC548

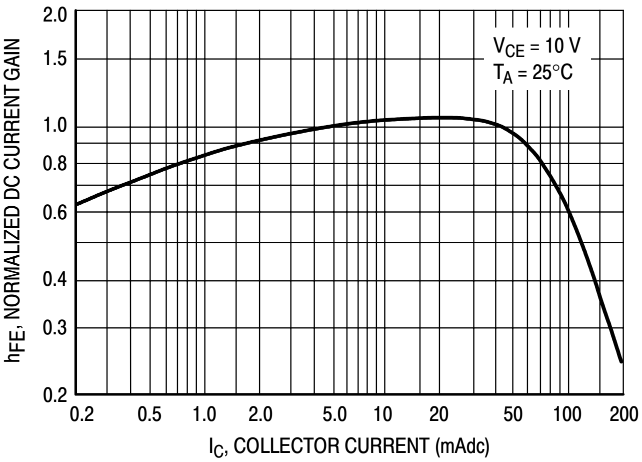


Figure 1. Normalized DC Current Gain

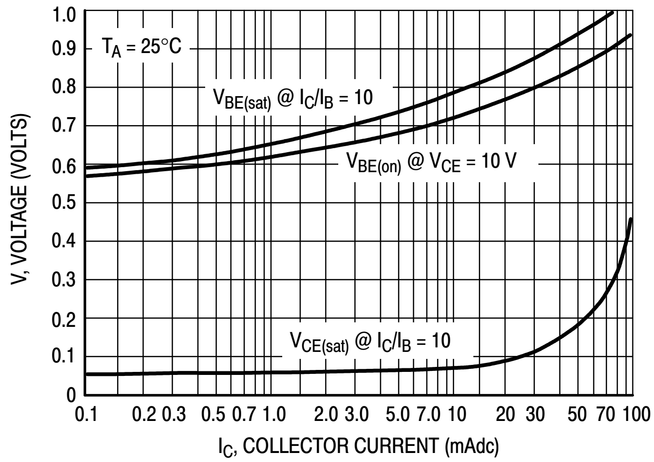


Figure 2. "Saturation" and "On" Voltages

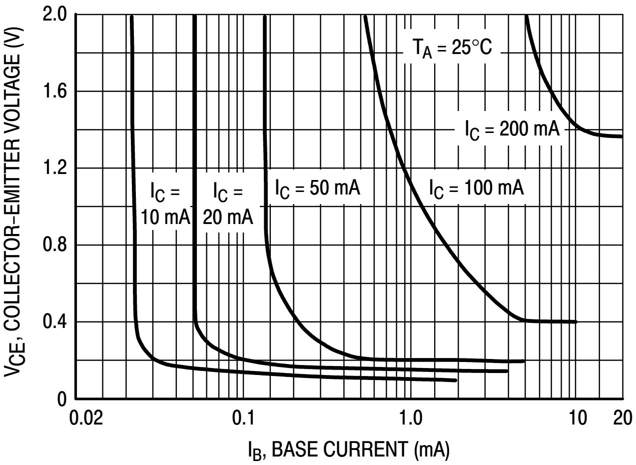


Figure 3. Collector Saturation Region

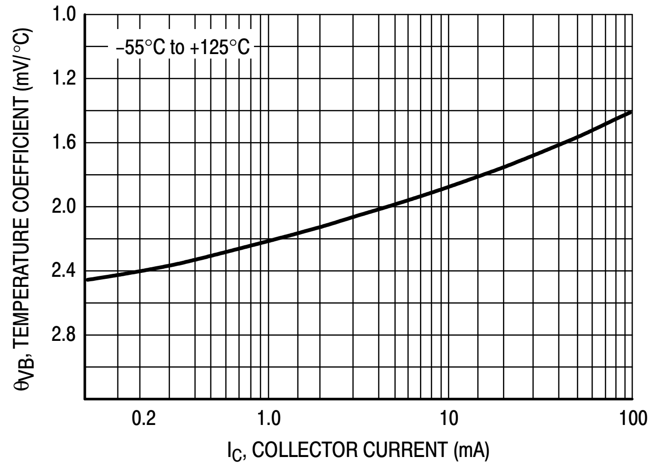


Figure 4. Base–Emitter Temperature Coefficient

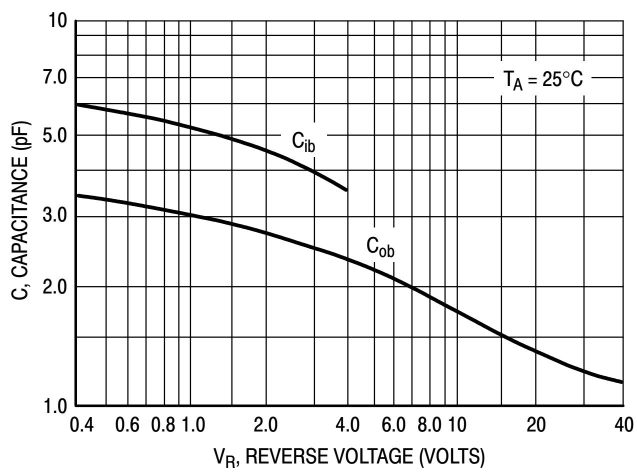


Figure 5. Capacitances

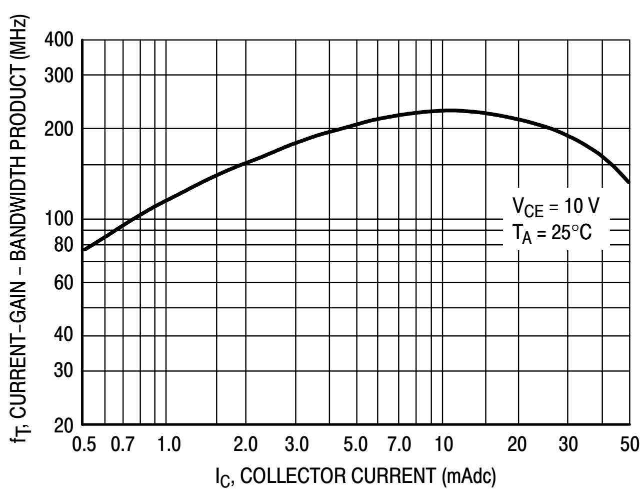


Figure 6. Current–Gain – Bandwidth Product

BC546

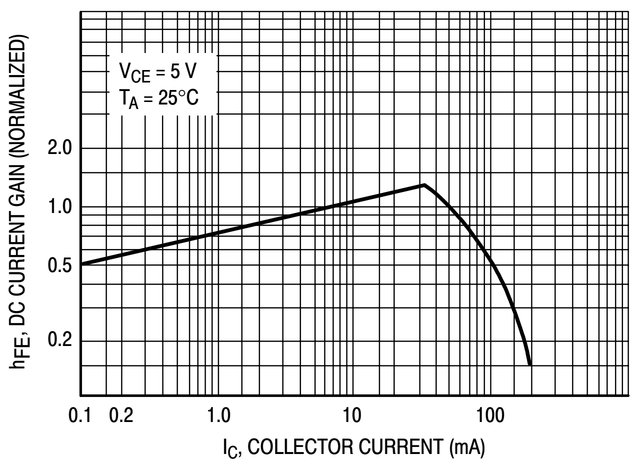


Figure 7. DC Current Gain

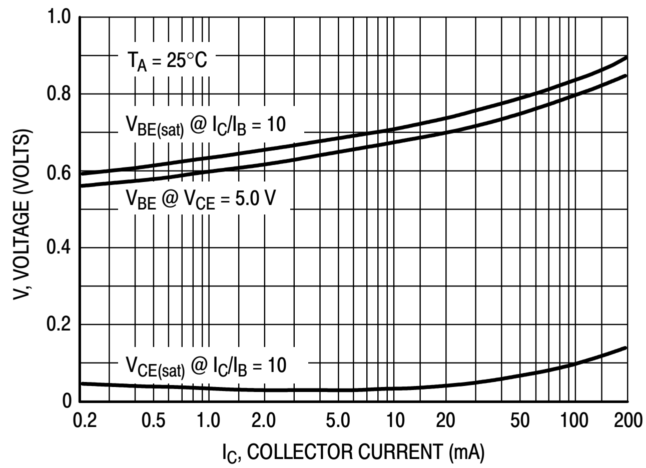


Figure 8. “On” Voltage

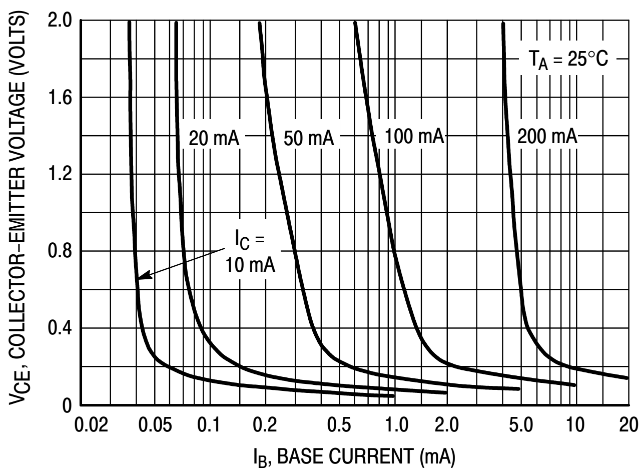


Figure 9. Collector Saturation Region

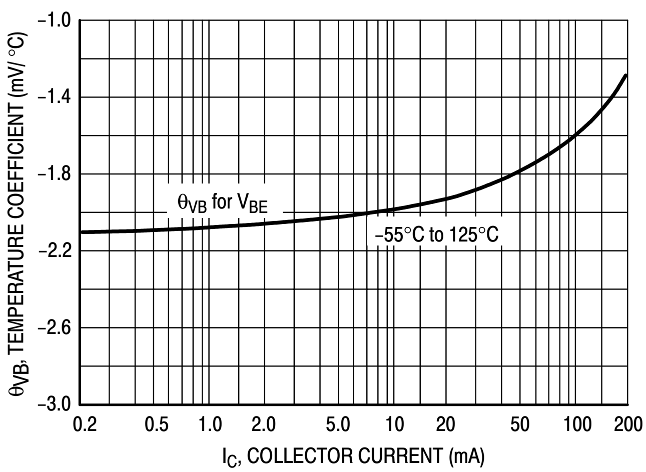


Figure 10. Base–Emitter Temperature Coefficient

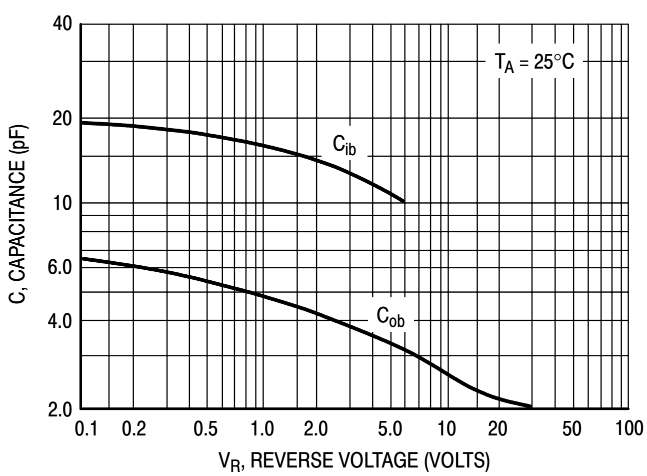


Figure 11. Capacitance

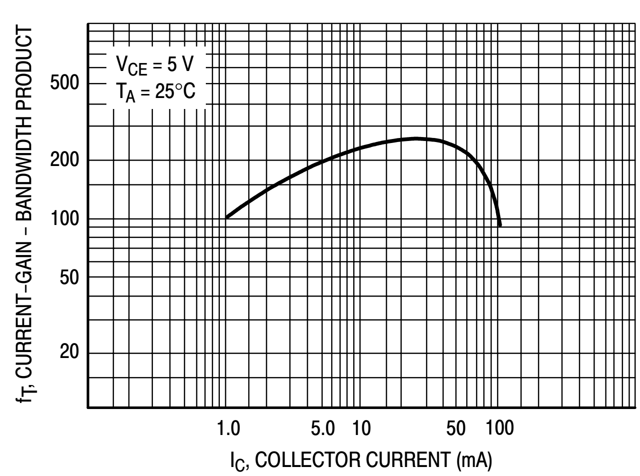
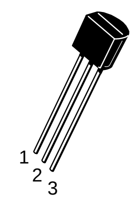


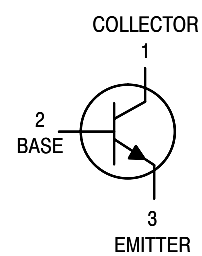
Figure 12. Current–Gain – Bandwidth Product

Low Noise Transistors
NPN Silicon

BC550C



CASE 29–11, STYLE 17
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	45	Vdc
Collector–Base Voltage	V_{CBO}	50	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	45	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0) (V_{CB} = 30 V, I_E = 0, T_A = +125°C)	I_{CBO}	 — —	 — —	 15 5.0	 nAdc µAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	—	15	nAdc

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)		100	270	—	
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)		420	500	800	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 0.5 mAdc)		—	0.075	0.25	
(I_C = 10 mAdc, I_B = see note 1)		—	0.3	0.6	
(I_C = 100 mAdc, I_B = 5.0 mAdc, see note 2)		—	0.25	0.6	
Base–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	—	1.1	—	Vdc
Base–Emitter On Voltage	$V_{BE(on)}$				Vdc
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)		—	0.52	—	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)		—	0.55	—	
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)		0.55	0.62	0.7	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	—	250	—	MHz
Collector–Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cbo}	—	2.5	—	pF
Small–Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 V, f = 1.0 kHz)	h_{fe}	450	600	900	—
Noise Figure					dB
(I_C = 200 μAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz)	NF_1	—	0.6	2.5	
(I_C = 200 μAdc, V_{CE} = 5.0 Vdc, R_S = 100 kΩ, f = 1.0 kHz)	NF_2	—	—	10	

NOTES:
1. I_B is value for which I_C = 11 mA at V_{CE} = 1.0 V.
2. Pulse test = 300 μs – Duty cycle = 2%.

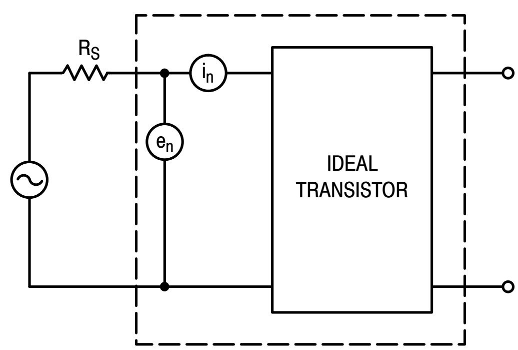


Figure 1. Transistor Noise Model

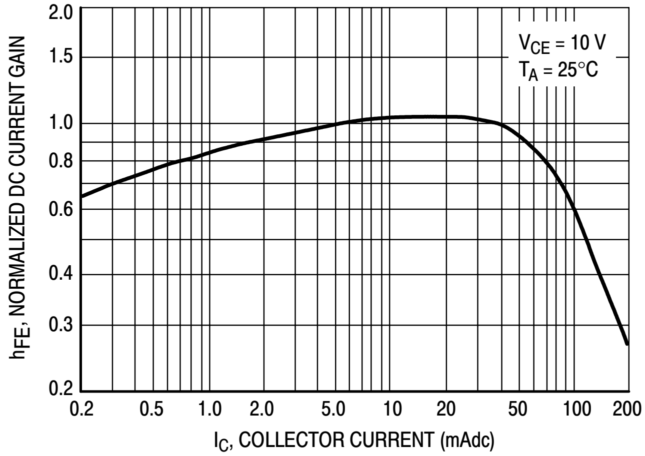


Figure 2. Normalized DC Current Gain

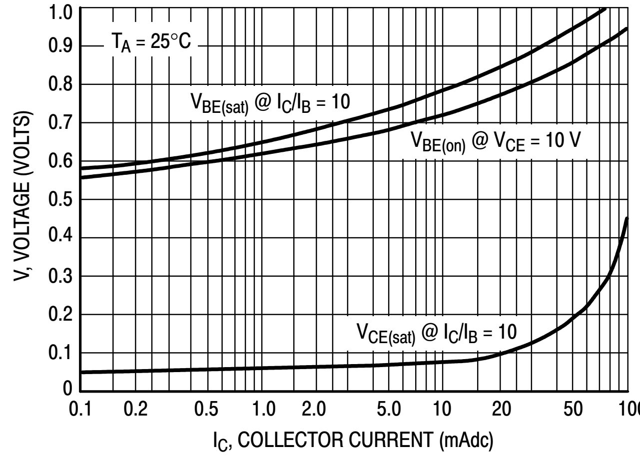


Figure 3. “Saturation” and “On” Voltages

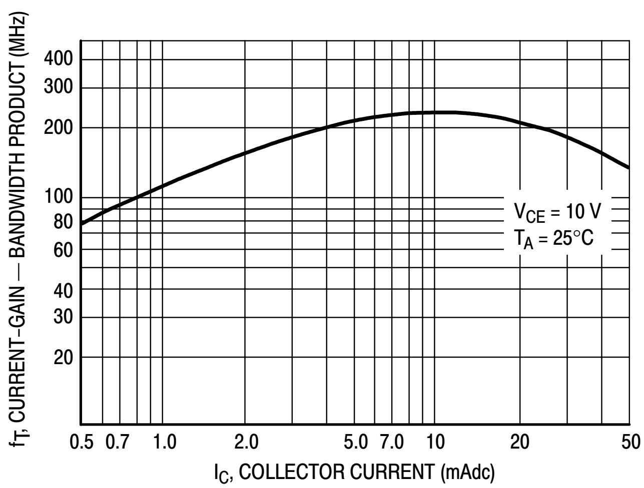


Figure 4. Current–Gain — Bandwidth Product

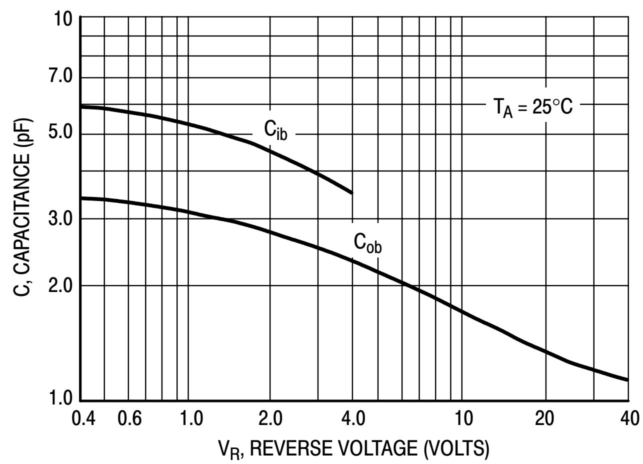


Figure 5. Capacitance

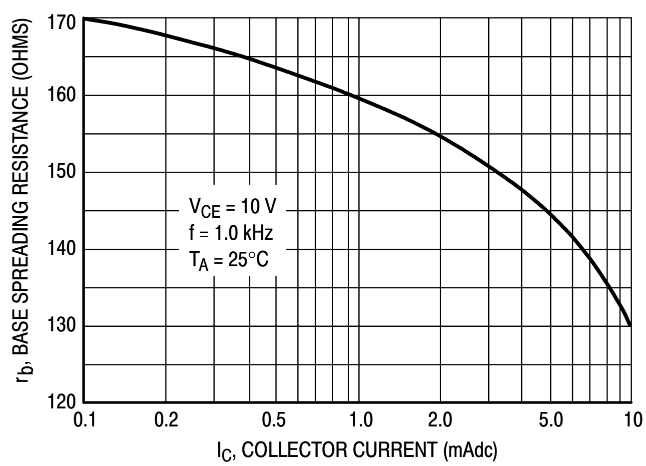


Figure 6. Base Spreading Resistance

BC556B, BC557, A, B, C, BC558B, C

Amplifier Transistors

PNP Silicon

ON Semiconductor™

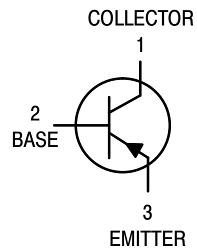
http://onsemi.com

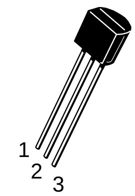
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage BC556 / BC557 / BC558	V_{CEO}	–65 / –45 / –30	Vdc
Collector-Base Voltage BC556 / BC557 / BC558	V_{CBO}	–80 / –50 / –30	Vdc
Emitter-Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Continuous / – Peak	I_C / I_{CM}	–100 / –200	mAdc
Base Current – Peak	I_{BM}	–200	mAdc
Total Device Dissipation @ T_A = 25°C / Derate above 25°C	P_D	625 / 5.0	mW / mW/°C
Total Device Dissipation @ T_C = 25°C / Derate above 25°C	P_D	1.5 / 12	Watts / mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W





CASE 29
TO–92
STYLE 17

ORDERING INFORMATION

Device	Package	Shipping
BC556B	TO–92	5000 Units/Box
BC556BRL1	TO–92	2000/Tape & Reel
BC556BZL1	TO–92	2000/Ammo Pack
BC557	TO–92	5000 Units/Box
BC557ZL1	TO–92	2000/Ammo Pack
BC557A	TO–92	5000 Units/Box
BC557AZL1	TO–92	2000/Ammo Pack
BC557B	TO–92	5000 Units/Box
BC557BRL1	TO–92	2000/Tape & Reel
BC557BZL1	TO–92	2000/Ammo Pack
BC557C	TO–92	5000 Units/Box
BC557CZL1	TO–92	2000/Ammo Pack
BC558B	TO–92	5000 Units/Box
BC558BRL	TO–92	2000/Tape & Reel
BC558BRL1	TO–92	2000/Tape & Reel
BC558BZL1	TO–92	2000/Ammo Pack
BC558C	TO–92	5000 Units/Box
BC558CRL1	TO–92	2000/Tape & Reel
BC558ZL1	TO–92	2000/Ammo Pack
BC558CZL1	TO–92	2000/Ammo Pack

June, 2000 – Rev. 1
Publication Order Number:
BC556/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage		$V_{(BR)CEO}$				V
(I_C = –2.0 mAdc, I_B = 0)	BC556		–65	–	–	
	BC557		–45	–	–	
	BC558		–30	–	–	
Collector–Base Breakdown Voltage		$V_{(BR)CBO}$				V
(I_C = –100 μAdc)	BC556		–80	–	–	
	BC557		–50	–	–	
	BC558		–30	–	–	
Emitter–Base Breakdown Voltage		$V_{(BR)EBO}$				V
(I_E = –100 μAdc, I_C = 0)	BC556		–5.0	–	–	
	BC557		–5.0	–	–	
	BC558		–5.0	–	–	
Collector–Emitter Leakage Current		I_{CES}				
(V_{CES} = –40 V)	BC556		–	–2.0	–100	nA
(V_{CES} = –20 V)	BC557		–	–2.0	–100	
	BC558		–	–2.0	–100	
(V_{CES} = –20 V, T_A = 125°C)	BC556		–	–	–4.0	μA
	BC557		–	–	–4.0	
	BC558		–	–	–4.0	

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = –10 µAdc, V_{CE} = –5.0 V)	A Series Device		–	90	–	
	B Series Devices		–	150	–	
	C Series Devices		–	270	–	
(I_C = –2.0 mAdc, V_{CE} = –5.0 V)	BC557		120	–	800	
	A Series Device		120	170	220	
	B Series Devices		180	290	460	
	C Series Devices		420	500	800	
(I_C = –100 mAdc, V_{CE} = –5.0 V)	A Series Device		–	120	–	
	B Series Devices		–	180	–	
	C Series Devices		–	300	–	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = –10 mAdc, I_B = –0.5 mAdc)			–	–0.075	–0.3	
(I_C = –10 mAdc, I_B = see Note 1)			–	–0.3	–0.6	
(I_C = –100 mAdc, I_B = –5.0 mAdc)			–	–0.25	–0.65	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$				V
(I_C = –10 mAdc, I_B = –0.5 mAdc)			–	–0.7	–	
(I_C = –100 mAdc, I_B = –5.0 mAdc)			–	–1.0	–	
Base–Emitter On Voltage		$V_{BE(on)}$				V
(I_C = –2.0 mAdc, V_{CE} = –5.0 Vdc)			–0.55	–0.62	–0.7	
(I_C = –10 mAdc, V_{CE} = –5.0 Vdc)			–	–0.7	–0.82	
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain – Bandwidth Product		f_T				MHz
(I_C = –10 mA, V_{CE} = –5.0 V, f = 100 MHz)	BC556		–	280	–	
	BC557		–	320	–	
	BC558		–	360	–	
Output Capacitance (V_{CB} = –10 V, I_C = 0, f = 1.0 MHz)		C_{ob}	–	3.0	6.0	pF
Noise Figure		NF				dB
(I_C = –0.2 mAdc, V_{CE} = –5.0 V,	BC556		–	2.0	10	
R_S = 2.0 kΩ, f = 1.0 kHz, Δf = 200 Hz)	BC557		–	2.0	10	
	BC558		–	2.0	10	
Small–Signal Current Gain		h_{fe}				–
(I_C = –2.0 mAdc, V_{CE} = 5.0 V, f = 1.0 kHz)	BC557		125	–	900	
	A Series Device		125	–	260	
	B Series Devices		240	–	500	
	C Series Devices		450	–	900	

Note 1: I_C = –10 mAdc on the constant base current characteristics, which yields the point I_C = –11 mAdc, V_{CE} = –1.0 V.

BC557/BC558

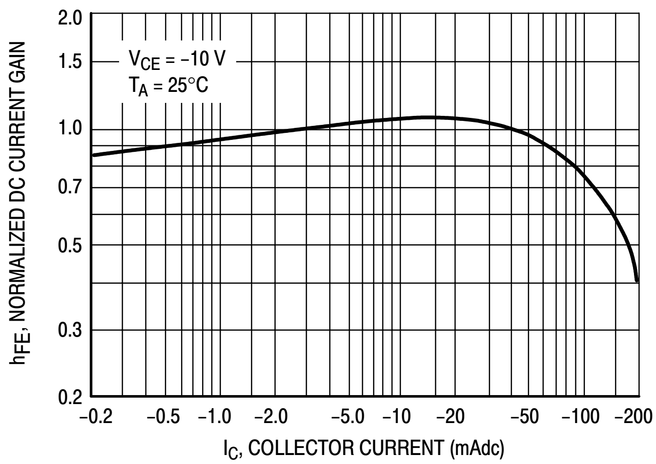


Figure 1. Normalized DC Current Gain

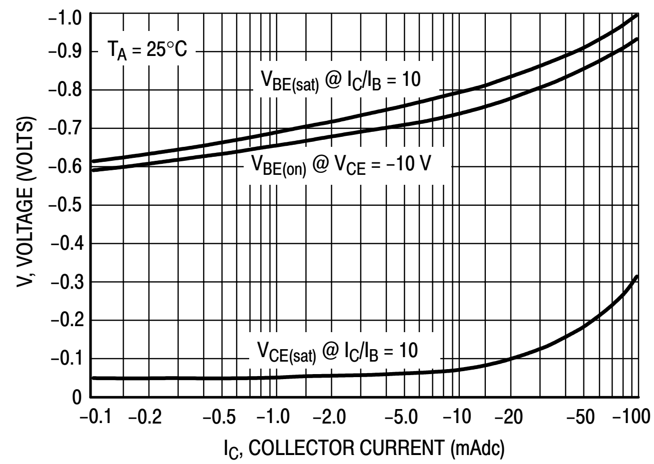


Figure 2. “Saturation” and “On” Voltages

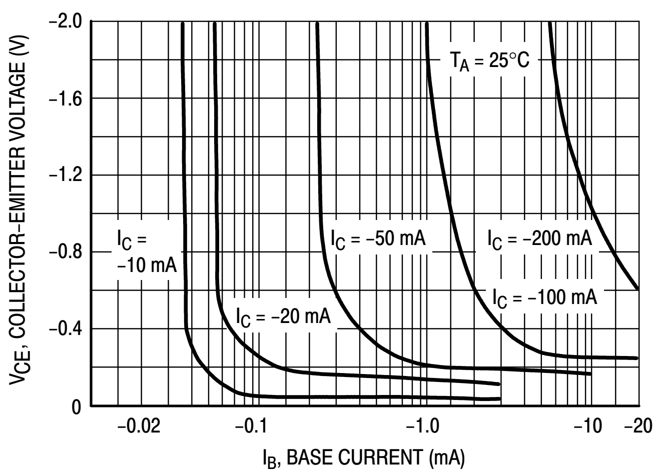


Figure 3. Collector Saturation Region

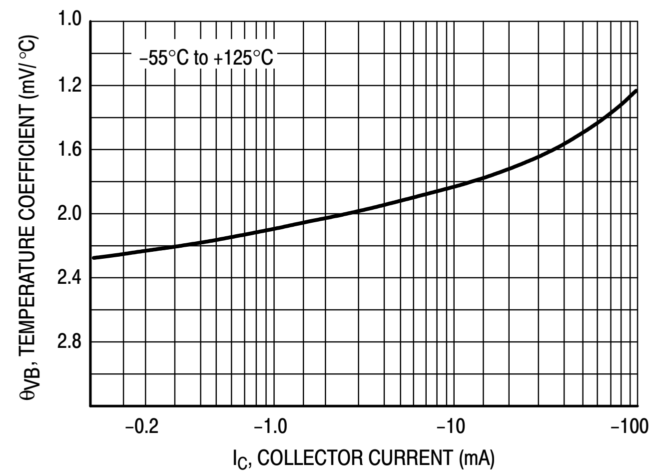


Figure 4. Base−Emitter Temperature Coefficient

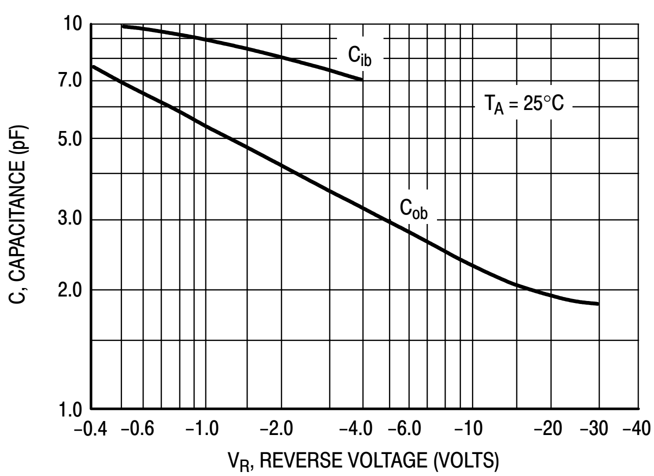


Figure 5. Capacitances

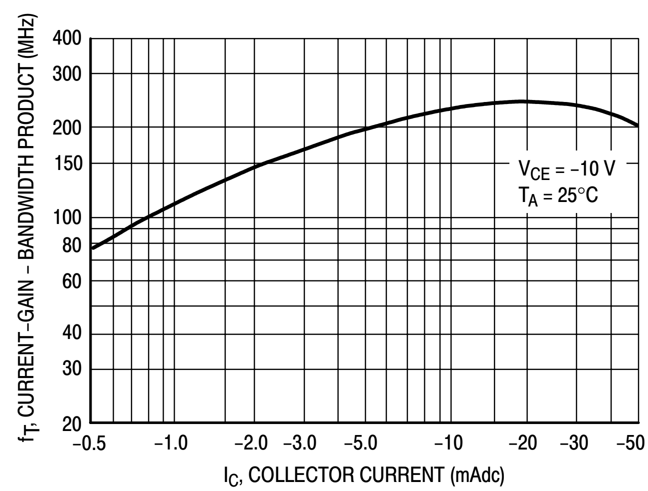


Figure 6. Current−Gain − Bandwidth Product

BC556

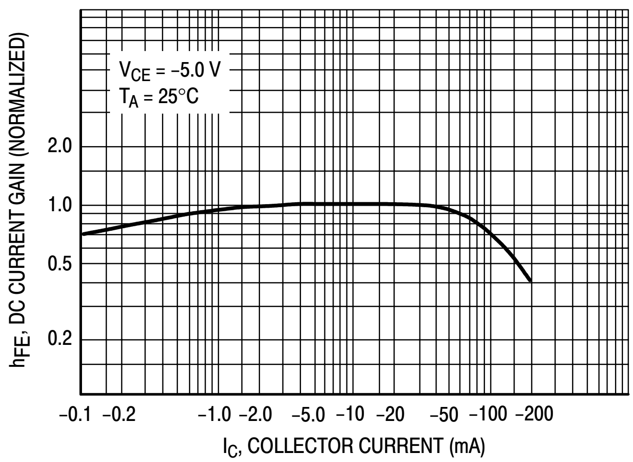


Figure 7. DC Current Gain

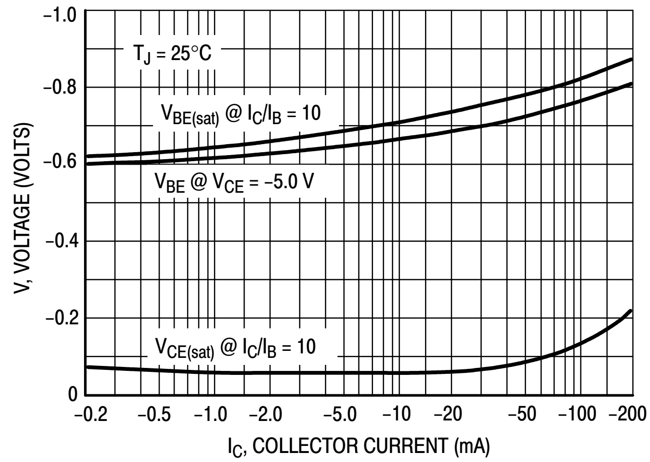


Figure 8. "On" Voltage

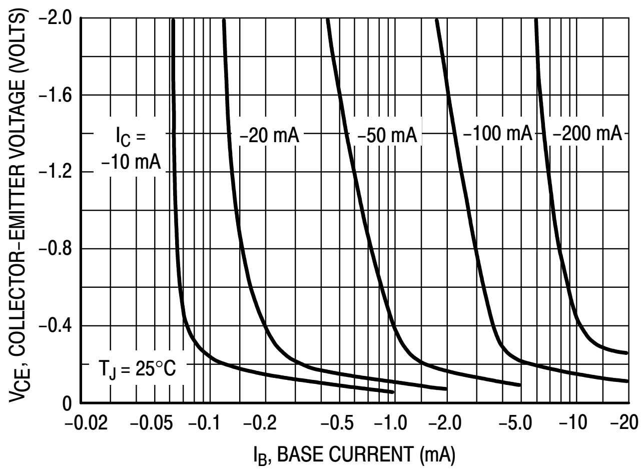


Figure 9. Collector Saturation Region

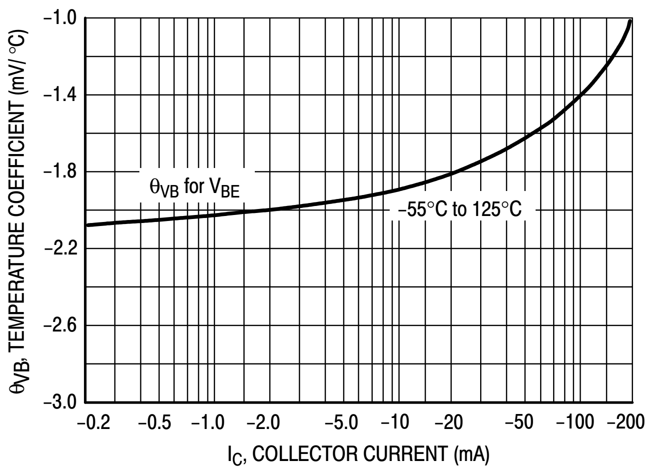


Figure 10. Base–Emitter Temperature Coefficient

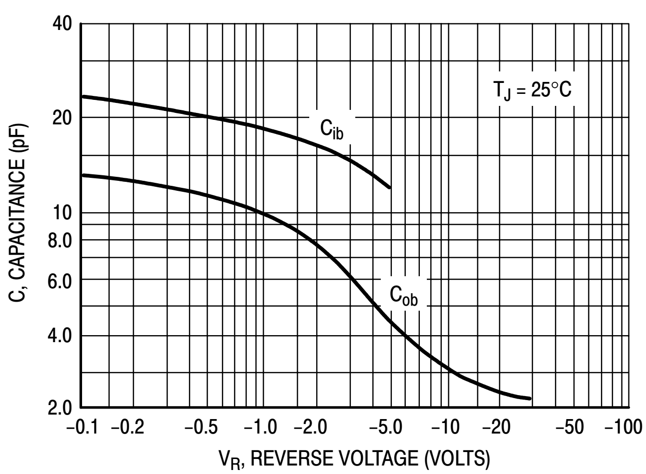


Figure 11. Capacitance

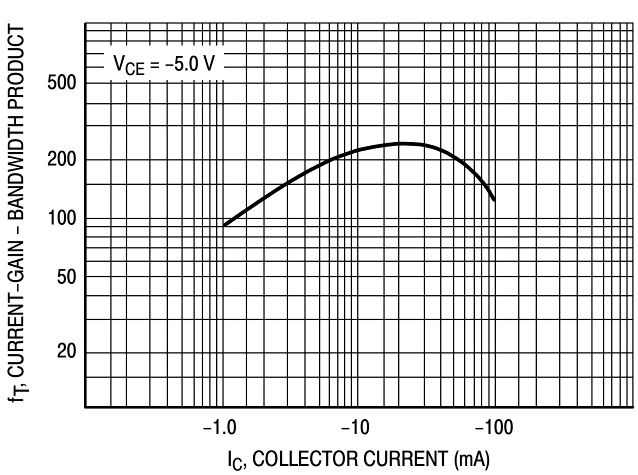


Figure 12. Current–Gain – Bandwidth Product

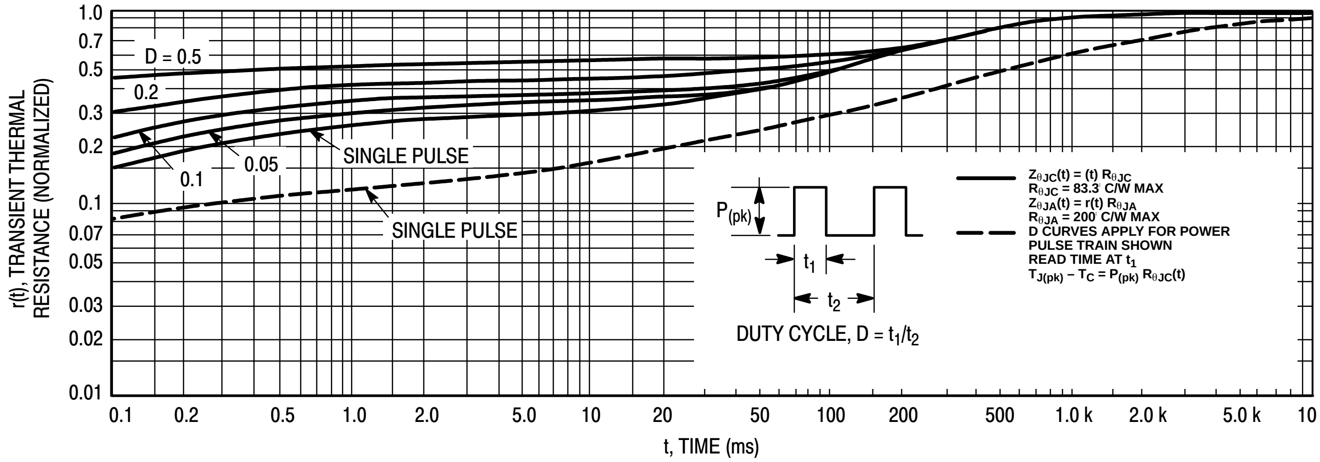


Figure 13. Thermal Response

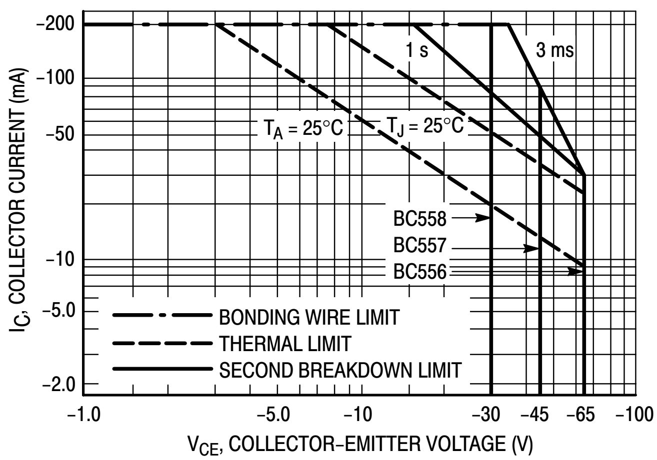


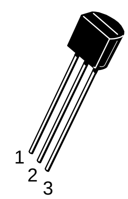
Figure 14. Active Region – Safe Operating Area

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

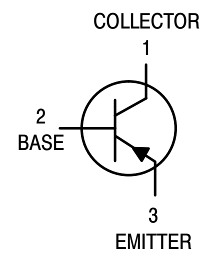
The data of Figure 14 is based upon $T_{J(pk)}$ = 150°C; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq$ 150°C. $T_{J(pk)}$ may be calculated from the data in Figure 13. At high case or ambient temperatures, thermal limitations will reduce the power than can be handled to values less than the limitations imposed by second breakdown.

Low Noise Transistors
PNP Silicon

BC559B, C
BC560C



CASE 29–04, STYLE 17
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	BC559	BC560	Unit
Collector–Emitter Voltage	V_{CEO}	–30	–45	Vdc
Collector–Base Voltage	V_{CBO}	–30	–50	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0		Vdc
Collector Current — Continuous	I_C	–100		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = –10 mAdc, I_B = 0)	 BC559 BC560	$V_{(BR)CEO}$	 –30 –45	 — —	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = –10 μAdc, I_E = 0)	 BC559 BC560	$V_{(BR)CBO}$	 –30 –50	 — —	 — —	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)		$V_{(BR)EBO}$	–5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = –30 Vdc, I_E = 0) (V_{CB} = –30 Vdc, I_E = 0, T_A = +125°C)		I_{CBO}	 — —	 — —	 –15 –5.0	 nAdc μAdc
Emitter Cutoff Current (V_{EB} = –4.0 Vdc, I_C = 0)		I_{EBO}	—	—	–15	nAdc

September, 2001 – Rev. 0
Publication Order Number:
BC559B/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = –10 µAdc, V_{CE} = –5.0 Vdc)	BC559B		100	150	—	
	BC559C/560C		100	270	—	
(I_C = –2.0 mAdc, V_{CE} = –5.0 Vdc)	BC559B		180	290	460	
	BC559C/560C		380	500	800	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = –10 mAdc, I_B = –0.5 mAdc)			—	–0.075	–0.25	
(I_C = –10 mAdc, I_B = see note 1)			—	–0.3	–0.6	
(I_C = –100 mAdc, I_B = –5.0 mAdc, see note 2)			—	–0.25	—	
Base–Emitter Saturation Voltage (I_C = –100 mAdc, I_B = –5.0 mAdc)		$V_{BE(sat)}$	—	–1.1	—	Vdc
Base–Emitter On Voltage		$V_{BE(on)}$				Vdc
(I_C = –10 µAdc, V_{CE} = –5.0 Vdc)			—	–0.52	—	
(I_C = –100 µAdc, V_{CE} = –5.0 Vdc)			—	–0.55	—	
(I_C = –2.0 mAdc, V_{CE} = –5.0 Vdc)			–0.55	–0.62	–0.7	
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –5.0 Vdc, f = 100 MHz)		f_T	—	250	—	MHz
Collector–Base Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)		C_{cbo}	—	2.5	—	pF
Small–Signal Current Gain		h_{fe}				—
(I_C = –2.0 mAdc, V_{CE} = –5.0 V, f = 1.0 kHz)	BC559B		240	330	500	
	BC559C/BC560C		450	600	900	
Noise Figure						dB
(I_C = –200 µAdc, V_{CE} = –5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz)		NF_1	—	0.5	2.0	
(I_C = –200 µAdc, V_{CE} = –5.0 Vdc, R_S = 100 kΩ, f = 1.0 kHz, Δf = 200 kHz)		NF_2	—	—	10	

NOTES:
1. I_B is value for which I_C = –11 mA at V_{CE} = –1.0 V.
2. Pulse test = 300 µs – Duty cycle = 2%.

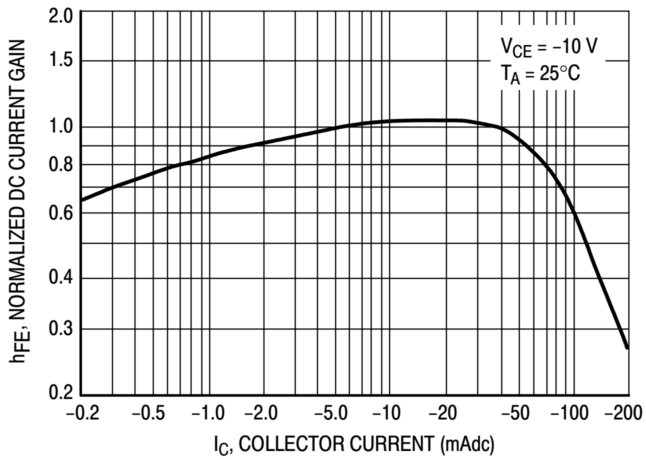


Figure 1. Normalized DC Current Gain

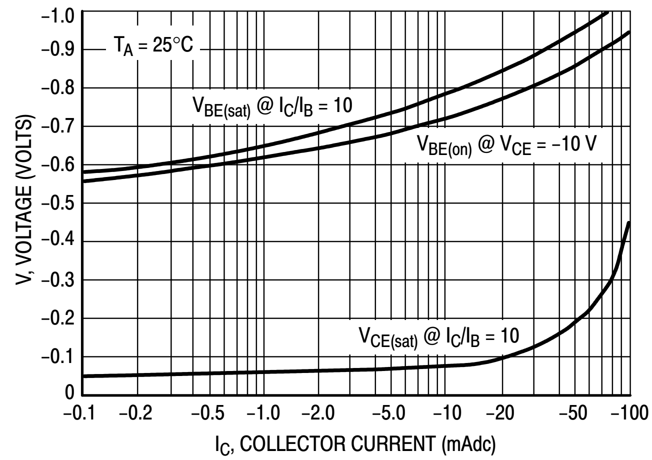


Figure 2. “Saturation” and “On” Voltages

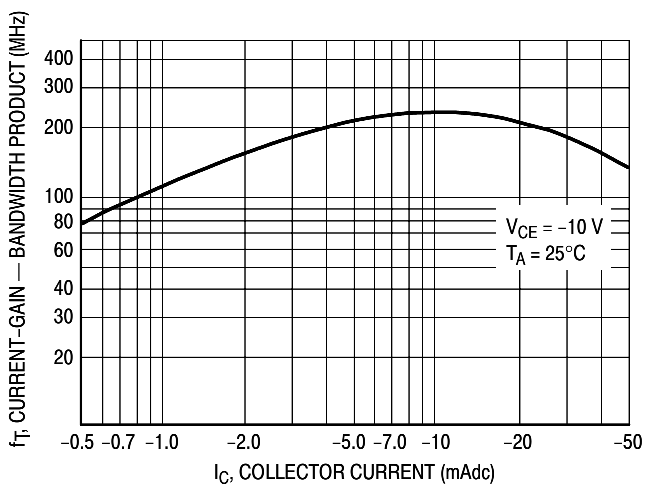


Figure 3. Current−Gain — Bandwidth Product

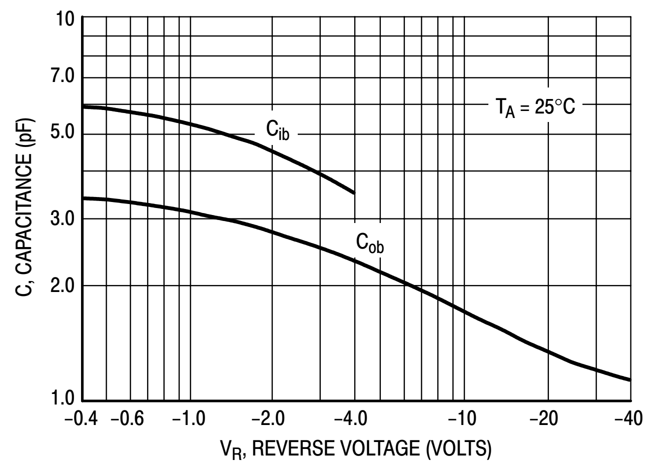


Figure 4. Capacitance

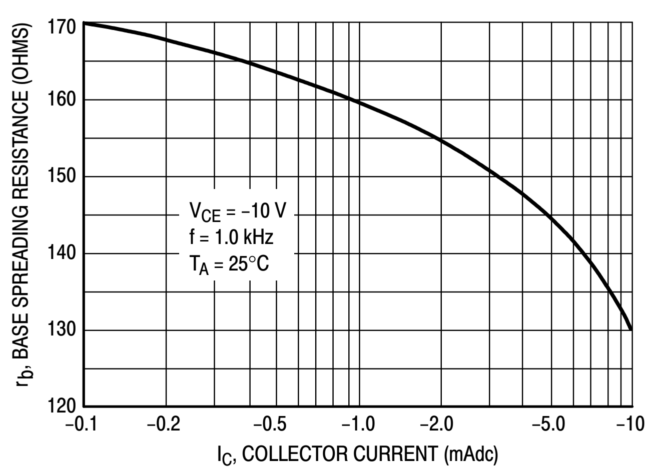


Figure 5. Base Spreading Resistance

Darlington Transistors
NPN Silicon

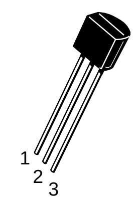
BC618

MAXIMUM RATINGS

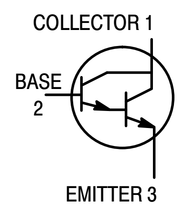
Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	55	Vdc
Collector–Base Voltage	V_{CBO}	80	Vdc
Emitter–Base Voltage	V_{EBO}	12	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



CASE 29–11, STYLE 17
TO–92 (TO–226AA)



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CEO}$	55	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	80	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	12	—	—	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, V_{BE} = 0)	I_{CES}	—	—	50	nAdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 10 Vdc, I_C = 0)	I_{EBO}	—	—	50	nAdc

May, 2001 – Rev.2
Publication Order Number:
BC618/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
Collector–Emitter Saturation Voltage (I_C = 200 mA, I_B = 0.2 mA)	$V_{CE(sat)}$	—	—	1.1	Vdc
Base–Emitter Saturation Voltage (I_C = 200 mA, I_B = 0.2 mA)	$V_{BE(sat)}$	—	—	1.6	Vdc
DC Current Gain	h_{FE}				—
(I_C = 100 µA, V_{CE} = 5.0 Vdc)		2000	—	—	
(I_C = 10 mA, V_{CE} = 5.0 Vdc)		4000	—	—	
(I_C = 200 mA, V_{CE} = 5.0 Vdc)		10000	—	50000	
(I_C = 1.0 A, V_{CE} = 5.0 Vdc)		4000	—	—	
DYNAMIC CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 500 mA, V_{CE} = 5.0 Vdc, P = 100 MHz)	f_T	150	—	—	MHz
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	4.5	7.0	pF
Input Capacitance (V_{EB} = 5.0 V, I_E = 0, f = 1.0 MHz)	C_{ib}	—	5.0	9.0	pF

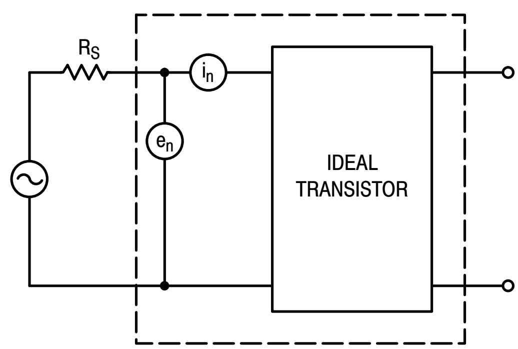


Figure 1. Transistor Noise Model

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

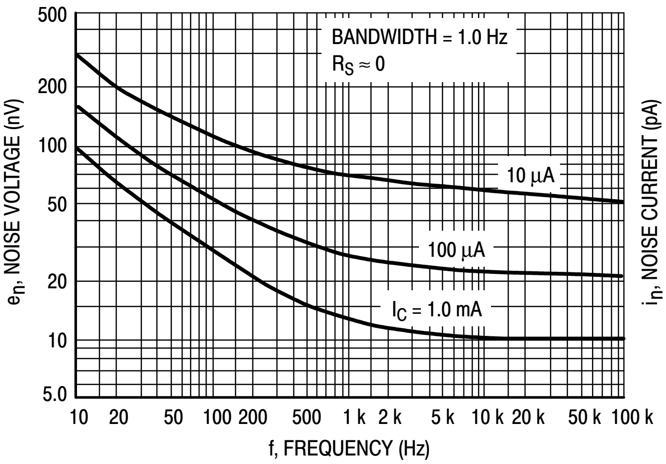


Figure 2. Noise Voltage

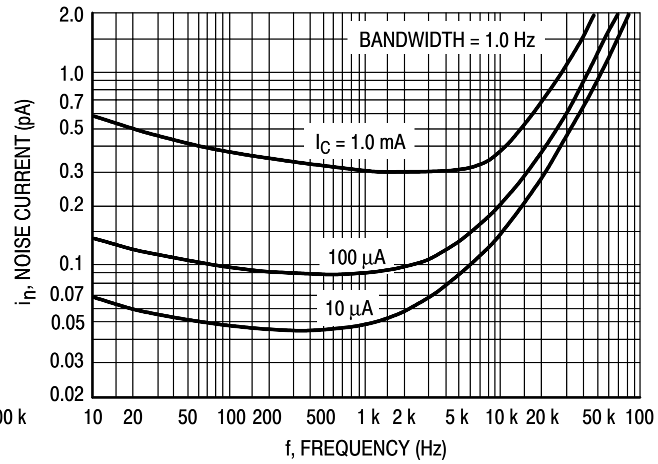


Figure 3. Noise Current

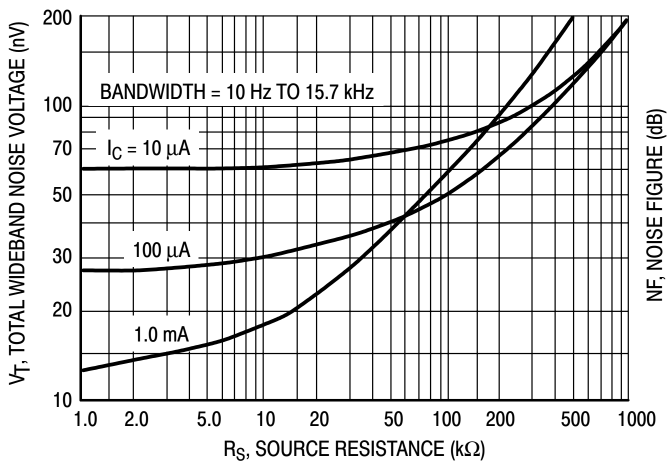


Figure 4. Total Wideband Noise Voltage

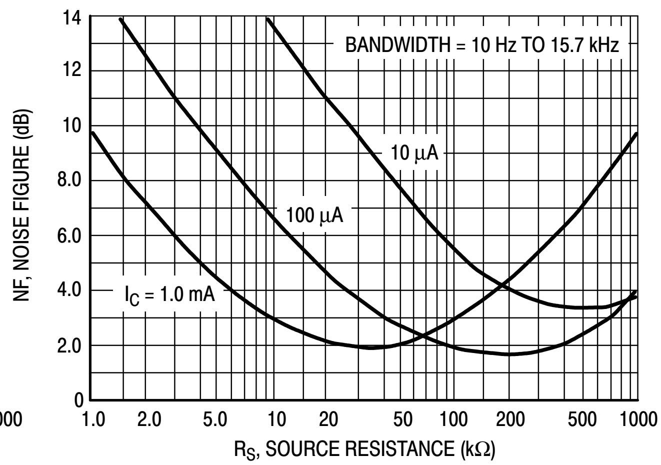


Figure 5. Wideband Noise Figure

SMALL–SIGNAL CHARACTERISTICS

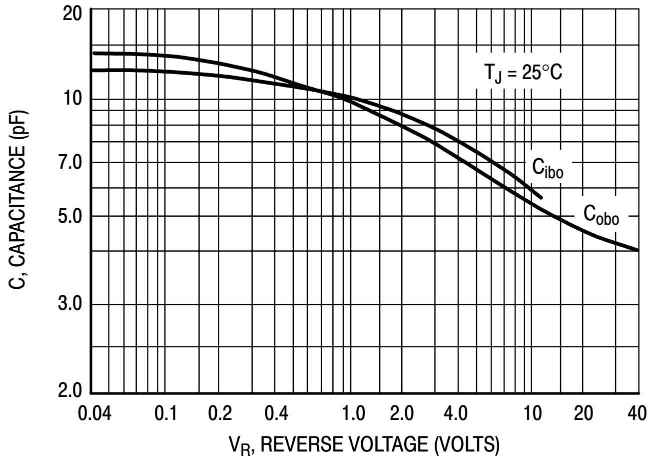


Figure 6. Capacitance

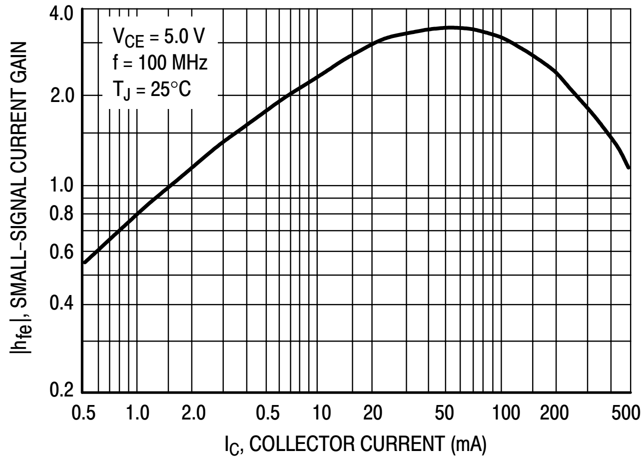


Figure 7. High Frequency Current Gain

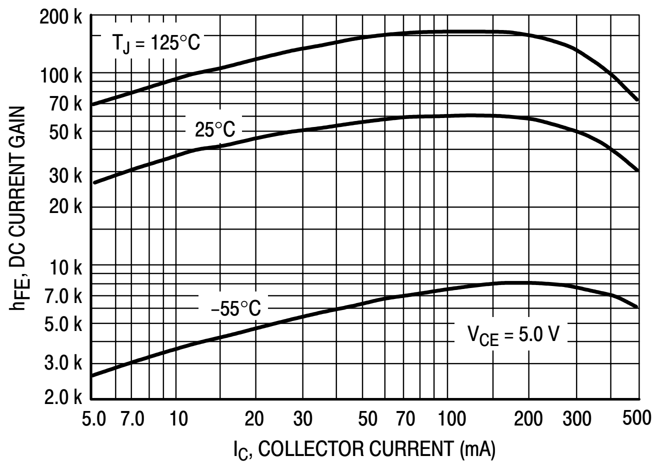


Figure 8. DC Current Gain

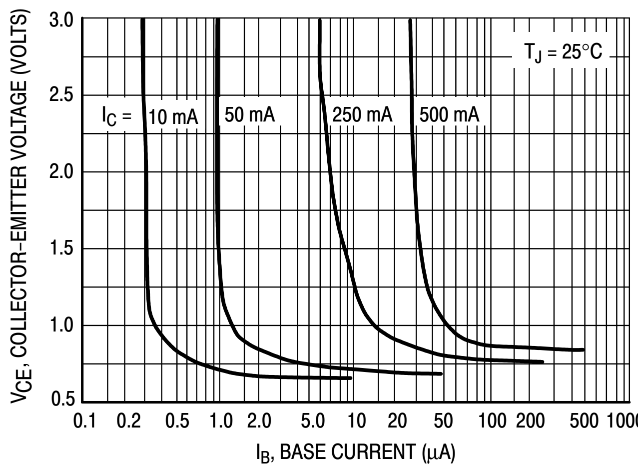


Figure 9. Collector Saturation Region

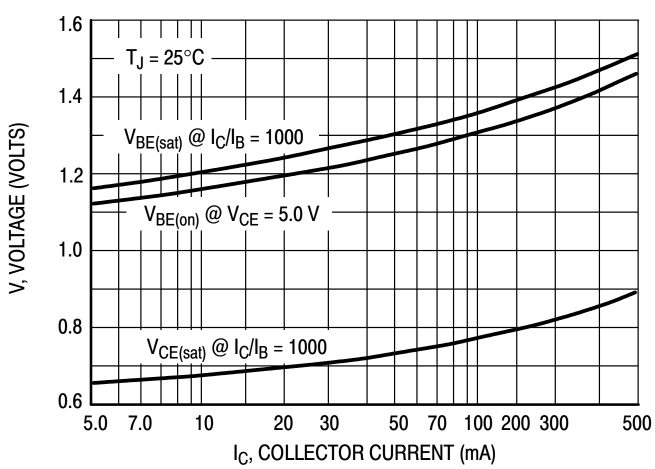


Figure 10. “On” Voltages

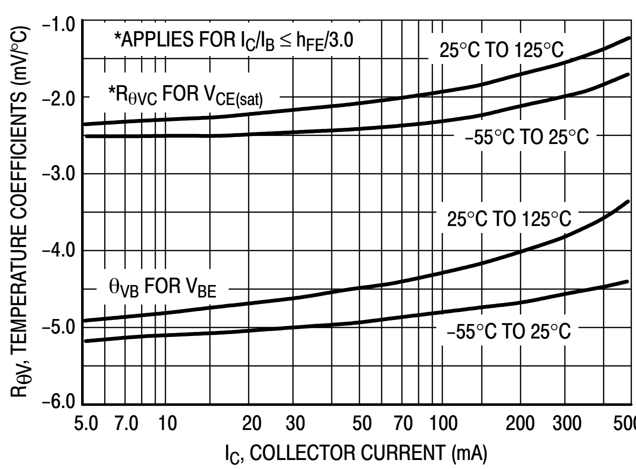


Figure 11. Temperature Coefficients

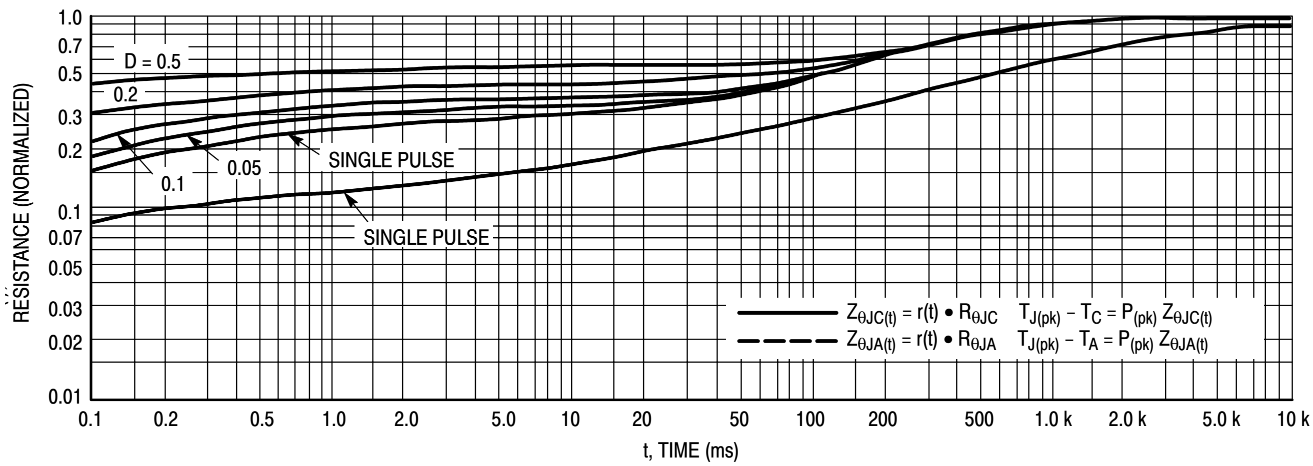


Figure 12. Thermal Response

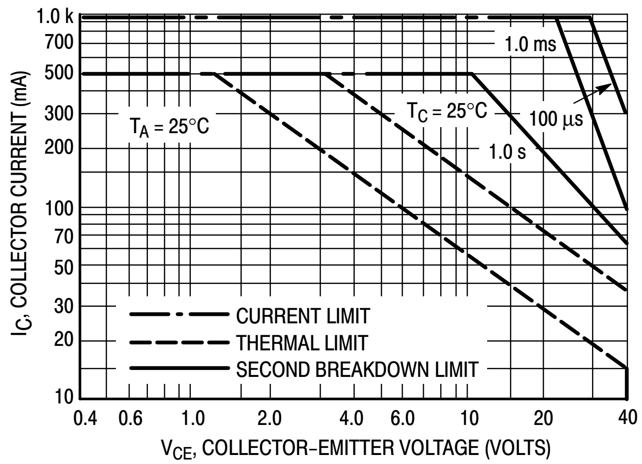
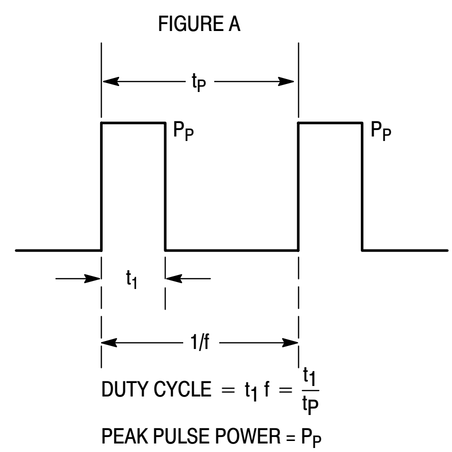


Figure 13. Active Region Safe Operating Area



Design Note: Use of Transient Thermal Resistance Data

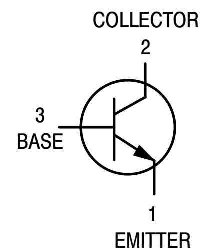
BC635, BC637, BC639, BC639-16

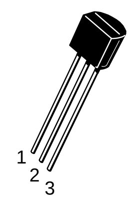
High Current Transistors

NPN Silicon

ON Semiconductor

http://onsemi.com





TO–92 (TO–226AA)
CASE 29
STYLE 14

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage BC635 BC637 BC639	V_{CEO}	 45 60 80	Vdc
Collector-Base Voltage BC635 BC637 BC639	V_{CBO}	 45 60 80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 625 5.0	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 800 12	 mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ORDERING INFORMATION

Device	Package	Shipping
BC635RL1	TO–92	2000/Tape & Reel
BC635ZL1	TO–92	2000/Ammo Pack
BC637	TO–92	5000 Units/Box
BC639	TO–92	5000 Units/Box
BC639RL1	TO–92	2000/Tape & Reel
BC639ZL1	TO–92	2000/Ammo Pack
BC639–16ZL1	TO–92	2000/Ammo Pack

June, 2000 – Rev. 3

Publication Order Number:
BC635/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (1)		$V_{(BR)CEO}$				Vdc
(I_C = 10 μAdc, I_B = 0)	BC635		45	—	—	
	BC637		60	—	—	
	BC639		80	—	—	
Collector–Emitter Zero–Gate Breakdown Voltage (1)		$V_{(BR)CES}$				Vdc
(I_C = 100 μAdc, I_B = 0)	BC639–16		120	—	—	
Collector–Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0)	BC635		45	—	—	
	BC637		60	—	—	
	BC639		80	—	—	
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current		I_{CBO}				
(V_{CB} = 30 Vdc, I_E = 0)			—	—	100	nAdc
(V_{CB} = 30 Vdc, I_E = 0, T_A = 125°C)			—	—	10	μAdc
ON CHARACTERISTICS (1)						
DC Current Gain		h_{FE}				—
(I_C = 5.0 mAdc, V_{CE} = 2.0 Vdc)			25	—	—	
(I_C = 150 mAdc, V_{CE} = 2.0 Vdc)	BC635		40	—	250	
	BC637		40	—	160	
	BC639		40	—	160	
	BC639–16ZLT1		100	—	250	
(I_C = 500 mA, V_{CE} = 2.0 V)			25	—	—	
Collector–Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{CE(sat)}$	—	—	0.5	Vdc
Base–Emitter On Voltage (I_C = 500 mAdc, V_{CE} = 2.0 Vdc)		$V_{BE(on)}$	—	—	1.0	Vdc
DYNAMIC CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 2.0 Vdc, f = 100 MHz)		f_T	—	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	—	7.0	—	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ib}	—	50	—	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle 2.0%.

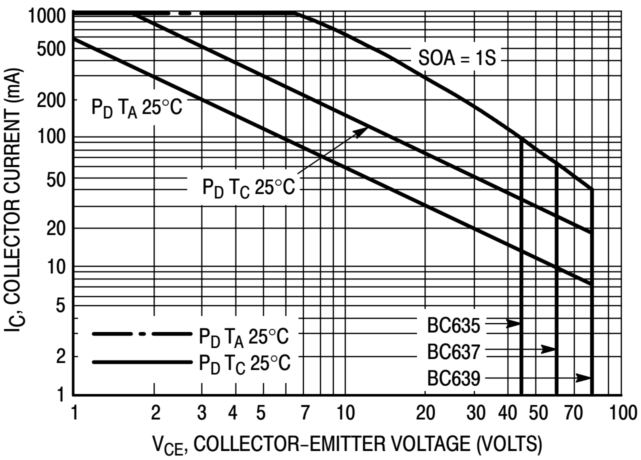


Figure 1. Active Region Safe Operating Area

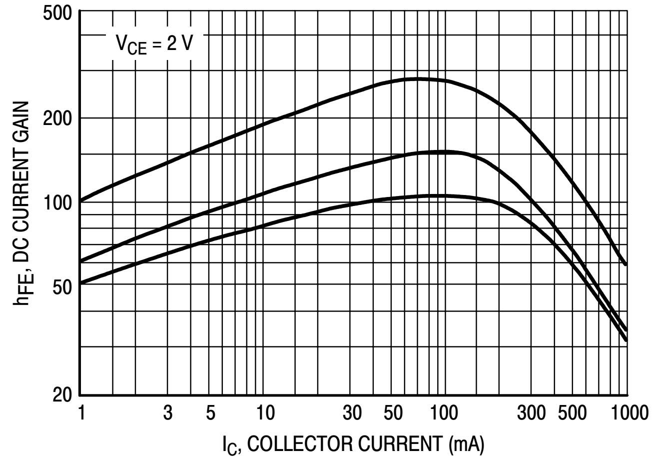


Figure 2. DC Current Gain

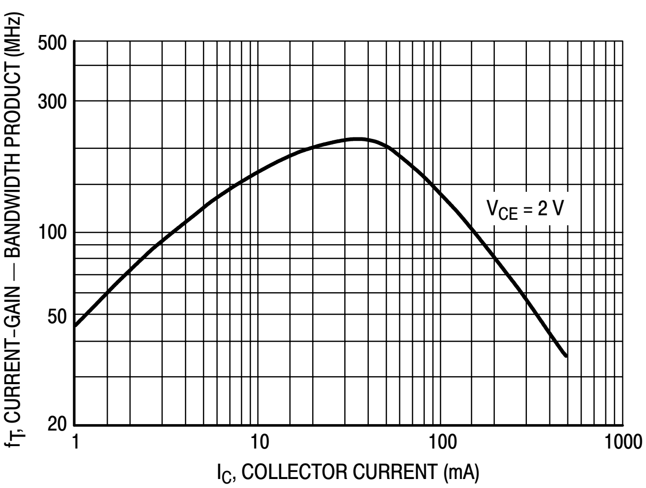


Figure 3. Current–Gain — Bandwidth Product

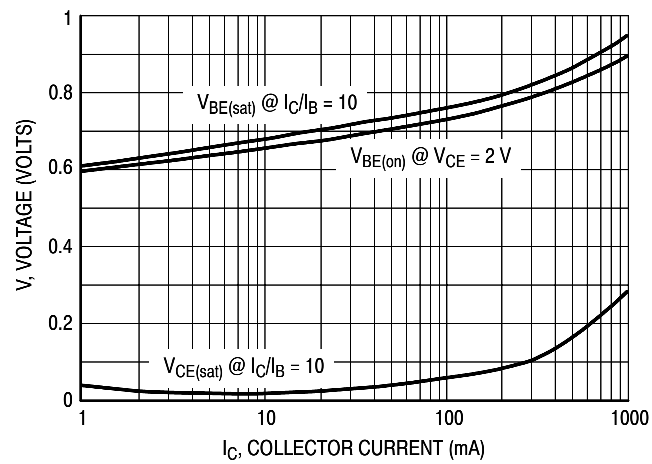


Figure 4. “Saturation” and “On” Voltages

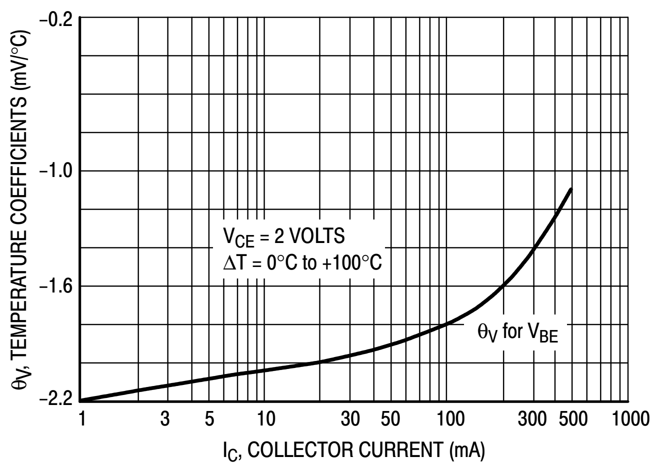


Figure 5. Temperature Coefficients

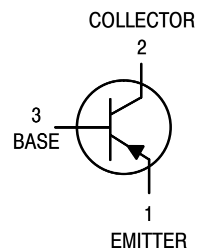
BC636, BC636-16, BC638, BC640, BC640-16

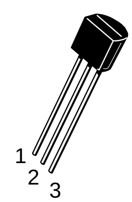
High Current Transistors

PNP Silicon

ON Semiconductor

http://onsemi.com





CASE 29
TO–92
STYLE 14

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage BC636 BC638 BC640	V_{CEO}	 –45 –60 –80	Vdc
Collector-Base Voltage BC636 BC638 BC640	V_{CBO}	 –45 –60 –80	Vdc
Emitter-Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current — Continuous	I_C	–0.5	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 625 5.0	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.5 12	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ORDERING INFORMATION

Device	Package	Shipping
BC636	TO–92	5000 Units/Box
BC636ZL1	TO–92	2000/Ammo Pack
BC636–16ZL1	TO–92	2000/Ammo Pack
BC638	TO–92	5000 Units/Box
BC638ZL1	TO–92	2000/Ammo Pack
BC640	TO–92	5000 Units/Box
BC640ZL1	TO–92	2000/Ammo Pack
BC640–16	TO–92	5000 Units/Box

June, 2000 – Rev. 1
Publication Order Number:
BC636/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = –10 mAdc, I_B = 0)	BC636 BC638 BC640	$V_{(BR)CEO}$	–45 –60 –80	— — —	— — —	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	BC636 BC638 BC640	$V_{(BR)CBO}$	–45 –60 –80	— — —	— — —	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)		$V_{(BR)EBO}$	–5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = –30 Vdc, I_E = 0) (V_{CB} = –30 Vdc, I_E = 0, T_A = 125°C)		I_{CBO}	— —	— —	–100 –10	nAdc μAdc
ON CHARACTERISTICS (1)						
DC Current Gain (I_C = –5.0 mAdc, V_{CE} = –2.0 Vdc) (I_C = –150 mAdc, V_{CE} = –2.0 Vdc) (I_C = –500 mA, V_{CE} = –2.0 V)	 BC636 BC636–16 BC638 BC640 BC640–16	h_{FE}	25 40 100 40 40 100 25	— — — — — — —	— 250 250 160 160 250 —	—
Collector–Emitter Saturation Voltage (I_C = –500 mAdc, I_B = –50 mAdc)		$V_{CE(sat)}$	— —	–0.25 –0.5	–0.5 —	Vdc
Base–Emitter On Voltage (I_C = –500 mAdc, V_{CE} = –2.0 Vdc)		$V_{BE(on)}$	—	—	–1.0	Vdc
DYNAMIC CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = –50 mAdc, V_{CE} = –2.0 Vdc, f = 100 MHz)		f_T	—	150	—	MHz
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	—	9.0	—	pF
Input Capacitance (V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ib}	—	110	—	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle 2.0%.

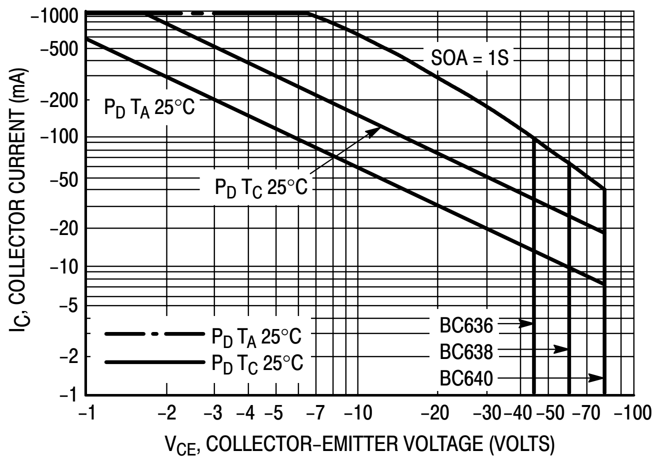


Figure 1. Active Region Safe Operating Area

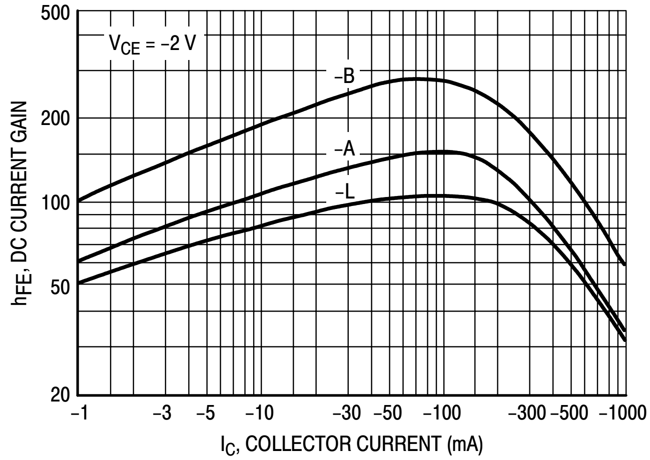


Figure 2. DC Current Gain

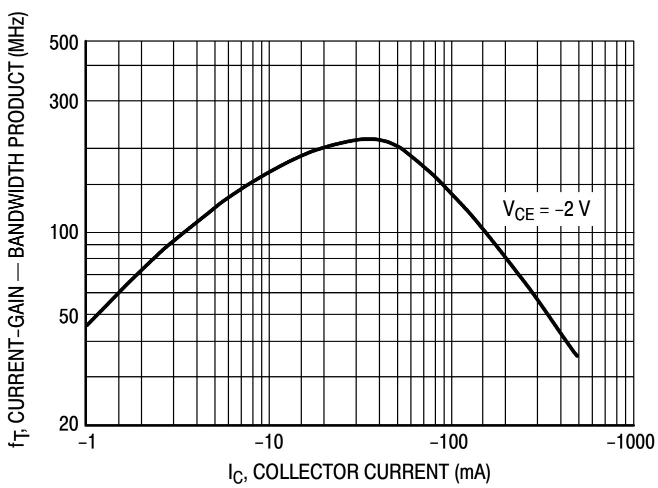


Figure 3. Current Gain Bandwidth Product

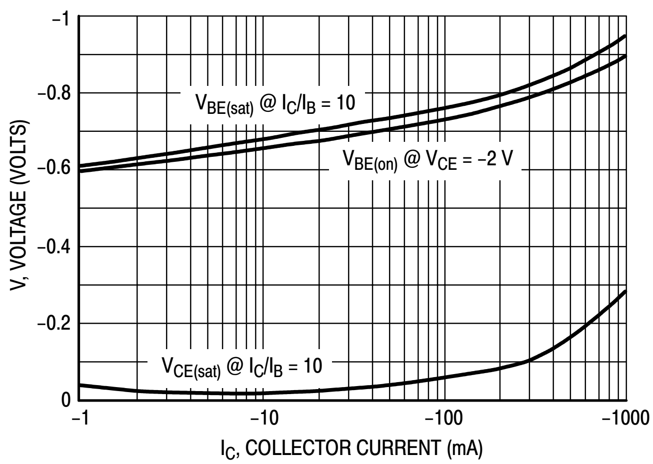


Figure 4. “Saturation” and “On” Voltages

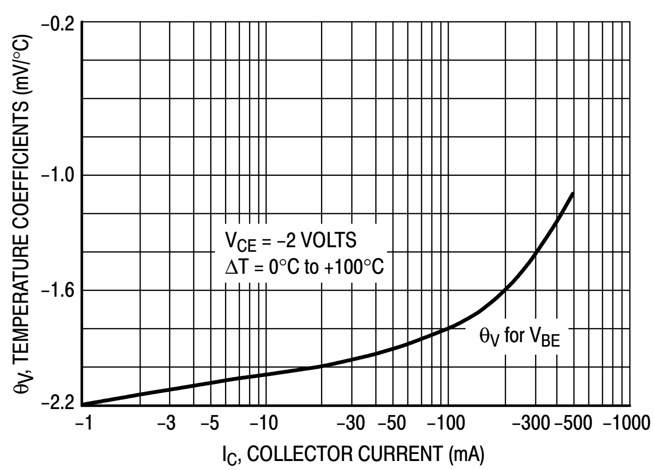
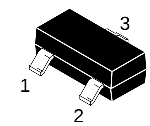


Figure 5. Temperature Coefficients

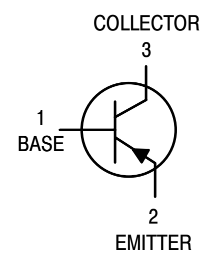
General Purpose Transistors

PNP Silicon

BC807-16LT1
BC807-25LT1
BC807-40LT1



CASE 318–08, STYLE 6
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–45	V
Collector–Base Voltage	V_{CBO}	–50	V
Emitter–Base Voltage	V_{EBO}	–5.0	V
Collector Current — Continuous	I_C	–500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board, (1) T_A = 25°C Derate above 25°C	P_D	 225 1.8	 mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate, (2) T_A = 25°C Derate above 25°C	P_D	 300 2.4	 mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BC807–16LT1 = 5A; BC807–25LT1 = 5B; BC807–40LT1 = 5C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = –10 mA)	$V_{(BR)CEO}$	–45	—	—	V
Collector–Emitter Breakdown Voltage (V_{EB} = 0, I_C = –10 μA)	$V_{(BR)CES}$	–50	—	—	V
Emitter–Base Breakdown Voltage (I_E = –1.0 μA)	$V_{(BR)EBO}$	–5.0	—	—	V
Collector Cutoff Current (V_{CB} = –20 V) (V_{CB} = –20 V, T_J = 150°C)	I_{CBO}	 — —	 — —	 –100 –5.0	 nA μA

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

March, 2001 – Rev. 3
Publication Order Number:
BC807–16LT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = –100 mA, V_{CE} = –1.0 V)	BC807–16		100	—	250	
	BC807–25		160	—	400	
	BC807–40		250	—	600	
(I_C = –500 mA, V_{CE} = –1.0 V)			40	—	—	
Collector–Emitter Saturation Voltage (I_C = –500 mA, I_B = –50 mA)		$V_{CE(sat)}$	—	—	–0.7	V
Base–Emitter On Voltage (I_C = –500 mA, I_B = –1.0 V)		$V_{BE(on)}$	—	—	–1.2	V
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = –10 mA, V_{CE} = –5.0 Vdc, f = 100 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = –10 V, f = 1.0 MHz)		C_{obo}	—	10	—	pF

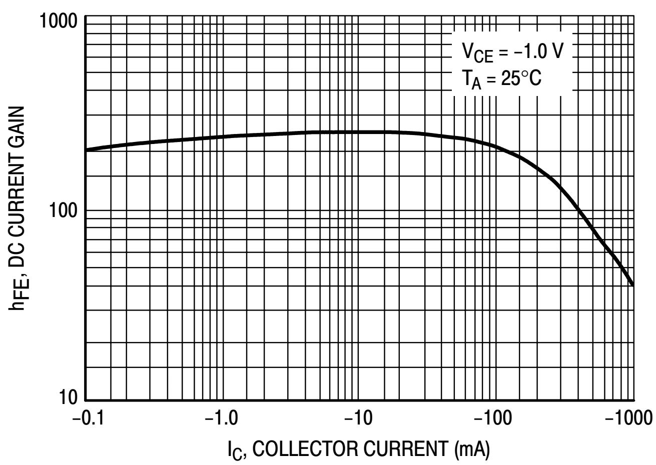


Figure 1. DC Current Gain

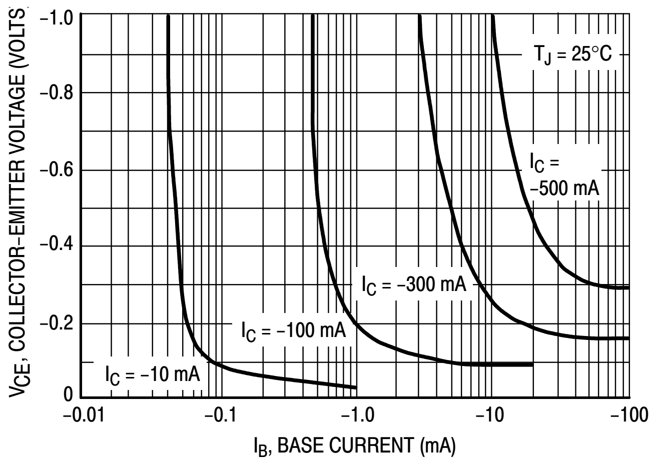


Figure 2. Saturation Region

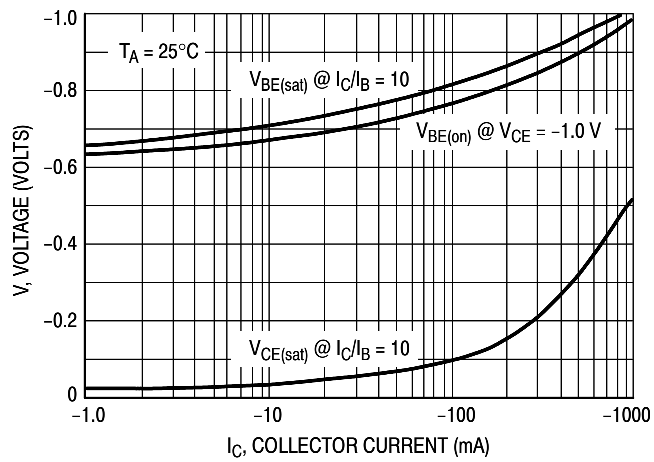


Figure 3. "On" Voltages

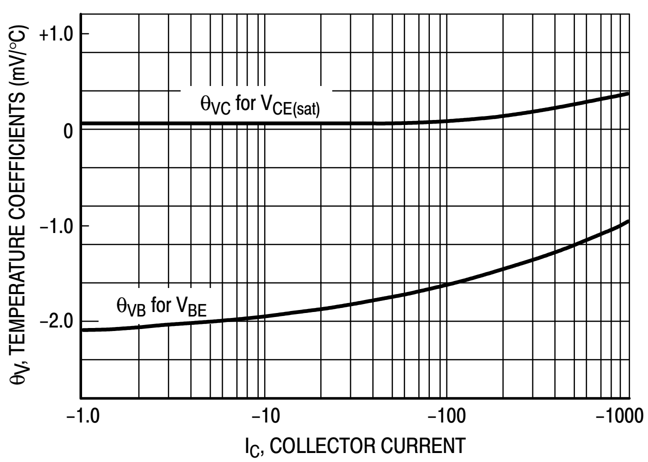


Figure 4. Temperature Coefficients

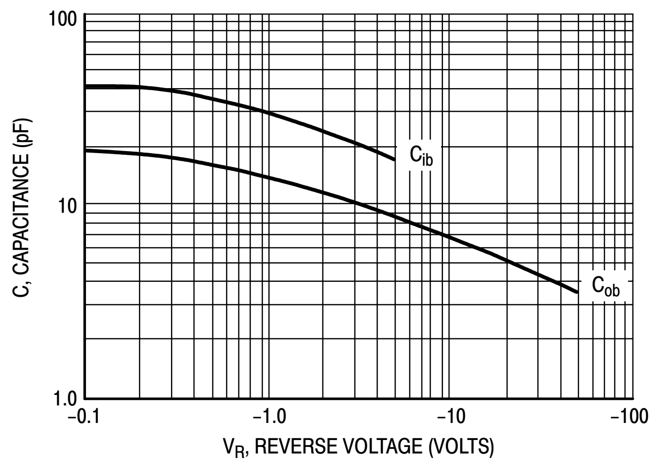
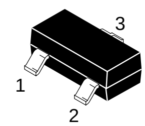


Figure 5. Capacitances

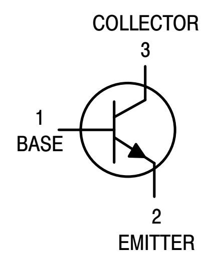
General Purpose Transistors

NPN Silicon

BC817-16LT1
BC817-25LT1
BC817-40LT1



CASE 318–08, STYLE 6
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	45	V
Collector–Base Voltage	V_{CBO}	50	V
Emitter–Base Voltage	V_{EBO}	5.0	V
Collector Current — Continuous	I_C	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board, (1) T_A = 25°C Derate above 25°C	P_D	 225 1.8	 mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate, (2) T_A = 25°C Derate above 25°C	P_D	 300 2.4	 mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BC817–16LT1 = 6A; BC817–25LT1 = 6B; BC817–40LT1 = 6C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = –10 mA)	$V_{(BR)CEO}$	45	—	—	V
Collector–Emitter Breakdown Voltage (V_{EB} = 0, I_C = –10 µA)	$V_{(BR)CES}$	50	—	—	V
Emitter–Base Breakdown Voltage (I_E = –1.0 µA)	$V_{(BR)EBO}$	5.0	—	—	V
Collector Cutoff Current (V_{CB} = 20 V) (V_{CB} = 20 V, T_A = 150°C)	I_{CBO}	 — —	 — —	 100 5.0	 nA µA

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 100 mA, V_{CE} = 1.0 V)	BC817–16		100	—	250	
	BC817–25		160	—	400	
	BC817–40		250	—	600	
(I_C = 500 mA, V_{CE} = 1.0 V)			40	—	—	
Collector–Emitter Saturation Voltage (I_C = 500 mA, I_B = 50 mA)		$V_{CE(sat)}$	—	—	0.7	V
Base–Emitter On Voltage (I_C = 500 mA, V_{CE} = 1.0 V)		$V_{BE(on)}$	—	—	1.2	V
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	—	10	—	pF

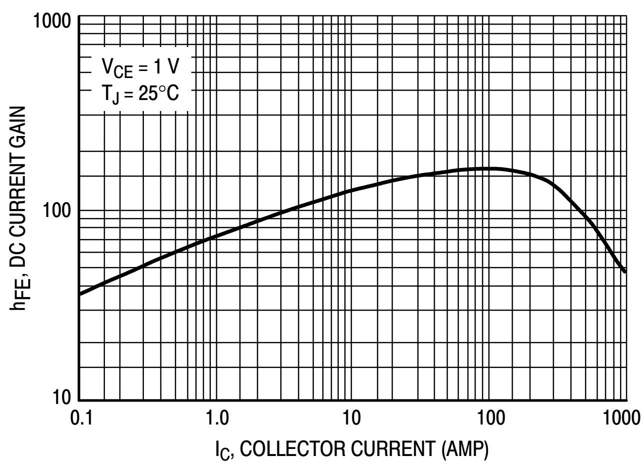


Figure 1. DC Current Gain

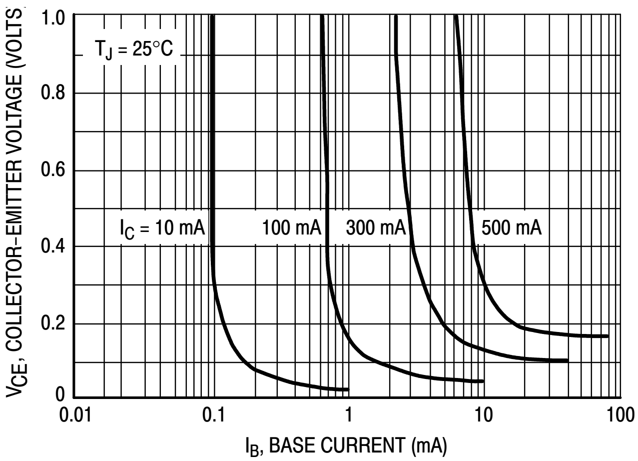


Figure 2. Saturation Region

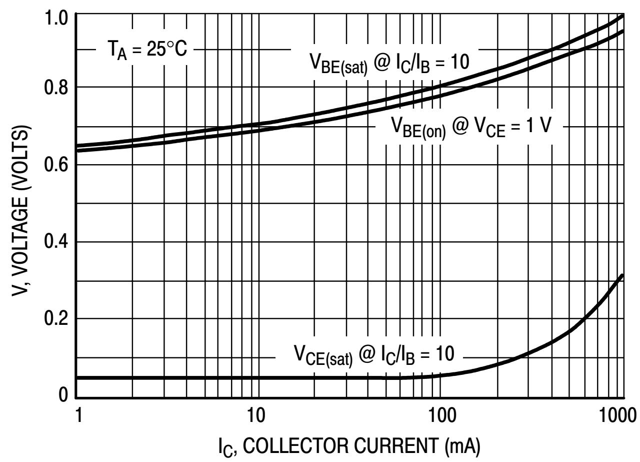


Figure 3. “On” Voltages

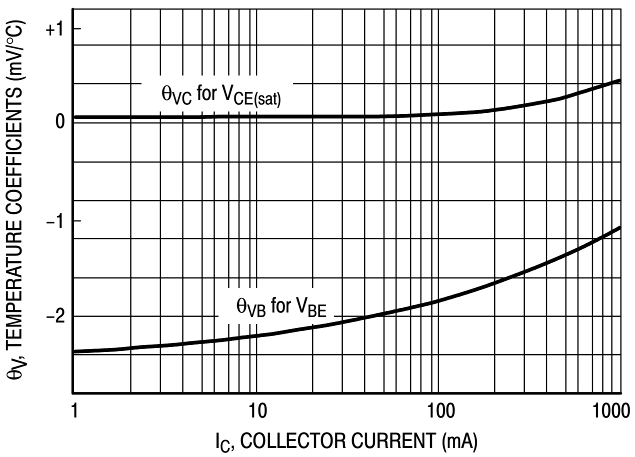


Figure 4. Temperature Coefficients

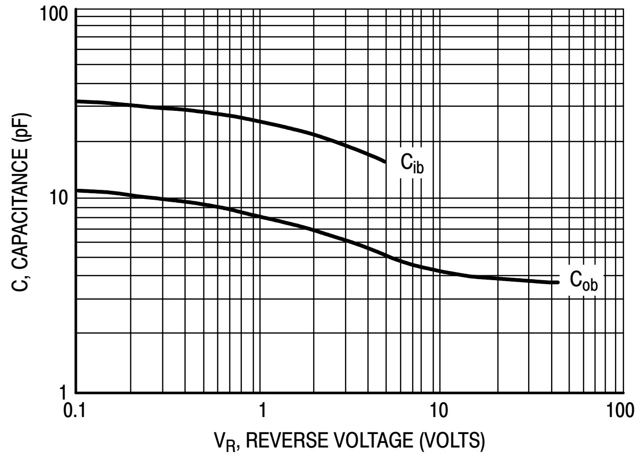


Figure 5. Capacitances

BC846ALT1 Series

BC846, BC847 and BC848 are Preferred Devices

General Purpose Transistors

NPN Silicon

- Moisture Sensitivity Level: 1
- ESD Rating – Human Body Model: >4000 V
  – Machine Model: >400 V

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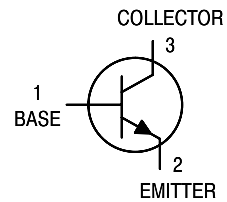


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}		Vdc
BC846		65	
BC847, BC850		45	
BC848, BC849		30	
Collector–Base Voltage	V_{CBO}		Vdc
BC846		80	
BC847, BC850		50	
BC848, BC849		30	
Emitter–Base Voltage	V_{EBO}		Vdc
BC846		6.0	
BC847, BC850		6.0	
BC848, BC849		5.0	
Collector Current – Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

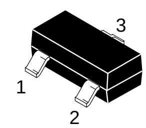
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board (Note 1.) $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient (Note 1.)	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate (Note 2.) $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance, Junction to Ambient (Note 2.)	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

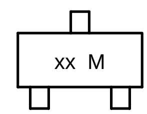
BC846ALT1 = 1A; BC846BLT1 = 1B; BC847ALT1 = 1E; BC847BLT1 = 1F; BC847CLT1 = 1G; BC848ALT1 = 1J; BC848BLT1 = 1K; BC848CLT1 = 1L; BC849BLT1 = 2B; BC849CLT1 = 2C; BC850BLT1 = 2F; BC850CLT1 = 2G

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

MARKING DIAGRAM



SOT–23
CASE 318
STYLE 6



xx = Device Code (See Table)
M = Date Code

ORDERING INFORMATION

Device	Package	Shipping
BC846ALT1	SOT–23	3000/Tape & Reel
BC846ALT3	SOT–23	10,000/Tape & Reel
BC846BLT1	SOT–23	3000/Tape & Reel
BC846BLT3	SOT–23	10,000/Tape & Reel
BC847ALT1	SOT–23	3000/Tape & Reel
BC847BLT1	SOT–23	3000/Tape & Reel
BC847CLT1	SOT–23	3000/Tape & Reel
BC847CLT3	SOT–23	10,000/Tape & Reel
BC848ALT1	SOT–23	3000/Tape & Reel
BC848BLT1	SOT–23	3000/Tape & Reel
BC848BLT3	SOT–23	10,000/Tape & Reel
BC848CLT1	SOT–23	3000/Tape & Reel
BC849BLT1	SOT–23	3000/Tape & Reel
BC849CLT1	SOT–23	3000/Tape & Reel
BC850BLT1	SOT–23	3000/Tape & Reel
BC850CLT1	SOT–23	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = 10 mA)	BC846A,B BC847A,B,C, BC850B,C BC848A,B,C, BC849B,C	$V_{(BR)CEO}$	65 45 30	– – –	– – –	V
Collector–Emitter Breakdown Voltage (I_C = 10 μA, V_{EB} = 0)	BC846A,B BC847A,B,C BC850B,C BC848A,B,C, BC849B,C	$V_{(BR)CES}$	80 50 30	– – –	– – –	V
Collector–Base Breakdown Voltage (I_C = 10 μA)	BC846A,B BC847A,B,C, BC850B,C BC848A,B,C, BC849B,C	$V_{(BR)CBO}$	80 50 30	– – –	– – –	V
Emitter–Base Breakdown Voltage (I_E = 1.0 μA)	BC846A,B BC847A,B,C, BC850B,C BC848A,B,C, BC849B,C	$V_{(BR)EBO}$	6.0 6.0 5.0	– – –	– – –	V
Collector Cutoff Current (V_{CB} = 30 V)	(V_{CB} = 30 V, T_A = 150°C)	I_{CBO}	– –	– –	15 5.0	nA μA
ON CHARACTERISTICS						
DC Current Gain (I_C = 10 μA, V_{CE} = 5.0 V)	BC846A, BC847A, BC848A BC846B, BC847B, BC848B BC847C, BC848C	h_{FE}	– – –	90 150 270	– – –	–
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC846A, BC847A, BC848A BC846B, BC847B, BC848B, BC849B, BC850B BC847C, BC848C, BC849C, BC850C		110 200 420	180 290 520	220 450 800	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA) (I_C = 100 mA, I_B = 5.0 mA)		$V_{CE(sat)}$	– –	– –	0.25 0.6	V
Base–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA) (I_C = 100 mA, I_B = 5.0 mA)		$V_{BE(sat)}$	– –	0.7 0.9	– –	V
Base–Emitter Voltage (I_C = 2.0 mA, V_{CE} = 5.0 V) (I_C = 10 mA, V_{CE} = 5.0 V)		$V_{BE(on)}$	580 –	660 –	700 770	mV
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain – Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	–	–	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	–	–	4.5	pF
Noise Figure (I_C = 0.2 mA, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	BC846A,B, BC847A,B,C, BC848A,B,C BC849B,C, BC850B,C	NF	– –	– –	10 4.0	dB

BC847, BC848, BC849, BC850

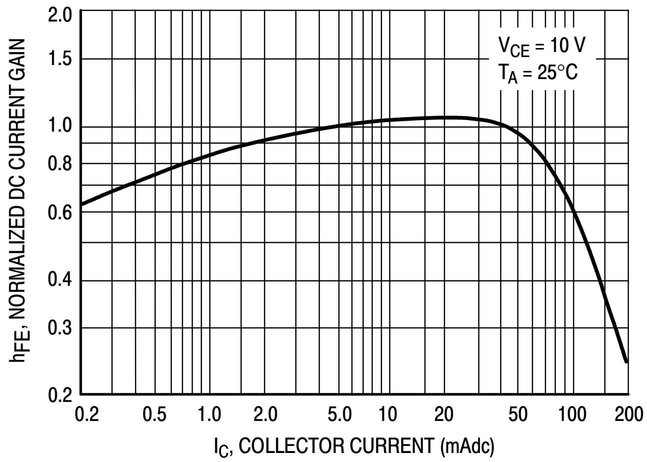


Figure 1. Normalized DC Current Gain

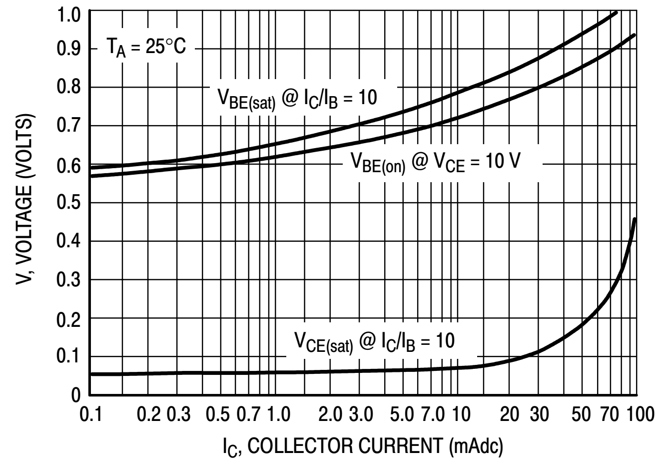


Figure 2. "Saturation" and "On" Voltages

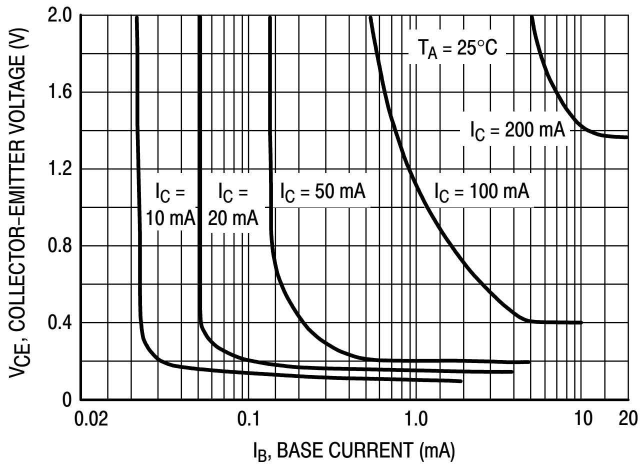


Figure 3. Collector Saturation Region

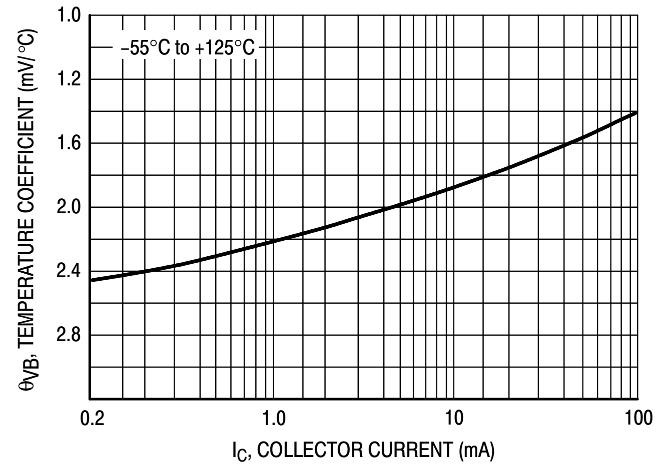


Figure 4. Base–Emitter Temperature Coefficient

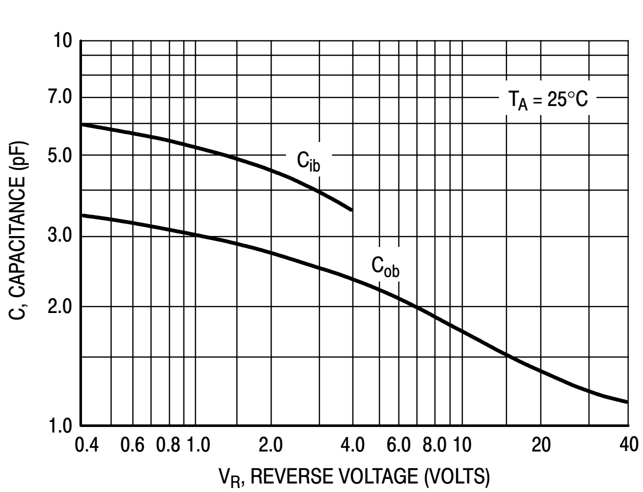


Figure 5. Capacitances

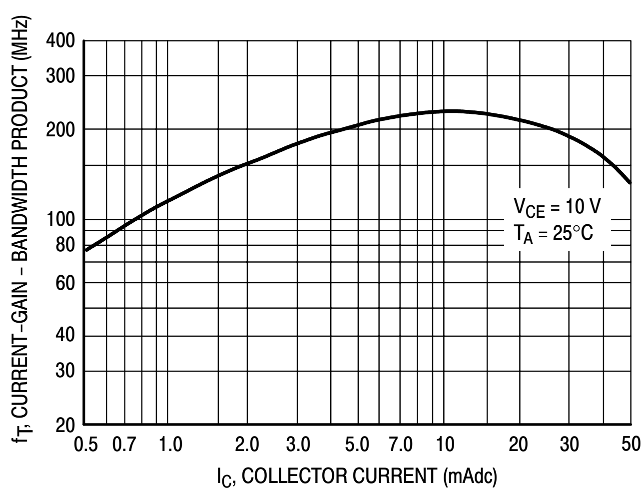


Figure 6. Current–Gain – Bandwidth Product

BC846

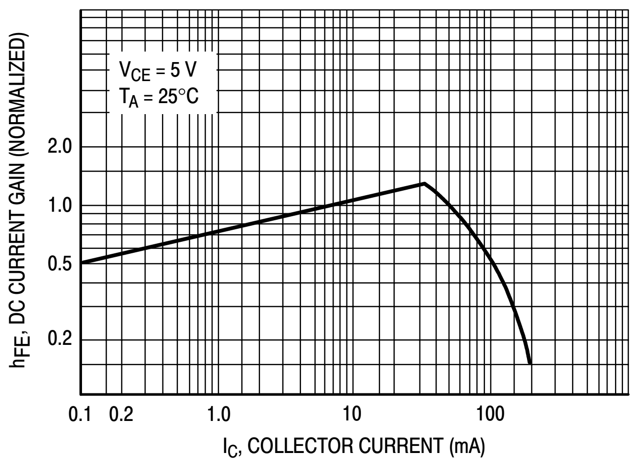


Figure 7. DC Current Gain

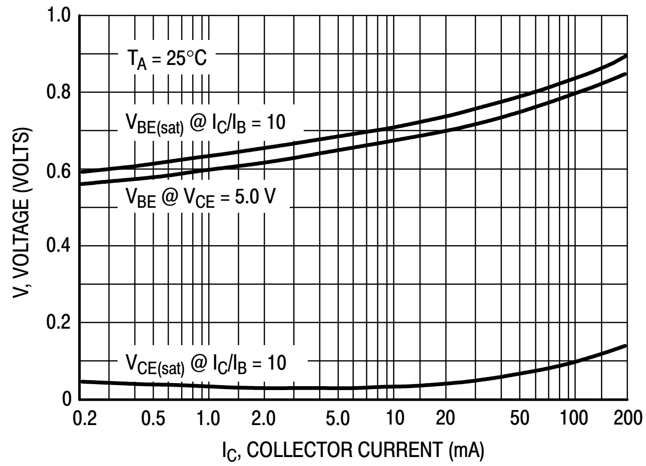


Figure 8. “On” Voltage

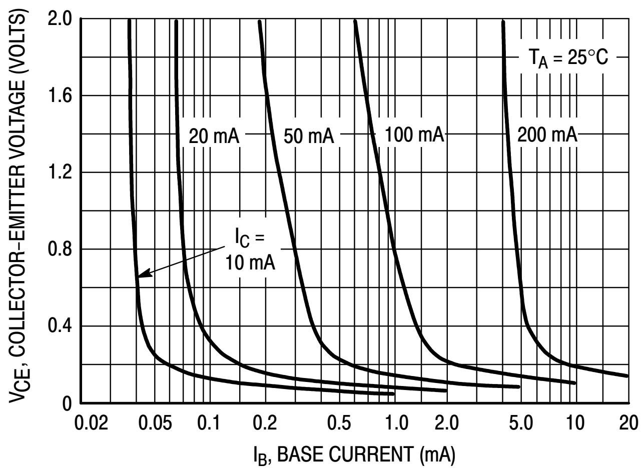


Figure 9. Collector Saturation Region

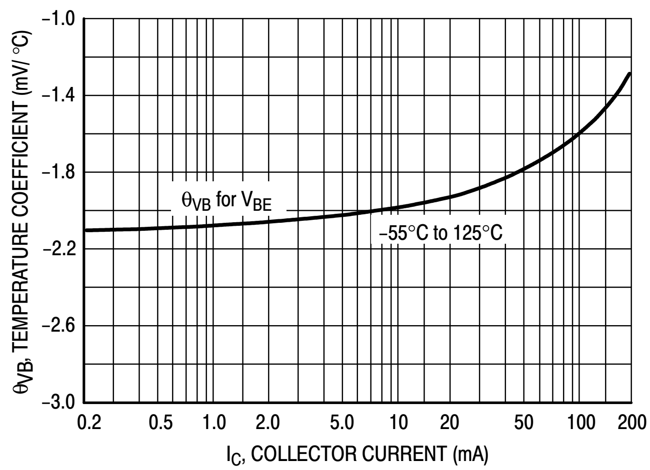


Figure 10. Base–Emitter Temperature Coefficient

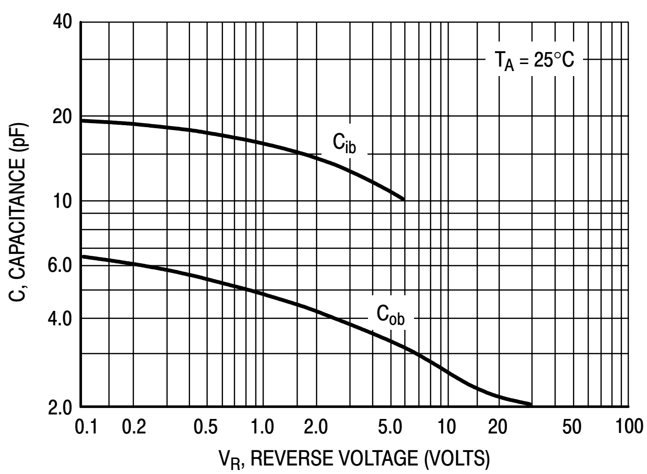


Figure 11. Capacitance

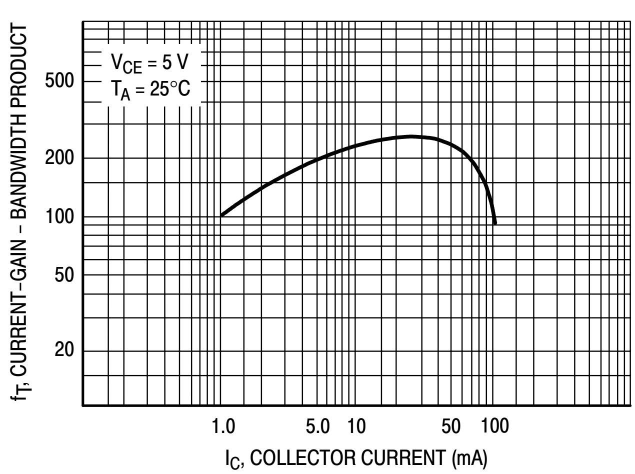


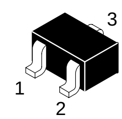
Figure 12. Current–Gain – Bandwidth Product

BC846AWT1 Series, BC847AWT1 Series, BC848AWT1 Series

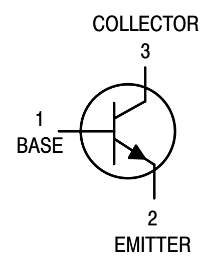
General Purpose Transistors

NPN Silicon

These transistors are designed for general purpose amplifier applications. They are housed in the SOT–323/SC–70 which is designed for low power surface mount applications.



CASE 419–02, STYLE 3
SOT–323/SC–70



MAXIMUM RATINGS

Rating	Symbol	BC846	BC847	BC848	Unit
Collector–Emitter Voltage	V_{CEO}	65	45	30	V
Collector–Base Voltage	V_{CBO}	80	50	30	V
Emitter–Base Voltage	V_{EBO}	6.0	6.0	5.0	V
Collector Current — Continuous	I_C	100	100	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board, (1) T_A = 25°C	P_D	150	mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	833	°C/W
Total Device Dissipation	P_D	2.4	mW/°C
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BC846AWT1 = 1A; BC846BWT1 = 1B; BC847AWT1 = 1E; BC847BWT1 = 1F;
BC847CWT1 = 1G; BC848AWT1 = 1J; BC848BWT1 = 1K; BC848CWT1 = 1L

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = 10 mA)	BC846 Series BC847 Series BC848 Series	$V_{(BR)CEO}$	65 45 30	— — —	— — —	V
Collector–Emitter Breakdown Voltage (I_C = 10 μA, V_{EB} = 0)	BC846 Series BC847 Series BC848 Series	$V_{(BR)CES}$	80 50 30	— — —	— — —	V
Collector–Base Breakdown Voltage (I_C = 10 μA)	BC846 Series BC847 Series BC848 Series	$V_{(BR)CBO}$	80 50 30	— — —	— — —	V
Emitter–Base Breakdown Voltage (I_E = 1.0 μA)	BC846 Series BC847 Series BC848 Series	$V_{(BR)EBO}$	6.0 6.0 5.0	— — —	— — —	V
Collector Cutoff Current (V_{CB} = 30 V) (V_{CB} = 30 V, T_A = 150°C)		I_{CBO}	— —	— —	15 5.0	nA μA

1. FR–5 = 1.0 x 0.75 x 0.062 in

September, 2001 – Rev. 2

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain (I_C = 10 μA, V_{CE} = 5.0 V)	BC846A, BC847A, BC848A	h_{FE}	—	90	—	—
	BC846B, BC847B, BC848B		—	150	—	
	BC847C, BC848C		—	270	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC846A, BC847A, BC848A		110	180	220	
	BC846B, BC847B, BC848B		200	290	450	
	BC847C, BC848C		420	520	800	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{CE(sat)}$	—	—	0.25	V
(I_C = 100 mA, I_B = 5.0 mA)			—	—	0.6	
Base–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{BE(sat)}$	—	0.7	—	V
(I_C = 100 mA, I_B = 5.0 mA)			—	0.9	—	
Base–Emitter Voltage (I_C = 2.0 mA, V_{CE} = 5.0 V)		$V_{BE(on)}$	580	660	700	mV
(I_C = 10 mA, V_{CE} = 5.0 V)			—	—	770	
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	—	—	4.5	pF
Noise Figure (I_C = 0.2 mA, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		NF	—	—	10	dB

BC847 SERIES & BC848 SERIES

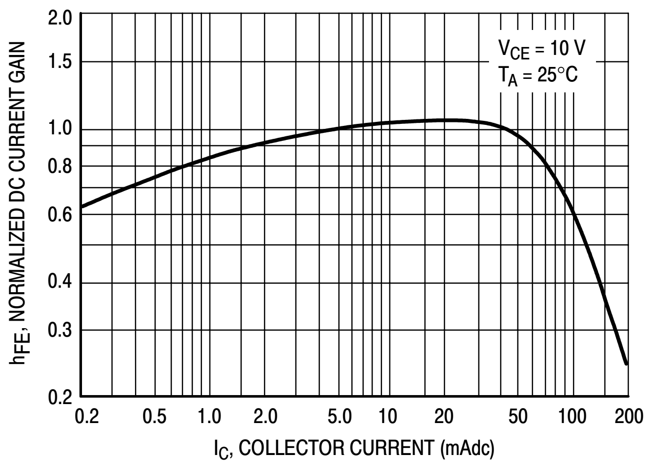


Figure 1. Normalized DC Current Gain

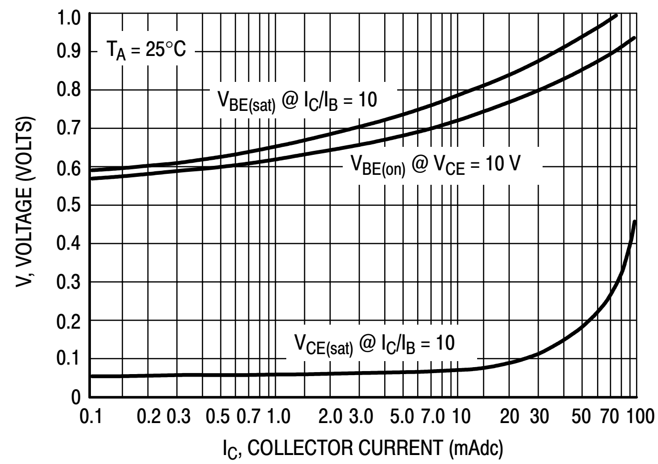


Figure 2. “Saturation” and “On” Voltages

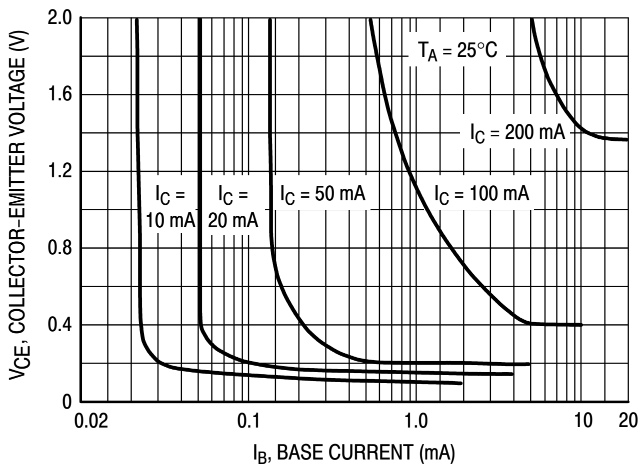


Figure 3. Collector Saturation Region

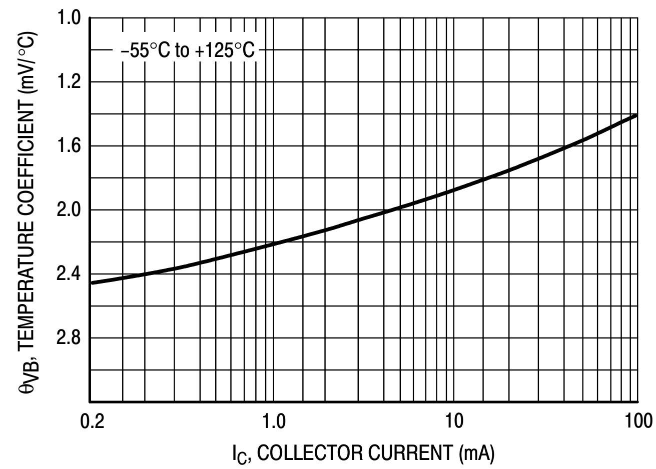


Figure 4. Base–Emitter Temperature Coefficient

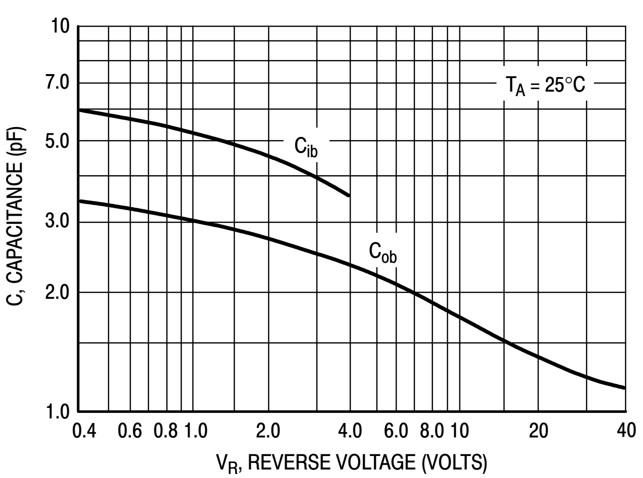


Figure 5. Capacitances

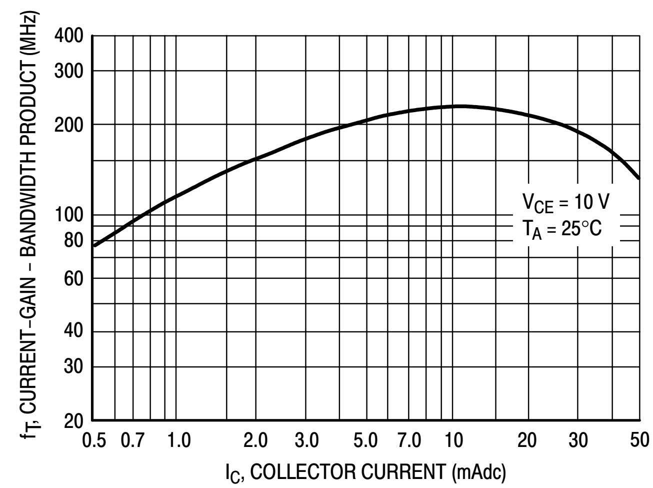


Figure 6. Current–Gain – Bandwidth Product

BC846 SERIES

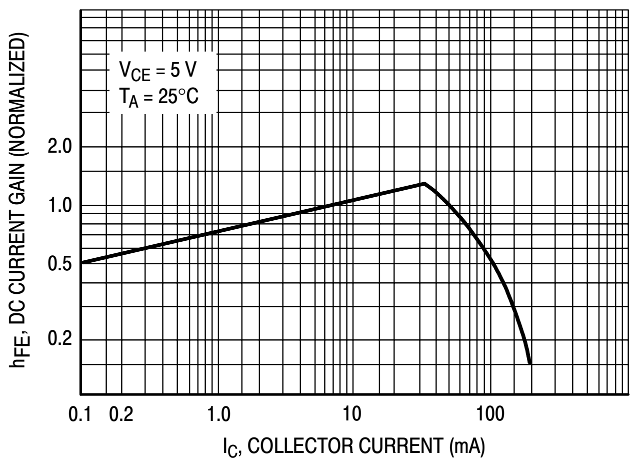


Figure 7. DC Current Gain

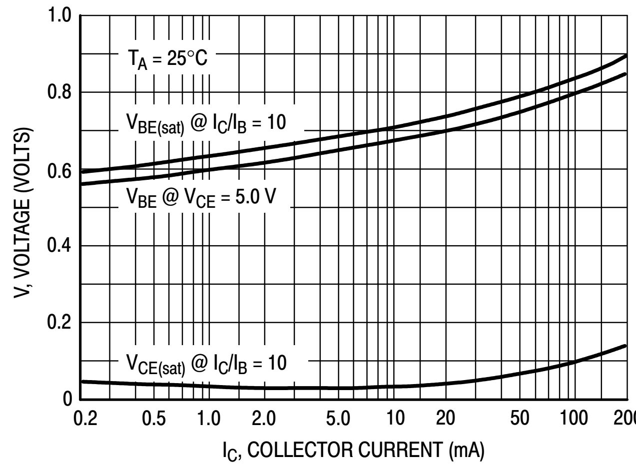


Figure 8. "On" Voltage

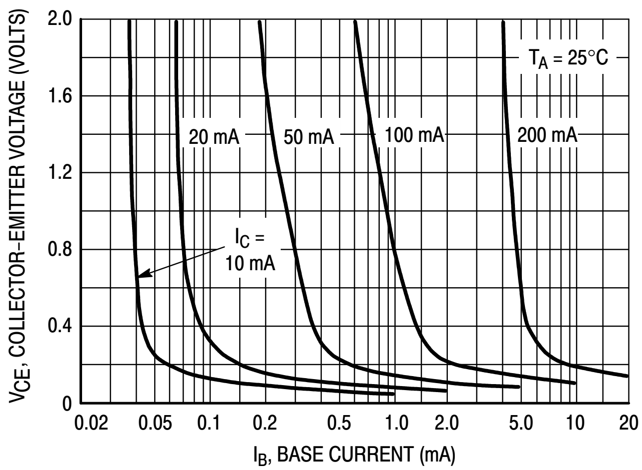


Figure 9. Collector Saturation Region

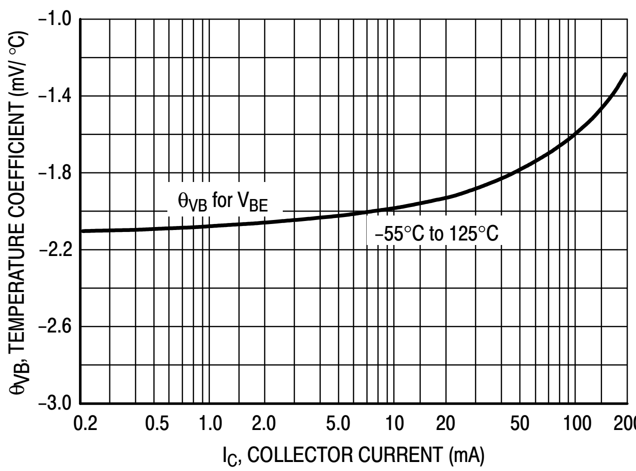


Figure 10. Base–Emitter Temperature Coefficient

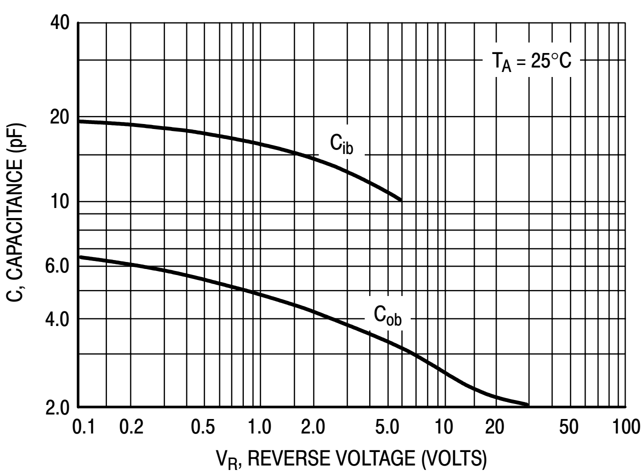


Figure 11. Capacitance

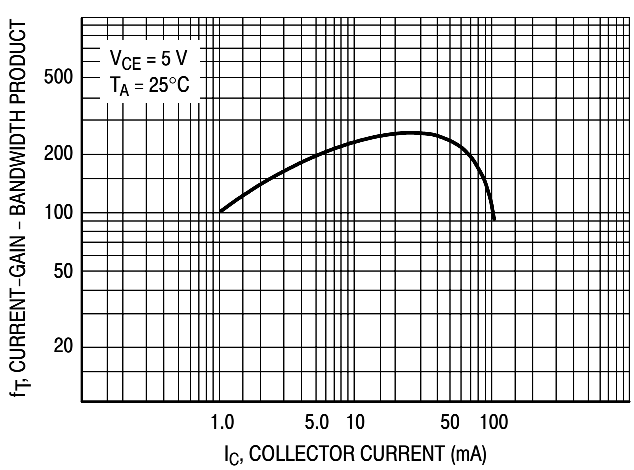


Figure 12. Current–Gain – Bandwidth Product

BC846BDW1T1, BC847BDW1T1 Series, BC848BDW1T1 Series

Dual General Purpose Transistors

NPN Duals

These transistors are designed for general purpose amplifier applications. They are housed in the SOT–363/SC–88 which is designed for low power surface mount applications.

- Device Marking:
  BC846BDW1T1 = 1B
  BC847BDW1T1 = 1F
  BC847CDW1T1 = 1G
  BC848BDW1T1 = 1K
  BC848CDW1T1 = 1L

MAXIMUM RATINGS

Rating	Symbol	BC846	BC847	BC848	Unit
Collector–Emitter Voltage	V_{CEO}	65	45	30	V
Collector–Base Voltage	V_{CBO}	80	50	30	V
Emitter–Base Voltage	V_{EBO}	6.0	6.0	5.0	V
Collector Current – Continuous	I_C	100	100	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation Per Device FR–5 Board (Note 1.) T_A = 25°C Derate Above 25°C	P_D	380 250 3.0	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	328	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–5 = 1.0 x 0.75 x 0.062 in

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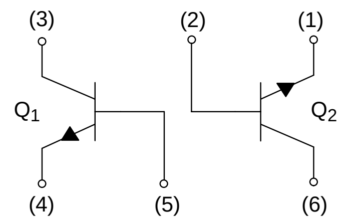
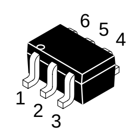
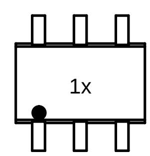




SOT–363
CASE 419B
STYLE 1

DEVICE MARKING



1x = Specific Device Code
x = B, F, G, K, L

ORDERING INFORMATION

Device	Package	Shipping
BC846BDW1T1	SOT–363	3000 Units/Reel
BC847BDW1T1	SOT–363	3000 Units/Reel
BC847CDW1T1	SOT–363	3000 Units/Reel
BC848BDW1T1	SOT–363	3000 Units/Reel
BC848CDW1T1	SOT–363	3000 Units/Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = 10 mA)	BC846 Series BC847 Series BC848 Series	$V_{(BR)CEO}$	65 45 30	– – –	– – –	V
Collector–Emitter Breakdown Voltage (I_C = 10 μA, V_{EB} = 0)	BC846 Series BC847 Series BC848 Series	$V_{(BR)CES}$	80 50 30	– – –	– – –	V
Collector–Base Breakdown Voltage (I_C = 10 μA)	BC846 Series BC847 Series BC848 Series	$V_{(BR)CBO}$	80 50 30	– – –	– – –	V
Emitter–Base Breakdown Voltage (I_E = 1.0 μA)	BC846 Series BC847 Series BC848 Series	$V_{(BR)EBO}$	6.0 6.0 5.0	– – –	– – –	V
Collector Cutoff Current (V_{CB} = 30 V) (V_{CB} = 30 V, T_A = 150°C)		I_{CBO}	– –	– –	15 5.0	nA μA
ON CHARACTERISTICS						
DC Current Gain (I_C = 10 μA, V_{CE} = 5.0 V)	BC846B, BC847B, BC848B BC847C, BC848C	h_{FE}	– –	150 270	– –	–
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC846B, BC847B, BC848B BC847C, BC848C		200 420	290 520	450 800	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA) (I_C = 100 mA, I_B = 5.0 mA)		$V_{CE(sat)}$	– –	– –	0.25 0.6	V
Base–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA) (I_C = 100 mA, I_B = 5.0 mA)		$V_{BE(sat)}$	– –	0.7 0.9	– –	V
Base–Emitter Voltage (I_C = 2.0 mA, V_{CE} = 5.0 V) (I_C = 10 mA, V_{CE} = 5.0 V)		$V_{BE(on)}$	580 –	660 –	700 770	mV
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain – Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	–	–	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	–	–	4.5	pF
Noise Figure (I_C = 0.2 mA, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ,f = 1.0 kHz, BW = 200 Hz)		NF	–	–	10	dB

TYPICAL CHARACTERISTICS – BC847 SERIES & BC848 SERIES

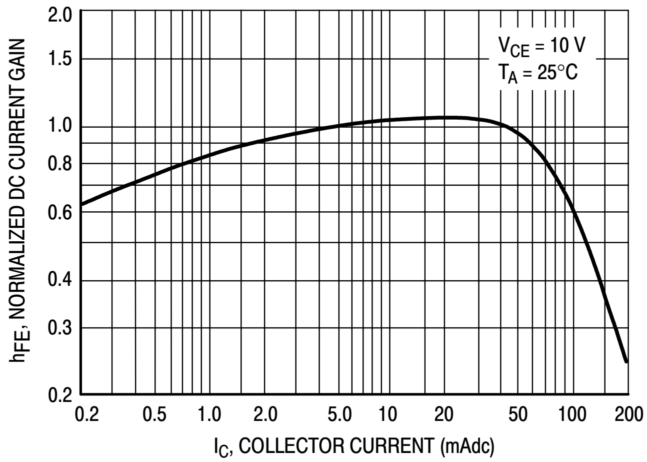


Figure 1. Normalized DC Current Gain

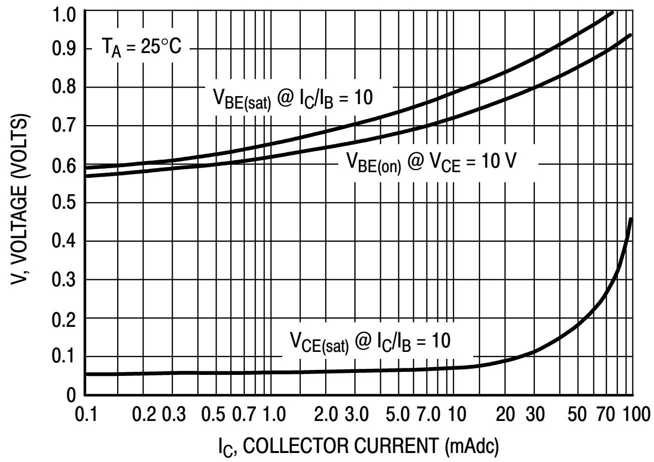


Figure 2. “Saturation” and “On” Voltages

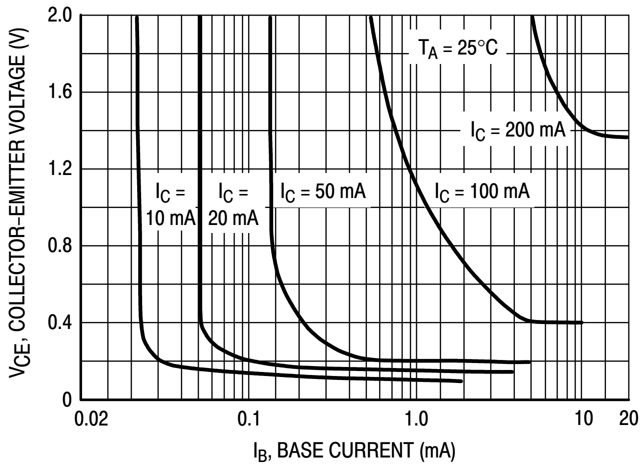


Figure 3. Collector Saturation Region

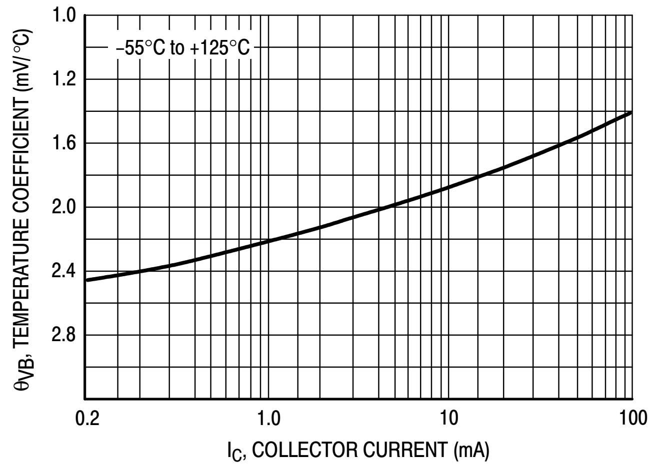


Figure 4. Base–Emitter Temperature Coefficient

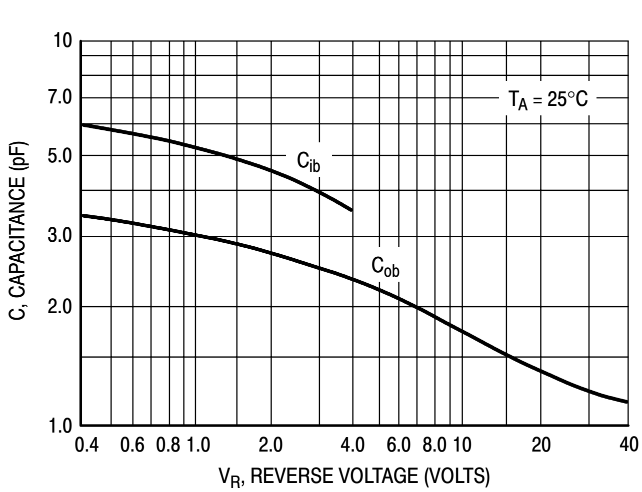


Figure 5. Capacitances

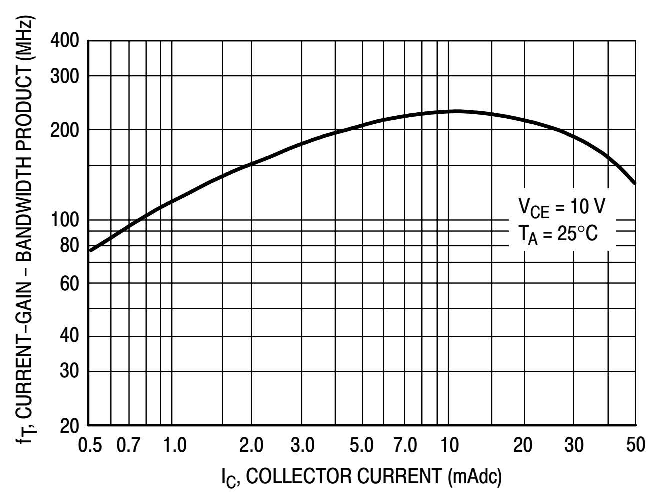


Figure 6. Current–Gain – Bandwidth Product

TYPICAL CHARACTERISTICS – BC846 SERIES

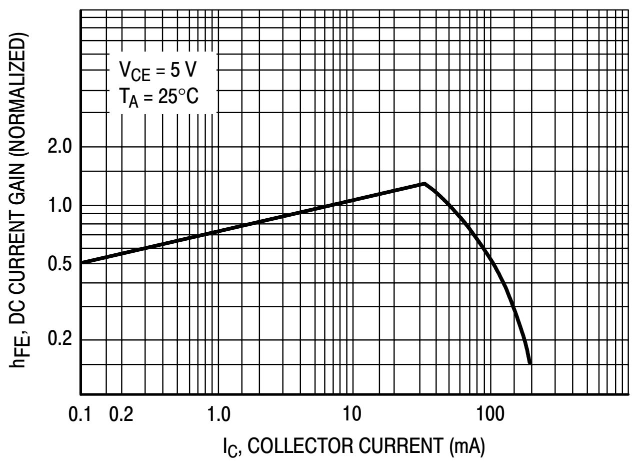


Figure 7. Normalized DC Current Gain

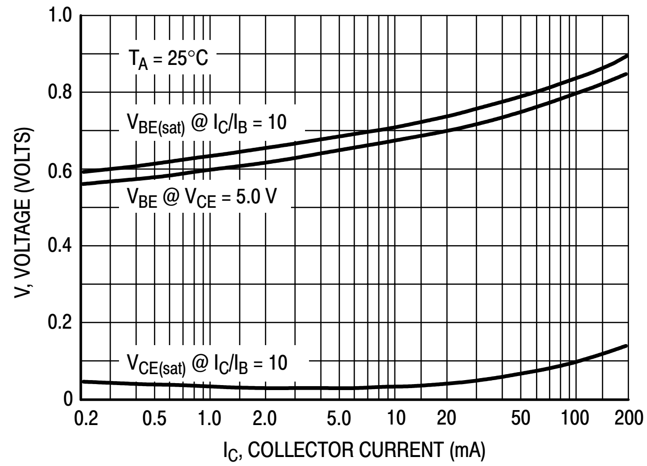


Figure 8. "On" Voltage

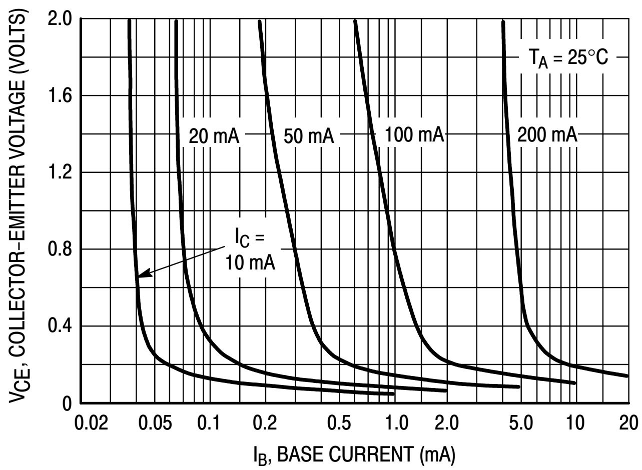


Figure 9. Collector Saturation Region

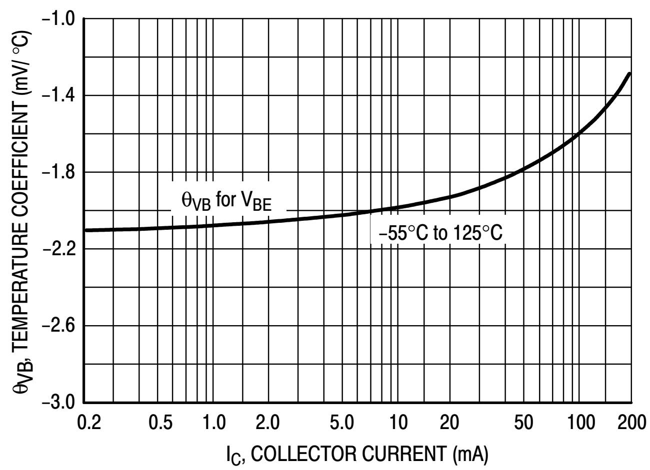


Figure 10. Base–Emitter Temperature Coefficient

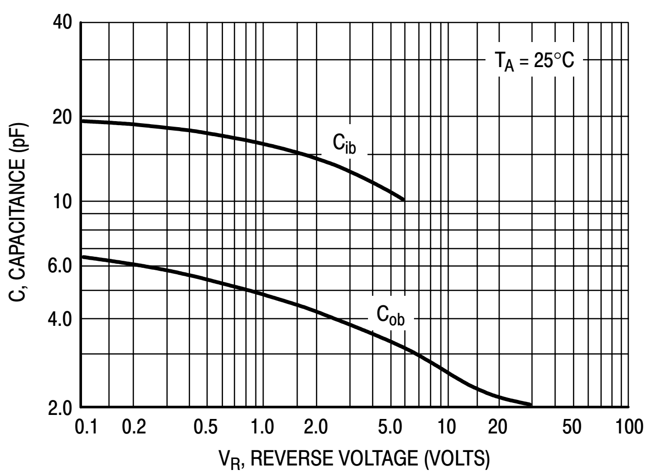


Figure 11. Capacitance

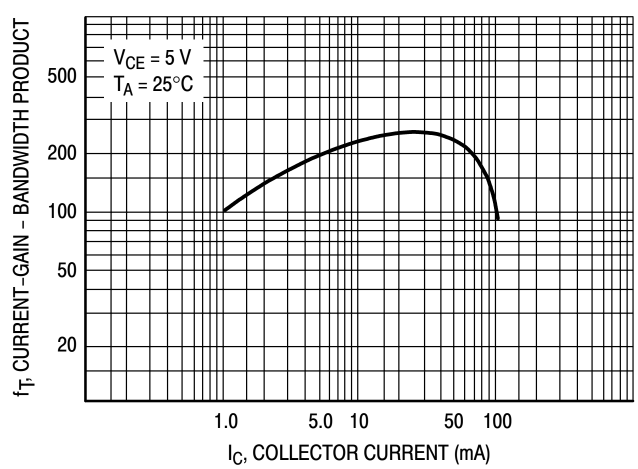


Figure 12. Current–Gain – Bandwidth Product

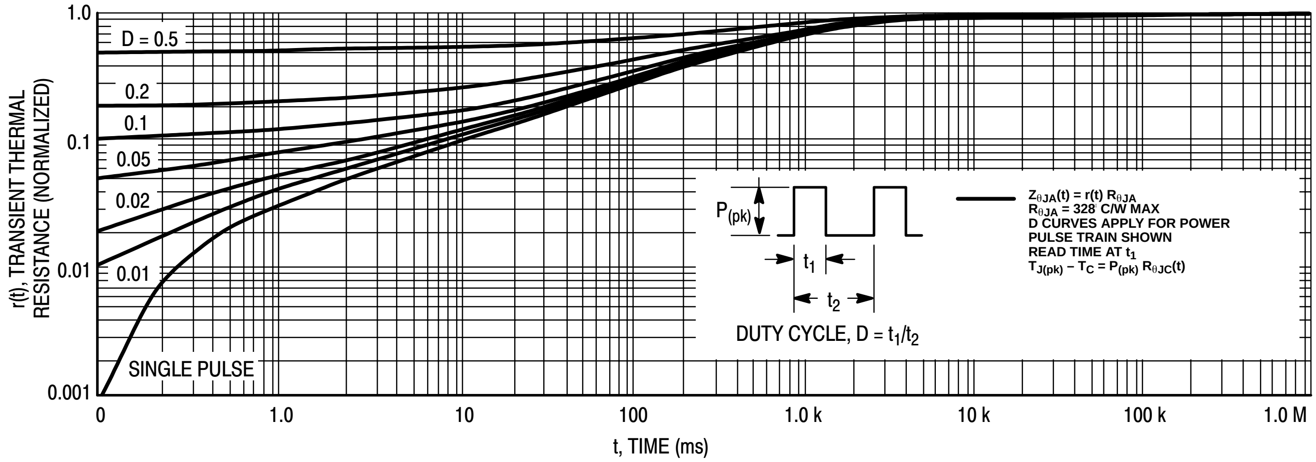


Figure 13. Thermal Response

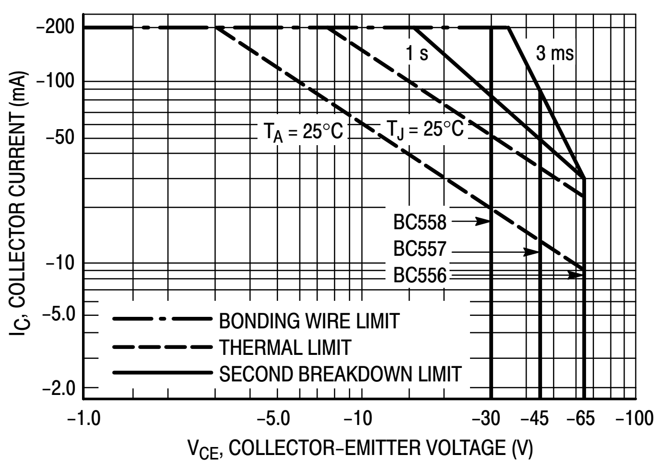


Figure 14. Active Region Safe Operating Area

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 14 is based upon $T_{J(pk)} = 150°C$; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 13. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by the secondary breakdown.

BC846BPDW1T1, BC847BPDW1T1 Series, BC848BPDW1T1 Series

Dual General Purpose Transistors

NPN/PNP Duals (Complimentary)

These transistors are designed for general purpose amplifier applications. They are housed in the SOT–363/SC–88 which is designed for low power surface mount applications.

- Device Marking:
  BC846BPDW1T1 = BB
  BC847BPDW1T1 = 13F
  BC847CPDW1T1 = 13G
  BC848BPDW1T1 = 13K
  BC848CPDW1T1 = 13L

MAXIMUM RATINGS – NPN

Rating	Symbol	BC846	BC847	BC848	Unit
Collector–Emitter Voltage	V_{CEO}	65	45	30	V
Collector–Base Voltage	V_{CBO}	80	50	30	V
Emitter–Base Voltage	V_{EBO}	6.0	6.0	5.0	V
Collector Current — Continuous	I_C	100	100	100	mAdc

MAXIMUM RATINGS – PNP

Rating	Symbol	BC846	BC847	BC848	Unit
Collector–Emitter Voltage	V_{CEO}	–65	–45	–30	V
Collector–Base Voltage	V_{CBO}	–80	–50	–30	V
Emitter–Base Voltage	V_{EBO}	–5.0	–5.0	–5.0	V
Collector Current — Continuous	I_C	–100	–100	–100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation Per Device FR–5 Board (1) $T_A = 25°C$ Derate Above 25°C	P_D	380 250 3.0	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	328	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–5 = 1.0 x 0.75 x 0.062 in

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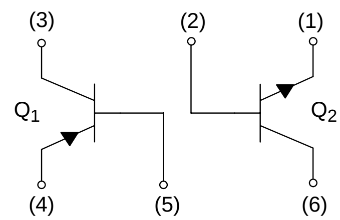
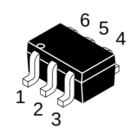
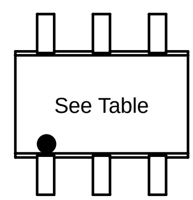




SOT–363/SC–88
CASE 419B
STYLE 1

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
BC846BPDW1T1	SOT–363	3000 Units/Reel
BC847BPDW1T1	SOT–363	3000 Units/Reel
BC847CPDW1T1	SOT–363	3000 Units/Reel
BC848BPDW1T1	SOT–363	3000 Units/Reel
BC848CPDW1T1	SOT–363	3000 Units/Reel

ELECTRICAL CHARACTERISTICS (NPN) (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = 10 mA)	BC846 Series BC847 Series BC848 Series	$V_{(BR)CEO}$	65 45 30	— — —	— — —	V
Collector–Emitter Breakdown Voltage (I_C = 10 μA, V_{EB} = 0)	BC846 Series BC847B Only BC848 Series	$V_{(BR)CES}$	80 50 30	— — —	— — —	V
Collector–Base Breakdown Voltage (I_C = 10 μA)	BC846 Series BC847 Series BC848 Series	$V_{(BR)CBO}$	80 50 30	— — —	— — —	V
Emitter–Base Breakdown Voltage (I_E = 1.0 μA)	BC846 Series BC847 Series BC848 Series	$V_{(BR)EBO}$	6.0 6.0 5.0	— — —	— — —	V
Collector Cutoff Current (V_{CB} = 30 V) (V_{CB} = 30 V, T_A = 150°C)		I_{CBO}	— —	— —	15 5.0	nA μA
ON CHARACTERISTICS						
DC Current Gain (I_C = 10 μA, V_{CE} = 5.0 V)	BC846B, BC847B, BC848B BC847C, BC848C	h_{FE}	— —	150 270	— —	—
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC846B, BC847B, BC848B BC847C, BC848C		200 420	290 520	475 800	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA) (I_C = 100 mA, I_B = 5.0 mA)		$V_{CE(sat)}$	— —	— —	0.25 0.6	V
Base–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA) (I_C = 100 mA, I_B = 5.0 mA)		$V_{BE(sat)}$	— —	0.7 0.9	— —	V
Base–Emitter Voltage (I_C = 2.0 mA, V_{CE} = 5.0 V) (I_C = 10 mA, V_{CE} = 5.0 V)		$V_{BE(on)}$	580 —	660 —	700 770	mV
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	—	—	4.5	pF
Noise Figure (I_C = 0.2 mA, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		NF	—	—	10	dB

ELECTRICAL CHARACTERISTICS (PNP) (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = –10 mA)	BC846 Series	$V_{(BR)CEO}$	–65	—	—	V
	BC847 Series		–45	—	—	
	BC848 Series		–30	—	—	
Collector–Emitter Breakdown Voltage (I_C = –10 μA, V_{EB} = 0)	BC846 Series	$V_{(BR)CES}$	–80	—	—	V
	BC847 Series		–50	—	—	
	BC848 Series		–30	—	—	
Collector–Base Breakdown Voltage (I_C = –10 μA)	BC846 Series	$V_{(BR)CBO}$	–80	—	—	V
	BC847 Series		–50	—	—	
	BC848 Series		–30	—	—	
Emitter–Base Breakdown Voltage (I_E = –1.0 μA)	BC846 Series	$V_{(BR)EBO}$	–5.0	—	—	V
	BC847 Series		–5.0	—	—	
	BC848 Series		–5.0	—	—	
Collector Cutoff Current (V_{CB} = –30 V)		I_{CBO}	—	—	–15	nA
(V_{CB} = –30 V, T_A = 150°C)			—	—	–4.0	μA
ON CHARACTERISTICS						
DC Current Gain (I_C = –10 μA, V_{CE} = –5.0 V)	BC846B, BC847B, BC848B	h_{FE}	—	150	—	—
	BC847C, BC848C		—	270	—	
(I_C = –2.0 mA, V_{CE} = –5.0 V)	BC846B, BC847B, BC848B		200	290	475	
	BC847C, BC848C		420	520	800	
Collector–Emitter Saturation Voltage (I_C = –10 mA, I_B = –0.5 mA)		$V_{CE(sat)}$	—	—	–0.3	V
(I_C = –100 mA, I_B = –5.0 mA)			—	—	–0.65	
Base–Emitter Saturation Voltage (I_C = –10 mA, I_B = –0.5 mA)		$V_{BE(sat)}$	—	–0.7	—	V
(I_C = –100 mA, I_B = –5.0 mA)			—	–0.9	—	
Base–Emitter On Voltage (I_C = –2.0 mA, V_{CE} = –5.0 V)		$V_{BE(on)}$	–0.6	—	–0.75	V
(I_C = –10 mA, V_{CE} = –5.0 V)			—	—	–0.82	
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = –10 mA, V_{CE} = –5.0 Vdc, f = 100 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = –10 V, f = 1.0 MHz)		C_{ob}	—	—	4.5	pF
Noise Figure (I_C = –0.2 mA, V_{CE} = –5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		NF	—	—	10	dB

TYPICAL NPN CHARACTERISTICS – BC846

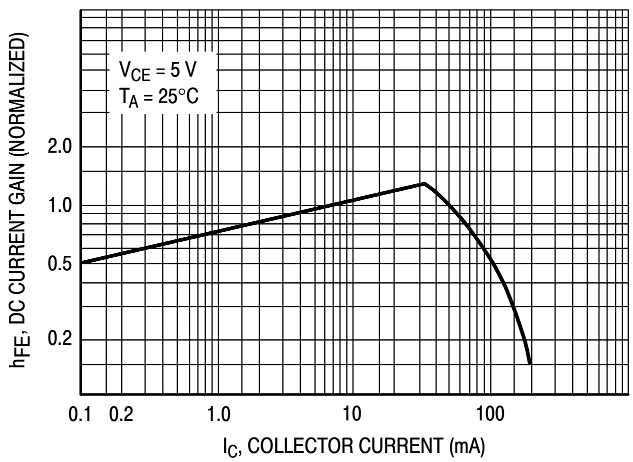


Figure 1. DC Current Gain

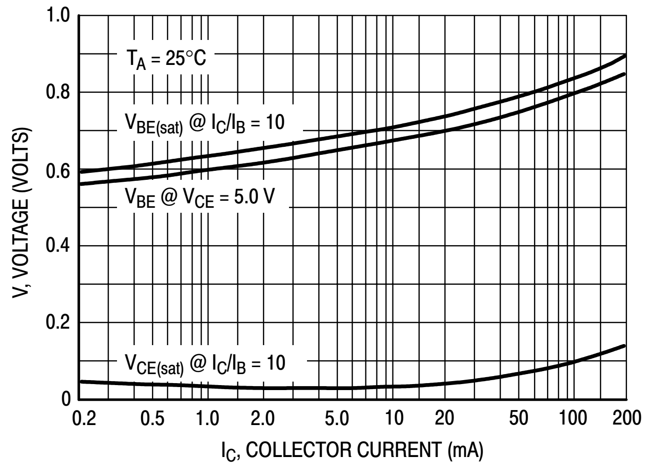


Figure 2. "On" Voltage

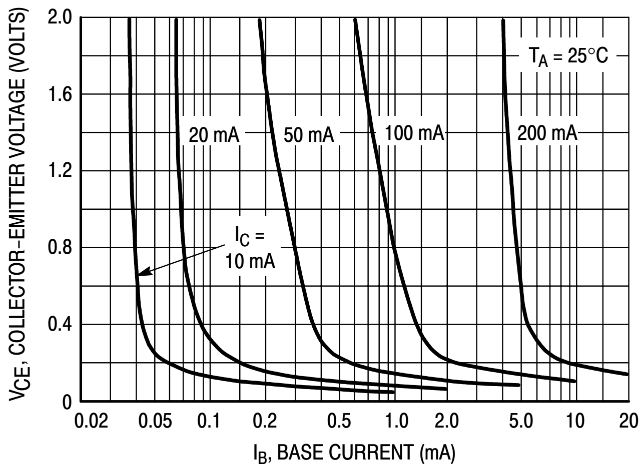


Figure 3. Collector Saturation Region

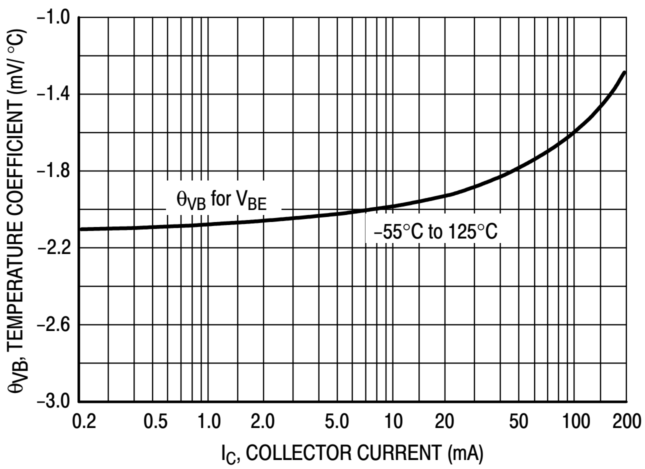


Figure 4. Base–Emitter Temperature Coefficient

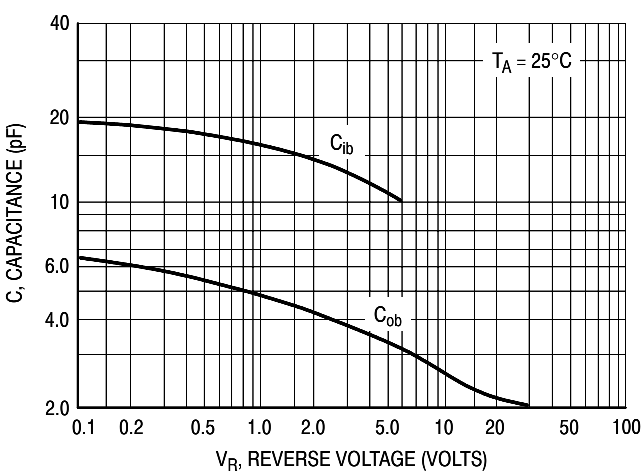


Figure 5. Capacitance

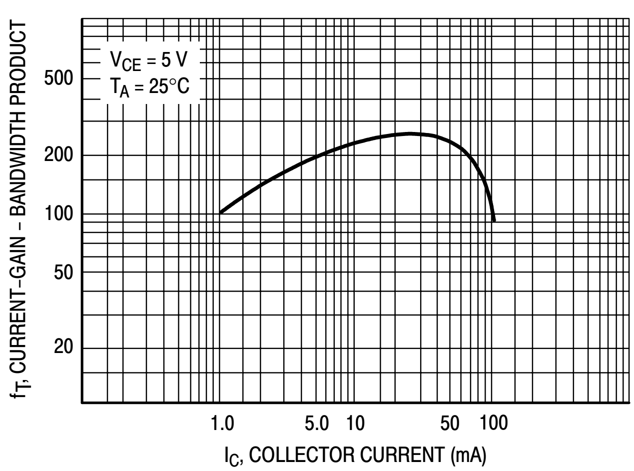


Figure 6. Current–Gain – Bandwidth Product

TYPICAL PNP CHARACTERISTICS — BC846

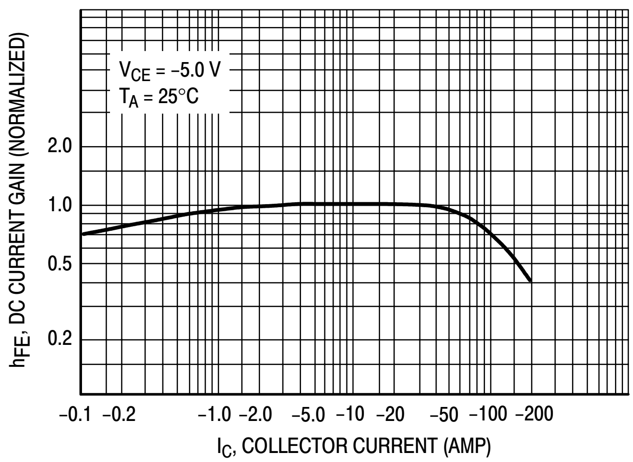


Figure 7. DC Current Gain

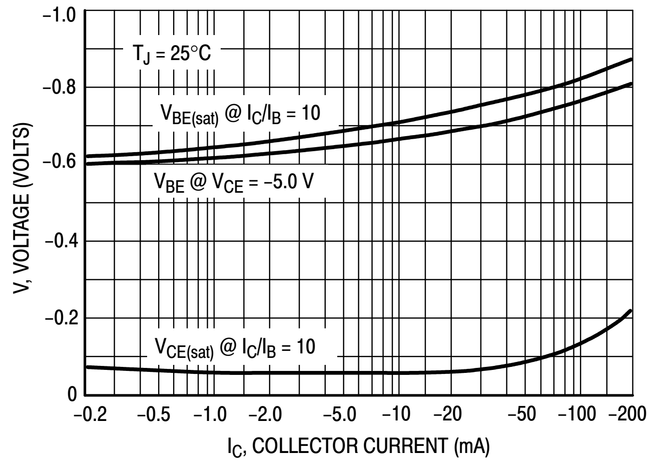


Figure 8. "On" Voltage

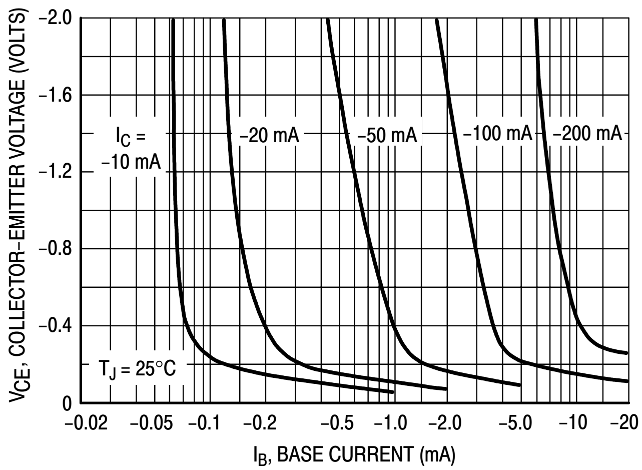


Figure 9. Collector Saturation Region

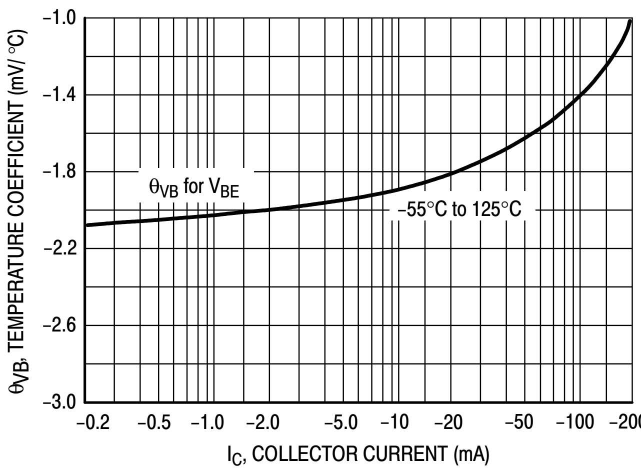


Figure 10. Base–Emitter Temperature Coefficient

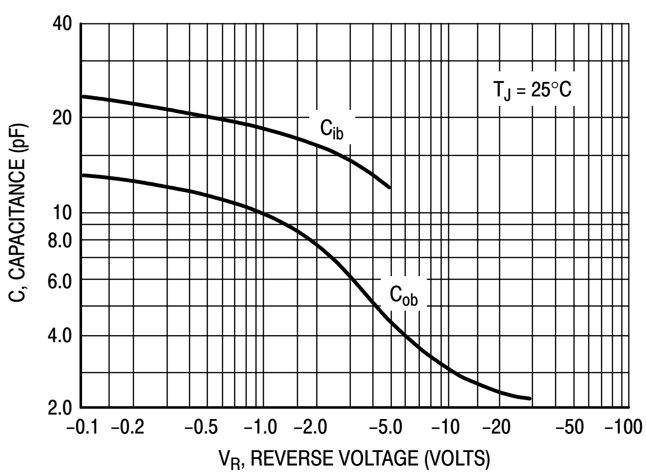


Figure 11. Capacitance

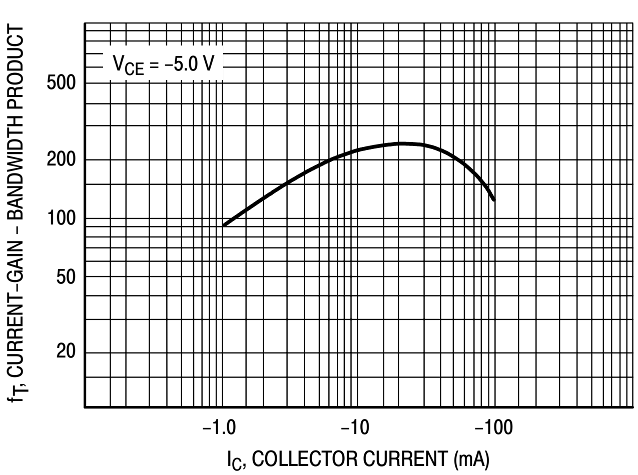


Figure 12. Current–Gain – Bandwidth Product

TYPICAL NPN CHARACTERISTICS – BC847 SERIES & BC848 SERIES

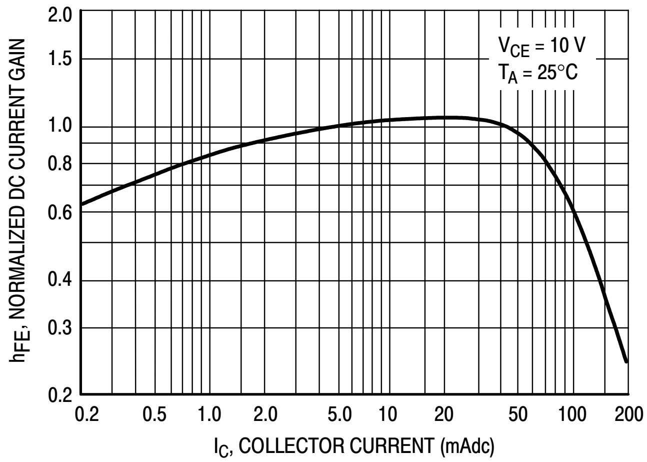


Figure 13. Normalized DC Current Gain

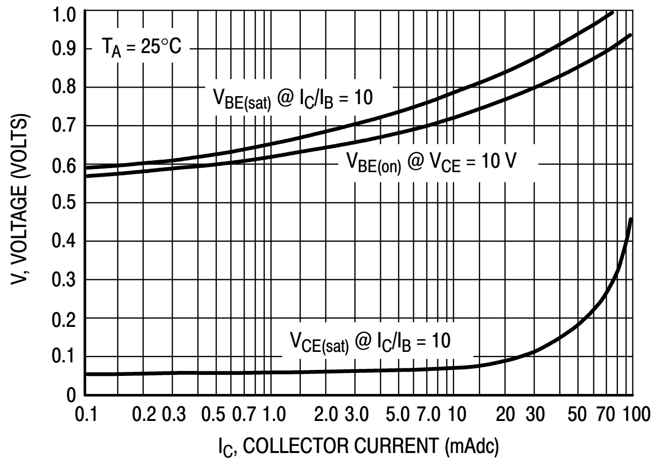


Figure 14. "Saturation" and "On" Voltages

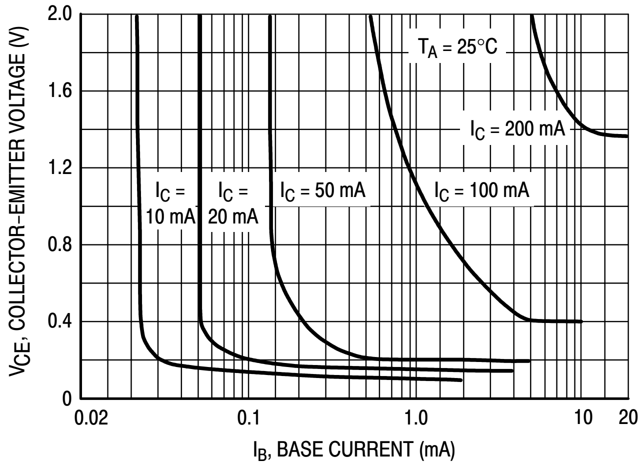


Figure 15. Collector Saturation Region

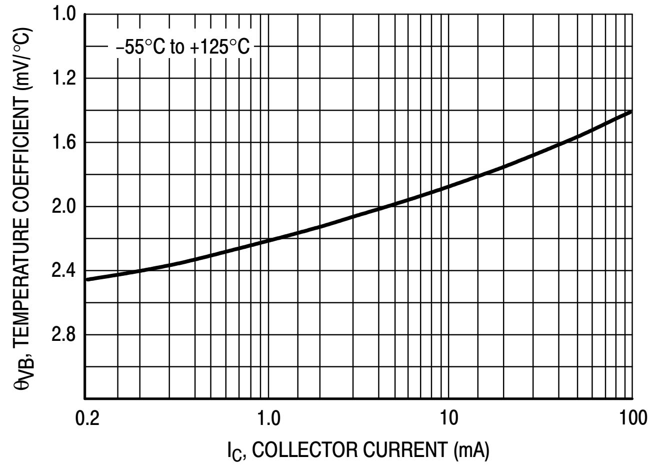


Figure 16. Base–Emitter Temperature Coefficient

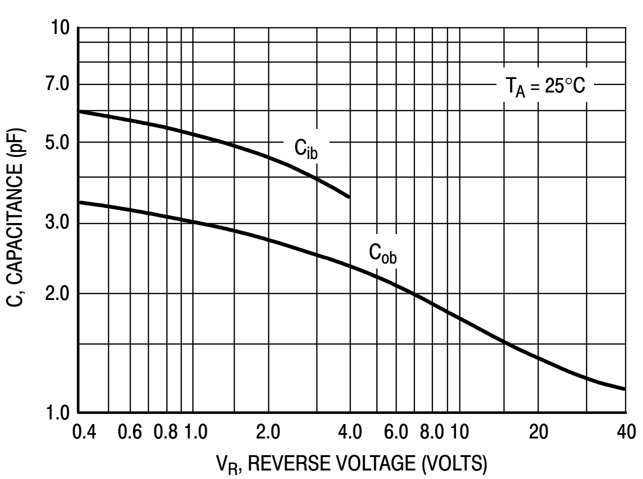


Figure 17. Capacitances

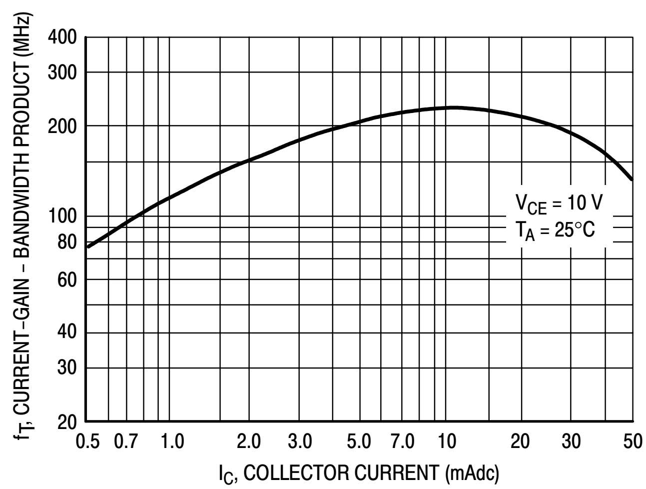


Figure 18. Current–Gain – Bandwidth Product

TYPICAL PNP CHARACTERISTICS — BC847 SERIES & BC848 SERIES

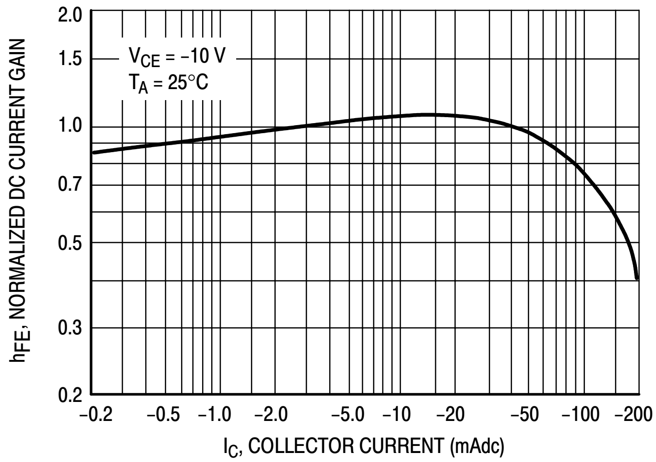


Figure 19. Normalized DC Current Gain

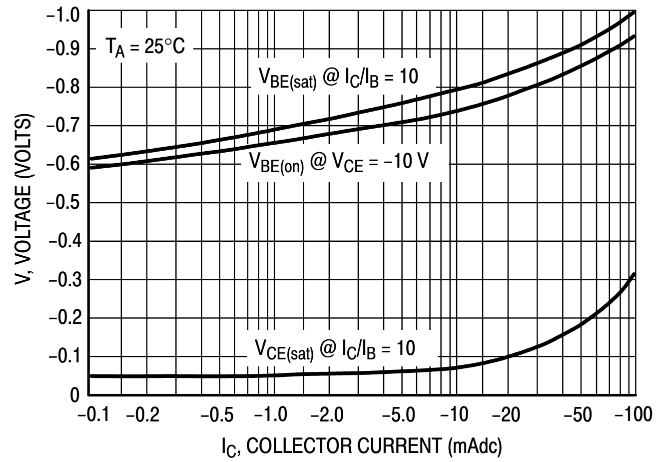


Figure 20. "Saturation" and "On" Voltages

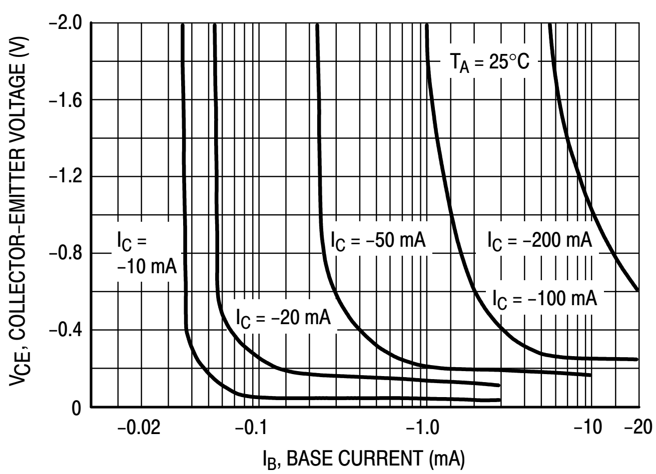


Figure 21. Collector Saturation Region

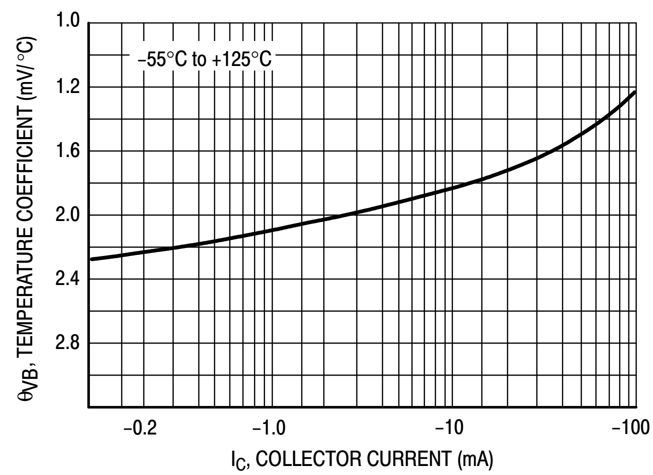


Figure 22. Base−Emitter Temperature Coefficient

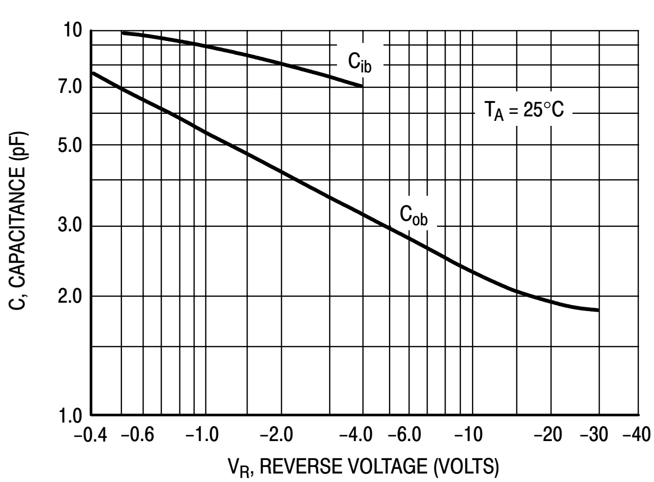


Figure 23. Capacitances

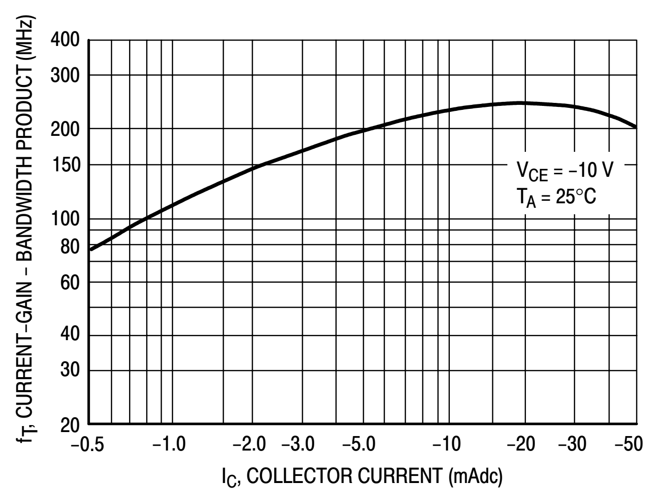


Figure 24. Current−Gain − Bandwidth Product

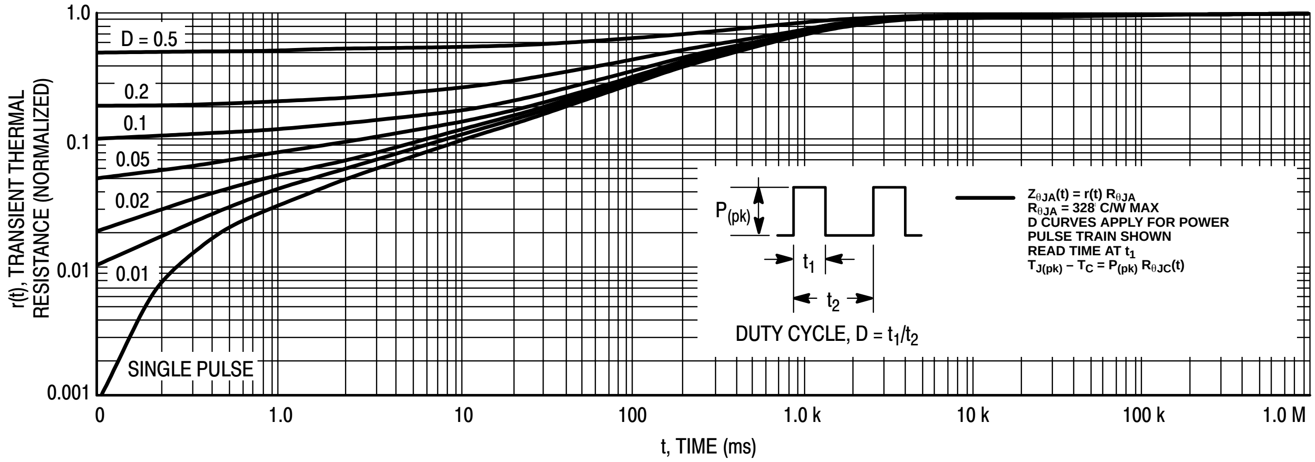


Figure 25. Thermal Response

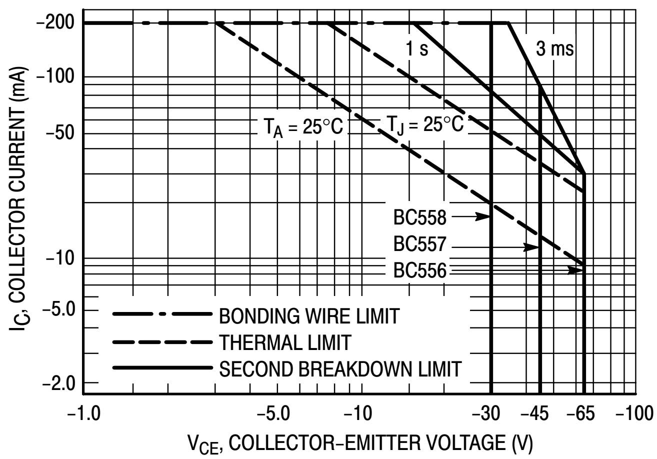


Figure 26. Active Region Safe Operating Area

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 26 is based upon $T_{J(pk)} = 150°C$; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 25. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by the secondary breakdown.

BC847BTT1, BC847CTT1

General Purpose Transistors

NPN Silicon

These transistors are designed for general purpose amplifier applications. They are housed in the SOT–416/SC–75 package which is designed for low power surface mount applications.

- Device Marking:
  BC847BTT1 = 1F
  BC847CTT1 = 1G

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Collector–Emitter Voltage	V_{CEO}	45	V
Collector–Base Voltage	V_{CBO}	50	V
Emitter–Base Voltage	V_{EBO}	6.0	V
Collector Current – Continuous	I_C	100	mAdc

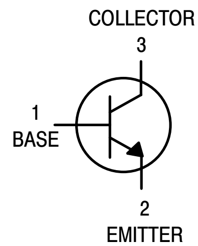
THERMAL CHARACTERISTICS

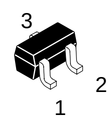
Characteristic	Symbol	Max	Unit
Total Device Dissipation, FR–4 Board (1) T_A = 25°C Derated above 25°C	P_D	200 1.6	mW mW/°C
Thermal Resistance, Junction to Ambient (1)	$R_{\theta JA}$	600	°C/W
Total Device Dissipation, FR–4 Board (2) T_A = 25°C Derated above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient (2)	$R_{\theta JA}$	400	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) FR–4 @ Minimum Pad
(2) FR–4 @ 1.0 × 1.0 Inch Pad

ON Semiconductor

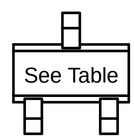
http://onsemi.com





CASE 463
SOT–416/SC–75
STYLE 1

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
BC847BTT1	SOT–416	3000 / Tape & Reel
BC847CTT1	SOT–416	3000 / Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = 10 mA)	BC847 Series	$V_{(BR)CEO}$	45	—	—	V
Collector–Emitter Breakdown Voltage (I_C = 10 μA, V_{EB} = 0)	BC847 Series	$V_{(BR)CES}$	50	—	—	V
Collector–Base Breakdown Voltage (I_C = 10 μA)	BC847 Series	$V_{(BR)CBO}$	50	—	—	V
Emitter–Base Breakdown Voltage (I_E = 1.0 μA)	BC847 Series	$V_{(BR)EBO}$	6.0	—	—	V
Collector Cutoff Current (V_{CB} = 30 V)		I_{CBO}	—	—	15	nA
(V_{CB} = 30 V, T_A = 150°C)			—	—	5.0	μA
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 μA, V_{CE} = 5.0 V)	BC847B		—	150	—	
	BC847C		—	270	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC847B		200	290	450	
	BC847C		420	520	800	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{CE(sat)}$	—	—	0.25	V
(I_C = 100 mA, I_B = 5.0 mA)			—	—	0.6	
Base–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{BE(sat)}$	—	0.7	—	V
(I_C = 100 mA, I_B = 5.0 mA)			—	0.9	—	
Base–Emitter Voltage (I_C = 2.0 mA, V_{CE} = 5.0 V)		$V_{BE(on)}$	580	660	700	mV
(I_C = 10 mA, V_{CE} = 5.0 V)			—	—	770	
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	—	—	4.5	pF
Noise Figure (I_C = 0.2 mA, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		NF	—	—	10	dB

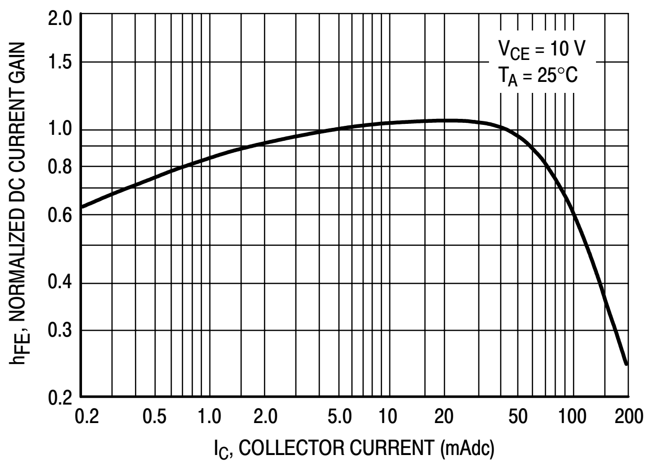


Figure 1. Normalized DC Current Gain

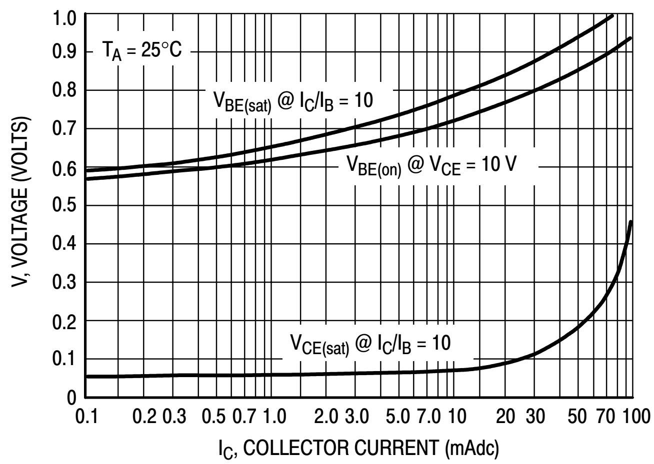


Figure 2. "Saturation" and "On" Voltages

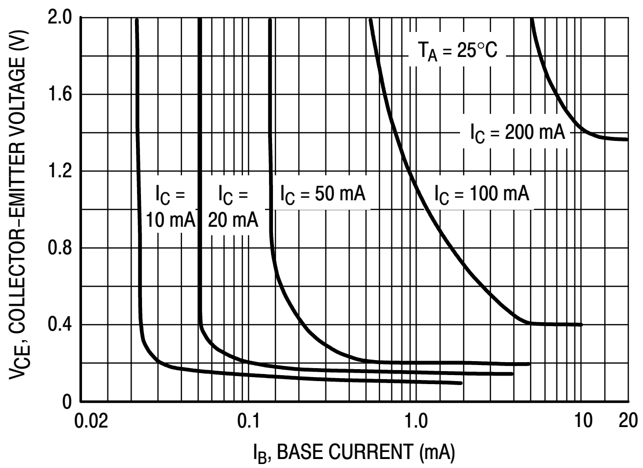


Figure 3. Collector Saturation Region

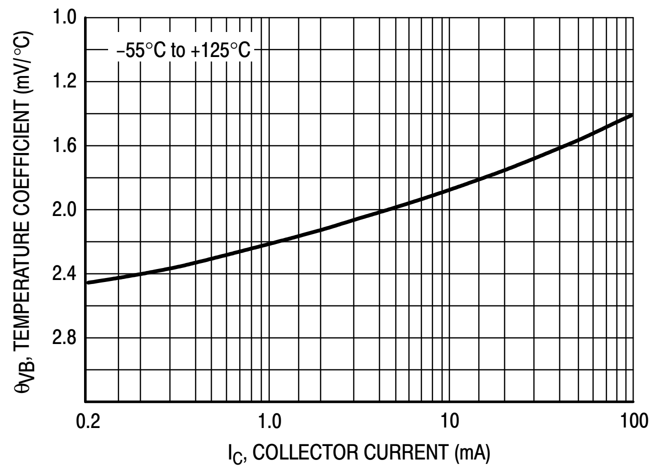


Figure 4. Base–Emitter Temperature Coefficient

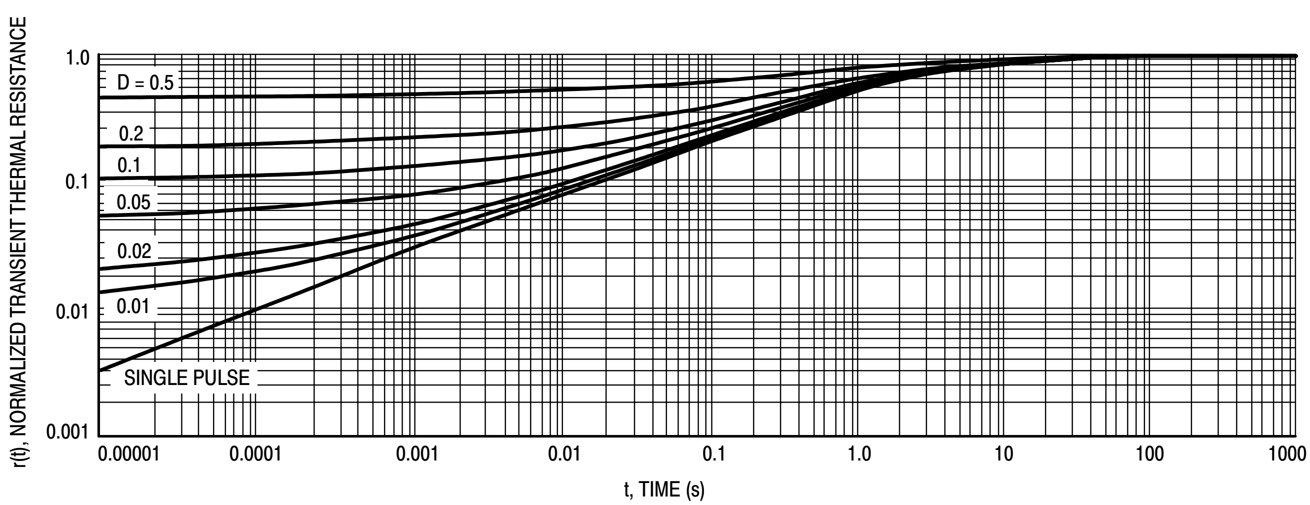


Figure 5. Normalized Thermal Response

BC847

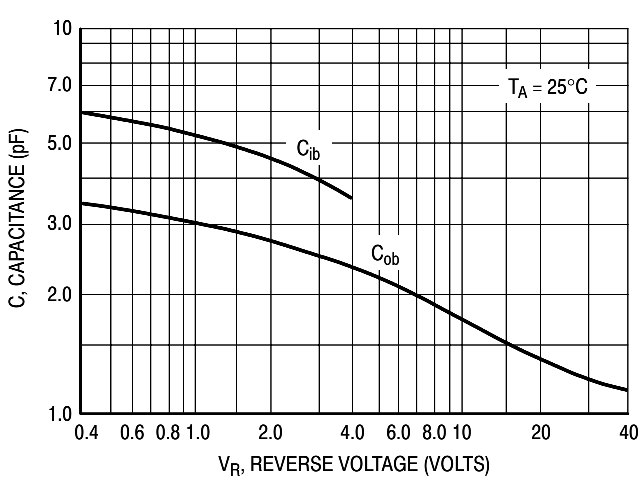


Figure 6. Capacitances

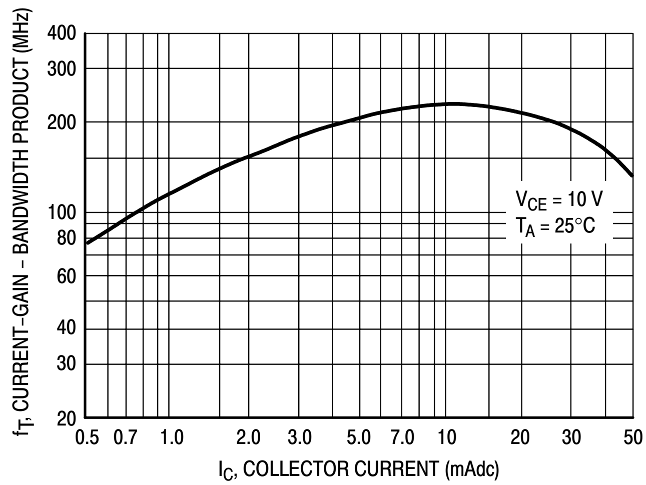


Figure 7. Current−Gain − Bandwidth Product

BC856ALT1 Series

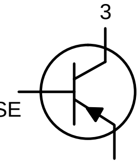
Preferred Devices

General Purpose Transistors

PNP Silicon

ON Semiconductor™

http://onsemi.com



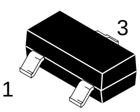
MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage BC856 BC857 BC858, BC859	V_{CEO}	–65 –45 –30	V
Collector-Base Voltage BC856 BC857 BC858, BC859	V_{CBO}	–80 –50 –30	V
Emitter–Base Voltage	V_{EBO}	–5.0	V
Collector Current – Continuous	I_C	–100	mAdc

THERMAL CHARACTERISTICS

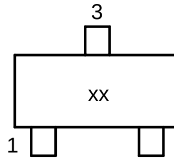
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board, (Note 1.) T_A = 25°C Derate above 25°C	P_D	 225 1.8	 mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate, (Note 2.) T_A = 25°C Derate above 25°C	P_D	 300 2.4	 mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

1. FR–5 = 1.0 x 0.75 x 0.062 in
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.



SOT–23
CASE 318
STYLE 6

MARKING DIAGRAM



xx = Device Code
(See Table Below)

ORDERING INFORMATION

Device	Package	Mark	Shipping
BC856ALT1	SOT–23	3A	3000/Tape & Reel
BC856BLT1	SOT–23	3B	3000/Tape & Reel
BC857ALT1	SOT–23	3E	3000/Tape & Reel
BC857BLT1	SOT–23	3F	3000/Tape & Reel
BC858ALT1	SOT–23	3J	3000/Tape & Reel
BC858BLT1	SOT–23	3K	3000/Tape & Reel
BC858CLT1	SOT–23	3L	3000/Tape & Reel
BC859BLT1	SOT–23	4B	3000/Tape & Reel
BC859CLT1	SOT–23	4C	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = –10 mA)	BC856 Series BC857 Series BC858, BC859 Series	$V_{(BR)CEO}$	–65 –45 –30	– – –	– – –	V
Collector–Emitter Breakdown Voltage (I_C = –10 μA, V_{EB} = 0)	BC856 Series BC857 Series BC858, BC859 Series	$V_{(BR)CES}$	–80 –50 –30	– – –	– – –	V
Collector–Base Breakdown Voltage (I_C = –10 μA)	BC856 Series BC857 Series BC858, BC859 Series	$V_{(BR)CBO}$	–80 –50 –30	– – –	– – –	V
Emitter–Base Breakdown Voltage (I_E = –1.0 μA)	BC856 Series BC857 Series BC858, BC859 Series	$V_{(BR)EBO}$	–5.0 –5.0 –5.0	– – –	– – –	V
Collector Cutoff Current (V_{CB} = –30 V) (V_{CB} = –30 V, T_A = 150°C)		I_{CBO}	– –	– –	–15 –4.0	nA μA
ON CHARACTERISTICS						
DC Current Gain (I_C = –10 μA, V_{CE} = –5.0 V)	BC856A, BC857A, BC858A BC856B, BC857B, BC858B BC858C	h_{FE}	– – –	90 150 270	– – –	–
(I_C = –2.0 mA, V_{CE} = –5.0 V)	BC856A, BC857A, BC858A BC856B, BC857B, BC858B, BC859B BC858C, BC859C		125 220 420	180 290 520	250 475 800	
Collector–Emitter Saturation Voltage (I_C = –10 mA, I_B = –0.5 mA) (I_C = –100 mA, I_B = –5.0 mA)		$V_{CE(sat)}$	 – –	 – –	 –0.3 –0.65	V
Base–Emitter Saturation Voltage (I_C = –10 mA, I_B = –0.5 mA) (I_C = –100 mA, I_B = –5.0 mA)		$V_{BE(sat)}$	 – –	 –0.7 –0.9	 – –	V
Base–Emitter On Voltage (I_C = –2.0 mA, V_{CE} = –5.0 V) (I_C = –10 mA, V_{CE} = –5.0 V)		$V_{BE(on)}$	 –0.6 –	 – –	 –0.75 –0.82	V
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain – Bandwidth Product (I_C = –10 mA, V_{CE} = –5.0 Vdc, f = 100 MHz)		f_T	100	–	–	MHz
Output Capacitance (V_{CB} = –10 V, f = 1.0 MHz)		C_{ob}	–	–	4.5	pF
Noise Figure (I_C = –0.2 mA, V_{CE} = –5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	BC856, BC857, BC858 Series BC859 Series	NF	– –	– –	10 4.0	dB

BC857/BC858/BC859

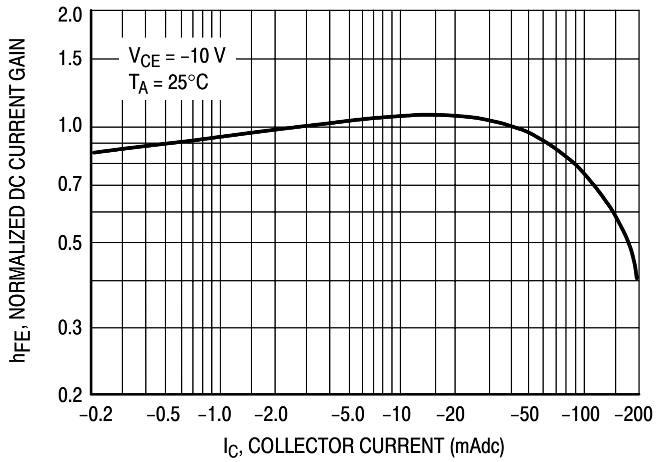


Figure 1. Normalized DC Current Gain

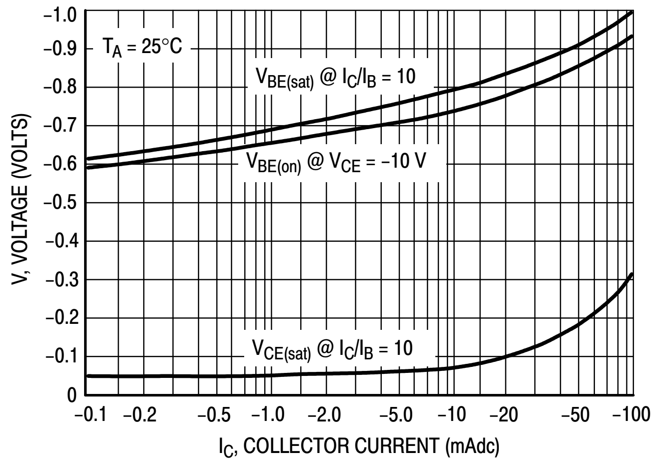


Figure 2. "Saturation" and "On" Voltages

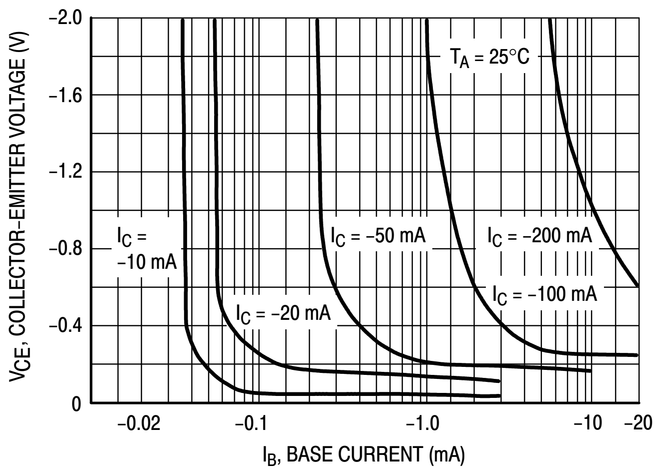


Figure 3. Collector Saturation Region

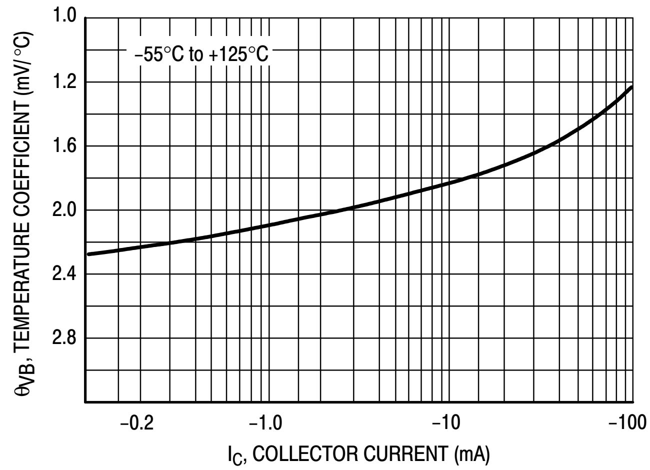


Figure 4. Base–Emitter Temperature Coefficient

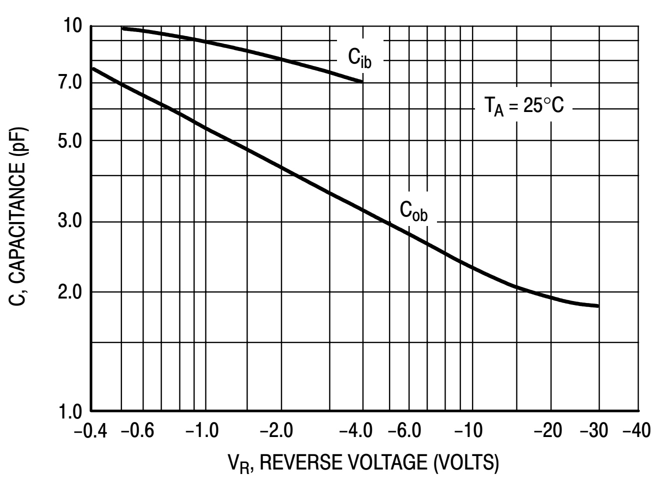


Figure 5. Capacitances

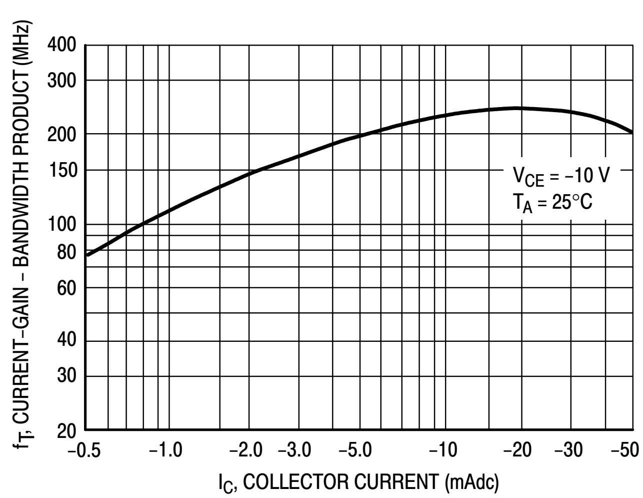


Figure 6. Current–Gain – Bandwidth Product

BC856

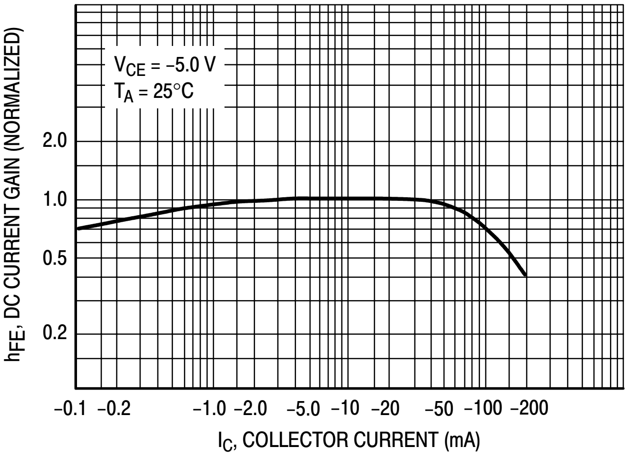


Figure 7. DC Current Gain

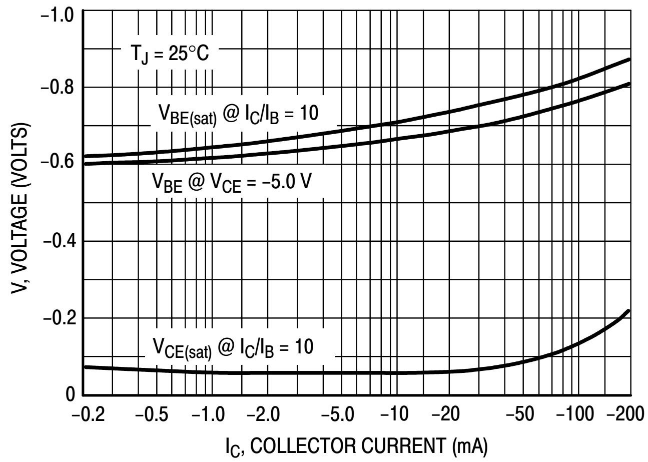


Figure 8. "On" Voltage

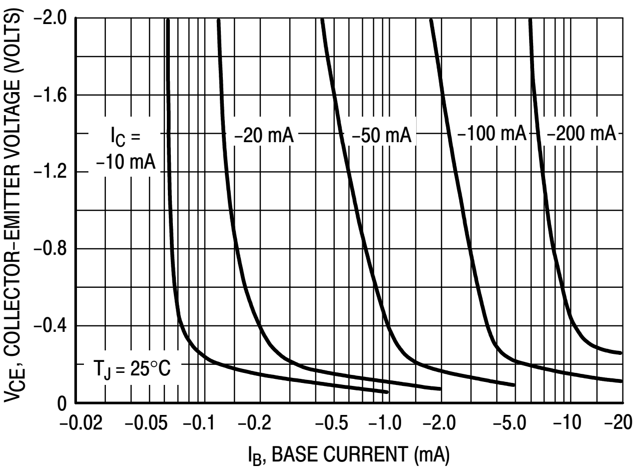


Figure 9. Collector Saturation Region

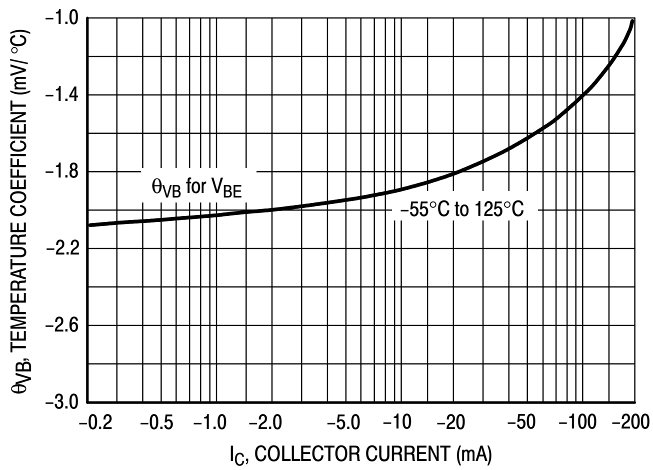


Figure 10. Base–Emitter Temperature Coefficient

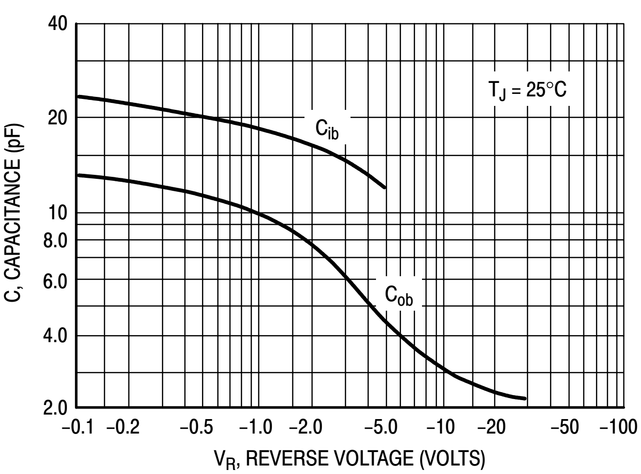


Figure 11. Capacitance

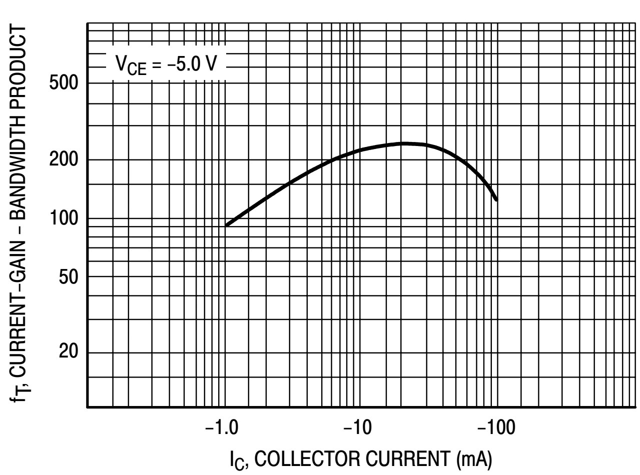


Figure 12. Current–Gain – Bandwidth Product

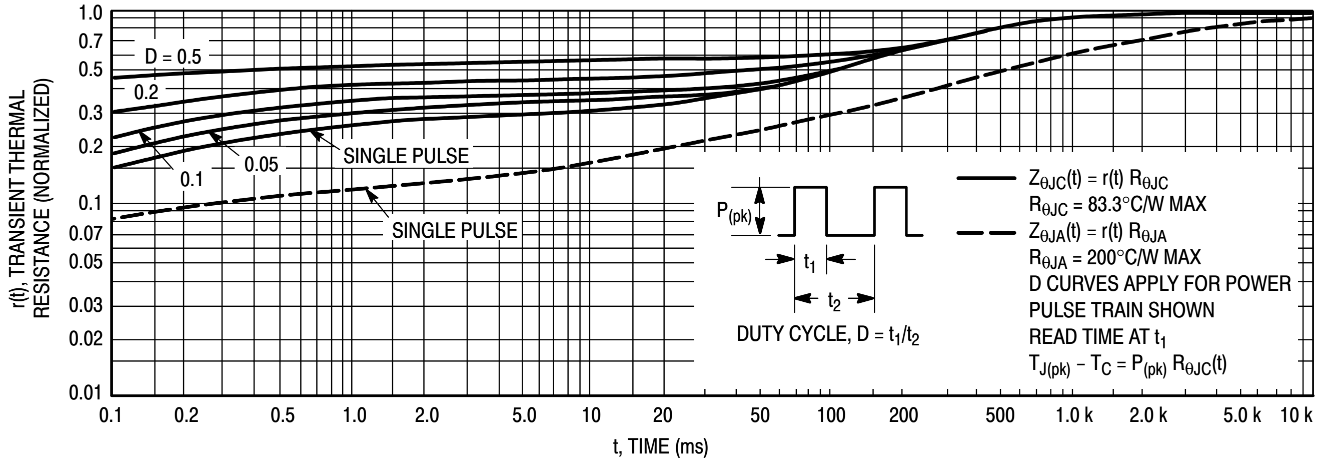


Figure 13. Thermal Response

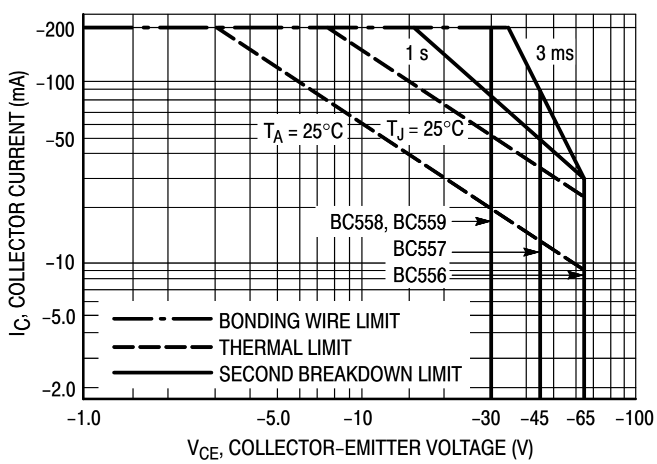


Figure 14. Active Region Safe Operating Area

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 14 is based upon $T_{J(pk)}$ = 150°C; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq$ 150°C. $T_{J(pk)}$ may be calculated from the data in Figure 13. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by the secondary breakdown.

BC856AWT1 Series, BC857BWT1 Series, BC858AWT1 Series

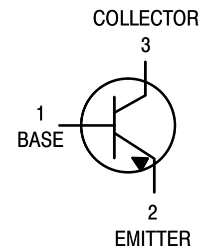
Preferred Devices

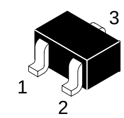
General Purpose Transistors

PNP Silicon

ON Semiconductor™

http://onsemi.com





SOT–323/SC–70
CASE 419
STYLE 3

These transistors are designed for general purpose amplifier applications. They are housed in the SOT–323/SC–70 which is designed for low power surface mount applications.

- Device Marking:
  BC856AWT1 = 3A
  BC856BWT1 = 3B
  BC857BWT1 = 3F
  BC857CWT1 = 3G
  BC858AWT1 = 3J
  BC858BWT1 = 3K

MAXIMUM RATINGS

Rating	Symbol	BC856	BC857	BC858	Unit
Collector–Emitter Voltage	V_{CEO}	–65	–45	–30	V
Collector–Base Voltage	V_{CBO}	–80	–50	–30	V
Emitter–Base Voltage	V_{EBO}	–5.0	–5.0	–5.0	V
Collector Current – Continuous	I_C	–100	–100	–100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board (1) $T_A = 25°C$	P_D	150	mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	833	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–5 = 1.0 x 0.75 x 0.062 in

DEVICE MARKING

ORDERING INFORMATION

Device	Package	Shipping
BC856AWT1	SOT–323	3000 Units/Reel
BC856BWT1	SOT–323	3000 Units/Reel
BC857BWT1	SOT–323	3000 Units/Reel
BC857CWT1	SOT–323	3000 Units/Reel
BC858AWT1	SOT–323	3000 Units/Reel
BC858BWT1	SOT–323	3000 Units/Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = –10 mA)	BC856 Series BC857 Series BC858 Series	$V_{(BR)CEO}$	–65 –45 –30	– – –	– – –	V
Collector–Emitter Breakdown Voltage (I_C = –10 μA, V_{EB} = 0)	BC856 Series BC857B Only BC858 Series	$V_{(BR)CES}$	–80 –50 –30	– – –	– – –	V
Collector–Base Breakdown Voltage (I_C = –10 μA)	BC856 Series BC857 Series BC858 Series	$V_{(BR)CBO}$	–80 –50 –30	– – –	– – –	V
Emitter–Base Breakdown Voltage (I_E = –1.0 μA)	BC856 Series BC857 Series BC858 Series	$V_{(BR)EBO}$	–5.0 –5.0 –5.0	– – –	– – –	V
Collector Cutoff Current (V_{CB} = –30 V) (V_{CB} = –30 V, T_A = 150°C)		I_{CBO}	– –	– –	–15 –4.0	nA μA
ON CHARACTERISTICS						
DC Current Gain (I_C = –10 μA, V_{CE} = –5.0 V)	BC856A, BC585A BC856B, BC857B, BC858B BC857C	h_{FE}	– – –	90 150 270	– – –	–
(I_C = –2.0 mA, V_{CE} = –5.0 V)	BC856A, BC858A BC856B, BC857B, BC858B BC857C		125 220 420	180 290 520	250 475 800	
Collector–Emitter Saturation Voltage (I_C = –10 mA, I_B = –0.5 mA) (I_C = –100 mA, I_B = –5.0 mA)		$V_{CE(sat)}$	– –	– –	–0.3 –0.65	V
Base–Emitter Saturation Voltage (I_C = –10 mA, I_B = –0.5 mA) (I_C = –100 mA, I_B = –5.0 mA)		$V_{BE(sat)}$	– –	–0.7 –0.9	– –	V
Base–Emitter On Voltage (I_C = –2.0 mA, V_{CE} = –5.0 V) (I_C = –10 mA, V_{CE} = –5.0 V)		$V_{BE(on)}$	–0.6 –	– –	–0.75 –0.82	V
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain – Bandwidth Product (I_C = –10 mA, V_{CE} = –5.0 Vdc, f = 100 MHz)		f_T	100	–	–	MHz
Output Capacitance (V_{CB} = –10 V, f = 1.0 MHz)		C_{ob}	–	–	4.5	pF
Noise Figure (I_C = –0.2 mA, V_{CE} = –5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		NF	–	–	10	dB

BC857/BC858

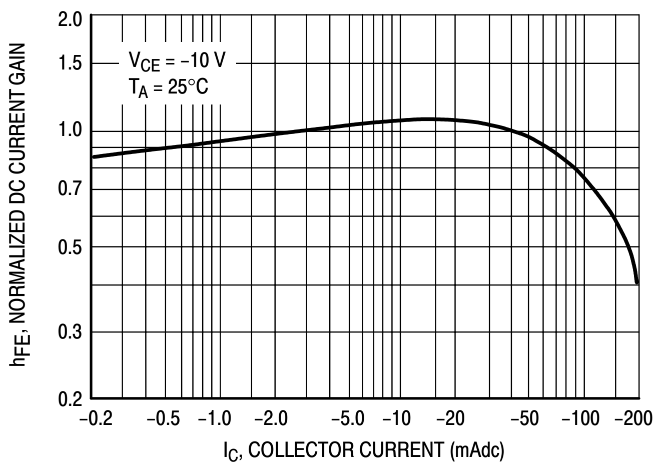


Figure 1. Normalized DC Current Gain

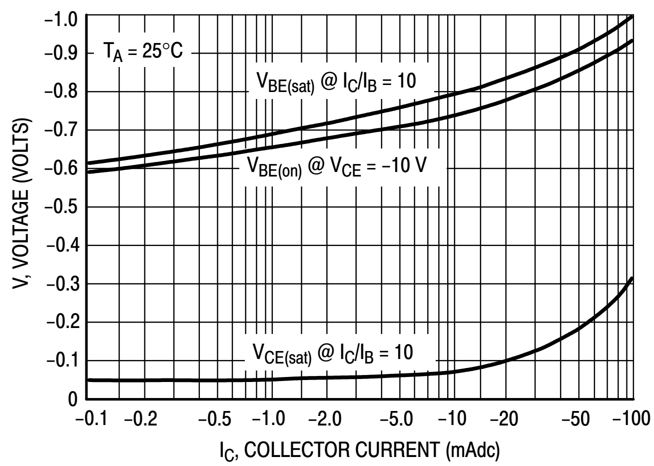


Figure 2. “Saturation” and “On” Voltages

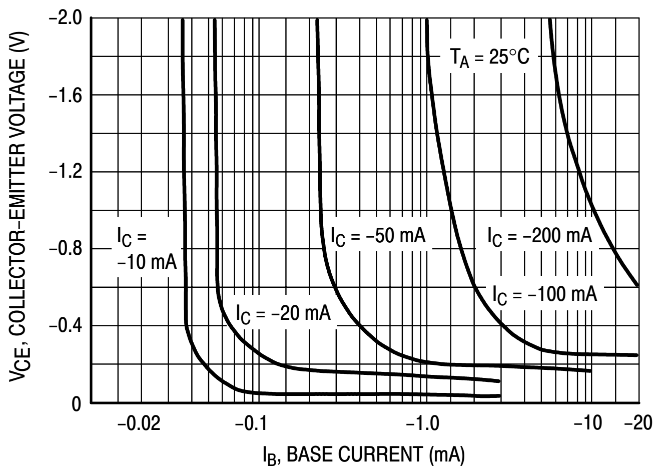


Figure 3. Collector Saturation Region

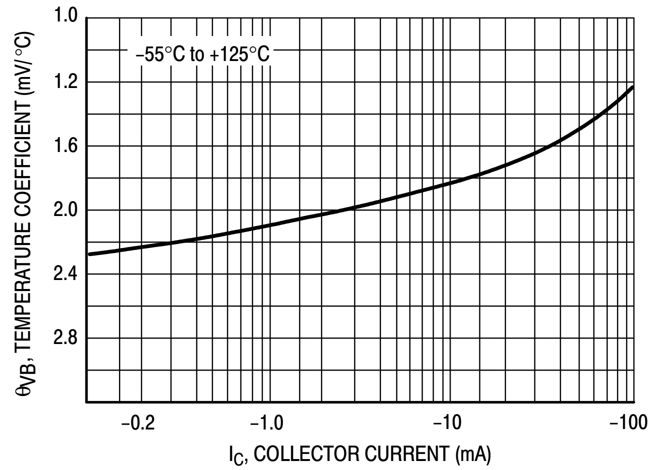


Figure 4. Base–Emitter Temperature Coefficient

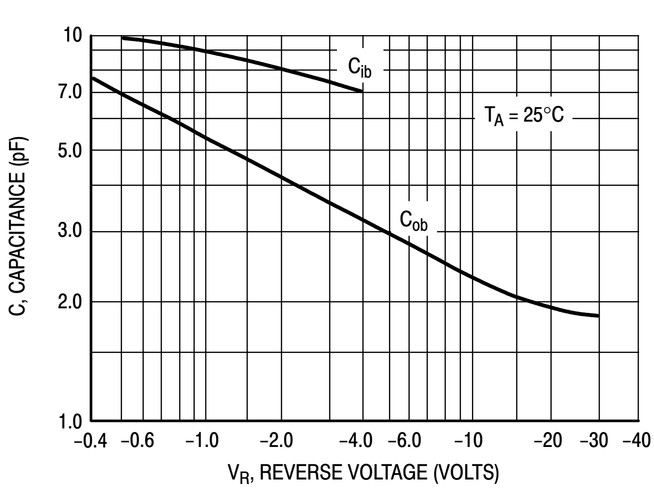


Figure 5. Capacitances

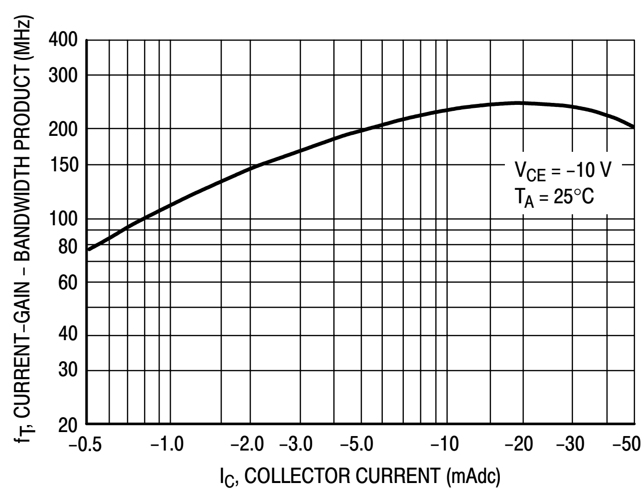


Figure 6. Current–Gain – Bandwidth Product

BC856

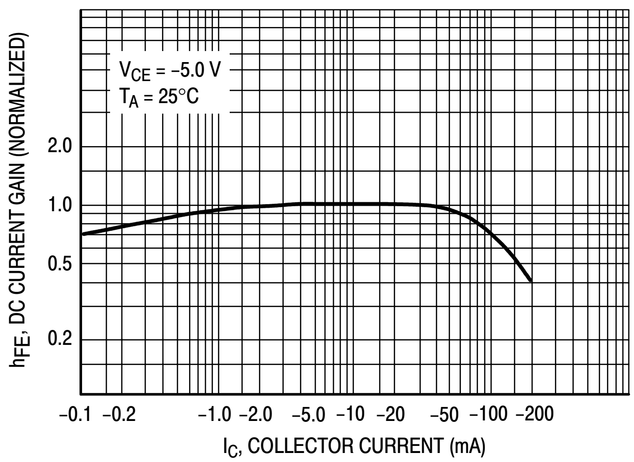


Figure 7. DC Current Gain

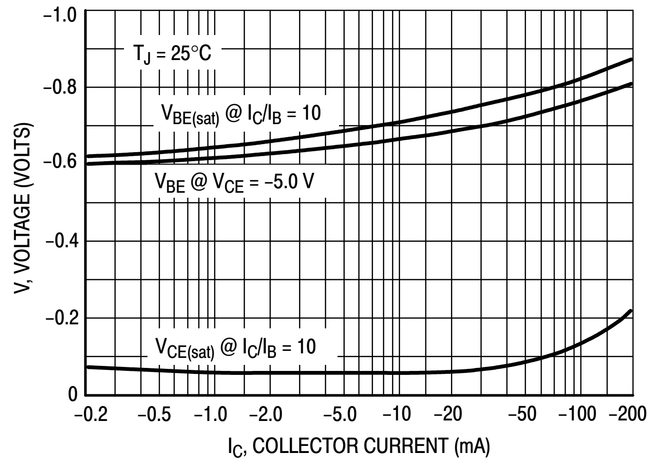


Figure 8. “On” Voltage

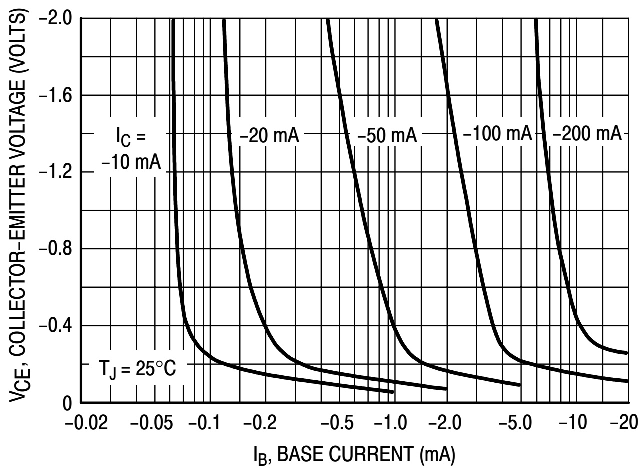


Figure 9. Collector Saturation Region

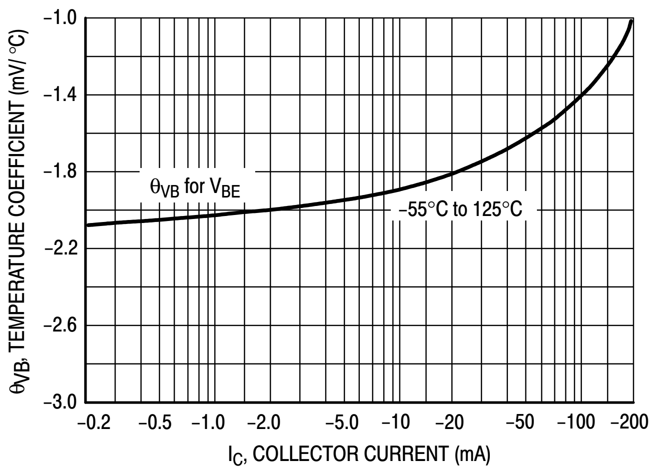


Figure 10. Base–Emitter Temperature Coefficient

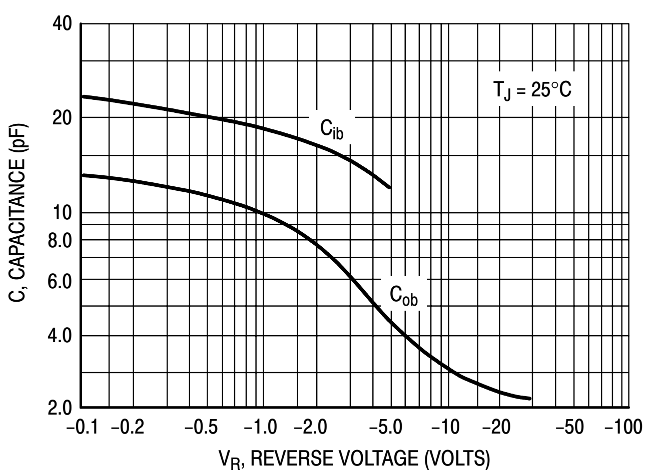


Figure 11. Capacitance

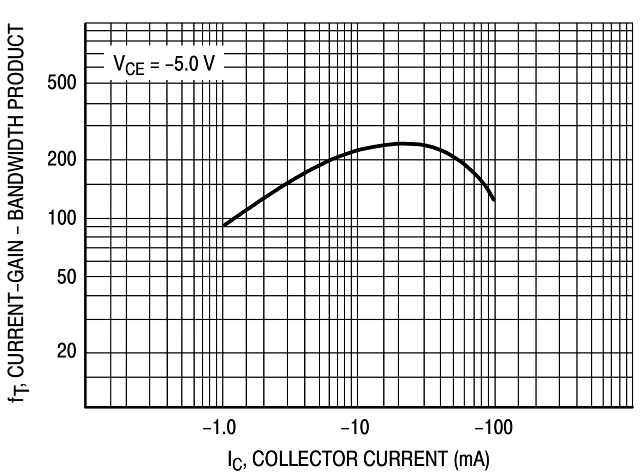


Figure 12. Current–Gain – Bandwidth Product

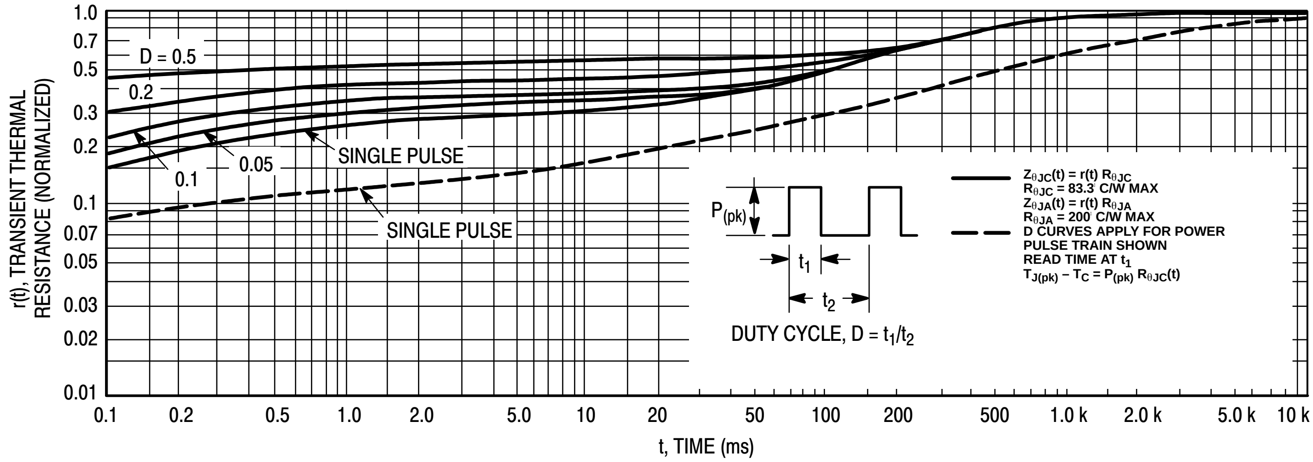


Figure 13. Thermal Response

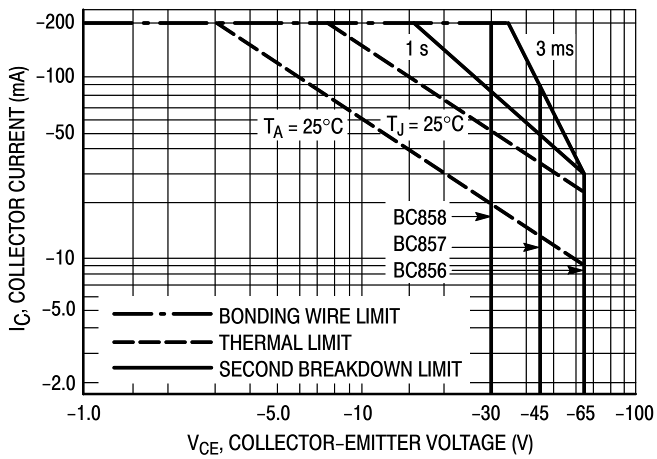


Figure 14. Active Region Safe Operating Area

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 14 is based upon $T_{J(pk)}$ = 150°C; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq$ 150°C. $T_{J(pk)}$ may be calculated from the data in Figure 13. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by the secondary breakdown.

BC856BDW1T1, BC857BDW1T1 Series, BC858BDW1T1 Series

Preferred Devices

Dual General Purpose Transistors

PNP Duals

These transistors are designed for general purpose amplifier applications. They are housed in the SOT–363/SC–88 which is designed for low power surface mount applications.

- Device Marking:
  BC856BDW1T1 = 3B
  BC857BDW1T1 = 3F
  BC857CDW1T1 = 3G
  BC858BDW1T1 = 3K
  BC858CDW1T1 = 3L

MAXIMUM RATINGS

Rating	Symbol	BC856	BC857	BC858	Unit
Collector–Emitter Voltage	V_{CEO}	–65	–45	–30	V
Collector–Base Voltage	V_{CBO}	–80	–50	–30	V
Emitter–Base Voltage	V_{EBO}	–5.0	–5.0	–5.0	V
Collector Current – Continuous	I_C	–100	–100	–100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation Per Device FR–5 Board (Note 1.) T_A = 25°C Derate Above 25°C	P_D	380 250 3.0	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	328	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–5 = 1.0 x 0.75 x 0.062 in

ON Semiconductor™

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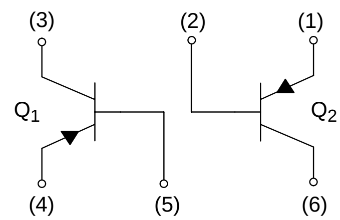
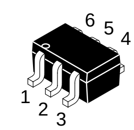
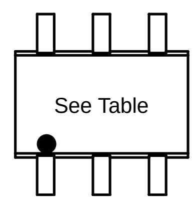




SOT–363/SC–88
CASE 419B
STYLE 1

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
BC856BDW1T1	SOT–363	3000 Units/Reel
BC857BDW1T1	SOT–363	3000 Units/Reel
BC857CDW1T1	SOT–363	3000 Units/Reel
BC858BDW1T1	SOT–363	3000 Units/Reel
BC858CDW1T1	SOT–363	3000 Units/Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = –10 mA)	BC856 Series	$V_{(BR)CEO}$	–65	–	–	V
	BC857 Series		–45	–	–	
	BC858 Series		–30	–	–	
Collector–Emitter Breakdown Voltage (I_C = –10 μA, V_{EB} = 0)	BC856 Series	$V_{(BR)CES}$	–80	–	–	V
	BC857B Only		–50	–	–	
	BC858 Series		–30	–	–	
Collector–Base Breakdown Voltage (I_C = –10 μA)	BC856 Series	$V_{(BR)CBO}$	–80	–	–	V
	BC857 Series		–50	–	–	
	BC858 Series		–30	–	–	
Emitter–Base Breakdown Voltage (I_E = –1.0 μA)	BC856 Series	$V_{(BR)EBO}$	–5.0	–	–	V
	BC857 Series		–5.0	–	–	
	BC858 Series		–5.0	–	–	
Collector Cutoff Current (V_{CB} = –30 V)		I_{CBO}	–	–	–15	nA
(V_{CB} = –30 V, T_A = 150°C)			–	–	–4.0	μA
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = –10 μA, V_{CE} = –5.0 V)	BC856B, BC857B, BC858B		–	150	–	
	BC857C, BC858C		–	270	–	
(I_C = –2.0 mA, V_{CE} = –5.0 V)	BC856B, BC857B, BC858B		220	290	475	
	BC857C, BC858C		420	520	800	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = –10 mA, I_B = –0.5 mA)			–	–	–0.3	
(I_C = –100 mA, I_B = –5.0 mA)			–	–	–0.65	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$				V
(I_C = –10 mA, I_B = –0.5 mA)			–	–0.7	–	
(I_C = –100 mA, I_B = –5.0 mA)			–	–0.9	–	
Base–Emitter On Voltage		$V_{BE(on)}$				V
(I_C = –2.0 mA, V_{CE} = –5.0 V)			–0.6	–	–0.75	
(I_C = –10 mA, V_{CE} = –5.0 V)			–	–	–0.82	
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain – Bandwidth Product (I_C = –10 mA, V_{CE} = –5.0 Vdc, f = 100 MHz)		f_T	100	–	–	MHz
Output Capacitance (V_{CB} = –10 V, f = 1.0 MHz)		C_{ob}	–	–	4.5	pF
Noise Figure (I_C = –0.2 mA, V_{CE} = –5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		NF	–	–	10	dB

TYPICAL CHARACTERISTICS – BC856

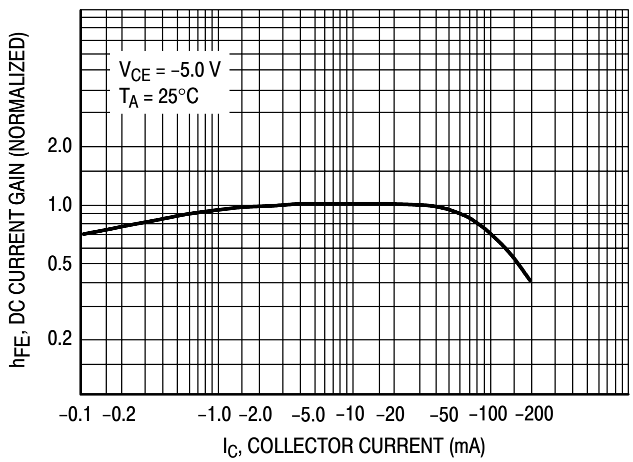


Figure 1. DC Current Gain

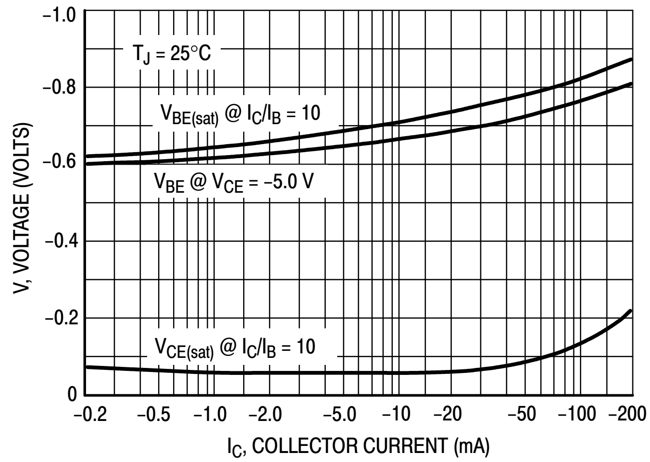


Figure 2. "On" Voltage

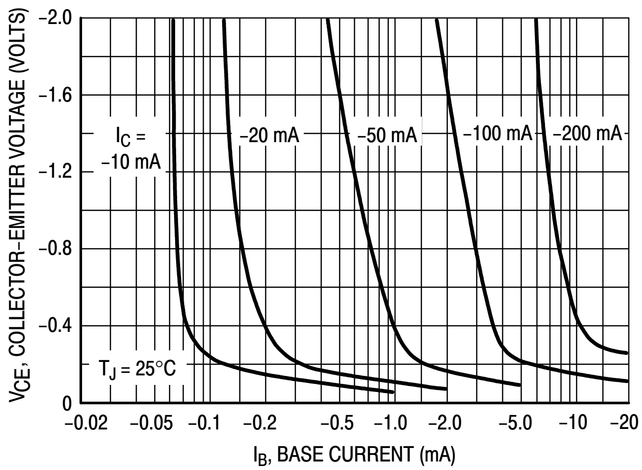


Figure 3. Collector Saturation Region

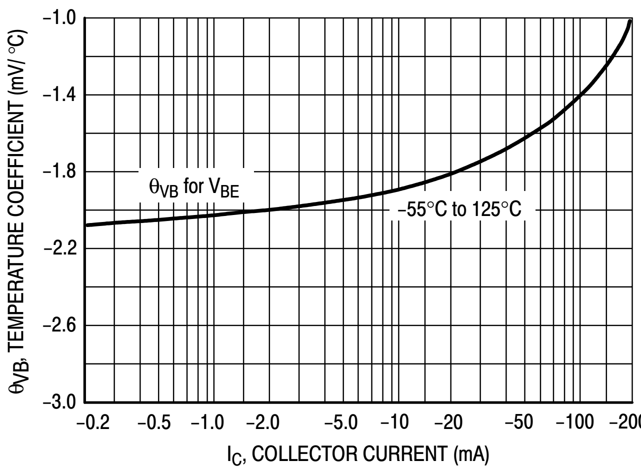


Figure 4. Base–Emitter Temperature Coefficient

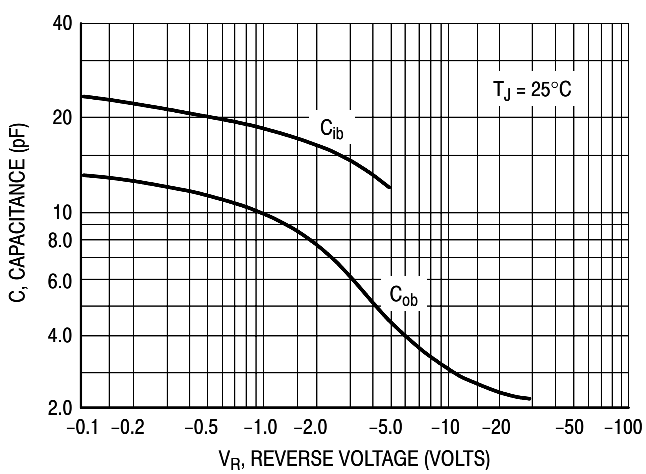


Figure 5. Capacitance

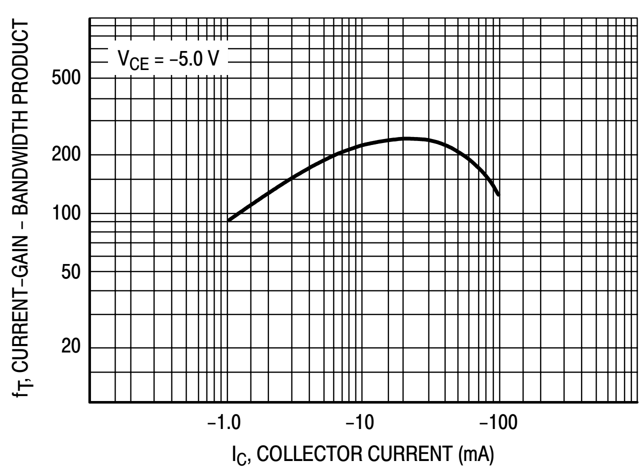


Figure 6. Current–Gain – Bandwidth Product

TYPICAL CHARACTERISTICS – BC857/BC858

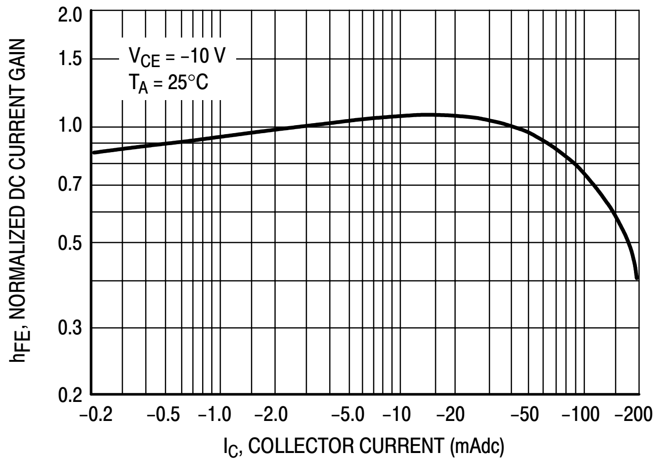


Figure 7. Normalized DC Current Gain

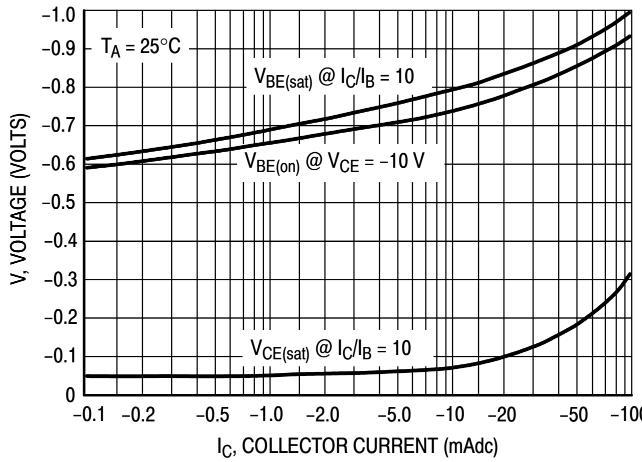


Figure 8. “Saturation” and “On” Voltages

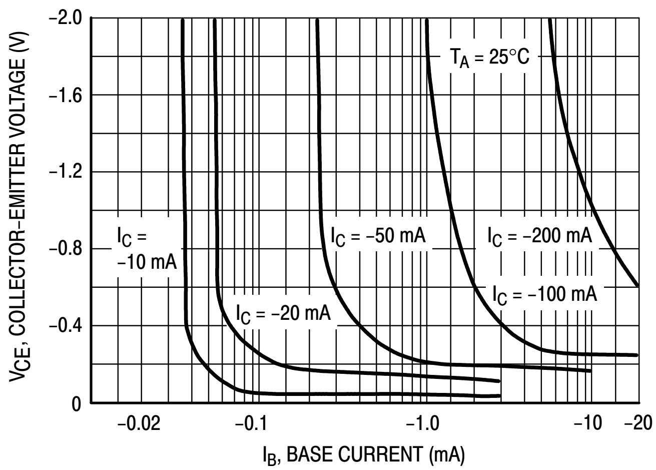


Figure 9. Collector Saturation Region

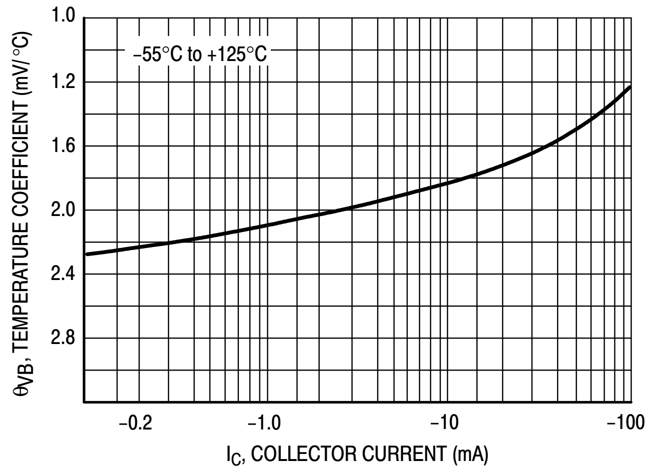


Figure 10. Base–Emitter Temperature Coefficient

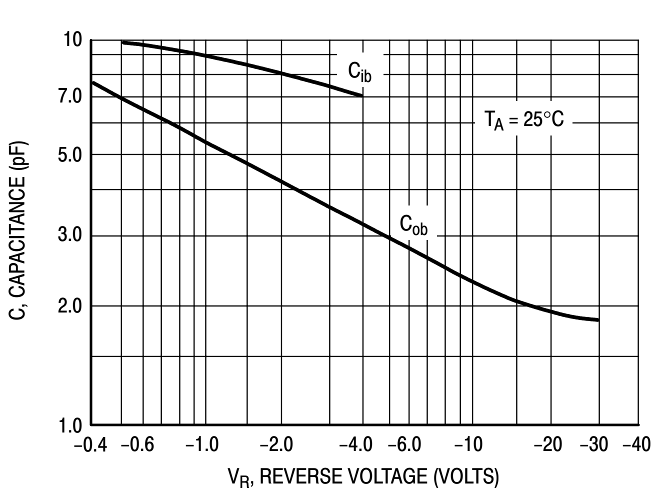


Figure 11. Capacitances

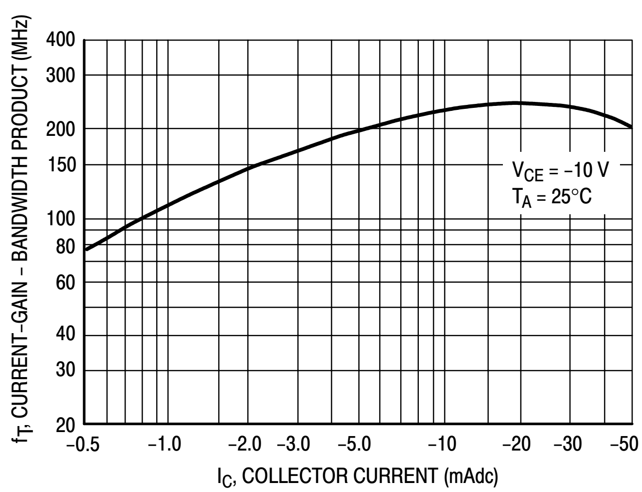


Figure 12. Current–Gain – Bandwidth Product

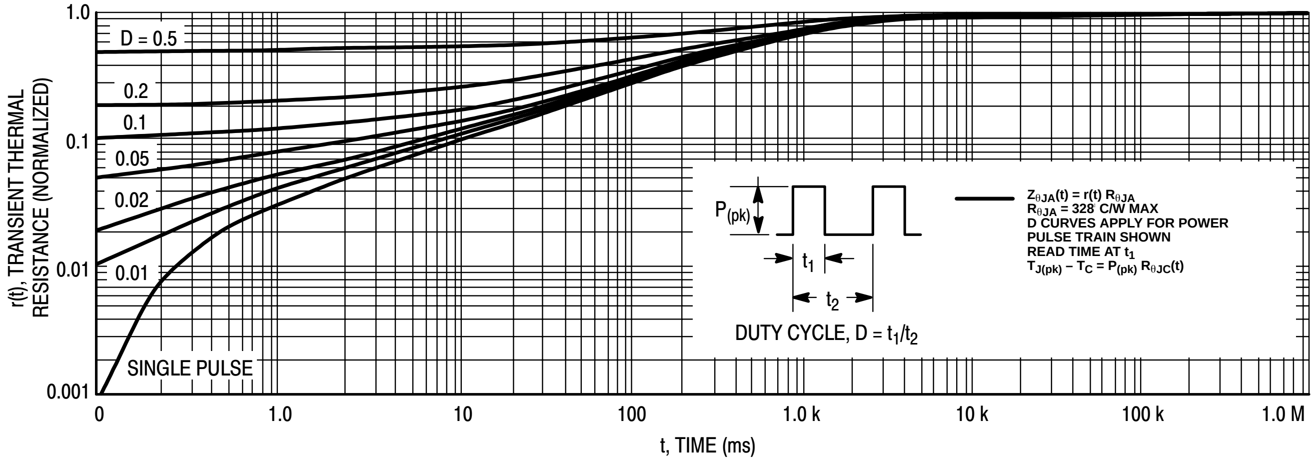


Figure 13. Thermal Response

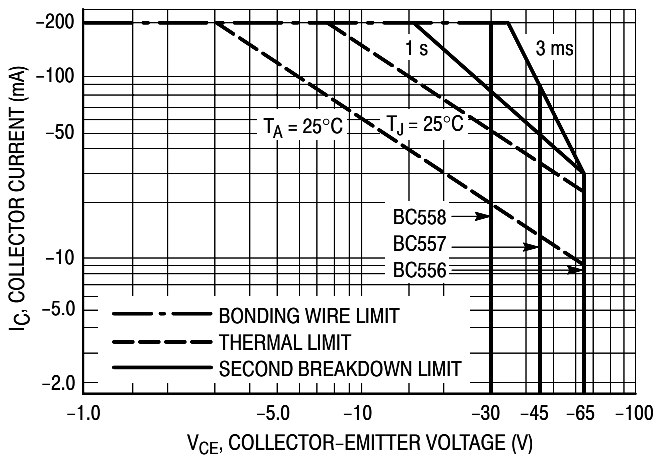


Figure 14. Active Region Safe Operating Area

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 14 is based upon $T_{J(pk)} = 150°C$; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 13. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by the secondary breakdown.

BC857BTT1, BC857CTT1

Preferred Devices

Advance Information

General Purpose Transistor

PNP Silicon

These transistors are designed for general purpose amplifier applications. They are housed in the SOT–416/SC–75 which is designed for low power surface mount applications.

- Device Marking:
  BC857BTT1 = 3F
  BC857CTT1 = 3G

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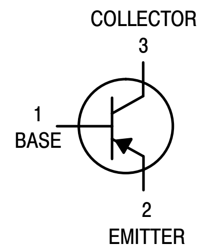
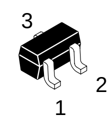




CASE 463
SOT–416/SC–75
STYLE 1

MAXIMUM RATINGS (T_A = 25°C)

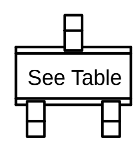
Rating	Symbol	Max	Unit
Collector–Emitter Voltage	V_{CEO}	–45	V
Collector–Base Voltage	V_{CBO}	–50	V
Emitter–Base Voltage	V_{EBO}	–5.0	V
Collector Current — Continuous	I_C	–100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, FR–4 Board (1) T_A = 25°C Derated above 25°C	P_D	200 1.6	mW mW/°C
Thermal Resistance, Junction to Ambient (1)	$R_{\theta JA}$	600	°C/W
Total Device Dissipation, FR–4 Board (2) T_A = 25°C Derated above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient (2)	$R_{\theta JA}$	400	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) FR–4 @ Minimum Pad
(2) FR–4 @ 1.0 × 1.0 Inch Pad

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
BC857BTT1	SOT–416	3000 / Tape & Reel
BC857CTT1	SOT–416	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = –10 mA)	BC857 Series	$V_{(BR)CEO}$	–45	—	—	V
Collector–Emitter Breakdown Voltage (I_C = –10 μA, V_{EB} = 0)	BC857B Only	$V_{(BR)CES}$	–50	—	—	V
Collector–Base Breakdown Voltage (I_C = –10 μA)	BC857 Series	$V_{(BR)CBO}$	–50	—	—	V
Emitter–Base Breakdown Voltage (I_E = –1.0 μA)	BC857 Series	$V_{(BR)EBO}$	–5.0	—	—	V
Collector Cutoff Current (V_{CB} = –30 V) (V_{CB} = –30 V, T_A = 150°C)		I_{CBO}	— —	— —	–15 –4.0	nA μA
ON CHARACTERISTICS						
DC Current Gain (I_C = –10 μA, V_{CE} = –5.0 V)	 BC857B BC857C	h_{FE}	 — —	 150 270	 — —	—
(I_C = –2.0 mA, V_{CE} = –5.0 V)	BC857B BC857C		220 420	290 520	475 800	
Collector–Emitter Saturation Voltage (I_C = –10 mA, I_B = –0.5 mA) (I_C = –100 mA, I_B = –5.0 mA)		$V_{CE(sat)}$	 — —	 — —	 –0.3 –0.65	V
Base–Emitter Saturation Voltage (I_C = –10 mA, I_B = –0.5 mA) (I_C = –100 mA, I_B = –5.0 mA)		$V_{BE(sat)}$	 — —	 –0.7 –0.9	 — —	V
Base–Emitter On Voltage (I_C = –2.0 mA, V_{CE} = –5.0 V) (I_C = –10 mA, V_{CE} = –5.0 V)		$V_{BE(on)}$	 –0.6 —	 — —	 –0.75 –0.82	V
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — Bandwidth Product (I_C = –10 mA, V_{CE} = –5.0 Vdc, f = 100 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = –10 V, f = 1.0 MHz)		C_{ob}	—	—	4.5	pF
Noise Figure (I_C = –0.2 mA, V_{CE} = –5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		NF	—	—	10	dB

TYPICAL CHARACTERISTICS

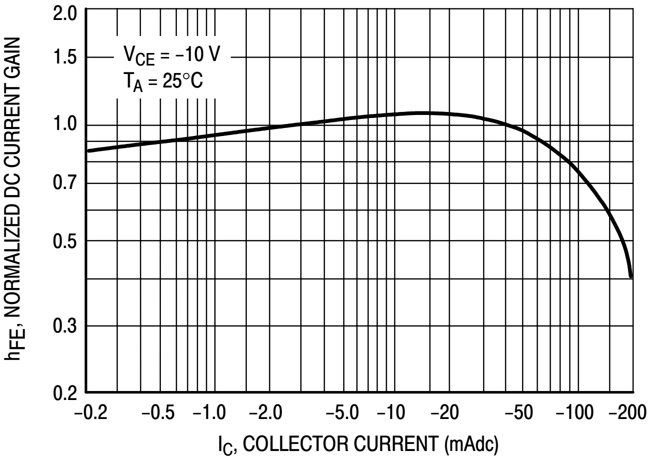


Figure 1. Normalized DC Current Gain

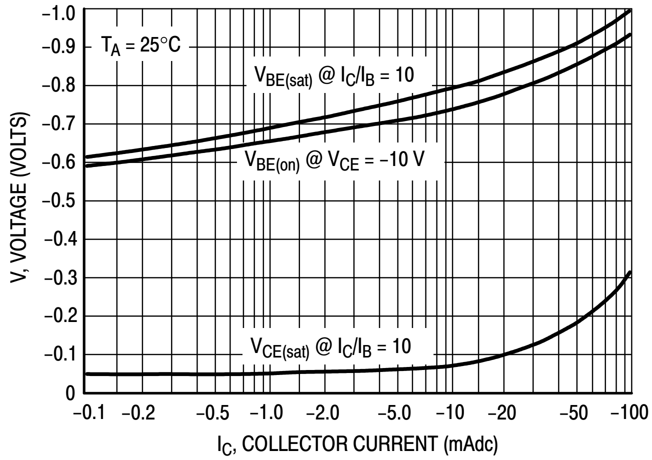


Figure 2. “Saturation” and “On” Voltages

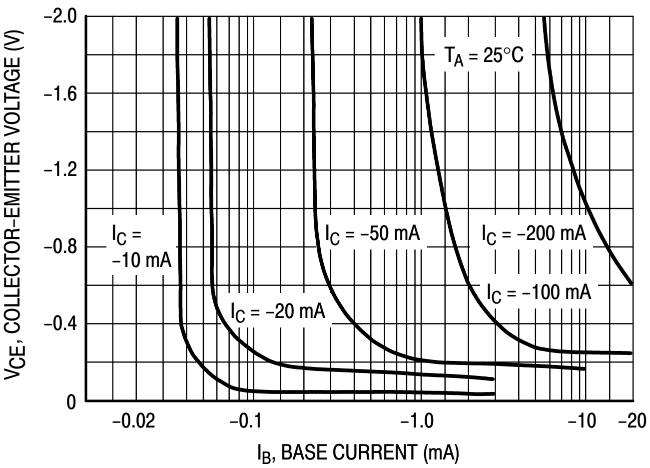


Figure 3. Collector Saturation Region

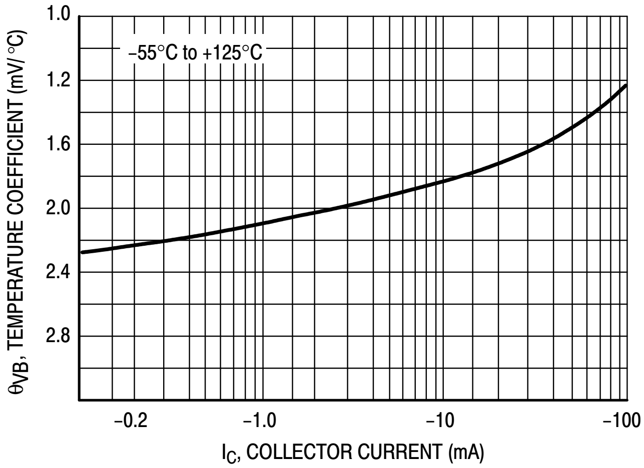


Figure 4. Base−Emitter Temperature Coefficient

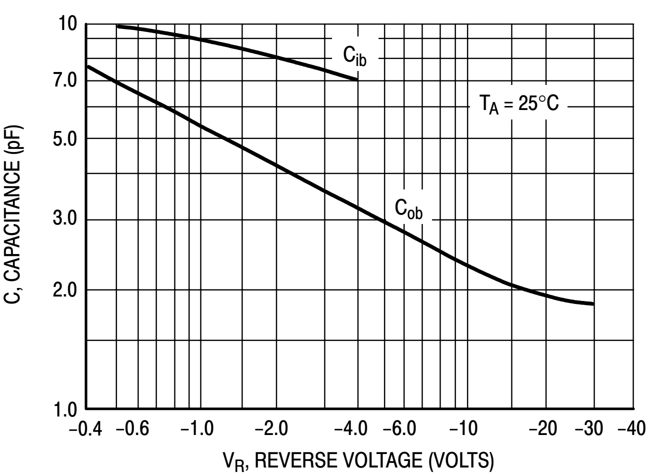


Figure 5. Capacitances

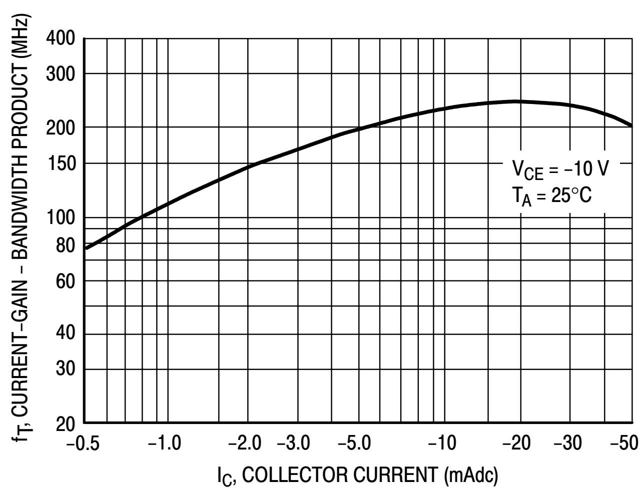


Figure 6. Current−Gain – Bandwidth Product

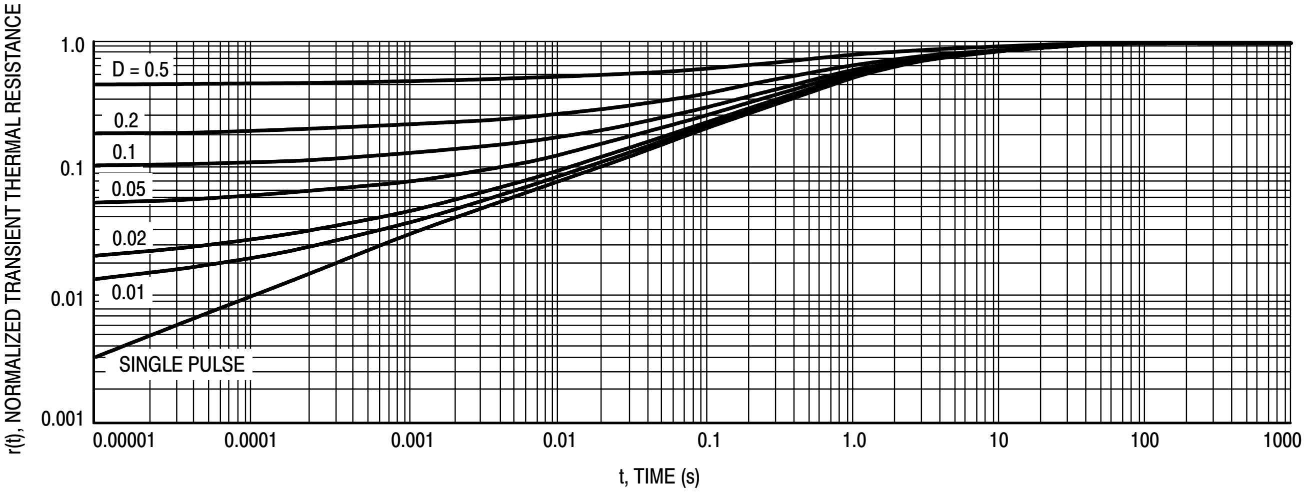


Figure 7. Thermal Response

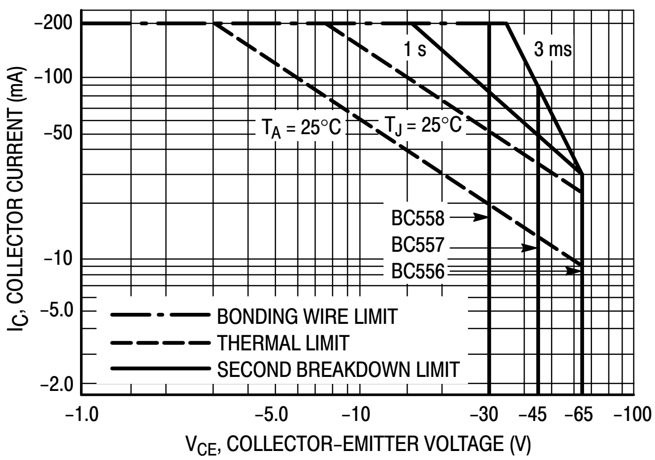


Figure 8. Active Region Safe Operating Area

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 8 is based upon $T_{J(pk)}$ = 150°C; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq$ 150°C. $T_{J(pk)}$ may be calculated from the data in Figure 7. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by the secondary breakdown.

BCP53T1 Series

Preferred Devices

PNP Silicon Epitaxial Transistors

This PNP Silicon Epitaxial transistor is designed for use in audio amplifier applications. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- High Current: 1.5 Amps
- NPN Complement is BCP56
- The SOT-223 Package can be soldered using wave or reflow. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
  Use BCP53T1 to order the 7 inch/1000 unit reel.
  Use BCP53T3 to order the 13 inch/4000 unit reel.
- Device Marking:
  BCP53T1 = AH
  BCP53–10T1 = AH–10
  BCP53–16T1 = AH–16

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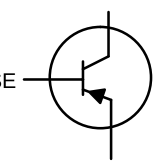
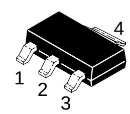
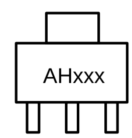
MEDIUM POWER HIGH CURRENT SURFACE MOUNT PNP TRANSISTORS





SOT–223
CASE 318E
STYLE 1

MARKING DIAGRAM



AHxxx = Device Code
xxx = –10 or –16

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	–80	Vdc
Collector-Base Voltage	V_{CBO}	–100	Vdc
Emitter-Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current	I_C	1.5	Adc
Total Power Dissipation @ T_A = 25°C (Note 1.) Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (surface mounted)	$R_{\theta JA}$	83.3	°C/W
Lead Temperature for Soldering, 0.0625″ from case Time in Solder Bath	T_L	260 10	°C Sec

1. Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 sq. in.

ORDERING INFORMATION

Device	Package	Shipping
BCP53T1	SOT–223	1000/Tape & Reel
BCP53–10T1	SOT–223	1000/Tape & Reel
BCP53–16T1	SOT–223	1000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–100	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–80	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = –100 μAdc, R_{BE} = 1.0 kohm)	$V_{(BR)CER}$	–100	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	–	–	Vdc
Collector-Base Cutoff Current (V_{CB} = –30 Vdc, I_E = 0)	I_{CBO}	–	–	–100	nAdc
Emitter-Base Cutoff Current (V_{EB} = –5.0 Vdc, I_C = 0)	I_{EBO}	–	–	–10	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = –5.0 mAdc, V_{CE} = –2.0 Vdc) All Part Types	h_{FE}	25	–	–	–
(I_C = –150 mAdc, V_{CE} = –2.0 Vdc) BCP53T1		40	–	250	
BCP53–10T1		63	–	160	
BCP53–16T1		100	–	250	
(I_C = –500 mAdc, V_{CE} = –2.0 Vdc) All Part Types		25	–	–	
Collector-Emitter Saturation Voltage (I_C = –500 mAdc, I_B = –50 mAdc)	$V_{CE(sat)}$	–	–	–0.5	Vdc
Base-Emitter On Voltage (I_C = –500 mAdc, V_{CE} = –2.0 Vdc)	$V_{BE(on)}$	–	–	–1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product (I_C = –10 mAdc, V_{CE} = –5.0 Vdc, f = 35 MHz)	f_T	–	50	–	MHz

TYPICAL ELECTRICAL CHARACTERISTICS

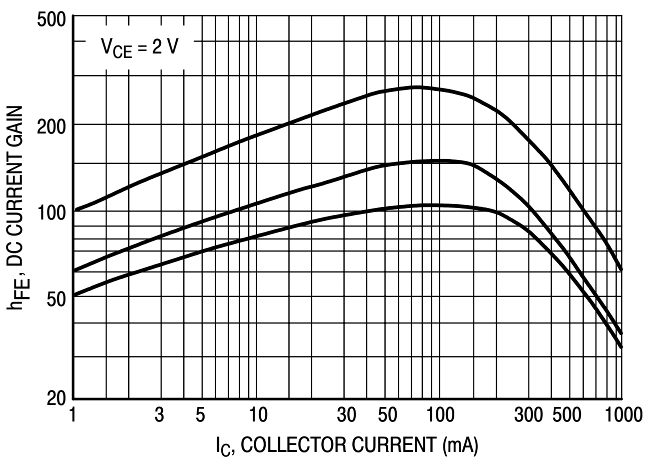


Figure 1. DC Current Gain

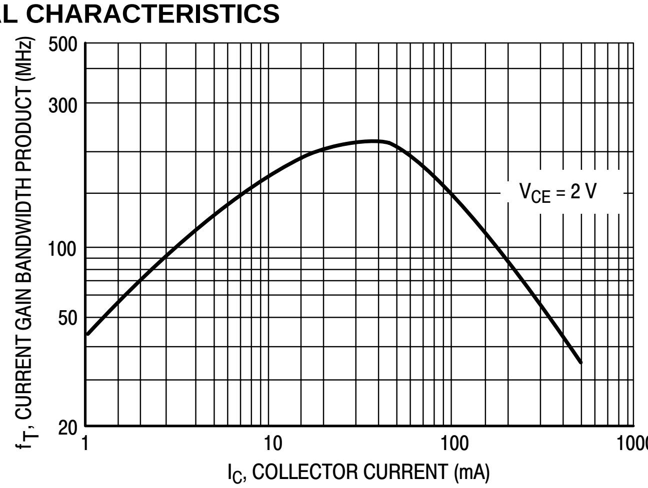


Figure 2. Current Gain Bandwidth Product

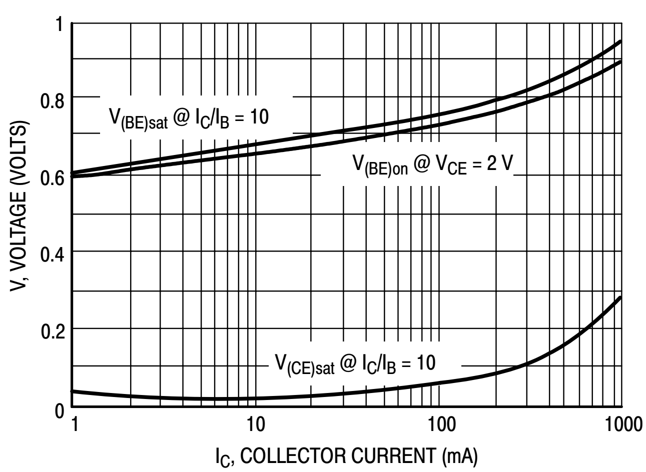


Figure 3. Saturation and "ON" Voltages

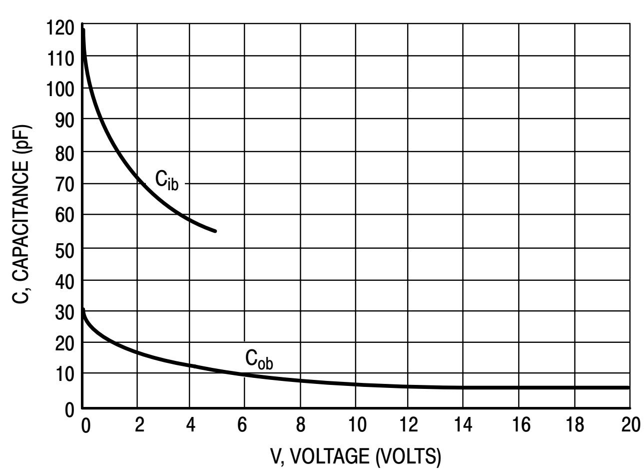


Figure 4. Capacitances

BCP56T1 Series

Preferred Devices

NPN Silicon Epitaxial Transistor

These NPN Silicon Epitaxial transistors are designed for use in audio amplifier applications. The device is housed in the SOT-223 package, which is designed for medium power surface mount applications.

- High Current: 1.0 Amp
- The SOT-223 package can be soldered using wave or reflow. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
  Use BCP56T1 to order the 7 inch/1000 unit reel
  Use BCP56T3 to order the 13 inch/4000 unit reel
- PNP Complement is BCP53T1
- Device Marking
  BCP56T1 = BH
  BCP56–10T1 = BH–10
  BCP56–16T1 = BH–16

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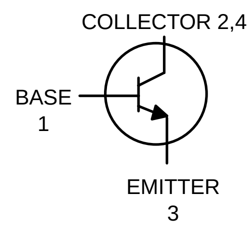
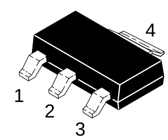
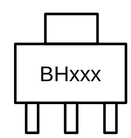
MEDIUM POWER
NPN SILICON
HIGH CURRENT
TRANSISTOR
SURFACE MOUNT





SOT–223, TO–261AA
CASE 318E
STYLE 1

MARKING DIAGRAM



BHxxx = Device Code
xxx = –10 or –16

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	80	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	5	Vdc
Collector Current	I_C	1	Adc
Total Power Dissipation @ T_A = 25°C (Note 1.) Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	–65 to 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction-to-Ambient (surface mounted)	$R_{\theta JA}$	83.3	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	T_L	260 10	°C Sec

1. Device mounted on a FR-4 glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.0625 in.; mounting pad for the collector lead = 0.93 sq. in.

ORDERING INFORMATION

Device	Package	Shipping
BCP56T1	SOT–223	1000/Tape & Reel
BCP56T3	SOT–223	4000/Tape & Reel
BCP56–10T1	SOT–223	1000/Tape & Reel
BCP56–16T1	SOT–223	1000/Tape & Reel
BCP56–16T3	SOT–223	4000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)		$V_{(BR)CBO}$	100	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	80	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	–	–	Vdc
Collector-Base Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	–	–	100	nAdc
Emitter-Base Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)		I_{EBO}	–	–	10	μAdc
ON CHARACTERISTICS (Note 2.)						
DC Current Gain		h_{FE}				–
(I_C = 5.0 mA, V_{CE} = 2.0 V)	All Part Types		25	–	–	
(I_C = 150 mA, V_{CE} = 2.0 V)	BCP56T1		40	–	250	
	BCP56-10T1		63	–	160	
	BCP56-16T1		100	–	250	
(I_C = 500 mA, V_{CE} = 2.0 V)	All Types		25	–	–	
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{CE(sat)}$	–	–	0.5	Vdc
Base-Emitter On Voltage (I_C = 500 mAdc, V_{CE} = 2.0 Vdc)		$V_{BE(on)}$	–	–	1.0	Vdc
DYNAMIC CHARACTERISTICS						
Current-Gain – Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 35 MHz)		f_T	–	130	–	MHz

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

TYPICAL ELECTRICAL CHARACTERISTICS

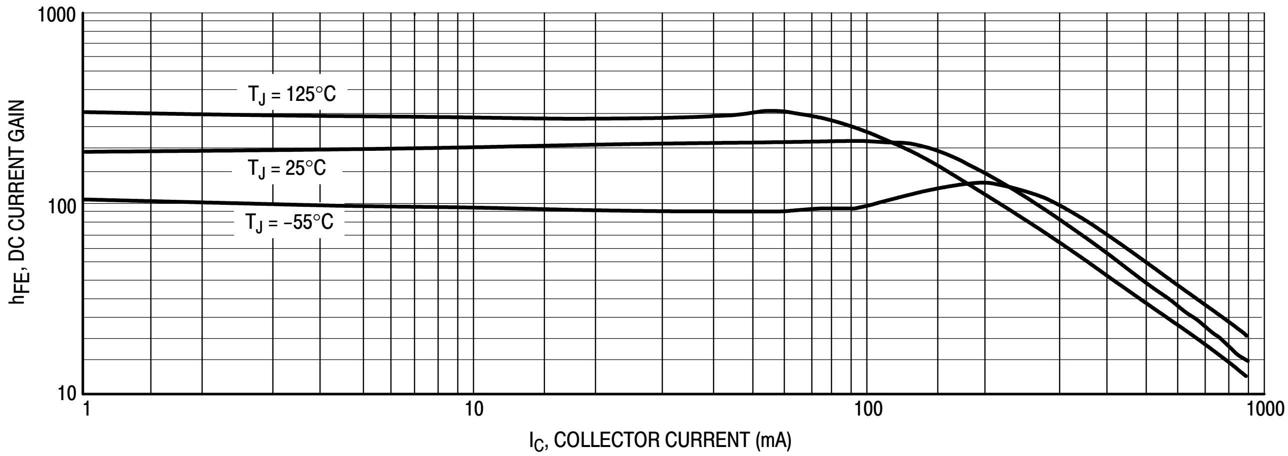


Figure 1. DC Current Gain

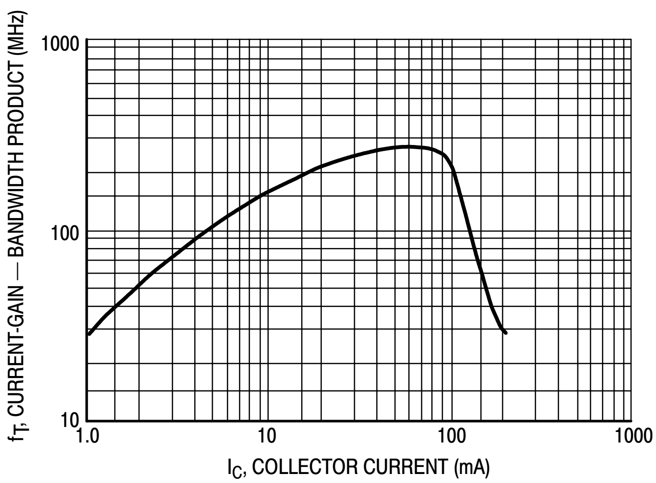


Figure 2. Current-Gain – Bandwidth Product

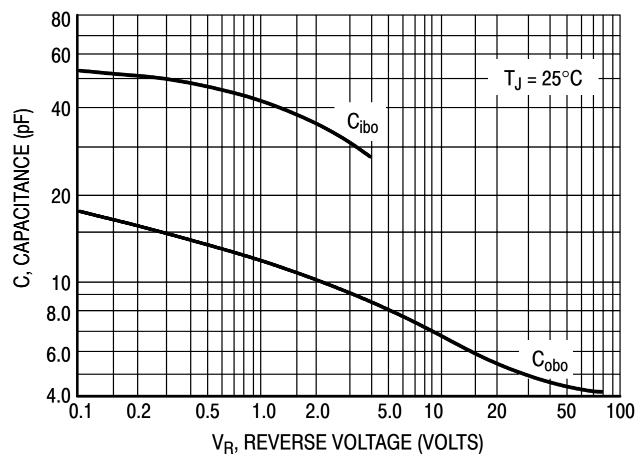


Figure 3. Capacitance

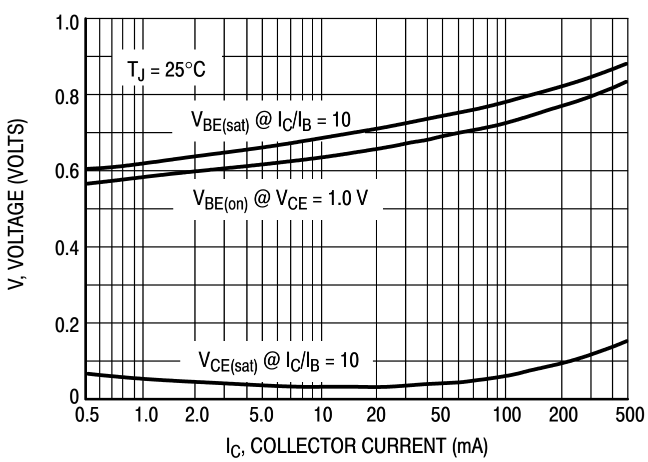


Figure 4. “On” Voltages

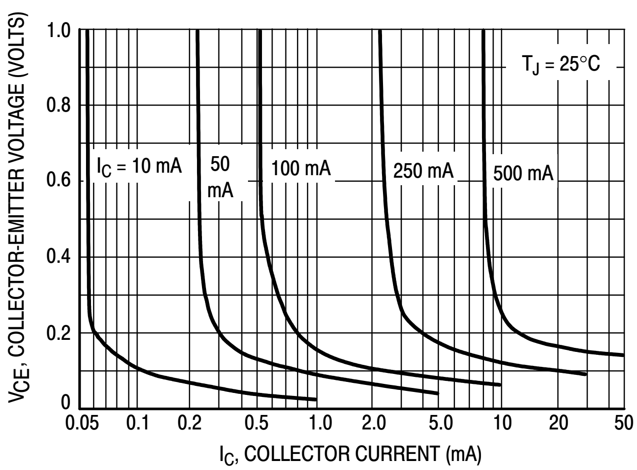


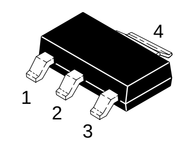
Figure 5. Collector Saturation Region

NPN Silicon Epitaxial Transistor

BCP68T1

ON Semiconductor Preferred Device

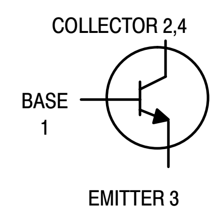
MEDIUM POWER
NPN SILICON
HIGH CURRENT
TRANSISTOR
SURFACE MOUNT



CASE 318E-04, STYLE 1
TO-261AA

This NPN Silicon Epitaxial Transistor is designed for use in low voltage, high current applications. The device is housed in the SOT-223 package, which is designed for medium power surface mount applications.

- High Current: I_C = 1.0 Amp
- The SOT-223 Package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
  Use BCP68T1 to order the 7 inch/1000 unit reel.
  Use BCP68T3 to order the 13 inch/4000 unit reel.
- The PNP Complement is BCP69T1



MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	5	Vdc
Collector Current	I_C	1	Adc
Total Power Dissipation @ T_A = 25°C(1) Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	–65 to 150	°C

DEVICE MARKING

CA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance — Junction-to-Ambient (surface mounted)	$R_{\theta JA}$	83.3	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	T_L	260 10	°C Sec

1. Device mounted on a FR-4 glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.0625 in.; mounting pad for the collector lead = 0.93 sq. in.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CES}$	25	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector-Base Cutoff Current (V_{CB} = 25 Vdc, I_E = 0)	I_{CBO}	—	—	10	μAdc
Emitter-Base Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	—	10	μAdc
ON CHARACTERISTICS (2)					
DC Current Gain	h_{FE}				—
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc)		50	—	—	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)		85	—	375	
(I_C = 1.0 Adc, V_{CE} = 1.0 Vdc)		60	—	—	
Collector-Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 100 mAdc)	$V_{CE(sat)}$	—	—	0.5	Vdc
Base-Emitter On Voltage (I_C = 1.0 Adc, V_{CE} = 1.0 Vdc)	$V_{BE(on)}$	—	—	1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	f_T	—	60	—	MHz

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

TYPICAL ELECTRICAL CHARACTERISTICS

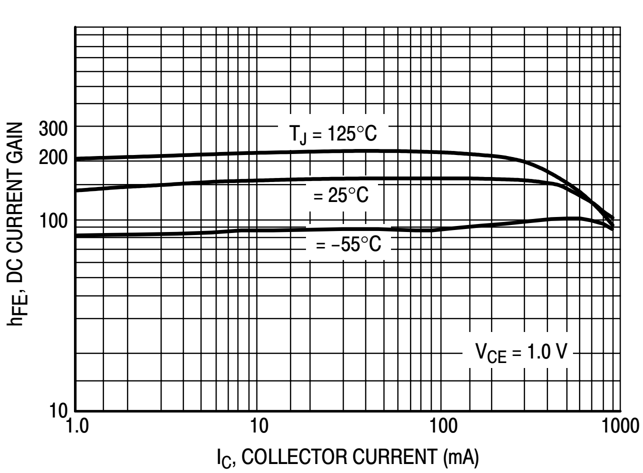


Figure 1. DC Current Gain

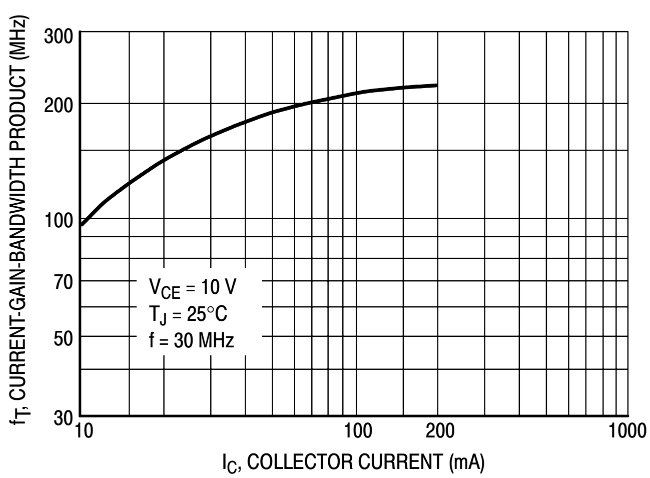


Figure 2. Current-Gain-Bandwidth Product

TYPICAL ELECTRICAL CHARACTERISTICS

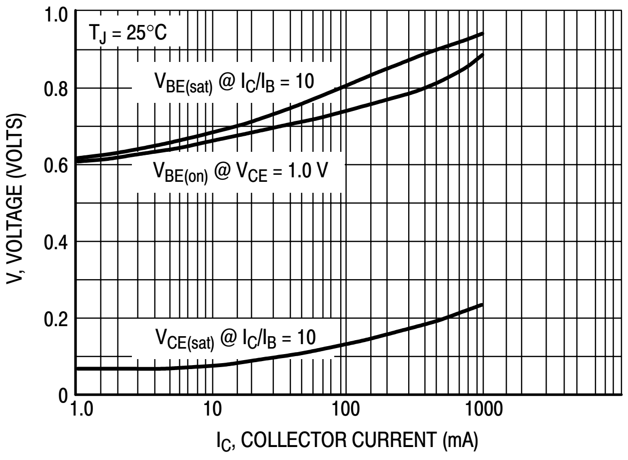


Figure 3. “On” Voltage

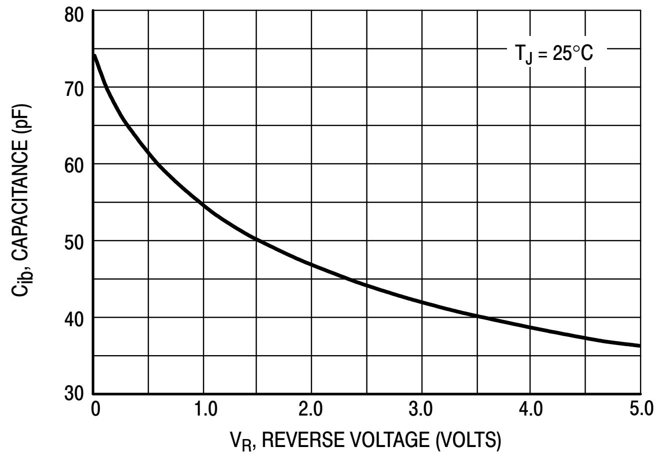


Figure 4. Capacitance

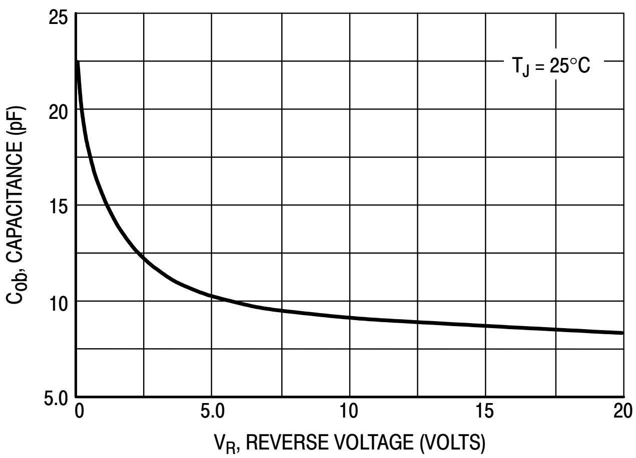


Figure 5. Capacitance

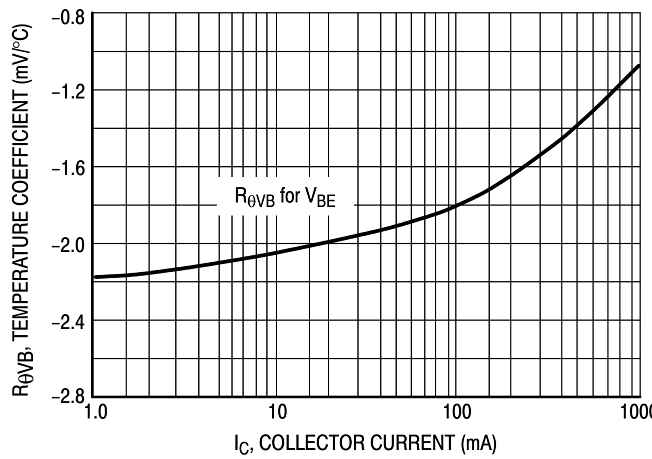


Figure 6. Base-Emitter Temperature Coefficient

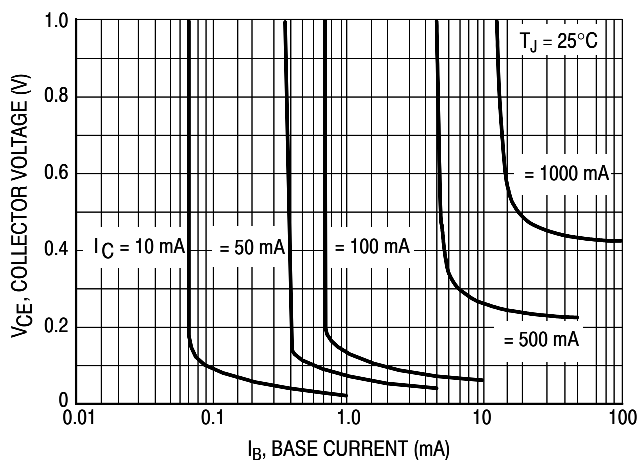


Figure 7. Saturation Region

PNP Silicon Epitaxial Transistor

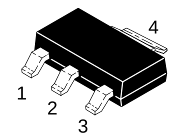
BCP69T1

ON Semiconductor Preferred Device

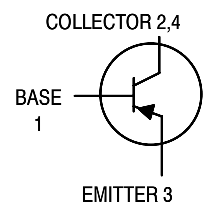
MEDIUM POWER PNP SILICON HIGH CURRENT TRANSISTOR SURFACE MOUNT

This PNP Silicon Epitaxial Transistor is designed for use in low voltage, high current applications. The device is housed in the SOT-223 package, which is designed for medium power surface mount applications.

- High Current: I_C = –1.0 Amp
- The SOT-223 Package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die.
- Available in 12 mm Tape and Reel
  Use BCP69T1 to order the 7 inch/1000 unit reel.
  Use BCP69T3 to order the 13 inch/4000 unit reel.
- NPN Complement is BCP68



CASE 318E-04, STYLE 1
TO-261AA



Preferred devices are recommended choices for future use and best overall value.

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	–25	Vdc
Collector-Base Voltage	V_{CBO}	–20	Vdc
Emitter-Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current	I_C	–1.0	Adc
Total Power Dissipation @ T_A = 25°C(1) Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	–65 to 150	°C

1. Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 sq. in.

DEVICE MARKING

CE

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance — Junction-to-Ambient (surface mounted)	$R_{\theta JA}$	83.3	°C/W
Lead Temperature for Soldering, 0.0625″ from case Time in Solder Bath	T_L	260 10	°C Sec

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = –100 µAdc, I_E = 0)	$V_{(BR)CES}$	–25	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = –10 µAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	—	Vdc

March, 2001 – Rev. 3
Publication Order Number:
BCP69T1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Cutoff Current (V_{CB} = –25 Vdc, I_E = 0)	I_{CBO}	—	—	–10	µAdc
Emitter-Base Cutoff Current (V_{EB} = –5.0 Vdc, I_C = 0)	I_{EBO}	—	—	–10	µAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				—
(I_C = –5.0 mAdc, V_{CE} = –10 Vdc)		50	—	—	
(I_C = –500 mAdc, V_{CE} = –1.0 Vdc)		85	—	375	
(I_C = –1.0 Adc, V_{CE} = –1.0 Vdc)		60	—	—	
Collector-Emitter Saturation Voltage (I_C = –1.0 Adc, I_B = –100 mAdc)	$V_{CE(sat)}$	—	—	–0.5	Vdc
Base-Emitter On Voltage (I_C = –1.0 Adc, V_{CE} = –1.0 Vdc)	$V_{BE(on)}$	—	—	–1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –5.0 Vdc)	f_T	—	60	—	MHz

TYPICAL ELECTRICAL CHARACTERISTICS

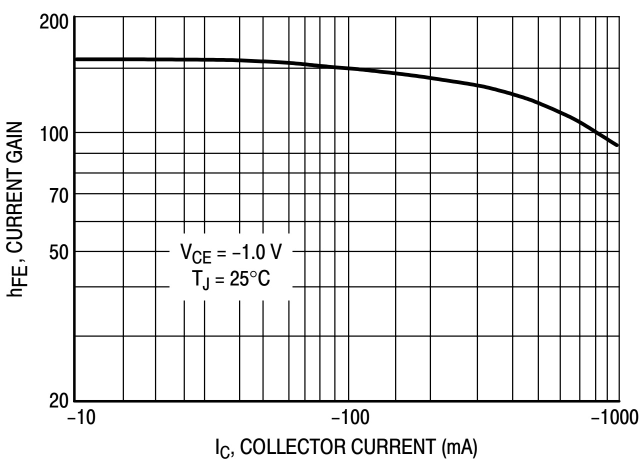


Figure 1. DC Current Gain

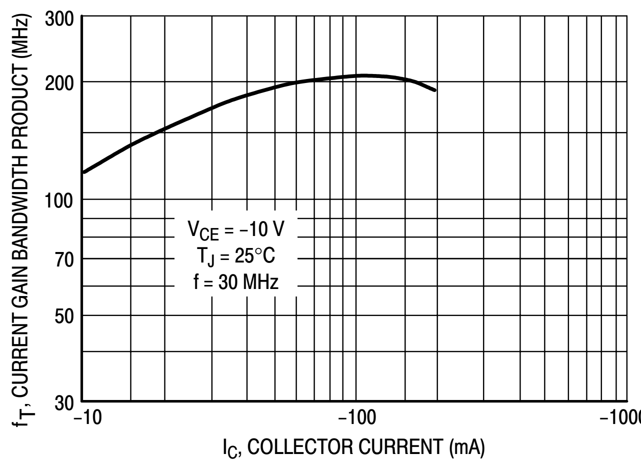


Figure 2. Current Gain Bandwidth Product

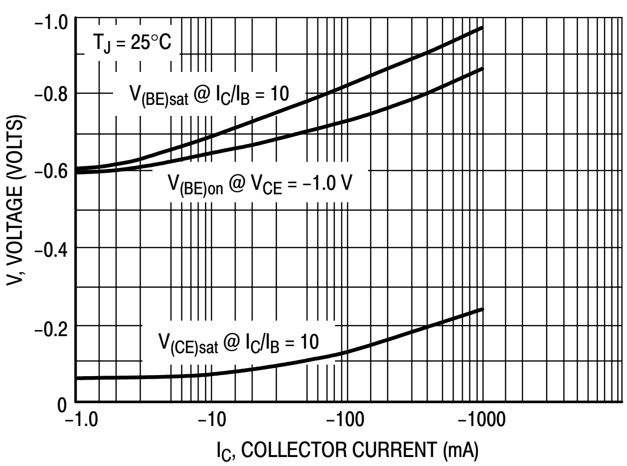


Figure 3. Saturation and "ON" Voltages

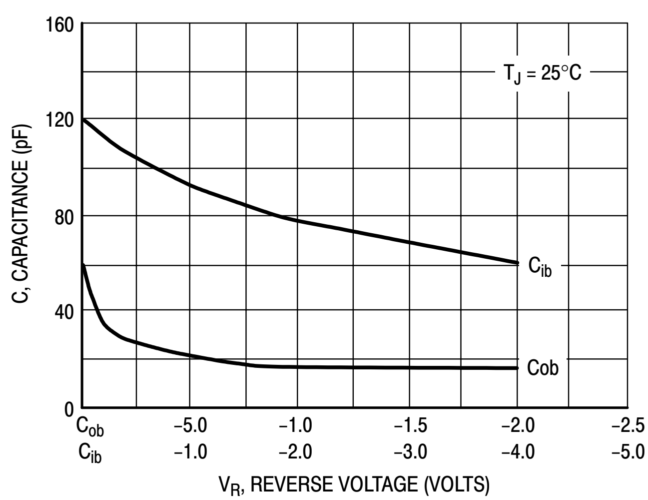


Figure 4. Capacitances

BCX56-10R1

Preferred Device

NPN Silicon Epitaxial Transistor

These NPN Silicon Epitaxial transistors are designed for use in audio amplifier applications. The device is housed in the SOT-89 package, which is designed for medium power surface mount applications.

- High Current: 1.0 Amp
- Available in 7 inch/1000 unit Tape and Reel
- Device Marking: BK

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	80	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	5	Vdc
Collector Current	I_C	1	Adc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D (Note 1.) (Note 2.)	 1.56 13 0.67 5.0	 Watts mW/°C Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	–65 to 150	°C

THERMAL CHARACTERISTICS

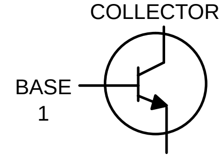
Characteristic	Symbol	Max	Unit
Thermal Resistance Junction-to-Ambient (surface mounted)	$R_{\theta JA}$ (Note 1.) (Note 2.)	 80 190	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	T_L	 260 10	 °C Sec

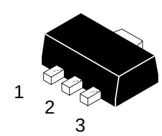
1. FR–4 @ 1.0 X 1.0 inch Pad
2. FR–4 @ Minimum Pad

ON Semiconductor™

http://onsemi.com

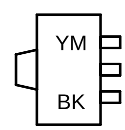
MEDIUM POWER NPN SILICON HIGH CURRENT TRANSISTOR SURFACE MOUNT





SOT–89
CASE 1213
STYLE 2

MARKING DIAGRAM



Y = Year Code
M = Month Code
BK = Device Code

ORDERING INFORMATION

Device	Package	Shipping
BCX56–10R1	SOT–89	1000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	100	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	80	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	–	–	Vdc
Collector-Base Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	100	nAdc
Emitter-Base Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)	I_{EBO}	–	–	10	μAdc
ON CHARACTERISTICS (Note 3.)					
DC Current Gain	h_{FE}				–
(I_C = 5.0 mA, V_{CE} = 2.0 V)		25	–	–	
(I_C = 150 mA, V_{CE} = 2.0 V)		63	–	160	
(I_C = 500 mA, V_{CE} = 2.0 V)		25	–	–	
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	–	–	0.5	Vdc
Base-Emitter On Voltage (I_C = 500 mAdc, V_{CE} = 2.0 Vdc)	$V_{BE(on)}$	–	–	1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 35 MHz)	f_T	–	130	–	MHz

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

TYPICAL ELECTRICAL CHARACTERISTICS

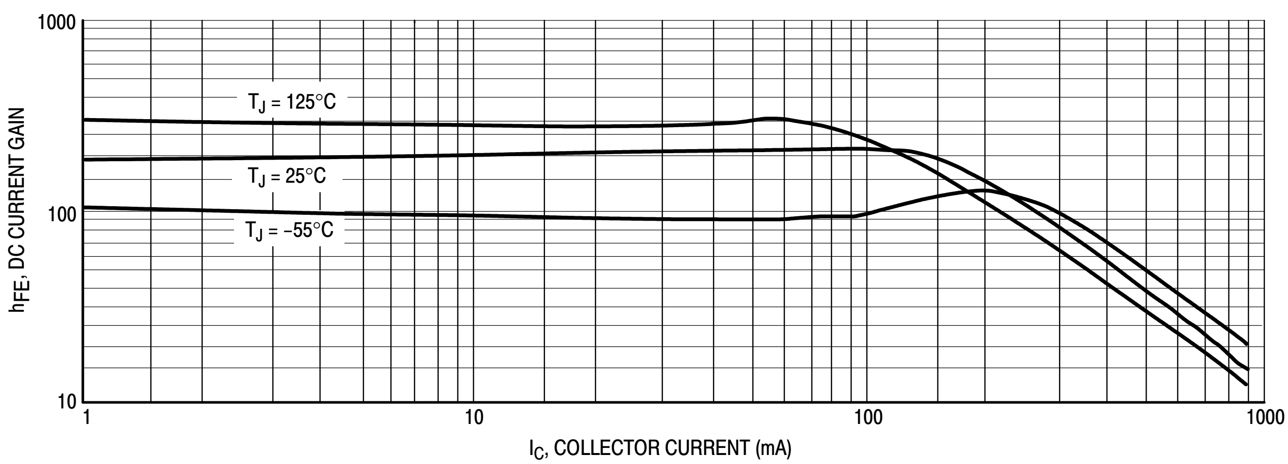


Figure 1. DC Current Gain

TYPICAL ELECTRICAL CHARACTERISTICS

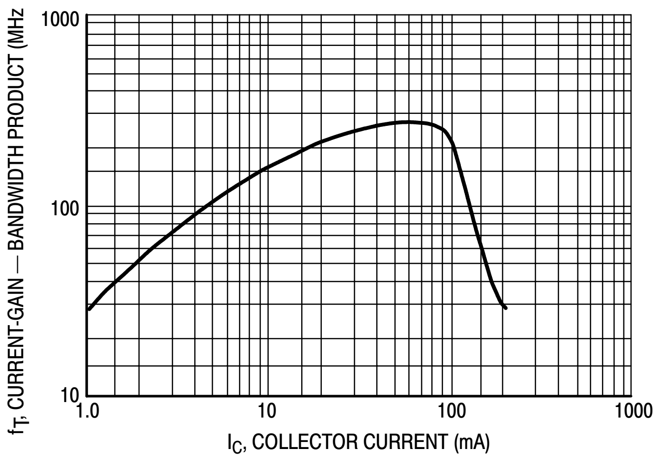


Figure 2. Current-Gain – Bandwidth Product

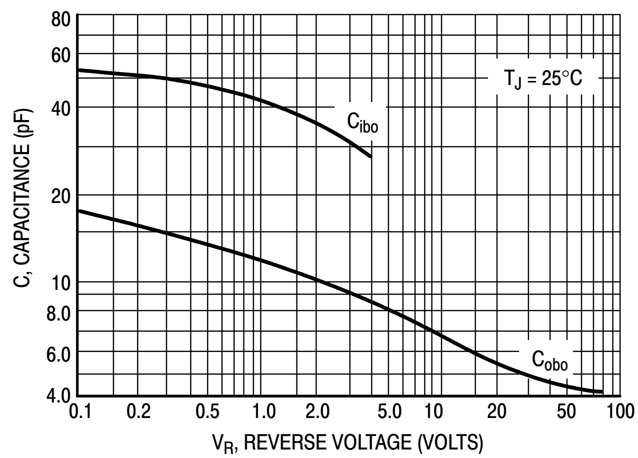


Figure 3. Capacitance

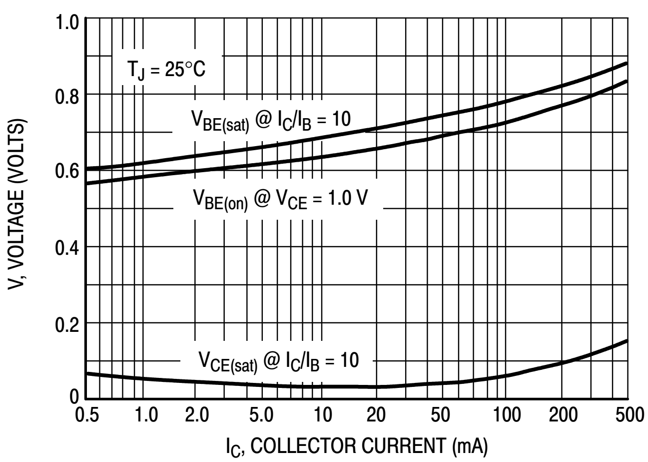


Figure 4. “On” Voltages

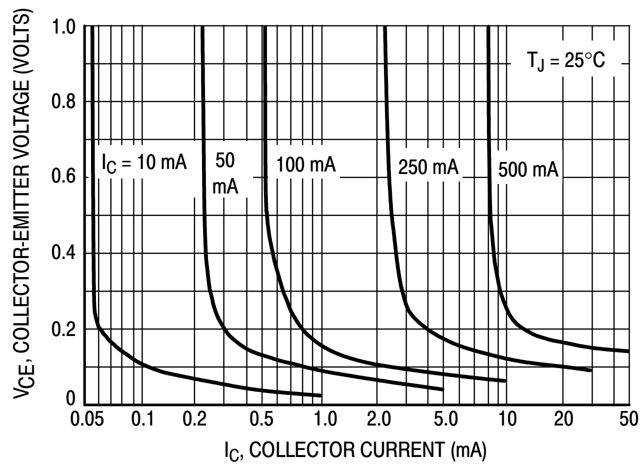


Figure 5. Collector Saturation Region

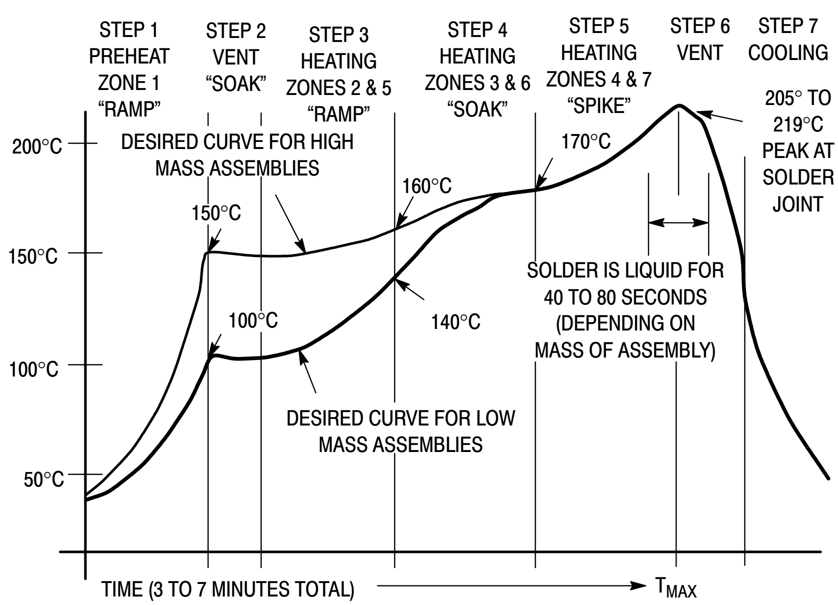


Figure 6. Typical Solder Heating Profile

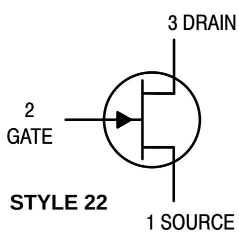
JFET VHF/UHF Amplifiers

N–Channel — Depletion

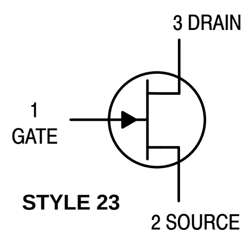
BF245A
BF245B

MAXIMUM RATINGS

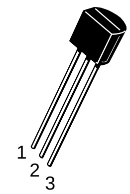
Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	±30	Vdc
Drain–Gate Voltage	V_{DG}	30	Vdc
Gate–Source Voltage	V_{GS}	30	Vdc
Drain Current	I_D	100	mAdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Channel Temperature Range	T_{stg}	–65 to +150	°C



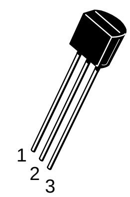
STYLE 22



STYLE 23



BF244A, BF244B
CASE 29–11, STYLE 22
TO–92 (TO–226AA)



BF245, BF245A,
BF245B, BF245C
CASE 29–11, STYLE 23
TO–92 (TO–226AA)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate–Source Breakdown Voltage (I_G = 1.0 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	30	—	—	Vdc
Gate–Source (V_{DS} = 15 Vdc, I_D = 200 μAdc)	BF245(1) BF245A, BF244A(2) BF245B, BF244B BF245C	V_{GS}	0.4 0.4 1.6 3.2	— — — —	7.5 2.2 3.8 7.5	Vdc
Gate–Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 10 nAdc)		$V_{GS(off)}$	–0.5	—	–8.0	Vdc
Gate Reverse Current (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSS}	—	—	5.0	nAdc
ON CHARACTERISTICS						
Zero–Gate–Voltage Drain Current (V_{DS} = 15 Vdc, V_{GS} = 0)	BF245(1) BF245A, BF244A(2) BF245B, BF244B BF245C	I_{DSS}	2.0 2.0 6.0 12	— — — —	25 6.5 15 25	mAdc

1. On orders against the BF245, any or all subgroups might be shipped.
2. On orders against the BF244A, any or all subgroups might be shipped.

June, 2001 – Rev. 0

Publication Order Number:
BF245A/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
SMALL–SIGNAL CHARACTERISTICS						
Forward Transfer Admittance	(V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|Y_{fs}\|$	3.0	—	6.5	mmhos
Output Admittance	(V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|Y_{os}\|$	—	40	—	μmhos
Forward Transfer Admittance	(V_{DS} = 15 Vdc, V_{GS} = 0, f = 200 MHz)	$\|Y_{fs}\|$	—	5.6	—	mmhos
Reverse Transfer Admittance	(V_{DS} = 15 Vdc, V_{GS} = 0, f = 200 MHz)	$\|Y_{rs}\|$	—	1.0	—	mmhos
Input Capacitance	(V_{DS} = 20 Vdc, $-V_{GS}$ = 1.0 Vdc)	C_{iss}	—	3.0	—	pF
Reverse Transfer Capacitance	(V_{DS} = 20 Vdc, $-V_{GS}$ = 1.0 Vdc, f = 1.0 MHz)	C_{rss}	—	0.7	—	pF
Output Capacitance	(V_{DS} = 20 Vdc, $-V_{GS}$ = 1.0 Vdc, f = 1.0 MHz)	C_{oss}	—	0.9	—	pF
Cut–off Frequency(3)	(V_{DS} = 15 Vdc, V_{GS} = 0)	$F_{(Yfs)}$	—	700	—	MHz

3. The frequency at which g_{fs} is 0.7 of its value at 1 kHz.

COMMON SOURCE CHARACTERISTICS

ADMITTANCE PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C)

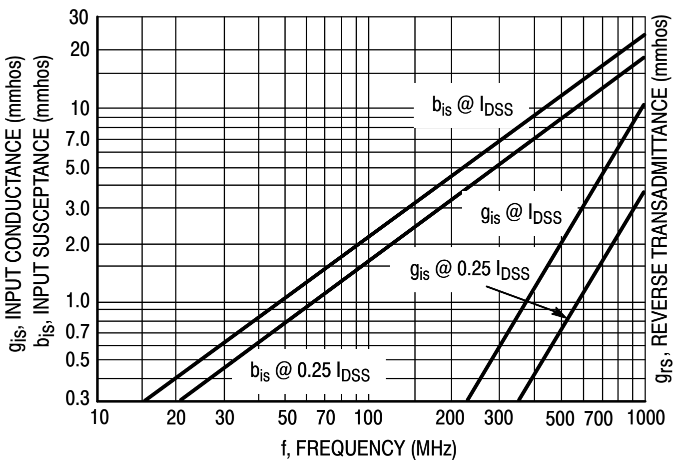


Figure 1. Input Admittance (y_{is})

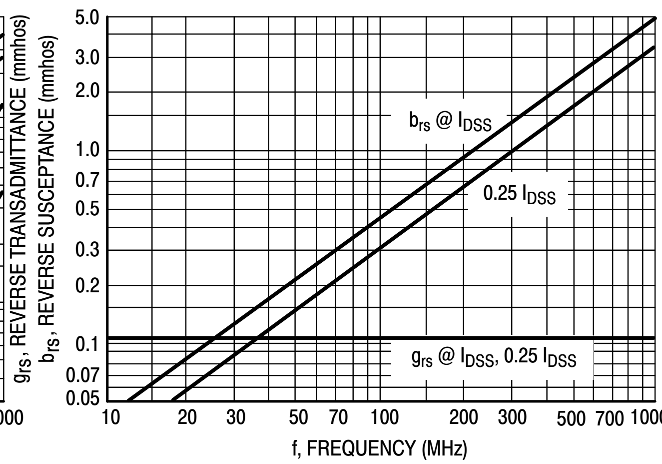


Figure 2. Reverse Transfer Admittance (y_{rs})

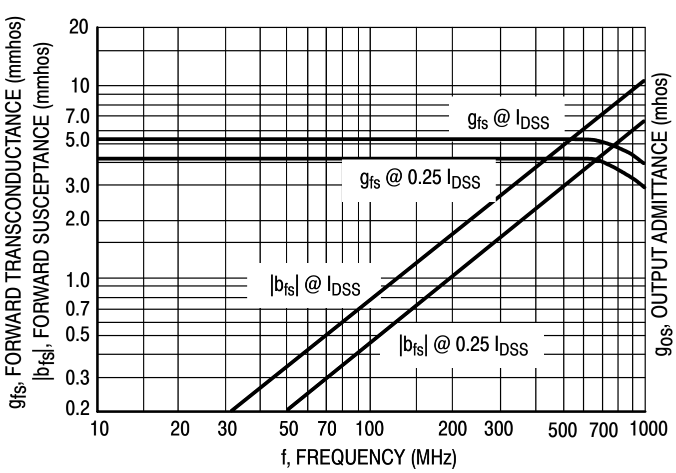


Figure 3. Forward Transadmittance (y_{fs})

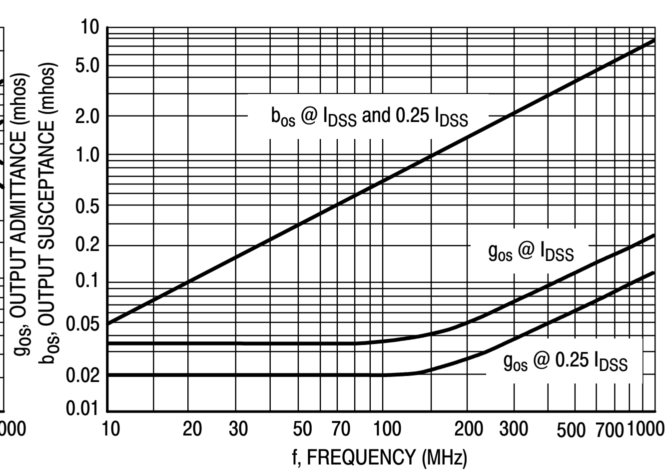


Figure 4. Output Admittance (y_{os})

COMMON SOURCE CHARACTERISTICS

S–PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

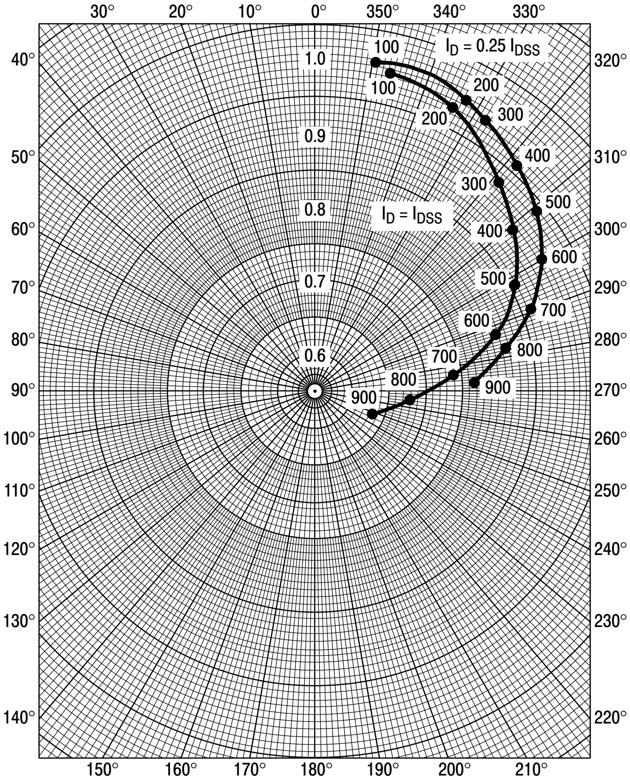


Figure 5. S_{11s}

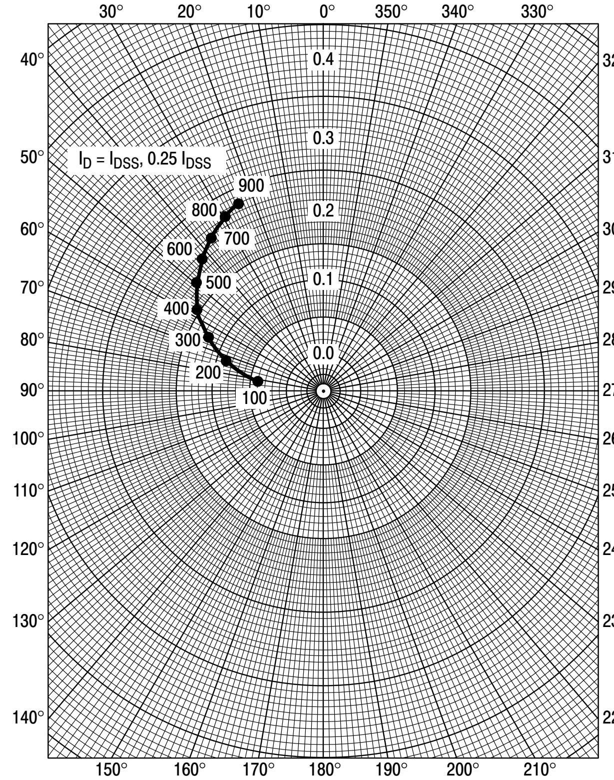


Figure 6. S_{12s}

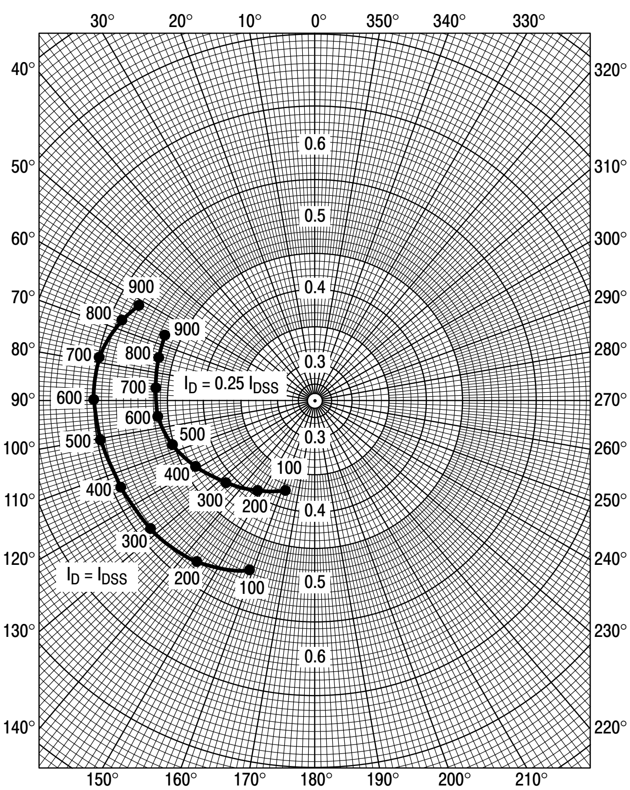


Figure 7. S_{21s}

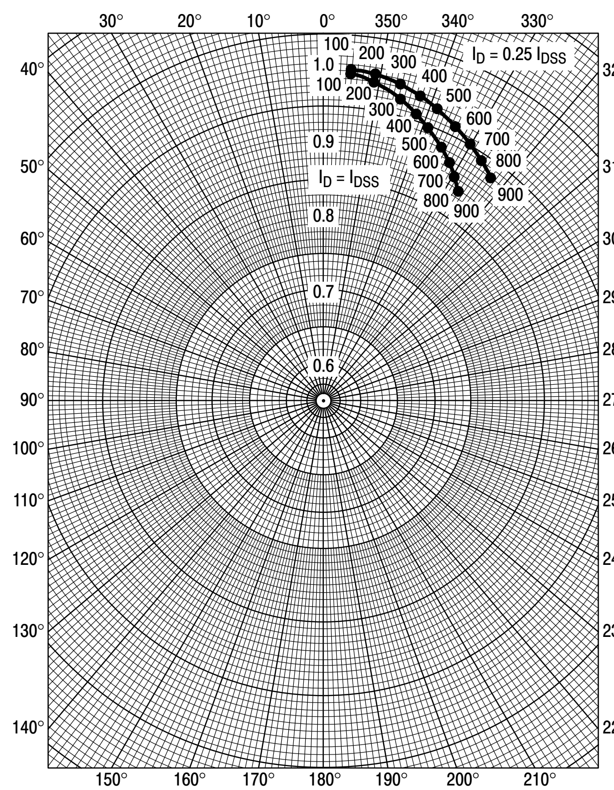


Figure 8. S_{22s}

COMMON GATE CHARACTERISTICS

ADMITTANCE PARAMETERS

(V_{DG} = 15 Vdc, $T_{channel}$ = 25°C)

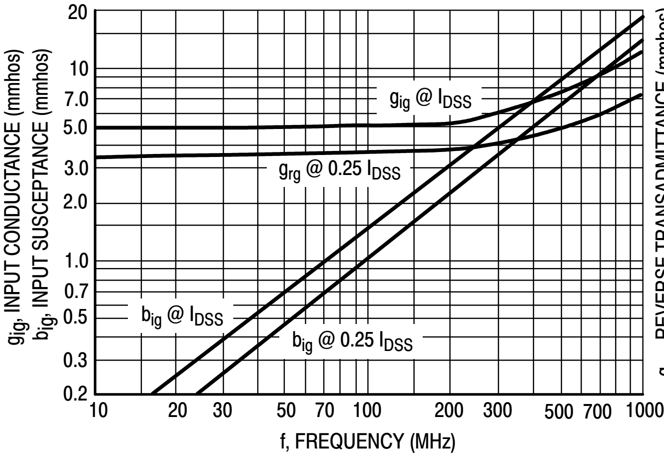


Figure 9. Input Admittance (y_{ig})

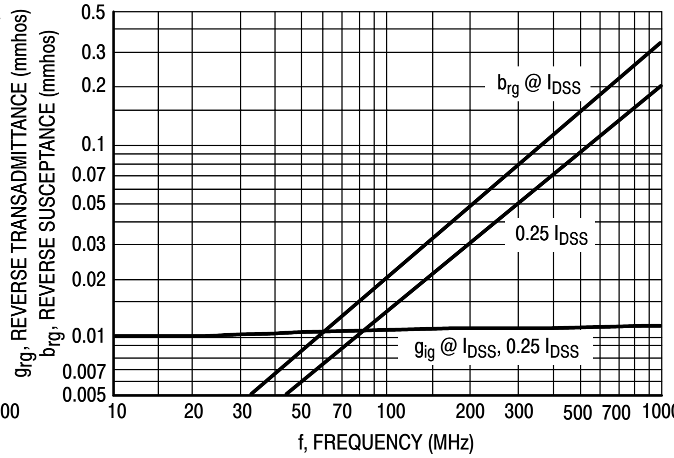


Figure 10. Reverse Transfer Admittance (y_{rg})

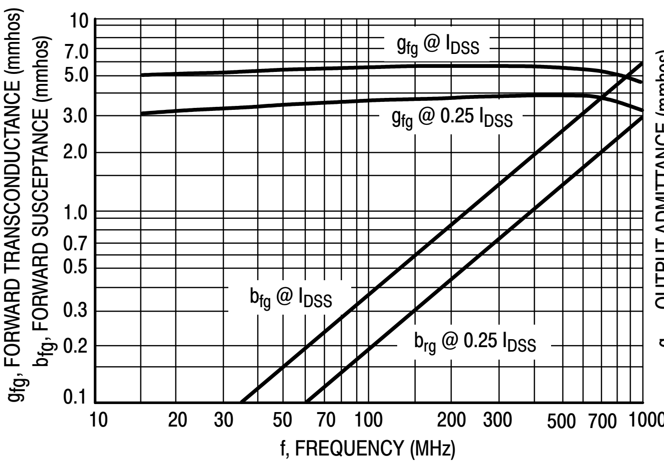


Figure 11. Forward Transfer Admittance (y_{fg})

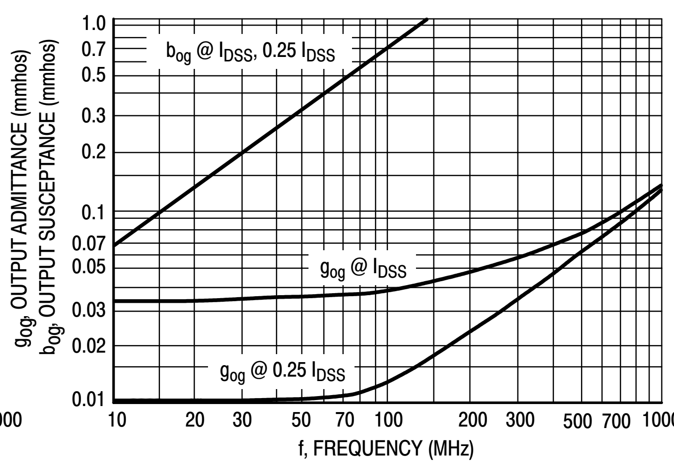


Figure 12. Output Admittance (y_{og})

COMMON GATE CHARACTERISTICS

S–PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

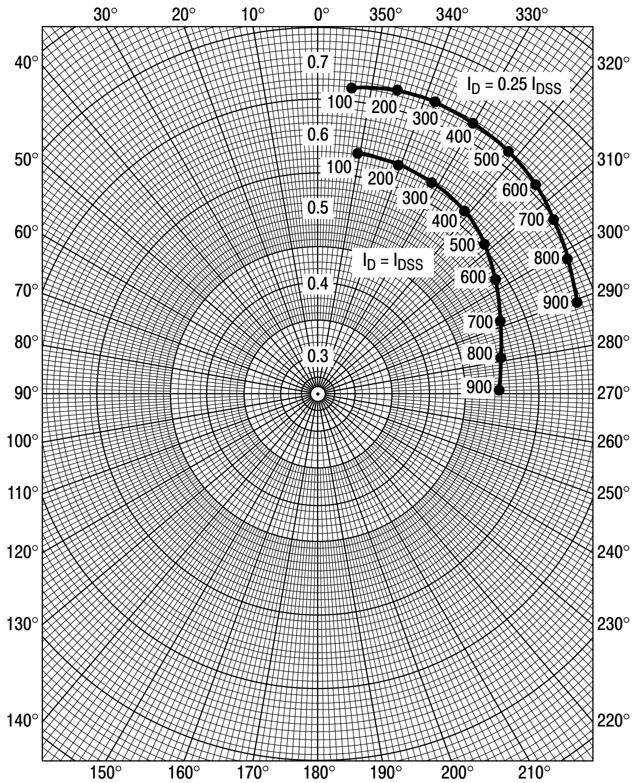


Figure 13. S_{11g}

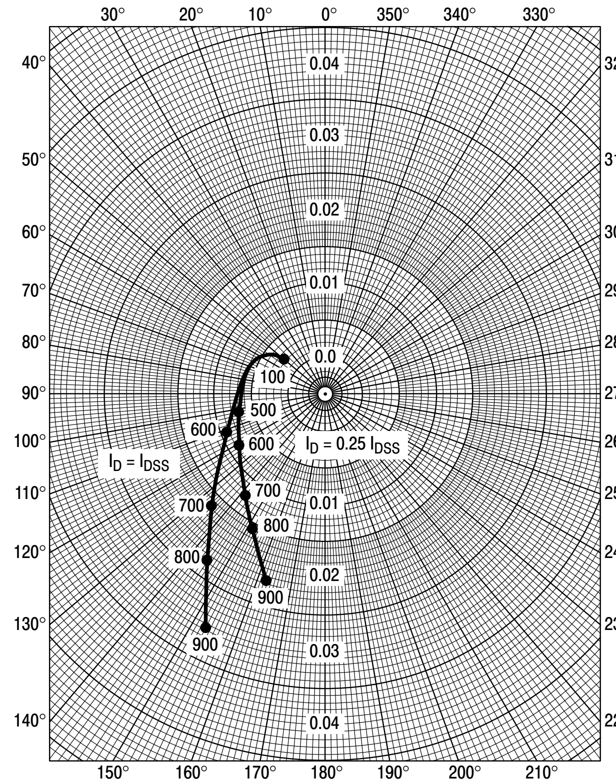


Figure 14. S_{12g}

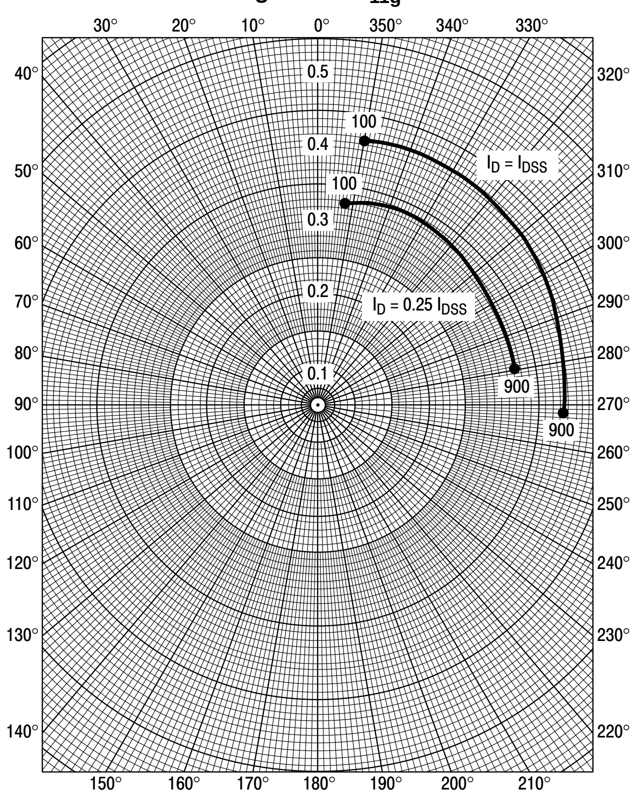


Figure 15. S_{21g}

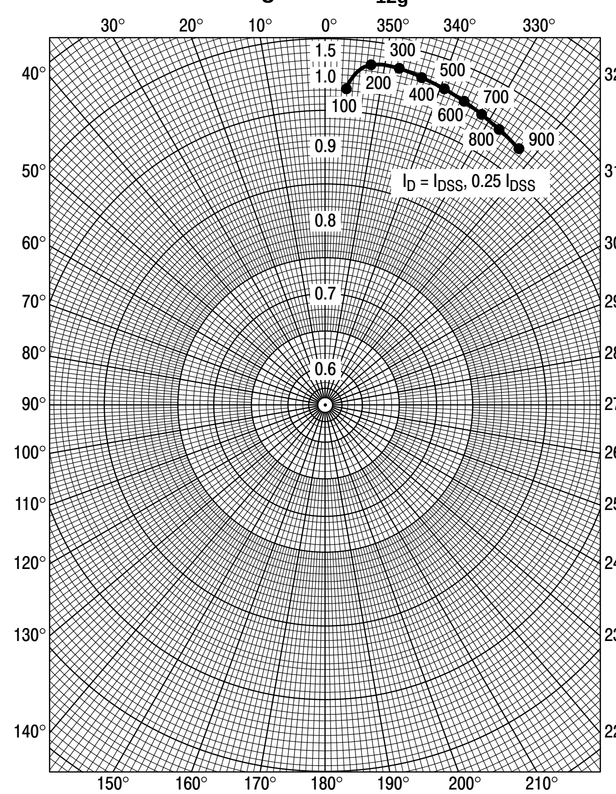


Figure 16. S_{22g}

BF256A

BF256A is a Preferred Device

JFET - General Purpose

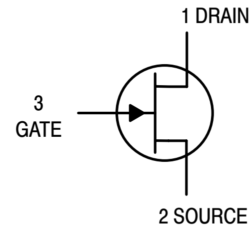
N–Channel

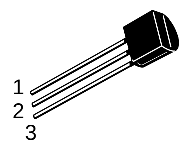
N–Channel Junction Field Effect Transistor designed for VHF and UHF applications.

- Low Cost TO–92 Type Package
- Forward Transfer Admittance, Y_{fs} = 4.5 mmhos (Min)
- Transfer Capacitance – C_{rss} = 0.7 (Typ)
- Power Gain at f = 800 MHz, Typ. = 11 dB

ON Semiconductor™

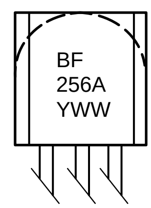
http://onsemi.com





TO–92
CASE 29
STYLE 5

MARKING DIAGRAMS



Y = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping
BF256A	TO–92	5000 Units/Box

Preferred devices are recommended choices for future use and best overall value.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	30	Vdc
Drain–Gate Voltage	V_{DG}	30	Vdc
Gate–Source Voltage	V_{GS}	30	Vdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.88	mW mW/°C
Operating and Storage Channel Temperature Range	$T_{channel}$, T_{stg}	–65 to +150	°C

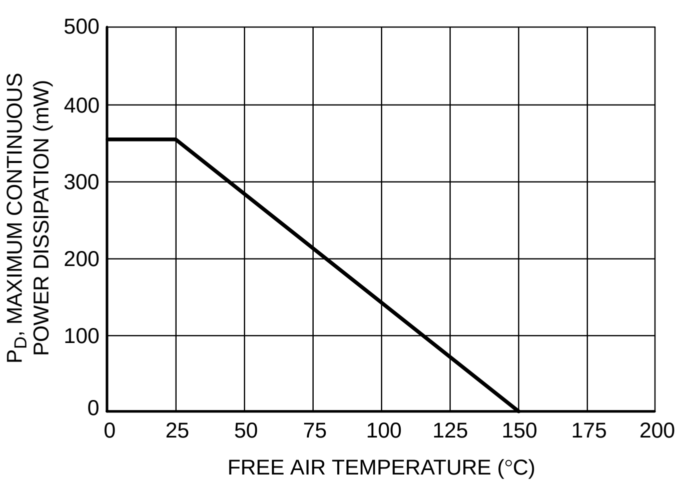


Figure 1. Power Derating Curve

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate–Source Breakdown Voltage	($-I_G$ = –1.0 μAdc, V_{DS} = 0)	$-V_{(BR)GSS}$	30	–	—	Vdc
Gate–Source Voltage	(V_{DS} = 15 Vdc, I_D = 200 μA)	$-V_{GS}$	0.5	—	7.5	Vdc
Gate Reverse Current	($-V_{GS}$ = 20 Vdc, V_{DS} = 0)	$-I_{GSS}$	—	—	5.0	nAdc
ON CHARACTERISTICS						
Zero–Gate–Voltage Drain Current (Note 1.)	(V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	3.0	–	7.0	mAdc
SMALL–SIGNAL CHARACTERISTICS						
Forward Transfer Admittance	(V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 kHz)	$\|Y_{fs}\|$	4.5	5.0	–	mmhos
Reverse Transfer Capacitance	(V_{DS} = 20 Vdc, $-V_{GS}$ = 1 Vdc, f = 1 MHz)	C_{rss}	–	0.7	–	pF
Output Capacitance	(V_{DS} = 20 Vdc, V_{GS} = 0, f = 1 MHz)	C_{oss}	–	1.0	–	pF
Cut–Off Frequency (Note 2.)	(V_{DS} = 15 Vdc, V_{GS} = 0)	f_{gfs}	–	1000	–	MHz

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.
2. The frequency at which gfs is 0.7 of its value at 1 KHz.

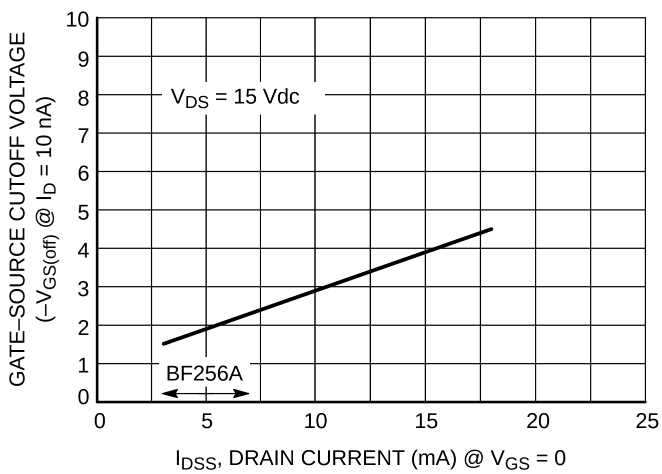


Figure 2. Correlation Between $-V_{GS(off)}$ and I_{DSS}

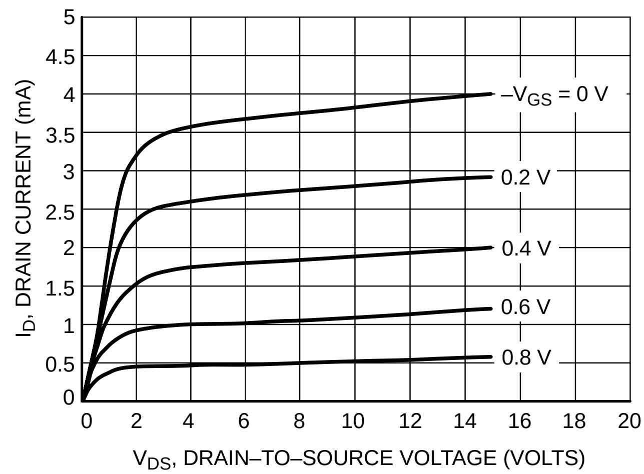


Figure 3. Drain Current versus Drain–to–Source Voltage

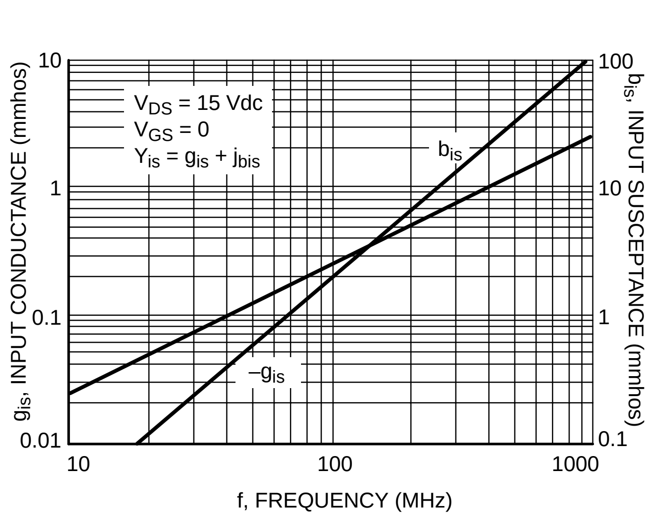


Figure 4. Input Admittance versus Frequency

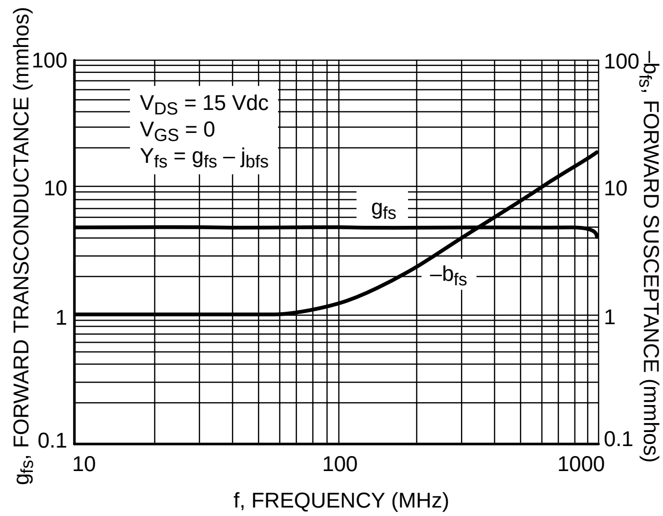


Figure 5. Forward Transfer Admittance versus Frequency

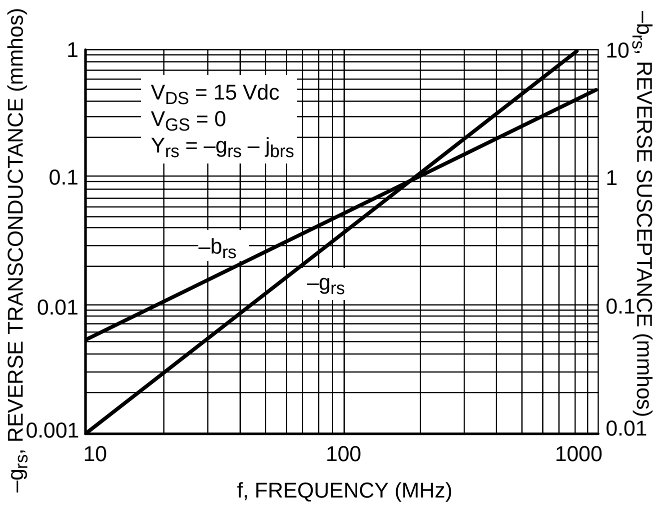


Figure 6. Reverse Transfer Admittance versus Frequency

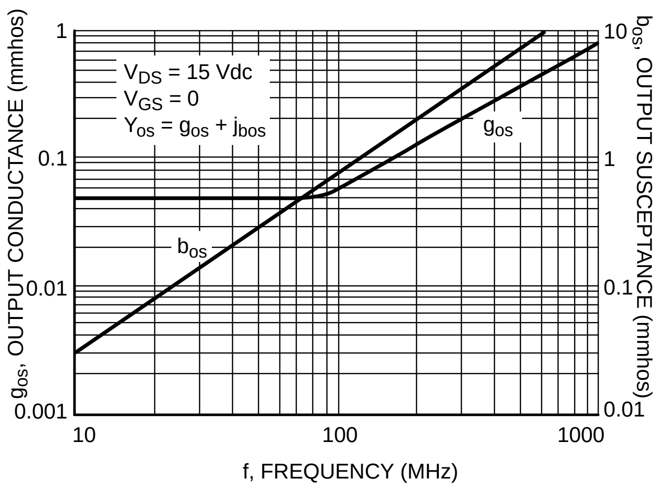


Figure 7. Output Admittance versus Frequency

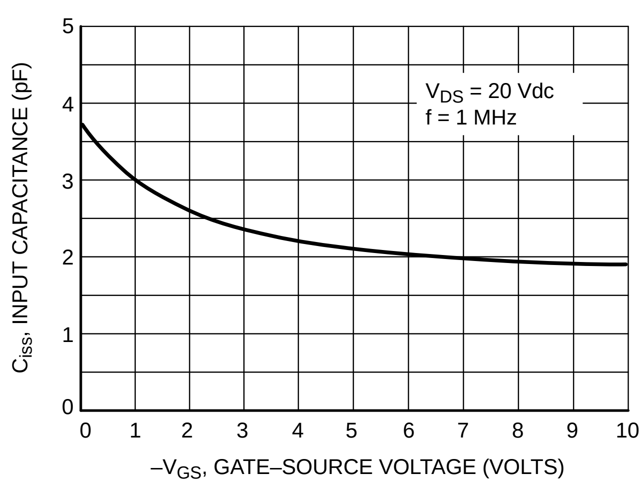


Figure 8. Input Capacitance versus Gate–Source Voltage

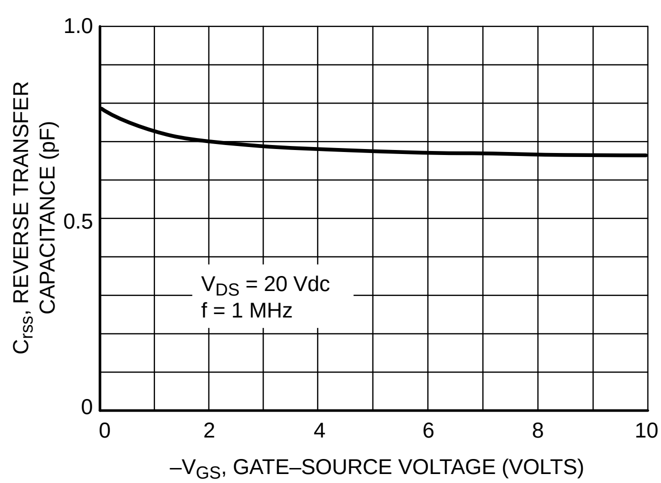
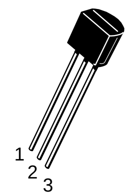


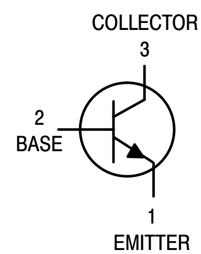
Figure 9. Reverse Transfer Capacitance versus Gate–Source Voltage

High Voltage Transistor
NPN Silicon

BF393



CASE 29–04, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	300	Vdc
Collector–Base Voltage	V_{CBO}	300	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B =0)	$V_{(BR)CEO}$	300	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	300	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CB} = 200 Vdc, I_E = 0)	I_{CBO}	—	0.1	μAdc
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

February, 2001 – Rev. 1

Publication Order Number:
BF393/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc)	h_{FE}	 25 40	 — —	—
Collector–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{CE(sat)}$	—	2.0	Vdc
Base–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{BE(sat)}$	—	2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS				
CurrentGain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)	f_T	50	—	MHz
Common Emitter Feedback Capacitance (V_{CB} = 60 Vdc, I_E = 0, f = 1.0 MHz)	C_{re}	—	2.0	pF

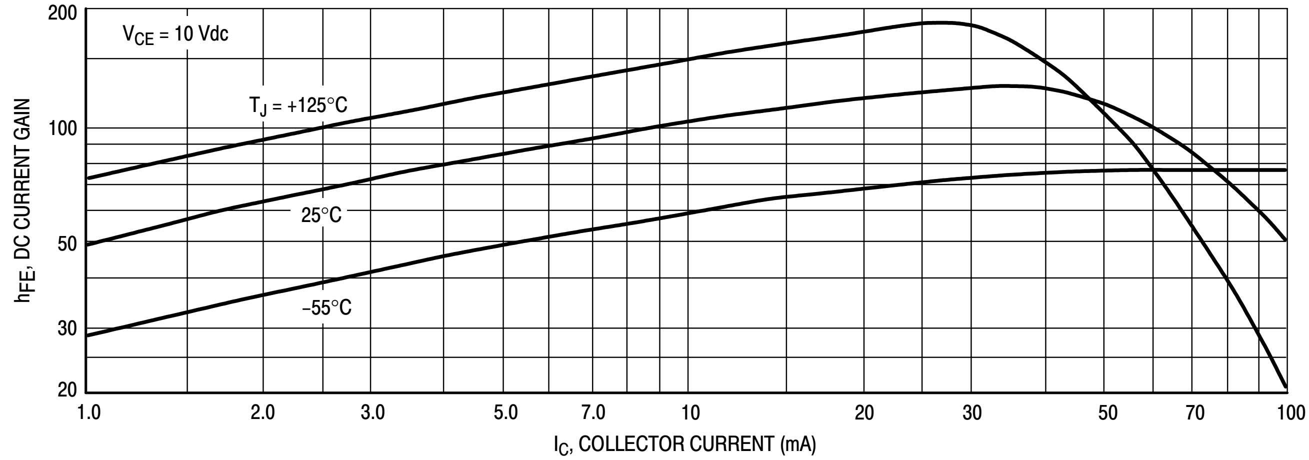


Figure 1. DC Current Gain

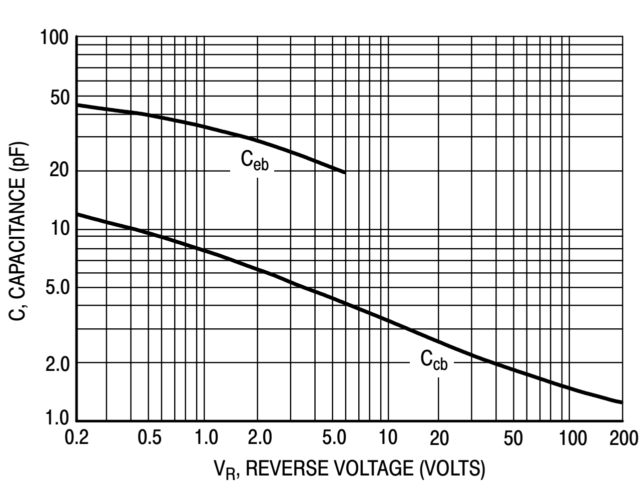


Figure 2. Capacitances

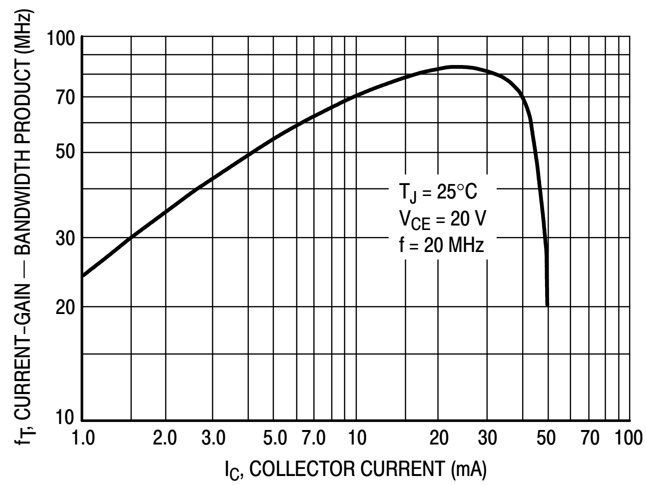


Figure 3. Current−Gain — Bandwidth Product

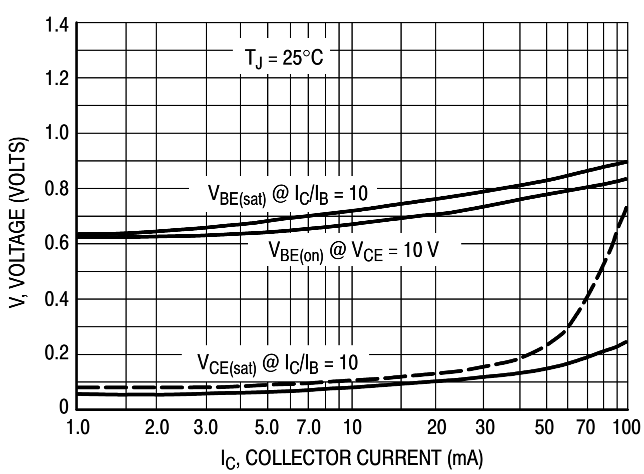


Figure 4. “On” Voltages

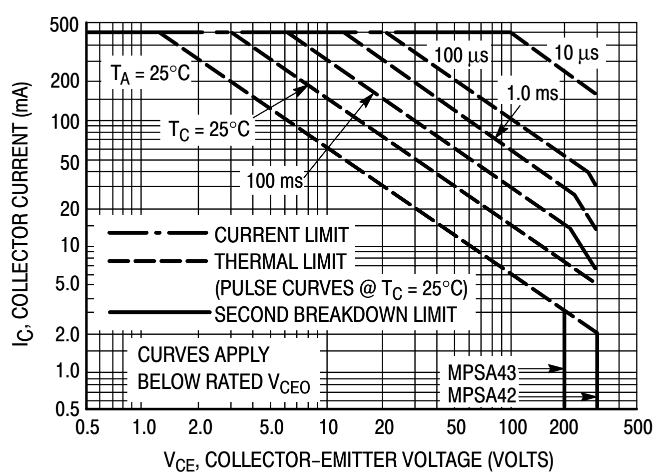
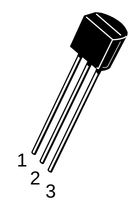


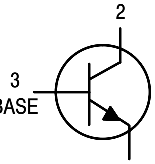
Figure 5. Maximum Forward Bias Safe Operating Area

High Voltage Transistors
NPN Silicon

BF422



CASE 29–11, STYLE 14
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	BF422	Unit
Collector–Emitter Voltage	V_{CEO}	250	Vdc
Collector–Base Voltage	V_{CBO}	250	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage[(1)] (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	250	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	250	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 200 Vdc, I_E = 0)	I_{CBO}	—	—	μAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	—	nAdc

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = 25 mAdc, V_{CE} = 20 Vdc)BF422	h_{FE}	50	—	—
Collector–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{BE(sat)}$	—	2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS				
CurrentGain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	f_T	60	—	MHz
Common Emitter Feedback Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{re}	—	1.6	pF

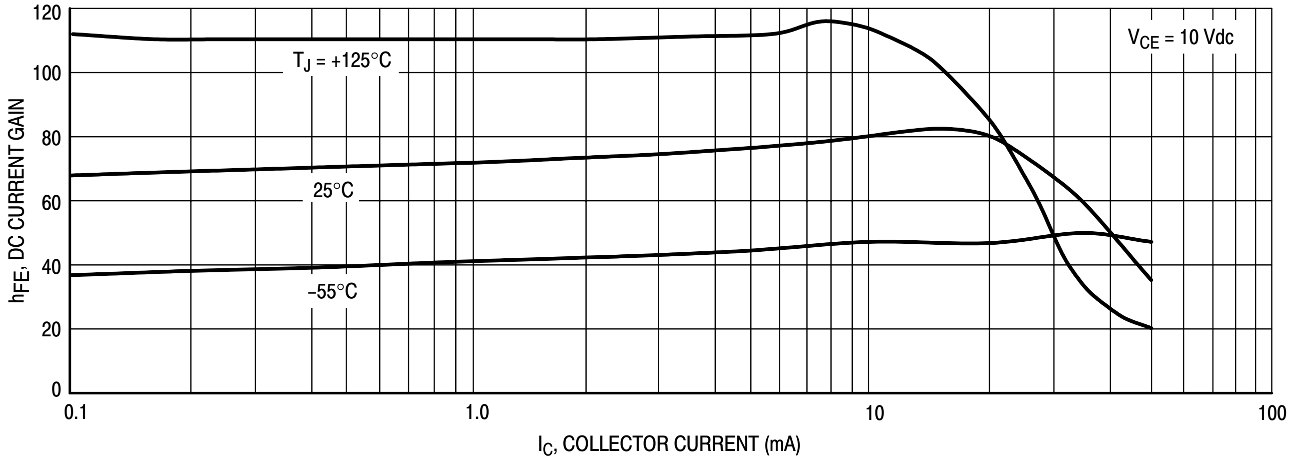


Figure 1. DC Current Gain

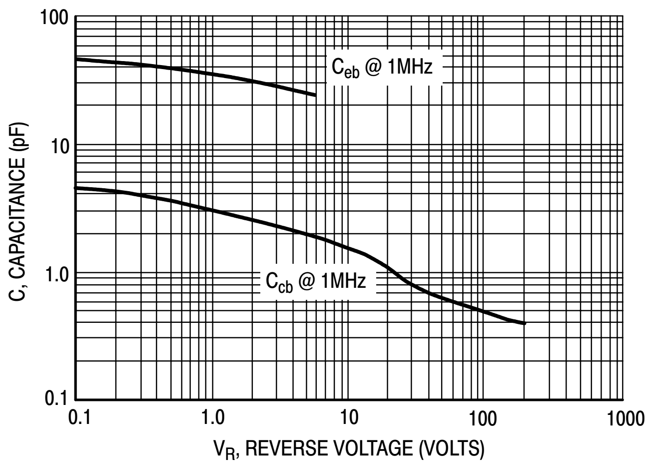


Figure 2. Capacitance

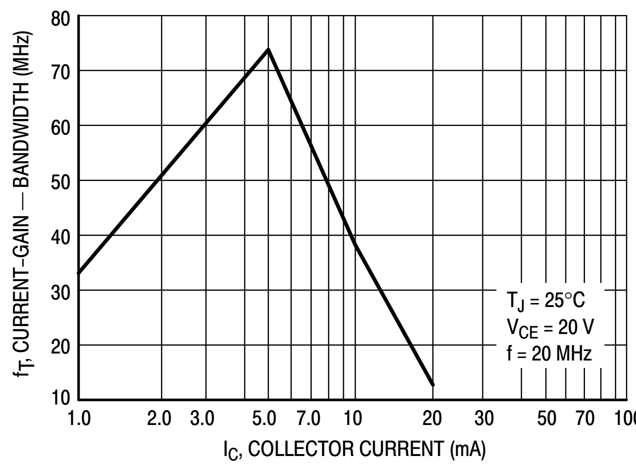


Figure 3. Current−Gain − Bandwidth

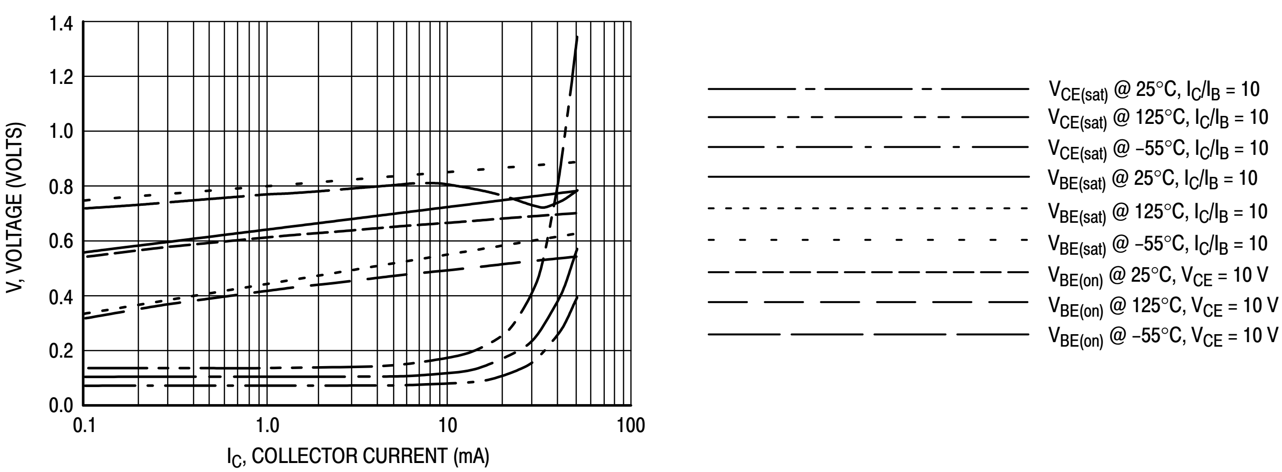
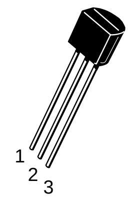


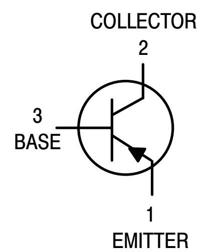
Figure 4. “ON” Voltages

High Voltage Transistors
PNP Silicon

BF423



CASE 29–11, STYLE 14
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	BF423	Unit
Collector–Emitter Voltage	V_{CEO}	–250	Vdc
Collector–Base Voltage	V_{CBO}	–250	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current — Continuous	I_C	–500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (1) (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–250	—	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–250	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –100 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	Vdc
Collector Cutoff Current (V_{CB} = –200 Vdc, I_E = 0)	I_{CBO}	—	—	μAdc
Emitter Cutoff Current (V_{EB} = –5.0 Vdc, I_C = 0)	I_{EBO}	—	—	nAdc

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

June, 2001 – Rev. 0

Publication Order Number:
BF423/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = –25 mA, V_{CE} = –20 Vdc)	h_{FE}	50	—	—
Collector–Emitter Saturation Voltage (I_C = –20 mAdc, I_B = –2.0 mAdc)	$V_{CE(sat)}$	—	–0.5	Vdc
Base–Emitter Saturation Voltage (I_C = –20 mA, I_B = –2.0 mA)	$V_{BE(sat)}$	—	–2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –10 Vdc, f = 20 MHz)	f_T	60	—	MHz
Common Emitter Feedback Capacitance (V_{CB} = –30 Vdc, I_E = 0, f = 1.0 MHz)	C_{re}	—	2.8	pF

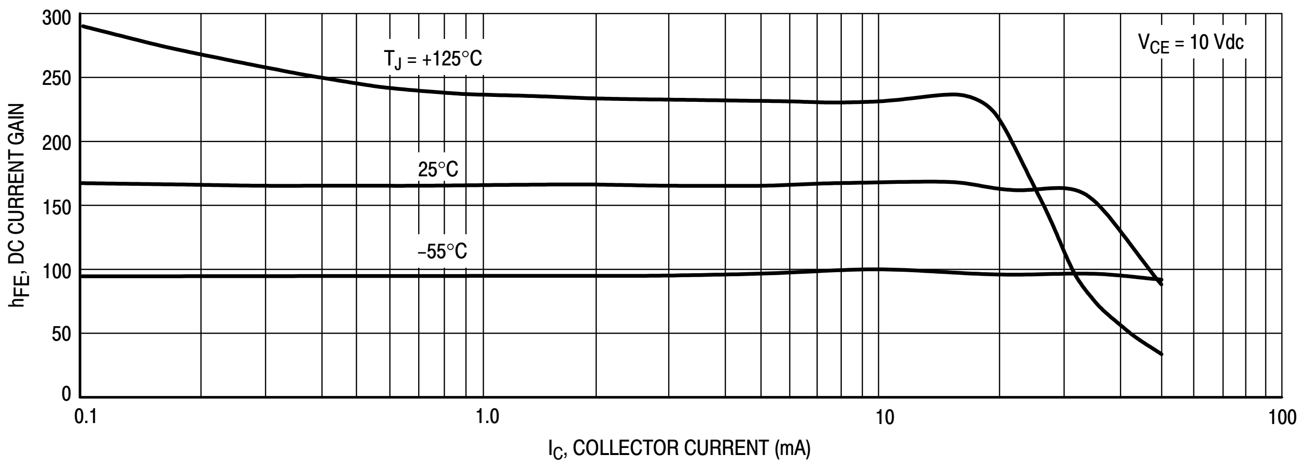


Figure 1. DC Current Gain

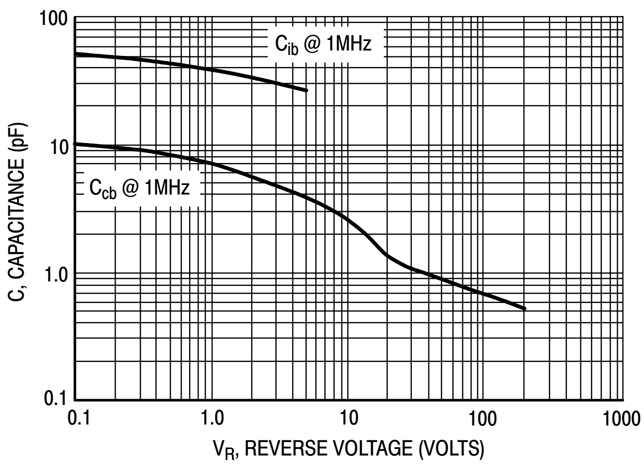


Figure 2. Capacitance

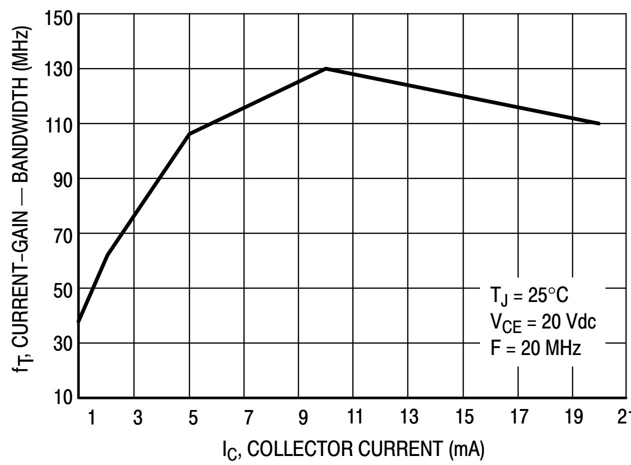


Figure 3. Current−Gain — Bandwidth

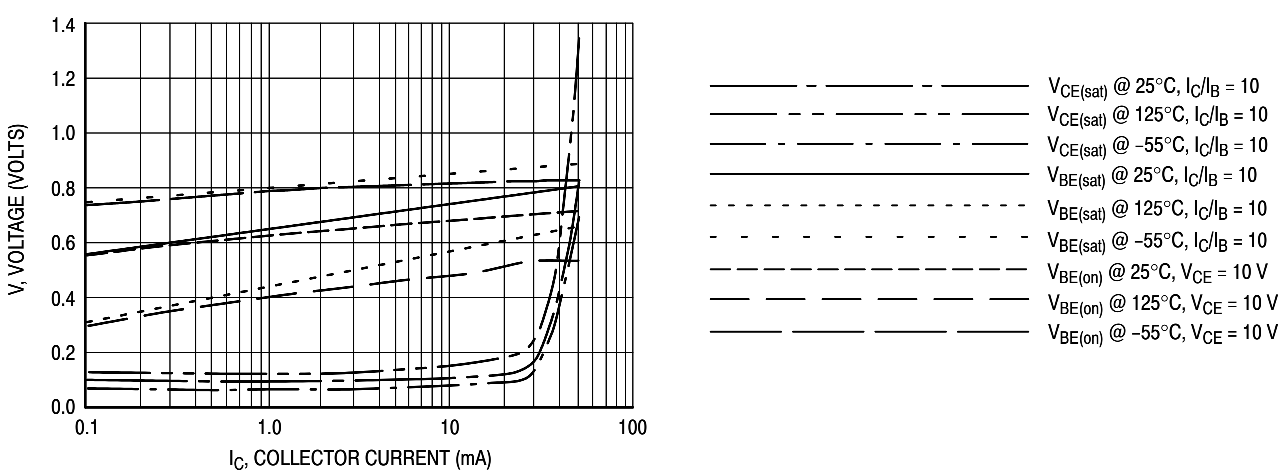
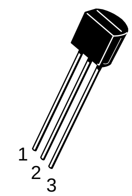


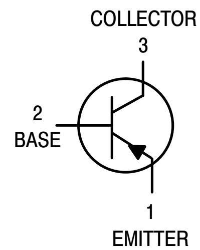
Figure 4. “ON” Voltages

BF493S

High Voltage Transistor
PNP Silicon



CASE 29–04, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–350	Vdc
Collector–Base Voltage	V_{CBO}	–350	Vdc
Emitter–Base Voltage	V_{EBO}	–6.0	Vdc
Collector Current — Continuous	I_C	–500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (1) (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–350	—	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–350	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –100 μAdc, I_C = 0)	$V_{(BR)EBO}$	–6.0	—	Vdc
Collector Cutoff Current (V_{CE} = –250 Vdc)	I_{CES}	—	–10	nAdc
Emitter Cutoff Current (V_{EB} = –6.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = –250 Vdc, I_E = 0, T_A = 25°C) (V_{CB} = –250 Vdc, I_E = 0, T_A = 100°C)	I_{CBO}	 — —	 –0.005 –1.0	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

March, 2001 – Rev. 1

Publication Order Number:
BF493S/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = –1.0 mAdc, V_{CE} = –10 Vdc)		25	—	
(I_C = –10 mAdc, V_{CE} = –10 Vdc)		40	—	
Collector–Emitter Saturation Voltage (I_C = –20 mAdc, I_B = –2.0 mAdc)	$V_{CE(sat)}$	—	–2.0	Vdc
Base–Emitter On Voltage (I_C = –20 mA, I_B = –2.0 mA)	$V_{BE(sat)}$	—	–2.0	Vdc
DYNAMIC CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 20 MHz)	f_T	50	—	MHz
Common–Emitter Feedback Capacitance (V_{CB} = –100 Vdc, I_E = 0, f = 1.0 MHz)	C_{re}	—	1.6	pF

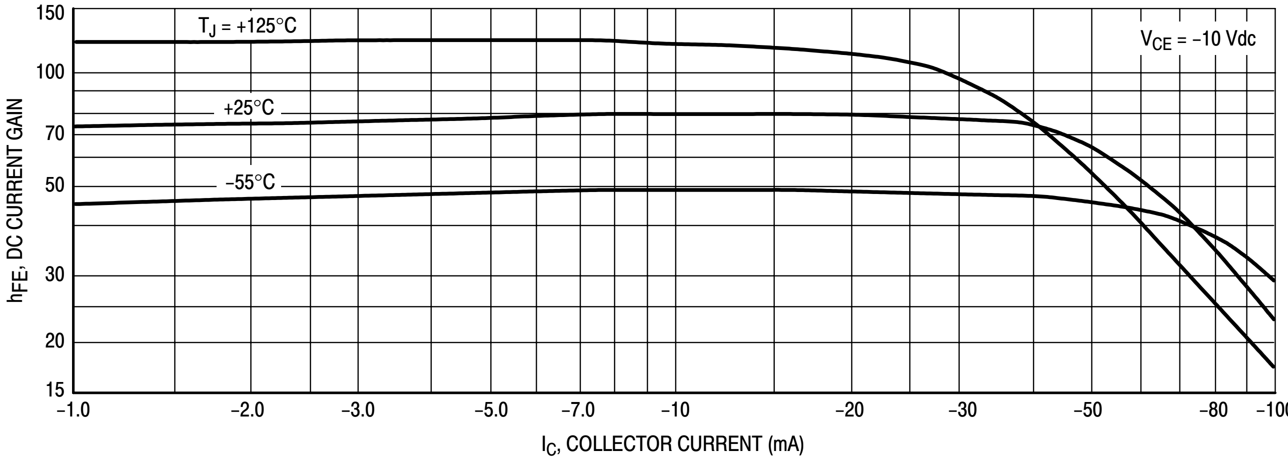


Figure 1. DC Current Gain

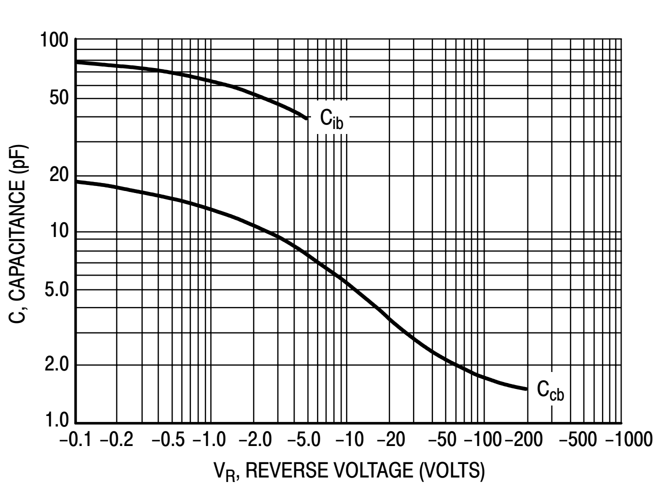


Figure 2. Capacitances

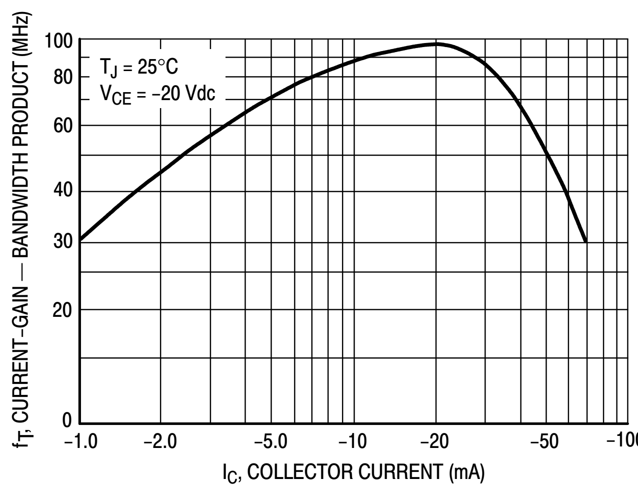


Figure 3. Current−Gain — Bandwidth Product

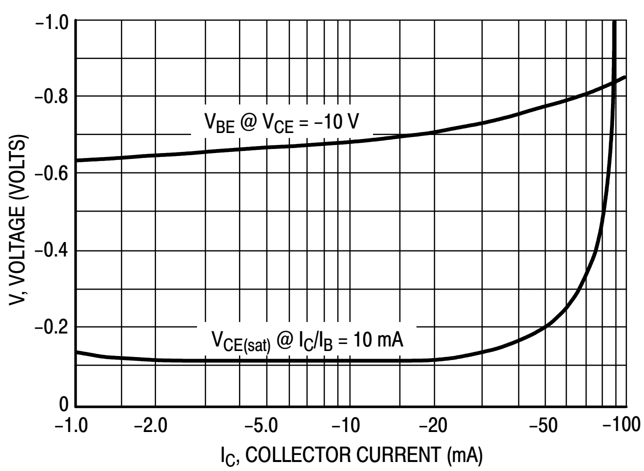


Figure 4. “On” Voltages

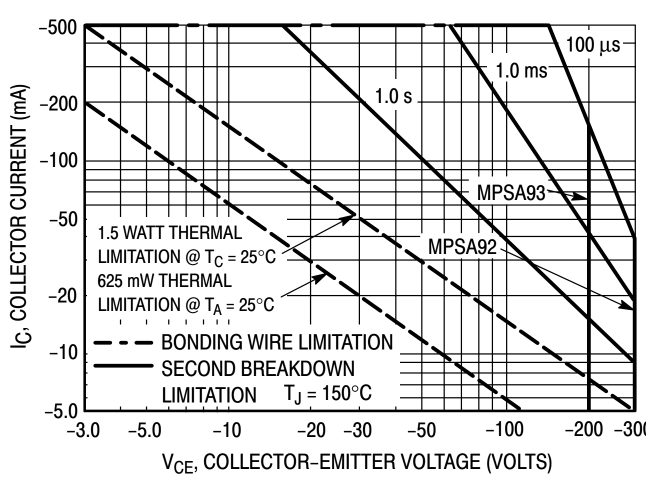


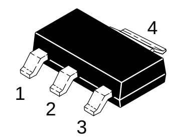
Figure 5. Active Region — Safe Operating Area

NPN Silicon Transistor

BF720T1

ON Semiconductor Preferred Device

NPN SILICON TRANSISTOR SURFACE MOUNT



CASE 318E-04, STYLE 1
SOT–223 (TO-261AA)

MAXIMUM RATINGS

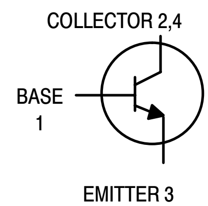
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	300	Vdc
Collector-Base Voltage	V_{CBO}	300	Vdc
Collector-Emitter Voltage	V_{CER}	300	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current	I_C	100	mAdc
Total Power Dissipation up to T_A = 25°C	P_D	1.5	Watts
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	150	°C

DEVICE MARKING

DC

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance from Junction-to-Ambient(1)	$R_{\theta JA}$	83.3	°C/W



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	300	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	300	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, R_{BE} = 2.7 kΩ)	$V_{(BR)CER}$	300	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector-Base Cutoff Current (V_{CB} = 200 Vdc, I_E = 0)	I_{CBO}	—	10	nAdc
Collector–Emitter Cutoff Current	I_{CER}			
(V_{CE} = 250 Vdc, R_{BE} = 2.7 kΩ)		—	50	nAdc
(V_{CE} = 200 Vdc, R_{BE} = 2.7 kΩ, T_J = 150°C)		—	10	μAdc

1. Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 in^2.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = 25 mAdc, V_{CE} = 20 Vdc)	h_{FE}	50	—	—
Collector-Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	—	0.6	Vdc
DYNAMIC CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 35 MHz)	f_T	60	—	MHz
Feedback Capacitance (V_{CE} = 30 Vdc, I_C = 0, f = 1.0 MHz)	C_{re}	—	1.6	pF

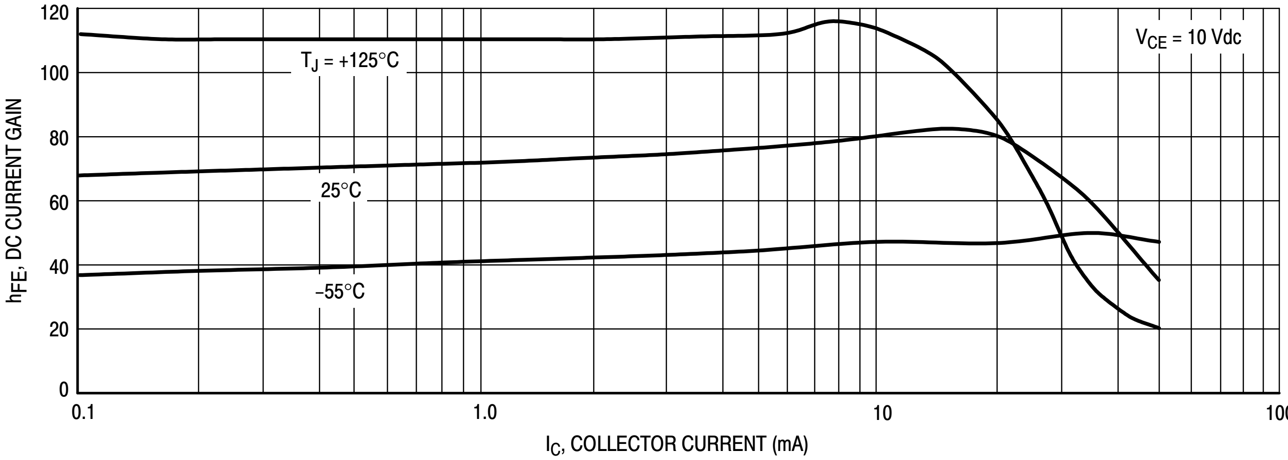


Figure 1. DC Current Gain

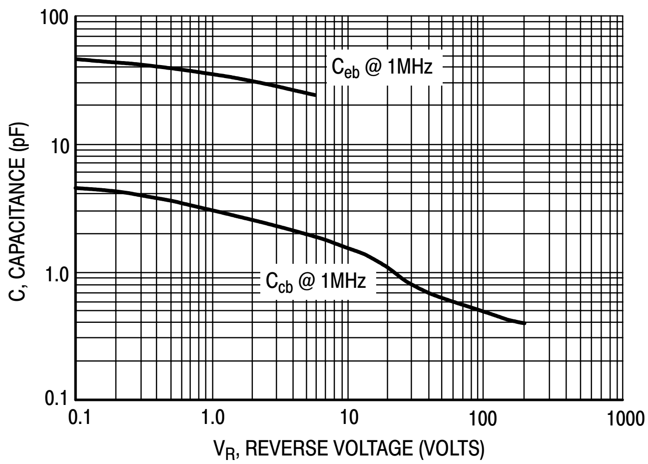


Figure 2. Capacitance

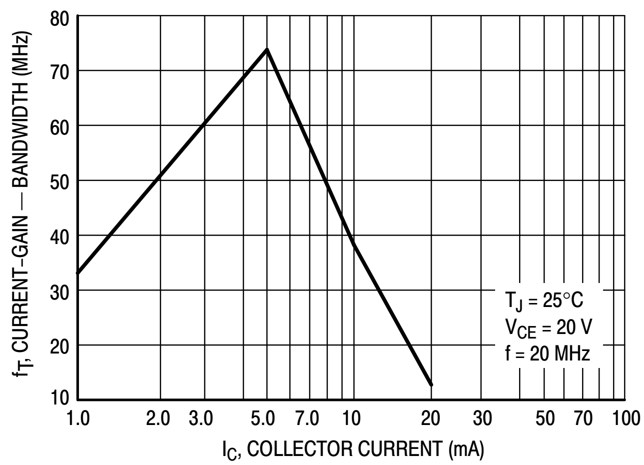


Figure 3. Current−Gain – Bandwidth

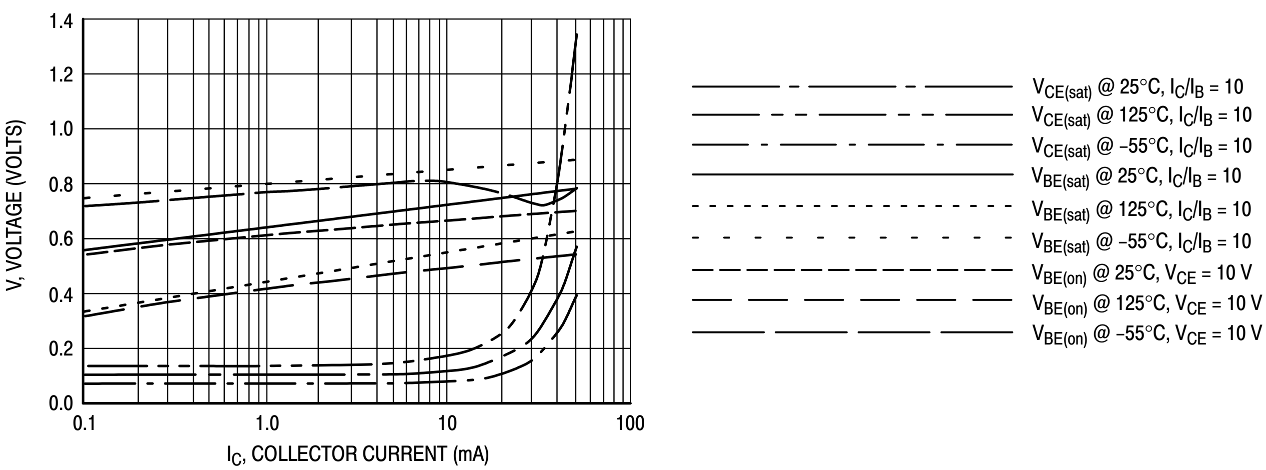


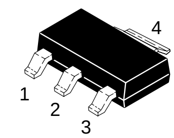
Figure 4. “ON” Voltages

BF721T1

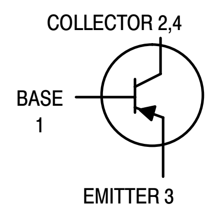
ON Semiconductors Preferred Device

PNP Silicon Transistor

PNP SILICON TRANSISTOR SURFACE MOUNT



CASE 318E-04, STYLE 1
SOT–223 (TO-261AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	–300	Vdc
Collector-Base Voltage	V_{CBO}	–300	Vdc
Collector-Emitter Voltage	V_{CER}	–300	Vdc
Emitter-Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current	I_C	–100	mAdc
Total Power Dissipation up to T_A = 25°C(1)	P_D	1.5	Watts
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	150	°C

DEVICE MARKING

DF

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance from Junction to Ambient(1)	$R_{\theta JA}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–300	—	Vdc
Collector-Base Breakdown Voltage (I_C = –100 µAdc, I_E = 0)	$V_{(BR)CBO}$	–300	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = –100 µAdc, R_{BE} = 2.7 kΩ)	$V_{(BR)CER}$	–300	—	Vdc
Emitter-Base Breakdown Voltage (I_E = –10 µAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	Vdc
Collector-Base Cutoff Current (V_{CB} = –200 Vdc, I_E = 0)	I_{CBO}	—	–10	nAdc
Collector–Emitter Cutoff Current (V_{CE} = –250 Vdc, R_{BE} = 2.7 kΩ) (V_{CE} = –200 Vdc, R_{BE} = 2.7 kΩ, T_J = 150°C)	I_{CER}	 — —	 –50 –10	 nAdc µAdc

1. Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 in^2.

Preferred devices are ON Semiconductors recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (V_{CE} = –25 mAdc, V_{CE} = –20 Vdc)	h_{FE}	50	—	—
Collector-Emitter Saturation Voltage (I_C = –30 mAdc, I_B = –5.0 mAdc)	$V_{CE(sat)}$	—	–0.8	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain — Bandwidth Product (V_{CE} = –10 Vdc, I_C = –10 mAdc, f = 35 MHz)	f_T	60	—	MHz
Feedback Capacitance (V_{CE} = –30 Vdc, I_C = 0, f = 1.0 MHz)	C_{re}	—	1.6	pF

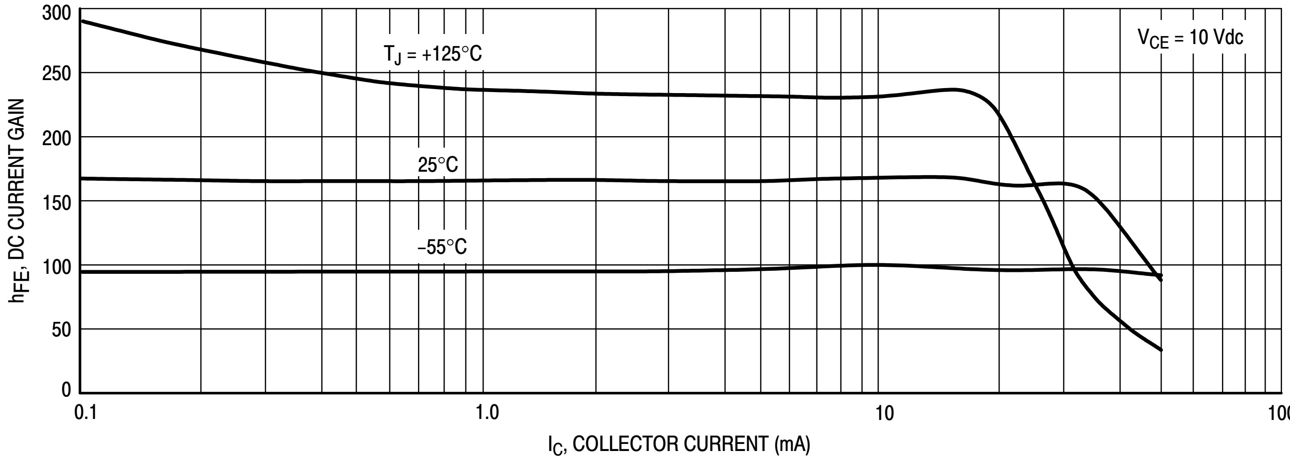


Figure 1. DC Current Gain

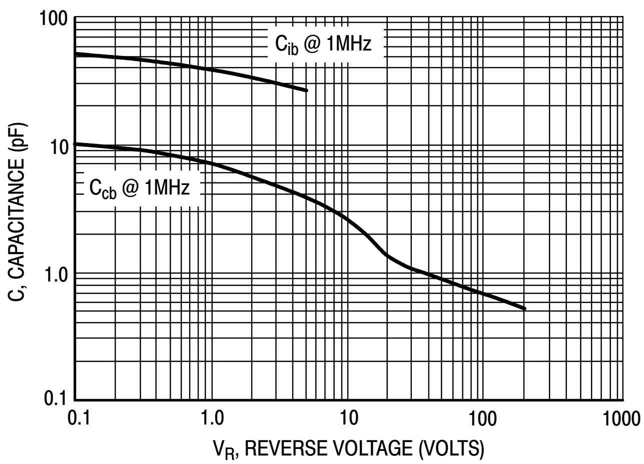


Figure 2. Capacitance

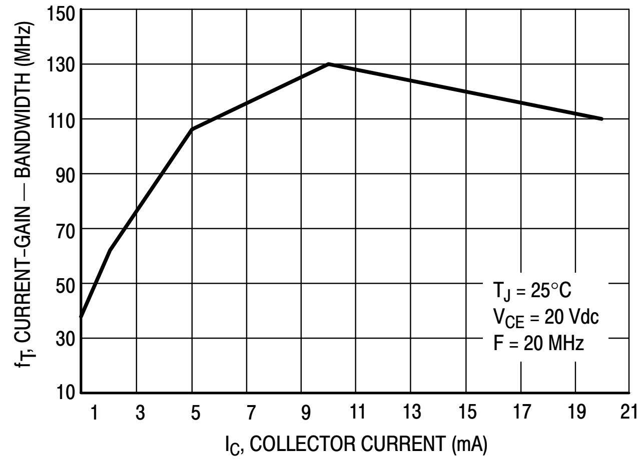


Figure 3. Current–Gain — Bandwidth

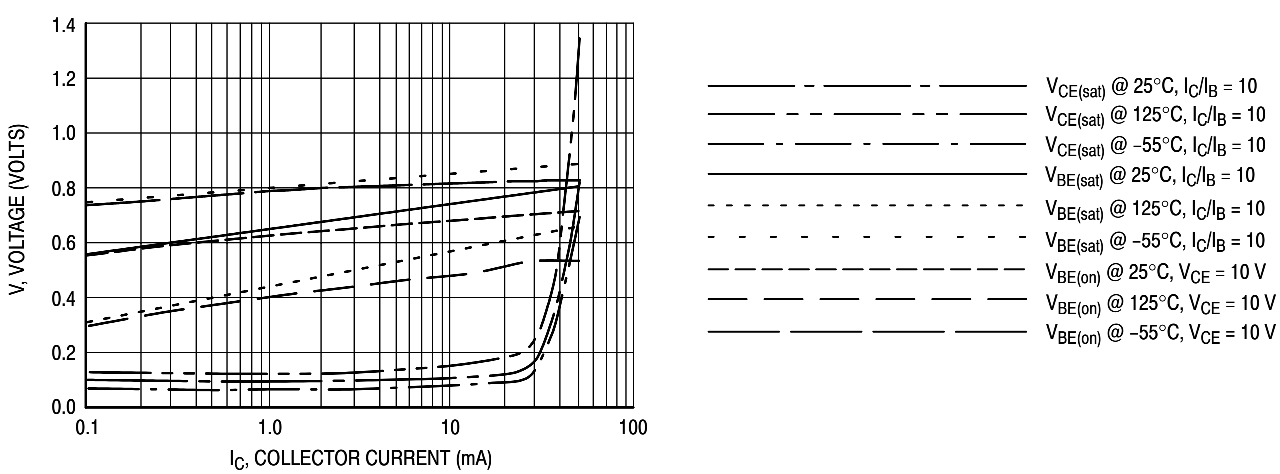


Figure 4. "ON" Voltages

BF959

VHF Transistor

NPN Silicon

ON Semiconductor™

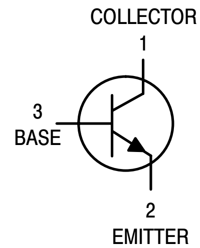
http://onsemi.com

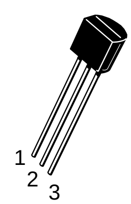
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	20	Vdc
Collector–Base Voltage	V_{CBO}	30	Vdc
Emitter–Base Voltage	V_{EBO}	3.0	Vdc
Collector Current – Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 625 5.0	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.5 12	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

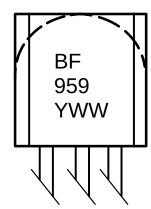
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W





TO–92
CASE 29
STYLE 21

MARKING DIAGRAM



Y = Year
W = Work Week

ORDERING INFORMATION

Device	Package	Shipping
BF959	TO–92	5000 Units/Box
BF959ZL1	TO–92	2000/Ammo Pack
BF959RL1	TO–92	2000 Units/Box

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	–	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	–	–	100	nAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				–
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc)		35	–	–	
(I_C = 20 mAdc, V_{CE} = 10 Vdc)		40	–	–	
Collector–Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 2.0 mAdc)	$V_{CE(sat)}$	–	–	1.0	Vdc
Base–Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 2.0 mAdc)	$V_{BE(sat)}$	–	–	1.0	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product	f_T				MHz
(I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		700	–	–	
(I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		600	–	–	
Common Emitter Feedback Capacitance (V_{CB} = 10 Vdc, P_f = 0, f = 10 MHz)	C_{re}	–	0.65	–	pF
Noise Figure (I_C = 4.0 mA, V_{CE} = 10 V, R_S = 50 Ω, f = 200 MHz)	N_f	–	3.0	–	dB

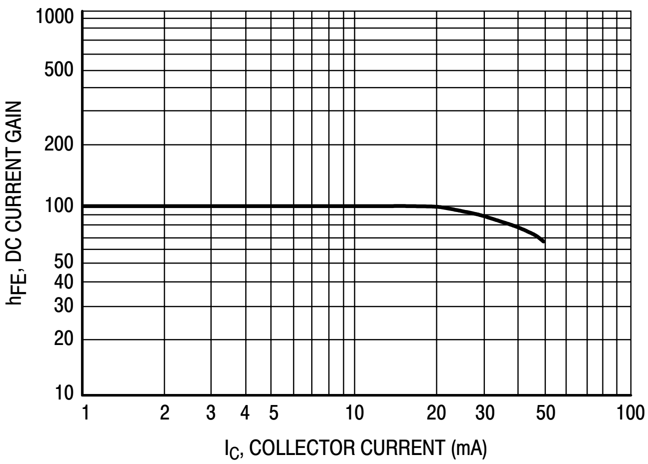


Figure 1. h_{FE} at 10 V

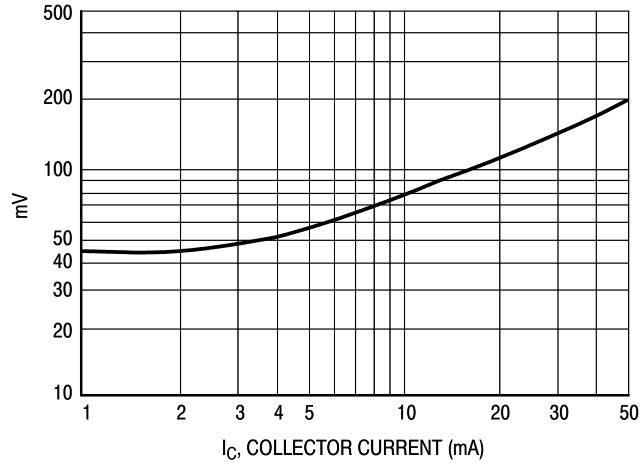


Figure 2. $V_{CE(sat)}$ at I_C/I_B = 10

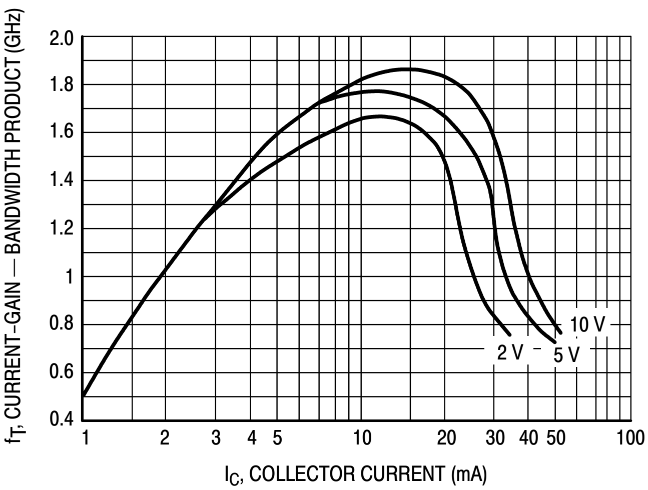


Figure 3. Current–Gain – Bandwidth Product

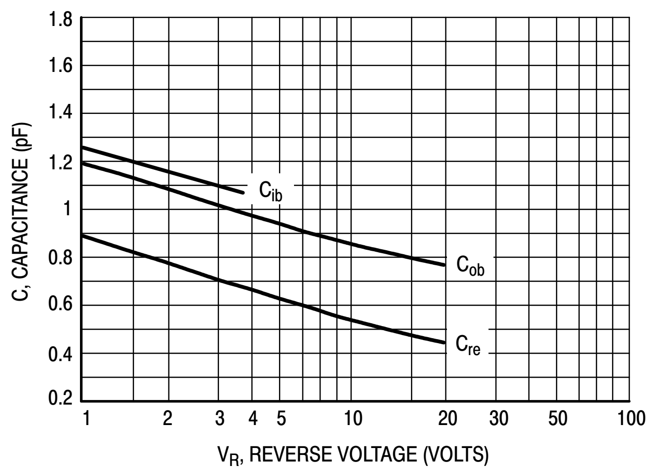


Figure 4. Capacitances

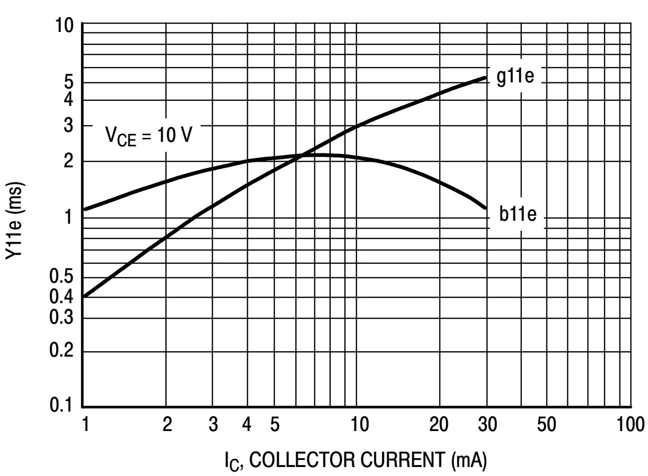


Figure 5. Input Impedance at 30 MHz

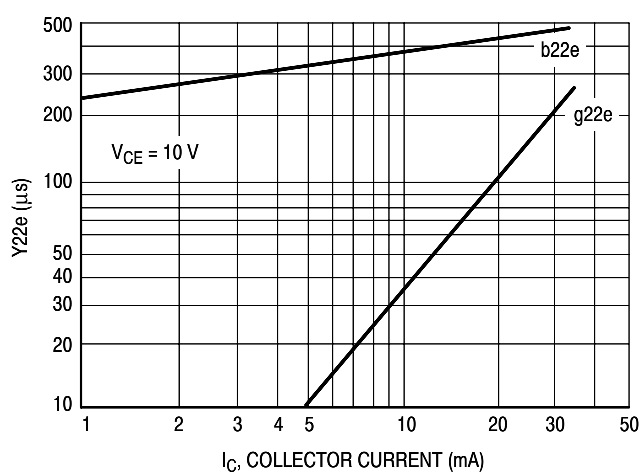
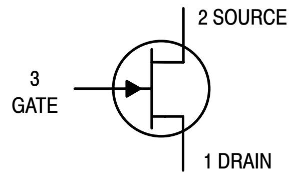


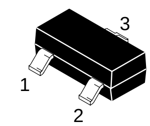
Figure 6. Output Impedance at 30 MHz

JFET Amplifiers

N–Channel

BFR30LT1
BFR31LT1





CASE 318–08, STYLE 10
SOT–23 (TO–236AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	25	Vdc
Gate–Source Voltage	V_{GS}	25	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BFR30LT1 = M1; BFR31LT1 = M2

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic			Symbol	Min	Max	Unit
OFF CHARACTERISTICS						
Gate Reverse Current	(V_{GS} = 10 Vdc, V_{DS} = 0)		I_{GSS}	—	0.2	nAdc
Gate Source Cutoff Voltage	(I_D = 0.5 nAdc, V_{DS} = 10 Vdc)	BFR30 BFR31	$V_{GS(OFF)}$	— —	5.0 2.5	Vdc
Gate Source Voltage	(I_D = 1.0 mAdc, V_{DS} = 10 Vdc) (I_D = 50 μAdc, V_{DS} = 10 Vdc)	BFR30 BFR31 BFR30 BFR31	V_{GS}	–0.7 — — —	–3.0 –1.3 –4.0 –2.0	Vdc

1. Device mounted on FR4 glass epoxy printed circuit board using the recommended footprint.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic			Symbol	Min	Max	Unit
ON CHARACTERISTICS						
Zero–Gate–Voltage Drain Current	(V_{DS} = 10 Vdc, V_{GS} = 0)	BFR30 BFR31	I_{DSS}	4.0 1.0	10 5.0	mAdc
SMALL–SIGNAL CHARACTERISTICS						
Forward Transconductance (I_D = 1.0 mAdc, V_{DS} = 10 Vdc, f = 1.0 kHz) (I_D = 200 μAdc, V_{DS} = 10 Vdc, f = 1.0 kHz)		 BFR30 BFR31 BFR30 BFR31	$\|y_{fs}\|$	 1.0 1.5 0.5 0.75	 4.0 4.5 — —	mAdc
Output Admittance (I_D = 1.0 mAdc, V_{DS} = 10 Vdc, f = 1.0 kHz) (I_D = 200 μAdc, V_{DS} = 10 Vdc)		 BFR30 BFR31	$\|y_{os}\|$	 40 20	 25 15	μAdc
Input Capacitance	(I_D = 1.0 mAdc, V_{DS} = 10 Vdc, f = 1.0 MHz) (I_D = 200 μAdc, V_{DS} = 10 Vdc, f = 1.0 MHz)		C_{iss}	— —	5.0 4.0	pF
Reverse Transfer Capacitance	(I_D = 1.0 mAdc, V_{DS} = 10 Vdc, f = 1.0 MHz) (I_D = 200 μAdc, V_{DS} = 10 Vdc, f = 1.0 MHz)		C_{rss}	— —	1.5 1.5	pF

TYPICAL CHARACTERISTICS

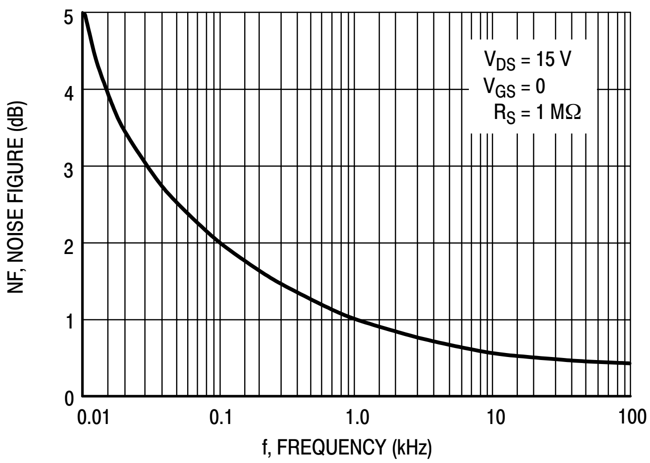


Figure 1. Noise Figure versus Frequency

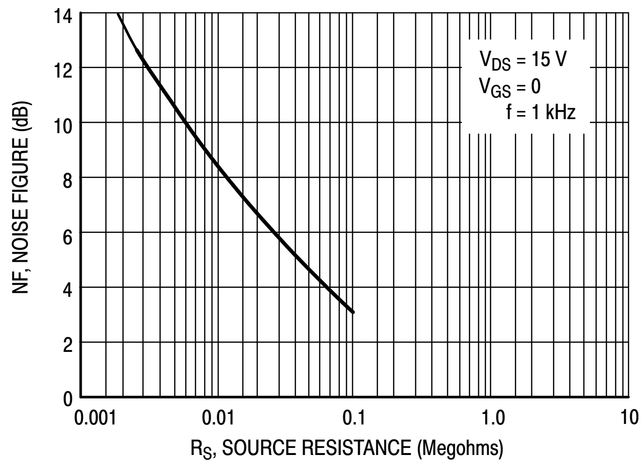


Figure 2. Noise Figure versus Source Resistance

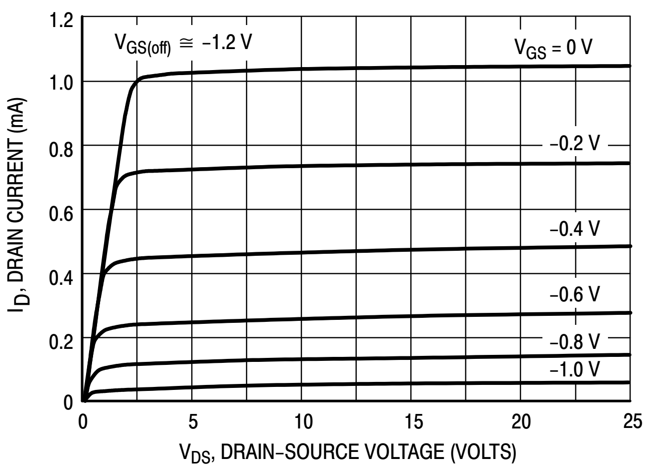


Figure 3. Typical Drain Characteristics

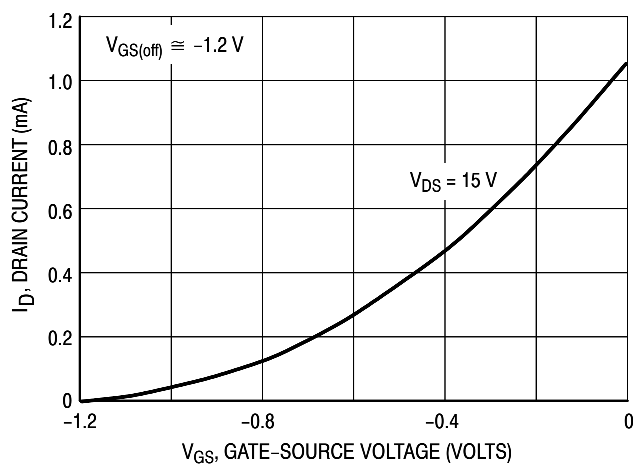


Figure 4. Common Source Transfer Characteristics

TYPICAL CHARACTERISTICS

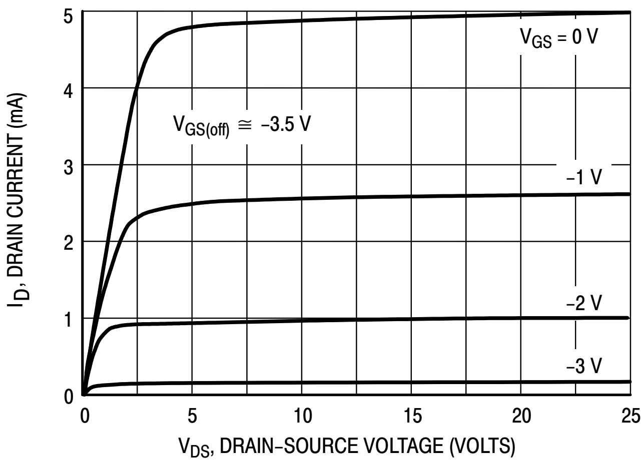


Figure 5. Typical Drain Characteristics

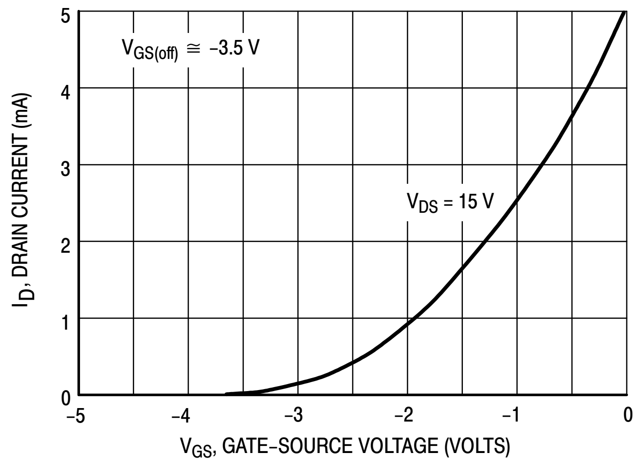


Figure 6. Common Source Transfer Characteristics

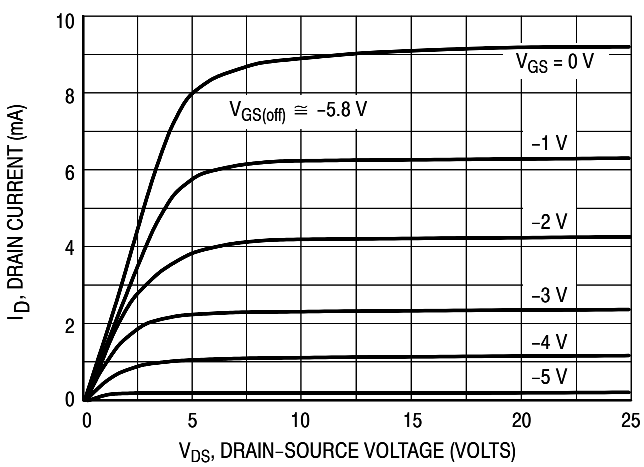


Figure 7. Typical Drain Characteristics

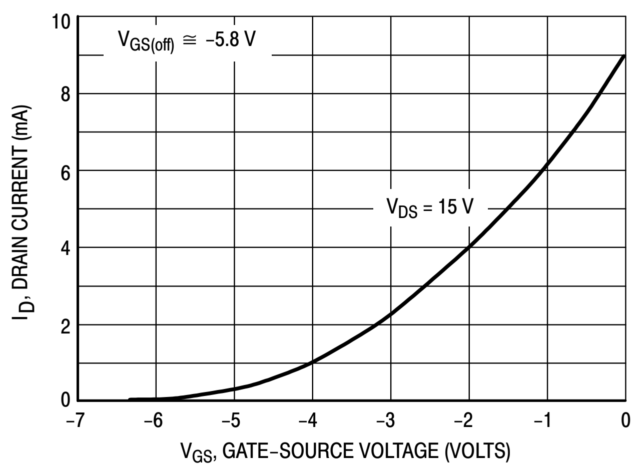


Figure 8. Common Source Transfer Characteristics

Note: Graphical data is presented for dc conditions. Tabular data is given for pulsed conditions (Pulse Width = 630 ms, Duty Cycle = 10%). Under dc conditions, self heating in higher I_{DSS} units reduces I_{DSS}.

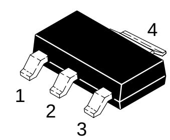
SOT-223 Package High Voltage Transistor

PNP Silicon

BSP16T1

ON Semiconductor Preferred Device

SOT–223 PACKAGE
PNP SILICON
HIGH VOLTAGE
TRANSISTOR
SURFACE MOUNT



CASE 318E-04, STYLE 1
TO-261AA

MAXIMUM RATINGS

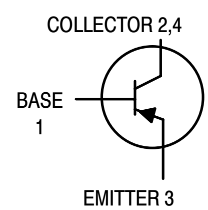
Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–300	Vdc
Collector–Base Voltage	V_{CBO}	–350	Vdc
Emitter–Base Voltage	V_{EBO}	–6.0	Vdc
Collector Current	I_C	–1000	mAdc
Base Current	I_B	–500	mAdc
Total Device Dissipation, T_A = 25°C (1)	P_D	1.5	Watts
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	150	°C

DEVICE MARKING

BT2

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	83.3	°C/W



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –50 mAdc, I_B = 0, L = 25 mH)	$V_{(BR)CEO}$	–300	—	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–300	—	Vdc
Collector–Emitter Cutoff Current (V_{CE} = –250 Vdc, I_B = 0)	I_{CES}	—	–50	μAdc
Collector–Base Cutoff Current (V_{CB} = –280 Vdc, I_E = 0)	I_{CBO}	—	–1.0	μAdc
Emitter–Base Cutoff Current (V_{EB} = –6.0 Vdc, I_C = 0)	I_{EBO}	—	–20	μAdc

1. Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 sq. in.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 3

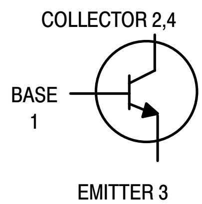
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (V_{CE} = –10 Vdc, I_C = –50 mAdc)	h_{FE}	30	120	—
Collector-Emitter Saturation Voltage (I_C = –50 mAdc, I_B = –5.0 mAdc)	$V_{CE(sat)}$	—	–2.0	Vdc
DYNAMIC CHARACTERISTICS				
Current Gain – Bandwidth Product (V_{CE} = –10 Vdc, I_C = –10 mAdc, f = 30 MHz)	f_T	15	—	MHz
Collector–Base Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	15	pF

NPN Silicon Epitaxial Transistor

This family of NPN Silicon Epitaxial transistors is designed for use as a general purpose amplifier and in switching applications. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

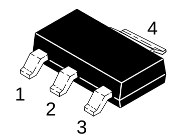
- High Voltage: $V_{(BR)CEO}$ of 250 and 350 Volts.
- The SOT-223 package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
  - T1 Configuration – 7 inch/1000 unit reel
  - T3 Configuration – 13 inch/4000 unit reel
- PNP Complement is BSP16T1



BSP19AT1

ON Semiconductor Preferred Device

SOT–223 PACKAGE
NPN SILICON
HIGH VOLTAGE
TRANSISTOR
SURFACE MOUNT



CASE 318E-04, STYLE 1
TO-261AA

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage (Open Base)	V_{CEO}	350	Vdc
Collector-Base Voltage (Open Emitter)	V_{CBO}	400	Vdc
Emitter-Base Voltage (Open Collector)	V_{EBO}	5.0	Vdc
Collector Current (DC)	I_C	1000	mAdc
Total Power Dissipation @ T_A = 25°C(1) Derate above 25°C	P_D	0.8 6.4	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to 150	°C
Junction Temperature	T_J	150	°C

DEVICE MARKING

SP19A

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance from Junction-to-Ambient	$R_{\theta JA}$	156	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	T_L	260 10	°C Sec

1. Device mounted on a FR-4 glass epoxy printed circuit board using minimum recommended footprint.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	350	—	Vdc
Collector-Base Cutoff Current (V_{CB} = 400 Vdc, I_E = 0)	I_{CBO}	—	20	nAdc
Emitter-Base Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	10	µAdc
ON CHARACTERISTICS (2)				
DC Current Gain (I_C = 20 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40	—	—
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 5.0 MHz)	f_T	70	—	MHz
Collector-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 4.0 mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 4.0 mAdc)	$V_{BE(sat)}$	—	1.3	Vdc

2. Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle = 2.0%

BSP52T1

Preferred Device

NPN Small-Signal Darlington Transistor

This NPN small signal darlington transistor is designed for use in switching applications, such as print hammer, relay, solenoid and lamp drivers. The device is housed in the SOT-223 package, which is designed for medium power surface mount applications.

- The SOT-223 Package can be soldered using wave or reflow. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
  Use BSP52T1 to order the 7 inch/1000 unit reel
- PNP Complement is BSP62T1

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Max	Unit
Collector-Emitter Voltage	V_{CES}	80	Vdc
Collector-Base Voltage	V_{CBO}	90	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current	I_C	1.0	Adc
Total Power Dissipation @ T_A = 25°C (Note 1.) Derate above 25°C	P_D	0.8 6.4	Watts mW/°C
Total Power Dissipation @ T_A = 25°C (Note 2.) Derate above 25°C	P_D	1.25 10	Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	–65 to 150	°C

THERMAL CHARACTERISTICS

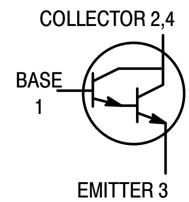
Characteristic	Symbol	Value	Unit
Thermal Resistance – Junction-to-Ambient (Note 1.)	$R_{\theta JA}$	156	°C/W
Thermal Resistance – Junction-to-Ambient (Note 2.)	$R_{\theta JA}$	100	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	T_L	260 10	°C Sec

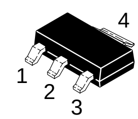
1. Device mounted on a FR-4 glass epoxy printed circuit board using minimum recommended footprint.
2. Device mounted on a FR-4 glass epoxy printed circuit board using 1 cm^2 pad.

ON Semiconductor™

http://onsemi.com

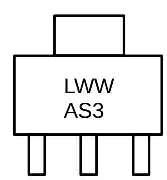
MEDIUM POWER NPN SILICON SURFACE MOUNT DARLINGTON TRANSISTOR





SOT–223
CASE 318E
STYLE 1

DEVICE MARKING



L	= Assembly Location
WW	= Date Code
AS3	= Specific Device Code

ORDERING INFORMATION

Device	Package	Shipping
BSP52T1	SOT–223	1000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

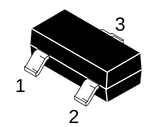
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	90	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	–	Vdc
Collector-Emitter Cutoff Current (V_{CE} = 80 Vdc, V_{BE} = 0)	I_{CES}	–	10	μAdc
Emitter-Base Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	–	10	μAdc
ON CHARACTERISTICS (Note 3.)				
DC Current Gain	h_{FE}			–
(I_C = 150 mAdc, V_{CE} = 10 Vdc)		1000	–	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)		2000	–	
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 0.5 mAdc)	$V_{CE(sat)}$	–	1.3	Vdc
Base-Emitter On Voltage (I_C = 500 mAdc, I_B = 0.5 mAdc)	$V_{BE(on)}$	–	1.9	Vdc

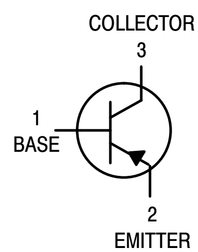
3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

High Voltage Transistor
PNP Silicon

BSS63LT1



CASE 318–08, STYLE 6
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–100	Vdc
Collector–Emitter Voltage R_{BE} = 10 kΩ	V_{CER}	–110	Vdc
Collector Current — Continuous	I_C	–100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BSS63LT1 = T1

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = –100 μAdc)	$V_{(BR)CEO}$	–100	—	—	Vdc
Collector–Emitter Breakdown Voltage (I_C = –10 μAdc, I_E = 0, R_{BE} = 10 kΩ)	$V_{(BR)CER}$	–110	—	—	Vdc
Collector–Base Breakdown Voltage (I_E = –10 μAdc, I_E = 0)	$V_{(BR)CBO}$	–110	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc)	$V_{(BR)EBO}$	–6.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = –90 Vdc, I_E = 0)	I_{CBO}	—	—	–100	nAdc
Collector Cutoff Current (V_{CE} = –110 Vdc, R_{BE} = 10 kΩ)	I_{CER}	—	—	–10	μAdc
Emitter Cutoff Current (V_{EB} = –6.0 Vdc, I_C = 0)	I_{EBO}	—	—	–200	nAdc

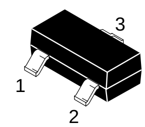
1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

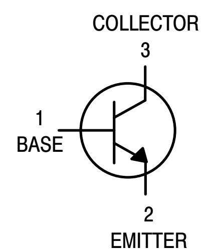
Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				—
(I_C = –10 mAdc, V_{CE} = –1.0 Vdc)		30	—	—	
(I_C = –25 mAdc, V_{CE} = –1.0 Vdc)		30	—	—	
Collector–Emitter Saturation Voltage (I_C = –25 mAdc, I_B = –2.5 mAdc)	$V_{CE(sat)}$	—	—	–250	mVdc
Base–Emitter Saturation Voltage (I_C = –25 mAdc, I_B = –2.5 mAdc)	$V_{BE(sat)}$	—	—	–900	mVdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = –25 mAdc, V_{CE} = –5.0 Vdc, f = 20 MHz)	f_T	50	95	—	MHz
Case Capacitance (I_E = I_C = 0, V_{CB} = –10 Vdc, f = 1.0 MHz)	C_C	—	—	20	pF

Driver Transistor
NPN Silicon

BSS64LT1



CASE 318–08, STYLE 6
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	80	Vdc
Collector–Base Voltage	V_{CBO}	120	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board[1] T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,[2] T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

BSS64LT1 = AM

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 4.0 mAdc)	$V_{(BR)CEO}$	80	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc)	$V_{(BR)CBO}$	120	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 90 Vdc) (T_A = 150°C)	I_{CBO}	 — —	 0.1 500	μAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc)	I_{EBO}	—	200	nAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (V_{CE} = 1.0 Vdc, I_C = 10 mAdc)	H_{FE}	20	—	—
Collector–Emitter Saturation Voltage (I_C = 4.0 mAdc, I_B = 400 μAdc) (I_C = 50 mAdc, I_B = 15 mAdc)	$V_{CE(sat)}$	— —	0.15 0.2	Vdc
Forward Base–Emitter Voltage	$V_{BE(sat)}$	—	—	—
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	f_T	60	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, f = 1.0 MHz)	C_{ob}	—	20	pF

DA121TT1

Preferred Device

Silicon Switching Diode

ON Semiconductor™

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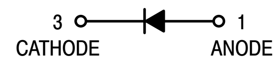
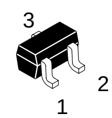




CASE 463
SOT–416/SC–75
STYLE 2

MAXIMUM RATINGS (T_A = 25°C)

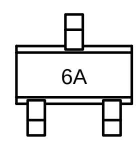
Rating	Symbol	Max	Unit
Continuous Reverse Voltage	V_R	80	V
Recurrent Peak Forward Current	I_F	200	mA
Peak Forward Surge Current Pulse Width = 10 μs	$I_{FM(surge)}$	500	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, FR–4 Board (1) T_A = 25°C Derated above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient (1)	$R_{\theta JA}$	555	°C/W
Total Device Dissipation, FR–4 Board (2) T_A = 25°C Derated above 25°C	P_D	360 2.9	mW mW/°C
Thermal Resistance, Junction to Ambient (2)	$R_{\theta JA}$	345	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) FR–4 @ Minimum Pad
(2) FR–4 @ 1.0 × 1.0 Inch Pad

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
DA121TT1	SOT–416	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Forward Voltage	V_F			mV
(I_F = 1.0 mA)		—	715	
(I_F = 10 mA)		—	866	
(I_F = 50 mA)		—	1000	
(I_F = 150 mA)		—	1250	
Reverse Current	I_R			μA
(V_R = 75 V)		—	1.0	
(V_R = 75 V, T_J = 150°C)		—	50	
(V_R = 25 V, T_J = 150°C)		—	30	
Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.0	pF
Reverse Recovery Time (I_F = I_R = 10 mA, R_L = 50 Ω) (Figure 1)	t_{rr}	—	6.0	ns
Stored Charge (I_F = 10 mA to V_R = 6.0 V, R_L = 500 Ω) (Figure 2)	QS	—	45	PC
Forward Recovery Voltage (I_F = 10 mA, t_r = 20 ns) (Figure 3)	V_{FR}	—	1.75	V

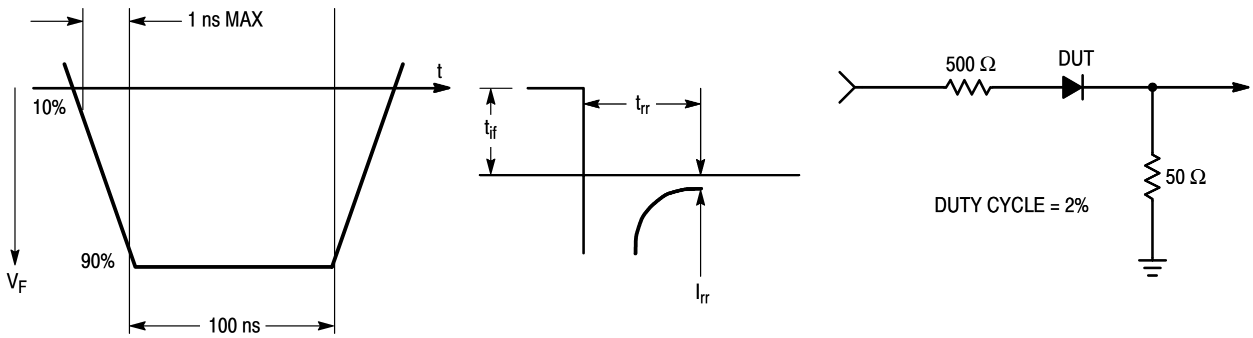


Figure 1. Reverse Recovery Time Equivalent Test Circuit

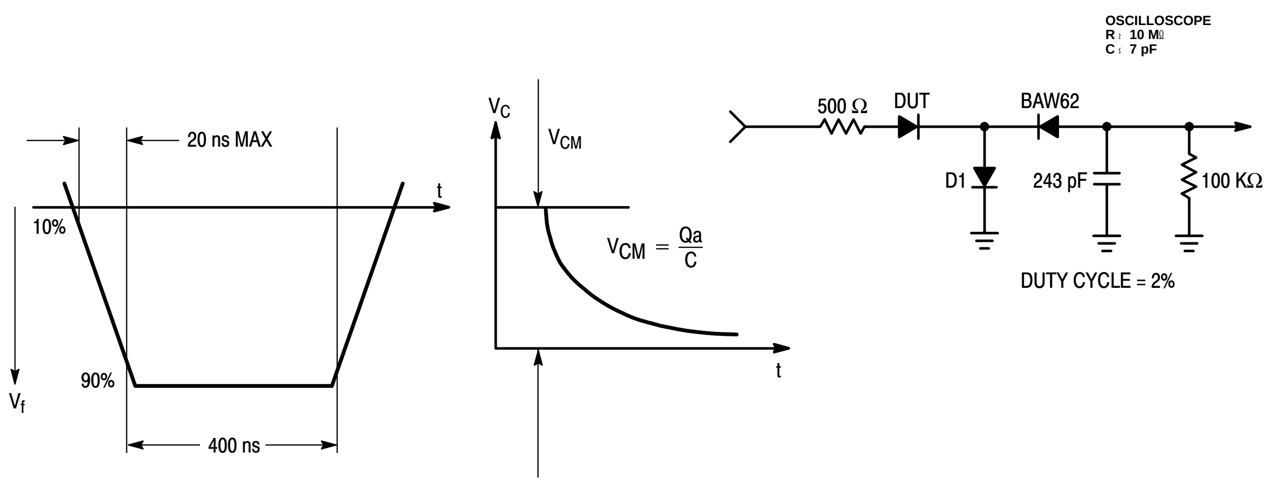


Figure 2. Recovery Charge Equivalent Test Circuit

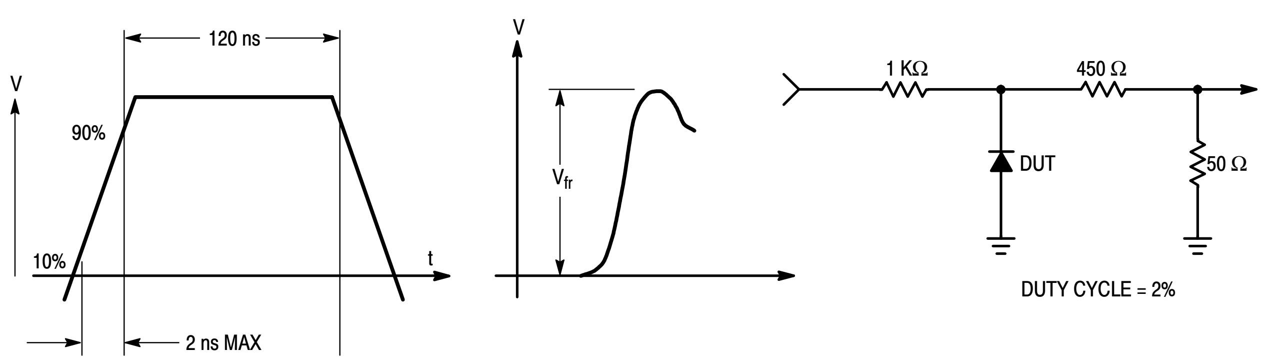


Figure 3. Forward Recovery Voltage Equivalent Test Circuit

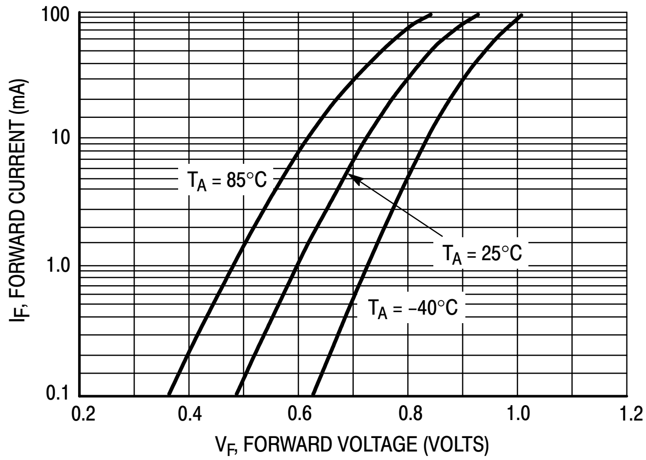


Figure 4. Forward Voltage

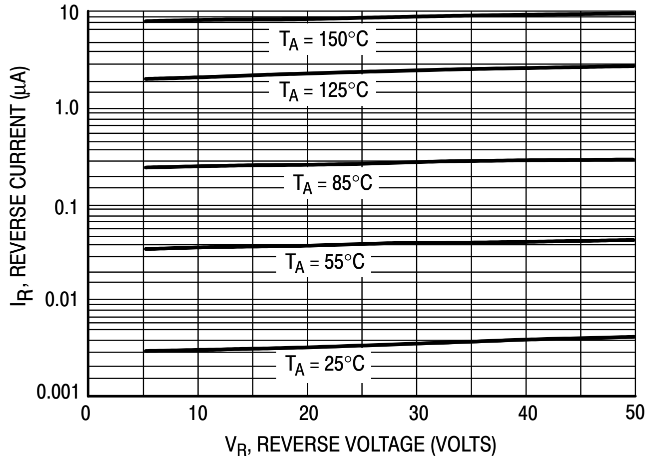


Figure 5. Leakage Current

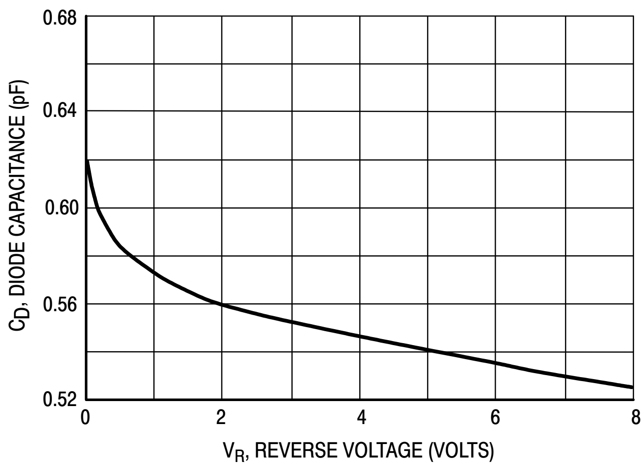


Figure 6. Capacitance

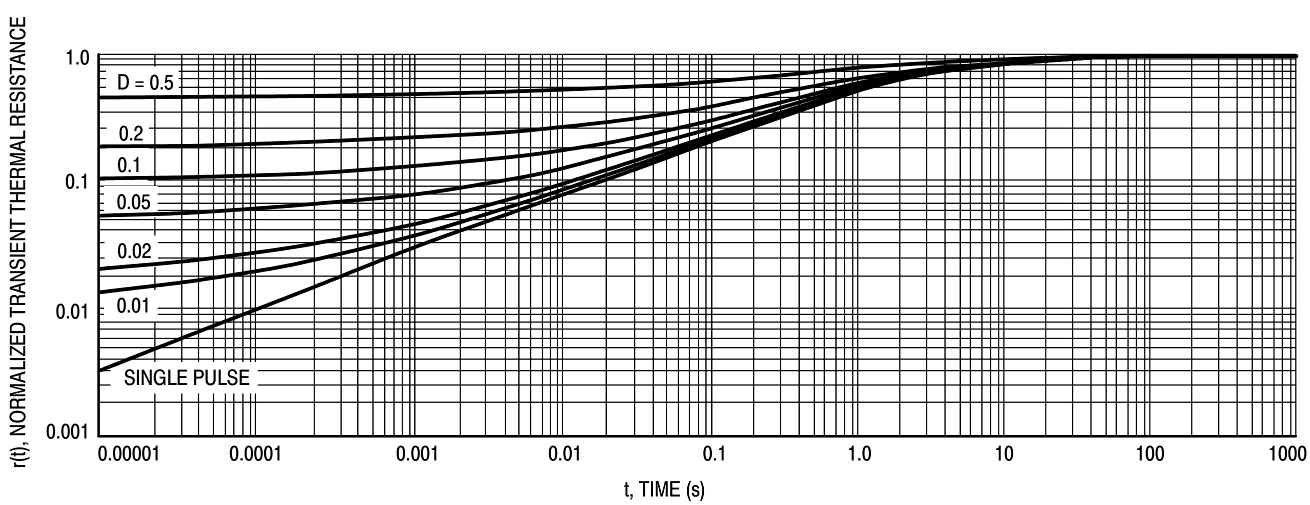


Figure 7. Normalized Thermal Response

DAN222

Common Cathode Silicon Dual Switching Diode

This Common Cathode Silicon Epitaxial Planar Dual Diode is designed for use in ultra high speed switching applications. This device is housed in the SOT–416/SC–90 package which is designed for low power surface mount applications, where board space is at a premium.

- Fast t_{rr}
- Low C_D
- Available in 8 mm Tape and Reel

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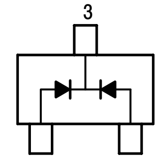
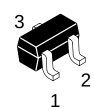
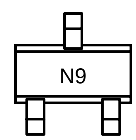




SOT–416
SC–90/SC–75
CASE 463
STYLE 3

MARKING DIAGRAM



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	80	Vdc
Peak Reverse Voltage	V_{RM}	80	Vdc
Forward Current	I_F	100	mAdc
Peak Forward Current	I_{FM}	300	mAdc
Peak Forward Surge Current	I_{FSM}(1)	2.0	Adc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	P_D	150	mW
Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

1. t = 1 μS

ORDERING INFORMATION

Device	Package	Shipping
DAN222	SOT–416	3000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	I_R	V_R = 70 V	—	0.1	μAdc
Forward Voltage	V_F	I_F = 100 mA	—	1.2	Vdc
Reverse Breakdown Voltage	V_R	I_R = 100 μA	80	—	Vdc
Diode Capacitance	C_D	V_R = 6.0 V, f = 1.0 MHz	—	3.5	pF
Reverse Recovery Time	t_{rr}(2)	I_F = 5.0 mA, V_R = 6.0 V, R_L = 100 Ω, I_{rr} = 0.1 I_R	—	4.0	ns

2. t_{rr} Test Circuit on following page.

TYPICAL ELECTRICAL CHARACTERISTICS

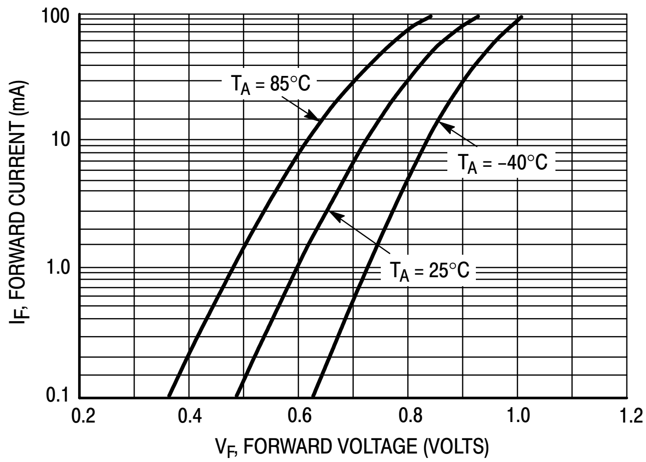


Figure 1. Forward Voltage

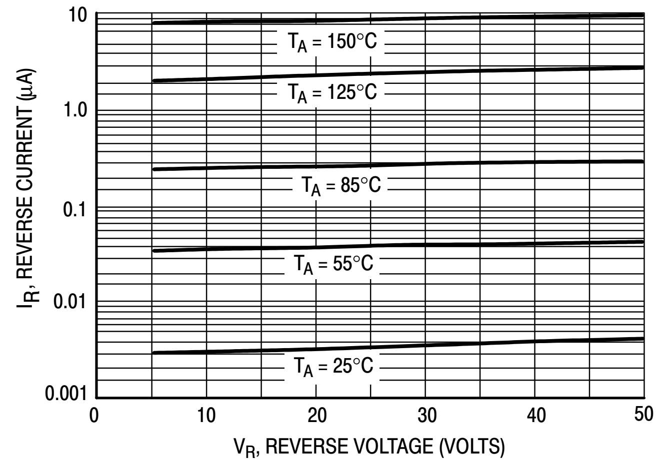


Figure 2. Reverse Current

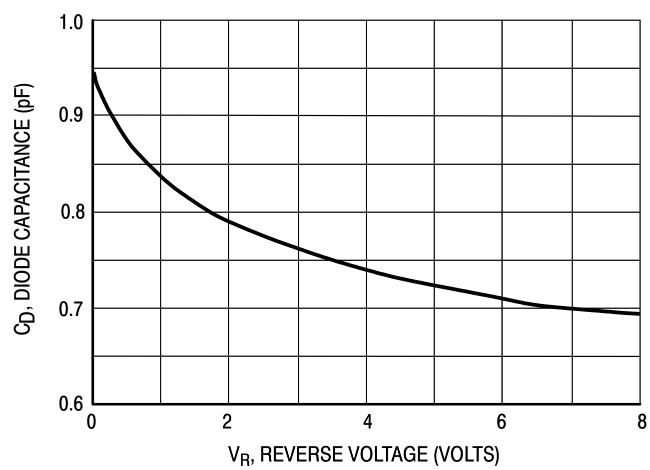


Figure 3. Diode Capacitance

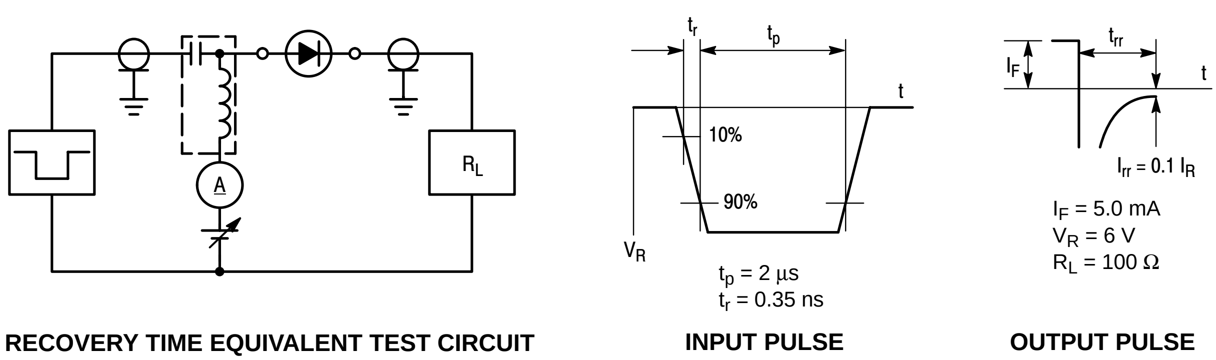


Figure 4. Reverse Recovery Time Test Circuit for the DAN222

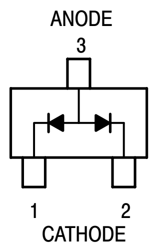
DAP222, DAP202U

Preferred Device

Common Anode Silicon Dual Switching Diodes

These Common Anode Silicon Epitaxial Planar Dual Diodes are designed for use in ultra high speed switching applications. The DAP222 device is housed in the SOT–416/SC–75 package which is designed for low power surface mount applications, where board space is at a premium. The DAP202U device is housed in the SC–70/SOT–323 package.

- Fast t_{rr}
- Low C_D
- Available in 8 mm Tape and Reel



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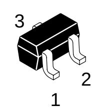
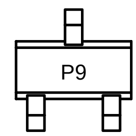
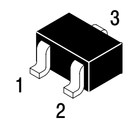


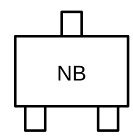
SOT–416
SC–75/SC–90
CASE 463
STYLE 3

MARKING DIAGRAMS





SC–70/SOT–323
CASE 419



ORDERING INFORMATION

Device	Package	Shipping
DAP222	SC–75	3000/Tape & Reel
DAP202U	SC–70	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	80	Vdc
Peak Reverse Voltage	V_{RM}	80	Vdc
Forward Current	I_F	100	mAdc
Peak Forward Current	I_{FM}	300	mAdc
Peak Forward Surge Current	I_{FSM}(1)	2.0	Adc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	P_D	150	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	I_R	V_R = 70 V	—	0.1	µAdc
Forward Voltage	V_F	I_F = 100 mA	—	1.2	Vdc
Reverse Breakdown Voltage	V_R	I_R = 100 µA	80	—	Vdc
Diode Capacitance	C_D	V_R = 6.0 V, f = 1.0 MHz	—	3.5	pF
Reverse Recovery Time DAP222 DAP202U	t_{rr}(2) t_{tt}(3)	I_F = 5.0 mA, V_R = 6.0 V, R_L = 100 Ω, I_{rr} = 0.1 I_R I_F = 5.0 mA, V_R = 6.0 V, R_L = 50 Ω, I_{rr} = 0.1 I_R	— –	4.0 10.0	ns

4. t = 1 µS
5. t_{rr} Test Circuit for DAP222 in Figure 4.
6. trr Test Circuit for DAP202U in Figure 5.

TYPICAL ELECTRICAL CHARACTERISTICS

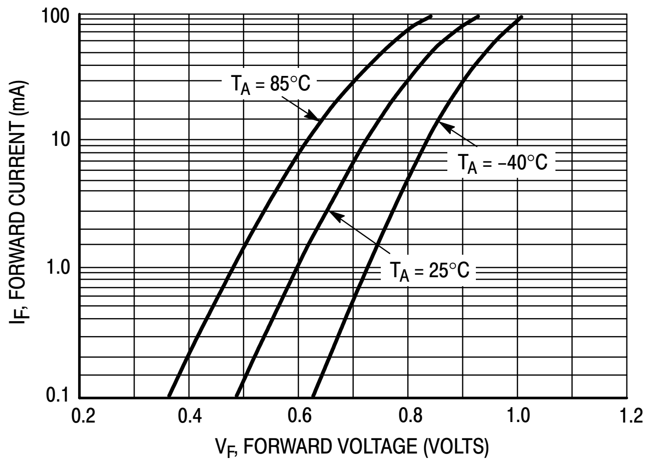


Figure 1. Forward Voltage

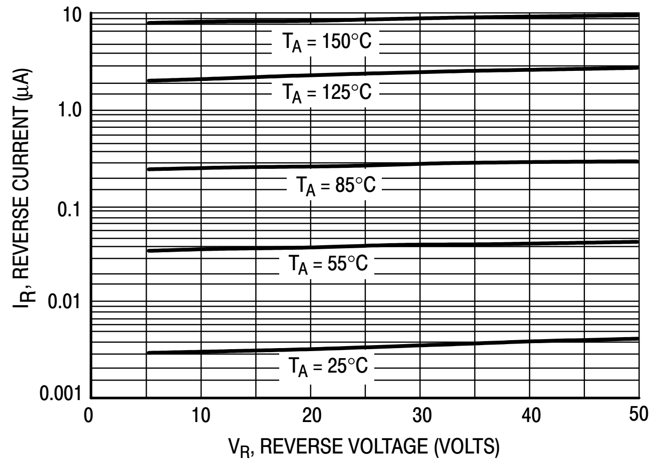


Figure 2. Reverse Current

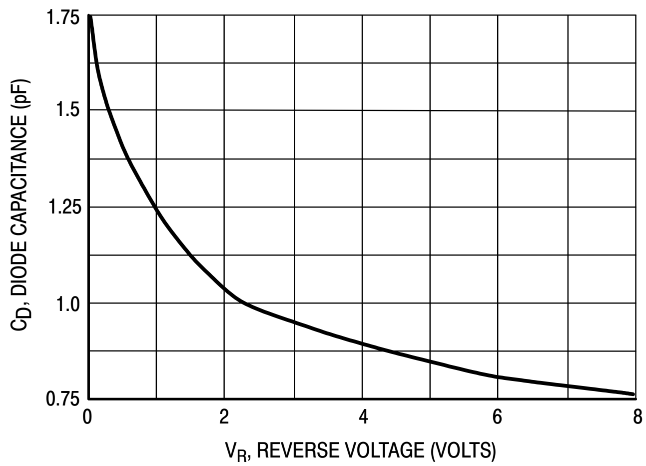
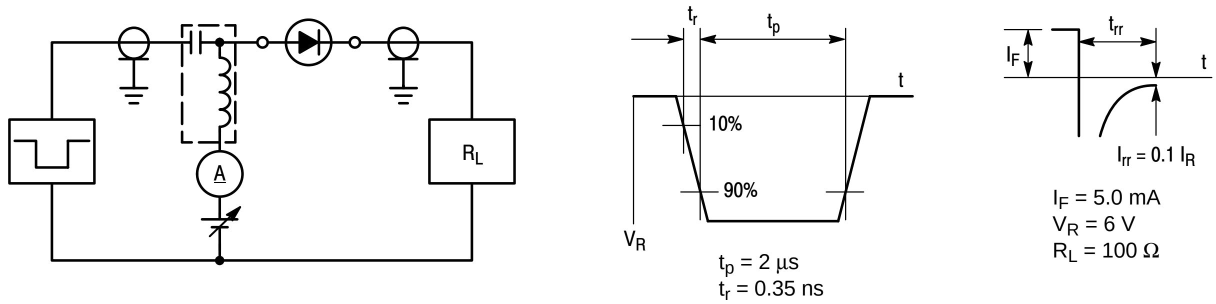
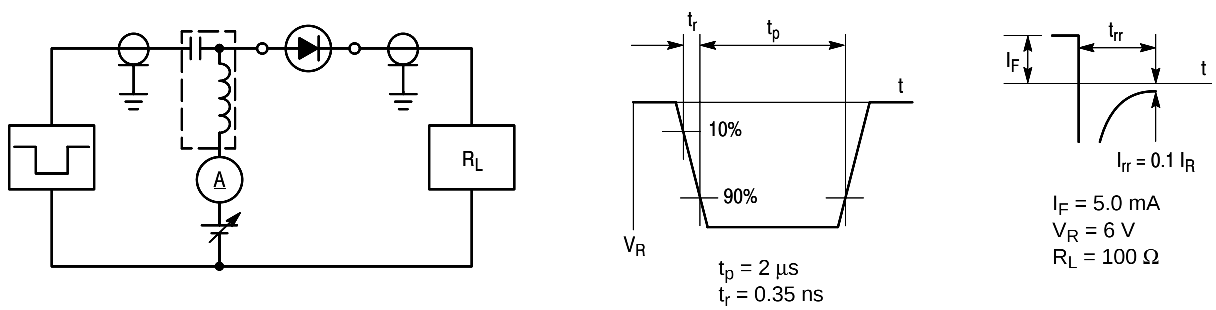


Figure 3. Diode Capacitance



RECOVERY TIME EQUIVALENT TEST CIRCUIT **INPUT PULSE** **OUTPUT PULSE**

Figure 4. Reverse Recovery Time Test Circuit for the DAP222



RECOVERY TIME EQUIVALENT TEST CIRCUIT **INPUT PULSE** **OUTPUT PULSE**

Figure 5. Reverse Recovery Time Test Circuit for the DAP202U

DTA114E Series

Preferred Devices

Bias Resistor Transistor

PNP Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the TO–92 package which is designed for through hole applications.

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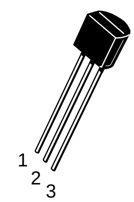
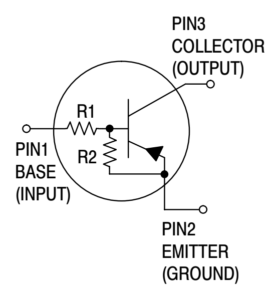
PNP SILICON BIAS RESISTOR TRANSISTOR



CASE 29
TO–92 (TO–226)
STYLE 1



Preferred devices are recommended choices for future use and best overall value.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc
Total Power Dissipation @ T_A = 25°C (1.) Derate above 25°C	P_D	 350 2.81	 mW mW/°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Ambient (surface mounted)	$R_{\theta JA}$	357	°C/W
Operating and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C
Maximum Temperature for Soldering Purposes, Time in Solder Bath	T_L	260 10	°C Sec

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)	Shipping
DTA114E	DTA114E	10	10	5000/Box
DTA124E	DTA124E	22	22	
DTA144E	DTA144E	47	47	
DTA114Y	DTA114Y	10	47	
DTA114T	DTA114T	10	∞	
DTA143T	DTA143T	4.7	∞	
DTB113E	DTB113E	1.0	1.0	
DTA123E	DTA123E	2.2	2.2	
DTA143E	DTA143E	4.7	4.7	
DTA143Z	DTA143Z	4.7	47	

1. Device mounted on a FR–4 glass epoxy printed circuit board using the minimum recommended footprint.

August, 2000 – Rev. 1
Publication Order Number:
DTA114E/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	—	—	100	nAdc
Collector–Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	—	—	500	nAdc
Emitter–Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	DTA114E	I_{EBO}	—	—	0.5	mAdc
	DTA124E		—	—	0.2	
	DTA144E		—	—	0.1	
	DTA114Y		—	—	0.2	
	DTA114T		—	—	0.9	
	DTA143T		—	—	1.9	
	DTB113E		—	—	4.3	
	DTA123E		—	—	2.3	
	DTA143E		—	—	1.5	
	DTA143Z		—	—	0.18	
Collector–Base Breakdown Voltage (I_C = 10 µA, I_E = 0)		$V_{(BR)CBO}$	50	—	—	Vdc
Collector–Emitter Breakdown Voltage (2.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	—	—	Vdc
ON CHARACTERISTICS (2.)						
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	DTA114E	h_{FE}	35	60	—	
	DTA124E		60	100	—	
	DTA144E		80	140	—	
	DTA114Y		80	140	—	
	DTA114T		160	250	—	
	DTA143T		160	250	—	
	DTB113E		3.0	5.0	—	
	DTA123E		8.0	15	—	
	DTA143E		15	27	—	
	DTA143Z		80	140	—	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$	—	—	0.25	Vdc
(I_C = 10 mA, I_E = 0.3 mA)	DTA144E/DTA114Y DTB113E/DTA143E					
(I_C = 10 mA, I_B = 5 mA)	DTA123E					
(I_C = 10 mA, I_B = 1 mA)	DTA114T/DTA143T/ DTA143Z/DTA124E					
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	DTA114E		—	—	0.2	
	DTA124E		—	—	0.2	
	DTA114Y		—	—	0.2	
	DTA114T		—	—	0.2	
	DTA143T		—	—	0.2	
	DTB113E		—	—	0.2	
	DTA123E		—	—	0.2	
	DTA143E		—	—	0.2	
	DTA143Z		—	—	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	DTA144E		—	—	0.2	

2. Pulse Test: Pulse Width < 300 µs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
Output Voltage (off)		V_{OH}	4.9	—	—	Vdc
(V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ)	DTA114T					
	DTA113T					
	DTA144E					
	DTA114Y					
	DTA143Z					
(V_{CC} = 5.0 V, V_B = 0.05 V, R_L = 1.0 kΩ)	DTB113E					
(V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	DTA114T					
	DTA143T					
	DTA123E					
	DTA143E					
Input Resistor	DTA114E	R1	7.0	10	13	kΩ
	DTA124E		15.4	22	28.6	
	DTA144E		32.9	47	61.1	
	DTA114Y		7.0	10	13	
	DTA114T		7.0	10	13	
	DTA143T		3.3	4.7	6.1	
	DTB113E		0.7	1.0	1.3	
	DTA123E		1.5	2.2	2.9	
	DTA143E		3.3	4.7	6.1	
	DTA143Z		3.3	4.7	6.1	
Resistor Ratio	DTA114E/DTA124E/DTA144E	R_1/R_2	0.8	1.0	1.2	
	DTA114Y		0.17	0.21	0.25	
	DTA114T/DTA143T		—	—	—	
	DTB113E/DTA123E/DTA143E		0.8	1.0	1.2	
	DTA143Z		0.055	0.1	0.185	

TYPICAL ELECTRICAL CHARACTERISTICS DTA114E

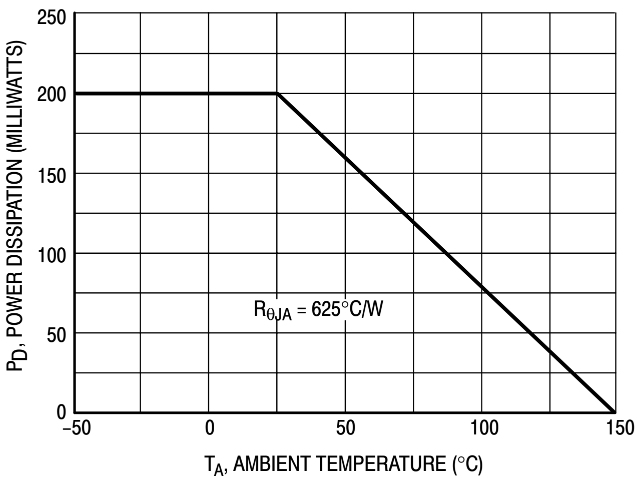


Figure 1. Derating Curve

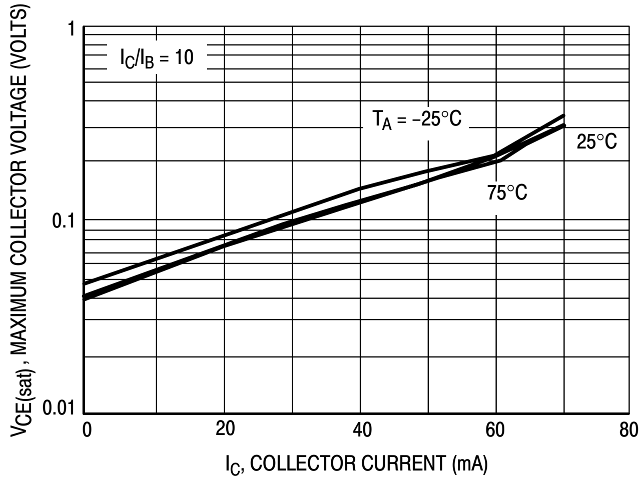


Figure 2. $V_{CE(sat)}$ versus I_C

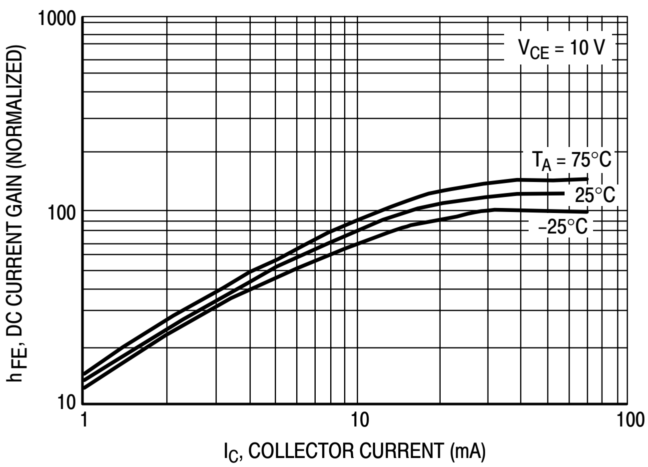


Figure 3. DC Current Gain

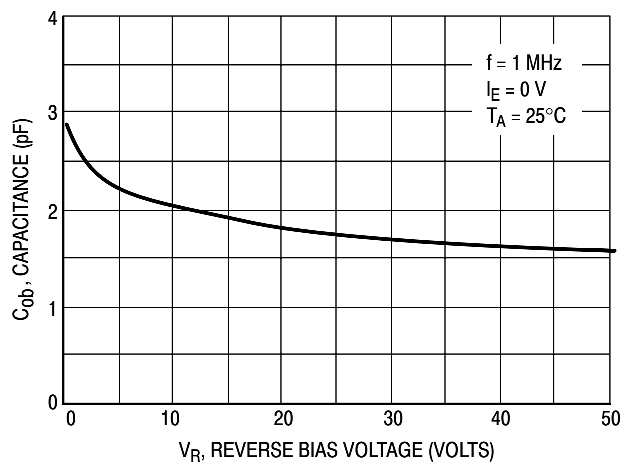


Figure 4. Output Capacitance

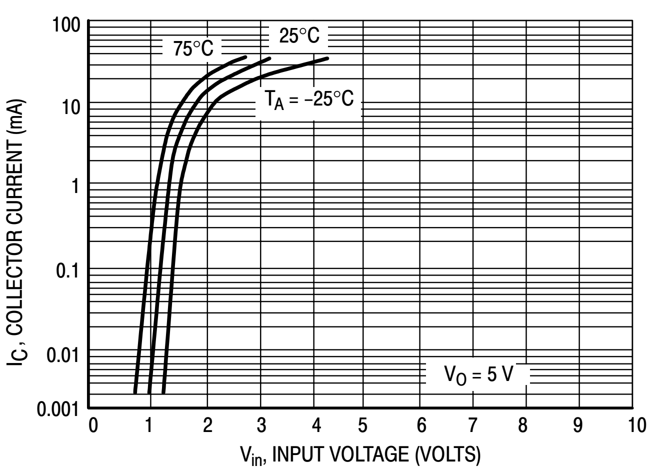


Figure 5. Output Current versus Input Voltage

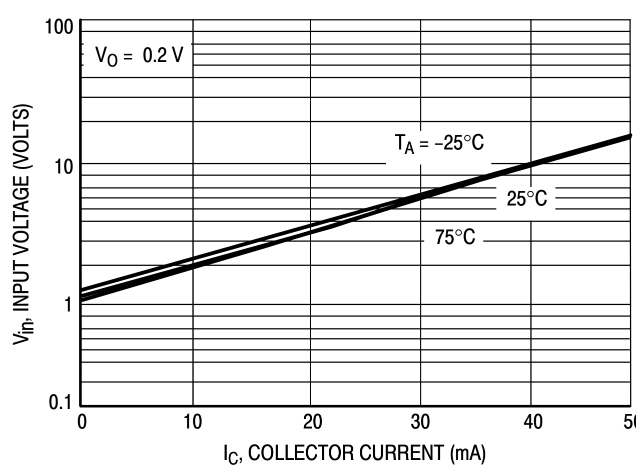


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
DTA124E

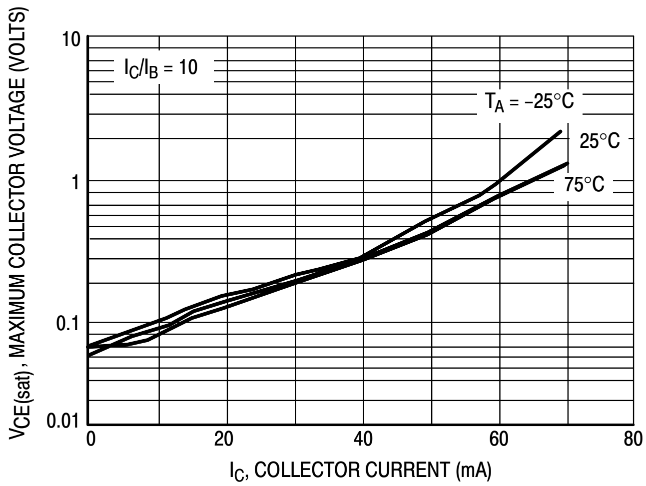


Figure 7. $V_{CE(sat)}$ versus I_C

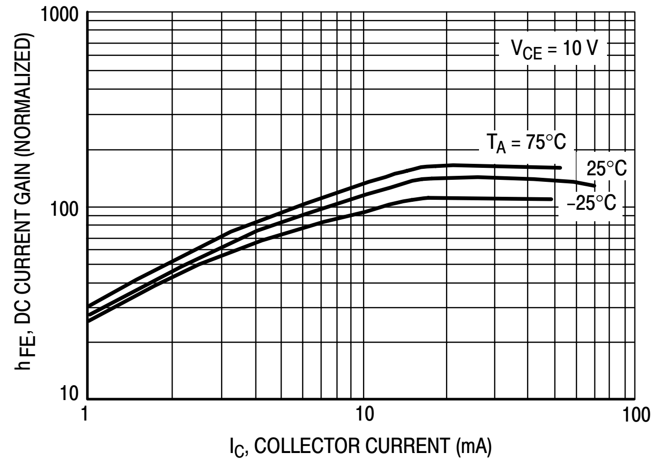


Figure 8. DC Current Gain

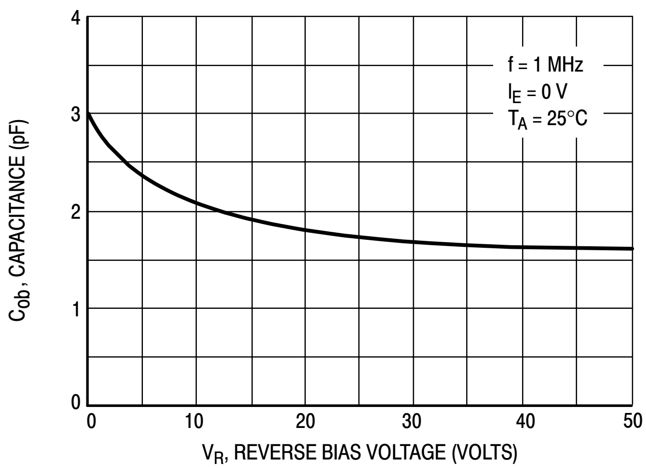


Figure 9. Output Capacitance

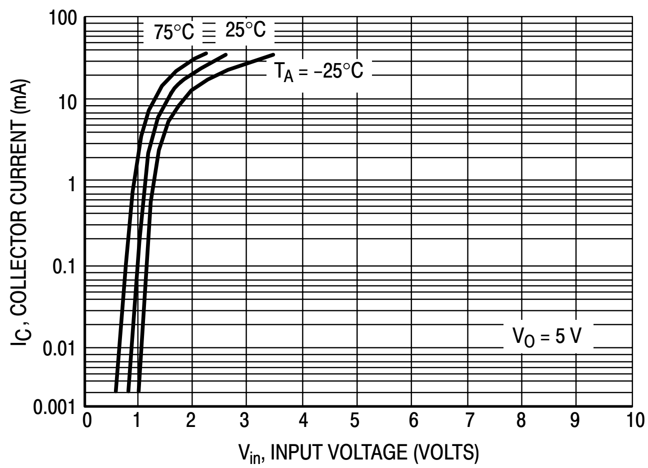


Figure 10. Output Current versus Input Voltage

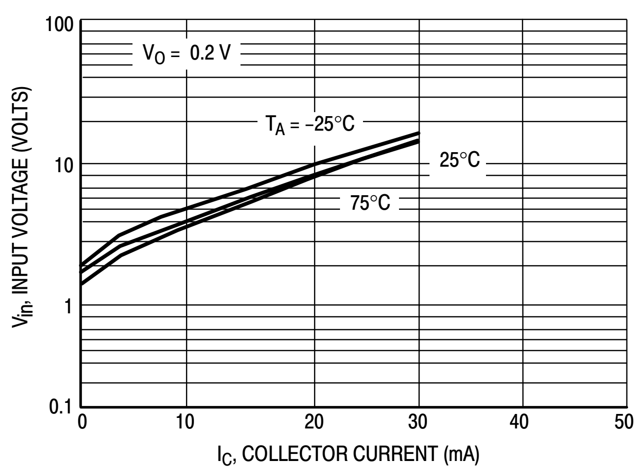


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
DTA144E

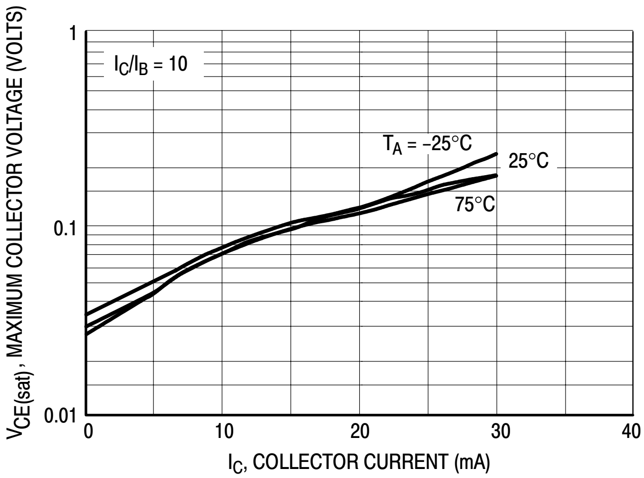


Figure 12. $V_{CE(sat)}$ versus I_C

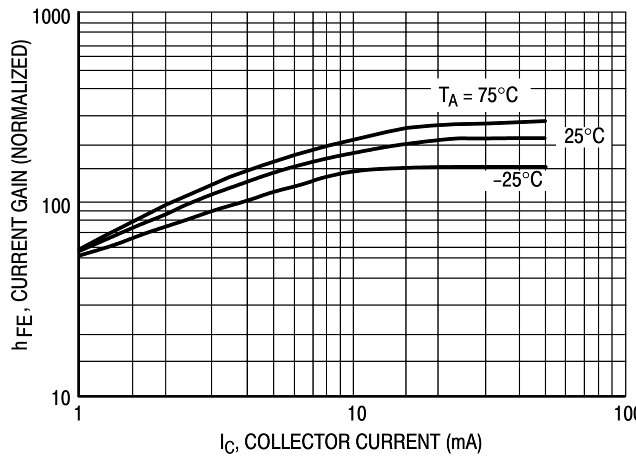


Figure 13. DC Current Gain

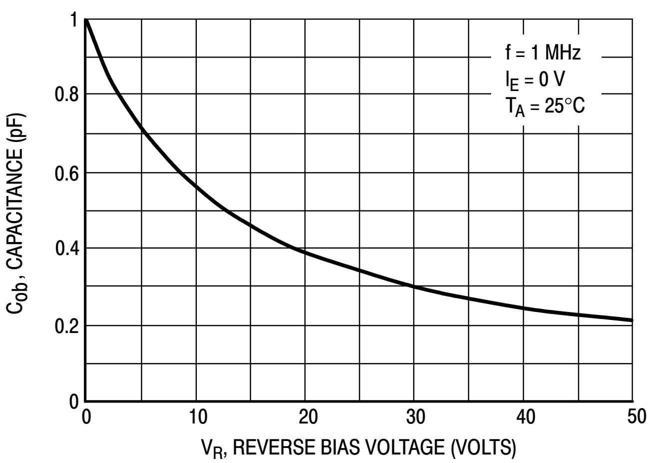


Figure 14. Output Capacitance

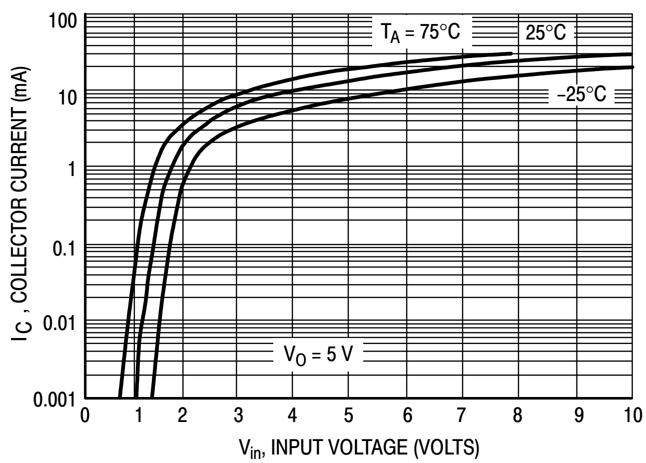


Figure 15. Output Current versus Input Voltage

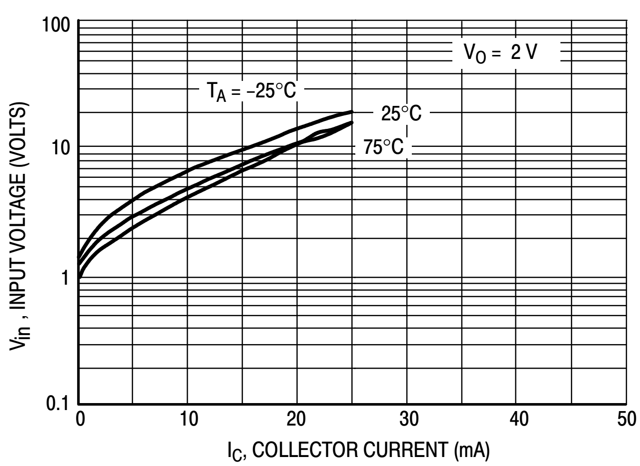


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
DTA114Y

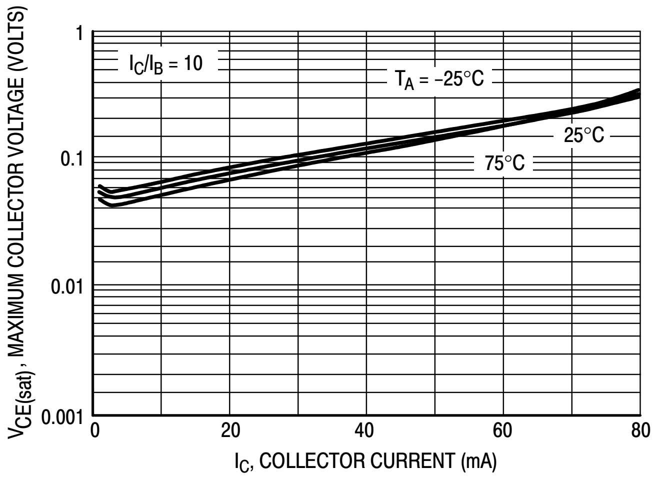


Figure 17. $V_{CE(sat)}$ versus I_C

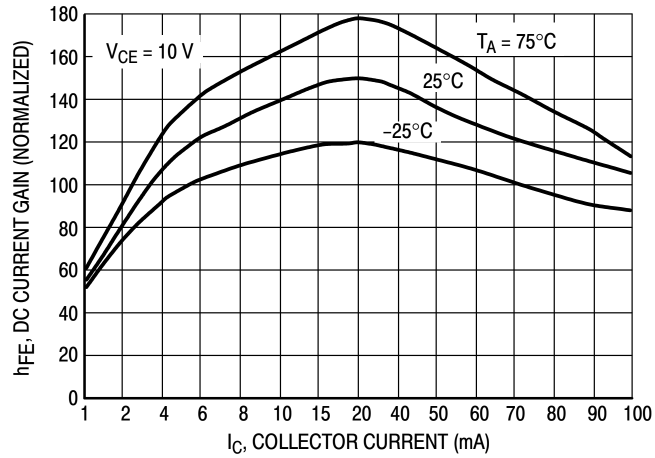


Figure 18. DC Current Gain

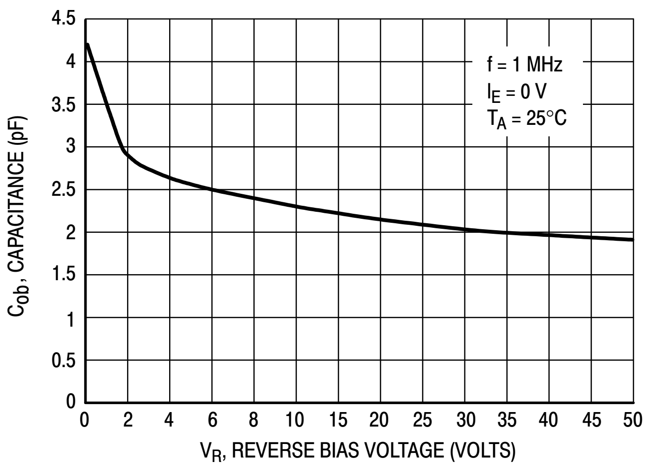


Figure 19. Output Capacitance

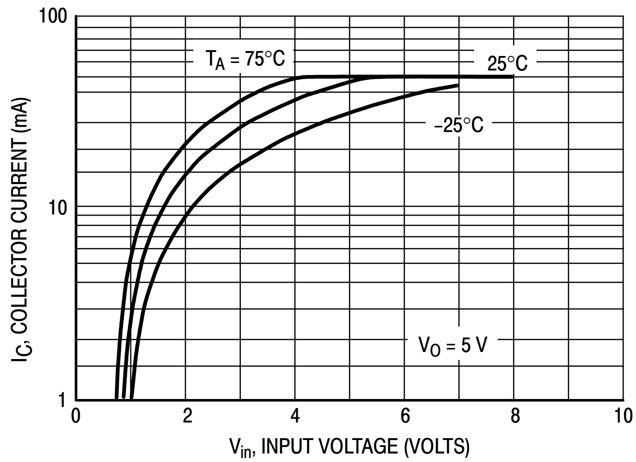


Figure 20. Output Current versus Input Voltage

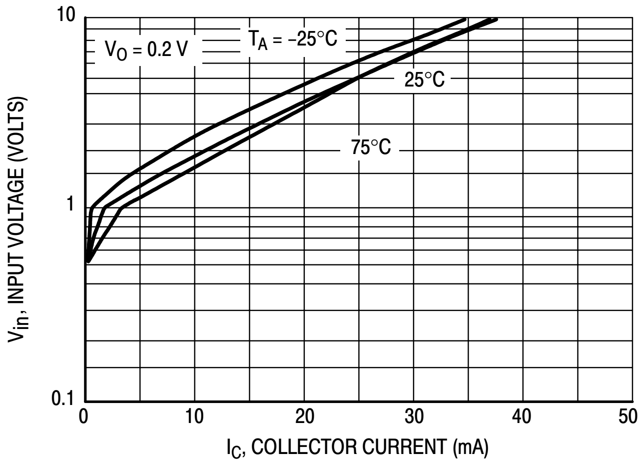


Figure 21. Input Voltage versus Output Current

Typical Application for PNP BRTs

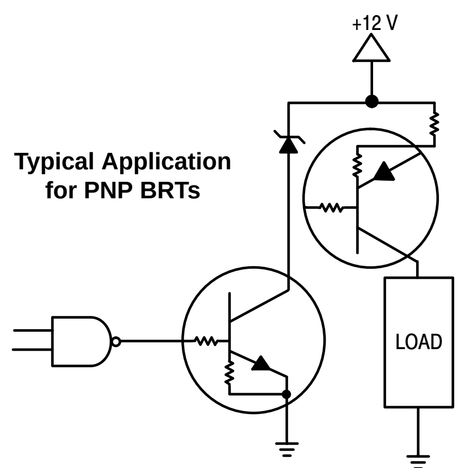


Figure 22. Inexpensive, Unregulated Current Source

DTA114EET1 Series

Preferred Devices

Bias Resistor Transistors

PNP Silicon Surface Mount Transistors with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC–75/SOT–416 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- The SC–75/SOT–416 package can be soldered using wave or reflow. The modified gull–winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm, 7 inch/3000 Unit Tape & Reel

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

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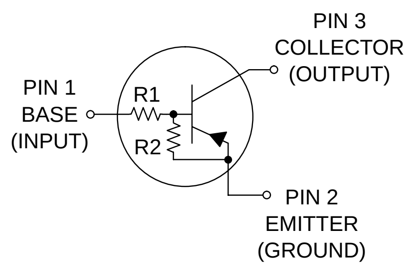
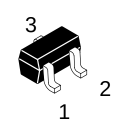
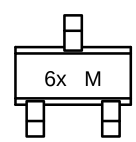
PNP SILICON BIAS RESISTOR TRANSISTORS





SC–75/SOT–416
CASE 463
STYLE 1

MARKING DIAGRAM



6x = Specific Device Code
x = (See Marking Table on page 391)
M = Date Code

Preferred devices are recommended choices for future use and best overall value.

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)	Shipping
DTA114EET1	6A	10	10	3000/Tape & Reel
DTA124EET1	6B	22	22	
DTA144EET1	6C	47	47	
DTA114YET1	6D	10	47	
DTA114TET1	6E	10	∞	
DTA143TET1	6F	4.7	∞	
DTA123EET1	6H	2.2	2.2	
DTA143EET1	6J	4.7	4.7	
DTA143ZET1	6K	4.7	47	
DTA124XET1	6L	22	47	
DTA123JET1	6M	2.2	47	
DTA115EET1	6N	100	100	
DTA144WET1	6P	47	22	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, FR–4 Board (Note 1.) @ T_A = 25°C Derate above 25°C	P_D	 200 1.6	 mW mW/°C
Thermal Resistance, Junction to Ambient (Note 1.)	$R_{\theta JA}$	600	°C/W
Total Device Dissipation, FR–4 Board (Note 2.) @ T_A = 25°C Derate above 25°C	P_D	 300 2.4	 mW mW/°C
Thermal Resistance, Junction to Ambient (Note 2.)	$R_{\theta JA}$	400	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 × 1.0 Inch Pad

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector–Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter–Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	DTA114EET1	I_{EBO}	–	–	0.5	mAdc
	DTA124EET1		–	–	0.2	
	DTA144EET1		–	–	0.1	
	DTA114YET1		–	–	0.2	
	DTA114TET1		–	–	0.9	
	DTA143TET1		–	–	1.9	
	DTA123EET1		–	–	2.3	
	DTA143EET1		–	–	1.5	
	DTA143ZET1		–	–	0.18	
	DTA124XET1		–	–	0.13	
	DTA123JET1		–	–	0.2	
	DTA115EET1		–	–	0.05	
	DTA144WET1		–	–	0.13	
Collector–Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector–Emitter Breakdown Voltage (Note 3.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc
ON CHARACTERISTICS (Note 3.)						
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	DTA114EET1	h_{FE}	35	60	–	
	DTA124EET1		60	100	–	
	DTA144EET1		80	140	–	
	DTA114YET1		80	140	–	
	DTA114TET1		160	250	–	
	DTA143TET1		160	250	–	
	DTA123EET1		8.0	15	–	
	DTA143EET1		15	27	–	
	DTA143ZET1		80	140	–	
	DTA124XET1		80	130	–	
	DTA123JET1		80	140	–	
	DTA115EET1		80	150	–	
	DTA144WET1		80	140	–	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_E = 0.3 mA) (I_C = 10 mA, I_B = 5 mA) DTA123EET1 (I_C = 10 mA, I_B = 1 mA) DTA114TET1/DTA143TET1/ DTA143ZET1/DTA124XET1/DTA143EET1		$V_{CE(sat)}$	–	–	0.25	Vdc
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	DTA114EET1		–	–	0.2	
	DTA124EET1		–	–	0.2	
	DTA114YET1		–	–	0.2	
	DTA114TET1		–	–	0.2	
	DTA143TET1		–	–	0.2	
	DTA123EET1		–	–	0.2	
	DTA143EET1		–	–	0.2	
	DTA143ZET1		–	–	0.2	
	DTA124XET1		–	–	0.2	
	DTA123JET1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	DTA144EET1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 5.5 V, R_L = 1.0 kΩ)	DTA115EET1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 4.0 V, R_L = 1.0 kΩ)	DTA144WET1		–	–	0.2	
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ) (V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	DTA114TET1 DTA143TET1 DTA123EET1 DTA143EET1	V_{OH}	4.9	–	–	Vdc

3. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
Input Resistor	DTA114EET1	R1	7.0	10	13	kΩ
	DTA124EET1		15.4	22	28.6	
	DTA144EET1		32.9	47	61.1	
	DTA114YET1		7.0	10	13	
	DTA114TET1		7.0	10	13	
	DTA143TET1		3.3	4.7	6.1	
	DTA123EET1		1.5	2.2	2.9	
	DTA143EET1		3.3	4.7	6.1	
	DTA143ZET1		3.3	4.7	6.1	
	DTA124XET1		15.4	22	28.6	
	DTA123JET1		1.54	2.2	2.86	
	DTA115EET1		70	100	130	
	DTA144WET1		32.9	47	61.1	
Resistor Ratio	DTA114EET1/DTA124EET1/DTA144EET1/ DTA115EET1	R_1/R_2	0.8	1.0	1.2	
	DTA114YET1		0.17	0.21	0.25	
	DTA114TET1/DTA143TET1		–	–	–	
	DTA123EET1/DTA143EET1		0.8	1.0	1.2	
	DTA143ZET1		0.055	0.1	0.185	
	DTA124XET1		0.38	0.47	0.56	
	DTA123JET1		0.038	0.047	0.056	
	DTA144WET1		1.7	2.1	2.6	

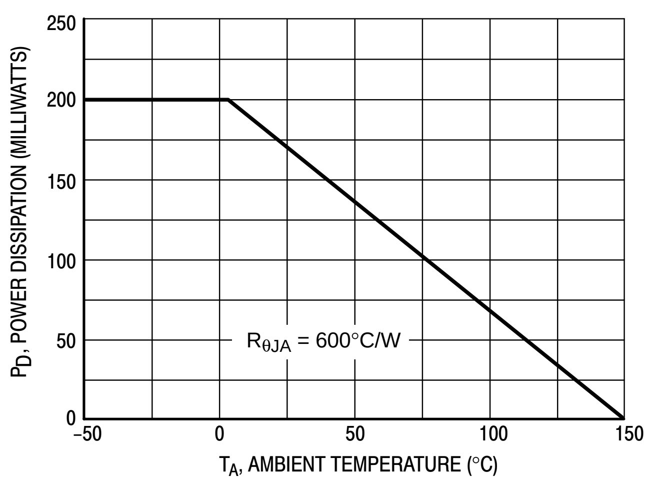


Figure 1. Derating Curve

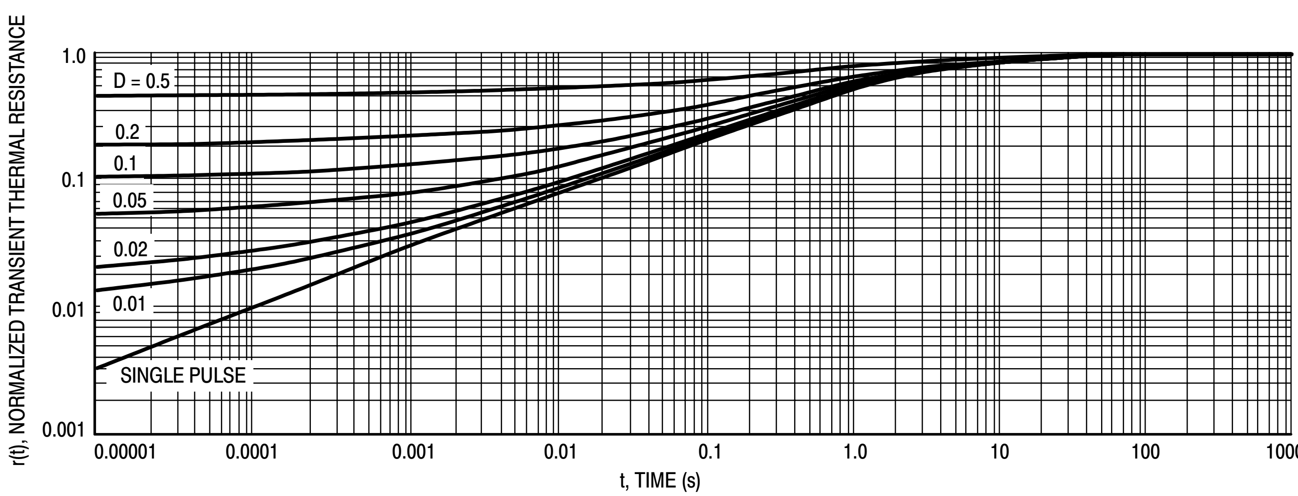


Figure 2. Normalized Thermal Response

TYPICAL ELECTRICAL CHARACTERISTICS – DTA114EET1

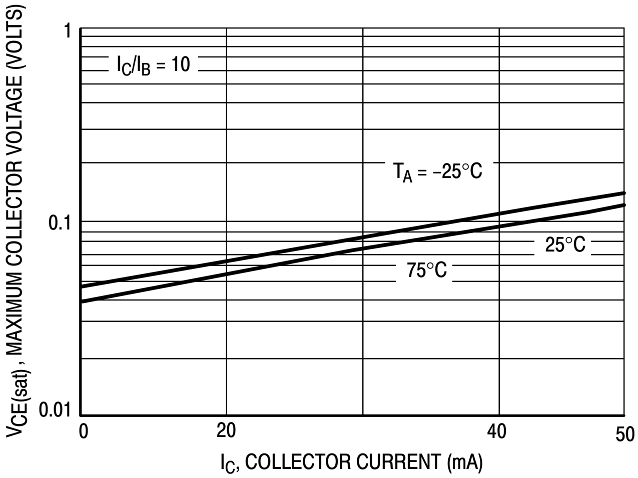


Figure 3. $V_{CE(sat)}$ versus I_C

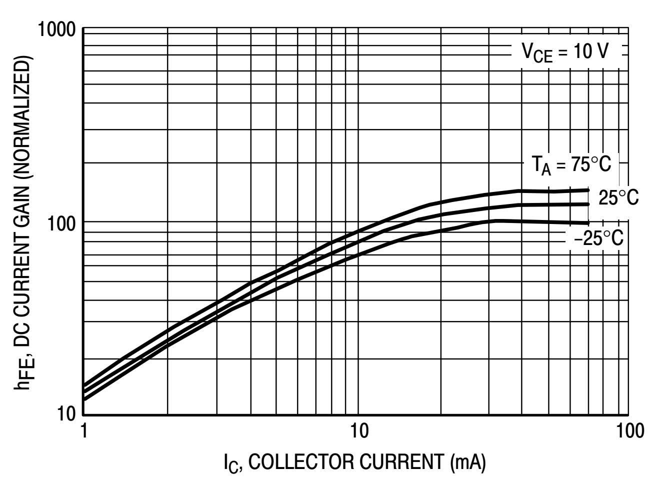


Figure 4. DC Current Gain

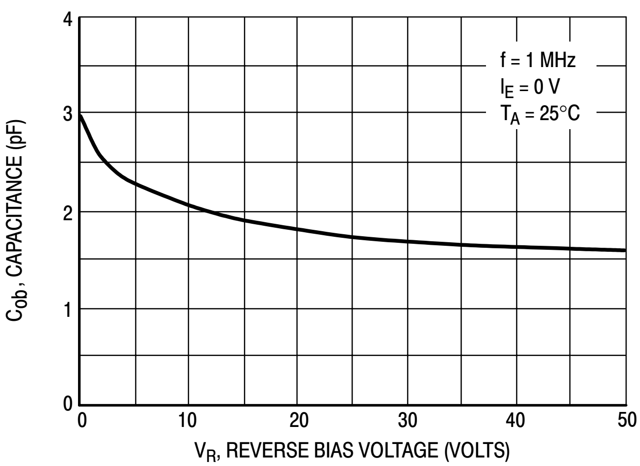


Figure 5. Output Capacitance

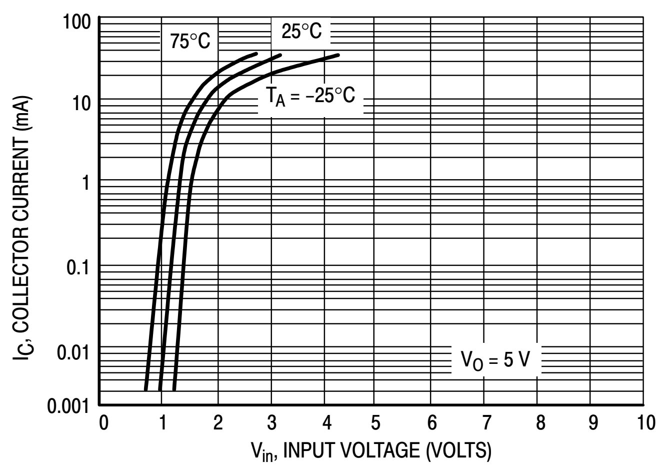


Figure 6. Output Current versus Input Voltage

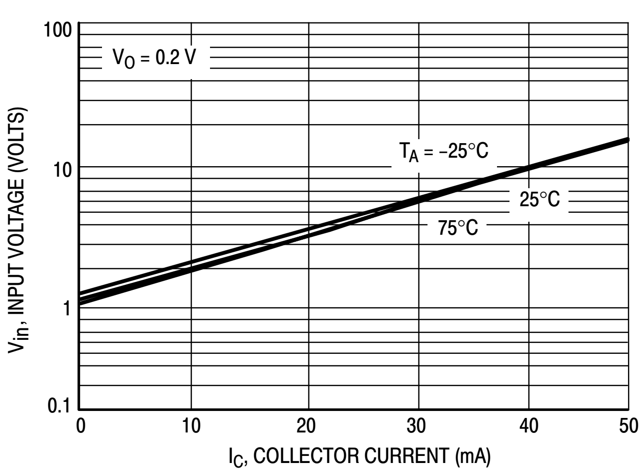


Figure 7. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – DTA124EET1

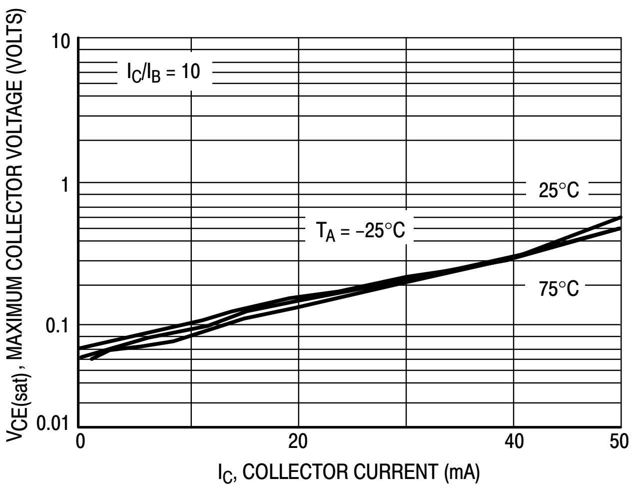


Figure 8. $V_{CE(sat)}$ versus I_C

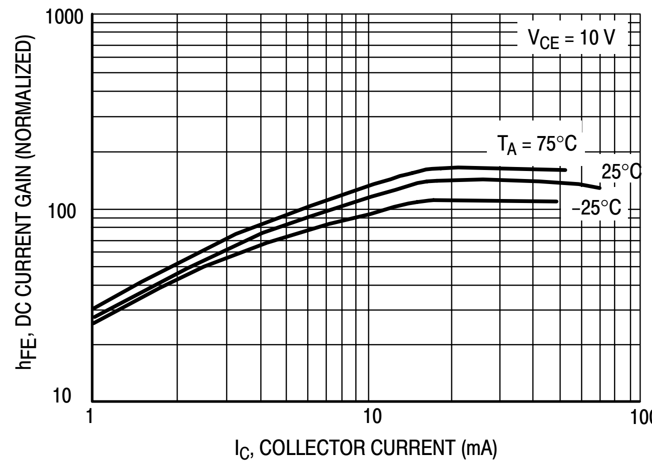


Figure 9. DC Current Gain

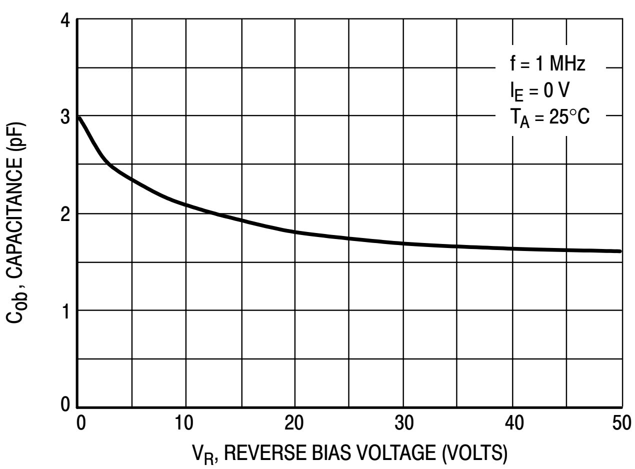


Figure 10. Output Capacitance

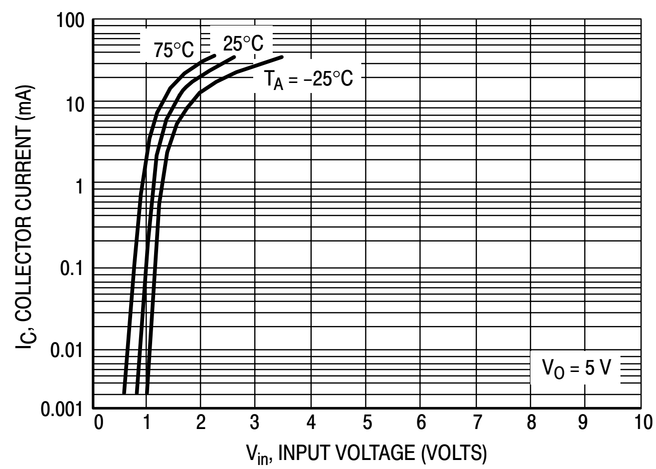


Figure 11. Output Current versus Input Voltage

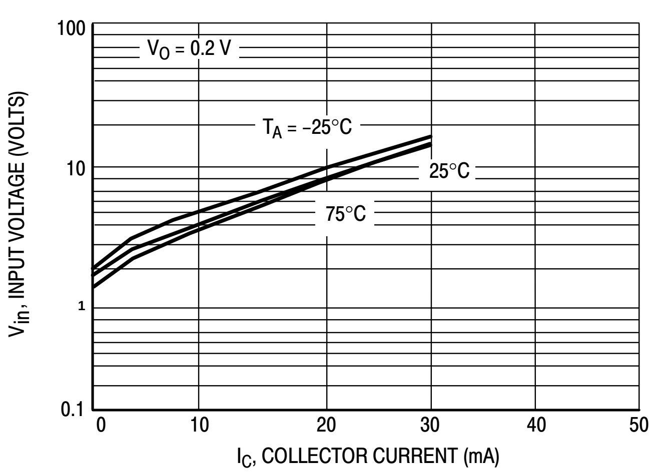


Figure 12. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – DTA144EET1

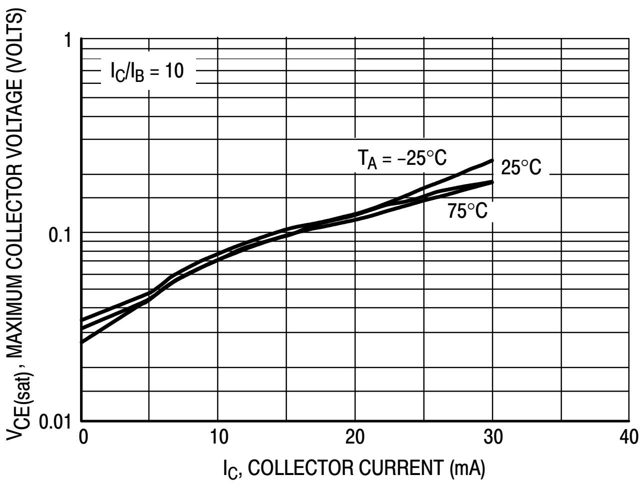


Figure 13. $V_{CE(sat)}$ versus I_C

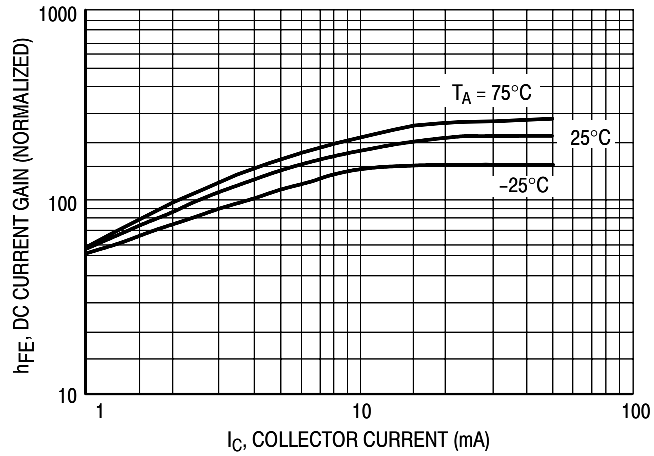


Figure 14. DC Current Gain

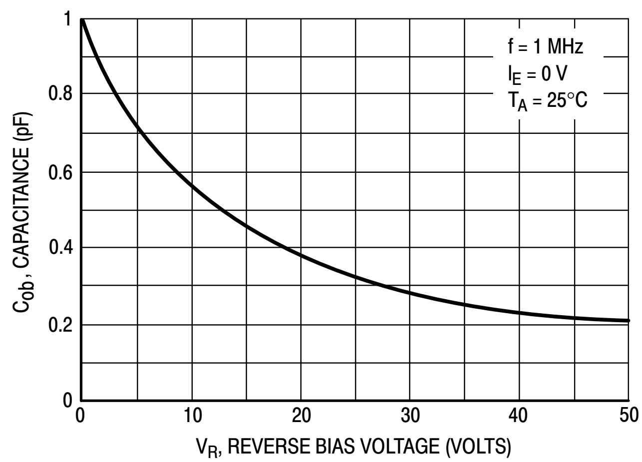


Figure 15. Output Capacitance

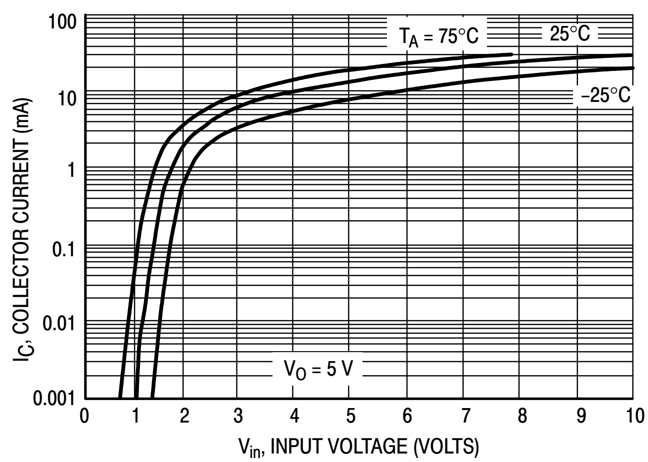


Figure 16. Output Current versus Input Voltage

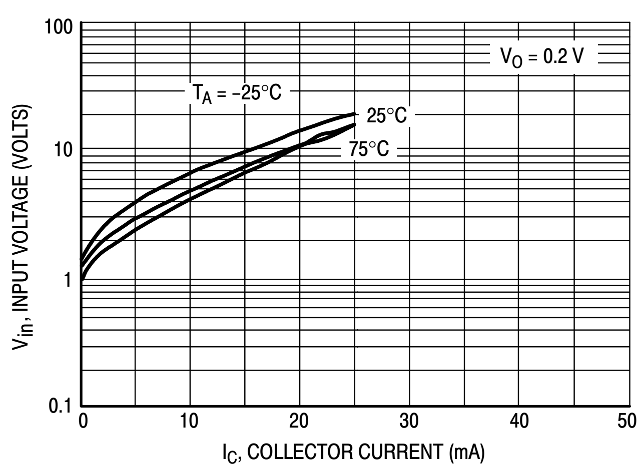


Figure 17. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – DTA114YET1

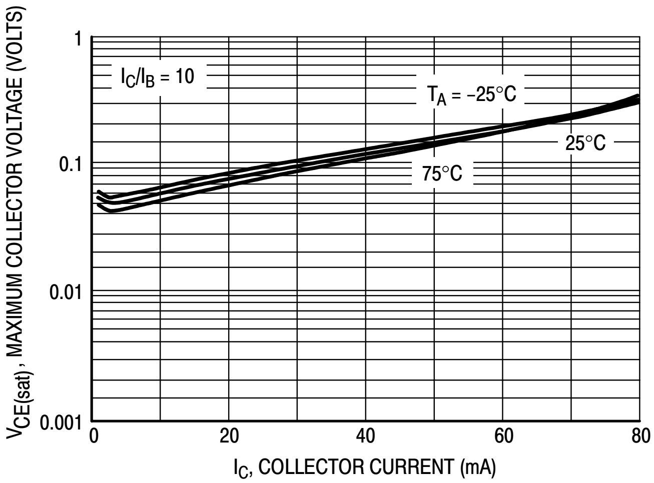


Figure 18. $V_{CE(sat)}$ versus I_C

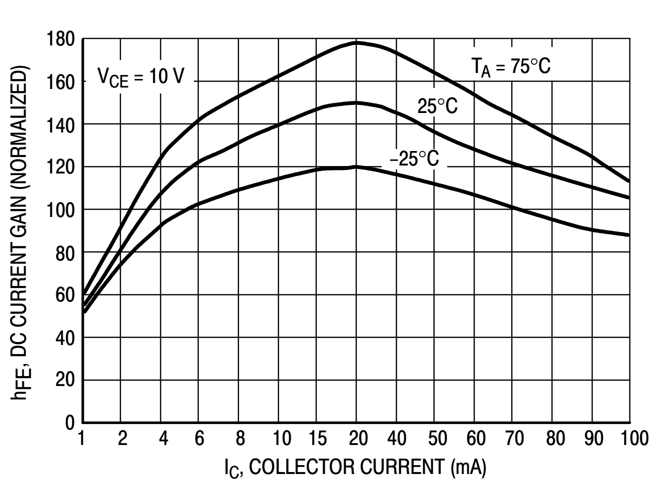


Figure 19. DC Current Gain

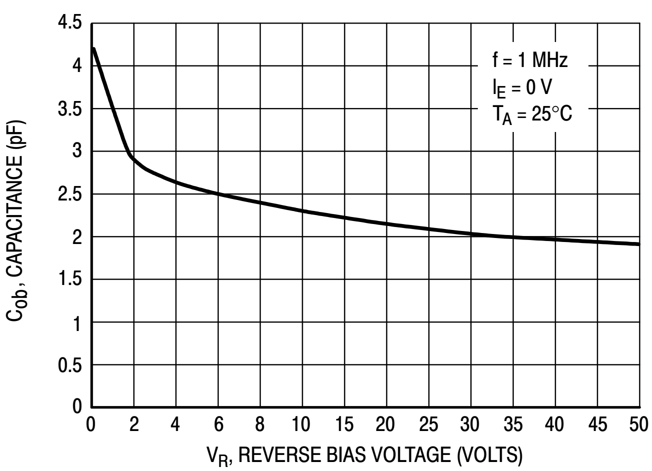


Figure 20. Output Capacitance

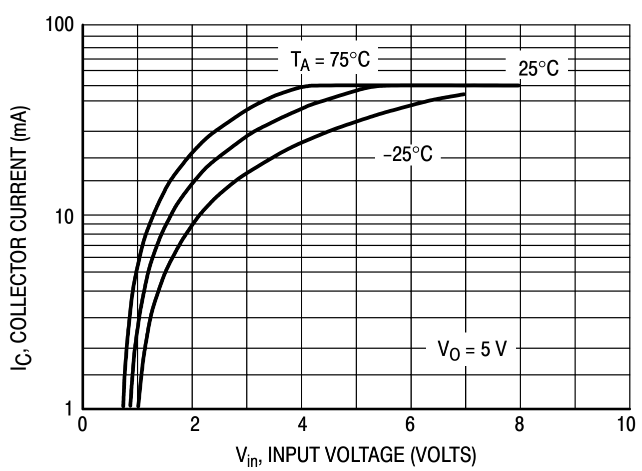


Figure 21. Output Current versus Input Voltage

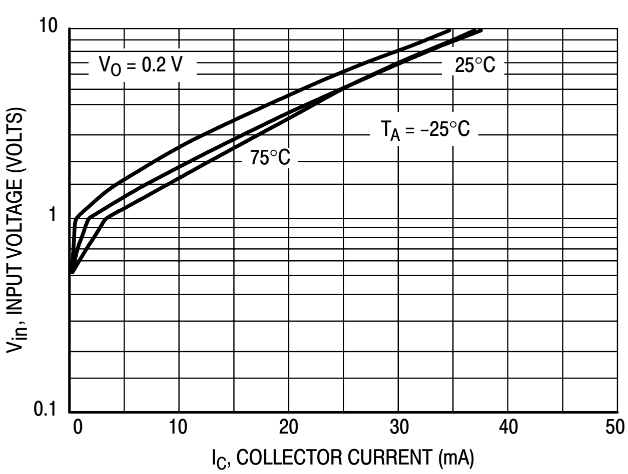


Figure 22. Input Voltage versus Output Current

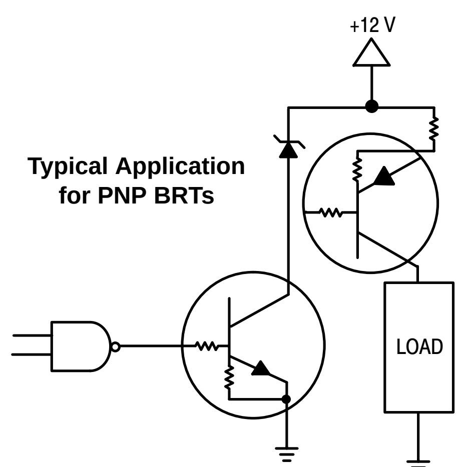


Figure 23. Inexpensive, Unregulated Current Source

TYPICAL ELECTRICAL CHARACTERISTICS — DTA115EET1

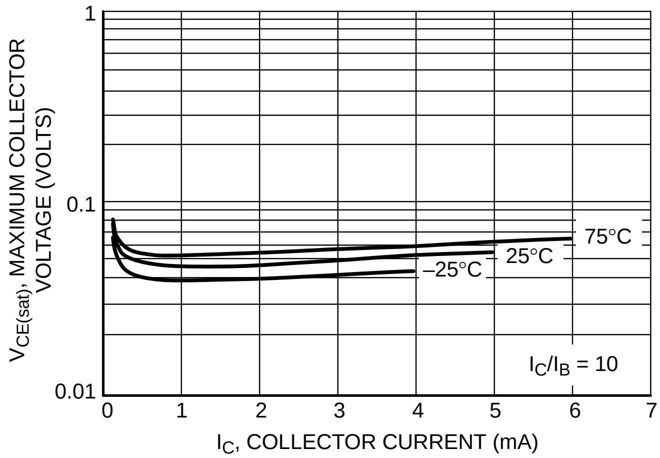


Figure 24. Maximum Collector Voltage versus Collector Current

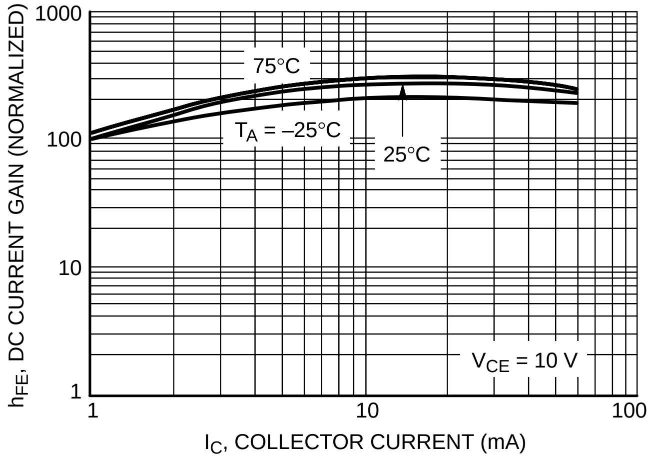


Figure 25. DC Current Gain

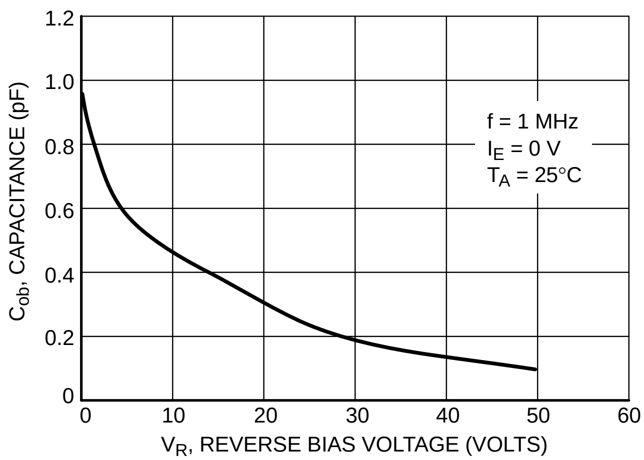


Figure 26. Output Capacitance

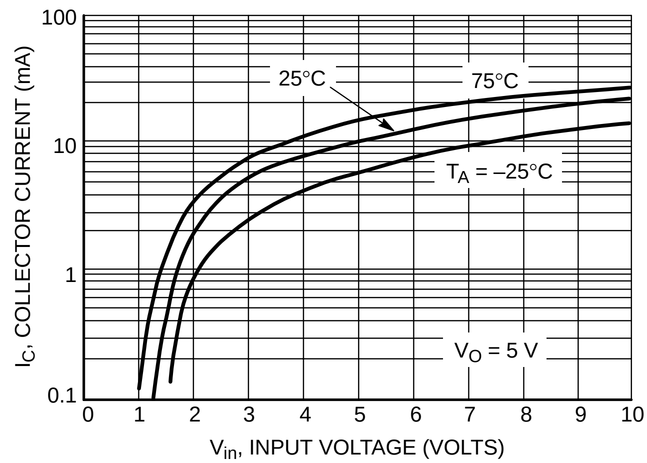


Figure 27. Output Current versus Input Voltage

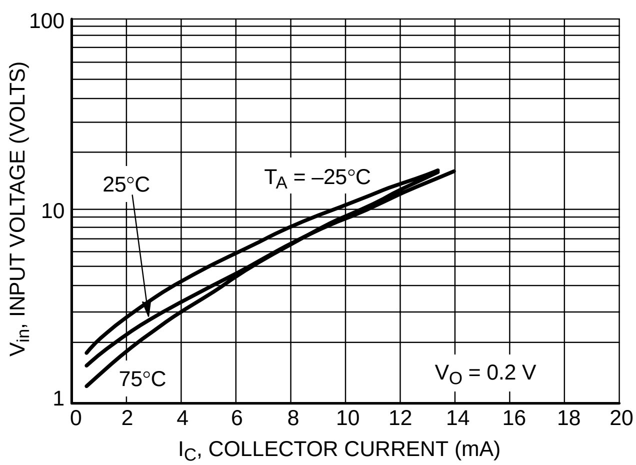


Figure 28. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — DTA144WET1

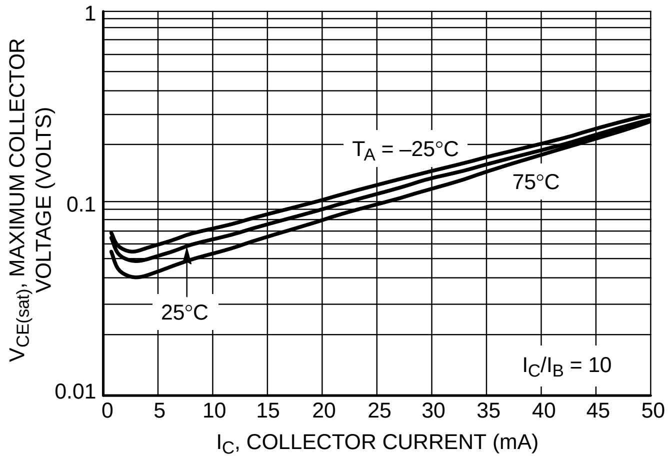


Figure 29. Maximum Collector Voltage versus Collector Current

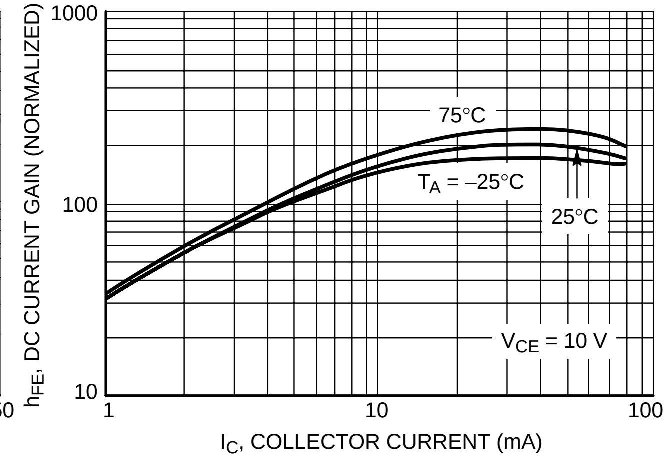


Figure 30. DC Current Gain

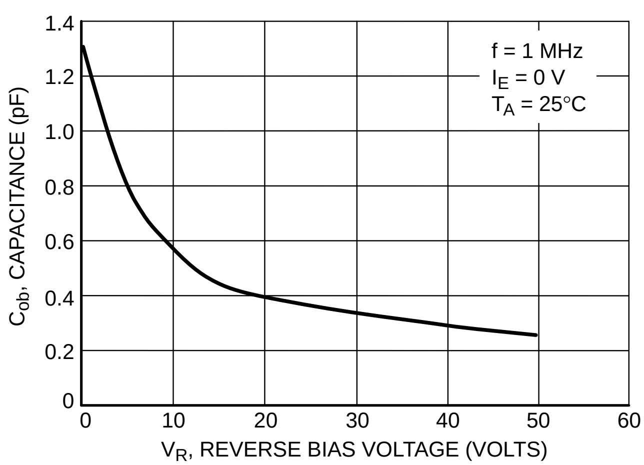


Figure 31. Output Capacitance

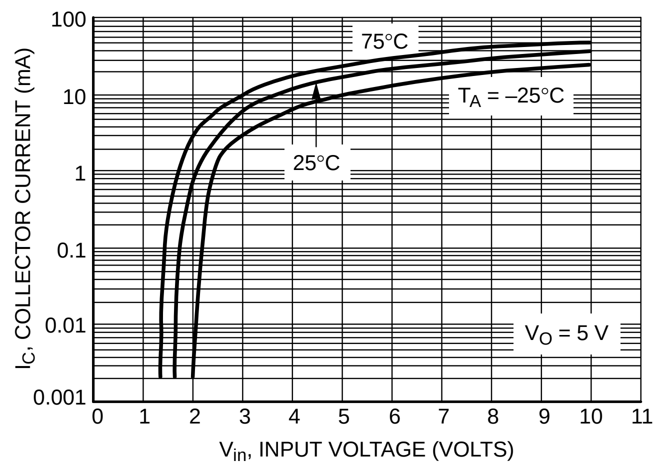


Figure 32. Output Current versus Input Voltage

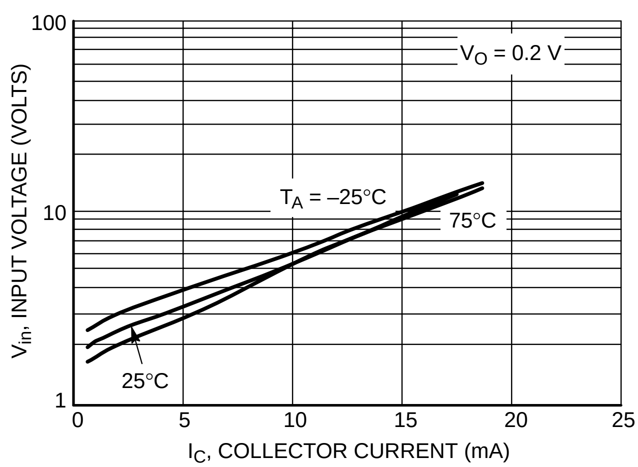


Figure 33. Input Voltage versus Output Current

DTA144TT1

Preferred Device

Bias Resistor Transistor

PNP Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC–59 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Moisture Sensitivity Level: 1
- ESD Rating – Human Body Model: Class 1
  – Machine Model: Class B
- The SC–59 package can be soldered using wave or reflow. The modified gull–winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
  Use the Device Number to order the 7 inch/3000 unit reel.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	230 (Note 1.) 338 (Note 2.) 1.8 (Note 1.) 2.7 (Note 2.)	mW °C/W
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	540 (Note 1.) 370 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{\theta JL}$	264 (Note 1.) 287 (Note 2.)	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)	Shipping
DTA144TT1	6T	47	∞	3000/Tape & Reel

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

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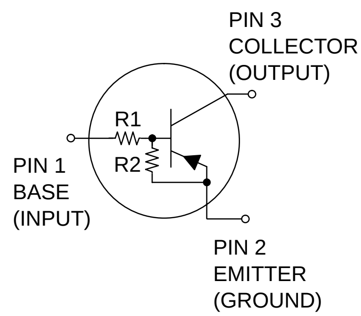
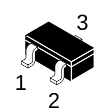
http://onsemi.com

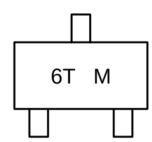
PNP SILICON BIAS RESISTOR TRANSISTOR





SC–59
CASE 318D
PLASTIC

MARKING DIAGRAM



6T = Specific Device Code
M = Date Code

ORDERING INFORMATION

Device	Package	Shipping
DTA144TT1	SC–59	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Base Cutoff Current (V_{CB} = 50 V, I_E = 0)	I_{CBO}	–	–	100	nAdc
Collector–Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)	I_{CEO}	–	–	500	nAdc
Emitter–Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	I_{EBO}	–	–	0.2	mAdc
Collector–Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	$V_{(BR)CBO}$	50	–	–	Vdc
Collector–Emitter Breakdown Voltage (Note 3.) (I_C = 2.0 mA, I_B = 0)	$V_{(BR)CEO}$	50	–	–	Vdc
ON CHARACTERISTICS (Note 3.)					
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	h_{FE}	160	350	–	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA)	$V_{CE(sat)}$	–	–	0.25	Vdc
Output Voltage (on) (V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	V_{OL}	–	–	0.2	Vdc
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	V_{OH}	4.9	–	–	Vdc
Input Resistor	R1	32.9	47	61.1	kΩ

3. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

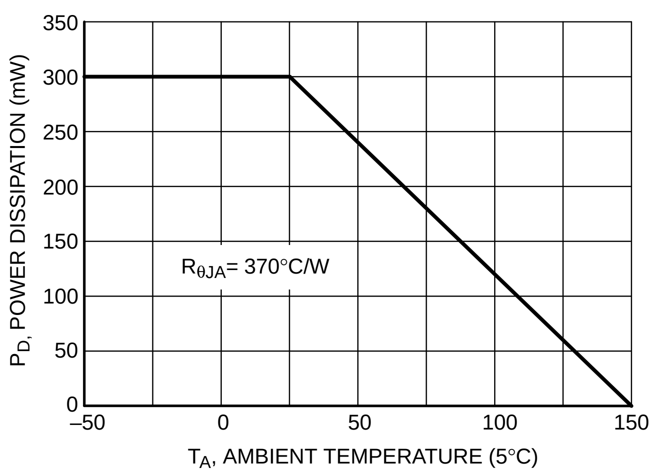


Figure 1. Derating Curve

DTC114E Series

Preferred Devices

Bias Resistor Transistor

NPN Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the TO–92 package which is designed for through hole applications.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc
Total Power Dissipation @ T_A = 25°C (Note 1.) Derate above 25°C	P_D	 350 2.81	 mW mW/°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Ambient (surface mounted)	$R_{\theta JA}$	357	°C/W
Operating and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C
Maximum Temperature for Soldering Purposes, Time in Solder Bath	T_L	260 10	°C Sec

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)	Shipping
DTC114E	DTC114E	10	10	5000/Box
DTC124E	DTC124E	22	22	
DTC144E	DTC144E	47	47	
DTC114Y	DTC114Y	10	47	
DTC114T	DTC114T	10	∞	
DTC143T	DTC143T	4.7	∞	
DTD113E	DTD113E	1.0	1.0	
DTC123E	DTC123E	2.2	2.2	
DTC143E	DTC143E	4.7	4.7	
DTC143Z	DTC143Z	4.7	47	

1. Device mounted on a FR–4 glass epoxy printed circuit board using the minimum recommended footprint.

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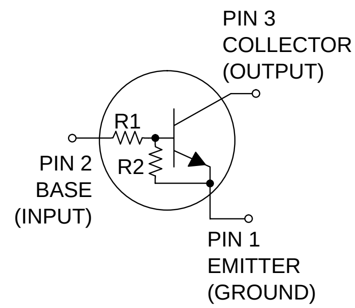
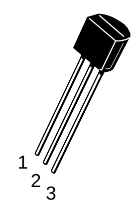
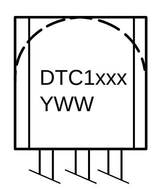
NPN SILICON BIAS RESISTOR TRANSISTOR





CASE 29
TO–92 (TO–226)
STYLE 1

MARKING DIAGRAM



DTC1 = Specific Device Code
xxx = (See Table)
Y = Year
WW = Work Week

Preferred devices are recommended choices for future use and best overall value.

January, 2001 – Rev. 2
Publication Order Number:
DTC114E/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector–Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter–Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	DTC114E	I_{EBO}	–	–	0.5	mAdc
	DTC124E		–	–	0.2	
	DTC144E		–	–	0.1	
	DTC114Y		–	–	0.2	
	DTC114T		–	–	0.9	
	DTC143T		–	–	1.9	
	DTD113E		–	–	4.3	
	DTC123E		–	–	2.3	
	DTC143E		–	–	1.5	
	DTC143Z		–	–	0.18	
Collector–Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector–Emitter Breakdown Voltage (Note 2.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc
ON CHARACTERISTICS (Note 2.)						
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	DTC114E	h_{FE}	35	60	–	
	DTC124E		60	100	–	
	DTC144E		80	140	–	
	DTC114Y		80	140	–	
	DTC114T		160	350	–	
	DTC143T		160	350	–	
	DTD113E		3.0	5.0	–	
	DTC123E		8.0	15	–	
	DTC143E		15	30	–	
	DTC143Z		80	200	–	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_E = 0.3 mA)	DTC144E/DTC114Y DTD113E/DTC143E	$V_{CE(sat)}$	–	–	0.25	Vdc
(I_C = 10 mA, I_B = 5 mA)	DTC123E					
(I_C = 10 mA, I_B = 1 mA)	DTC114T/DTC143T/ DTC143Z/DTC124E					
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	DTC114E		–	–	0.2	
	DTC124E		–	–	0.2	
	DTC114Y		–	–	0.2	
	DTC114T		–	–	0.2	
	DTC143T		–	–	0.2	
	DTD113E		–	–	0.2	
	DTC123E		–	–	0.2	
	DTC143E		–	–	0.2	
	DTC143Z		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	DTC144E		–	–	0.2	

2. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ) (V_{CC} = 5.0 V, V_B = 0.05 V, R_L = 1.0 kΩ) (V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	 DTC114E DTC124E DTC144E DTC114Y DTC123E DTC143E DTD113E DTC114T DTC143T DTC143Z	V_{OH}	4.9	–	–	Vdc
Input Resistor	DTC114E DTC124E DTC144E DTC114Y DTC114T DTC143T DTD113E DTC123E DTC143E DTC143Z	R1	7.0 15.4 32.9 7.0 7.0 3.3 0.7 1.5 3.3 3.3	10 22 47 10 10 4.7 1.0 2.2 4.7 4.7	13 28.6 61.1 13 13 6.1 1.3 2.9 6.1 6.1	kΩ
Resistor Ratio	DTC114E/DTC124E/DTC144E DTC114Y DTC114T/DTC143T DTD113E/DTC123E/DTC143E DTC143Z	R_1/R_2	0.8 0.17 – 0.8 0.055	1.0 0.21 – 1.0 0.1	1.2 0.25 – 1.2 0.185	

TYPICAL ELECTRICAL CHARACTERISTICS
DTC114E

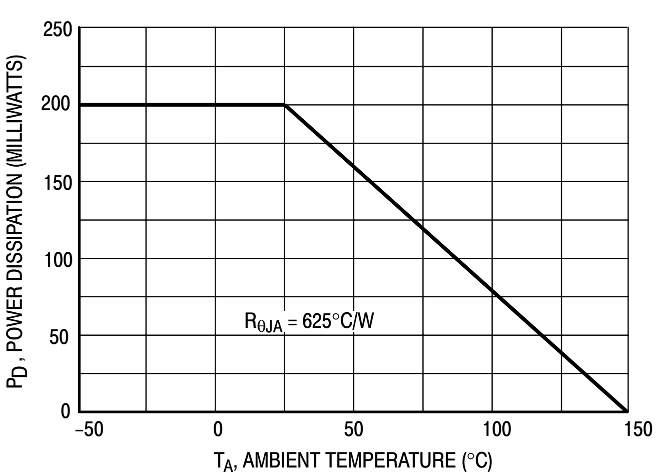


Figure 1. Derating Curve

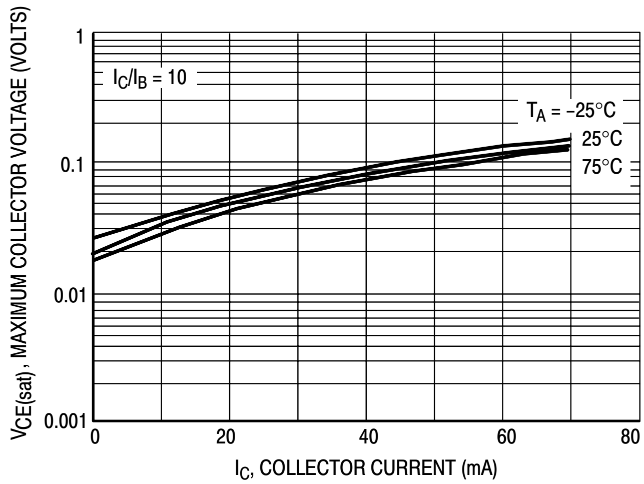


Figure 2. $V_{CE(sat)}$ versus I_C

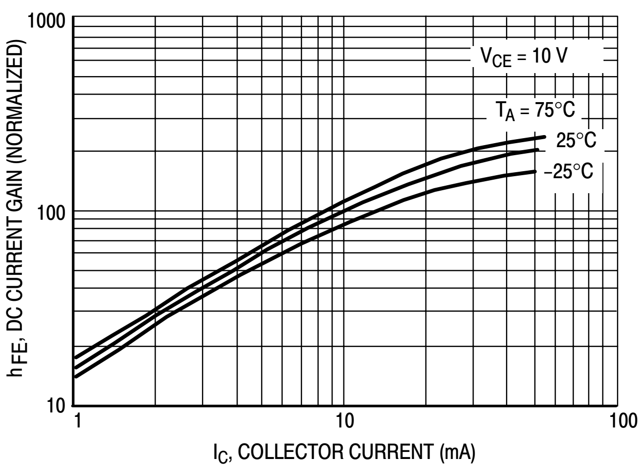


Figure 3. DC Current Gain

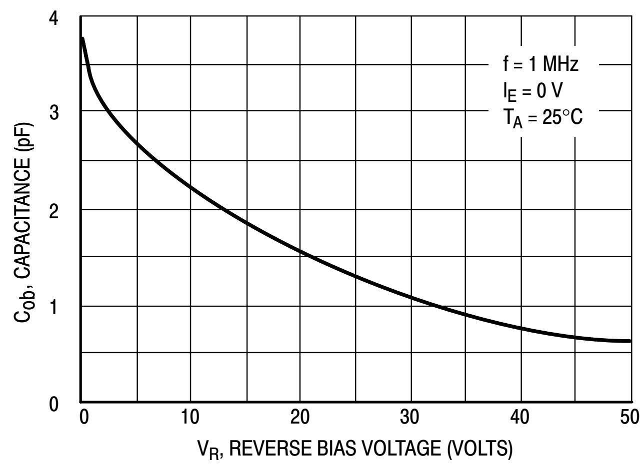


Figure 4. Output Capacitance

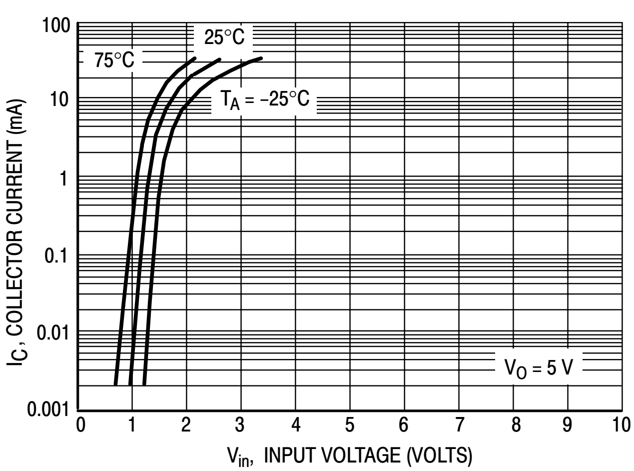


Figure 5. $V_{CE(sat)}$ versus I_C

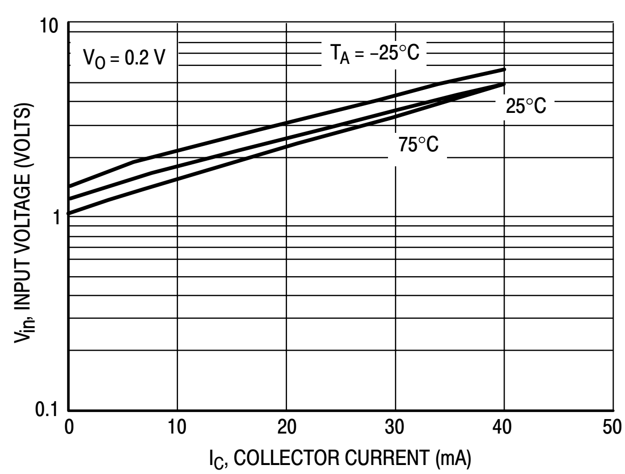


Figure 6. $V_{CE(sat)}$ versus I_C

TYPICAL ELECTRICAL CHARACTERISTICS
DTC124E

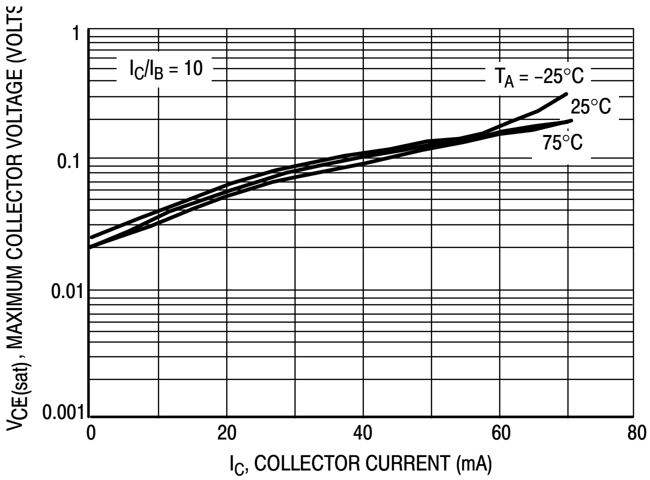


Figure 7. $V_{CE(sat)}$ versus I_C

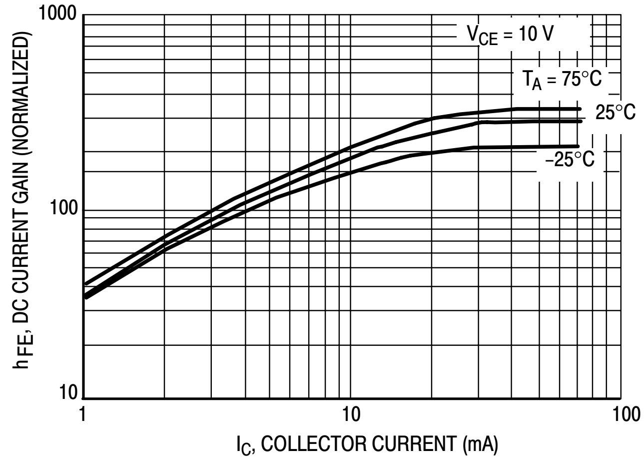


Figure 8. DC Current Gain

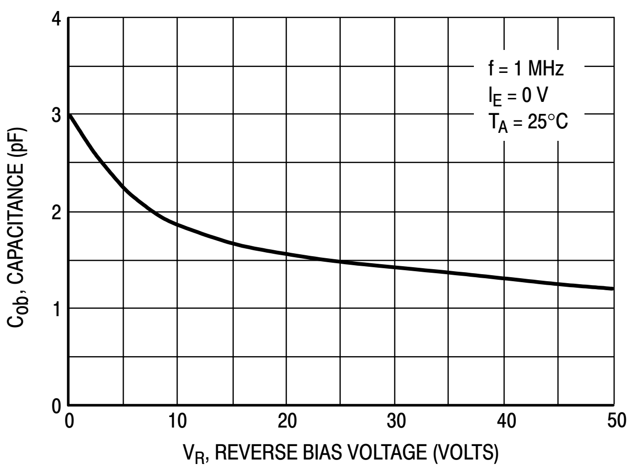


Figure 9. Output Capacitance

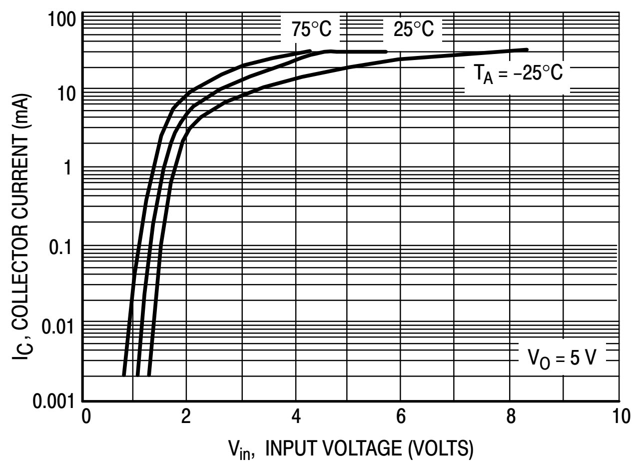


Figure 10. Output Current versus Input Voltage

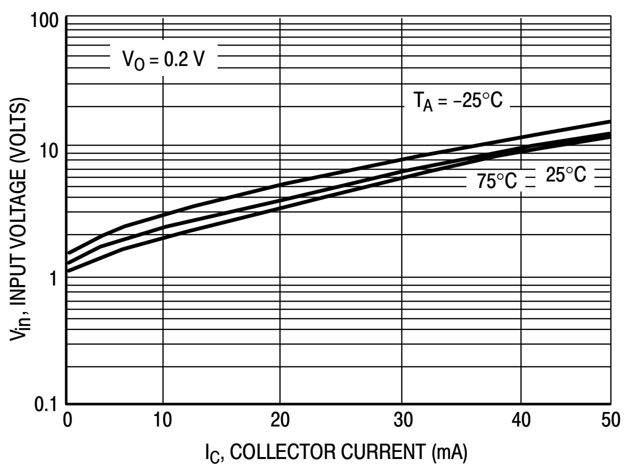


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
DTC144E

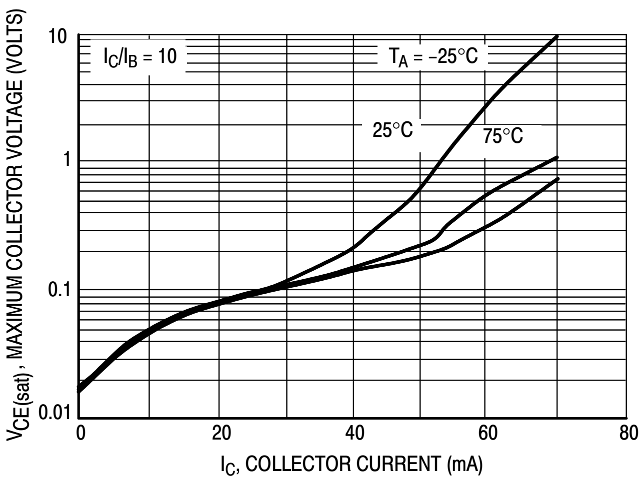


Figure 12. $V_{CE(sat)}$ versus I_C

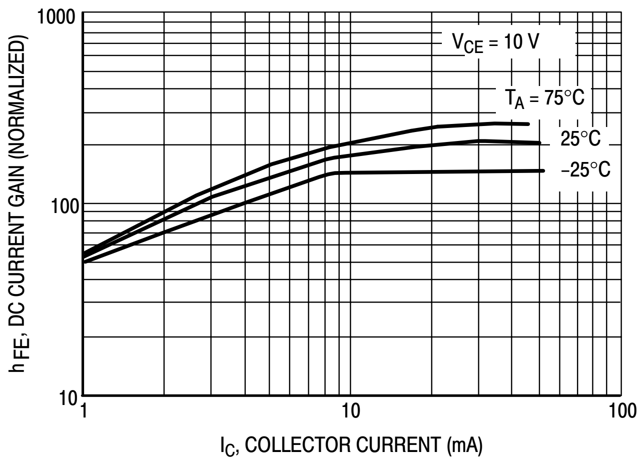


Figure 13. DC Current Gain

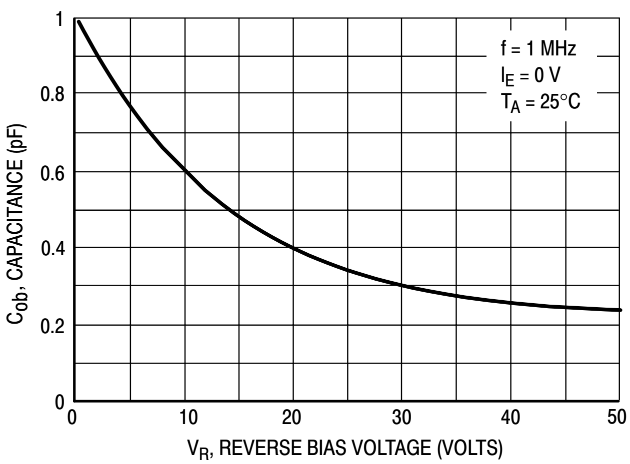


Figure 14. Output Capacitance

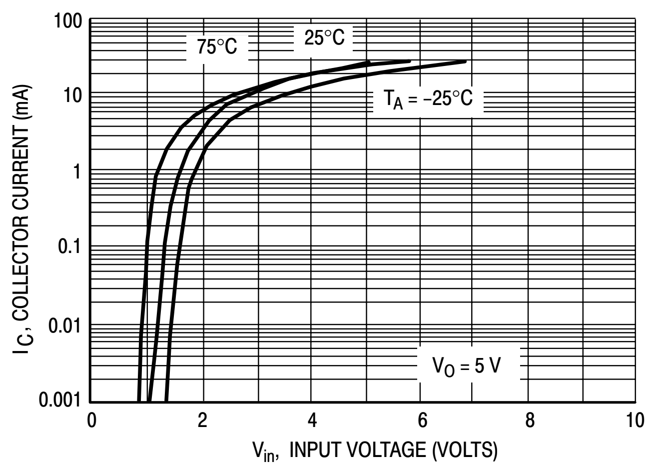


Figure 15. Output Current versus Input Voltage

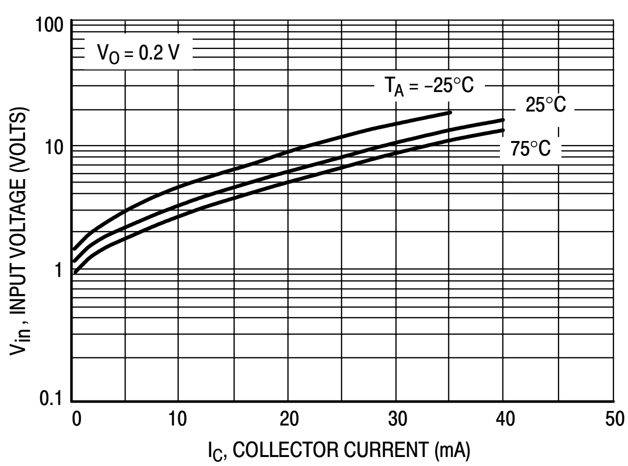


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
DTC114Y

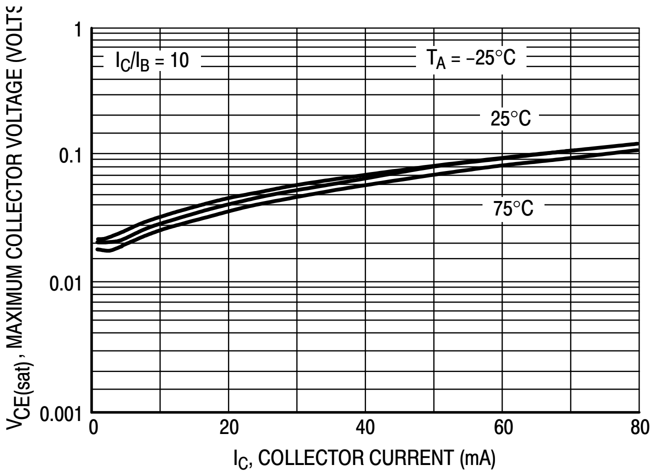


Figure 17. $V_{CE(sat)}$ versus I_C

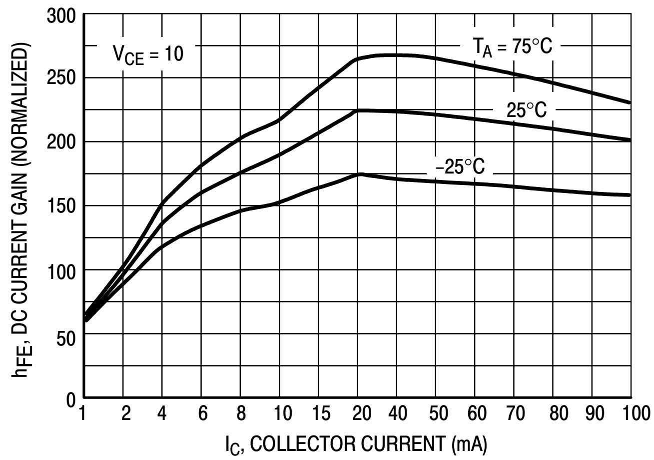


Figure 18. DC Current Gain

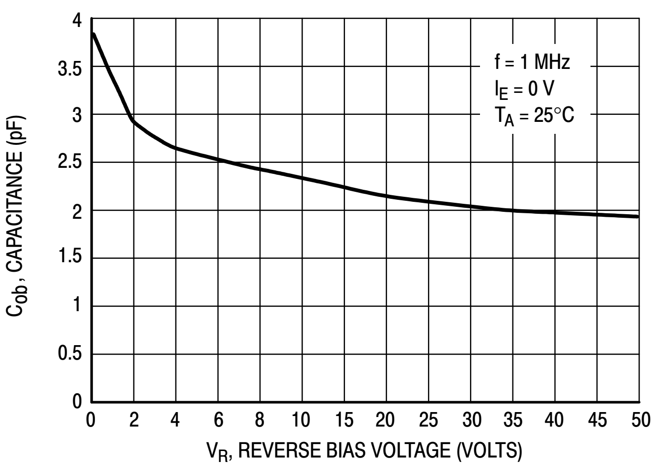


Figure 19. Output Capacitance

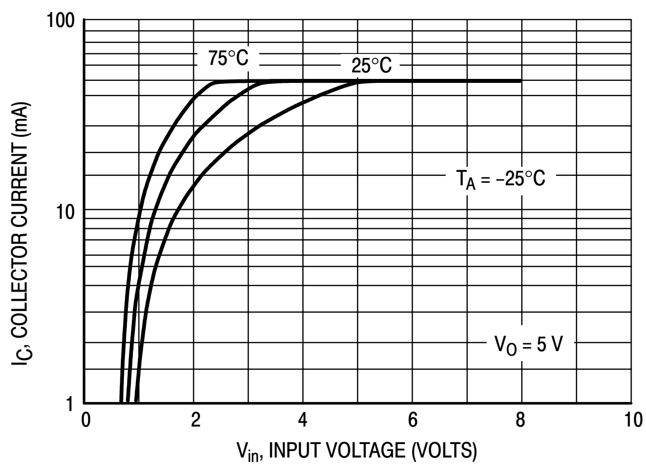


Figure 20. Output Current versus Input Voltage

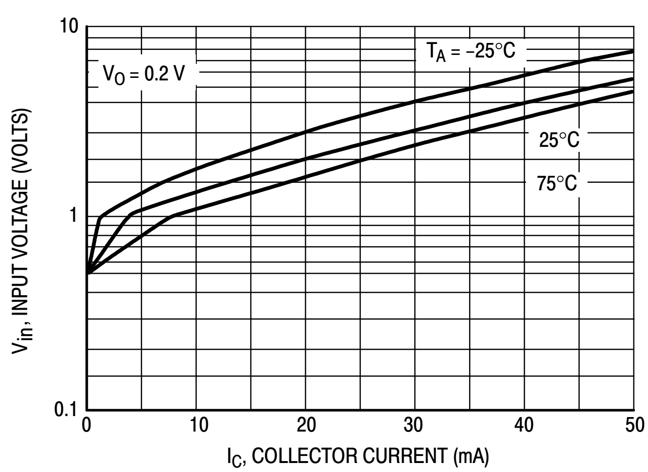


Figure 21. Input Voltage versus Output Current

TYPICAL APPLICATIONS FOR NPN BRTs

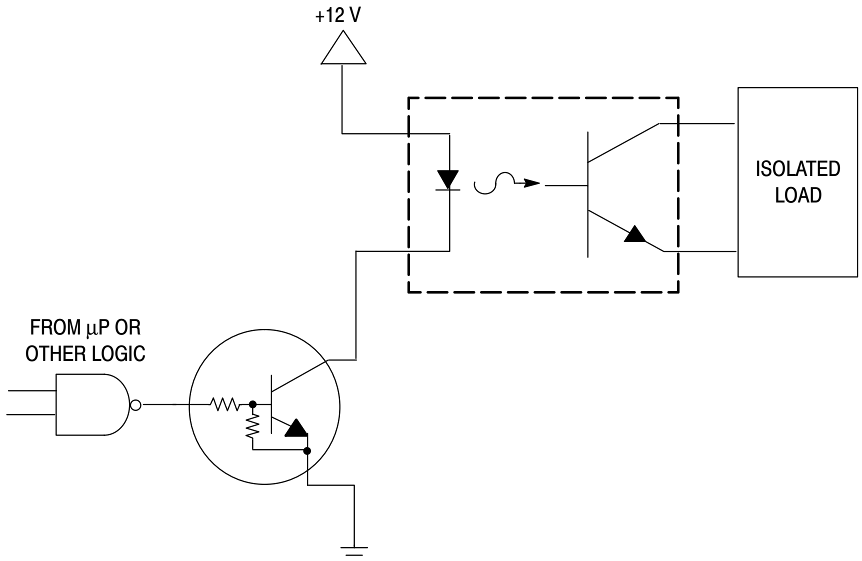


Figure 22. Level Shifter: Connects 12 or 24 Volt Circuits to Logic

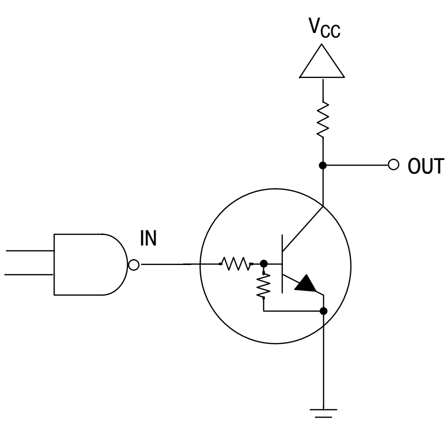


Figure 23. Open Collector Inverter: Inverts the Input Signal

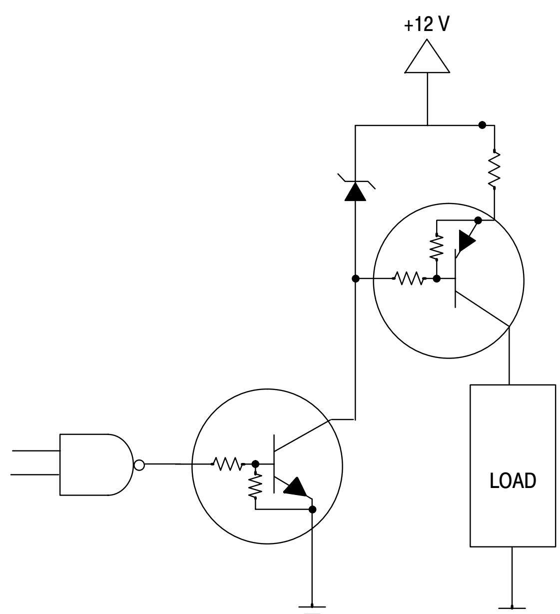


Figure 24. Inexpensive, Unregulated Current Source

DTC114EET1 Series

Bias Resistor Transistor

NPN Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC–75/SOT–416 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- The SC–75/SOT–416 package can be soldered using wave or reflow. The modified gull–winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm, 7 inch/3000 Unit Tape & Reel

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

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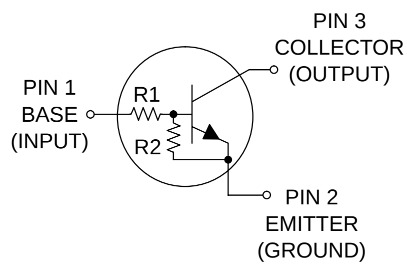
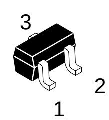
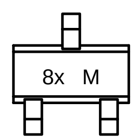
NPN SILICON BIAS RESISTOR TRANSISTORS





SC–75/SOT–416
CASE 463
STYLE 1

MARKING DIAGRAM



8x	= Specific Device Code	
x	= (See Marking Table on page 411)	
M	= Date Code	

January, 2001 – Rev. 3
Publication Order Number:
DTC114EET1/D

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)	Shipping
DTC114EET1	8A	10	10	3000/Tape & Reel
DTC124EET1	8B	22	22	
DTC144EET1	8C	47	47	
DTC114YET1	8D	10	47	
DTC114TET1	8E	10	∞	
DTC143TET1	8F	4.7	∞	
DTC123EET1	8H	2.2	2.2	
DTC143EET1	8J	4.7	4.7	
DTC143ZET1	8K	4.7	47	
DTC124XET1	8L	22	47	
DTC123JET1	8M	2.2	47	
DTC115EET1	8N	100	100	
DTC144WET1	8P	47	22	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, FR–4 Board (Note 1.) @ T_A = 25°C Derate above 25°C	P_D	 200 1.6	 mW mW/°C
Thermal Resistance, Junction to Ambient (Note 1.)	$R_{\theta JA}$	600	°C/W
Total Device Dissipation, FR–4 Board (Note 2.) @ T_A = 25°C Derate above 25°C	P_D	 300 2.4	 mW mW/°C
Thermal Resistance, Junction to Ambient (Note 2.)	$R_{\theta JA}$	400	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 × 1.0 Inch Pad

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector–Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter–Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	DTC114EET1	I_{EBO}	–	–	0.5	mAdc
	DTC124EET1		–	–	0.2	
	DTC144EET1		–	–	0.1	
	DTC114YET1		–	–	0.2	
	DTC114TET1		–	–	0.9	
	DTC143TET1		–	–	1.9	
	DTC123EET1		–	–	2.3	
	DTC143EET1		–	–	1.5	
	DTC143ZET1		–	–	0.18	
	DTC124XET1		–	–	0.13	
	DTC123JET1		–	–	0.2	
	DTC115EET1		–	–	0.05	
	DTC144WET1		–	–	0.13	
Collector–Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector–Emitter Breakdown Voltage (Note 3.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc
ON CHARACTERISTICS (Note 3.)						
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	DTC114EET1	h_{FE}	35	60	–	
	DTC124EET1		60	100	–	
	DTC144EET1		80	140	–	
	DTC114YET1		80	140	–	
	DTC114TET1		160	350	–	
	DTC143TET1		160	350	–	
	DTC123EET1		8.0	15	–	
	DTC143EET1		15	30	–	
	DTC143ZET1		80	200	–	
	DTC124XET1		80	150	–	
	DTC123JET1		80	140	–	
	DTC115EET1		80	150	–	
	DTC144WET1		80	140	–	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.3 mA) (I_C = 10 mA, I_B = 5 mA) DTC123EET1 (I_C = 10 mA, I_B = 1 mA) DTC143TET1/DTC114TET1/ DTC143EET1/DTC143ZET1/DTC124XET1		$V_{CE(sat)}$	–	–	0.25	Vdc
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	DTC114EET1		–	–	0.2	
	DTC124EET1		–	–	0.2	
	DTC114YET1		–	–	0.2	
	DTC114TET1		–	–	0.2	
	DTC143TET1		–	–	0.2	
	DTC123EET1		–	–	0.2	
	DTC143EET1		–	–	0.2	
	DTC143ZET1		–	–	0.2	
	DTC124XET1		–	–	0.2	
	DTC123JET1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	DTC144EET1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 5.5 V, R_L = 1.0 kΩ)	DTC115EET1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 4.0 V, R_L = 1.0 kΩ)	DTC144WET1		–	–	0.2	
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ) (V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	DTC143TET1 DTC143ZET1 DTC114TET1	V_{OH}	4.9	–	–	Vdc

3. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
Input Resistor	DTC114EET1	R1	7.0	10	13	kΩ
	DTC124EET1		15.4	22	28.6	
	DTC144EET1		32.9	47	61.1	
	DTC114YET1		7.0	10	13	
	DTC114TET1		7.0	10	13	
	DTC143TET1		3.3	4.7	6.1	
	DTC123EET1		1.5	2.2	2.9	
	DTC143EET1		3.3	4.7	6.1	
	DTC143ZET1		3.3	4.7	6.1	
	DTC124XET1		15.4	22	28.6	
	DTC123JET1		1.54	2.2	2.86	
	DTC115EET1		70	100	130	
	DTC144WET1		32.9	47	61.1	
Resistor Ratio	DTC114EET1/DTC124EET1/DTC144EET1/ DTC115EET1	R_1/R_2	0.8	1.0	1.2	
	DTC114YET1		0.17	0.21	0.25	
	DTC143TET1/DTC114TET1		–	–	–	
	DTC123EET1/DTC143EET1		0.8	1.0	1.2	
	DTC143ZET1		0.055	0.1	0.185	
	DTC124XET1		0.38	0.47	0.56	
	DTC123JET1		0.038	0.047	0.056	
	DTC144WET1		1.7	2.1	2.6	

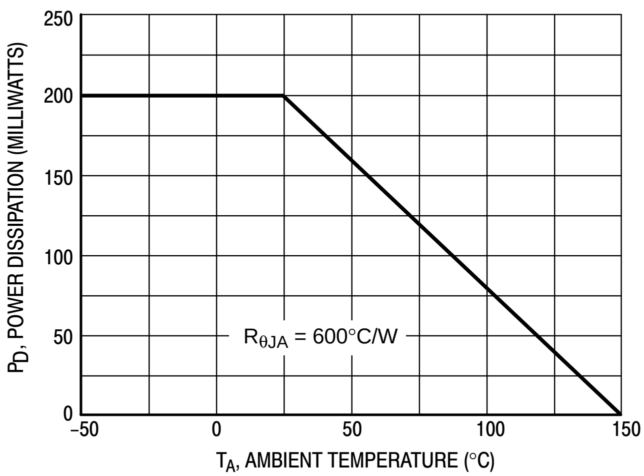


Figure 1. Derating Curve

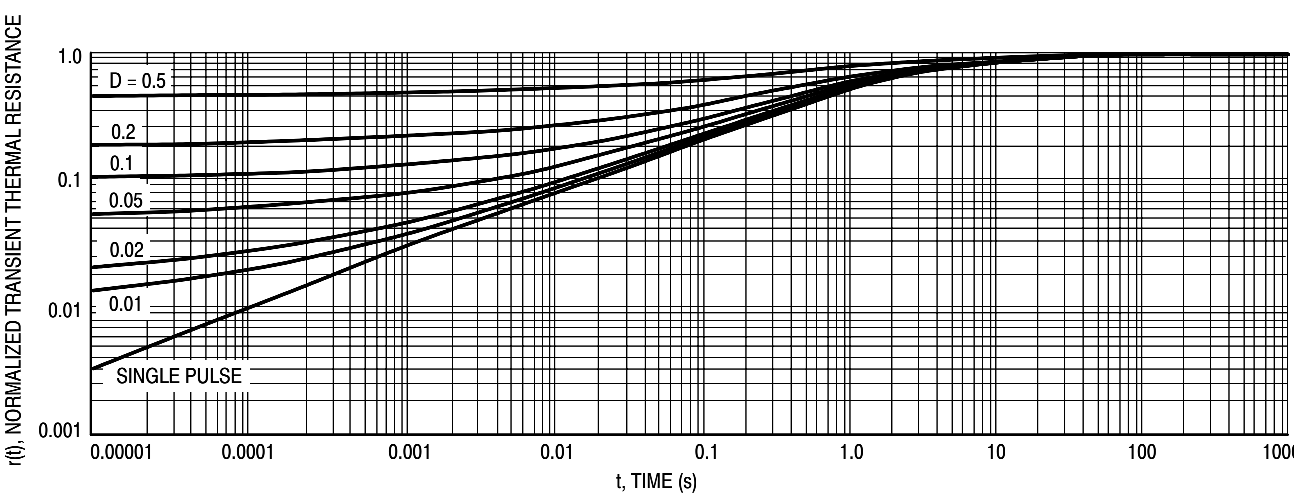


Figure 2. Normalized Thermal Response

TYPICAL ELECTRICAL CHARACTERISTICS – DTC114EET1

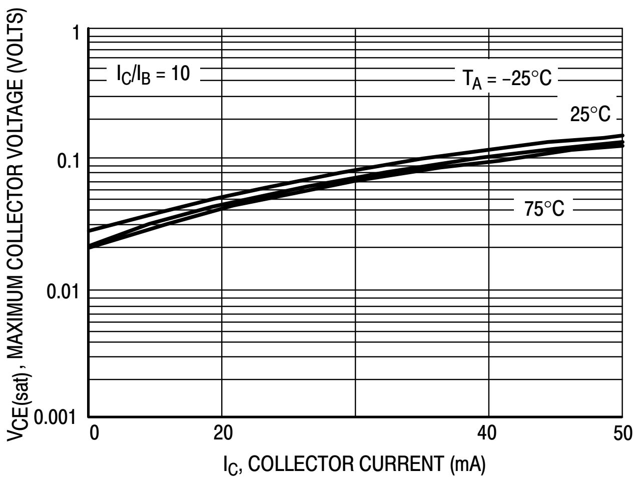


Figure 3. $V_{CE(sat)}$ versus I_C

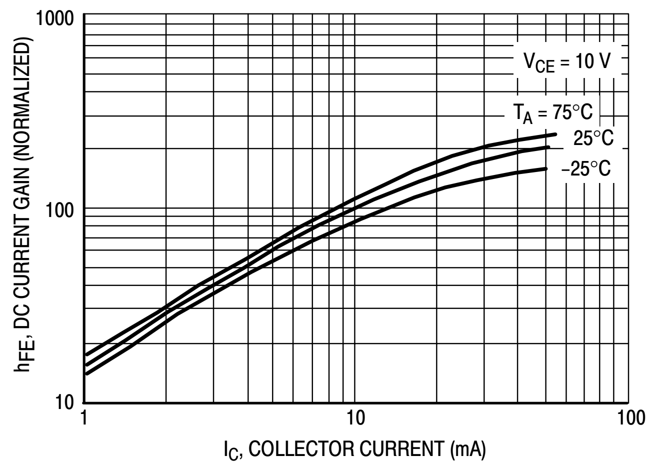


Figure 4. DC Current Gain

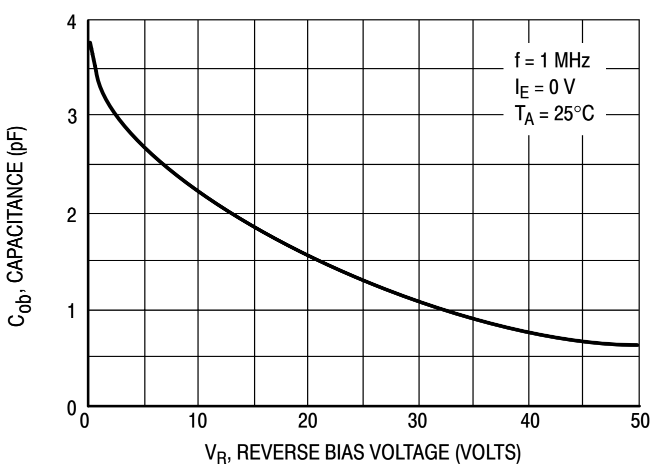


Figure 5. Output Capacitance

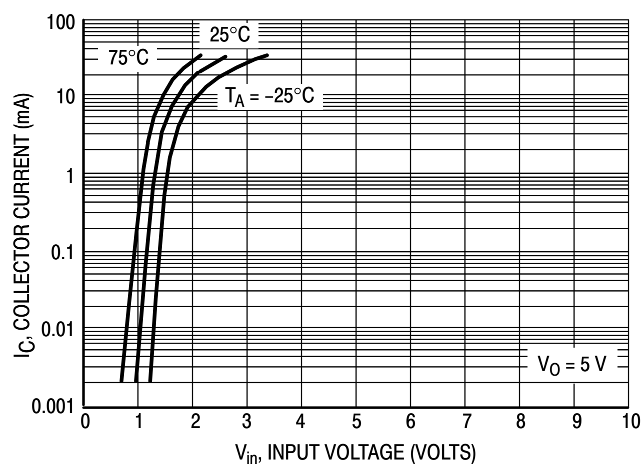


Figure 6. Output Current versus Input Voltage

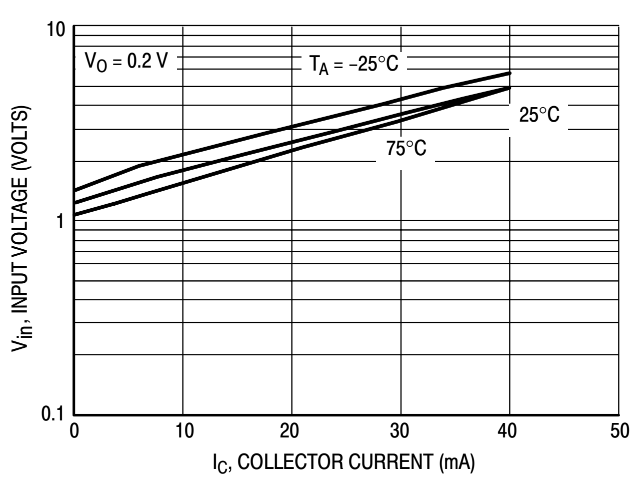


Figure 7. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – DTC124EET1

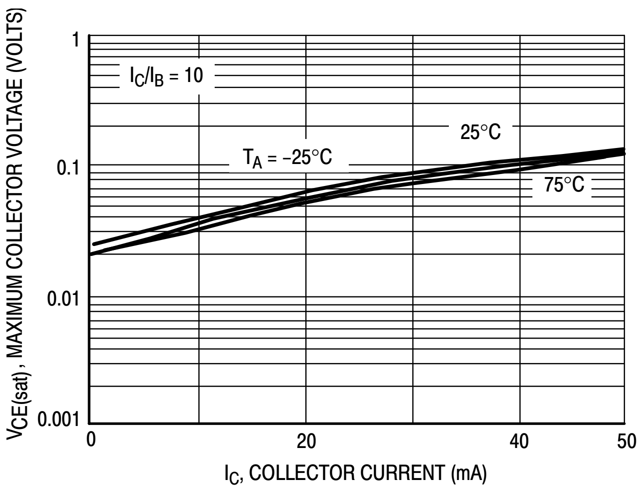


Figure 8. $V_{CE(sat)}$ versus I_C

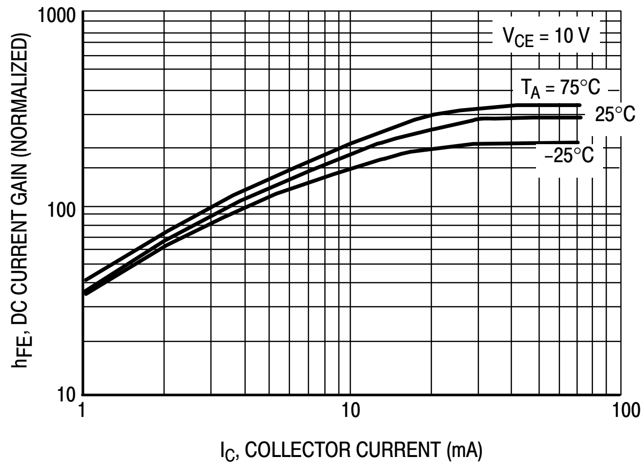


Figure 9. DC Current Gain

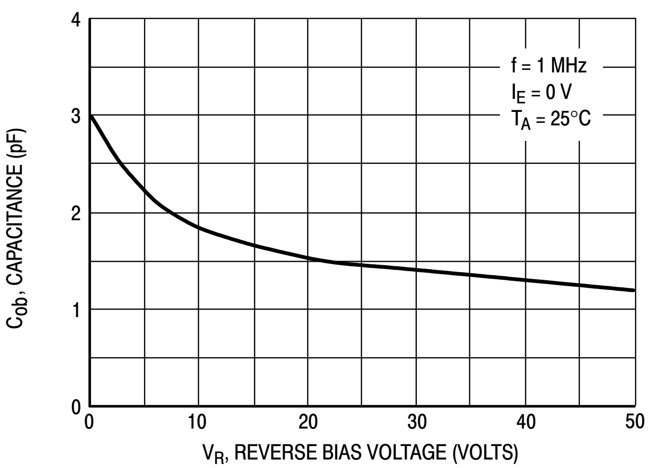


Figure 10. Output Capacitance

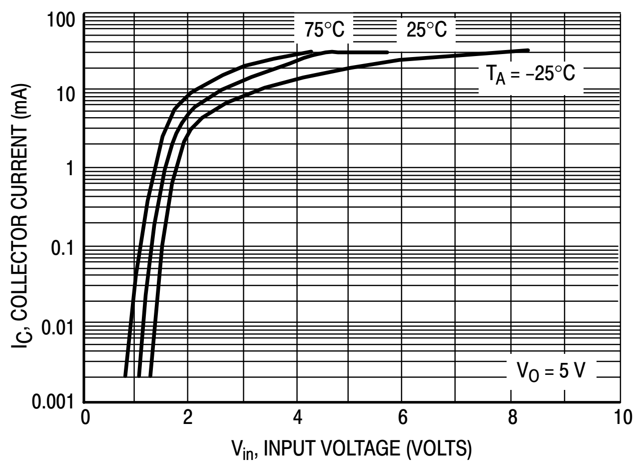


Figure 11. Output Current versus Input Voltage

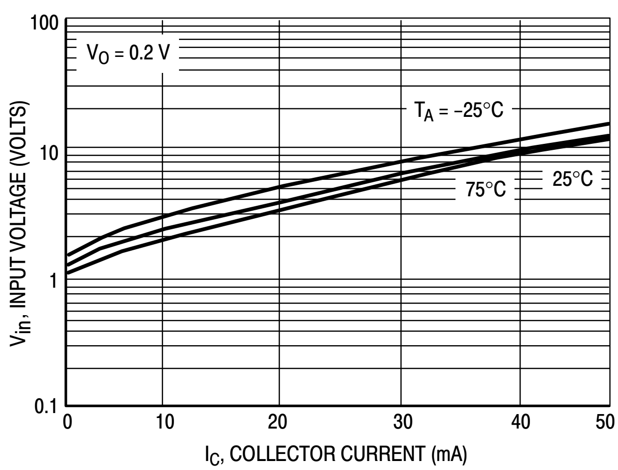


Figure 12. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – DTC144EET1

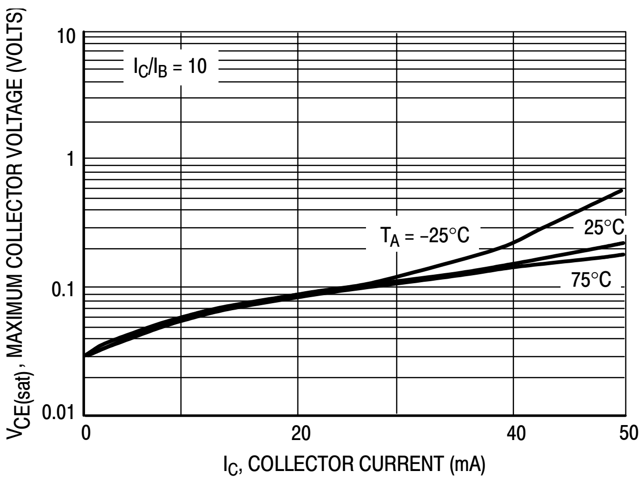


Figure 13. $V_{CE(sat)}$ versus I_C

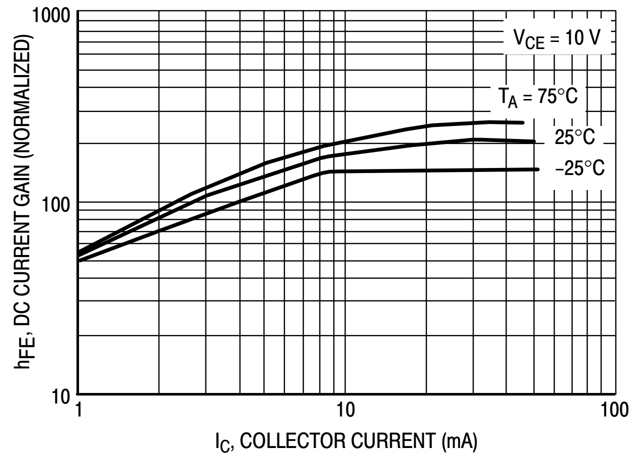


Figure 14. DC Current Gain

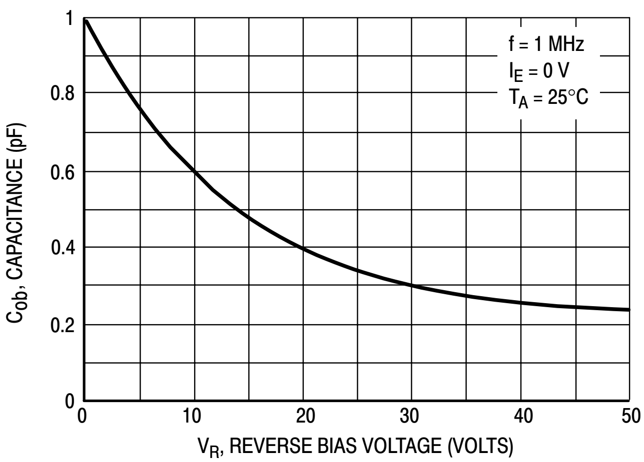


Figure 15. Output Capacitance

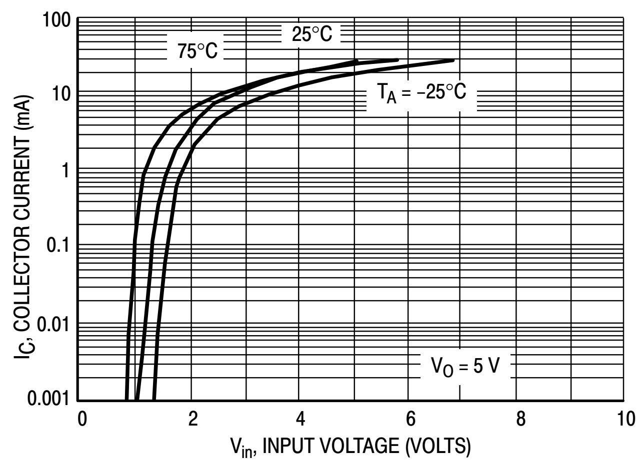


Figure 16. Output Current versus Input Voltage

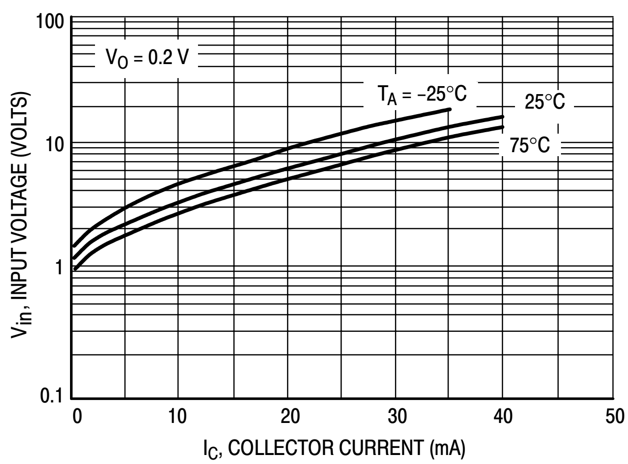


Figure 17. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – DTC114YET1

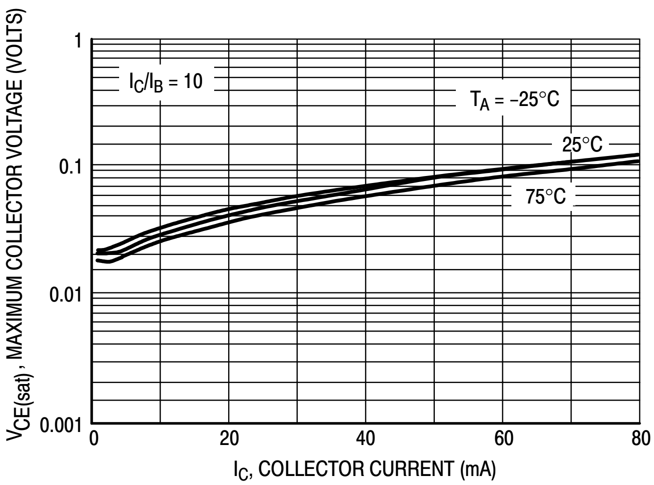


Figure 18. $V_{CE(sat)}$ versus I_C

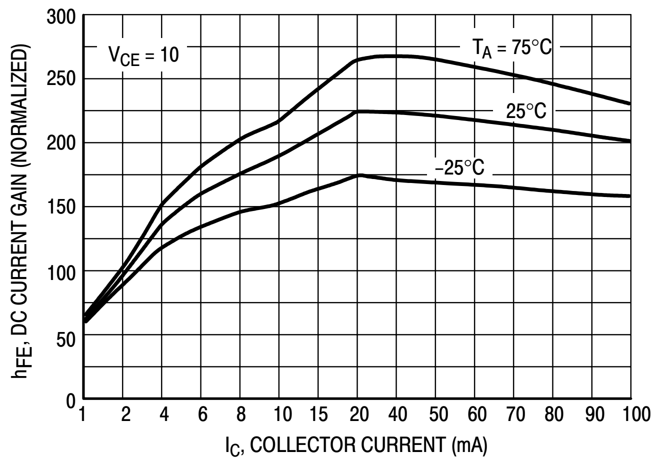


Figure 19. DC Current Gain

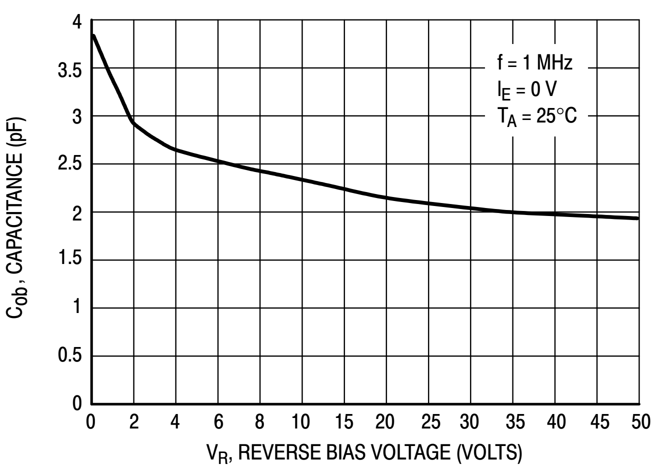


Figure 20. Output Capacitance

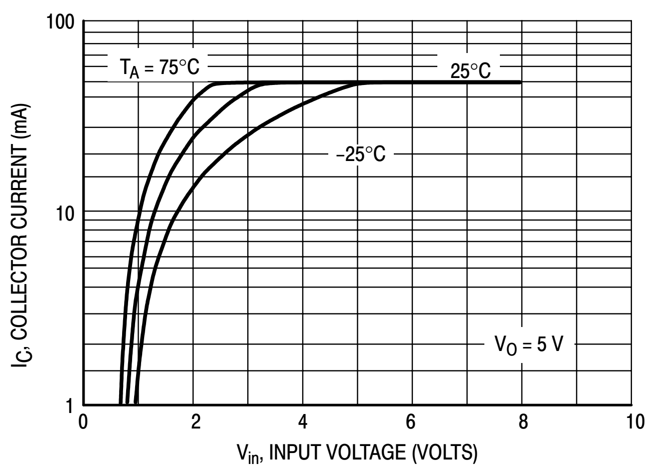


Figure 21. Output Current versus Input Voltage

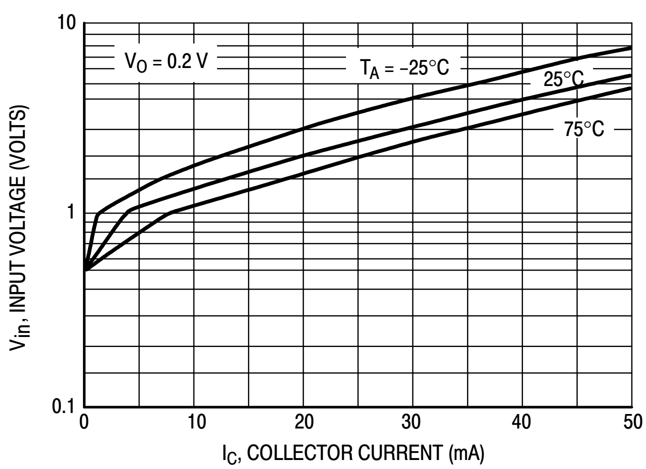


Figure 22. Input Voltage versus Output Current

TYPICAL APPLICATIONS FOR NPN BRTs

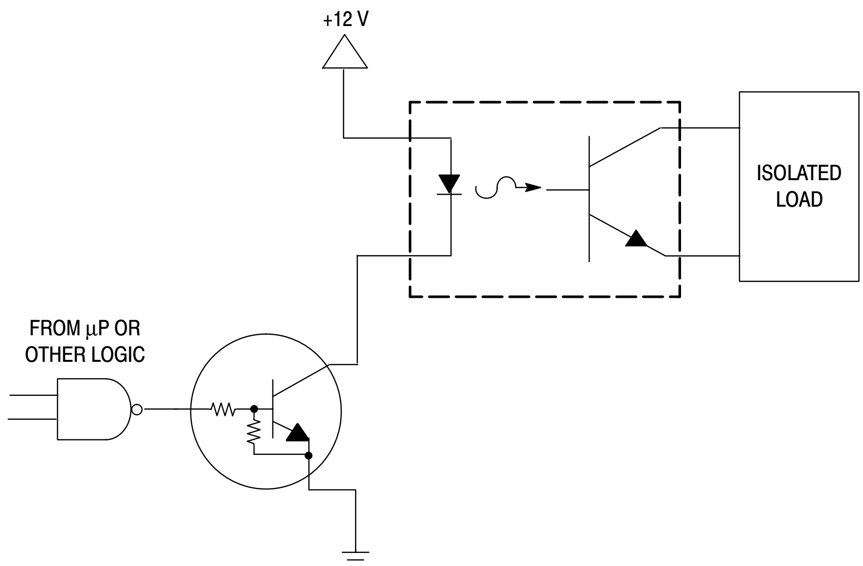


Figure 23. Level Shifter: Connects 12 or 24 Volt Circuits to Logic

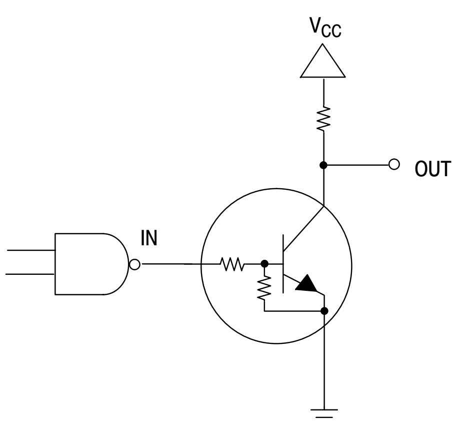


Figure 24. Open Collector Inverter: Inverts the Input Signal

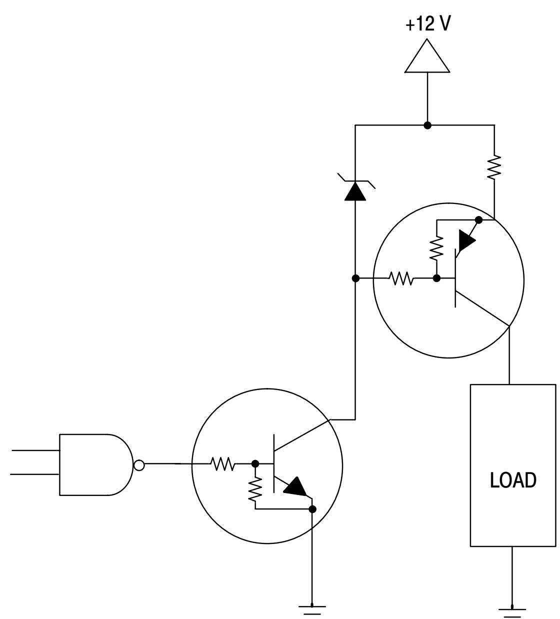


Figure 25. Inexpensive, Unregulated Current Source

DTC144TT1

Preferred Device

Bias Resistor Transistor

NPN Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC–59 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Moisture Sensitivity Level: 1
- ESD Rating – Human Body Model: Class 1
  – Machine Model: Class B
- The SC–59 package can be soldered using wave or reflow. The modified gull–winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
  Use the Device Number to order the 7 inch/3000 unit reel.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	230 (Note 1.) 338 (Note 2.) 1.8 (Note 1.) 2.7 (Note 2.)	mW °C/W
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	540 (Note 1.) 370 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{\theta JL}$	264 (Note 1.) 287 (Note 2.)	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)	Shipping
DTC144TT1	8T	47	∞	3000/Tape & Reel

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

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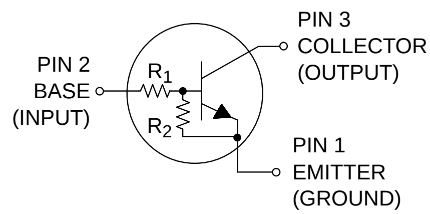
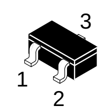
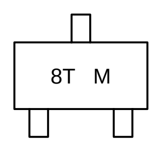
NPN SILICON BIAS RESISTOR TRANSISTOR





SC–59
CASE 318D
STYLE 1

MARKING DIAGRAM



8T = Specific Device Code
M = Date Code

ORDERING INFORMATION

Device	Package	Shipping
DTC144TT1	SC–59	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Cutoff Current (V_{CB} = 50 V, I_E = 0)	I_{CBO}	–	–	100	nAdc
Collector-Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)	I_{CEO}	–	–	500	nAdc
Emitter-Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	I_{EBO}	–	–	0.2	mAdc
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	$V_{(BR)CBO}$	50	–	–	Vdc
Collector-Emitter Breakdown Voltage (Note 3.) (I_C = 2.0 mA, I_B = 0)	$V_{(BR)CEO}$	50	–	–	Vdc
ON CHARACTERISTICS (Note 3.)					
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	h_{FE}	160	350	–	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{CE(sat)}$	–	–	0.25	Vdc
Output Voltage (on) (V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	V_{OL}	–	–	0.2	Vdc
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	V_{OH}	4.9	–	–	Vdc
Input Resistor	R_1	32.9	47	61.1	kΩ

3. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

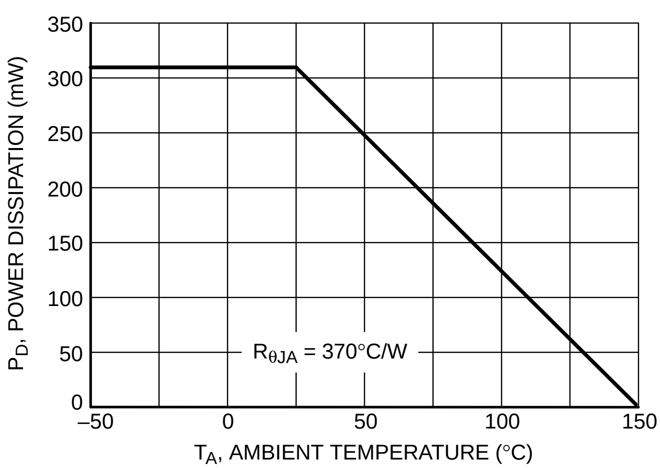


Figure 1. Derating Curve

TYPICAL APPLICATIONS FOR NPN BRTs

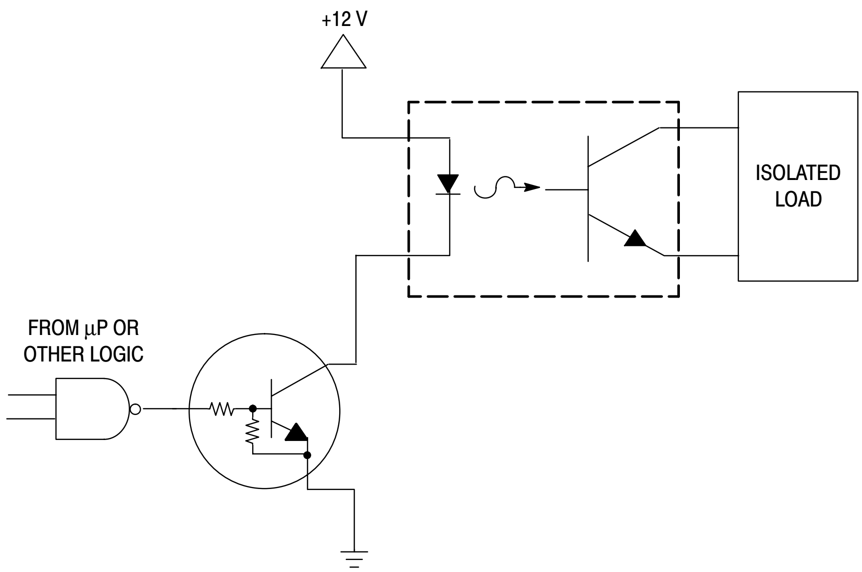


Figure 2. Level Shifter: Connects 12 or 24 Volt Circuits to Logic

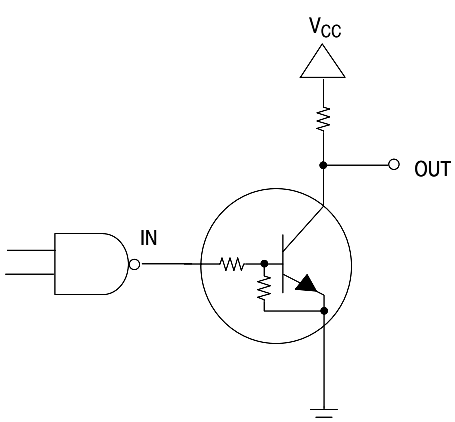


Figure 3. Open Collector Inverter: Inverts the Input Signal

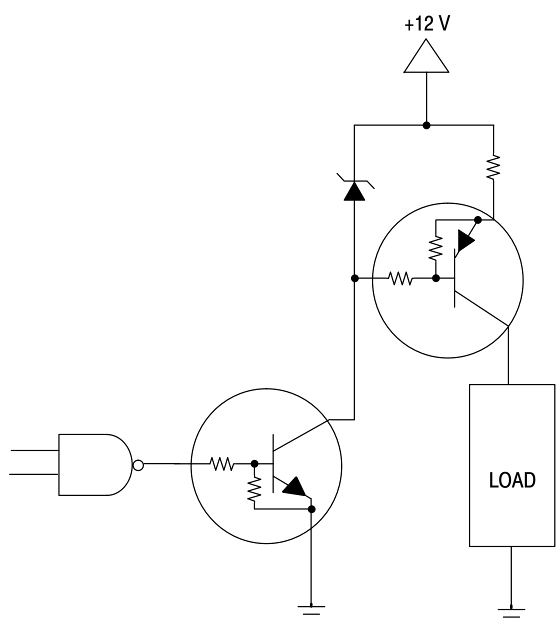


Figure 4. Inexpensive, Unregulated Current Source

JFET - General Purpose

N–Channel – Depletion

N–Channel Junction Field Effect Transistors, depletion mode (Type A) designed for general purpose audio amplifiers, analog switches and choppers.

- N–Channel for Higher Gain
- Drain and Source Interchangeable
- High AC Input Impedance
- High DC Input Resistance
- Low $R_{DS(on)} < 18\ \Omega$
- Fast Switching $t_{d(on)} + t_r = 8.0$ ns (Typp)
- Low Noise $\overline{en} = 6.0\ nV/\sqrt{Hz}$ @ 10 Hz (Typ)

ON Semiconductor™

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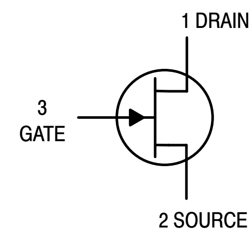
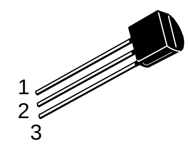
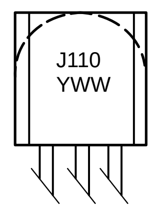




TO–92
CASE 29
STYLE 5

MARKING DIAGRAMS



Y = Year
WW = Work Week

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Gate–Source Voltage	V_{GS}	–25	Vdc
Drain–Gate Voltage	V_{DG}	–25	Vdc
Gate Current	I_G	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 310 2.82	 mW mW/°C
Operating Junction Temp Range	T_J	135	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

ORDERING INFORMATION

Device	Package	Shipping
J110	TO–92	5000 Units/Box
J110RLRA	TO–92	2000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
STATIC CHARACTERISTICS					
Gate–Source Breakdown Voltage	(I_G = –1.0 μAdc)	$V_{(BR)GSS}$	–25	–	Vdc
Gate Reverse Current	(V_{GS} = –15 Vdc, V_{DS} = 0) (V_{GS} = –15 Vdc, V_{DS} = 0, T_A = 100°C)	I_{GSS}	– –	–3.0 –200	nAdc
Gate–Source Cutoff Voltage	(V_{DS} = 5.0 Vdc, I_D = 1.0 μAdc)	$V_{GS(off)}$	–0.5	–4.0	Vdc
Drain Source On–Resistance	(V_{DS} = < 1.0 V, V_{GS} = 0 V)	$R_{DS(on)}$	10	–	mAdc
Zero–Gate–Voltage Drain Current (Note 1.)	(V_{DS} = 15 Vdc)	I_{DSS}	10	–	mAdc
DYNAMIC CHARACTERISTICS					
Drain–Gate and Source–Gate On–Capacitance (V_{DS} = V_{GS} = 0, f = 1.0 MHz)		$C_{dg(on)}$ + $C_{sg(on)}$	–	85	pF
Drain–Gate Off–Capacitance	(V_{GS} = –10 Vdc, f = 1.0 MHz)	$C_{dg(off)}$	–	15	pF
Source–Gate Off–Capacitance	(V_{GS} = –10 Vdc, f = 1.0 MHz)	$C_{sg(off)}$	–	15	pF

1. Pulse Width = 300 μs, Duty Cycle = 3.0%.

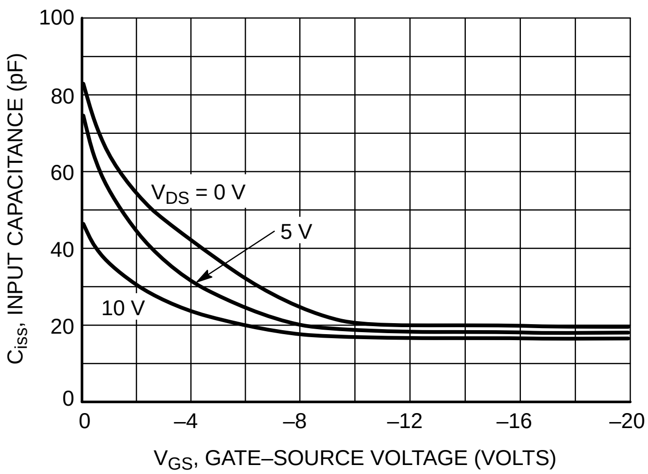


Figure 1. Common Source Input Capacitance versus Gate–Source Voltage

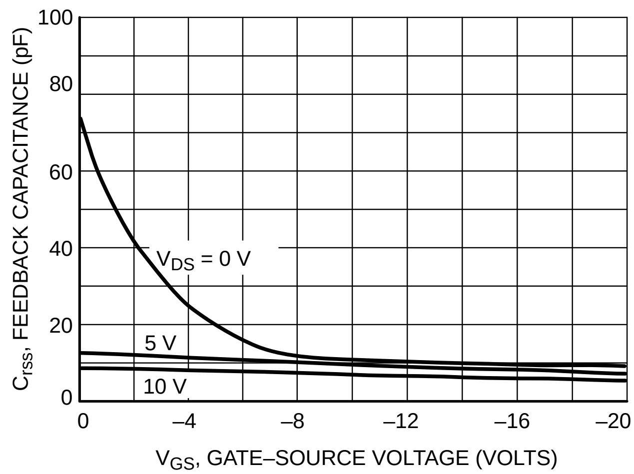


Figure 2. Common Source Reverse Feedback Capacitance versus Gate–Source Voltage

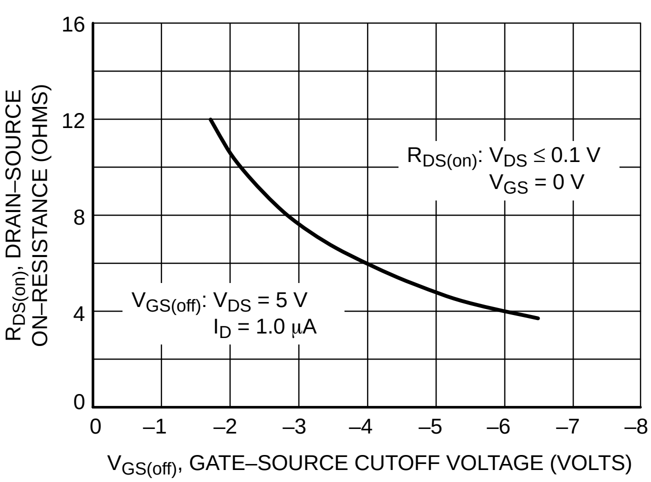


Figure 3. On–Resistance versus Gate–Source Cutoff Voltage

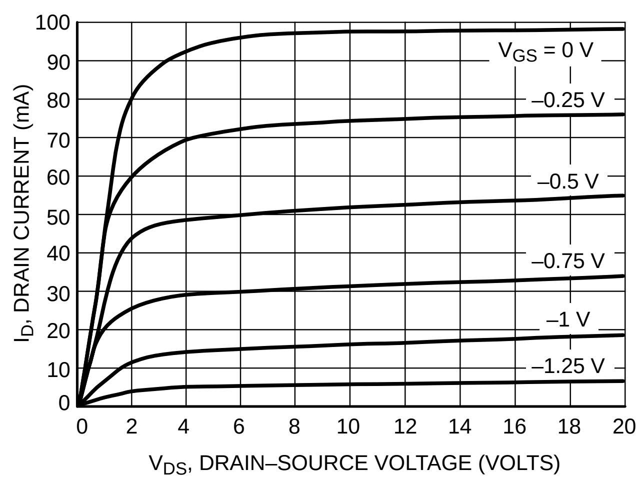


Figure 4. Output Characteristic $V_{GS(off)}$ = –2 V

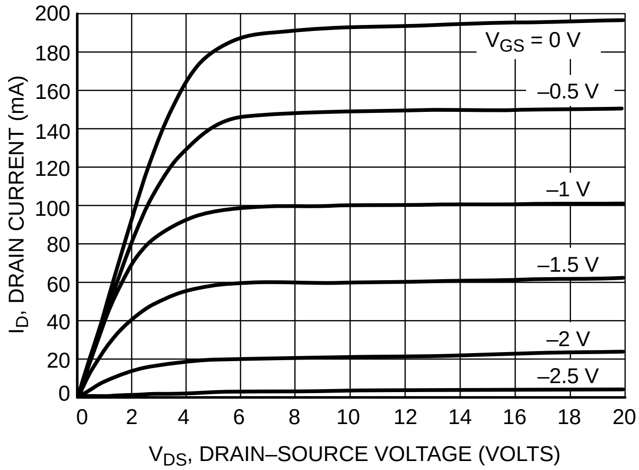


Figure 5. Output Characteristic
$V_{GS(off)}$ = –3 V

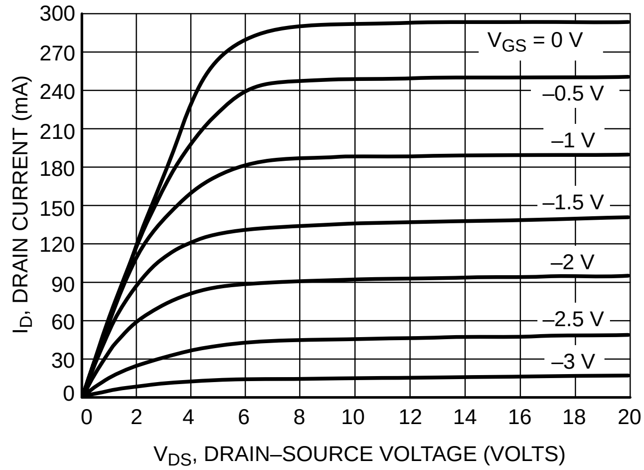


Figure 6. Output Characteristic
$V_{GS(off)}$ = –4 V

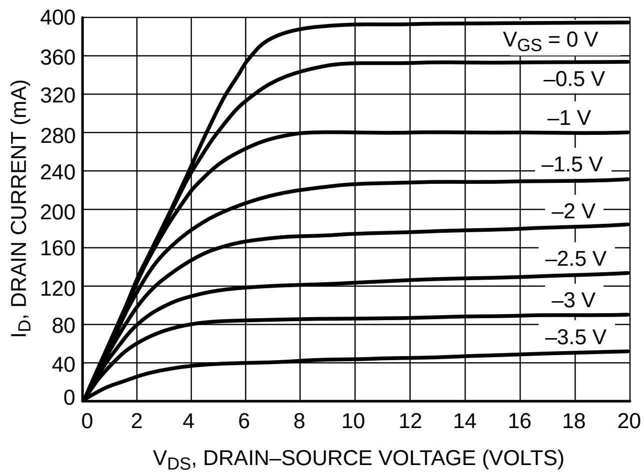
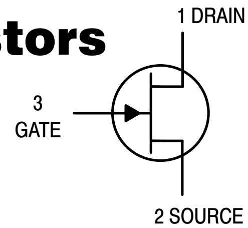


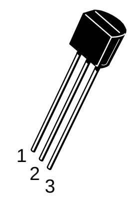
Figure 7. Output Characteristic
$V_{GS(off)}$ = –5 V

J111
J112
J113

JFET Chopper Transistors

N–Channel — Depletion





CASE 29–11, STYLE 5
TO–92 (TO–226AA)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Gate Voltage	V_{DG}	–35	Vdc
Gate–Source Voltage	V_{GS}	–35	Vdc
Gate Current	I_G	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Lead Temperature	T_L	300	°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate–Source Breakdown Voltage (I_G = –1.0 μAdc)		$V_{(BR)GSS}$	35	—	Vdc
Gate Reverse Current (V_{GS} = –15 Vdc)		I_{GSS}	—	–1.0	nAdc
Gate Source Cutoff Voltage (V_{DS} = 5.0 Vdc, I_D = 1.0 μAdc)	J111 J112 J113	$V_{GS(off)}$	–3.0 –1.0 –0.5	–10 –5.0 –3.0	Vdc
Drain–Cutoff Current (V_{DS} = 5.0 Vdc, V_{GS} = –10 Vdc)		$I_{D(off)}$	—	1.0	nAdc
ON CHARACTERISTICS					
Zero–Gate–Voltage Drain Current(1) (V_{DS} = 15 Vdc)	J111 J112 J113	I_{DSS}	20 5.0 2.0	— — —	mAdc
Static Drain–Source On Resistance (V_{DS} = 0.1 Vdc)	J111 J112 J113	$r_{DS(on)}$	— — —	30 50 100	Ω
Drain Gate and Source Gate On–Capacitance (V_{DS} = V_{GS} = 0, f = 1.0 MHz)		$C_{dg(on)}$ + $C_{sg(on)}$	—	28	pF
Drain Gate Off–Capacitance (V_{GS} = –10 Vdc, f = 1.0 MHz)		$C_{dg(off)}$	—	5.0	pF
Source Gate Off–Capacitance (V_{GS} = –10 Vdc, f = 1.0 MHz)		$C_{sg(off)}$	—	5.0	pF

1. Pulse Width = 300 μs, Duty Cycle = 3.0%.

June, 2001 – Rev. 1
Publication Order Number:
J111/D

TYPICAL SWITCHING CHARACTERISTICS

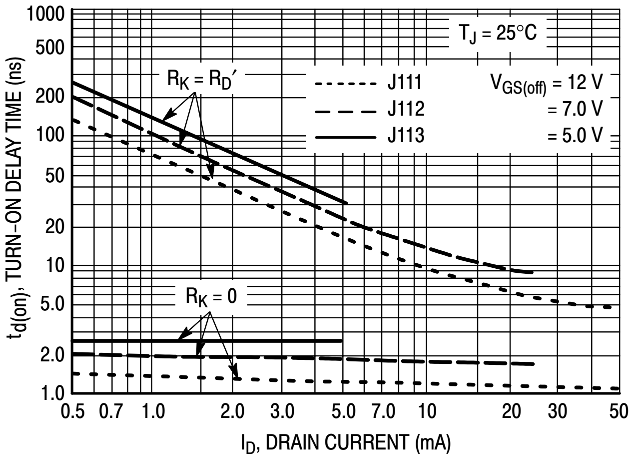


Figure 1. Turn–On Delay Time

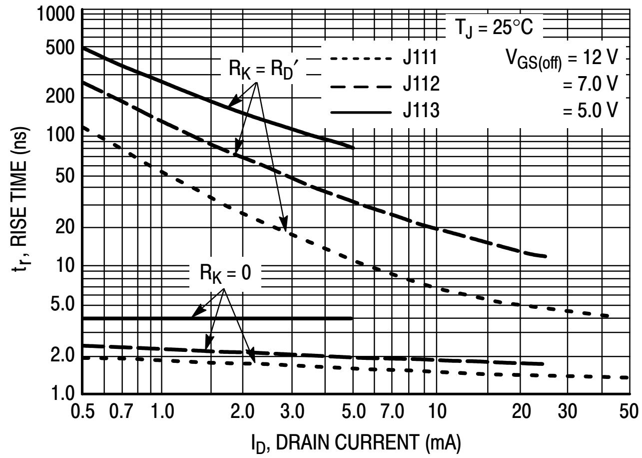


Figure 2. Rise Time

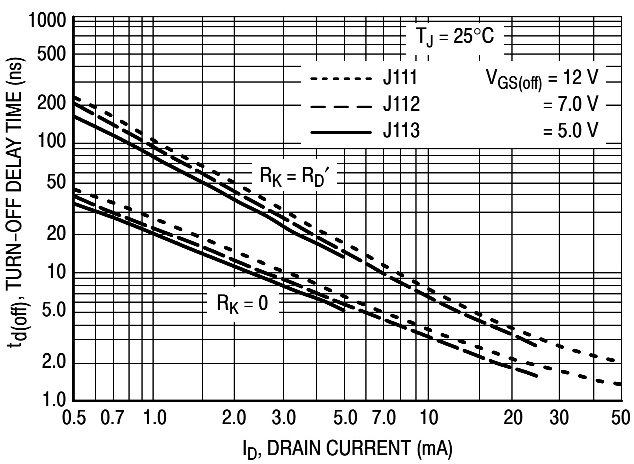


Figure 3. Turn–Off Delay Time

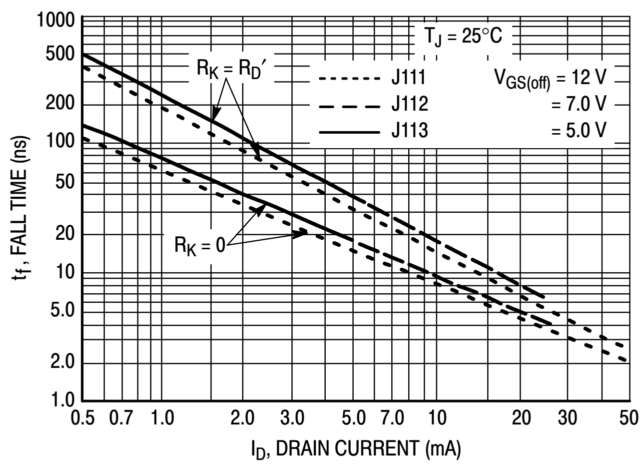


Figure 4. Fall Time

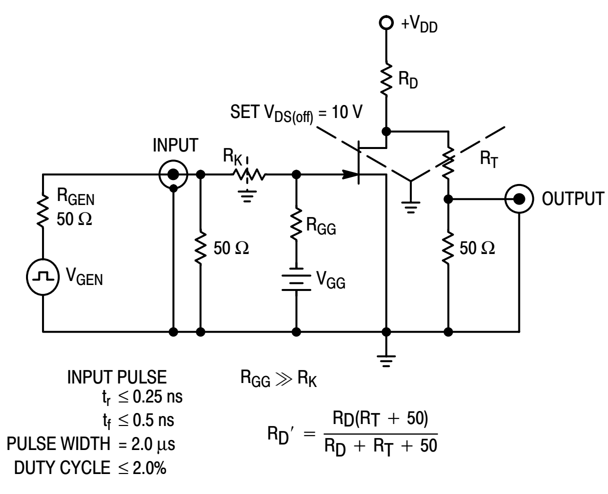


Figure 5. Switching Time Test Circuit

NOTE 1

The switching characteristics shown above were measured using a test circuit similar to Figure 5. At the beginning of the switching interval, the gate voltage is at Gate Supply Voltage ($-V_{GG}$). The Drain–Source Voltage (V_{DS}) is slightly lower than Drain Supply Voltage (V_{DD}) due to the voltage divider. Thus Reverse Transfer Capacitance (C_{rss}) or Gate–Drain Capacitance (C_{gd}) is charged to $V_{GG} + V_{DS}$.

During the turn–on interval, Gate–Source Capacitance (C_{gs}) discharges through the series combination of R_{Gen} and R_K. C_{gd} must discharge to $V_{DS(on)}$ through R_G and R_K in series with the parallel combination of effective load impedance (R'_D) and Drain–Source Resistance (r_{ds}). During the turn–off, this charge flow is reversed.

Predicting turn–on time is somewhat difficult as the channel resistance r_{ds} is a function of the gate–source voltage. While C_{gs} discharges, V_{GS} approaches zero and r_{ds} decreases. Since C_{gd} discharges through r_{ds}, turn–on time is non–linear. During turn–off, the situation is reversed with r_{ds} increasing as C_{gd} charges.

The above switching curves show two impedance conditions; 1) R_K is equal to R_D, which simulates the switching behavior of cascaded stages where the driving source impedance is normally the load impedance of the previous stage, and 2) $R_K = 0$ (low impedance) the driving source impedance is that of the generator.

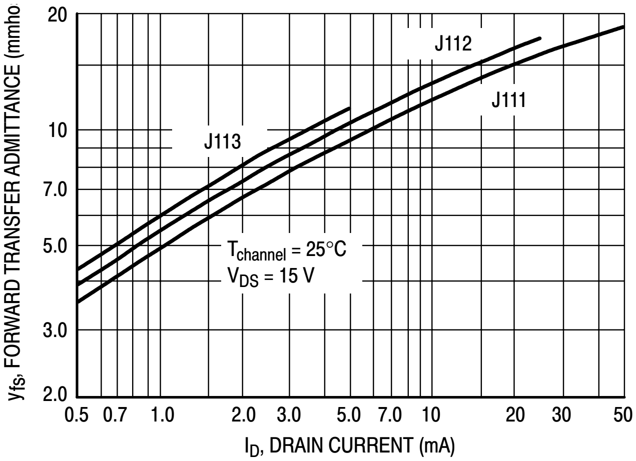


Figure 6. Typical Forward Transfer Admittance

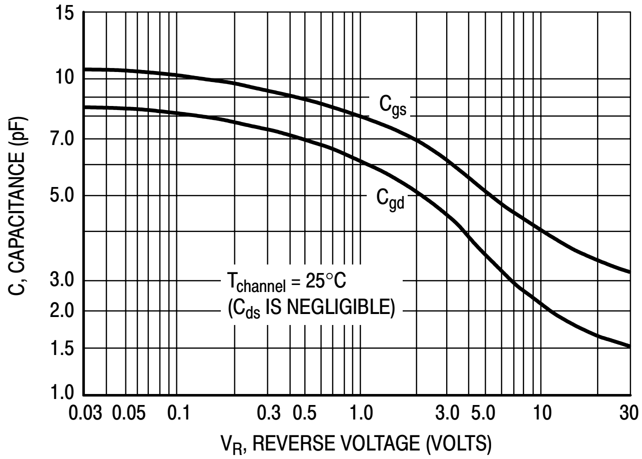


Figure 7. Typical Capacitance

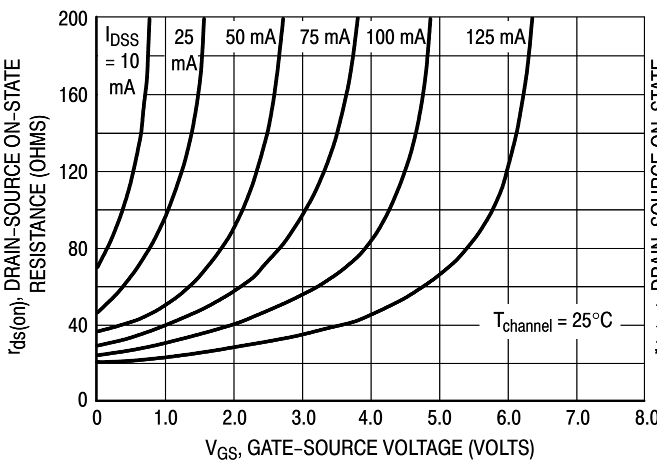


Figure 8. Effect of Gate–Source Voltage On Drain–Source Resistance

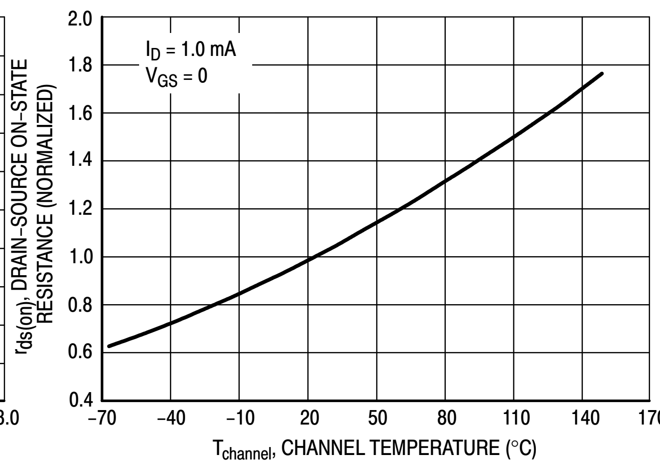


Figure 9. Effect of Temperature On Drain–Source On–State Resistance

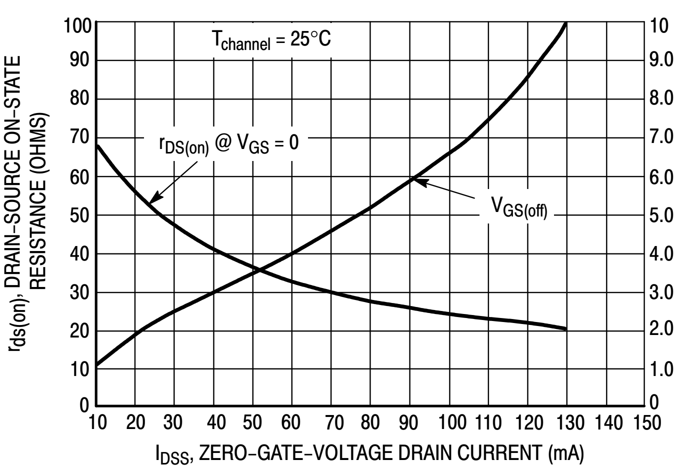


Figure 10. Effect of I_{DSS} On Drain–Source Resistance and Gate–Source Voltage

NOTE 2

The Zero–Gate–Voltage Drain Current (I_{DSS}), is the principle determinant of other J-FET characteristics. Figure 10 shows the relationship of Gate–Source Off Voltage ($V_{GS(off)}$ and Drain–Source On Resistance ($r_{ds(on)}$) to I_{DSS}. Most of the devices will be within ±10% of the values shown in Figure 10. This data will be useful in predicting the characteristic variations for a given part number.

For example:

Unknown

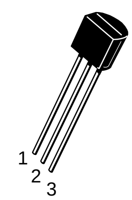
$r_{ds(on)}$ and V_{GS} range for an J112

The electrical characteristics table indicates that an J112 has an I_{DSS} range of 25 to 75 mA. Figure 10, shows $r_{ds(on)}$ = 52 Ohms for I_{DSS} = 25 mA and 30 Ohms for I_{DSS} = 75 mA. The corresponding V_{GS} values are 2.2 volts and 4.8 volts.

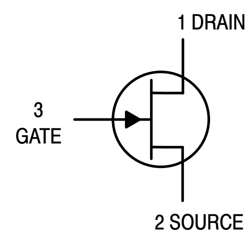
JFET VHF/UHF Amplifiers
N–Channel – Depletion

J309
J310

ON Semiconductor Preferred Devices



CASE 29–11, STYLE 5
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	25	Vdc
Gate–Source Voltage	V_{GS}	25	Vdc
Forward Gate Current	I_{GF}	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Junction Temperature Range	T_J	–65 to +125	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate–Source Breakdown Voltage (I_G = –1.0 µAdc, V_{DS} = 0)		$V_{(BR)GSS}$	–25	–	–	Vdc
Gate Reverse Current (V_{GS} = –15 Vdc, V_{DS} = 0, T_A = 25°C) (V_{GS} = –15 Vdc, V_{DS} = 0, T_A = +125°C)		I_{GSS}	 – –	 – –	 –1.0 –1.0	 nAdc µAdc
Gate Source Cutoff Voltage (V_{DS} = 10 Vdc, I_D = 1.0 nAdc)	 J309 J310	$V_{GS(off)}$	 –1.0 –2.0	 – –	 –4.0 –6.5	Vdc
ON CHARACTERISTICS						
Zero–Gate–Voltage Drain Current(1) (V_{DS} = 10 Vdc, V_{GS} = 0)	 J309 J310	I_{DSS}	 12 24	 – –	 30 60	mAdc
Gate–Source Forward Voltage (V_{DS} = 0, I_G = 1.0 mAdc)		$V_{GS(f)}$	–	–	1.0	Vdc

Characteristic		Symbol	Min	Typ	Max	Unit
SMALL–SIGNAL CHARACTERISTICS						
Common–Source Input Conductance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 100 MHz)	J309 J310	$Re(y_{is})$	– –	0.7 0.5	– –	mmhos
Common–Source Output Conductance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 100 MHz)		$Re(y_{os})$	–	0.25	–	mmhos
Common–Gate Power Gain (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 100 MHz)		G_{pg}	–	16	–	dB

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 3.0%.

Characteristic		Symbol	Min	Typ	Max	Unit
SMALL–SIGNAL CHARACTERISTICS (continued)						
Common–Source Forward Transconductance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 100 MHz)		$Re(y_{fs})$	–	12	–	mmhos
Common–Gate Input Conductance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 100 MHz)		$Re(y_{ig})$	–	12	–	mmhos
Common–Source Forward Transconductance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 1.0 kHz)	J309 J310	g_{fs}	10000 8000	– –	20000 18000	μmhos
Common–Source Output Conductance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 1.0 kHz)		g_{os}	–	–	250	μmhos
Common–Gate Forward Transconductance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 1.0 kHz)	J309 J310	g_{fg}	– –	13000 12000	– –	μmhos
Common–Gate Output Conductance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 1.0 kHz)	J309 J310	g_{og}	– –	100 150	– –	μmhos
Gate–Drain Capacitance (V_{DS} = 0, V_{GS} = –10 Vdc, f = 1.0 MHz)		C_{gd}	–	1.8	2.5	pF
Gate–Source Capacitance (V_{DS} = 0, V_{GS} = –10 Vdc, f = 1.0 MHz)		C_{gs}	–	4.3	5.0	pF
FUNCTIONAL CHARACTERISTICS						
Equivalent Short–Circuit Input Noise Voltage (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 100 Hz)		$\bar{e}_n$	–	10	–	$nV/\sqrt{Hz}$

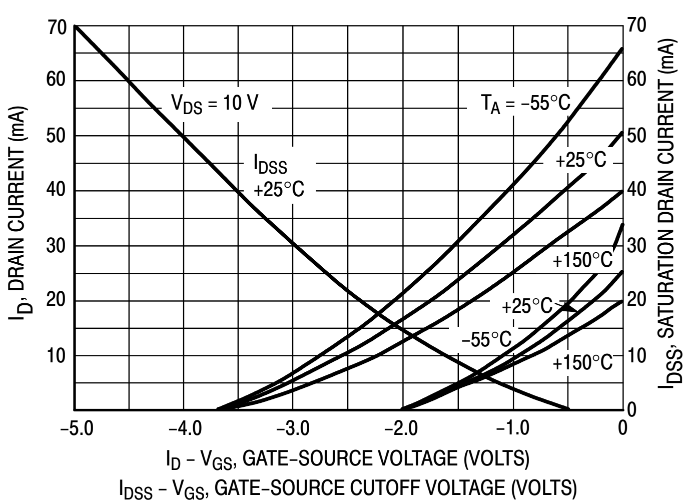


Figure 1. Drain Current and Transfer Characteristics versus Gate–Source Voltage

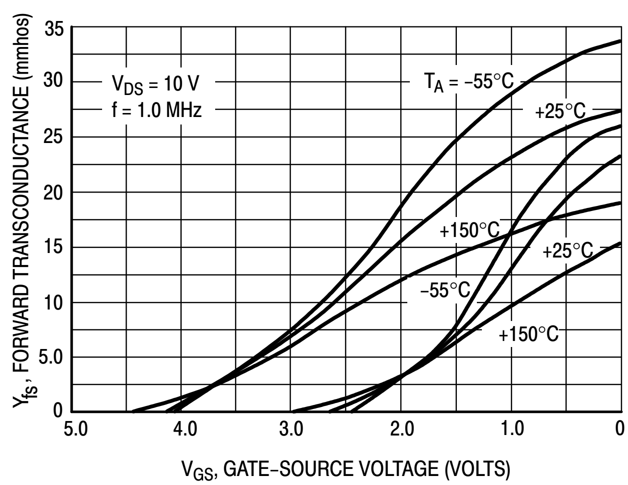


Figure 2. Forward Transconductance versus Gate–Source Voltage

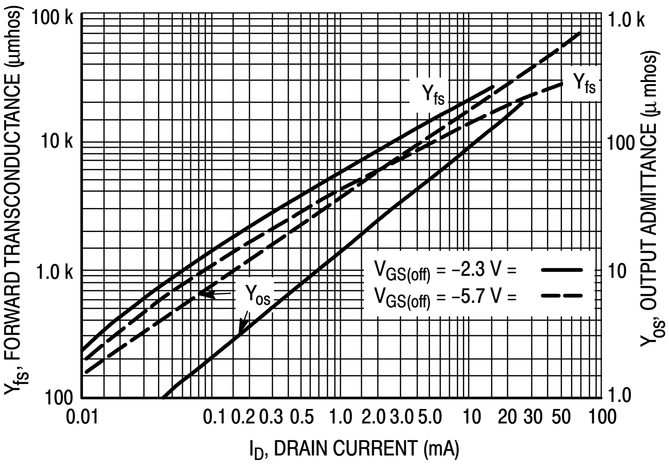


Figure 3. Common−Source Output Admittance and Forward Transconductance versus Drain Current

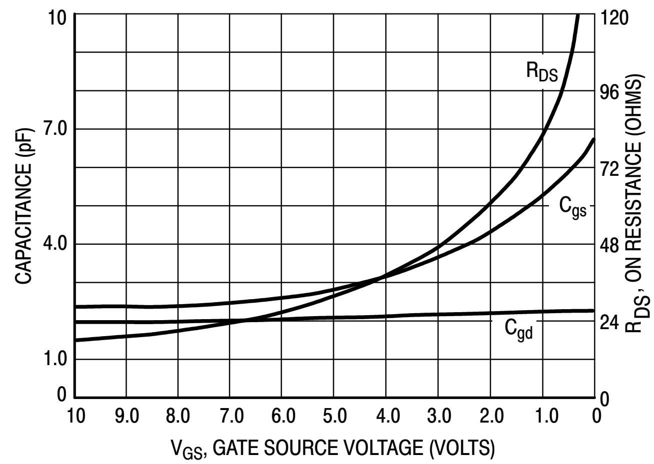


Figure 4. On Resistance and Junction Capacitance versus Gate−Source Voltage

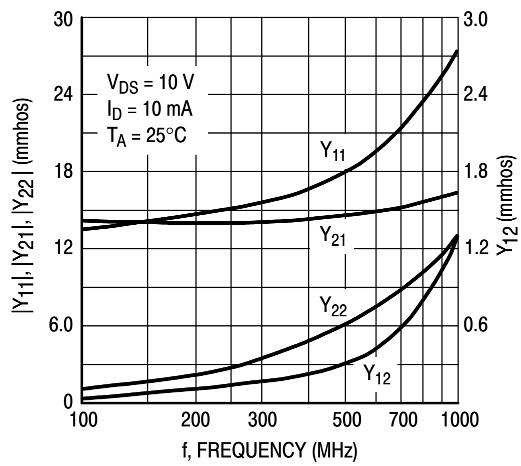


Figure 5. Common−Gate Y Parameter Magnitude versus Frequency

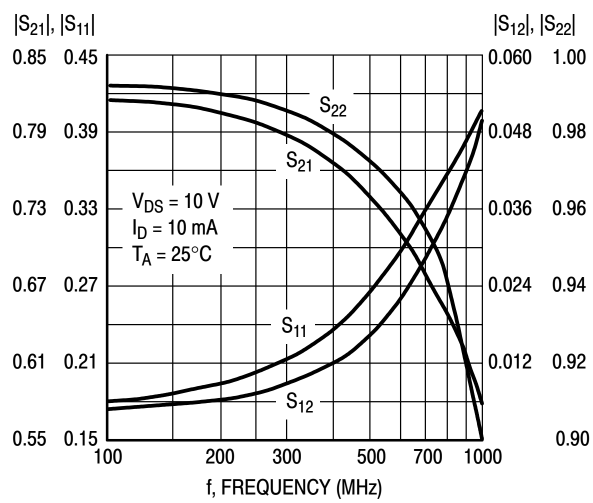


Figure 6. Common−Gate S Parameter Magnitude versus Frequency

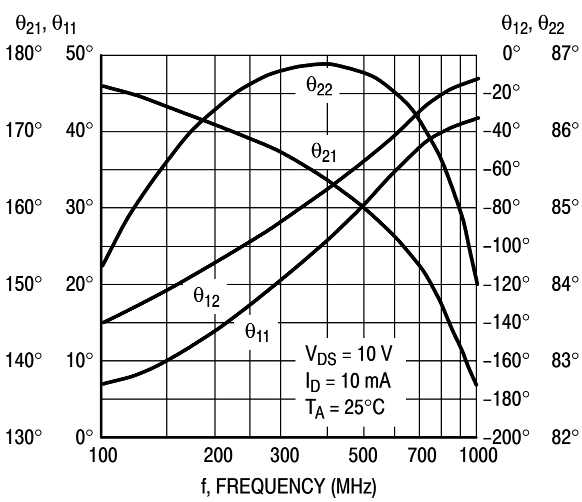


Figure 7. Common−Gate Y Parameter Phase−Angle versus Frequency

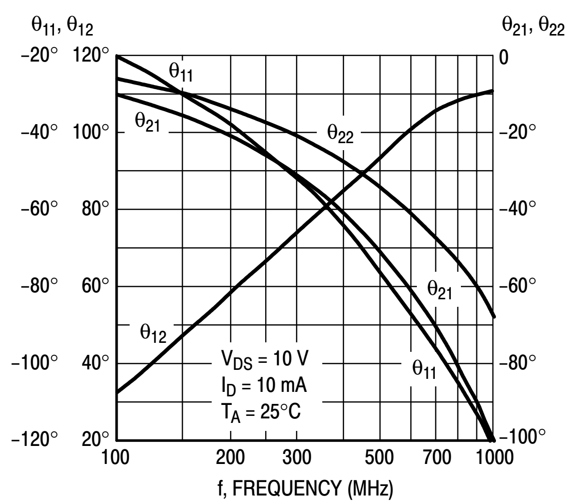


Figure 8. S Parameter Phase−Angle versus Frequency

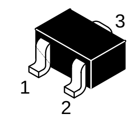
M1MA141KT1 M1MA142KT1

ON Semiconductor Preferred Devices

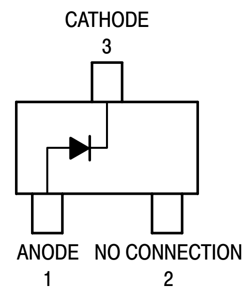
Single Silicon Switching Diode

This Silicon Epitaxial Planar Diode is designed for use in ultra high speed switching applications. This device is housed in the SC–70 package which is designed for low power surface mount applications.

- Fast t_{rr}, < 3.0 ns
- Low C_D, < 2.0 pF
- Available in 8 mm Tape and Reel
  Use M1MA141/2KT1 to order the 7 inch/3000 unit reel.
  Use M1MA141/2KT3 to order the 13 inch/10,000 unit reel.



CASE 419–04, STYLE 2
SC–70/SOT–323



Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

MAXIMUM RATINGS (T_A = 25°C)

Rating		Symbol	Value	Unit
Reverse Voltage	M1MA141KT1	V_R	40	Vdc
	M1MA142KT1		80	
Peak Reverse Voltage	M1MA141KT1	V_{RM}	40	Vdc
	M1MA142KT1		80	
Forward Current		I_F	100	mAdc
Peak Forward Current		I_{FM}	225	mAdc
Peak Forward Surge Current		$I_{FSM}^{(1)}$	500	mAdc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	P_D	150	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

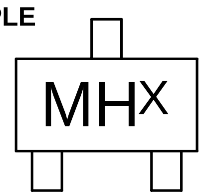
Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA141KT1	I_R	V_R = 35 V	—	0.1	µAdc
	M1MA142KT1		V_R = 75 V	—	0.1	
Forward Voltage		V_F	I_F = 100 mA	—	1.2	Vdc
Reverse Breakdown Voltage	M1MA141KT1	V_R	I_R = 100 µA	40	—	Vdc
	M1MA142KT1			80	—	
Diode Capacitance		C_D	V_R = 0, f = 1.0 MHz	—	2.0	pF
Reverse Recovery Time (Figure 1)		$t_{rr}^{(2)}$	I_F = 10 mA, V_R = 6.0 V, R_L = 100 Ω, I_{rr} = 0.1 I_R	—	3.0	ns

1. t = 1 SEC
2. t_{rr} Test Circuit

DEVICE MARKING — EXAMPLE

Marking Symbol

Type No.	141K	142K
Symbol	MH	MI



The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

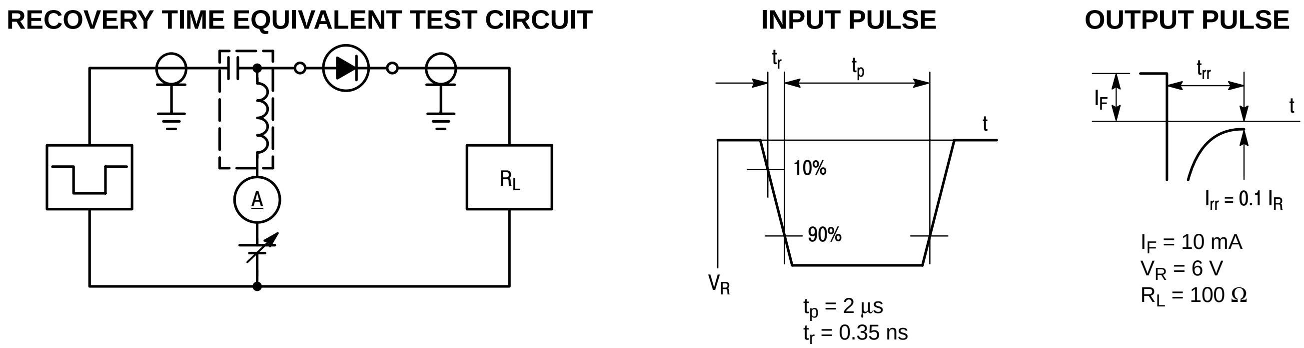


Figure 1. Recovery Time Equivalent Test Circuit

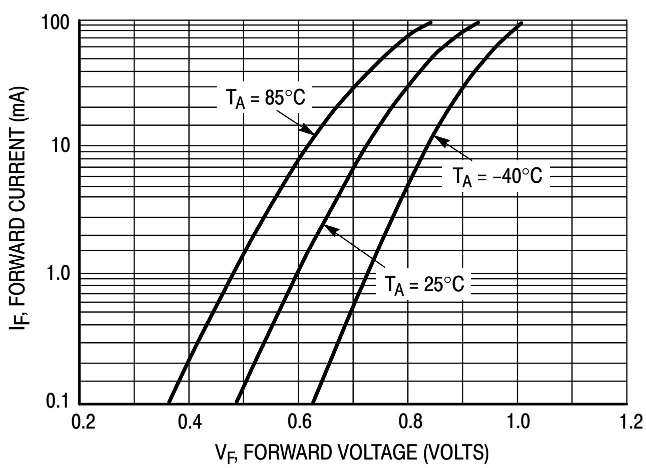


Figure 2. Forward Voltage

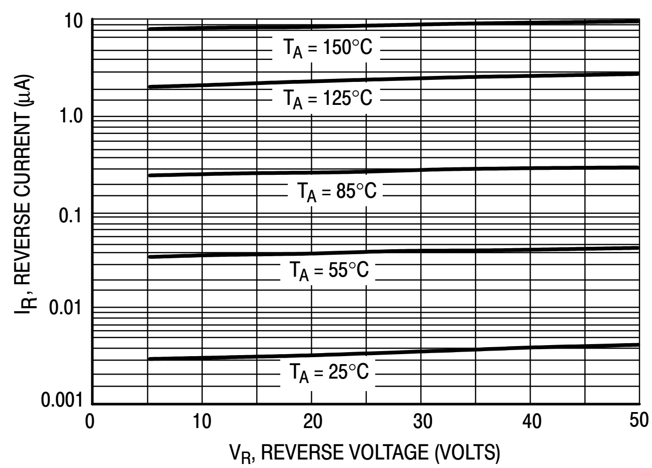


Figure 3. Reverse Current

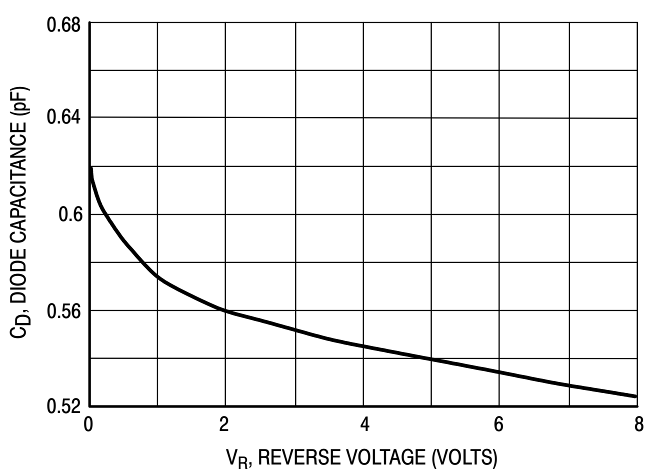


Figure 4. Diode Capacitance

M1MA141WAT1
M1MA142WAT1

ON Semiconductor Preferred Devices

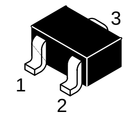
Common Anode Silicon Dual Switching Diode

This Common Anode Silicon Epitaxial Planar Dual Diode is designed for use in ultra high speed switching applications. This device is housed in the SC–70 package which is designed for low power surface mount applications.

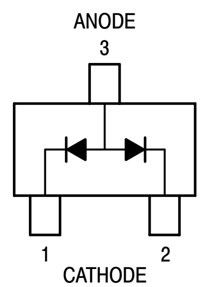
- Fast t_{rr}, < 10 ns
- Low C_D, < 15 pF
- Available in 8 mm Tape and Reel

  Use M1MA141/2WAT1 to order the 7 inch/3000 unit reel.

  Use M1MA141/2WAT3 to order the 13 inch/10,000 unit reel.



CASE 419–04, STYLE 4
SC–70/SOT–323



MAXIMUM RATINGS (T_A = 25°C)

Rating		Symbol	Value	Unit
Reverse Voltage	M1MA141WAT1	V_R	40	Vdc
	M1MA142WAT1		80	
Peak Reverse Voltage	M1MA141WAT1	V_{RM}	40	Vdc
	M1MA142WAT1		80	
Forward Current	Single	I_F	100	mAdc
	Dual		150	
Peak Forward Current	Single	I_{FM}	225	mAdc
	Dual		340	
Peak Forward Surge Current	Single	I_{FSM}(1)	500	mAdc
	Dual		750	

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	P_D	150	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA141WAT1	I_R	V_R = 35 V	—	0.1	µAdc
	M1MA142WAT1		V_R = 75 V	—	0.1	
Forward Voltage		V_F	I_F = 100 mA	—	1.2	Vdc
Reverse Breakdown Voltage	M1MA141WAT1	V_R	I_R = 100 µA	40	—	Vdc
	M1MA142WAT1			80	—	
Diode Capacitance		C_D	V_R = 0, f = 1.0 MHz	—	15	pF
Reverse Recovery Time (Figure 1)		t_{rr}(2)	I_F = 10 mA, V_R = 6.0 V, R_L = 100 Ω, I_{rr} = 0.1 I_R	—	10	ns

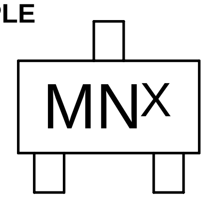
1. t = 1 SEC
2. t_{rr} Test Circuit

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

DEVICE MARKING — EXAMPLE

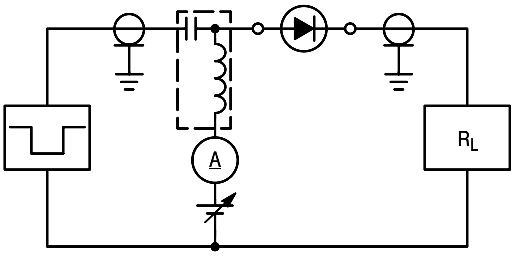
Marking Symbol

Type No.	141WA	142WA
Symbol	MN	MO

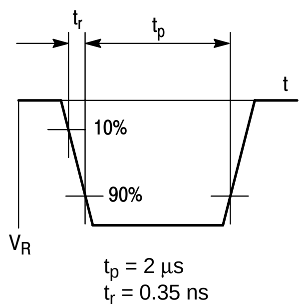


The “X” represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

RECOVERY TIME EQUIVALENT TEST CIRCUIT



INPUT PULSE



OUTPUT PULSE

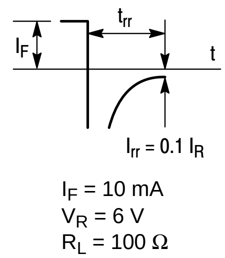


Figure 1. Recovery Time Equivalent Test Circuit

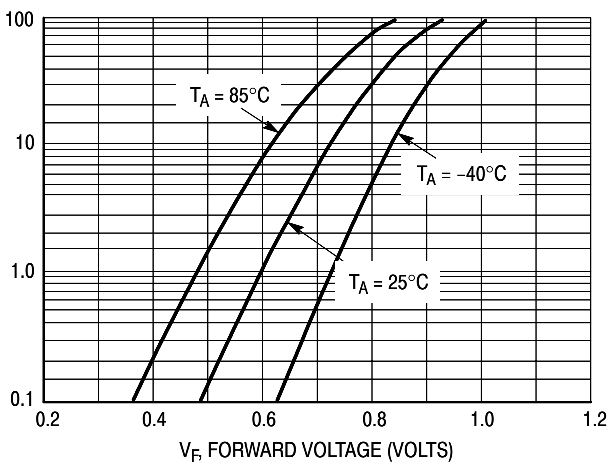


Figure 2. Forward Voltage

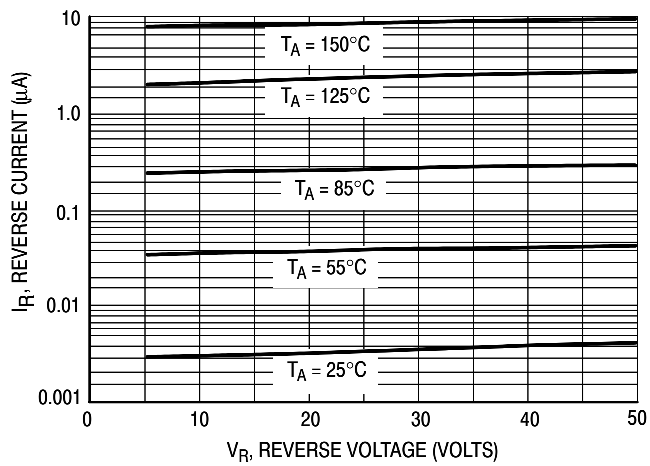


Figure 3. Reverse Current

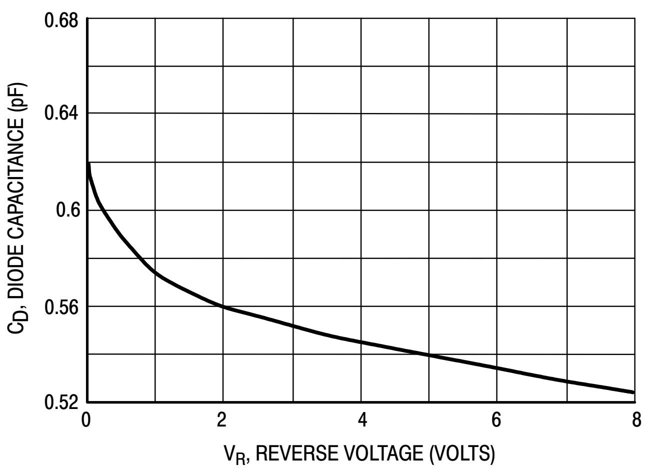


Figure 4. Diode Capacitance

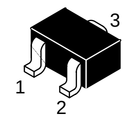
Common Cathode Silicon Dual Switching Diode

M1MA141WKT1
M1MA142WKT1

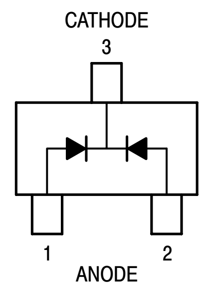
ON Semiconductor Preferred Devices

This Common Cathode Silicon Epitaxial Planar Dual Diode is designed for use in ultra high speed switching applications. This device is housed in the SC–70 package which is designed for low power surface mount applications.

- Fast t_{rr}, < 3.0 ns
- Low C_D, < 2.0 pF
- Available in 8 mm Tape and Reel
  Use M1MA141/2WKT1 to order the 7 inch/3000 unit reel.
  Use M1MA141/2WKT3 to order the 13 inch/10,000 unit reel.



CASE 419–04, STYLE 5
SC–70/SOT–323



MAXIMUM RATINGS (T_A = 25°C)

Rating		Symbol	Value	Unit
Reverse Voltage	M1MA141WKT1	V_R	40	Vdc
	M1MA142WKT1		80	
Peak Reverse Voltage	M1MA141WKT1	V_{RM}	40	Vdc
	M1MA142WKT1		80	
Forward Current	Single	I_F	100	mAdc
	Dual		150	
Peak Forward Current	Single	I_{FM}	225	mAdc
	Dual		340	
Peak Forward Surge Current	Single	I_{FSM}(1)	500	mAdc
	Dual		750	

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	P_D	150	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA141WKT1	I_R	V_R = 35 V	—	0.1	µAdc
	M1MA142WKT1		V_R = 75 V	—	0.1	
Forward Voltage		V_F	I_F = 100 mA	—	1.2	Vdc
Reverse Breakdown Voltage	M1MA141WKT1	V_R	I_R = 100 µA	40	—	Vdc
	M1MA142WKT1			80	—	
Diode Capacitance		C_D	V_R = 0, f = 1.0 MHz	—	2.0	pF
Reverse Recovery Time (Figure 1)		t_{rr}(2)	I_F = 10 mA, V_R = 6.0 V, R_L = 100 Ω, I_{rr} = 0.1 I_R	—	3.0	ns

1. t = 1 SEC
2. t_{rr} Test Circuit

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

DEVICE MARKING — EXAMPLE

Marking Symbol

Type No.	141WK	142WK
Symbol	MT	MU

The “X” represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

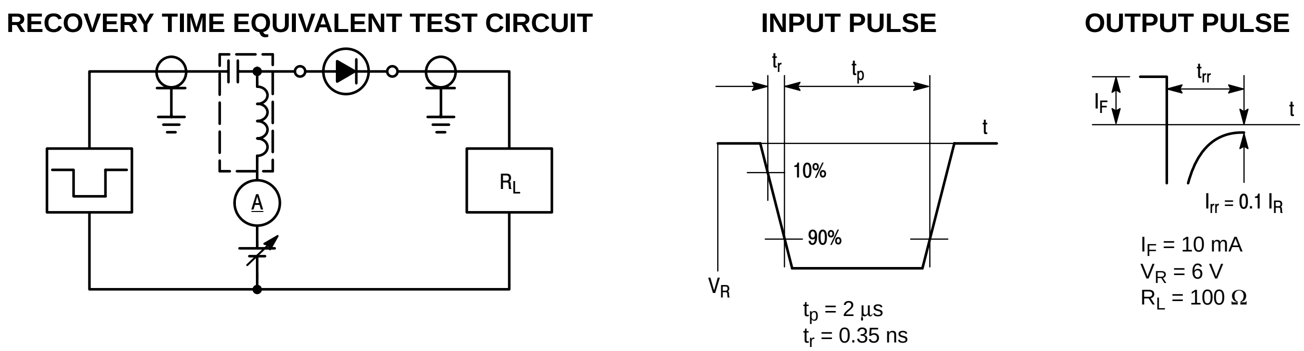


Figure 1. Recovery Time Equivalent Test Circuit

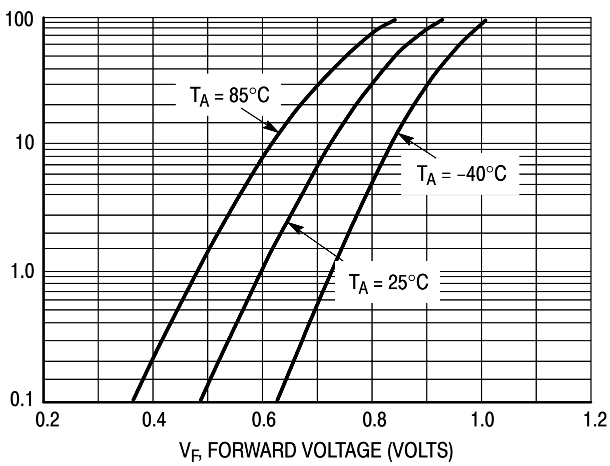


Figure 2. Forward Voltage

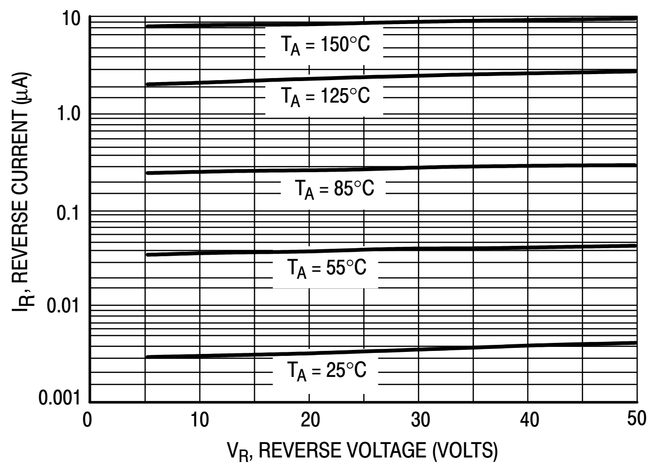


Figure 3. Reverse Current

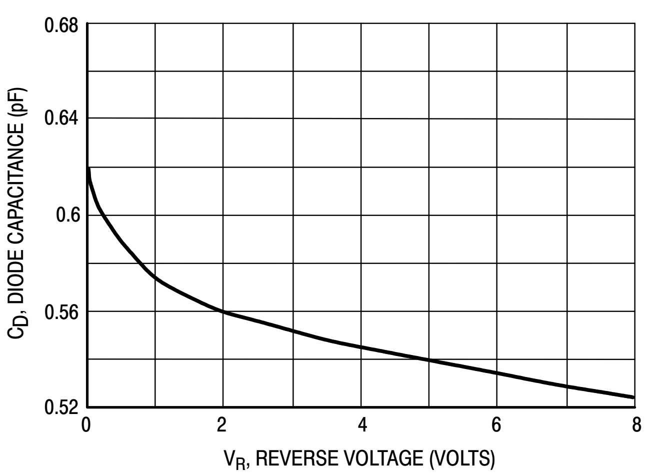


Figure 4. Diode Capacitance

Single Silicon Switching Diodes

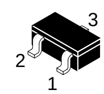
M1MA151AT1
M1MA152AT1

ON Semiconductor Preferred Devices

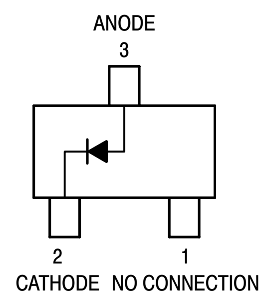
These Silicon Epitaxial Planar Diodes are designed for use in ultra high speed switching applications. These devices are housed in the SC–59 package which is designed for low power surface mount applications.

- Fast t_{rr}, < 3.0 ns
- Low C_D, < 2.0 pF
- Available in 8 mm Tape and Reel
  Use M1MA151/2AT1 to order the 7 inch/3000 unit reel.
  Use M1MA151/2AT3 to order the 13 inch/10,000 unit reel.

SC–59 PACKAGE
SINGLE SILICON
SWITCHING DIODES
40/80 V–100 mA
SURFACE MOUNT



CASE 318D–04, STYLE 4
SC–59



MAXIMUM RATINGS (T_A = 25°C)

Rating		Symbol	Value	Unit
Reverse Voltage	M1MA151AT1	V_R	40	Vdc
	M1MA152AT1		80	
Peak Reverse Voltage	M1MA151AT1	V_{RM}	40	Vdc
	M1MA152AT1		80	
Forward Current		I_F	100	mAdc
Peak Forward Current		I_{FM}	225	mAdc
Peak Forward Surge Current		I_{FSM}(1)	500	mAdc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA151AT1	I_R	V_R = 35 V	—	0.1	µAdc
	M1MA152AT1		V_R = 75 V	—	0.1	
Forward Voltage		V_F	I_F = 100 mA	—	1.2	Vdc
Reverse Breakdown Voltage	M1MA151AT1	V_R	I_R = 100 µA	40	—	Vdc
	M1MA152AT1			80	—	
Diode Capacitance		C_D	V_R = 0, f = 1.0 MHz	—	2.0	pF
Reverse Recovery Time (Figure 1)		t_{rr}(2)	I_F = 10 mA, V_R = 6.0 V, R_L = 100 Ω, I_{rr} = 0.1 I_R	—	3.0	ns

1. t = 1 SEC
2. t_{rr} Test Circuit

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

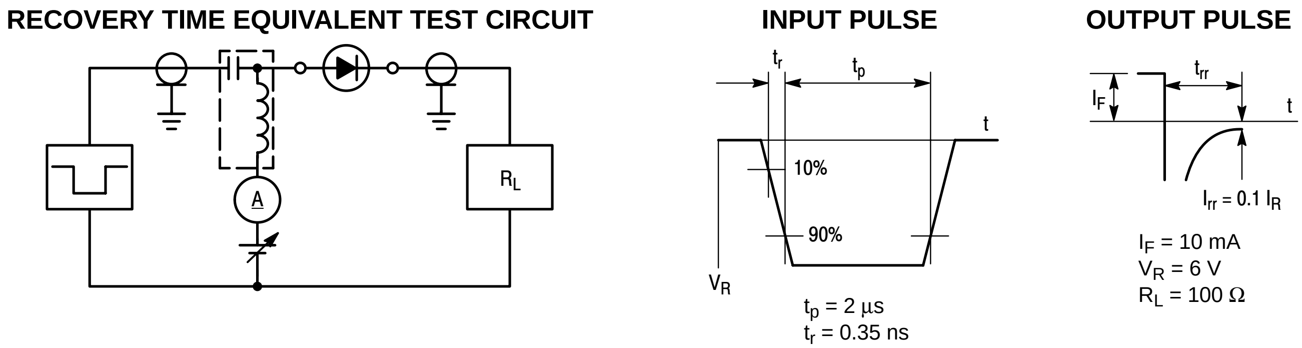
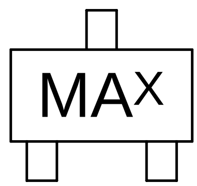


Figure 1. Reverse Recovery Time Equivalent Test Circuit

DEVICE MARKING

Marking Symbol

Type No.	151A	152A
Symbol	MA	MB



The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

Single Silicon Switching Diodes

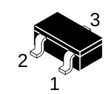
M1MA151KT1
M1MA152KT1

ON Semiconductor Preferred Devices

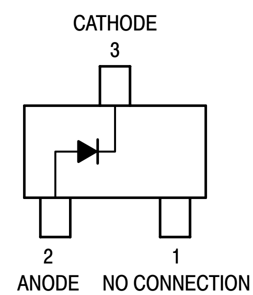
These Silicon Epitaxial Planar Diodes are designed for use in ultra high speed switching applications. These devices are housed in the SC–59 package which is designed for low power surface mount applications.

- Fast t_{rr}, < 3.0 ns
- Low C_D, < 2.0 pF
- Available in 8 mm Tape and Reel
  Use M1MA151/2KT1 to order the 7 inch/3000 unit reel.
  Use M1MA151/2KT3 to order the 13 inch/10,000 unit reel.

SC–59 PACKAGE
SINGLE SILICON
SWITCHING DIODES
40/80 V–100 mA
SURFACE MOUNT



CASE 318D–04, STYLE 2
SC–59



MAXIMUM RATINGS (T_A = 25°C)

Rating		Symbol	Value	Unit
Reverse Voltage	M1MA151KT1	V_R	40	Vdc
	M1MA152KT1		80	
Peak Reverse Voltage	M1MA151KT1	V_{RM}	40	Vdc
	M1MA152KT1		80	
Forward Current		I_F	100	mAdc
Peak Forward Current		I_{FM}	225	mAdc
Peak Forward Surge Current		$I_{FSM}^{(1)}$	500	mAdc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA151KT1	I_R	V_R = 35 V	—	0.1	μAdc
	M1MA152KT1		V_R = 75 V	—	0.1	
Forward Voltage		V_F	I_F = 100 mA	—	1.2	Vdc
Reverse Breakdown Voltage	M1MA151KT1	V_R	I_R = 100 μA	40	—	Vdc
	M1MA152KT1			80	—	
Diode Capacitance		C_D	V_R = 0, f = 1.0 MHz	—	2.0	pF
Reverse Recovery Time (Figure 1)		$t_{rr}^{(2)}$	I_F = 10 mA, V_R = 6.0 V, R_L = 100 Ω, I_{rr} = 0.1 I_R	—	3.0	ns

1. t = 1 SEC
2. t_{rr} Test Circuit

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

RECOVERY TIME EQUIVALENT TEST CIRCUIT **INPUT PULSE** **OUTPUT PULSE**

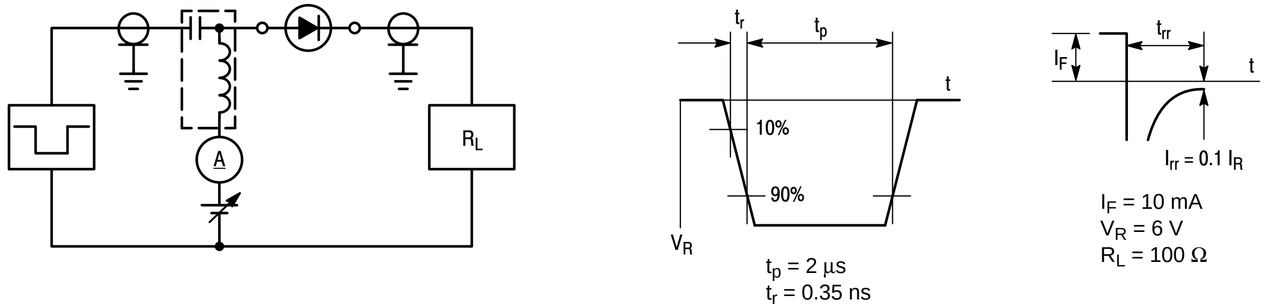
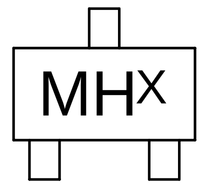


Figure 1. Reverse Recovery Time Equivalent Test Circuit

DEVICE MARKING — EXAMPLE

Marking Symbol

Type No.	151K	152K
Symbol	MH	MI



The “X” represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

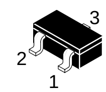
Common Anode Silicon Dual Switching Diodes

M1MA151WAT1
M1MA152WAT1

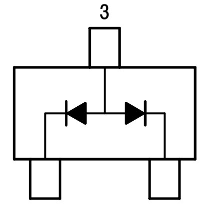
ON Semiconductor Preferred Devices

These Common Anode Silicon Epitaxial Planar Dual Diodes are designed for use in ultra high speed switching applications. These devices are housed in the SC–59 package which is designed for low power surface mount applications.

- Fast t_{rr}, < 10 ns
- Low C_D, < 15 pF
- Available in 8 mm Tape and Reel
  Use M1MA151/2WAT1 to order the 7 inch/3000 unit reel.
  Use M1MA151/2WAT3 to order the 13 inch/10,000 unit reel.



CASE 318D–04, STYLE 5
SC–59



MAXIMUM RATINGS (T_A = 25°C)

Rating		Symbol	Value	Unit
Reverse Voltage	M1MA151WAT1	V_R	40	Vdc
	M1MA152WAT1		80	
Peak Reverse Voltage	M1MA151WAT1	V_{RM}	40	Vdc
	M1MA152WAT1		80	
Forward Current	Single	I_F	100	mAdc
	Dual		150	
Peak Forward Current	Single	I_{FM}	225	mAdc
	Dual		340	
Peak Forward Surge Current	Single	I_{FSM}(1)	500	mAdc
	Dual		750	

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA151WAT1	I_R	V_R = 35 V	—	0.1	µAdc
	M1MA152WAT1		V_R = 75 V	—	0.1	
Forward Voltage		V_F	I_F = 100 mA	—	1.2	Vdc
Reverse Breakdown Voltage	M1MA151WAT1	V_R	I_R = 100 µA	40	—	Vdc
	M1MA152WAT1			80	—	
Diode Capacitance		C_D	V_R = 0, f = 1.0 MHz	—	15	pF
Reverse Recovery Time (Figure 1)		t_{rr}(2)	I_F = 10 mA, V_R = 6.0 V, R_L = 100 Ω, I_{rr} = 0.1 I_R	—	10	ns

1. t = 1 SEC
2. t_{rr} Test Circuit

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 4
Publication Order Number:
M1MA151WAT1/D

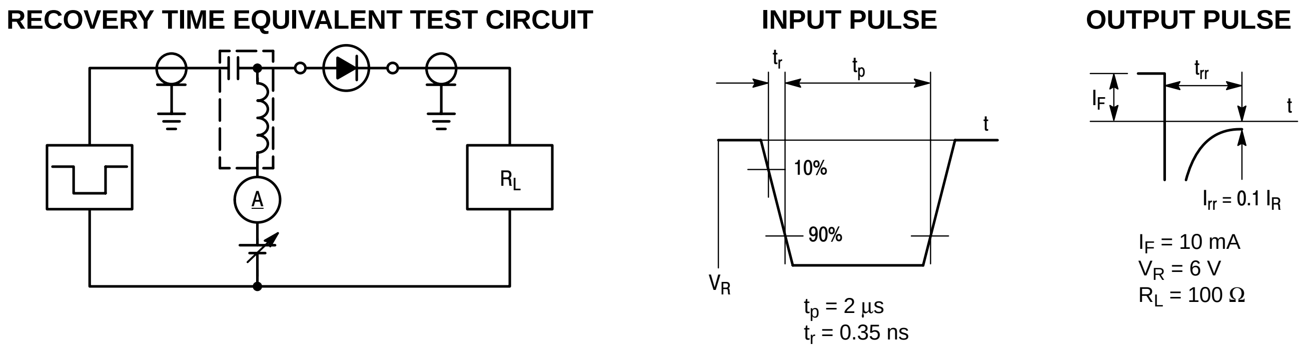
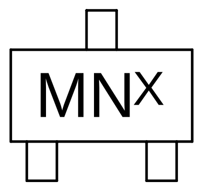


Figure 1. Reverse Recovery Time Equivalent Test Circuit

DEVICE MARKING — EXAMPLE

Marking Symbol

Type No.	151WA	152WA
Symbol	MN	MO



The “X” represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

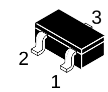
Common Cathode Silicon Dual Switching Diodes

M1MA151WKT1
M1MA152WKT1

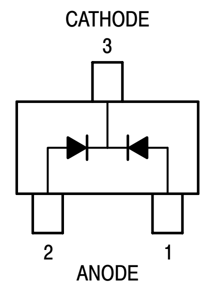
ON Semiconductor Preferred Devices

These Common Cathode Silicon Epitaxial Planar Dual Diodes are designed for use in ultra high speed switching applications. These devices are housed in the SC–59 package which is designed for low power surface mount applications.

- Fast t_{rr}, < 3.0 ns
- Low C_D, < 2.0 pF
- Available in 8 mm Tape and Reel
  Use M1MA151/2WKT1 to order the 7 inch/3000 unit reel.
  Use M1MA151/2WKT3 to order the 13 inch/10,000 unit reel.



CASE 318D–04, STYLE 3
SC–59



MAXIMUM RATINGS (T_A = 25°C)

Rating		Symbol	Value	Unit
Reverse Voltage	M1MA151WKT1	V_R	40	Vdc
	M1MA152WKT1		80	
Peak Reverse Voltage	M1MA151WKT1	V_{RM}	40	Vdc
	M1MA152WKT1		80	
Forward Current	Single	I_F	100	mAdc
	Dual		150	
Peak Forward Current	Single	I_{FM}	225	mAdc
	Dual		340	
Peak Forward Surge Current	Single	I_{FSM}(1)	500	mAdc
	Dual		750	

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic		Symbol	Condition	Min	Max	Unit
Reverse Voltage Leakage Current	M1MA151WKT1	I_R	V_R = 35 V	—	0.1	µAdc
	M1MA152WKT1		V_R = 75 V	—	0.1	
Forward Voltage		V_F	I_F = 100 mA	—	1.2	Vdc
Reverse Breakdown Voltage	M1MA151WKT1	V_R	I_R = 100 µA	40	—	Vdc
	M1MA152WKT1			80	—	
Diode Capacitance		C_D	V_R = 0, f = 1.0 MHz	—	2.0	pF
Reverse Recovery Time (Figure 1)		t_{rr}(2)	I_F = 10 mA, V_R = 6.0 V, R_L = 100 Ω, I_{rr} = 0.1 I_R	—	3.0	ns

1. t = 1 SEC
2. t_{rr} Test Circuit

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

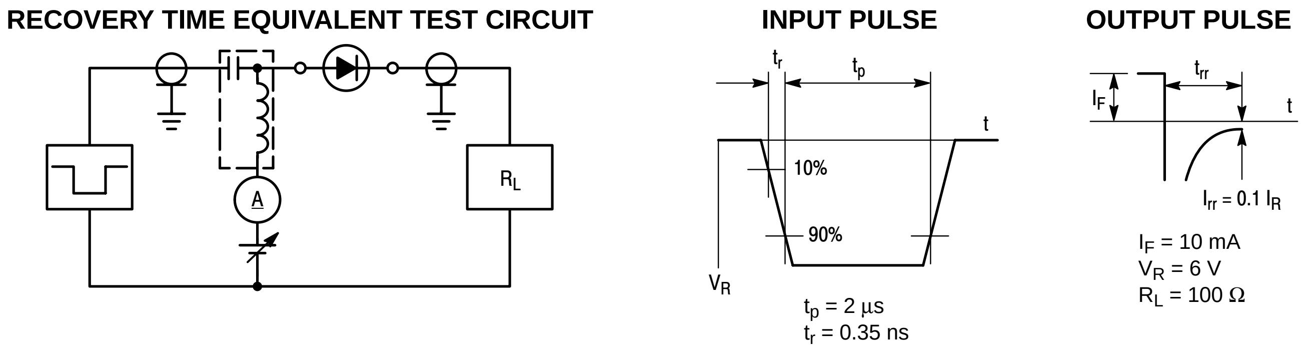
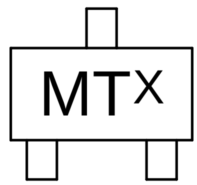


Figure 1. Reverse Recovery Time Equivalent Test Circuit

DEVICE MARKING — EXAMPLE

Marking Symbol

Type No.	151WK	152WK
Symbol	MT	MU



The “X” represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

M1MA174T1

Preferred Device

Silicon Switching Diode

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	100	V
Recurrent Peak Forward Current	I_F	200	mA
Peak Forward Surge Current Pulse Width = 10 µs	$I_{FM(surge)}$	500	mA
Total Power Dissipation, One Diode Loaded T_A = 25°C Derate above 25°C Mounted on a Ceramic Substrate (10 x 8 x 0.6 mm)	P_D	200 1.6	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

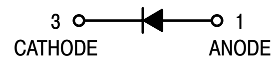
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient One Diode Loaded Mounted on a Ceramic Substrate (10 x 8 x 0.6 mm)	$R_{\theta JA}$	0.625	°C/mW

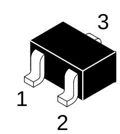
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage (I_R = 100 µAdc)	$V_{(BR)}$	100	–	Vdc
Reverse Voltage Leakage Current (V_R = 20 Vdc) (V_R = 75 Vdc)	I_R	 – –	 25 5.0	 nAdc µAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_T	–	4.0	pF
Forward Voltage (I_F = 10 mAdc)	V_F	–	1.0	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc) (Figure 1)	t_{rr}	–	4.0	ns

ON Semiconductor™

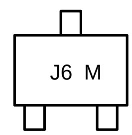
http://onsemi.com





SC–70/SOT–323
CASE 419
STYLE 2

MARKING DIAGRAM



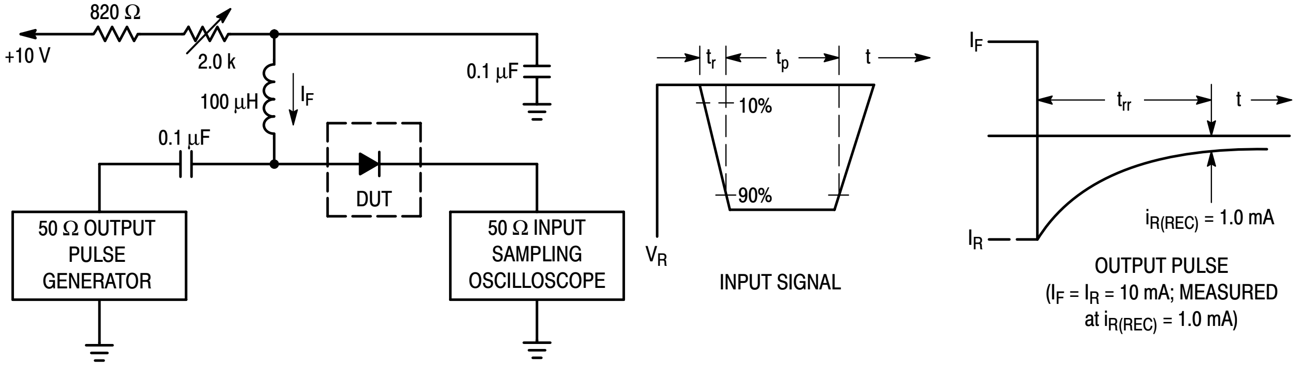
J6 = Device Code
M = Date Code

ORDERING INFORMATION

Device	Package	Shipping
M1MA174T1	SC–70	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

April, 2001 – Rev. 0
Publication Order Number:
M1MA174T1/D



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

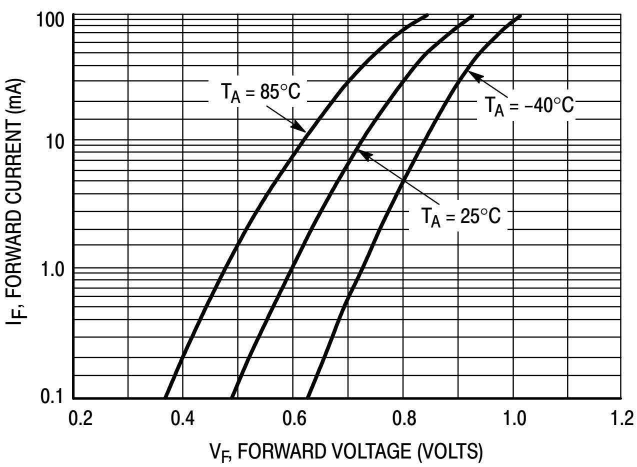


Figure 2. Forward Voltage

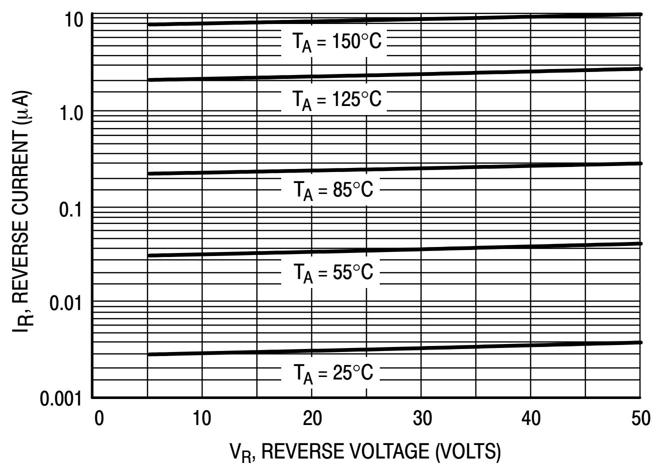


Figure 3. Leakage Current

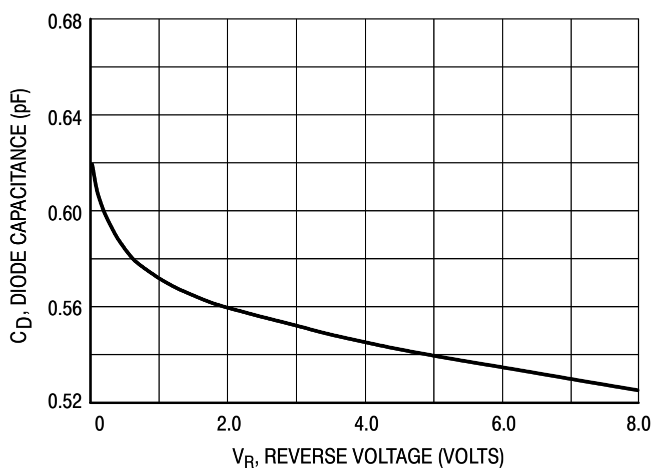


Figure 4. Capacitance

MBD101
MMBD101LT1

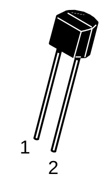
ON Semiconductor Preferred Devices

Schottky Barrier Diodes

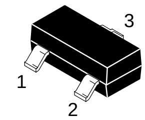
Designed primarily for UHF mixer applications but suitable also for use in detector and ultra–fast switching circuits. Supplied in an inexpensive plastic package for low–cost, high–volume consumer requirements. Also available in Surface Mount package.

- Low Noise Figure — 6.0 dB Typ @ 1.0 GHz
- Very Low Capacitance — Less Than 1.0 pF @ Zero Volts
- High Forward Conductance — 0.5 Volts (Typ) @ I_F = 10 mA

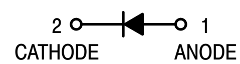
SILICON SCHOTTKY BARRIER DIODES



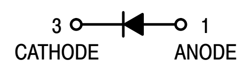
CASE 182–06, STYLE 1
TO–92 2–Lead (TO–226AC)



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



TO–92 (2–Lead)



SOT–23
(Pin 2 Not Connected)

MAXIMUM RATINGS

		MBD101	MMBD101LT1	
Rating	**Symbol**	**Value**		**Unit**
Reverse Voltage	V_R	7.0		Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 280 2.2	 225 1.8	 mW mW/°C
Junction Temperature	T_J	+150		°C
Storage Temperature Range	T_{stg}	–55 to +150		°C

DEVICE MARKING

MMBD101LT1 = 4M

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	7.0	10	—	Volts
Diode Capacitance (V_R = 0, f = 1.0 MHz, Note 1)	C_T	—	0.88	1.0	pF
Forward Voltage(1) (I_F = 10 mAdc)	V_F	—	0.5	0.6	Volts
Reverse Leakage (V_R = 3.0 Vdc)	I_R	—	0.02	0.25	μAdc

ORDERING INFORMATION

Device	Package	Shipping
MBD101	TO–92	5000/Bulk
MMBD101LT1	SOT–23	3000/Tape & Reel

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

TYPICAL CHARACTERISTICS

(T_A = 25°C unless noted)

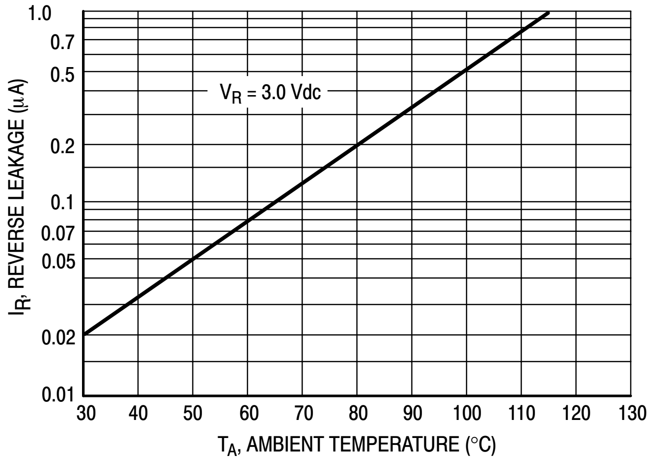


Figure 1. Reverse Leakage

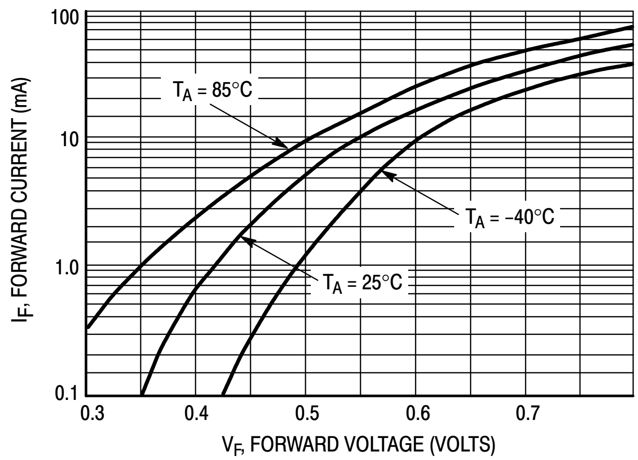


Figure 2. Forward Voltage

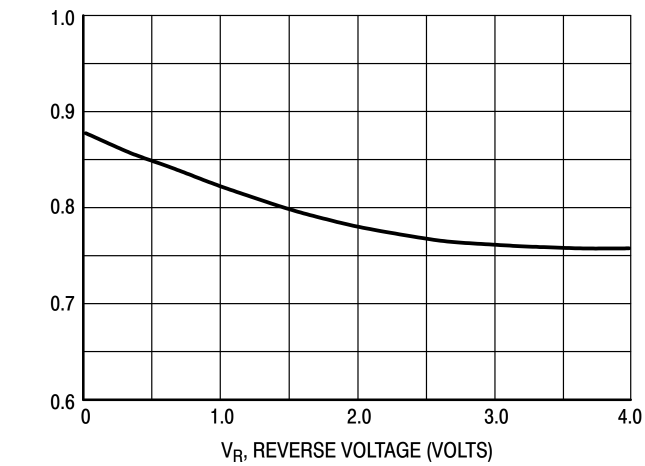


Figure 3. Capacitance

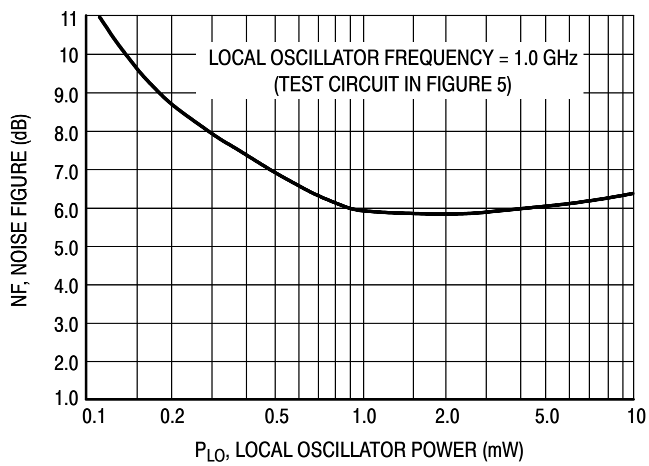


Figure 4. Noise Figure

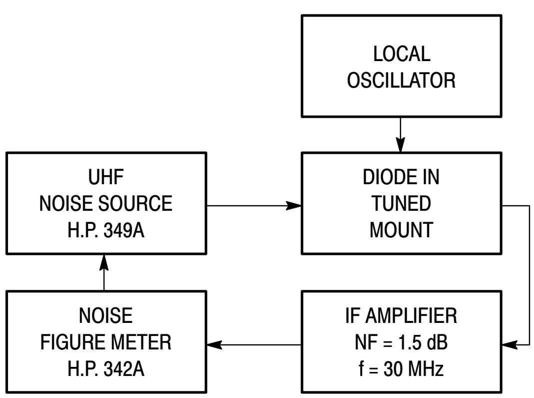


Figure 5. Noise Figure Test Circuit

NOTES ON TESTING AND SPECIFICATIONS

Note 1 — C_C and C_T are measured using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

Note 2 — Noise figure measured with diode under test in tuned diode mount using UHF noise source and local oscillator (LO) frequency of 1.0 GHz. The LO power is adjusted for 1.0 mW. IF amplifier NF = 1.5 dB, f = 30 MHz, see Figure 5.

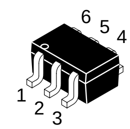
Note 3 — L_S is measured on a package having a short instead of a die, using an impedance bridge (Boonton Radio Model 250A RX Meter).

MBD110DWT1
MBD330DWT1
MBD770DWT1

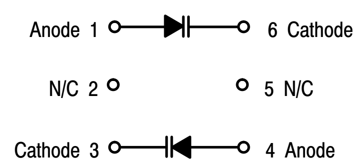
ON Semiconductor Preferred Devices

Dual Schottky Barrier Diodes

Application circuit designs are moving toward the consolidation of device count and into smaller packages. The new SOT–363 package is a solution which simplifies circuit design, reduces device count, and reduces board space by putting two discrete devices in one small six–leaded package. The SOT–363 is ideal for low–power surface mount applications where board space is at a premium, such as portable products.



CASE 419B–01, STYLE 6
SOT–363



Surface Mount Comparisons:

	SOT–363	SOT–23
Area (mm^2) Max Package P_D (mW) Device Count	4.6 120 2	7.6 225 1

Space Savings:

Package	1 × SOT–23	2 × SOT–23
SOT–363	40%	70%

The MBD110DW, MBD330DW, and MBD770DW devices are spin–offs of our popular MMBD101LT1, MMBD301LT1, and MMBD701LT1 SOT–23 devices. They are designed for high–efficiency UHF and VHF detector applications. Readily available to many other fast switching RF and digital applications.

- Extremely Low Minority Carrier Lifetime
- Very Low Capacitance
- Low Reverse Leakage

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Reverse Voltage	MBD110DWT1 MBD330DWT1 MBD770DWT1	V_R	7.0 30 70	Vdc
Forward Power Dissipation T_A = 25°C		P_F	120	mW
Junction Temperature		T_J	–55 to +125	°C
Storage Temperature Range		T_{stg}	–55 to +150	°C

DEVICE MARKING

MBD110DWT1 = M4 MBD330DWT1 = T4 MBD770DWT1 = H5

Thermal Clad is a trademark of the Bergquist Company.

March, 2001 – Rev.2

Publication Order Number:
MBD110DWT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage		$V_{(BR)R}$				Volts
(I_R = 10 μA)	MBD110DWT1		7.0	10	—	
	MBD330DWT1		30	—	—	
	MBD770DWT1		70	—	—	
Diode Capacitance		C_T				pF
(V_R = 0, f = 1.0 MHz, Note 1)	MBD110DWT1		—	0.88	1.0	
Total Capacitance		C_T				pF
(V_R = 15 Volts, f = 1.0 MHz)	MBD330DWT1		—	0.9	1.5	
(V_R = 20 Volts, f = 1.0 MHz)	MBD770DWT1		—	0.5	1.0	
Reverse Leakage		I_R				
(V_R = 3.0 V)	MBD110DWT1		—	0.02	0.25	μA
(V_R = 25 V)	MBD330DWT1		—	13	200	nAdc
(V_R = 35 V)	MBD770DWT1		—	9.0	200	nAdc
Noise Figure		NF				dB
(f = 1.0 GHz, Note 2)	MBD110DWT1		—	6.0	—	
Forward Voltage		V_F				Vdc
(I_F = 10 mA)	MBD110DWT1		—	0.5	0.6	
(I_F = 1.0 mAdc)	MBD330DWT1		—	0.38	0.45	
(I_F = 10 mA)			—	0.52	0.6	
(I_F = 1.0 mAdc)	MBD770DWT1		—	0.42	0.5	
(I_F = 10 mA)			—	0.7	1.0	

TYPICAL CHARACTERISTICS
MBD110DWT1

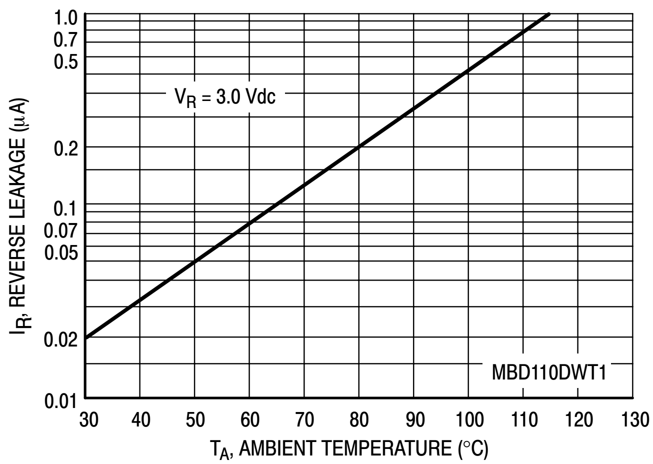


Figure 1. Reverse Leakage

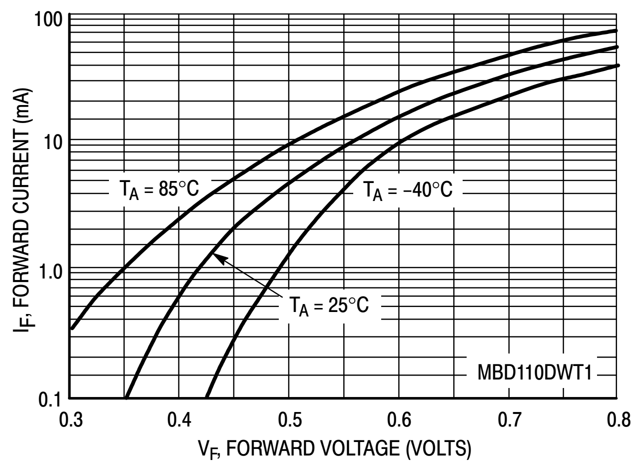


Figure 2. Forward Voltage

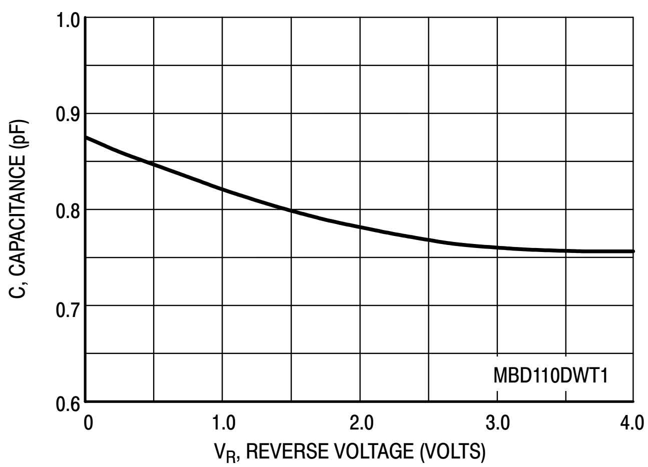


Figure 3. Capacitance

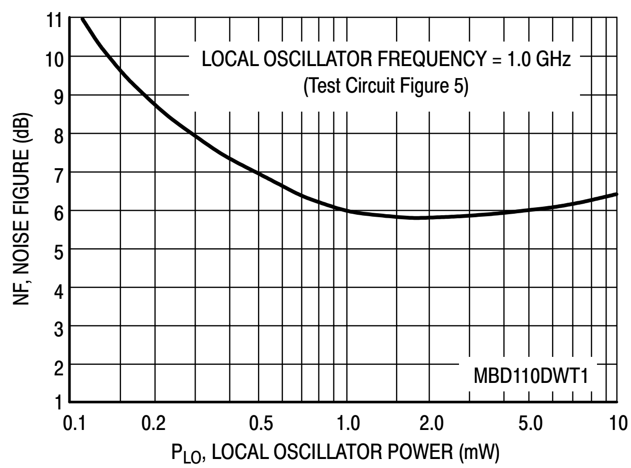


Figure 4. Noise Figure

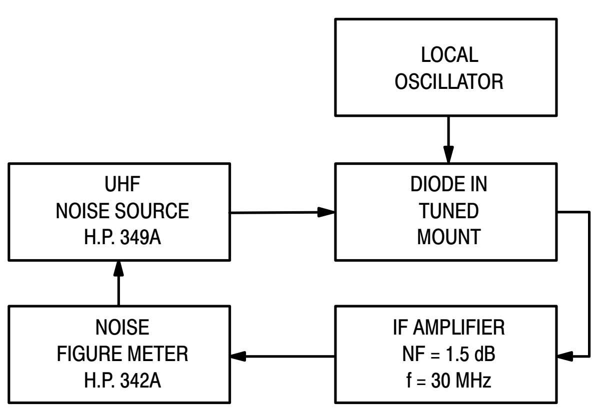


Figure 5. Noise Figure Test Circuit

NOTES ON TESTING AND SPECIFICATIONS

Note 1 – C_C and C_T are measured using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

Note 2 – Noise figure measured with diode under test in tuned diode mount using UHF noise source and local oscillator (LO) frequency of 1.0 GHz. The LO power is adjusted for 1.0 mW. IF amplifier NF = 1.5 dB, f = 30 MHz, see Figure 5.

Note 3 – L_S is measured on a package having a short instead of a die, using an impedance bridge (Boonton Radio Model 250A RX Meter).

TYPICAL CHARACTERISTICS
MBD330DWT1

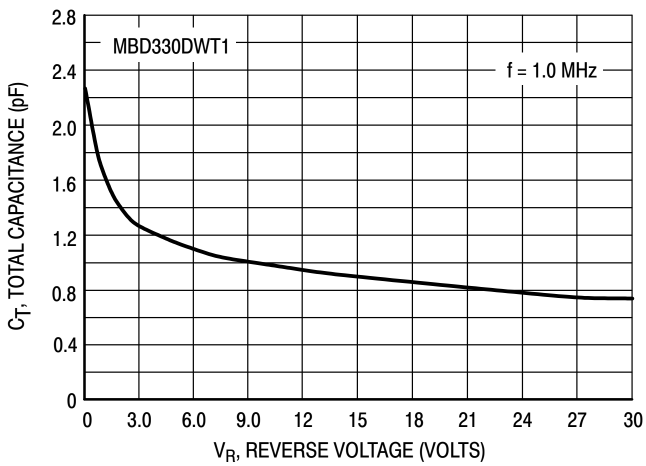


Figure 6. Total Capacitance

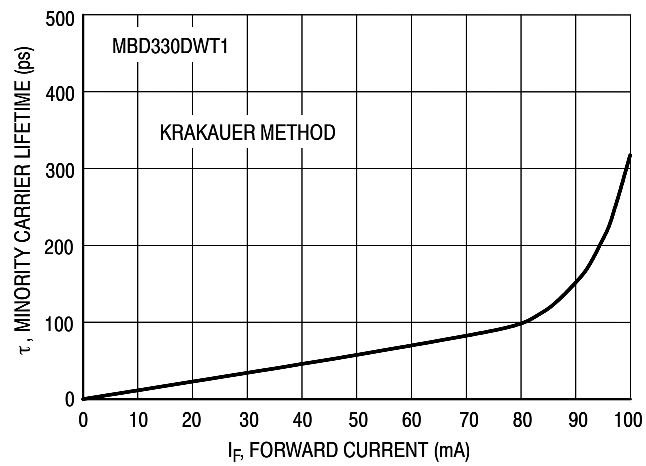


Figure 7. Minority Carrier Lifetime

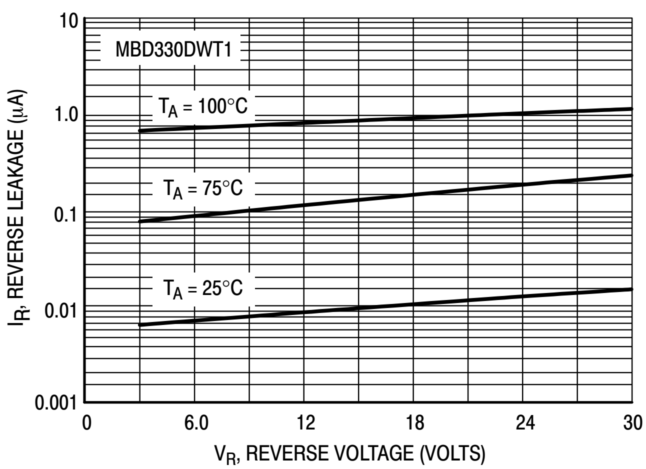


Figure 8. Reverse Leakage

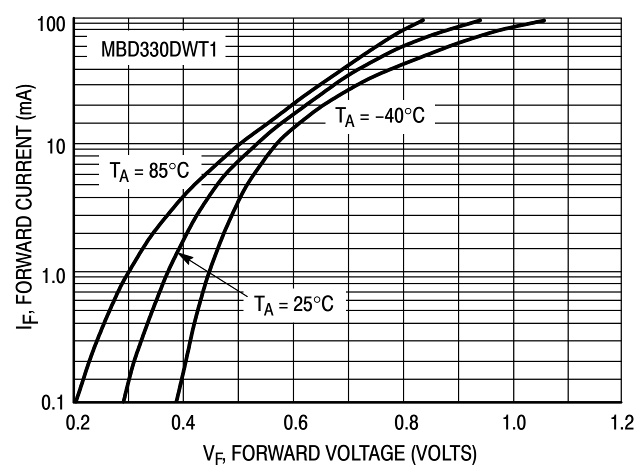


Figure 9. Forward Voltage

TYPICAL CHARACTERISTICS
MBD770DWT1

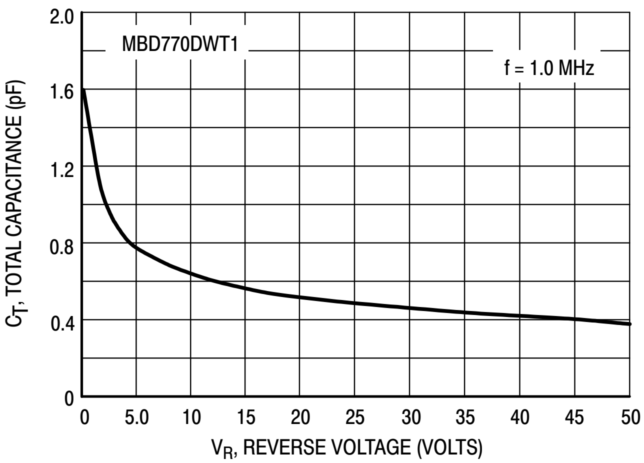


Figure 10. Total Capacitance

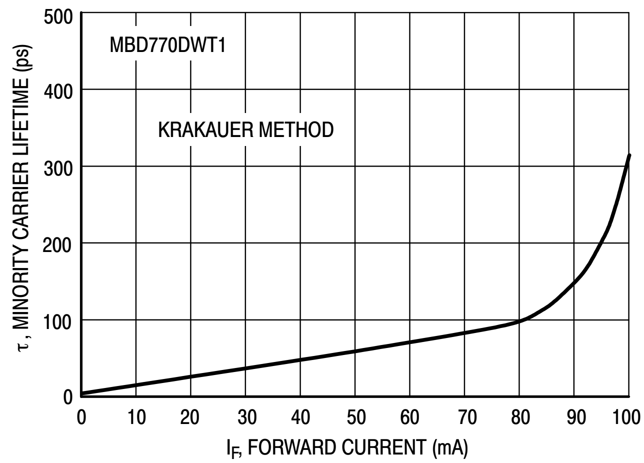


Figure 11. Minority Carrier Lifetime

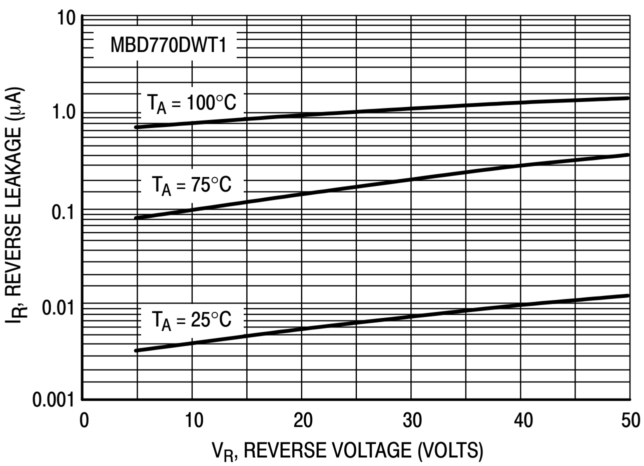


Figure 12. Reverse Leakage

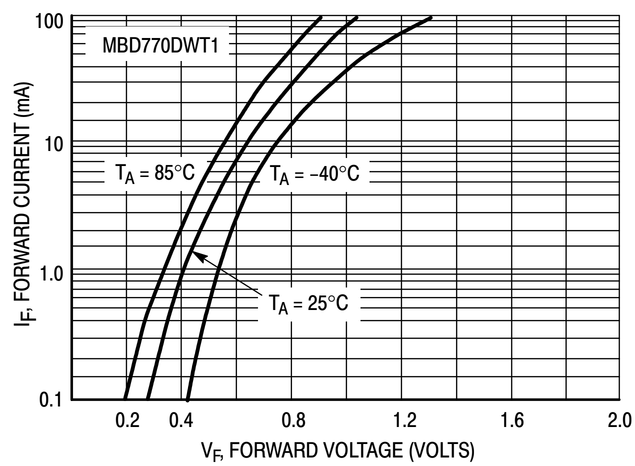


Figure 13. Forward Voltage

Silicon Hot-Carrier Diodes
SCHOTTKY Barrier Diodes

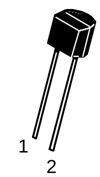
MBD301
MMBD301LT1

ON Semiconductor Preferred Devices

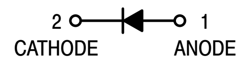
These devices are designed primarily for high–efficiency UHF and VHF detector applications. They are readily adaptable to many other fast switching RF and digital applications. They are supplied in an inexpensive plastic package for low–cost, high–volume consumer and industrial/commercial requirements. They are also available in a Surface Mount package.

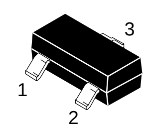
- Extremely Low Minority Carrier Lifetime – 15 ps (Typ)
- Very Low Capacitance – 1.5 pF (Max) @ V_R = 15 V
- Low Reverse Leakage – I_R = 13 nAdc (Typ) MBD301, MMBD301

30 VOLTS
SILICON HOT–CARRIER
DETECTOR AND SWITCHING
DIODES

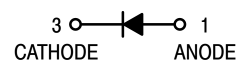


CASE 182–06, STYLE 1
(TO–226AC)
MBD301





CASE 318–08, STYLE 8
SOT–23 (TO–236AB)
MMBD301LT1



MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

		MBD301	MMBD301LT1	
Rating	**Symbol**	**Value**		**Unit**
Reverse Voltage	V_R	30		Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	280 2.8	200 2.0	mW mW/°C
Operating Junction Temperature Range	T_J	–55 to +125		°C
Storage Temperature Range	T_{stg}	–55 to +150		°C

DEVICE MARKING

MMBD301LT1 = 4T

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	30	—	—	Volts
Total Capacitance (V_R = 15 V, f = 1.0 MHz) Figure 1	C_T	—	0.9	1.5	pF
Reverse Leakage (V_R = 25 V) Figure 3	I_R	—	13	200	nAdc
Forward Voltage (I_F = 1.0 mAdc) Figure 4	V_F	—	0.38	0.45	Vdc
Forward Voltage (I_F = 10 mAdc) Figure 4	V_F	—	0.52	0.6	Vdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1
Publication Order Number:
MBD301/D

TYPICAL ELECTRICAL CHARACTERISTICS

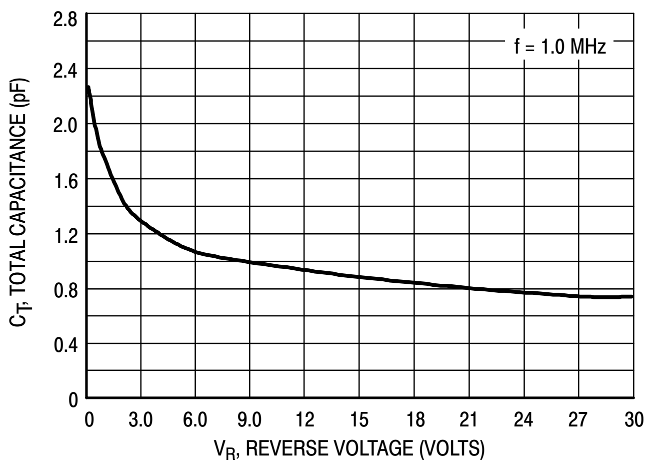


Figure 1. Total Capacitance

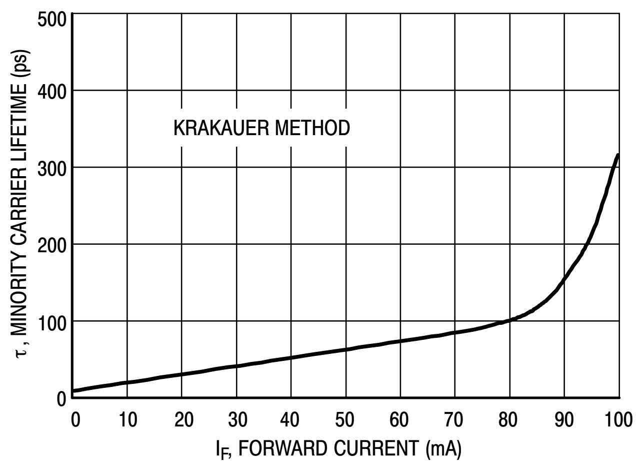


Figure 2. Minority Carrier Lifetime

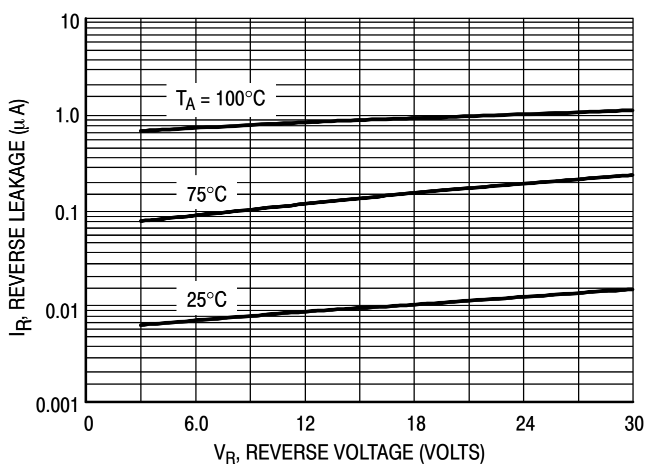


Figure 3. Reverse Leakage

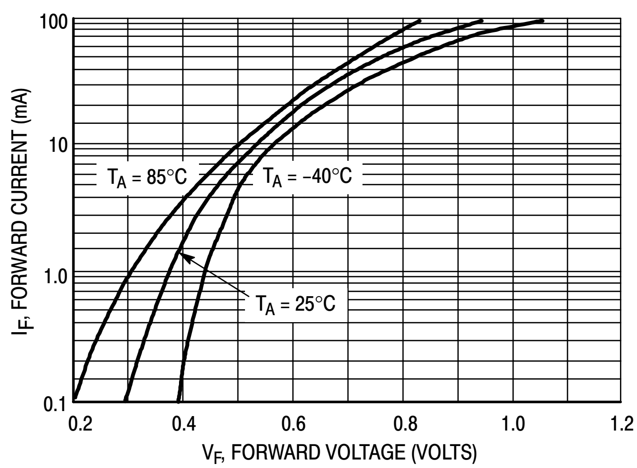


Figure 4. Forward Voltage

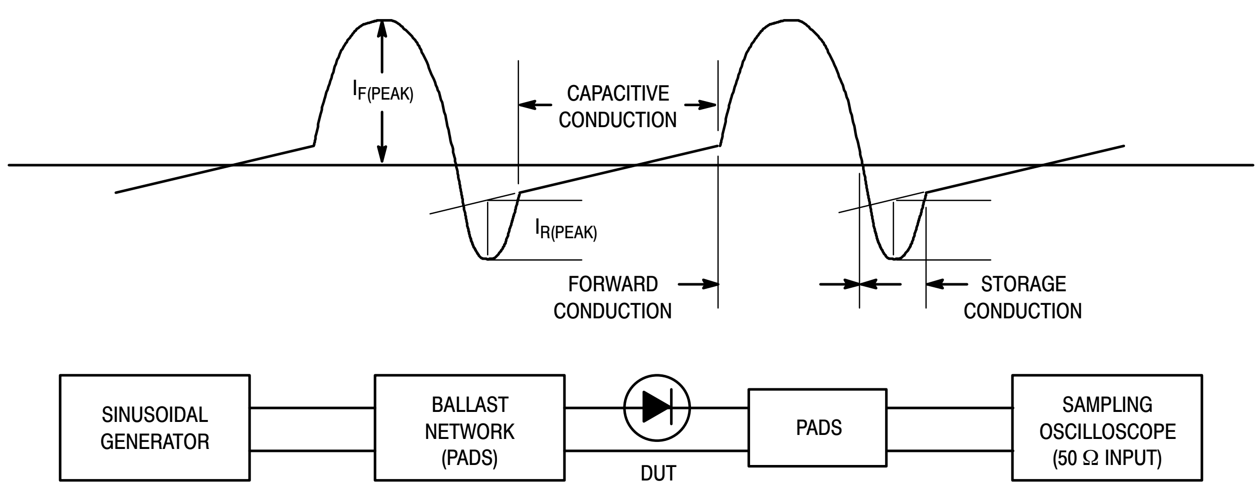


Figure 5. Krakauer Method of Measuring Lifetime

Dual Schottky Barrier Diodes

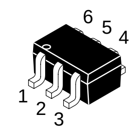
MBD54DWT1

ON Semiconductor Preferred Device

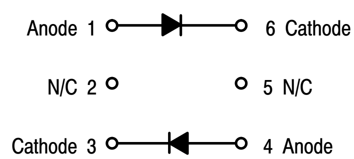
These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Low Forward Voltage — 0.35 V @ I_F = 10 mAdc

30 VOLTS
DUAL HOT–CARRIER
DETECTOR AND SWITCHING
DIODES



CASE 419B–01, STYLE 6
SOT–363



MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 150 1.2	 mW mW/°C
Forward Current (DC)	I_F	200 Max	mA
Junction Temperature	T_J	125 Max	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

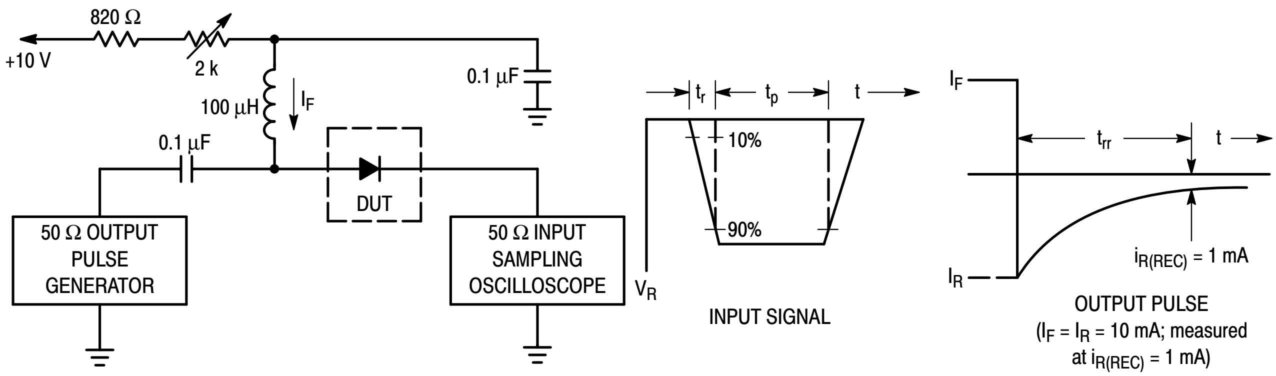
DEVICE MARKING

MBD54DWT1 = BL

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (EACH DIODE)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	30	—	—	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	—	7.6	10	pF
Reverse Leakage (V_R = 25 V)	I_R	—	0.5	2.0	μAdc
Forward Voltage (I_F = 0.1 mAdc)	V_F	—	0.22	0.24	Vdc
Forward Voltage (I_F = 30 mAdc)	V_F	—	0.41	0.5	Vdc
Forward Voltage (I_F = 100 mAdc)	V_F	—	0.52	1.0	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc) Figure 1	t_{rr}	—	—	5.0	ns
Forward Voltage (I_F = 1.0 mAdc)	V_F	—	0.29	0.32	Vdc
Forward Voltage (I_F = 10 mAdc)	V_F	—	0.35	0.40	Vdc
Forward Current (DC)	I_F	—	—	200	mAdc
Repetitive Peak Forward Current	I_{FRM}	—	—	300	mAdc
Non–Repetitive Peak Forward Current (t < 1.0 s)	I_{FSM}	—	—	600	mAdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

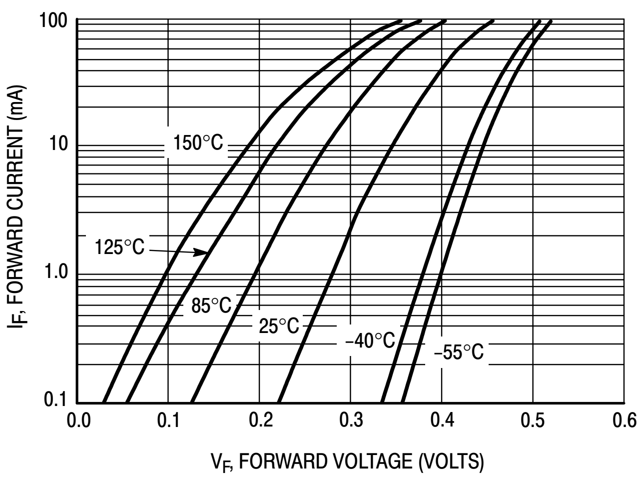


Figure 2. Forward Voltage

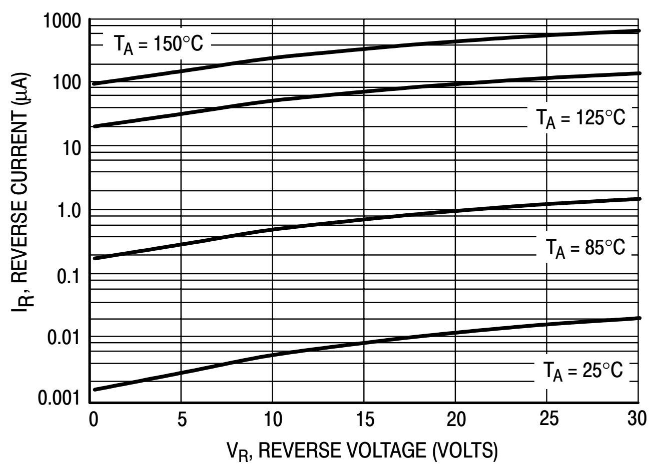


Figure 3. Leakage Current

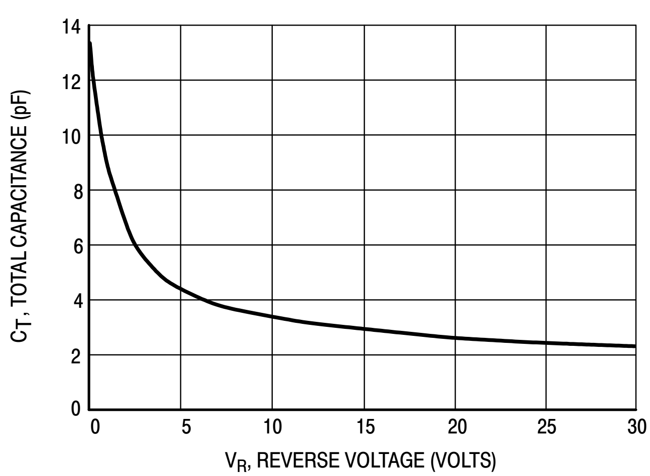


Figure 4. Total Capacitance

MBD701
MMBD701LT1

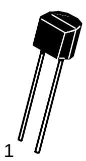
ON Semiconductor Preferred Devices

Silicon Hot-Carrier Diodes
Schottky Barrier Diodes

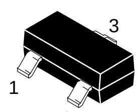
These devices are designed primarily for high–efficiency UHF and VHF detector applications. They are readily adaptable to many other fast switching RF and digital applications. They are supplied in an inexpensive plastic package for low–cost, high–volume consumer and industrial/commercial requirements. They are also available in a Surface Mount package.

- Extremely Low Minority Carrier Lifetime – 15 ps (Typ)
- Very Low Capacitance – 1.0 pF @ V_R = 20 V
- High Reverse Voltage – to 70 Volts
- Low Reverse Leakage – 200 nA (Max)

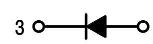
70 VOLTS
HIGH–VOLTAGE
SILICON HOT–CARRIER
DETECTOR AND SWITCHING
DIODES



CASE 182–06, STYLE 1
(TO–226AC)



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

		MBD701	MMBD701LT1	
Rating	**Symbol**	**Value**		**Unit**
Reverse Voltage	V_R	70		Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	280 2.8	200 2.0	mW mW/°C
Operating Junction Temperature Range	T_J	–55 to +125		°C
Storage Temperature Range	T_{stg}	–55 to +150		°C

DEVICE MARKING

MMBD701LT1 = 5H

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	70	—	—	Volts
Total Capacitance (V_R = 20 V, f = 1.0 MHz) Figure 1	C_T	—	0.5	1.0	pF
Reverse Leakage (V_R = 35 V) Figure 3	I_R	—	9.0	200	nAdc
Forward Voltage (I_F = 1.0 mAdc) Figure 4	V_F	—	0.42	0.5	Vdc
Forward Voltage (I_F = 10 mAdc) Figure 4	V_F	—	0.7	1.0	Vdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1
Publication Order Number:
MBD701/D

TYPICAL ELECTRICAL CHARACTERISTICS

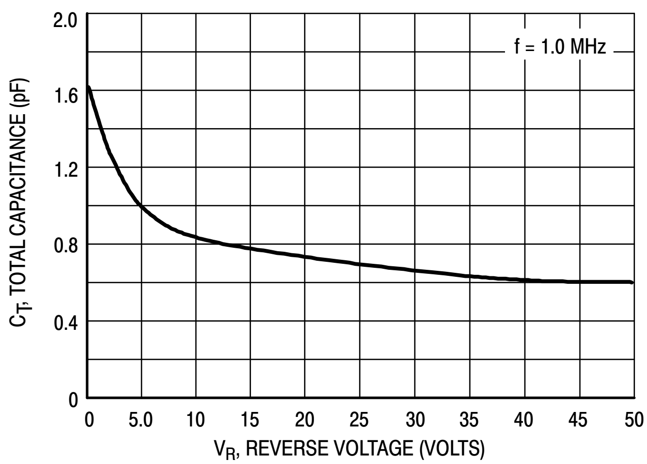


Figure 1. Total Capacitance

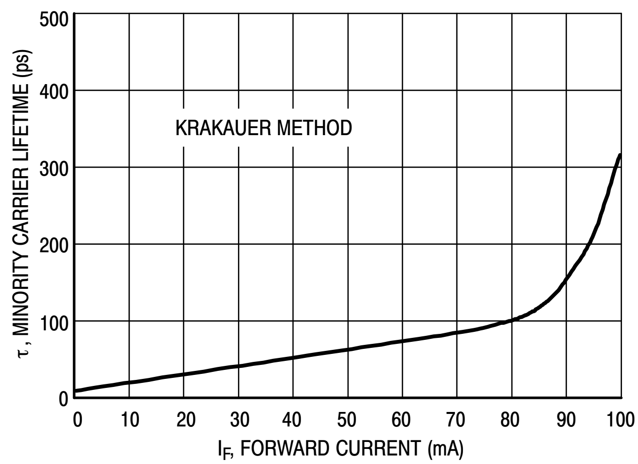


Figure 2. Minority Carrier Lifetime

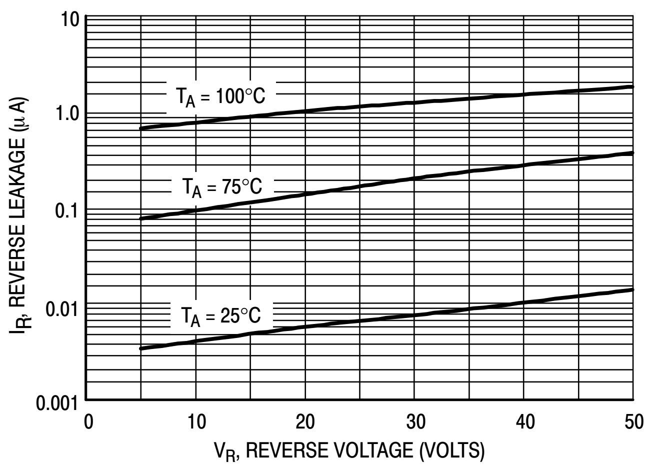


Figure 3. Reverse Leakage

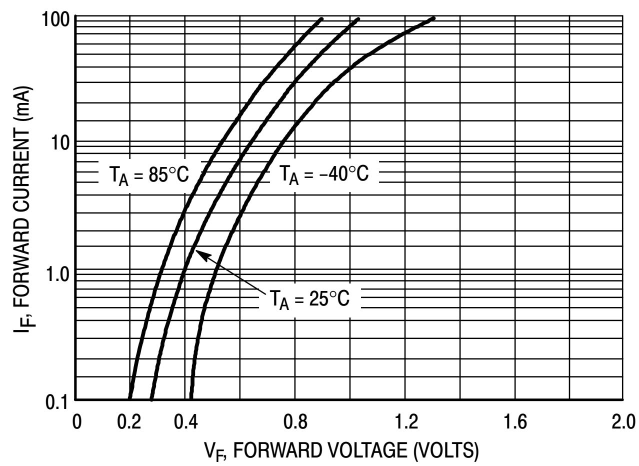


Figure 4. Forward Voltage

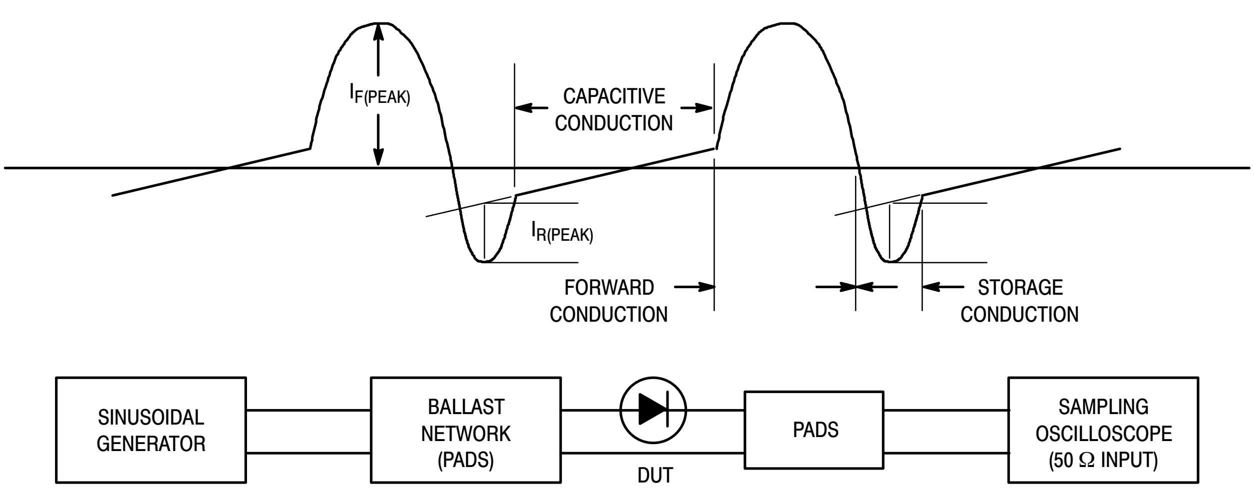


Figure 5. Krakauer Method of Measuring Lifetime

MBT35200MT1

High Current Surface Mount PNP Silicon Switching Transistor for Load Management in Portable Applications

ON Semiconductor

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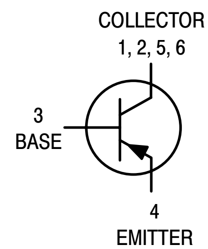
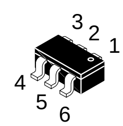
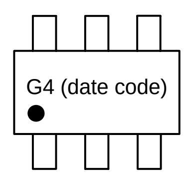
35 VOLTS
2.0 AMPS
PNP TRANSISTOR





CASE 318G
TSOP
STYLE 6

DEVICE MARKING



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Collector-Emitter Voltage	V_{CEO}	–35	Vdc
Collector-Base Voltage	V_{CBO}	–55	Vdc
Emitter-Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Continuous	I_C	–2.0	Adc
Collector Current – Peak	I_{CM}	–5.0	A
Electrostatic Discharge	ESD	HBM Class 3 MM Class C	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (Note 1.)	625 5.0	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (Note 1.)	200	°C/W
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (Note 2.)	1.0 8.0	W mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (Note 2.)	120	°C/W
Thermal Resistance, Junction to Lead #1	$R_{\theta JL}$	80	°C/W
Total Device Dissipation (Single Pulse < 10 sec.)	$P_{Dsingle}$ (Notes 2. & 3.)	1.75	W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 X 1.0 inch Pad
3. ref: Figure 9

ORDERING INFORMATION

Device	Package	Shipping
MBT35200MT1	Case 318G	3000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typical	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–35	–45	–	Vdc
Collector–Base Breakdown Voltage (I_C = –0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	–55	–65	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	–7.0	–	Vdc
Collector Cutoff Current (V_{CB} = –35 Vdc, I_E = 0)	I_{CBO}	–	–0.03	–0.1	μAdc
Collector–Emitter Cutoff Current (V_{CES} = –35 Vdc)	I_{CES}	–	–0.03	–0.1	μAdc
Emitter Cutoff Current (V_{EB} = –4.0 Vdc)	I_{EBO}	–	–0.01	–0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain (1)	h_{FE}				
(I_C = –1.0 A, V_{CE} = –1.5 V)		100	200	–	
(I_C = –1.5 A, V_{CE} = –1.5 V)		100	200	400	
(I_C = –2.0 A, V_{CE} = –3.0 V)		100	200	–	
Collector–Emitter Saturation Voltage (Note 4.)	$V_{CE(sat)}$				V
(I_C = –0.8 A, I_B = –0.008 A)		–	–0.125	–0.15	
(I_C = –1.2 A, I_B = –0.012 A)		–	–0.175	–0.20	
(I_C = –2.0 A, I_B = –0.02 A)		–	–0.260	–0.31	
Base–Emitter Saturation Voltage (Note 4.) (I_C = –1.2 A, I_B = –0.012 A)	$V_{BE(sat)}$	–	–0.68	–0.85	V
Base–Emitter Turn–on Voltage (Note 4.) (I_C = –2.0 A, V_{CE} = –3.0 V)	$V_{BE(on)}$	–	–0.81	–0.875	V
Cutoff Frequency (I_C = –100 mA, V_{CE} = –5.0 V, f = 100 MHz)	f_T	100	–	–	MHz
Input Capacitance (V_{EB} = –0.5 V, f = 1.0 MHz)	Cibo	–	600	650	pF
Output Capacitance (V_{CB} = –3.0 V, f = 1.0 MHz)	Cobo	–	85	100	pF
Turn–on Time (V_{CC} = –10 V, I_{B1} = –100 mA, I_C = –1 A, R_L = 3 Ω)	t_{on}	–	35	–	nS
Turn–off Time (V_{CC} = –10 V, I_{B1} = I_{B2} = –100 mA, I_C = 1 A, R_L = 3 Ω)	t_{off}	–	225	–	nS

4. Pulsed Condition: Pulse Width = 300 μsec, Duty Cycle ≤ 2%

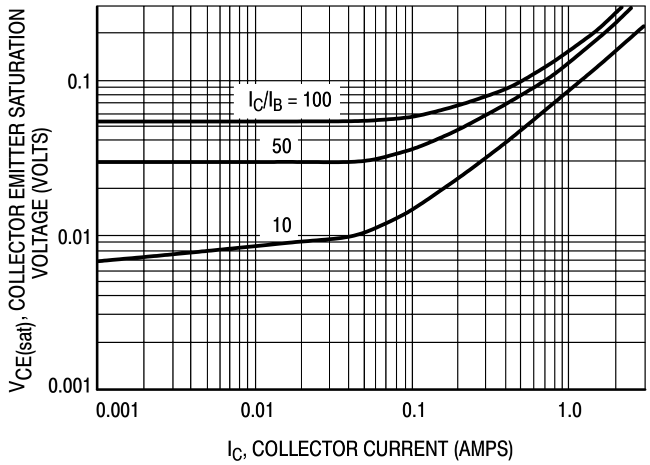


Figure 1. Collector Emitter Saturation Voltage versus Collector Current

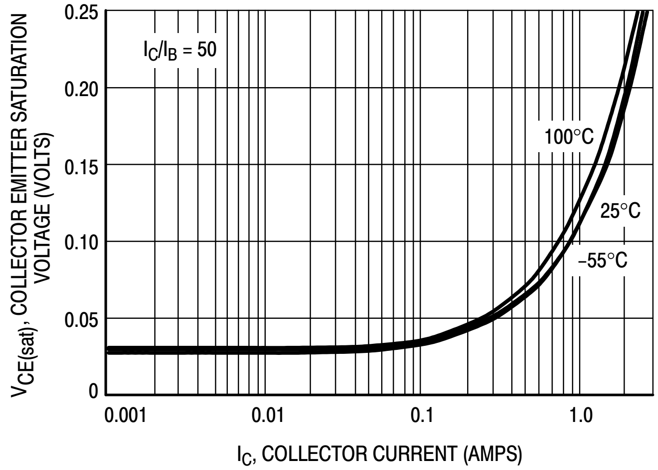


Figure 2. Collector Emitter Saturation Voltage versus Collector Current

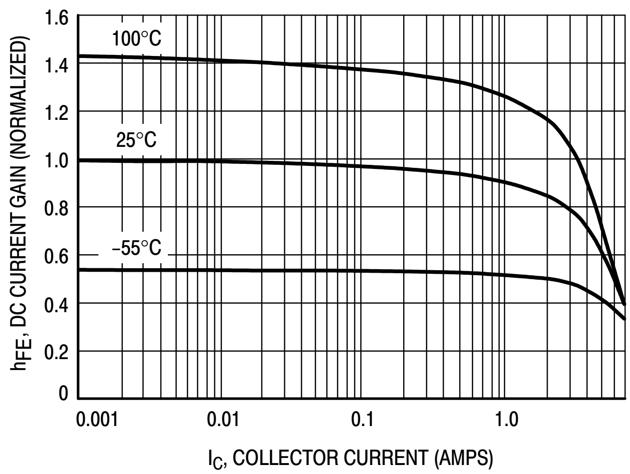


Figure 3. DC Current Gain versus Collector Current

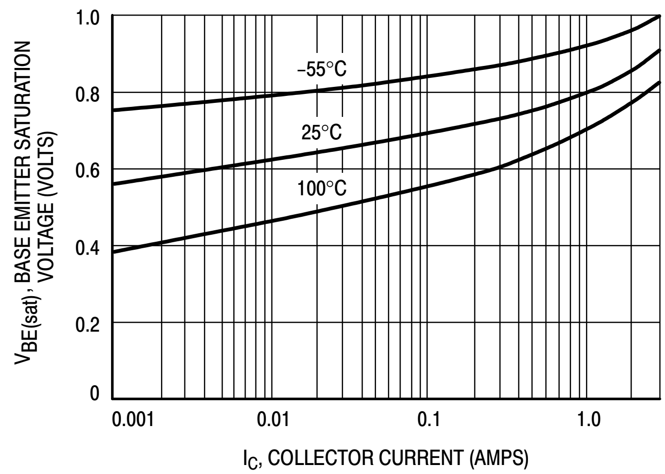


Figure 4. Base Emitter Saturation Voltage versus Collector Current

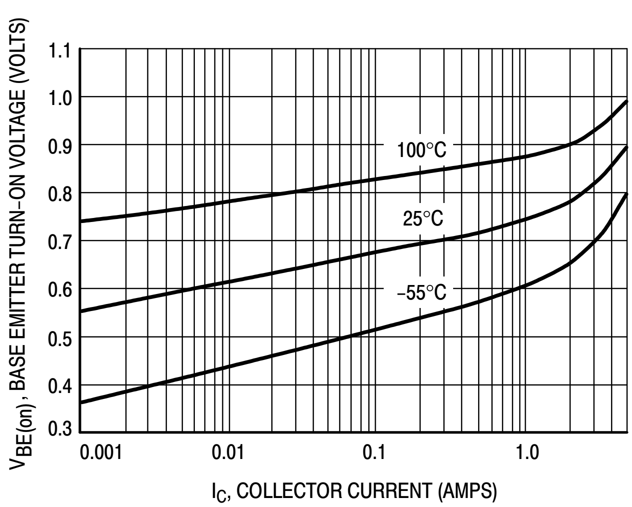


Figure 5. Base Emitter Turn−On Voltage versus Collector Current

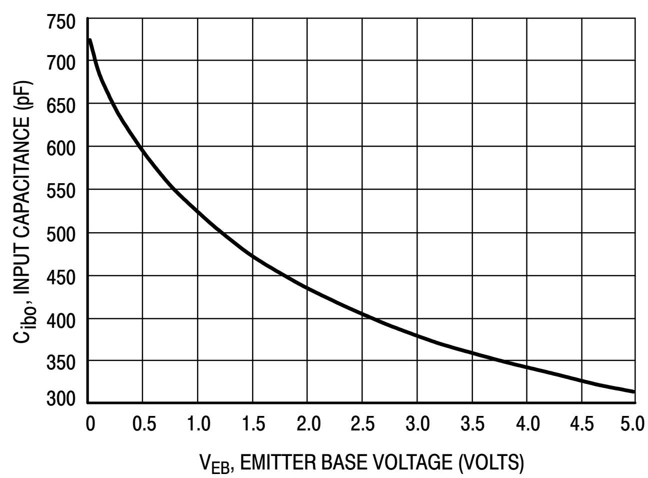


Figure 6. Input Capacitance

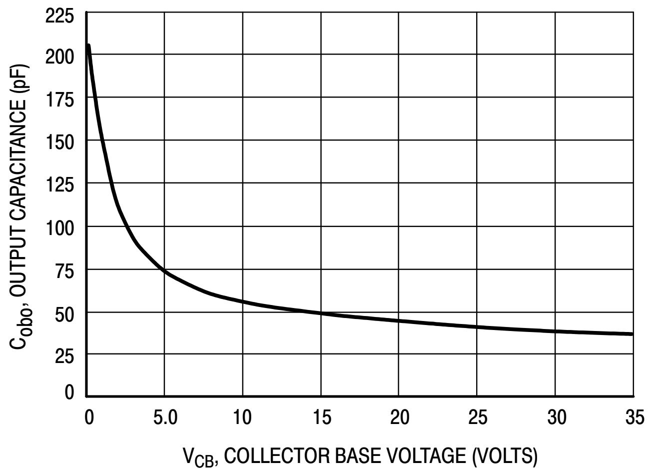


Figure 7. Output Capacitance

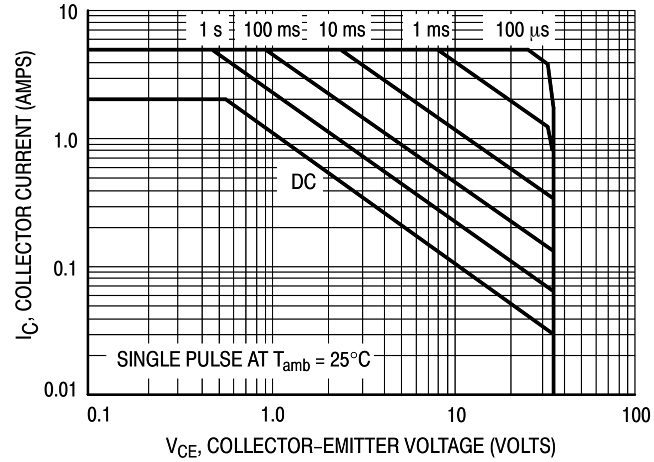


Figure 8. Safe Operating Area

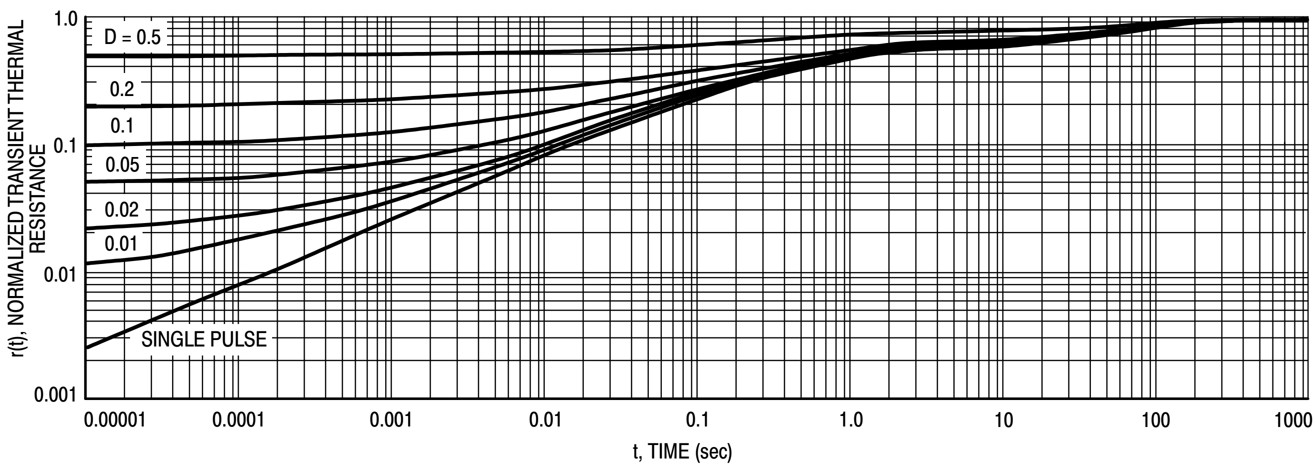


Figure 9. Normalized Thermal Response

MBT3904DW1T1

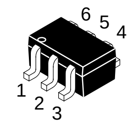
Dual General Purpose Transistor

The MBT3904DW1T1 device is a spin–off of our popular SOT–23/SOT–323 three–leaded device. It is designed for general purpose amplifier applications and is housed in the SOT–363 six–leaded surface mount package. By putting two discrete devices in one package, this device is ideal for low–power surface mount applications where board space is at a premium.

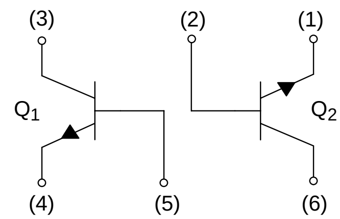
- h_{FE}, 100–300
- Low $V_{CE(sat)}$, ≤ 0.4 V
- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Available in 8 mm, 7–inch/3,000 Unit Tape and Reel
- Device Marking: MBT3904DW1T1 = MA

ON Semiconductor™

http://onsemi.com



SOT–363/SC–88
CASE 419B
STYLE 1



MBT3904DW1T1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	60	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current – Continuous	I_C	200	mAdc
Electrostatic Discharge	ESD	HBM>16000, MM>2000	V

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Package Dissipation(1) T_A = 25°C	P_D	150	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	833	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. Device mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.

ORDERING INFORMATION

Device	Package	Shipping
MBT3904DW1T1	SOT–363	3000 Units/Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(2) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	–	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	–	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{BL}	–	50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{CEX}	–	50	nAdc
ON CHARACTERISTICS (2)				
DC Current Gain	h_{FE}			–
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)		40	–	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)		70	–	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)		60	–	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		30	–	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		–	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		–	0.3	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		–	0.95	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain – Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	300	–	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	–	4.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	–	8.0	pF

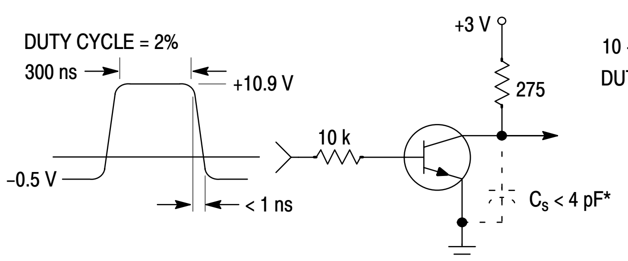
2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤2.0%.

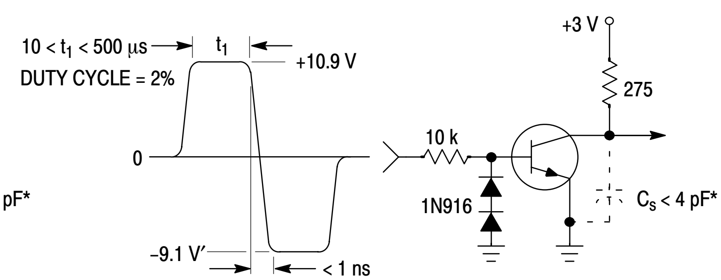
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
Input Impedance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	h_{ie}	1.0 2.0	10 12	k Ω
Voltage Feedback Ratio (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	h_{re}	0.5 0.1	8.0 10	X 10^{-4}
Small–Signal Current Gain (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	h_{fe}	100 100	400 400	–
Output Admittance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	h_{oe}	1.0 3.0	40 60	μmhos
Noise Figure (V_{CE} = 5.0 Vdc, I_C = 100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)	NF	– –	5.0 4.0	dB

SWITCHING CHARACTERISTICS

Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = –0.5 Vdc)	t_d	–	35	ns
Rise Time	(I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_r	–	35	
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc)	t_s	–	200	ns
Fall Time	(I_{B1} = I_{B2} = 1.0 mAdc)	t_f	–	50	





* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit

Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

T_J = 25°C
T_J = 125°C

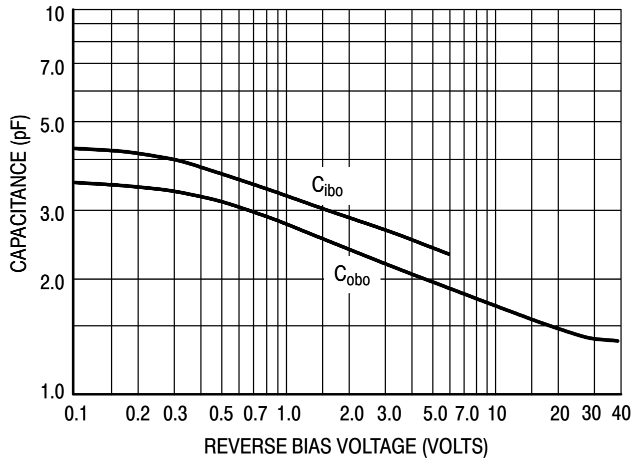


Figure 3. Capacitance

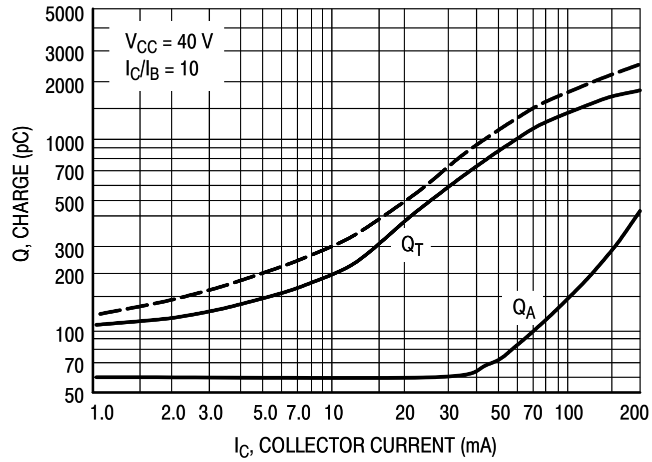


Figure 4. Charge Data

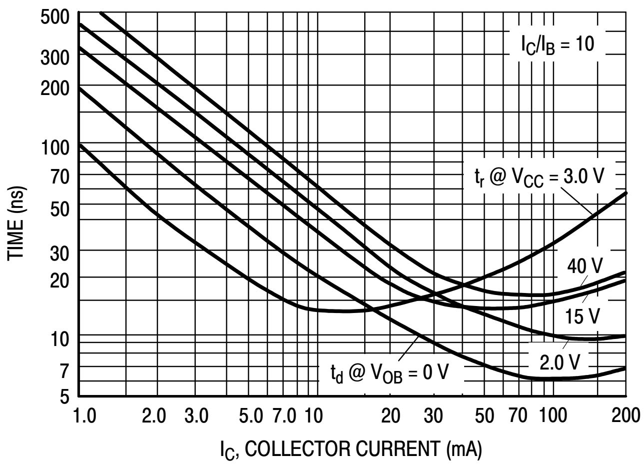


Figure 5. Turn−On Time

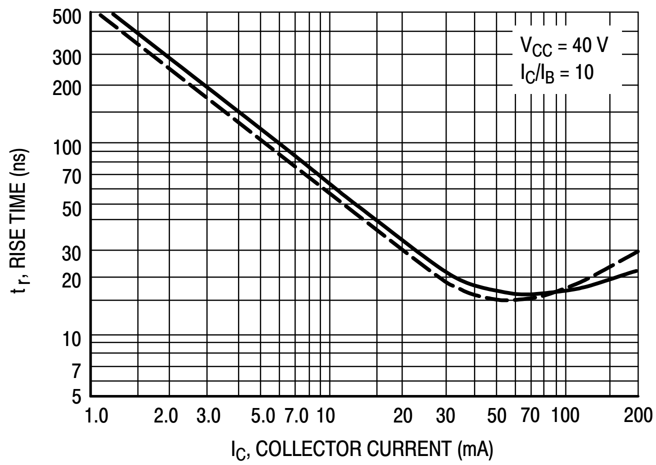


Figure 6. Rise Time

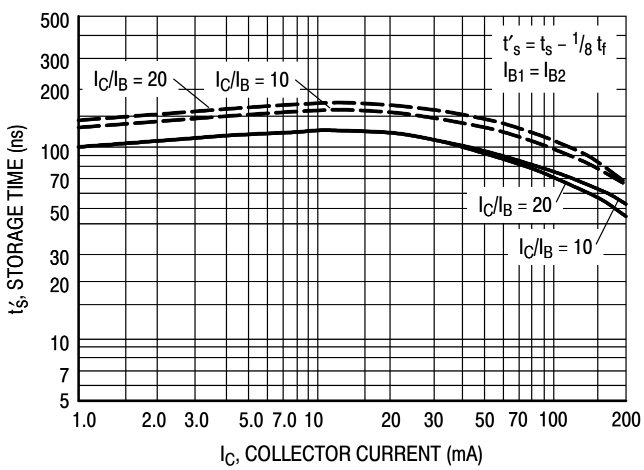


Figure 7. Storage Time

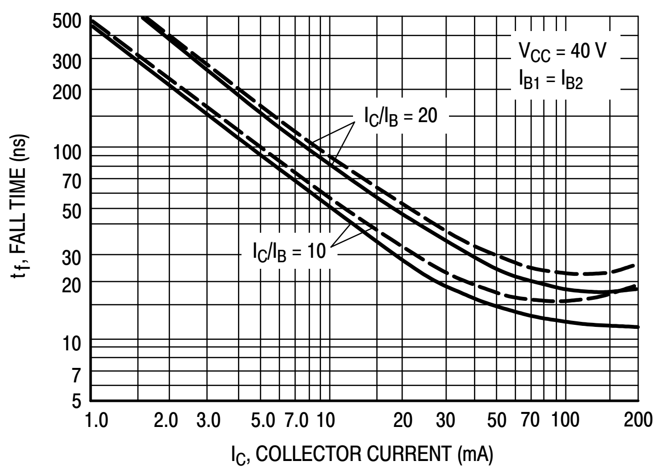


Figure 8. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = 5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

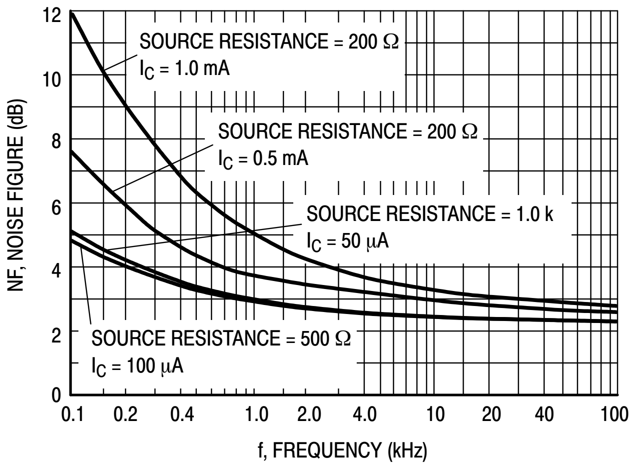


Figure 9. Noise Figure

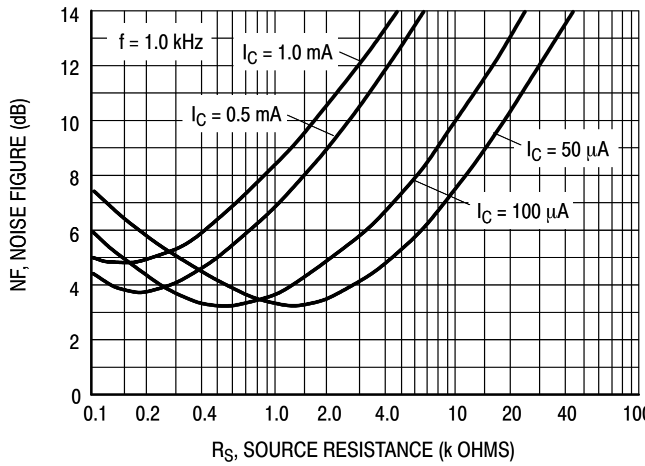


Figure 10. Noise Figure

h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

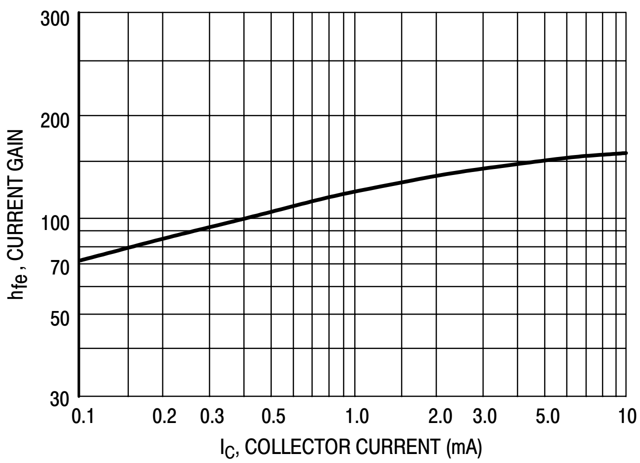


Figure 11. Current Gain

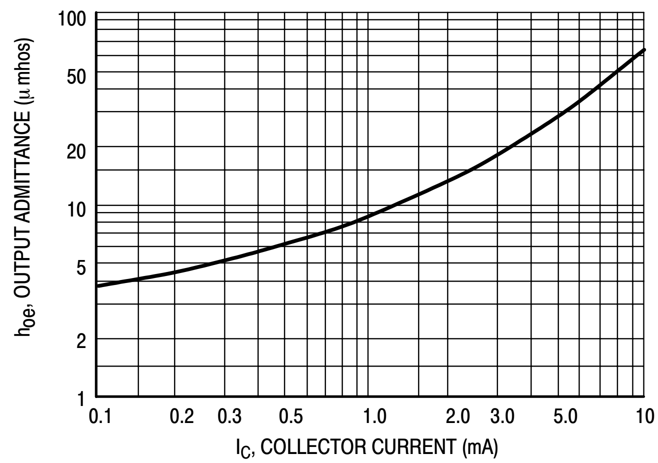


Figure 12. Output Admittance

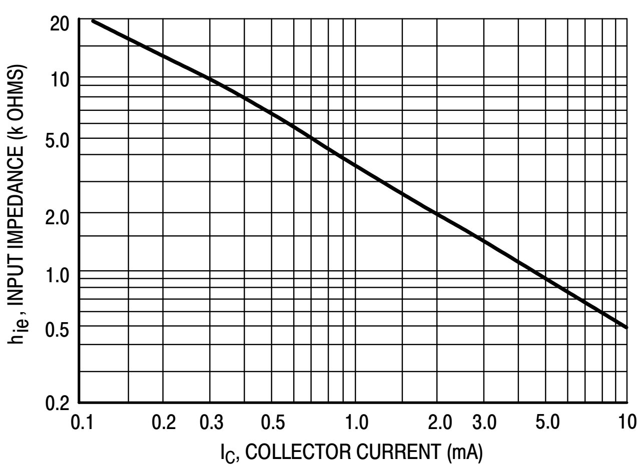


Figure 13. Input Impedance

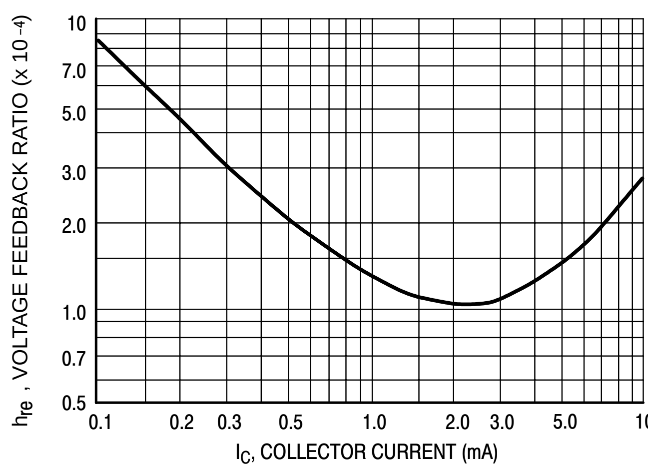


Figure 14. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

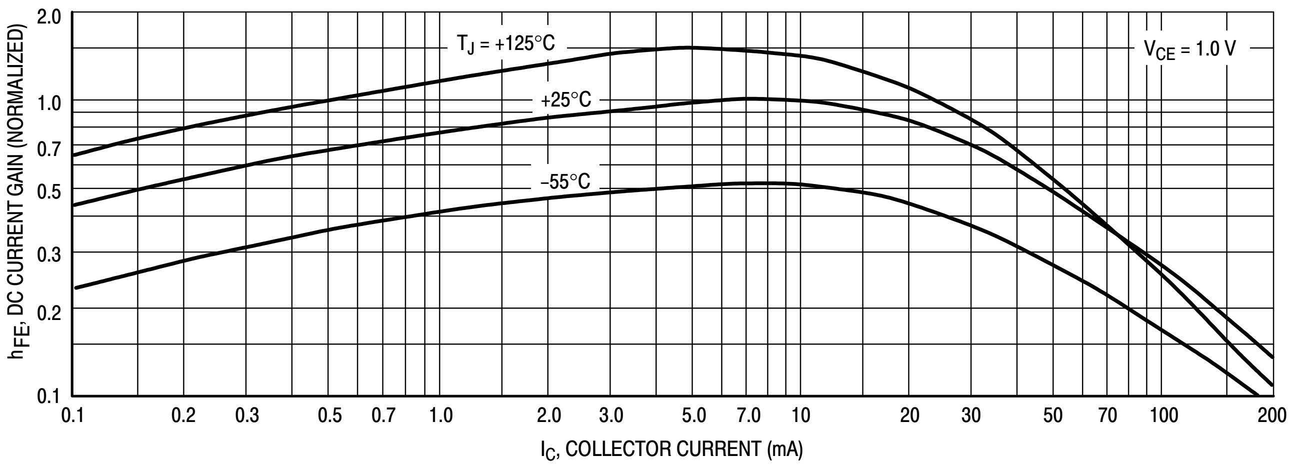


Figure 15. DC Current Gain

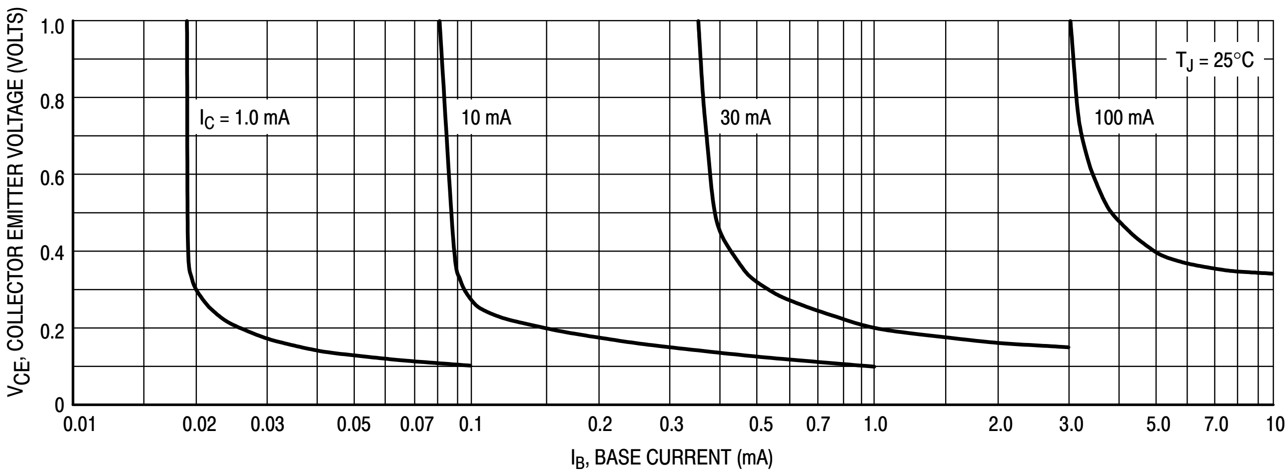


Figure 16. Collector Saturation Region

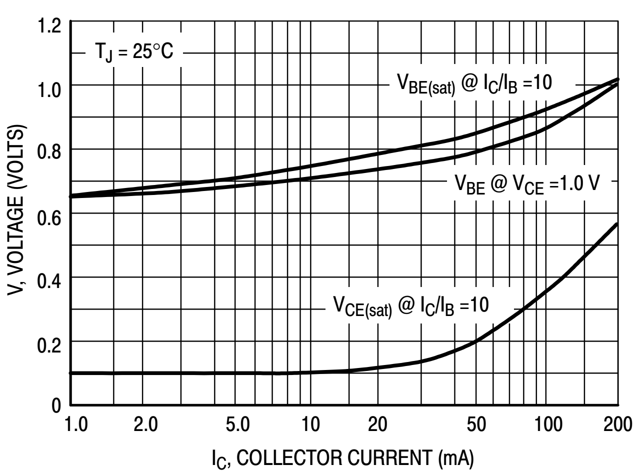


Figure 17. “ON” Voltages

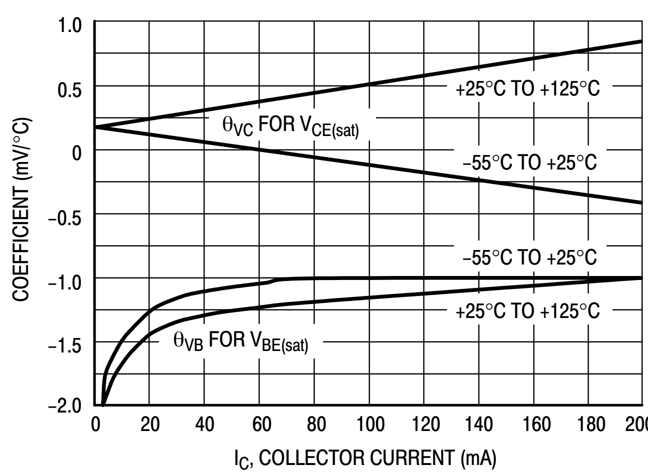


Figure 18. Temperature Coefficients

MBT3906DW1T1

Dual General Purpose Transistor

The MBT3906DW1T1 device is a spin–off of our popular SOT–23/SOT–323 three–leaded device. It is designed for general purpose amplifier applications and is housed in the SOT–363 six–leaded surface mount package. By putting two discrete devices in one package, this device is ideal for low–power surface mount applications where board space is at a premium.

- h_{FE}, 100–300
- Low $V_{CE(sat)}$, ≤ 0.4 V
- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Available in 8 mm, 7–inch/3,000 Unit Tape and Reel
- Device Marking: MBT3906DW1T1 = A2

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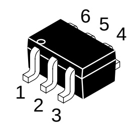
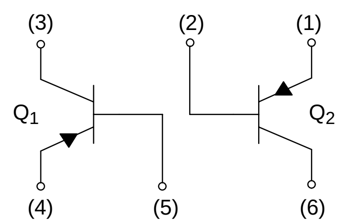


SOT–363/SC–88
CASE 419B
STYLE 1



MBT3906DW1T1

ORDERING INFORMATION

Device	Package	Shipping
MBT3906DW1T1	SOT–363	3000 Units/Reel

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–40	Vdc
Collector–Base Voltage	V_{CBO}	–40	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Continuous	I_C	–200	mAdc
Electrostatic Discharge	ESD	HBM>16000, MM>2000	V

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Package Dissipation(1) T_A = 25°C	P_D	150	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	833	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. Device mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.

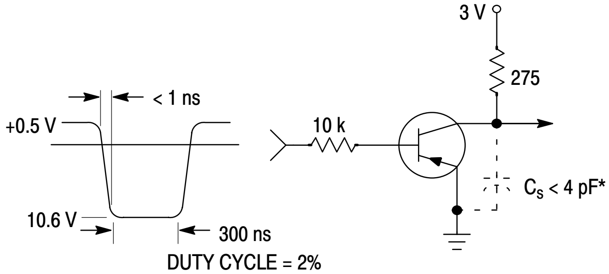
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

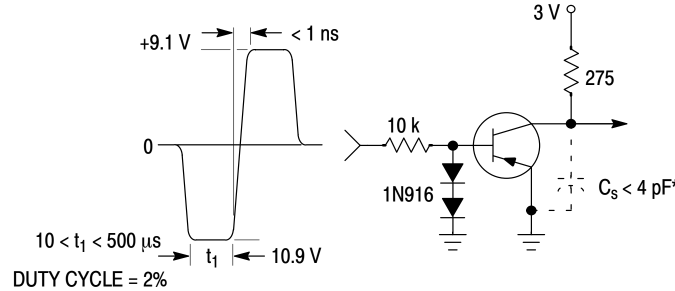
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(2)	$V_{(BR)CEO}$	–40	–	Vdc
Collector–Base Breakdown Voltage	$V_{(BR)CBO}$	–40	–	Vdc
Emitter–Base Breakdown Voltage	$V_{(BR)EBO}$	–5.0	–	Vdc
Base Cutoff Current	I_{BL}	–	–50	nAdc
Collector Cutoff Current	I_{CEX}	–	–50	nAdc
ON CHARACTERISTICS (2)				
DC Current Gain (I_C = –0.1 mAdc, V_{CE} = –1.0 Vdc) (I_C = –1.0 mAdc, V_{CE} = –1.0 Vdc) (I_C = –10 mAdc, V_{CE} = –1.0 Vdc) (I_C = –50 mAdc, V_{CE} = –1.0 Vdc) (I_C = –100 mAdc, V_{CE} = –1.0 Vdc)	h_{FE}	 60 80 100 60 30	 – – 300 – –	–
Collector–Emitter Saturation Voltage (I_C = –10 mAdc, I_B = –1.0 mAdc) (I_C = –50 mAdc, I_B = –5.0 mAdc)	$V_{CE(sat)}$	 – –	 –0.25 –0.4	Vdc
Base–Emitter Saturation Voltage (I_C = –10 mAdc, I_B = –1.0 mAdc) (I_C = –50 mAdc, I_B = –5.0 mAdc)	$V_{BE(sat)}$	 –0.65 –	 –0.85 –0.95	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain – Bandwidth Product	f_T	250	–	MHz
Output Capacitance	C_{obo}	–	4.5	pF
Input Capacitance	C_{ibo}	–	10.0	pF

2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤2.0%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
Input Impedance (V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)		h_{ie}	2.0	12	k Ω
Voltage Feedback Ratio (V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)		h_{re}	0.1	10	X 10^{-4}
Small–Signal Current Gain (V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)		h_{fe}	100	400	–
Output Admittance (V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)		h_{oe}	3.0	60	μmhos
Noise Figure (V_{CE} = –5.0 Vdc, I_C = –100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)		NF	–	4.0	dB
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = –3.0 Vdc, V_{BE} = 0.5 Vdc)	t_d	–	35	ns
Rise Time	(I_C = –10 mAdc, I_{B1} = –1.0 mAdc)	t_r	–	35	
Storage Time	(V_{CC} = –3.0 Vdc, I_C = –10 mAdc)	t_s	–	225	ns
Fall Time	(I_{B1} = I_{B2} = –1.0 mAdc)	t_f	–	75	



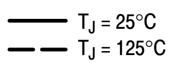


* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit

Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS



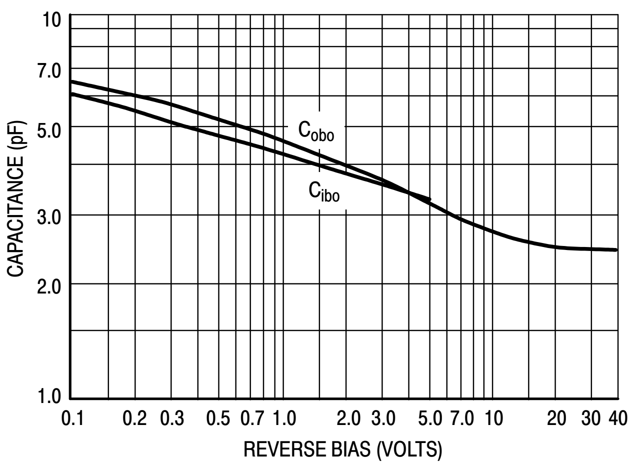


Figure 3. Capacitance

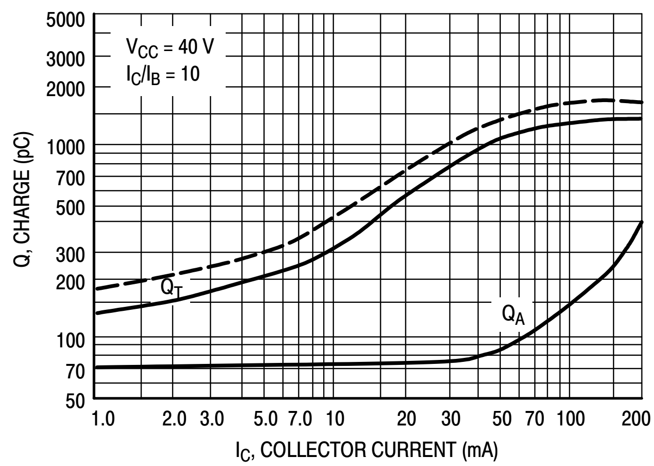


Figure 4. Charge Data

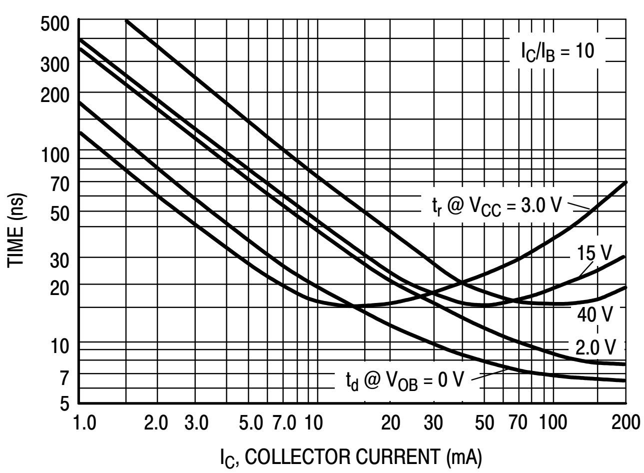


Figure 5. Turn−On Time

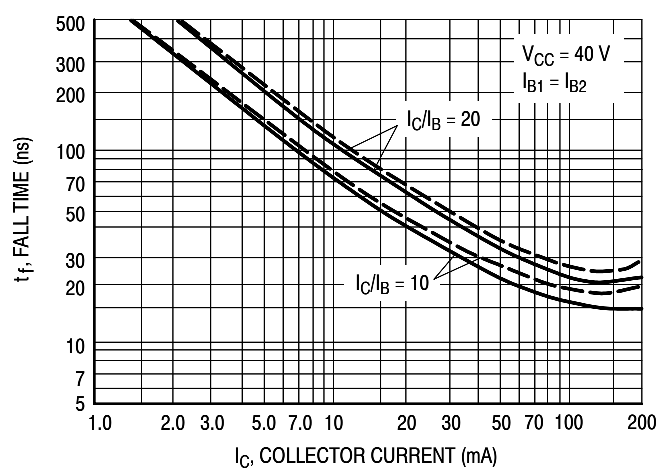


Figure 6. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = –5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

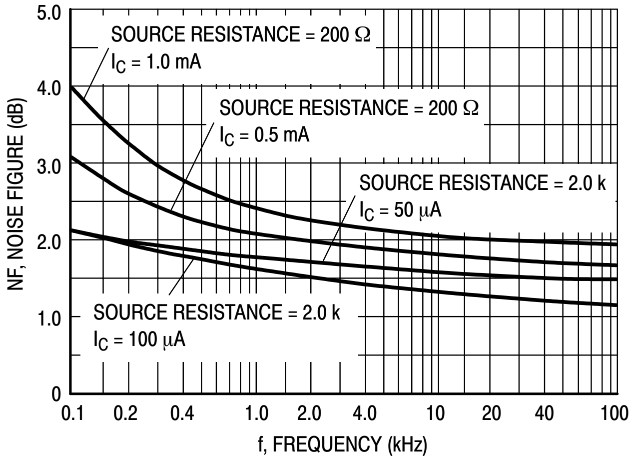


Figure 7.

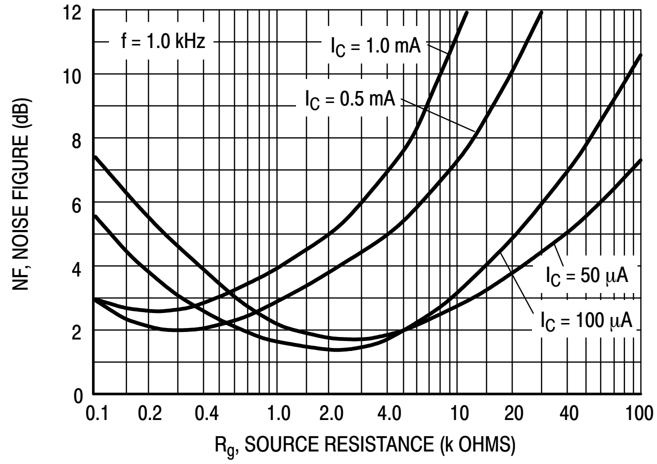


Figure 8.

h PARAMETERS

(V_{CE} = –10 Vdc, f = 1.0 kHz, T_A = 25°C)

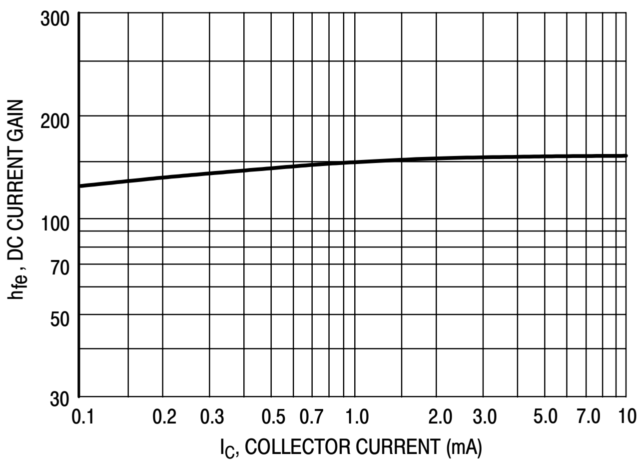


Figure 9. Current Gain

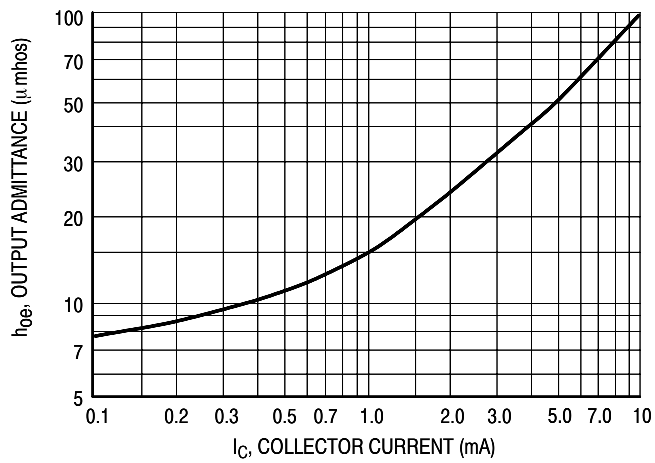


Figure 10. Output Admittance

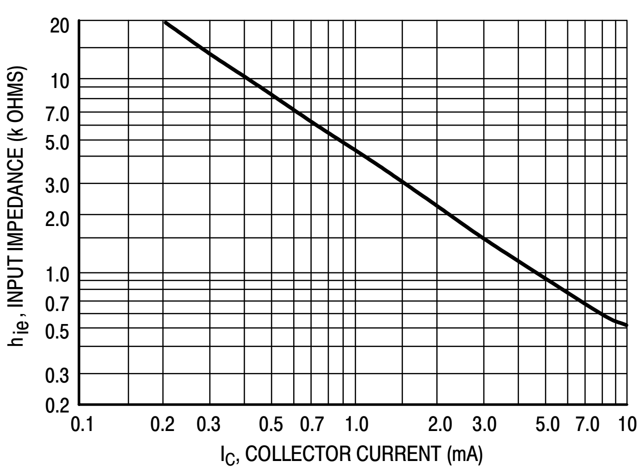


Figure 11. Input Impedance

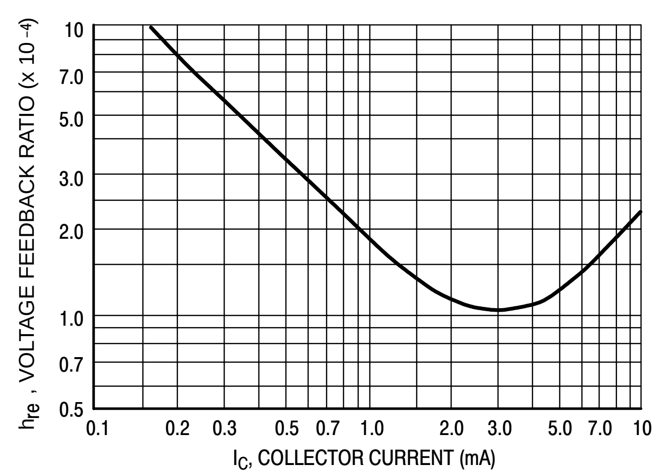


Figure 12. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

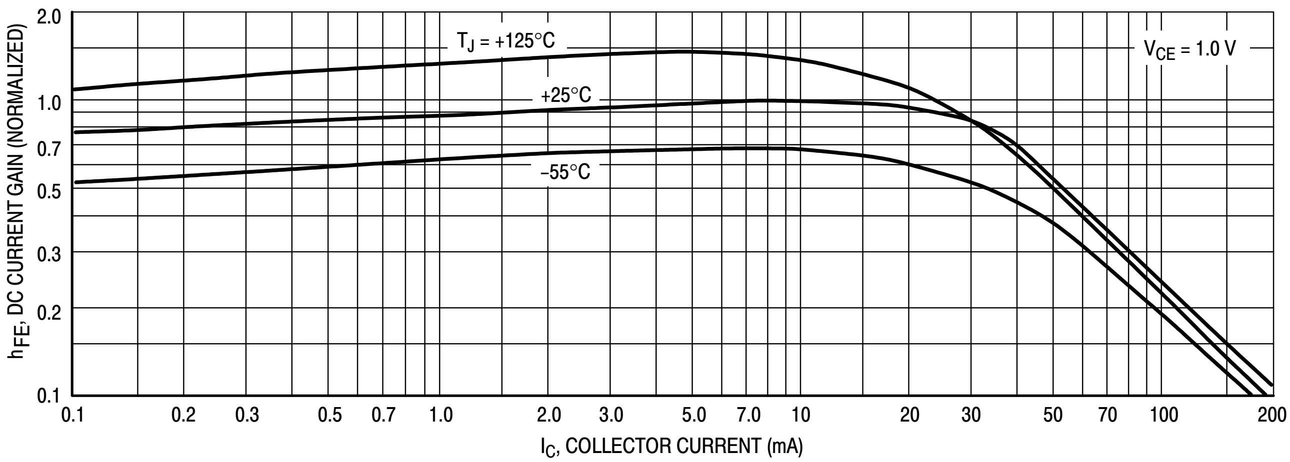


Figure 13. DC Current Gain

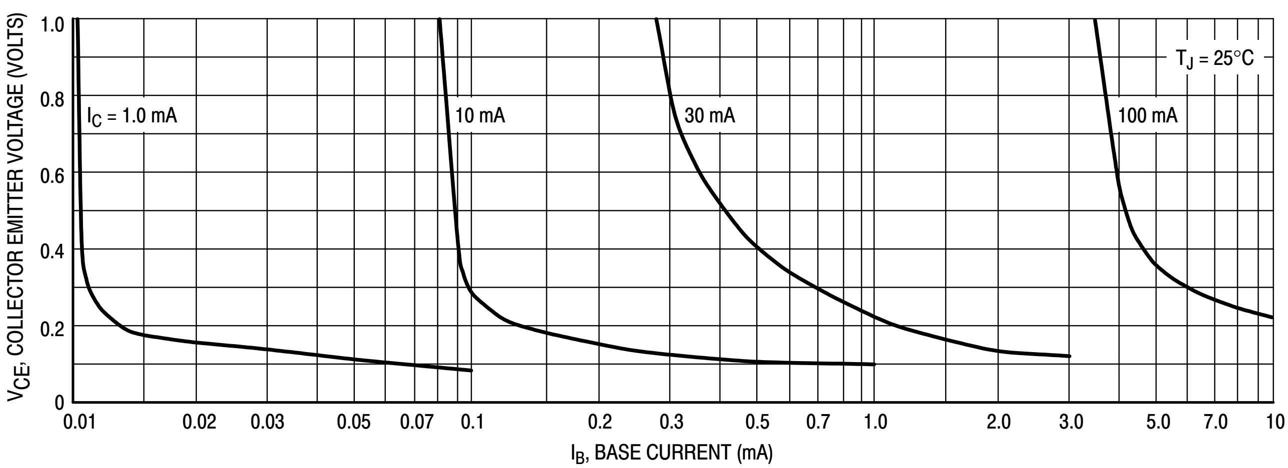


Figure 14. Collector Saturation Region

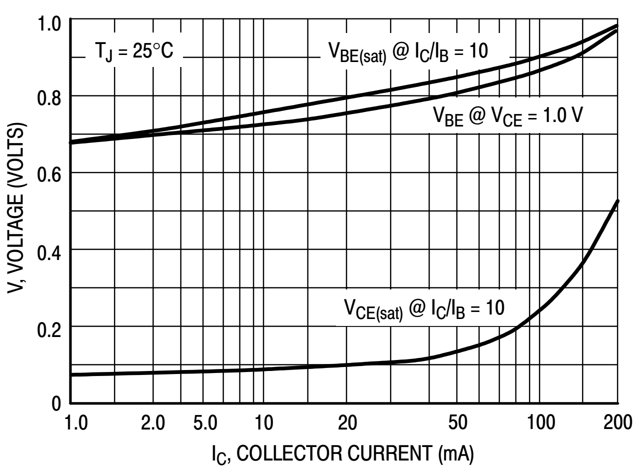


Figure 15. "ON" Voltages

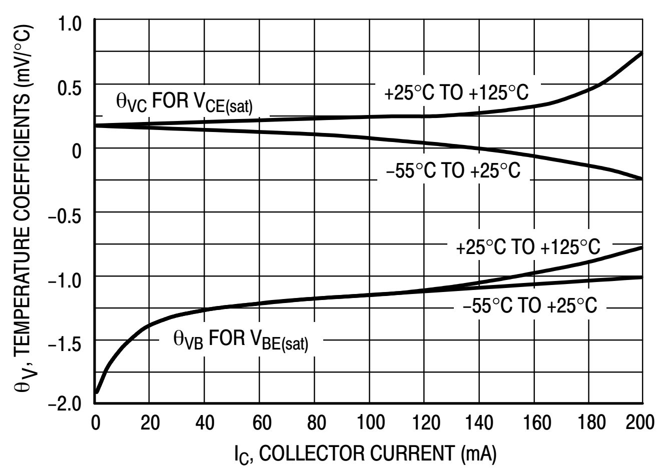


Figure 16. Temperature Coefficients

MBT3946DW1T1

Dual General Purpose Transistor

The MBT3946DW1T1 device is a spin–off of our popular SOT–23/SOT–323 three–leaded device. It is designed for general purpose amplifier applications and is housed in the SOT–363 six–leaded surface mount package. By putting two discrete devices in one package, this device is ideal for low–power surface mount applications where board space is at a premium.

- h_{FE}, 100–300
- Low $V_{CE(sat)}$, ≤ 0.4 V
- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Available in 8 mm, 7–inch/3,000 Unit Tape and Reel
- Device Marking: MBT3946DW1T1 = 46

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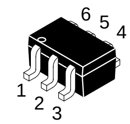
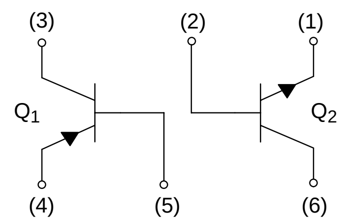


SOT–363/SC–88
CASE 419B
STYLE 1



MBT3946DW1T1*

*Q1 NPN
Q2 PNP

ORDERING INFORMATION

Device	Package	Shipping
MBT3946DW1T1	SOT–363	3000 Units/Reel

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage (NPN) (PNP)	V_{CEO}	 40 –40	Vdc
Collector–Base Voltage (NPN) (PNP)	V_{CBO}	 60 –40	Vdc
Emitter–Base Voltage (NPN) (PNP)	V_{EBO}	 6.0 –5.0	Vdc
Collector Current – Continuous (NPN) (PNP)	I_C	 200 –200	mAdc
Electrostatic Discharge	ESD	HBM>16000, MM>2000	V

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Package Dissipation(1) T_A = 25°C	P_D	150	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	833	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. Device mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage[2]		$V_{(BR)CEO}$			Vdc
(I_C = 1.0 mAdc, I_B = 0)	(NPN)		40	–	
(I_C = –1.0 mAdc, I_B = 0)	(PNP)		–40	–	
Collector–Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 10 μAdc, I_E = 0)	(NPN)		60	–	
(I_C = –10 μAdc, I_E = 0)	(PNP)		–40	–	
Emitter–Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_E = 10 μAdc, I_C = 0)	(NPN)		6.0	–	
(I_E = –10 μAdc, I_C = 0)	(PNP)		–5.0	–	
Base Cutoff Current		I_{BL}			nAdc
(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	(NPN)		–	50	
(V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	(PNP)		–	–50	
Collector Cutoff Current		I_{CEX}			nAdc
(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	(NPN)		–	50	
(V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	(PNP)		–	–50	
ON CHARACTERISTICS (2)					
DC Current Gain		h_{FE}			–
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	(NPN)		40	–	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)			70	–	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)			30	–	
(I_C = –0.1 mAdc, V_{CE} = –1.0 Vdc)	(PNP)		60	–	
(I_C = –1.0 mAdc, V_{CE} = –1.0 Vdc)			80	–	
(I_C = –10 mAdc, V_{CE} = –1.0 Vdc)			100	300	
(I_C = –50 mAdc, V_{CE} = –1.0 Vdc)			60	–	
(I_C = –100 mAdc, V_{CE} = –1.0 Vdc)			30	–	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	(NPN)		–	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	0.3	
(I_C = –10 mAdc, I_B = –1.0 mAdc)	(PNP)		–	–0.25	
(I_C = –50 mAdc, I_B = –5.0 mAdc)			–	–0.4	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	(NPN)		0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	0.95	
(I_C = –10 mAdc, I_B = –1.0 mAdc)	(PNP)		–0.65	–0.85	
(I_C = –50 mAdc, I_B = –5.0 mAdc)			–	–0.95	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product		f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	(NPN)		300	–	
(I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)	(PNP)		250	–	
Output Capacitance		C_{obo}			pF
(V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	(NPN)		–	4.0	
(V_{CB} = –5.0 Vdc, I_E = 0, f = 1.0 MHz)	(PNP)		–	4.5	
Input Capacitance		C_{ibo}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	(NPN)		–	8.0	
(V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)	(PNP)		–	10.0	

2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤2.0%.

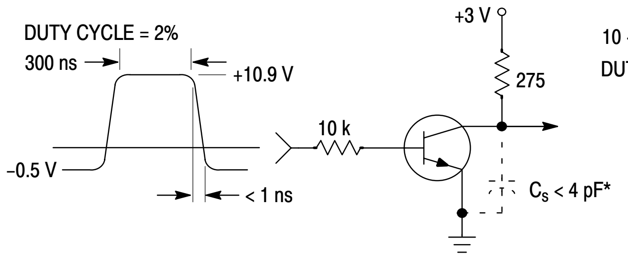
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

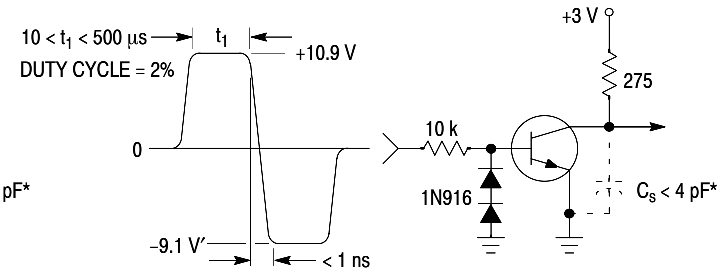
Characteristic		Symbol	Min	Max	Unit
Input Impedance		h_{ie}			k Ω
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	(NPN)		1.0	10	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	(PNP)		2.0	12	
Voltage Feedback Ratio		h_{re}			X 10^{-4}
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	(NPN)		0.5	8.0	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	(PNP)		0.1	10	
Small–Signal Current Gain		h_{fe}			–
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	(NPN)		100	400	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	(PNP)		100	400	
Output Admittance		h_{oe}			μmhos
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	(NPN)		1.0	40	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	(PNP)		3.0	60	
Noise Figure		NF			dB
(V_{CE} = 5.0 Vdc, I_C = 100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)	(NPN)		–	5.0	
(V_{CE} = –5.0 Vdc, I_C = –100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)	(PNP)		–	4.0	

SWITCHING CHARACTERISTICS

			Symbol	Min	Max	Unit
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = –0.5 Vdc)	(NPN)	t_d	–	35	ns
	(V_{CC} = –3.0 Vdc, V_{BE} = 0.5 Vdc)	(PNP)		–	35	
Rise Time	(I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	(NPN)	t_r	–	35	
	(I_C = –10 mAdc, I_{B1} = –1.0 mAdc)	(PNP)		–	35	
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc)	(NPN)	t_s	–	200	ns
	(V_{CC} = –3.0 Vdc, I_C = –10 mAdc)	(PNP)		–	225	
Fall Time	(I_{B1} = I_{B2} = 1.0 mAdc)	(NPN)	t_f	–	50	
	(I_{B1} = I_{B2} = –1.0 mAdc)	(PNP)		–	75	

(NPN)





* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit

Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

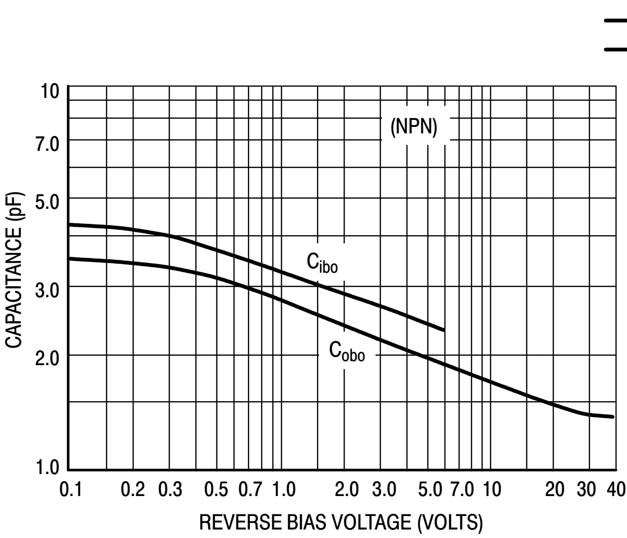


Figure 3. Capacitance

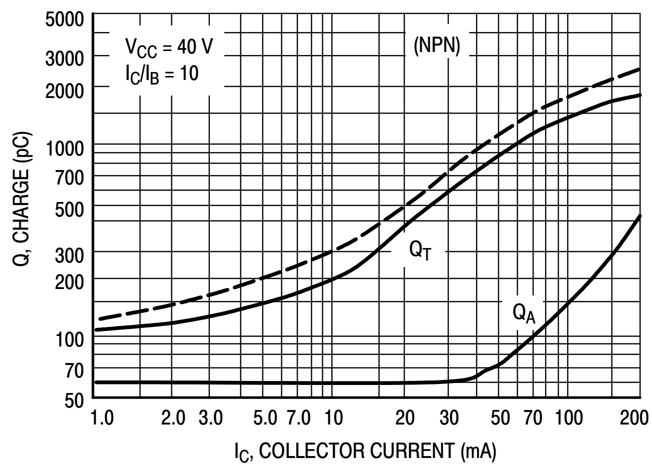


Figure 4. Charge Data

(NPN)

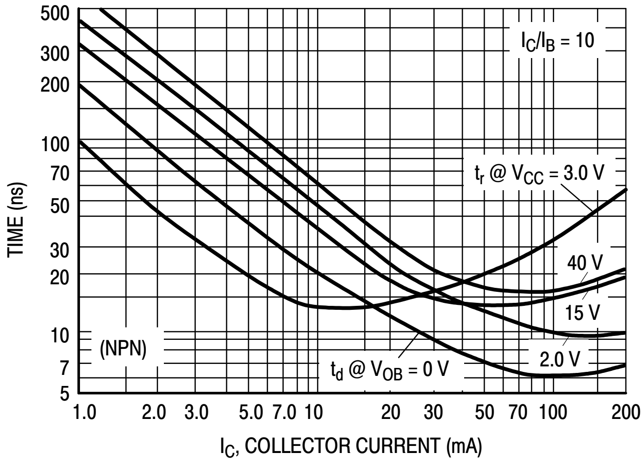


Figure 5. Turn–On Time

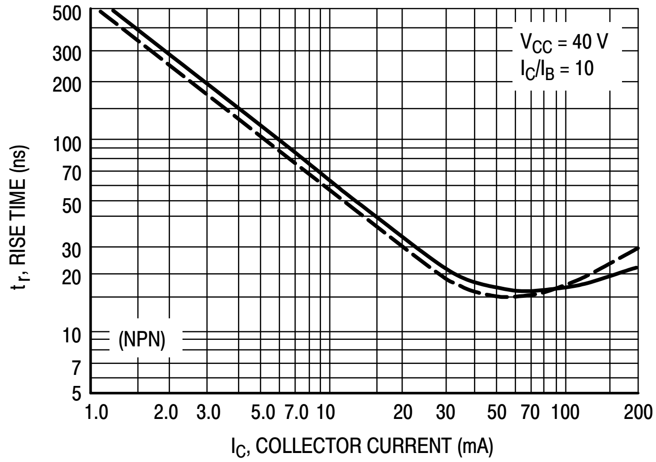


Figure 6. Rise Time

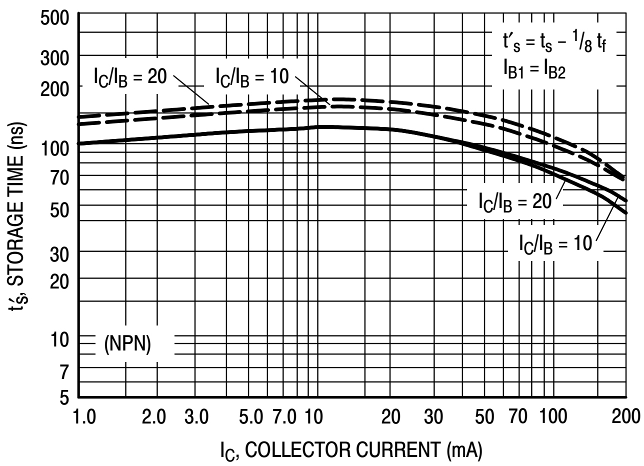


Figure 7. Storage Time

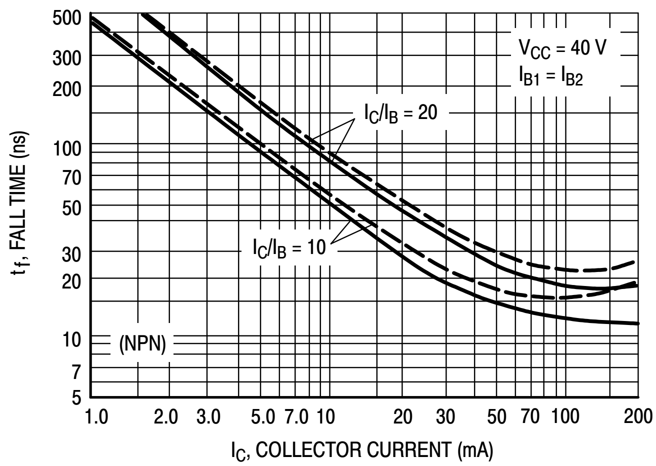


Figure 8. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = 5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

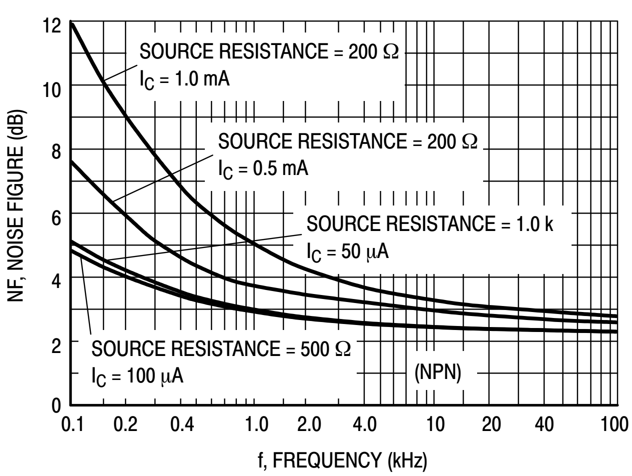


Figure 9. Noise Figure

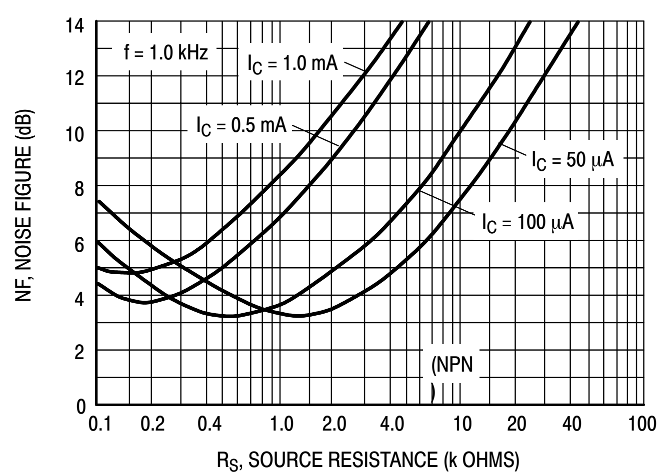


Figure 10. Noise Figure

(NPN)

h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

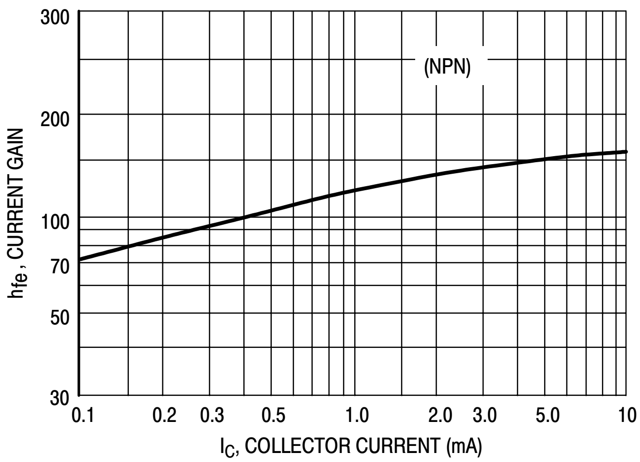


Figure 11. Current Gain

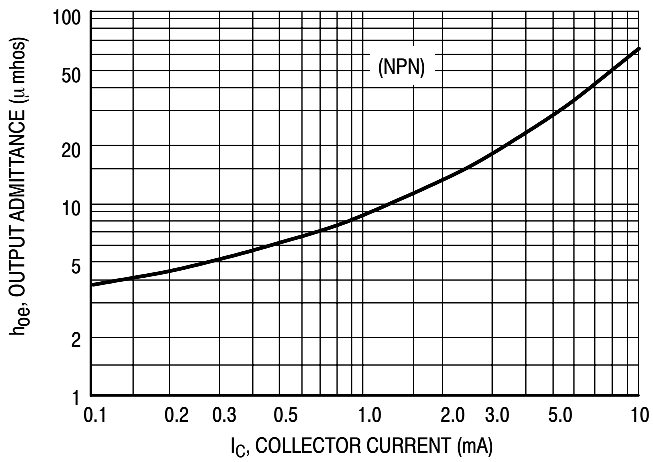


Figure 12. Output Admittance

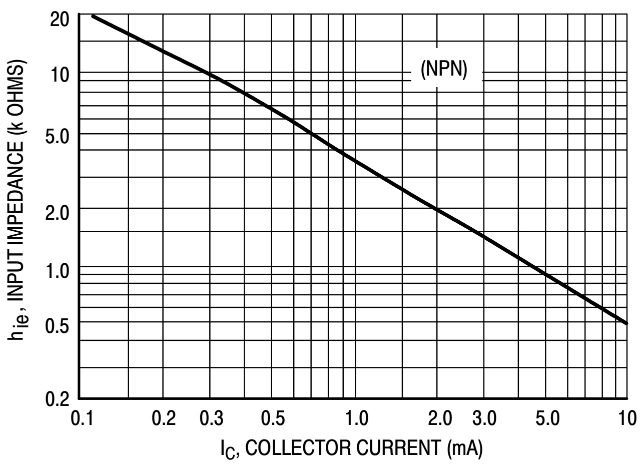


Figure 13. Input Impedance

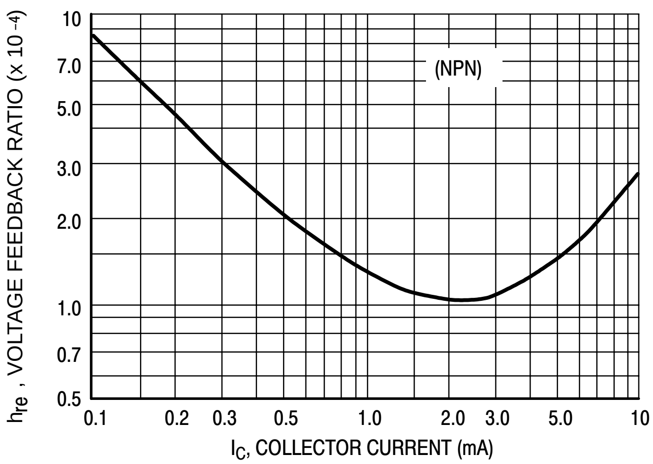


Figure 14. Voltage Feedback Ratio

(NPN)

TYPICAL STATIC CHARACTERISTICS

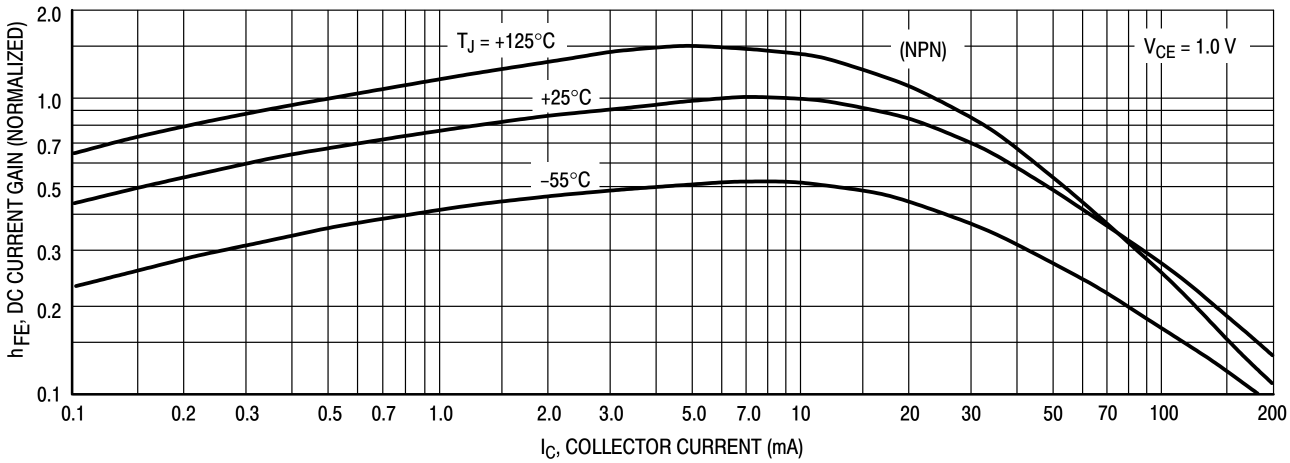


Figure 15. DC Current Gain

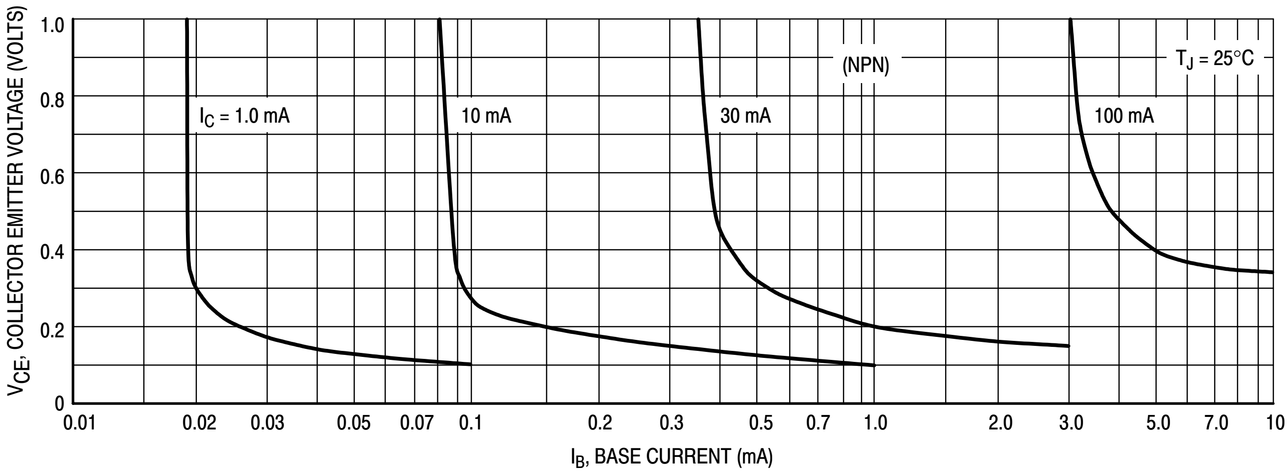


Figure 16. Collector Saturation Region

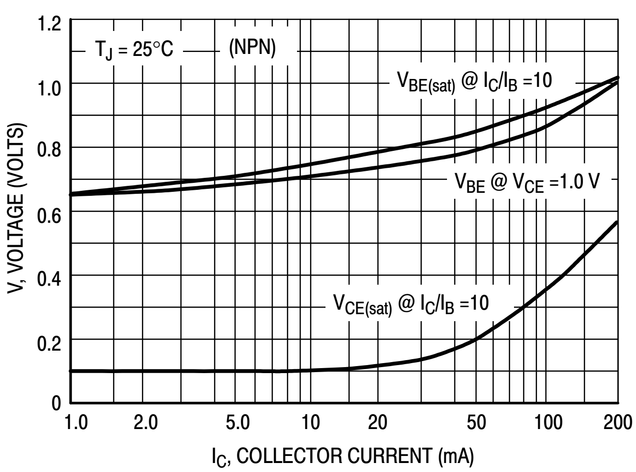


Figure 17. “ON” Voltages

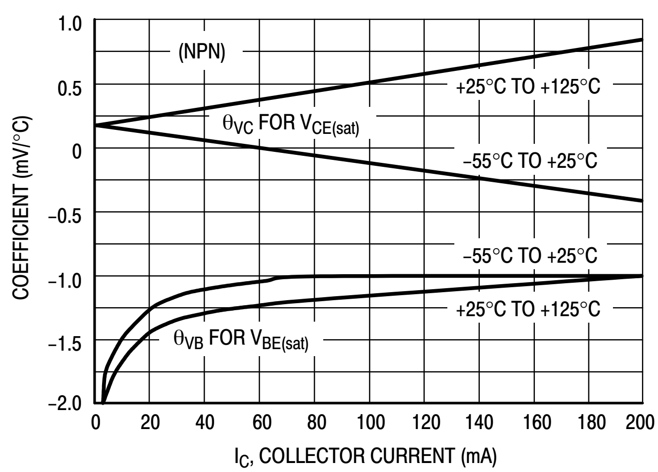
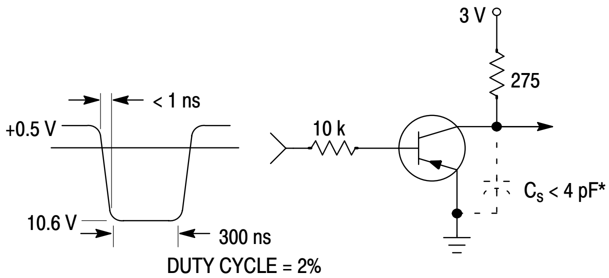
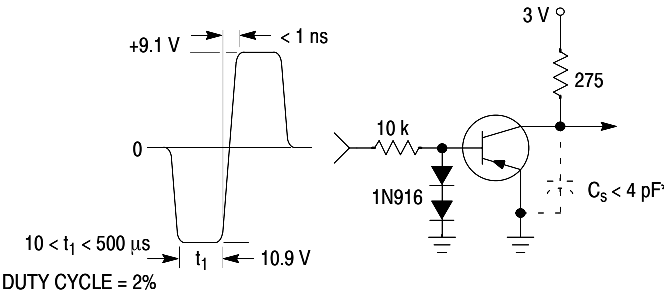


Figure 18. Temperature Coefficients

(PNP)





* Total shunt capacitance of test jig and connectors

Figure 19. Delay and Rise Time Equivalent Test Circuit

Figure 20. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

—— T_J = 25°C
– – T_J = 125°C

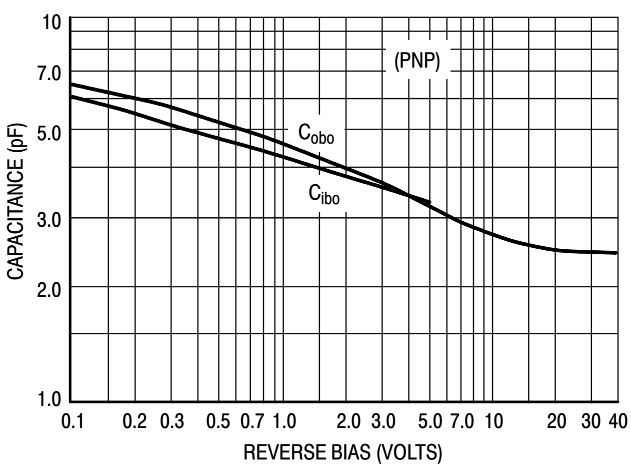


Figure 21. Capacitance

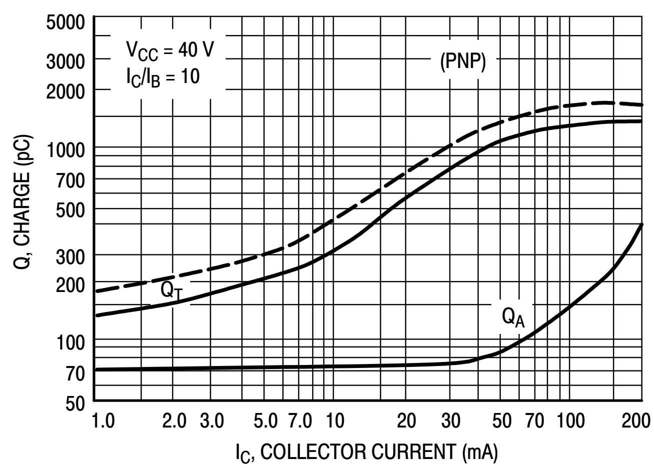


Figure 22. Charge Data

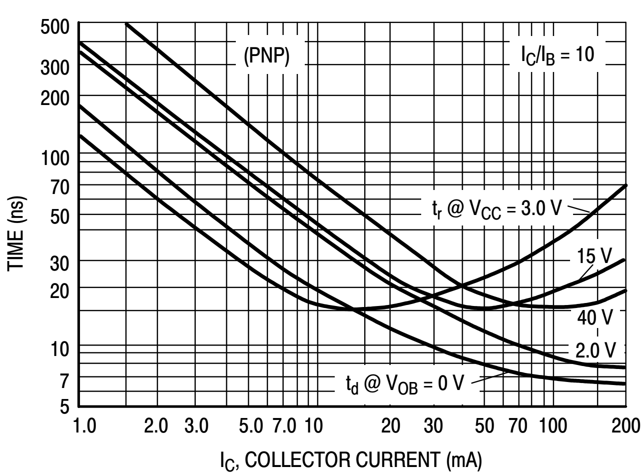


Figure 23. Turn−On Time

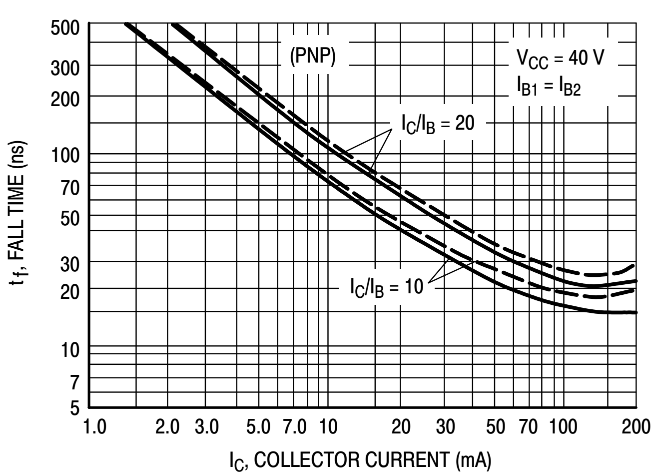


Figure 24. Fall Time

(PNP)

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = –5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

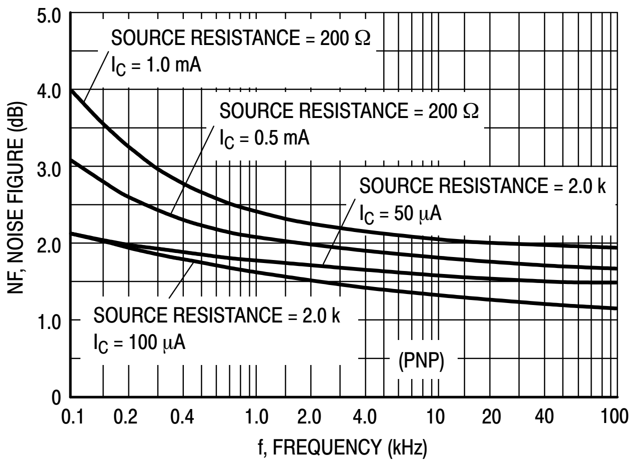


Figure 25.

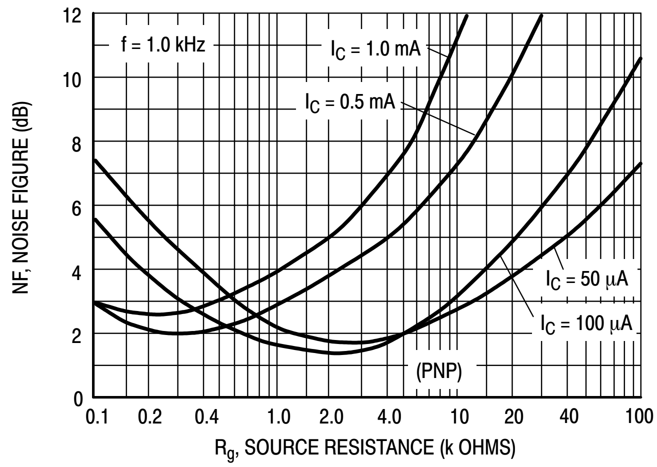


Figure 26.

h PARAMETERS

(V_{CE} = –10 Vdc, f = 1.0 kHz, T_A = 25°C)

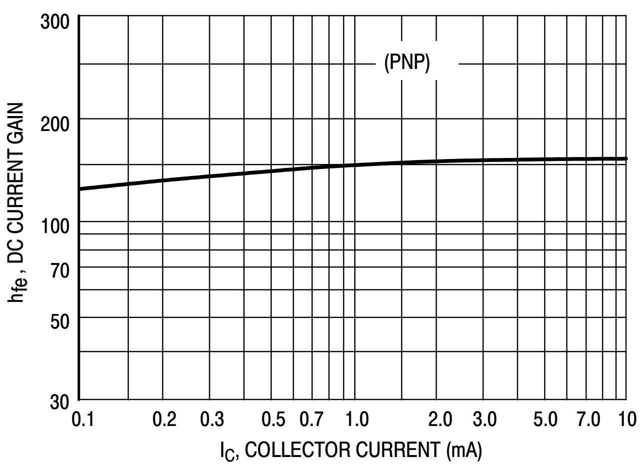


Figure 27. Current Gain

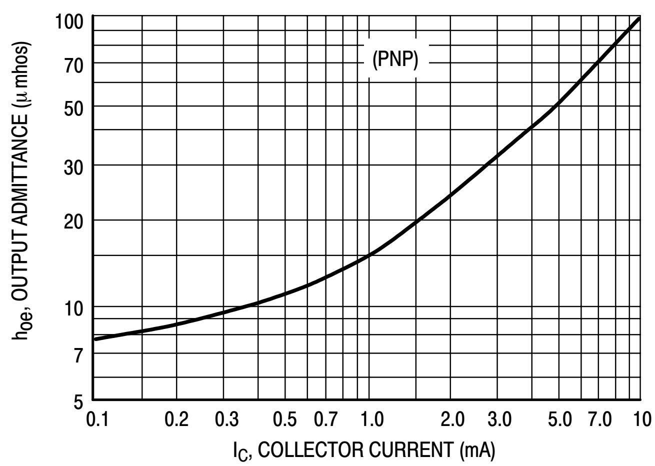


Figure 28. Output Admittance

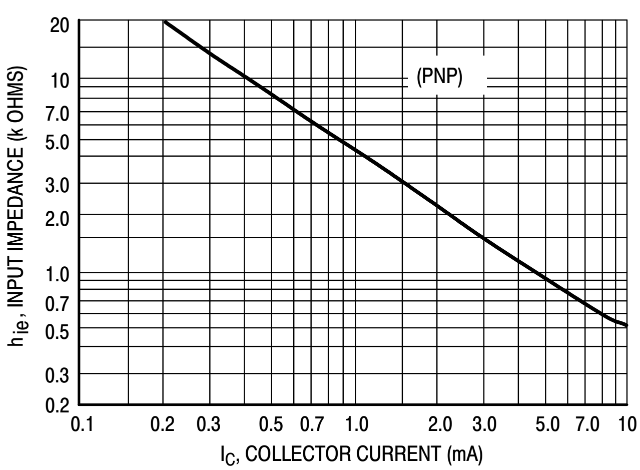


Figure 29. Input Impedance

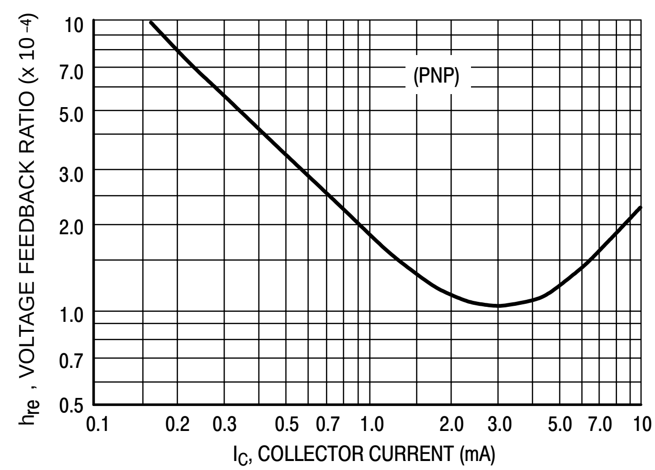


Figure 30. Voltage Feedback Ratio

(PNP)

TYPICAL STATIC CHARACTERISTICS

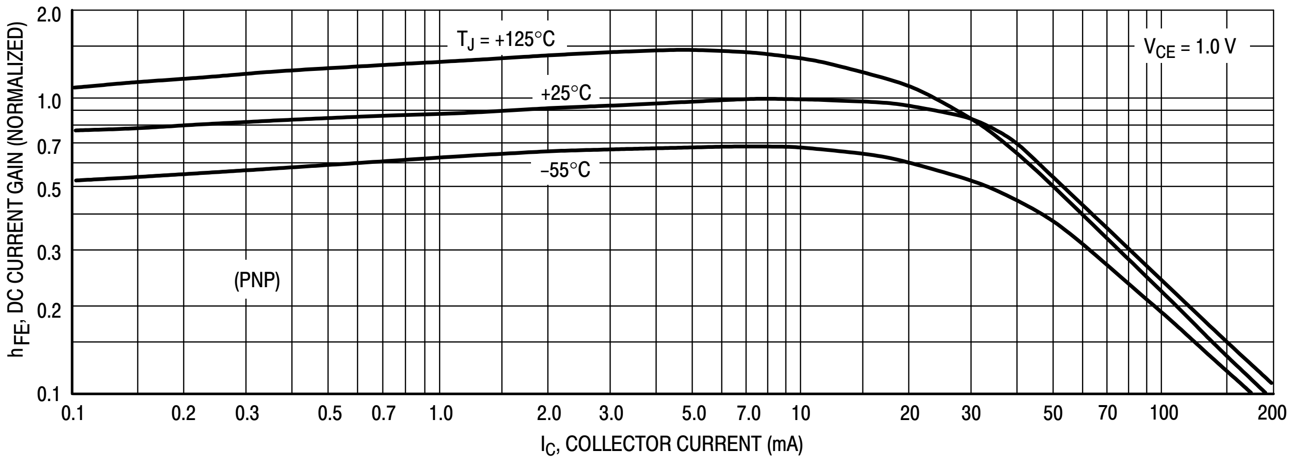


Figure 31. DC Current Gain

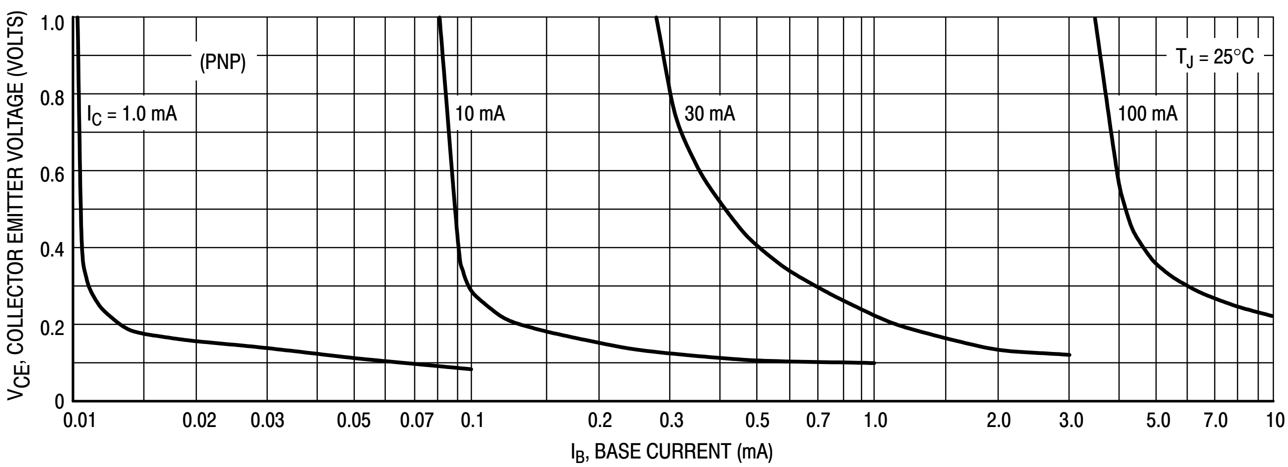


Figure 32. Collector Saturation Region

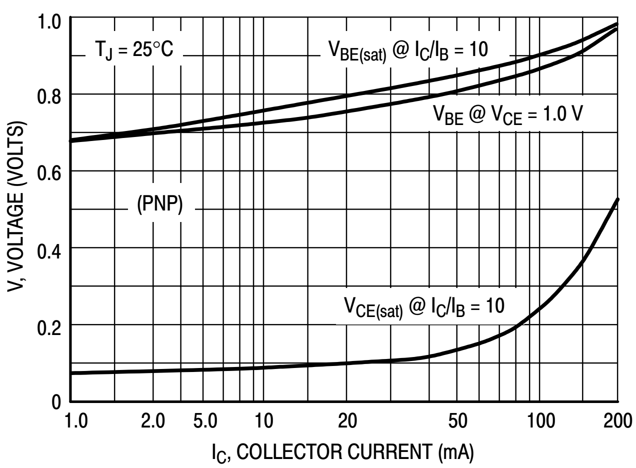


Figure 33. “ON” Voltages

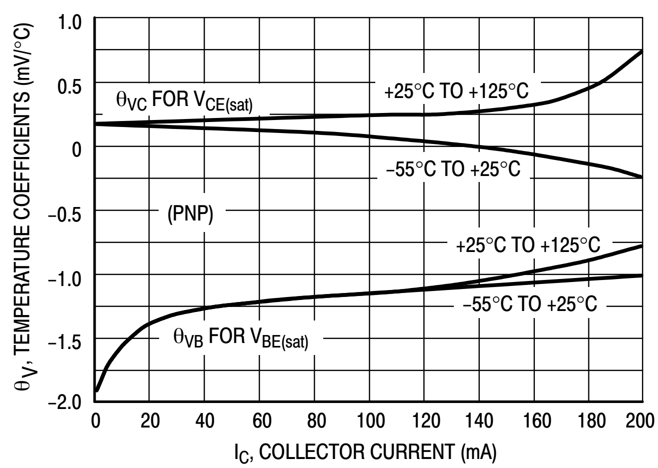
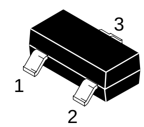


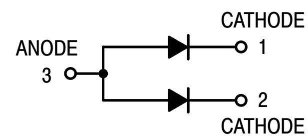
Figure 34. Temperature Coefficients

Monolithic Dual Switching Diodes

MMBD2835LT1
MMBD2836LT1



CASE 318–08, STYLE 12
SOT–23 (TO–236AB)



MAXIMUM RATINGS (EACH DIODE)

Rating		Symbol	Value	Unit
Reverse Voltage	MMBD2835LT1 MMBD2836LT1	V_R	35 75	Vdc
Forward Current		I_F	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

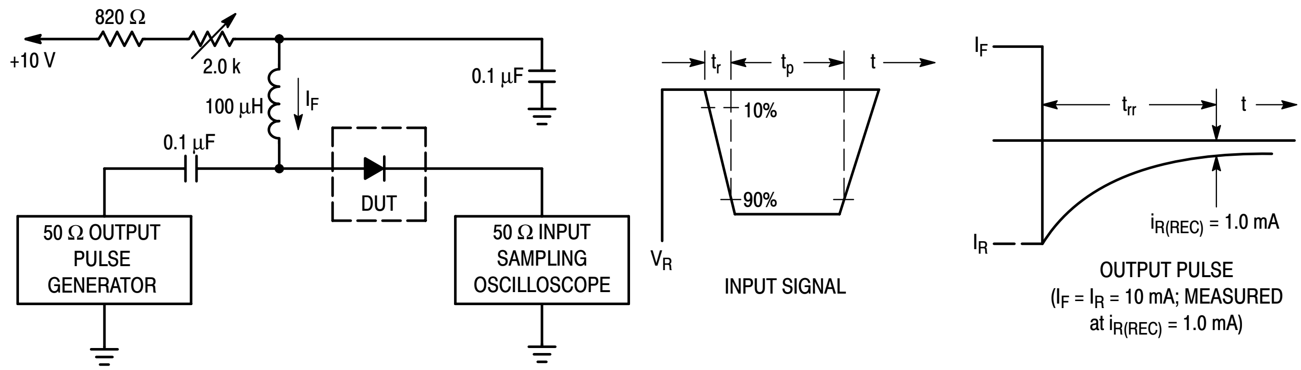
DEVICE MARKING

MMBD2835LT1 = A3X; MMBD2836LT1 = A2X

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (EACH DIODE)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Reverse Breakdown Voltage (I_R = 100 µAdc)	MMBD2835LT1 MMBD2836LT1	$V_{(BR)}$	35 75	— —	Vdc
Reverse Voltage Leakage Current (Note 3) (V_R = 30 Vdc) (V_R = 50 Vdc)	 MMBD2835LT1 MMBD2836LT1	I_R	— —	 100 100	nAdc
Diode Capacitance (V_R = 0 V, f = 1.0 MHz)		C_T	—	4.0	pF
Forward Voltage (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 100 mAdc)		V_F	— — —	1.0 1.0 1.2	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)		t_{rr}	—	4.0	ns

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. For each individual diode while the second diode is unbiased.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

CURVES APPLICABLE TO EACH CATHODE

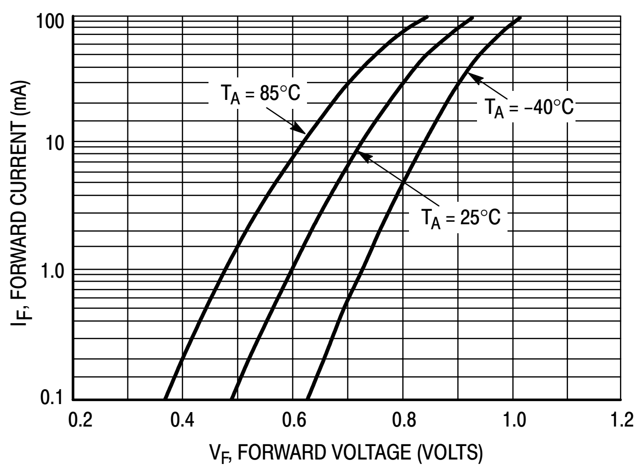


Figure 2. Forward Voltage

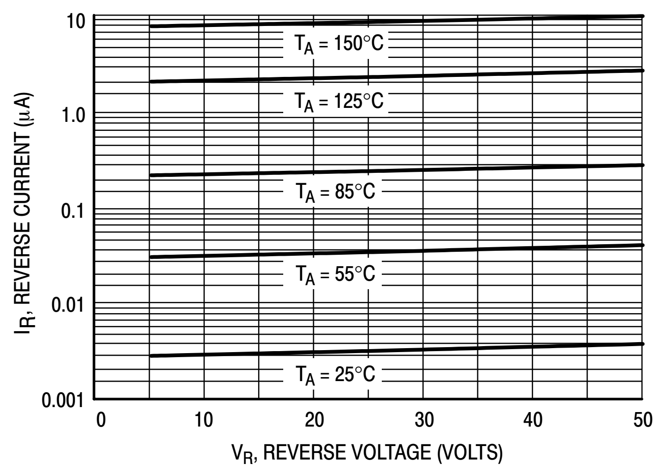


Figure 3. Leakage Current

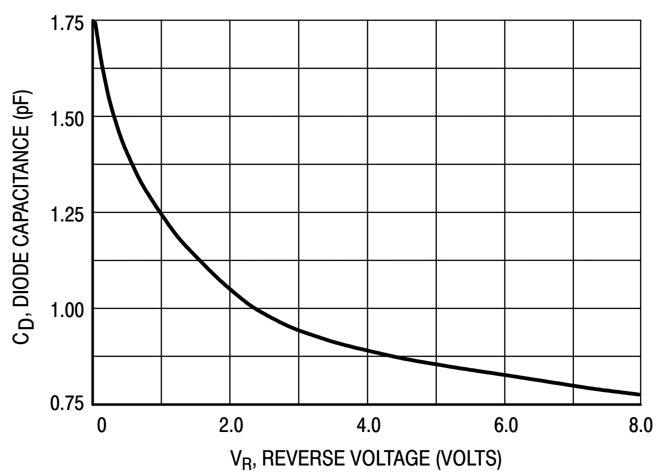
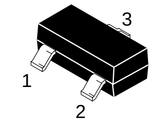


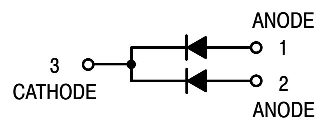
Figure 4. Capacitance

Monolithic Dual Switching Diodes

MMBD2837LT1
MMBD2838LT1



CASE 318–08, STYLE 9
SOT–23 (TO–236AB)



MAXIMUM RATINGS (EACH DIODE)

Rating		Symbol	Value	Unit
Peak Reverse Voltage		V_{RM}	75	Vdc
D.C. Reverse Voltage	MMBD2837LT1 MMBD2838LT1	V_R	30 50	Vdc
Peak Forward Current		I_{FM}	450 300	mAdc
Average Rectified Current		I_O	150 100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

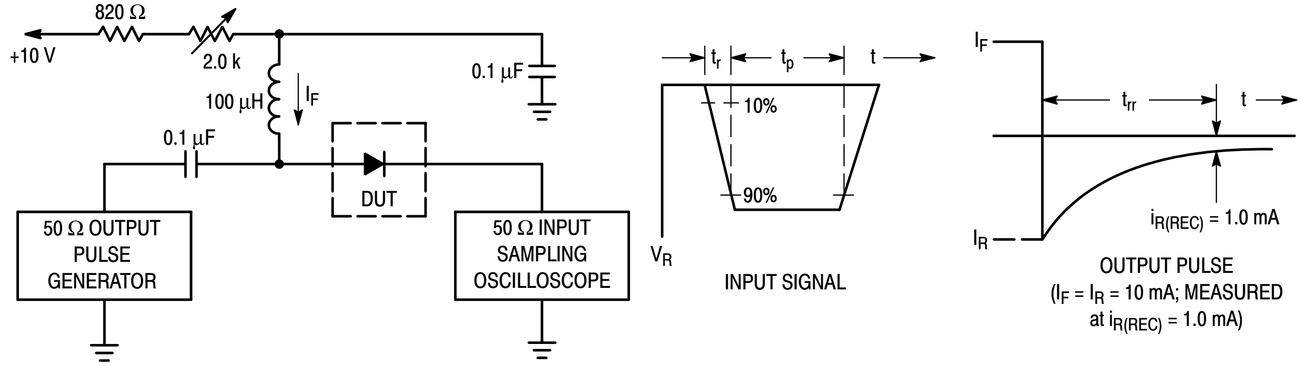
DEVICE MARKING

MMBD2837LT1 = A5; MMBD2838LT1 = MA6

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) **(EACH DIODE)**

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	MMBD2837LT1 MMBD2838LT1	$V_{(BR)}$	35 75	— —	Vdc
Reverse Voltage Leakage Current (Note 3.) (V_R = 30 Vdc) (V_R = 50 Vdc)	 MMBD2837LT1 MMBD2838LT1	I_R	 — —	 0.1 0.1	μAdc
Diode Capacitance (V_R = 0 V, f = 1.0 MHz)		C_T	—	4.0	pF
Forward Voltage (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 100 mAdc)		V_F	— — —	1.0 1.0 1.2	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)		t_{rr}	—	4.0	ns

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. For each individual diode while the second diode is unbiased.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

CURVES APPLICABLE TO EACH CATHODE

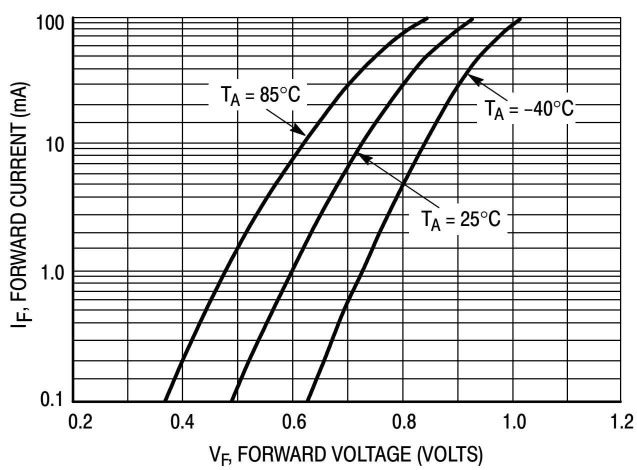


Figure 2. Forward Voltage

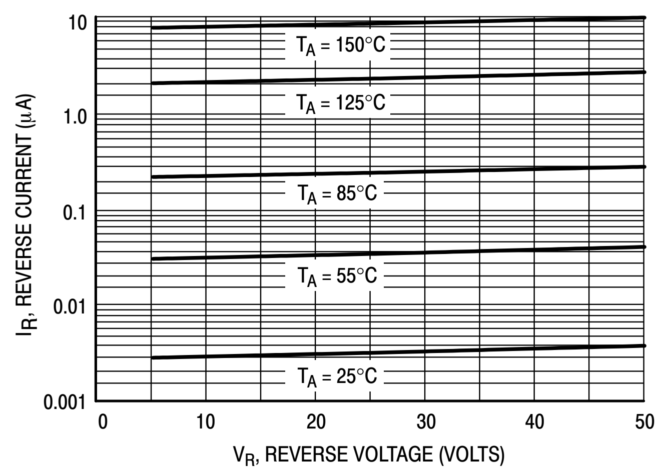


Figure 3. Leakage Current

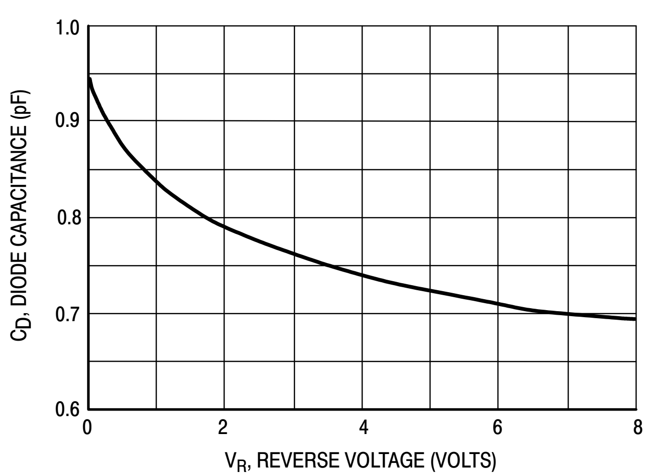


Figure 4. Capacitance

MMBD330T1, MMBD770T1

Schottky Barrier Diodes

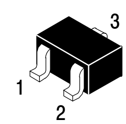
Schottky barrier diodes are designed primarily for high–efficiency UHF and VHF detector applications. Readily available to many other fast switching RF and digital applications. They are housed in the SOT–323/SC–70 package which is designed for low–power surface mount applications.

- Extremely Low Minority Carrier Lifetime
- Very Low Capacitance
- Low Reverse Leakage
- Available in 8 mm Tape and Reel

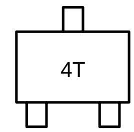
ON Semiconductor™

http://onsemi.com

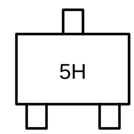
MARKING DIAGRAMS



SC–70/SOT–323
CASE 419



MMBD330T1



MMBD770T1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage MMBD330T1 MMBD770T1	V_R	30 70	Vdc
Forward Power Dissipation T_A = 25°C	P_F	120	mW
Junction Temperature	T_J	–55 to +125	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBD330T1 = 4T
MMBD770T1 = 5H

ORDERING INFORMATION

Device	Package	Shipping
MMBD330T1	SC–70	3000/Tape & Reel
MMBD770T1	SC–70	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 µA)	 MMBD330T1 MMBD770T1	$V_{(BR)R}$	 30 70	 — —	 — —	Volts
Diode Capacitance (V_R = 15 Volts, f = 1.0 MHZ) (V_R = 20 Volts, f = 1.0 MHZ)	 MMBD330T1 MMBD770T1	C_T	 — —	 0.9 0.5	 1.5 1.0	pF
Reverse Leakage (V_R = 25 V) (V_R = 35 V)	 MMBD330T1 MMBD770T1	I_R	 — —	 13 9.0	 200 200	nAdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mA) (I_F = 1.0 mAdc) (I_F = 10 mA)	 MMBD330T1 MMBD770T1 	V_F	 — — — —	 0.38 0.52 0.42 0.70	 0.45 0.60 0.50 1.0	Vdc

TYPICAL CHARACTERISTICS
MMBD330T1

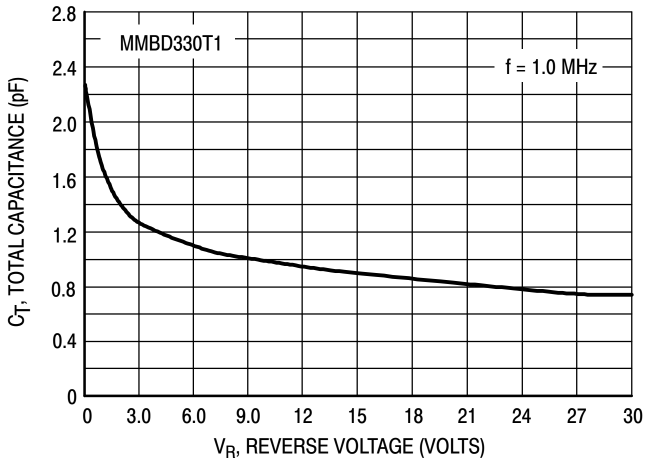


Figure 1. Total Capacitance

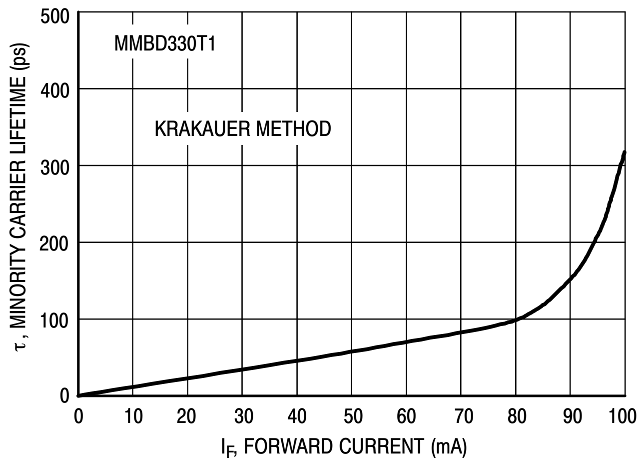


Figure 2. Minority Carrier Lifetime

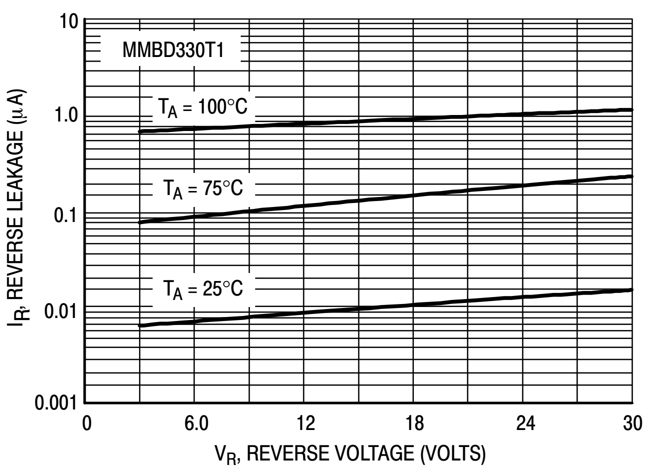


Figure 3. Reverse Leakage

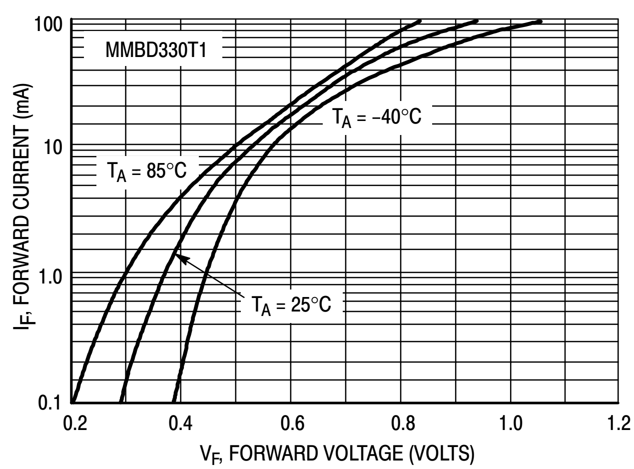


Figure 4. Forward Voltage

TYPICAL CHARACTERISTICS
MMBD770T1

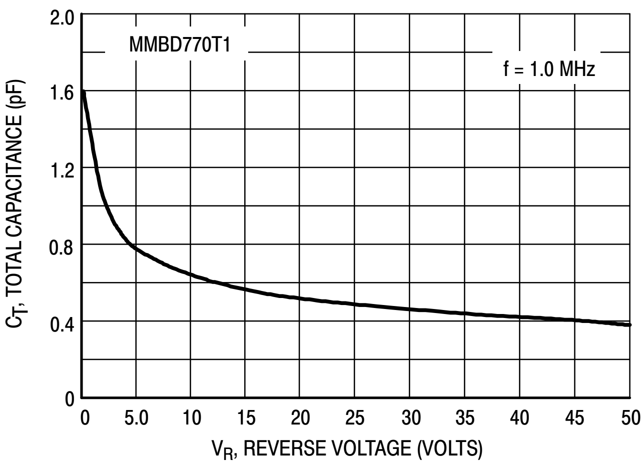


Figure 5. Total Capacitance

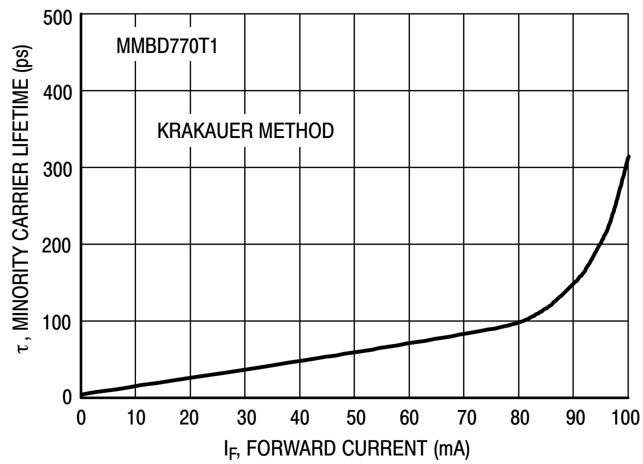


Figure 6. Minority Carrier Lifetime

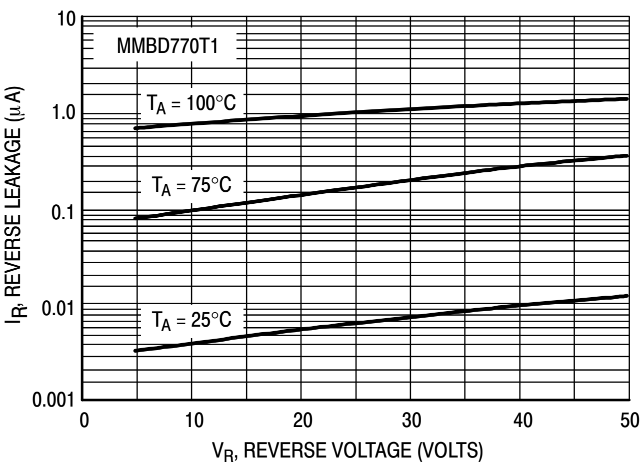


Figure 7. Reverse Leakage

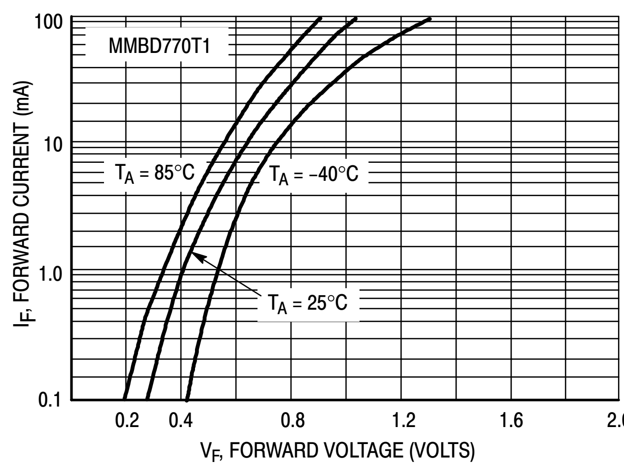


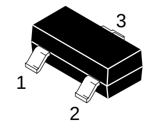
Figure 8. Forward Voltage

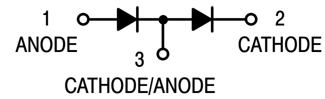
MMBD352LT1
MMBD353LT1
MMBD354LT1
MMBD355LT1

Dual Hot Carrier Mixer Diodes

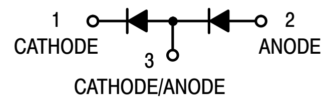
These devices are designed primarily for UHF mixer applications but are suitable also for use in detector and ultra–fast switching circuits.

- Very Low Capacitance — Less Than 1.0 pF @ Zero Volts
- Low Forward Voltage — 0.5 Volts (Typ) @ I_F = 10 mA

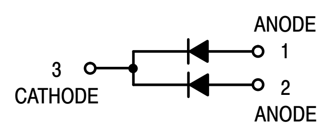




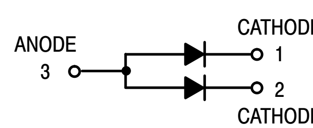
MMBD352LT1
CASE 318–08, STYLE 11
SOT–23 (TO–236AB)



MMBD353LT1
CASE 318–08, STYLE 19
SOT–23 (TO–236AB)



MMBD354LT1
CASE 318–08, STYLE 9
SOT–23 (TO–236AB)



MMBD355LT1
CASE 318–08, STYLE 12
SOT–23 (TO–236AB)

MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	7.0	V_{CC}

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBD352LT1 = M5G; MMBD353LT1 = M4F; MMBD354LT1 = M6H; MMBD355LT1 = MJ1

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) **(EACH DIODE)**

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Forward Voltage (I_F = 10 mAdc)	V_F	—	0.60	V
Reverse Voltage Leakage Current (Note 3.) (V_R = 3.0 V) (V_R = 7.0 V)	I_R	 — —	 0.25 10	μA
Capacitance (V_R = 0 V, f = 1.0 MHz)	C	—	1.0	pF

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. For each individual diode while the second diode is unbiased.

TYPICAL CHARACTERISTICS

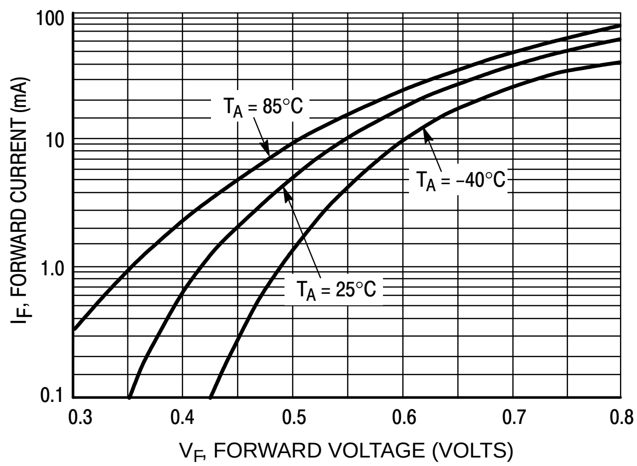


Figure 1. Forward Voltage

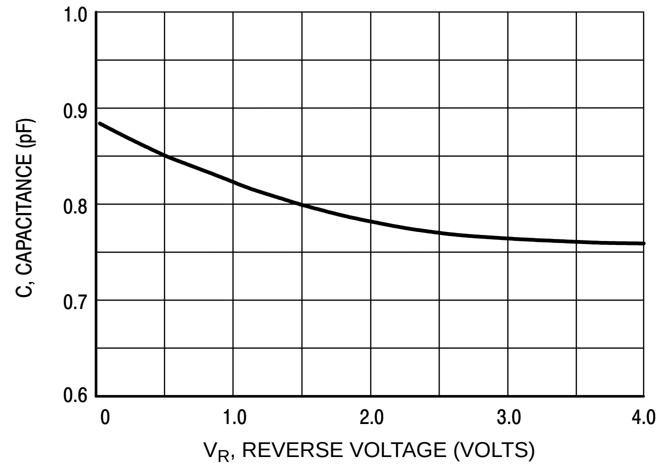


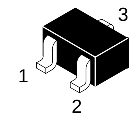
Figure 2. Capacitance

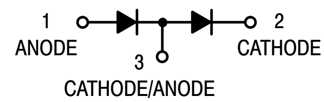
Dual Schottky Barrier Diode

MMBD352WT1

These devices are designed primarily for UHF mixer applications but are suitable also for use in detector and ultra–fast switching circuits.

- Very Low Capacitance — Less Than 1.0 pF @ Zero Volts
- Low Forward Voltage — 0.5 Volts (Typ) @ I_F = 10 mA





MMBD352WT1
CASE 419–04, STYLE 9
SOT–323 (SC–70)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	7.0	V_{CC}

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	200 1.6	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	625	°C/W
Total Device Dissipation Alumina Substrate(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBD352WT1 = M5

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Forward Voltage (I_F = 10 mAdc)	V_F	—	0.60	V
Reverse Voltage Leakage Current (V_R = 3.0 V) (V_R = 7.0 V)	I_R	 — —	 0.25 10	µA
Capacitance (V_R = 0 V, f = 1.0 MHz)	C	—	1.0	pF

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

March, 2001 – Rev. 1

Publication Order Number:
MMBD352WT1/D

TYPICAL CHARACTERISTICS

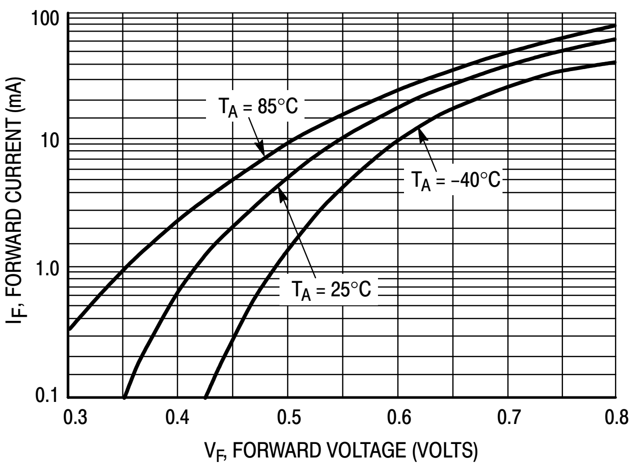


Figure 1. Forward Voltage

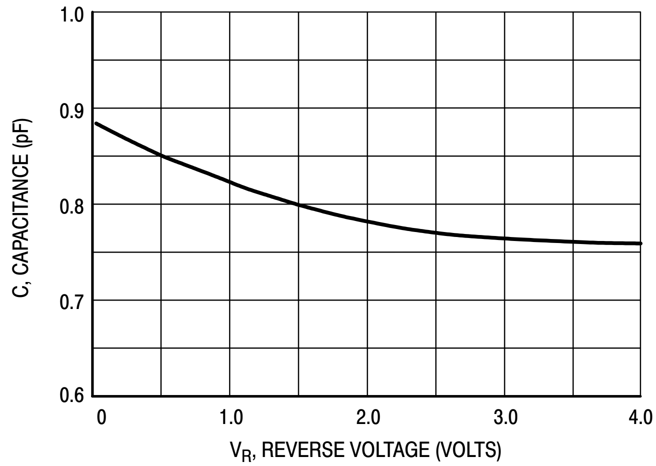


Figure 2. Capacitance

Dual Hot-Carrier Diodes

Schottky Barrier Diodes

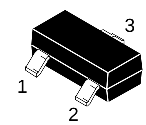
These devices are designed primarily for high–efficiency UHF and VHF detector applications. They are readily adaptable to many other fast switching RF and digital applications. They are supplied in an inexpensive plastic package for low–cost, high–volume consumer and industrial/commercial requirements.

- Extremely Low Minority Carrier Lifetime
- Very Low Capacitance
- Low Reverse Leakage

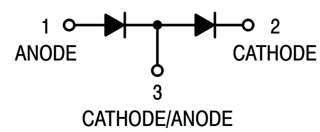
MMBD452LT1

ON Semiconductor Preferred Devices

30 VOLTS
DUAL HOT–CARRIER
DETECTOR AND SWITCHING
DIODES



CASE 318–08, STYLE 11
SOT–23 (TO–236AB)



MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 225 1.8	 mW mW/°C
Operating Junction Temperature Range	T_J	–55 to +125	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBD452LT1 = 5N

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (EACH DIODE)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	30	—	—	Volts
Total Capacitance (V_R = 15 V, f = 1.0 MHz) Figure 1	C_T	—	0.9	1.5	pF
Reverse Leakage (V_R = 25 V) Figure 3	I_R	—	13	200	nAdc
Forward Voltage (I_F = 1.0 mAdc) Figure 4	V_F	—	0.38	0.45	Vdc
Forward Voltage (I_F = 10 mAdc) Figure 4	V_F	—	0.52	0.6	Vdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1
Publication Order Number:
MMBD452LT1/D

TYPICAL ELECTRICAL CHARACTERISTICS

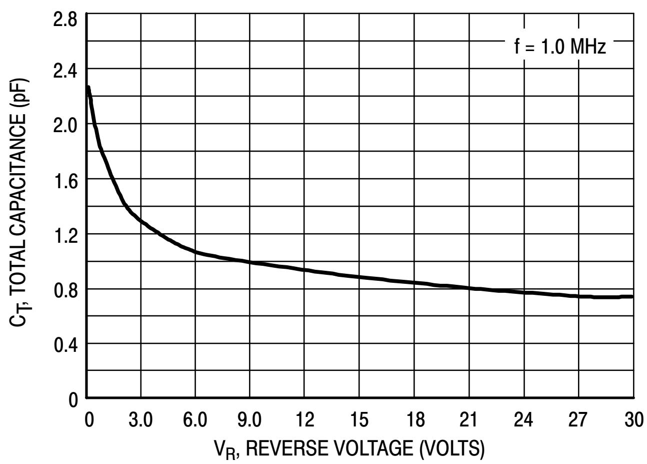


Figure 1. Total Capacitance

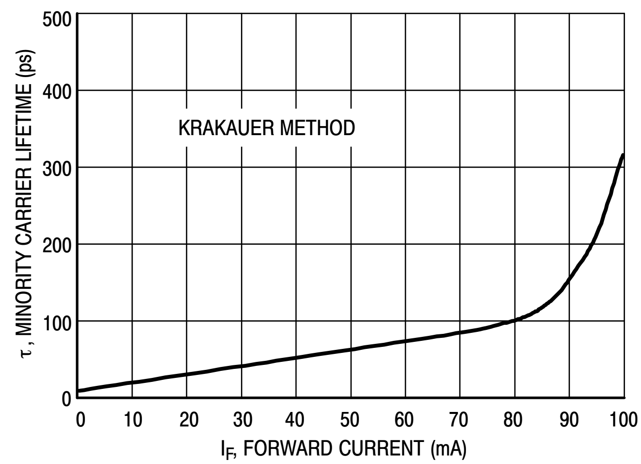


Figure 2. Minority Carrier Lifetime

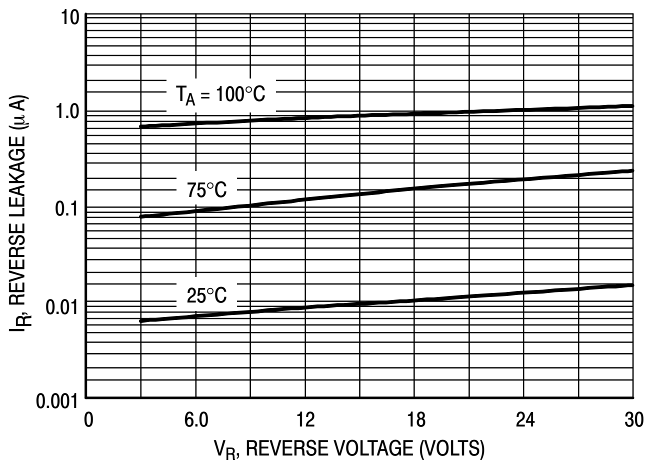


Figure 3. Reverse Leakage

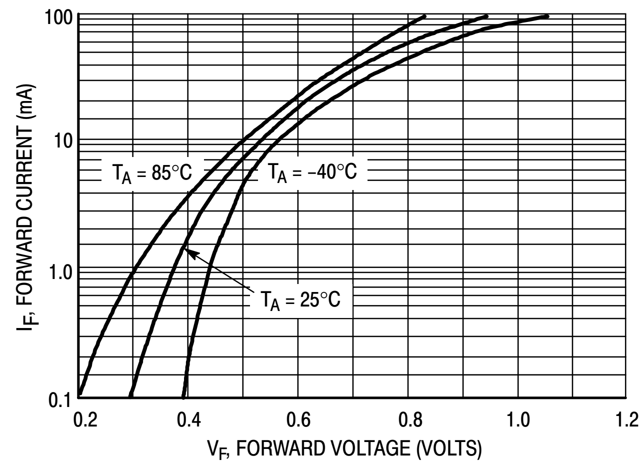


Figure 4. Forward Voltage

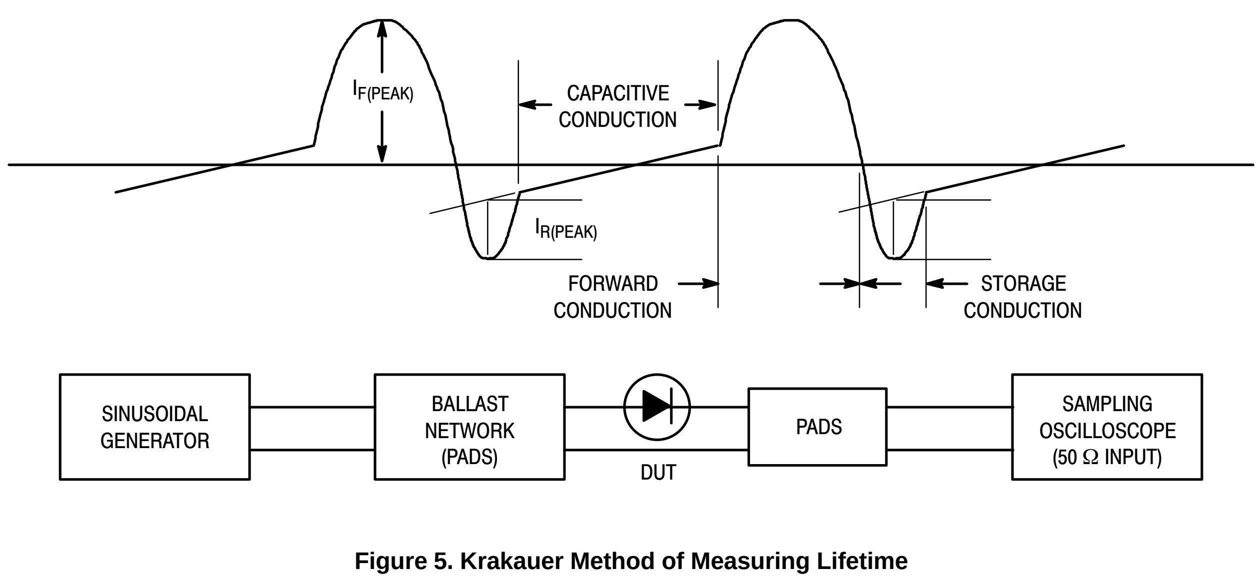
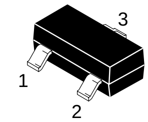


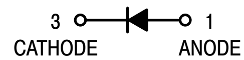
Figure 5. Krakauer Method of Measuring Lifetime

Switching Diode

MMBD6050LT1



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board[(1)] T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,[(2)] T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

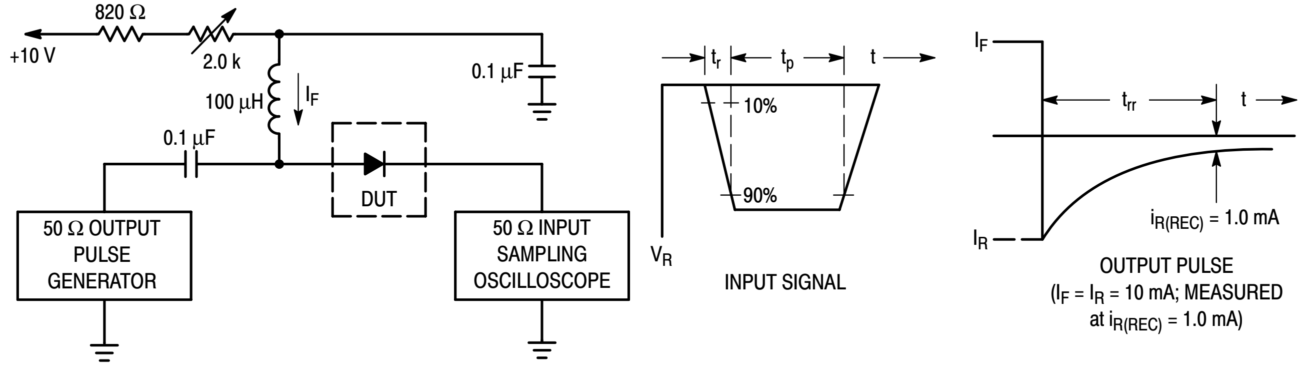
DEVICE MARKING

MMBD6050LT1 = 5A

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 µAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (V_R = 50 Vdc)	I_R	—	0.1	µAdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 100 mAdc)	V_F	 0.55 0.85	 0.7 1.1	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	4.0	ns
Capacitance (V_R = 0 V)	C	—	2.5	pF

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

TYPICAL CHARACTERISTICS

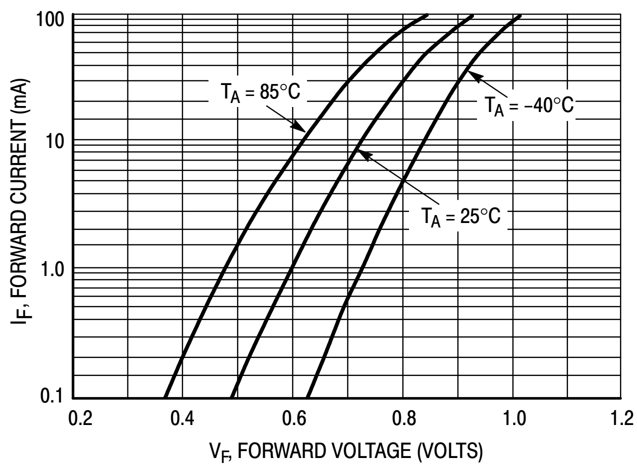


Figure 2. Forward Voltage

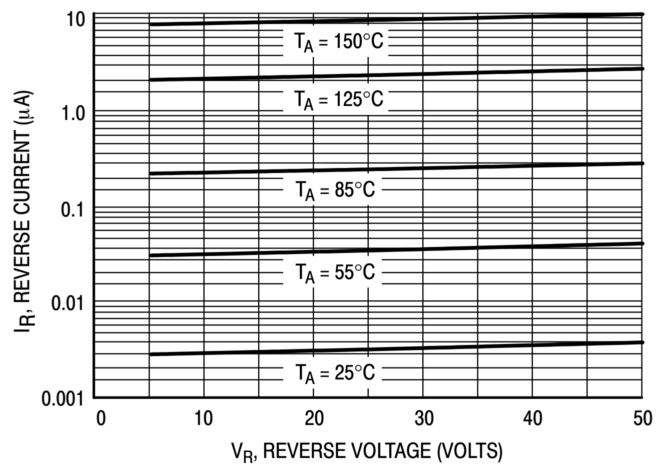


Figure 3. Leakage Current

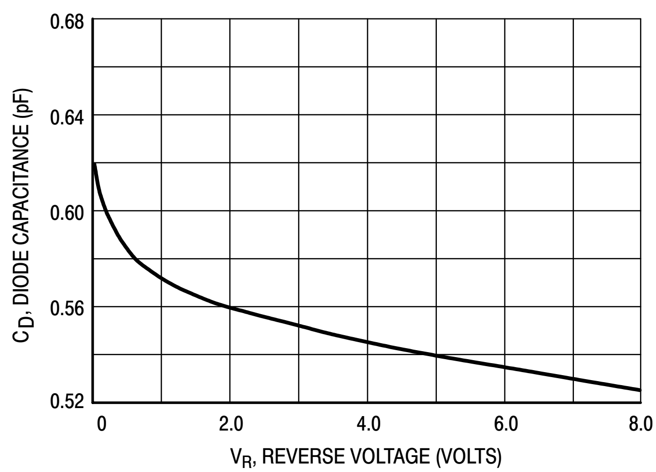


Figure 4. Capacitance

MMBD6100LT1

Monolithic Dual Switching Diode

ON Semiconductor

http://onsemi.com

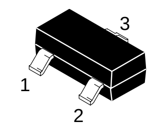
MAXIMUM RATINGS (EACH DIODE)

Symbol	Rating	Value	Unit
V_R	Reverse Voltage	70	Vdc
I_F	Forward Current	200	mAdc
$I_{FM(surge)}$	Peak Forward Surge Current	500	mAdc

THERMAL CHARACTERISTICS

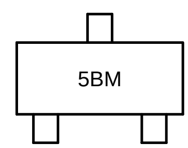
Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation, FR–5 Board (1) T_A = 25°C Derate above 25°C	225 1.8	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	556	°C/W
P_D	Total Device Dissipation Alumina Substrate, (2) T_A = 25°C Derate above 25°C	300 2.4	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	417	°C/W
T_J, T_{stg}	Junction and Storage Temperature Range	–55 to +150	°C

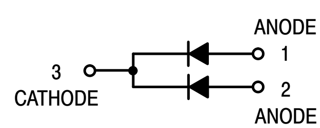
(1) FR–5 = 1.0 × 0.75 × 0.062 in.
(2) Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.



PLASTIC
SOT–23S
CASE 318

DEVICE MARKING



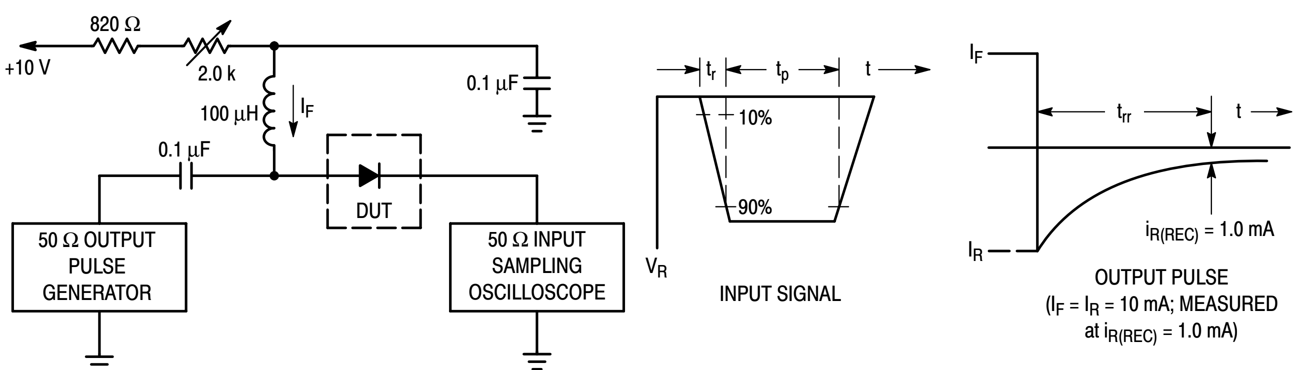


ORDERING INFORMATION

Device	Package	Shipping
MMBD6100LT1	SOT–23S	3000/Tape & Reel
MMBD6100LT3	SOT–23S	10,000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) **(EACH DIODE)**

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 µAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (V_R = 50 Vdc) (For each individual diode while the second diode is unbiased)	I_R	—	0.1	µAdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 100 mAdc)	V_F	 0.55 0.8	 0.7 1.1	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	4.0	ns
Capacitance (V_R = 0 V)	C	—	2.5	pF



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

CURVES APPLICABLE TO EACH CATHODE

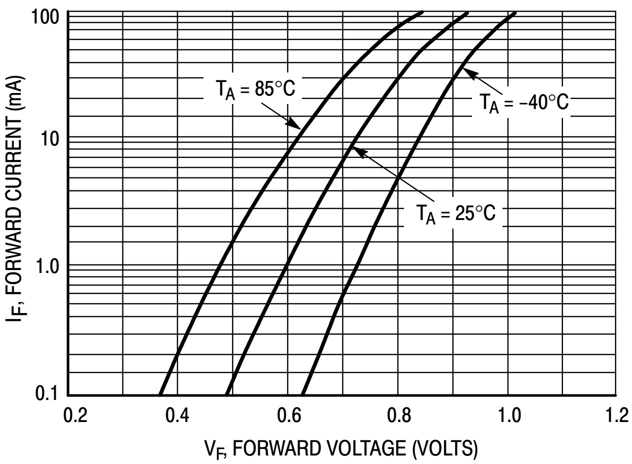


Figure 2. Forward Voltage

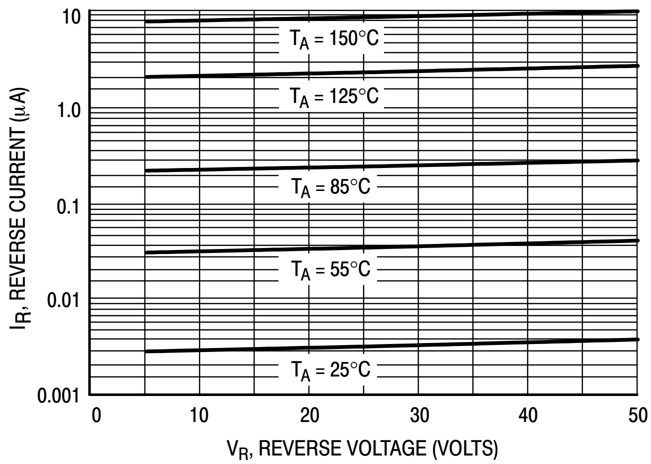


Figure 3. Leakage Current

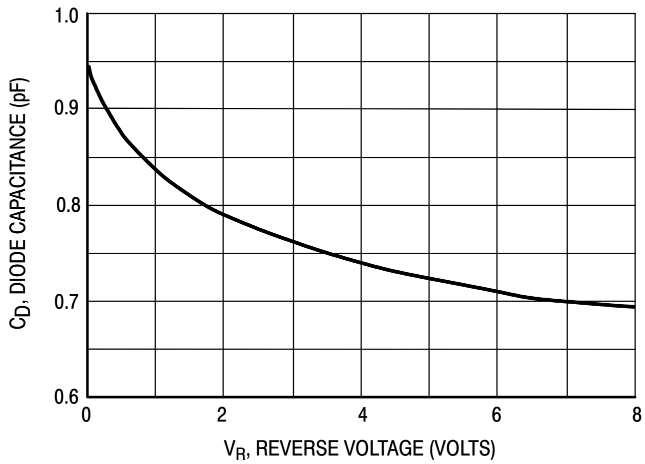
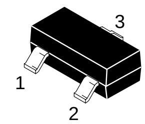


Figure 4. Capacitance

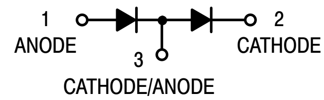
Dual Switching Diode

MMBD7000LT1

ON Semiconductor Preferred Device



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	100	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBD7000LT1 = M5C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (EACH DIODE)

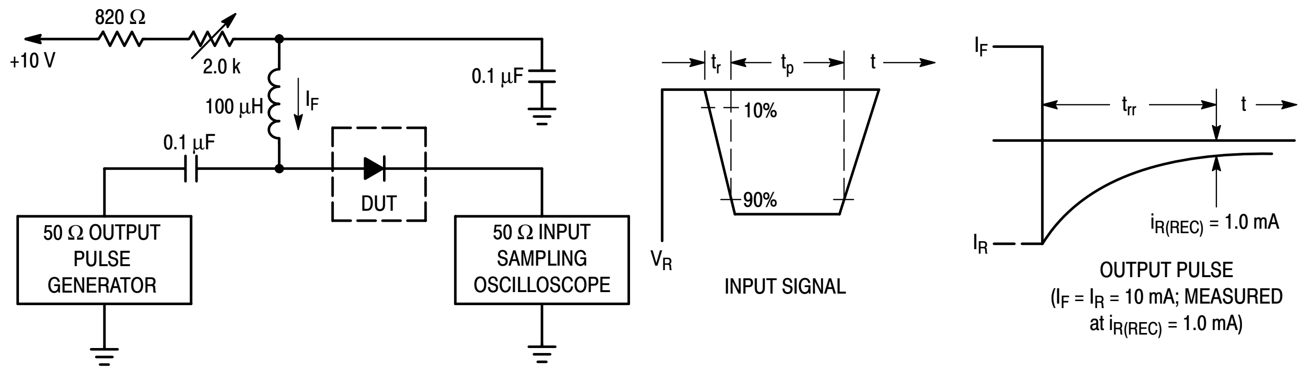
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 µAdc)	$V_{(BR)}$	100	—	Vdc
Reverse Voltage Leakage Current (V_R = 50 Vdc) (V_R = 100 Vdc) (V_R = 50 Vdc, 125°C)	 I_R I_{R2} I_{R3}	 — — —	 1.0 3.0 100	µAdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 100 mAdc)	V_F	 0.55 0.67 0.75	 0.7 0.82 1.1	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc) (Figure 1)	t_{rr}	—	4.0	ns
Capacitance (V_R = 0 V)	C	—	1.5	pF

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1

Publication Order Number:
MMBD7000LT1/D



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

CURVES APPLICABLE TO EACH DIODE

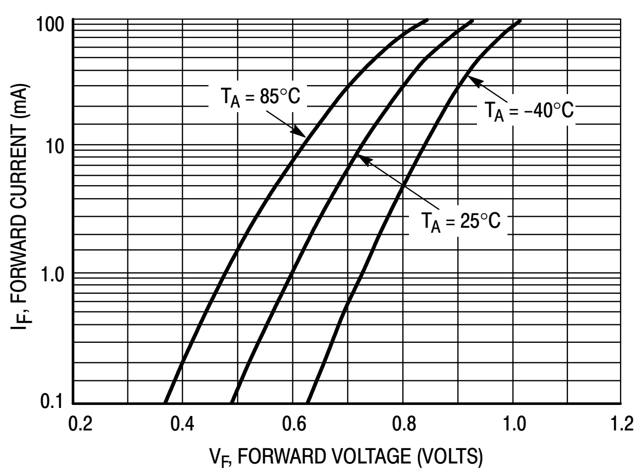


Figure 2. Forward Voltage

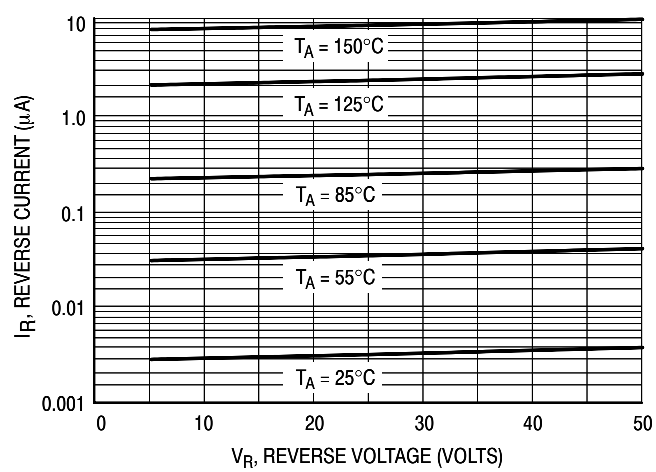


Figure 3. Leakage Current

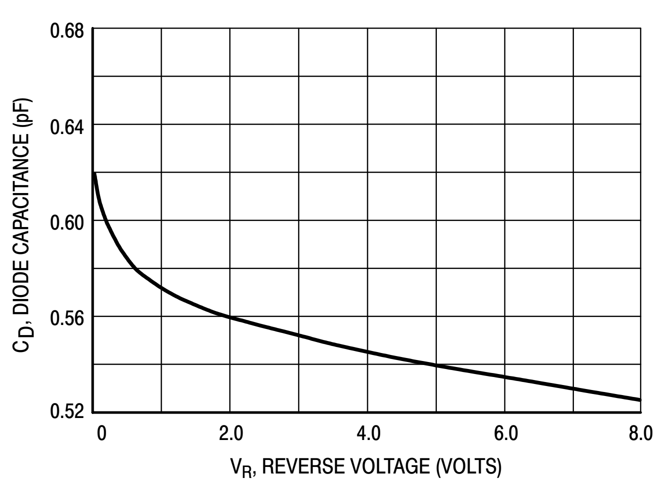


Figure 4. Capacitance

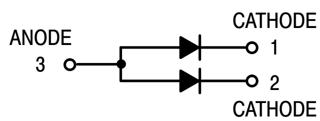
MMBD717LT1

ON Semiconductor Preferred Device

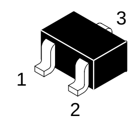
Common Anode Schottky Barrier Diodes

These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Extremely Low Forward Voltage — 0.28 Volts (Typ) @ I_F = 1 mAdc



20 VOLT SCHOTTKY BARRIER DETECTOR AND SWITCHING DIODES



CASE 419–04, STYLE 4
SOT–323 (SC–70)

MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	20	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	 200 1.6	 mW mW/°C
Operating Junction Temperature Range	T_J	–55 to +150	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

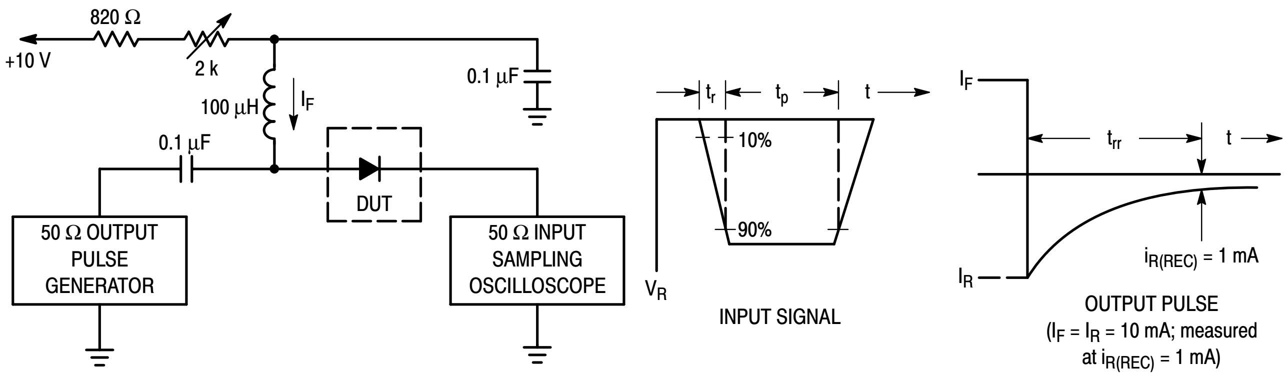
DEVICE MARKING

MMBD717LT1 = B3

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	20	—	—	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	—	2.0	2.5	pF
Reverse Leakage (V_R = 10 V) (For each individual diode while the second diode is unbiased)	I_R	—	0.05	1.0	μAdc
Forward Voltage (I_F = 1.0 mAdc)	V_F	—	0.28	0.37	Vdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

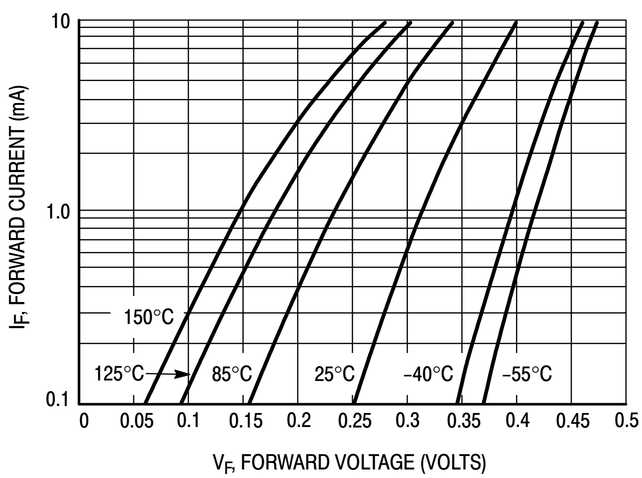


Figure 2. Typical Forward Voltage

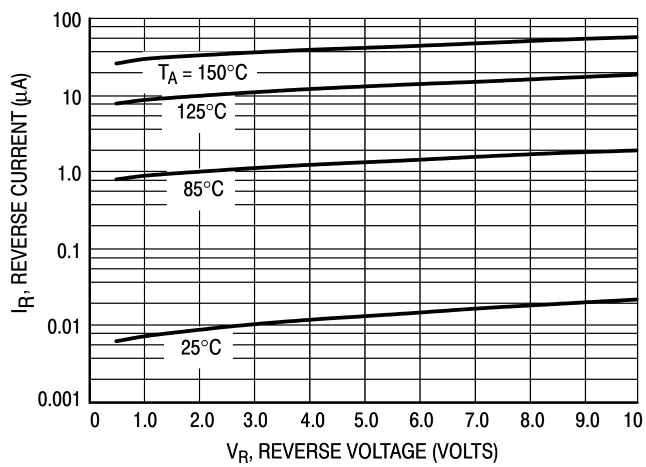


Figure 3. Reverse Current versus Reverse Voltage

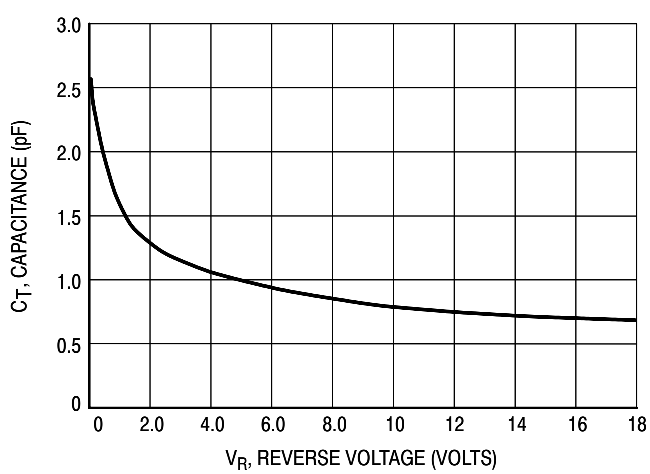


Figure 4. Typical Capacitance

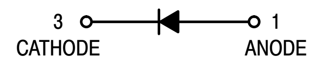
MMBD914LT1

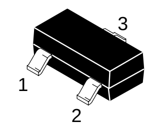
Preferred Device

High-Speed Switching Diode

ON Semiconductor™

http://onsemi.com





SOT–23S
CASE 318
STYLE 8

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	100	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

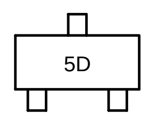
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board (Note 1.) T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate (Note 2.) T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage (I_R = 100 μAdc)	$V_{(BR)}$	100	–	Vdc
Reverse Voltage Leakage Current	I_R			
(V_R = 20 Vdc)		–	25	nAdc
(V_R = 75 Vdc)		–	5.0	μAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_T	–	4.0	pF
Forward Voltage (I_F = 10 mAdc)	V_F	–	1.0	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc) (Figure 1)	t_{rr}	–	4.0	ns

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

MARKING DIAGRAM

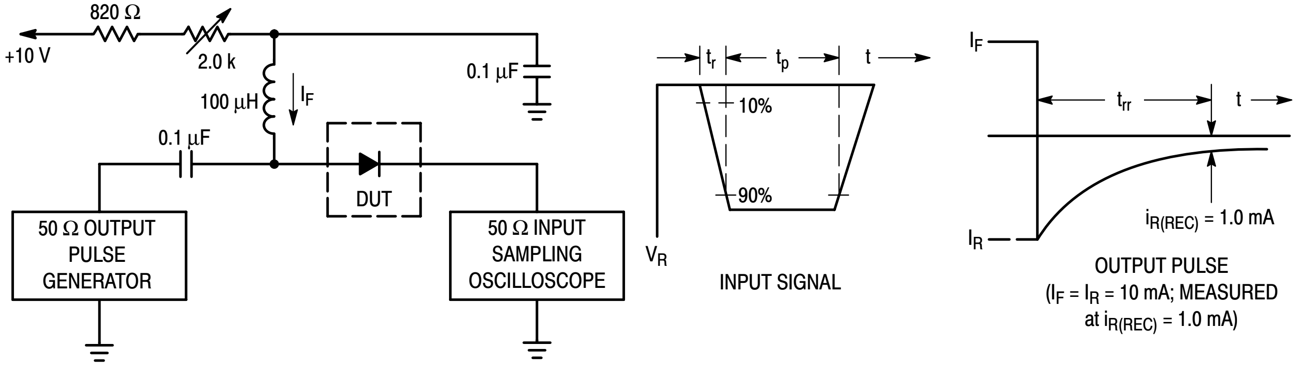


5D = Device Code

ORDERING INFORMATION

Device	Package	Shipping
MMBD914LT1	SOT–23	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

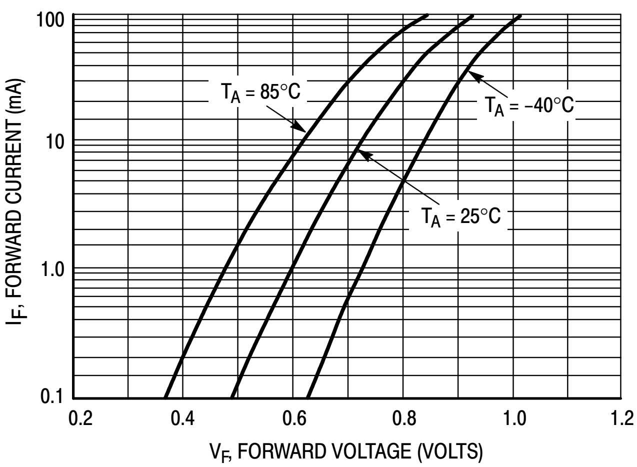


Figure 2. Forward Voltage

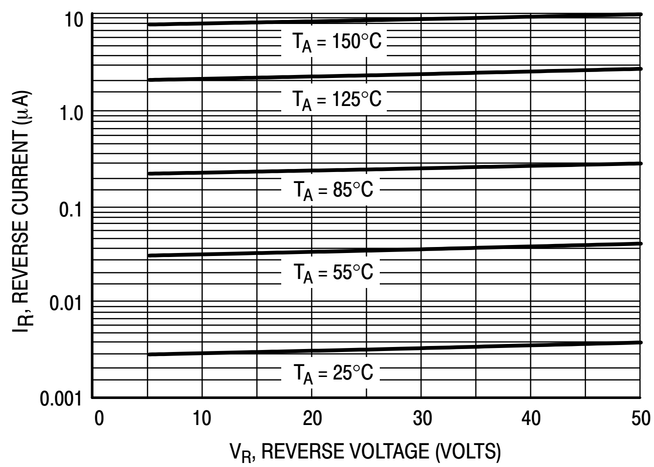


Figure 3. Leakage Current

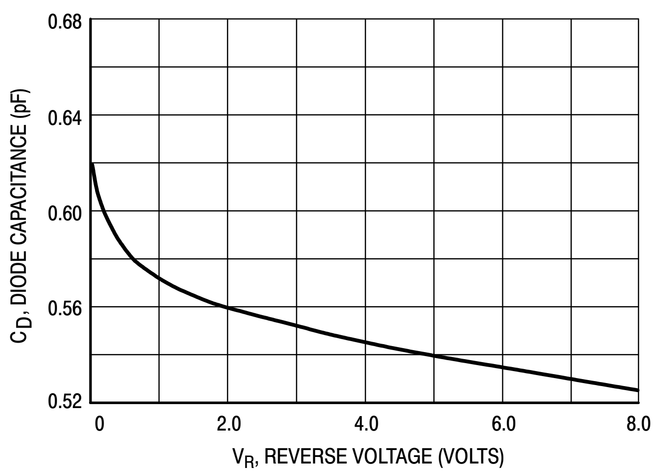
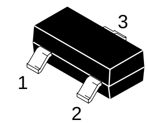


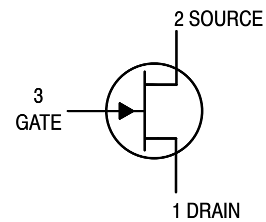
Figure 4. Capacitance

JFET Switching Transistors
N–Channel

MMBF4391LT1
MMBF4392LT1
MMBF4393LT1



CASE 318–08, STYLE 10
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	30	Vdc
Drain–Gate Voltage	V_{DG}	30	Vdc
Gate–Source Voltage	V_{GS}	30	Vdc
Forward Gate Current	$I_{G(f)}$	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBF4391LT1 = 6J; MMBF4392LT1 = 6K; MMBF4393LT1 = 6G

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate–Source Breakdown Voltage (I_G = 1.0 µAdc, V_{DS} = 0)		$V_{(BR)GSS}$	30	—	Vdc
Gate Reverse Current (V_{GS} = 15 Vdc, V_{DS} = 0, T_A = 25°C) (V_{GS} = 15 Vdc, V_{DS} = 0, T_A = 100°C)		I_{GSS}	 — —	 1.0 0.20	 nAdc µAdc
Gate–Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 10 nAdc)	 MMBF4391LT1 MMBF4392LT1 MMBF4393LT1	$V_{GS(off)}$	 –4.0 –2.0 –0.5	 –10 –5.0 –3.0	Vdc
Off–State Drain Current (V_{DS} = 15 Vdc, V_{GS} = –12 Vdc) (V_{DS} = 15 Vdc, V_{GS} = –12 Vdc, T_A = 100°C)		$I_{D(off)}$	 — —	 1.0 1.0	 nAdc µAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.

March, 2001 – Rev. 1
Publication Order Number:
MMBF4391LT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
Zero–Gate–Voltage Drain Current		I_{DSS}			mAdc
(V_{DS} = 15 Vdc, V_{GS} = 0)	MMBF4391LT1		50	150	
	MMBF4392LT1		25	75	
	MMBF4393LT1		5.0	30	
Drain–Source On–Voltage		$V_{DS(on)}$			Vdc
(I_D = 12 mAdc, V_{GS} = 0)	MMBF4391LT1		—	0.4	
(I_D = 6.0 mAdc, V_{GS} = 0)	MMBF4392LT1		—	0.4	
(I_D = 3.0 mAdc, V_{GS} = 0)	MMBF4393LT1		—	0.4	
Static Drain–Source On–Resistance		$r_{DS(on)}$			Ω
(I_D = 1.0 mAdc, V_{GS} = 0)	MMBF4391LT1		—	30	
	MMBF4392LT1		—	60	
	MMBF4393LT1		—	100	
SMALL–SIGNAL CHARACTERISTICS					
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	—	14	pF
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = 12 Vdc, f = 1.0 MHz)		C_{rss}	—	3.5	pF

TYPICAL CHARACTERISTICS

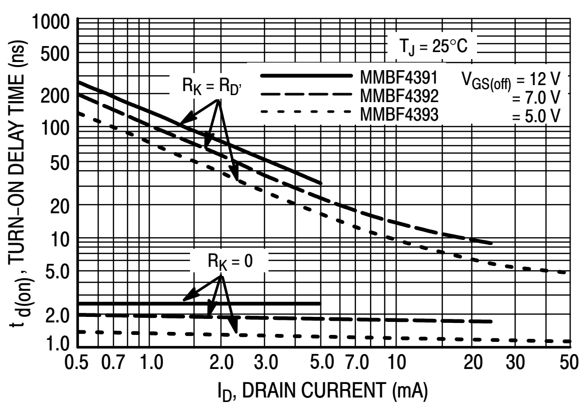


Figure 1. Turn–On Delay Time

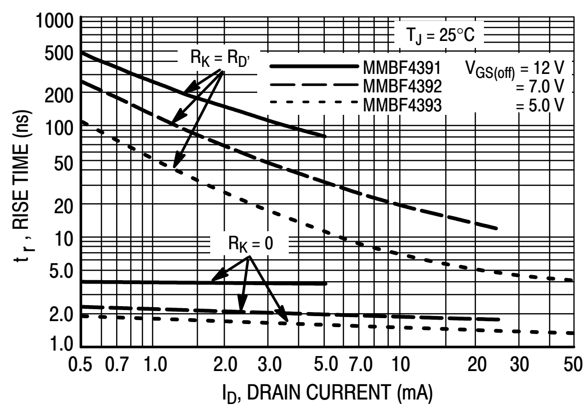


Figure 2. Rise Time

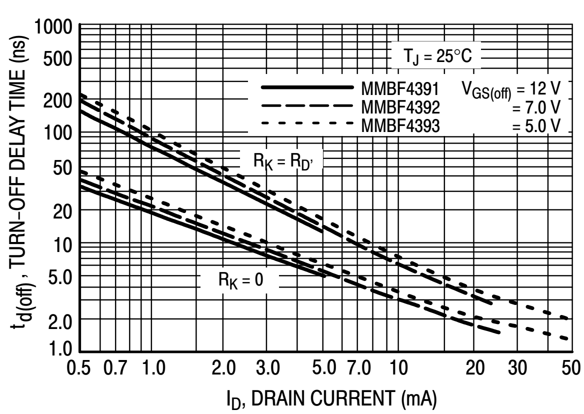


Figure 3. Turn–Off Delay Time

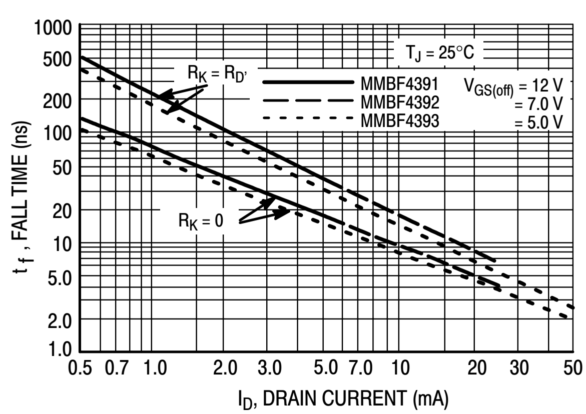


Figure 4. Fall Time

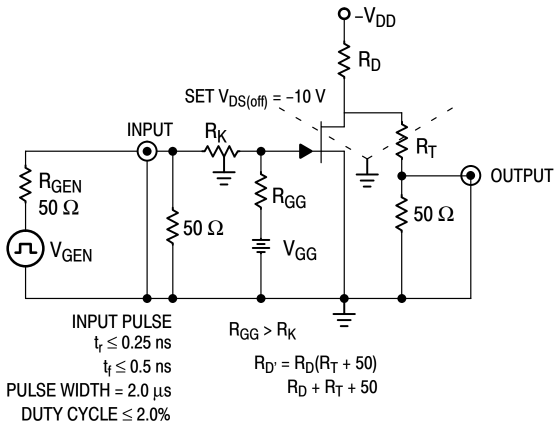


Figure 5. Switching Time Test Circuit

NOTE 1

The switching characteristics shown above were measured using a test circuit similar to Figure 5. At the beginning of the switching interval, the gate voltage is at Gate Supply Voltage ($-V_{GG}$). The Drain–Source Voltage (V_{DS}) is slightly lower than Drain Supply Voltage (V_{DD}) due to the voltage divider. Thus Reverse Transfer Capacitance (C_{rss}) of Gate–Drain Capacitance (C_{gd}) is charged to $V_{GG} + V_{DS}$.

During the turn–on interval, Gate–Source Capacitance (C_{gs}) discharges through the series combination of R_{Gen} and R_K. C_{gd} must discharge to $V_{DS(on)}$ through R_G and R_K in series with the parallel combination of effective load impedance (R'_D) and Drain–Source Resistance (r_{DS}). During the turn–off, this charge flow is reversed.

Predicting turn–on time is somewhat difficult as the channel resistance r_{DS} is a function of the gate–source voltage. While C_{gs} discharges, V_{GS} approaches zero and r_{DS} decreases. Since C_{gd} discharges through r_{DS}, turn–on time is non–linear. During turn–off, the situation is reversed with r_{DS} increasing as C_{gd} charges.

The above switching curves show two impedance conditions; 1) R_K is equal to $R_{D'}$ which simulates the switching behavior of cascaded stages where the driving source impedance is normally the load impedance of the previous stage, and 2) $R_K = 0$ (low impedance) the driving source impedance is that of the generator.

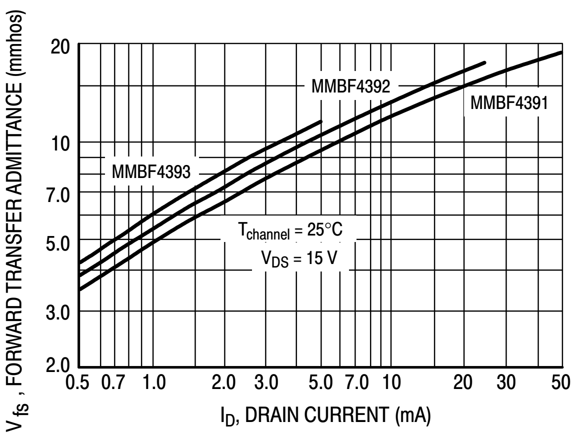


Figure 6. Typical Forward Transfer Admittance

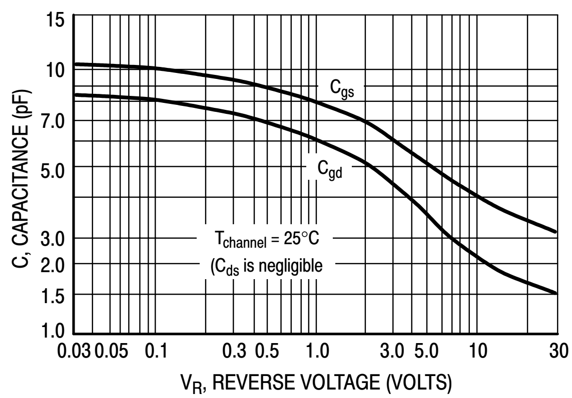


Figure 7. Typical Capacitance

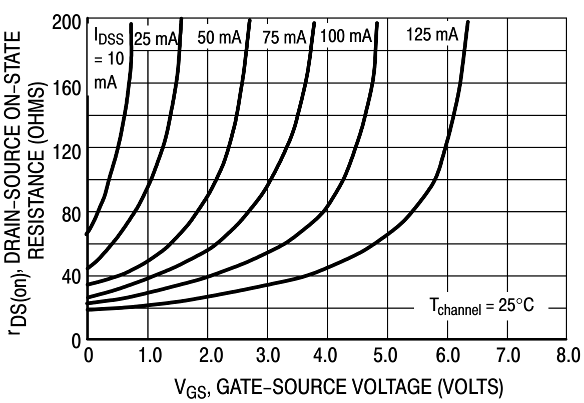


Figure 8. Effect of Gate–Source Voltage on Drain–Source Resistance

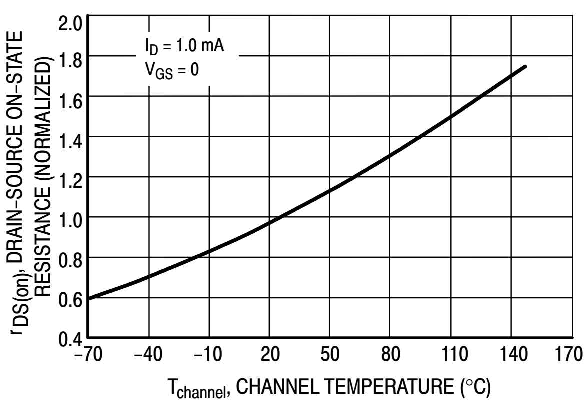


Figure 9. Effect of Temperature on Drain–Source On–State Resistance

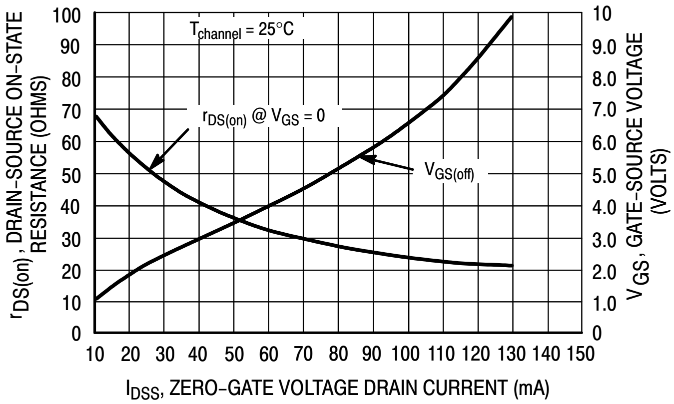


Figure 10. Effect of I_{DSS} on Drain–Source Resistance and Gate–Source Voltage

NOTE 2

The Zero–Gate–Voltage Drain Current (I_{DSS}) is the principle determinant of other J–FET characteristics. Figure 10 shows the relationship of Gate–Source Off Voltage ($V_{GS(off)}$) and Drain–Source On Resistance ($r_{DS(on)}$) to I_{DSS}. Most of the devices will be within ±10% of the values shown in Figure 10. This data will be useful in predicting the characteristic variations for a given part number.

For example:

Unknown

$r_{DS(on)}$ and V_{GS} range for an MMBF4392

The electrical characteristics table indicates that an MMBF4392 has an I_{DSS} range of 25 to 75 mA. Figure 10 shows $r_{DS(on)}$ = 52 Ohms for I_{DSS} = 25 mA and 30 Ohms for I_{DSS} = 75 mA. The corresponding V_{GS} values are 2.2 volts and 4.8 volts.

JFET
VHF/UHF Amplifier Transistor
N–Channel

MMBF4416LT1

ON Semiconductor Preferred Device

MAXIMUM RATINGS

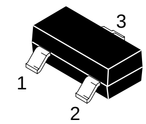
Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	30	Vdc
Drain–Gate Voltage	V_{DG}	30	Vdc
Gate–Source Voltage	V_{GS}	30	Vdc
Gate Current	I_G	10	mAdc

THERMAL CHARACTERISTICS

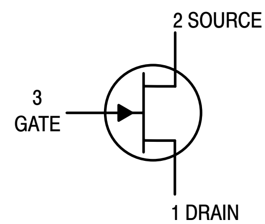
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBF4416LT1 = M6A



CASE 318–08, STYLE 10
SOT–23 (TO–236AB)



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate–Source Breakdown Voltage (I_G = 1.0 µAdc, V_{DS} = 0)	$V_{(BR)GSS}$	30	—	Vdc
Gate Reverse Current (V_{GS} = 20 Vdc, V_{DS} = 0) (V_{GS} = 20 Vdc, V_{DS} = 0, T_A = 150°C)	I_{GSS}	 — —	 1.0 200	nAdc
Gate Source Cutoff Voltage (I_D = 1.0 nAdc, V_{DS} = 15 Vdc)	$V_{GS(off)}$	—	–6.0	Vdc
Gate Source Voltage (I_D = 0.5 mAdc, V_{DS} = 15 Vdc)	V_{GS}	–1.0	–5.5	Vdc
ON CHARACTERISTICS				
Zero–Gate–Voltage Drain Current (V_{GS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	5.0	15	mAdc
Gate–Source Forward Voltage (I_G = 1.0 mAdc, V_{DS} = 0)	$V_{GS(f)}$	—	1.0	Vdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
SMALL–SIGNAL CHARACTERISTICS				
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\lvert Y_{fs} \rvert$	4500	7500	μmhos
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\lvert y_{os} \rvert$	—	50	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	4.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 10 MHz)	C_{rss}	—	0.8	pF
Output Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	2.0	pF

COMMON SOURCE CHARACTERISTICS

ADMITTANCE PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C)

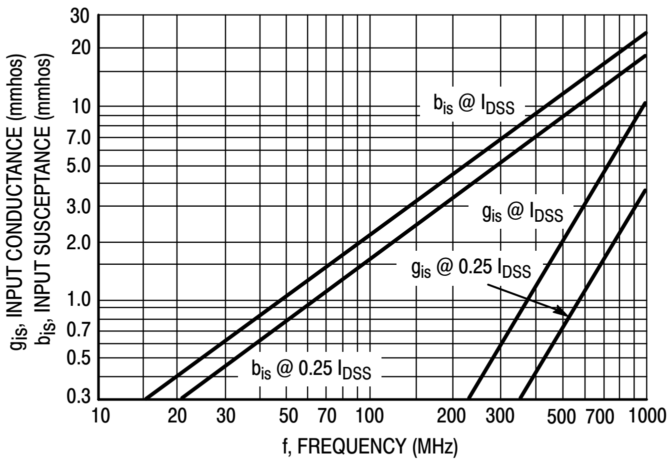


Figure 1. Input Admittance (y_{is})

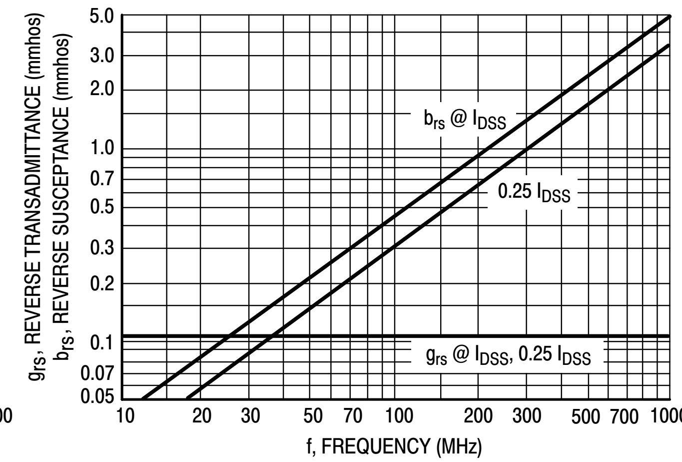


Figure 2. Reverse Transfer Admittance (y_{rs})

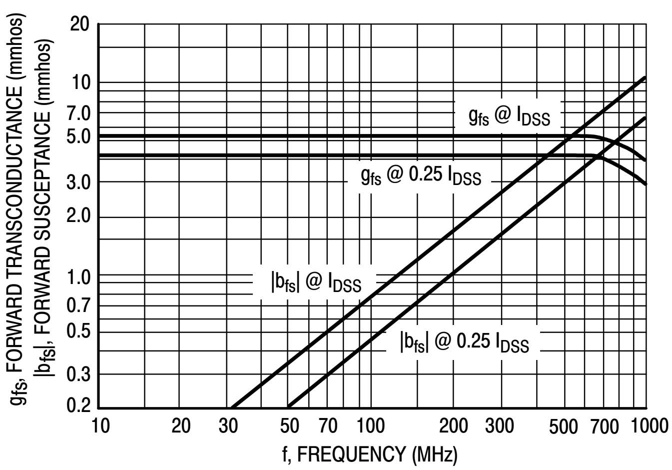


Figure 3. Forward Transadmittance (y_{fs})

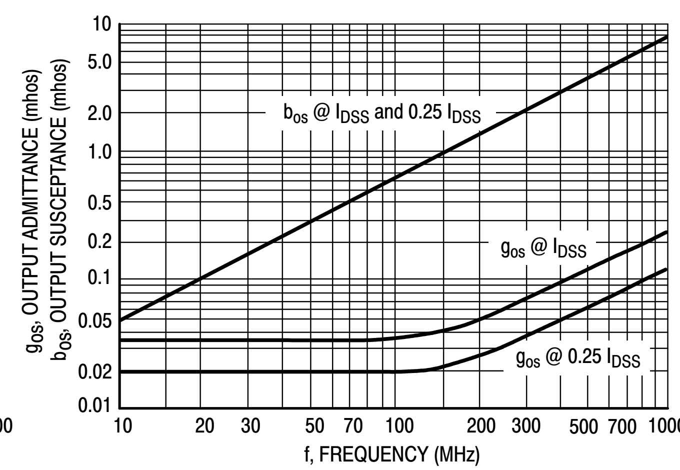


Figure 4. Output Admittance (y_{os})

COMMON SOURCE CHARACTERISTICS

S–PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

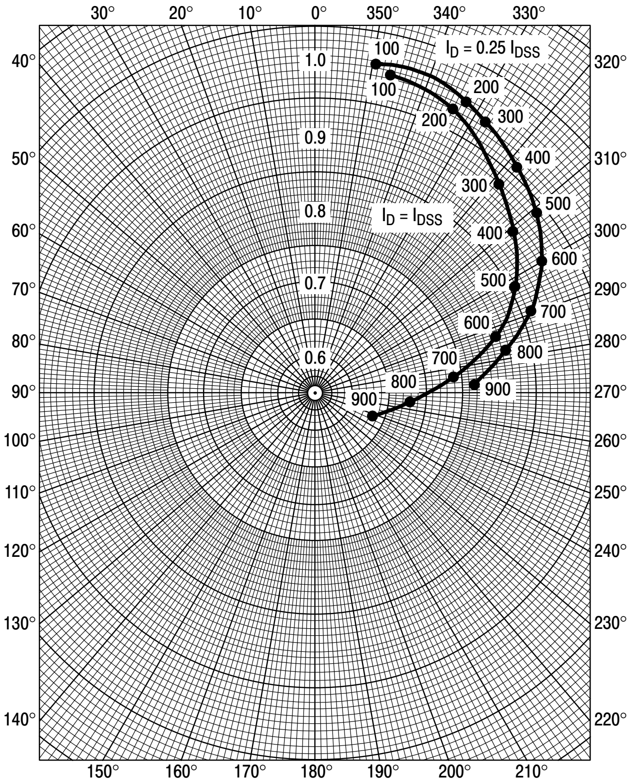


Figure 5. S_{11s}

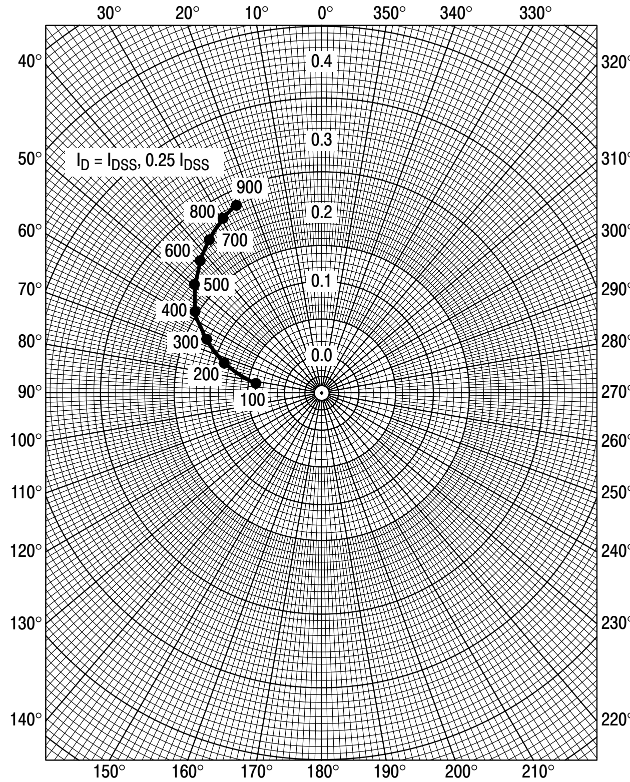


Figure 6. S_{12s}

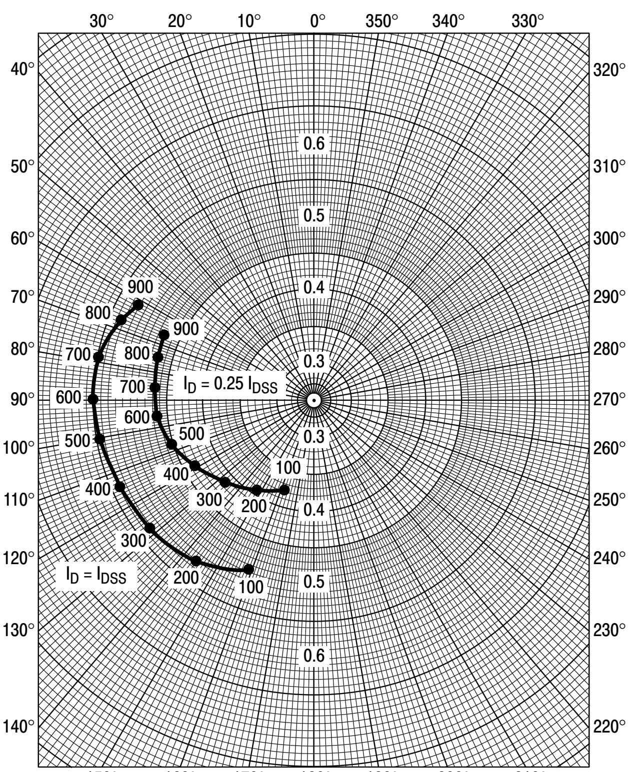


Figure 7. S_{21s}

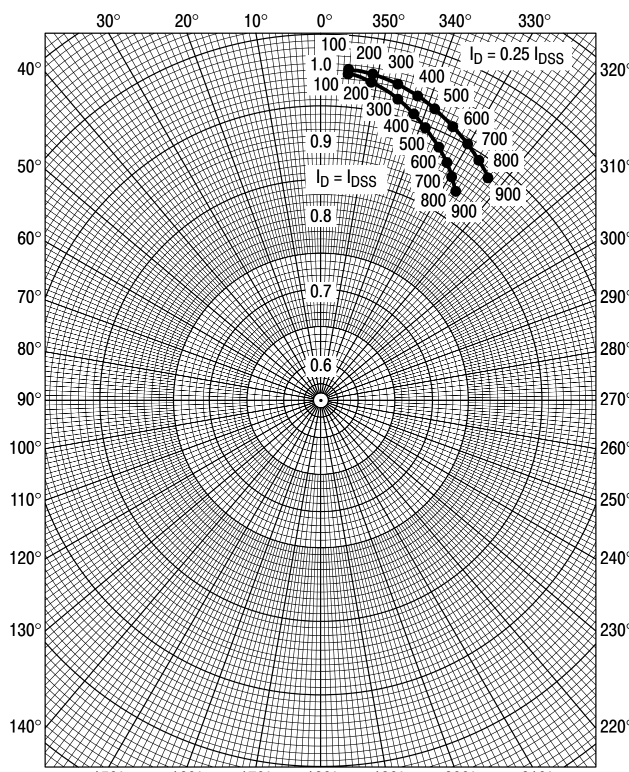


Figure 8. S_{22s}

COMMON GATE CHARACTERISTICS

ADMITTANCE PARAMETERS

(V_{DG} = 15 Vdc, $T_{channel}$ = 25°C)

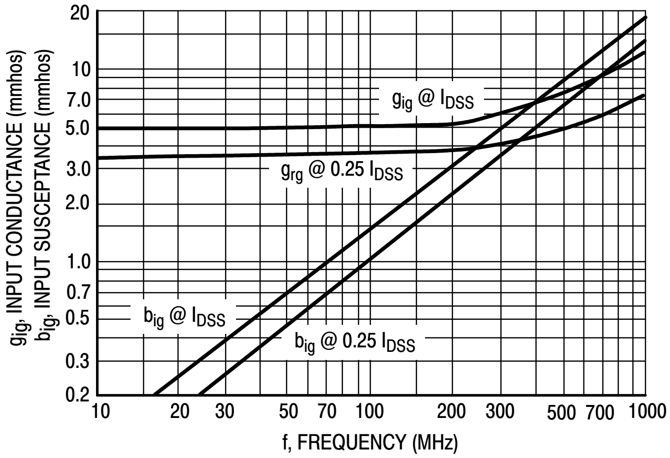


Figure 9. Input Admittance (y_{ig})

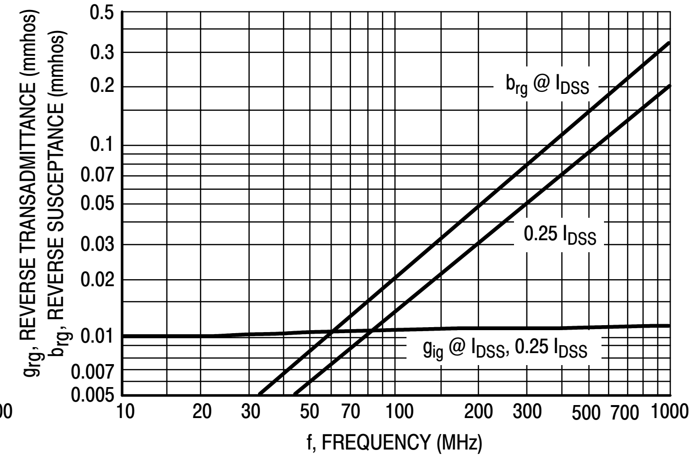


Figure 10. Reverse Transfer Admittance (y_{rg})

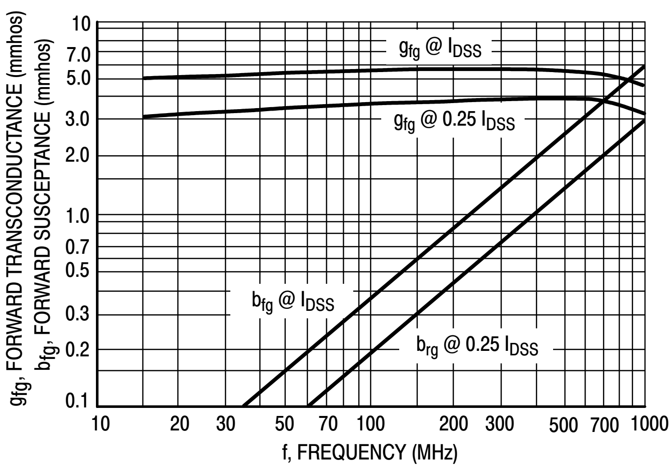


Figure 11. Forward Transfer Admittance (y_{fg})

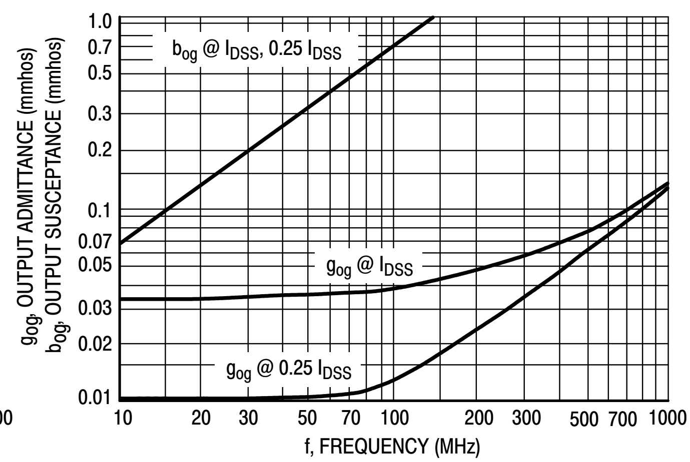


Figure 12. Output Admittance (y_{og})

COMMON GATE CHARACTERISTICS

S–PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

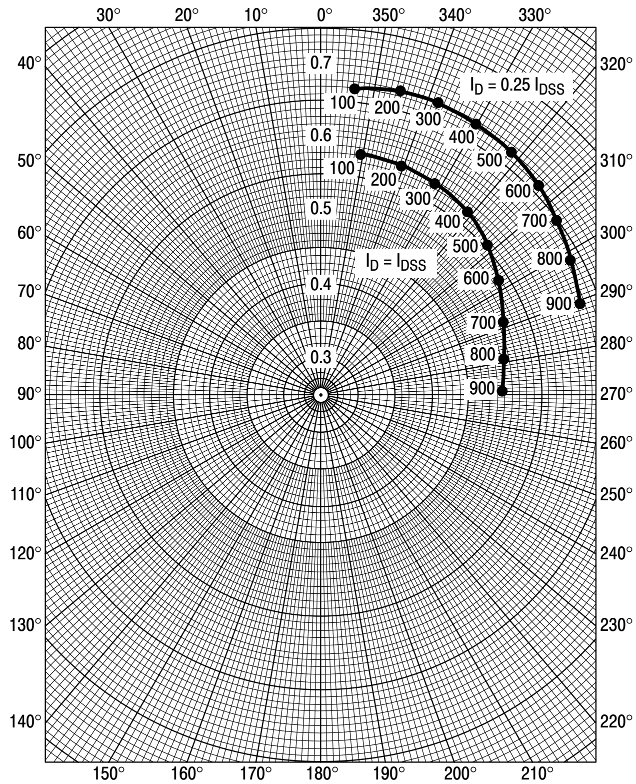


Figure 13. S_{11g}

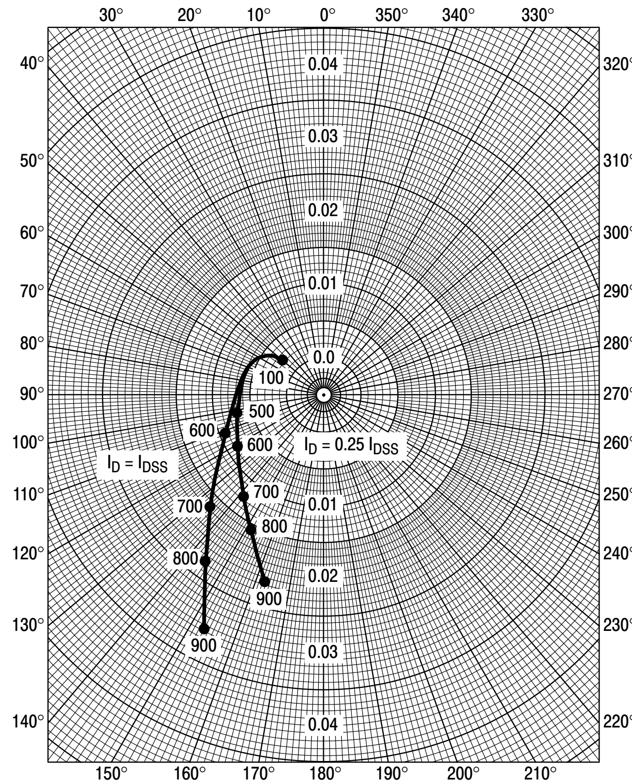


Figure 14. S_{12g}

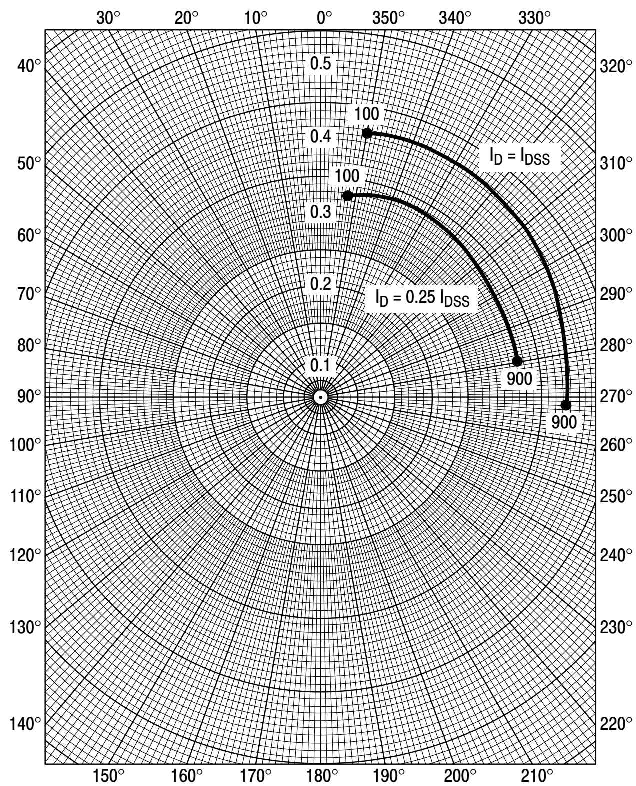


Figure 15. S_{21g}

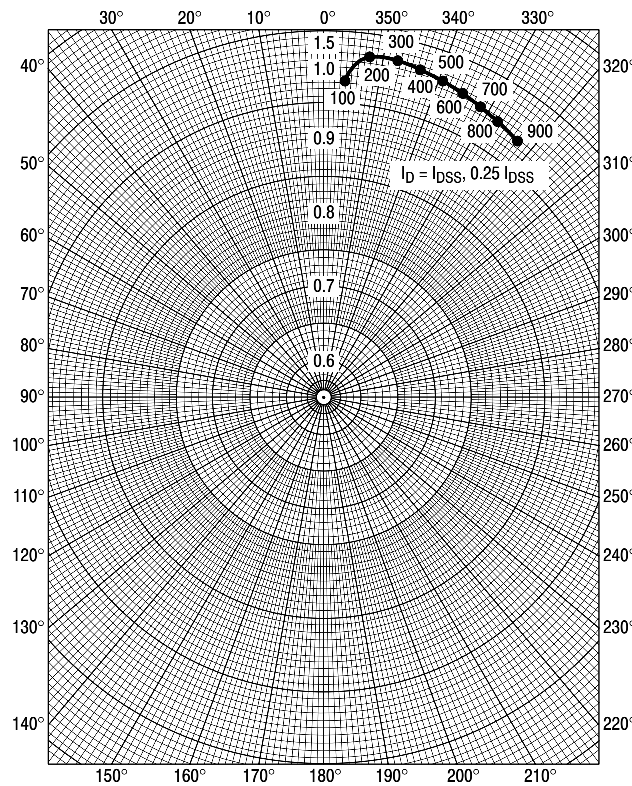
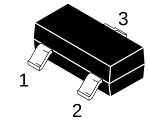


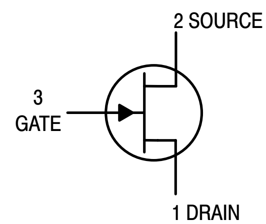
Figure 16. S_{22g}

JFET - General Purpose Transistor
N–Channel

MMBF5457LT1



CASE 318–08, STYLE 10
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	25	Vdc
Drain–Gate Voltage	V_{DG}	25	Vdc
Reverse Gate–Source Voltage	$V_{GS(r)}$	25	Vdc
Gate Current	I_G	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBF5457LT1 = 6D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Gate–Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	25	–	–	Vdc
Gate Reverse Current (V_{GS} = 15 Vdc, V_{DS} = 0) (V_{GS} = 15 Vdc, V_{DS} = 0, T_A = 100°C)	I_{GSS}	 – –	 – –	 1.0 200	nAdc
Gate Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 10 nAdc)	$V_{GS(off)}$	0.5	–	–6.0	Vdc
Gate Source Voltage (V_{DS} = 15 Vdc, I_D = 100 μAdc)	V_{GS}	–	–2.5	–	Vdc
ON CHARACTERISTICS					
Zero–Gate–Voltage Drain Current(2) (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	1.0	–	5.0	mAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Pulse Test: Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
SMALL–SIGNAL CHARACTERISTICS					
Forward Transfer Admittance(2) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\lvert Y_{fs} \rvert$	1000	–	5000	µmhos
Reverse Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\lvert y_{rs} \rvert$	–	10	50	µmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	–	4.5	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	–	1.5	3.0	pF

2. Pulse Test: Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

TYPICAL CHARACTERISTICS

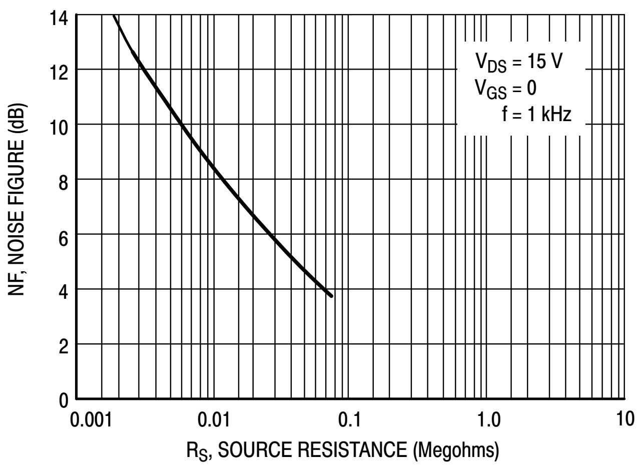


Figure 1. Noise Figure versus Source Resistance

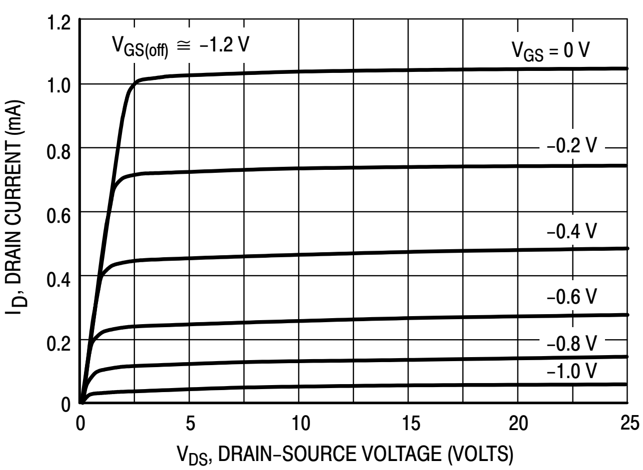


Figure 2. Typical Drain Characteristics

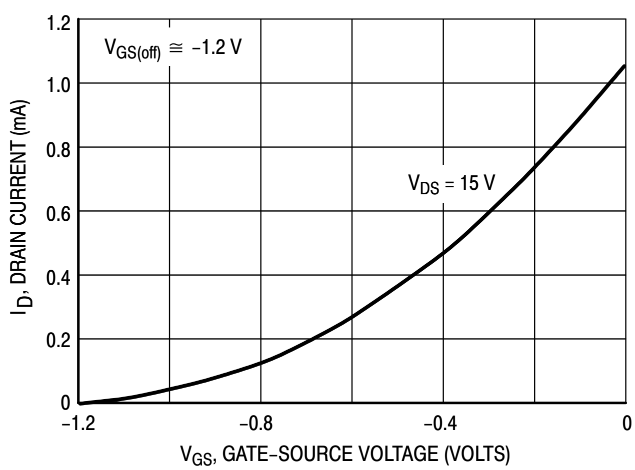


Figure 3. Common Source Transfer Characteristics

TYPICAL CHARACTERISTICS

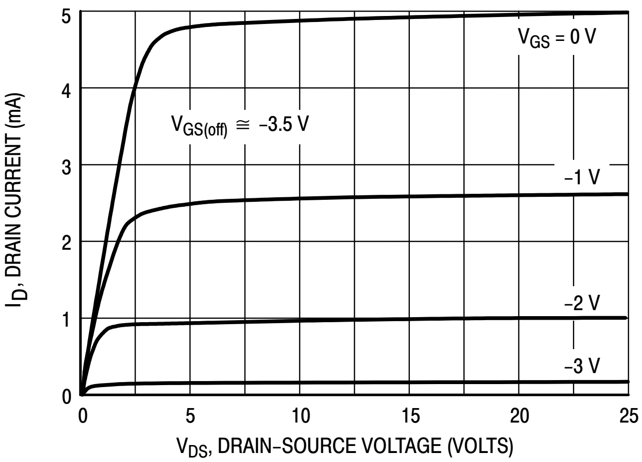


Figure 4. Typical Drain Characteristics

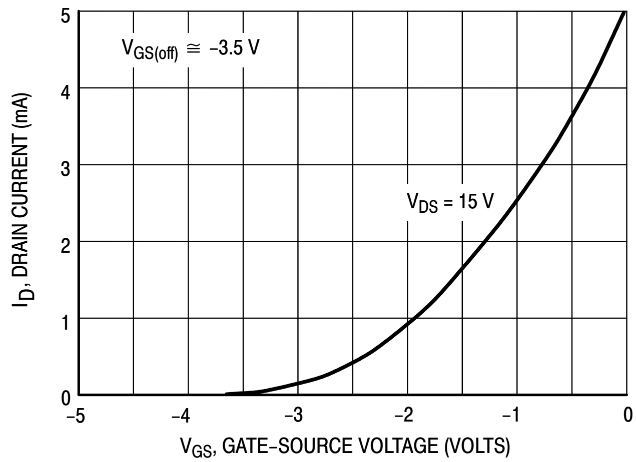


Figure 5. Common Source Transfer Characteristics

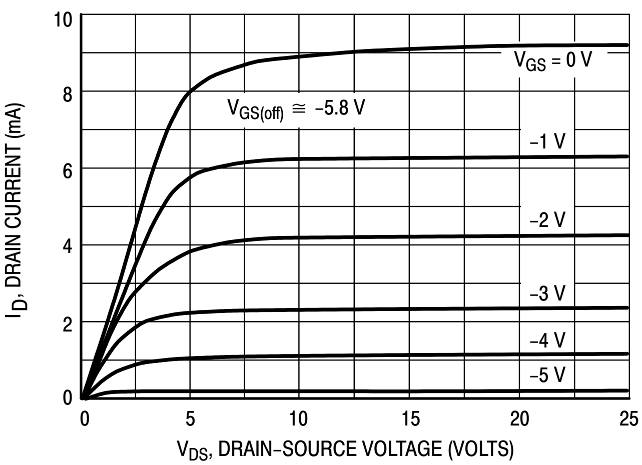


Figure 6. Typical Drain Characteristics

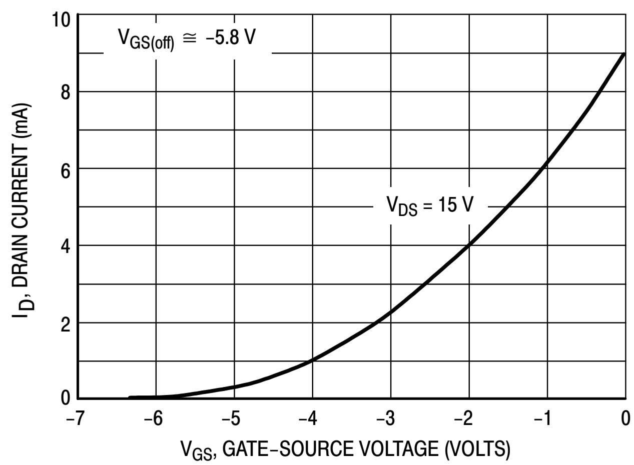


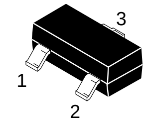
Figure 7. Common Source Transfer Characteristics

Note: Graphical data is presented for dc conditions. Tabular data is given for pulsed conditions (Pulse Width = 630 ms, Duty Cycle = 10%). Under dc conditions, self heating in higher I_{DSS} units reduces I_{DSS}.

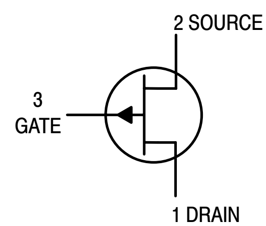
JFET - General Purpose Transistor

P–Channel

MMBF5460LT1



CASE 318–08, STYLE 10
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Gate Voltage	V_{DG}	40	Vdc
Reverse Gate–Source Voltage	V_{GSR}	40	Vdc
Forward Gate Current	I_{GF}	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBF5460LT1 = 6E

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Gate–Source Breakdown Voltage (I_G = 10 µAdc, V_{DS} = 0)	$V_{(BR)GSS}$	40	—	—	Vdc
Gate Reverse Current (V_{GS} = 20 Vdc, V_{DS} = 0) (V_{GS} = 20 Vdc, V_{DS} = 0, T_A = 100°C)	I_{GSS}	 — —	 — —	 5.0 1.0	 nAdc µAdc
Gate Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 1.0 µAdc)	$V_{GS(off)}$	0.75	—	6.0	Vdc
Gate Source Voltage (V_{DS} = 15 Vdc, I_D = 0.1 mAdc)	V_{GS}	0.5	—	4.0	Vdc
ON CHARACTERISTICS					
Zero–Gate–Voltage Drain Current (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	–1.0	—	–5.0	mAdc
SMALL–SIGNAL CHARACTERISTICS					
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|Y_{fs}\|$	1000	—	4000	µmhos
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|y_{os}\|$	—	—	75	µmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	5.0	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	1.0	2.0	pF

1. FR–5 = 1.0 × 0.75 × 0.062 in.

March, 2001 – Rev. 1
Publication Order Number:
MMBF5460LT1/D

DRAIN CURRENT versus GATE SOURCE VOLTAGE

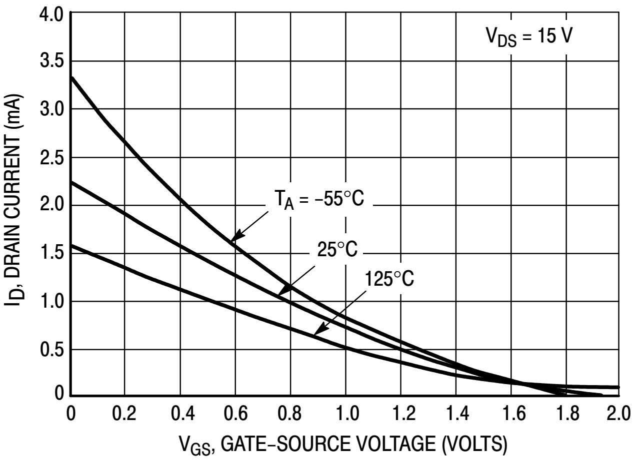


Figure 1. $V_{GS(off)}$ = 2.0 Volts

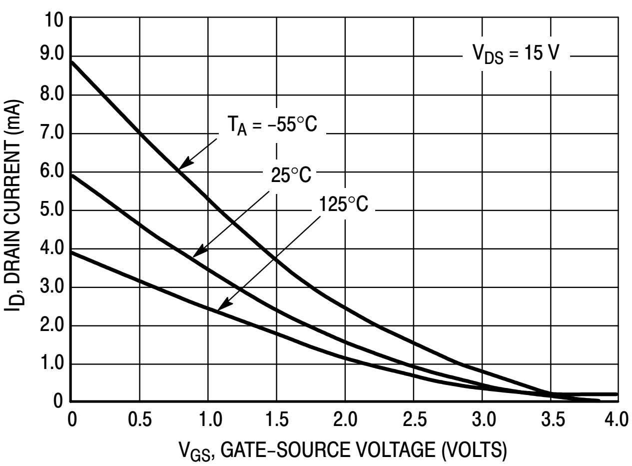


Figure 2. $V_{GS(off)}$ = 4.0 Volts

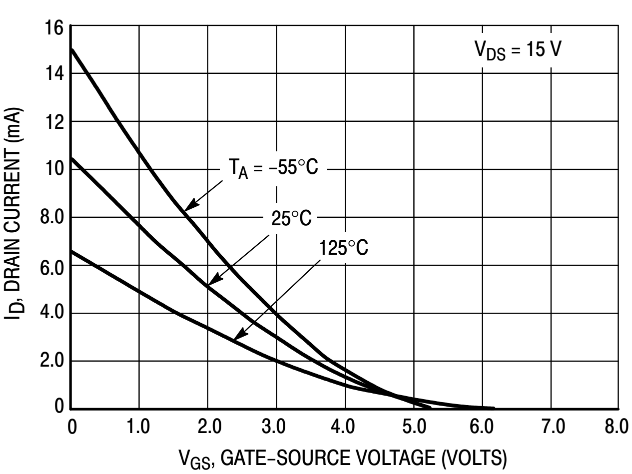


Figure 3. $V_{GS(off)}$ = 5.0 Volts

FORWARD TRANSFER ADMITTANCE versus DRAIN CURRENT

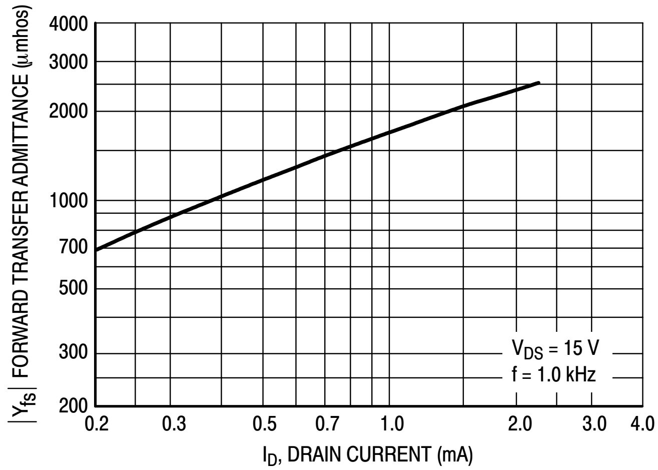


Figure 4. $V_{GS(off)}$ = 2.0 Volts

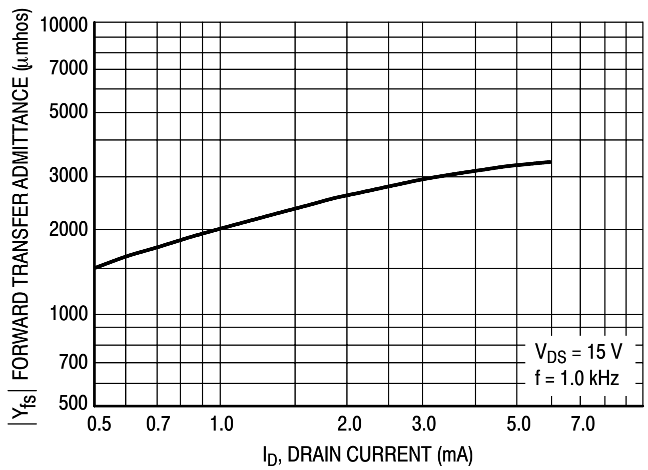


Figure 5. $V_{GS(off)}$ = 4.0 Volts

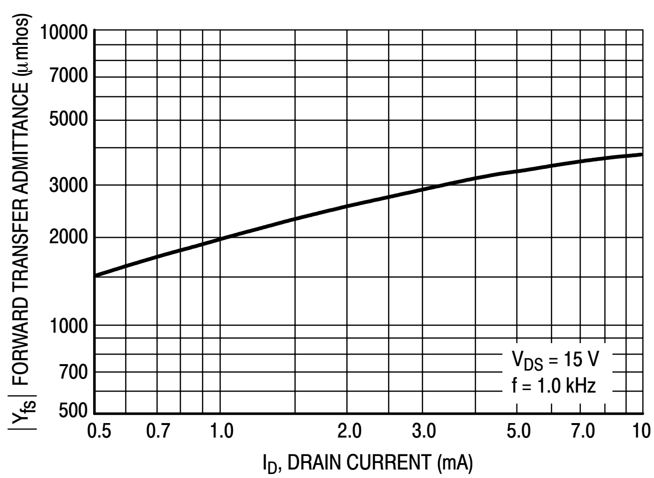


Figure 6. $V_{GS(off)}$ = 5.0 Volts

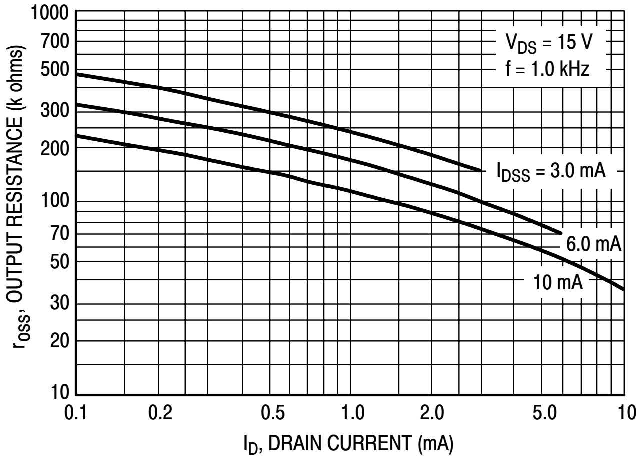


Figure 7. Output Resistance versus Drain Current

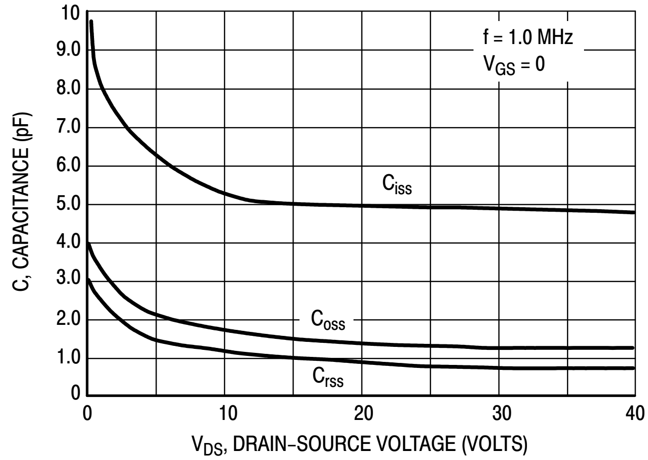


Figure 8. Capacitance versus Drain–Source Voltage

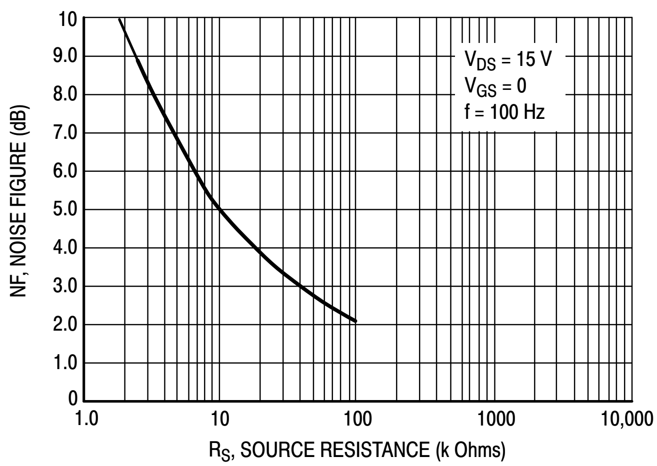
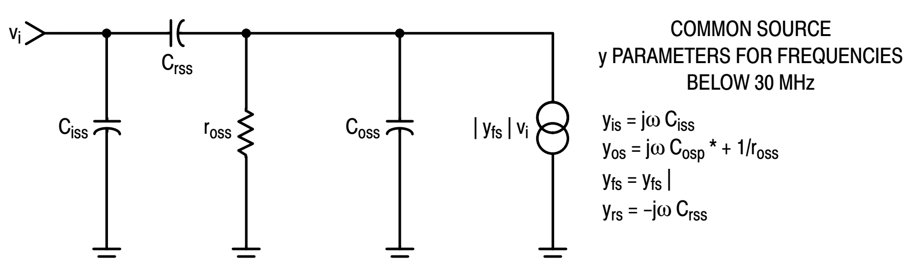


Figure 9. Noise Figure versus Source Resistance



*C_{osp} is C_{oss} in parallel with Series Combination of C_{iss} and C_{rss}.

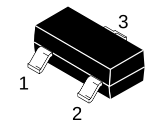
NOTE:
1. Graphical data is presented for dc conditions. Tabular data is given for pulsed conditions (Pulse Width = 630 ms, Duty Cycle = 10%).

Figure 10. Equivalent Low Frequency Circuit

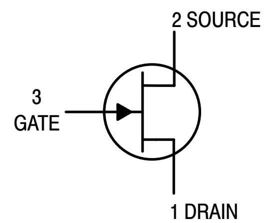
JFET Transistor
N–Channel

MMBF5484LT1

ON Semiconductor Preferred Device



CASE 318–08, STYLE 10
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Gate Voltage	V_{DG}	25	Vdc
Reverse Gate–Source Voltage	$V_{GS(r)}$	25	Vdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Continuous Device Dissipation at or Below T_C = 25°C Linear Derating Factor	P_D	200 2.8	mW mW/°C
Storage Channel Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBF5484LT1 = 6B

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate–Source Breakdown Voltage (I_G = –1.0 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	–25	—	Vdc
Gate Reverse Current (V_{GS} = –20 Vdc, V_{DS} = 0) (V_{GS} = –20 Vdc, V_{DS} = 0, T_A = 100°C)	I_{GSS}	 — —	 –1.0 –0.2	 nAdc μAdc
Gate Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 10 nAdc)	$V_{GS(off)}$	–0.3	–3.0	Vdc
ON CHARACTERISTICS				
Zero–Gate–Voltage Drain Current (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	1.0	5.0	mAdc
SMALL–SIGNAL CHARACTERISTICS				
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|Y_{fs}\|$	3000	6000	μmhos
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|y_{os}\|$	—	50	μmhos

1. FR–5 = 1.0 × 0.75 × 0.062 in.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
SMALL–SIGNAL CHARACTERISTICS (Continued)				
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	5.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 10 MHz)	C_{rss}	—	1.0	pF
Output Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	2.0	pF

COMMON SOURCE CHARACTERISTICS

ADMITTANCE PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C)

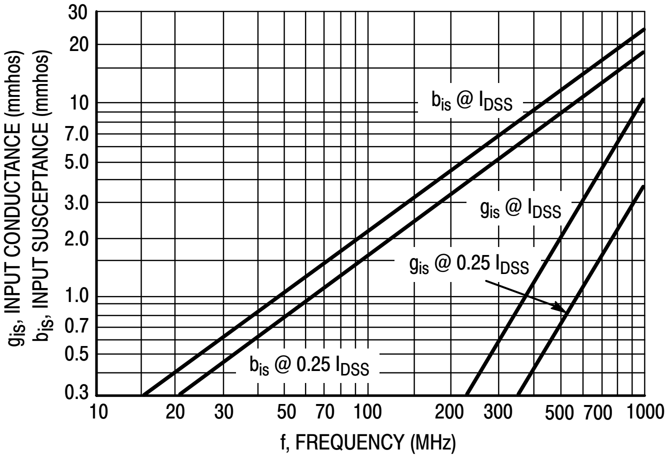


Figure 1. Input Admittance (y_{is})

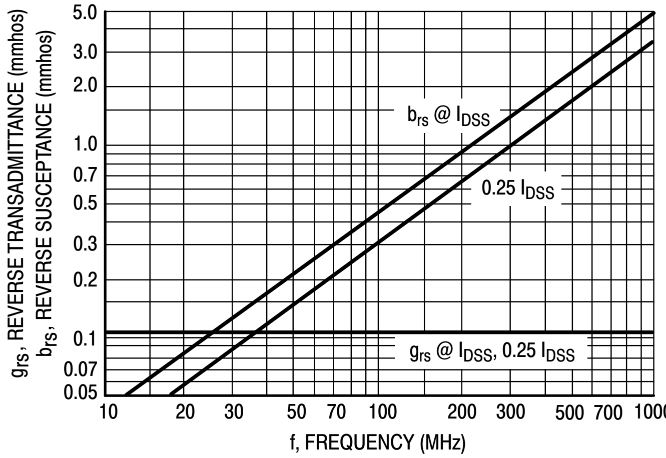


Figure 2. Reverse Transfer Admittance (y_{rs})

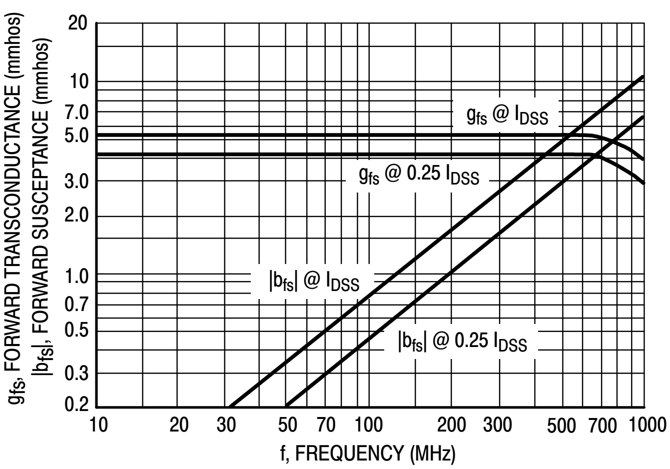


Figure 3. Forward Transadmittance (y_{fs})

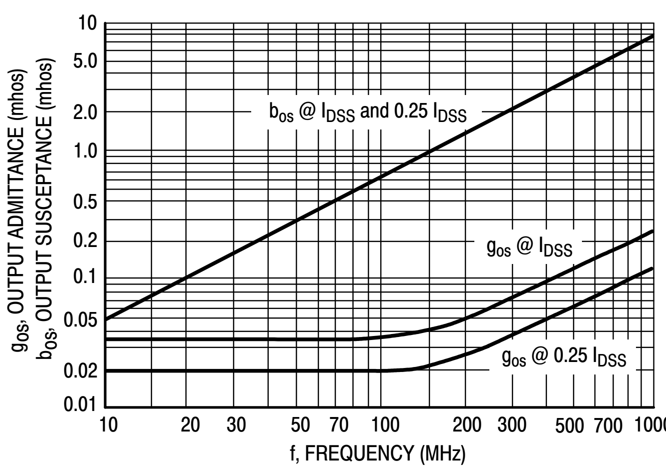


Figure 4. Output Admittance (y_{os})

COMMON SOURCE CHARACTERISTICS

S–PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

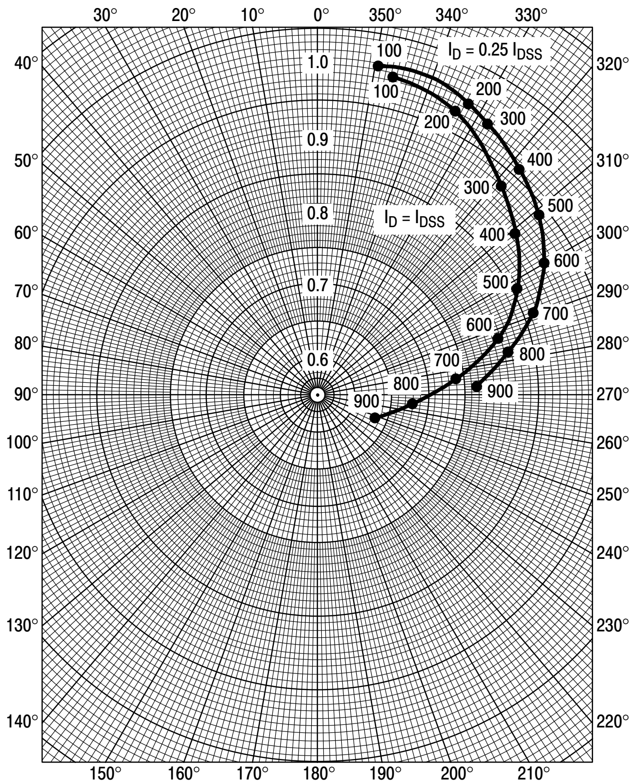


Figure 5. S_{11s}

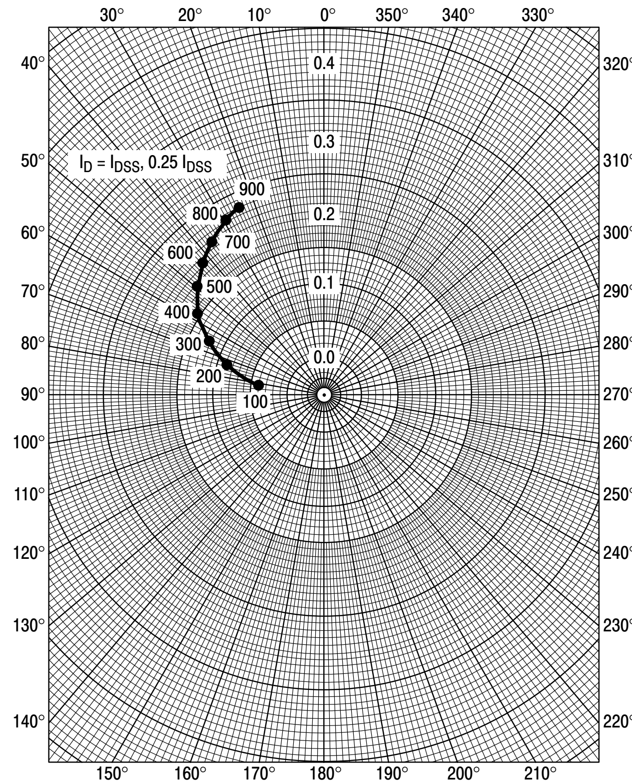


Figure 6. S_{12s}

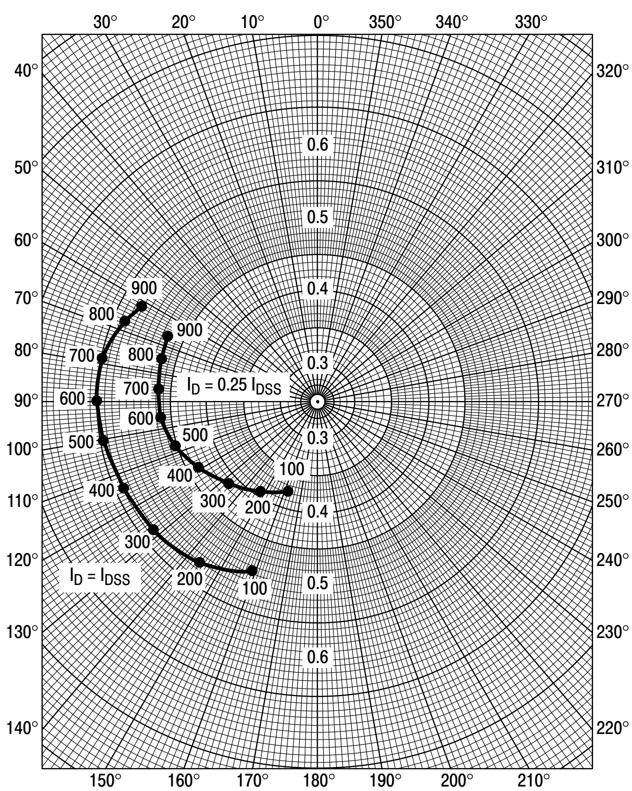


Figure 7. S_{21s}

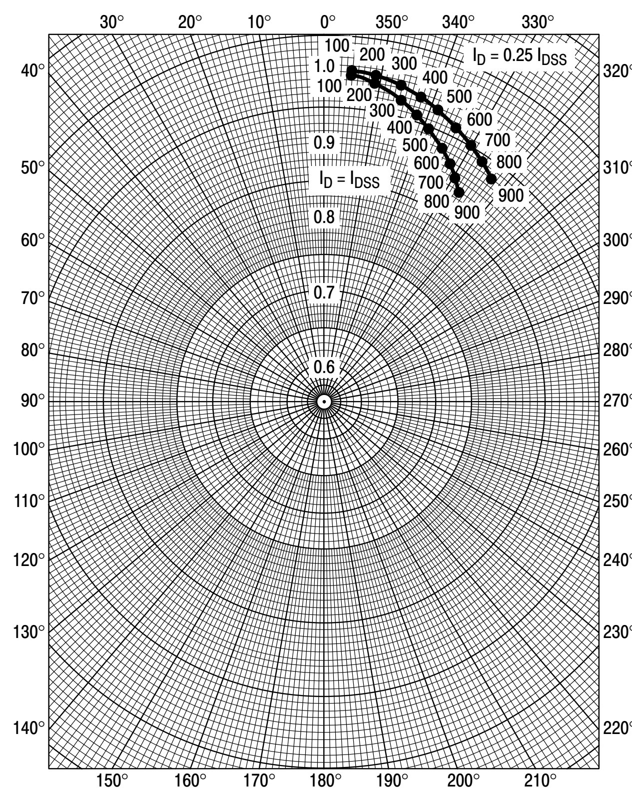


Figure 8. S_{22s}

COMMON GATE CHARACTERISTICS

ADMITTANCE PARAMETERS

(V_{DG} = 15 Vdc, $T_{channel}$ = 25°C)

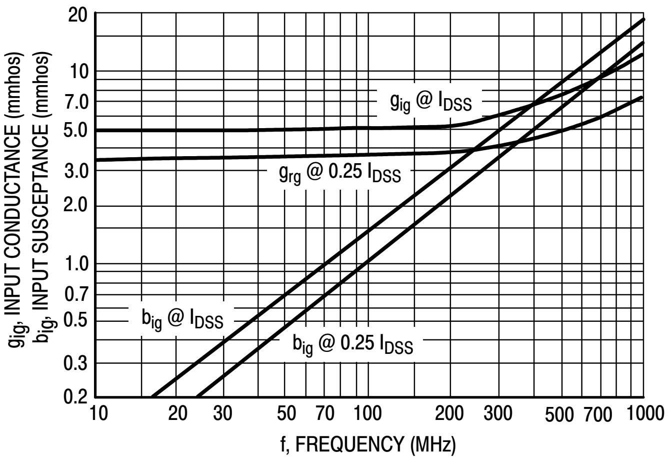


Figure 9. Input Admittance (y_{ig})

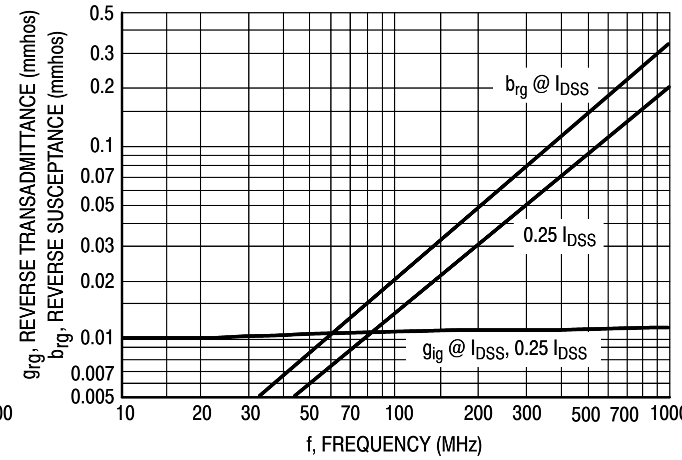


Figure 10. Reverse Transfer Admittance (y_{rg})

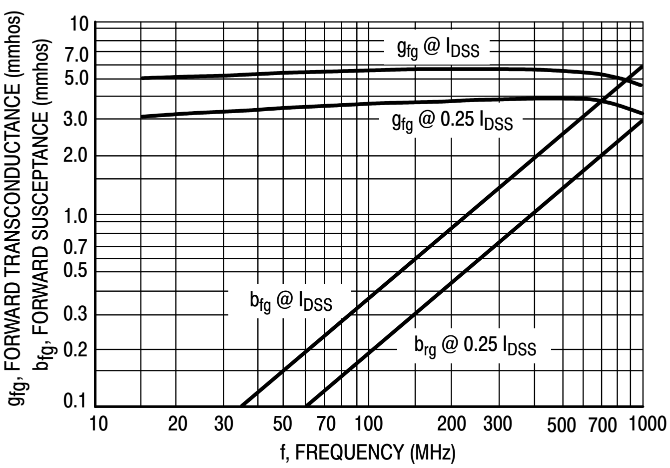


Figure 11. Forward Transfer Admittance (y_{fg})

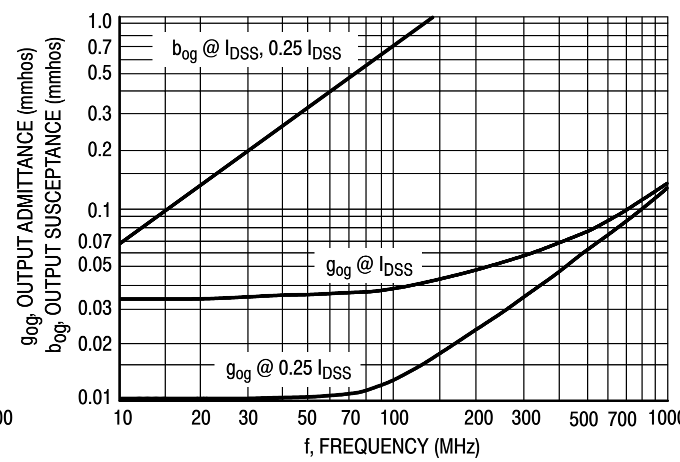


Figure 12. Output Admittance (y_{og})

COMMON GATE CHARACTERISTICS
S–PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

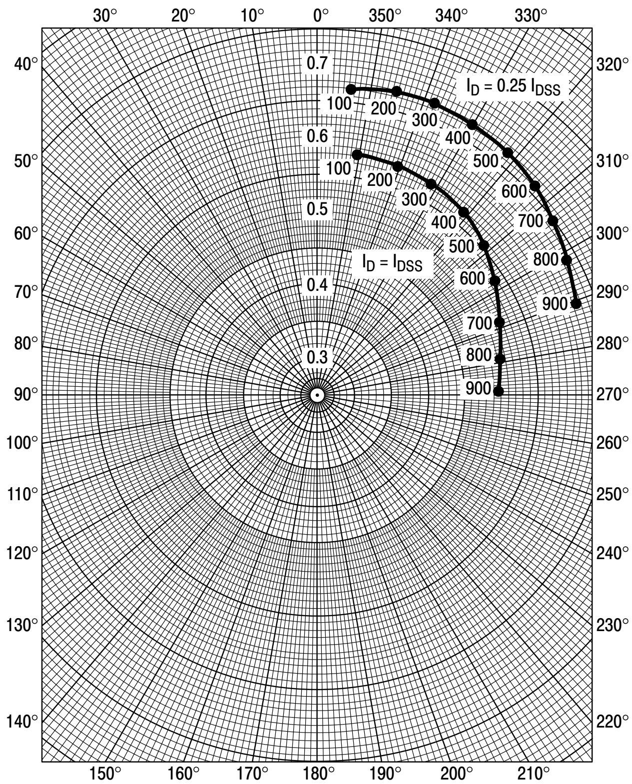


Figure 13. S_{11g}

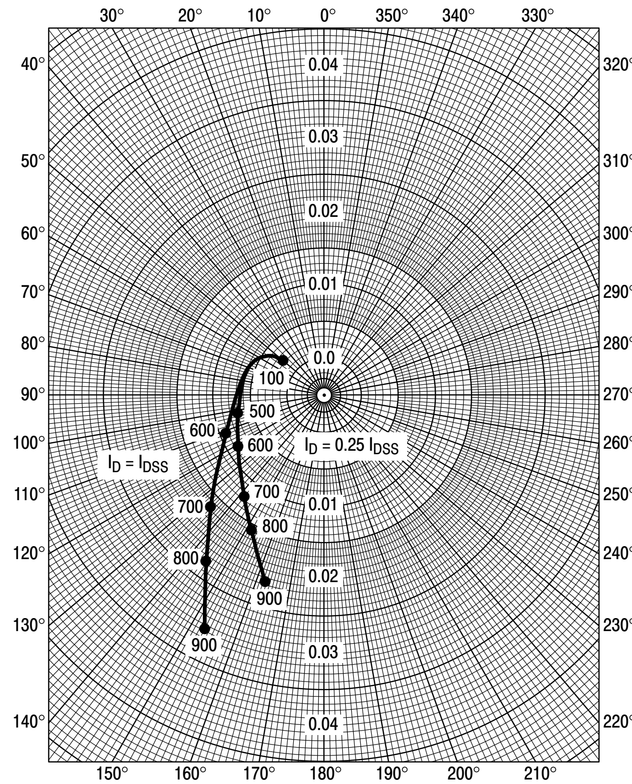


Figure 14. S_{12g}

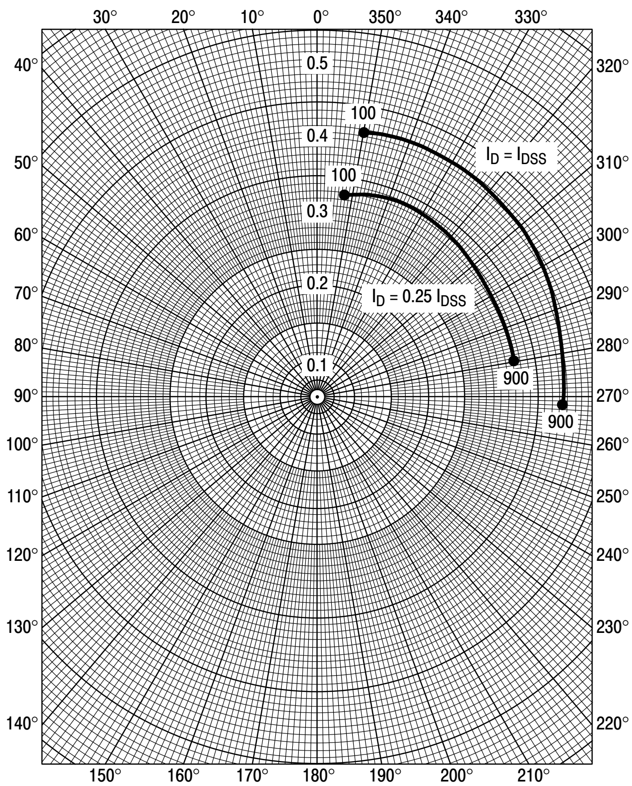


Figure 15. S_{21g}

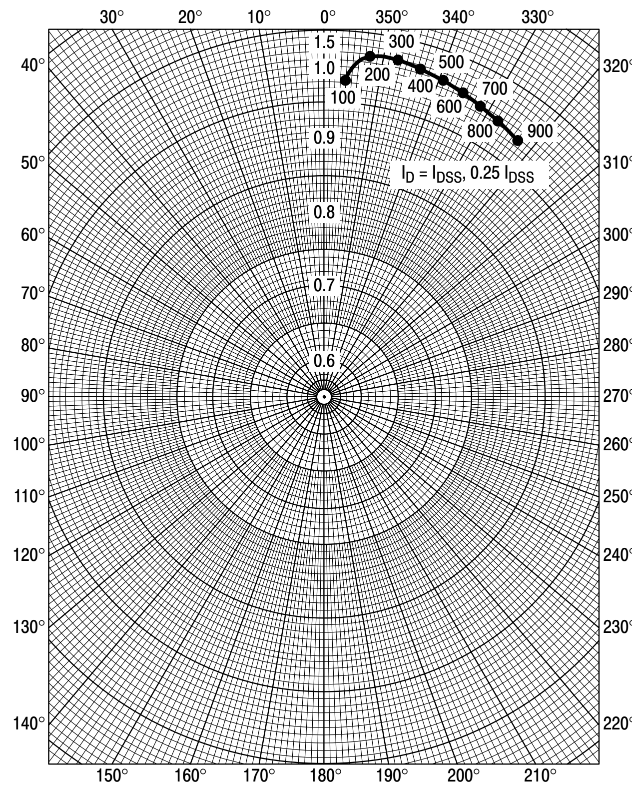
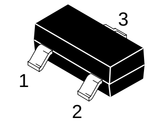


Figure 16. S_{22g}

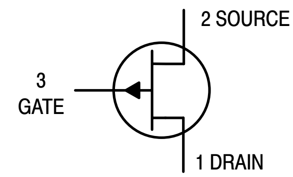
JFET Chopper
P–Channel – Depletion

MMBFJ175LT1

ON Semiconductor Preferred Device



CASE 318–08, STYLE 10
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Gate Voltage	V_{DG}	25	V
Reverse Gate–Source Voltage	$V_{GS(r)}$	–25	V

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board[(1)] T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBFJ175LT1 = 6W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate–Source Breakdown Voltage (V_{DS} = 0, I_D = 1.0 µA)		$V_{(BR)GSS}$	30	–	V
Gate Reverse Current (V_{DS} = 0 V, V_{GS} = 20 V)		I_{GSS}	–	1.0	nA
Gate–Source Cutoff Voltage (V_{DS} = 15, I_D = 10 nA)		$V_{GS(OFF)}$	3.0	6.0	V
ON CHARACTERISTICS					
Zero–Gate–Voltage Drain Current [(2)] (V_{GS} = 0, V_{DS} = 15 V)		I_{DSS}	7.0	60	mA
Drain Cutoff Current (V_{DS} = 15 V, V_{GS} = 10 V)		$I_{D(off)}$	–	1.0	nA
Drain Source On Resistance (I_D = 500 µA)		$r_{DS(on)}$	–	125	Ω
Input Capacitance	V_{DS} = 0, V_{GS} = 10 V f = 1.0 MHz	C_{iss}	–	11	pF
Reverse Transfer Capacitance		C_{rss}	–	5.5	

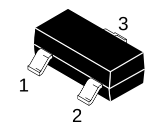
1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

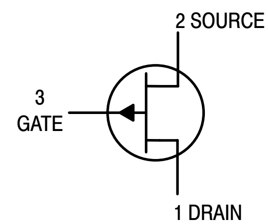
JFET Chopper

P–Channel – Depletion

MMBFJ177LT1



CASE 318–08, STYLE 10
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Gate Voltage	V_{DG}	25	Vdc
Reverse Gate–Source Voltage	$V_{GS(r)}$	–25	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBFJ177LT1 = 6Y

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

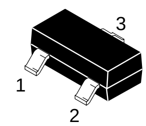
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate–Source Breakdown Voltage (V_{DS} = 0, I_D = 1.0 μAdc)		$V_{(BR)GSS}$	30	–	Vdc
Gate Reverse Current (V_{DS} = 0 Vdc, V_{GS} = 20 Vdc)		I_{GSS}	–	1.0	nAdc
Gate Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 10 nAdc)		$V_{GS(off)}$	0.8	2.5	Vdc
ON CHARACTERISTICS					
Zero–Gate–Voltage Drain Current(2) (V_{GS} = 0, V_{DS} = 15 Vdc)		I_{DSS}	1.5	20	mAdc
Drain Cutoff Current (V_{DS} = 15 Vdc, V_{GS} = 10 Vdc)		$I_{D(off)}$	–	1.0	nAdc
Drain Source On Resistance (I_D = 500 μAdc)		$r_{DS(on)}$	–	300	Ω
Input Capacitance	V_{DS} = 0, V_{GS} = 10 Vdc f = 1.0 MHz	C_{iss}	–	11	pF
Reverse Transfer Capacitance		C_{rss}	–	5.5	

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Pulse Test: Pulse Width < 300 μs, Duty Cycle ≤ 2%.

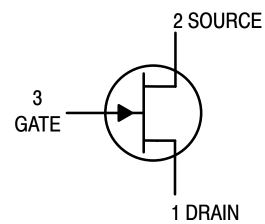
JFET - VHF/UHF Amplifier Transistor

N–Channel

MMBFJ309LT1
MMBFJ310LT1



CASE 318–08, STYLE 10
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	25	Vdc
Gate–Source Voltage	V_{GS}	25	Vdc
Gate Current	I_G	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBFJ309LT1 = 6U; MMBFJ310LT1 = 6T

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate–Source Breakdown Voltage (I_G = –1.0 µAdc, V_{DS} = 0)		$V_{(BR)GSS}$	–25	–	–	Vdc
Gate Reverse Current (V_{GS} = –15 Vdc) (V_{GS} = –15 Vdc, T_A = 125°C)		I_{GSS}	– –	– –	–1.0 –1.0	nAdc µAdc
Gate Source Cutoff Voltage (V_{DS} = 10 Vdc, I_D = 1.0 nAdc)	MMBFJ309 MMBFJ310	$V_{GS(off)}$	–1.0 –2.0	– –	–4.0 –6.5	Vdc
ON CHARACTERISTICS						
Zero–Gate–Voltage Drain Current (V_{DS} = 10 Vdc, V_{GS} = 0)	MMBFJ309 MMBFJ310	I_{DSS}	12 24	– –	30 60	mAdc
Gate–Source Forward Voltage (I_G = 1.0 mAdc, V_{DS} = 0)		$V_{GS(f)}$	–	–	1.0	Vdc
SMALL–SIGNAL CHARACTERISTICS						
Forward Transfer Admittance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 1.0 kHz)		$\|Y_{fs}\|$	8.0	–	18	mmhos
Output Admittance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 1.0 kHz)		$\|y_{os}\|$	–	–	250	µmhos
Input Capacitance (V_{GS} = –10 Vdc, V_{DS} = 0 Vdc, f = 1.0 MHz)		C_{iss}	–	–	5.0	pF
Reverse Transfer Capacitance (V_{GS} = –10 Vdc, V_{DS} = 0 Vdc, f = 1.0 MHz)		C_{rss}	–	–	2.5	pF
Equivalent Short–Circuit Input Noise Voltage (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 100 Hz)		$\overline{e}_n$	–	10	–	$nV/\sqrt{Hz}$

1. FR–5 = 1.0 × 0.75 × 0.062 in.

March, 2001 – Rev. 1
Publication Order Number:
MMBFJ309LT1/D

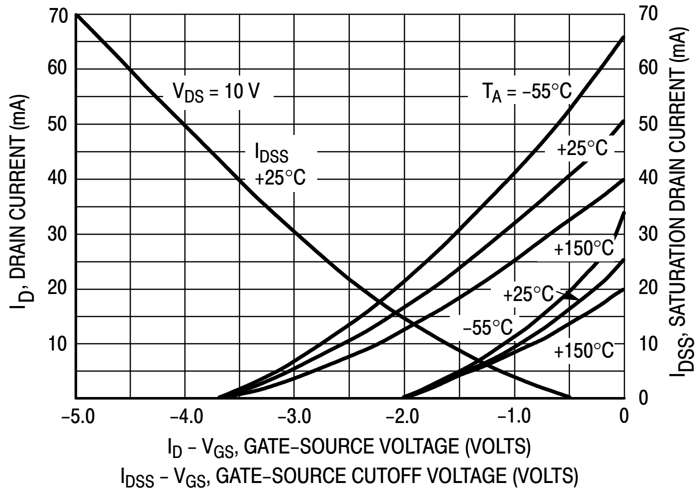


Figure 1. Drain Current and Transfer Characteristics versus Gate–Source Voltage

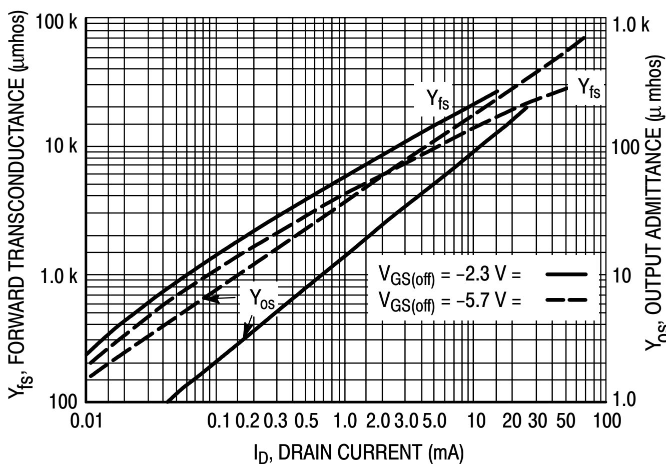


Figure 2. Common–Source Output Admittance and Forward Transconductance versus Drain Current

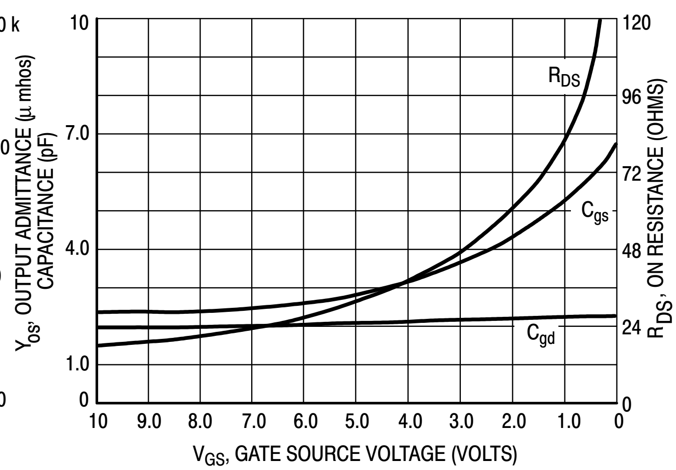


Figure 3. On Resistance and Junction Capacitance versus Gate–Source Voltage

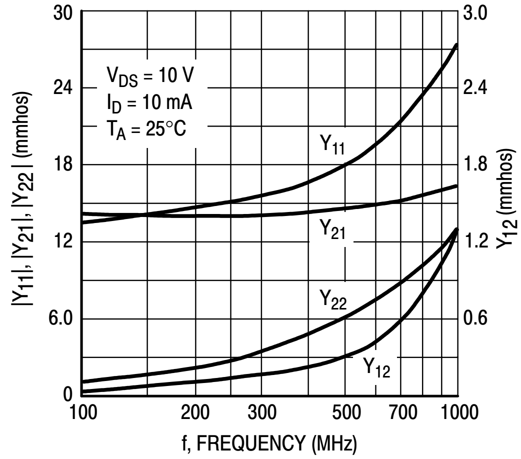


Figure 4. Common–Gate Y Parameter Magnitude versus Frequency

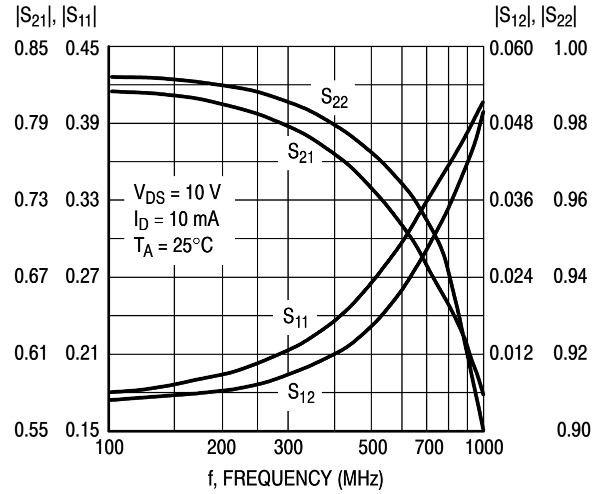


Figure 5. Common–Gate S Parameter Magnitude versus Frequency

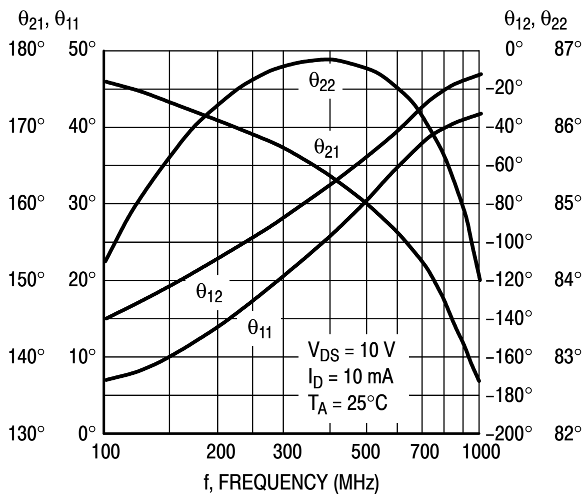


Figure 6. Common–Gate Y Parameter Phase–Angle versus Frequency

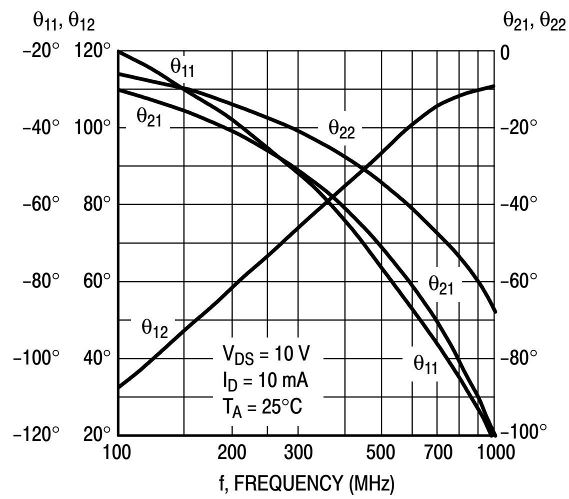


Figure 7. S Parameter Phase–Angle versus Frequency

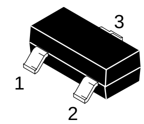
JFET Transistor
N–Channel

MMBFU310LT1

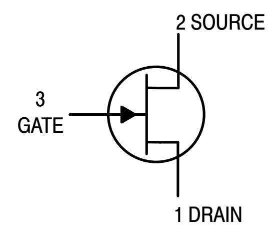
ON Semiconductor Preferred Device

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	25	Vdc
Gate–Source Voltage	V_{GS}	25	Vdc
Gate Current	I_G	10	mAdc



CASE 318–08, STYLE 10
SOT–23 (TO–236AB)



THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBFU310LT1 = 6C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate–Source Breakdown Voltage (I_G = –1.0 µAdc, V_{DS} = 0)	$V_{(BR)GSS}$	–25	–	Vdc
Gate 1 Leakage Current (V_{GS} = –15 Vdc, V_{DS} = 0)	I_{G1SS}	–	–150	pA
Gate 2 Leakage Current (V_{GS} = –15 Vdc, V_{DS} = 0, T_A = 125°C)	I_{G2SS}	–	–150	nAdc
Gate Source Cutoff Voltage (V_{DS} = 10 Vdc, I_D = 1.0 nAdc)	$V_{GS(off)}$	–2.5	–6.0	Vdc
ON CHARACTERISTICS				
Zero–Gate–Voltage Drain Current (V_{DS} = 10 Vdc, V_{GS} = 0)	I_{DSS}	24	60	mAdc
Gate–Source Forward Voltage (I_G = 10 mAdc, V_{DS} = 0)	$V_{GS(f)}$	–	1.0	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Forward Transfer Admittance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 1.0 kHz)	$\|Y_{fs}\|$	10	18	mmhos
Output Admittance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 1.0 kHz)	$\|y_{os}\|$	–	250	µmhos
Input Capacitance (V_{GS} = –10 Vdc, V_{DS} = 0 Vdc, f = 1.0 MHz)	C_{iss}	–	5.0	pF
Reverse Transfer Capacitance (V_{GS} = –10 Vdc, V_{DS} = 0 Vdc, f = 1.0 MHz)	C_{rss}	–	2.5	pF

1. FR–5 = 1.0 × 0.75 × 0.062 in.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

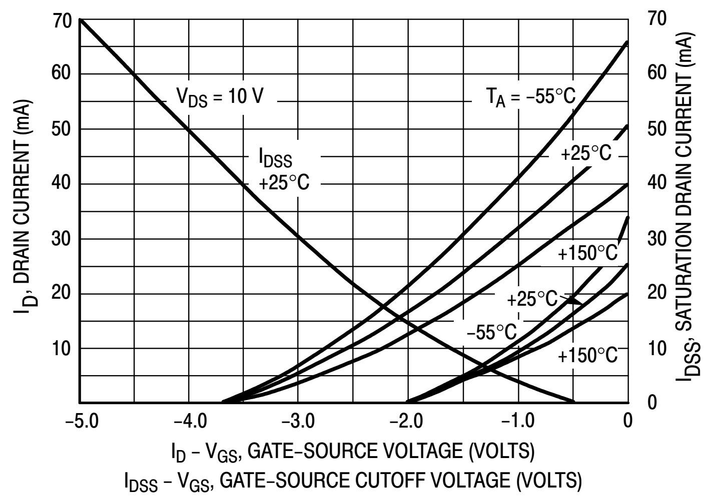


Figure 1. Drain Current and Transfer Characteristics versus Gate−Source Voltage

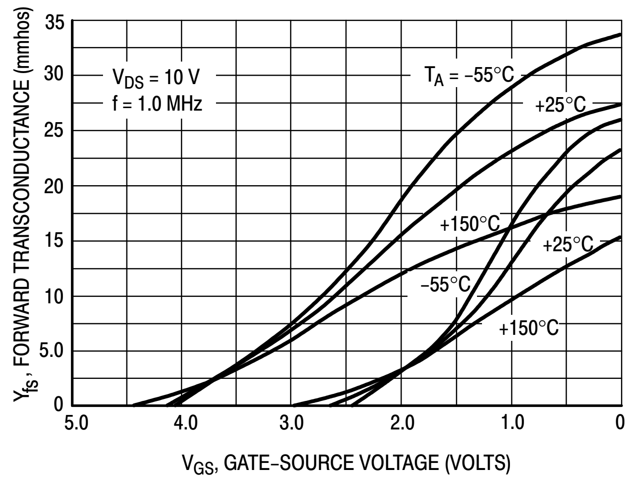


Figure 2. Forward Transconductance versus Gate−Source Voltage

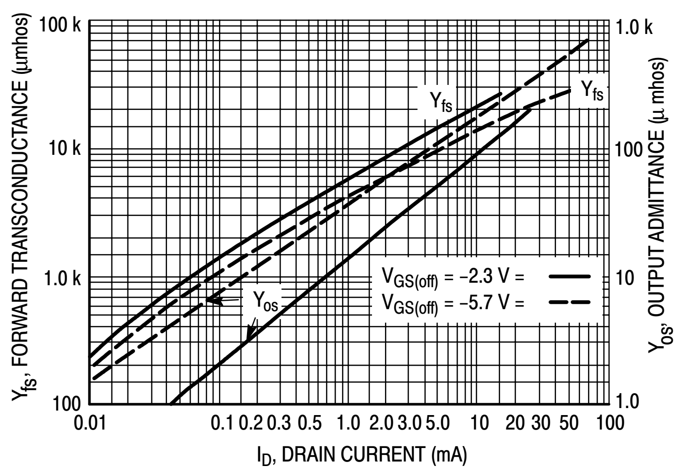


Figure 3. Common−Source Output Admittance and Forward Transconductance versus Drain Current

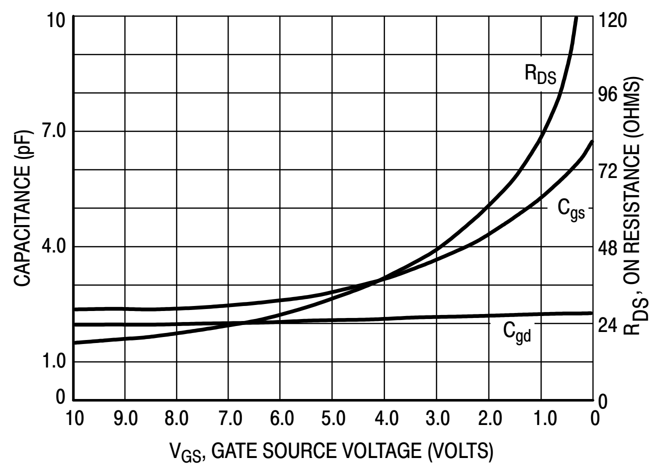


Figure 4. On Resistance and Junction Capacitance versus Gate−Source Voltage

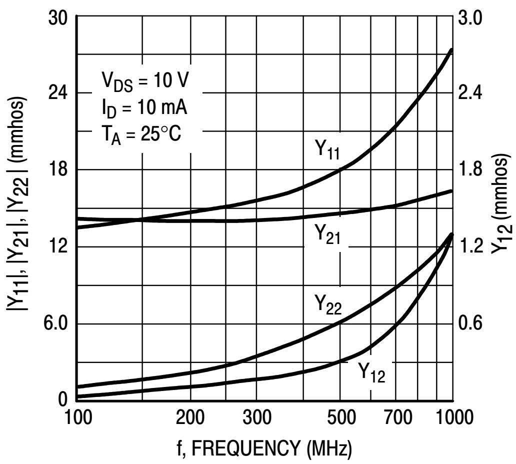


Figure 5. Common–Gate Y Parameter Magnitude versus Frequency

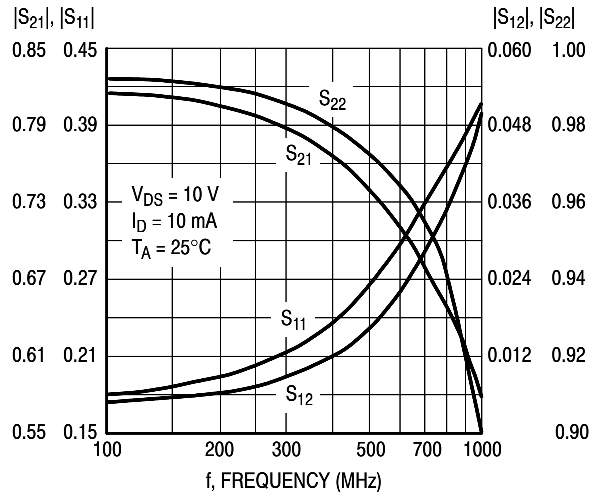


Figure 6. Common–Gate S Parameter Magnitude versus Frequency

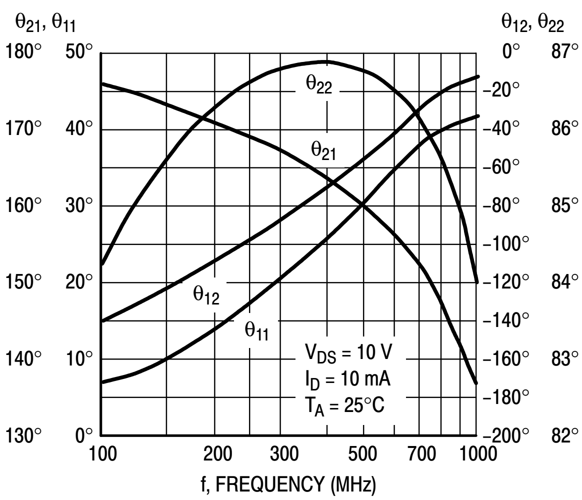


Figure 7. Common–Gate Y Parameter Phase–Angle versus Frequency

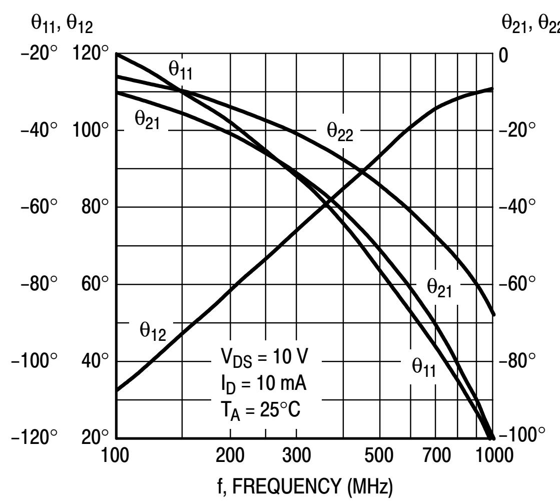


Figure 8. S Parameter Phase–Angle versus Frequency

General Purpose Transistors

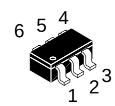
PNP Bipolar Junction Transistor

(Complementary NPN Device: MMBT2132T1/T3)

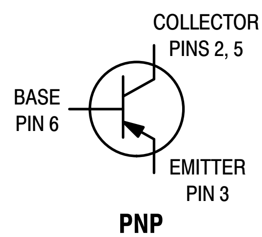
NOTE: Voltage and Current are negative for the PNP Transistor.

MMBT2131T1
MMBT2131T3

0.7 AMPERES
30 VOLTS – $V_{(BR)CEO}$
342 mW



CASE 318F–02, STYLE 2
SC–59 – 6 Lead



MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	30	V
Collector–Base Voltage	V_{CBO}	40	V
Emitter–Base Voltage	V_{EBO}	5.0	V
Collector Current	I_C	700	mA
Base Current	I_B	350	mA
Total Power Dissipation @ T_C = 25°C Total Power Dissipation @ T_C = 85°C Thermal Resistance – Junction to Ambient (1)	P_D P_D $R_{\theta JA}$	342 178 366	mW mW °C/W
Total Power Dissipation @ T_C = 25°C Total Power Dissipation @ T_C = 85°C Thermal Resistance – Junction to Ambient (2)	P_D P_D $R_{\theta JA}$	665 346 188	mW mW °C/W
Operating and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Base Breakdown Voltage	(I_C = 100 μAdc)	$V_{(BR)CBO}$	40	–	–	Vdc
Collector–Emitter Breakdown Voltage	(I_C = 10 mAdc)	$V_{(BR)CEO}$	30	–	–	Vdc
Emitter–Base Breakdown Voltage	(I_E = 100 μAdc)	$V_{(BR)EBO}$	5.0	–	–	Vdc
Collector Cutoff Current	(V_{CB} = 25 Vdc, I_E = 0 Adc) (V_{CB} = 25 Vdc, I_E = 0 Adc, T_A = 125°C)	I_{CBO}	– –	– –	1.0 10	μAdc
Emitter Cutoff Current	(V_{EB} = 5.0 Vdc, I_C = 0 Adc)	I_{EBO}	–	–	10	μAdc
ON CHARACTERISTICS						
DC Current Gain	(V_{CE} = 3.0 Vdc, I_C = 100 mAdc)	h_{FE}	150	–	–	Vdc
Collector–Emitter Saturation Voltage	(I_C = 500 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	–	–	0.25	Vdc
Collector–Emitter Saturation Voltage	(I_C = 700 mAdc, I_B = 70 mAdc)	$V_{CE(sat)}$	–	–	0.4	Vdc
Base–Emitter Saturation Voltage	(I_C = 700 mAdc, I_B = 70 mAdc)	$V_{BE(sat)}$	–	–	1.1	Vdc
Collector–Emitter Saturation Voltage	(I_C = 700 mAdc, V_{CE} = 1.0 Vdc)	$V_{BE(on)}$	–	–	1.0	Vdc

1. Minimum FR–4 or G–10 PCB, Operating to Steady State.
2. Mounted onto a 2″ square FR–4 Board (1″ sq. 2 oz Cu 0.06″ thick single sided), Operating to Steady State.

June, 2001 – Rev. 1
Publication Order Number:
MMBT2131T1/D

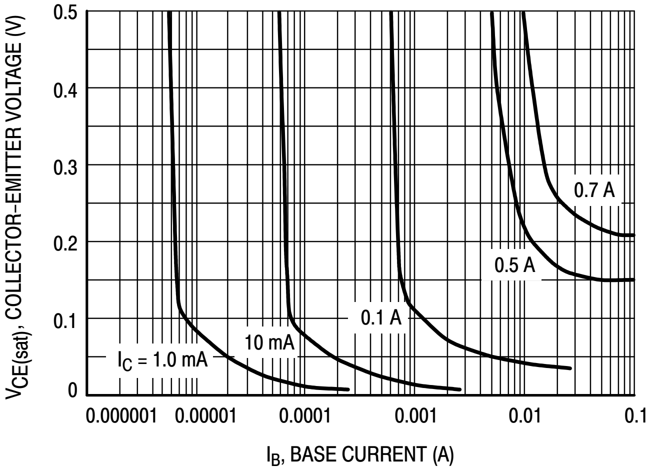


Figure 1. Collector Saturation Region

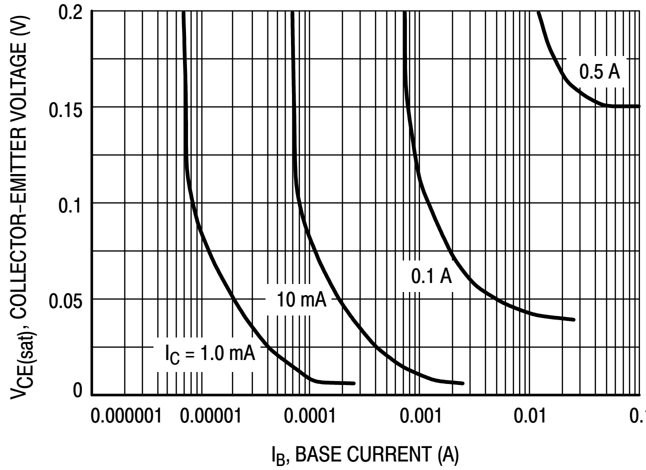


Figure 2. Collector Saturation Region

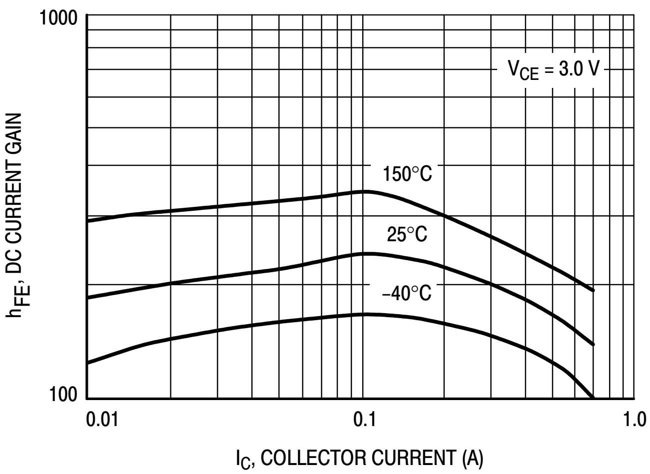


Figure 3. DC Current Gain

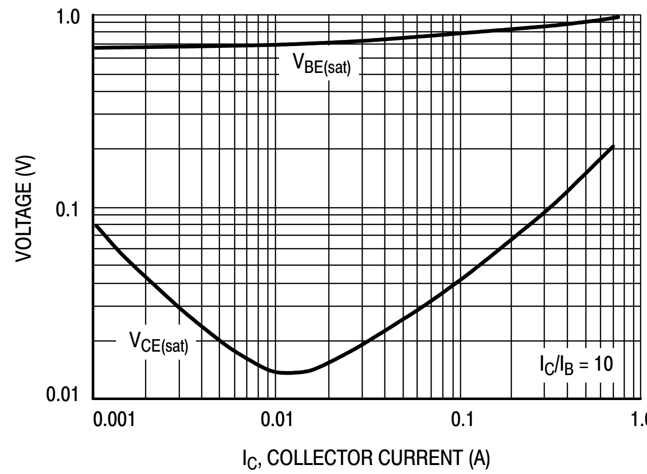


Figure 4. “ON” Voltages

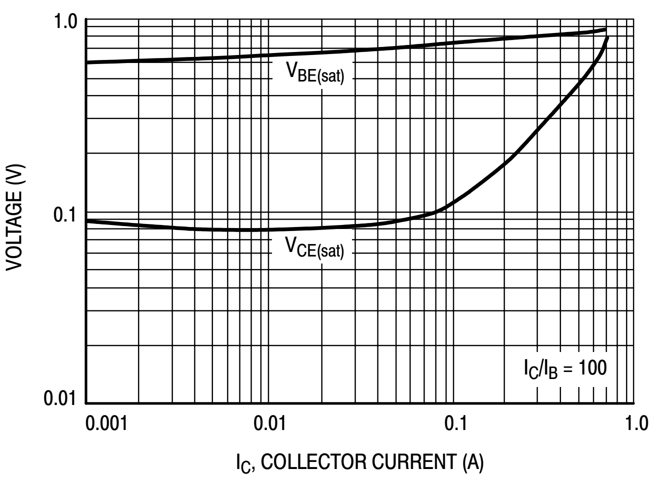


Figure 5. “ON” Voltages

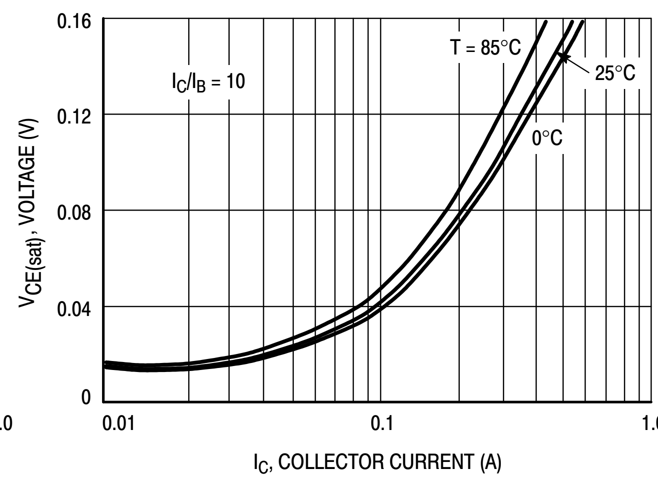


Figure 6. Collector–Emitter Saturation Voltage

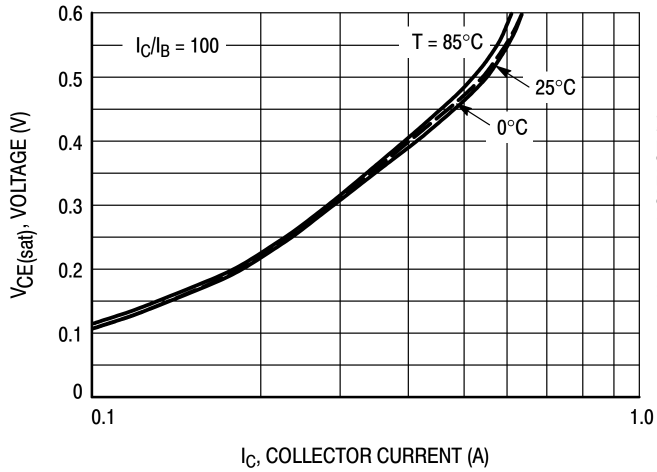


Figure 7. Collector–Emitter Saturation Voltage

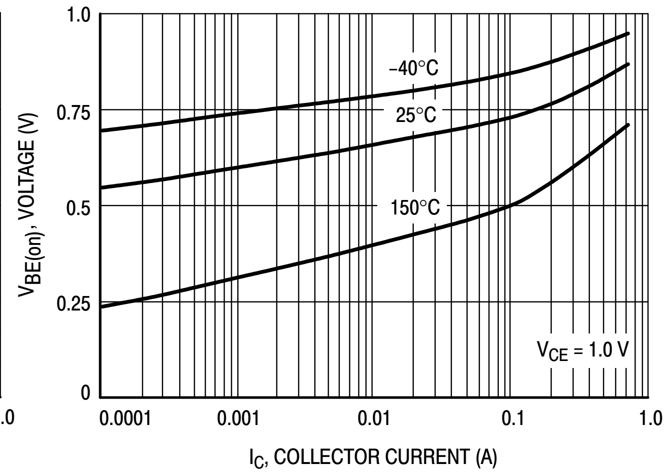


Figure 8. $V_{BE(on)}$ Voltage

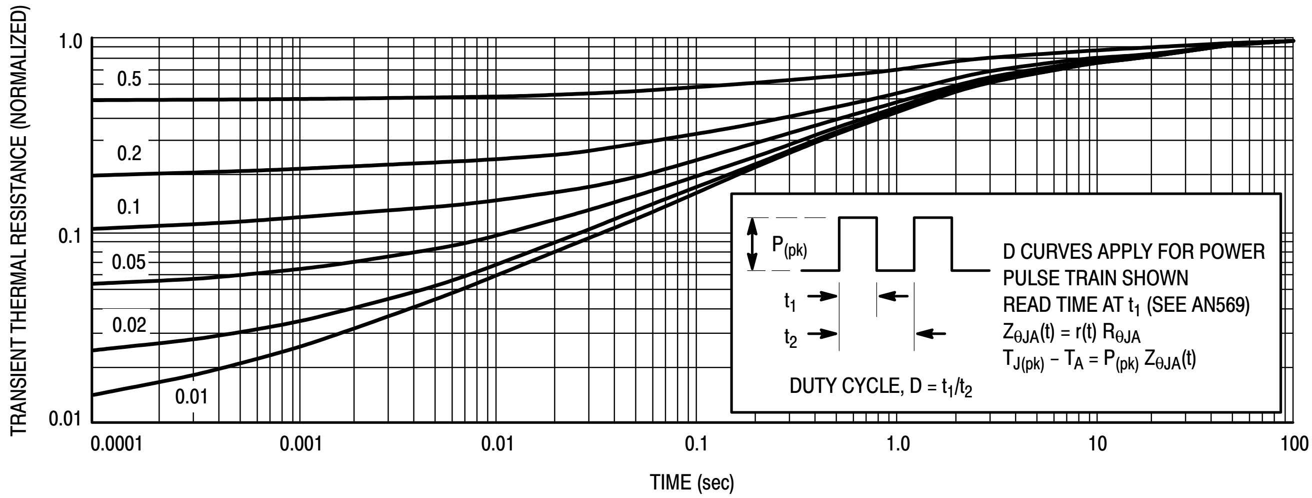


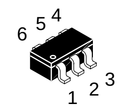
Figure 9. Thermal Response Curve

MMBT2132T1
MMBT2132T3

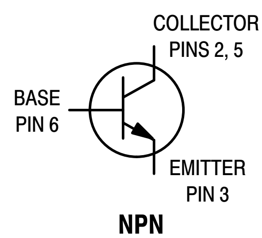
General Purpose Transistors
NPN Bipolar Junction Transistor

(Complementary PNP Device: MMBT2131T1/T3)

0.7 AMPERES
30 VOLTS – $V_{(BR)CEO}$
342 mW



CASE 318F–03, STYLE 2
SC–59 – 6 Lead



MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	30	V
Collector–Base Voltage	V_{CBO}	40	V
Emitter–Base Voltage	V_{EBO}	5.0	V
Collector Current	I_C	700	mA
Base Current	I_B	350	mA
Total Power Dissipation @ T_C = 25°C Total Power Dissipation @ T_C = 85°C Thermal Resistance – Junction to Ambient (1)	P_D P_D $R_{\theta JA}$	342 178 366	mW mW °C/W
Total Power Dissipation @ T_C = 25°C Total Power Dissipation @ T_C = 85°C Thermal Resistance – Junction to Ambient (2)	P_D P_D $R_{\theta JA}$	665 346 188	mW mW °C/W
Operating and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Base Breakdown Voltage	(I_C = 100 μAdc)	$V_{(BR)CBO}$	40	–	–	Vdc
Collector–Emitter Breakdown Voltage	(I_C = 10 mAdc)	$V_{(BR)CEO}$	30	–	–	Vdc
Emitter–Base Breakdown Voltage	(I_E = 100 μAdc)	$V_{(BR)EBO}$	5.0	–	–	Vdc
Collector Cutoff Current	(V_{CB} = 25 Vdc, I_E = 0 Adc) (V_{CB} = 25 Vdc, I_E = 0 Adc, T_A = 125°C)	I_{CBO}	– –	– –	1.0 10	μAdc
Emitter Cutoff Current	(V_{EB} = 5.0 Vdc, I_C = 0 Adc)	I_{EBO}	–	–	10	μAdc
ON CHARACTERISTICS						
DC Current Gain	(V_{CE} = 3.0 Vdc, I_C = 100 mAdc)	h_{FE}	150	–	–	Vdc
Collector–Emitter Saturation Voltage	(I_C = 500 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	–	–	0.25	Vdc
Collector–Emitter Saturation Voltage	(I_C = 700 mAdc, I_B = 70 mAdc)	$V_{CE(sat)}$	–	–	0.4	Vdc
Base–Emitter Saturation Voltage	(I_C = 700 mAdc, I_B = 70 mAdc)	$V_{BE(sat)}$	–	–	1.1	Vdc
Collector–Emitter Saturation Voltage	(I_C = 700 mAdc, V_{CE} = 1.0 Vdc)	$V_{BE(on)}$	–	–	1.0	Vdc

1. Minimum FR–4 or G–10 PCB, Operating to Steady State.
2. Mounted onto a 2″ square FR–4 Board (1″ sq. 2 oz Cu 0.06″ thick single sided), Operating to Steady State.

June, 2001 – Rev. 1

Publication Order Number:
MMBT2132T1/D

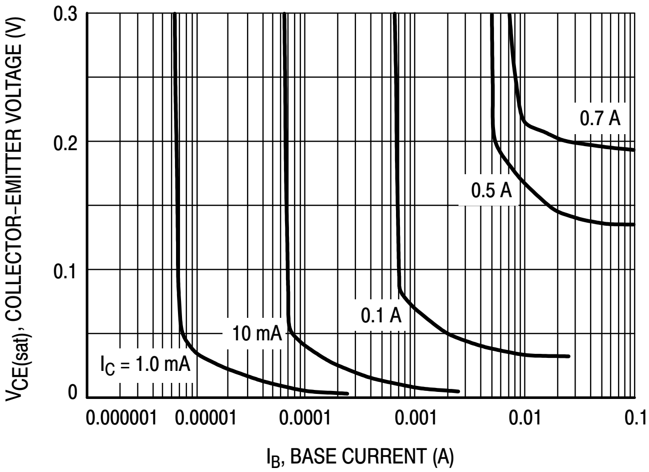


Figure 1. Collector Saturation Region

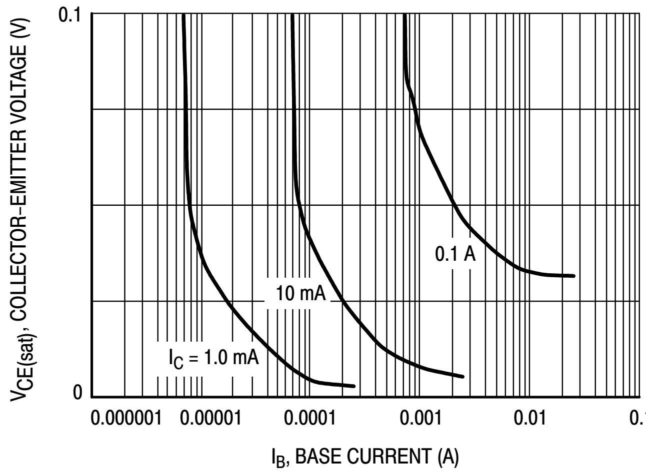


Figure 2. Collector Saturation Region

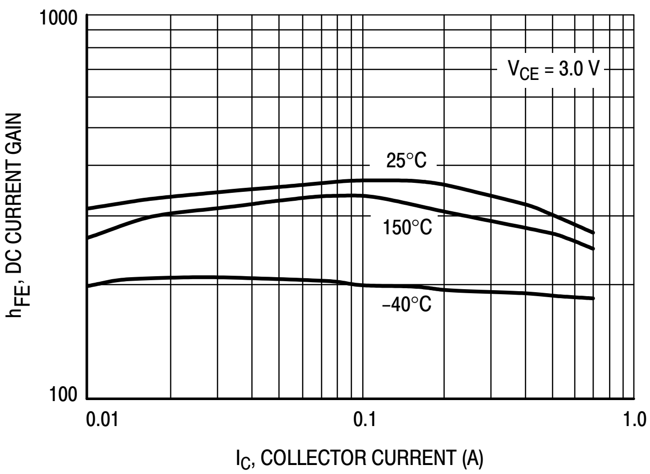


Figure 3. DC Current Gain

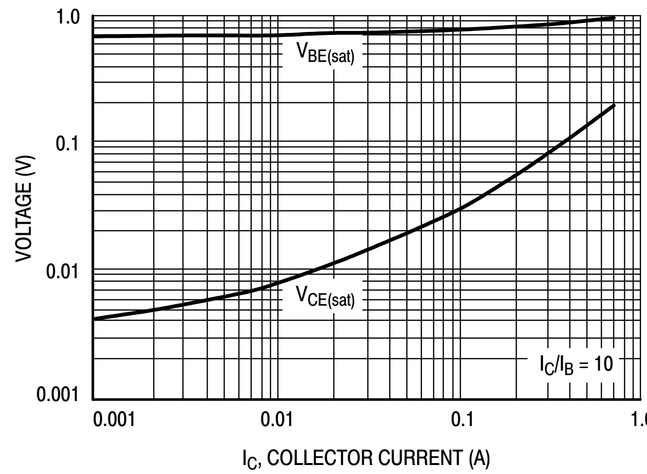


Figure 4. "ON" Voltages

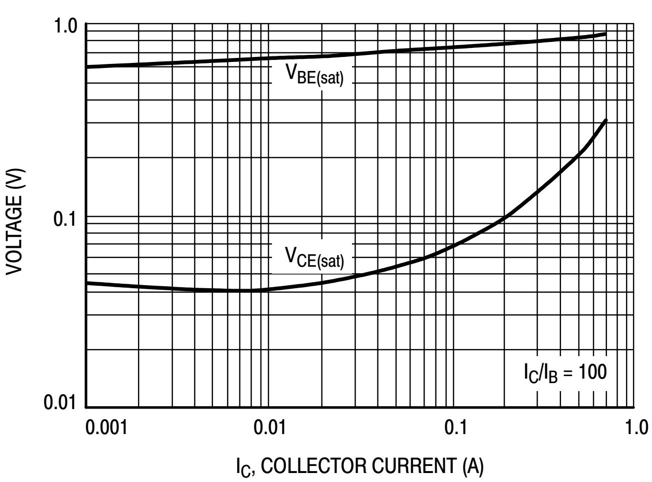


Figure 5. "ON" Voltages

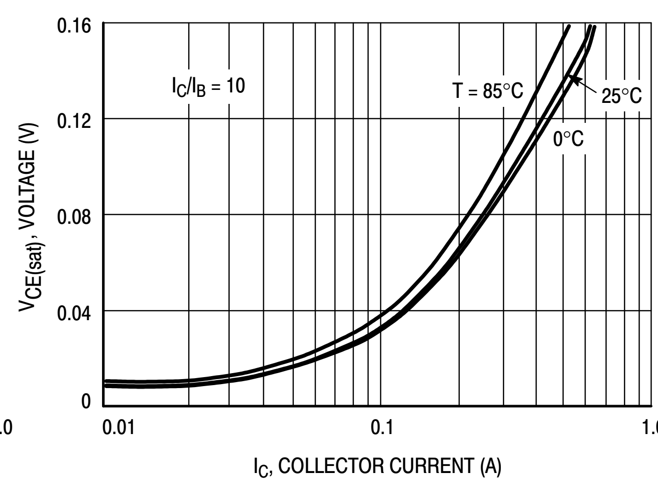


Figure 6. Collector–Emitter Saturation Voltage

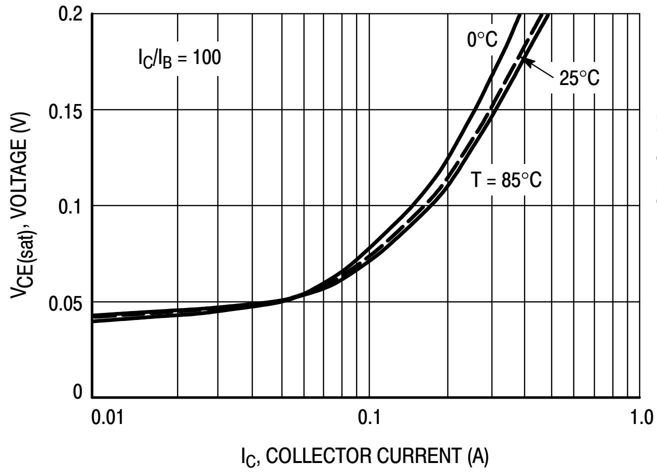


Figure 7. Collector–Emitter Saturation Voltage

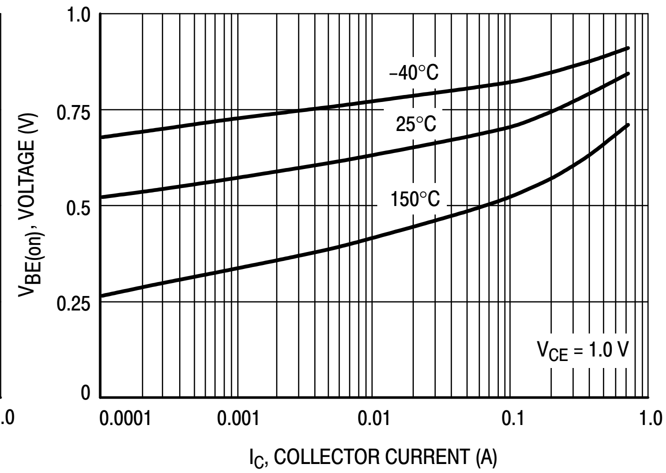


Figure 8. $V_{BE(on)}$ Voltage

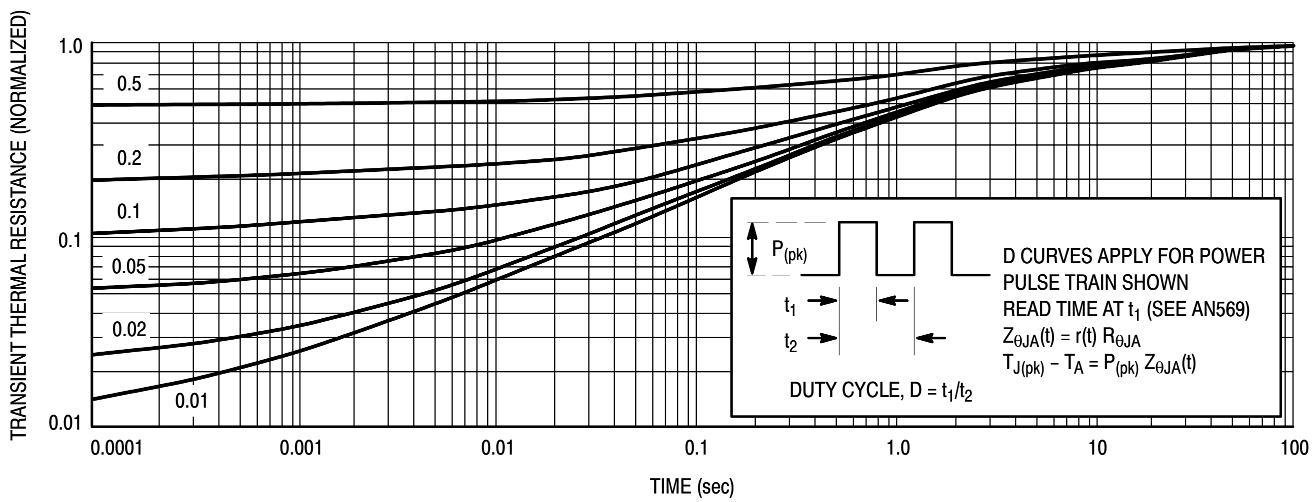


Figure 9. Thermal Response Curve

MMBT2222ATT1

Preferred Device

General Purpose Transistor

NPN Silicon

These transistors are designed for general purpose amplifier applications. They are housed in the SOT–416/SC–75 package which is designed for low power surface mount applications.

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	75	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current – Continuous	I_C	600	mAdc

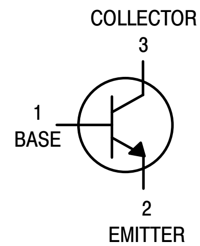
THERMAL CHARACTERISTICS

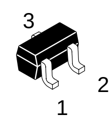
Characteristic	Symbol	Max	Unit
Total Device Dissipation, (1) T_A = 25°C	P_D	150	mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	833	°C/W
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) Device mounted on FR–4 glass epoxy printed circuit board using the minimum recommended footpad.

ON Semiconductor

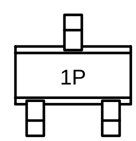
http://onsemi.com





CASE 463
SOT–416/SC–75
STYLE 1

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
MMBT2222ATT1	SOT–416	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

April, 2000 – Rev. 1

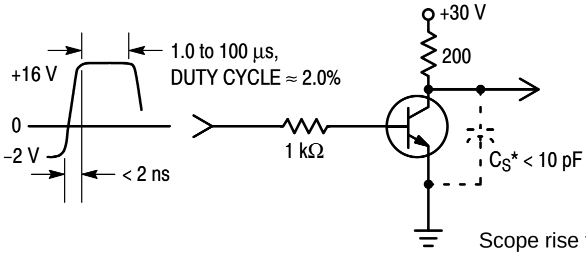
Publication Order Number:
MMBT2222ATT1/D

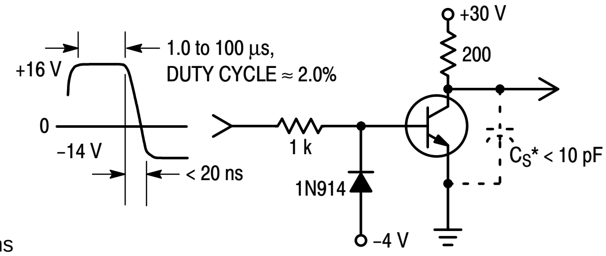
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	75	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current (V_{CE} = 60 Vdc, V_{EB} = 3.0 Vdc)		I_{BL}	—	20	nAdc
Collector Cutoff Current (V_{CE} = 60 Vdc, V_{EB} = 3.0 Vdc)		I_{CEX}	—	10	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain (1)		H_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)			35	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)			50	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)			75	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)			100	—	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)			40	—	
Collector–Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	0.3	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	1.0	
Base–Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			0.6	1.2	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	2.0	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	300	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	30	pF
Input Impedance (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)		h_{ie}	0.25	1.25	k ohms
Voltage Feedback Ratio (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)		h_{re}	—	4.0	X 10^{-4}
Small–Signal Current Gain (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)		h_{fe}	75	375	—
Output Admittance (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)		h_{oe}	25	200	μmhos
Noise Figure (V_{CE} = 10 Vdc, I_C = 100 μAdc, R_S = 1.0 k ohms, f = 1.0 kHz)		NF	—	4.0	dB
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = –0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	—	10	ns
Rise Time		t_r	—	25	
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	—	225	ns
Fall Time		t_f	—	60	

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS





Scope rise time < 4 ns
*Total shunt capacitance of test jig, connectors, and oscilloscope.

Figure 1. Turn−On Time

Figure 2. Turn−Off Time

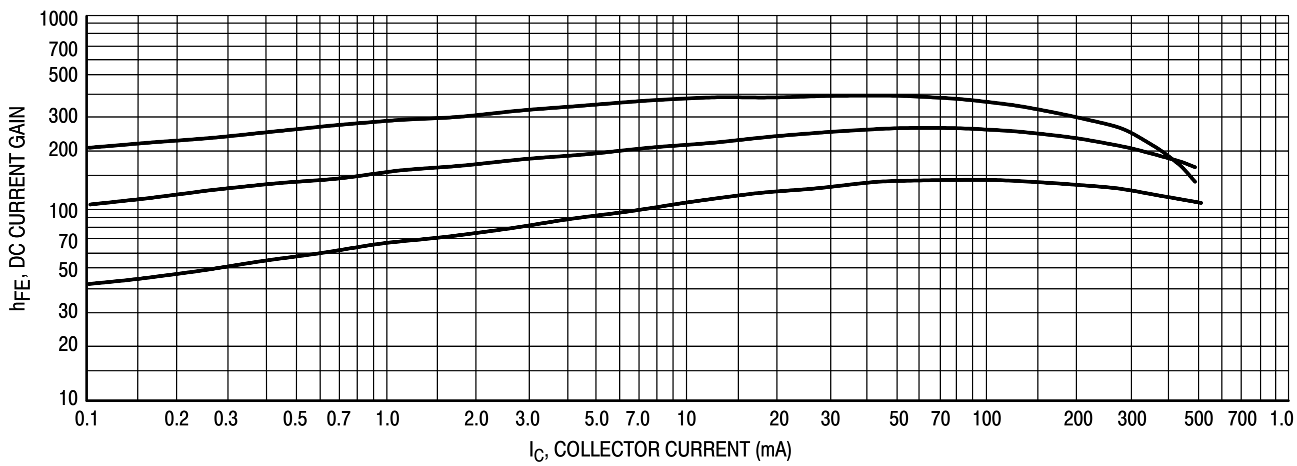


Figure 3. DC Current Gain

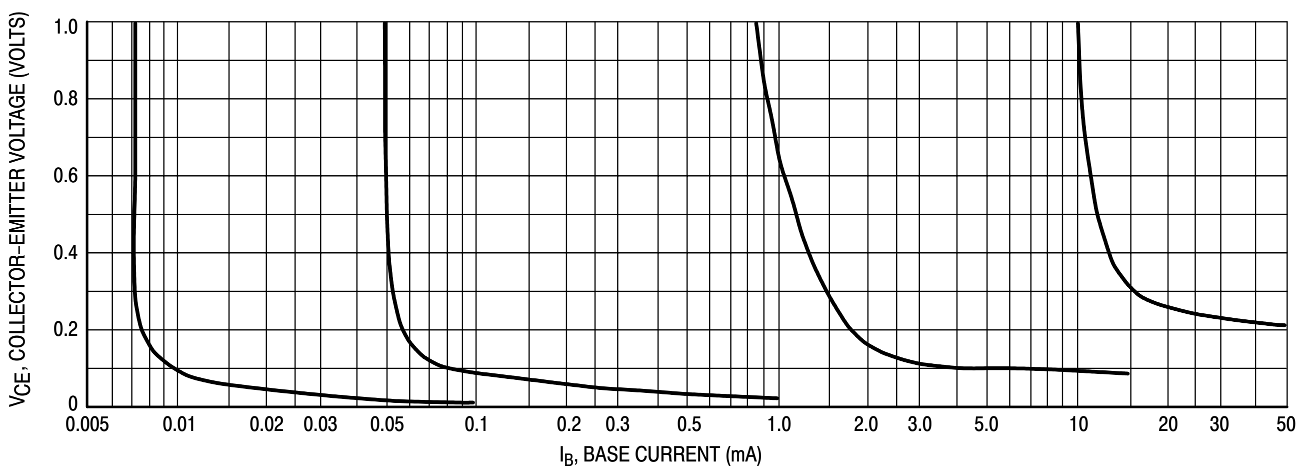


Figure 4. Collector Saturation Region

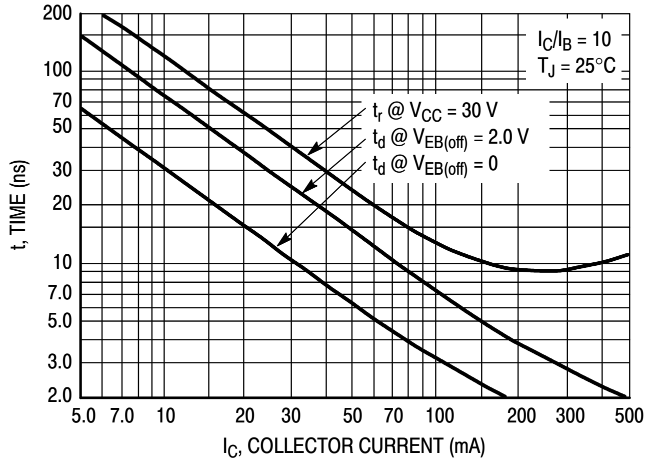


Figure 5. Turn−On Time

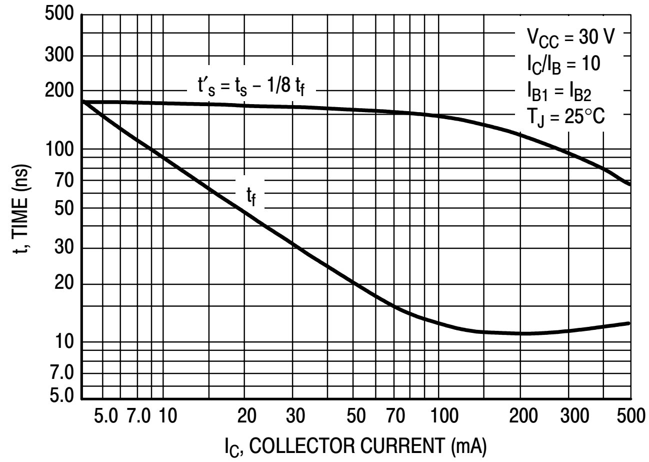


Figure 6. Turn−Off Time

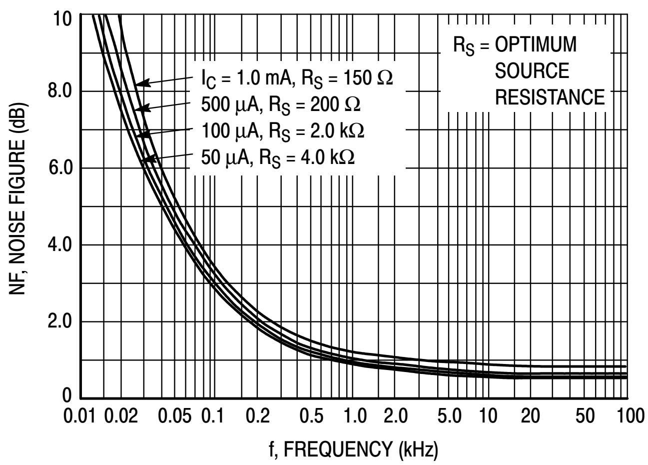


Figure 7. Frequency Effects

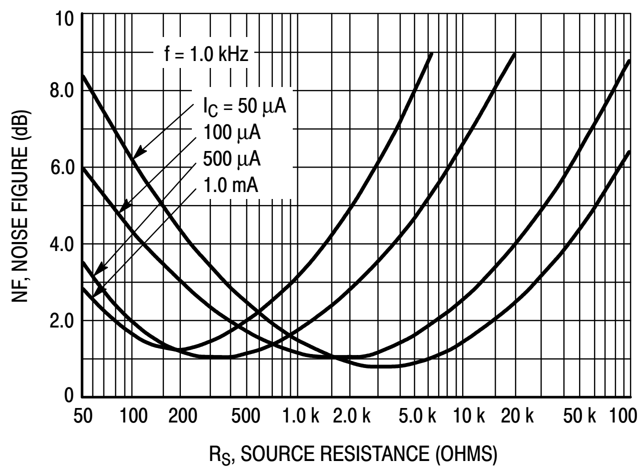


Figure 8. Source Resistance Effects

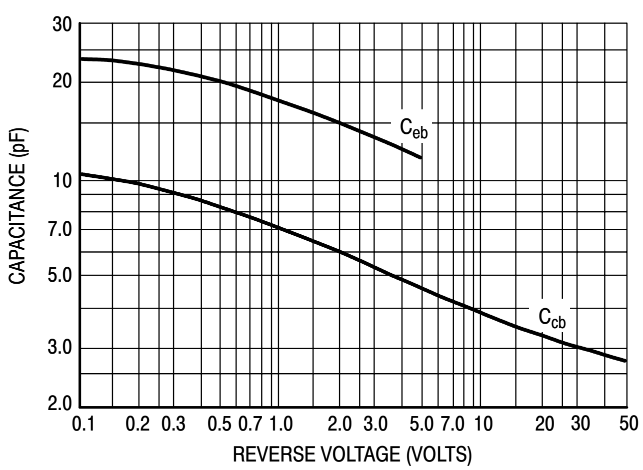


Figure 9. Capacitances

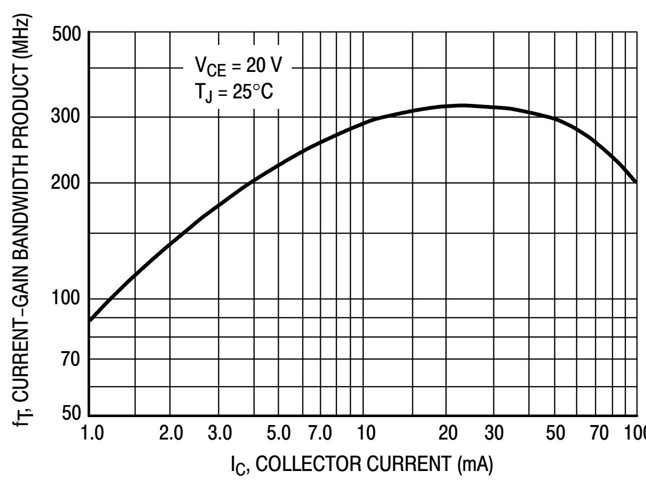


Figure 10. Current−Gain Bandwidth Product

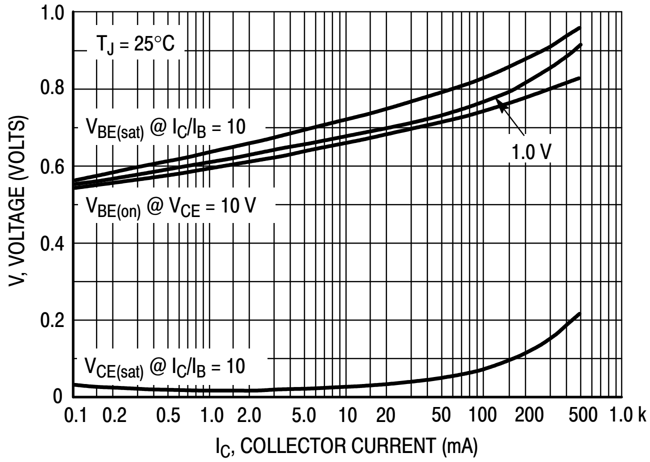


Figure 11. “On” Voltages

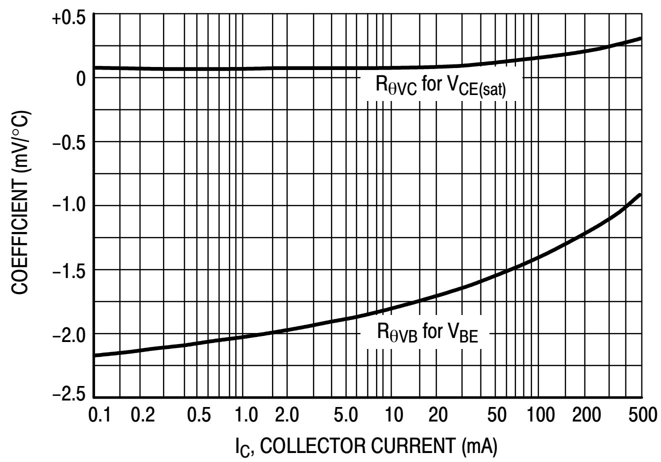


Figure 12. Temperature Coefficients

MMBT2222AWT1

Preferred Device

General Purpose Transistor

NPN Silicon

These transistors are designed for general purpose amplifier applications. They are housed in the SOT–323/SC–70 package which is designed for low power surface mount applications.

ON Semiconductor™

http://onsemi.com

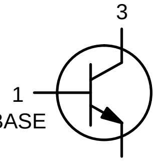
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	75	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current – Continuous	I_C	600	mAdc

THERMAL CHARACTERISTICS

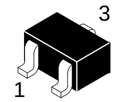
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board T_A = 25°C	P_D	150	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	833	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

COLLECTOR
3



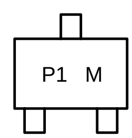
1
BASE

2
EMITTER



SC–70
CASE 419
STYLE 3

MARKING DIAGRAM



P1 = Specific Device Code
M = Date Code

ORDERING INFORMATION

Device	Package	Shipping
MMBT2222AWT1	SC–70	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

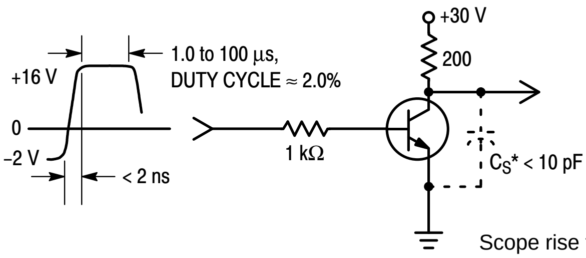
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (Note 1.) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	–	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	75	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	–	Vdc
Base Cutoff Current (V_{CE} = 60 Vdc, V_{EB} = 3.0 Vdc)	I_{BL}	–	20	nAdc
Collector Cutoff Current (V_{CE} = 60 Vdc, V_{EB} = 3.0 Vdc)	I_{CEX}	–	10	nAdc
ON CHARACTERISTICS (Note 1.)				
DC Current Gain (Note 1.)	H_{FE}			–
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)		35	–	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		50	–	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		75	–	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)		100	300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)		40	–	
Collector–Emitter Saturation Voltage (Note 1.)	$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)		–	0.3	
(I_C = 500 mAdc, I_B = 50 mAdc)		–	1.0	
Base–Emitter Saturation Voltage (Note 1.)	$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)		0.6	1.2	
(I_C = 500 mAdc, I_B = 50 mAdc)		–	2.0	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain – Bandwidth Product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	300	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	–	8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	–	30	pF
Input Impedance (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)	h_{ie}	0.25	1.25	k ohms
Voltage Feedback Ratio (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)	h_{re}	–	4.0	X 10^{-4}
Small–Signal Current Gain (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)	h_{fe}	75	375	–
Output Admittance (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)	h_{oe}	25	200	μmhos
Noise Figure (V_{CE} = 10 Vdc, I_C = 100 μAdc, R_S = 1.0 kΩ, f = 1.0 kHz)	NF	–	4.0	dB

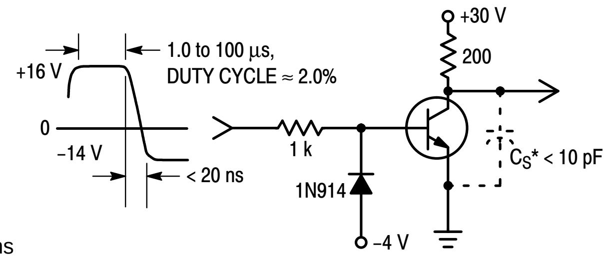
SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = –0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	–	10	ns
Rise Time		t_r	–	25	
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	–	225	ns
Fall Time		t_f	–	60	

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS





Scope rise time < 4 ns
*Total shunt capacitance of test jig, connectors, and oscilloscope.

Figure 1. Turn–On Time

Figure 2. Turn–Off Time

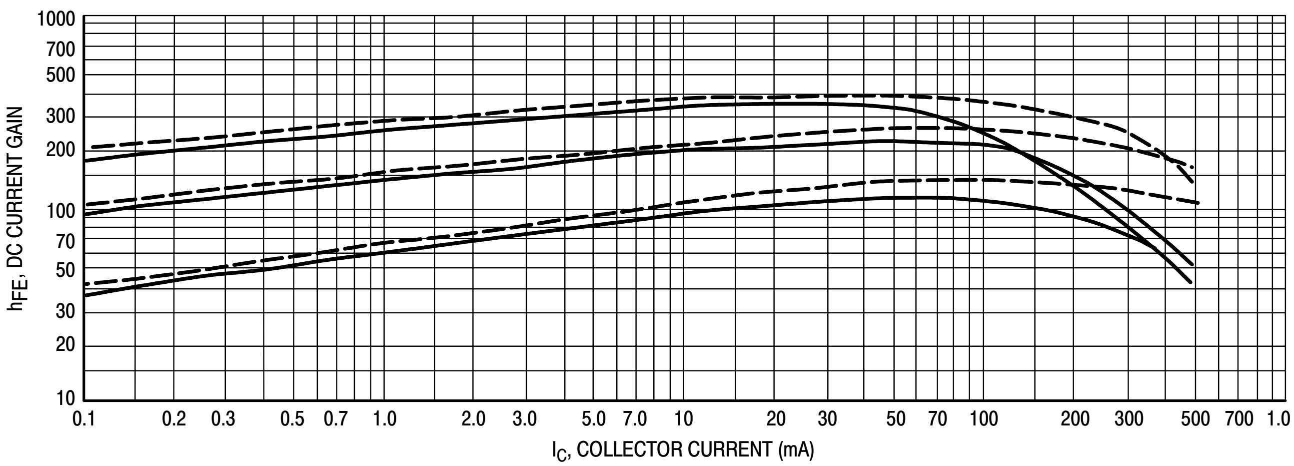


Figure 3. DC Current Gain

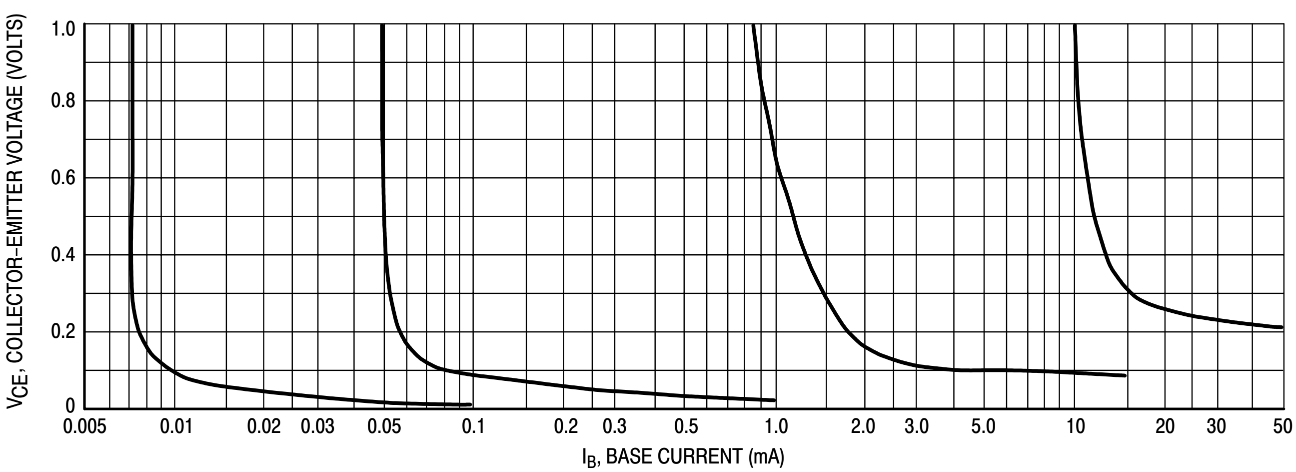


Figure 4. Collector Saturation Region

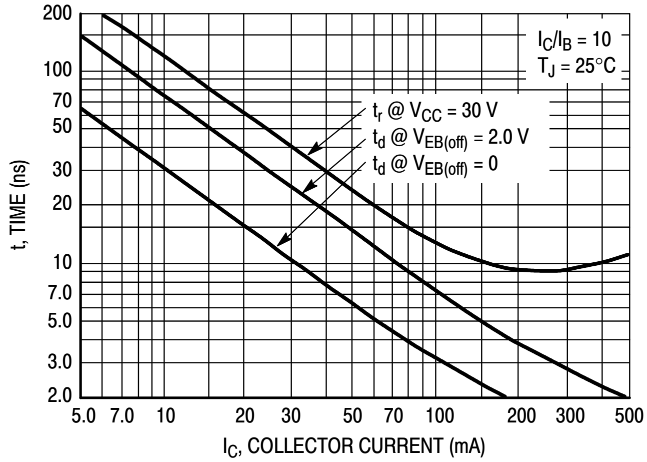


Figure 5. Turn−On Time

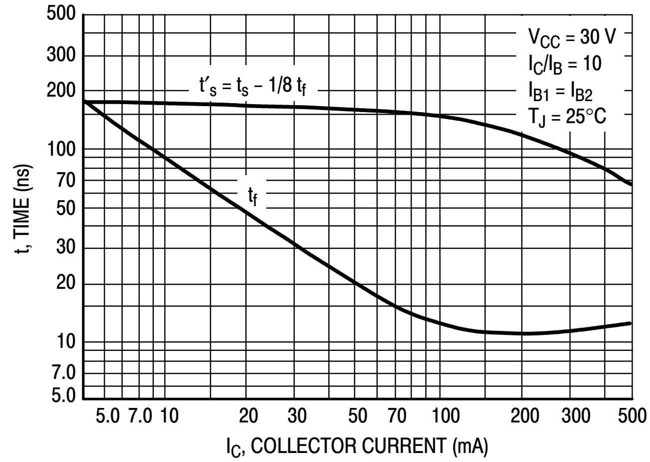


Figure 6. Turn−Off Time

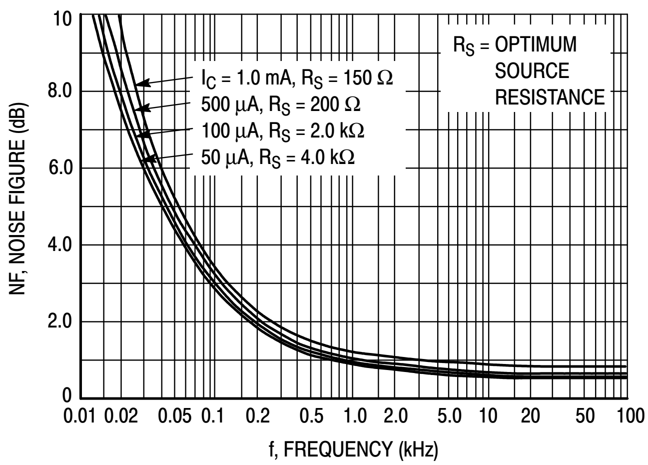


Figure 7. Frequency Effects

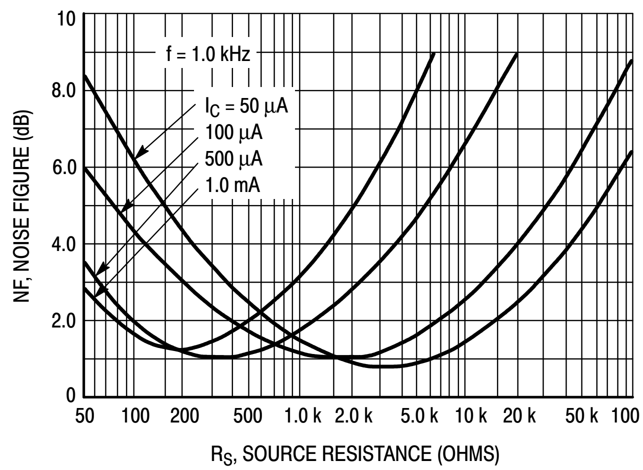


Figure 8. Source Resistance Effects

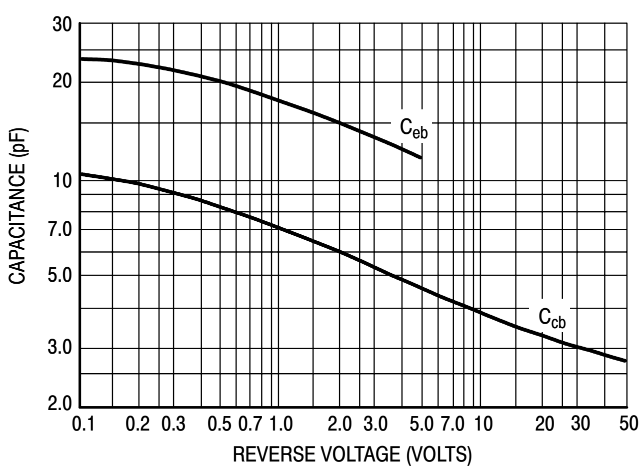


Figure 9. Capacitances

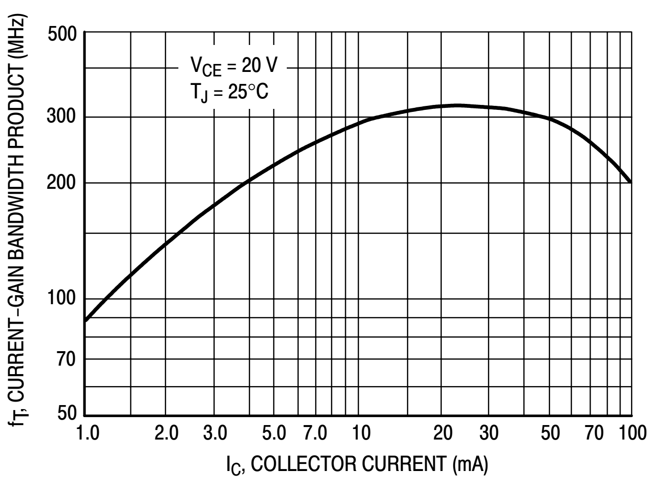


Figure 10. Current−Gain Bandwidth Product

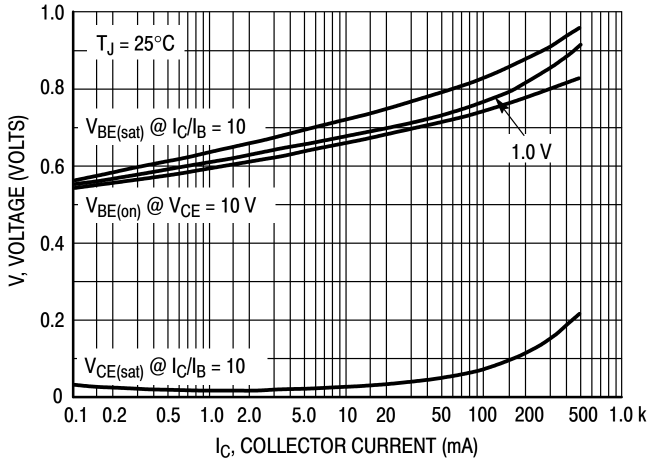


Figure 11. “On” Voltages

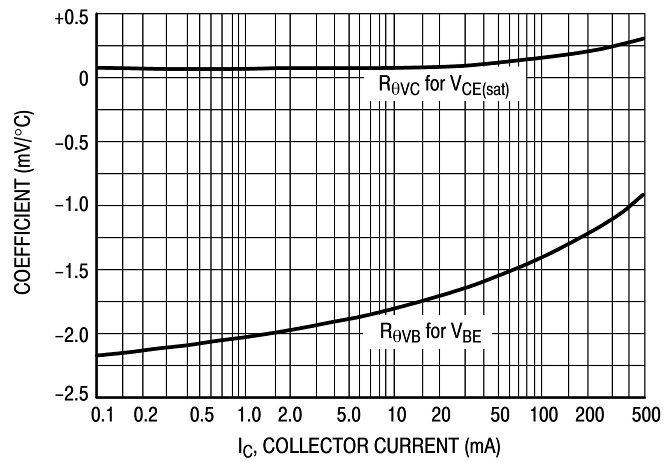


Figure 12. Temperature Coefficients

MMBT2222LT1, MMBT2222ALT1

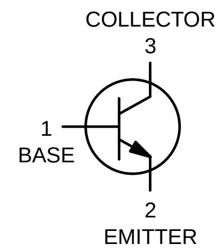
MMBT2222ALT1 is a Preferred Device

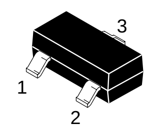
General Purpose Transistors

NPN Silicon

ON Semiconductor™

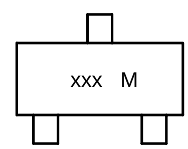
http://onsemi.com





SOT–23
CASE 318
STYLE 6

MARKING DIAGRAM



xxx = Specific Device Code
(M1B = MMBT2222LT1,
1P = MMBT2222ALT1)
M = Date Code

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}		Vdc
MMBT2222LT1		30	
MMBT2222ALT1		40	
Collector–Base Voltage	V_{CBO}		Vdc
MMBT2222LT1		60	
MMBT2222ALT1		75	
Emitter–Base Voltage	V_{EBO}		Vdc
MMBT2222LT1		5.0	
MMBT2222ALT1		6.0	
Collector Current – Continuous	I_C	600	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board (Note 1) T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate (Note 2) T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

ORDERING INFORMATION

Device	Package	Shipping
MMBT2222LT1	SOT–23	3000/Tape & Reel
MMBT2222ALT1	SOT–23	3000/Tape & Reel
MMBT2222LT3	SOT–23	10,000/Tape & Reel
MMBT2222ALT3	SOT–23	10,000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	MMBT2222 MMBT2222A	$V_{(BR)CEO}$	30 40	– –	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	MMBT2222 MMBT2222A	$V_{(BR)CBO}$	60 75	– –	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	MMBT2222 MMBT2222A	$V_{(BR)EBO}$	5.0 6.0	– –	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MMBT2222A	I_{CEX}	–	10	nAdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 50 Vdc, I_E = 0, T_A = 125°C) (V_{CB} = 60 Vdc, I_E = 0, T_A = 125°C)	MMBT2222 MMBT2222A MMBT2222 MMBT2222A	I_{CBO}	– – – –	0.01 0.01 10 10	μAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	MMBT2222A	I_{EBO}	–	100	nAdc
Base Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MMBT2222A	I_{BL}	–	20	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 10 Vdc) (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = –55°C) (I_C = 150 mAdc, V_{CE} = 10 Vdc) (Note 2.) (I_C = 150 mAdc, V_{CE} = 1.0 Vdc) (Note 2.) (I_C = 500 mAdc, V_{CE} = 10 Vdc) (Note 2.)	 MMBT2222A only MMBT2222 MMBT2222A	h_{FE}	 35 50 75 35 100 50 30 40	 – – – – 300 – – –	–
Collector–Emitter Saturation Voltage (Note 2.) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	 MMBT2222 MMBT2222A MMBT2222 MMBT2222A	$V_{CE(sat)}$	 – – – –	 0.4 0.3 1.6 1.0	Vdc
Base–Emitter Saturation Voltage (Note 2.) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	 MMBT2222 MMBT2222A MMBT2222 MMBT2222A	$V_{BE(sat)}$	 – 0.6 – –	 1.3 1.2 2.6 2.0	Vdc

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

SMALL–SIGNAL CHARACTERISTICS

Current–Gain – Bandwidth Product (Note 3.) (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MMBT2222 MMBT2222A	f_T	250 300	– –	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	–	8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MMBT2222 MMBT2222A	C_{ibo}	– –	30 25	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h_{ie}	2.0 0.25	8.0 1.25	kΩ
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h_{re}	– –	8.0 4.0	X 10^{-4}
Small–Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h_{fe}	50 75	300 375	–
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222A MMBT2222A	h_{oe}	5.0 25	35 200	μmhos
Collector Base Time Constant (I_E = 20 mAdc, V_{CB} = 20 Vdc, f = 31.8 MHz)	MMBT2222A	rb, C_c	–	150	ps
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)	MMBT2222A	NF	–	4.0	dB

SWITCHING CHARACTERISTICS (MMBT2222A only)

Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = –0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	–	10	ns
Rise Time		t_r	–	25	
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	–	225	ns
Fall Time		t_f	–	60	

3. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

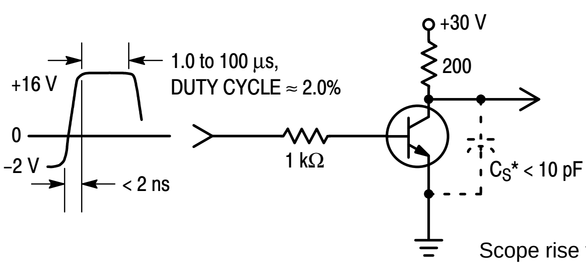
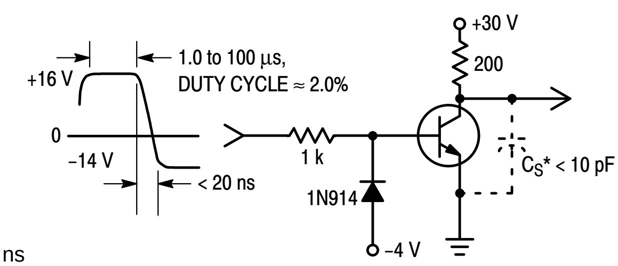


Figure 1. Turn–On Time



Scope rise time < 4 ns
*Total shunt capacitance of test jig, connectors, and oscilloscope.

Figure 2. Turn–Off Time

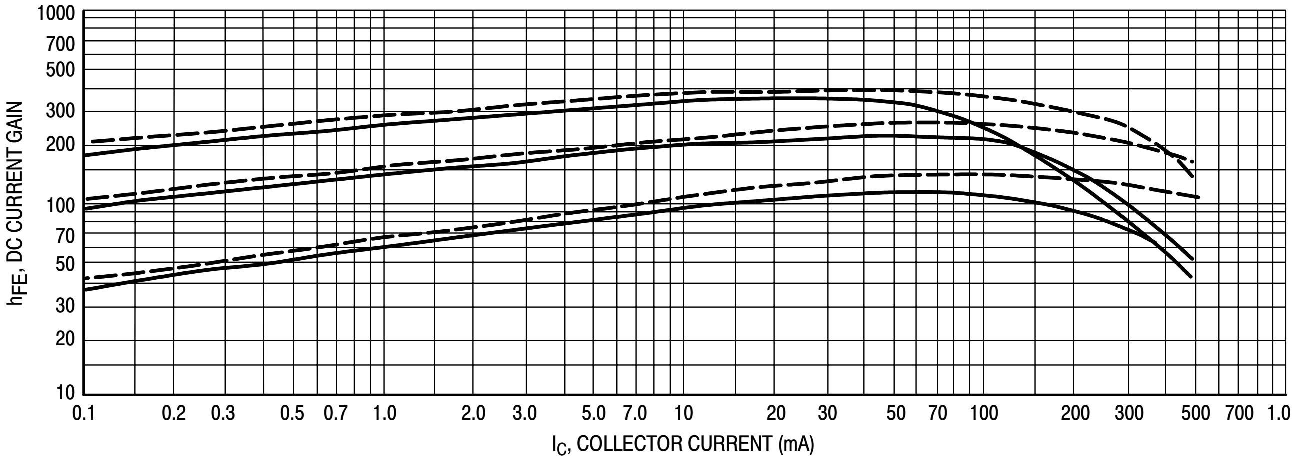


Figure 3. DC Current Gain

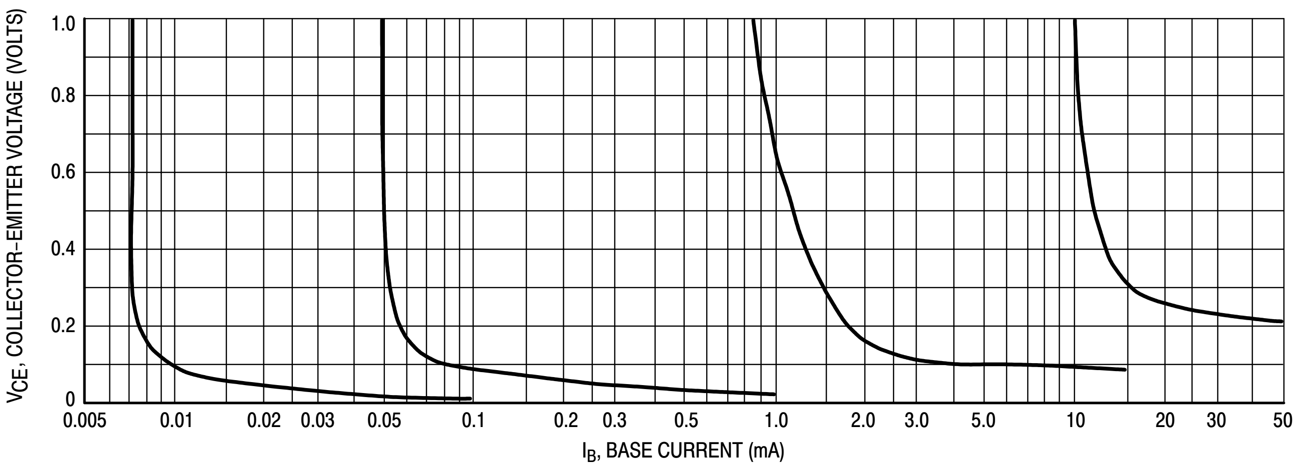


Figure 4. Collector Saturation Region

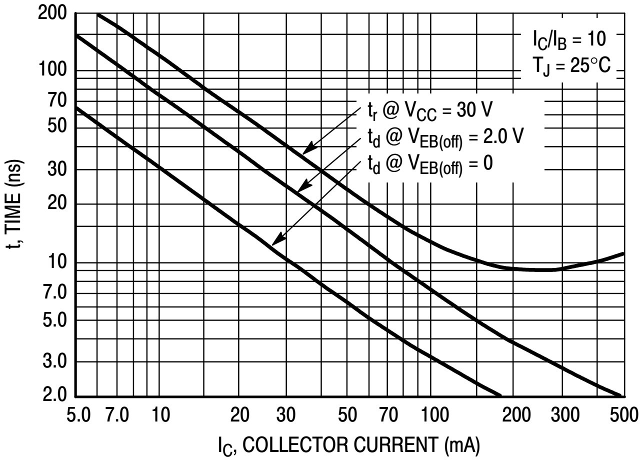


Figure 5. Turn−On Time

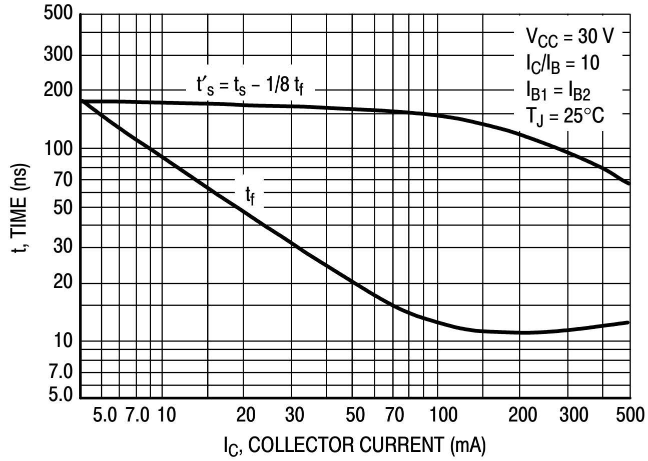


Figure 6. Turn−Off Time

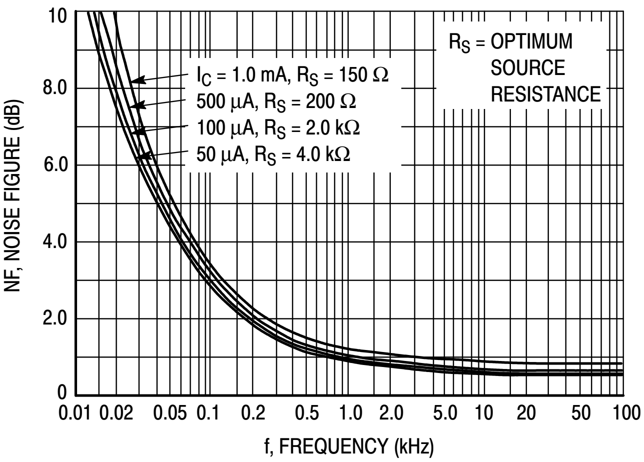


Figure 7. Frequency Effects

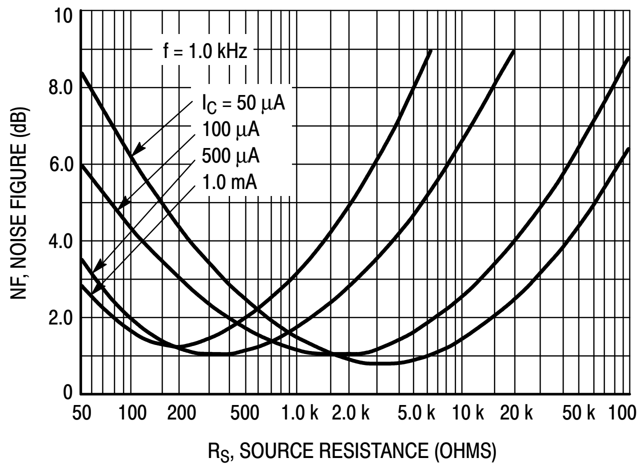


Figure 8. Source Resistance Effects

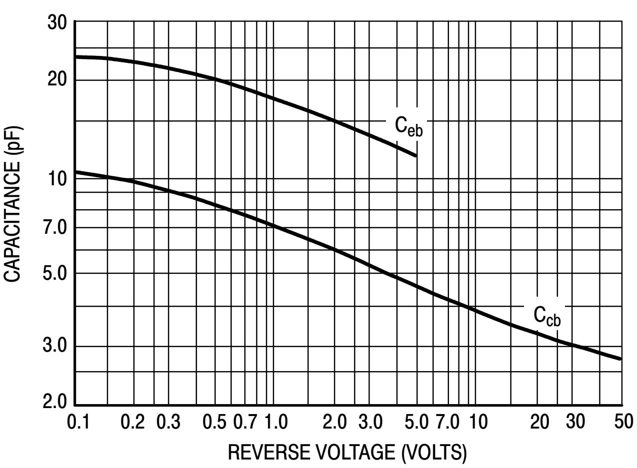


Figure 9. Capacitances

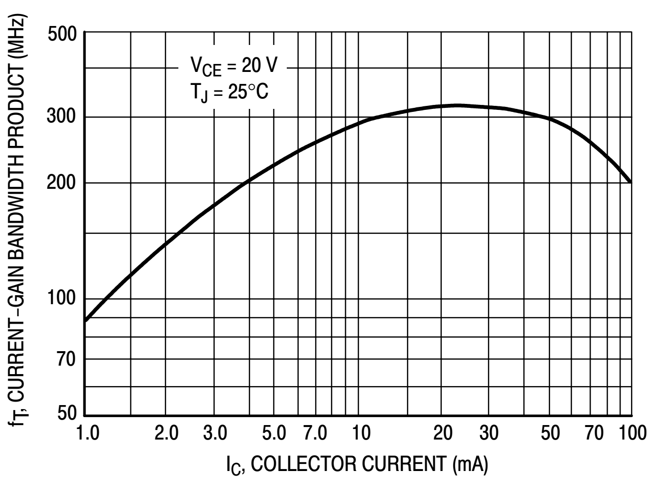


Figure 10. Current−Gain Bandwidth Product

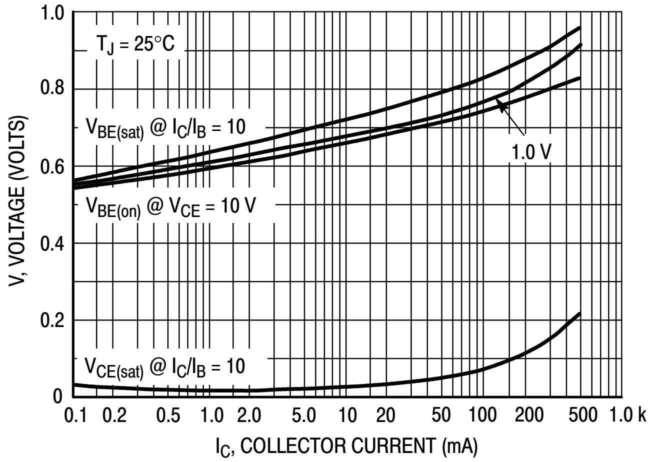


Figure 11. "On" Voltages

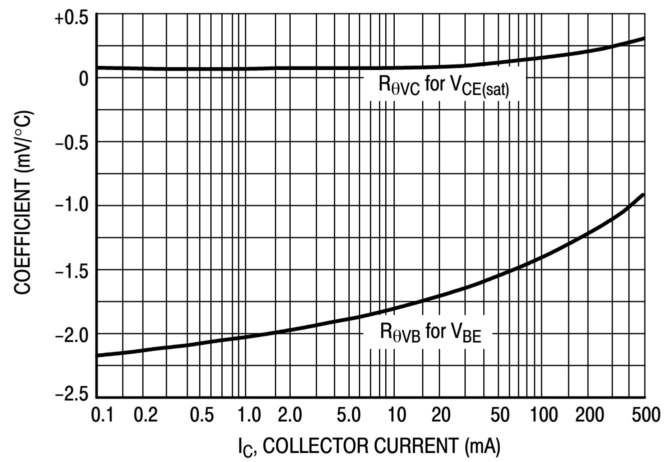
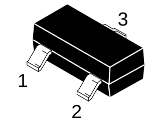


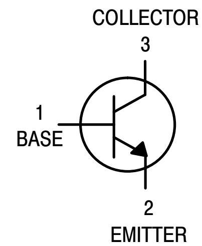
Figure 12. Temperature Coefficients

Low Noise Transistor
NPN Silicon

MMBT2484LT1



CASE 318–08, STYLE 6
SOT–23 (TO–236)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	60	Vdc
Collector–Base Voltage	V_{CBO}	60	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT2484LT1 = 1U

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	60	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 45 Vdc, I_E = 0) (V_{CB} = 45 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	 — —	 10 10	 nAdc μAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	10	nAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

October, 2001 – Rev. 2
Publication Order Number:
MMBT2484LT1/D

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	 250 —	 — 800	—
Collector–Emitter Saturation Voltage (I_C = 1.0 mAdc, I_B = 0.1 mAdc)	$V_{CE(sat)}$	—	0.35	Vdc
Base–Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	0.95	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	6.0	pF
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	3.0	dB

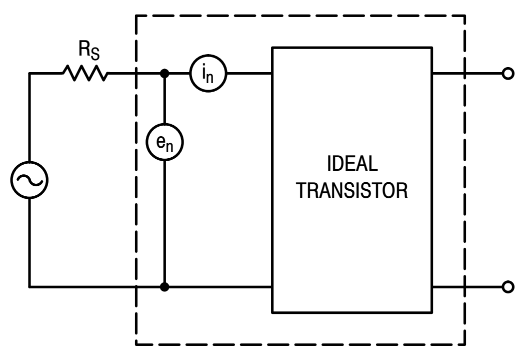


Figure 1. Transistor Noise Model

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

NOISE VOLTAGE

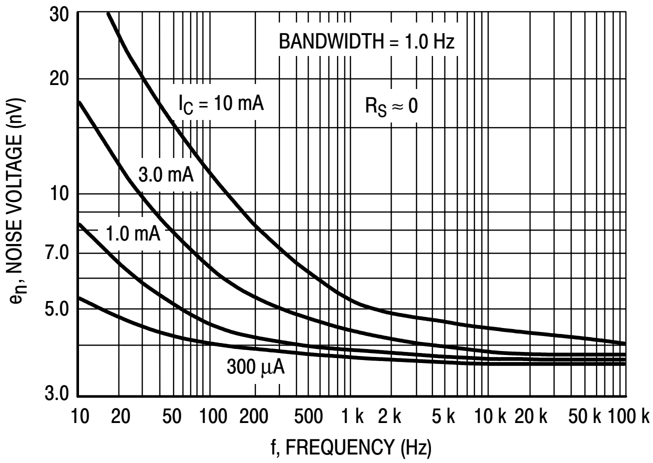


Figure 2. Effects of Frequency

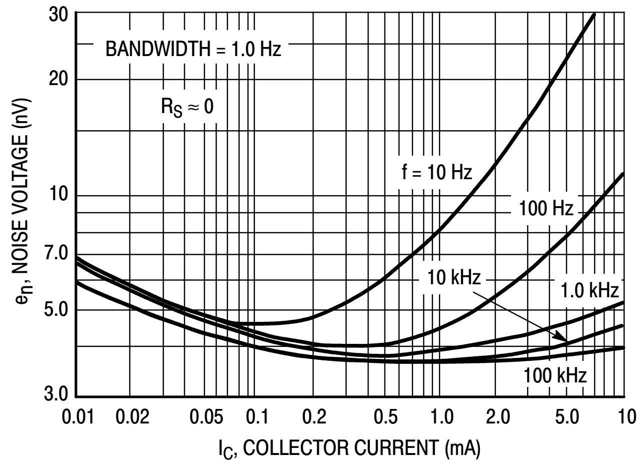


Figure 3. Effects of Collector Current

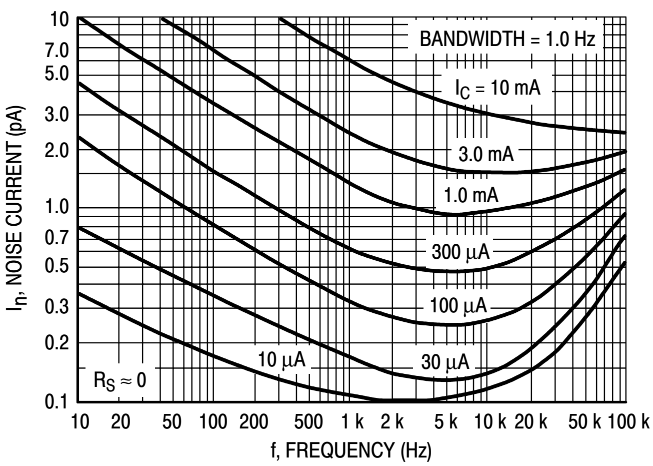


Figure 4. Noise Current

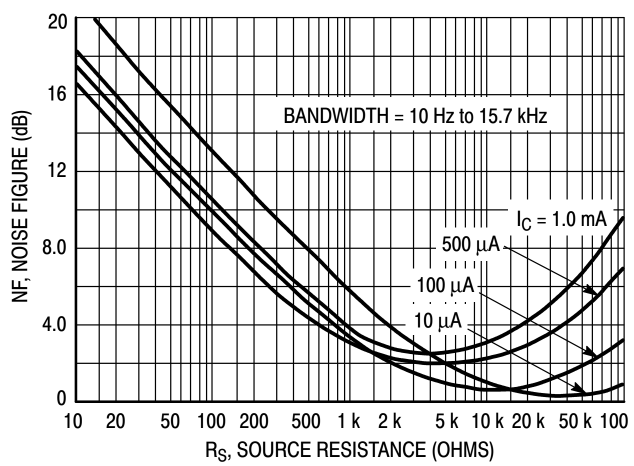


Figure 5. Wideband Noise Figure

100 Hz NOISE DATA

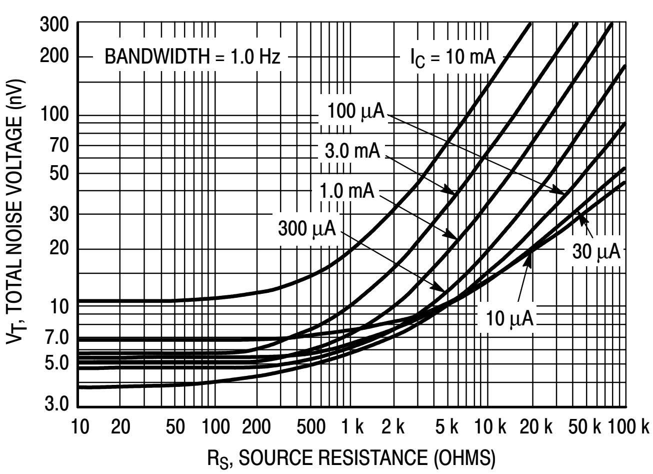


Figure 6. Total Noise Voltage

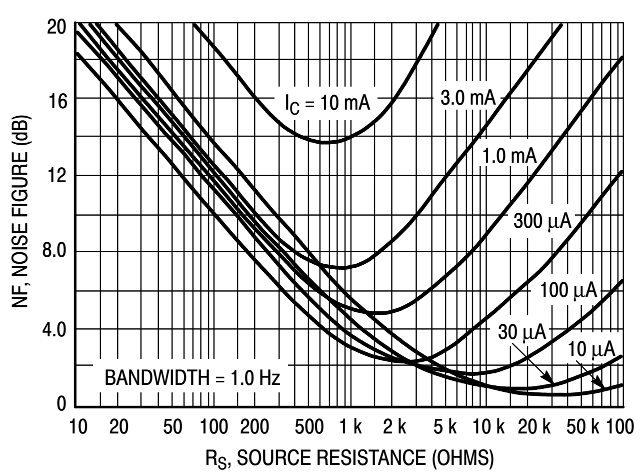


Figure 7. Noise Figure

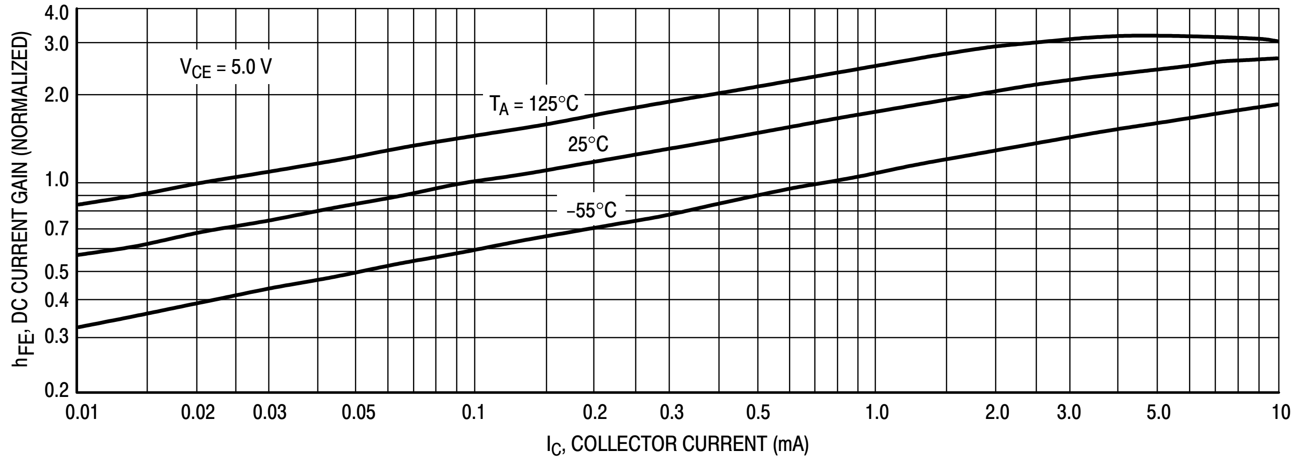


Figure 8. DC Current Gain

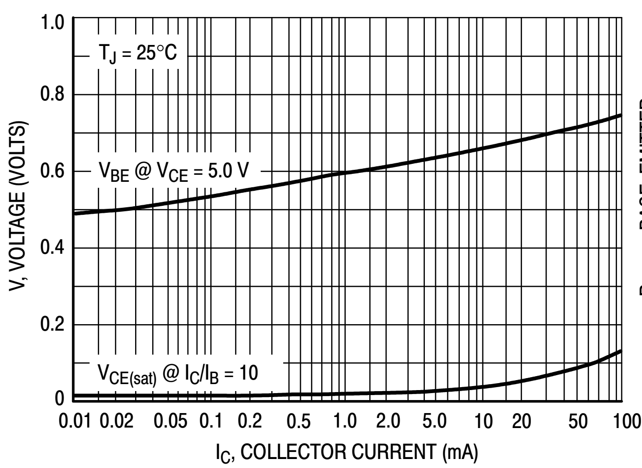


Figure 9. "On" Voltages

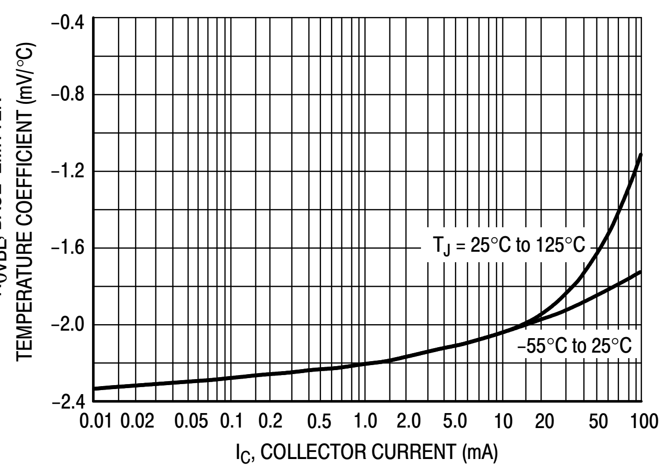


Figure 10. Temperature Coefficients

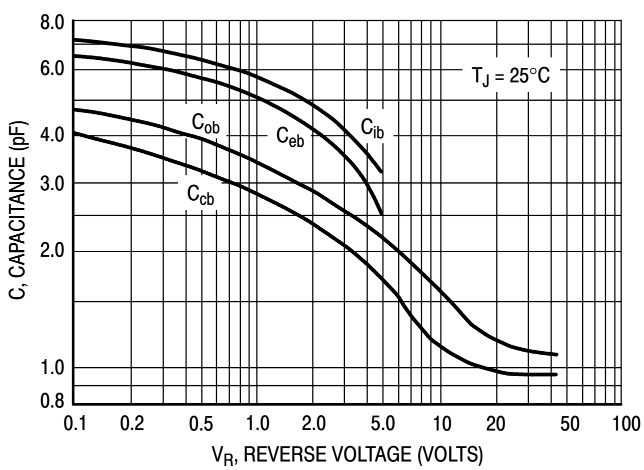


Figure 11. Capacitance

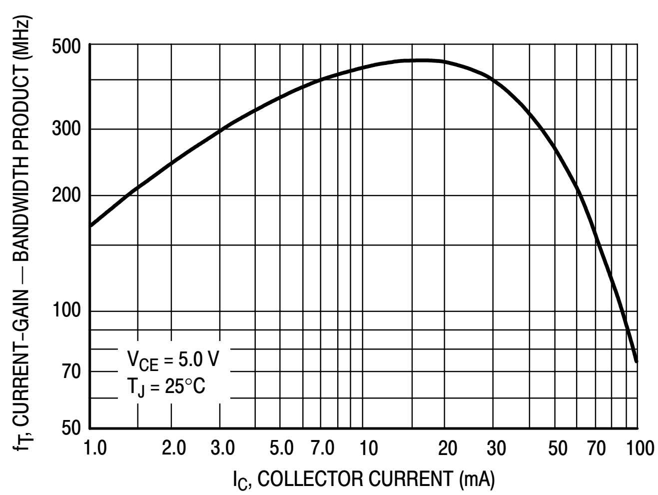


Figure 12. Current−Gain — Bandwidth Product

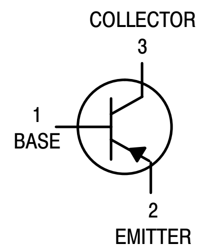
MMBT2907ALT1

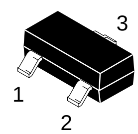
General Purpose Transistors

PNP Silicon

ON Semiconductor™

http://onsemi.com





SOT–23 (TO–236AB)
CASE 318
STYLE 6

MAXIMUM RATINGS

Rating	Symbol	2907A	Unit
Collector–Emitter Voltage	V_{CEO}	–60	Vdc
Collector–Base Voltage	V_{CBO}	–60	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current — Continuous	I_C	–600	mAdc

THERMAL CHARACTERISTICS

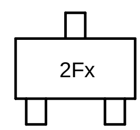
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(3) (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–60	—	Vdc
Collector–Base Breakdown Voltage (I_C = –10 μAdc, I_E = 0)	$V_{(BR)CBO}$	–60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	Vdc
Collector Cutoff Current (V_{CE} = –30 Vdc, $V_{BE(off)}$ = –0.5 Vdc)	I_{CEX}	—	–50	nAdc
Collector Cutoff Current (V_{CB} = –50 Vdc, I_E = 0) (V_{CB} = –50 Vdc, I_E = 0, T_A = 125°C)	I_{CBO}	— —	–0.010 –10	μAdc
Base Current (V_{CE} = –30 Vdc, $V_{EB(off)}$ = –0.5 Vdc)	I_B	—	–50	nAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

DEVICE MARKING



x = Monthly Date Code

ORDERING INFORMATION

Device	Package	Shipping
MMBT2907ALT1	SOT–23	3000 Units/Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = –0.1 mAdc, V_{CE} = –10 Vdc)		75	—	
(I_C = –1.0 mAdc, V_{CE} = –10 Vdc)		100	—	
(I_C = –10 mAdc, V_{CE} = –10 Vdc)		100	—	
(I_C = –150 mAdc, V_{CE} = –10 Vdc) (3)		100	300	
(I_C = –500 mAdc, V_{CE} = –10 Vdc) (3)		50	—	
Collector–Emitter Saturation Voltage (3)	$V_{CE(sat)}$			Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)		—	–0.4	
(I_C = –500 mAdc, I_B = –50 mAdc)		—	–1.6	
Base–Emitter Saturation Voltage (3)	$V_{BE(sat)}$			Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)		—	–1.3	
(I_C = –500 mAdc, I_B = –50 mAdc)		—	–2.6	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (3),(4)	f_T			MHz
(I_C = –50 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)		200	—	
Output Capacitance	C_{obo}			pF
(V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)		—	8.0	
Input Capacitance	C_{ibo}			pF
(V_{EB} = –2.0 Vdc, I_C = 0, f = 1.0 MHz)		—	30	

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Turn–On Time	(V_{CC} = –30 Vdc, I_C = –150 mAdc, I_{B1} = –15 mAdc)	t_{on}	—	45	ns
Delay Time		t_d	—	10	
Rise Time		t_r	—	40	
Turn–Off Time	(V_{CC} = –6.0 Vdc, I_C = –150 mAdc, I_{B1} = I_{B2} = –15 mAdc)	t_{off}	—	100	ns
Storage Time		t_s	—	80	
Fall Time		t_f	—	30	

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
4. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

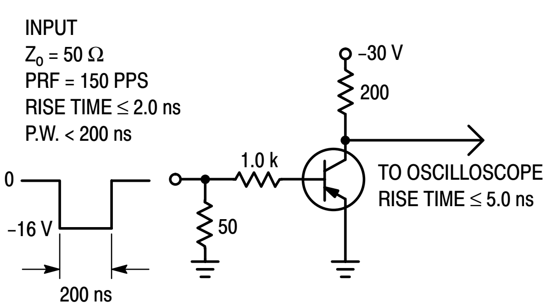


Figure 1. Delay and Rise Time Test Circuit

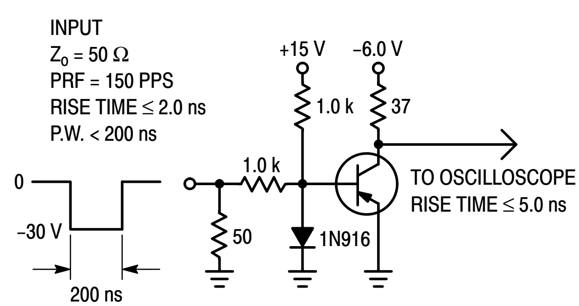


Figure 2. Storage and Fall Time Test Circuit

TYPICAL CHARACTERISTICS

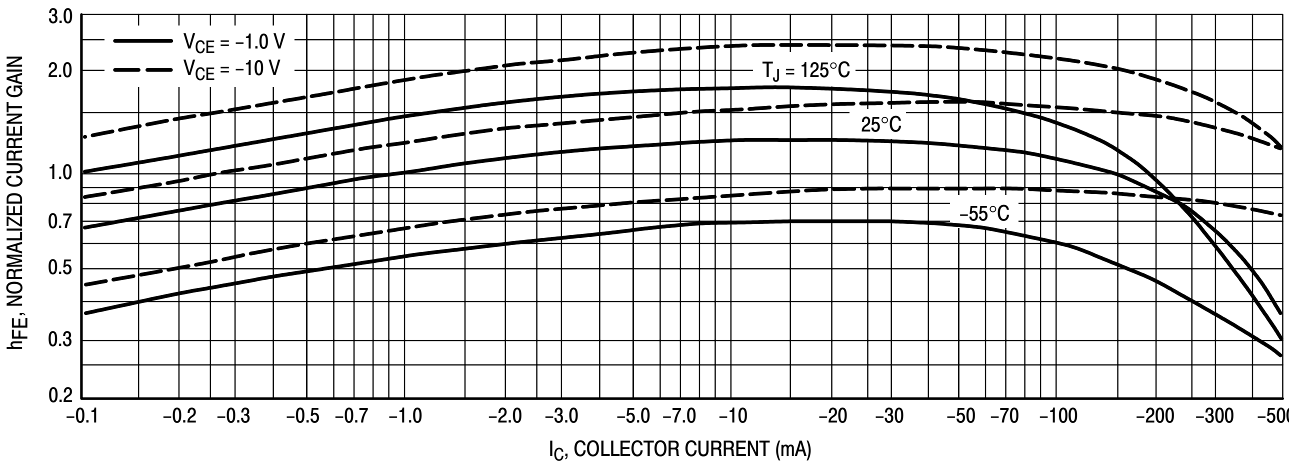


Figure 3. DC Current Gain

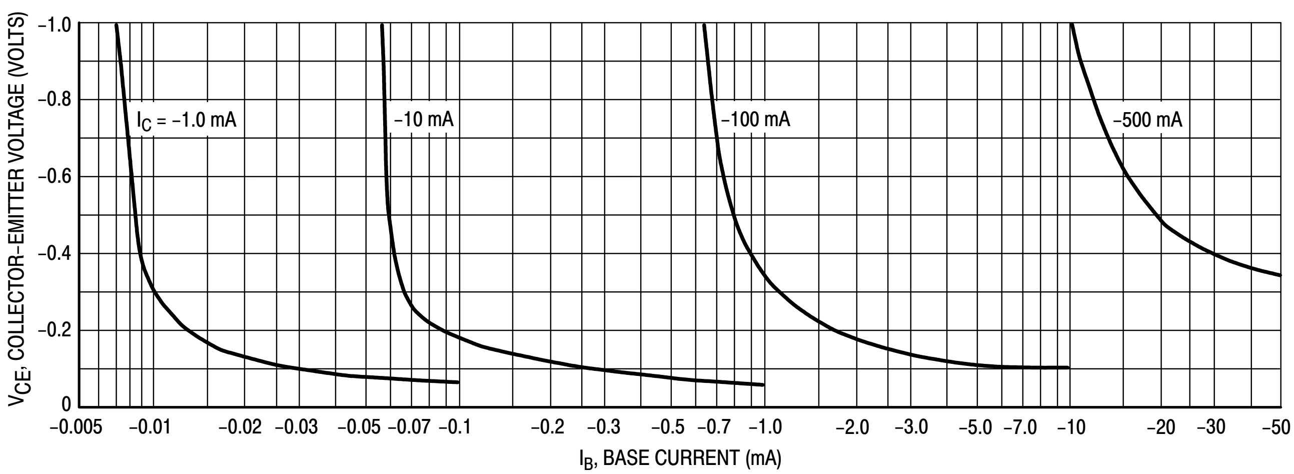


Figure 4. Collector Saturation Region

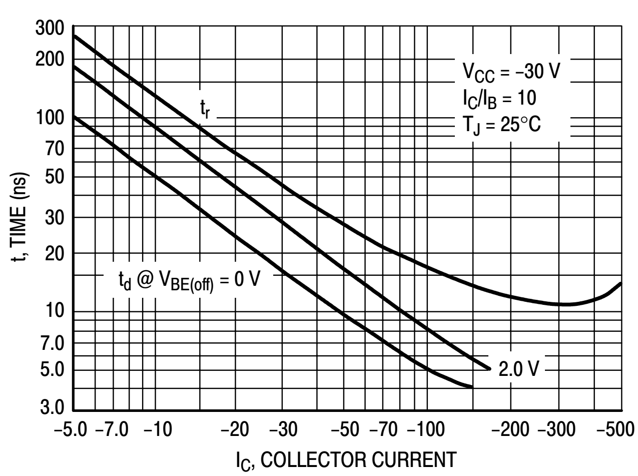


Figure 5. Turn−On Time

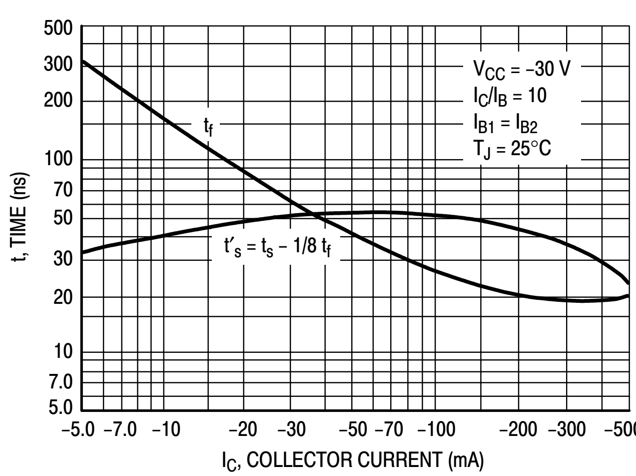


Figure 6. Turn−Off Time

TYPICAL SMALL–SIGNAL CHARACTERISTICS

NOISE FIGURE

V_{CE} = 10 Vdc, T_A = 25°C

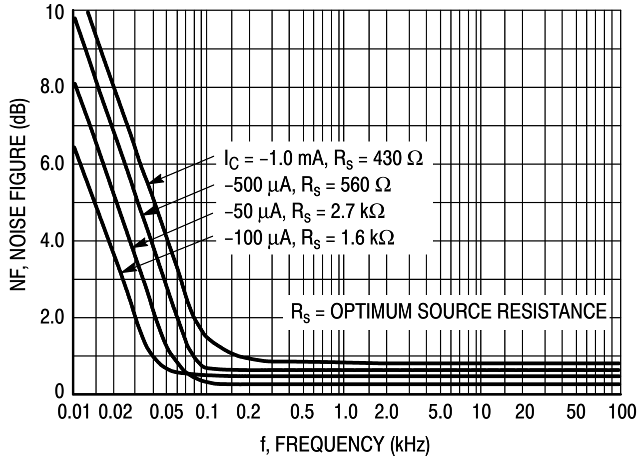


Figure 7. Frequency Effects

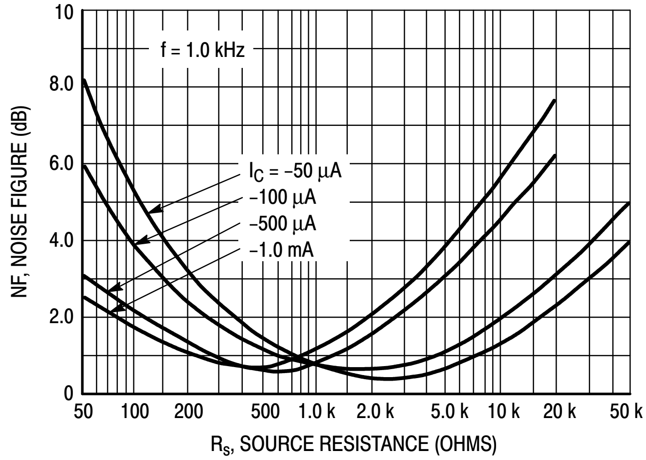


Figure 8. Source Resistance Effects

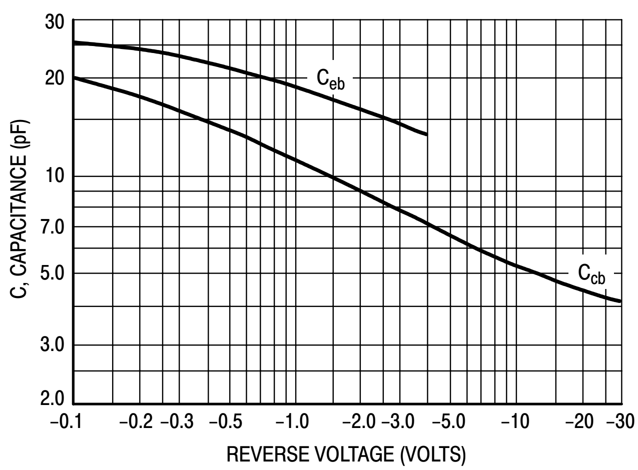


Figure 9. Capacitances

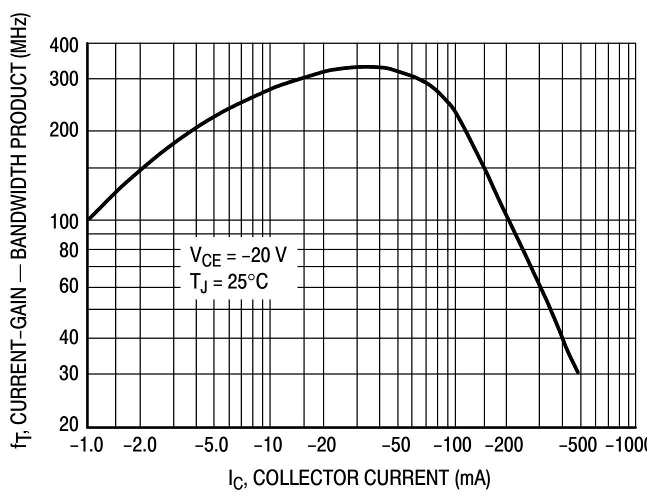


Figure 10. Current–Gain — Bandwidth Product

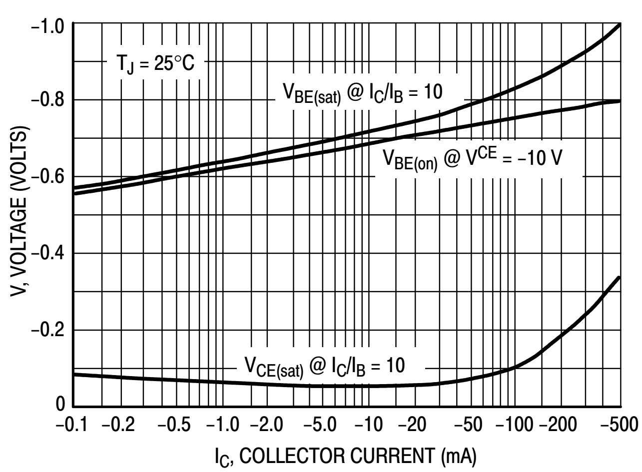


Figure 11. "On" Voltage

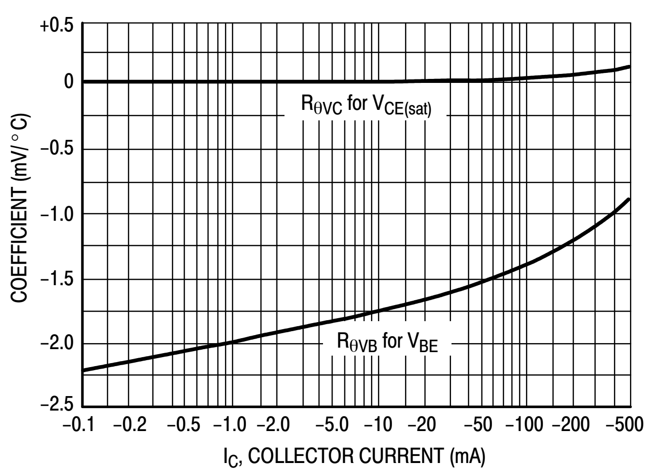


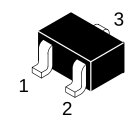
Figure 12. Temperature Coefficients

General Purpose Transistor
PNP Silicon

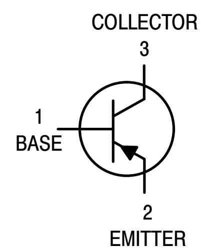
These transistors are designed for general purpose amplifier applications. They are housed in the SOT–323/SC–70 package which is designed for low power surface mount applications.

MMBT2907AWT1

ON Semiconductor Preferred Device



CASE 419–04, STYLE 3
SOT–323/SC–70



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–60	Vdc
Collector–Base Voltage	V_{CBO}	–60	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current — Continuous	I_C	–600	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C	P_D	150	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	833	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT2907AWT1 = 20

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(2) (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–60	—	Vdc
Collector–Base Breakdown Voltage (I_C = –10 mAdc, I_E = 0)	$V_{(BR)CBO}$	–60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	Vdc
Base Cutoff Current (V_{CE} = –30 Vdc, $V_{EB(off)}$ = –0.5 Vdc)	I_{BL}	—	–50	nAdc
Collector Cutoff Current (V_{CE} = –30 Vdc, $V_{EB(off)}$ = –0.5 Vdc)	I_{CEX}	—	–50	nAdc

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1

Publication Order Number:
MMBT2907AWT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain (1)		H_{FE}			—
(I_C = –0.1 mAdc, V_{CE} = –10 Vdc)			75	—	
(I_C = –1.0 mAdc, V_{CE} = –10 Vdc)			100	—	
(I_C = –10 mAdc, V_{CE} = –10 Vdc)			100	—	
(I_C = –150 mAdc, V_{CE} = –10 Vdc)			100	—	
(I_C = –500 mAdc, V_{CE} = –10 Vdc)			50	—	
Collector–Emitter Saturation Voltage[1]		$V_{CE(sat)}$			Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)			—	–0.4	
(I_C = –500 mAdc, I_B = –50 mAdc)			—	–1.6	
Base–Emitter Saturation Voltage[1]		$V_{BE(sat)}$			Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)			—	–1.3	
(I_C = –500 mAdc, I_B = –50 mAdc)			—	–2.6	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = –50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	—	MHz
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	8.0	pF
Input Capacitance (V_{EB} = –2.0 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	30	pF
SWITCHING CHARACTERISTICS					
Turn–On Time	(V_{CC} = –30 Vdc, I_C = –150 mAdc, I_{B1} = –15 mAdc)	t_{on}	—	45	ns
Delay Time		t_d	—	10	
Rise Time		t_r	—	40	
Storage Time	(V_{CC} = –6.0 Vdc, I_C = –150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	—	80	
Fall Time		t_f	—	30	
Turn–Off Time		t_{off}	—	100	

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Switching Transistor
PNP Silicon

MMBT3640LT1

MAXIMUM RATINGS

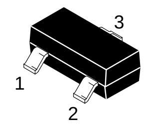
Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–12	Vdc
Collector–Base Voltage	V_{CBO}	–12	Vdc
Emitter–Base Voltage	V_{EBO}	–4.0	Vdc
Collector Current — Continuous	I_C	–80	mAdc

THERMAL CHARACTERISTICS

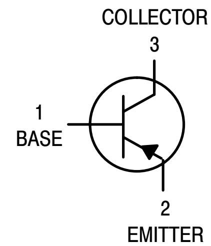
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT3640LT1 = 2J



CASE 318–08, STYLE 6
SOT–23 (TO–236AB)



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –100 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	–12	—	Vdc
Collector–Emitter Sustaining Voltage(1) (I_C = –10 mAdc, I_B = 0)	$V_{CEO(sus)}$	–12	—	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–12	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –100 μAdc, I_C = 0)	$V_{(BR)EBO}$	–4.0	—	Vdc
Collector Cutoff Current (V_{CE} = –6.0 Vdc, V_{BE} = 0) (V_{CE} = –6.0 Vdc, V_{BE} = 0, T_A = 65°C)	I_{CES}	 — —	 –0.01 –1.0	μAdc
Base Cutoff Current (V_{CE} = –6.0 Vdc, V_{EB} = 0)	I_B	—	–10	nAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

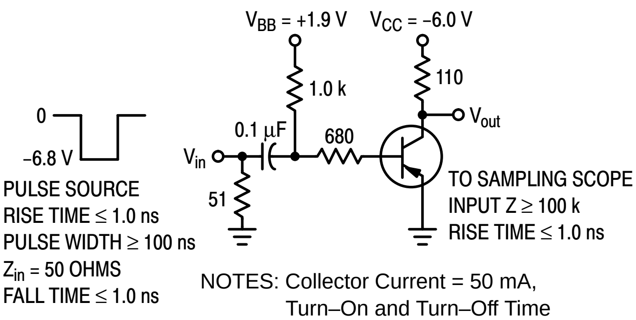
Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1
Publication Order Number:
MMBT3640LT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

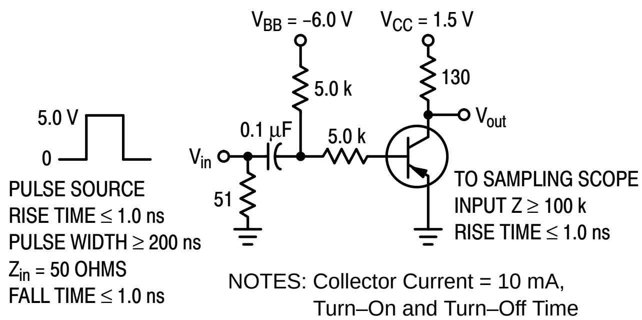
Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS(3)					
DC Current Gain (I_C = –10 mAdc, V_{CE} = –0.3 Vdc) (I_C = –50 mAdc, V_{CE} = –1.0 Vdc)		h_{FE}	 30 20	 120 —	—
Collector–Emitter Saturation Voltage (I_C = –10 mAdc, I_B = –1.0 mAdc) (I_C = –50 mAdc, I_B = –5.0 mAdc) (I_C = –10 mAdc, I_B = –1.0 mAdc, T_A = 65°C)		$V_{CE(sat)}$	 — — —	 –0.2 –0.6 –0.25	Vdc
Base–Emitter Saturation Voltage (I_C = –10 mAdc, I_B = –0.5 mAdc) (I_C = –10 mAdc, I_B = –1.0 mAdc) (I_C = –50 mAdc, I_B = –5.0 mAdc)		$V_{BE(sat)}$	 –0.75 –0.8 —	 –0.95 –1.0 –1.5	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –5.0 Vdc, f = 100 MHz)		f_T	500	—	MHz
Output Capacitance (V_{CB} = –5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	3.5	pF
Input Capacitance (V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	3.5	pF
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = –6.0 Vdc, I_C = –50 mAdc, $V_{EB(off)}$ = –1.9 Vdc, I_{B1} = –5.0 mAdc)	t_d	—	10	ns
Rise Time		t_r	—	30	
Storage Time	(V_{CC} = –6.0 Vdc, I_C = –50 mAdc, I_{B1} = I_{B2} = –5.0 mAdc)	t_s	—	20	ns
Fall Time		t_f	—	12	
Turn–On Time (V_{CC} = –6.0 Vdc, I_C = –50 mAdc, $V_{EB(off)}$ = –1.9 Vdc, I_{B1} = –5.0 mAdc) (V_{CC} = –1.5 Vdc, I_C = –10 mAdc, I_{B1} = –0.5 mAdc)		t_{on}	 — —	 25 60	ns
Turn–Off Time (V_{CC} = –6.0 Vdc, I_C = –50 mAdc, $V_{EB(off)}$ = –1.9 Vdc, I_{B1} = I_{B2} = –5.0 mAdc) (V_{CC} = –1.5 Vdc, I_C = –10 mAdc, I_{B1} = I_{B2} = –0.5 mAdc)		t_{off}	 — —	 35 75	ns

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.



NOTES: Collector Current = 50 mA, Turn–On and Turn–Off Time Base Currents = 5.0 mA.

Figure 1.



NOTES: Collector Current = 10 mA, Turn–On and Turn–Off Time Base Currents = 0.5 mA.

Figure 2.

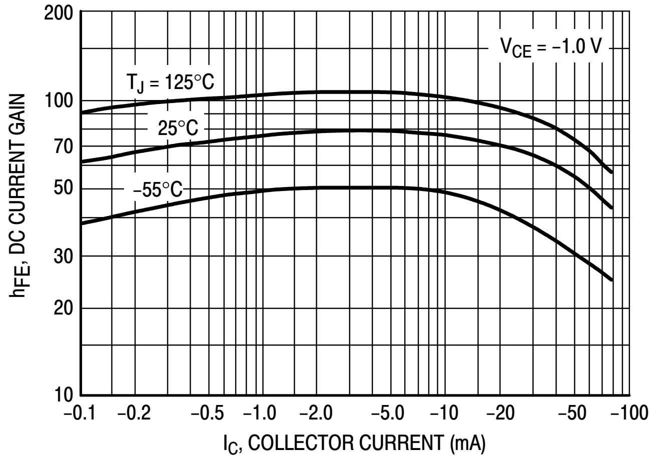


Figure 3. DC Current Gain

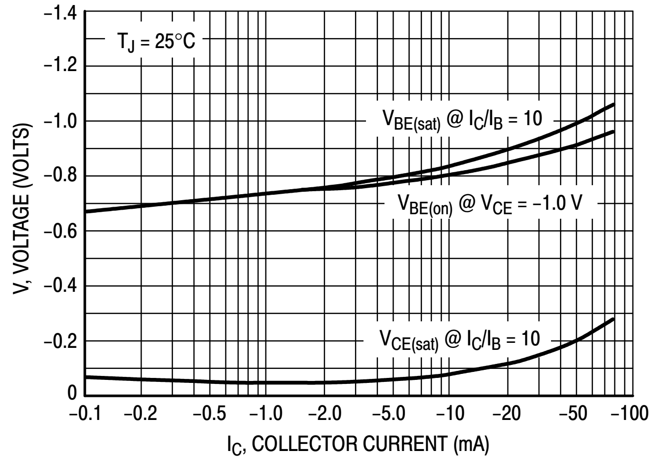


Figure 4. "On" Voltages

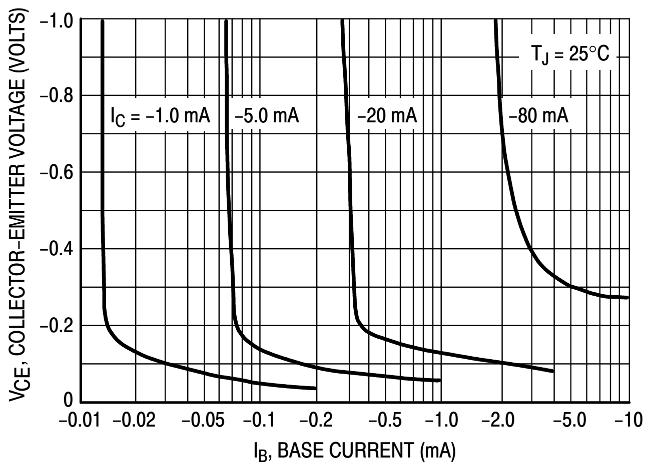


Figure 5. Collector Saturation Region

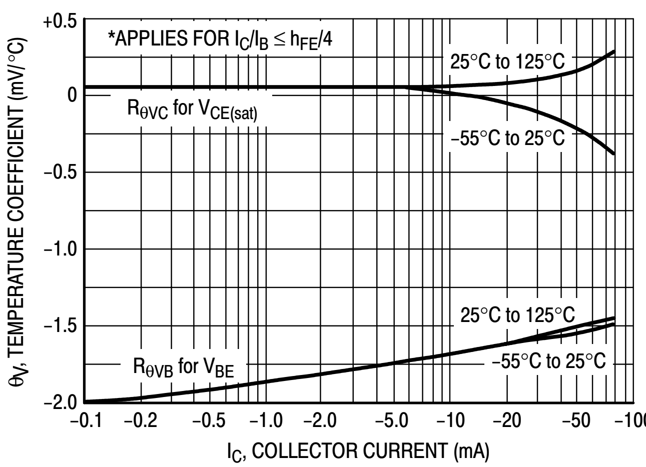


Figure 6. Temperature Coefficients

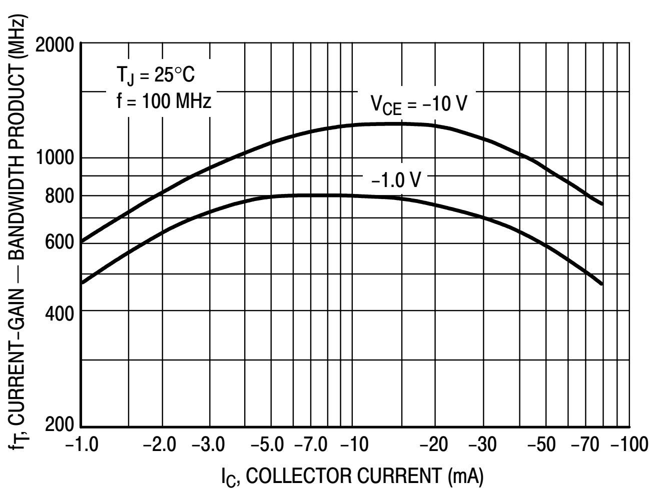


Figure 7. Current–Gain — Bandwidth Product

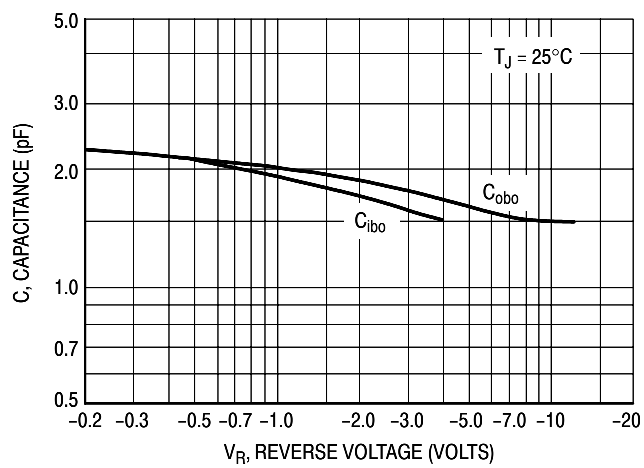
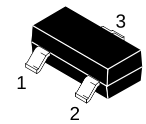


Figure 8. Capacitance

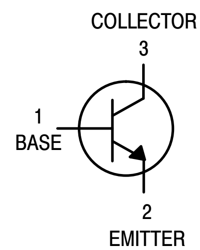
General Purpose Transistor
NPN Silicon

MMBT3904LT1

ON Semiconductor Preferred Device



CASE 318–08, STYLE 6
SOT–23 (TO–236)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	60	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT3904LT1 = 1AM

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (3) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{BL}	—	50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{CEX}	—	50	nAdc

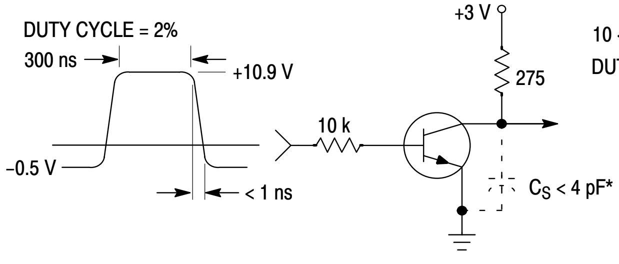
1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

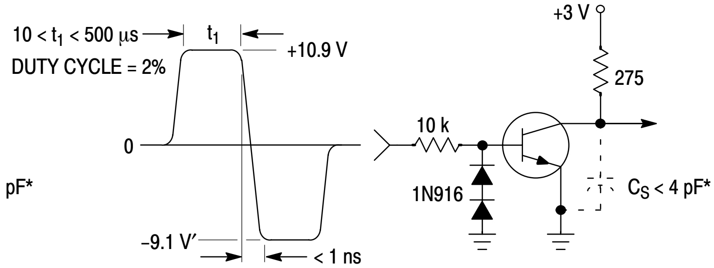
Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS[3]					
DC Current Gain (1)		H_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)			40	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)			70	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)			60	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)			30	—	
Collector–Emitter Saturation Voltage (3)		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			—	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			—	0.3	
Base–Emitter Saturation Voltage (3)		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			—	0.95	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	300	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	4.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	8.0	pF
Input Impedance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)		h_{ie}	1.0	10	k ohms
Voltage Feedback Ratio (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)		h_{re}	0.5	8.0	X 10^{-4}
Small–Signal Current Gain (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)		h_{fe}	100	400	—
Output Admittance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)		h_{oe}	1.0	40	μmhos
Noise Figure (V_{CE} = 5.0 Vdc, I_C = 100 μAdc, R_S = 1.0 k ohms, f = 1.0 kHz)		NF	—	5.0	dB
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = –0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_d	—	35	ns
Rise Time		t_r	—	35	
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_s	—	200	ns
Fall Time		t_f	—	50	

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.



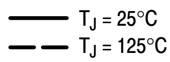


* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit

Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS



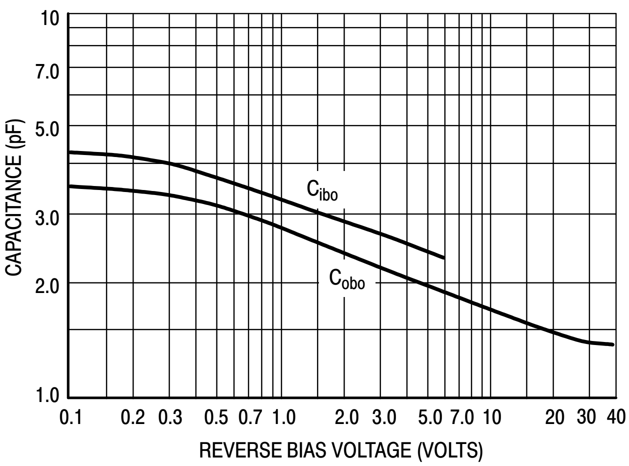


Figure 3. Capacitance

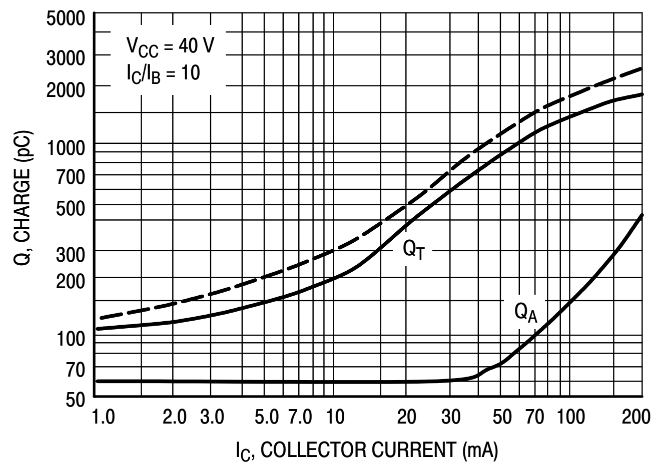


Figure 4. Charge Data

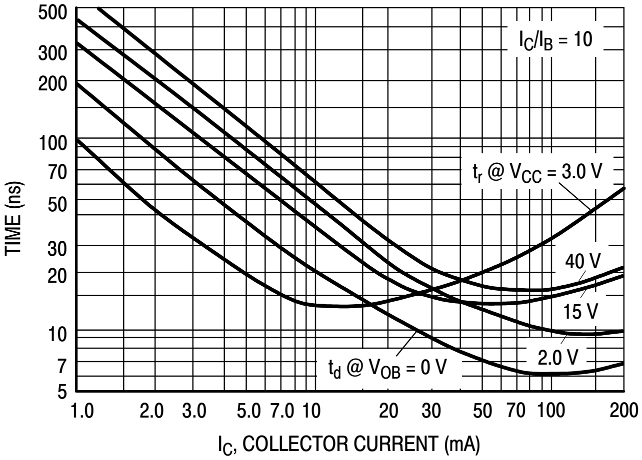


Figure 5. Turn–On Time

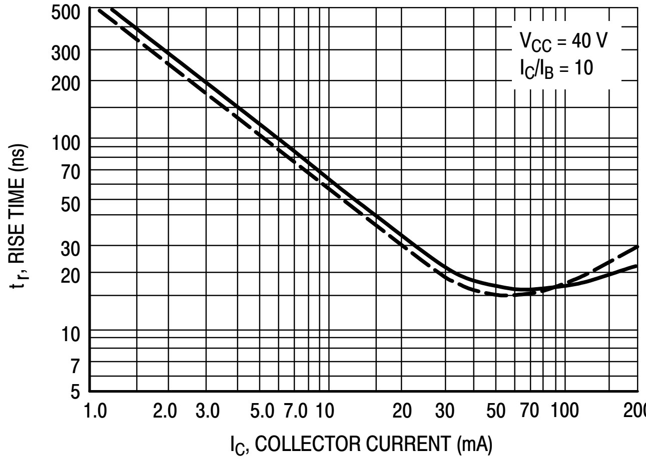


Figure 6. Rise Time

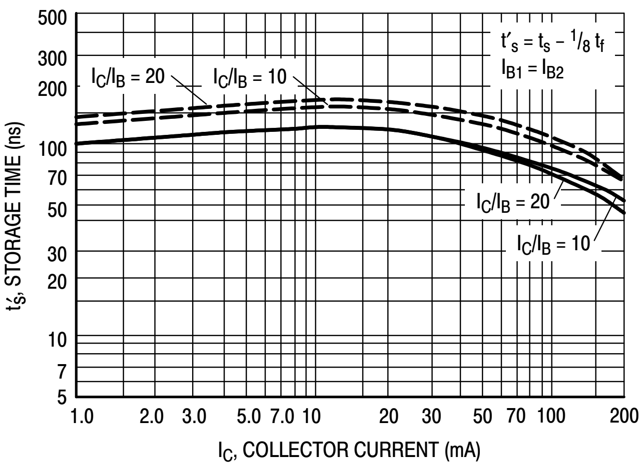


Figure 7. Storage Time

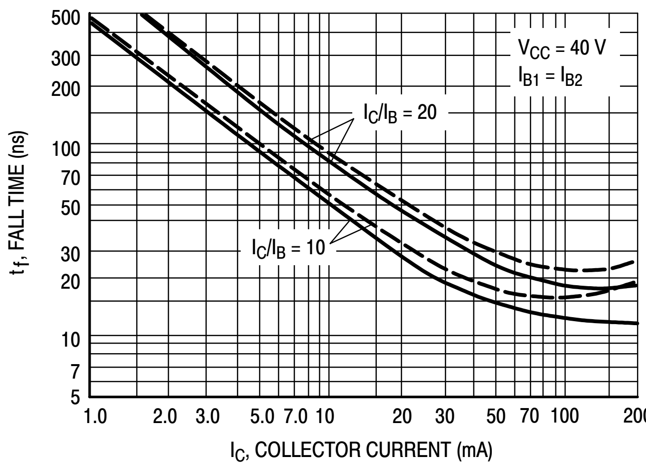


Figure 8. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = 5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

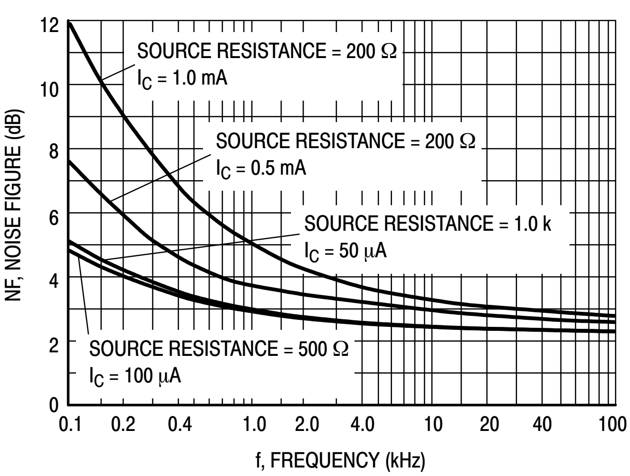


Figure 9.

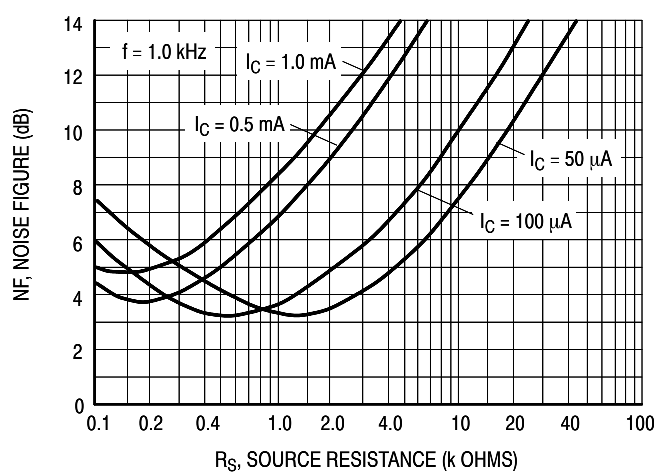


Figure 10.

h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

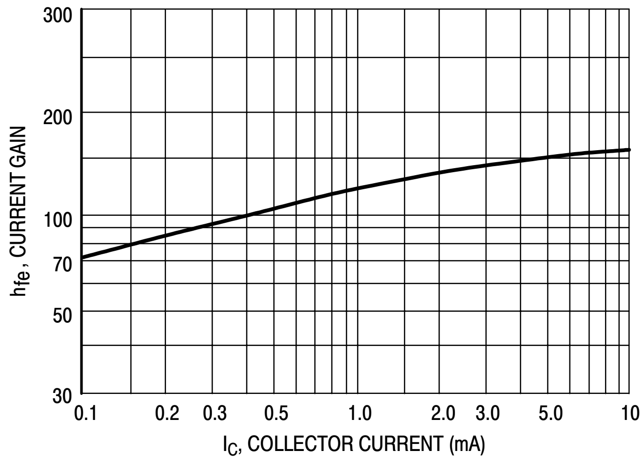


Figure 11. Current Gain

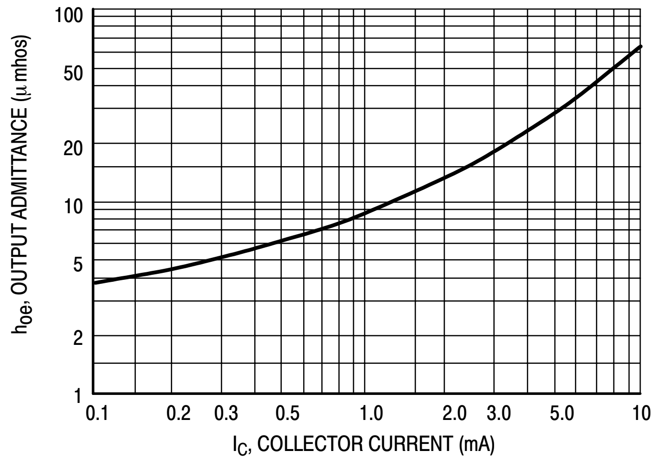


Figure 12. Output Admittance

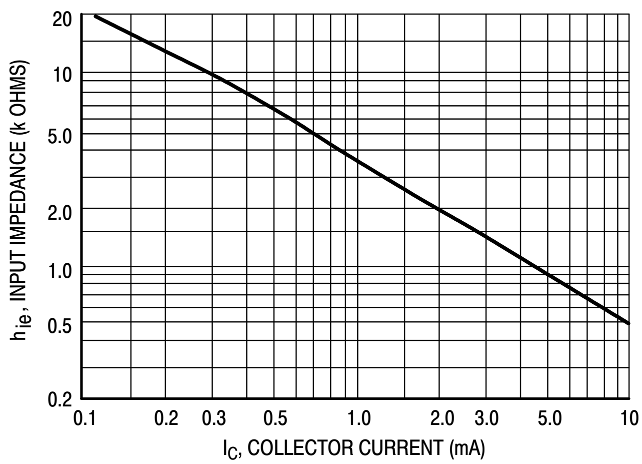


Figure 13. Input Impedance

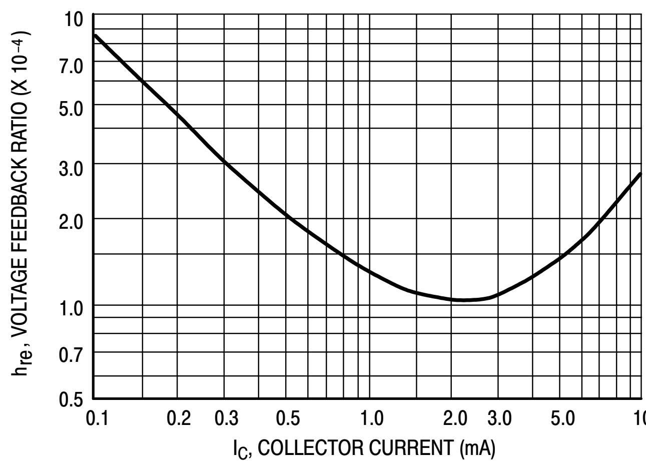


Figure 14. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

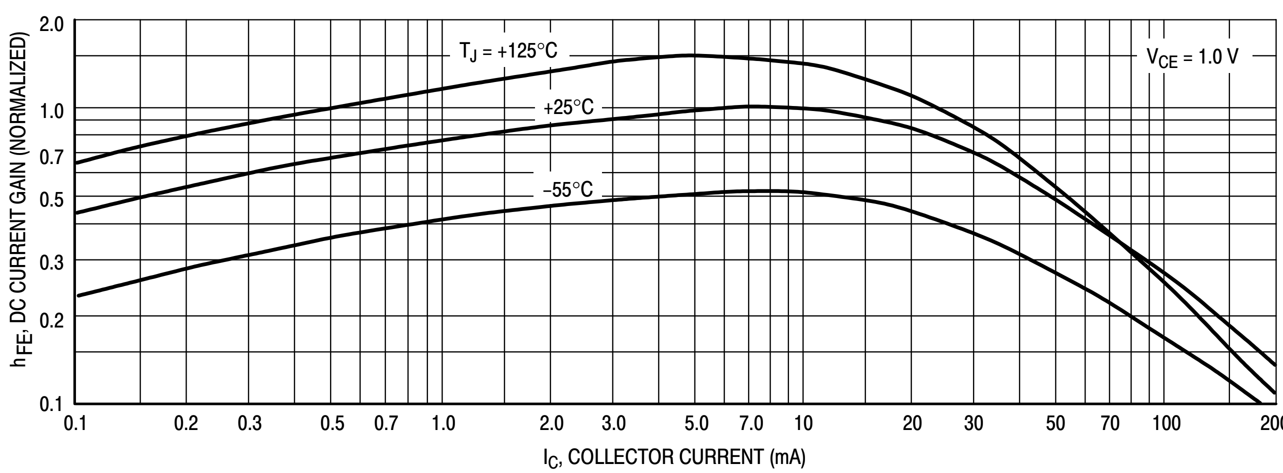


Figure 15. DC Current Gain

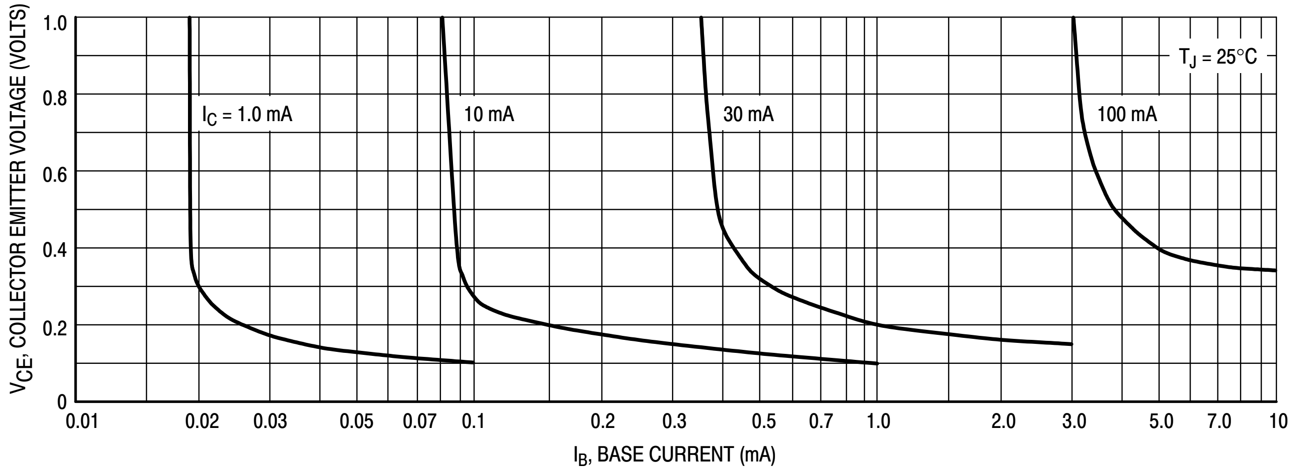


Figure 16. Collector Saturation Region

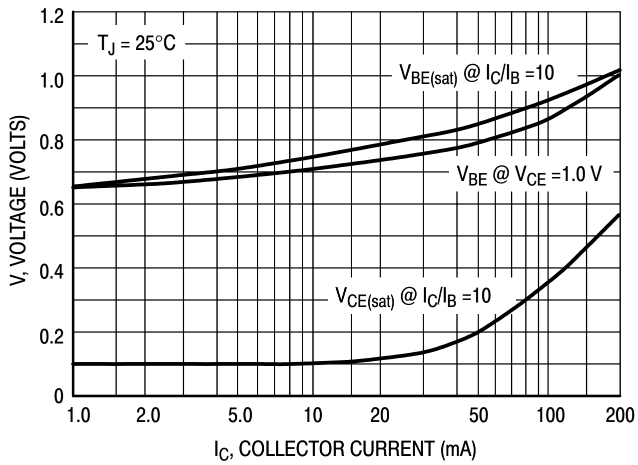


Figure 17. "ON" Voltages

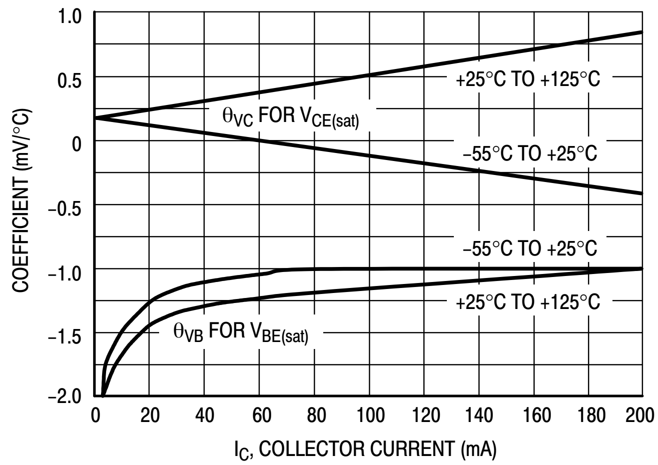


Figure 18. Temperature Coefficients

MMBT3904TT1

General Purpose Transistors

MMBT3904TT1 – NPN Silicon

This transistor is designed for general purpose amplifier applications. It is housed in the SOT–416/SC–75 package which is designed for low power surface mount applications.

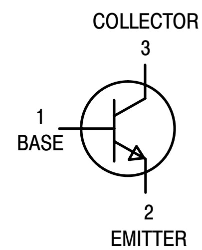
- Device Marking:
  MMBT3904TT1 = AM

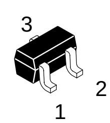
ON Semiconductor™

http://onsemi.com

GENERAL PURPOSE AMPLIFIER TRANSISTORS SURFACE MOUNT

MMBT3904TT1





CASE 463
SOT–416/SC–75
STYLE 1

MAXIMUM RATINGS (T_A = 25°C)

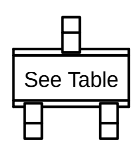
Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	60	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current – Continuous	I_C	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, FR–4 Board (1) T_A = 25°C Derated above 25°C	P_D	200 1.6	mW mW/°C
Thermal Resistance, Junction to Ambient (1)	$R_{\theta JA}$	600	°C/W
Total Device Dissipation, FR–4 Board (2) T_A = 25°C Derated above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient (2)	$R_{\theta JA}$	400	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) FR–4 @ Minimum Pad
(2) FR–4 @ 1.0 × 1.0 Inch Pad

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
MMBT3904TT1	SOT–416	3000 / Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (3) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40 –40	– –	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60 –40	– –	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0 –5.0	– –	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{BL}	– –	50 –50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{CEX}	– –	50 –50	nAdc
ON CHARACTERISTICS (3)				
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 50 mAdc, V_{CE} = 1.0 Vdc) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	 40 70 100 60 30	 – – 300 – –	–
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	 – –	 0.2 0.3	Vdc
Base–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	 0.65 –	 0.85 0.95	Vdc

(3) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

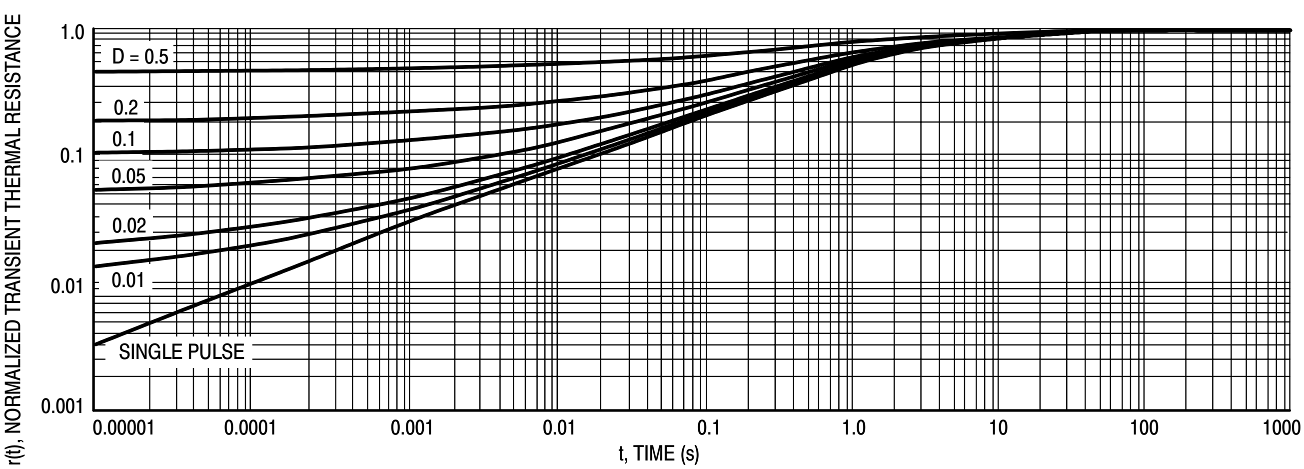
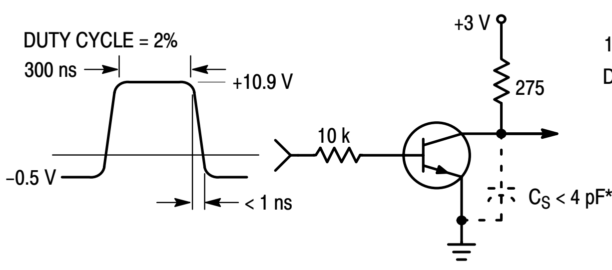
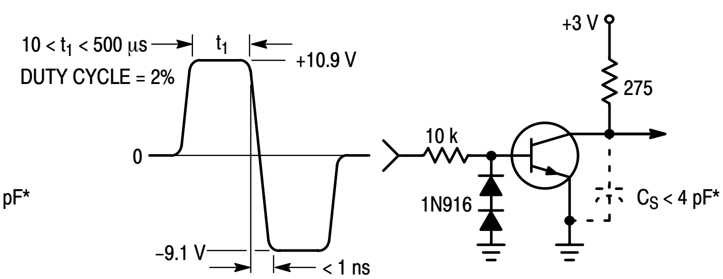


Figure 1. Normalized Thermal Response

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic			Symbol	Min	Max	Unit
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain – Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)			f_T	300	–	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)			C_{obo}	–	4.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)			C_{ibo}	–	8.0	pF
Input Impedance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)			h_{ie}	1.0	10	k Ω
Voltage Feedback Ratio (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)			h_{re}	0.5	8.0	X 10^{-4}
Small–Signal Current Gain (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)			h_{fe}	100	400	–
Output Admittance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)			h_{oe}	1.0	40	μmhos
Noise Figure (V_{CE} = 5.0 Vdc, I_C = 100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)			NF	–	5.0	dB
SWITCHING CHARACTERISTICS						
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = –0.5 Vdc)	MMBT3904TT1	t_d	–	35	ns
Rise Time	(I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	MMBT3904TT1	t_r	–	35	
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc)	MMBT3904TT1	t_s	–	200	ns
Fall Time	(I_{B1} = I_{B2} = 1.0 mAdc)	MMBT3904TT1	t_f	–	50	





* Total shunt capacitance of test jig and connectors

Figure 2. Delay and Rise Time Equivalent Test Circuit

Figure 3. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

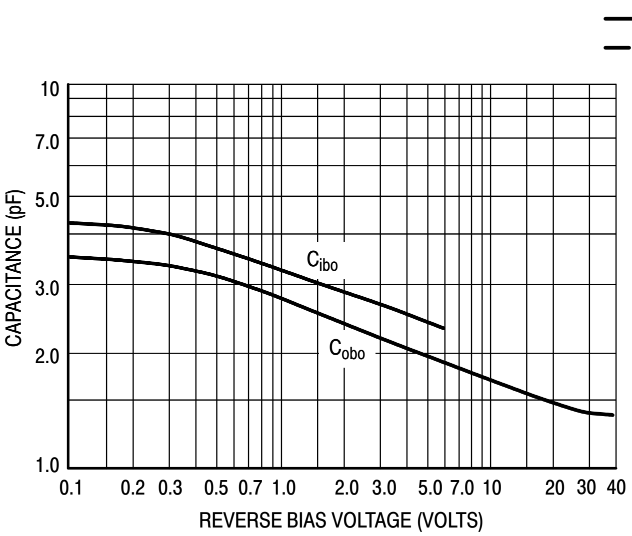


Figure 4. Capacitance

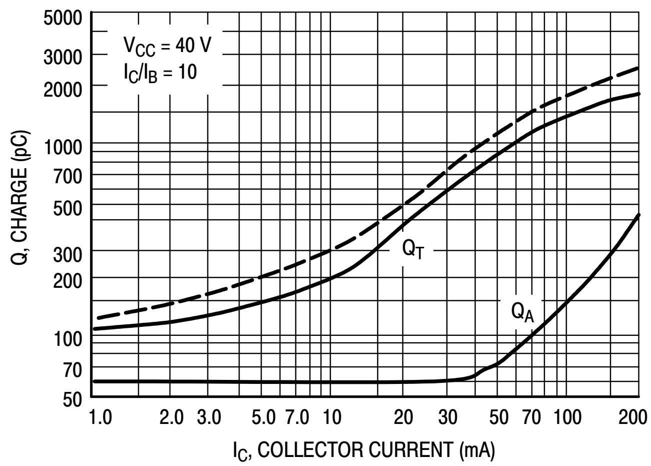


Figure 5. Charge Data

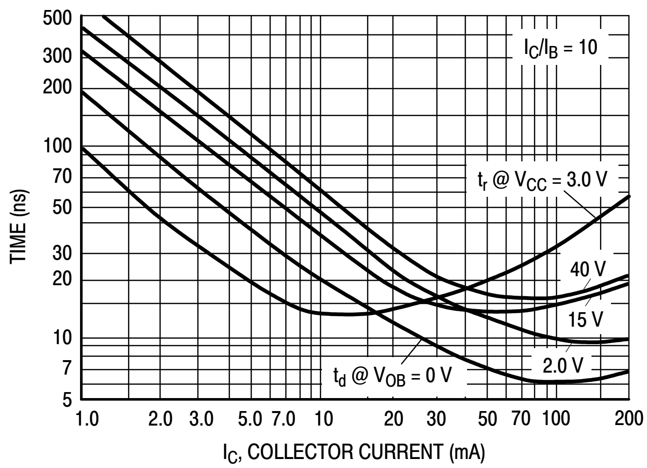


Figure 6. Turn−On Time

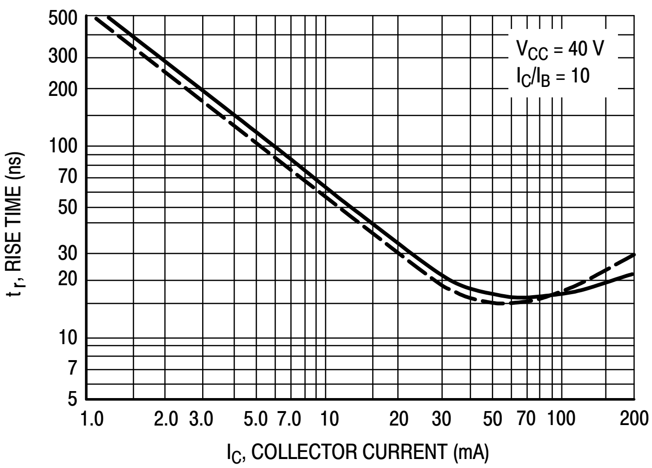


Figure 7. Rise Time

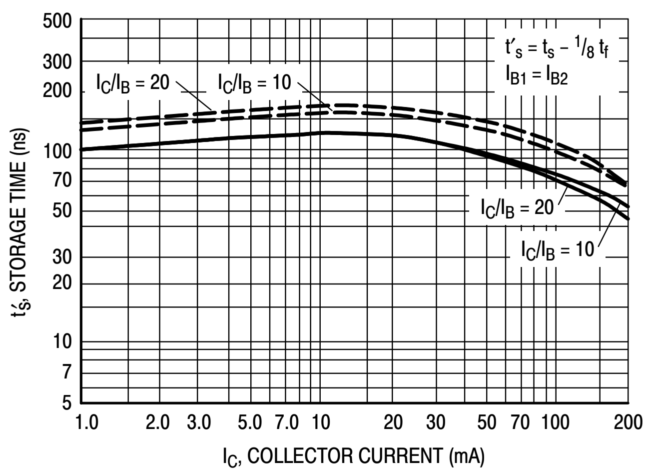


Figure 8. Storage Time

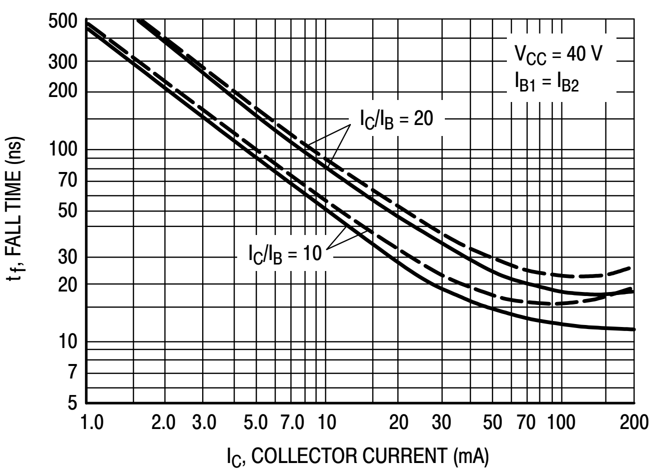


Figure 9. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = 5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

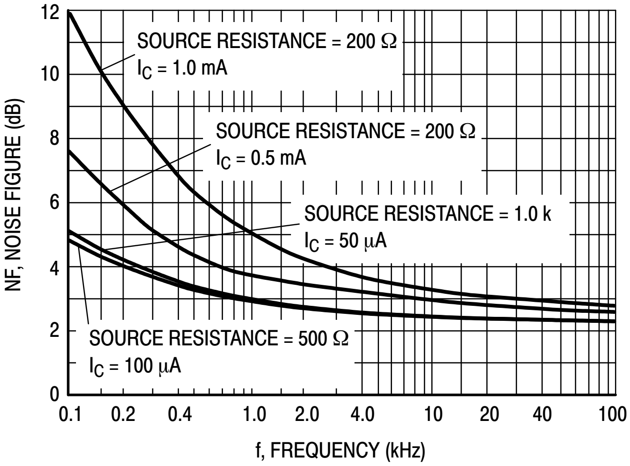


Figure 10. Noise Figure

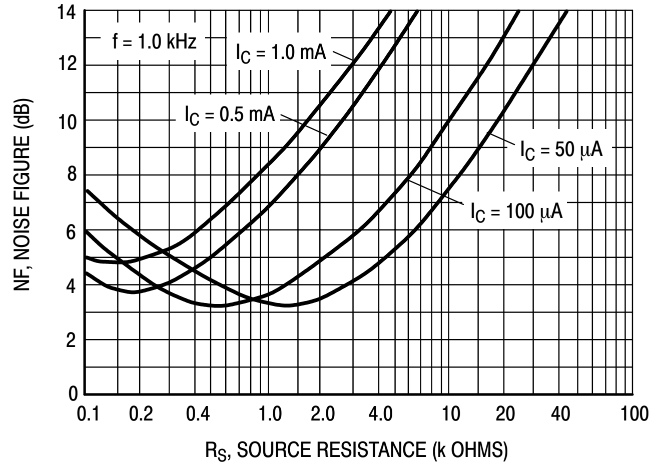


Figure 11. Noise Figure

h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

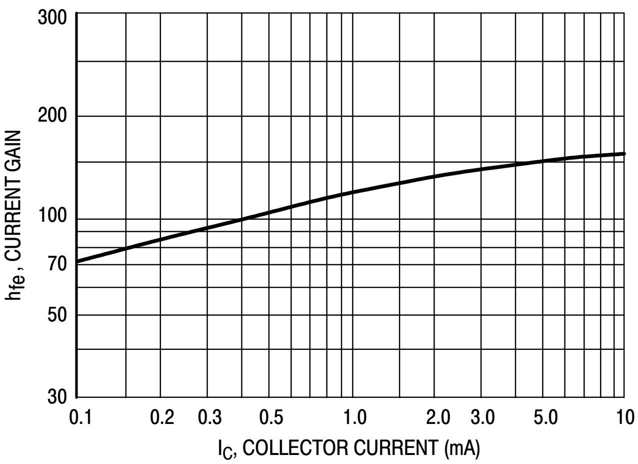


Figure 12. Current Gain

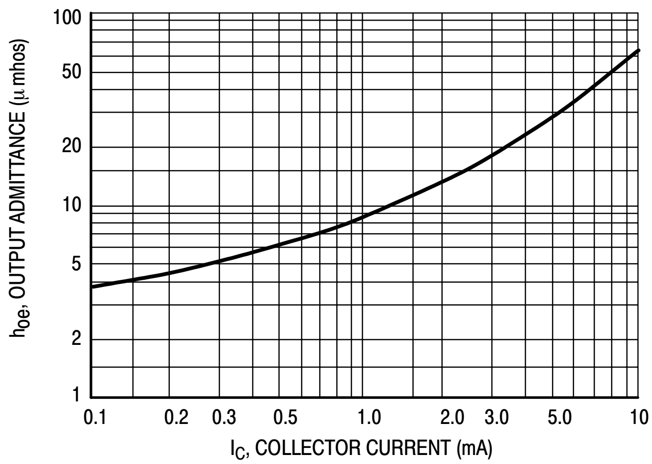


Figure 13. Output Admittance

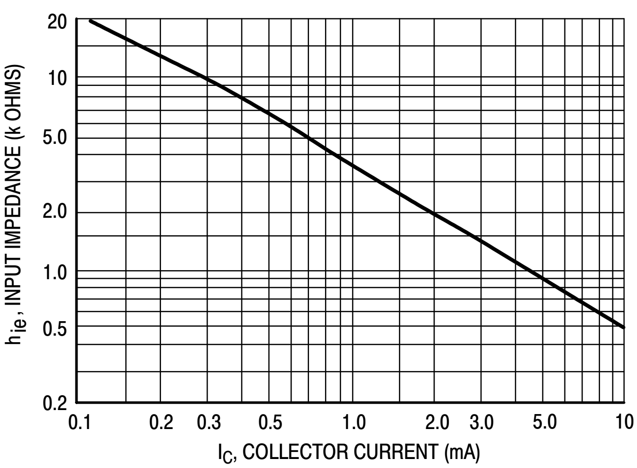


Figure 14. Input Impedance

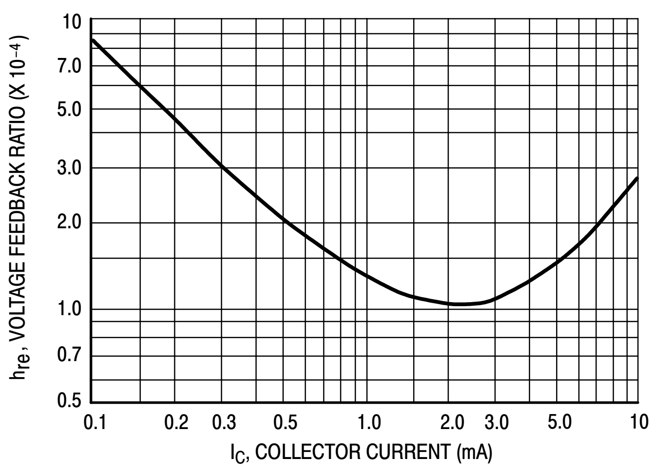


Figure 15. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

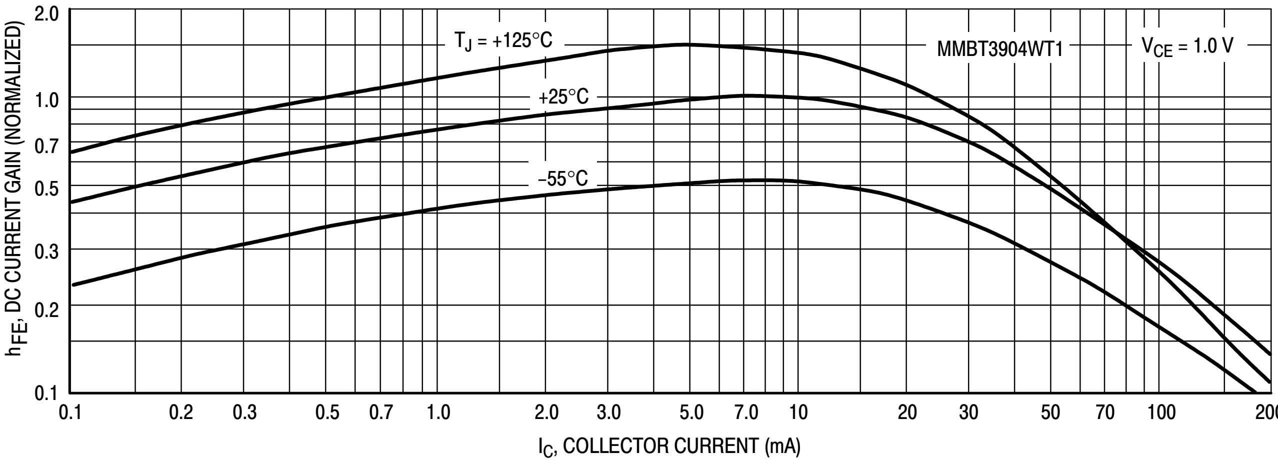


Figure 16. DC Current Gain

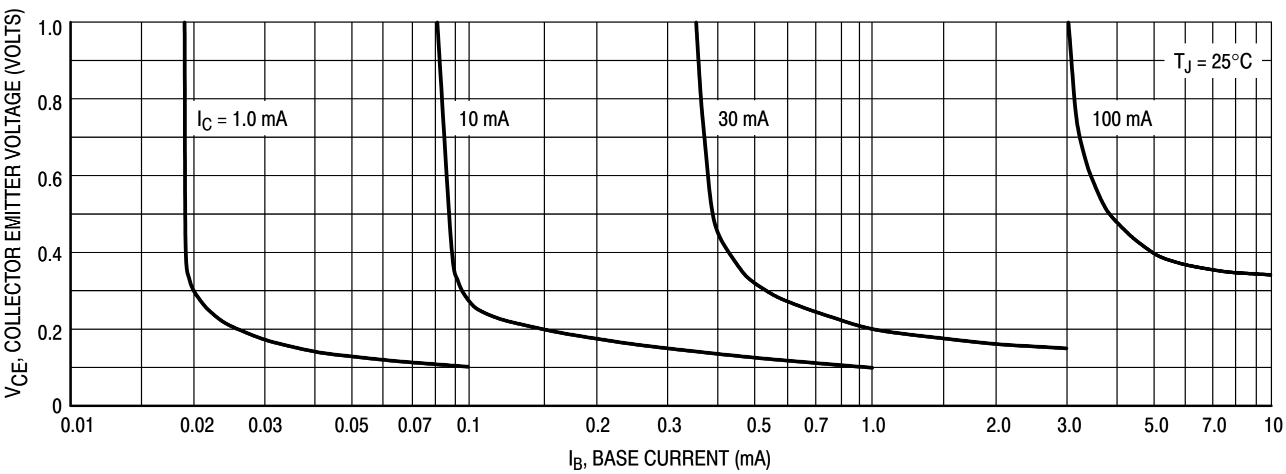


Figure 17. Collector Saturation Region

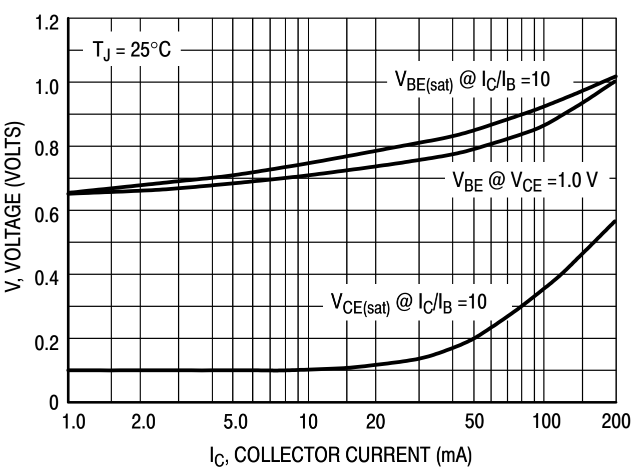


Figure 18. "ON" Voltages

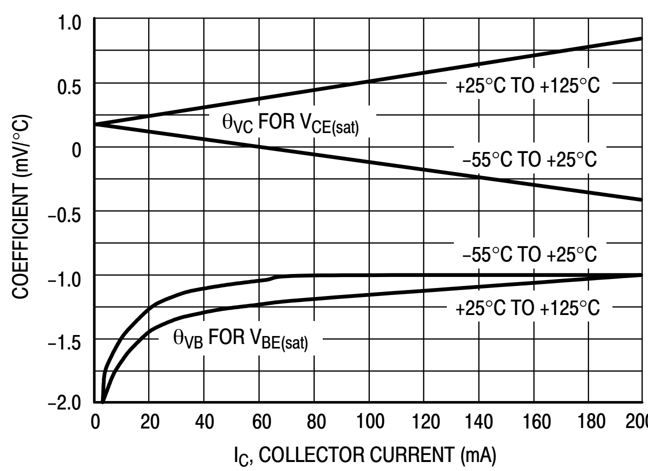
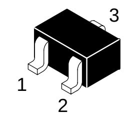


Figure 19. Temperature Coefficients

General Purpose Transistors
NPN and PNP Silicon

These transistors are designed for general purpose amplifier applications. They are housed in the SOT–323/SC–70 which is designed for low power surface mount applications.

PNP
MMBT3904WT1
NPN
MMBT3906WT1



CASE 419–04, STYLE 3
SOT–323/SC–70

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Collector–Emitter Voltage	MMBT3904WT1 MMBT3906WT1	V_{CEO}	40 –40	Vdc
Collector–Base Voltage	MMBT3904WT1 MMBT3906WT1	V_{CBO}	60 –40	Vdc
Emitter–Base Voltage	MMBT3904WT1 MMBT3906WT1	V_{EBO}	6.0 –5.0	Vdc
Collector Current — Continuous	MMBT3904WT1 MMBT3906WT1	I_C	200 –200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation(1) T_A = 25°C	P_D	150	mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	833	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT3904WT1 = AM
MMBT3906WT1 = 2A

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(2) (I_C = 1.0 mAdc, I_B = 0) (I_C = –1.0 mAdc, I_B = 0)	 MMBT3904WT1 MMBT3906WT1	$V_{(BR)CEO}$	 40 –40	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0) (I_C = –10 μAdc, I_E = 0)	 MMBT3904WT1 MMBT3906WT1	$V_{(BR)CBO}$	 60 –40	 — —	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0) (I_E = –10 μAdc, I_C = 0)	 MMBT3904WT1 MMBT3906WT1	$V_{(BR)EBO}$	 6.0 –5.0	 — —	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc) (V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	 MMBT3904WT1 MMBT3906WT1	I_{BL}	 — —	 50 –50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc) (V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	 MMBT3904WT1 MMBT3906WT1	I_{CEX}	 — —	 50 –50	nAdc

1. Device mounted on FR4 glass epoxy printed circuit board using the minimum recommended footprint.
2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

March, 2001 – Rev. 1
Publication Order Number:
MMBT3904WT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS(2)					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	MMBT3904WT1		40	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)			70	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)			60	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)			30	—	
(I_C = –0.1 mAdc, V_{CE} = –1.0 Vdc)	MMBT3906WT1		60	—	
(I_C = –1.0 mAdc, V_{CE} = –1.0 Vdc)			80	—	
(I_C = –10 mAdc, V_{CE} = –1.0 Vdc)			100	300	
(I_C = –50 mAdc, V_{CE} = –1.0 Vdc)			60	—	
(I_C = –100 mAdc, V_{CE} = –1.0 Vdc)			30	—	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	MMBT3904WT1		—	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			—	0.3	
(I_C = –10 mAdc, I_B = –1.0 mAdc)	MMBT3906WT1		—	–0.25	
(I_C = –50 mAdc, I_B = –5.0 mAdc)			—	–0.4	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	MMBT3904WT1		0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			—	0.95	
(I_C = –10 mAdc, I_B = –1.0 mAdc)	MMBT3906WT1		–0.65	–0.85	
(I_C = –50 mAdc, I_B = –5.0 mAdc)			—	–0.95	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product		f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MMBT3904WT1		300	—	
(I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)	MMBT3906WT1		250	—	
Output Capacitance		C_{obo}			pF
(V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	MMBT3904WT1		—	4.0	
(V_{CB} = –5.0 Vdc, I_E = 0, f = 1.0 MHz)	MMBT3906WT1		—	4.5	
Input Capacitance		C_{ibo}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MMBT3904WT1		—	8.0	
(V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)	MMBT3906WT1		—	10.0	
Input Impedance		h_{ie}			k Ω
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904WT1		1.0	10	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MMBT3906WT1		2.0	12	
Voltage Feedback Ratio		h_{re}			X 10^{-4}
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904WT1		0.5	8.0	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MMBT3906WT1		0.1	10	
Small–Signal Current Gain		h_{fe}			—
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904WT1		100	400	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MMBT3906WT1		100	400	
Output Admittance		h_{oe}			μmhos
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz)	MMBT3904WT1		1.0	40	
(V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)	MMBT3906WT1		3.0	60	
Noise Figure		NF			dB
(V_{CE} = 5.0 Vdc, I_C = 100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)	MMBT3904WT1		—	5.0	
(V_{CE} = –5.0 Vdc, I_C = –100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)	MMBT3906WT1		—	4.0	

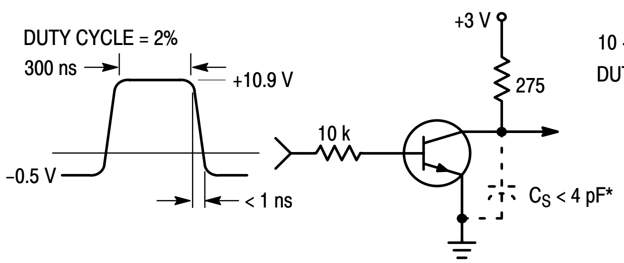
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

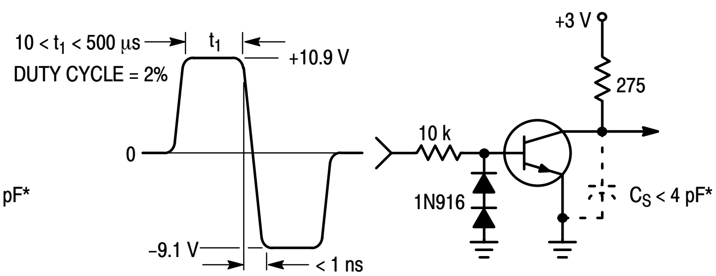
SMALL–SIGNAL CHARACTERISTICS

Characteristic	Condition		Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS						
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = –0.5 Vdc)	MMBT3904WT1	t_d	—	35	ns
	(V_{CC} = –3.0 Vdc, V_{BE} = 0.5 Vdc)	MMBT3906WT1		—	35	
Rise Time	(I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	MMBT3904WT1	t_r	—	35	
	(I_C = –10 mAdc, I_{B1} = –1.0 mAdc)	MMBT3906WT1		—	35	
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc)	MMBT3904WT1	t_s	—	200	ns
	(V_{CC} = –3.0 Vdc, I_C = –10 mAdc)	MMBT3906WT1		—	225	
Fall Time	(I_{B1} = I_{B2} = 1.0 mAdc)	MMBT3904WT1	t_f	—	50	
	(I_{B1} = I_{B2} = –1.0 mAdc)	MMBT3906WT1		—	75	

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MMBT3904WT1





* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit

Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

$T_J = 25°C$
$T_J = 125°C$

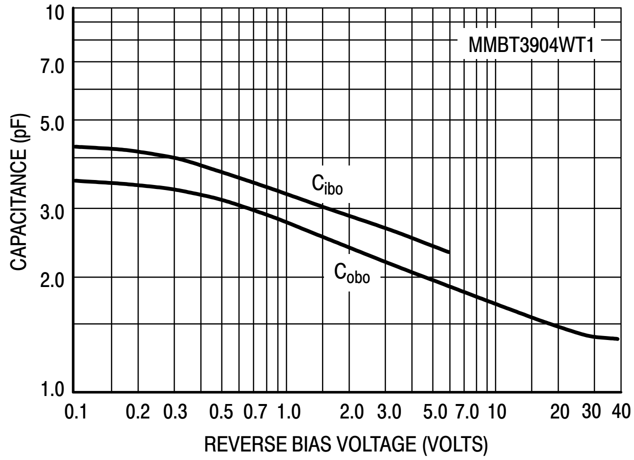


Figure 3. Capacitance

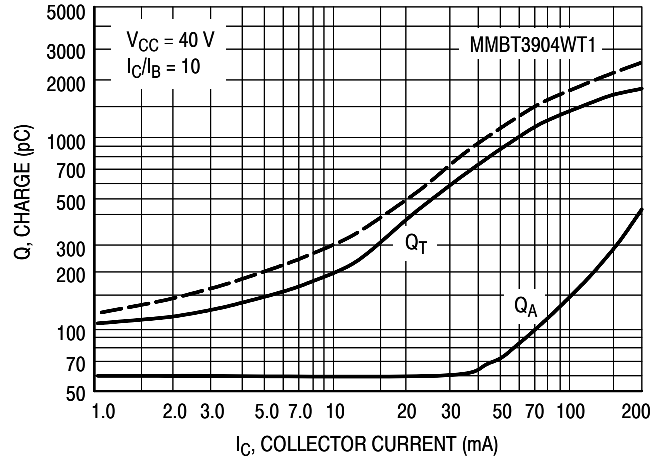


Figure 4. Charge Data

MMBT3904WT1

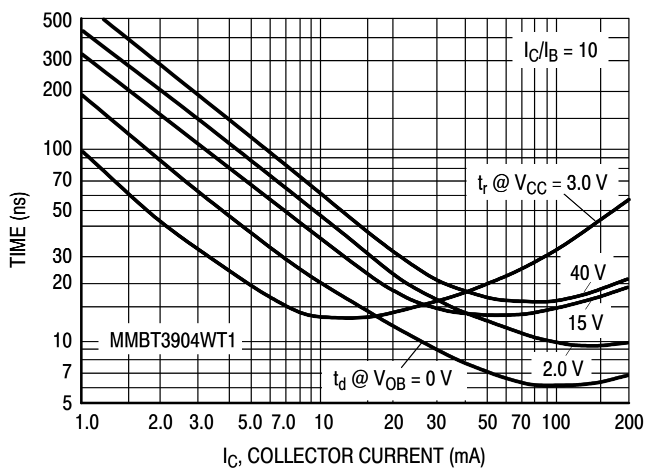


Figure 5. Turn–On Time

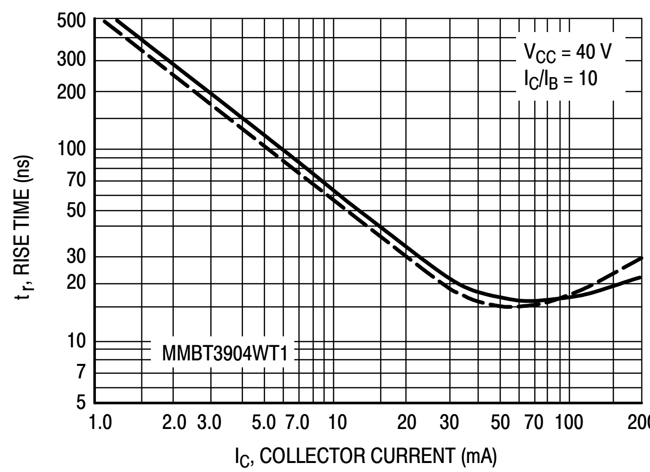


Figure 6. Rise Time

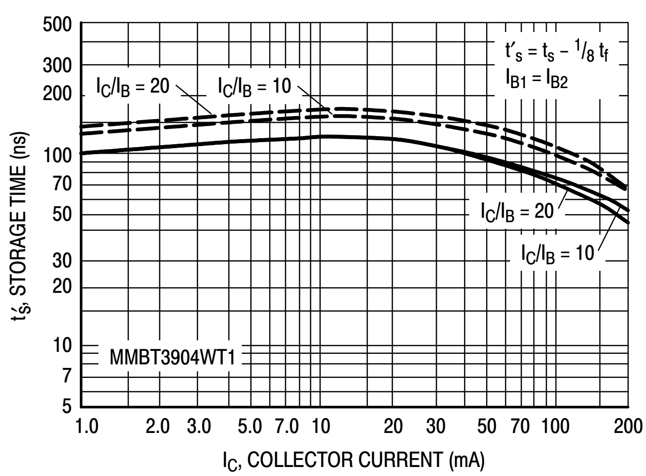


Figure 7. Storage Time

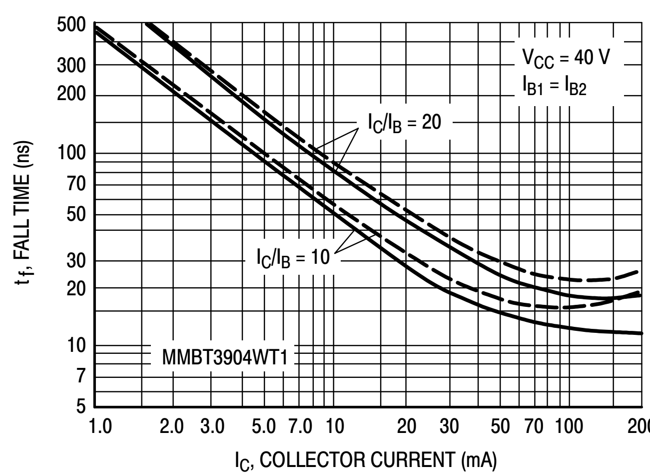


Figure 8. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = 5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

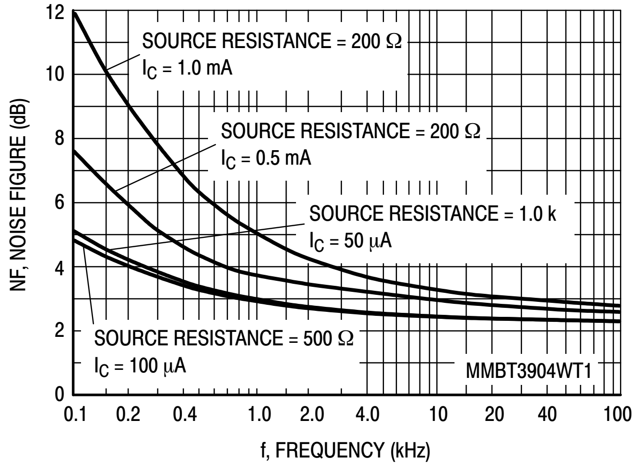


Figure 9. Noise Figure

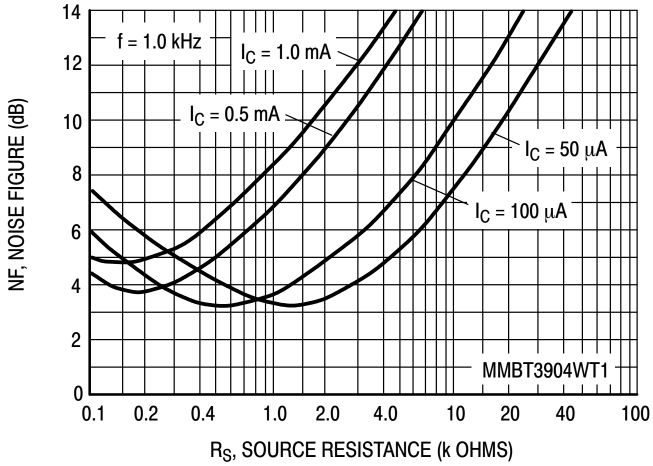


Figure 10. Noise Figure

MMBT3904WT1

h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

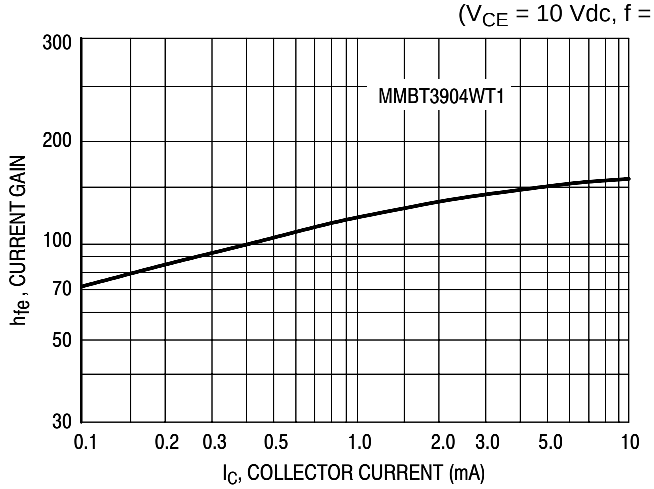


Figure 11. Current Gain

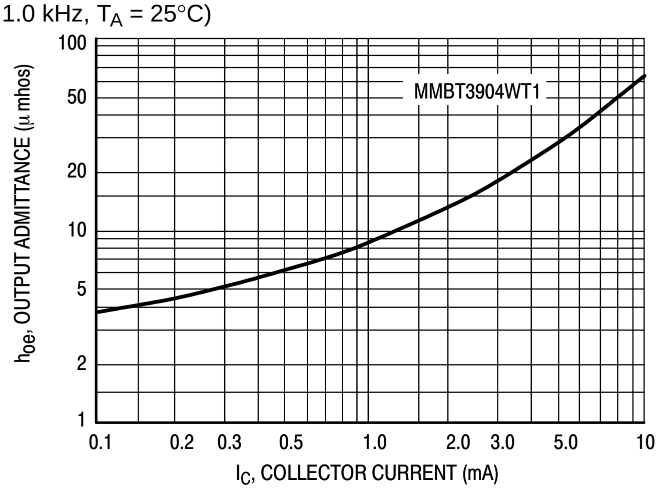


Figure 12. Output Admittance

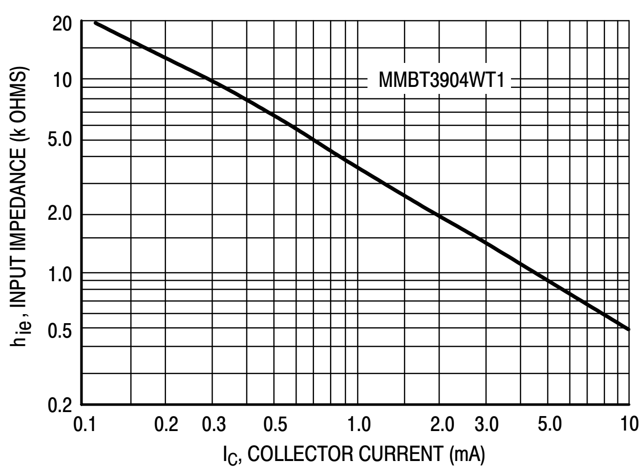


Figure 13. Input Impedance

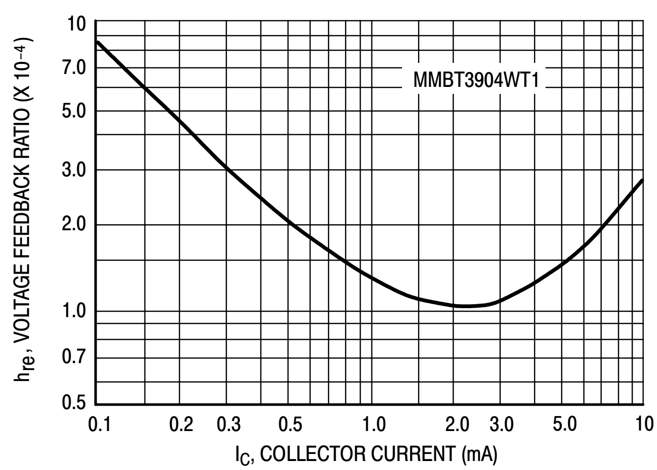


Figure 14. Voltage Feedback Ratio

MMBT3904WT1

TYPICAL STATIC CHARACTERISTICS

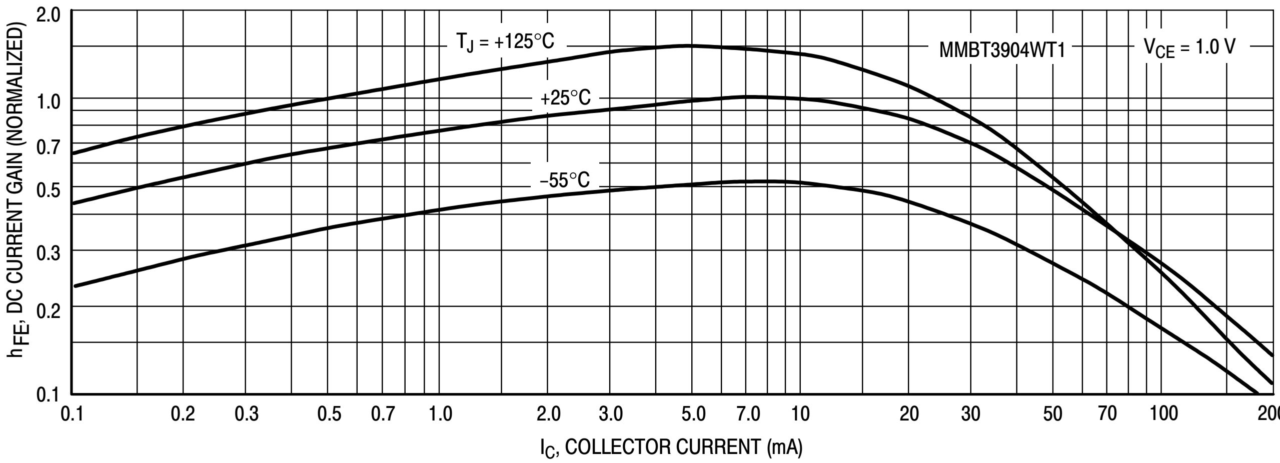


Figure 15. DC Current Gain

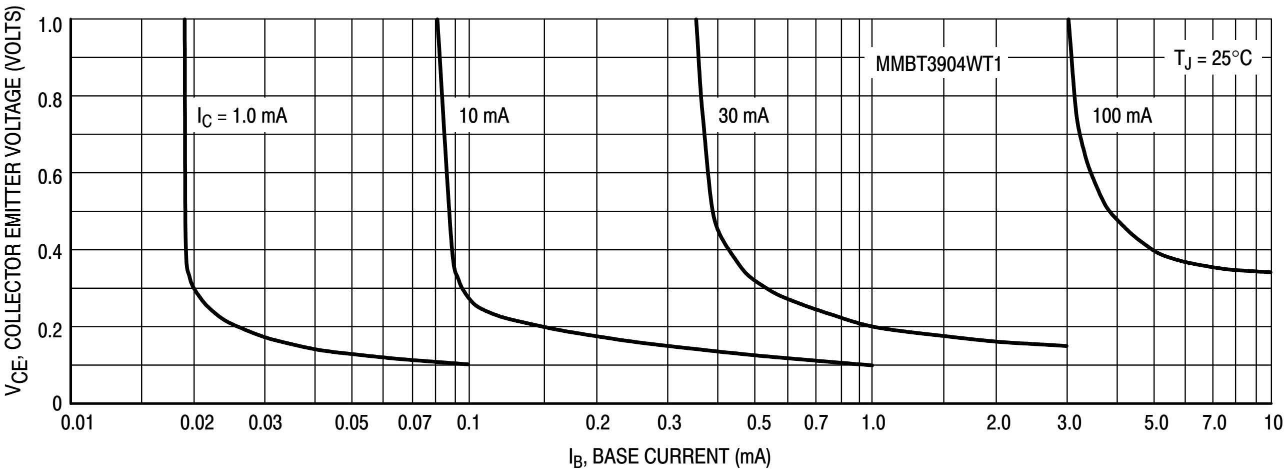


Figure 16. Collector Saturation Region

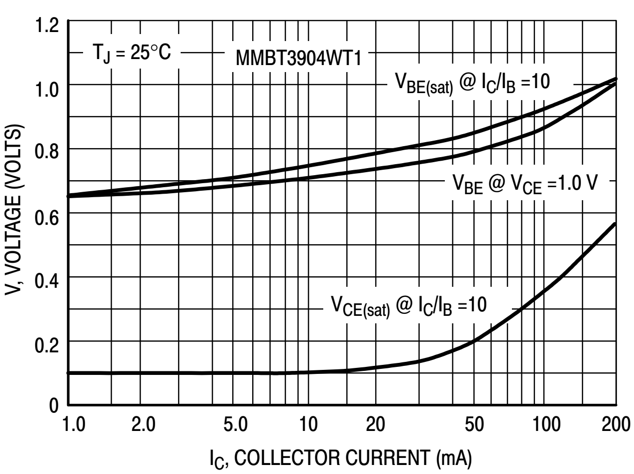


Figure 17. "ON" Voltages

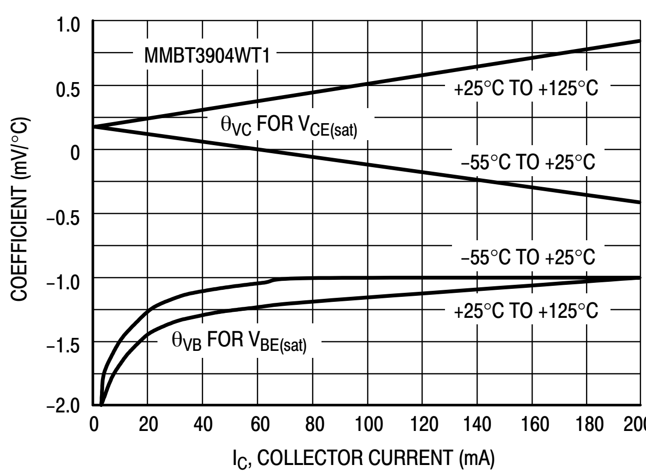
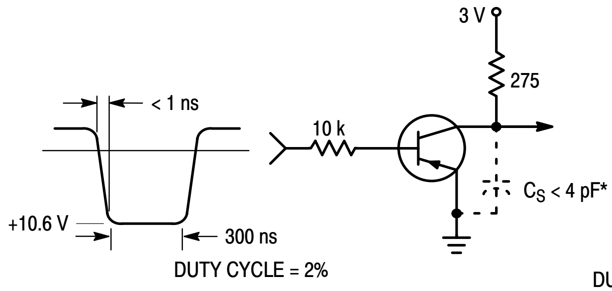
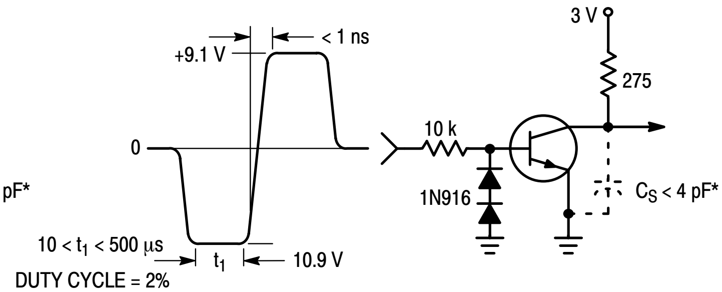


Figure 18. Temperature Coefficients

MMBT3906WT1



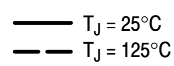


* Total shunt capacitance of test jig and connectors

Figure 19. Delay and Rise Time Equivalent Test Circuit

Figure 20. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS



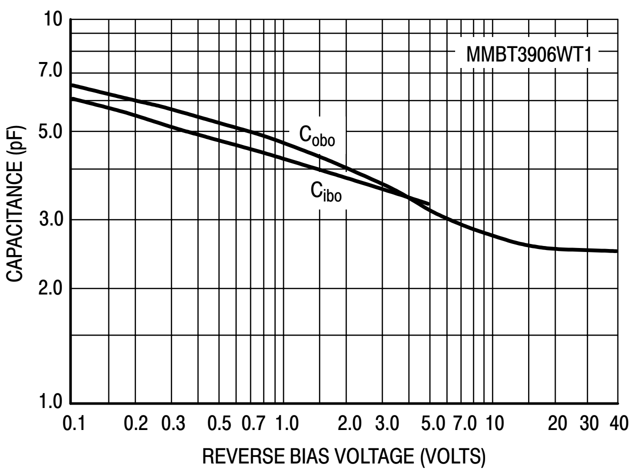


Figure 21. Capacitance

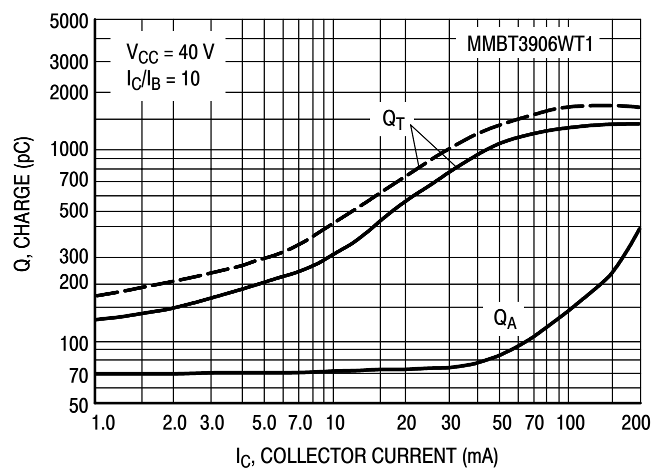


Figure 22. Charge Data

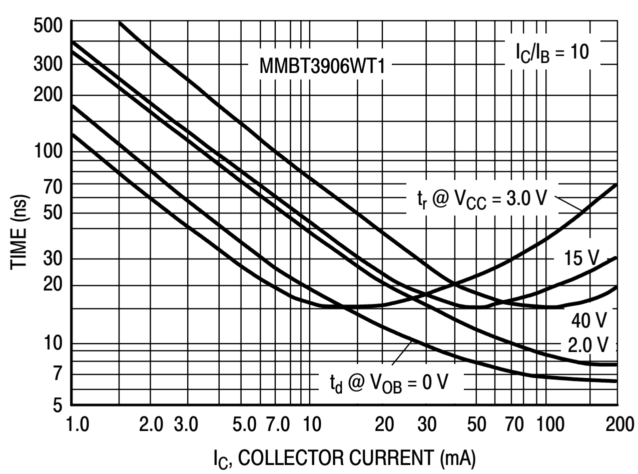


Figure 23. Turn–On Time

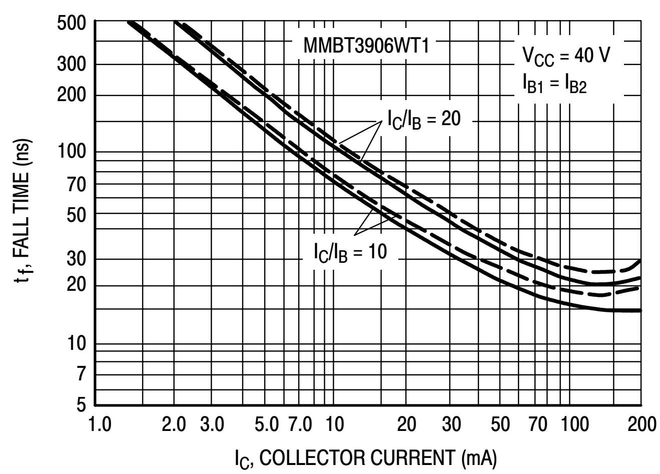


Figure 24. Fall Time

MMBT3906WT1

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

(V_{CE} = –5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

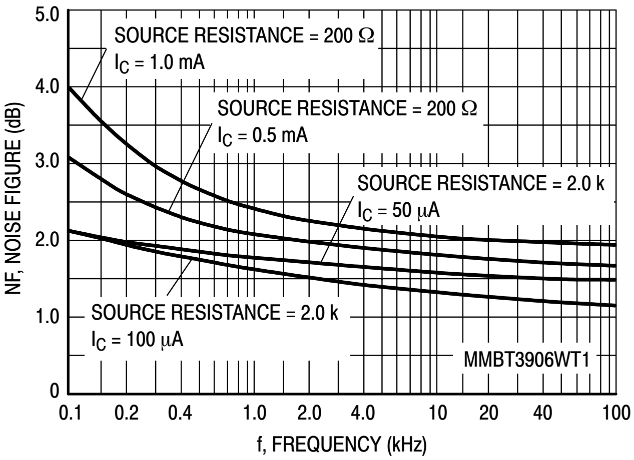


Figure 25.

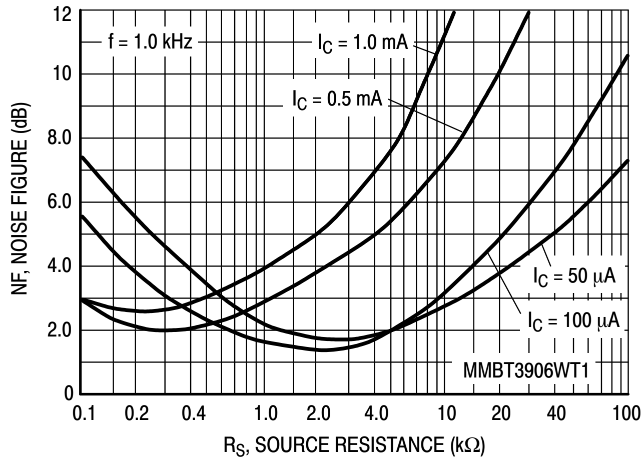


Figure 26.

h PARAMETERS

(V_{CE} = –10 Vdc, f = 1.0 kHz, T_A = 25°C)

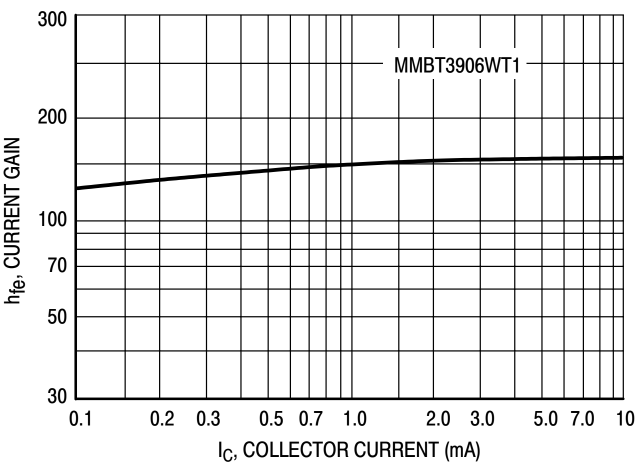


Figure 27. Current Gain

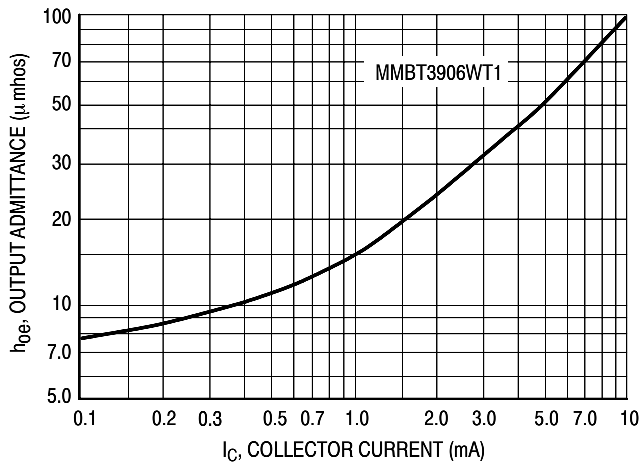


Figure 28. Output Admittance

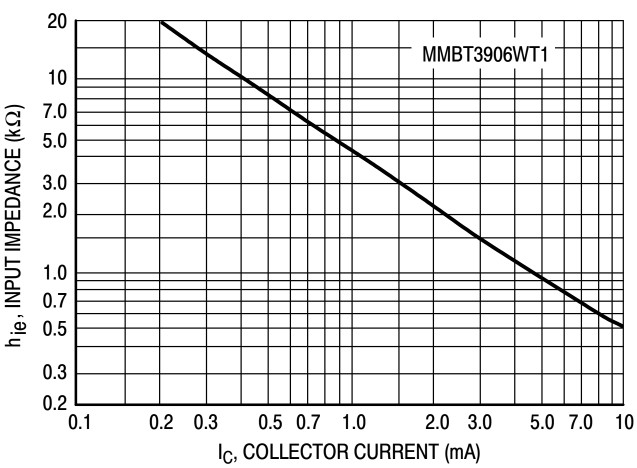


Figure 29. Input Impedance

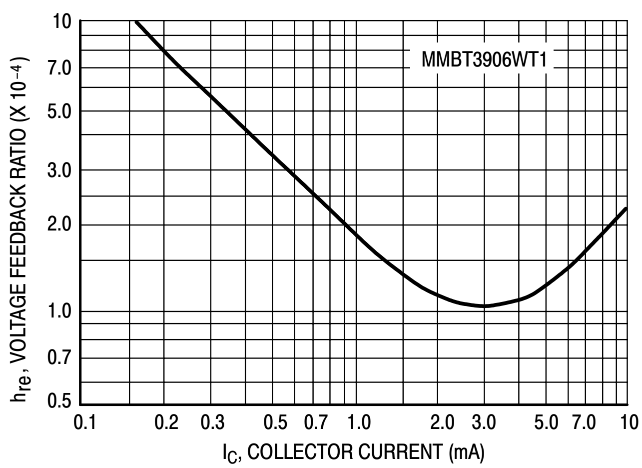


Figure 30. Voltage Feedback Ratio

MMBT3906WT1

STATIC CHARACTERISTICS

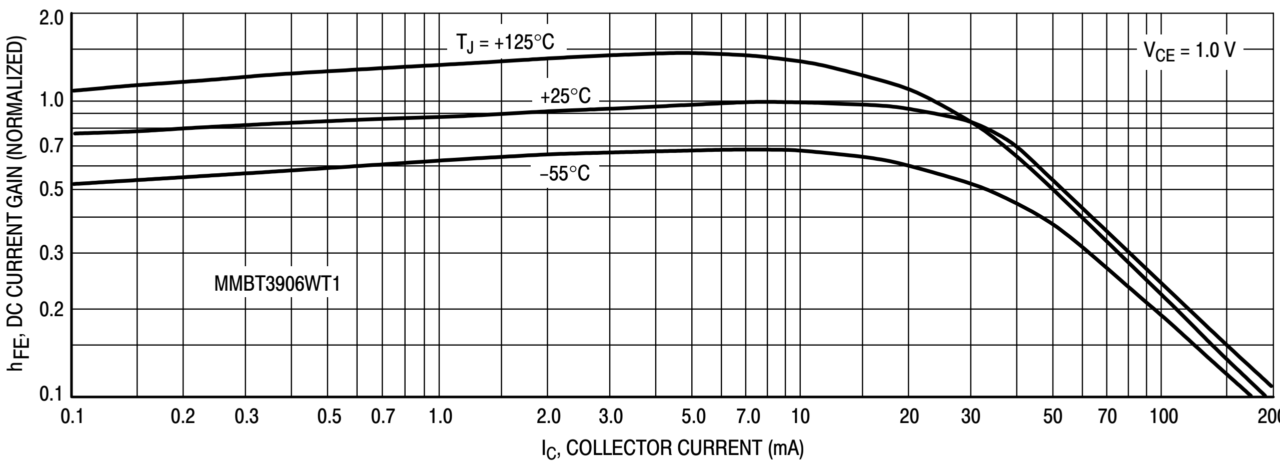


Figure 31. DC Current Gain

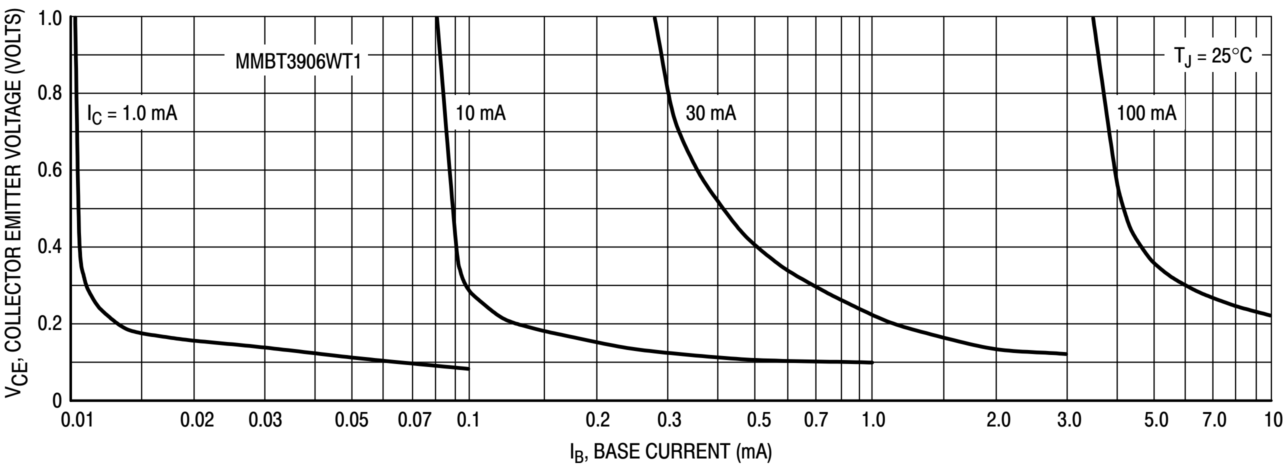


Figure 32. Collector Saturation Region

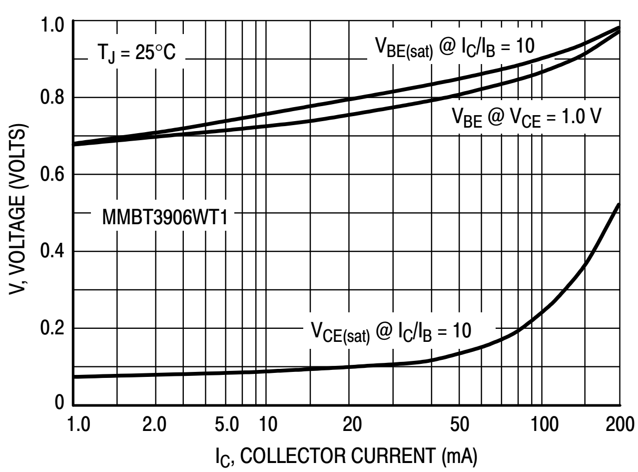


Figure 33. “ON” Voltages

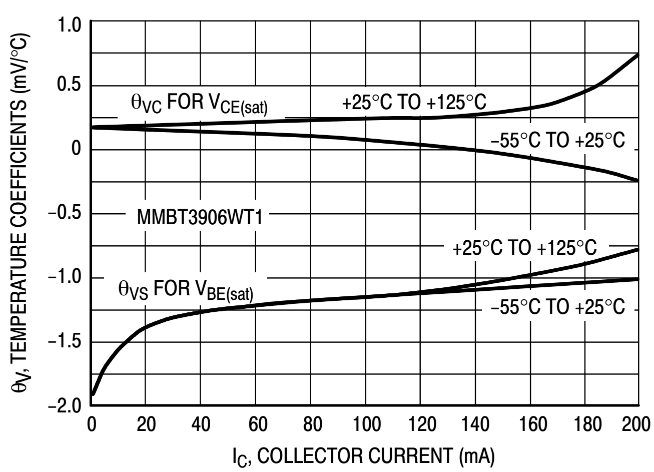
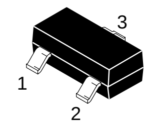


Figure 34. Temperature Coefficients

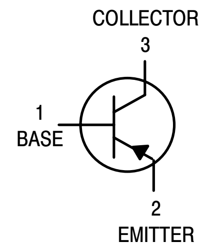
General Purpose Transistor
PNP Silicon

MMBT3906LT1

ON Semiconductor Preferred Device



CASE 318–08, STYLE 6
SOT–23 (TO–236)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–40	Vdc
Collector–Base Voltage	V_{CBO}	–40	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current — Continuous	I_C	–200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT3906LT1 = 2A

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(3) (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–40	—	Vdc
Collector–Base Breakdown Voltage (I_C = –10 μAdc, I_E = 0)	$V_{(BR)CBO}$	–40	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	Vdc
Base Cutoff Current (V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	I_{BL}	—	–50	nAdc
Collector Cutoff Current (V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	I_{CEX}	—	–50	nAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 2

Publication Order Number:
MMBT3906LT1/D

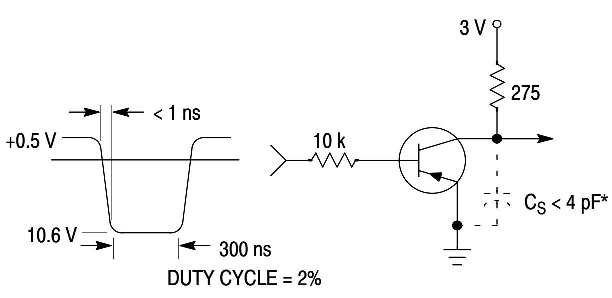
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

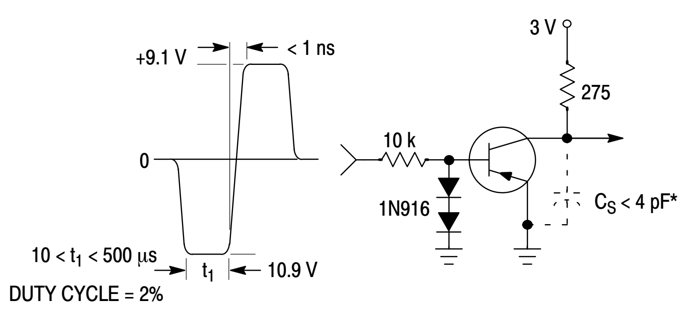
Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS(3)				
DC Current Gain	H_{FE}			—
(I_C = –0.1 mAdc, V_{CE} = –1.0 Vdc)		60	—	
(I_C = –1.0 mAdc, V_{CE} = –1.0 Vdc)		80	—	
(I_C = –10 mAdc, V_{CE} = –1.0 Vdc)		100	300	
(I_C = –50 mAdc, V_{CE} = –1.0 Vdc)		60	—	
(I_C = –100 mAdc, V_{CE} = –1.0 Vdc)		30	—	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = –10 mAdc, I_B = –1.0 mAdc)		—	–0.25	
(I_C = –50 mAdc, I_B = –5.0 mAdc)		—	–0.4	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = –10 mAdc, I_B = –1.0 mAdc)		–0.65	–0.85	
(I_C = –50 mAdc, I_B = –5.0 mAdc)		—	–0.95	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)	f_T	250	—	MHz
Output Capacitance (V_{CB} = –5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	4.5	pF
Input Capacitance (V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	10	pF
Input Impedance (I_C = –1.0 mAdc, V_{CE} = –10 Vdc, f = 1.0 kHz)	h_{ie}	2.0	12	kΩ
Voltage Feedback Ratio (I_C = –1.0 mAdc, V_{CE} = –10 Vdc, f = 1.0 kHz)	h_{re}	0.1	10	X 10^{-4}
Small–Signal Current Gain (I_C = –1.0 mAdc, V_{CE} = –10 Vdc, f = 1.0 kHz)	h_{fe}	100	400	—
Output Admittance (I_C = –1.0 mAdc, V_{CE} = –10 Vdc, f = 1.0 kHz)	h_{oe}	3.0	60	μmhos
Noise Figure (I_C = –100 μAdc, V_{CE} = –5.0 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)	NF	—	4.0	dB

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Delay Time	(V_{CC} = –3.0 Vdc, V_{BE} = 0.5 Vdc, I_C = –10 mAdc, I_{B1} = –1.0 mAdc)	t_d	—	35	ns
Rise Time		t_r	—	35	
Storage Time	(V_{CC} = –3.0 Vdc, I_C = –10 mAdc, I_{B1} = I_{B2} = –1.0 mAdc)	t_s	—	225	ns
Fall Time		t_f	—	75	

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.





* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit

Figure 2. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

$T_J = 25°C$ (solid line)
$T_J = 125°C$ (dashed line)

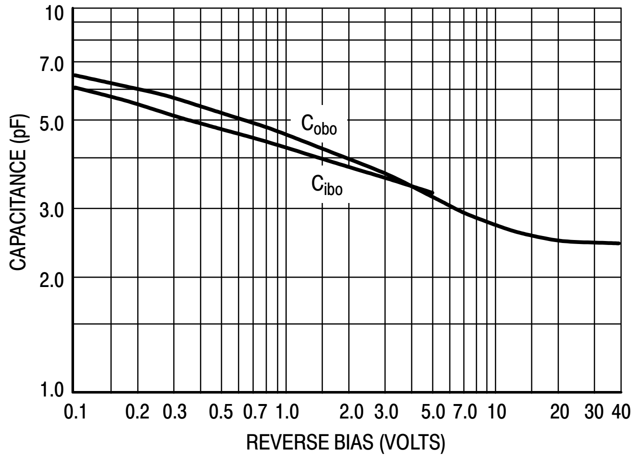


Figure 3. Capacitance

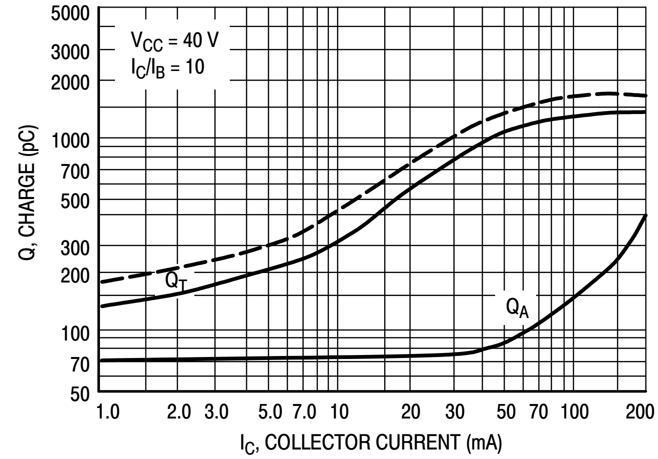


Figure 4. Charge Data

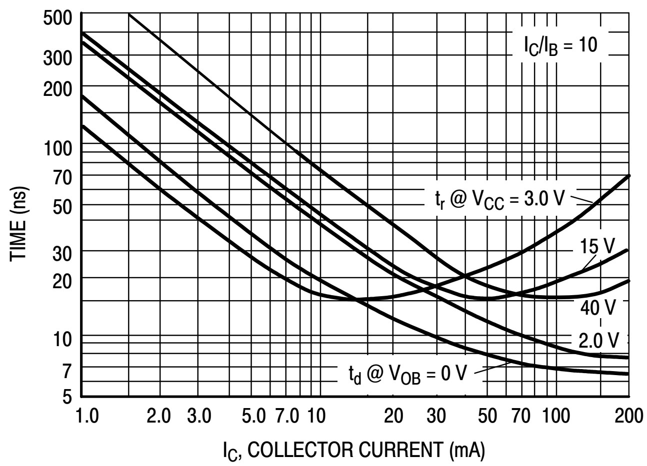


Figure 5. Turn–On Time

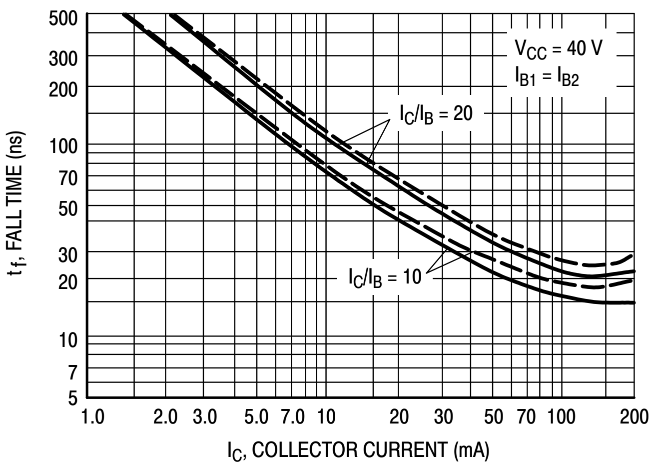


Figure 6. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = –5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

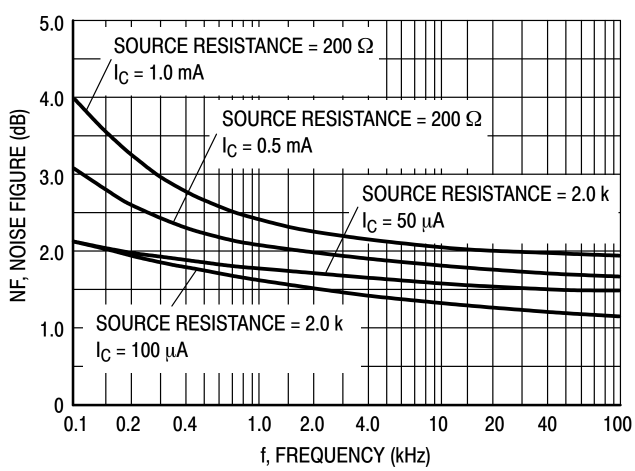


Figure 7.

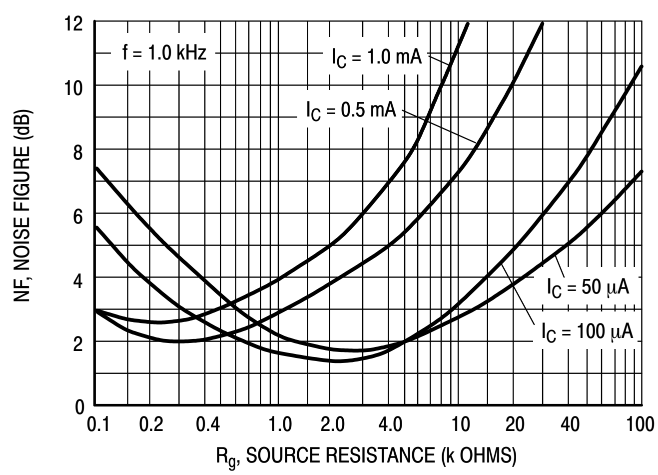


Figure 8.

h PARAMETERS

(V_{CE} = –10 Vdc, f = 1.0 kHz, T_A = 25°C)

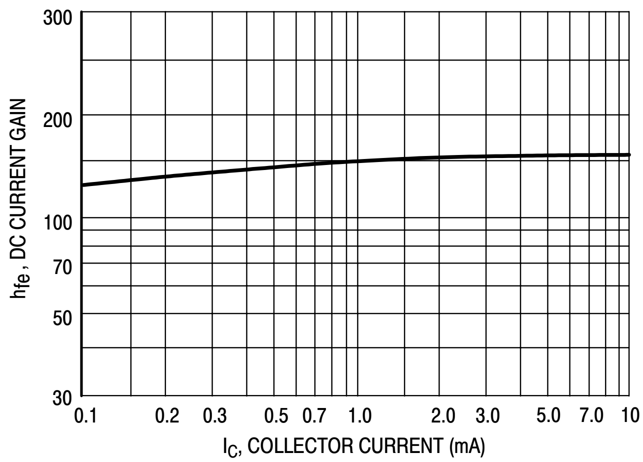


Figure 9. Current Gain

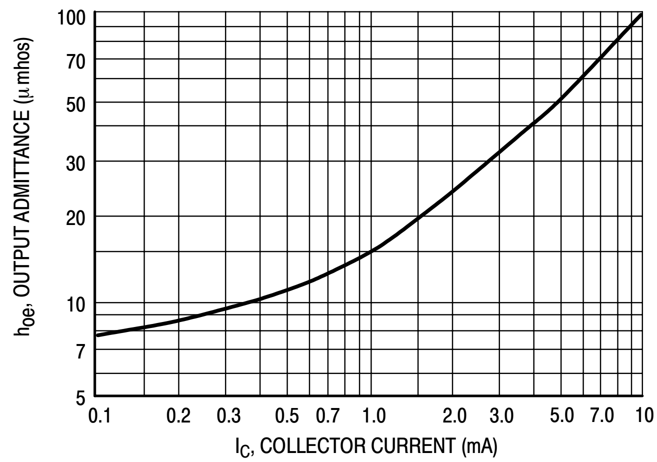


Figure 10. Output Admittance

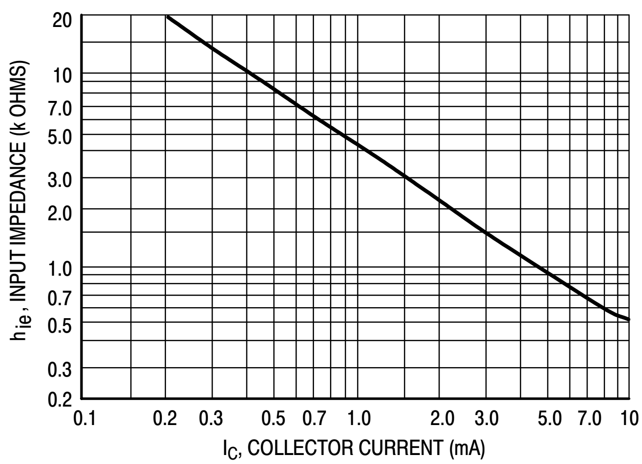


Figure 11. Input Impedance

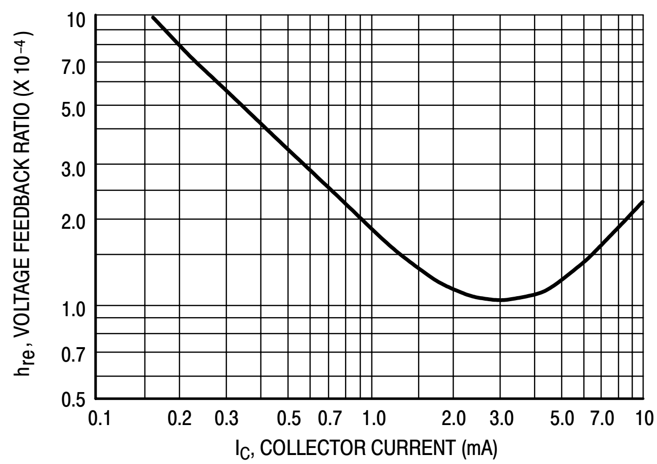


Figure 12. Voltage Feedback Ratio

TYPICAL STATIC CHARACTERISTICS

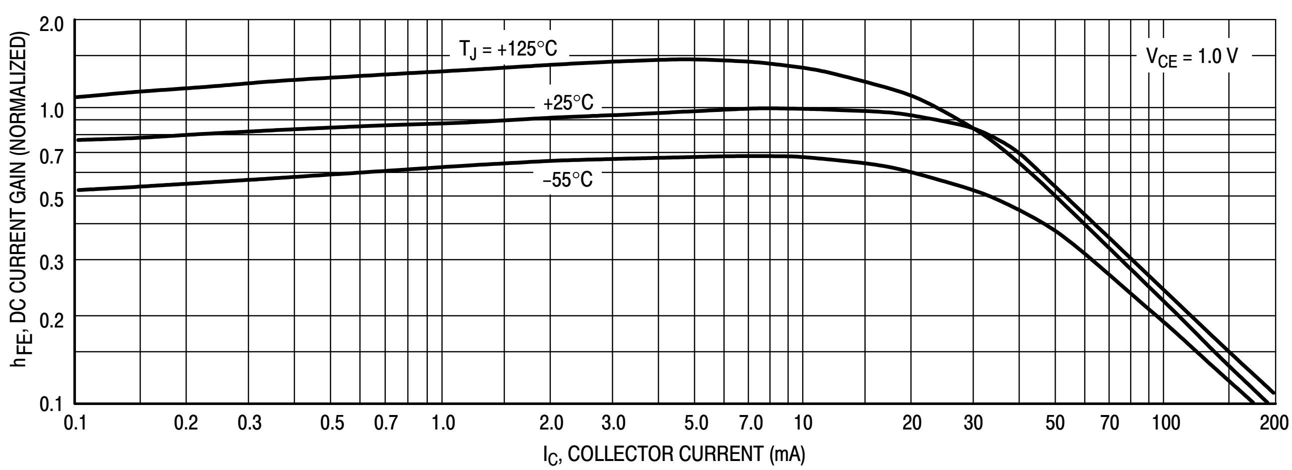


Figure 13. DC Current Gain

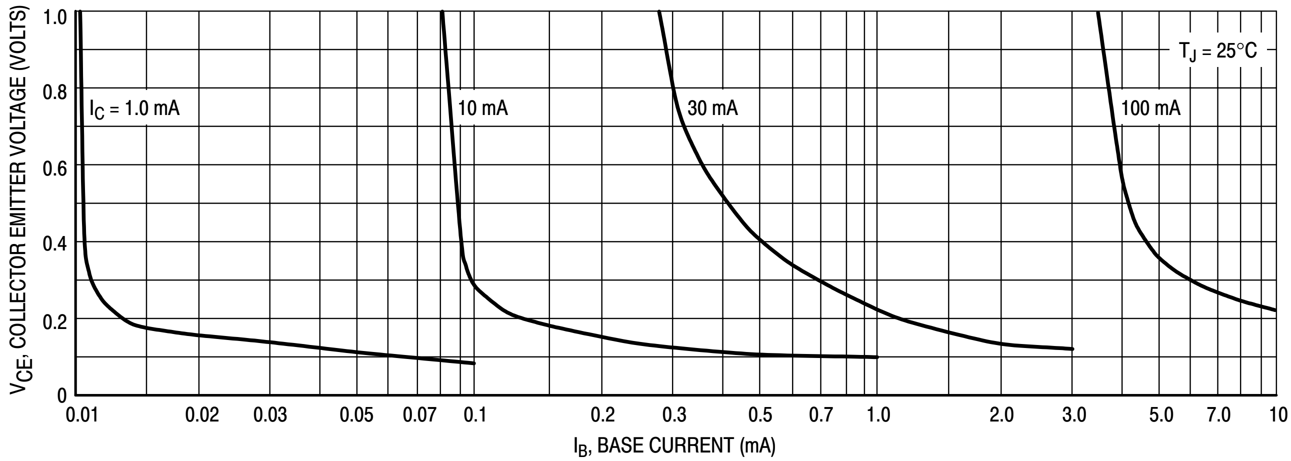


Figure 14. Collector Saturation Region

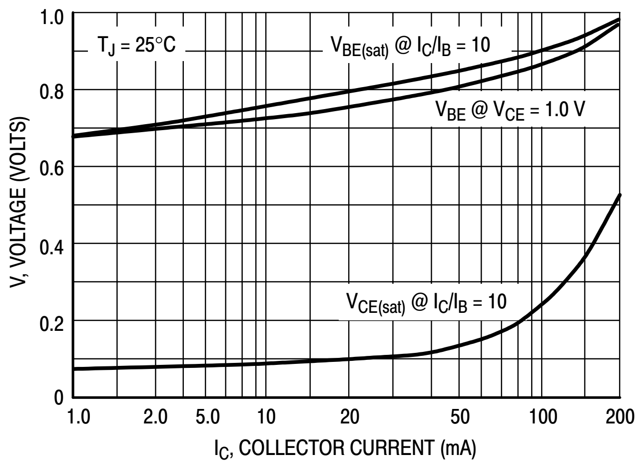


Figure 15. "ON" Voltages

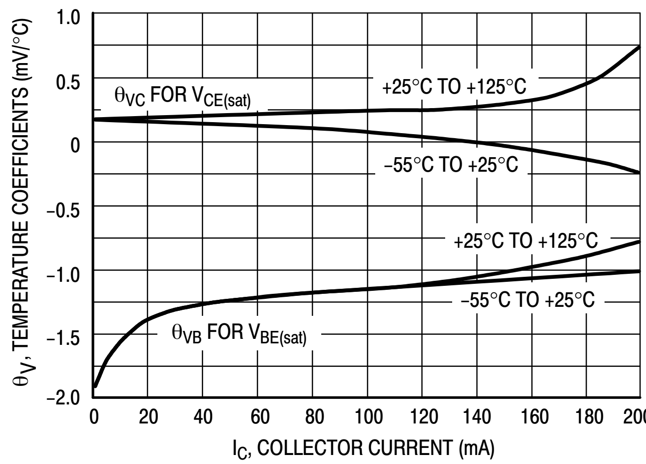


Figure 16. Temperature Coefficients

MMBT3906TT1

General Purpose Transistors

MMBT3906TT1 – PNP Silicon

This transistor is designed for general purpose amplifier applications. It is housed in the SOT–416/SC–75 package which is designed for low power surface mount applications.

- Device Marking:
  MMBT3906TT1 = 2A

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–40	Vdc
Collector–Base Voltage	V_{CBO}	–40	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Continuous	I_C	–200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, FR–4 Board (1) T_A = 25°C Derated above 25°C	P_D	200 1.6	mW mW/°C
Thermal Resistance, Junction to Ambient (1)	$R_{\theta JA}$	600	°C/W
Total Device Dissipation, FR–4 Board (2) T_A = 25°C Derated above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient (2)	$R_{\theta JA}$	400	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) FR–4 @ Minimum Pad
(2) FR–4 @ 1.0 × 1.0 Inch Pad

ON Semiconductor™

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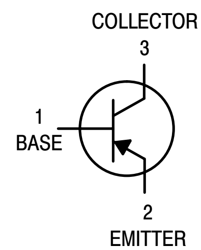
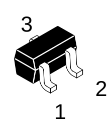
GENERAL PURPOSE AMPLIFIER TRANSISTORS SURFACE MOUNT

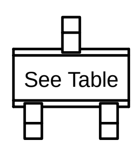
MMBT3906TT1





CASE 463
SOT–416/SC–75
STYLE 1

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
MMBT3906TT1	SOT–416	3000 / Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (3) (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–40	–	Vdc
Collector–Base Breakdown Voltage (I_C = –10 μAdc, I_E = 0)	$V_{(BR)CBO}$	–40	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	–	Vdc
Base Cutoff Current (V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	I_{BL}	–	–50	nAdc
Collector Cutoff Current (V_{CE} = –30 Vdc, V_{EB} = –3.0 Vdc)	I_{CEX}	–	–50	nAdc
ON CHARACTERISTICS (3)				
DC Current Gain	h_{FE}			–
(I_C = –0.1 mAdc, V_{CE} = –1.0 Vdc)		60	–	
(I_C = –1.0 mAdc, V_{CE} = –1.0 Vdc)		80	–	
(I_C = –10 mAdc, V_{CE} = –1.0 Vdc)		100	300	
(I_C = –50 mAdc, V_{CE} = –1.0 Vdc)		60	–	
(I_C = –100 mAdc, V_{CE} = –1.0 Vdc)		30	–	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = –10 mAdc, I_B = –1.0 mAdc)		–	–0.25	
(I_C = –50 mAdc, I_B = –5.0 mAdc)		–	–0.4	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = –10 mAdc, I_B = –1.0 mAdc)		–0.65	–0.85	
(I_C = –50 mAdc, I_B = –5.0 mAdc)		–	–0.95	

(3) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

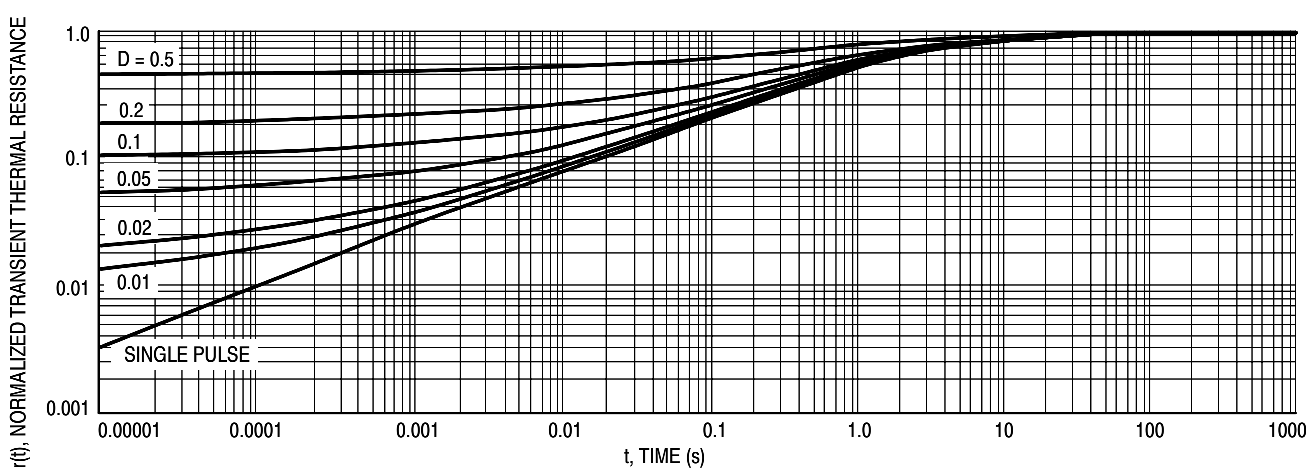
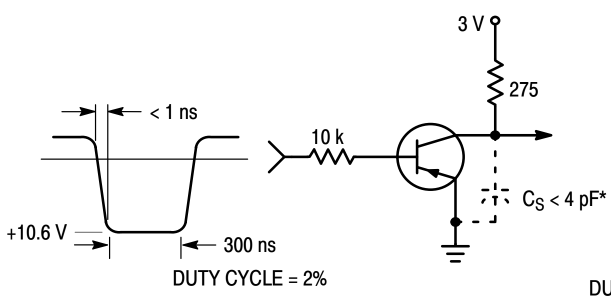
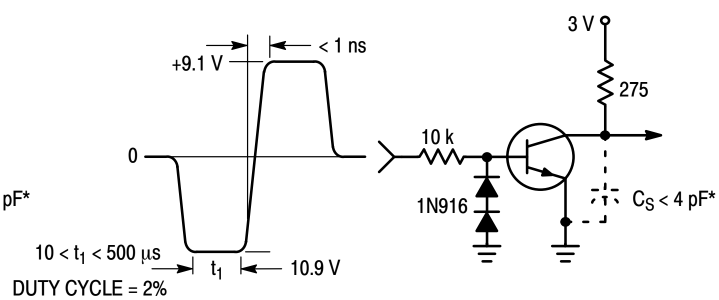


Figure 1. Normalized Thermal Response

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)		f_T	250	–	MHz
Output Capacitance (V_{CB} = –5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	–	4.5	pF
Input Capacitance1 (V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	–	10.0	pF
Input Impedance (V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)		h_{ie}	2.0	12	k Ω
Voltage Feedback Ratio (V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)		h_{re}	0.1	10	X 10^{-4}
Small–Signal Current Gain (V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)		h_{fe}	100	400	–
Output Admittance (V_{CE} = –10 Vdc, I_C = –1.0 mAdc, f = 1.0 kHz)		h_{oe}	3.0	60	μmhos
Noise Figure (V_{CE} = –5.0 Vdc, I_C = –100 μAdc, R_S = 1.0 k Ω, f = 1.0 kHz)		NF	–	4.0	dB
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = –3.0 Vdc, V_{BE} = 0.5 Vdc)	t_d	–	35	ns
Rise Time	(I_C = –10 mAdc, I_{B1} = –1.0 mAdc)	t_r	–	35	
Storage Time	(V_{CC} = –3.0 Vdc, I_C = –10 mAdc)	t_s	–	225	ns
Fall Time	(I_{B1} = I_{B2} = –1.0 mAdc)	t_f	–	75	





* Total shunt capacitance of test jig and connectors

Figure 2. Delay and Rise Time Equivalent Test Circuit

Figure 3. Storage and Fall Time Equivalent Test Circuit

TYPICAL TRANSIENT CHARACTERISTICS

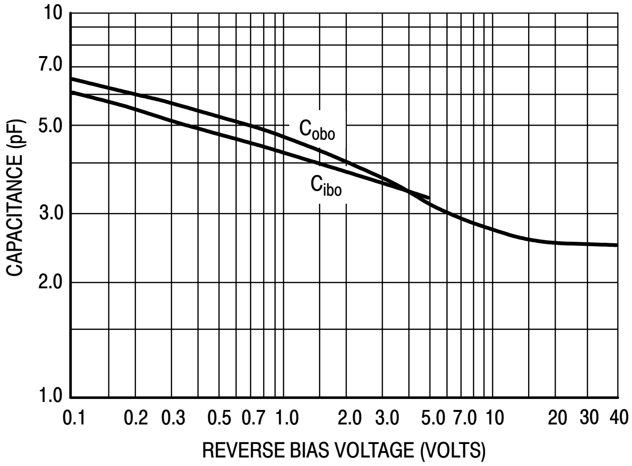


Figure 4. Capacitance

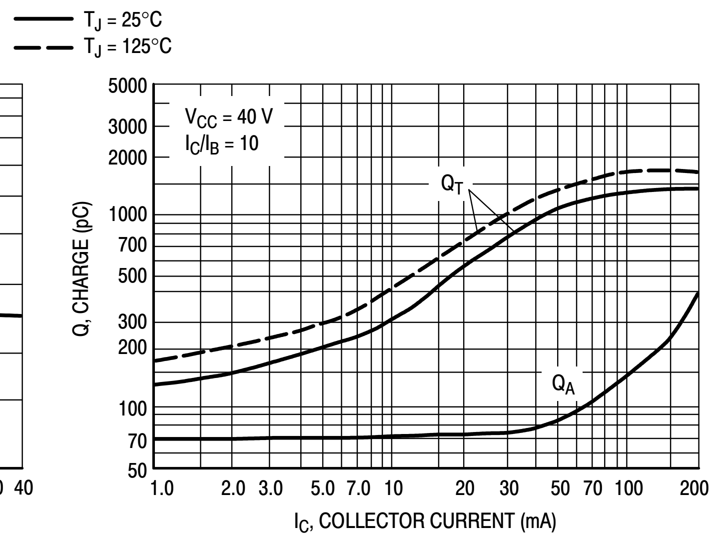


Figure 5. Charge Data

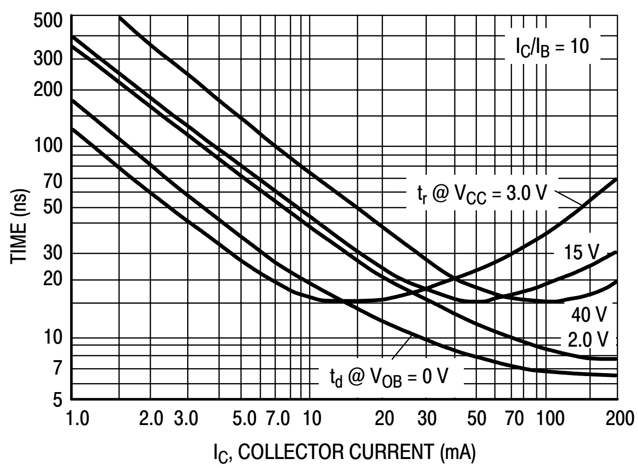


Figure 6. Turn−On Time

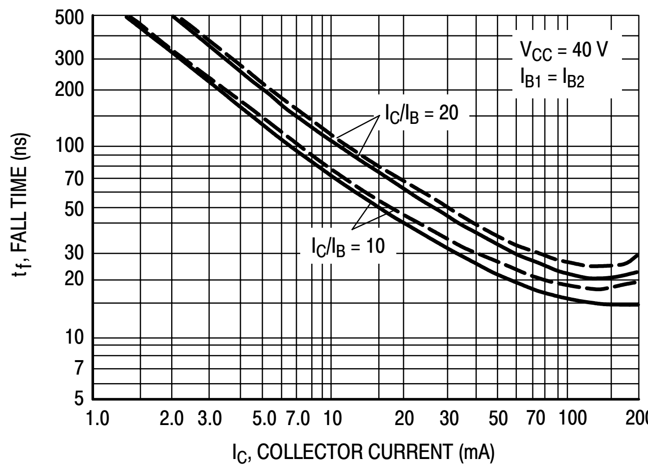


Figure 7. Fall Time

TYPICAL AUDIO SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = –5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

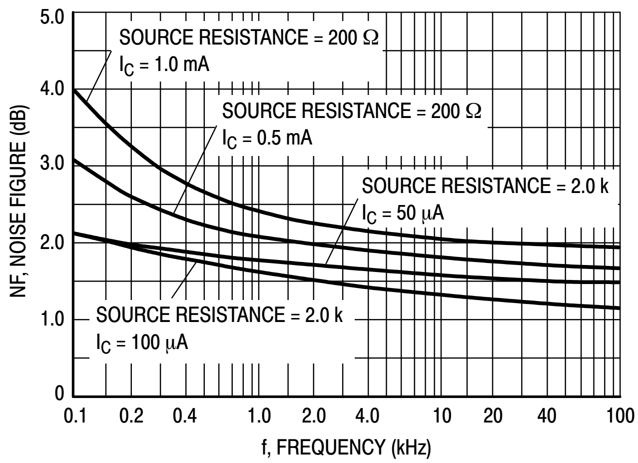


Figure 8.

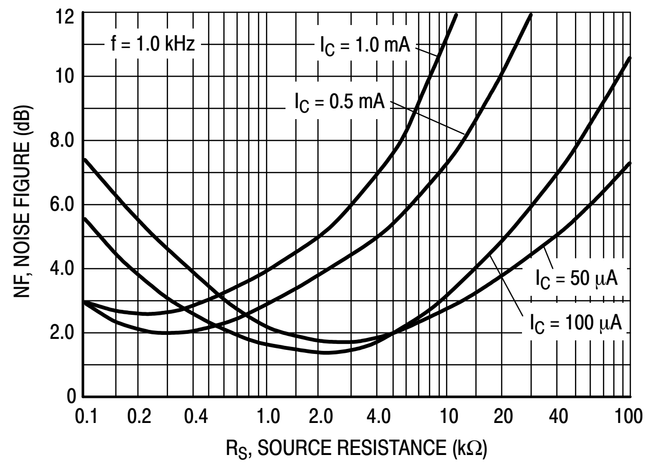


Figure 9.

h PARAMETERS

(V_{CE} = –10 Vdc, f = 1.0 kHz, T_A = 25°C)

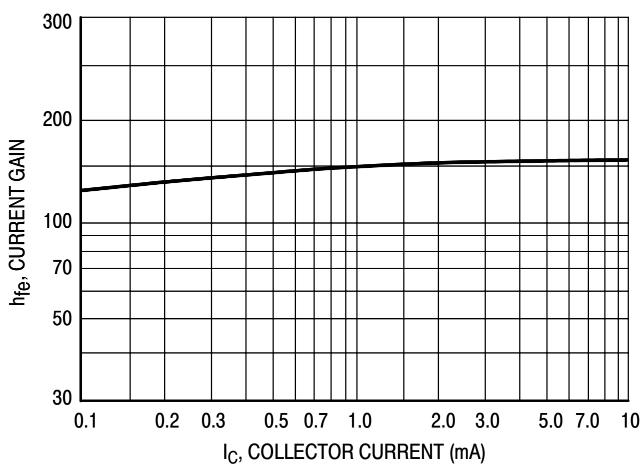


Figure 10. Current Gain

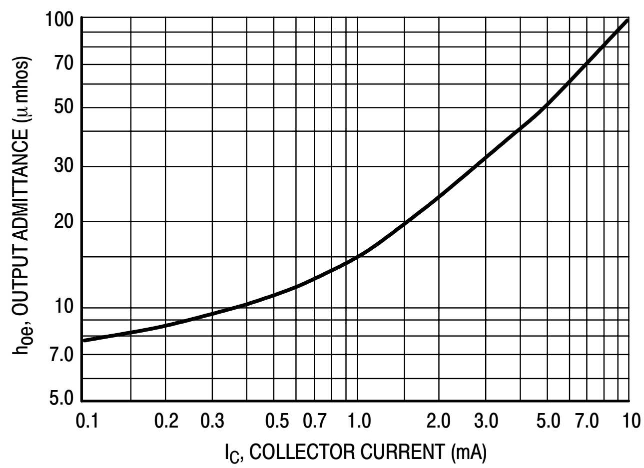


Figure 11. Output Admittance

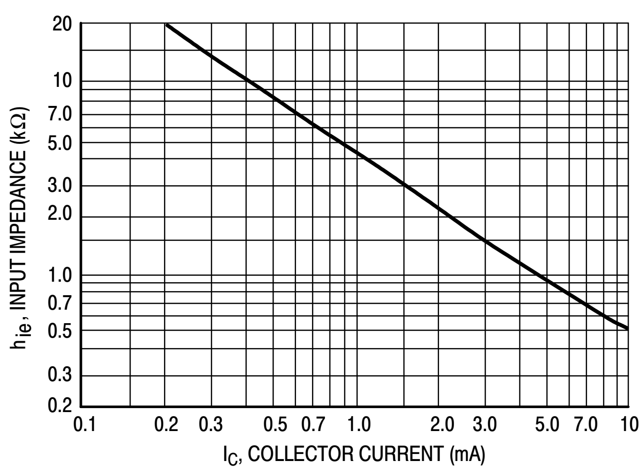


Figure 12. Input Impedance

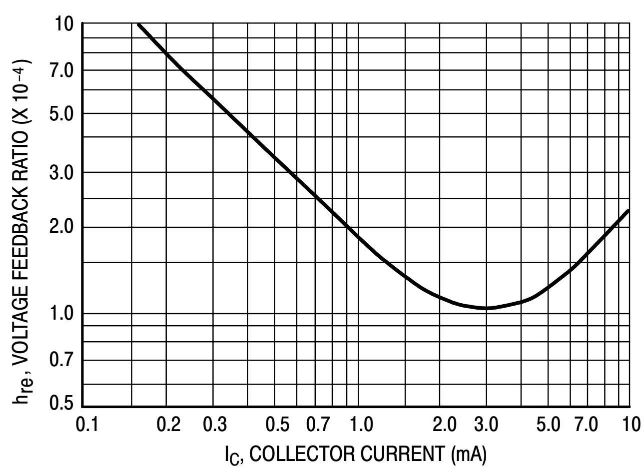


Figure 13. Voltage Feedback Ratio

STATIC CHARACTERISTICS

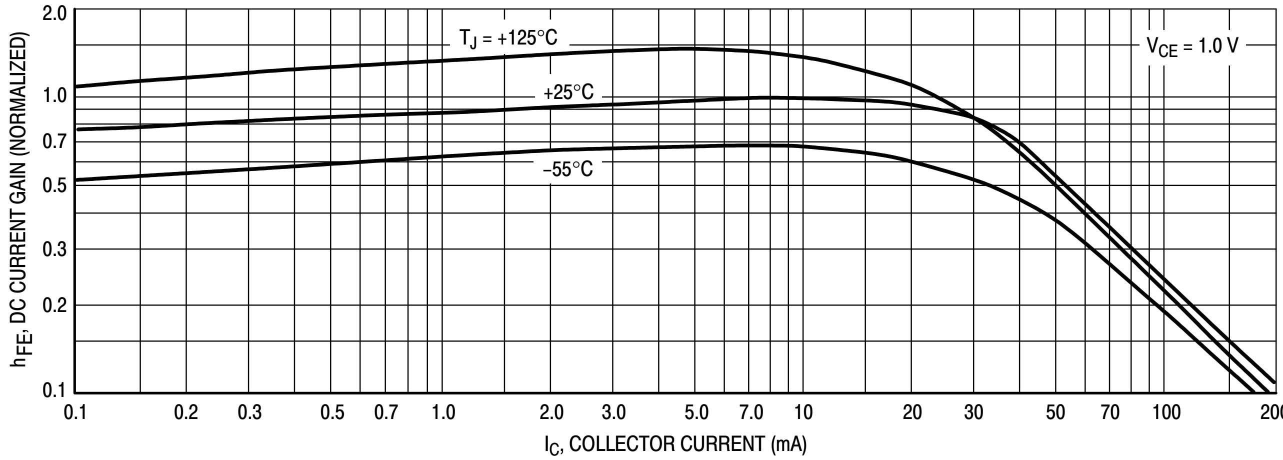


Figure 14. DC Current Gain

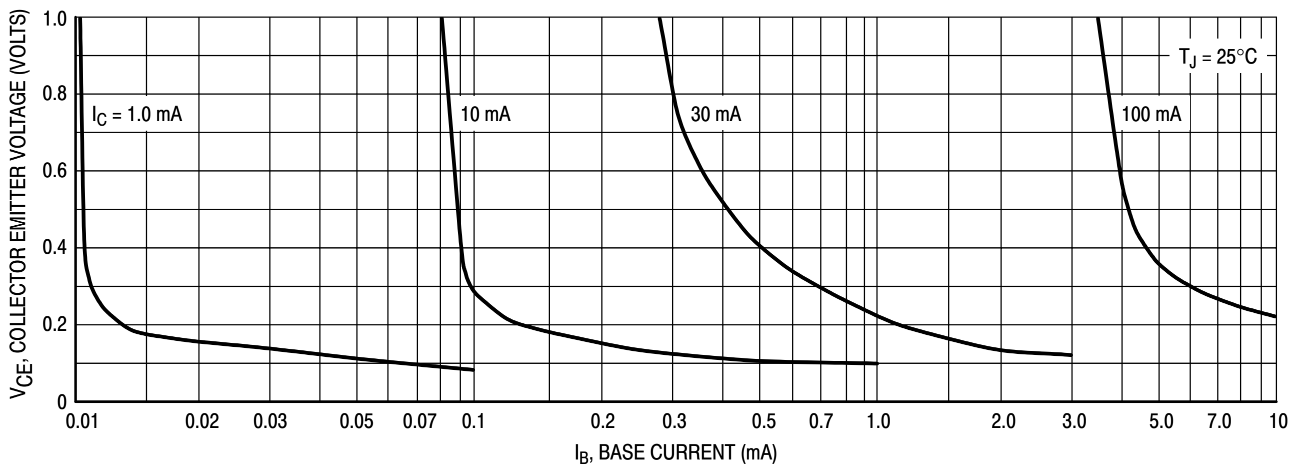


Figure 15. Collector Saturation Region

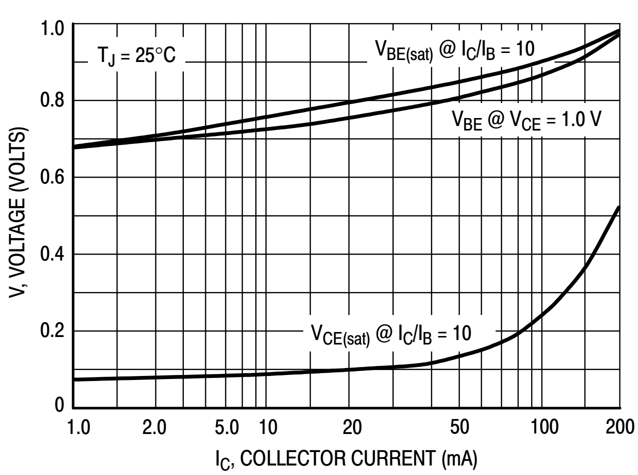


Figure 16. "ON" Voltages

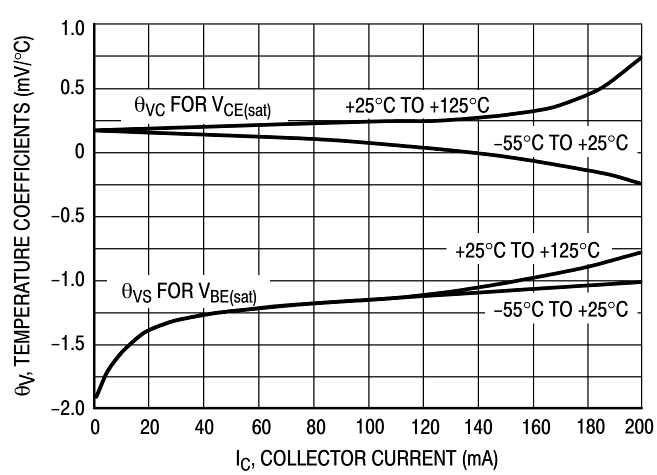


Figure 17. Temperature Coefficients

MMBT4124LT1

General Purpose Transistor

NPN Silicon

ON Semiconductor™

http://onsemi.com

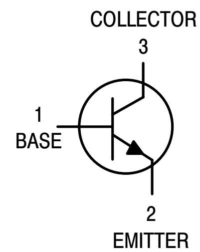
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	25	Vdc
Collector–Base Voltage	V_{CBO}	30	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current – Continuous	I_C	200	mAdc

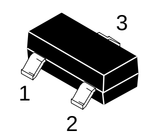
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board (Note 1.) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate (Note 2.) T_A = 25°C Derate above 25°C	P_D	300 2.4	Watts mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

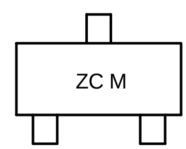
1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.



SOT–23 (TO–236)
CASE 318–08
STYLE 6



MARKING DIAGRAM



M = Date Code

ORDERING INFORMATION

Device	Package	Shipping
MMBT4124LT1	SOT–23	3000 Tape & Reel

October, 2001 – Rev. 0
Publication Order Number:
MMBT4124LT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (Note 3.) (I_C = 1.0 mAdc, I_E = 0)	$V_{(BR)CEO}$	25	–	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	–	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	–	50	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	–	50	nAdc
ON CHARACTERISTICS				
DC Current Gain (Note 3.)	h_{FE}			–
(I_C = 2.0 mAdc, V_{CE} = 1.0 Vdc)		120	360	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)		60	–	
Collector–Emitter Saturation Voltage (Note 3.) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	–	0.3	Vdc
Base–Emitter Saturation Voltage (Note 3.) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	–	0.95	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain – Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	300	–	MHz
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	–	8.0	pF
Collector–Base Capacitance (I_E = 0, V_{CB} = 5.0 V, f = 1.0 MHz)	C_{cb}	–	4.0	pF
Small–Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, R_S = 10 k ohm, f = 1.0 kHz)	h_{fe}	120	480	–
Current Gain – High Frequency	$\lvert h_{fe}\rvert$			–
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		3.0	–	
(I_C = 2.0 mAdc, V_{CE} = 10 V, f = 1.0 kHz)		120	480	
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohm, f = 1.0 kHz)	NF	–	5.0	dB

3. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

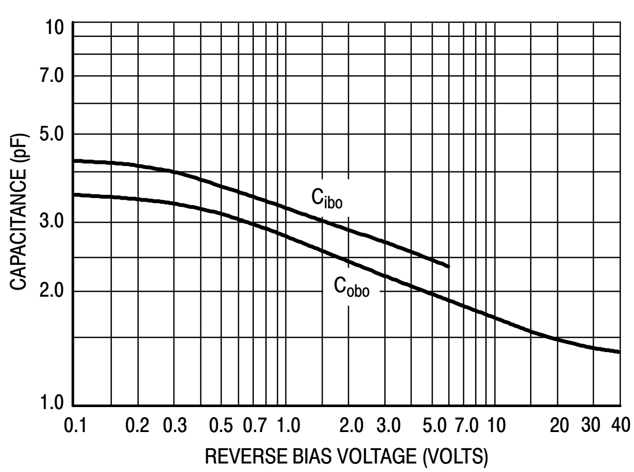


Figure 1. Capacitance

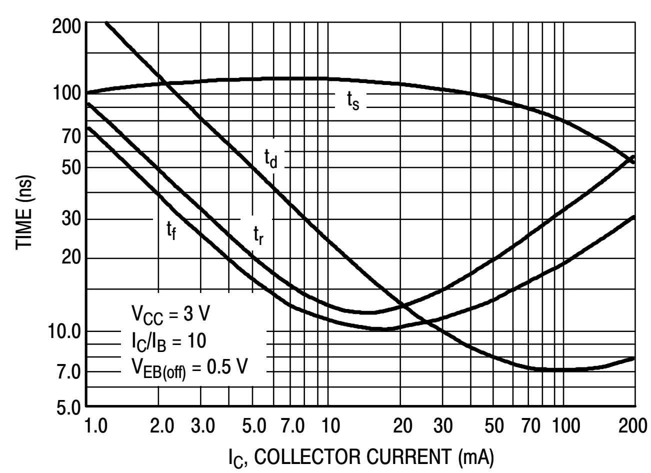


Figure 2. Switching Times

AUDIO SMALL–SIGNAL CHARACTERISTICS

NOISE FIGURE

(V_{CE} = 5 Vdc, T_A = 25°C)
Bandwidth = 1.0 Hz

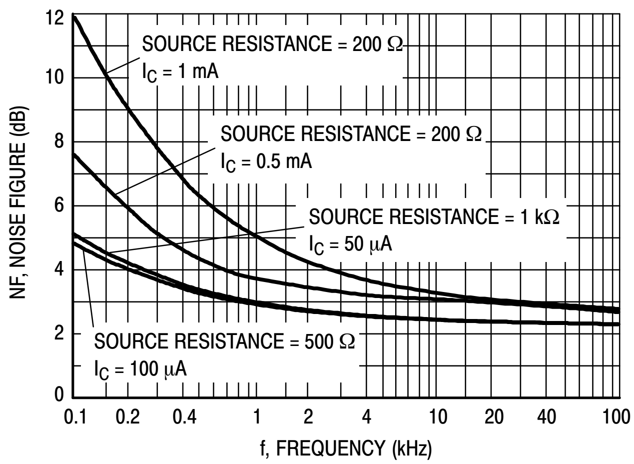


Figure 3. Frequency Variations

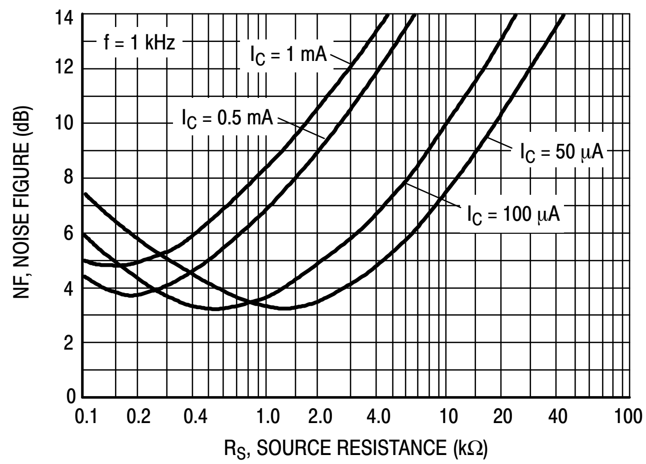


Figure 4. Source Resistance

h PARAMETERS

(V_{CE} = 10 V, f = 1 kHz, T_A = 25°C)

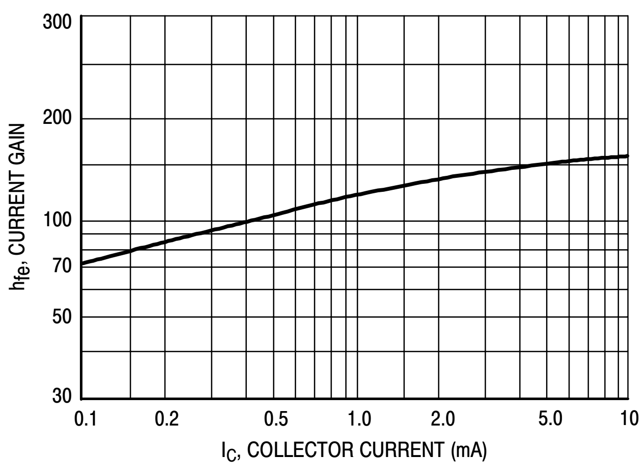


Figure 5. Current Gain

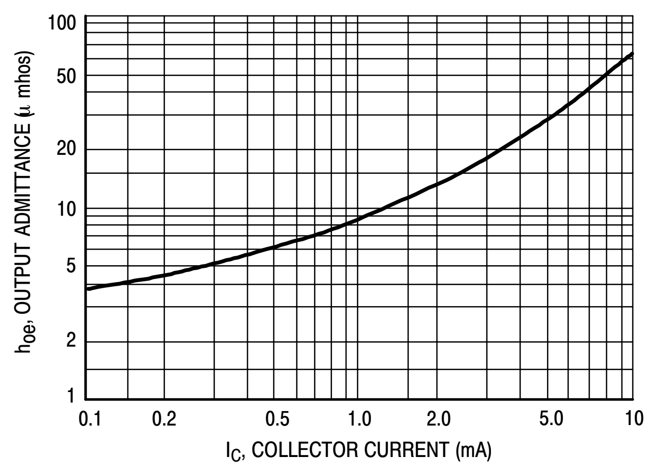


Figure 6. Output Admittance

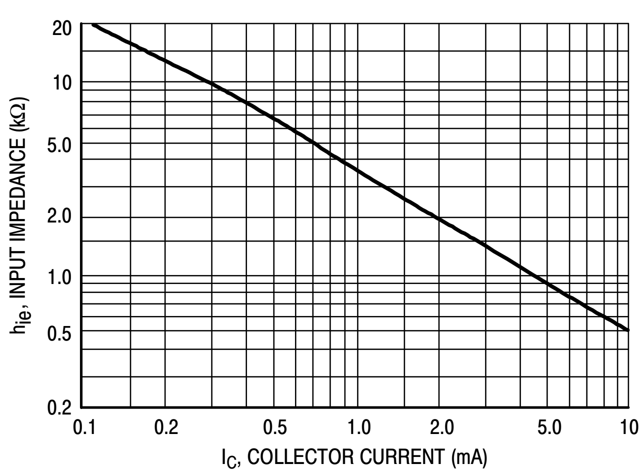


Figure 7. Input Impedance

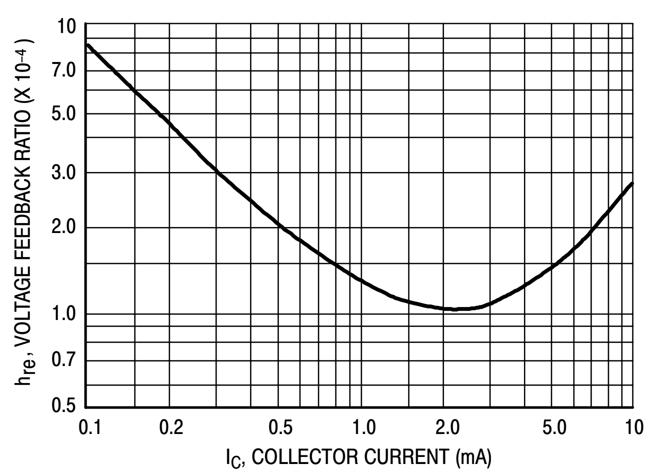


Figure 8. Voltage Feedback Ratio

STATIC CHARACTERISTICS

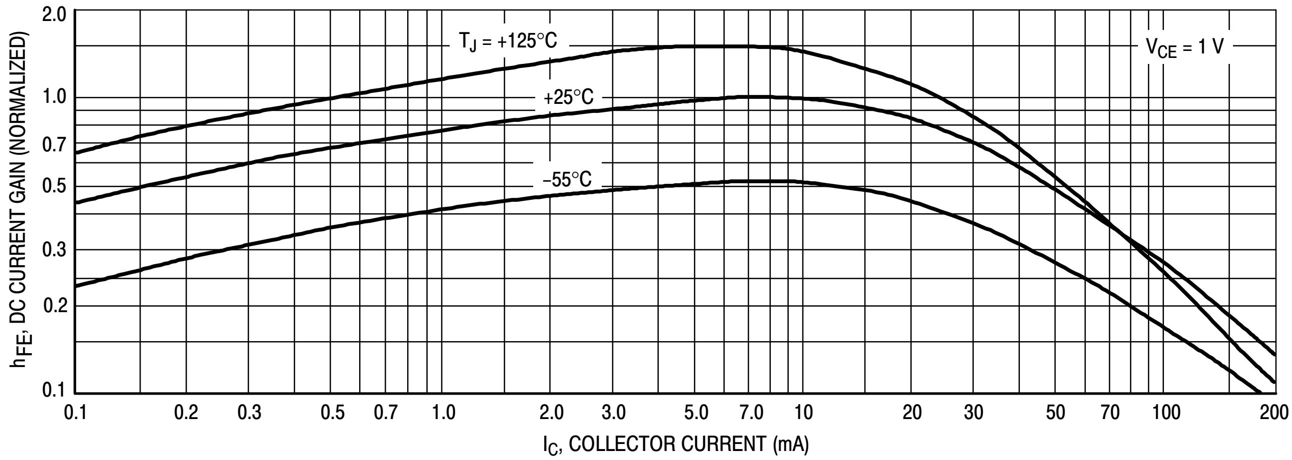


Figure 9. DC Current Gain

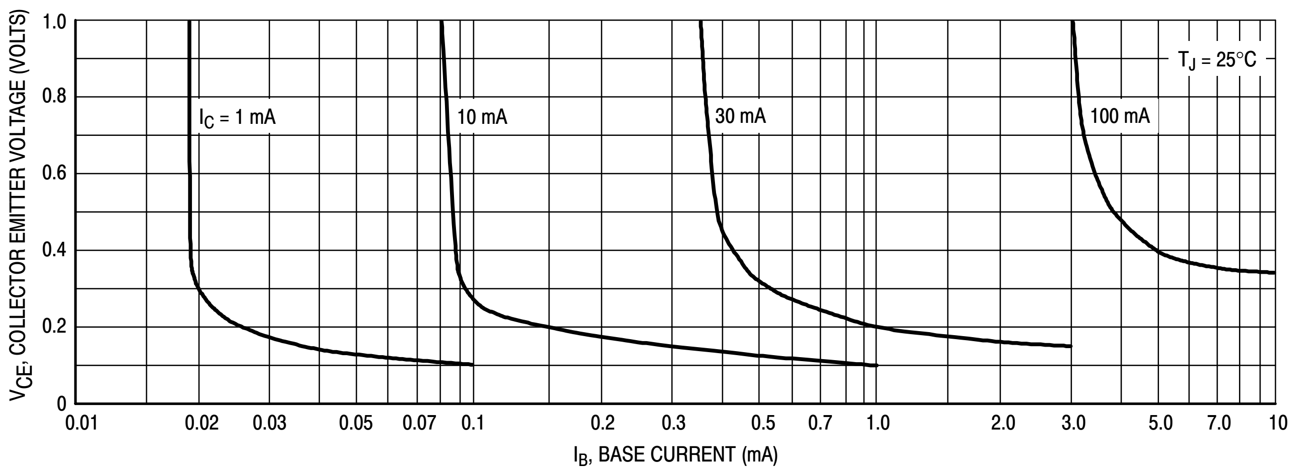


Figure 10. Collector Saturation Region

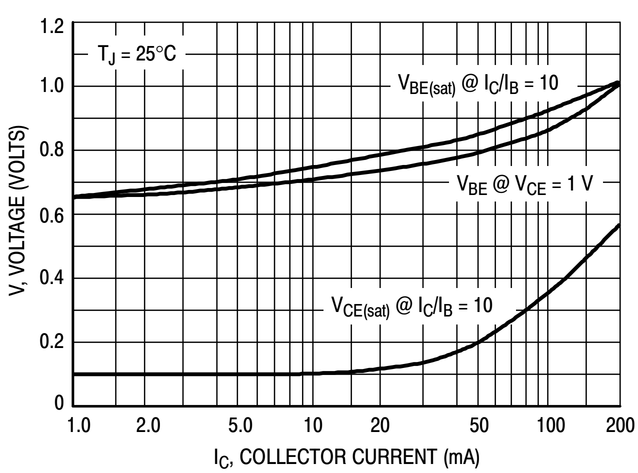


Figure 11. “On” Voltages

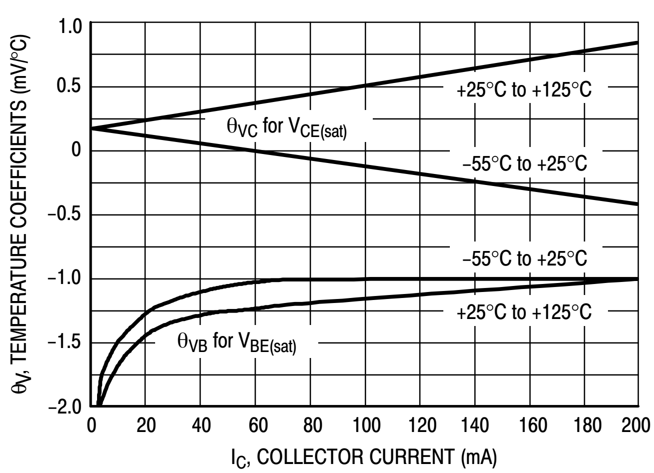
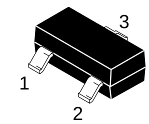


Figure 12. Temperature Coefficients

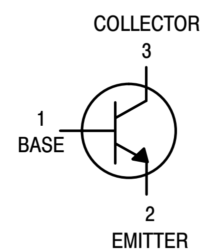
Switching Transistor
NPN Silicon

MMBT4401LT1

ON Semiconductor Preferred Device



CASE 318–08, STYLE 6
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	60	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	600	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT4401LT1 = 2X

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(3) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector–Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current (V_{CE} = 35 Vdc, V_{EB} = 0.4 Vdc)	I_{BEV}	—	0.1	μAdc
Collector Cutoff Current (V_{CE} = 35 Vdc, V_{EB} = 0.4 Vdc)	I_{CEX}	—	0.1	μAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

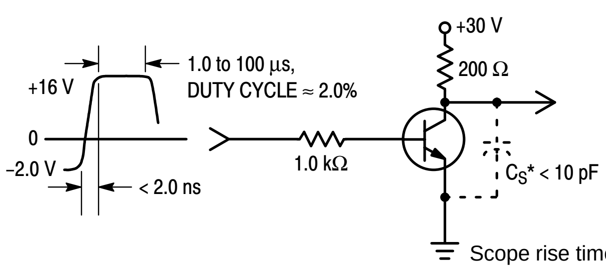
March, 2001 – Rev. 1
Publication Order Number:
MMBT4401LT1/D

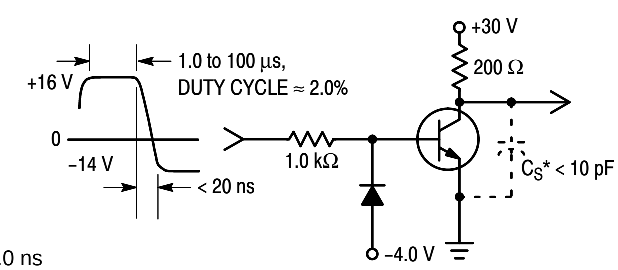
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS(3)					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)			20	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)			40	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			80	—	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)			100	300	
(I_C = 500 mAdc, V_{CE} = 2.0 Vdc)			40	—	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	0.4	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	0.75	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			0.75	0.95	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	1.2	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	250	—	MHz
Collector–Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	6.5	pF
Emitter–Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{eb}	—	30	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{ie}	1.0	15	kΩ
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{re}	0.1	8.0	X 10^{-4}
Small–Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{fe}	40	500	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	1.0	30	μmhos
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 30 Vdc, V_{EB} = 2.0 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	—	15	ns
Rise Time		t_r	—	20	
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	—	225	ns
Fall Time		t_f	—	30	

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS





Scope rise time < 4.0 ns
*Total shunt capacitance of test jig connectors, and oscilloscope

Figure 1. Turn–On Time **Figure 2. Turn–Off Time**

TRANSIENT CHARACTERISTICS

25°C (solid line) 100°C (dashed line)

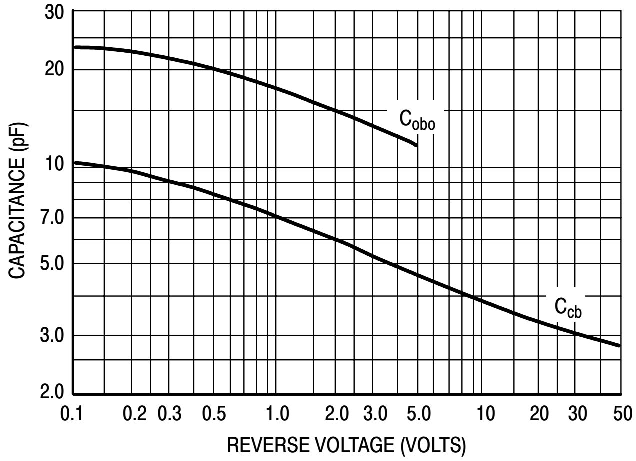


Figure 3. Capacitances

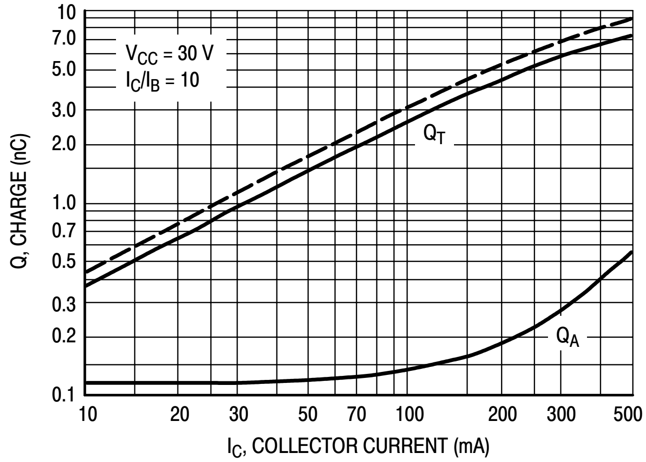


Figure 4. Charge Data

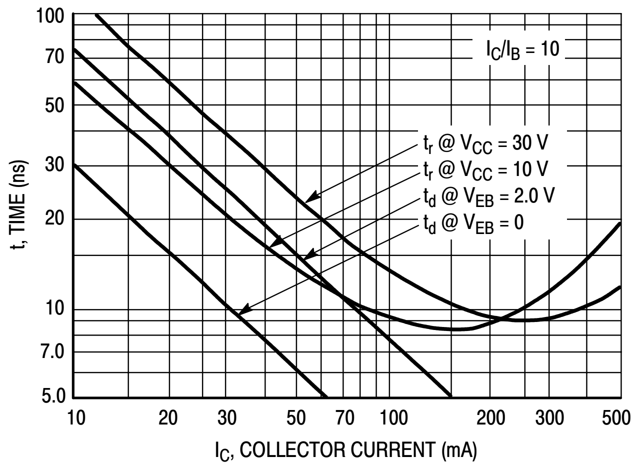


Figure 5. Turn–On Time

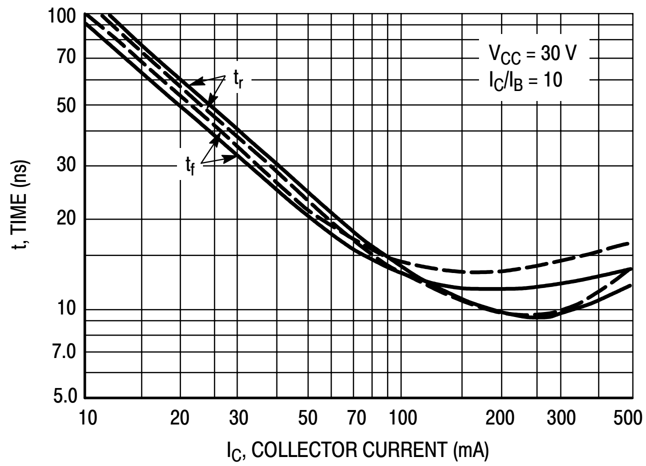


Figure 6. Rise and Fall Times

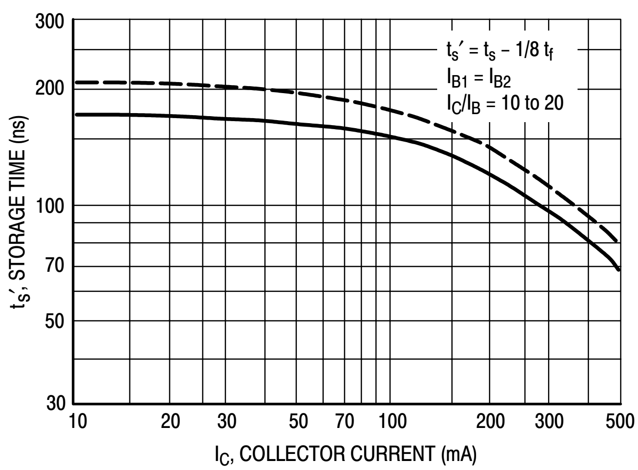


Figure 7. Storage Time

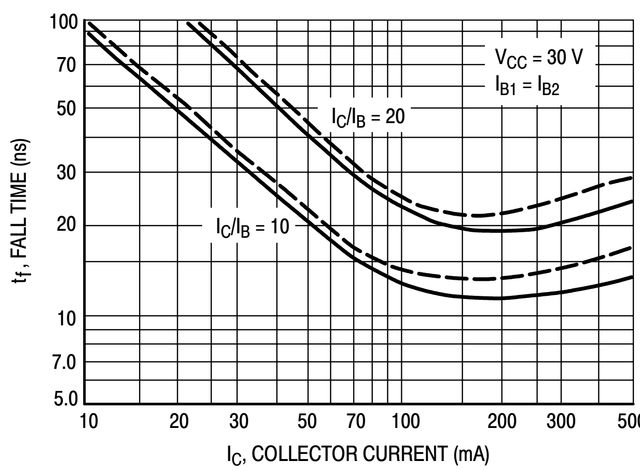


Figure 8. Fall Time

SMALL–SIGNAL CHARACTERISTICS

NOISE FIGURE

V_{CE} = 10 Vdc, T_A = 25°C; Bandwidth = 1.0 Hz

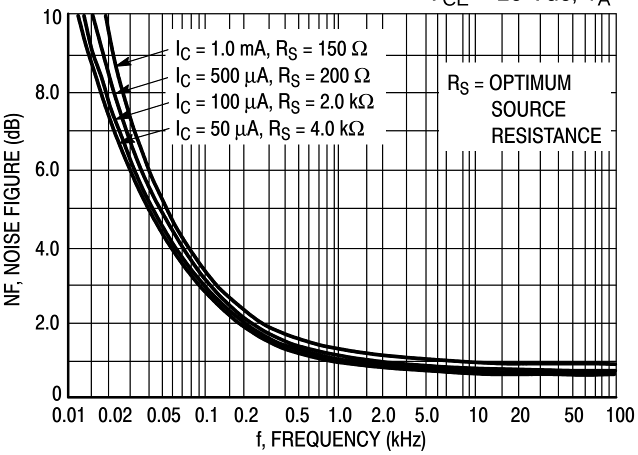


Figure 9. Frequency Effects

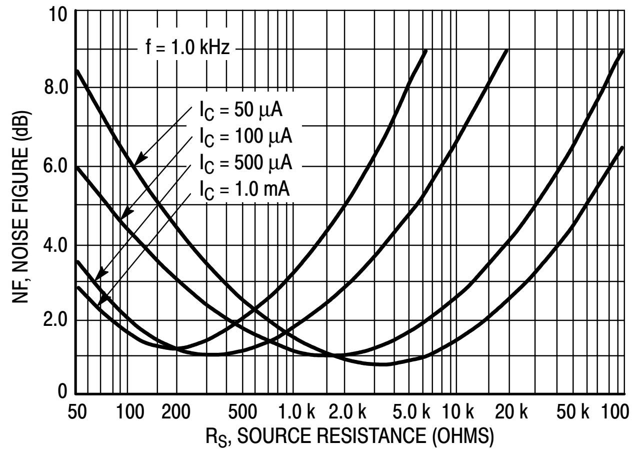


Figure 10. Source Resistance Effects

h PARAMETERS

V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C

This group of graphs illustrates the relationship between h_{fe} and other “h” parameters for this series of transistors. To obtain these curves, a high–gain and a low–gain unit were selected from the MMBT4401LT1 lines, and the same units were used to develop the correspondingly numbered curves on each graph.

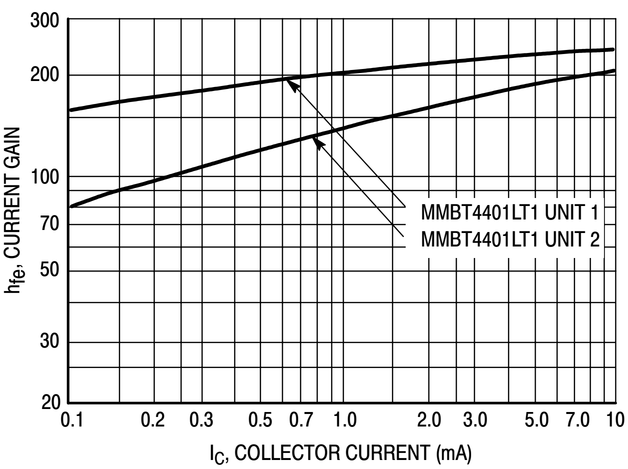


Figure 11. Current Gain

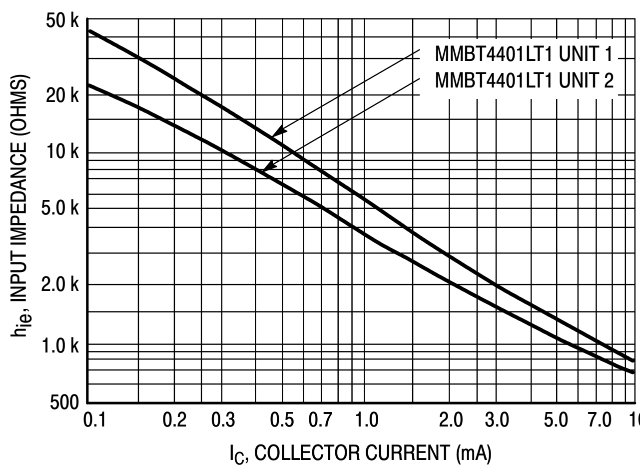


Figure 12. Input Impedance

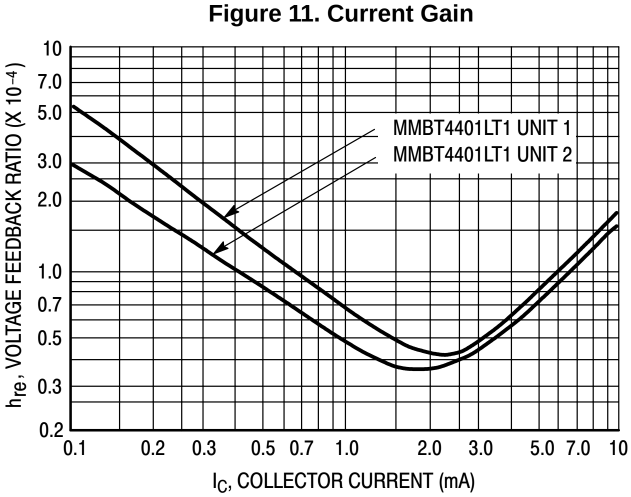


Figure 13. Voltage Feedback Ratio

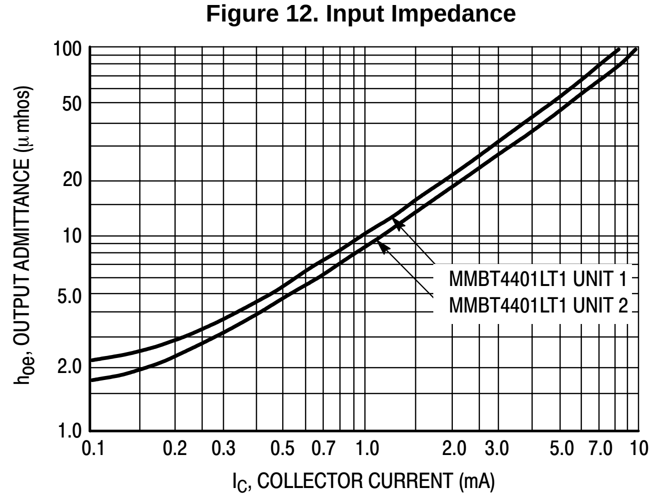


Figure 14. Output Admittance

STATIC CHARACTERISTICS

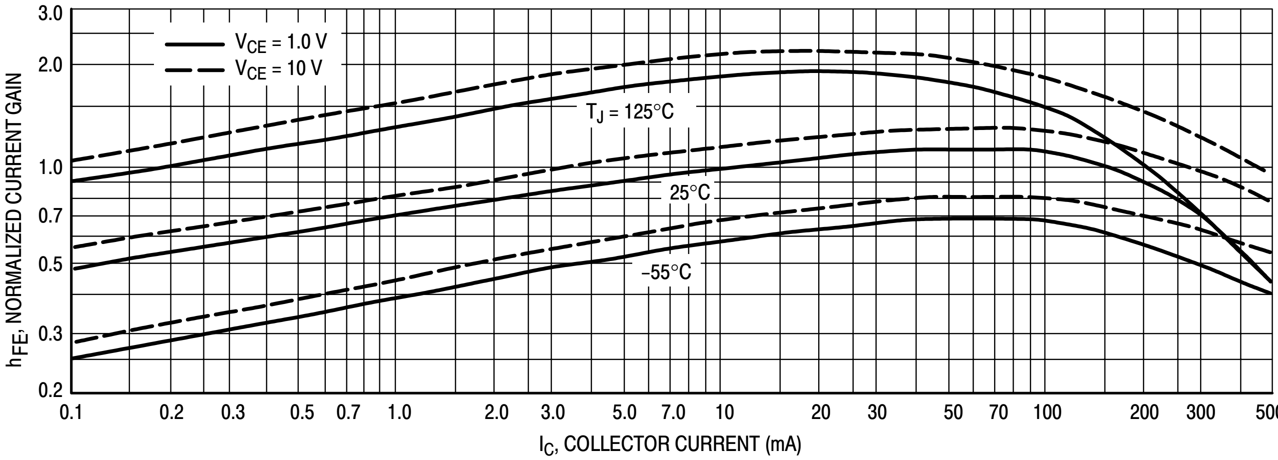


Figure 15. DC Current Gain

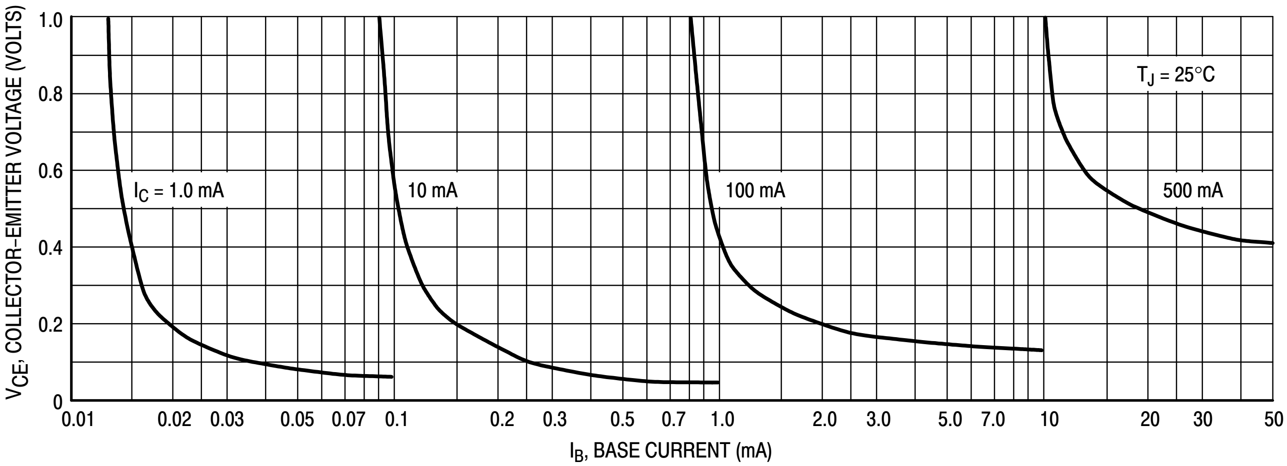


Figure 16. Collector Saturation Region

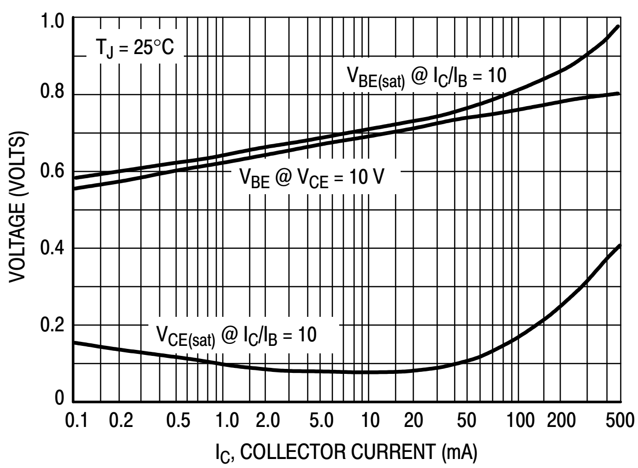


Figure 17. "On" Voltages

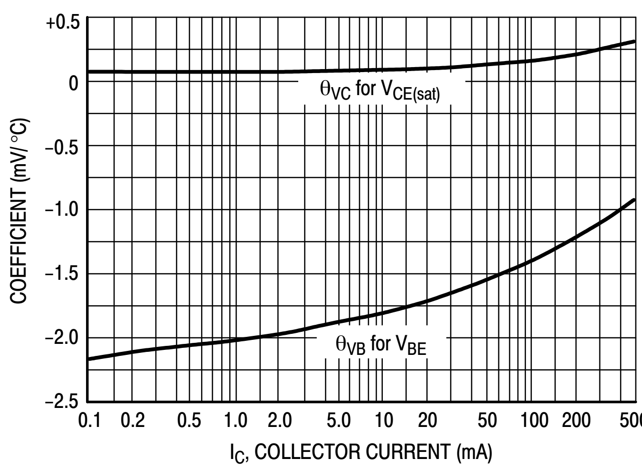
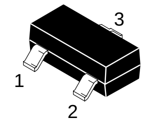


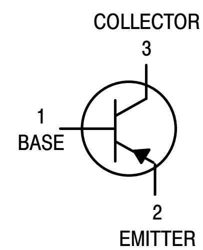
Figure 18. Temperature Coefficients

Switching Transistor
PNP Silicon

MMBT4403LT1



CASE 318–08, STYLE 6
SOT–23 (TO–236)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–40	Vdc
Collector–Base Voltage	V_{CBO}	–40	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current — Continuous	I_C	–600	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board[1] T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,[2] T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT4403LT1 = 2T

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage[3] (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–40	—	Vdc
Collector–Base Breakdown Voltage (I_C = –0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	–40	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	Vdc
Base Cutoff Current (V_{CE} = –35 Vdc, V_{EB} = –0.4 Vdc)	I_{BEV}	—	–0.1	µAdc
Collector Cutoff Current (V_{CE} = –35 Vdc, V_{EB} = –0.4 Vdc)	I_{CEX}	—	–0.1	µAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

March, 2001 – Rev. 1
Publication Order Number:
MMBT4403LT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

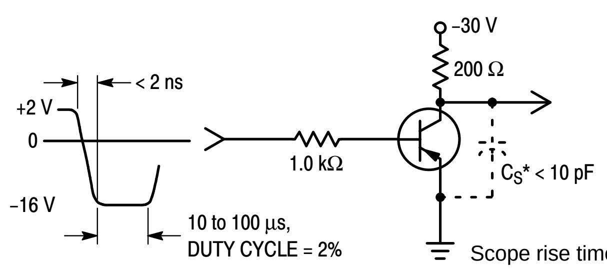
Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = –0.1 mAdc, V_{CE} = –1.0 Vdc)		30	—	
(I_C = –1.0 mAdc, V_{CE} = –1.0 Vdc)		60	—	
(I_C = –10 mAdc, V_{CE} = –1.0 Vdc)		100	—	
(I_C = –150 mAdc, V_{CE} = –2.0 Vdc)(3)		100	300	
(I_C = –500 mAdc, V_{CE} = –2.0 Vdc)(3)		20	—	
Collector–Emitter Saturation Voltage(3)	$V_{CE(sat)}$			Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)		—	–0.4	
(I_C = –500 mAdc, I_B = –50 mAdc)		—	–0.75	
Base–Emitter Saturation Voltage (3)	$V_{BE(sat)}$			Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)		–0.75	–0.95	
(I_C = –500 mAdc, I_B = –50 mAdc)		—	–1.3	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = –20 mAdc, V_{CE} = –10 Vdc, f = 100 MHz)	f_T	200	—	MHz
Collector–Base Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	8.5	pF
Emitter–Base Capacitance (V_{BE} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{eb}	—	30	pF
Input Impedance (I_C = –1.0 mAdc, V_{CE} = –10 Vdc, f = 1.0 kHz)	h_{ie}	1.5	15	kΩ
Voltage Feedback Ratio (I_C = –1.0 mAdc, V_{CE} = –10 Vdc, f = 1.0 kHz)	h_{re}	0.1	8.0	X 10^{-4}
Small–Signal Current Gain (I_C = –1.0 mAdc, V_{CE} = –10 Vdc, f = 1.0 kHz)	h_{fe}	60	500	—
Output Admittance (I_C = –1.0 mAdc, V_{CE} = –10 Vdc, f = 1.0 kHz)	h_{oe}	1.0	100	μmhos

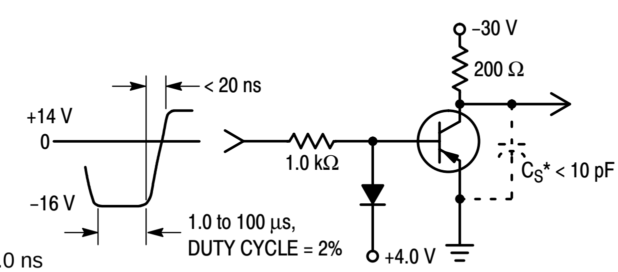
SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Delay Time	(V_{CC} = –30 Vdc, V_{EB} = –2.0 Vdc, I_C = –150 mAdc, I_{B1} = –15 mAdc)	t_d	—	15	ns
Rise Time		t_r	—	20	
Storage Time	(V_{CC} = –30 Vdc, I_C = –150 mAdc, I_{B1} = I_{B2} = –15 mAdc)	t_s	—	225	ns
Fall Time		t_f	—	30	

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUIT





Scope rise time < 4.0 ns
*Total shunt capacitance of test jig connectors, and oscilloscope

Figure 1. Turn–On Time **Figure 2. Turn–Off Time**

TRANSIENT CHARACTERISTICS

—— 25°C — — 100°C

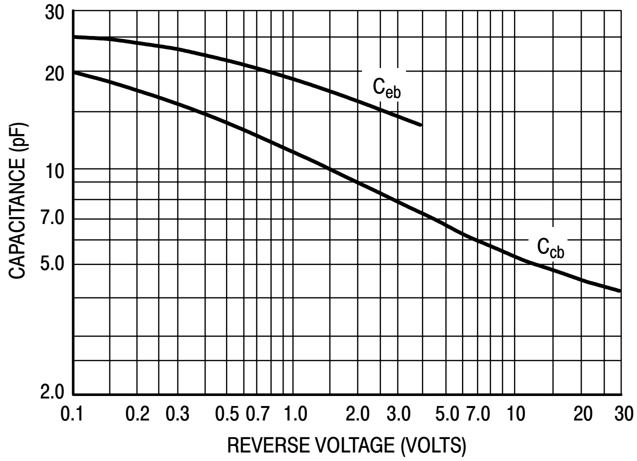


Figure 3. Capacitances

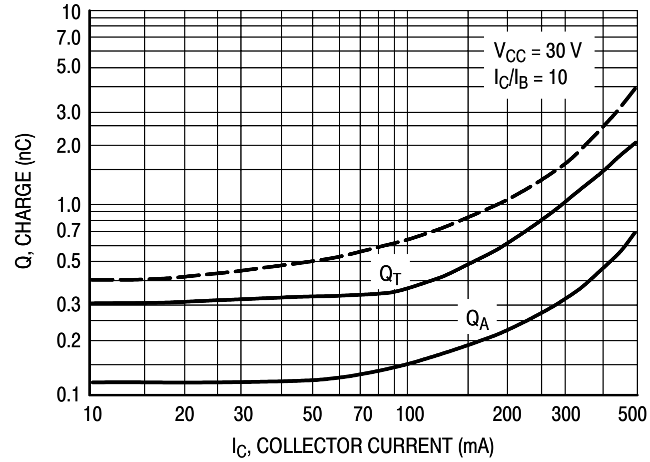


Figure 4. Charge Data

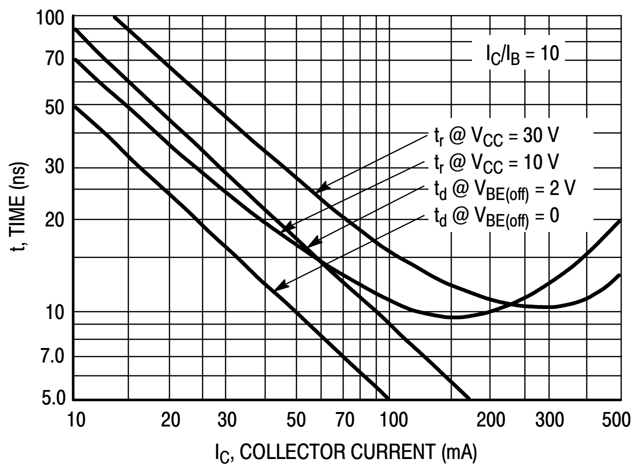


Figure 5. Turn–On Time

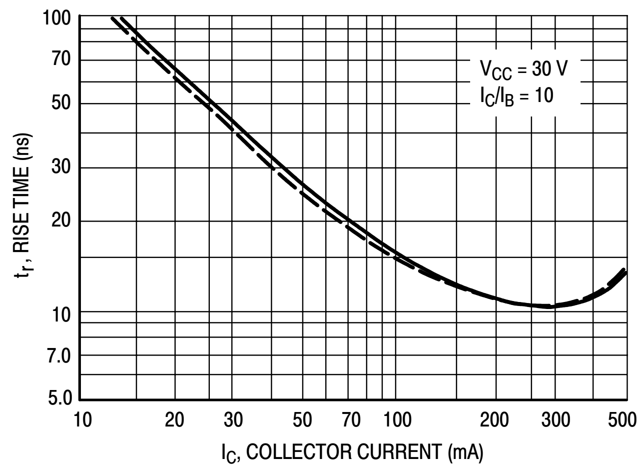


Figure 6. Rise Time

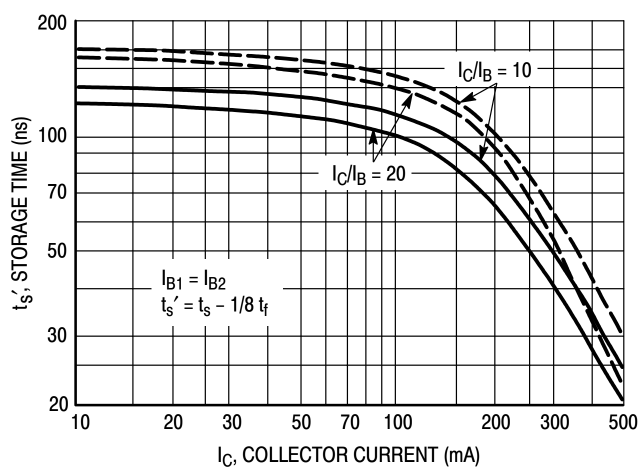


Figure 7. Storage Time

SMALL–SIGNAL CHARACTERISTICS

NOISE FIGURE

V_{CE} = –10 Vdc, T_A = 25°C; Bandwidth = 1.0 Hz

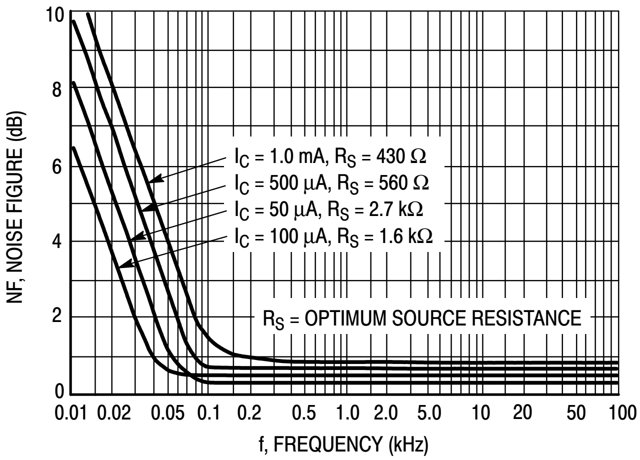


Figure 8. Frequency Effects

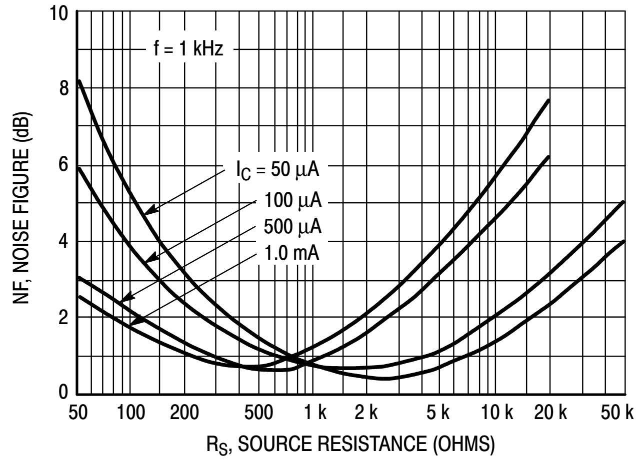


Figure 9. Source Resistance Effects

h PARAMETERS

V_{CE} = –10 Vdc, f = 1.0 kHz, T_A = 25°C

This group of graphs illustrates the relationship between h_{fe} and other "h" parameters for this series of transistors. To obtain these curves, a high–gain and a low–gain unit were selected from the MMBT4403LT1 lines, and the same units were used to develop the correspondingly–numbered curves on each graph.

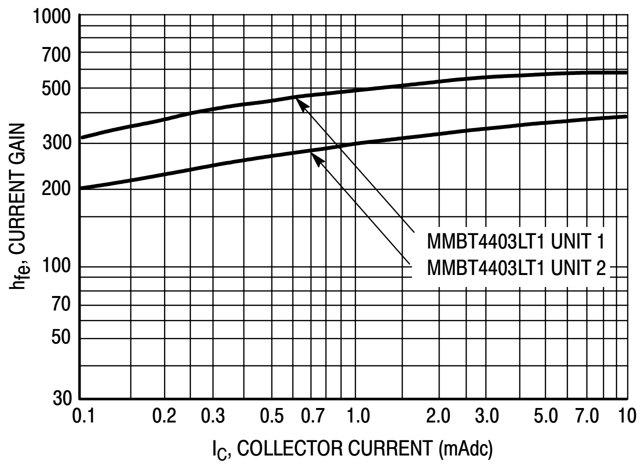


Figure 10. Current Gain

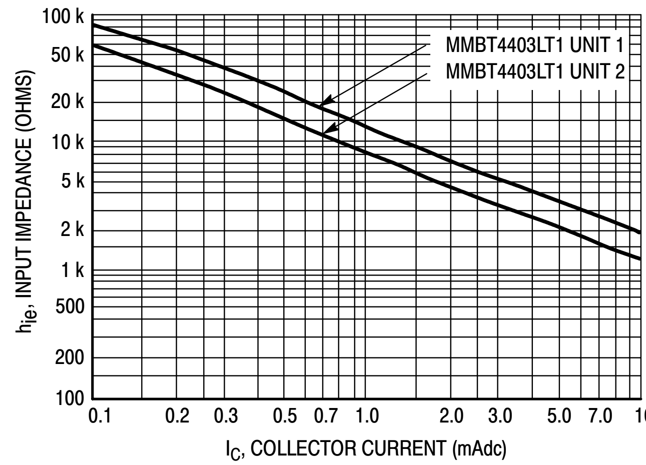


Figure 11. Input Impedance

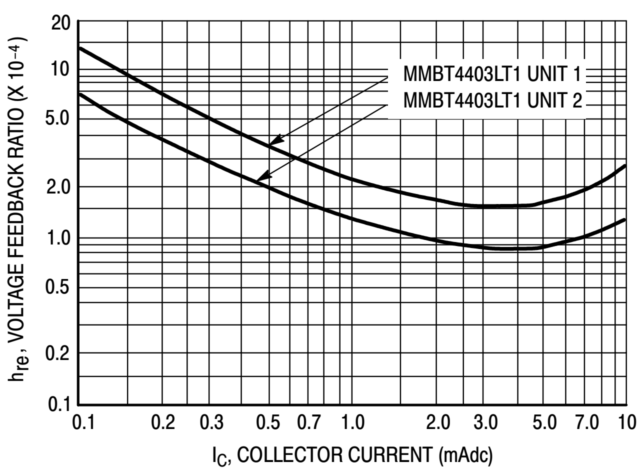


Figure 12. Voltage Feedback Ratio

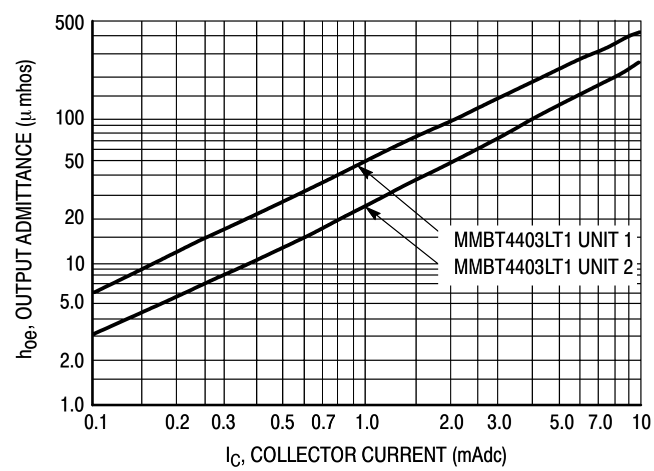


Figure 13. Output Admittance

STATIC CHARACTERISTICS

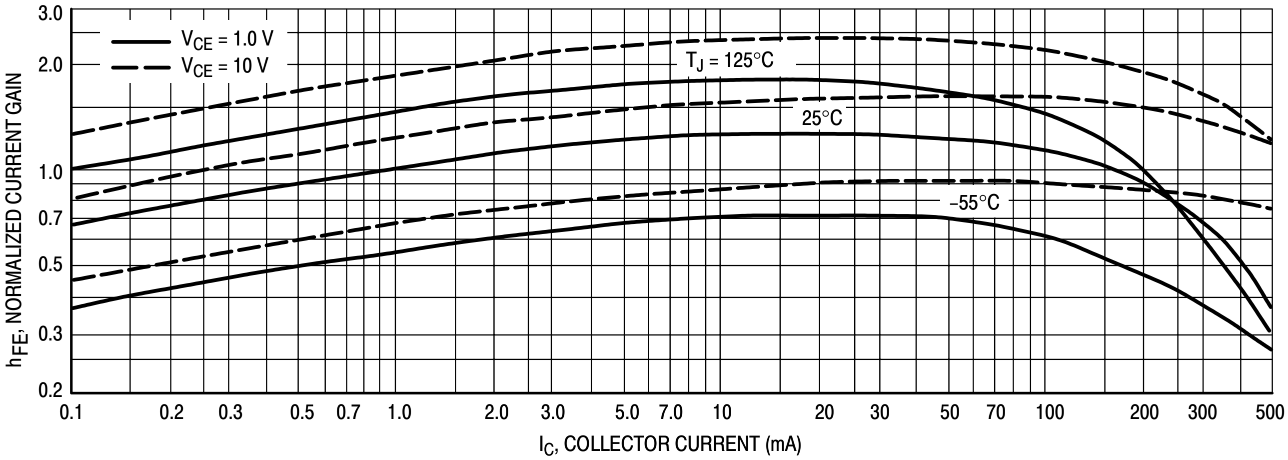


Figure 14. DC Current Gain

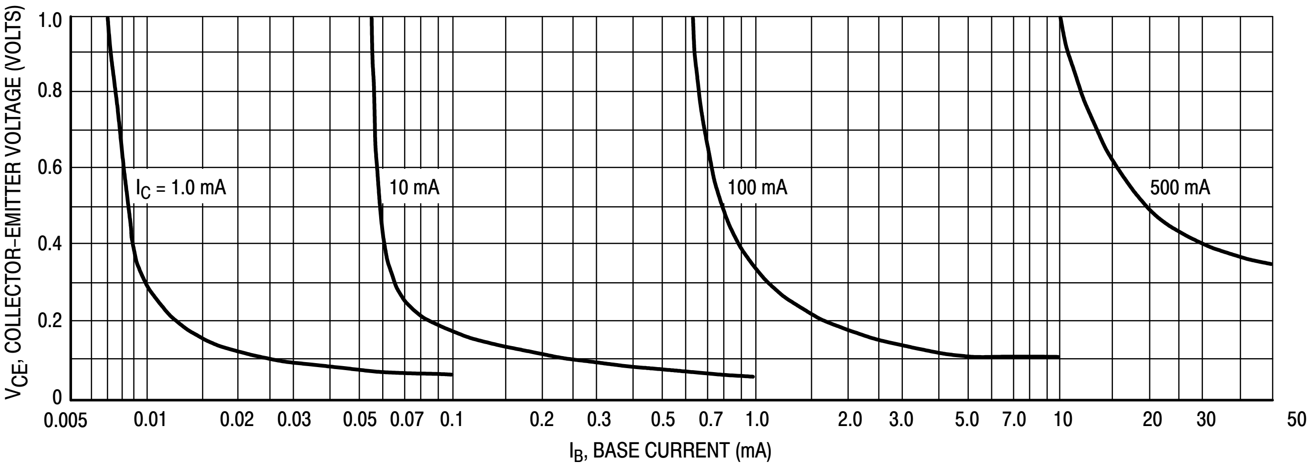


Figure 15. Collector Saturation Region

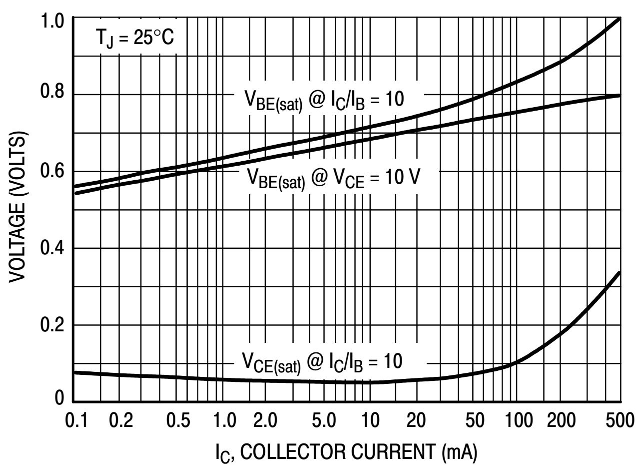


Figure 16. "On" Voltages

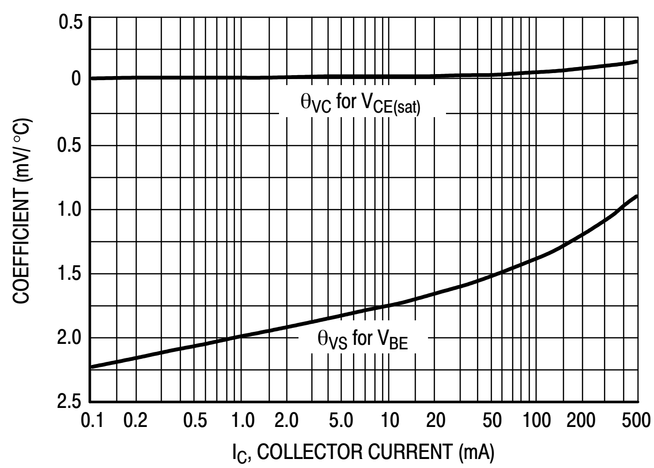


Figure 17. Temperature Coefficients

MMBT489LT1

High Current Surface Mount NPN Silicon Switching Transistor for Load Management in Portable Applications

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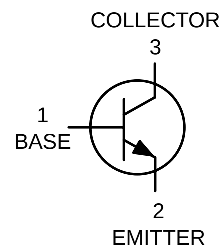
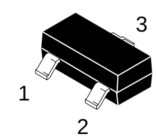
30 VOLTS
2.0 AMPS
NPN TRANSISTOR





SOT–23 (TO–236)
CASE 318–08
STYLE 6

MAXIMUM RATINGS (T_A = 25°C)

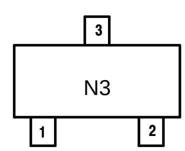
Rating	Symbol	Max	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current – Continuous	I_C	1.0	Vdc
Collector Current – Peak	I_{CM}	2.0	A

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (Note 1.)	310 2.5	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (Note 1.)	403	°C/W
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (Note 2.)	710 5.7	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (Note 2.)	176	°C/W
Total Device Dissipation (Single Pulse < 10 sec.)	$P_{Dsingle}$	575	mW
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 X 1.0 inch Pad

DEVICE MARKING



N3 = Specific Device Code

ORDERING INFORMATION

Device	Package	Shipping
MMBT489LT1	SOT–23	3000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	–	Vdc
Collector–Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	50	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	0.1	μAdc
Collector–Emitter Cutoff Current (V_{CES} = 30 Vdc)	I_{CES}	–	0.1	μAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc)	I_{EBO}	–	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain (Note 1.) (I_C = 50 mA, V_{CE} = 5.0 V) (I_C = 0.5 A, V_{CE} = 5.0 V) (I_C = 1.0 A, V_{CE} = 5.0 V)	h_{FE}	 300 300 200	 – 900 –	
Collector–Emitter Saturation Voltage (Note 1.) (I_C = 1.0 A, I_B = 100 mA) (I_C = 0.5 A, I_B = 50 mA) (I_C = 0.1 A, I_B = 1.0 mA)	$V_{CE(sat)}$	 – – –	 0.200 0.125 0.075	V
Base–Emitter Saturation Voltage (Note 1.) (I_C = 1.0 A, I_B = 0.1 A)	$V_{BE(sat)}$	–	1.1	V
Base–Emitter Turn–on Voltage (Note 1.) (I_C = 1.0 mA, V_{CE} = 2.0 V)	$V_{BE(on)}$	–	1.1	V
Cutoff Frequency (I_C = 100 mA, V_{CE} = 5.0 V, f = 100 MHz	f_T	100	–	MHz
Output Capacitance (f = 1.0 MHz)	C_{obo}	–	15	pF

1. Pulsed Condition: Pulse Width = 300 μsec, Duty Cycle ≤ 2%

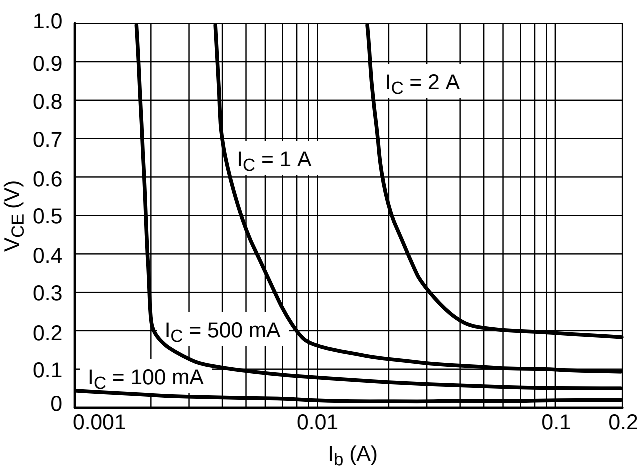


Figure 1. V_{CE} versus I_b

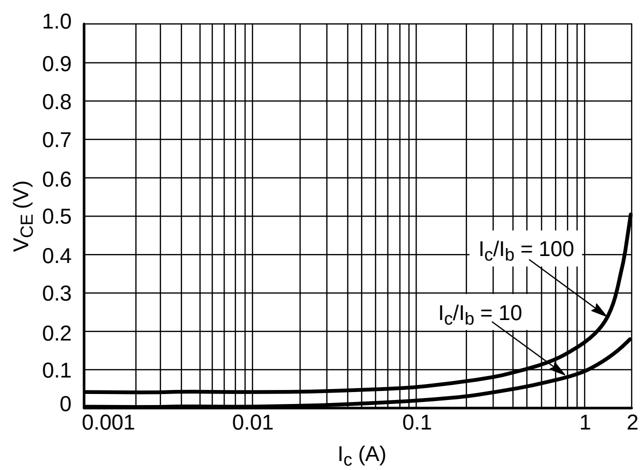


Figure 2. V_{CE} versus I_c

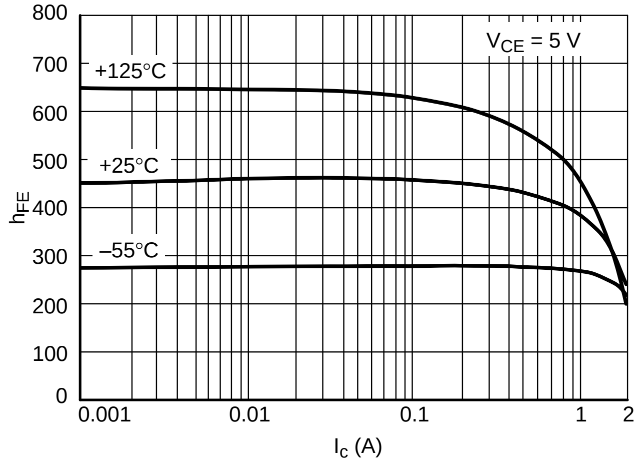


Figure 3. h_{FE} versus I_c

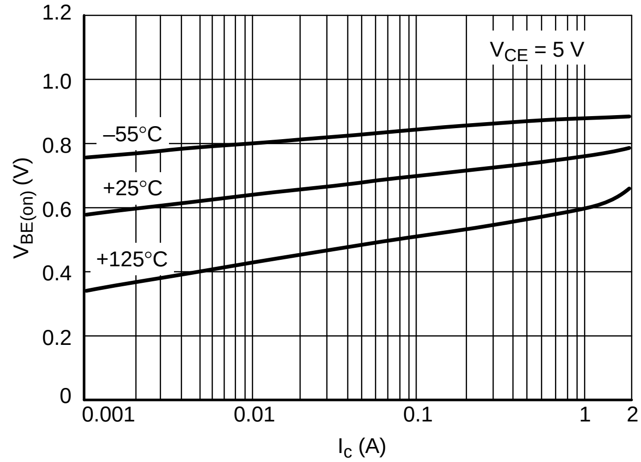


Figure 4. $V_{BE(on)}$ versus I_c

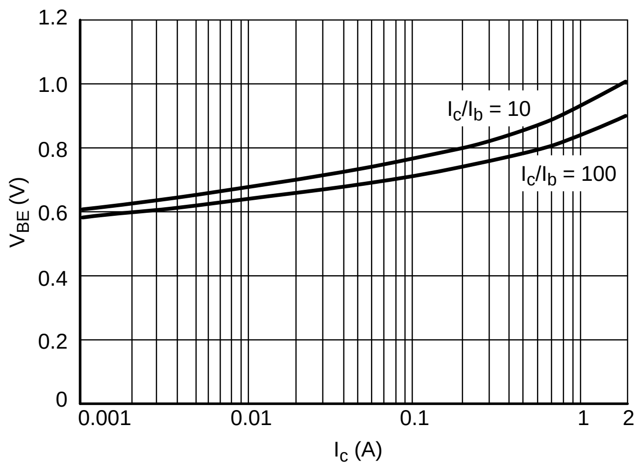


Figure 5. $V_{BE(sat)}$ versus I_c

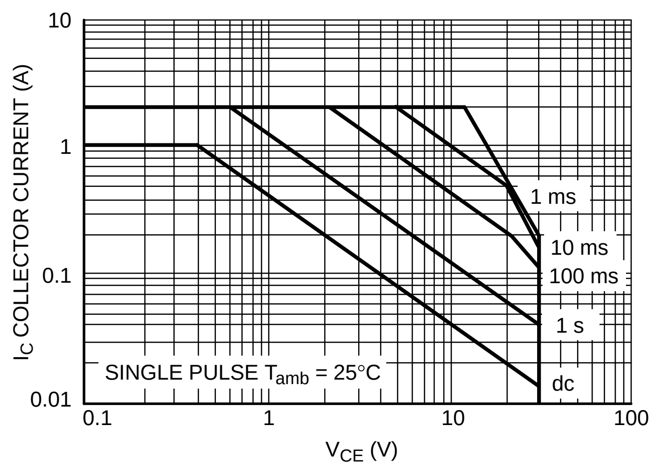


Figure 6. Safe Operating Area

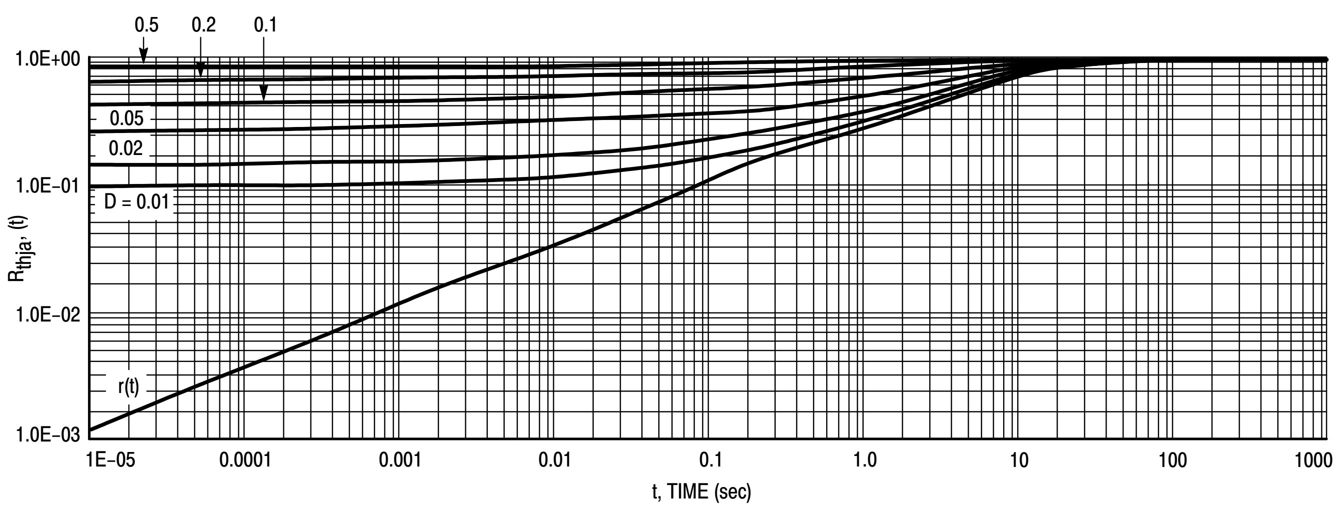
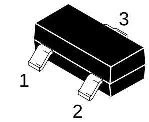


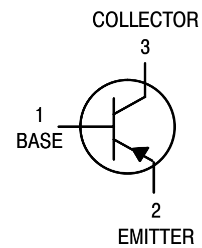
Figure 7. Normalized Thermal Response

Low Noise Transistor
PNP Silicon

MMBT5087LT1



CASE 318–08, STYLE 6
SOT–23 (TO–236)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–50	Vdc
Collector–Base Voltage	V_{CBO}	–50	Vdc
Emitter–Base Voltage	V_{EBO}	–3.0	Vdc
Collector Current — Continuous	I_C	–50	mAdc

DEVICE MARKING

MMBT5087LT1 = 2Q

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate, (2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–50	—	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–50	—	Vdc
Collector Cutoff Current (V_{CB} = –10 Vdc, I_E = 0) (V_{CB} = –35 Vdc, I_E = 0)	I_{CBO}	 — —	 –10 –50	nAdc

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = –100 µAdc, V_{CE} = –5.0 Vdc)		250	800	
(I_C = –1.0 mAdc, V_{CE} = –5.0 Vdc)		250	—	
(I_C = –10 mAdc, V_{CE} = –5.0 Vdc)		250	—	
Collector–Emitter Saturation Voltage (I_C = –10 mAdc, I_B = –1.0 mAdc)	$V_{CE(sat)}$	—	–0.3	Vdc
Base–Emitter Saturation Voltage (I_C = –10 mAdc, I_B = –1.0 mAdc)	$V_{BE(sat)}$	—	0.85	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = –500 µAdc, V_{CE} = –5.0 Vdc, f = 20 MHz)	f_T	40	—	MHz
Output Capacitance (V_{CB} = –5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	4.0	pF
Small–Signal Current Gain (I_C = –1.0 mAdc, V_{CE} = –5.0 Vdc, f = 1.0 kHz)	h_{fe}	250	900	—
Noise Figure	NF			dB
(I_C = –20 mAdc, V_{CE} = –5.0 Vdc, R_S = 10 kΩ, f = 1.0 kHz)		—	2.0	
(I_C = –100 µAdc, V_{CE} = –5.0 Vdc, R_S = 3.0 kΩ, f = 1.0 kHz)		—	2.0	

TYPICAL NOISE CHARACTERISTICS

(V_{CE} = –5.0 Vdc, T_A = 25°C)

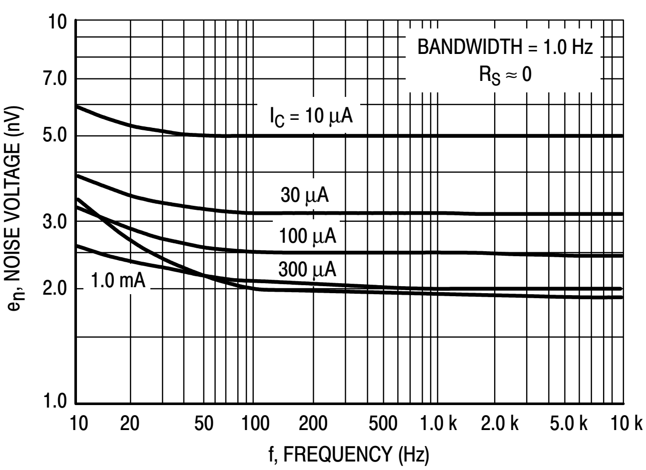


Figure 1. Noise Voltage

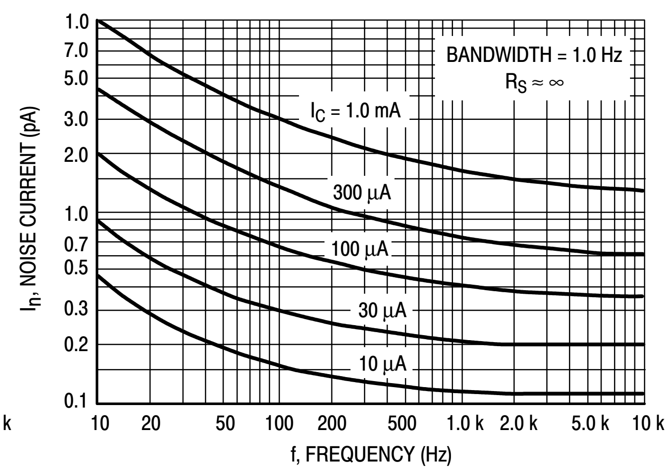


Figure 2. Noise Current

NOISE FIGURE CONTOURS

(V_{CE} = –5.0 Vdc, T_A = 25°C)

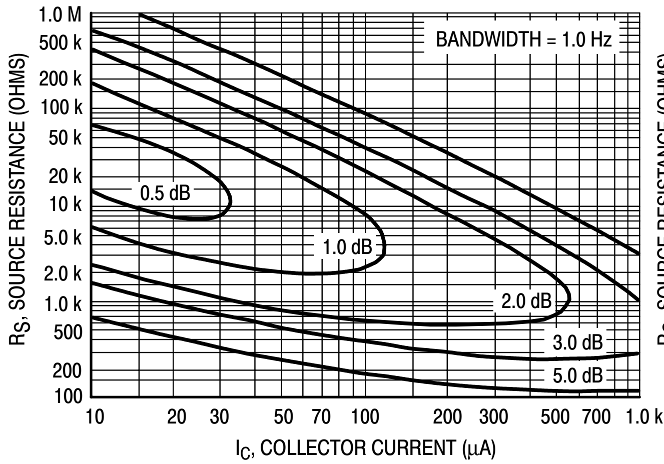


Figure 3. Narrow Band, 100 Hz

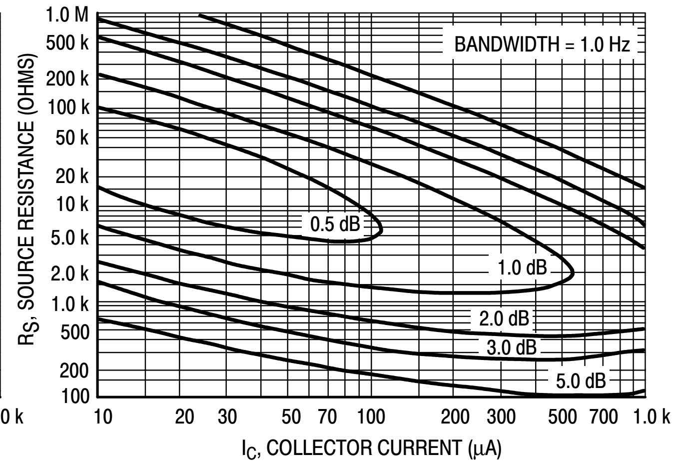


Figure 4. Narrow Band, 1.0 kHz

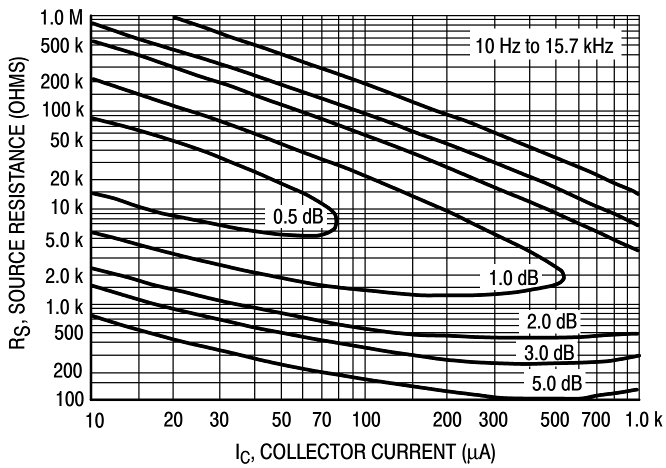


Figure 5. Wideband

Noise Figure is Defined as:

$$NF = 20 \log_{10}\left[\frac{e_n^2 + 4KTR_S + I_n^2 R_S^2}{4KTR_S}\right]^{1/2}$$

e_n = Noise Voltage of the Transistor referred to the input. (Figure 3)
I_n = Noise Current of the Transistor referred to the input. (Figure 4)
K = Boltzman's Constant (1.38 x 10^{-23} j/°K)
T = Temperature of the Source Resistance (°K)
R_S = Source Resistance (Ohms)

TYPICAL STATIC CHARACTERISTICS

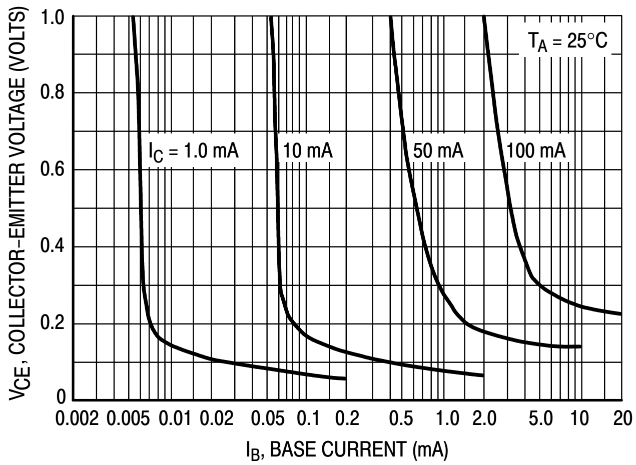


Figure 6. Collector Saturation Region

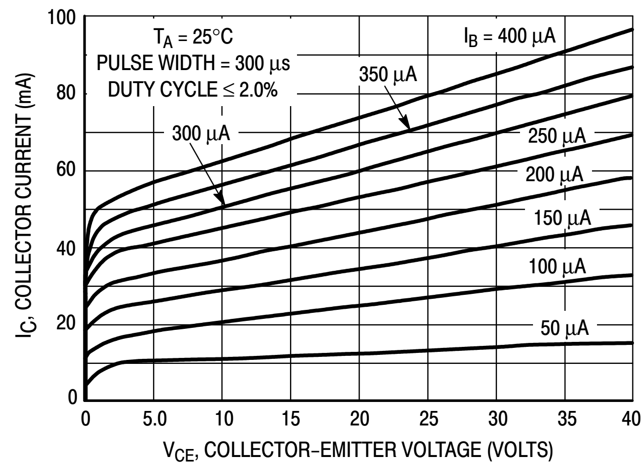


Figure 7. Collector Characteristics

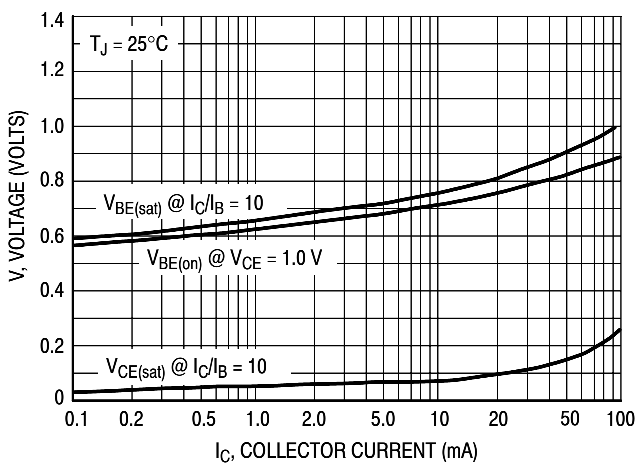


Figure 8. "On" Voltages

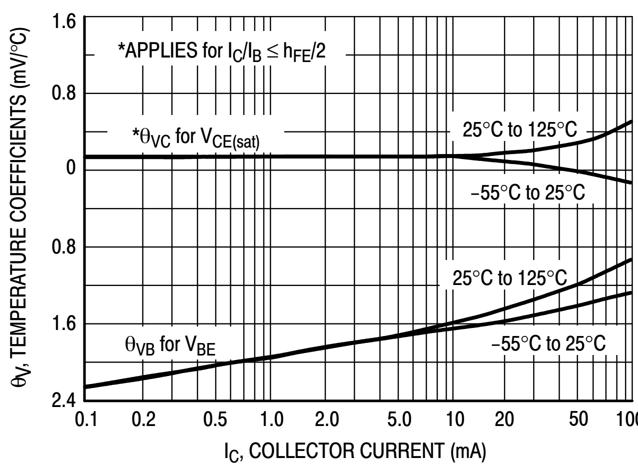


Figure 9. Temperature Coefficients

TYPICAL DYNAMIC CHARACTERISTICS

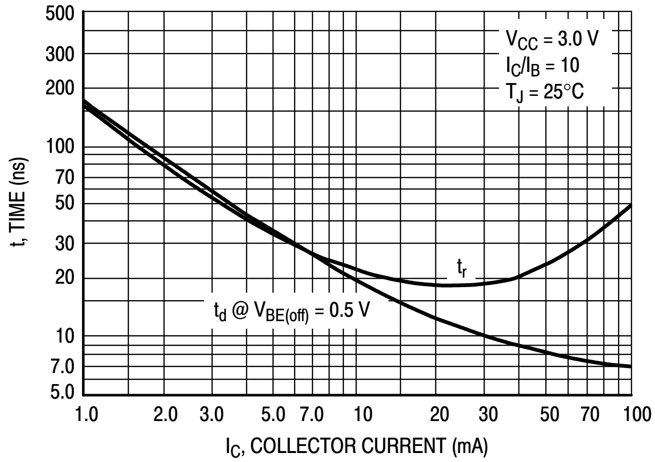


Figure 10. Turn–On Time

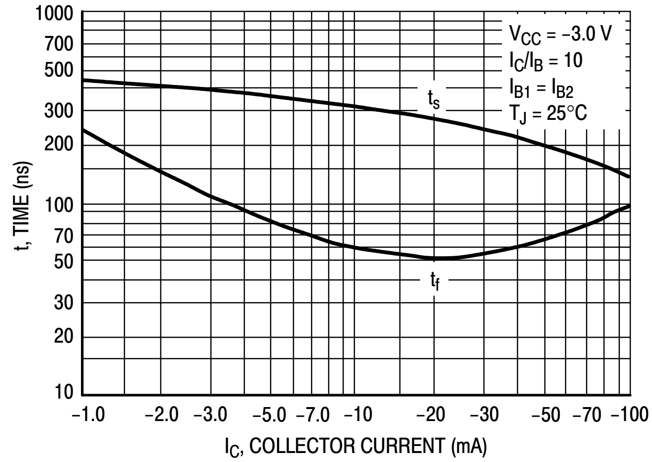


Figure 11. Turn–Off Time

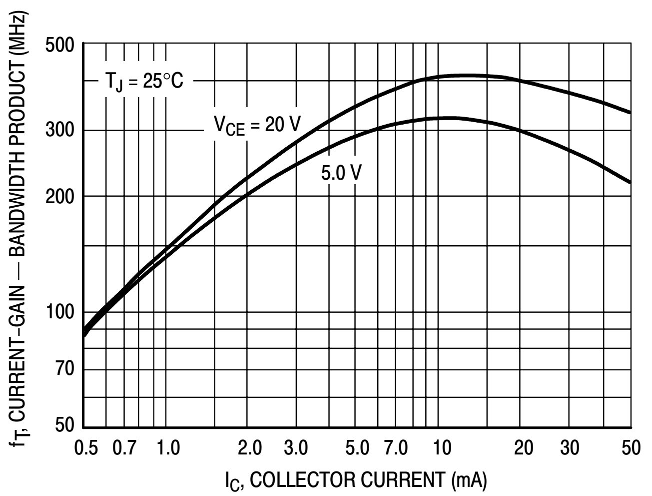


Figure 12. Current–Gain — Bandwidth Product

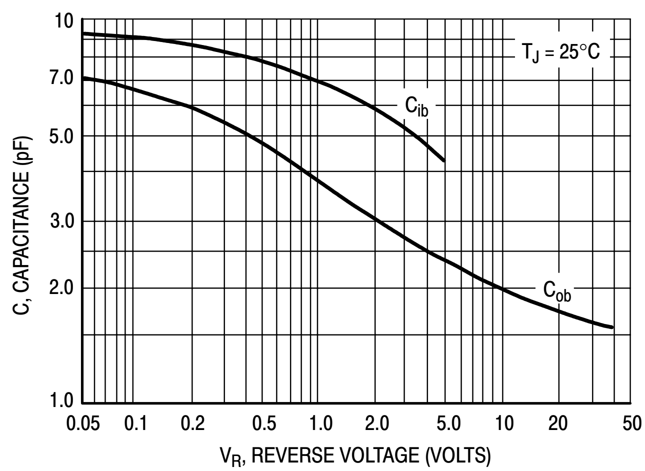


Figure 13. Capacitance

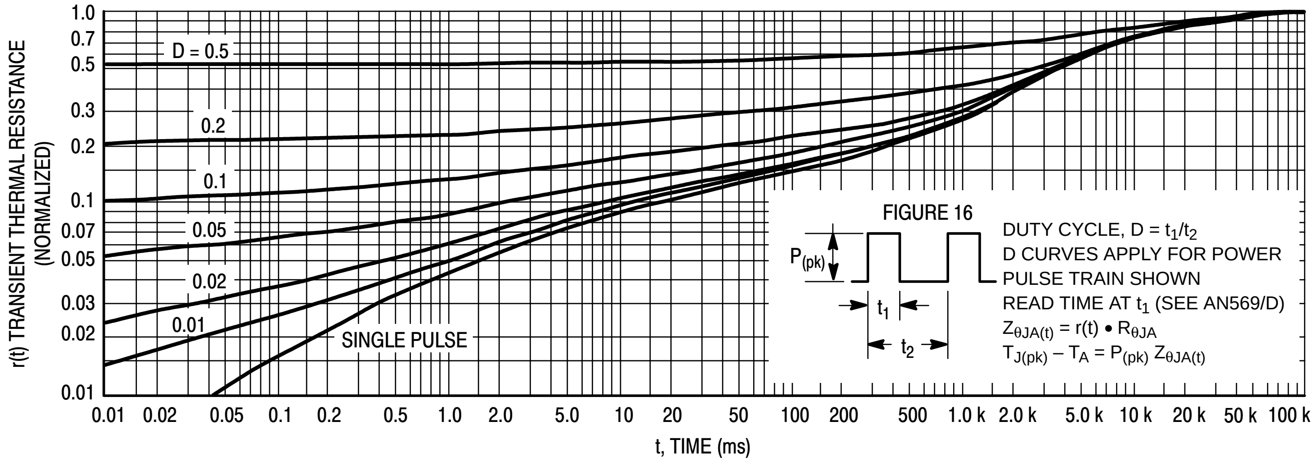


Figure 14. Thermal Response

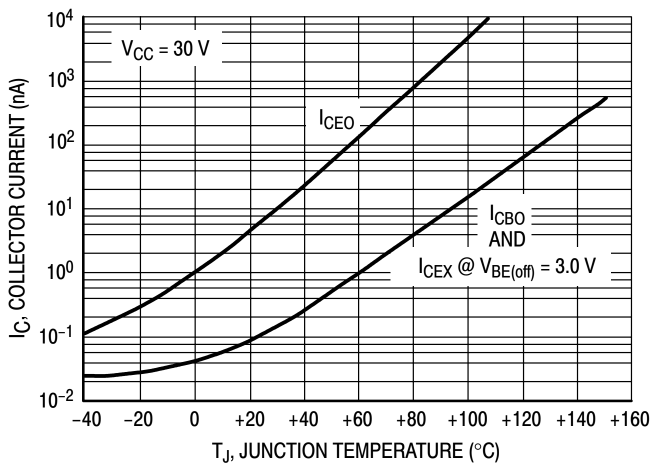


Figure 15. Typical Collector Leakage Current

DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 16. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 14 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 14 by the steady state value $R_{\theta JA}$.

Example:

Dissipating 2.0 watts peak under the following conditions:

t_1 = 1.0 ms, t_2 = 5.0 ms (D = 0.2)

Using Figure 14 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

The peak rise in junction temperature is therefore

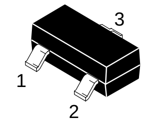
$\Delta T = r(t) \times P_{(pk)} \times R_{\theta JA} = 0.22 \times 2.0 \times 200 = 88°C.$

For more information, see ON Semiconductor Application Note AN569/D, available from the Literature Distribution Center or on our website at **www.onsemi.com**.

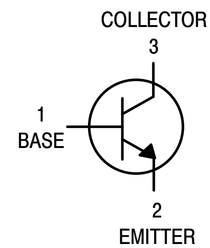
Low Noise Transistors
NPN Silicon

MMBT5088LT1
MMBT5089LT1

MMBT5089LT1 is a Preferred Device



CASE 318–08, STYLE 6
SOT–23 (TO–236AF)



MAXIMUM RATINGS

Rating	Symbol	5088LT1	5089LT1	Unit
Collector–Emitter Voltage	V_{CEO}	30	25	Vdc
Collector–Base Voltage	V_{CBO}	35	30	Vdc
Emitter–Base Voltage	V_{EBO}	4.5		Vdc
Collector Current — Continuous	I_C	50		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT5088LT1 = 1Q; MMBT5089LT1 = 1R

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	 MMBT5088 MMBT5089	$V_{(BR)CEO}$	 30 25	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 MMBT5088 MMBT5089	$V_{(BR)CBO}$	 35 30	 — —	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) (V_{CB} = 15 Vdc, I_E = 0)	 MMBT5088 MMBT5089	I_{CBO}	 — —	 50 50	nAdc
Emitter Cutoff Current ($V_{EB(off)}$ = 3.0 Vdc, I_C = 0) ($V_{EB(off)}$ = 4.5 Vdc, I_C = 0)	 MMBT5088 MMBT5089	I_{EBO}	 — —	 50 100	nAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 100 µAdc, V_{CE} = 5.0 Vdc)	MMBT5088		300	900	
	MMBT5089		400	1200	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	MMBT5088		350	—	
	MMBT5089		450	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MMBT5088		300	—	
	MMBT5089		400	—	
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{BE(sat)}$	—	0.8	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 500 µAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	50	—	MHz
Collector–Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz emitter guarded)		C_{cb}	—	4.0	pF
Emitter–Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz collector guarded)		C_{eb}	—	10	pF
Small Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	MMBT5088	h_{fe}	350	1400	—
	MMBT5089		450	1800	
Noise Figure (I_C = 100 µAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 1.0 kHz)	MMBT5088	NF	—	3.0	dB
	MMBT5089		—	2.0	

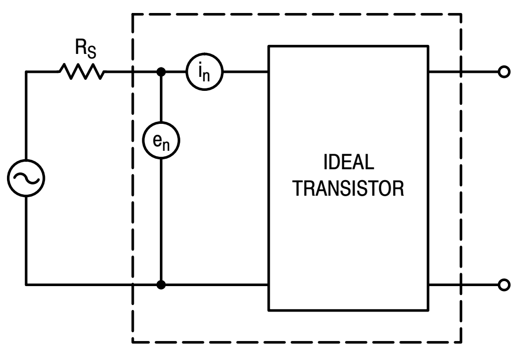


Figure 1. Transistor Noise Model

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

NOISE VOLTAGE

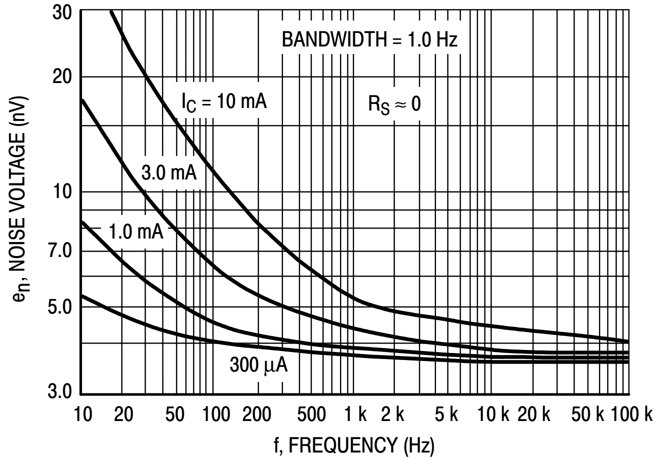


Figure 2. Effects of Frequency

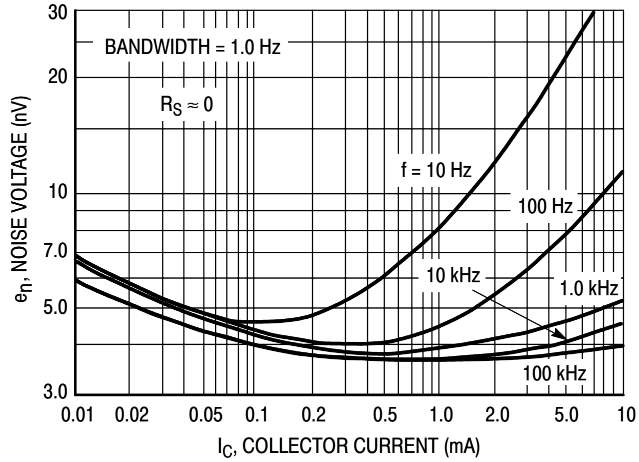


Figure 3. Effects of Collector Current

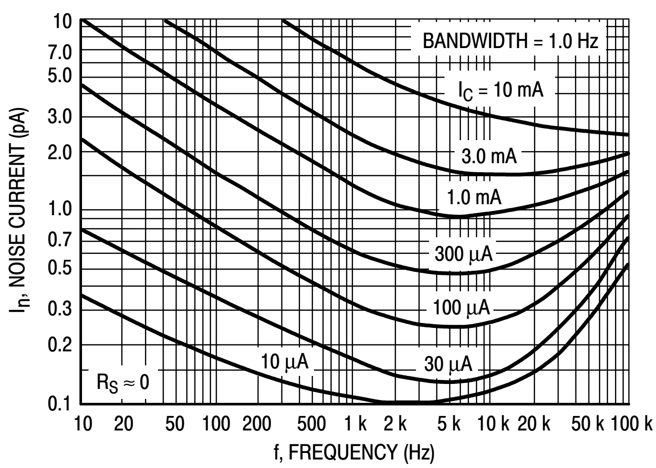


Figure 4. Noise Current

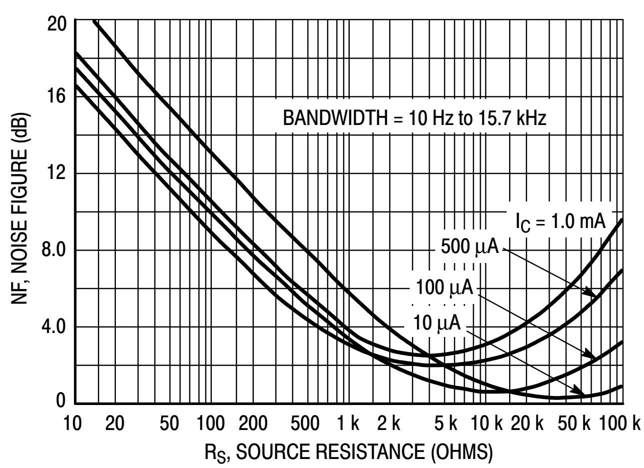


Figure 5. Wideband Noise Figure

100 Hz NOISE DATA

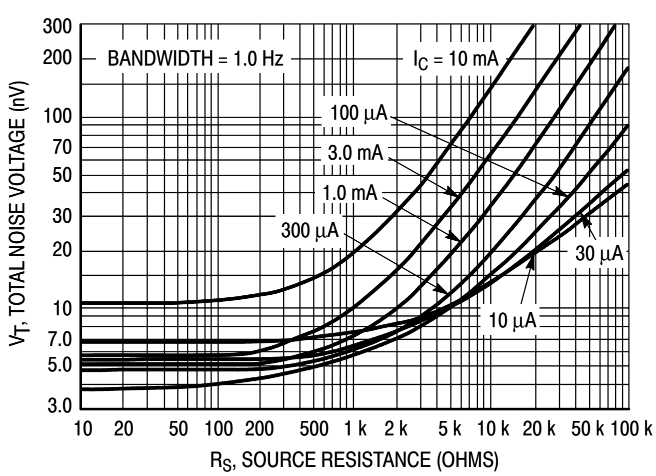


Figure 6. Total Noise Voltage

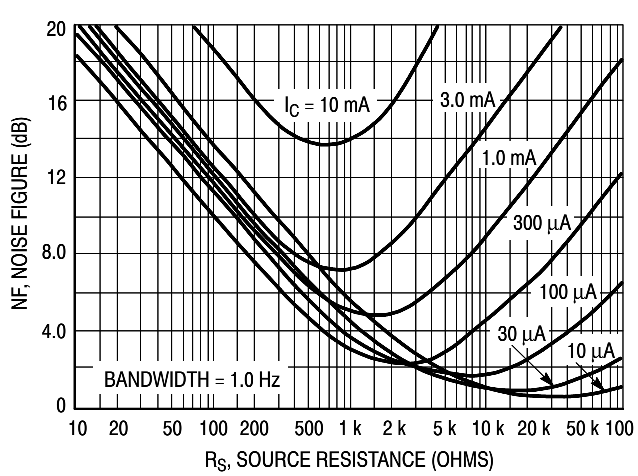


Figure 7. Noise Figure

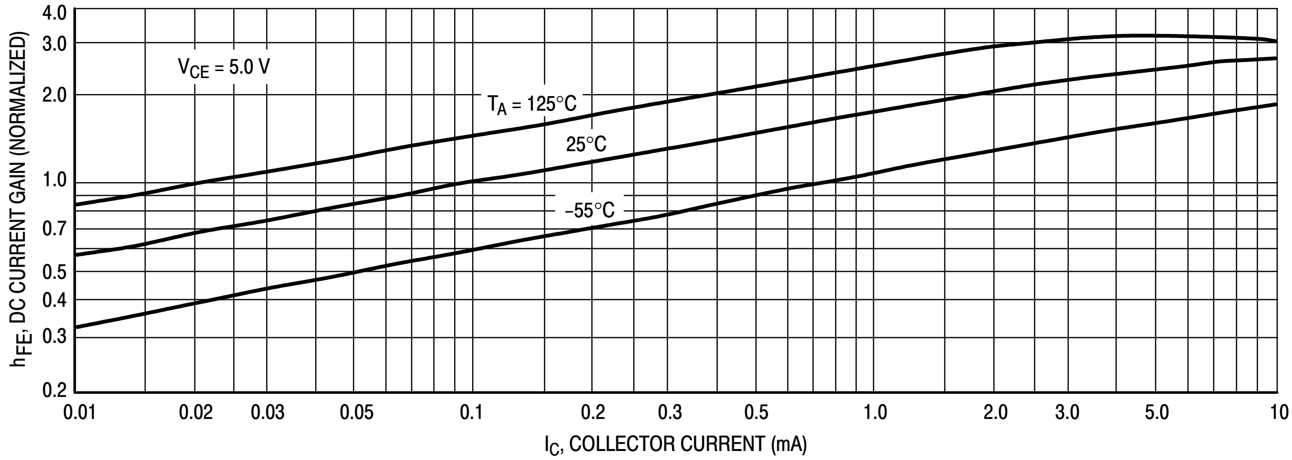


Figure 8. DC Current Gain

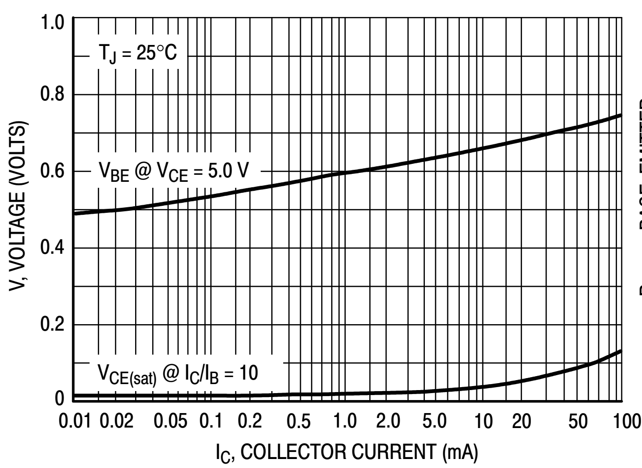


Figure 11. “On” Voltages

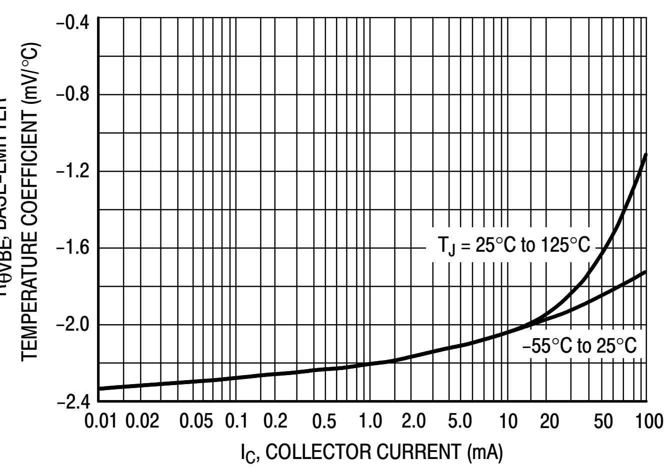


Figure 9. Temperature Coefficients

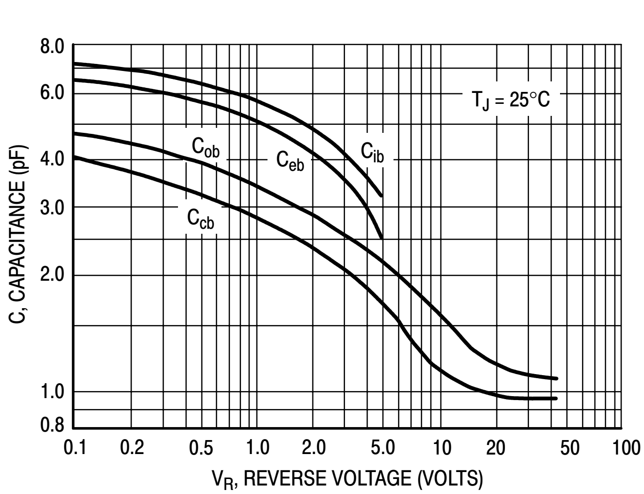


Figure 12. Capacitance

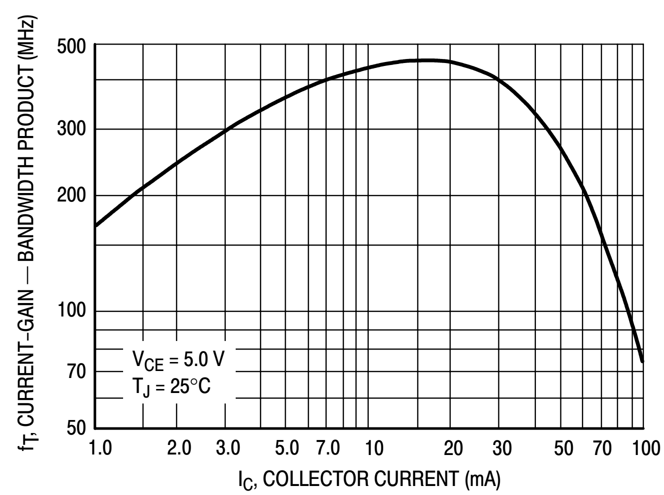
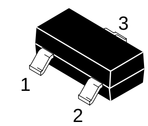


Figure 10. Current−Gain — Bandwidth Product

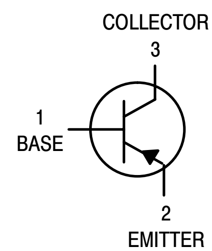
High Voltage Transistor
PNP Silicon

MMBT5401LT1

ON Semiconductor Preferred Device



CASE 318–08, STYLE 6
SOT–23 (TO–236AF)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–150	Vdc
Collector–Base Voltage	V_{CBO}	–160	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current — Continuous	I_C	–500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT5401LT1 = 2L

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–150	—	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–160	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	Vdc
Collector Cutoff Current (V_{CB} = –120 Vdc, I_E = 0) (V_{CB} = –120 Vdc, I_E = 0, T_A = 100°C)	I_{CES}	— —	–50 –50	nAdc μAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1
Publication Order Number:
MMBT5401LT/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = –1.0 mAdc, V_{CE} = –5.0 Vdc)		50	—	
(I_C = –10 mAdc, V_{CE} = –5.0 Vdc)		60	240	
(I_C = –50 mAdc, V_{CE} = –5.0 Vdc)		50	—	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = –10 mAdc, I_B = –1.0 mAdc)		—	–0.2	
(I_C = –50 mAdc, I_B = –5.0 mAdc)		—	–0.5	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = –10 mAdc, I_B = –1.0 mAdc)		—	–1.0	
(I_C = –50 mAdc, I_B = –5.0 mAdc)		—	–1.0	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –10 Vdc, f = 100 MHz)	f_T	100	300	MHz
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Small Signal Current Gain (I_C = –1.0 mAdc, V_{CE} = –10 Vdc, f = 1.0 kHz)	h_{fe}	40	200	—
Noise Figure (I_C = –200 μAdc, V_{CE} = –5.0 Vdc, R_S = 10 Ω, f = 1.0 kHz)	NF	—	8.0	dB

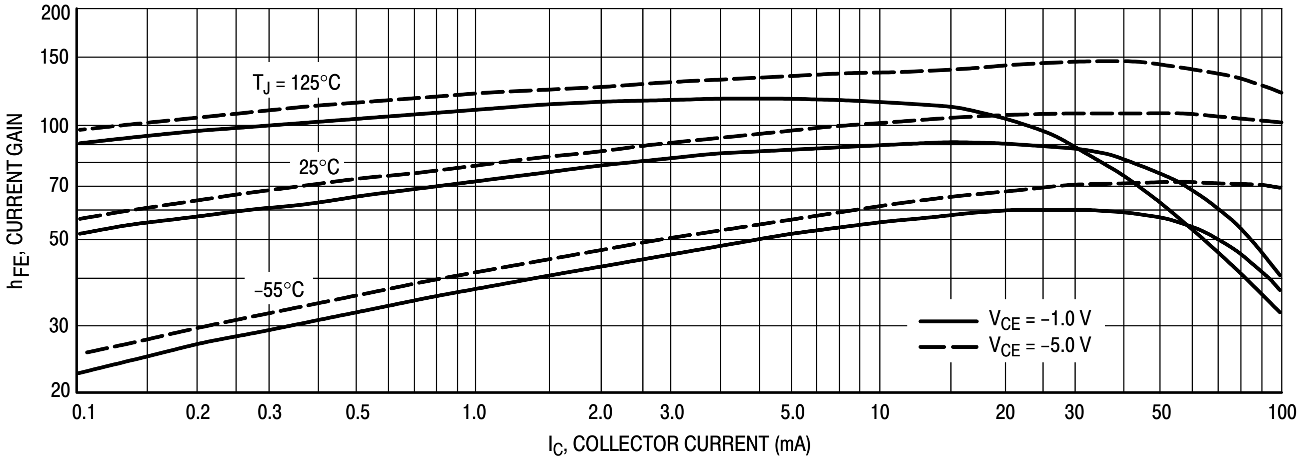


Figure 1. DC Current Gain

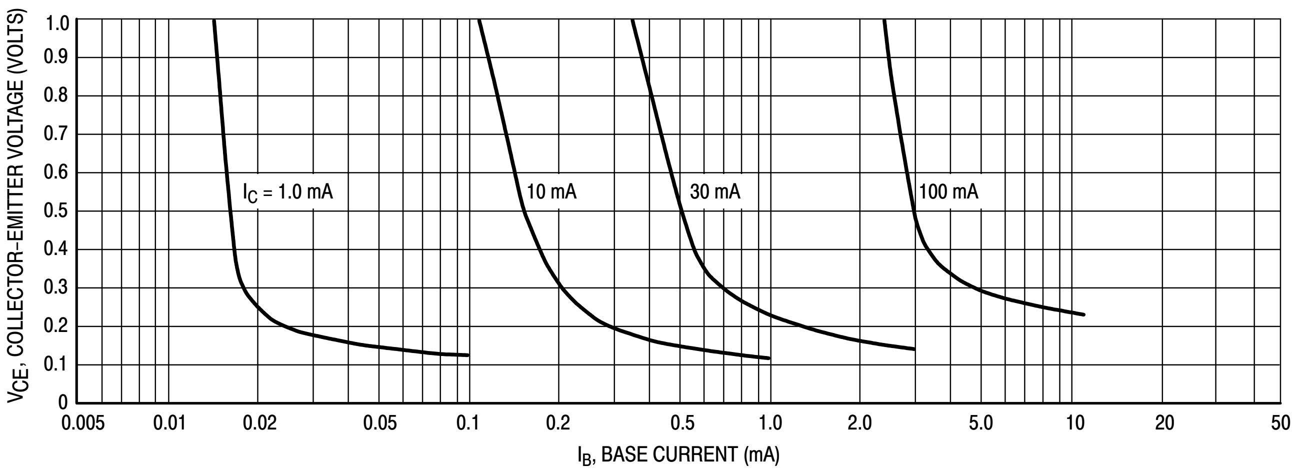


Figure 2. Collector Saturation Region

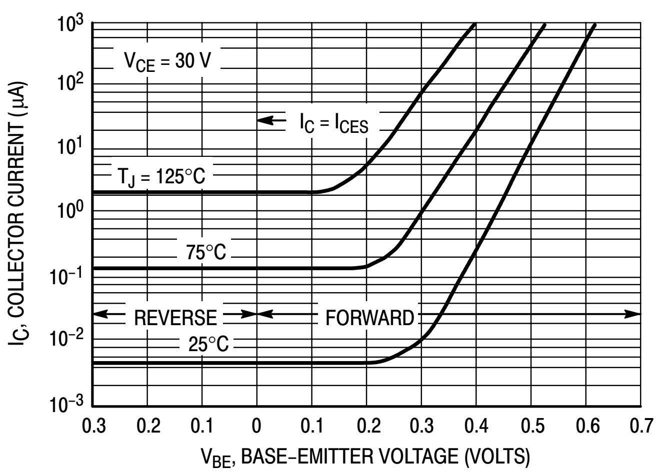


Figure 3. Collector Cut−Off Region

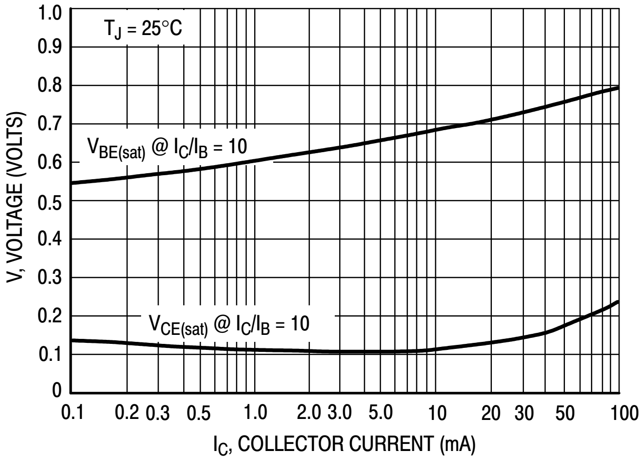


Figure 4. “On” Voltages

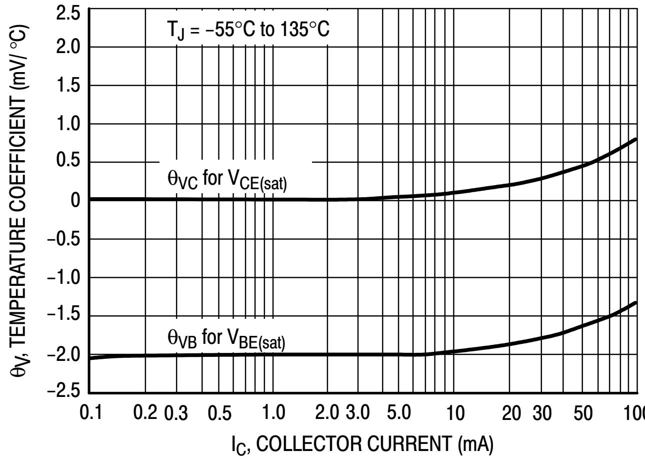
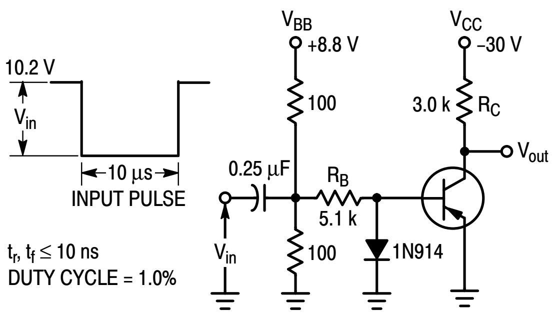


Figure 5. Temperature Coefficients



Values Shown are for I_C @ 10 mA

Figure 6. Switching Time Test Circuit

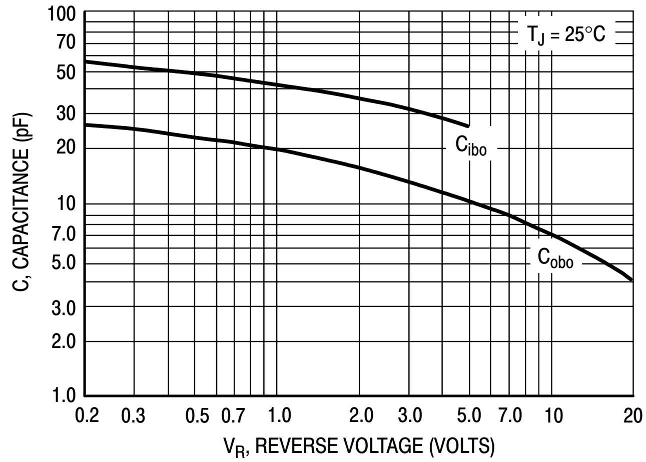


Figure 7. Capacitances

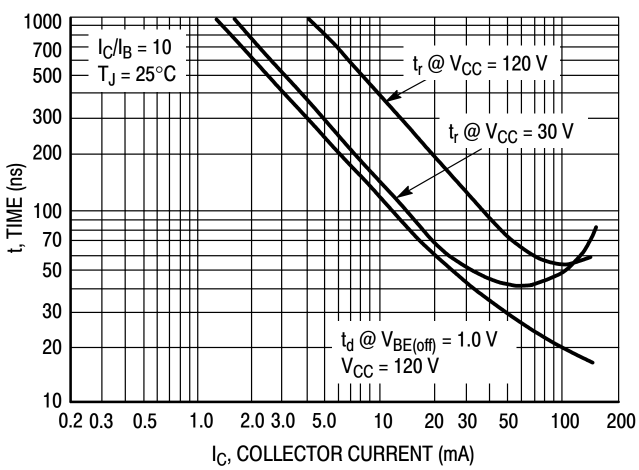


Figure 8. Turn–On Time

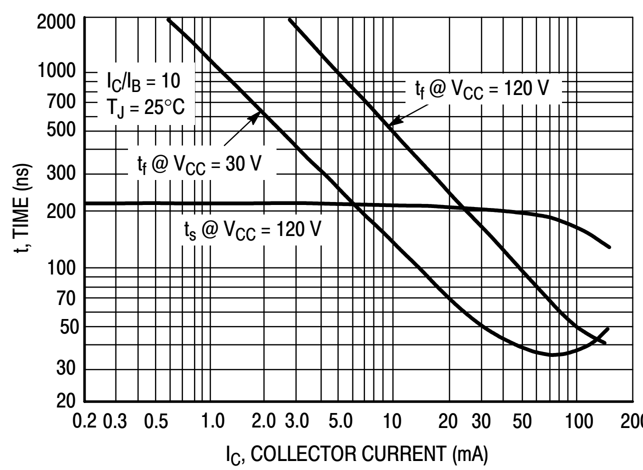
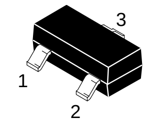


Figure 9. Turn–Off Time

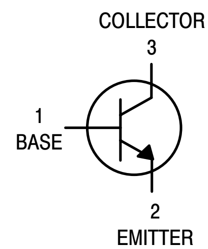
High Voltage Transistors
NPN Silicon

MMBT5550LT1
MMBT5551LT1

MMBT5551LT1 is a Preferred Device



CASE 318–08, STYLE 6
SOT–23 (TO–236)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	140	Vdc
Collector–Base Voltage	V_{CBO}	160	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	600	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT5550LT1 = M1F; MMBT5551LT1 = G1

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(3) (I_C = 1.0 mAdc, I_B = 0)	 MMBT5550 MMBT5551	$V_{(BR)CEO}$	 140 160	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 MMBT5550 MMBT5551	$V_{(BR)CBO}$	 160 180	 — —	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	 6.0	 —	Vdc
Collector Cutoff Current (V_{CB} = 100 Vdc, I_E = 0) (V_{CB} = 120 Vdc, I_E = 0) (V_{CB} = 100 Vdc, I_E = 0, T_A = 100°C) (V_{CB} = 120 Vdc, I_E = 0, T_A = 100°C)	 MMBT5550 MMBT5551 MMBT5550 MMBT5551	I_{CBO}	 — — — —	 100 50 100 50	 nAdc μAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	 —	 50	nAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	MMBT5550		60	—	
	MMBT5551		80	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MMBT5550		60	250	
	MMBT5551		80	250	
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	MMBT5550		20	—	
	MMBT5551		30	—	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	Both Types		—	0.15	
(I_C = 50 mAdc, I_B = 5.0 mAdc)	MMBT5550		—	0.25	
	MMBT5551		—	0.20	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	Both Types		—	1.0	
(I_C = 50 mAdc, I_B = 5.0 mAdc)	MMBT5550		—	1.2	
	MMBT5551		—	1.0	

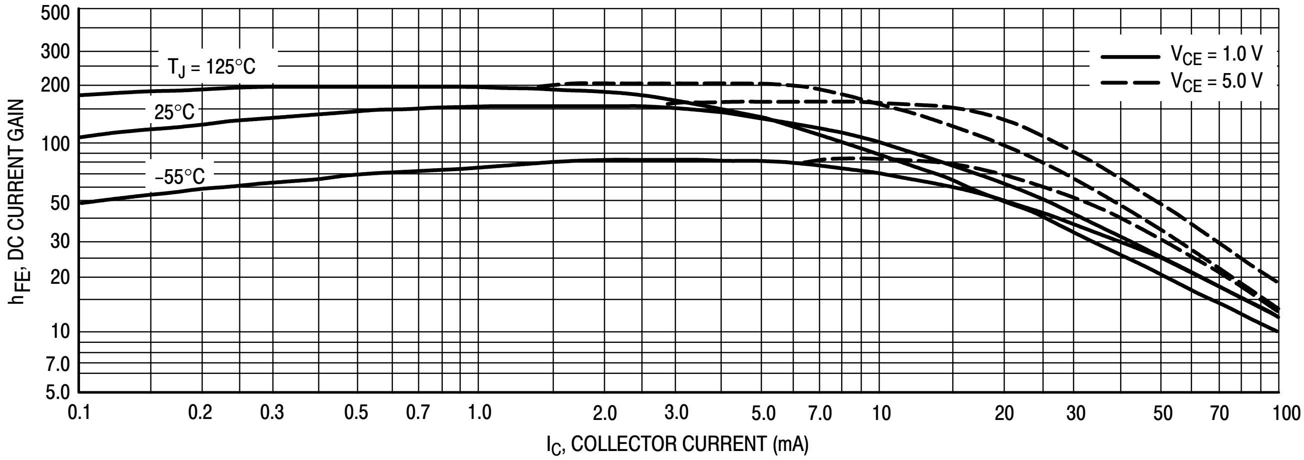


Figure 1. DC Current Gain

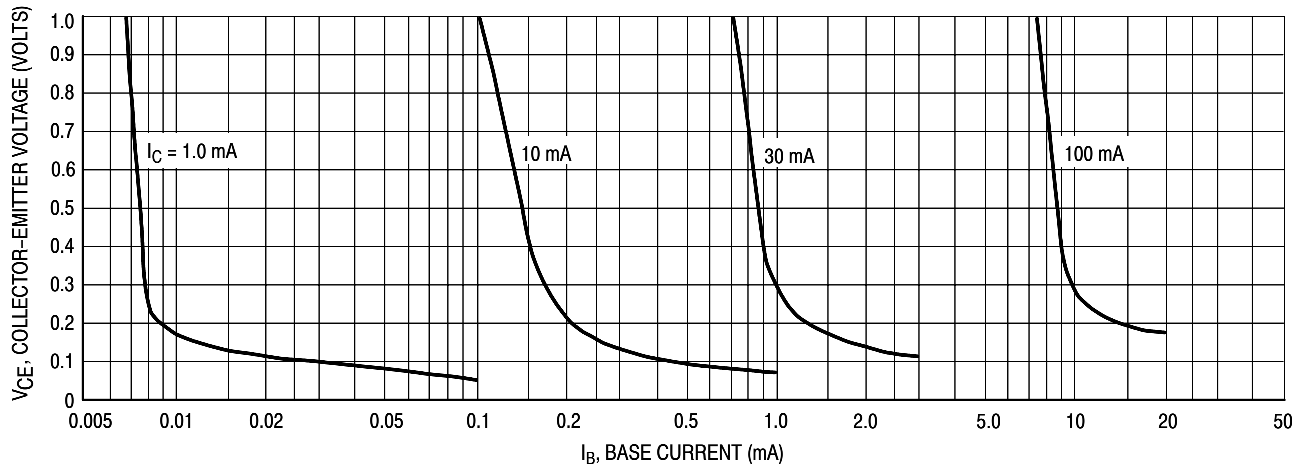


Figure 2. Collector Saturation Region

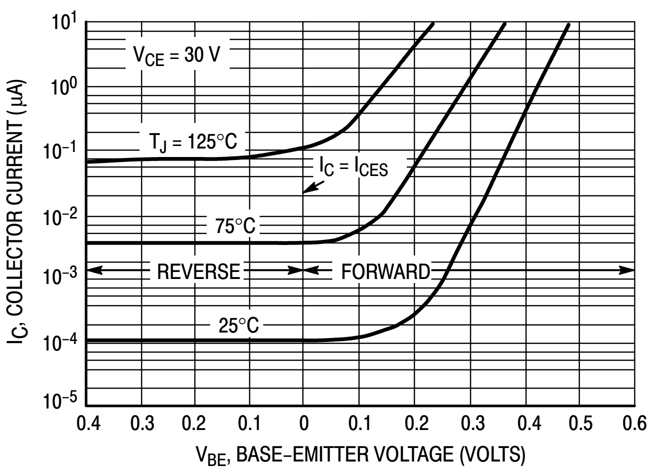


Figure 3. Collector Cut−Off Region

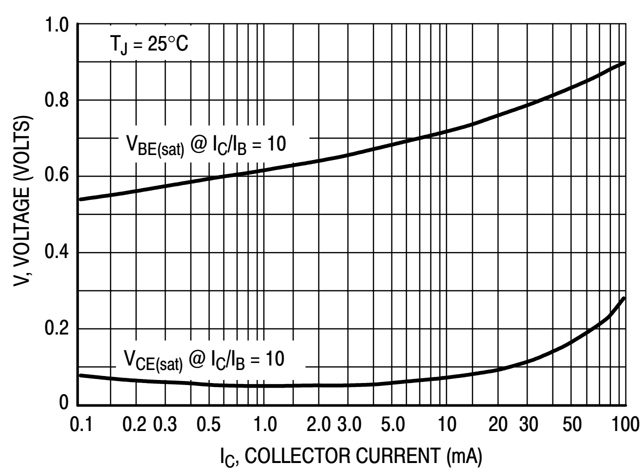


Figure 4. “On” Voltages

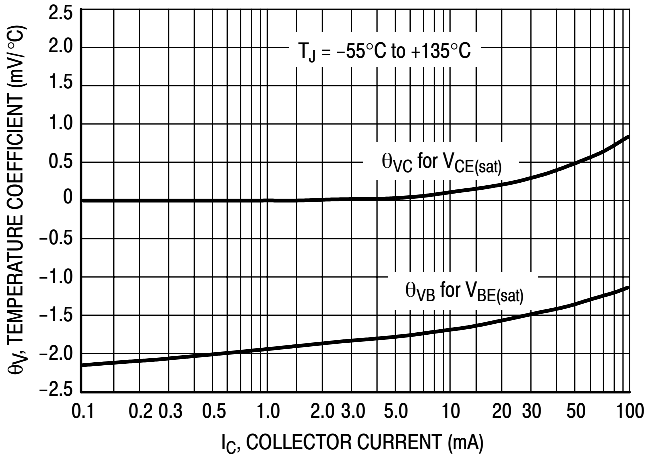
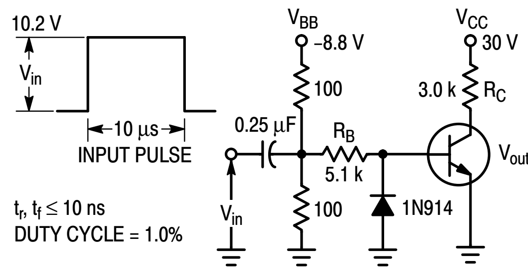


Figure 5. Temperature Coefficients



Values Shown are for I_C @ 10 mA

Figure 6. Switching Time Test Circuit

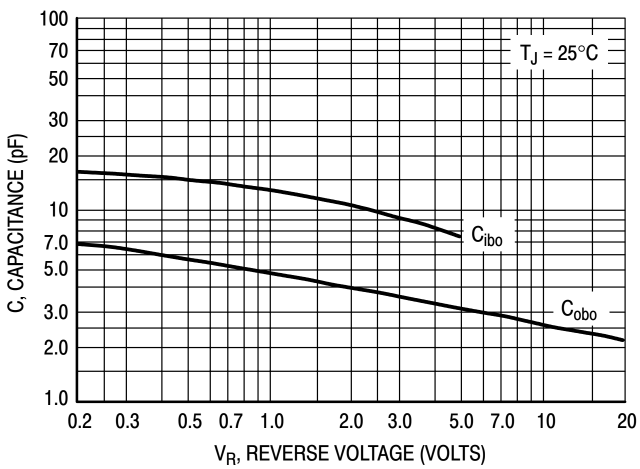


Figure 7. Capacitances

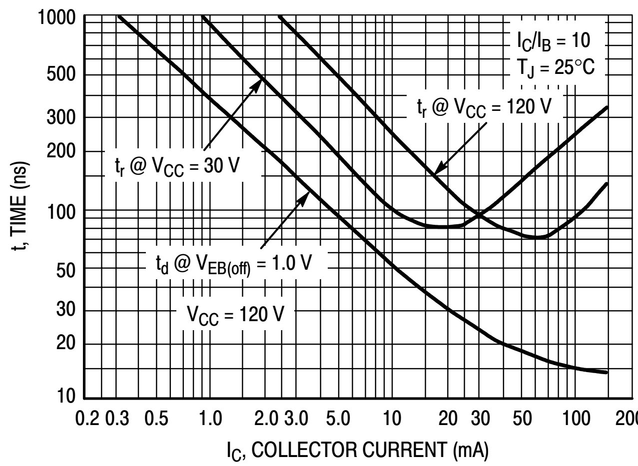


Figure 8. Turn–On Time

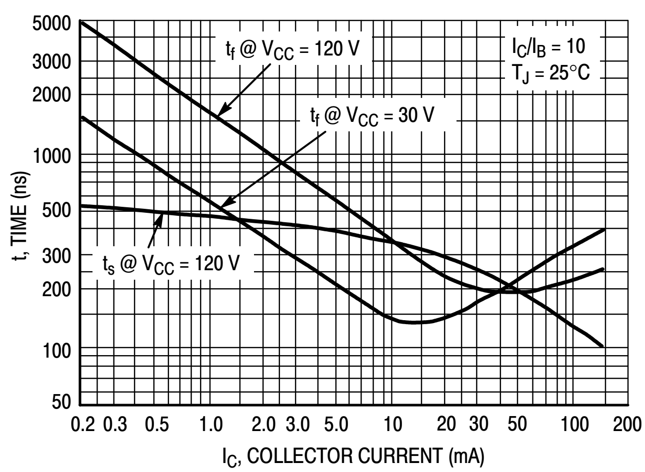
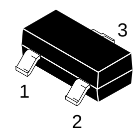


Figure 9. Turn–Off Time

High Current Surface Mount PNP Silicon Switching Transistor for Load Management in Portable Applications

MMBT589LT1

30 VOLTS
2.0 AMPS
PNP TRANSISTOR



CASE 318–08, STYLE 6
SOT–23 (TO–236AB)

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Collector–Emitter Voltage	V_{CEO}	–30	Vdc
Collector–Base Voltage	V_{CBO}	–50	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Continuous	I_C	–1.0	Adc
Collector Current – Peak	I_{CM}	–2.0	A

DEVICE MARKING

MMBT589LT1 = G3

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (1)	310 2.5	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (1)	403	°C/W
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (2)	710 5.7	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (2)	176	°C/W
Total Device Dissipation (Single Pulse < 10 sec.)	$P_{Dsingle}$ (3)	575	mW
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 X 1.0 inch Pad
3. ref: Figure 8

August, 2001 – Rev. 1

Publication Order Number:
MMBT589LT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–30	–	Vdc
Collector–Base Breakdown Voltage (I_C = –0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	–50	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	–	Vdc
Collector Cutoff Current (V_{CB} = –30 Vdc, I_E = 0)	I_{CBO}	–	–0.1	μAdc
Collector–Emitter Cutoff Current (V_{CES} = –30 Vdc)	I_{CES}	–	–0.1	μAdc
Emitter Cutoff Current (V_{EB} = –4.0 Vdc)	I_{EBO}	–	–0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain (1) (Figure 1)	h_{FE}			
(I_C = –1.0 mA, V_{CE} = –2.0 V)		100	–	
(I_C = –500 mA, V_{CE} = –2.0 V)		100	300	
(I_C = –1.0 A, V_{CE} = –2.0 V)		80	–	
(I_C = 2.0 A, V_{CE} = –2.0 V)		40	–	
Collector–Emitter Saturation Voltage (1) (Figure 3)	$V_{CE(sat)}$			V
(I_C = –0.5 A, I_B = –0.05 A)		–	–0.25	
(I_C = –1.0 A, I_B = 0.1 A)		–	–0.30	
(I_C = –2.0 A, I_B = –0.2 A)		–	–0.65	
Base–Emitter Saturation Voltage (1) (Figure 2) (I_C = –1.0 A, I_B = –0.1 A)	$V_{BE(sat)}$	–	–1.2	V
Base–Emitter Turn–on Voltage (1) (I_C = –1.0 A, V_{CE} = –2.0 V)	$V_{BE(on)}$	–	–1.1	V
Cutoff Frequency (I_C = –100 mA, V_{CE} = –5.0 V, f = 100 MHz)	f_T	100	–	MHz
Output Capacitance (f = 1.0 MHz)	Cobo	–	15	pF

1. Pulsed Condition: Pulse Width = 300 msec, Duty Cycle ≤ 2%

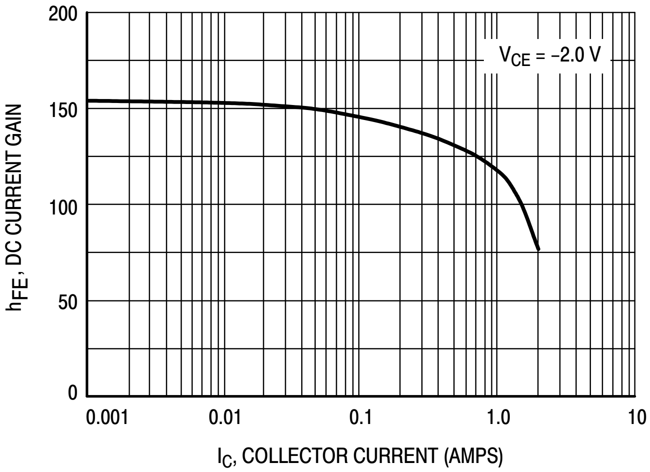


Figure 1. DC Current Gain versus Collector Current

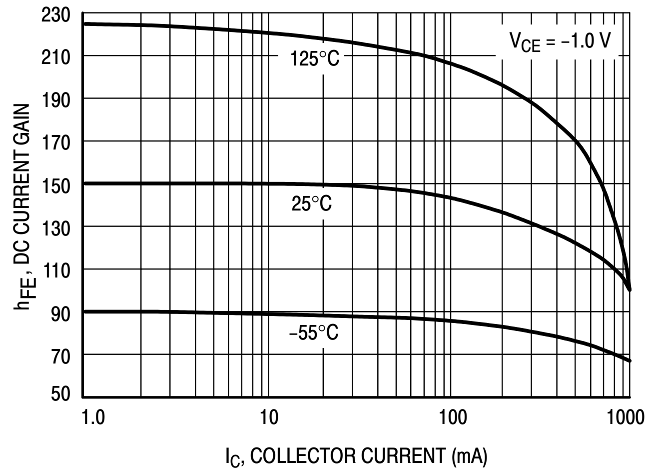


Figure 2. DC Current Gain versus Collector Current

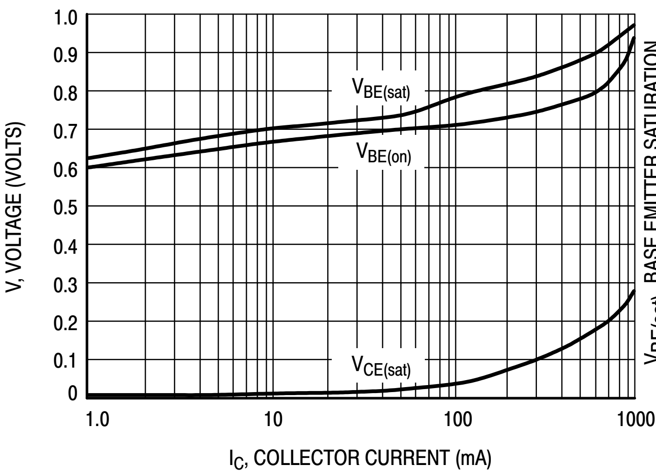


Figure 3. “On” Voltages

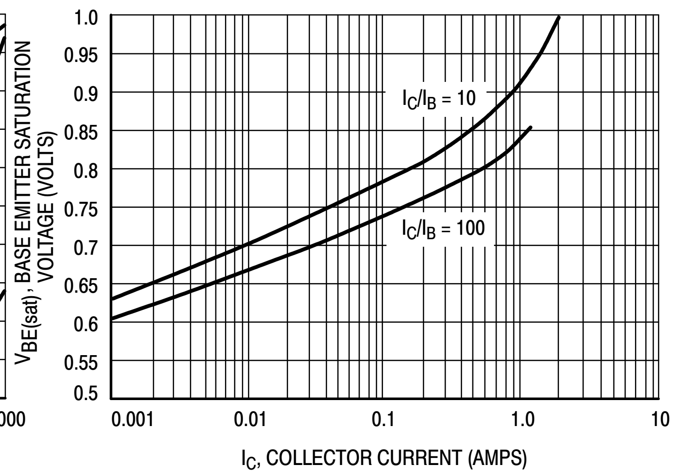


Figure 4. Base Emitter Saturation Voltage versus Collector Current

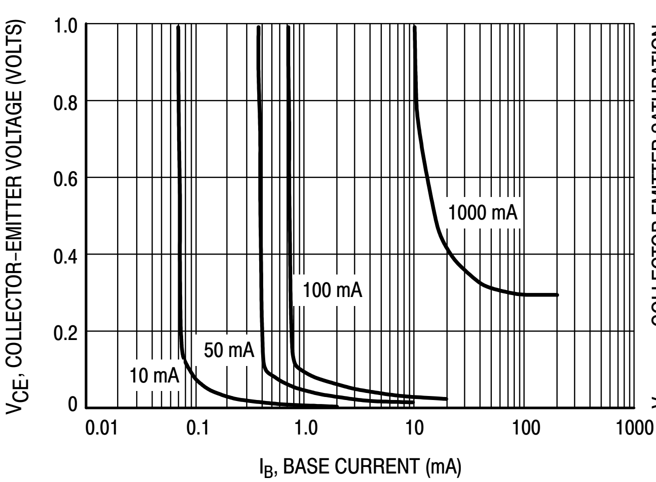


Figure 5. Collector Emitter Saturation Voltage versus Collector Current

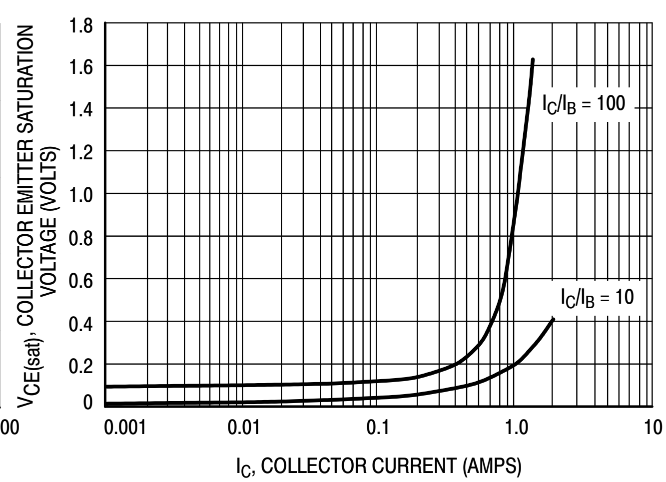


Figure 6. Collector Emitter Saturation Voltage versus Collector Current

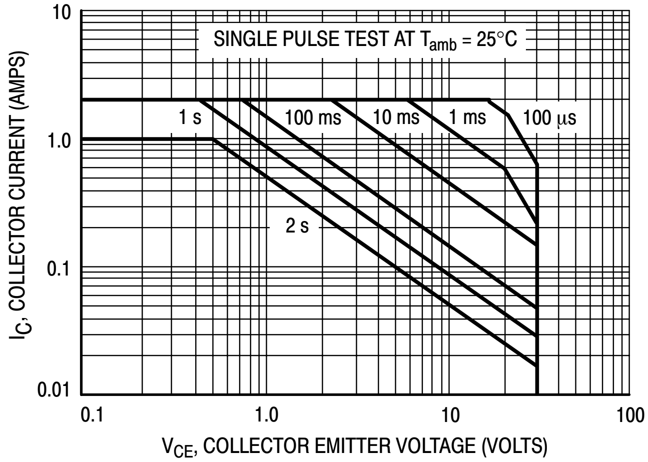


Figure 7. Safe Operating Area

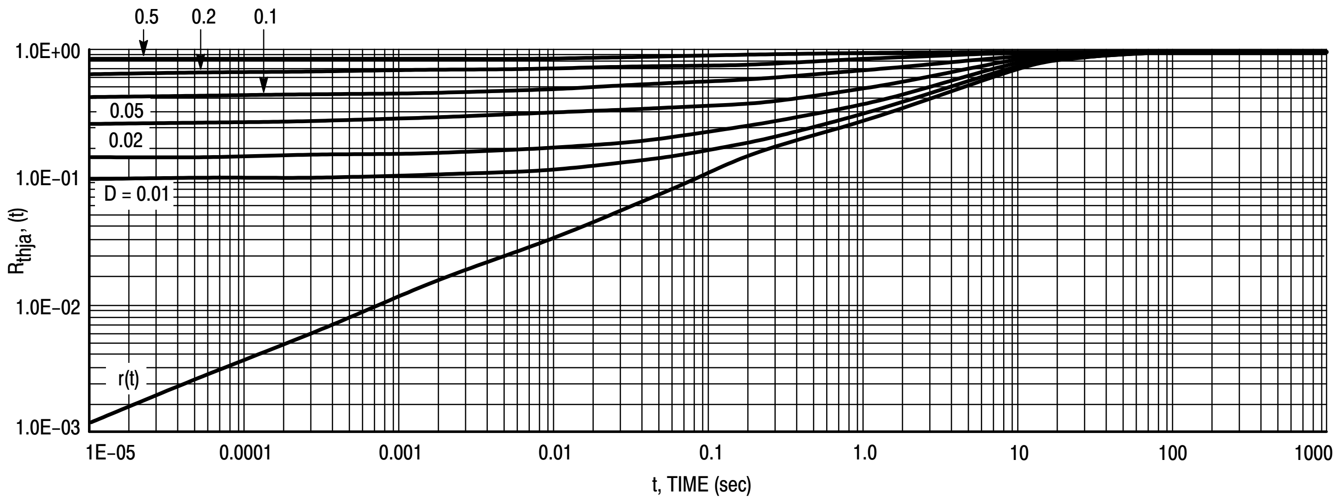
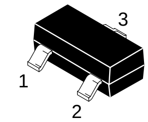


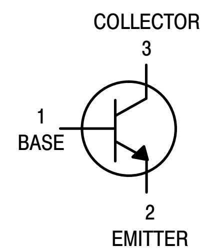
Figure 8. Normalized Thermal Response

Amplifier Transistors
NPN Silicon

MMBT6428LT1
MMBT6429LT1



CASE 318–08, STYLE 6
SOT–23 (TO–236)



MAXIMUM RATINGS

Rating	Symbol	6428LT1	6429LT1	Unit
Collector–Emitter Voltage	V_{CEO}	50	45	Vdc
Collector–Base Voltage	V_{CBO}	60	55	Vdc
Emitter–Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	200		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board[(1)] T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,[(2)] T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT6428LT1 = 1KM; MMBT6429LT1 = 1L

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0) (I_C = 1.0 mAdc, I_B = 0)	 MMBT6428 MMBT6429	$V_{(BR)CEO}$	 50 45	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0) (I_C = 0.1 mAdc, I_E = 0)	 MMBT6428 MMBT6429	$V_{(BR)CBO}$	 60 55	 — —	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc)		I_{CES}	—	0.1	µAdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	—	0.01	µAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)		I_{EBO}	—	0.01	µAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

March, 2001 – Rev. 1

Publication Order Number:
MMBT6428LT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 0.01 mAdc, V_{CE} = 5.0 Vdc)	MMBT6428		250	—	
	MMBT6429		500	—	
(I_C = 0.1 mAdc, V_{CE} = 5.0 Vdc)	MMBT6428		250	650	
	MMBT6429		500	1250	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	MMBT6428		250	—	
	MMBT6429		500	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MMBT6428		250	—	
	MMBT6429		500	—	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 0.5 mAdc)			—	0.2	
(I_C = 100 mAdc, I_B = 5.0 mAdc)			—	0.6	
Base–Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 5.0 mAdc)		$V_{BE(on)}$	0.56	0.66	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	700	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	3.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	8.0	pF

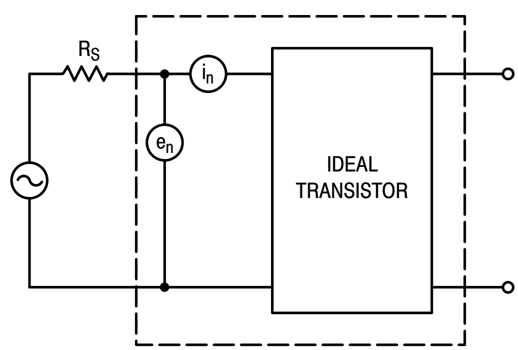


Figure 1. Transistor Noise Model

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

NOISE VOLTAGE

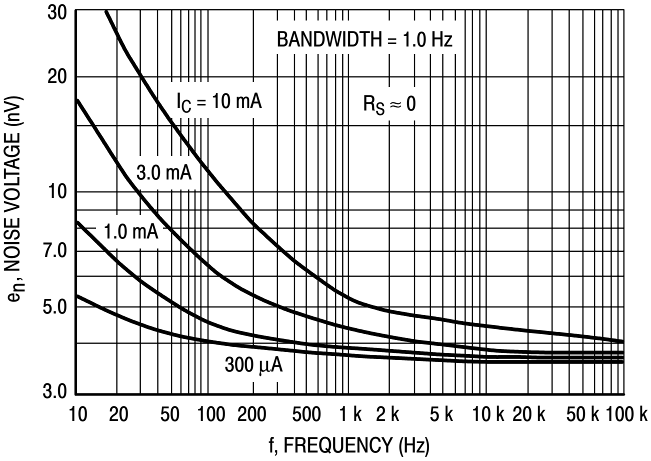


Figure 2. Effects of Frequency

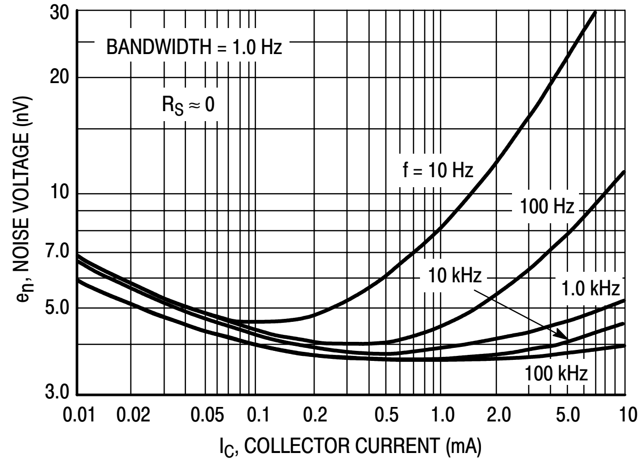


Figure 3. Effects of Collector Current

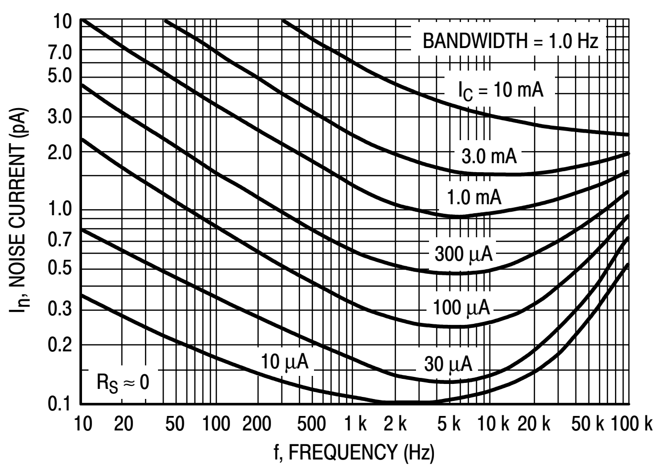


Figure 4. Noise Current

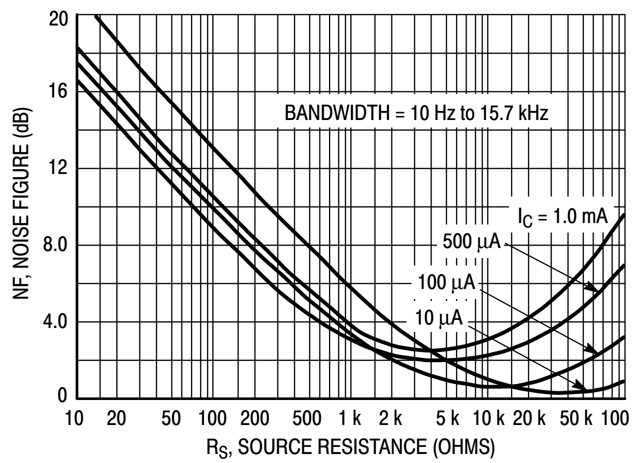


Figure 5. Wideband Noise Figure

100 Hz NOISE DATA

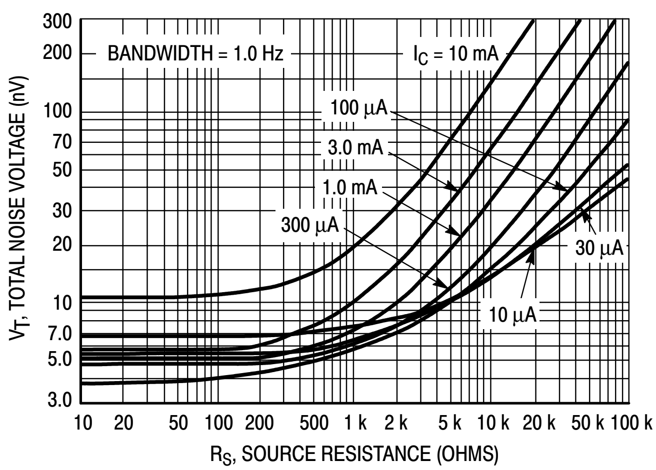


Figure 6. Total Noise Voltage

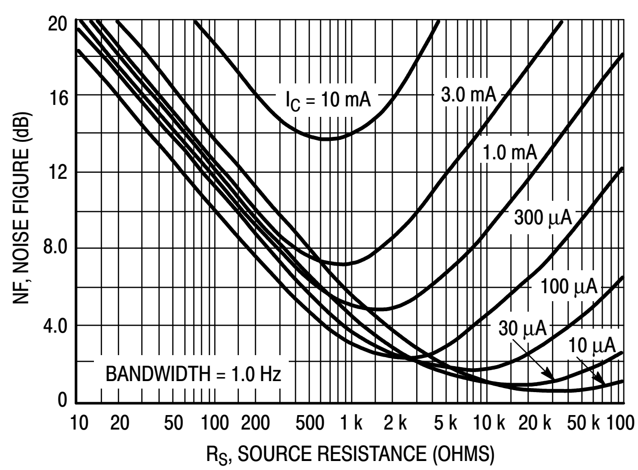


Figure 7. Noise Figure

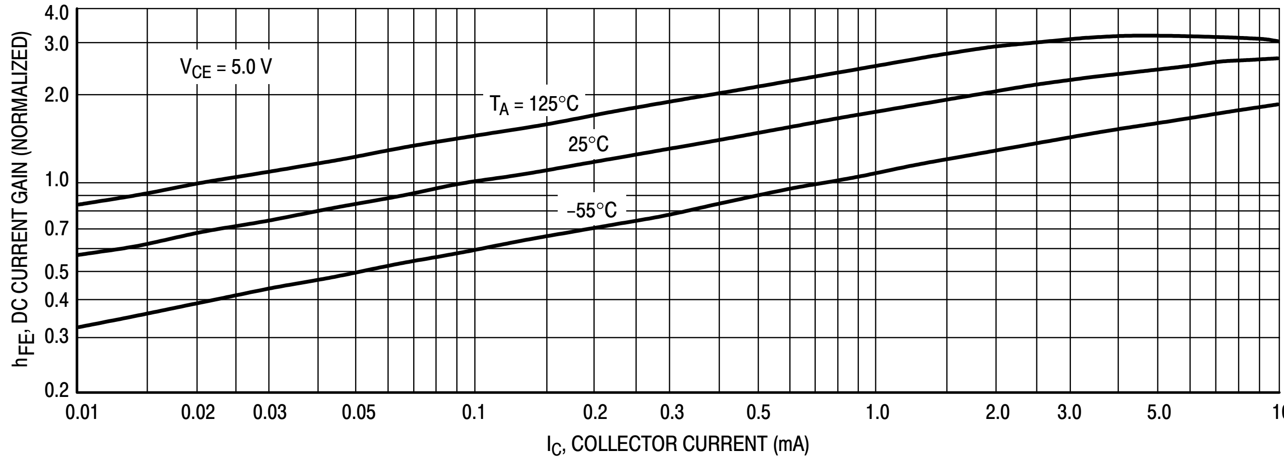


Figure 8. DC Current Gain

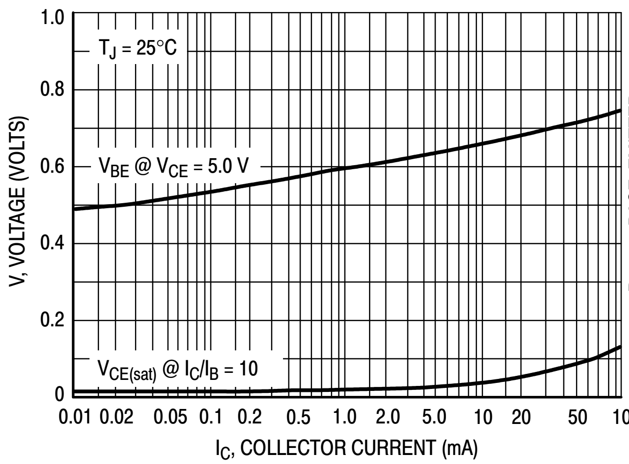


Figure 9. "On" Voltages

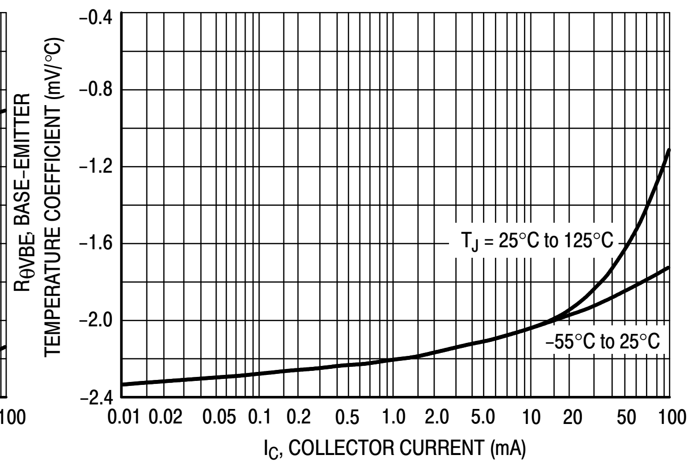


Figure 10. Temperature Coefficients

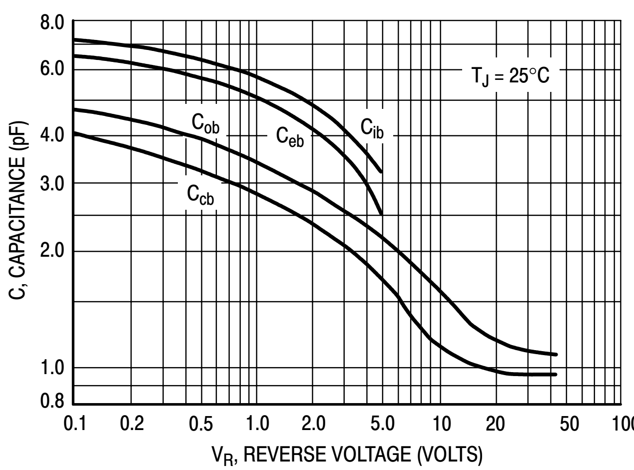


Figure 11. Capacitance

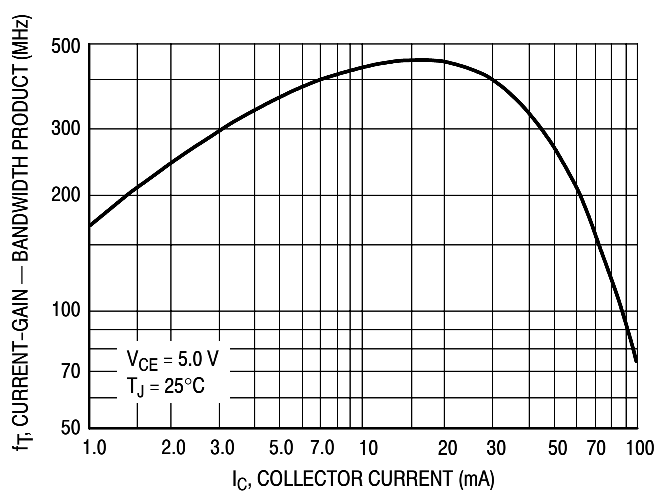
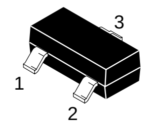


Figure 12. Current−Gain — Bandwidth Product

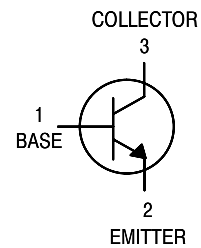
ON Semiconductor

High Voltage Transistor
NPN Silicon

MMBT6517LT1



CASE 318–08, STYLE 6
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	350	Vdc
Collector–Base Voltage	V_{CBO}	350	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Base Current	I_B	250	mAdc
Collector Current — Continuous	I_C	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board[1] T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,[2] T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT6517LT1 = 1Z

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 1.0 mAdc)	$V_{(BR)CEO}$	350	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc)	$V_{(BR)CBO}$	350	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CB} = 250 Vdc)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc)	I_{EBO}	—	50	nAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

March, 2001 – Rev. 1

Publication Order Number:
MMBT6517LT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		20	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		30	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)		30	200	
(I_C = 50 mAdc, V_{CE} = 10 Vdc)		20	200	
(I_C = 100 mAdc, V_{CE} = 10 Vdc)		15	—	
Collector–Emitter Saturation Voltage (3)	$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.30	
(I_C = 20 mAdc, I_B = 2.0 mAdc)		—	0.35	
(I_C = 30 mAdc, I_B = 3.0 mAdc)		—	0.50	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	1.0	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.75	
(I_C = 20 mAdc, I_B = 2.0 mAdc)		—	0.85	
(I_C = 30 mAdc, I_B = 3.0 mAdc)		—	0.90	
Base–Emitter On Voltage	$V_{BE(on)}$			Vdc
(I_C = 100 mAdc, V_{CE} = 10 Vdc)		—	2.0	
SMALL–SIGNAL CHARACTERISTICS				
Current Gain — Bandwidth Product	f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)		40	200	
Collector–Base Capacitance	C_{cb}			pF
(V_{CB} = 20 Vdc, f = 1.0 MHz)		—	6.0	
Emitter–Base Capacitance	C_{eb}			pF
(V_{EB} = 0.5 Vdc, f = 1.0 MHz)		—	80	

3. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

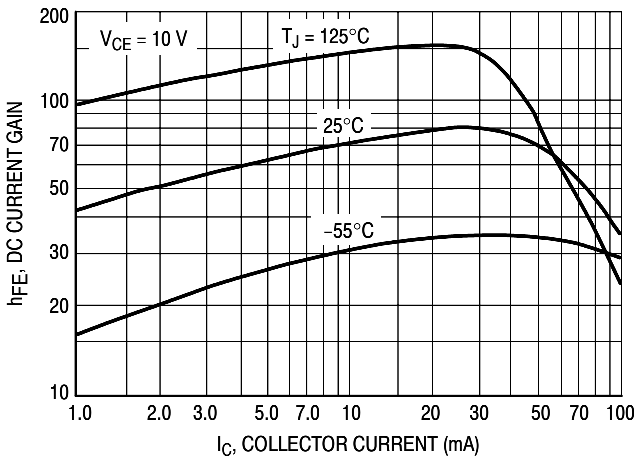


Figure 1. DC Current Gain

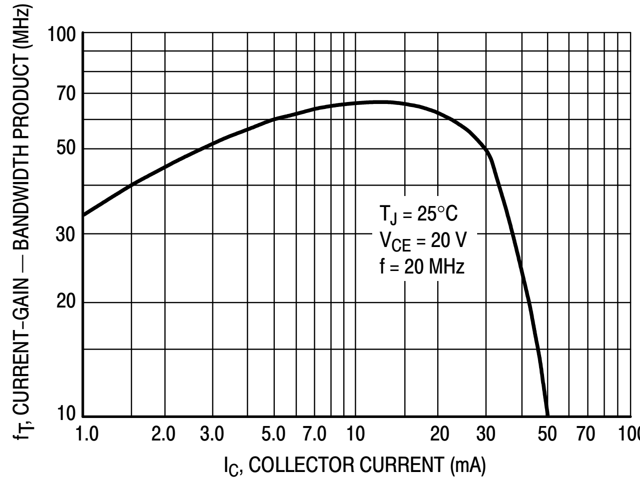


Figure 2. Current–Gain — Bandwidth Product

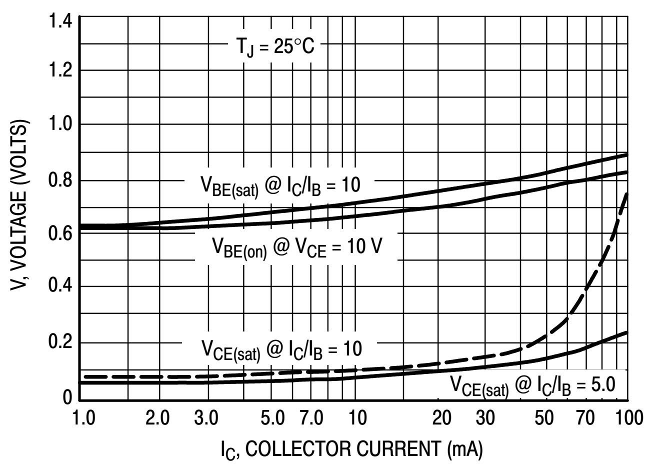


Figure 3. "On" Voltages

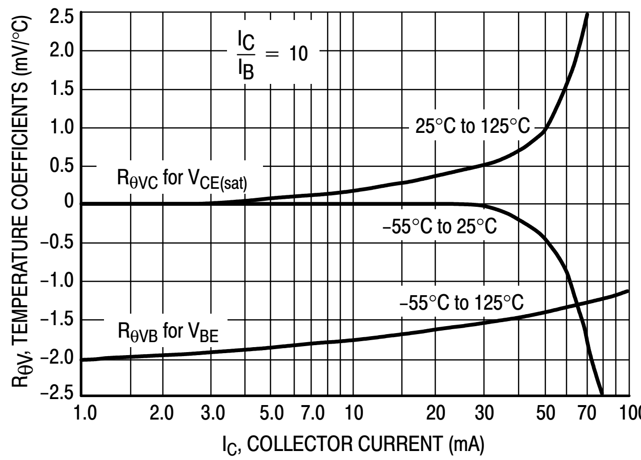


Figure 4. Temperature Coefficients

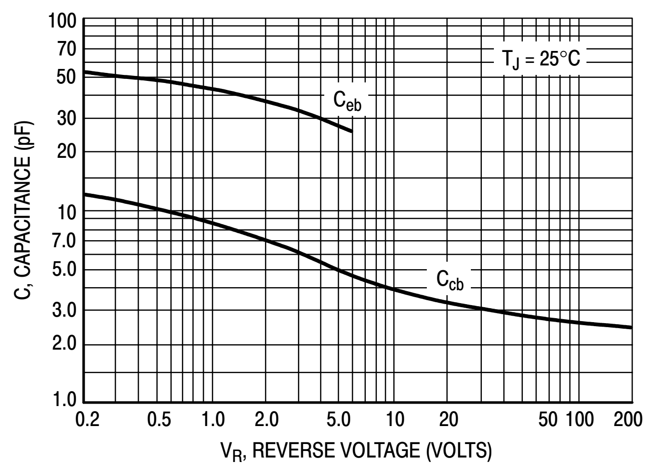


Figure 5. Capacitance

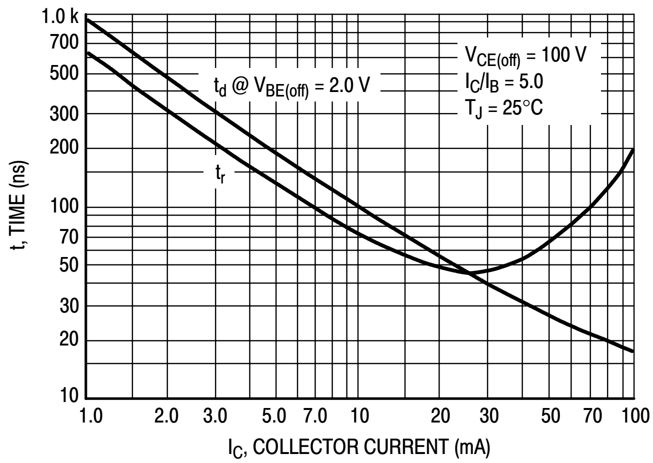


Figure 6. Turn–On Time

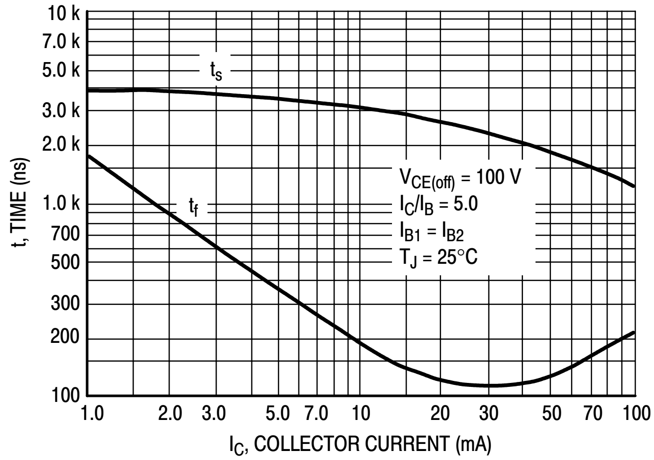


Figure 7. Turn–Off Time

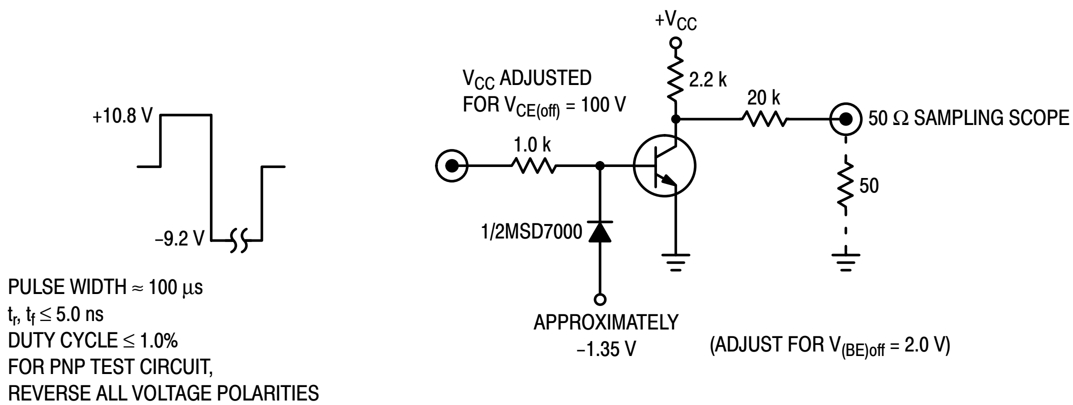


Figure 8. Switching Time Test Circuit

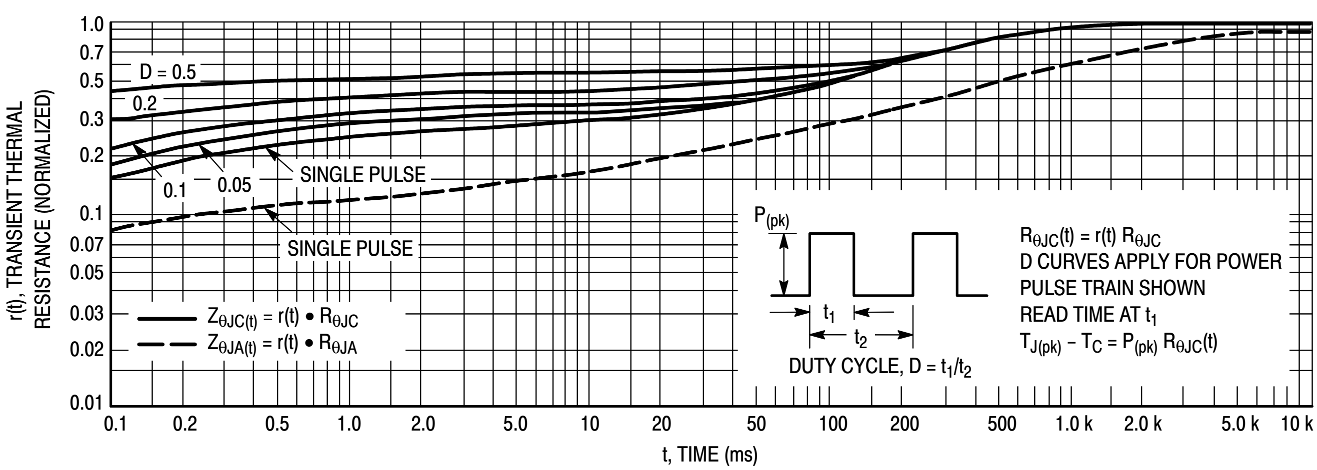
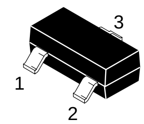


Figure 9. Thermal Response

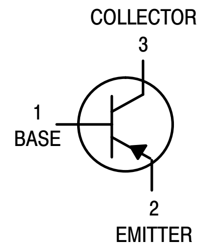
High Voltage Transistor

PNP Silicon

MMBT6520LT1



CASE 318–08, STYLE 6
SOT–23 (TO–236AF)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–350	Vdc
Collector–Base Voltage	V_{CBO}	–350	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Base Current	I_B	–250	mA
Collector Current — Continuous	I_C	–500	mAdc

DEVICE MARKING

MMBT6520LT1 = 2Z

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board (1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate, (2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –1.0 mA)	$V_{(BR)CEO}$	–350	—	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μA)	$V_{(BR)CBO}$	–350	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μA)	$V_{(BR)EBO}$	–5.0	—	Vdc
Collector Cutoff Current (V_{CB} = –250 V)	I_{CBO}	—	–50	nA
Emitter Cutoff Current (V_{EB} = –4.0 V)	I_{EBO}	—	–50	nA

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina

March, 2001 – Rev. 1
Publication Order Number:
MMBT6520LT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = –1.0 mA, V_{CE} = –10 V)		20	—	
(I_C = –10 mA, V_{CE} = –10 V)		30	—	
(I_C = –30 mA, V_{CE} = –10 V)		30	200	
(I_C = –50 mA, V_{CE} = –10 V)		20	200	
(I_C = –100 mA, V_{CE} = –10 V)		15	—	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = –10 mA, I_B = –1.0 mA)		—	–0.30	
(I_C = –20 mA, I_B = –2.0 mA)		—	–0.35	
(I_C = –30 mA, I_B = –3.0 mA)		—	–0.50	
(I_C = –50 mA, I_B = –5.0 mA)		—	–1.0	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = –10 mA, I_B = –1.0 mA)		—	–0.75	
(I_C = –20 mA, I_B = –2.0 mA)		—	–0.85	
(I_C = –30 mA, I_B = –3.0 mA)		—	–0.90	
Base–Emitter On Voltage (I_C = –100 mA, V_{CE} = –10 V)	$V_{BE(on)}$	—	–2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = –10 mA, V_{CE} = –20 V, f = 20 MHz)	f_T	40	200	MHz
Collector–Base Capacitance (V_{CB}= –20 V, f = 1.0 MHz)	C_{cb}	—	6.0	pF
Emitter–Base Capacitance (V_{EB}= –0.5 V, f = 1.0 MHz)	C_{eb}	—	100	pF

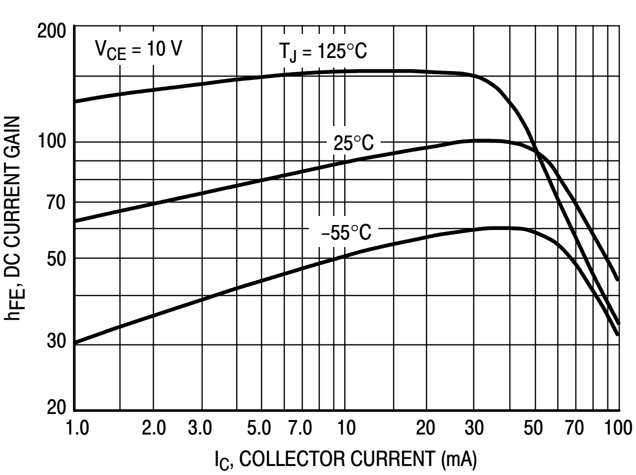


Figure 1. DC Current Gain

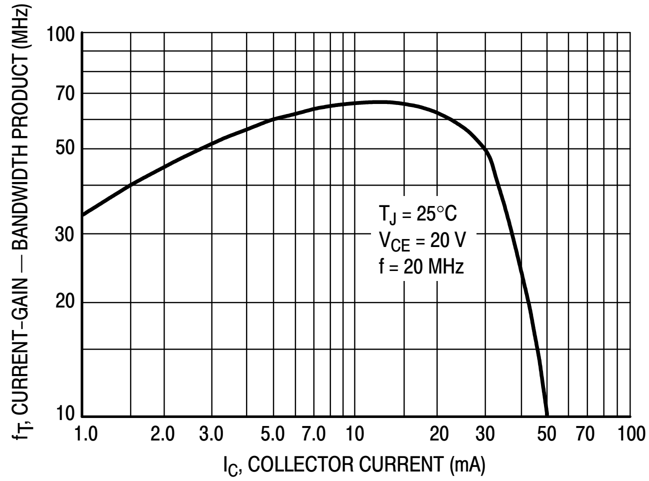


Figure 2. Current–Gain — Bandwidth Product

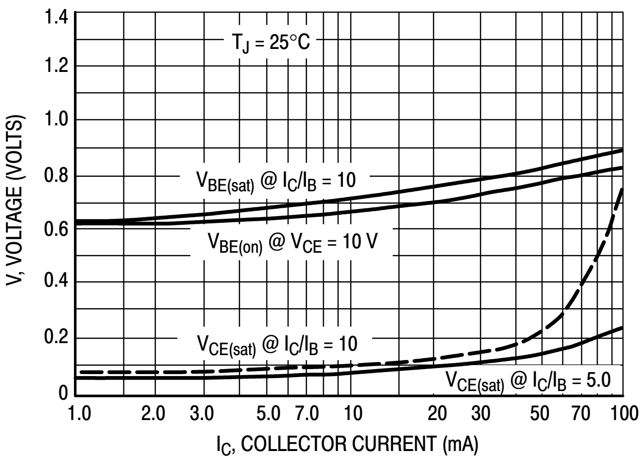


Figure 3. “On” Voltages

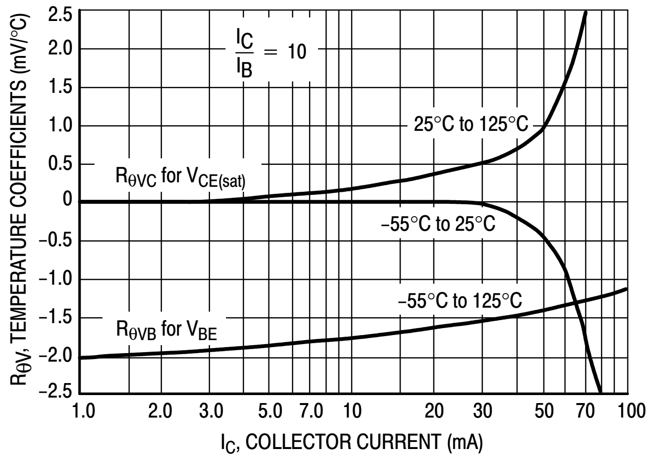


Figure 4. Temperature Coefficients

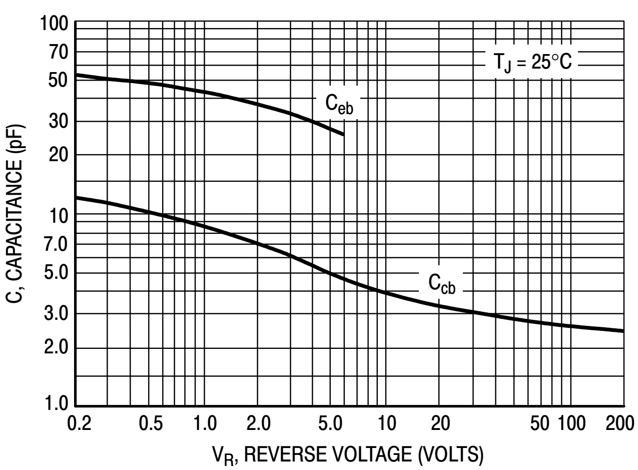


Figure 5. Capacitance

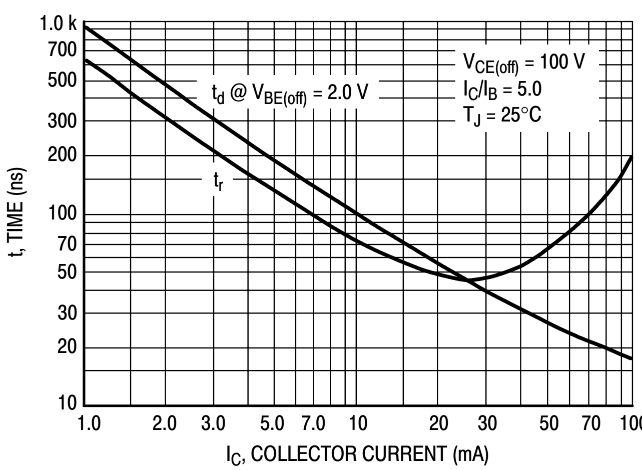


Figure 6. Turn–On Time

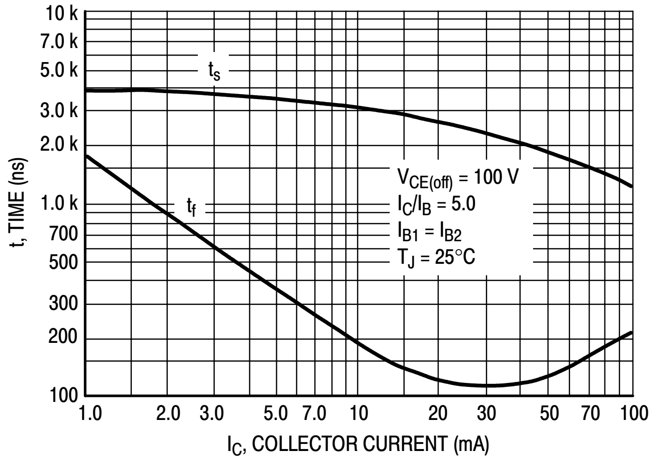


Figure 7. Turn–Off Time

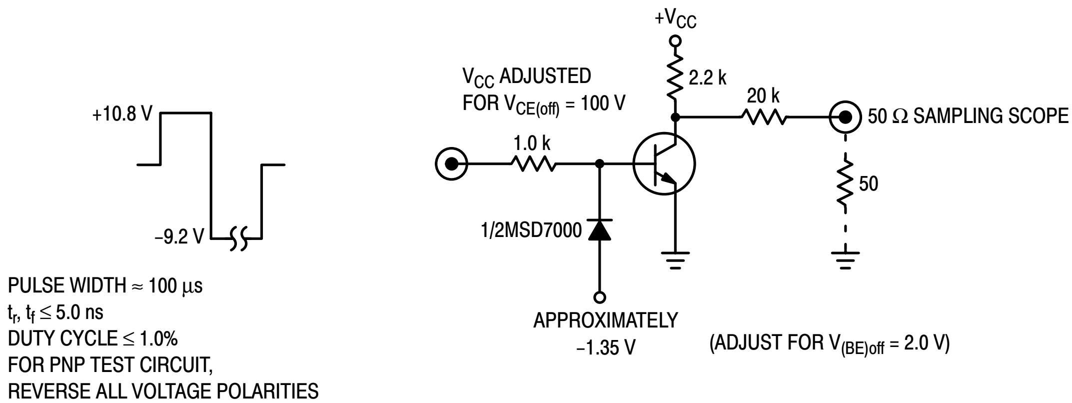


Figure 8. Switching Time Test Circuit

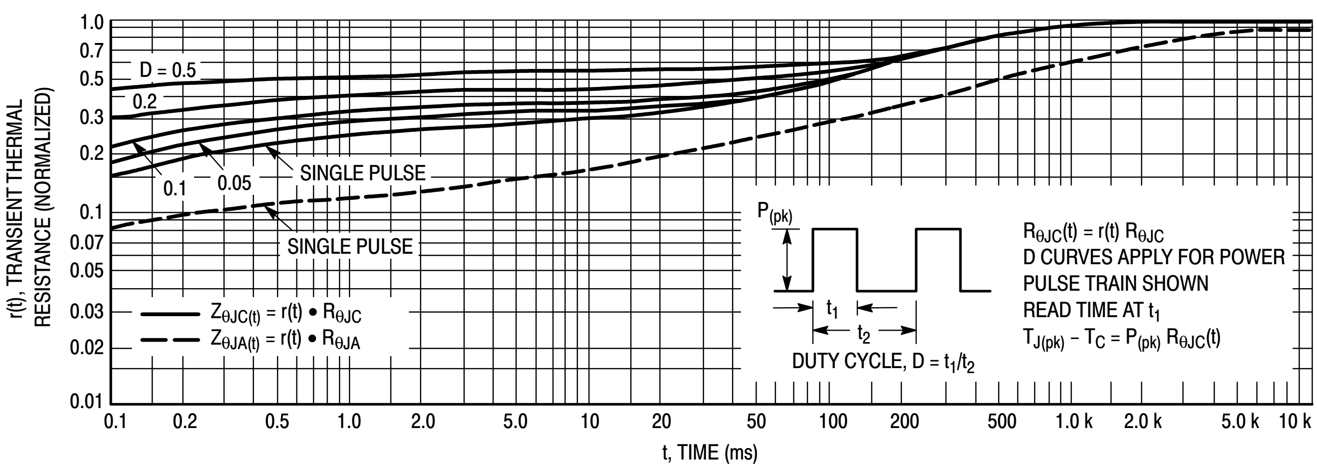


Figure 9. Thermal Response

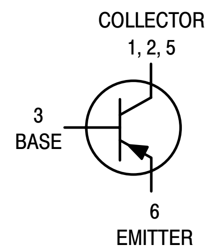
MMBT6589T1

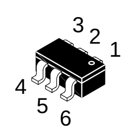
High Current Surface Mount PNP Silicon Switching Transistor for Load Management in Portable Applications

ON Semiconductor

http://onsemi.com

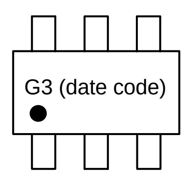
30 VOLTS
2.0 AMPS
PNP TRANSISTOR





CASE 318G
TSOP–6
STYLE 7

DEVICE MARKING



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Collector-Emitter Voltage	V_{CEO}	–30	Vdc
Collector-Base Voltage	V_{CBO}	–50	Vdc
Emitter-Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Continuous	I_C	–1.0	Adc
Collector Current – Peak	I_{CM}	–2.0	A
Electrostatic Discharge	ESD	HBM Class 3 MM Class C	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (1)	540 4.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (1)	230	°C/W
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (2)	925 7.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (2)	135	°C/W
Total Device Dissipation (Single Pulse < 10 sec.)	$P_{Dsingle}$ (2)(3)	1.3	W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) FR–4 @ Minimum Pad
(2) FR–4 @ 1.0 X 1.0 inch Pad
(3) ref: Figure 8

ORDERING INFORMATION

Device	Package	Shipping
MMBT6589T1	TSOP–6	3000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–30	–	Vdc
Collector–Base Breakdown Voltage (I_C = –0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	–50	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	–	Vdc
Collector Cutoff Current (V_{CB} = –30 Vdc, I_E = 0)	I_{CBO}	–	–0.1	μAdc
Collector–Emitter Cutoff Current (V_{CES} = –30 Vdc)	I_{CES}	–	–0.1	μAdc
Emitter Cutoff Current (V_{EB} = –4.0 Vdc)	I_{EBO}	–	–0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain (1) (Figure 1)	h_{FE}			
(I_C = –1.0 mA, V_{CE} = –2.0 V)		100	–	
(I_C = –500 mA, V_{CE} = –2.0 V)		100	300	
(I_C = –1.0 A, V_{CE} = –2.0 V)		80	–	
(I_C = 2.0 A, V_{CE} = –2.0 V)		40	–	
Collector–Emitter Saturation Voltage (1) (Figure 3)	$V_{CE(sat)}$			V
(I_C = –0.5 A, I_B = –0.05 A)		–	–0.25	
(I_C = –1.0 A, I_B = 0.1 A)		–	–0.30	
(I_C = –2.0 A, I_B = –0.2 A)		–	–0.65	
Base–Emitter Saturation Voltage (1) (Figure 2) (I_C = –1.0 A, I_B = –0.1 A)	$V_{BE(sat)}$	–	–1.2	V
Base–Emitter Turn–on Voltage (1) (I_C = –1.0 A, V_{CE} = –2.0 V)	$V_{BE(on)}$	–	–1.1	V
Cutoff Frequency (I_C = –100 mA, V_{CE} = –5.0 V, f = 100 MHz)	f_T	100	–	MHz
Output Capacitance (V_{CB} = –5.0 V, f = 1.0 MHz)	Cobo	–	20	pF

1. Pulsed Condition: Pulse Width = 300 μsec, Duty Cycle ≤ 2%

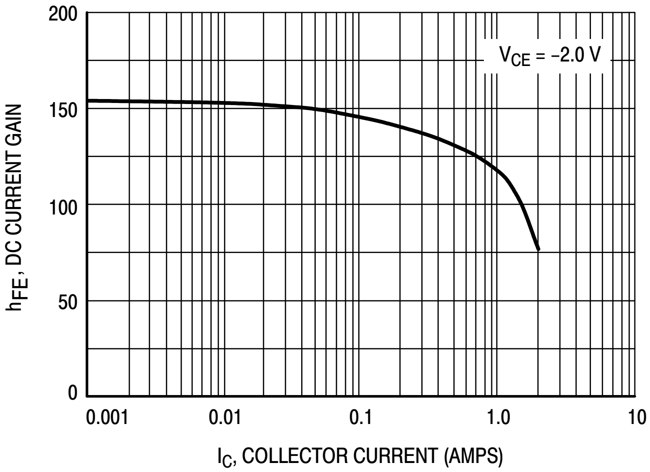


Figure 1. DC Current Gain versus Collector Current

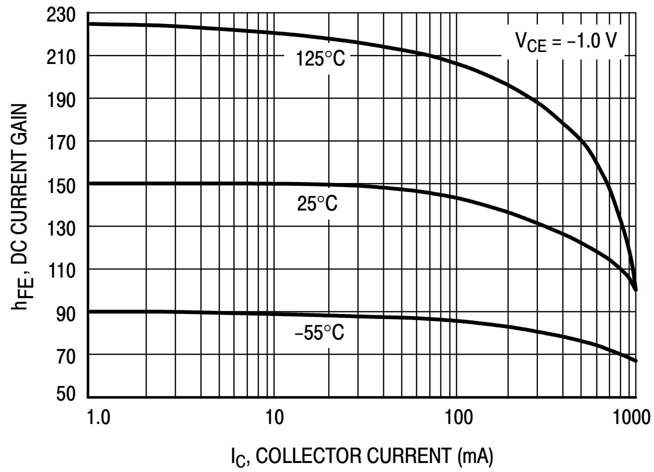


Figure 2. DC Current Gain versus Collector Current

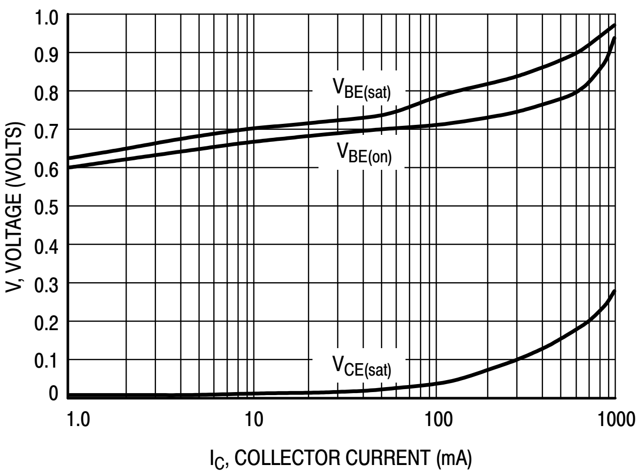


Figure 3. “On” Voltages

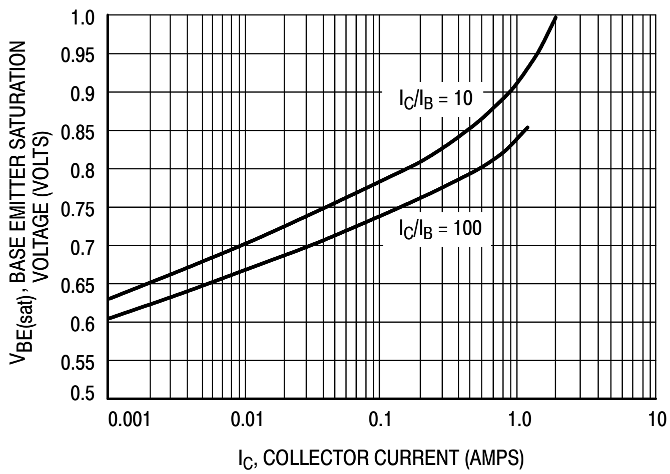


Figure 4. Base Emitter Saturation Voltage versus Collector Current

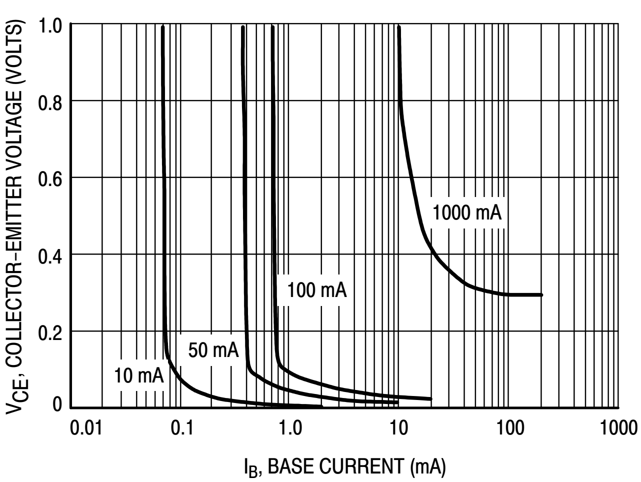


Figure 5. Collector Emitter Saturation Voltage versus Collector Current

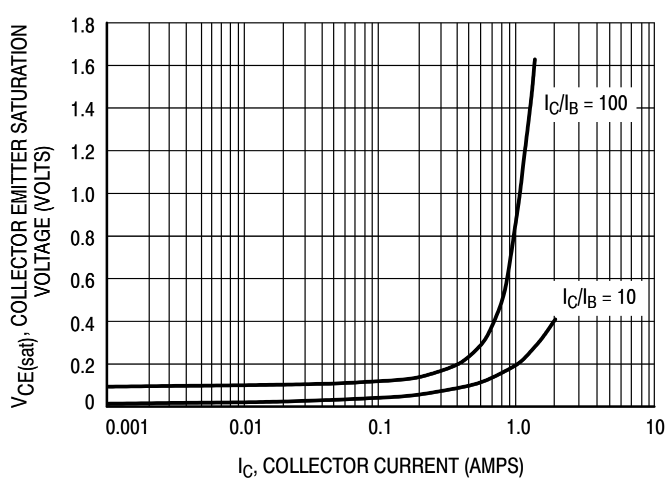


Figure 6. Collector Emitter Saturation Voltage versus Collector Current

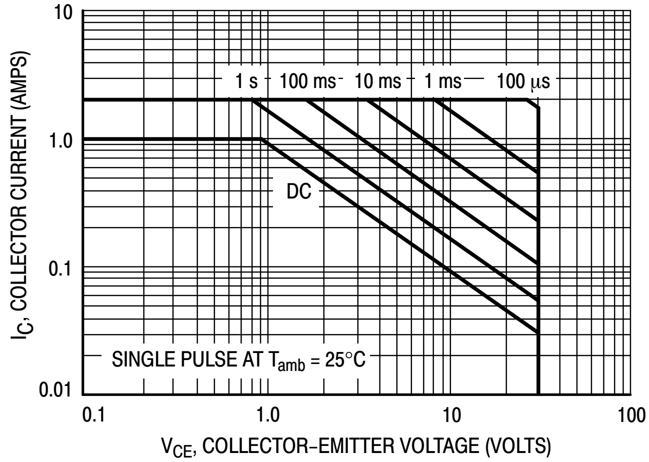


Figure 7. Safe Operating Area

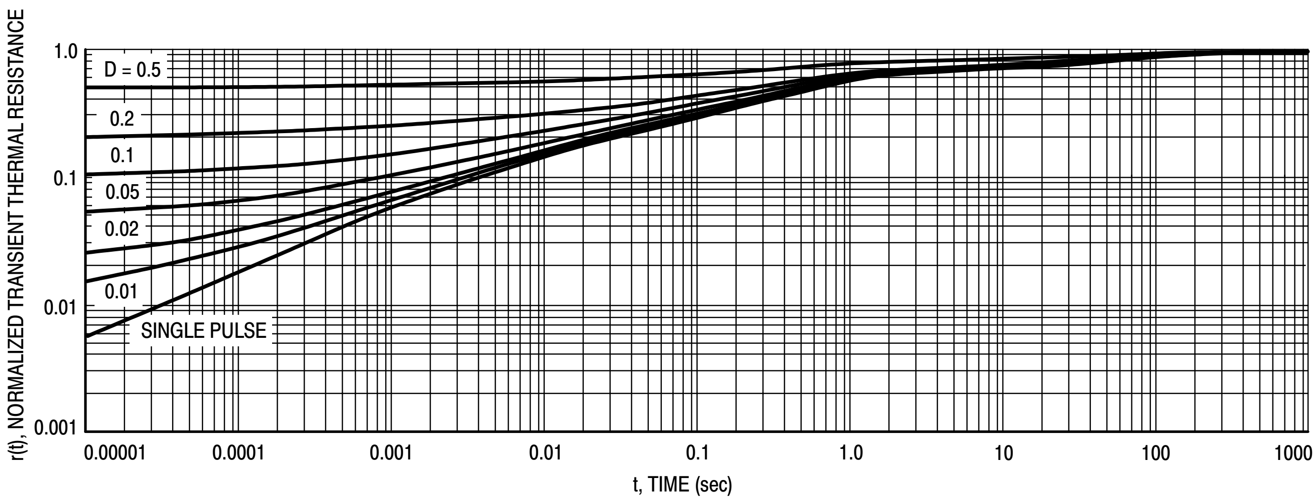
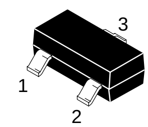


Figure 8. Normalized Thermal Response

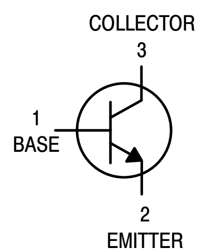
VHF/UHF Transistor

NPN Silicon

MMBT918LT1



CASE 318–08, STYLE 6
SOT–23 (TO–236)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	15	Vdc
Collector–Base Voltage	V_{CBO}	30	Vdc
Emitter–Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board,(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBT918LT1 = M3B

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 3.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	Vdc
Collector–Base Breakdown Voltage (I_C = 1.0 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	20	—	—
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	600	—	MHz
Output Capacitance	C_{obo}			pF
(V_{CB} = 0 Vdc, I_E = 0, f = 1.0 MHz)		—	3.0	
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		—	1.7	
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	2.0	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 Ω, f = 60 MHz) (Figure 1)	NF	—	6.0	dB
Power Output (I_C = 8.0 mAdc, V_{CB} = 15 Vdc, f = 500 MHz)	P_{out}	30	—	mW
Common–Emitter Amplifier Power Gain (I_C = 6.0 mAdc, V_{CB} = 12 Vdc, f = 200 MHz)	G_{pe}	11	—	dB

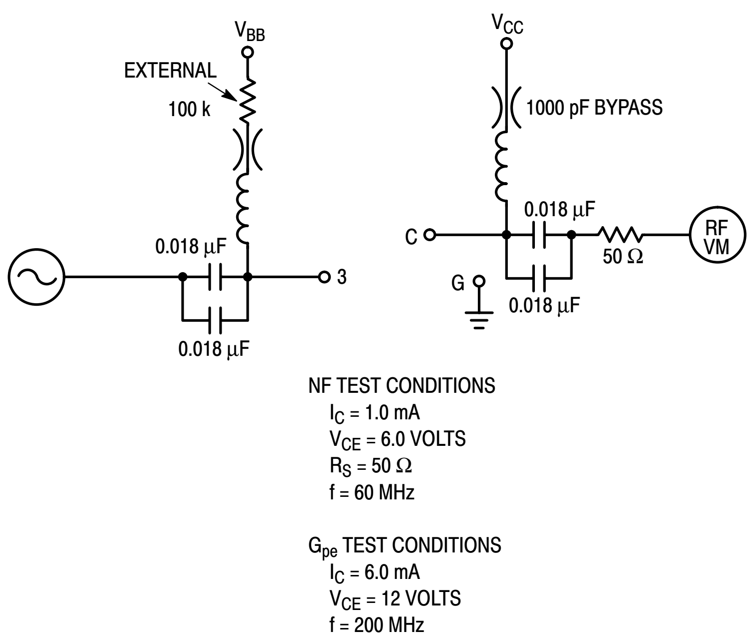
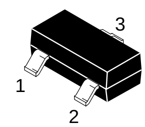


Figure 1. NF, G_{pe} Measurement Circuit 20–200

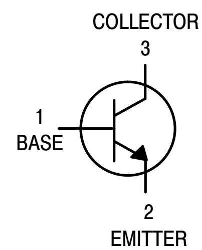
MMBTA05LT1
MMBTA06LT1

MMBTA06LT1 us a Preferred Device

Driver Transistors
NPN Silicon



CASE 318–08, STYLE 6
SOT–23 (TO–236)



MAXIMUM RATINGS

Rating	Symbol	MMBTA05	MMBTA06	Unit
Collector–Emitter Voltage	V_{CEO}	60	80	Vdc
Collector–Base Voltage	V_{CBO}	60	80	Vdc
Emitter–Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	500		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBTA05LT1 = 1H; MMBTA06LT1 = 1GM

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (3) (I_C = 1.0 mAdc, I_B = 0)	 MMBTA05 MMBTA06	$V_{(BR)CEO}$	 60 80	 — —	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, I_B = 0)		I_{CES}	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 80 Vdc, I_E = 0)	 MMBTA05 MMBTA06	I_{CBO}	 — —	 0.1 0.1	μAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.
3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		100	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		100	—	
Collector–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	—	0.25	Vdc
Base–Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	$V_{BE(on)}$	—	1.2	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product(4) (I_C = 10 mA, V_{CE} = 2.0 V, f = 100 MHz)	f_T	100	—	MHz

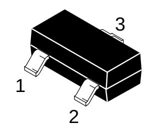
4. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

MMBTA13LT1
MMBTA14LT1

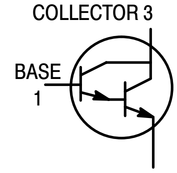
MMBTA14LT1 is a Preferred Device

Darlington Amplifier Transistors

NPN Silicon



CASE 318–08, STYLE 6
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CES}	30	Vdc
Collector–Base Voltage	V_{CBO}	30	Vdc
Emitter–Base Voltage	V_{EBO}	10	Vdc
Collector Current — Continuous	I_C	300	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board[1] $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,[2] $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBTA13LT1 = 1M; MMBTA14LT1 = 1N

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage ($I_C = 100\ \mu Adc$, $V_{BE} = 0$)	$V_{(BR)CES}$	30	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{EB} = 10$ Vdc, $I_C = 0$)	I_{EBO}	—	100	nAdc

1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1

Publication Order Number:
MMBTA13LT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS[3]					
DC Current Gain		h_{FE}			—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MMBTA13		5000	—	
	MMBTA14		10,000	—	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	MMBTA13		10,000	—	
	MMBTA14		20,000	—	
Collector–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 0.1 mAdc)		$V_{CE(sat)}$	—	1.5	Vdc
Base–Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		V_{BE}	—	2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product[4] (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	125	—	MHz

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
4. $f_T = |h_{fe}| \bullet f_{test}$.

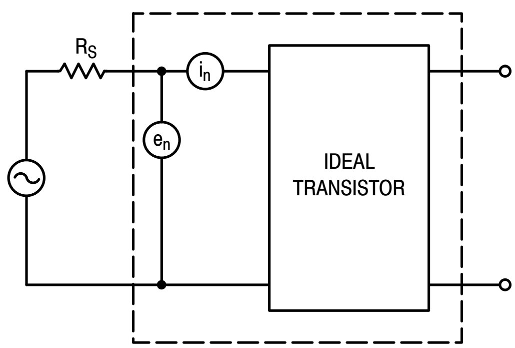


Figure 1. Transistor Noise Model

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

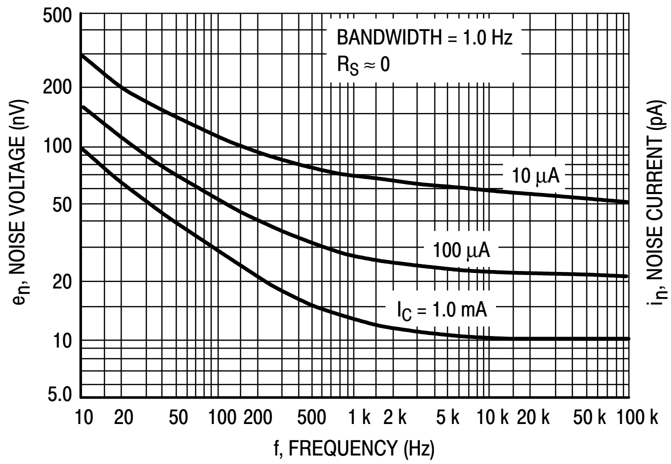


Figure 2. Noise Voltage

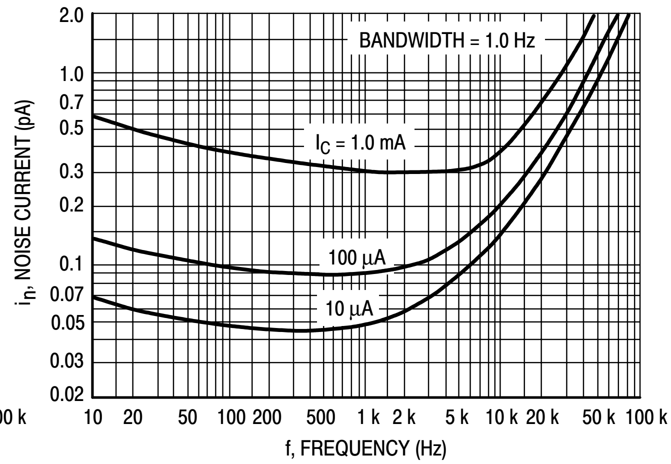


Figure 3. Noise Current

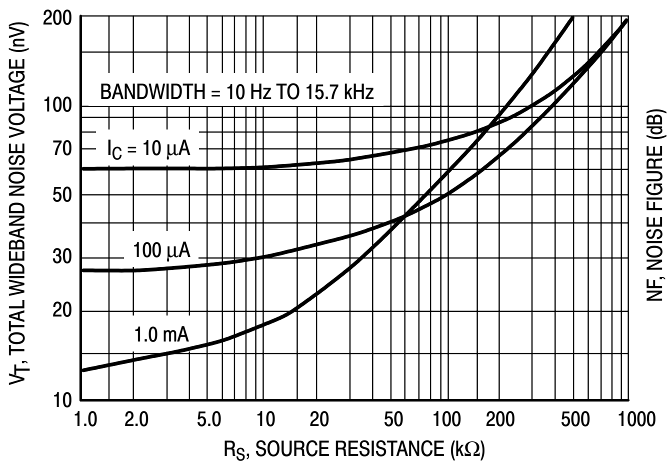


Figure 4. Total Wideband Noise Voltage

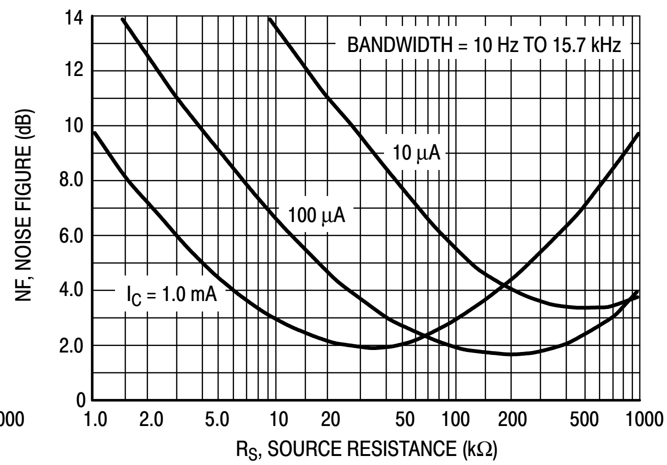


Figure 5. Wideband Noise Figure

SMALL–SIGNAL CHARACTERISTICS

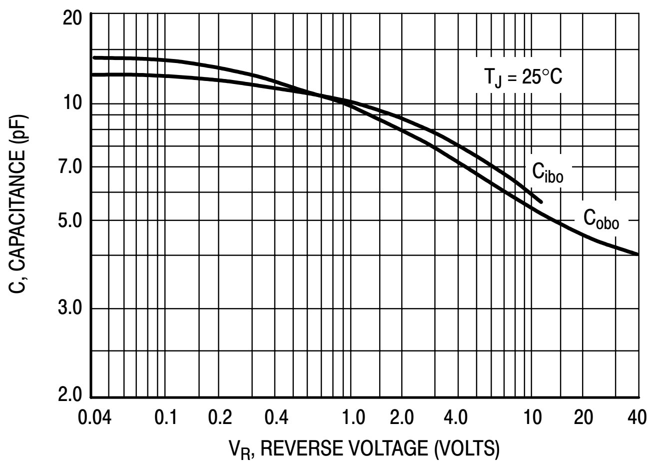


Figure 6. Capacitance

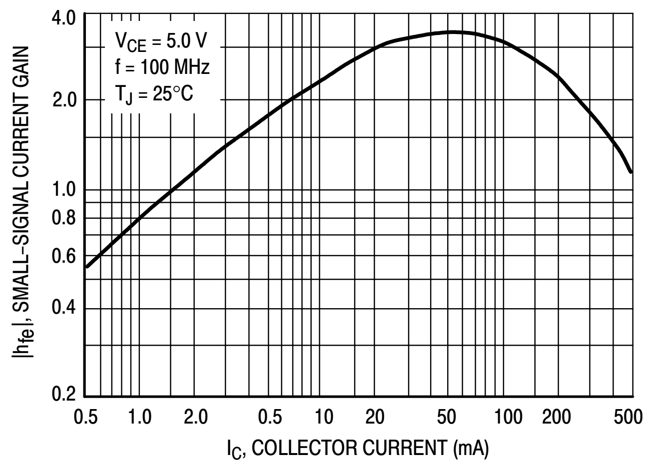


Figure 7. High Frequency Current Gain

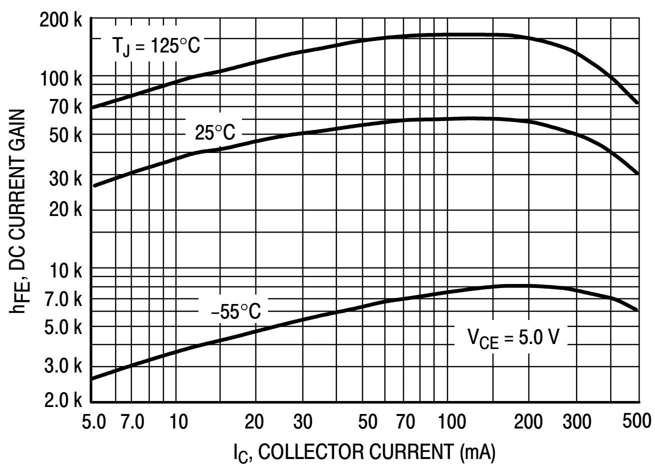


Figure 8. DC Current Gain

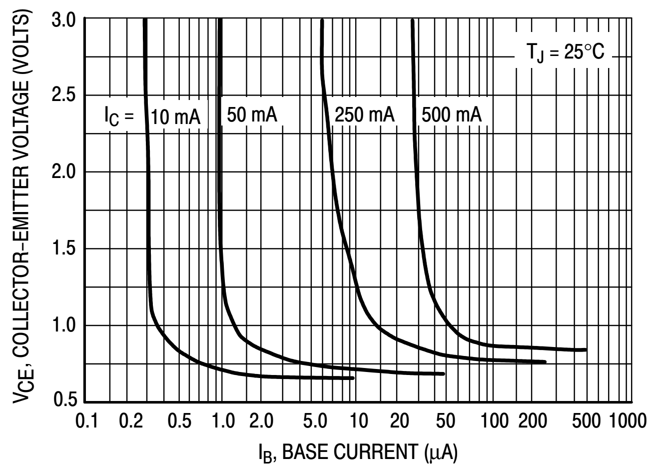


Figure 9. Collector Saturation Region

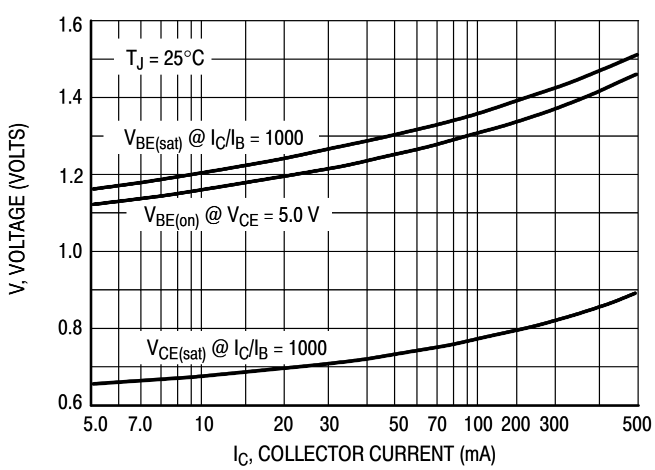


Figure 10. “On” Voltages

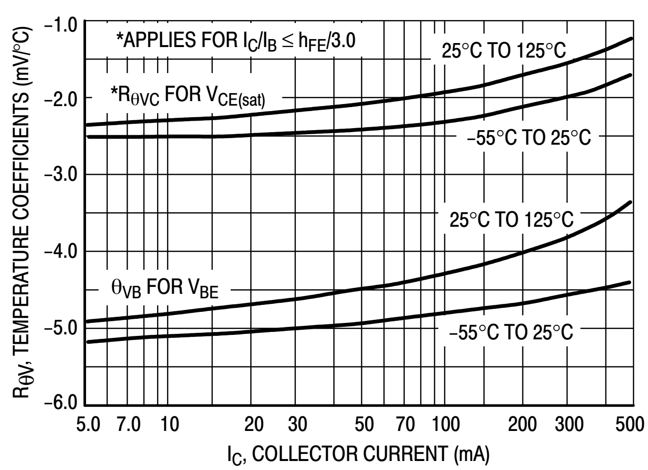


Figure 11. Temperature Coefficients

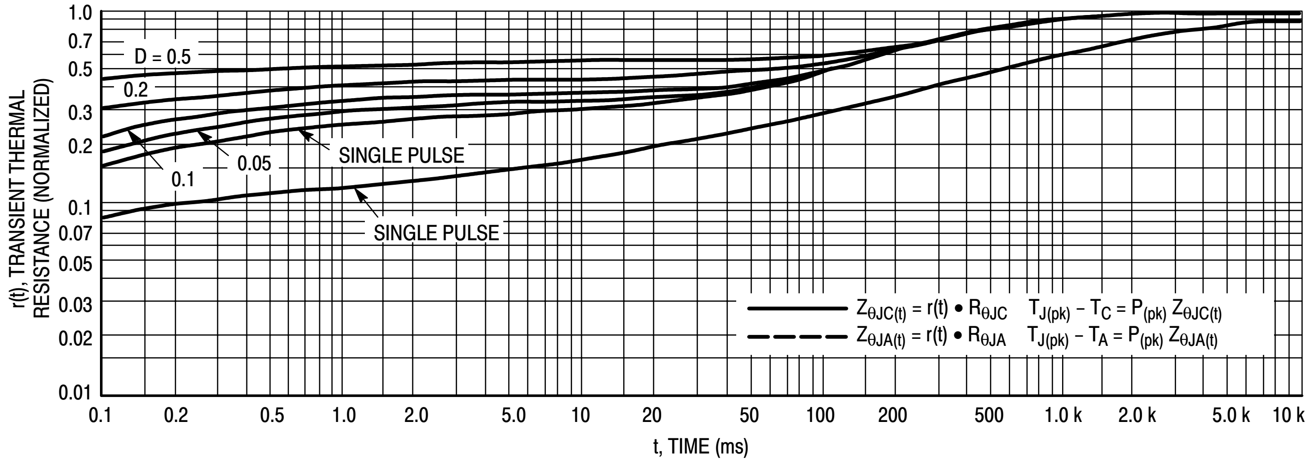


Figure 12. Thermal Response

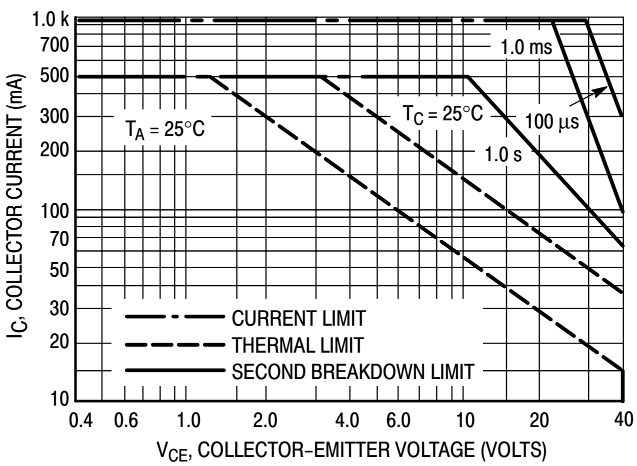
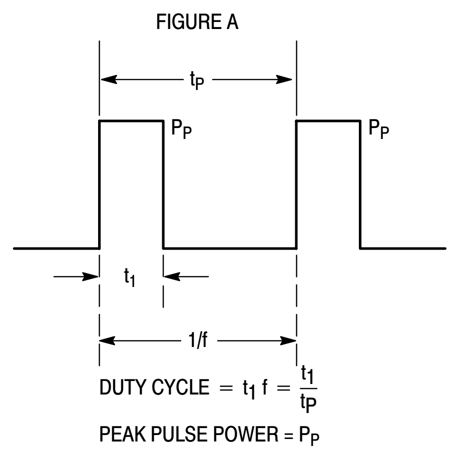


Figure 13. Active Region Safe Operating Area

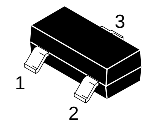


Design Note: Use of Transient Thermal Resistance Data

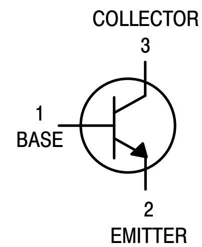
High Voltage Transistor
NPN Silicon

MMBTA42LT1

ON Semiconductor Preferred Device



CASE 318–08, STYLE 6
SOT–23 (TO–236)



MAXIMUM RATINGS

Rating	Symbol	MMBTA43	Unit
Collector–Emitter Voltage	V_{CEO}	200	Vdc
Collector–Base Voltage	V_{CBO}	200	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	500	mAdc

DEVICE MARKING

MMBTA42LT1 = 1D; MMBTA43LT1 = M1E

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board,(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(3) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	300	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	300	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CB} = 200 Vdc, I_E = 0)	I_{CBO}	—	0.1	μAdc
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	μAdc

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.
3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

June, 2001 – Rev. 3
Publication Order Number:
MMBTA42LT1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS(3)				
DC Current Gain	h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		25	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		40	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)		40	—	
Collector–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)2	$V_{CE(sat)}$	—	0.5	Vdc
Base–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{BE(sat)}$	—	0.9	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	50	—	MHz
Collector–Base Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	3.0	pF

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

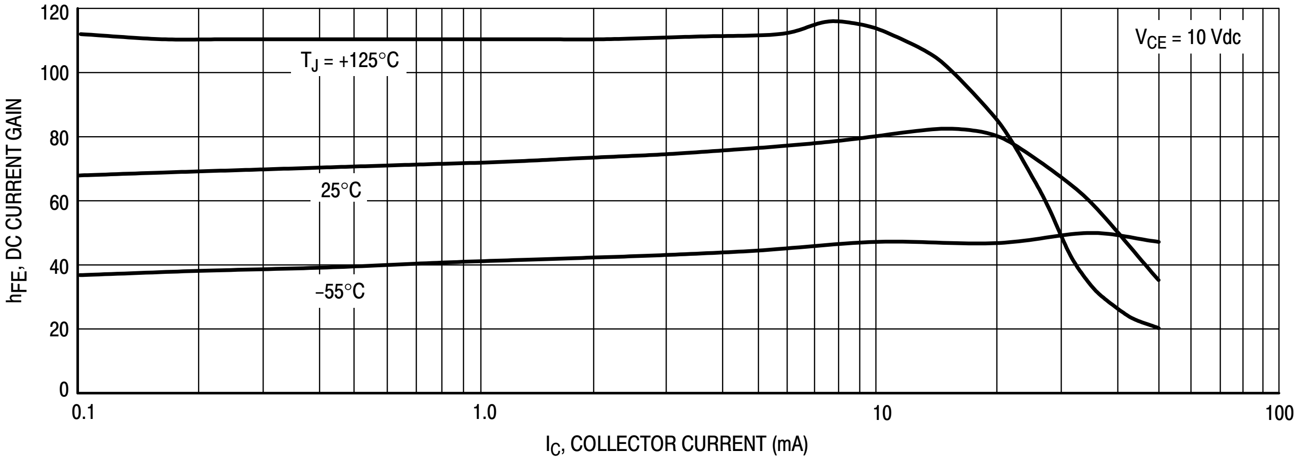


Figure 1. DC Current Gain

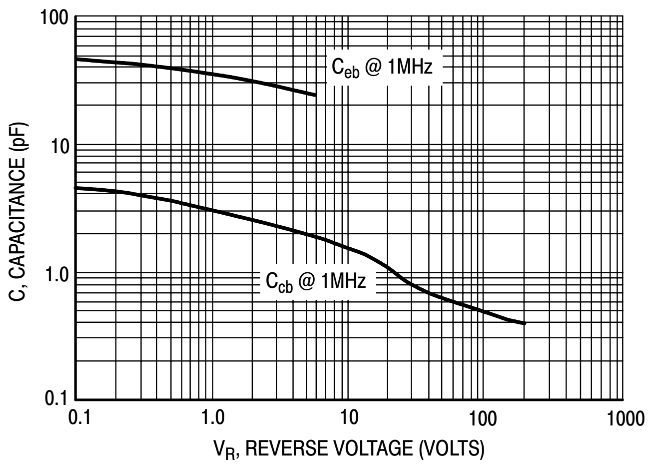


Figure 2. Capacitance

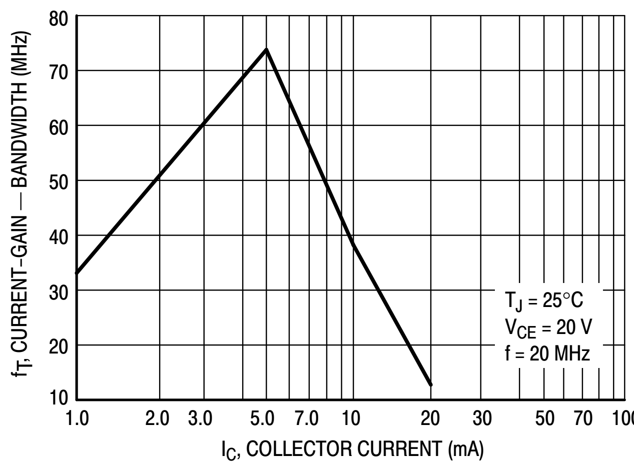


Figure 3. Current–Gain – Bandwidth

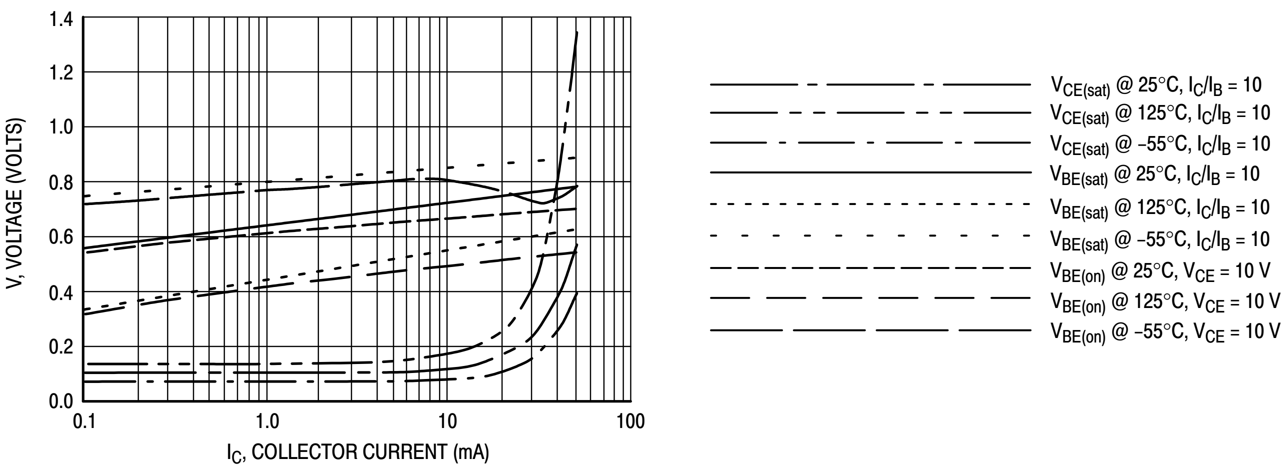


Figure 4. “ON” Voltages

Driver Transistors

PNP Silicon

MMBTA55LT1
MMBTA56LT1

MMBTA56LT1 is a Preferred Device

MAXIMUM RATINGS

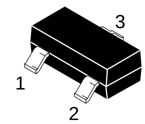
Rating	Symbol	MMBTA55	MMBTA56	Unit
Collector–Emitter Voltage	V_{CEO}	–60	–80	Vdc
Collector–Base Voltage	V_{CBO}	–60	–80	Vdc
Emitter–Base Voltage	V_{EBO}	–4.0		Vdc
Collector Current – Continuous	I_C	–500		mAdc

DEVICE MARKING

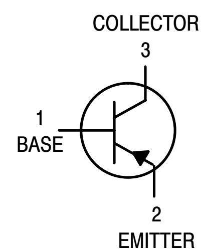
MMBTA55LT1 = 2H; MMBTA56LT1 = 2GM

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board,(1) $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C



CASE 318–08, STYLE 6
SOT–23 (TO–236)



ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(3) ($I_C = –1.0$ mAdc, $I_B = 0$)	MMBTA55 MMBTA56	$V_{(BR)CEO}$	–60 –80	– –	Vdc
Emitter–Base Breakdown Voltage ($I_E = –100$ µAdc, $I_C = 0$)		$V_{(BR)EBO}$	–4.0	–	Vdc
Collector Cutoff Current ($V_{CE} = –60$ Vdc, $I_B = 0$)		I_{CES}	–	–0.1	µAdc
Collector Cutoff Current ($V_{CB} = –60$ Vdc, $I_E = 0$) ($V_{CB} = –80$ Vdc, $I_E = 0$)	MMBTA55 MMBTA56	I_{CBO}	– –	–0.1 –0.1	µAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = –10$ mAdc, $V_{CE} = –1.0$ Vdc) ($I_C = –100$ mAdc, $V_{CE} = –1.0$ Vdc)		h_{FE}	100 100	– –	–
Collector–Emitter Saturation Voltage ($I_C = –100$ mAdc, $I_B = –10$ mAdc)		$V_{CE(sat)}$	–	–0.25	Vdc
Base–Emitter On Voltage ($I_C = –100$ mAdc, $V_{CE} = –1.0$ Vdc)		$V_{BE(on)}$	–	–1.2	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product(4) ($I_C = –100$ mAdc, $V_{CE} = –1.0$ Vdc, f = 100 MHz)		f_T	50	–	MHz

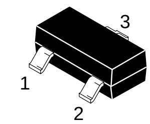
1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.
3. Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.
4. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

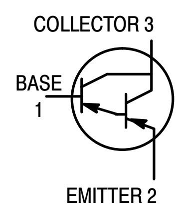
Darlington Transistors
PNP Silicon

MMBTA63LT1
MMBTA64LT1

MMBTA64LT1 is a Preferred Device



CASE 318–08, STYLE 6
SOT–23 (TO–236AF)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CES}	–30	Vdc
Collector–Base Voltage	V_{CBO}	–30	Vdc
Emitter–Base Voltage	V_{EBO}	–10	Vdc
Collector Current – Continuous	I_C	–500	mAdc

DEVICE MARKING

MMBTA63LT1 = 2U; MMBTA64LT1 = 2V

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board,(1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = –100 µAdc)		$V_{(BR)CEO}$	–30	–	Vdc
Collector Cutoff Current (V_{CB} = –30 Vdc)		I_{CBO}	–	–100	nAdc
Emitter Cutoff Current (V_{EB} = –10 Vdc)		I_{EBO}	–	–100	nAdc
ON CHARACTERISTICS					
DC Current Gain(3)		h_{FE}			–
(I_C = –10 mAdc, V_{CE} = –5.0 Vdc)	MMBTA63		5,000	–	
(I_C = –10 mAdc, V_{CE} = –5.0 Vdc)	MMBTA64		10,000	–	
(I_C = –100 mAdc, V_{CE} = –5.0 Vdc)	MMBTA63		10,000	–	
(I_C = –100 mAdc, V_{CE} = –5.0 Vdc)	MMBTA64		20,000	–	
Collector–Emitter Saturation Voltage (I_C = –100 mAdc, I_B = –0.1 mAdc)		$V_{CE(sat)}$	–	–1.5	Vdc
Base–Emitter On Voltage (I_C = –100 mAdc, V_{CE} = –5.0 Vdc)		$V_{BE(on)}$	–	–2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = –10 mAdc, V_{CE} = –5.0 Vdc, f = 100 MHz)		f_T	125	–	MHz

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.
3. Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1

Publication Order Number:
MMBTA63LT1/D

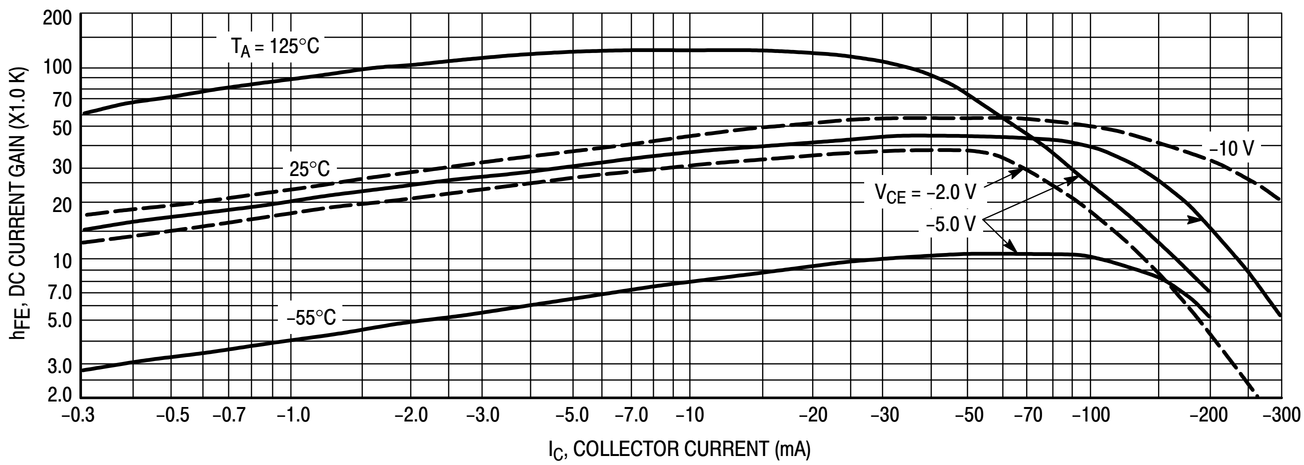


Figure 1. DC Current Gain

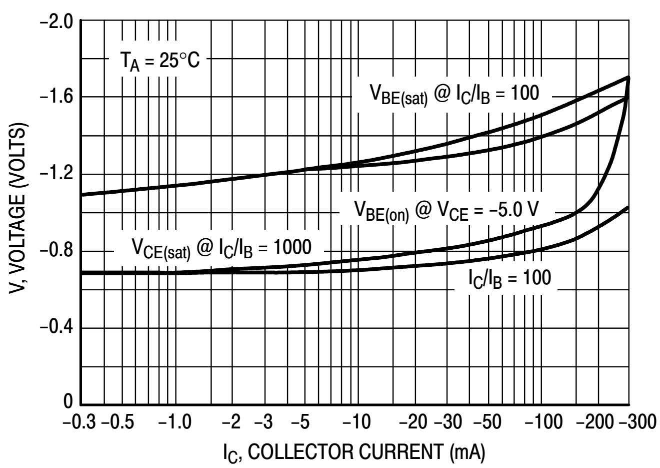


Figure 3. “On” Voltage

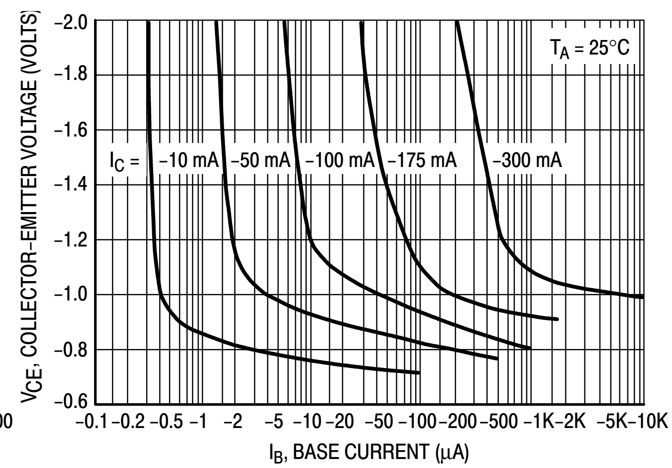


Figure 2. Collector Saturation Region

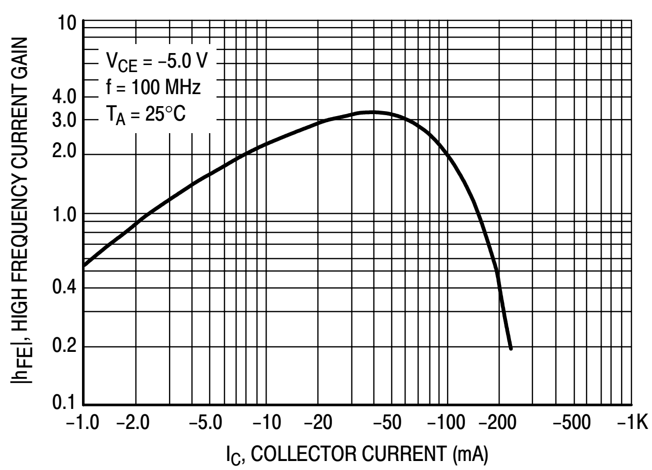
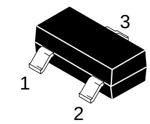


Figure 4. High Frequency Current Gain

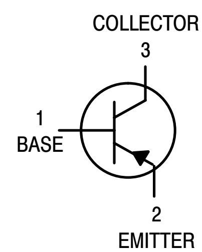
High Voltage Transistor
PNP Silicon

MMBTA92LT1

Preferred Device



CASE 318–08, STYLE 6
SOT–23 (TO–236AF)



MAXIMUM RATINGS

Rating	Symbol	MMBTA92	Unit
Collector–Emitter Voltage	V_{CEO}	–300	Vdc
Collector–Base Voltage	V_{CBO}	–300	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Continuous	I_C	–500	mAdc

DEVICE MARKING

MMBTA92LT1 = 2D

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board,(1) $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,(2) $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(3) ($I_C = –1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	–300	–	Vdc
Collector–Base Breakdown Voltage ($I_C = –100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	–300	–	Vdc
Emitter–Base Breakdown Voltage ($I_E = –100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	–5.0	–	Vdc
Collector Cutoff Current ($V_{CB} = –200$ Vdc, $I_E = 0$)	I_{CBO}	–	–0.25	μAdc
Emitter Cutoff Current ($V_{EB} = –3.0$ Vdc, $I_C = 0$)	I_{EBO}	–	–0.1	μAdc

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.
3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS[3]				
DC Current Gain (I_C = –1.0 mAdc, V_{CE} = –10 Vdc) (I_C = –10 mAdc, V_{CE} = –10 Vdc) (I_C = –30 mAdc, V_{CE} = –10 Vdc)	h_{FE}	 25 40 25	 – – –	–
Collector–Emitter Saturation Voltage (I_C = –20 mAdc, I_B = –2.0 mAdc)	$V_{CE(sat)}$	–	–0.5	Vdc
Base–Emitter Saturation Voltage (I_C = –20 mAdc, I_B = –2.0 mAdc)	$V_{BE(sat)}$	–	–0.9	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain – Bandwidth Product (I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)	f_T	50	–	MHz
Collector–Base Capacitance (V_{CB} = –20 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	6.0	pF

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

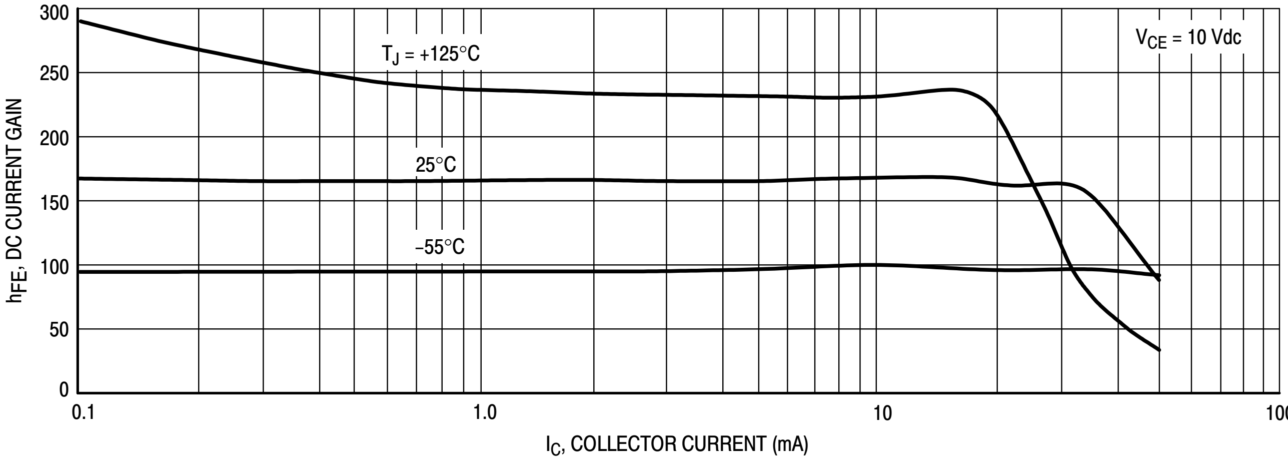


Figure 1. DC Current Gain

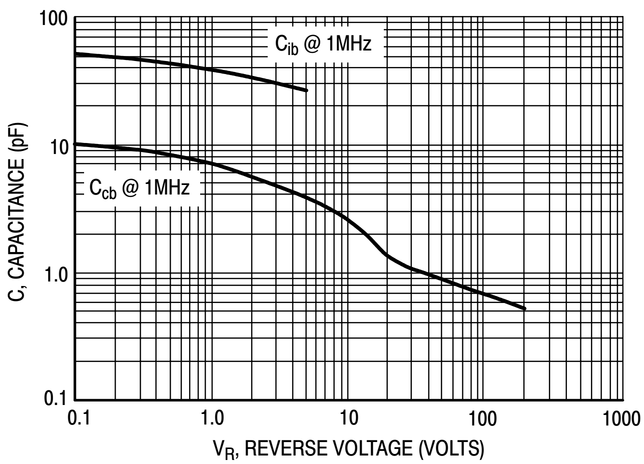


Figure 2. Capacitance

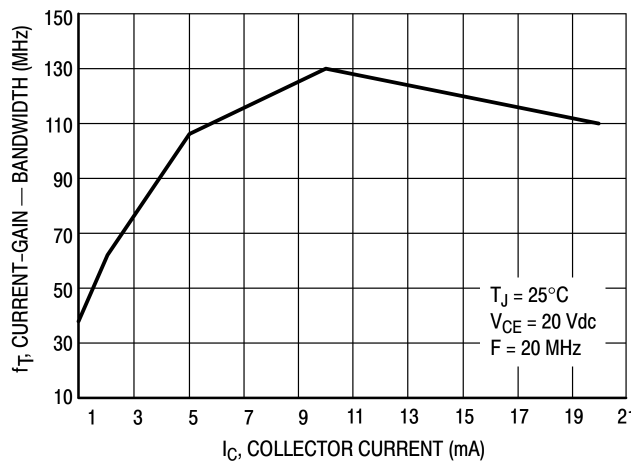


Figure 3. Current–Gain – Bandwidth

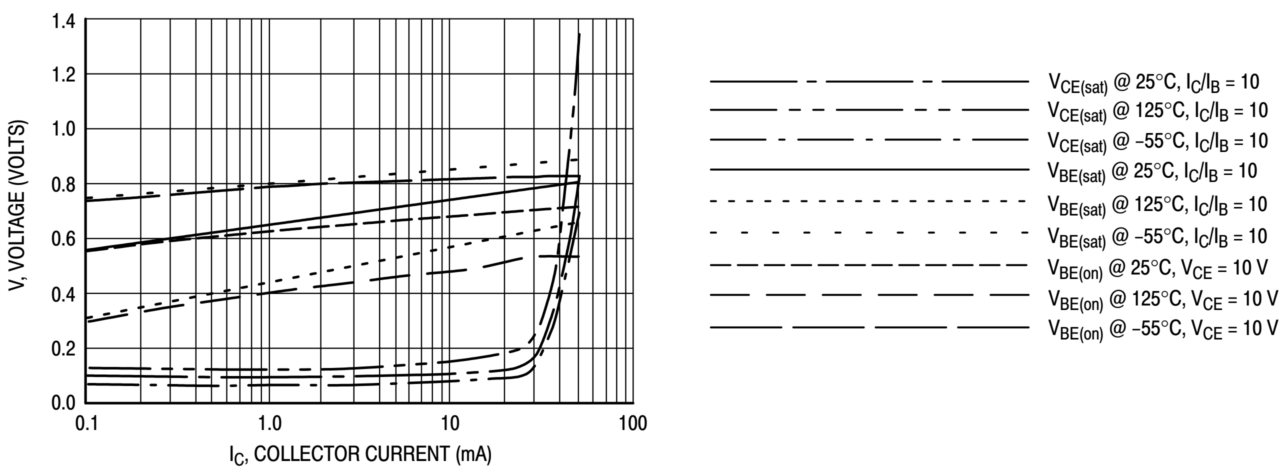


Figure 4. “ON” Voltages

MMBTH10LT1, MMBTH10-4LT1

Preferred Devices

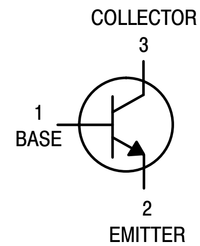
VHF/UHF Transistor

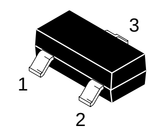
NPN Silicon

- Device Marking: 3EM

ON Semiconductor

http://onsemi.com





CASE 318
SOT–23
STYLE 6

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board (1) T_A = 25°C Derate above 25°C	P_D	 225 1.8	 mW mW/°C
Thermal Resistance, Junction to Ambient (1)	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate (2) T_A = 25°C Derate above 25°C	P_D	 300 2.4	 mW mW/°C
Thermal Resistance, Junction to Ambient (2)	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) FR–5 = 1.0 x 0.75 x 0.062 in.
(2) Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina

ORDERING INFORMATION

Device	Package	Shipping
MMBTH10LT1	SOT–23	3000/Tape & Reel
MMBTH10–4LT1	SOT–23	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 25 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
Emitter Cutoff Current (V_{EB} = 2.0 Vdc, I_C = 0)	I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 mAdc, V_{CE} = 10 Vdc) MMBTH10LT1	h_{FE}	60	—	—	—
MMBTH10–4LT1		120	—	240	
Collector–Emitter Saturation Voltage (I_C = 4.0 mAdc, I_B = 0.4 mAdc)	$V_{CE(sat)}$	—	—	0.5	Vdc
Base–Emitter On Voltage (I_C = 4.0 mAdc, V_{CE} = 10 Vdc)	V_{BE}	—	—	0.95	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz) MMBTH10LT1	f_T	650	—	—	MHz
MMBTH10–4LT1		800	—	—	
Collector–Base Capacitance (V_{CB}= 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	0.7	pF
Common–Base Feedback Capacitance (V_{CB}= 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{rb}	—	—	0.65	pF
Collector Base Time Constant (I_C= 4.0 mAdc, V_{CB} = 10 Vdc, f = 31.8 MHz)	$rb'C_c$	—	—	9.0	ps

TYPICAL CHARACTERISTICS

COMMON–BASE y PARAMETERS versus FREQUENCY

(V_{CB} = 10 Vdc, I_C = 4.0 mAdc, T_A = 25°C)

y_{ib}, INPUT ADMITTANCE

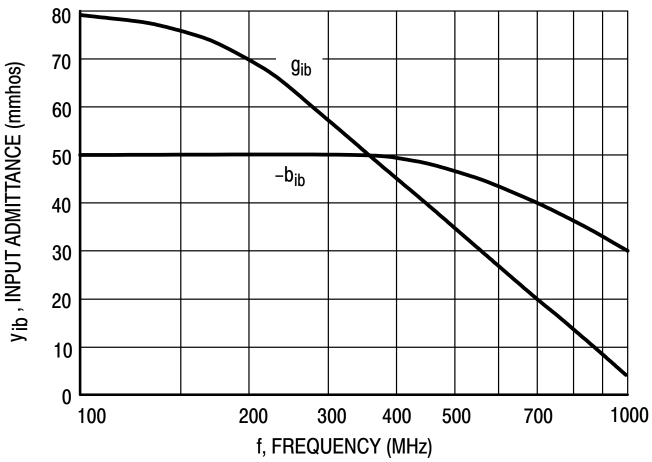


Figure 1. Rectangular Form

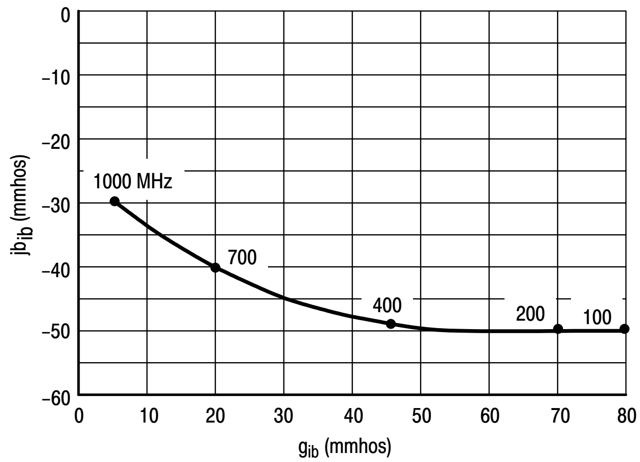


Figure 2. Polar Form

y_{fb}, FORWARD TRANSFER ADMITTANCE

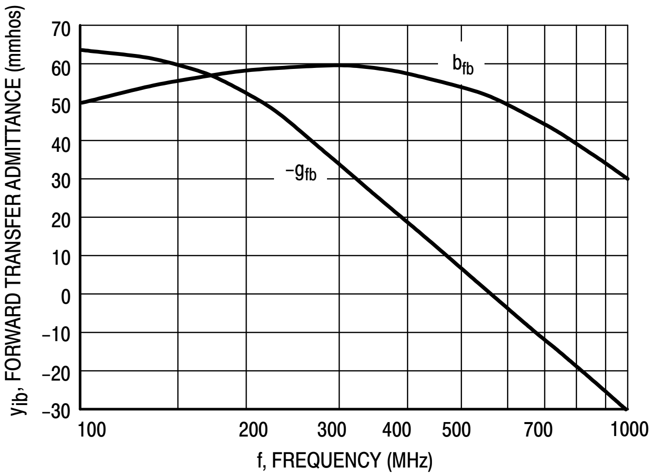


Figure 3. Rectangular Form

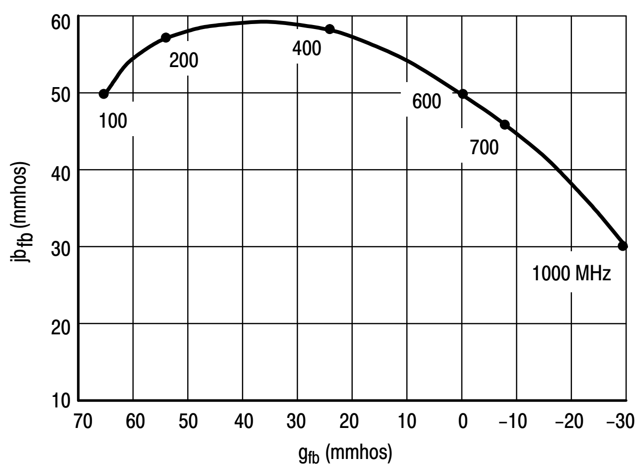


Figure 4. Polar Form

TYPICAL CHARACTERISTICS

COMMON–BASE y PARAMETERS versus FREQUENCY
(V_{CB} = 10 Vdc, I_C = 4.0 mAdc, T_A = 25°C)

y_{rb}, REVERSE TRANSFER ADMITTANCE

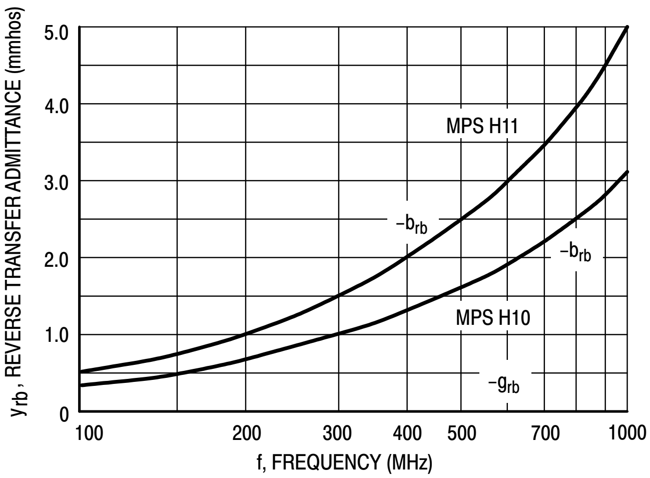


Figure 5. Rectangular Form

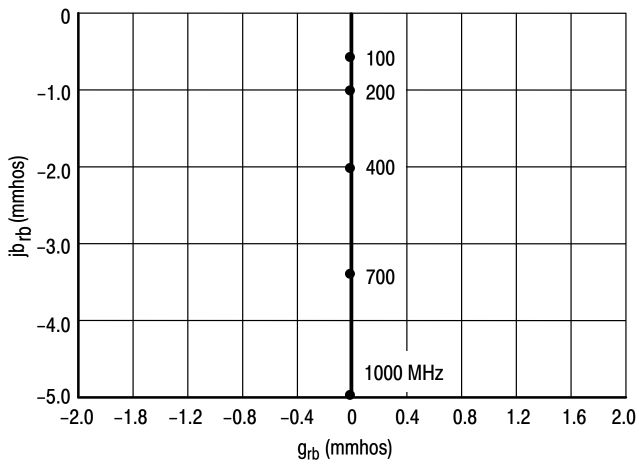


Figure 6. Polar Form

y_{ob}, OUTPUT ADMITTANCE

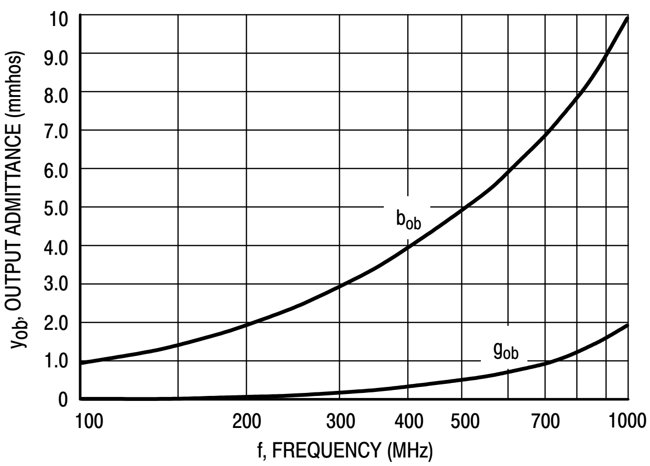


Figure 7. Rectangular Form

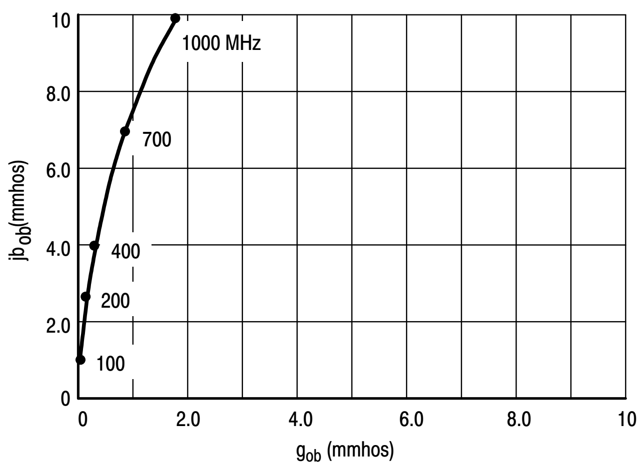


Figure 8. Polar Form

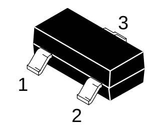
MMBV105GLT1

ON Semiconductor Preferred Device

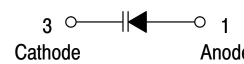
Silicon Tuning Diode

This device is designed in the Surface Mount package for general frequency control and tuning applications. It provides solid–state reliability in replacement of mechanical tuning methods.

- Controlled and Uniform Tuning Ratio



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Vdc
Forward Current	I_F	200	mAdc
Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBV105GLT1 = M4E

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	Vdc
Reverse Voltage Leakage Current (V_R = 28 Vdc)	I_R	—	50	nAdc

Device Type	C_T V_R = 25 Vdc, f = 1.0 MHz pF		Q V_R = 3.0 Vdc f = 50 MHz	C_R C_3/C_{25} f = 1.0 MHz	
	Min	Max	Typ	Min	Max
MMBV105GLT1	1.5	2.8	250	4.0	6.5

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 2

Publication Order Number:
MMBV105GLT1/D

TYPICAL CHARACTERISTICS

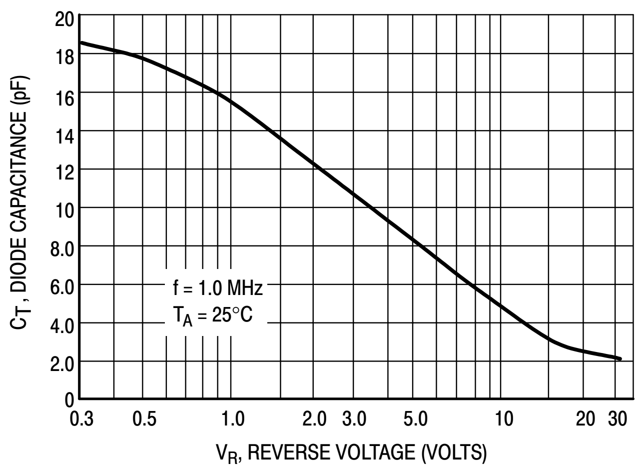


Figure 1. Diode Capacitance

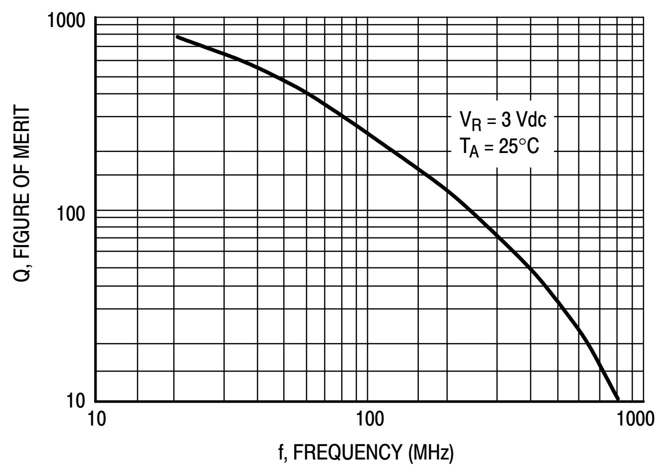


Figure 2. Figure of Merit

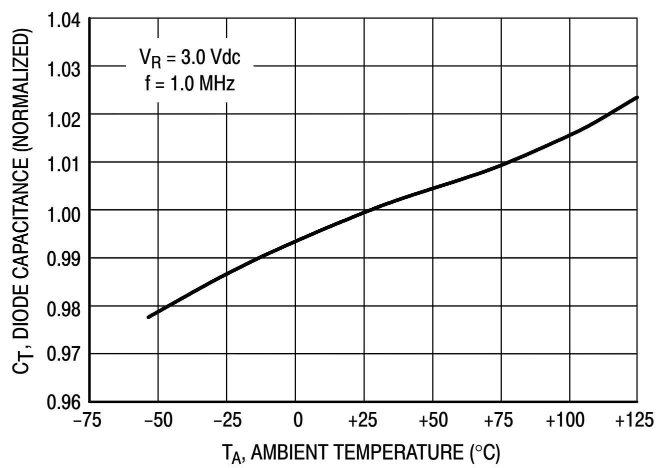


Figure 3. Diode Capacitance

Silicon Epicap Diodes

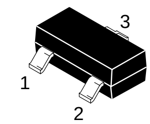
Designed for general frequency control and tuning applications; providing solid–state reliability in replacement of mechanical tuning methods.

- High Q with Guaranteed Minimum Values at VHF Frequencies
- Controlled and Uniform Tuning Ratio
- Available in Surface Mount Package

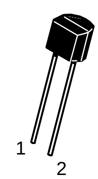
MMBV109LT1, MV209

MMBV109LT1 and MV209 are Preferred Devices

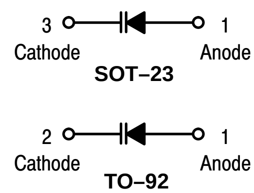
26–32 pF
VOLTAGE VARIABLE
CAPACITANCE DIODES



CASE 318–08, STYLE 6
SOT–23 (TO–236AB)



CASE 182–06, STYLE 1
TO–92 (TO–226AC)



MAXIMUM RATINGS

Rating	Symbol	MMBV109LT1	MV209	Unit
Reverse Voltage	V_R	30		Vdc
Forward Current	I_F	200		mAdc
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 2.0	200 1.6	mW mW/°C
Junction Temperature	T_J	+125		°C
Storage Temperature Range	T_{stg}	–55 to +150		°C

DEVICE MARKING

MMBV109LT1 = M4A, MV209 = MV209

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 µAdc)	$V_{(BR)R}$	30	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc)	I_R	—	—	0.1	µAdc
Diode Capacitance Temperature Coefficient (V_R = 3.0 Vdc, f = 1.0 MHz)	TC_C	—	300	—	ppm/°C

	C_t, Diode Capacitance V_R = 3.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 3.0 Vdc f = 50 MHz	C_R, Capacitance Ratio C_3/C_{25} f = 1.0 MHz (Note 1)	
Device	Min	Nom	Max	Min	Min	Max
MMBV109LT1, MV209	26	29	32	200	5.0	6.5

1. C_R is the ratio of C_t measured at 3 Vdc divided by C_t measured at 25 Vdc.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

October, 2001 – Rev. 3
Publication Order Number:
MMBV109LT1/D

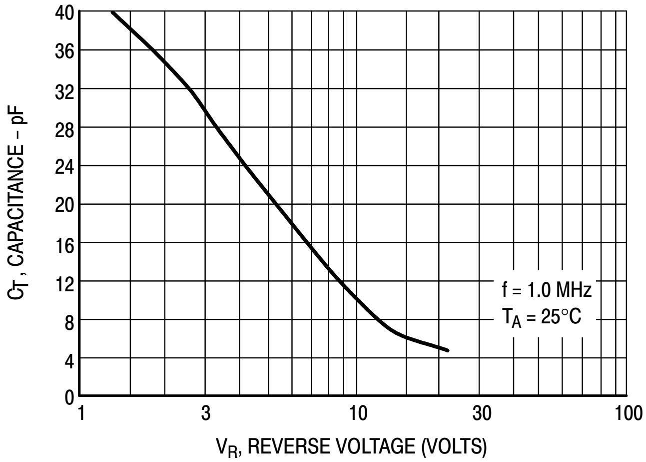


Figure 1. DIODE CAPACITANCE

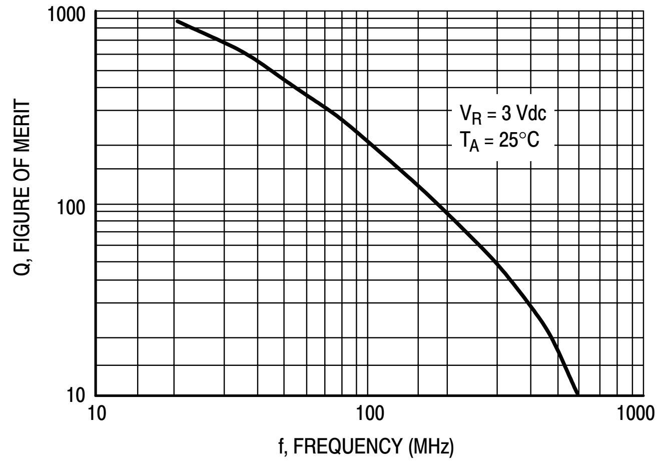


Figure 2. FIGURE OF MERIT

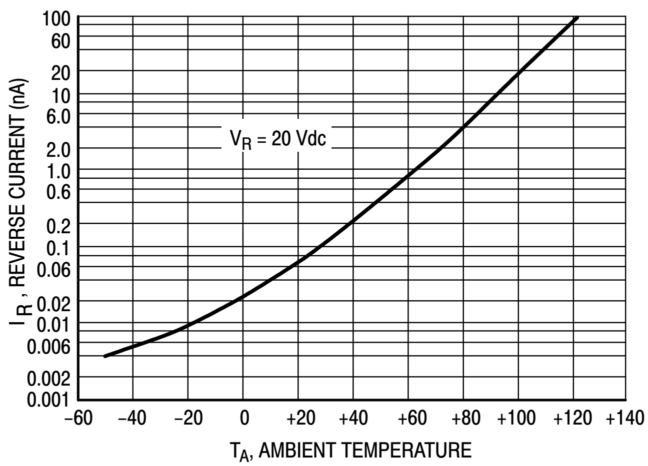


Figure 3. LEAKAGE CURRENT

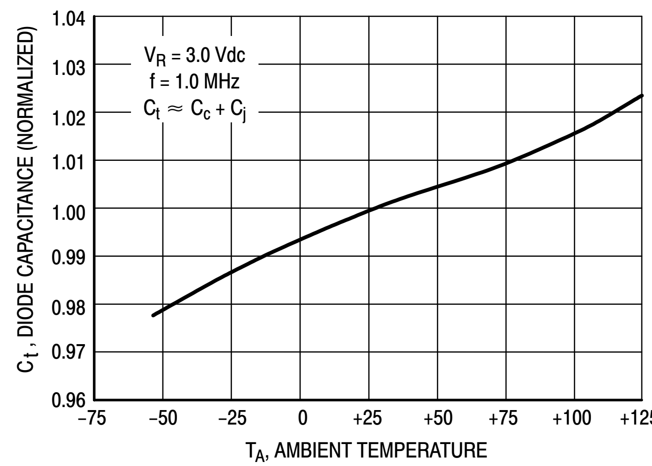


Figure 4. DIODE CAPACITANCE

NOTES ON TESTING AND SPECIFICATIONS

1. C_R is the ratio of C_t measured at 3.0 Vdc divided by C_t measured at 25 Vdc.

MMBV2101LT1 Series, MV2105, MV2101, MV2109, LV2205, LV2209

ON Semiconductor™

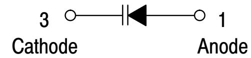
http://onsemi.com

Silicon Tuning Diodes

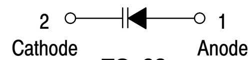
6.8–100 pF, 30 Volts
Voltage Variable Capacitance Diodes

These devices are designed in popular plastic packages for the high volume requirements of FM Radio and TV tuning and AFC, general frequency control and tuning applications. They provide solid–state reliability in replacement of mechanical tuning methods. Also available in a Surface Mount Package up to 33 pF.

- High Q
- Controlled and Uniform Tuning Ratio
- Standard Capacitance Tolerance – 10%
- Complete Typical Design Curves



SOT–23



TO–92

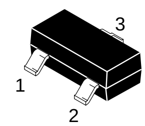
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Vdc
Forward Current	I_F	200	mAdc
Forward Power Dissipation @ T_A = 25°C MMBV21xx Derate above 25°C @ T_A = 25°C MV21xx Derate above 25°C LV22xx	P_D	 225 1.8 280 2.8	mW mW/°C
Junction Temperature	T_J	+150	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

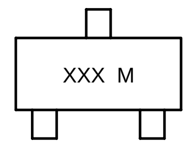
DEVICE MARKING

MMBV2101LT1 = M4G	MMBV2108LT1 = 4X	MV2109 = MV2109
MMBV2103LT1 = 4H	MMBV2109LT1 = 4J	LV2205 = LV2205
MMBV2105LT1 = 4U	MV2101 = MV2101	LV2209 = LV2209
MMBV2107LT1 = 4W	MV2105 = MV2105	

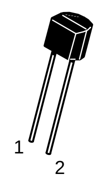
MARKING DIAGRAM



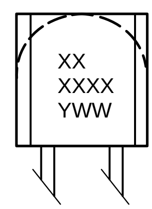
TO–236AB, SOT–23
CASE 318–08
STYLE 8



XXX = Device Code*
M = Date Code
* See Table



TO–226AC, TO–92
CASE 182
STYLE 1



XX = Device Code Line 1*
XXXX = Device Code Line 2*
M = Date Code
* See Table

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc) MMBV21xx, MV21xx LV22xx	$V_{(BR)R}$	 30 25	 – –	 – –	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_A = 25°C)	I_R	–	–	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	–	280	–	ppm/°C

Preferred devices are recommended choices for future use and best overall value.

Device	C_T, Diode Capacitance V_R = 4.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 4.0 Vdc, f = 50 MHz	TR, Tuning Ratio C_2/C_{30} f = 1.0 MHz		
	Min	Nom	Max	Typ	Min	Typ	Max
MMBV2101LT1/MV2101	6.1	6.8	7.5	450	2.5	2.7	3.2
MMBV2103LT1	9.0	10	11	400	2.5	2.9	3.2
LV2205/MMBV2105LT1/MV2105	13.5	15	16.5	400	2.5	2.9	3.2
MMBV2107LT1	19.8	22	24.2	350	2.5	2.9	3.2
MMBV2108LT1	24.3	27	29.7	300	2.5	3.0	3.2
LV2209MMBV2109LT1/MV2109	29.7	33	36.3	200	2.5	3.0	3.2

MMBV2101LT1, MMBV2103LT1, MMBV2105LT1, MMBV2107LT1 thru MMBV2109LT1, are also available in bulk. Use the device title and drop the "T1" suffix when ordering any of these devices in bulk.

PARAMETER TEST METHODS

1. C_T, DIODE CAPACITANCE

($C_T = C_C + C_J$). C_T is measured at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

2. TR, TUNING RATIO

TR is the ratio of C_T measured at 2.0 Vdc divided by C_T measured at 30 Vdc.

3. Q, FIGURE OF MERIT

Q is calculated by taking the G and C readings of an admittance bridge at the specified frequency and substituting in the following equations:

$$Q = \frac{2\pi fC}{G}$$

(Boonton Electronics Model 33AS8 or equivalent). Use Lead Length ≈ 1/16".

4. TC_C, DIODE CAPACITANCE TEMPERATURE COEFFICIENT

TC_C is guaranteed by comparing C_T at V_R = 4.0 Vdc, f = 1.0 MHz, T_A = –65°C with C_T at V_R = 4.0 Vdc, f = 1.0 MHz, T_A = +85°C in the following equation, which defines TC_C:

$$TC_C = \left|\frac{C_T(+85°C) - C_T(-65°C)}{85 + 65}\right| \cdot \frac{10^6}{C_T(25°C)}$$

Accuracy limited by measurement of C_T to ±0.1 pF.

TYPICAL DEVICE CHARACTERISTICS

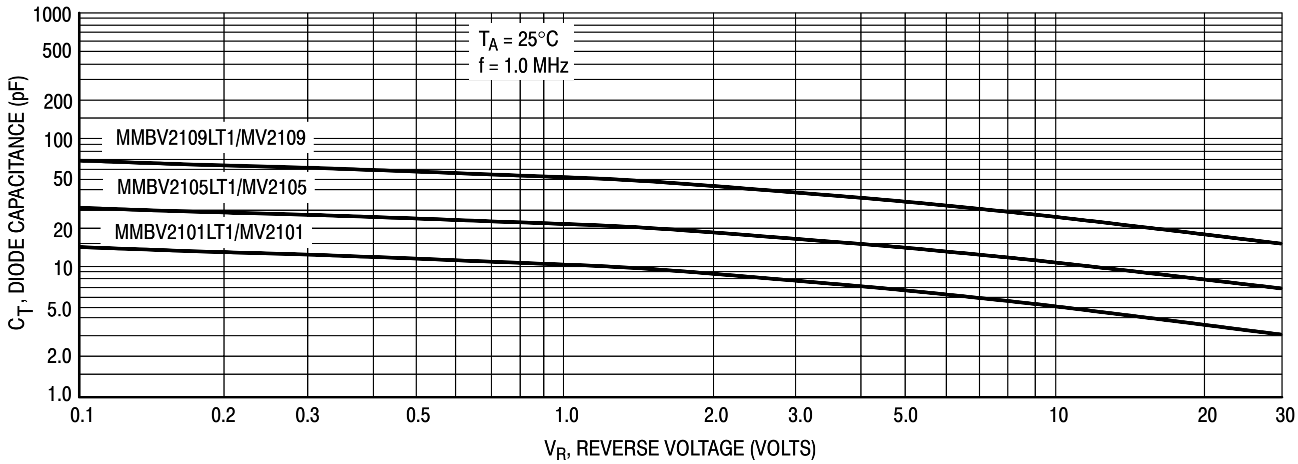


Figure 1. Diode Capacitance versus Reverse Voltage

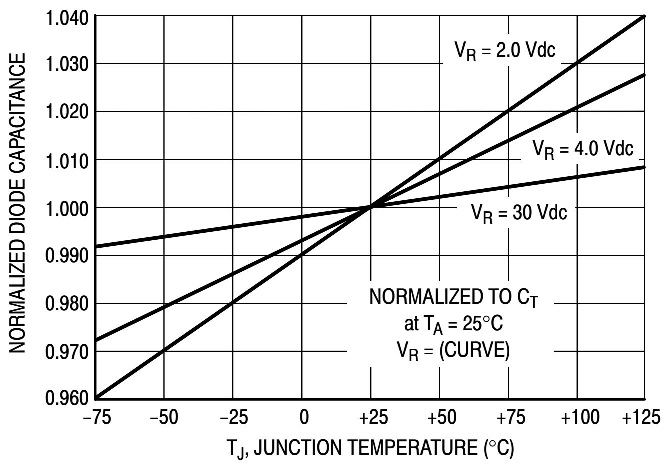


Figure 2. Normalized Diode Capacitance versus Junction Temperature

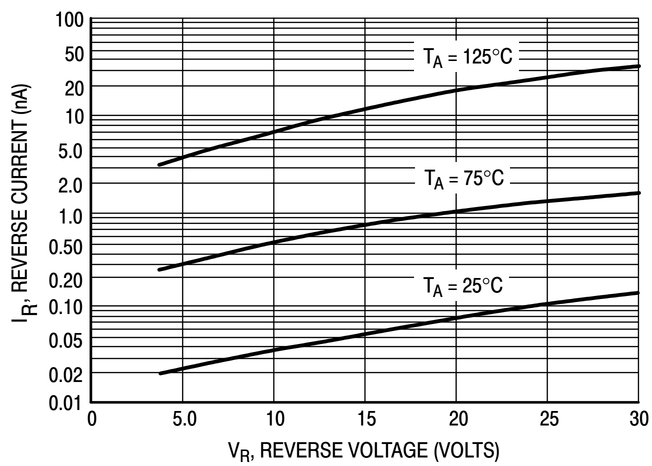


Figure 3. Reverse Current versus Reverse Bias Voltage

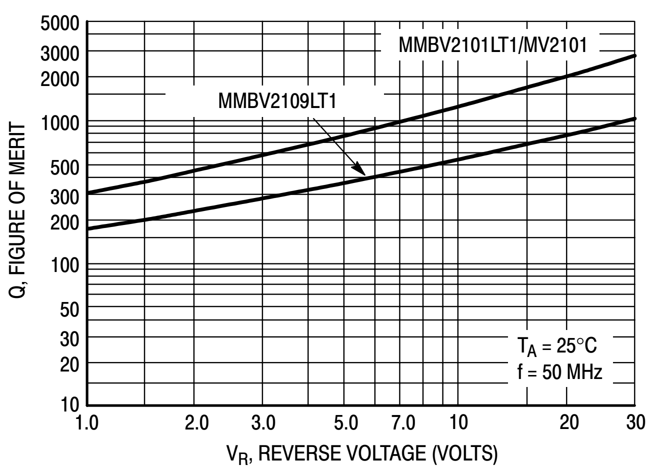


Figure 4. Figure of Merit versus Reverse Voltage

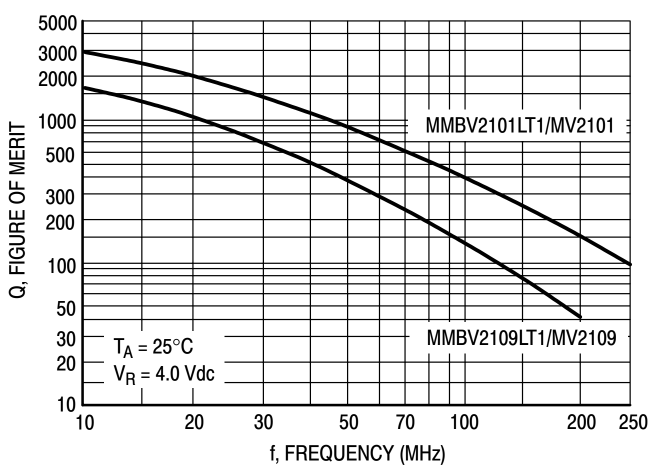


Figure 5. Figure of Merit versus Frequency

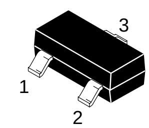
Silicon Tuning Diode

MMBV3102LT1

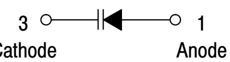
ON Semiconductor Preferred Device

This device is designed in the Surface Mount package for general frequency control and tuning applications. It provides solid–state reliability in replacement of mechanical tuning methods.

- High Q with Guaranteed Minimum Values at VHF Frequencies
- Controlled and Uniform Tuning Ratio



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Vdc
Forward Current	I_F	200	mAdc
Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBV3102LT1 = M4C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_A = 25°C)	I_R	—	—	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	—	300	—	ppm/°C

	C_t, Diode Capacitance V_R = 3.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 3.0 Vdc f = 50 MHz	C_R, Capacitance Ratio C_3/C_{25} f = 1.0 MHz	
Device	**Min**	**Nom**	**Max**	**Min**	**Min**	**Typ**
MMBV3102LT1	20	22	25	200	4.5	4.8

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

TYPICAL CHARACTERISTICS

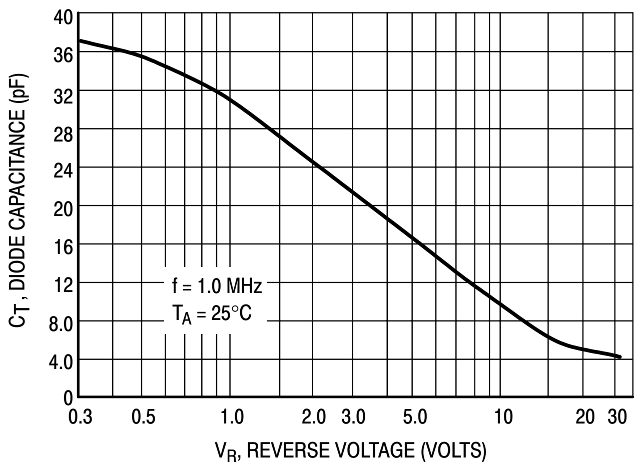


Figure 1. Diode Capacitance

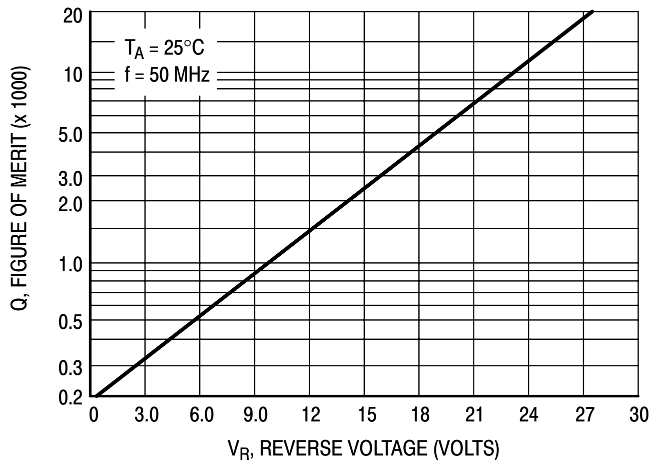


Figure 2. Figure of Merit

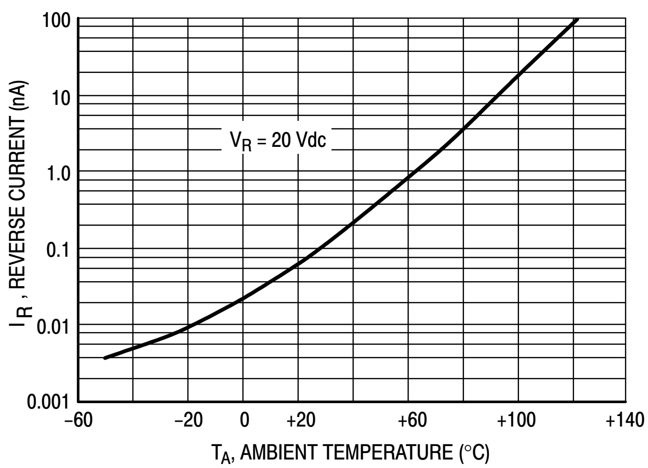


Figure 3. Leakage Current

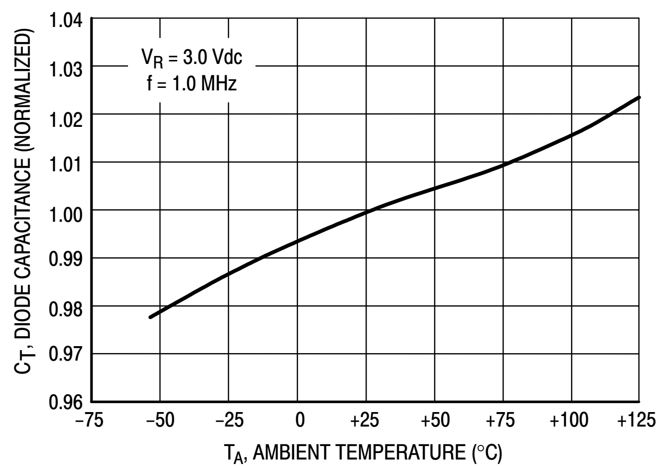


Figure 4. Diode Capacitance

NOTES ON TESTING AND SPECIFICATIONS

1. C_R is the ratio of C_T measured at 3.0 Vdc divided by C_T measured at 25 Vdc.

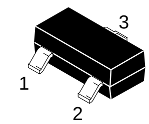
Silicon Pin Diode

MMBV3401LT1

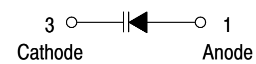
ON Semiconductor Preferred Device

This device is designed primarily for VHF band switching applications but is also suitable for use in general–purpose switching circuits. Supplied in a Surface Mount package.

- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Capacitance — 0.7 pF (Typ) at V_R = 20 Vdc
- Very Low Series Resistance at 100 MHz — 0.34 Ohms (Typ) @ I_F = 10 mAdc



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	35	Vdc
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 2.0	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBV3401LT1 = 4D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	35	—	—	Vdc
Diode Capacitance (V_R = 20 Vdc)	C_T	—	—	1.0	pF
Series Resistance (Figure 5) (I_F = 10 mAdc, f = 100 MHz)	R_S	—	—	0.7	Ω
Reverse Leakage Current (V_R = 25 Vdc)	I_R	—	—	0.1	μAdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

TYPICAL CHARACTERISTICS

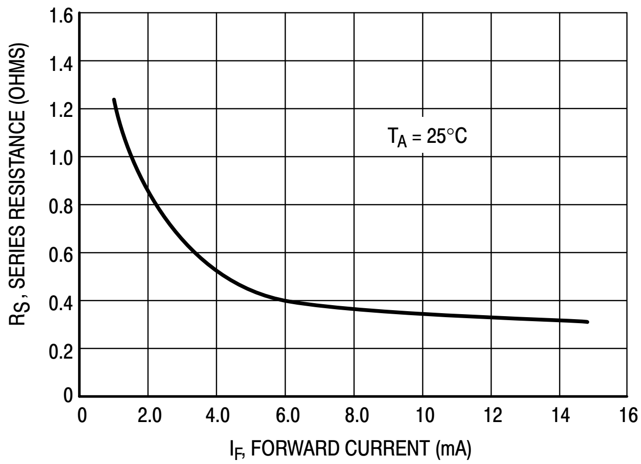


Figure 1. Series Resistance

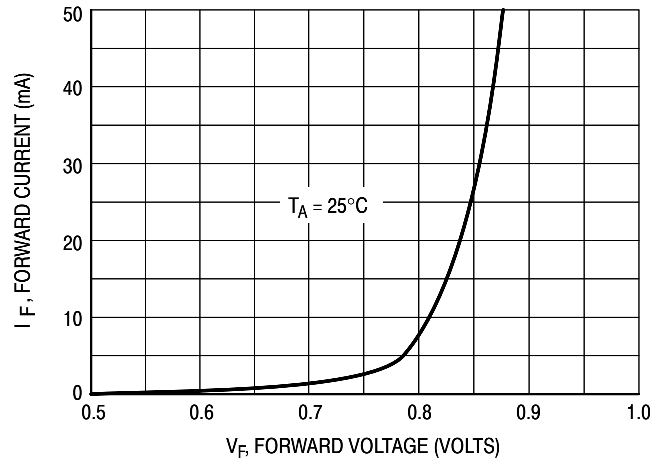


Figure 2. Forward Voltage

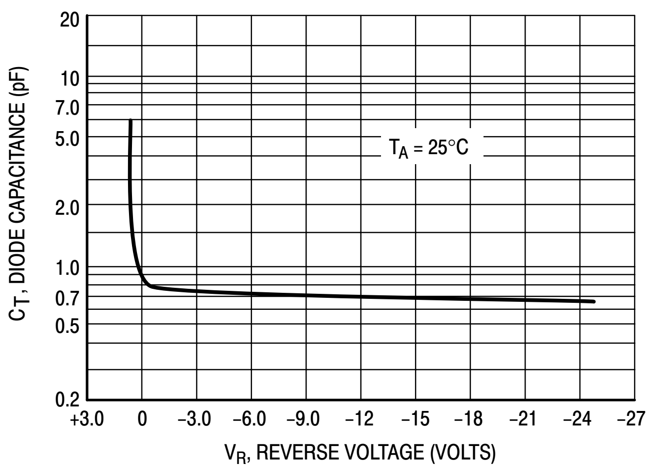


Figure 3. Diode Capacitance

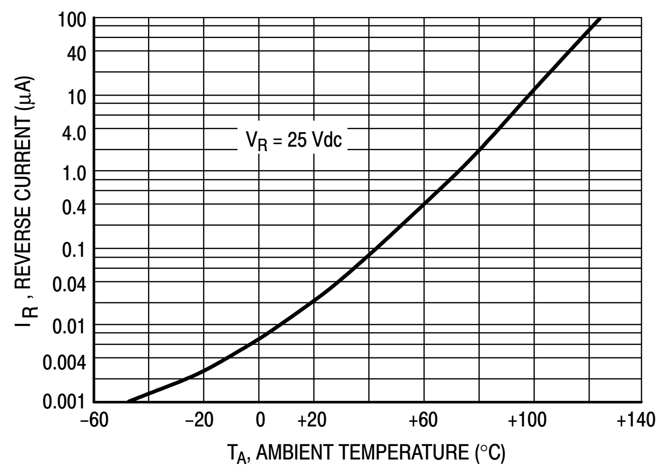


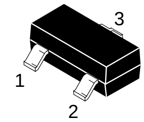
Figure 4. Leakage Current

MMBV3700LT1
MPN3700

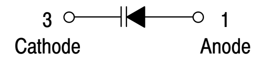
High Voltage Silicon Pin Diodes

These devices are designed primarily for VHF band switching applications but are also suitable for use in general–purpose switching circuits. They are supplied in a cost–effective plastic package for economical, high–volume consumer and industrial requirements. They are also available in surface mount.

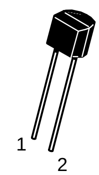
- Long Reverse Recovery Time t_{rr} = 300 ns (Typ)
- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Series Resistance @ 100 MHz – R_S = 0.7 Ohms (Typ) @ I_F = 10 mAdc
- Reverse Breakdown Voltage = 200 V (Min)



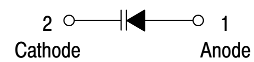
CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



SOT–23



CASE 182–06, STYLE 1
TO–92 (TO–226AC)



TO–92

MAXIMUM RATINGS

Rating	Symbol	MPN3700	MMBV3700LT1	Unit
Reverse Voltage	V_R	200		Vdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	 280 2.8	 200 2.0	 mW mW/°C
Junction Temperature	T_J	+125		°C
Storage Temperature Range	T_{stg}	–55 to +150		°C

DEVICE MARKING

MMBV3700LT1 = 4R

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	200	–	–	Vdc
Diode Capacitance (V_R = 20 Vdc, f = 1.0 MHz)	C_T	–	–	1.0	pF
Series Resistance (Figure 5) (I_F = 10 mAdc)	R_S	–	0.7	1.0	Ω
Reverse Leakage Current (V_R = 150 Vdc)	I_R	–	–	0.1	μAdc
Reverse Recovery Time (I_F = I_R = 10 mAdc)	t_{rr}	–	300	–	ns

March, 2001 – Rev. 1
Publication Order Number:
MMBV3700LT1D

TYPICAL CHARACTERISTICS

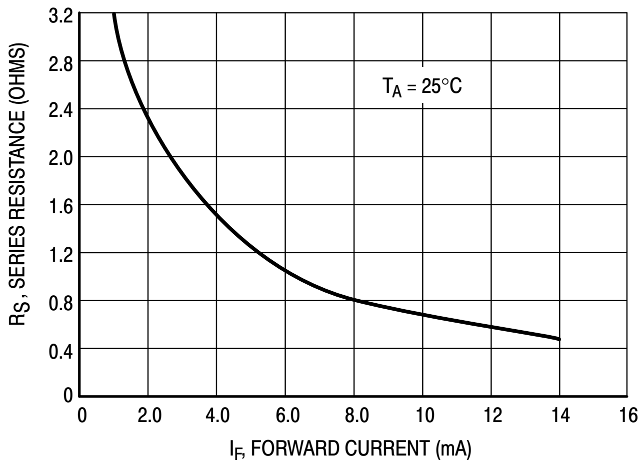


Figure 1. Series Resistance

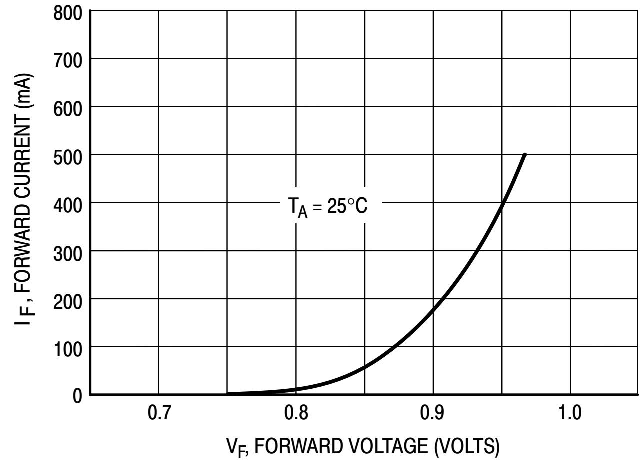


Figure 2. Forward Voltage

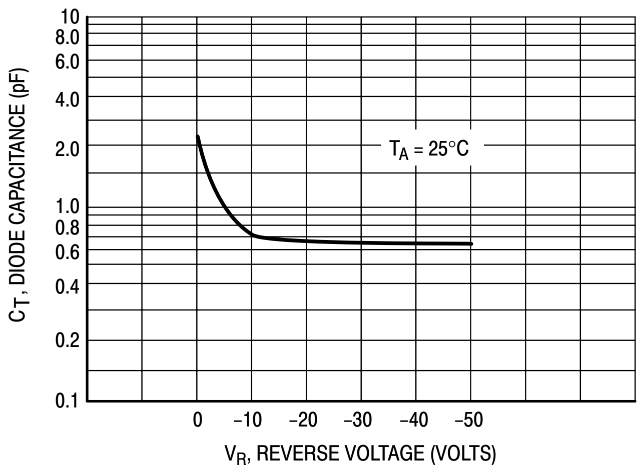


Figure 3. Diode Capacitance

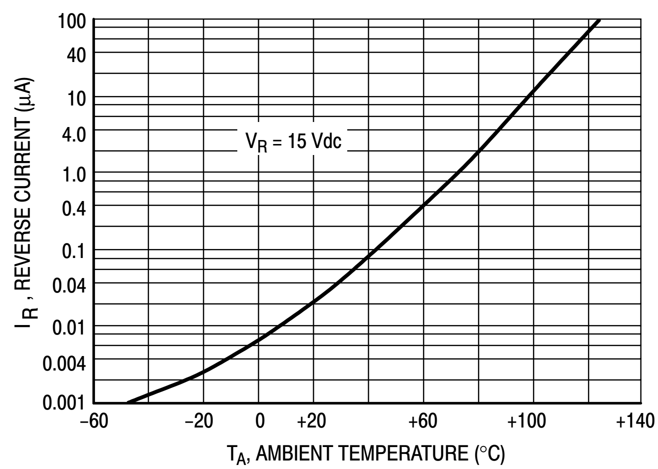


Figure 4. Leakage Current

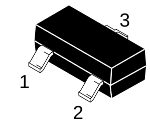
MMBV409LT1

ON Semiconductor Preferred Device

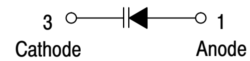
Silicon Tuning Diode

These devices are designed for general frequency control and tuning applications. They provide solid–state reliability in replacement of mechanical tuning methods.

- High Q with Guaranteed Minimum Values at VHF Frequencies
- Controlled and Uniform Tuning Ratio
- Available in Surface Mount Package



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Values	Unit
Reverse Voltage	V_R	20	Vdc
Forward Current	I_F	200	mAdc
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	 225 1.8	 mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

DEVICE MARKING

MMBV409LT1 = X5

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	20	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 15 Vdc)	I_R	—	—	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 3.0 Vdc, f = 1.0 MHz)	TC_C	—	300	—	ppm/°C

	C_t, Diode Capacitance V_R = 3.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 3.0 Vdc f = 50 MHz	C_R, Capacitance Ratio C_3/C_8 f = 1.0 MHz(1)	
Device	**Min**	**Nom**	**Max**	**Min**	**Min**	**Max**
MMBV409LT1, MV409	26	29	32	200	1.5	1.9

1. C_R is the ratio of C_t measured at 3 Vdc divided by C_t measured at 8 Vdc.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

TYPICAL CHARACTERISTICS

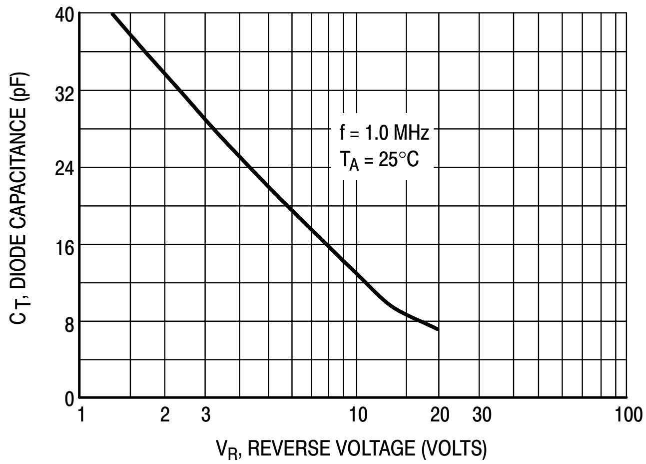


Figure 1. Diode Capacitance

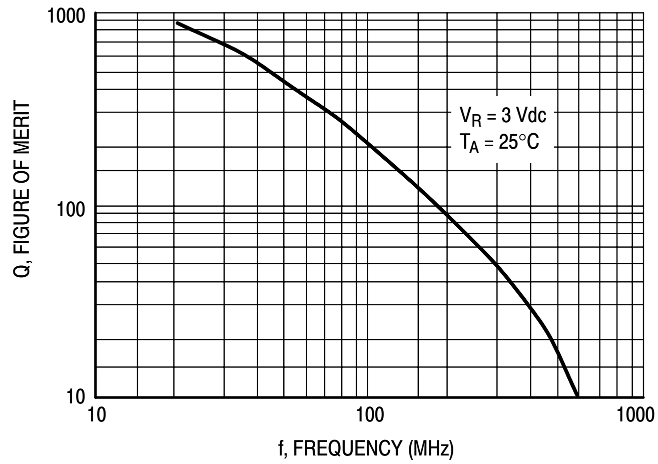


Figure 2. Figure of Merit

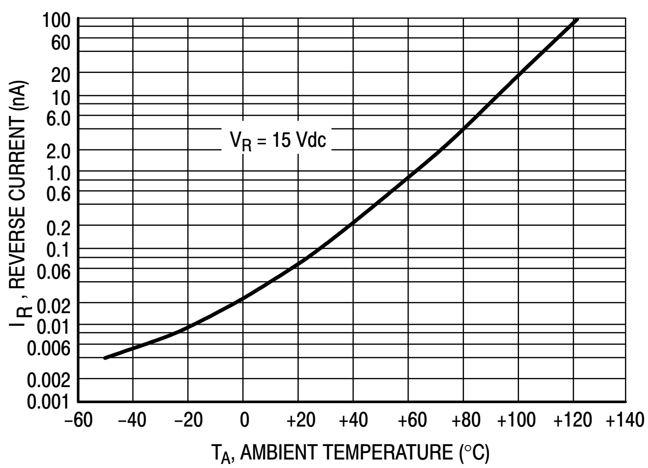


Figure 3. Leakage Current

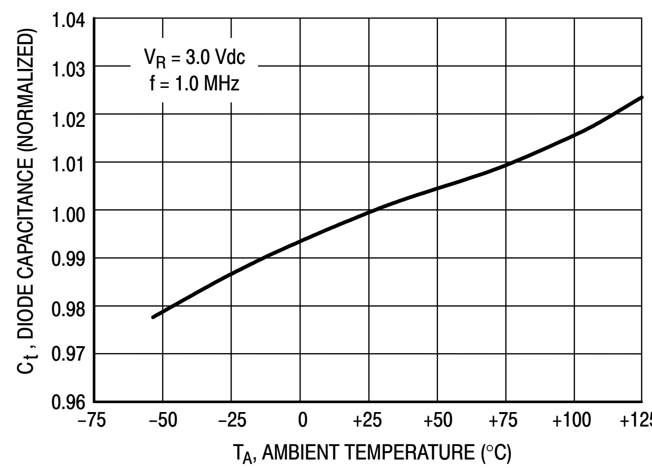


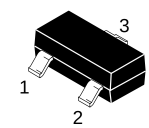
Figure 4. Diode Capacitance

Silicon Tuning Diode

MMBV432LT1

ON Semiconductor Preferred Device

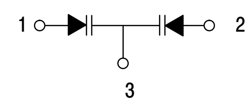
DUAL VOLTAGE VARIABLE CAPACITANCE DIODE



CASE 318–08, STYLE 9
SOT–23 (TO–236AB)

This device is designed for FM tuning, general frequency control and tuning, or any top–of–the–line application requiring back–to–back diode configuration for minimum signal distortion and detuning. This device is supplied in the SOT–23 plastic package for high volume, pick and place assembly requirements.

- High Figure of Merit — Q = 150 (Typ) @ V_R = 2.0 Vdc, f = 100 MHz
- Guaranteed Capacitance Range
- Dual Diodes – Save Space and Reduce Cost
- Surface Mount Package
- Available in 8 mm Tape and Reel
- Monolithic Chip Provides Improved Matching – Guaranteed ± 1.0% (Max) Over Specified Tuning Range



MAXIMUM RATINGS (Each Diode)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	14	Vdc
Forward Current	I_F	200	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	–55 to +125	°C

DEVICE MARKING

MMBV432LT1 = M4B

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) **(EACH DIODE)**

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	14	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 9.0 Vdc)	I_R	—	—	100	nAdc
Diode Capacitance (V_R = 2.0 Vdc, f = 1.0 MHz)	C_T	43	—	48.1	pF
Capacitance Ratio C2/C8 (f = 1.0 MHz)	C_R	1.5	—	2.0	—
Figure of Merit (V_R = 2.0 Vdc, f = 100 MHz)	Q	100	150	—	—

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

TYPICAL CHARACTERISTICS (Each Diode)

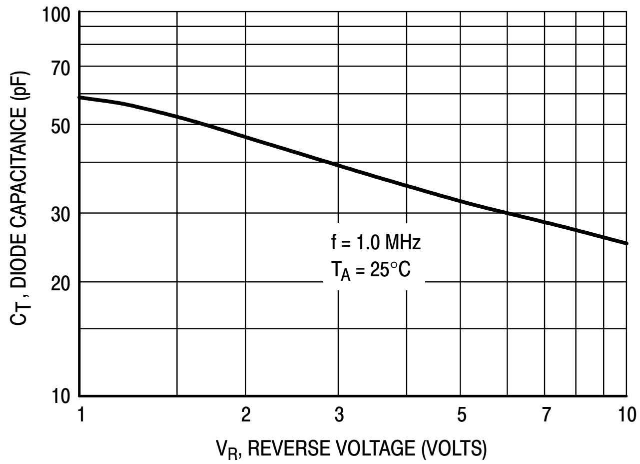


Figure 1. Diode Capacitance

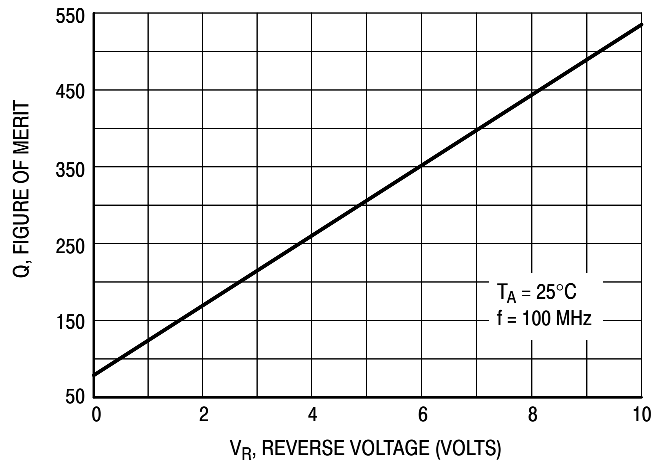


Figure 2. Figure of Merit versus Voltage

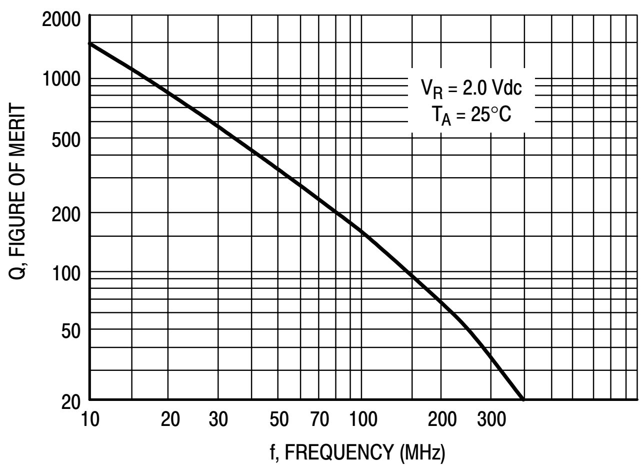


Figure 3. Figure of Merit versus Frequency

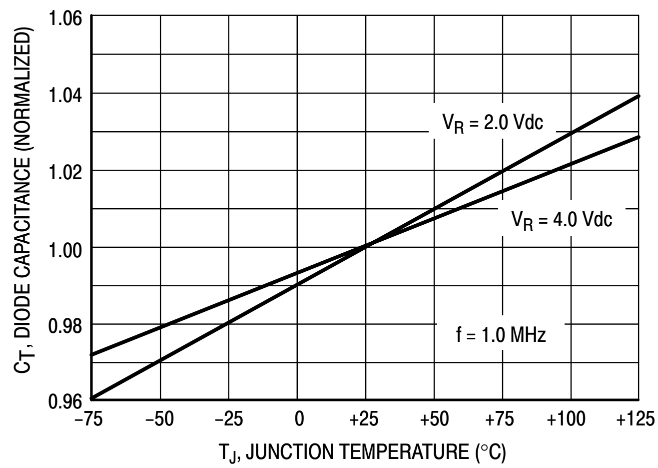


Figure 4. Diode Capacitance versus Temperature

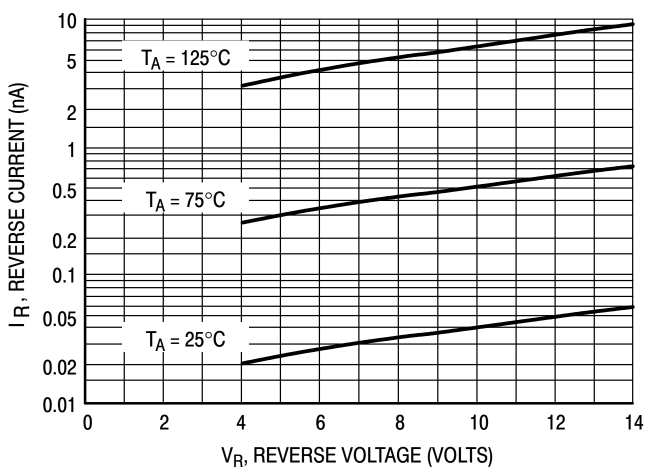


Figure 5. Reverse Current versus Reverse Voltage

Silicon Tuning Diode

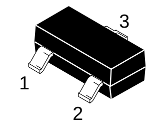
This device is designed for FM tuning, general frequency control and tuning, or any top–of–the–line application requiring back–to–back diode configuration for minimum signal distortion and detuning. This device is supplied in the SOT–23 plastic package for high volume, pick and place assembly requirements.

- High Figure of Merit — Q = 450 (Typ) @ V_R = 3.0 Vdc, f = 50 MHz
- Guaranteed Capacitance Range
- Dual Diodes – Save Space and Reduce Cost
- Surface Mount Package
- Available in 8 mm Tape and Reel
- Monolithic Chip Provides Improved Matching
- Hyper Abrupt Junction Process Provides High Tuning Ratio

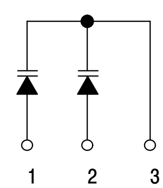
MMBV609LT1

ON Semiconductor Preferred Device

DUAL VOLTAGE VARIABLE CAPACITANCE DIODE



CASE 318–08, STYLE 9
SOT–23 (TO–236AB)



MAXIMUM RATINGS (Each Diode)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	20	Vdc
Forward Current	I_F	100	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	–55 to +125	°C

DEVICE MARKING

MMBV609LT1 = 5L

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) **(EACH DIODE)**

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	20	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 15 Vdc)	I_R	—	—	10	nAdc
Diode Capacitance (V_R = 3.0 Vdc, f = 1.0 MHz)	C_T	26	—	32	pF
Capacitance Ratio C3/C8 (f = 1.0 MHz)	C_R	1.8	—	2.4	—
Figure of Merit (V_R = 3.0 Vdc, f = 50 MHz)	Q	250	450	—	—

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1

Publication Order Number:
MMBV609LT1/D

TYPICAL CHARACTERISTICS

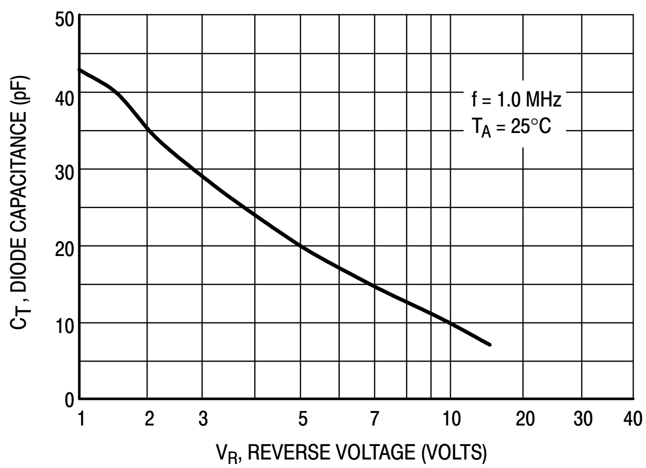


Figure 1. Diode Capacitance

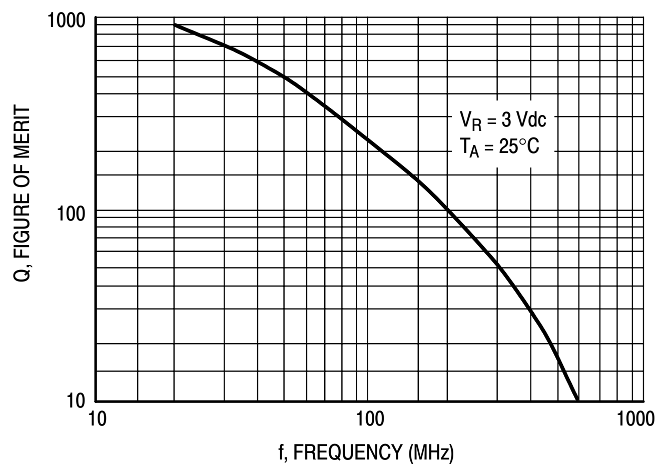


Figure 2. Figure of Merit

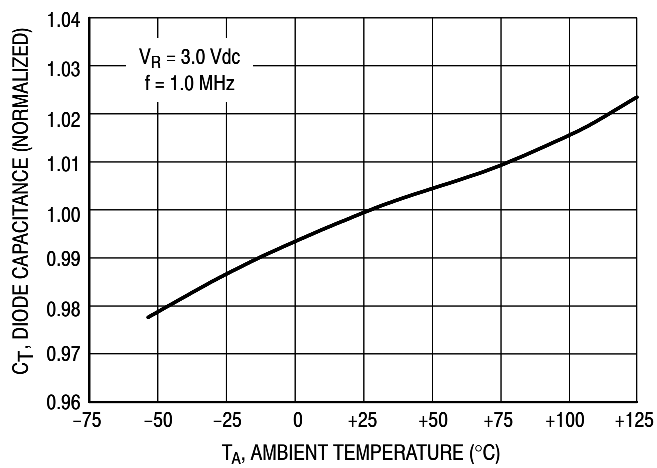


Figure 3. Diode Capacitance

MMBV809LT1

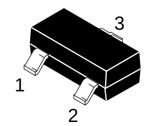
ON Semiconductor Preferred Device

Silicon Tuning Diode

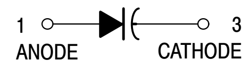
This device is designed for 900 MHz frequency control and tuning applications. It provides solid–state reliability in replacement of mechanical tuning methods.

- Controlled and Uniform Tuning Ratio
- Available in Surface Mount Package
- Available in 8 mm Tape and Reel

4.5–6.1 pF
VOLTAGE VARIABLE
CAPACITANCE DIODE



CASE 318–08, STYLE 8
SOT–23 (TO–236AB)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	20	Vdc
Forward Current	I_F	20	mAdc
Total Power Dissipation(1) @ T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	–55 to +125	°C

1. FR5 Board 1.0 x 0.75 x 0.62 in.

DEVICE MARKING

MMBV809LT1 = 5K

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic – All Types	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	20	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 15 Vdc)	I_R	—	—	50	nAdc

	C_t, Diode Capacitance V_R = 2.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 3.0 Vdc f = 500 MHz	C_R, Capacitance Ratio C_2/C_8 f = 1.0 MHz(2)	
Device	Min	Typ	Max	Typ	Min	Max
MMBV809LT1	4.5	5.3	6.1	75	1.8	2.6

2. C_R is the ratio of C_t measured at 2.0 Vdc divided by C_t measured at 8.0 Vdc.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

TYPICAL CHARACTERISTICS

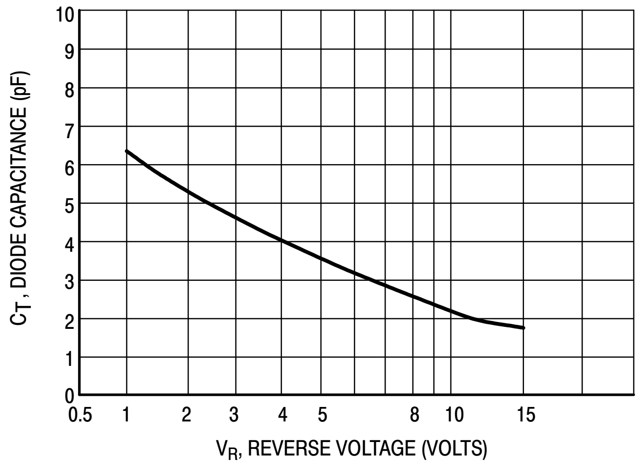


Figure 1. Diode Capacitance

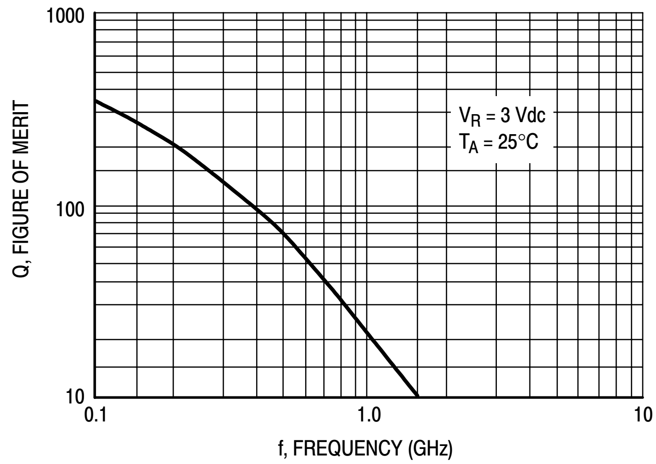


Figure 2. Figure of Merit

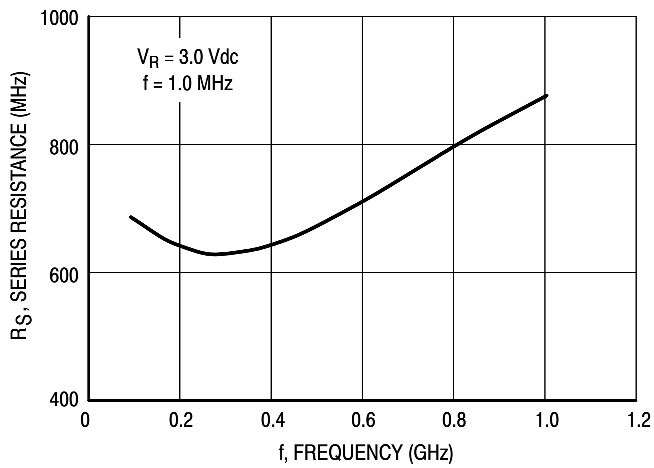


Figure 3. Series Resistance

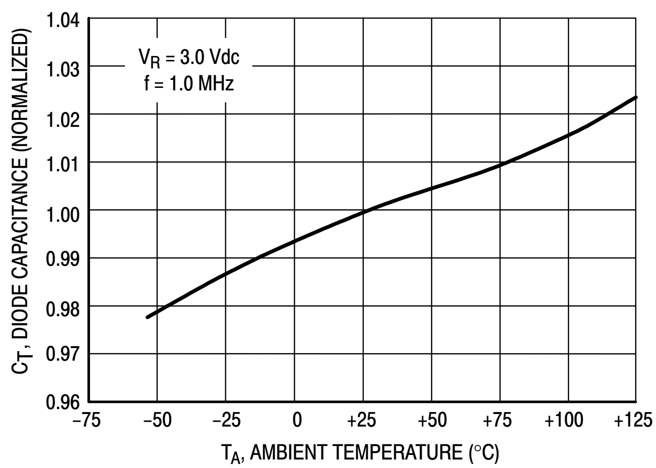


Figure 4. Diode Capacitance

MMDL101T1

Schottky Barrier Diode

Schottky barrier diodes are designed primarily for high–efficiency UHF and VHF detector applications. Readily available to many other fast switching RF and digital applications.

- Very Low Capacitance — Less than 1.0 pF @ Zero Volts
- Low Noise Figure — 6.0 dB Typ @ 1.0 GHz
- Device Marking: 4M

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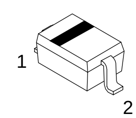
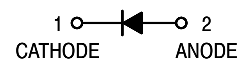
1.0 pF SCHOTTKY BARRIER DIODE



PLASTIC
SOD–323
CASE 477



MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Reverse Voltage	7.0	Vdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* $T_A = 25°C$	200	mW
	Derate above 25°C	1.57	mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature Range	–55 to +150	°C

*FR–5 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMDL101T1	SOD–323	3000 / Tape & Reel

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage ($I_R = 10\ \mu A$)	$V_{(BR)R}$	7.0	10	—	Volts
Diode Capacitance ($V_R = 0$, f = 1.0 MHZ, Note 1)	C_T	—	0.88	1.0	pF
Reverse Leakage ($V_R = 3.0$ V)	I_R	—	20	250	nAdc
Noise Figure (f = 1.0 GHz, Note 2)	NF	—	6.0	—	dB
Forward Voltage ($I_F = 10$ mA)	V_F	—	0.5	0.6	Vdc

*Notes on Next Page

January, 2000 – Rev. 0
Publication Order Number:
MMDL101T1/D

TYPICAL CHARACTERISTICS

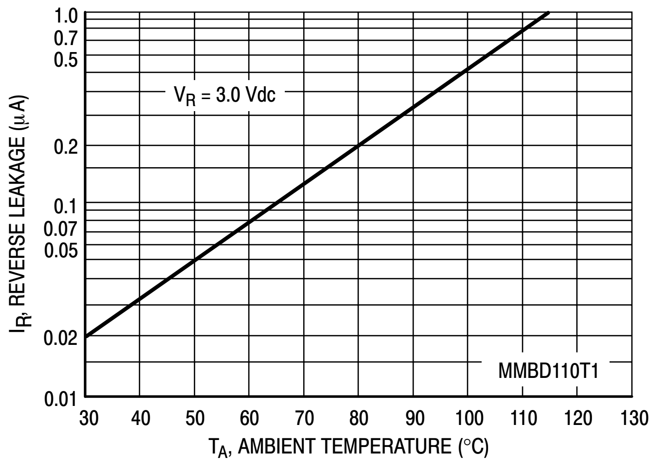


Figure 1. Reverse Leakage

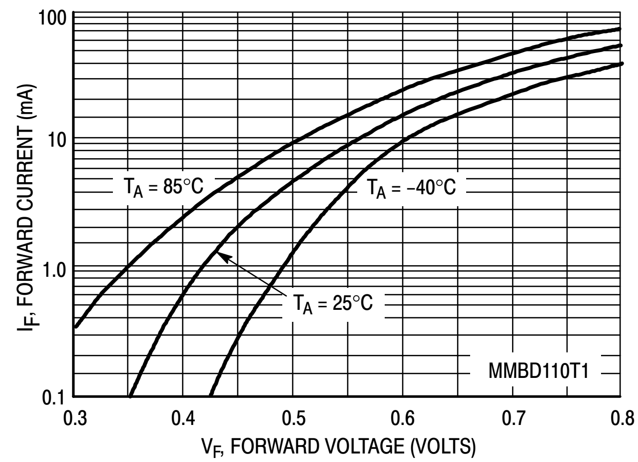


Figure 2. Forward Voltage

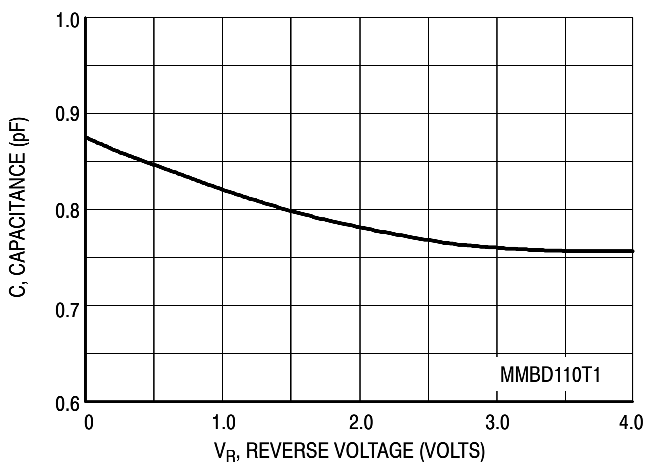


Figure 3. Capacitance

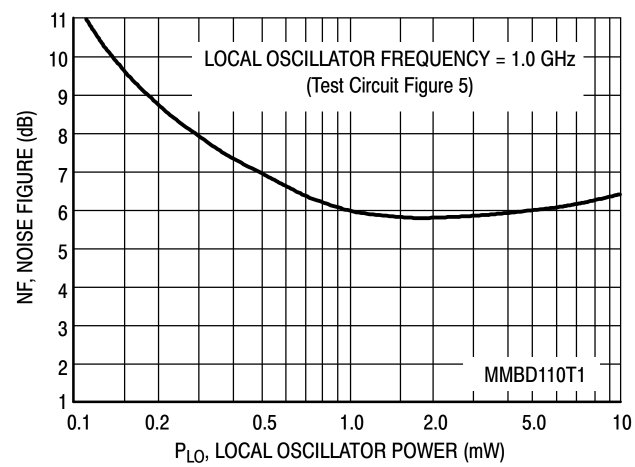


Figure 4. Noise Figure

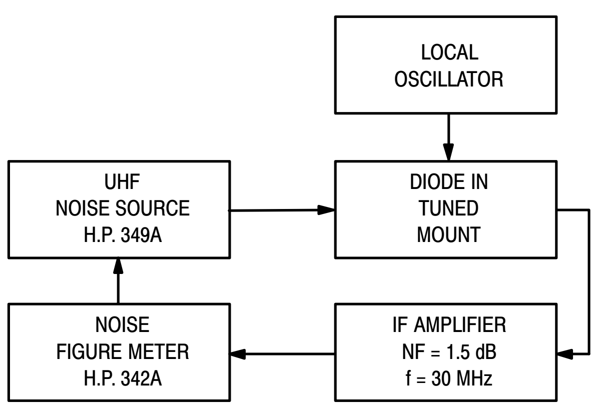


Figure 5. Noise Figure Test Circuit

NOTES ON TESTING AND SPECIFICATIONS

Note 1 — C_C and C_T are measured using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

Note 2 — Noise figure measured with diode under test in tuned diode mount using UHF noise source and local oscillator (LO) frequency of 1.0 GHz. The LO power is adjusted for 1.0 mW. IF amplifier NF = 1.5 dB, f = 30 MHz, see Figure 5.

MMDL301T1

Preferred Device

Silicon Hot-Carrier Diodes

Schottky Barrier Diode

These devices are designed primarily for high–efficiency UHF and VHF detector applications. They are readily adaptable to many other fast switching RF and digital applications. They are supplied in an inexpensive plastic package for low–cost, high–volume consumer and industrial/commercial requirements. They are available in a Surface Mount package.

- Extremely Low Minority Carrier Lifetime – 15 ps (Typ)
- Very Low Capacitance – 1.5 pF (Max) @ V_R = 15 V
- Low Reverse Leakage – I_R = 13 nAdc (Typ)
- Device Marking: 4T

ON Semiconductor™

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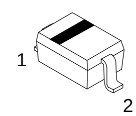
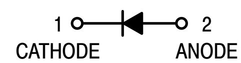
30 VOLTS SILICON HOT–CARRIER DETECTOR AND SWITCHING DIODES



PLASTIC
SOD–323
CASE 477



MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

Symbol	Rating	Value	Unit
V_R	Reverse Voltage	30	Volts

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C Derate above 25°C	200 1.57	mW mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature Range	–55 to +150	°C

*FR–5 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMDL301T1	SOD–323	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	30	—	—	Volts
Total Capacitance (V_R = 15 V, f = 1.0 MHz) Figure 1	C_T	—	0.9	1.5	pF
Reverse Leakage (V_R = 25 V) Figure 3	I_R	—	13	200	nAdc
Forward Voltage (I_F = 1.0 mAdc) Figure 4	V_F	—	0.38	0.45	Vdc
Forward Voltage (I_F = 10 mAdc) Figure 4	V_F	—	0.52	0.6	Vdc

January, 2000 – Rev. 0

Publication Order Number:
MMDL301T1/D

TYPICAL ELECTRICAL CHARACTERISTICS

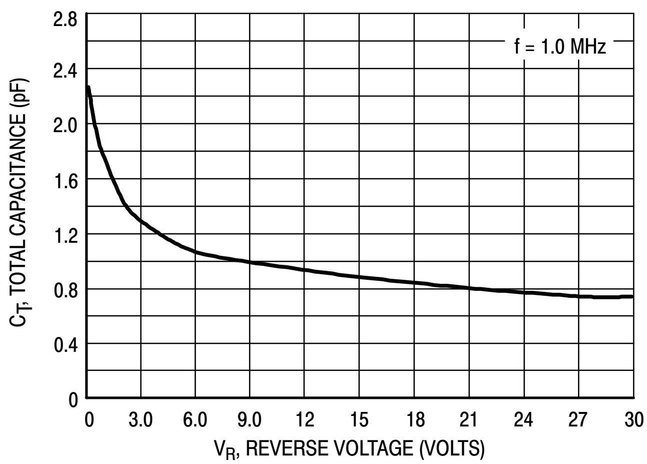


Figure 1. Total Capacitance

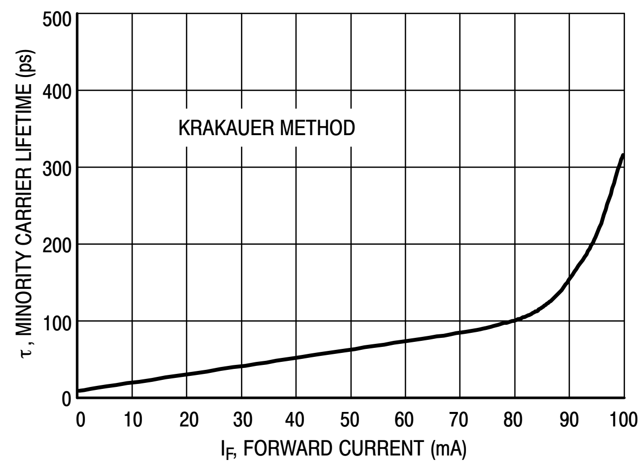


Figure 2. Minority Carrier Lifetime

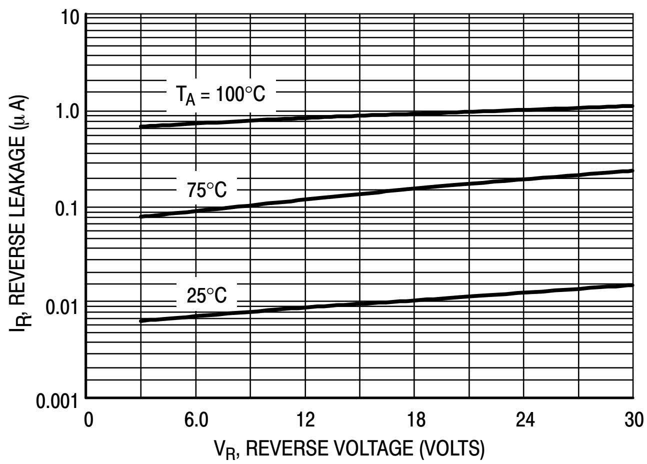


Figure 3. Reverse Leakage

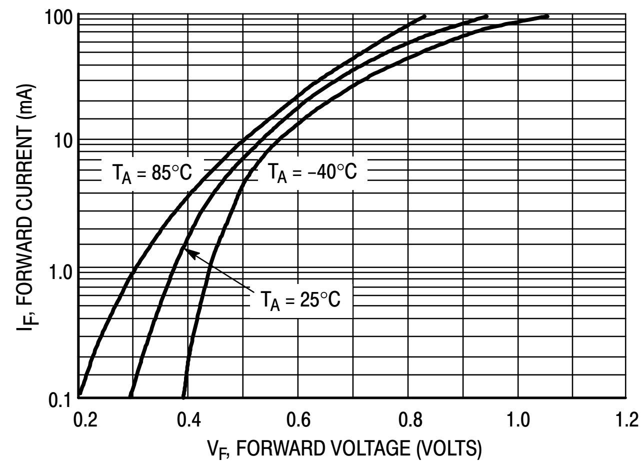


Figure 4. Forward Voltage

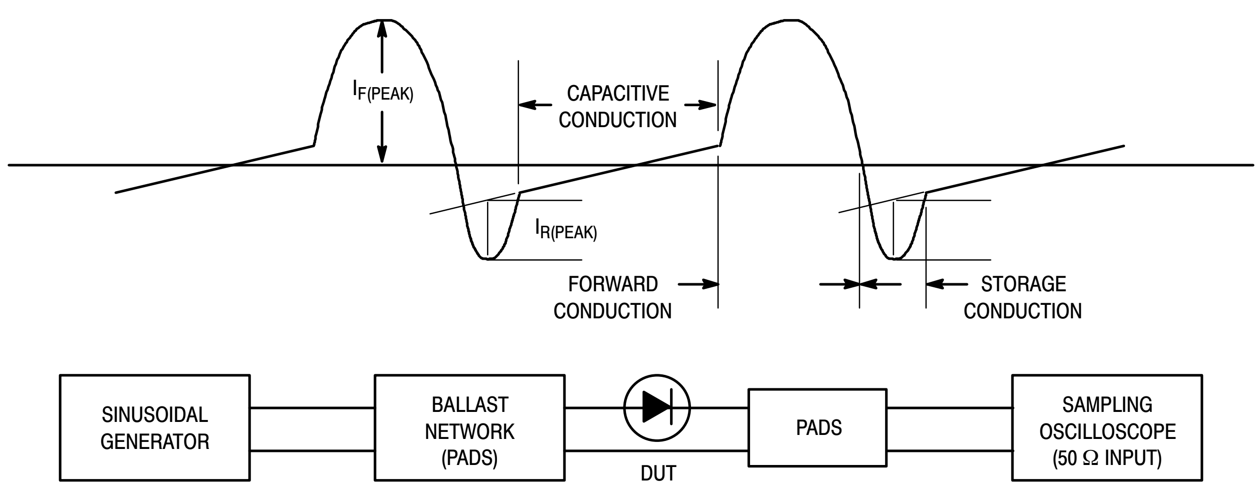


Figure 5. Krakauer Method of Measuring Lifetime

Switching Diode

MMDL6050T1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

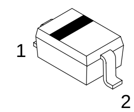
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	200 1.57	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	635	°C/W
Junction and Storage Temperature	T_J, T_{stg}	150	°C

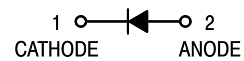
*FR-4 Minimum Pad

DEVICE MARKING

MMDL6050T1 = 5A



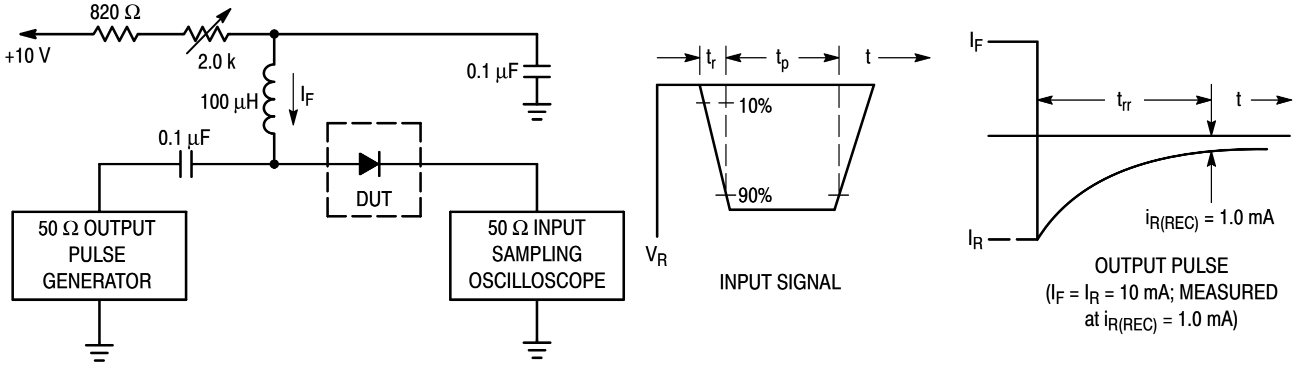
CASE 477–02, STYLE 1
SOD–323



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	70	–	Vdc
Reverse Voltage Leakage Current (V_R = 50 Vdc)	I_R	–	0.1	μAdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 100 mAdc)	V_F	 0.55 0.85	 0.7 1.1	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	–	4.0	ns
Capacitance (V_R = 0 V)	C	–	2.5	pF

June, 2001 – Rev. 1
Publication Order Number:
MMDL6050T1/D



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

TYPICAL CHARACTERISTICS

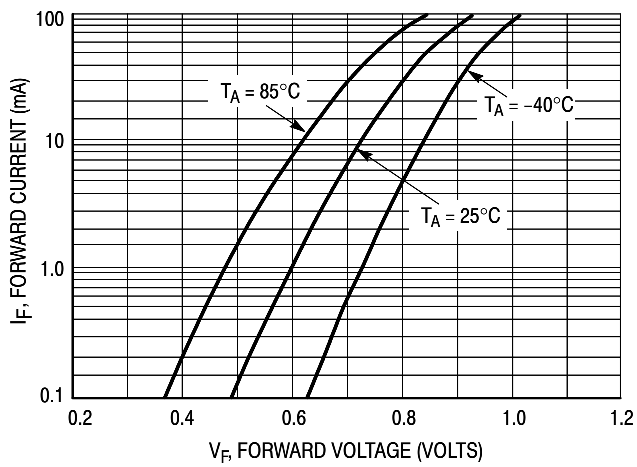


Figure 2. Forward Voltage

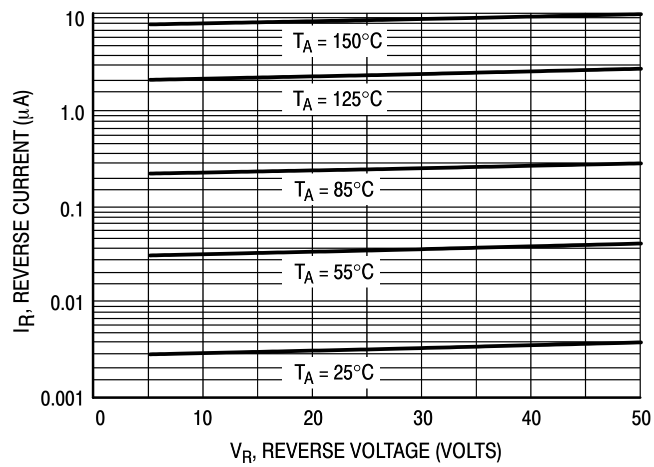


Figure 3. Leakage Current

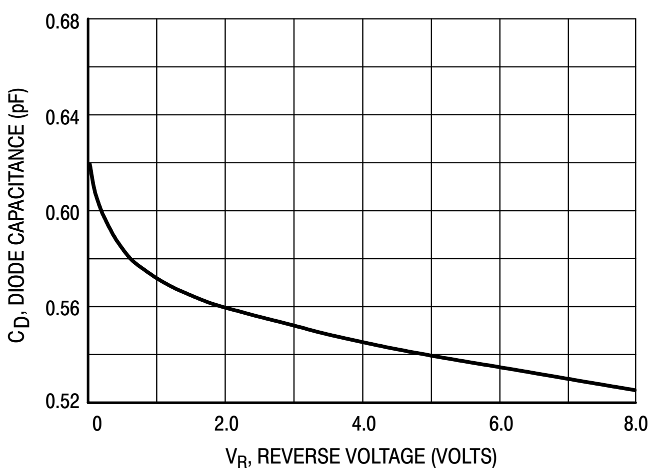


Figure 4. Capacitance

MMDL770T1

Schottky Barrier Diode

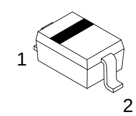
Schottky barrier diodes are designed primarily for high–efficiency UHF and VHF detector applications. Readily available to many other fast switching RF and digital applications.

- Extremely Low Minority Carrier Lifetime
- Very Low Capacitance – 1.0 pF @ 20 V
- Low Reverse Leakage – 200 nA (max)
- High Reverse Voltage – 70 Volts (min)
- Available in 8 mm Tape and Reel
- Device Marking: 5H

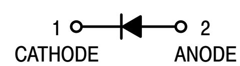
ON Semiconductor™

http://onsemi.com

1.0 pF SCHOTTKY BARRIER DIODE



PLASTIC
SOD–323
CASE 477



MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Reverse Voltage	70	Vdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C Derate above 25°C	200 1.57	mW mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature Range	–55 to +150	°C

*FR–5 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMDL770T1	SOD–323	3000 / Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	70	–	–	Volts
Diode Capacitance (V_R = 20 Volts, f = 1.0 MHZ)	C_T	–	0.5	1.0	pF
Reverse Leakage (V_R = 35 V)	I_R	–	9.0	200	nAdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mA)	V_F	–	0.7	1.0	Vdc

TYPICAL CHARACTERISTICS

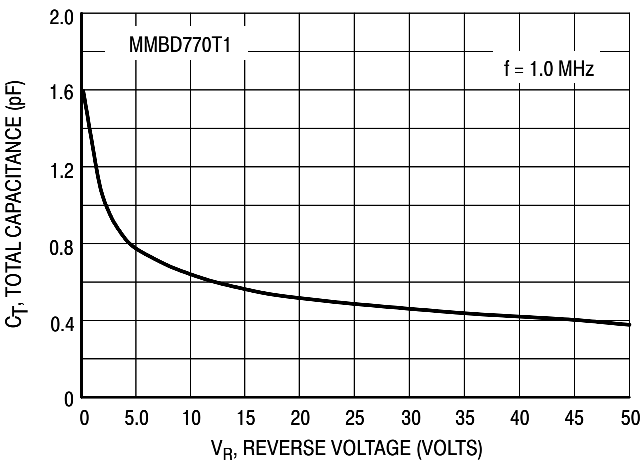


Figure 1. Total Capacitance

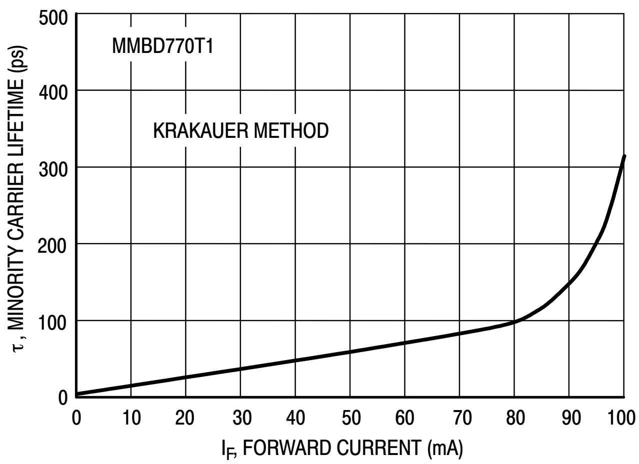


Figure 2. Minority Carrier Lifetime

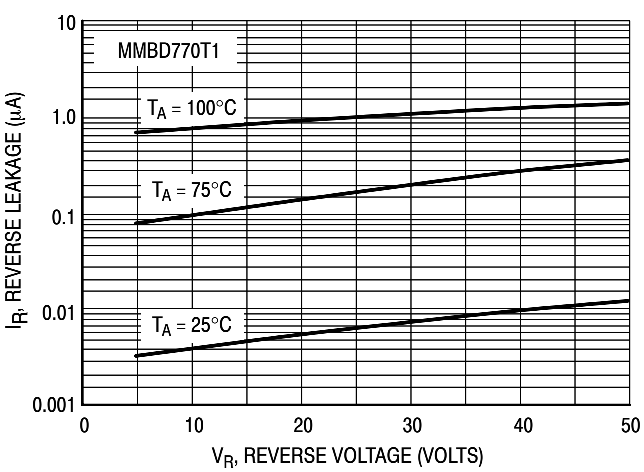


Figure 3. Reverse Leakage

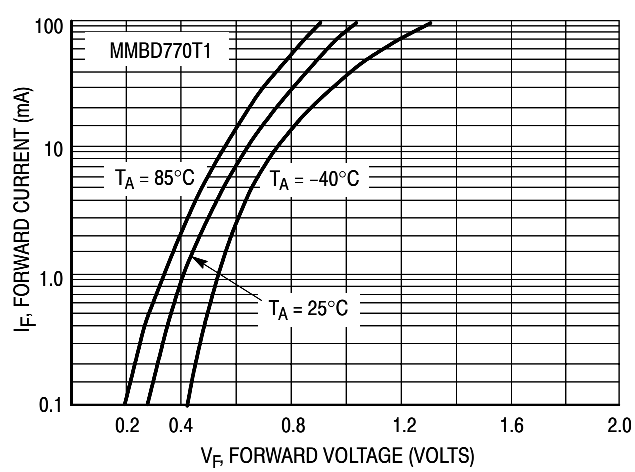
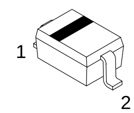


Figure 4. Forward Voltage

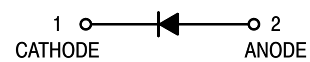
High-Speed Switching Diode

MMDL914T1

ON Semiconductor Preferred Device



CASE 477–02, STYLE 1
SOD–323



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	100	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	200 1.57	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	635	°C/W
Junction and Storage Temperature	T_J, T_{stg}	150	°C

*FR-4 Minimum Pad

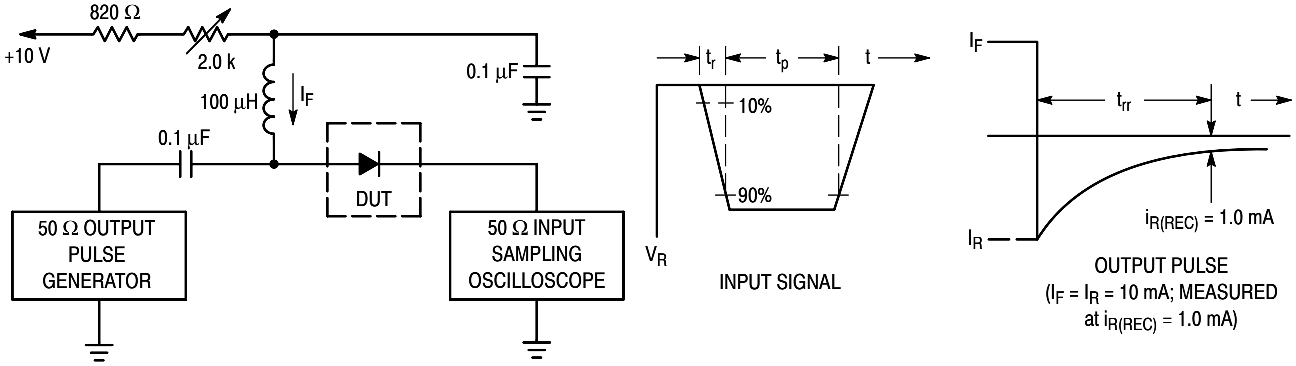
DEVICE MARKING

MMDL914T1 = 5D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage (I_R = 100 μAdc)	$V_{(BR)}$	100	–	Vdc
Reverse Voltage Leakage Current (V_R = 20 Vdc) (V_R = 75 Vdc)	I_R	 – –	 25 5.0	 nAdc μAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_T	–	4.0	pF
Forward Voltage (I_F = 10 mAdc)	V_F	–	1.0	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc) (Figure 1)	t_{rr}	–	4.0	ns

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

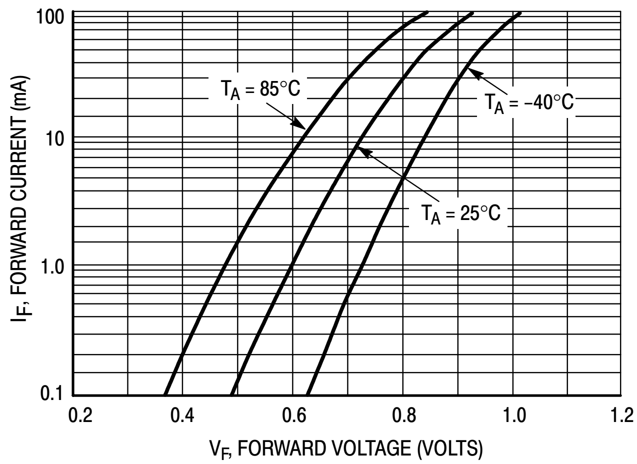


Figure 2. Forward Voltage

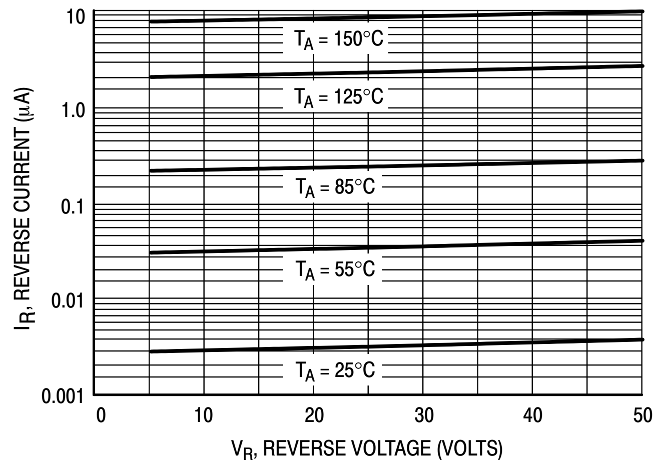


Figure 3. Leakage Current

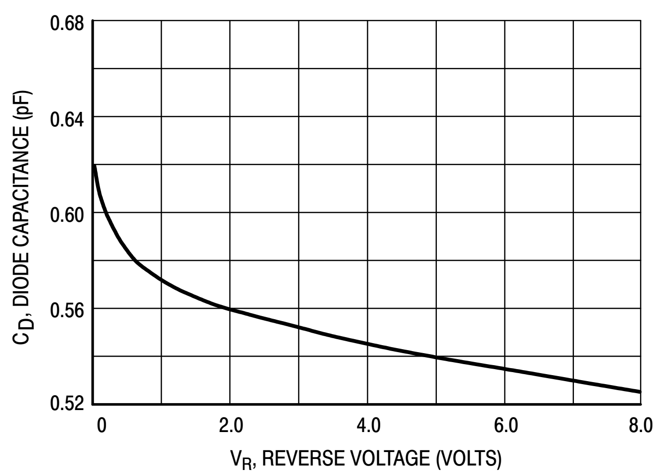


Figure 4. Capacitance

MMPQ2222A

Preferred Device

Quad General Purpose Transistor

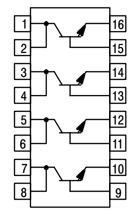
NPN Silicon

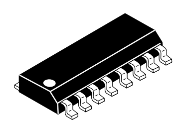
ON Semiconductor™

http://onsemi.com

MAXIMUM RATINGS

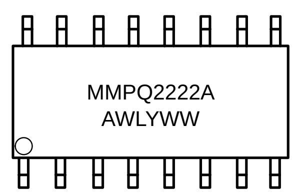
Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CB}	75	Vdc
Emitter–Base Voltage	V_{EB}	5.0	Vdc
Collector Current – Continuous	I_C	500	mAdc
		Four Transistors Equal Power	
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	 1.0 8.0	Watts mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	 2.4 19.2	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C





SO–16
CASE 751B
STYLE 4

MARKING DIAGRAM



MMPQ2222A = Specific Device Code
A = Assembly Location
WL = Wafer Lot
Y = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping
MMPQ2222A	SO–16	48 Units/Rail

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (Note 1.) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	–	–	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	75	–	–	Vdc
Emitter–Base Breakdown Voltage (I_B = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0 –	– –	– –	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 60 Vdc, I_E = 0)	I_{CBO}	 – –	 – –	 50 10	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	–	–	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (Note 1.) (I_C = 100 μA, V_{CE} = 10 V) (I_C = 1.0 mA, V_{CE} = 10 V) (I_C = 10 mA, V_{CE} = 10 V) (I_C = 150 mA, V_{CE} = 10 V) (I_C = 500 mA, V_{CE} = 10 V) (I_C = 150 mA, V_{CE} = 1.0 V)	h_{FE}	 35 50 75 100 40 50	 – – – – – –	 – – – 300 – –	–
Collector–Emitter Saturation Voltage (Note 1.) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	 – –	 – –	 0.3 1.0	Vdc
Base–Emitter Saturation Voltage (Note 1.) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{BE(sat)}$	 – –	 – –	 1.2 2.0	Vdc
DYNAMIC CHARACTERISTICS					
Current–Gain – Bandwidth Product (Note 1.) (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	350	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	4.5	–	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	–	17	–	pF
SWITCHING CHARACTERISTICS					
Turn–On Time (V_{CC} = 30 Vdc, $V_{BE(off)}$ = –0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_{on}	–	25	–	ns
Turn–Off Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_{off}	–	250	–	ns

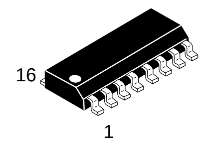
1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

MMPQ2369

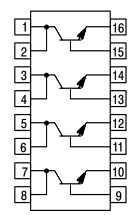
ON Semiconductor Preferred Device

Quad Switching Transistor

NPN Silicon



CASE 751B–05, STYLE 4
SO–16



MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector–Emitter Voltage	V_{CEO}	15		Vdc
Collector–Base Voltage	V_{CB}	40		Vdc
Emitter–Base Voltage	V_{EB}	4.5		Vdc
Collector Current — Continuous	I_C	500		mAdc
		Each Transistor	**Four Transistors Equal Power**	
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.4 3.2	0.72 6.4	Watts mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.66 5.3	1.92 15.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	—	0.4	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain[1]	h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		40	—	—	
(I_C = 100 mAdc, V_{CE} = 2.0 Vdc)		20	—	—	
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	—	0.25	Vdc
Base–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	—	0.9	Vdc
DYNAMIC CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	450	550	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	2.5	4.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	—	3.0	5.0	pF
SWITCHING CHARACTERISTICS					
Turn–On Time (V_{CC} = 3.0 Vdc, $V_{EB(off)}$ = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc)	t_{on}	—	9.0	—	ns
Turn–Off Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 1.5 mAdc)	t_{off}	—	15	—	ns

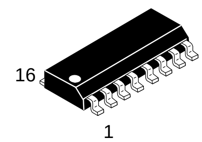
1. Pulse Test: Pulse Width $\leq$ 300 μs; Duty Cycle $\leq$ 2.0%.

Quad Memory Driver Transistor

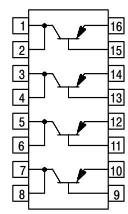
PNP Silicon

MMPQ3467

ON Semiconductor Preferred Device



CASE 751B–05, STYLE 4
SO–16



MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector–Emitter Voltage	V_{CEO}	–40		Vdc
Collector–Base Voltage	V_{CB}	–40		Vdc
Emitter–Base Voltage	V_{EB}	–5.0		Vdc
Collector Current — Continuous	I_C	–1.0		Adc
		Each Transistor	**Four Transistors Equal Power**	
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.52 4.2	1.2 9.6	Watts mW/°C
Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage[(1)] (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–40	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = –10 μAdc, I_E = 0)	$V_{(BR)CBO}$	–40	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = –30 Vdc, I_E = 0)	I_{CBO}	—	—	–200	nAdc
Emitter Cutoff Current (V_{EB} = –3.0 Vdc, I_C = 0)	I_{EBO}	—	—	–200	nAdc

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 3

Publication Order Number:
MMPQ3467/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

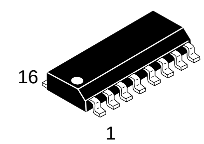
Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain[(1)] (I_C = –500 mAdc, V_{CE} = –1.0 Vdc)	h_{FE}	20	—	—	—
Collector–Emitter Saturation Voltage[(1)] (I_C = –500 mAdc, I_B = –50 mAdc)	$V_{CE(sat)}$	—	–0.23	–0.5	Vdc
Base–Emitter Saturation Voltage[(1)] (I_C = –500 mAdc, I_B = –50 mAdc)	$V_{BE(sat)}$	—	–0.9	–1.2	Vdc
DYNAMIC CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = –50 mAdc, V_{CE} = –10 Vdc, f = 100 MHz)	f_T	—	190	—	MHz
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	10	—	pF
Input Capacitance (V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	—	55	—	pF
SWITCHING CHARACTERISTICS					
Turn–On Time (I_C = –500 mAdc, I_{B1} = –50 mAdc)	t_{on}	—	20	—	ns
Turn–Off Time (I_C = –500 mAdc, I_{B1} = I_{B2} = –50 mAdc)	t_{off}	—	60	—	ns

1. Pulse Test: Pulse Width $\leq$ 300 μs; Duty Cycle $\leq$ 2.0%.

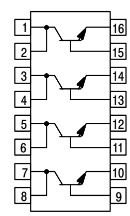
Quad Amplifier/Switch Transistor
NPN Silicon

MMPQ3904

ON Semiconductor Preferred Device



CASE 751B–05, STYLE 4
SO–16



MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector–Emitter Voltage	V_{CEO}	40		Vdc
Collector–Base Voltage	V_{CB}	60		Vdc
Emitter–Base Voltage	V_{EB}	6.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
		Each Transistor	**Four Transistors Equal Power**	
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	 0.4 3.2	 800 6.4	 mW mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	 0.66 5.3	 1.92 15.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage[(1)] (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	—	50	nAdc

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain	h_{FE}				—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)		30	90	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)		50	160	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		75	200	—	
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.1	0.2	Vdc
Base–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	0.65	0.85	Vdc
DYNAMIC CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	250	300	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	2.0	4.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	—	4.0	8.0	pF
SWITCHING CHARACTERISTICS					
Turn–On Time (I_C = 10 Vdc, $V_{BE(off)}$ = –0.5 Vdc, I_{B1} = 1.0 mAdc)	t_{on}	—	37	—	ns
Turn–Off Time (I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_{off}	—	136	—	ns

1. Pulse Test: Pulse Width $\leq$ 300 μs; Duty Cycle $\leq$ 2.0%.

Quad Amplifier/Switch Transistor

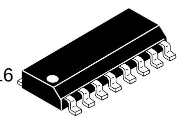
PNP Silicon

MMPQ3906

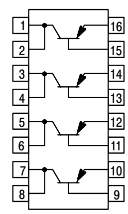
ON Semiconductor Preferred Device

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector–Emitter Voltage	V_{CEO}	–40		Vdc
Collector–Base Voltage	V_{CB}	–40		Vdc
Emitter–Base Voltage	V_{EB}	–5.0		Vdc
Collector Current — Continuous	I_C	–200		mAdc
		Each Transistor	**Four Transistors Equal Power**	
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.4 3.2	800 6.4	mW mW/°C
Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.66 5.3	1.92 15.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C



CASE 751B–05, STYLE 4
SO–16



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(1) (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–40	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = –10 μAdc, I_E = 0)	$V_{(BR)CBO}$	–40	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = –30 Vdc, I_E = 0)	I_{CBO}	—	—	–50	nAdc
Emitter Cutoff Current (V_{EB} = –4.0 Vdc, I_C = 0)	I_{EBO}	—	—	–50	nAdc

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 2
Publication Order Number:
MMPQ3906/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain	h_{FE}				—
(I_C = –0.1 mAdc, V_{CE} = –1.0 Vdc)		40	160	—	
(I_C = –1.0 mAdc, V_{CE} = –1.0 Vdc)		60	180	—	
(I_C = –10 mAdc, V_{CE} = –1.0 Vdc)		75	200	—	
Collector–Emitter Saturation Voltage (I_C = –10 mAdc, I_B = –1.0 mAdc)	$V_{CE(sat)}$	—	–0.1	–0.25	Vdc
Base–Emitter Saturation Voltage (I_C = –10 mAdc, I_B = –1.0 mAdc)	$V_{BE(sat)}$	—	–0.65	–0.85	Vdc
DYNAMIC CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)	f_T	200	250	—	MHz
Output Capacitance (V_{CB} = –5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	3.3	4.5	pF
Input Capacitance (V_{EB} = –0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	—	4.8	10	pF
SWITCHING CHARACTERISTICS					
Turn–On Time (I_C = –10 mAdc, $V_{BE(off)}$ = 0.5 Vdc, I_{B1} = –1.0 mAdc)	t_{on}	—	43	—	ns
Turn–Off Time (I_C = –10 mAdc, I_{B1} = I_{B2} = –1.0 mAdc)	t_{off}	—	155	—	ns

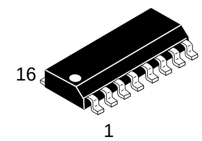
1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

Quad Complementary Pair Transistor

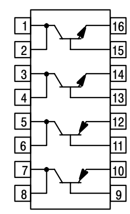
PNP/NPN Silicon

MMPQ6700

Voltage and current are negative for PNP transistors



CASE 751B–05, STYLE 4
SO–16



MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector–Emitter Voltage	V_{CEO}	40		Vdc
Collector–Base Voltage	V_{CB}	40		Vdc
Emitter–Base Voltage	V_{EB}	5.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
		Each Transistor	**Four Transistors Equal Power**	
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.4 3.2	0.72 6.4	Watts mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.66 5.3	1.92 15.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage[(1)] (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	50	nAdc
ON CHARACTERISTICS[(1)]				
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	 35 50 70	 — — —	—
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.25	Vdc
Base–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	0.9	Vdc
DYNAMIC CHARACTERISTICS				
Current–Gain — Bandwidth Product[(1)] (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	4.5	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz) PNP NPN	C_{ib}	 — —	 10 8.0	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MMSD103T1

Preferred Device

High Voltage Switching Diode

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	250	Vdc
Peak Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	625	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Forward Power Dissipation, FR–5 Board (Note 1.) @ T_A = 25°C Derate above 25°C	P_F	400 3.2	mW mW/°C
Thermal Resistance, Junction to Case	$R_{\theta JL}$	174	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	492	°C/W
Junction Temperature	T_J	125 Max	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

1. FR–5 = 1.0 × 0.75 × 0.062 in.

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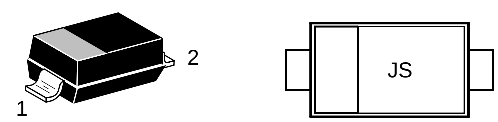
MARKING DIAGRAM



CASE 425–04, STYLE 1
SOD–123

JS = Specific Device Code

ORDERING INFORMATION

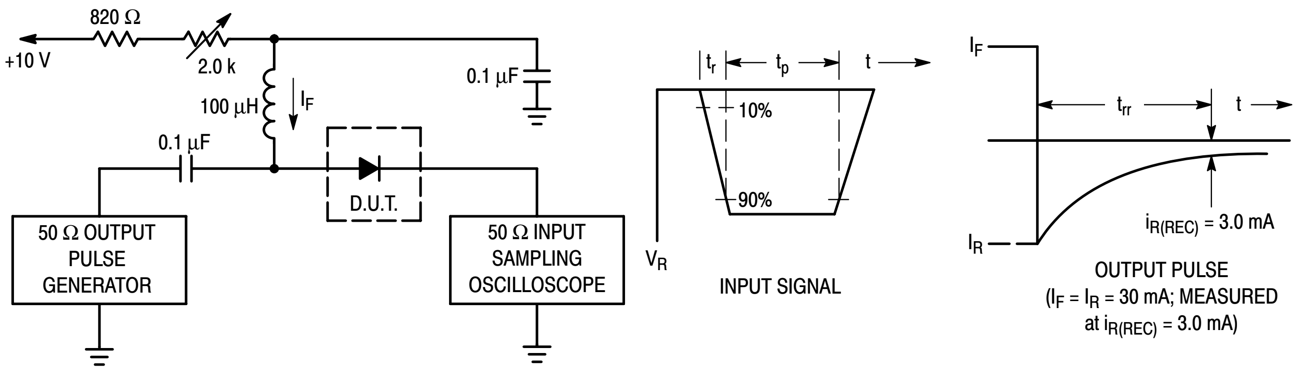
Device	Package	Shipping
MMSD103T1	SOD–123	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Voltage Leakage Current (V_R = 200 Vdc) (V_R = 200 Vdc, T_J = 150°C)	I_R	— —	1.0 100	μAdc
Reverse Breakdown Voltage (I_{BR} = 100 μAdc)	$V_{(BR)}$	250	—	Vdc
Forward Voltage (I_F = 100 mAdc) (I_F = 200 mAdc)	V_F	— —	1000 1250	mV
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	5.0	pF
Reverse Recovery Time (I_F = I_R = 30 mAdc, R_L = 100 Ω)	t_{rr}	—	50	ns

August, 2000 – Rev. 0
Publication Order Number:
MMSD103T1/D



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 30 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 30 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

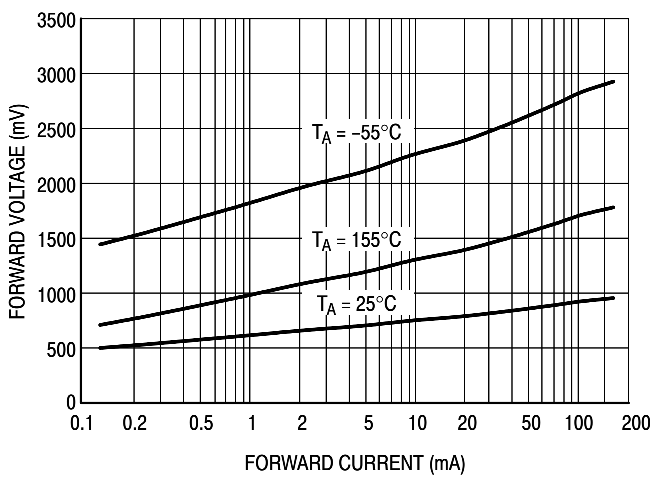


Figure 2. Forward Voltage

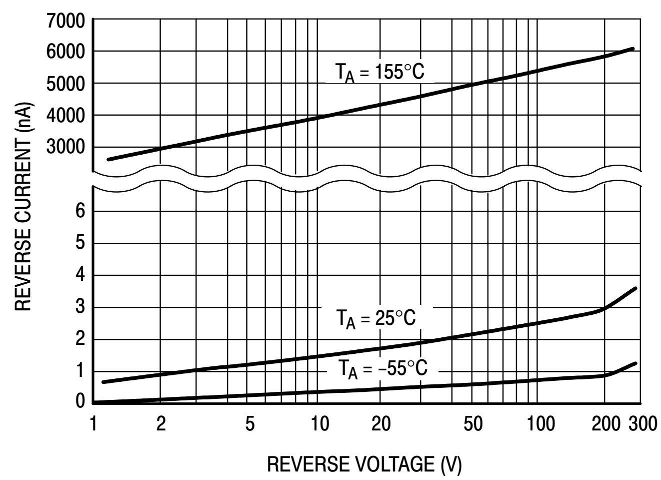


Figure 3. Reverse Leakage

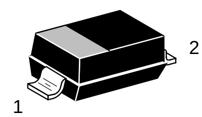
SOD-123 Schottky Barrier Diodes

The MMSD301T1, and MMSD701T1 devices are spin–offs of our popular MMBD301LT1, and MMBD701LT1 SOT–23 devices. They are designed for high–efficiency UHF and VHF detector applications. Readily available to many other fast switching RF and digital applications.

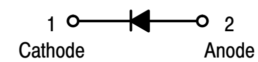
- Extremely Low Minority Carrier Lifetime
- Very Low Capacitance
- Low Reverse Leakage

MMSD301T1
MMSD701T1

ON Semiconductor Preferred Devices



CASE 425–04, STYLE 1
SOD–123



MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Reverse Voltage	MMSD301T1 MMSD701T1	V_R	30 70	Vdc
Forward Power Dissipation $T_A = 25°C$		P_F	225	mW
Junction Temperature		T_J	–55 to +125	°C
Storage Temperature Range		T_{stg}	–55 to +150	°C

DEVICE MARKING

MMSD301T1 = XT, MMSD701T1 = XH

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage ($I_R = 10\ \mu A$)	 MMSD301T1 MMSD701T1	$V_{(BR)R}$	 30 70	 — —	 — —	Volts
Diode Capacitance ($V_R = 0$, f = 1.0 MHz, Note 1)	 MMSD301T1 MMSD701T1	C_T	 — —	 0.9 0.5	 1.5 1.0	pF
Total Capacitance ($V_R = 15$ Volts, f = 1.0 MHz) ($V_R = 20$ Volts, f = 1.0 MHz)	 MMSD301T1 MMSD701T1	C_T	 — —	 0.9 0.5	 1.5 1.0	pF
Reverse Leakage ($V_R = 25$ V) ($V_R = 35$ V)	 MMSD301T1 MMSD701T1	I_R	 — —	 13 9.0	 200 200	 nAdc nAdc
Forward Voltage ($I_F = 1.0$ mAdc) ($I_F = 10$ mA) ($I_F = 1.0$ mAdc) ($I_F = 10$ mA)	 MMSD301T1 MMSD701T1 	V_F	 — — — —	 0.38 0.52 0.42 0.7	 0.45 0.6 0.5 1.0	Vdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

September, 2001 – Rev. 2

Publication Order Number:
MMSD301T1/D

TYPICAL CHARACTERISTICS
MMSD301T1

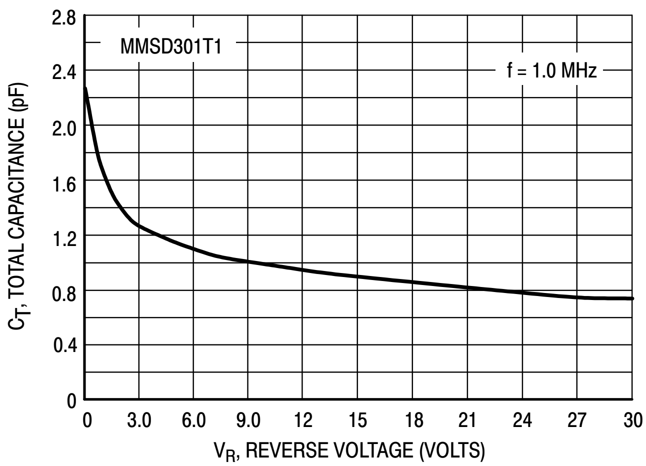


Figure 1. Total Capacitance

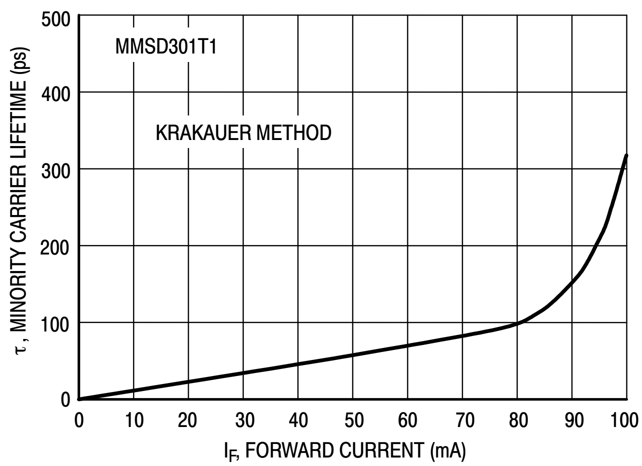


Figure 2. Minority Carrier Lifetime

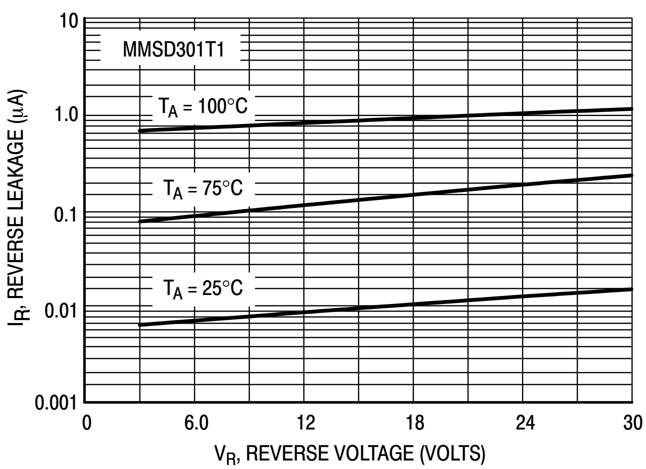


Figure 3. Reverse Leakage

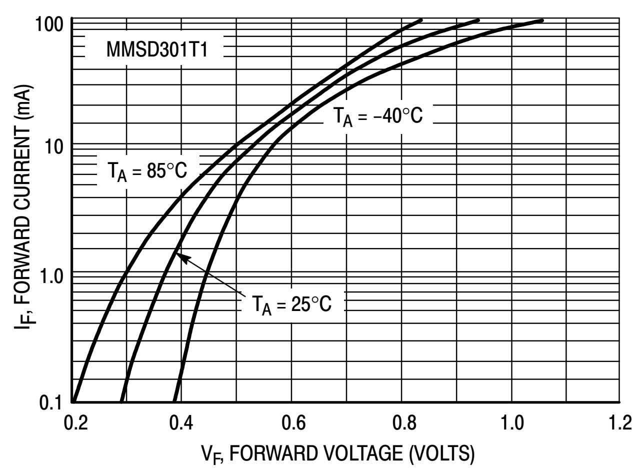


Figure 4. Forward Voltage

TYPICAL CHARACTERISTICS
MMSD701T1

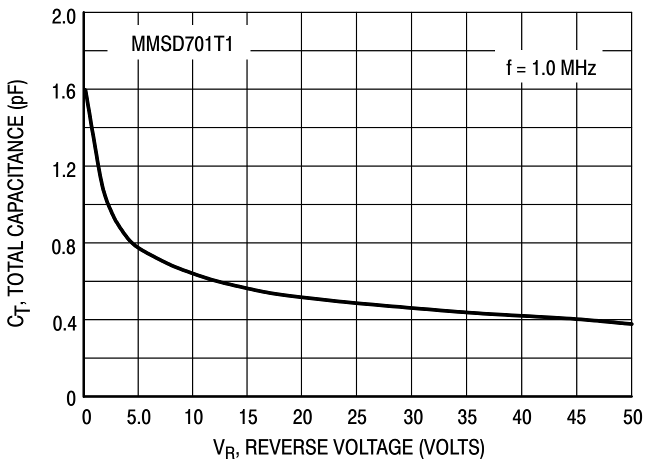


Figure 5. Total Capacitance

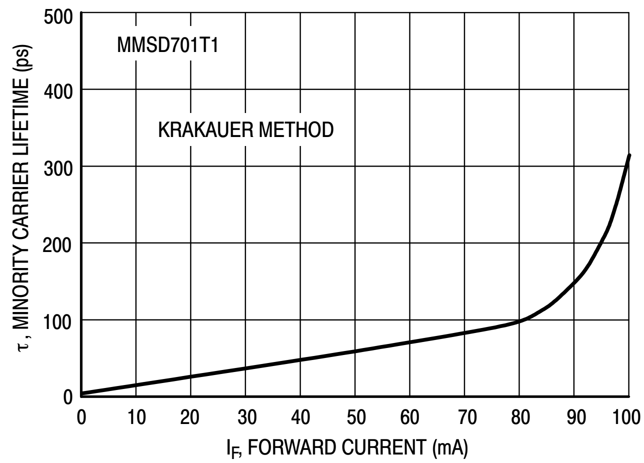


Figure 6. Minority Carrier Lifetime

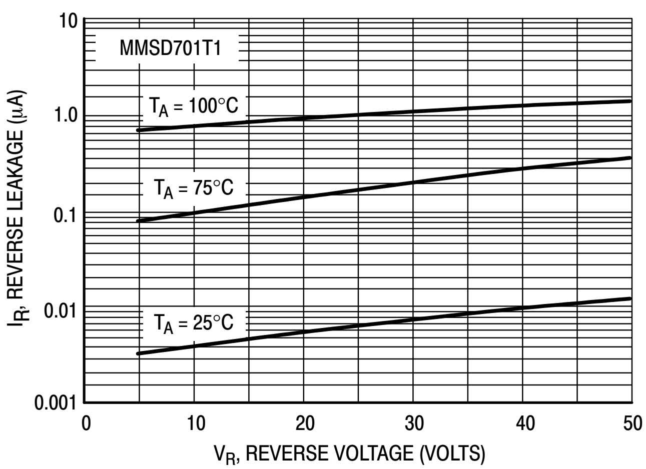


Figure 7. Reverse Leakage

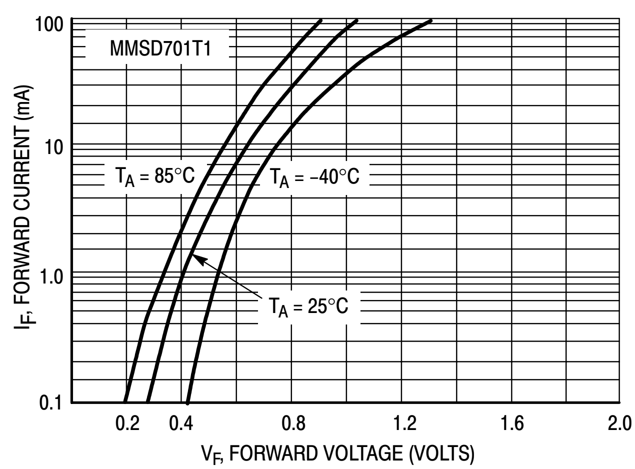


Figure 8. Forward Voltage

MMSD4148T1

Switching Diode

The switching diode has the following features:

- SOD–123 Surface Mount Package
- High Breakdown Voltage
- Fast Speed Switching Time
- Available in 8 mm Tape and Reel

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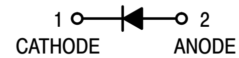
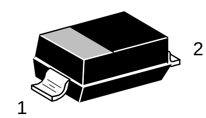
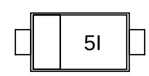




PLASTIC
SOD–123
CASE 425

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
MMSD4148T1	SOD–123	3000 / Tape & Reel

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	100	Vdc
Peak Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

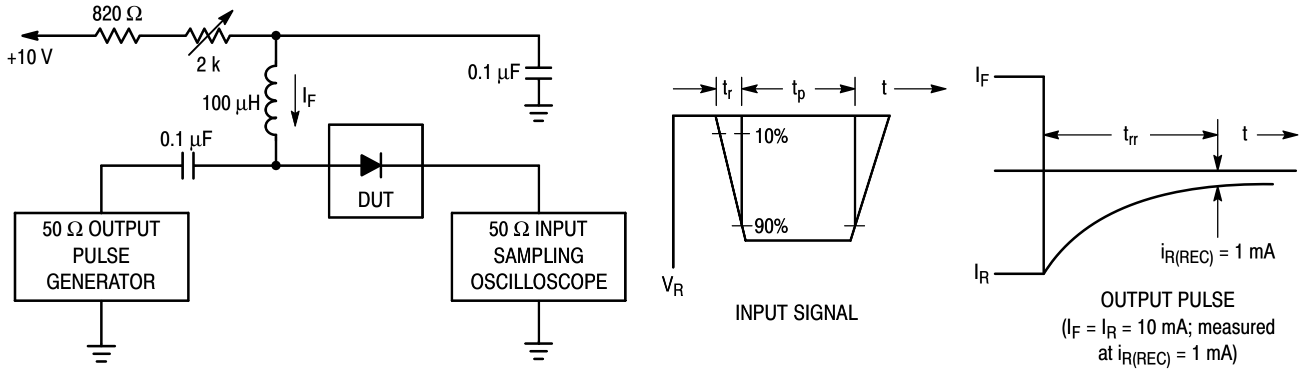
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board (1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate (2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage (I_{BR} = 100 μAdc)	$V_{(BR)}$	100	—	Vdc
Reverse Voltage Leakage Current (V_R = 20 Vdc) (V_R = 75 Vdc)	I_R	— —	25 5.0	nAdc μAdc
Forward Voltage (I_F = 10 mAdc)	V_F	—	1000	mVdc
Diode Capacitance (V_R = 0 Vdc, f = 1.0 MHz)	C_D	—	4.0	pF
Reverse Recovery Time (I_F = I_R = 10 mAdc) (Figure 1)	t_{rr}	—	4.0	ns

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

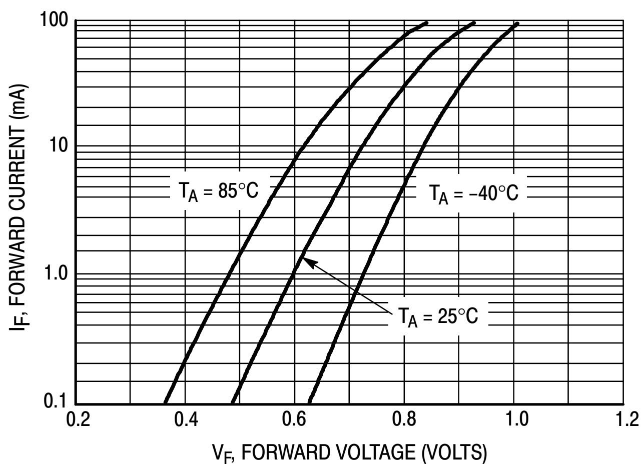


Figure 2. Forward Voltage

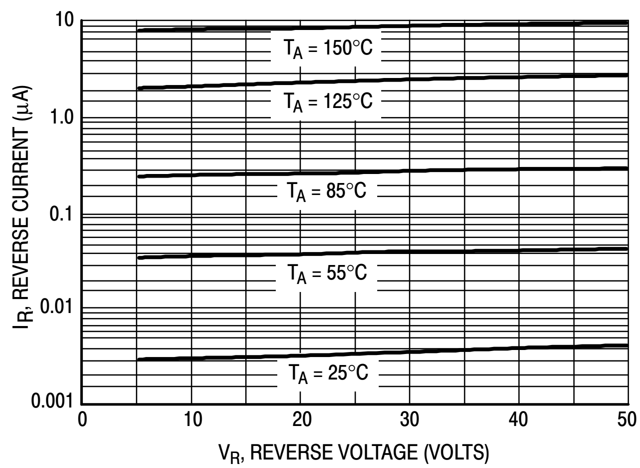


Figure 3. Leakage Current

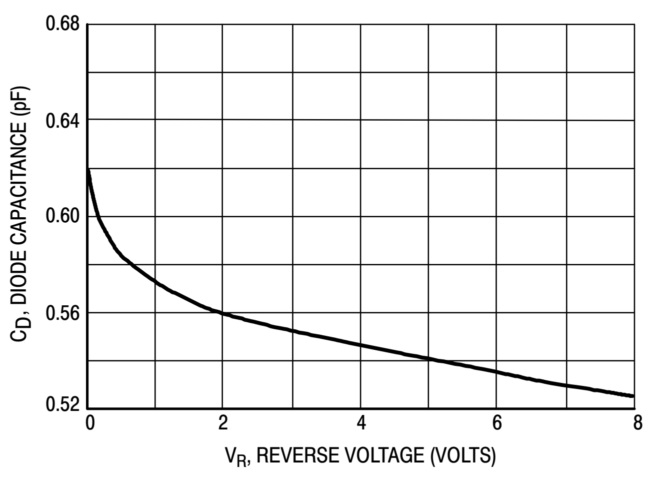


Figure 4. Capacitance

MMSD71RKT1

Switching Diode

The switching diode has the following features:

- SOD–123 Surface Mount Package
- High Breakdown Voltage
- Fast Speed Switching Time
- Available in 8 mm Tape and Reel

ON Semiconductor™

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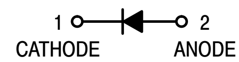
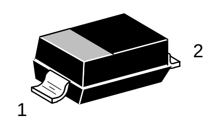
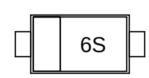




PLASTIC
SOD–123
CASE 425

DEVICE MARKING



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	80	Vdc
Peak Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board (1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate (2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

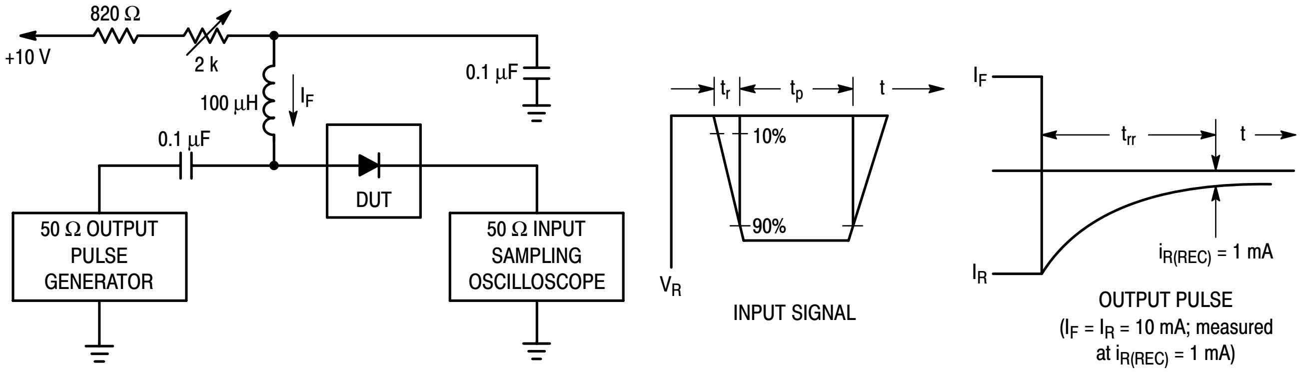
ORDERING INFORMATION

Device	Package	Shipping
MMSD71RKT1	SOD–123	3000 / Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage (I_{BR} = 100 μAdc)	$V_{(BR)}$	80	–	Vdc
Reverse Voltage Leakage Current (V_R = 80 Vdc)	I_R	–	500	nAdc
Forward Voltage (I_F = 100 mAdc)	V_F	–	1200	mVdc
Diode Capacitance (V_R = 0.5 Vdc, f = 1.0 MHz)	C_D	–	2.0	pF
Reverse Recovery Time (I_F = I_R = 10 mAdc) (Figure 1)	t_{rr}	–	4.0	ns

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

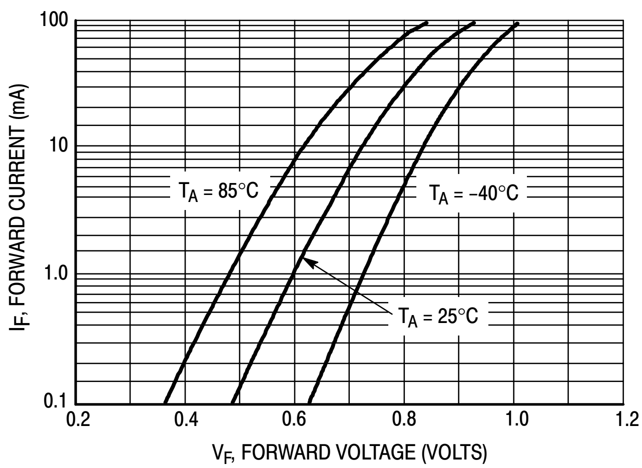


Figure 2. Forward Voltage

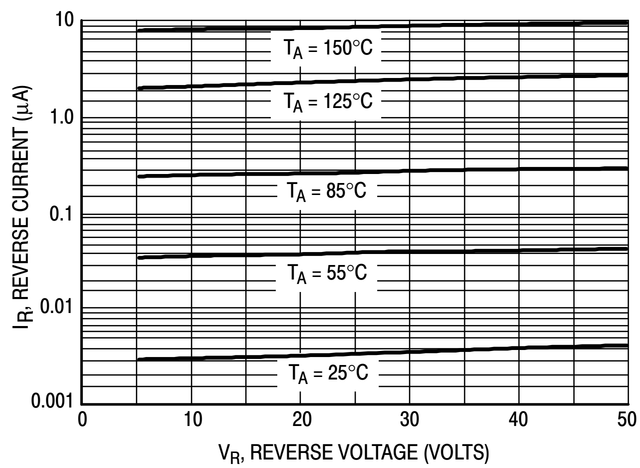


Figure 3. Leakage Current

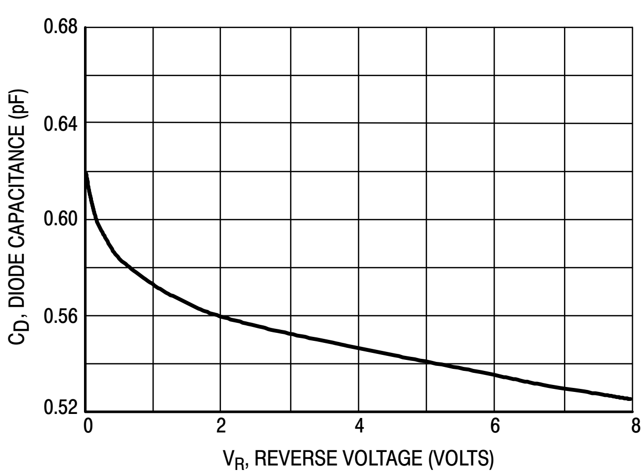


Figure 4. Capacitance

MMSD914T1

Preferred Device

Switching Diode

The switching diode has the following features:

- SOD–123 Surface Mount Package
- High Breakdown Voltage
- Fast Speed Switching Time

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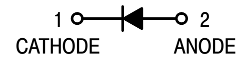
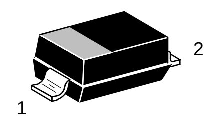
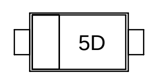




PLASTIC
SOD–123
CASE 425

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
MMSD914T1	SOD–123	3000 / Tape & Reel

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	100	Vdc
Peak Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

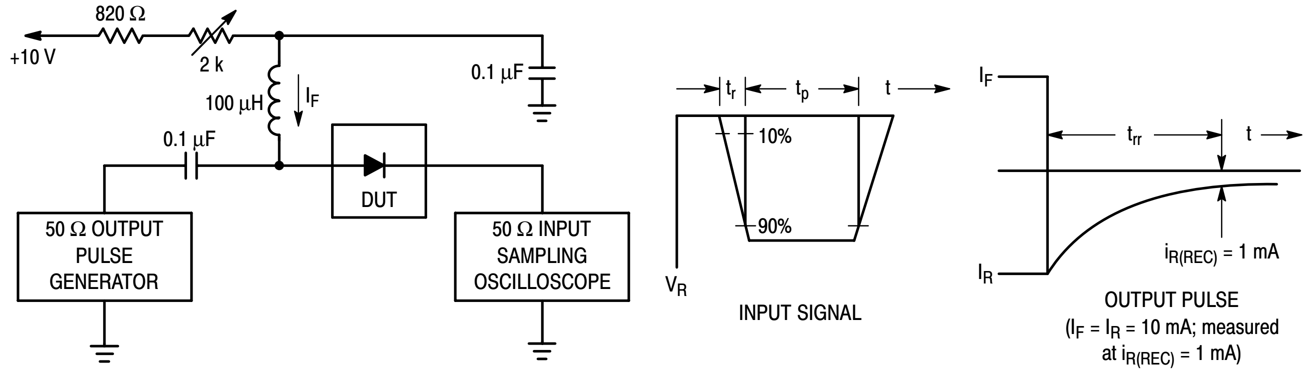
Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board (1) T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate (2) T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage (I_{BR} = 100 μAdc)	$V_{(BR)}$	100	—	Vdc
Reverse Voltage Leakage Current (V_R = 20 Vdc) (V_R = 75 Vdc)	I_R	— —	25 5.0	nAdc μAdc
Forward Voltage (I_F = 10 mAdc)	V_F	—	1000	mVdc
Diode Capacitance (V_R = 0 Vdc, f = 1.0 MHz)	C_D	—	4.0	pF
Reverse Recovery Time (I_F = I_R = 10 mAdc) (Figure 1)	t_{rr}	—	4.0	ns

1. FR–5 = 1.0 x 0.75 x 0.062 in.
2. Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina

Preferred devices are recommended choices for future use and best overall value.



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

Figure 1. Recovery Time Equivalent Test Circuit

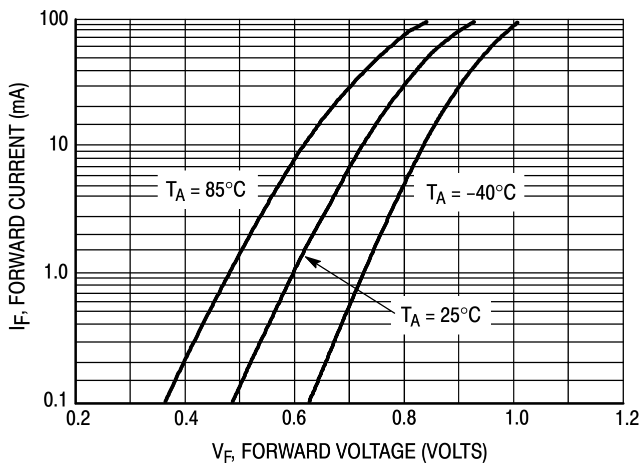


Figure 2. Forward Voltage

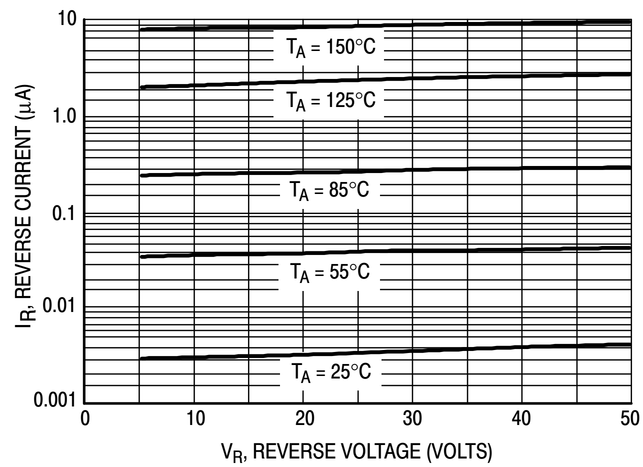


Figure 3. Leakage Current

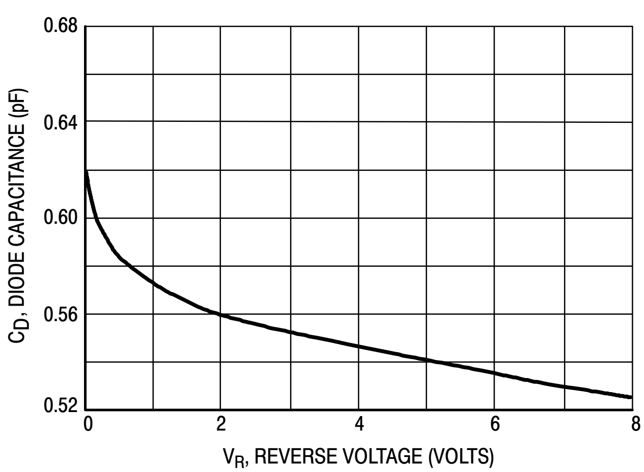


Figure 4. Capacitance

MMUN2111LT1 Series

Preferred Devices

Bias Resistor Transistors

PNP Silicon Surface Mount Transistors with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base-emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SOT-23 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- The SOT-23 package can be soldered using wave or reflow. The modified gull-winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel. Use the Device Number to order the 7 inch/3000 unit reel. Replace “T1” with “T3” in the Device Number to order the 13 inch/10,000 unit reel.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	246 (Note 1.) 400 (Note 2.) 1.5 (Note 1.) 2.0 (Note 2.)	mW °C/W
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	508 (Note 1.) 311 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{\theta JL}$	174 (Note 1.) 208 (Note 2.)	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

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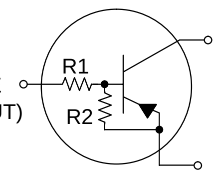
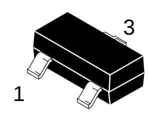
PIN 1
BASE
(INPUT)



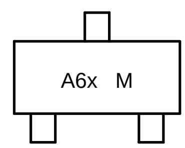
PIN 3
COLLECTOR
(OUTPUT)

PIN 2
EMITTER
(GROUND)



SOT–23
CASE 318
STYLE 6

MARKING DIAGRAM



A6x = Device Marking
x = A – L (See Page 735)
M = Date Code

DEVICE MARKING INFORMATION

See specific marking information in the device marking table on page 735 of this data sheet.

Preferred devices are recommended choices for future use and best overall value.

DEVICE MARKING AND RESISTOR VALUES

Device	Package	Marking	R1 (K)	R2 (K)	Shipping
MMUN2111LT1 MMUN2111LT3	SOT–23	A6A	10	10	3000/Tape & Reel 10,000/Tape & Reel
MMUN2112LT1 MMUN2112LT3	SOT–23	A6B	22	22	3000/Tape & Reel 10,000/Tape & Reel
MMUN2113LT1 MMUN2113LT3	SOT–23	A6C	47	47	3000/Tape & Reel 10,000/Tape & Reel
MMUN2114LT1 MMUN2114LT3	SOT–23	A6D	10	47	3000/Tape & Reel 10,000/Tape & Reel
MMUN2115LT1 (Note 3.) MMUN2115LT3	SOT–23	A6E	10	∞	3000/Tape & Reel 10,000/Tape & Reel
MMUN2116LT1 (Note 3.) MMUN2116LT3	SOT–23	A6F	4.7	∞	3000/Tape & Reel 10,000/Tape & Reel
MMUN2130LT1 (Note 3.) MMUN2130LT3	SOT–23	A6G	1.0	1.0	3000/Tape & Reel 10,000/Tape & Reel
MMUN2131LT1 (Note 3.) MMUN2131LT3	SOT–23	A6H	2.2	2.2	3000/Tape & Reel 10,000/Tape & Reel
MMUN2132LT1 (Note 3.) MMUN2132LT3	SOT–23	A6J	4.7	4.7	3000/Tape & Reel 10,000/Tape & Reel
MMUN2133LT1 (Note 3.) MMUN2133LT3	SOT–23	A6K	4.7	47	3000/Tape & Reel 10,000/Tape & Reel
MMUN2134LT1 (Note 3.) MMUN2134LT3	SOT–23	A6L	22	47	3000/Tape & Reel 10,000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector-Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter-Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	MMUN2111LT1	I_{EBO}	–	–	0.5	mAdc
	MMUN2112LT1		–	–	0.2	
	MMUN2113LT1		–	–	0.1	
	MMUN2114LT1		–	–	0.2	
	MMUN2115LT1		–	–	0.9	
	MMUN2116LT1		–	–	1.9	
	MMUN2130LT1		–	–	4.3	
	MMUN2131LT1		–	–	2.3	
	MMUN2132LT1		–	–	1.5	
	MMUN2133LT1		–	–	0.18	
	MMUN2134LT1		–	–	0.13	
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector-Emitter Breakdown Voltage (Note 4.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc

3. New devices. Updated curves to follow in subsequent data sheets.
4. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Note 5.)						
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	MMUN2111LT1 MMUN2112LT1 MMUN2113LT1 MMUN2114LT1 MMUN2115LT1 MMUN2116LT1 MMUN2130LT1 MMUN2131LT1 MMUN2132LT1 MMUN2133LT1 MMUN2134LT1	h_{FE}	35 60 80 80 160 160 3.0 8.0 15 80 80	60 100 140 140 250 250 5.0 15 27 140 130	– – – – – – – – – – –	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_E = 0.3 mA) (I_C = 10 mA, I_B = 5 mA) MMUN2130LT1/MMUN2131LT1 (I_C = 10 mA, I_B = 1 mA) MMUN2115LT1/MMUN2116LT1/ MMUN2132LT1/MMUN2133LT1/MMUN2134LT1		$V_{CE(sat)}$	–	–	0.25	Vdc
Output Voltage (on) (V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ) (V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	 MMUN2111LT1 MMUN2112LT1 MMUN2114LT1 MMUN2115LT1 MMUN2116LT1 MMUN2130LT1 MMUN2131LT1 MMUN2132LT1 MMUN2133LT1 MMUN2134LT1 MMUN2113LT1	V_{OL}	 – – – – – – – – – – –	 – – – – – – – – – – –	 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	Vdc
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ) (V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ) (V_{CC} = 5.0 V, V_B = 0.050 V, R_L = 1.0 kΩ)	 MMUN2115LT1 MMUN2116LT1 MMUN2131LT1 MMUN2132LT1 MMUN2130LT1	V_{OH}	4.9	–	–	Vdc
Input Resistor	MMUN2111LT1 MMUN2112LT1 MMUN2113LT1 MMUN2114LT1 MMUN2115LT1 MMUN2116LT1 MMUN2130LT1 MMUN2131LT1 MMUN2132LT1 MMUN2133LT1 MMUN2134LT1	R1	7.0 15.4 32.9 7.0 7.0 3.3 0.7 1.5 3.3 3.3 15.4	10 22 47 10 10 4.7 1.0 2.2 4.7 4.7 22	13 28.6 61.1 13 13 6.1 1.3 2.9 6.1 6.1 28.6	k Ω
Resistor Ratio	MMUN2111LT1/MMUN2112LT1/MMUN2113LT1 MMUN2114LT1 MMUN2115LT1/MMUN2116LT1 MMUN2130LT1/MMUN2131LT1/MMUN2132LT1 MMUN2133LT1	R_1/R_2	0.8 0.17 – 0.8 0.055	1.0 0.21 – 1.0 0.1	1.2 0.25 – 1.2 0.185	

5. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

TYPICAL ELECTRICAL CHARACTERISTICS
MMUN2111LT1

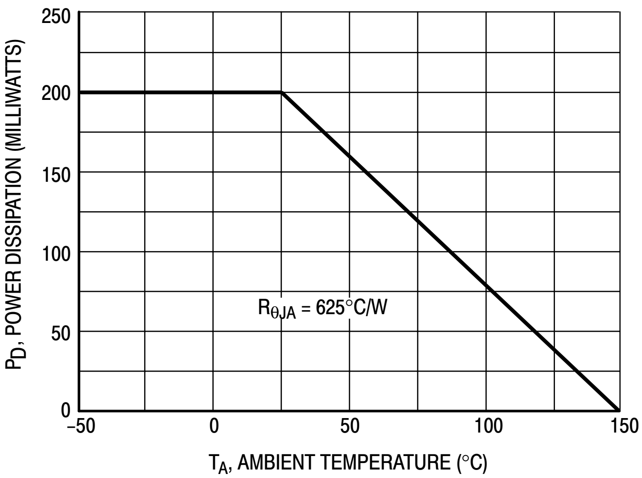


Figure 1. Derating Curve

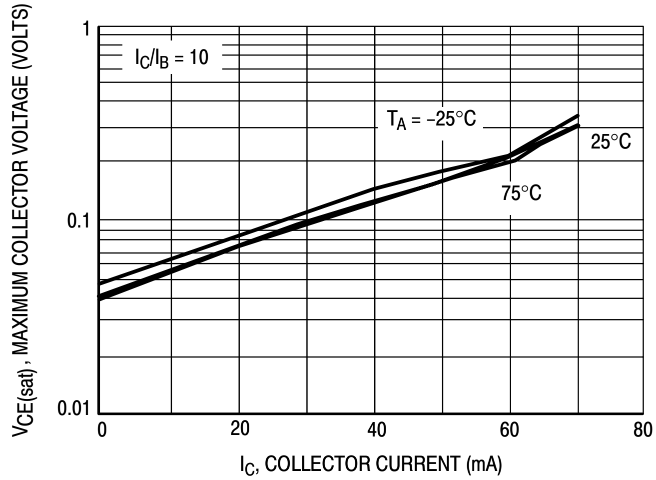


Figure 2. $V_{CE(sat)}$ versus I_C

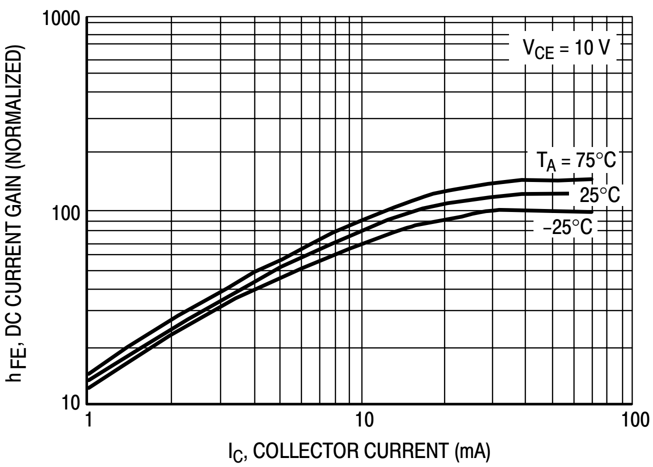


Figure 3. DC Current Gain

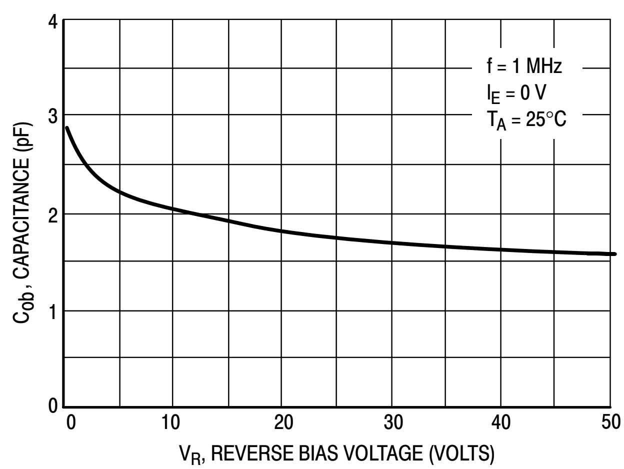


Figure 4. Output Capacitance

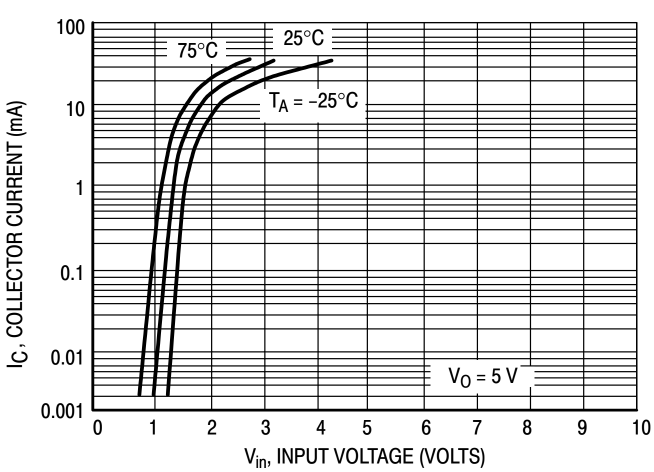


Figure 5. Output Current versus Input Voltage

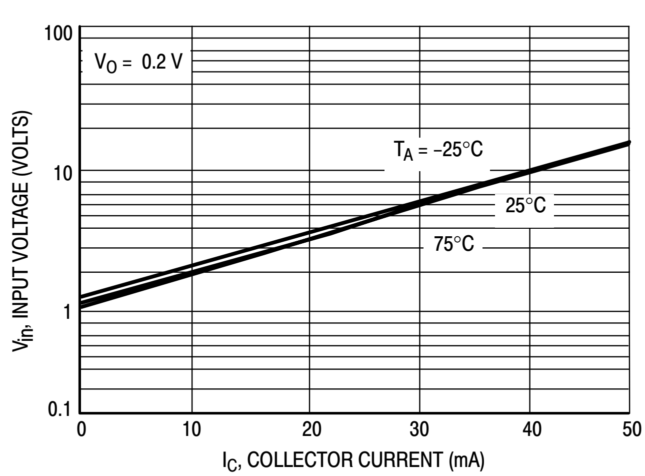


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
MMUN2112LT1

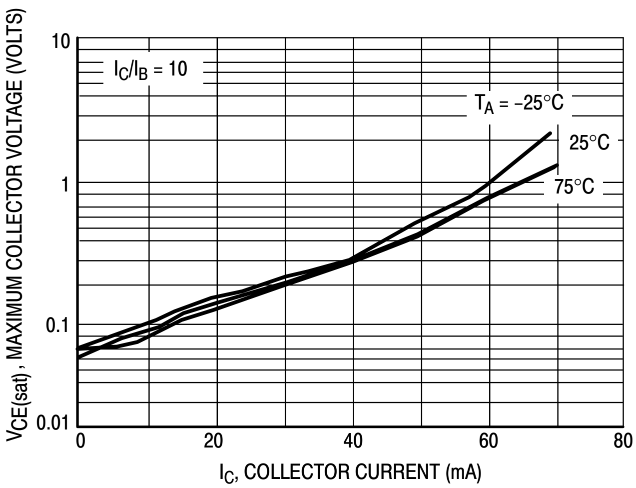


Figure 7. $V_{CE(sat)}$ versus I_C

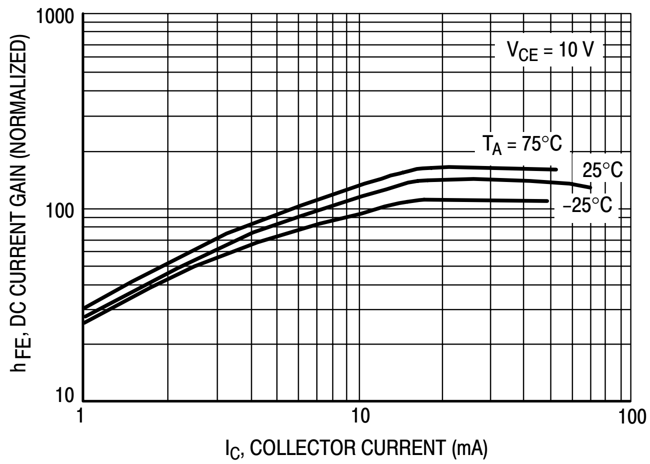


Figure 8. DC Current Gain

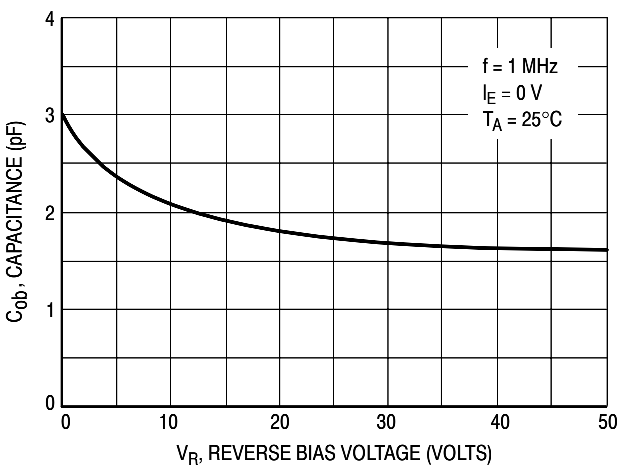


Figure 9. Output Capacitance

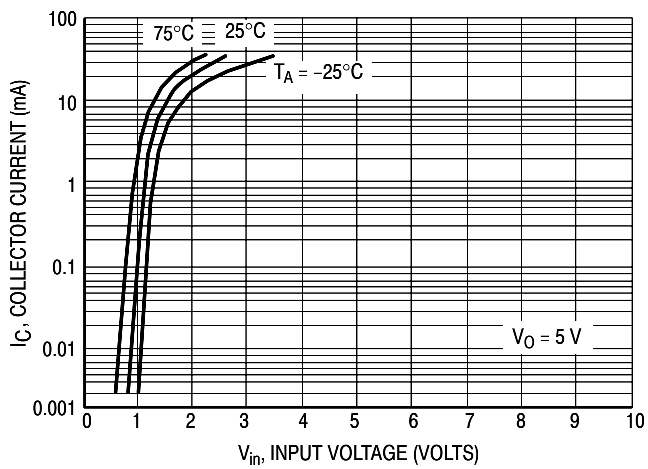


Figure 10. Output Current versus Input Voltage

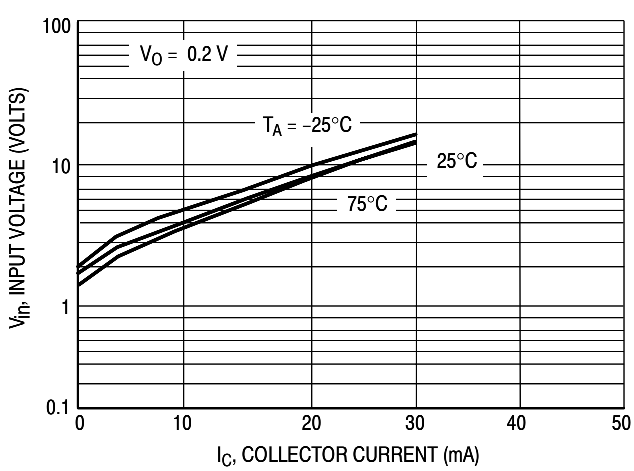


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
MMUN2113LT1

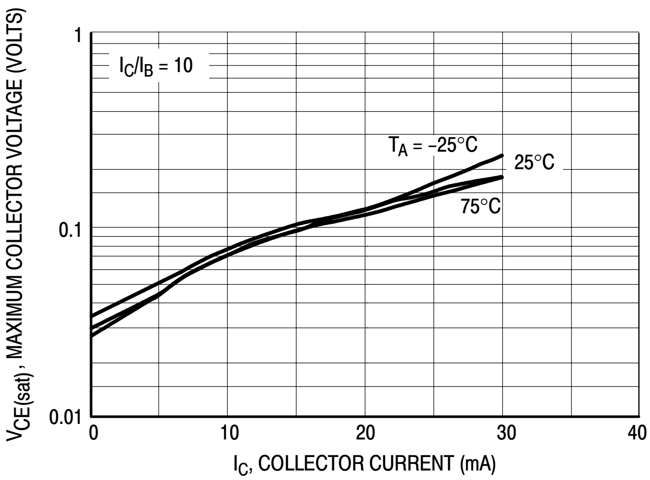


Figure 12. $V_{CE(sat)}$ versus I_C

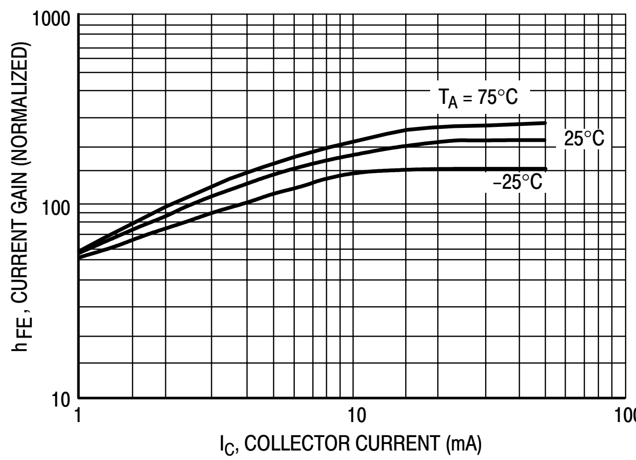


Figure 13. DC Current Gain

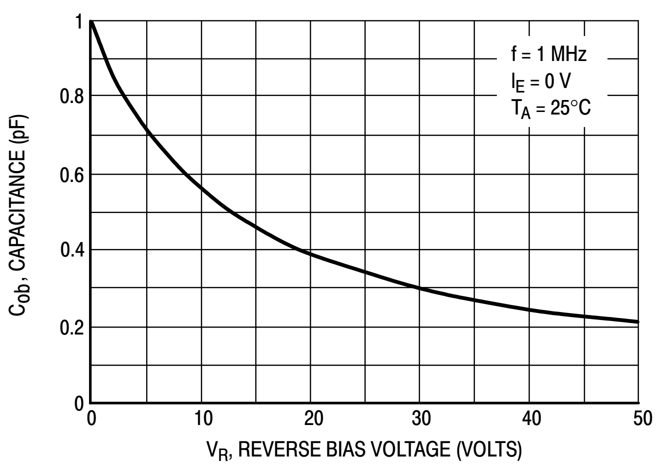


Figure 14. Output Capacitance

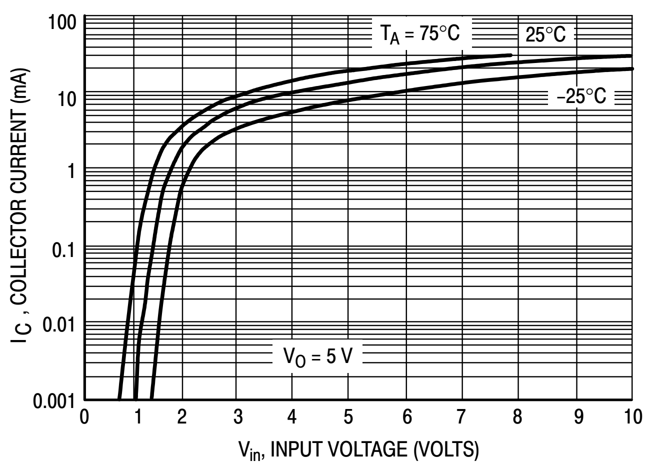


Figure 15. Output Current versus Input Voltage

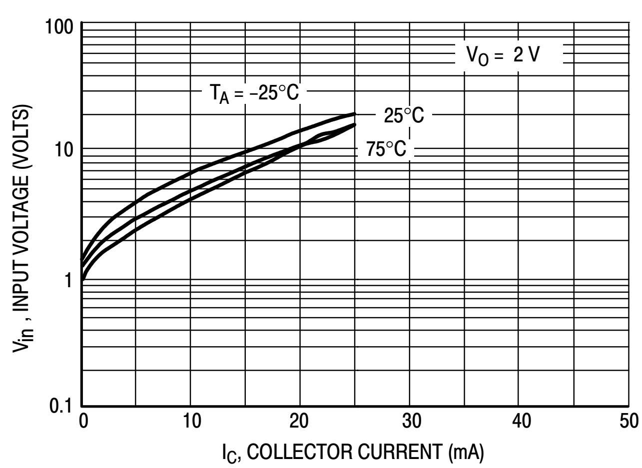


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
MMUN2114LT1

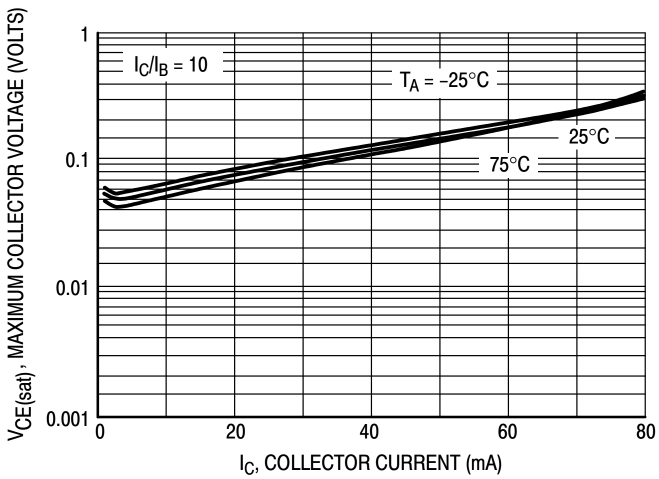


Figure 17. $V_{CE(sat)}$ versus I_C

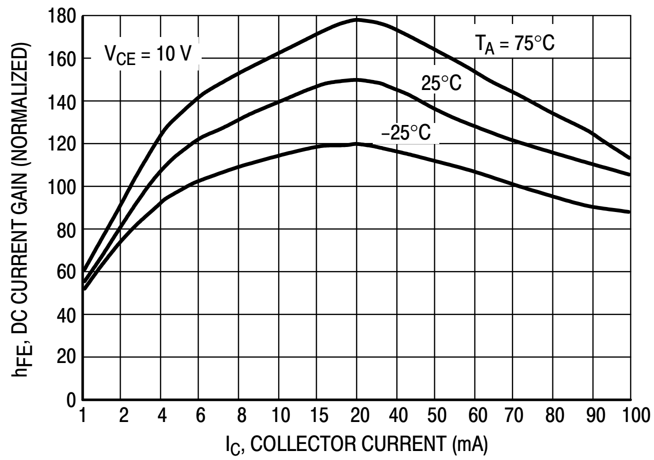


Figure 18. DC Current Gain

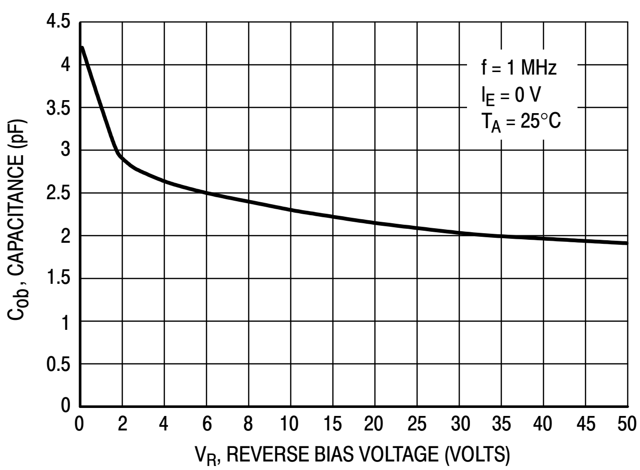


Figure 19. Output Capacitance

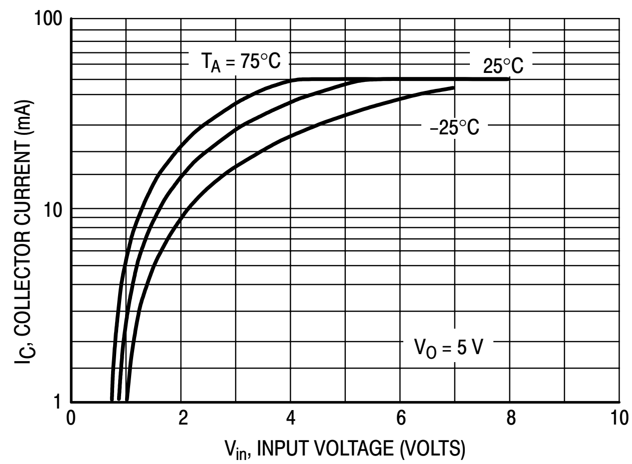


Figure 20. Output Current versus Input Voltage

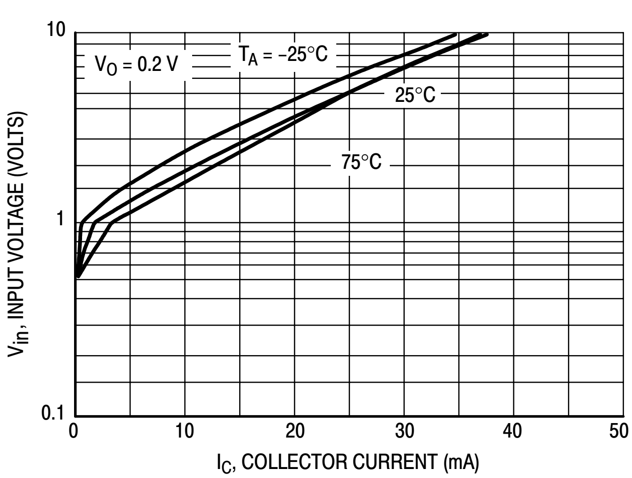


Figure 21. Input Voltage versus Output Current

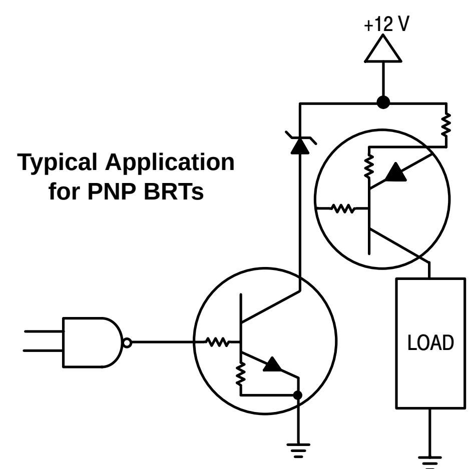


Figure 22. Inexpensive, Unregulated Current Source

MMUN2211LT1 Series

Preferred Devices

Bias Resistor Transistor

NPN Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base-emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SOT-23 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space and Component Count
- The SOT-23 package can be soldered using wave or reflow. The modified gull-winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel. Use the Device Number to order the 7 inch/3000 unit reel. Replace “T1” with “T3” in the Device Number to order the13 inch/10,000 unit reel.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc
Total Power Dissipation @ T_A = 25°C (Note 1.) Derate above 25°C	P_D	200 1.6	mW mW/°C

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1(K)	R2(K)
MMUN2211LT1	A8A	10	10
MMUN2212LT1	A8B	22	22
MMUN2213LT1	A8C	47	47
MMUN2214LT1	A8D	10	47
MMUN2215LT1	A8E	10	∞
MMUN2216LT1	A8F	4.7	∞
MMUN2230LT1	A8G	1.0	1.0
MMUN2231LT1	A8H	2.2	2.2
MMUN2232LT1	A8J	4.7	4.7
MMUN2233LT1	A8K	4.7	47
MMUN2234LT1	A8L	22	47
MMUN2235LT1	A8M	2.2	47
MMUN2238LT1	A8R	2.2	∞
MMUN2241LT1	A8U	100	∞

1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.

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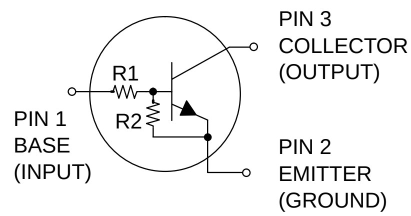
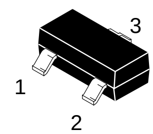
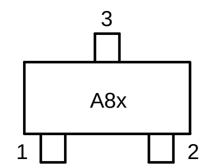


MARKING DIAGRAM



SOT–23
CASE 318
STYLE 6



A8x = Device Code
x = (See Table)

ORDERING INFORMATION

Device	Package	Shipping
MMUN2211LT1	SOT–23	3000/Tape & Reel
MMUN2212LT1	SOT–23	3000/Tape & Reel
MMUN2213LT1	SOT–23	3000/Tape & Reel
MMUN2214LT1	SOT–23	3000/Tape & Reel
MMUN2215LT1	SOT–23	3000/Tape & Reel
MMUN2216LT1	SOT–23	3000/Tape & Reel
MMUN2230LT1	SOT–23	3000/Tape & Reel
MMUN2231LT1	SOT–23	3000/Tape & Reel
MMUN2232LT1	SOT–23	3000/Tape & Reel
MMUN2233LT1	SOT–23	3000/Tape & Reel
MMUN2234LT1	SOT–23	3000/Tape & Reel
MMUN2235LT1	SOT–23	3000/Tape & Reel
MMUN2238LT1	SOT–23	3000/Tape & Reel
MMUN2241LT1	SOT–23	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

January, 2001 – Rev. 2

Publication Order Number:
MMUN2211LT1/D

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Resistance – Junction-to-Ambient (surface mounted)	$R_{\theta JA}$	625	°C/W
Operating and Storage Temperature Range	T_J, T_{stg}	–65 to +150	°C
Maximum Temperature for Soldering Purposes, Time in Solder Bath	T_L	260 10	°C Sec

ELECTRICAL CHARACTERISTICS (T$_A$ = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector-Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter-Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	MMUN2211LT1 MMUN2212LT1 MMUN2213LT1 MMUN2214LT1 MMUN2215LT1 MMUN2216LT1 MMUN2230LT1 MMUN2231LT1 MMUN2232LT1 MMUN2233LT1 MMUN2234LT1 MMUN2235LT1 MMUN2238LT1 MMUN2241LT1	I_{EBO}	– – – – – – – – – – – – – –	– – – – – – – – – – – – – –	0.5 0.2 0.1 0.2 0.9 1.9 4.3 2.3 1.5 0.18 0.13 0.2 4.0 0.1	mAdc
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector-Emitter Breakdown Voltage (Note 2.), (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc
ON CHARACTERISTICS (Note 2.)						
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	MMUN2211LT1 MMUN2212LT1 MMUN2213LT1 MMUN2214LT1 MMUN2215LT1 MMUN2216LT1 MMUN2230LT1 MMUN2231LT1 MMUN2232LT1 MMUN2233LT1 MMUN2234LT1 MMUN2235LT1 MMUN2238LT1 MMUN2241LT1	h_{FE}	35 60 80 80 160 160 3.0 8.0 15 80 80 80 160 160	60 100 140 140 350 350 5.0 15 30 200 150 140 350 350	– – – – – – – – – – – – – –	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.3 mA) (I_C = 10 mA, I_B = 5 mA) MMUN2230LT1/MMUN2231LT1 (I_C = 10 mA, I_B = 1 mA) MMUN2215LT1/MMUN2216LT1 MMUN2232LT1/MMUN2233LT1/MMUN2234LT1/ MMUN2235LT1/MMUN2238LT1		$V_{CE(sat)}$	–	–	0.25	Vdc

2. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Note 3.)						
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 k Ω)	MMUN2211LT1		–	–	0.2	
	MMUN2212LT1		–	–	0.2	
	MMUN2214LT1		–	–	0.2	
	MMUN2215LT1		–	–	0.2	
	MMUN2216LT1		–	–	0.2	
	MMUN2230LT1		–	–	0.2	
	MMUN2231LT1		–	–	0.2	
	MMUN2232LT1		–	–	0.2	
	MMUN2233LT1		–	–	0.2	
	MMUN2234LT1		–	–	0.2	
	MMUN2235LT1		–	–	0.2	
	MMUN2238LT1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 k Ω)	MMUN2213LT1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 5.0 V, R_L = 1.0 k Ω)	MMUN2241LT1		–	–	0.2	
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 k Ω)		V_{OH}	4.9	–	–	Vdc
(V_{CC} = 5.0 V, V_B = 0.050 V, R_L = 1.0 k Ω)	MMUN2230LT1					
(V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 k Ω)	MMUN2215LT1					
	MMUN2216LT1					
	MMUN2233LT1					
	MMUN2238LT1					
Input Resistor	MMUN2211LT1	R1	7.0	10	13	kΩ
	MMUN2212LT1		15.4	22	28.6	
	MMUN2213LT1		32.9	47	61.1	
	MMUN2214LT1		7.0	10	13	
	MMUN2215LT1		7.0	10	13	
	MMUN2216LT1		3.3	4.7	6.1	
	MMUN2230LT1		0.7	1.0	1.3	
	MMUN2231LT1		1.5	2.2	2.9	
	MMUN2232LT1		3.3	4.7	6.1	
	MMUN2233LT1		3.3	4.7	6.1	
	MMUN2234LT1		15.4	22	28.6	
	MMUN2235LT1		1.54	2.2	2.86	
	MMUN2238LT1		1.54	2.2	2.88	
	MMUN2241LT1		70	100	130	
Resistor Ratio	MMUN2211LT1/MMUN2212LT1/MMUN2213LT1	R1/R2	0.8	1.0	1.2	
	MMUN2214LT1		0.17	0.21	0.25	
	MMUN2215LT1/MMUN2216LT1/MMUN2238LT1		–	–	–	
	MMUN2241LT1		–	–	–	
	MMUN2230LT1/MMUN2231LT1/MMUN2232LT1		0.8	1.0	1.2	
	MMUN2233LT1		0.055	0.1	0.185	
	MMUN2234LT1		0.38	0.47	0.56	
	MMUN2235LT1		0.038	0.047	0.056	

3. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%.

TYPICAL ELECTRICAL CHARACTERISTICS
MMUN2211LT1

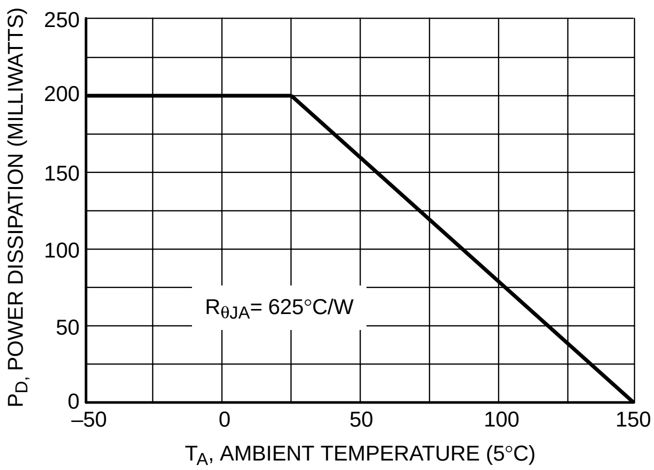


Figure 1. Derating Curve

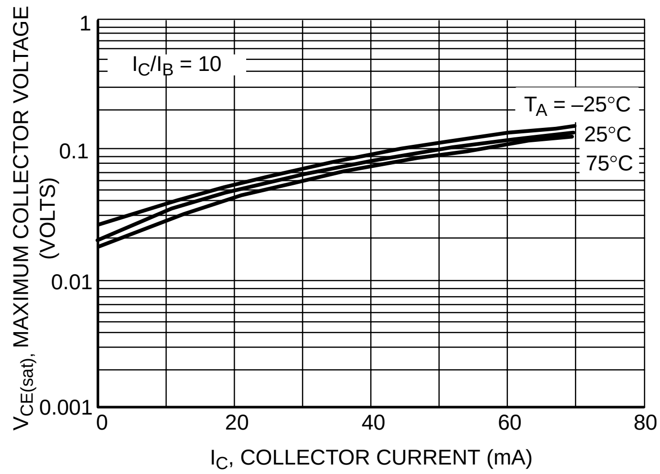


Figure 2. $V_{CE(sat)}$ vs. I_C

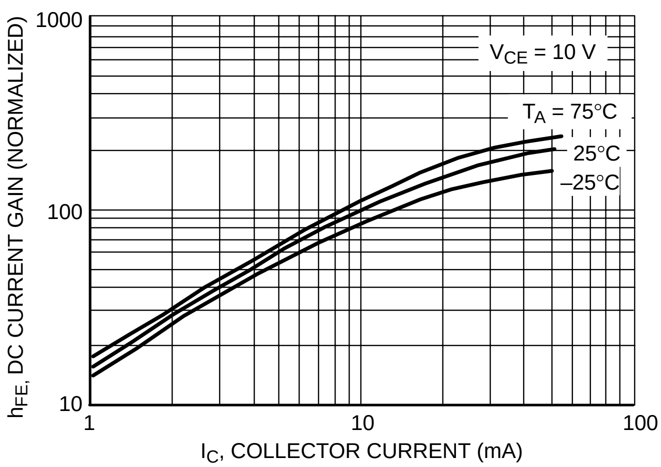


Figure 3. DC Current Gain

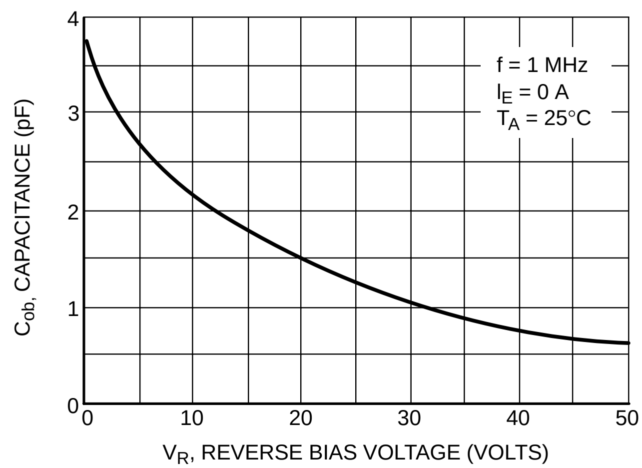


Figure 4. Output Capcitance

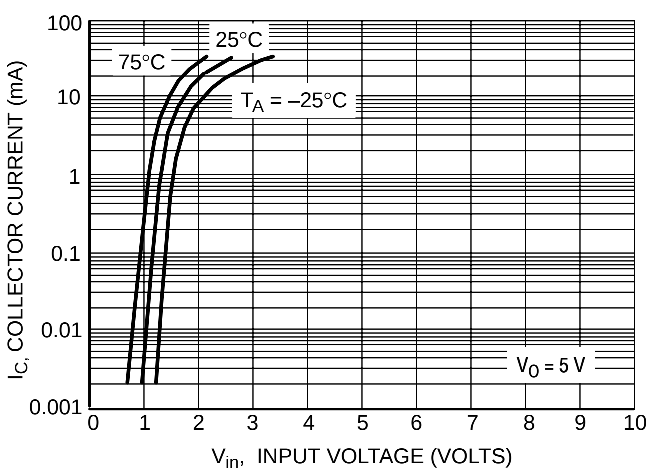


Figure 5. Output Current vs. Input Voltage

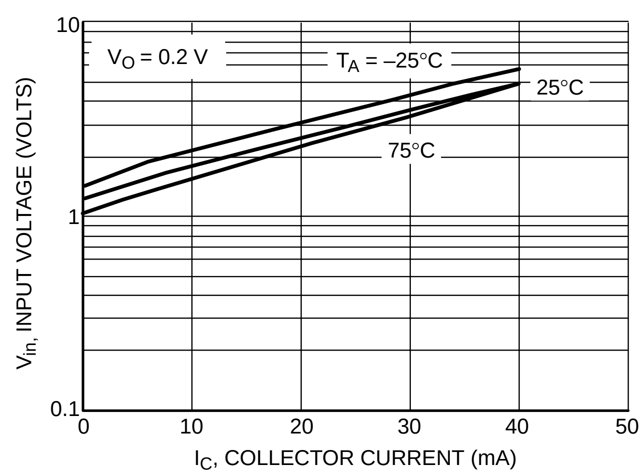


Figure 6. Input Voltage vs. Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
MMUN2212LT1

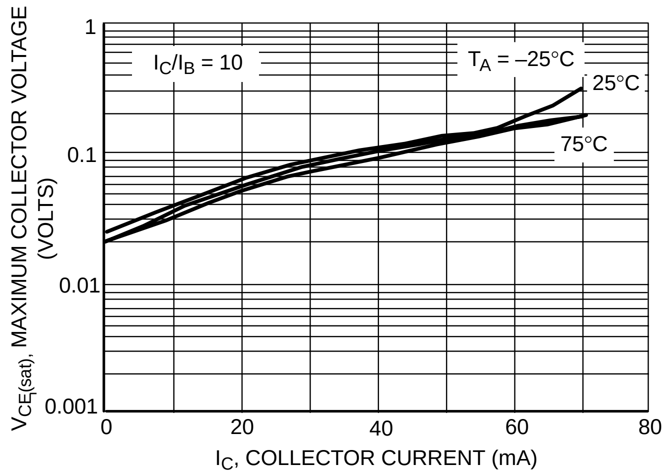


Figure 7. $V_{CE(sat)}$ vs. I_C

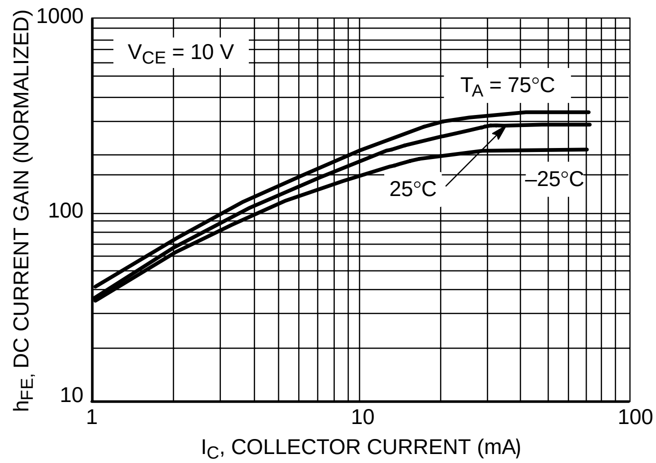


Figure 8. DC Current Gain

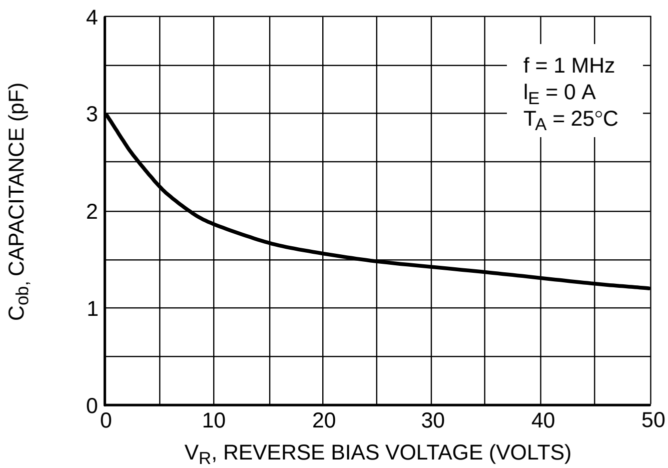


Figure 9. Output Capacitance

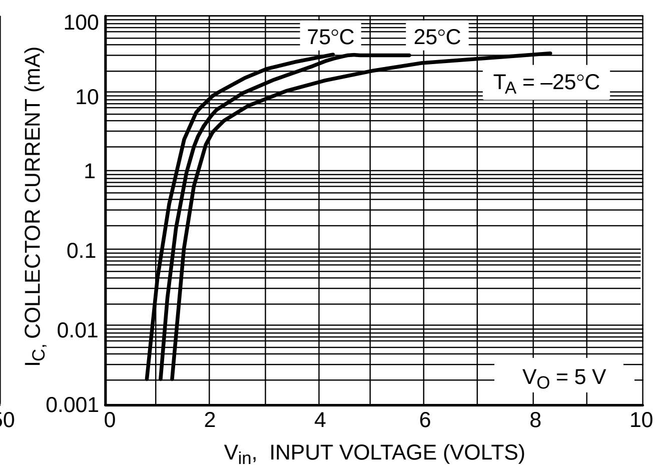


Figure 10. Output Current vs. Input Voltage

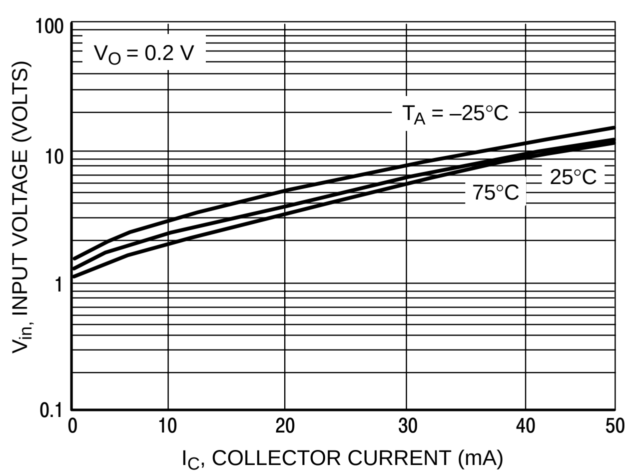


Figure 11. Input Voltage vs. Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
MMUN2213LT1

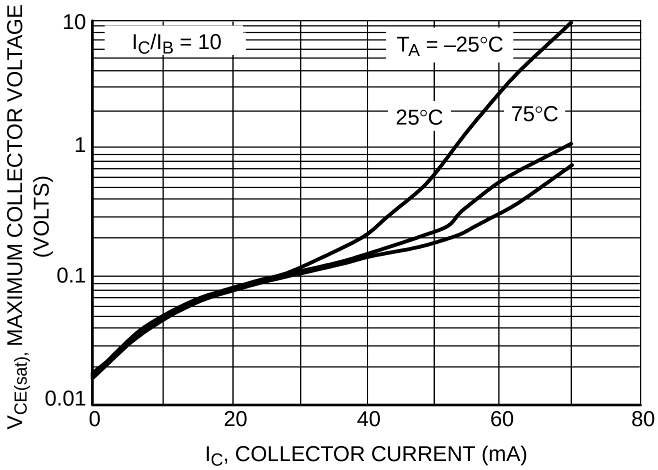


Figure 12. $V_{CE(sat)}$ vs. I_C

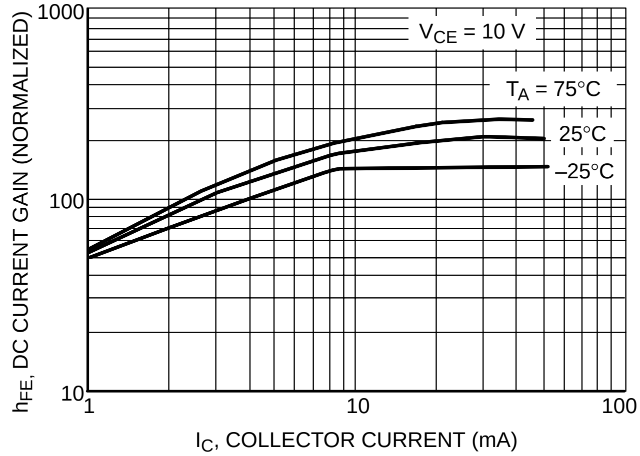


Figure 13. DC Current Gain

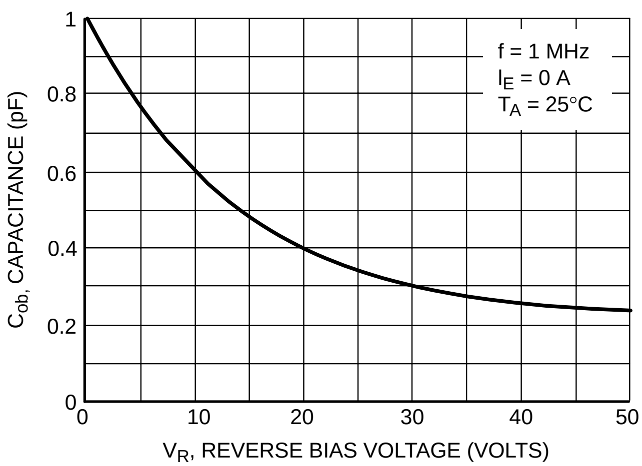


Figure 14. Output Capacitance

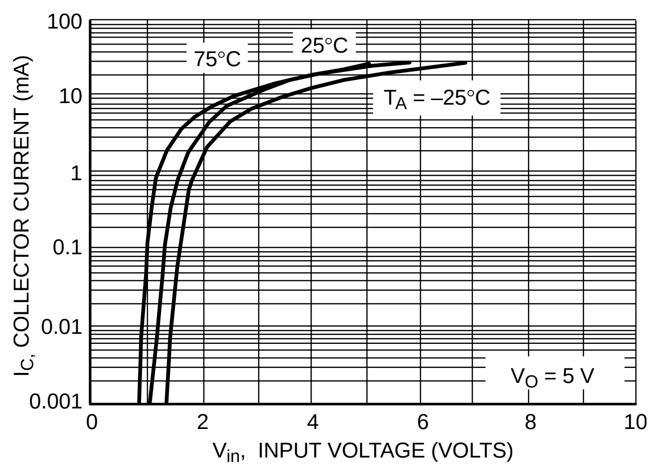


Figure 15. Output Current vs. Input Voltage

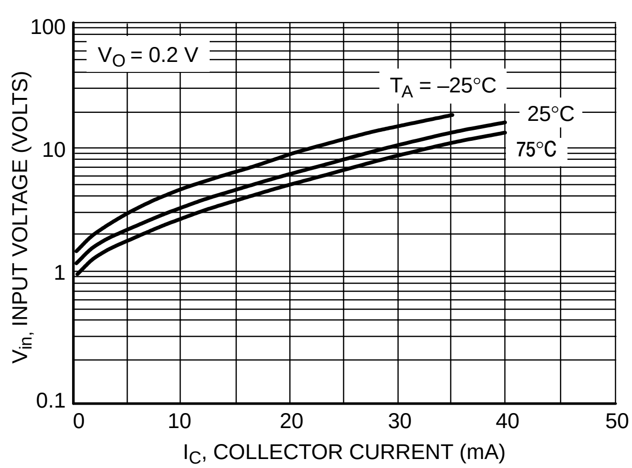


Figure 16. Input Voltage vs. Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
MMUN2214LT1

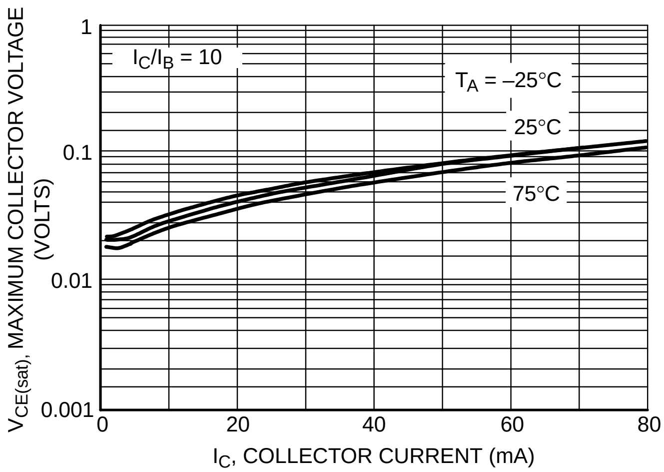


Figure 17. $V_{CE(sat)}$ vs. I_C

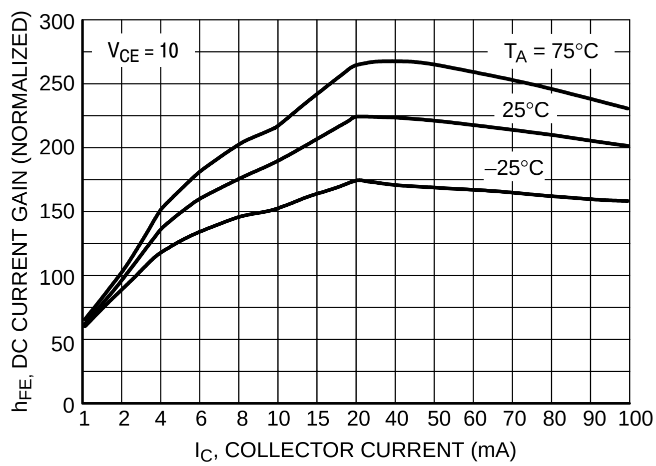


Figure 18. DC Current Gain

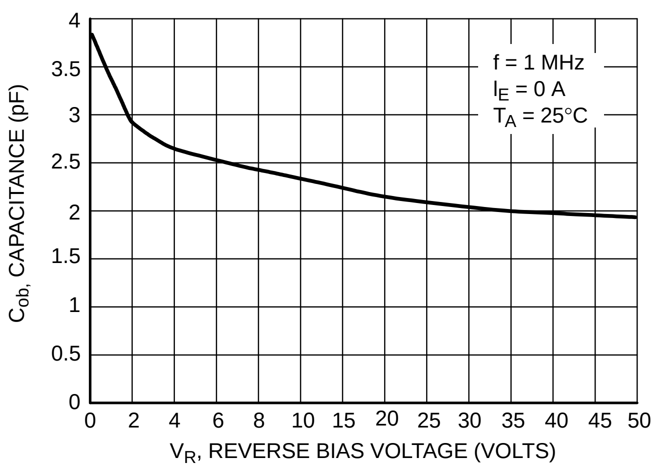


Figure 19. Output Capacitance

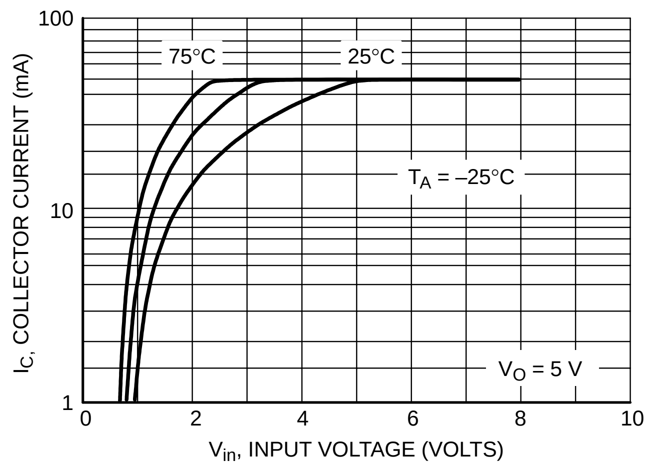


Figure 20. Output Current vs. Input Voltage

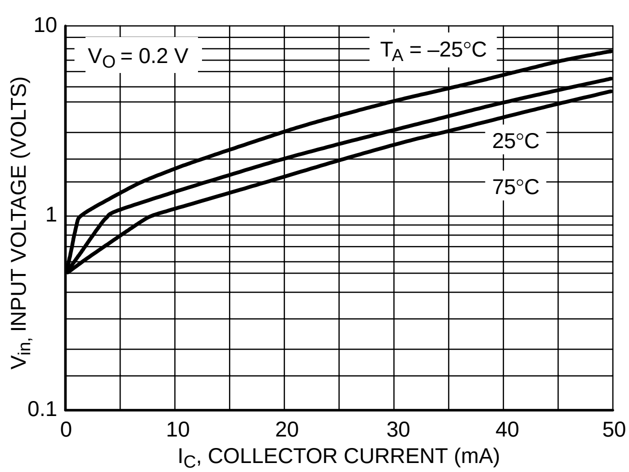


Figure 21. Input Voltage vs. Output Current

TYPICAL ELECTRICAL CHARACTERISTICS
MMUN2232LT1

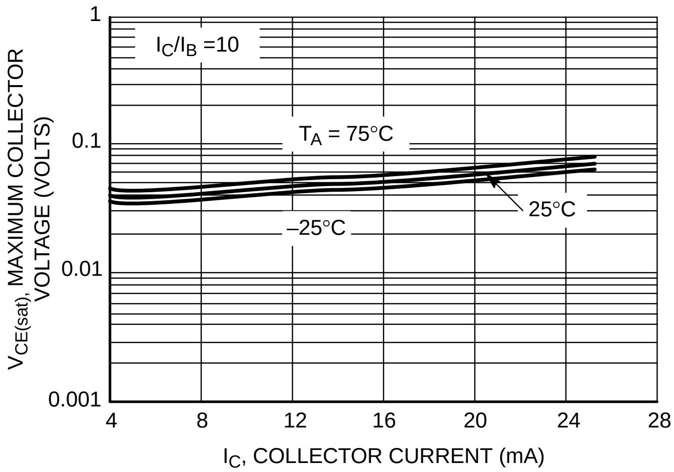


Figure 22. $V_{CE(sat)}$ vs. I_C

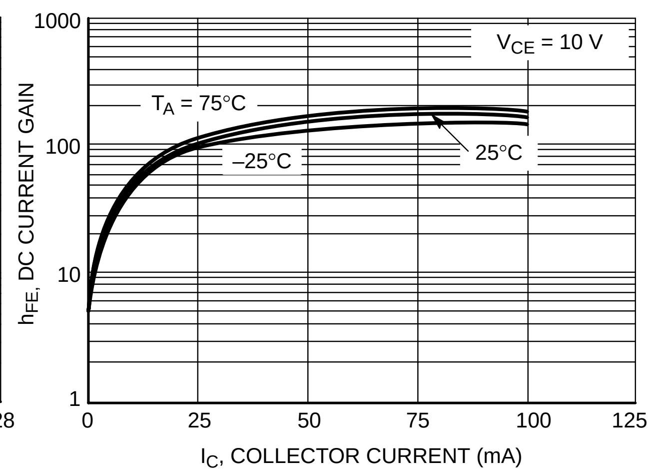


Figure 23. DC Current Gain

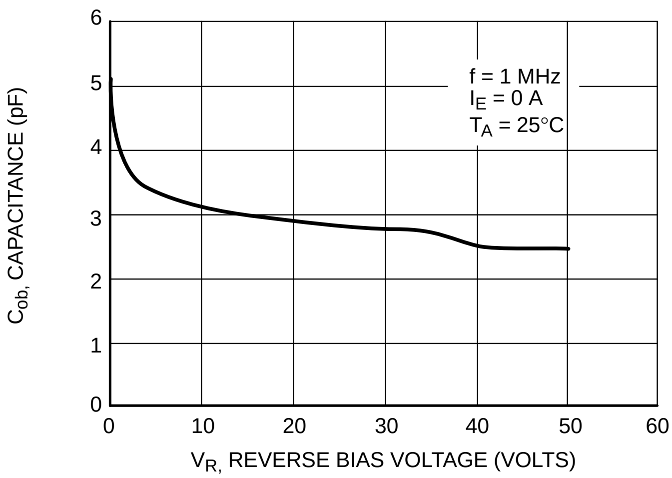


Figure 24. Output Capacitance

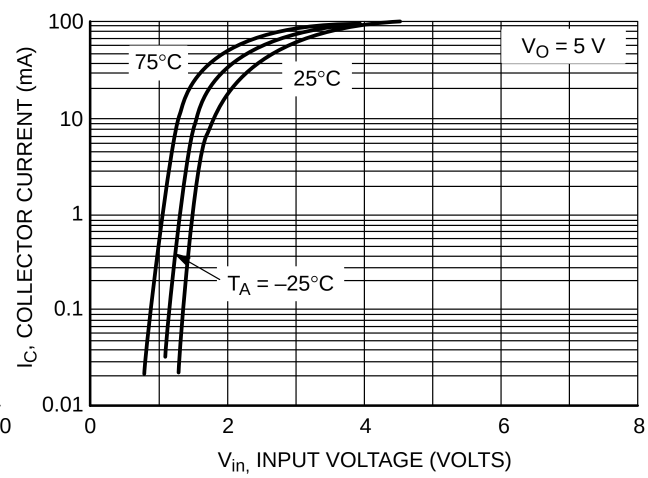


Figure 25. Output Current vs. Input Voltage

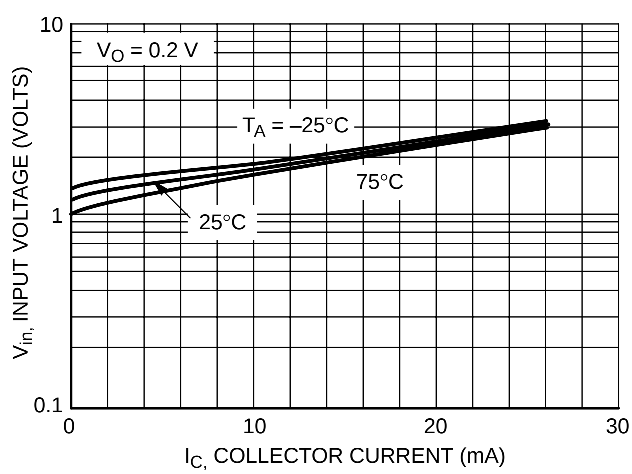


Figure 26. Output Voltage vs. Input Current

TYPICAL ELECTRICAL CHARACTERISTICS
MMUN2233LT1

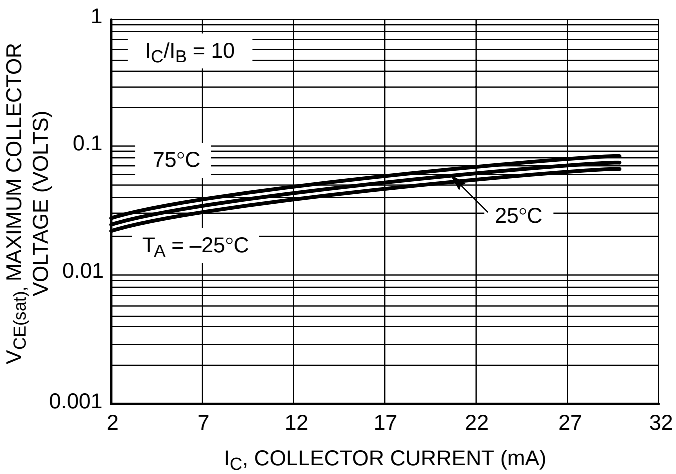


Figure 27. $V_{CE(sat)}$ vs. I_C

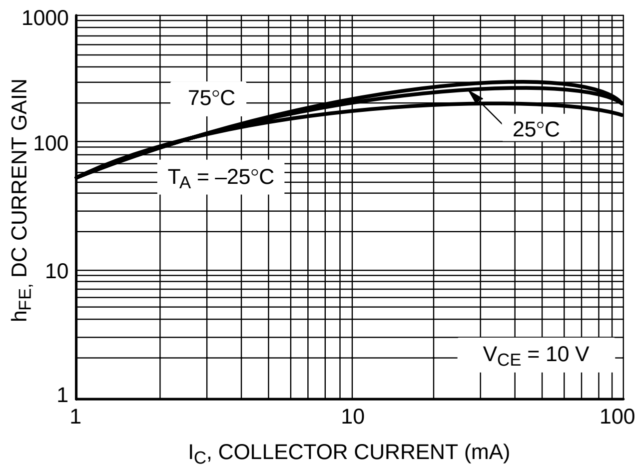


Figure 28. DC Current Gain

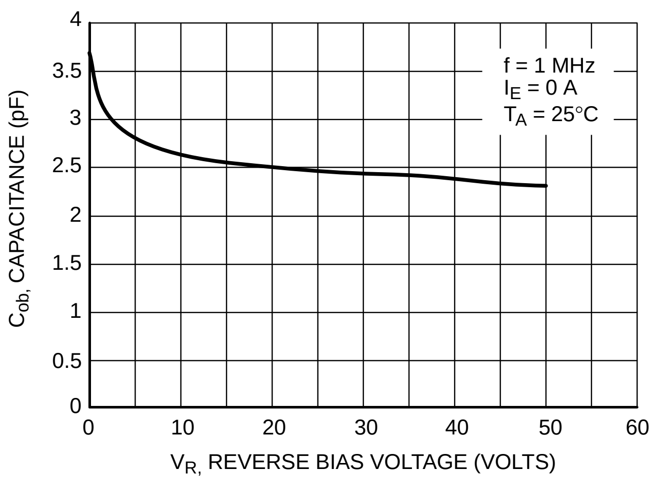


Figure 29. Output Capacitance

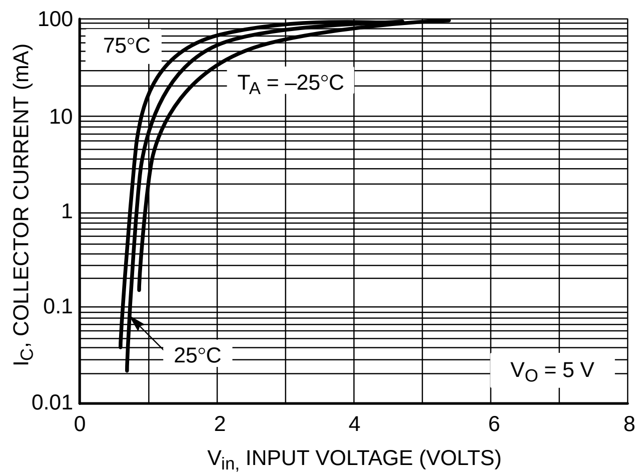


Figure 30. Output Current vs. Input Voltage

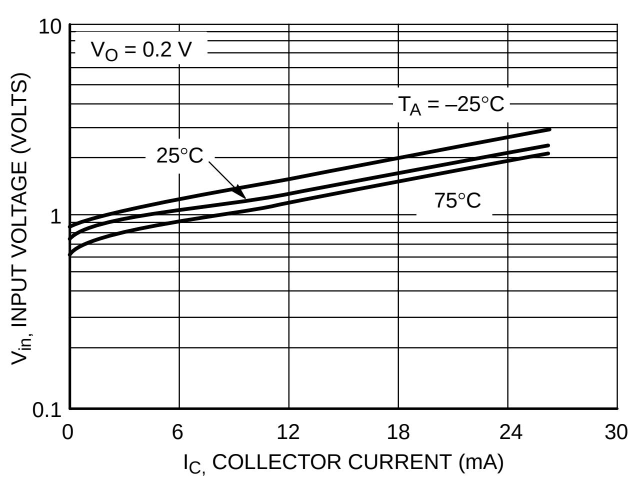


Figure 31. Input Voltage vs. Output Current

TYPICAL APPLICATIONS FOR NPN BRTs

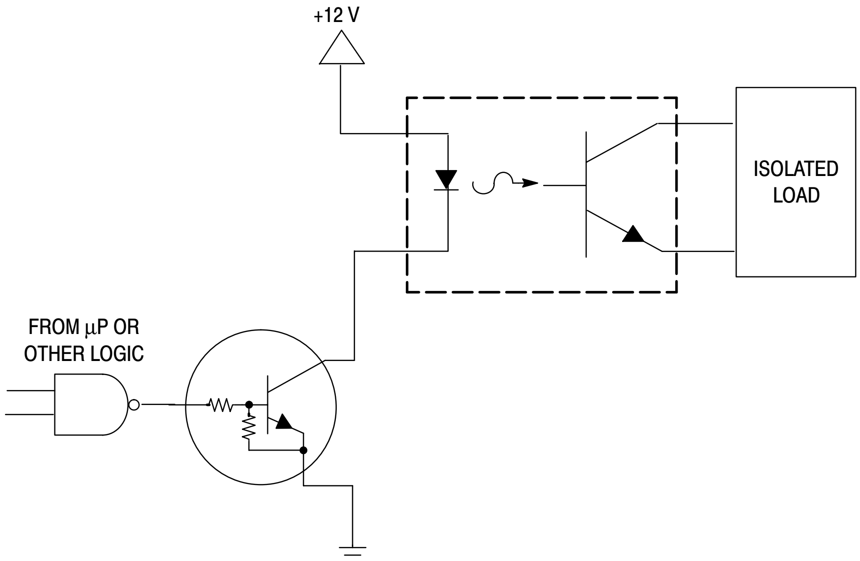


Figure 32. Level Shifter: Connects 12 or 24 Volt Circuits to Logic

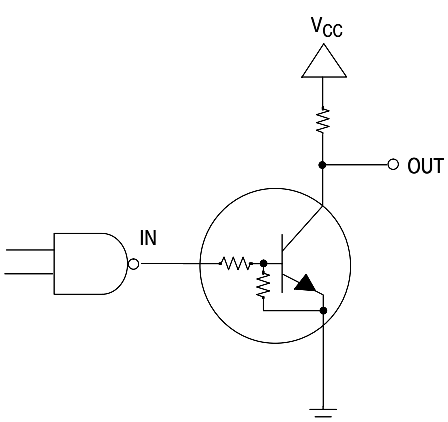


Figure 33. Open Collector Inverter: Inverts the Input Signal

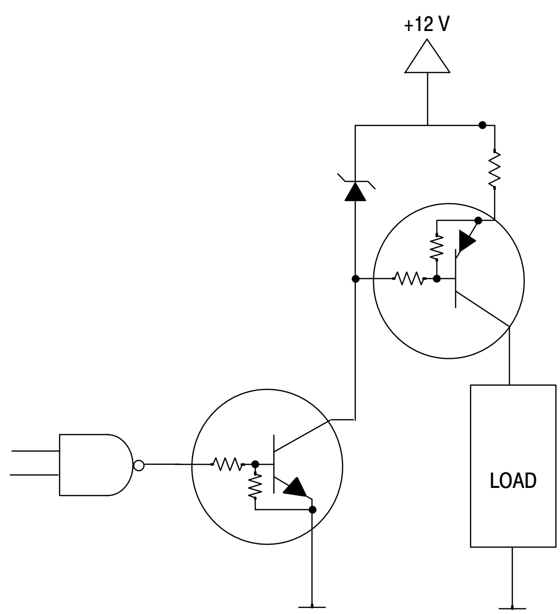


Figure 34. Inexpensive, Unregulated Current Source

MMVL105GT1

Preferred Device

Silicon Tuning Diode

This device is designed in the Surface Mount package for general frequency control and tuning applications. It provides solid–state reliability in replacement of mechanical tuning methods.

- Controlled and Uniform Tuning Ratio
- Device Marking: 4E

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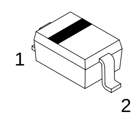
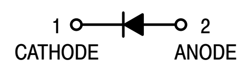
30 VOLT
VOLTAGE VARIABLE
CAPACITANCE DIODE



PLASTIC
SOD–323
CASE 477



MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Continuous Reverse Voltage	30	Vdc
I_F	Peak Forward Current	200	mAdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C Derate above 25°C	200 1.57	mW mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature	150	°C

*FR–4 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMVL105GT1	SOD–323	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)		$V_{(BR)R}$	30	—	Vdc
Reverse Voltage Leakage Current (V_R = 28 Vdc)		I_R	—	50	nAdc

Device Type	C_T V_R = 25 Vdc, f = 1.0 MHz pF		Q V_R = 3.0 Vdc f = 50 MHz	C_R C_3/C_{25} f = 1.0 MHz	
	Min	**Max**	**Typ**	**Min**	**Max**
MMVL105GT1	1.5	2.8	250	4.0	6.5

TYPICAL CHARACTERISTICS

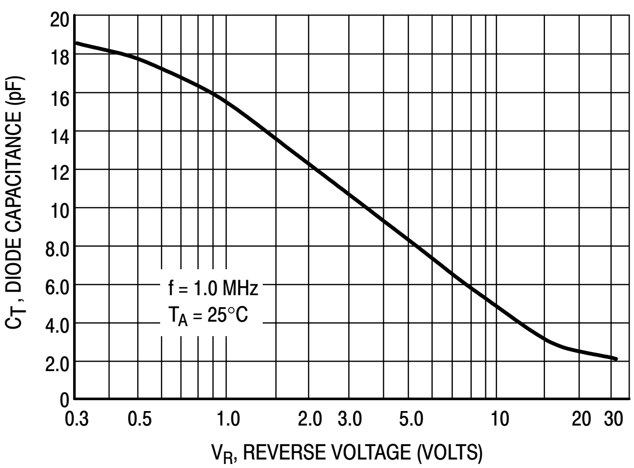


Figure 1. Diode Capacitance

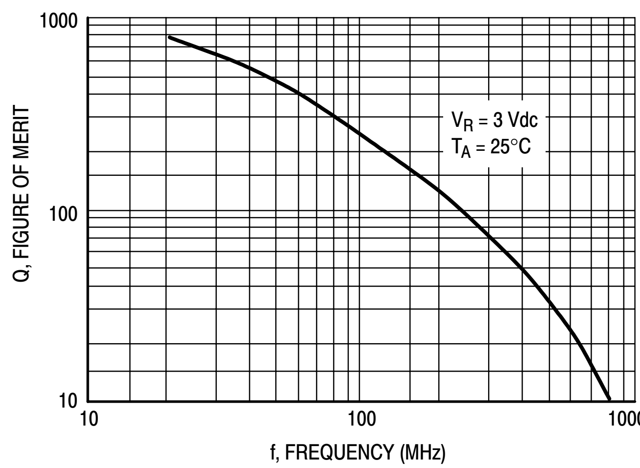


Figure 2. Figure of Merit

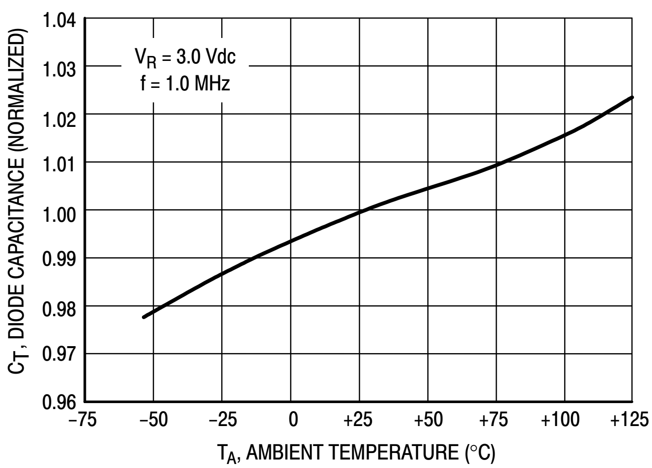


Figure 3. Diode Capacitance

MMVL109T1

Preferred Device

Silicon Epicap Diodes

Designed for general frequency control and tuning applications; providing solid–state reliability in replacement of mechnaical tuning methods.

- High Q with Guaranteed Minimum Values at VHF Frequencies
- Controlled and Uniform Tuning Ratio
- Surface Mount Package
- Device Marking: 4A

ON Semiconductor™

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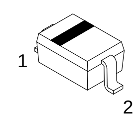
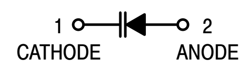
26–32 pF
VOLTAGE VARIABLE
CAPACITANCE DIODES



PLASTIC
SOD–323
CASE 477



MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Continuous Reverse Voltage	30	Vdc
I_F	Peak Forward Current	200	mAdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C Derate above 25°C	200 1.57	mW mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature Range	–55 to +150	°C

*FR–5 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMVL109T1	SOD–323	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

January, 2000 – Rev. 0

Publication Order Number:
MMVL109T1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc)	I_R	—	—	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 3.0 Vdc, f = 1.0 MHz)	TC_C	—	300	—	ppm/°C

	C_t, Diode Capacitance V_R = 3.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 3.0 Vdc f = 50 MHz	C_R, Capacitance Ratio C_3/C_{25} f = 1.0 MHz (Note 1)	
Device	**Min**	**Nom**	**Max**	**Min**	**Min**	**Max**
MMVL109T1	26	29	32	200	5.0	6.5

1. C_R is the ratio of C_t measured at 3 Vdc divided by C_t measured at 25 Vdc.

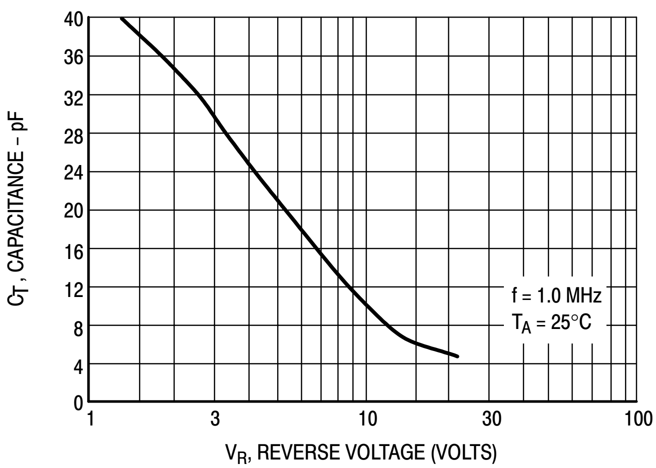


Figure 1. DIODE CAPACITANCE

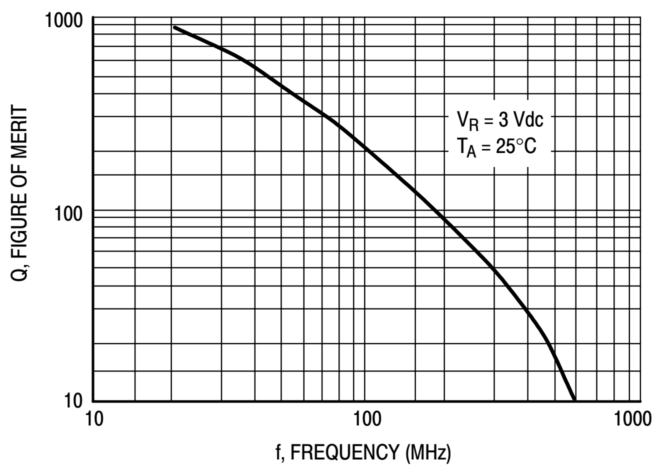


Figure 2. FIGURE OF MERIT

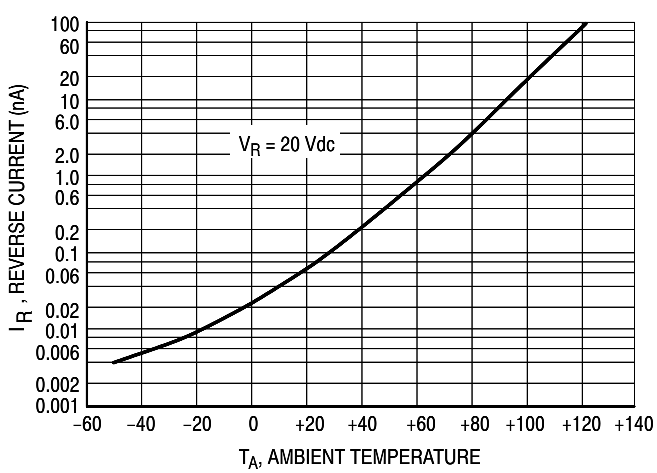


Figure 3. LEAKAGE CURRENT

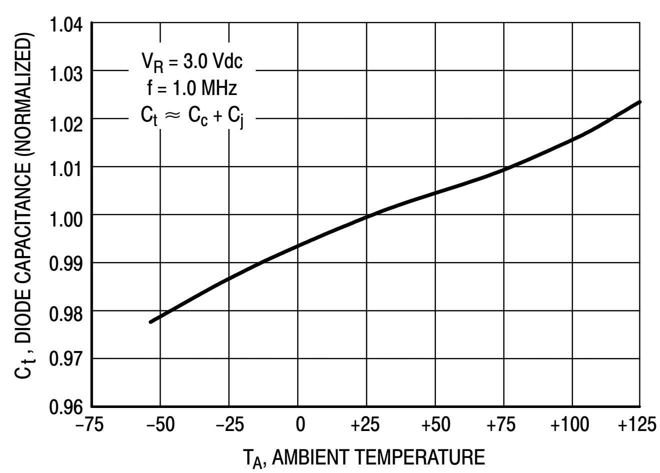


Figure 4. DIODE CAPACITANCE

NOTES ON TESTING AND SPECIFICATIONS

1. C_R is the ratio of C_t measured at 3.0 Vdc divided by C_t measured at 25 Vdc.

MMVL2101T1

Preferred Device

Silicon Tuning Diode

These devices are designed in the popular Plastic Surface Mount Package for high volume requirements of FM Radio and TV tuning and AFC, general frequency control and tuning applications.They provide solid–state reliability in replacement of mechanical tuning methods.

- High Q
- Controlled and Uniform Tuning Ratio
- Standard Capacitance Tolerance – 10%
- Complete Typical Design Curves
- Device Marking: 4G

ON Semiconductor™

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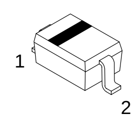
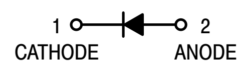
30 VOLTS
VOLTAGE VARIABLE
CAPACITANCE DIODE



PLASTIC
SOD–323
CASE 477



MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Continuous Reverse Voltage	30	Vdc
I_F	Peak Forward Current	200	mAdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C Derate above 25°C	200 1.57	mW mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature	150	°C

*FR–4 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMVL2101T1	SOD–323	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_A = 25°C)	I_R	—	—	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	—	280	—	ppm/°C

Device	C_T, Diode Capacitance V_R = 4.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 4.0 Vdc, f = 50 MHz	TR, Tuning Ratio C_2/C_{30} f = 1.0 MHz		
	Min	Nom	Max	Typ	Min	Typ	Max
MMVL2101T1	6.1	6.8	7.5	450	2.5	2.7	3.2

PARAMETER TEST METHODS

1. C_T, DIODE CAPACITANCE

($C_T = C_C + C_J$). C_T is measured at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

2. TR, TUNING RATIO

TR is the ratio of C_T measured at 2.0 Vdc divided by C_T measured at 30 Vdc.

3. Q, FIGURE OF MERIT

Q is calculated by taking the G and C readings of an admittance bridge at the specified frequency and substituting in the following equations:

$$Q = \frac{2\pi fC}{G}$$

(Boonton Electronics Model 33AS8 or equivalent). Use Lead Length ≈ 1/16".

4. TC_C, DIODE CAPACITANCE TEMPERATURE COEFFICIENT

TC_C is guaranteed by comparing C_T at V_R = 4.0 Vdc, f = 1.0 MHz, T_A = –65°C with C_T at V_R = 4.0 Vdc, f = 1.0 MHz, T_A = +85°C in the following equation, which defines TC_C:

$$TC_C = \left| \frac{C_T(+85°C) - C_T(-65°C)}{85 + 65} \right| \cdot \frac{10^6}{C_T(25°C)}$$

Accuracy limited by measurement of C_T to ±0.1 pF.

TYPICAL DEVICE CHARACTERISTICS

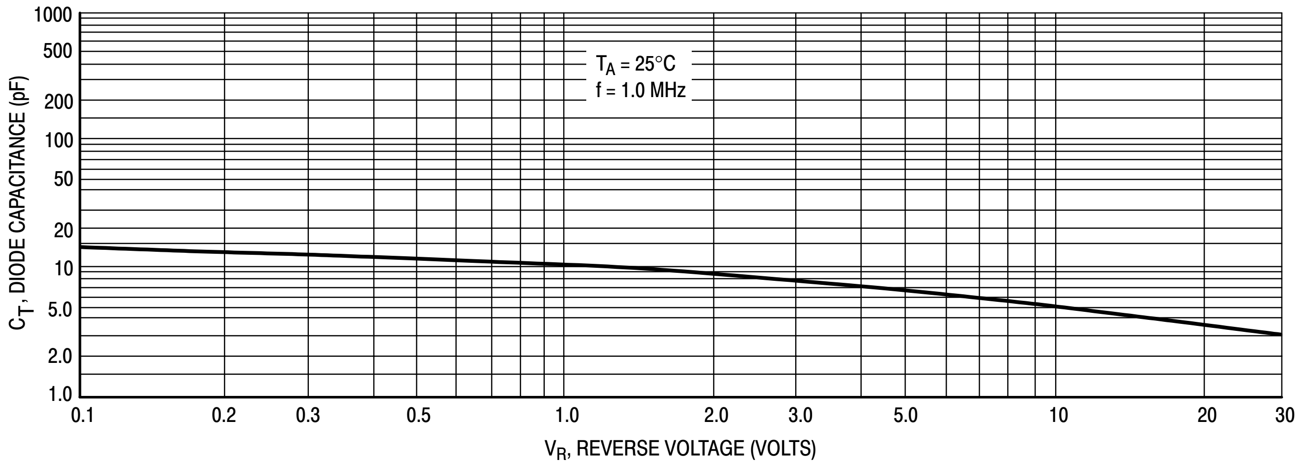


Figure 1. Diode Capacitance versus Reverse Voltage

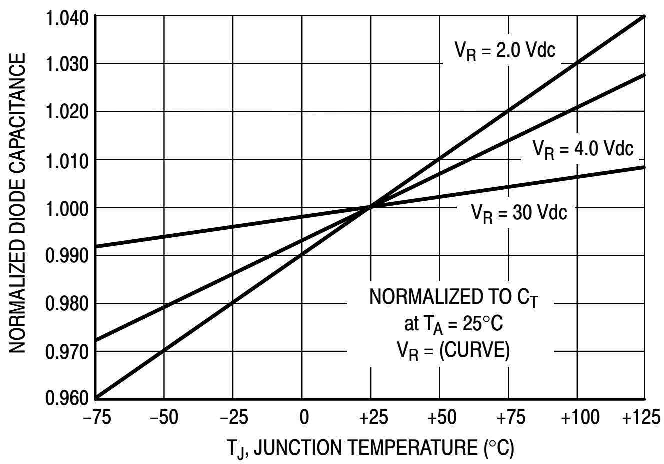


Figure 2. Normalized Diode Capacitance versus Junction Temperature

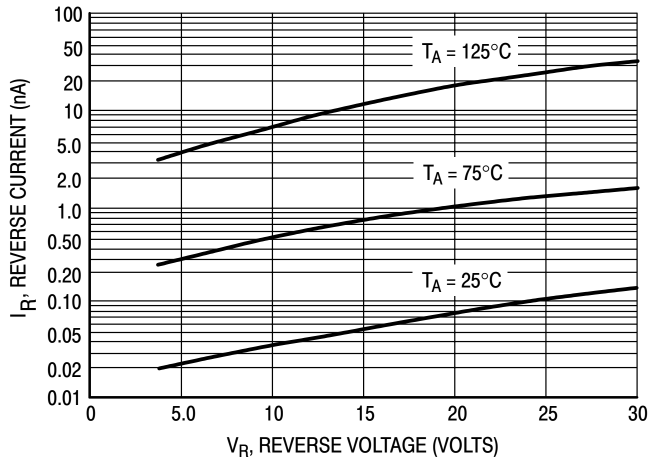


Figure 3. Reverse Current versus Reverse Bias Voltage

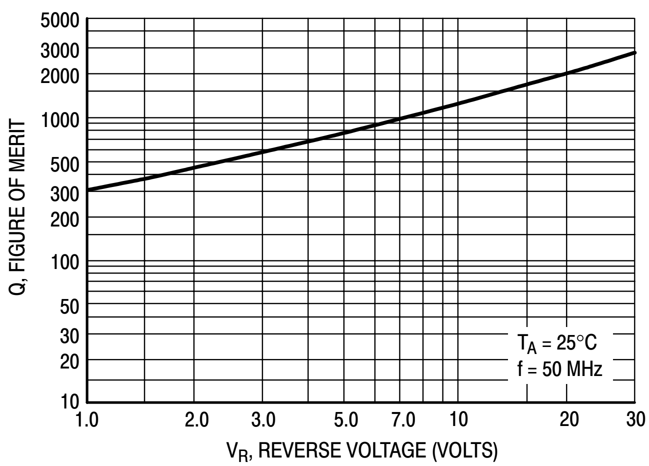


Figure 4. Figure of Merit versus Reverse Voltage

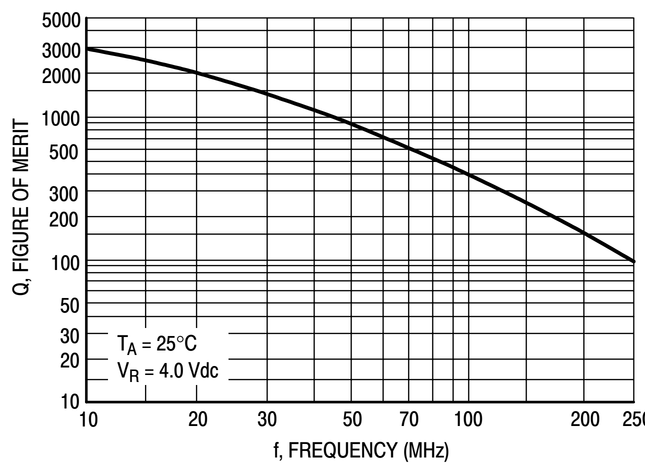


Figure 5. Figure of Merit versus Frequency

MMVL2105T1

Preferred Device

Silicon Tuning Diode

These devices are designed in the popular Plastic Surface Mount Package for high volume requirements of FM Radio and TV tuning and AFC, general frequency control and tuning applications.They provide solid–state reliability in replacement of mechanical tuning methods.

- High Q
- Controlled and Uniform Tuning Ratio
- Standard Capacitance Tolerance – 10%
- Complete Typical Design Curves
- Device Marking: 4U

ON Semiconductor™

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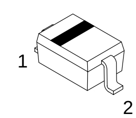
30 VOLTS
VOLTAGE VARIABLE
CAPACITANCE DIODE



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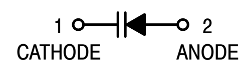
SOD–323
CASE 477



MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Continuous Reverse Voltage	30	Vdc
I_F	Peak Forward Current	200	mAdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C	200	mW
	Derate above 25°C	1.57	mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature	150	°C

*FR–5 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMVL2105T1	SOD–323	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_A = 25°C)	I_R	—	—	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	—	280	—	ppm/°C

Device	C_T, Diode Capacitance V_R = 4.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 4.0 Vdc, f = 50 MHz	TR, Tuning Ratio C_2/C_{30} f = 1.0 MHz		
	Min	Nom	Max	Typ	Min	Typ	Max
MMVL2105T1	13.5	15	16.5	400	2.5	2.9	3.2

PARAMETER TEST METHODS

1. C_T, DIODE CAPACITANCE

($C_T = C_C + C_J$). C_T is measured at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

2. TR, TUNING RATIO

TR is the ratio of C_T measured at 2.0 Vdc divided by C_T measured at 30 Vdc.

3. Q, FIGURE OF MERIT

Q is calculated by taking the G and C readings of an admittance bridge at the specified frequency and substituting in the following equations:

$$Q = \frac{2\pi fC}{G}$$

(Boonton Electronics Model 33AS8 or equivalent). Use Lead Length ≈ 1/16”.

4. TC_C, DIODE CAPACITANCE TEMPERATURE COEFFICIENT

TC_C is guaranteed by comparing C_T at V_R = 4.0 Vdc, f = 1.0 MHz, T_A = –65°C with C_T at V_R = 4.0 Vdc, f = 1.0 MHz, T_A = +85°C in the following equation, which defines TC_C:

$$TC_C = \left|\frac{C_T(+85°C) - C_T(-65°C)}{85 + 65}\right| \cdot \frac{10^6}{C_T(25°C)}$$

Accuracy limited by measurement of C_T to ±0.1 pF.

TYPICAL DEVICE CHARACTERISTICS

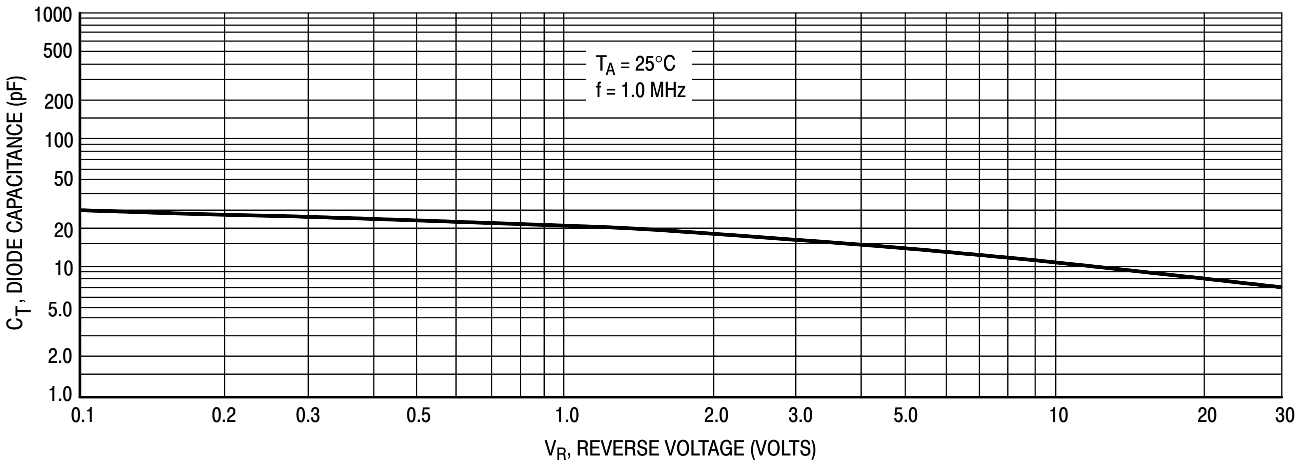


Figure 1. Diode Capacitance versus Reverse Voltage

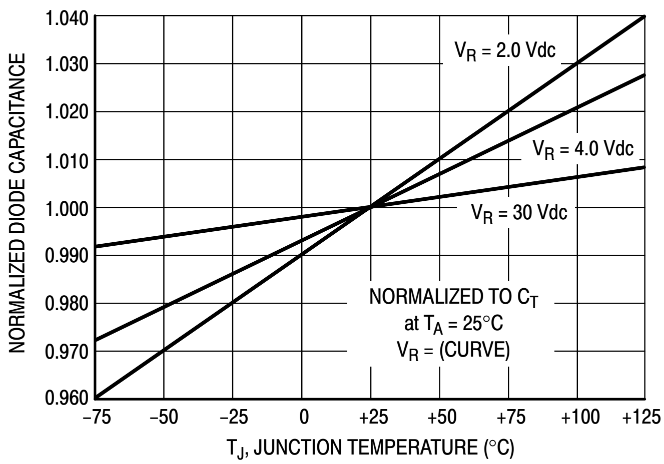


Figure 2. Normalized Diode Capacitance versus Junction Temperature

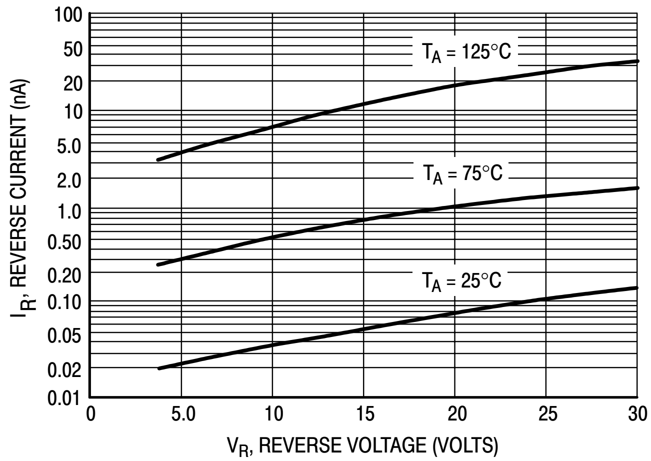


Figure 3. Reverse Current versus Reverse Bias Voltage

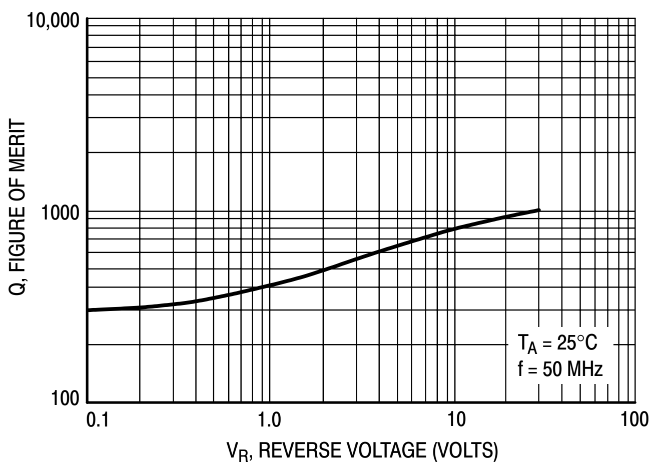


Figure 4. Figure of Merit versus Reverse Voltage

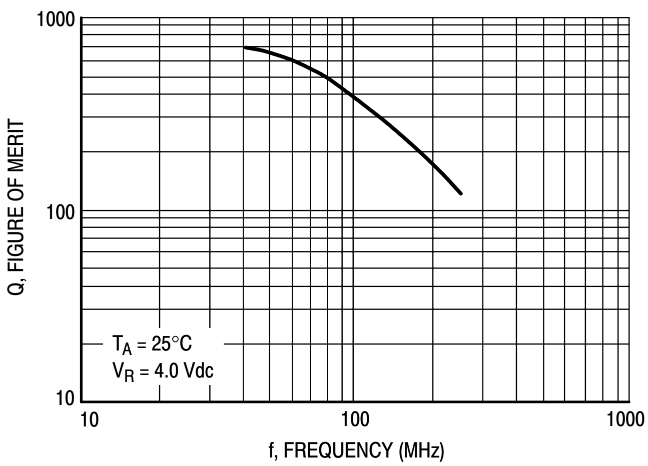


Figure 5. Figure of Merit versus Frequency

MMVL3102T1

Preferred Device

Silicon Tuning Diode

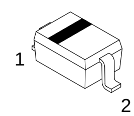
This device is designed in the Surface Mount package for general frequency control and tuning applications. It provides solid–state reliability in replacement of mechanical tuning methods.

- High Q with Guaranteed Minimum Values at VHF Frequencies
- Controlled and Uniform Tuning Ratio
- Device Marking: 4C

ON Semiconductor™

http://onsemi.com

22 pF (Nominal) 30 VOLTS VOLTAGE VARIABLE CAPACITANCE DIODE



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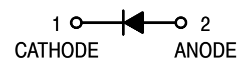
SOD–323
CASE 477



MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Continuous Reverse Voltage	30	Vdc
I_F	Peak Forward Current	200	mAdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C Derate above 25°C	200 1.57	mW mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature	150	°C

*FR–4 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMVL3102T1	SOD–323	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_A = 25°C)	I_R	—	—	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	—	300	—	ppm/°C

	C_t, Diode Capacitance V_R = 3.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 3.0 Vdc f = 50 MHz	C_R, Capacitance Ratio C_3/C_{25} f = 1.0 MHz	
Device	**Min**	**Nom**	**Max**	**Min**	**Min**	**Typ**
MMVL3102T1	20	22	25	200	4.5	4.8

TYPICAL CHARACTERISTICS

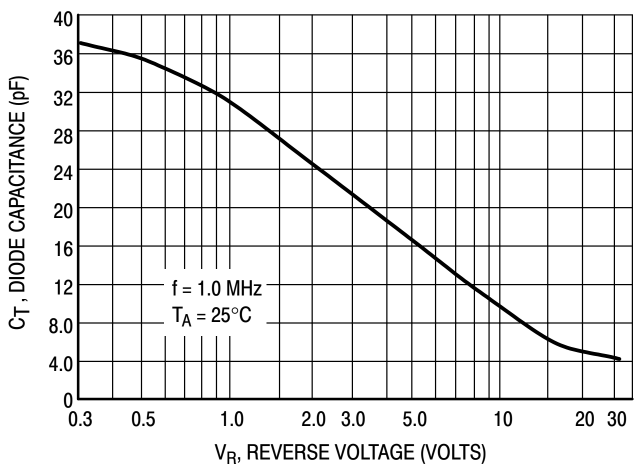


Figure 1. Diode Capacitance

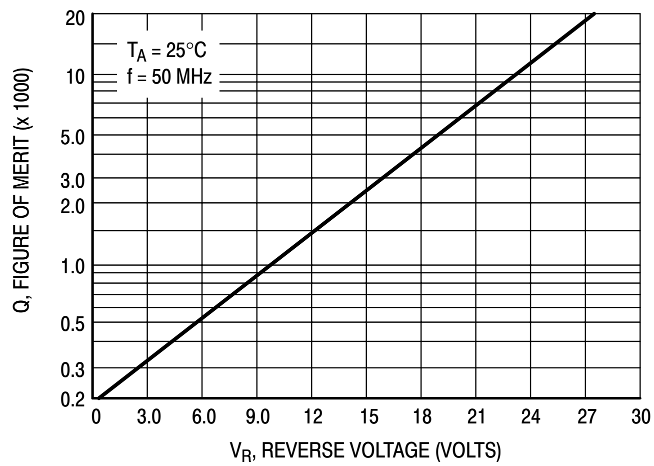


Figure 2. Figure of Merit

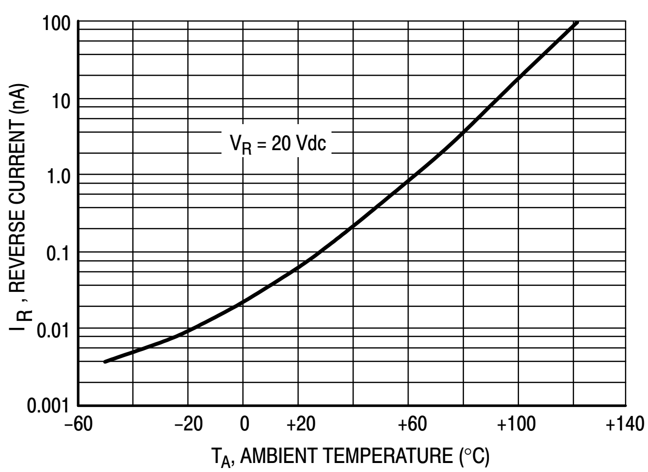


Figure 3. Leakage Current

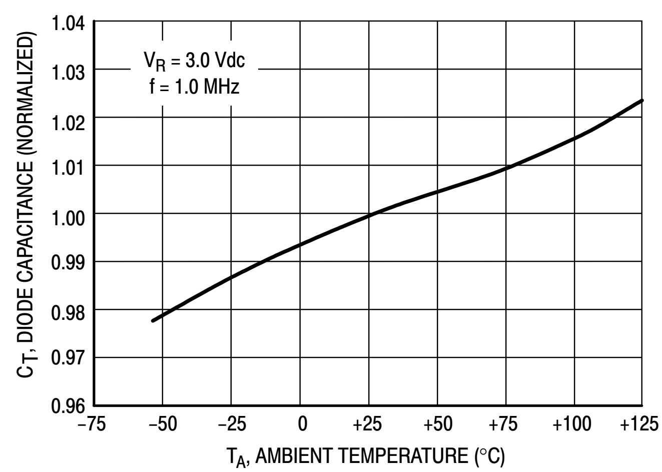


Figure 4. Diode Capacitance

NOTES ON TESTING AND SPECIFICATIONS

1. C_R is the ratio of C_T measured at 3.0 Vdc divided by C_T measured at 25 Vdc.

MMVL3401T1

Preferred Device

Silicon Pin Diode

This device is designed primarily for VHF band switching applications but is also suitable for use in general–purpose switching circuits. Supplied in a Surface Mount package.

- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Capacitance — 0.7 pF Typ at V_R = 20 Vdc
- Very Low Series Resistance at 100 MHz — 0.34 Ohms (Typ) @ I_F = 10 mAdc
- Device Marking: 4D

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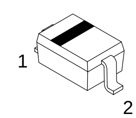
http://onsemi.com

SILICON PIN SWITCHING DIODE



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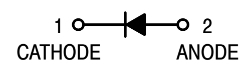
SOD–323
CASE 477



MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Continuous Reverse Voltage	20	Vdc
I_F	Peak Forward Current	20	mAdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C Derate above 25°C	200 1.57	mW mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature	150	°C

*FR–4 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMVL3401T1	SOD–323	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

January, 2000 – Rev. 1

Publication Order Number:
MMVL3401T1/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	35	—	—	Vdc
Diode Capacitance (V_R = 20 Vdc)	C_T	—	—	1.0	pF
Series Resistance (Figure 5) (I_F = 10 mAdc, f = 100 MHz)	R_S	—	—	0.7	Ω
Reverse Leakage Current (V_R = 25 Vdc)	I_R	—	—	0.1	μAdc

TYPICAL CHARACTERISTICS

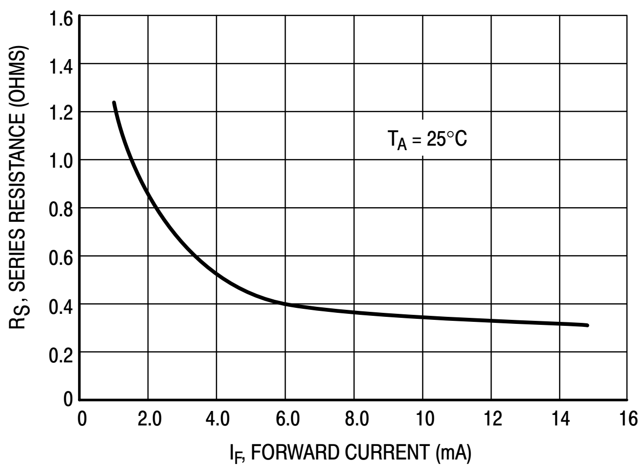


Figure 1. Series Resistance

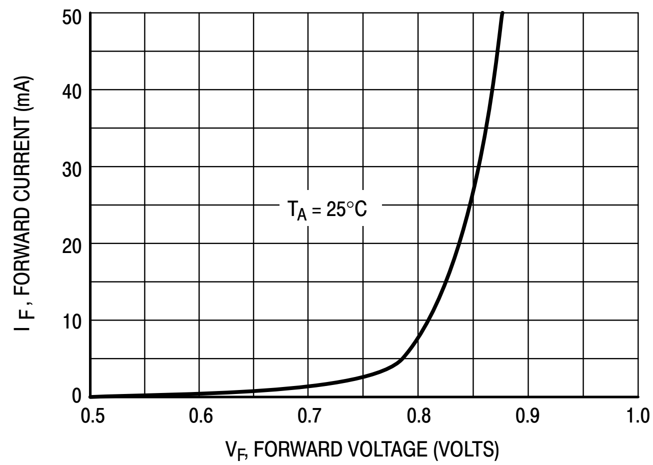


Figure 2. Forward Voltage

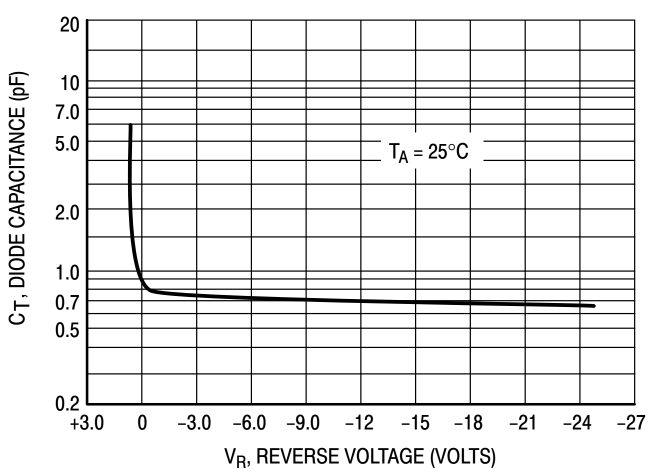


Figure 3. Diode Capacitance

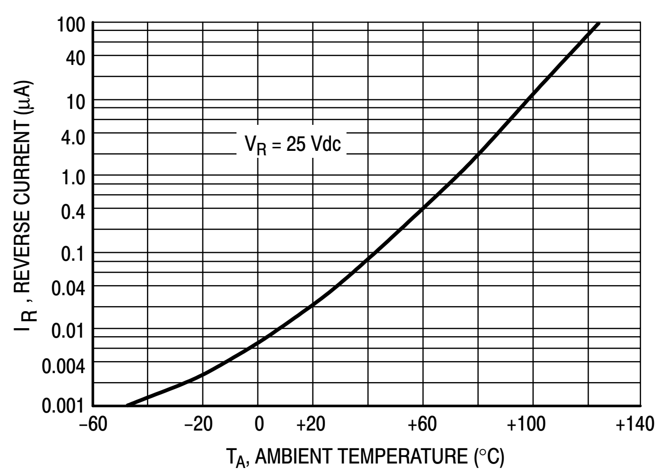


Figure 4. Leakage Current

MMVL3700T1

High Voltage Silicon Pin Diode

These devices are designed primarily for VHF band switching applications but are also suitable for use in general–purpose switching circuits. They are supplied in a cost–effective plastic surface mount package for economical, high–volume consumer and industrial requirements.

- Long Reverse Recovery Time t_{rr} = 300 ns (Typ)
- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Series Resistance @ 100 MHz — R_S = 0.7 Ohms (Typ) @ I_F = 10 mAdc
- Reverse Breakdown Voltage = 200 V (Min)
- Device Marking: 4R

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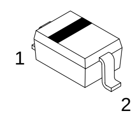
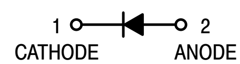
SILICON PIN SWITCHING DIODE



PLASTIC
SOD–323
CASE 477



MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Continuous Reverse Voltage	200	Vdc
I_F	Peak Forward Current	20	mAdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C Derate above 25°C	200 1.57	mW mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature	150	°C

*FR–4 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMVL3700T1	SOD–323	3000 / Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	200	—	—	Vdc
Diode Capacitance (V_R = 20 Vdc, f = 1.0 MHz)	C_T	—	—	1.0	pF
Series Resistance (I_F = 10 mAdc)	R_S	—	0.7	1.0	Ω
Reverse Leakage Current (V_R = 150 Vdc)	I_R	—	—	0.1	μAdc
Reverse Recovery Time ($I_F = I_R$ = 10 mAdc)	t_{rr}	—	300	—	ns

TYPICAL CHARACTERISTICS

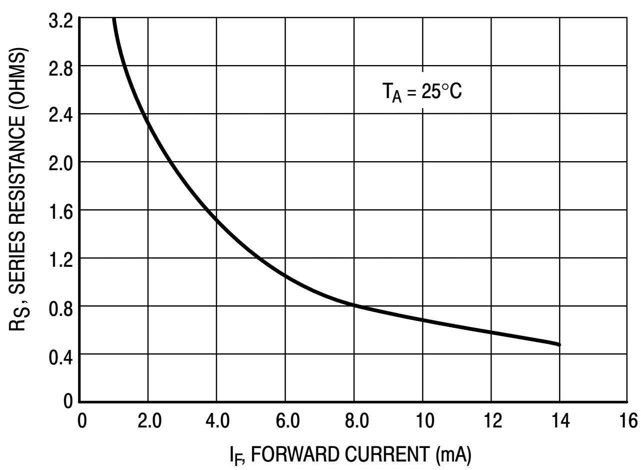


Figure 1. Series Resistance

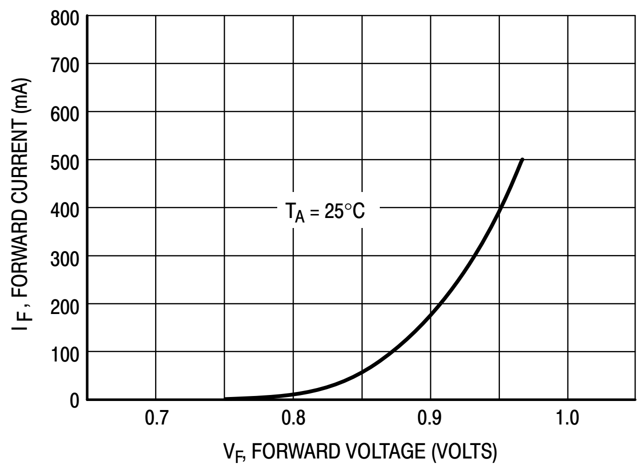


Figure 2. Forward Voltage

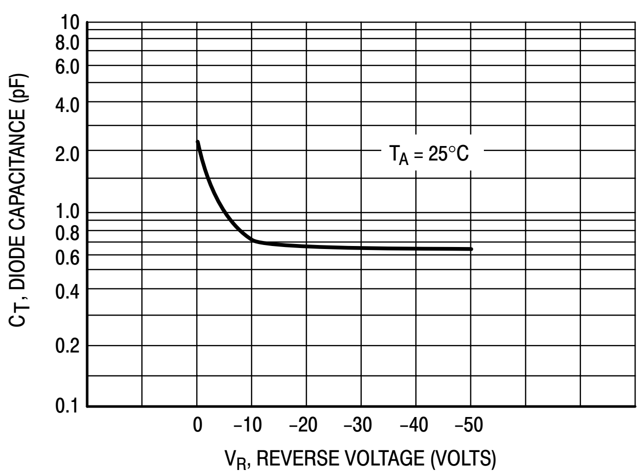


Figure 3. Diode Capacitance

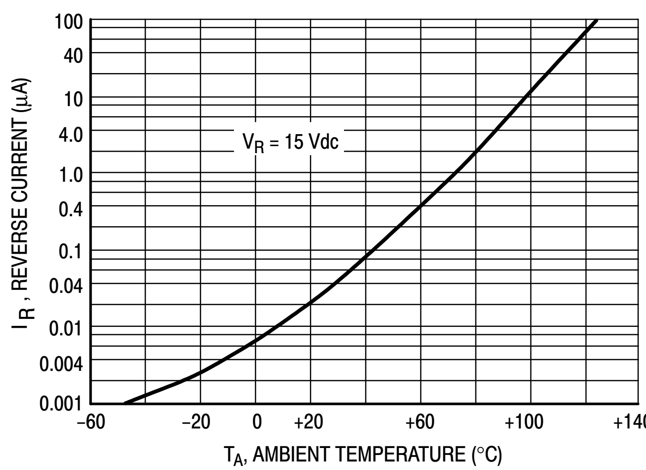


Figure 4. Leakage Current

MMVL409T1

Preferred Device

Silicon Tuning Diode

These devices are designed for general frequency control and tuning applications. They provide solid–state reliability in replacement of mechanical tuning methods.

- High Q with Guaranteed Minimum Values at VHF Frequencies
- Controlled and Uniform Tuning Ratio
- Surface Mount Package
- Device Marking: X5

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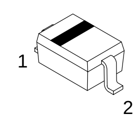
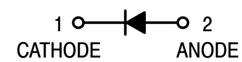
VOLTAGE VARIABLE CAPACITANCE DIODE



PLASTIC
SOD–323
CASE 477



MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Continuous Reverse Voltage	20	Vdc
I_F	Peak Forward Current	200	mAdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C	200	mW
	Derate above 25°C	1.57	mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature	150	°C

*FR–4 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMVL409T1	SOD–323	3000 / Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	20	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 15 Vdc)	I_R	—	—	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 3.0 Vdc, f = 1.0 MHz)	TC_C	—	300	—	ppm/°C

	C_t, Diode Capacitance V_R = 3.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 3.0 Vdc f = 50 MHz	C_R, Capacitance Ratio C_3/C_8 f = 1.0 MHz(1)	
Device	**Min**	**Nom**	**Max**	**Min**	**Min**	**Max**
MMVL409T1	26	29	32	200	1.5	1.9

1. C_R is the ratio of C_t measured at 3 Vdc divided by C_t measured at 8 Vdc.

TYPICAL CHARACTERISTICS

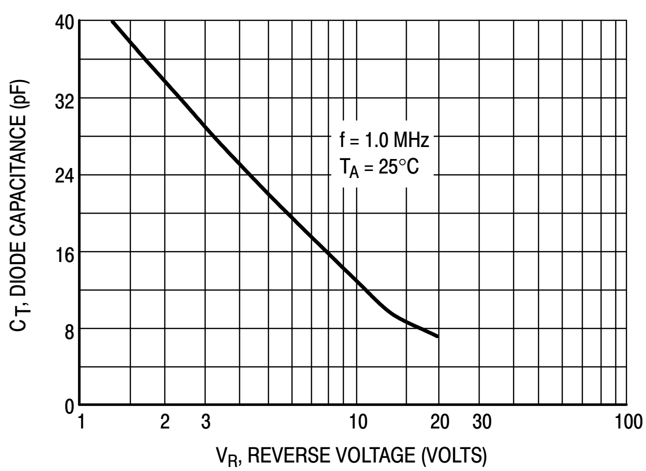


Figure 1. Diode Capacitance

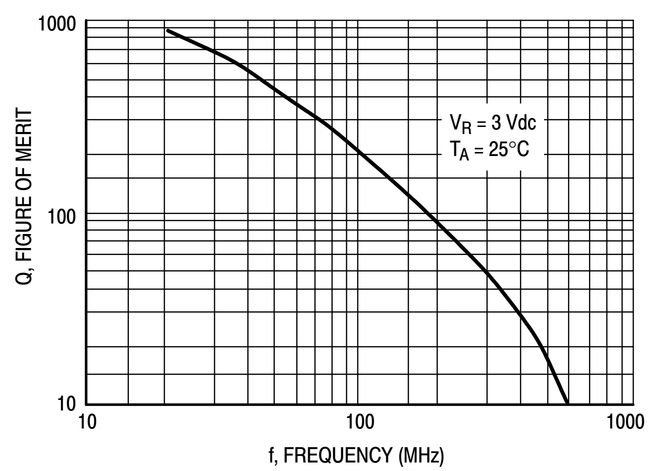


Figure 2. Figure of Merit

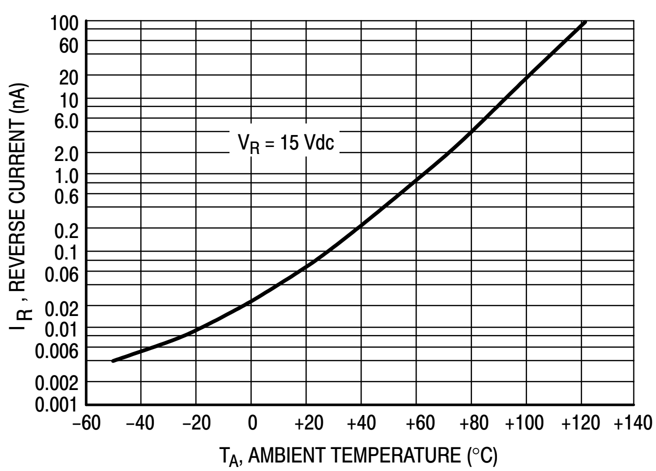


Figure 3. Leakage Current

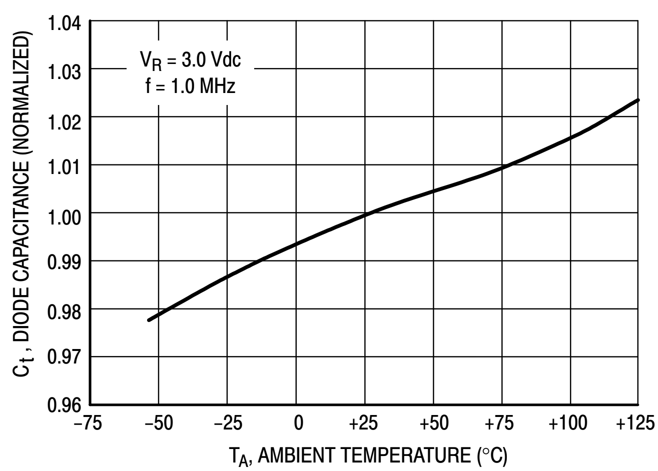


Figure 4. Diode Capacitance

MMVL809T1

Silicon Tuning Diode

This device is designed for 900 MHz frequency control and tuning applications. It provides solid–state reliability in replacement of mechanical tuning methods.

- Controlled and Uniform Tuning Ratio
- Surface Mount Package
- Available in 8 mm Tape and Reel
- Device Marking: 5K

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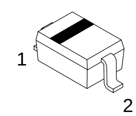
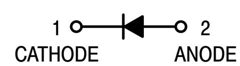
4.5 – 6.1 pF
VOLTAGE VARIABLE
CAPACITANCE DIODE



PLASTIC
SOD–323
CASE 477



MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_R	Continuous Reverse Voltage	20	Vdc
I_F	Peak Forward Current	20	mAdc

THERMAL CHARACTERISTICS

Symbol	Characteristic	Max	Unit
P_D	Total Device Dissipation FR–5 Board,* T_A = 25°C Derate above 25°C	200 1.57	mW mW/°C
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	635	°C/W
T_J, T_{stg}	Junction and Storage Temperature	150	°C

*FR–4 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
MMVL809T1	SOD–323	3000 / Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic – All Types	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	20	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 15 Vdc)	I_R	—	—	50	nAdc

	C_t, Diode Capacitance V_R = 2.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 3.0 Vdc f = 500 MHz	C_R, Capacitance Ratio C_2/C_8 f = 1.0 MHz[1]	
Device	**Min**	**Typ**	**Max**	**Typ**	**Min**	**Max**
MMVL809T1	4.5	5.3	6.1	75	1.8	2.6

1. C_R is the ratio of C_t measured at 2.0 Vdc divided by C_t measured at 8.0 Vdc.

TYPICAL CHARACTERISTICS

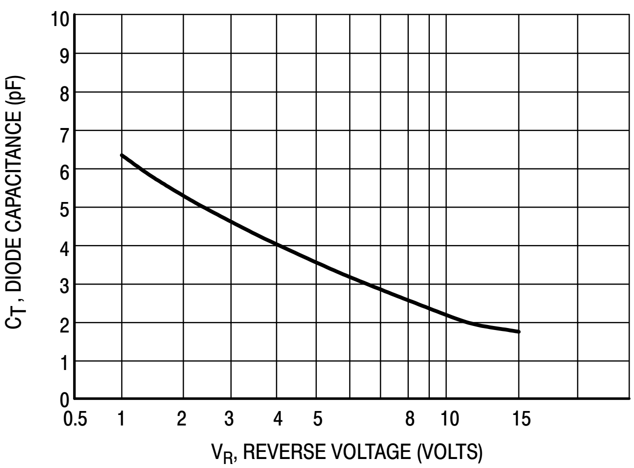


Figure 1. Diode Capacitance

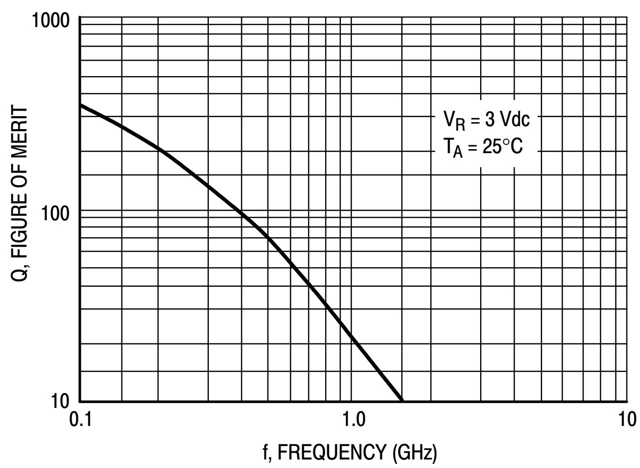


Figure 2. Figure of Merit

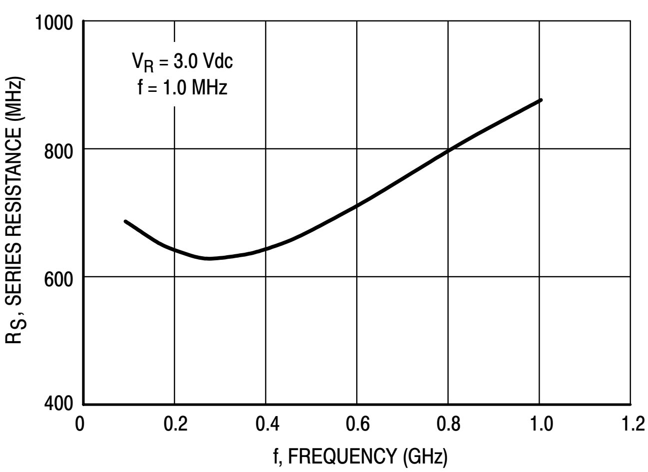


Figure 3. Series Resistance

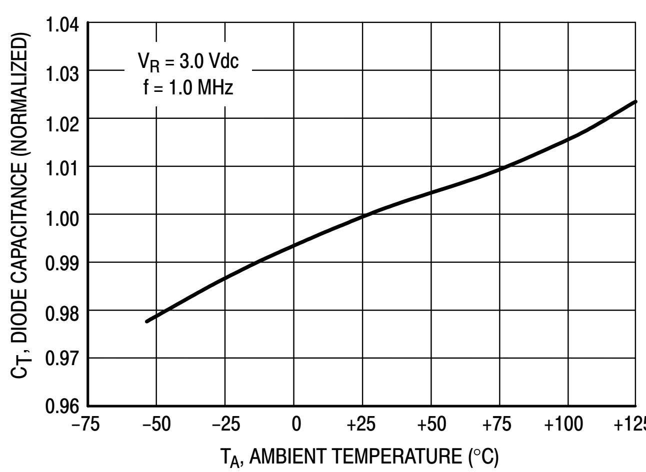
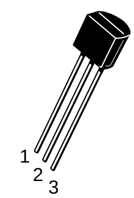


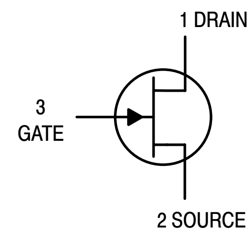
Figure 4. Diode Capacitance

JFET VHF Amplifier
N–Channel – Depletion

MPF102



CASE 29–11, STYLE 5
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	25	Vdc
Drain–Gate Voltage	V_{DG}	25	Vdc
Gate–Source Voltage	V_{GS}	–25	Vdc
Gate Current	I_G	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Junction Temperature Range	T_J	125	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate–Source Breakdown Voltage (I_G = –10 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	–25	–	Vdc
Gate Reverse Current (V_{GS} = –15 Vdc, V_{DS} = 0) (V_{GS} = –15 Vdc, V_{DS} = 0, T_A = 100°C)	I_{GSS}	 – –	 –2.0 –2.0	 nAdc μAdc
Gate–Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 2.0 nAdc)	$V_{GS(off)}$	–	–8.0	Vdc
Gate–Source Voltage (V_{DS} = 15 Vdc, I_D = 0.2 mAdc)	V_{GS}	–0.5	–7.5	Vdc
ON CHARACTERISTICS				
Zero–Gate–Voltage Drain Current(1) (V_{DS} = 15 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	2.0	20	mAdc
SMALL–SIGNAL CHARACTERISTICS				
Forward Transfer Admittance(1) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)	$\lvert y_{fs} \rvert$	 2000 1600	 7500 –	μmhos
Input Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)	$Re(y_{is})$	–	800	μmhos
Output Conductance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)	$Re(y_{os})$	–	200	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	–	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	–	3.0	pF

1. Pulse Test; Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

March, 2001 – Rev. 1
Publication Order Number:
MPF102/D

COMMON SOURCE CHARACTERISTICS

ADMITTANCE PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C)

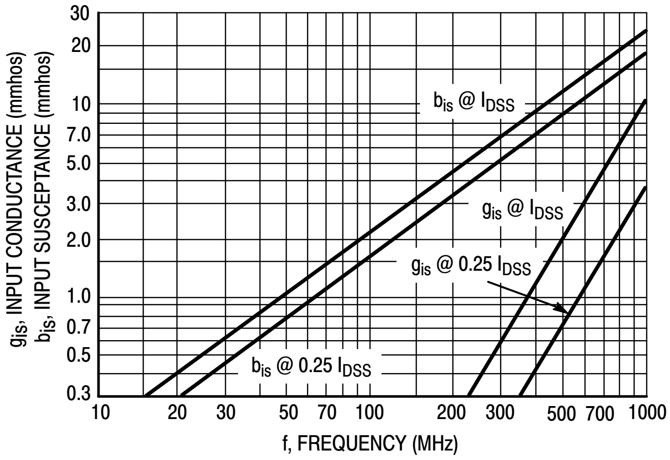


Figure 1. Input Admittance (y_{is})

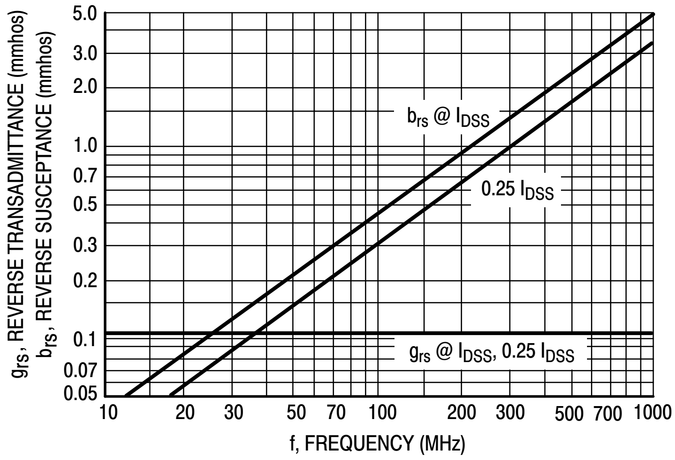


Figure 2. Reverse Transfer Admittance (y_{rs})

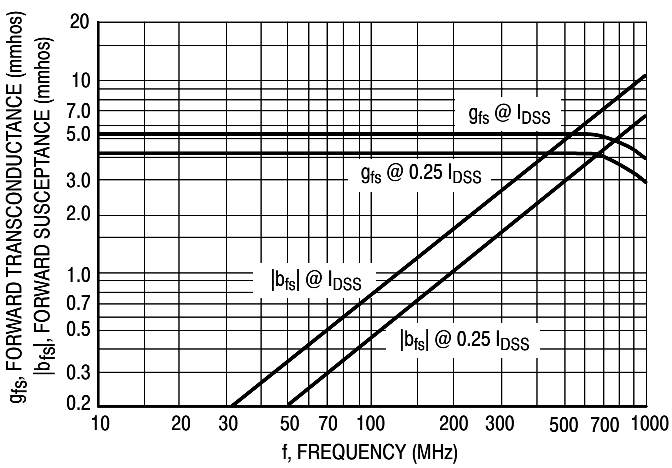


Figure 3. Forward Transadmittance (y_{fs})

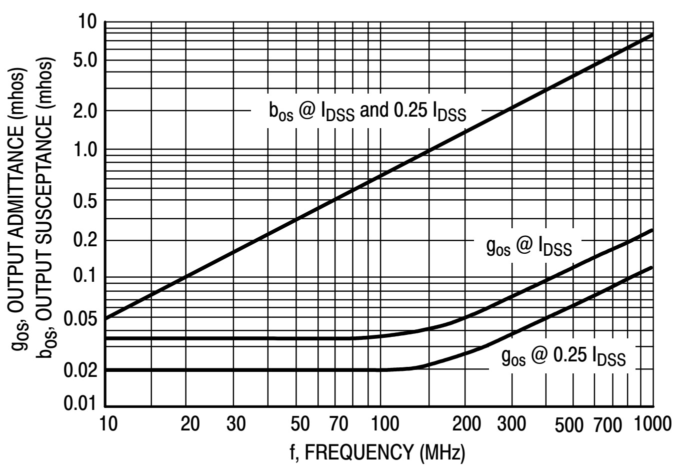


Figure 4. Output Admittance (y_{os})

COMMON SOURCE CHARACTERISTICS
S–PARAMETERS
(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

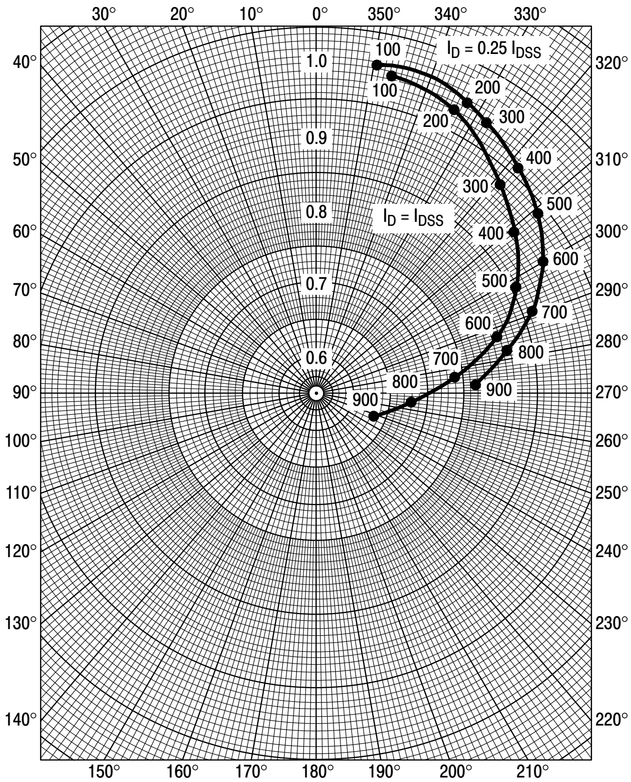


Figure 5. S_{11s}

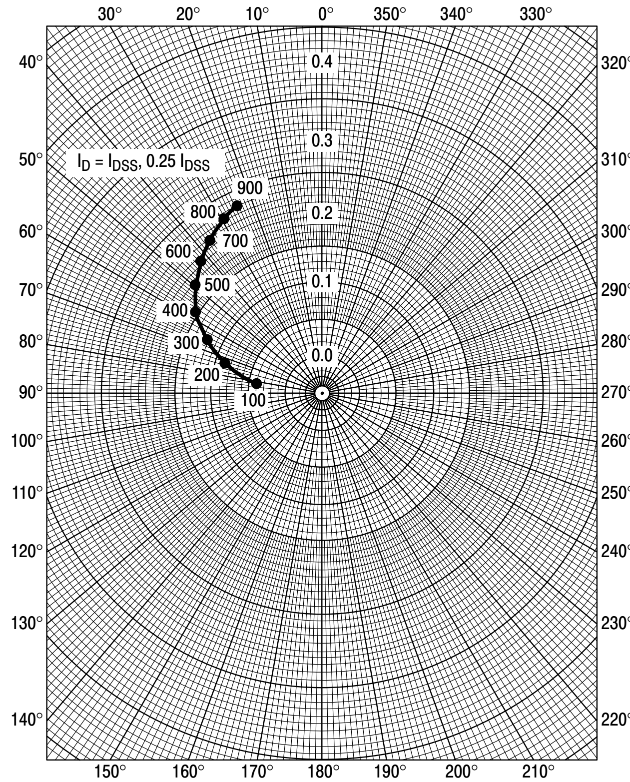


Figure 6. S_{12s}

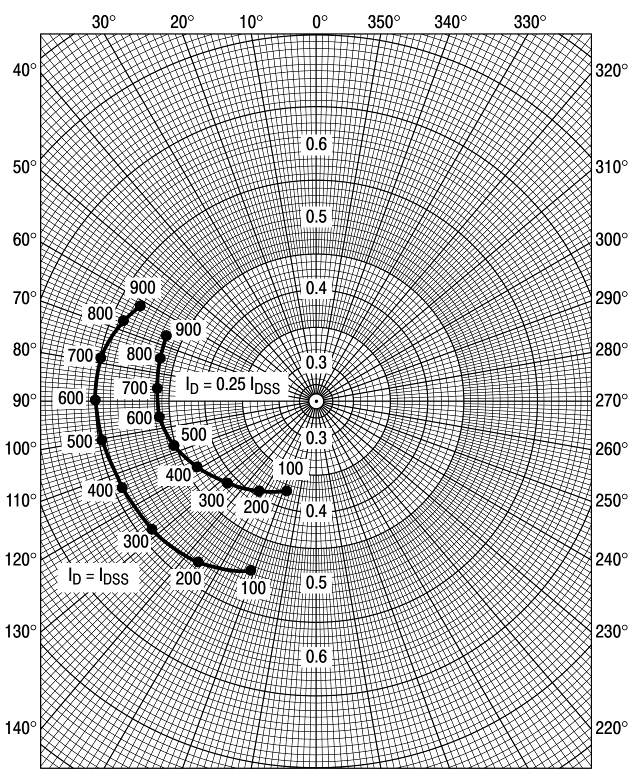


Figure 7. S_{21s}

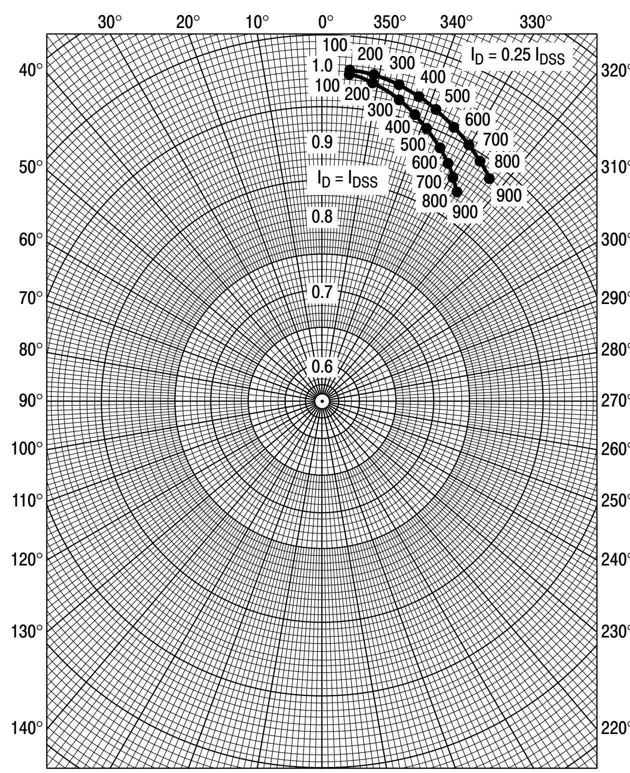


Figure 8. S_{22s}

COMMON GATE CHARACTERISTICS
ADMITTANCE PARAMETERS

(V_{DG} = 15 Vdc, $T_{channel}$ = 25°C)

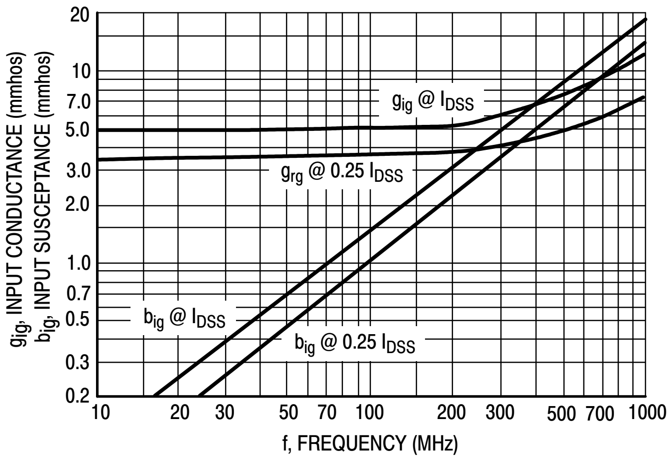


Figure 9. Input Admittance (y_{ig})

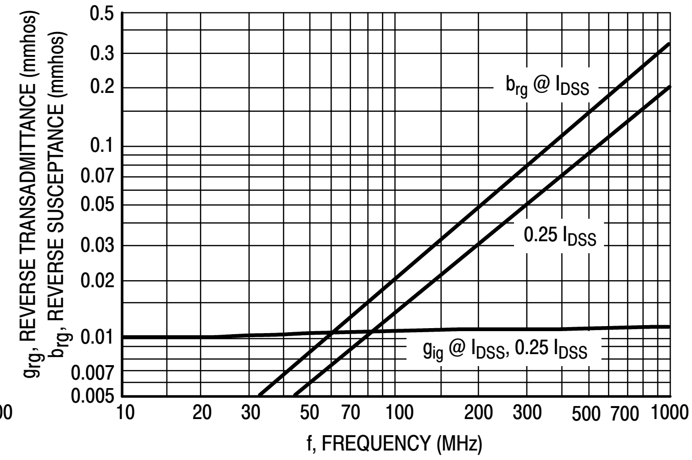


Figure 10. Reverse Transfer Admittance (y_{rg})

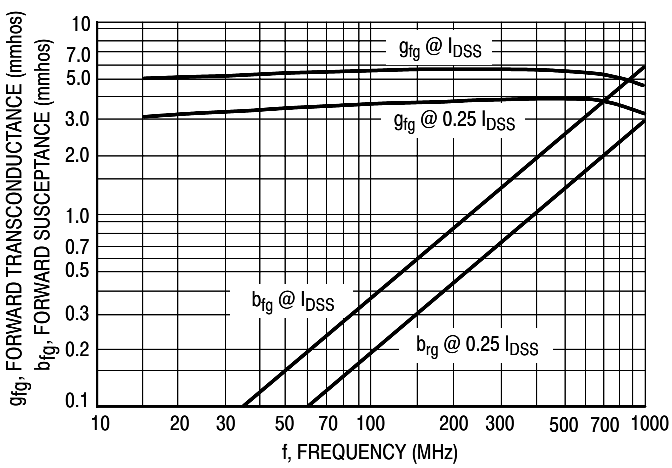


Figure 11. Forward Transfer Admittance (y_{fg})

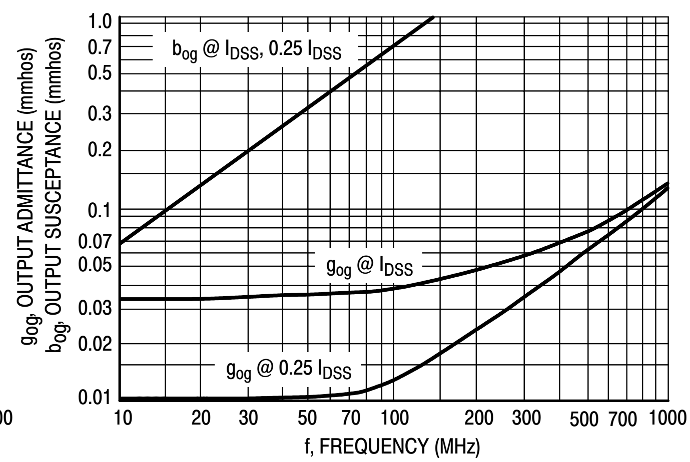


Figure 12. Output Admittance (y_{og})

COMMON GATE CHARACTERISTICS
S–PARAMETERS
(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

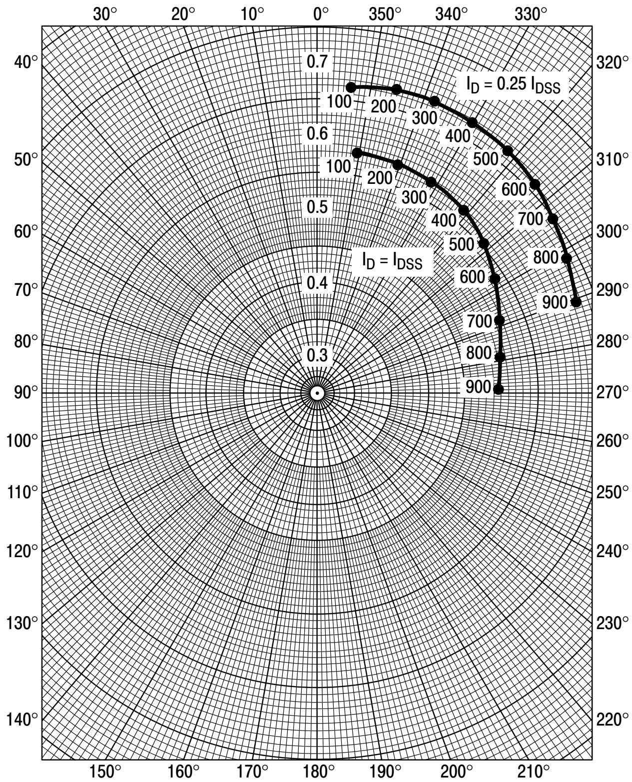


Figure 13. S_{11g}

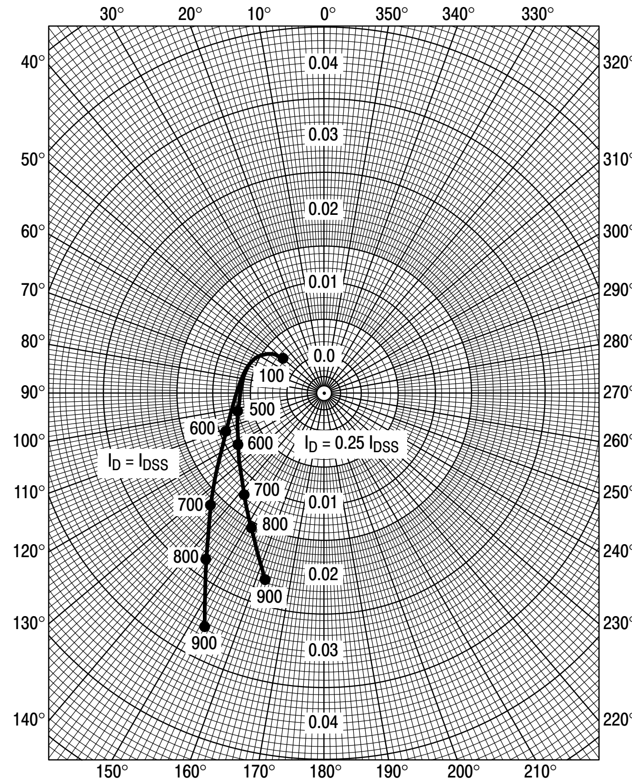


Figure 14. S_{12g}

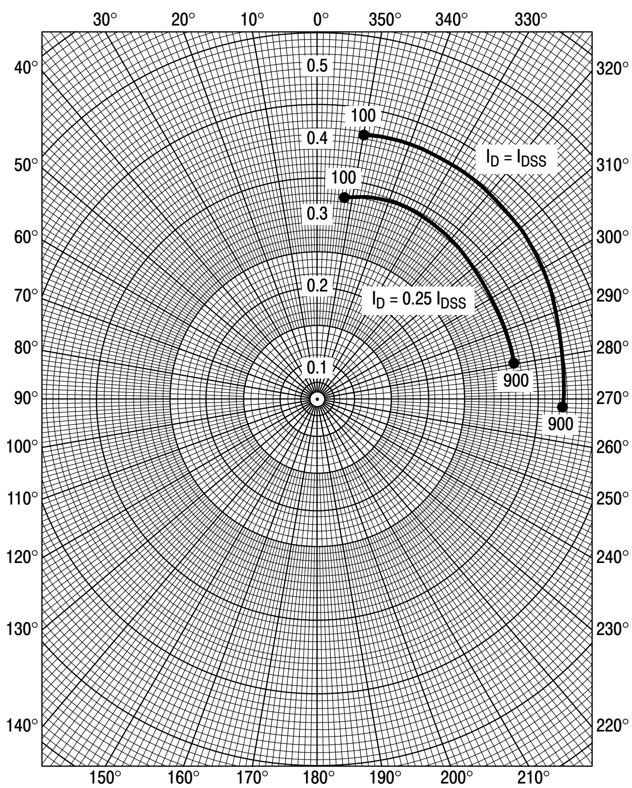


Figure 15. S_{21g}

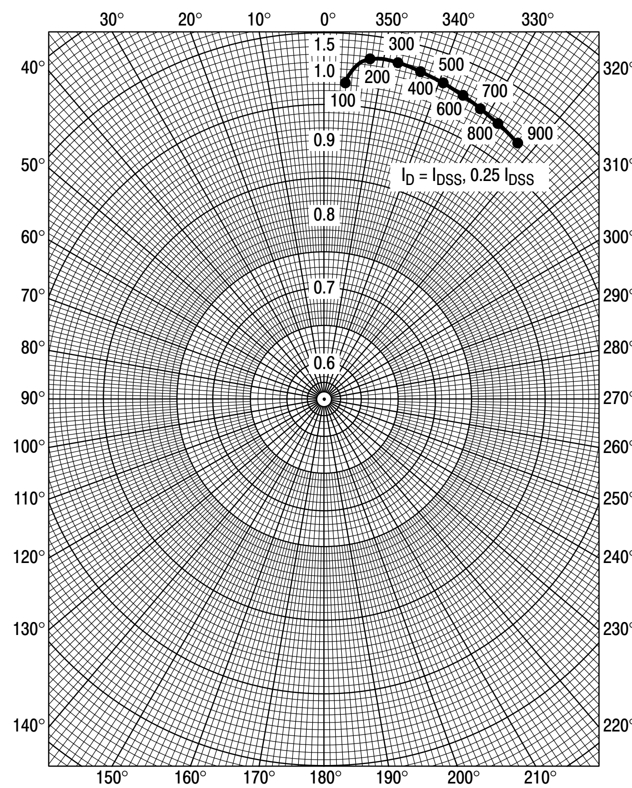
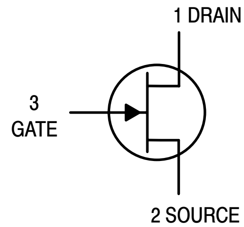


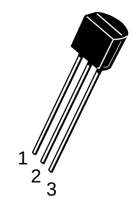
Figure 16. S_{22g}

JFETs Switching
N–Channel – Depletion



MPF4392
MPF4393

ON Semiconductors Preferred Devices



CASE 29–11, STYLE 5
TO–92 (TO–226AA)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DS}	30	Vdc
Drain–Gate Voltage	V_{DG}	30	Vdc
Gate–Source Voltage	V_{GS}	30	Vdc
Forward Gate Current	$I_{G(f)}$	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Operating and Storage Channel Temperature Range	$T_{channel}$, T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate–Source Breakdown Voltage (I_G = 1.0 µAdc, V_{DS} = 0)		$V_{(BR)GSS}$	30	–	–	Vdc
Gate Reverse Current (V_{GS} = 15 Vdc, V_{DS} = 0) (V_{GS} = 15 Vdc, V_{DS} = 0, T_A = 100°C)		I_{GSS}	 – –	 – –	 1.0 0.2	 nAdc µAdc
Drain–Cutoff Current (V_{DS} = 15 Vdc, V_{GS} = 12 Vdc) (V_{DS} = 15 Vdc, V_{GS} = 12 Vdc, T_A = 100°C)		$I_{D(off)}$	 – –	 – –	 1.0 0.1	 nAdc µAdc
Gate Source Voltage (V_{DS} = 15 Vdc, I_D = 10 nAdc)	 MPF4392 MPF4393	V_{GS}	 –2.0 –0.5	 – –	 –5.0 –3.0	Vdc
ON CHARACTERISTICS						
Zero–Gate–Voltage Drain Current[(1)] (V_{DS} = 15 Vdc, V_{GS} = 0)	 MPF4392 MPF4393	I_{DSS}	 25 5.0	 – –	 75 30	mAdc
Drain–Source On–Voltage (I_D = 6.0 mAdc, V_{GS} = 0) (I_D = 3.0 mAdc, V_{GS} = 0)	 MPF4392 MPF4393	$V_{DS(on)}$	 – –	 – –	 0.4 0.4	Vdc
Static Drain–Source On Resistance (I_D = 1.0 mAdc, V_{GS} = 0)	 MPF4392 MPF4393	$r_{DS(on)}$	 – –	 – –	 60 100	Ω
SMALL–SIGNAL CHARACTERISTICS						
Forward Transfer Admittance (V_{DS} = 15 Vdc, I_D = 25 mAdc, f = 1.0 kHz) (V_{DS} = 15 Vdc, I_D = 5.0 mAdc, f = 1.0 kHz)	 MPF4392 MPF4393	$\|y_{fs}\|$	 – –	 17 12	 – –	mmhos

1. Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 3.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 2
Publication Order Number:
MPF4392/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
SMALL–SIGNAL CHARACTERISTICS (continued)						
Drain–Source "ON" Resistance (V_{GS} = 0, I_D = 0, f = 1.0 kHz)	MPF4392	$r_{ds(on)}$	–	–	60	Ω
	MPF4393		–	–	100	
Input Capacitance (V_{GS} = 15 Vdc, V_{DS} = 0, f = 1.0 MHz)		C_{iss}	–	6.0	10	pF
Reverse Transfer Capacitance (V_{GS} = 12 Vdc, V_{DS} = 0, f = 1.0 MHz)		C_{rss}	–	2.5	3.5	pF
(V_{DS} = 15 Vdc, I_D = 10 mAdc, f = 1.0 MHz)			–	3.2	–	
SWITCHING CHARACTERISTICS						
Rise Time (See Figure 2) ($I_{D(on)}$ = 6.0 mAdc)	MPF4392	t_r	–	2.0	5.0	ns
($I_{D(on)}$ = 3.0 mAdc)	MPF4393		–	2.5	5.0	
Fall Time (See Figure 4) ($V_{GS(off)}$ = 7.0 Vdc)	MPF4392	t_f	–	15	20	ns
($V_{GS(off)}$ = 5.0 Vdc)	MPF4393		–	29	35	
Turn–On Time (See Figures 1 and 2) ($I_{D(on)}$ = 6.0 mAdc)	MPF4392	t_{on}	–	4.0	15	ns
($I_{D(on)}$ = 3.0 mAdc)	MPF4393		–	6.5	15	
Turn–Off Time (See Figures 3 and 4) ($V_{GS(off)}$ = 7.0 Vdc)	MPF4392	t_{off}	–	20	35	ns
($V_{GS(off)}$ = 5.0 Vdc)	MPF4393		–	37	55	

TYPICAL SWITCHING CHARACTERISTICS

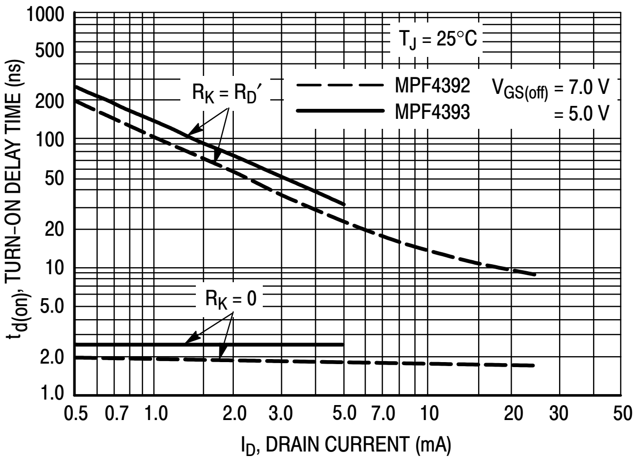


Figure 1. Turn–On Delay Time

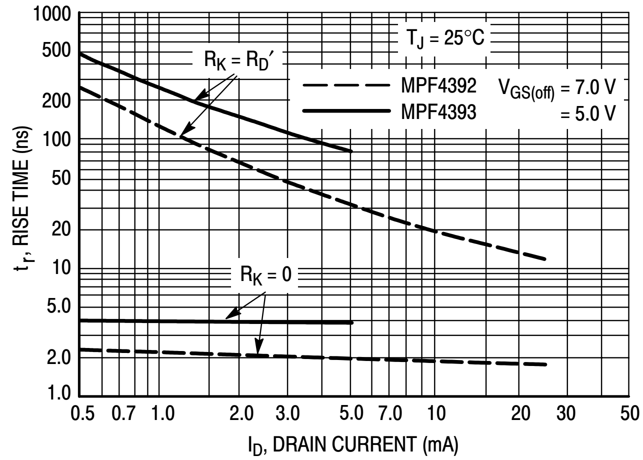


Figure 2. Rise Time

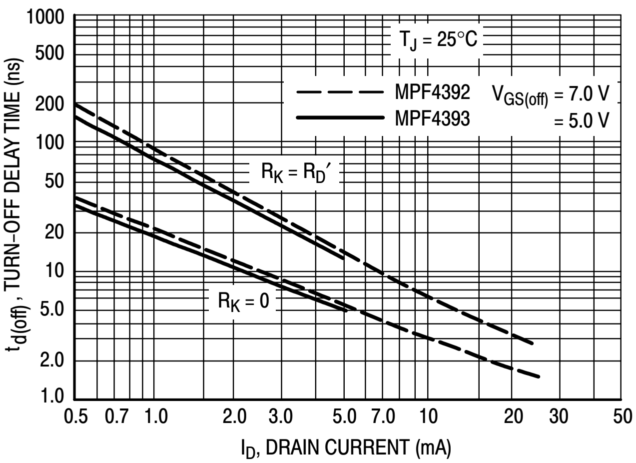


Figure 3. Turn–Off Delay Time

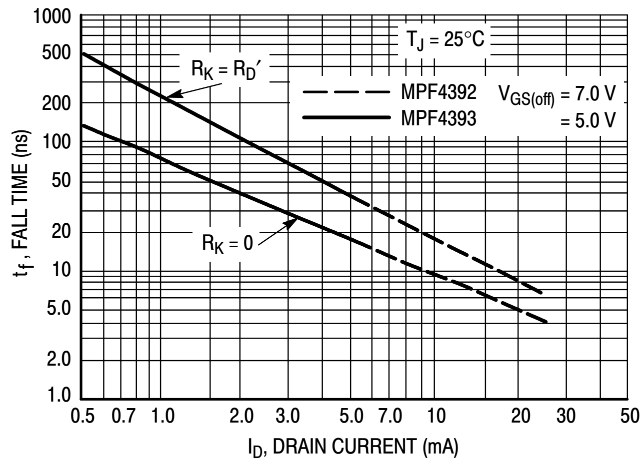


Figure 4. Fall Time

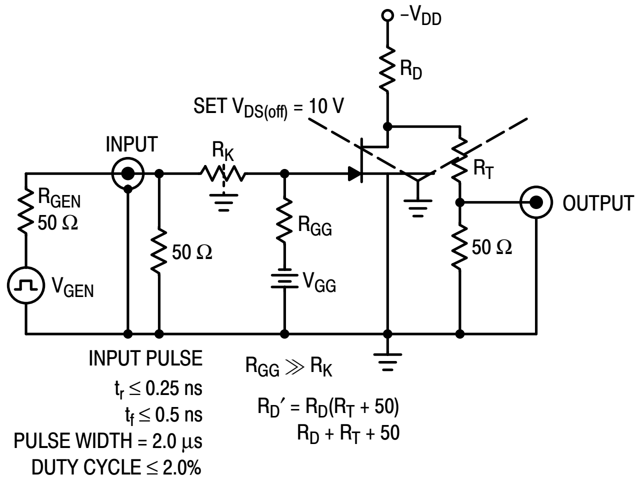


Figure 5. Switching Time Test Circuit

NOTE 1

The switching characteristics shown above were measured using a test circuit similar to Figure 5. At the beginning of the switching interval, the gate voltage is at Gate Supply Voltage ($-V_{GG}$). The Drain–Source Voltage (V_{DS}) is slightly lower than Drain Supply Voltage (V_{DD}) due to the voltage divider. Thus Reverse Transfer Capacitance (C_{rss}) or Gate–Drain Capacitance (C_{gd}) is charged to $V_{GG} + V_{DS}$.

During the turn–on interval, Gate–Source Capacitance (C_{gs}) discharges through the series combination of R_{Gen} and R_K. C_{gd} must discharge to $V_{DS(on)}$ through R_G and R_K in series with the parallel combination of effective load impedance (R'_D) and Drain–Source Resistance (r_{ds}). During the turn–off, this charge flow is reversed.

Predicting turn–on time is somewhat difficult as the channel resistance r_{ds} is a function of the gate–source voltage. While C_{gs} discharges, V_{GS} approaches zero and r_{ds} decreases. Since C_{gd} discharges through r_{ds}, turn–on time is non–linear. During turn–off, the situation is reversed with r_{ds} increasing as C_{gd} charges.

The above switching curves show two impedance conditions: 1) R_K is equal to R_D' which simulates the switching behavior of cascaded stages where the driving source impedance is normally the load impedance of the previous stage, and 2) $R_K = 0$ (low impedance) the driving source impedance is that of the generator.

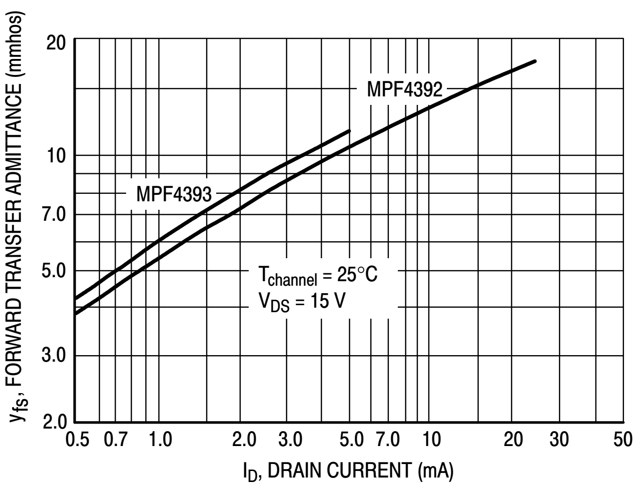


Figure 6. Typical Forward Transfer Admittance

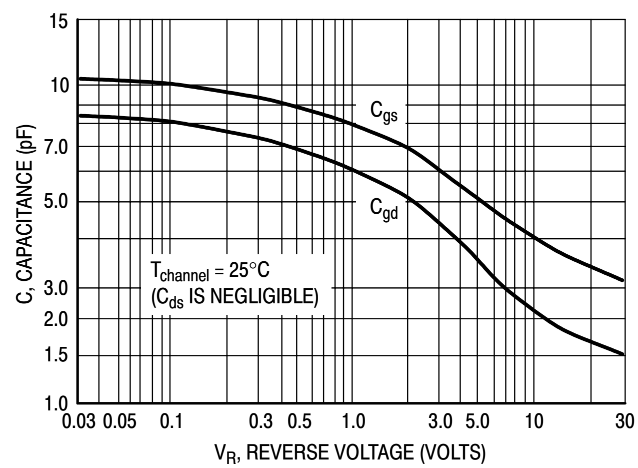


Figure 7. Typical Capacitance

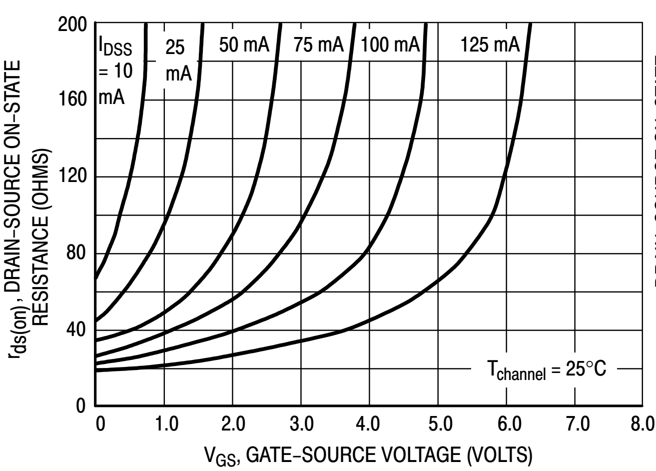


Figure 8. Effect of Gate–Source Voltage On Drain–Source Resistance

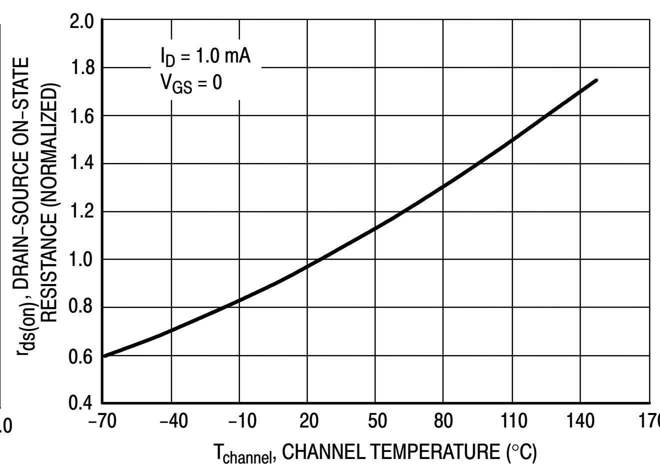


Figure 9. Effect of Temperature On Drain–Source On–State Resistance

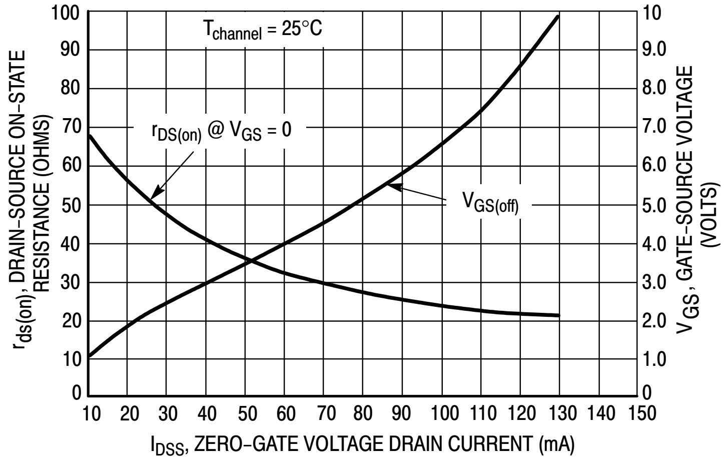


Figure 10. Effect of I_{DSS} On Drain–Source Resistance and Gate–Source Voltage

NOTE 2

The Zero–Gate–Voltage Drain Current (I_{DSS}), is the principle determinant of other J–FET characteristics. Figure 10 shows the relationship of Gate–Source Off Voltage ($V_{GS(off)}$) and Drain–Source On Resistance ($r_{ds(on)}$) to I_{DSS}. Most of the devices will be within ±10% of the values shown in Figure 10. This data will be useful in predicting the characteristic variations for a given part number.

For example:

Unknown

$r_{ds(on)}$ and V_{GS} range for an MPF4392

The electrical characteristics table indicates that an MPF4392 has an I_{DSS} range of 25 to 75 mA. Figure 10 shows $r_{ds(on)}$ = 52 Ohms for I_{DSS} = 25 mA and 30 Ohms for I_{DSS} = 75 mA. The corresponding V_{GS} values are 2.2 volts and 4.8 volts.

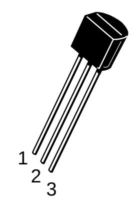
JFET Switching

N–Channel – Depletion

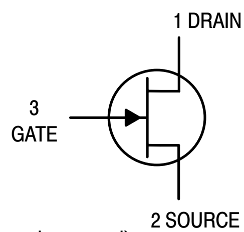
MPF4856

MAXIMUM RATINGS

Rating	Symbol	MPF4856	Unit
Drain–Source Voltage	V_{DS}	+40	Vdc
Drain–Gate Voltage	V_{DG}	+40	Vdc
Reverse Gate–Source Voltage	V_{GSR}	–40	Vdc
Forward Gate Current	I_{GF}	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.4	mW mW/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C



CASE 29–11, STYLE 5
TO–92 (TO–226AA)



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate–Source Breakdown Voltage (I_G = 1.0 µAdc, V_{DS} = 0)	$V_{(BR)GSS}$	–40	–	Vdc
Gate Reverse Current (V_{GS} = –20 Vdc, V_{DS} = 0) (V_{GS} = –20 Vdc, V_{DS} = 0, T_A = 150°C)	I_{GSS}	– –	0.25 0.5	nAdc µAdc
Gate Source Cutoff Voltage	$V_{GS(off)}$	–4.0	–10	Vdc
Drain–Cutoff Current (V_{DS} = 15 Vdc, V_{GS} = –10 Vdc) (V_{DS} = 15 Vdc, V_{GS} = –10 Vdc, T_A = 150°C)	$I_{D(off)}$	– –	0.25 0.5	nAdc µAdc
ON CHARACTERISTICS				
Zero–Gate–Voltage Drain Current(1)	I_{DSS}	50	–	mAdc
Drain–Source On–Voltage (I_D = 20 mAdc, V_{GS} = 0)	$V_{DS(on)}$	–	0.75	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Drain–Source “ON” Resistance	$r_{ds(on)}$	–	25	Ω
Input Capacitance (V_{DS} = 0, V_{GS} = –10 Vdc, f = 1.0 MHz)	C_{iss}	–	18	pF
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = –10 Vdc, f = 1.0 MHz)	C_{rss}	–	8.0	pF

1. Pulse Test: Pulse Width < 300 µs, Duty Cycle ≤ 2.0%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic			Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS						
Turn–On Delay Time	Conditions for MPF4856, MPF4859: (V_{DD} = 10 Vdc, $I_{D(on)}$ = 20 mAdc, $V_{GS(on)}$ = 0, $V_{GS(off)}$ = –10 Vdc)	MPF4856, MPF4859 MPF4857, MPF4860 MPF4861	$t_{d(on)}$	– – –	6.0 6.0 10	ns
Rise Time	Conditions for MPF4857, MPF4860: (V_{DD} = 10 Vdc, $I_{D(on)}$ = 10 mAdc, $V_{GS(on)}$ = 0, $V_{GS(off)}$ = –6.0 Vdc)	MPF4856, MPF4859 MPF4857, MPF4860 MPF4861	t_r	– – –	3.0 4.0 10	ns
Turn–Off Time	Conditions for MPF4858, MPF4861: (V_{DD} = 10 Vdc, $I_{D(on)}$ = 5.0 mAdc, $V_{GS(on)}$ = 0, $V_{GS(off)}$ = –4.0 Vdc)	MPF4856, MPF4859 MPF4857, MPF4860 MPF4861	t_{off}	– – –	25 50 100	ns

TYPICAL SWITCHING CHARACTERISTICS

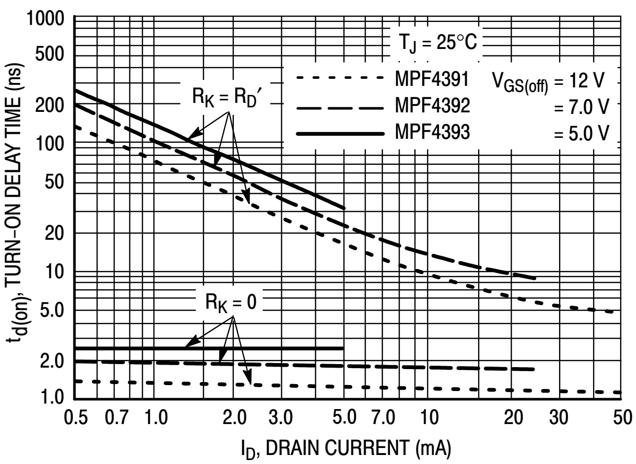


Figure 1. Turn–On Delay Time

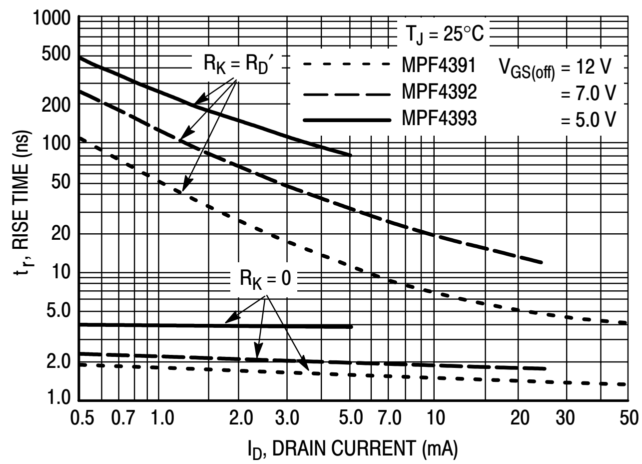


Figure 2. Rise Time

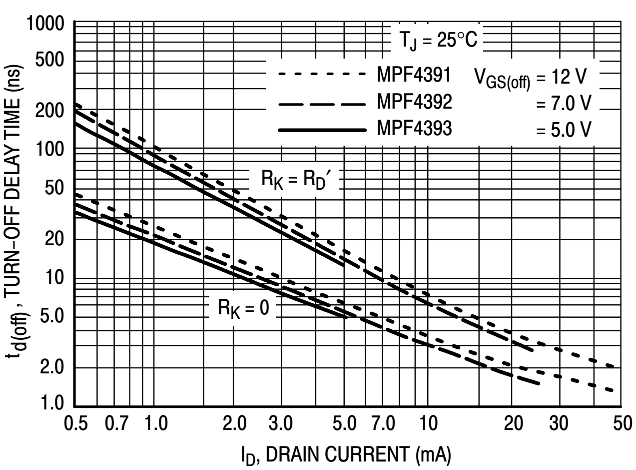


Figure 3. Turn–Off Delay time

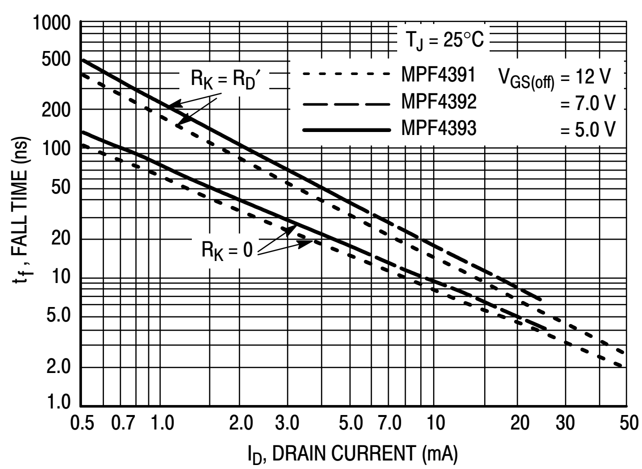


Figure 4. Fall Time

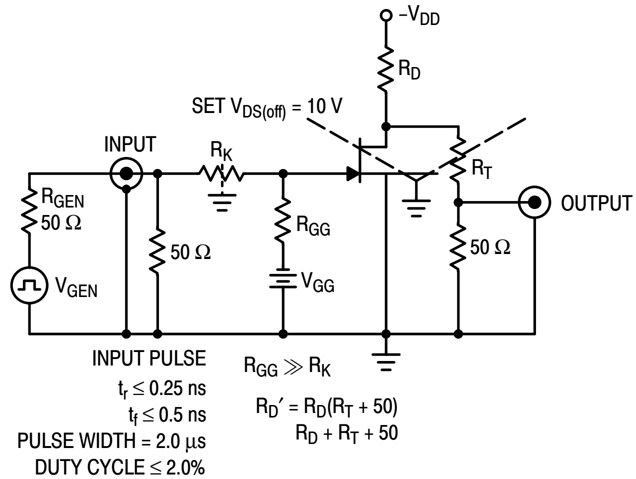


Figure 5. Switching Time Test Circuit

NOTE 1

The switching characteristics shown above were measured using a test circuit similar to Figure 5. At the beginning of the switching interval, the gate voltage is at Gate Supply Voltage ($-V_{GG}$). The Drain–Source Voltage (V_{DS}) is slightly lower than Drain Supply Voltage (V_{DD}) due to the voltage divider. Thus Reverse Transfer Capacitance (C_{rss}) or Gate–Drain Capacitance (C_{gd}) is charged to $V_{GG} + V_{DS}$.

During the turn–on interval, Gate–Source Capacitance (C_{gs}) discharges through the series combination of R_{Gen} and R_K. C_{gd} must discharge to $V_{DS(on)}$ through R_G and R_K in series with the parallel combination of effective load impedance (R'_D) and Drain–Source Resistance (r_{ds}). During the turn–off, this charge flow is reversed.

Predicting turn–on time is somewhat difficult as the channel resistance r_{ds} is a function of the gate–source voltage. While C_{gs} discharges, V_{GS} approaches zero and r_{ds} decreases. Since C_{gd} discharges through r_{ds}, turn–on time is non–linear. During turn–off, the situation is reversed with r_{ds} increasing as C_{gd} charges.

The above switching curves show two impedance conditions: 1) R_K is equal to R_D' which simulates the switching behavior of cascaded stages where the driving source impedance is normally the load impedance of the previous stage, and 2) $R_K = 0$ (low impedance) the driving source impedance is that of the generator.

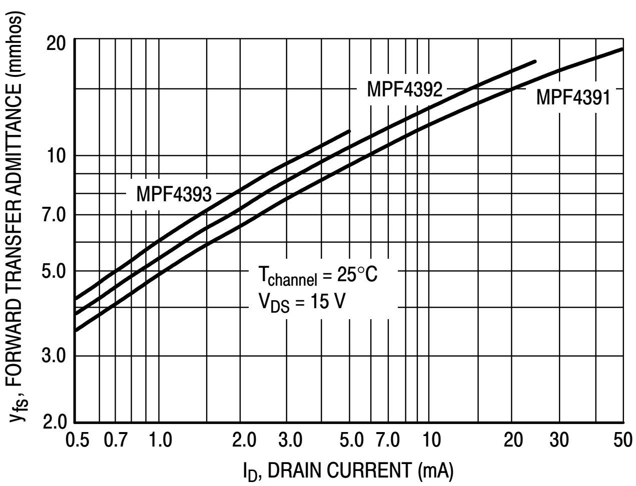


Figure 6. Typical Forward Transfer Admittance

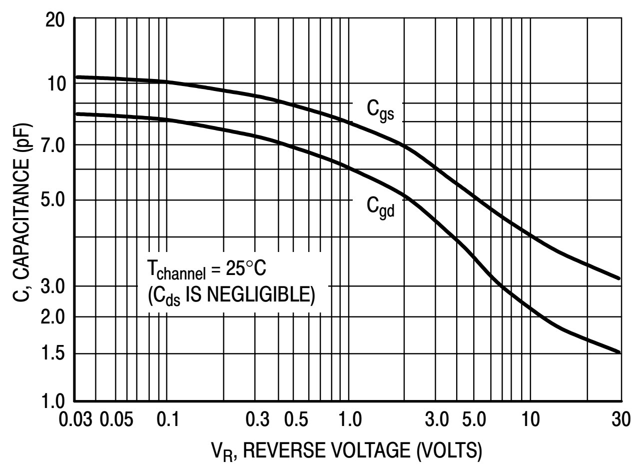


Figure 7. Typical Capacitance

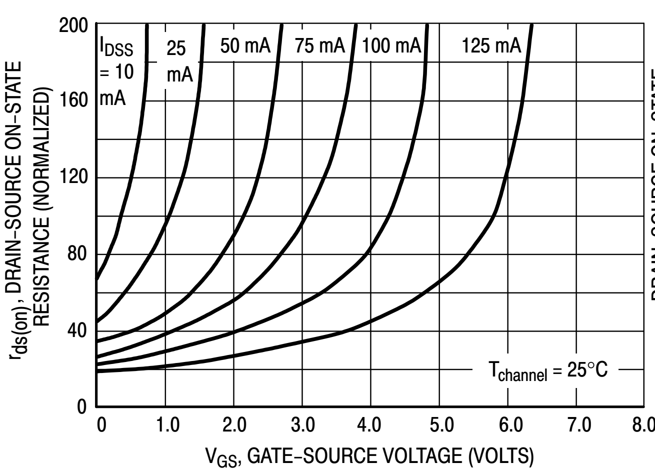


Figure 8. Effect of Gate–Source Voltage On Drain–Source Resistance

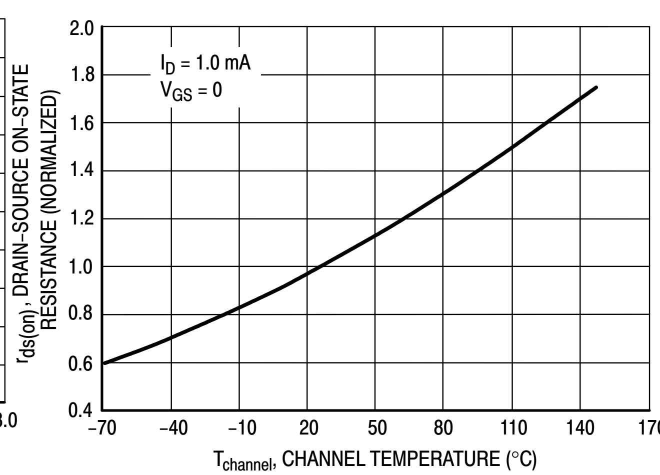


Figure 9. Effect of Temperature On Drain–Source On–State Resistance

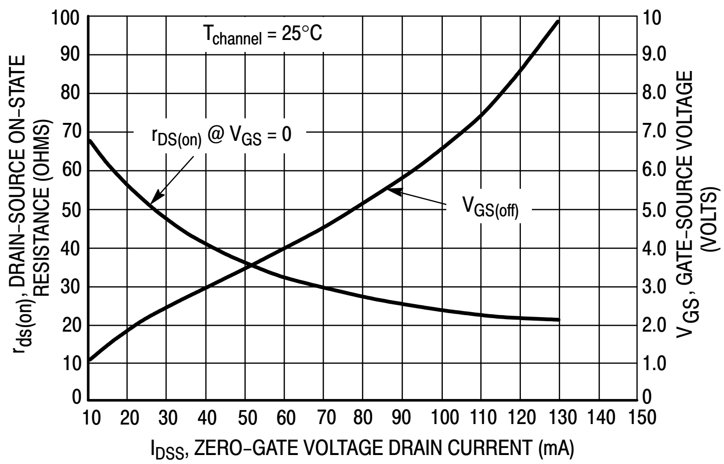


Figure 10. Effect of I_{DSS} On Drain–Source Resistance and Gate–Source Voltage

NOTE 2

The Zero–Gate–Voltage Drain Current (I_{DSS}), is the principle determinant of other J–FET characteristics. Figure 10 shows the relationship of Gate–Source Off Voltage ($V_{GS(off)}$) and Drain–Source On Resistance ($r_{ds(on)}$) to I_{DSS}. Most of the devices will be within ±10% of the values shown in Figure 10. This data will be useful in predicting the characteristic variations for a given part number.

For example:

Unknown

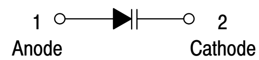
$r_{ds(on)}$ and V_{GS} range for an MPF4392

The electrical characteristics table indicates that an MPF4392 has an I_{DSS} range of 25 to 75 mA. Figure 10 shows $r_{ds(on)}$ = 52 Ohms for I_{DSS} = 25 mA and 30 Ohms for I_{DSS} = 75 mA. The corresponding V_{GS} values are 2.2 volts and 4.8 volts.

Silicon Pin Diode

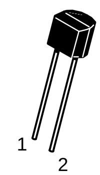
This device is designed primarily for VHF band switching applications but is also suitable for use in general–purpose switching circuits. It is supplied in a cost–effective TO–92 type plastic package for economical, high–volume consumer and industrial requirements.

- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Series Resistance @ 100 MHz — R_S = 0.7 Ohms (Typ) @ I_F = 10 mAdc
- Sturdy TO–92 Style Package for Handling Ease



MPN3404

SILICON PIN SWITCHING DIODE



CASE 182–06, STYLE 1
TO–92 (TO–226AC)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	20	Vdc
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 4.0	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	20	—	—	Vdc
Diode Capacitance (V_R = 15 Vdc, f = 1.0 MHz)	C_T	—	1.3	2.0	pF
Series Resistance (Figure 5) (I_F = 10 mAdc)	R_S	—	0.7	0.85	Ω
Reverse Leakage Current (V_R = 15 Vdc)	I_R	—	—	0.1	μAdc

March, 2001 – Rev.1
Publication Order Number:
MPN3404/D

TYPICAL CHARACTERISTICS

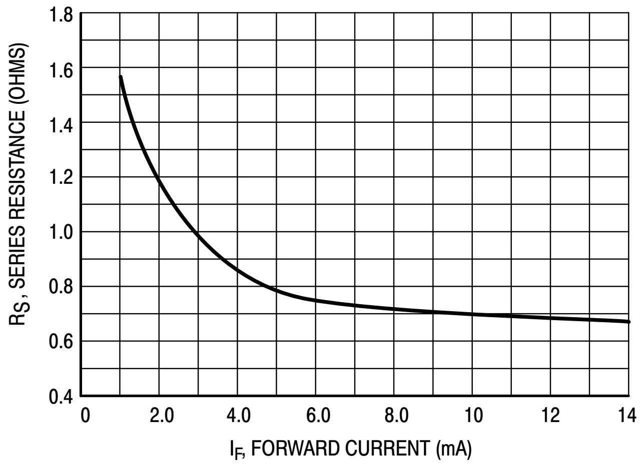


Figure 1. Series Resistance

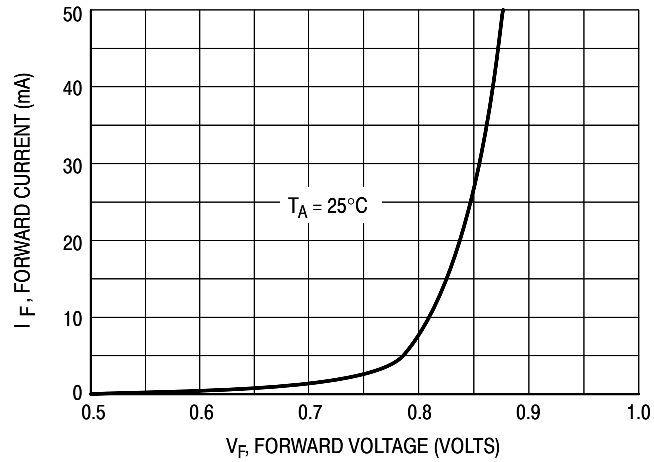


Figure 2. Forward Voltage

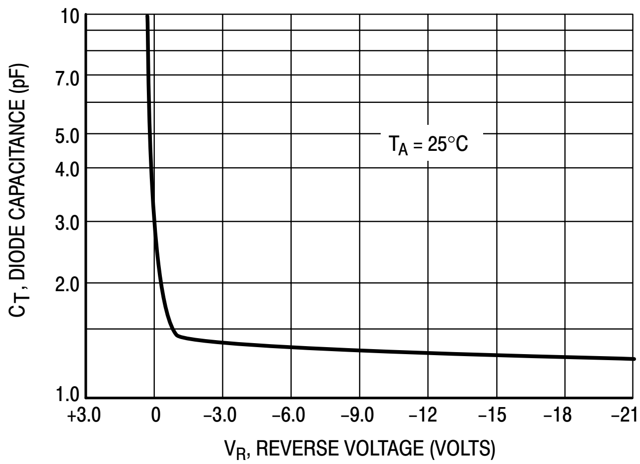


Figure 3. Diode Capacitance

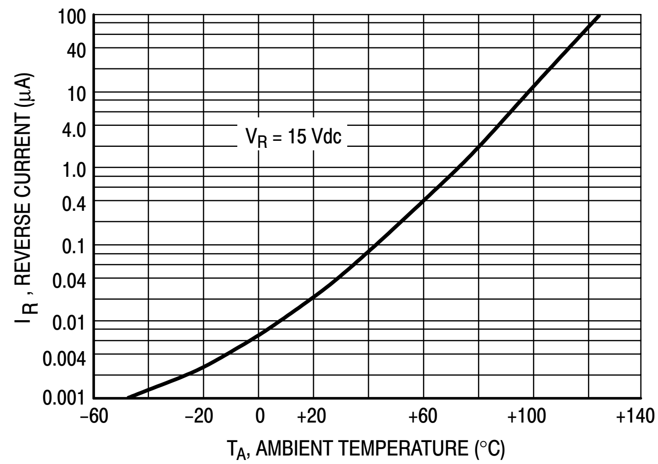


Figure 4. Leakage Current

MPS2222, MPS2222A

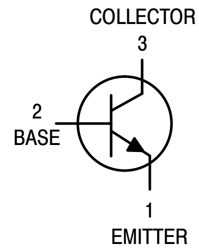
MPS2222A is a Preferred Device

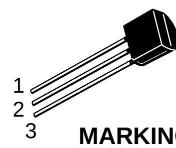
General Purpose Transistors

NPN Silicon

ON Semiconductor™

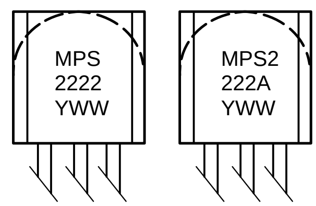
http://onsemi.com





TO–92
CASE 29
STYLE 1

MARKING DIAGRAMS



Y = Year
WW = Work Week

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage MPS2222 MPS2222A	V_{CEO}	 30 40	Vdc
Collector–Base Voltage MPS2222 MPS2222A	V_{CBO}	 60 75	Vdc
Emitter–Base Voltage MPS2222 MPS2222A	V_{EBO}	 5.0 6.0	Vdc
Collector Current – Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 625 5.0	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.5 12	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ORDERING INFORMATION

Device	Package	Shipping
MPS2222	TO–92	5000 Units/Box
MPS2222A	TO–92	5000 Units/Box
MPS2222ARLRA	TO–92	2000/Tape & Reel
MPS2222ARLRM	TO–92	2000/Ammo Pack
MPS2222ARLRP	TO–92	2000/Ammo Pack
MPS2222RLRA	TO–92	2000/Tape & Reel
MPS2222RLRM	TO–92	2000/Ammo Pack
MPS2222RLRP	TO–92	2000/Ammo Pack

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage	MPS2222	$V_{(BR)CEO}$	30	–	Vdc
(I_C = 10 mAdc, I_B = 0)	MPS2222A		40	–	
Collector–Base Breakdown Voltage	MPS2222	$V_{(BR)CBO}$	60	–	Vdc
(I_C = 10 μAdc, I_E = 0)	MPS2222A		75	–	
Emitter–Base Breakdown Voltage	MPS2222	$V_{(BR)EBO}$	5.0	–	Vdc
(I_E = 10 μAdc, I_C = 0)	MPS2222A		6.0	–	
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MPS2222A	I_{CEX}	–	10	nAdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 50 Vdc, I_E = 0)	MPS2222		–	0.01	
(V_{CB} = 60 Vdc, I_E = 0)	MPS2222A		–	0.01	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 125°C)	MPS2222		–	10	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 125°C)	MPS2222A		–	10	
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	MPS2222A	I_{EBO}	–	100	nAdc
Base Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MPS2222A	I_{BL}	–	20	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			–
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)			35	–	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)			50	–	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)			75	–	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = –55°C)	MPS2222A only		35	–	
(I_C = 150 mAdc, V_{CE} = 10 Vdc) (Note 1.)			100	300	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc) (Note 1.)			50	–	
(I_C = 500 mAdc, V_{CE} = 10 Vdc) (Note 1.)	MPS2222		30	–	
	MPS2222A		40	–	
Collector–Emitter Saturation Voltage (Note 1.)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	MPS2222		–	0.4	
	MPS2222A		–	0.3	
(I_C = 500 mAdc, I_B = 50 mAdc)	MPS2222		–	1.6	
	MPS2222A		–	1.0	
Base–Emitter Saturation Voltage (Note 1.)		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	MPS2222		–	1.3	
	MPS2222A		0.6	1.2	
(I_C = 500 mAdc, I_B = 50 mAdc)	MPS2222		–	2.6	
	MPS2222A		–	2.0	

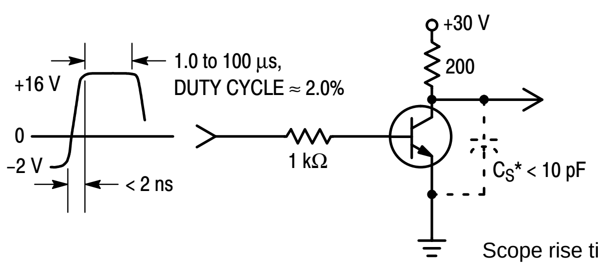
1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

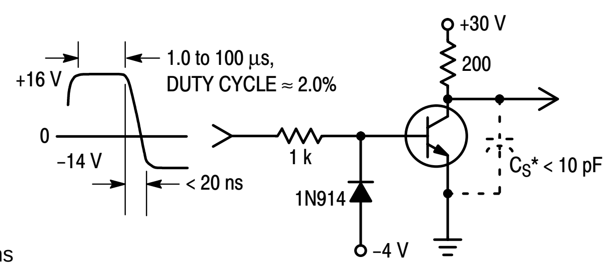
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (Note 2.) (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MPS2222 MPS2222A	f_T	250 300	– –	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	–	8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MPS2222 MPS2222A	C_{ibo}	– –	30 25	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A MPS2222A	h_{ie}	2.0 0.25	8.0 1.25	kΩ
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A MPS2222A	h_{re}	– –	8.0 4.0	X 10^{-4}
Small–Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A MPS2222A	h_{fe}	50 75	300 375	–
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A MPS2222A	h_{oe}	5.0 25	35 200	μmhos
Collector Base Time Constant (I_E = 20 mAdc, V_{CB} = 20 Vdc, f = 31.8 MHz)	MPS2222A	$rb'C_c$	–	150	ps
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)	MPS2222A	NF	–	4.0	dB
SWITCHING CHARACTERISTICS MPS2222A only					
Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = –0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figure 1)	t_d	–	10	ns
Rise Time		t_r	–	25	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 2)	t_s	–	225	ns
Fall Time		t_f	–	60	ns

2. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

SWITCHING TIME EQUIVALENT TEST CIRCUITS





Scope rise time < 4 ns
*Total shunt capacitance of test jig, connectors, and oscilloscope.

Figure 1. Turn–On Time **Figure 2. Turn–Off Time**

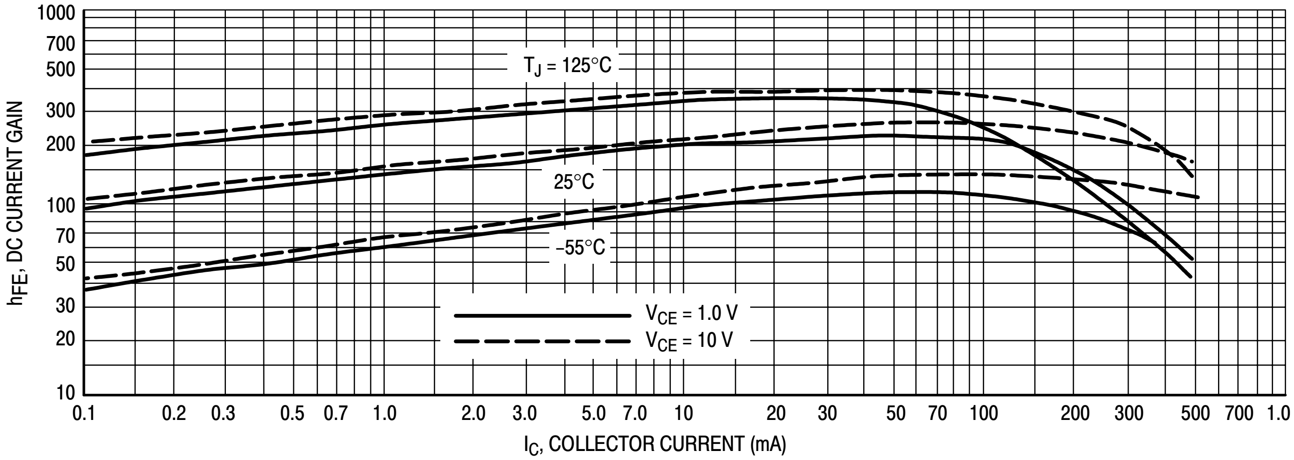


Figure 3. DC Current Gain

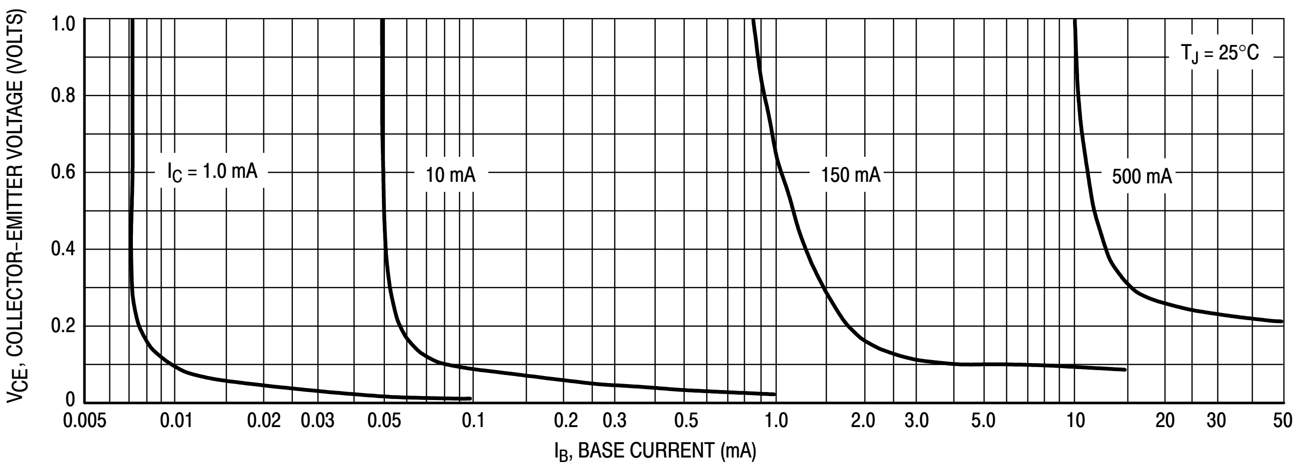


Figure 4. Collector Saturation Region

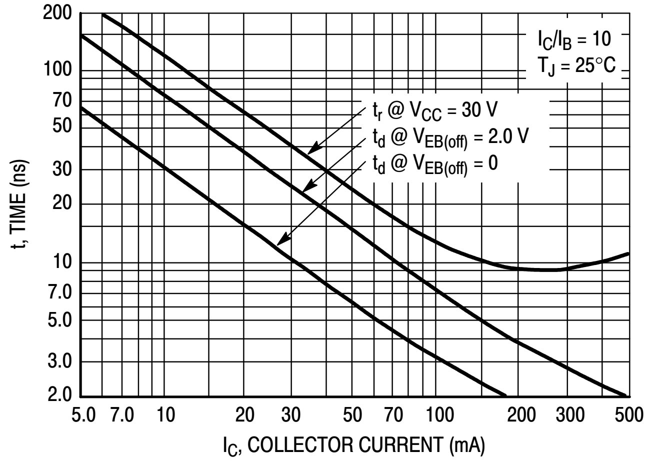


Figure 5. Turn−On Time

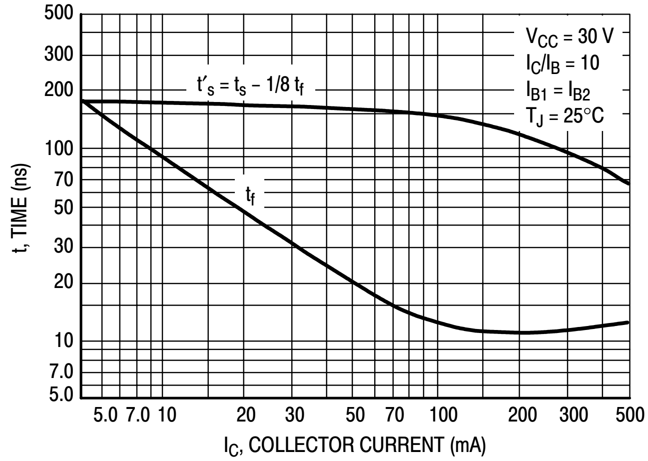


Figure 6. Turn−Off Time

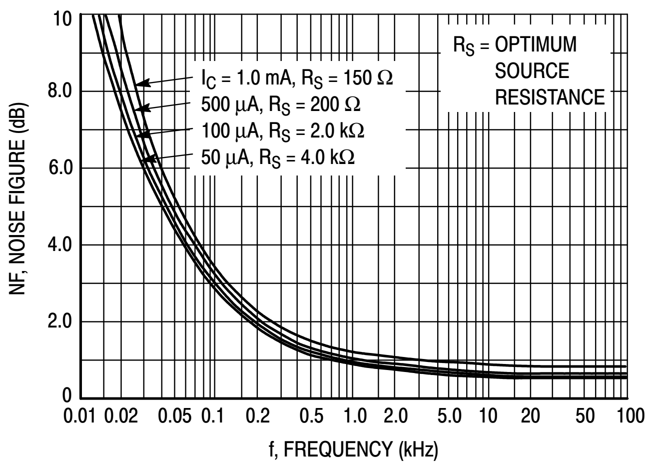


Figure 7. Frequency Effects

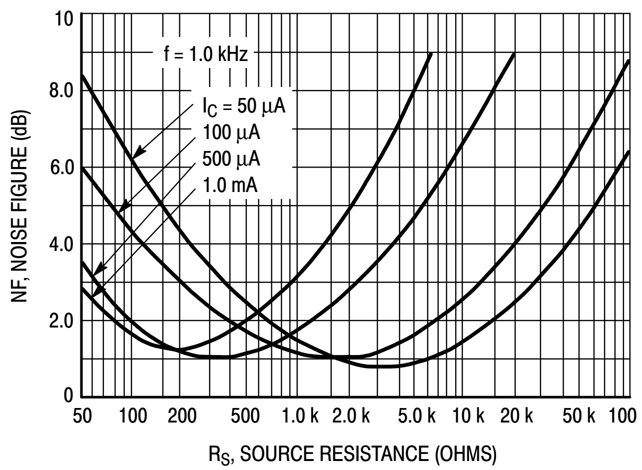


Figure 8. Source Resistance Effects

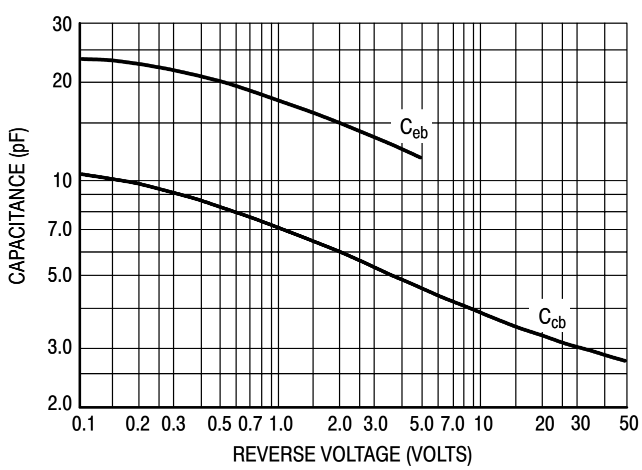


Figure 9. Capacitances

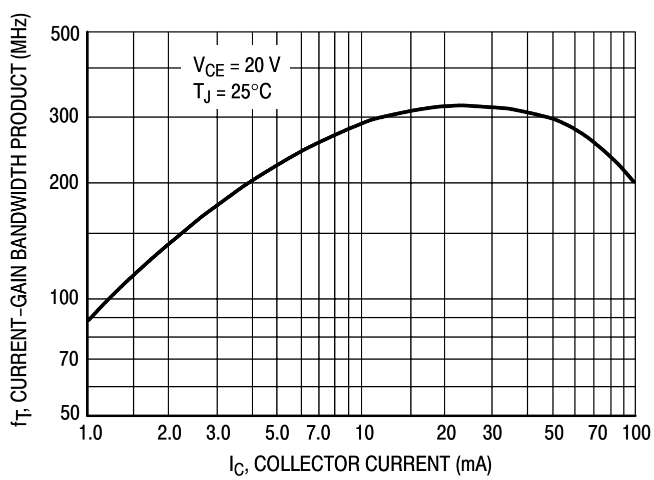


Figure 10. Current−Gain Bandwidth Product

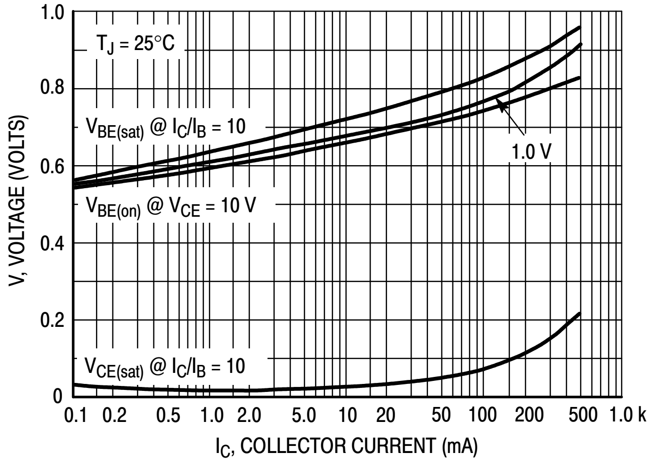


Figure 11. "On" Voltages

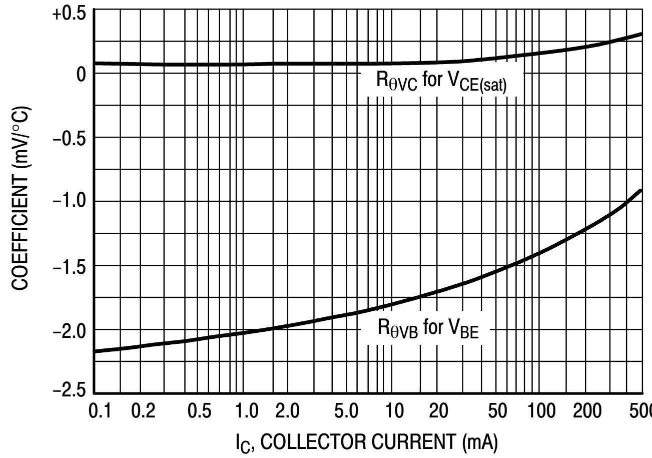


Figure 12. Temperature Coefficients

Switching Transistors
NPN Silicon

MPS2369
MPS2369A*

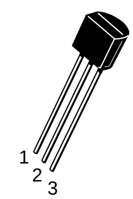
*ON Semiconductor Preferred Device

MAXIMUM RATINGS

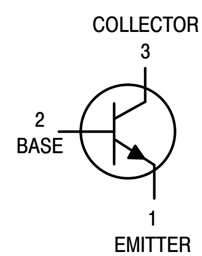
Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	15	Vdc
Collector–Emitter Voltage	V_{CES}	40	Vdc
Collector–Base Voltage	V_{CBO}	40	Vdc
Emitter–Base Voltage	V_{EBO}	4.5	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage[(1)] (I_C = 10 mAdc, I_B = 0)	MPS2369A	$V_{(BR)CEO}$	15	—	—	Vdc
Collector–Emitter Breakdown Voltage (I_C = 10 μAdc, V_{BE} = 0)	MPS2369,A	$V_{(BR)CES}$	40	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	MPS2369,A	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	MPS2369,A	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) (V_{CB} = 20 Vdc, I_E = 0, T_A = 125°C)	MPS2369,A	I_{CBO}	 — —	 — —	 0.4 30	μAdc
Collector Cutoff Current (V_{CE} = 20 Vdc, V_{BE} = 0)	MPS2369,A	I_{CES}	—	—	0.4	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

June, 2001 – Rev. 2

Publication Order Number:
MPS2369/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain[1]		h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	MPS2369A		—	—	120	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc, T_A = –55°C)	MPS2369		20	—	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	MPS2369		40	—	120	
(I_C = 10 mAdc, V_{CE} = 0.35 Vdc)	MPS2369A		40	—	—	
(I_C = 10 mAdc, V_{CE} = 0.35 Vdc, T_A = –55°C)	MPS2369A		20	—	—	
(I_C = 30 mAdc, V_{CE} = 0.4 Vdc)	MPS2369A		30	—	—	
(I_C = 100 mAdc, V_{CE} = 2.0 Vdc)	MPS2369		20	—	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	MPS2369A		20	—	—	
Collector–Emitter Saturation Voltage[1]		$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	MPS2369		—	—	0.25	
(I_C = 10 mAdc, I_B = 1.0 mAdc)	MPS2369A		—	—	0.20	
(I_C = 10 mAdc, I_B = 1.0 mAdc, T_A = +125°C)	MPS2369A		—	—	0.30	
(I_C = 30 mAdc, I_B = 3.0 mAdc)	MPS2369A		—	—	0.25	
(I_C = 100 mAdc, I_B = 10 mAdc)	MPS2369A		—	—	0.50	
Base–Emitter Saturation Voltage[1]		$V_{BE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	MPS2369		0.7	—	0.85	
(I_C = 10 mAdc, I_B = 1.0 mAdc, T_A = +125°C)	MPS2369A		0.5	—	—	
(I_C = 10 mAdc, I_B = 1.0 mAdc, T_A = –55°C)	MPS2369A		—	—	1.02	
(I_C = 30 mAdc, I_B = 3.0 mAdc)	MPS2369A		—	—	1.15	
(I_C = 100 mAdc, I_B = 10 mAdc)	MPS2369A		—	—	1.60	
SMALL–SIGNAL CHARACTERISTICS						
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	MPS2369,A	C_{obo}	—	—	4.0	pF
Small–Signal Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	MPS2369,A	h_{fe}	5.0	—	—	—
SWITCHING CHARACTERISTICS						
Storage Time (I_{B1} = I_{B2} = I_C = 10 mAdc) (Figure 3)	MPS2369,A	t_s	—	5.0	13	ns
Turn–On Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc) (Figure 1)	MPS2369,A	t_{on}	—	8.0	12	ns
Turn–Off Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 1.5 mAdc) (Figure 2)	MPS2369,A	t_{off}	—	10	18	ns

1. Pulse Test: Pulse Width $\leq$ 300 μs, Duty Cycle $\leq$ 2.0%.

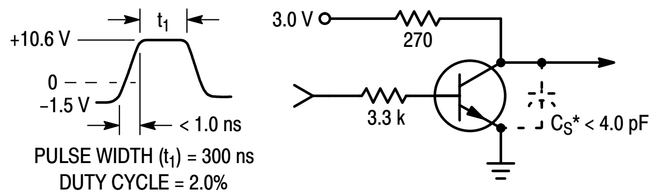


Figure 1. t_{on} Circuit

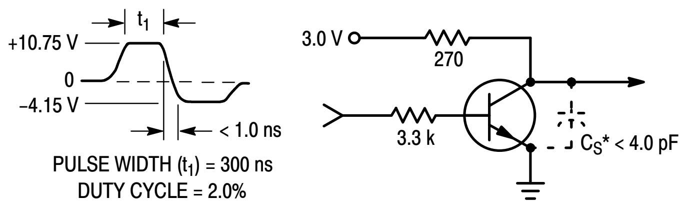


Figure 2. t_{off} Circuit

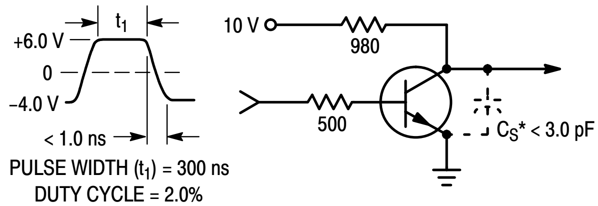


Figure 3. Storage Test Circuit

*Total shunt capacitance of test jig and connectors.

MPS2907A

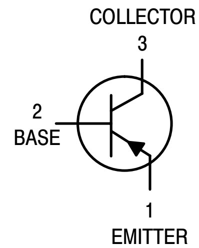
Preferred Device

General Purpose Transistors

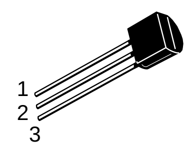
PNP Silicon

ON Semiconductor™

http://onsemi.com

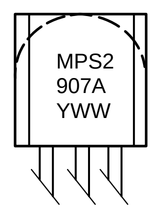


STYLE 1



TO–92
CASE 29
STYLES 1, 14

MARKING DIAGRAMS



Y = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping
MPS2907A	TO–92	5000 Units/Box
MPS2907ARLRA	TO–92	2000/Tape & Reel
MPS2907ARLRE	TO–92	2000/Ammo Pack
MPS2907ARLRM	TO–92	2000/Ammo Pack
MPS2907ARLRP	TO–92	2000/Ammo Pack

Preferred devices are recommended choices for future use and best overall value.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–60	Vdc
Collector–Base Voltage	V_{CBO}	–60	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Continuous	I_C	–600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (Note 1.) (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–60	–	Vdc
Collector–Base Breakdown Voltage (I_C = –10 μAdc, I_E = 0)	$V_{(BR)CBO}$	–60	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	–	Vdc
Collector Cutoff Current (V_{CE} = –30 Vdc, $V_{EB(off)}$ = –0.5 Vdc)	I_{CEX}	–	–50	nAdc
Collector Cutoff Current	I_{CBO}			μAdc
(V_{CB} = –50 Vdc, I_E = 0)		–	–0.01	
(V_{CB} = –50 Vdc, I_E = 0, T_A = 150°C)		–	–10	
Base Current (V_{CE} = –30 Vdc, $V_{EB(off)}$ = –0.5 Vdc)	I_B	–	–50	nAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			–
(I_C = –0.1 mAdc, V_{CE} = –10 Vdc)		75	–	
(I_C = –1.0 mAdc, V_{CE} = –10 Vdc)		100	–	
(I_C = –10 mAdc, V_{CE} = –10 Vdc)		100	–	
(I_C = –150 mAdc, V_{CE} = –10 Vdc) (Note 1.)		100	300	
(I_C = –500 mAdc, V_{CE} = –10 Vdc) (Note 1.)		50	–	
Collector–Emitter Saturation Voltage (Note 1.)	$V_{CE(sat)}$			Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)		–	–0.4	
(I_C = –500 mAdc, I_B = –50 mAdc)		–	–1.6	
Base–Emitter Saturation Voltage (Note 1.)	$V_{BE(sat)}$			Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)		–	–1.3	
(I_C = –500 mAdc, I_B = –50 mAdc)		–	–2.6	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain – Bandwidth Product (Notes 1. and 2.), (I_C = –50 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)	f_T	200	–	MHz
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	–	8.0	pF
Input Capacitance (V_{EB} = –2.0 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	–	30	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Turn–On Time	(V_{CC} = –30 Vdc, I_C = –150 mAdc, I_{B1} = –15 mAdc) (Figures 1 and 5)	t_{on}	–	45	ns
Delay Time		t_d	–	10	ns
Rise Time		t_r	–	40	ns
Turn–Off Time	(V_{CC} = –6.0 Vdc, I_C = –150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 2)	t_{off}	–	100	ns
Storage Time		t_s	–	80	ns
Fall Time		t_f	–	30	ns

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.
2. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

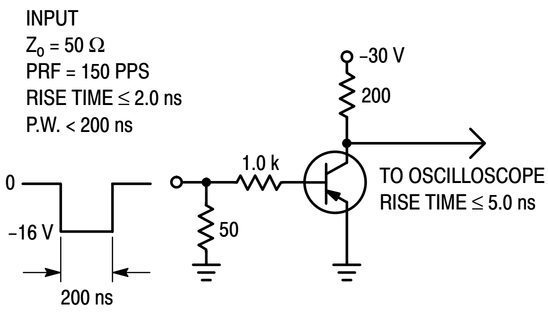


Figure 1. Delay and Rise Time Test Circuit

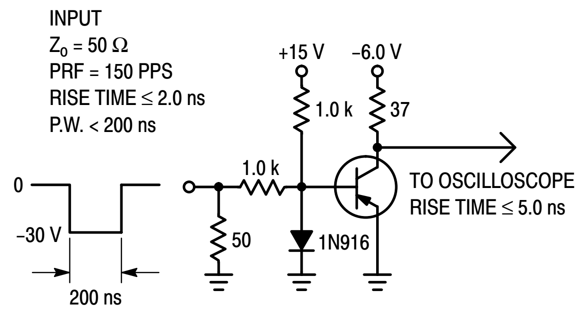


Figure 2. Storage and Fall Time Test Circuit

TYPICAL CHARACTERISTICS

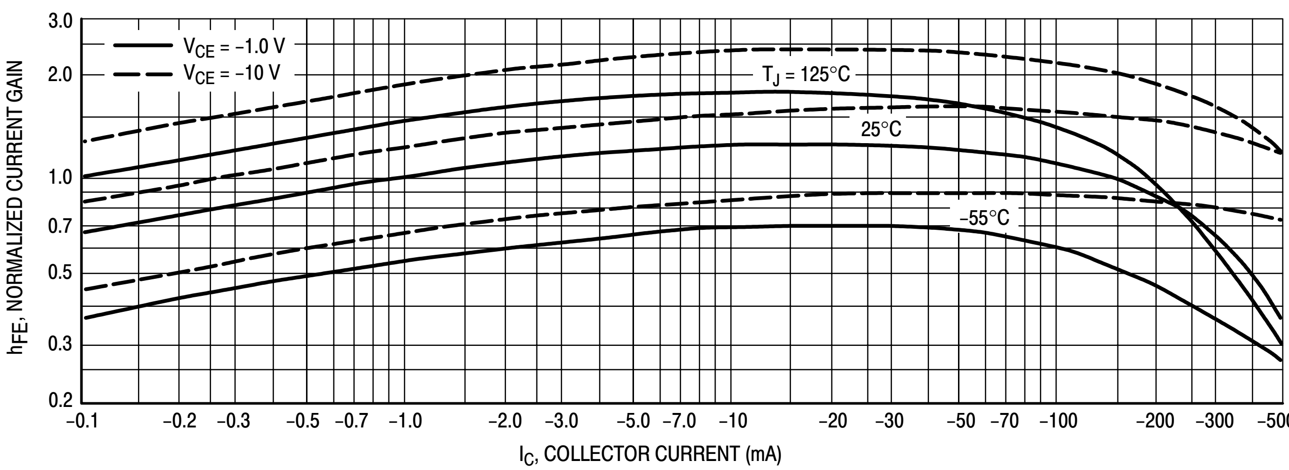


Figure 3. DC Current Gain

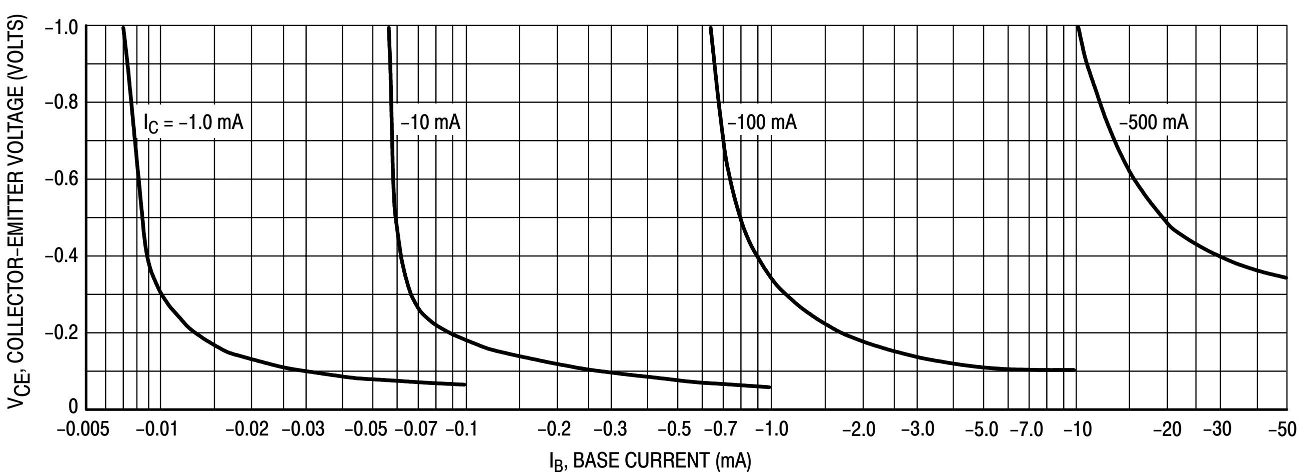


Figure 4. Collector Saturation Region

TYPICAL CHARACTERISTICS

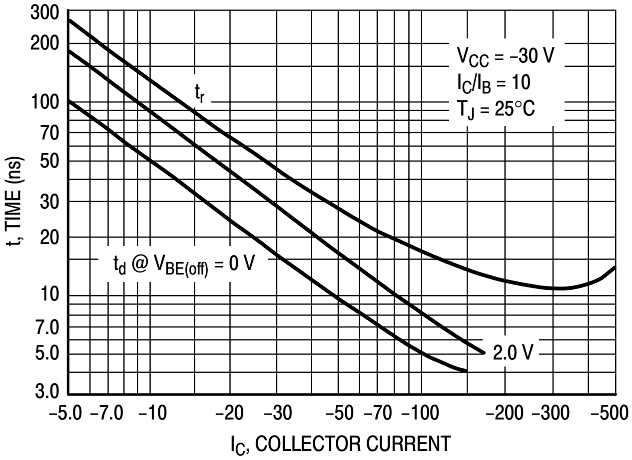


Figure 5. Turn–On Time

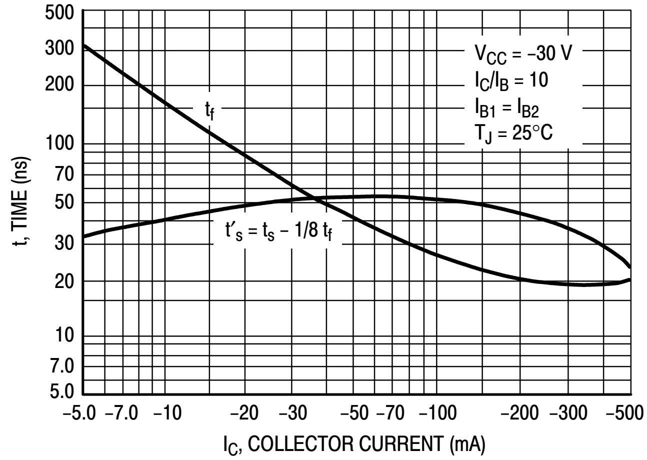


Figure 6. Turn–Off Time

TYPICAL SMALL–SIGNAL CHARACTERISTICS

NOISE FIGURE

V_{CE} = 10 Vdc, T_A = 25°C

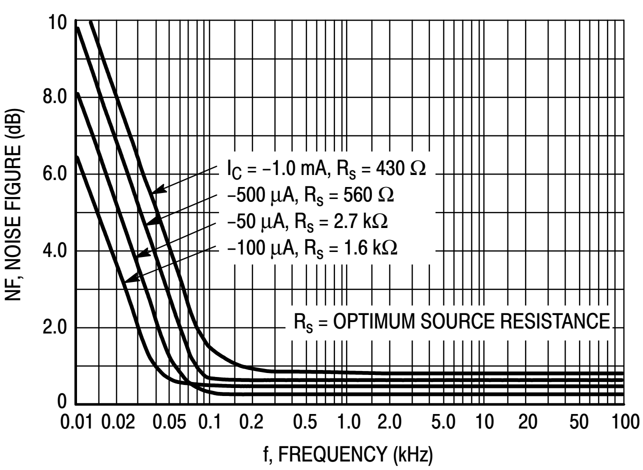


Figure 7. Frequency Effects

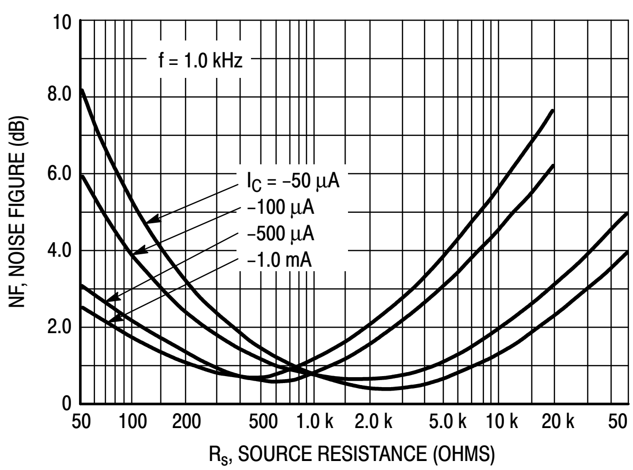


Figure 8. Source Resistance Effects

TYPICAL SMALL–SIGNAL CHARACTERISTICS
NOISE FIGURE
V_{CE} = 10 Vdc, T_A = 25°C

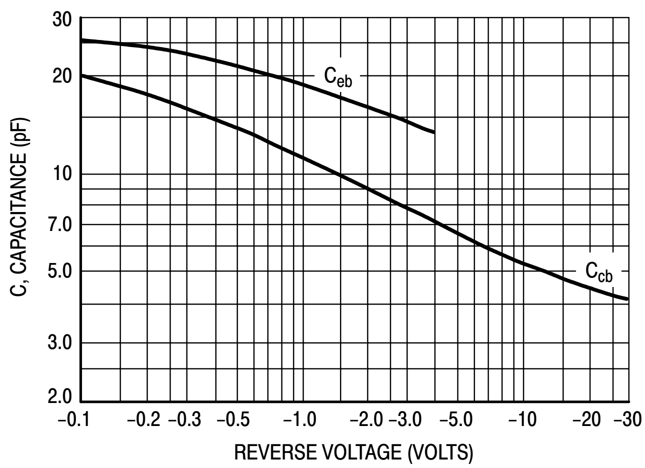


Figure 9. Capacitances

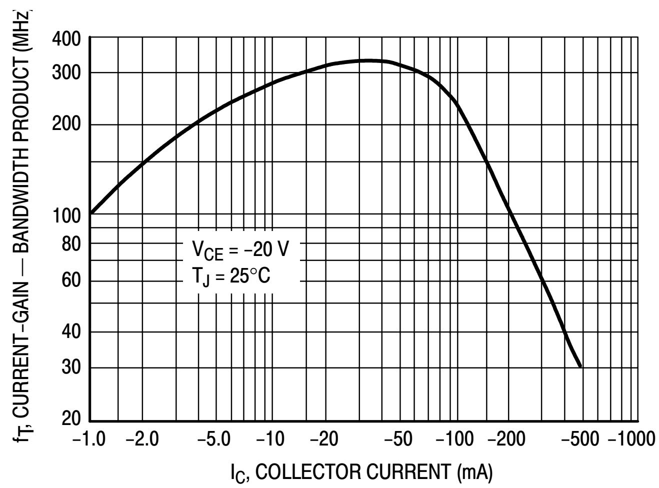


Figure 10. Current–Gain — Bandwidth Product

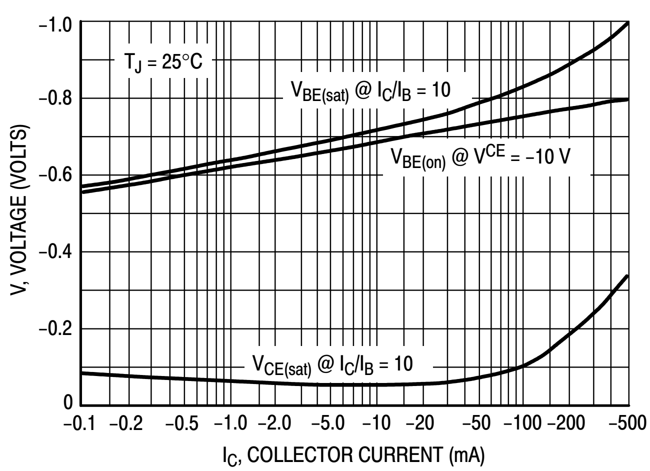


Figure 11. “On” Voltage

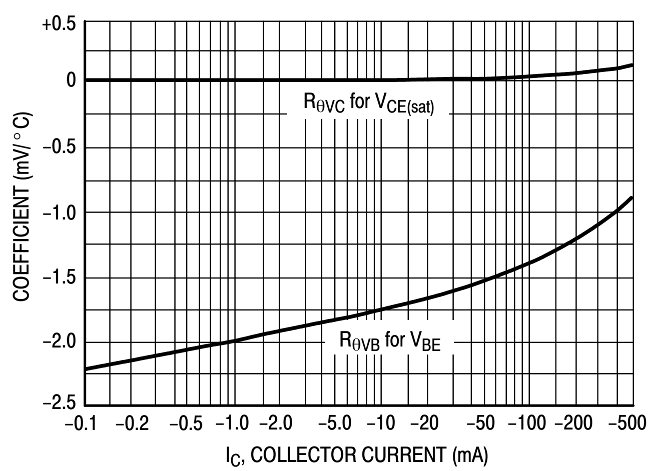
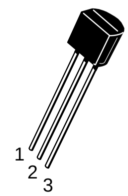


Figure 12. Temperature Coefficients

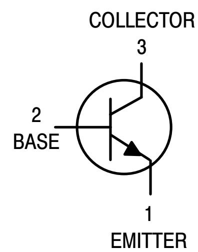
Switching Transistor
NPN Silicon

MPS3646

ON Semiconductor Preferred Device



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	15	Vdc
Collector–Emitter Voltage	V_{CES}	40	Vdc
Collector–Base Voltage	V_{CBO}	40	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous — 10 μs Pulse	I_C	300 500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	40	—	Vdc
Collector–Emitter Sustaining Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{CEO(sus)}$	15	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 20 Vdc, V_{BE} = 0) (V_{CE} = 20 Vdc, V_{BE} = 0, T_A = 65°C)	I_{CES}	 — —	 0.5 3.0	μAdc
ON CHARACTERISTICS(1)				
DC Current Gain (I_C = 30 mAdc, V_{CE} = 0.4 Vdc) (I_C = 100 mAdc, V_{CE} = 0.5 Vdc) (I_C = 300 mA, V_{CE} = 1.0 Vdc)	h_{FE}	 30 25 15	 120 — —	—
Collector–Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 3.0 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc) (I_C = 300 mAdc, I_B = 30 mAdc) (I_C = 30 mA, I_B = 3.0 mA, T_A = 65°C)	$V_{CE(sat)}$	 — — — —	 0.2 0.28 0.5 0.3	Vdc
Base–Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 3.0 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc) (I_C = 300 mAdc, I_B = 30 mA)	$V_{BE(sat)}$	 0.73 — —	 0.95 1.2 1.7	Vdc

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

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ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	350	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	5.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	9.0	pF
SWITCHING CHARACTERISTICS					
Turn–On Time	(V_{CC} = 10 Vdc, I_C = 300 mAdc, I_{B1} = 30 mAdc) (Figure 1)	t_{on}	—	18	ns
Delay Time		t_d	—	10	ns
Rise Time		t_r	—	15	ns
Turn–Off Time	(V_{CC} = 10 Vdc, I_C = 300 mAdc, I_{B1} = I_{B2} = 30 mAdc) (Figure 1)	t_{off}	—	28	ns
Fall Time		t_f	—	15	ns
Storage Time (V_{CC} = 10 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 10 mAdc) (Figure 2)		t_s	—	18	ns

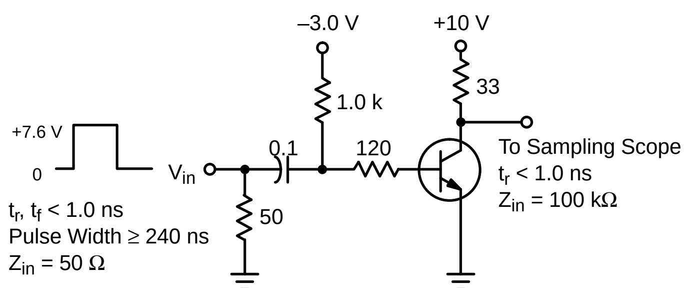


Figure 1. Switching Time Test Circuit

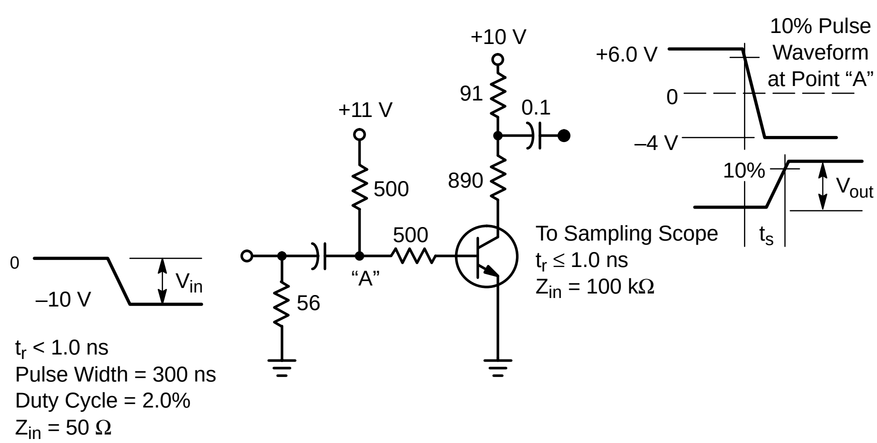


Figure 2. Charge Storage Time Test Circuit

CURRENT GAIN CHARACTERISTICS

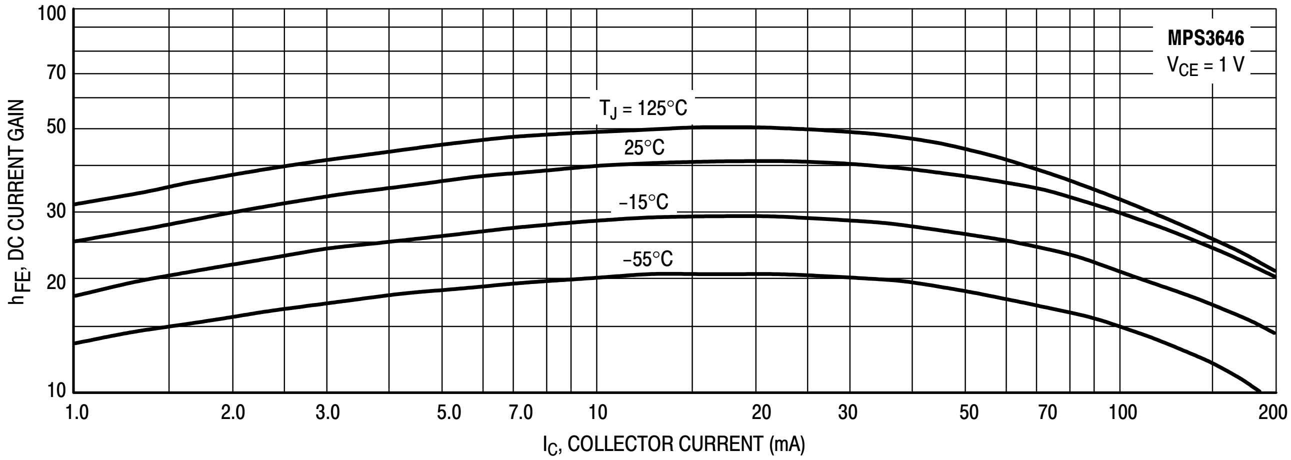


Figure 3. Minimum Current Gain

“ON” CONDITION CHARACTERISTICS

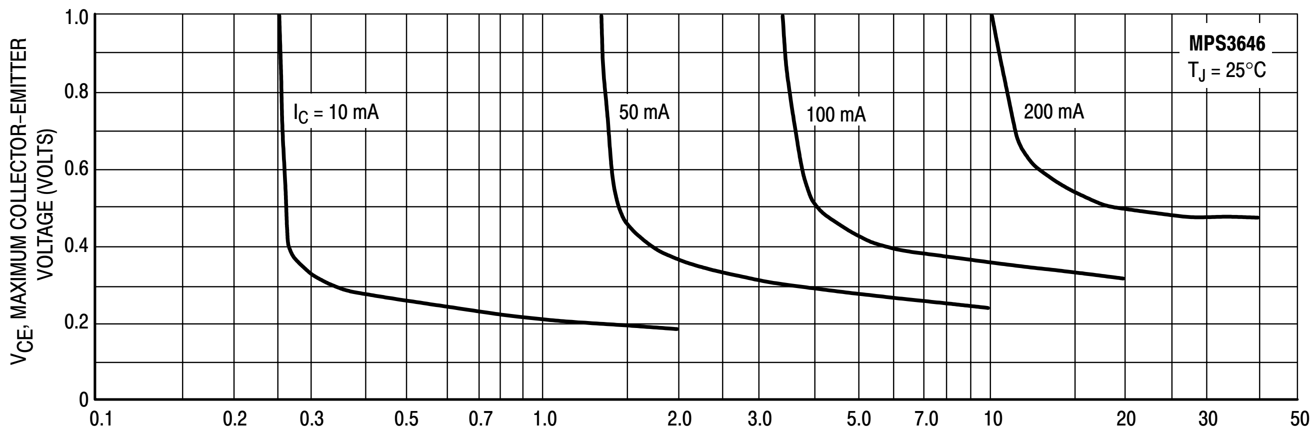


Figure 4. Collector Saturation Region

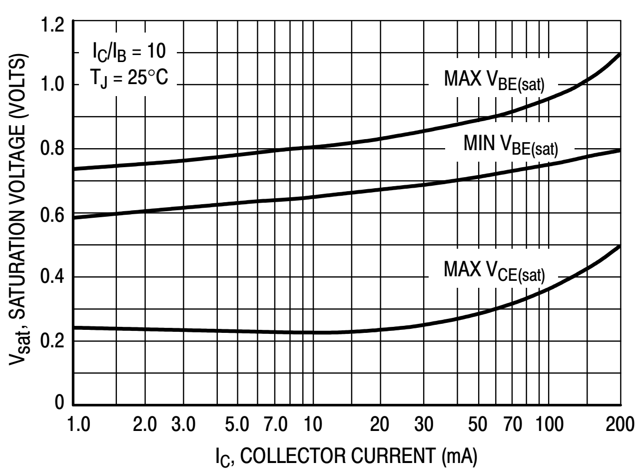


Figure 5. Saturation Voltage Limits

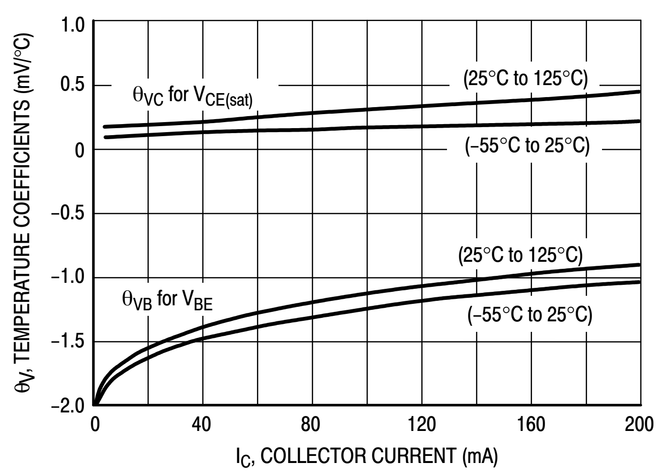


Figure 6. Temperature Coefficients

DYNAMIC CHARACTERISTICS

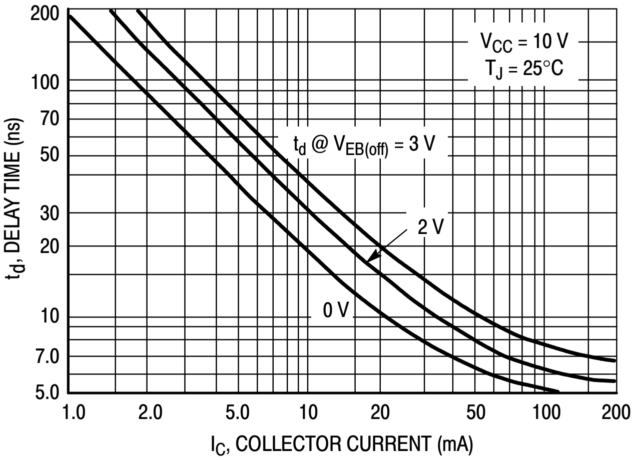


Figure 7. Delay Time

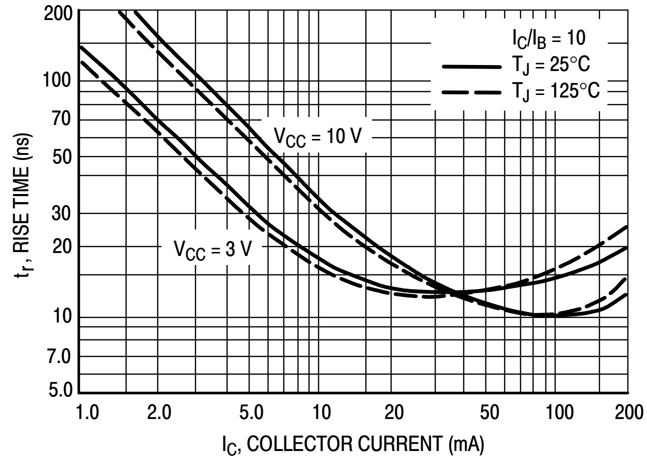


Figure 8. Rise Time

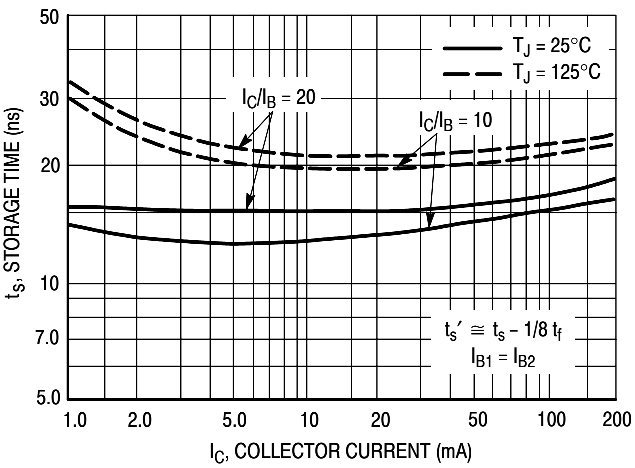


Figure 9. Storage Time

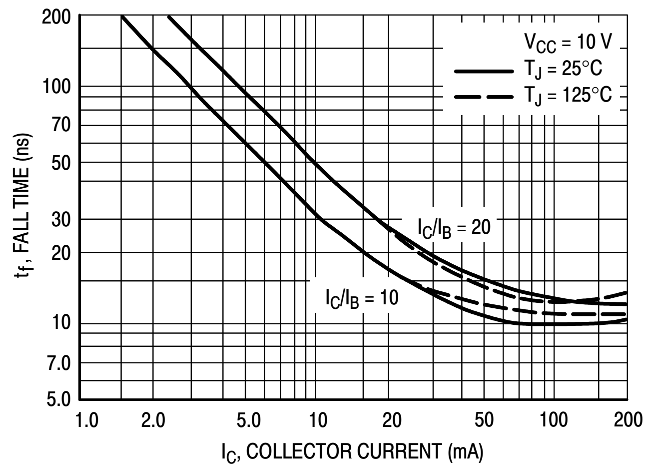


Figure 10. Fall Time

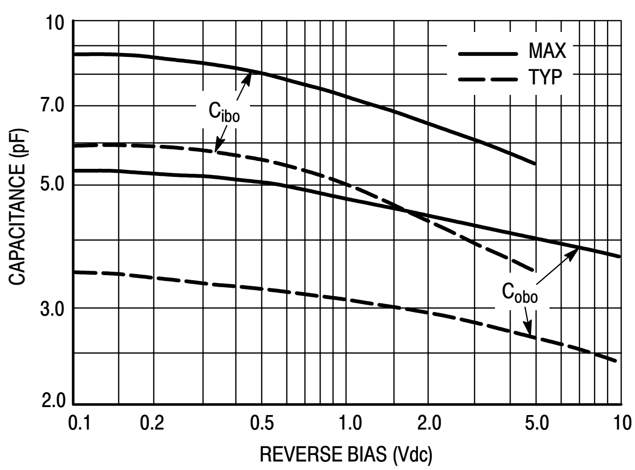


Figure 11. Junction Capacitance

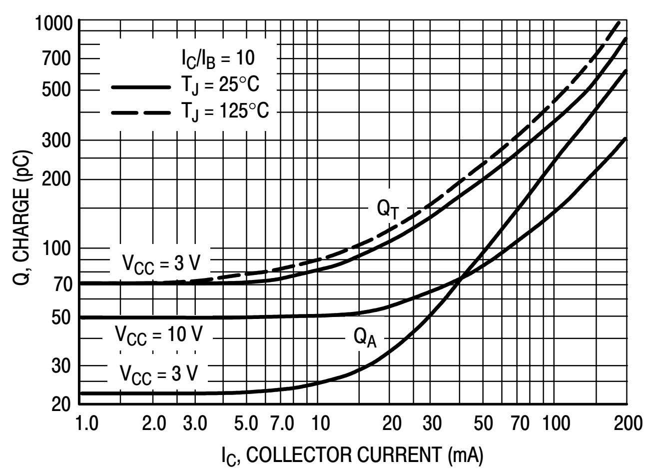
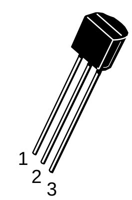


Figure 12. Maximum Charge Data

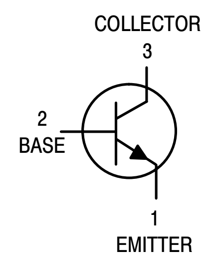
General Purpose Transistor

NPN Silicon

MPS3904



CASE 29–04, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	60	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Power Dissipation @ T_A = 60°C	P_D	450	mW
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	I_{CEX}	—	50	nAdc
Base Cutoff Current (V_{CE} = 30 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	I_{BL}	—	50	nAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

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ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

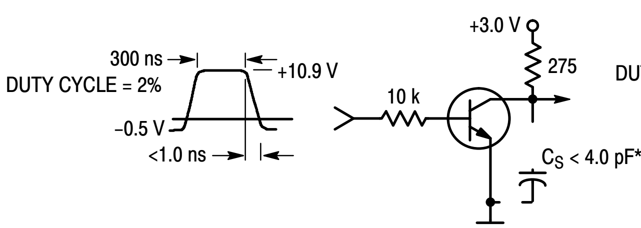
Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS(1)				
DC Current Gain	h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)		40	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)		70	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)		60	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		30	—	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	0.3	
Base–Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	1.1	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	300	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	4.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	8.0	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{ie}	1.0	10	kΩ
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{re}	0.5	8.0	$X\ 10^{-4}$
Small–Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	100	400	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{oe}	1.0	40	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)	NF	—	5.0	dB

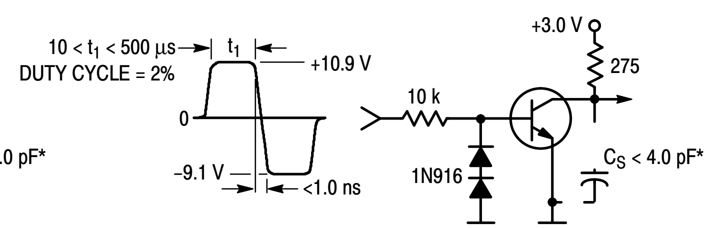
SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Delay Time	(V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = –0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_d	—	35	ns
Rise Time		t_r	—	50	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_s	—	900	ns
Fall Time		t_f	—	90	ns

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

EQUIVALENT SWITCHING TIME TEST CIRCUITS





*Total shunt capacitance of test jig and connectors

Figure 1. Turn–On Time

Figure 2. Turn–Off Time

TYPICAL NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

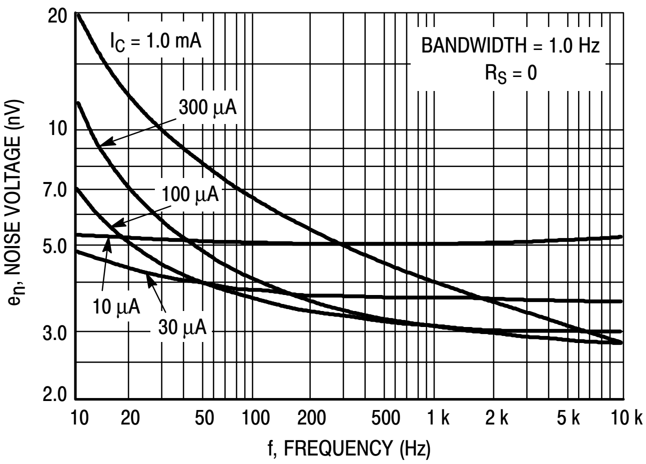


Figure 3. Noise Voltage

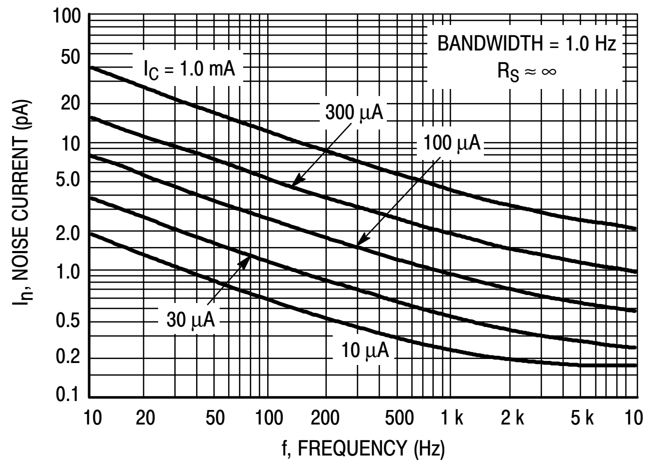


Figure 4. Noise Current

NOISE FIGURE CONTOURS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

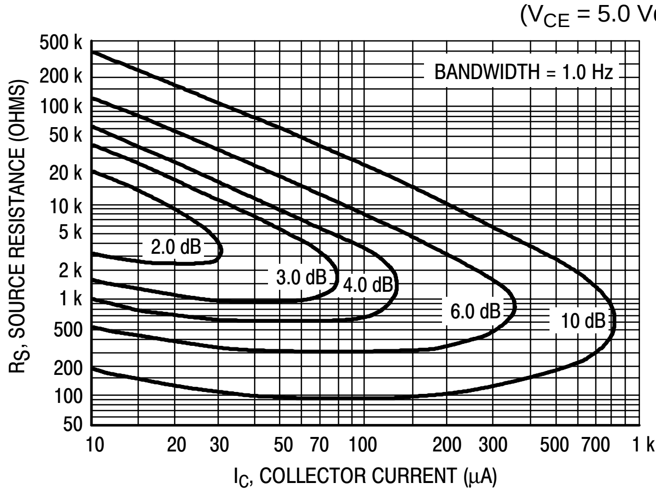


Figure 5. Narrow Band, 100 Hz

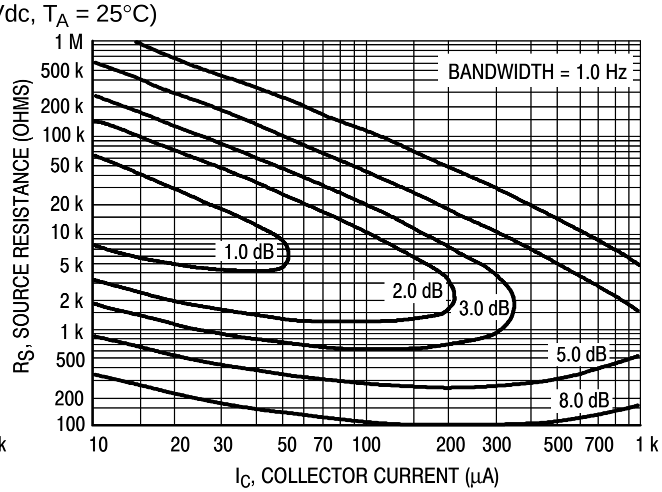


Figure 6. Narrow Band, 1.0 kHz

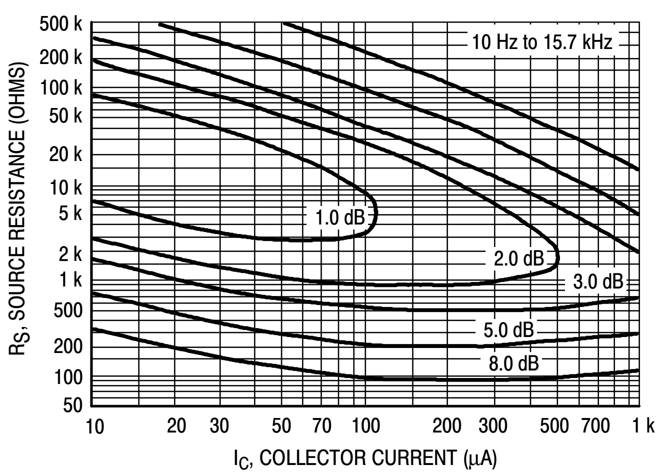


Figure 7. Wideband

Noise Figure is defined as:

$$NF = 20 \log_{10}\left(\frac{e_n^2 + 4KTR_S + I_n^2 R_S^2}{4KTR_S}\right)^{1/2}$$

e_n = Noise Voltage of the Transistor referred to the input. (Figure 3)
I_n = Noise Current of the Transistor referred to the input. (Figure 4)
K = Boltzman's Constant (1.38 x 10^{-23} j/°K)
T = Temperature of the Source Resistance (°K)
R_S = Source Resistance (Ohms)

TYPICAL STATIC CHARACTERISTICS

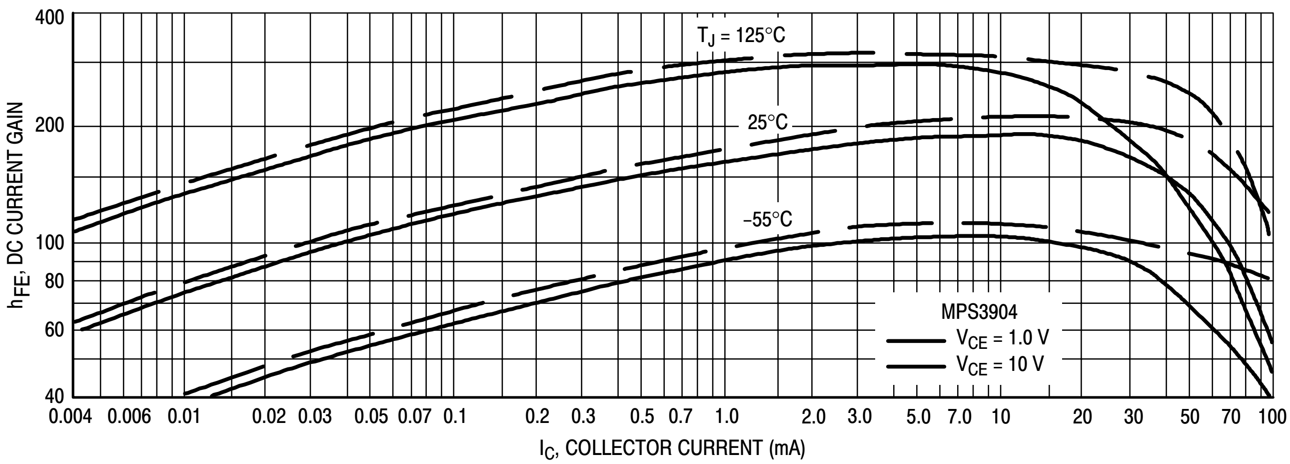


Figure 8. DC Current Gain

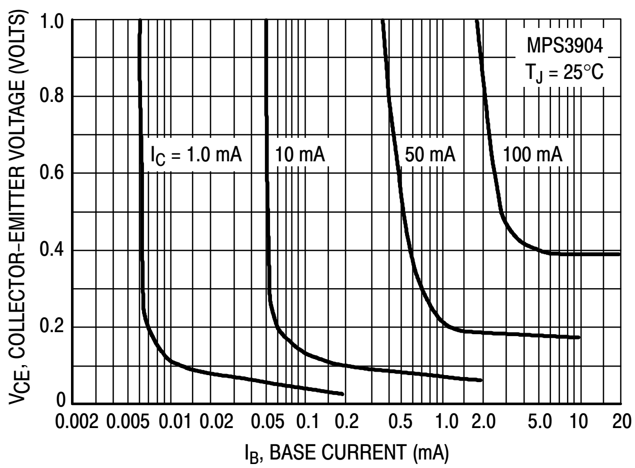


Figure 9. Collector Saturation Region

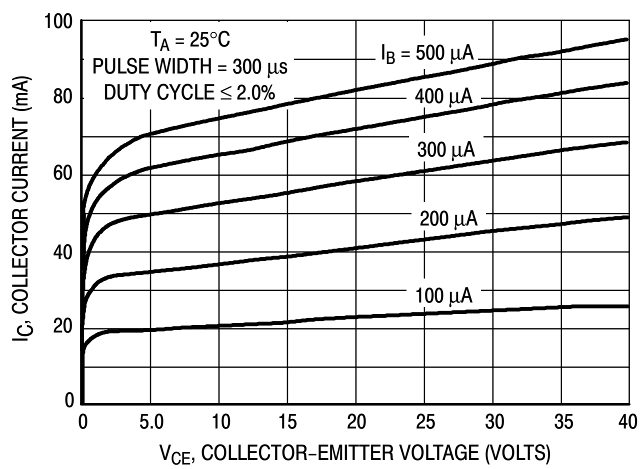


Figure 10. Collector Characteristics

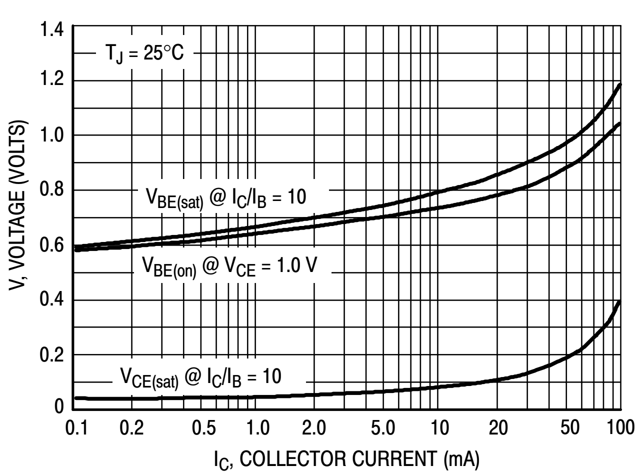


Figure 11. “On” Voltages

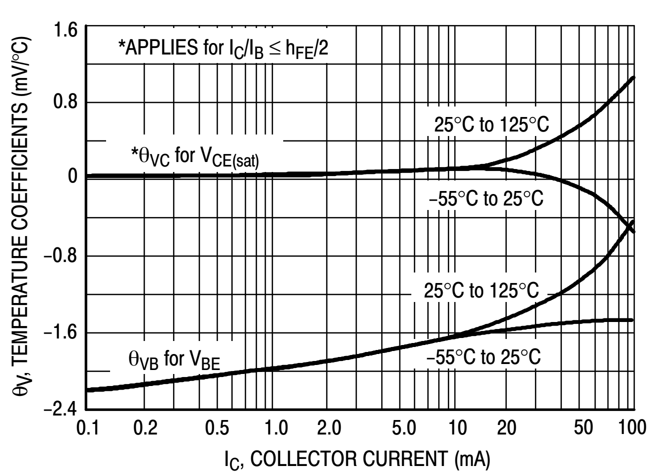


Figure 12. Temperature Coefficients

TYPICAL DYNAMIC CHARACTERISTICS

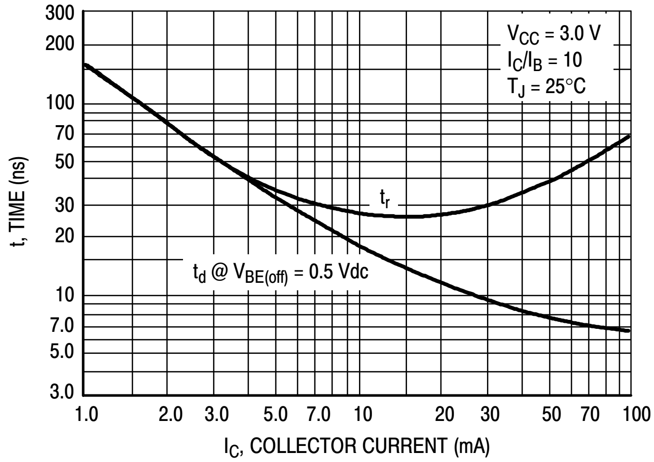


Figure 13. Turn–On Time

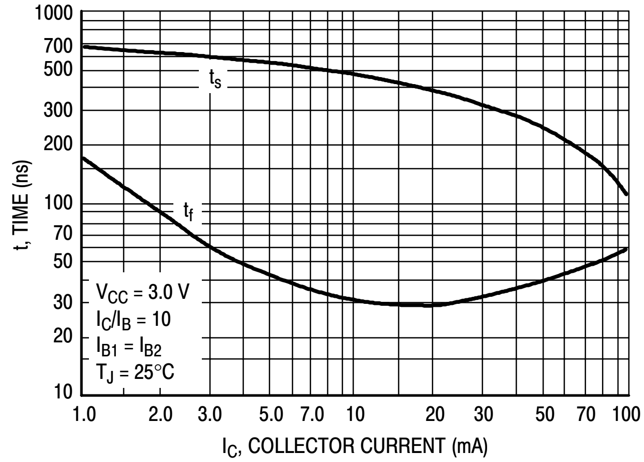


Figure 14. Turn–Off Time

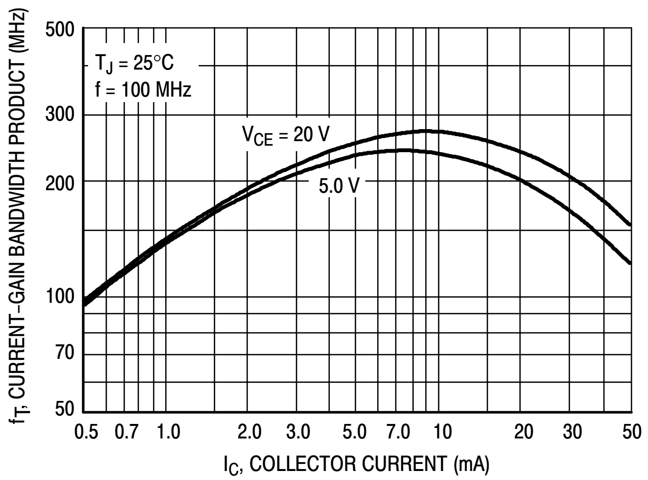


Figure 15. Current–Gain — Bandwidth Product

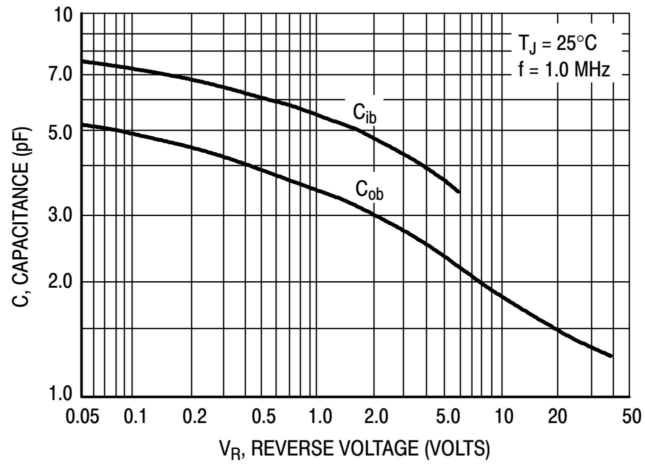


Figure 16. Capacitance

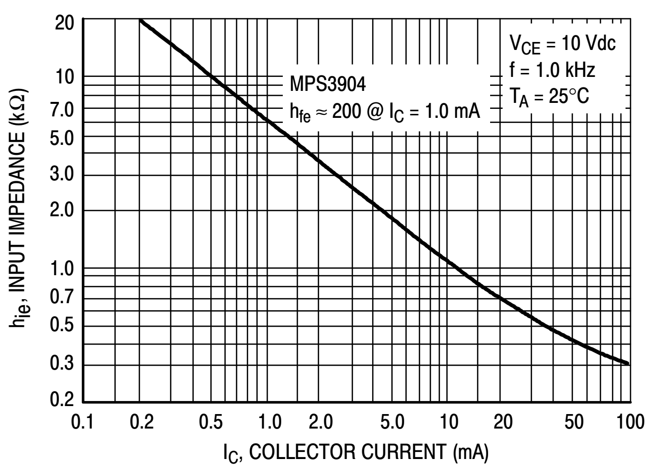


Figure 17. Input Impedance

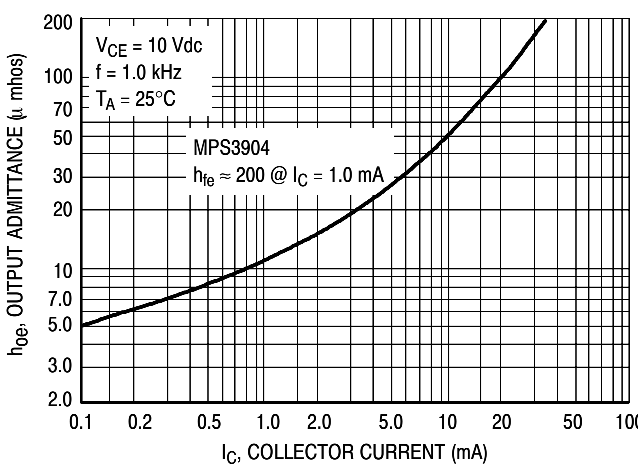


Figure 18. Output Admittance

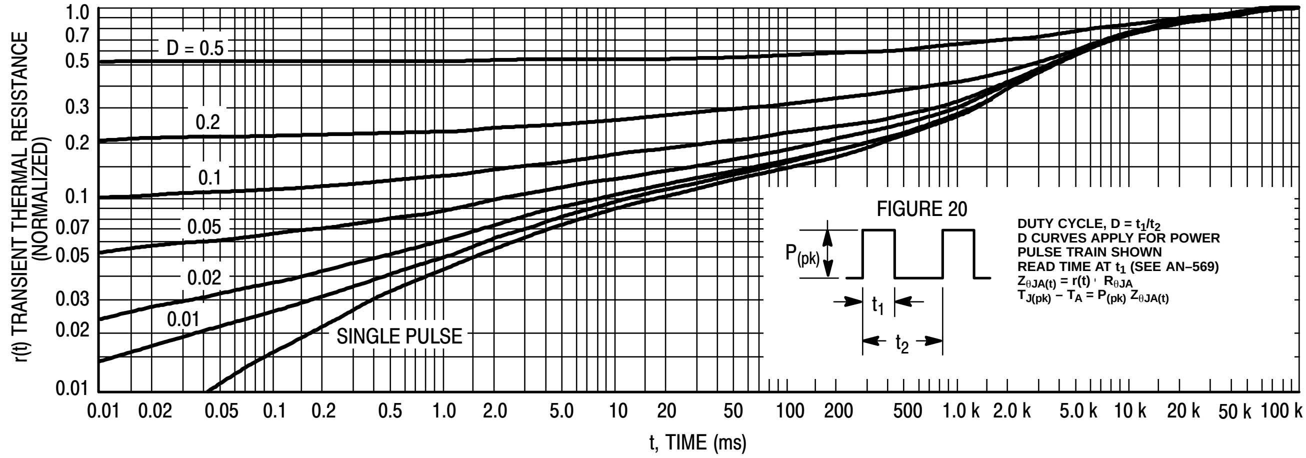


Figure 19. Thermal Response

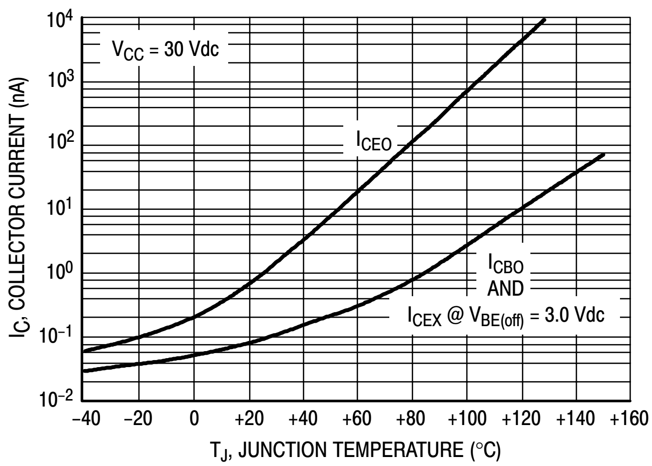


Figure 21.

DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 20. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 19 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 19 by the steady state value $R_{\theta JA}$.

Example:

The MPS3904 is dissipating 2.0 watts peak under the following conditions:

t_1 = 1.0 ms, t_2 = 5.0 ms. (D = 0.2)

Using Figure 19 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

The peak rise in junction temperature is therefore

$\Delta T = r(t) \times P_{(pk)} \times R_{\theta JA} = 0.22 \times 2.0 \times 200 = 88°C$.

For more information, see ON Semiconductor Application Note AN569/D, available from the Literature Distribution Center or on our website at **www.onsemi.com**.

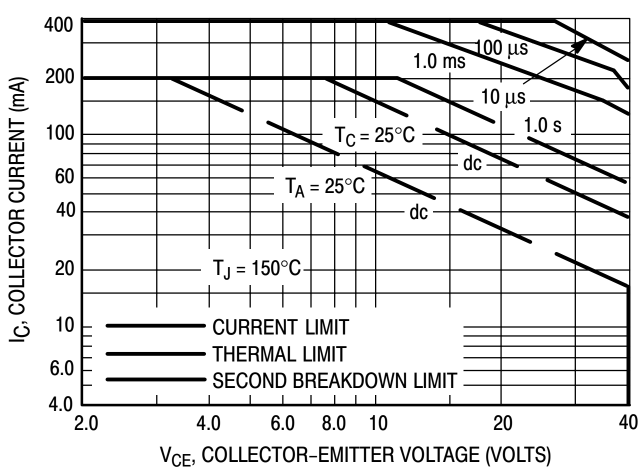


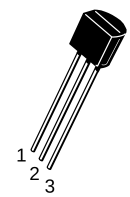
Figure 22.

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

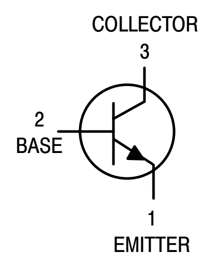
The data of Figure 22 is based upon $T_{J(pk)}$ = 150°C; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 19. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

MPS4124

Amplifier Transistor
NPN Silicon



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CE}	25	Vdc
Collector–Base Voltage	V_{CB}	30	Vdc
Emitter–Base Voltage	V_{EB}	5.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

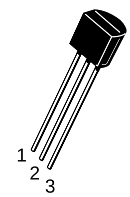
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)	$V_{(BR)CEO}$	25	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	$V_{(BR)CBO}$	30	—	Vdc
Emitter–Base Breakdown Voltage (I_C = 0, I_E = 10 μA)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 20 V, I_E = 0)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 V, I_C = 0)	I_{EBO}	—	50	nAdc

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = 2.0 mA, V_{CE} = 1.0 V) (I_C = 50 mA, V_{CE} = 1.0 V)	h_{FE}	 120 60	 360 —	—
Collector–Emitter Saturation Voltage (I_C = 50 mA, I_B = 5.0 mA)	$V_{CE(sat)}$	—	0.3	Vdc
Base–Emitter Saturation Voltage (I_C = 50 mA, I_B = 5.0 mA)	$V_{BE(sat)}$	—	0.95	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz)	f_T	170	—	MHz
Output Capacitance (V_{CB} = 5.0 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	4.0	pF
Input Capacitance (V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz)	C_{ib}	—	13.5	pF
Small–Signal Current Gain (I_C = 2.0 mA, V_{CE} = 1.0 V, f = 1.0 kHz)	h_{fe}	120	480	—
Noise Figure (I_C = 100 μA, V_{CE} = 5.0 V, R_S = 1.0 kΩ, f = 1.0 kHz)	NF	—	5.0	dB

Amplifier Transistor
PNP Silicon

MPS4126



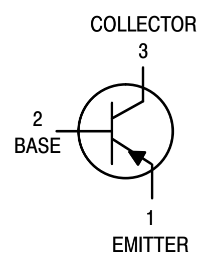
CASE 29–04, STYLE 1
TO–92 (TO–226AA)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CE}	–25	Vdc
Collector–Base Voltage	V_{CB}	–25	Vdc
Emitter–Base Voltage	V_{EB}	–4.0	Vdc
Collector Current — Continuous	I_C	–200	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –1.0 mA, I_B = 0)	$V_{(BR)CEO}$	–25	—	Vdc
Collector–Base Breakdown Voltage (I_C = –10 μA, I_E = 0)	$V_{(BR)CBO}$	–25	—	Vdc
Emitter–Base Breakdown Voltage (I_C = 0, I_E = –10 μA)	$V_{(BR)EBO}$	–4.0	—	Vdc
Collector Cutoff Current (V_{CB} = –20 V, I_E = 0)	I_{CBO}	—	–50	nAdc
Emitter Cutoff Current (V_{EB} = –3.0 V, I_C = 0)	I_{EBO}	—	–50	nAdc

March, 2001 – Rev. 1
Publication Order Number:
MPS4126/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = –2.0 mA, V_{CE} = –1.0 V)		120	360	
(I_C = –50 mA, V_{CE} = –1.0 V)		60	—	
Collector–Emitter Saturation Voltage (I_C = –50 mA, I_B = –5.0 mA)	$V_{CE(sat)}$	—	–0.4	Vdc
Base–Emitter Saturation Voltage (I_C = –50 mA, I_B = –5.0 mA)	$V_{BE(sat)}$	—	–0.95	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = –10 mA, V_{CE} = –20 V, f = 100 MHz)	f_T	170	—	MHz
Output Capacitance (V_{CB} = –5.0 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	4.5	pF
Input Capacitance (V_{EB} = –0.5 V, I_C = 0, f = 1.0 MHz)	C_{ib}	—	11.5	pF
Small–Signal Current Gain (I_C = –2.0 mA, V_{CE} = 1.0 V, f = 1.0 kHz)	h_{fe}	120	480	—
Noise Figure (I_C = –100 μA, V_{CE} = –5.0 V, R_S = 1.0 kΩ, f = 1.0 kHz)	NF	—	4.0	dB

MPS5172

General Purpose Transistor

NPN Silicon

ON Semiconductor™

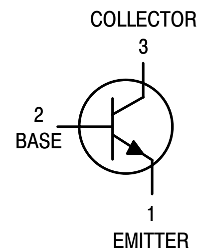
http://onsemi.com

MAXIMUM RATINGS

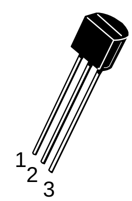
Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	25	Vdc
Collector–Base Voltage	V_{CBO}	25	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current – Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Power Dissipation @ T_A = 60°C	P_D	450	mW
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

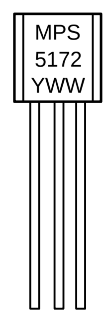
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



TO–92 (TO–226)
CASE 29–11
STYLE 1



MARKING DIAGRAM



Y = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping
MPS5172	TO–92	Bulk

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (Note 1.) (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	25	–	Vdc
Collector Cutoff Current (V_{CE} = 25 V, I_B = 0)	I_{CES}	–	100	nAdc
Collector Cutoff Current	I_{CBO}			
(V_{CB} = 25 V, I_E = 0)		–	100	nAdc
(V_{CB} = 25 V, I_E = 0, T_A = 100°C)		–	10	μAdc
Emitter Cutoff Current (V_{EB} = 5.0 V, I_C = 0)	I_{EBO}	–	100	nAdc
ON CHARACTERISTICS (Note 1.)				
DC Current Gain (V_{CE} = 10 V, I_C = 10 mA)	h_{FE}	100	500	–
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	–	0.25	Vdc
Base–Emitter On Voltage (I_C = 10 mAdc, V_{CE} = 10 V)	$V_{BE(on)}$	0.5	1.25	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Collector–Base Capacitance (V_{CB} = 10 V, f = 1.0 MHz)	C_{cb}	1.6	10	pF
Small–Signal Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	100	750	–

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

TYPICAL STATIC CHARACTERISTICS

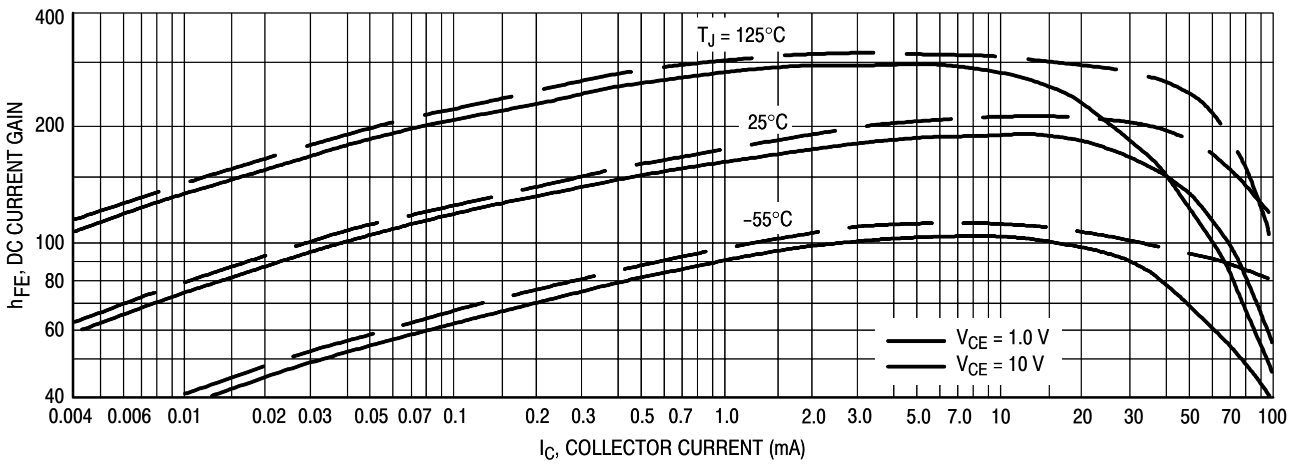


Figure 1. DC Current Gain

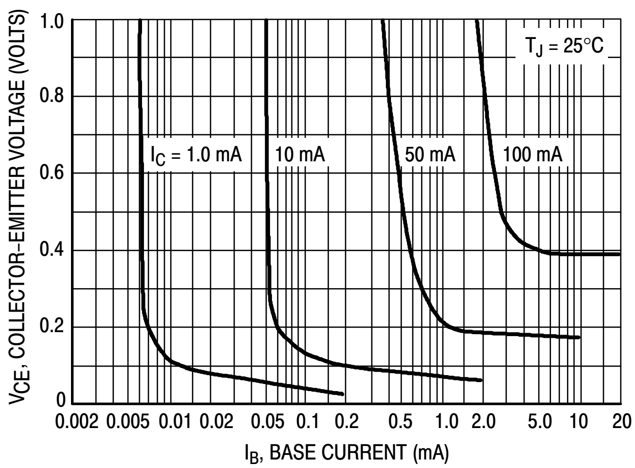


Figure 2. Collector Saturation Region

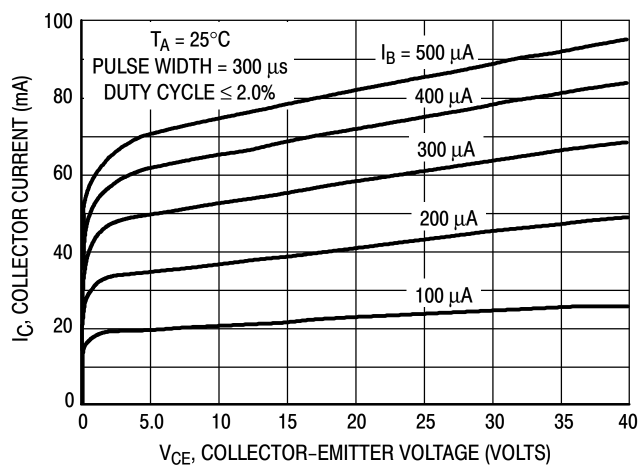


Figure 3. Collector Characteristics

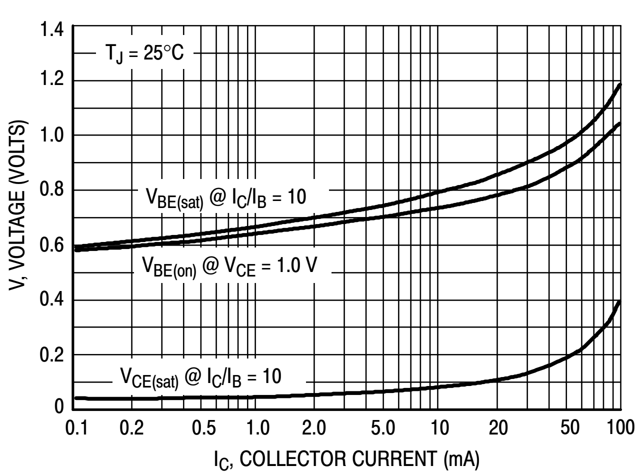


Figure 4. “On” Voltages

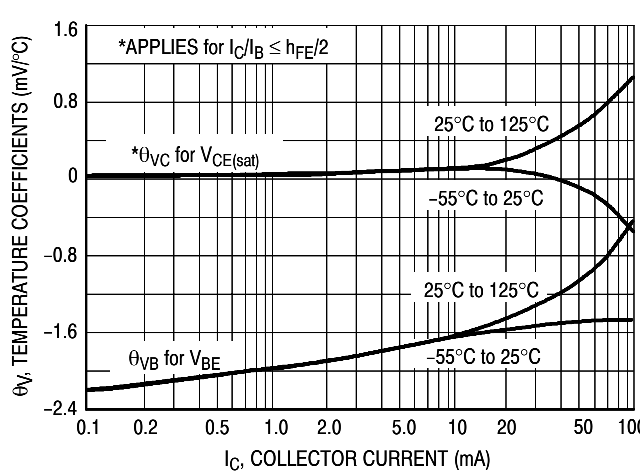


Figure 5. Temperature Coefficients

TYPICAL DYNAMIC CHARACTERISTICS

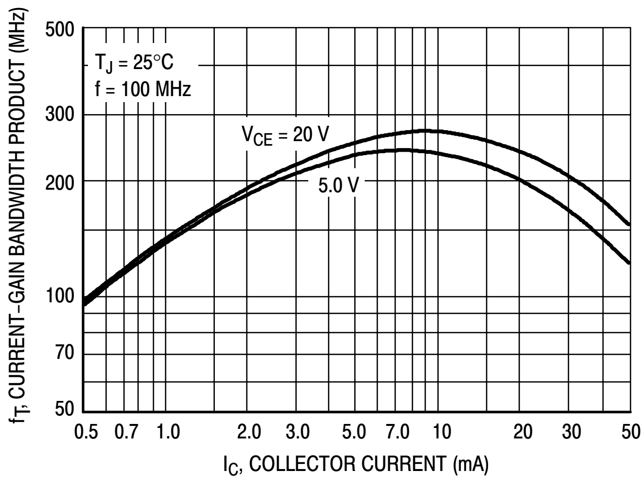


Figure 6. Current–Gain – Bandwidth Product

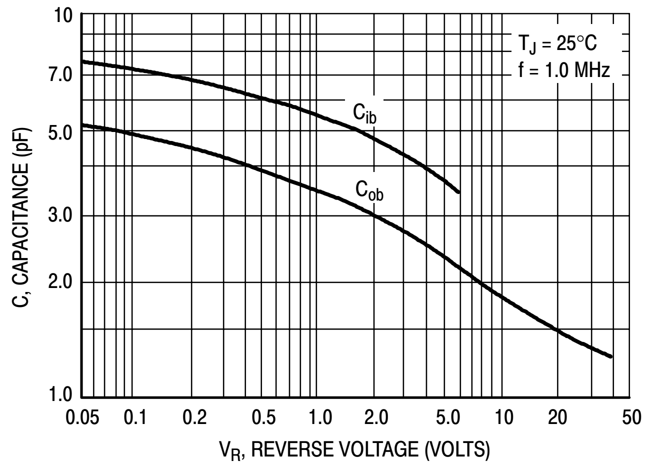


Figure 7. Capacitance

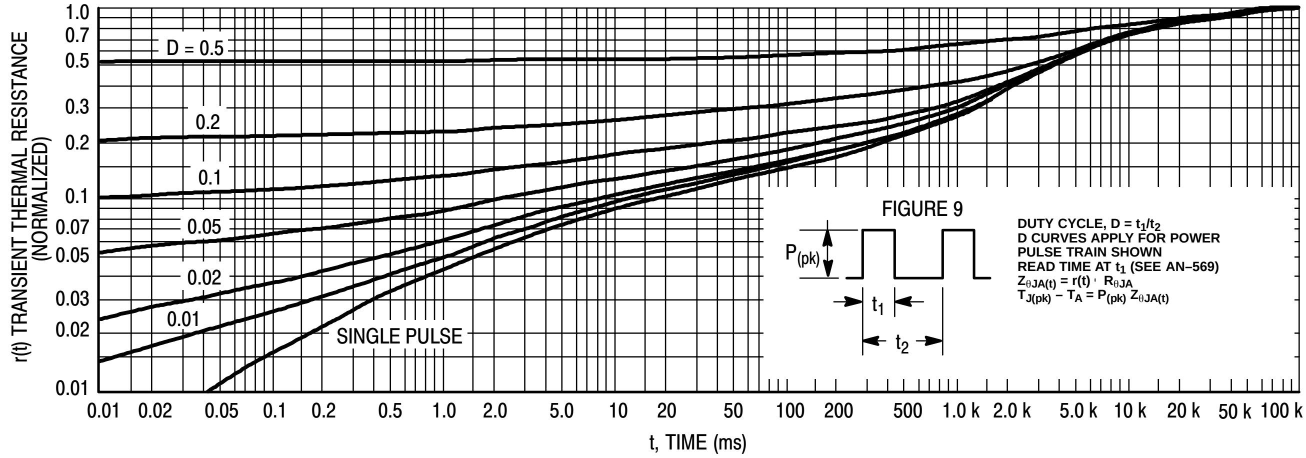


Figure 8. Thermal Response

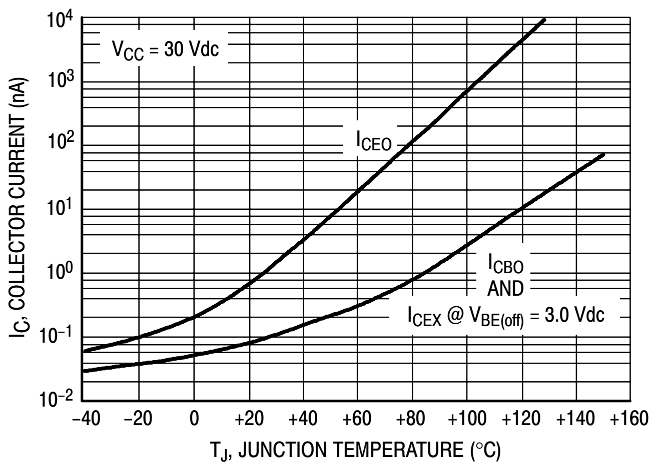


Figure 10.

DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 9. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 8 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 8 by the steady state value $R_{\theta JA}$.

Example:

The MPS3904 is dissipating 2.0 watts peak under the following conditions:

$t_1 = 1.0$ ms, $t_2 = 5.0$ ms. (D = 0.2)

Using Figure 8 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

The peak rise in junction temperature is therefore

$\Delta T = r(t) \times P_{(pk)} \times R_{\theta JA} = 0.22 \times 2.0 \times 200 = 88°C$.

For more information, see ON Semiconductor Application Note AN569/D, available from the Literature Distribution Center or on our website at **www.onsemi.com**.

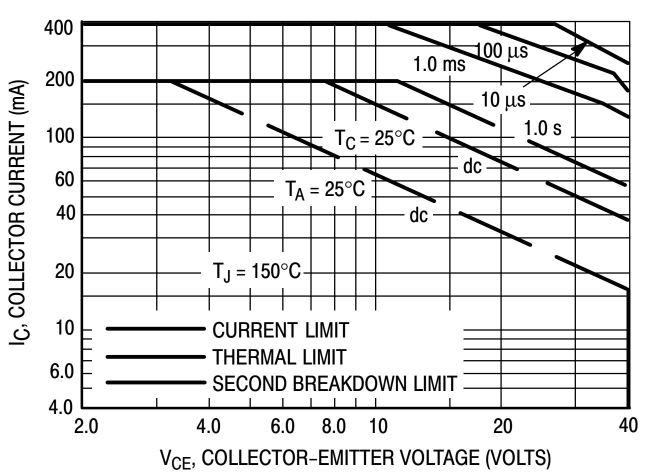


Figure 11.

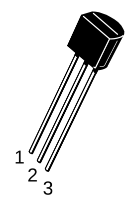
The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 11 is based upon $T_{J(pk)} = 150°C$; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 8. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

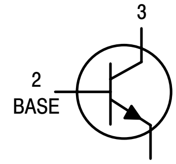
High Frequency Transistor
NPN Silicon

MPS5179

ON Semiconductor Preferred Device



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	12	Vdc
Collector–Base Voltage	V_{CBO}	20	Vdc
Emitter–Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.71	mW mW/°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Sustaining Voltage (I_C = 3.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	12	—	Vdc
Collector–Base Breakdown Voltage (I_C = 0.001 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0) (V_{CB} = 15 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	 — —	 0.02 1.0	µAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	25	250	—
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	1.0	Vdc

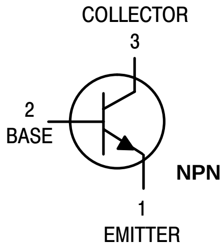
Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

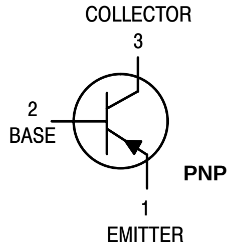
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product[1] (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	900	2000	MHz
Collector–Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{cb}	—	1.0	pF
Small Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 kHz)	h_{fe}	25	300	—

1. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

Amplifier Transistors

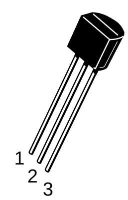




NPN
MPS650
MPS651*
PNP
MPS750
MPS751*

Voltage and current are negative for PNP transistors

***ON Semiconductor Preferred Devices**



CASE 29–10, STYLE 1
TO–92 (TO–226AL)

MAXIMUM RATINGS

Rating	Symbol	MPS650 MPS750	MPS651 MPS751	Unit
Collector–Emitter Voltage	V_{CE}	40	60	Vdc
Collector–Base Voltage	V_{CB}	60	80	Vdc
Emitter–Base Voltage	V_{EB}	5.0		Vdc
Collector Current — Continuous	I_C	2.0		Adc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	 MPS650, MPS750 MPS651, MPS751	$V_{(BR)CEO}$	 40 60	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 MPS650, MPS750 MPS651, MPS751	$V_{(BR)CBO}$	 60 80	 — —	Vdc
Emitter–Base Breakdown Voltage (I_C = 0, I_E = 10 μAdc)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 80 Vdc, I_E = 0)	 MPS650, MPS750 MPS651, MPS751	I_{CBO}	 — —	 0.1 0.1	μAdc
Emitter Cutoff Current (V_{EB} = 4.0 V, I_C = 0)		I_{EBO}	—	0.1	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]				
DC Current Gain	h_{FE}			—
(I_C = 50 mA, V_{CE} = 2.0 V)		75	—	
(I_C = 500 mA, V_{CE} = 2.0 V)		75	—	
(I_C = 1.0 A, V_{CE} = 2.0 V)		75	—	
(I_C = 2.0 A, V_{CE} = 2.0 V)		40	—	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = 2.0 A, I_B = 200 mA)		—	0.5	
(I_C = 1.0 A, I_B = 100 mA)		—	0.3	
Base–Emitter On Voltage (I_C = 1.0 A, V_{CE} = 2.0 V)	$V_{BE(on)}$	—	1.0	Vdc
Base–Emitter Saturation Voltage (I_C = 1.0 A, I_B = 100 mA)	$V_{BE(sat)}$	—	1.2	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product[2] (I_C = 50 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	75	—	MHz

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.
2. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

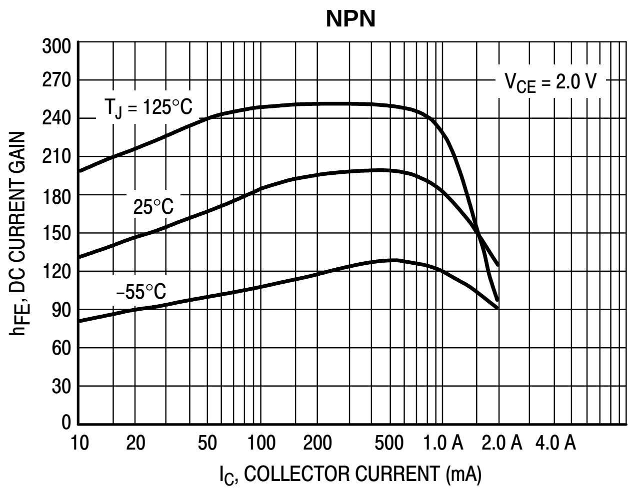


Figure 1. MPS650, MPS651 Typical DC Current Gain

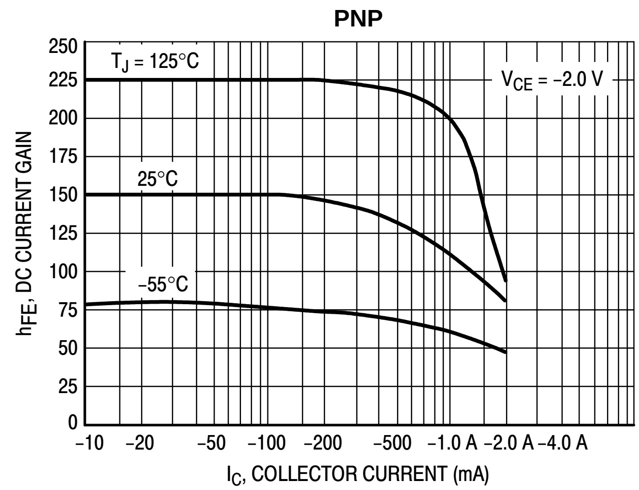


Figure 2. MPS750, MPS751 Typical DC Current Gain

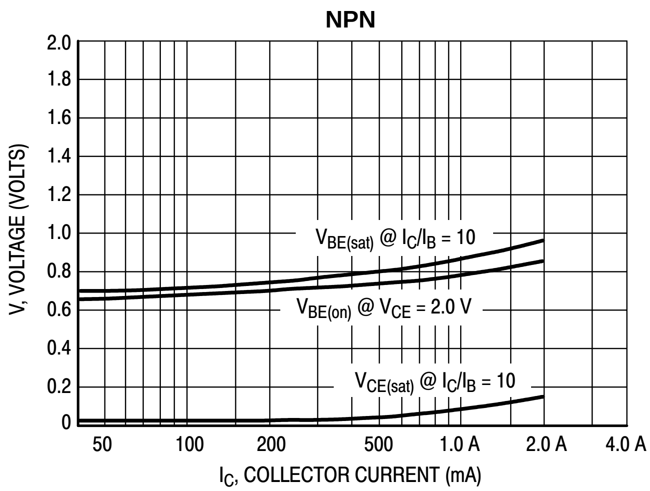


Figure 3. MPS650, MPS651 On Voltages

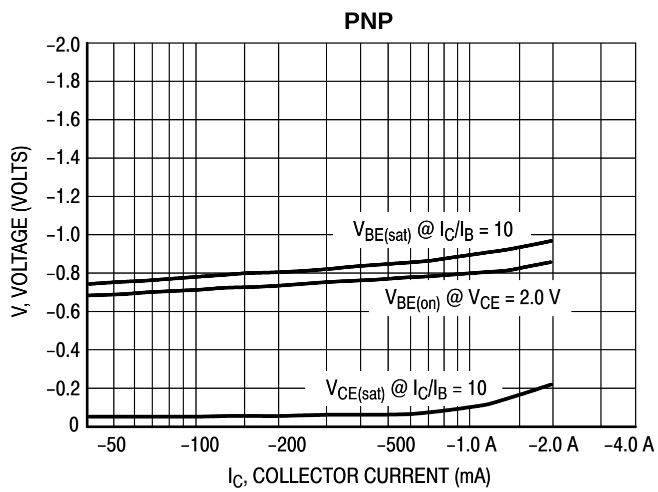


Figure 4. MPS750, MPS751 On Voltages

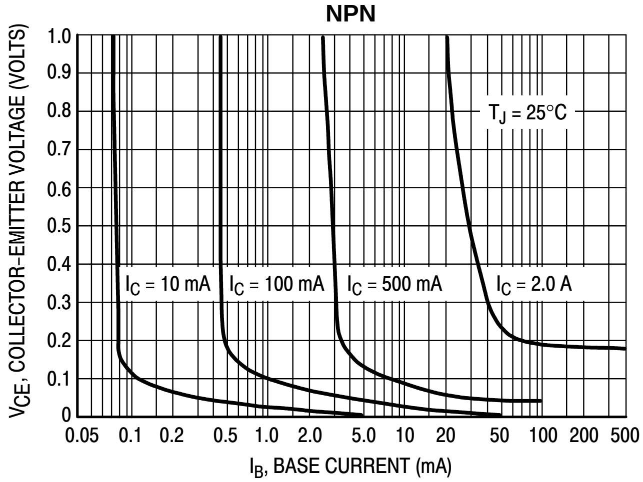


Figure 5. MPS650, MPS651
Collector Saturation Region

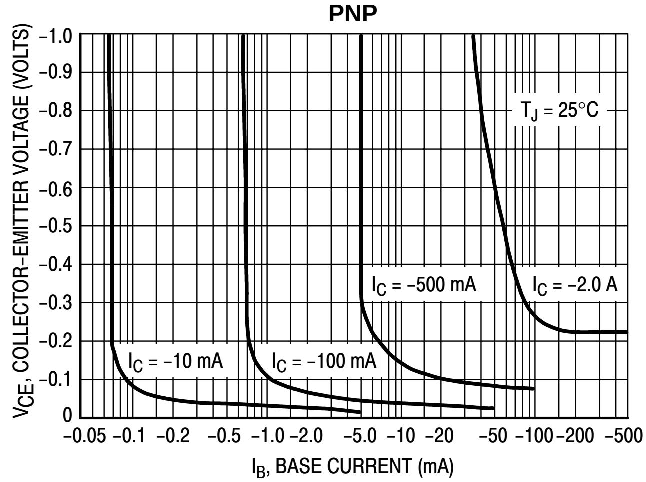


Figure 6. MPS750, MPS751
Collector Saturation Region

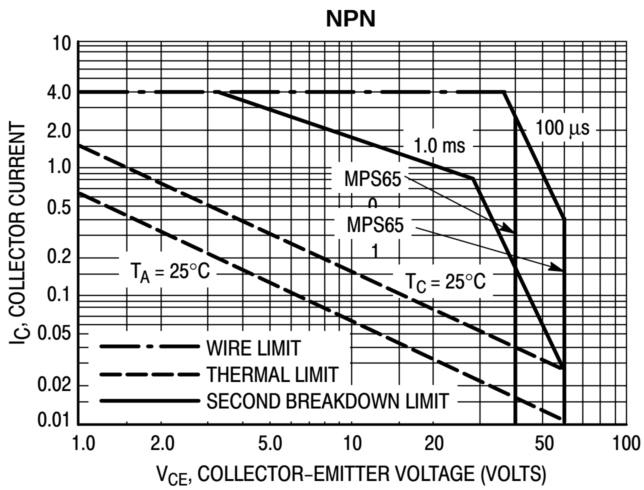


Figure 7. MPS650, MPS651 SOA,
Safe Operating Area

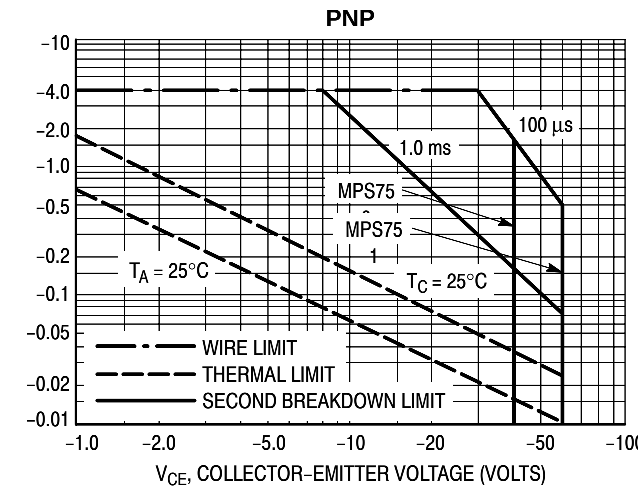
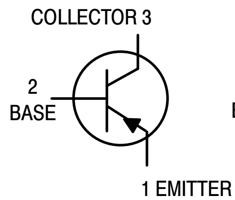
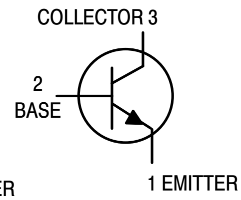


Figure 8. MPS750, MPS751 SOA,
Safe Operating Area

Amplifier Transistors

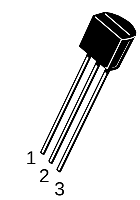




NPN MPS6521* PNP MPS6523

Voltage and current are negative for PNP transistors

***ON Semiconductor Preferred Device**



CASE 29–11, STYLE 1
TO–92 (TO–226AA)

MAXIMUM RATINGS

Rating	Symbol	NPN	PNP	Unit
Collector–Emitter Voltage MPS6521 MPS6523	V_{CEO}	 25 —	 — 25	Vdc
Collector–Base Voltage MPS6521 MPS6523	V_{CBO}	 40 —	 — 25	Vdc
Emitter–Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	100		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (Printed Circuit Board Mounting)	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 0.5 mAdc, I_B = 0)	$V_{(BR)CEO}$	25	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0) MPS6521 (V_{CB} = 20 Vdc, I_E = 0) MPS6523	I_{CBO}	 — —	 0.05 0.05	μAdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

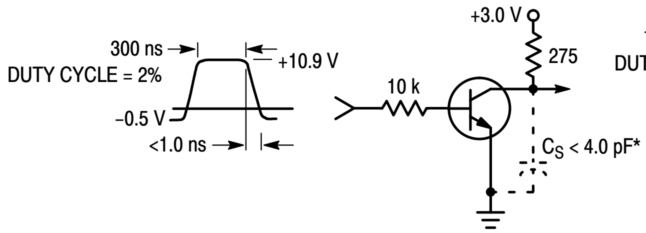
March, 2001 – Rev. 1

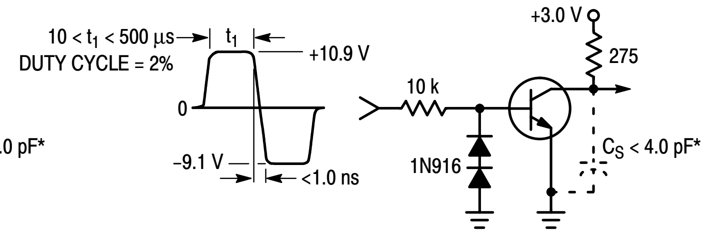
Publication Order Number:
MPS6521/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 100 μAdc, V_{CE} = 10 Vdc)	MPS6521		150	—	
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc)	MPS6521		300	600	
(I_C = 100 μAdc, V_{CE} = 10 Vdc)	MPS6523		150	—	
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc)	MPS6523		300	600	
Collector–Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	3.5	pF
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 k Ω, Power Bandwidth = 15.7 kHz, 3.0 dB points @ 10 Hz and 10 kHz)		NF	—	3.0	dB

NPN
MPS6521
EQUIVALENT SWITCHING TIME TEST CIRCUITS





*Total shunt capacitance of test jig and connectors

Figure 1. Turn–On Time **Figure 2. Turn–Off Time**

TYPICAL NOISE CHARACTERISTICS
(V_{CE} = 5.0 Vdc, T_A = 25°C)

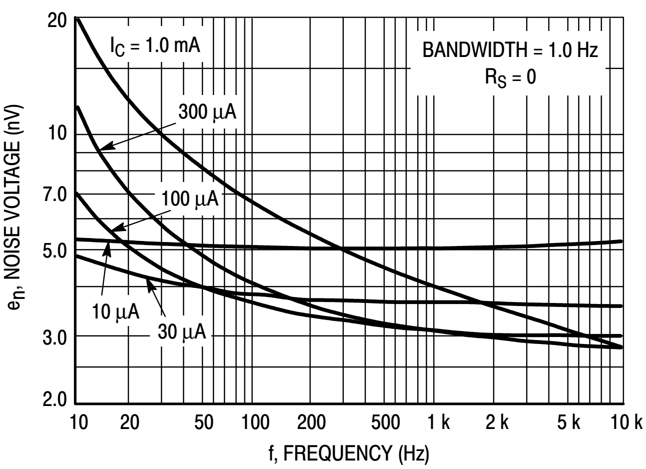


Figure 3. Noise Voltage

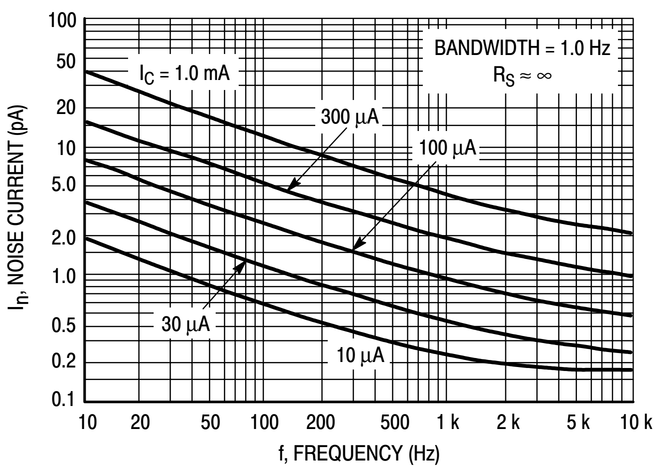


Figure 4. Noise Current

NPN
MPS6521
NOISE FIGURE CONTOURS
(V_{CE} = 5.0 Vdc, T_A = 25°C)

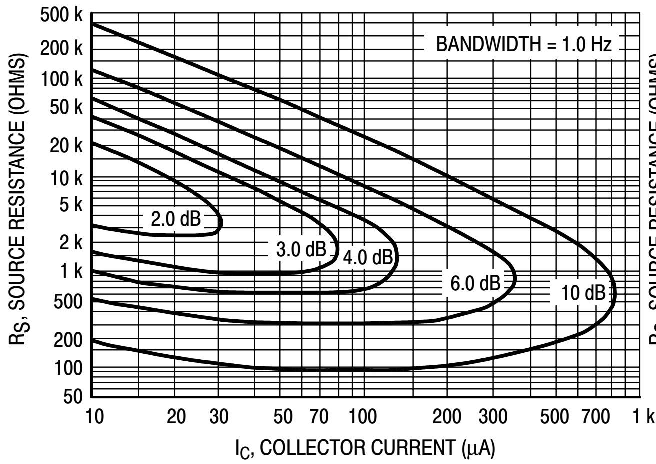


Figure 5. Narrow Band, 100 Hz

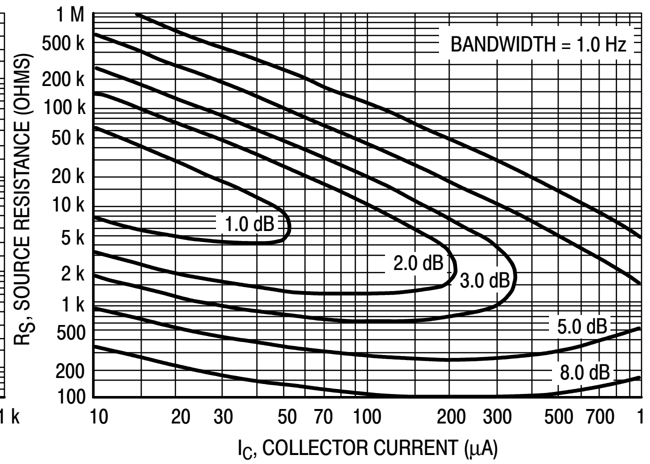


Figure 6. Narrow Band, 1.0 kHz

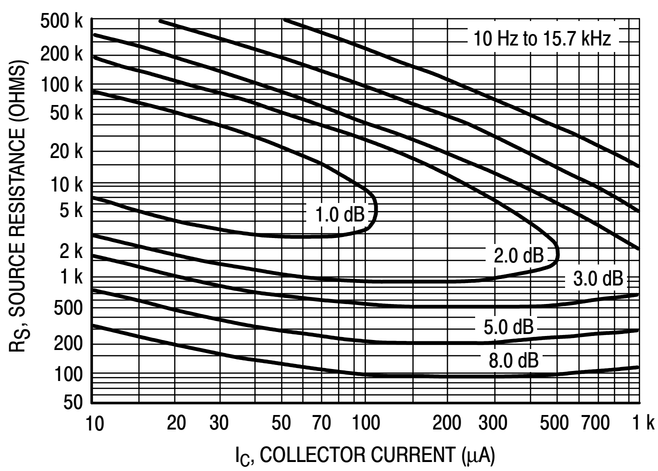


Figure 7. Wideband

Noise Figure is defined as:

$$NF = 20 \log_{10}\left(\frac{e_n^2 + 4KTR_S + I_n^2 R_S^2}{4KTR_S}\right)^{1/2}$$

e_n = Noise Voltage of the Transistor referred to the input. (Figure 3)
I_n = Noise Current of the Transistor referred to the input. (Figure 4)
K = Boltzman's Constant (1.38 x 10^{-23} j/°K)
T = Temperature of the Source Resistance (°K)
R_S = Source Resistance (Ohms)

NPN
MPS6521
TYPICAL STATIC CHARACTERISTICS

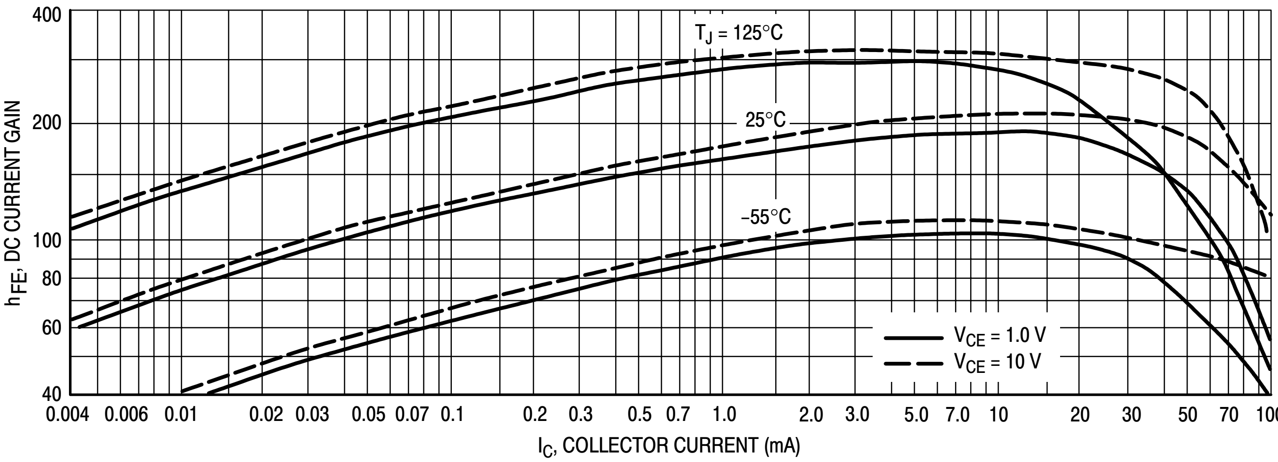


Figure 8. DC Current Gain

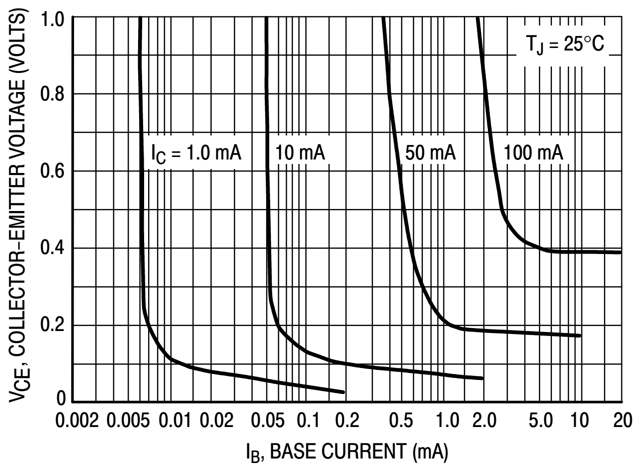


Figure 9. Collector Saturation Region

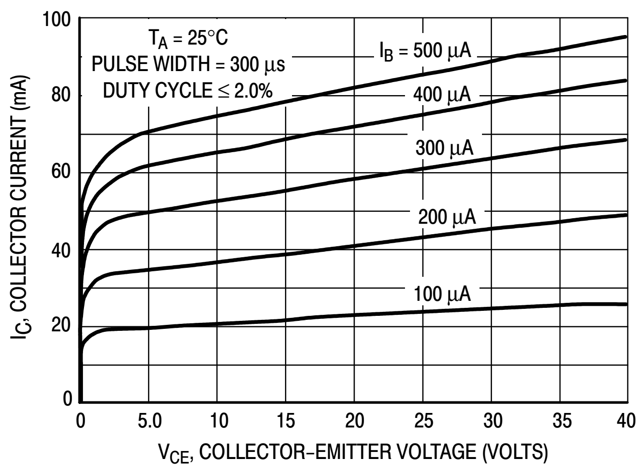


Figure 10. Collector Characteristics

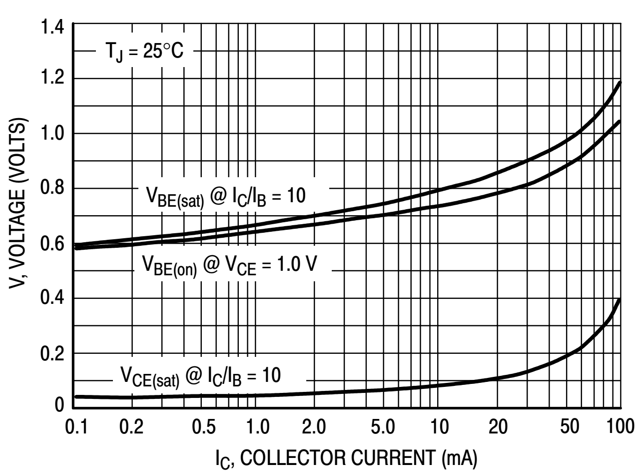


Figure 11. "On" Voltages

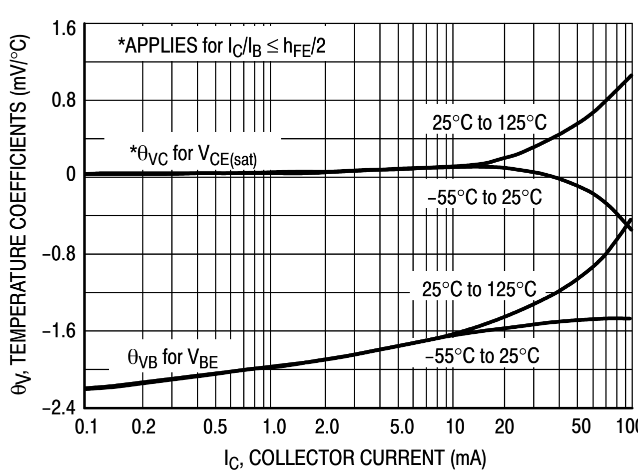


Figure 12. Temperature Coefficients

NPN
MPS6521
TYPICAL DYNAMIC CHARACTERISTICS

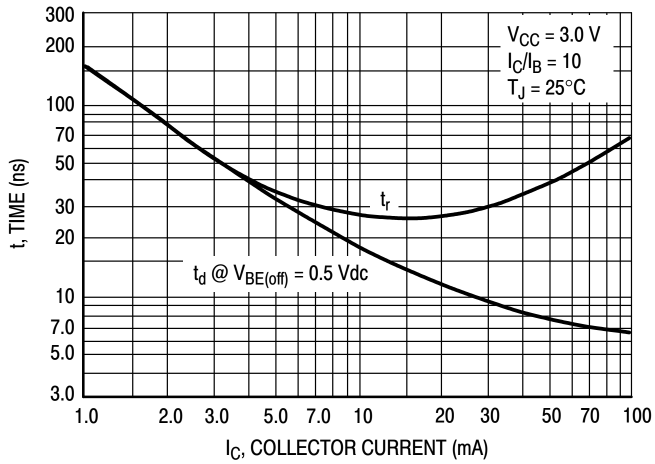


Figure 13. Turn–On Time

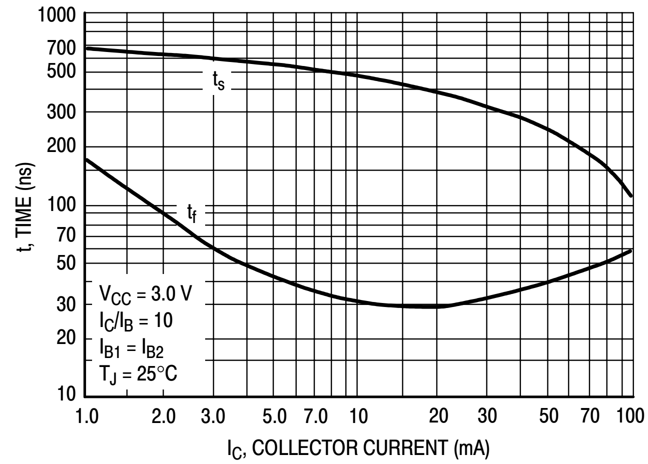


Figure 14. Turn–Off Time

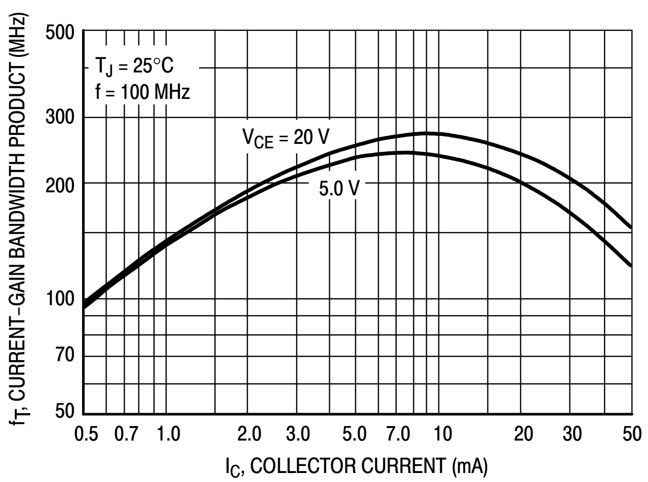


Figure 15. Current–Gain — Bandwidth Product

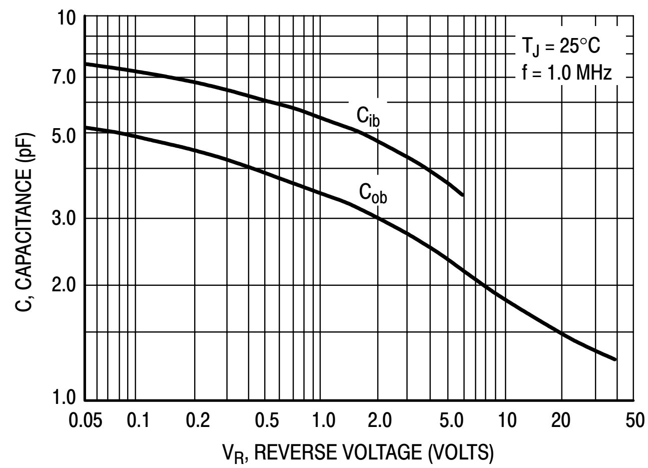


Figure 16. Capacitance

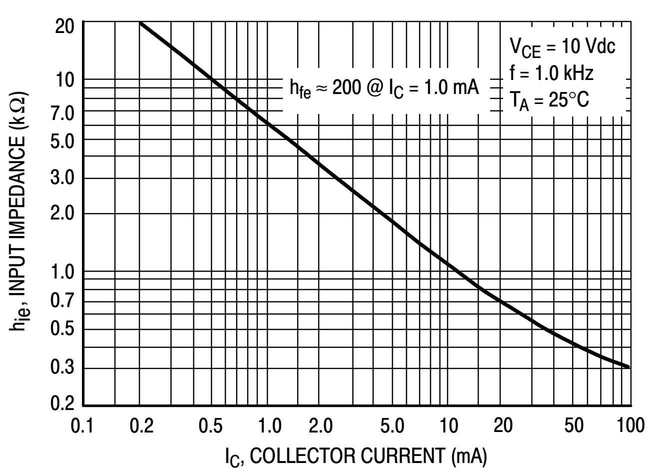


Figure 17. Input Impedance

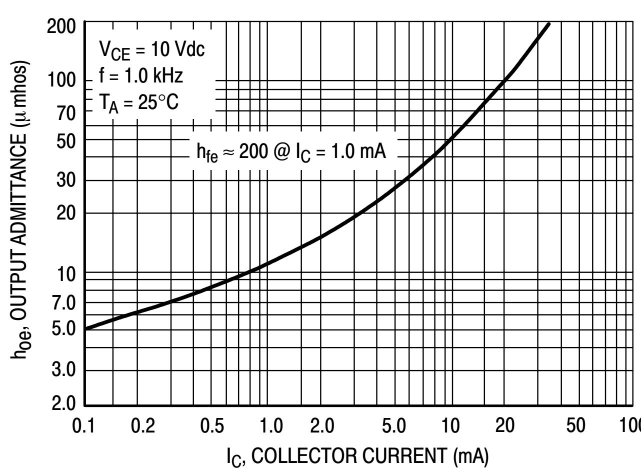


Figure 18. Output Admittance

NPN
MPS6521

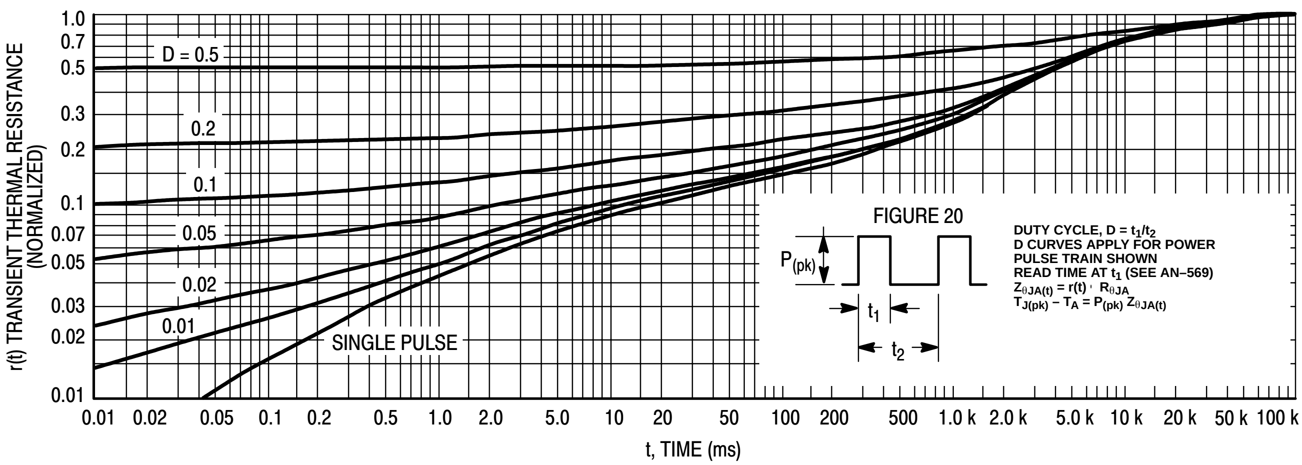


Figure 19. Thermal Response

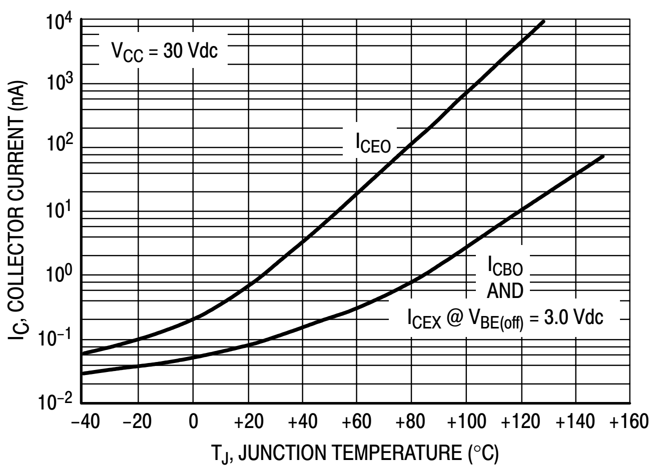


Figure 21.

DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 20. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 19 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 19 by the steady state value $R_{\theta JA}$.

Example:

The MPS6521 is dissipating 2.0 watts peak under the following conditions:

t_1 = 1.0 ms, t_2 = 5.0 ms. (D = 0.2)

Using Figure 19 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

The peak rise in junction temperature is therefore

$\Delta T = r(t) \times P_{(pk)} \times R_{\theta JA} = 0.22 \times 2.0 \times 200 = 88°C$.

For more information, see ON Semiconductor Application Note AN569/D, available from the Literature Distribution Center or on our website at **www.onsemi.com**.

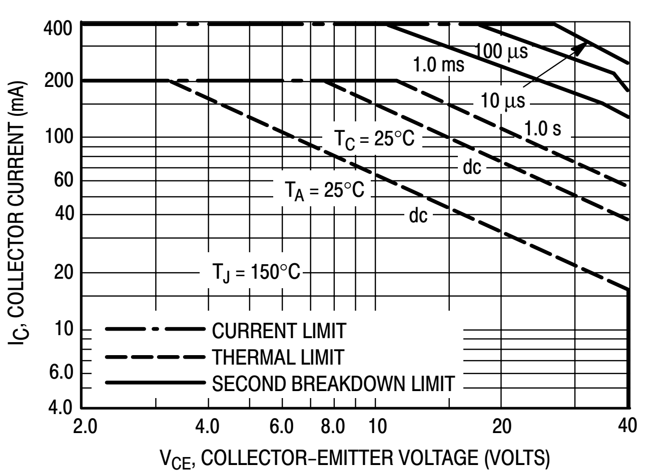


Figure 22.

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 22 is based upon $T_{J(pk)}$ = 150°C; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 19. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

PNP
MPS6523
TYPICAL NOISE CHARACTERISTICS

(V_{CE} = –5.0 Vdc, T_A = 25°C)

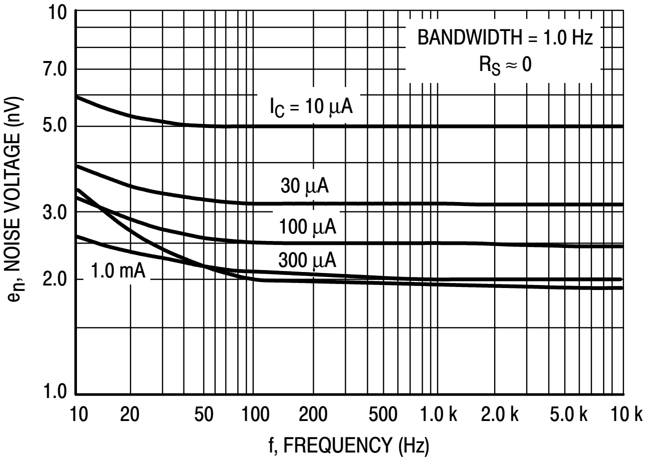


Figure 23. Noise Voltage

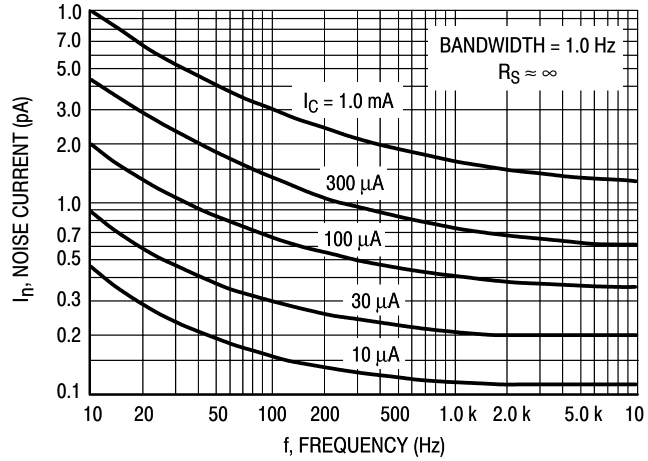


Figure 24. Noise Current

NOISE FIGURE CONTOURS

(V_{CE} = –5.0 Vdc, T_A = 25°C)

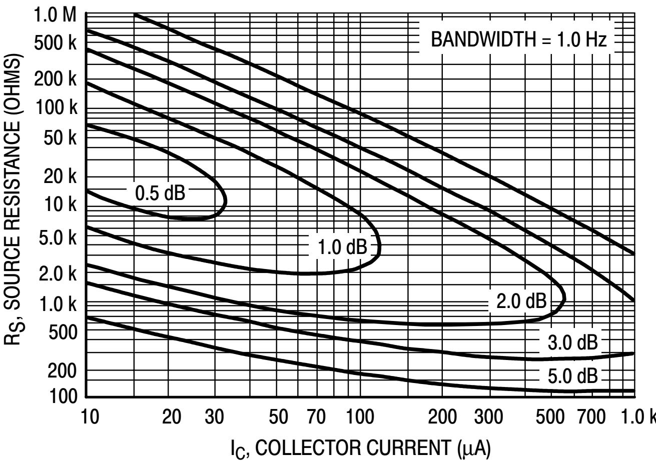


Figure 25. Narrow Band, 100 Hz

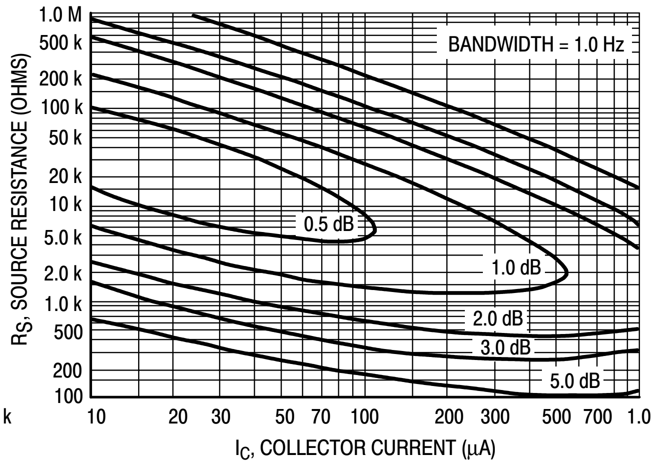


Figure 26. Narrow Band, 1.0 kHz

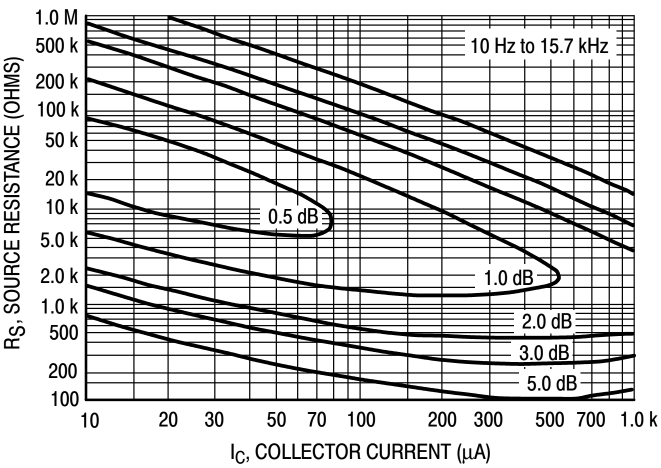


Figure 27. Wideband

Noise Figure is Defined as:

$$NF = 20 \log_{10}\left[\frac{e_n^2 + 4KTR_S + I_n^2 R_S^2}{4KTR_S}\right]^{1/2}$$

e_n = Noise Voltage of the Transistor referred to the input. (Figure 3)
I_n = Noise Current of the Transistor referred to the input. (Figure 4)
K = Boltzman’s Constant (1.38 x 10^{-23} j/°K)
T = Temperature of the Source Resistance (°K)
R_S = Source Resistance (Ohms)

PNP
MPS6523
TYPICAL STATIC CHARACTERISTICS

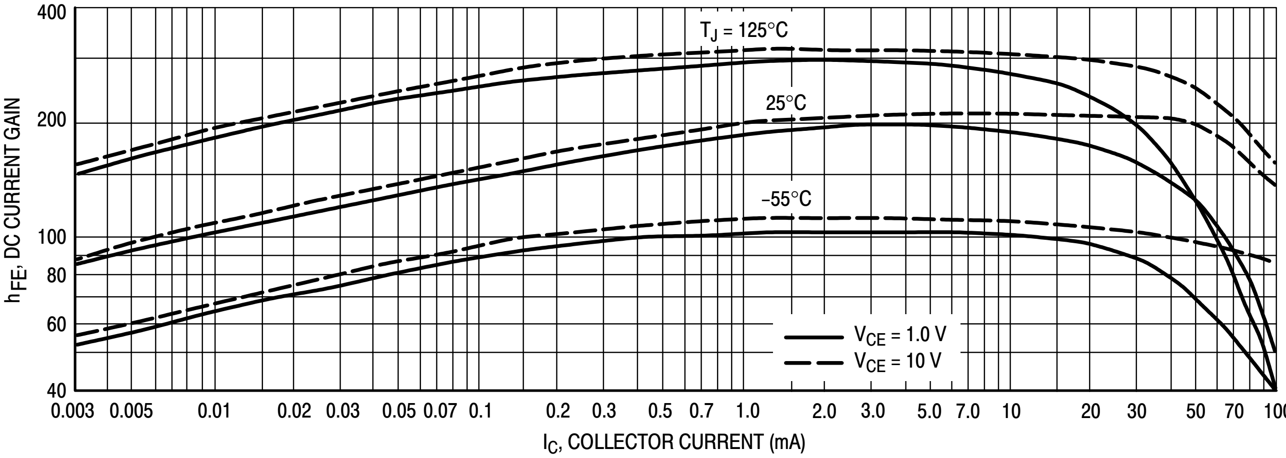


Figure 28. DC Current Gain

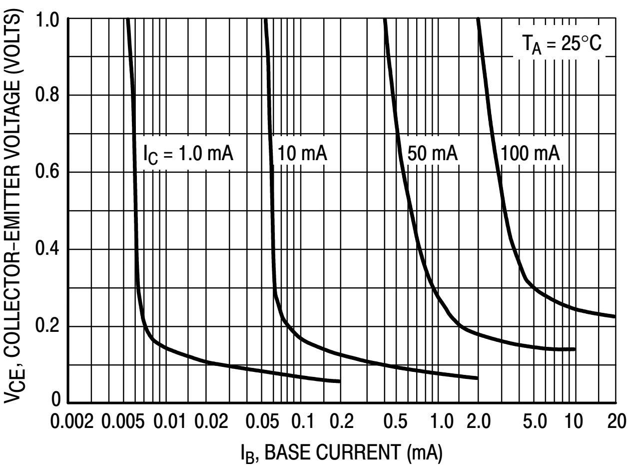


Figure 29. Collector Saturation Region

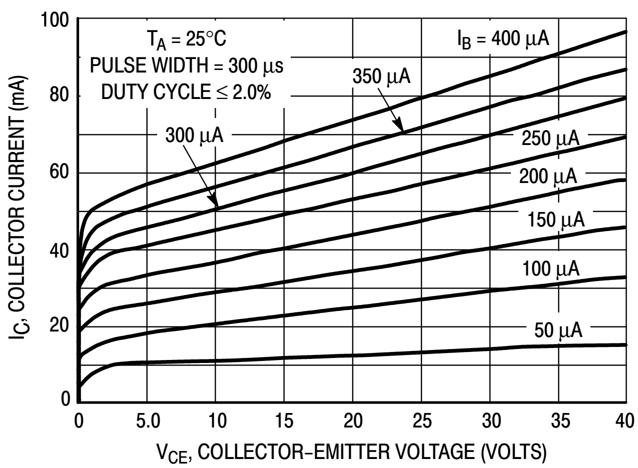


Figure 30. Collector Characteristics

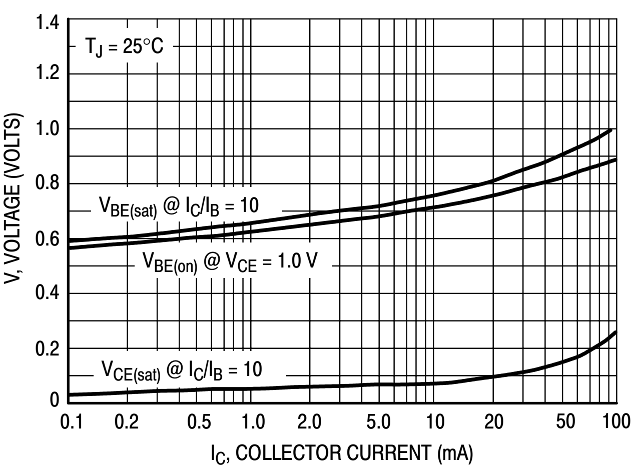


Figure 31. “On” Voltages

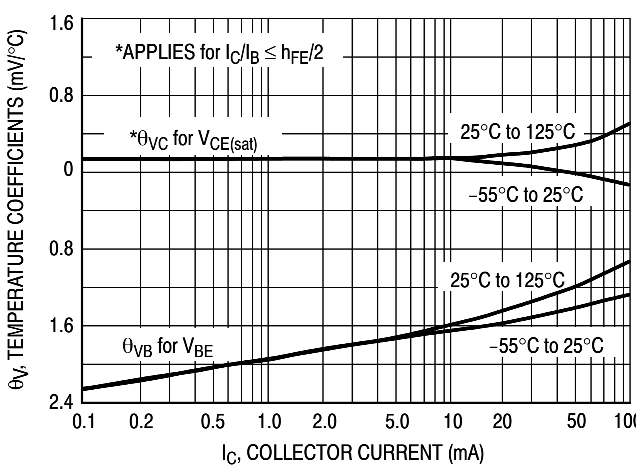


Figure 32. Temperature Coefficients

PNP
MPS6523
TYPICAL DYNAMIC CHARACTERISTICS

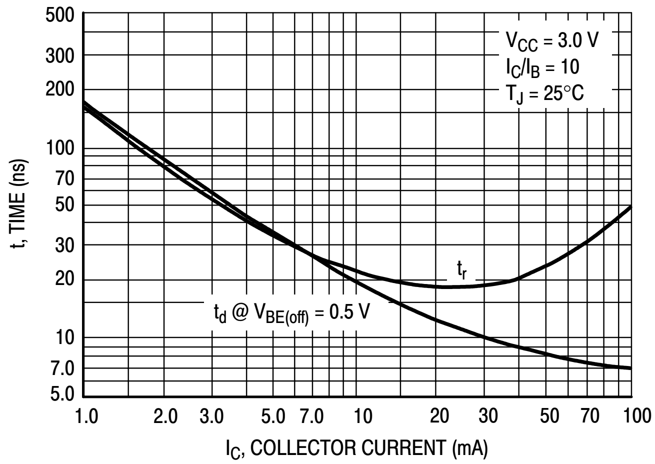


Figure 33. Turn–On Time

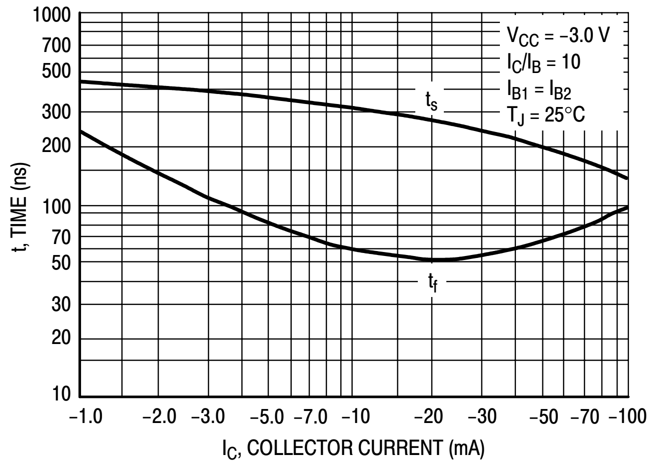


Figure 34. Turn–Off Time

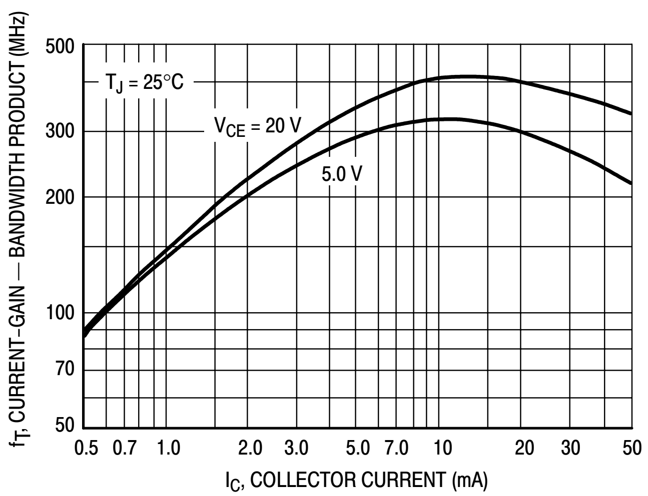


Figure 35. Current–Gain — Bandwidth Product

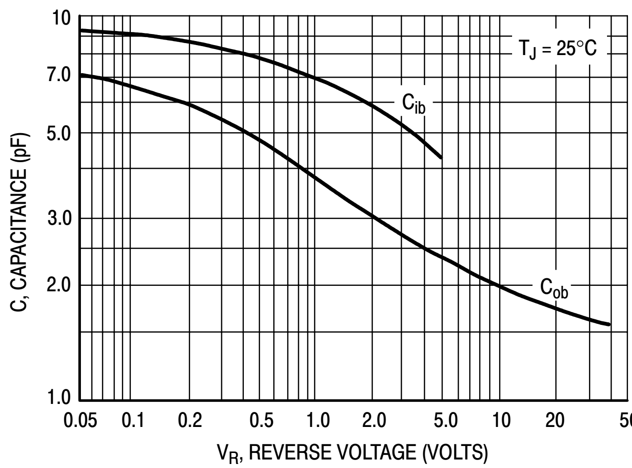


Figure 36. Capacitance

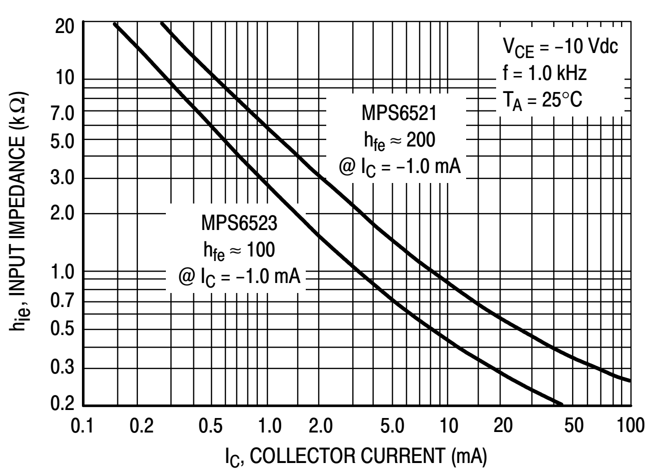


Figure 37. Input Impedance

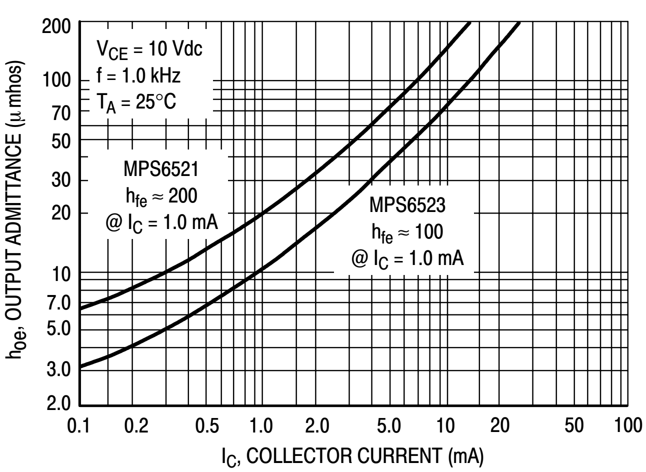


Figure 38. Output Admittance

PNP
MPS6523

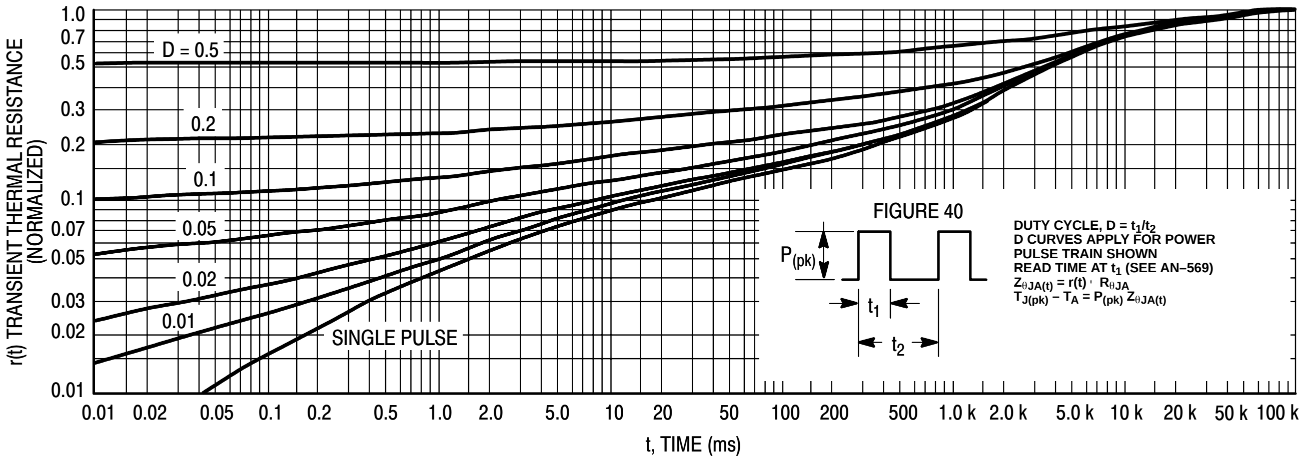


Figure 39. Thermal Response

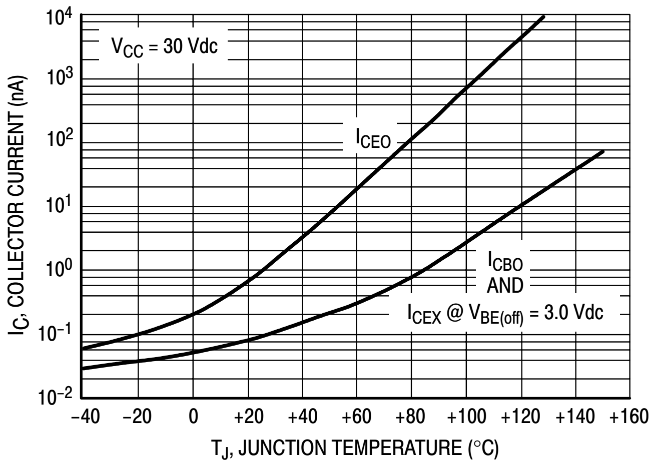


Figure 41.

DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 40. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 39 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 39 by the steady state value $R_{\theta JA}$.

Example:

The MPS6523 is dissipating 2.0 watts peak under the following conditions:

$t_1 = 1.0$ ms, $t_2 = 5.0$ ms. (D = 0.2)

Using Figure 39 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

The peak rise in junction temperature is therefore

$\Delta T = r(t) \times P_{(pk)} \times R_{\theta JA} = 0.22 \times 2.0 \times 200 = 88°C.$

For more information, see ON Semiconductor Application Note AN569/D, available from the Literature Distribution Center or on our website at **www.onsemi.com**.

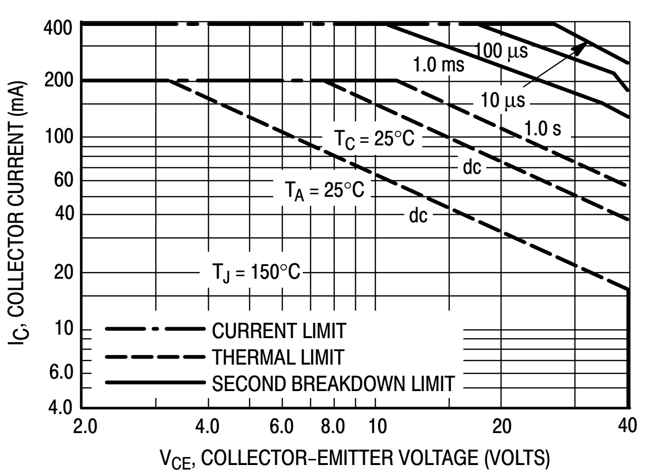


Figure 42.

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

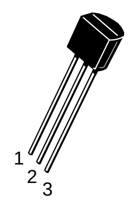
The data of Figure 42 is based upon $T_{J(pk)} = 150°C$; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 39. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

Amplifier Transistors

NPN
MPS6601
MPS6602*
PNP
MPS6651
MPS6652*

Voltage and current are negative for PNP transistors

***ON Semiconductor Preferred Device**



CASE 29–11, STYLE 1
TO–92 (TO–226AA)

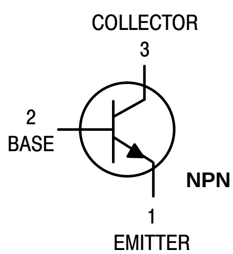
MAXIMUM RATINGS

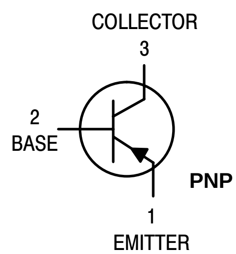
Rating	Symbol	Value	Unit
Collector–Emitter Voltage MPS6601/6651 MPS6602/6652	V_{CEO}	25 40	Vdc
Collector–Base Voltage MPS6601/6651 MPS6602/6652	V_{CBO}	25 30	Vdc
Emitter–Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1000	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}^{(1)}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

1. $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.





Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	MPS6601/6651 MPS6602/6652	$V_{(BR)CEO}$	25 40	— —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	MPS6601/6651 MPS6602/6652	$V_{(BR)CBO}$	25 40	— —	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CE} = 25 Vdc, I_B = 0) (V_{CE} = 30 Vdc, I_B = 0)	MPS6601/6651 MPS6602/6652	I_{CES}	— —	0.1 0.1	μAdc
Collector Cutoff Current (V_{CB} = 25 Vdc, I_E = 0) (V_{CB} = 30 Vdc, I_E = 0)	MPS6601/6651 MPS6602/6652	I_{CBO}	— —	0.1 0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 1.0 Vdc) (I_C = 500 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1000 mAdc, V_{CE} = 1.0 Vdc)		h_{FE}	50 50 30	— — —	—
Collector–Emitter Saturation Voltage (I_C = 1000 mAdc, I_B = 100 mAdc)		$V_{CE(sat)}$	—	0.6	Vdc
Base–Emitter On Voltage (I_C = 500 mAdc, V_{CE} = 1.0 Vdc)		$V_{BE(on)}$	—	1.2	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	100	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	30	pF
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 40 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc, $t_p \geq$ 300 ns Duty Cycle)	t_d	—	25	ns
Rise Time		t_r	—	30	ns
Storage Time		t_s	—	250	ns
Fall Time		t_f	—	50	ns

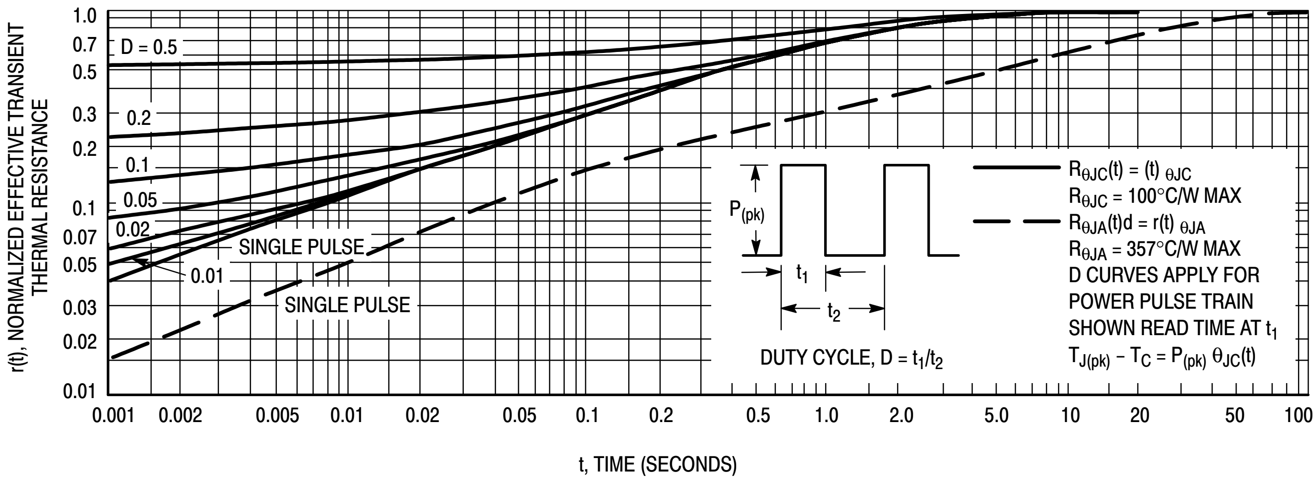
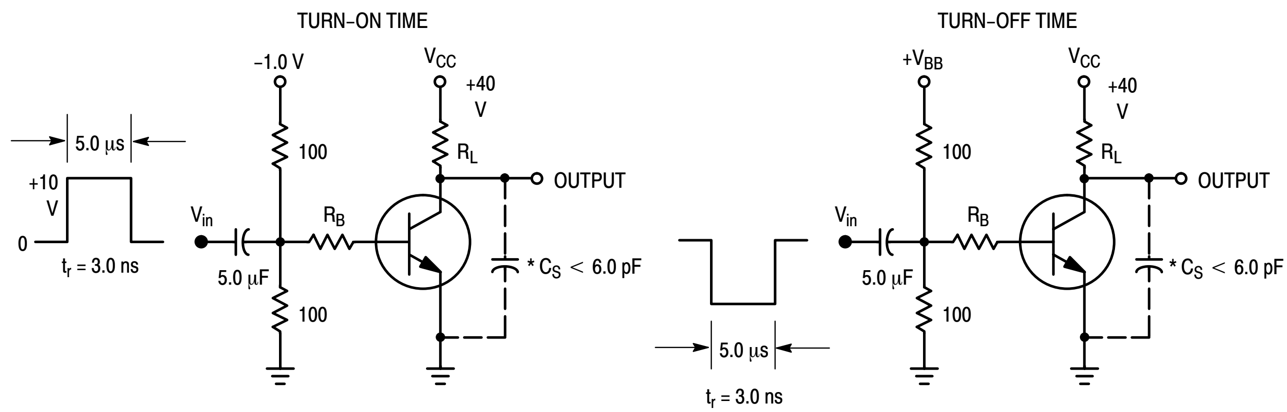


Figure 1. Thermal Response



*Total Shunt Capacitance of Test Jig and Connectors
For PNP Test Circuits, Reverse All Voltage Polarities

Figure 2. Switching Time Test Circuits

NPN

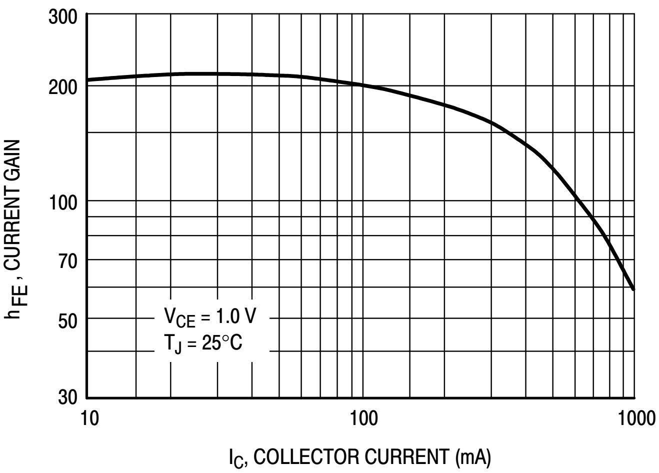


Figure 3. MPS6601/6602 DC Current Gain

PNP

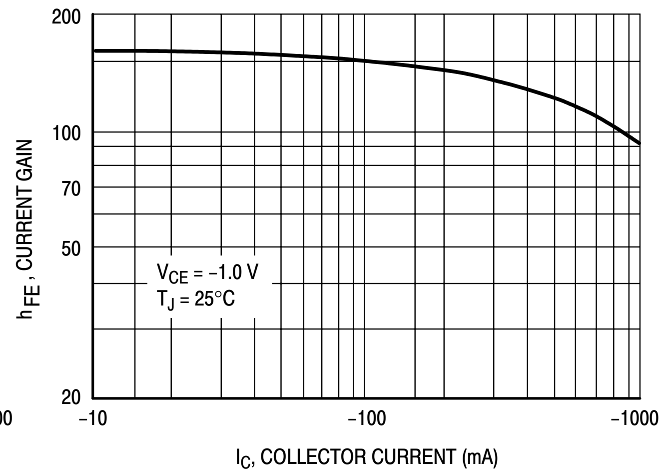


Figure 4. MPS6651/6652 DC Current Gain

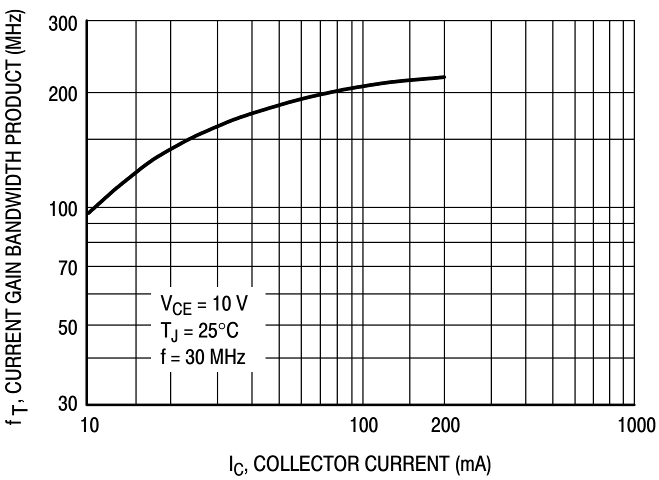


Figure 5. Current Gain Bandwidth Product

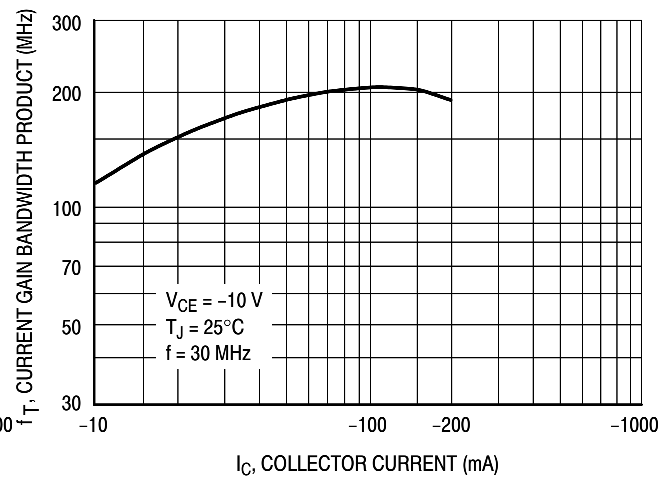


Figure 6. Current Gain Bandwidth Product

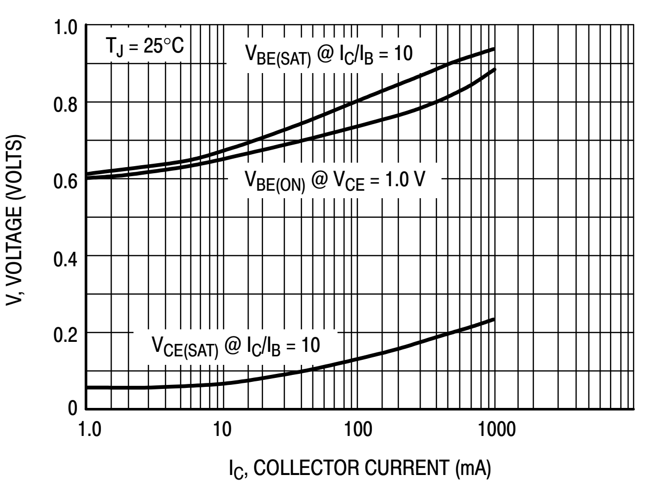


Figure 7. On Voltages

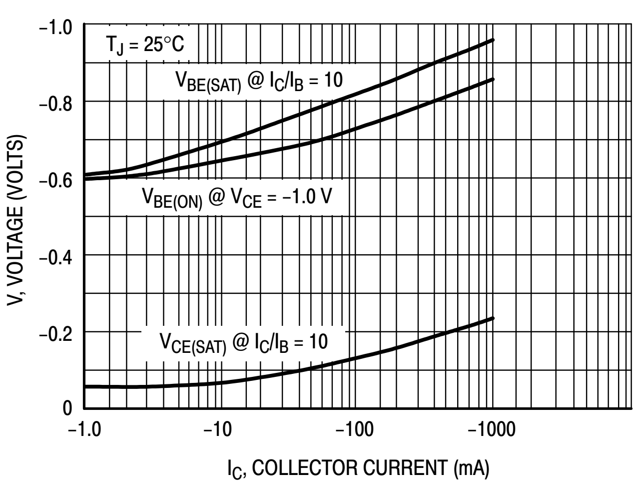


Figure 8. On Voltages

NPN

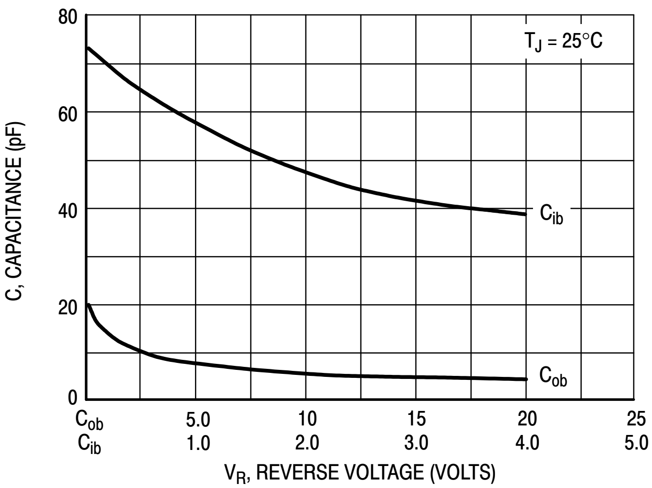


Figure 9. Capacitance

PNP

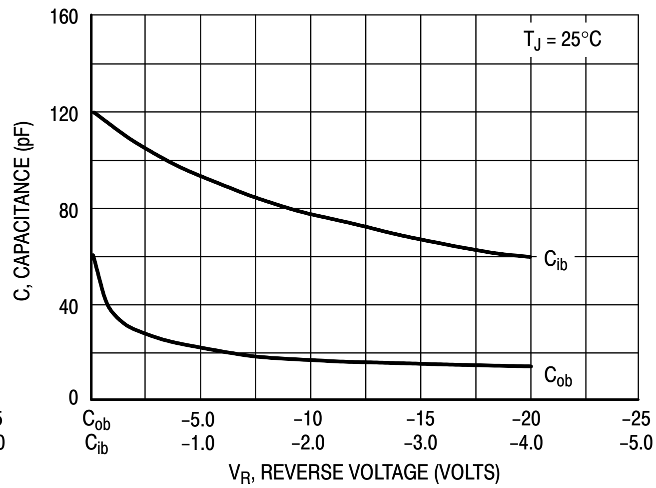


Figure 10. Capacitance

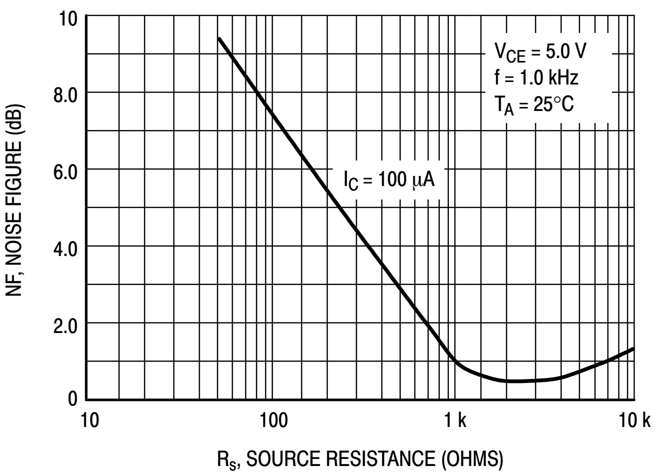


Figure 11. MPS6601/6602 Noise Figure

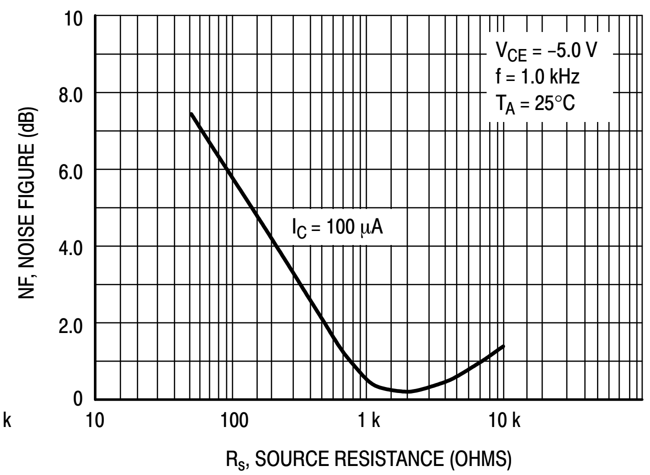


Figure 12. MPS6651/6652 Noise Figure

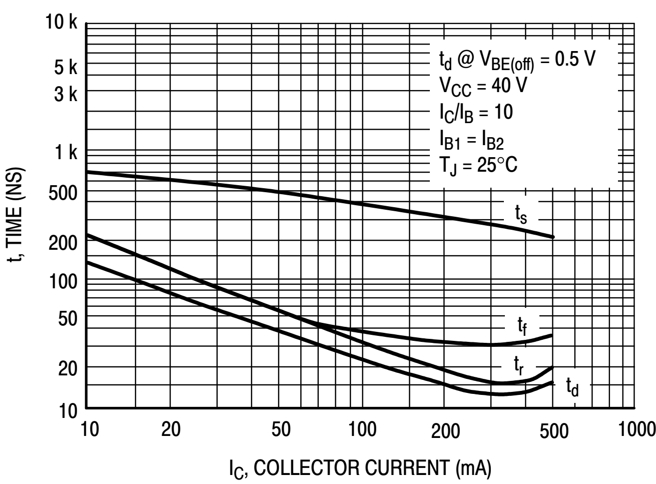


Figure 13. MPS6601/6602 Switching Times

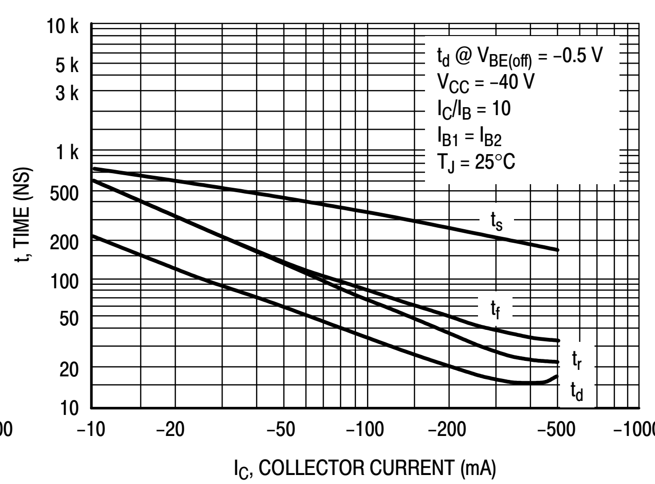


Figure 14. MPS6651/6652 Switching Times

NPN **PNP**

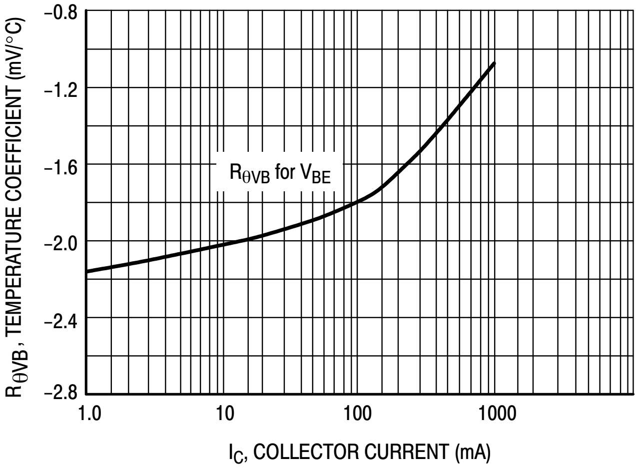


Figure 15. Base−Emitter Temperature Coefficient

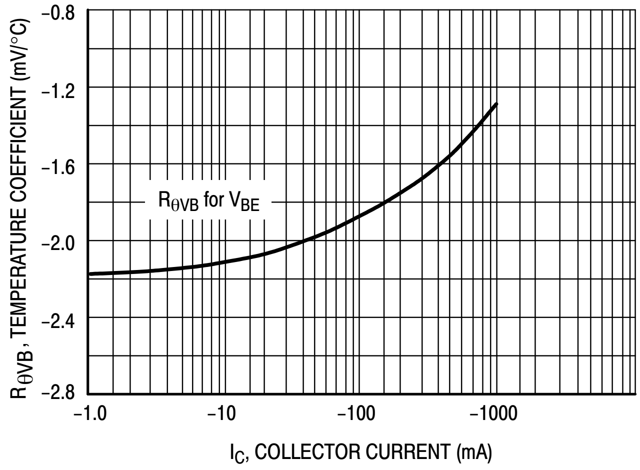


Figure 16. Base−Emitter Temperature Coefficient

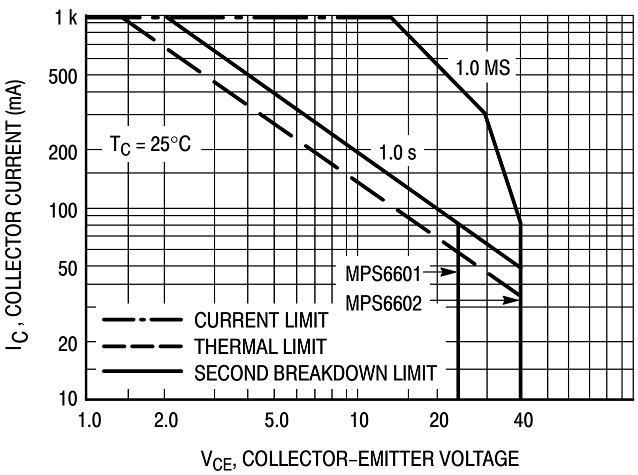


Figure 17. Safe Operating Area

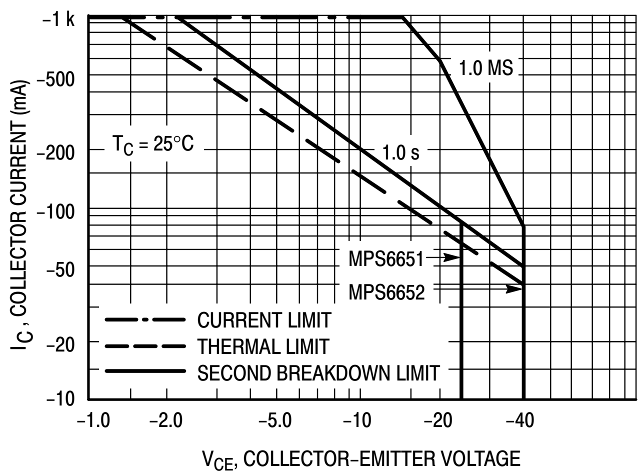


Figure 18. Safe Operating Area

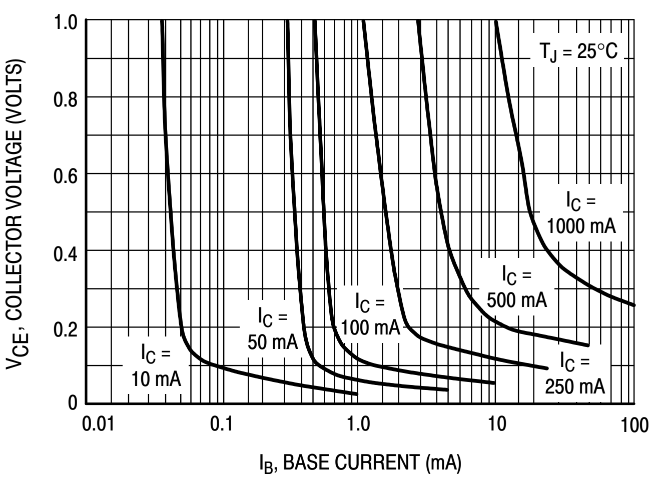


Figure 19. MPS6601/6602 Saturation Region

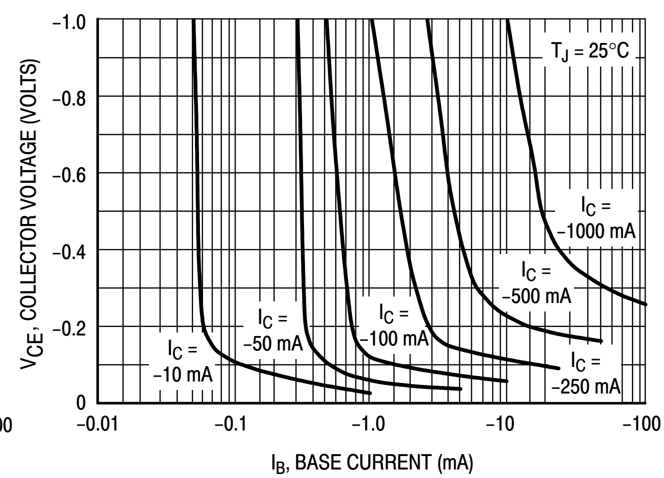


Figure 20. MPS6651/6652 Saturation Region

MPS6729

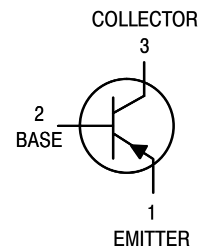
Preferred Device

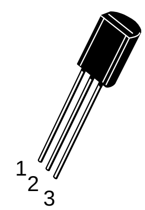
One Watt Amplifier Transistor

PNP Silicon

ON Semiconductor™

http://onsemi.com





TO–92 (TO–226)
CASE 29–10
STYLE 1

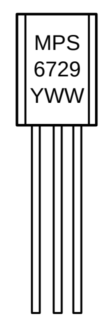
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–80	Vdc
Collector–Base Voltage	V_{CBO}	–80	Vdc
Emitter–Base Voltage	V_{EBO}	–4.0	Vdc
Collector Current – Continuous	I_C	–500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

MARKING DIAGRAM



Y = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping
MPS6729	TO–92	Bulk

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (Note 1.) (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–80	–	Vdc
Collector–Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	–80	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	–	Vdc
Collector Cutoff Current (V_{CB} = –60 Vdc, I_E = 0)	I_{CBO}	–	–0.1	μAdc
Emitter Cutoff Current (V_{EB} = –5.0 Vdc, I_C = 0)	I_{EBO}	–	–10	μAdc
ON CHARACTERISTICS (Note 1.)				
DC Current Gain	h_{FE}			–
(I_C = –50 mAdc, V_{CE} = –1.0 Vdc)		80	–	
(I_C = –250 mAdc, V_{CE} = –1.0 Vdc)		50	250	
Collector–Emitter Saturation Voltage (I_C = –250 mAdc, I_B = –10 mAdc)	$V_{CE(sat)}$	–	–0.5	Vdc
Base–Emitter On Voltage (I_C = –250 mAdc, V_{CE} = –1.0 Vdc)	$V_{BE(on)}$	–	–1.2	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Collector–Base Capacitance (V_{CB} = –10 Vdc, f = 1.0 MHz)	C_{cb}	–	30	pF
Small–Signal Current Gain (I_C = 200 mA, V_{CE} = 5.0 V, f = 20 MHz)	h_{fe}	2.5	25	

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

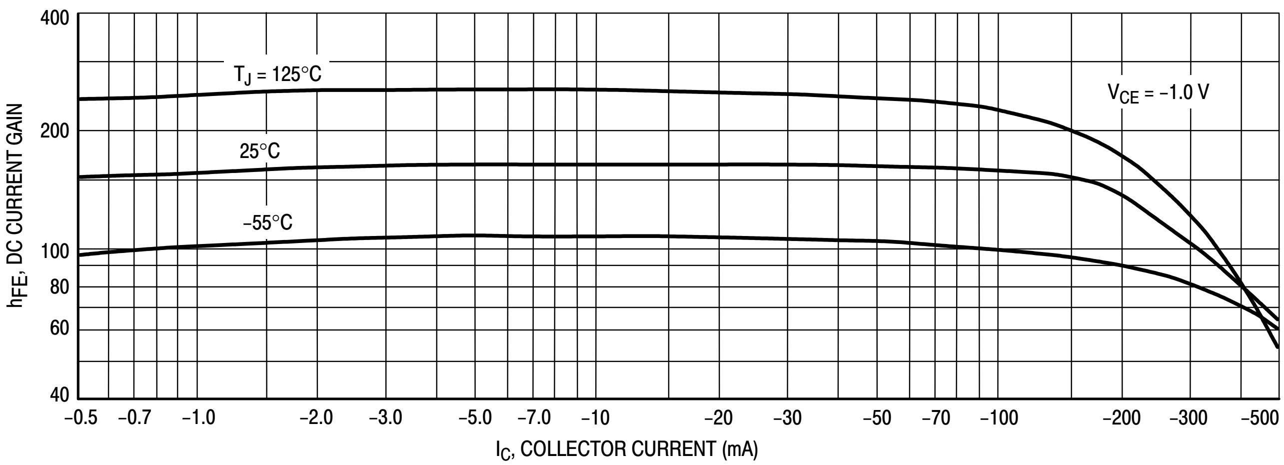


Figure 1. DC Current Gain

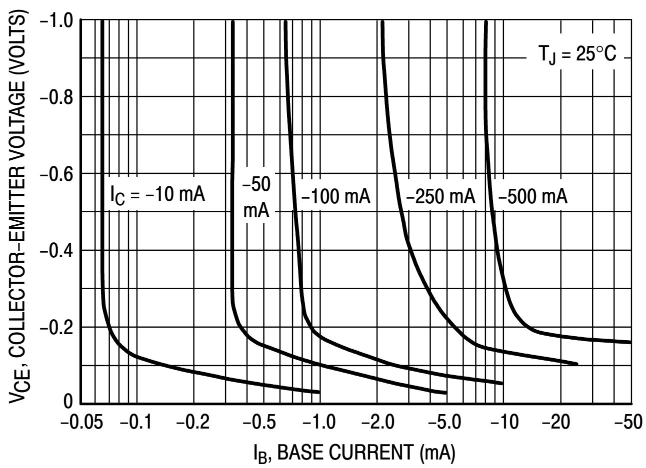


Figure 2. Collector Saturation Region

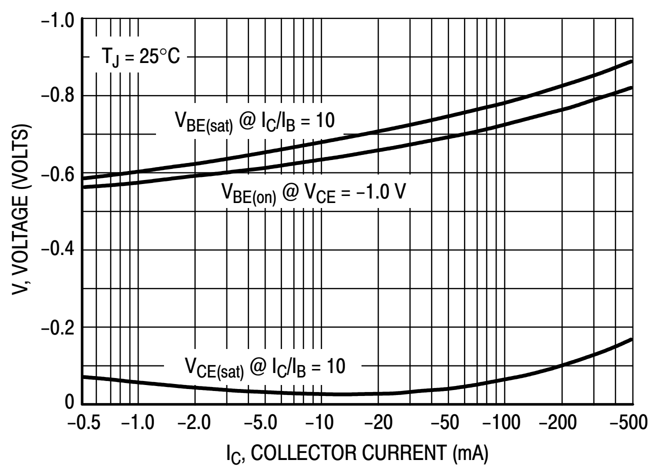


Figure 3. “On” Voltages

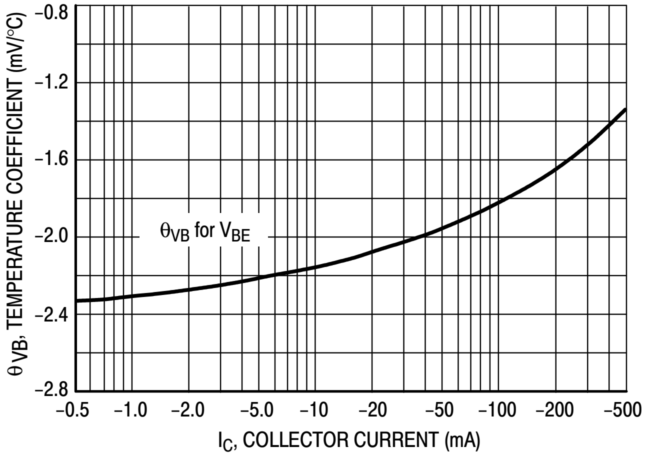


Figure 4. Base–Emitter Temperature Coefficient

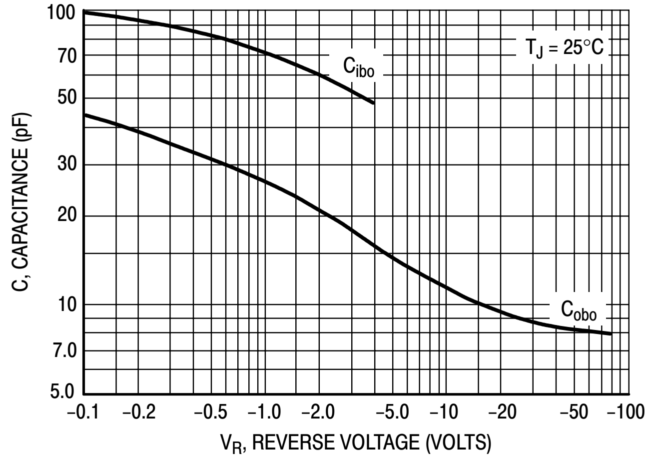


Figure 5. Capacitance

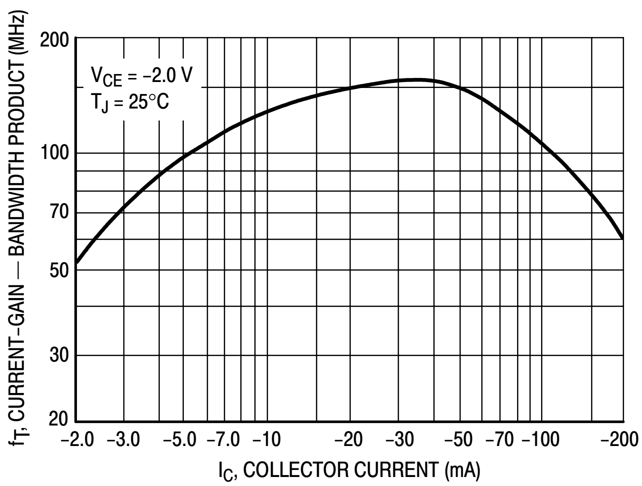


Figure 6. Current–Gain – Bandwidth Product

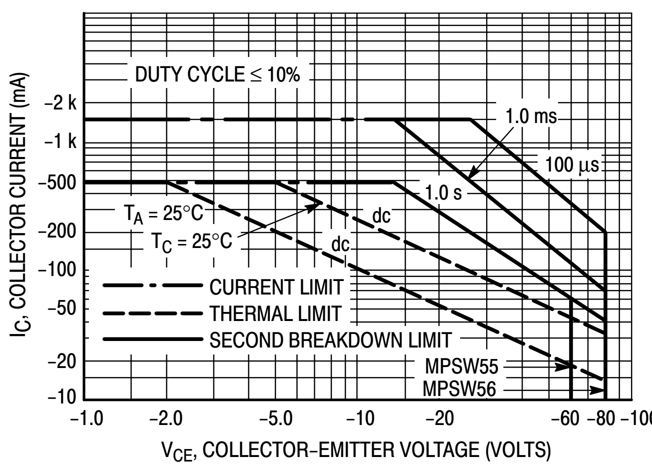


Figure 7. Active Region – Safe Operating Area

Amplifier Transistors

NPN
MPS8098
MPS8099*
PNP
MPS8598
MPS8599*

Voltage and current are negative for PNP transistors

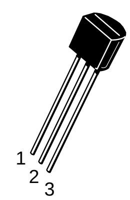
***ON Semiconductor Preferred Device**

MAXIMUM RATINGS

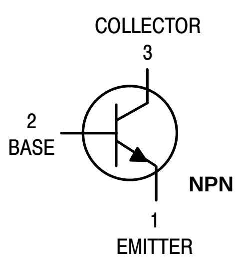
Rating	Symbol	MPS8098 MPS8598	MPS8099 MPS8599	Unit
Collector–Emitter Voltage	V_{CEO}	60	80	Vdc
Collector–Base Voltage	V_{CBO}	60	80	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	5.0	Vdc
Collector Current – Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

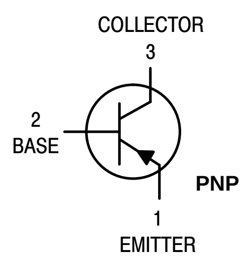
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



CASE 29–11, STYLE 1
TO–92 (TO–226AA)





Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage[(1)] (I_C = 10 mAdc, I_B = 0)	MPS8098, MPS8598 MPS8099, MPS8599	$V_{(BR)CEO}$	60 80	— —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	MPS8098, MPS8598 MPS8099, MPS8599	$V_{(BR)CBO}$	60 80	— —	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	MPS8098, MPS8099 MPS8598, MPS8599	$V_{(BR)EBO}$	6.0 5.0	— —	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, I_B = 0)		I_{CES}	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 80 Vdc, I_E = 0)	MPS8098, MPS8598 MPS8099, MPS8599	I_{CBO}	— —	0.1 0.1	μAdc
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0) (V_{EB} = 4.0 Vdc, I_C = 0)	MPS8098, MPS8099 MPS8598, MPS8599	I_{EBO}	— —	0.1 0.1	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

ON CHARACTERISTICS[(1)]

Characteristic		Symbol	Min	Max	Unit
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc) (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}	100 100 75	300 — —	—
Collector–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 5.0 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	— —	0.4 0.3	Vdc
Base–Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MPS8098, MPS8598 MPS8099, MPS8599	$V_{BE(on)}$	0.5 0.6	0.7 0.8	Vdc

SMALL–SIGNAL CHARACTERISTICS

Characteristic		Symbol	Min	Max	Unit
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	150	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	MPS8098, MPS8099 MPS8598, MPS8599	C_{obo}	— —	6.0 8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MPS8098, MPS8099 MPS8598, MPS8599	C_{ibo}	— —	25 30	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

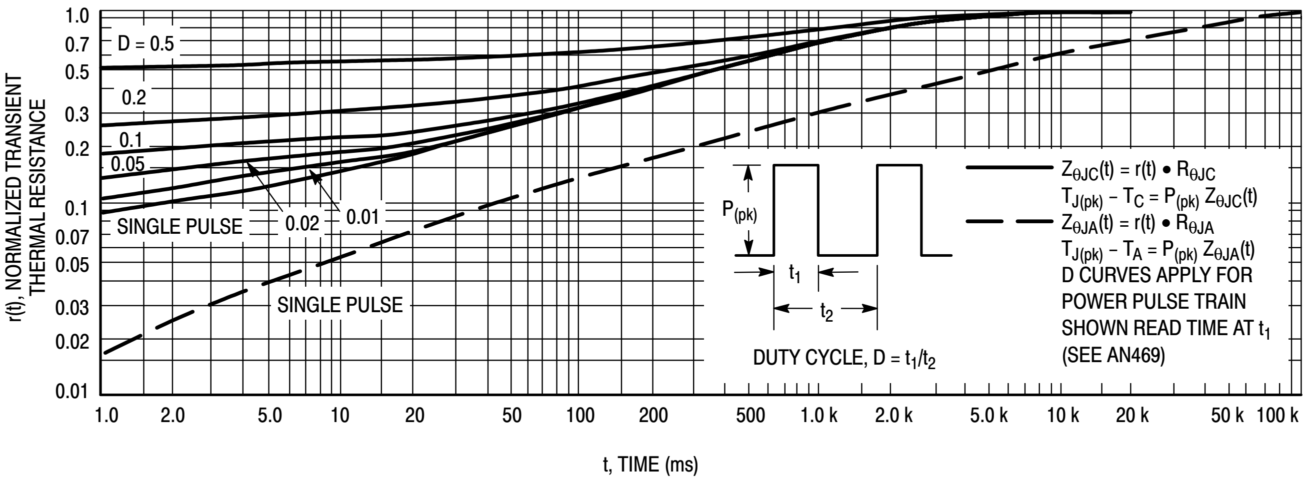
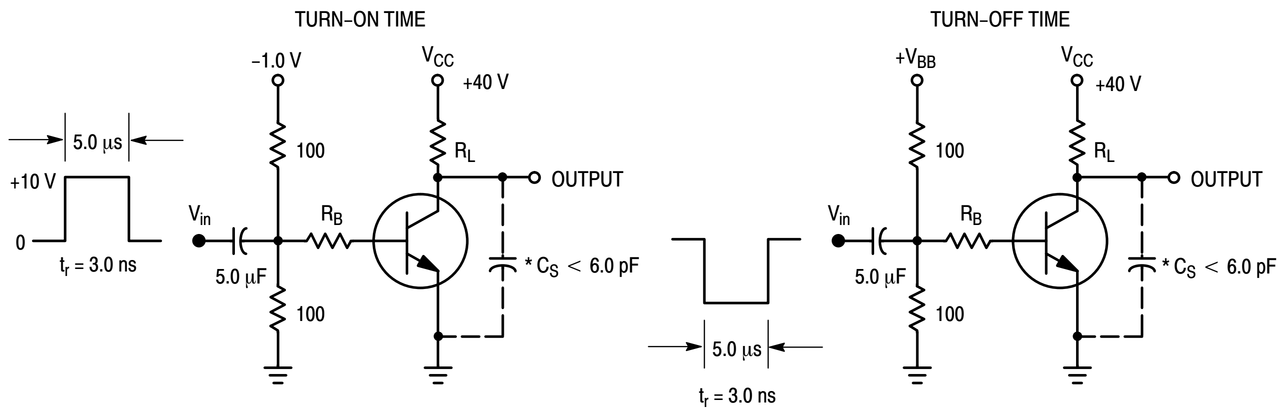


Figure 1. MPS8098, MPS8099, MPS8598 and MPS8599 Thermal Response



*Total Shunt Capacitance of Test Jig and Connectors
For PNP Test Circuits, Reverse All Voltage Polarities

Figure 2. Switching Time Test Circuits

NPN

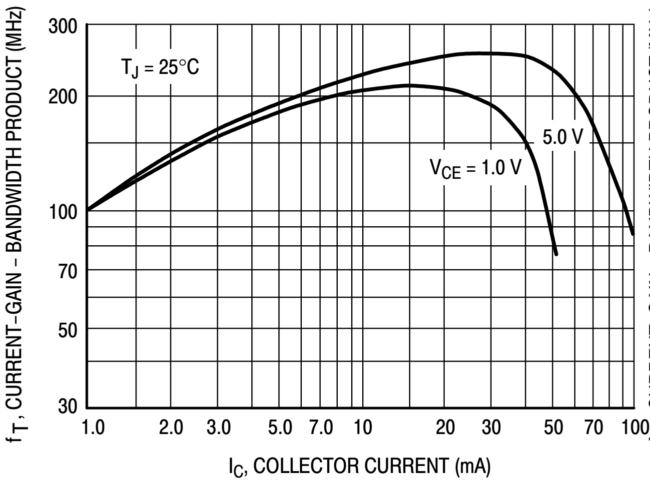


Figure 3. MPS8098/99 Current–Gain — Bandwidth Product

PNP

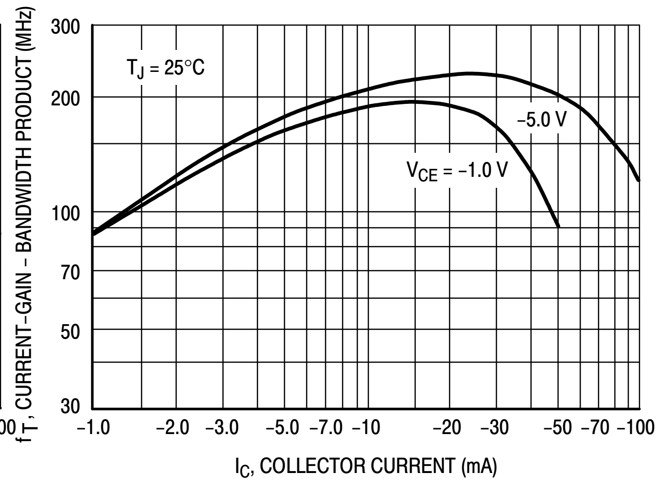


Figure 4. MPS8598/99 Current–Gain — Bandwidth Product

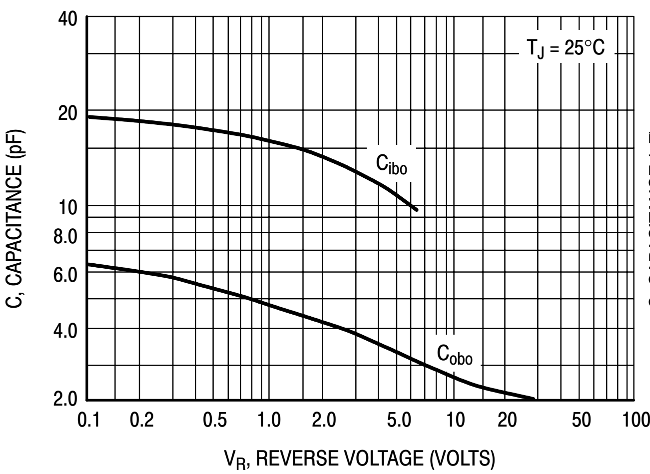


Figure 5. MPS8098/99 Capacitance

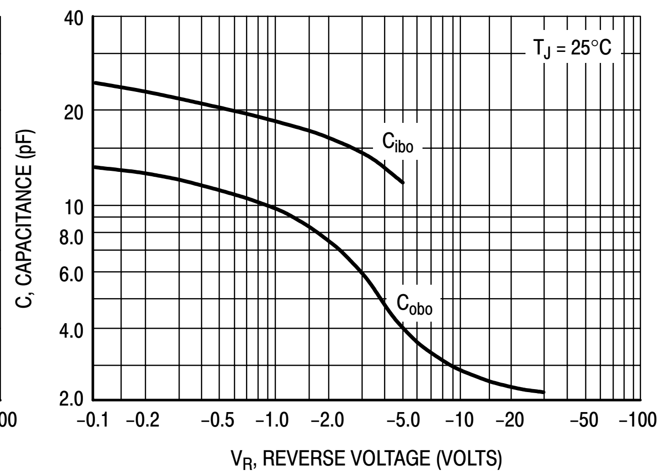


Figure 6. MPS8598/99 Capacitance

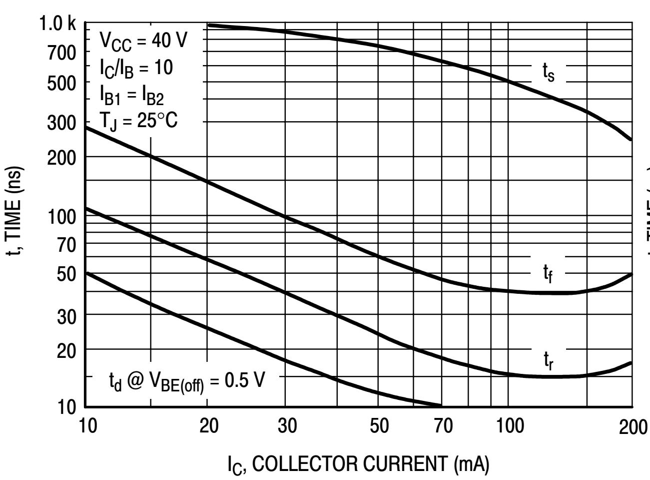


Figure 7. MPS8098/99 Switching Times

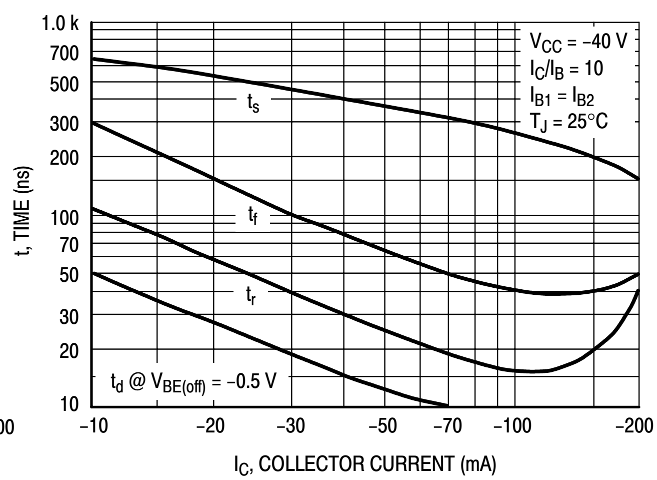


Figure 8. MPS8598/99 Switching Times

NPN

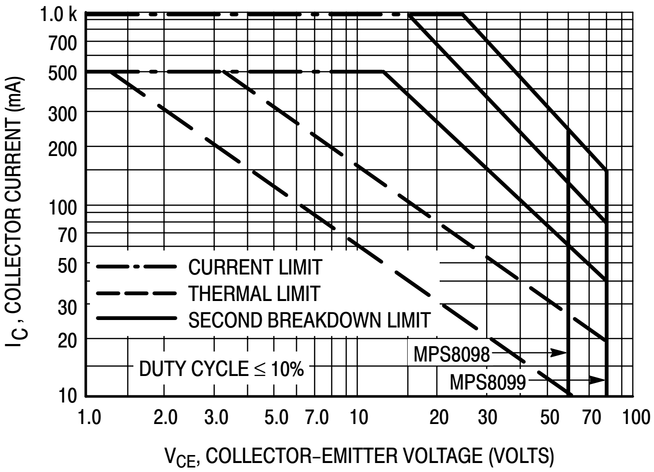


Figure 9. MPS8098/99 Active–Region Safe Operating Area

PNP

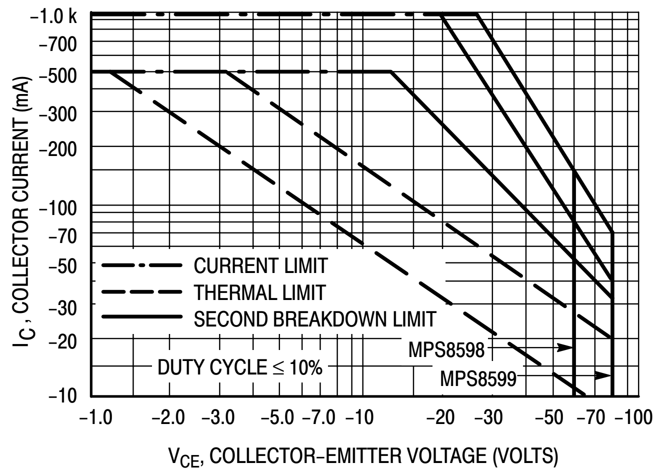


Figure 10. MPS8598/99 Active–Region Safe Operating Area

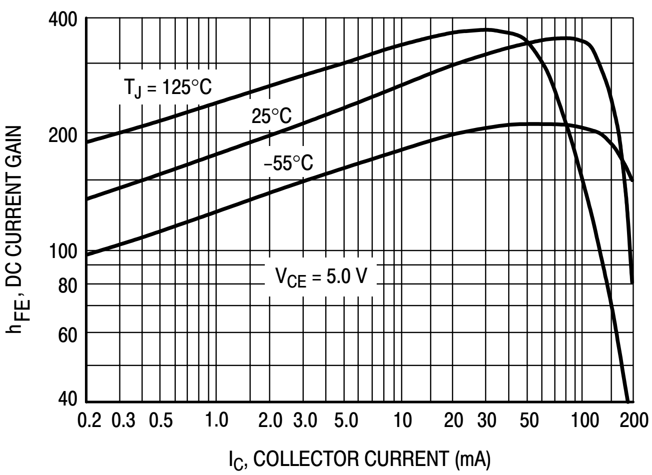


Figure 11. MPS8098/99 DC Current Gain

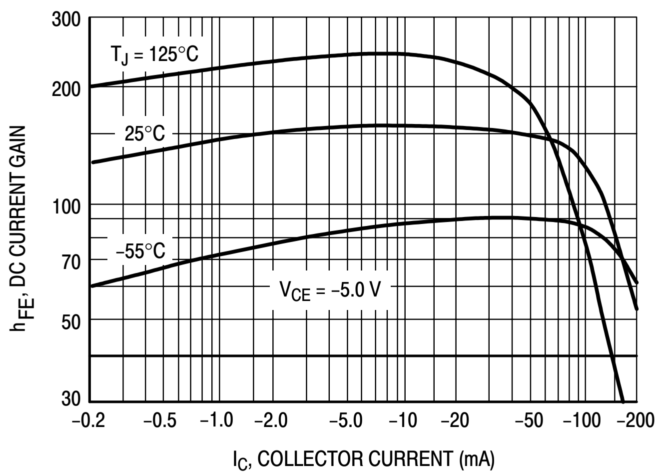


Figure 12. MPS8598/99 DC Current Gain

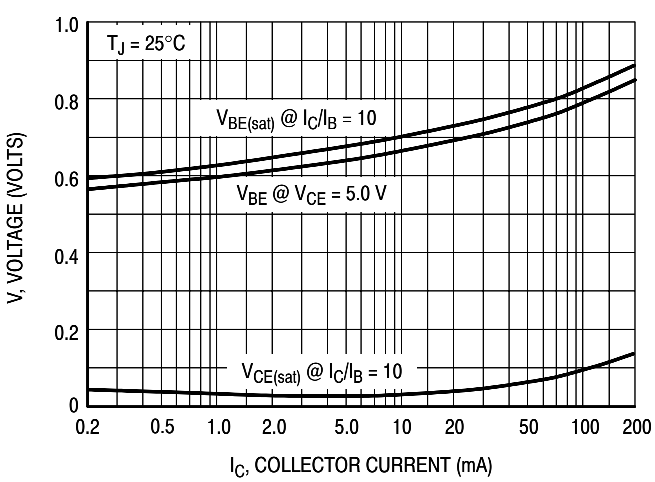


Figure 13. MPS8098/99 “ON” Voltages

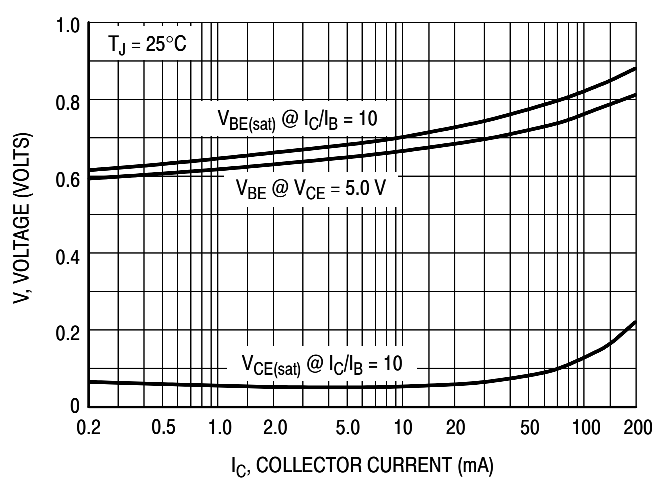


Figure 14. MPS8598/99 “ON” Voltages

NPN

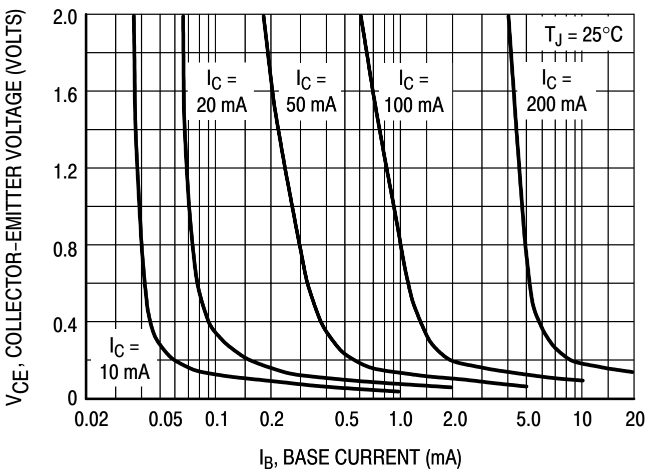


Figure 15. MPS8098/99 Collector Saturation Region

PNP

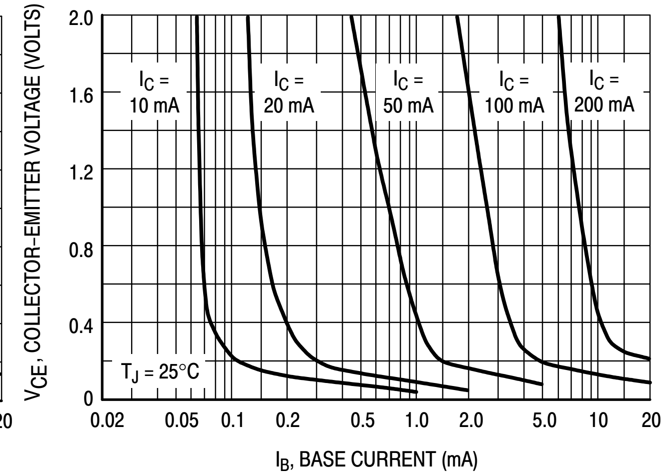


Figure 16. MPS8598/99 Collector Saturation Region

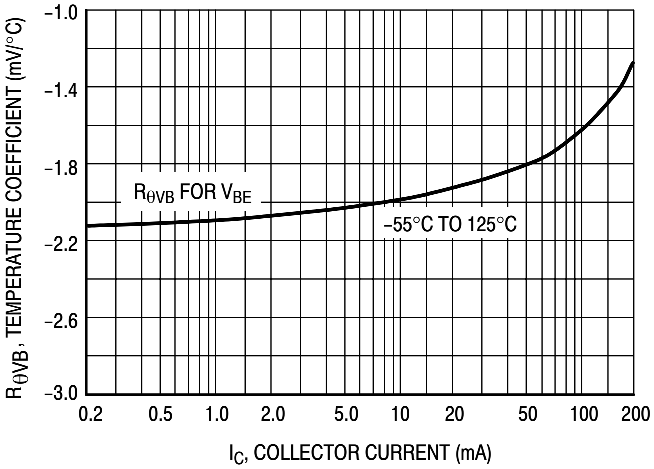


Figure 17. MPS8098/99 Base−Emitter Temperature Coefficient

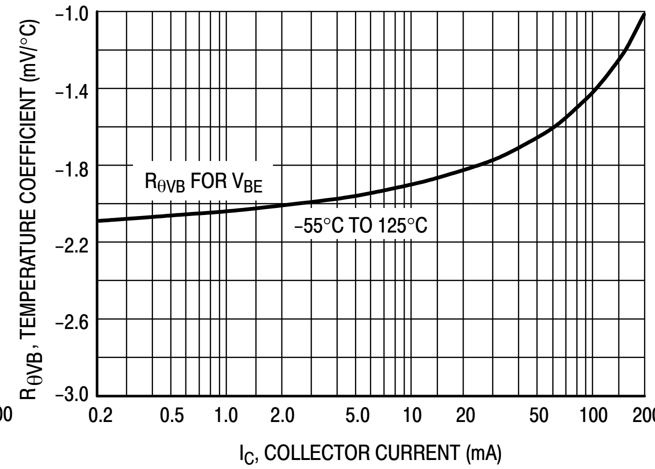
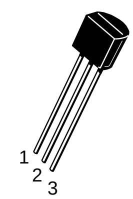


Figure 18. MPS8598/99 Base−Emitter Temperature Coefficient

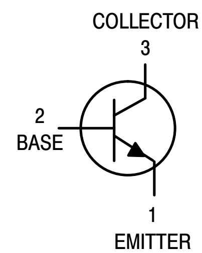
Amplifier Transistors
NPN Silicon

MPS918*
MPS3563

*ON Semiconductor Preferred Device



CASE 29–10, STYLE 1
TO–92 (TO–226AL)



MAXIMUM RATINGS

Rating	Symbol	MPS918	MPS3563	Unit
Collector–Emitter Voltage	V_{CEO}	15	12	Vdc
Collector–Base Voltage	V_{CBO}	30	30	Vdc
Emitter–Base Voltage	V_{EBO}	3.0	2.0	Vdc
Collector Current — Continuous	I_C	50		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.85 6.8		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	147	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(2) (I_C = 3.0 mAdc, I_B = 0)	 MPS918 MPS3563	$V_{(BR)CEO}$	 15 12	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = 1.0 μAdc, I_E = 0) (I_C = 100 μAdc, I_E = 0)	 MPS918 MPS3563	$V_{(BR)CBO}$	 30 30	 — —	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	 MPS918 MPS3563	$V_{(BR)EBO}$	 3.0 2.0	 — —	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	 MPS918 MPS3563	I_{CBO}	 — —	 10 50	nAdc

1. $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 1.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1
Publication Order Number:
MPS918/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
DC Current Gain[2]		h_{FE}			—
(I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	MPS918		20	—	
(I_C = 8.0 mAdc, V_{CE} = 10 Vdc)	MPS3563		20	200	
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	MPS918	$V_{CE(sat)}$	—	0.4	Vdc
Base–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	MPS918	$V_{BE(sat)}$	—	1.0	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product[2]		f_T			MHz
(I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	MPS918		600	—	
(I_C = 8.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	MPS3563		600	1500	
Output Capacitance		C_{obo}			pF
(V_{CB} = 0 Vdc, I_E = 0, f = 1.0 MHz)	MPS918		—	3.0	
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	MPS918		—	1.7	
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	MPS3563		—	1.7	
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MPS918	C_{ibo}	—	2.0	pF
Small–Signal Current Gain (I_C = 8.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS3563	h_{fe}	20	250	—
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, R_S = 400 kΩ, f = 60 MHz)	MPS918	NF	—	6.0	dB
FUNCTIONAL TEST					
Common–Emitter Amplifier Power Gain		G_{pe}			dB
(I_C = 6.0 mAdc, V_{CB} = 12 Vdc, f = 200 MHz)	MPS918		15	—	
(I_C = 8.0 mAdc, V_{CE} = 10 Vdc, f = 200 MHz) (G_{fd} + G_{re} < –20 dB)	MPS3563		14	—	
Power Output (I_C = 8.0 mAdc, V_{CB} = 15 Vdc, f = 500 MHz)	MPS918	P_{out}	30	—	mW
Oscillator Collector Efficiency (I_C = 8.0 mAdc, V_{CB} = 15 Vdc, P_{out} = 30 mW, f = 500 MHz)	MPS918	η	25	—	%

2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 1.0%.

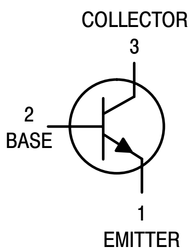
MPSA05, MPSA06, MPSA55, MPSA56

MPSA06 and MPSA56 are Preferred Devices

Amplifier Transistors

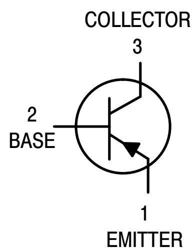
Voltage and Current are Negative for PNP Transistors

NPN



STYLE 1
MPSA05, MPSA06

PNP



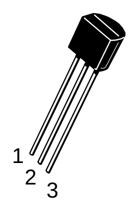
STYLE 1
MPSA55, MPSA56

ON Semiconductor™

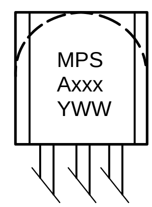
http://onsemi.com

NPN
MPSA05, MPSA06
PNP
MPSA55, MPSA56

TO–92
CASE 29
STYLE 1



MARKING DIAGRAM



MPSA = Specific Device Code
xxx = 05, 06, 55 or 56
Y = Year
WW = Work Week

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage MPSA05, MPSA55 MPSA06, MPSA56	V_{CEO}	 60 80	Vdc
Collector–Base Voltage MPSA05, MPSA55 MPSA06, MPSA56	V_{CBO}	 60 80	Vdc
Emitter–Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 625 5.0	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.5 12	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (Note 1.)	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

1. $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

ORDERING INFORMATION

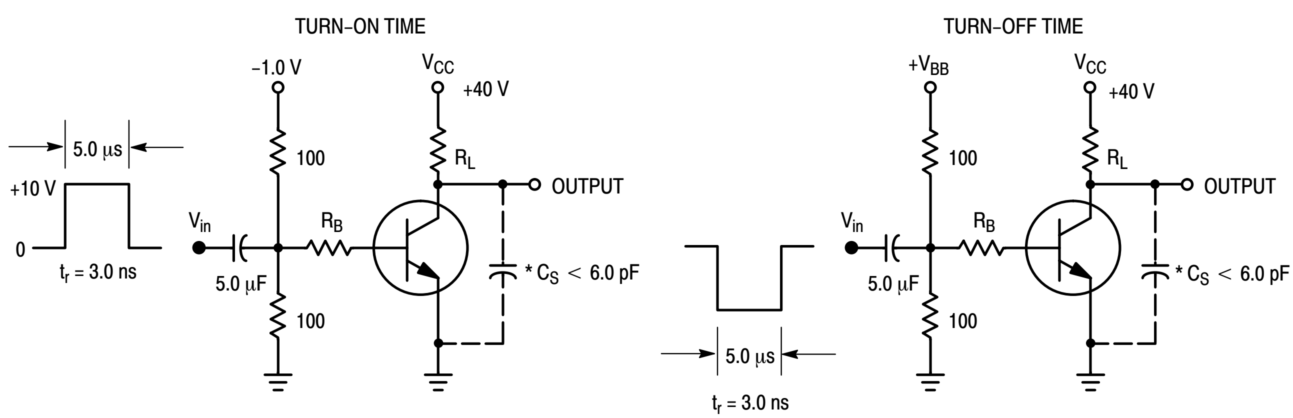
Device	Package	Shipping
MPSA05	TO–92	5000 Units/Box
MPSA05RLRA	TO–92	2000/Tape & Reel
MPSA05RLRM	TO–92	2000/Ammo Pack
MPSA06	TO–92	5000 Units/Box
MPSA06RLRA	TO–92	2000/Tape & Reel
MPSA06RLRM	TO–92	2000/Ammo Pack
MPSA06RLRP	TO–92	2000/Ammo Pack
MPSA55	TO–92	5000 Units/Box
MPSA55RLRA	TO–92	2000/Tape & Reel
MPSA56	TO–92	5000 Units/Box
MPSA56RLRA	TO–92	2000/Tape & Reel
MPSA56RLRM	TO–92	2000/Ammo Pack
MPSA56RLRP	TO–92	2000/Ammo Pack

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (Note 2.) (I_C = 1.0 mAdc, I_B = 0)	MPSA05, MPSA55 MPSA06, MPSA56	$V_{(BR)CEO}$	60 80	– –	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.0	–	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, I_B = 0)		I_{CES}	–	0.1	μAdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 80 Vdc, I_E = 0)	MPSA05, MPSA55 MPSA06, MPSA56	I_{CBO}	– –	0.1 0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		h_{FE}	100 100	– –	–
Collector–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	–	0.25	Vdc
Base–Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		$V_{BE(on)}$	–	1.2	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (Note 3.) (I_C = 10 mA, V_{CE} = 2.0 V, f = 100 MHz) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc, f = 100 MHz)	MPSA05 MPSA06 MPSA55 MPSA56	f_T	100 50	– –	MHz

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.
3. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.



*Total Shunt Capacitance of Test Jig and Connectors
For PNP Test Circuits, Reverse All Voltage Polarities

Figure 1. Switching Time Test Circuits

NPN | **PNP**

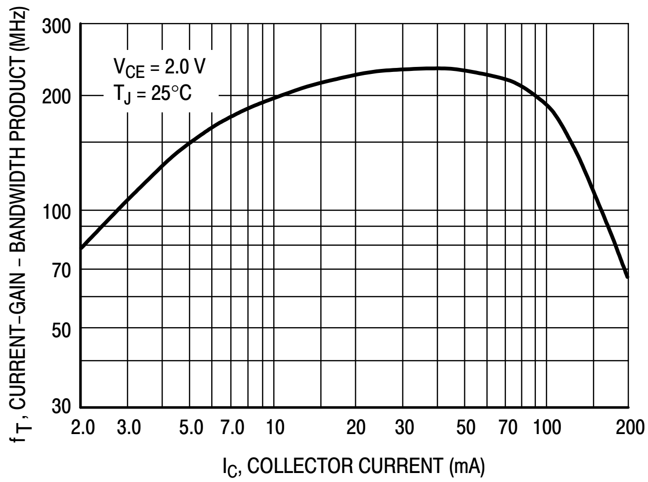


Figure 2. MPSA05/06 Current–Gain — Bandwidth Product

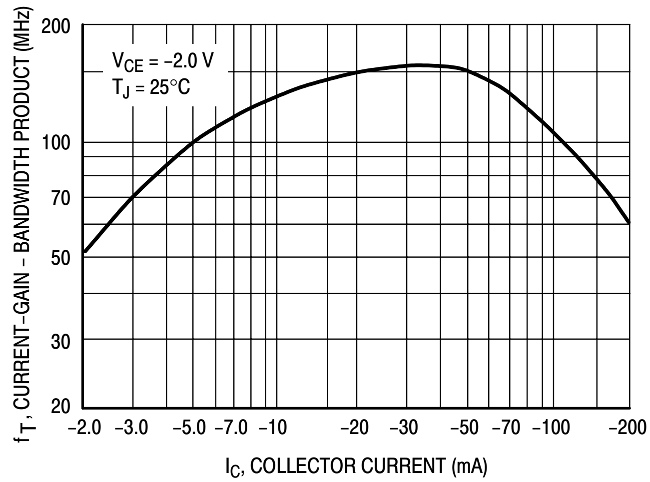


Figure 3. MPSA55/56 Current–Gain — Bandwidth Product

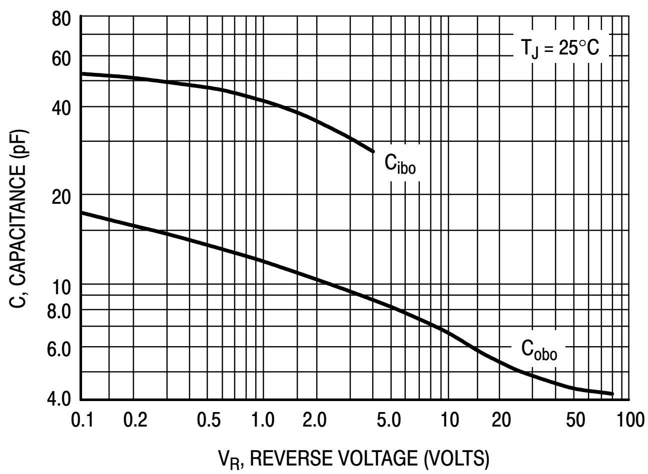


Figure 4. MPSA05/06 Capacitance

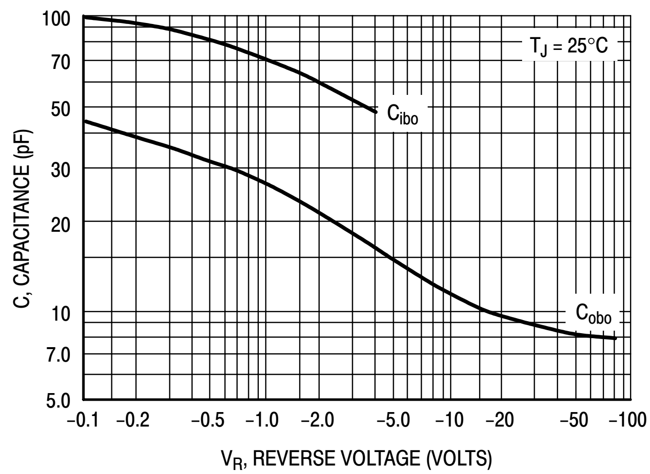


Figure 5. MPSA55/56 Capacitance

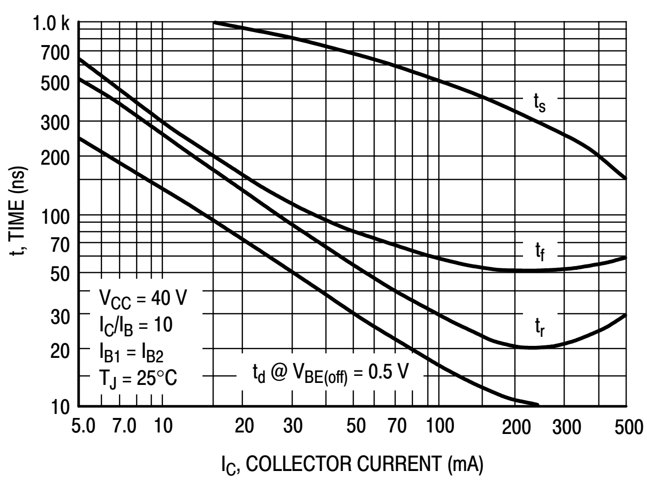


Figure 6. MPSA05/06 Switching Time

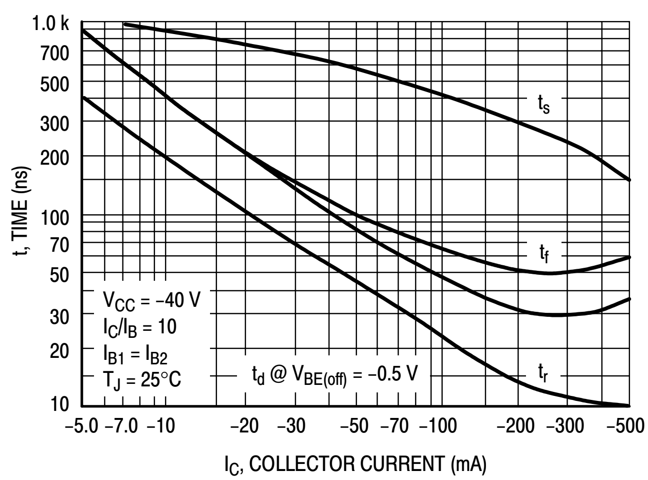


Figure 7. MPSA55/56 Switching Time

NPN

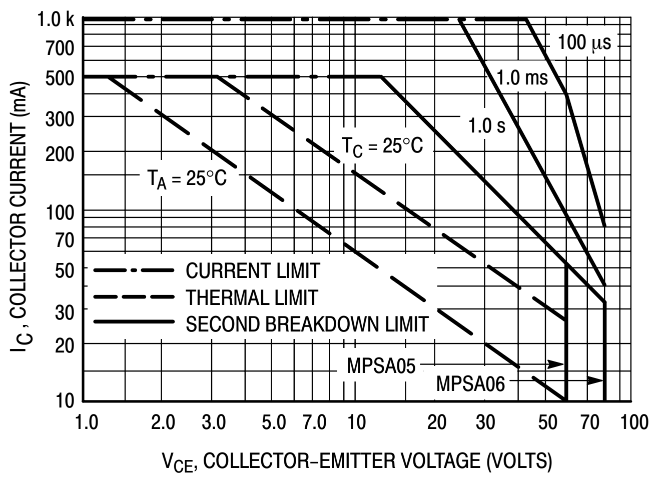


Figure 8. MPSA05/06 Active–Region Safe Operating Area

PNP

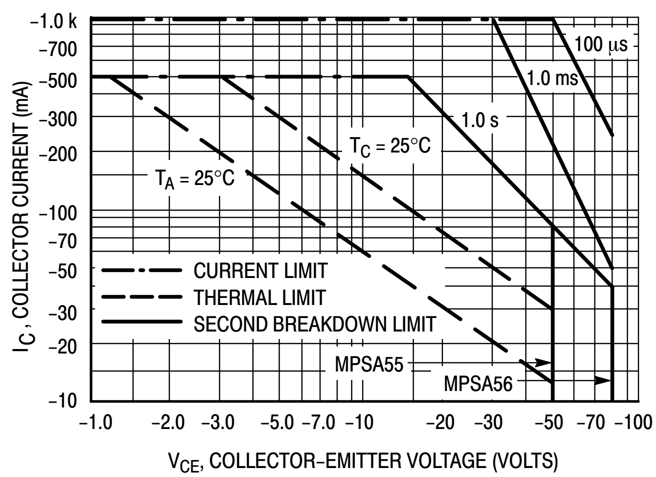


Figure 9. MPSA55/56 Active–Region Safe Operating Area

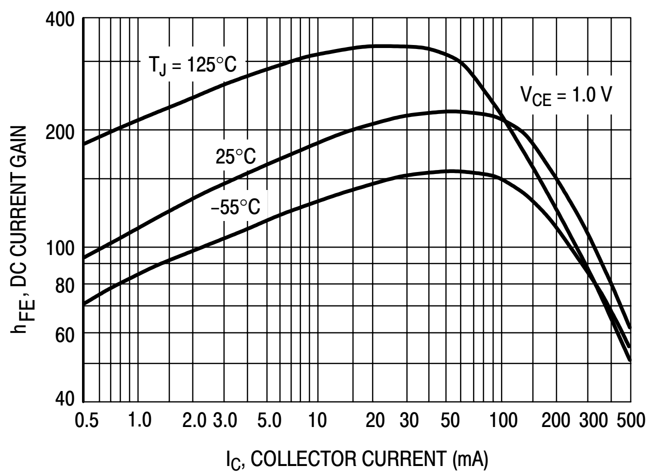


Figure 10. MPSA05/06 DC Current Gain

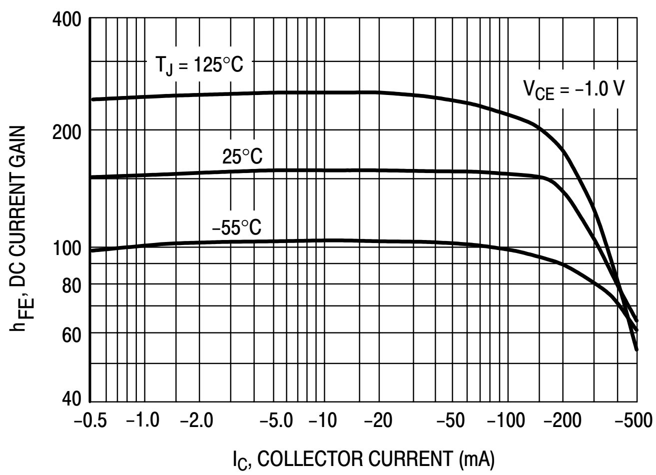


Figure 11. MPSA55/56 DC Current Gain

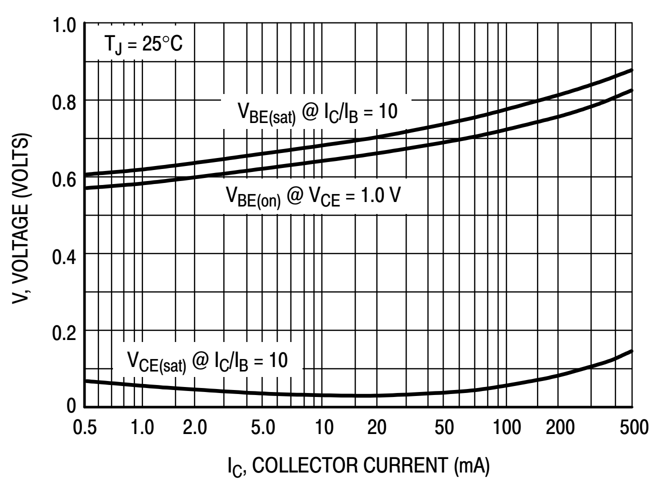


Figure 12. MPSA05/06 "ON" Voltages

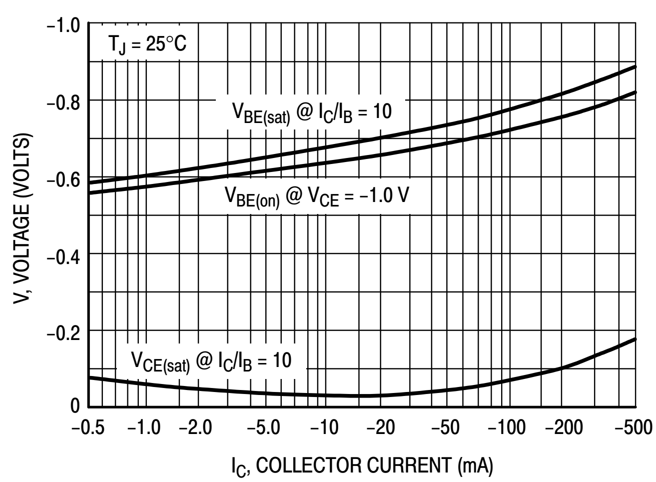


Figure 13. MPSA55/56 "ON" Voltages

NPN

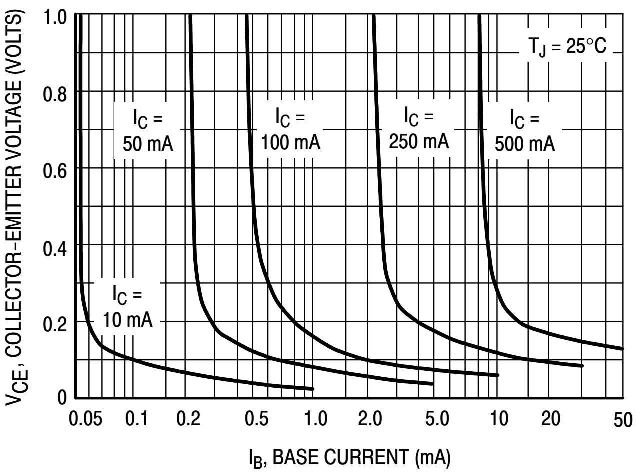


Figure 14. MPSA05/06 Collector Saturation Region

PNP

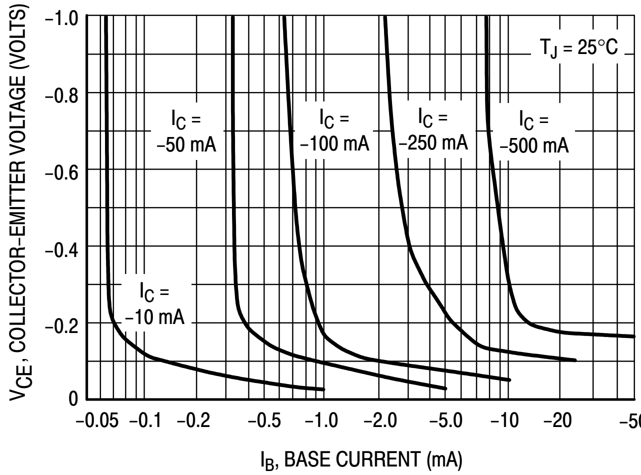


Figure 15. MPSA55/56 Collector Saturation Region

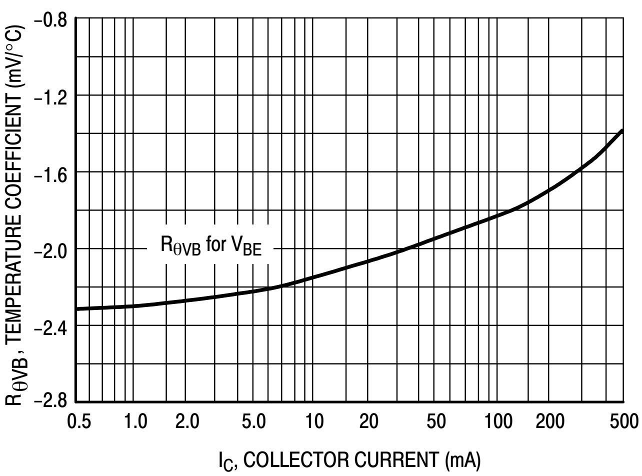


Figure 16. MPSA05/06 Base–Emitter Temperature Coefficient

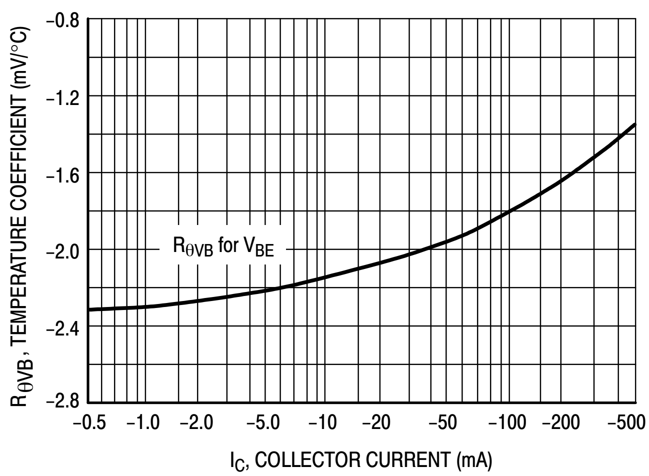


Figure 17. MPSA55/56 Base–Emitter Temperature Coefficient

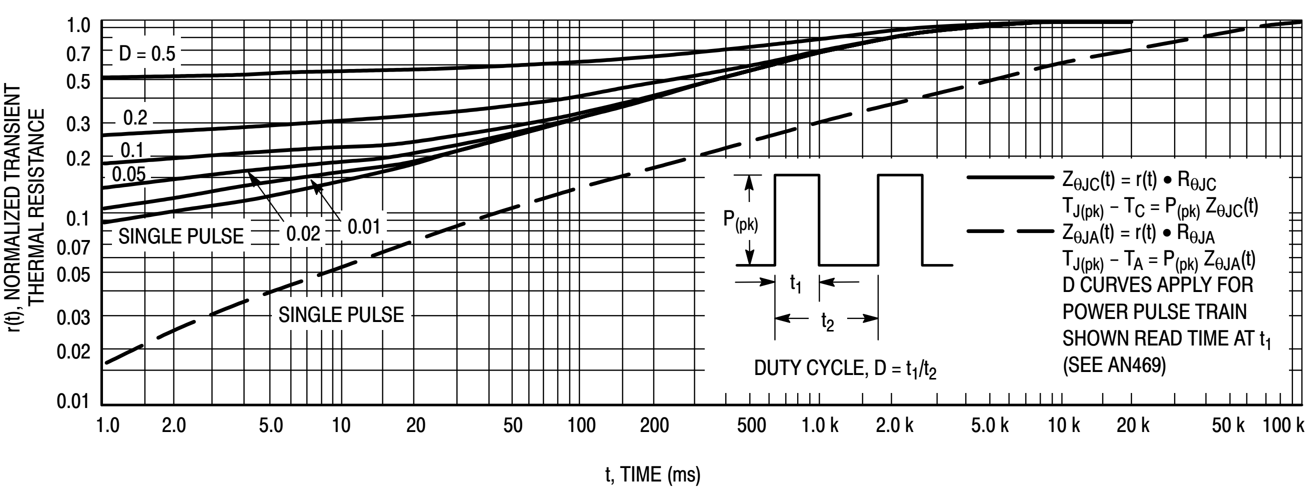
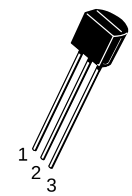


Figure 18. MPSA05, MPSA06, MPSA55 and MPSA56 Thermal Response

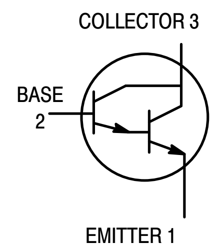
Darlington Transistors
NPN Silicon

MPSA13
MPSA14*

***ON Semiconductor Preferred Device**



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CES}	30	Vdc
Collector–Base Voltage	V_{CBO}	30	Vdc
Emitter–Base Voltage	V_{EBO}	10	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 100 μAdc, I_B = 0)	$V_{(BR)CES}$	30	—	Vdc
Collector Cutoff Current (V_{CB}= 30 Vdc, I_E = 0)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{EB}= 10 Vdc, I_C = 0)	I_{EBO}	—	100	nAdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain		h_{FE}			—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MPSA13		5,000	—	
	MPSA14		10,000	—	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	MPSA13		10,000	—	
	MPSA14		20,000	—	
Collector–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 0.1 mAdc)		$V_{CE(sat)}$	—	1.5	Vdc
Base–Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	—	2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product[2] (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	125	—	MHz

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.
2. $f_T = |h_{fe}| \cdot f_{test}$.

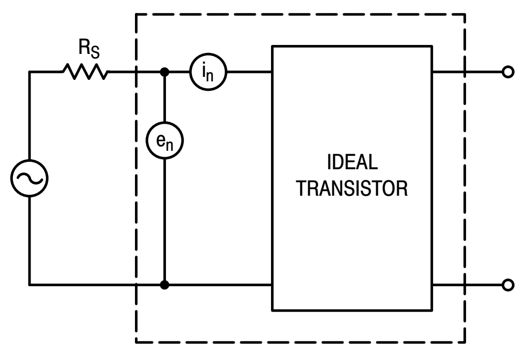


Figure 1. Transistor Noise Model

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

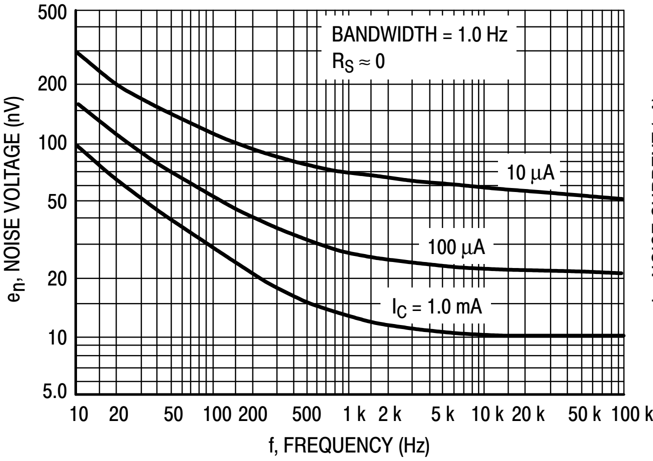


Figure 2. Noise Voltage

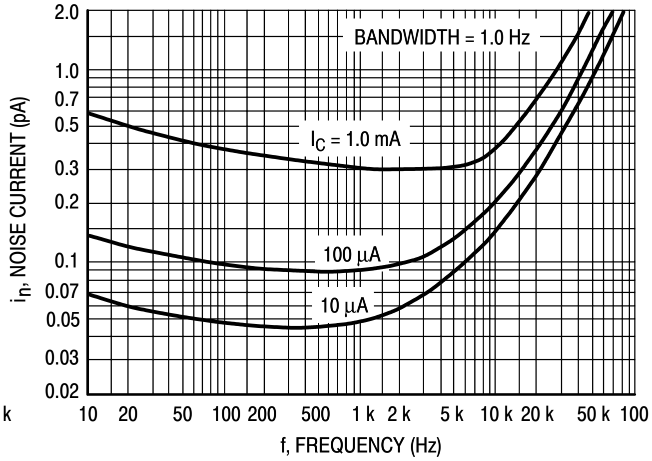


Figure 3. Noise Current

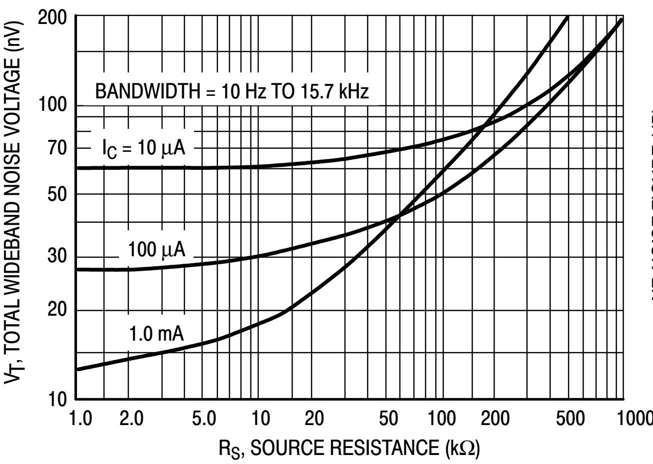


Figure 4. Total Wideband Noise Voltage

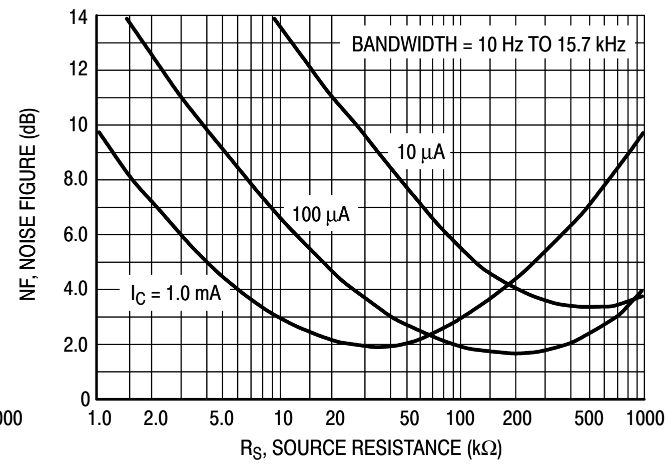


Figure 5. Wideband Noise Figure

SMALL–SIGNAL CHARACTERISTICS

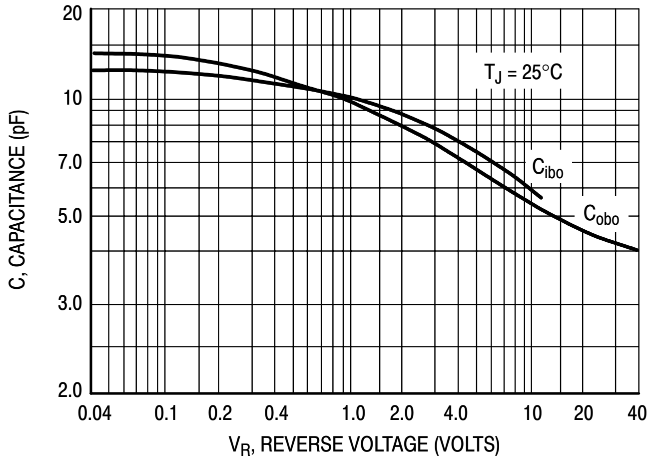


Figure 6. Capacitance

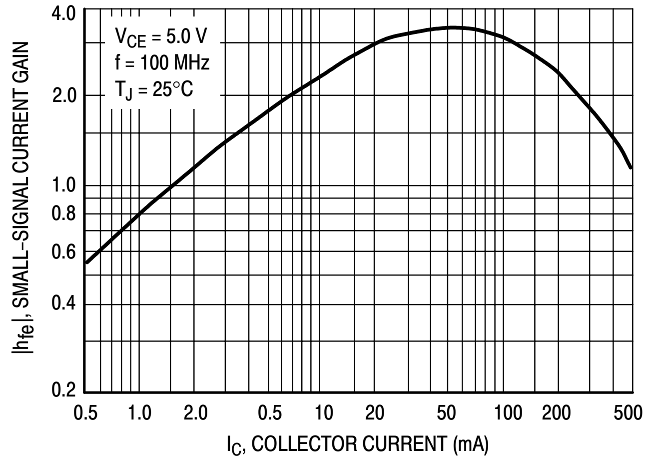


Figure 7. High Frequency Current Gain

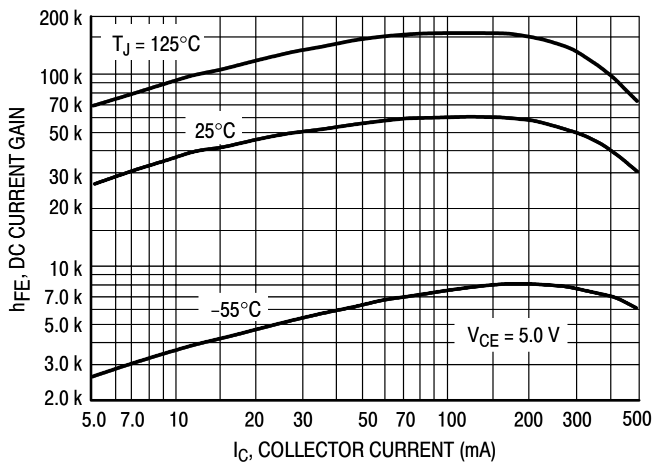


Figure 8. DC Current Gain

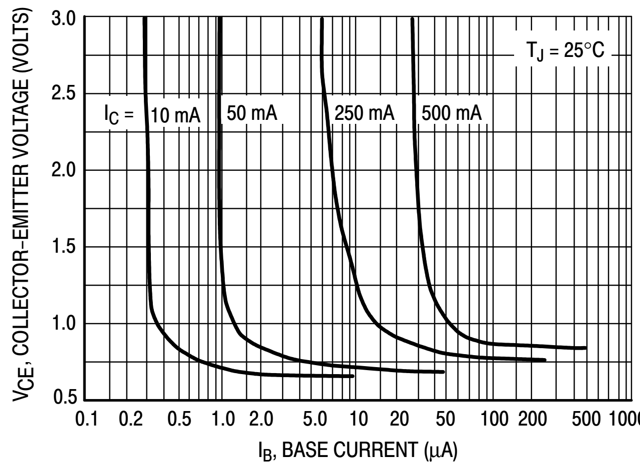


Figure 9. Collector Saturation Region

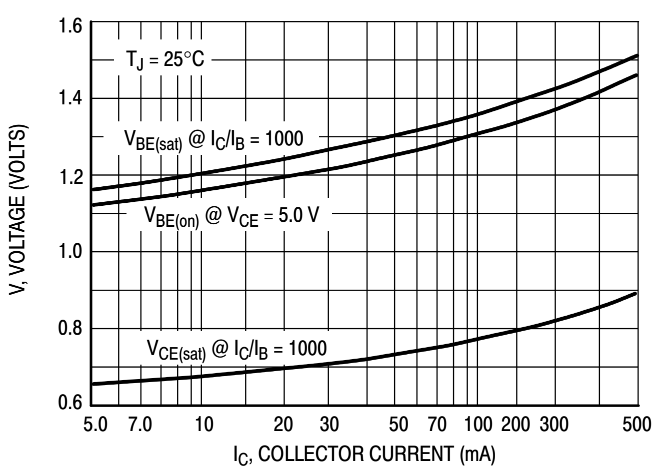


Figure 10. “On” Voltages

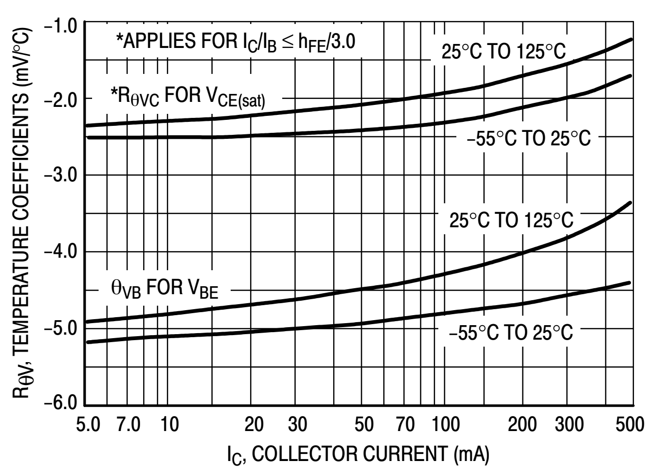


Figure 11. Temperature Coefficients

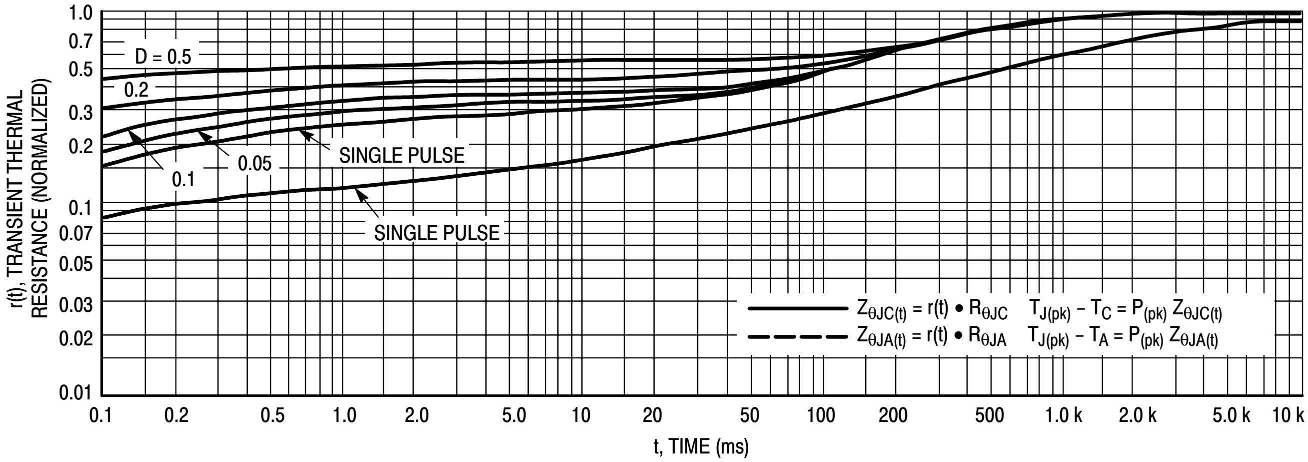


Figure 12. Thermal Response

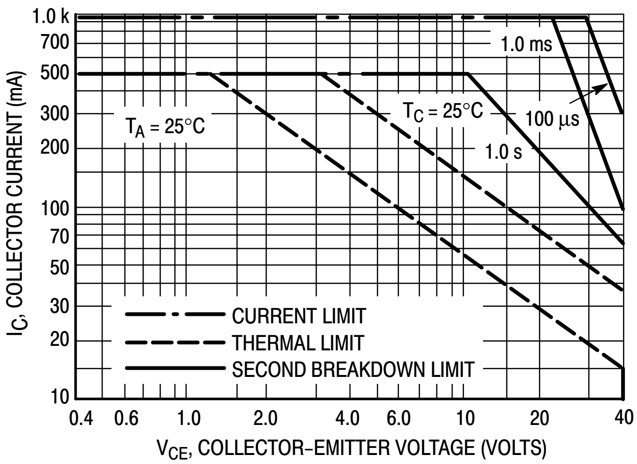
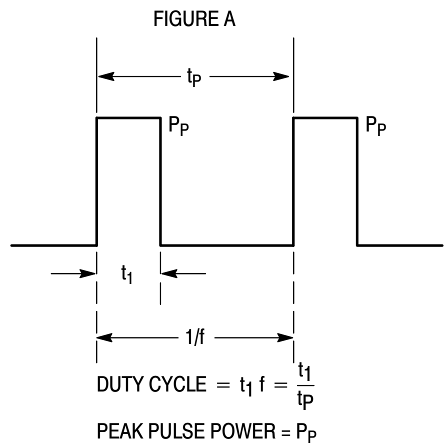


Figure 13. Active Region Safe Operating Area

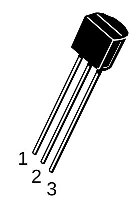


Design Note: Use of Transient Thermal Resistance Data

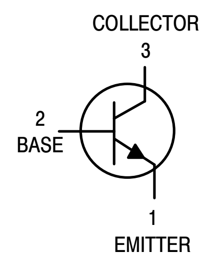
Low Noise Transistor
NPN Silicon

MPSA18

ON Semiconductor Preferred Device



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	45	Vdc
Collector–Base Voltage	V_{CBO}	45	Vdc
Emitter–Base Voltage	V_{EBO}	6.5	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	45	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	1.0	50	nAdc

1. $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1
Publication Order Number:
MPSA18/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS(2)					
DC Current Gain	h_{FE}				—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)		400	580	—	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)		500	850	—	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)		500	1100	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)		500	1150	1500	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 0.5 mAdc)		—	—	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	0.08	0.3	
Base–Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	0.6	0.7	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	100	160	—	MHz
Collector–Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	1.7	3.0	pF
Emitter–Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{eb}	—	5.6	6.5	pF
Noise Figure	NF				dB
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 1.0 kHz)		—	0.5	1.5	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ, f = 100 Hz)		—	4.0	—	
Equivalent Short Circuit Noise Voltage (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ, f = 100 Hz)	V_T	—	6.5	—	$nV/\sqrt{Hz}$

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

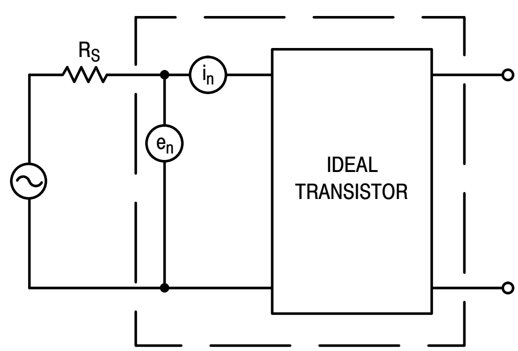


Figure 1. Transistor Noise Model

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

NOISE VOLTAGE

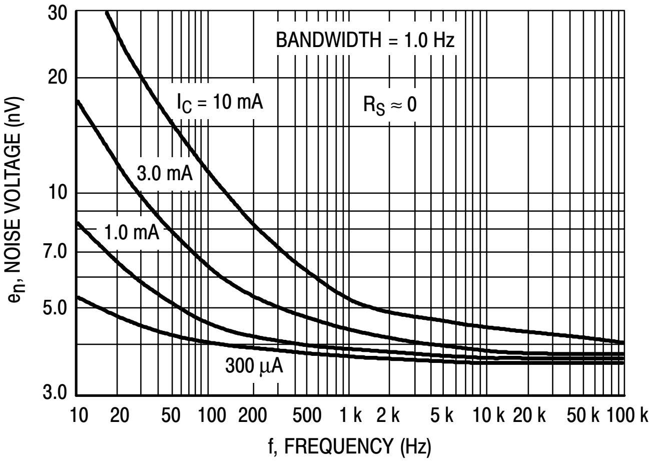


Figure 2. Effects of Frequency

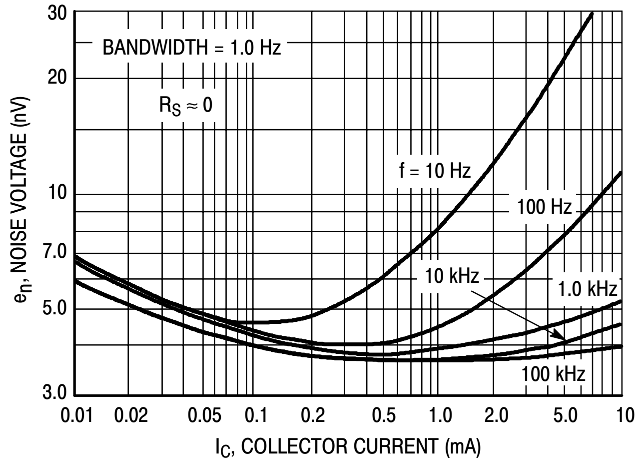


Figure 3. Effects of Collector Current

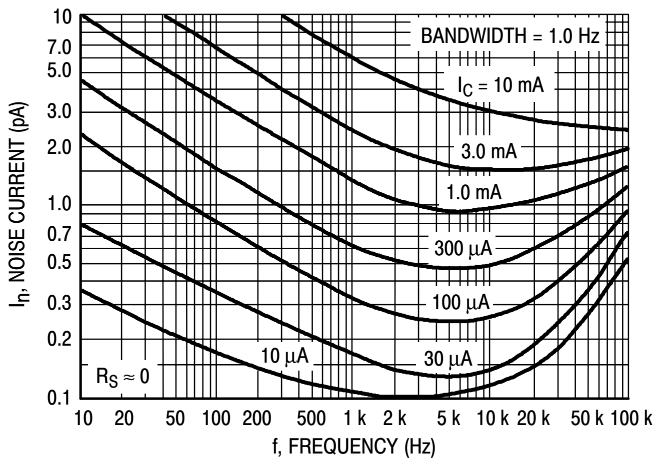


Figure 4. Noise Current

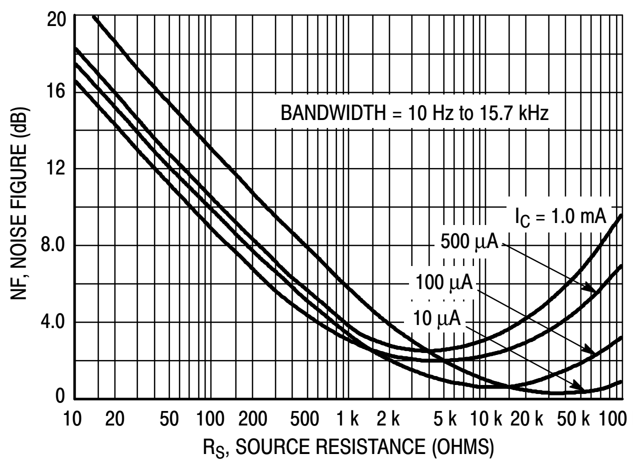


Figure 5. Wideband Noise Figure

100 Hz NOISE DATA

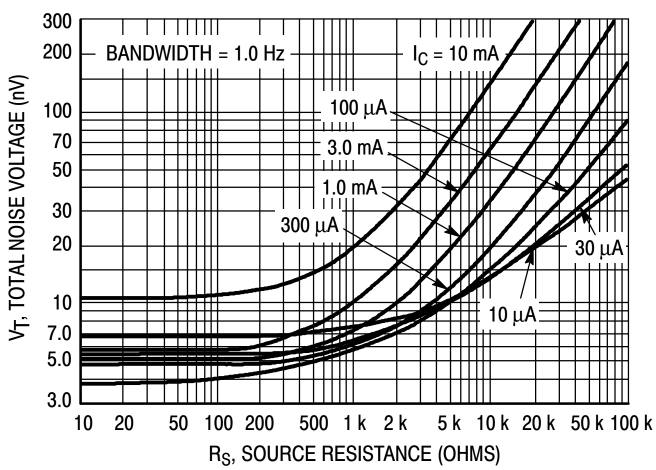


Figure 6. Total Noise Voltage

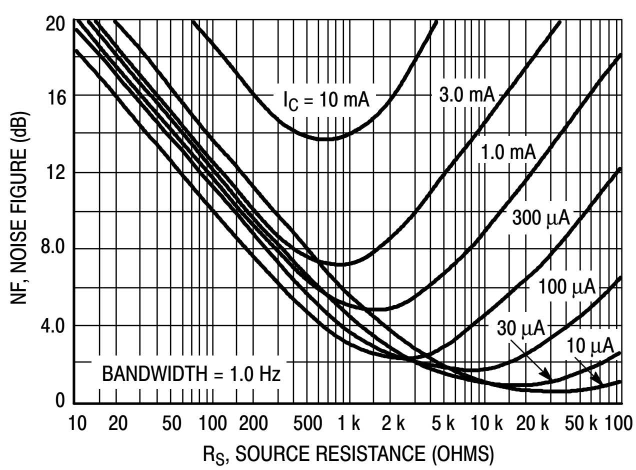


Figure 7. Noise Figure

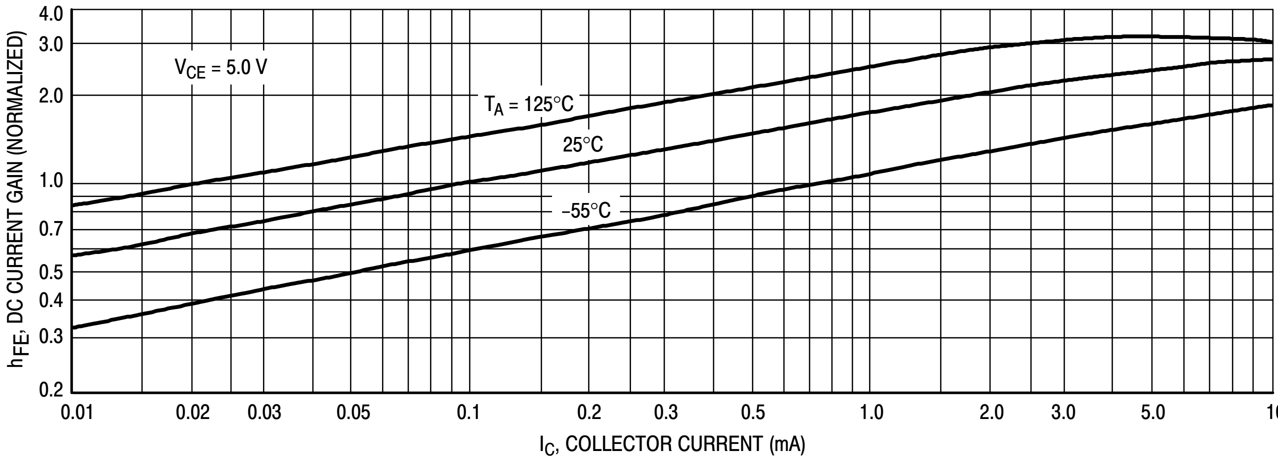


Figure 8. DC Current Gain

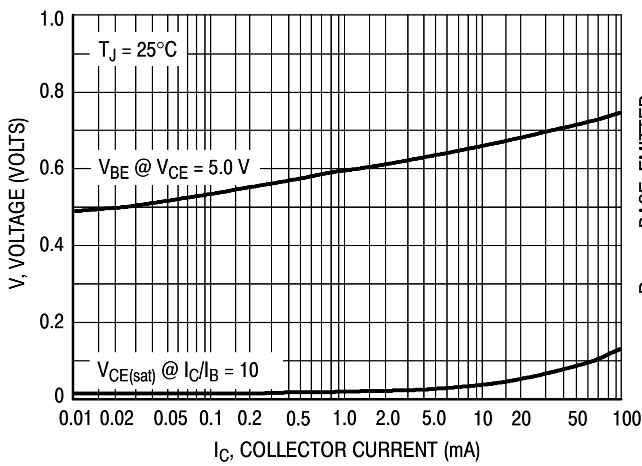


Figure 9. "On" Voltages

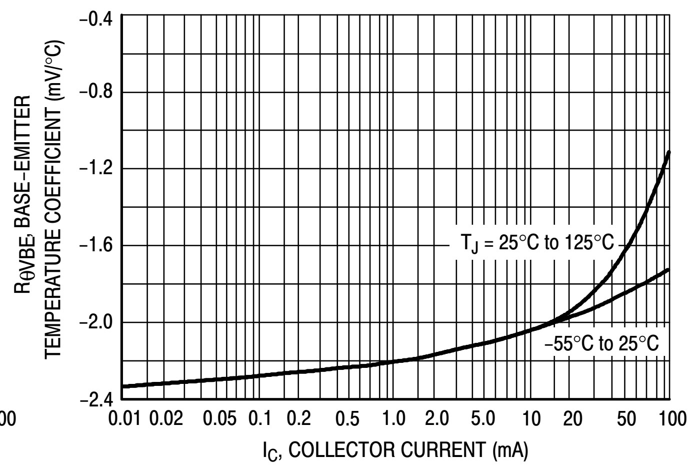


Figure 10. Temperature Coefficients

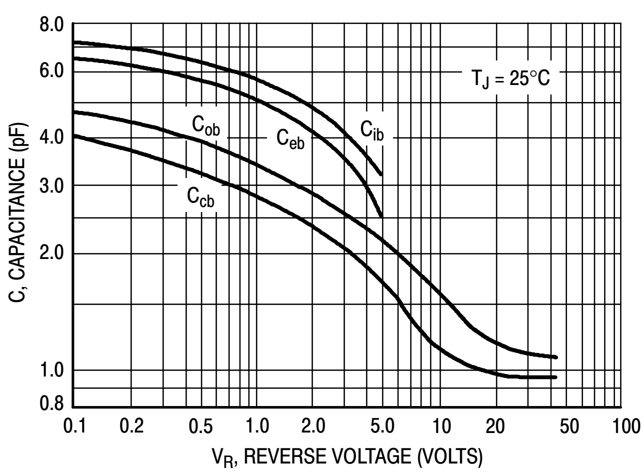


Figure 11. Capacitance

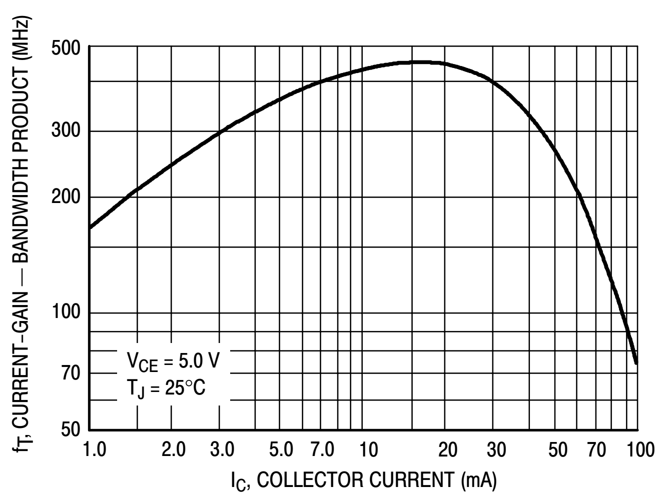
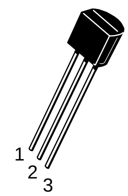


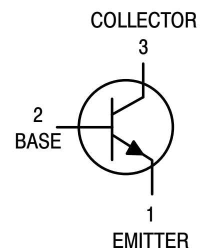
Figure 12. Current−Gain — Bandwidth Product

Amplifier Transistor
NPN Silicon

MPSA20



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	4.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(2) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	100	nAdc

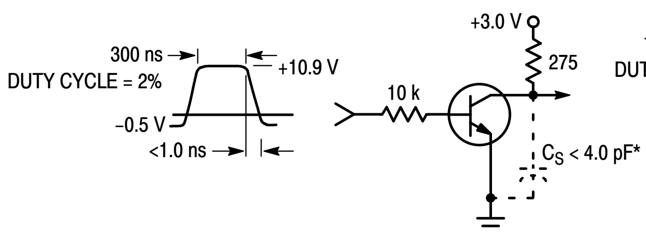
1. $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

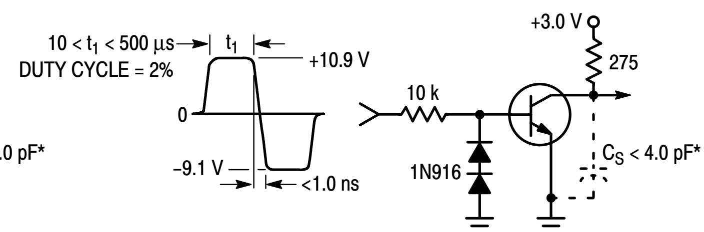
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain(2) (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40	400	—
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.25	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product(2) (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	125	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	4.0	pF

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

EQUIVALENT SWITCHING TIME TEST CIRCUITS





*Total shunt capacitance of test jig and connectors

Figure 1. Turn–On Time

Figure 2. Turn–Off Time

TYPICAL NOISE CHARACTERISTICS
(V_{CE} = 5.0 Vdc, T_A = 25°C)

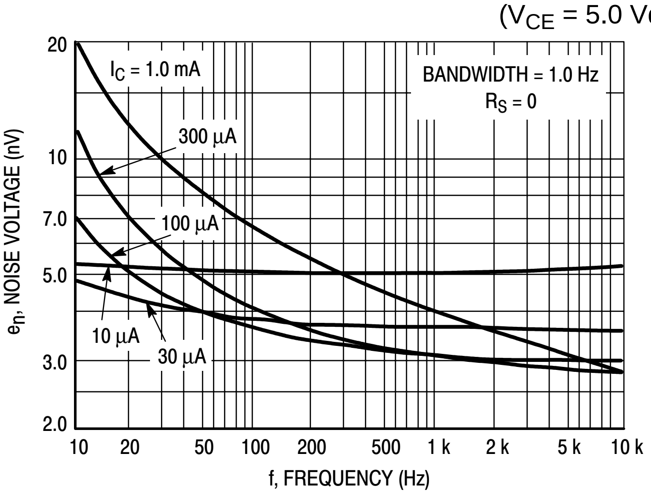


Figure 3. Noise Voltage

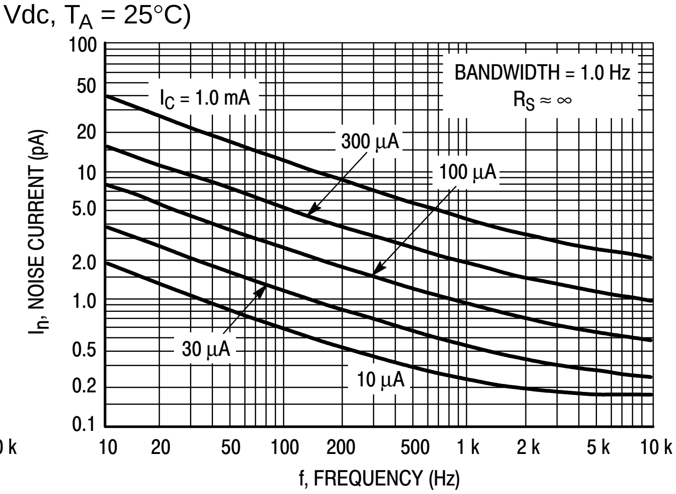


Figure 4. Noise Current

NOISE FIGURE CONTOURS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

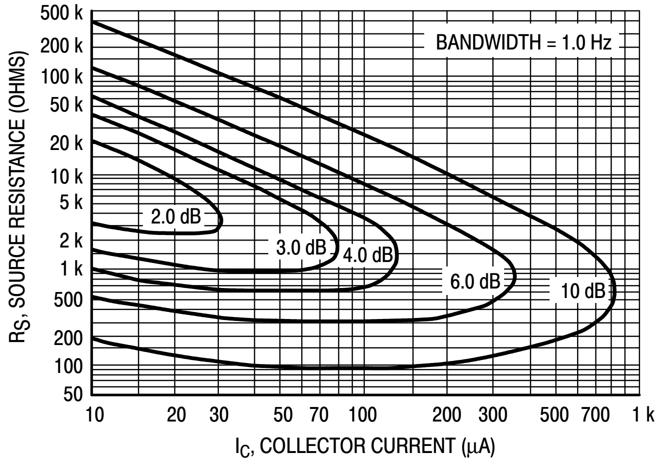


Figure 5. Narrow Band, 100 Hz

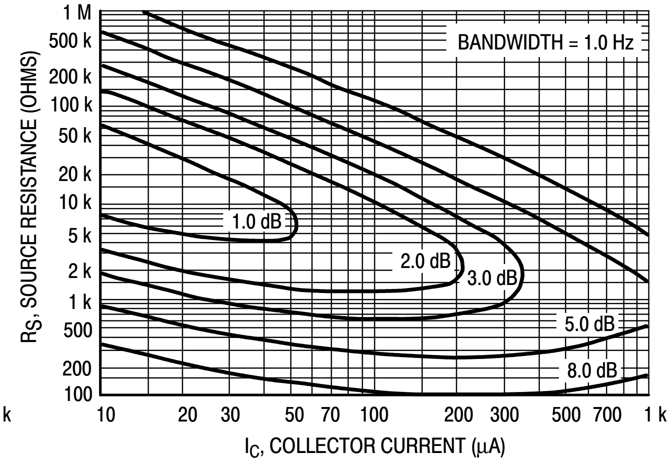


Figure 6. Narrow Band, 1.0 kHz

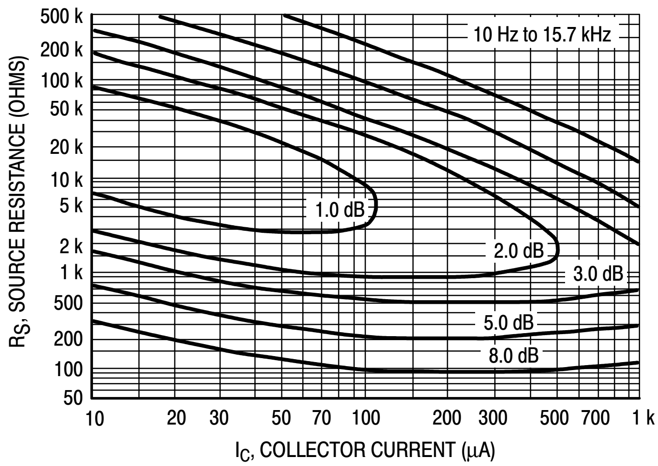


Figure 7. Wideband

Noise Figure is defined as:

$$NF = 20 \log_{10}\left(\frac{e_n^2 + 4KTR_S + I_n^2 R_S^2}{4KTR_S}\right)^{1/2}$$

e_n = Noise Voltage of the Transistor referred to the input. (Figure 3)
I_n = Noise Current of the Transistor referred to the input. (Figure 4)
K = Boltzman's Constant (1.38×10^{-23} j/°K)
T = Temperature of the Source Resistance (°K)
R_S = Source Resistance (Ohms)

TYPICAL STATIC CHARACTERISTICS

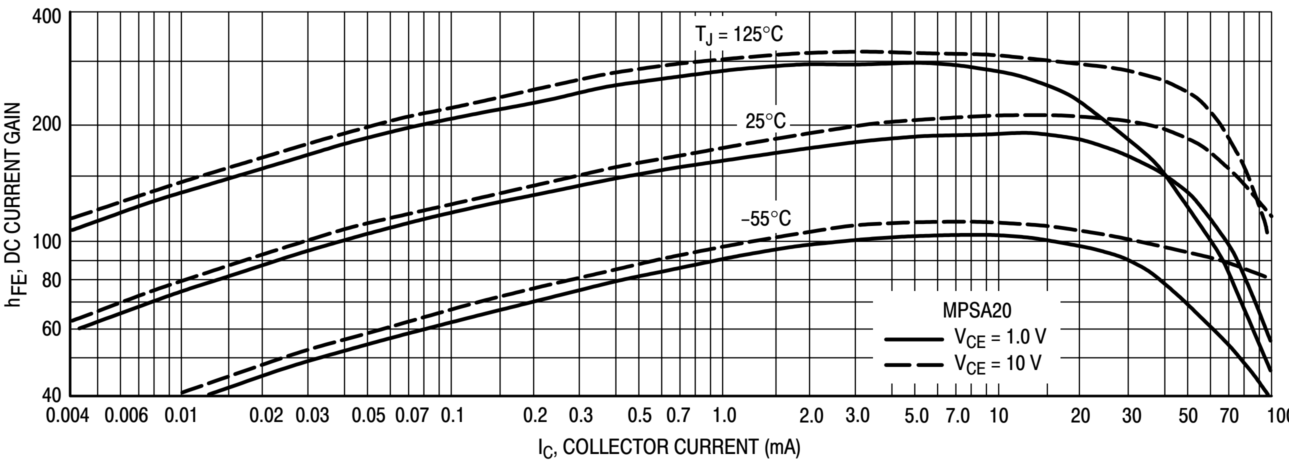


Figure 8. DC Current Gain

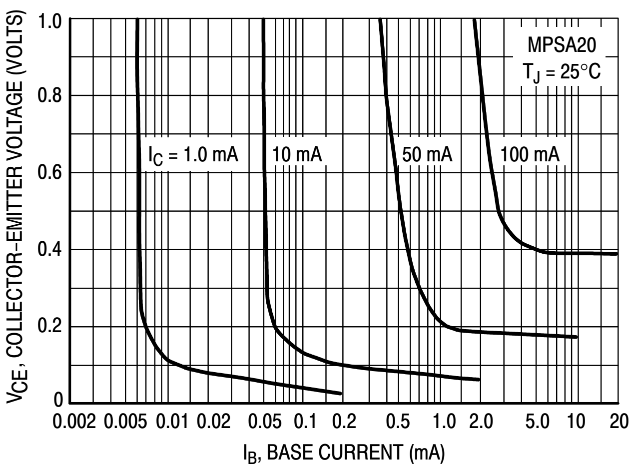


Figure 9. Collector Saturation Region

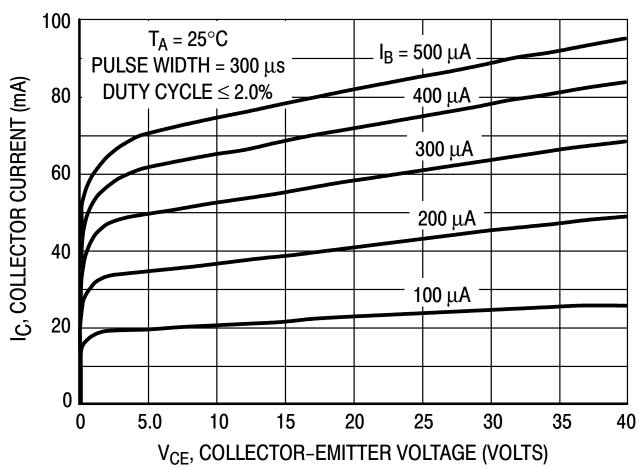


Figure 10. Collector Characteristics

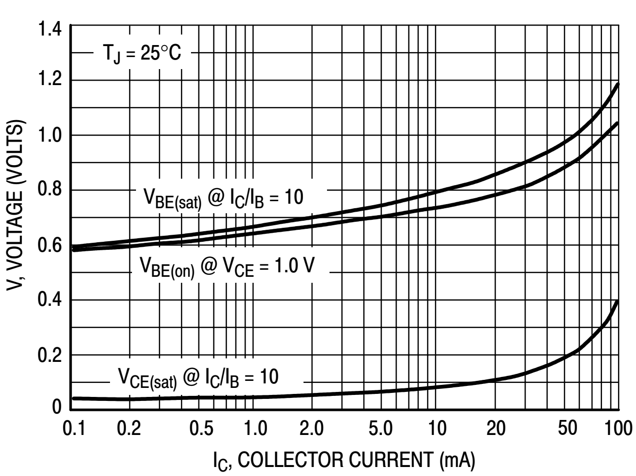


Figure 11. “On” Voltages

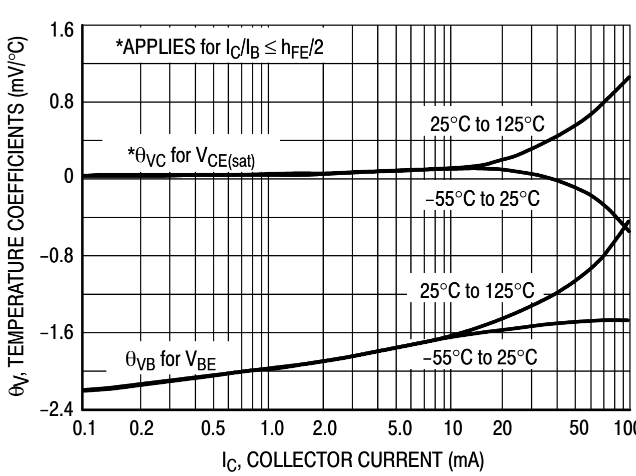


Figure 12. Temperature Coefficients

TYPICAL DYNAMIC CHARACTERISTICS

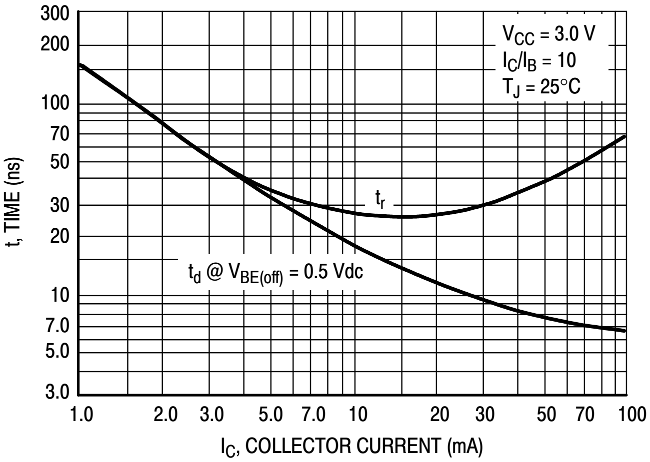


Figure 13. Turn–On Time

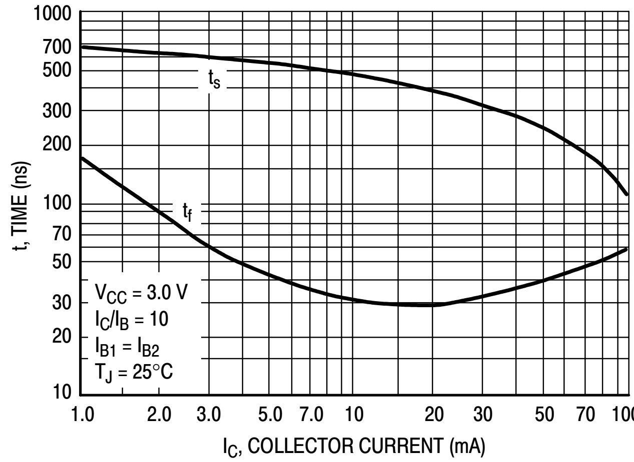


Figure 14. Turn–Off Time

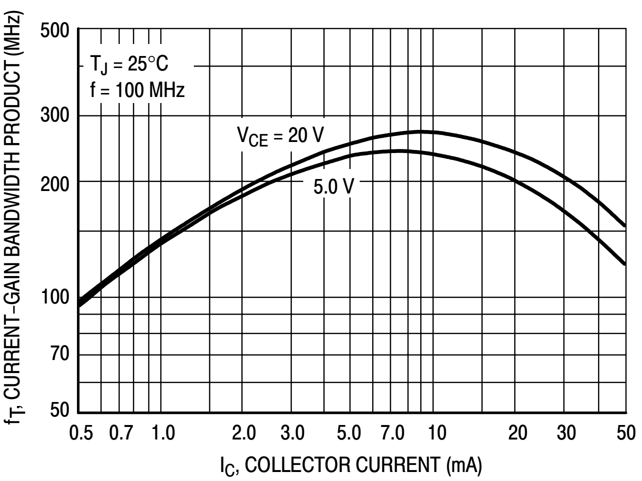


Figure 15. Current–Gain — Bandwidth Product

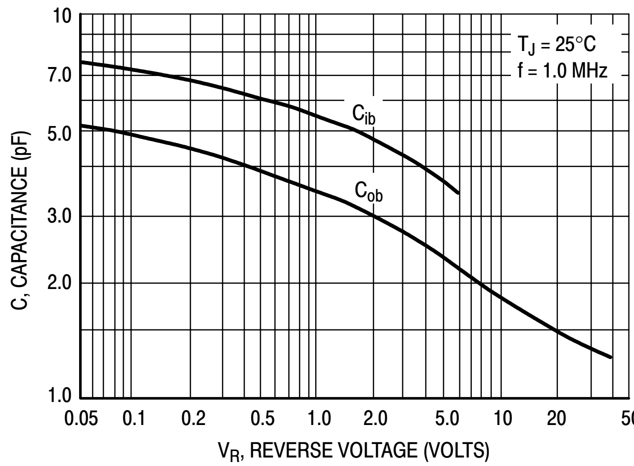


Figure 16. Capacitance

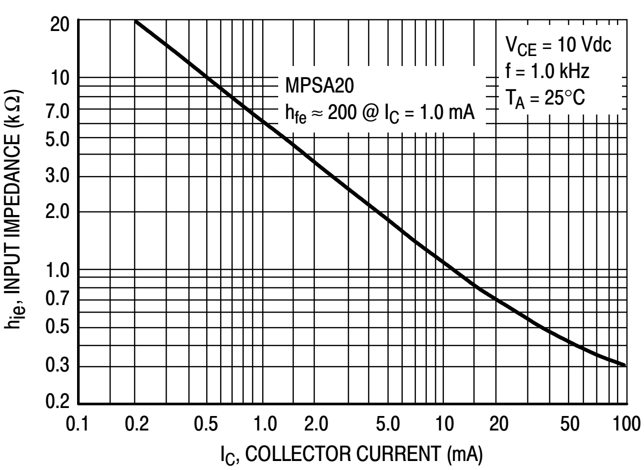


Figure 17. Input Impedance

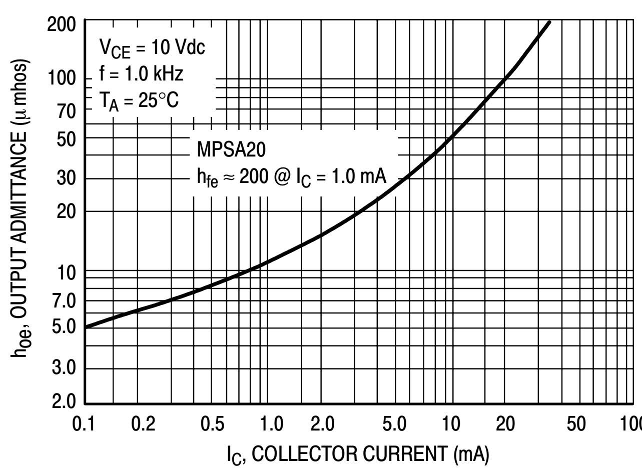


Figure 18. Output Admittance

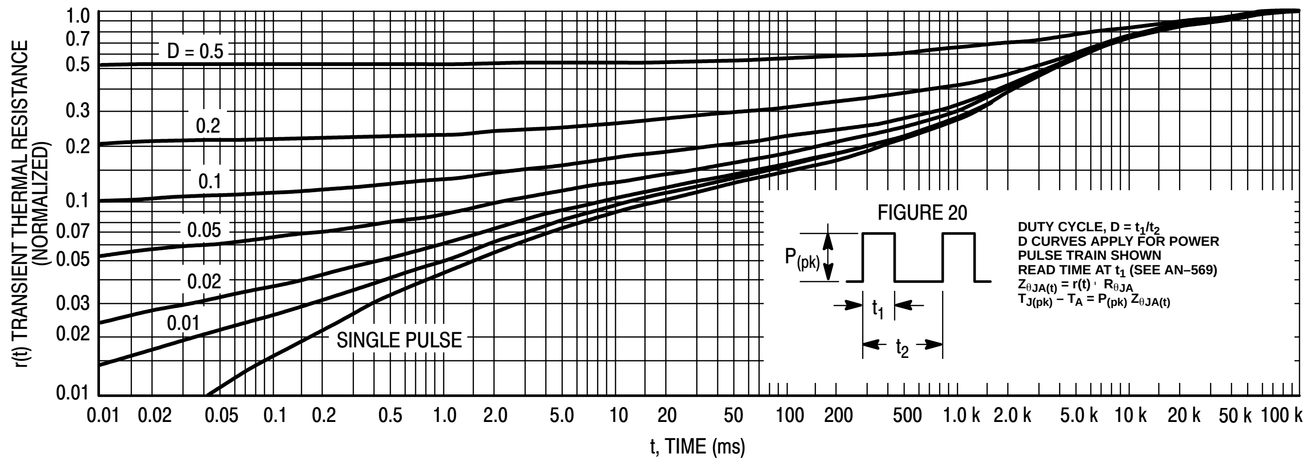


Figure 19. Thermal Response

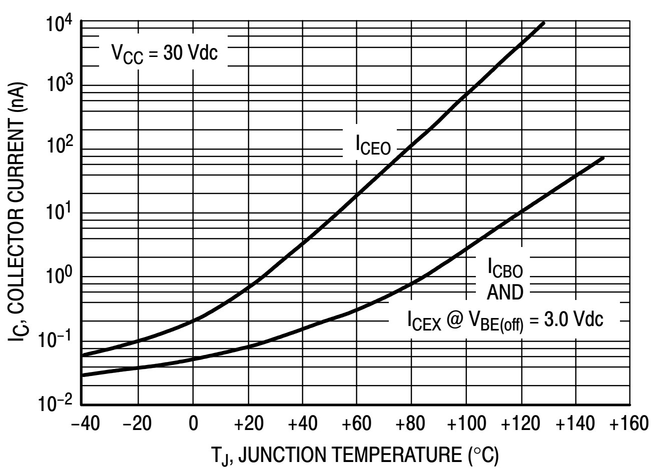


Figure 21.

DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 20. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 19 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 19 by the steady state value $R_{\theta JA}$.

Example:

Dissipating 2.0 watts peak under the following conditions:

t_1 = 1.0 ms, t_2 = 5.0 ms. (D = 0.2)

Using Figure 19 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

The peak rise in junction temperature is therefore

$\Delta T = r(t) \times P_{(pk)} \times R_{\theta JA} = 0.22 \times 2.0 \times 200 = 88°C.$

For more information, see ON Semiconductor Application Note AN569/D, available from the Literature Distribution Center or on our website at **www.onsemi.com**.

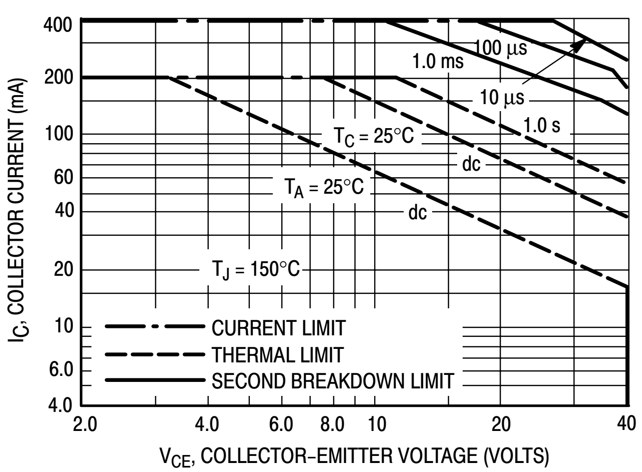


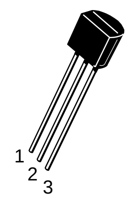
Figure 22.

The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

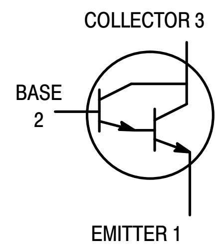
The data of Figure 22 is based upon $T_{J(pk)}$ = 150°C; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq$ 150°C. $T_{J(pk)}$ may be calculated from the data in Figure 19. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

Darlington Transistor
NPN Silicon

MPSA27



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	MPSA27	Unit
Collector–Emitter Voltage	V_{CES}	60	Vdc
Emitter–Base Voltage	V_{EBO}	10	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0) (V_{CB} = 40 V, I_E = 0) (V_{CB} = 50 V, I_E = 0)	I_{CBO}	—	—	100	nAdc
Collector Cutoff Current (V_{CE} = 30 V, V_{BE} = 0) (V_{CE} = 40 V, V_{BE} = 0) (V_{CE} = 50 V, V_{BE} = 0)	I_{CES}	—	—	500	nAdc
Emitter Cutoff Current (V_{EB} = 10 Vdc)	I_{EBO}	—	—	100	nAdc

March, 2001 – Rev. 1

Publication Order Number:
MPSA27/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain (I_C = 10 mA, V_{CE} = 5.0 V) (I_C = 100 mA, V_{CE} = 5.0 V)	h_{FE}	 10,000 10,000	 — —	 — —	—
Collector–Emitter Saturation Voltage (I_C = 100 mA, I_B = 0.1 mAdc)	$V_{CE(sat)}$	—	—	1.5	Vdc
Base–Emitter On Voltage (I_C = 100 mA, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	—	2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Small Signal Current Gain (I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)	h_{fe}	1.25	2.4	—	—

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

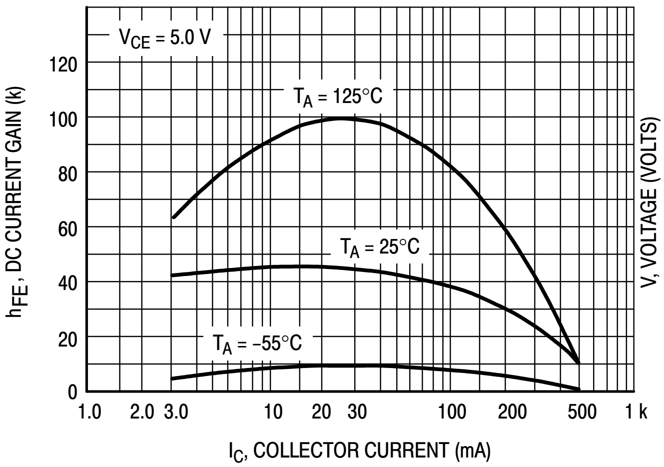


Figure 1. DC Current Gain

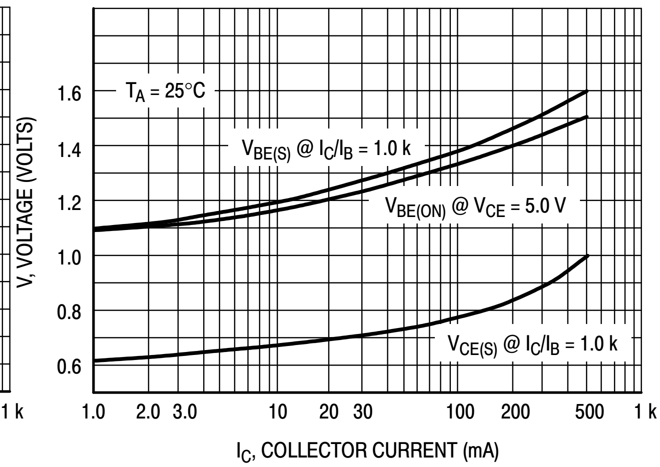


Figure 2. “ON” Voltages

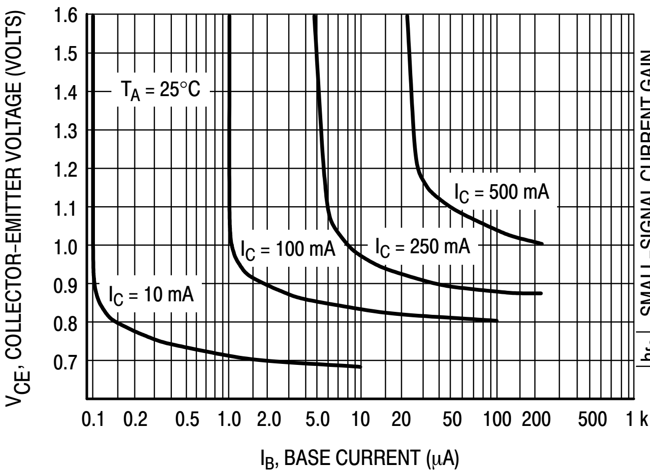


Figure 3. Collector Saturation Region

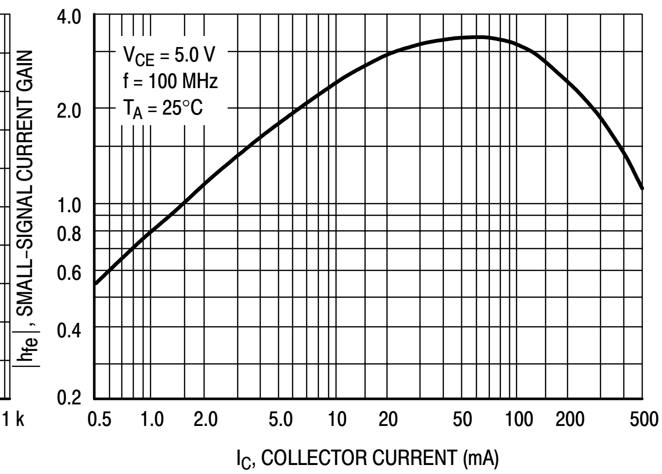


Figure 4. High Frequency Current Gain

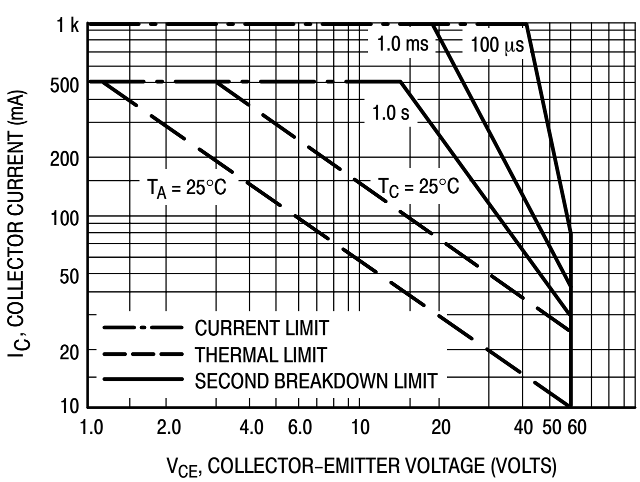


Figure 5. Active Region — Safe Operating Area

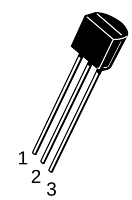
Darlington Transistors
NPN Silicon

MPSA28
MPSA29*

*ON Semiconductor Preferred Device

MAXIMUM RATINGS

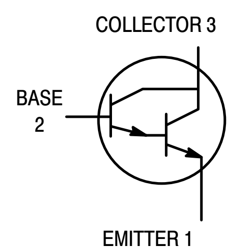
Rating	Symbol	MPSA28	MPSA29	Unit
Collector–Emitter Voltage	V_{CES}	80	100	Vdc
Collector–Base Voltage	V_{CBO}	80	100	Vdc
Emitter–Base Voltage	V_{EBO}	12		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C



CASE 29–11, STYLE 1
TO–92 (TO–226AA)

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	MPSA28 MPSA29	$V_{(BR)CES}$	80 100	— —	— —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	MPSA28 MPSA29	$V_{(BR)CBO}$	80 100	— —	— —	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	12	—	—	Vdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 80 Vdc, I_E = 0)	MPSA28 MPSA29	I_{CBO}	— —	— —	100 100	nAdc
Collector Cutoff Current (V_{CE} = 60 Vdc, V_{BE} = 0) (V_{CE} = 80 Vdc, V_{BE} = 0)	MPSA28 MPSA29	I_{CES}	— —	— —	500 500	nAdc
Emitter Cutoff Current (V_{EB} = 10 Vdc, I_C = 0)		I_{EBO}	—	—	100	nAdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1

Publication Order Number:
MPSA28/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain	h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)		10,000	—	—	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		10,000	—	—	
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 0.01 mAdc)		—	0.7	1.2	
(I_C = 100 mAdc, I_B = 0.1 mAdc)		—	0.8	1.5	
Base–Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	1.4	2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product[2] (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	125	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	5.0	8.0	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
2. $f_T = h_{fe} \cdot f_{test}$.

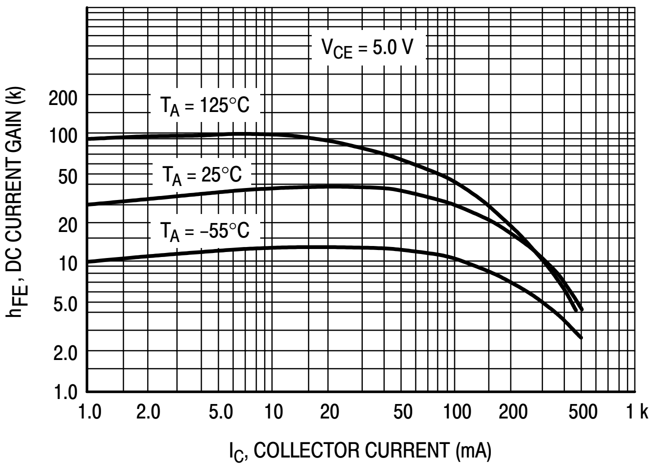


Figure 6. DC Current Gain

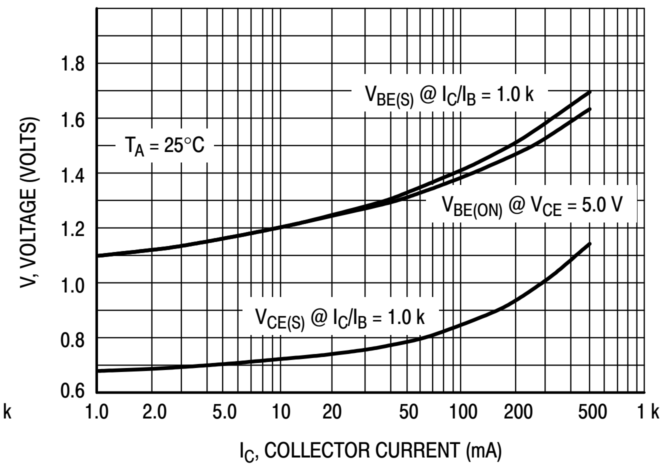


Figure 7. "ON" Voltages

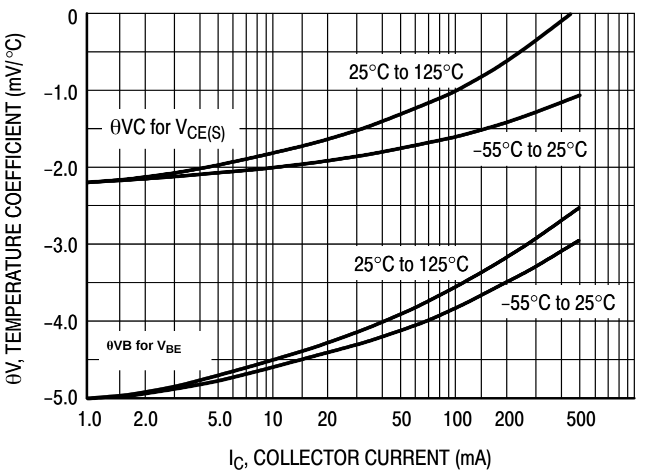


Figure 8. Temperature Coefficients

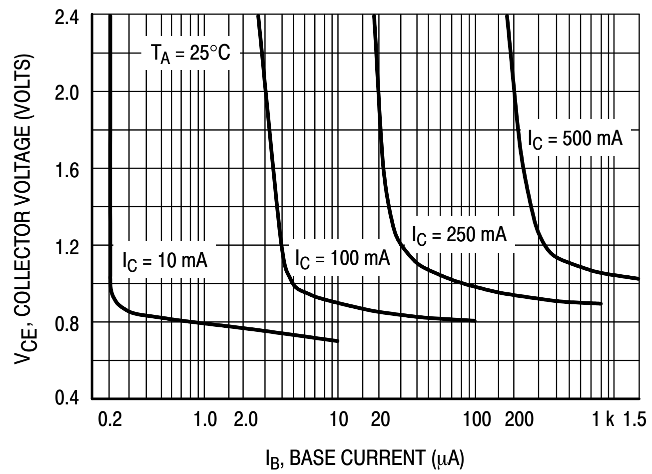


Figure 9. Collector Saturation Region

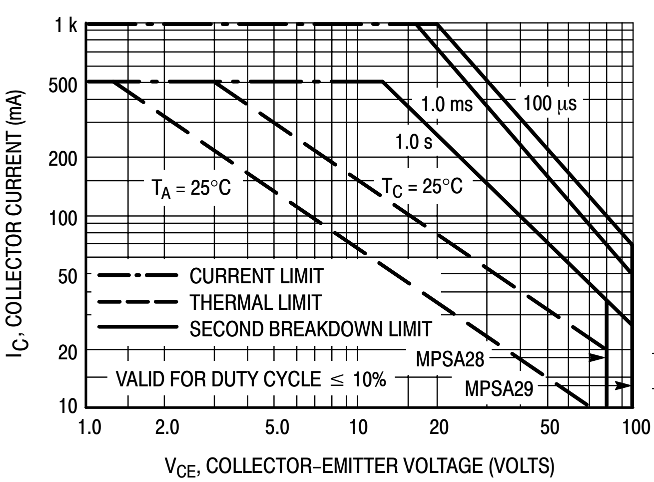


Figure 10. Active Region — Safe Operating Area

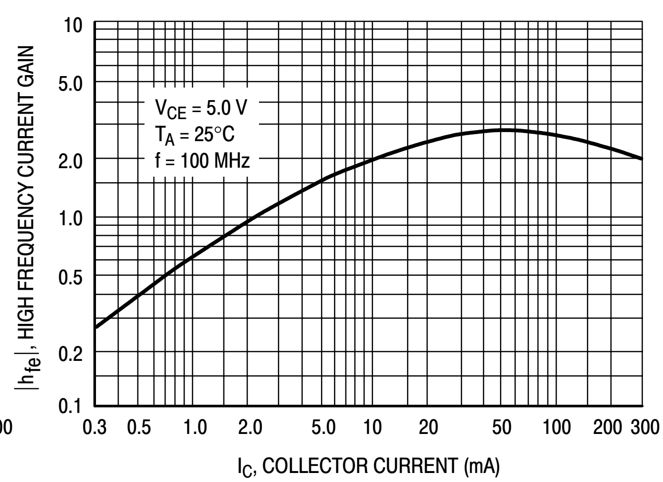


Figure 11. High Frequency Current Gain

MPSA42, MPSA43

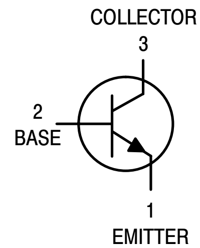
MPSA42 is a Preferred Device

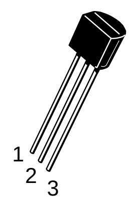
High Voltage Transistors

NPN Silicon

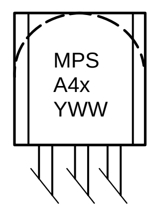
ON Semiconductor™

http://onsemi.com





MARKING DIAGRAM



MPSA4x = Specific Device Code
x = 2 or 3
Y = Year
W = Work Week

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage MPSA43 / MPSA42	V_{CEO}	200 / 300	Vdc
Collector–Base Voltage MPSA43 / MPSA42	V_{CBO}	200 / 300	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current – Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C / Derate above 25°C	P_D	625 / 5.0	mW / mW/°C
Total Device Dissipation @ T_C = 25°C / Derate above 25°C	P_D	1.5 / 12	Watts / mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/mW
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/mW

ORDERING INFORMATION

Device	Package	Shipping
MPSA42	TO–92	5000 Units/Box
MPSA42RLRA	TO–92	2000/Tape & Reel
MPSA42RLRE	TO–92	2000/Tape & Reel
MPSA42RLRF	TO–92	5000 Units/Box
MPSA42RLRM	TO–92	2000/Ammo Pack
MPSA42RLRP	TO–92	2000/Ammo Pack
MPSA43	TO–92	5000 Units/Box
MPSA43RLRA	TO–92	2000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (Note 1.) (I_C = 1.0 mAdc, I_B = 0)	MPSA42 MPSA43	$V_{(BR)CEO}$	300 200	– –	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	MPSA42 MPSA43	$V_{(BR)CBO}$	300 200	– –	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	–	Vdc
Collector Cutoff Current (V_{CB} = 200 Vdc, I_E = 0) (V_{CB} = 160 Vdc, I_E = 0)	MPSA42 MPSA43	I_{CBO}	– –	0.1 0.1	μAdc
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0) (V_{EB} = 4.0 Vdc, I_C = 0)	MPSA42 MPSA43	I_{EBO}	– –	0.1 0.1	μAdc
ON CHARACTERISTICS (Note 1.)					
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 30 mAdc, V_{CE} = 10 Vdc)		h_{FE}	25 40 40	– – –	–
Collector–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	MPSA42 MPSA43	$V_{CE(sat)}$	– –	0.5 0.4	Vdc
Base–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{BE(sat)}$	–	0.9	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	50	–	MHz
Collector–Base Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	MPSA42 MPSA43	C_{cb}	– –	3.0 4.0	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

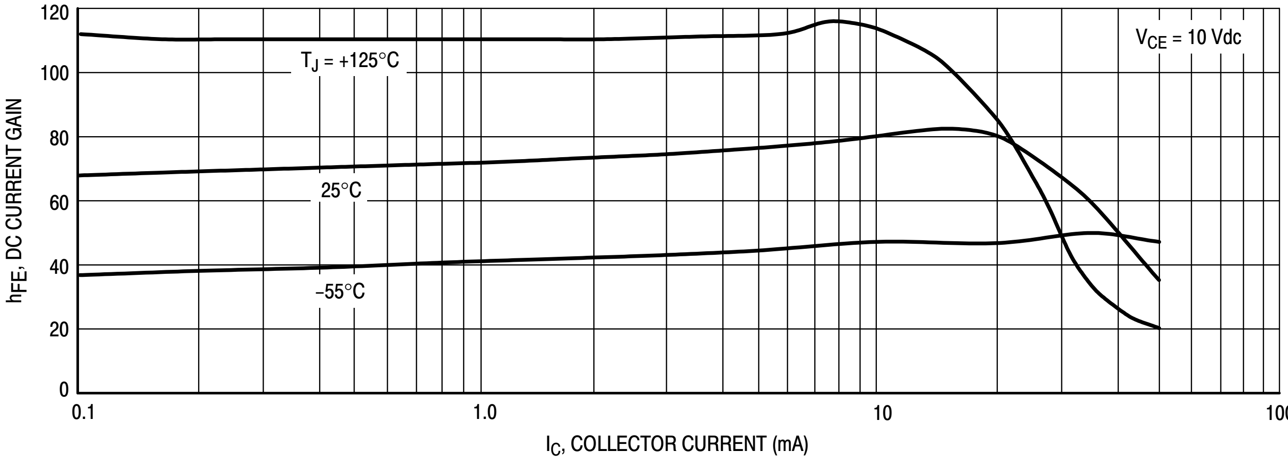


Figure 12. DC Current Gain

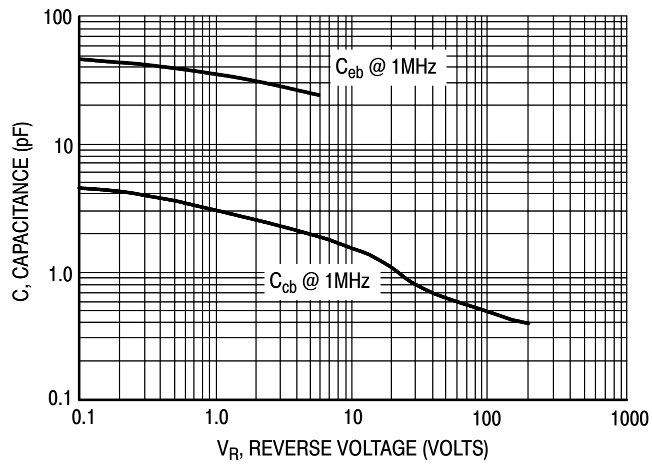


Figure 13. Capacitance

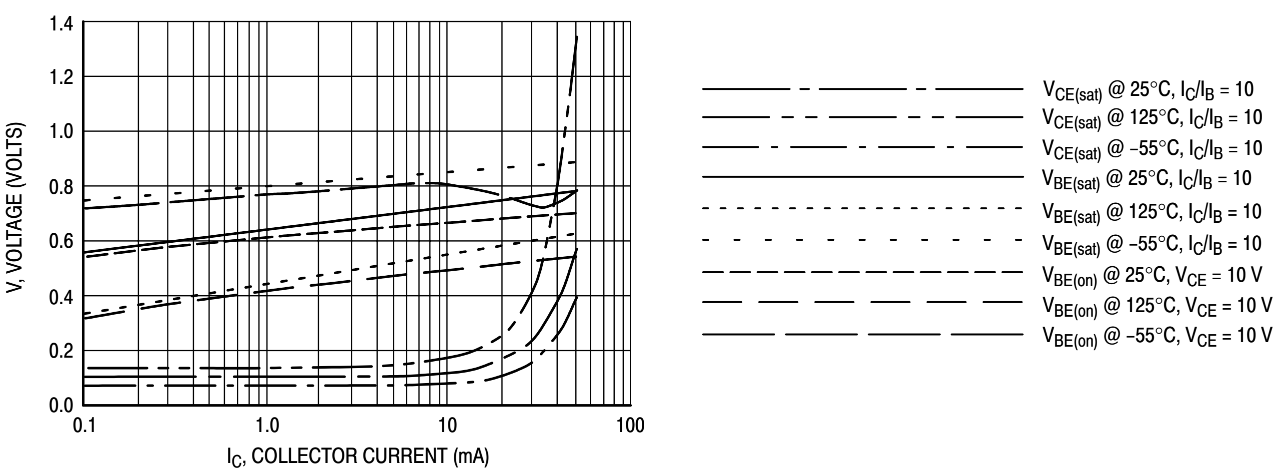
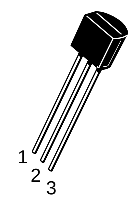


Figure 14. “ON” Voltages

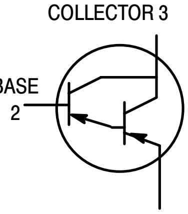
Darlington Transistors
PNP Silicon

MPSA62
MPSA63
MPSA64

MPSA64 is a Preferred Device



CASE 29–04, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	MPSA62	MPSA63 MPSA64	Unit
Collector–Emitter Voltage	V_{CES}	–20	–30	Vdc
Collector–Base Voltage	V_{CBO}	–20	–30	Vdc
Emitter–Base Voltage	V_{EBO}	–10		Vdc
Collector Current — Continuous	I_C	–500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –100 µAdc, V_{BE} = 0) MPSA62 MPSA63, MPSA64	$V_{(BR)CES}$	 –20 –30	 — —	Vdc
Collector Cutoff Current (V_{CB}= –15 Vdc, I_E = 0) MPSA62 (V_{CB} = –30 Vdc, I_E = 0) MPSA63, MPSA64	I_{CBO}	 — —	 –100 –100	nAdc
Emitter Cutoff Current (V_{EB} = –10 Vdc, I_C = 0)	I_{EBO}	—	–100	nAdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain		h_{FE}			—
(I_C = –10 mAdc, V_{CE} = –5.0 Vdc)	MPSA63		5,000	—	
	MPSA64		10,000	—	
	MPSA62		20,000	—	
(I_C = –100 mAdc, V_{CE} = –5.0 Vdc)	MPSA63		10,000	—	
	MPSA64		20,000	—	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = –10 mAdc, I_B = –0.01 mAdc)	MPSA62		—	–1.0	
(I_C = –100 mAdc, I_B = –0.1 mAdc)	MPSA63, MPSA64		—	–1.5	
Base–Emitter On Voltage		$V_{BE(on)}$			Vdc
(I_C = –10 mAdc, V_{CE} = –5.0 Vdc)	MPSA62		—	–1.4	
(I_C = –100 mAdc, V_{CE} = –5.0 Vdc)	MPSA63, MPSA64		—	–2.0	
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product[2]		f_T	125	—	MHz
(I_C = –100 mAdc, V_{CE} = –5.0 Vdc, f = 100 MHz)	MPSA63, MPSA64				

1. Pulse Test: Pulse Width $\leq$ 300 μs; Duty Cycle $\leq$ 2.0%.
2. $f_T = |h_{fe}| \bullet f_{test}$.

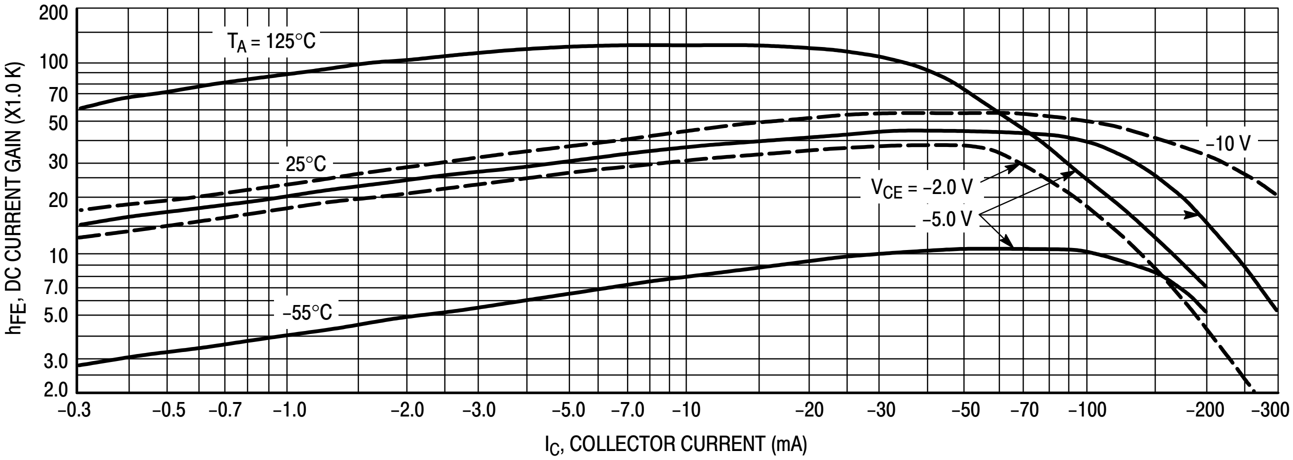


Figure 1. DC Current Gain

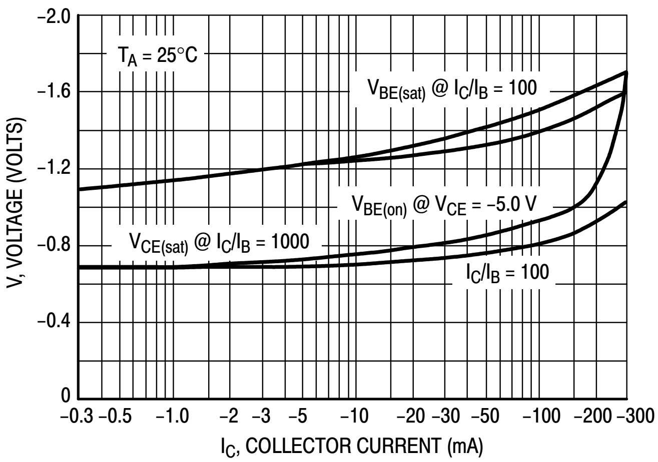


Figure 2. “On” Voltage

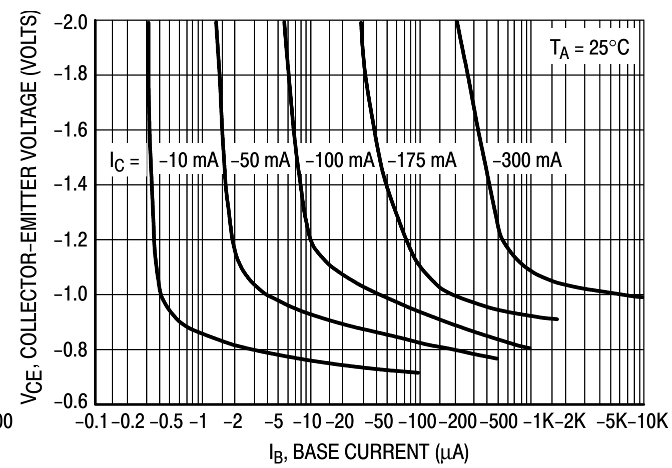


Figure 3. Collector Saturation Region

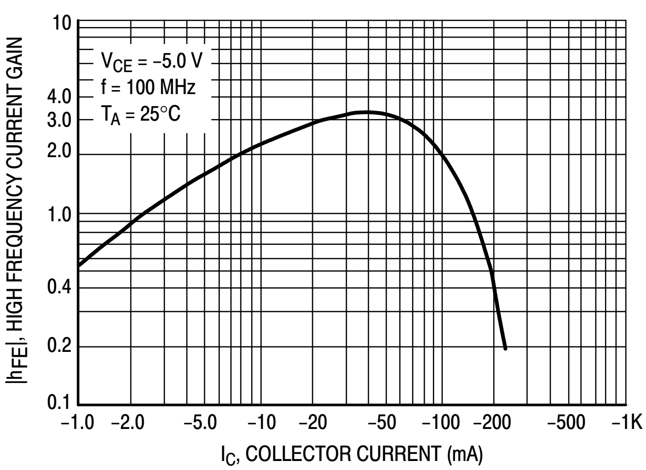


Figure 4. High Frequency Current Gain

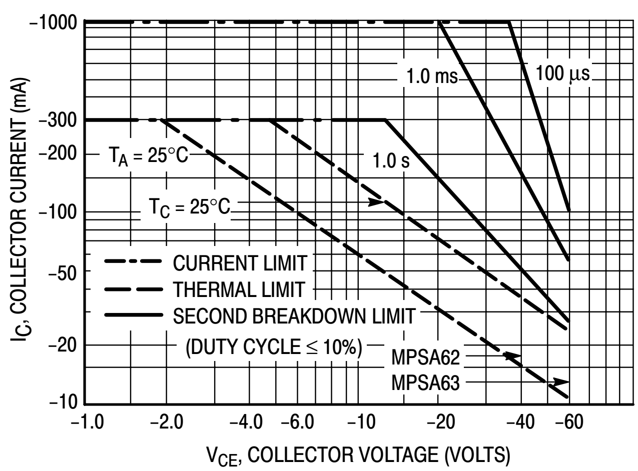
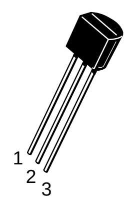


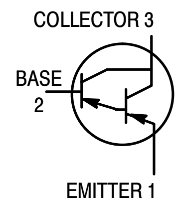
Figure 5. Active Region, Safe Operating Area

Darlington Transistors
PNP Silicon

MPSA75
MPSA77



CASE 29–11, STYLE 1
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	MPSA75	MPSA77	Unit
Collector–Emitter Voltage	V_{CES}	–40	–60	Vdc
Emitter–Base Voltage	V_{EBO}	–10		Vdc
Collector Current — Continuous	I_C	–500		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = –100 μAdc, V_{BE} = 0)	MPSA75 MPSA77	$V_{(BR)CES}$	–40 –60	— —	— —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	MPSA75 MPSA77	$V_{(BR)CBO}$	–40 –60	— —	— —	Vdc
Collector Cutoff Current (V_{CB}= –30 V, I_E = 0) (V_{CB} = –50 V, I_E = 0)	 MPSA75 MPSA77	I_{CBO}	 — —	 — —	 –100 –100	nAdc
Collector Cutoff Current (V_{CE} = –30 V, V_{BE} = 0) (V_{CE} = –50 V, V_{BE} = 0)	 MPSA75 MPSA77	I_{CES}	 — —	 — —	 –500 –500	nAdc
Emitter Cutoff Current (V_{EB} = –10 Vdc)		I_{EBO}	—	—	–100	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = –10 mA, V_{CE} = –5.0 V) (I_C = –100 mA, V_{CE} = –5.0 V)		h_{FE}	 10,000 10,000	 — —	 — —	—
Collector–Emitter Saturation Voltage (I_C = –100 mA, I_B = –0.1 mAdc)		$V_{CE(sat)}$	—	—	–1.5	Vdc
Base–Emitter On Voltage (I_C = –100 mA, V_{CE} = –5.0 Vdc)		V_{BE}	—	—	–2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — High Frequency (I_C = –10 mA, V_{CE} = –5.0 V, f = 100 MHz)		$\lvert h_{fe} \rvert$	1.25	2.4	—	—

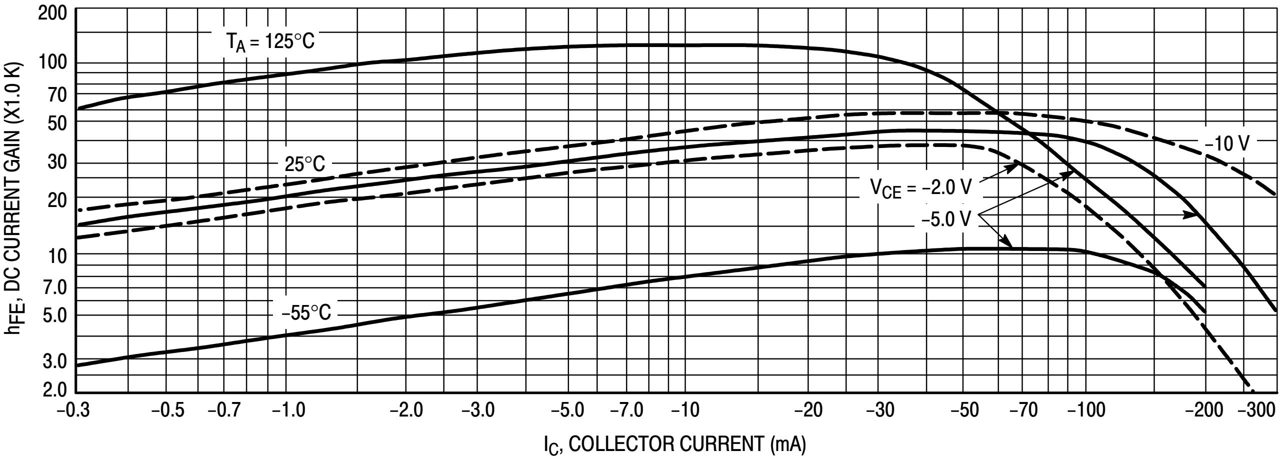


Figure 1. DC Current Gain

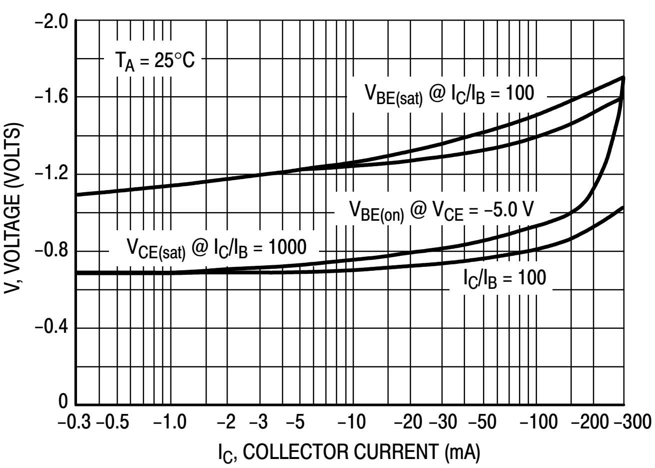


Figure 2. “On” Voltage

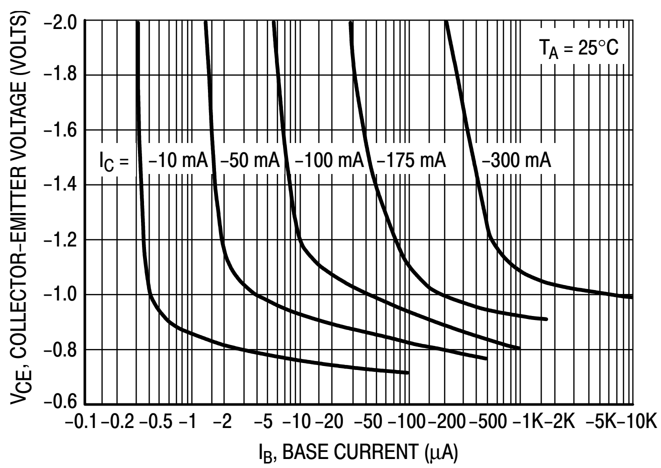


Figure 3. Collector Saturation Region

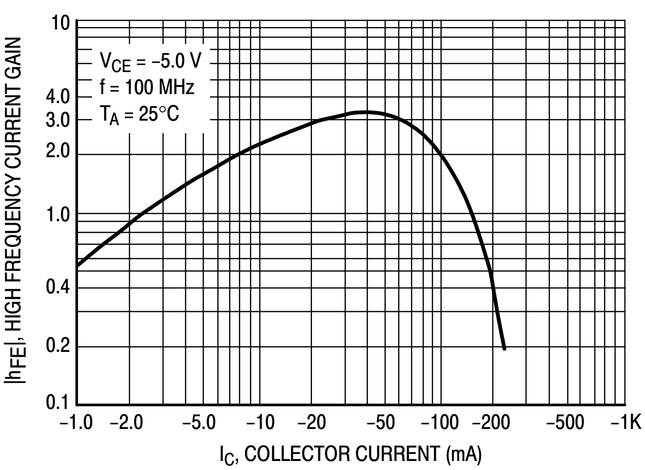


Figure 4. High Frequency Current Gain

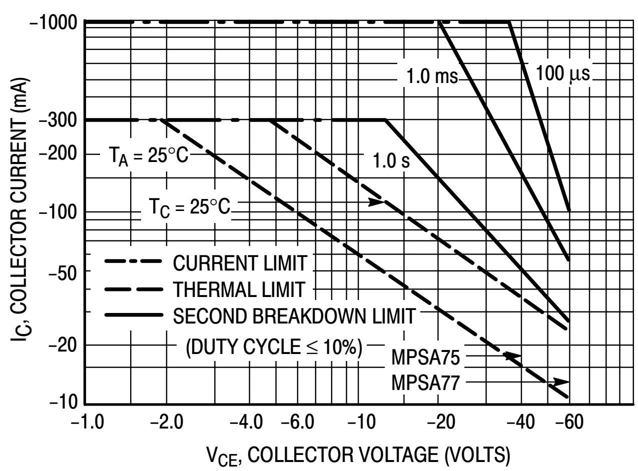


Figure 5. Active Region, Safe Operating Area

MPSA92, MPSA93

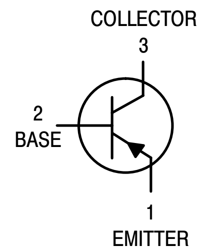
MPSA92 is a Preferred Device

High Voltage Transistors

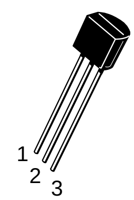
PNP Silicon

ON Semiconductor™

http://onsemi.com

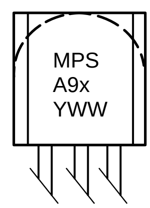


STYLE 1
MPSA92, MPSA93



TO–92
CASE 29
STYLES 1, 14

MARKING DIAGRAM



MPSA9 = Specific Device Code
x = 2 or 2
Y = Year
W = Work Week

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage MPSA93 MPSA92	V_{CEO}	 –200 –300	Vdc
Collector–Base Voltage MPSA93 MPSA92	V_{CBO}	 –200 –300	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Continuous	I_C	–500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 625 5.0	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.5 12	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ORDERING INFORMATION

Device	Package	Shipping
MPSA92	TO–92	5000 Units/Box
MPSA92RLRA	TO–92	2000/Tape & Reel
MPSA92RLRE	TO–92	2000/Tape & Reel
MPSA92RLRM	TO–92	2000/Ammo Pack
MPSA92RLRP	TO–92	2000/Ammo Pack
MPSA93	TO–92	5000 Units/Box
MPSA93RLRA	TO–92	2000/Tape & Reel
MPSA93RLRM	TO–92	2000/Ammo Pack

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (Note 1.) (I_C = –1.0 mAdc, I_B = 0)	MPSA92 MPSA93	$V_{(BR)CEO}$	–300 –200	– –	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	MPSA92 MPSA93	$V_{(BR)CBO}$	–300 –200	– –	Vdc
Emitter–Base Breakdown Voltage (I_E = –100 μAdc, I_C = 0)		$V_{(BR)EBO}$	–5.0	–	Vdc
Collector Cutoff Current (V_{CB} = –200 Vdc, I_E = 0) (V_{CB} = –160 Vdc, I_E = 0)	MPSA92 MPSA93	I_{CBO}	– –	–0.25 –0.25	μAdc
Emitter Cutoff Current (V_{EB} = –3.0 Vdc, I_C = 0)		I_{EBO}	–	–0.1	μAdc
ON CHARACTERISTICS (Note 1.)					
DC Current Gain (I_C = –1.0 mAdc, V_{CE} = –10 Vdc) (I_C = –10 mAdc, V_{CE} = –10 Vdc) (I_C = –30 mAdc, V_{CE} = –10 Vdc)	All Types All Types MPSA92 MPSA93	h_{FE}	25 40 25 25	– – – –	–
Collector–Emitter Saturation Voltage (I_C = –20 mAdc, I_B = –2.0 mAdc)	MPSA92 MPSA93	$V_{CE(sat)}$	– –	–0.5 –0.4	Vdc
Base–Emitter Saturation Voltage (I_C = –20 mAdc, I_B = –2.0 mAdc)		$V_{BE(sat)}$	–	–0.9	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)		f_T	50	–	MHz
Collector–Base Capacitance (V_{CB} = –20 Vdc, I_E = 0, f = 1.0 MHz)	MPSA92 MPSA93	C_{cb}	– –	6.0 8.0	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

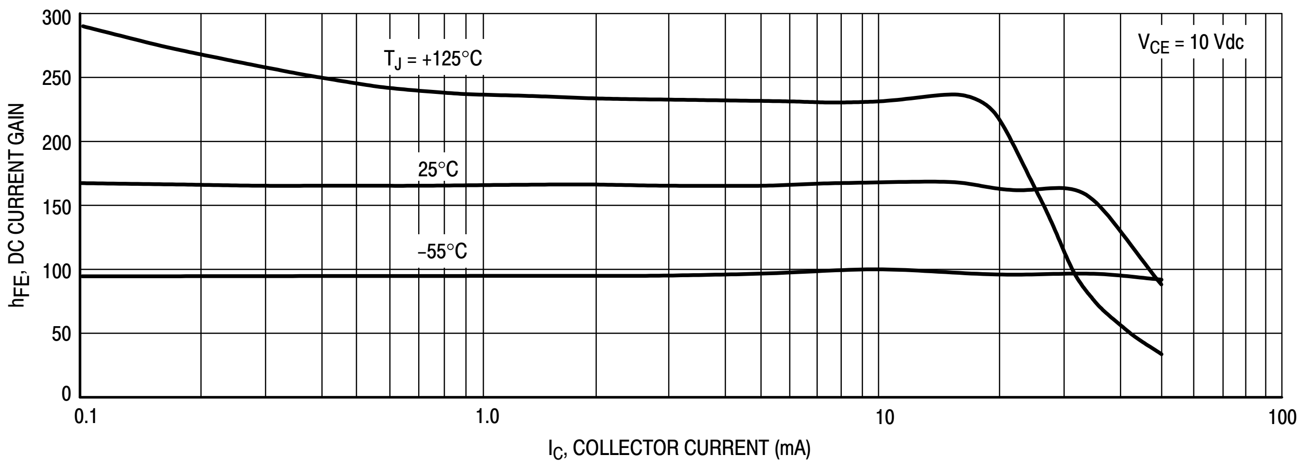


Figure 1. DC Current Gain

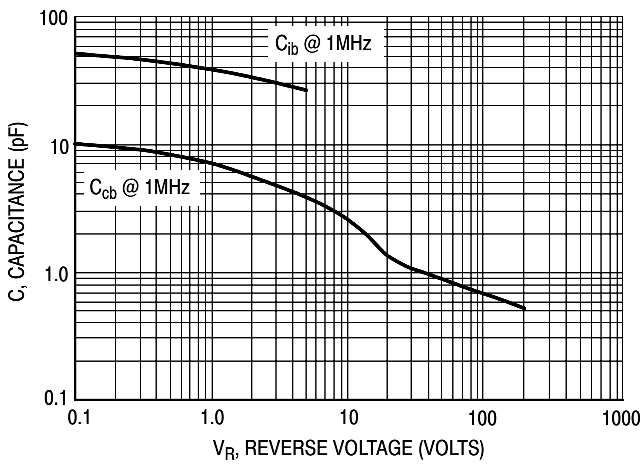


Figure 2. Capacitance

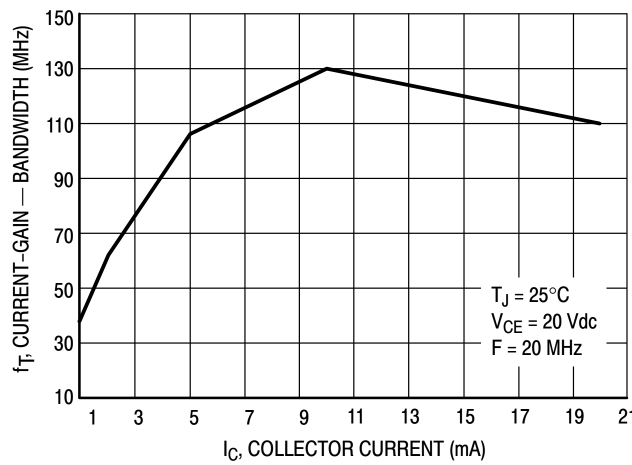


Figure 3. Current−Gain – Bandwidth

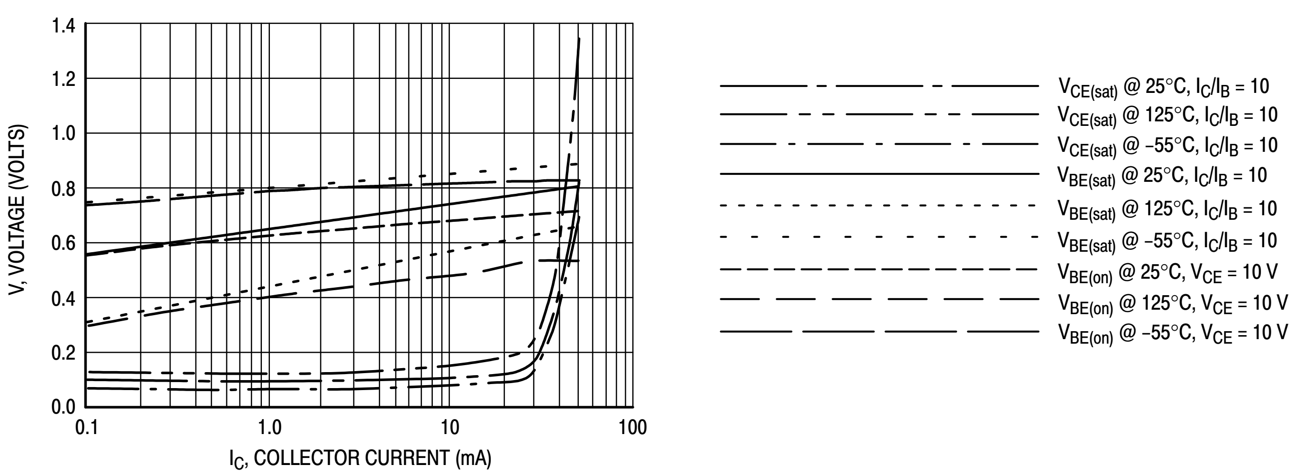
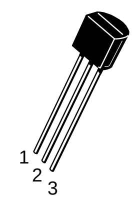


Figure 4. ”ON” Voltages

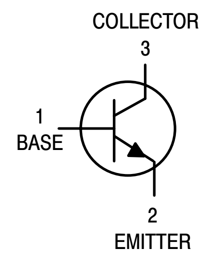
VHF/UHF Transistor
NPN Silicon

MPSH10

ON Semiconductor Preferred Devices



CASE 29–04, STYLE 2
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	25	Vdc
Collector–Base Voltage	V_{CBO}	30	Vdc
Emitter–Base Voltage	V_{EBO}	3.0	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	25	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 25 Vdc, I_E = 0)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{EB} = 2.0 Vdc, I_C = 0)	I_{EBO}	—	100	nAdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

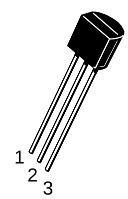
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = 4.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	60	—	—
Collector–Emitter Saturation Voltage (I_C = 4.0 mAdc, I_B = 0.4 mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base–Emitter On Voltage (I_C = 4.0 mAdc, V_{CE} = 10 Vdc)	$V_{BE(on)}$	—	0.95	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	650	—	MHz
Collector–Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.7	pF
Common–Base Feedback Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{rb}	0.35	0.65	pF
Collector Base Time Constant (I_C = 4.0 mAdc, V_{CB} = 10 Vdc, f = 31.8 MHz)	$rb'C_c$	—	9.0	ps

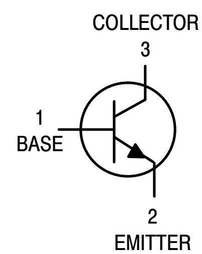
CATV Transistor
NPN Silicon

MPSH17

ON Semiconductor Preferred Device



CASE 29–11, STYLE 2
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	15	Vdc
Collector–Base Voltage	V_{CBO}	20	Vdc
Emitter–Base Voltage	V_{EBO}	3.0	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (Printed Circuit Board Mounting)	$R_{\theta JA}$	357	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

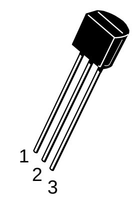
March, 2001 – Rev. 1
Publication Order Number:
MPSH17/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	25	—	250	—
Collector–Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	—	0.5	—
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	800	—	—	MHz
Collector–Base Capacitance (V_{CB} = 10 Vdc, f = 1.0 MHz)	C_{cb}	0.3	—	0.9	pF
Small–Signal Current Gain (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	30	—	—	—
Noise Figure (I_C = 5.0 mAdc, V_{CC} = 12 Vdc, R_S = 50 ohms, f = 200 MHz)	NF	—	—	6.0	dB
FUNCTIONAL TEST					
Amplifier Power Gain (I_C = 5.0 mAdc, V_{CC} = 12 Vdc, R_S = 50 ohms, f = 200 MHz)	G_{pe}	—	24	—	dB

Amplifier Transistor
PNP Silicon

MPSL51



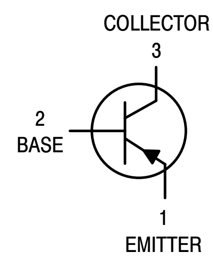
CASE 29–11, STYLE 1
TO–92 (TO–226AA)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–100	Vdc
Collector–Base Voltage	V_{CBO}	–100	Vdc
Emitter–Base Voltage	V_{EBO}	–4.0	Vdc
Collector Current — Continuous	I_C	–600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage[(1)] (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–100	—	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–100	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–4.0	—	Vdc
Collector Cutoff Current (V_{CB} = –50 Vdc, I_E = 0)	I_{CBO}	—	–1.0	μAdc
Emitter Cutoff Current (V_{EB} = –3.0 Vdc, I_C = 0)	I_{EBO}	—	–100	nAdc

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

March, 2001 – Rev. 1
Publication Order Number:
MPSL51/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]				
DC Current Gain[1] (I_C = –50 mAdc, V_{CE} = –5.0 Vdc)	h_{FE}	40	250	—
Collector–Emitter Saturation Voltage (I_C = –10 mAdc, I_B = –1.0 mAdc) (I_C = –50 mAdc, I_B = –5.0 mAdc)	$V_{CE(sat)}$	— —	–0.25 –0.30	Vdc
Base–Emitter Saturation Voltage (I_C = –10 mAdc, I_B = –1.0 mAdc) (I_C = –50 mAdc, I_B = –5.0 mAdc)	$V_{BE(sat)}$	— —	–1.2 –1.2	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –10 Vdc, f = 20 MHz)	f_T	60	—	MHz
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	8.0	pF
Small–Signal Current Gain (I_C = –1.0 mAdc, V_{CE} = –10 Vdc, f = 1.0 kHz)	h_{fe}	20	—	—

1. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

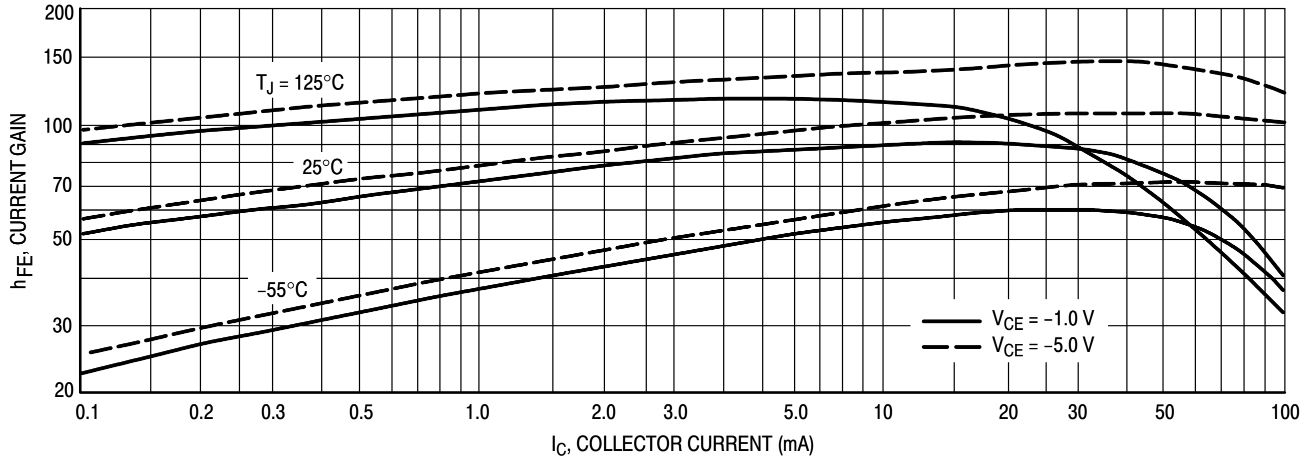


Figure 1. DC Current Gain

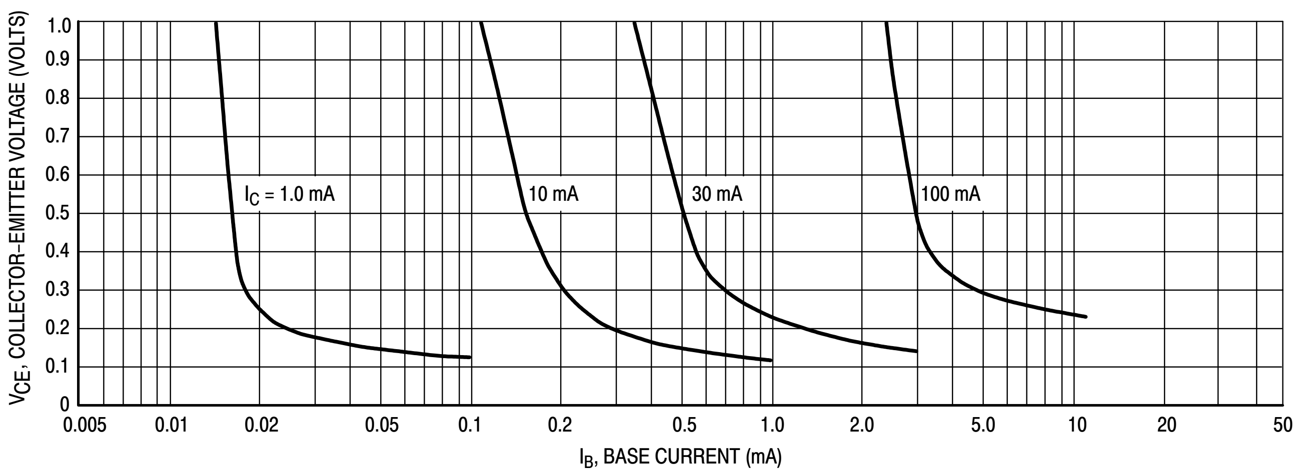


Figure 2. Collector Saturation Region

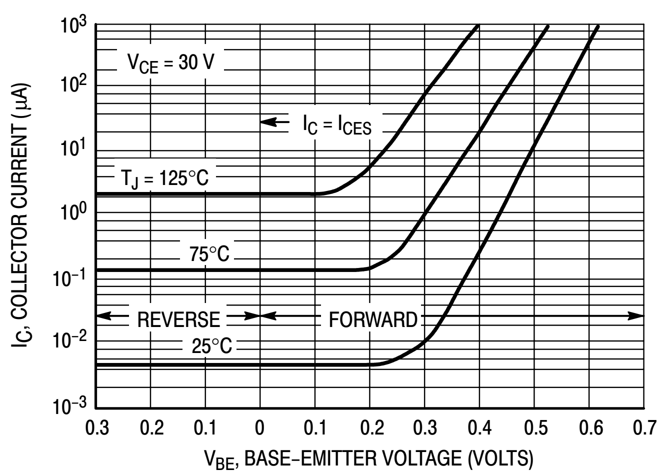


Figure 3. Collector Cut–Off Region

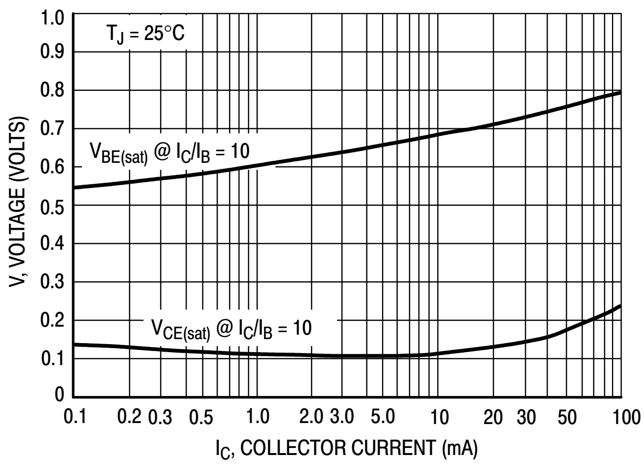


Figure 4. "On" Voltages

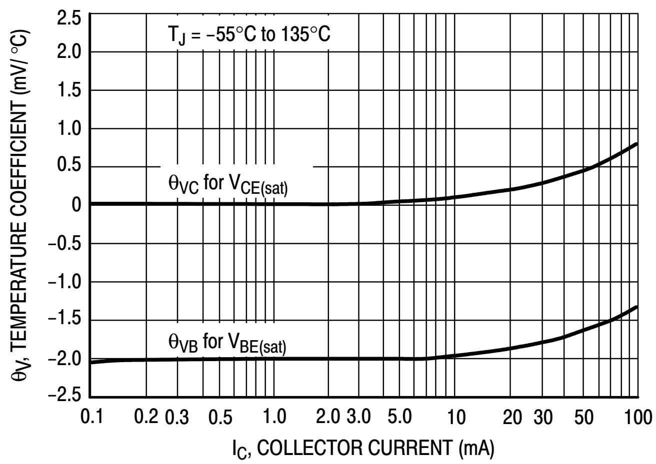


Figure 5. Temperature Coefficients

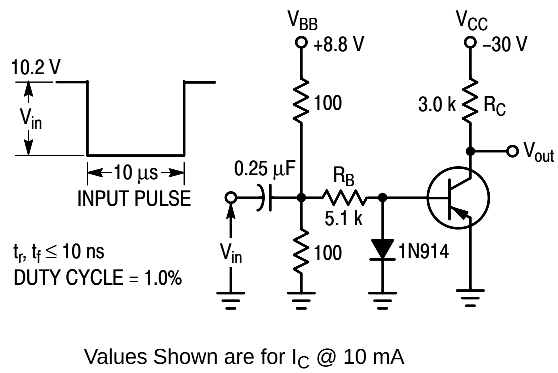


Figure 6. Switching Time Test Circuit

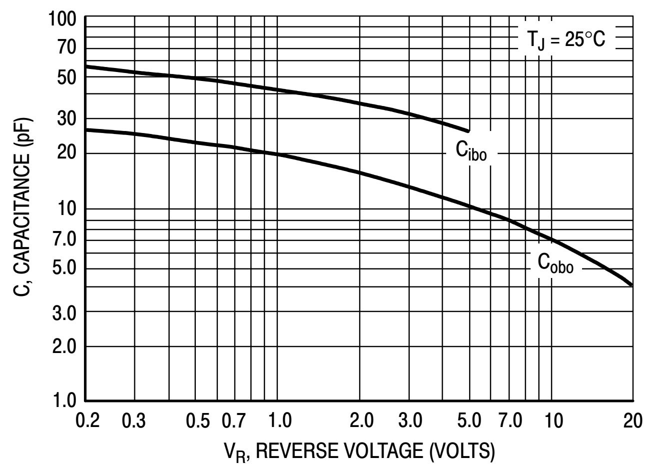


Figure 7. Capacitances

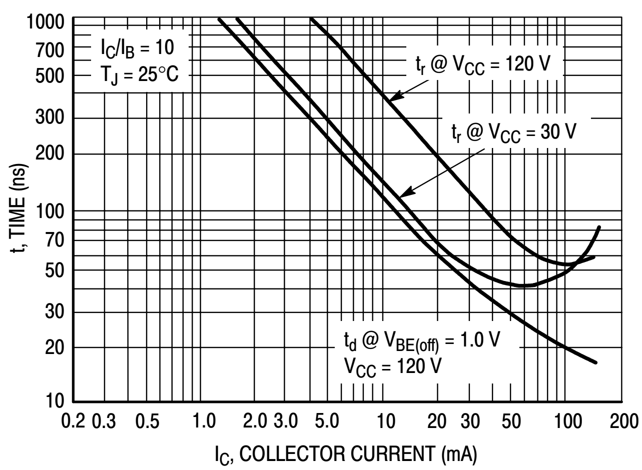


Figure 8. Turn–On Time

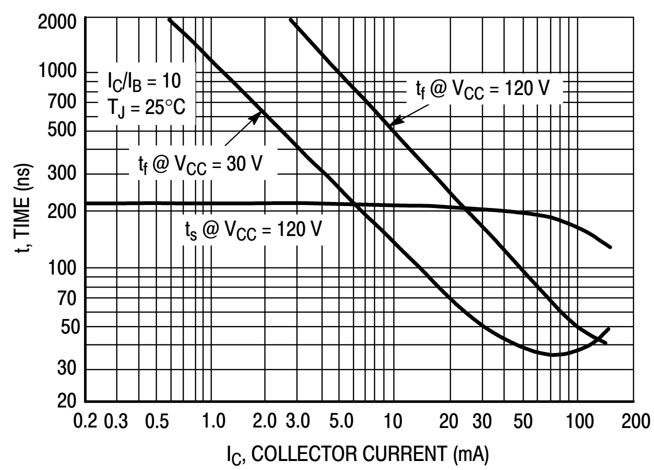


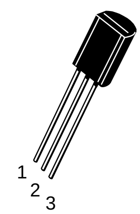
Figure 9. Turn–Off Time

One Watt High Current Transistors

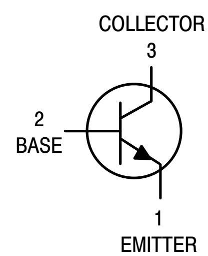
NPN Silicon

MPSW01
MPSW01A*

*ON Semiconductor Preferred Device



CASE 29–10, STYLE 1
TO–92 (TO–226AE)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage MPSW01 MPSW01A	V_{CEO}	 30 40	Vdc
Collector–Base Voltage MPSW01 MPSW01A	V_{CBO}	 40 50	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	1000	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage[(1)] (I_C = 10 mAdc, I_B = 0)	 MPSW01 MPSW01A	$V_{(BR)CEO}$	 30 40	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 MPSW01 MPSW01A	$V_{(BR)CBO}$	 40 50	 — —	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0) (V_{CB} = 40 Vdc, I_E = 0)	 MPSW01 MPSW01A	I_{CBO}	 — —	 0.1 0.1	μAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	0.1	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]				
DC Current Gain (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1000 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	 55 60 50	 — — —	—
Collector–Emitter Saturation Voltage (I_C = 1000 mAdc, I_B = 100 mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base–Emitter On Voltage (I_C = 1000 mAdc, V_{CE} = 1.0 Vdc)	$V_{BE(on)}$	—	1.2	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	f_T	50	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	20	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

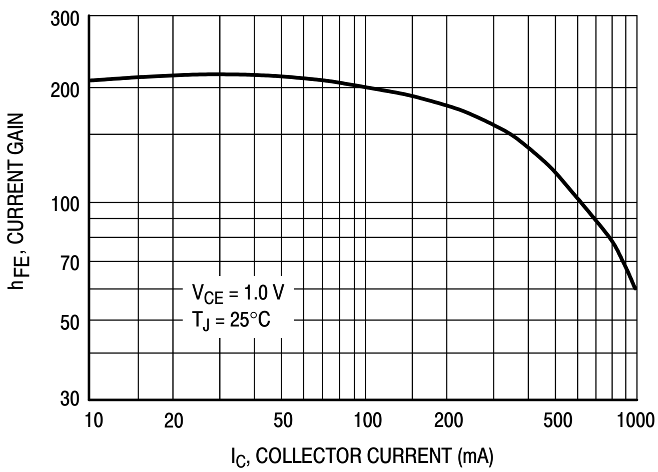


Figure 1. DC Current Gain

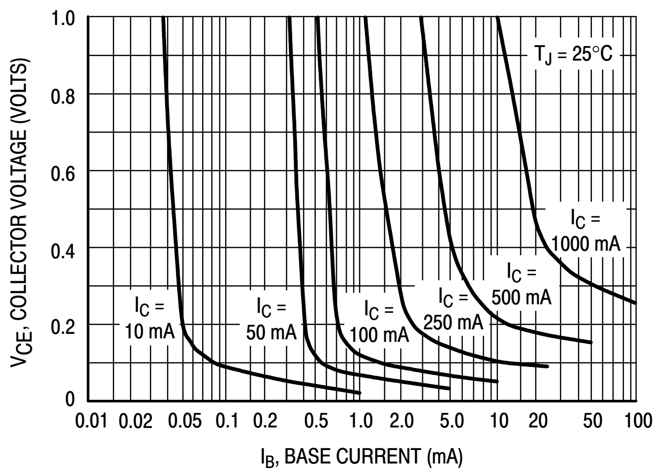


Figure 2. Collector Saturation Region

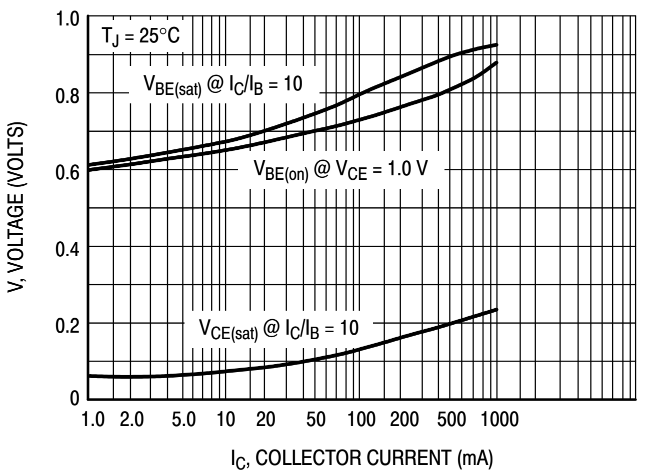


Figure 3. "ON" Voltages

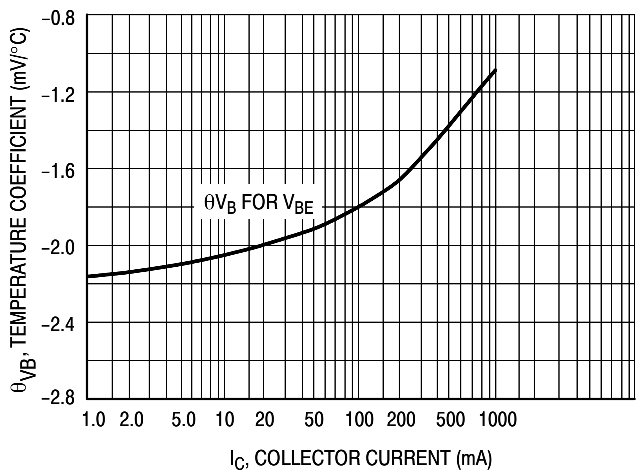


Figure 4. Temperature Coefficient

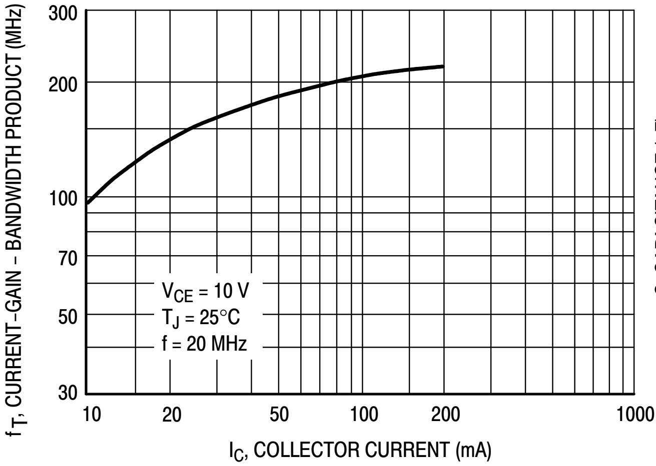


Figure 5. Current Gain — Bandwidth Product

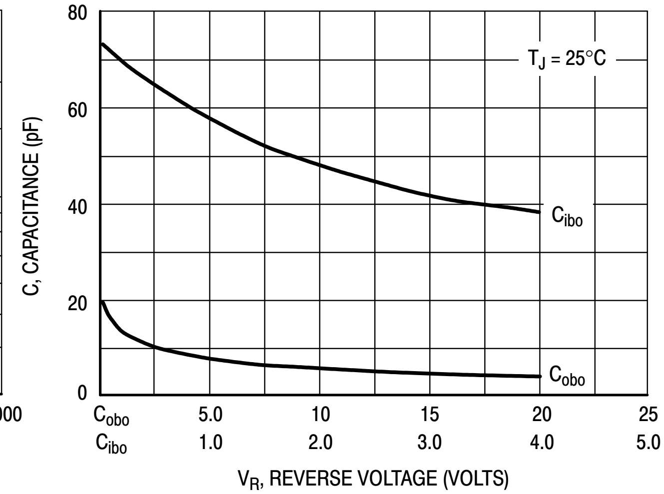


Figure 6. Capacitance

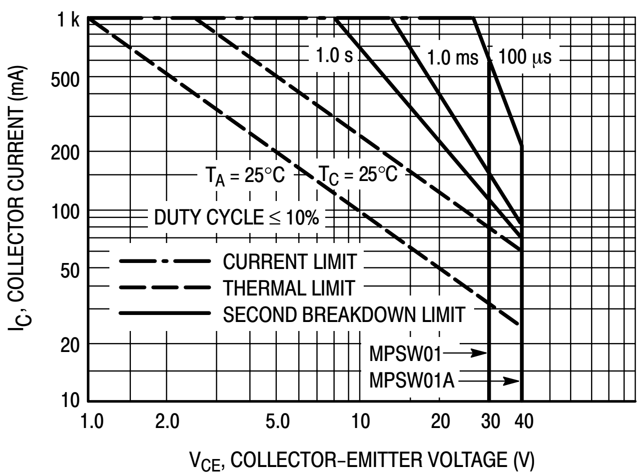


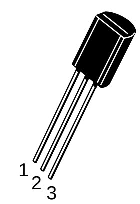
Figure 7. Active Region — Safe Operating Area

One Watt Amplifier Transistors

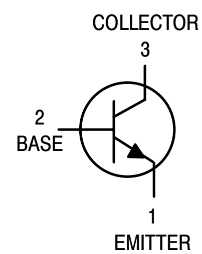
NPN Silicon

MPSW05
MPSW06

MPSW06 is a Preferred Device



CASE 29–10, STYLE 1
TO–92 (TO–226AE)



MAXIMUM RATINGS

Rating	Symbol	MPSW05	MPSW06	Unit
Collector–Emitter Voltage	V_{CEO}	60	80	Vdc
Collector–Base Voltage	V_{CBO}	60	80	Vdc
Emitter–Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage[(1)]		$V_{(BR)CEO}$			Vdc
(I_C = 1.0 mAdc, I_B = 0)	MPSW05		60	—	
	MPSW06		80	—	
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current		I_{CES}			μAdc
(V_{CE} = 40 Vdc, I_B = 0)	MPSW05		—	0.5	
(V_{CE} = 60 Vdc, I_B = 0)	MPSW06		—	0.5	
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 40 Vdc, I_E = 0)	MPSW05		—	0.1	
(V_{CB} = 60 Vdc, I_E = 0)	MPSW06		—	0.1	
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	0.1	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]				
DC Current Gain (I_C = 50 mAdc, V_{CE} = 1.0 Vdc) (I_C = 250 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	 80 60	 — —	—
Collector–Emitter Saturation Voltage (I_C = 250 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base–Emitter Saturation Voltage (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(sat)}$	—	1.2	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 200 mAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)	f_T	50	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)	C_{obo}	—	12	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

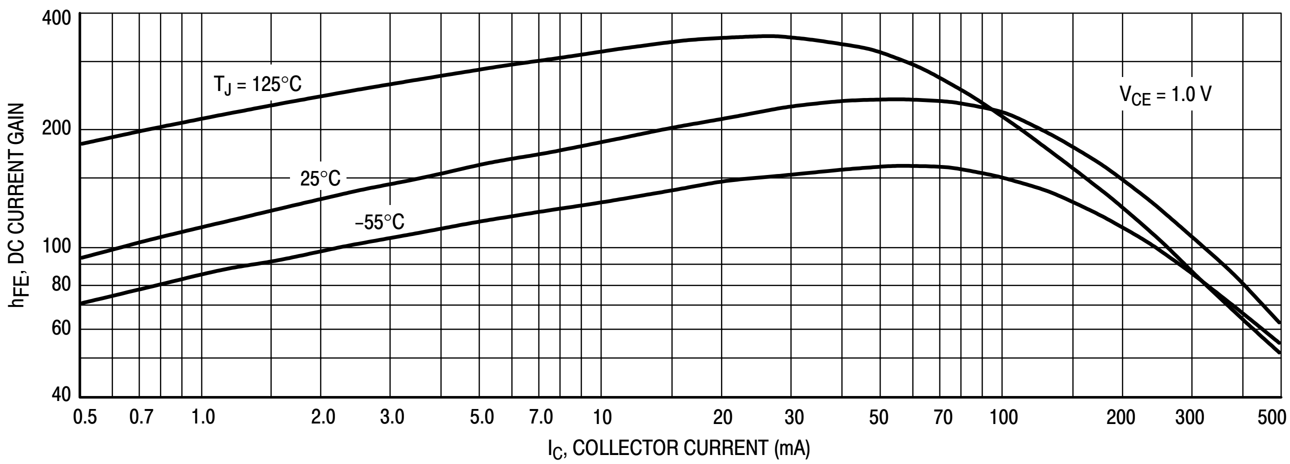


Figure 1. DC Current Gain

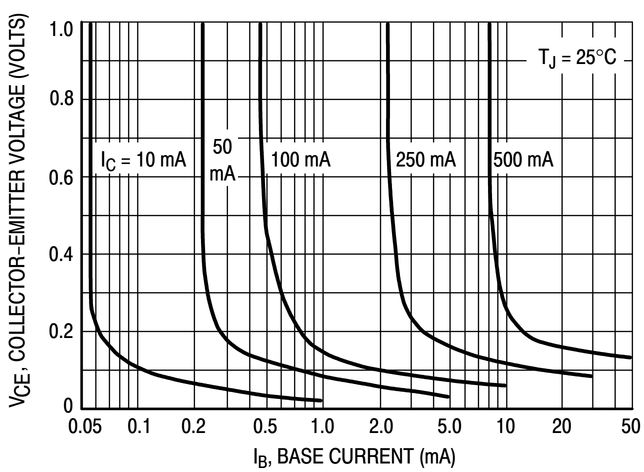


Figure 2. Collector Saturation Region

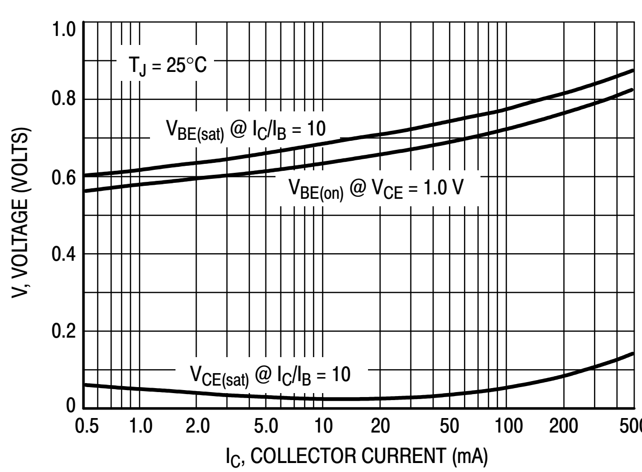


Figure 3. "On" Voltages

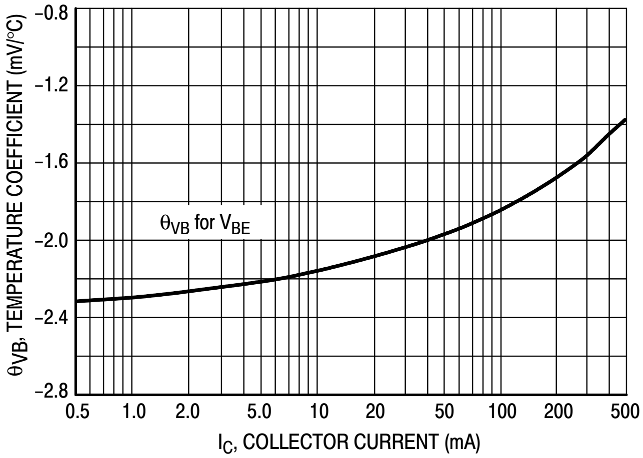


Figure 4. Base–Emitter Temperature Coefficient

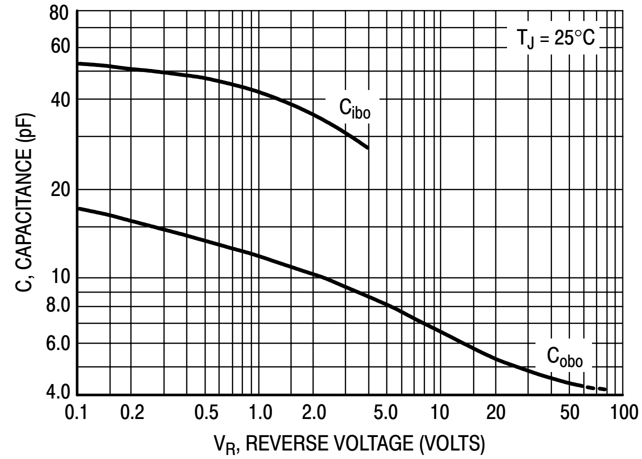


Figure 5. Capacitance

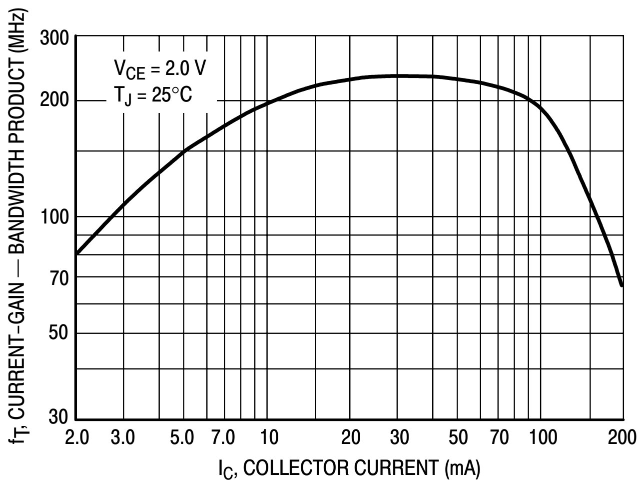


Figure 6. Current–Gain — Bandwidth Product

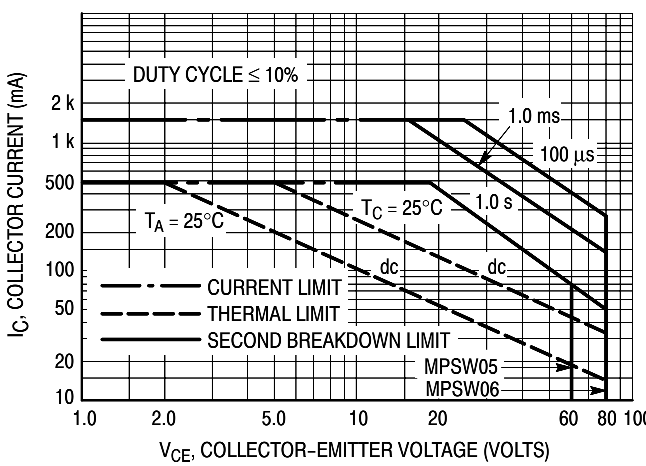
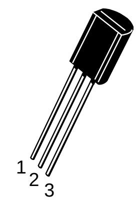


Figure 7. Active Region — Safe Operating Area

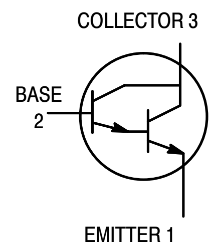
One Watt Darlington Transistors

NPN Silicon

MPSW13
MPSW14



CASE 29–10, STYLE 1
TO–92 (TO–226AE)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CES}	30	Vdc
Collector–Base Voltage	V_{CBO}	30	Vdc
Emitter–Base Voltage	V_{EBO}	10	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	30	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{EB} = 10 Vdc, I_C = 0)	I_{EBO}	—	100	nAdc

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	 MPSW13 MPSW14	h_{FE}	 5,000 10,000	 — —	—
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	MPSW13 MPSW14		10,000 20,000	— —	
Collector–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 0.1 mAdc)		$V_{CE(sat)}$	—	1.5	Vdc
Base–Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	—	2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product[2] (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	125	—	MHz

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
2. $f_T = |h_{fe}| \bullet f_{test}$.

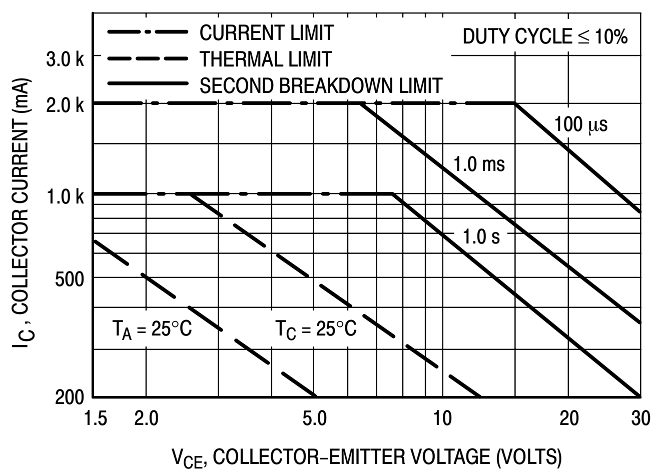


Figure 1. Active Region — Safe Operating Area

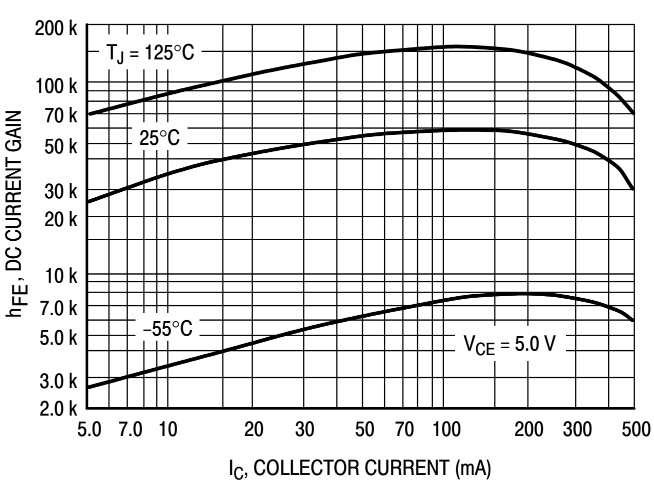


Figure 2. DC Current Gain

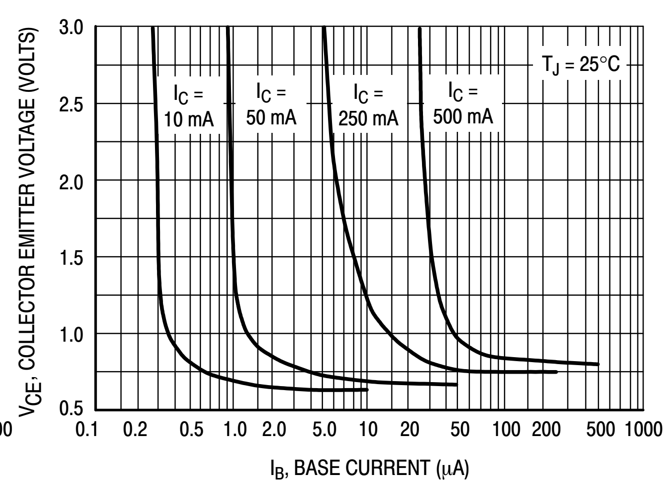


Figure 3. Collector Saturation Region

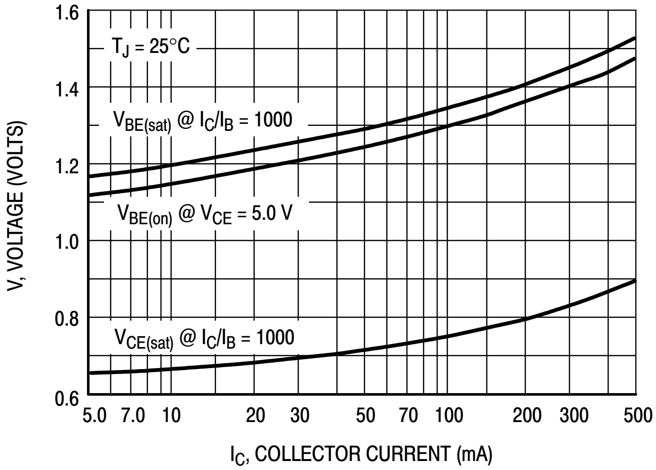


Figure 4. "ON" Voltages

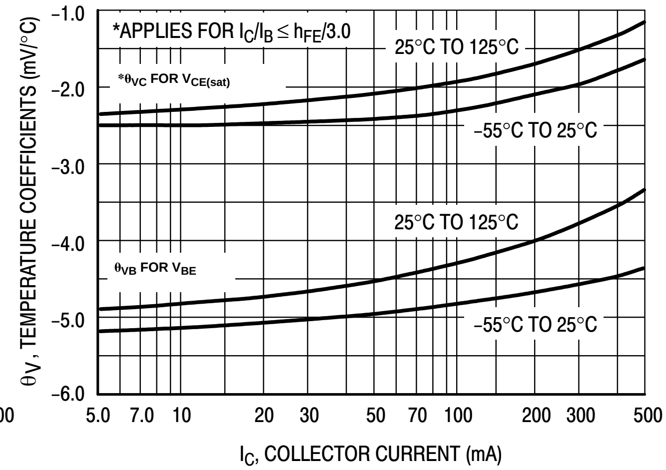


Figure 5. Temperature Coefficients

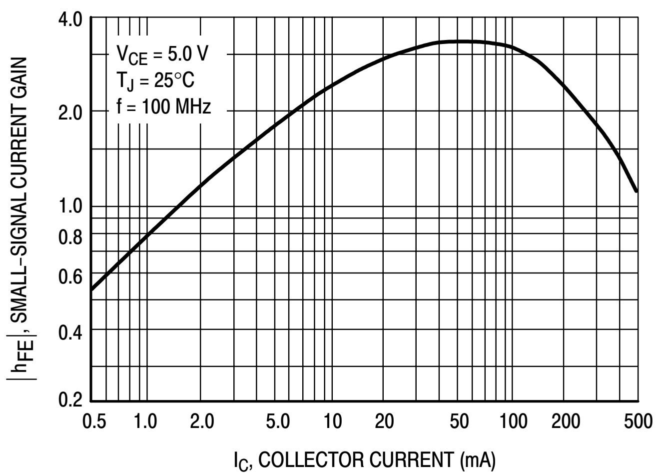


Figure 6. High Frequency Current Gain

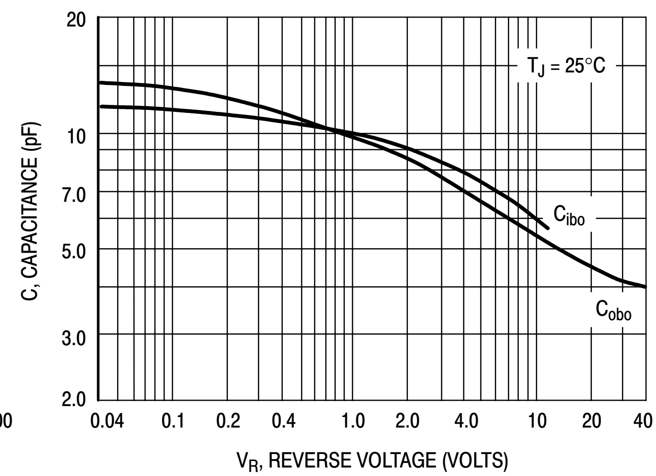
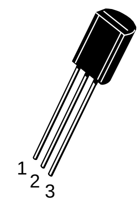


Figure 7. Capacitance

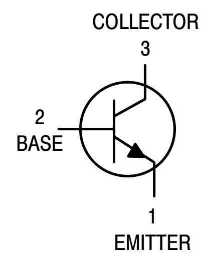
One Watt High Voltage Transistor
NPN Silicon

MPSW42

ON Semiconductor Preferred Device



CASE 29–10, STYLE 1
TO–92 (TO–226AE)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	300	Vdc
Collector–Base Voltage	V_{CBO}	300	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	300	—	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	300	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CB} = 200 Vdc, I_E = 0)	I_{CBO}	—	0.1	μAdc
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 30 mAdc, V_{CE} = 10 Vdc)	h_{FE}	 25 40 40	 — — —	—
Collector–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{BE(sat)}$	—	0.9	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)	f_T	50	—	MHz
Collector Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	3.0	pF

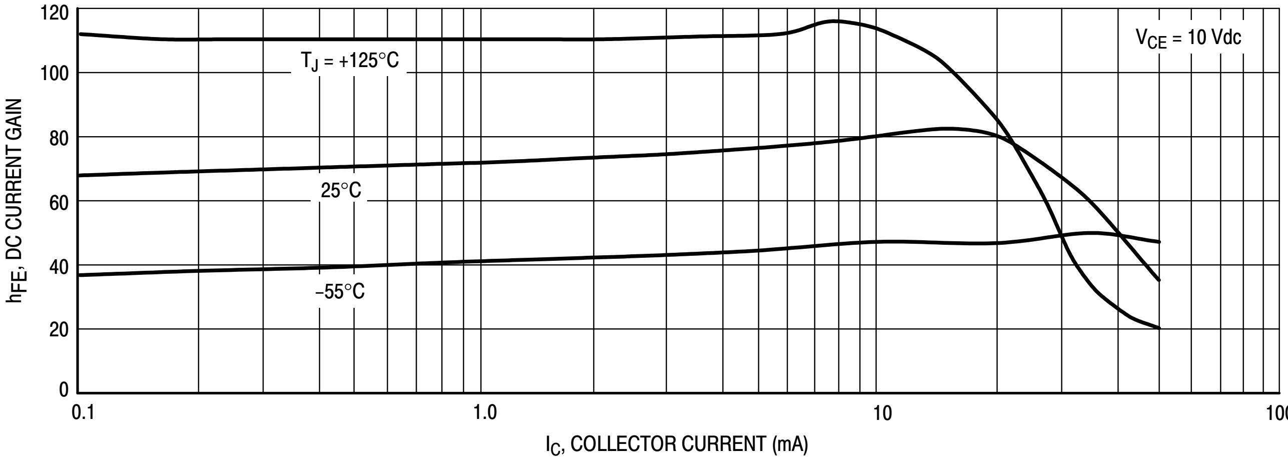


Figure 1. DC Current Gain

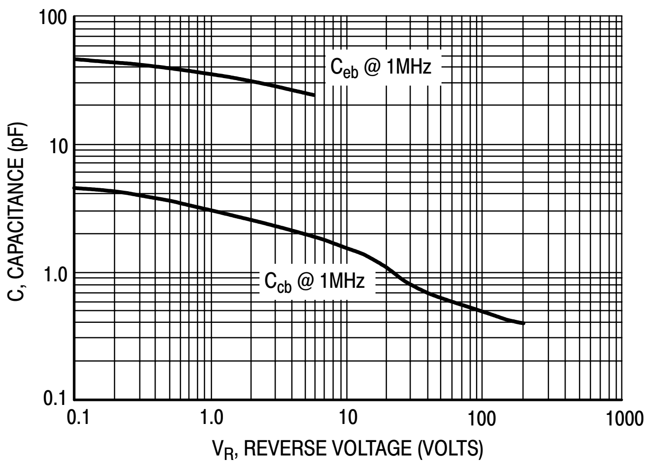


Figure 2. Capacitance

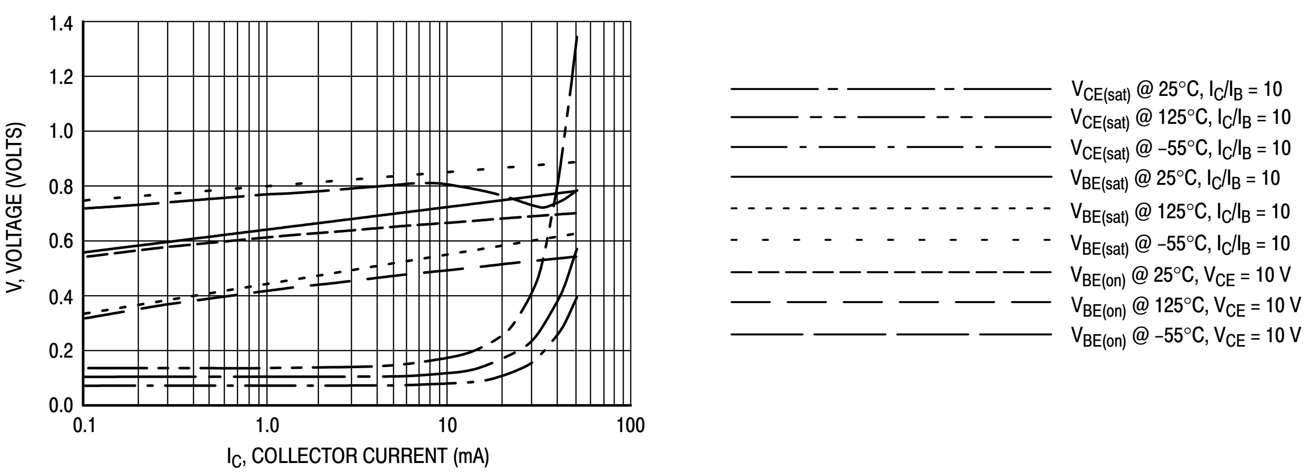


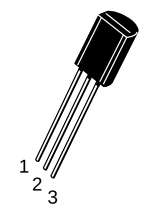
Figure 3. ”ON” Voltages

One Watt Darlington Transistors

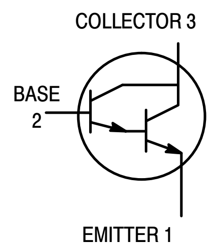
NPN Silicon

MPSW45
MPSW45A*

*ON Semiconductor Preferred Device



CASE 29–10, STYLE 1
TO–92 (TO–226AE)



MAXIMUM RATINGS

Rating	Symbol	MPSW45	MPSW45A	Unit
Collector–Emitter Voltage	V_{CES}	40	50	Vdc
Collector–Base Voltage	V_{CBO}	50	60	Vdc
Emitter–Base Voltage	V_{EBO}	12	12	Vdc
Collector Current — Continuous	I_C	1.0	1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0		Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	 MPSW45 MPSW45A	$V_{(BR)CES}$	 40 50	 — —	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 MPSW45 MPSW45A	$V_{(BR)CBO}$	 50 60	 — —	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	12	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0) (V_{CB} = 40 Vdc, I_E = 0)	 MPSW45 MPSW45A	I_{CBO}	 — —	 100 100	nAdc
Emitter Cutoff Current (V_{EB} = 10 Vdc, I_C = 0)		I_{EBO}	—	100	nAdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]				
DC Current Gain	h_{FE}			—
(I_C = 200 mAdc, V_{CE} = 5.0 Vdc)		25,000	150,000	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc)		15,000	—	
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)		4,000	—	
Collector–Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 2.0 mAdc)	$V_{CE(sat)}$	—	1.5	Vdc
Base–Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 2.0 mAdc)	$V_{BE(sat)}$	—	2.0	Vdc
Base–Emitter On Voltage (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain – Bandwidth Product (I_C = 200 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	100	—	MHz
Collector–Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	6.0	pF

1. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2.0%.

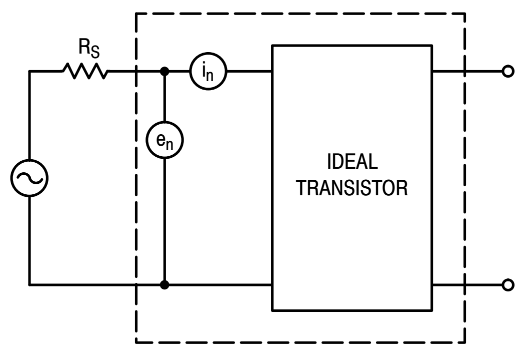


Figure 1. Transistor Noise Model

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

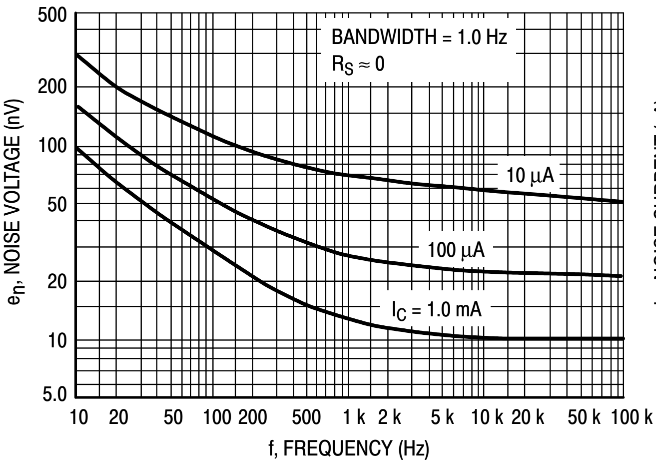


Figure 2. Noise Voltage

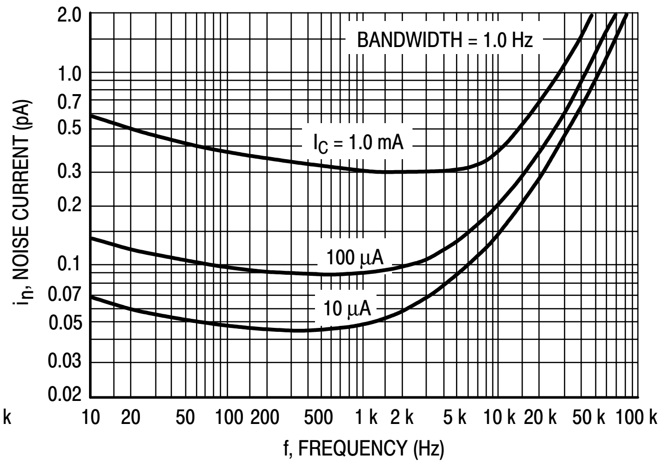


Figure 3. Noise Current

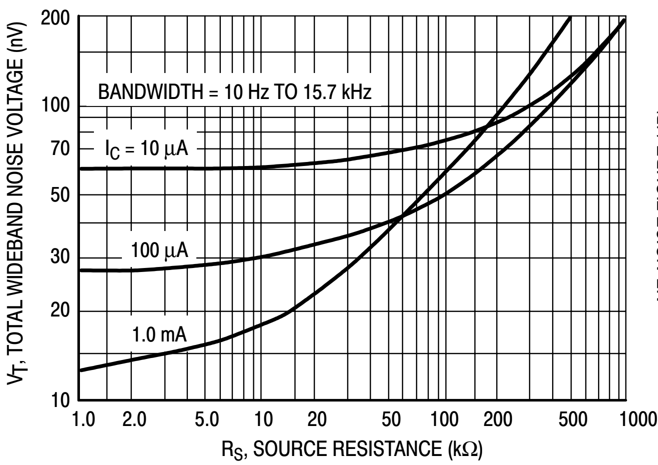


Figure 4. Total Wideband Noise Voltage

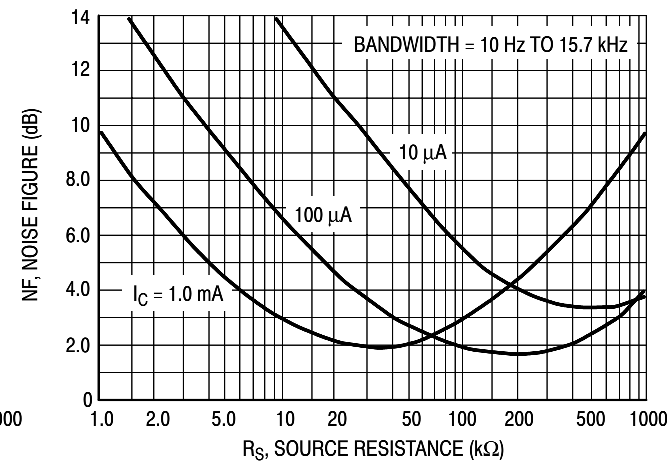


Figure 5. Wideband Noise Figure

SMALL–SIGNAL CHARACTERISTICS

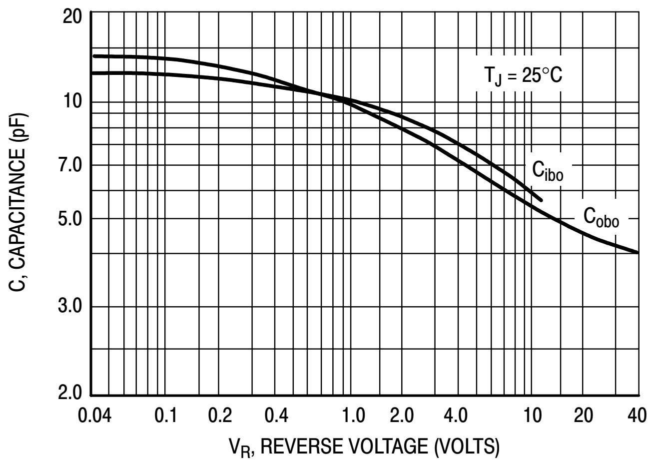


Figure 6. Capacitance

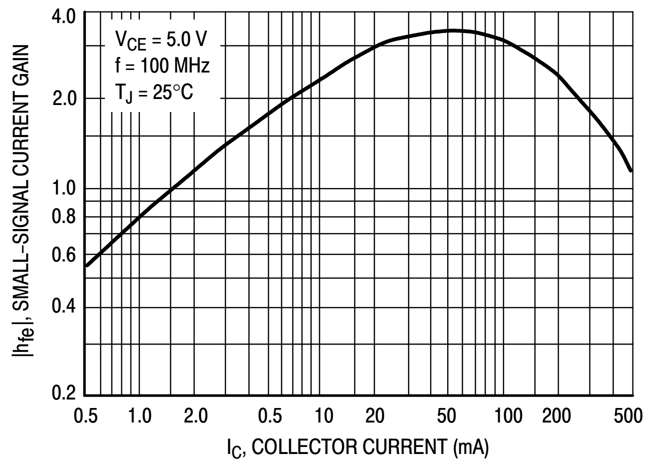


Figure 7. High Frequency Current Gain

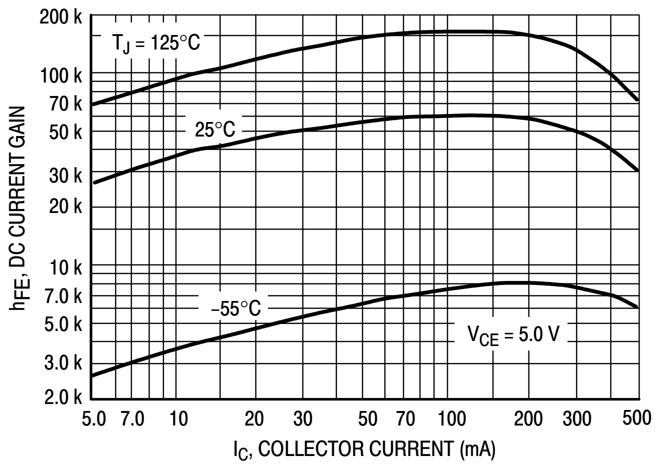


Figure 8. DC Current Gain

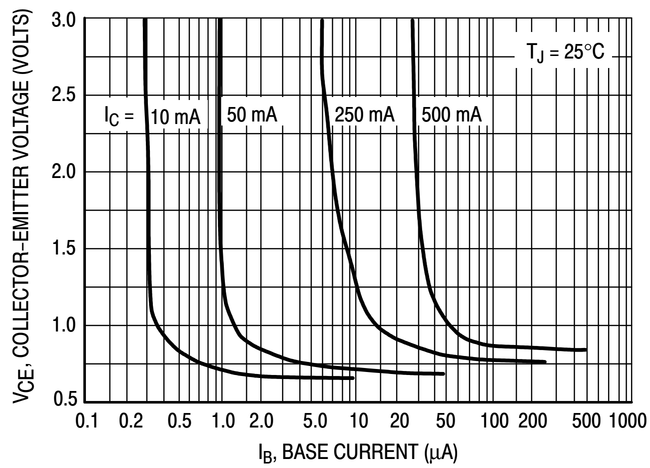


Figure 9. Collector Saturation Region

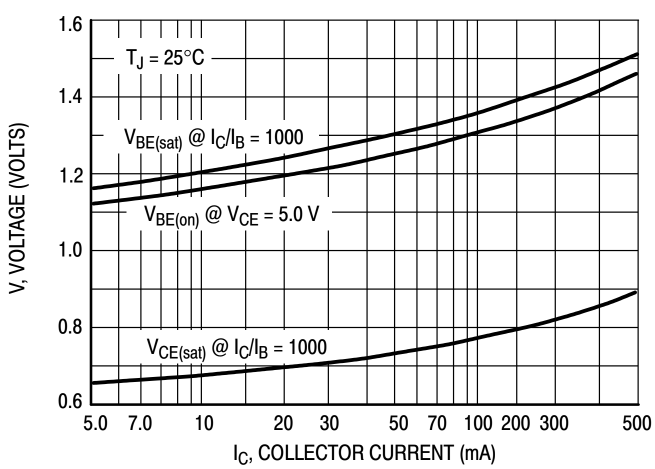


Figure 10. “On” Voltages

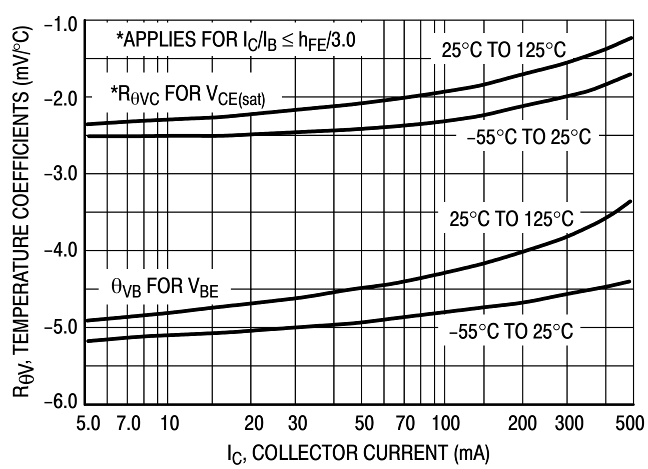


Figure 11. Temperature Coefficients

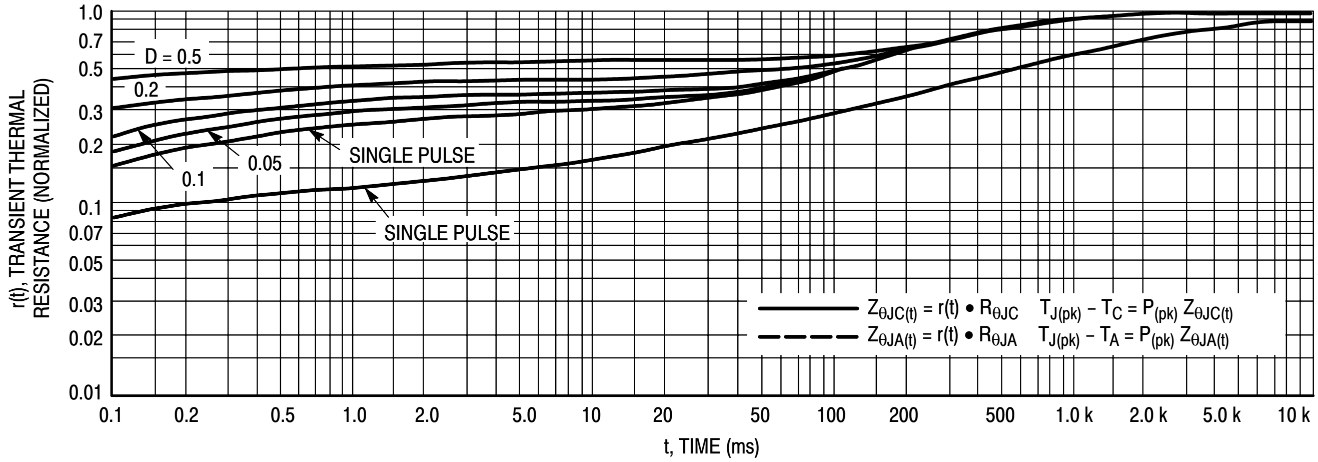


Figure 12. Thermal Response

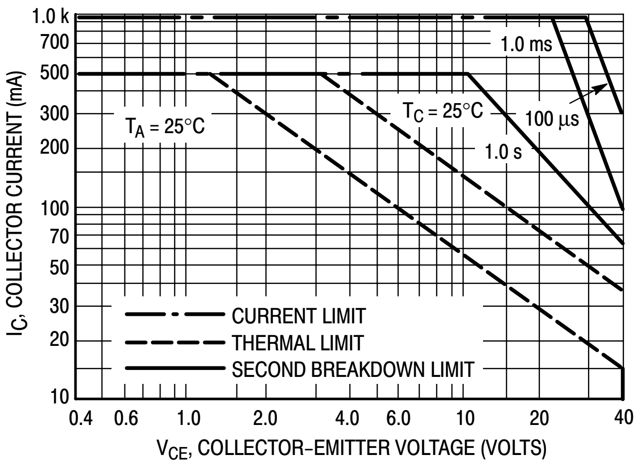
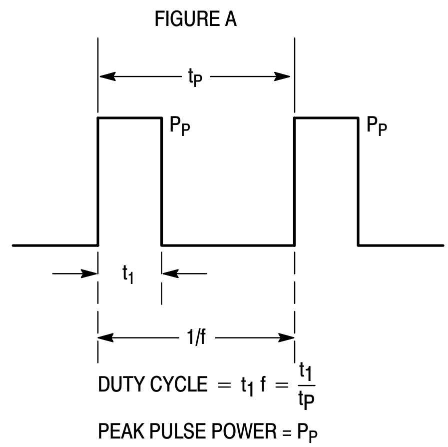


Figure 13. Active Region Safe Operating Area



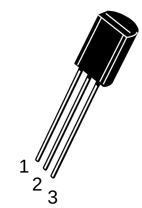
Design Note: Use of Transient Thermal Resistance Data

One Watt High Current Transistors

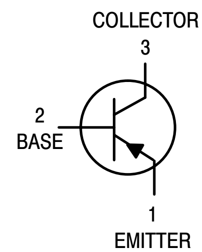
PNP Silicon

MPSW51
MPSW51A*

*ON Semiconductor Preferred Device



CASE 29–10, STYLE 1
TO–92 (TO–226AE)



MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Collector–Emitter Voltage	MPSW51 MPSW51A	V_{CEO}	–30 –40	Vdc
Collector–Base Voltage	MPSW51 MPSW51A	V_{CBO}	–40 –50	Vdc
Emitter–Base Voltage		V_{EBO}	–5.0	Vdc
Collector Current — Continuous		I_C	–1000	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C		P_D	1.0 8.0	Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C		P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range		T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(1) (I_C = –1.0 mAdc, I_B = 0)	MPSW51 MPSW51A	$V_{(BR)CEO}$	–30 –40	— —	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	MPSW51 MPSW51A	$V_{(BR)CBO}$	–40 –50	— —	Vdc
Emitter–Base Breakdown Voltage (I_E = –100 μAdc, I_C = 0)		$V_{(BR)EBO}$	–5.0	—	Vdc
Collector Cutoff Current (V_{CB} = –30 Vdc, I_E = 0) (V_{CB} = –40 Vdc, I_E = 0)	MPSW51 MPSW51A	I_{CBO}	— —	–0.1 –0.1	μAdc
Emitter Cutoff Current (V_{EB} = –3.0 Vdc, I_C = 0)		I_{EBO}	—	–0.1	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain (I_C = –10 mAdc, V_{CE} = –1.0 Vdc) (I_C = –100 mAdc, V_{CE} = –1.0 Vdc) (I_C = –1000 mAdc, V_{CE} = –1.0 Vdc)	h_{FE}	 55 60 50	 — — —	—
Collector–Emitter Saturation Voltage (I_C = –1000 mAdc, I_B = –100 mAdc)	$V_{CE(sat)}$	—	–0.7	Vdc
Base–Emitter On Voltage (I_C = –1000 mAdc, V_{CE} = –1.0 Vdc)	$V_{BE(on)}$	—	–1.2	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain – Bandwidth Product (I_C = –50 mAdc, V_{CE} = –10 Vdc, f = 20 MHz)	f_T	50	—	MHz
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	30	pF

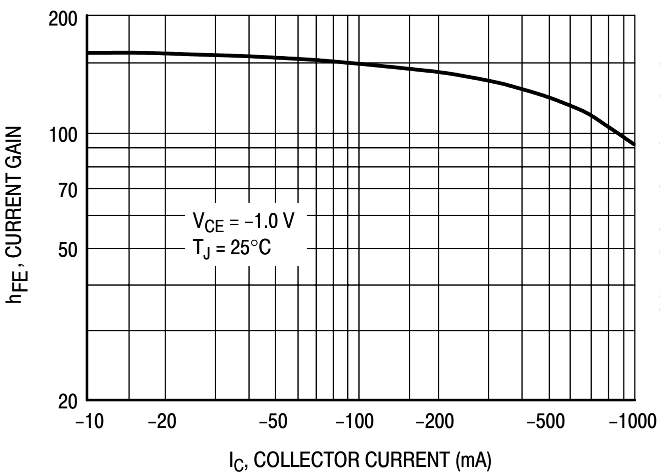


Figure 1. DC Current Gain

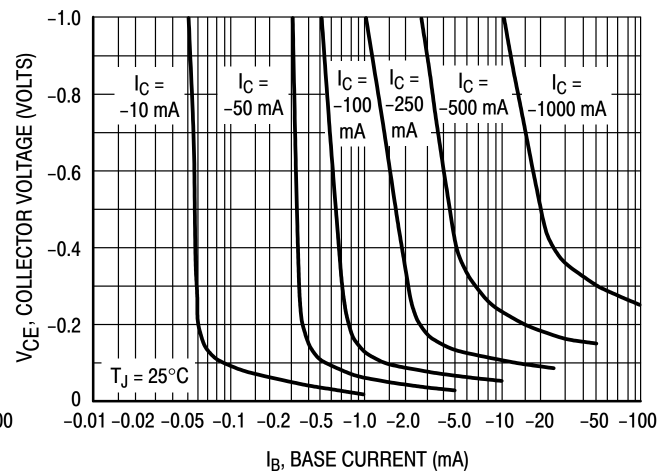


Figure 2. Collector Saturation Region

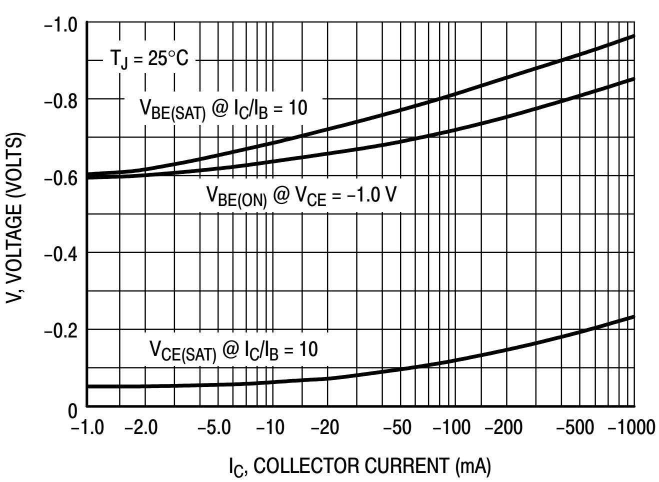


Figure 3. “ON” Voltages

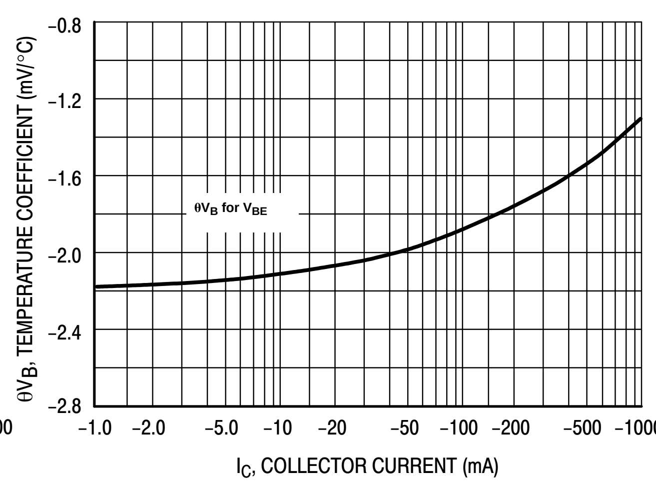


Figure 4. Temperature Coefficient

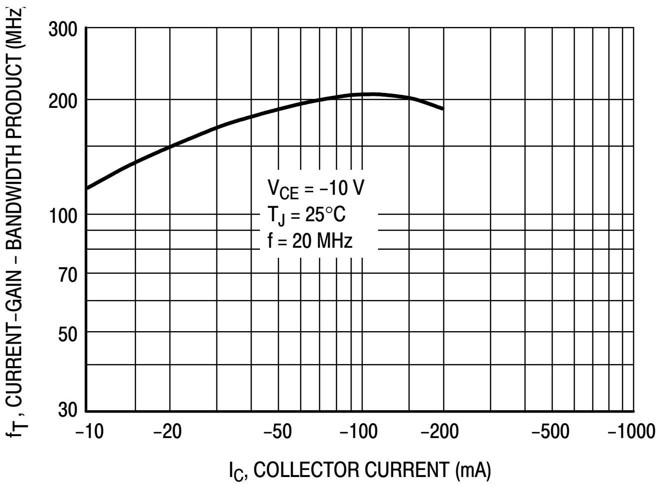


Figure 5. Current Gain — Bandwidth Product

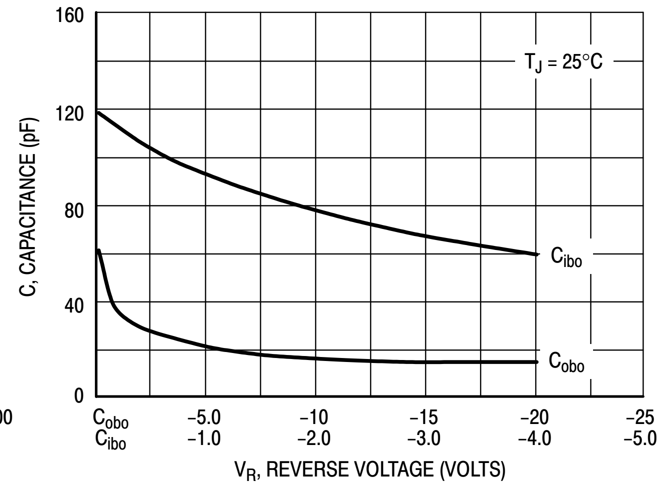


Figure 6. Capacitance

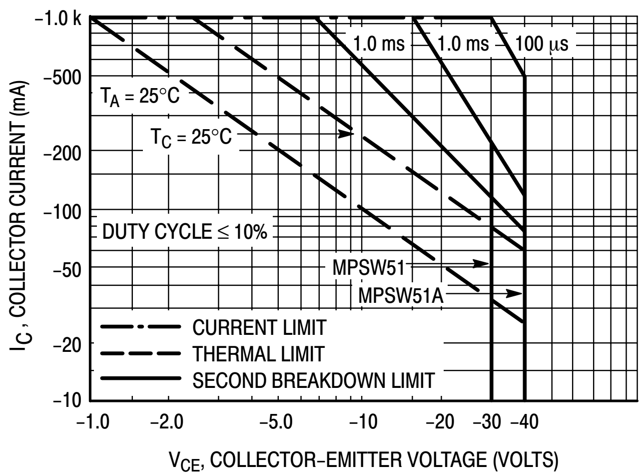
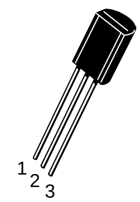


Figure 7. Active Region — Safe Operating Area

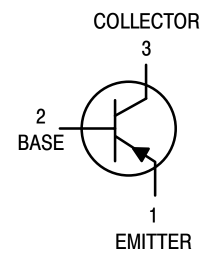
One Watt Amplifier Transistors
PNP Silicon

MPSW55
MPSW56

MPSW56 is a Preferred Device



CASE 29–10, STYLE 1
TO–92 (TO–226AE)



MAXIMUM RATINGS

Rating	Symbol	MPSW55	MPSW56	Unit
Collector–Emitter Voltage	V_{CEO}	–60	–80	Vdc
Collector–Base Voltage	V_{CBO}	–60	–80	Vdc
Emitter–Base Voltage	V_{EBO}	–4.0		Vdc
Collector Current — Continuous	I_C	–500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage(1) (I_C = –1.0 mAdc, I_B = 0)	 MPSW55 MPSW56	$V_{(BR)CEO}$	 –60 –80	 — —	Vdc
Emitter–Base Breakdown Voltage (I_E = –100 μAdc, I_C = 0)		$V_{(BR)EBO}$	–4.0	—	Vdc
Collector Cutoff Current (V_{CE} = –40 Vdc, I_B = 0) (V_{CE} = –60 Vdc, I_B = 0)	 MPSW55 MPSW56	I_{CES}	 — —	 –0.5 –0.5	μAdc
Collector Cutoff Current (V_{CB} = –40 Vdc, I_E = 0) (V_{CB} = –60 Vdc, I_E = 0)	 MPSW55 MPSW56	I_{CBO}	 — —	 –0.1 –0.1	μAdc
Emitter Cutoff Current (V_{EB} = –3.0 Vdc, I_C = 0)		I_{EBO}	—	–0.1	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS(1)				
DC Current Gain (I_C = –50 mAdc, V_{CE} = –1.0 Vdc) (I_C = –250 mAdc, V_{CE} = –1.0 Vdc)	h_{FE}	 100 50	 — —	—
Collector–Emitter Saturation Voltage (I_C = –250 mAdc, I_B = –10 mAdc)	$V_{CE(sat)}$	—	–0.5	Vdc
Base–Emitter On Voltage (I_C = –250 mAdc, V_{CE} = –5.0 Vdc)	$V_{BE(on)}$	—	–1.2	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = –250 mAdc, V_{CE} = –5.0 Vdc, f = 20 MHz)	f_T	50	—	MHz
Output Capacitance (V_{CB} = –10 Vdc, f = 1.0 MHz)	C_{obo}	—	15	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

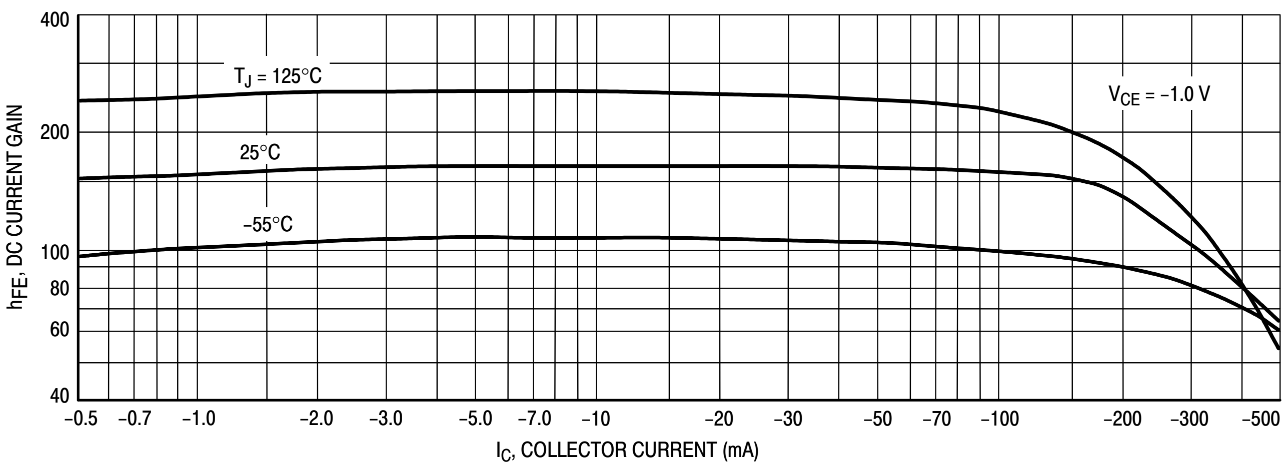


Figure 1. DC Current Gain

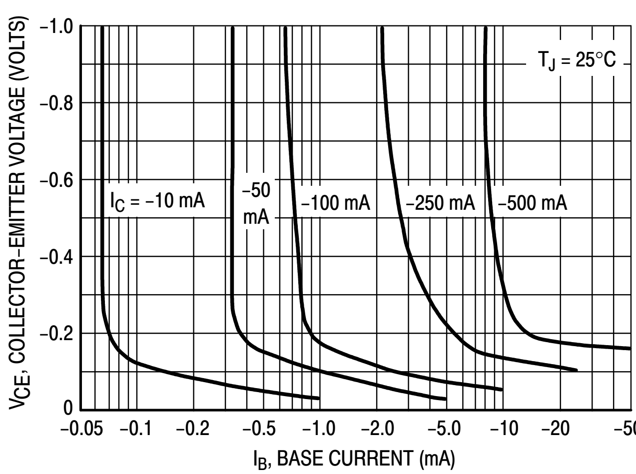


Figure 2. Collector Saturation Region

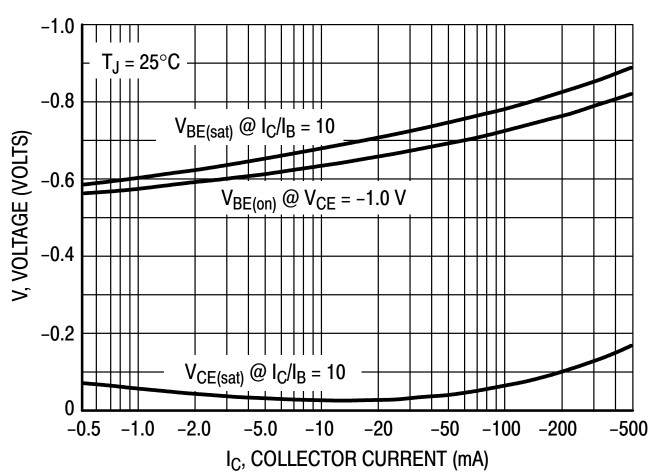


Figure 3. "On" Voltages

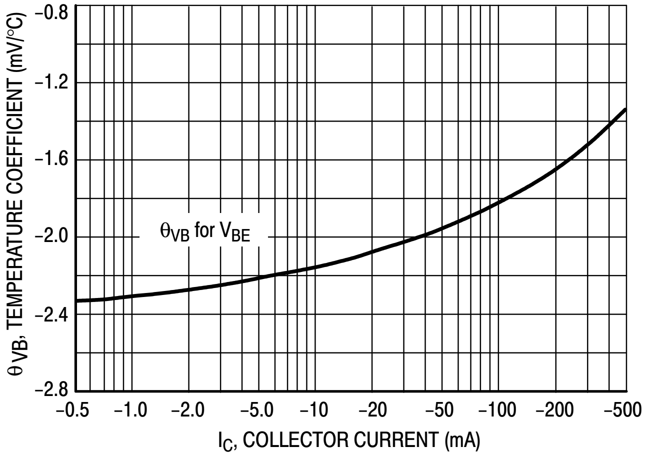


Figure 4. Base–Emitter Temperature Coefficient

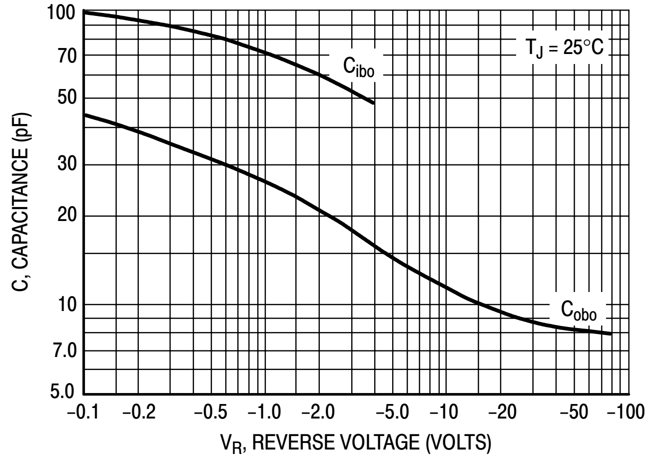


Figure 5. Capacitance

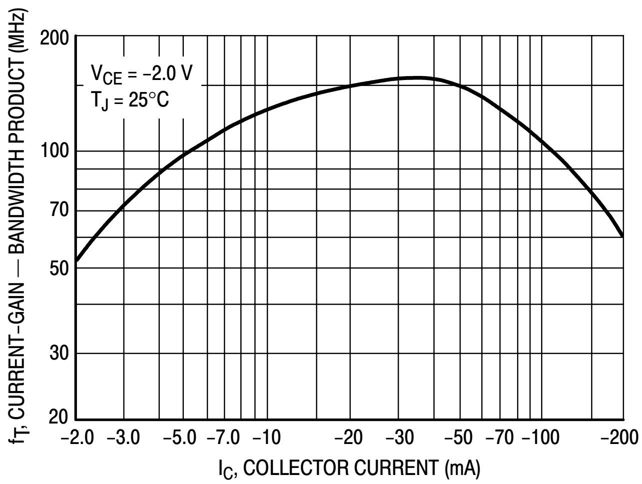


Figure 6. Current–Gain — Bandwidth Product

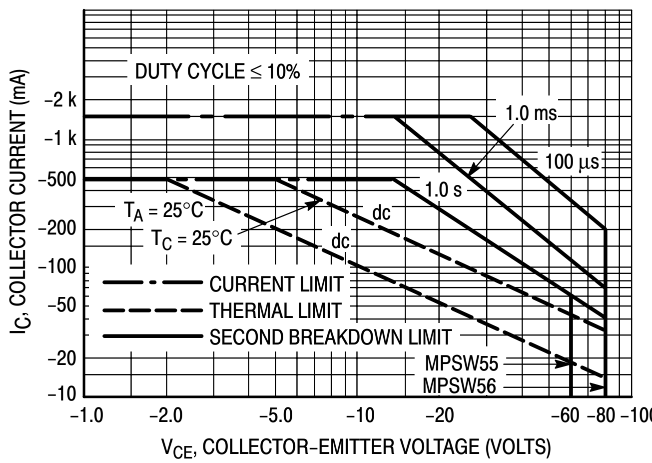
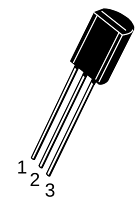


Figure 7. Active Region — Safe Operating Area

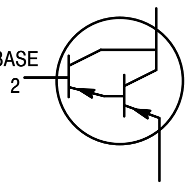
One Watt Darlington Transistors
PNP Silicon

MPSW63
MPSW64*

*ON Semiconductor Preferred Device



CASE 29–10, STYLE 1
TO–92 (TO–226AE)



MAXIMUM RATINGS

Rating	Symbol	MPSW63 MPSW64	Unit
Collector–Emitter Voltage	V_{CES}	–30	Vdc
Collector–Base Voltage	V_{CBO}	–30	Vdc
Emitter–Base Voltage	V_{EBO}	–10	Vdc
Collector Current — Continuous	I_C	–500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –100 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	–30	—	Vdc
Collector Cutoff Current (V_{CB} = –30 Vdc, I_E = 0)	I_{CBO}	—	–100	nAdc
Emitter Cutoff Current (V_{EB} = –10 Vdc, I_C = 0)	I_{EBO}	—	–100	nAdc

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]					
DC Current Gain		h_{FE}			—
(I_C = –10 mAdc, V_{CE} = –5.0 Vdc)	MPSW63		5,000	—	
	MPSW64		10,000	—	
(I_C = –100 mAdc, V_{CE} = –5.0 Vdc)	MPSW63		10,000	—	
	MPSW64		20,000	—	
Collector–Emitter Saturation Voltage (I_C = –100 mAdc, I_B = –0.1 mAdc)		$V_{CE(sat)}$	—	–1.5	Vdc
Base–Emitter On Voltage (I_C = –100 mAdc, V_{CE} = –5.0 Vdc)		$V_{BE(on)}$	—	–2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain — Bandwidth Product[2] (I_C = –10 mAdc, V_{CE} = –5.0 Vdc, f = 100 MHz)		f_T	125	—	MHz

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
2. $f_T = |h_{fe}| \bullet f_{test}$.

TYPICAL ELECTRICAL CHARACTERISTICS

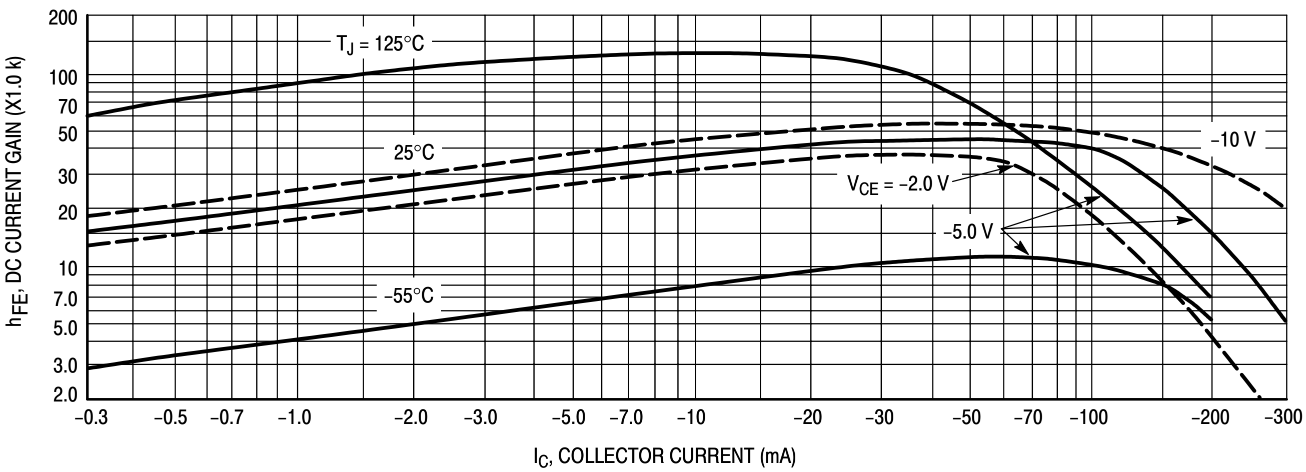


Figure 1. DC Current Gain

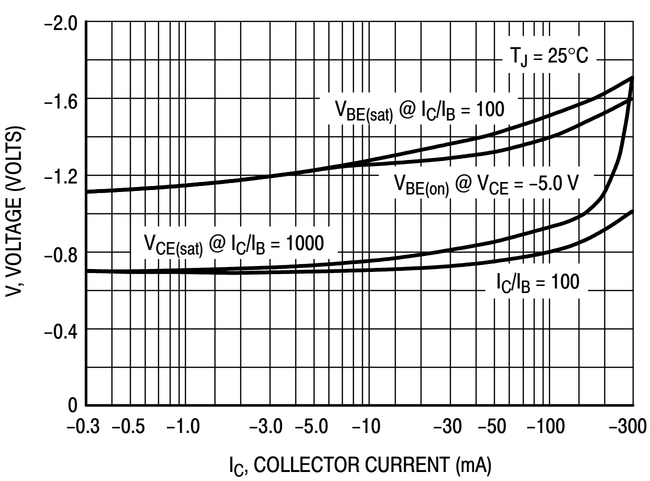


Figure 2. "ON" Voltage

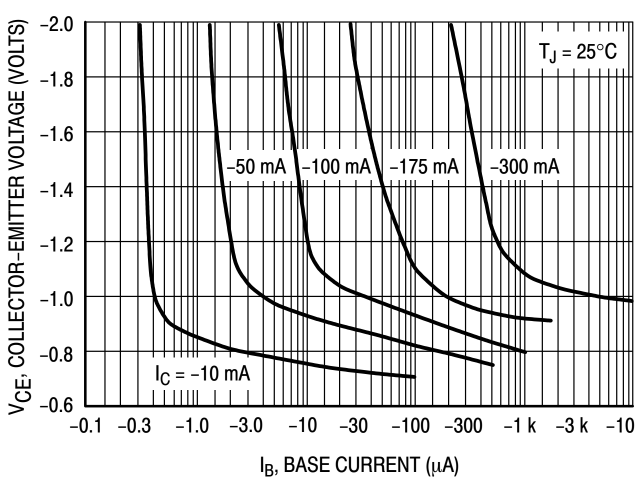


Figure 3. Collector Saturation Region

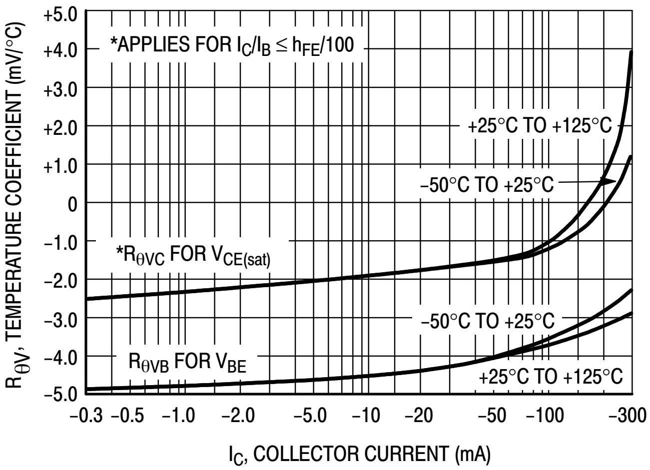


Figure 4. Temperature Coefficients

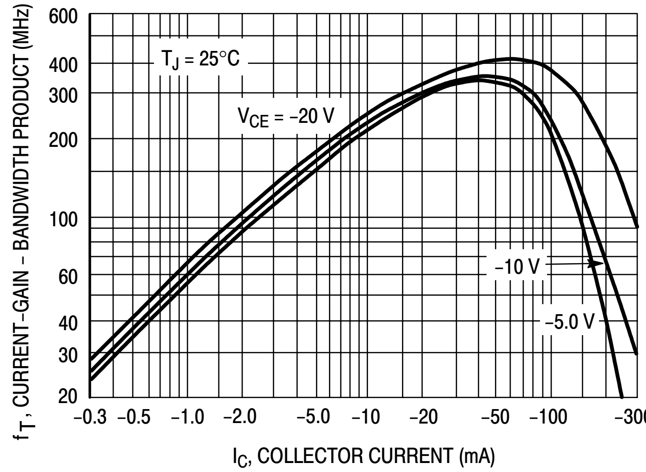


Figure 5. Current–Gain — Bandwidth Product

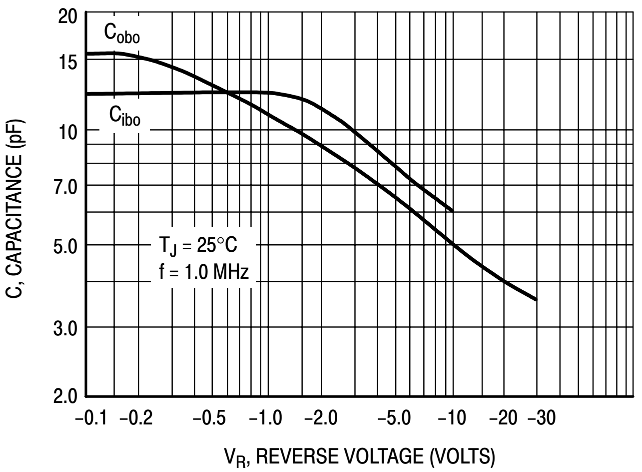


Figure 6. Capacitance

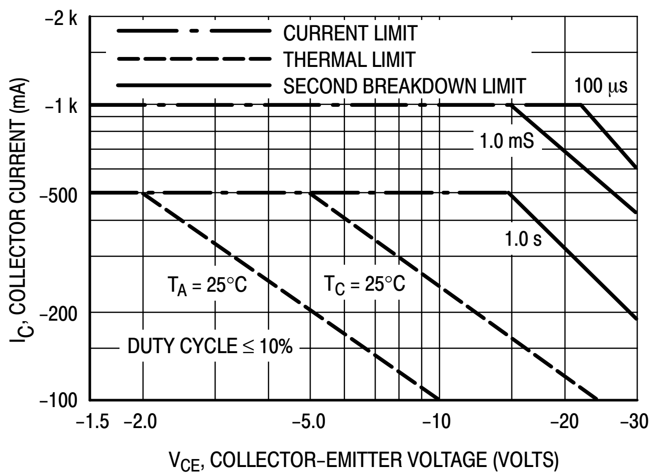


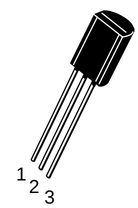
Figure 7. Active Region, Safe Operating Area

One Watt High Voltage Transistor

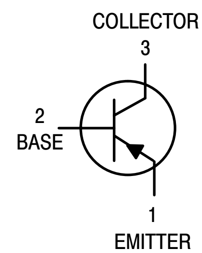
PNP Silicon

MPSW92

ON Semiconductor Preferred Device



CASE 29–10, STYLE 1
TO–92 (TO–226AE)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–300	Vdc
Collector–Base Voltage	V_{CBO}	–300	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current — Continuous	I_C	–500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(1) (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–300	—	Vdc
Collector–Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–300	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –100 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	Vdc
Collector Cutoff Current (V_{CB} = –200 Vdc, I_E = 0)	I_{CBO}	—	–0.25	μAdc
Emitter Cutoff Current (V_{EB} = –3.0 Vdc, I_C = 0)	I_{EBO}	—	–0.1	μAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 2

Publication Order Number:
MPSW92/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS[1]				
DC Current Gain	h_{FE}			—
(I_C = –1.0 mAdc, V_{CE} = –10 Vdc)		25	—	
(I_C = –10 mAdc, V_{CE} = –10 Vdc)		40	—	
(I_C = –30 mAdc, V_{CE} = –10 Vdc)		25	—	
Collector–Emitter Saturation Voltage (I_C = –20 mAdc, I_B = –2.0 mAdc)	$V_{CE(sat)}$	—	–0.5	Vdc
Base–Emitter Saturation Voltage (I_C = –20 mAdc, I_B = –2.0 mAdc)	$V_{BE(sat)}$	—	–0.9	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 20 MHz)	f_T	50	—	MHz
Collector–Base Capacitance (V_{CB} = –20 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	6.0	pF

1. Pulse Test: Pulse Width $\leq$ 300 μs, Duty Cycle $\leq$ 2.0%.

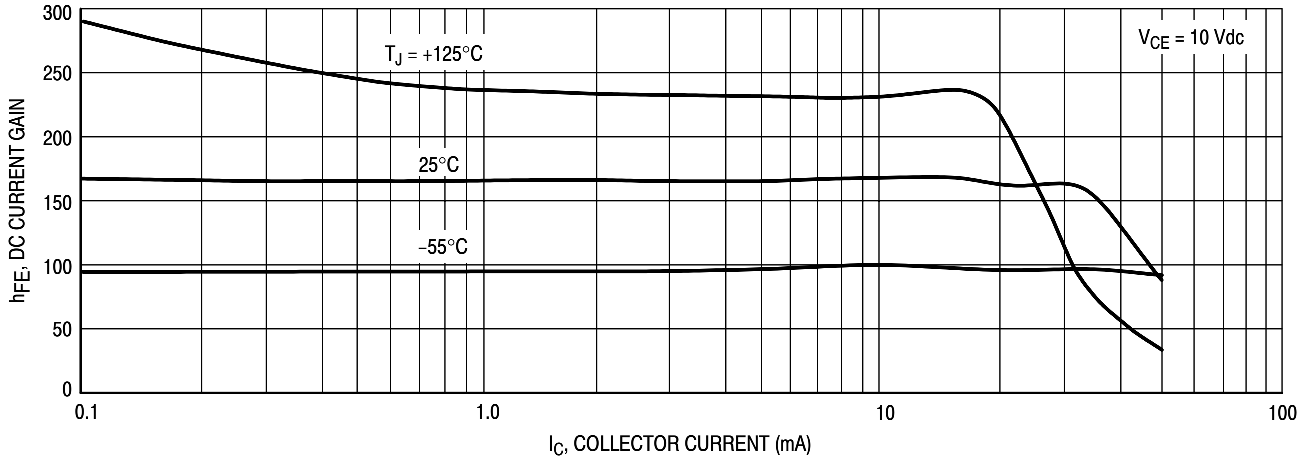


Figure 1. DC Current Gain

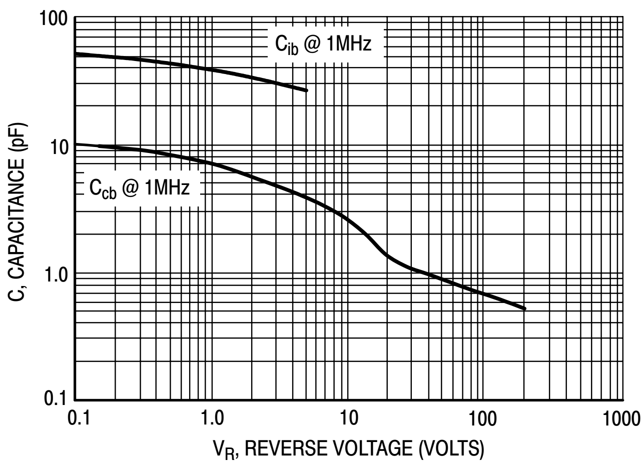


Figure 2. Capacitance

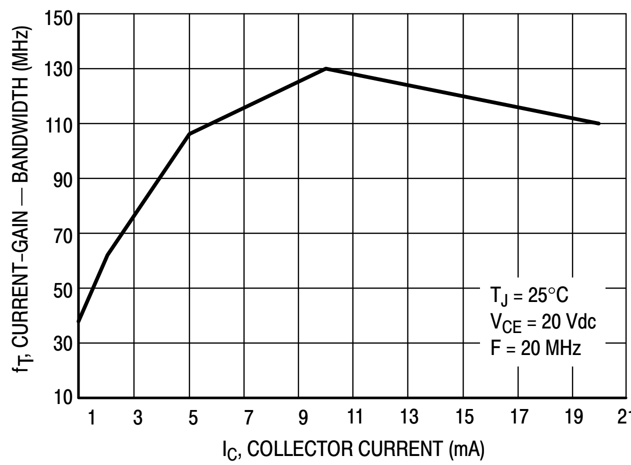


Figure 3. Current–Gain — Bandwidth

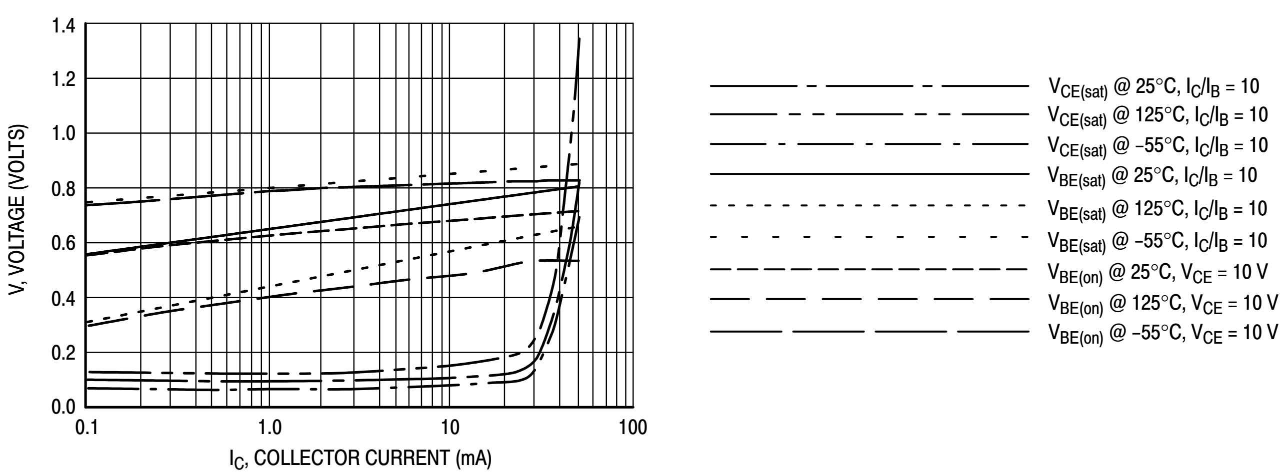


Figure 4. ”ON” Voltages

MSA1162GT1, MSA1162YT1

General Purpose Amplifier Transistors

PNP Surface Mount

- Moisture Sensitivity Level: 1
- ESD Rating: TBD

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	$V_{(BR)CBO}$	60	Vdc
Collector–Emitter Voltage	$V_{(BR)CEO}$	50	Vdc
Emitter–Base Voltage	$V_{(BR)EBO}$	7.0	Vdc
Collector Current – Continuous	I_C	100	mAdc
Collector Current – Peak	$I_{C(P)}$	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 to +150	°C

ON Semiconductor™

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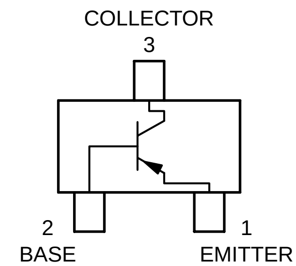
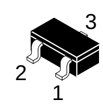
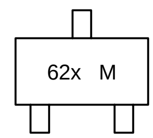




SC–59
CASE 318D
STYLE 1

MARKING DIAGRAM



62x = Specific Device Code
x = G or Y
M = Date Code

ORDERING INFORMATION

Device †	Package	Shipping
MSA1162GT1	SC–59	3000/Tape & Reel
MSA1162YT1	SC–59	3000/Tape & Reel

†The "T1" suffix refers to a 7 inch reel.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Collector–Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	–	Vdc
Collector–Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)	$V_{(BR)EBO}$	7.0	–	Vdc
Collector–Base Cutoff Current (V_{CB} = 45 Vdc, I_E = 0)	I_{CBO}	–	0.1	µAdc
Collector–Emitter Cutoff Current	I_{CEO}			
(V_{CE} = 10 Vdc, I_B = 0)		–	0.1	µAdc
(V_{CE} = 30 Vdc, I_B = 0)		–	2.0	nAdc
(V_{CE} = 30 Vdc, I_B = 0, T_A = 80°C)		–	1.0	mAdc
DC Current Gain (Note 1.)	h_{FE}			–
(V_{CE} = 6.0 Vdc, I_C = 2.0 mAdc) MSA1162YT1		120	240	
MSA1162GT1		200	400	
Collector–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	0.5	Vdc

1. Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

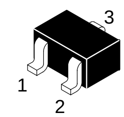
PNP Silicon General Purpose Amplifier Transistor

MSB1218A-RT1

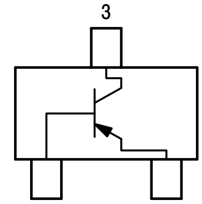
ON Semiconductor Preferred Devices

This PNP Silicon Epitaxial Planar Transistor is designed for general purpose amplifier applications. This device is housed in the SC–70/SOT–323 package which is designed for low power surface mount applications.

- High h_{FE}, 210–460
- Low $V_{CE(sat)}$, < 0.5 V
- Available in 8 mm, 7–inch/3000 Unit Tape and Reel



CASE 419–04, STYLE 3
SC–70/SOT–323



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	$V_{(BR)CBO}$	45	Vdc
Collector–Emitter Voltage	$V_{(BR)CEO}$	45	Vdc
Emitter–Base Voltage	$V_{(BR)EBO}$	7.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Collector Current — Peak	$I_{C(P)}$	200	mAdc

DEVICE MARKING

MSB1218A–RT1 = BR

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation(1)	P_D	150	mW
Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	–55 ~ +150	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Collector–Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	45	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	45	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_E = 0)	$V_{(BR)EBO}$	7.0	—	Vdc
Collector–Base Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	0.1	μA
Collector–Emitter Cutoff Current (V_{CE} = 10 Vdc, I_B = 0)	I_{CEO}	—	100	μA
DC Current Gain(2) (V_{CE} = 10 Vdc, I_C = 2.0 mAdc)	h_{FE1}	210	340	—
Collector–Emitter Saturation Voltage(2) (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	—	0.5	Vdc

1. Device mounted on a FR–4 glass epoxy printed circuit board using the minimum recommended footprint.
2. Pulse Test: Pulse Width ≤ 300 μs, D.C. ≤ 2%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 3

Publication Order Number:
MSB1218A–RT1/D

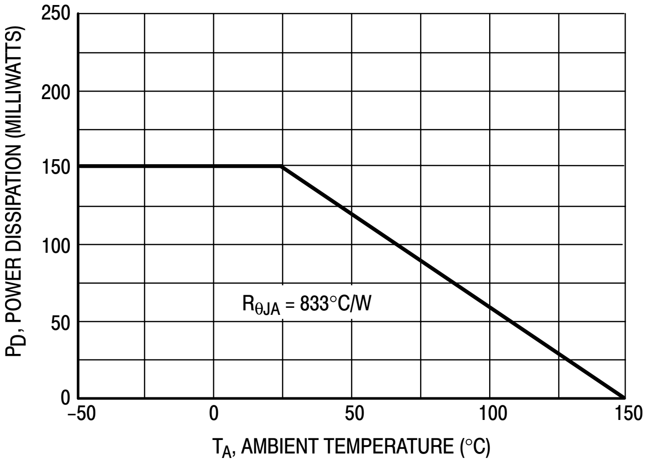


Figure 1. Derating Curve

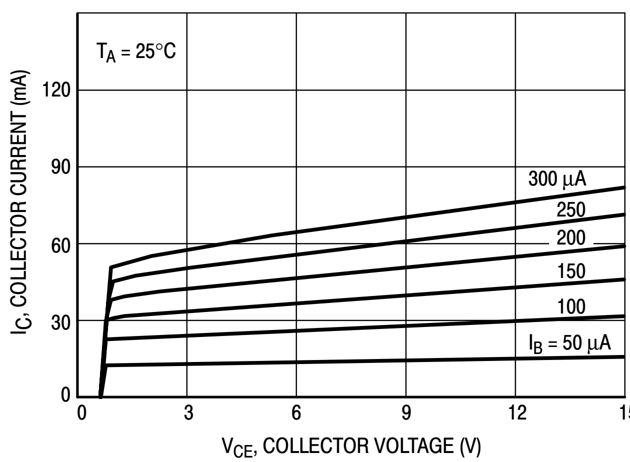


Figure 2. I_C – V_{CE}

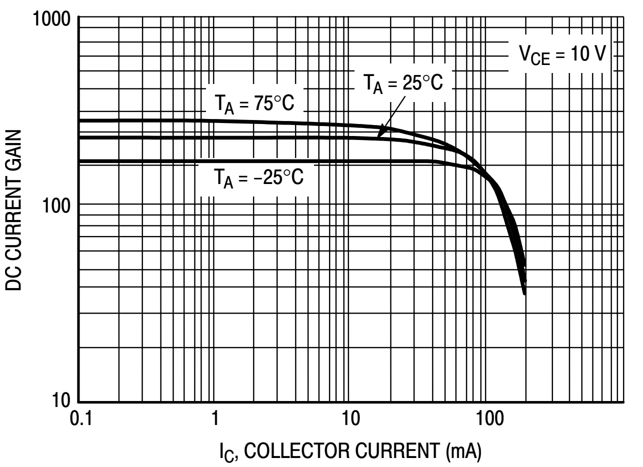


Figure 3. DC Current Gain

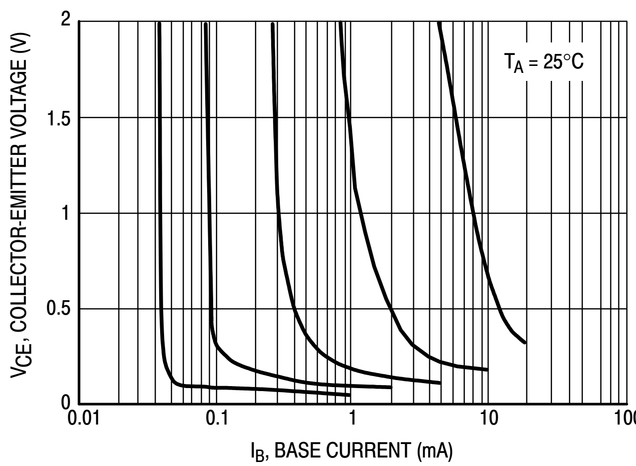


Figure 4. Collector Saturation Region

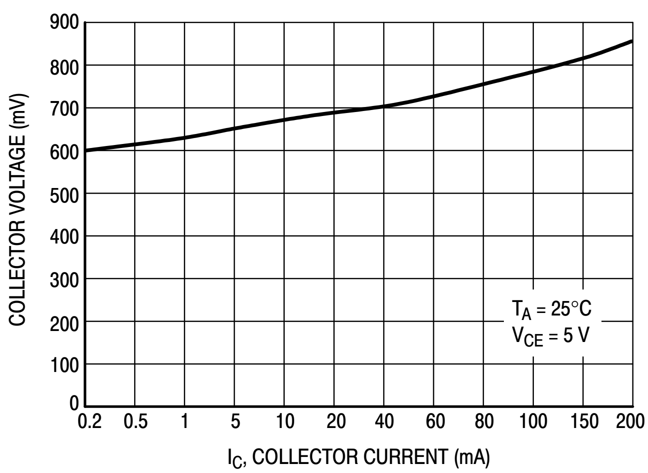


Figure 5. On Voltage

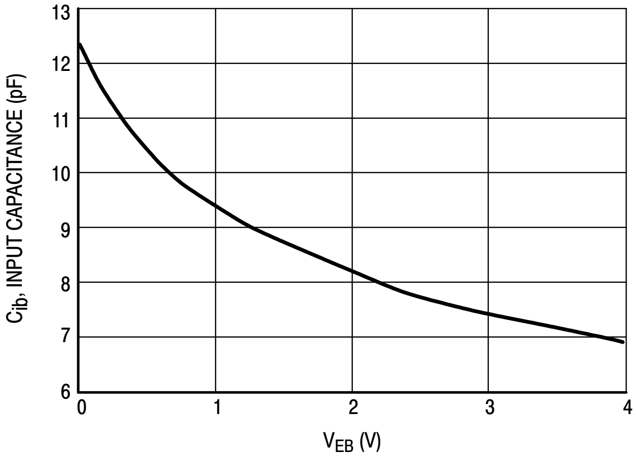


Figure 6. Capacitance

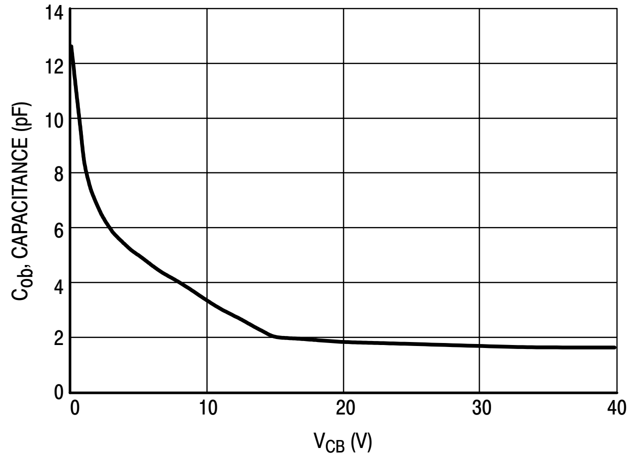
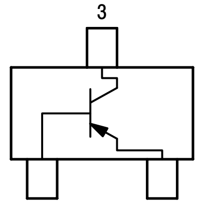


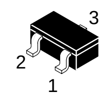
Figure 7. Capacitance

PNP General Purpose Amplifier Transistor Surface Mount

MSB709-RT1

ON Semiconductor Preferred Device





CASE 318D–04, STYLE 1
SC–59

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	$V_{(BR)CBO}$	–60	Vdc
Collector–Emitter Voltage	$V_{(BR)CEO}$	–45	Vdc
Emitter–Base Voltage	$V_{(BR)EBO}$	–7.0	Vdc
Collector Current — Continuous	I_C	–100	mAdc
Collector Current — Peak	$I_{C(P)}$	–200	mAdc

THERMAL CHARACTERISTICS

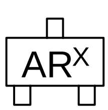
Characteristic	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Min	Max	Unit
Collector–Emitter Breakdown Voltage (I_C = –2.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–45	—	Vdc
Collector–Base Breakdown Voltage (I_C = –10 µAdc, I_E = 0)	$V_{(BR)CBO}$	–60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 µAdc, I_E = 0)	$V_{(BR)EBO}$	–7.0	—	Vdc
Collector–Base Cutoff Current (V_{CB} = –45 Vdc, I_E = 0)	I_{CBO}	—	–0.1	µAdc
Collector–Emitter Cutoff Current (V_{CE} = –10 Vdc, I_B = 0)	I_{CEO}	—	–100	nAdc
DC Current Gain[(1)] (V_{CE} = –10 Vdc, I_C = –2.0 mAdc)	h_{FE1}	210	340	—
Collector–Emitter Saturation Voltage (I_C = –100 mAdc, I_B = –10 mAdc)	$V_{CE(sat)}$	—	–0.5	Vdc

1. Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

DEVICE MARKING



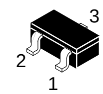
The “X” represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

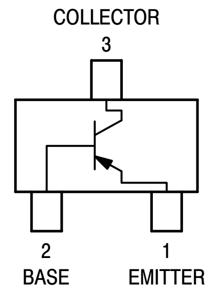
PNP General Purpose Amplifier Transistor Surface Mount

MSB710-RT1

ON Semiconductor Preferred Device



CASE 318D–04, STYLE 1
SC–59



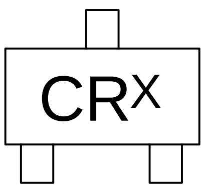
MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	$V_{(BR)CBO}$	–60	Vdc
Collector–Emitter Voltage	$V_{(BR)CEO}$	–50	Vdc
Emitter–Base Voltage	$V_{(BR)EBO}$	–7.0	Vdc
Collector Current — Continuous	I_C	–500	mAdc
Collector Current — Peak	$I_{C(P)}$	–1.0	Adc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

DEVICE MARKING



The “X” represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Min	Max	Unit
Collector–Emitter Breakdown Voltage (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–50	—	Vdc
Collector–Base Breakdown Voltage (I_C = –10 µAdc, I_E = 0)	$V_{(BR)CBO}$	–60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 µAdc, I_C = 0)	$V_{(BR)EBO}$	–7.0	—	Vdc
Collector–Base Cutoff Current (V_{CB} = –20 Vdc, I_E = 0)	I_{CBO}	—	–0.1	µAdc
DC Current Gain(1)				—
(V_{CE} = –10 Vdc, I_C = –150 mAdc)	h_{FE1}	120	240	
(V_{CE} = –10 Vdc, I_C = 500 mAdc)	h_{FE2}	40	—	
Collector–Emitter Saturation Voltage (I_C = –300 mAdc, I_B = –30 mAdc)	$V_{CE(sat)}$	—	–0.6	Vdc
Collector–Base Saturation Voltage (I_C = –300 mAdc, I_B = –30 mAdc)	$V_{BE(sat)}$	—	–1.5	Vdc
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	15	pF

1. Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

MSB92WT1, MSB92AWT1

Preferred Device

Product Preview

PNP Silicon General Purpose High Voltage Transistor

This PNP Silicon Planar Transistor is designed for general purpose amplifier applications. This device is housed in the SC-70/SOT-323 package which is designed for low power surface mount applications.

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector-Base Voltage	$V_{(BR)CBO}$	–300	Vdc
Collector-Emitter Voltage	$V_{(BR)CEO}$	–300	Vdc
Emitter-Base Voltage	$V_{(BR)EBO}$	–5.0	Vdc
Collector Current – Continuous	I_C	500	mAdc
Electrostatic Discharge	ESD	MBM > 16,000, MM > 2,000	V

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power Dissipation (Note 1.)	P_D	150	mW
Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	–55 ~ +150	°C

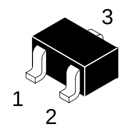
1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.

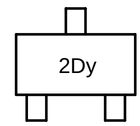
ON Semiconductor

http://onsemi.com

DEVICE MARKINGS

MSB92WT1

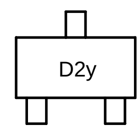




y = Date Code

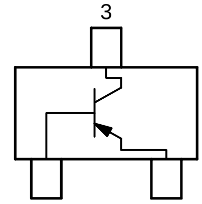
SC–70/SOT–323
CASE 419
STYLE 3

MSB92AWT1



y = Date Code

COLLECTOR
3



1 BASE
2 EMITTER

ORDERING INFORMATION

Device	Package	Shipping
MSB92WT1	SC–70/ SOT–323	8mm Tape & Reel (7–inch/3000 Unit)
MSB92AWT1	SC–70/ SOT–323	8mm Tape & Reel (7–inch/3000 Unit)

Preferred devices are recommended choices for future use and best overall value.

This document contains information on a product under development. ON Semiconductor reserves the right to change or discontinue this product without notice.

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Collector-Emitter Breakdown Voltage (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–300	–	Vdc
Collector-Base Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–300	–	Vdc
Emitter-Base Breakdown Voltage (I_E = –100 μAdc, I_E = 0)	$V_{(BR)EBO}$	–5.0	–	Vdc
Collector-Base Cutoff Current (V_{CB} = –200 Vdc, I_E = 0)	I_{CBO}	–	–0.25	μA
Emitter–Base Cutoff Current (V_{EB} = –3.0 Vdc, I_B = 0)	I_{EBO}	–	–0.1	μA
DC Current Gain (Note 2.) MSB92WT1: (V_{CE} = –10 Vdc, I_C = –1.0 mAdc) MSB92AWT1: (V_{CE} = –10 Vdc, I_C = –1.0 mAdc) (V_{CE} = –10 Vdc, I_C = –10 mAdc) (V_{CE} = –10 Vdc, I_C = –30 mAdc)	 h_{FE1} h_{FE1} h_{FE2} h_{FE3}	 25 120 40 25	 – 200 – –	–
Collector-Emitter Saturation Voltage (Note 2.) (I_C = –20 mAdc, I_B = –2.0 mAdc)	$V_{CE(sat)}$	–	–0.5	Vdc
Base–Emitter Saturation Voltage (I_C = –20 mAdc, I_B = –2.0 mAdc)	$V_{BE(sat)}$	–	–0.9	Vdc

SMALL SIGNAL CHARACTERISTICS

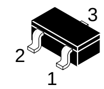
Characteristic	Symbol	Min	Max	Unit
Current–Gain – Bandwidth Product (I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 20 MHz)	f_T	50	–	MHz
Collector–Base Capacitance (V_{CB} = –20 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	6.0	pF

2. Pulse Test: Pulse Width ≤ 300 μs, D.C. ≤ 2%.

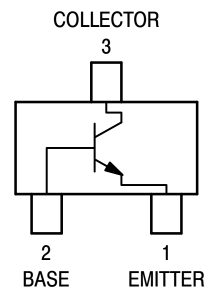
NPN RF Amplifier Transistors Surface Mount

MSC2295-BT1
MSC2295-CT1

ON Semiconductor Preferred Devices



CASE 318D–04, STYLE 1
SC–59



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	$V_{(BR)CBO}$	30	Vdc
Collector–Emitter Voltage	$V_{(BR)CEO}$	20	Vdc
Emitter–Base Voltage	$V_{(BR)EBO}$	5.0	Vdc
Collector Current — Continuous	I_C	30	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

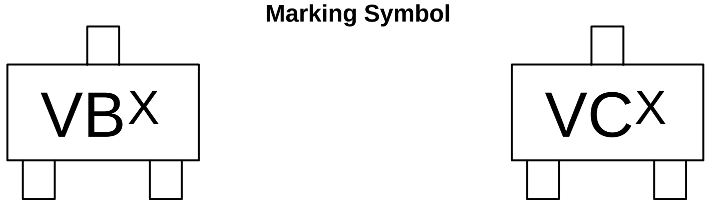
ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Min	Max	Unit
Collector–Base Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	0.1	µAdc
DC Current Gain(1) (V_{CB} = 10 Vdc, I_C = –1.0 mAdc) MSC2295–BT1	h_{FE}	70	140	—
MSC2295–CT1		110	220	
Collector–Gain — Bandwidth Product (V_{CB} = 10 Vdc, I_E = –1.0 mAdc)	f_T	150	—	MHz
Reverse Transistor Capacitance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 10.7 MHz)	C_{re}	—	1.5	pF

1. Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

DEVICE MARKING

Marking Symbol



MSC2295–BT1 **MSC2295–CT1**

The “X” represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

MSC2712GT1

General Purpose Amplifier Transistor

NPN Surface Mount

- Moisture Sensitivity Level: 1
- ESD Rating: TBD

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	$V_{(BR)CBO}$	60	Vdc
Collector–Emitter Voltage	$V_{(BR)CEO}$	50	Vdc
Emitter–Base Voltage	$V_{(BR)EBO}$	7.0	Vdc
Collector Current – Continuous	I_C	100	mAdc
Collector Current – Peak	$I_{C(P)}$	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 to +150	°C

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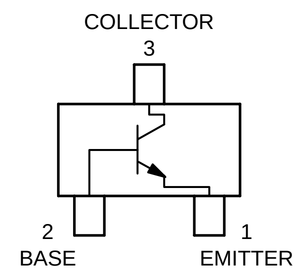
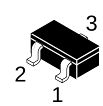
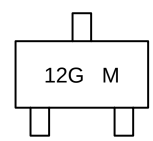




SC–59
CASE 318D
STYLE 1

MARKING DIAGRAM



12G = Specific Device Code
M = Date Code

ORDERING INFORMATION

Device †	Package	Shipping
MSC2712GT1	SC–59	3000/Tape & Reel

†The “T1” suffix refers to a 7 inch reel.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

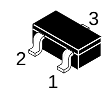
Characteristic	Symbol	Min	Max	Unit
Collector–Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	–	Vdc
Collector–Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)	$V_{(BR)EBO}$	7.0	–	Vdc
Collector–Base Cutoff Current (V_{CB} = 45 Vdc, I_E = 0)	I_{CBO}	–	0.1	µAdc
Collector–Emitter Cutoff Current (V_{CE} = 10 Vdc, I_B = 0) (V_{CE} = 30 Vdc, I_B = 0) (V_{CE} = 30 Vdc, I_B = 0, T_A = 80°C)	I_{CEO}	 – – –	 0.1 2.0 1.0	 µAdc nAdc mAdc
DC Current Gain (Note 1.) (V_{CE} = 6.0 Vdc, I_C = 2.0 mAdc)	h_{FE}	 200	 400	–
Collector–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	0.5	Vdc

1. Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

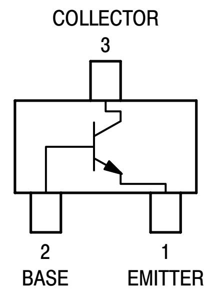
NPN RF Amplifier Transistor Surface Mount

MSC3130T1

ON Semiconductor Preferred Device



CASE 318D–04, STYLE 1
SC–59



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	V_{CBO}	15	Vdc
Collector–Emitter Voltage	V_{CEO}	10	Vdc
Emitter–Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

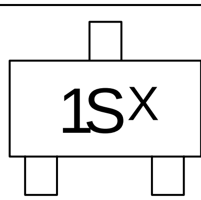
ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Min	Max	Unit
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	1.0	μAdc
Collector–Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)	V_{CEO}	10	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	V_{EBO}	3.0	—	Vdc
DC Current Gain(1) (V_{CE} = 4.0 Vdc, I_C = 5.0 mAdc)	h_{FE}	75	400	—
Collector–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 4.0 mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Current–Gain — Bandwidth Product (V_{CB} = 4.0 Vdc, I_E = –5.0 mAdc)	f_T	1.4	2.5	GHz

1. Pulse Test: Pulse Width ≤ 300 μs, D.C. ≤ 2%.

DEVICE MARKING

Marking Symbol



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Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 1

Publication Order Number:
MSC3130T1/D

MSC3930-BT1

Preferred Device

NPN RF Amplifier Transistor

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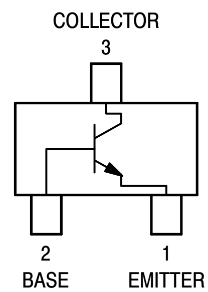
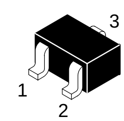
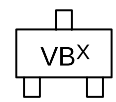




SOT–323/SC–70
CASE 419
STYLE 3

MARKING DIAGRAM



X = Date Code

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	$V_{(BR)CBO}$	30	Vdc
Collector–Emitter Voltage	$V_{(BR)CEO}$	20	Vdc
Emitter–Base Voltage	$V_{(BR)EBO}$	5.0	Vdc
Collector Current — Continuous	I_C	30	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Min	Max	Unit
Collector–Base Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	0.1	μAdc
DC Current Gain(1) (V_{CB} = 10 Vdc, I_C = –1.0 mAdc)	h_{FE}	70	140	—
Collector–Gain — Bandwidth Product (V_{CB} = 10 Vdc, I_E = –1.0 mAdc)	f_T	150	—	MHz
Reverse Transistor Capacitance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 10.7 MHz)	C_{re}	—	1.5	pF

1. Pulse Test: Pulse Width ≤ 300 μs, D.C. ≤ 2%.

ORDERING INFORMATION

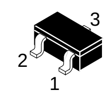
Device	Package	Shipping
MSC3930–BT1	SC–70	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

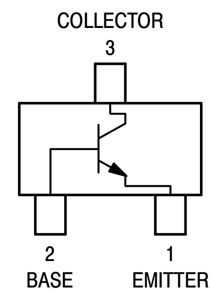
NPN Low Voltage Output Amplifiers - Surface Mount

MSD1328-RT1
MSD1328-ST1

ON Semiconductor Preferred Device



CASE 318D–04, STYLE 1
SC–59



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	$V_{(BR)CBO}$	25	Vdc
Collector–Emitter Voltage	$V_{(BR)CEO}$	20	Vdc
Emitter–Base Voltage	$V_{(BR)EBO}$	12	Vdc
Collector Current — Continuous	I_C	500	mAdc
Collector Current — Peak	$I_{C(P)}$	1000	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

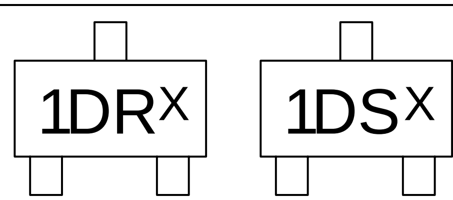
ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic		Symbol	Min	Max	Unit
Collector–Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	20	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0)		$V_{(BR)CBO}$	25	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 µAdc, I_E = 0)		$V_{(BR)EBO}$	12	—	Vdc
Collector–Base Cutoff Current (V_{CB} = 25 Vdc, I_E = 0)		I_{CBO}	—	0.1	µAdc
DC Current Gain(1) (V_{CE} = 2.0 Vdc, I_C = 500 mAdc)	MSD1328–RT1 MSD1328–ST1	h_{FE}	200 300	350 500	—
Collector–Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 20 mAdc)		$V_{CE(sat)}$	—	0.4	Vdc
Base–Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{BE(sat)}$	—	1.2	Vdc

1. Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

DEVICE MARKING

Marking Symbols



MSD1328–RT1   MSD1328–ST1

The “X” represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

October, 2001 – Rev. 2

Publication Order Number:
MSD1328–RT1/D

MSD1819A-RT1

Preferred Device

General Purpose Amplifier Transistor

NPN Silicon Surface Mount

This NPN Silicon Epitaxial Planar Transistor is designed for general purpose amplifier applications. This device is housed in the SC-70/SOT-323 package which is designed for low power surface mount applications.

- High h_{FE}, 210–460
- Low $V_{CE(sat)}$, < 0.5 V
- Available in 8 mm, 7-inch/3000 Unit Tape and Reel
- Moisture Sensitivity Level 1
- ESD Protection: Human Body Model > 4000 V
  Machine Model > 400 V

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector-Base Voltage	$V_{(BR)CBO}$	60	Vdc
Collector-Emitter Voltage	$V_{(BR)CEO}$	50	Vdc
Emitter-Base Voltage	$V_{(BR)EBO}$	7.0	Vdc
Collector Current – Continuous	I_C	100	mAdc
Collector Current – Peak	$I_{C(P)}$	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Power Dissipation (Note 1.)	P_D	150	mW
Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	–55 ~ +150	°C

1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.

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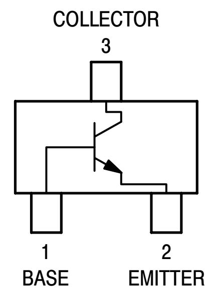
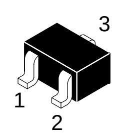
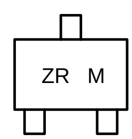




SC–70
CASE 419
STYLE 3

MARKING DIAGRAM



ZR = Specific Device Code
M = Date Code

ORDERING INFORMATION

Device	Package	Shipping
MSD1819A–RT1	SC–70	3000/Tape & Reel
MSD1819A–RT3	SC–70	10,000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

January, 2001 – Rev. 3
Publication Order Number:
MSD1819A–RT1/D

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	–	Vdc
Collector-Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 µAdc, I_E = 0)	$V_{(BR)EBO}$	7.0	–	Vdc
Collector-Base Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	–	0.1	µA
Collector-Emitter Cutoff Current (V_{CE} = 10 Vdc, I_B = 0)	I_{CEO}	–	0.1	µA
DC Current Gain (Note 2.) (V_{CE} = 10 Vdc, I_C = 2.0 mAdc) (V_{CE} = 2.0 Vdc, I_C = 100 mAdc)	 h_{FE1} h_{FE2}	 210 90	 340 –	–
Collector-Emitter Saturation Voltage (Note 2.) (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	0.5	Vdc

2. Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

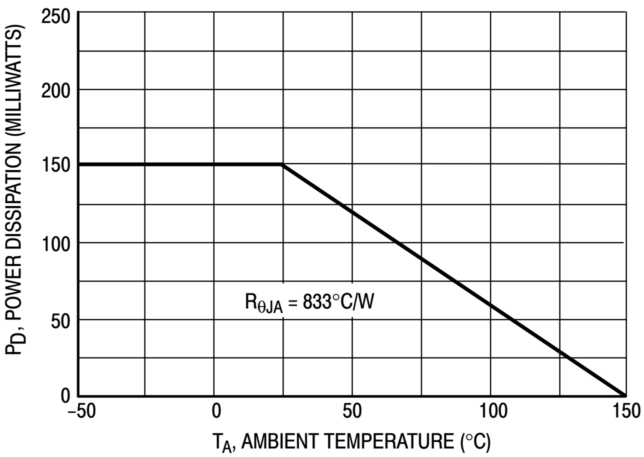


Figure 1. Derating Curve

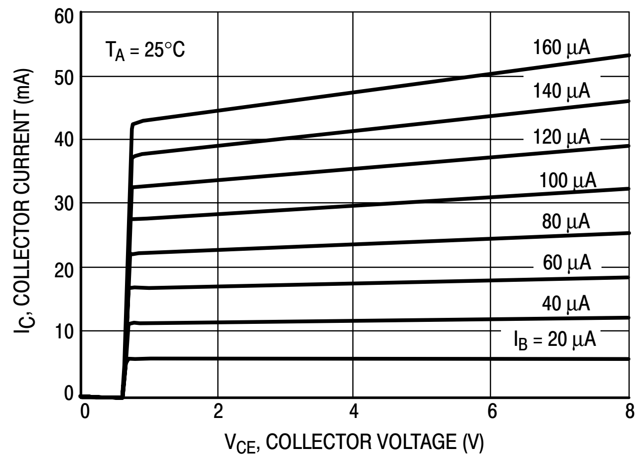


Figure 2. I_C – V_{CE}

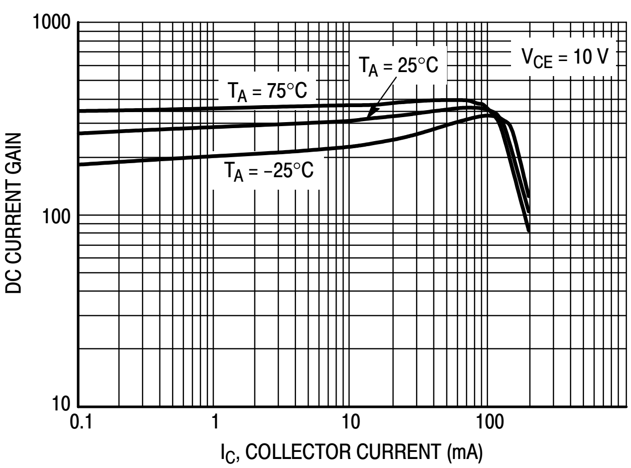


Figure 3. DC Current Gain

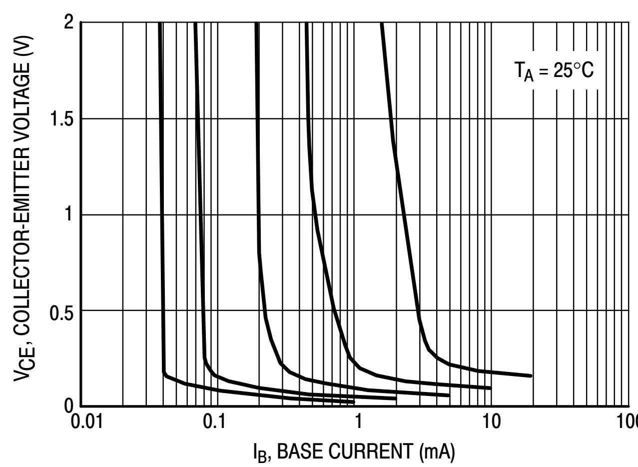


Figure 4. Collector Saturation Region

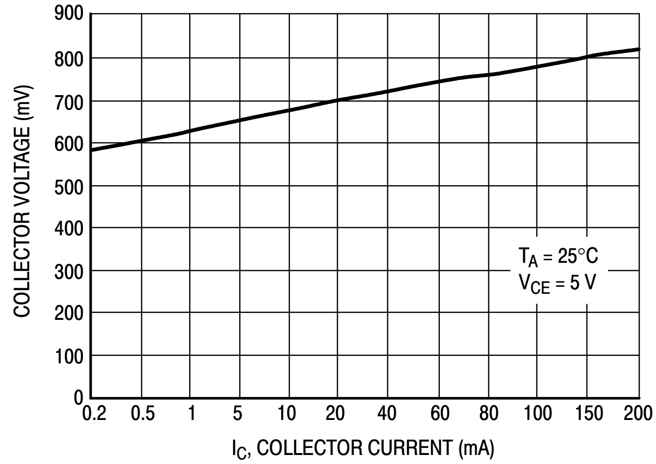


Figure 5. On Voltage

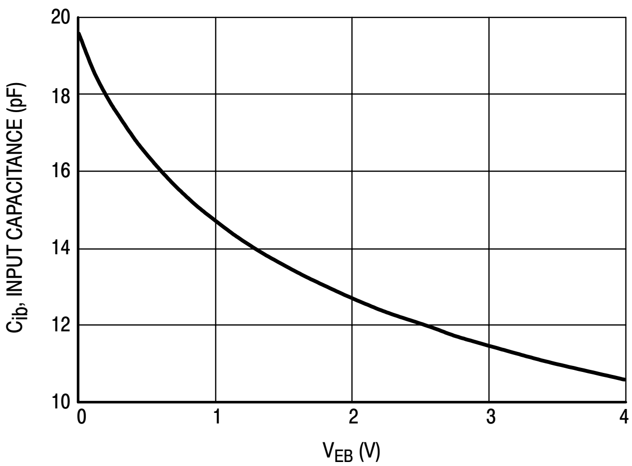


Figure 6. Capacitance

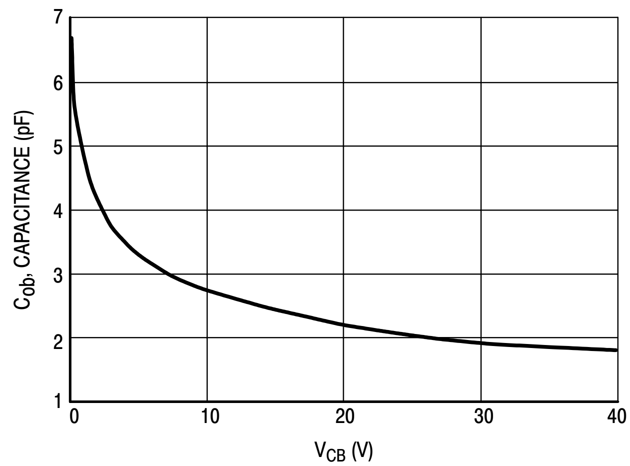


Figure 7. Capacitance

MSD2714AT1

Preferred Device

VHF/UHF Transistor

NPN Silicon

ON Semiconductor

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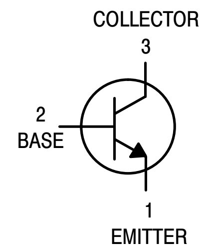
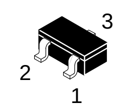




CASE 318D
SC–59
STYLE 1

MAXIMUM RATINGS

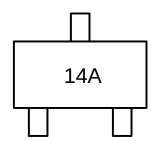
Rating	Symbol	Max	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board T_A = 25°C Derate above 25°C	P_D (1)	225 1.8	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate, T_A = 25°C Derate above 25°C	P_D (2)	300 2.4	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	625	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

(1) FR–5 = 1.0 X 0.75 X 0.062 in.
(2) Alumina = 0.4 X 0.3 X 0.024 in. 99.5% alumina

DEVICE MARKING



ORDERING INFORMATION

Device	Package	Shipping
MSD2714AT1	SC–59	TBD

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 35 Vdc, I_E = 0)	I_{CBO}	—	—	500	nAdc
Emitter Cutoff Current (V_{EB} = 3.5 Vdc, I_C = 0)	I_{EBO}	—	—	500	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc)	h_{FE}	90	—	180	—
Base–Emitter On Voltage (I_C = 4.0 mAdc, V_{CE} = 10 Vdc)	V_{BE}	—	—	0.95	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	650	—	—	MHz
Collector–Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	0.7	pF
Common–Base Feedback Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{rb}	—	—	0.65	pF
Collector Base Time Constant (I_C = 4.0 mAdc, V_{CB} = 10 Vdc, f = 31.8 MHz)	$rb'C_c$	—	—	9.0	ps

TYPICAL CHARACTERISTICS

COMMON–BASE y PARAMETERS versus FREQUENCY
(V_{CB} = 10 Vdc, I_C = 4.0 mAdc, T_A = 25°C)

y_{ib}, INPUT ADMITTANCE

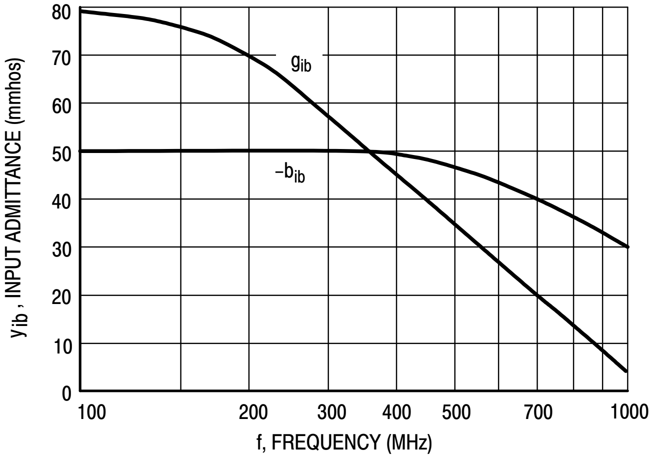


Figure 1. Rectangular Form

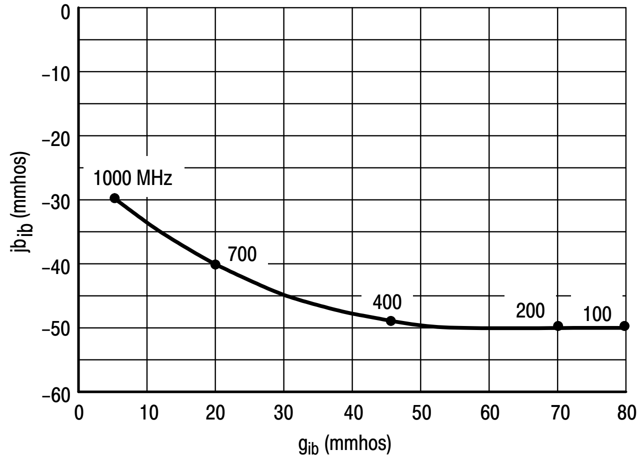


Figure 2. Polar Form

y_{fb}, FORWARD TRANSFER ADMITTANCE

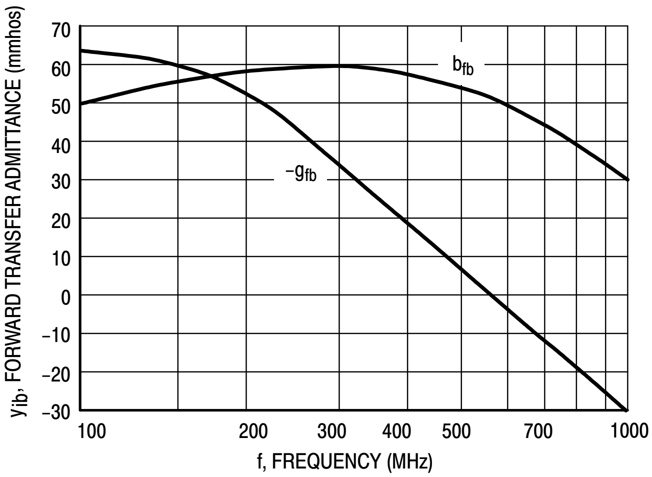


Figure 3. Rectangular Form

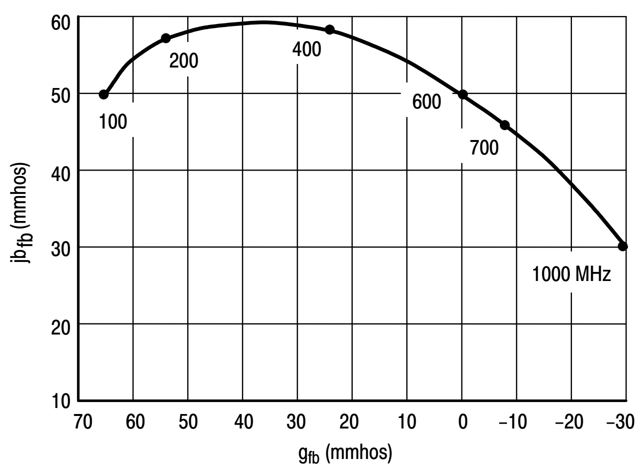


Figure 4. Polar Form

TYPICAL CHARACTERISTICS

COMMON–BASE y PARAMETERS versus FREQUENCY
(V_{CB} = 10 Vdc, I_C = 4.0 mAdc, T_A = 25°C)

y_{rb}, REVERSE TRANSFER ADMITTANCE

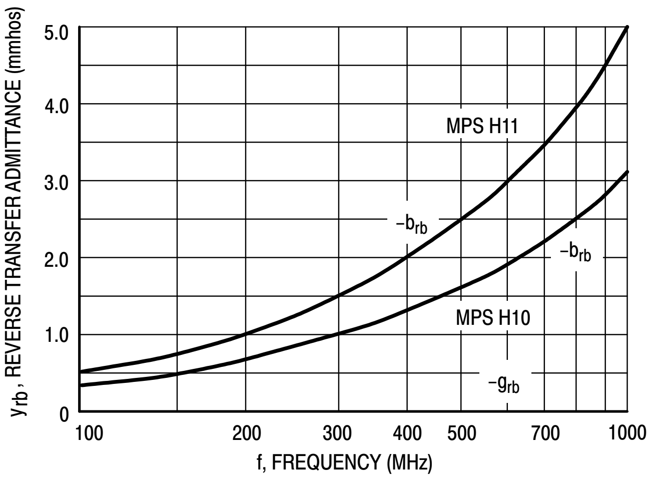


Figure 5. Rectangular Form

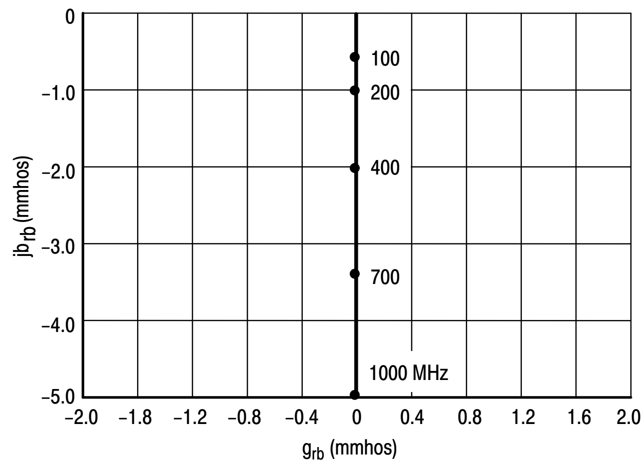


Figure 6. Polar Form

y_{ob}, OUTPUT ADMITTANCE

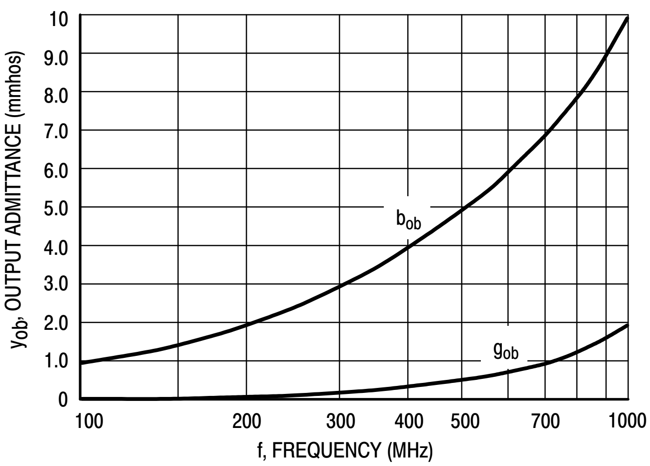


Figure 7. Rectangular Form

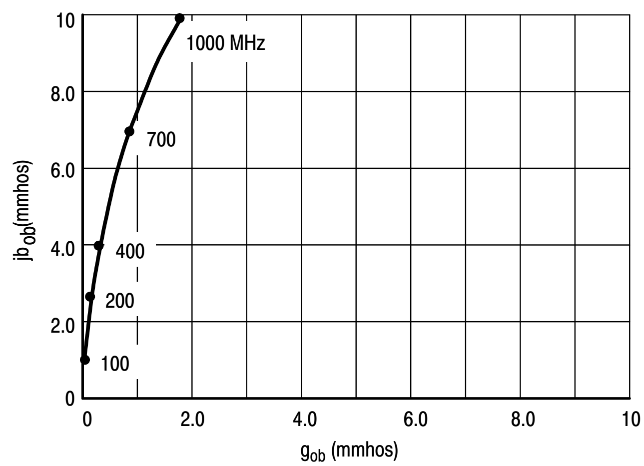


Figure 8. Polar Form

MSD42WT1

Preferred Device

NPN Silicon General Purpose High Voltage Transistor

This NPN Silicon Planar Transistor is designed for general purpose amplifier applications. This device is housed in the SC-70/SOT-323 package which is designed for low power surface mount applications.

ON Semiconductor™

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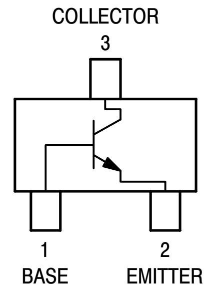
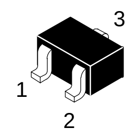
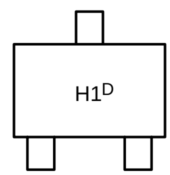


SC–70 (SOT–323)
CASE 419–04
STYLE 3



MARKING DIAGRAM



D = Date Code

ORDERING INFORMATION

Device	Package	Shipping
MSD42WT1	SC–70/SOT–323	3000 Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector-Base Voltage	$V_{(BR)CBO}$	300	Vdc
Collector-Emitter Voltage	$V_{(BR)CEO}$	300	Vdc
Emitter-Base Voltage	$V_{(BR)EBO}$	6.0	Vdc
Collector Current – Continuous	I_C	150	mAdc

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Power DissipatioN (Note 3)	P_D	150	mW
Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	–55～+150	°C

ELECTRICAL CHARACTERISTICS

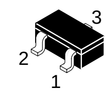
Characteristic	Symbol	Min	Max	Unit
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	300	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	300	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_E = 0)	$V_{(BR)EBO}$	6.0	–	Vdc
Collector-Base Cutoff Current (V_{CB} = 200 Vdc, I_E = 0)	I_{CBO}	–	0.1	μA
Emitter–Base Cutoff Current (V_{EB} = 6.0 Vdc, I_B = 0)	I_{EBO}	–	0.1	μA
DC Current Gain (Note 4)				–
(V_{CE} = 10 Vdc, I_C = 1.0 mAdc)	h_{FE1}	25	–	
(V_{CE} = 10 Vdc, I_C = 30 mAdc)	h_{FE2}	40	–	
Collector-Emitter Saturation Voltage (Note 4) (I_C = 200 mAdc, I_B = 2.0 mAdc)	$V_{CE(sat)}$	–	0.5	Vdc

3. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.
4. Pulse Test: Pulse Width ≤ 300 μs, D.C. ≤ 2%.

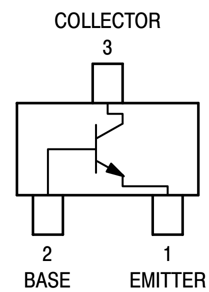
NPN General Purpose Amplifier Transistors Surface Mount

MSD601-RT1
MSD601-ST1

MSD601–RT1 is a Preferred Device



CASE 318D–04, STYLE 1
SC–59



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	$V_{(BR)CBO}$	60	Vdc
Collector–Emitter Voltage	$V_{(BR)CEO}$	50	Vdc
Emitter–Base Voltage	$V_{(BR)EBO}$	7.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Collector Current — Peak	$I_{C(P)}$	200	mAdc

THERMAL CHARACTERISTICS

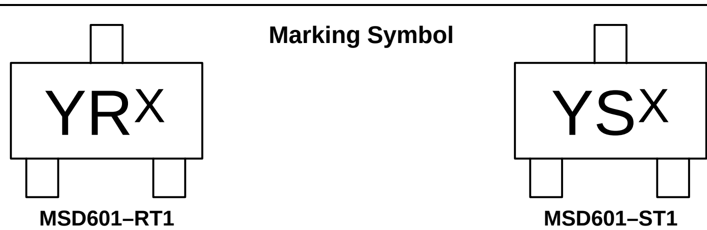
Characteristic	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic		Symbol	Min	Max	Unit
Collector–Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	50	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)		$V_{(BR)EBO}$	7.0	—	Vdc
Collector–Base Cutoff Current (V_{CB} = 45 Vdc, I_E = 0)		I_{CBO}	—	0.1	µAdc
Collector–Emitter Cutoff Current (V_{CE} = 10 Vdc, I_B = 0)		I_{CEO}	—	100	nAdc
DC Current Gain(1)					—
(V_{CE} = 10 Vdc, I_C = 2.0 mAdc)	MSD601–RT1	h_{FE1}	210	340	
	MSD601–ST1		290	460	
(V_{CE} = 2.0 Vdc, I_C = 100 mAdc)		h_{FE2}	90	—	
Collector–Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	—	0.5	Vdc

1. Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

DEVICE MARKING



The "X" represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

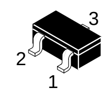
March, 2001 – Rev. 3

Publication Order Number:
MSD601–RT1/D

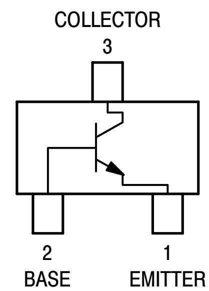
NPN General Purpose Amplifier Transistor Surface Mount

MSD602-RT1

ON Semiconductor Preferred Device



CASE 318D–04, STYLE 1
SC–59



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Value	Unit
Collector–Base Voltage	$V_{(BR)CBO}$	60	Vdc
Collector–Emitter Voltage	$V_{(BR)CEO}$	50	Vdc
Emitter–Base Voltage	$V_{(BR)EBO}$	7.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Collector Current — Peak	$I_{C(P)}$	1.0	Adc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Power Dissipation	P_D	200	mW
Junction Temperature	T_J	150	°C
Storage Temperature	T_{stg}	–55 ~ +150	°C

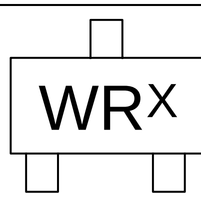
ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Min	Max	Unit
Collector–Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)	$V_{(BR)EBO}$	7.0	—	Vdc
Collector–Base Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	0.1	µAdc
DC Current Gain(1) (V_{CE} = 10 Vdc, I_C = 150 mAdc) (V_{CE} = 10 Vdc, I_C = 500 mAdc)	 h_{FE1} h_{FE2}	 120 40	 240 —	—
Collector–Emitter Saturation Voltage (I_C = 300 mAdc, I_B = 30 mAdc)	$V_{CE(sat)}$	—	0.6	Vdc
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	15	pF

1. Pulse Test: Pulse Width ≤ 300 µs, D.C. ≤ 2%.

DEVICE MARKING

Marking Symbol

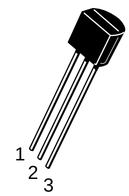


The “X” represents a smaller alpha digit Date Code. The Date Code indicates the actual month in which the part was manufactured.

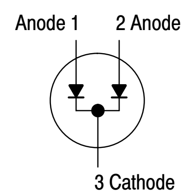
Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

MSD6100

Dual Switching Diode Common Cathode



CASE 29–11, STYLE 3
TO–92 (TO–226AA)



MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	100	Vdc
Recurrent Peak Forward Current	I_F	200	mAdc
Peak Forward Surge Current (Pulse Width = 10 µsec)	$I_{FM(surge)}$	500	mAdc
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D(1)	625 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}(1)	–55 to +135	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (EACH DIODE)

Characteristic	Symbol	Min	Max	Unit
Breakdown Voltage ($I_{(BR)}$ = 100 µAdc)	$V_{(BR)}$	100	—	Vdc
Reverse Current	I_R			µAdc
(V_R = 100 Vdc)		—	5.0	
(V_R = 50 Vdc)		—	0.1	
(V_R = 50 Vdc, T_A = 125°C)		—	50	
Forward Voltage	V_F			Vdc
(I_F = 1.0 mAdc)		0.55	0.7	
(I_F = 10 mAdc)		0.67	0.82	
(I_F = 100 mAdc)		0.75	1.1	
Capacitance (V_R = 0)	C	—	1.5	pF
Reverse Recovery Time (I_F = I_R = 10 mAdc, V_R = 5.0 Vdc, i_{rr} = 1.0 mAdc)	t_{rr}	—	4.0	ns

1. Continuous package improvements have enhanced these guaranteed Maximum Ratings as follows: P_D = 1.0 W @ T_C = 25°C, Derate above 25°C — 8.0 mW/°C, T_J = –65 to +150°C, θJC = 125°C/W.

March, 2001 – Rev. 1

Publication Order Number:
MSD6100/D

TYPICAL CHARACTERISTICS

Curves Applicable to Each Anode

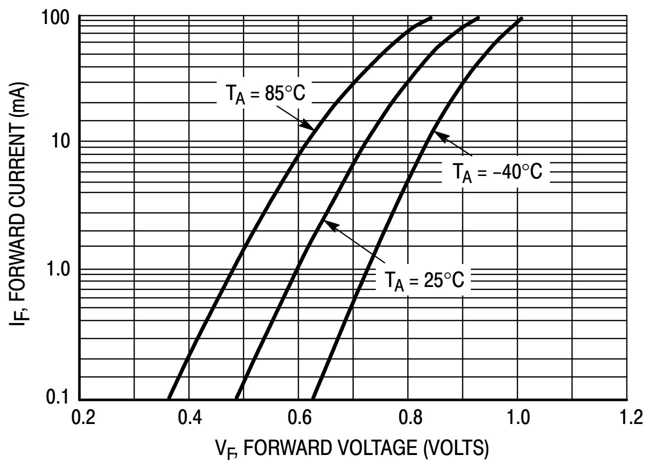


Figure 1. Forward Voltage

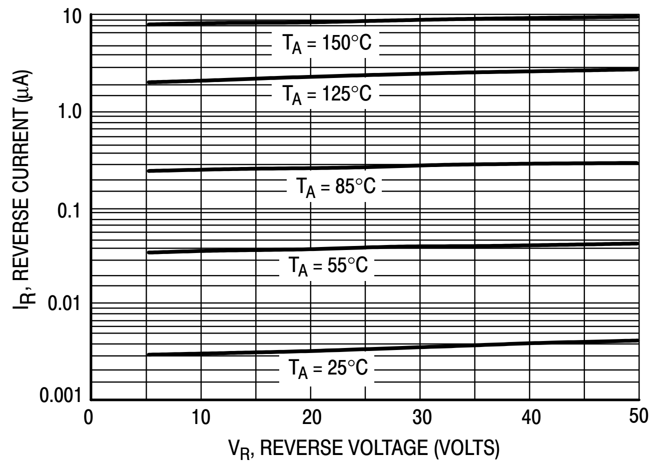


Figure 2. Leakage Current

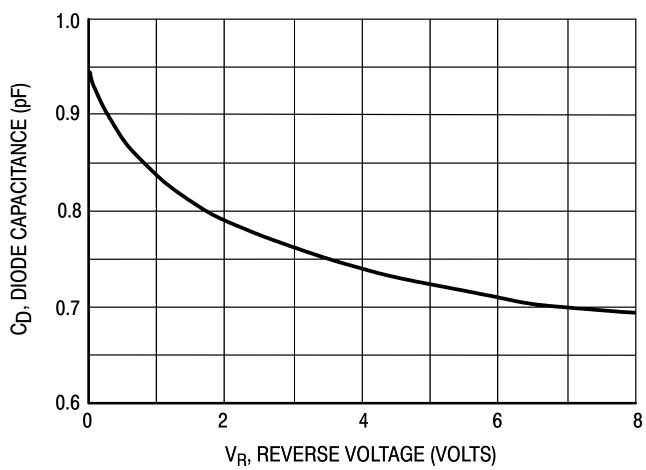
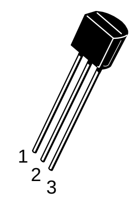


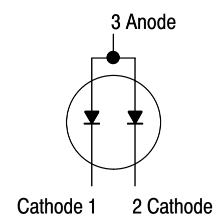
Figure 3. Capacitance

MSD6150

Dual Diode Common Anode



CASE 29–11, STYLE 4
TO–92 (TO–226AA)



MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Peak Forward Recurrent Current	I_F	200	mAdc
Peak Forward Surge Current (Pulse Width = 10 µsec)	$I_{FM(surge)}$	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D(1)	625 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}(1)	–55 to +135	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (EACH DIODE)

Characteristic	Symbol	Min	Typ	Max	Unit
Breakdown Voltage ($I_{(BR)}$ = 100 µAdc)	$V_{(BR)}$	70	—	—	Vdc
Reverse Current (V_R = 50 Vdc)	I_R	—	—	0.1	µAdc
Forward Voltage (I_F = 10 mAdc)	V_F	—	0.80	1.0	Vdc
Capacitance (V_R = 0)	C	—	5.0	8.0	pF
Reverse Recovery Time ($I_F = I_R$ = 10 mAdc, V_R = 5.0 Vdc, i_{rr} = 1.0 mAdc)	t_{rr}	—	—	100	ns

1. Continuous package improvements have enhanced these guaranteed Maximum Ratings as follows: P_D = 1.0 W @ T_C = 25°C, Derate above 8.0 mW/°C, P_D = 10 W @ T_C = 25°C, Derate above 80 mW/°C, T_J, T_{stg} = –55 to +150°C, θJC = 12.5°C/W, θJA = 125°C.

March, 2001 – Rev. 1

Publication Order Number:
MSD6150/D

TYPICAL CHARACTERISTICS

Curves Applicable to Each Cathode

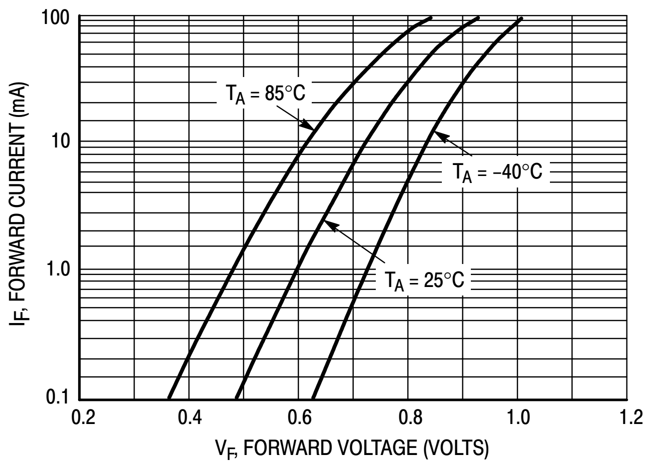


Figure 1. Forward Voltage

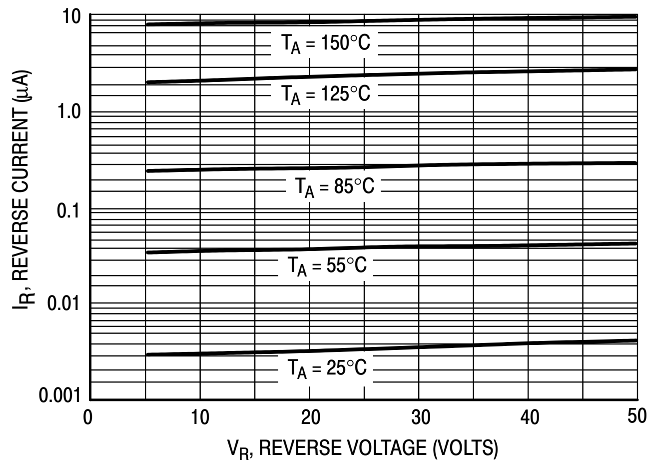


Figure 2. Leakage Current

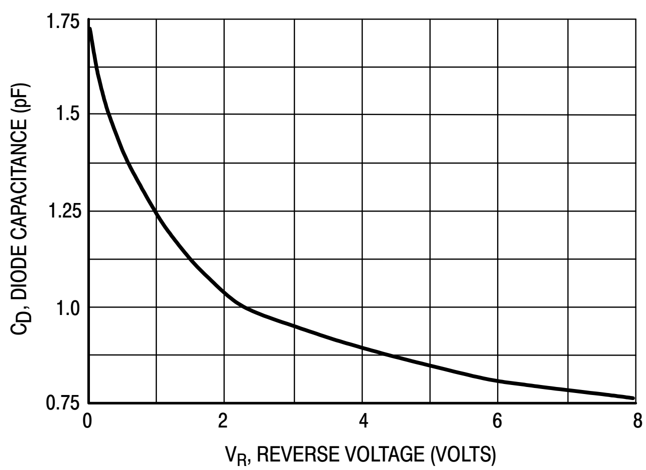


Figure 3. Capacitance

MUN2111T1 Series

Preferred Devices

Bias Resistor Transistors

PNP Silicon Surface Mount Transistors with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC–59 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Moisture Sensitivity Level: 1
- ESD Rating – Human Body Model: Class 1
  – Machine Model: Class B
- The SC–59 package can be soldered using wave or reflow. The modified gull–winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
  Use the Device Number to order the 7 inch/3000 unit reel.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

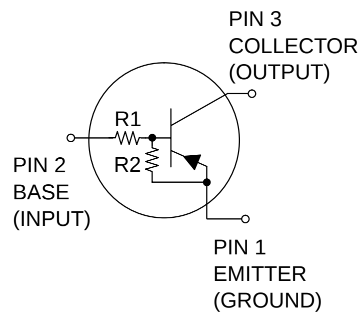
THERMAL CHARACTERISTICS

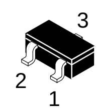
Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	230 (Note 1.) 338 (Note 2.) 1.8 (Note 1.) 2.7 (Note 2.)	mW °C/W
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	540 (Note 1.) 370 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{\theta JL}$	264 (Note 1.) 287 (Note 2.)	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

ON Semiconductor™

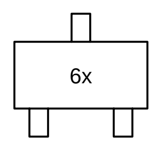
http://onsemi.com





SC–59
CASE 318D
PLASTIC

MARKING DIAGRAM



6x = Device Code
x = A – T*

ORDERING INFORMATION

See detailed ordering and shipping information on page 957 of this data sheet.

DEVICE MARKING INFORMATION

*See device marking table on page 957 of this data sheet.

Preferred devices are recommended choices for future use and best overall value.

DEVICE MARKING AND RESISTOR VALUES

Device	Package	Marking	R1 (K)	R2 (K)	Shipping
MUN2111T1	SC–59	6A	10	10	3000/Tape & Reel
MUN2112T1	SC–59	6B	22	22	3000/Tape & Reel
MUN2113T1	SC–59	6C	47	47	3000/Tape & Reel
MUN2114T1	SC–59	6D	10	47	3000/Tape & Reel
MUN2115T1 (Note 3.)	SC–59	6E	10	∞	3000/Tape & Reel
MUN2116T1 (Note 3.)	SC–59	6F	4.7	∞	3000/Tape & Reel
MUN2130T1 (Note 3.)	SC–59	6G	1.0	1.0	3000/Tape & Reel
MUN2131T1 (Note 3.)	SC–59	6H	2.2	2.2	3000/Tape & Reel
MUN2132T1 (Note 3.)	SC–59	6J	4.7	4.7	3000/Tape & Reel
MUN2133T1 (Note 3.)	SC–59	6K	4.7	47	3000/Tape & Reel
MUN2134T1 (Note 3.)	SC–59	6L	22	47	3000/Tape & Reel
MUN2136T1	SC–59	6N	100	100	3000/Tape & Reel
MUN2137T1	SC–59	6P	47	22	3000/Tape & Reel
MUN2140T1 (Note 3.)	SC–59	6T	47	∞	3000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector–Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter–Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	MUN2111T1	I_{EBO}	–	–	0.5	mAdc
	MUN2112T1		–	–	0.2	
	MUN2113T1		–	–	0.1	
	MUN2114T1		–	–	0.2	
	MUN2115T1		–	–	0.9	
	MUN2116T1		–	–	1.9	
	MUN2130T1		–	–	4.3	
	MUN2131T1		–	–	2.3	
	MUN2132T1		–	–	1.5	
	MUN2133T1		–	–	0.18	
	MUN2134T1		–	–	0.13	
	MUN2136T1		–	–	0.05	
	MUN2137T1		–	–	0.13	
	MUN2140T1		–	–	0.20	
Collector–Base Breakdown Voltage (I_C = 10 µA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector–Emitter Breakdown Voltage (Note 4.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc

3. New resistor combinations. Updated curves to follow in subsequent data sheets.
4. Pulse Test: Pulse Width < 300 µs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Note 5.)						
DC Current Gain	MUN2111T1	h_{FE}	35	60	–	
(V_{CE} = 10 V, I_C = 5.0 mA)	MUN2112T1		60	100	–	
	MUN2113T1		80	140	–	
	MUN2114T1		80	140	–	
	MUN2115T1		160	250	–	
	MUN2116T1		160	250	–	
	MUN2130T1		3.0	5.0	–	
	MUN2131T1		8.0	15	–	
	MUN2132T1		15	27	–	
	MUN2133T1		80	140	–	
	MUN2134T1		80	130	–	
	MUN2136T1		80	150	–	
	MUN2137T1		80	140	–	
	MUN2140T1		120	250	–	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 10 mA, I_B = 0.3 mA)	MUN2111T1		–	–	0.25	
	MUN2112T1		–	–	0.25	
	MUN2113T1		–	–	0.25	
	MUN2114T1		–	–	0.25	
	MUN2115T1		–	–	0.25	
	MUN2130T1		–	–	0.25	
	MUN2136T1		–	–	0.25	
	MUN2137T1		–	–	0.25	
(I_C = 10 mA, I_B = 5.0 mA)	MUN2131T1		–	–	0.25	
(I_C = 10 mA, I_B = 1.0 mA)	MUN2116T1		–	–	0.25	
	MUN2132T1		–	–	0.25	
	MUN2134T1		–	–	0.25	
	MUN2140T1		–	–	0.25	
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	MUN2111T1		–	–	0.2	
	MUN2112T1		–	–	0.2	
	MUN2114T1		–	–	0.2	
	MUN2115T1		–	–	0.2	
	MUN2116T1		–	–	0.2	
	MUN2130T1		–	–	0.2	
	MUN2131T1		–	–	0.2	
	MUN2132T1		–	–	0.2	
	MUN2133T1		–	–	0.2	
	MUN2134T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	MUN2113T1		–	–	0.2	
	MUN2140T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 5.5 V, R_L = 1.0 kΩ)	MUN2136T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 4.0 V, R_L = 1.0 kΩ)	MUN2137T1		–	–	0.2	

5. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Note 6.) (Continued)						
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ)		V_{OH}	4.9	–	–	Vdc
(V_{CC} = 5.0 V, V_B = 0.050 V, R_L = 1.0 kΩ)	MUN2130T1					
(V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	MUN2115T1					
	MUN2116T1					
	MUN2131T1					
	MUN2132T1					
	MUN2140T1					
Input Resistor	MUN2111T1	R1	7.0	10	13	kΩ
	MUN2112T1		15.4	22	28.6	
	MUN2113T1		32.9	47	61.1	
	MUN2114T1		7.0	10	13	
	MUN2115T1		7.0	10	13	
	MUN2116T1		3.3	4.7	6.1	
	MUN2130T1		0.7	1.0	1.3	
	MUN2131T1		1.5	2.2	2.9	
	MUN2132T1		3.3	4.7	6.1	
	MUN2133T1		3.3	4.7	6.1	
	MUN2134T1		15.4	22	28.6	
	MUN2136T1		70	100	130	
	MUN2137T1		32.9	47	61.1	
	MUN2140T1		32.9	47	61.1	
Resistor Ratio	MUN2111T1/MUN2112T1/MUN2113T1/ MUN2136T1	R_1/R_2	0.8	1.0	1.2	
	MUN2114T1		0.17	0.21	0.25	
	MUN2115T1/MUN2116T1/MUN2140T1		–	–	–	
	MUN2130T1/MUN2131T1/MUN2132T1		0.8	1.0	1.2	
	MUN2133T1		0.055	0.1	0.185	
	MUN2134T1		0.38	0.47	0.56	
	MUN2137T1		1.7	2.1	2.6	

6. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

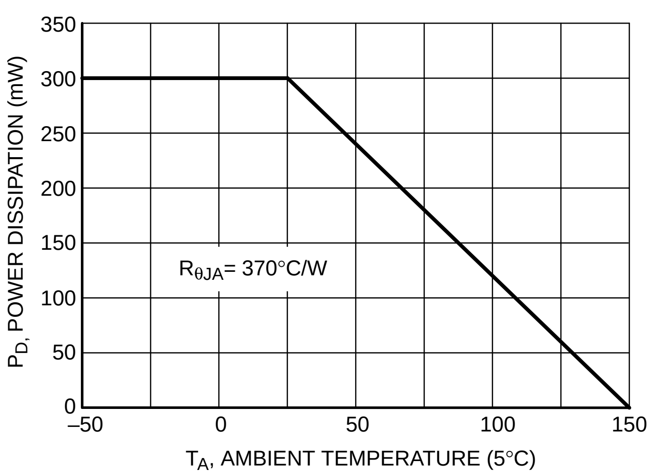


Figure 1. Derating Curve

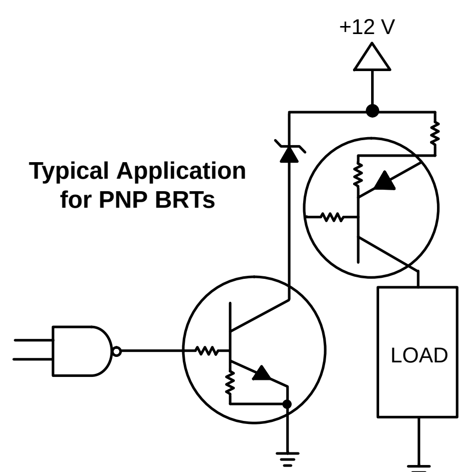


Figure 2. Inexpensive, Unregulated Current Source

TYPICAL ELECTRICAL CHARACTERISTICS – MUN2111T1

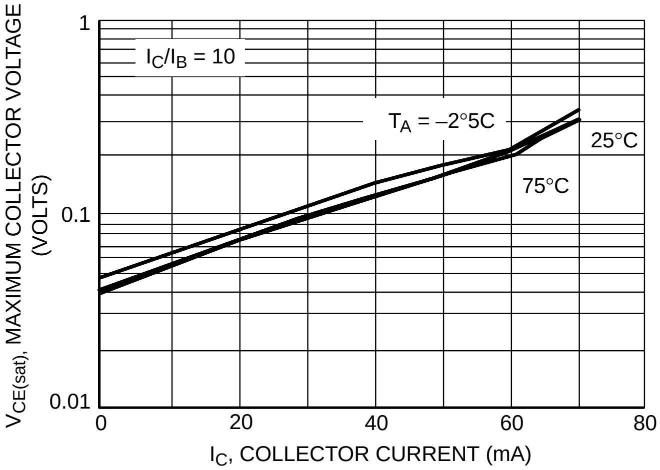


Figure 3. $V_{CE(sat)}$ vs. I_C

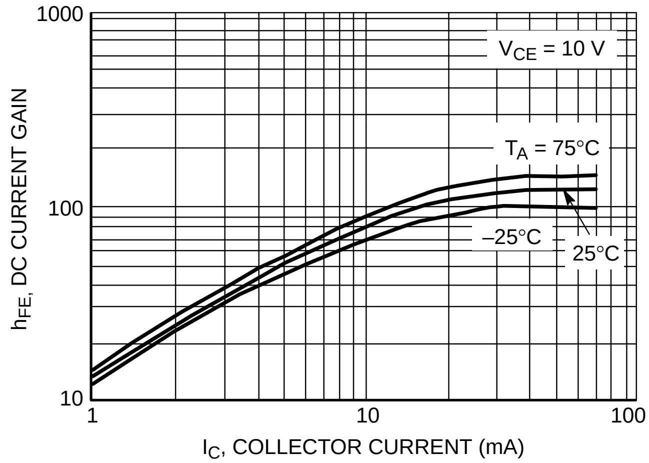


Figure 4. DC Current Gain

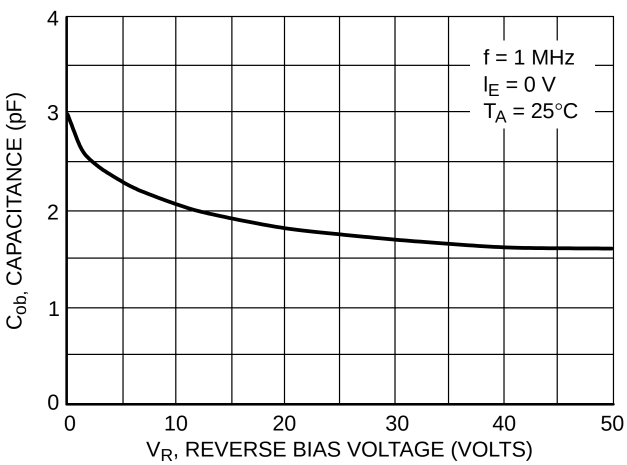


Figure 5. Output Capacitance

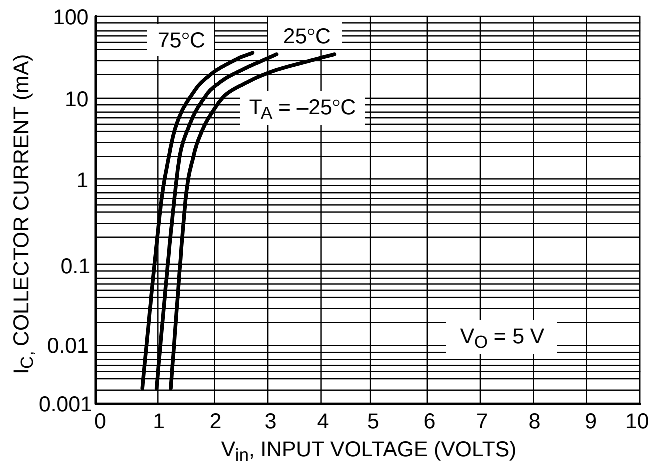


Figure 6. Output Current vs. Input Voltage

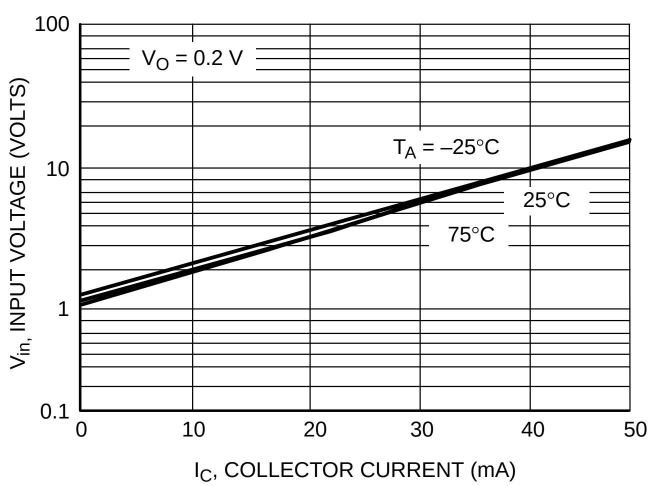


Figure 7. Input Voltage vs. Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN2112T1

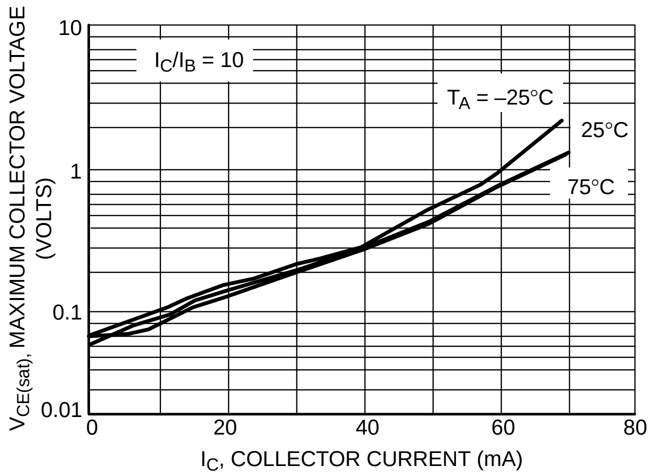


Figure 8. $V_{CE(sat)}$ vs. I_C

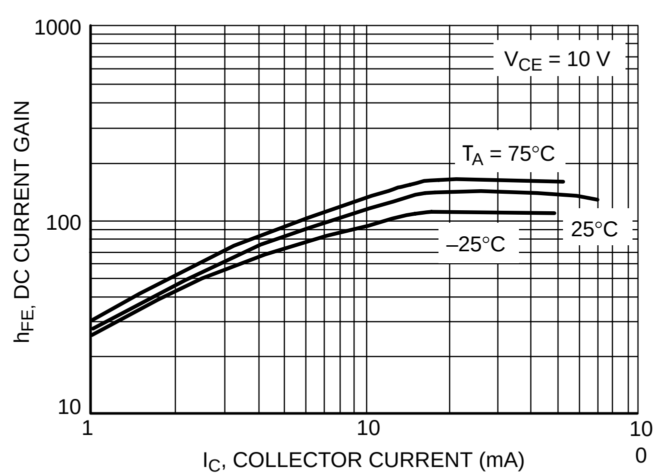


Figure 9. DC Current Gain

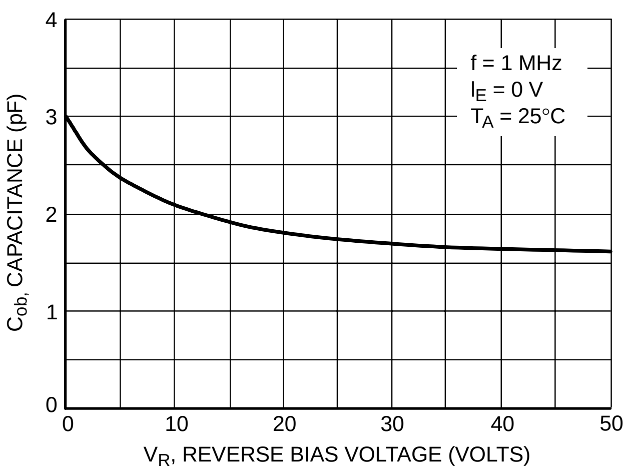


Figure 10. Output Capacitance

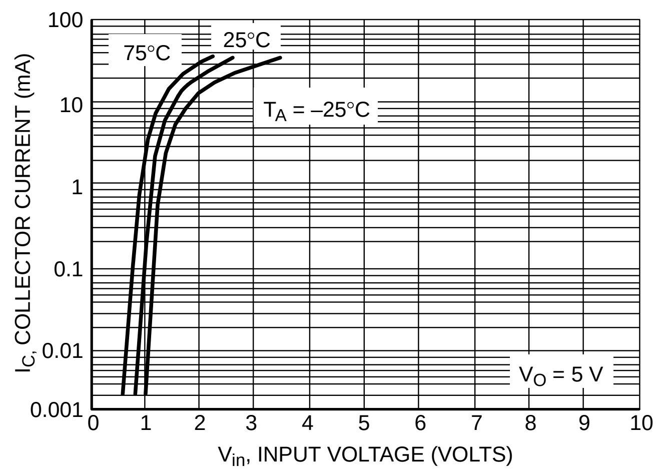


Figure 11. Output Current vs. Input Voltage

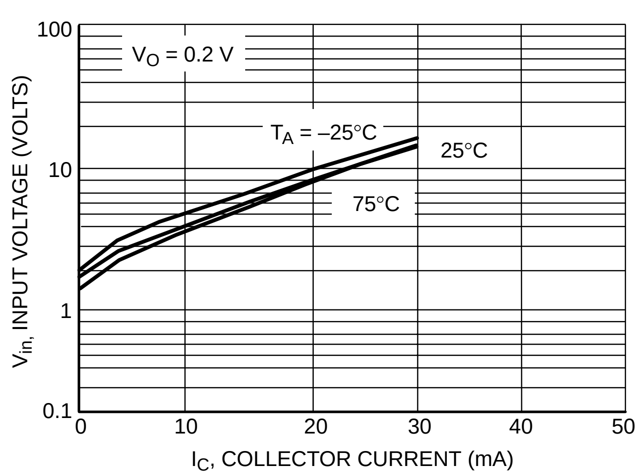


Figure 12. Input Voltage vs. Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN2113T1

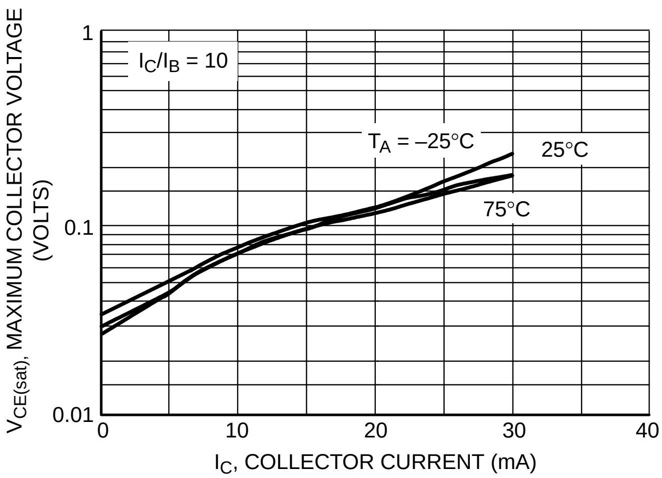


Figure 13. $V_{CE(sat)}$ vs. I_C

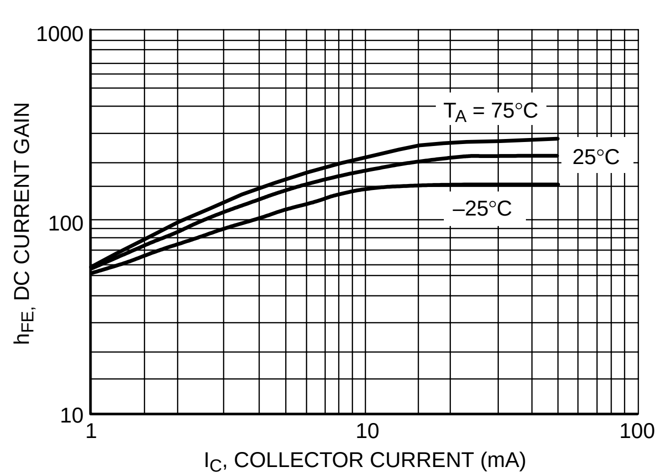


Figure 14. DC Current Gain

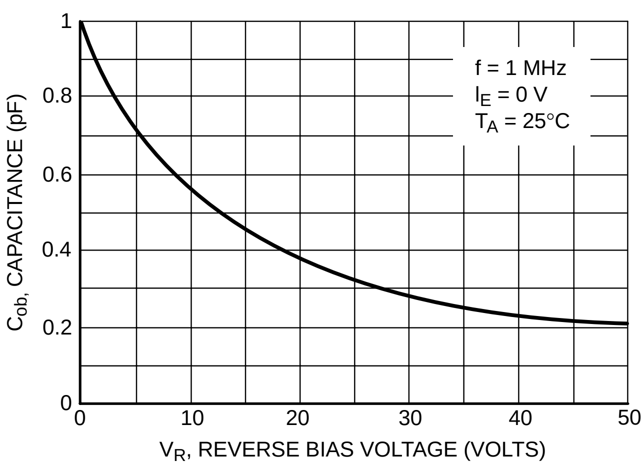


Figure 15. Output Capacitance

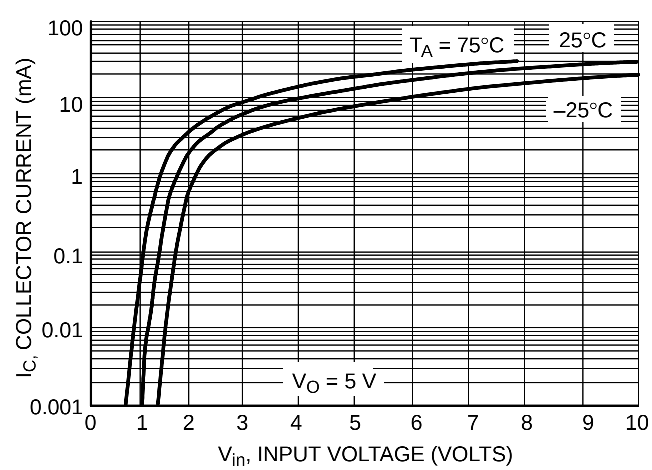


Figure 16. Output Current vs. Input Voltage

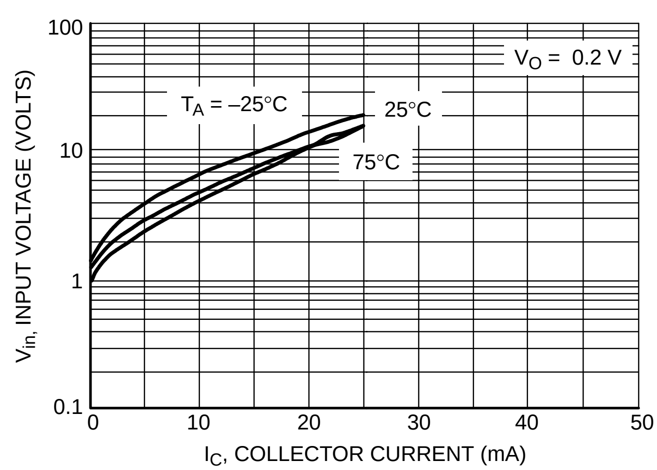


Figure 17. Input Voltage vs. Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN2114T1

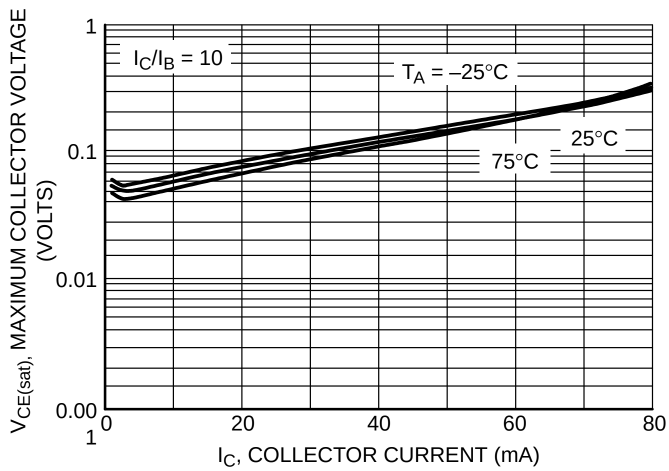


Figure 18. $V_{CE(sat)}$ vs. I_C

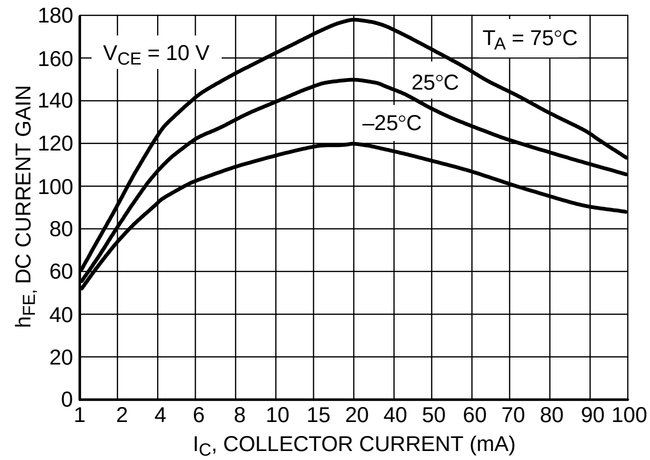


Figure 19. DC Current Gain

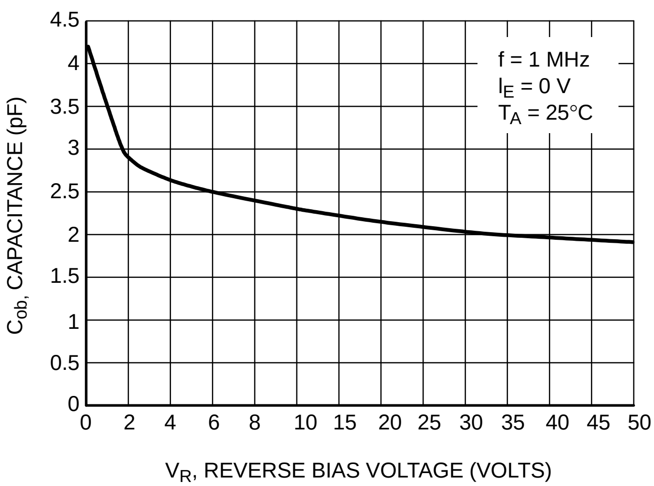


Figure 20. Output Capacitance

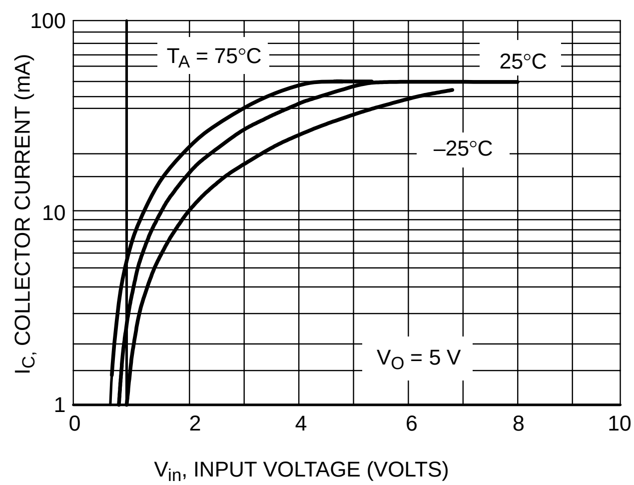


Figure 21. Output Current vs. Input Voltage

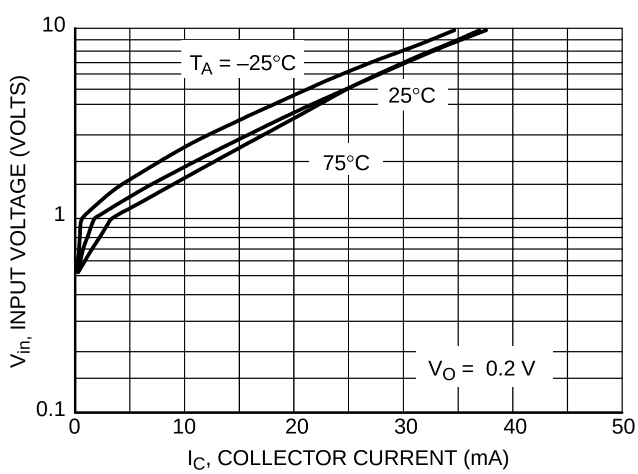


Figure 22. Input Voltage vs. Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN2131T1

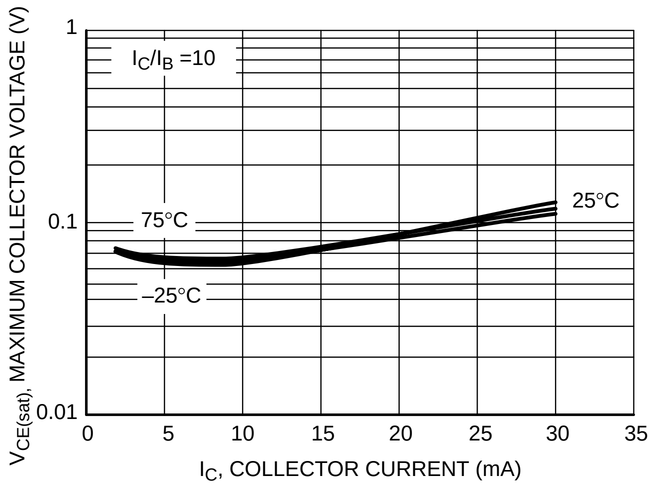


Figure 23. $V_{CE(sat)}$ vs. I_C

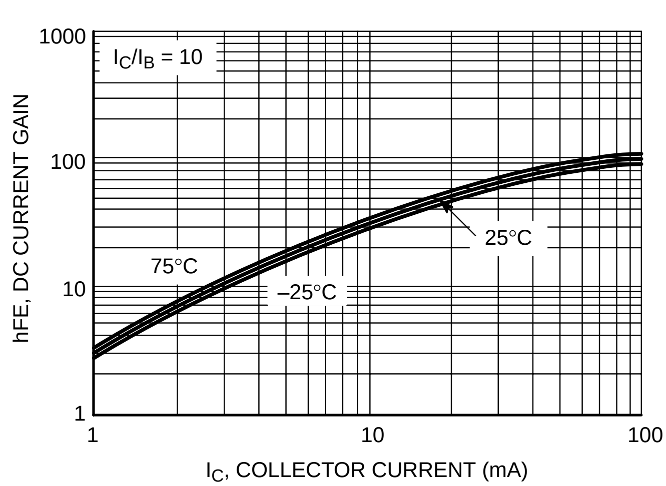


Figure 24. DC Current Gain

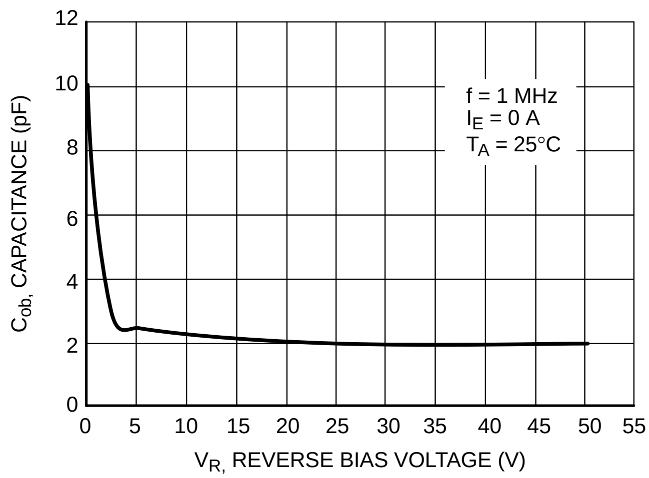


Figure 25. Output Capacitance

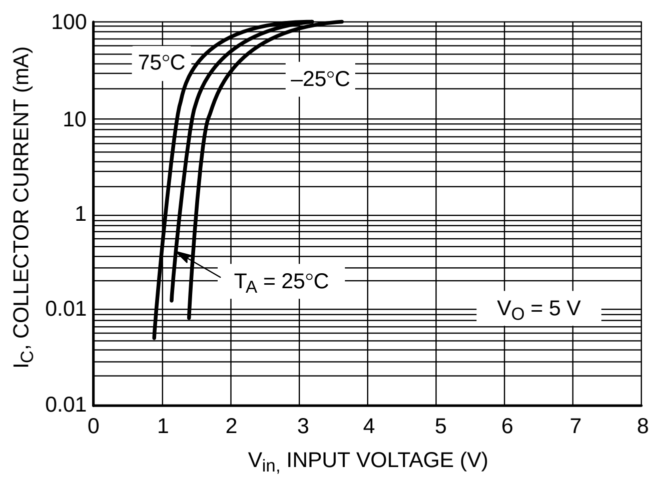


Figure 26. Output Current vs. Input Voltage

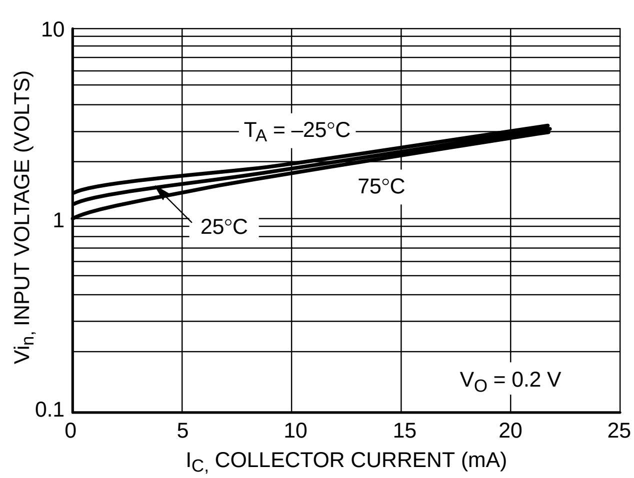


Figure 27. Input Voltage vs. Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN2136T1

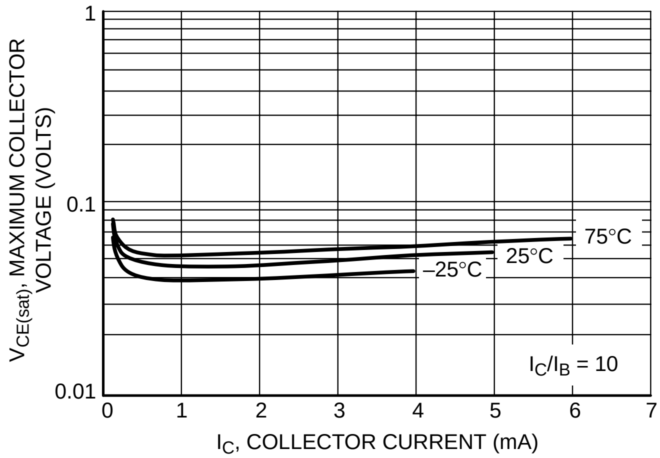


Figure 28. Maximum Collector Voltage versus Collector Current

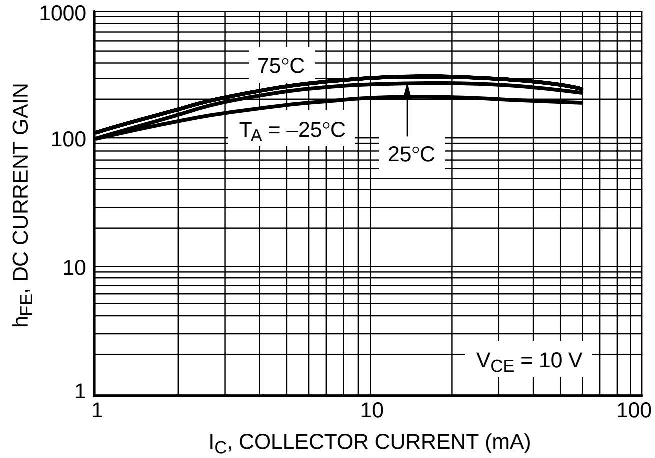


Figure 29. DC Current Gain

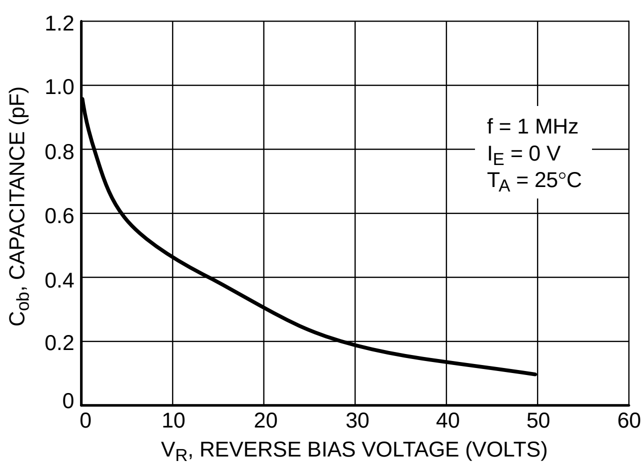


Figure 30. Output Capacitance

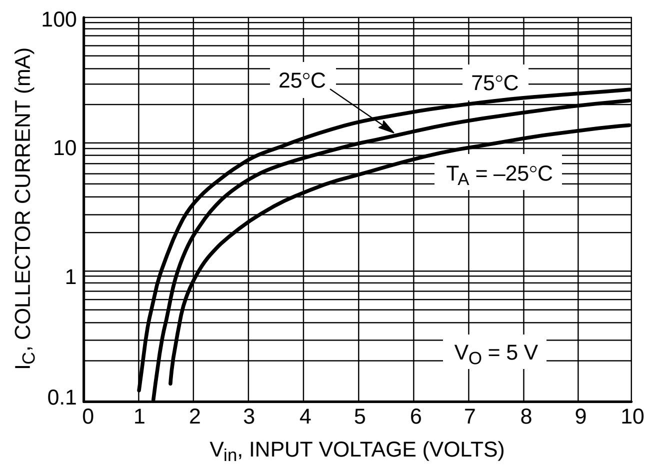


Figure 31. Output Current versus Input Voltage

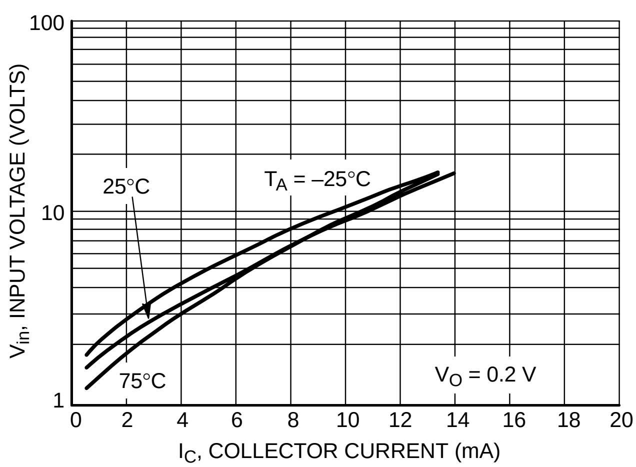


Figure 32. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN2137T1

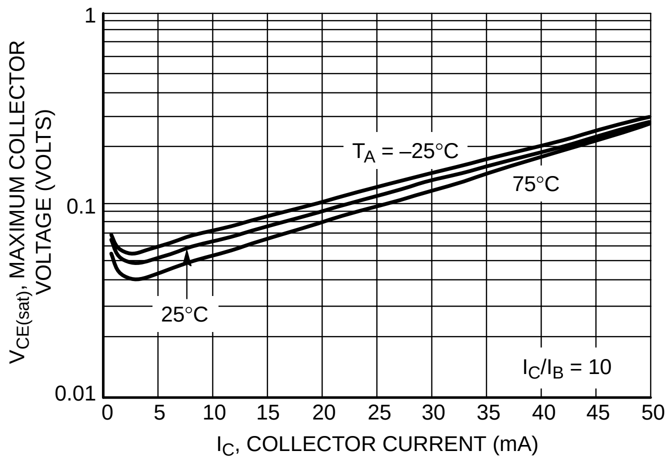


Figure 33. Maximum Collector Voltage versus Collector Current

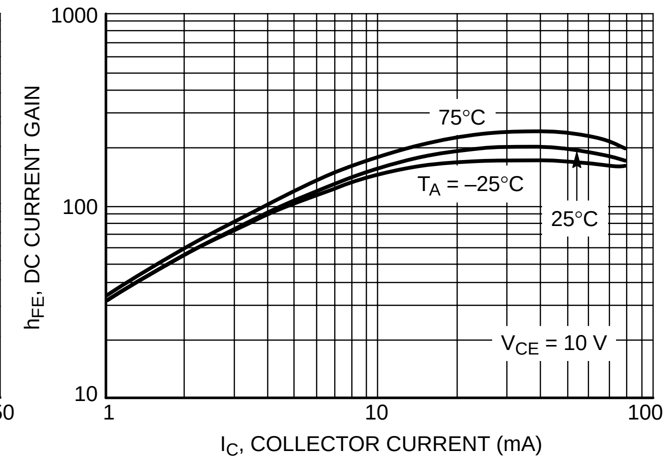


Figure 34. DC Current Gain

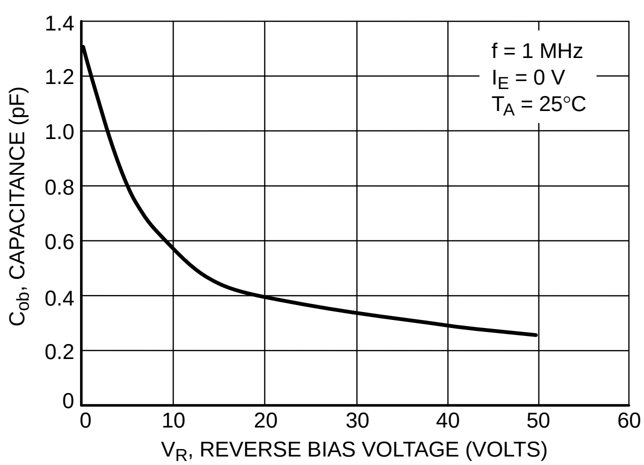


Figure 35. Output Capacitance

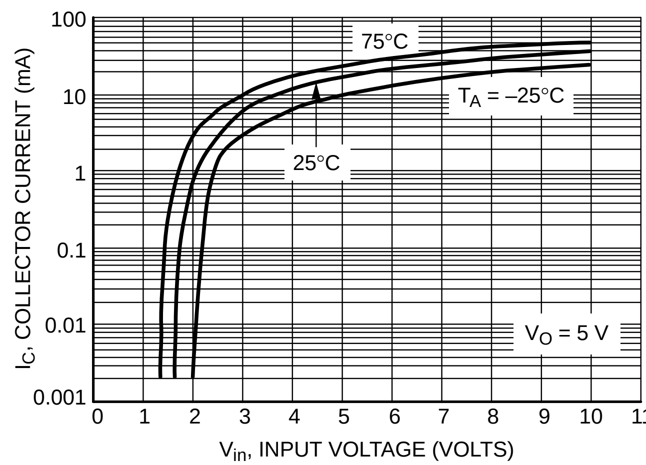


Figure 36. Output Current versus Input Voltage

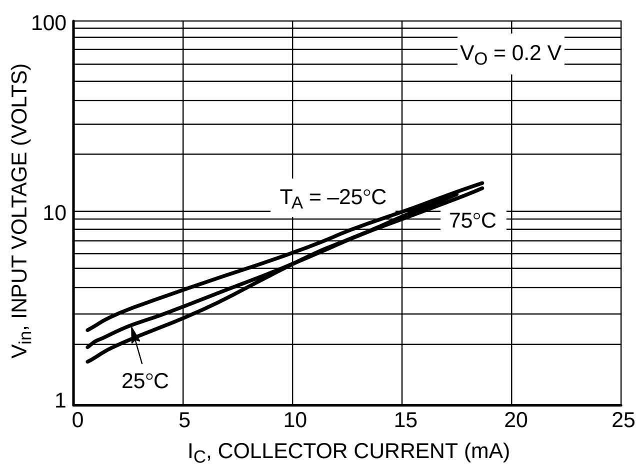


Figure 37. Input Voltage versus Output Current

MUN2211T1 Series

Preferred Devices

Bias Resistor Transistors

NPN Silicon Surface Mount Transistors with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC–59 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Moisture Sensitivity Level: 1
- ESD Rating – Human Body Model: Class 1
  – Machine Model: Class B
- The SC–59 package can be soldered using wave or reflow. The modified gull–winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
  Use the Device Number to order the 7 inch/3000 unit reel.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

THERMAL CHARACTERISTICS

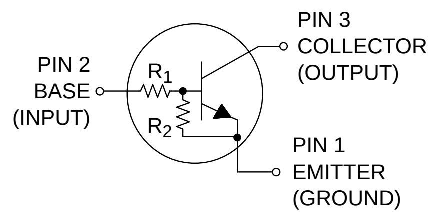
Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	230 (Note 1.) 338 (Note 2.) 1.8 (Note 1.) 2.7 (Note 2.)	mW °C/W
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	540 (Note 1.) 370 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{\theta JL}$	264 (Note 1.) 287 (Note 2.)	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

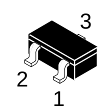
1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

ON Semiconductor™

http://onsemi.com

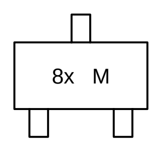
NPN SILICON BIAS RESISTOR TRANSISTORS





SC–59
CASE 318D
STYLE 1

MARKING DIAGRAM



8x = Specific Device Code
M = Date Code

DEVICE MARKING INFORMATION

See specific marking information in the device marking table on page 968 of this data sheet.

Preferred devices are recommended choices for future use and best overall value.

DEVICE MARKING AND RESISTOR VALUES

Device	Package	Marking	R1 (K)	R2 (K)	Shipping
MUN2211T1	SC–59	8A	10	10	3000/Tape & Reel
MUN2212T1	SC–59	8B	22	22	3000/Tape & Reel
MUN2213T1	SC–59	8C	47	47	3000/Tape & Reel
MUN2214T1	SC–59	8D	10	47	3000/Tape & Reel
MUN2215T1 (Note 3.)	SC–59	8E	10	∞	3000/Tape & Reel
MUN2216T1 (Note 3.)	SC–59	8F	4.7	∞	3000/Tape & Reel
MUN2230T1 (Note 3.)	SC–59	8G	1.0	1.0	3000/Tape & Reel
MUN2231T1 (Note 3.)	SC–59	8H	2.2	2.2	3000/Tape & Reel
MUN2232T1 (Note 3.)	SC–59	8J	4.7	4.7	3000/Tape & Reel
MUN2233T1 (Note 3.)	SC–59	8K	4.7	47	3000/Tape & Reel
MUN2234T1 (Note 3.)	SC–59	8L	22	47	3000/Tape & Reel
MUN2236T1	SC–59	8N	100	100	3000/Tape & Reel
MUN2237T1	SC–59	8P	47	22	3000/Tape & Reel
MUN2240T1 (Note 3.)	SC–59	8T	47	∞	3000/Tape & Reel
MUN2241T1 (Note 3.)	SC–59	8U	100	∞	3000/Tape & Reel

3. New devices. Updated curves to follow in subsequent data sheets.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector-Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter-Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	MUN2211T1	I_{EBO}	–	–	0.5	mAdc
	MUN2212T1		–	–	0.2	
	MUN2213T1		–	–	0.1	
	MUN2214T1		–	–	0.2	
	MUN2215T1		–	–	0.9	
	MUN2216T1		–	–	1.9	
	MUN2230T1		–	–	4.3	
	MUN2231T1		–	–	2.3	
	MUN2232T1		–	–	1.5	
	MUN2233T1		–	–	0.18	
	MUN2234T1		–	–	0.13	
	MUN2236T1		–	–	0.05	
	MUN2237T1		–	–	0.13	
	MUN2240T1		–	–	0.2	
	MUN2241T1		–	–	0.1	
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector-Emitter Breakdown Voltage (Note 4.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc
ON CHARACTERISTICS (Note 4.)						
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	MUN2211T1	h_{FE}	35	60	–	
	MUN2212T1		60	100	–	
	MUN2213T1		80	140	–	
	MUN2214T1		80	140	–	
	MUN2215T1		160	350	–	
	MUN2216T1		160	350	–	
	MUN2230T1		3.0	5.0	–	
	MUN2231T1		8.0	15	–	
	MUN2232T1		15	30	–	
	MUN2233T1		80	200	–	
	MUN2234T1		80	150	–	
	MUN2236T1		80	150	–	
	MUN2237T1		80	140	–	
	MUN2240T1		160	350	–	
	MUN2241T1		160	350	–	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.3 mA) (I_C = 10 mA, I_B = 5 mA) MUN2230T1/MUN2231T1 (I_C = 10 mA, I_B = 1 mA) MUN2215T1/MUN2216T1/ MUN2232T1/MUN2233T1/MUN2234T1		$V_{CE(sat)}$	–	–	0.25	Vdc
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	MUN2211T1		–	–	0.2	
	MUN2212T1		–	–	0.2	
	MUN2214T1		–	–	0.2	
	MUN2215T1		–	–	0.2	
	MUN2216T1		–	–	0.2	
	MUN2230T1		–	–	0.2	
	MUN2231T1		–	–	0.2	
	MUN2232T1		–	–	0.2	
	MUN2233T1		–	–	0.2	
	MUN2234T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	MUN2213T1		–	–	0.2	
	MUN2240T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 5.5 V, R_L = 1.0 kΩ)	MUN2236T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 4.0 V, R_L = 1.0 kΩ)	MUN2237T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 5.0 V, R_L = 1.0 kΩ)	MUN2241T1		–	–	0.2	

4. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Note 5.) (Continued)						
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ)		V_{OH}	4.9	–	–	Vdc
(V_{CC} = 5.0 V, V_B = 0.050 V, R_L = 1.0 kΩ)	MUN2230T1					
(V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	MUN2215T1					
	MUN2216T1					
	MUN2233T1					
	MUN2240T1					
Input Resistor	MUN2211T1	R_1	7.0	10	13	kΩ
	MUN2212T1		15.4	22	28.6	
	MUN2213T1		32.9	47	61.1	
	MUN2214T1		7.0	10	13	
	MUN2215T1		7.0	10	13	
	MUN2216T1		3.3	4.7	6.1	
	MUN2230T1		0.7	1.0	1.3	
	MUN2231T1		1.5	2.2	2.9	
	MUN2232T1		3.3	4.7	6.1	
	MUN2233T1		3.3	4.7	6.1	
	MUN2234T1		15.4	22	28.6	
	MUN2235T1		70	100	130	
	MUN2236T1		32.9	47	61.1	
	MUN2237T1		70	100	130	
	MUN2240T1		32.9	47	61.1	
	MUN2241T1		70	100	100	
Resistor Ratio	MUN2211T1/MUN2212T1/MUN2213T1/ MUN2236T1	R_1/R_2	0.8	1.0	1.2	
	MUN2214T1		0.17	0.21	0.25	
	MUN2215T1/MUN2216T1/MUN2240T1/ MUN2241T1		–	–	–	
	MUN2230T1/MUN2231T1/MUN2232T1		0.8	1.0	1.2	
	MUN2233T1		0.055	0.1	0.185	
	MUN2234T1		0.38	0.47	0.56	
	MUN2237T1		1.7	2.1	2.6	

5. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

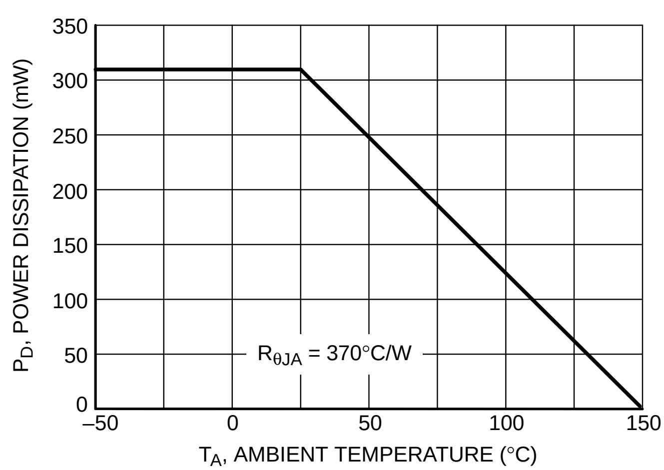


Figure 1. Derating Curve

TYPICAL ELECTRICAL CHARACTERISTICS – MUN2211T1

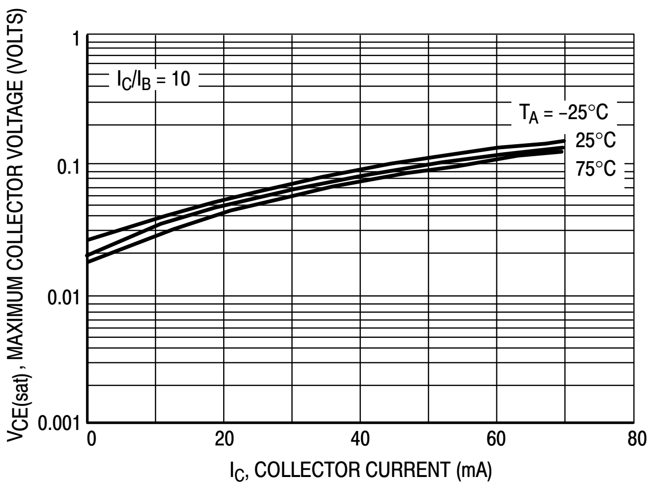


Figure 2. $V_{CE(sat)}$ versus I_C

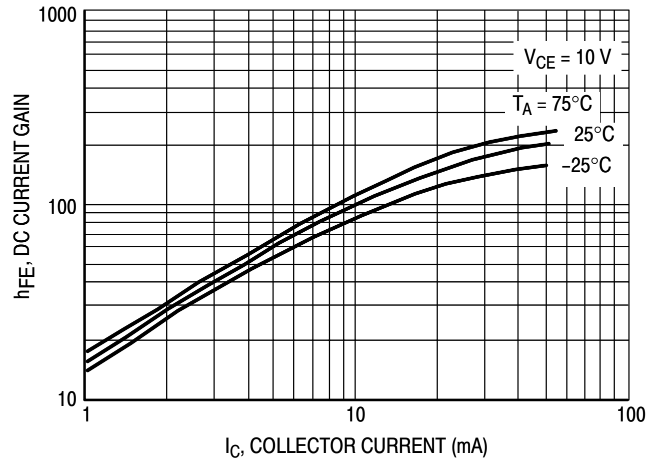


Figure 3. DC Current Gain

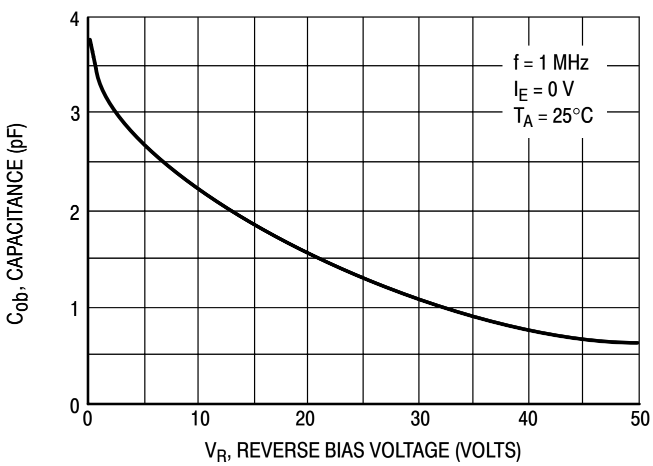


Figure 4. Output Capacitance

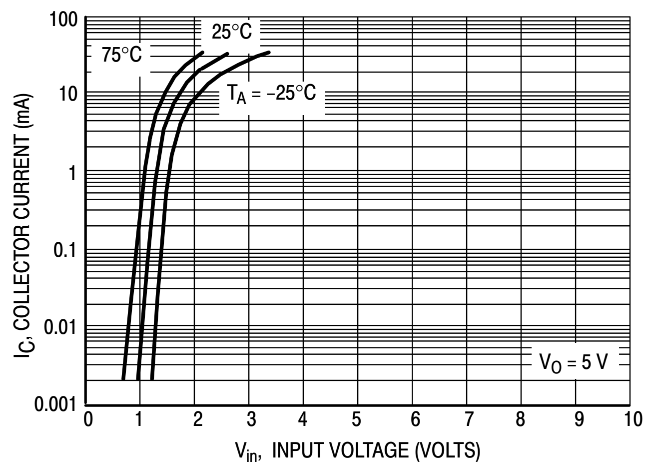


Figure 5. Output Current versus Input Voltage

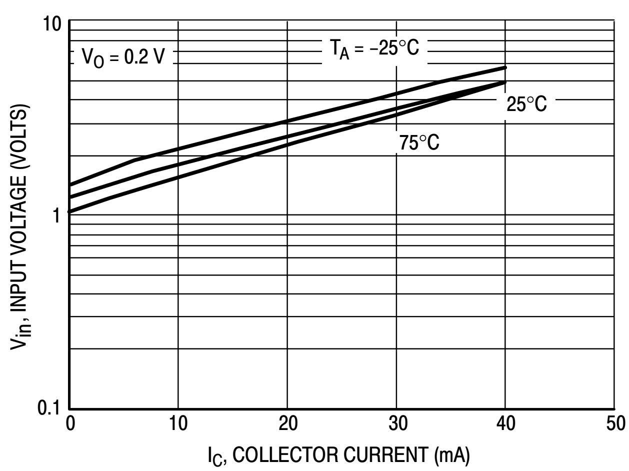


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN2212T1

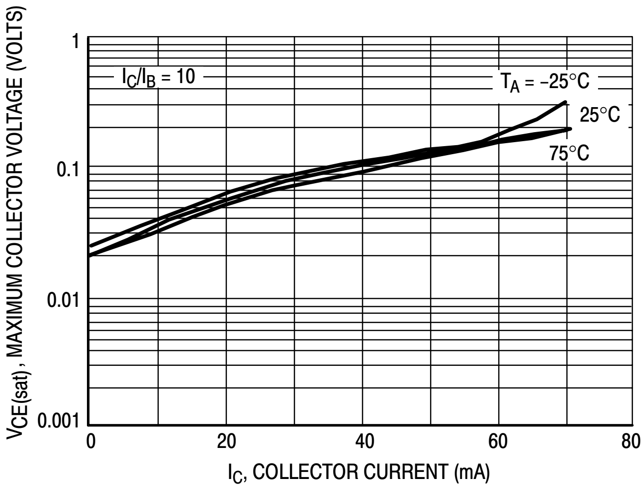


Figure 7. $V_{CE(sat)}$ versus I_C

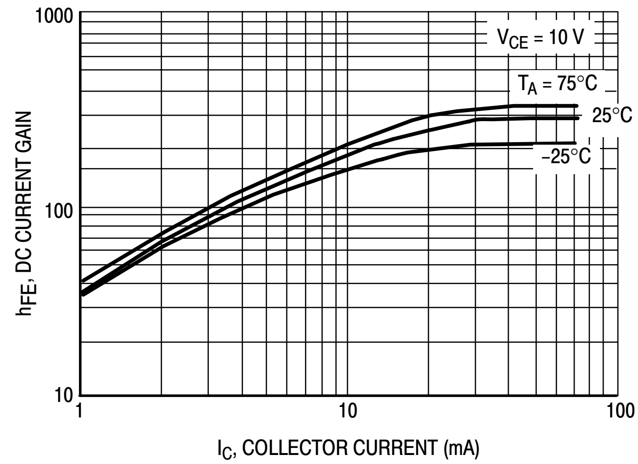


Figure 8. DC Current Gain

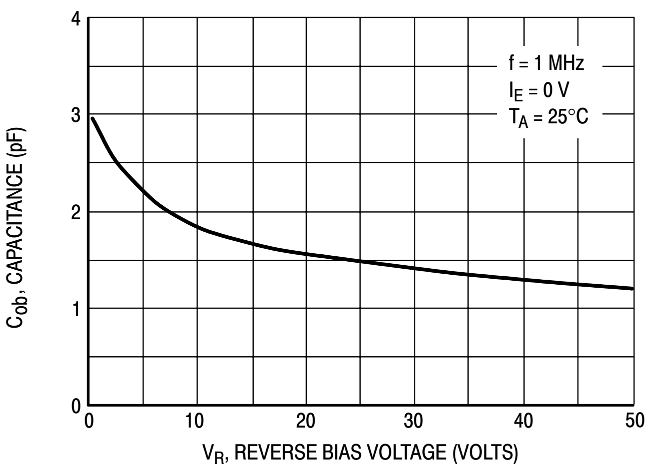


Figure 9. Output Capacitance

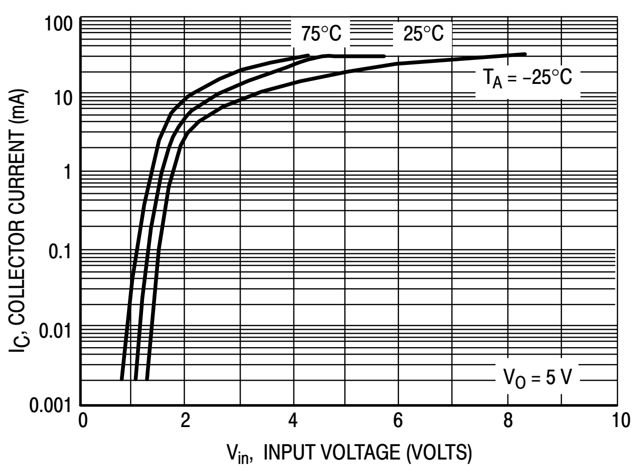


Figure 10. Output Current versus Input Voltage

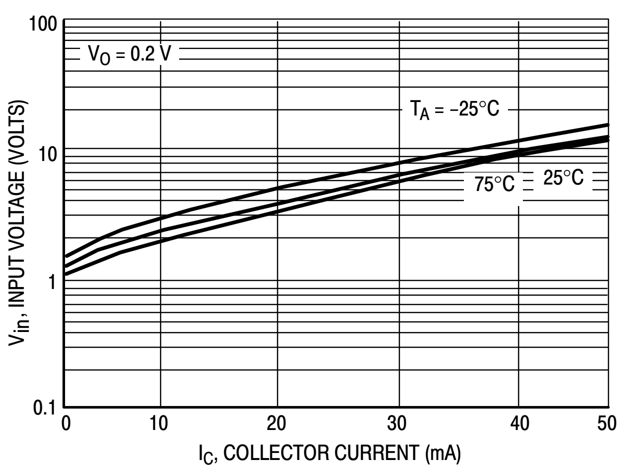


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN2213T1

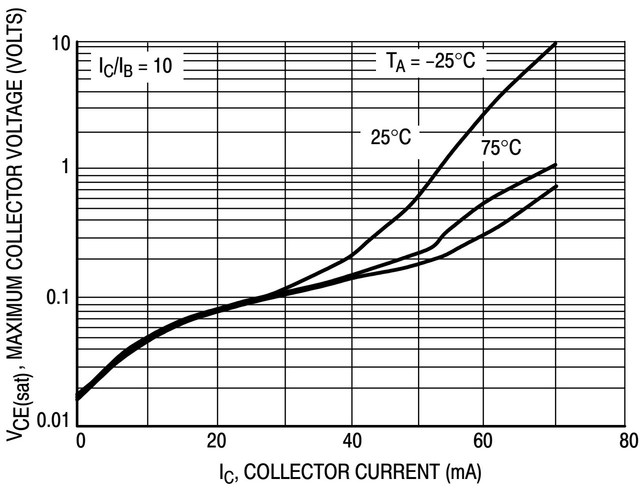


Figure 12. $V_{CE(sat)}$ versus I_C

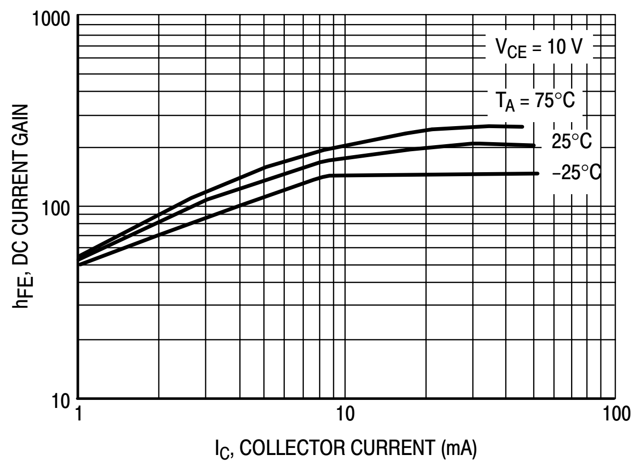


Figure 13. DC Current Gain

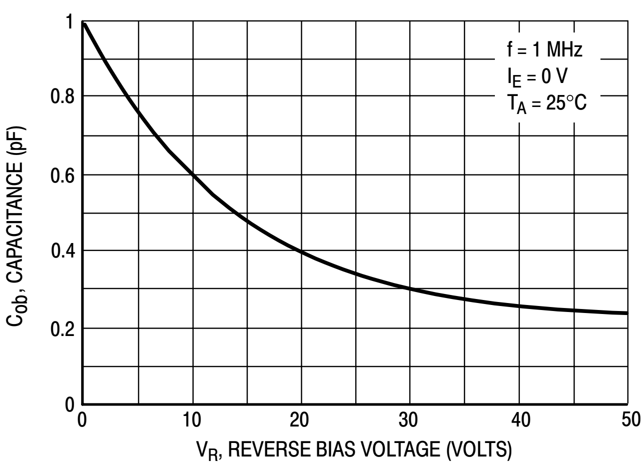


Figure 14. Output Capacitance

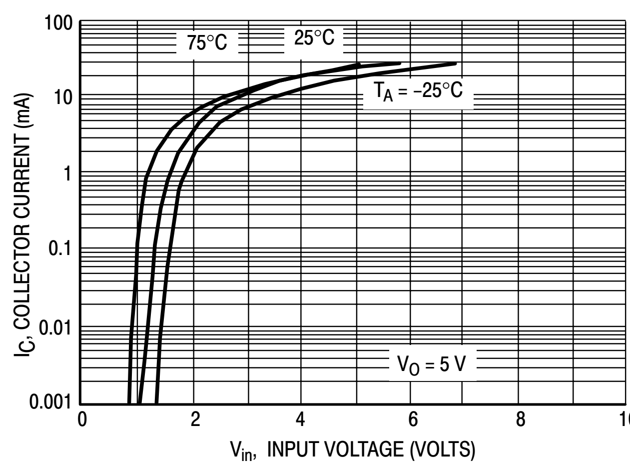


Figure 15. Output Current versus Input Voltage

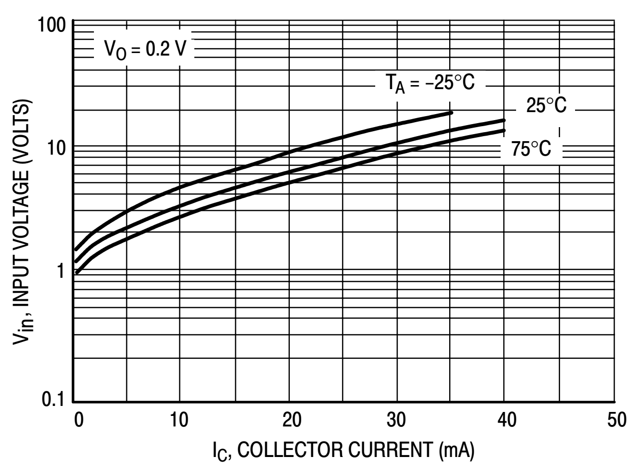


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN2214T1

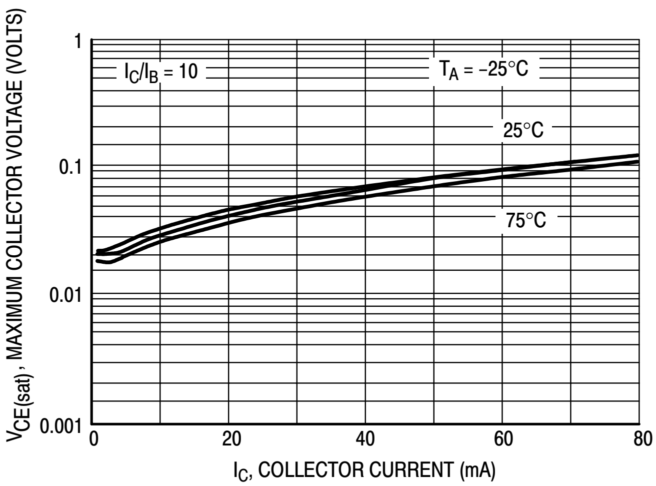


Figure 17. $V_{CE(sat)}$ versus I_C

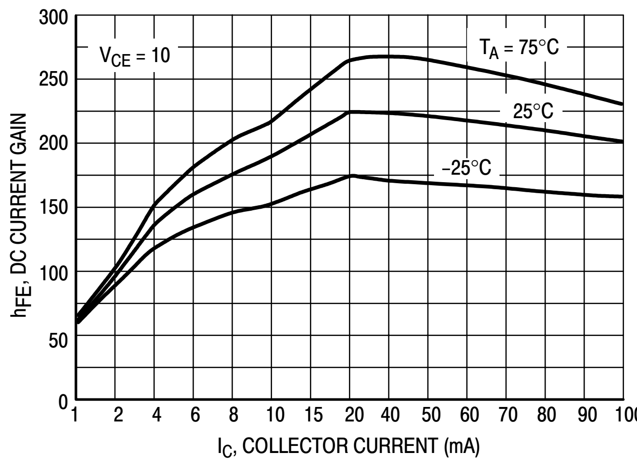


Figure 18. DC Current Gain

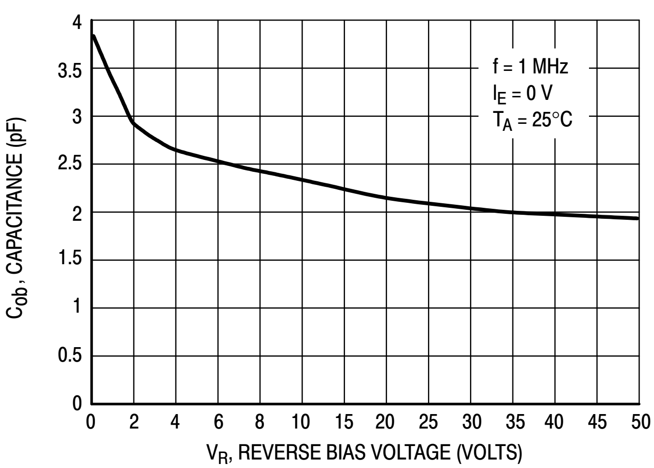


Figure 19. Output Capacitance

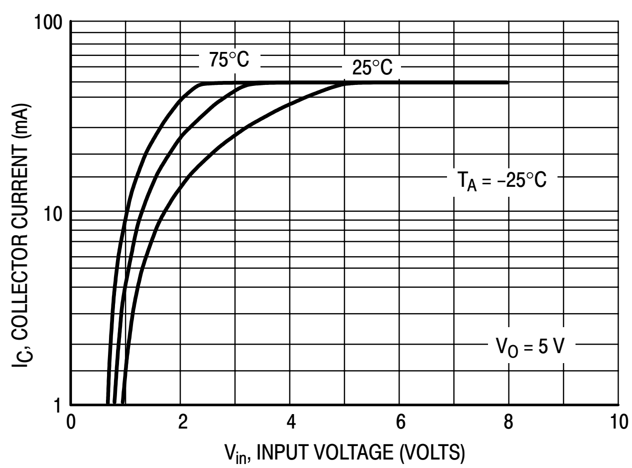


Figure 20. Output Current versus Input Voltage

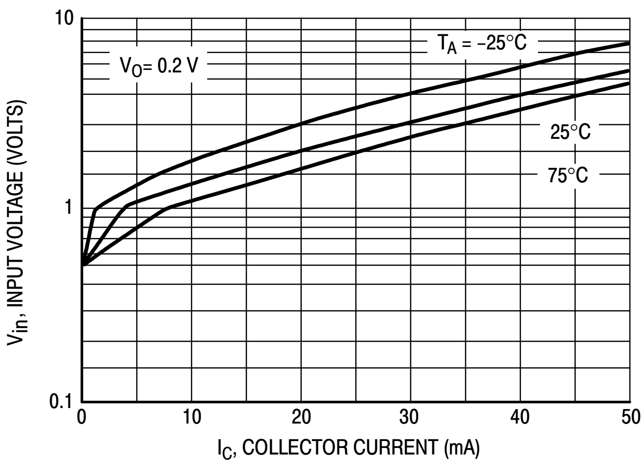


Figure 21. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN2236T1

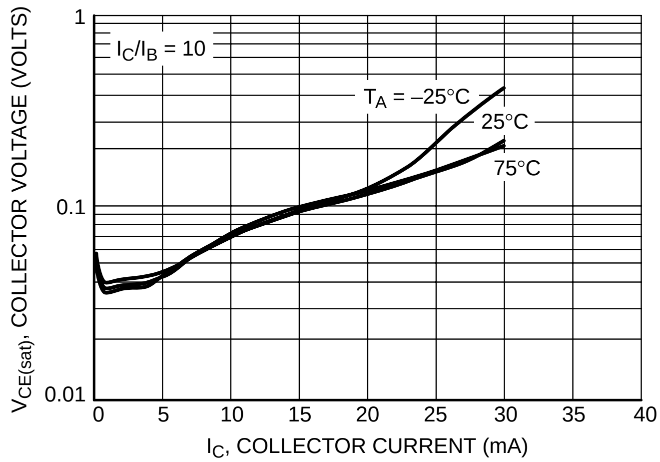


Figure 22. $V_{CE(sat)}$ versus I_C

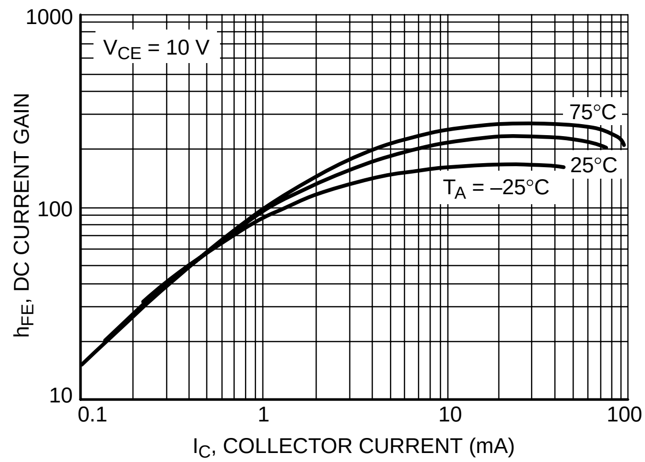


Figure 23. DC Current Gain

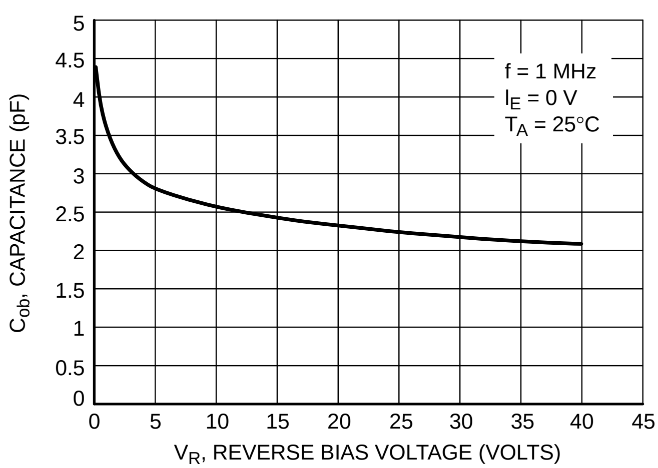


Figure 24. Output Capacitance

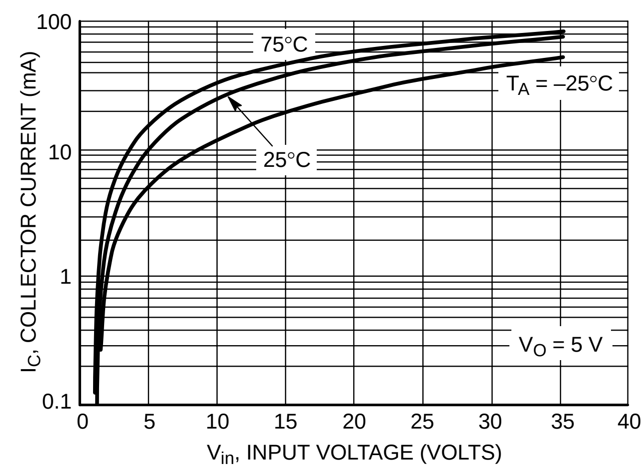


Figure 25. Output Current versus Input Voltage

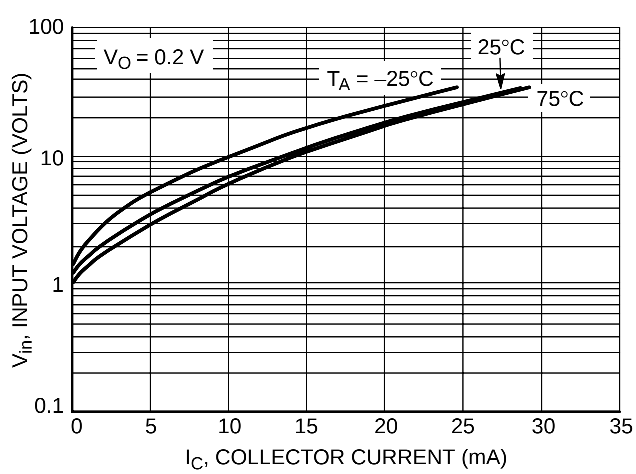


Figure 26. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN2237T1

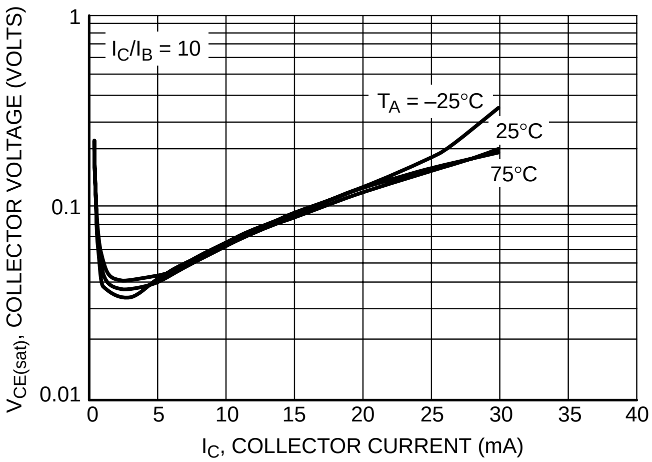


Figure 27. $V_{CE(sat)}$ versus I_C

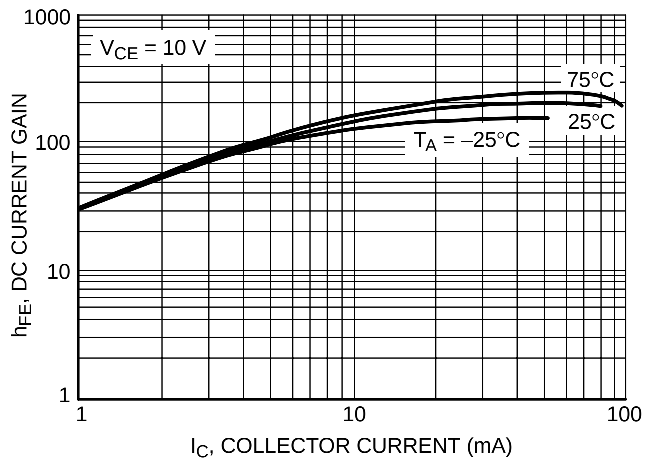


Figure 28. DC Current Gain

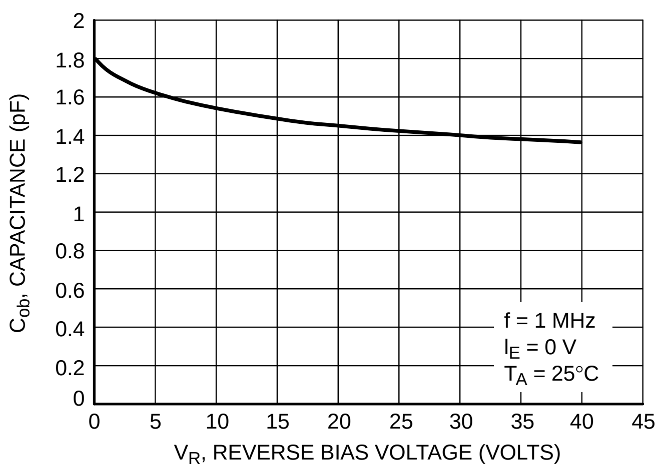


Figure 29. Output Capacitance

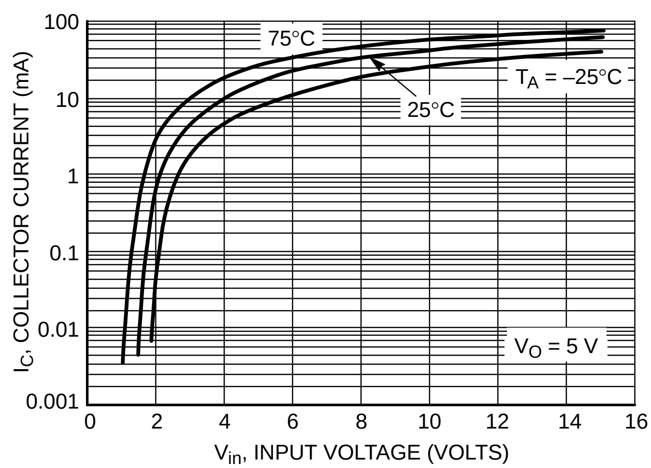


Figure 30. Output Current versus Input Voltage

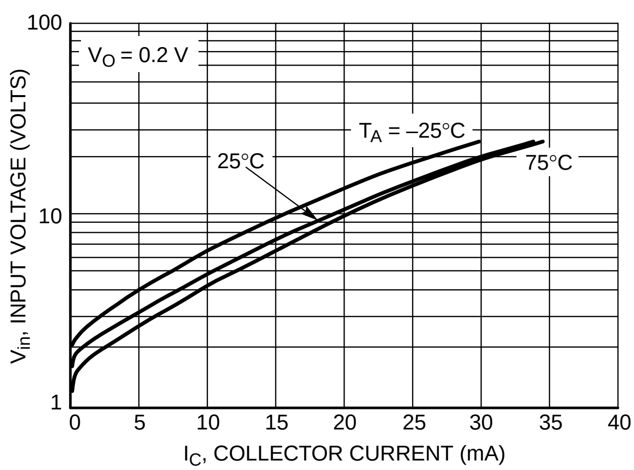


Figure 31. Input Voltage versus Output Current

TYPICAL APPLICATIONS FOR NPN BRTs

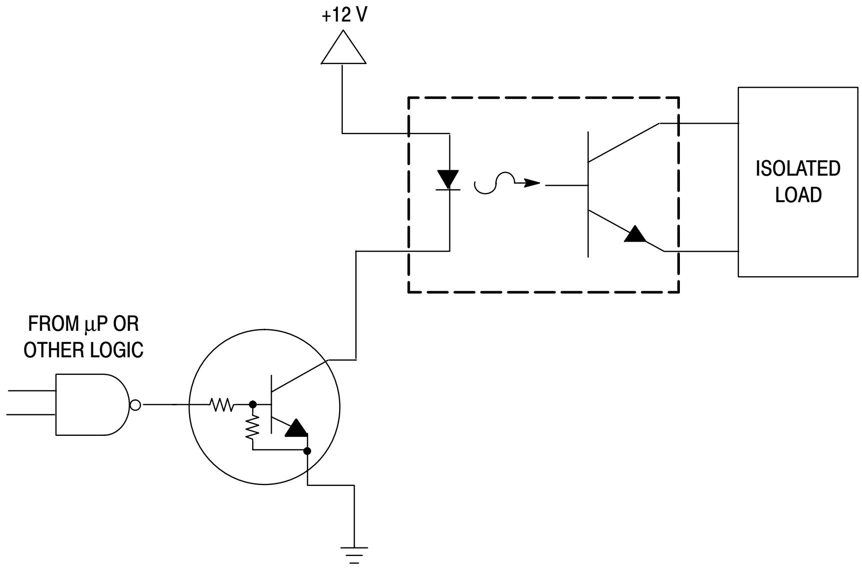


Figure 32. Level Shifter: Connects 12 or 24 Volt Circuits to Logic

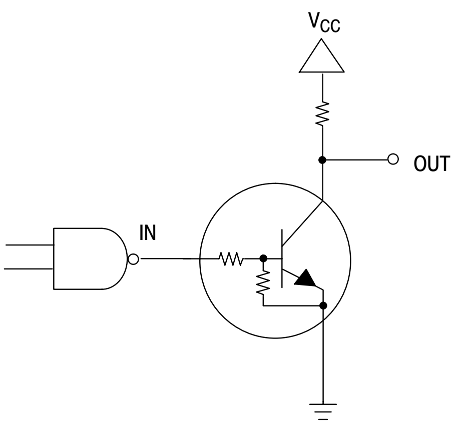


Figure 33. Open Collector Inverter: Inverts the Input Signal

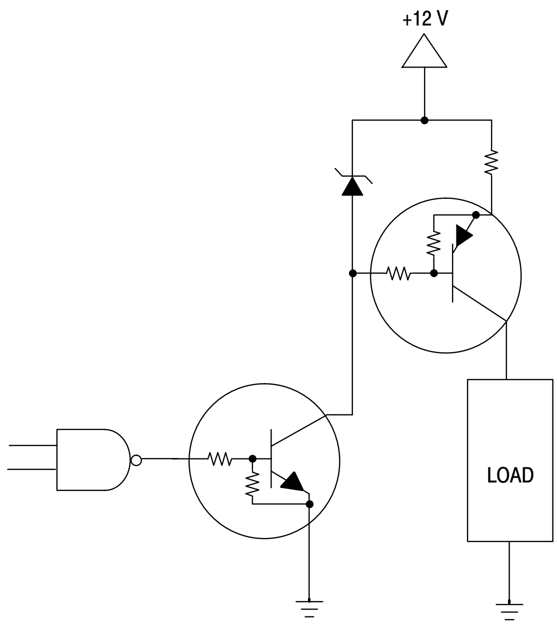


Figure 34. Inexpensive, Unregulated Current Source

MUN5111DW1T1 Series

Preferred Devices

Dual Bias Resistor Transistors

PNP Silicon Surface Mount Transistors with Monolithic Bias Resistor Network

The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. These digital transistors are designed to replace a single device and its external resistor bias network. The BRT eliminates these individual components by integrating them into a single device. In the MUN5111DW1T1 series, two BRT devices are housed in the SOT–363 package which is ideal for low–power surface mount applications where board space is at a premium.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Available in 8 mm, 7 inch/3000 Unit Tape and Reel

MAXIMUM RATINGS

(T_A = 25°C unless otherwise noted, common for Q_1 and Q_2)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	–50	Vdc
Collector-Emitter Voltage	V_{CEO}	–50	Vdc
Collector Current	I_C	–100	mAdc

THERMAL CHARACTERISTICS

Characteristic (One Junction Heated)	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	187 (Note 1.) 256 (Note 2.) 1.5 (Note 1.) 2.0 (Note 2.)	mW mW/°C
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	670 (Note 1.) 490 (Note 2.)	°C/W
Characteristic (Both Junctions Heated)	**Symbol**	**Max**	**Unit**
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	250 (Note 1.) 385 (Note 2.) 2.0 (Note 1.) 3.0 (Note 2.)	mW mW/°C
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	493 (Note 1.) 325 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{\theta JL}$	188 (Note 1.) 208 (Note 2.)	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

ON Semiconductor™

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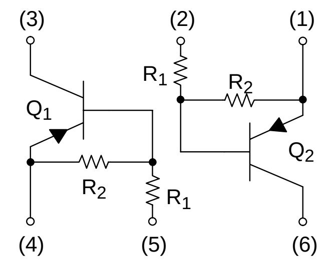
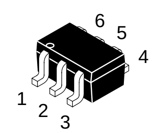
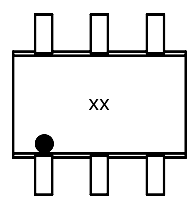




SOT–363
CASE 419B
STYLE 1

MARKING DIAGRAM



xx = Device Marking (See Page 979)

DEVICE MARKING INFORMATION

See specific marking information in the device marking table on page 979 of this data sheet.

Preferred devices are recommended choices for future use and best overall value.

DEVICE MARKING AND RESISTOR VALUES

Device	Package	Marking	R1 (K)	R2 (K)	Shipping
MUN5111DW1T1	SOT–363	0A	10	10	3000/Tape & Reel
MUN5112DW1T1	SOT–363	0B	22	22	3000/Tape & Reel
MUN5113DW1T1	SOT–363	0C	47	47	3000/Tape & Reel
MUN5114DW1T1	SOT–363	0D	10	47	3000/Tape & Reel
MUN5115DW1T1 (Note 3.)	SOT–363	0E	10	∞	3000/Tape & Reel
MUN5116DW1T1 (Note 3.)	SOT–363	0F	4.7	∞	3000/Tape & Reel
MUN5130DW1T1 (Note 3.)	SOT–363	0G	1.0	1.0	3000/Tape & Reel
MUN5131DW1T1 (Note 3.)	SOT–363	0H	2.2	2.2	3000/Tape & Reel
MUN5132DW1T1 (Note 3.)	SOT–363	0J	4.7	4.7	3000/Tape & Reel
MUN5133DW1T1 (Note 3.)	SOT–363	0K	4.7	47	3000/Tape & Reel
MUN5134DW1T1 (Note 3.)	SOT–363	0L	22	47	3000/Tape & Reel
MUN5135DW1T1 (Note 3.)	SOT–363	0M	2.2	47	3000/Tape & Reel
MUN5136DW1T1 (Note 3.)	SOT–363	0N	100	100	3000/Tape & Reel
MUN5137DW1T1 (Note 3.)	SOT–363	0P	47	22	3000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted, common for Q_1 and Q_2)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Cutoff Current (V_{CB} = –50 V, I_E = 0)		I_{CBO}	–	–	–100	nAdc
Collector-Emitter Cutoff Current (V_{CE} = –50 V, I_B = 0)		I_{CEO}	–	–	–500	nAdc
Emitter-Base Cutoff Current (V_{EB} = –6.0 V, I_C = 0)	MUN5111DW1T1	I_{EBO}	–	–	–0.5	mAdc
	MUN5112DW1T1		–	–	–0.2	
	MUN5113DW1T1		–	–	–0.1	
	MUN5114DW1T1		–	–	–0.2	
	MUN5115DW1T1		–	–	–0.9	
	MUN5116DW1T1		–	–	–1.9	
	MUN5130DW1T1		–	–	–4.3	
	MUN5131DW1T1		–	–	–2.3	
	MUN5132DW1T1		–	–	–1.5	
	MUN5133DW1T1		–	–	–0.18	
	MUN5134DW1T1		–	–	–0.13	
	MUN5135DW1T1		–	–	–0.2	
	MUN5136DW1T1		–	–	–0.05	
	MUN5137DW1T1		–	–	–0.13	
Collector-Base Breakdown Voltage (I_C = –10 μA, I_E = 0)		$V_{(BR)CBO}$	–50	–	–	Vdc
Collector-Emitter Breakdown Voltage (Note 4.) (I_C = –2.0 mA, I_B = 0)		$V_{(BR)CEO}$	–50	–	–	Vdc
ON CHARACTERISTICS (Note 4.)						
Collector-Emitter Saturation Voltage (I_C = –10 mA, I_E = –0.3 mA) (I_C = –10 mA, I_B = –5 mA) MUN5130DW1T1/MUN5131DW1T1 (I_C = –10 mA, I_B = –1 mA) MUN5115DW1T1/MUN5116DW1T1 MUN5132DW1T1/MUN5133DW1T1/MUN5134DW1T1		$V_{CE(sat)}$	–	–	–0.25	Vdc

3. New resistor combinations. Updated curves to follow in subsequent data sheets.
4. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted, common for Q_1 and Q_2) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Note 5.) (Continued)						
DC Current Gain	MUN5111DW1T1	h_{FE}	35	60	–	
(V_{CE} = –10 V, I_C = –5.0 mA)	MUN5112DW1T1		60	100	–	
	MUN5113DW1T1		80	140	–	
	MUN5114DW1T1		80	140	–	
	MUN5115DW1T1		160	250	–	
	MUN5116DW1T1		160	250	–	
	MUN5130DW1T1		3.0	5.0	–	
	MUN5131DW1T1		8.0	15	–	
	MUN5132DW1T1		15	27	–	
	MUN5133DW1T1		80	140	–	
	MUN5134DW1T1		80	130	–	
	MUN5135DW1T1		80	140	–	
	MUN5136DW1T1		80	130	–	
	MUN5137DW1T1		80	140	–	
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = –5.0 V, V_B = –2.5 V, R_L = 1.0 kΩ)	MUN5111DW1T1		–	–	–0.2	
	MUN5112DW1T1		–	–	–0.2	
	MUN5114DW1T1		–	–	–0.2	
	MUN5115DW1T1		–	–	–0.2	
	MUN5116DW1T1		–	–	–0.2	
	MUN5130DW1T1		–	–	–0.2	
	MUN5131DW1T1		–	–	–0.2	
	MUN5132DW1T1		–	–	–0.2	
	MUN5133DW1T1		–	–	–0.2	
	MUN5134DW1T1		–	–	–0.2	
	MUN5135DW1T1		–	–	–0.2	
(V_{CC} = –5.0 V, V_B = –3.5 V, R_L = 1.0 kΩ)	MUN5113DW1T1		–	–	–0.2	
(V_{CC} = –5.0 V, V_B = –5.5 V, R_L = 1.0 kΩ)	MUN5136DW1T1		–	–	–0.2	
(V_{CC} = –5.0 V, V_B = –4.0 V, R_L = 1.0 kΩ)	MUN5137DW1T1		–	–	–0.2	
Output Voltage (off) (V_{CC} = –5.0 V, V_B = –0.5 V, R_L = 1.0 kΩ)		V_{OH}	–4.9	–	–	Vdc
(V_{CC} = –5.0 V, V_B = –0.05 V, R_L = 1.0 kΩ)	MUN5130DW1T1					
(V_{CC} = –5.0 V, V_B = –0.25 V, R_L = 1.0 kΩ)	MUN5115DW1T1					
	MUN5116DW1T1					
	MUN5131DW1T1					
	MUN5133DW1T1					
Input Resistor	MUN5111DW1T1	R_1	7.0	10	13	k Ω
	MUN5112DW1T1		15.4	22	28.6	
	MUN5113DW1T1		32.9	47	61.1	
	MUN5114DW1T1		7.0	10	13	
	MUN5115DW1T1		7.0	10	13	
	MUN5116DW1T1		3.3	4.7	6.1	
	MUN5130DW1T1		0.7	1.0	1.3	
	MUN5131DW1T1		1.5	2.2	2.9	
	MUN5132DW1T1		3.3	4.7	6.1	
	MUN5133DW1T1		3.3	4.7	6.1	
	MUN5134DW1T1		15.4	22	28.6	
	MUN5135DW1T1		1.54	2.2	2.86	
	MUN5136DW1T1		70	100	130	
	MUN5137DW1T1		32.9	47	61.1	
Resistor Ratio	MUN5111DW1T1/MUN5112DW1T1/	R_1/R_2				
	MUN5113DW1T1/MUN5136DW1T1		0.8	1.0	1.2	
	MUN5114DW1T1		0.17	0.21	0.25	
	MUN5115DW1T1/MUN5116DW1T1		–	–	–	
	MUN5130DW1T1/MUN5131DW1T1/MUN5132DW1T1		0.8	1.0	1.2	
	MUN5133DW1T1		0.055	0.1	0.185	
	MUN5134DW1T1		0.38	0.47	0.56	
	MUN5135DW1T1		0.038	0.047	0.056	
	MUN5137DW1T1		1.7	2.1	2.6	

5. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ALL MUN5111DW1T1 SERIES DEVICES

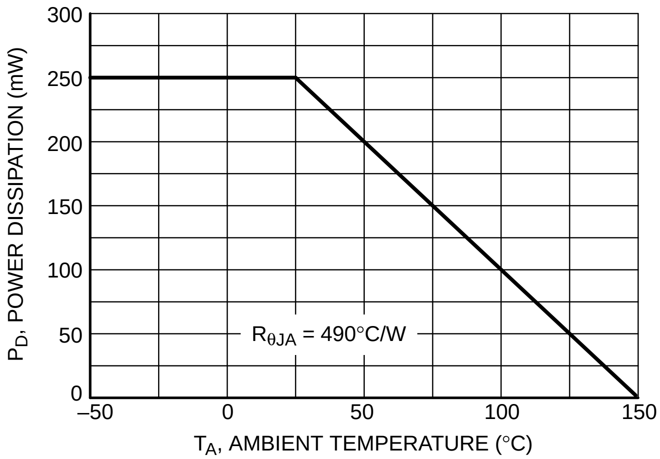


Figure 1. Derating Curve – ALL DEVICES

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5111DW1T1

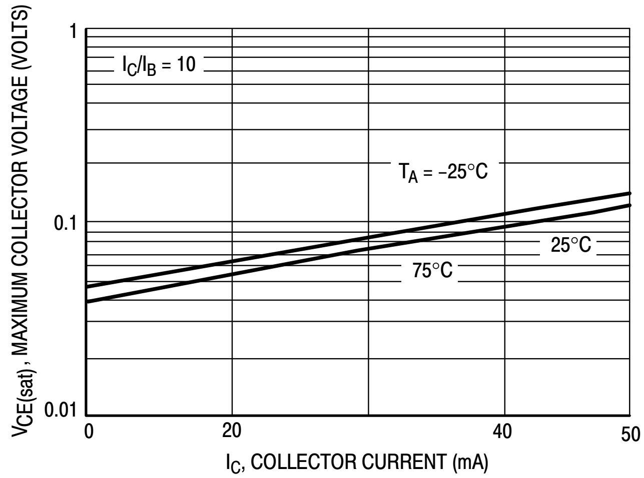


Figure 2. $V_{CE(sat)}$ versus I_C

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5111DW1T1

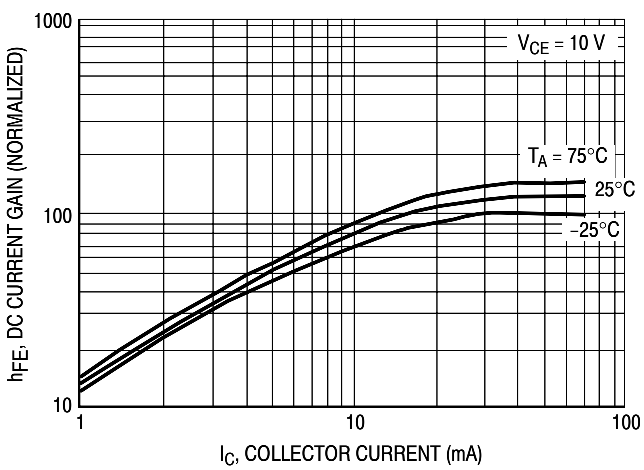


Figure 3. DC Current Gain

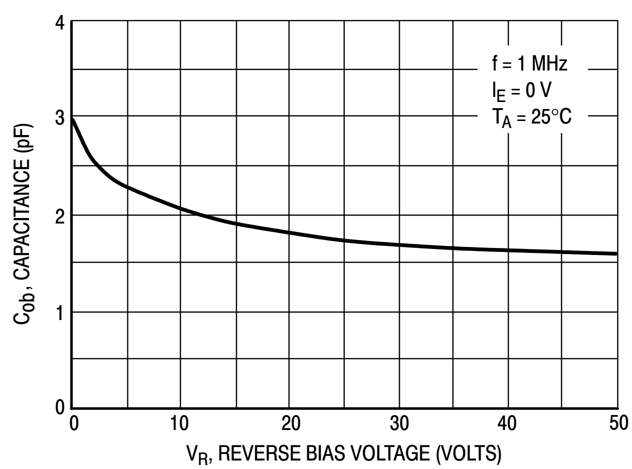


Figure 4. Output Capacitance

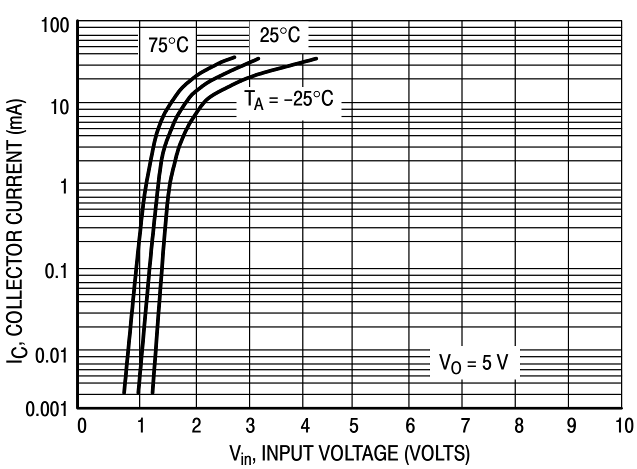


Figure 5. Output Current versus Input Voltage

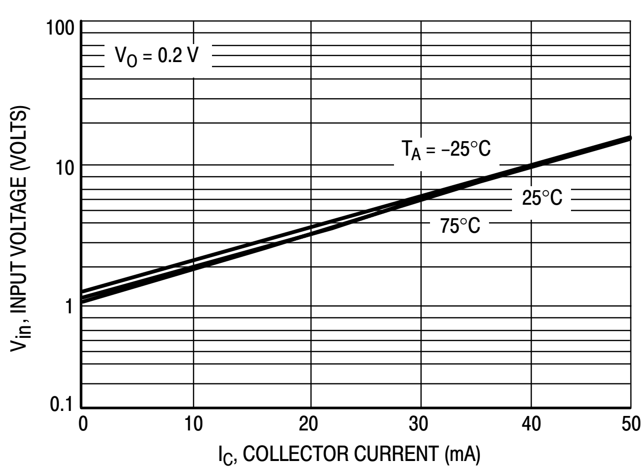


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5112DW1T1

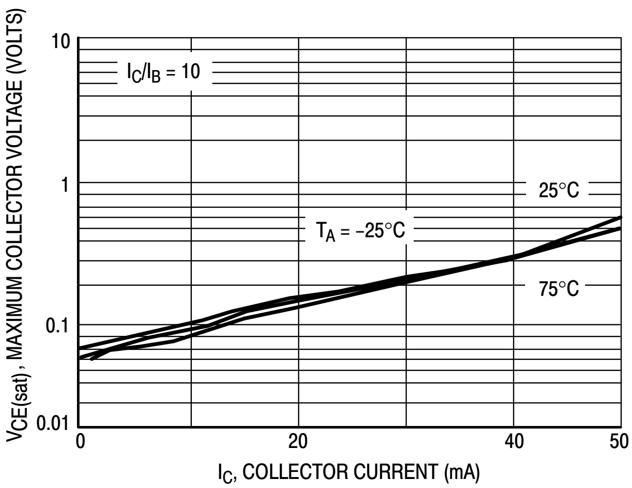


Figure 7. $V_{CE(sat)}$ versus I_C

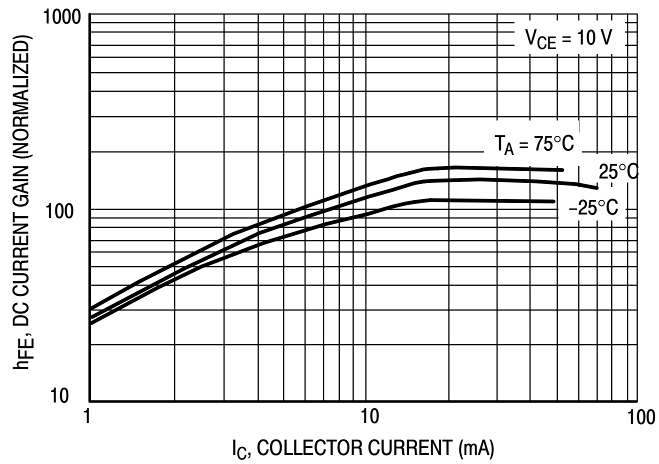


Figure 8. DC Current Gain

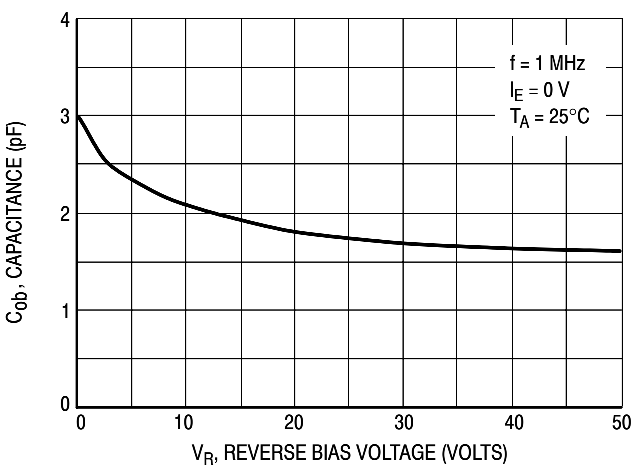


Figure 9. Output Capacitance

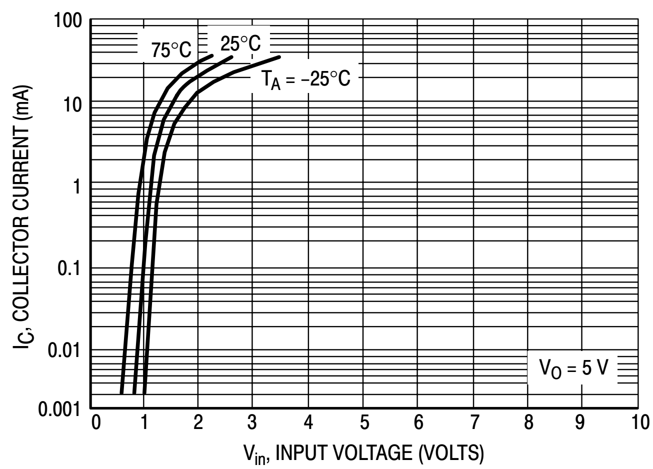


Figure 10. Output Current versus Input Voltage

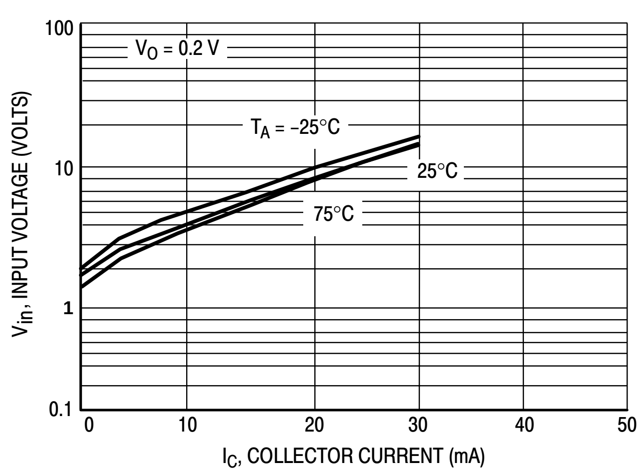


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5113DW1T1

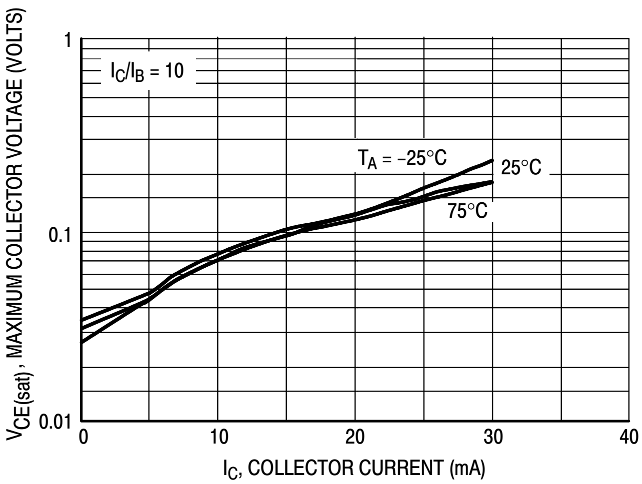


Figure 12. $V_{CE(sat)}$ versus I_C

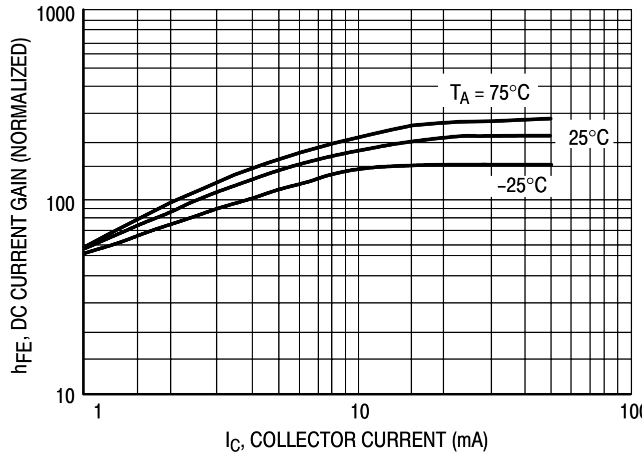


Figure 13. DC Current Gain

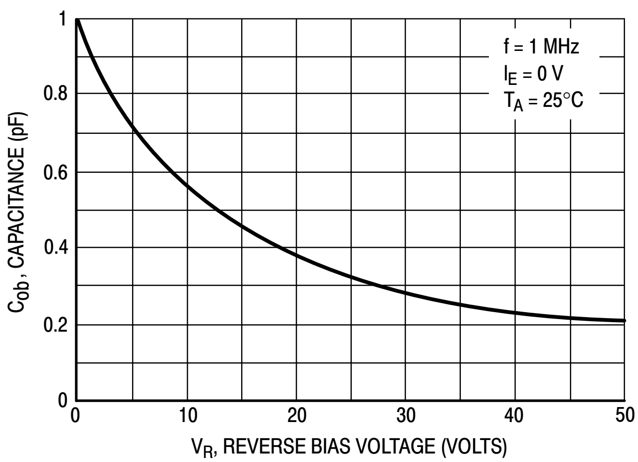


Figure 14. Output Capacitance

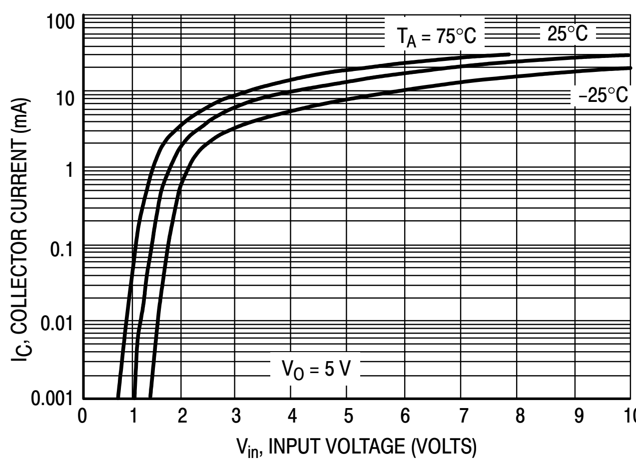


Figure 15. Output Current versus Input Voltage

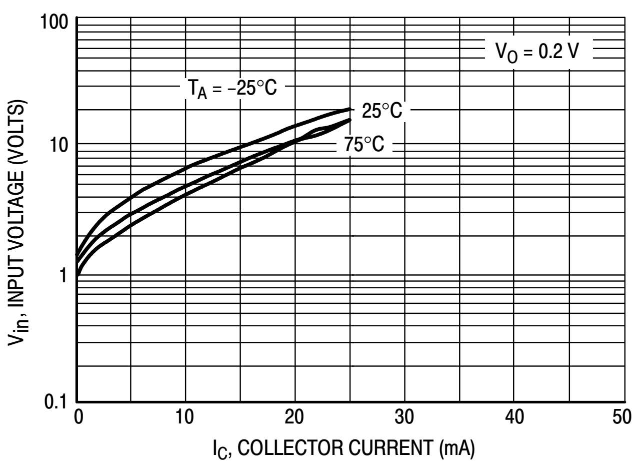


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5114DW1T1

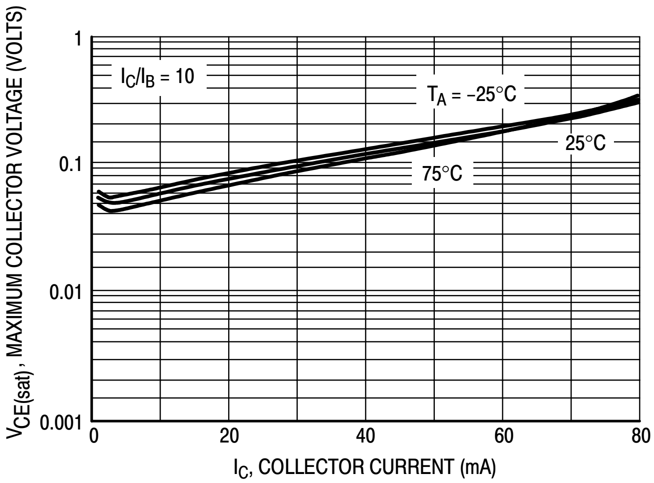


Figure 17. $V_{CE(sat)}$ versus I_C

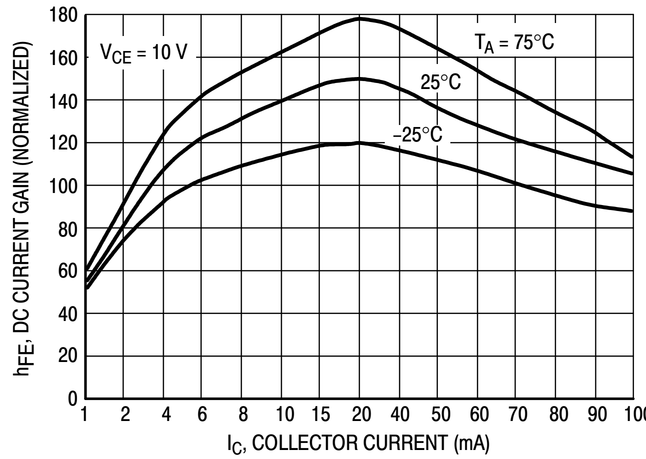


Figure 18. DC Current Gain

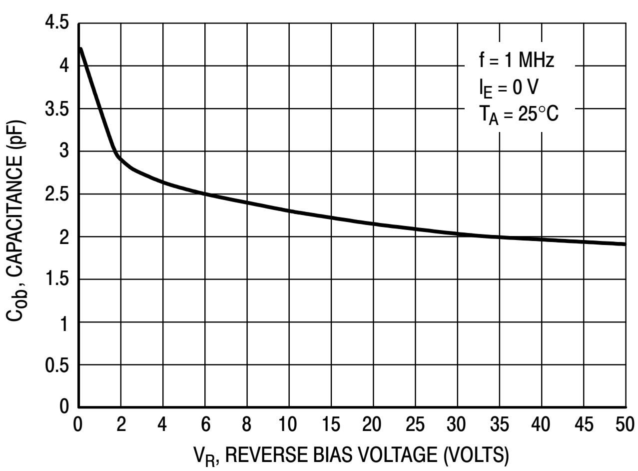


Figure 19. Output Capacitance

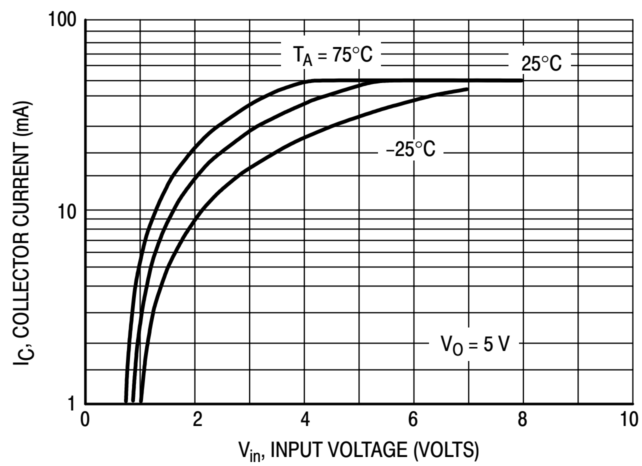


Figure 20. Output Current versus Input Voltage

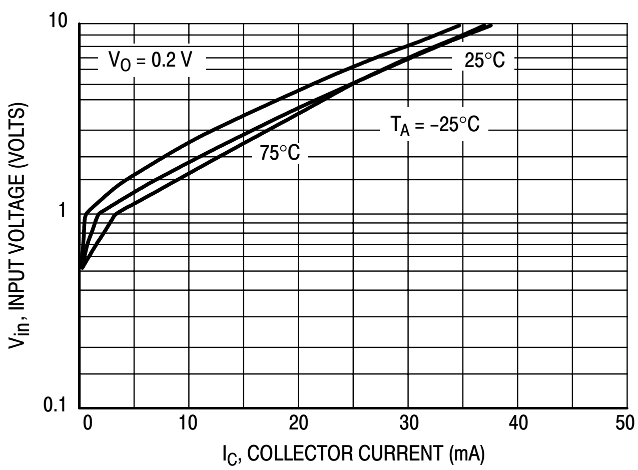


Figure 21. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5115DW1T1

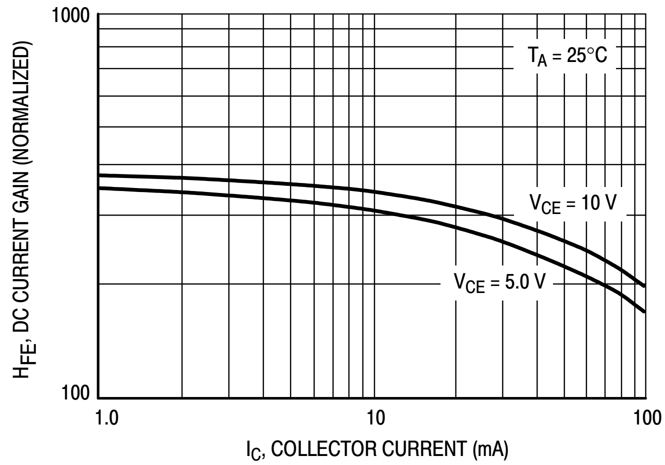


Figure 22. DC Current Gain

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5116DW1T1

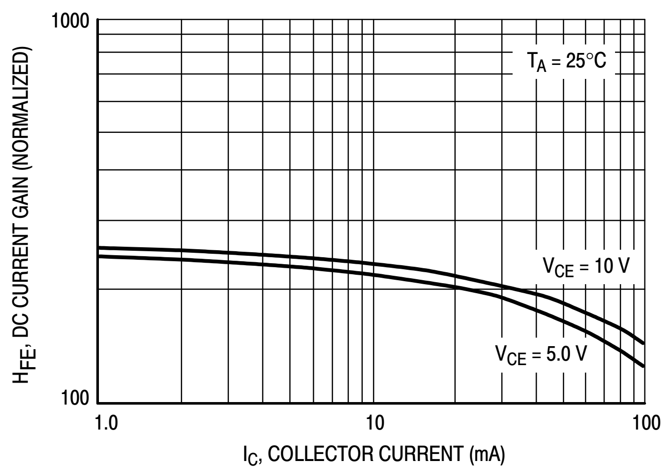


Figure 23. DC Current Gain

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5136DW1T1

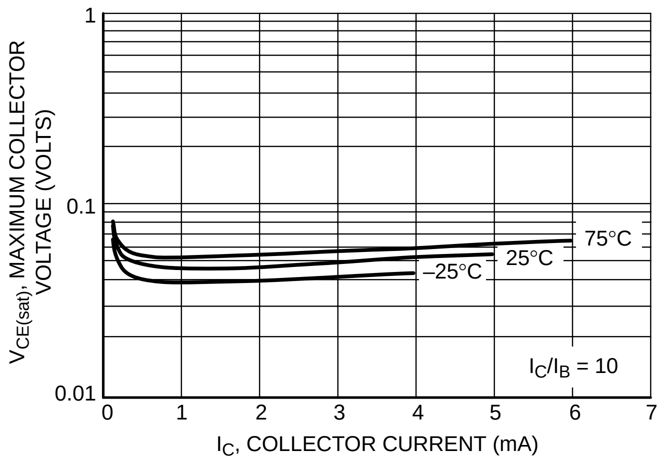


Figure 24. Maximum Collector Voltage versus Collector Current

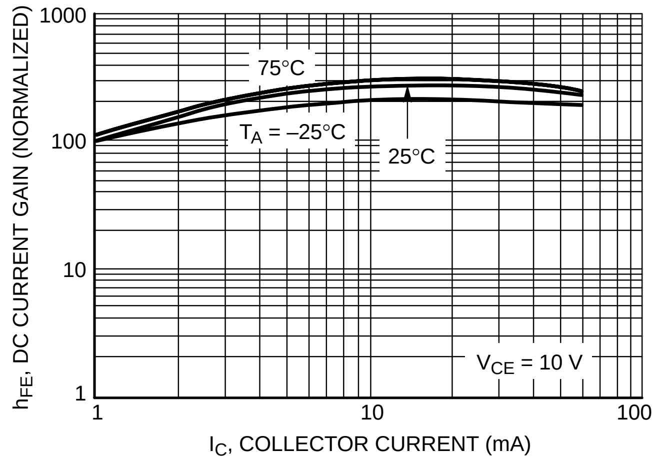


Figure 25. DC Current Gain

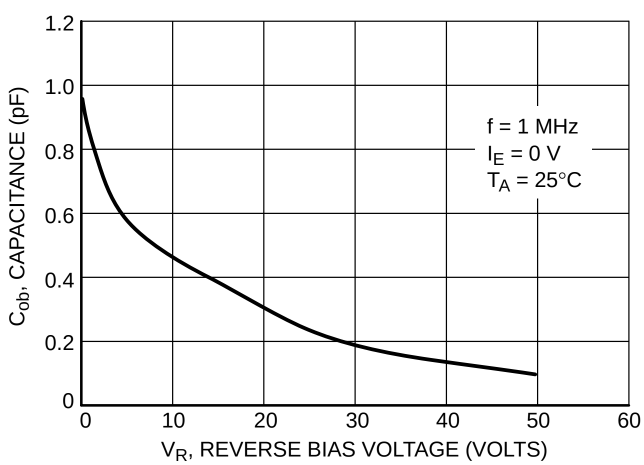


Figure 26. Output Capacitance

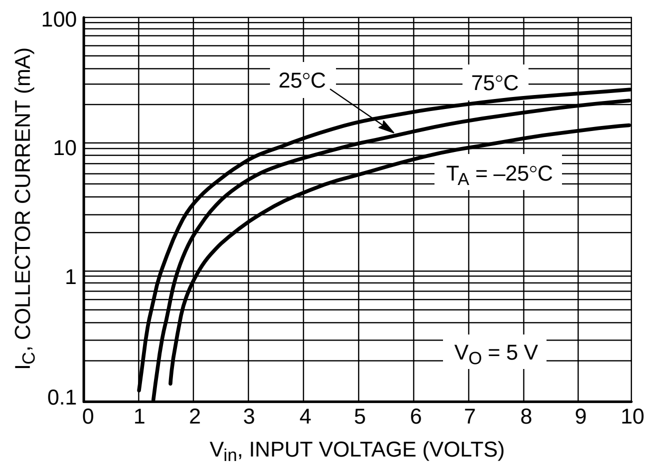


Figure 27. Output Current versus Input Voltage

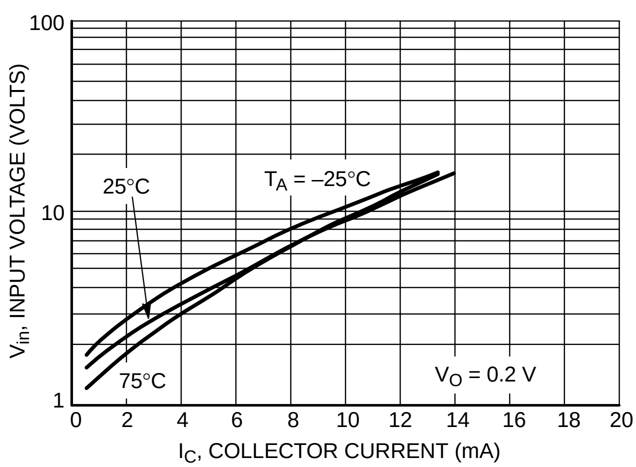


Figure 28. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5137DW1T1

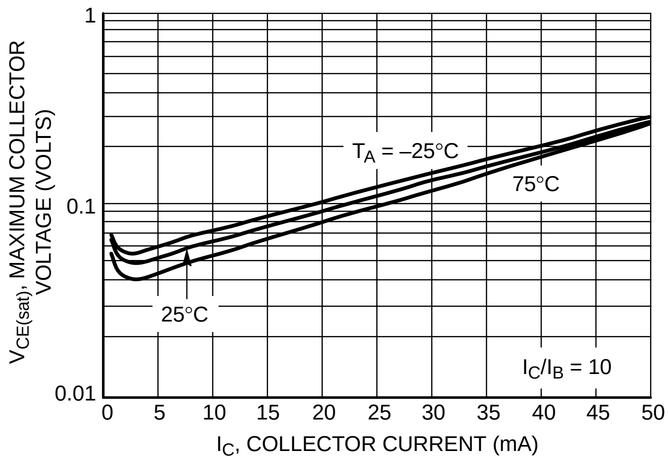


Figure 29. Maximum Collector Voltage versus Collector Current

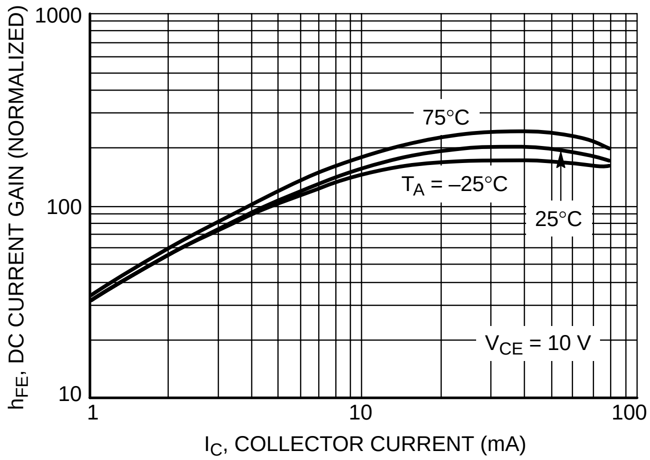


Figure 30. DC Current Gain

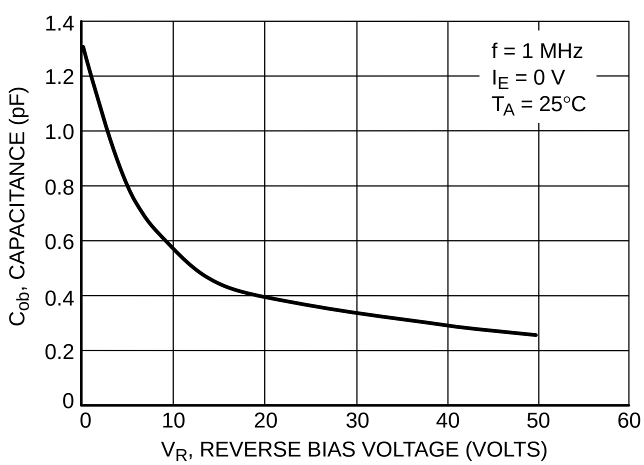


Figure 31. Output Capacitance

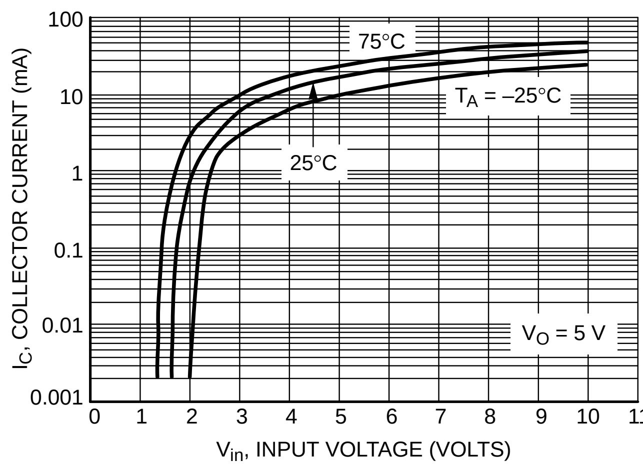


Figure 32. Output Current versus Input Voltage

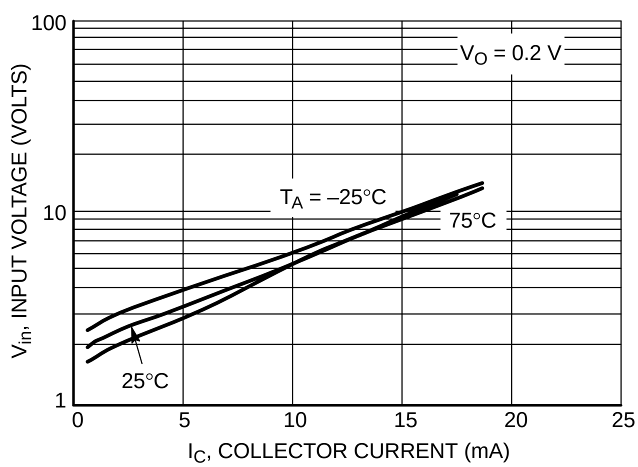


Figure 33. Input Voltage versus Output Current

MUN5111T1 Series

Preferred Devices

Bias Resistor Transistor

PNP Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC–70/SOT–323 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- The SC–70/SOT–323 package can be soldered using wave or reflow. The modified gull–winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
  Use the Device Number to order the 7 inch/3000 unit reel.
  Replace “T1” with “T3” in the Device Number to order the 13 inch/10,000 unit reel.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	202 (Note 1.) 310 (Note 2.) 1.6 (Note 1.) 2.5 (Note 2.)	mW °C/W
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	618 (Note 1.) 403 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{\theta JL}$	280 (Note 1.) 332 (Note 2.)	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

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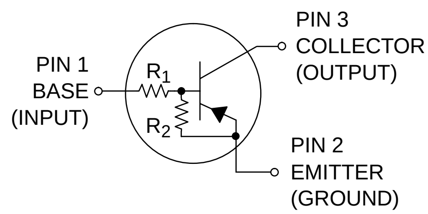
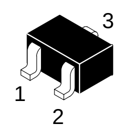
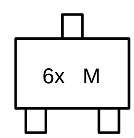
PNP SILICON BIAS RESISTOR TRANSISTORS





SC–70/SOT–323
CASE 419
STYLE 3

MARKING DIAGRAM



6x = Specific Device Code
x = (See Marking Table)
M = Date Code

DEVICE MARKING INFORMATION

See specific marking information in the device marking table on page 989 of this data sheet.

Preferred devices are recommended choices for future use and best overall value.

DEVICE MARKING AND RESISTOR VALUES

Device	Package	Marking	R1 (K)	R2 (K)	Shipping
MUN5111T1	SC–70/SOT–323	6A	10	10	3000/Tape & Reel
MUN5112T1	SC–70/SOT–323	6B	22	22	3000/Tape & Reel
MUN5113T1 MUN5113T3	SC–70/SOT–323	6C	47	47	3000/Tape & Reel 10,000/Tape & Reel
MUN5114T1	SC–70/SOT–323	6D	10	47	3000/Tape & Reel
MUN5115T1 (Note 3.)	SC–70/SOT–323	6E	10	∞	3000/Tape & Reel
MUN5116T1 (Note 3.)	SC–70/SOT–323	6F	4.7	∞	3000/Tape & Reel
MUN5130T1 (Note 3.)	SC–70/SOT–323	6G	1.0	1.0	3000/Tape & Reel
MUN5131T1 (Note 3.)	SC–70/SOT–323	6H	2.2	2.2	3000/Tape & Reel
MUN5132T1 (Note 3.)	SC–70/SOT–323	6J	4.7	4.7	3000/Tape & Reel
MUN5133T1 (Note 3.)	SC–70/SOT–323	6K	4.7	47	3000/Tape & Reel
MUN5134T1 (Note 3.)	SC–70/SOT–323	6L	22	47	3000/Tape & Reel
MUN5135T1 (Note 3.)	SC–70/SOT–323	6M	2.2	47	3000/Tape & Reel
MUN5136T1	SC–70/SOT–323	6N	100	100	3000/Tape & Reel
MUN5137T1	SC–70/SOT–323	6P	47	22	3000/Tape & Reel

3. New devices. Updated curves to follow in subsequent data sheets.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector–Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter–Base Cutoff Current	MUN5111T1	I_{EBO}	–	–	0.5	mAdc
(V_{EB} = 6.0 V, I_C = 0)	MUN5112T1		–	–	0.2	
	MUN5113T1		–	–	0.1	
	MUN5114T1		–	–	0.2	
	MUN5115T1		–	–	0.9	
	MUN5116T1		–	–	1.9	
	MUN5130T1		–	–	4.3	
	MUN5131T1		–	–	2.3	
	MUN5132T1		–	–	1.5	
	MUN5133T1		–	–	0.18	
	MUN5134T1		–	–	0.13	
	MUN5135T1		–	–	0.2	
	MUN5136T1		–	–	0.05	
	MUN5137T1		–	–	0.13	
Collector–Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector–Emitter Breakdown Voltage (Note 4.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc
ON CHARACTERISTICS (Note 4.)						
DC Current Gain	MUN5111T1	h_{FE}	35	60	–	
(V_{CE} = 10 V, I_C = 5.0 mA)	MUN5112T1		60	100	–	
	MUN5113T1		80	140	–	
	MUN5114T1		80	140	–	
	MUN5115T1		160	250	–	
	MUN5116T1		160	250	–	
	MUN5130T1		3.0	5.0	–	
	MUN5131T1		8.0	15	–	
	MUN5132T1		15	27	–	
	MUN5133T1		80	140	–	
	MUN5134T1		80	130	–	
	MUN5135T1		80	140	–	
	MUN5136T1		80	150	–	
	MUN5137T1		80	140	–	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_E = 0.3 mA) (I_C = 10 mA, I_B = 5 mA) MUN5130T1/MUN5131T1 (I_C = 10 mA, I_B = 1 mA) MUN5115T1/MUN5116T1/ MUN5132T1/MUN5133T1/MUN5134T1		$V_{CE(sat)}$	–	–	0.25	Vdc
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	MUN5111T1		–	–	0.2	
	MUN5112T1		–	–	0.2	
	MUN5114T1		–	–	0.2	
	MUN5115T1		–	–	0.2	
	MUN5116T1		–	–	0.2	
	MUN5130T1		–	–	0.2	
	MUN5131T1		–	–	0.2	
	MUN5132T1		–	–	0.2	
	MUN5133T1		–	–	0.2	
	MUN5134T1		–	–	0.2	
	MUN5135T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	MUN5113T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 5.5 V, R_L = 1.0 kΩ)	MUN5136T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 4.0 V, R_L = 1.0 kΩ)	MUN5137T1		–	–	0.2	

4. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ)		V_{OH}	4.9	–	–	Vdc
(V_{CC} = 5.0 V, V_B = 0.050 V, R_L = 1.0 kΩ)	MUN5130T1					
(V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	MUN5115T1					
	MUN5116T1					
	MUN5131T1					
	MUN5132T1					
Input Resistor	MUN5111T1	R1	7.0	10	13	kΩ
	MUN5112T1		15.4	22	28.6	
	MUN5113T1		32.9	47	61.1	
	MUN5114T1		7.0	10	13	
	MUN5115T1		7.0	10	13	
	MUN5116T1		3.3	4.7	6.1	
	MUN5130T1		0.7	1.0	1.3	
	MUN5131T1		1.5	2.2	2.9	
	MUN5132T1		3.3	4.7	6.1	
	MUN5133T1		3.3	4.7	6.1	
	MUN5134T1		15.4	22	28.6	
	MUN5135T1		1.54	2.2	2.86	
	MUN5136T1		70	100	130	
	MUN5137T1		32.9	47	61.1	
Resistor Ratio	MUN5111T1/MUN5112T1/MUN5113T1/ MUN5136T1	R_1/R_2	0.8	1.0	1.2	
	MUN5114T1		0.17	0.21	0.25	
	MUN5115T1/MUN5116T1		–	–	–	
	MUN5130T1/MUN5131T1/MUN5132T1		0.8	1.0	1.2	
	MUN5133T1		0.055	0.1	0.185	
	MUN5134T1		0.38	0.47	0.56	
	MUN5135T1		0.038	0.047	0.056	
	MUN5137T1		1.7	2.1	2.6	

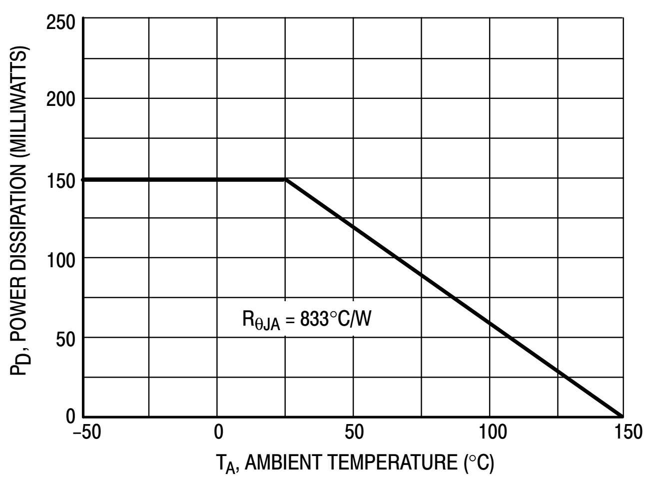


Figure 1. Derating Curve

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5111T1

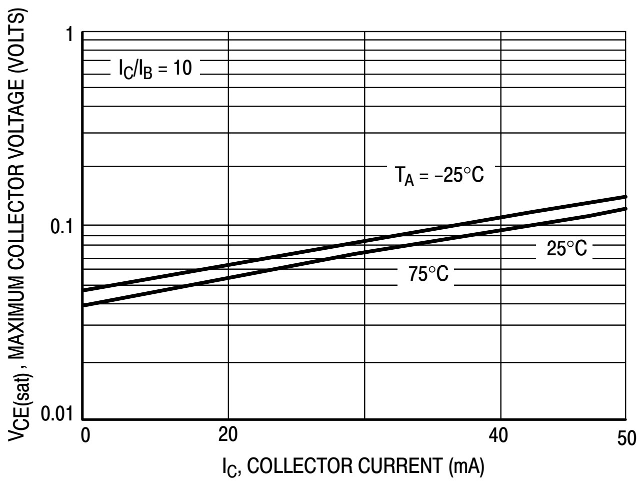


Figure 2. $V_{CE(sat)}$ versus I_C

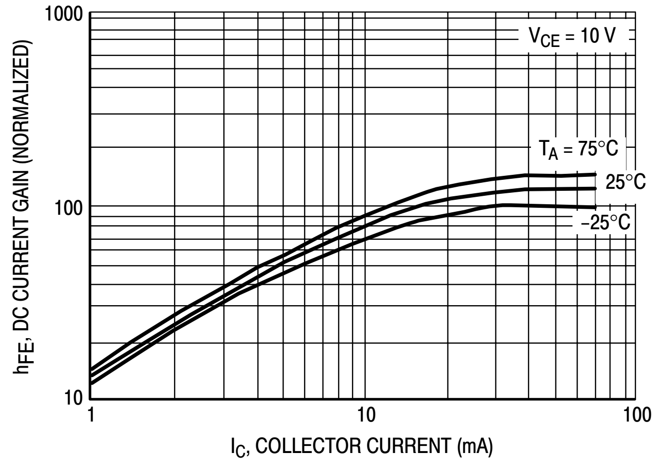


Figure 3. DC Current Gain

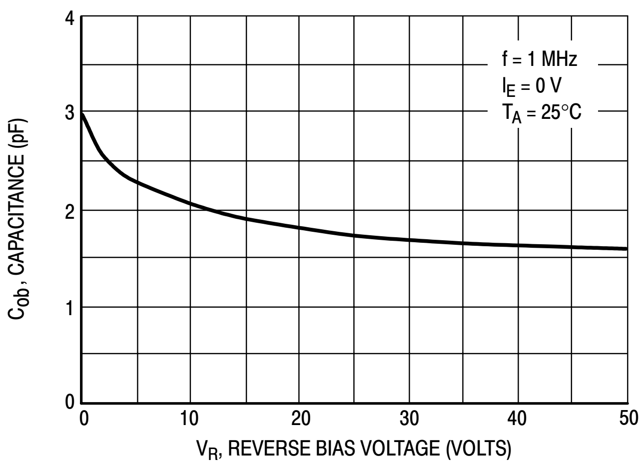


Figure 4. Output Capacitance

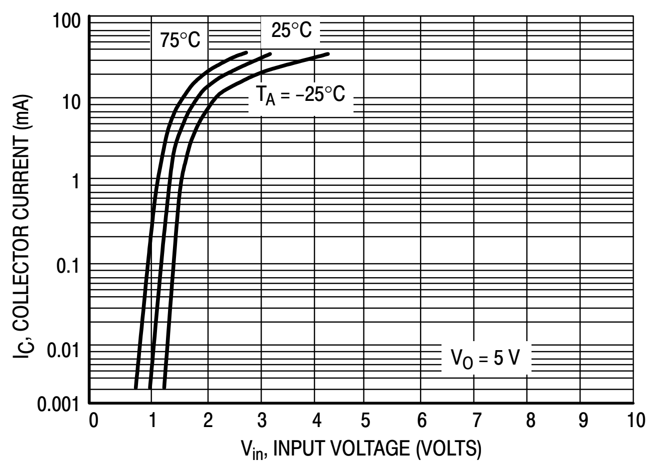


Figure 5. Output Current versus Input Voltage

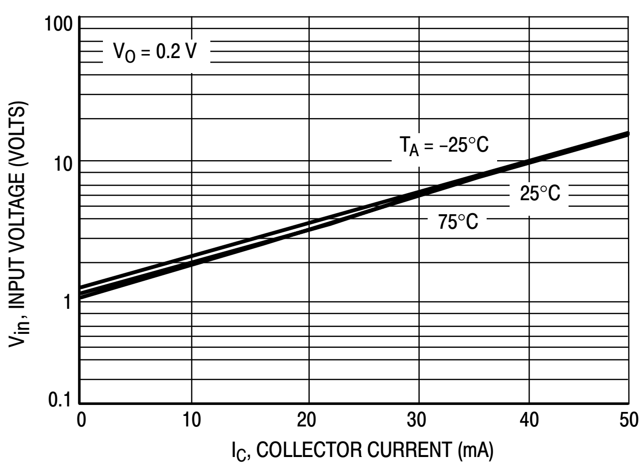


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5112T1

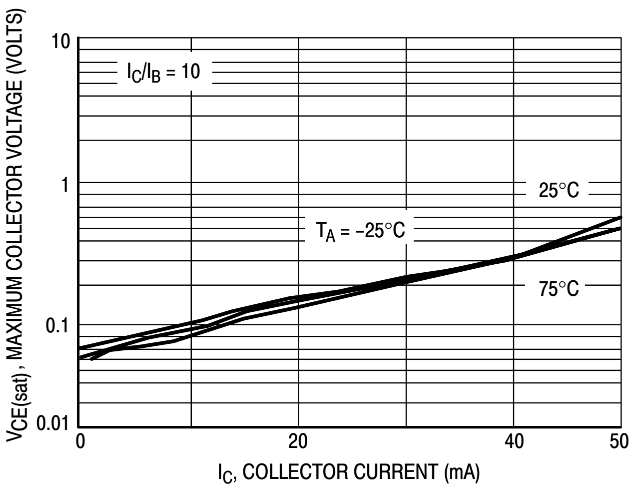


Figure 7. $V_{CE(sat)}$ versus I_C

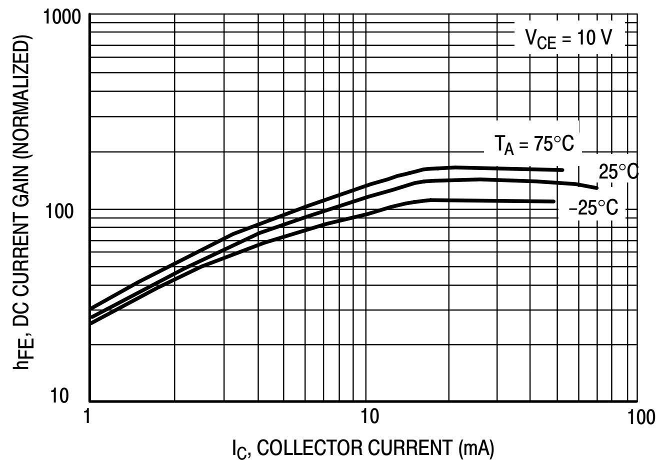


Figure 8. DC Current Gain

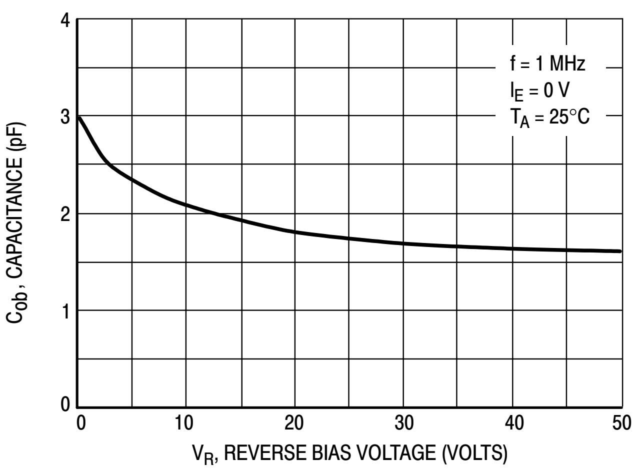


Figure 9. Output Capacitance

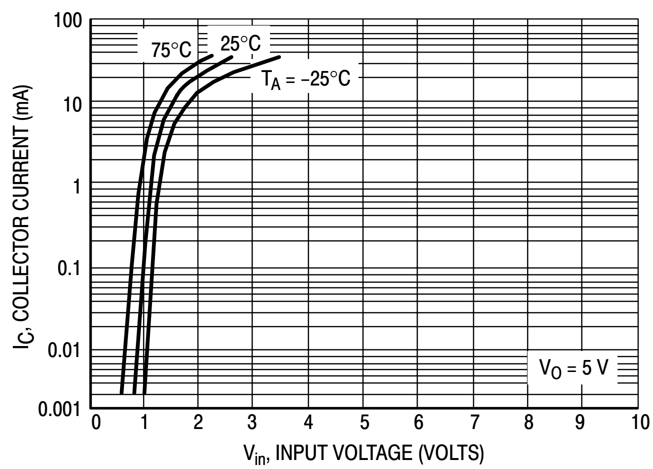


Figure 10. Output Current versus Input Voltage

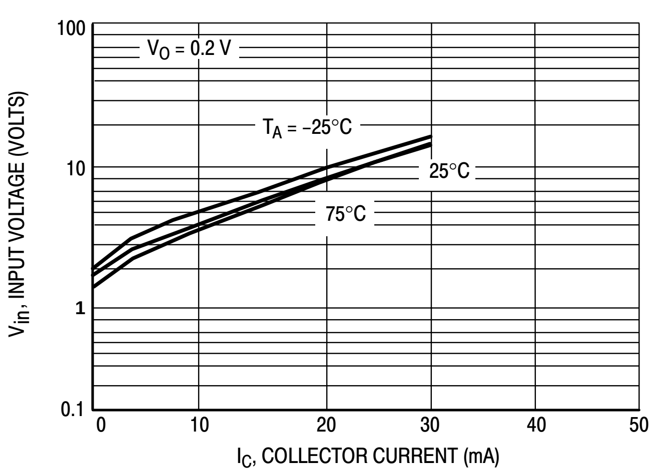


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5113T1

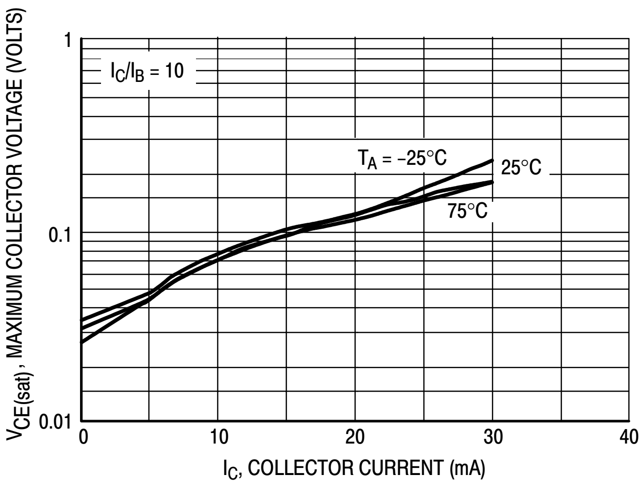


Figure 12. $V_{CE(sat)}$ versus I_C

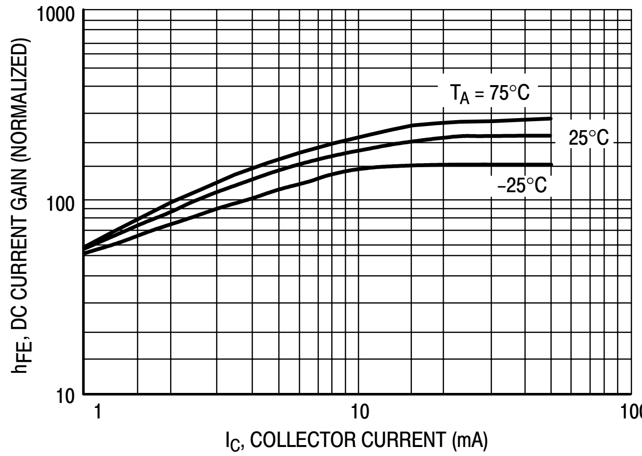


Figure 13. DC Current Gain

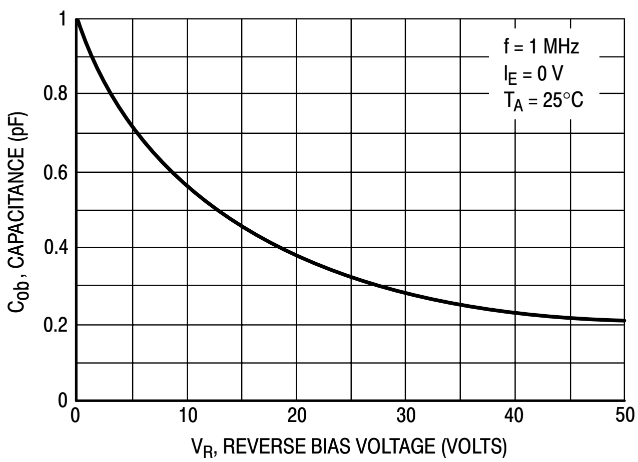


Figure 14. Output Capacitance

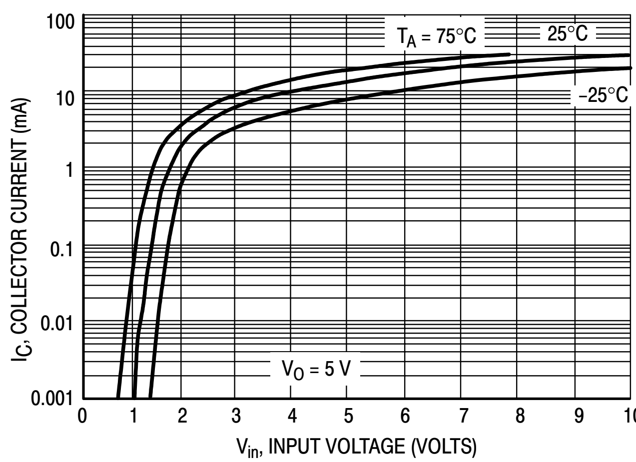


Figure 15. Output Current versus Input Voltage

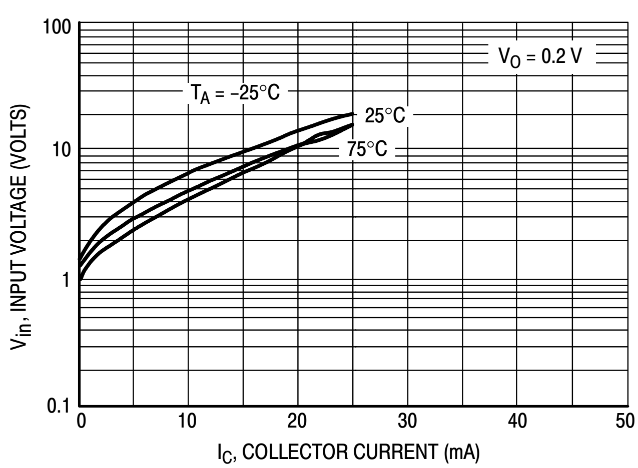


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5114T1

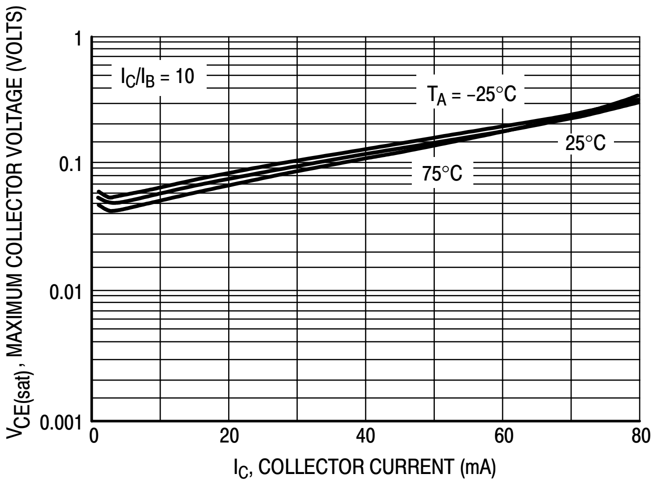


Figure 17. $V_{CE(sat)}$ versus I_C

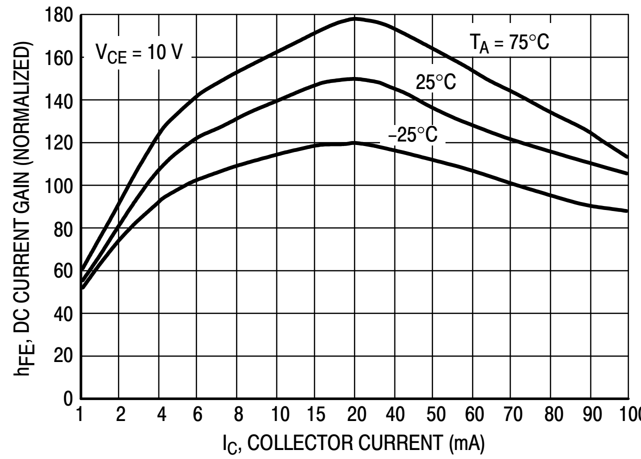


Figure 18. DC Current Gain

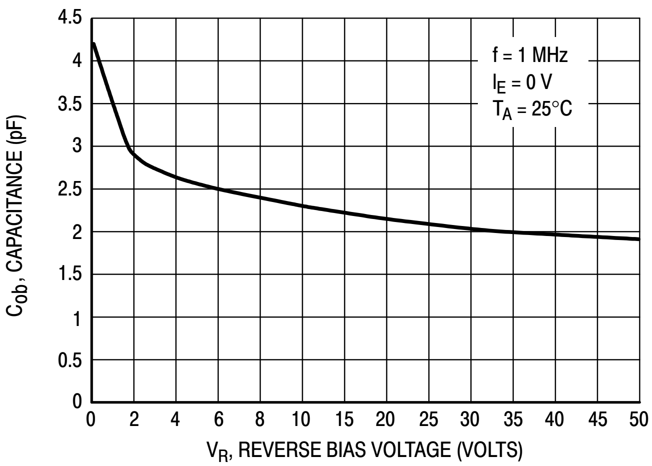


Figure 19. Output Capacitance

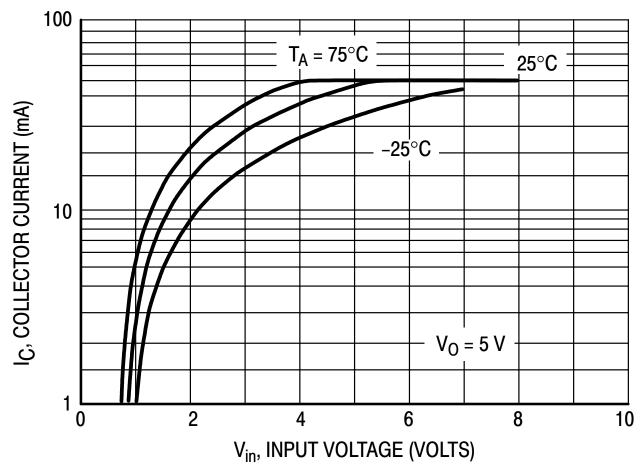


Figure 20. Output Current versus Input Voltage

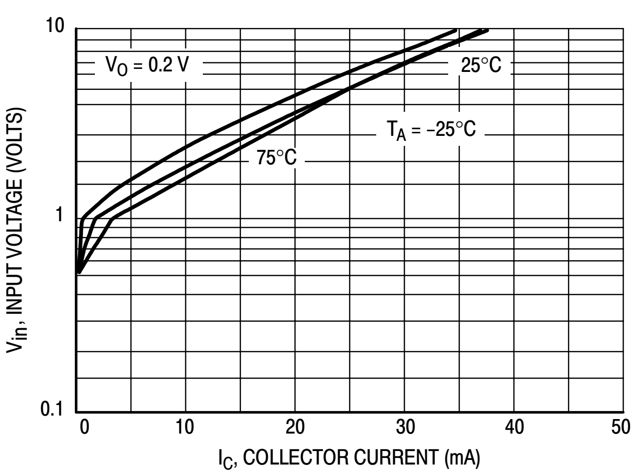


Figure 21. Input Voltage versus Output Current

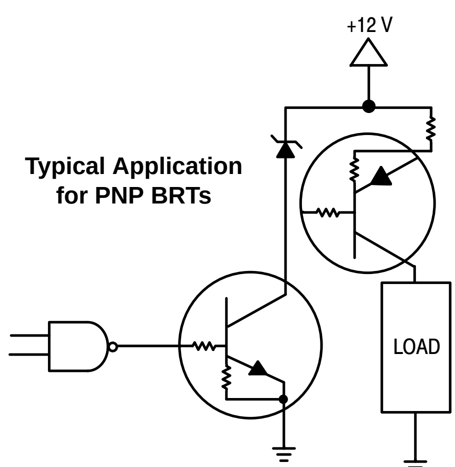


Figure 22. Inexpensive, Unregulated Current Source

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5136T1

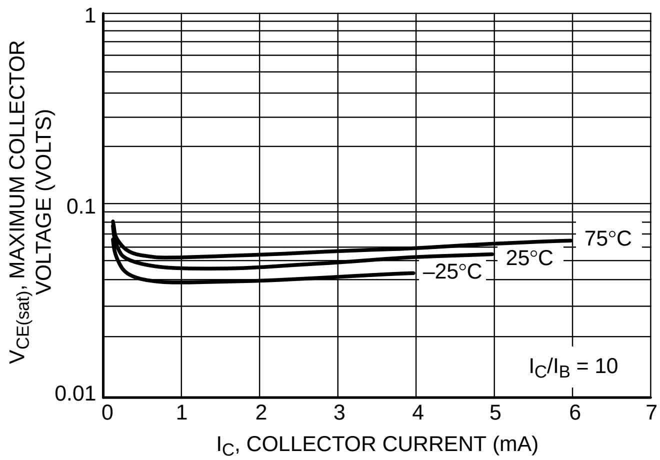


Figure 23. Maximum Collector Voltage versus Collector Current

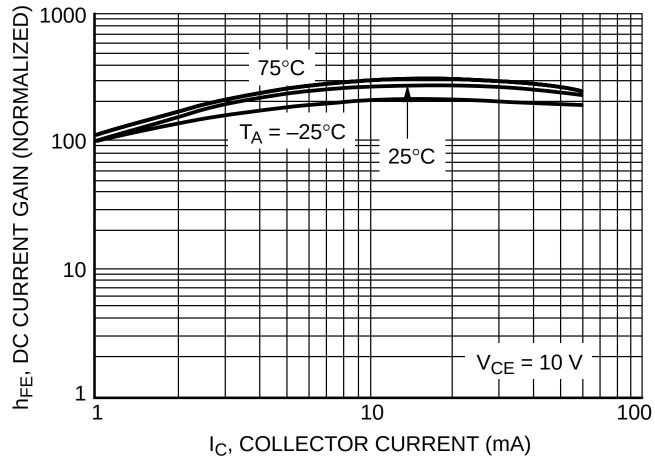


Figure 24. DC Current Gain

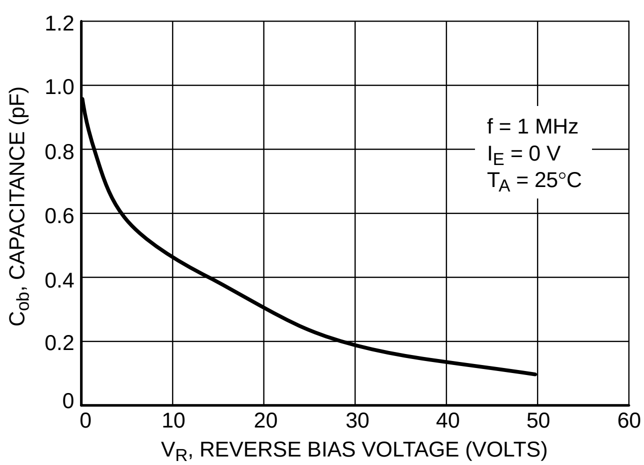


Figure 25. Output Capacitance

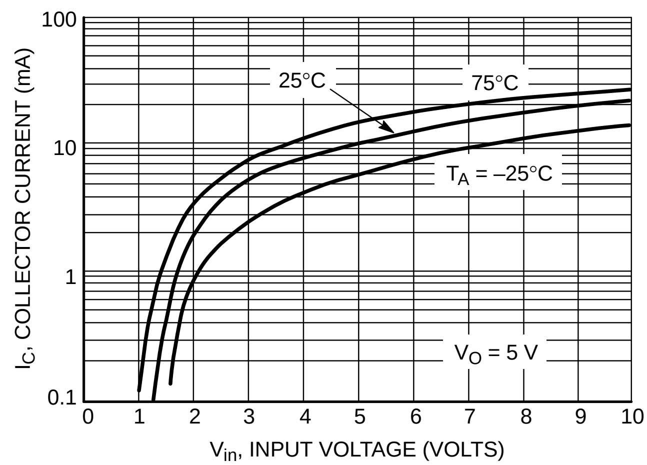


Figure 26. Output Current versus Input Voltage

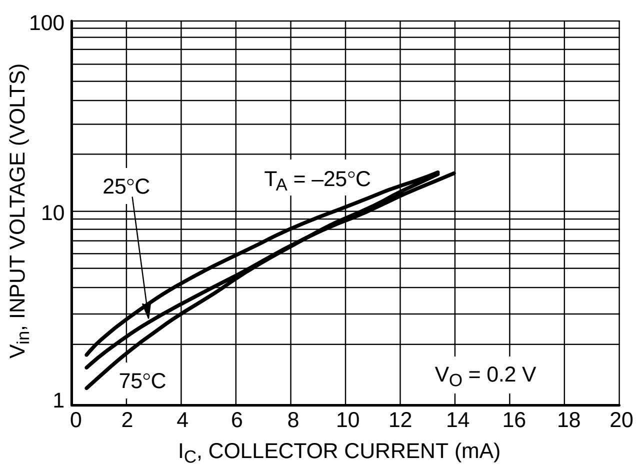


Figure 27. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5137T1

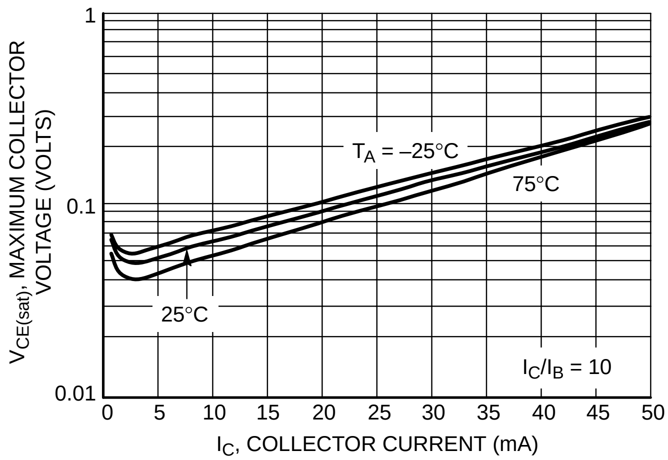


Figure 28. Maximum Collector Voltage versus Collector Current

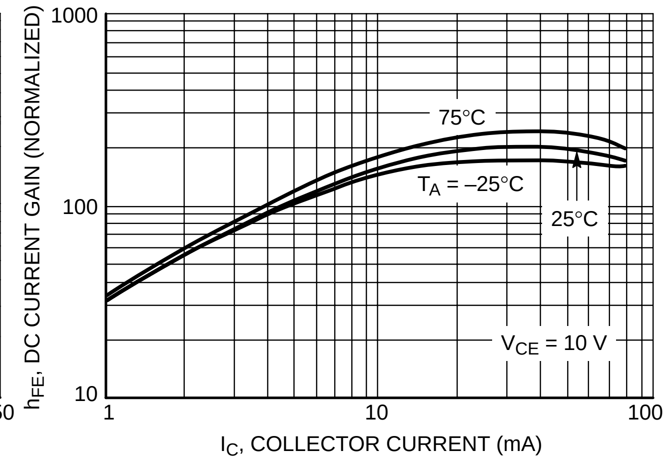


Figure 29. DC Current Gain

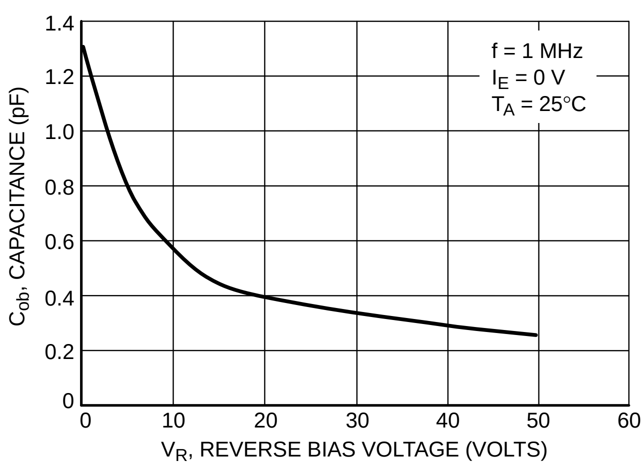


Figure 30. Output Capacitance

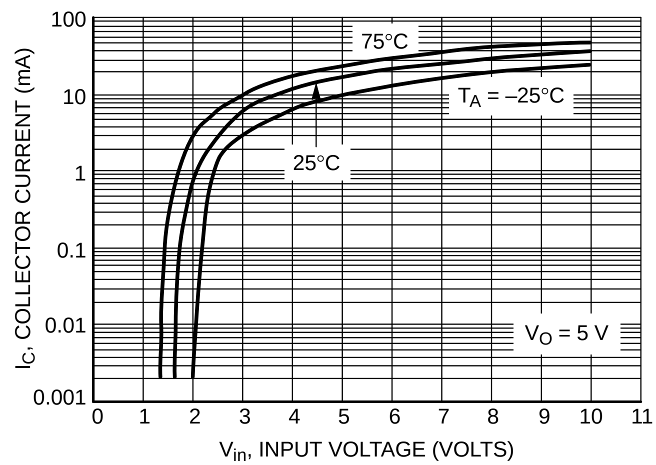


Figure 31. Output Current versus Input Voltage

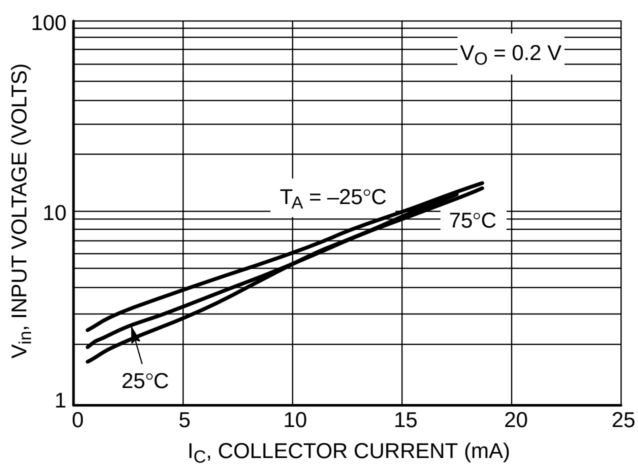


Figure 32. Input Voltage versus Output Current

MUN5211DW1T1 Series

Preferred Devices

Dual Bias Resistor Transistors

NPN Silicon Surface Mount Transistors with Monolithic Bias Resistor Network

The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. These digital transistors are designed to replace a single device and its external resistor bias network. The BRT eliminates these individual components by integrating them into a single device. In the MUN5211DW1T1 series, two BRT devices are housed in the SOT–363 package which is ideal for low power surface mount applications where board space is at a premium.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Available in 8 mm, 7 inch/3000 Unit Tape and Reel

MAXIMUM RATINGS

(T_A = 25°C unless otherwise noted, common for Q_1 and Q_2)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic (One Junction Heated)	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	187 (Note 1.) 256 (Note 2.) 1.5 (Note 1.) 2.0 (Note 2.)	mW mW/°C
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	670 (Note 1.) 490 (Note 2.)	°C/W
Characteristic (Both Junctions Heated)	**Symbol**	**Max**	**Unit**
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	250 (Note 1.) 385 (Note 2.) 2.0 (Note 1.) 3.0 (Note 2.)	mW mW/°C
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	493 (Note 1.) 325 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{\theta JL}$	188 (Note 1.) 208 (Note 2.)	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

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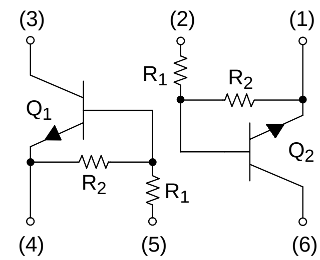
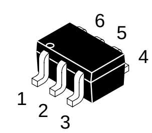
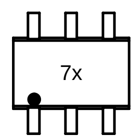




SOT–363
CASE 419B
STYLE 1

MARKING DIAGRAM



7x = Device Marking
(See Page 999)

DEVICE MARKING INFORMATION

See specific marking information in the device marking table on page 999 of this data sheet.

Preferred devices are recommended choices for future use and best overall value.

DEVICE MARKING AND RESISTOR VALUES

Device	Package	Marking	R1 (K)	R2 (K)	Shipping
MUN5211DW1T1	SOT–363	7A	10	10	3000/Tape & Reel
MUN5212DW1T1	SOT–363	7B	22	22	3000/Tape & Reel
MUN5213DW1T1	SOT–363	7C	47	47	3000/Tape & Reel
MUN5214DW1T1	SOT–363	7D	10	47	3000/Tape & Reel
MUN5215DW1T1 (Note 3.)	SOT–363	7E	10	∞	3000/Tape & Reel
MUN5216DW1T1 (Note 3.)	SOT–363	7F	4.7	∞	3000/Tape & Reel
MUN5230DW1T1 (Note 3.)	SOT–363	7G	1.0	1.0	3000/Tape & Reel
MUN5231DW1T1 (Note 3.)	SOT–363	7H	2.2	2.2	3000/Tape & Reel
MUN5232DW1T1 (Note 3.)	SOT–363	7J	4.7	4.7	3000/Tape & Reel
MUN5233DW1T1 (Note 3.)	SOT–363	7K	4.7	47	3000/Tape & Reel
MUN5234DW1T1 (Note 3.)	SOT–363	7L	22	47	3000/Tape & Reel
MUN5235DW1T1 (Note 3.)	SOT–363	7M	2.2	47	3000/Tape & Reel
MUN5236DW1T1 (Note 3.)	SOT–363	7N	100	100	3000/Tape & Reel
MUN5237DW1T1 (Note 3.)	SOT–363	7P	47	22	3000/Tape & Reel

ELECTRICAL CHARACTERISTICS

(T_A = 25°C unless otherwise noted, common for Q_1 and Q_2)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector-Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter-Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	MUN5211DW1T1	I_{EBO}	–	–	0.5	mAdc
	MUN5212DW1T1		–	–	0.2	
	MUN5213DW1T1		–	–	0.1	
	MUN5214DW1T1		–	–	0.2	
	MUN5215DW1T1		–	–	0.9	
	MUN5216DW1T1		–	–	1.9	
	MUN5230DW1T1		–	–	4.3	
	MUN5231DW1T1		–	–	2.3	
	MUN5232DW1T1		–	–	1.5	
	MUN5233DW1T1		–	–	0.18	
	MUN5234DW1T1		–	–	0.13	
	MUN5235DW1T1		–	–	0.2	
	MUN5236DW1T1		–	–	0.05	
	MUN5237DW1T1		–	–	0.13	
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector-Emitter Breakdown Voltage (Note 4.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc

3. New resistor combinations. Updated curves to follow in subsequent data sheets.
4. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS
(T_A = 25°C unless otherwise noted, common for Q_1 and Q_2) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Note 5.)						
DC Current Gain	MUN5211DW1T1	h_{FE}	35	60	–	
(V_{CE} = 10 V, I_C = 5.0 mA)	MUN5212DW1T1		60	100	–	
	MUN5213DW1T1		80	140	–	
	MUN5214DW1T1		80	140	–	
	MUN5215DW1T1		160	350	–	
	MUN5216DW1T1		160	350	–	
	MUN5230DW1T1		3.0	5.0	–	
	MUN5231DW1T1		8.0	15	–	
	MUN5232DW1T1		15	30	–	
	MUN5233DW1T1		80	200	–	
	MUN5234DW1T1		80	150	–	
	MUN5235DW1T1		80	140	–	
	MUN5236DW1T1		80	150	–	
	MUN5237DW1T1		80	140	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	–	–	0.25	Vdc
(I_C = 10 mA, I_B = 0.3 mA)						
(I_C = 10 mA, I_B = 5 mA)	MUN5230DW1T1/MUN5231DW1T1					
(I_C = 10 mA, I_B = 1 mA)	MUN5215DW1T1/MUN5216DW1T1					
	MUN5232DW1T1/MUN5233DW1T1/MUN5234DW1T1					
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	MUN5211DW1T1		–	–	0.2	
	MUN5212DW1T1		–	–	0.2	
	MUN5214DW1T1		–	–	0.2	
	MUN5215DW1T1		–	–	0.2	
	MUN5216DW1T1		–	–	0.2	
	MUN5230DW1T1		–	–	0.2	
	MUN5231DW1T1		–	–	0.2	
	MUN5232DW1T1		–	–	0.2	
	MUN5233DW1T1		–	–	0.2	
	MUN5234DW1T1		–	–	0.2	
	MUN5235DW1T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	MUN5213DW1T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 5.5 V, R_L = 1.0 kΩ)	MUN5236DW1T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 4.0 V, R_L = 1.0 kΩ)	MUN5237DW1T1		–	–	0.2	
Output Voltage (off)		V_{OH}	4.9	–	–	Vdc
(V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ)						
(V_{CC} = 5.0 V, V_B = 0.050 V, R_L = 1.0 kΩ)	MUN5230DW1T1					
(V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	MUN5215DW1T1					
	MUN5216DW1T1					
	MUN5233DW1T1					

5. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS
(T_A = 25°C unless otherwise noted, common for Q_1 and Q_2) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Note 6.) (Continued)						
Input Resistor	MUN5211DW1T1	R1	7.0	10	13	k Ω
	MUN5212DW1T1		15.4	22	28.6	
	MUN5213DW1T1		32.9	47	61.1	
	MUN5214DW1T1		7.0	10	13	
	MUN5215DW1T1		7.0	10	13	
	MUN5216DW1T1		3.3	4.7	6.1	
	MUN5230DW1T1		0.7	1.0	1.3	
	MUN5231DW1T1		1.5	2.2	2.9	
	MUN5232DW1T1		3.3	4.7	6.1	
	MUN5233DW1T1		3.3	4.7	6.1	
	MUN5234DW1T1		15.4	22	28.6	
	MUN5235DW1T1		1.54	2.2	2.86	
	MUN5236DW1T1		70	100	130	
	MUN5237DW1T1		32.9	47	61.1	
Resistor Ratio	MUN5211DW1T1/MUN5212DW1T1/ MUN5213DW1T1/MUN5236DW1T1	R1/R2	0.8	1.0	1.2	
	MUN5214DW1T1		0.17	0.21	0.25	
	MUN5215DW1T1/MUN5216DW1T1		–	–	–	
	MUN5230DW1T1/MUN5231DW1T1/MUN5232DW1T1		0.8	1.0	1.2	
	MUN5233DW1T1		0.055	0.1	0.185	
	MUN5234DW1T1		0.38	0.47	0.56	
	MUN5235DW1T1		0.038	0.047	0.056	
	MUN5237DW1T1		1.7	2.1	2.6	

6. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

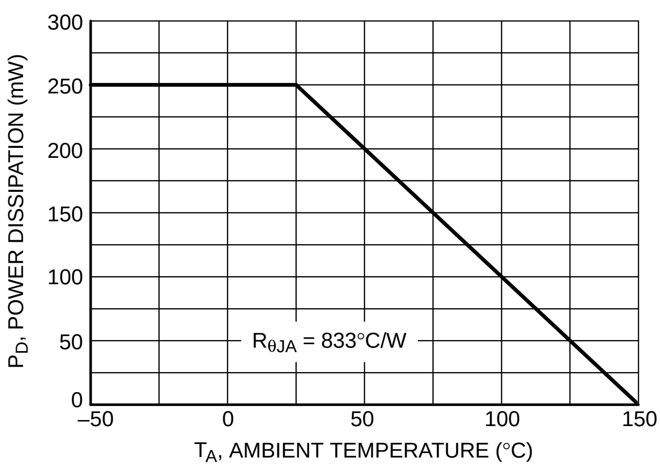


Figure 1. Derating Curve

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5211DW1T1

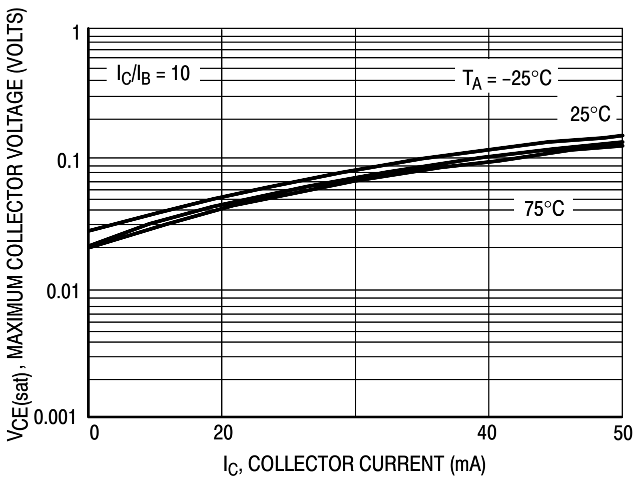


Figure 2. $V_{CE(sat)}$ versus I_C

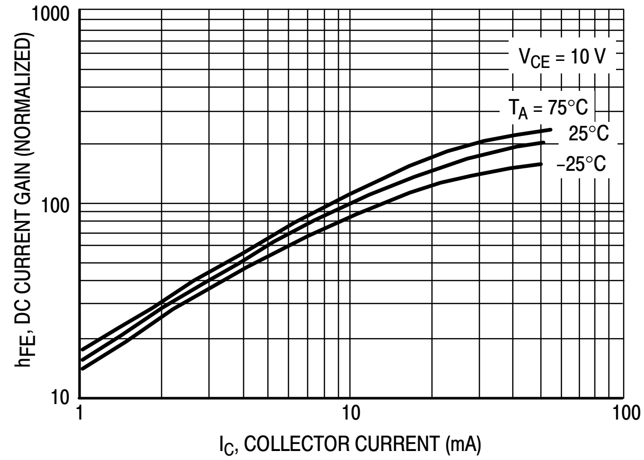


Figure 3. DC Current Gain

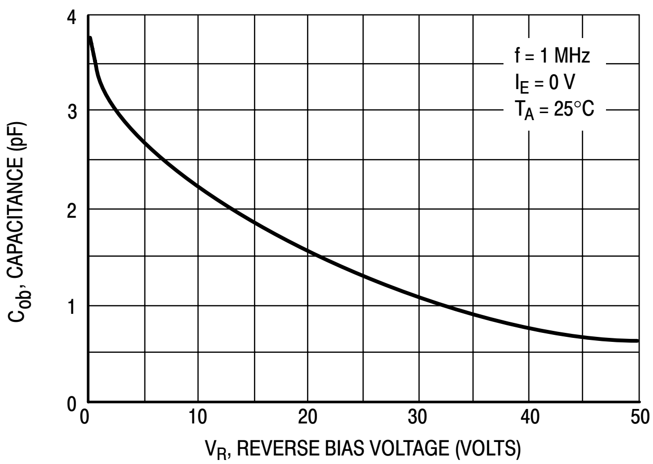


Figure 4. Output Capacitance

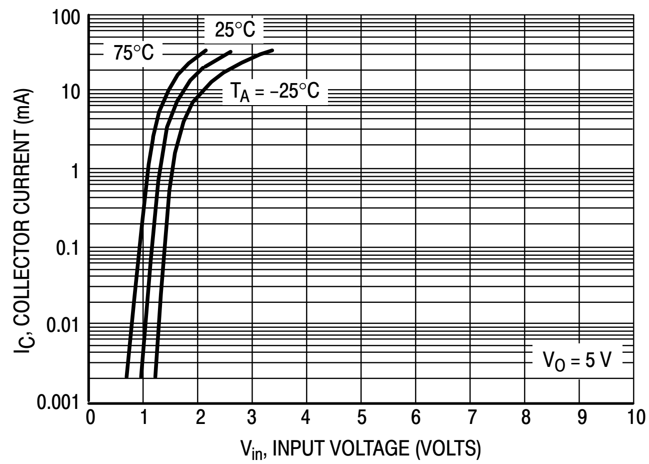


Figure 5. Output Current versus Input Voltage

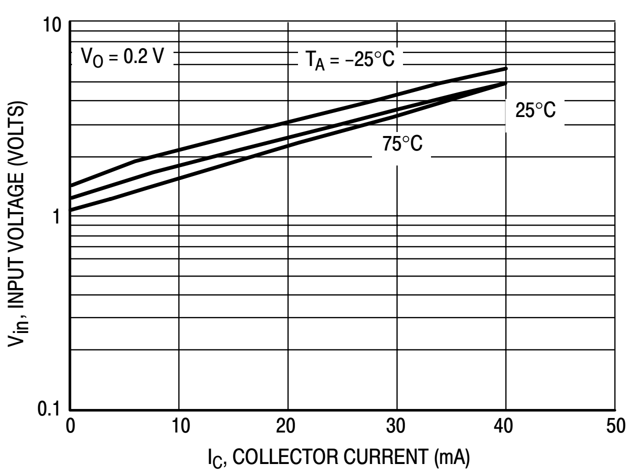


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5212DW1T1

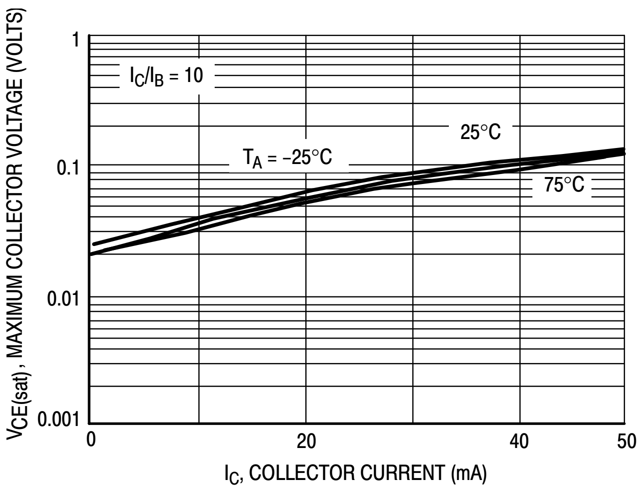


Figure 7. $V_{CE(sat)}$ versus I_C

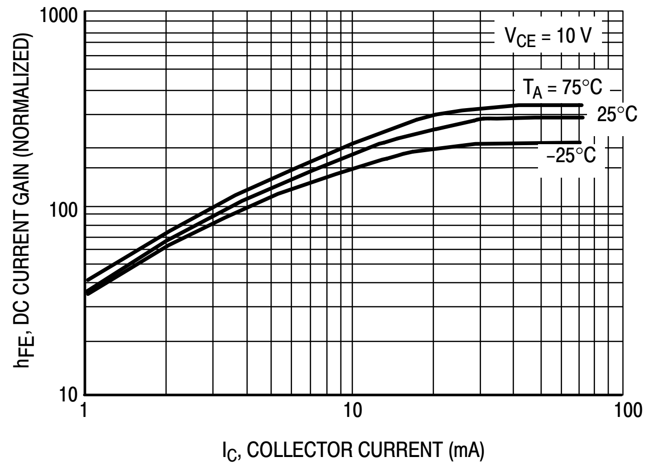


Figure 8. DC Current Gain

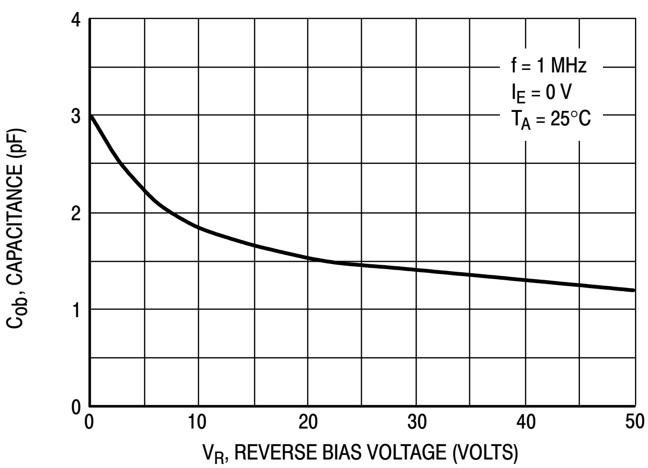


Figure 9. Output Capacitance

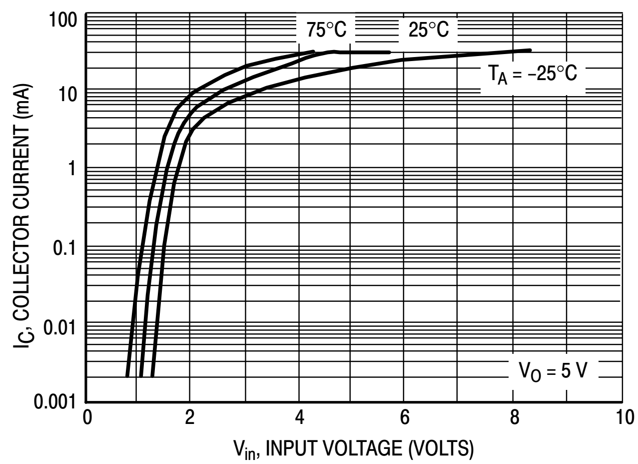


Figure 10. Output Current versus Input Voltage

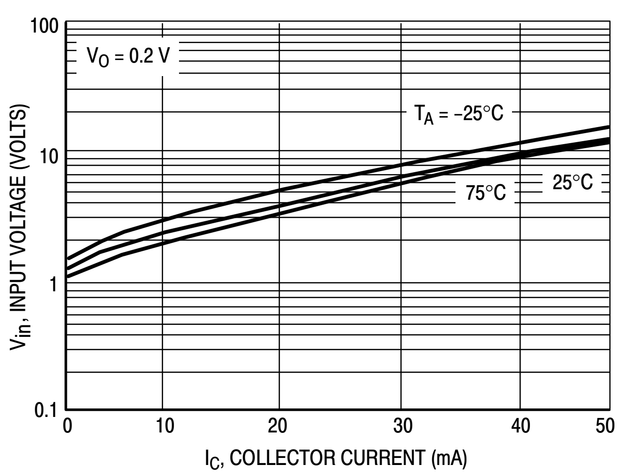


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5213DW1T1

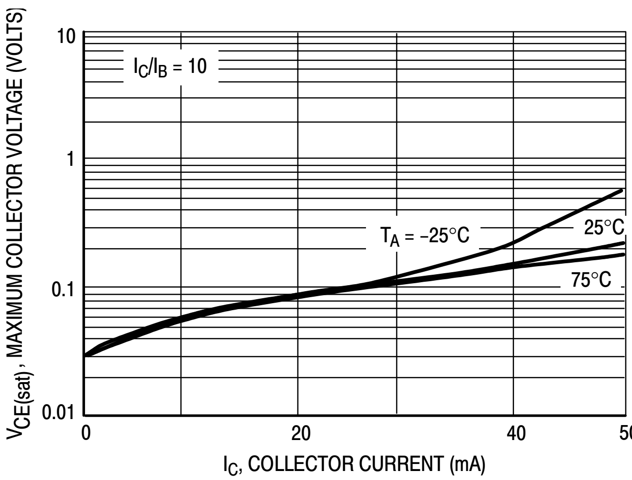


Figure 12. $V_{CE(sat)}$ versus I_C

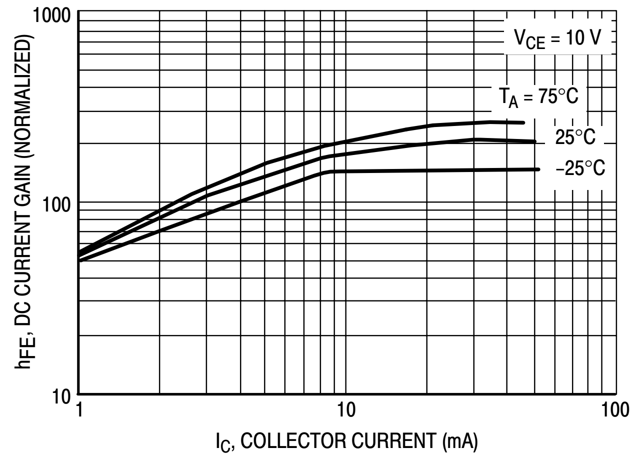


Figure 13. DC Current Gain

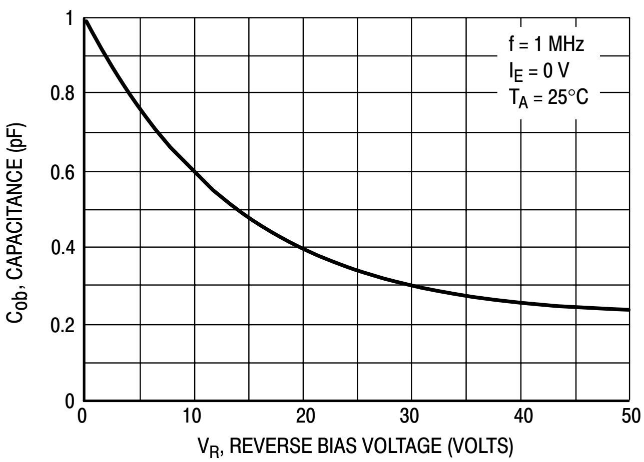


Figure 14. Output Capacitance

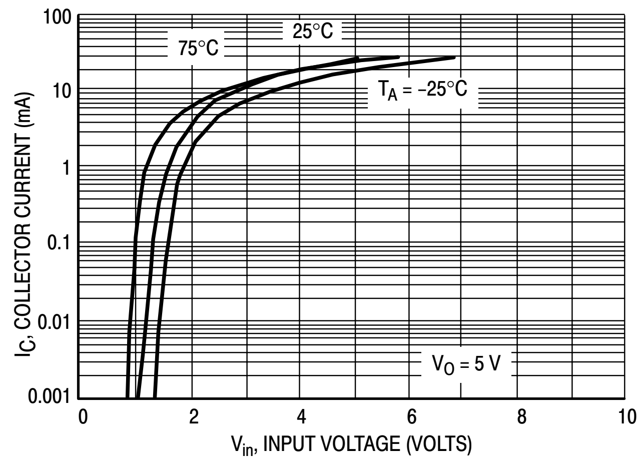


Figure 15. Output Current versus Input Voltage

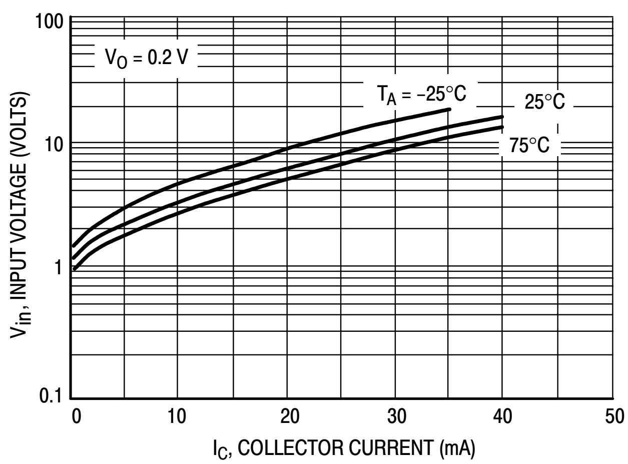


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — MUN5214DW1T1

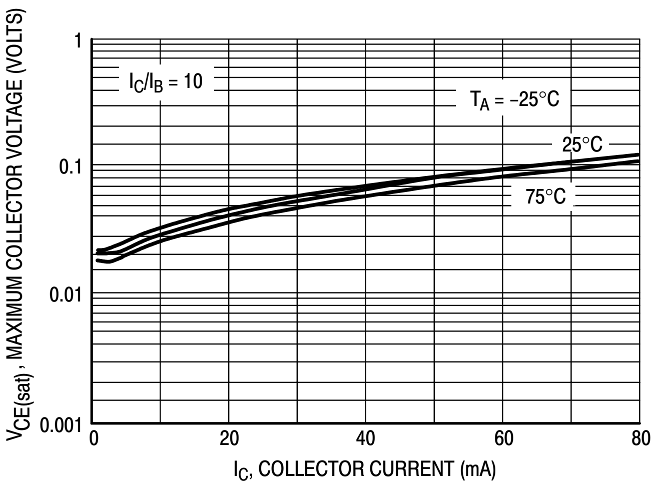


Figure 17. $V_{CE(sat)}$ versus I_C

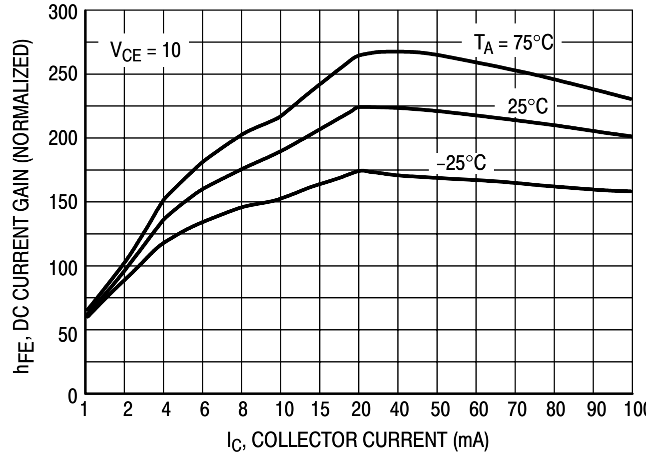


Figure 18. DC Current Gain

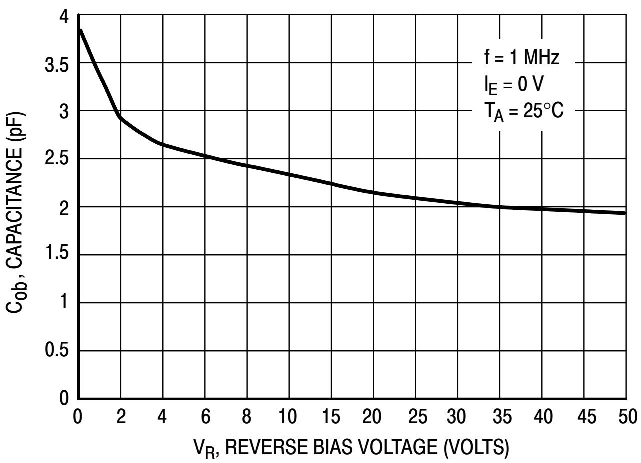


Figure 19. Output Capacitance

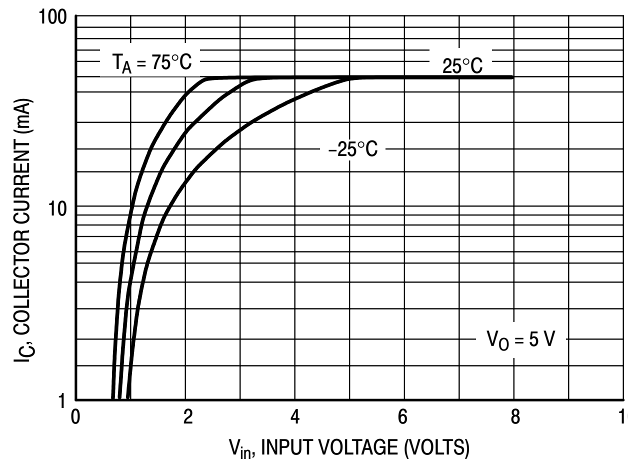


Figure 20. Output Current versus Input Voltage

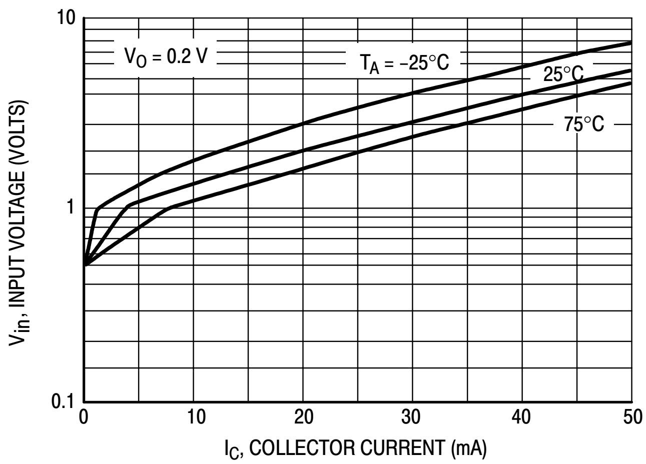


Figure 21. Input Voltage versus Output Current

MUN5211T1 Series

Preferred Devices

Bias Resistor Transistor

NPN Silicon Surface Mount Transistor with Monolithic Bias Resistor Network

This new series of digital transistors is designed to replace a single device and its external resistor bias network. The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. The BRT eliminates these individual components by integrating them into a single device. The use of a BRT can reduce both system cost and board space. The device is housed in the SC–70/SOT–323 package which is designed for low power surface mount applications.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- The SC–70/SOT–323 package can be soldered using wave or reflow. The modified gull–winged leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 8 mm embossed tape and reel
  Use the Device Number to order the 7 inch/3000 unit reel.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	202 (Note 1.) 310 (Note 2.) 1.6 (Note 1.) 2.5 (Note 2.)	mW mW/°C
Thermal Resistance – Junction-to-Ambient	$R_{θJA}$	618 (Note 1.) 403 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{θJL}$	280 (Note 1.) 332 (Note 2.)	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

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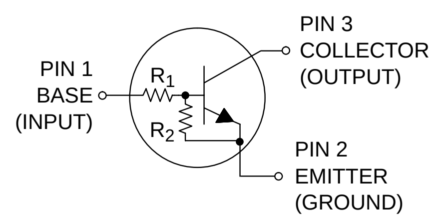
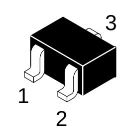
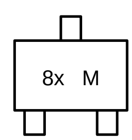
NPN SILICON BIAS RESISTOR TRANSISTORS





SC–70/SOT–323
CASE 419
STYLE 3

MARKING DIAGRAM



8x	= Specific Device Code
x	= (See Marking Table)
M	= Date Code

DEVICE MARKING INFORMATION

See specific marking information in the device marking table on page 1007 of this data sheet.

Preferred devices are recommended choices for future use and best overall value.

January, 2001 – Rev. 4
Publication Order Number:
MUN5211T1/D

DEVICE MARKING AND RESISTOR VALUES

Device	Package	Marking	R1 (K)	R2 (K)	Shipping
MUN5211T1	SC–70/SOT–323	8A	10	10	3000/Tape & Reel
MUN5212T1	SC–70/SOT–323	8B	22	22	3000/Tape & Reel
MUN5213T1	SC–70/SOT–323	8C	47	47	3000/Tape & Reel
MUN5214T1	SC–70/SOT–323	8D	10	47	3000/Tape & Reel
MUN5215T1 (Note 3.)	SC–70/SOT–323	8E	10	∞	3000/Tape & Reel
MUN5216T1 (Note 3.)	SC–70/SOT–323	8F	4.7	∞	3000/Tape & Reel
MUN5230T1 (Note 3.)	SC–70/SOT–323	8G	1.0	1.0	3000/Tape & Reel
MUN5231T1 (Note 3.)	SC–70/SOT–323	8H	2.2	2.2	3000/Tape & Reel
MUN5232T1 (Note 3.)	SC–70/SOT–323	8J	4.7	4.7	3000/Tape & Reel
MUN5233T1 (Note 3.)	SC–70/SOT–323	8K	4.7	47	3000/Tape & Reel
MUN5234T1 (Note 3.)	SC–70/SOT–323	8L	22	47	3000/Tape & Reel
MUN5235T1 (Note 3.)	SC–70/SOT–323	8M	2.2	47	3000/Tape & Reel
MUN5236T1 (Note 3.)	SC–70/SOT–323	8N	100	100	3000/Tape & Reel
MUN5237T1 (Note 3.)	SC–70/SOT–323	8P	47	22	3000/Tape & Reel

3. New devices. Updated curves to follow in subsequent data sheets.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector-Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter-Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	MUN5211T1	I_{EBO}	–	–	0.5	mAdc
	MUN5212T1		–	–	0.2	
	MUN5213T1		–	–	0.1	
	MUN5214T1		–	–	0.2	
	MUN5215T1		–	–	0.9	
	MUN5216T1		–	–	1.9	
	MUN5230T1		–	–	4.3	
	MUN5231T1		–	–	2.3	
	MUN5232T1		–	–	1.5	
	MUN5233T1		–	–	0.18	
	MUN5234T1		–	–	0.13	
	MUN5235T1		–	–	0.2	
	MUN5236T1		–	–	0.05	
	MUN5237T1		–	–	0.13	
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector-Emitter Breakdown Voltage (Note 4.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc
ON CHARACTERISTICS (Note 4.)						
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	MUN5211T1	h_{FE}	35	60	–	
	MUN5212T1		60	100	–	
	MUN5213T1		80	140	–	
	MUN5214T1		80	140	–	
	MUN5215T1		160	350	–	
	MUN5216T1		160	350	–	
	MUN5230T1		3.0	5.0	–	
	MUN5231T1		8.0	15	–	
	MUN5232T1		15	30	–	
	MUN5233T1		80	200	–	
	MUN5234T1		80	150	–	
	MUN5235T1		80	140	–	
	MUN5236T1		80	150	–	
	MUN5237T1		80	140	–	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.3 mA) (I_C = 10 mA, I_B = 5 mA) MUN5230T1/MUN5231T1 (I_C = 10 mA, I_B = 1 mA) MUN5215T1/MUN5216T1/ MUN5232T1/MUN5233T1/MUN5234T1		$V_{CE(sat)}$	–	–	0.25	Vdc
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	MUN5211T1		–	–	0.2	
	MUN5212T1		–	–	0.2	
	MUN5214T1		–	–	0.2	
	MUN5215T1		–	–	0.2	
	MUN5216T1		–	–	0.2	
	MUN5230T1		–	–	0.2	
	MUN5231T1		–	–	0.2	
	MUN5232T1		–	–	0.2	
	MUN5233T1		–	–	0.2	
	MUN5234T1		–	–	0.2	
	MUN5235T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	MUN5213T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 5.5 V, R_L = 1.0 kΩ)	MUN5236T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 4.0 V, R_L = 1.0 kΩ)	MUN5237T1		–	–	0.2	

4. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Note 5.) (Continued)					
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ) (V_{CC} = 5.0 V, V_B = 0.050 V, R_L = 1.0 kΩ) MUN5230T1 (V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ) MUN5215T1 MUN5216T1 MUN5233T1	V_{OH}	4.9	–	–	Vdc
Input Resistor MUN5211T1	R_1	7.0	10	13	kΩ
MUN5212T1		15.4	22	28.6	
MUN5213T1		32.9	47	61.1	
MUN5214T1		7.0	10	13	
MUN5215T1		7.0	10	13	
MUN5216T1		3.3	4.7	6.1	
MUN5230T1		0.7	1.0	1.3	
MUN5231T1		1.5	2.2	2.9	
MUN5232T1		3.3	4.7	6.1	
MUN5233T1		3.3	4.7	6.1	
MUN5234T1		15.4	22	28.6	
MUN5235T1		1.54	2.2	2.86	
MUN5236T1		70	100	130	
MUN5237T1		32.9	47	61.1	
Resistor Ratio MUN5211T1/MUN5212T1/MUN5213T1/ MUN5236T1	R_1/R_2	0.8	1.0	1.2	
MUN5214T1		0.17	0.21	0.25	
MUN5215T1/MUN5216T1		–	–	–	
MUN5230T1/MUN5231T1/MUN5232T1		0.8	1.0	1.2	
MUN5233T1		0.055	0.1	0.185	
MUN5234T1		0.38	0.47	0.56	
MUN5235T1		0.038	0.047	0.056	
MUN5237T1		1.7	2.1	2.6	

5. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

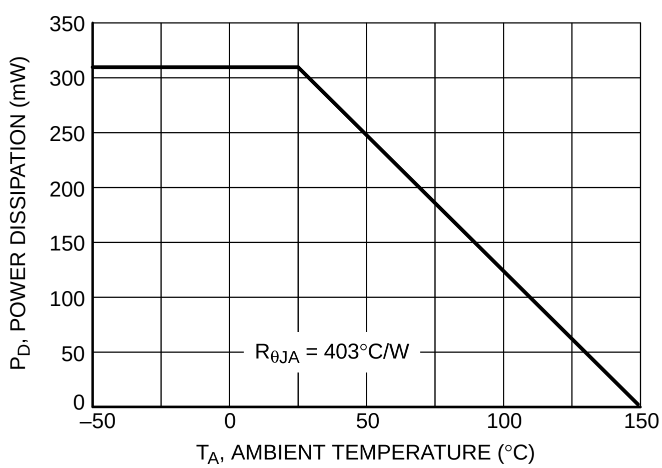


Figure 1. Derating Curve

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5211T1

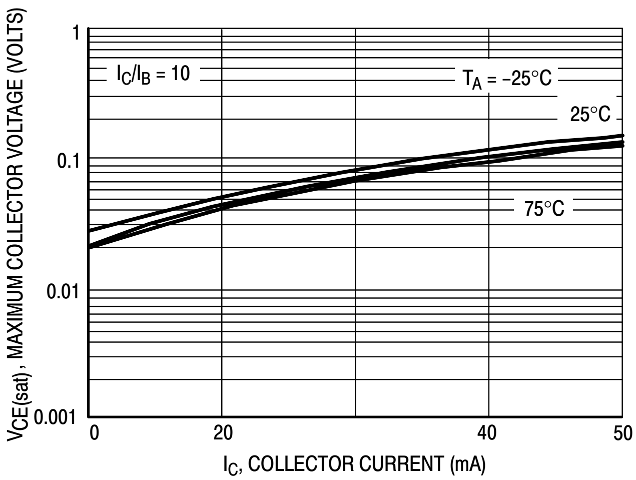


Figure 2. $V_{CE(sat)}$ versus I_C

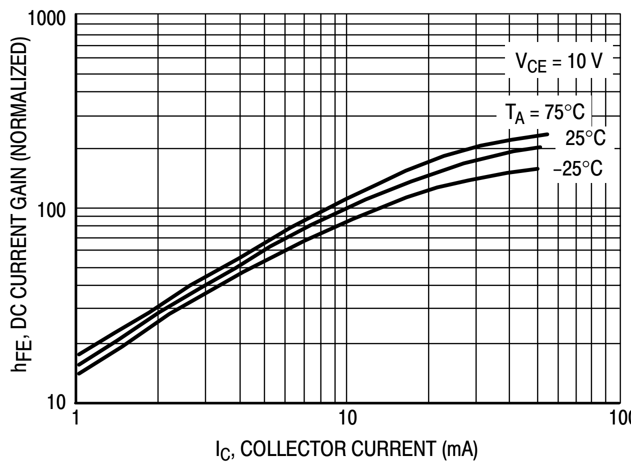


Figure 3. DC Current Gain

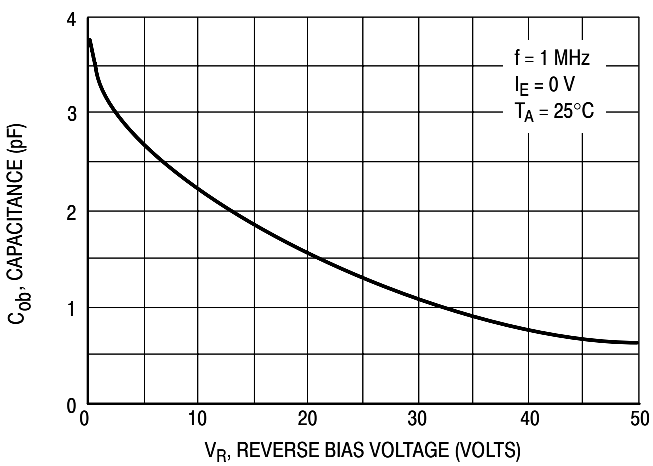


Figure 4. Output Capacitance

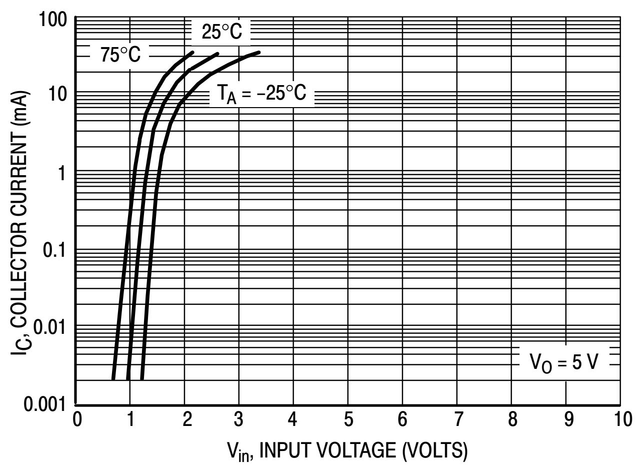


Figure 5. Output Current versus Input Voltage

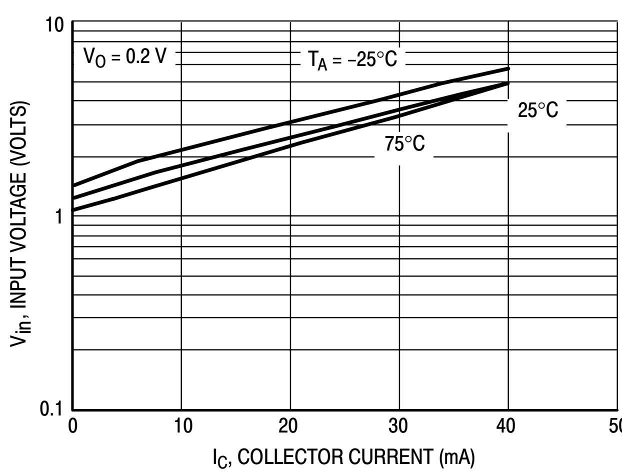


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5212T1

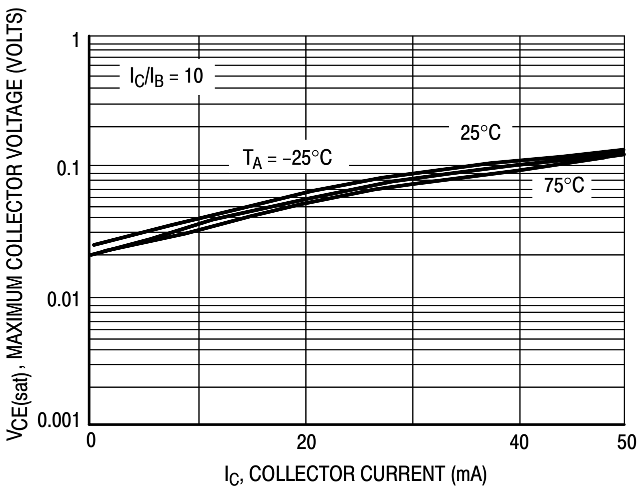


Figure 7. $V_{CE(sat)}$ versus I_C

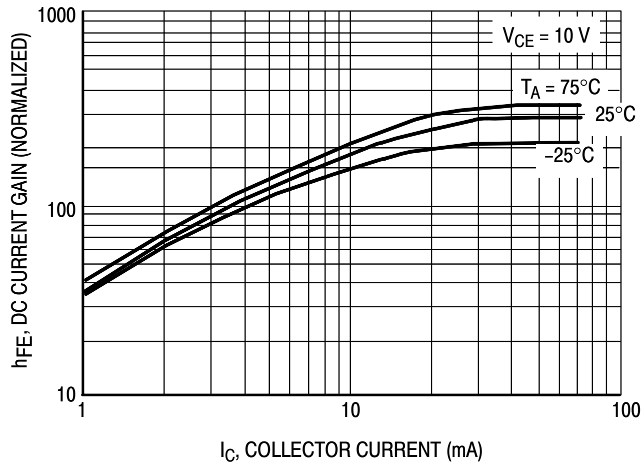


Figure 8. DC Current Gain

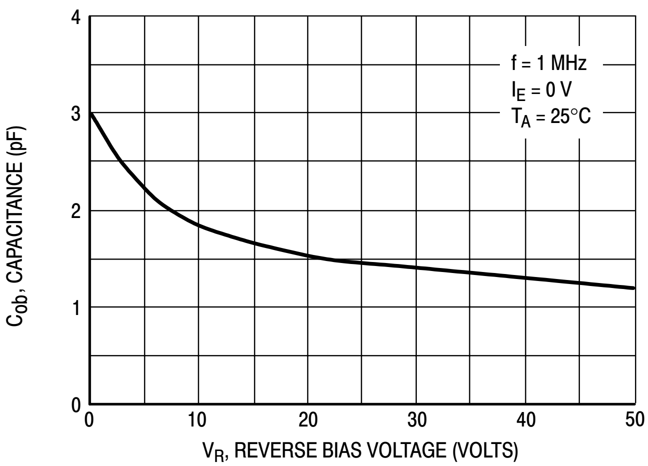


Figure 9. Output Capacitance

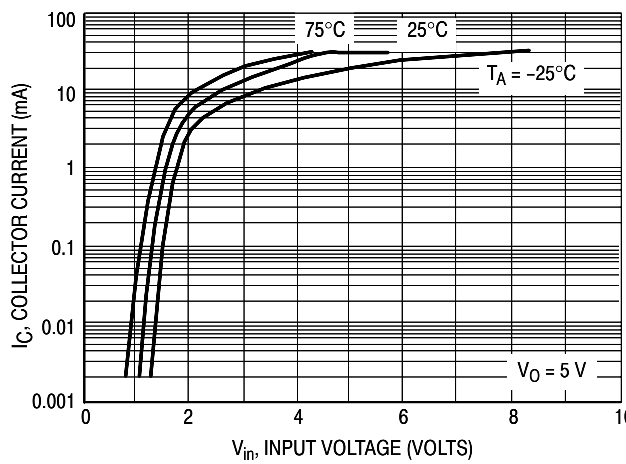


Figure 10. Output Current versus Input Voltage

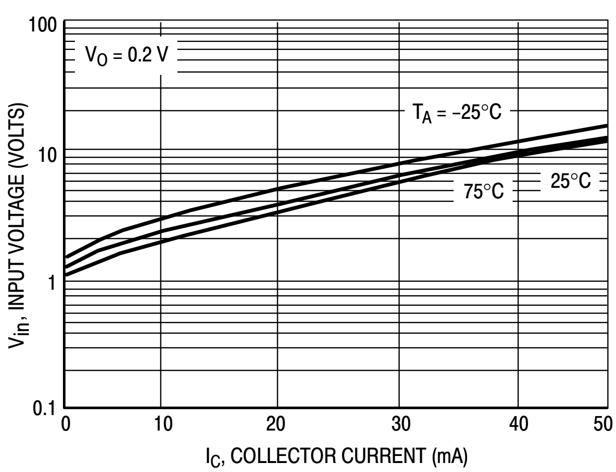


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5213T1

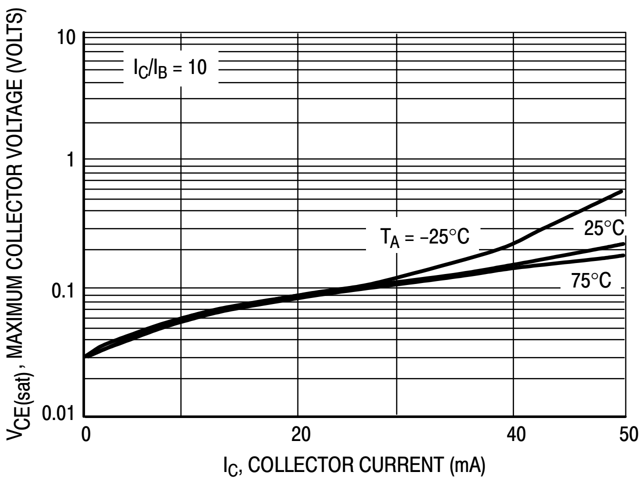


Figure 12. $V_{CE(sat)}$ versus I_C

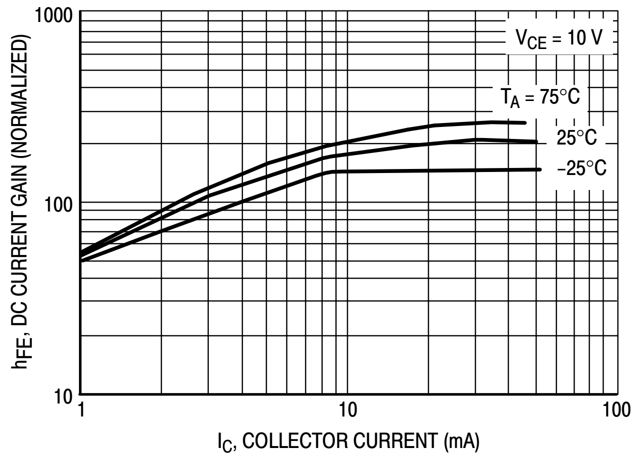


Figure 13. DC Current Gain

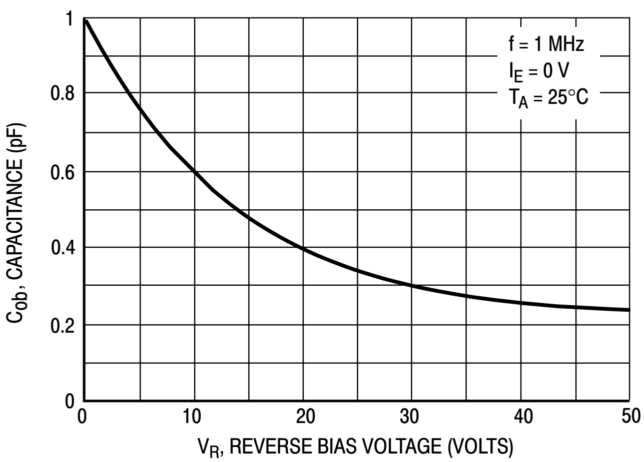


Figure 14. Output Capacitance

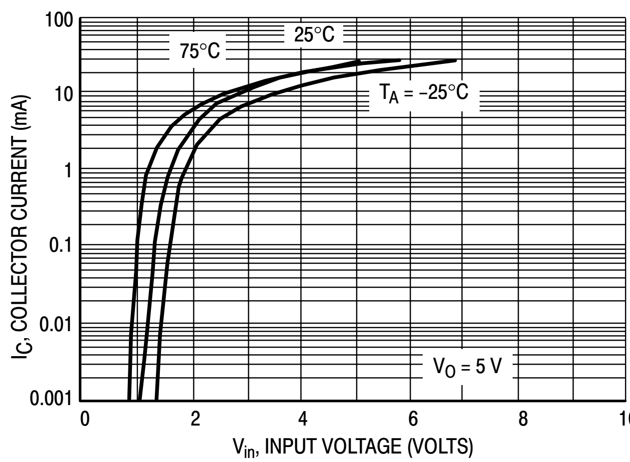


Figure 15. Output Current versus Input Voltage

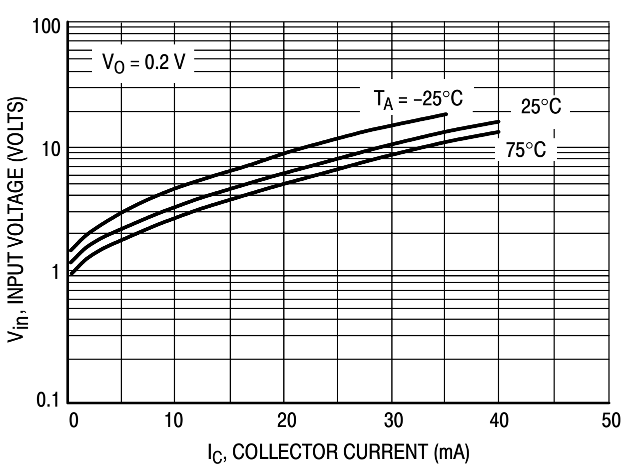


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5214T1

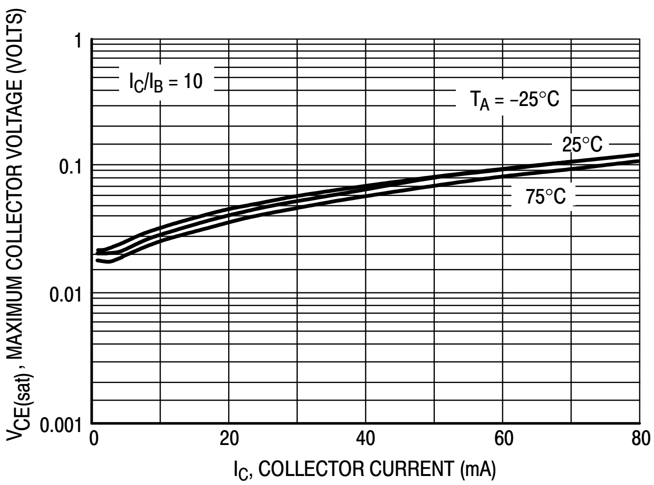


Figure 17. $V_{CE(sat)}$ versus I_C

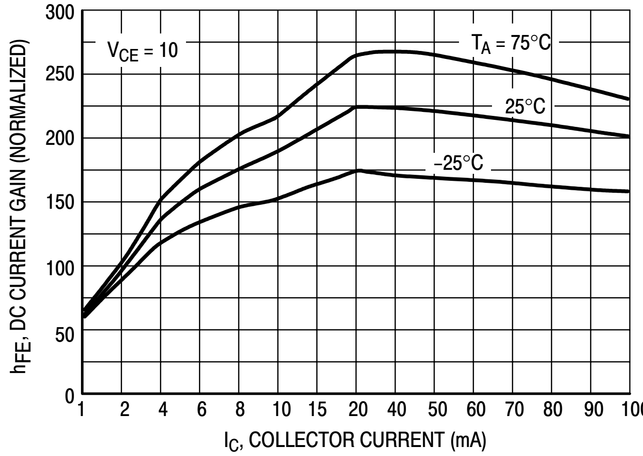


Figure 18. DC Current Gain

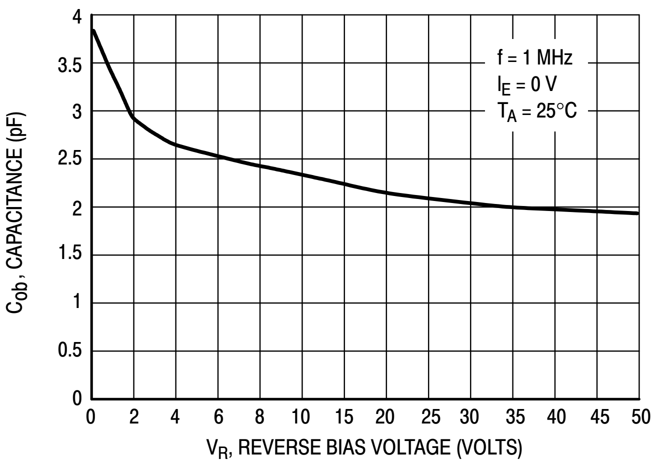


Figure 19. Output Capacitance

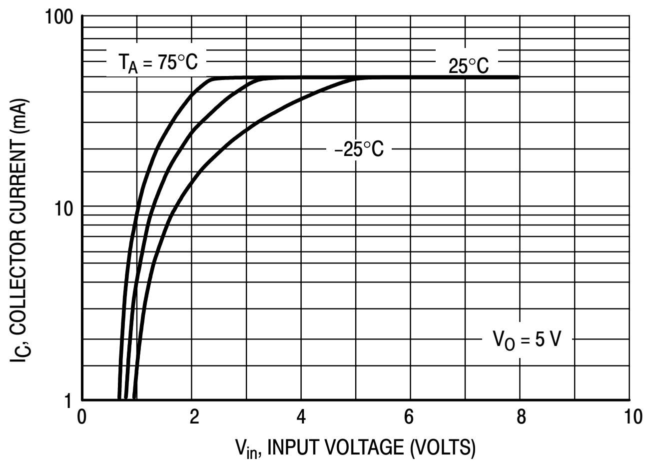


Figure 20. Output Current versus Input Voltage

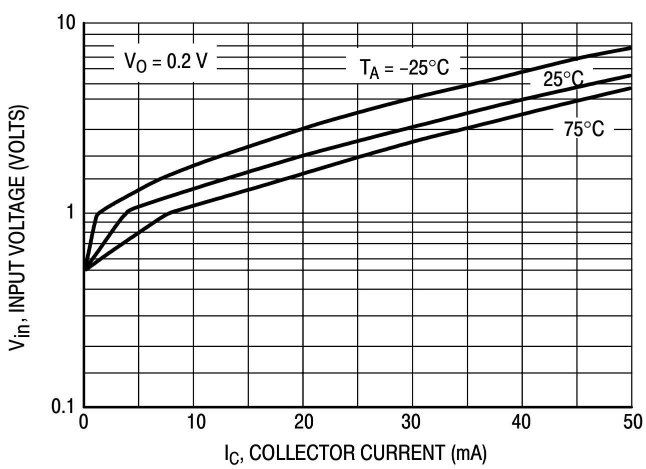


Figure 21. Input Voltage versus Output Current

TYPICAL APPLICATIONS FOR NPN BRTs

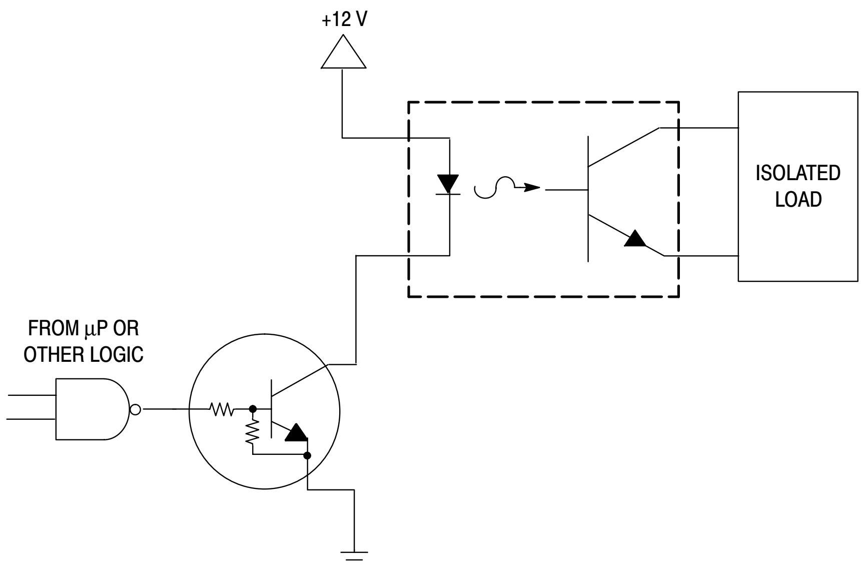


Figure 22. Level Shifter: Connects 12 or 24 Volt Circuits to Logic

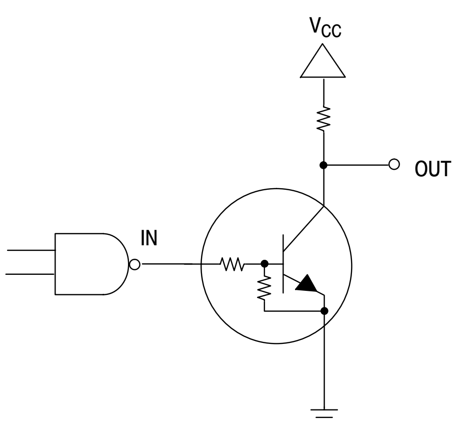


Figure 23. Open Collector Inverter:
Inverts the Input Signal

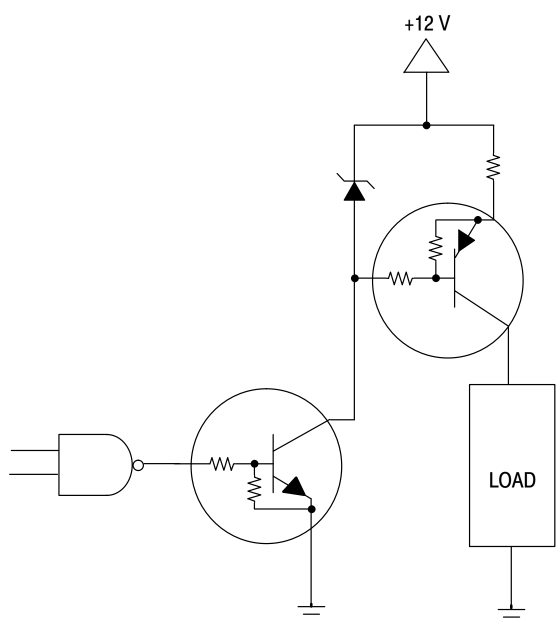


Figure 24. Inexpensive, Unregulated Current Source

MUN5311DW1T1 Series

Preferred Devices

Dual Bias Resistor Transistors

NPN and PNP Silicon Surface Mount Transistors with Monolithic Bias Resistor Network

The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. These digital transistors are designed to replace a single device and its external resistor bias network. The BRT eliminates these individual components by integrating them into a single device. In the MUN5311DW1T1 series, two complementary BRT devices are housed in the SOT–363 package which is ideal for low power surface mount applications where board space is at a premium.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Available in 8 mm, 7 inch/3000 Unit Tape and Reel

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted, common for Q_1 and Q_2, – minus sign for Q_1 (PNP) omitted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic (One Junction Heated)	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	187 (Note 1.) 256 (Note 2.) 1.5 (Note 1.) 2.0 (Note 2.)	mW mW/°C
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	670 (Note 1.) 490 (Note 2.)	°C/W
Characteristic (Both Junctions Heated)	**Symbol**	**Max**	**Unit**
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	250 (Note 1.) 385 (Note 2.) 2.0 (Note 1.) 3.0 (Note 2.)	mW mW/°C
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	493 (Note 1.) 325 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{\theta JL}$	188 (Note 1.) 208 (Note 2.)	°C/W
Junction and Storage Temperature	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

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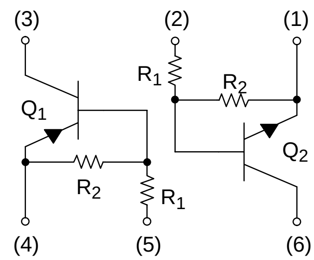
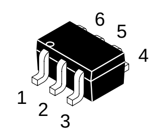
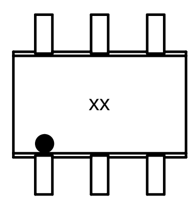




SOT–363
CASE 419B
STYLE 1

MARKING DIAGRAM



xx = Device Marking
(See Page 1016)

DEVICE MARKING INFORMATION

See specific marking information in the device marking table on page 1016 of this data sheet.

Preferred devices are recommended choices for future use and best overall value.

DEVICE MARKING AND RESISTOR VALUES

Device	Package	Marking	R1 (K)	R2 (K)	Shipping
MUN5311DW1T1	SOT–363	11	10	10	3000/Tape & Reel
MUN5312DW1T1	SOT–363	12	22	22	3000/Tape & Reel
MUN5313DW1T1	SOT–363	13	47	47	3000/Tape & Reel
MUN5314DW1T1	SOT–363	14	10	47	3000/Tape & Reel
MUN5315DW1T1 (Note 3.)	SOT–363	15	10	∞	3000/Tape & Reel
MUN5316DW1T1 (Note 3.)	SOT–363	16	4.7	∞	3000/Tape & Reel
MUN5330DW1T1 (Note 3.)	SOT–363	30	1.0	1.0	3000/Tape & Reel
MUN5331DW1T1 (Note 3.)	SOT–363	31	2.2	2.2	3000/Tape & Reel
MUN5332DW1T1 (Note 3.)	SOT–363	32	4.7	4.7	3000/Tape & Reel
MUN5333DW1T1 (Note 3.)	SOT–363	33	4.7	47	3000/Tape & Reel
MUN5334DW1T1 (Note 3.)	SOT–363	34	22	47	3000/Tape & Reel
MUN5335DW1T1 (Note 3.)	SOT–363	35	2.2	47	3000/Tape & Reel

ELECTRICAL CHARACTERISTICS

(T_A = 25°C unless otherwise noted, common for Q_1 and Q_2, – minus sign for Q_1 (PNP) omitted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector-Emitter Cutoff Current (V_{CE} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter-Base Cutoff Current (V_{EB} = 6.0 V, I_C = 0)	MUN5311DW1T1	I_{EBO}	–	–	0.5	mAdc
	MUN5312DW1T1		–	–	0.2	
	MUN5313DW1T1		–	–	0.1	
	MUN5314DW1T1		–	–	0.2	
	MUN5315DW1T1		–	–	0.9	
	MUN5316DW1T1		–	–	1.9	
	MUN5330DW1T1		–	–	4.3	
	MUN5331DW1T1		–	–	2.3	
	MUN5332DW1T1		–	–	1.5	
	MUN5333DW1T1		–	–	0.18	
	MUN5334DW1T1		–	–	0.13	
	MUN5335DW1T1		–	–	0.2	
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector-Emitter Breakdown Voltage (Note 4.) (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc

3. New resistor combinations. Updated curves to follow in subsequent data sheets.
4. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

ELECTRICAL CHARACTERISTICS
(T_A = 25°C unless otherwise noted, common for Q_1 and Q_2, – minus sign for Q_1 (PNP) omitted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Note 5.)						
DC Current Gain	MUN5311DW1T1	h_{FE}	35	60	–	
(V_{CE} = 10 V, I_C = 5.0 mA)	MUN5312DW1T1		60	100	–	
	MUN5313DW1T1		80	140	–	
	MUN5314DW1T1		80	140	–	
	MUN5315DW1T1		160	350	–	
	MUN5316DW1T1		160	350	–	
	MUN5330DW1T1		3.0	5.0	–	
	MUN5331DW1T1		8.0	15	–	
	MUN5332DW1T1		15	30	–	
	MUN5333DW1T1		80	200	–	
	MUN5334DW1T1		80	150	–	
	MUN5335DW1T1		80	140	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	–	–	0.25	Vdc
(I_C = 10 mA, I_B = 0.3 mA)						
(I_C = 10 mA, I_B = 5 mA) MUN5330DW1T1/MUN5331DW1T1						
(I_C = 10 mA, I_B = 1 mA) MUN5315DW1T1/MUN5316DW1T1						
MUN5332DW1T1/MUN5333DW1T1/MUN5334DW1T1						
Output Voltage (on)		V_{OL}				Vdc
(V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)	MUN5311DW1T1		–	–	0.2	
	MUN5312DW1T1		–	–	0.2	
	MUN5314DW1T1		–	–	0.2	
	MUN5315DW1T1		–	–	0.2	
	MUN5316DW1T1		–	–	0.2	
	MUN5330DW1T1		–	–	0.2	
	MUN5331DW1T1		–	–	0.2	
	MUN5332DW1T1		–	–	0.2	
	MUN5333DW1T1		–	–	0.2	
	MUN5334DW1T1		–	–	0.2	
	MUN5335DW1T1		–	–	0.2	
(V_{CC} = 5.0 V, V_B = 3.5 V, R_L = 1.0 kΩ)	MUN5313DW1T1		–	–	0.2	
Output Voltage (off)		V_{OH}	4.9	–	–	Vdc
(V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ)						
(V_{CC} = 5.0 V, V_B = 0.050 V, R_L = 1.0 kΩ)	MUN5330DW1T1					
(V_{CC} = 5.0 V, V_B = 0.25 V, R_L = 1.0 kΩ)	MUN5315DW1T1					
	MUN5316DW1T1					
	MUN5333DW1T1					
Input Resistor	MUN5311DW1T1	R1	7.0	10	13	k Ω
	MUN5312DW1T1		15.4	22	28.6	
	MUN5313DW1T1		32.9	47	61.1	
	MUN5314DW1T1		7.0	10	13	
	MUN5315DW1T1		7.0	10	13	
	MUN5316DW1T1		3.3	4.7	6.1	
	MUN5330DW1T1		0.7	1.0	1.3	
	MUN5331DW1T1		1.5	2.2	2.9	
	MUN5332DW1T1		3.3	4.7	6.1	
	MUN5333DW1T1		3.3	4.7	6.1	
	MUN5334DW1T1		15.4	22	28.6	
	MUN5335DW1T1		1.54	2.2	2.86	
Resistor Ratio	MUN5311DW1T1/MUN5312DW1T1/MUN5313DW1T1	R1/R2	0.8	1.0	1.2	
	MUN5314DW1T1		0.17	0.21	0.25	
	MUN5315DW1T1/MUN5316DW1T1		–	–	–	
	MUN5330DW1T1/MUN5331DW1T1/MUN5332DW1T1		0.8	1.0	1.2	
	MUN5333DW1T1		0.055	0.1	0.185	
	MUN5334DW1T1		0.38	0.47	0.56	
	MUN5335DW1T1		0.038	0.047	0.056	

5. Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%

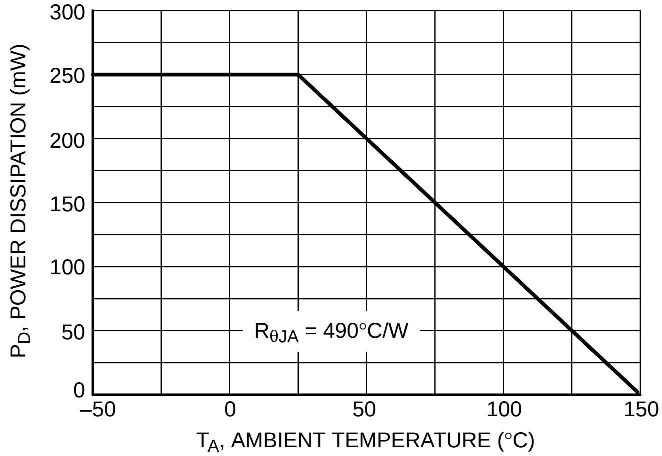


Figure 1. Derating Curve

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5311DW1T1 NPN TRANSISTOR

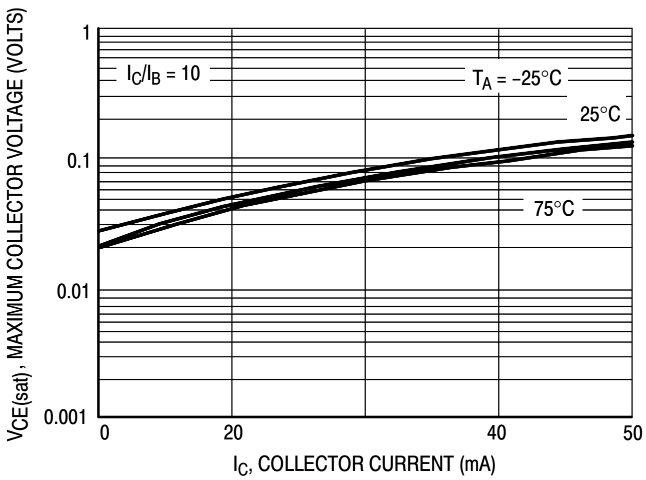


Figure 2. $V_{CE(sat)}$ versus I_C

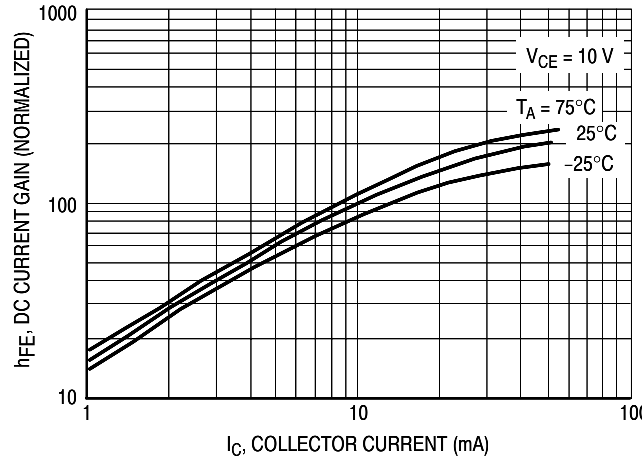


Figure 3. DC Current Gain

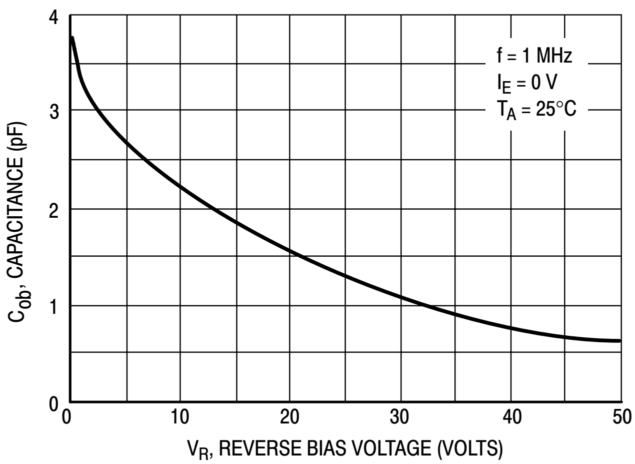


Figure 4. Output Capacitance

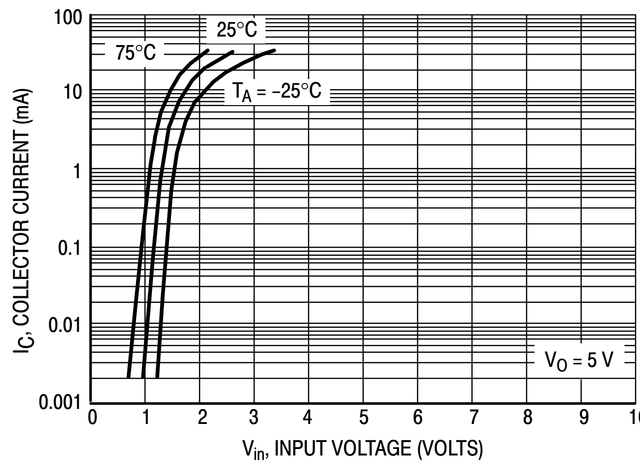


Figure 5. Output Current versus Input Voltage

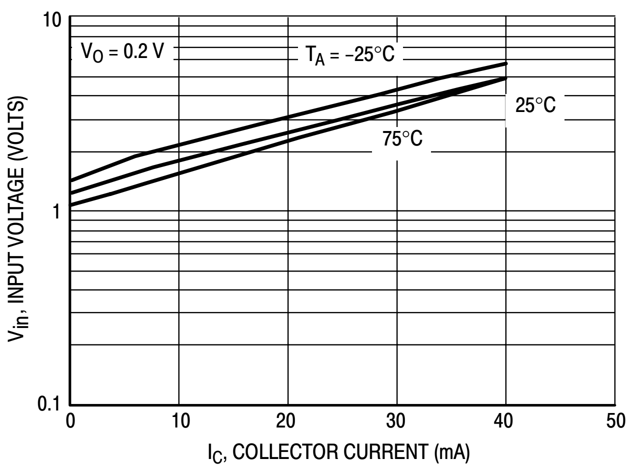


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5311DW1T1 PNP TRANSISTOR

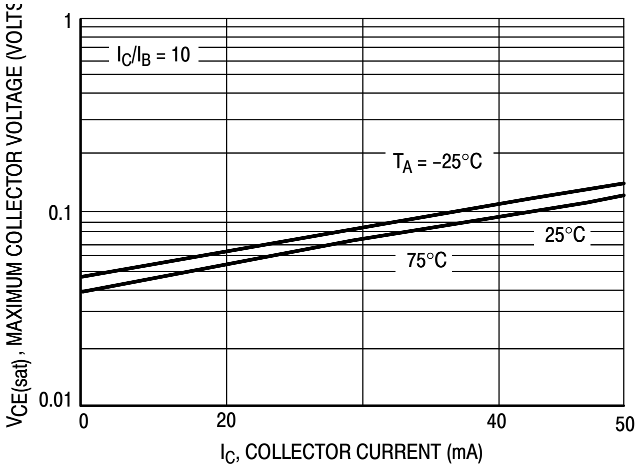


Figure 7. $V_{CE(sat)}$ versus I_C

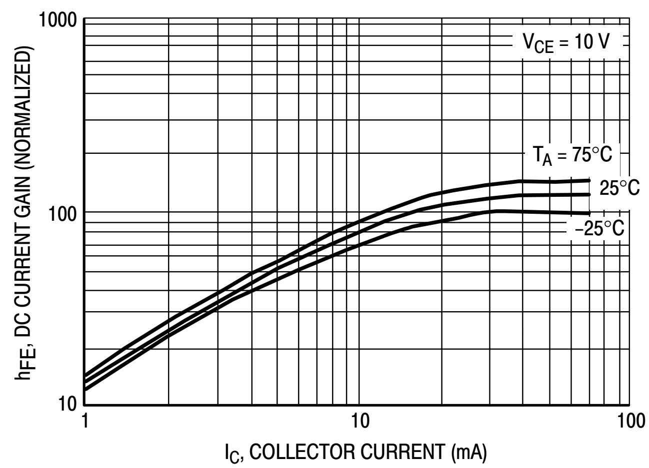


Figure 8. DC Current Gain

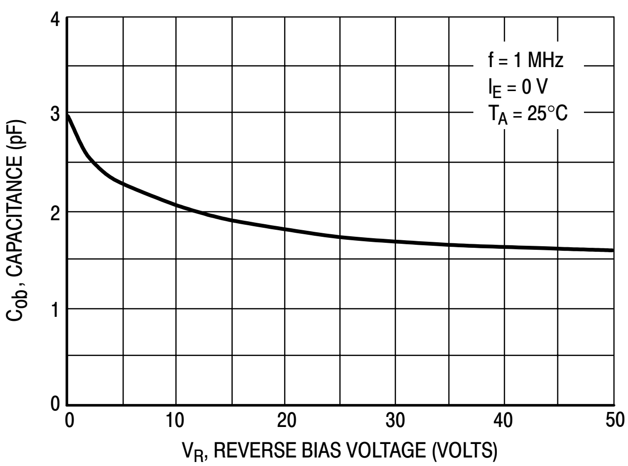


Figure 9. Output Capacitance

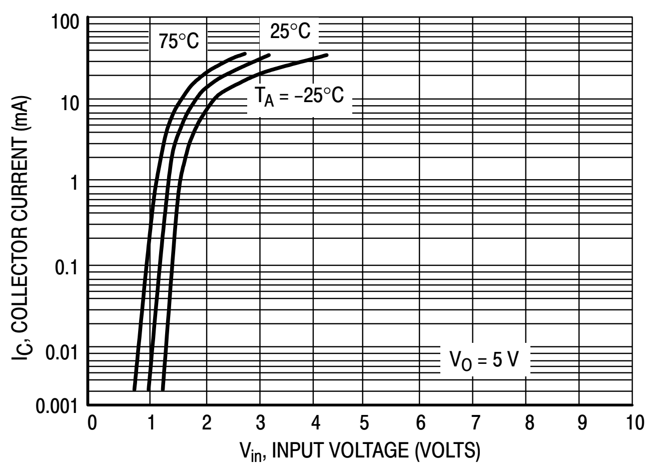


Figure 10. Output Current versus Input Voltage

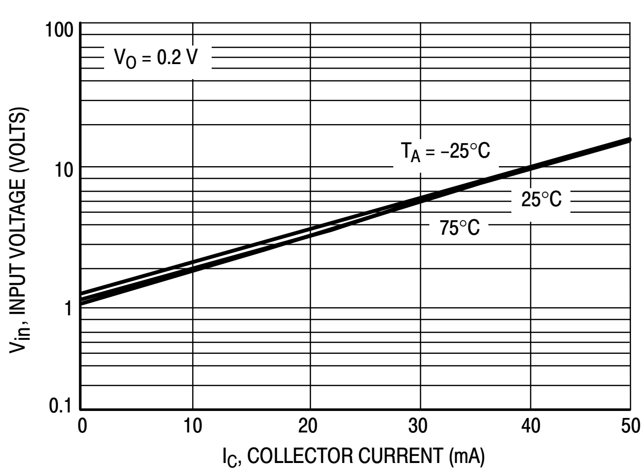


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5312DW1T1 NPN TRANSISTOR

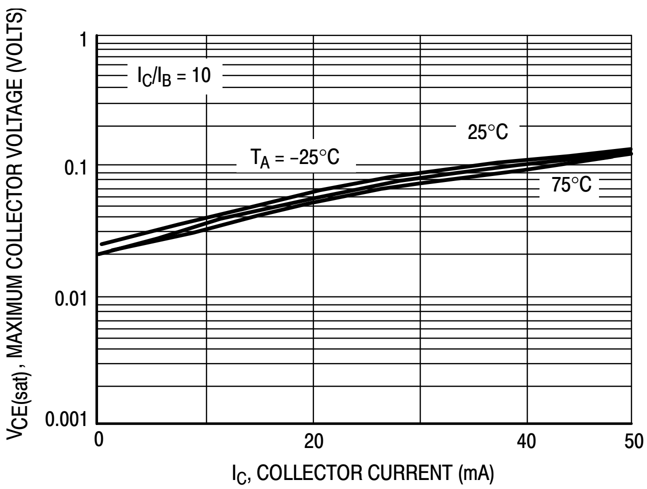


Figure 12. $V_{CE(sat)}$ versus I_C

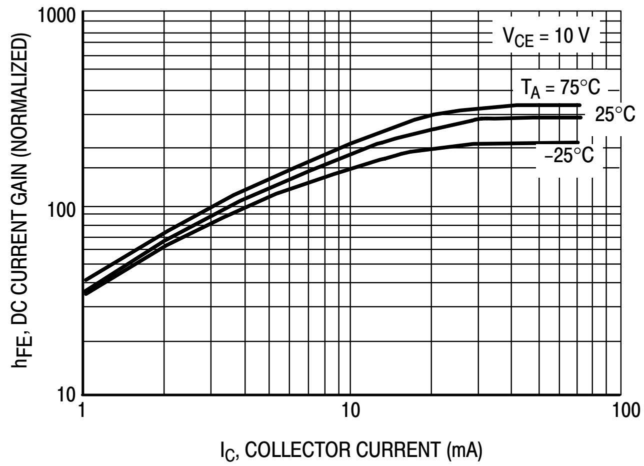


Figure 13. DC Current Gain

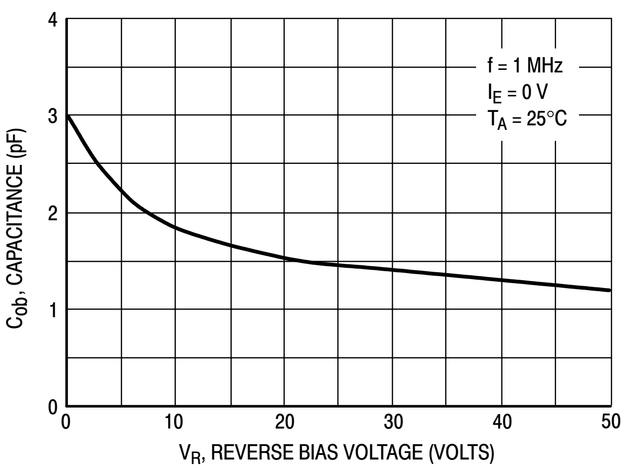


Figure 14. Output Capacitance

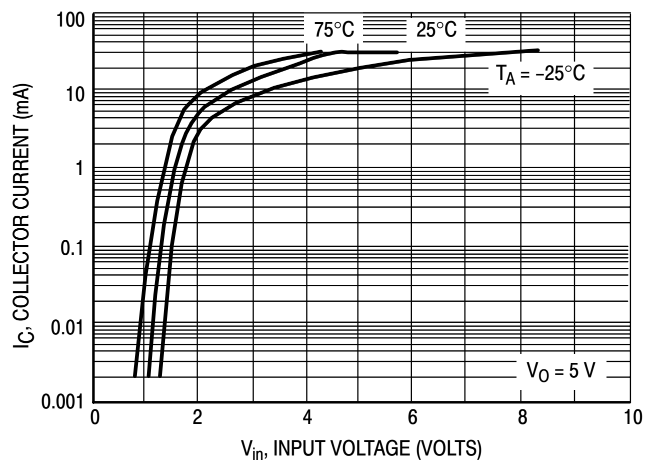


Figure 15. Output Current versus Input Voltage

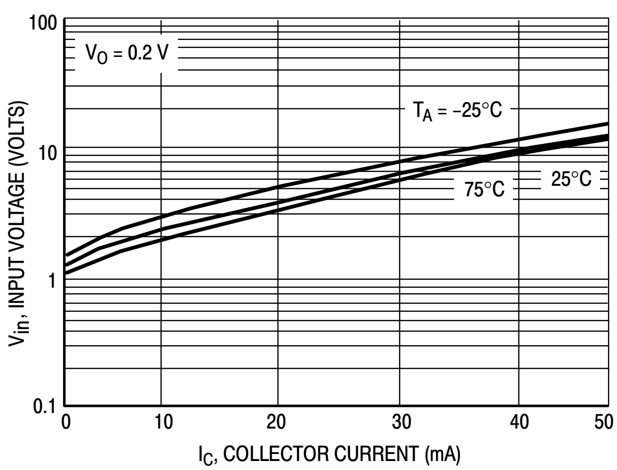


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5312DW1T1 PNP TRANSISTOR

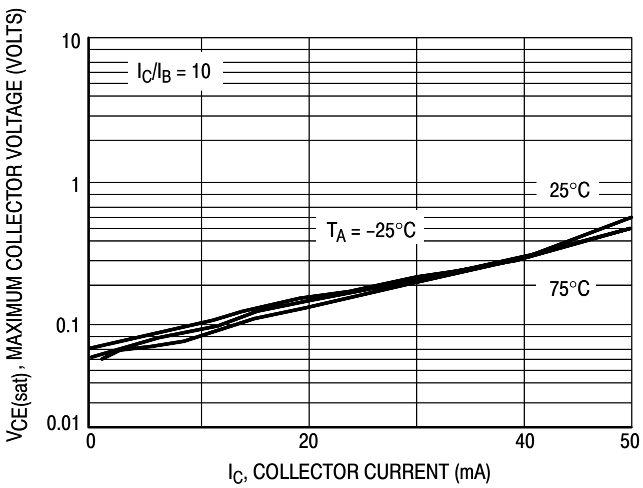


Figure 17. $V_{CE(sat)}$ versus I_C

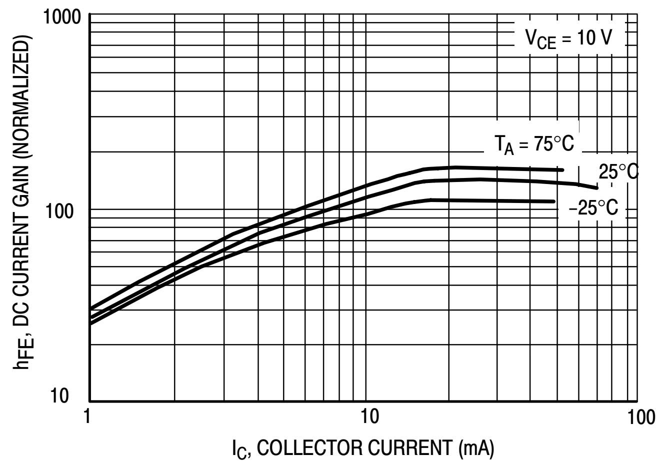


Figure 18. DC Current Gain

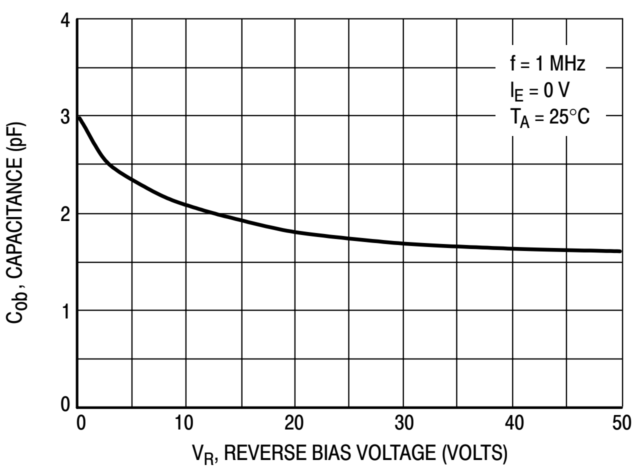


Figure 19. Output Capacitance

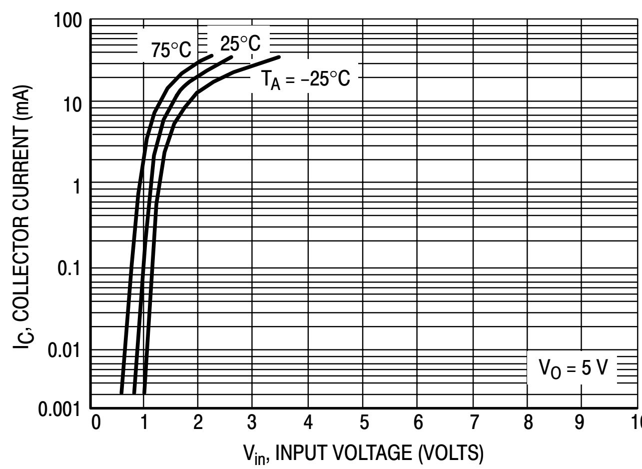


Figure 20. Output Current versus Input Voltage

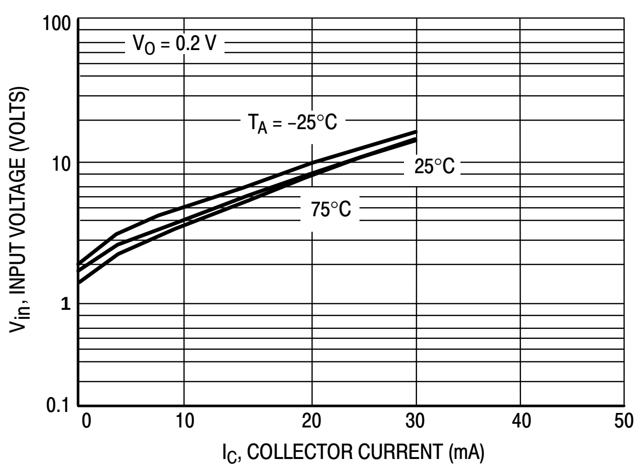


Figure 21. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5313DW1T1 NPN TRANSISTOR

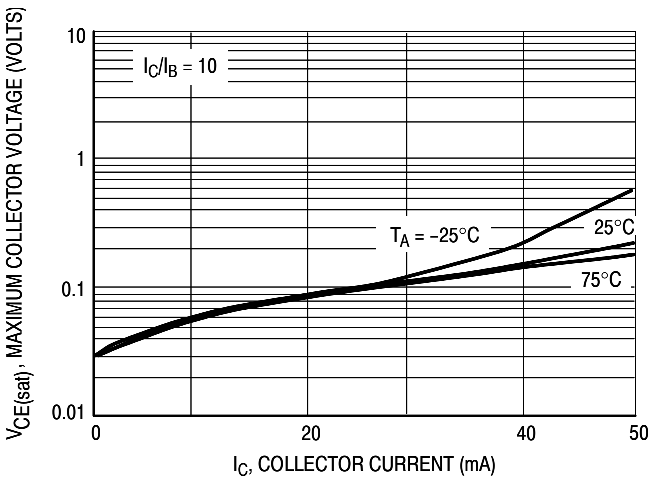


Figure 22. $V_{CE(sat)}$ versus I_C

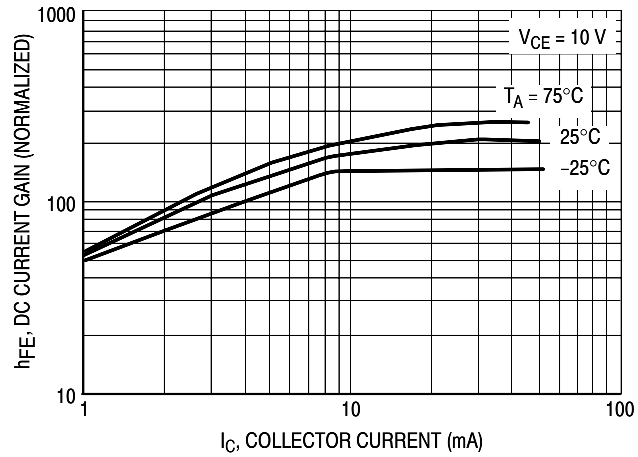


Figure 23. DC Current Gain

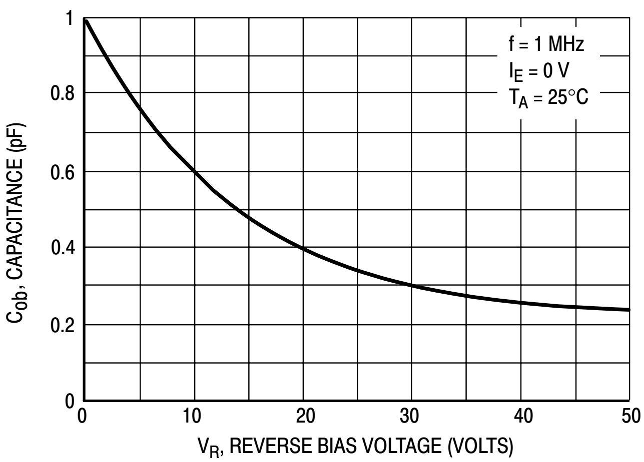


Figure 24. Output Capacitance

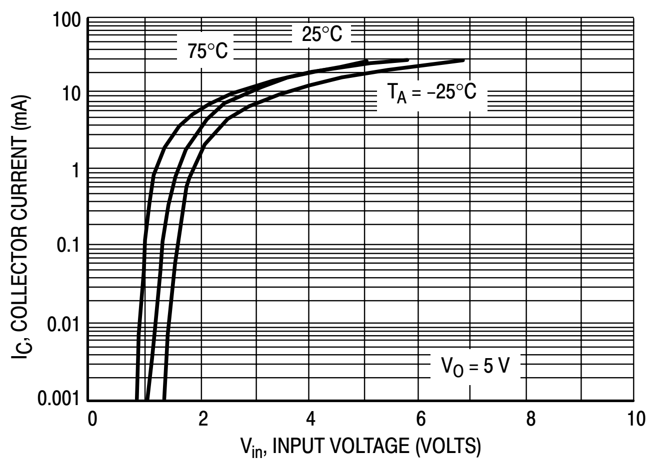


Figure 25. Output Current versus Input Voltage

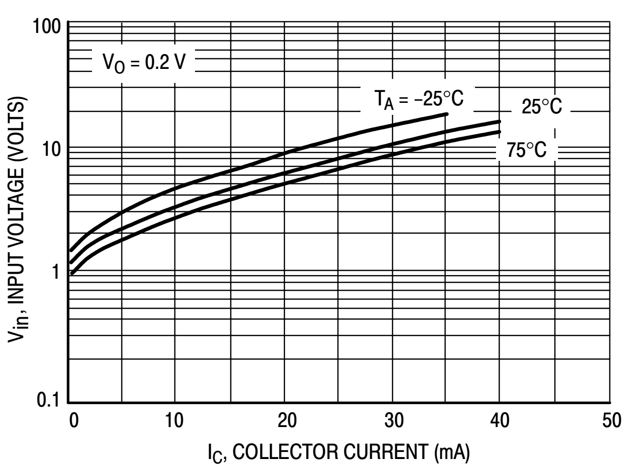


Figure 26. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5313DW1T1 PNP TRANSISTOR

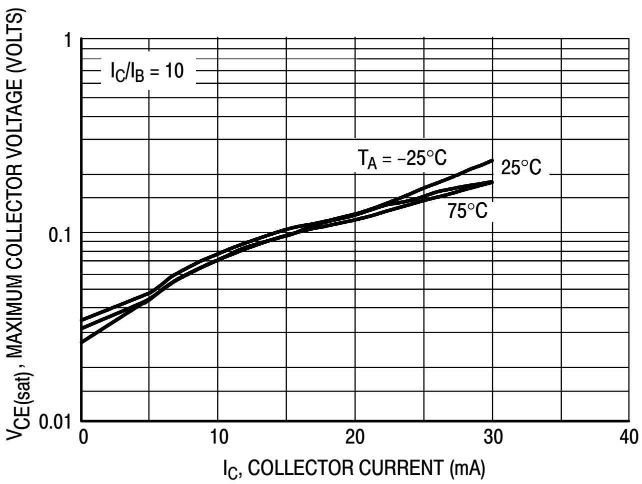


Figure 27. $V_{CE(sat)}$ versus I_C

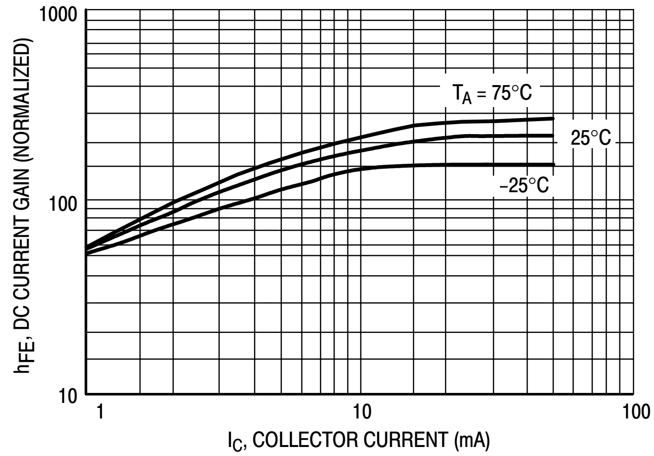


Figure 28. DC Current Gain

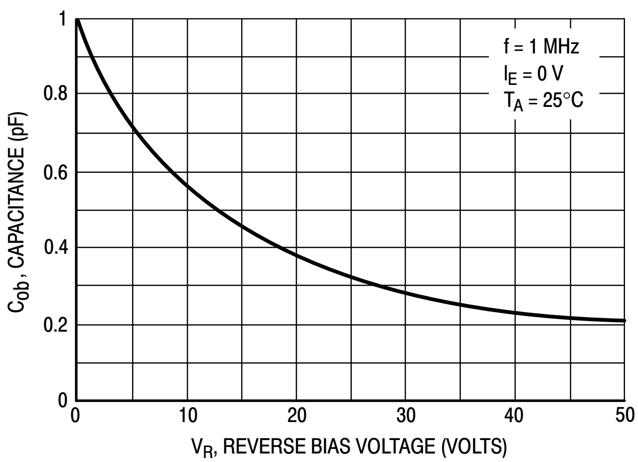


Figure 29. Output Capacitance

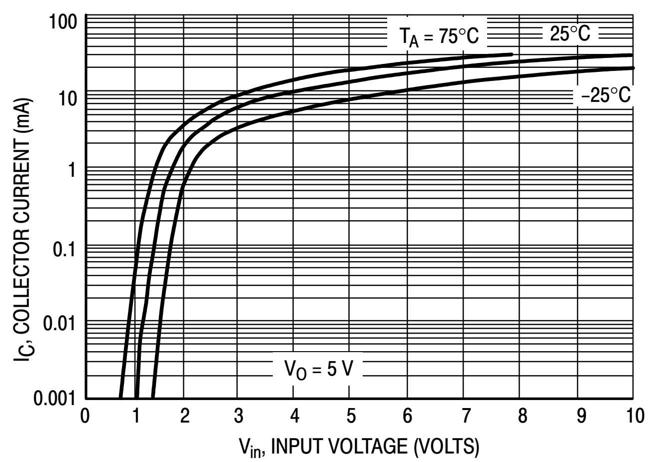


Figure 30. Output Current versus Input Voltage

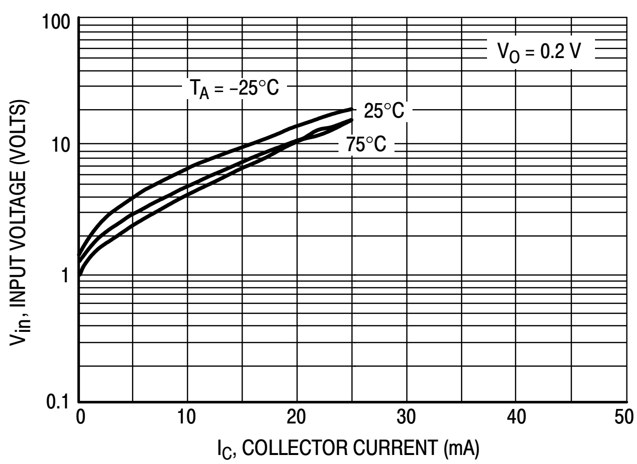


Figure 31. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5314DW1T1 NPN TRANSISTOR

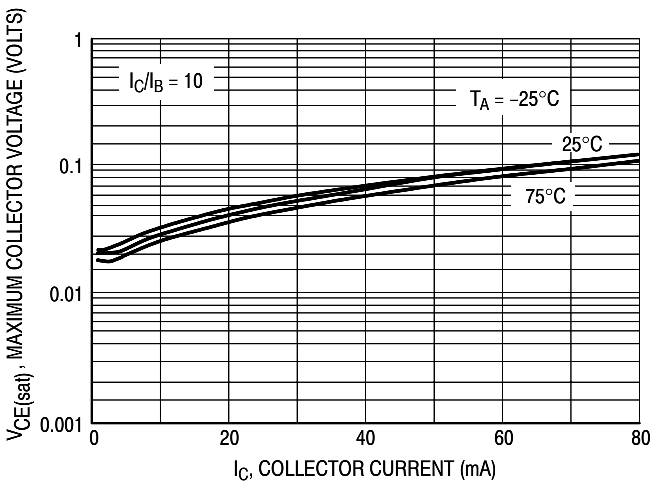


Figure 32. $V_{CE(sat)}$ versus I_C

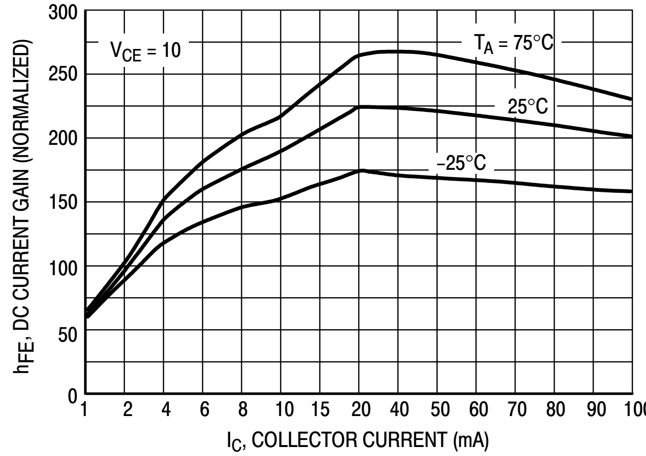


Figure 33. DC Current Gain

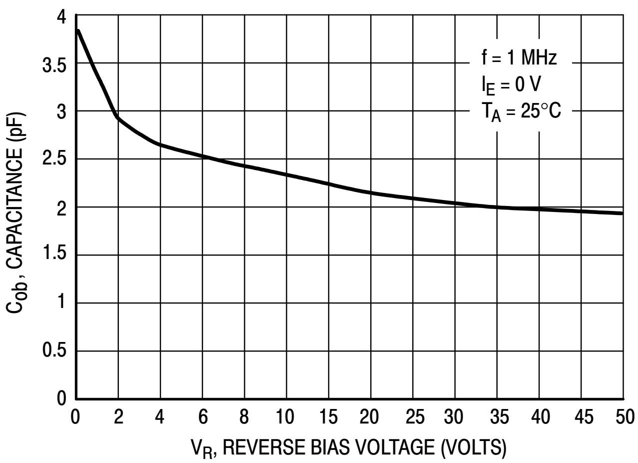


Figure 34. Output Capacitance

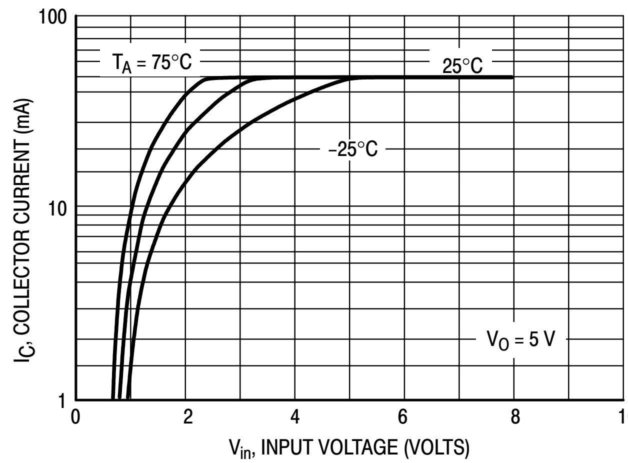


Figure 35. Output Current versus Input Voltage

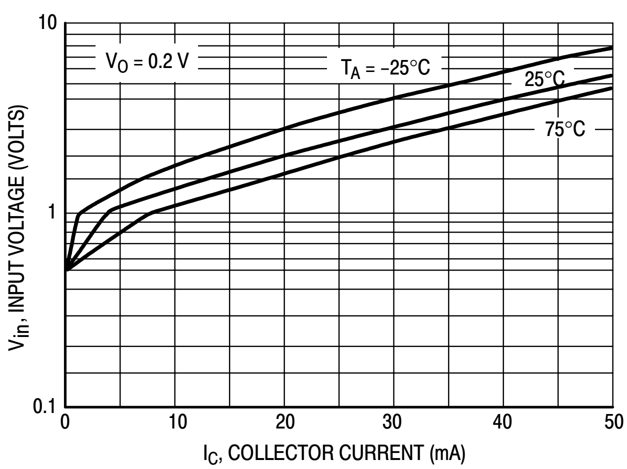


Figure 36. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5314DW1T1 PNP TRANSISTOR

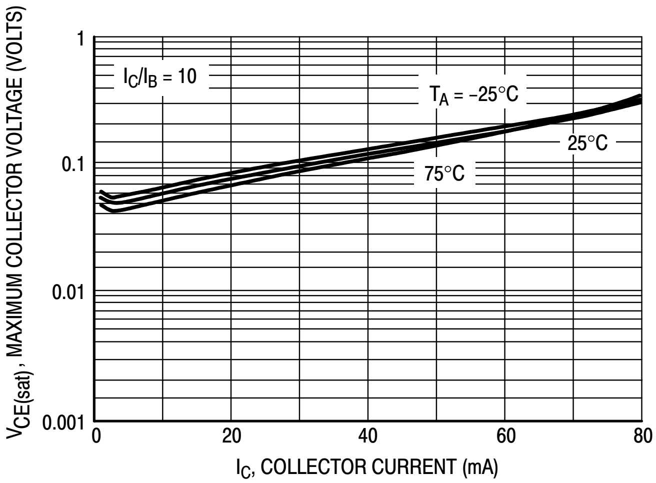


Figure 37. $V_{CE(sat)}$ versus I_C

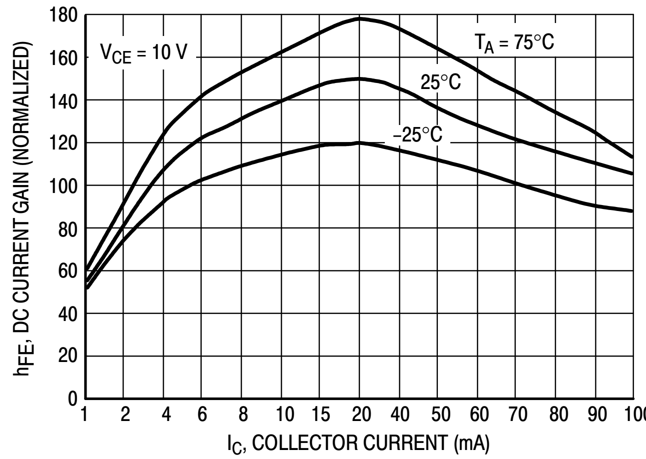


Figure 38. DC Current Gain

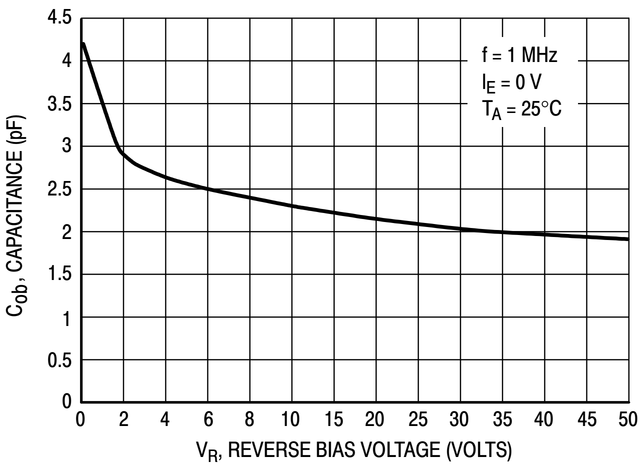


Figure 39. Output Capacitance

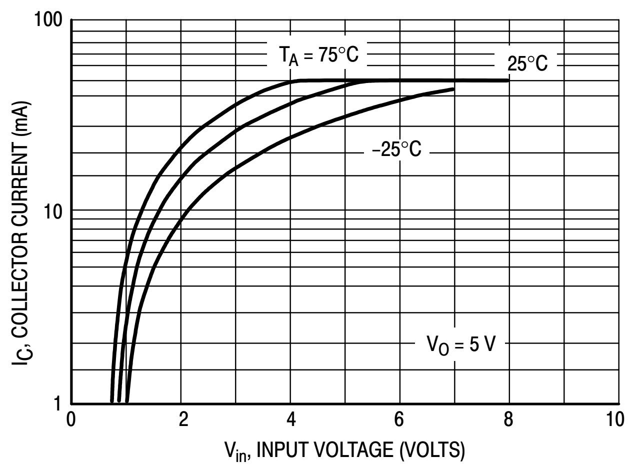


Figure 40. Output Current versus Input Voltage

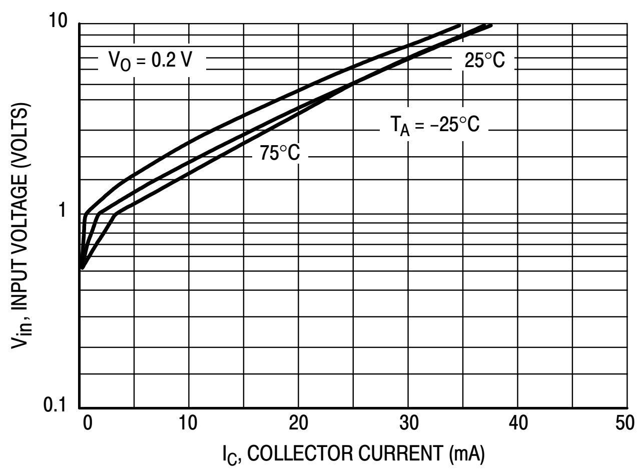


Figure 41. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5315DW1T1

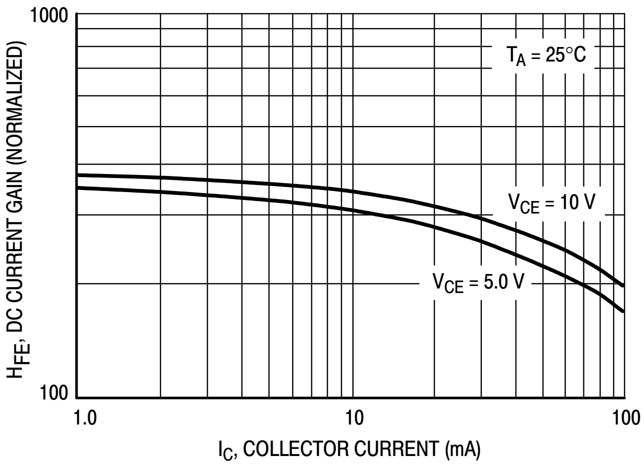


Figure 42. DC Current Gain – PNP

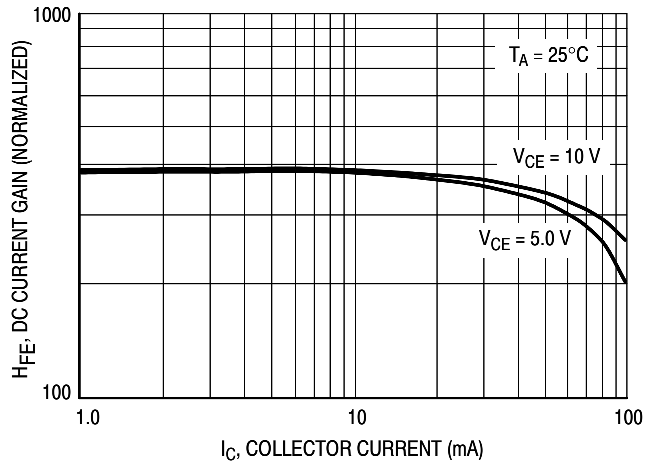


Figure 43. DC Current Gain – NPN

TYPICAL ELECTRICAL CHARACTERISTICS – MUN5316DW1T1

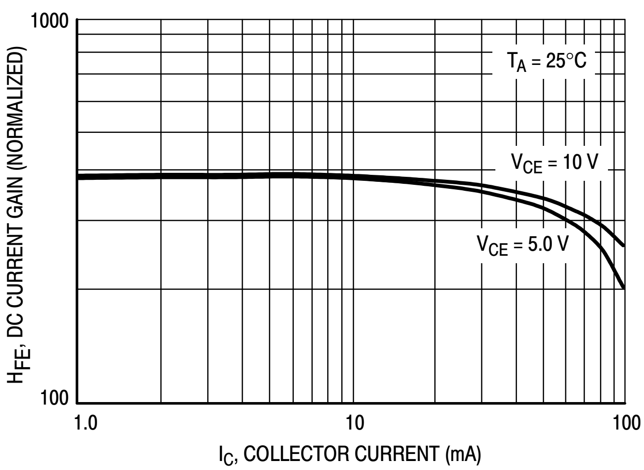


Figure 44. DC Current Gain – PNP

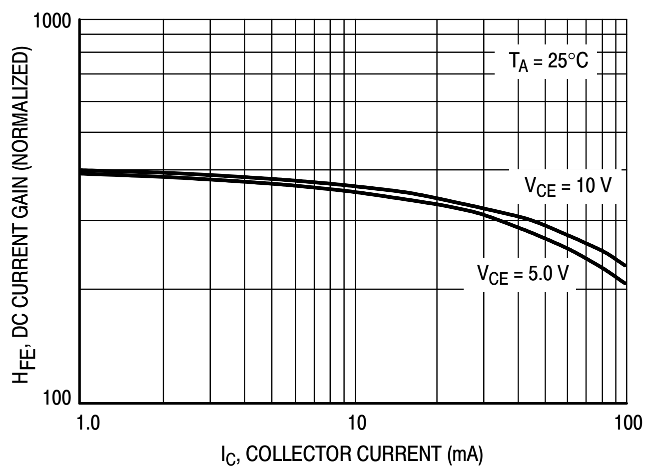


Figure 45. DC Current Gain – NPN

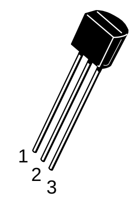
MV104

DUAL VOLTAGE VARIABLE CAPACITANCE DIODE

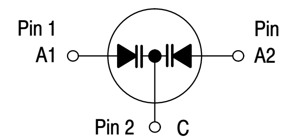
Silicon Tuning Diode

This device is designed for FM tuning, general frequency control and tuning, or any top–of–the–line application requiring back–to–back diode configurations for minimum signal distortion and detuning.

- High Figure of Merit — Q = 140 (Typ) @ V_R = 3.0 Vdc, f = 100 MHz
- Guaranteed Capacitance Range 37–42 pF @ V_R = 3.0 Vdc (MV104)
- Dual Diodes – Save Space and Reduce Cost
- Monolithic Chip Provides Near Perfect Matching – Guaranteed ± 1.0% (Max) Over Specified Tuning Range



CASE 29–11, STYLE 15
TO–92 (TO–226AA)



MAXIMUM RATINGS (EACH DIODE)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	32	Vdc
Forward Current	I_F	200	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	280 2.8	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	–55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) **(EACH DIODE)**

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	32	—	—	Vdc
Reverse Voltage Leakage Current T_A = 25°C (V_R = 30 Vdc) T_A = 60°C	I_R	— —	— —	50 500	nAdc
Diode Capacitance Temperature Coefficient (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	—	280	—	ppm/°C

	C_T, Diode Capacitance V_R = 3.0 Vdc, f = 1.0 MHz pF		Q, Figure of Merit V_R = 3.0 Vdc f = 100 MHz		C_R, Capacitance Ratio C_3/C_{30} f = 1.0 MHz	
Device	**Min**	**Max**	**Min**	**Typ**	**Min**	**Max**
MV104	37	42	100	140	2.5	2.8

TYPICAL CHARACTERISTICS (Each Diode)

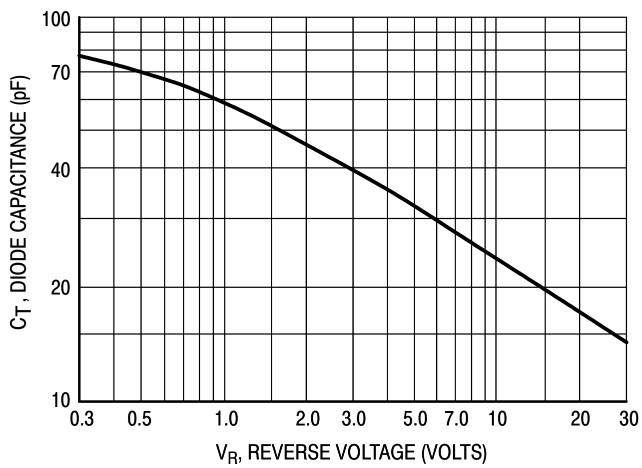


Figure 1. Diode Capacitance (Each Diode)

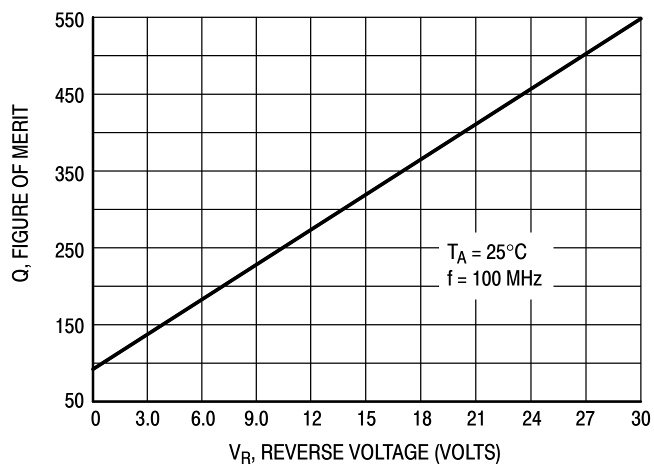


Figure 2. Figure of Merit versus Voltage

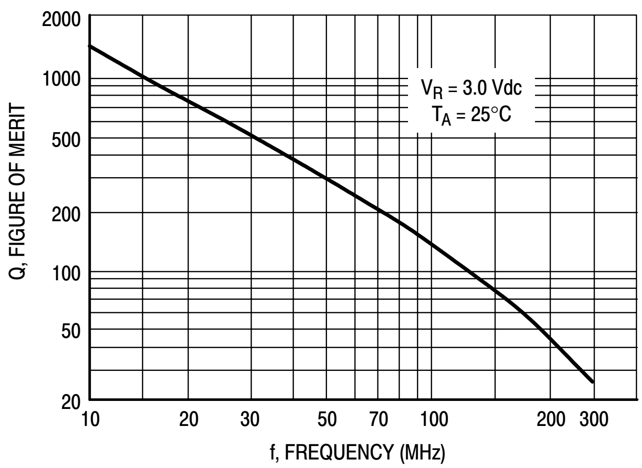


Figure 3. Figure of Merit versus Frequency

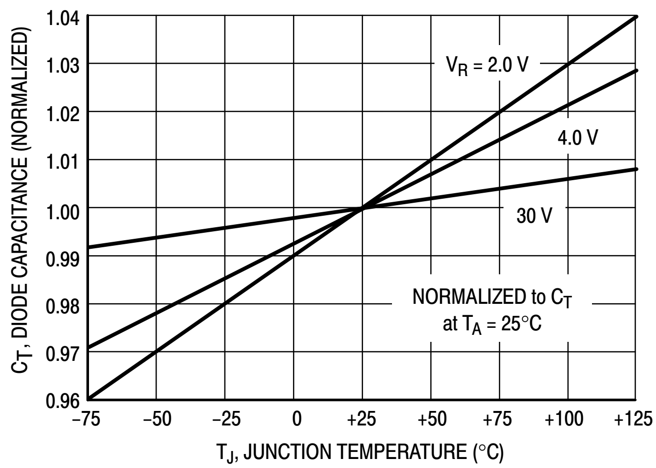


Figure 4. Diode Capacitance versus Temperature

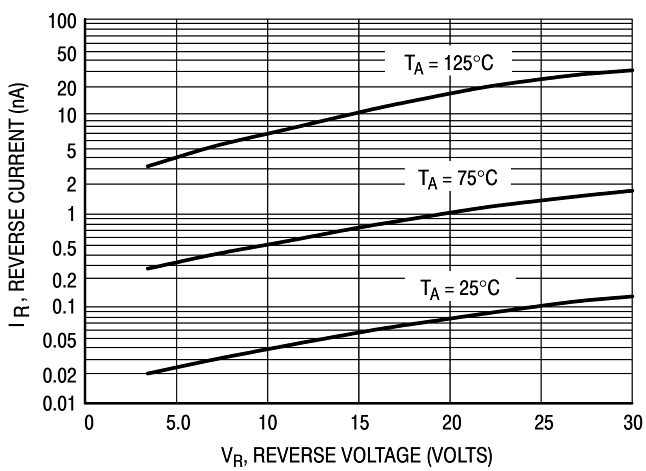


Figure 5. Reverse Current versus Reverse Voltage

NSF2250WT1

Advance Information

NPN Silicon Oscillator and Mixer Transistor

The NSF2250WT1 NPN silicon epitaxial bipolar transistor is intended for use in general purpose UHF oscillator and mixer applications. It is suitable for automovtive keyless entry and TV tuner designs.

The device features stable oscillation and small frequency drift during changes in the supply voltage and over the ambient temperature range.

Features

- High Gain Bandwidth Product: f_T = 2000 MHz Minimum
- Tightly Controlled h_{FE} Range: h_{FE} = 120 to 250
- Low Feedback Capacitance: C_{RE} = 0.45 pF Typical

MAXIMUM RATINGS

Parameters	Symbol	Units	Ratings
Collector to Base Voltage	V_{CBO}	V	30
Collector to Emitter Voltage	V_{CEO}	V	15
Emitter to Base Voltage	VE_{BO}	V	3.0
Collector Current	I_C	mA	50
Electrostatic Discharge	ESD	HBM – Class 1C MM – Class A	

THERMAL CHARACTERISTICS

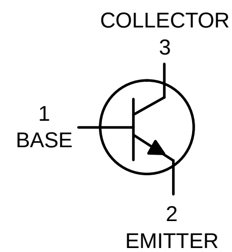
Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D	202 (Note 1.) 310 (Note 2.) 1.6 (Note 1.) 2.5 (Note 2.)	mW mW/°C
Thermal Resistance – Junction-to-Ambient	$R_{\theta JA}$	618 (Note 1.) 403 (Note 2.)	°C/W
Thermal Resistance – Junction-to-Lead	$R_{\theta JL}$	280 (Note 1.) 332 (Note 2.)	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 x 1.0 inch Pad

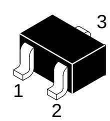
This document contains information on a new product. Specifications and information herein are subject to change without notice.

ON Semiconductor™

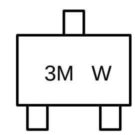
http://onsemi.com



MARKING DIAGRAM



SOT–323/SC–70
CASE 419
STYLE 3



3M = Specific Device Code
W = Date Code

ORDERING INFORMATION

Device	Package	Shipping
NSF2250WT1	SOT–323	3000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
Collector Cutoff Current, V_{CB} = 12 V, I_E = 0	I_{CBO}	–	–	0.1	μA
DC Current Gain, V_{CE} = 10 V, I_C = 5.0 mA	h_{FE}	120	–	250	–
Collector Saturation Voltage, I_C = 10 mA, I_B = 1.0 mA	$V_{CE(sat)}$	–	–	0.5	V
Gain Bandwidth Product, V_{CE} = 3 V, I_E = –5.0 mA	f_T	2.0	2.3	–	GHz
Output Capacitance, V_{CB} = 3 V, I_E = 0 mA, f = 1.0 MHz	C_{OB}	–	0.7	1.2	pF
Collector to Base Time Constant, V_{CE} = 3 V, I_E = –5.0 mA, f = 31.9 MHz	$C_C \bullet r_{b'b}$	–	3.5	8.0	ps
Feedback Capacitance, V_{CB} = 10 V, I_E = 0 mA, f = 1.0 MHz	C_{RE}	–	4.5	–	pF

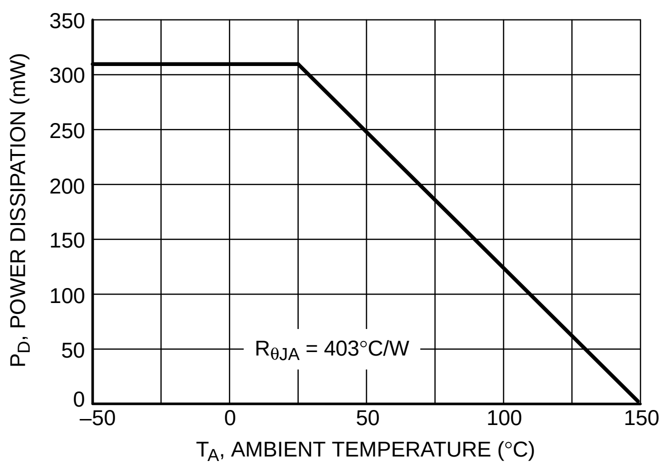


Figure 1. Derating Curve

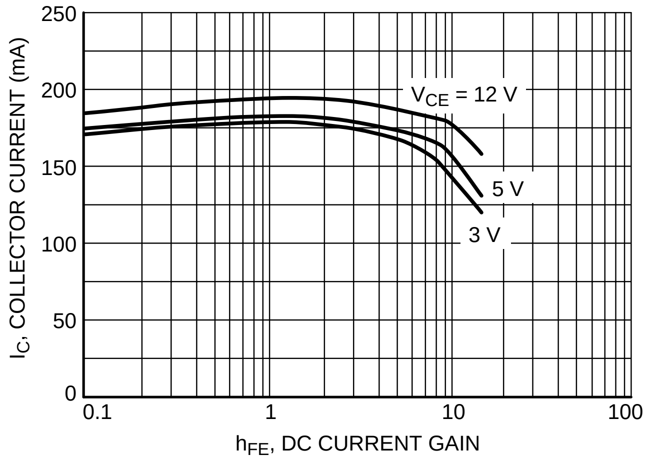


Figure 2. DC Current Gain versus Collector Current

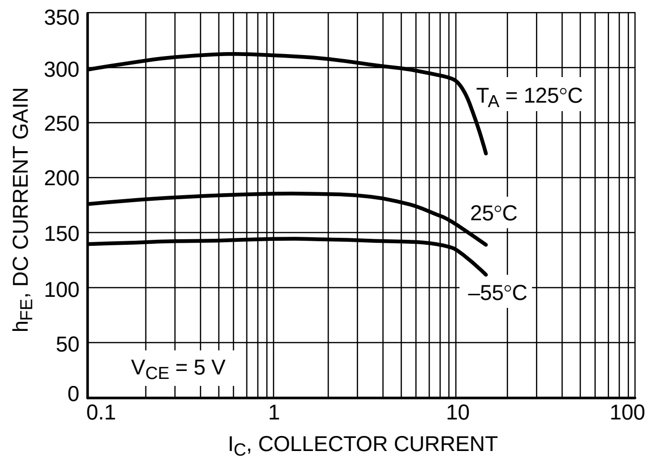


Figure 3. DC Current Gain versus Collector Current

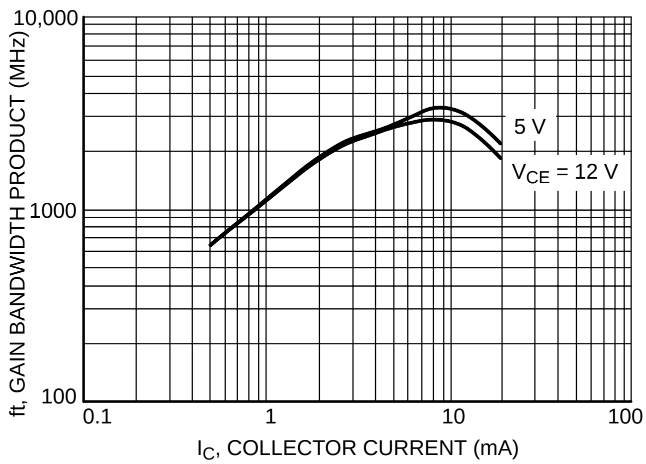


Figure 4. Gain Bandwidth Product versus Collector Current

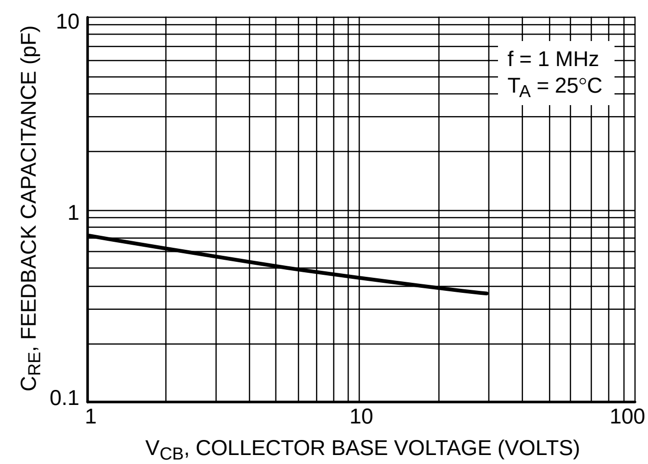


Figure 5. Device Capacitance versus Collector Base Voltage

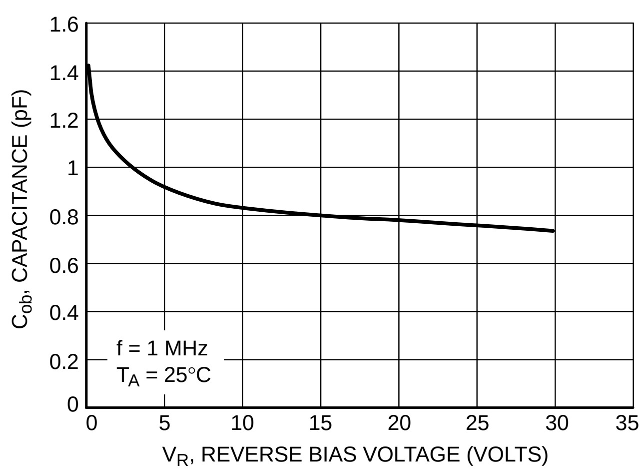


Figure 6. Output Capacitance

TYPICAL COMMON EMITTER SCATTERING PARAMETER (T_A = 25°C)

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
V_{CE} = 2.5 V, I_C = 2.5 mA								
50	0.926	–14.124	6.803	162.639	0.018	82.792	0.973	–7.062
100	0.855	–26.794	6.224	148.649	0.034	73.296	0.921	–12.818
200	0.667	–47.287	5.033	126.317	0.058	62.292	0.807	–19.210
300	0.513	–60.931	4.072	110.981	0.074	58.641	0.736	–21.979
400	0.411	–70.342	3.326	100.524	0.090	57.333	0.694	–23.695
500	0.342	–77.461	2.831	92.771	0.104	56.067	0.670	–25.311
600	0.297	–84.335	2.445	86.222	0.117	55.166	0.651	–27.095
700	0.261	–90.986	2.154	80.493	0.131	53.800	0.637	–29.095
800	0.236	–97.798	1.935	75.382	0.144	52.087	0.627	–31.026
900	0.218	–104.905	1.755	70.672	0.155	50.745	0.617	–33.167
1000	0.205	–112.449	1.617	66.258	0.168	49.386	0.608	–35.352
1500	0.190	–147.224	1.200	48.079	0.219	42.418	0.575	–46.016
2000	0.215	–171.677	1.011	33.299	0.258	35.910	0.544	–58.267
2500	0.230	–172.291	0.889	20.271	0.294	31.024	0.510	–68.713
3000	0.236	–155.125	0.866	10.984	0.340	28.868	0.450	–81.517

TYPICAL COMMON EMITTER SCATTERING PARAMETER (T_A = 25°C)

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
V_{CE} = 3 V, I_C = 5 mA								
50	0.858	–20.126	12.065	156.269	0.017	78.802	0.945	–10.278
100	0.733	–36.552	10.452	139.116	0.029	69.100	0.850	–16.656
200	0.493	–58.358	7.472	115.678	0.047	62.893	0.712	–20.497
300	0.362	–69.976	5.544	103.053	0.062	62.188	0.653	–21.545
400	0.288	–78.272	4.337	94.866	0.075	61.876	0.621	–22.551
500	0.242	–85.666	3.582	88.592	0.090	61.259	0.603	–23.975
600	0.212	–93.237	3.048	83.504	0.103	59.861	0.590	–25.526
700	0.190	–101.308	2.656	78.785	0.116	58.802	0.580	–27.405
800	0.177	–109.656	2.375	74.561	0.128	57.017	0.573	–29.334
900	0.167	–118.336	2.145	70.348	0.141	55.629	0.563	–31.402
1000	0.163	–127.188	1.968	66.700	0.153	53.851	0.555	–33.301
1500	0.176	–164.287	1.435	50.083	0.203	47.574	0.528	–43.164
2000	0.210	–174.155	1.187	35.998	0.246	41.767	0.501	–54.213
2500	0.226	–159.754	1.034	23.227	0.288	36.614	0.469	–63.689
3000	0.239	–144.224	0.995	14.088	0.340	34.458	0.413	–74.387

TYPICAL COMMON EMITTER SCATTERING PARAMETER (T_A = 25°C)

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
V_{CE} = 3 V, I_C = 10 mA								
50	0.643	–35.313	15.384	140.063	0.015	69.823	0.864	–14.048
100	0.459	–53.013	11.650	121.580	0.024	63.636	0.738	–17.013
200	0.289	–70.035	7.214	104.714	0.040	65.531	0.647	–17.265
300	0.225	–80.644	5.260	96.934	0.053	66.205	0.618	–18.444
400	0.192	–91.607	4.122	91.266	0.068	66.344	0.598	–20.216
500	0.172	–102.488	3.419	86.447	0.082	64.574	0.584	–22.273
600	0.161	–113.748	2.929	82.212	0.096	63.206	0.572	–24.418
700	0.156	–125.151	2.575	78.231	0.107	61.822	0.561	–26.828
800	0.155	–135.549	2.313	74.282	0.119	60.606	0.553	–28.821
900	0.156	–145.469	2.099	70.461	0.131	59.154	0.543	–31.132
1000	0.163	–153.718	1.925	67.004	0.141	57.409	0.536	–33.247
1500	0.201	–175.526	1.415	50.535	0.193	52.024	0.505	–43.365
2000	0.237	–159.398	1.173	36.726	0.240	46.396	0.477	–54.652
2500	0.247	–147.097	1.021	24.113	0.289	41.529	0.444	–64.094
3000	0.259	–133.925	0.982	15.023	0.346	38.491	0.382	–75.243

TYPICAL COMMON EMITTER SCATTERING PARAMETER (T_A = 25°C)

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
V_{CE} = 10 V, I_C = 5 mA								
50	0.877	–17.278	11.972	157.707	0.012	81.580	0.972	–7.268
100	0.765	–31.274	10.386	140.944	0.022	72.099	0.900	–12.126
200	0.539	–49.213	7.575	118.277	0.037	66.849	0.803	–14.944
300	0.406	–57.758	5.678	105.478	0.049	66.104	0.757	–16.182
400	0.334	–63.347	4.464	97.467	0.062	65.473	0.729	–17.508
500	0.286	–68.461	3.698	91.347	0.073	64.460	0.717	–19.007
600	0.252	–73.828	3.159	86.264	0.085	63.014	0.706	–20.874
700	0.227	–79.612	2.766	81.745	0.095	62.100	0.697	–22.551
800	0.208	–86.135	2.474	77.803	0.106	60.785	0.690	–24.442
900	0.190	–93.121	2.237	73.571	0.116	59.532	0.682	–26.405
1000	0.179	–100.507	2.047	70.150	0.125	57.905	0.674	–28.385
1500	0.162	–139.494	1.495	53.949	0.169	52.604	0.652	–37.411
2000	0.185	–167.453	1.242	40.156	0.207	47.697	0.631	–47.834
2500	0.200	–175.534	1.082	27.306	0.247	44.045	0.609	–55.962
3000	0.208	–159.130	1.050	18.234	0.296	42.716	0.557	–65.696

V_{CE} = 2.5 V, I_C = 2.5 mA

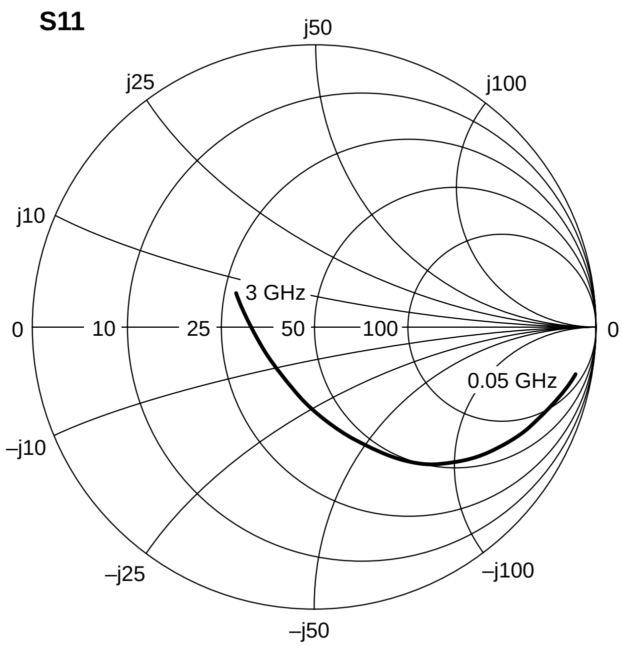


Figure 7. Input Reflection Coefficient

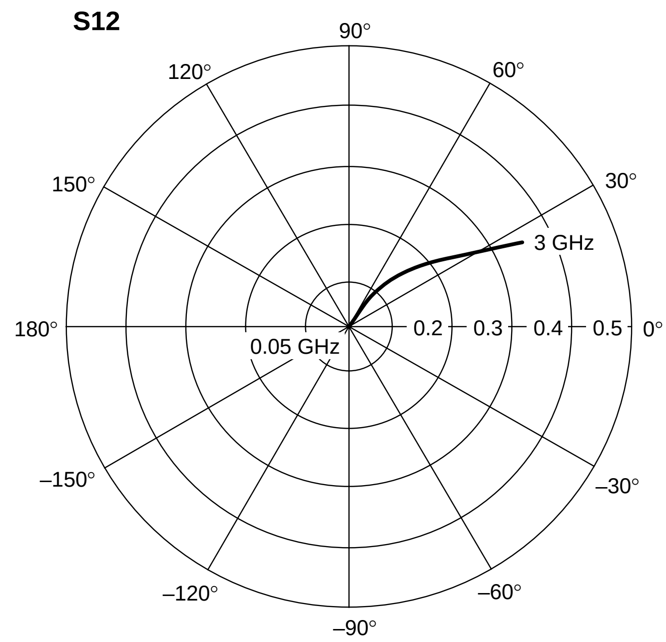


Figure 8. Reverse Transmission Coefficient

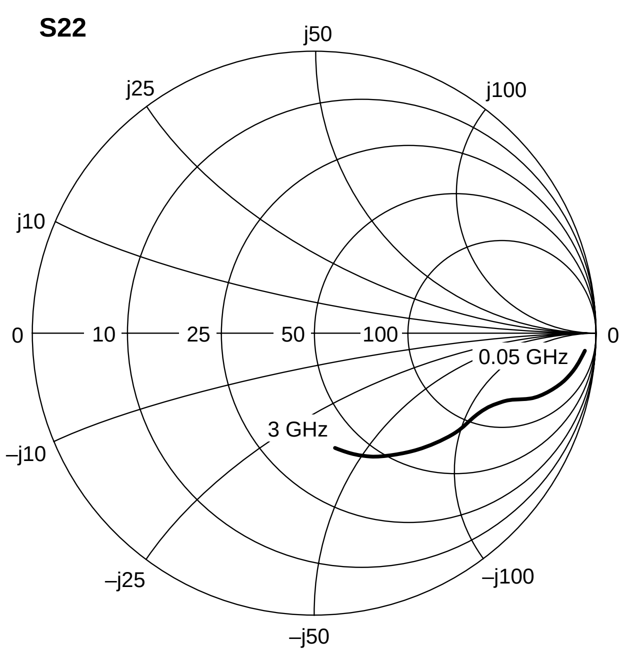


Figure 9. Output Reflection Coefficient

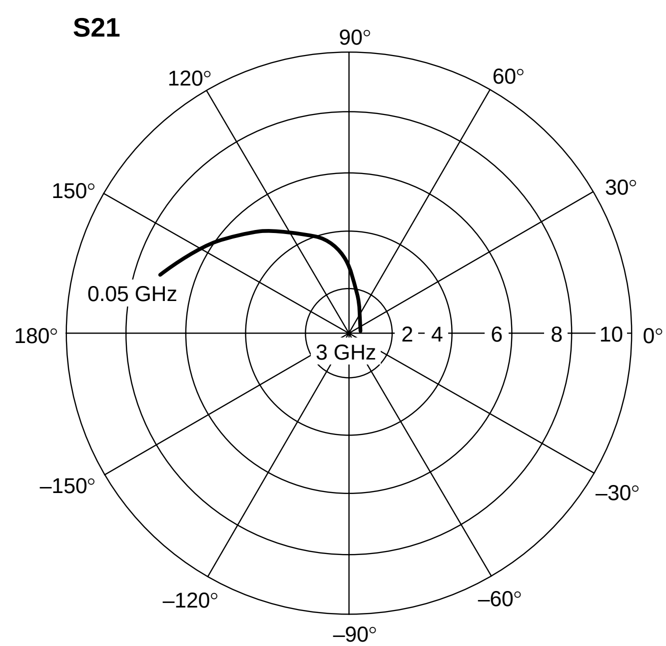


Figure 10. Forward Transmission Coefficient

V_{CE} = 3.0 V, I_C = 10 mA

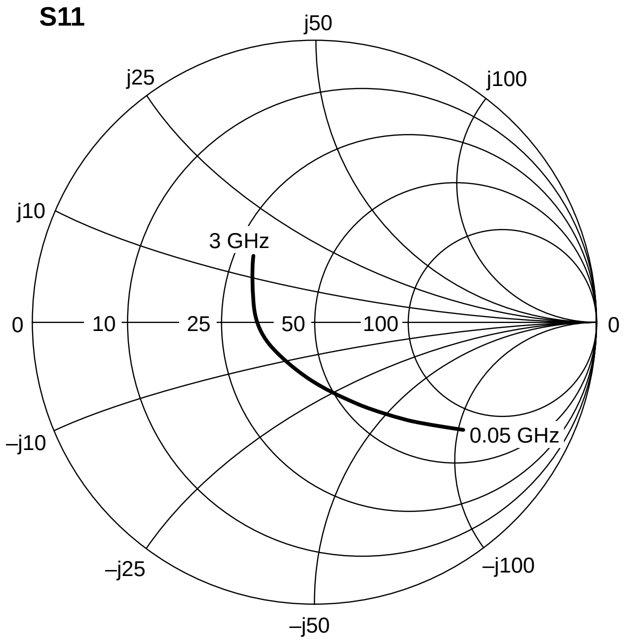


Figure 11. Input Reflection Coefficient

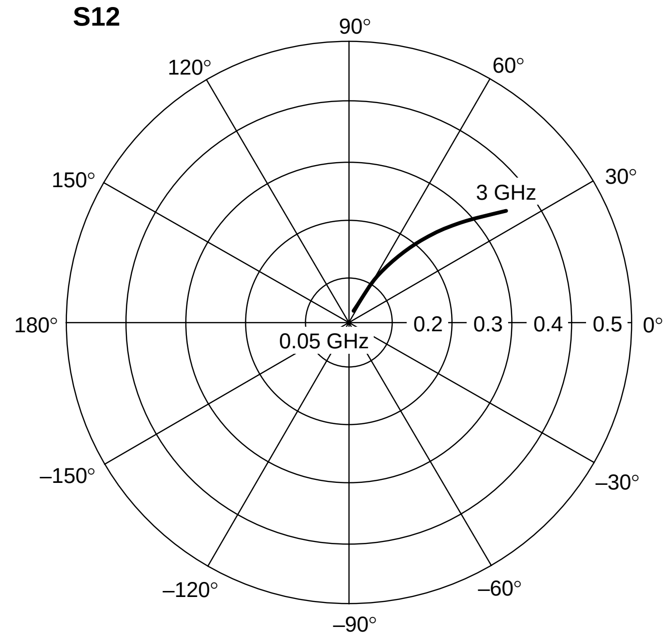


Figure 12. Reverse Transmission Coefficient

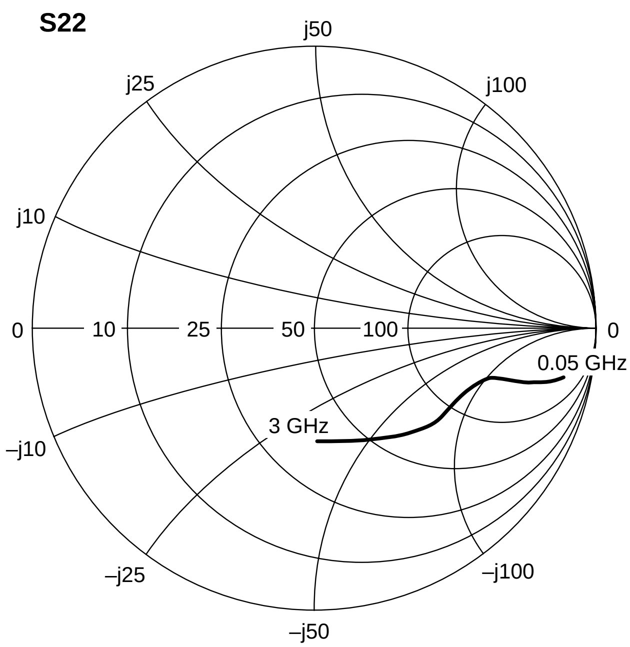


Figure 13. Output Reflection Coefficient

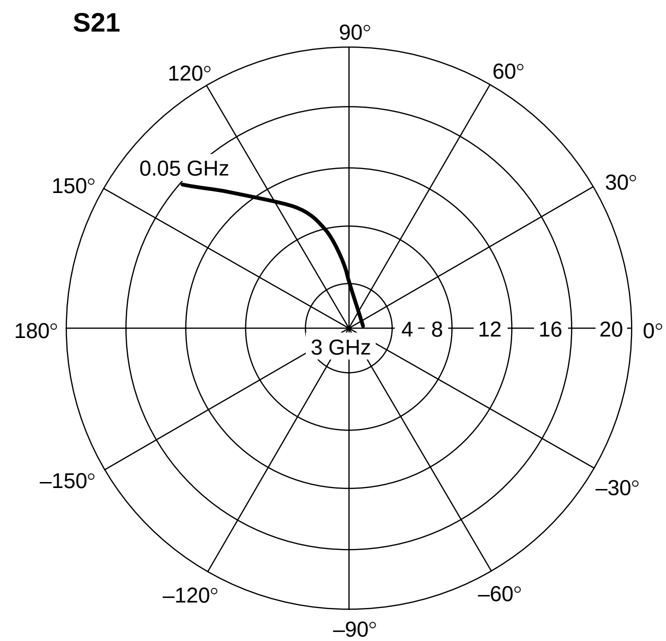


Figure 14. Forward Transmission Coefficient

TYPICAL COMMON BASE SCATTERING PARAMETER (T_A = 25°C)

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
V_{CE} = 2.5 V, I_C = 2.5 mA								
50	0.627	176.455	1.6218	–3.3808	0.003	81.692	1.006	–1.7455
100	0.626	172.821	1.6153	–6.8404	0.008	87.954	1.002	–3.5734
200	0.622	165.583	1.6042	–13.205	0.014	92.620	1.005	–6.7806
400	0.608	151.867	1.5630	–26.289	0.031	96.834	1.006	–13.779
600	0.589	138.455	1.5099	–39.579	0.052	96.285	1.016	–21.141
800	0.566	126.103	1.4461	–52.382	0.076	94.675	1.022	–28.553
1000	0.541	114.811	1.3613	–65.315	0.102	90.577	1.026	–36.519
1500	0.476	89.445	1.1404	–98.892	0.170	78.774	1.014	–57.448
2000	0.397	68.206	0.8928	–133.58	0.233	68.003	0.922	–77.708

TYPICAL COMMON BASE SCATTERING PARAMETER (T_A = 25°C)

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
V_{CE} = 3 V, I_C = 5 mA								
50	0.781	176.95	1.7732	–3.0425	0.004	85.472	1.006	–1.6658
100	0.780	174.093	1.7625	–5.9870	0.006	88.871	1.002	–3.5604
200	0.776	168.012	1.7622	–11.733	0.013	94.408	1.004	–6.7723
400	0.759	156.688	1.7285	–23.541	0.029	100.70	1.006	–13.627
600	0.743	145.893	1.6911	–35.161	0.047	100.93	1.015	–20.799
800	0.725	135.660	1.6441	–46.886	0.071	98.938	1.024	–28.057
1000	0.709	126.241	1.5817	–58.697	0.095	95.803	1.031	–35.921
1500	0.674	103.465	1.4275	–90.316	0.172	85.633	1.037	–56.915
2000	0.620	81.3686	1.1968	–123.89	0.249	73.589	0.957	–77.953

TYPICAL COMMON BASE SCATTERING PARAMETER (T_A = 25°C)

Freq	S11		S21		S12		S22	
MHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
V_{CE} = 3 V, I_C = 10 mA								
50	0.867	176.898	1.8601	–3.2938	0.004	88.195	1.006	–1.7132
100	0.863	173.941	1.8432	–6.3479	0.007	90.044	1.001	–3.6916
200	0.851	167.942	1.8370	–12.359	0.014	91.598	1.003	–6.9503
400	0.821	157.527	1.7814	–23.95	0.029	96.128	1.003	–13.909
600	0.795	148.933	1.7303	–34.993	0.045	97.955	1.011	–21.082
800	0.782	139.487	1.6831	–46.443	0.067	98.521	1.018	–28.456
1000	0.773	131.501	1.6327	–57.916	0.091	96.532	1.024	–36.296
1500	0.765	110.253	1.4975	–89.11	0.169	88.005	1.031	–57.462
2000	0.730	87.937	1.2711	–123.21	0.253	76.070	0.950	–78.777

V_{CE} = 2.5 V, I_C = 2.5 mA

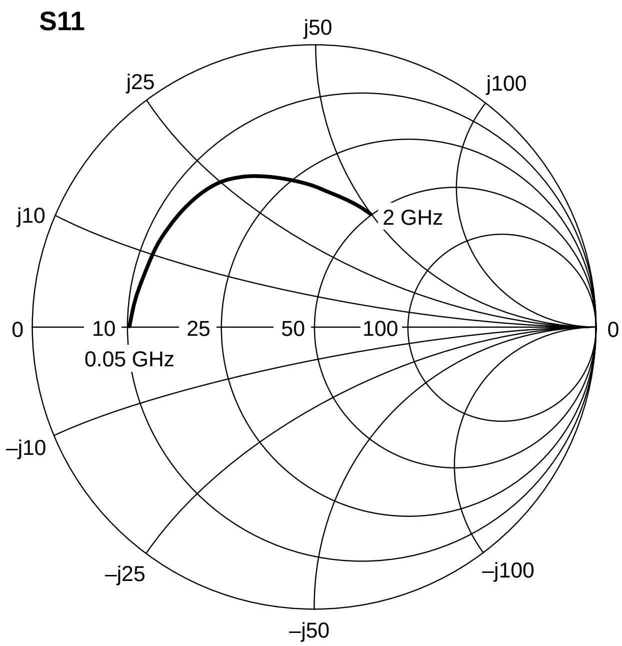


Figure 15. Input Reflection Coefficient

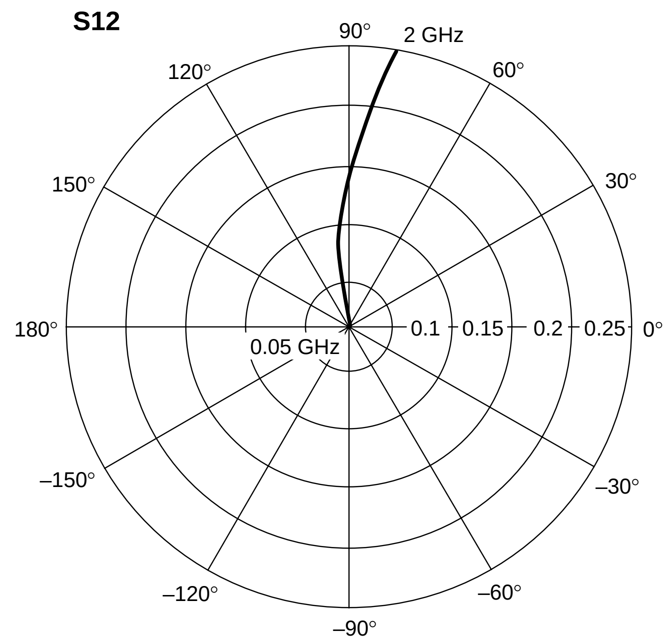


Figure 16. Reverse Transmission Coefficient

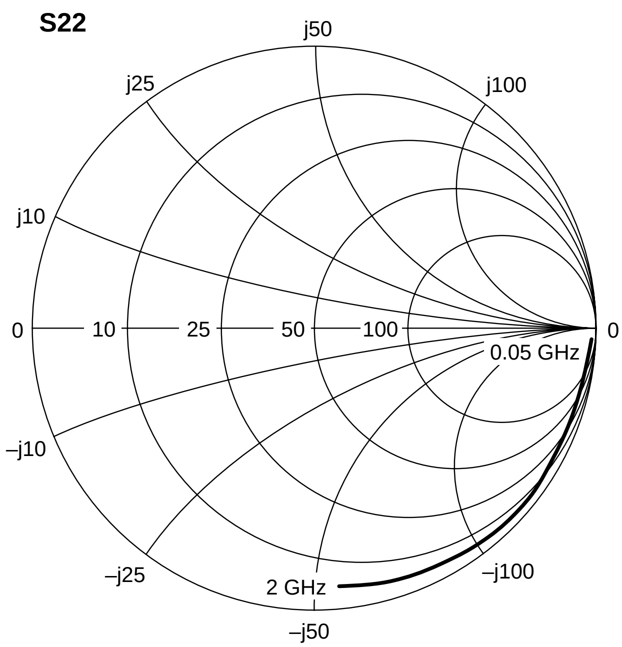


Figure 17. Output Reflection Coefficient

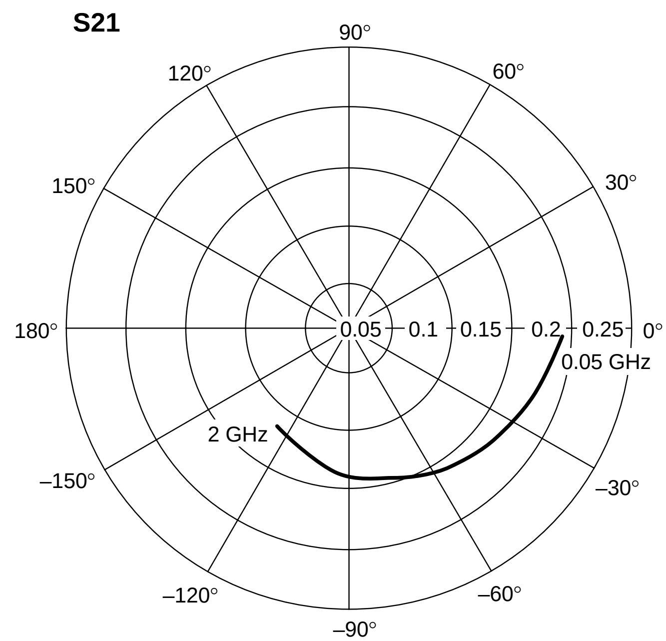


Figure 18. Forward Transmission Coefficient

NSL12TT1

Advance Information

High Current Surface Mount PNP Silicon Low $V_{CE(sat)}$ Transistor for Battery Operated Applications

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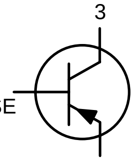
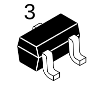
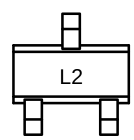
12 VOLTS
1.0 AMPS
PNP TRANSISTOR





CASE 463
SOT–416/SC–75
STYLE 1

DEVICE MARKING



L2 = Specific Device Code

ORDERING INFORMATION

Device	Package	Shipping
NSL12TT1	SOT–416	3000/Tape & Reel

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Collector-Emitter Voltage	V_{CEO}	–12	Vdc
Collector-Base Voltage	V_{CBO}	–20	Vdc
Emitter-Base Voltage	V_{EBO}	–4.0	Vdc
Collector Current – Peak – Continuous	I_C	–1.0 –0.5	Adc
Electrostatic Discharge	ESD	HBM Class 3B MM Class C	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (Note 1)	210 1.7	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (Note 1)	595	°C/W
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (Note 2)	365 2.9	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (Note 2)	340	°C/W
Thermal Resistance, Junction to Lead #3	$R_{\theta JL}$	205	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 X 1.0 inch Pad

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typical	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–12	–18	–	Vdc
Collector–Base Breakdown Voltage (I_C = –0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	–20	–28	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	–4.0	–7.0	–	Vdc
Collector Cutoff Current (V_{CB} = –12 Vdc, I_E = 0)	I_{CBO}	–	–0.03	–0.1	μAdc
Collector–Emitter Cutoff Current (V_{CES} = –9 Vdc)	I_{CES}	–	–0.03	–0.1	μAdc
Emitter Cutoff Current (V_{EB} = –4.0 Vdc)	I_{EBO}	–	–0.01	–0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain (Note 3.)	h_{FE}				
(I_C = –100 mA, V_{CE} = –1.0 V)		150	200	–	
(I_C = –100 mA, V_{CE} = –2.0 V)		150	200	–	
(I_C = –500 mA, V_{CE} = –2.0 V)		100	150	–	
Collector–Emitter Saturation Voltage (Note 3.)	$V_{CE(sat)}$				V
(I_C = –50 mA, I_B = –0.5 mA)		–	–0.070	–0.110	
(I_C = –100 mA, I_B = –1.0 mA)		–	–0.110	–0.150	
(I_C = –250 mA, I_B = –2.5 mA)		–	–0.190	–0.240	
(I_C = –250 mA, I_B = –5.0 mA)		–	–0.165	–	
(I_C = –500 mA, I_B = –5.0 mA)		–	–0.300	–0.370	
(I_C = –500 mA, I_B = –50 mA)		–	–0.210	–	
(I_C = –1.0 A, I_B = –100 mA)		–	–0.410	–	
Base–Emitter Saturation Voltage (Note 3.) (I_C = –150 mA, I_B = –20 mA)	$V_{BE(sat)}$	–	–0.81	–0.90	V
Base–Emitter Turn–on Voltage (Note 3.) (I_C = –150 mA, V_{CE} = –3.0 V)	$V_{BE(on)}$	–	–0.81	–0.875	V
Input Capacitance (V_{EB} = 0 V, f = 1.0 MHz)	C_{ibo}	–	52	–	pF
Output Capacitance (V_{CB} = 0 V, f = 1.0 MHz)	C_{obo}	–	30	–	pF
Turn–On Time (I_{BI} = –50 mA, I_C = –500 mA, R_L = 3.0 Ω)	t_{on}	–	50	–	ns
Turn–Off Time (I_{B1} = I_{B2} = –50 mA, I_C = –500 mA, R_L = 3.0 Ω)	t_{off}	–	80	–	ns

3. Pulsed Condition: Pulse Width = 300 μsec, Duty Cycle ≤ 2%

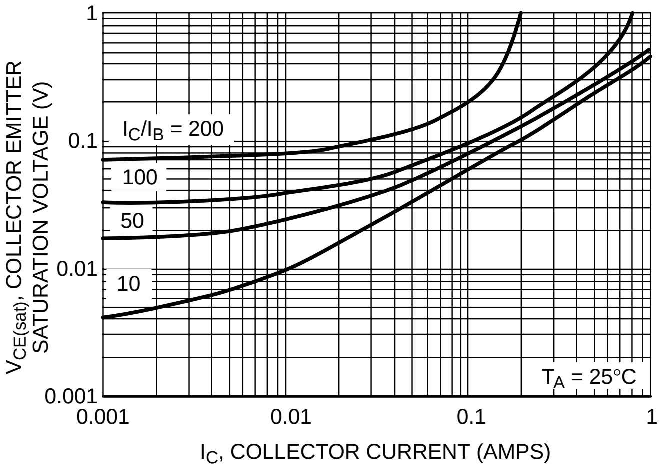


Figure 1. Collector Emitter Saturation Voltage vs. Collector Current

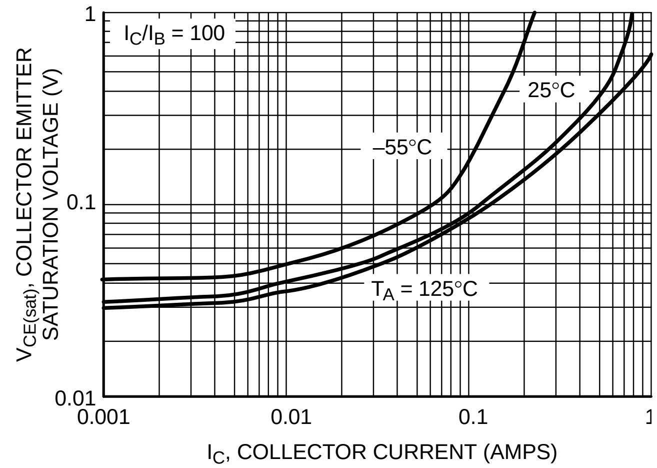


Figure 2. Collector Emitter Saturation Voltage vs. Collector Current

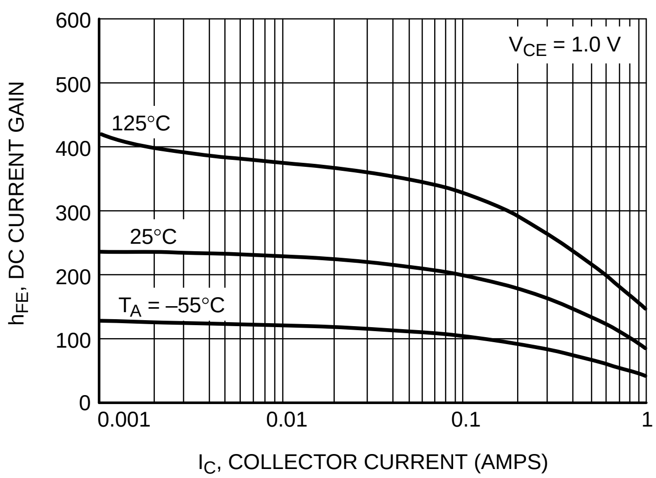


Figure 3. DC Current Gain

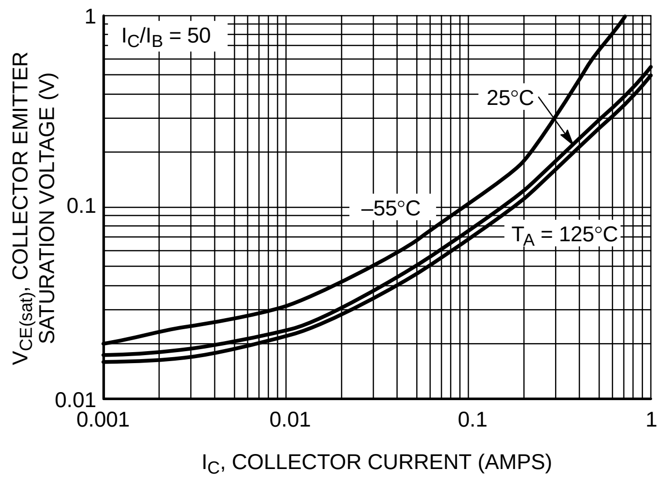


Figure 4. Collector Emitter Saturation Voltage vs. Collector Current

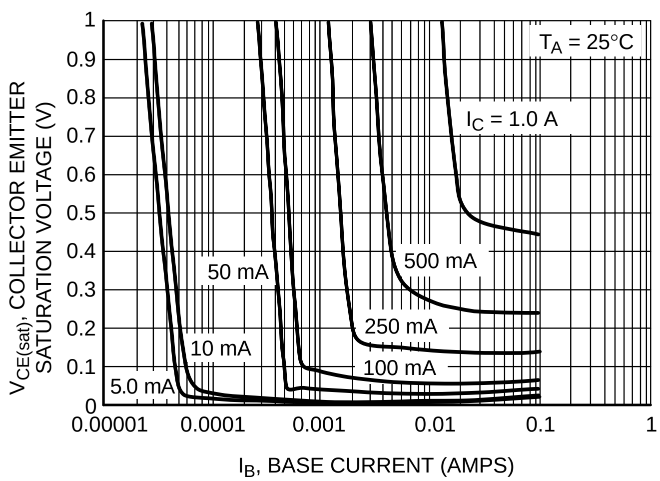


Figure 5. Collector Emitter Saturation Voltage vs Base Current

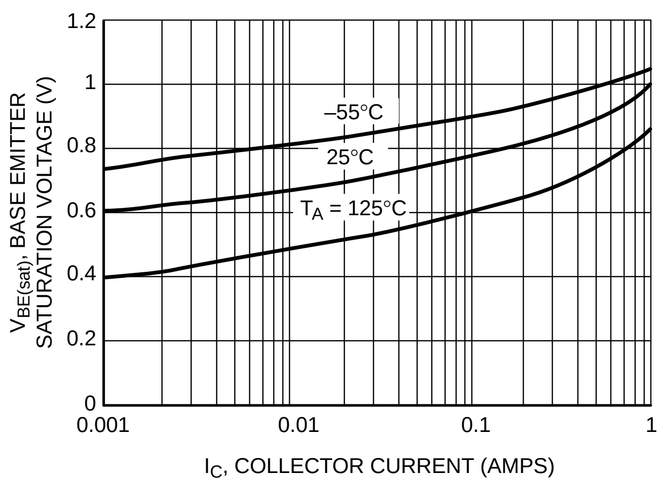


Figure 6. Base Emitter Saturation Voltage vs. Collector Current

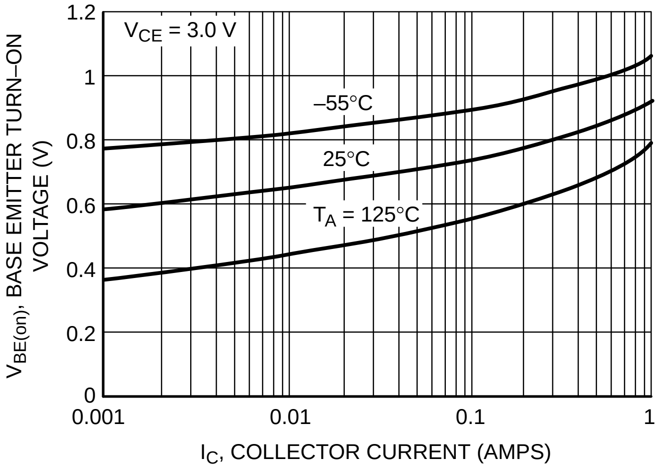


Figure 7. Base Emitter Turn−On Voltage vs. Collector Current

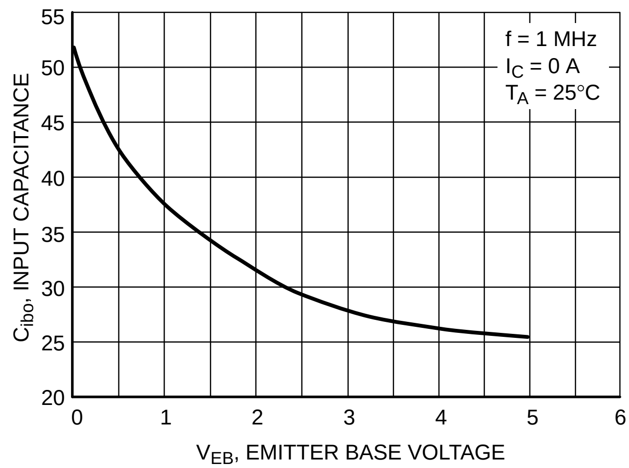


Figure 8. Input Capacitance

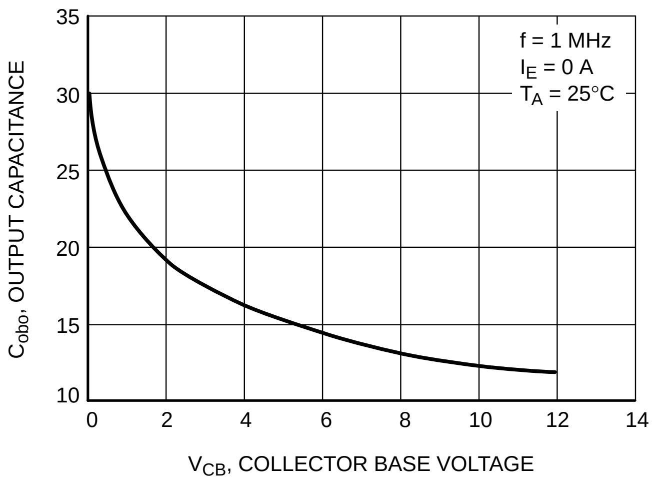


Figure 9. Output Capacitance

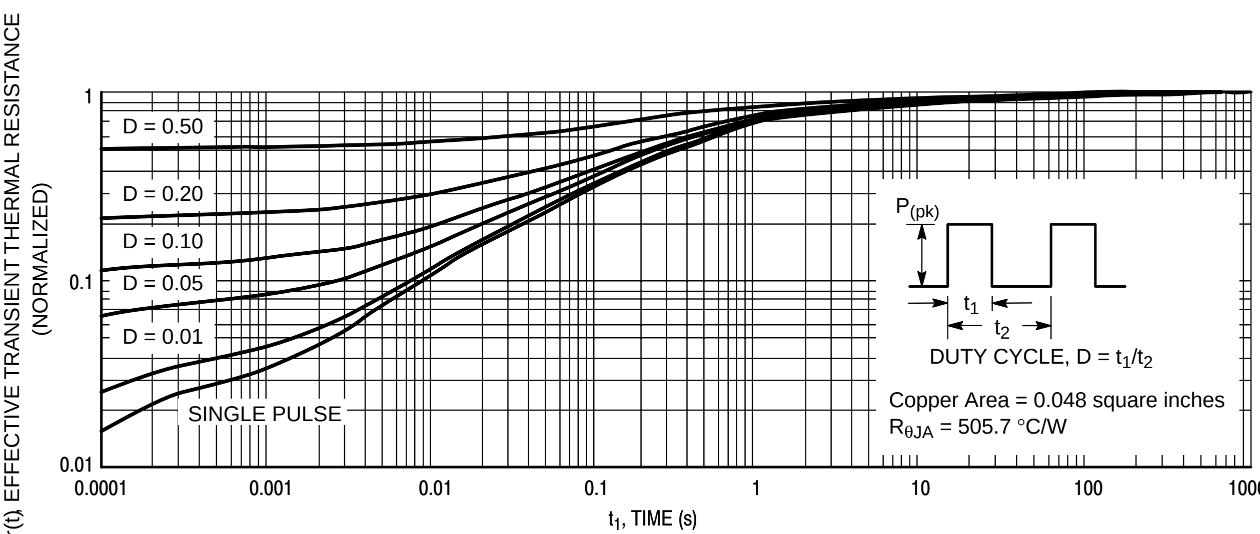


Figure 10. Normalized Thermal Response

NSL35TT1

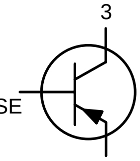
Advance Information

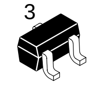
High Current Surface Mount PNP Silicon Low $V_{CE(sat)}$ Transistor for Battery Operated Applications

ON Semiconductor™

http://onsemi.com

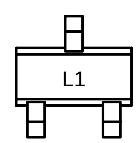
35 VOLTS
1.0 AMPS
PNP TRANSISTOR





CASE 463
SOT–416/SC–75
STYLE 1

DEVICE MARKING



L1 = Specific Device Code

ORDERING INFORMATION

Device	Package	Shipping
NSL35TT1	SOT–416	3000/Tape & Reel

MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Collector-Emitter Voltage	V_{CEO}	–35	Vdc
Collector-Base Voltage	V_{CBO}	–50	Vdc
Emitter-Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current – Peak – Continuous	I_C	–1.0 –500	Adc mAdc
Electrostatic Discharge	ESD	HBM Class 3B MM Class C	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (Note 1)	210 1.7	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (Note 1)	595	°C/W
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (Note 2)	365 2.9	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (Note 2)	340	°C/W
Thermal Resistance, Junction to Lead #3	$R_{\theta JL}$	205	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 X 1.0 inch Pad

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typical	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–35	–45	–	Vdc
Collector–Base Breakdown Voltage (I_C = –0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	–50	–65	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	–7.0	–	Vdc
Collector Cutoff Current (V_{CB} = –35 Vdc, I_E = 0)	I_{CBO}	–	–0.03	–0.1	μAdc
Collector–Emitter Cutoff Current (V_{CES} = –30 Vdc)	I_{CES}	–	–0.03	–0.1	μAdc
Emitter Cutoff Current (V_{EB} = –4.0 Vdc)	I_{EBO}	–	–0.01	–0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain (Note 4.) (I_C = –100 mA, V_{CE} = –1.0 V) (I_C = –100 mA, V_{CE} = –2.0 V) (I_C = –250 mA, V_{CE} = –2.0 V)	h_{FE}	 100 100 100	 180 180 150	 – – –	
Collector–Emitter Saturation Voltage (Note 4.) (I_C = –50 mA, I_B = –0.5 mA) (I_C = –100 mA, I_B = –1.0 mA) (I_C = –250 mA, I_B = –2.5 mA) (I_C = –250 mA, I_B = –5.0 mA) (I_C = –500 mA, I_B = –50 mA)	$V_{CE(sat)}$	 – – – – –	 –0.090 –0.200 –0.320 –0.170 –0.270	 –0.130 –0.350 –0.450 – –0.350	V
Base–Emitter Saturation Voltage (Note 4.) (I_C = –150 mA, I_B = –20 mA)	$V_{BE(sat)}$	–	–0.81	–0.9	V
Base–Emitter Turn–on Voltage (Note 4.) (I_C = –150 mA, V_{CE} = –3.0 V)	$V_{BE(on)}$	–	–0.81	–0.875	V
Input Capacitance (V_{EB} = 0 V, f = 1.0 MHz)	C_{ibo}	–	45	–	pF
Output Capacitance (V_{CB} = 0 V, f = 1.0 MHz)	C_{obo}	–	18	–	pF
Turn–On Time (I_{BI} = –50 mA, I_C = –500 mA, R_L = 3.0 Ω)	t_{on}	–	40	–	ns
Turn–Off Time (I_{B1} = I_{B2} = –50 mA, I_C = –500 mA, R_L = 3.0 Ω)	t_{off}	–	70	–	ns

4. Pulsed Condition: Pulse Width = 300 μsec, Duty Cycle ≤ 2%

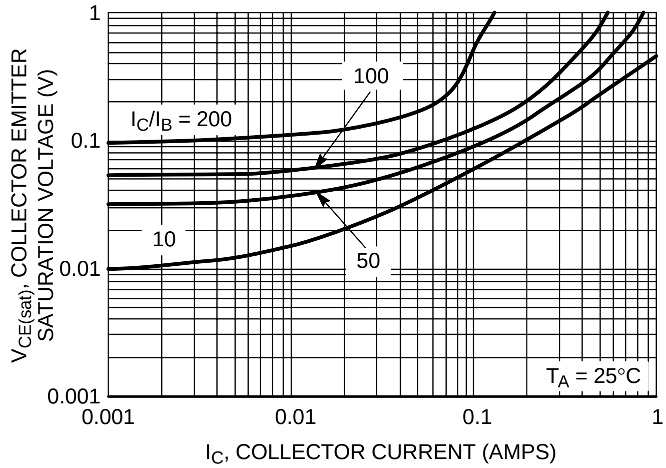


Figure 1. Collector Emitter Saturation Voltage vs. Collector Current

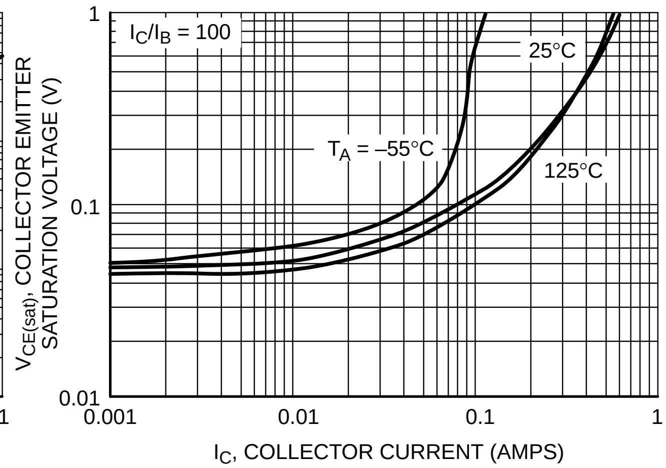


Figure 2. Collector Emitter Saturation Voltage vs. Collector Current

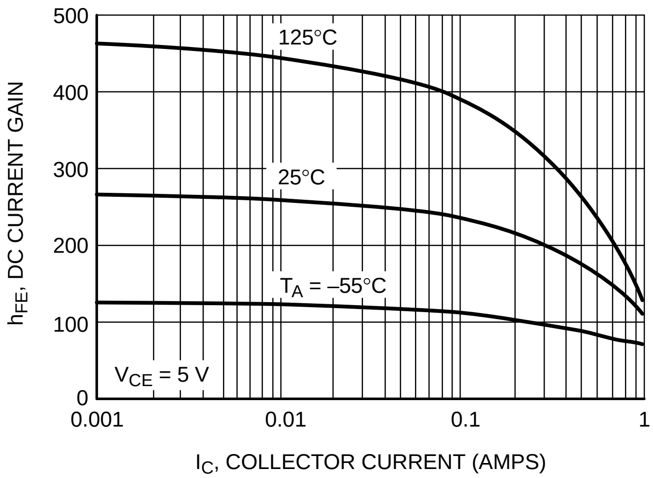


Figure 3. DC Current Gain

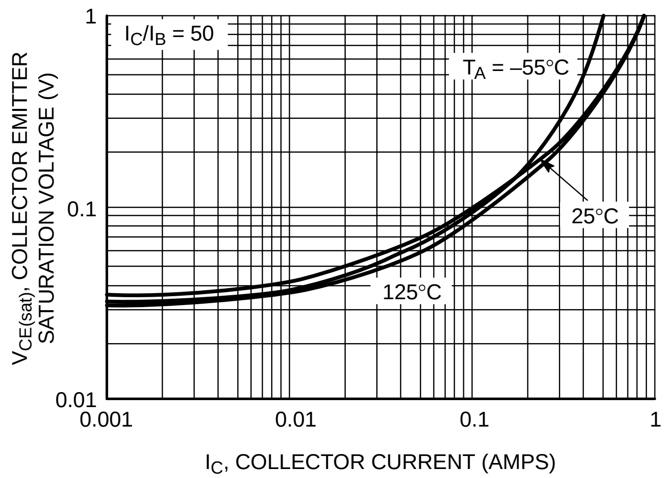


Figure 4. Collector Emitter Saturation Voltage vs. Collector Current

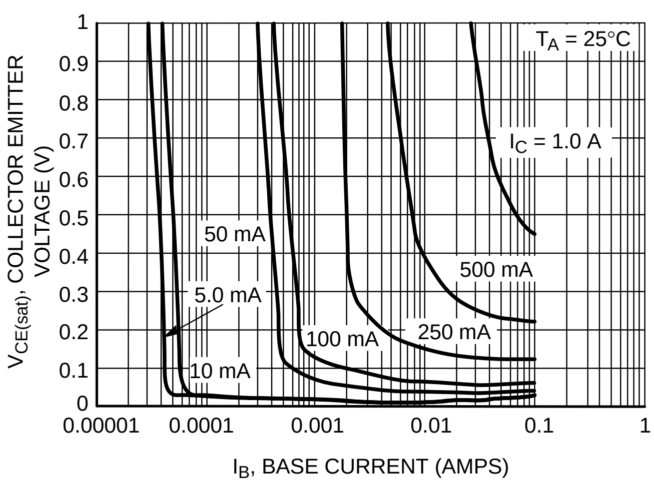


Figure 5. Collector Emitter Saturation Voltage vs. Base Current

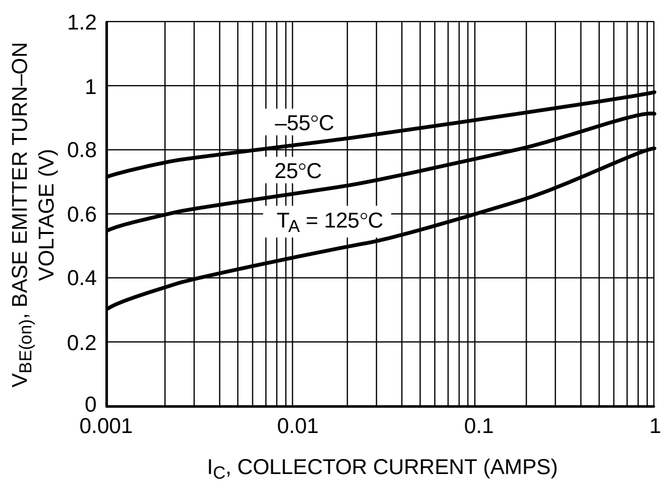


Figure 6. Base Emitter Saturation Voltage vs. Collector Current

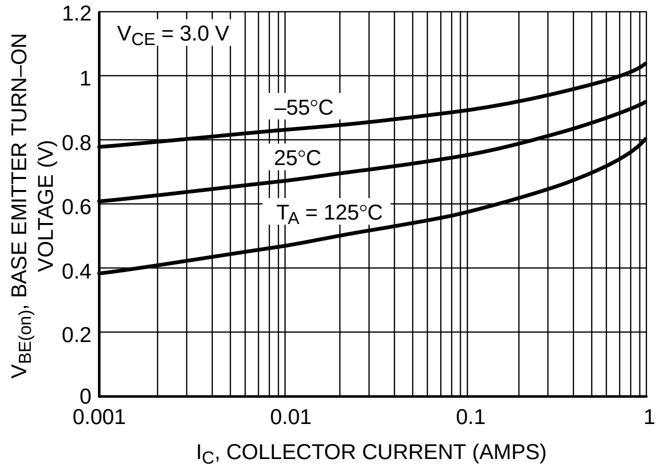


Figure 7. Base Emitter Turn−On Voltage vs. Collector Current

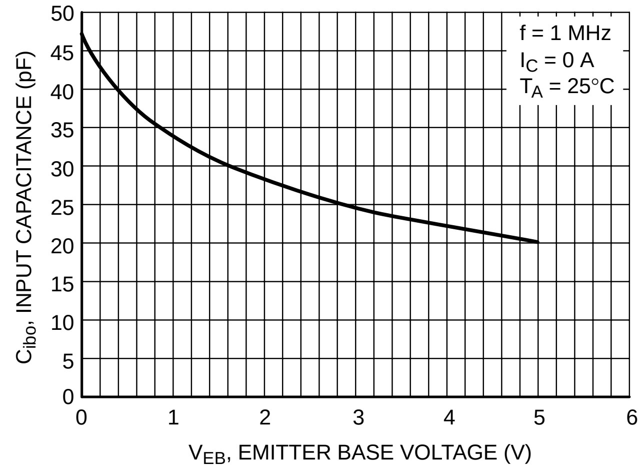


Figure 8. Input Capacitance

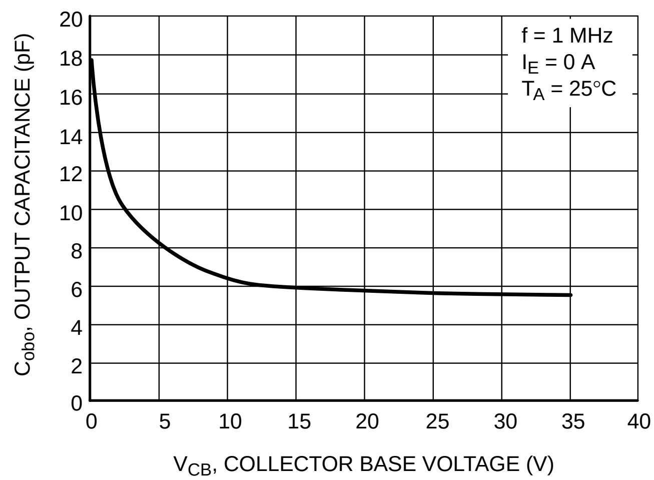


Figure 9. Output Capacitance

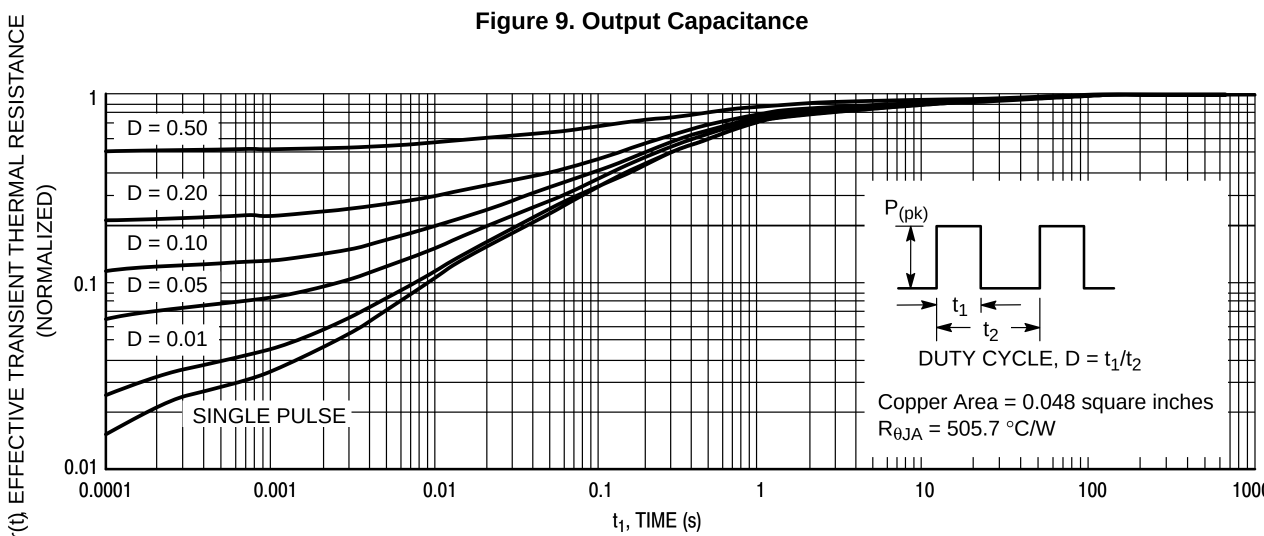


Figure 10. Normalized Thermal Response

NSL5TT1

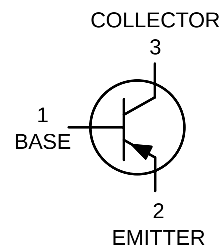
Advance Information

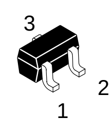
High Current Surface Mount PNP Silicon Switching Transistor for Load Management in Portable Applications

ON Semiconductor™

http://onsemi.com

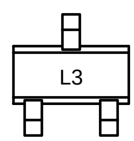
5 VOLTS
1.0 AMPS
PNP TRANSISTOR





CASE 463
SOT–416/SC–75
STYLE 1

DEVICE MARKING



MAXIMUM RATINGS (T_A = 25°C)

Rating	Symbol	Max	Unit
Collector-Emitter Voltage	V_{CEO}	–5.0	Vdc
Collector-Base Voltage	V_{CBO}	–10	Vdc
Emitter-Base Voltage	V_{EBO}	–4.0	Vdc
Collector Current – Peak – Continuous	I_C	–1.0 –0.5	Adc
Electrostatic Discharge	ESD	HBM Class 3 MM Class C	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (Note 1.)	210 1.7	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (Note 1.)	595	°C/W
Total Device Dissipation T_A = 25°C Derate above 25°C	P_D (Note 2.)	365 2.9	mW mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (Note 2.)	340	°C/W
Thermal Resistance, Junction to Lead #3	$R_{\theta JL}$	205	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

1. FR–4 @ Minimum Pad
2. FR–4 @ 1.0 X 1.0 inch Pad

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ORDERING INFORMATION

Device	Package	Shipping
NSL5TT1	SOT–416	3000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typical	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–5.0	–9.0	–	Vdc
Collector–Base Breakdown Voltage (I_C = –0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	–10	–15	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	–4.0	–7.0	–	Vdc
Collector Cutoff Current (V_{CB} = –5.0 Vdc, I_E = 0)	I_{CBO}	–	–0.03	–0.1	μAdc
Collector–Emitter Cutoff Current (V_{CES} = –5.0 Vdc)	I_{CES}	–	–0.03	–0.1	μAdc
Emitter Cutoff Current (V_{EB} = –4.0 Vdc)	I_{EBO}	–	–0.01	–0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain (Note 3.) (I_C = –10 mA, V_{CE} = –1.0 V) (I_C = –150 mA, V_{CE} = –2.0 V) (I_C = –500 mA, V_{CE} = –2.0 V)	h_{FE}	 100 100 100	 250 250 200	 – – –	
Collector–Emitter Saturation Voltage (Note 3.) (I_C = –50 mA, I_B = –0.5 mA) (I_C = –100 mA, I_B = –1.0 mA) (I_C = –250 mA, I_B = –2.5 mA) (I_C = –250 mA, I_B = –5.0 mA) (I_C = –500 mA, I_B = –5.0 mA) (I_C = –500 mA, I_B = –50 mA) (I_C = –1.0 A, I_B = –100 mA)	$V_{CE(sat)}$	 – – – – – – –	 –0.050 –0.080 –0.130 –0.110 –0.240 –0.180 –0.340	 – – – – – – –	V
Base–Emitter Saturation Voltage (Note 3.) (I_C = –150 mA, I_B = –20 mA)	$V_{BE(sat)}$	–	–0.81	–0.9	V
Base–Emitter Turn–on Voltage (Note 3.) (I_C = –150 mA, V_{CE} = –3.0 V)	$V_{BE(on)}$	–	–0.81	–0.875	V

3. Pulsed Condition: Pulse Width = 300 μsec, Duty Cycle ≤ 2%

Amplifier Transistors
NPN Silicon

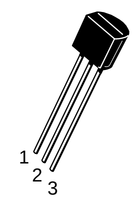
P2N2222A

MAXIMUM RATINGS

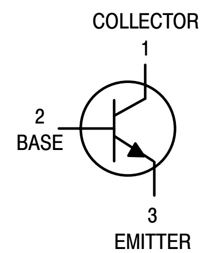
Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	40	Vdc
Collector–Base Voltage	V_{CBO}	75	Vdc
Emitter–Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W



CASE 29–11, STYLE 17
TO–92 (TO–226AA)



ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	75	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	I_{CEX}	—	10	nAdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 60 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	 — —	 0.01 10	μAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	10	nAdc
Collector Cutoff Current (V_{CE} = 10 V)	I_{CEO}	—	10	nAdc
Base Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	I_{BEX}	—	20	nAdc

March, 2001 – Rev. 1

Publication Order Number:
P2N2222A/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)		35	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		50	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		75	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = –55°C)		35	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)(1)		100	300	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)(1)		50	—	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)(1)		40	—	
Collector–Emitter Saturation Voltage(1)	$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)		—	0.3	
(I_C = 500 mAdc, I_B = 50 mAdc)		—	1.0	
Base–Emitter Saturation Voltage(1)	$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)		0.6	1.2	
(I_C = 500 mAdc, I_B = 50 mAdc)		—	2.0	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product(2) (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	300	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	25	pF
Input Impedance	h_{ie}			kΩ
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		2.0	8.0	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		0.25	1.25	
Voltage Feedback Ratio	h_{re}			X 10^{-4}
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		—	8.0	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		—	4.0	
Small–Signal Current Gain	h_{fe}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		50	300	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		75	375	
Output Admittance	h_{oe}			μmhos
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		5.0	35	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		25	200	
Collector Base Time Constant (I_E = 20 mAdc, V_{CB} = 20 Vdc, f = 31.8 MHz)	$rb'C_c$	—	150	ps
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)	N_F	—	4.0	dB
SWITCHING CHARACTERISTICS				
Delay Time — (V_{CC} = 30 Vdc, $V_{BE(off)}$ = –2.0 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figure 1)	t_d	—	10	ns
Rise Time — (V_{CC} = 30 Vdc, $V_{BE(off)}$ = –2.0 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figure 1)	t_r	—	25	ns
Storage Time — (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 2)	t_s	—	225	ns
Fall Time — (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 2)	t_f	—	60	ns

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
2. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

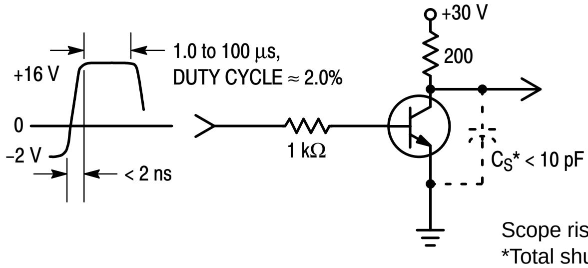


Figure 1. Turn–On Time

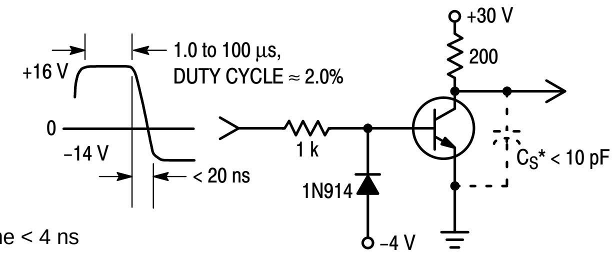


Figure 2. Turn–Off Time

Scope rise time < 4 ns
*Total shunt capacitance of test jig, connectors, and oscilloscope.

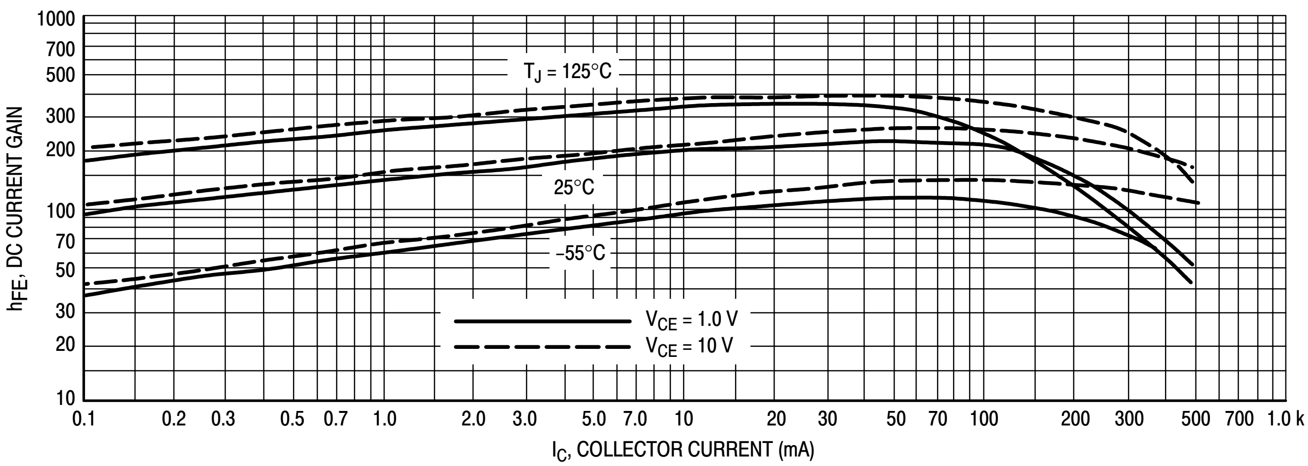


Figure 3. DC Current Gain

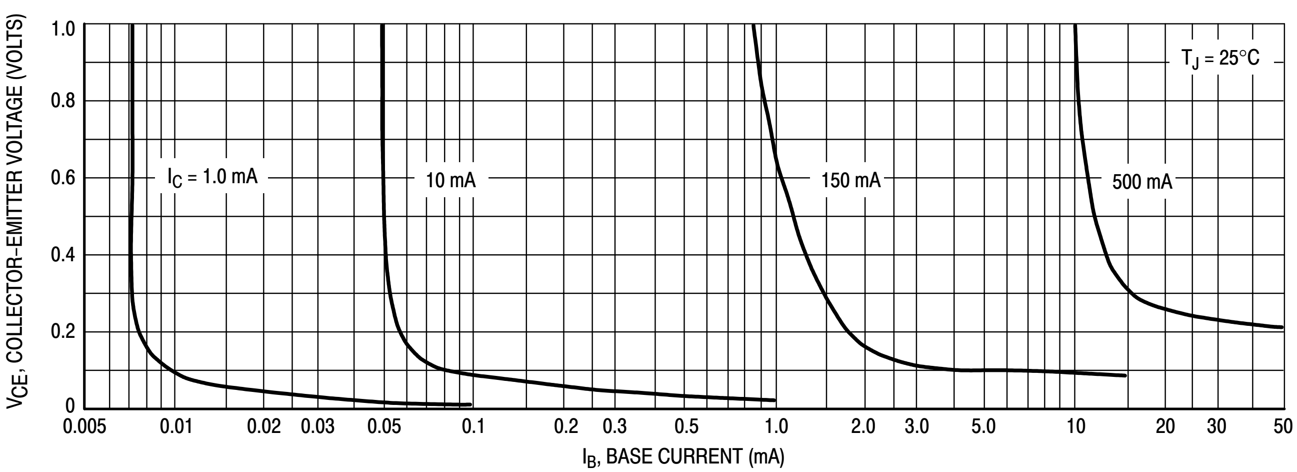


Figure 4. Collector Saturation Region

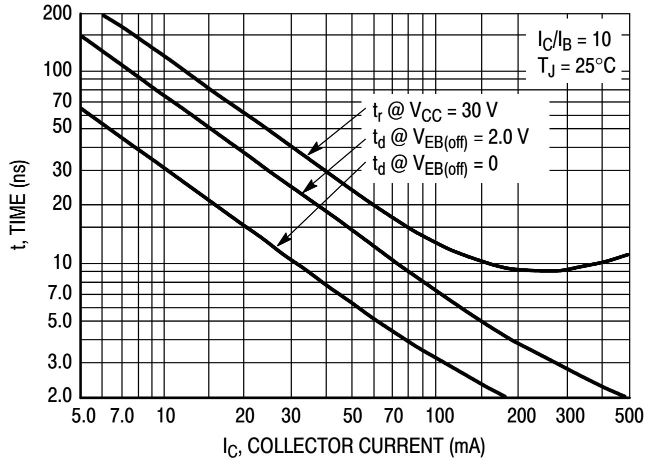


Figure 5. Turn−On Time

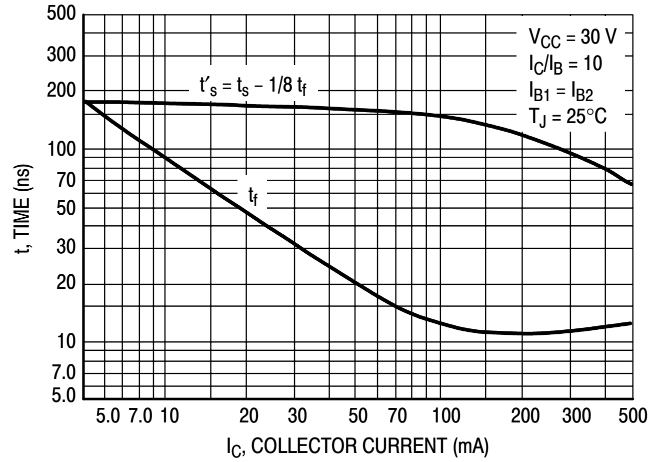


Figure 6. Turn−Off Time

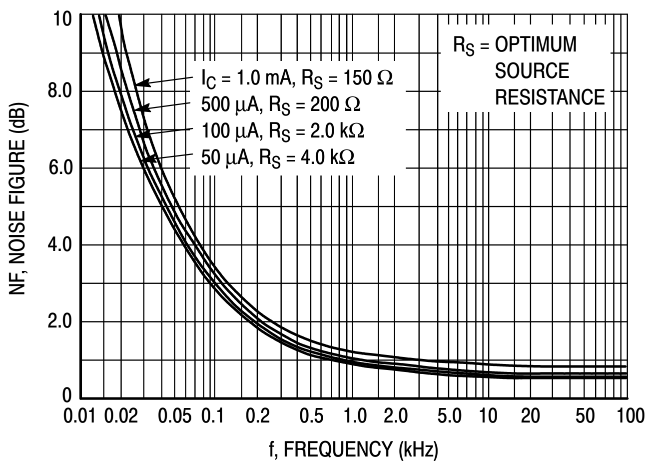


Figure 7. Frequency Effects

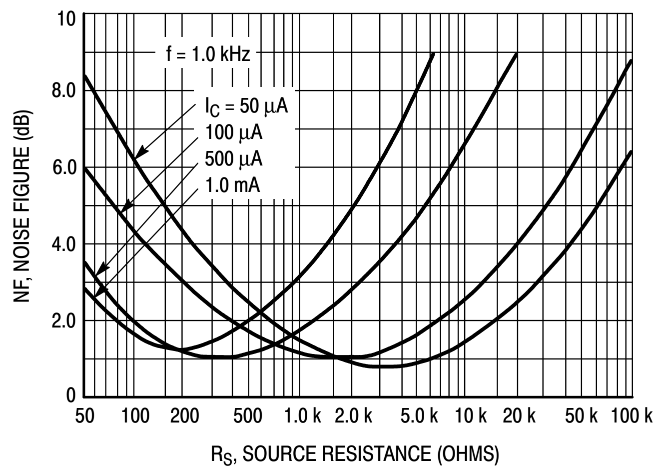


Figure 8. Source Resistance Effects

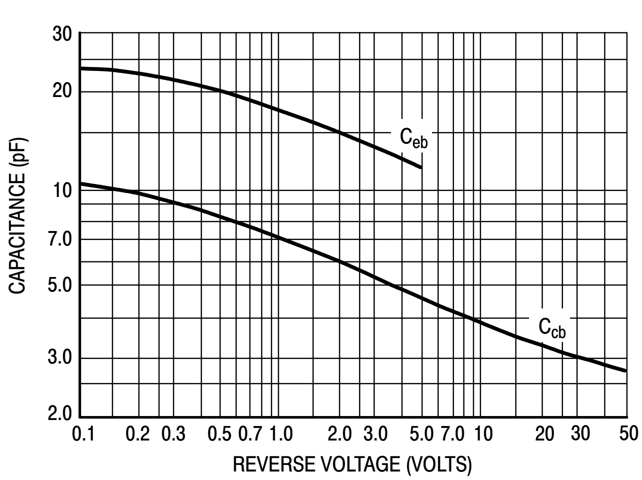


Figure 9. Capacitances

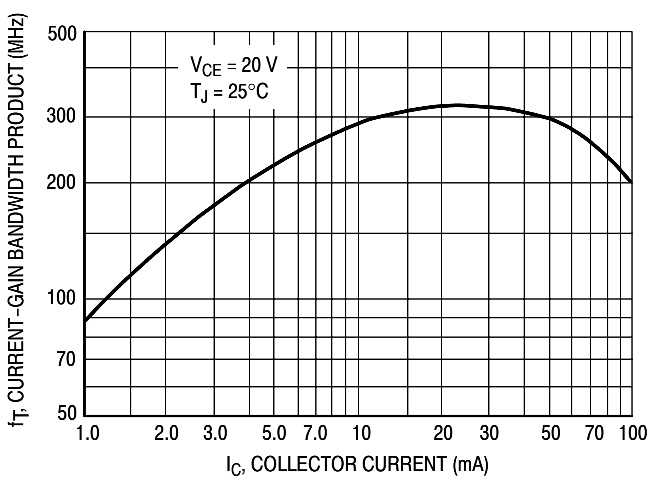


Figure 10. Current−Gain Bandwidth Product

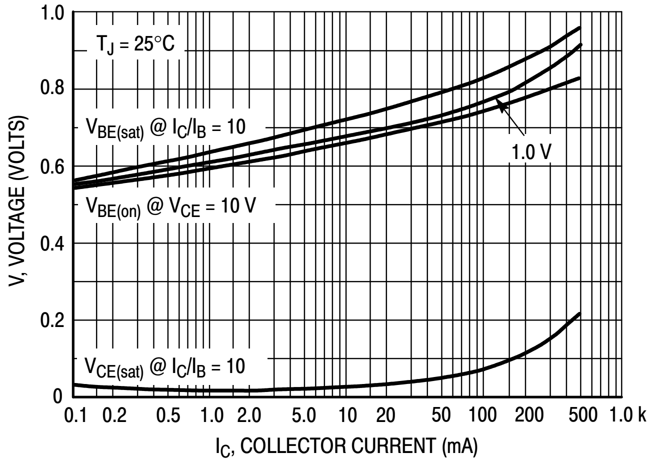


Figure 11. "On" Voltages

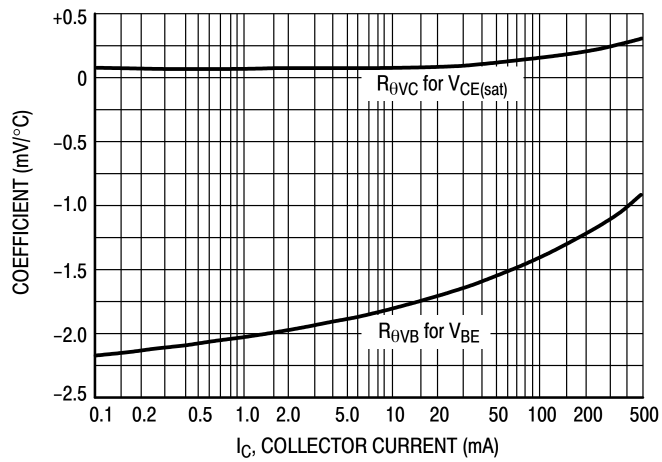
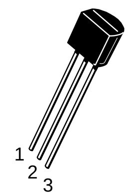


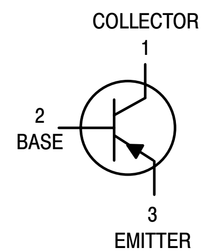
Figure 12. Temperature Coefficients

Amplifier Transistor
PNP Silicon

P2N2907A



CASE 29–11, STYLE 17
TO–92 (TO–226AA)



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–60	Vdc
Collector–Base Voltage	V_{CBO}	–60	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current — Continuous	I_C	–600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage(1) (I_C = –10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–60	—	Vdc
Collector–Base Breakdown Voltage (I_C = –10 μAdc, I_E = 0)	$V_{(BR)CBO}$	–60	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	Vdc
Collector Cutoff Current (V_{CE} = –30 Vdc, $V_{EB(off)}$ = –0.5 Vdc)	I_{CEX}	—	–50	nAdc
Collector Cutoff Current (V_{CB} = –50 Vdc, I_E = 0) (V_{CB} = –50 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	 — —	 –0.01 –10	μAdc
Emitter Cutoff Current (V_{EB} = –3.0 Vdc)	I_{EBO}	—	–10	nAdc
Collector Cutoff Current (V_{CE} = –10 V)	I_{CEO}	—	–10	nAdc
Base Cutoff Current (V_{CE} = –30 Vdc, $V_{EB(off)}$ = –0.5 Vdc)	I_{BEX}	—	–50	nAdc

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = –0.1 mAdc, V_{CE} = –10 Vdc)		75	—	
(I_C = –1.0 mAdc, V_{CE} = –10 Vdc)		100	—	
(I_C = –10 mAdc, V_{CE} = –10 Vdc)		100	—	
(I_C = –150 mAdc, V_{CE} = –10 Vdc)(1)		100	300	
(I_C = –500 mAdc, V_{CE} = –10 Vdc)(1)		50	—	
Collector–Emitter Saturation Voltage(1)	$V_{CE(sat)}$			Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)		—	–0.4	
(I_C = –500 mAdc, I_B = –50 mAdc)		—	–1.6	
Base–Emitter Saturation Voltage(1)	$V_{BE(sat)}$			Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)		—	–1.3	
(I_C = –500 mAdc, I_B = –50 mAdc)		—	–2.6	
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain — Bandwidth Product(1), (2) (I_C = –50 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)	f_T	200	—	MHz
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	8.0	pF
Input Capacitance (V_{EB} = –2.0 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	30	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Turn–On Time	(V_{CC} = –30 Vdc, I_C = –150 mAdc, I_{B1} = –15 mAdc) (Figures 1 and 5)	t_{on}	—	50	ns
Delay Time		t_d	—	10	ns
Rise Time		t_r	—	40	ns
Turn–Off Time	(V_{CC} = –6.0 Vdc, I_C = –150 mAdc, I_{B1} = I_{B2} = –15 mAdc) (Figure 2)	t_{off}	—	110	ns
Storage Time		t_s	—	80	ns
Fall Time		t_f	—	30	ns

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
2. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

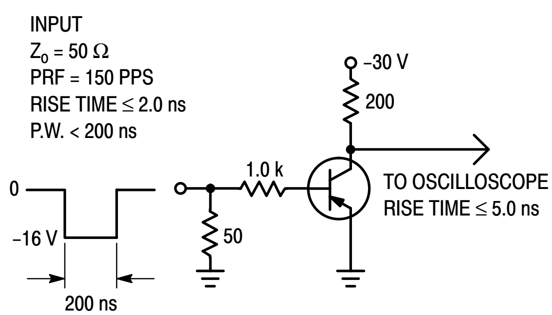


Figure 1. Delay and Rise Time Test Circuit

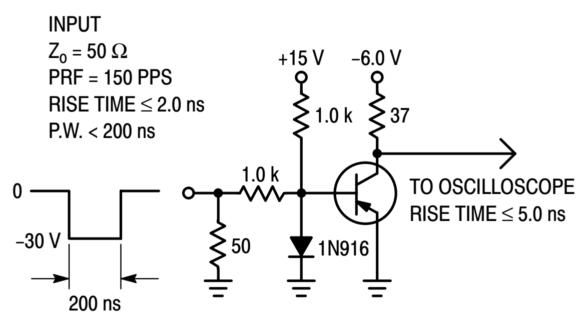


Figure 2. Storage and Fall Time Test Circuit

TYPICAL CHARACTERISTICS

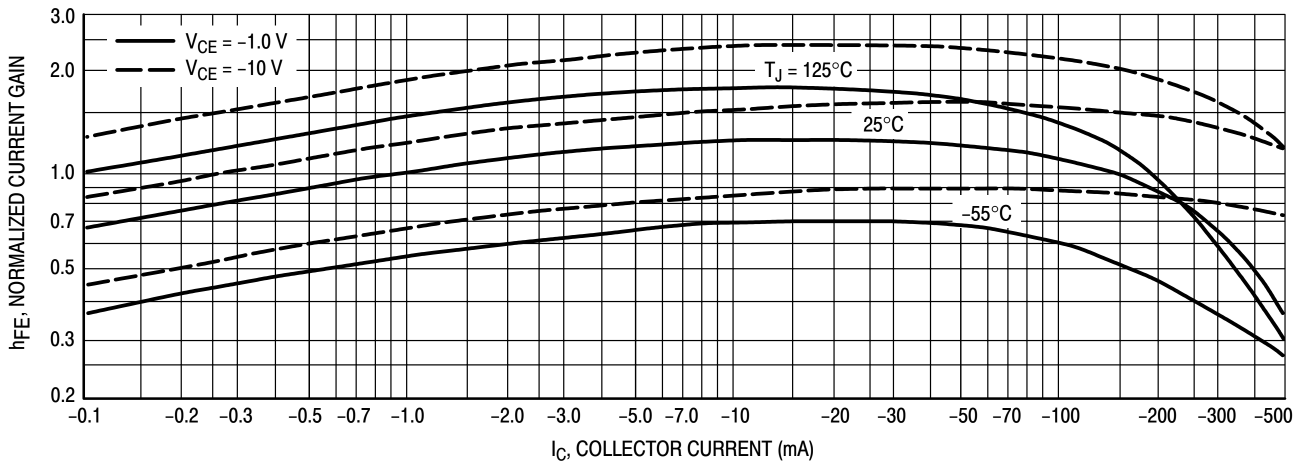


Figure 3. DC Current Gain

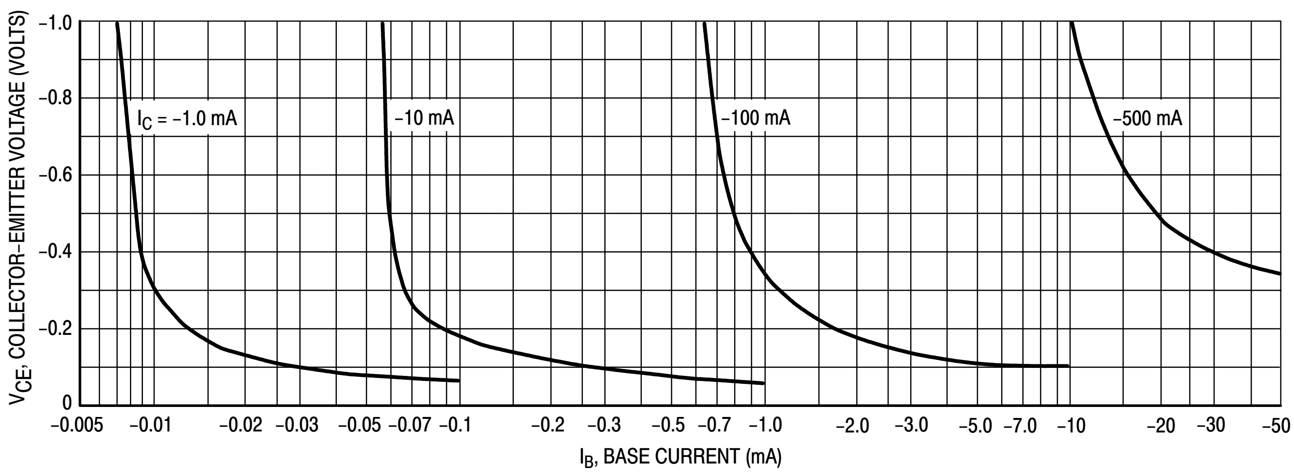


Figure 4. Collector Saturation Region

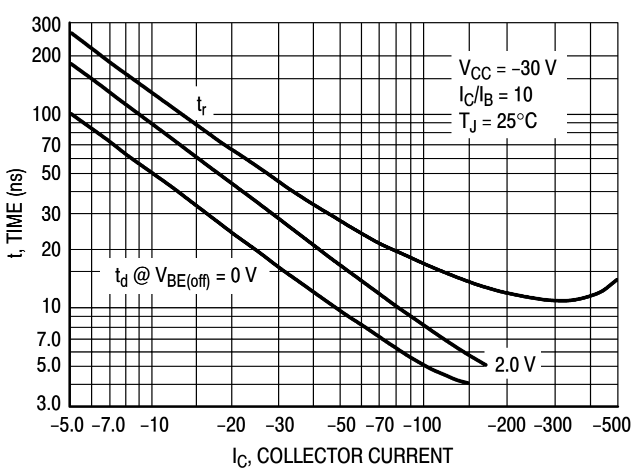


Figure 5. Turn–On Time

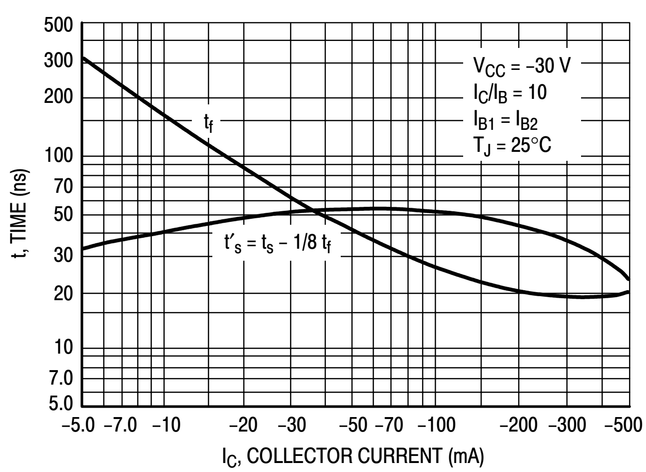


Figure 6. Turn–Off Time

TYPICAL SMALL–SIGNAL CHARACTERISTICS

NOISE FIGURE

V_{CE} = 10 Vdc, T_A = 25°C

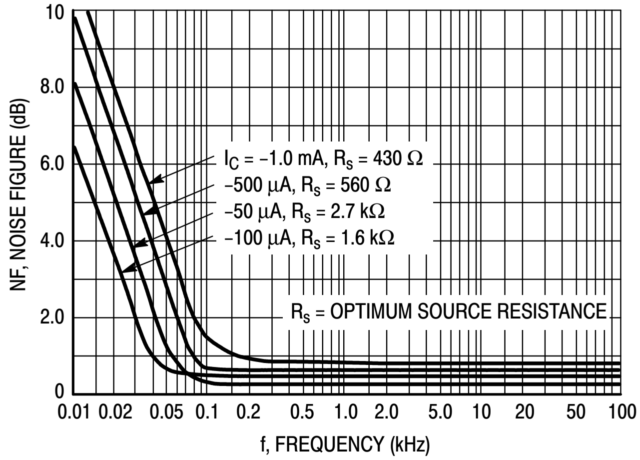


Figure 7. Frequency Effects

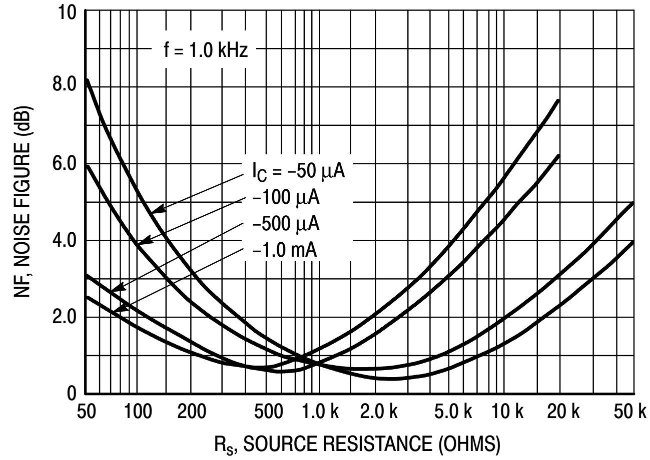


Figure 8. Source Resistance Effects

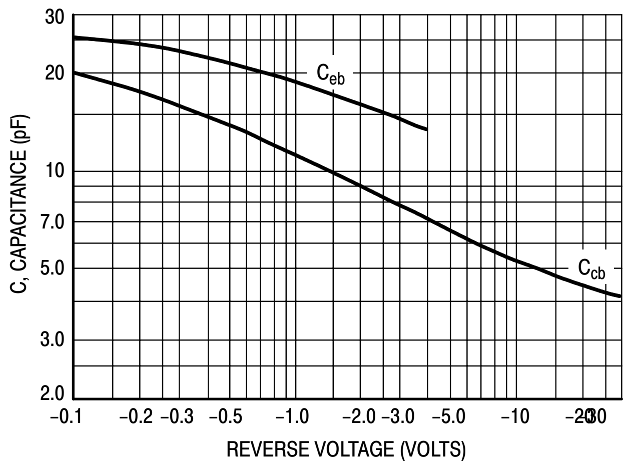


Figure 9. Capacitances

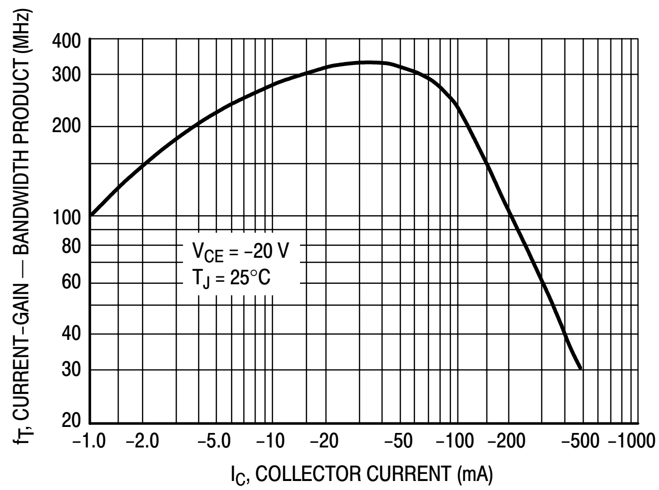


Figure 10. Current–Gain — Bandwidth Product

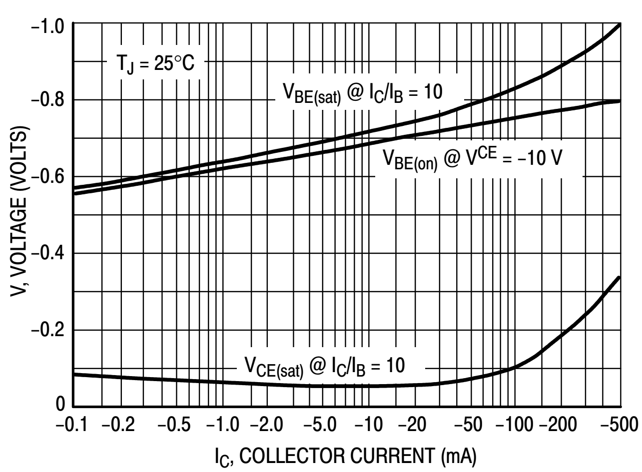


Figure 11. “On” Voltage

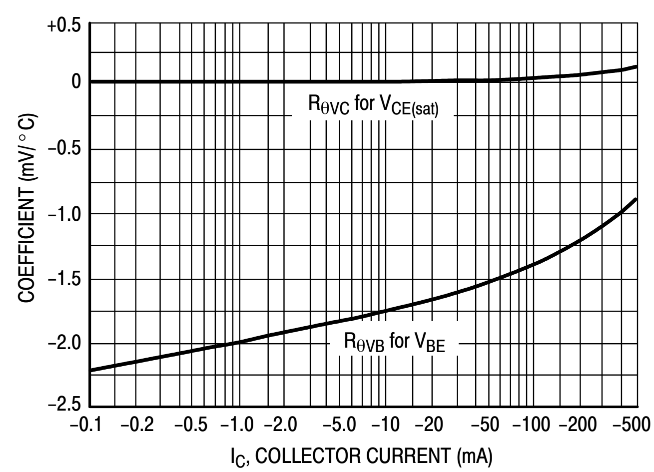
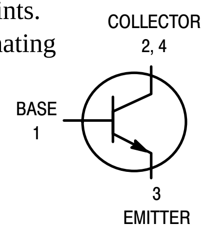


Figure 12. Temperature Coefficients

NPN Silicon Planar Epitaxial Transistor

This NPN Silicon Epitaxial transistor is designed for use in linear and switching applications. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

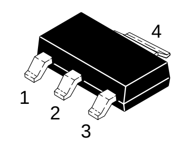
- PNP Complement is PZT2907AT1
- The SOT-223 package can be soldered using wave or reflow.
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die.
- Available in 12 mm tape and reel
  Use PZT2222AT1 to order the 7 inch/1000 unit reel.
  Use PZT2222AT3 to order the 13 inch/4000 unit reel.



PZT2222AT1

ON Semiconductor Preferred Device

**SOT-223 PACKAGE
NPN SILICON
TRANSISTOR
SURFACE MOUNT**



**CASE 318E-04, STYLE 1
TO-261AA**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	75	Vdc
Emitter-Base Voltage (Open Collector)	V_{EBO}	6.0	Vdc
Collector Current	I_C	600	mAdc
Total Power Dissipation up to T_A = 25°C(1)	P_D	1.5	Watts
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Junction Temperature	T_J	150	°C

THERMAL CHARACTERISTICS

Thermal Resistance from Junction to Ambient	$R_{\theta JA}$	83.3	°C/W
Lead Temperature for Soldering, 0.0625″ from case Time in Solder Bath	T_L	260 10	°C Sec

DEVICE MARKING

P1F

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	75	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Base-Emitter Cutoff Current (V_{CE} = 60 Vdc, V_{BE} = – 3.0 Vdc)	I_{BEX}	—	20	nAdc
Collector-Emitter Cutoff Current (V_{CE} = 60 Vdc, V_{BE} = – 3.0 Vdc)	I_{CEX}	—	10	nAdc
Emitter-Base Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	100	nAdc

1. Device mounted on an epoxy printed circuit board 1.575 inches x 1.575 inches x 0.059 inches; mounting pad for the collector lead min. 0.93 inches^2.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 3
Publication Order Number:
PZT2222AT1/D

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS (continued)				
Collector-Base Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 60 Vdc, I_E = 0, T_A = 125°C)	I_{CBO}	 — —	 10 10	 nAdc μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 10 Vdc) (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = – 55°C) (I_C = 150 mAdc, V_{CE} = 10 Vdc) (I_C = 150 mAdc, V_{CE} = 1.0 Vdc) (I_C = 500 mAdc, V_{CE} = 10 Vdc)	h_{FE}	 35 50 70 35 100 50 40	 — — — — 300 — —	—
Collector-Emitter Saturation Voltages (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	 — —	 0.3 1.0	Vdc
Base-Emitter Saturation Voltages (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{BE(sat)}$	 0.6 —	 1.2 2.0	Vdc
Input Impedance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz) (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)	h_{ie}	 2.0 0.25	 8.0 1.25	kΩ
Voltage Feedback Ratio (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz) (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)	h_{re}	 — —	 $8.0x10^{-4}$ $4.0x10^{-4}$	—
Small-Signal Current Gain (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz) (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)	$\|h_{fe}\|$	 50 75	 300 375	—
Output Admittance (V_{CE} = 10 Vdc, I_C = 1.0 mAdc, f = 1.0 kHz) (V_{CE} = 10 Vdc, I_C = 10 mAdc, f = 1.0 kHz)	h_{oe}	 5.0 25	 35 200	μmhos
Noise Figure (V_{CE} = 10 Vdc, I_C = 100 μAdc, f = 1.0 kHz)	F	—	4.0	dB
DYNAMIC CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	300	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_c	—	8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_e	—	25	pF

SWITCHING TIMES (T_A = 25°C)

	Conditions	Symbol	Min	Max	Unit
Delay Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, $I_{B(on)}$ = 15 mAdc, $V_{EB(off)}$ = 0.5 Vdc) Figure 1	t_d	—	10	ns
Rise Time		t_r	—	25	
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, $I_{B(on)}$ = $I_{B(off)}$ = 15 mAdc) Figure 2	t_s	—	225	ns
Fall Time		t_f	—	60	

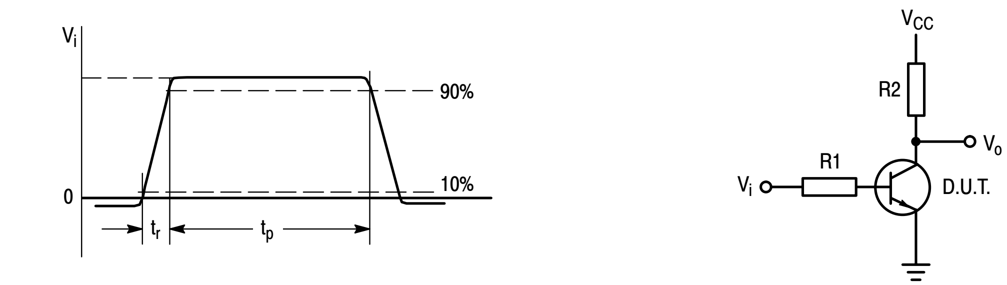


Figure 1. Input Waveform and Test Circuit for Determining Delay Time and Rise Time

V_i = – 0.5 V to +9.9 V, V_{CC} = +30 V, R1 = 619 Ω, R2 = 200 Ω.

PULSE GENERATOR:				**OSCILLOSCOPE:**			
PULSE DURATION	t_p	≤	**200 ns**	**INPUT IMPEDANCE**	Z_i	>	**100 kΩ**
RISE TIME	t_r	≤	**2 ns**	**INPUT CAPACITANCE**	C_i	<	**12 pF**
DUTY FACTOR	δ	=	**0.02**	**RISE TIME**	t_r	<	**5 ns**

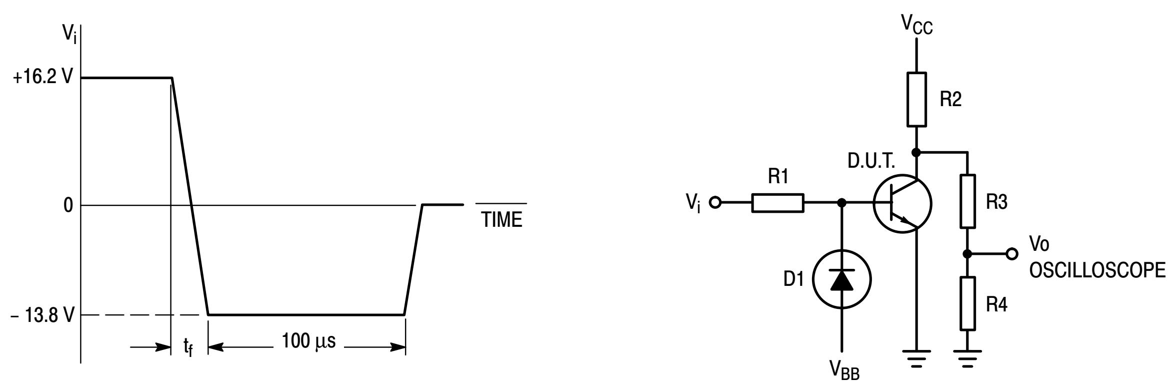


Figure 2. Input Waveform and Test Circuit for Determining Storage Time and Fall Time

PNP Silicon Epitaxial Transistor

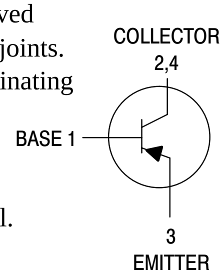
PZT2907AT1

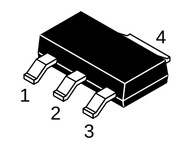
ON Semiconductor Preferred Device

This PNP Silicon Epitaxial transistor is designed for use in linear and switching applications. The device is housed in the SOT-223 package which is designed for medium power surface mount applications.

- NPN Complement is PZT2222AT1
- The SOT-223 package can be soldered using wave or reflow
- SOT-223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering eliminating the possibility of damage to the die.
- Available in 12 mm tape and reel
  Use PZT2907AT1 to order the 7 inch/1000 unit reel.
  Use PZT2907AT3 to order the 13 inch/4000 unit reel.

SOT-223 PACKAGE
PNP SILICON
TRANSISTOR
SURFACE MOUNT





CASE 318E-04, STYLE 1
TO-261AA

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	–60	Vdc
Collector-Base Voltage	V_{CBO}	–60	Vdc
Emitter-Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current	I_C	–600	mAdc
Total Power Dissipation @ T_A = 25°C(1) Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	–65 to 150	°C

THERMAL CHARACTERISTICS

Thermal Resistance — Junction-to-Ambient (surface mounted)	$R_{\theta JA}$	83.3	°C/W
Lead Temperature for Soldering, 0.0625″ from case Time in Solder Bath	T_L	260 10	°C Sec

DEVICE MARKING

P2F

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage (I_C = –10 μAdc, I_E = 0)	$V_{(BR)CBO}$	–60	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	–60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	—	Vdc
Collector-Base Cutoff Current (V_{CB} = –50 Vdc, I_E = 0)	I_{CBO}	—	—	–10	nAdc
Collector-Emitter Cutoff Current (V_{CE} = –30 Vdc, V_{BE} = 0.5 Vdc)	I_{CEX}	—	—	–50	nAdc
Base-Emitter Cutoff Current (V_{CE} = –30 Vdc, V_{BE} = –0.5 Vdc)	I_{BEX}	—	—	–50	nAdc

1. Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 sq. in.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS(2)						
DC Current Gain		h_{FE}				—
(I_C = –0.1 mAdc, V_{CE} = –10 Vdc)			75	—	—	
(I_C = –1.0 mAdc, V_{CE} = –10 Vdc)			100	—	—	
(I_C = –10 mAdc, V_{CE} = –10 Vdc)			100	—	—	
(I_C = –150 mAdc, V_{CE} = –10 Vdc)			100	—	300	
(I_C = –500 mAdc, V_{CE} = –10 Vdc)			50	—	—	
Collector-Emitter Saturation Voltages		$V_{CE(sat)}$				Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)			—	—	–0.4	
(I_C = –500 mAdc, I_B = –50 mAdc)			—	—	–1.6	
Base-Emitter Saturation Voltages		$V_{BE(sat)}$				Vdc
(I_C = –150 mAdc, I_B = –15 mAdc)			—	—	–1.3	
(I_C = –500 mAdc, I_B = –50 mAdc)			—	—	–2.6	
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = –50 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)		f_T	200	—	—	MHz
Output Capacitance (V_{CB} = –10 Vdc, I_E = 0, f = 1.0 MHz)		C_c	—	—	8.0	pF
Input Capacitance (V_{EB} = –2.0 Vdc, I_C = 0, f = 1.0 MHz)		C_e	—	—	30	pF
SWITCHING TIMES						
Turn-On Time	(V_{CC} = –30 Vdc, I_C = –150 mAdc, I_{B1} = –15 mAdc)	t_{on}	—	—	45	ns
Delay Time		t_d	—	—	10	
Rise Time		t_r	—	—	40	
Turn-Off Time	(V_{CC} = –6.0 Vdc, I_C = –150 mAdc, I_{B1} = I_{B2} = –15 mAdc)	t_{off}	—	—	100	ns
Storage Time		t_s	—	—	80	
Fall Time		t_f	—	—	30	

2. Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle = 2.0%.

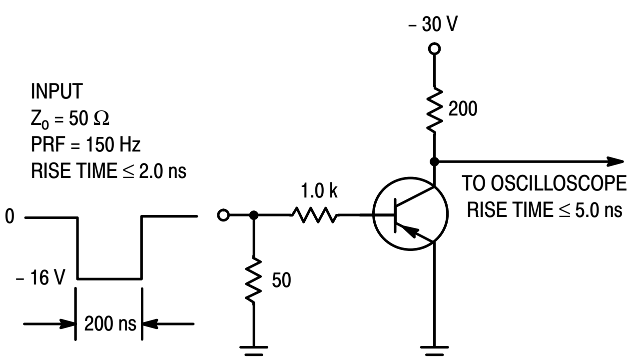


Figure 1. Delay and Rise Time Test Circuit

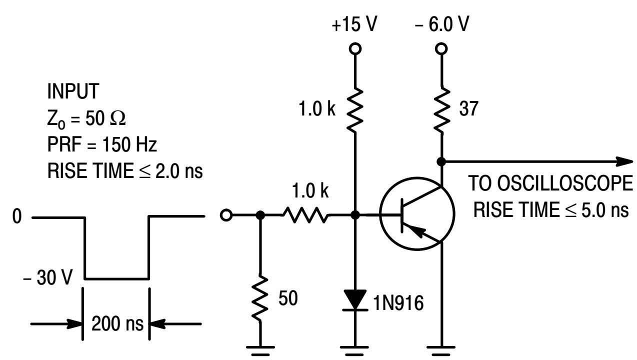


Figure 2. Storage and Fall Time Test Circuit

TYPICAL ELECTRICAL CHARACTERISTICS

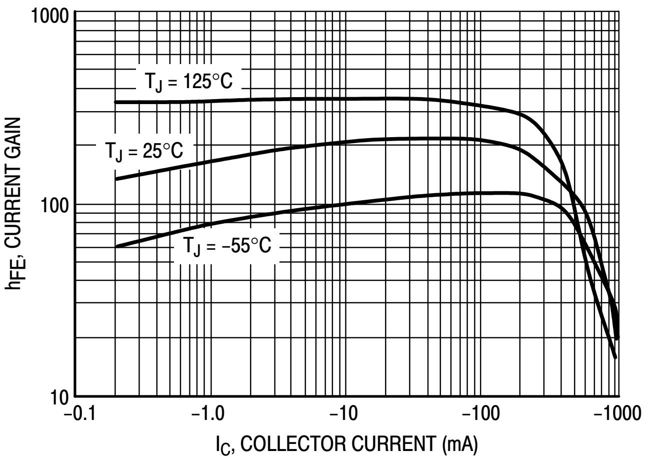


Figure 3. DC Current Gain

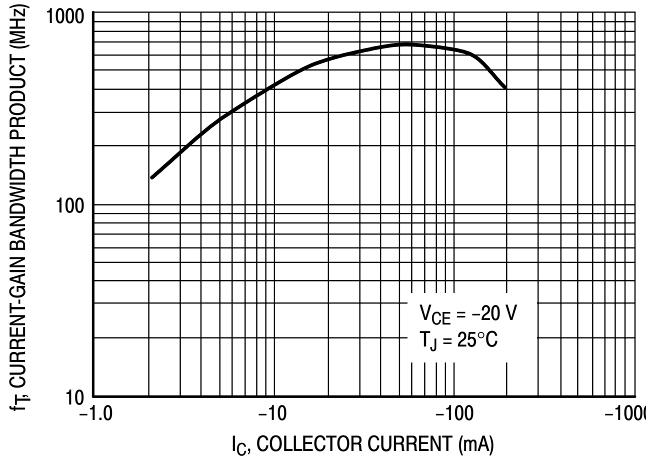


Figure 4. Current Gain Bandwidth Product

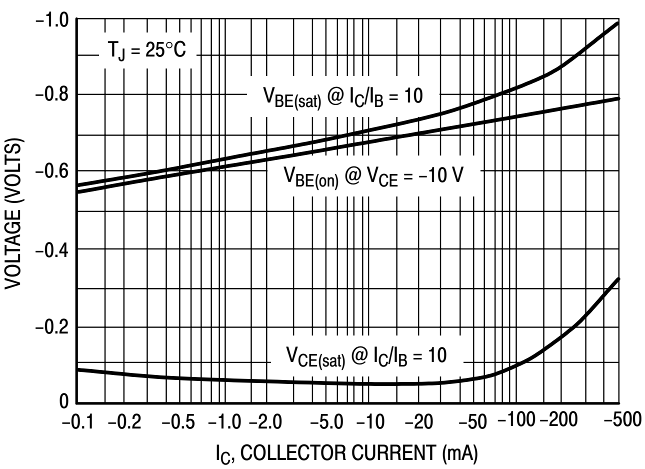


Figure 5. “ON” Voltage

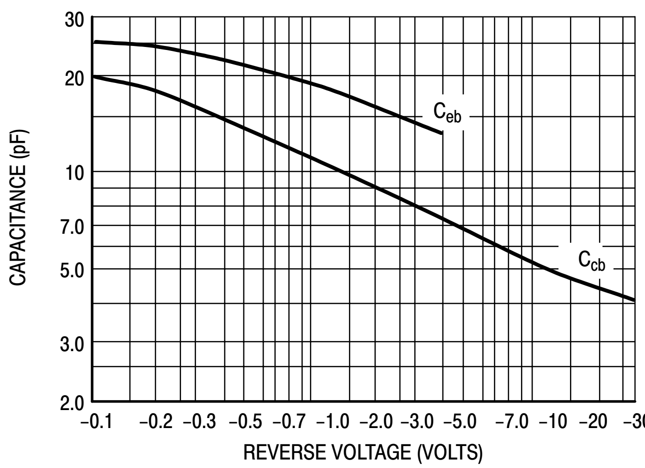


Figure 6. Capacitances

NPN Silicon Planar Epitaxial Transistor

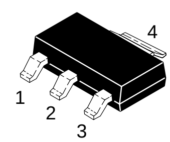
This NPN Silicon Epitaxial transistor is designed for use in industrial and consumer applications. The device is housed in the SOT–223 package which is designed for medium power surface mount applications.

- High Current: 2.0 Amp
- The SOT–223 package can be soldered using wave or reflow.
- SOT–223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die.
- Available in 12 mm Tape and Reel
  Use PZT651T1 to order the 7 inch/1000 unit reel
  Use PZT651T3 to order the 13 inch/4000 unit reel
- PNP Complement is PZT751T1

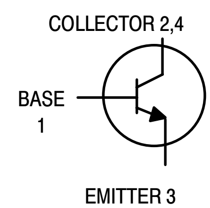
PZT651T1

ON Semiconductor Preferred Device

SOT–223 PACKAGE
HIGH CURRENT
NPN SILICON
TRANSISTOR
SURFACE MOUNT



CASE 318E–04, STYLE 1
TO–261AA



MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	60	Vdc
Collector–Base Voltage	V_{CBO}	80	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current	I_C	2.0	Adc
Total Power Dissipation @ T_A = 25°C$^{(1)}$ Derate above 25°C	P_D	0.8 6.4	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to 150	°C
Junction Temperature	T_J	150	°C

DEVICE MARKING

651

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance from Junction–to–Ambient in Free Air	$R_{\theta JA}$	156	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	T_L	260 10	°C Sec

1. Device mounted on a FR–4 glass epoxy printed circuit board using minimum recommended footprint.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	60	—	Vdc
Collector–Emitter Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	80	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Base–Emitter Cutoff Current (V_{EB} = 4.0 Vdc)	I_{EBO}	—	0.1	μAdc
Collector–Base Cutoff Current (V_{CB} = 80 Vdc, I_E = 0)	I_{CBO}	—	100	nAdc
ON CHARACTERISTICS (2)				
DC Current Gain	h_{FE}			—
(I_C = 50 mAdc, V_{CE} = 2.0 Vdc)		75	—	
(I_C = 500 mAdc, V_{CE} = 2.0 Vdc)		75	—	
(I_C = 1.0 Adc, V_{CE} = 2.0 Vdc)		75	—	
(I_C = 2.0 Adc, V_{CE} = 2.0 Vdc)		40	—	
Collector–Emitter Saturation Voltages	$V_{CE(sat)}$			Vdc
(I_C = 2.0 Adc, I_B = 200 mAdc)		—	0.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)		—	0.3	
Base–Emitter Voltages (I_C = 1.0 Adc, V_{CE} = 2.0 Vdc)	$V_{BE(on)}$	—	1.0	Vdc
Base–Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 100 mAdc)	$V_{BE(sat)}$	—	1.2	Vdc
Current–Gain — Bandwidth (I_C = 50 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	75	—	MHz

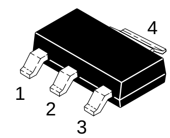
2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%

PZT751T1
ON Semiconductor Preferred Device

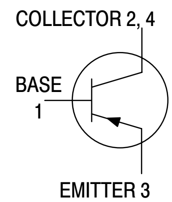
PNP Silicon Planar Epitaxial Transistor

This PNP Silicon Epitaxial transistor is designed for use in industrial and consumer applications. The device is housed in the SOT–223 package which is designed for medium power surface mount applications.

- High Current: 2.0 Amp
- The SOT–223 Package can be soldered using wave or reflow.
- SOT–223 package ensures level mounting, resulting in improved thermal conduction, and allows visual inspection of soldered joints. The formed leads absorb thermal stress during soldering, eliminating the possibility of damage to the die
- Available in 12 mm Tape and Reel
  Use PZT751T1 to order the 7 inch/1000 unit reel.
  Use PZT751T3 to order the 13 inch/4000 unit reel.
- NPN Complement is PZT651T1



CASE 318E-11, STYLE 1
TO-261AA



MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	60	Vdc
Collector–Base Voltage	V_{CBO}	80	Vdc
Emitter–Base Voltage	V_{EBO}	5.0	Vdc
Collector Current	I_C	2.0	Adc
Total Power Dissipation @ T_A = 25°C(1) Derate above 25°C	P_D	0.8 6.4	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to 150	°C
Junction Temperature	T_J	150	°C

DEVICE MARKING

ZT751

THERMAL CHARACTERISTICS

Thermal Resistance from Junction–to–Ambient in Free Air	$R_{\theta JA}$	156	°C/W
Maximum Temperature for Soldering Purposes Time in Solder Bath	T_L	260 10	°C Sec

1. Device mounted on a FR–4 glass epoxy printed circuit board using minimum recommended footprint.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	60	—	Vdc
Collector–Emitter Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	80	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Base–Emitter Cutoff Current (V_{EB} = 4.0 Vdc)	I_{EBO}	—	0.1	μAdc
Collector–Base Cutoff Current (V_{CB} = 80 Vdc, I_E = 0)	I_{CBO}	—	100	nAdc
ON CHARACTERISTICS (2)				
DC Current Gain	h_{FE}			—
(I_C = 50 mAdc, V_{CE} = 2.0 Vdc)		75	—	
(I_C = 500 mAdc, V_{CE} = 2.0 Vdc)		75	—	
(I_C = 1.0 Adc, V_{CE} = 2.0 Vdc)		75	—	
(I_C = 2.0 Adc, V_{CE} = 2.0 Vdc)		40	—	
Collector–Emitter Saturation Voltages	$V_{CE(sat)}$			Vdc
(I_C = 2.0 Adc, I_B = 200 mAdc)		—	0.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)		—	0.3	
Base–Emitter Voltages (I_C = 1.0 Adc, V_{CE} = 2.0 Vdc)	$V_{BE(on)}$	—	1.0	Vdc
Base–Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 100 mAdc)	$V_{BE(sat)}$	—	1.2	Vdc
Current–Gain–Bandwidth (I_C = 50 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	75	—	MHz

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

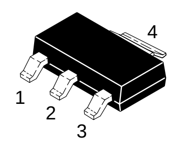
High Voltage Transistor Surface Mount

NPN Silicon

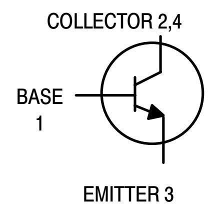
PZTA42T1

ON Semiconductor Preferred Device

SOT–223 PACKAGE
NPN SILICON
HIGH VOLTAGE
TRANSISTOR
SURFACE MOUNT



CASE 318E-04, STYLE 1
TO-261AA



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage (Open Base)	V_{CEO}	300	Vdc
Collector-Base Voltage (Open Emitter)	V_{CBO}	300	Vdc
Emitter-Base Voltage (Open Collector)	V_{EBO}	6.0	Vdc
Collector Current (DC)	I_C	500	mAdc
Total Power Dissipation @ T_A = 25°C(1)	P_D	1.5	Watts
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	150	°C

DEVICE MARKING

P1D

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction-to-Ambient(1)	$R_{\theta JA}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(2) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	300	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	300	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector-Base Cutoff Current (V_{CB} = 200 Vdc, I_E = 0)	I_{CBO}	—	0.1	μAdc
Emitter-Base Cutoff Current (V_{BE} = 6.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	μAdc

1. Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min 0.93 in^2.
2. Pulse Test Conditions, t_p = 300 μs, δ = 0.02.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

ON CHARACTERISTICS

DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 30 mAdc, V_{CE} = 10 Vdc)	h_{FE}	 25 40 40	 — — —	—

DYNAMIC CHARACTERISTICS

Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	50	—	MHz
Feedback Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	C_{re}	—	3.0	pF
Collector-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{BE(sat)}$	—	0.9	Vdc

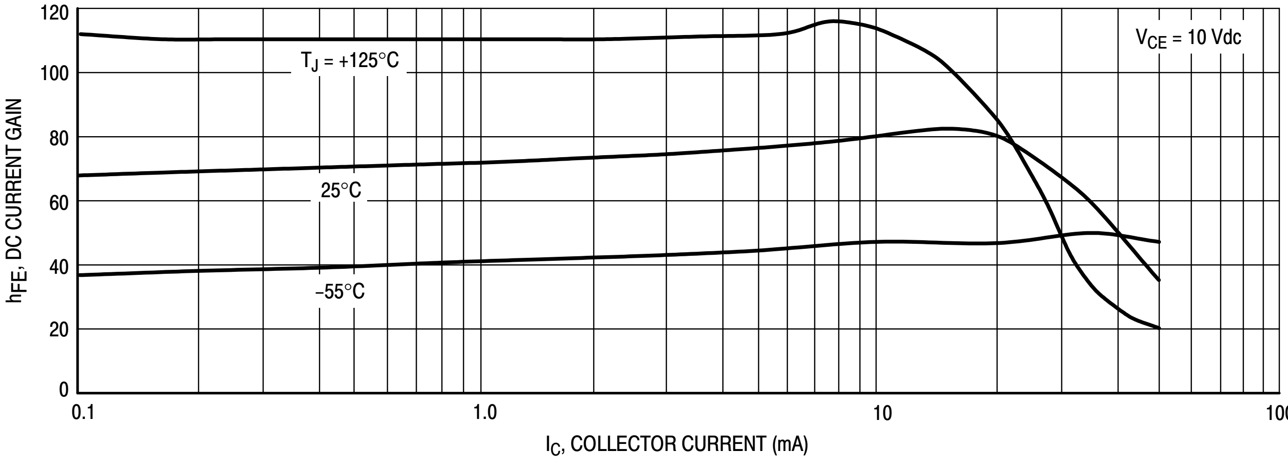


Figure 7. DC Current Gain

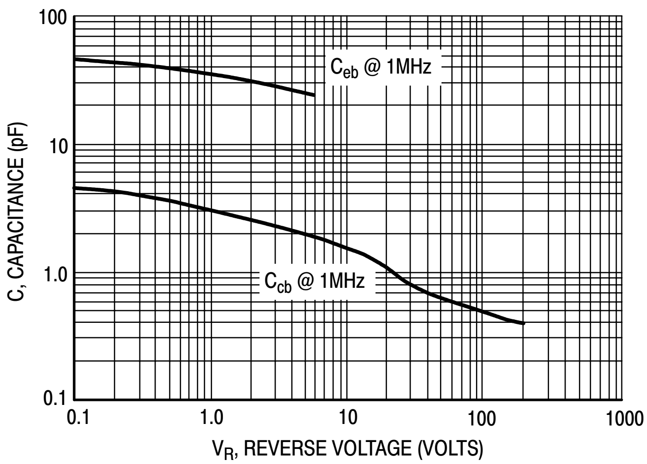


Figure 8. Capacitance

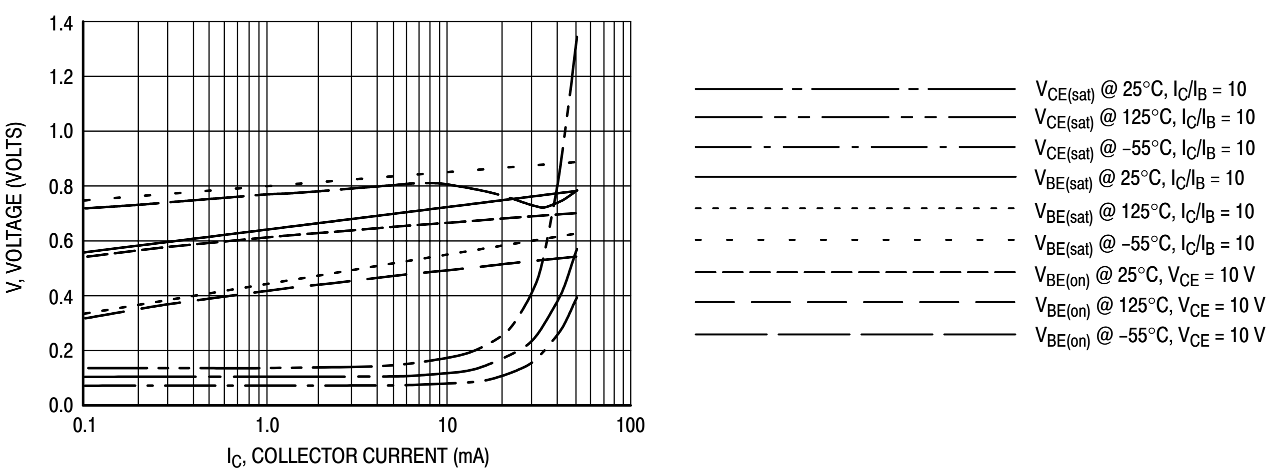


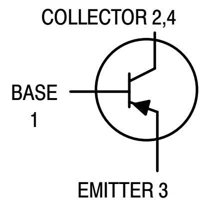
Figure 9. “ON” Voltages

PZTA92T1

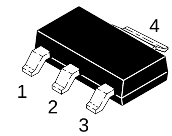
ON Semiconductor Preferred Device

High Voltage Transistor

PNP Silicon



SOT–223 PACKAGE
PNP SILICON
HIGH VOLTAGE TRANSISTOR
SURFACE MOUNT



CASE 318E–04, STYLE 1
TO–261AA

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–300	Vdc
Collector–Base Voltage	V_{CBO}	–300	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current	I_C	–500	mAdc
Total Power Dissipation up to T_A = 25°C(1)	P_D	1.5	Watts
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	150	°C

DEVICE MARKING

P2D

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance from Junction to Ambient(1)	$R_{\theta JA}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–300	—	Vdc
Collector–Base Breakdown Voltage (I_C = –100 µAdc, I_E = 0)	$V_{(BR)CBO}$	–300	—	Vdc
Emitter–Base Breakdown Voltage (I_E = –100 µAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	—	Vdc
Collector–Base Cutoff Current (V_{CB} = –200 Vdc, I_E = 0)	I_{CBO}	—	–0.25	µAdc
Emitter–Base Cutoff Current (V_{BE} = –3.0 Vdc, I_C = 0)	I_{EBO}	—	–0.1	µAdc
ON CHARACTERISTICS				
DC Current Gain(2)	h_{FE}			—
(I_C = –1.0 mAdc, V_{CE} = –10 Vdc)		25	—	
(I_C = –10 mAdc, V_{CE} = –10 Vdc)		40	—	
(I_C = –30 mAdc, V_{CE} = –10 Vdc)		25	—	
Saturation Voltages				Vdc
(I_C = –20 mAdc, I_B = –2.0 mAdc)	$V_{CE(sat)}$	—	–0.5	
(I_C = –20 mAdc, I_B = –2.0 mAdc)	$V_{BE(sat)}$	—	–0.9	
DYNAMIC CHARACTERISTICS				
Collector–Base Capacitance @ f = 1.0 MHz (V_{CB} = –20 Vdc, I_E = 0)	C_{cb}	—	6.0	pF
Current–Gain — Bandwidth Product (I_C = –10 mAdc, V_{CE} = –20 Vdc, f = 100 MHz)	f_T	50	—	MHz

1. Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 in^2.
2. Pulse Test: Pulse Width ≤ 300 µs; Duty Cycle = 2.0%.

Preferred devices are ON Semiconductor recommended choices for future use and best overall value.

March, 2001 – Rev. 4
Publication Order Number:
PZTA92T1/D

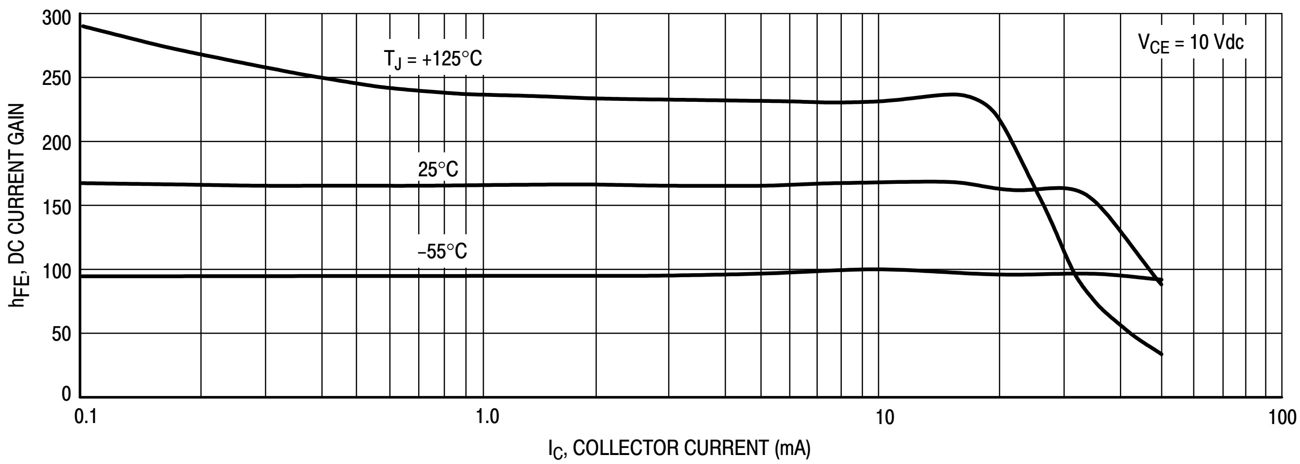


Figure 1. DC Current Gain

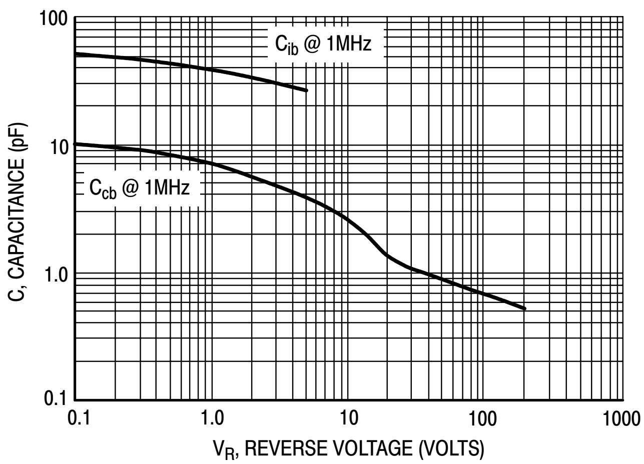


Figure 2. Capacitance

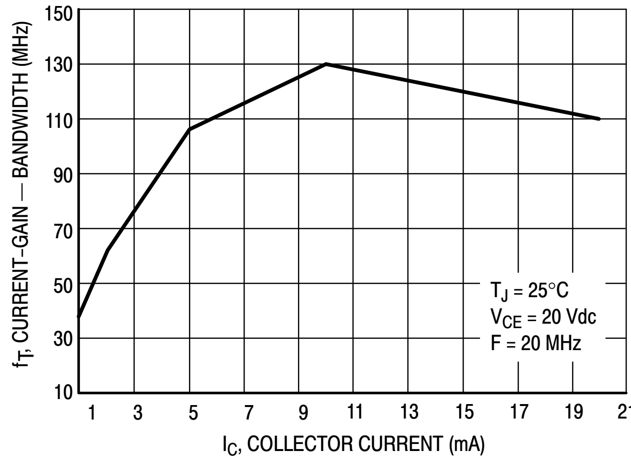


Figure 3. Current–Gain — Bandwidth

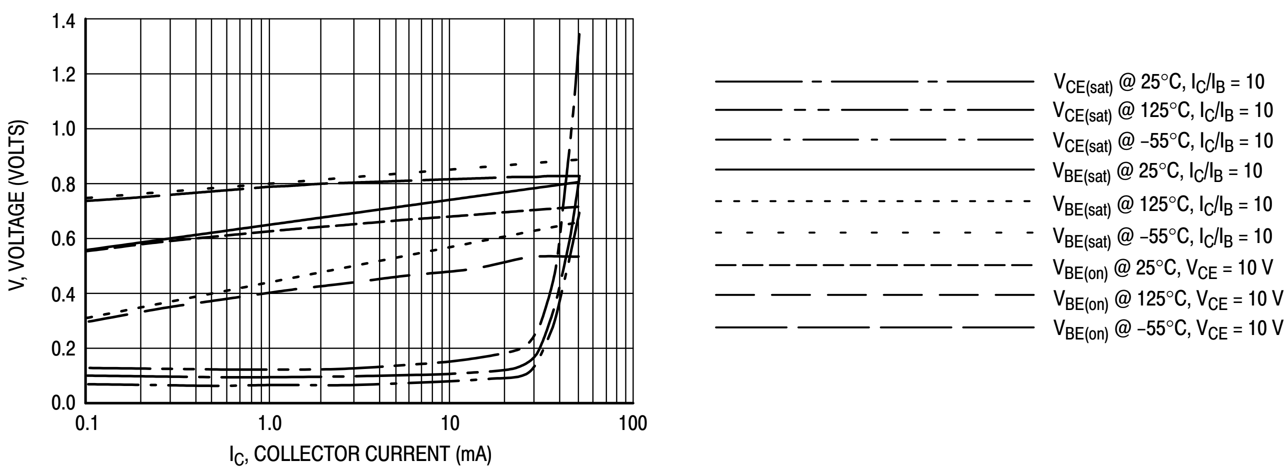


Figure 4. ”ON” Voltages

PZTA96ST1

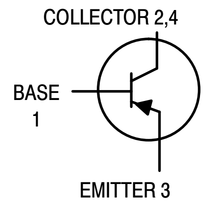
Preferred Device

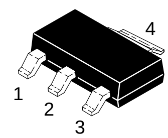
High Voltage Transistor

PNP Silicon

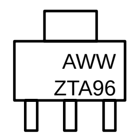
ON Semiconductor™

http://onsemi.com





SOT–223, TO–261AA
CASE 318E
STYLE 1



A = Location
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping
PZTA96ST1	SOT–223	1000/Tape & Reel
PZTA96ST3	SOT–223	4000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	–450	Vdc
Collector–Base Voltage	V_{CBO}	–450	Vdc
Emitter–Base Voltage	V_{EBO}	–5.0	Vdc
Collector Current	I_C	–500	mAdc
Total Power Dissipation Up to T_A = 25°C (Note 1.)	P_D	1.5	Watts
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance from Junction to Ambient (Note 1.)	$R_{\theta JA}$	83.3	°C

ELECTRICAL CHARACTERISTICS (Note 2.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = –1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	–450	–	Vdc
Collector–Emitter Breakdown Voltage (I_C = –100 μAdc, I_E = 0)	$V_{(BR)CBO}$	–450	–	Vdc
Emitter–Base Breakdown Voltage (I_E = –10 μAdc, I_C = 0)	$V_{(BR)EBO}$	–5.0	–	Vdc
Collector–Base Cutoff Current (V_{CB} = –400 Vdc, I_E = 0)	I_{CBO}	–	–0.1	μAdc
Emitter–Base Cutoff Current (V_{BE} = –4.0 Vdc, I_C = 0)	I_{EBO}	–	–0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain (Note 3.) (I_C = –10 mAdc, V_{CE} = –10 Vdc)	h_{FE}	50	150	–
Saturation Voltages (I_C = –20 mAdc, I_B = –2.0 mAdc) (I_C = –20 mAdc, I_B = –2.0 mAdc)	 $V_{CE(sat)}$ $V_{BE(sat)}$	 – –	 –0.6 –1.0	Vdc

1. Device mounted on a glass epoxy printed circuit board 1.575 in. x 1.575 in. x 0.059 in.; mounting pad for the collector lead min. 0.93 in^2.
2. T_A = 25°C unless otherwise noted.
3. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle = 2.0%.

RB751V40T1

Schottky Barrier Diode

These Schottky barrier diodes are designed for high speed switching applications, circuit protection, and voltage clamping. Extremely low forward voltage reduces conduction loss. Miniature surface mount package is excellent for hand held and portable applications where space is limited.

- Extremely Fast Switching Speed
- Extremely Low Forward Voltage – 0.28 Volts (Typ) @ I_F = 1 mAdc
- Low Reverse Current

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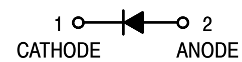
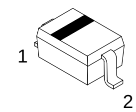
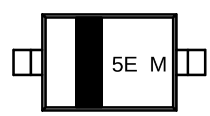
40 V SCHOTTKY BARRIER DIODE





SOD–323
CASE 477
PLASTIC

MARKING DIAGRAMS



5E = Specific Device Code
M = Date Code

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Peak Reverse Voltage	V_{RM}	40	V
Reverse Voltage	V_R	30	Vdc
Electrostatic Discharge	E_{SD}	HBM Class: 1C MM Class: A	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR–5 Board, (Note 1.) T_A = 25°C Derate above 25°C	P_D	200 1.57	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	635	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	–55 to +150	°C

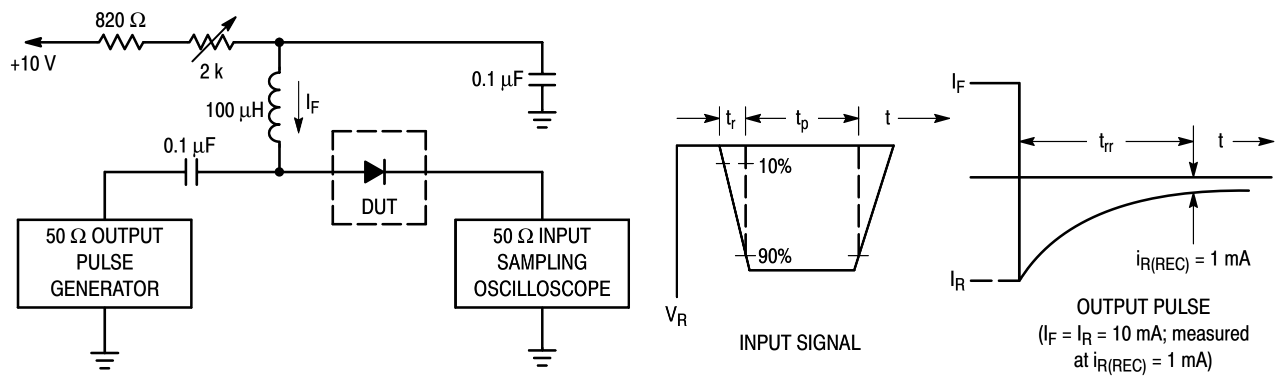
1. FR–5 Minimum Pad

ORDERING INFORMATION

Device	Package	Shipping
RB751V40T1	SOD–323	3000/Tape & Reel

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	30	–	–	Volts
Total Capacitance (V_R = 1.0 V, f = 1.0 MHz)	C_T	–	2.0	2.5	pF
Reverse Leakage (V_R = 30 V)	I_R	–	300	500	nAdc
Forward Voltage (I_F = 1.0 mAdc)	V_F	–	0.28	0.37	Vdc



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

Figure 1. Recovery Time Equivalent Test Circuit

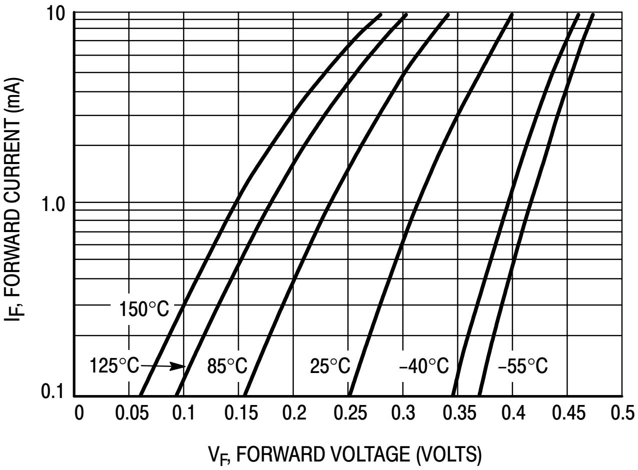


Figure 2. Typical Forward Voltage

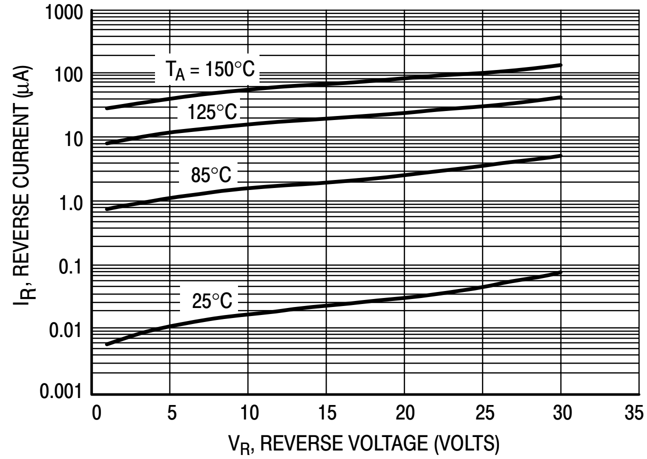


Figure 3. Reverse Current versus Reverse Voltage

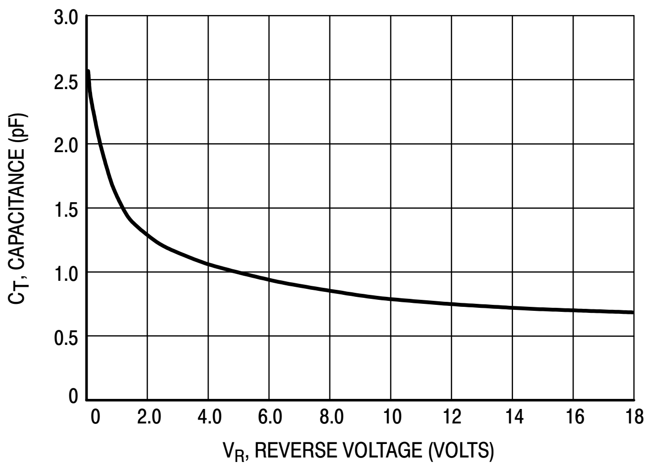


Figure 4. Typical Capacitance

UMA4NT1, UMA6NT1

Preferred Devices

Dual Common Emitter Bias Resistor Transistors

PNP Silicon Surface Mount Transistors with Monolithic Bias Resistor Network

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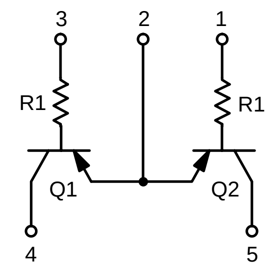
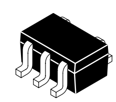


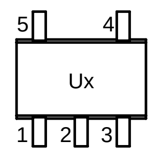
The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. These digital transistors are designed to replace a single device and its external resistor bias network. The BRT eliminates these individual components by integrating them into a single device. In the UMC2NT1 series, two BRT devices are housed in the SOT–353 package which is ideal for low power surface mount applications where board space is at a premium.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Available in 8 mm, 7 inch/3000 Unit Tape and Reel



SC–88A/SOT–353
CASE 419A
STYLE 7

MARKING DIAGRAM



Ux = Device Marking
x = 0 or 1

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted, common for Q_1 and Q_2, – minus sign for Q_1 (PNP) omitted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

THERMAL CHARACTERISTICS

Thermal Resistance – Junction-to-Ambient (surface mounted)	$R_{\theta JA}$	833	°C/W
Operating and Storage Temperature Range	T_J, T_{stg}	–65 to +150	°C
Total Package Dissipation @ T_A = 25°C (Note 1.)	P_D	150	mW

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	R1 (K)	R2 (K)
UMA4NT1	U0	10	∞
UMA6NT1	U1	47	∞

1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.

ORDERING INFORMATION

Device	Package	Shipping
UMA4NT1	SOT–323	3000/Tape & Reel
UMA6NT1	SOT–323	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector-Emitter Cutoff Current (V_{CB} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter-Base Cutoff Current (V_{EB} = 6.0, I_C = 5.0 mA)	UMA4NT1 UMA6NT1	I_{EBO}	– –	– –	0.9 0.2	mAdc
ON CHARACTERISTICS						
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	UMA4NT1 UMA6NT1	h_{FE}	160 160	250 250	– –	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.3 mA)		$V_{CE(SAT)}$	–	–	0.25	Vdc
Output Voltage (on) (V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)		V_{OL}	–	–	0.2	Vdc
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ)		V_{OH}	4.9	–	–	Vdc
Input Resistor	UMA4NT1 UMA6NT1	R1	7.0 33	10 47	13 61	kΩ

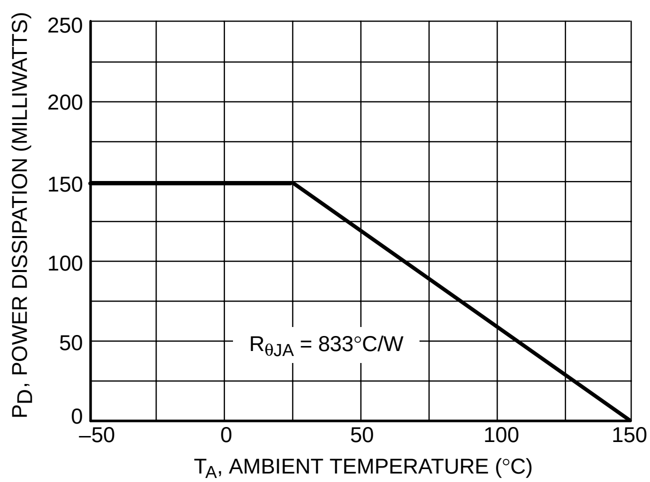


Figure 1. Derating Curve

Typical Electrical Characteristics – UMA4NT1

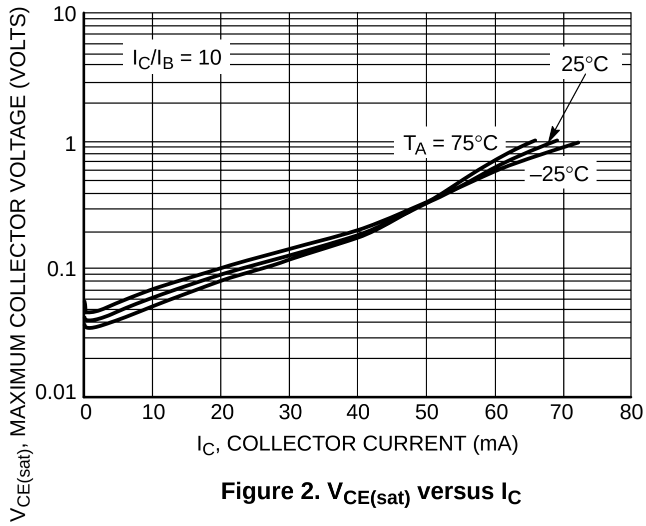


Figure 2. $V_{CE(sat)}$ versus I_C

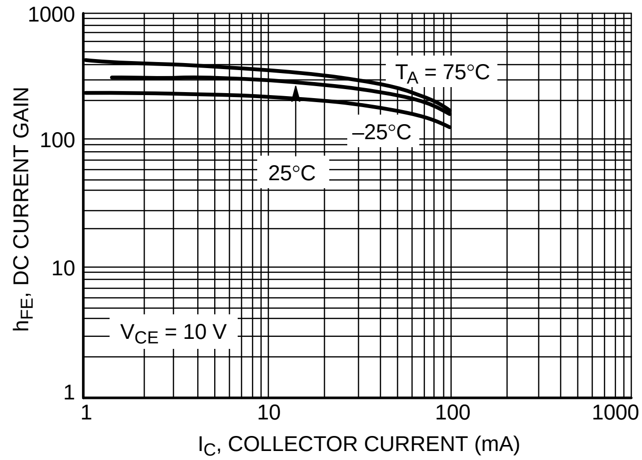


Figure 3. DC Current Gain

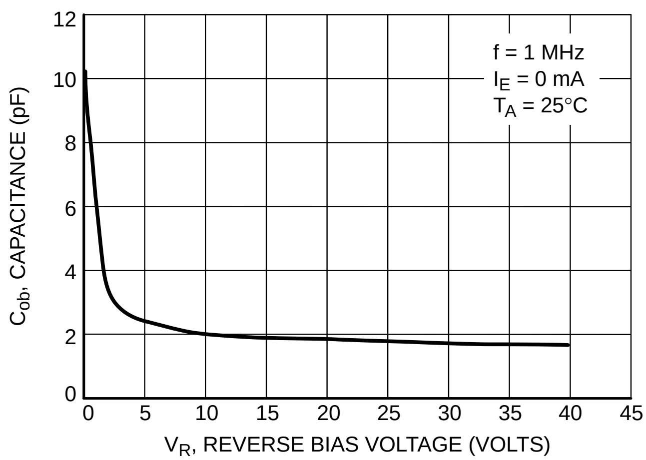


Figure 4. Output Capacitance

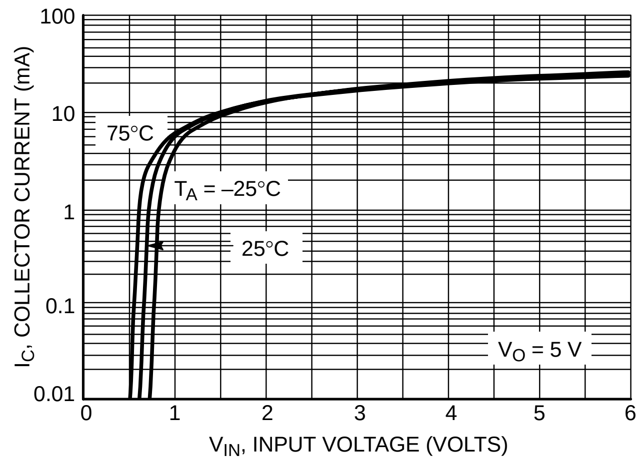


Figure 5. Output Current versus Input Voltage

Typical Electrical Characteristics – UMA6NT1

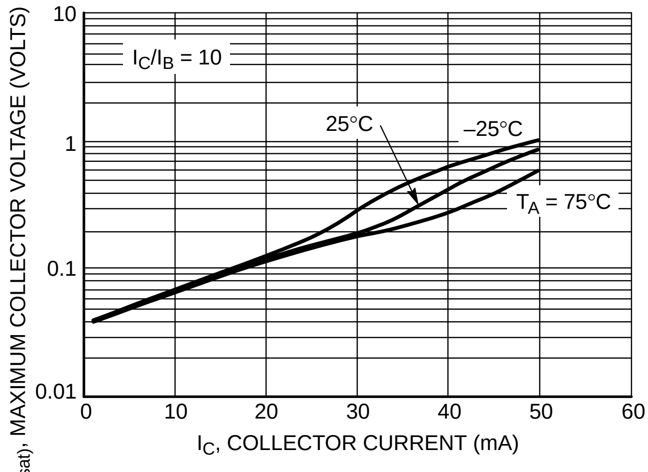


Figure 6. $V_{CE(sat)}$ versus I_C

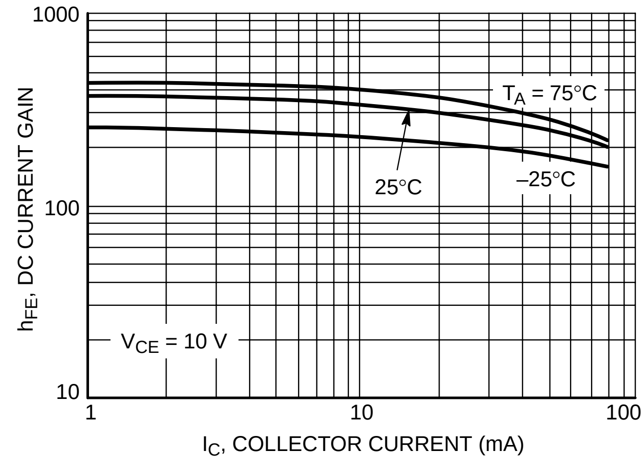


Figure 7. DC Current Gain

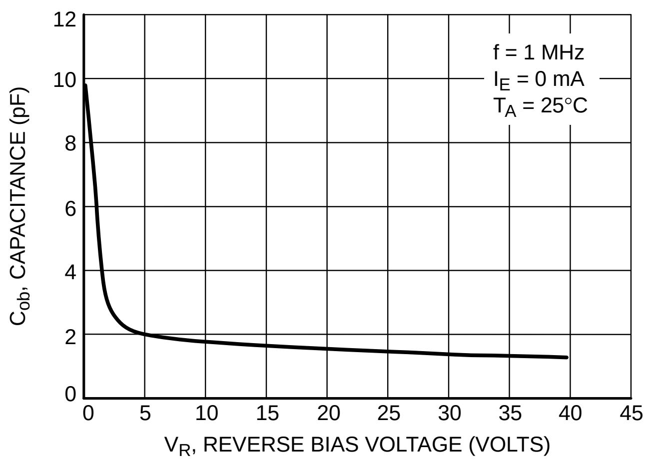


Figure 8. Output Capacitance

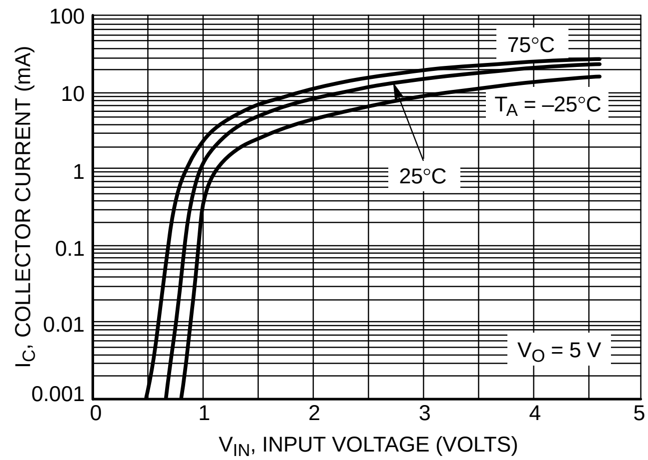


Figure 9. Output Current versus Input Voltage

UMC2NT1, UMC3NT1, UMC5NT1

Preferred Devices

Dual Common Base-Collector Bias Resistor Transistors

NPN and PNP Silicon Surface Mount Transistors with Monolithic Bias Resistor Network

The BRT (Bias Resistor Transistor) contains a single transistor with a monolithic bias network consisting of two resistors; a series base resistor and a base–emitter resistor. These digital transistors are designed to replace a single device and its external resistor bias network. The BRT eliminates these individual components by integrating them into a single device. In the UMC2NT1 series, two complementary BRT devices are housed in the SOT–353 package which is ideal for low power surface mount applications where board space is at a premium.

- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Available in 8 mm, 7 inch/3000 Unit Tape and Reel.

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted, common for Q_1 and Q_2, – minus sign for Q_1 (PNP) omitted)

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	50	Vdc
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector Current	I_C	100	mAdc

THERMAL CHARACTERISTICS

Thermal Resistance – Junction-to-Ambient (surface mounted)	$R_{\theta JA}$	833	°C/W
Operating and Storage Temperature Range	T_J, T_{stg}	–65 to +150	°C
Total Package Dissipation @ T_A = 25°C (Note 1.)	P_D	150	mW

DEVICE MARKING AND RESISTOR VALUES

Device	Marking	Transistor 1 – PNP		Transistor 2 – NPN	
		R1 (K)	R2 (K)	R1 (K)	R2 (K)
UMC2NT1	U2	22	22	22	22
UMC3NT1	U3	10	10	10	10
UMC5NT1	U5	4.7	10	47	47

1. Device mounted on a FR-4 glass epoxy printed circuit board using the minimum recommended footprint.

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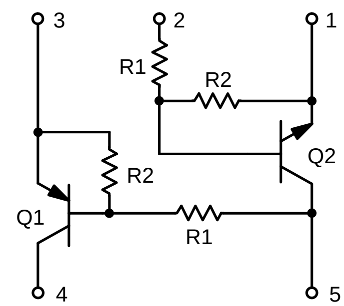
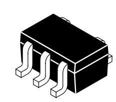
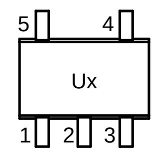




SC–88A/SOT–323
CASE 419A
STYLE 6

MARKING DIAGRAM



Ux = Device Marking
x = 2, 3 or 5

ORDERING INFORMATION

Device	Package	Shipping
UMC2NT1	SOT–323	3000/Tape & Reel
UMC3NT1	SOT–323	3000/Tape & Reel
UMC5NT1	SOT–323	3000/Tape & Reel

Preferred devices are recommended choices for future use and best overall value.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Q1 TRANSISTOR: PNP						
OFF CHARACTERISTICS						
Collector-Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector-Emitter Cutoff Current (V_{CB} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter-Base Cutoff Current (V_{EB} = 6.0, I_C = 5.0 mA)	UMC2NT1 UMC3NT1 UMC5NT1	I_{EBO}	– – –	– – –	0.2 0.5 1.0	mAdc
ON CHARACTERISTICS						
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	UMC2NT1 UMC3NT1 UMC5NT1	h_{FE}	60 35 20	100 60 35	– – –	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.3 mA)		$V_{CE(SAT)}$	–	–	0.25	Vdc
Output Voltage (on) (V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)		V_{OL}	–	–	0.2	Vdc
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ)		V_{OH}	4.9	–	–	Vdc
Input Resistor	UMC2NT1 UMC3NT1 UMC5NT1	R1	15.4 7.0 3.3	22 10 4.7	28.6 13 6.1	kΩ
Resistor Ratio	UMC2NT1 UMC3NT1 UMC5NT1	R1/R2	0.8 0.8 0.38	1.0 1.0 0.47	1.2 1.2 0.56	
Q2 TRANSISTOR: NPN						
OFF CHARACTERISTICS						
Collector-Base Cutoff Current (V_{CB} = 50 V, I_E = 0)		I_{CBO}	–	–	100	nAdc
Collector-Emitter Cutoff Current (V_{CB} = 50 V, I_B = 0)		I_{CEO}	–	–	500	nAdc
Emitter-Base Cutoff Current (V_{EB} = 6.0, I_C = 5.0 mA)	UMC2NT1 UMC3NT1 UMC5NT1	I_{EBO}	– – –	– – –	0.2 0.5 0.1	mAdc
ON CHARACTERISTICS						
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	50	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 2.0 mA, I_B = 0)		$V_{(BR)CEO}$	50	–	–	Vdc
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA)	UMC2NT1 UMC3NT1 UMC5NT1	h_{FE}	60 35 80	100 60 140	– – –	
Collector–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.3 mA)		$V_{CE(SAT)}$	–	–	0.25	Vdc
Output Voltage (on) (V_{CC} = 5.0 V, V_B = 2.5 V, R_L = 1.0 kΩ)		V_{OL}	–	–	0.2	Vdc
Output Voltage (off) (V_{CC} = 5.0 V, V_B = 0.5 V, R_L = 1.0 kΩ)		V_{OH}	4.9	–	–	Vdc
Input Resistor	UMC2NT1 UMC3NT1 UMC5NT1	R1	15.4 7.0 33	22 10 47	28.6 13 61	kΩ
Resistor Ratio	UMC2NT1 UMC3NT1 UMC5NT1	R1/R2	0.8 0.8 0.8	1.0 1.0 1.0	1.2 1.2 1.2	

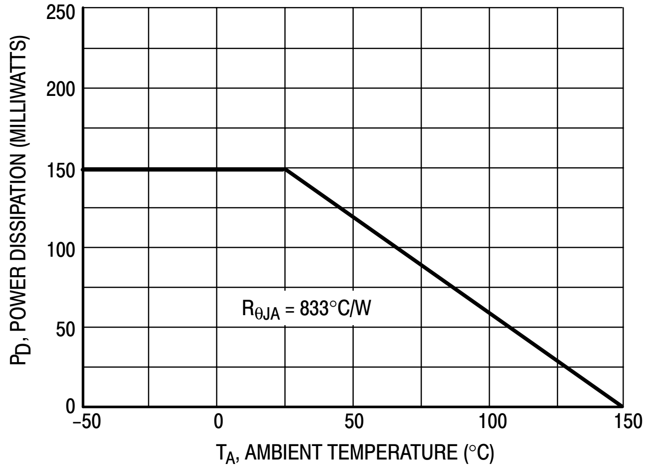


Figure 1. Derating Curve

TYPICAL ELECTRICAL CHARACTERISTICS — UMC2NT1 PNP TRANSISTOR

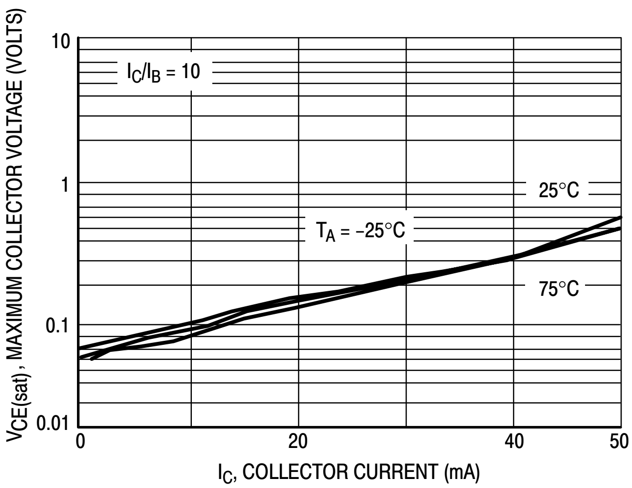


Figure 2. $V_{CE(sat)}$ versus I_C

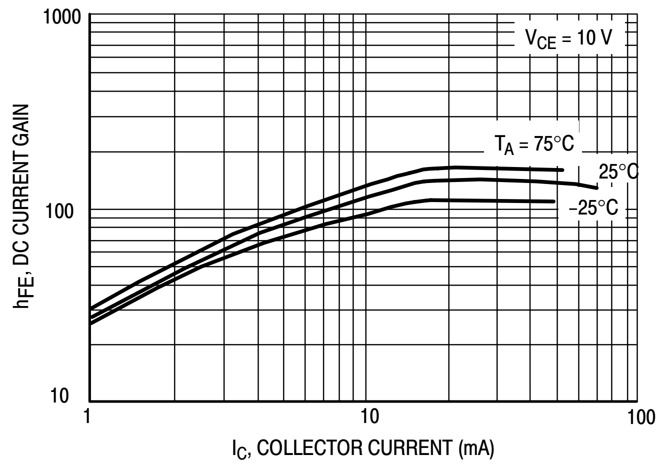


Figure 3. DC Current Gain

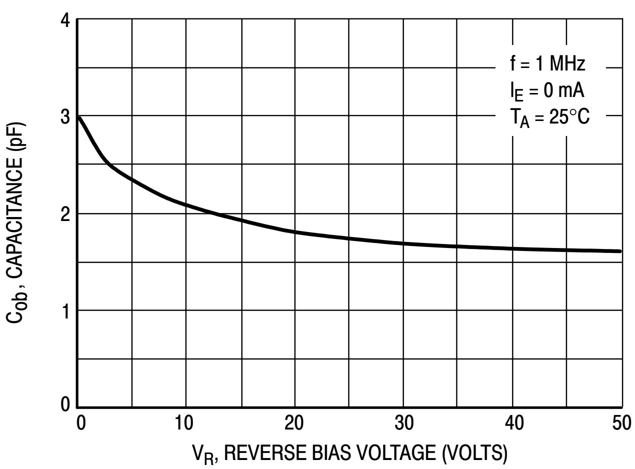


Figure 4. Output Capacitance

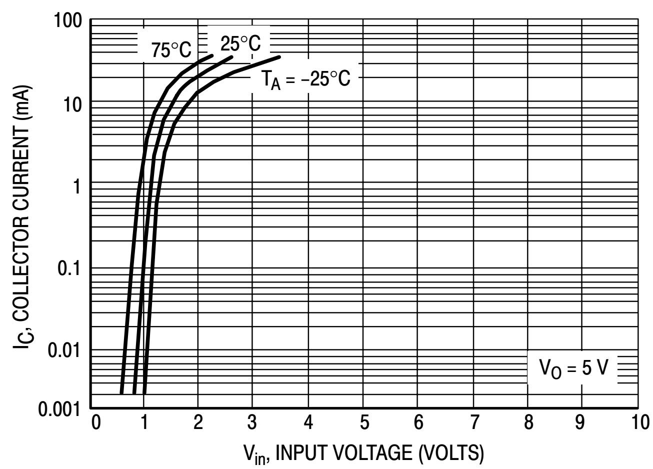


Figure 5. Output Current versus Input Voltage

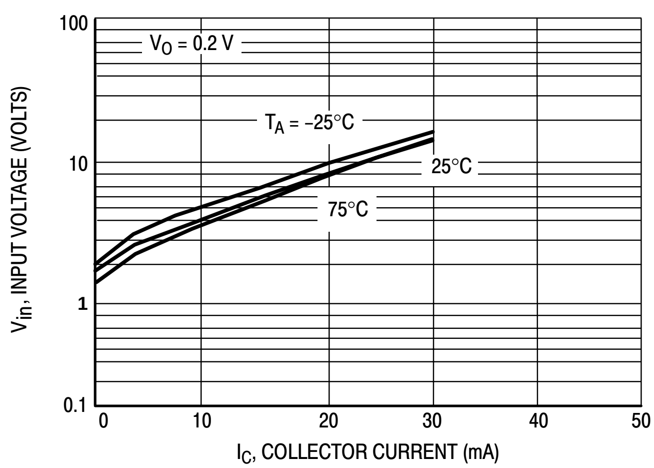


Figure 6. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — UMC2NT1 NPN TRANSISTOR

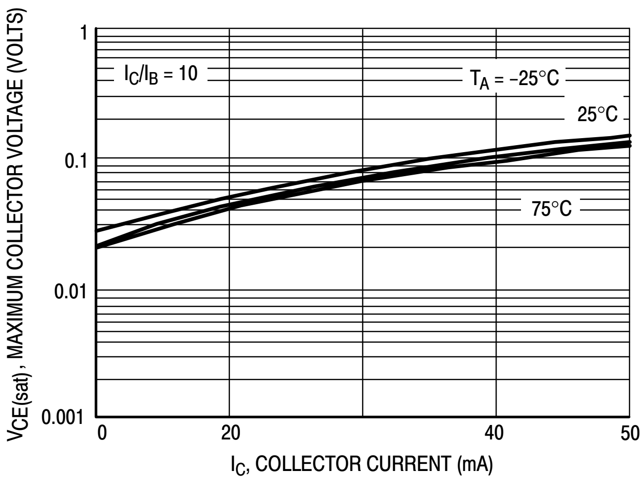


Figure 7. $V_{CE(sat)}$ versus I_C

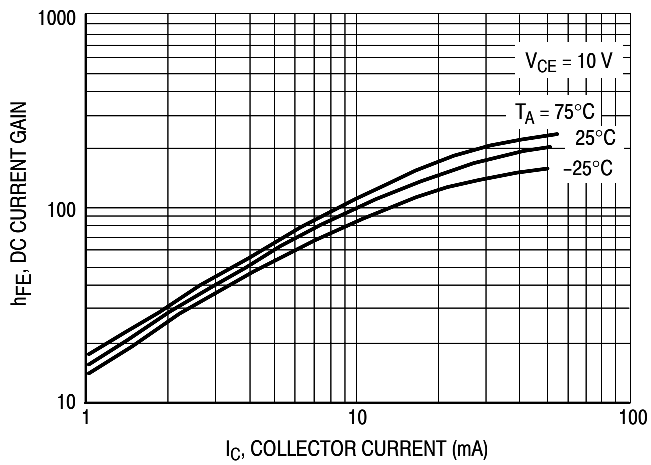


Figure 8. DC Current Gain

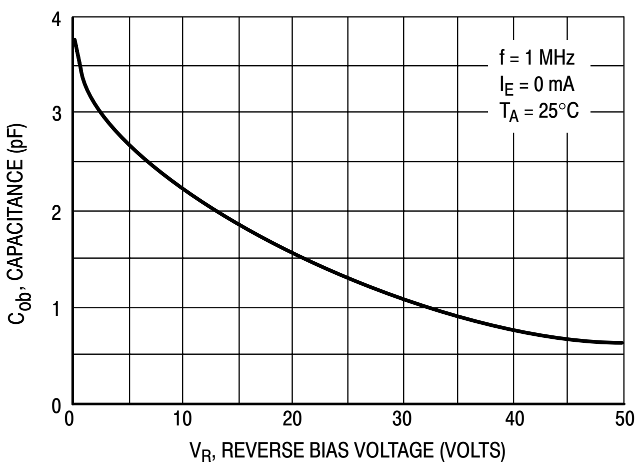


Figure 9. Output Capacitance

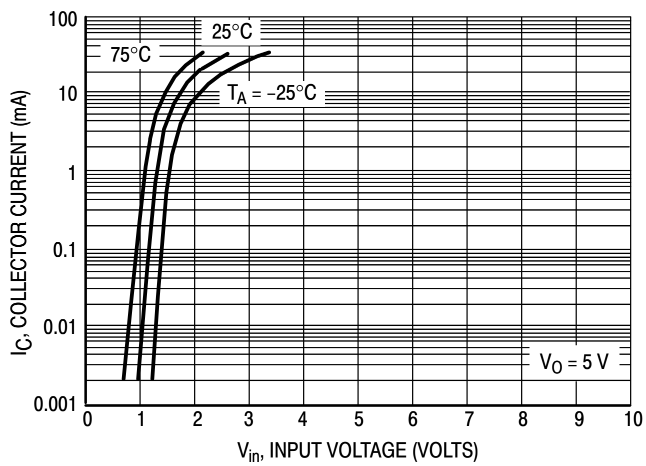


Figure 10. Output Current versus Input Voltage

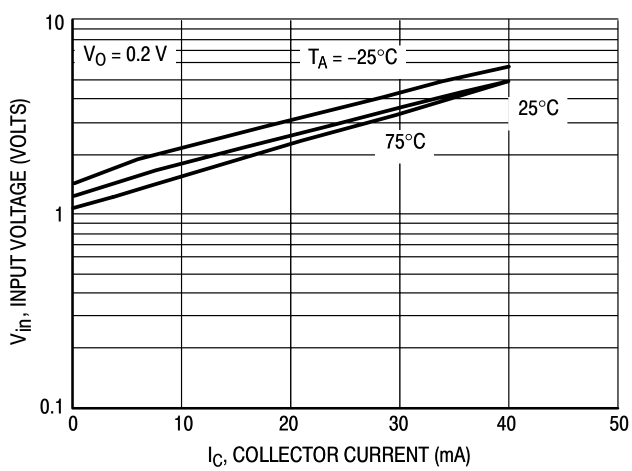


Figure 11. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — UMC3NT1 PNP TRANSISTOR

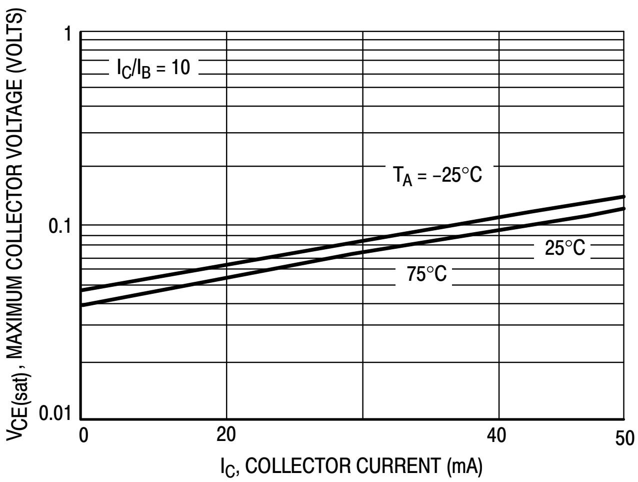


Figure 12. $V_{CE(sat)}$ versus I_C

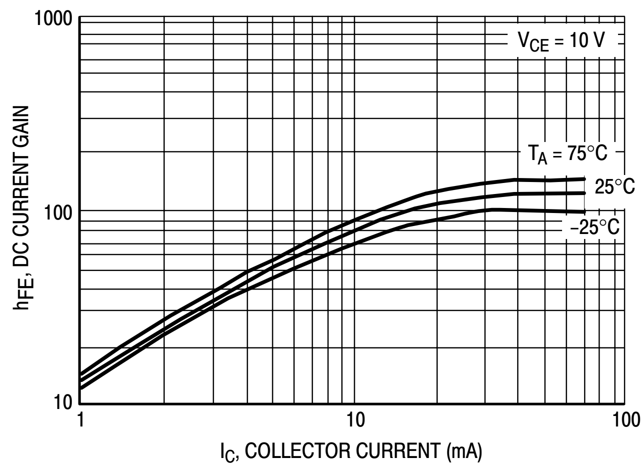


Figure 13. DC Current Gain

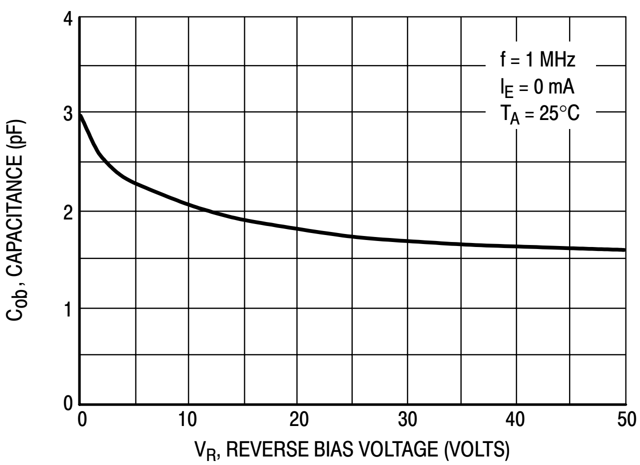


Figure 14. Output Capacitance

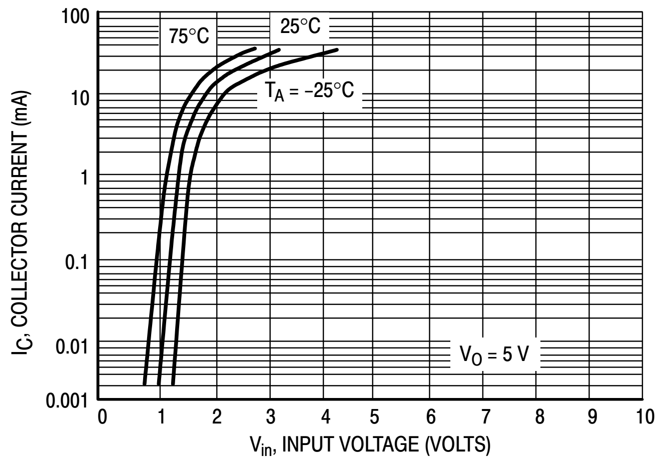


Figure 15. Output Current versus Input Voltage

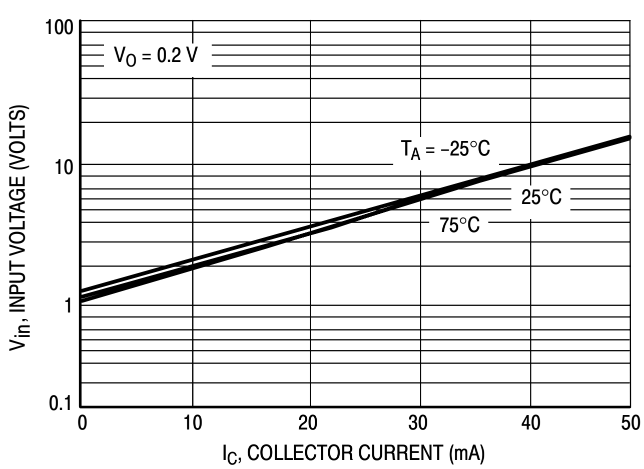


Figure 16. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — UMC3NT1 NPN TRANSISTOR

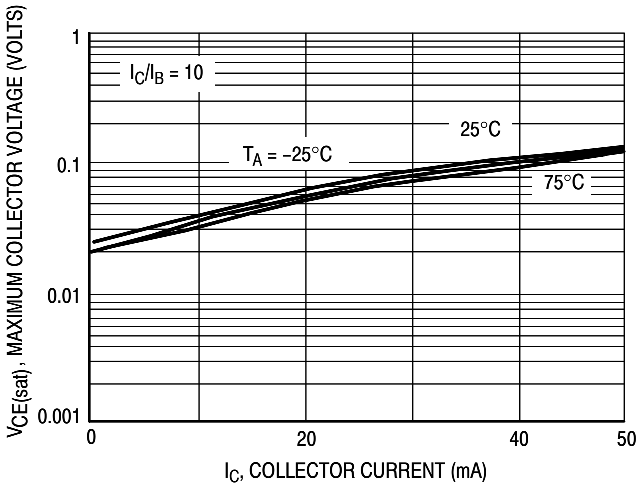


Figure 17. $V_{CE(sat)}$ versus I_C

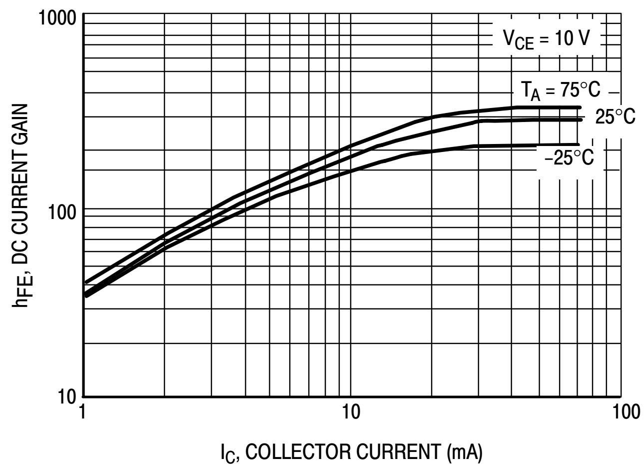


Figure 18. DC Current Gain

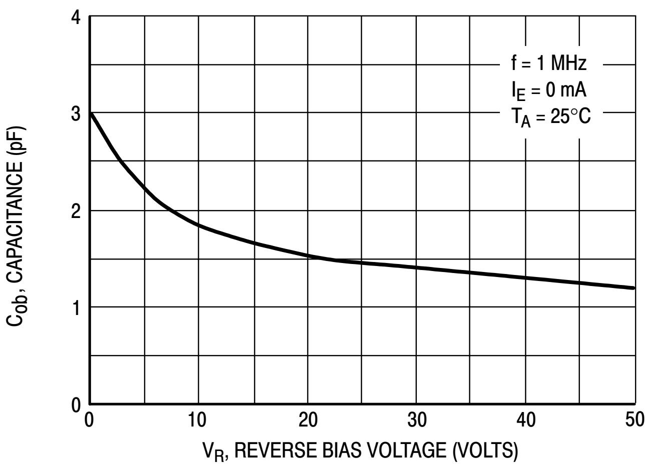


Figure 19. Output Capacitance

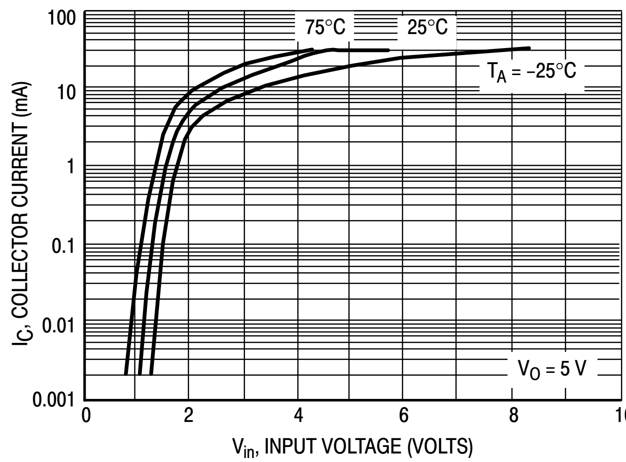


Figure 20. Output Current versus Input Voltage

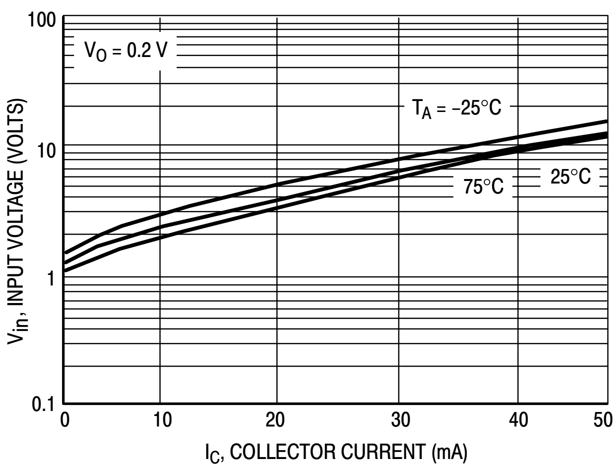


Figure 21. Input Voltage versus Output Current

TYPICAL ELECTRICAL CHARACTERISTICS — UMC5NT1 PNP TRANSISTOR

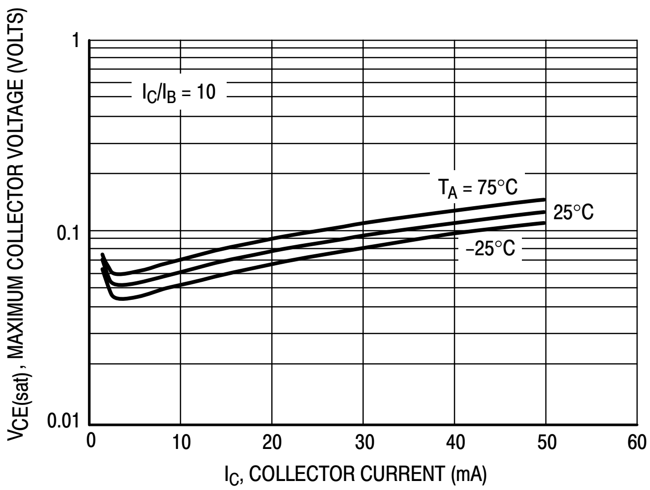


Figure 22. $V_{CE(sat)}$ versus I_C

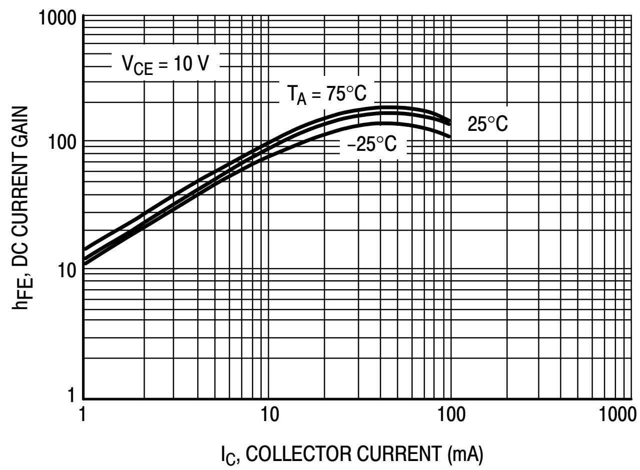


Figure 23. DC Current Gain

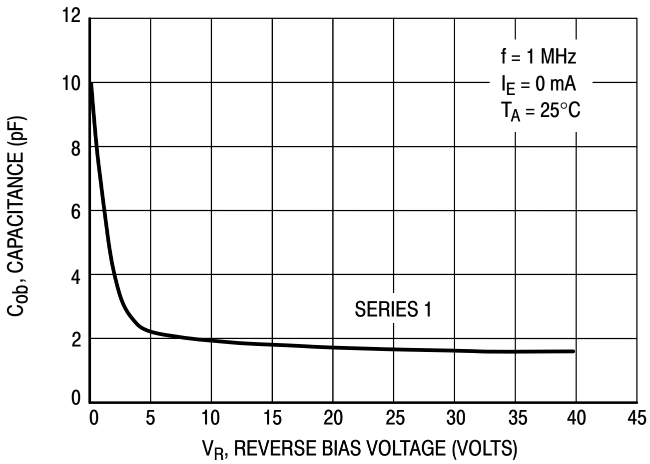


Figure 24. Output Capacitance

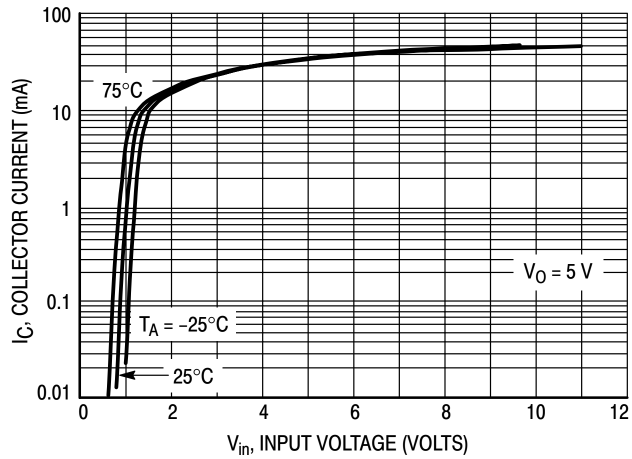


Figure 25. Output Current versus Input Voltage

TYPICAL ELECTRICAL CHARACTERISTICS — UMC5NT1 NPN TRANSISTOR

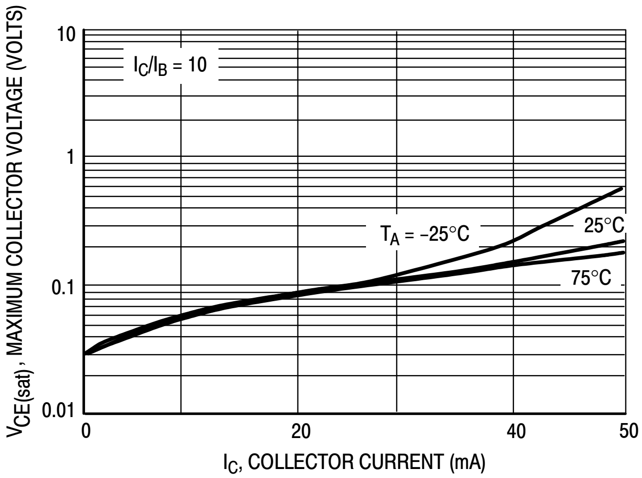


Figure 26. $V_{CE(sat)}$ versus I_C

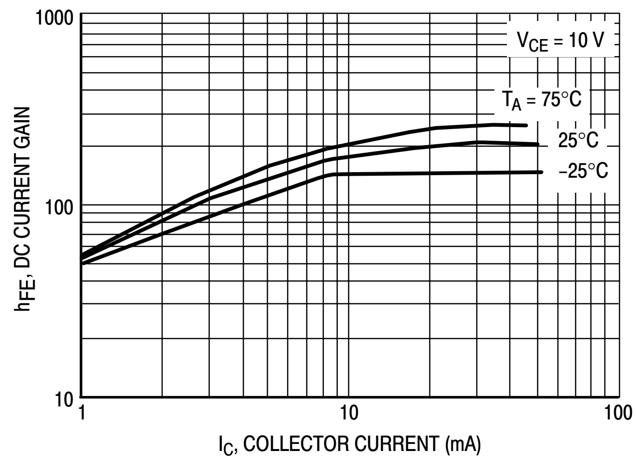


Figure 27. DC Current Gain

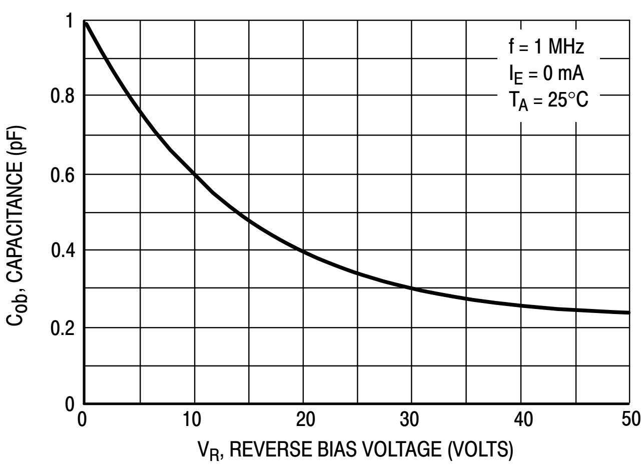


Figure 28. Output Capacitance

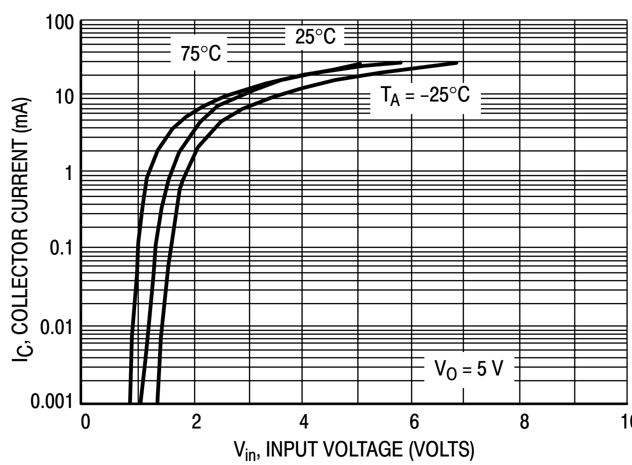


Figure 29. Output Current versus Input Voltage

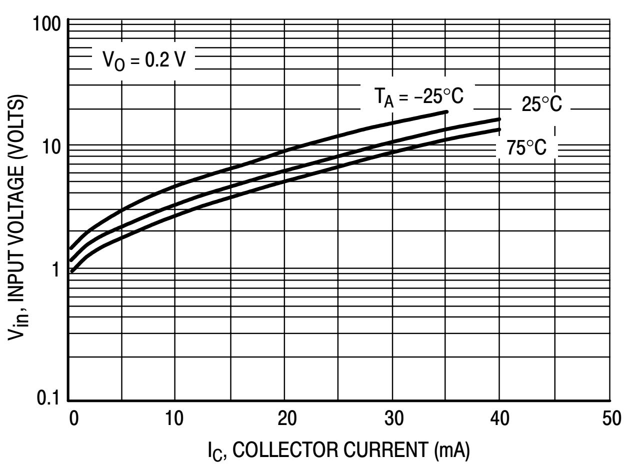


Figure 30. Input Voltage versus Output Current

CHAPTER 3
Packaging and Case Outlines

DL126TRS/D

Tape & Reel and Packaging Specifications for Small-Signal Transistors, FETs and Diodes

Excerpted from the ON Semiconductor Small–Signal Transistors, FETs and Diodes Device Data Book, DL126/D.

ON Semiconductor™

http://onsemi.com

Embossed Tape and Reel is used to facilitate automatic pick and place equipment feed requirements. The tape is used as the shipping container for various products and requires a minimum of handling. The antistatic/conductive tape provides a secure cavity for the product when sealed with the "peel–back" cover tape.

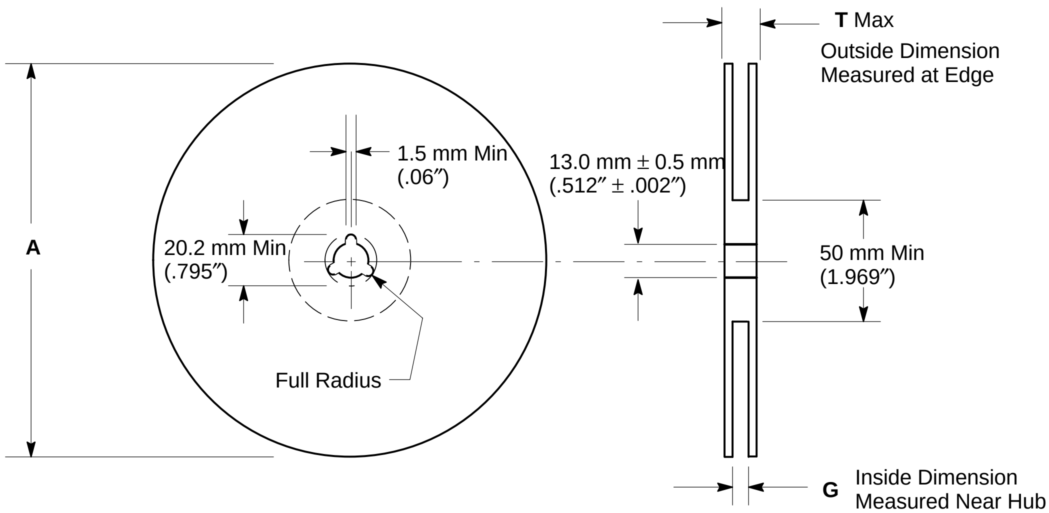
- Two Reel Sizes Available (7″ and 13″)
- Used for Automatic Pick and Place Feed Systems
- Minimizes Product Handling
- EIA 481, –1, –2
- SOT–23, SC–59, SC–70/SOT–323, SC–75/SOT–416/SC–90, SC–88/SOT–363, SC–88A/SOT–353, SC–74/TSOP–6, SOD–123, SOD–323 in 8 mm Tape
- SOT–89, SOT–223 in 12 mm Tape
- SO–16 in 16 mm Tape

Use the standard device title and add the required suffix as listed in the option table below (Table 1). Note that the individual reels have a finite number of devices depending on the type of product contained in the tape. Also note the minimum lot size is one full reel for each line item, and orders are required to be in increments of the single reel quantity.

Table 1. EMBOSSED TAPE AND REEL ORDERING INFORMATION

Package	Tape Width (mm)	Pitch mm (inch)	Reel Size mm (inch)	Devices Per Reel and Minimum Order Quantity	Device Suffix
SOT–23	8 8	4	178 (7) 330 (13)	3,000 10,000	T1 T3
SC–59	8	4	178 (7)	3,000	T1
SC–70, SOT–323	8 8	4	178 (7) 330 (13)	3,000 10,000	T1 T3
SC–75, SOT–416, SC–90	8	4	178 (7)	3,000	T1
SC–88, SOT–363	8	4	178 (7)	3,000	T1
SC–88A, SOT–353	8	4	178 (7)	3,000	T1
SC–74, TSOP–6	8	4	178 (7)	3,000	T1
SOD–123	8 8	4	178 (7) 330 (13)	3,000 10,000	T1 T3
SOD–323	8	4	178 (7)	3,000	T1
SOT–89	12	8	178 (7)	1,000	T1
SOT–223	12 12	8	178 (7) 330 (13)	1,000 4,000	T1 T3
SO–16	16 16	8	178 (7) 330 (13)	500 2,500	R1 R2

EMBOSSED TAPE AND REEL DATA FOR DISCRETES



Size	A Max	G	T Max
8 mm	330 mm (12.992″)	8.4 mm + 1.5 mm, –0.0 (.33″ + .059″, –0.00)	14.4 mm (.56″)
12 mm	330 mm (12.992″)	12.4 mm + 2.0 mm, –0.0 (.49″ + .079″, –0.00)	18.4 mm (.72″)
16 mm	360 mm (14.173″)	16.4 mm + 2.0 mm, –0.0 (.646″ + .078″, –0.00)	22.4 mm (.882″)
24 mm	360 mm (14.173″)	24.4 mm + 2.0 mm, –0.0 (.961″ + .070″, –0.00)	30.4 mm (1.197″)

Figure 1. Reel Dimensions

Metric Dimensions Govern — English are in parentheses for reference only

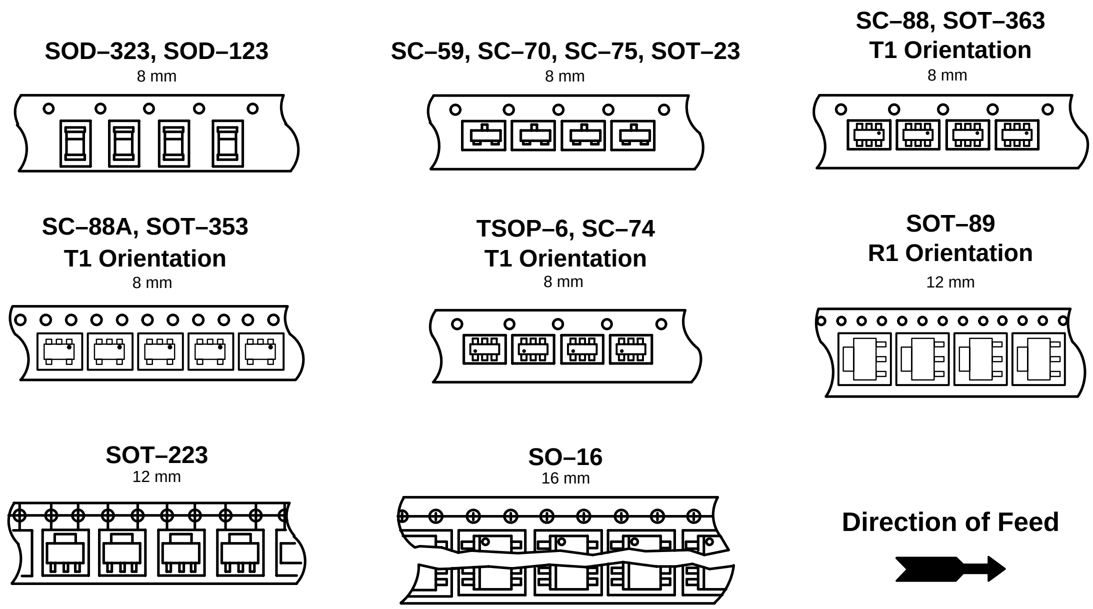


Figure 2. Typical Reel Orientations

Figure 3. CARRIER TAPE SPECIFICATIONS

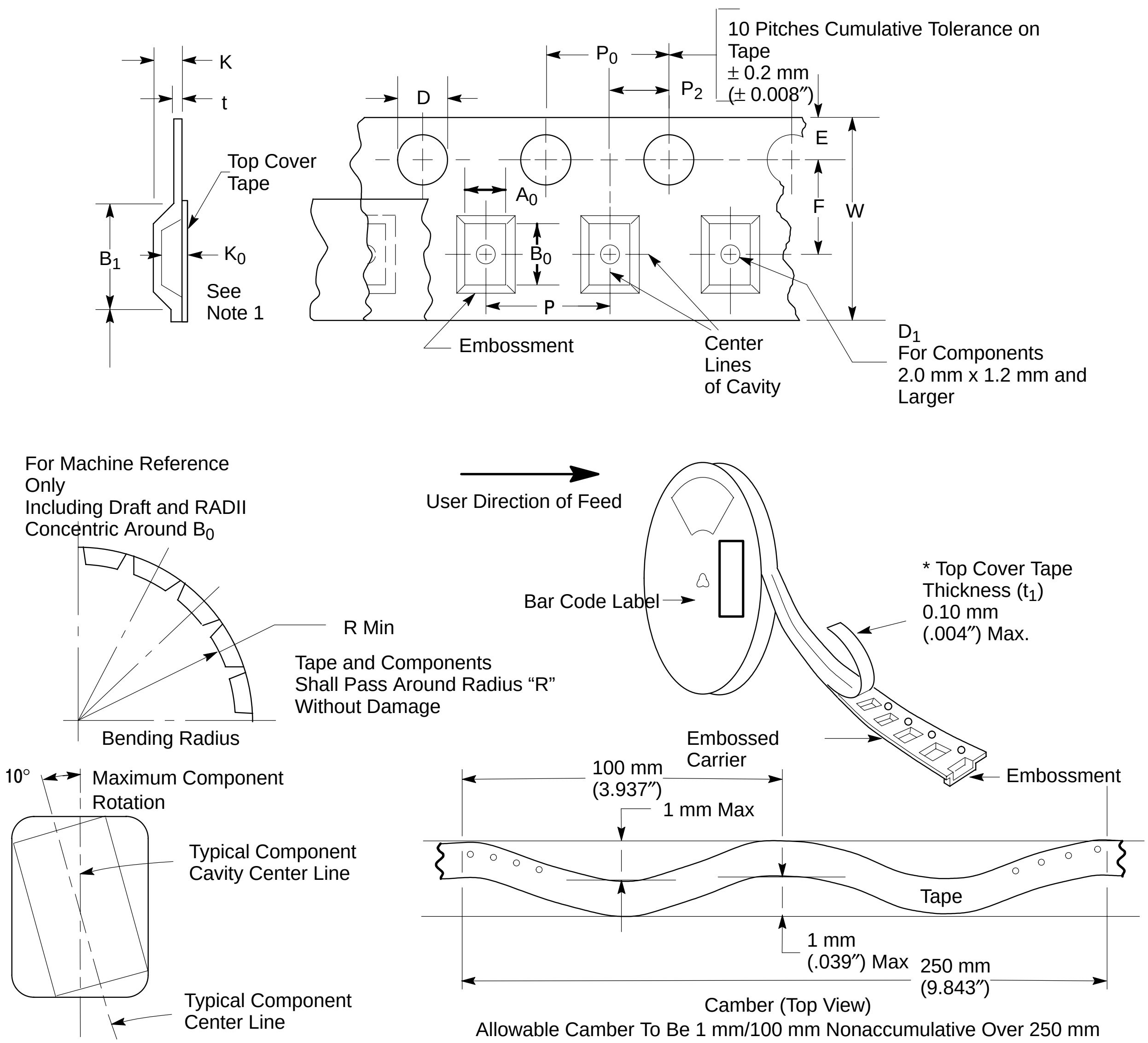


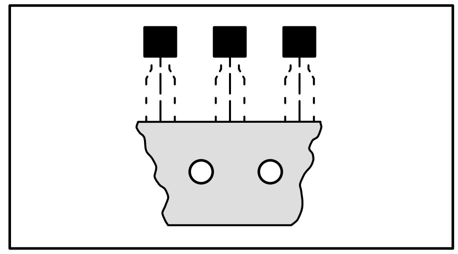
Table 2. DIMENSIONS

Tape Size	B_1 Max	D	D_1	E	F	K	P_0	P_2	R Min	T Max	W Max
8 mm	4.55 mm (.179″)	1.5+0.1 mm −0.0 (.059+.004″ −0.0)	1.0 Min (.039″)	1.75±0.1 mm (.069±.004″)	3.5±0.05 mm (.138±.002″)	2.4 mm Max (.094″)	4.0±0.1 mm (.157±.004″)	2.0±0.1 mm (.079±.002″)	25 mm (.98″)	0.6 mm (.024″)	8.3 mm (.327″)
12 mm	8.2 mm (.323″)		1.5 mm Min (.060″)		5.5±0.05 mm (.217±.002″)	6.4 mm Max (.252″)			30 mm (1.18″)		12±.30 mm (.470±.012″)
16 mm	12.1 mm (.476″)				7.5±0.10 mm (.295±.004″)	7.9 mm Max (.311″)					16.3 mm (.642″)
24 mm	20.1 mm (.791″)				11.5±0.1 mm (.453±.004″)	11.9 mm Max (.468″)					24.3 mm (.957″)

Metric dimensions govern — English are in parentheses for reference only.

1. A_0, B_0, and K_0 are determined by component size. The clearance between the components and the cavity must be within 0.05 mm min. to 0.50 mm max., the component cannot rotate more than 10° within the determined cavity.
2. If B_1 exceeds 4.2 mm (0.165) for 8 mm embossed tape, the tape may not feed through all tape feeders.
3. Pitch information is contained in Table 1. Embossed Tape and Reel Ordering Information on pg. 1093.

TO-92 EIA, IEC, EIAJ Radial Tape in Fan Fold Box or On Reel



Radial tape in fan fold box or on reel of the reliable TO–92 package are the best methods of capturing devices for automatic insertion in printed circuit boards. These methods of taping are compatible with various equipment for active and passive component insertion.

- Available in Fan Fold Box
- Available on 365 mm Reels
- Accommodates All Standard Inserters
- Allows Flexible Circuit Board Layout
- 2.5 mm Pin Spacing for Soldering
- EIA–468, IEC 286–2, EIAJ RC1008B

Ordering Notes:

When ordering radial tape in fan fold box or on reel, specify the style per Figures 4 through 7. Add the suffix "RLR" and "Style" to the device title, i.e. MPS3904RLRA. This will be a standard MPS3904 leadformed, radial taped and supplied on a reel per Figure 4.

Fan Fold Box Information — Order in increments of 2000.

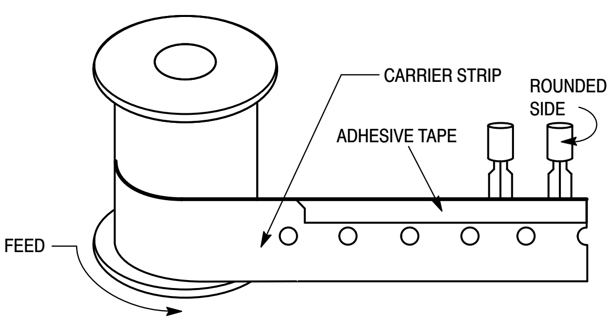
Reel Information — Order in increments of 2000.

US/European Suffix Conversions

US	EUROPE
RLRA	RL
RLRE	RL1
RLRM	ZL1

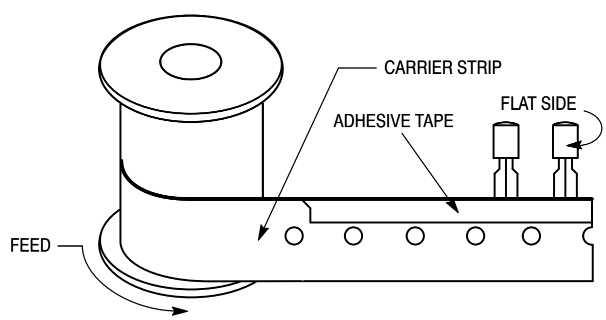
Package Suffixes

Device Suffix	Leadform Type	Shipping
(None)	Straight	5000/Bag
RLRA	Leadformed	2000/Tape & Reel
RLRE	Leadformed	2000/Tape & Reel
RLRM	Leadformed	2000/Fan Fold Box
RLRP	Leadformed	2000/Fan Fold Box



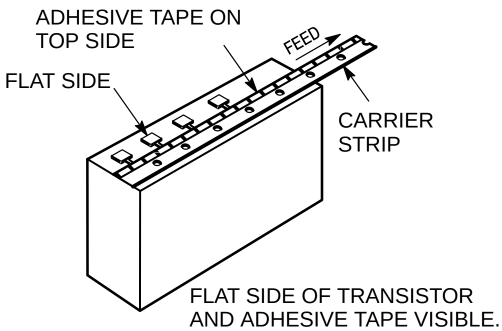
Rounded side of transistor and adhesive tape visible.

Figure 4. Style A



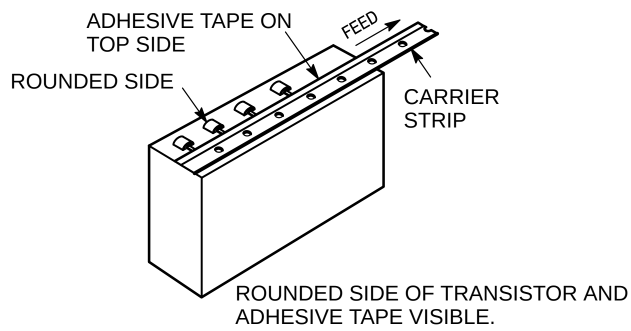
Flat side of transistor and adhesive tape visible.

Figure 5. Style E



Style M fan fold box is equivalent to styles E and F of reel pack dependent on feed orientation from box.

Figure 6. Style M



Style P fan fold box is equivalent to styles A and B of reel pack dependent on feed orientation from box.

Figure 7. Style P

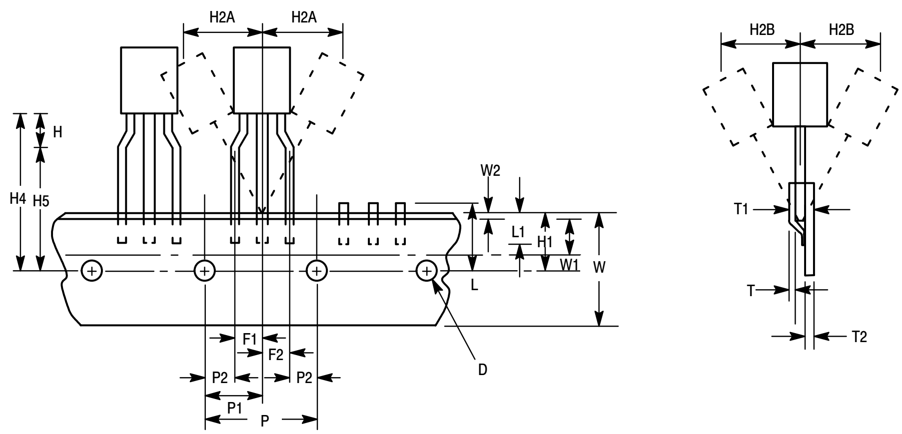


Figure 8. Device Positioning on Tape

Dimensions for Device Positioning on Tape for Fan Fold Box

Symbol	Item	Specification			
		Inches		Millimeter	
		Min	Max	Min	Max
D	Tape Feedhole Diameter	0.1496	0.1653	3.8	4.2
D2	Component Lead Thickness Dimension	0.015	0.020	0.38	0.51
F1, F2	Component Lead Pitch	0.0945	0.110	2.4	2.8
H	Bottom of Component to Seating Plane	.059	.156	1.5	4.0
H1	Feedhole Location	0.3346	0.3741	8.5	9.5
H2A	Deflection Left or Right	0	0.039	0	1.0
H2B	Deflection Front or Rear	0	0.051	0	1.0
H4	Feedhole to Bottom of Component	0.7086	0.768	18	19.5
H5	Feedhole to Seating Plane	0.610	0.649	15.5	16.5
L	Defective Unit Clipped Dimension	0.3346	0.433	8.5	11
L1	Lead Wire Enclosure	0.09842	—	2.5	—
P	Feedhole Pitch	0.4921	0.5079	12.5	12.9
P1	Feedhole Center to Center Lead	0.2342	0.2658	5.95	6.75
P2	First Lead Spacing Dimension	0.1397	0.1556	3.55	3.95
T	Adhesive Tape Thickness	0.06	0.08	0.15	0.20

Dimensions for Device Positioning on Tape for Fan Fold Box

Symbol	Item	Specification			
		Inches		Millimeter	
		Min	Max	Min	Max
T1	Overall Taped Package Thickness	—	0.0567	—	1.44
T2	Carrier Strip Thickness	0.014	0.027	0.35	0.65
W	Carrier Strip Width	0.6889	0.7481	17.5	19
W1	Adhesive Tape Width	0.2165	0.2841	5.5	6.3
W2	Adhesive Tape Position	.0059	0.01968	.15	0.5

NOTES:
1. Maximum alignment deviation between leads not to be greater than 0.2 mm.
2. Defective components shall be clipped from the carrier tape such that the remaining protrusion (L) does not exceed a maximum of 11 mm.
3. Component lead to tape adhesion must meet the pull test requirements established in Figures 5, 6 and 7.
4. Maximum non–cumulative variation between tape feed holes shall not exceed 1 mm in 20 pitches.
5. Holddown tape not to extend beyond the edge(s) of carrier tape and there shall be no exposure of adhesive.
6. No more than 1 consecutive missing component is permitted.
7. A tape trailer and leader, having at least three feed holes is required before the first and after the last component.
8. Splices will not interfere with the sprocket feed holes.

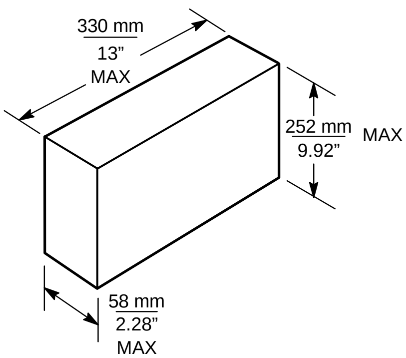
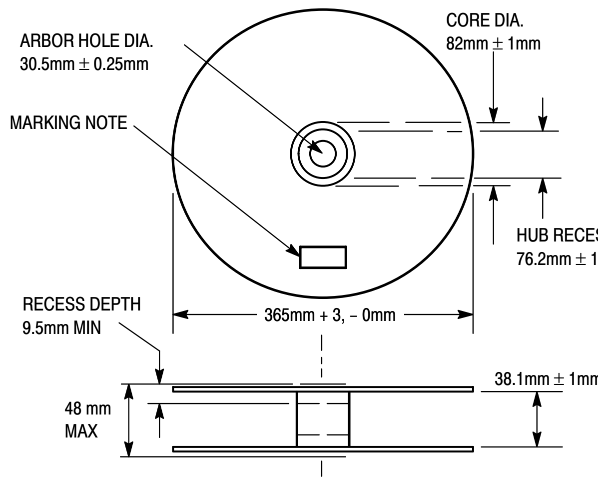


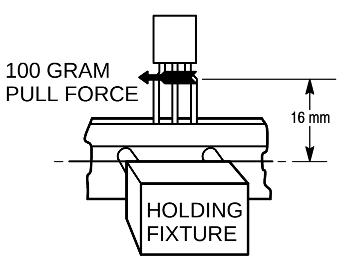
Figure 9. Fan Fold Box Dimensions



Material used must not cause deterioration of components or degrade lead solderability

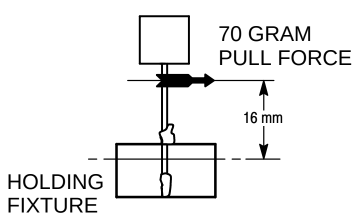
Figure 10. Reel Dimensions

ADHESION PULL TESTS



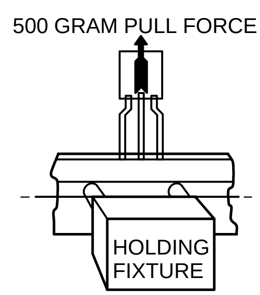
The component shall not pull free with a 300 gram load applied to the leads for 3 ± 1 second.

Figure 11. Test #1



The component shall not pull free with a 70 gram load applied to the leads for 3 ± 1 second.

Figure 12. Test #2

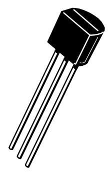


There shall be no deviation in the leads and no component leads shall be pulled free of the tape with a 500 gram load applied to the component body for 3 ± 1 second.

Figure 13. Test #3

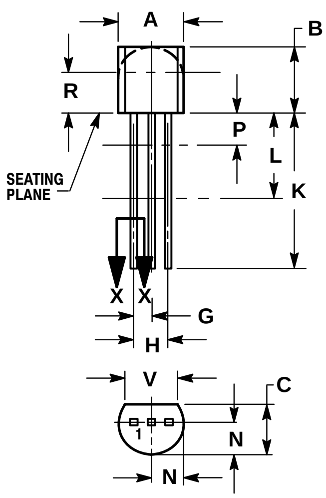
Case Outlines

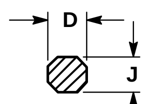
Case Outlines



TO–226AA, TO–92
CASE 29–11
ISSUE AL

SCALE 1:1

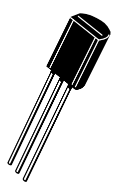




SECTION X–X

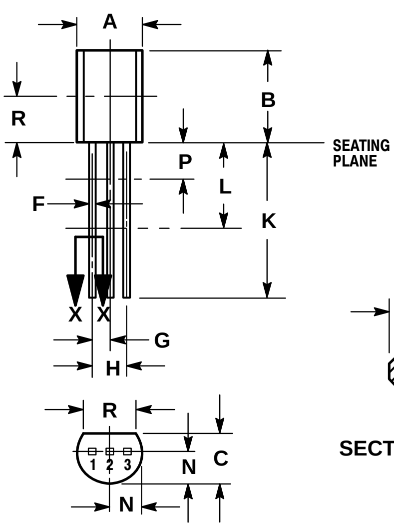
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

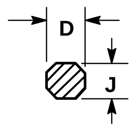
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---



TO–226AE, TO–92
(1 WATT)
CASE 29–10
ISSUE AL

SCALE 1:1

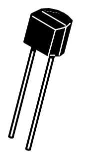




SECTION X–X

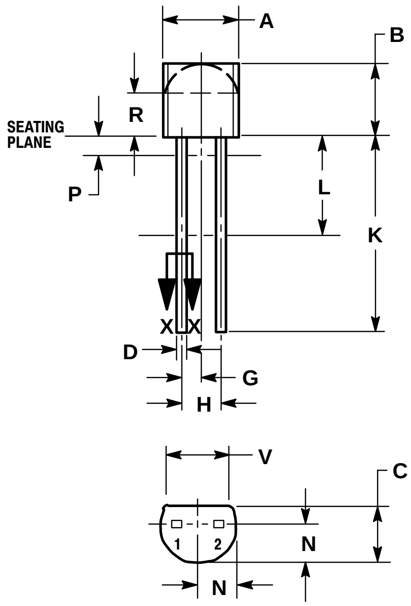
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. DIMENSION F APPLIES BETWEEN P AND L. DIMENSIONS D AND J APPLY BETWEEN L AND K MIMIMUM. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

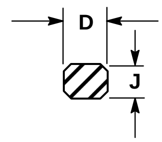
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.44	5.21
B	0.290	0.310	7.37	7.87
C	0.125	0.165	3.18	4.19
D	0.018	0.021	0.457	0.533
F	0.016	0.019	0.407	0.482
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.018	0.024	0.46	0.61
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.135	---	3.43	---



TO–226AC, TO–92
2–LEAD
CASE 182–06
ISSUE L

SCALE 1:1

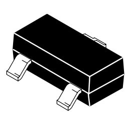




SECTION X–X

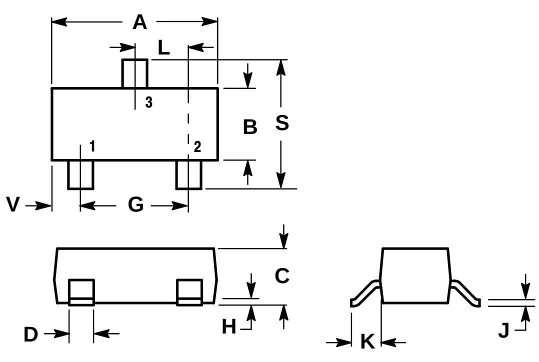
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND ZONE R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.21
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.050 BSC		1.27 BSC	
H	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.41
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.03	2.66
P	---	0.050	---	1.27
R	0.115	---	2.93	---
V	0.135	---	3.43	---



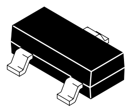
TO–236AB, SOT–23
CASE 318–08
ISSUE AH

SCALE 4:1



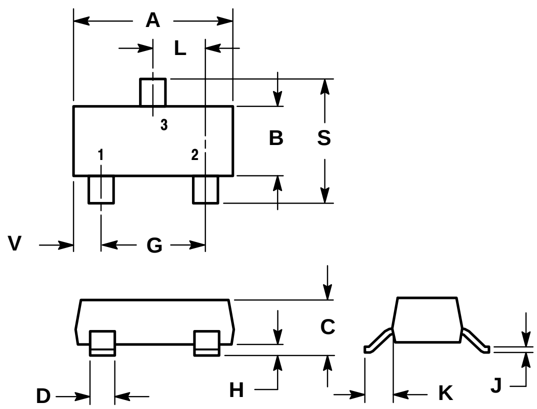
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318–03 AND –07 OBSOLETE, NEW STANDARD 318–08.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.1102	0.1197	2.80	3.04
B	0.0472	0.0551	1.20	1.40
C	0.0350	0.0440	0.89	1.11
D	0.0150	0.0200	0.37	0.50
G	0.0701	0.0807	1.78	2.04
H	0.0005	0.0040	0.013	0.100
J	0.0034	0.0070	0.085	0.177
K	0.0140	0.0285	0.35	0.69
L	0.0350	0.0401	0.89	1.02
S	0.0830	0.1039	2.10	2.64
V	0.0177	0.0236	0.45	0.60



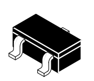
TO–236, SOT–23
CASE 318–09
ISSUE AH

SCALE 4:1



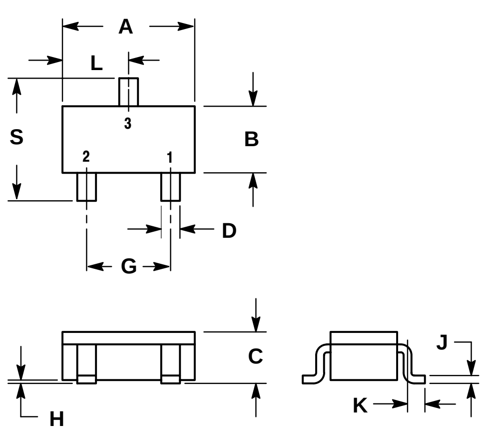
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIUMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318–01, –02, AND –06 OBSOLETE, NEW STANDARD 318–09.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.1102	0.1197	2.80	3.04
B	0.0472	0.0551	1.20	1.40
C	0.0385	0.0498	0.99	1.26
D	0.0140	0.0200	0.36	0.50
G	0.0670	0.0826	1.70	2.10
H	0.0040	0.0098	0.10	0.25
J	0.0034	0.0070	0.085	0.177
K	0.0180	0.0236	0.45	0.60
L	0.0350	0.0401	0.89	1.02
S	0.0830	0.0984	2.10	2.50
V	0.0177	0.0236	0.45	0.60



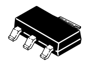
SC–59
CASE 318D–04
ISSUE F

SCALE 2:1



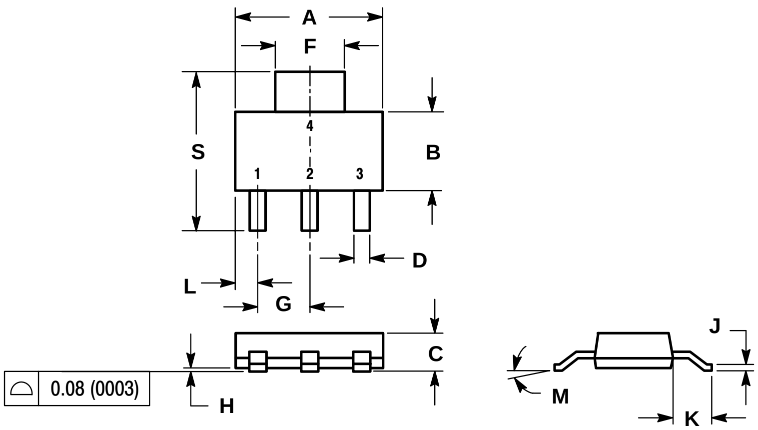
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	2.70	3.10	0.1063	0.1220
B	1.30	1.70	0.0512	0.0669
C	1.00	1.30	0.0394	0.0511
D	0.35	0.50	0.0138	0.0196
G	1.70	2.10	0.0670	0.0826
H	0.013	0.100	0.0005	0.0040
J	0.09	0.18	0.0034	0.0070
K	0.20	0.60	0.0079	0.0236
L	1.25	1.65	0.0493	0.0649
S	2.50	3.00	0.0985	0.1181



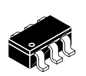
SOT–223, TO–261AA
CASE 318E–04
ISSUE K

SCALE 1:1



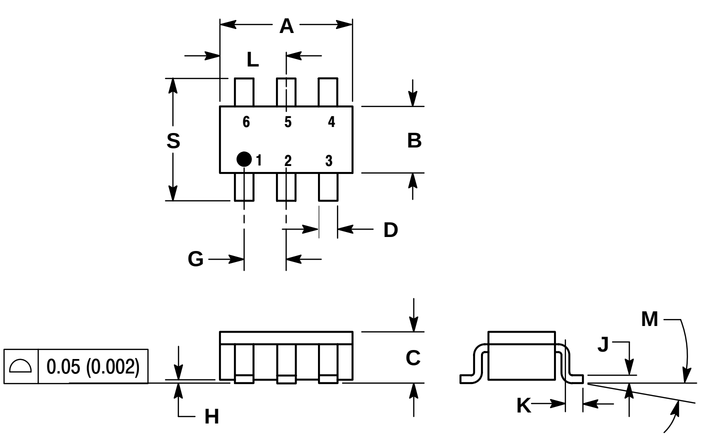
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.249	0.263	6.30	6.70
B	0.130	0.145	3.30	3.70
C	0.060	0.068	1.50	1.75
D	0.024	0.035	0.60	0.89
F	0.115	0.126	2.90	3.20
G	0.087	0.094	2.20	2.40
H	0.0008	0.0040	0.020	0.100
J	0.009	0.014	0.24	0.35
K	0.060	0.078	1.50	2.00
L	0.033	0.041	0.85	1.05
M	0 °	10 °	0 °	10 °
S	0.264	0.287	6.70	7.30



SC–74, SC–59
CASE 318F–03
ISSUE F

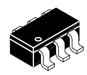
SCALE 2:1



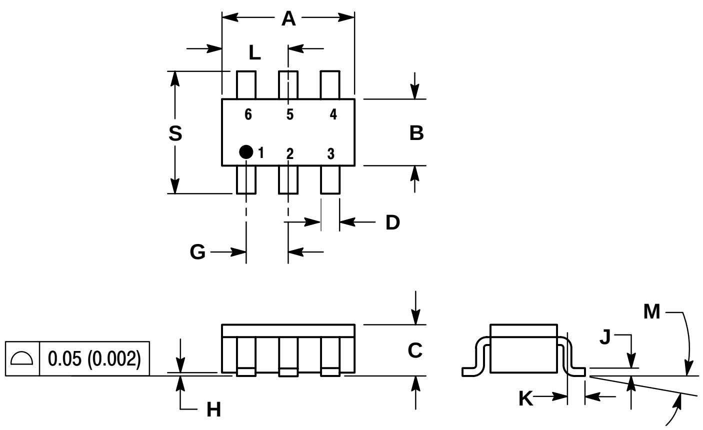
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318F–01 AND –02 OBSOLETE. NEW STANDARD 318F–03.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.1142	0.1220	2.90	3.10
B	0.0512	0.0669	1.30	1.70
C	0.0354	0.0433	0.90	1.10
D	0.0098	0.0197	0.25	0.50
G	0.0335	0.0413	0.85	1.05
H	0.0005	0.0040	0.013	0.100
J	0.0040	0.0102	0.10	0.26
K	0.0079	0.0236	0.20	0.60
L	0.0493	0.0649	1.25	1.65
M	0 °	10 °	0 °	10 °
S	0.0985	0.1181	2.50	3.00

TSOP–6
CASE 318G–02
ISSUE H



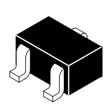
SCALE 2:1



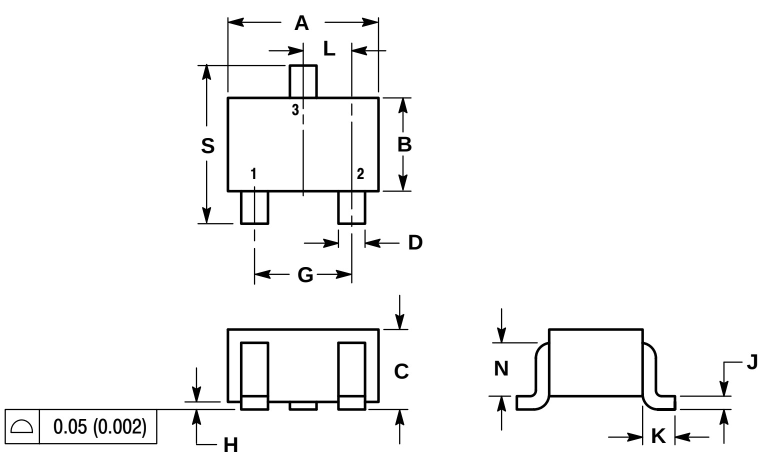
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	2.90	3.10	0.1142	0.1220
B	1.30	1.70	0.0512	0.0669
C	0.90	1.10	0.0354	0.0433
D	0.25	0.50	0.0098	0.0197
G	0.85	1.05	0.0335	0.0413
H	0.013	0.100	0.0005	0.0040
J	0.10	0.26	0.0040	0.0102
K	0.20	0.60	0.0079	0.0236
L	1.25	1.55	0.0493	0.0610
M	0°	10°	0°	10°
S	2.50	3.00	0.0985	0.1181

SC–70, SOT–323
CASE 419–04
ISSUE L

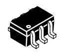


SCALE 4:1



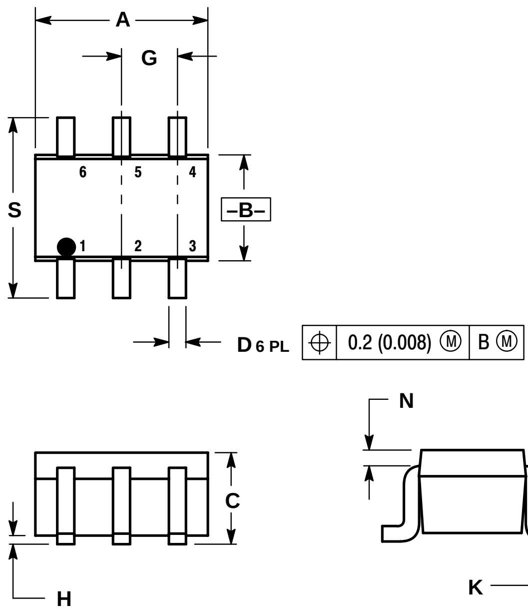
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.032	0.040	0.80	1.00
D	0.012	0.016	0.30	0.40
G	0.047	0.055	1.20	1.40
H	0.000	0.004	0.00	0.10
J	0.004	0.010	0.10	0.25
K	0.017 REF		0.425 REF	
L	0.026 BSC		0.650 BSC	
N	0.028 REF		0.700 REF	
S	0.079	0.095	2.00	2.40



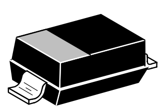
SCALE 2:1

SC–88, SOT–363
CASE 419B–02
ISSUE H



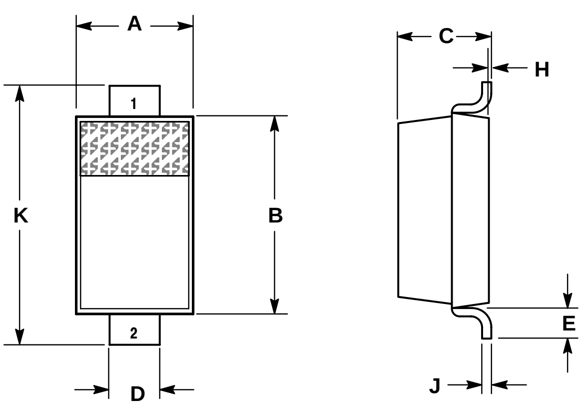
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.031	0.043	0.80	1.10
D	0.004	0.012	0.10	0.30
G	0.026 BSC		0.65 BSC	
H	---	0.004	---	0.10
J	0.004	0.010	0.10	0.25
K	0.004	0.012	0.10	0.30
N	0.008 REF		0.20 REF	
S	0.079	0.087	2.00	2.20



SOD–123
CASE 425–04
ISSUE C

SCALE 5:1

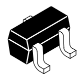


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

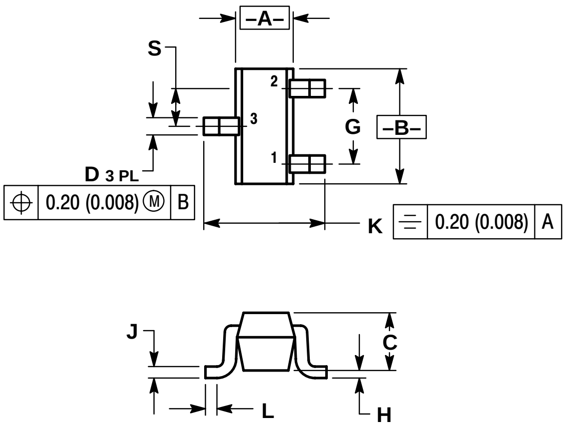
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.055	0.071	1.40	1.80
B	0.100	0.112	2.55	2.85
C	0.037	0.053	0.95	1.35
D	0.020	0.028	0.50	0.70
E	0.01	---	0.25	---
H	0.000	0.004	0.00	0.10
J	---	0.006	---	0.15
K	0.140	0.152	3.55	3.85

STYLE 1:
PIN 1. CATHODE
2. ANODE

SOT–416, SC–75, SC–90
CASE 463–01
ISSUE B



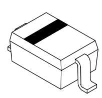
SCALE 4:1



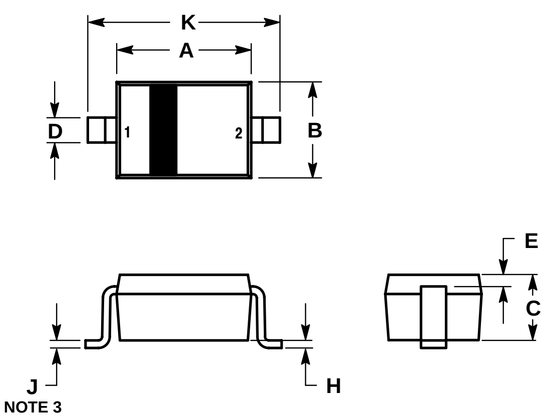
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	0.70	0.80	0.028	0.031
B	1.40	1.80	0.055	0.071
C	0.60	0.90	0.024	0.035
D	0.15	0.30	0.006	0.012
G	1.00 BSC		0.039 BSC	
H	---	0.10	---	0.004
J	0.10	0.25	0.004	0.010
K	1.45	1.75	0.057	0.069
L	0.10	0.20	0.004	0.008
S	0.50 BSC		0.020 BSC	

SOD–323
CASE 477–02
ISSUE B



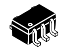
SCALE 4:1



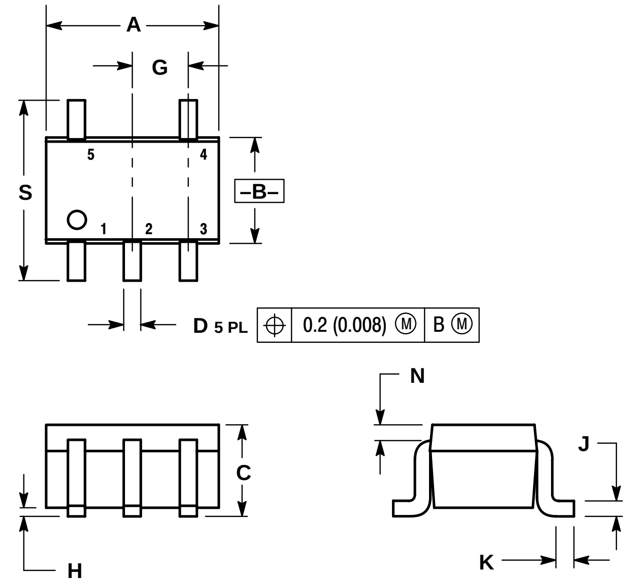
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. LEAD THICKNESS SPECIFIED PER L/F DRAWING WITH SOLDER PLATING.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	1.60	1.80	0.063	0.071
B	1.15	1.35	0.045	0.053
C	0.80	1.00	0.031	0.039
D	0.25	0.40	0.010	0.016
E	0.15 REF		0.006 REF	
H	0.00	0.10	0.000	0.004
J	0.089	0.177	0.0035	0.0070
K	2.30	2.70	0.091	0.106

SC–88A, SOT–353, SC70–5 (5–LEAD)
CASE 419A–02
ISSUE F



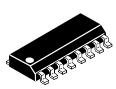
SCALE 2:1



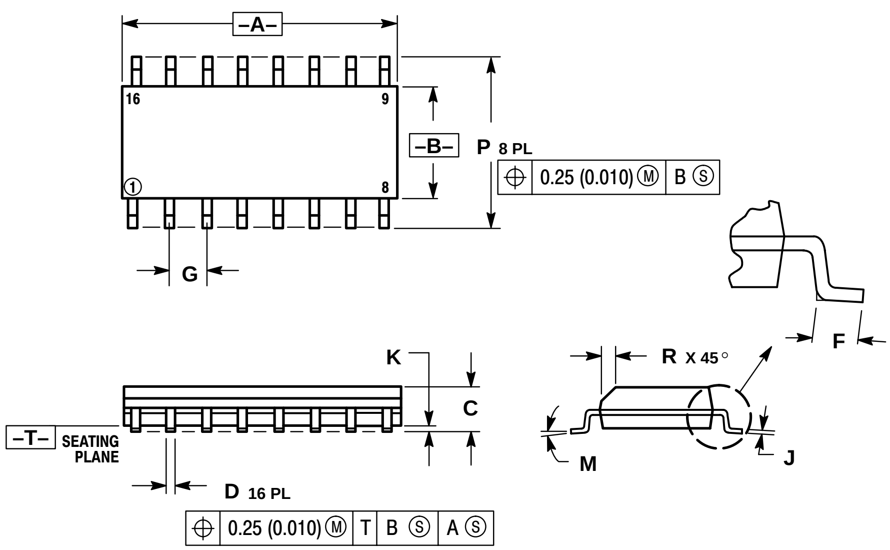
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419A–01 OBSOLETE. NEW STANDARD 419A–02.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.031	0.043	0.80	1.10
D	0.004	0.012	0.10	0.30
G	0.026 BSC		0.65 BSC	
H	---	0.004	---	0.10
J	0.004	0.010	0.10	0.25
K	0.004	0.012	0.10	0.30
N	0.008 REF		0.20 REF	
S	0.079	0.087	2.00	2.20

SO–16
CASE 751B–05
ISSUE J



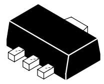
SCALE 1:1



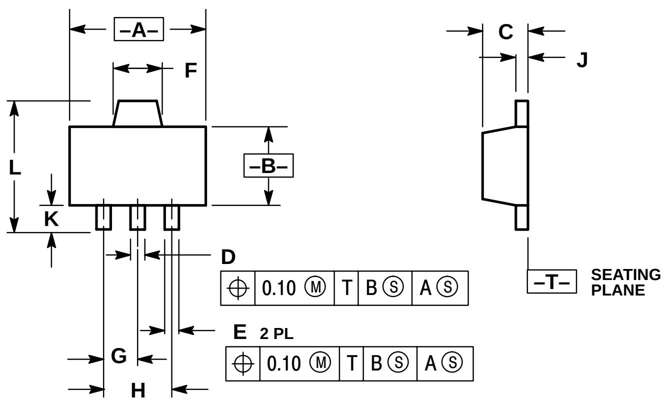
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

SOT–89 (3–LEAD)
CASE 1213–02
ISSUE C



SCALE 2:1



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETERS
3. 1213–01 OBSOLETE, NEW STANDARD 1213–02.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.40	4.60	0.173	0.181
B	2.40	2.60	0.094	0.102
C	1.40	1.60	0.055	0.063
D	0.37	0.57	0.015	0.022
E	0.32	0.52	0.013	0.020
F	1.50	1.83	0.059	0.072
G	1.50 BSC		0.059 BSC	
H	3.00 BSC		0.118 BSC	
J	0.30	0.50	0.012	0.020
K	0.80	---	0.031	---
L	---	4.25	---	0.167

Surface Mount Package Information

The following pages contain information about ON Semiconductor's Surface Mount Pacakages including:

- Mimium Recommended Footprint
- Power Dissipation
- Soldering Precautions
- Solder Stencil Guidelines
- Typical Solder Heating Profile

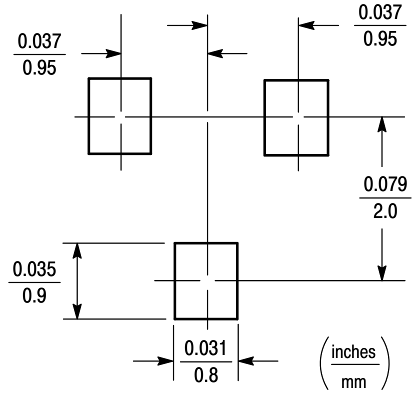
for the following Surface Mount Packages:

- SOT–23
- SC–59
- SOT–223
- TSOP–6 (SC–74)
- SC–70 (SOT–323)
- SOT–363 (SC–88)
- SOD–123 (SC–77)
- SOT–416 (SC–75, SC–90)
- SOT–353 (SC–88A)
- SO–16

INFORMATION FOR USING THE SOT–23 SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SOT–23

SOT–23 POWER DISSIPATION

The power dissipation of the SOT–23 is a function of the pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient, and the operating temperature, T_A. Using the values provided on the data sheet for the SOT–23 package, P_D can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 225 milliwatts.

$$P_D = \frac{150°C - 25°C}{556°C/W} = 225 \text{ milliwatts}$$

The 556°C/W for the SOT–23 package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 225 milliwatts. There are other alternatives to achieving higher power dissipation from the SOT–23 package. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, an aluminum core board, the power dissipation can be doubled using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

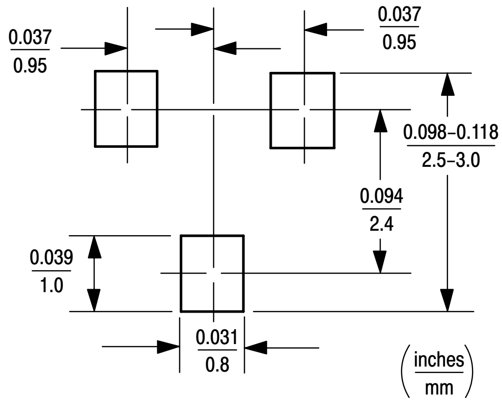
- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference shall be a maximum of 10°C.
- The soldering temperature and time shall not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient shall be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

INFORMATION FOR USING THE SC–59 SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SC–59 POWER DISSIPATION

The power dissipation of the SC–59 is a function of the pad size. This can vary from the minimum pad size for soldering to the pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R\theta_{JA}$, the thermal resistance from the device junction to ambient; and the operating temperature, T_A. Using the values provided on the data sheet, P_D can be calculated as follows.

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 338 milliwatts.

$$P_D = \frac{150°C - 25°C}{370°C/W} = 338 \text{ milliwatts}$$

The 370°C/W assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 338 milliwatts. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, the power dissipation can be doubled using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

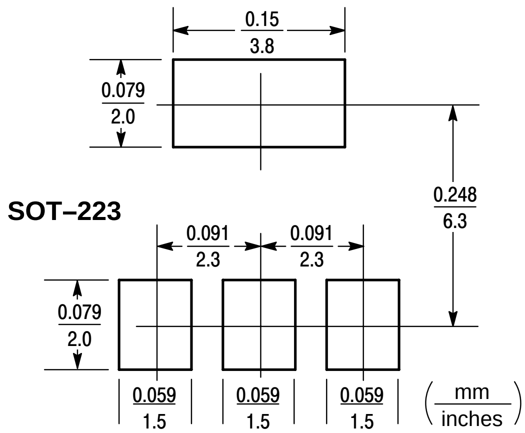
- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference should be a maximum of 10°C.
- The soldering temperature and time should not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient should be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

INFORMATION FOR USING THE SOT–223 SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SOT–223 POWER DISSIPATION

The power dissipation of the SOT–223 is a function of the pad size. This can vary from the minimum pad size for soldering to the pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R\theta_{JA}$, the thermal resistance from the device junction to ambient; and the operating temperature, T_A. Using the values provided on the data sheet for the SOT–223 package, P_D can be calculated as follows.

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 1.5 watts.

$$P_D = \frac{150°C - 25°C}{83.3°C/W} = 1.50 \text{ watts}$$

The 83.3°C/W assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 1.5 watts. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, a higher power dissipation of 1.6 watts can be achieved using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

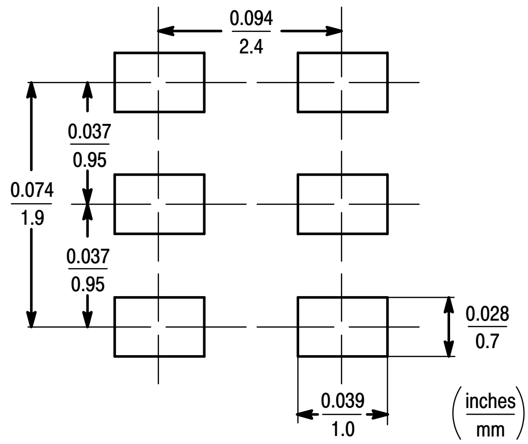
- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference should be a maximum of 10°C.
- The soldering temperature and time should not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient should be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

INFORMATION FOR USING THE TSOP–6 SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



TSOP–6

TSOP–6 POWER DISSIPATION

The power dissipation of the TSOP–6 is a function of the pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient, and the operating temperature, T_A. Using the values provided on the data sheet for the TSOP–6 package, P_D can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 310 milliwatts.

$$P_D = \frac{150°C - 25°C}{403°C/W} = 310 \text{ milliwatts}$$

The 403°C/W for the TSOP–6 package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 310 milliwatts. There are other alternatives to achieving higher power dissipation from the TSOP–6 package. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, an aluminum core board, the power dissipation can be doubled using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

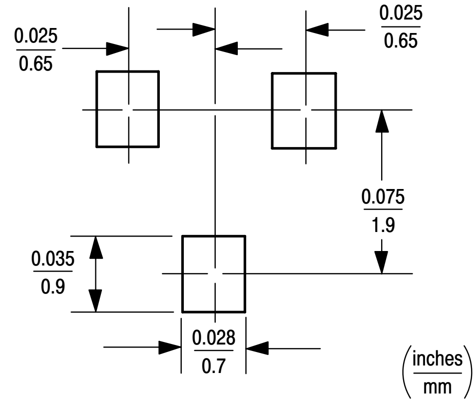
- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference shall be a maximum of 10°C.
- The soldering temperature and time shall not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient shall be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

INFORMATION FOR USING THE SC–70/SOT–323 SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SC–70/SOT–323 POWER DISSIPATION

The power dissipation of the SC–70/SOT–323 is a function of the pad size. This can vary from the minimum pad size for soldering to the pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R\theta_{JA}$, the thermal resistance from the device junction to ambient; and the operating temperature, T_A. Using the values provided on the data sheet, P_D can be calculated as follows.

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 200 milliwatts.

$$P_D = \frac{150°C - 25°C}{0.625°C/W} = 200 \text{ milliwatts}$$

The 0.625°C/W assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 200 milliwatts. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, a higher power dissipation of 300 milliwatts can be achieved using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

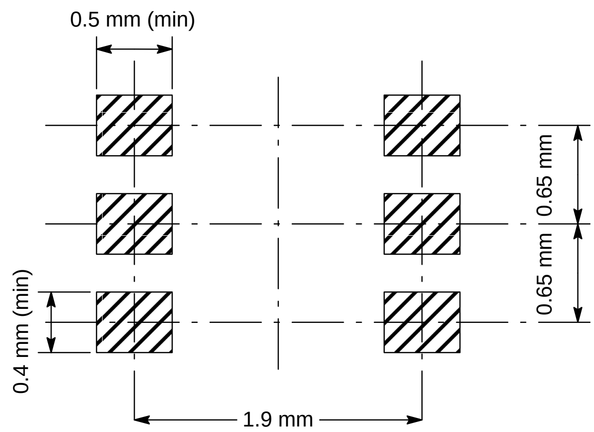
- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference should be a maximum of 10°C.
- The soldering temperature and time should not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient should be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

INFORMATION FOR USING THE SOT–363 SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SOT–363

SOT–363 POWER DISSIPATION

The power dissipation of the SOT–363 is a function of the pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient, and the operating temperature, T_A. Using the values provided on the data sheet for the SOT–363 package, P_D can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 150 milliwatts.

$$P_D = \frac{150°C - 25°C}{833°C/W} = 150 \text{ milliwatts}$$

The 833°C/W for the SOT–363 package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 150 milliwatts. There are other alternatives to achieving higher power dissipation from the SOT–363 package. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, an aluminum core board, the power dissipation can be doubled using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

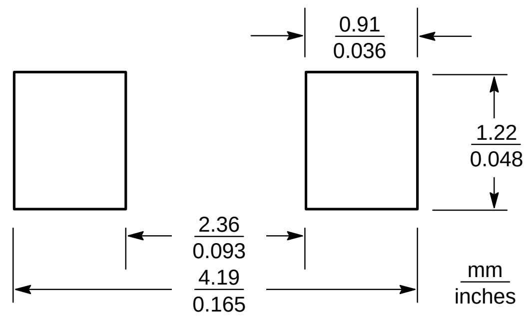
- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference shall be a maximum of 10°C.
- The soldering temperature and time shall not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient shall be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

INFORMATION FOR USING THE SOD–123 SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SOD–123

SOD–123 POWER DISSIPATION

The power dissipation of the SOD–123 is a function of the pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient, and the operating temperature, T_A. Using the values provided on the data sheet for the SOD–123 package, P_D can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 225 milliwatts.

$$P_D = \frac{150°C - 25°C}{556°C/W} = 225 \text{ milliwatts}$$

The 556°C/W for the SOD–123 package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 225 milliwatts. There are other alternatives to achieving higher power dissipation from the SOD–123 package. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, an aluminum core board, the power dissipation can be doubled using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

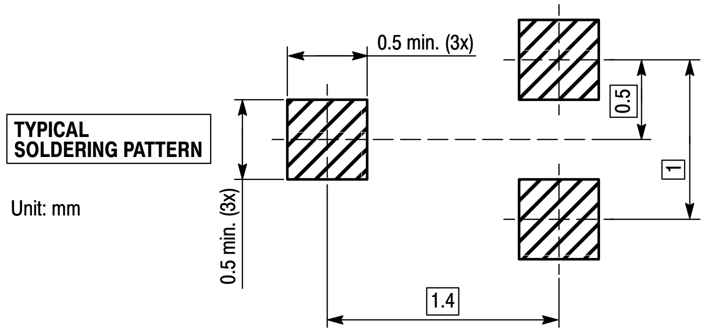
- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference shall be a maximum of 10°C.
- The soldering temperature and time shall not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient shall be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

INFORMATION FOR USING THE SOT–416 SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SOT–416/SC–90 POWER DISSIPATION

The power dissipation of the SOT–416/SC–90 is a function of the pad size. This can vary from the minimum pad size for soldering to the pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R\theta_{JA}$, the thermal resistance from the device junction to ambient; and the operating temperature, T_A. Using the values provided on the data sheet, P_D can be calculated as follows.

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 125 milliwatts.

$$P_D = \frac{150°C - 25°C}{833°C/W} = 150 \text{ milliwatts}$$

The 833°C/W assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 150 milliwatts. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, a higher power dissipation can be achieved using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

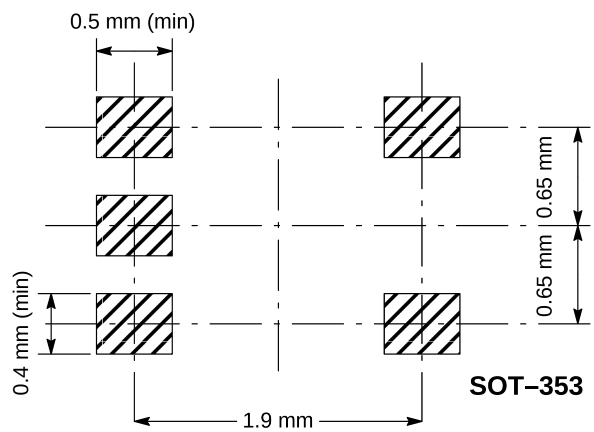
- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference should be a maximum of 10°C.
- The soldering temperature and time should not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient should be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

INFORMATION FOR USING THE SOT–353/SC–88A SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SOT–353/SC–88A POWER DISSIPATION

The power dissipation of the SOT–353/SC–88A is a function of the pad size. This can vary from the minimum pad size for soldering to the pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient; and the operating temperature, T_A. Using the values provided on the data sheet, P_D can be calculated as follows.

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 125 milliwatts.

$$P_D = \frac{150°C - 25°C}{833°C/W} = 150 \text{ milliwatts}$$

The 833°C/W assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 150 milliwatts. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, a higher power dissipation can be achieved using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

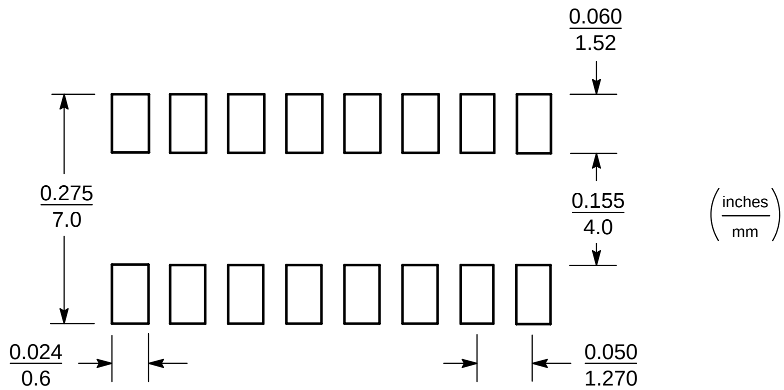
- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference should be a maximum of 10°C.
- The soldering temperature and time should not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient should be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

INFORMATION FOR USING THE SO–16 SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SO–16

SO–16 POWER DISSIPATION

The power dissipation of the SO–16 is a function of the pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient, and the operating temperature, T_A. Using the values provided on the data sheet for the SO–16 package, P_D can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 1.0 watt.

$$P_D = \frac{150°C - 25°C}{125°C/W} = 1.0 \text{ watt}$$

The 125°C/W for the SO–16 package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 1.0 watt. There are other alternatives to achieving higher power dissipation from the SO–16 package. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, an aluminum core board, the power dissipation can be doubled using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference shall be a maximum of 10°C.
- The soldering temperature and time shall not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient shall be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

SOLDER STENCIL GUIDELINES

Prior to placing surface mount components onto a printed circuit board, solder paste must be applied to the pads. A solder stencil is required to screen the optimum amount of solder paste onto the footprint. The stencil is made of brass or stainless steel with a typical thickness of 0.008 inches. The stencil opening size for the surface mounted package should be the same as the pad size on the printed circuit board, i.e., a 1:1 registration.

TYPICAL SOLDER HEATING PROFILE

For any given circuit board, there will be a group of control settings that will give the desired heat pattern. The operator must set temperatures for several heating zones, and a figure for belt speed. Taken together, these control settings make up a heating "profile" for that particular circuit board. On machines controlled by a computer, the computer remembers these profiles from one operating session to the next. Figure 7 shows a typical heating profile for use when soldering a surface mount device to a printed circuit board. This profile will vary among soldering systems but it is a good starting point. Factors that can affect the profile include the type of soldering system in use, density and types of components on the board, type of solder used, and the type of board or substrate material being used. This profile shows temperature versus time. The line on the graph shows the actual temperature that might be experienced on the surface of a test board at or near a central solder joint. The two profiles are based on a high density and a low density board. The Vitronics SMD310 convection/infrared reflow soldering system was used to generate this profile. The type of solder used was 62/36/2 Tin Lead Silver with a melting point between 177–189°C. When this type of furnace is used for solder reflow work, the circuit boards and solder joints tend to heat first. The components on the board are then heated by conduction. The circuit board, because it has a large surface area, absorbs the thermal energy more efficiently, then distributes this energy to the components. Because of this effect, the main body of a component may be up to 30 degrees cooler than the adjacent solder joints.

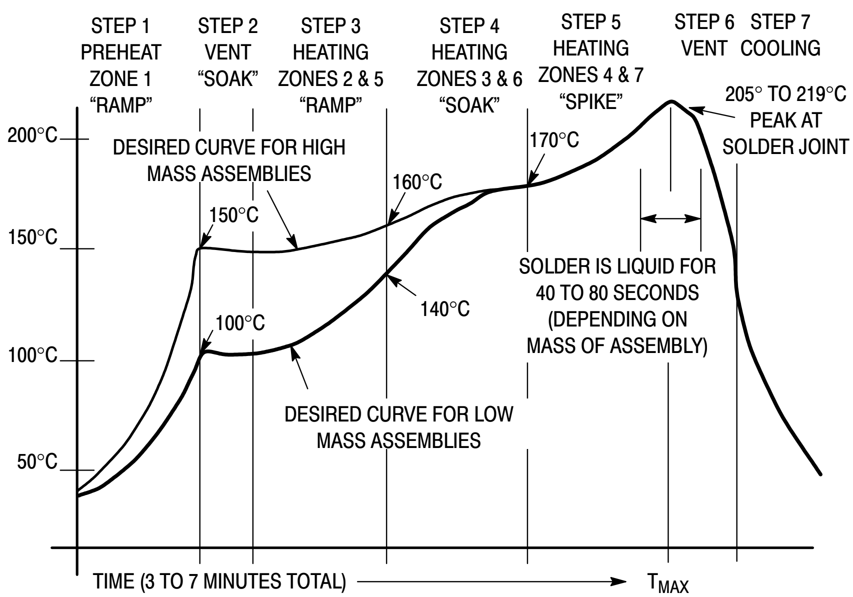


Figure 1. Typical Solder Heating Profile

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